# FINAL DRAFT

# American Creek
# Alternative Restoration Plan

**April 15, 2022**

***Prepared by***

**New Mexico Environment Department Surface Water Quality Bureau**

in cooperation with

**the Cimarron Watershed Alliance**

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**https://www.env.nm.gov/swqb/**

**~or~**

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***Cover Photo:***
*View to the west along American Creek (SWQB staff, 2021)*

## Contents

## List of Acronyms

| | |
|---|---|
| ARP | Alternative Restoration Plan |
| AU | Assessment Unit |
| Alliance | Cimarron Watershed Alliance |
| BAER | Burn Area Emergency Rehabilitation |
| BMP | Best Management Practice |
| CFRP | Collaborative Forest Restoration Program |
| CWA | Clean Water Act |
| EPA | U.S. Environmental Protection Agency |
| HQCWAL | High Quality Coldwater Aquatic Life |
| HUC | Hydrologic Unit Code |
| LA | Load Allocation |
| MCAL | Marginal Coldwater Aquatic Life |
| MOS | Margin of Safety |
| NMAC | New Mexico Administrative Code |
| NMED | New Mexico Environment Department |
| NPS | Nonpoint Source |
| ONRW | Outstanding National Resource Water |
| PC | Primary Contact |
| RPS | Recovery Potential Screening tool |
| RUSLE | Revised Universal Soil Loss Equation |
| STEPL | Spreadsheet Tool for the Estimation of Pollutant Load |
| SWQB | Surface Water Quality Bureau |
| TMDL | Total Maximum Daily Load |
| USFS | U.S. Forest Service |
| WAP | Wetlands Action Plan |
| WLA | Waste Load Allocation |
| WBP | Watershed-Based Plan |

## Executive summary

American Creek is located within the Cimarron Watershed (HUC 11080002) in northeastern New Mexico. The Cimarron Watershed Alliance (Alliance) was formed in 2001 to provide local input on water quality issues within HUC 11080002 that were identified on prior Clean Water Act (CWA) §303(d) Lists of impaired waters (https://www.env.nm.gov/swqb/303d-305b/). The Alliance developed a Watershed Restoration Action Strategy (WRAS) in 2003 to guide watershed restoration efforts (Alliance, 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 the watershed. After initial development of the WRAS, the Environmental Protection Agency (EPA) provided additional planning guidance to direct restoration projects and address nonpoint source pollution (EPA, 2008). Based on this guidance, the Alliance updated their original WRAS to include the nine required elements of a watershed-based plan (WBP) (Alliance, 2017). There was active public involvement throughout the development of the plan, and the Alliance guided and reviewed all phases of the planning effort with technical assistance from the New Mexico Environment Department Surface Water Quality Bureau (SWQB).

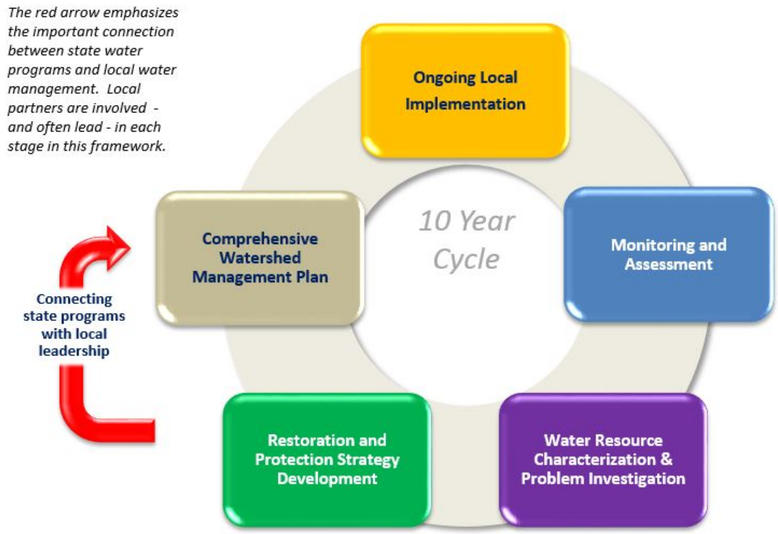
The Moreno Valley is that portion of the Cimarron watershed upstream of Eagle Nest Lake in Colfax County, comprising five 12-digit HUCs. American Creek is located within one of these five HUC-12s, called Outlet Cieneguilla Creek (HUC 110800020104). The Moreno Valley Wetland Action Plan (WAP) was completed in 2016 (Alliance, 2016) to address wetland restoration in the valley.

SWQB completed a comprehensive two-year water quality survey of the Canadian River basin, including the Cimarron Watershed, in 2015-2016. These data were validated and assessed against applicable water quality standards to develop the 2018-2020 Clean Water Act §303(d)/§305(b) Integrated Report and List (NMED/SWQB, 2018). Based the 2015-2016 survey data, American Creek has been listed as impaired for total recoverable aluminum and *E. coli* bacteria (data and assessment details shown in **Appendix B**). The next SWQB survey in this basin is scheduled for 2025-2026.

Total maximum daily load (TMDL) planning documents have been developed for a large number of stream reach-pollutant pairs in the Cimarron watershed (NMED/SWQB, 1999, 2001, 2004, 2010, and 2011). Rather than the traditional path of a TMDL followed by Watershed Based Plan (WBP) development for the newly identified impairments in the Cimarron Watershed, SWQB and the Alliance selected American Creek to be the first example in New Mexico of in-house development of a combined WBP and TMDL, to be called an Alternative Restoration Plan (ARP). Relevant information from the existing Cimarron WBP and Moreno Valley WAP are included in this document as appropriate to the American Creek drainage. This ARP is intended to fulfill the requirements necessary to receive both WBP and TMDL acceptance from EPA Region 6 Section 319 and TMDL programs, in accordance with the crosswalk in **Appendix A**. As with the Cimarron WBP, this ARP is subject to adaptive management and should be updated as new information and data become available and resources allow.

## What is a Watershed-Based Plan & Alternative Restoration Plan?

New Mexico takes a watershed approach, similar to that of many states, to addressing surface water impairments. This approach incorporates water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results into an approximately 8 to 10-year cycle that addresses both restoration and protection. The watershed approach can facilitate a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health.




Since the late 1990s, TMDL planning documents have primarily been developed in-house by the NMED SWQB for assessment unit (AU, or water body)-pollutant pairs that don't meet state water quality standards. Once EPA approves a TMDL, local stakeholder groups in those watersheds are then eligible to submit proposals to receive CWA §319 funding to develop a WBP to address impairments that have TMDLs. Once SWQB and EPA Region 6 accept a WBP, stakeholders are eligible to submit implementation proposals to receive CWA §319 funding for specific on-the-ground restoration activities in accordance with the WBP (EPA, 2008).

The long-term vision for the CWA §303(d) Program, collaboratively developed by EPA and their state and tribal counterparts, encourages state and tribal water quality programs to consider alternatives to the prioritization of traditional TMDL planning documents when other planning approaches are more appropriate or can lead to quicker on-the-ground results (EPA, 2013 and 2015). An alternative restoration approach is a near-term plan, or description of actions, with a schedule and milestones, that is more immediately beneficial or practicable to achieving water quality standards, and is particularly appropriate in watersheds with active, engaged stakeholders.

Alternative Restoration Plan[1] and nine-element WBPs contain much of the same elements and information, thus combining these two efforts is the most efficient path forward once impairments have been identified. Combining these efforts is expected to reduce the time it takes to get from planning to on-the-ground projects. The nine elements, and the information common to both TMDL and WBP formats, are presented in the main body of this report. A crosswalk of WBP elements compared to ARP components is provided in **Appendix A**. **Appendix B** contains loading calculations for the impaired water quality parameters, and **Appendix C** provides details of the input parameters and the output report from the Bacterial Source Load Calculator model.

[1] https://www.epa.gov/tmdl/alternative-restoration-plans

The ARP utilizes a watershed-scale approach to identify strategies for addressing nonpoint source pollution that will cumulatively achieve the water quality targets. This report informs and builds upon local planning efforts, but ultimately the local partners and stakeholders will decide what projects and activities to include in their specific local plans and restoration implementation grant proposals and efforts.

| **Table ES1: ARP for American Creek (Cieneguilla Creek to headwaters)** | |
|---|---|
| New Mexico Standards Segment | American Creek (Cieneguilla Creek to headwaters) |
| Assessment Unit Identifier | NM-2306.A_066 |
| NPDES Permit(s) | None |
| Segment Length | 5.99 miles |
| Parameters of Concern | Aluminum, *E.coli* |
| Designated Uses Affected | HQCWAL, PC |
| USGS Hydrologic Unit Code | 11080002 |
| Scope/size of Watershed | 6.12 square miles |
| Land Type | 21b – Crystalline Subalpine Forests; 21c - Crystalline Mid-Elevation Forests; 21j – Grassland Parks |
| Land Use/Cover | 80.5% evergreen forest; 13.8% shrub/scrub; 3.6% deciduous forest |
| Land Management | 67.1% Private; 32.9% NM Dept of Game & Fish |
| Geology | 50.5% metamorphic; 34.1% igneous and metamorphic; 6.1% unconsolidated; 5.1% sedimentary; 4.0% igneous |
| Probable Sources | Dam or impoundment, Fire suppression, Gravel or dirt roads, Grazing in the riparian zone, Legacy logging, Loss of riparian habitat, Low water crossing, Rangeland grazing, Water diversions, Waterfowl, Wildlife other than waterfowl |
| IR Category | 5-alt |
| Priority Ranking | High |
| Existing TMDLs | None |
| | **WLA + MOS + LA = TMDL** |
| Aluminum (lbs/day) | 0 + 0.37 + 3.31 = 3.68 |
| E. coli (cfu/day) | 0 + $3.10 \times 10^7$ + $2.79 \times 10^8$ = $3.10 \times 10^8$ |

## Section 1. Watershed overview and description

The Cimarron River is part of the Canadian River Basin. The Cimarron River originates in the Sangre de Cristo Mountains of north-central New Mexico and flows generally eastward to the Canadian River (**Figure 1**). The watershed is approximately 1,032 $mi^2$ in size and lies on the eastern slopes of the Sangre de Cristo Mountains within Colfax County. Elevations in the watershed range from 12,441 ft atop Baldy Mountain to 5,770 ft at USGS Gage 07211000 in Springer, NM. Annual precipitation ranges from 30 inches in the mixed conifer forests at higher elevations to 15 inches in the semiarid grasslands at lower elevations. See the Cimarron WBP for additional details about the entire 8-digit HUC (Alliance, 2017).

American Creek, a headwaters source of the Cimarron River, is located in the broad, semi-arid Moreno Valley. The long-term average annual precipitation is about 15 inches per year (annual precipitation varying from below 10 inches to more than 20 inches), according to data from the Eagle Nest Climate Station (Alliance, 2016). The valley includes three perennial drainages that flow into Eagle Nest Lake, a major supply reservoir for northeastern New Mexico. The American Creek (Cieneguilla Creek to headwaters) AU has a 6.1 $mi^2$ drainage area within the Outlet Cieneguilla Creek HUC-12 (110800020104). American Creek discharges into Cieneguilla Creek, which is listed as impaired for *E. coli*, plant nutrients, sedimentation/siltation, temperature and turbidity. Additional details about the entire valley are provided in the Moreno Valley WAP (Alliance, 2016).

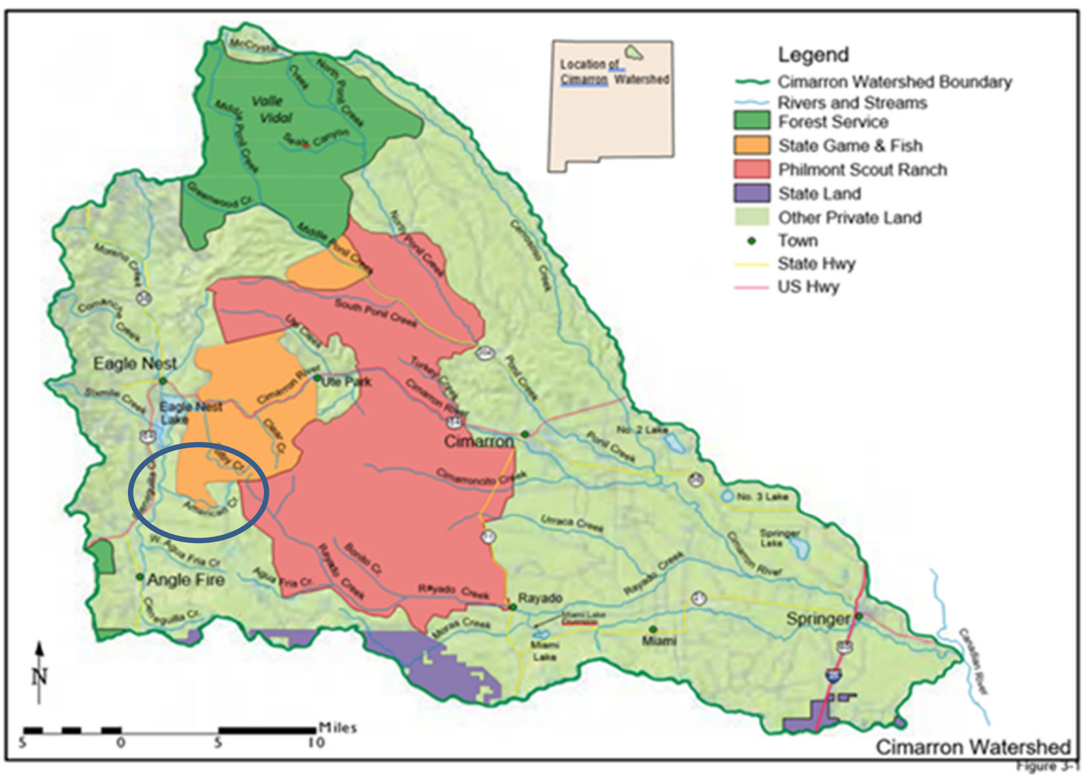



**Figure 1. The Cimarron HUC-8 (11080002). The circle indicates the location of American Creek.**

Geology in the American Creek drainage is predominantly igneous and felsic metavolcanic rock with interspersed areas of clastic and metasedimentary formations (Chronic, 1987; **Figure 2**). The high percentage of felsic minerals may constitute a natural source of aluminum in this watershed. Structural geology of the Moreno Valley is complex, as a result of several cycles of alternating deposition with faulting and other deformations (Colpitts and Smith, 1990).

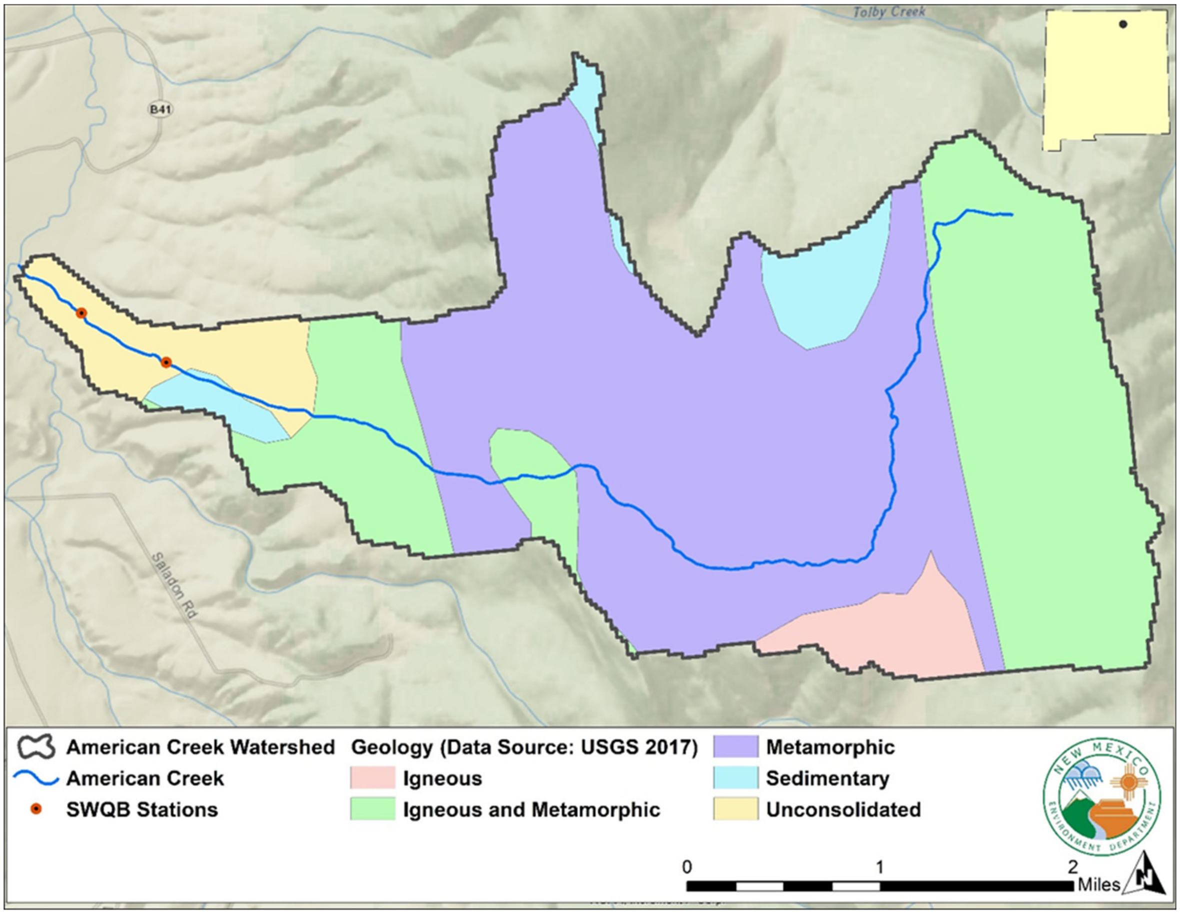



**Figure 2. General surface geology of the American Creek drainage.**

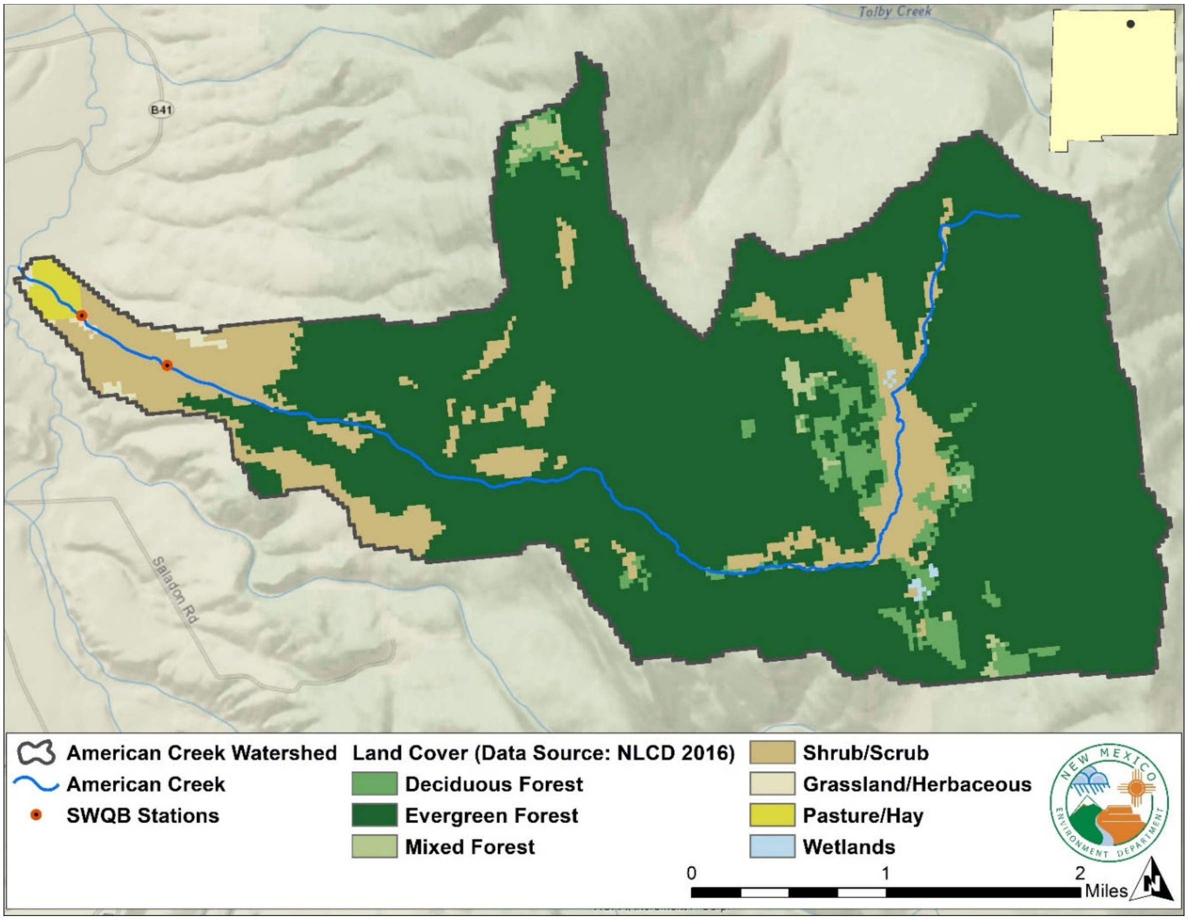



**Figure 3. Land cover categories in the American Creek drainage.**

Although the USGS National Land Cover Database (as shown on **Figure 3**) identifies the headwaters area, where there is a series of springs, as shrub/scrub, it is actually characterized by extensive sedge-dominated herbaceous slope wetlands (**Figures 4** and **5**). Shrub cover is low and the species is primarily potentilla. Perennial flow of springwater is probably the reason that American Creek flows all year round. In addition to the headwaters wetlands, there is one off-channel spring located where the watercourse emerges from forest, and there may be an unknown amount of groundwater input in the difficult-to-access forested reach.

The American Creek watershed is dominated (86%) by forested land (evergreens with deciduous patches) (**Figure 3**). The eastern portion of the drainage is part of the Crystalline Subalpine Forests Level IV Ecoregion, characterized by high mountain landscapes with subalpine vegetation including coniferous forests of Engelmann spruce, ponderosa pine, and Douglas fir, with interspersed aspen groves (Griffith et al., 2006). There is an extensive network of legacy logging roads in the forest (**Figure 4**), a few of which are maintained for management access.

Natural vegetation on the middle elevations of the watershed, in the Crystalline Mid-elevation Forests Level IV Ecoregion, is dominated by ponderosa pine, with some pinyon-juniper on lower and south-facing slopes (Griffith et al., 2006). Current forest conditions are typical of the region: second and third growth forests altered in species richness, density, and composition by selective logging, fire suppression and natural disturbance regimes including insect infestation. American Creek Ranch and the New Mexico Department of Game and Fish (NMDGF) have each conducted some limited forest restoration projects to open up the canopy and encourage aspen growth. Riparian zone vegetation is generally characterized by alder, willow, cottonwood, and various herbaceous species.

**Figure 4. American Creek headwaters, showing historic logging roads, springs/seeps, and area of herbaceous slope wetlands**

The lower elevations near Cieneguilla Creek are in the Grassland Parks Level IV Ecoregion, high intermontaine valleys dominated in their natural condition by mixed bunchgrasses (Griffith et al., 2006). However, the grasses currently present in the lower American Creek drainage are mostly non-native forage species such as Kentucky bluegrass, perennial rye and crested wheatgrass. The USGS National Land Cover Database classifies the current vegetation of these meadows mostly as shrub/scrub (**Figure 3**). The proportion of shrub cover varies from place to place within the drainage. Most of the shrubs are rabbitbrush, also known as chamisa. The American Creek Ranch engages in active brush control. Woody riparian vegetation is sparse in the lower valley, consisting mostly of scattered groves of mature narrow-leaf cottonwood.

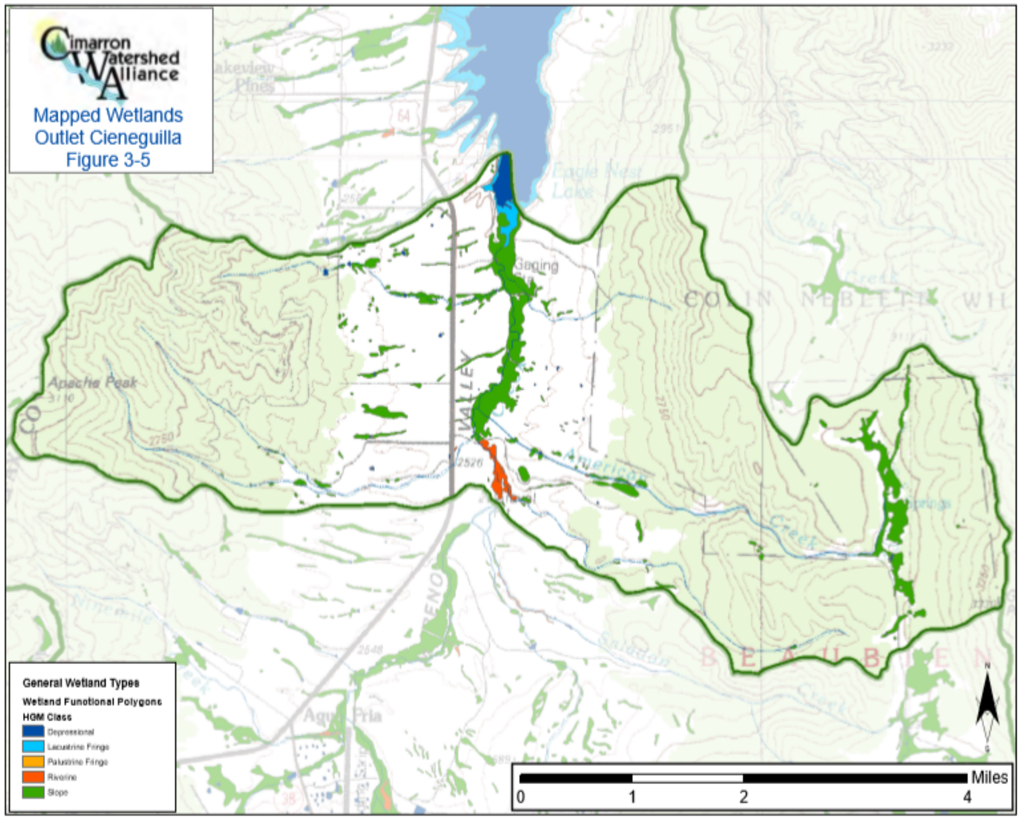



**Figure 5. Mapped wetlands in the 12-digit HUC including American Creek, from Alliance, 2016.**

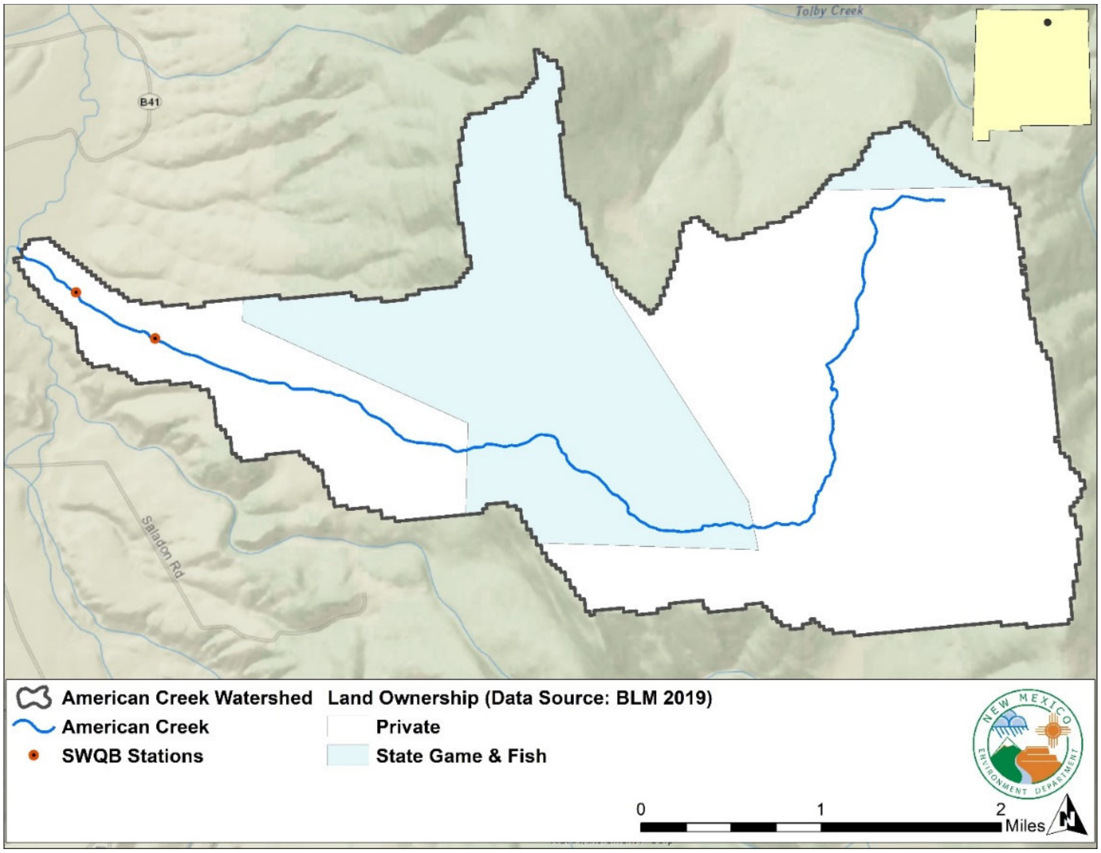



**Figure 6. Land ownership in the American Creek drainage.**

The American Creek drainage is 33% owned and managed by NMDGF (**Figure 6**), as part of the Colin Neblett State Wildlife Area. Livestock grazing is not permitted on the NMDGF property, which is forested with 30+ years of growth, and has only one active road, which is not accessible by motor vehicle to the general public. The management goal is wildlife habitat, in support of hunting, fishing and other wildlife-associated recreation.

The remainder is divided between three privately owned ranches. The predominant land use was historically logging and is now dispersed cattle/livestock grazing, wildlife habitat and recreation. In response to elk forage utilization and recent drought conditions, livestock numbers have been reduced on those parts of the watershed where they are grazed in the summer months. There are two in-channel impoundments (ponds) on the Monte Verde Ranch property. There is a major cattle trail at the bottom end of the lower pond which appears to be actively eroding. Approximately half of the American Creek flow is diverted seasonally to three irrigation ditches, using temporary rock-and-tarpaulin dams.

## Section 2. Identification of impairment causes and sources

### WBP ELEMENT A. IDENTIFY AND QUANTIFY SOURCES OF POLLUTION IN WATERSHED

The first EPA-required element of a WBP is identification of the cause(s) of water quality impairment in the area of interest. Specifically, these are the chemical or bacterial pollutants, or physical conditions (for example, excessive temperature), that are documented as causes of impairment for a particular water body or stream reach on the most recent State of New Mexico CWA §303(d)/ §305(b) List.[2] A Cimarron WBP was completed in 2012, and revised in 2017. TMDLs have not been established for any of the Cimarron watershed impairments first listed on the 2018-2020 §303(d)/ §305(b) List, and they are not addressed in the 2017 WBP revision.

Surface water quality data used to determine the impairments discussed in this document were collected during the SWQB 2015-2016 Canadian River Watershed survey (NMED/SWQB, 2016). Data, assessments, and target loading calculations are provided in **Appendix B**. Sampling techniques used during the survey are detailed in SWQB's standard operating procedures[3]. The data were assessed using SWQB's listing methodologies[4]. Sampling results are housed in SWQB's provisional water quality database (SQUID) and uploaded to EPA's Water Quality Exchange (WQX) database after they are verified and validated. Identified impairments of American Creek, relative to New Mexico's Water Quality Standards (WQS), are total recoverable aluminum (TR Al), an impairment of the high quality coldwater aquatic life designated use, and *E. coli,* an impairment of the primary contact designated use.

The next step is to identify the probable source categories leading to the cause(s) of impairment that must be controlled in order to achieve the load reductions necessary to meet designated uses. The source categories of the water quality impairment are the land uses, other activities, and natural conditions that alone or collectively lead to the cause(s) of impairment. For example, loss of riparian vegetation can contribute to increased water temperatures due to increased solar gain (i.e., less streamside shading), as well as increased sedimentation due to destabilized stream banks.

**Table 1** provides a summary of probable source categories of pollution in American Creek based on source information previous documented in the Cimarron WPB (Alliance, 2017) and Moreno Valley WAP (Alliance, 2016), SWQB staff observations, review of satellite imagery and GIS layers, and input received from landowners and other stakeholders.

[2] https://www.env.nm.gov/surface-water-quality/303d-305b/

[3] https://www.env.nm.gov/surface-water-quality/protocols-and-planning/

[4] https://www.env.nm.gov/surface-water-quality/calm/

**Table 1. Probable source summary for total recoverable aluminum and *E. coli* in American Creek**

| Probable Sources |
|---|
| Dam or impoundment |
| Fire suppression |
| Gravel or dirt roads |
| Grazing in the riparian zone |
| Legacy logging |
| Loss of riparian habitat |
| Low water crossing |
| Rangeland grazing |
| Water diversions |
| Waterfowl |
| Wildlife other than waterfowl |

Both aluminum and bacteria are subject to complex fate and transport in the environment, making it difficult to estimate loads directly. The underlying geology is the only feasible ultimate source of aluminum in the stream, whether entering the stream through sediment introduced by overland flow or possibly through high concentrations in the spring water. There are only two residences in the drainage, one of which is not continuously occupied, so human or pet activity is not considered a potential significant source of bacteria. The two potential sources are wildlife (including waterfowl) and livestock.

The two pollutants are considered individually below.

## 2.1 Total recoverable aluminum

Increased metals in the water column can commonly be linked to sediment transport and accumulation where the metals are a constituent part of watershed geology. Aluminum (Al) is the third most common element in the Earth's crust and the most common metal. There is an exchangeable fraction of Al with soils, sediments, and precipitated organic material. However, the Geochemical Atlas of Europe (FOREGS, 2005) found that "[p]atterns in stream water [Al] data are markedly different from distributions in the solid sample media, indicating predominance of exogenic factors (topography, climate, vegetation) over bedrock geology control for Al in streams." Anthropogenic surface disturbance could be considered an exogenic factor.

Surface geology of the American Creek drainage is predominantly metamorphic, with small areas of sedimentary and mafic volcanic rocks (**Figure 2**). Metamorphic rock Al oxide concentrations are variable, ranging from 12-24%, and mafic geology contains up to 16%. Most sedimentary rocks are quite low in Al, with the exception of shale which may contain up to 15% (FOREGS, 2005). American Creek is the only water body in the Moreno Valley with an aluminum impairment. Tolby and Rayado Creeks, tributaries to the Cimarron River which originate on the other side of the ridge nearest the American Creek headwaters, are also not impaired for aluminum.

Aluminum is present in natural waters in a complex of chemical forms. Aluminum is relatively insoluble at pH 6 to 8, but the solubility of Al increases under more acidic and more alkaline conditions, in the presence of complexing ligands, and at lower temperatures (Gensemer and Playle, 1999). Therefore, in addition to fine sediment mobilized by overland flow, normal aqueous chemical processes enhanced by the slight natural acidity of snow and rain can dissolve some of the abundant, naturally-occurring aluminum and deliver it into a river system. Aqueous Al is comprised of inorganic Al hydroxy species, of which gibbsite is the most abundant in the pH range (7.3-8.6, median value 8.0) measured by grab samples in American Creek. However, the SWQB sonde record from American Creek in September of 2016 shows that pH does at least occasionally dip below 7 (lowest pH on the sonde record is 6.53). During the 2015-16 water quality survey, TR Al concentrations in American Creek did not show any correlation with concurrent pH at the sampling site.

Cory et al. (2006) found that discharge from "[f]orested catchment sites underlain by mineral soils had higher total Al concentrations . . . than catchments with larger wetland area, despite significantly higher pH". They attributed this to control of Al solubility by organic complexes in the wetland soil. Their result seems to contradict the fact that humic and fulvic acid aluminum complexation is known to increase solubility. A reasonable explanatory hypothesis might be that organic or inorganic complexes formed in the low-energy subsurface environment of the wet meadows become bound to some degree with the fine-particle organic soils.

During the 2015-16 SWQB survey, American Creek turbidity was generally quite low; therefore, none of the samples were filtered (the SOP requires filtration when turbidity is greater than 30 NTU), so that TR Al in these samples is equal to total Al, comprising particulate, colloidal and dissolved forms. There was one exceedance of the chronic TR Al criterion during a period of higher than usual turbidity and flow during spring runoff, as well as one exceedance during low turbidity levels in the fall (**Appendix B**). The springtime measurement also exceeded the applicable acute criterion. The ratio of dissolved to total aluminum in samples which did not exceed the WQS (n=3) ranged from 9% to 23%, with a mean of 17%. That ratio for samples which were in exceedance of the WQS (n=2) ranged from 36% to 52%, with a mean of 44%.

### 2.1.1 Targeting of geographic areas

The primary purpose of this section is to suggest priority or critical areas for BMP and management implementation. These potential areas of increased sediment contribution will be confirmed by field observation and by local partners'/stakeholders' expertise and knowledge of the watershed.

Increased concentration of aluminum in natural surface waters is often the result of increased erosion and weathering of naturally occurring sources of aluminum in resident soils and geology. As a starting point, SWQB performed a stream channel sedimentation risk assessment by evaluating areas of high erosion potential identified by the Revised Universal Soil Loss Equation (RUSLE). This widely used mathematical model estimates topsoil erosion potential through integration of local rainfall energy, soil type erodibility, slope angle and length, and land cover metrics. Linard et al. (2014) calculated RUSLE values for the state of New Mexico using 2011 landcover data, which SWQB subsequently updated using 2016 landcover data. The resulting GIS raster coverage provides mean annual erosion potential estimates at 30-meter spatial resolution. Areas of low erosion potential were excluded from further investigation, while remaining areas were reclassified as moderate (yellow), high (orange) and extreme (red), then clipped to the watershed of interest (**Figures 7** and **8**).

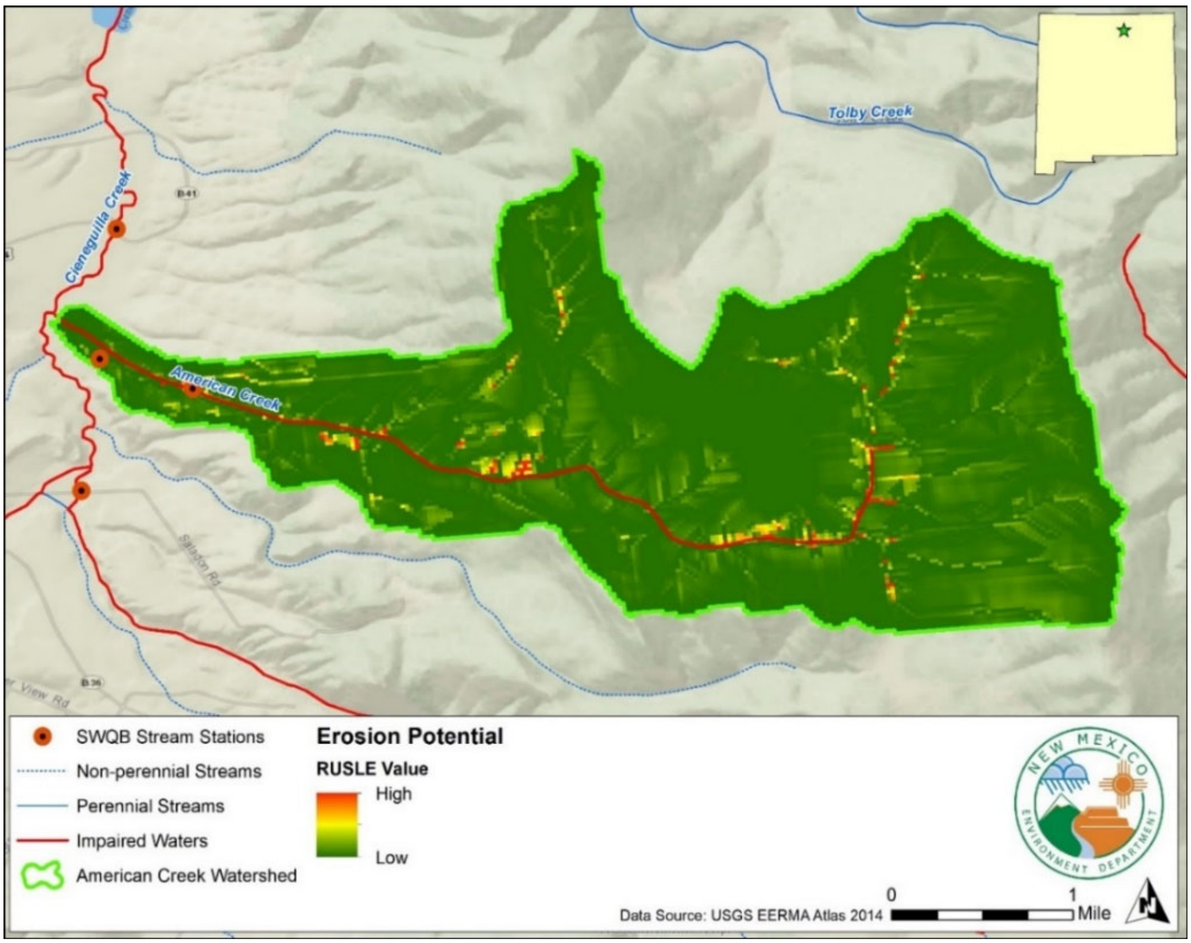



**Figure 7. American Creek watershed erosion potential map based on RUSLE**

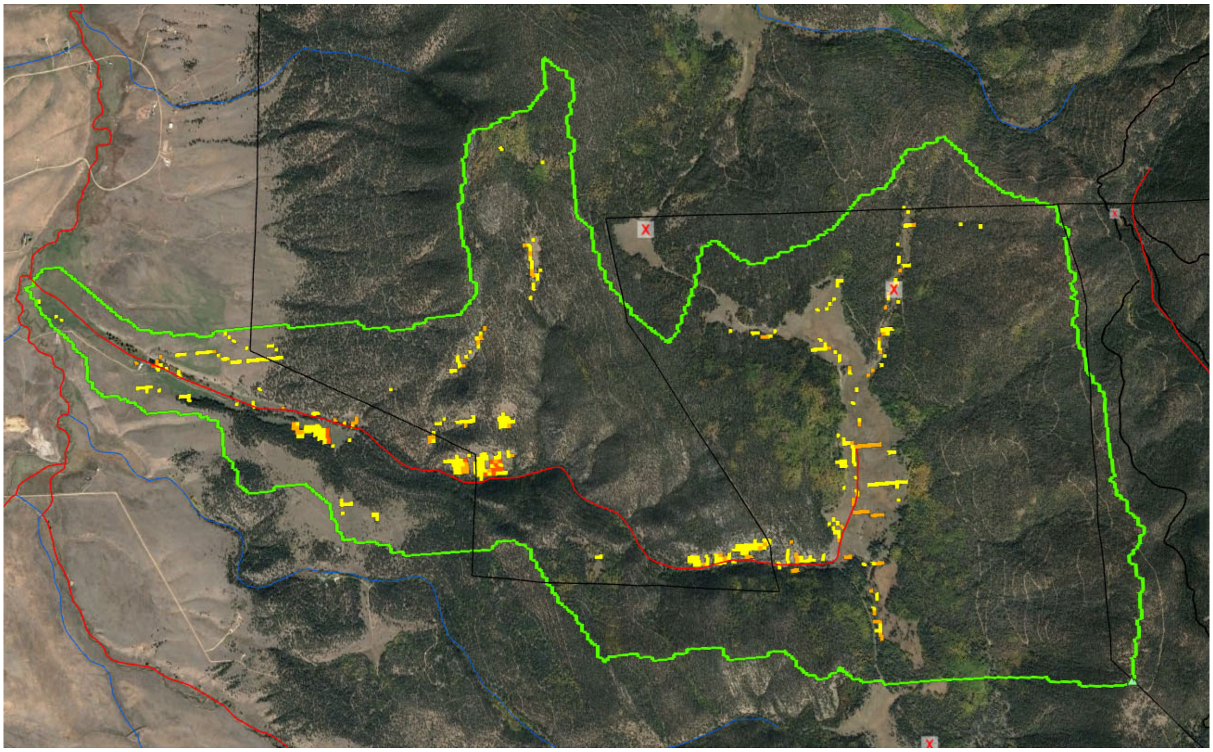


**Figure 8. American Creek watershed erosion potential map based on RUSLE (overlaid on Google Earth)**

While RUSLE provides quantitative numeric estimates of areal erosion potential in units of soil mass lost annually, the most appropriate and informative use of RUSLE estimates is qualitative in nature. It is also important to keep in mind that the RUSLE erosion-control practice factor (P) was set to 1.0 (no conservation treatment) to generate the coverage because the model was designed to represent an undeveloped condition (Linard et al., 2014). Therefore, this is just a starting point to identify areas with naturally high erosion potential based on the physiographic, precipitation, and vegetative inputs in RUSLE. Additional review of available imagery and GIS layers, local and agency knowledge, reference to the Cimarron WBP and Moreno Valley WAP, and ground-truthing should be used to confirm target areas.

## 2.2 Bacteria (*E. coli*)

*Escherichia coli (E. coli*) is a species of coliform bacteria that is present in the intestinal tracts and feces of warm-blooded animals. Most *E. coli* are harmless and constitute an important element of a healthy digestive tract. However, some strains of *E. coli* are pathogenic, meaning they can cause illness, either diarrhea or illness outside of the intestinal tract. It is also used as an indicator of the potential presence of other pathogens that may present human health concerns. Excess bacteria has been a documented impairment elsewhere in the Moreno Valley as early as the 2003 Watershed Restoration Action Strategy (Alliance, 2003); however, the *E. coli* impairment of American Creek was first listed in 2020, based on results of the 2015-16 SWQB water quality survey.

In the American Creek drainage, the *E. coli* impairment status (4 exceedances of the applicable single sample criterion out of 8 samples taken) was documented predominantly during lower flows at summer sampling events, with one additional exceedance in October. *E. coli* levels were lowest during higher flows/spring runoff. Hulvey et al. (2021) found that *E. coli* peaked in midsummer in Utah streams running through grazed or ungrazed grasslands (the peaks were higher in grazed drainages), and Fluke et al. (2019) reported that concentrations were higher at higher water temperatures. This pattern is also consistent with the seasonal variability (highest in August) noted in a bacterial source tracking study of Moreno and Cieneguilla Creeks (NMSU, 2010). For samples taken near the outlet of Cieneguilla Creek, that study documented wildlife sources (24.8% avian, 14.4% raccoon and 8.8% elk/deer) as well as anthropogenic sources (7.2% horse, 6.4% cattle, 6.4% dog+cat, and 7.2% human). These percentages can only indicate source trends, because meaningful statistics typically cannot be applied to source tracking data. The results suggest that wildlife, including avian sources, are likely significant sources of bacteria to streams and tributaries upstream of Eagle Nest Lake (NMSU, 2010).

Stock ponds in the headwaters area attract waterfowl that may contribute to *E. coli* exceedances downstream. Poorly constructed or located stock ponds can also accelerate erosion. These high elevation stock ponds constitute important migratory bird stopover habitat. Loss of migratory habitat is generally considered a major avian conservation concern. Hence, watershed planners must consider the value of habitat conservation as well as the value of water quality improvement, when deciding whether to implement measures that would remove or modify the ponds. Elk populations are high in the American Creek area relative to historic levels, and elk may also contribute significantly to the water quality impairment. There are two in-line ponds on American Creek. The ponds may contribute to *E. coli* loading, by providing favorable conditions for bacterial colonies to reproduce and survive. Fluke et al. (2019) found that fine or sandy sediments are likely to harbor higher bacteria concentrations than cobble bed channels. They state that sediment-water interactions on *E. coli* concentrations are poorly understood and the dynamics of local source/sink propagation down a fluvial network cannot be predicted.

### 1.2.1 Bacteria Source Load Calculator (BSLC)

SWQB selected the BSLC model (Zeckoski et al., 2005), version 4.0, to characterize bacteria sources in the American Creek drainage. The model outputs are in colony forming units (cfu) of fecal coliform bacteria. New Mexico's bacteria water quality standards are expressed in cfu of *E. coli*. Ratios of fecal coliform to *E. coli* are site-specific, and a ratio could not be established using available data for American Creek. Therefore, the BSLC model results can be viewed only as relative contribution from wildlife and livestock sources.

The American Creek ranch grazes 250 yearling cows on the headwaters wet meadows, for only a two to three week period, with rest years interspersed. Monte Verde Ranch grazes 300 head on the lower elevation pastures, from May 1 to Sept 1, but reduces that to 120 cows in drought years. A limitation of the BLSC is the defining assumption that all animals of a particular species are managed in the same way. Therefore, we have run the model assuming a low stocking rate (120 cows for 4 months), as would be the case in a drought year with American Creek Ranch pasture being rested.

Areas with high elevation wet meadows interspersed with mixed conifer forest support some of the largest elk herds in NM. The model input elk population of the American Creek drainage was calculated based on published density estimates for Colorado National Forests which were considered to have large herds. The elk density entered into the model exceeds the NMDGF estimate for adjacent Game Management Unit 55A, which is considered to have an inflated population since it includes the highly productive Valle Vidal, and the very large Vermejo Park Ranch, which is specifically managed for elk. The American Creek deer population for the model was calculated based on a density estimate provided by the NMDGF. However, there are no data from which to estimate local migratory waterfowl populations, so SWQB used the model default values.

For the most part, SWQB used the default values loaded in the BSLC spreadsheet. Input data and their sources, and the output report, are shown in **Appendix C**. The BSLC results indicate that livestock sources account for 86% of the in-stream fecal bacterial load. Of the 14% attributed to wildlife, elk are the source for 68%. This result suggests that BMPs (such as fencing, riparian buffer vegetation, or berms) designed to reduce direct cattle access and overland flow into the stream along the lower elevation pasture area, may be effective in reducing the bacterial load.

## 2.3 Data gaps

SWQB monitors ambient water quality on an approximate eight to ten-year rotational schedule. SWQB conducts two-year surveys in part to address temporal variability. SWQB does not perform separate, specific subwatershed studies to characterize the exact location of potential source areas contributing to identified water quality exceedances, which are typically documented at one station at the downstream end of an AU. Since available water quality data are limited, they do not fully reflect the range of temporal and spatial variability for each constituent within a characterized stream reach. Additional data would help to better characterize the spatial and temporal variability of water quality in American Creek, to inform restoration efforts.

Probable sources of water quality impairment in this ARP were initially identified during SWQB's 2015-2016 water quality survey. As noted above, SWQB staff made estimates of contributions from probable sources utilizing existing reports, visual observations of the watershed, GIS tools, and consultation with local landowners and natural resource professionals familiar with the watershed. Springs and seeps in the headwaters area and along the channel may contribute to naturally elevated aluminum (**Figure 6**). Testing the water emerging from the springs could identify baseline aluminum concentrations.

Aerial imagery shows a network of logging roads throughout tha upper elevations (**Figure 6**). The roads are constructed in stony soil which is not especially prone to erosion, and they appear to be stable for the most part; however, there may be nick points of instability that could contribute excess sediment to the watershed. One hypothesis is that increased sediment transport due to the large amount of logging roads is still working its way through the system even though this area hasn't been actively logged since the 1960s. Further investigation of the condition of these roads, especially in relationship to dikes and sills, surface water pathways, erosive slopes, and vegetative buffers, is warranted to target potential project areas.

Additional water quality monitoring along the watercourse could help target potential source areas needing treatment. Simultaneous sampling above and below low water crossings and in-channel ponds could elucidate whether they contribute to the impairments. Water quality data collected upstream and downstream of where dikes and sills intersect the stream channel would provide additional insight into how these natural features contribute to water quality impairments.

As watershed restoration activities are implemented, continued water quality monitoring focused on the impaired constituents will be needed, to refine water quality goals and improvements during implementation. Concurrent information about flow and irrigation status should also be recorded. Once this ARP is accepted, SWQB anticipates being available to assist by conducting a pre-project sampling event to determine TR Al concentration from the headwaters springs and *E. coli* concentration at several points along the creek. Any EPA-funded data collection by parties outside of NMED to collect quantitative data would need to complete a Quality Assurance Project Plan approved by the EPA.

**Table 2. Summary of data gaps regarding water quality impairments of American Creek, Colfax County, NM**

| | |
|---|---|
| Headwaters slope wetlands | Sample emerging groundwater for aluminum concentration |
| Active roads | Document condition of road and low water crossings |
| Historic logging roads | Inventory and inspect condition |
| Grassland pastures | Evaluate cover and condition |
| Riparian zone | Evaluate woody cover/ shade |
| American Creek channel | Simultaneous bacteria sampling above and below ponds;<br>Evaluate stability and bank erosion |

## 2.4 Load reduction estimates

### WPB ELEMENT B. IDENTIFY WATER QUALITY TARGET OR GOAL AND POLLUTANT REDUCTIONS NEEDED TO ACHIEVE GOAL

The next EPA-required element of a WBP is to identify clear water quality targets and load reductions necessary to meet water quality targets and goals. If a TMDL has already been established for a particular impairment, this information is usually found in the existing TMDL planning document(s). For each AU-cause pair, the ARP provides standard calculations and approaches to estimate current load, target load based on water quality goals, and the overall load reduction necessary to achieve the target load. Load calculations and supporting data for American Creek are provided in **Appendix B** and summarized on **Table 3**.

**Table 3. Overall load reduction estimates needed to meet water quality goals**

| Assessment Unit | Cause of Impairment | Measured Load | Target Load | Load Reduction |
|---|---|---|---|---|
| American Creek (Cieneguilla Creek to headwaters) | TR Al | 10.11 lbs/day | 3.31 lbs/day | 67% |
| | *E. coli* | $2.17 \times 10^9$ cfu/day | $2.79 \times 10^8$ cfu/day | 87% |

In addition to the initial loading, several ambient parameters have been documented to influence coliform bacteria survival and, potentially, regrowth, in freshwater bodies (Fluke et al., 2019: Howell et al., 1996; Wcislo and Chrost, 2000). Abiotic factors include visible light, ultraviolet light, temperature, organic and metal pollutants, dissolved organic matter, suspended sediment concentration and particle size, and pH. Biotic, or ecological, factors include viral parasites and protozoan predators. Bacterial concentrations may become elevated when bacteria-laden sediment is re-suspended during storm events or by other subsequent disturbance such as trampling by livestock (Fluke et al., 2006; Howell et al., 1996). Although SWQB believes that it is often useful to discuss the magnitude of water quality exceedances, the “percent load reduction” value can be calculated in multiple ways and as a result is often misinterpreted. Therefore, the load reduction estimate provided for *E. coli* should be viewed as representing a starting point for restoration discussions.

Since precise load reductions are exceedingly difficult to derive (see Section 2.1 and 2.2, above), and there is a paucity of both site-specific data and published information about load reduction efficiencies for these particular contaminants, we will assume that there is a qualitative positive relationship between pollutant loading and sediment delivery to the stream. Management measures listed below were selected primarily to reduce sediment transport and may be modified as data gaps are filled, providing a better picture of watershed processes.

## Section 3. Management measures

*WBP ELEMENT C. IDENTIFY THE BEST MANAGEMENT PRACTICES (BMPS) THAT WILL HELP TO ACHIEVE REDUCTIONS NEEDED TO MEET WATER QUALITY GOAL/TARGET*

The third required element is to describe the management measures needed to meet load reduction goals. This implementation planning effort is the heart of the WBP, and documents: 1) priority areas for restoration activities, 2) suggested management measures to address sources in order to meet water quality targets, and 3) a schedule of actions designed to meet targets with clear milestones and dates.

Restoration attempts to improve ecosystem integrity and the relationships between all system components. It focuses on ecological processes that maintain and restore watershed functions. A restored system is self-maintaining, resilient, and can achieve full site potential. Restoration may require a combination of practices to succeed. There are two primary categories of restoration actions. Typically, surface water impairments driven by non-point source activities are addressed by implementing best management practices (BMPs) and land management measures.

- **BMPs** are structural measures that focus on reducing the impacts of degradation and attempting to mitigate underlying stressors and/or accelerate natural recovery processes. They are typically applied on a limited scale and thus may not result in landscape-scale recovery. However, they are effective in treating localized problem areas at the reach scale. Structural mitigation measures may include sediment basins, animal waste lagoons, fencing, terraces, and other constructed means of reducing pollutant loading to surface water and ground water. However, BMPs must be coupled with appropriate management measures to have long-term success.

- **Management measures** that address the root cause or source of contamination 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, resulting in long-term solutions instead of temporary fixes. Nonstructural efforts, often referred to as nonstructural BMPs or passive restoration, include measures that remove or manage environmental stressors. In many instances, a natural system can repair past degradation once stressors are removed. Although removing stressors allows for recovery, the system may not achieve full site potential if chemical, physical, or biological integrity remains fragmented.

Example BMPs and management measures to address common causes and sources of impairment in New Mexico are presented in Appendix B of the NM NPS Management Plan.[5] The implementation strategies, including timelines and interim measures, provided in this section are the result of best professional judgment based on what is known at this time, and thus should be considered approximate. The proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

## 3.1 Best Management Practices

Management measures intended to improve watershed health have already been implemented by some of the American Creek landowners. These include forest health treatments, fence maintenance, brush control, limiting grazing to available forage as determined by range monitoring, short grazing seasons, grazing rest years, adapting grazing practices during drought, and covering fens and springs with slash mats of small diameter timber to cover bare ground and prevent grazing/watering at those points.

Proposed additional management measures are summarized on **Table 4**, followed by a more detailed narrative description. Asterisks indicate Natural Resource Conservation Service practices which have been documented to significantly reduce sediment delivery (Lenhart et al., 2017). Numbers in parentheses show the range of sediment removal efficiency as assigned in the EPA Spreadsheet Tool for Estimating Pollutant Loads[6].

[5] https://www.env.nm.gov/surface-water-quality/nps-plan/

[6] https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl

**Table 4. Summary of Management Measures to improve watershed condition of the American Creek drainage**

| | **Proposed Measure/BMP** |
|---|---|
| Measures to Reduce Total Recoverable Aluminum (from soil erosion) | |
| Roads (active and historical) | Provide frequent drainage with outsloping where feasible, grade reversals, and frequent cross-drains such as rolling dips *<br><br>Address known soil erosion points of inactive roads with low-tech, hand-built erosion control structures. (0.41-0.71)<br><br>Inventory and stabilize low water crossings *<br><br>Locate roads away from streams<br><br>Maintain a buffer strip of undisturbed soil and vegetation between the road and stream * (0.53-0.65)<br><br>Porous rock crossings and culvert removals where a road intercepts an alluvial fan or crosses the stream; media lunas and flow splitters where the road bisects an alluvial fan *<br><br>Remove poorly placed culverts and improve road alignments * |
| Forest management | Reduce tree density and restore natural fire regimes to reduce risk of high intensity wildfire and increase native herbaceous ground cover<br><br>Maintain fire breaks |
| Streambank stabilization | Revegetate with native riparian woody plants * (0.53), fence to protect plantings (0.59)<br><br>Inventory and stabilize locations of excessive bank erosion * (0.58-0.75)<br><br>Restore channel stability and natural geomorphologic conditions *<br><br>Reduce channel incision *<br><br>Host short courses about erosion control for landowners in the Moreno Valley |

| | |
|---|---|
| Wetland restoration | Provide assistance for landowners who are interested in beaver reintroduction<br><br>Stabilize/ repair headcuts *<br><br>Armor stock pond spillways and control animal access (0.33)<br><br>Install fencing to protect springs and fens from livestock and elk * (0.59)<br><br>Install water-spreading BMPs to expand wetted area * |
| **Measures to Reduce *E. coli* (from animal feces)** | |
| Wildlife/<br><br>Waterfowl | Use BMPs described above for TR Al to prevent excessive contaminated sediment from entering the stream<br><br>Construct elk exclosures at sensitive areas of wetland or streambank * (0.59)<br><br>Construct low barriers along grassland contours, to increase infiltration and reduce delivery of contaminants to the stream * |
| Livestock grazing | Use livestock/wildlife water development and/or salt blocks to better distribute use *<br><br>Install riparian fencing to protect riparian vegetation *<br><br>Control livestock/wildlife use in sensitive areas including riparian/wetland areas *<br><br>Implement planned grazing systems such as rest/rotation, seasonal or pasture rotation * (0.33)<br><br>Host short courses about grazing management for livestock producers in the Moreno Valley |

**Wetland restoration.** The headwater slope wetlands of American Creek, on the CS Ranch, are decreasing in extent due to several stressors, including ranch roads that need to be stabilized. Channelized flow across the alluvial fans feeding the slope wetlands needs to be interrupted and returned to sheetflow. Stock ponds have been placed in wetlands with poorly placed culverts causing headcuts to migrate up-valley though slope wetlands. In some locations, large headcuts are migrating up-valley through incised channels in the slope wetlands. Several excellent opportunities have been identified to reestablish sheetflow and improve the health of headwater wetlands of American Creek and their ability to filter pollutants (Alliance, 2016). Wetland vegetation will expand due to restored sheetflow from stressor removal and water spreading techniques.

**Roads.** 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.*** 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 such as rolling dips, 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.

**Forest management.** Ponderosa pine and mixed conifer forest restoration may include thinning (with lop and scatter or biomass removal or pile burning), timber harvesting, prescribed burning, use of natural fire, and re-seeding. While there will be great differences in forest restoration programs from place to place and from prescription to prescription, in broad terms the direct impact of thinning or timber harvesting on soil loss and sediment retention is most likely very limited. This management measure has more promise as a method to protect water quality (and other watershed resources and values) than to improve near-term water quality.

Catastrophic or crown fires have the potential to cause severe erosion and sedimentation, as well as the influx of other contaminants into water bodies. Fuel reduction projects can cause some fires to have fewer impacts by reducing ladder fuels, allowing for a more natural fire regime in ponderosa pine and mixed conifer forests (as opposed to 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. Installation of swales, sediment ponds, log contouring, mulching, and reseeding after fires can also potentially help to mitigate fire impacts.

**Streambank stabilization.**

- *Restoring channel stability and natural geomorphologic conditions.* Stabilizing channels will connect streams to floodplains and reduce erosion and sedimentation. Reestablishing 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 with establishing riparian vegetation.

- ***Restoring riparian vegetation**.* Healthy riparian areas stabilize soil and can 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.

**Livestock grazing.** Prescribed grazing is the controlled harvest of vegetation by using grazing or browsing animals, managed with the intent to maintain or improve watershed conditions, including water quality and quantity. For example, the EPA recommends that grazing time is limited, on grazed forest, native pasture, or rangeland, 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. Under managed grazing, the range will recover much more quickly and will be in better condition which decreases the need for destocking under drought conditions. 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 may be beneficial for water quality in American Creek include:

o ***Herding and Rotation***. Reducing the duration of grazing has been shown to reduce the amount of time that stream *E. coli* levels are elevated, and adjusting the seasonal timing (from mid-summer to early or late season) can reduce peak *E. coli* concentrations (Hulvey et al., 2021). 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.

o ***Grazing*** should be keyed to range monitoring, where no more than 25- 50% of the forage is used in any one rotation.

o ***A drought management plan*** can be written and adhered to, with triggers based on precipitation and range condition.

o ***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 pastures when possible). Alternatively, dormant season grazing on the riparian pastures 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.

o ***Fencing*** may be more appropriate in some cases than rotational herding to control livestock or wildlife access to key areas.

○ ***Placement of mineral and salt blocks*** should be used to draw animals to underutilized areas away from the creek banks and stock tanks. Blocks should never be placed adjacent to the water or in sensitive wetlands.

## 3.2 Technical and financial assistance needed

### WBP ELEMENT D: DESCRIBE THE FINANCIAL AND TECHNICAL ASSISTANCE NEEDED TO IMPLEMENT BMPS IDENTIFIED IN ELEMENT C

This section includes identification of available funding opportunities as well as technical resources needed to implement priority restoration efforts and management strategies. **Table 5** lists the estimated unit costs for implementing the management, outreach, and monitoring measures identified in this plan. Each management measure cost is based on an estimate of the cost of materials, equipment, and labor, with an additional ten percent added for design, consultation, meetings, and planning at a level of detail beyond the scope of this ARP. It is anticipated that projects developed to implement this watershed plan will include design and planning phases to provide more detailed information, such as the precise locations and placements of structures.

Actual costs are likely to be relatively high for projects of this sort, because the area is remote and difficult to access. There are economies of scale to consider. For example, getting equipment to these remote areas and completing multiple structures with one mobilization brings costs down.

**Table 5. Summary Financial Assistance Requirements**

| Project Type | Cost/Unit |
|---|---|
| Cut bank stabilization | $2,000 / location |
| Head cut stabilization | $5,000 / Zuni Bowl or Log Drop Structure |
| Low water crossing improvements | $7,000.00 / Low Water Crossing |
| Riparian vegetation improvements | $2,000 / mile |
| Slope wetland stabilization and restoration | $6,000 / acre |
| Road upgrades | $2,000 / mile |
| Wildlife exclosures | $6,000 / exclosure |
| Education and outreach (see Section 5 for details) | $10,000 / workshop |
| Monitoring and administration (see Tables 2 and 6 for details) | $25-40 / cooperator hour*<br>$80-100 / consultant hour*<br>$20-25 / Aluminum sample lab analysis<br>$25-45 / *E. coli* sample lab analysis |

**Labor rates on Table 5 are based on NMED's typical range for cooperators, and the EPA maximum reimbursement for consultants (sub-contractors) using CWA Section 319 funding. Other funding sources are likely to have their own specific limits on reimbursement rates.*

For successful implementation of this ARP, a variety of funding and volunteer resources will be required. The funding available through NMED nonpoint source management programs is unlikely to be the sole source for completing the activities listed above. To obtain a better success rate for implementation, other potential funding sources will 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 on public forests that sustain additional forestry projects. In the American Creek drainage, the NMDGF property may be eligible for CFRP projects. 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 Forestry Division*** offers funding to improve the health of New Mexico Community Forests and Watersheds. The funding focuses on developing sustainable fuel reduction projects to reduce fire risks that can help to protect the watershed from post-fire erosion and sedimentation. Funding proposals are staggered throughout the year. Projects that involve storm water management/water quality improvement are supported by the funding, and non-profit agencies such as the Cimarron Watershed Alliance are eligible for funding. Projects that couple fuel reduction with economic benefits of the harvested forest products would also be possible in the Cimarron watershed. The New Mexico 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 would be eligible for this funding, particularly those related to the water supply from the Eagle Nest Reservoir. Funding applications can be completed and submitted only by an eligible public entity, so the Alliance 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 national directive started 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.

- Potential partners for completing research and monitoring tasks are the ***New Mexico Universities,*** particularly the University of New Mexico Water Resources Program at 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 monitoring.

- ***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 Alliance are eligible recipients. The ability to repay the loan will be central to applicability in the Cimarron Watershed.

- 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 ***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.

## 3.3 Management measures timeline

### WBP ELEMENT F. ESTIMATE A SCHEDULE TO IMPLEMENT BMPS IDENTIFIED IN PLAN

### WBP ELEMENT G. DESCRIBE THE MILESTONES AND ESTIMATED TIME FRAMES FOR THE IMPLEMENTATION OF BMPS

The schedule for implementing the NPS management measures identified in the WBP is dependent on funding for project implementation. Most projects will require a 3-year cycle for funding, final design, and implementation (**Table 6**), to be followed by approximately 5 years of post-restoration monitoring. The schedule below is based on the assumption that funding will become available, from various public and private sources that are not entirely predictable. It is considered a best-case scenario for reaching watershed restoration goals, and lack of necessary funding will extend the schedule. This schedule therefore represents a realistic, achievable template for restoration, but not an immutable commitment.

The American Creek watershed can be roughly divided into three ecological parts, based on land cover type, as follows: the headwaters area slope wetlands (CS Ranch); the forested slopes (CS Ranch, American Creek Ranch, and NMDGF); and the grassland pastures closer to Cieneguilla Creek (American Creek Ranch and Monte Verde Ranch). One feasible approach would be to start watershed improvements from the top of the watershed, by first implementing management measures that target the slope wetlands forming the American Creek headwaters. Implementation would then move on to channel stabilization and measures to improve riparian and upland conditions in the lower elevation pastures. Education and outreach measures to encourage wider implementation of BMPs and management measures likely to lead to pollutant load reductions, could begin once the initial physical BMPs are in place.

American Creek is within the perimeter of a NM Forestry Division Forest and Watershed Restoration Act (FAWRA) project, called the Cimarron Range Forest Management Initiative. The project would treat forested land over 10 years (FY 2022-2032), across a 40,000-acre area, to protect against high-intensity catastrophic fire. Additionally, the project would kick-start ongoing forest treatment activities that would offer a small but steady flow of forest products and jobs for forestry operations and wood products

**TABLE 6. PROJECT IMPLEMENTATION SCHEDULE**

| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 and beyond |
|---|---|---|---|---|---|---|---|---|---|
| Headwaters wetland restoration | | | | | | | | | |
| Apply for funding | | | | | | | | | |
| Implement measures from Table 4 | | | | | | | | | |
| Forest management | | | | | | | | | |
| FAWRA wildfire risk reduction (funded through 2032) | | | | | | | | | |
| Grazing and pasture management | | | | | | | | | |
| Apply for funding/ Survey and assess site-specific needs | | | | | | | | | |
| Implement measures from Table 4 | | | | | | | | | |
| Road and streambank stabilization | | | | | | | | | |
| Apply for funding/ Survey and assess site-specific needs | | | | | | | | | |
| Implement measures from Table 4 | | | | | | | | | |
| Education and outreach | | | | | | | | | |
| Share progress with Cimarron Watershed Alliance membership, at annual meetings and other gatherings | | | | | | | | | |
| Apply for funding | | | | | | | | | |
| Conduct on-site public workshops to demonstrate watershed restoration and encourage similar efforts | | | | | | | | | |

manufacturers in the region. The requested funding is $300,000 for 2022 to initiate the project, and $300,000 each year from 2023 until 2032, for a total of $3,000,000. This project will complement a number of nearby forest restoration treatments which are planned, on-going, or have been completed, by various land-managing entities in the Cimarron watershed.

Evaluation of the need for specific implementation actions and structure locations has already been completed for the wetland restoration, and is included in 2022 funding for the forest thinning, by the Alliance and NM State Forestry, respectively. Grazing management is being practiced in the areas where grazing is allowed (private land), but further evaluation of potential adjustments is warranted.

## Section 4. Monitoring plan

### WBP ELEMENT H. IDENTIFY THE CRITERIA THAT WILL BE USED TO ASSESS WATER QUALITY IMPROVEMENT AS THE PLAN IS IMPLEMENTED

The ultimate goal of projects described in this ARP is the de-listing of American Creek for *E. coli* and TR Al, relative to the NM WQS. Therefore, the primary measure of success will be removal of American Creek from the Integrated List of impaired waters. New Mexico utilizes a targeted, rotational watershed approach to ambient water quality monitoring. NMED's water quality survey is currently scheduled to return to the upper Canadian basin in 2025-26. The results of that watershed survey will be reported in the 2028-2030 IR. The primary measure of restoration success will be attainment of applicable water quality standards by the following SWQB monitoring cycle, estimated to occur in approximately 2033-34, to be followed by de-listing.

Additional stakeholder-identified goals include:

- Retain/restore forest with structural complexity reminiscent of natural disturbance regimes.
- Limited disturbance/development.
- Creek is no longer incised and adjacent floodplain and wetlands are reconnected.
- Retain desirable elements of the current watershed conditions.
- Serve as a demonstration project for future Alternative Restoration Plan projects within the Cimarron 8-digit HUC 11080002.

### WBP ELEMENT I. DESCRIBE THE MONITORING PLAN THAT WILL COLLECT WATER QUALITY DATA NEED TO MEASURE WATER QUALITY IMPROVEMENT

Two general types of monitoring will be conducted to document implementation of this Plan:

**Implementation Monitoring**

Progress towards implementing the identified BMPs and management measures specified in **Table 4**, will be tracked and reported in revisions of this plan or the Cimarron WBP, and in reports required by organizations funding implementation of this plan. Each individual structure and treated area should be designated with a tracking number and GPS position and photographed periodically, to determine whether the measure has been effective at its intended site-specific purpose (e.g., prevent bank erosion) and whether any maintenance or adjustments are necessary. Implementation monitoring will provide photographic evidence that structures have accomplished their site-specific goals, which will be essential information in recruiting more implementers and in qualifying for some sources of funding.

**Effectiveness Monitoring**

If this Plan is accepted in 2022, the earliest that implementation could begin would be the 2024 field season. By the time of the 2025-26 SWQB survey, enough time may not have elapsed to see the effects of full implementation. Thus the 2025-26 survey could serve as interim effectiveness monitoring, depending on the status of BMP implementation. The primary measure of restoration success will be attainment of applicable water quality standards by the following SWQB monitoring cycle, estimated to occur in approximately 2033-34, to be followed by de-listing.

Additional interim monitoring of TR Al and/or *E. coli* may be conducted by the Alliance, the landowners, or the SWQB, as needed to evaluate the success of implementation measures. The SWQB can either assist with or conduct interim monitoring, including development of detailed study designs. Any EPA-funded projects to collect quantitative data by parties outside of NMED, would need to complete a Quality Assurance Project Plan approved by EPA. Parties conducting water sampling or other data collection below the creek diversion points, should ascertain whether flow will be (or was) diverted on the day of sampling.

Effectiveness monitoring may be conducted using an approach outlined by Grabow et al. (1992). The specific approach would be the upstream/downstream, before/after approach, in which data are collected from points above and below BMP implementation, both before and after BMP implementation. This approach is cost effective, feasible for non-statisticians, and has the promise of permitting scientifically valid conclusions regarding whether pollutant loading has changed between sampling points. Due to natural variations in water quality that are unrelated to BMP implementation, the method cannot be expected to detect real water quality changes of small magnitude, and so should not be relied upon entirely as an indicator of short-term progress.

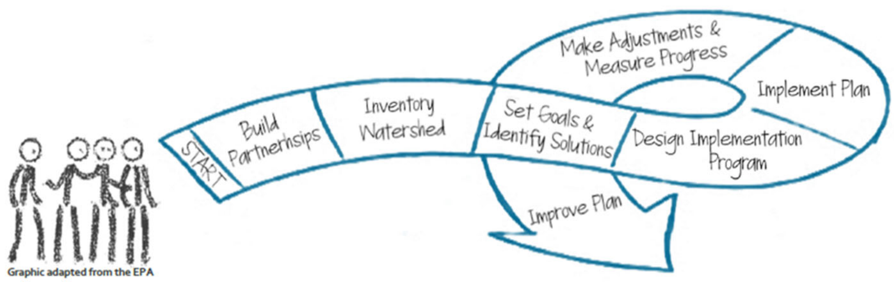
**Table 7. Summary and schedule of effectiveness monitoring needs**

| | | |
|---|---|---|
| Pre-treatment monitoring | Measure *E. coli* and TR Al concentrations at selected points along the American Creek channel, prior to implementing any BMPs, fill additional data gaps (see **Table 2**) | 2022-2024, by SWQB staff with Alliance and/or landowner logistical assistance, pending availability of resources |
| Implementation monitoring | Keep a record of implementation progress, including repeat photographs to document the condition of BMPs over time if funding is available | 2023-2033 by the Alliance and other watershed partners, as reported to funding agencies; NM State Forestry will keep records of FAWRA project implementation |
| Effectiveness monitoring | Measure *E. coli* and TR Al concentrations at selected points along the American Creek channel, after BMP implementation | 2025-26 and 2033-34 SWQB surveys; additional interim monitoring may be conducted by SWQB or other parties, as resources allow |

## Section 5. Public participation, education, and outreach

WBP ELEMENT E. DESCRIBE THE OUTREACH TO STAKEHOLDERS AND HOW THEIR INPUT WAS INCORPORATED AND THE ROLE OF STAKEHOLDERS TO IMPLEMENT THE PLAN

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful stakeholder engagement. This process is distinguished from the broader term "public participation" in that civic engagement encompasses a higher, more interactive level of involvement. SWQB selected the American Creek drainage to be the first example of in-house development of an Alternative Restoration Plan in New Mexico. To date, the majority of WBPs have been written by CWA 319 grant recipients. Because of the overlap between TMDL elements and WBP elements (see **Appendix A**), many states, including New Mexico, are exploring how to improve the efficiency of developing action plans to address NPS issues by capitalizing more on in-house planning, TMDL, and restoration expertise as well as newly emerging technological resources to improve water quality.



Graphic adapted from the EPA

SWQB has coordinated with the Alliance for many years on developing and implementing restoration of the Cimarron watershed. Initial efforts to form a watershed group in the Cimarron Watershed began in 2001, in response to water quality investigations performed by the SWQB as part of their Clean Water Act deliverables which identified water quality impairments in several streams and rivers in the Cimarron Watershed. The group developed by-laws and incorporated as a 501(c)(3) non-profit in 2004. The Alliance is composed of volunteers from both incorporated and unincorporated areas of Colfax County, and usually holds a monthly stakeholder meeting that is open to the general public. Stakeholders from various interest groups including government officials, state and federal agency personnel, civic group representatives, ranchers, businesspeople, and community members, have participated in the Alliance, with the common interest of maintaining and improving water quality and water quantity within the Cimarron Watershed. Collectively, Alliance members represent more than one million acres of private property (Alliance, 2017).

The Alliance'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." Their stated objectives are (Alliance, 2017):

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 Alliance collaborates with a variety of partners. The partner organizations past or presently involved in Alliance activities include the following:

- New Mexico Environment Department/Surface Water Quality Bureau
- U.S. Forest Service (USFS)
- Quivira Coalition
- New Mexico State Parks Division
- New Mexico State Forestry Division
- New Mexico Department of 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, Ute Park and Angel Fire
- Trout Unlimited
- High Plains Grassland Alliance
- Many local residents

American Creek landowners completed a questionnaire about their portion of the drainage, and their site managers accompanied Alliance and SWQB personnel during reconnaissance site visits. SWQB staff also visited the Game Commission owned portion of the drainage, accompanied by a NMDGF biologist. The Alliance provided review and comment on preliminary drafts of this plan, as well as facilitating private landowner engagement in the process.

Because many nonpoint source pollution reduction strategies rely on voluntary implementation by landowners, effective ongoing stakeholder engagement to create social capital (trust, networks and positive relationships) with those who will implement BMPs is a pivotal part of the overall plan for moving forward. Although there are only four landowners in the American Creek drainage, similar water quality impairments and sources are prevalent throughout the Moreno Valley. Outreach to a wider group of landowners is warranted since it would encourage the adoption of restoration practices that could improve water quality over a larger area.

The education and information program to support achieving and maintaining water quality standards can be divided into three main phases. The first and second phases are the implementation phases in which water quality standards will be achieved. The third phase is a maintenance phase, in which the goal is maintenance of water quality to meet standards.

**Phase I: Engage early implementers**

The first implementation phase will rely on application for project funding by American Creek landowners and the Alliance, who are already familiar with the principles of the plan and many of the management measures to be implemented. Active members of the Cimarron Watershed Alliance are the best source of early implementers and advocates.

**Phase II: Encourage widespread implementation**

Early implementers would be encouraged to host workshops on unpaved roads BMPs, riparian grazing management, and erosion prevention. In order for the plan to have a broader watershed effect, at least one more round of more implementers will need to be recruited for creating Alternative Restoration or WBPs at the scale of single or few stream reaches. Coordination is a key element of encouraging widespread implementation. The Alliance is best suited for filling this role.

Erosion prevention workshops proposed under this education program are of two main types. The first, focused on streambank stabilization methods and natural fluvial functioning, can assist landowners with preventing excessive erosion and recognizing characteristics of streams, such as the periodic tendency to flood, that are better adapted to than fought. In some circumstances, banks may be strategically protected with structures or planted, to accelerate natural channel evolution processes towards a more stable form, and workshops may be used to help participants recognize and promote those processes. The second type of erosion prevention workshop may be used to teach techniques of upland erosion prevention. These workshop subjects are not mutually exclusive, but each of these subjects is appropriate for a two- to three-day workshop.

It is hoped that the first few workshops outlined above will generate interest among another round of landowners, who may then produce and attend additional workshops. Because American Creek is easily accessed from Highway 64, it is an ideal location for workshops and lasting riparian streambank stabilization or grazing management projects demonstration visible to the public and other landowners in the Moreno Valley. Participation in workshops is the main way for landowners to see the results of proposed management measures, and hosting workshops will likely be a key incentive for some landowners to support implementation.

Another aspect of promoting more widespread implementation is to address other objectives that landowners may have, such as increased forage for livestock, and drier conditions on roads during snowmelt or periods of frequent rains. During later workshops, participants will revisit past work, be presented with summaries of monitoring data indicating whether goals are being met, and progress may be reported in local newsletters or list-serves to make this information more widely known.

**Phase III: Incentives to maintain water quality**

As water quality improves in the impaired reach, protection of that improvement is desired. The notion that landscape level problems related to erosion can be addressed with a one-time round of BMP installation ignores the underlying reasons for present conditions. The education efforts in Phase I and II will highlight incentives to maintain water quality improvements where they occur. Acceptance of practices to protect water quality depends on social factors well beyond the scope of this plan. Some economic incentives to maintain water quality are as follows:

- *Ponderosa Pine Forest Restoration*

  Provided that sufficient fuel is maintained to carry periodic fire, ponderosa pine forest restoration may produce an increase in available forage for livestock. In areas with homes or other infrastructure, reducing the risk of severe forest fire intensity protects property value. Also, once restored, the costs of utilizing prescribed natural fire to maintain ponderosa pine forest in a natural state are much lower than conducting prescribed burns or actively thinning trees to permit the use of fire without causing crown fires.

- *Grazing BMPs*

  The management measures described above have some potential to produce better weight gains in livestock, partially compensating for the costs of those practices. Increased demand for grass-fed or local beef, or conversely decreased subsidization of corn- or soy-fed beef production systems, may improve the economics of public lands livestock production and thus may make some new costs of production more affordable.

- *Unpaved Roads BMPs*

  Properly drained roads concentrate runoff less than roads which capture or retain flow on their surfaces. Properly drained roads also require less maintenance to correct erosion problems, they generally produce less wear and tear on vehicles, and they may support faster average speeds.

- *Riparian Grazing Management*

  Limiting grazing within riparian areas to short periods of intense grazing may result in better herbaceous plant production, and protection of woody riparian plants sufficient to increase bank stability. In addition to the economics of raising livestock, hay production, and leasing pastures, increased streambank stability (i.e., reduced erosion) provides an incentive for landowners to pursue improved management options. Increased streambank stability in the vicinity of diversions may also reduce costs of maintaining the diversions.

- *Bank Stabilization BMPs*

  In addition to the benefits of reducing or changing grazing pressure described above, more active management measures also generally reduce erosion and may protect irrigation infrastructure.

- *Arroyo Treatments*

  The treatments identified by this plan may help landowners preserve or increase the value of their property by reducing and stabilizing gullies and arroyo cut banks.

## REFERENCES


Chronic, Halka. 1987. Roadside Geology of New Mexico. Mountain Press Publishing Company. Missoula, MT.

Cimarron Watershed Alliance (Alliance). Cimarron Watershed Alliance. 2003. Watershed Restoration Action Strategy/Watershed Implementation Plan. August 2003 Draft.

_____. 2016. Moreno Valley Wetland Action Plan. https://www.env.nm.gov/wp-content/uploads/2017/07/Moreno-WAP-Final-8-28-16.pdf.

_____. 2017. Cimarron Watershed-Based Plan, First revision. https://www.env.nm.gov/surface-water-quality/wbp/.

Colpitts, R.M., Jr, and C.T. Smith. 1990. Geology of the Moreno Valley, Colfax County, New Mexico. New Mexico Geological Society 41st Annual Fall Field Conference Guidebook. https://nmgs.nmt.edu/publications/guidebooks/downloads/41/41_p0219_p0228.pdf.

Cory, N., I. Buffam, H. Laudon, S. Kohler and K. Bishop. 2006. Landscape control of stream water aluminum in a boreal catchment during spring flood. Env. Sci. Tech. 40:3494-3500.

Fluke, J., R. Gonzalez-Pinzon and B. Thomson. 2019. Riverbed sediments control the spatiotemporal variability of *E. coli* in a highly managed, arid river. Frontiers in Water 1:4.

Forum of European Geological Surveys (FOREGS). 2005. Geochemical Atlas of Europe, Part 2. http://weppi.gtk.fi/publ/foregsatlas/part2.php

Gensemer, Robert and Richard Playle. 1999. The Bioavailability and Toxicity of Aluminum in Aquatic Environments. Critical Reviews in Environmental Science and Technology - CRIT REV ENVIRON SCI TECHNOL. 29. Pages 315-450.

Grabow, G.L., J. Spooner, L. A. Lombardo, and D. E. Line. 1992. Detecting water quality changes before and after BMP implementation: use of a spreadsheet for statistical analysis. NWQEP Notes 92: 1 – 9. www.bae.ncsu.edu/programs/extension/wqg/issues/92.pdf.

Griffith, G.E., J.M. Omernik, M.M. McGraw, G.Z. Jacobi, C.M. Canavan, T.S. Schrader, D. Mercer, R. Hill and B.C. Moran. 2006. Ecoregions of New Mexico (color poster with map, descriptive text, summary tables, and photographs): Reston, VA. U.S. Geological Survey.

Howell, J.M., M.S. Coyne and P.L. Cornelius. 1996. Effect of sediment particle size and temperature on fecal bacteria mortality rates and the fecal coliform/fecal streptococci ratio. Journal Environmental Quality 25: 1216-1220.

Hulvey, K.B., C.D. Mellon and A.R. Kleinhesselink. 2021. Rotational grazing can mitigate ecosystem service trade-offs between livestock production and water quality in semi-arid rangelands. J Appl Ecol, June 2021.

Lenhart, C., B. Gordon, J. Peterson, W. Eshenaur, L. Gifford, B. Wilson, J. Stamper, L. Krider and N. Utt. 2017. Agricultural BMP Handbook for Minnesota, 2nd Edition. St. Paul, MN: Minnesota Dept of Agriculture.

Linard, J.I., et al. 2014. Two decision-support tools for assessing the potential effects of energy development on hydrologic resources as part of the Energy and Environment in the Rocky Mountain Area interactive energy atlas. U.S. Geological Survey Open-File Report 2014–1158. https://pubs.usgs.gov/of/2014/1158/.

New Mexico Environment Department Surface Water Quality Bureau (NMED/SWQB). 1999. Total Maximum Daily Load for Temperature on North Ponil Creek. Santa Fe, NM. https://www.env.nm.gov/surface-water-quality/tmdl/ .

_____. 2001. Total Maximum Daily Load for Turbidity in Middle Ponil Creek and Ponil Creek. Santa Fe, NM. https://www.env.nm.gov/surface-water-quality/tmdl/.

_____. 2004. Total Maximum Daily Load for Turbidity, Stream Bottom Deposits, and Total Phosphorus in the Canadian River Basin (Cimmaron). Santa Fe, NM. https://www.env.nm.gov/surface-water-quality/tmdl/.

_____. 2010. Total Maximum Daily Load (TMDL) Cimarron River (Canadian River to Headwaters). July. Santa Fe, NM. https://www.env.nm.gov/surface-water-quality/tmdl/.

_____. 2011. Total Maximum Daily Load (TMDL) for Waters of the Valle Vidal. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/tmdl/ .

_____. 2016. Sampling Summary: Canadian River and Dry Cimarron River Watersheds. December. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/.

_____. 2018. 2018-2020 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/2018-2020-ir/.

New Mexico State University (NMSU). 2010. Smith, Dr. Geoff; GBS Environmental, LLC and NMSU Biology Department. Bacterial Source Tracking Study in the Cimarron New Mexico Watershed; in cooperation with Cimarron Watershed Alliance board members and local Angel Fire High School students.

U.S Environmental Protection Agency (EPA). 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. March. Office of Water. Nonpoint Source Control Branch. Washington, D.C. Available at: https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters.

_____. 2013. A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program. Available at: https://www.epa.gov/sites/production/files/2015-07/documents/vision_303d_program_dec_2013.pdf

_____. 2015. Information Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions. Memorandum dated August 13, 2015. Office of Wetlands, Oceans, and Watersheds. Washington, D.C. Available at: https://www.epa.gov/tmdl/integrated-reporting-guidance.

Wcislo, R. and R.J. Chrost. 2000. Survival of *Escherichia coli* in Freshwater. Polish Journal of Environmental Studies 9(3):215-222.

Zeckoski, R.W., B.L. Benham, S.B. Shah, M.L. Wolfe, K.M. Brannan, M. Al-Smadi, T.A. Dillaha, S. Mostaghimi and C.D. Heatwole. 2005. BSLC: A tool for bacteria source characterization for watershed management. Appl. Engineering in Agriculture: Sept, 2005.

# Appendix A

## Nine-Element WBP, TMDL, and SWQB ARP Crosswalk

| WBP Element | WBP Element Description | SWQB ARP section where addressed | ARP Component and Notes |
|---|---|---|---|
| A | An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the needed load reductions estimated in the next element. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed. | **Section 1 Watershed overview and description,** should include:<br>• Water body ID number (AU_ID)<br>• 12-digit HUC(s)<br>• Overview geology, land use, and land management maps<br>• Include recent SWQB WQ monitoring stations on map(s)<br><br>**Section 2 Identification of impairment causes and sources,** should include:<br>• Brief summary of recent WQ monitoring efforts<br>• Cause(s) of impairment from most current CWA 303(d)/305(b) Integrated List<br>• Probable source(s) with relative source contribution estimates or ranking<br>. | 1. Identification of specific impaired water water(s) addressed by the alternative restoration approach, and identification of all sources contributing to the impairment. |
| B | An estimate of the load reductions expected for the management measures. | **Section 2.4 Load reduction estimates,** should include:<br>• Water quality standards-based target loads<br>• Current or existing loads based on available data and/or models<br>• Overall load reduction estimates to meet target goals<br>. | 2. Analysis to support why the State believes that the implementation of the alternative restoration approach is expected to achieve WQS. |

<table>
<tr><td>C</td><td>A description of the NPS management measures that will need to be implemented to achieve the load reductions, and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.</td><td>Section 2.1.1 Targeting of geographic areas, should include:<br>• Soil erosion potential map based on USGS NM/CO RUSLE coverages<br>• Other supporting maps/GIS tools showing critical areas.<br><br>Section 3, Management measures, should include:<br>• Description of management measures needed to achieve load reduction<br>• Source-specific BMP reduction information using tools such as STEPL, WEPP roads, etc.</td><td rowspan="4">3. An Action Plan or Implementation Plan to document: a) the actions to address all sources necessary to achieve WQS, b) a schedule of actions designed to meet WQS with clear milestones and dates, which includes interim milestones and target dates with clear deliverables<br><br>4. Identification of available funding opportunities to implement the alternative restoration plan.<br><br>5. Identification of all parties committed, and/or additional parties needed, to take actions that are expected to meet WQS.<br><br>6. An estimate or projection of the time when WQS will be met</td></tr>
<tr><td>D</td><td>An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.</td><td>Section 3.2 Technical and financial assistance needed, should include:<br>• Table of expected cost estimates per BMP proposed<br>• A table, list, or description of available funding sources and organizations</td></tr>
<tr><td>F</td><td>A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.</td><td rowspan="2">Section 3.3 Management measures timeline, should include:<br>• Interim x-year milestones in Strategies table<br>• A schedule with proposed controls and target completion dates<br>• A description of interim measurable milestones</td></tr>
<tr><td>G</td><td>A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.</td></tr>
<tr><td>H</td><td>A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards.</td><td>Section 4 Monitoring plan, should include:<br>• BMP-specific monitoring plans<br>• A plan for effectiveness monitoring designed to show</td><td>7. Plans for effectiveness monitoring to: demonstrate progress made toward achieving WQS following implementation; identify needed</td></tr>
</table>

| | | | |
|---|---|---|---|
| I | A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.<br><br>[Per EPA guidance, this element is intended to be watershed-scale] | restoration progress and ID corrective measures<br>• Description of watershed-scale monitoring (i.e., next MASS rotational survey)<br>• A plan to periodically evaluate the alt plan to determine if it's on track to meet WQS or if adjustments need to be made | improvement for adaptive management as the project progresses; and evaluate the success of actions and outcome. |
| E | An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented. | **Section 5 Public participation, education and outreach,** should include:<br>• Summary of stakeholder meetings and public notices<br>• Future plans to sustain stakeholder engagement<br>• A table, list, or description of parties committed to or assisting with implementation | 5. Identification of all parties committed, and/or additional parties needed, to take actions that are expected to meet WQS. |

# Appendix B

# Loading Calculations (TMDL)

This appendix provides target loads, measured loads, and associated overall load reduction needed for assessment unit (AU)-parameter pairs discussed in this ARP. Also included is a presentation of the data collected by the 2015-16 water quality survey, which were used to assess the impairments.

American Creek falls under water quality standards Section 20.6.4.309 NMAC.

***20.6.4.309 CANADIAN RIVER BASIN: - The Mora river and perennial reaches of its tributaries upstream from the state highway 434 bridge in Mora except lakes identified in 20.6.4.313 NMAC, all perennial reaches of tributaries to the Mora river upstream from the USGS gaging station at La Cueva, perennial reaches of Coyote creek and its tributaries, the Cimarron river and its perennial tributaries above state highway 21 in Cimarron except Eagle Nest lake, all perennial reaches of tributaries to the Cimarron river north and northwest of highway 64 except north and south Shuree ponds, perennial reaches of Rayado creek and its tributaries above Miami lake diversion, Ocate creek and perennial reaches of its tributaries upstream of Ocate, perennial reaches of the Vermejo river upstream from Rail canyon and all other perennial reaches of tributaries to the Canadian river northwest and north of U.S. highway 64 in Colfax county unless included in other segments.***

***A. Designated uses:*** *domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, and primary contact; and public water supply on the Cimarron river upstream from Cimarron and on perennial reaches of Rayado creek and its tributaries.*

***B. Criteria:*** *the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 500 µS/cm or less; the monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.*

*[20.6.4.309 NMAC - Rp 20 NMAC 6.1.2306, 10/12/2000; A, 7/19/2001; A, 5/23/2005; A, 12/1/2010; A, 7/10/2012]*

*[**NOTE:** The segment covered by this section was divided effective 5/23/2005. The standards for the additional segment are under 20.6.4.310 NMAC. The standards for Shuree ponds are in 20.6.4.314 NMAC and the standards for Eagle Nest lake are in 20.6.4.315 NMAC, effective 7/10/2012]*

## 1.0 WATER QUALITY DATA

The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Dry Cimarron and Upper and Lower Canadian basins in 2015-2016 (NMED/SWQB, 2016). Causes of impairment were determined based on application of SWQB's listing methodology (NMED/SWQB, 2017). Total recoverable aluminum (TR Al) and *E. coli* were determined to be causes of impairment in American Creek and documented in the CWA 303(d)/305(b) Integrated Report and List (NMED/SWQB, 2018). The *E. coli* impairment impacts the primary contact designated use, and the TR Al impairment impacts the aquatic life designated use.

Available sampling data from the SWQB 2015-2016 Canadian River water quality survey, applicable TR Al water quality criteria and exceedance ratios are summarized in **Tables B.1** and **B.2**. Acute and chronic TR Al criteria are based on concurrent hardness. "Total recoverable" reflects the language in 20.6.4.900.I(1) NMAC which states "*For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize the mineral phase as specified by the department.*"

Based on recommendations from an aluminum filtration study conducted by SWQB staff (NMED/SWQB 2012), samples that will be analyzed for TR Al are field filtered using a filter of 10 µm pore size that minimizes mineral-phase aluminum without restricting amorphous or colloidal phases, when concurrent turbidity exceeds 30 NTU. However, American Creek turbidity was below 30 NTU for all survey sampling events, so none of the samples were filtered. The applicable single sample *E. coli* criterion is 235 cfu/100 mL.

**Table B.1 2015-2016 survey data from monitoring station 05Americ000.5 - American Creek above Cieneguilla Creek[a]. Exceedances of the applicable criterion are in bold red font.**

| Date | Turbidity (NTU) | Flow (cfs) | Hardness (mg/L) | TR Al Acute Criterion (mg/L) | TR Al Chronic Criterion (mg/L) | TR Al (mg/L) | E. coli (cfu/100 mL) |
|---|---|---|---|---|---|---|---|
| 4/23/15 | 7.3 | 1.75 [b] | -- | -- | -- | -- | 5.2 |
| 7/16/15 | 6.4 | 2 [b] | -- | -- | -- | -- | **435.2** |
| 8/19/15 | 16.9 | 1.5 [b] | 41 | 1.00 | 0.40 | 0.13 | 101.7 |
| 10/15/15 | 0 | 0.5 [b] | 45 | 1.15 | 0.46 | 0.08 | **410.6** |
| 4/14/16 | 28.5 | 3 [b] | 25 | 0.51 | 0.21 | **2.3** | 4.1 |
| 6/30/16 | 2.5 | 0.69 | -- | -- | -- | -- | **>2419.6** |
| 7/19/16 | 1.9 | 0.57 | 43 | 1.08 | 0.43 | 0.21 | **1046.2** |
| 9/1/16 | 3.6 | 0.81 | 43 | 1.08 | 0.43 | **0.76** | 166.4 |

**NOTES**:
*a) The monitoring station was moved from below the in-channel ponds, to a location above the lower pond, at an undetermined time during the water quality survey.*
*b) Flow visually estimated.*

**Table B.2 Exceedance ratios from monitoring station 05Americ000.5 - American Creek above Cieneguilla Creek[a]**

| Assessment Unit | Cause of Impairment | Exceedances (chronic) | Exceedances (acute) |
|---|---|---|---|
| American Creek (Cieneguilla Creek to headwaters) | TR Al | 2/5 | 1/5 |
| | *E. coli* | -- | 4/8 |

**NOTES**:
*a) The monitoring station was moved from below the in-channel ponds, to a location above the lower pond, at an undetermined time during the water quality survey.*

## 2.0 CRITICAL FLOW DETERMINATION

The target load is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. There are no USGS or other stream gages from which to derive flow in American Creek. As shown in **Table B.1** and **Figure B.1**, TR Al impairment occurs at relatively high flows. Association of Al concentration with high flows is a generally observed phenomenon (Cory et al., 2006). TR Al concentrations measured during the lowest flow conditions in American Creek did not exceed the applicable water quality criteria during the 2015-2016 Canadian River survey. Therefore, a flow value that corresponds with a higher probability of water quality exceedances was selected as the critical flow for TR Al in American Creek. The average of the three highest concurrent flow measurements/estimates taken during TR Al sampling were used to estimate a critical flow value of 1.77 cfs (1.14 MGD). Note that even though there was not an exceedance on 8/19/15, this higher flow value was still used to determine the higher critical flow.

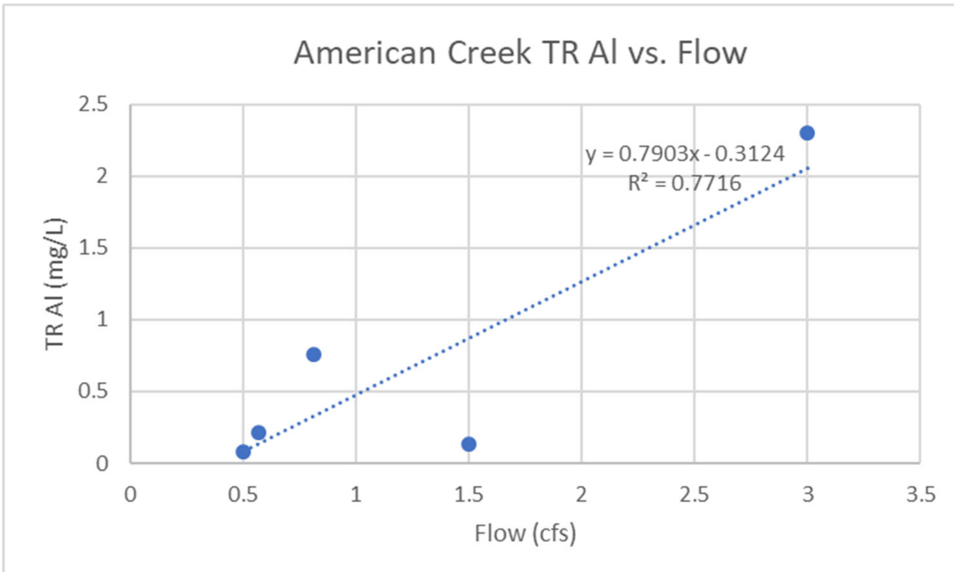



**Figure B.1 American Creek TR Al concentration in relation to concurrent stream discharge**

Conversely, *E. coli* exceedances mostly occurred during lower flows in American Creek. Therefore, low flow was selected as the critical condition for this parameter. In New Mexico, the low flow critical condition is typically defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years. Because American Creek is ungaged, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of the American Creek watershed is above 7,500 ft, so the mountain regression equation was used. The following mountainous regions regression equation (Equation 3.1) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer, 2002):

***Equation B.1***: $4Q3 = 7.3287 \times 10^{-5} DA^{0.70} P_w{}^{3.58} S^{1.35}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area ($mi^2$)
$P_w$ = Average basin mean winter precipitation (inches)
S = Average basin slope (ft/ft)

The 4Q3 calculation using Waltemeyer's method is presented in **Table B.3.** Parameters used in the equation were obtained using StreamStats, an online GIS application developed by the US Geological Survey (https://streamstats.usgs.gov/ss/). The critical flow was converted from cfs to million gallons per day (MGD) using the conversion factor 0.646.

**Table B.3 Calculation of critical flow for *E. coli* target loads**

| Assessment Unit | Average Elevation (ft) | Drainage Area ($mi^2$) | Mean Winter Precipitation (in) | Average Basin Slope (ft/ft) | 4Q3 (cfs) | 4Q3 (MGD) |
|---|---|---|---|---|---|---|
| American Creek (Cieneguilla Creek to headwaters) | 9640 | 6.12 | 9.43 | 0.21 | 0.1 | 0.065 |

It is important to keep in mind that the target load is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year, and from year to year, in these systems, the actual load at any given time will vary based on the changing flow conditions. Management of load during critical flow periods in order to achieve water quality standards is the goal of restoration efforts.

## 3.0 TARGET LOAD CALCULATION

The water-quality based Total Maximum Daily Load (TMDL) calculation is as follows:

*WQS criterion x critical flow x unit conversion factor = Total Maximum Daily Load*

Total maximum daily loads are presented on **Table B.4** for the critical flow conditions. The chronic aluminum criterion was calculated using a hardness value of 39.4 mg/l, which is the average hardness measured in American Creek during the two-year Canadian River watershed survey. The TMDL for *E. coli* bacteria is based on achievement of the segment-specific monthly geometric mean numeric criterion associated with the primary contact designated use. If the single sample criterion was used and achieved as a target, the geometric mean criterion might still not be achieved.

**Table B.4 Calculation of TMDLs**

| Assessment Unit | Cause of Impairment | Criterion | Critical Flow (MGD) | Conversion Factor | TMDL |
|---|---|---|---|---|---|
| American Creek (Cieneguilla Creek to headwaters) | TR Al | 0.39 mg/L | 1.14 | 8.34 | 3.68 lb/day |
| | *E. coli* | 126 cfu/100 mL | 0.065 | $3.79 \times 10^7$ | $3.10 \times 10^8$ cfu/day |

The TMDL is further allocated to a margin of safety (MOS), waste load allocation (WLA), for permitted point sources, and load allocation (LA), for non-point sources, according to the formula:

*WLA + LA + MOS = TMDL*

### 3.1 Margin of Safety

The margin of safety (MOS) is intended to account for uncertainty in available data. The MOS may be implicit, utilizing conservative assumptions for calculation of the target loading capacity. In this WBP/Alternative Plan, an implicit MOS for TR Al assumes that aluminum is a conservative pollutant (meaning it is a pollutant that does not readily degrade in the environment). The monthly geometric mean criterion (rather than the single sample criterion) is utilized in TMDL calculations to provide an implicit MOS for *E. coli*. An additional **explicit MOS of 10%** is assigned for both pollutants, to account for uncertainties inherent in estimating critical flow.

### 3.2 Waste Load Allocation (WLA)

The WLA is the portion of the TMDL allocated to point source activities in the watershed. There are no active National Pollutant Discharge Elimination System (NPDES) permits in the American Creek drainage. Sediment and associated contaminants are considered components of industrial storm water discharges covered under NPDES General Permits. Stormwater discharges from construction activities are transient, occurring mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) for construction sites greater than one acre, or less than one acre if they are part of a common plan of development, requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, and managerial and structural solids, erosion, and sediment control Best Management Practices (BMPs), and/or other controls. BMPs and other controls are designed to prevent to the maximum extent practicable an increase in sediment load and flow velocity during and after construction compared to pre-construction conditions to the water body, or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc., in order to assure that waste load allocations and/or applicable water quality standards, including the antidegradation policy, are met. This requirement applies both during and after construction operations.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. While these sources are not given individual allocations, they are addressed through other means, including BMPs, and other stormwater pollution prevention conditions. Implementation of a SWPPP that meets the requirements of a General Permit is generally assumed to be consistent with this target load determination. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA). Therefore, the WLA for this target load is zero.

### 3.3 Load Allocation (LA)

The LA is the portion of the TMDL allocated to non-point source activities in the watershed, including natural contributors such as geology, soils, and topography. The extensive data collection and analyses necessary to determine background TR Al and *E. coli* loads are beyond available staff and financial resources. Therefore, it is assumed that a portion of the load allocation is from natural background conditions. The results of a bacteria source tracking study conducted in the Moreno Valley infer that there are likely significant contributions from wildlife sources of *E. coli* in the tributaries of Cieneguilla Creek (NMSU, 2010). However, the results of the Bacterial Load Source Calculator model indicate that livestock are the most significant source in the American Creek drainage.

## 4.0 OVERAL LOAD REDUCTION NEEDED

Since there are no point sources discharging to this water body, the target loads in **Table B.5** are equal to the load allocations.

**Table B.5 Load reduction estimates to meet water quality standards in American Creek (Cieneguilla Creek to headwaters)**

| Cause of Impairment | TMDL | 10% MOS | Target Load (LA) | Measured Load | Load Reduction[b] |
|---|---|---|---|---|---|
| TR Al | 3.68 lbs/day | 0.37 lbs/day | 3.31 lbs/day | 10.11 lbs/day | 67% |
| *E. coli* | $3.10 \times 10^8$ cfu/day | $3.10 \times 10^7$ cfu/day | $2.79 \times 10^8$ cfu/day | $2.17 \times 10^9$ cfu/day | 87% |

**NOTES**: *a) The measured load was calculated using the critical flow and the average measured concentration at flows that were used to calculate the critical flow.*

*b) Load reduction is the percent by which the measured load must be reduced to achieve the target load and is calculated as follows: 100 x (Measured Load – Target Load) / Measured Load.*

## REFERENCES:


Cory, N., I. Buffam, H. Laudon, S. Kohler and K. Bishop. 2006. Landscape control of stream water aluminum in a boreal catchment during spring flood. Env. Sci. Tech. 40:3494-3500.

New Mexico Environment Department Surface Water Quality Bureau (NMED/SWQB). 2012. Aluminum filtration study. Santa Fe, NM. Available at: https://www.env.nm.gov/swqb/documents/swqbdocs/Standards/AluminumFiltration/AluminumFiltrationStudy08-24-2012.pdf.

_____. 2016. Sampling Summary: Canadian River and Dry Cimarron River Watersheds. December. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/.

_____. 2017. Procedures for Assessing Standards Attainment for the State of New Mexico CWA §303(d)/ §305(b) Integrated Report: Comprehensive Assessment and Listing Methodology (CALM). Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/calm/.

_____. 2018. 2018-2020 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/2018-2020-ir/.

New Mexico State University (NMSU). 2010. Smith, Dr. Geoff; GBS Environmental, LLC and NMSU Biology Department. Bacterial Source Tracking Study in the Cimarron New Mexico Watershed; in cooperation with CWA board members and local Angel Fire High School students.

Waltemeyer, Scott D. 2002. Analysis of the Magnitude and Frequency of the 4-Day Annual Low Flow and Regression Equations for Estimating the 4-Day, 3-Year Low-Flow Frequency at Ungaged Sites on Unregulated Streams in New Mexico. USGS Water-Resources Investigations Report 01-4271. Albuquerque, NM

# Appendix C

## Bacteria Source Load Calculator

**Table B. 2. Select manure and fecal coliform production rate reference values used in the BSLC**

| Animal | Animal Weight (kg)[a] | Manure Production Rate (kg/animal/day)[b] | Fecal Coliform Production Rate (cfu/day-animal) |
|---|---|---|---|
| Dairy cow | 635[c] | 52[d] | $2.50 \times 10^{10}$[e] |
| Beef cattle | 450[f] | 27[g] | $3.30 \times 10^{10}$[h] |
| Sheep | 27[c] | 1.08[i] | $1.2 \times 10^{10}$[i] |
| Chicken layers | 1.8[c] | 0.115[i] | $1.4 \times 10^{8}$[i] |
| Chicken broilers | 0.9[c] | 0.0765[i] | $8.9 \times 10^{7}$[j] |
| Turkeys | 6.8[c] | 0.320[i] | $9.3 \times 10^{7}$[i] |
| Goat | 64[c] | — | $2.8 \times 10^{10}$[k] |
| Horse | 450[c] | — | $4.2 \times 10^{10}$[i] |
| Deer | — | — | $3.5 \times 10^{8}$[l] |
| Raccoon | — | — | $5.0 \times 10^{7}$[m] |
| Muskrat | — | — | $2.5 \times 10^{7}$[n] |
| Goose | | — | $8.0 \times 10^{8}$[o] |
| Duck | 1.4[c] | — | $2.4 \times 10^{9}$[i] |
| Beaver | — | — | $2.0 \times 10^{5}$[p] |

[a]Animal weight only given where it was used to calculate manure or fecal coliform production rates.
[b]Manure production rates only needed for animals whose manure is applied.
[c]*ASAE Standards* (1998).
[d]Calculated from Barth (1992) for given animal weight in second column.
[e]Based on estimates ranging from $1.7 \times 10^4$ to $>8.0 \times 10^6$ cfu/g manure as given by Yagow (2001), Geldreich (1978), and *ASAE Standards* (1998); and on mass of feces from *ASAE Standards* (1998).
[f]VADCR (1993).
[g]MWPS (1993).
[h]Based on estimates ranging from $6.5 \times 10^1$ to $>8.0 \times 10^6$ cfu/g manure as given by Yagow (2001), Geldreich (1978), and *ASAE Standards* (1998); and on mass of feces from *ASAE Standards* (1998).
[i]Calculated from *ASAE Standards* (1998).
[j]Assume fecal coliform density is the same as in layer manure; calculate based on manure production rates in *ASAE Standards* (1998).
[k]Calculated from sheep fecal coliform and ratio of sheep and goat weights.
[l]Calculated from Yagow (2001) fecal coliform densities and Harlow (1984) forage intake and dry matter digestibility analyses.
[m]Assumed twice the contribution from muskrats.
[n]Calculated from Yagow (2001) fecal coliform densities and Kator and Rhodes (1996) mass of feces.
[o]Calculated from Moyer and Hyer (2003).
[p]Calculated from Maptech, Inc. (2000).

**Table B. 4. Wildlife habitat areas and population estimates**

| Wildlife Type | Habitat | Population Density (animal/ha-habitat) | Source of Information |
|---|---|---|---|
| Deer | Entire watershed | 0.12 | MapTech (2000) |
| Raccoons | Low density on forests not in high density area; high density on forest within 183 m of a permanent water source or 0.8 km of cropland | Low density: 0.040<br>High density: 0.12 | Virginia Department of Game and Inland Fisheries (personal communication, 2004) |
| Muskrats | 26/km of ditch or medium sized stream[a] intersecting cropland; 13/km of ditch or medium sized stream intersecting pasture; 16/km of pond or lake edge; 81/km of slow-moving river edge | -see habitat column- | Virginia Department of Game and Inland Fisheries (personal communication, 2004) |
| Beavers | 91-m buffer around streams and impoundments in forest and pasture | 0.037 | Density calculated from colony size estimates from MDC (1997) and colony density estimates by Stromayer (1999); habitat modified from estimates by MapTech (2000) |
| Geese | 91-m buffer around main streams and impoundments | 0.19 – off season<br>0.27 – peak season | Moyer and Hyer (2003) |
| Ducks | 91-m buffer around main streams and impoundments | 0.15 – off season<br>0.23 – peak season | Habitat area from Moyer and Hyer (2003) |
| Wild Turkey | Entire Watershed except urban and farmstead | 0.025 | Brannan et al. (2002) |

[a]For practical purposes at the Center for Watershed Studies, we assume a ditch or medium-sized stream is a perennial stream or canal/ditch that would show up as a line (not an area) on a USGS quad sheet; generally this corresponds to NHD (USGS, 2005) FCODEs 46004, 46005, 46006, and 33602 or TIGER (U.S. Census Bureau, 2002) CFFC codes H11, H13, and H21. These classifications should be field-checked prior to use.

Livestock input: 120 beef cattle present from May 1 to Sept 1.

Wildlife input (estimated number of animals):

| Deer | Elk | Raccoons | Muskrats | Beavers | Geese | Ducks | Wild Turkeys |
|---|---|---|---|---|---|---|---|
| 49 | 87 | 84 | 0 | 0 | 27 peak<br>19 secondary | 23 peak<br>15 secondary | 40 |

Human activities input: 2 residences with older septic systems, 1 resident per house.

Modification from BLSC default values shown in Tables B2 and B4, above:

> Deer population density was based on the low end of a range estimated by NM Department of Game & Fish.
>
> Deer bacteria production was modified proportional to average animal weight, to reflect that these are mule deer rather than white-tails (the default species in the model).
>
> Elk was added as a wildlife species. Elk population density is approximated by published perceived high densities reported for National Forests in Colorado.
>
> Elk bacteria production was modified proportional to average animal weight, relative to the white-tailed deer default value.
>
> Beaver or muskrats are not known to currently occupy the watershed.
>
> Waterfowl habitat was defined as the entire wet meadow area, plus a 91 m buffer around the two ponds, rather than a 91 m buffer from the stream channel.
>
> Waterfowl peak season is defined as July – September.

# Report Summary

These are values used in writing the TMDL report and/or presentation.

| | Liquid | | | Poultry | | | Solid | | |
|---|---|---|---|---|---|---|---|---|---|
| | acres | gal | cfu | acres | lbs | cfu | acres | lbs | cfu |
| Cropland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pasture 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pasture 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pasture 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Manure produced per year | | | gal or lb/year | | | |
|---|---|---|---|---|---|---|
| Animal | Confinem | Loafing Lo | Pasture 1 | Pasture 2 | Pasture 3 | Streams |
| Milk | 0 | 0 | 0 | 0 | 0 | 0 |
| Dry | 0 | | 0 | 0 | 0 | 0 |
| Heifer | 0 | | 0 | 0 | 0 | 0 |
| Beef | 0 | 0 | 852435 | 0 | 0 | 33165 |
| Sheep | 0 | 0 | 0 | 0 | 0 | 0 |

| | FC Load | cfu/year | | Load Breakdown | Percent Contribution |
|---|---|---|---|---|---|
| Milkers | 0 | | Streams | 2.24E+13 | 3.95% |
| Dry | 0 | | Crops | 0.00E+00 | 0.00% |
| Heifer | 0 | | Pasture | 4.79E+14 | 84.61% |
| Beef | 1.82E+13 | | Residenti | 1.06E+12 | 0.19% |
| Horses | 0 | | Forest | 6.38E+13 | 11.26% |
| Sheep | 0 | | LoafingLo | 0.00E+00 | 0.00% |
| Wildlife | 4.13E+12 | | Die-off | 0.00E+00 | 0.00% |
| ight Pipes | 0 | | | | |
| Crops | 0 | | | | |
| Pasture 1 | 4.79E+14 | | | | |
| Pasture 2 | 0 | | | | |
| Pasture 3 | 0 | | | | |
| esidential | 1.06E+12 | | | | |
| Forest | 6.38E+13 | | | | |
| afing Lots | 0 | | | | |
| CropApp | 0 | | | | |
| P1App | 0 | | | | |
| P2App | 0 | | | | |
| P3App | 0 | | | | |

| | FCProd | cfu/year | | Production Breakdown | Percent Contribution |
|---|---|---|---|---|---|
| Milkers | 0 | | Agricultur | 4.87E+14 | 85.97% |
| Dry | 0 | | Wildlife | 7.84E+13 | 13.84% |
| Heifer | 0 | | Humans | 7.31E+11 | 0.13% |
| Beef | 4.87E+14 | | Pets | 3.29E+11 | 0.06% |
| Layers | 0 | | | | |
| Broilers | 0 | | | | |
| Turkeys | 0 | | | | |
| Horses | 0 | | | | |
| Sheep | 0 | | | | |
| Deer | 8.77E+12 | | | | |
| Raccoons | 1.53E+12 | | | | |
| Muskrats | 0 | | | | |
| Beavers | 0 | | | | |
| Geese | 3.86E+12 | | | | |
| Wild Turk | 1.36E+12 | | | | |
| Ducks | 9.51E+12 | | | | |
| Humans | 7.31E+11 | | | | |
| Pets | 3.29E+11 | | | | |
| Elk | 5.34E+13 | | | | |

| | Sewered | Unsewered |
|---|---|---|
| atershed Population | #VALUE! | 2 |