Sulphur Creek Watershed

Wetlands Action Plan

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Prepared by

Los Amigos de Valles Caldera

and the

New Mexico Environment Department Wetlands Program

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COVER PHOTO: Volunteers with Albuquerque Wildlife Federation building a series of one rock dams and zuni bowls to stop erosion below a large pond in Valle Seco. Photo courtesy of Kristina G. Fisher, 2015.

EXECUTIVE SUMMARY

Sulphur Creek is located in the Jemez Mountains at the headwaters of San Antonio Creek within Valles Caldera National Preserve (VCNP) in Sandoval County, New Mexico. This is an area with significant beauty, wildlife, and water resources. The Sulphur Creek Watershed includes Valle Seco, Sulphur Creek and Redondo Creek areas. One hundred and fifteen (115) acres of wetlands have been identified in Sulphur Creek Watershed including slope wetlands, riverine wetlands, depressional wetlands and pond fringe wetlands. These wetlands have been negatively impacted by the effects of historic timber extraction (logging), livestock and wildlife grazing, roads and hydrothermal exploration. In particular, many slope wetlands in the watershed were desiccated due to erosion and channelization that lowers the water table and captures sheet flow. However, with careful planning and appropriate restoration techniques, many of these wetlands have potential for recovery.

This Wetlands Action Plan (WAP) defines strategies for protecting and restoring wetlands in the Sulphur Creek watershed, and supplements the Jemez Watershed Restoration Action Strategy (Jemez Watershed Group, 2005) which addresses water quality impairments, including metals, temperature and turbidity for Redondo Creek, and conductivity and pH for Sulphur Creek. Several stakeholder organizations that have worked in the watershed are identified in the WAP, as are current and potential funding sources. The protection and restoration of wetlands in the Sulphur Creek Watershed continues to support improved water quality conditions in Sulphur Creek and Redondo Creek, increase diverse vegetative and animal species, and provides a buffer for wildfires and drought.

WAP recommendations include the following wetlands protection and restoration actions:

- Wetlands restoration in Tributary 3 of Valle Seco, the headwaters of Sulphur Creek, as well as ongoing monitoring and maintenance of prior restoration work in Valle Seco;
- Wetlands restoration in Redondo Meadows, coupled with instream restoration and planting of woody vegetation along Redondo Creek;
- Construction of rolling dips and porous fill along sections of VC08 to address storm water runoff, and closure of VC06 and Alamo Canyon Road to all but emergency vehicles and bicycles;
- Assessment and mitigation of wetland stressors in a private inholding along Sulphur Creek; and
- Forest thinning/prescribed burning in the upper reaches of Sulphur Creek Watershed.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

Figure **Page**

LIST OF ACRONYMS

Acronym	Full Name
AIH	Aquatic Invertebrate Habitat
AMO	Atlantic Multidecadal Oscillation
AU	Assessment Unit
BAER	Burned Area Emergency Response
BISON-M	Biota Information System of New Mexico
BSS	Bank and Shoreline Stabilization
CS	Carbon Sequestration
CSDP	Continental Scientific Drilling Program
CWA	Clean Water Act
FH	Fish Habitat
GIS	Geographic Information System
GR	Groundwater Recharge
HGM	Hydrogeomorphic
HQCAL	High Quality Cold Water Aquatic Life
IPCC	Intergovernmental Panel on Climate Change
Los Amigos	Los Amigos de Valles Caldera
NAWCA	North American Wetlands Conservation Act
NM	New Mexico
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NHNM	Natural Heritage New Mexico
NMHPD	New Mexico Historic Preservation Division
NMISC	New Mexico Interstate Stream Commission
NMOSE	New Mexico Office of State Engineer
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NT	Nutrient Transformation
OWH	Other Wildlife Habitat
PDO	Pacific Decadal Index
RERI	River Ecosystem Restoration Initiative
SM	Streamflow Maintenance

SR	Sediment and Other Particulate Retention
SWD	Surface Water Detention
SWQB	Surface Water Quality Bureau
TES	Terrestrial Ecosystem Survey
TMDL	Total Maximum Daily Load
US	United States
UNM	University of New Mexico
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGCRP	United States Global Change Research Program
VCNP or Preserve	Valles Caldera National Preserve
WAP	Wetland Action Plan
WBIRD	Water Bird Habitat
WRAS	Watershed Restoration Action Strategy
WSS	Web Soil Survey

1. Introduction

Sulphur Creek Watershed (HUC #130202020202) is a 25.4 mi^2 watershed located in the Jemez Mountains in Sandoval County, NM. (Figure 1-1). The watershed includes two perennial streams, Sulphur Creek and Redondo Creek. Redondo Creek is 6 miles long from its headwaters to its confluence with Sulphur Creek. Sulphur Creek is approximately 8 miles long from the headwaters to its confluence with San Antonio Creek. Sulphur Creek includes a major tributary, Alamo Canyon.

The purpose of this Wetlands Action Plan (WAP) is to define strategies for protecting and restoring wetlands in the Sulphur Creek Watershed. This WAP covers the portions of the watershed within Valles Caldera National Preserve (VCNP) which is most of the watershed.

In 2003, the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) completed total maximum daily loads (TMDLs) for many of the reaches of the Jemez watershed including those within the Preserve (NMED, 2003). A Watershed Restoration Action Strategy (WRAS) was prepared for the Jemez Watershed (Jemez Watershed Group, 2005). The WRAS lists specific water quality problems; identifies sources of contamination causing those problems; and provides a schedule of action items to be undertaken to abate those sources along with estimated funding requirements to perform these actions. A WRAS is a non-regulatory, voluntary approach to addressing non-point source impacts that affect water quality.

SWQB provides guidance to facilitate watershed groups throughout New Mexico to develop “Wetlands Action Plans” as an additional component of their WRAS. A “Wetlands Action Plan” is a planning document designed specifically to address wetlands within the boundaries of a specific watershed.

Los Amigos de Valles Caldera (Los Amigos) contracted with the NMED to complete this WAP for the Sulphur Creek Watershed. Los Amigos, a 501(c) (3) non-profit group, is the “Friends” group for VCNP, and focuses on supporting VCNP for present and future generations through outreach, education, restoration, and collaboration.

Wetlands are “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE, 2007).” Wetlands generally include swamps, marshes, bogs, fens and similar areas; lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface of the land. Wetlands must have one or more of the following attributes: (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The health of wetlands in many cases is inherently bound to its surrounding environment and water resources, therefore, the condition of riparian areas and water sources are contained in the WAP. This WAP will become an addendum to the WRAS that covers watersheds in the Preserve. The protection and restoration of wetlands in the Sulphur Creek watershed will continue to support improved water quality conditions in VCNP as well as in creeks downstream.

This Sulphur Creek WAP covers the following categories:

- A general description of the watershed including climate, soils, geology and groundwater, surface water, water quality, vegetation, wildlife, and land use (Section 2);
- A resource analysis including an inventory of wetlands based on previously completed mapping (Section 3);
- Identification of threats and impairment to wetlands in the watershed (Section 4);
- A recommended action plan that identifies measures to protect and restore wetlands and potential funding sources to help pay for the work (Section 5); and
- A recommended plan for public involvement that will address educational programs focusing on wetlands, and build a core of volunteers that will engage in a variety of activities as public service to protect wetlands resources. (Section 6).

This WAP was developed based on currently available information and may be revised when additional information becomes available.

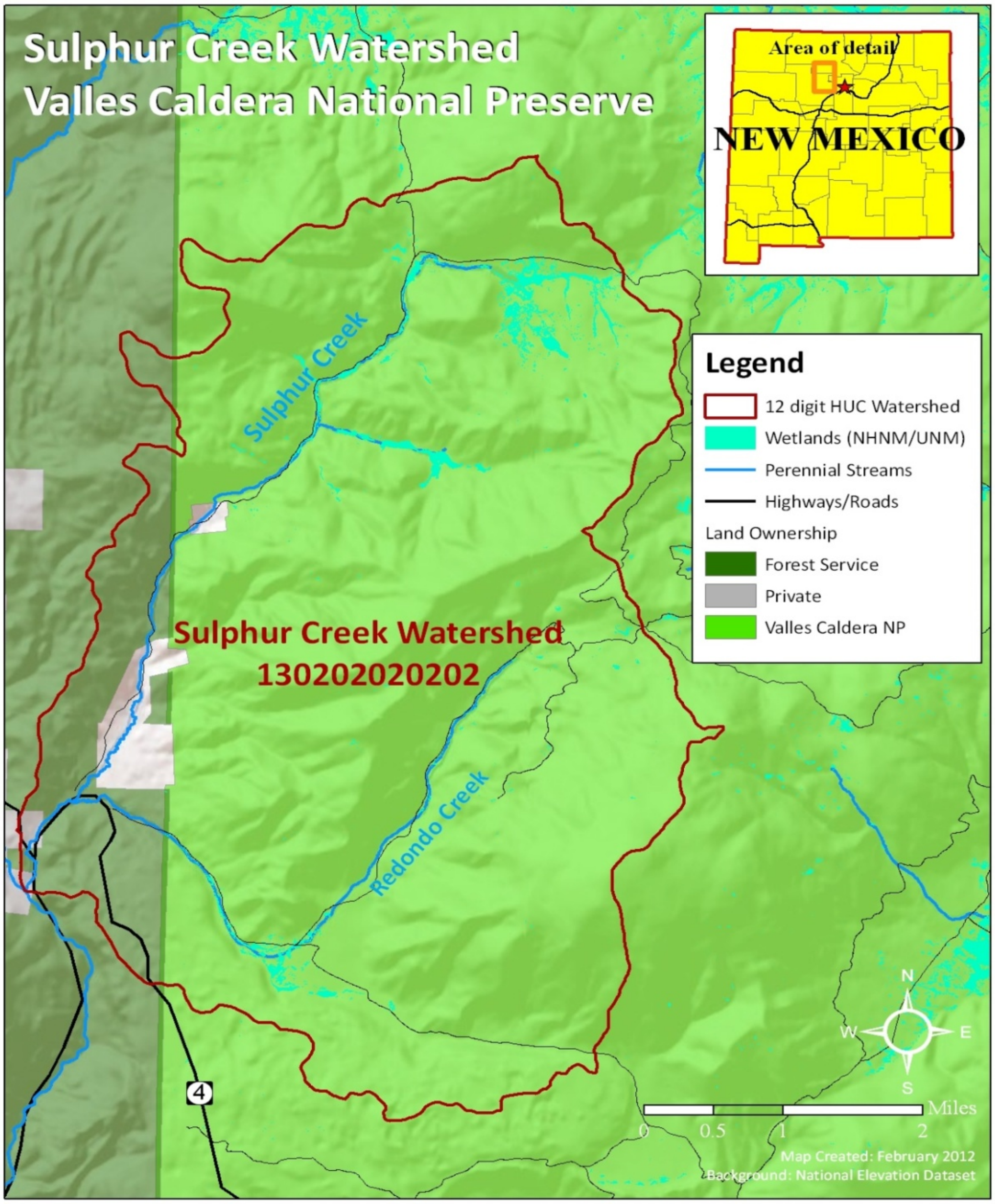

Figure 1-1. General Location Map

2. Sulphur Creek Watershed

Sulphur Creek Watershed is located in the VCNP in the Jemez Mountains and includes two perennial drainages and riparian corridors, Sulphur Creek and Redondo Creek. Sulphur Creek's main tributary is Alamo Canyon.

2-1. Physical Geography and History

The Preserve is located in the heart of the Jemez Mountains in Sandoval County, north central New Mexico and is surrounded principally by the Santa Fe National Forest. Bandelier National Monument abuts the Preserve on its southeast corner and Santa Clara Pueblo is situated on its northeast boundary. Los Alamos is located about 18 miles east of the Preserve headquarters. The watershed is contained within the 8-digit HUC 13020202. Elevations range from 8,000 to 11,000 feet. The Preserve was formerly the privately owned "Baca Ranch." The 89,000-acre property was purchased by the federal government in 2000 through the Valles Caldera Preservation Act and was managed by Valles Caldera National Trust for 15 years. VCNP became part of the National Park Service system on October 1, 2015 and has undergone new management changes, including the development of a Landscape Restoration & Stewardship Plan – Final Environmental Impact Statement (Valles Caldera Trust, 2015), and a current draft Foundation Document (Valles Caldera National Preserve, 2017) that addresses many land management and environmental issues on the Preserve.

Sulphur Creek Watershed is typical of many areas that have experienced intensive historical use of the landscape, including clear-cut timber harvesting, heavy livestock grazing (sheep, then cattle) and hydrothermal exploration. These activities resulted in the creation of numerous inadequately constructed and maintained roads, overgrazed grasslands, depleted vegetation in wetland and riparian zones, eroding stream banks and advancing headcuts throughout the watershed. The results of these land use practices led to an increased erosive tendency of the land. Many wetlands have become channelized with numerous gullies that lower the water table and desiccate the wetlands.

The rivers and streams of the Preserve are its lifeblood. Their health is a major indicator of the condition of the Preserve in general. With minor exceptions, the headwater streams that flow out from the Preserve are entirely contained within its boundaries, making the Preserve a self-contained watershed unit. With no other land or land managers upstream from the Preserve, any changes in the quality of water leaving the Preserve or in the ecological condition of its aquatic and riparian communities are wholly attributable to the interplay of human activities, ecological succession, geology, climate, and other natural processes occurring within the Preserve.

The basins of the Preserve contain many unique and uncommon aquatic and wetland features, ranging from warm and extremely acidic geothermal waters to numerous springs, seeps, and marshy wetlands. These water-rich environments, combined with the Preserve’s many creeks and streams, provide a robust foundation for the ecological diversity and productivity that characterize the Preserve.

The Preserve contains slope wetlands supported by seeps emanating from fractures present along the highest peaks. Slope wetlands are found where there is a discharge of groundwater to the land surface. Principal water sources are groundwater return flow and interflow from surrounding uplands as well as precipitation. Hydrodynamics are dominated by downslope unidirectional water flow. On the Preserve, slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland.

Approximately 27 miles of streams within the Preserve offer habitat suitable for trout. The most common impairment to these streams is a lack of pools due to sedimentation and stream channel profiles that are wider and shallower than they should be. Other stream segments within the Preserve, however, feature habitats that are in excellent condition and can serve as models for the eventual restoration of the impaired reaches.

2-2. Climate

Average temperatures in the Preserve are 22°F (-6°C) in January and 60°F (16°C) in July. Temperature extremes range from a high of 84°F (29 C) in summer to -30°F (-34°C) in winter. The average annual precipitation in the Preserve is approximately 24 inches with over 50% from summer rains, typically monsoons. Snowfall occurs in the watershed from approximately December through March, and in many locations, because of high elevation factors especially in north facing areas, roads are not passable until late April. (www.nps.gov/vall/planyourvisit/basicinfo.htm)

The New Mexico climate is historically variable with cycles of drought along with short-term storm events; conditions that are influenced by natural cycles such as el Niño/la Niña, the Pacific Decadal Index (PDO) and the Atlantic Multidecadal Oscillation (AMO). Weather records dating back to 1914 indicate warmer temperatures and drier conditions on the Preserve over the past century (VCNP, 2015). This trend is expected to continue. Scientists have identified the Southwest as a climate change hotspot—an area whose climate is particularly vulnerable to an increase in greenhouse gases in the atmosphere (Diffenbaugh et al. 2008). Effects of climate change that are predicted for the Jemez Mountains and throughout New Mexico include (Enquist et al., 2008; NMOSE/NMISC, 2006; USGCRP, 2009):

- Temperature is expected to continue to rise, resulting in increased evaporation and evapotranspiration.
- Precipitation is expected to be more concentrated and intense, so that increases in the frequency and severity of flooding are also projected.
- Streamflow is projected to decrease overall due to lower snowpack and higher evapotranspiration, and peak runoff will occur earlier and be diminished.

Additional stresses on wetlands due to increasing temperatures, evaporation, and intense precipitation events magnify the importance of protecting and restoring wetland resources. Wetlands provide buffering qualities to receiving streams. Wetlands also provide a mechanism for the subsurface hydrology to move slower through the system, and provide a barrier to moving sediment during flashy precipitation events.

2-3. Soils

Santa Fe National Forest soils were inventoried as ecological units in the Terrestrial Ecosystem Survey of the Santa Fe National Forest (USFS, 1993). This method considers soil genesis in an ecological context and combines the biotic and abiotic aspects of soils using climate and vegetation to form an ecological unit. Soil classification (USDA/NRCS, 1999), properties (USFS, 1985), interpretations, and productivity were measured and inferred through the assessment by TES. Scientific planning for soil conservation and water management requires knowledge of the relationships among those factors that cause loss of soil and water and those that help to reduce such losses (Renard et al, 1997).

The valley soils in the within the Preserve are an association of three dissimilar soils which occur in a repeatable pattern that can be discerned over the landscape (soil association). The soils extend from adjacent to the aquatic sources up slope to a drier upland position. This mapping unit includes a hydric soil (Cumulic Haplaquolls, fine-loamy, mixed) near the stream, an adjacent alluvial soil (Pachic Udic Haploborolls, fine-loamy, mixed), and a coarser textured hydric soil on alluvial benches and bars (Typic Haplaquolls, loamy-skeletal, mixed) (USFS, 1993). This soil has a high revegetation potential.

2-4. Effective Ground Cover and Riparian Vegetation

Soils within the Preserve are like soils in the surrounding Santa Fe National Forest. These soils have a potential for producing plant biomass. Within the broad valleys the dominant growth form is grass and forbs. Local effective ground cover varies and production of herbaceous vegetation is considerably below potential over wide areas of the Preserve (USFS, 1993). The vegetation map of the Preserve characterizes Montane Wet Meadows and Montane Wetlands as "*herbaceous vegetation of valley bottoms and* *swales dominated by grasses, rushes and sedges, many of which are either facultative or obligate wetland species."* (Muldavin et al., 2006)

Table 2-1.Plants Associated with Montane Wet Meadows and Wetlands in the Valle Caldera National Preserve (Muldavin et al., 2006)

Plant Alliance	Primary Components	Secondary Components	Inclusions
Montane Wet Meadow	Tufted Hairgrass-Woolly Cinquefoil Tufted Hairgrass-Baltic Rush Grassland Baltic Rush-Kentucky Bluegrass Kentucky Bluegrass-Common Dandelion	Tufted Hairgrass-Smallwing Sedge Pine Dropseed-Baltic Rush	Arizona Fescue - Kentucky Bluegrass Northwest Territory Sedge-Smallwing Sedge
Montane Wetlands	Northwest Territory Sedge-Smallwing Sedge Woolly Sedge-Common Spikerush	Northwest Territory Sedge-Longstyle Rush Water Sedge-Northwest Territory Sedge Tufted Hairgrass-Northwest Territory Sedge Kentucky Bluegrass-Common Dandelion	Tufted Hairgrass/Woolly Cinquefoil Baltic Rush-Kentucky Bluegrass Baltic Rush-Tufted Hairgrass Grassland Narrowleaf Burreed Herbaceous Alliance

Woody riparian plants found in the Jemez Mountains such as thin leaf alder, Bebbs willow, Mountain willow, and Narrow leaf cottonwood offer increased bank stability and riparian structure (Correll, 1972). Due to the low stream gradient in the valleys of the Preserve, woody plants might not be expected in the large open valleys; but as stream gradient increases the expectation of woody species should increase. These species are evident just off the Preserve on National Forest System lands and offer variety to the riparian/wetland ecosystem. Woody riparian vegetation on the Preserve is limited to the higher reaches in the watersheds and dominated by a few mature plants. Where woody vegetation is found, the plants show the effects of heavy browsing by elk (Figure 2-1). Much of this browsing occurs in the late winter and early spring, when the twigs of woody plants prepare for spring growth before the first grasses in the parks and meadows turn green. These woody stems offer rich nutrition at a time of year when other food in scarce. Before elk were present, it may be that sheep had the same effect. It is possible that these pressures, augmented by decades of ungulate grazing, have removed woody riparian vegetation from part of its natural range within the Preserve, but the limits of that range are not well understood.

Sulphur Creek currently has historic stands of woody vegetation at the headwaters in Valle Seco, in Alamo Canyon, and along the creek below Alamo Canyon.

Figure 2-1. An historic willow stand in Valle Seco that shows effects of heavy browsing by elk. In 2016 a protective exclosure was built around these willows.

There is a unique wetland complex in the Alamo Canyon tributary to Sulphur Creek that consists of a large grassy montane fen known as "Alamo Bog." Unlike other fens in the region, the fen is highly acidic as a result of sulfuric acid inputs from underlying warm springs. Over the course of 9,000-plus years, it has accumulated more than 12 feet of organic peat intermixed with sediments. In addition, the wetland complex also contains a bog birch (*Betula glandulosa*) community that is found nowhere else in New Mexico. Overall, this highly acidic and deep fen along with the bog birch make up a globally rare ecosystem type (Muldavin and Tonne, 2003).

2-5. Geology and Groundwater

The 1.25 million-year-old massive crater in the Valles Caldera (13-mi diameter) is the centerpiece of the Jemez Volcanic Field in north central New Mexico. This caldera, Valle Grande, was formed when the volcanic pile collapsed in response to a huge eruption of ash (Bandelier Tuff) from the magma chamber. Subsequent resurgence of magma formed domes along the caldera ring fracture, including Redondo Peak which is over 3000 feet above the caldera floor. Following the resurgence of Redondo Peak, the first of many eruptive flows from ring fractures in the caldera formed the dome at Cerro del Medio, followed by Cerro del Abrigo. This continued counter clockwise around the ring fracture creating the domes in the northern half of the Preserve; these eruptions periodically blocked flows from San Antonio Creek, forming a series of northern caldera lakes that would periodically drain as rising lake levels eventually breached the volcanic deposits.

From about 550,000 to 500,000 years ago, the southwestern portion of the Preserve experienced additional dome formation eruptions, creating Cerro la Jara and South Mountain. These eruptions plugged the outflow of the ancestral East Fork of the Jemez River, forming yet another deep, freshwater lake in what is now the Valle Grande. About 250,000 years ago, this lake breached, emptying the caldera of water and sediments and forming the San Diego Canyon to the southwest.

Approximately 55,000 years ago, an explosive eruption occurred in the southwest corner creating the crater known as El Cajete. The resulting pyroclastic flow filled in much of the Jemez River valley, and through subsequent erosion by the Jemez River, produced the striking landmark known as Battleship Rock where the waters from San Antonio Creek and Sulphur Creek meet the East Fork Jemez River. Then, about 40,000 years ago, the last known eruption produced the broad sloping landform in the southwest corner of the Preserve, known as the Banco Bonito. Valles Caldera, while not the largest, is one of the most intact calderas in the world, making it ideal for studying the complex geology of caldera formation. (Goff et al., 2011; Goff, 2009; Kempter and Huelster, 2016; VCNP, 2015.)

The mineralized and geothermal spring systems are caused by flow of groundwater through the caldera. The water flows near the top of a subsurface body of igneous rock that still may be partially molten. Some of the water rises to the surface to supply fumaroles and hot springs.

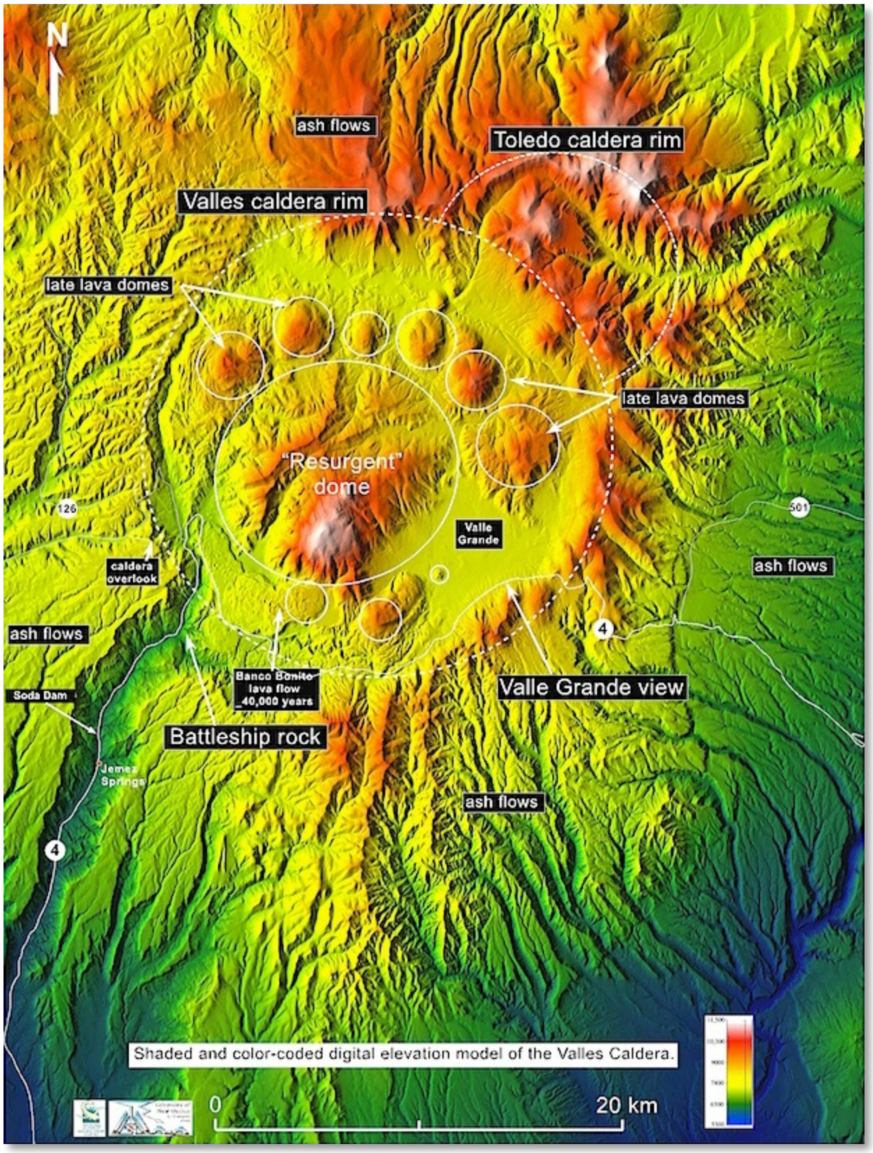

Figure 2-2. Aerial view of Valles Caldera National Preserve showing volcanic landforms that dominate the landscape (NM Museum of Natural History& Science, 2017).

2-6. Surface Hydrology

At various times during the geologic history, lakes have filled parts of the caldera, and the soils that formed from the sediments that collected beneath the lakes help account for the development of grassland valleys. The lake filling the Valle Grande breached the southern rim of the Valles Caldera, causing erosion that sculpted the present-day valley of the Jemez River (Reneau et al., 2007). The San Antonio Creek system flows south out of the northern portion of VCNP where is it is joined by the East Fork Jemez River. Sulphur Creek and Redondo Creek are tributaries to San Antonio Creek.

2-7. Water Quality and Condition of Rivers

Surface water in the Sulphur Creek Watershed has several water quality impairments as indicated by the Clean Water Act Section 303d list (NMED, 2016). See Table 2-2.

Table 2-2**.** Surface Water Quality Impairment in the Sulphur Creek Watershed

Location	Pollutant	First Listed	TMDL Date
Sulphur Creek	Aluminum- total rec.- chronic	2016	No TMDL in place
	pH	2016	No TMDL in place. TMDL written in 2002. Then SWQB broke Sulphur into 3 AU's, VCNP to headwaters – 2006 action. The aquatic life use was changed from high quality coldwater to limited aquatic life, thus removing the specific conductance criterion. Therefore, pH and specific conductivity were removed as causes of non-support and the associated TMDLs will be withdrawn.
	Temperature	2016	No TMDL in place
	Turbidity	2010	No TMDL in place
Redondo Creek	pH	2016	No TMDL in place
	Turbidity	2000	2003
	Temperature	2000	2003

Turbidity was identified as an impairment to Redondo Creek in 1998. In 2003, the NMED SWQB completed TMDLs for many of the reaches of the Jemez Watershed including those within the Preserve (NMED, 2003). Sulphur Creek was broken into three assessment units (AU), San Antonio Creek to Redondo Creek, Redondo Creek to VCNP boundary and VCNP boundary to headwaters. In each segment, pH exceeded the High Quality Cold Aquatic Life (HQCAL) criteria. Specific conductance, aluminum, and pH were listed as causes of non-support in 2008. In 2010, turbidity was added to this list. However, in 2012, NMED/SWQB changed the segment-specific criteria because the low pH is naturally occurring, which influences both specific conductance and aluminum. pH and specific conductivity were removed as causes of non-support, and the associated TMDLs withdrawn leaving turbidity as the sole cause of impairment.

The aquatic life use was changed from high quality coldwater to limited aquatic life and segment specific criteria. In 2016, aluminum- chronic and temperature were added as impairments for Sulphur Creek, and temperature was added for Redondo Creek (NMED, 2016). TMDLS have not been developed for the more recent impairment listings.

Potential sources of stream impairment are thought to be soil erosion resulting from a variety of natural and other activities such as grazing, recreation, stream bank modification/erosion, removal of riparian vegetation, silviculture, road construction and maintenance, channel widening, and other unknown causes.

The WRAS, prepared for the Jemez Watershed (Jemez Watershed Group, 2005) lists specific water quality problems; identifies sources of contamination causing those problems; and provides a schedule of action items to be undertaken to abate those sources along with estimated funding requirements to perform these actions. The Jemez WRAS does not have much information on the Sulphur Creek watershed; therefore, this WAP will update and fill gaps in that document.

2-8. Threatened and Endangered Species–Vegetation and Wildlife

The Jemez Watershed contains several unique species including Giant helleborine (*Epipactis gigantea)*, Bunchberry dogwood (*Cornus canadensis)* and Bog birch (*Betula glandulosa*). Sapello Canyon larkspur is the only sensitive plant species recorded within the Jemez Watershed. This is a New Mexico endemic found only at high elevations in the Jemez, Sangre de Cristo, and Sandia Mountains, and is listed by Natural Heritage New Mexico (NHNM) as a "Species of Concern." (NHNM, 2017) Bog birch, although a somewhat common species at higher latitudes of the U.S. and Canada is restricted in New Mexico to Alamo Canyon wetland complex on the west side of VCNP.

Currently there are a few non-native plants on VCNP deemed noxious in the state of New Mexico. The Preserve has a program to eradicate these plants: Canada thistle (*Cirsium arvense),* Bull thistle (*Cirsium vulgare),* Musk thistle (*Carduus Nutans*), and Oxeye daisy *(Leucanthemum vulgare)* (VCNP, 2017. Foundation Document).

Table 2-3 is a list of state and federally threatened and endangered animal species in Sandoval County. Note that this list covers the entire county rather than just VCNP.

Table 2-3.Threatened and Endangered Animal Species in Sandoval County, NM (BISON-M, 2017)

Threatened and Endangered Species in Sandoval County, NM			
	Common Name	**Scientific Name**	**Status**
Mammals	Spotted bat	*Euderma maculatum*	State NM: Threatened
	Pacific marten	*Martes caurina*	State NM: Threatened
	Meadow jumping mouse	*Zapus hudsonius luteus*	Federal: Endangered State NM: Endangered
Birds	Brown pelican	*Pelecanus occidentalis*	State NM: Endangered
	Common black hawk	*Buteogallus anthracinus*	State NM: Threatened
	Bald eagle	*Haliaeetus leucocephalus*	State NM: Threatened
	Peregrine falcon	*Falco peregrinus*	State NM: Threatened
	Arctic peregrine falcon	*Falco peregrinus tundrius*	State NM: Threatened
	Neotropic cormorant	*Phalacrocorax brasilianus*	State NM: Threatened
	Yellow-billed cuckoo (western population)	*Coccyzus americana occidentalis*	Federal: Threatened
	Mexican spotted owl	*Strix occidentalis lucida*	Federal: Threatened
	Broad-billed hummingbird	*Cynanthus latirostria*	State NM: Threatened
	Costa’s hummingbird	*Calypte costae*	State NM: Threatened
	Violet-crowned hummingbird	*Amazilia violiceps*	State NM: Threatened
	Southwestern willow flycatcher	*Empidonax traillii extimus*	Federal: Endangered State NM: Endangered
	Gray vireo	*Vireo vicinior*	State NM: Threatened
	Baird's sparrow	*Ammodramus bairdii*	State NM: Threatened
Fish	Rio Grande silvery minnow	*Hybognathus amarus*	Federal: Endangered State NM: Endangered

Amphibians/ Mollusks	Jemez Mountains salamander	*Plethedon neomexicanus*	Federal: Endangered State NM: Endangered
	Wrinkled marshsnail	*Stagnicola caperata*	State NM: Endangered
	Paper pondshell	*Utterbackia imbecillis*	State NM: Endangered

In addition to currently threatened and endangered species, several fish and wildlife species have been extirpated from their range in the Jemez Mountains or had their range significantly reduced over the last century. Extirpated species include Mexican gray wolf (*Canis lupus baileyi*), Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*), Northern leopard frog (*Lithobates pipiens*), and American beaver (*Castor canadensis*) (VCNP, 2010).

2-9. Land Use and Ownership

The Sulphur Creek headwaters and upper reaches of the watershed is public land, currently managed by VCNP, now part of National Park Service (NPS). Along lower Sulphur Creek there is a 40-acre private inholding within VCNP. This property is of interest to the NPS because of the unique geothermal and mineralized springs characteristics of this section. Elk Valley Property subdivision along lower Sulphur Creek is a residential/vacation home community with numerous private landowners. The lowest part of the watershed is public land administered by the United States Forest Service (USFS), Santa Fe National Forest, Jemez Ranger District. This WAP addresses most of the watershed that is owned and managed by the NPS.

Figure 2-3. 40-acre private inholding along lower Sulphur Creek.

3. Wetland Inventory

The National Wetlands Inventory was updated for wetlands in the Jemez Mountains in 2015. This WAP is being developed based on the most recent mapping and classification of wetlands in the Sulphur Creek Watershed, as described in Section 3.1.

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

Wetlands exhibit one or more of the following characteristics (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate predominantly consists of undrained hydric soil or contains hydric soil indicators and/or redoxymorphic features that indicate saturation periodically; and (3) at some period during the growing season of each year, the substrate is non-soil and either saturated with water or covered by shallow water. Because of the climatic variability of New Mexico which sometimes includes long periods of drought that dry up even the most persistent water sources, wetlands are not expected to be saturated each year.

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

3-1. Wetland Mapping and Classification

NMED updated the National Wetland Inventory for the Jemez Mountains as part of ongoing efforts that will eventually provide updates for the entire state excluding tribal lands. Previous wetland mapping in New Mexico was sparse and dated. NMED contracted with GeoSpatial Services of Saint Mary's University of Minnesota to complete the Geographic Information System (GIS)-based mapping. A report titled "Mapping and Classification of Wetlands in the Jemez Mountains" includes updated mapping and classification for VCNP (Stark et al., 2016).

Wetlands for the project area were mapped and classified using on-screen digitizing methods established in GIS. Aerial imagery, combined with soils, topographic, hydrologic, and land cover data sets, was used as a base map (Stark et al., 2016). The mapping performed by Saint Mary's University is consistent with the Wetlands and

Deepwater Habitats Classification used for the National Wetland Inventory (NWI), which classifies wetlands by system (Cowardin et al., 1979).

Three systems are present in the Jemez Mountains mapping area:

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

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

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

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

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

Detailed mapping for each of these NWI classifications is available on the NWI Mapper website: https://www.fws.gov/wetlands/data/mapper.html.

3-2. Hydrogeomorphic Classification

In addition to the NWI system, other systems of wetlands classifications are commonly used to distinguish various types and characteristics between wetland resources. The SWQB Wetlands Program uses Brinson's Hydrogeomorphic (HGM) wetland classification (Brinson, 1993) for the Wetlands Action Plan process, because this classification system is the easiest to understand. The HGM classification system, based on geomorphic settings, water sources, and hydrodynamics, results in 6 wetlands classifications based on these 3 essential functions (NMED, 2016). Four of these systems are present in the Sulphur Creek Watershed:

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

Figure 3-1. Riverine wetlands in the watershed typically consist of narrow bands along Redondo and Sulphur Creek where it is not too incised. Photo courtesy of WildEarth Guardians.

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

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

Figure 3-2. Depressional wetlands in Alamo Canyon. Depressional wetlands in the watershed occur as small historic stock ponds.

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

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

Figure 3-3. Slope wetlands in Tributary 1 of Valle Seco (2012) prior to restoration (thin ribbon of dark green in center of photo). Construction of water-spreading structures (e.g. plug and pond structures, worm ditches and media lunas) subsequently expanded the slope wetland acreage across the valley.

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

Figure 3-4. Palustrine (pond) fringe wetlands around a large stock pond in Valle Seco that is frequented by water fowl. Raising the spillway level by six inches with a one-rock dam expanded these wetlands.

A total of 115 acres of wetlands were mapped in the Sulphur Creek Watershed. See Figures 3-5, 3-6 and 3-7. Table3-1 shows the number of acres and relative percentages of HGM classes of wetlands. Most of the wetlands in the watershed are slope wetlands (60 acres- 52.2%) that occur on hillsides or on the valley floor. Riverine wetlands (45 acres- 39.4%) occur along Sulphur and Redondo creeks and in Alamo Canyon. Depressional wetlands (10 acres- 8.4%) include small ponds located throughout the watershed. Palustrine (Pond) Fringe wetlands occur around the small ponds, but these are too small to appear as discrete polygons. It should be noted that this mapping represents 2014 conditions and does not reflect increases in wetland acreage that were created in 2014-2017 through active wetland restoration work discussed in Chapter 5.

Table 3-1. HGM Classes in Sulphur Creek Watershed

HGM Class		
HGM Class	Acres	Percent
Slope	60	52.2
Riverine	45	39.4
Depressional	10	8.4
Total	115	100

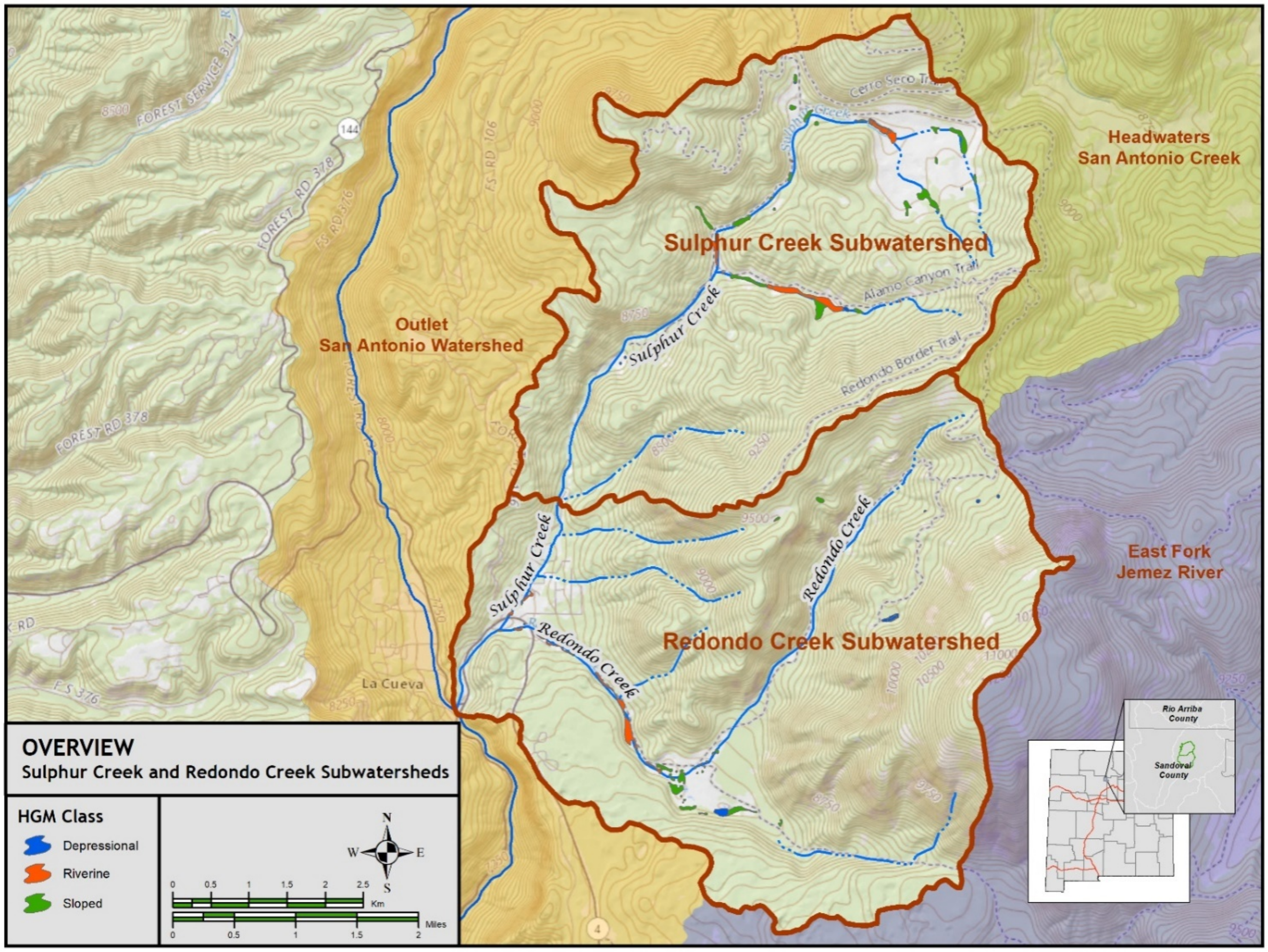

Figure 3-5. Overview of Wetlands in the Sulphur Creek Watershed

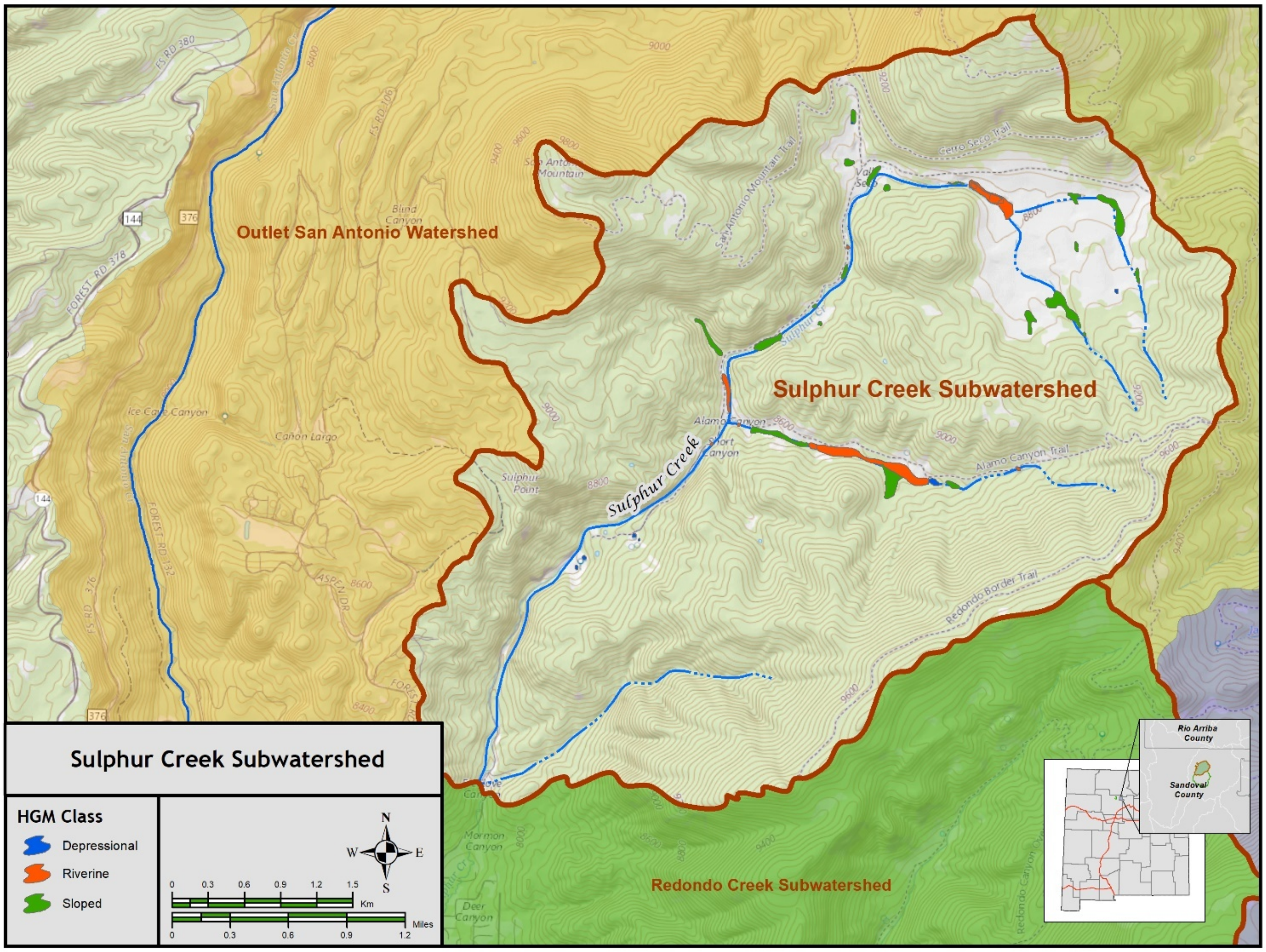

Figure 3-6. Mapped Wetlands Along Sulphur Creek

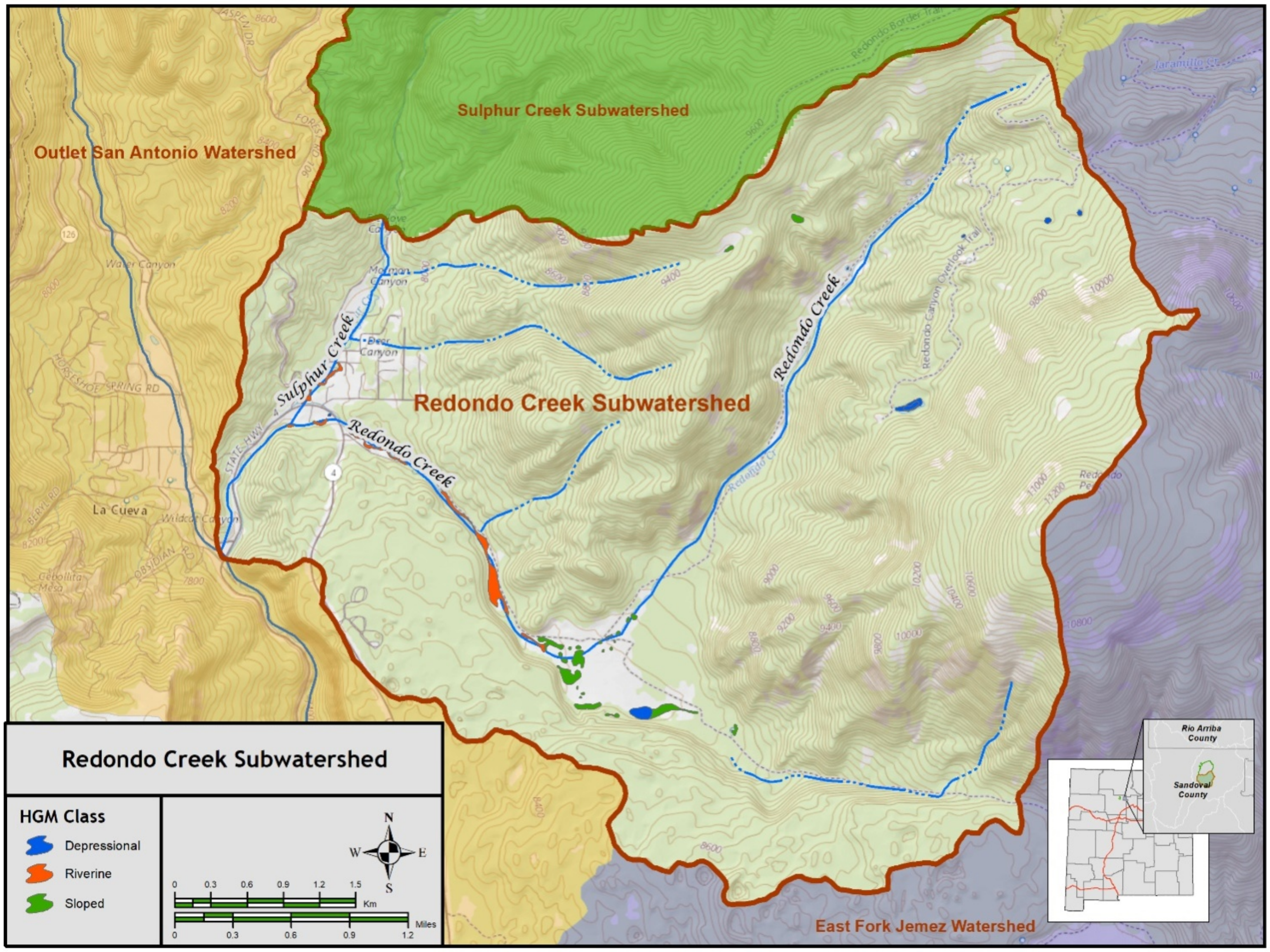

Figure 3-7. Mapped Wetlands along Redondo Creek

3-3. Wetland Functional Assessment

A wetland functional assessment was completed as part the Jemez wetlands mapping project. Wetland functions that were assessed within the project study areas include the following (Stark et al., 2016):

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

Results from the wetland functional assessment indicated that carbon sequestration, nutrient transformation, streamflow maintenance, waterfowl and waterbird habitat, and other wildlife habitat are the most commonly occurring wetland functions in the project area.

3-4. Information Gaps

The primary data gap related to the Sulphur Creek Watershed wetlands is the current lack of detailed field assessment for the Redondo Creek area. Reference conditions were not established for the watershed as part of this WAP. The purpose of establishing reference conditions is to attempt to determine the state of the watershed area prior to any development or anthropogenic interference. No rapid assessment methods have been performed on wetlands in the watershed, and will probably not be performed until NMED has developed a method for slope wetlands.

4. Wetland Threats and Impairments

Many of the threats and impairments to wetlands in the Sulphur Creek Watershed were due to historic land uses and practices. Some of these uses persist, although in most cases the uses have ceased while the impairments remain.

4-1. Roads

There are many historic two track roads on VCNP that run through wetlands or along the valley floors adjacent to wetlands, as well as a network of roads in the forested areas that were created and used for timber extraction. These roads have captured and concentrated water, resulting in erosion and desiccation of wetlands. The modern roads are better, but some are still a cause for concern with respect to wetlands and fisheries habitat degradation (Zeedyk and Vrooman, 2017).

4-2. Livestock and Wildlife Grazing

Grazing on the Baca Ranch occurred since late in the 19thcentury. Sheep were grazed until about 1940, when cattle were introduced. There are about 30,000 acres of grassland on the Preserve. During the 1950-1960s, approximately 12,000 head of cattle grazed on the Baca Ranch annually. From the late 1960s through 1999 approximately 5,000-6,000 head were grazing the grasslands annually (Anchuetz and Merlan, 2007). When the Valles Caldera National Trust took over management of the Preserve in 2000, livestock grazing continued as part of the experimental management policy but with reduced numbers. Approximately 700 head of cattle grazed each year between 2000 and 2016. Currently, cattle grazing is not permitted in the Sulphur Creek Watershed. This is a recent development (2016) and the wetlands are now just starting to recover from historic grazing effects. (personal communication, Jorge Silva-Bañuelos, Superintendent VCNP, 2017)

Large Elk herds on VCNP have also impacted wetlands by disturbing soil, wallowing and overgrazing in riparian areas. Overgrazing reduces wetland vegetation and initiates or exacerbates erosion, including the development of headcuts and pedestals in wetlands and the decimation of woody vegetation (Zeedyk et al., 2014). However, even though the elk herds are large in the Preserve, elk move more frequently than cattle do, due to predation.

Figure 4-1. Elk grazing in the Sulphur Creek Watershed.

Figure 4-2. Cattle grazing in Valle Seco, July 2015.

4-3. Beaver Extirpation

Beavers were present historically in the Valles Caldera area as indicated by a 2006 survey (Sperry et al., 2006). Beaver trapping was an historic economic activity that decimated beaver populations. In Sulphur Creek, there are intact beaver dams, beaver-gnawed stumps and downed trees, but beaver are no longer present in the watershed. Beaver dams provide many benefits including: improving water quality, storing surface water and ground water, reducing downstream flood impacts and providing habitat to diverse terrestrial, avian and aquatic species. There is a strong correlation between the presence of beavers and the health and abundance of wetlands; conversely, wetlands areas can become degraded as the water table drops after beaver dams are removed from an area. The extirpation of beavers from the Sulphur Creek Watershed indicates the loss of these ecosystem services.

Figure 4-3. In this April 2013 photo, historic beaver activity is visible along lower Sulphur Creek where old beaver dams appear as berms across the creek valley. Photo courtesy of WildEarth Guardians.

4-4. Wildfire/Post-Fire Flooding, Erosion and Sedimentation

Wildfires can cause water quality impairments, particularly turbidity, sedimentation, and temperature impacts. The Thompson Ridge fire occurred in June 2013. The fire was human-caused and burned 23,965 acres of grass, ponderosa and mixed conifer within the fire perimeter (InciWeb, July 3, 2013).

The fire burned patches throughout Redondo Creek subwatershed, and included the east side of the Sulphur Creek subwatershed. The west side of the Sulphur Creek watershed was not burned. The burn intensity map (Figure 4-4) shows 74% low/unburned severity; 23% moderate severity; and 3% high severity. Many areas in the watershed were not burned at all.

“The BAER assessment team evaluated soil burn severity and slope topography to identify opportunities for hillslope treatment to reduce the likelihood of erosion, sedimentation and flash flooding from the Thompson Ridge burned area. The team also identified roads within, adjacent to and downstream from the burned area needing emergency response actions. BAER archeologists recommended emergency stabilization treatments for cultural resources within the burned area that may be impacted by increased run-off and soil erosion.” (Inciweb, July 31, 2013)

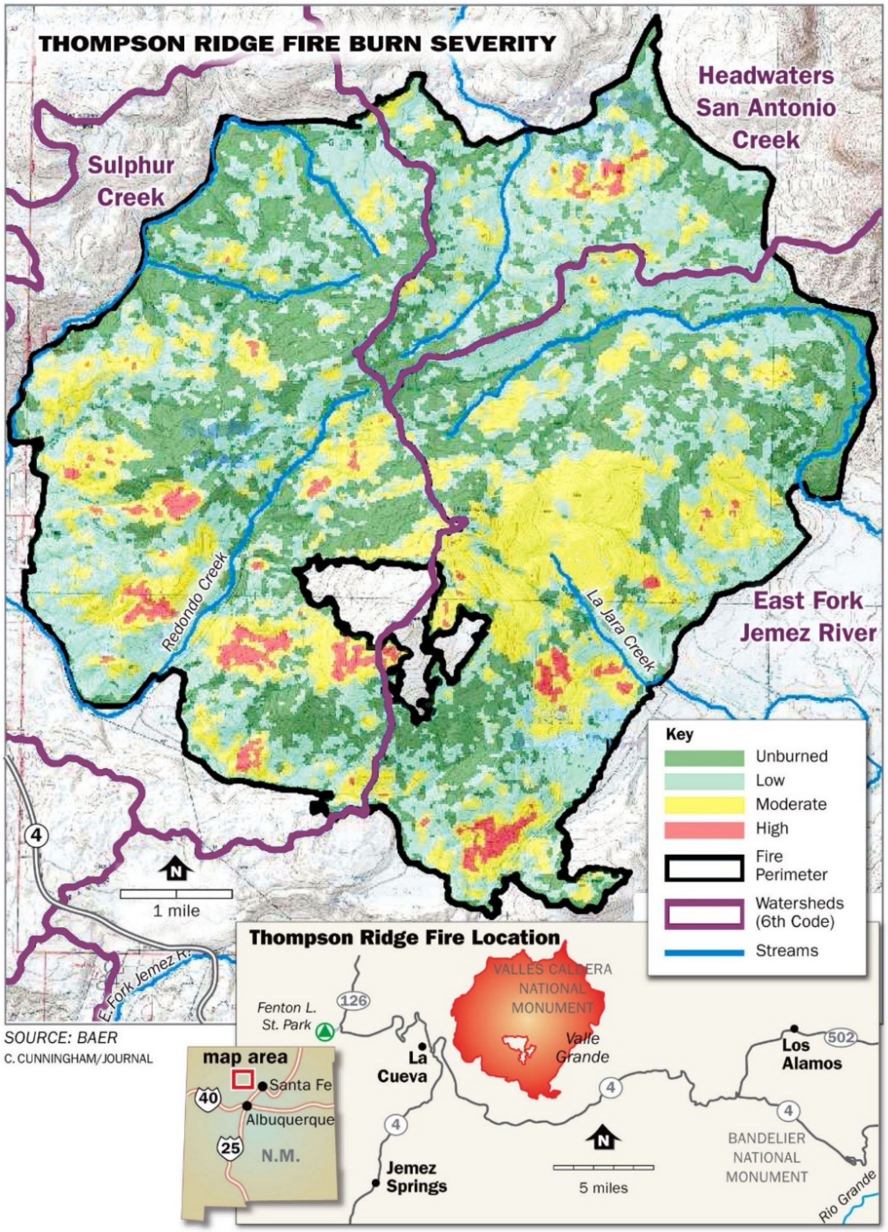

Figure 4-4. The Thompson Ridge fire burn severity map shows that the high severity burn areas were in the high elevation forested areas, which affects runoff to the wetlands. The wetland areas were not directly burned (Inciweb, July 31, 2013)

Figure 4-5. Thompson Ridge Fire, June 11, 2013 burning on Redondo Peak. Photo courtesy of WildEarth Guardians.

Figure 4-6. Scour along Redondo Creek that occurred from post-fire flooding after the Thompson Ridge fire. Photo courtesy of WildEarth Guardians.

Figure 4-7. Sediment deposition along Redondo Creek after the Thompson Ridge fire. Photo courtesy of WildEarth Guardians.

In June 2017, a smaller wildfire occurred east of the Sulphur Creek watershed. It was called El Cajete fire and burned approximately 1,400 acres. Fire conditions occur when soil and air humidity is low, plant conditions are dry and as is typical in this area in the spring, winds that fuel wildfires.

4-5. Geothermal Energy Development

The only known high-temperature geothermal system in New Mexico is found on the southwest side of Redondo Peak, a resurgent dome in the Preserve. The Valles reservoir is under pressured and liquid-dominated with a base temperature in excess of 260^{o}C (500^{o}F). Locally, small vapor-dominated systems overlie the liquid dominated system; where, boiling and permeability is lower (Goff, 2002). In the 1970s and early-1980s, the Baca Land and Cattle Company and UNOCAL Geothermal performed exploration and drilling on the Valles geothermal system. In 1977, a 50- MWe power plant was proposed as a part of collaboration of UNOCAL Geothermal, Public Service Company of New Mexico (PNM), and the U.S. Department of Energy (USDOE). Geothermal energy exploration left numerous earthen modifications, sometimes massive, in Redondo Canyon and Sulphur Canyon. Geothermal well pads were carved into the mountainsides and exploration activities damaged sites with unique geothermal resources. In 1982, the project was terminated due to a failure to obtain the necessary fluid production from drilling and from various disputes over land and water use. Since 1982, strategic parts of the Valles system were drilled as a part of the Continental Scientific Drilling Program (CSDP) (Goff and Nielsen, 1986), including bore holes along

Sulphur Creek and in Alamo Canyon. Future geothermal development of the Valles geothermal system is uncertain, although it would likely occur outside the boundaries of VCNP.

4-6. Silviculture

Forested areas of the Preserve consist primarily of Ponderosa pine (*Pinus ponderosa*) and at higher elevations White fir (*Abies concolor*) and a mix of spruce (*Picea spp*.), Quaking aspen (*Populus tremuloides*), and Douglas fir (*Pseudotsuga menziesii*). High quantities of timber harvesting occurred on the Preserve, which equated to over 60% of the forested acreage within the last 70 years (Anchuetz and Merlan, 2007). The forests that were logged in the past were replanted with young trees, which have resulted in single-age group stands.

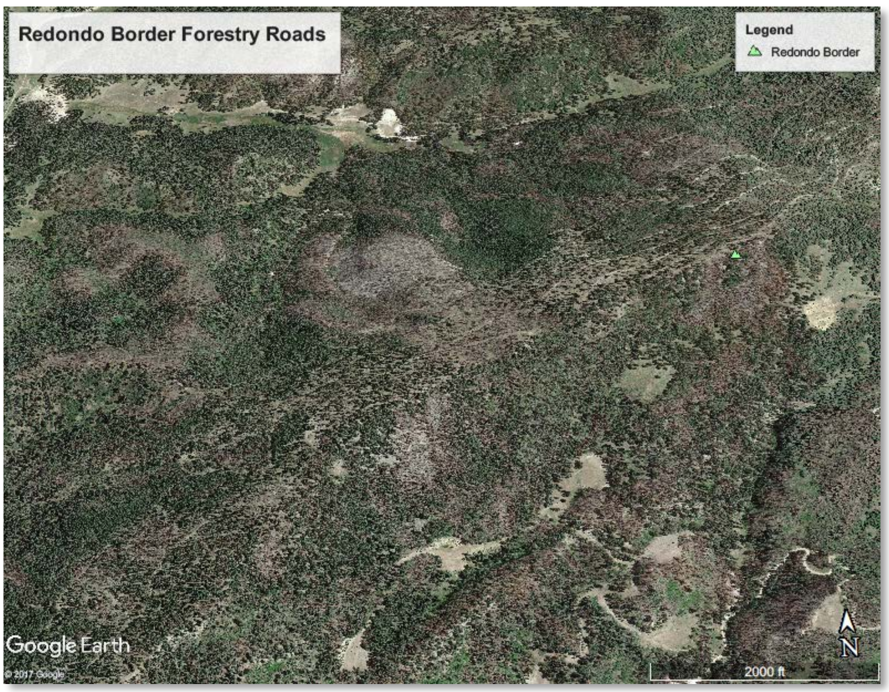

Figure 4-8. The Redondo Border ridge between Alamo Canyon (top of the photo) and Upper Redondo Creek (bottom right) has numerous logging roads that illustrate the extent of historic timber harvesting. The roads are shown as light brown lines running NE to SW. This photo also shows Thompson Ridge burn areas in dark brown.

4-7. Earthen Tanks and Dams

There are several historic stock tanks in the watershed. The stock tanks have earthen dams that capture surface and ground water flow that would otherwise hydrate slope wetlands. Although water leaks through the dams, the slope wetlands are somewhat desiccated downstream of the tanks. Spillways of some of tanks have eroded and caused gullies to form downstream. Despite being detrimental to wetlands, the tanks provide important open-water habitat for amphibians and water fowl, as well as a reliable source of drinking water for wildlife. VCNP staff are currently surveying these tanks throughout the Preserve.

5. Actions to Protect and Restore Wetlands

5-1. Past Wetland and Riparian Restoration Projects.

Several projects and activities have been undertaken to protect and restore wetlands in the Sulphur Creek Watershed within the past decade.

Alamo Canyon Project (Project Title: Restoring Wetlands and Wet Meadows on the Valles Caldera National Preserve.)

In 2007-2008, Los Amigos conducted an innovative wetlands restoration project in Alamo Canyon. Geothermal exploration conducted in the past created steep, eroding slopes due to road development and well pads that were depositing sediment to the valley. This was the first project that Los Amigos and NMED applied innovative structures used to control erosion, reverse headcutting and gullying and protect and restore wetlands including fens. See Figure 5-1. The restoration design was created by Zeedyk Ecological Consulting. Table 5-1 summarizes the structures built.

Figure 5-1. Media luna on the main well pad in Alamo Canyon, 2010. Photo courtesy of Steve Vrooman.

Table 5-1.Wetland Restoration Structures Built in Alamo Canyon

Structure Type	Number of Structures
Rock Rundown	7
Media Luna	9
One Rock Dam	24
Zuni Bowl	14
One Log Dam	3
Rolling Dip (road drain)	23
Large Rock rundown (spillway from well pad)	2

The project included construction of exclosures by volunteers to protect habitat for the rare Bog birch (*Betula pumila*); 35 people participated in this endeavor. See Figures 5-2 and 5-3. The project was funded by federal CWA Section 104(b) (3) Wetlands Program Development funds.

Figure 5-2. Los Amigos de Valles Caldera volunteers installing fence to protect Bog birch.

Figure 5-3. Regeneration of Bog birch.

Lower Sulphur Creek Riparian Planting

In 2012-2013, WildEarth Guardians constructed elk exclosures and planted woody vegetation species along Sulphur Creek downstream of Alamo Canyon. At this location, there are intact (but unoccupied) beaver ponds. The project was funded by the State of New Mexico River Ecosystem Restoration Initiative (RERI).

Figure 5-4. Elk exclosure along Sulphur Creek below Alamo Canyon.

Redondo Creek Riparian Planting

In 2010-2013, WildEarth Guardians constructed elk exclosures and planted woody vegetation species along two miles of Redondo Creek. Fifteen large exclosures and several small exclosures were constructed; 15,000 willows, 600 cottonwoods, and 500 riparian forage species were planted. The project sustained moderate damage following large flows post-Thompson Ridge Fire, including altering the channel and its streambanks, causing planted vegetation to be washed away, and damaging the exclosures. The project was funded by State of New Mexico RERI funds.

Figure 5-5. Elk exclosure along Redondo Creek.

In Spring of 2017 WildEarth Guardians received funding from Collaborative Forest Restoration Program (USDA) to improve the work they had done earlier on the downstream section (USFS) of Redondo Creek that had been damaged by post-Thompson Ridge Fire flooding. This project was also focused on protecting the federally endangered listed New Mexico Meadow jumping mouse (*Zapushudsonius luteus*).

Redondo Creek Culvert Replacement/Wetland Expansion

In 2013, WildEarth Guardians and Stream Dynamics, Inc. reconnected an abandoned, historic portion of the Redondo Creek channel to the main channel thereby directing a majority of the surface water flow away from a diversion channel and road into an approximately 24-acre drained wetland/wet meadow complex. This hydrological reconnection aids in aquifer recharge and flood attenuation, and is expected to increase base flow during the low-flow summer months in the lower portions of Redondo Creek by slowly releasing stored groundwater into the system. The project was located near the junction of Road VC02 and VC03, and was funded by federal North American Wetlands Conservation Act (NAWCA) funds.

<u>Thompson Ridge Fire Burned Area Emergency Response (BAER)</u>

Post-Thompson Ridge Fire BAER treatments were completed by July 13, 2013 and included cutting and removing burned trees near roads and buildings throughout the burned area including the historic cabins in VCNP. The trees were anchored into place to serve as barriers to redirect flood waters and debris away from the cabins. Debris was removed from creeks, streams, roads and arroyos. This wildfire occurred before the expected monsoon and floods carrying ash, sediment and debris would be hazardous. Scheduled aerial rehabilitation operations dropped seed over specified areas above homes in the Sulphur Creek area. The seed mix included annual barley. Water control features were placed on roads and trails to minimize damage and log trash racks were installed in Sulphur Creek to catch post-fire debris (InciWeb, July 31, 2013).

Figure 5-6. Trash rack built by the BAER Team to catch debris along lower Sulphur Creek after the Thompson Ridge Fire. Photo courtesy of Jim Counce.

Innovative Restoration of Wetlands Along Sulphur Creek

In 2014-2017, NMED Wetlands Program and Los Amigos restored 41.6 acres of slope wetlands in Valle Seco and along upper Sulphur Creek using innovative water-spreading and erosion control techniques and with funds from EPA Region 6 Wetlands Program Development Grant awarded to NMED Wetlands Program. Thirty-two “plug and pond” structures were built. Eighty-six ancillary structures were also built, including: plug and spread structures, rock or sod Zuni bowls, one rock dams, rock rundowns, rock laybacks, media lunas, contour swales, media lunas, rock laybacks, rolling dips, bypass channels, and tree felling. The project repaired incised channels and numerous headcuts to slow the flow of water, spread the water, raise the water table to re-hydrate historic wetlands, and increase water storage in the wetlands.

The project included constructing a grazing exclosure around a rare stand of Bebb’s willows in a slope wetland at the top of Valle Seco. The project also included work on two stock tanks, fixing the spillways so that erosion no longer occurs, and wildlife can reap the benefits of these open water areas. This project is the subject of a technical guide titled: *The Plug and Pond Treatment: Restoring Sheetflow to High Elevation Slope Wetlands in New Mexico* (Zeedyk and Vrooman, 2017) which was also funded through NMED Wetlands Program by EPA Region 6 Clean Water Act Section 104(b)(3) funds.

Table 5-2. Wetland Restoration Structures Built at Sulphur Creek

Structure Type	Number of Structures
Bypass channel	1
Contour swales	20
Low water crossing	2
Media Luna	3
One rock dam	30
Plug and pond	32
Plug and spread	2
Rock layback	1
Rock rundown	7
Rock Zuni bowl	10
Sod Zuni bowl	3
Tree felling (multiple trees)	1

Worm ditch	5
Bebb’s willow exclosure	1
Rolling dip	7

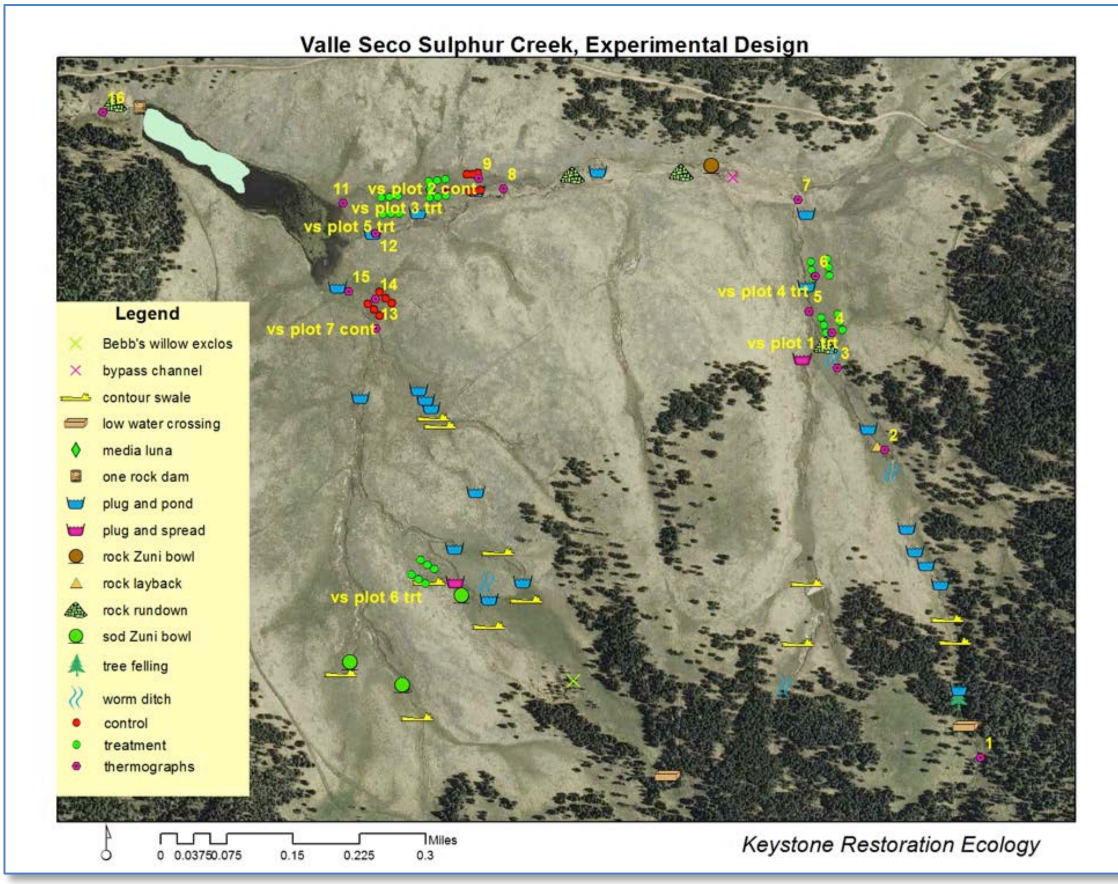

Figure 5-7. Map showing locations of treatments and monitoring sites in Valle Seco.

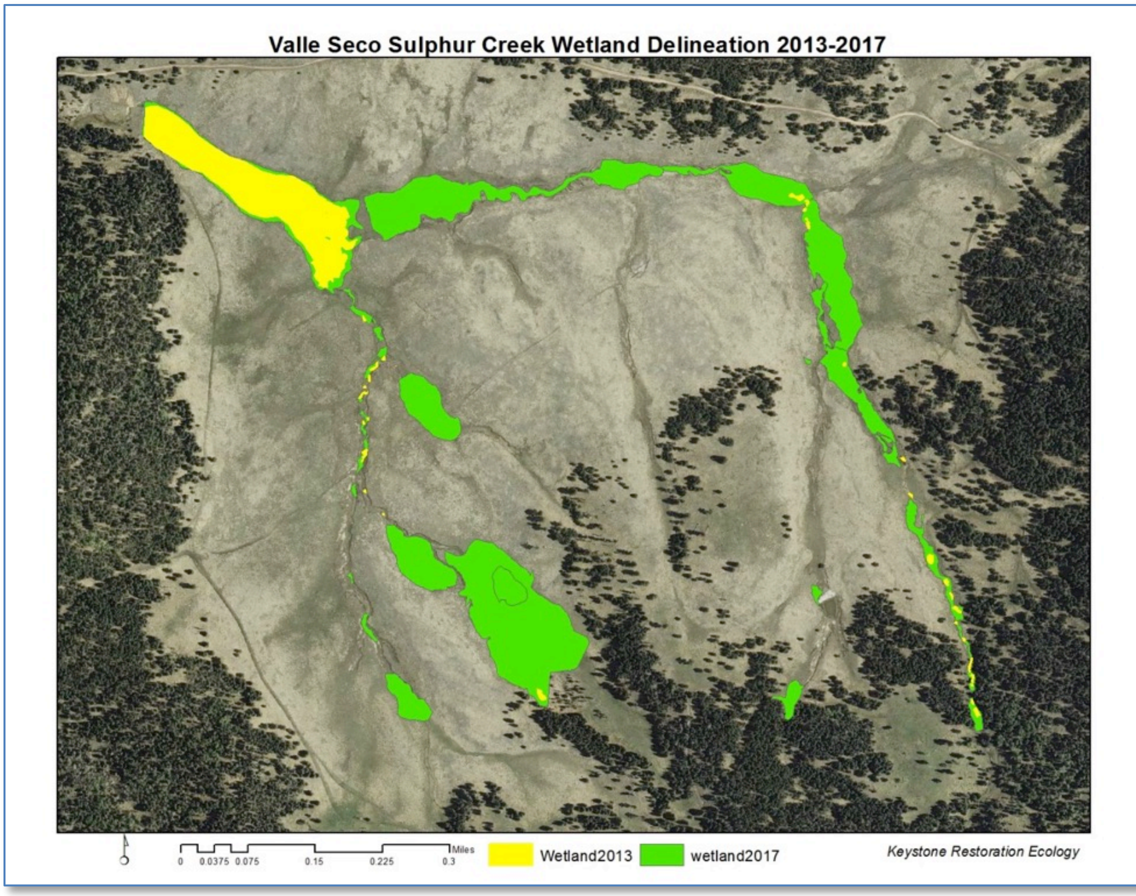

Figure 5-8. Map showing wetlands before and after treatment in Valle Seco.

Figure 5-9. Plug and pond treatment in Valle Seco just after construction. Photo courtesy of Steve Vrooman, 2016.

Figure 5-10. Volunteers building a media luna along Sulphur Creek. Photo courtesy of Albuquerque Wildlife Federation.

VCNP Cattle Grazing Policy

The history of the Preserve chronicles cattle grazing operations during the last century. Cattle grazing as it was done in the past has contributed to soil erosion loss of riparian vegetation, and stream and wetland degradation. In 2016, VCNP changed the cattle grazing policy for the Preserve. In 2017, the Preserve issued a 'request for application' for the grazing program. They have authorized the number of cattle to 257 animal units/month based on forage consumption data, 40% consumption is allowed. The grazing fee is also increased to $20.00 AU/M. Most of the grazing will be located at Rincon de los Soldados and the Valle de los Posos, the eastern flank of the Preserve, There is to be no cattle grazing at any riparian site in the Preserve. However, there are still issues with trespassing cattle. All cattle have been removed from the Sulphur Creek Watershed and there are no plans to permit future cattle grazing in the area (personal communication, Jorge Silva-Bañuelos, Superintendent, Valles Caldera National Preserve, 2017).

VCNP Wildfire Mitigation

Treatments to alleviate future wildfires include thinning of dense Ponderosa Pine (Pinus ponderosa) stands with follow-up prescribed fires when conditions allow. At present, the Cerro Seco is undergoing thinning management treatment. VCNP, 2017 Foundation Document (draft).

5-2. Land Stewardship Plan

VCNP wrote a June 2014, Landscape Restoration & Stewardship Plan – Final Environmental Impact Statement in order to satisfy National Environmental Policy Act requirements for a broad spectrum of future restoration activities (VCNP, 2015). For riparian and wetland restoration, the plan includes the following:

"*In combination with road management actions as described above, we are also proposing to restore wetland and riparian areas throughout the Preserve. The objectives of this restoration work are to optimize interflow; minimize overland flow; increase base flow; reduce sediments, dissolved oxygen and other water quality impairments; and reduce stream temperatures. The wetland and wet meadow systems containing the Preserve's riparian areas and streams comprise just over 6,800 acres, mostly within the open vale systems. Restoration activities would include:*

- *Restoring streambanks and channels to address site-specific erosion.*
- *Planting trees and shrubs.*

- *Placing of rock or log and fabric dams, or using Zuni bowl techniques to protect and restore wetlands and mitigate ongoing erosion.*

- *Removing road and water control features to restore wetlands.*

- *Repairing or decommissioning earthen tanks and dams.*

- *Installing weirs or channel modifications to slow the development or reduce the consequences of meander cutoffs.*

Many water quality and stream condition issues are addressed through the treatment of forests, grasslands, and road management actions. The priority for riparian restoration is to continue ongoing restoration in San Antonio, Sulphur, and Redondo creeks within the San Antonio and Sulphur 6th code watersheds, especially post Las Conchas fire rehabilitation in Indios and San Antonio creeks. As additional funding is available, the trust would begin restoration actions in Jaramillo and the East Fork of the Jemez River."

5-3. Specific Wetland Restoration Actions for Sulphur Creek Watershed

Table 5-1 offers a summary of specific actions in the watershed that complement prior restoration projects and are consistent with VCNP's Landscape Restoration and Stewardship Plan – Final Environmental Impact Statement (VCNP, 2015). The actions are further described in narrative below.

Table 5-3. Sulphur Creek Watershed Threats/Impairments and Protection/Restoration Actions

	Location	Threat/Impairment	Protection/Restoration Action
1.	Valle Seco Tributary 3	Captured water Channelized flow Headcutting Gully formation Desiccated wetlands	Water-spreading and erosion control structures, such as: plug and pond structures, one rock dams, worm ditches, contour swales, Zuni bowls, media lunas; ongoing monitoring and maintenance of prior Valle Seco wetlands restoration work
2.	Sulphur Creek private inholding – hydrothermal area	Property has buildings and vehicles that are falling into disrepair and may emit pollutants into nearby wetlands	Assessment needed of this area to determine actions

	Location	Threat/Impairment	Protection/Restoration Action
	downstream of Alamo Canyon		
3.	Redondo Creek and wetlands restoration	Water quality impairments, turbidity and temperature.	In-channel measures, such as post vanes, baffles, one rock dams, media lunas, willow planting or other measures that will improve bank stability, slow and redistribute flows, and reconnect channels with floodplains to prevent erosion and sedimentation in wetland areas.
4.	Redondo Creek riparian vegetation	Water quality impairments, turbidity and temperature	Woody plant species would provide shade Reduce sediment to the stream Encourage diverse species including beavers.
5.	VC08 Road	Poor road maintenance Channelized flow accelerating bed and bank erosion Sedimentation in wetlands	Poorly designed roads may be restored through realignment, porous fill for road crossing, proper drainage, and other methods (Zeedyk et al., 2014; Zeedyk, 2006).
6.	Alamo Canyon Road	Poor road maintenance Channelized flow accelerating bed and bank erosion Sedimentation in wetlands	Road closure except for emergencies and bicycles
7.	VC06 Road above Valle Seco	Poor road maintenance Channelized flow accelerating bed and bank erosion Sedimentation in wetlands	Road closure except for emergencies

	Location	Threat/Impairment	Protection/Restoration Action
8.	Forested areas, including Thompson Ridge fire burn areas	Wildfire threat or sedimentation from burn areas	Forest thinning Prescribed burns

Valle Seco-Tributary 3

Considerable wetlands restoration work was accomplished in Valle Seco in 2013-2017 and the methods used have been demonstrated to be effective. Tributary 3 of Valle Seco was treated but there are remaining channels, gullies and headcuts that have dessicated the wetlands. Existing wetlands in Tributary 3 are at risk of drying as well. Tributary 3 should be treated with the methods described in *The Plug and Pond Treatment: Restoring Sheetflow to High Elevation Slope Wetlands in New Mexico,* including plug and pond structures and ancillary structures. In addition, ongoing monitoring and maintenance of the 2013-2017 wetlands restoration work in Valle Seco is recommended.

Sulphur Creek Private Inholding Assessment

The private inholding is shown on Figure 1-1 as private property shaded light gray within the Valles Caldera National Preserve boundary. Sulphur Creek flows through the northwest side of the property, and there appear to be seeps, springs, and spring-fed ponds on the property. There are abandoned buildings, vehicles, and debris piles of unknown substances. The National Park Service has considered acquiring the property but a property transaction has not occurred to date. Because the impacts of historical property use have had an unknown effect on wetlands and water resources, it is recommended that an environmental assessment be performed on the property. Mitigation actions would follow the recommendations of such assessment.

Redondo Creek- Wetlands and Creek Restoration

Recommended actions for Redondo Creek include: rewetting historic wetlands, constructing instream and bank stability structures along the creek, and planting woody riparian vegetation along the creek. The Redondo Meadows wetland complex area should be treated with the methods described in *The Plug and Pond Treatment: Restoring Sheetflow to High Elevation Slope Wetlands in New Mexico,* including plug and pond structures and ancillary structures. In addition, in-channel measures, such as post vanes, baffles, one rock dams, media lunas, willow planting or other measures will improve bank stability, slow and redistribute flows, and reconnect channels with floodplains to prevent erosion and sedimentation in wetland areas. Revegetating the riparian corridor along Redondo Creek downstream of Redondo Meadows will restore riparian habitat, promote the natural recruitment of beaver, decrease stream temperature and reduce stream sedimentation.

Road Maintenance and/or Closures

Storm water on some of the roads in the watershed is channelized, contributing to erosion along and downstream of the road and excess sedimentation in downstream wetlands. In their current condition, these roads are stressors to wetlands. Road VC06 above Valle Seco and the Alamo Canyon Road are not well-maintained and are not used frequently. It is recommended that these roads be closed by VCNP or use of the roads be restricted only to emergency vehicles and bicycles.

Road VC08 runs along Sulphur Creek and is one of the entrances to VCNP. Although rolling dips were completed during 2016-2017 along Road VC08 to protect wetlands, there is remaining work that should be accomplished. It is recommended that additional rolling dips be installed for improved drainage, and that porous fill be installed at the crossing below the intersection of VC08 and VC06. Rolling dips will shed water off the road without channelization, and porous fill will allow water to move under the road more effectively.

Forest Thinning

In order to reduce the risk of catastrophic fires that negatively impact wetlands and surrounding landscape, it is recommended that forest thinning or prescribed burns occur in the upper reaches of Sulphur Creek Watershed.

5-3. Potential Funding Sources

Table 5-4 lists potential funding sources for wetlands protection and restoration.

Table 5-4 Potential Funding Sources for Wetland Restoration

Source	Agency	Grant
Federal	Environmental Protection Agency	Clean Water Act Section 319 Watershed Restoration Grants
		5 Star Restoration Challenge Grant Program
		Environmental Education Grants
	National Park Service	SharePoint Cooperative Agreement
		Challenge Cost Share
		National Maritime Heritage Grant (lol)
	Natural Resource Conservation Service	Environmental Quality Incentive Program (private lands cost-matching)
		Wildlife Habitat Incentive Program
		Wetland Reserve Program
	U.S. Fish and Wildlife Service	North American Wetland Conservation Act
		Fish Passage
	U.S. Forest Service	Collaborative Forest Restoration Program
		Collaborative Forest Landscape Restoration Program
State	State of New Mexico	River Stewardship Program
	NM Game and Fish Department	Potential matching monies for other grants
	New Mexico Community Foundation	NM River Conservation & Restoration Fund
	New Mexico State Forestry	New Mexico Forestry Division Watershed Restoration Project
	New Mexico Energy, Minerals and Natural Resource Department	Youth Conservation Corps
	New Mexico Water Trust Board Grants	Grants can be used for watershed restoration
Private	Rio Grande Water Fund – Stream, Wetland, Aquatic Resources Program	
	Patagonia 1% for the Planet Grant and World Trout Initiative	
	Western Native Trout Initiative	Improve fish habitat
	Orvis Conservation Grant Program	
	National Fish and Wildlife Foundation	
	Trout Unlimited	Improve fish habitat

	Wildlife Conservation Society	Watershed restoration
	Mitigation Funds	
	Private Donors	
	Volunteer Labor	Los Amigos de Valles Caldera
		Albuquerque Wildlife Federation
		Local Scout Troops

6. Local, Public Involvement Strategy

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

The following organizations are important stakeholders for the Sulphur Creek Watershed.

National Park Service – Valles Caldera National Preserve owns and manages the Preserve. The staff with the Preserve have a draft Foundation Document that outlines resources, values and needs.

Los Amigos de Valles Caldera was created in 2004 as a "friends" group, finalized its 501(c)(3) status in 2007, and supports the National Park Service in accomplishing its goals at VCNP. Specifically, Los Amigos de Valles Caldera was organized to support VCNP for present and future generations through outreach, education, restoration, and collaboration. (Los Amigos de Valles Caldera, 2017). Los Amigos de Valles Caldera has been actively leading river and wetlands restoration projects in the Preserve since its creation. Currently, Los Amigos has two RERI funded project grants and a project funded by the Wildlife Conservation Society in various parts of the Preserve.

Albuquerque Wildlife Federation is an all-volunteer 501(c)(3) organization focused on New Mexico's wildlife and habitat resources. Among AWF's dedicated and able volunteers are wildlife experts, public land stewards, sportsmen and hunters, and most especially, ordinary citizens committed to conservation of nature's wealth for personal satisfaction and for future generations. Albuquerque Wildlife Federation has participated in several successful volunteer workshops in VCNP, including five workshops along Sulphur Creek from 2013-2017.

WildEarth Guardians is a 501(c)(3) organization that protects and restores the wildlife, wild places, wild rivers, and health of the American West. As part of their wild rivers program, they have constructed elk/cattle exclosures and planted riparian vegetation on several streams in the Preserve.

Elk Valley Property Homeowners Association is the association for property owners along Sulphur Creek downstream of the Preserve. The association has garnered state funds ($20,000) along with $10,000 from landowners to contract with Keystone Restoration Ecology, Inc. to improve Forest Road 105 (VC08) as it intersects Freelove Canyon and Sulphur Creek.

Defenders of Wildlife is a national 501(c)(3) organization that works to protect and restore imperiled wildlife across North America and around the world. Members from this organization have been volunteering with the Los Amigos projects.

Continued outreach efforts involving these stakeholders will be a key component for the successful implementation of the WAP. Los Amigos has shared environmental projects with their membership through “mail chimp” notices. Los Amigos, Albuquerque Wildlife Federation and Preserve staff also share information on social media, particularly “Facebook”. Los Amigos will distribute newsletters and other educational information about wetlands from the Valle Grande Bookstore in the Preserve.

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