Cebolla Canyon Closed Basin Watershed
Cibola County, New Mexico
Wetland Action Plan

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Credits

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Cover Photo by Maryann McGraw (September 2014)

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ACRONYMS:

ACEC	Area of Critical Environmental Concern
ARRA	American Recovery and Reinvestment Act
AUMs	Animal Unit Months
AWF	Albuquerque Wildlife Federation
BLM	Bureau of Land Management
CAC	Citizens' Advisory Committee
CG	Cottonwood Gulch
DOI	Department of Interior
EMNCA	El Malpais National Conservation Area
EPA	Environmental Protection Agency
HGM	Hydrogeomorphic
NAWCA	North American Wetlands Conservation Act
NEEF	National Environment Education Foundation
NFWF	National Fish and Wildlife Foundation
NHNM	Natural Heritage New Mexico
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWTF	National Wild Turkey Federation
OSM	Office of Surface Mining
QAPP	Quality Assurance Project Plan

RERI	New Mexico's River Ecosystem Restoration Initiative
RPA	Rio Puerco Alliance
RPFO	Rio Puerco Field Office
RPMC	Rio Puerco Management Committee
SCA	Student Conservation Association
SCC	Southwest Conservation Corps
SUH	Southwest Urban Hydrology
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U. S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VISTA	Volunteers in Service to America
WAP	Wetland Action Plan
WRCC	Western Region Climate Center
WSA	Wilderness Study Area

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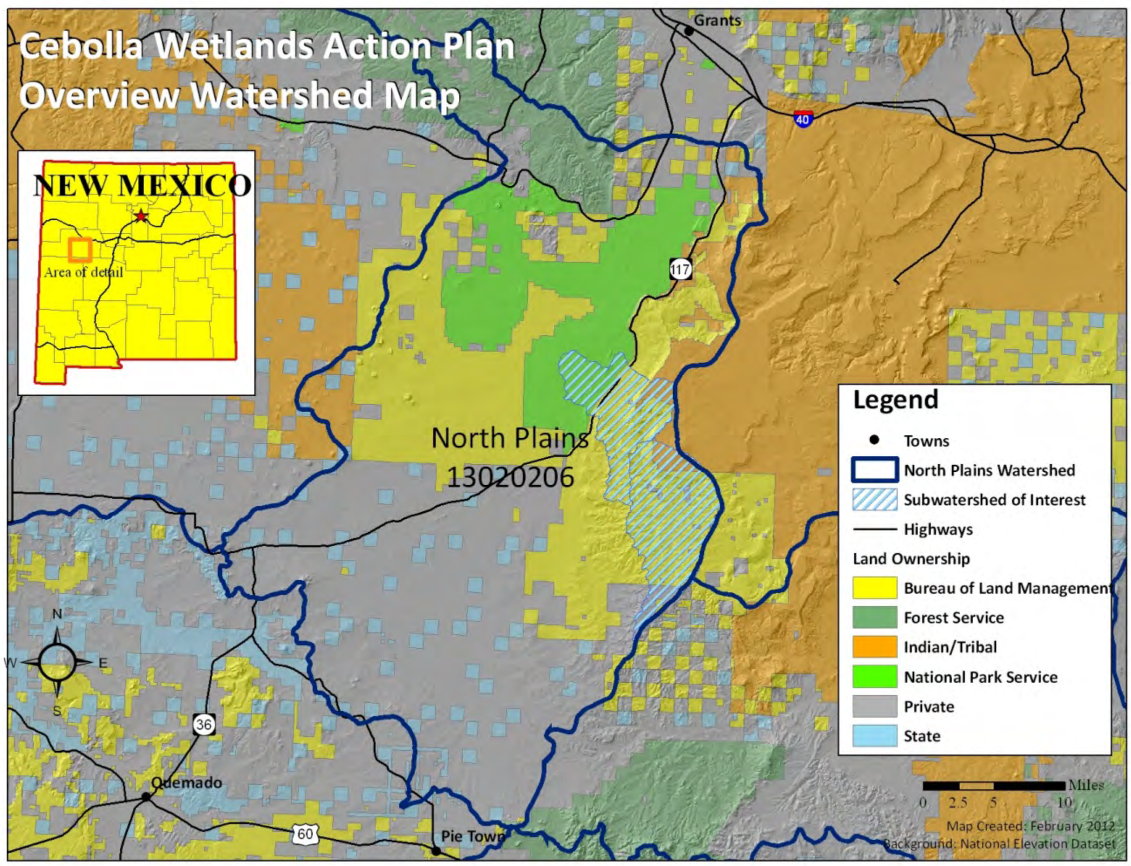
1. INTRODUCTION

New Mexico wetlands support a great variety of species and are crucial for their survival. In semi-arid regions, wetlands provide habitat, water, food for wildlife and livestock, and contribute to sustaining biodiversity. Due to the limited availability of water, species often compete for this resource with agricultural expansion. In the past, species' habitats have been greatly reduced when wetlands were modified or lost. The Cebolla Canyon Wetland, in west-central New Mexico, is an example of this; early stream diversion and human interventions have led to the reduction and near disappearance of the wetland's natural hydrologic system.

Since 1994, different agencies and organizations have initiated and completed several restoration projects to rehabilitate the Cebolla Canyon wetland. Today, large portions of the wetland have been restored, but the need for further management measures in protecting and restoring the wetland persists.



2. CEBOLLA WETLAND

The Cebolla Canyon watershed has beautiful contrasting landscapes from the breathtakingly lush valley views that surreally melt into the sandstone canyon walls lined with piñon, juniper, and ponderosa trees to the rugged black lava flows of the El Malpais ("The Badlands") National Monument. In addition to its beauty, Cebolla Canyon is the location of an extremely important wetland significant to wildlife and water-dependent plant communities in an arid setting. The sedimentary formations punctuated by lava flows have developed wetland springs and playas. The perennial springs formed a wetland habitat that has now dried out considerably due to human intervention.

The headwaters of Cebolla Creek lie near Cebollita Peak in the east and to the south. The Cebolla Creek and its tributaries are predominantly intermittent and only flow as a result of storm events. Lower in the Cebolla Creek Canyon and within the floodplain lies an important ground-water dependent wetland ecosystem supported by Cebolla Springs and Cebollita Springs. Where these springs surface, their flow down the valley would hydrate the entire floodplain creating a marsh. These types of wetlands are considered to be slope wetlands using the Hydrogeomorphic classification system (Brinson 2003). However, the floodplain also contains the Cebolla Creek. Wetlands immediately downstream of Cebolla Springs slope wetlands are considered to be predominantly riverine as the supporting hydrology becomes again dominated by precipitation-driven flow events.

Manipulations of the Cebolla Creek watershed and particularly the stream channel and floodplain have greatly altered the flow and hydrology of the stream, which has displaced the creek from its natural drainage. Following these alterations, head cutting has occurred that severely dried out adjacent wetland areas.

Since 1994 restoration efforts by a number of organizations including but not limited to the Bureau of Land Management (BLM), the Albuquerque Wildlife Federation (AWF), the New Mexico Environment Department Surface Water Quality Bureau Wetlands Program (SWQB Wetlands Program), and the Rio Puerco Alliance (RPA) have resulted in an expansion of the wetland area. The most recent report regarding wetland restoration prepared for the Rio Puerco Alliance in 2013 (Vrooman, 2013) that between 2010 and 2013, 3.8 acres were added to the Cebolla Creek in Reaches 0-5 totaling 20.5 acres of wetland.

3. PURPOSE OF THE WETLAND ACTION PLAN

This area has been a magnet for wildlife and humans for centuries. However, due to numerous historical activities, such as hydromodification, irrigation diversions, livestock grazing, and road building, there are currently major impairments to stream hydrology, attendant floodplain and spring-fed wetlands. Because of the scarcity of perennial water in the area (the next closest source is approximately 40 miles distant), the spring-dependent wetlands and the associated stream and floodplain have been the focus of intense restoration efforts. Initial wetland restoration was undertaken by government agencies and non-governmental organizations. These efforts have resulted in an impressive recovery of wetland areas and showcase results of passive and active ecological restoration techniques. Although encouraging signs of ecosystem recovery exist, there remains a need for further rehabilitation and monitoring of the Cebolla Canyon wetland.

The purpose of this document is to describe how wetlands and riparian resources are being and going to be restored and protected in the North Plains Watershed. This Wetlands Action Plan also documents lessons learned, findings, and community feedback gathered during the planning for wetlands. The most practical purpose for this document has been that anyone can refer to it about priorities, funding resources, and important next steps. It is also a reference document for developing future proposals for wetland restoration iniatives.

This Wetland Action Plan (WAP) hopes to provide information about areas that are still in need of mitigation and thus channel future action to those areas.

4. WETLAND ACTION PLAN

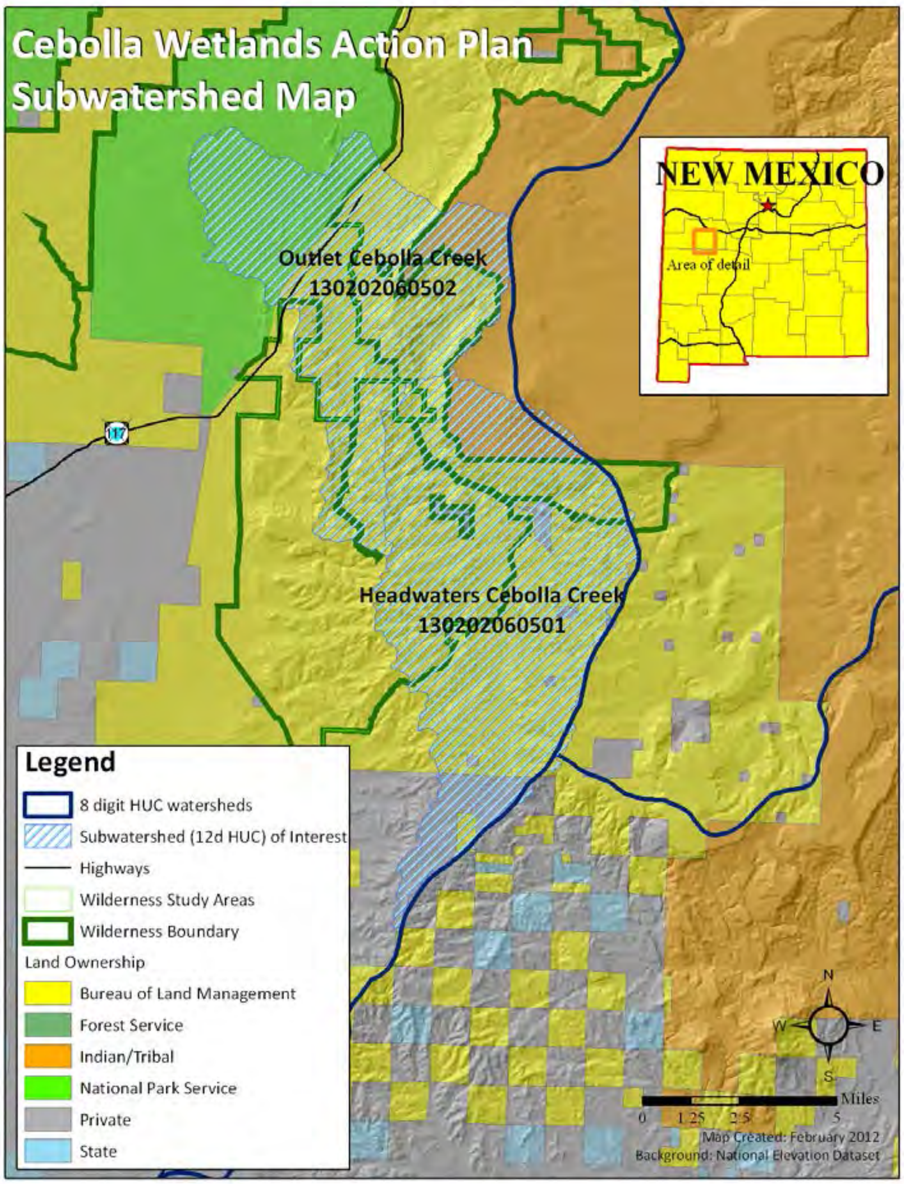
As part of a New Mexico Environment Department Surface Water Quality Bureau Wetlands Program restoration project entitled *Restoring and Protecting Wetlands in Cebolla Canyon Closed Basin,* a WAP for the Cebolla Canyon watershed was required. A WAP is a planning document designed specifically to address wetlands within the boundaries of a specific watershed. A WAP provides guidance for protection and restoration of wetlands, as well as emphasizes water quality benefits and ecological integrity, preservation of wildlife corridors, habitat conservation of threatened and endangered species, migratory birds, and other species of concern.

This plan is written for community partnerships, state and local institutions, and conservation groups who are involved in the preservation, conservation, and restoration of wetlands and riparian areas within a watershed. The WAP includes descriptive landscape background information and information for three major planning components: resource analysis, resource management, and a local involvement strategy. These planning components help ensure that watershed planning and any other local planning activities adequately address wetland management issues. Since certain data and information are currently unavailable, part of the goal of this plan is to fill these information gaps and help direct future action. The development and refinement of the watershed WAP will be an ongoing process.

5. WETLAND BACKGROUND

5.1 LOCATION

The Cebolla Canyon Wetland is located 72 miles west of Albuquerque, New Mexico in Cibola County within the North Plains Closed Basin watershed (HUC 13020206) (see Map 1, page 11). The portion of Cebolla Canyon this WAP addresses is the Headwaters Cebolla Creek sub-watershed (HUC 130202060501), which covers approximately 356,333 acres and the Outlet Cebolla Creek sub-watershed (HUC 130202060502) with an area of 22,125 acres (see Map 2, below).



5.2 HISTORICAL BACKROUND

Due to the location of Cebolla Canyon's boundaries within the El Malpais National Conservation Area, it is difficult to obtain the history of this small isolated area while not discussing the broader El Malpais area. Prior to Spanish settlement and the eventual homesteaders, there is little documentation citing Cebolla Canyon specifically. Although the lack of data is a hindrance to direct referential comprehension of the pre-Anglo era, it does not necessarily prohibit the discussion of archeological findings within and in the near vicinity to provide a reasonable idea of the area's history and development.

5.2.1 Ancestral Puebloan

Chaco Canyon, New Mexico, is one of the most important Ancestral Puebloan (also known as the Anazasi) sites in the western United States. It is located about 85 miles northwest of Cebolla Canyon. There is evidence of habitation in the Chaco Canyon area prior to 900 B.C. but it did not become a major cultural center until sometime between 300-400 A.D., when inhabitants began to use an advanced irrigation farming system (Stuart, 2000). The Ancestral Puebloan town of Pueblo Bonito, in Chaco Canyon, housed around 1,150 persons, 800 rooms and 37 kivas. Threatening Rock, one of the most dominant structures in the pueblo, was home for more than 1,000 persons and lasted over 1,000 years.

Even though the occupants of the area were part of an advanced culture, Chaco Canyon´s inhabitants did not know about the wheel. In building their infrastructure, they had to "…load big timbers and slabs of sandstone from the mountains more than 50 miles away" (Ayer, 1993). Their simple technology and considerable distance between resources made for a logical general expansion of Chaco Canyon that influenced more remote locations, as Ayer (1993) reports: "Not all Anasazi moved into communities, some families lived in single unit homes in cliffs quite far from the main population centers." The distance traveled to find and harvest resources and the movement of families indicates long distances of communication and settlement stemming out from Chaco Canyon. According to David E. Stuart (2000), the peoples of Chaco Canyon had a multitude of "sister" pueblos in their more than "…40,000 square miles of roadways, granaries and distinct trading villages in the basin lands of North America." Remnants of some of those Pueblos have been found on Cebollita Mesa, a very short distance from Cebolla Canyon (Stuart, 2000)

Cebollita Mesa overlooks the wetland areas of Cebolla Canyon as well as the location of four important sites, identified by archeologists, as remains from the Pueblo II period (A.D. 950-1100). The most significant of these archeological sites from the Cebollita Mesa was a structure that had nearly 300 rooms. According to Bureau of Land Management (BLM) archeologist, Gretchen Obenaus, "isolated surveys have found an extensive number of Paleo Indian sites within Cebolla Canyon and even more in the area of Cebollita Mesa."

As the Pueblo peoples moved out from the cultural centers, they brought with them their extensive farming knowledge; they harvested corn, squash, beans, cotton—their daily lives revolved around these crops. Pueblos with available water sources irrigated from the rivers, while the Pueblos with limited water resources used dryland farming techniques that relied on multiple fields over a range of environments to compensate for the sporadic rainfall of the region (Owen, 2004). Since Cebolla Canyon has a constant water source at the springs and is part of a major drainage, it is no wonder that a multitude of ancient agricultural sites have been identified. In an interview, Gretchen Obenaus noted, “We know they used the area extensively for agriculture. From the mouth of Cebolla Canyon there are lots of prehistoric fields up and down the area. We see prehistoric sites on the high ground above Cebolla Canyon as well. We know where there was water and flat land. It was being used for agriculture.”

As more serious farmers, the early Puebloans began “…to improve the growing conditions of particular fields by terracing, irrigation, and gridding” (Ortiz, 1979). Even though land shaping advancements were made, they continued to use crude tools such as digging sticks that were “…hardened wood shafts used to make holes in the earth for planting seeds of corn, beans, and squash in gardens” (BLM Colorado, 2012). Nevertheless, they farmed intensely on both large and small patches of land and were quite efficient in producing large amounts of food.

Historians and archeologists are not exactly sure why, but around A.D. 1300 the Ancestral Puebloans in this area begin to disappear. In an interview with Eleanor Ayer, Ayer claimed that “…a great drought struck Chaco Canyon around 1130 A.D. and lasted around 50 years.” As the drought persisted, people began moving into canyons. Ayer stated, “the Anasazi at Kayenta in Arizona moved into the canyons hoping to have enough water to water their crops and continue farming.” However, as the drought continued to intensify, it was found that there was insufficient moisture, which forced the Puebloans to abandon the canyon by 1300 A.D.

Before the desertion of Cebolla by the Ancestral Puebloans, it is quite easy to imagine Cebolla with its lush valley bottom as a series of irrigated farm systems. Land was molded and shaped to sow seeds, harvested and processed by the community with crude tools. Because of the springs and large basin, the farming trend continued. Wet fertile land in a dry desert climate is rare, and to think that the industrialized Anglo man was the only one to have molded and worked this land is just not so.

5.2.2 Zuni /Acoma Pueblos

The cultural demise of the Ancestral Puebloan Peoples in this area gave way to two defining pueblos: the Zuni and the Acoma. During 1300-1500 of the Pueblo IV Period, Zuni Pueblo and other prehistoric towns were founded as the population in the area consolidated in the Zuni River Valley. By the middle of Pueblo IV Period, Zuni had seven settlements called Cibola. Each village contained 200 people or more (Ayer, 1993).

Lobo Canyon Petroglyph

East of Zuni, geographically adjacent to Cebolla Canyon, on top of Mesa Encantada, was the pueblo Acoma, also known as Sky City. Not unlike their predecessors, the Zuni and Acoma were agriculturalists and cotton growers. There was significant trading between the two Pueblos; the trail between Zuni and Acoma is still a popular hiking destination today.

Although the locations of the Acoma and Zuni Pueblos are near Cebolla, there are no indications of Pueblo IV (A.D. 1400-1600) settlements within Cebolla Canyon (Gretchen Obenaus). A study in 1951 used, "…a critical examination…to provide exact information and systematic collection and analysis of data" (Ruppé, 1990) for Acoma land claims against the United States Government, does indicate an extremely strong Acoma presence in Cebolla Canyon and Cebollita Mesa just nine miles to the north. Nels C. Nelson's field drawings from 1952 indicate that the "…ruins in Cebolla Canyon are identical with those of Cebollita and Veteados Canyons" (Ruppé, 1990). The 1952 survey of Cebollita Mesa and Veteados Canyon found 228 housing sites with 2,615 rooms (Ruppé, 1990). Sadly, the funding ran short for this expedition and findings regarding Cebolla Canyon were not documented. Nelson´s photos of the area indicate that, "there may have been a larger occupation in Cebolla Canyon than in the other canyon areas," and that the range in "…cultural periods with growing certainty extends from San Jose to Pueblo IV," connecting it "…to the modern Pueblo of Acoma" (Ruppé, 1990).

The walls and buildings of this era are no longer present since "…homesteaders used them as sources of building stone and removed all traces of them. Skill of the ancient masons was such that free-standing walls no more than 46 cm thick were capable of maintaining a height of about 2.5 m until the 1920´s when they were knocked down for their blocks" (Ruppé, 1990). At any rate, the life and land as the Native Americans of the Southwest knew it, was about to change forever with "La Entrada" of the Spanish in 1539. With the entrance of the Spaniards comes a whole new written and documented perception of the land surrounding Cebolla Canyon.

5.2.3 Spanish/Navajo

In 1539 Fray Marcos de Niza went north to Arizona and New Mexico in search of the fabled “Seven Cities of Cibola.” Niza was selected to escort the Spanish conquistadors and given the special authoritative powers by the Pope with “…full authority. . .in matters relating to the conversion of the Indians” (Hallenbeck, 1989). On his journey to the north, a Moor named Estéban accompanied Marcos. As they searched desperately for signs of riches and gold throughout the poor agricultural societies of the southwest, Estéban heard a rumor of riches from native peoples. Estéban went against Marcos and disobeyed orders by making contact with the Zuni. He showed little respect for the Zuni peoples and their authority, and it is said that they killed him, chopped his body up and sent it to each of the villages for future invaders to see (Ayer, 1993).

Although he never made it to Cibola for fear of his life, Fray Marcos de Niza wrote an untruthful report claiming the area to have tremendous riches. Believing the account, another group, headed by Francisco Vásquez de Coronado left Mexico a year later in search of the Seven Cities of Cibola. What he found were “…poor farmers who had no knowledge of gold or its value.” Following Marcos´s directions, Coronado’s army passed through the Zuni Pueblo and went to Acoma, which was seen and documented for the first time in 1540. The village described as “Acuco” was situated where it currently is today on the “Peñol,” a large rocky mountain (Ayer, 1993).

The Acoma stronghold called “Sky City” is located a short distance away from Cebolla Canyon on Mesa Encantada. A later Spanish expedition to the area in 1582 by Antonio de Espejo, an explorer, begins to detail the region and its land use. He states:

> “We found a Pueblo called Acoma where there appeared to be more than 6,000 souls…they had cisterns of water at the top with many provisions. Here they gave us mantas of cotton, deer, buffalo hides and many provisions consisting of maize and turkeys. These people have their fields about two leagues from this site on a medium sized river whose water they intercept for irrigating purposes as they water their fields with many partitions of the water near the river in a marsh. We also found Castillan roses and Castillan onions that grow in this country without cultivation…the mountain people (Querechos) around the settlements come to their aid. They carry on trade with the peoples of the settlements taking to them salt, game such as deer rabbits and hares and trade for cotton other things” (Minge, 1976).

Espejo left Acoma heading westward (Sedgwick, 1927). He states in his diary “We marched four leagues up a river which originates in some badlands. We found many irrigated maize fields with canals and dams as if the Spanish had built them” (Minge, 1976).

Analyzing this documentation there are three things of unique and pertinent interest to the near areas of Cebolla Canyon. The first thing that is of interest is the reference to the “Castillan onion” which in Spanish is the word Cebolla. The areas around the Acoma village today take on the respectful names of: Cebollita Mesa (little onion), Cebollita Canyon and Cebolla Canyon. The second interest is that upon leaving the village, they travel west about four leagues and come to badlands. This distance would be around 14.6 miles, which is almost the exact distance from the Acoma Village on the Zuni-Acoma trail to the marshy areas of the Cebollita Canyon—near the terminus of Cebolla Creek in the North Plains of the Closed Basin on NM117 in the current day El Malpais National Conservation Area.

This information is also extremely relevant for an understanding of what the area surrounding Cebolla Canyon looked like in 1582. Although we do not have a direct historic reference to Cebolla Canyon, we may come to appreciate that the areas around the Acoma village towards the Malpais badlands along the Acoma-Zuni trail were full of intensively irrigated farmlands with infrastructure similar to European civilizations. Ruppé’s claim that Cebolla Canyon was more populated than Cebollita Canyon during this time period suggests a similar landscape in Cebolla Canyon.

As more Spaniards moved into New Mexican Territory, they brought with them domesticated livestock. At the same time a more nomadic and aggressive Navajo tribe began to move into the territory. In 1636, when Friar Benavides wrote a description of the early Navajos, they were already farming and at least partially sedentary. They learned the rudiments of raising crops from their Pueblo neighbors (Vogt 1961). However, sheep and goats acquired through raiding and trading were already making their appearance. The Navajos raided Spanish settlements for sheep, horses and fresh produce. They were raiding the Spanish as early as 1608 (Worcester, 1947).

During the 1700s, the Navajos raided Spanish settlements and the Spaniards responded with military action. This action forced the Navajo south into the Cebollita Mesa (Schroeder, 1965) (Reeve, 1960). Spanish settlers began to move into the mountains as well. Throughout this time period, the human population and the sheep population continued to increase. “In general, most families owned herds although their numbers remained small” (Bailey, 1986). But in the 1800s, economic subsistence began to shift from farming and hunting to herding while the introduction of the railroad to the Malpais area would only further increase herding and livestock in the area.

5.2.4 Basque, Cattle Ranching and Timber Industries

In 1881, a railroad station was built in Grants, New Mexico, less than 30 miles away from Cebolla Canyon. With the railroad came a steady increase in population with economic opportunities for export.

> "With the advent of the railroad, ranchers had a means of transporting their livestock to market. Moreover, the railroad encouraged the ranchers to expand their herds. New Mexico's sheep census skyrocketed following the subjugation of the Indians and the coming of the railroad. No longer did Navajo devastate the surrounding flocks. Settlers expanded their herds without fear of livestock loss. In 1870, the New Mexico sheep count numbered 619,000 animals statewide. Ten years later the sheep population exploded to 3.9 million" (Magnum, 1990).

The Malpais became grounds for mass sheep production. Spanish sheepherders bought or acquired a vast portion of the Malpais lands up to the Acoma Reservation. Basque herders from France and Spain moved in to tend to the flocks of "…typically ten to twelve thousand" requiring a "…grazing land equivalent to three townships or an area 18 miles long and 18 miles wide" (Magnum, 1990). The flocks would bounce up and down the Malpais range moving locations three to four times a day, eventually arriving in Grants for shearing and slaughtering. As the number of sheep began to increase so did the cattle though not nearly to the same capacity. In the statewide census of 1880, there were only 347,936 cattle compared to 3.9 million sheep. But the Malpais area was a very important grazing ground and the surrounding population began to recognize the cattle industry as profitable. The Acoma Nation started their own cattle business; in 1884, the Acoma Land and Cattle Company merged with the Cebolla Cattle Company to control "41,592 acres east of the Malpais" (Magnum, 1990). The massive numbers of cattle would continue to increase and with the profitability came a greater number of inhabitants to the region.

With a railroad and new inhabitants came the need for more industry and jobs in the area, making the timber industry an obvious candidate to increase economic activity. The Southern Pacific began its expansion near Grants in 1880, making the Zuni Mountains and Cebolla Mesa a prime location for timber harvesting. Joe Lally in his 2012 report on sawmill culture (Lally J. , 2012), stated that the "…forested areas in and around Cebolla Canyon supplied much of the timber used to satisfy the increased demand for lumber and crossties," which were numbering upwards of "110 million crossties per year at the turn of the century." It is suspected that for this very reason various sawmill production facilities were constructed in Cebolla Canyon. Large-scale timber operations in the Cebolla Canyon area were not restricted to corporations. According to Lally, "…it was very common for teams of individuals" during the late 1800s and early 1900s "…to go themselves and cut small to medium diameter trees to use for sales and for building purposes." With the timber and livestock usage clearly taking hold in Cebolla Canyon, came the advent of more used and accessible roads allowing eager modern homesteaders the opportunity to build and colonize within the walls of the Canyon.

Ruin of a homesteader's cabin in Cebolla Canyon.

5.2.5 Homesteaders

Due to dramatic changes in the post-World War I and dustbowl eras, people decided to move west and leave their farms. Instead of going to California, many families decided to try the high desert of New Mexico. The Savage family from Texas was one example that decided to homestead Cebolla Canyon sometime in the early 1930s (Towner, 2010) (Magnum, 1990). They built various public and private cabins, a schoolhouse, corrals, barns, dugouts, and outhouses, totaling around 20 structures. The Savages attempted to make a living farming beans, corn, and cane in the valleys but found it very difficult. According to the records, the Savages possessed limited amounts of livestock: 10 head of cattle and 6 horses (Towner, 2009). The absolute decimation of the southwest lands was due to overgrazing from the 1860s to 1930s that resulted in a federally enforced livestock reduction in the 1930s. The Taylor Grazing Act directly affected all the herds and flocks in the Malpais area, including those on Navajo and Acoma land.

In his harvest testimonial chart, Towner describes the agricultural situation in Cebolla Canyon at this time as nearly impossible. The Savages' seeded area during their four growing seasons (1935-39) averaged 13 acres of corn, 10 acres of beans and 7 acres of cane. From those areas they harvested minimal returns and had no crop yield due to a severe drought in 1939. To access their fields, and their nearly 250 acres of grazing lands, they built a series of roads. To irrigate the crops, the Savages dug irrigation and drainage ditches. Shortly after the abandonment of the area, a mere 10-20 years later, a series of headcuts began to form.

Towner notes this degradation claiming that one of the roads created by the Savages formed an “Arroyo Road” which he states “…could not have existed prior to the occupation of the site” in Cebolla Canyon. “The rainwater,” Towner continues, “…flooded the ruts in the road and downcut,” which is a process that takes place extremely quickly. Towner’s report is limited to the archeological finds of the Savage ranch because it fails to take into consideration the many roads existing due to timber production in other parts of Cebolla Canyon. Nor does it take into account the massive amount of cutting that was taking place in the canyon walls at the time.

During the 1940s to 1950s, Cebolla Canyon underwent a severe transformation from its original state. It continued its use as grazing lands for livestock, yet was uninhabited. Instead of living in a single, permanent camp by their fields, families began using separate summer and winter camps, where forage and water were available for their livestock (Bailey, 1986).

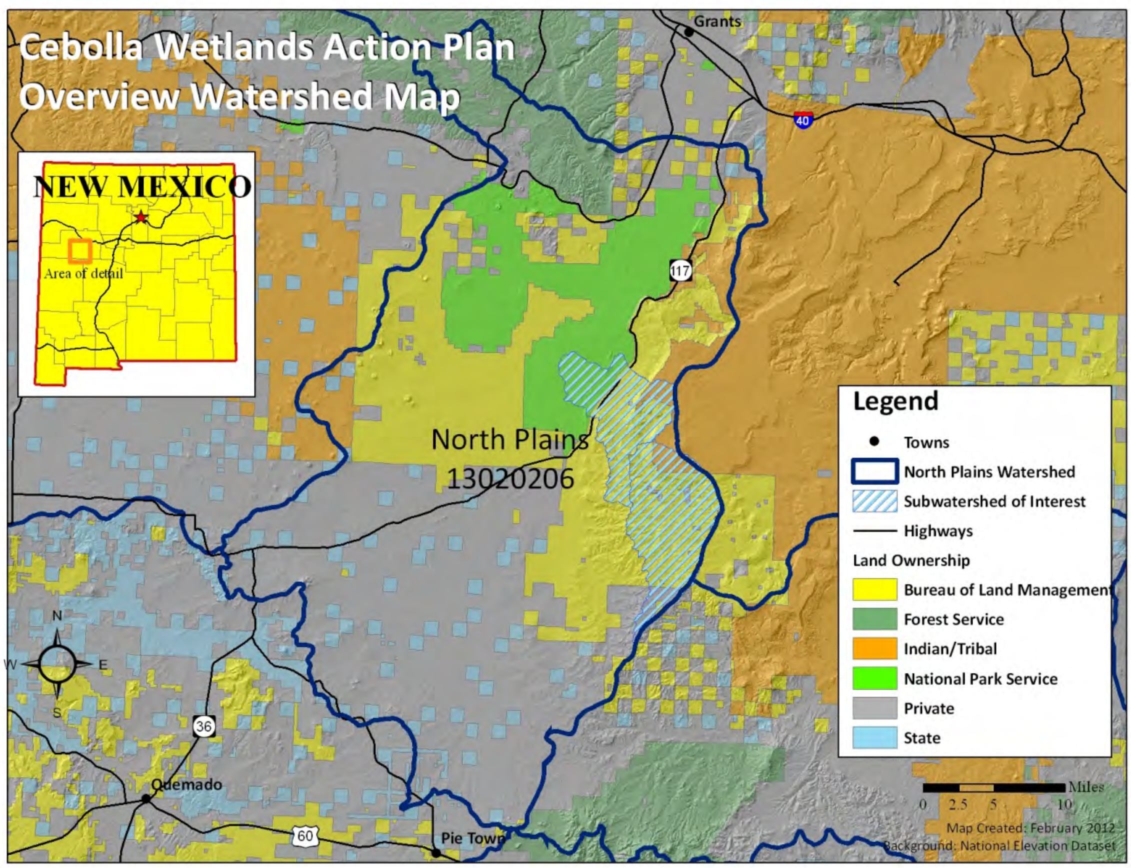
In addition, the hills were harshly thinned for railroad production and unchecked roads zigzagged their way through the territory. During weather events, a less vegetated sloped area has a much higher erosion rate and less infiltration than one that is vegetated. The amount of sediment traveling from the hills off the roads and valleys was likely substantial.

There is no doubt that Cebolla Canyon has been changed and molded over time, but the last 60 years have produced a rapid degradation that resulted in what exists today.

5.3 BLM/NCA/WILDERNESS ESTABLISHMENT

In 1976 the BLM became a multi-faceted agency with the Federal Land Policy and Management Act (1976), which “allowed a variety of uses on their [BLM] land while simultaneously trying to preserve the natural resources in them.” This act gave the BLM the power to inventory land for potential wilderness status. Around this time the Malpais had been given the designation of an outstanding natural area and because of this legal standing the BLM began studying its lands for possible wilderness areas, one of those areas being Cebolla Canyon. Steve Fisher, BLM El Malpais project coordinator, said, “As the early 80s came around after studying the areas we drafted the first environmental impact statement.” At the same time the town of Grants was experiencing a collapse in the uranium mining industry and many people were being laid off. The town was trying to survive economically. U.S. Representative Bill Richardson was the congressional delegate for the area and in 1986 began attempting to push a bill through in order to make the area a national monument and create jobs. Richardson’s political opposition, U.S. Senator Pete Domenici, blocked the bill and brought out William Penn Mott who had recently been appointed the 12th National Park Service (NPS) director in 1985 by Ronald Regan “to look at the land.”

According to Steve Fischer, “Richardson and Domenici came to a compromise that focused on the splitting the lava flow area, making some parts U.S. Forest Service Land and some a National Monument. At the time there were only three other Conservation Wilderness Areas," and with Ronald Regan's signature on the bill in 1988 forming El Malpais National Monument, and Cebolla Wilderness Area (61,600 acres) became the fourth wilderness area in the United States. To complete the canyon's transformation into more pristine and intact wilderness area, the BLM made some land trades with individuals and families who owned land in Cebolla Canyon and were using the area for ranching purposes. Bruce King, the longest serving New Mexican Governor, and his brothers owned a large portion of Cebolla Canyon, which included Cebolla Springs. In 1994, the BLM traded the Kings for some valuable land surrounding Santa Fe in a land swap effectively bringing Cebolla Canyon under their jurisdiction. Mr. Fisher commented on what Cebolla Springs looked like prior to the land swap: "There was no riparian area in all of Cebolla Canyon. No riparian vegetation, no upland grasses in canyon bottom no sedges, no rushes. The Kings who owned Cebolla Springs had diversions into two ditches, which still remain today. In fact, the so-called Cebolla Creek is not in its true location--it's an irrigation ditch. When I first started to go to the area in 1977, what was supposed to be Cebolla Spring was not impressive at all and was almost nonexistent. Today, it is real riparian area, and has been radically altered (Steve Fisher, personal communication 2013)."



5.4 DEFINITIONS

5.4.1 Wetland Definition/Classification

The U.S. Fish and Wildlife Service (USFWS) defines wetlands as, "transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow waters" (Tiner, NA) and must have one or more of these three attributes:

- At least periodically, the land must support predominantly hydrophytes (wetland plants).
- The substrate is predominantly un-drained hydric soil.
- Rocky, gravelly, or sandy areas that are saturated with or covered by shallow water at some time during the growing season (Cowardin, 1979).

The EPA on the other hand defines a wetland as:

> "Those areas that are inundated or saturated by surface or groundwater 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. Wetlands generally include swamps, marshes, bogs and similar areas" (EPA, 2013).

The State of New Mexico defines "**Wetlands"** as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (NMAC 20.6.4). In more general terms, a wetland is the aquatic ecosystem at the interface, or transitional zone, between upland, dry ecosystems and deeper water aquatic ecosystems, such as rivers or lakes. Wetlands are also found in isolated locations away from other bodies of surface water. For assessment and management purposes, the NMED Surface Water Quality Bureau Wetlands Program uses the following definition:

Wetlands. Wetlands are aquatic systems with physical, chemical and biological attributes that are transitional between terrestrial (or upland) and deeper water aquatic systems. In wetland ecosystems the water table is usually at or near the surface, or the land is covered by shallow water. Wetlands have one or more of the following attributes: (1) at least periodically, the land supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate is predominantly hydric soil or contains hydric soil indicators and/or redoxymorphic features that indicate saturation periodically; and (3) the substrate is non-soil such as bedrock or boulders, and is saturated with water or covered by shallow water at some time during the growing season. 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.

The upland limit of a wetland is where soil and vegetation is not influenced by shallow water or a water table near the surface, displays predominantly mesophytic or xerophytic plant cover that cannot tolerate saturated soil conditions, soil that is non-hydric and land that is not saturated some time during the growing season. The lower boundary between wetlands and deeper water habitat associated with riverine and lacustrine systems lies at 2 meters (6.6 feet) below low water, or the maximum depth at which emergent plants normally grow.

Because ecosystem services and functions of wetlands are tied to the continuum and mosaic of the entire ecosystem, the hyporheic zone (local water table) is also part of a wetland. Linkages include exchange of water and materials along vertical surface/subsurface (hyporheic) water exchanges.

Riparian Areas. Riparian areas are intrinsically connected to and interdependent on the water sources and hydrologic regimes that also support wetlands. Riparian areas include entire floodplains able to support vegetation dependent on runoff and overbank flow, scour, sedimentation, infiltration and shallow groundwater. They include areas considered as somewhat drier portions of a wetland ecosystem and are characterized by phreatophytic and mesophytic vegetation and habitats also associated with flowing or stationary bodies of water. They are dependent on existence of perennial, intermittent or ephemeral surface water and/or hyporheic zones. Riparian areas occupy the same areas of the landscape as wetlands, may contribute to the same functions within the landscape, and are interdependent, and, therefore, are considered together as part of a wetlands ecosystem and constituting a wetlands assessment.

Buffers. Buffers are non-disturbance or minimally disturbed areas surrounding a wetland/ riparian area where natural vegetation is maintained to protect wetlands and riparian areas from the impacts of stormwater floods, a variety of pollutants, and solid waste from adjacent terrain (Kusler et al. 2003). Buffers provide the functions and services associated with contiguous natural habitat adjacent to wetlands and riparian areas. Land cover elements which are considered acceptable buffer include natural uplands (forests, grasslands, shrublands), swales, nature or wildland parks, unmaintained old fields, and rangeland in good condition. These buffer elements are expected not to disrupt ecosystem connectivity, provide habitat connectivity, and provide protective services such as preventing erosion, reducing pollutant contamination and preventing encroachment of undesirable landscape elements and activities that affect wetland resources. Wetland assessments include assessment of the condition and extent of buffer areas (NMED, 2013).

The EPA recognizes both the Cowardin Classification System and the Hydrogeomorphic (HGM) Wetlands Classification System. The Cowardin system is used by the U.S. Fish and Wildlife Service (USFWS) for the National Wetlands Inventory (NWI). In this system, "…wetlands are classified by landscape position, vegetation cover and hydrologic regime. The Cowardin System includes five major wetland types: marine, tidal, lacustrine, palustrine and riverine" (Cowardin, 1979).

Developed by the U.S. Army Corps of Engineers (USACE), HGM Classification of Wetlands is considered a wetland functional assessment approach (USDA/NRCS, 2008) where "…wetlands are classified by their geomorphic setting, dominant water source (e.g., precipitation, groundwater or surface water) and hydrodynamics." HGM includes five major wetland classes: "…riverine, slope, depressional, flat and fringe" (EPA, 2013).

5.4.2 Cebolla Classification Using the Cowardin System

Cebolla Canyon wetlands are considered a palustrine wetland type. Palustrine is defined by the Cowardin Classification System as:

All non-tidal wetlands vegetated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such tidal wetlands where ocean-derived salinities are below 0.5 percent. This category also includes wetlands lacking such hydrophytic vegetation but with all of the following characteristics:

- Area less than 20 acres
- Lacking an active wave-formed or bedrock boundary
- Water depth in the deepest part of the basin is less than 2 meters (6.6 ft.)
- Ocean derived salinities less than 0.5 ppt.

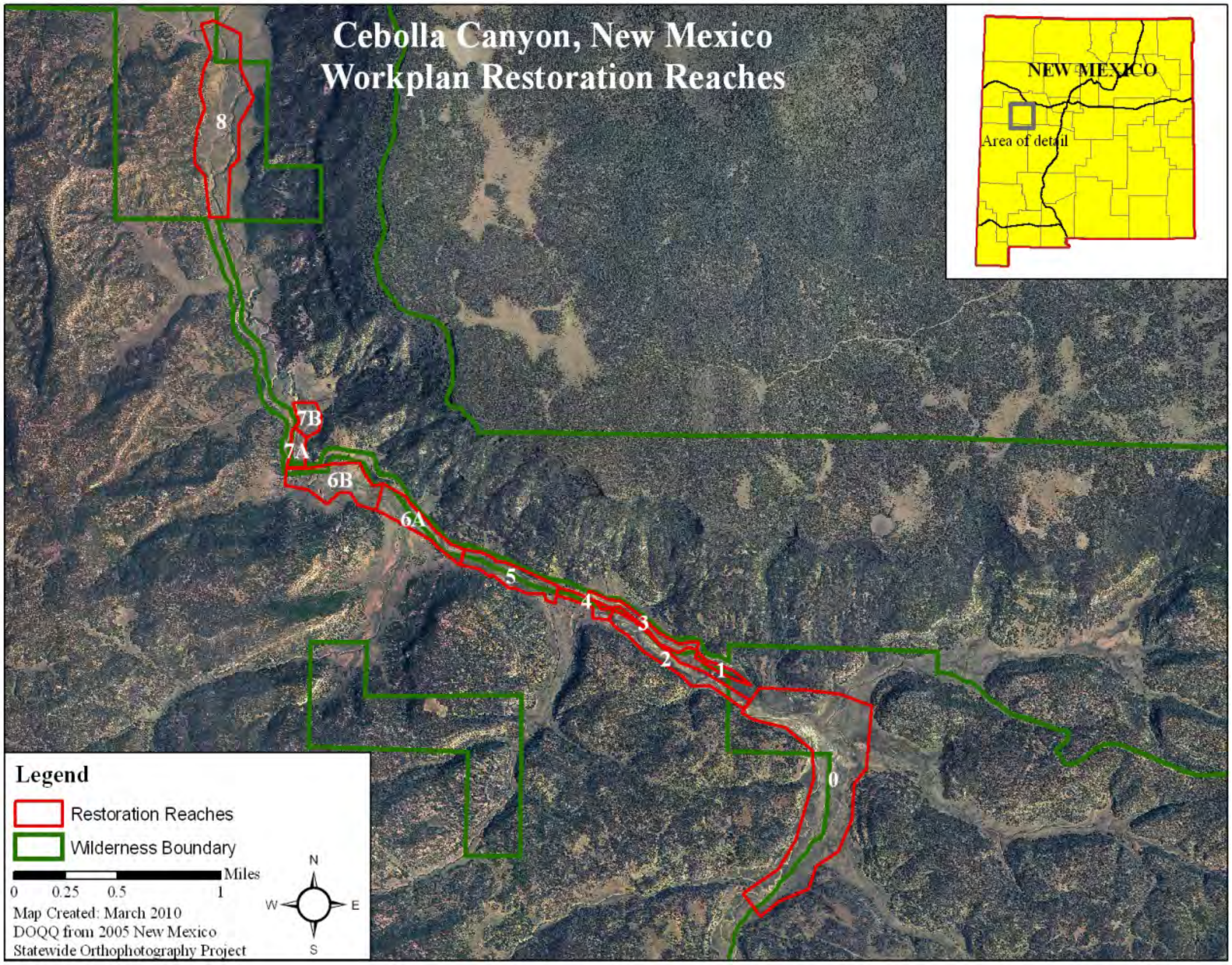
The palustrine class groups the vegetated wetlands commonly known as "…marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds." Palustrine wetlands are found "…shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers" (USGS, 2013).

Unfortunately, the NWI for the Cebolla Canyon wetlands has not been digitized, but a PDF of the 1:100K 1984 30 x 50 minute series paper map "Acoma Pueblo" is available at *www.fws.gov/ifw2es/nwi/Raster.html*. Some of the Cebolla Canyon Watershed wetlands and their classification codes using the Cowardin System are shown on this map.

5.4.3 Cebolla Wetlands Classification Using HGM

Part of Cebolla Canyon, from approximately Lobo Canyon to an area approximately 10 miles downstream, was divided into reaches for restoration work. The reaches were delineated from 0-8 (see map below). These reaches were in the valley, where homesteaders in the 1930s diverted water from the Creek and springs for agriculture. They were felt to be critical areas that needed the most restoration. Wetlands and riparian ecosystems in other areas, for example some tributaries to Cebolla Creek, are not currently part of this discussion, although the potential for restoration will be addressed as part of the Cebolla Canyon watershed future actions.

The wetlands in Reaches 2 through 8 are considered riverine. Wetlands immediately downstream of Cebolla Springs (Reaches 1 to 2) are considered to be slope wetlands. Below is a description of the characteristics of of these wetlands.


Cebolla Canyon, New Mexico
Workplan Restoration Reaches
NEW MEXICO
Area of detail
8
7B
7A
6B
6A
5
4
3
2
1
0
Legend
Restoration Reaches
Wilderness Boundary
Miles
0 0.25 0.5 1
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Map Created: March 2010
DOQQ from 2005 New Mexico
Statewide Orthophotography Project

5.4.3.1 Riverine Wetlands

Riverine wetlands occur in flood plains and riparian corridors in association with stream channels. Dominant water sources are often overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. However, sources may be interflow and return flow from adjacent uplands, occasional overland flow from adjacent uplands, tributary inflow, and precipitation. At their headwaters, riverine wetlands often are replaced by slope or depressional wetlands where the channel morphology may disappear. They may intergrade with poorly drained flats or uplands. Perennial flow in the channel is not a requirement (USDA/NRCS, 2008).

5.4.3.2 Slope Wetlands

Slope wetlands are normally found where there is a discharge of ground water to the land surface. They normally occur on sloping land; elevation gradients may range from steep hillsides to slight slopes. Principal water sources are usually ground water return flow and interflow from surrounding uplands, as well as precipitation. Hydrodynamics are dominated by downslope unidirectional water flow. Slope wetlands can occur in flat landscapes if ground water discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturation of subsurface and surface flows and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the Slope wetland. Fens, a low and marshy or frequently flooded area of land, are a common example (USDA/NRCS, 2008).

Wetland area at Cebolla Spring in 2008, restored by AWF. (See pages; photo courtesy of Gene Tatum.)

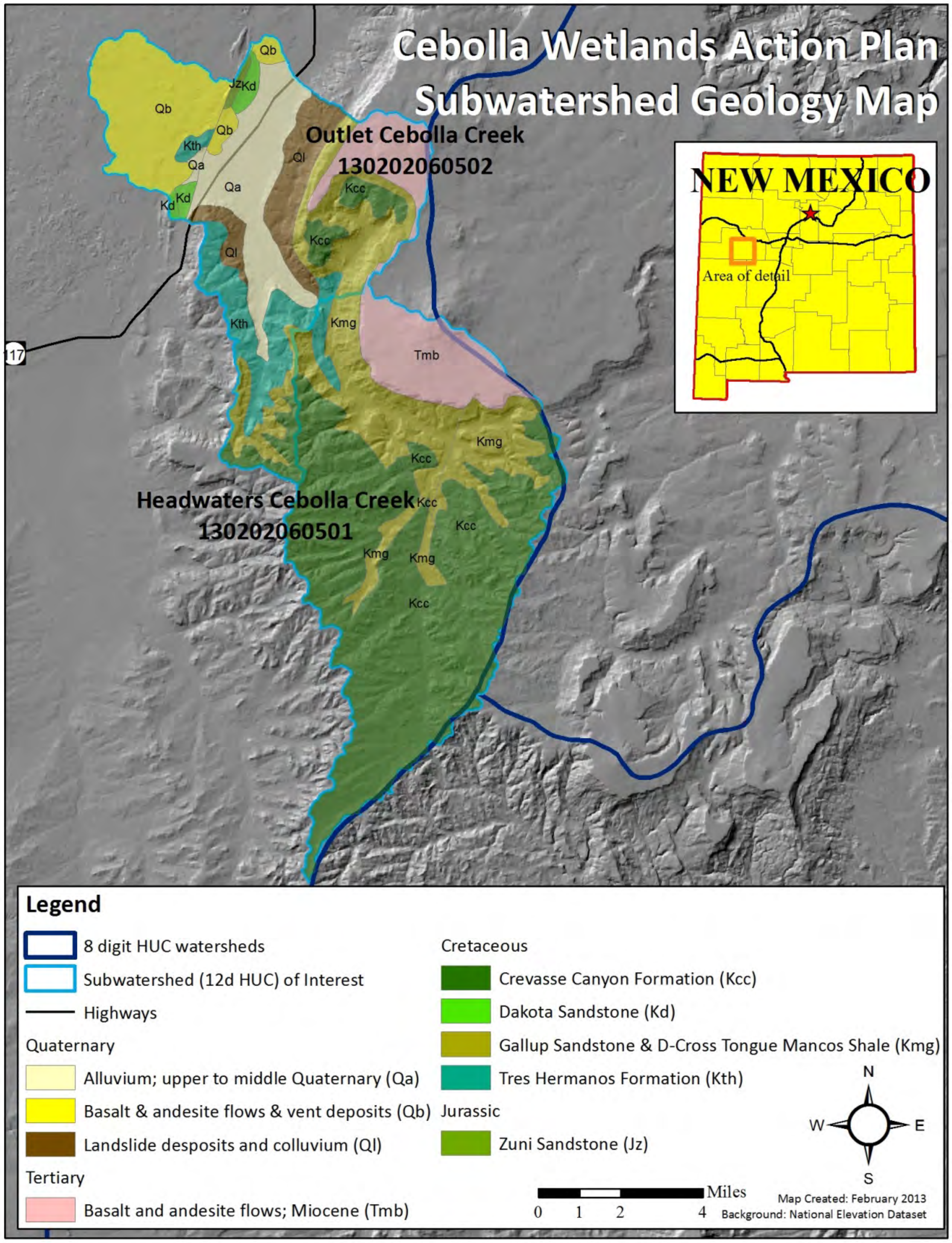
6. RESOURCE ANALYSIS

The resource analysis helps to understand the ecology of the land by providing physiographic information. Beyond ecological characteristics, it is also important to understand the socioeconomic status of the human occupants around the area in order to holistically monitor and define the social relationship of the occupants and the land. Natural resources have more than mere aesthetics for human recreation, and their cataloguing and recognition are primary components for their conservation.

6.1 GEOLOGY AND GEOGRAPHY

The North Plains closed basin is extremely rich in geologic history as it is located at the intersection of Colorado Plateau sedimentary formations and a volcanic region, which has shown relatively recent activity around 4,000 years ago.

Being that Cebolla Canyon is just southeast of the lava flows it possesses quite different geological structure that is defined without question by its sandstone (*Holocene and Pleistocene*). A geologic survey done by Charles H. Maxwell in 1986 indicates that the mesa tops to the south are predominantly a Crevasse Canyon Formation (*Upper Cretaceous*). This is about a 330-ft thick sequence of light yellowish-gray to white sandstone and siltstone, carbonaceous shale, and coal beds. The northern mesas on Cebollita Peak are basalt flows (*Pliocene*). This is typically seen on Cap Mesas and is generally aphanitic and vesicular olivine basalt. These areas are normally covered with soil, alluvium and pine trees. It is about 65-100 feet thick. There is a strong presence along the southern walls of Gallup Sandstone (*Upper Cretaceous*), which has an upper sandstone layer and a silty shale unit at the base. It is light brown and is fine to medium grained. The valley bottoms are the remnants or alluvial runoffs of the Holocene and Pleistocene formations, and are composed largely of silt and fine-grained sand with a few coarse pebbles.



The greater El Malpais region on the other hand is largely covered by lava flows that are relatively young, created by lava that poured from vents in the plain, which erupted periodically. The eruptions began approximately 200,000 years ago with the last eruption was documented as 3,000 years ago. Cerro Encierro, Cerro Bandera and Cerro Rendija are the oldest of the volcanoes that erupted; Bandera and McCartys Crater caused the most recent eruption. Four types of volcanoes are found within El Malpais: basalt cones, cinder cones, shield volcanoes, and composite volcanoes (Robinson, 1994).

6.1.1 Basalt Lava Cones

Basalt lava cones are the smallest occurring volcanoes in El Malpais. Basalt lava cones are known for shooting lava out at high velocities as well as spreading quickly. Large craters are a typical outcome, measuring as long as two miles across and several hundred feet deep, with steep slopes (Robinson, 1994).

6.1.2 Cinder Cones

Cinder cones are larger than basalt cone volcanoes. Cinder cones have released most of the lava flows in El Malpais. Cinder cones are created from foamy cinders that have accumulated around a vent. One of the oldest volcanoes, Cerro Bandera, is a cinder cone volcano. Since cinder cone volcanoes consist of cinder (*scoria*), and cinder has a very vesicular character, most of their lava is released at the base or site of the volcano cone (Robinson, 1994).

6.1.3 Shield Cones

Shield cone volcanoes earned their name after their shape, as they have a warrior like shield in their profile. When erupting, lava flows into all directions, forming a summit vent and creating a “broad and gently slowing cone” (USGS, 2005). Shield cone volcanoes are built over time, from the accumulation of numerous eruptions, where the lava is spread over great distances, cooling as a “thin, gently dipping sheet” (USGS, 2005). The Cerro Rendija, Cero Hoy, McCartys Crater and a fourth unnamed volcano are all shield cone volcanoes that are located in El Malpais.

6.1.4 Composite

Composite or strato-volcanoes are the largest of their kind. Composite volcanoes are generally tall, symmetrically shaped, and are composed of layers of lava flow, volcanic ash, and cinders. In the vicinity of Malpais we find two composite volcanoes: Mt. Taylor and St. Helens (Robinson, 1994).

6.1.5 Lava Flows Formations

The lava flows that have manifested in El Malpais bear different features. Blocky flows are created by “chunks of hardened lava carried along and then piled up” (Robinson, 1994). Squeeze-ups are formed when the outer crust is fractured and filled with molten material. Kipuka, which translates to “Island of fertile ground” in Hawaiian, are islands of land that are enclosed in lava. The biggest Kipuka in El Malpais is called Hole-in-the-wall and found in the western portion of El Malpais (BLM, 2013). Sinkholes are collapsed depressions where the solidified surface caved in. Lava tubes formed when molten rock flowed underneath a solidified crust, creating a tunnel. The longest tube in El Malpais measures sixteen miles, which is also the longest known tunnel in North America.

Various significant lava flows have been identified through El Malpais. The McCartys flow is one of the youngest flows, with its creation dating back around three thousand years, and is also one of the largest lava flows produced in El Malpais. The Bandera flow was poured from the Bandera crater and is the second youngest lava flow found in the vicinity of El Malpais. The Hoya de Cibola flow is a shield volcano including a close by crater on the west edge of El Malpais. The El Calderon crater is the oldest known source of lava flows that moved east and north, but much of its original lava flow is covered by soils and younger lava flows. The so-called Twin Craters, composed of the Twin Craters, Lost Women, and Lava Crater, is a collection of neighboring cinder cone volcanoes that produced lava flows that overlapped each other and "because of their similarities they are classed as one flow unit" (Robinson, 1994).

6.1.6 Lava Rock Formation and Composition

After the lava flows solidified, various rock formations formed. Gases escaped or were trapped in the rock, creating bubbles that consolidated. Minerals were trapped in the rock and formed crystals. The black and dark red color of the basalt arises from minerals that contain iron and magnesium.

6.1.7 Sandstone Ridge and Mesas

State Road 117 in the northwest of Cebolla Canyon, is framed by sandstone ridges and mesas. Two hundred ninety to two hundred and forty million years ago, during the Permian time, the sea had reached this area and left marine limestone and gypsum formations in "alternating layers with red muds and sands" (Robinson, 1994) behind. These remnants of the sea eventually formed the Abo Formations consisting of dark red shale and sandstone and the Yeso Formation composed of light red sandstone and light grey limestone and shale, as well as the Glorieta Formation with cream-colored sandstone and the San Andreas Formation composed of light grey limestone.

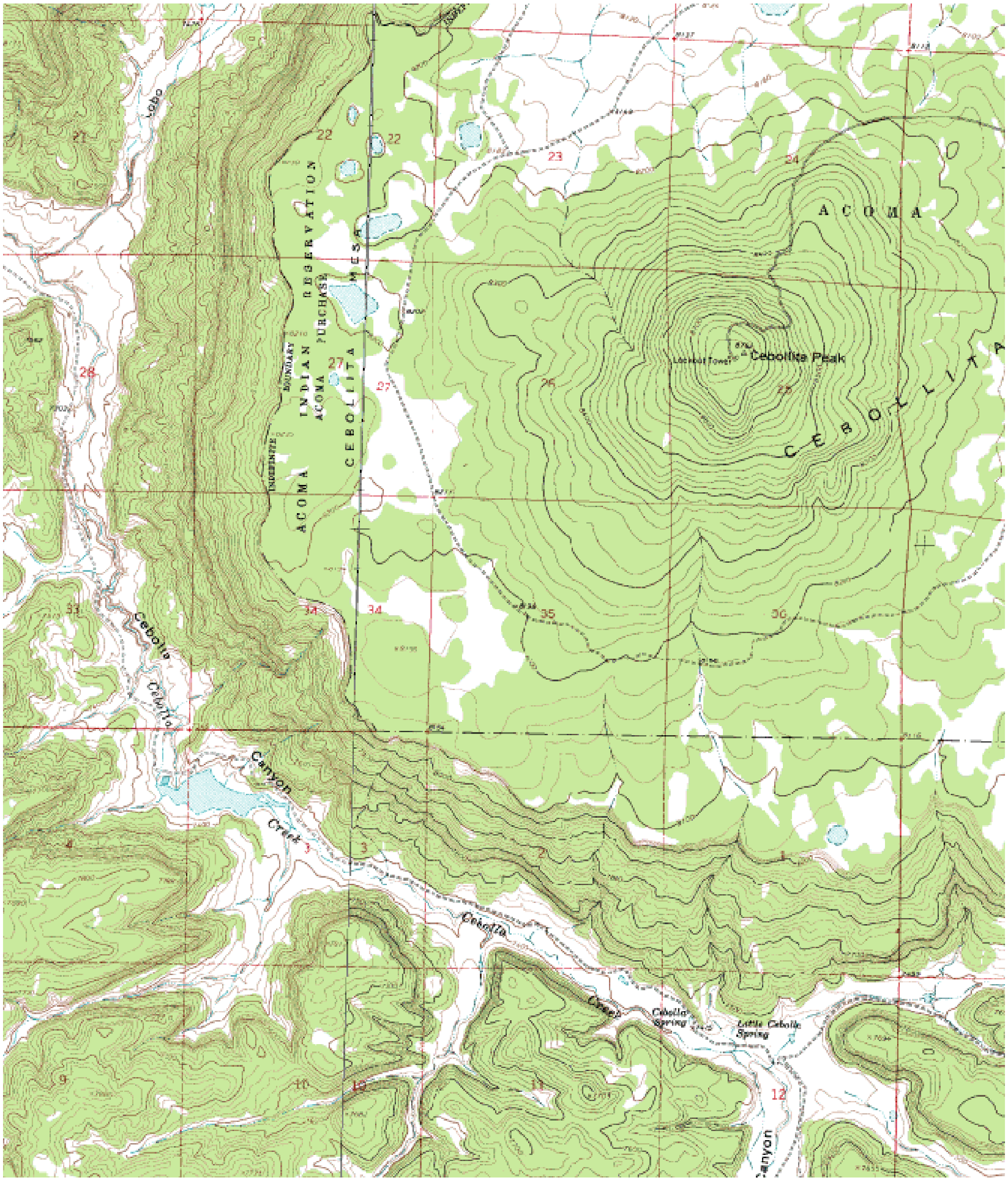
In the period that followed, from one hundred and forty to two hundred and forty million years ago, the area was above sea level and changed according to the climate from desert to forest. Hot winds brought sand and rivers deposited silts. The Chile Formation was composed of dark red shale; sandstone and conglomerate as well as the Zuni Formation feed off the materials that the winds and rivers left.

During the late Cretaceous period, one hundred and thirty-eight to sixty-three million years ago, the sea moved "back and forth across the Zuni Mountains" (Robinson, 1994). The water deposited dark shale and buff-colored sandstones that contained a multitude of fossils. The areas bordering the sea became coal deposits. Around seventy million years ago, the water retreated one last time, the Zuni Mountains were pushed up, and erosion started to expose Precambrian granite and the different layers of deposition.

6.2 TOPOGRAPHY

The highest elevation within the Cebolla Canyon Watershed is at the edge of the canyon near Cebollita Peak at just above 8,762 feet, and the lowest elevation is at just below 7,200 feet near Lobo Canyon. The major drainage is Cebolla Canyon, which has named tributaries of Sand Canyon and Lobo Canyon. The area is characterized by mesas, rock outcrops, canyons, and valley bottoms.

Reach 0 View downstream of Cebolla natural channel in the center with Side Valley Right #2 and 3.



Portion of Acoma 71/2 minute quadrangle map showing typical topography around Cebollita Peak and the major springs within Cebolla Canyon.

6.3 SOILS

6.3.1 Soil Properties

The soils of Cebolla Canyon are restricted to the geologic parent material (i.e., sandstone, siltstone, and shale) in conjunction with environmental factors such as topography, organisms, and climate. Therefore, in this environment the soils are going to be silty, sandy well-drained soils that have low molecular bondage making them highly erodible. In some areas, clay particles accumulate in the valley bottom, which restrict rapid infiltration, and perch water on the surface.

6.3.1.1 Rock Outcrop-Versilla-Mion Complex

According to the Natural Resources Conservation Service (NRCS), the largest component of soil units in the Lower Cebolla Watershed is a Rock Outcrop-Versilla-Mion complex *(515 on the soil map)*, where Rock Outcrop occupies 47 percent and Mion and Vessilla 20 percent each. This complex is found in areas with a slope range between 3 to 55 percent and at an elevation of 5,800 to 7,500 feet with an annual mean precipitation of 12 to 16 inches a year.

The Rock outcrop has very low to moderately high abilities to transmit water, which consequently encourages runoff. The Versilla series on the other hand consists of shallow, well-drained, permeable soils with a 20 percent clay content and rapid runoff characteristics. This series is formed from eolian and alluvial material that weathered from sandstone. It is found predominantly “on narrow ridges, hills, breaks and mesas of bedrock controlled landscapes” (USDA/NRCS, 2009). This soil is intermittently moist from July to October and November to March and dries during the months of May and June.

The Mion soil series is formed from fine textured material weathered from shale, claystone, or sandstone found in hills and upland areas. This shallow soil is well drained and only slowly permeable. Suitable uses for the Mion soils are range and wildlife habitat and these soils are vegetated by sideoats grama, blue grama, little bluestem, needle-and-thread, fringed sage, yucca, oak, piñon, and juniper.

6.3.1.2 Hickman-Catman

The Hickman-Catman *(25 on the soil map)* complex composes 10 percent of the lower Cebolla Watershed and consists of 45 percent Hickman and similar soils as well as 40 percent Catman. It is found in areas of zero to six percent slope at an elevation of 6,500 to 7,500 feet with an annual range of mean precipitation of 12 to 16 inches.

The Hickman series consists of 18 to 35 percent clay. It is “very deep, well drained, moderately slowly permeable soils that formed in alluvium derived from valley fill materials on flood plains and valley floors” (USDA/NRCS, 2009). This soil stays moist for large parts of the year November through April, and is intermittently moist from July through October, with the driest months being May to June. Suitable uses for Hickman series are predominantly livestock grazing and they are vegetated by alkali sacaton, giant sacaton, blue grama, and western wheatgrass.

Catman series are well drained and very slowly permeable and formed from alluvium that was acquired from sandstone and shale. Catman soils are found in floodplains, upland drainage-ways and playas. It receives around 14 inches of precipitation annually and occupies and area of zero to six percent slope. Catman soils stay intermittently moist July through September and December through March with its driest month being April through June. Catman series soils are suitable for livestock grazing and are vegetated predominantly by western wheatgrass, vine-mesquite, alkali sacaton, and four-wing saltbush. (USDA/NRCS, 2009)

6.3.1.3 Nogal-Galestina

Nogal-Galestina (550 on the soil map) sandy loams compose 7.6 percent of the lower Cebolla Watershed. It is found in areas with a one to ten percent slope and at an elevation of 6,800 to 7,500 feet and receives between 14 and 16 inches of precipitation annually.

Nogal soils are found in areas with one to ten percent slope at an elevation of 6,000 to 7,5000 feet. It consists of moderately deep and well-drained soils composed of material that formed through the weathering of gypsiferous shale. It is found on hills with slopes ranging from one to 50 percent and it receives mean annual precipitation of around 16 inches. These soils stay moist during the first 30 to 40 consecutive days following the winter solstice. Suitable uses for Nogal soils are livestock grazing and wildlife habitat and they are vegetated by piñon, alligator and one-seed juniper, wavy-leaf oak, sideoats grama, and western wheatgrass.

The Galestina series are soils that are deep, well drained and slowly permeable that formed in alluvium. Slopes are between one and eight percent receiving around 15 inches of precipitation annually and are found on hills and mesas with an elevation of 6,800 to 7,300 feet. The soils are moist during 30 to 40 consecutive days following the winter solstice. The Galestina soil series is vegetated predominantly with western wheatgrass, blue grama, sideoats grama, and scattered piñon and one-seed juniper and are suitable for livestock grazing. (USDA/NRCS, 2009)

6.3.1.4 Catman-Silkie Association

The Catman-Silkie Association *(525 on the soil map)* soils are found in areas with a one to ten percent slope at an elevation of 6,500 to 7,500 feet and receive 12 to 16 inches of rain annually.

Catman series soils are well drained and very slowly permeable. They were formed from alluvium that was acquired from sandstone and shale. Catman soils are found in floodplains, upland drainage ways, and playas. It receives around 14 inches of precipitation annually and occupies an area of zero to six percent slope. Catman soils stay intermittently moist July through September and December through March with its driest months being April through June. Catman series soils are suitable for livestock grazing and vegetated predominantly by western wheatgrass, vine-mesquite, alkali sacaton, and four-wing saltbush.

The Silkie series is characterized by deep, well-drained, very slowly permeable soils that are formed in alluvium from sandstone and shale. This series is found in areas with a slope of three to ten percent at an elevation ranging from 6,600 to 7,500 feet, receiving an average of 15 inches of precipitation annually. Its soils are moist 30 to 40 consecutive days after the winter solstice and are found on valley side slopes (USDA/NRCS, 2009).

6.3.1.5 Valnor-Techado Association

The Valnor-Techado Association (*591 on the soil map*) is found at a slope of two to twenty-five percent at an elevation of 7,200 to 8,900 feet with a mean annual precipitation of around 16 to 22 inches.

The Valnor series consist of moderately deep and well-drained soils that formed in slope alluvium, which derived from interbedded shale and sandstone on high plateaus, hills and ridges. The soils are found on hills, ridges, plateaus and mesas with a slope range of two to twenty-five percent at an elevation of 7,100 to 8,200 feet with a mean annual precipitation of around 17 inches. The soils are intermittently moist from July through September and December through April. The soils are suitable for grazing and wood production and are vegetated with blue grama, western wheatgrass, piñon, Rocky Mountain juniper, and ponderosa pine.

The Techado soil series is characterized by shallow, well-drained and slowly permeable soils that formed in slope alluvium and colluvium over residuum derived from shale and sandstone. These soils are found on summits of mesas, dipslopes of cuestas, hills, ridges and mountains on slopes that range between two to sixty percent at an elevation of 6,600 to 8,900 feet with a mean annual precipitation of 18 inches. The soils are intermittently moist from May through October and are driest in May and June. Techado soils are suitable for grazing and wood production and are vegetated with piñon, ponderosa pine, Rocky Mountain juniper and oakbrush (USDA/NRCS, 2009).

6.3.1.6 Paguate Cobbly Clay Loam

The Paguate cobbly clay loam (*291 on the soil map*) are moderately deep, well drained, slowly permeable soils that formed in alluvium derived from basalt on mesas and plateaus. The soils are found in areas with one to five percent slopes, at an elevation of 7,000 to 8,000 feet with a mean annual precipitation of 15 inches. The soils stay moist intermittently 30 to 40 consecutive days after the winter solstice (USDA/NRCS, 2009).

6.3.1.7 Pinitos-Ribera Sandy Loam

The Pinitos-Ribera sandy loam soils (*555 on the soil map*) are found at slopes ranging from one to ten percent at an elevation of 6,800 to 7,500 feet and receive mean annual precipitation of 14 to 16 inches.

The Pinitos soil series is characterized by very deep, well drained, moderately permeable soils that developed in eolian and alluvial material derived from sandstone and shale on hills, fan terraces, cuestas and mesas. The slope ranges from one to 15 percent at an elevation of 6,700 to

7,800 feet with an annual mean of 14 to 16 inches of rainfall. Pinitos soils are found on hills, mesas, cuestas and fan terraces. The soils are moist 30 to 40 consecutive after winter solstice. They are suitable for rangeland uses and are vegetated by blue grama, piñon and juniper.

The Ribera series is characterized by moderately deep sandstone bedrock soils that are well drained and formed in mixed material deposited by wind and water. They are found on upland fans and in valley fill side slopes with slopes ranging from one to nine percent at an elevation of 6,000 to 7,800 feet and receiving mean annual precipitation of 16 to 18 inches. Ribera soils are predominantly suitable for rangeland and are vegetated by blue grama, sand dropseed, snakeweed, cholla, piñon, and juniper.

6.3.1.8 Trag-Techado-Rock Outcrop Complex

The Trag-Techado-Rock Outcrop complex is found in areas with a three to 55 percent slope at an elevation of 7,200 to 8,900 feet and receives a mean of 16 to 22 inches rain annually.

The Trag soil series is characterized by very deep, well-drained soils that formed from weathered granite and schist material found on mountains, slopes and fans. It's found in areas with a 1 to 40 percent slope at an elevation of 6,800 to 8,900 feet and receives 15 to 22 inches of rain annually. Trag soils are suitable for rangeland and are vegetated with mainly blue grama, big and little bluestem, junegrass, some forbs and shrubs, and widely spaced ponderosa pine.

The Techado soil series is characterized by shallow, well-drained and slowly permeable soils that formed in slope alluvium and colluvium over residuum derived from shale and sandstone. These soils are found on summits of mesas, dipslopes of cuestas, hills, ridges and mountains on slopes that range between two to sixty percent at an elevation of 6,600 to 8,900 feet with a mean annual precipitation of 18 inches. The soils are intermittently moist from May through October and are driest in May and June. Techado soils are suitable for grazing and wood production and are vegetated with piñon, ponderosa pine, Rocky Mountain juniper, and oakbrush.

The Rock Outcrop obtains properties with very low to moderately high abilities to transmit water and consequently encourages runoff. The Vessilla series on the other hand consists of shallow, well-drained, permeable soils with 20 percent clay content and rapid runoff characteristics. This series is formed from eolian and alluvial material that weathered from sandstone. It is found predominantly "on narrow ridges, hills, breaks and mesas of bedrock controlled landscapes" (USDA/NRCS, 2009). This soil is intermittently moist from July to October and November to March and dries during the months of May and June.

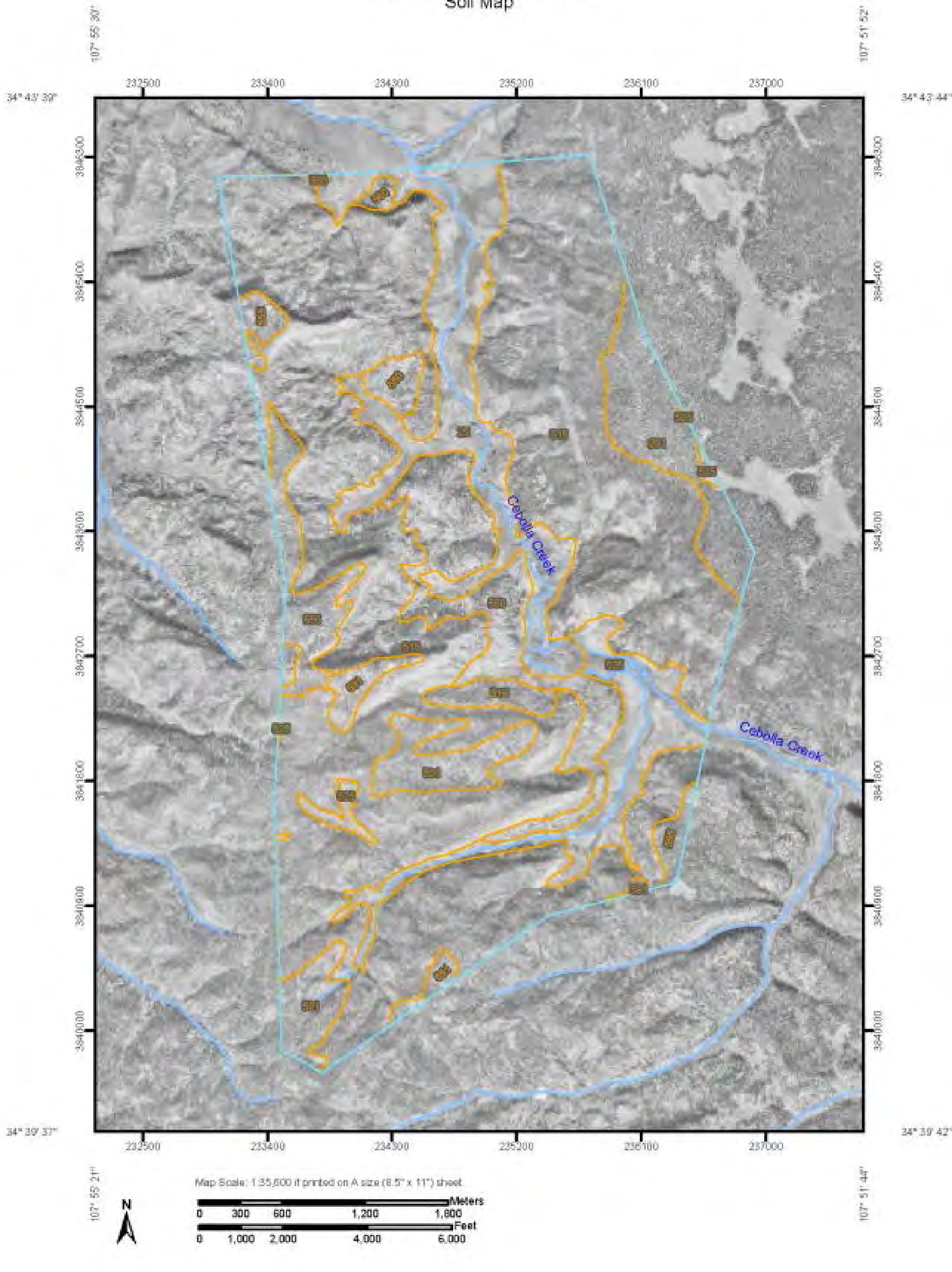
Other soils composing the upper Cebolla Watershed are present at less than one percent and are not described here (USDA/NRCS, 2009).

i. Soil Resource Table

Lower Cebolla Watershed				
Map Unit Symbol	**Map Unit Name**	**Acres AOI**	**Slope**	**Percent of AOI**
25	Hickman-Catman complex,	432.8	1 to 6 percent	10.0%
291	Paguate cobbly clay loam	177,4	1 to 5 percent	4.1%
515	Rock Outcrop-Versilla-Mion complex	2,714.2	3 to 55 percent	62.5%
525	Catman Silkie association	245.1	1 to 10 percent	5.6%
535	Millpaw loam	5.9	0 to 5 percent	0.1%
550	Nogal-Galestina sandy loams	330	1 to 10 percent	7.6%
555	555 Pinitos-Ribera sandy loam	163.3	1 to 10 percent	3.8%
560	Flugle-Teco association	14.2	1 to 8 percent	0.3%
591	Valnor-Techado association	220.3	2 to 25 percent	5.1%
615	Trag-Techado-Rock Outcrop complex	40.2	3 to 55 percent	0.9%
Middle Cebolla Watershed				
Map Unit Symbol	**Map Unit Name**	**Acres AOI**	**Slope**	**Percent of AOI**
290	Paguate-Hackroy complex	45.0	1 to 5 percent	0.5%
291	Paguate cobbly clay loam	957.1	1 to 5 percent	10.3%
515	Rock Outcrop-Versilla-Mion complex	1,884.4	3 to 55 percent	20.3%
525	Catman Silkie association	774.0	1 to 10 percent	8.3%
555	555 Pinitos-Ribera sandy loam	126.6	1 to 10 percent	1.4%
591	Valnor-Techado association	5,133.0	2 to 25 percent	55.3%
615	Trag-Techado-Rock Outcrop complex	360.8	3 to 55 percent	3.9%
Upper Cebolla Watershed				
Map Unit Symbol	**Map Unit Name**	**Acres AOI**	**Slope**	**Percent of AOI**
515	Rock outcrop-Versilla-Mion complex	2,050.0	3 to 55 percent	20.8%
525	Catman Silkie association	931.5	1 to 10 percent	9.5%
550	Nogal-Galestina sandy loams	205.3	1 to 10 percent	2.1%
591	Valnor-Techado association	6,655.4	2 to 25 percent	67.6%
W	Water	NA	7.0	0.2%

(USDA/NRCS, 2009)

Custom Soil Resource Report
Soil Map



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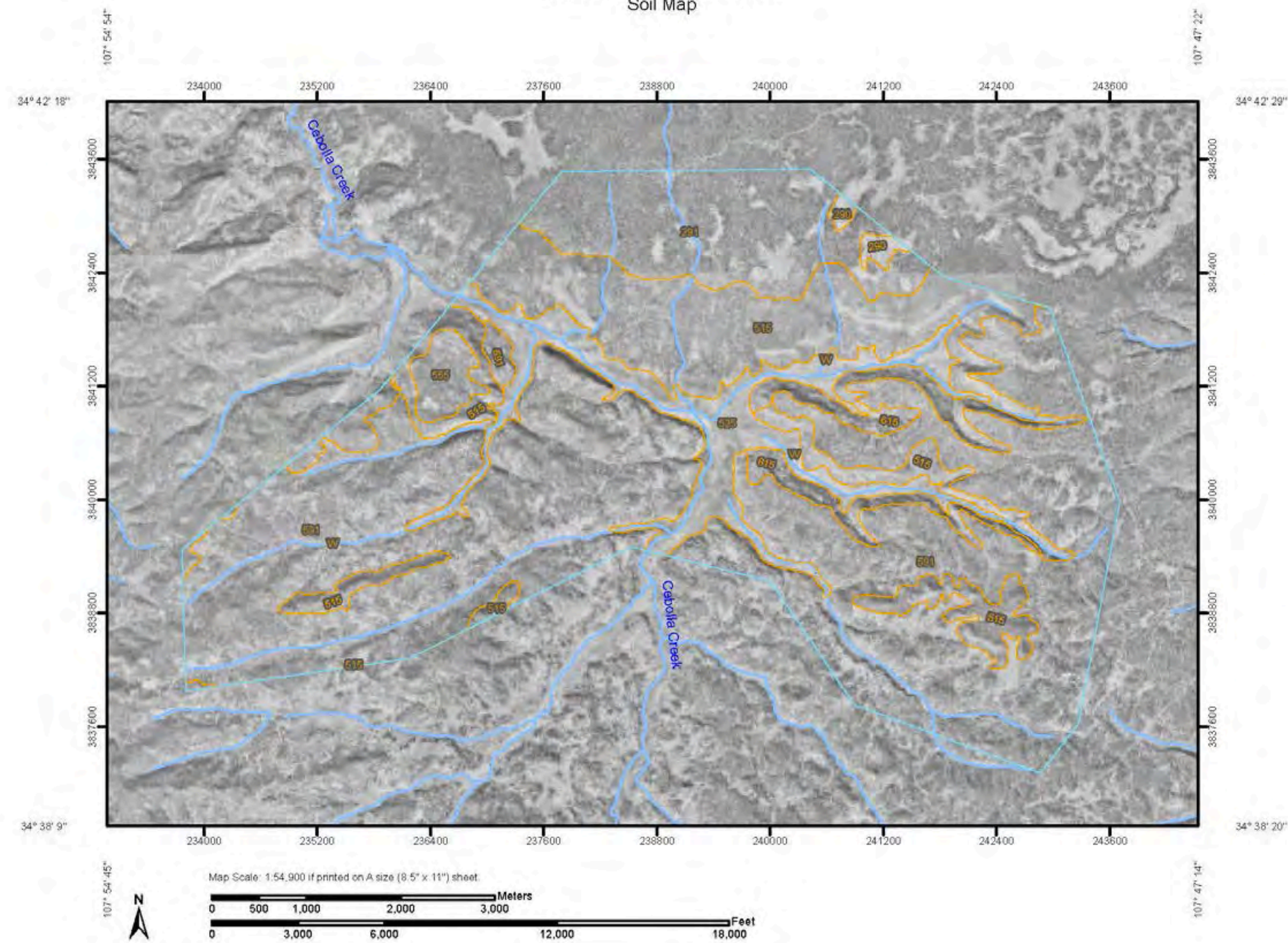
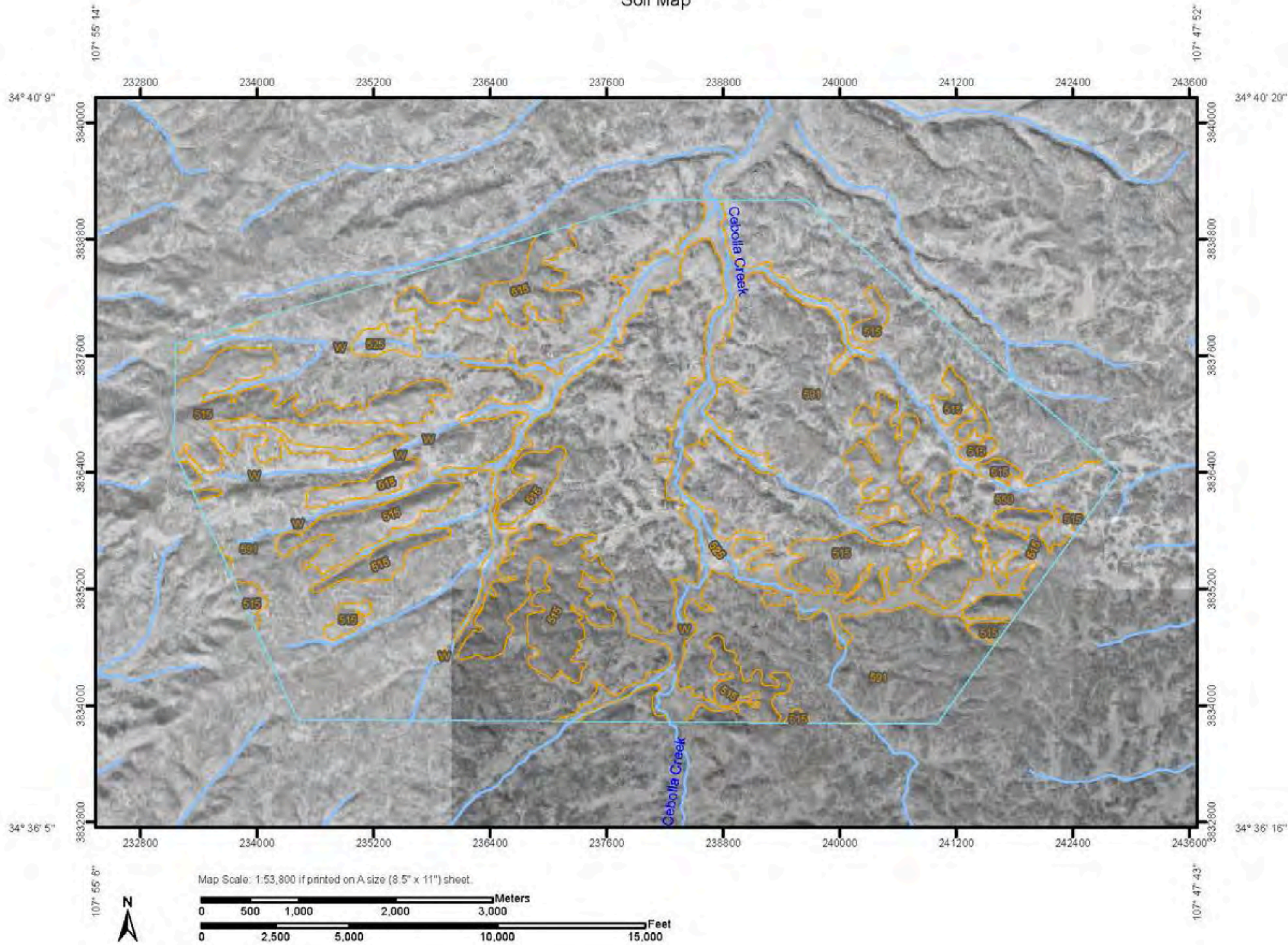


Soil Map


Cebolla Creek
Cebolla Creek
Map Scale: 1:53,800 if printed on A size (8.5" x 11") sheet.
Meters
0 500 1,000 2,000 3,000
Feet
0 2,500 5,000 10,000 15,000
N
34° 40' 9"
34° 40' 20"
34° 36' 5"
34° 36' 16"
107° 55' 14"
107° 47' 52"
107° 55' 6"
107° 47' 43"

6.3.2 Hydraulic Soils

Hydraulic soil type allows us to understand the runoff potential for the soil. That is to say that this is the amount of water that the soil is able to absorb before it reaches capacity. The soils in the United States are given a letter rating from A-D.

Group A: Soils are deep, well drained and have a high infiltration rate.
Group B: Soils are moderately deep somewhat well drained and have moderate infiltration rate.
Group C: Soils have slow infiltration rate when thoroughly wet. They have a layer that impedes the downward movement of water or soils of moderately fine texture.
Group D: Soils having a very slow infiltration rate or have a high runoff potential. This group consists mainly of clays layers near the surface. (USDA/NRCS, 2009)

The following table illustrates the runoff potential for the main soil types in Cebolla Canyon.

ii. Hydraulic Soil Rating:

Soil Type	Rating
Rock Outcrop-Versilla-Mion (515)	D
Catman-Silkie (525)	D
Valnor-Techado (591)	C
Trag-Techado-Rock Outcrop (615)	D

These ratings confirm the soils infiltration abilities to be very poor. With low infiltration rates comes high amounts of surface water movement and erosion potential, as well as perched water once the floodwater disperses downstream, creating wetland formation opportunities.

6.3.3 Available Water Capacity

Available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants. “The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer.” The soil’s ability to retain water and make it available for plants is crucial for vegetative growth in times of extreme weather conditions such as droughts (USDA/NRCS, 2009).

The following table illustrates the runoff potential for the main soil types in Cebolla Canyon.

iii. Available Water Capacity:

Soil Type	Rating
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	0.15
Valnor-Techado (591)	0.16
Trag-Techado-Rock Outcrop (615)	0.16

6.3.4 The Water Erosion Factor

The water erosion factor is used to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates, which are numerical on a scale of 0.02-0.69, are based on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity. The higher the numerical value, the more vulnerable the soil is to sheet and rill erosion (USDA/NRCS, 2009).

iv. Sheet and Rill Erosion Potential:

Soil Type	Rating
Rock outcrop-Vessilla-Mion (515)	N/A
Catman-Silkie (525)	0.32
Valnor-Techado (591)	0.32
Trag-Techado-Rock Outcrop (615)	0.15

These ratings show that all the soils in the survey are vulnerable to rill and sheet erosions when saturated during weather events. This erosion is visible today with the frequent occurrence of headcuts and gullies.

6.3.5 Wind Erodibility Index

Wind Erodibility Index gives a numerical value to the exposure of the soil to wind erosion. The number estimates the amount of erosion that will take place per acre per year due to wind erosion. This number is related to bare soil, without vegetation, and is influenced primarily by aggregate size and surface features such as rocks and other debris (USDA/NRCS, 2009).

v. Wind Erodibility:

Soil Type (tons) per acre per year	Rating
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	86
Valnor-Techado (591)	48
Trag-Techado-Rock Outcrop (615)	56

6.3.6 Organic Matter

Organic matter is the plant and animal deposits in the soil represented at the different stages of decomposition. Organic matter is fundamental in the production of new soil humus, which is a highly chemically and biologically active portion of the soil. It is measured by weight of the soil material that is less than two millimeters in diameter. But the rating given below is a richness percentage. The higher the number, the richer is the soil in organic matter (USDA/NRCS, 2009).

vi. Organic Matter Rating:

Soil Type (tons) per acre per year	Rating
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	0.31
Valnor-Techado (591)	0.57
Trag-Techado-Rock Outcrop (615)	0.57

These numbers demonstrate a mid to lower range of organic material present in the soils. These numbers also give a good indication to the decomposition rate of the present vegetation in the soils.

6.3.7 Clay

Clay consists of mineral soil particles that are less than 0.002 millimeter in diameter. The amount of clay influences the shrink-swell and plasticity of the soil. “The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture” (USDA/NRCS, 2009).

vii. Soil Clay Content:

Soil Type Percentage Clay	Rating
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	60.1
Valnor-Techado (591)	38.4
Trag-Techado-Rock Outcrop (615)	25.3

6.3.8 Sand

Sand consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. “The estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter” (USDA/NRCS, 2009). The amount of sand is extremely important for soil functionality and hydrology.

viii. Percent Sand:

Soil Type	Percent Sand in Soil
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	15.0
Valnor-Techado (591)	30.6
Trag-Techado-Rock Outcrop (615)	54.1

6.3.9 Silt

Silt in the soil consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. Silt levels determine soil hydrology, erosion rates, and soil physicality. The rating below is based on percentage of silt present in the survey.

ix. Silt Content:

Soil Type	Percent
Rock Outcrop-Versilla-Mion (515)	N/A
Catman-Silkie (525)	24.8
Valnor-Techado (591)	31.0
Trag-Techado-Rock Outcrop (615)	20.6

6.3.10 Hydric Soils

The occurrences of hydric (i.e, wetland) soils were compiled for the North Plains watershed from the soil data from the NRCS (NRCS/USDA, 2012) (http://soildatamart. nrcs.usda.gov/). The "Cibola Area, New Mexico, Parts of Cibola, McKinley, and Valencia Counties" (survey# NM682) and "Catron County, New Mexico, Northern Part" (survey# NM648) surveys were used to cover the analysis area. The "Hydric Soils" pre-formatted report identified "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under

natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation." This analysis resulted in 10 hydric soil types being identified within the North Plains closed basin survey area. These soils are found in floodplains, drainageways, swales, and all soils fall under the hydric criterion of "soils that are frequently flooded for long or very long duration during the growing season." Surprisingly, more playas were not identified with this analysis, but this could be due to the large scale of the soil types versus the small scale of the individual playas. The larger analysis can assist in wetland delineation, wetland mapping, planning projects, and targeting future wetland restoration projects.

x. Hydric Soil found within the North Plains Closed Basin:

Soil Type	Number	Slope
Hickman-Catman complex Cibola	25	1 to 6
Warm Springs loam Cibola	30	0 to 2
Catman clay loam Cibola	70	1 to 3
Catman sandy clay loam Cibola	73	1 to 3
Saladon clay loam Cibola	300	0 to 5
Catman-Silkie association Cibola	525	1 to 10
Pietown-Hickman complex Catron	422	0 to 5
Catman-Hickman complex Catron	425	1 to 5
Catman silty clay Catron	494	0 to 2

6.4 ECOLOGY

6.4.1 Ecotypes

6.4.1.1 Wetland and Plant Communities (Natural Heritage New Mexico Program Information)

Natural Heritage New Mexico (NHNM) performs research on the conservation and sustainable management of New Mexico's biodiversity. They have compiled an inventory of the State's wetland vegetation communities. This inventory is a "hierarchical vegetation classification which provides detailed information about individual wetland plant community types including: marshes, streamside riparian areas, playas, wet meadows, lakeshores, and peatlands" (Muldavin, 2000).

Applying the NHNM wetland vegetative data to Cebolla gives a better understanding of existing conditions, community types, transitional states, composition, and structure. The following table displays the New Mexico wetlands vegetation classification for the communities presently occurring at Cebolla.

xi. Wetland Vegetation

New Mexico Wetlands Vegetation Classification	National Vegetation Classification Cross walk and Scientific Name
Lowland persistent emergent wetland: Semi-permanently flooded	V.A. 5n1 Semi-permanently flooded temperate or subpolar grassland

Broadleaf Cattail Alliance	*Typha latifolia* Herbaceous Alliance
Baltic Rush Alliance	*Juncus balticus* Flooded Herbaceous Alliance
Needle-leaved Scrub Shrub Wetland	
Lowland Exotic Needle-leaved Deciduous Scrub Shrub Wetland	
Temporarily Flooded Salt Cedar Alliance	*Tamarix spp.*

6.4.1.2 Baltic Rush Alliance (semi-permanently flooded)

Baltic Rush (*Juncus balticus*) is found in flooded temperate or subpolar grasslands between 5,675-7,850 feet. The soils are hydric and rich in organic material and are "young Typic or Mollic Fluvaquents with silty coarse-loamy textures" (Muldavin, 2000).

<u>Other vegetative species typically present are:</u>

- Shortawn foxtail (*Alopecurus aequalis*)
- Porcupine sedge (*Carex hystericina*)
- Nebraska sedge (*Carex nebrascensis*)
- Clustered field sedge (*Carex pragracilis*)
- Common Spikerush (*Eleocharis palustris*)
- Alkcali muhly (*Muhlembergia aspertfolia*)
- Other *Juncus* species

These communities are found in low alluvial bars, islands, moderate gradient streams or rivers, back channels, pond edges, and spring-fed wet meadows.

6.4.1.3 Needle-leaved Scrub Shrub Wetland

The needle-leaved scrub shrub wetland, or Salt Cedar Alliance, is distributed throughout the Western United States and Great Plains. As the name suggests the Alliance consists of salt cedar. Salt cedar is found in every basin in New Mexico and is considered to be an invasive exotic plant. The community of salt cedar trees represented in Cebolla Canyon is small (75±25). There are future plans for its removal as it may compromise the intended wetland community by outcompeting native wetland species.

The salt cedar community is found at elevations of 3,825-6,000 feet. The community occurs often in basins, narrow canyons, on alluvial flats, around playas and in poor as well as rich soil types. A dominant species with shrub canopies forming 40-60 percent cover also has an understory that is "grassy and strongly dominated by luxuriant alkali sacaton and bottomland bunchgrass" (Muldavian, 2000).

Other present species are often:

- Sandbur (*Cenchrus caroltntanus*)
- Bristlegrass (*Setaria leucoptia*)
- Spike dropseed (*Sporobolus contractus*).
- Forbs vary and the same variety is not often continuous.

6.4.2 Existing Vegetation

The existing wetland vegetation species list will expand over time but for now the following table gives a preliminary list from vegetation monitoring efforts.

xii. Vegetation Species List

Species List	
Scientific Name	**Common Name**
Achillea millefolium	yarrow
Achnatherum hymenoides	Indian ricegrass
Achnatherum robustrum	sleepygrass
Artemisa dracunculus	tarragon
Artemisia frigida	sagewort
Atriplex canescens	flowering saltbrush
Bouteloua barbata	6-week grama
Bouteloua gracilis	blue gramma
Bromus tectorum	cheatgrass
Carex praegraclis	field sedge
Chrysothamnus nauseosus	rabbitbrush
Cleome serrulate	beeplant
Conyza canadensis	horseweed
Desciraonia pinnate	Western tansy-mustard
Eleocharis palustris	spikerush
Eleocharis quinqueflora	few-flowered spikerush
Elymus smithii	Western-wheatgrass
Epilobium ciliatum	epilobium
Erigeron divergens	margarita
Euphorbia sp.	euphorbia species (spurge)
Euphorbia spathilate	warty spurge
Festuca arundinacea	tall fescue
Grindelia squarosa	gumweed
Gutierrezia sarothrae	snakeweek
Hackelia hirsute	stickseed

Hordeum jubatum	foxtail barley
Juncus balticus	baltic rush
Juncus torrey	torre's rush
Kochia scoparia	kochia
Lycopus asper	bugleweed
Lycurus phieoides	wolf tall
Melilotus officinalis	yellow sweet clover
Muhienbergia asperifolia	scratchgrass
Muhienbergia Montana	mountain muhly
Muhienbergia repens	creeping muhly
Opuntia sp.	prickly pear
Plantago patagonica	wooly plantain
Poa pratensis	Kentucky bluegrass
Polygonum puncatatum	smartweed
Portulaca oleracea	pursiane
Prunella vulgaris	self-heal mint
Ranunculus scelaratus	cursed butter-cup
Ratibida tagetes	Mexican hat
Rumex crispus	dock
Salsola kali	Russian thistle
Schoenoplectus tabernaemontani	bulrush
Soiribilis aeroides	alkali scaton
Sporobolus contractus	spike dropseed
Tamarix ssp.	Salt cedar Tamarix
Taraxacum officinale	dandelion
Thelesperma subnudum	cota
Thermopsis montana	goldenpea
Tragopogon dubius	salsify
Typha latigolia	cattail
Vicia americana	American vetch
Vulpia octoflora	fescue

7.3.3 Ecoregions

An ecoregion is a defined area that is larger than an ecosystem but smaller than a bioregion and ecozone. They contain characteristic, geographically distinct assemblages of natural communities and species. Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components (Bryce, 1999). In the following section we will identify the Cebolla

Canyon Ecoregions using a New Mexico EPA ecoregional map and then elaborate on the ecoregion types.

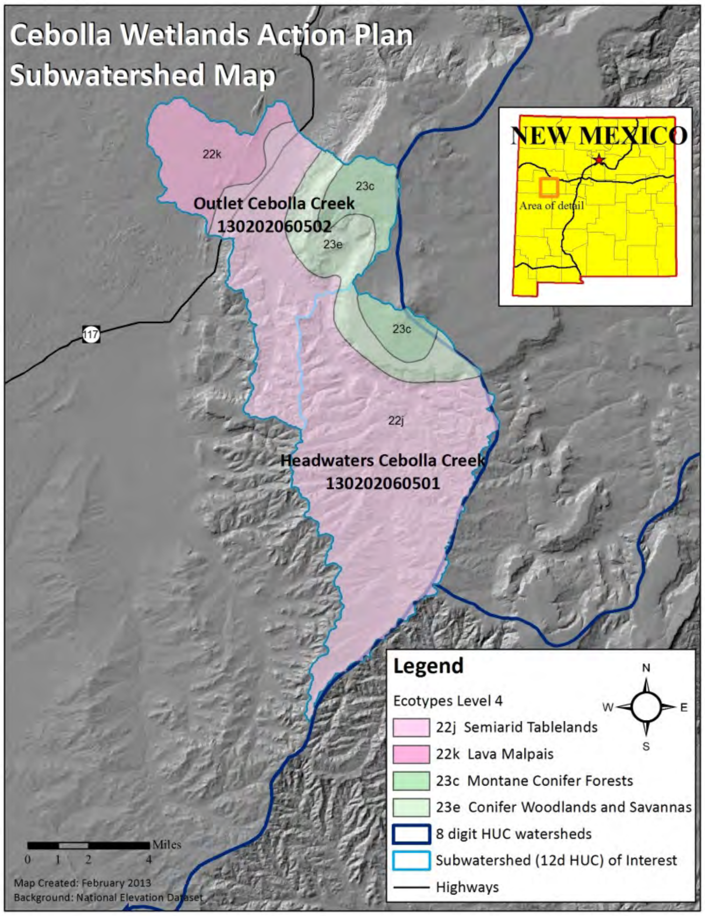
Cebolla Canyon contains three Ecoregions types: 22j Semiarid Tablelands, 23c Montane Conifer Forest, and 23e Conifer Woodlands and Savannas.

6.3.3.1 Semiarid Tablelands

This ecoregion consists of mesas, plateaus, valleys, and canyons formed mostly from flat to gently dipping sedimentary rocks, along with some areas of Tertiary and Quaternary volcanic fields. The region contains areas of high relief as well as some relief plains. Bedrock exposures are common. Grass, shrubs, and woodland cover the tablelands. It lacks the denser pine forests of the higher and more mountainous Ecoregion 23. Scattered junipers occur on shallow, stony soils, and are dense in some areas. Piñon-juniper woodland is also common in some areas. Saltbush species, alkali sacaton, sand dropseed, and mixed grama grasses occur (Omernik & al, 2009).

6.3.3.2 Montane Conifer Forests

The montane conifer forest is found west of the Rio Grande at elevations from about 7,000 to 9,500 feet. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry. Some Douglas fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. In the far south, other oaks appear, such as silverleaf oak, netleaf oak, Arizona white oak, and Emory oak. The summer rains are especially important for herbaceous plants. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks. Livestock grazing, logging, and recreation are the primary land uses. Wildfire is an important feature influencing the forested ecosystems in this region (Omernik & al, 2009).



6.3.3.3 Conifer Woodlands and Savannas

This ecoregion is an area of mostly piñon-juniper woodlands, with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands. The region is generally cooler, with more uniform winter and summer seasonal moisture compared to Ecoregion 23b. It lacks the milder winters, wetter summers, chaparral, Madrean oaks, and other species of Ecoregion 23b Madrean Lower Montane Woodlands (Omernik & al, 2009).

6.4.4 Threatened and Endangered Species

6.4.4.1 Federally Listed Threatened, Endangered and Candidate Species

There are five federally listed threatened, endangered and candidate species that are likely to occur in Cibola County, according to the USFWS; however only two are found within or near the planning area. Following is a list of threatened, endangered and candidate species that are potentially found in Cibola County:

- The yellow-billed cuckoo (*Coccyzus americanus*), a candidate, which occasionally occurs in the riparian areas of Cebolla Canyon.
- The Zuni bluehead sucker (*Catostomus discobolus yarrow*), a candidate as well, found amongst others in low-velocity pools and pool-runs.
- The endangered southwestern willow flycatcher (*Empidonax traillii extimus*), found in scrubby, brushy areas, swamps and open woodland.
- The endangered black-footed ferret (*Mustela nigripes*), found in grasslands, as well as steppe and shrub steppe. However, this species might have already been extirpated in New Mexico.
- The threatened Mexican spotted owl (*Strix occidentalis lucida*), found in mixed-conifer forests.

As mentioned above, only two of these species have been sited in Cebolla Canyon: the yellow-billed cuckoo and the Southwestern willow flycatcher.

6.4.4.2 New Mexico State Threatened, Endangered and Sensitive Animal Species

Additionally, New Mexico has listed five species that are threatened or sensitive faunal species, which potentially occur in or close to Cebolla Canyon. Listed below are those that are likely to occur in the planning area.

- The threatened bald eagle *(Haliaeetus leucocephalus alascanus*), that rarely migrates into the planning area, but is not known to reside or breed here.
- The threatened gray vireo (*Vireo vicinior*), found in semi-arid thorn scrubs, oak-juniper woodlands as well as piñon-juniper, dry chaparral, mesquite, and riparian willow habitats. This species is occasionally found in the piñon-juniper woodlands in Cebolla Canyon during the summer months.

- The little brown occult bat (*Myotis lucifugus occultus*) with a sensitive status, is found in caves and hollow trees, but is not a permanent resident in New Mexico.
- The threatened spotted bat (*Euderma maculatum*) is found in ponderosa pine, piñon-juniper woodlands as well as canyon bottoms and open pastures.
- The red fox (*Vulpes vulpes fulva*) with a sensitive status, is found in open and semi-open habitats, but avoids dense forests.

6.4.4.3 Federal Animal Species of Concern

There are two federal species of concern that are likely to appear in or close to Cebolla Canyon. The Townsend's big-eared bat (*Corynorhinus townsedii)* is known to appear in areas with caves or mines but will also occupy hollow trees for roosting. It has recently been seen in Reach 8 of the restoration area. The northern goshawk also occasionally resides in the planning area. It is found in mature coniferous stands and will forage in open habitats.

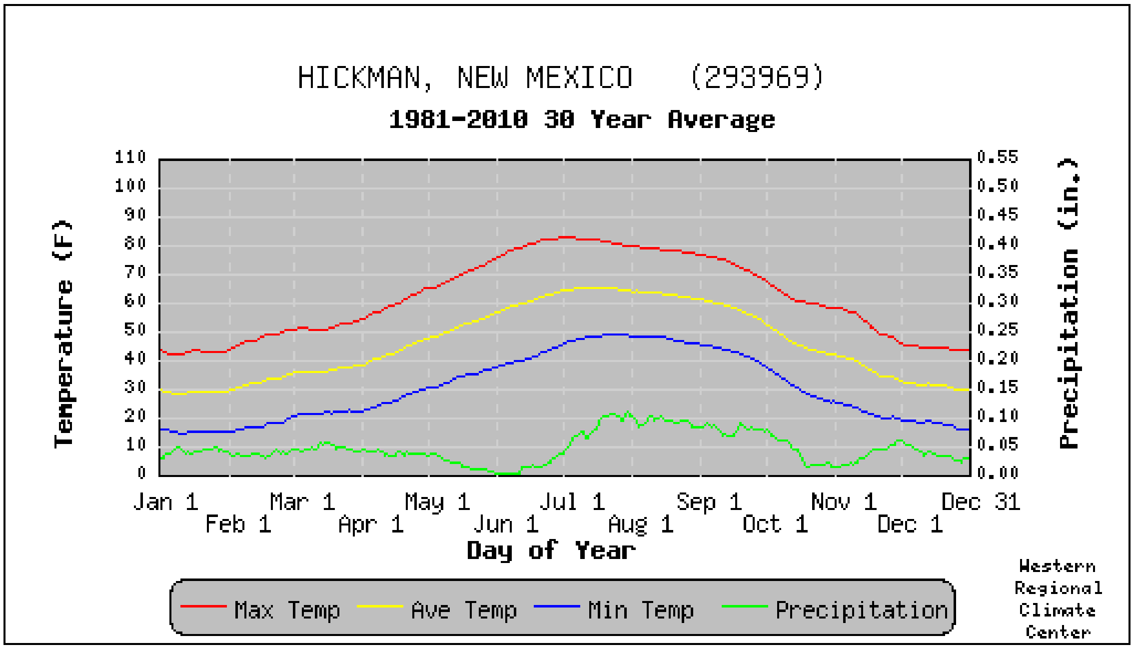
6.4.4.4 Threatened and Endangered Species and Species of Concern – Flora

Two threatened plant species as well as two species of concern are likely to occur in or near Cebolla Canyon. Listed below are the species that are potentially present.

- The threatened Pecos sunflower (*Helianthus paradoxus*) is found in soils that are permanently saturated because it requires a permanent water source for survival. However, Cebolla and Cebollita springs are not known to support this species.
- The threatened Zuni fleabane (*Erigeron rhizomatus*) is known to occur at higher elevations in Cibola County south of Cebolla Canyon.
- The Acoma fleabane (*Erigeron acomanus*) is a federal species of concern found on shaded, sandy slopes.
- The cinder phacelia (*Phacelia serrate*) is also a federal species of concern that occurs on volcanic scoria slopes, which are not found in Cebolla Canyon, but are found in close proximity within El Malpais.

6.5 CLIMATE

Cebolla Canyon is located in semi-arid west-central New Mexico. According to the Western Regional Climate Center (WRCC, 2014) the area receives approximately 12 inches annually, with most of its precipitation falling between July and September. Temperatures vary from average highs in the sixties to average lows in the twenties. Extreme temperatures can reach down to below zero as well as above to above 90° Fahrenheit.



6.6 HYDROLOGY

The Cebolla stream is predominantly intermittent and only flows as a result of storm events. After such events, the water will percolate into "the groundwater systems within the following weeks" (NPS, 2012). Because of underlying eolian deposits, erosion is a constant concern within the area.

Most of the Cebolla Canyon Wetlands are classified as palustrine wetland types that we defined earlier in section 5.3.2 'Cebolla Classification using the Cowardin System.' The wetlands in Reaches 2 through 8 are considered Riverine. Wetlands immediately downstream of Cebolla Springs (Reaches 1 to 2) are considered to be slope wetlands.

As mentioned previously, manipulations of the Cebolla Creek stream channel had greatly altered the flow and hydrology, which displaced the stream from its natural drainage. Following these alterations, head cutting occurred that dried out adjacent wetland areas.

Since 1994 restoration efforts by a number of organizations including but not limited to the BLM, the AWF, the SWQB Wetlands Program, and the RPA have resulted in an expansion of the wetland area. The most recent report regarding wetland restoration prepared for the Rio Puerco Alliance in 2013 (Vrooman, 2013) showed that between 2010 and 2013, 3.8 acres were added to the Cebolla Creek Reaches 0-5 totaling 20.5 acres of wetland. This can be attributed to the restoration techniques. "Simple actions such as plugging a gully with sandbags started a chain reaction that filled a 200 foot gully and created a 10 acre wetland that continues to expand today" (Vrooman, 2013). Additionally, there were 29.4 acres, which according to Vrooman, were areas that have "wetland hydrology but did not have wetland vegetation."

Hydrologic information on Cebolla Canyon (USGS hydraulic unit codes [HUC] 130202060501 and 130202060502) and North Plains (HUC 13020206) is limited, with no current or historical U.S. Geological Survey gages in the watershed. Hydrology monitoring systems were put into place during the 2011 restoration project to measure precipitation and groundwater levels. A geomorphological study of Cebolla Creek channel was conducted by Steve Vrooman of Keystone Restoration Ecology prior to the 2011 restoration work. The following section will examine the data in Reaches 0 and 7.

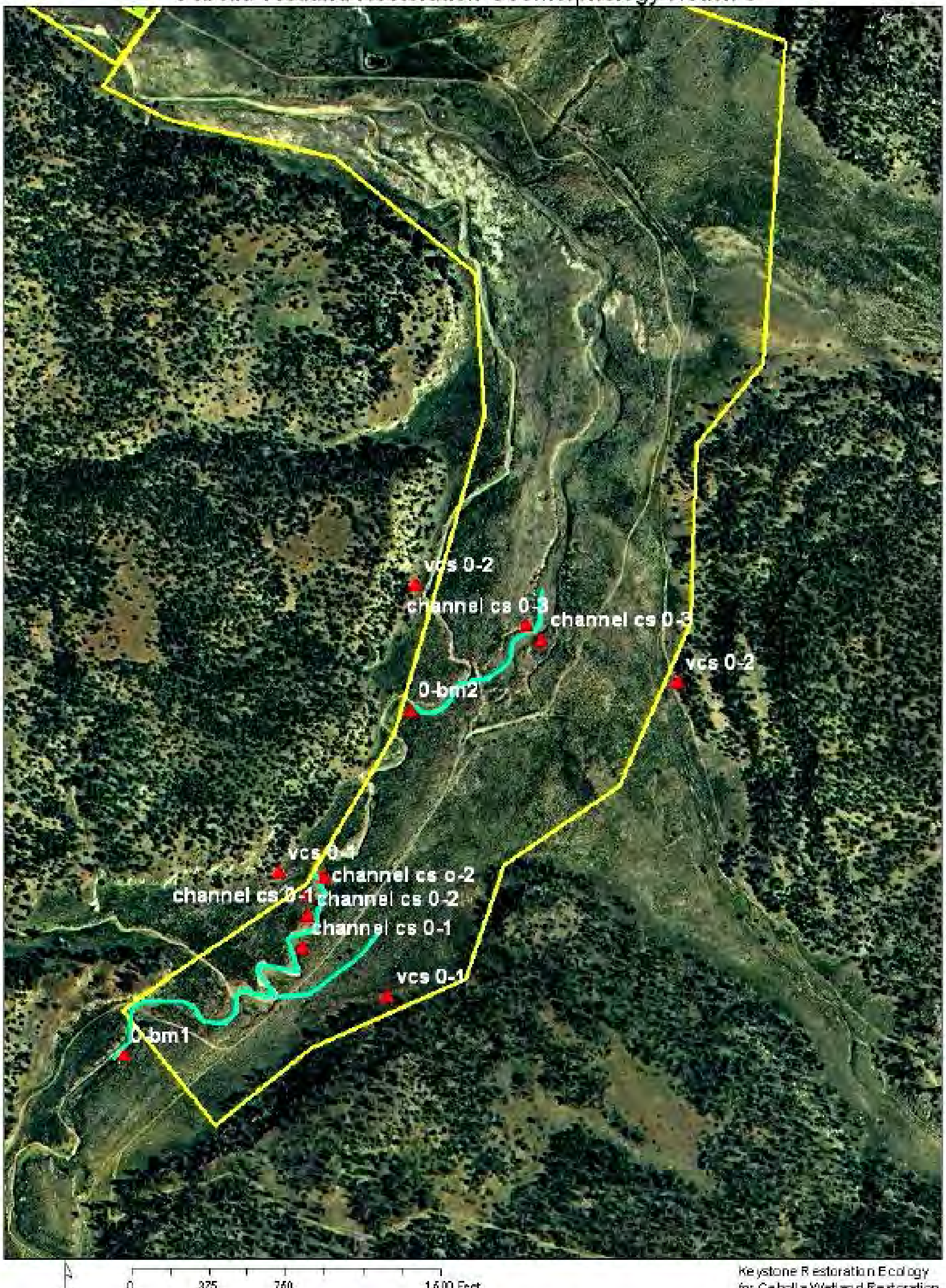
Vrooman used the Rosgen channel classification system to characterize and identify the channel types in Cebolla Creek. The necessary information needed to determine geomorphic setting, hydraulic tendencies, and channel type is:

- Cros sectional area
- Bankfull width
- Width to depth ratio
- Entrenchment ratio
- Slope
- Manning´s N
- Stream flow
- Q (cfs)

The channel processes and assessments are "crucial to understand the regime flow patterns and to stratify empirical hydraulic and sediment relations of the condition to minimize variance" (Rosgen, 2007).

Cebolla Creek Reference Reach. A reference reach is "a portion of a river segment that represents a stable channel within a particular valley morphology. The morphological data collected is used for extrapolation to disturbed or unstable reaches in similar valley types for the purposes of restoration, stream enhancement, stabilization, and stream naturalization schemes" (Rosgen, 1998). Vrooman identified the cross-sectional area 0-1, in the Southeast quadrant of Reach 0, as the bankfull (frequent occurring peak flow) reference reach.

Cebolla Wetland Restoration Geomorphology Reach 0



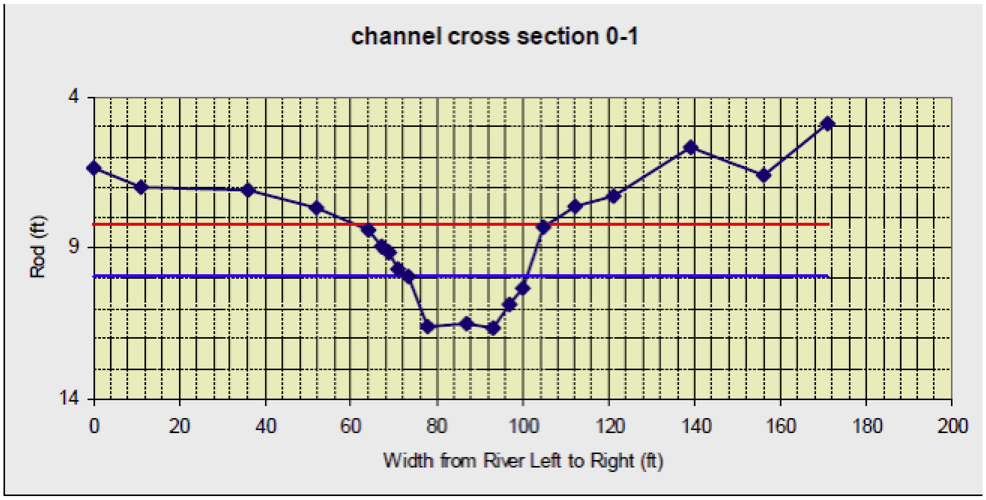
Cross Section 0-1 Data	
Cross section area	36 square feet
Bankfull width	26.5
Width to depth ratio	20.1
Flood prone width	41 ft.
Entrenchment ratio	1.5
Stream flow	Ephemeral
Bed Material	Silt/Sand
Slope	0.05
Channel type	**Bc**

At this cross section, the Bc channel type is an indication that the channel has two Rosgen stream classifications characteristics. The capital B is an indication of the dominant characteristics. According to Rosgen a type B channel is generally characterized as "moderately entrenched with moderate gradient, riffle dominated channel with infrequently spaced pools" with landform and soil features of "moderate relief, collovial deposition. Moderate entrenchment and width/depth ratio. Narrow gently sloping valleys and predominate rapids with scour pools" (Rosgen, 1994,1996). The B channel type classification characteristics are the following:

- Entrenchment ratio 1.4 to 2.2
- W/D ratio >12
- Sinuosity >1.2
- Slope 0.02 to 0.039

The lowercase c gives an indication of a more accurate landform and soil features as well as slope. Rosgen states that a type c channel has "broad valleys with terraces, in association with flood plains and alluvial soils. Slightly entrenched with well-defined meandering channels and riffle/pool bed morphology" (Rosgen, 1994, 1996). The C channel type classification characteristics are the following:

- Entrenchment ratio <2.2
- W/D ratio >12
- Sinuosity >1.2
- Slope <0.02



Vrooman identified Reach 7 as an area where flood debris was located and could be a good indicator of levels for a 50-year flood.

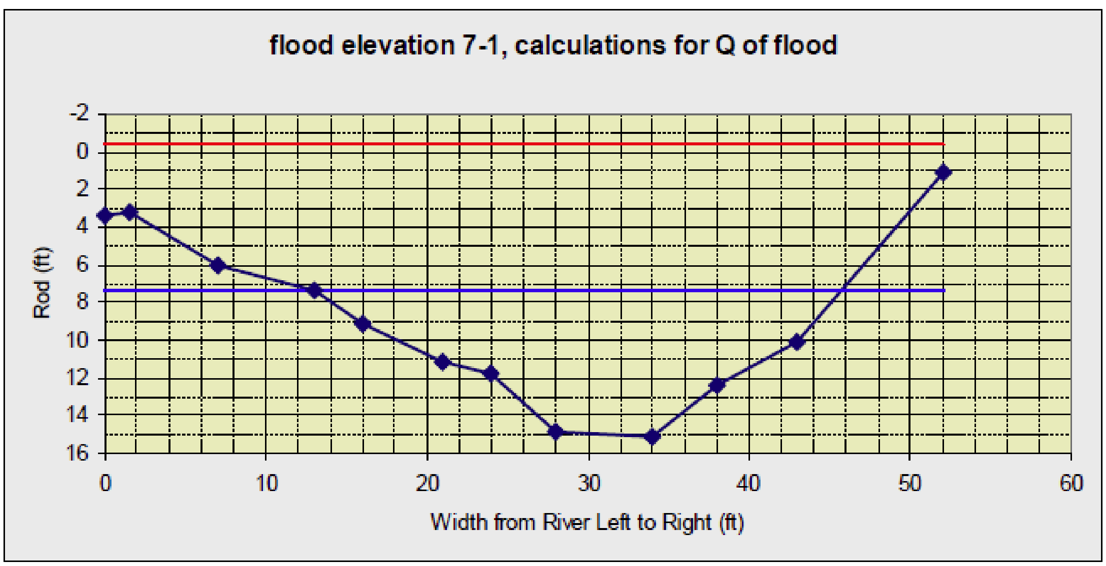
Cross section 7-1 data

Cross section area	33.7 square feet
Bankfull width	16 ft.
W/D ratio	8.1
Flood prone width	30 ft.
Entrenchment ratio	1.9:1
Slope	0.04
Stream flow	Ephemeral
Bed Material	Silt/Sand
Q (cfs)	1075
Manning N	.038 (estimated)
Channel type	**G**

A Rosgen type G channel is generally described as an "entrenched gully with step/pools and low width to depth ratio on moderate gradients." Its landscape and soil features have "gullied morphology with moderate slopes and low width to depth ratio. Narrow valleys or deeply incised in alluvial or colluvial, materials. It is unstable with grade control problems and high bank erosion rates" (Rosgen, 1994, 1996).

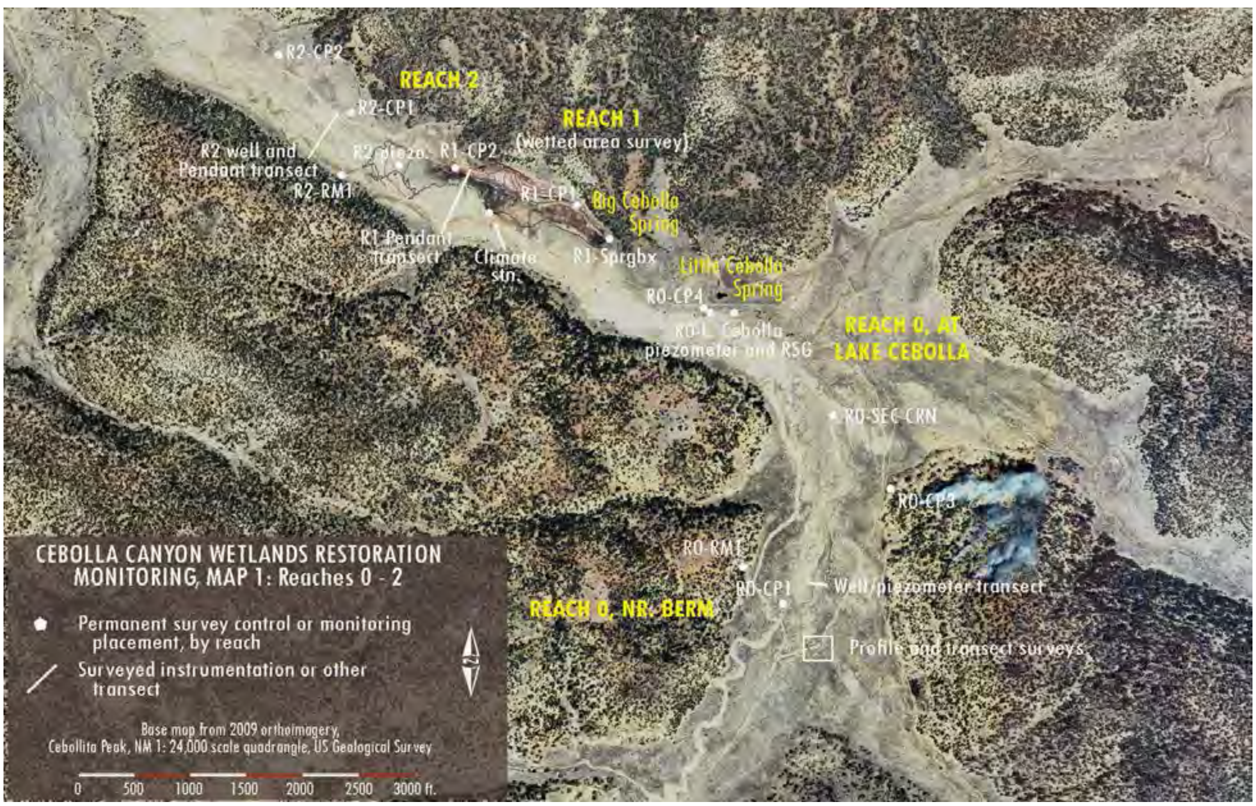
The G channel type classification characteristics are the following:

- Entrenchment <1.4
- Width/depth ratio <12
- Sinuosity >1.2
- Slope <0.039

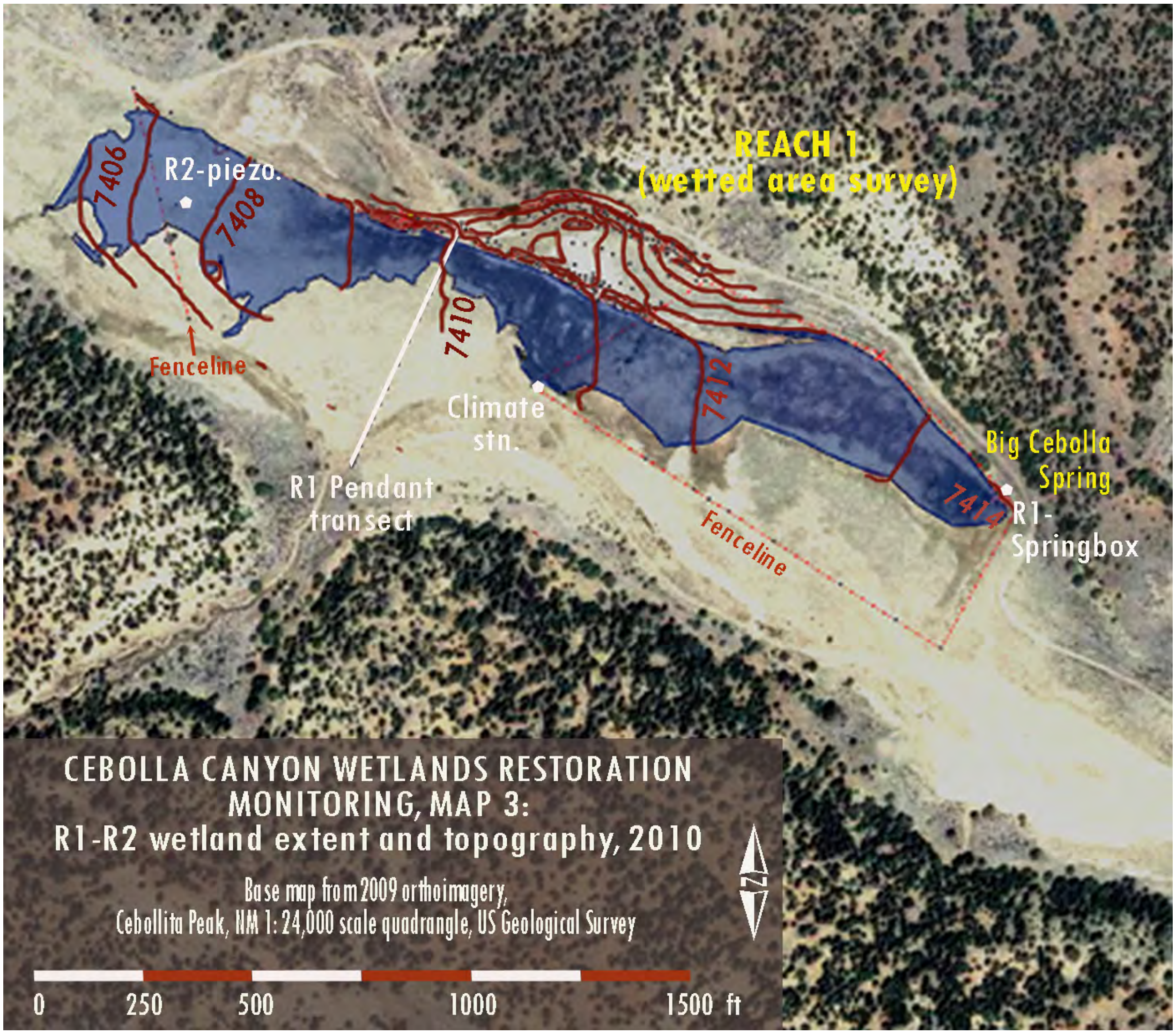


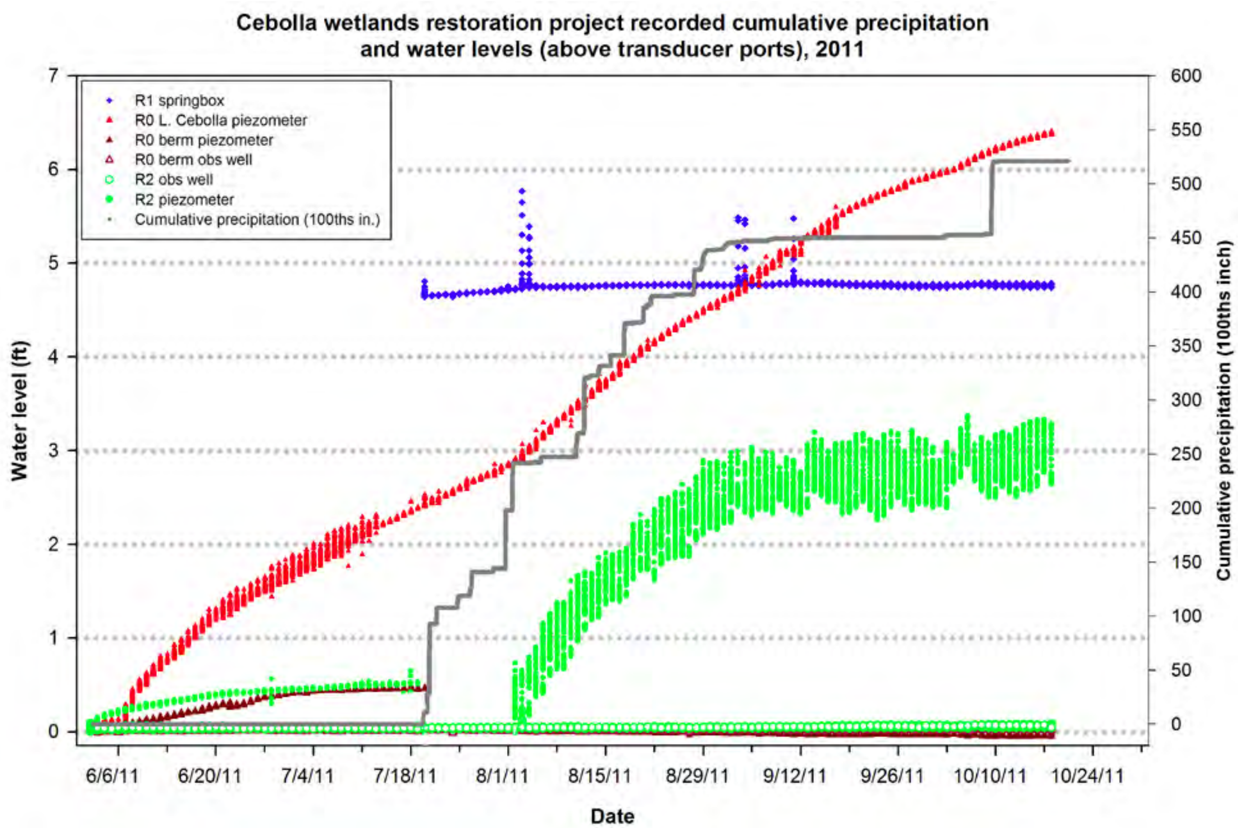
Estimating the bankfull stage allows for the classification of stream types, “establishes dimensionless ratios of key morphological variables” (Rosgen, 2008) and helps to identify potentially impaired streams with stable stream data. Knowing bankfull stage allows for a variety of predictions such as velocity and discharge and active bed characteristics.

A ground monitoring system was put into place to monitor the wetland restoration effort in Cebolla Canyon, “to determine the effectiveness of restoration work on expanding the remnant wetland zones into larger areas they are believed to have historically occupied” (Soles, 2011). The majority of monitoring devices were put into place in July 2011 and the rest in October of 2011. The monitoring equipment collected ground and surface water levels and temperature at stations in reaches 0, 1 and 2 at stratigic locations where restoration efforts where going to take place. The findings showed a slow increasing level of sustained moisture especially in the Cebolla Springs area (see images below). According to Soles, “there has been an overall increase in the wetted area due to land management and restoration practices, and the wetted surface area



is anticipated to increase farther, particularly down-valley, as a consequence of future restoration work” (Soles, 2011). Further data showed an increase of water depth below Cebolla Springs as well. The graph below shows Cebolla Spring’s water depth increasing subsequently giving more moisture to the area below.


REACH 1
(wetted area survey)
R2-piezo.
7406
7408
7410
7412
7414
Fenceline
Fenceline
Climate
stn.
R1 Pendant
transect
Big Cebolla
Spring
R1-
Springbox
CEBOLLA CANYON WETLANDS RESTORATION
MONITORING, MAP 3:
R1-R2 wetland extent and topography, 2010
Base map from 2009 orthoimagery,
Cebollita Peak, NM 1: 24,000 scale quadrangle, US Geological Survey
N
0 250 500 1000 1500 ft



The gray line indicates moisture received during the study period. The red line indicates Cebolla Spring's moisture levels increase along the gray line. The solid green circle below is the data collection from the monitoring station below the springs. The rest of the monitoring stations seem to increase slowly or show similar levels of moisture.

Because of the limited hydrologic data available, more data collection for the entire valley would provide a better picture of the current hydrology and its departure from reference conditions. Additional restoration could then be targeted to additional critical sites within the watershed.

6.7 LAND USE

6.7.1 Land Ownership and Land Use

Cebolla Canyon is located within the El Malpais National Conservation Area and the Cebolla Wilderness Study Area (WSA) as well as the Canyon's WSA. The greatest portion of Cebolla Canyon is BLM land with 1,759,434.23 acres, a smaller portion of Cebolla Canyon is in private hands (447,519.97), 128,343.93 acres are Indian tribal, and only 4.61 acres are State owned. All of the planning area is BLM Public Lands (see Map on page 11).

xiii. Land Ownership

Ownership	Acres	%
BLM	1759,434.23	75.5%
Indian reservation	128,343.93	5.49%
Private	447,519.97	19%
State	4.61	>0.01%

The planning area is also located within the Techado Mesa Allotment, #00209 (portions of reach 0) and the El Malpais Allotment, #00203 according to the BLM (BLM, 2011). Annually 4,654 Animal Unit Months (AUMs) are authorized on the Techado Mesa Allotment and 23,484 AUMs on the El Malpais Allotment. The two ranches that hold these grazing permits within Cebolla Canyon are the York Ranch and F&F Ranch. The York Ranch is owned by a company operating out of Chicago and is the same company building the Wild Horse subdivision located to the south of Cebolla Canyon.

Cebolla Canyon is also used for recreational activities: hiking, hunting, camping, wildlife viewing, equestrian travel, cultural study, and picnicking as well as back country driving and mountain biking.

Cebolla Canyon is quite famous for its hunting and draws people from all over the United States. Cebolla Canyon falls under the New Mexico Game and Fish Department Game Management Unit 13. Between 2010 and 2011 Deer and Elk seasons, 2,953 licenses were issued for Unit 13. For the hunters, the roads in Cebolla Canyon near the wilderness areas make it a popular access area in the spring and fall.

The Cebolla Canyon road provides this access to Cebolla Canyon, and has been the object of restoration and protection efforts because it is a significant source for erosion. Parts of the road are only passable by high clearance 4WD vehicles. Most of the wetland lies adjacent to this road, within only 500 feet.

6.7.2 Wilderness Area

Cebolla Canyon is located within and adjacent to the Cebolla Wilderness that spans an area of 62,000 acres. This Wilderness area was established by Congress through P.L. 100-225 as part of El Malpais National Conservation Area (EMNCA)

6.8 WILDLIFE HABITAT

The Cebolla Canyon Wetland provides an important wildlife habitat and "has become a hotspot for biodiversity" (BLM, 2011). The recent wetland and riparian improvements have expanded this habitat. In semiarid regions, such as Cebolla Canyon, riparian areas are essential in "maintaining the overall ecosystem health, despite their comparative small size" (BLM, 2000). Recent management techniques have created more habitat for species that use the riparian area as forage, sources of water and cover. There are four different species of game animals seen in Cebolla Canyon: elk, mule deer, black beer, and wild turkey. In addition, four mammalian carnivores were found using the wetland: the mountain lion, coyote, gray fox, and the spotted/striped skunk. There are also a variety of other mammalian species including rodents and lagomorphs. There are birds, such as: American kestrel, Cooper's/Swainson's hawks, Northern Goshawk, mountain/western bluebirds, gray flycatcher, mountain plover, hummingbirds, warblers, sparrows, phoebes, tanagers, jays, kingbirds, pewees, turkey vultures, vireos, various species of owl, and other species of resident and migratory birds that occur in and around Cebolla Canyon (BLM, 2000). In recent years, Cebolla Canyon has started to attract a number of water birds, including mallards, rails, and herons. The Canyon provides habitat to a variety of reptiles such as garter snakes, bullsnakes, rattlesnakes, and other species of snakes and lizards. Cebolla Canyon is also home to a variety of bat species including the Townsend's big-eared bat or *Corynorhinus townsedii*, as well as the red bat or *Lasiurus blossevillii*, both of which are currently federal species of concern (M. & Perry, 2010). A salamander was recently spotted near the wetlands of Cebolla Canyon.

Big-eared bat or Corynorhinus townsedii

Salamander found near Cebolla Canyon wetlands 2013.

7. REFERENCE POINTS AND OTHER AREAS OF INTEREST

Identifying potential reference areas is an important component of restoration, among other things. These areas are seen as the best representations of ecosystem productivity and functionality. The reference reach is a river segment that represents a stable channel within a particular valley morphology. The reference reach is used to develop natural channel design criteria based upon measured morphological relations associated with the bankfull stage for a specific stable stream type. Specific data on stream channel dimension, pattern, and profile are collected and presented by dimensionless ratios by stream type. The morphological data collected are used for extrapolation to disturbed, or unstable reaches in similar valley types for the purposes of restoration, stream enhancement, stabilization, and stream naturalization schemes. Bankfull discharge and dimensions from streamgage stations for a particular hydro-physiographic region are correlated with drainage area to develop regional curves for extrapolation to non-gaged reaches. *(The Reference Reach - A Blueprint for Natural Channel Design, Dave Rosgen)*

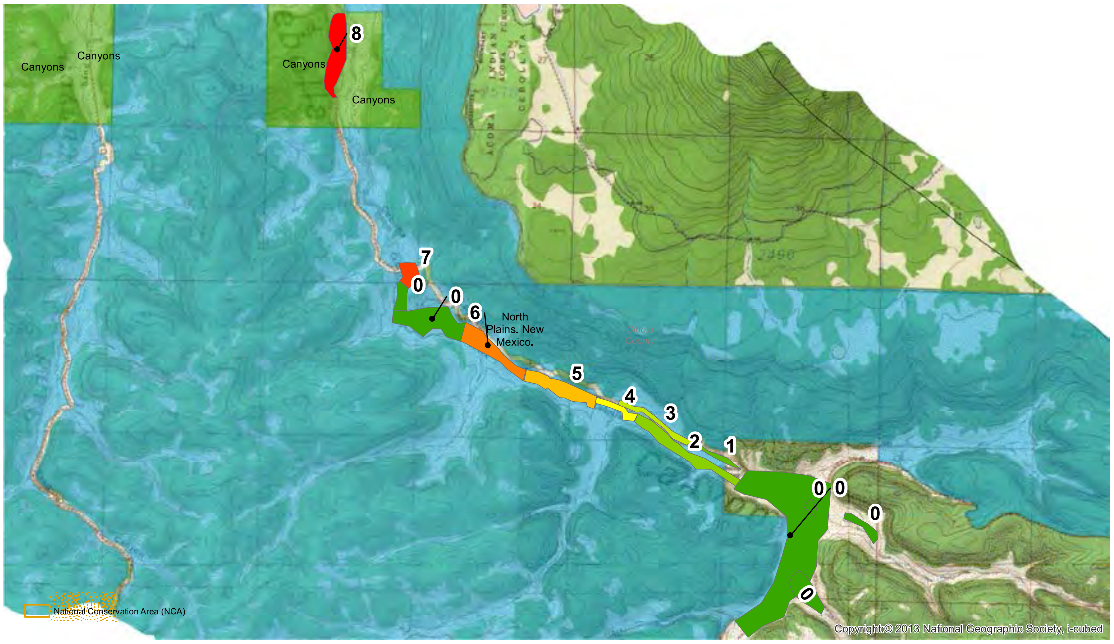
The best reference area in Cebolla Canyon is located in Reach 5 because it is the least impacted area within the canyon.

Reach 5.

There are various wetlands of interest in and around Cebolla Canyon. These wetlands have been identified by a number of professional contributors to this paper and are cited as interesting possibilities for reference, conservation and restoration efforts.

- North Pasture
- Cienegita Springs located on the Acoma reservation
- Various valley bottoms in the upper Cebolla Creek Watershed
- Cebollita Springs

Cebolla Spring Reaches



This map is showing the different Reaches of Cebolla Canyon that have been delineated.

8. WETLAND DELINATION, CURRENT CONDITIONS

8.1 WETLAND DELINEATION

Wetland delineation is the process of surveying wetlands and their properties to determine their boundaries. A wetland delineation was performed in 2009 at Cebolla Creek by Steve Vrooman (Keystone Restoration Ecology) and Matt Schultz (NMED) in accordance with the USACE Wetland Delineation Manual (1987) and the Regional Supplement for the Arid West Region (2008). The wetland delination was performed on the Reaches 0 to 8. These Reaches do not cover the entire valley, so additional wetland delineation needs to be performed to examine the entire area.

This study was meant to determine the boundaries of the wetlands at the time and enable the tracking of future wetland expansions. The mapping was performed using a GPS (sub-meter Trimble). In 2013 another delineation survey was performed to determine how the wetland boundaries had changed.

xiv. 2013 Wetland Delineation

Location	Delineated wetland in acres 2010	Delineated wetland in acres 2013	Wetland hydrology in 2013
Lake Cebolla (Reach 0)	2.9	2.9	
Reaches 1-2	13.33	16.9	
Reaches 4-5	0.37	0.7	
Total acres	**16.6 acres**	**20.5 acres**	**29.4 acres**

8.2 GENERAL WETLAND CONDITIONS

The current wetland condition is improving around the Cebolla Springs wetland areas due to passive and active restoration techniques. According to the final report on the restoration of Cebolla Canyon completed in 2013 (see Appendix), remarkable improvements have been noted. The following is a summary of the findings of the report.

8.2.1 Added Wetland

Over the timeframe of the grant-funded projects, the delineated wetland areas around Cebolla Canyon increased by about 4 acres. Additionally, the wetland extended downstream into Reaches 4 and 5 for around 1,000 feet and areas with wetland hydrology expanded to 29.4 acres. The Cebolla Creek channel has also "almost been eliminated for 1500 feet, between Reach 0 and 2. This creates the potential for wetlands in this area" (Vrooman, 2013). The potential for more expansion is huge, especially around Lake Cebolla. This area was formerly a sheet-flow valley and has filled rapidly from below, near the Big Cebolla Spring. It is possible that a geomorphic threshold has been crossed, and more aggradation will continue to fill the channel and spread water across the valley.

8.2.2 Plant communities

Most of the vegetation transects showed poor results. Only Reach 1 increased its wetland plant communities. All other Reaches: Reach 0, Reach 2, Reach 4, and Reaches 5-6, experienced poor to middling results.

The especially dry winter and spring of 2013 could have influenced the poor outcome of the vegetation cover in Cebolla Canyon. Additionally, damaging storm events in September of 2013 produced flooding in Cebolla Canyon and "may have some role in the reduction in cover for many species especially forbs such as Rocky Mountain beeplant (*Cleome serrulata*), which can be dominant on freshly deposited sandy soils, but needs springtime moisture to germinate. The vast fields that were seen in Reaches 0 and 2 in 2010, 2011 and 2012 were missing in 2013, either spring or fall" (Vrooman, 2013).

8.2.3 Grazing

The report noted that grazing pressure appeared to be strong in 2013 and left its mark on the wetland. Around 50 cattle grazed Reaches 5 and 6 as well as in Reach 0, 2 and 4. Grazing intensity was noticed, "in the cover of Baltic Rush, which had never before (from 2010 to 2012) been grazed 'to the nub'. While other, more palatable plant species had been grazed down, Baltic Rush had remained ungrazed until 2013" (Vrooman, 2013).

9. THREATS AND IMPAIRMENTS

Threats and impairments to the Cebolla wetlands come in many forms, of which the majority are human caused. This section will explore some of these threats and their consequences.

9.1 DRAINING OF WETLANDS

The technique for draining wetlands is in itself a diversion of waters away from its pooling wet areas. Draining was historically done through trenching and the laying of clay pipes. Although in Cebolla this technique is not known to have been used, other water diversions have lead to wetlands being drained and reduced, as they have taken the water out of the valley bottoms where wetlands were located.

9.2 HISTORICAL HYDROMODIFICATIONS

Hydromodification is the altering of the natural flow of water through a landscape. The natural hydrological flow patterns are essential drivers of ecosystem services in any given landscape. Modifications of hydraulic flow effectively alter and degrade habitat, water quality, and essential ecosystem functions. Some hydromodifications come from (but are not limited to), "land resources development for agriculture, energy, mining, forestry, transportation, residential housing; and water resources development for irrigation" (Mohamoud, 2009).

As we have seen in the above sections, Cebolla has a consistent history of hydromodifications. From early irrigation techniques of Native Americans to tree felling for railroad ties and agricultural manipulations, the hydraulic functions of Cebolla Canyon have been manipulated in one way or another.

9.3 WATER IMPOUNDMENTS/DIVERSIONS

Water impoundments and diversions can be found throughout the canyon. Water impoundments are manmade structures. They are pools or pits created to capture water primarily used for livestock. Diversions are any manmade structure or earthmoving that diverts the water from its natural flow.

Cebolla Spring stock pond.

It is hard to say how many water impoundments there are throughout Cebolla Canyon, but within the planning area there are at least six that are highly visible. Five of these impoundments are ponds for livestock. Their physical traits vary but they are generally square or circular, relatively deep (over ten feet) and quite large. Although water pools in these installations, the trade off for their ecological services in comparison to wetlands is minimal. They capture and cut natural flow regimes and are high traffic, low vegetative sites due to livestock use.

Smaller diversions have been used frequently, especially in Cebolla Springs. Diversions were used to route water out of and away from the channel making more space in the valley bottom for farming crops. More impoundments/diversions can be seen in the form of dams in Reach 0 as well as above the project site in a multitude of locations.

9.4 ROADS

Roads play an important role in hydromodifications. They alter water movement across the landscape, "which can concentrate and accelerate flow and cause soil erosion and sediment deposits, gully formation and divert surface and subsurface flows causing areas

Gully in Cebolla Canyon

to lose productivity ” (Zeedyk, 2006). Unpaved and rural roads play an especially large role in hydromodifications; they are often times not maintained and evolve organically with usage and weather events.

Cebolla Canyon’s road comes off of State Highway 117 and runs along Cebolla Creek crossing it various times. The road is considered to be a low standard road which is “a single lane constructed of native materials un-surfaced without permanent drainage structures” (Zeedyk, 2006). It is hard to determine the exact square footage of Cebolla Canyon’s road because of its changing dimensions. But an approximate estimate yields in the planning area (Reach 0-7) that the road has a length of 34, 565 ft. and is about 10 feet wide. This gives us around 345,650 square feet or 7.9 acres of road.

Beyond drainage and subsequent erosion from the existing road, Cebolla Creek and some of its tributaries run in old road locations. That is to say, old wagon and work roads have become the creek and tributaries. This can be seen in Reaches 4-5 near some of the Savage Ranch ruins. The water is running down an old road site and is causing rapidly expanding gullies.

In 2009 the American Recovery and Reinvestment Act (ARRA) helped the BLM to fund a project to relocate a 1.8 mile section of the Cebolla Canyon road. The road had altered the hydrology in the valley by trapping the water in the roadbed. After the relocation water could spread again over the valley bottom and help expand the wetland. The road had been moved out of the valley in Reach 0, and is now no longer channeling water. Additionally Rangeland Hands improved about 4-5 miles of the rest of the road. The 2013 Monitoring Report confirmed that “the construction of a rolling dip road drain in the valley, as well as the BLM road work …

ensured that floodwaters from this valley are spreading across the largest area possible and are flowing in center of the valley" (Vrooman, 2013).

9.5 CONCENTRATION OF FLOWS/CHANNEL INCISIONS

Concentrated flow implies a sufficient amount of energy to move materials and erode. Such erosion takes the forms of rills, ephemeral gullies, gullies, channels, streams, and rivers. Incised channels are a direct cause of concentrated (not dispersed) flows. Incisions are caused by the dropping of the channel bed levels when long-term erosion exceeds sedimentation. "In a typical incising channel, the streambed degrades until the critical bank height is exceeded and the bank fails, increasing channel width and sediment load" (Fischenich, 2000). Channel modification, usually straightening, is probably the most common cause of incision. After a channel becomes incised, the water loses its ability to reach the flood plain and spread during storm events, and will become increasingly concentrated in the channel. Water continues to run through the confined channel system quicker and at higher flow volumes accelerating the incision process.

Flow concentration and incisions are not limited to the creek and river channels but can be found anywhere forming gullies where water drainage occurs in land that is not protected by vegetation. Gullies are an issue all over Cebolla Canyon as well as in almost all the project areas in the canyon. In lower sections of the creek, the incisions are over 50 feet deep. Increased grass and vegetative cover throughout the watershed would help disperse and absorb overland flow helping to prevent gully formation and concentrated flow.

10.EXISTING RESOURCE MANAGEMENT PLANS

10.1 RESOURCE MANAGEMENT PLAN, BLM

Although Cebolla Canyon is a designated Wilderness, its management plan is lumped together with El Malpais National Conservation Area. Because of its uniqueness El Malpais has received a special designation as an Area of Critical Environmental Concern (ACEC) and has special management prescriptions to protect certain "significant values, Congressional designations…living emphasis to significant resources or activities" (BLM, 2012). This special designation prompted a specific "stand-alone plan" to consolidate all decisions and Management guidance to the Rio Puerco Field Office (RPFO). The following section is an overview of some key points in the resource management plan *(www.blm.gov/nm/st/en/fo/Rio_Puerco_Field_Office/rpfo_planning/rpfo_draft_rmp.html).*

The resource management plan of the AFO takes into consideration:

- Interpretation and public education plan
- Public facilities plan
- Natural and cultural resources management plans
- Wildlife management plan
- Recreation
- Monitoring/Studying
- Fire Management
- Law Enforcement

There are also four standard management goals established by the BLM for designated wilderness. These standard management practices are integrated into the resource management plans in order to maintain the pristine uniqueness of the wilderness area. The practices are:

- Provide for the long-term protection and preservation of the area's wilderness, manage the area's natural condition.
- Manage the area so visitors can use and enjoy it but only in a way that leaves it unimpaired for the future.
- Manage the area using the minimum tools, equipment, and structures needed to successfully, safely, and economically accomplish tasks while least degrading wilderness values, temporarily or permanently.
- Manage the nonconforming but accepted uses allowed by the Wilderness Act that prevent unnecessary or undue degradation of the area's wilderness character. (BLM)

10.2 CEBOLLA CANYON WETLAND INTEGRATED MANAGEMENT PRACTICES, BLM

The following is a breakdown of important key points for Cebolla's integrated Management practices by section.

1. ***Interpretation and Public Education***
   Develop media guides and maintain interpretive wayside exhibits. Education and materials for the support, understanding and protection of Wilderness areas. Area geology, Wilderness safety, and Leave No Trace ethics.
2. ***Public Facilities Plan***
   Trail improvements for recreation users and resource protection. Existing recreational facilities on the wilderness perimeters will remain in place. Upgrade of Visitor facilities at trailheads and entry points. Additional on-site information to educate the public. Placement of signs to identify the boundaries, wilderness name and regulations governing use. Maintain roads to reduce erosion and improve access opportunities.

3. ***Natural and Cultural Management Plans***
   Preventing unauthorized vehicle intrusions through patrolling. Manage the Dittert Site, the Lobo Canyon Petroglyphs, and outstanding homestead-era sites. Compliance with the National Historic Preservation Act. Offsite information to concentrate visitations to certain prehistoric sites. Traditional American Indian cultural practices will be allowed to continue.
4. ***Wildlife Management Plan***
   Wildlife habitat management will be guided by the BLM's Wilderness Management Policy. Hunting and trapping will be permitted under applicable State and Federal laws. Livestock grazing will take place in permitted areas.
5. ***Recreation***
   Motorized vehicle access inside designated wilderness will be limited to authorized users. Access will be allowed only to non-Federal inholdings and livestock grazing operations. Allottees may use motorized vehicles on authorized routes to access windmills for annual maintenance, fences every five years, and dirt tanks every ten years.
6. ***Identified Ecoregions and Management***
   a. *Forests and Woodlands*
      Manage ponderosa pine stands for increased reproduction, health, and rehabilitation of degraded sites. Maintain healthy piñon-juniper stands. Provide and establish for natural communities of trees. This program is meant to build and be combined with other ecoregion programs.
   b. ***Rangeland***
      The goal is to maintain healthy multifunctional rangelands and ensure that livestock grazing management on each allotment contributes natural vegetative objectives.
   c. ***Riparian and Wetland Habitat***
      The goal of this program is to manage the riparian and wetland habitats in the Plan Area for their protection and enhancement. BLM policy is to achieve a healthy and productive ecological condition for all public riparian areas. Riparian-wetland management goals and objectives fall into four general management strategies: maintenance of existing riparian conditions; improvement of degraded riparian conditions; recovery of lost riparian areas; and development of new riparian area.

10.3 RESTORATION AND MANAGEMENT PRACTICES PRIORITIZATION, BLM

The following is the prioritization or management objective of the ecosystems and habitats.

1. ***Riparian Areas***
   All properly functioning springs and associated riparian/wetland habitats on BLM-administered lands will be maintained at that level. Those that are "Nonfunctional" or "Functional-At Risk" will be managed to be improved. The AFO will maintain or improve these features either by using livestock exclosures, or through grazing management practices to maintain and/or improve them to properly functioning condition. Plantings of native species and removal of invasive species will take place where appropriate and when necessary.
2. ***Removal or Repair of Fencing that Impedes Movement of wildlife***
   All fences that prohibit movement of wildlife will be redesigned.
3. ***Prairie Dog Colony Enhancement***
   Work to eliminate illegal shootings within the Prairie Dog Colony Enhancement Area in North Pasture area. Move the Cebolla Canyon Road from its junction with NM 117 to approximately three miles south. Work with the NMDG&F to eliminate plague from the prairie dog colony in order to reestablish the black-footed ferret.
4. ***Prescribed Burns***
   Reforestation and habitat improvement through prescribed burns will take place.

11. WETLANDS ASSESSMENT

The current wetland condition is improving around the Cebolla Springs wetland area due to passive and active restoration techniques. The historic irrigation diversions dried out wetlands and caused headcutting in and along the main channel and the tributaries, cutting off water supply to historic wetland areas. These are areas have been targeted and major improvements can been seen.

11.1 PROPER FUNCTIONING WETLAND CONDITION

The proper functioning condition of wetlands is best defined through the interaction and quality of the vegetation, soil structure, and hydrology. A properly functioning wetland according to the BLM and other governmental departments must support adequate vegetation in order to dissipate stream energy during storm events, reduce erosion, improve water quality, filter sediment, capture bedload, and aid floodplain development. It must improve water retention and ground water recharge; develop rootmass to stabilize banks; and develop diverse ponding in order to create habitat and greater biodiversity (Prichard, 1998).

11.2 NONFUNCTIONAL WETLAND CONDITION

A nonfunctional wetland is a wetland area that clearly is not providing adequate vegetation, not reducing erosion, not improving water quality, and lacking certain physical attributes such as a floodplain. If one of these characteristics occurs within a wetland, it indicates non-functionality and can be determined through a set of 17 qualitative questions.

11.3 CEBOLLA CANYON WETLAND FUNCTIONS

Parts of the Cebolla Canyon Wetlands will under the current conditions likely not meet proper functioning standards and are considered nonfunctional or functional at risk. However through recent restoration and protection measures substantial areas in the wetland have been restored and will meet proper functioning wetland standards.

11.4 WETLANDS FUNCTIONS AND VALUES

Functions:

Each wetland type provides a unique suite of physical and biological functions. Therefore, the value of each wetland is different and can be estimated by its importance or the worth "of one or more of its functions to society" (Novitzki, 2009). Humans are just now beginning to understand all the benefits of wetlands. Some of these wetland functions are:

- Habitat for fish and wildlife, including critical habitat for endangered species
- Enhanced water quality and filtration
- Ground water recharge
- Flood control
- Shoreline buffering and erosion control

Values:

The EPA calls wetlands the "biological supermarket" and states that they are one of the most productive ecosystems in the world. Wetland values are relative to their location, climate, and society. Each wetland provides a multitude of services but one or more services is eventually defined by the society that surrounds it. For example, states Richard P. Novitzki, "timber production may be improved by draining a wetland site, whereas waterfowl production may be improved by impounding more water…Furthermore, society may have to choose among wetland functions that benefit individuals or small groups, that are of value to most of society, or that are important to the maintenance of the wetland itself." In the end, society is the determining factor as to what services and functions are considered relevant and important to humans.

11.5 CEBOLLA CANYON ECOSYSTEM SERVICES

The ecosystem services of Cebolla Canyon wetlands are defined as conservatory as the area is a closed basin and is partially within a Wilderness area. The ecosystem services are primarily intended to provide essential habitat and resources for diverse plant and animal species, aquifer recharge, reduce erosion and improve water quality. These overarching services have, of course, underlying economic services that will be provided to human beings. Some of these are:

- Higher quality habitat for hunting and tourism
- Higher feed quality/growth for cattle
- Less erosion
- Improved water storage

12. PAST AND EXISTING MANAGEMENT MEASURES

There have been a series of projects in Cebolla Canyon with restorative objectives. From land swaps to small-scale plantings the objective to improve the quality of the ecosystem has clearly been kept in mind. The following explores some of these projects' plans, reasoning and goals.

12.1 BLM PRIVATE LAND EXCHANGE

As we have already learned in a previous section, the BLM wanted to expand and combine Cebolla Canyon's total area through land purchasing and exchanging private lands. During the creation of the El Malpais National Conservation Area congressional limitations to the bill required the BLM to: "acquire only those minimum lands in the NCA needed to achieve management purposes and should use cost-effective alternatives to purchase when available." Land protection planning is guided primarily by the policy statement (1982) guiding use of Land and Water Conservation Funds.

Due to this, in 1987, some 93,000 acres of 351,000 (26%) of the land in the NCA remained in private landholdings. Some of these private lands blocked access to the wilderness area and some "key natural and cultural resources in the NCA like Cebolla Springs" and "scenic quality areas of important integrity" (Mutz, 2005) were privately owned. In 1994, an important land exchange took place with the King Brothers who agreed to exchange an ecologically important piece of land in Cebolla Canyon for real-estate plots outside of Santa Fe, New Mexico.

There has recently been talk of adding about "4,000 acres of the Brazo non-wilderness areas to the Cebolla Wilderness Area" (Mutz, 2005).

12.2 FENCING OF CEBOLLA SPRINGS

At the time of the exchange, Cebolla Springs and the surrounding areas were highly degraded. According to Bill Zeedyk, former Albuquerque Wildlife Federation (AWF) chairman/restoration specialist and other witnesses there was a deep gully approximately eight feet deep that ran through the spring's area. The BLM fenced the springs sometime in the 1990s and then in 2000 asked AWF to help maintain the fence. AWF dug and placed a new cross-valley fence and then constructed a new fence downstream in 2003.

The fence was put in place mainly to keep livestock out of the springs area and allow for vegetative growth. Although the occasional cow entered, the passive restoration technique was a success and wetland vegetation recuperated at a rapid pace. The incredible improvement showcased the importance and professional knowledge of AWF members allowing them to have access to more projects in the canyon.

Picket baffles AWF constructed in Reach 8 in 2010.

12.3 AWF HISTORY IN THE AREA

Around the same time as the fencing project, AWF (an all-volunteer non-profit organization, focused on New Mexico's wildlife and habitat resources. See nmwildlife.org for more information.) placed sandbags or burrito dams around the springs to maintain and spread the water out on the valley right. The water began to create more vegetation, which began to fill in the eight-foot gully. As the gully filled with subsequent floods, the water coming down spread out across the valley augmenting perennial flow from the springs. The wetlands area around the springs before AWF's restoration actions was no more than one acre, whereas today it is over 20 acres and has moved downstream outside of the fenced area.

AWF working at the project site in April 2012.

Seeing the progress made, AWF began to re-vegetate selected areas with plantings of willow (*Salix*), cottonwood (*Populous*), and Baltic Rush (*Junicus balticus*). Downstream in Reach 8 AWF started an induced meandering project in a deep gully in an attempt to raise the bed of the stream and eventually allow for floodplain access.

12.4 HABITAT STAMP PROGRAM INVOLVEMENT

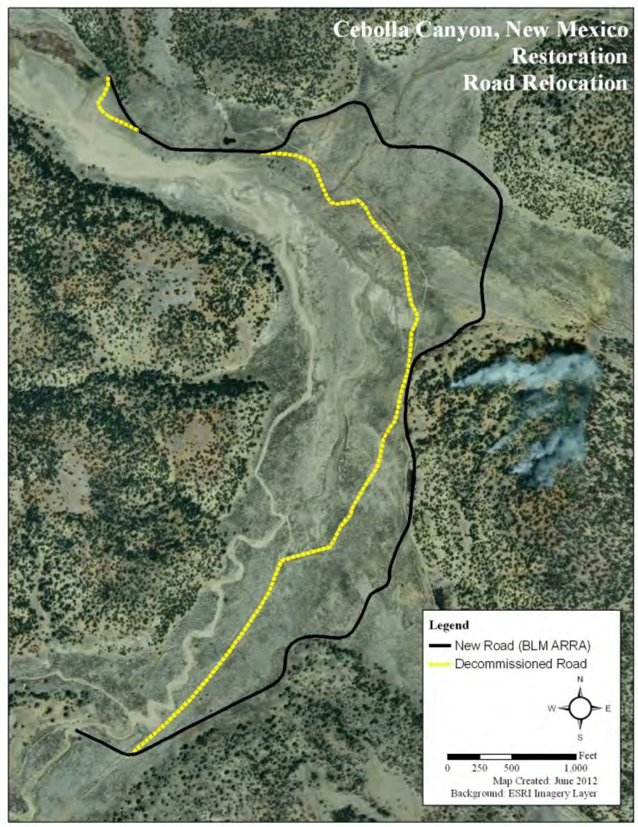
The Habitat Stamp Program cooperators protect ecologically diverse wildlife and fish habitats on U. S. Forest Service (USFS) and BLM managed lands. Licensed hunters, anglers, and trappers on public lands are required to purchase a stamp from the NMDGF. This money then goes to “proactive” habitat restoration/improvement projects. A Citizens' Advisory Committee (CAC) reviews potential projects, which they pass on to the State Game Commission.

Once accepted, the project is done by a competent organization accompanied by volunteers and professionals. AWF has participated alongside the BLM on numerous occasions with funding from the Habitat Stamp Program in Cebolla on improvement projects of wetlands, waterways, and riparian areas.

12.5 ARRA BLM ROAD PROJECT

The American Recovery and Reinvestment Act (ARRA) of 2009 helped to fund a project on the upper portion of the Cebolla Canyon Road. The project’s goal was to relocate Cebolla Canyon Road away from Cebolla Springs and ephemeral playa lakes.

A one-mile portion of road through Reach 0 was moved valley right up against the foothill of the canyon instead of having it run through the valley bottom. The road was re-cut, tilled and a layer of small diameter cobble was placed on top for infiltration purposes.



Map of relocated Cebolla Canyon Road away from Cebolla Springs.

12.5.1 Analysis of 2011 Cebolla Creek Restoration Project

The Cebolla Creek Wetland Restoration Project was funded by two grants. One grant was obtained by SWQB Wetlands Program through EPA 104(b)(3) of the Clean Water Act called: "Restoring and Protecting Wetlands in Cebolla Canyon Closed Basin" CD #966857-01-0C (FY2008) and the second grant was obtained by RPA through the State of New Mexico's River Ecosystem Restoration Initiative (RERI) and is called "Restoring Cebolla Canyon," PSC #09-667-5000-0015. The grants were employed to fund restoration efforts in different reaches of the total project area. While the RERI grant funding ended at the end of June of 2012, the SWQB Wetlands Program funding was extended through June 30, 2014.

A wetland delineation was performed in 2013 to estimate whether the restoration efforts had restored wetlands within Cebolla Canyon. The final report found that around 4 acres of wetland were added and the wetland had extended downstream. Additionally, 29.4 acres of wetland hydrology was detected in areas that did not have these characteristics before. Future monitoring is needed to show the continued spread and growth of the Cebolla canyon wetland areas.

13. RECOMMENDATIONS & PRIORITIZATION, RESTORATION/ PROTECTION MEASURES

In previous projects, different restoration measures have proven to be successful in Cebolla Canyon. Therefore, similar measures should be employed in future restoration projects. The restoration techniques include: installation of erosion control, grade control and headcut control structures as well as induced meandering measures as developed by Bill Zeedyk. Fencing protects project areas from livestock grazing while native vegetation is re-established. Infrastructure, such as roads can promote erosion and therefore need to be managed or modified to reduce runoff into the stream. Riparian and wetland plantings will encourage infiltration as well as provide important habitat for native species. Noxious weed control will allow native species to find habitat and support erosion control.

13.1 RECOMMENDATIONS AND PRIORITIZATION ACCORDING TO THE CEBOLLA WETLAND FINAL REPORT (2013)

According to the most recent monitoring report on the Cebolla Canyon Wetland in 2013, the wetland has expanded more than 4 acres and further wetland expansion is expected especially around Lake Cebolla. The former sheet-flow valley around Lake Cebolla has filled and "it is possible that a geomorphic threshold has been crossed, and more aggradation will continue to fill the channel and spread water across the valley, however, only time will tell" (Vrooman, 2013). The following sections are findings and recommendations made by the monitoring:

13.1.1 Rabbitbrush as Indicator for Change

An experiment with rabbitbrush concluded that the number of plants would decrease when soil saturation increases, and sites that have seen a decrease of rabbitbrush can turn into wetlands. Therefore, this rabbitbrush mortality is an indication for change and wetland expansion (Vrooman, 2013) and sites with rabbitbrush mortality should see greater attention, protection, and continued restoration.

13.1.2 The Role of Plants

Grass-like plants play an important role in stabilizing soils and are crucial in the expansion of the wetland. The cold season species Baltic rush, common spikerush, Kentucky bluegrass, and chairmaker's bulrush capture freshly deposited soils and hold them in place.

These plants have the ability to grow even through thick layers of sediment and these functions are contributing to the expansion of the Cebolla wetland.

13.1.3 Grazing

Year long heavy grazing can have devastating effects on the wetland because the plant species mentioned above are being removed, which destabilizes the soils and encourages erosion. Therefore, the report suggests three management practices that can aid to protect wetland vegetation.

13.1.3.1 Grazing Plan

A grazing plan is needed to exclude cattle from important areas in Reach 0, 2, and 4 during springtime to allow the cold season species to establish, as well as less grazing in late summer and fall to allow these species to go to seed.

13.1.3.2 Repair Fencing

The fence around Cebolla Spring has been damaged by floods during summer storm events in 2013 or cut down by the public or buried by sediments. This fence is at the core of the restoration efforts, to protect native vegetation that then would provide seeds and root stock to the downstream reaches. Therefore, repairing the fence can aid all parts of the wetland.

13.1.3.3 Trigger Points

Small exclosures of areas where sediment and water can be stored should be a focus for future management measures. These exclosures allow vegetation to grow, which in turn will help in stabilizing the soil and filling eroded stream channels. Two of these enclosures have been damaged during the summer flood events, but are scheduled for repair by the BLM in January.

The following are sites to install new exclosures as recommended by the Cebolla Creek Wetland Restoration Monitoring Report:

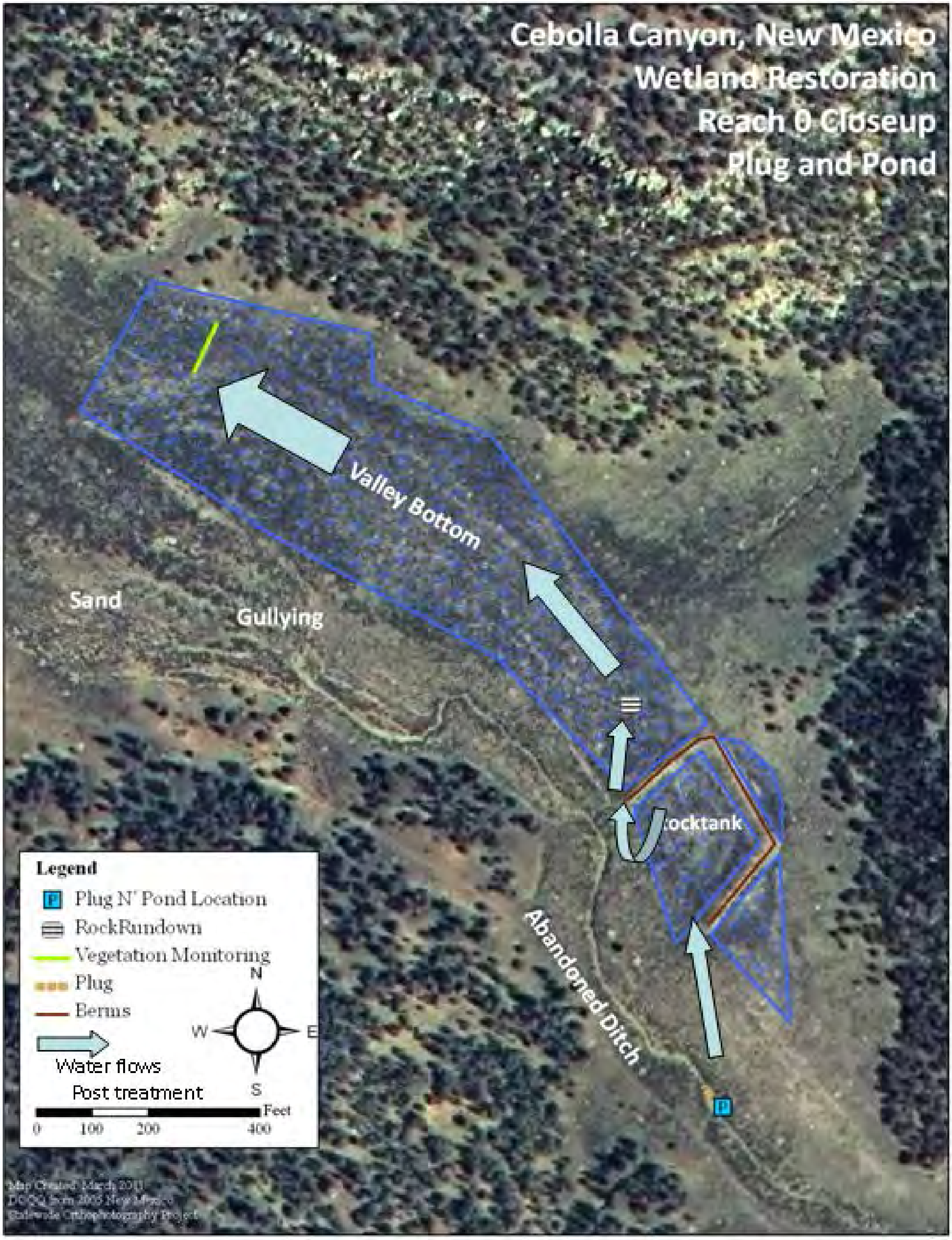
1. Mini-exclosure around Filter dam and berm breach in Reach 0. This will create wetland area due to the storage of water and sediment. Healthy, un-grazed vegetation will accelerate this process.
2. Mini-exclosure at top of Lake Cebolla, needs repair.
3. Mini-exclosure at bottom of Lake Cebolla, needs repair.
4. Mini-exclosure at large one-rock dam between Reaches 2 and 4, this trigger point will fill the valley upstream if allowed to fill in with sediments.
5. Mini- exclosure at boundary of Reaches 4 and 5 will grow wetland vegetation and capture more sediment.

13.2 LITTLE CEBOLLA SPRING – STOCK POND CONVERSION

Little Cebolla Spring is a spring fed stock pond located in a small pasture and is actively used by livestock for water. There is some hydric vegetation present such as rushes and sedges. The dam, holding the pond, is low and wide and the pond is around 3 to 5 inches deep when filled. There is no obvious spillway or head-cutting.

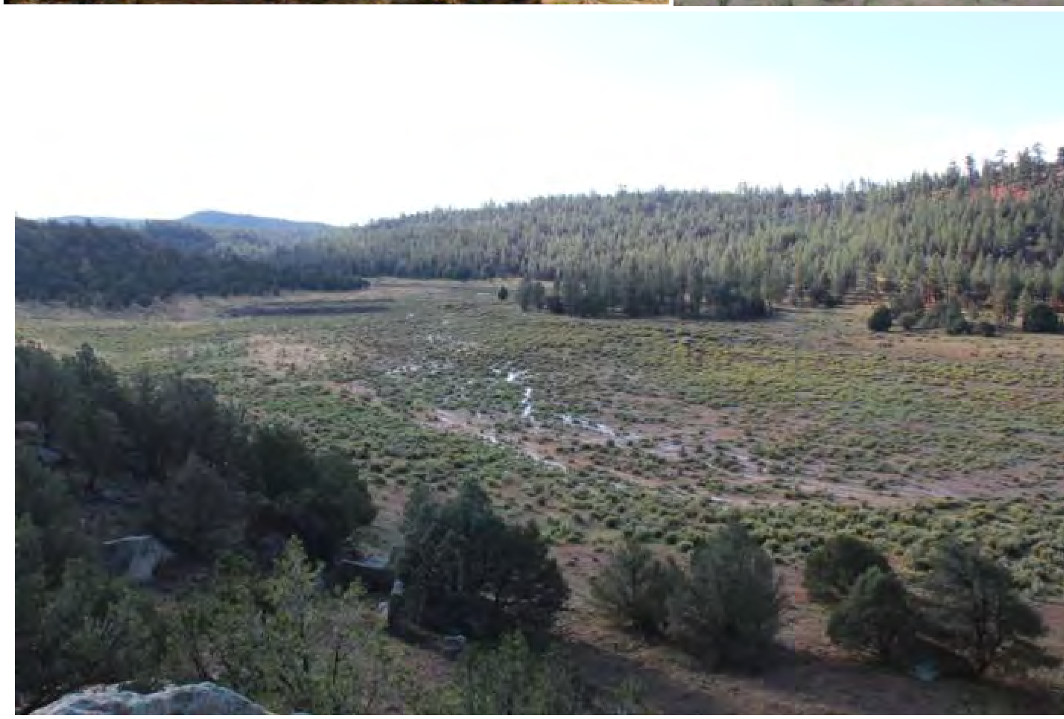
This site has a great potentional for a conversion from water impoundment with the sole purpose of watering stock to wetland pond with substantional provision of wildlife habitat. Expanding the pond and creating protected habitat would also improve the overall water quality and benefit the lifestock as well as wildlife species.

To expand the pond an excavator could help move the soil and compacting of the soil would help increase the water storage. Added and reconfigured fencing would protect the pond and manage the livestock access creating valuable wetland habitat.



13.3 FUTURE PLUG AND PONDS

Plug and ponds are constructed from native soils and wetland sod to plug the channel. The chart above shows the plug and pond used in Reach 0. An abandoned ditch in Reach 0 was diverting water away from the valley bottom and spilling the water out into sand without any wetland potential. We used the plug and pond technique to restore water flow to the natural valley bottom with hydric soils and wetland potential.

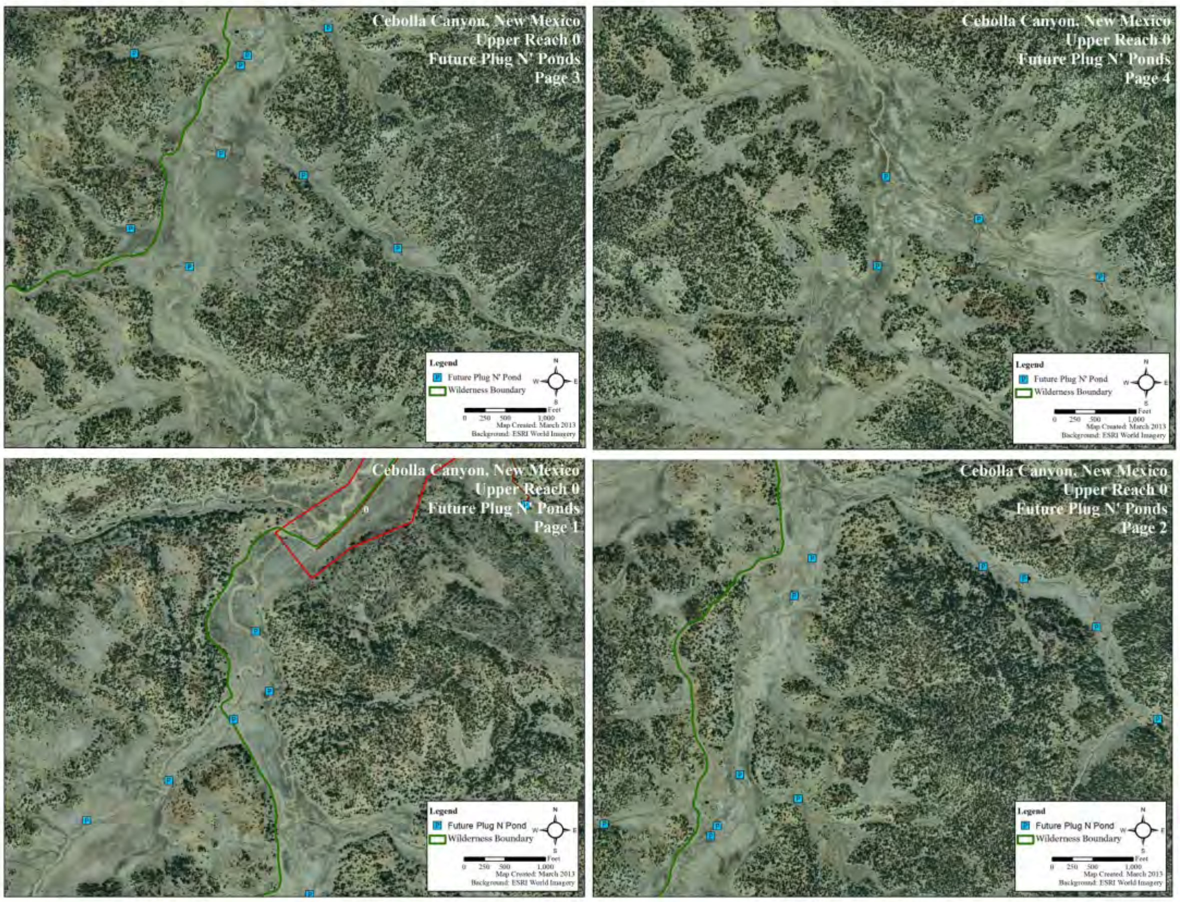


[Top left] Before plug and pond construction. [Top right] Water is once again accessing the stock tank benefitting the permittee. [Left] Water is returned to the Valley Bottom, increasing wetland potential.

Plug and pond structures spread water over the floodplain and to create a temporary pond. These techniques have proven to restore wetlands effectively by enabling the stream to replenish the floodplain, reducing the energy of the water flow and re-watering nearby meadows. Implementation of this technique generally results in a higher water table, encourages the growth of riparian vegetation, and provides cooler water for fish and wildlife.

Bill Zeedyk and Steve Vrooman have identified sites that would benefit from plug and pond restoration structures. Below are maps of the Cebolla Canyon Wetlands with proposed locations for plug and pond structures. These locations were identified before the floods in 2013. Therefore a new assessment of those sites might be necessary to determine whether the need still persists and or whether there are new sites in need of a this type of treatment.

Proposed sites for new plug and pond structures.



13.4 REPAIRING OF RESTORATION STRUCTURES AND ADAPTIVE MANAGEMENT

Floods in fall 2013 have moved large amounts of water and sediment through Cebolla Canyon and have damaged restoration structures. These will need to be repaired. Sedimentation has also changed the valley bottom morphology and possibly created the need for new restoration structures. Therefore a new assessment of the wetland should be undertaken to identify where restoration structures are necessary.

13.5 WETLAND DELINEATION

Wetland delineation is the process of surveying wetlands and their properties to determine their boundaries. So far the delineation efforts were focused on Reach 0 to 8 and have not spanned the entire wetland. In order to determine the overall boundaries of the wetland a new delineation process should be performed capturing the entire wetland. In addition, delineations should be conducted on a regular basis (every two or three years) to determine long-term improvements to the wetlands from restoration measures, or losses from climate or man-made effects.

13.6 SPECIES REINTRODUCTION

The Cebolla Canyon Steering Committee discussed the need to re-introduce some missing species to the area to restore the ecosystem. Among the species discussed were:

- Muskrat, which could help diversify marsh habitat.
- Montane vole, which has not been seen in the area.
- Mexican vole. There is a good chance of its occurrence the area.
- Meadow Jumping Mouse. There is no historic evidence it was in the area.
- Leopard Frog.
- Western Chorus Frog.
- Canyon Tree Frog.
- Fish species.
- Tawny bellied cotton rat. These are a vole surrogate, according to Jim, and he has seen them in the Grants area.

The opportunity to use the functioning restored ecosystems in Cebolla Canyon to allow these fragile species to survive there is being researched and considered. Wetlands are now expanding because of current work there, and it will be determined by a host of wildlife and other experts if the system is ready for this next step.

The Committee discussed how we might re-introduce species.

- Survey/literature search – what might already be there, what might have occurred historically, and what is the role of the species in the ecosystem?
- Locate suitable release sites so the species will have a reasonable chance of survival.
- Determine the manner of release (soft release, provide shelter, etc.).
- Where will they come from? Transplant stock, how will they be caught?
- Timing – when do we release which?
- Veterinary study to determine if the candidates for release are disease free.
- For NEPA, the possibility of something going wrong will need to be considered and how it would be mitigated.

- Permits and permit requirements. Will they be needed? Some species might be protected.

According to BLM , these efforts must conform to the Resource Management Plan (RMP) for the El Malpais and the Land Use Plan (LUP) that is part of the RMP. Right now, the only species that was analyzed for translocation/augmentation in the plan was the Prairie Dog. For other establishments, the BLM will need to have a thorough analysis in the LUP. Therefore, a Plan Amendment to incorporate new species may be required.

To iniate the process of re-introduction of a species, whether or not the species are already there must be determined. If the species is found, a strong justification to augment the existing population would be necessary. If they are definitely no longer in the area, a determination for the necessity and feasibility of re-introducing the species would be needed. This would involve NEPA and Section 7 consultation. Information would include species habitat range, whether the Cebolla Canyon habitat is suitable, the populations' genetics. and the minimum viable population.

Durin the Cebolla Canyon Steering Committee meeting in 2010 regarding the re-introduction of species, the following comments were made:

Dale asked if we could get a jumpstart on the inventory. Andrea said that there shouldn't be any hindrance in starting surveys for the species on this list. This is a phased process; it will likely take a lot of time. Also there will be budgetary hurdles to leap. Therefore, starting promptly, even if it takes awhile, is a very important first step.

Tom wondered what effects the re-introduction would have on trapping or hunting which are all legal activities on the project site.

Love Road Sanctuary wants to purchase the York Ranch and bring horses out to Cebolla. We will need a lot of support to convince them that it's not a good idea.

Barbara asked if surveys have to be done by DFG/BLM employees. Ed said that whoever did them, they had to have credentials and collection permits. Funding or paying BLM or federal employees might be an issue.

Bill suggested that we look at the most likely species first (i.e., pick 3). Tom said that the BLM would support that. Andrea said she would check on the NEPA requirements. Barbara will send the Fuhrman University small mammal survey to Jim Stuart.

13.7 ADDITIONAL PROTECTION AND RESTORATION MEASURES

The table below lists additional protection and restoration measures that would benefit the Cebolla Canyon Wetlands.

xv. Restoration Measures

Objective/Action	Time Frame	Partner
New Grazing Plan	Urgent	BLM
Repair of Riparian Fences, Exclosures	Urgent and ongoing	BLM, RPA, AWF
New Riparian Pasture	Urgent	BLM
Stock Pond Conversion	1-2 years	RPA, BLM, Bat Conservation International
Plug and Ponds (19+)	1-2 years	RPA
Trigger Point Exclosures	Urgent	RPA, AWF, BLM
More Road Repair	1 year	BLM
Species Re-introduction	1 year	BLM, RPA, USFWS
Reconnaissance to Determine Restoration Work Needed in Other Reaches	Urgent	RPA, AWF

xvi. Monitoring

Objective/Action	Time Frame	Partner
Continue to assess wetland ecosystem conditions and functions of the Cebolla Canyon Wetlands	ongoing	Watershed groups and NGO partners
Generate web based up-to-date map and information database of the condition of the wetland.	ongoing	SWQB, USFWS, universities and NGO partners
Establish a program to update stakeholders on the conditions, improvements and challenges that the wetland is facing in terms of changing climate patterns and land use.	ongoing	SWQB, USFWS, universities and NGO partners

xvii. Outreach

Objective/Action	Time Frame	Partner
Continue to develop outreach strategies to inform and educate different stakeholder groups about relevant wetland ecosystem services as benefits of wetland restoration and protection.	ongoing	SWQB, NGO and government agencies
Continue to target school and youth groups in Grants and Acoma to support and be actively engaged in wetland restoration and protection efforts	ongoing	SWQB, NGO and schools
Continue to engage new groups,such as Sierra Club and National Wild Turkey Federation, in restoration work	ongoing	RPA, BLM, AWF, NMED, NMDFG, EMNCA, RPMC

Develop an Adopt-a-Wetland program to raise awareness and money for restoration and protection projects	ongoing	SWQB, NGO and schools
Continue Steering Committee Meetings	Urgent	RPA, BLM, AWF, NMED, NMDFG, EMNCA, RPMC
Continue Cebolla Summer Wetlands Academy	Urgent	RPA, BLM
Display at the Ranger Station	Urgent	RPA, BLM

14.OUTREACH AND LOCAL INVOLVEMENT STRATEGY

14.1 STEERING COMMITTEE

A steering committee was established shortly after the Cebolla Canyon restoration project began, composed of stakeholders, contractors, and cooperators representing the NMED, BLM, RPA, AWF, NMDGF, El Malpais National Conservation Area (EMNCA), and the Rio Puerco Management Committee (RPMC). There were eight Steering Committee Meetings held. The group is willing to continue meeting for future projects.

14.2 CORE OF VOLUNTEERS

14.2.1 Current Groups involved

AWF has been involved in Cebolla Canyon since 2000. They have been conducting at least two work weekends a year for the past five years under the various projects RPA has received funding for. They have made a commitment to continue this work into the future.

National Wild Turkey Federation (NWTF) has been holding at least one work weekend a year for the past two years. They too, have made a commitment to continue with this work. The Pueblo of Acoma Youth & Community Corps is a program of the Southwest Conservation Corps' (SCC) Ancestral Lands office that has done both volunteer and paid work in the area for us.

14.2.2 Future Groups to Engage

A number of other groups will be asked to contribute to the restoarion of Cebolla Canyon watershed. These currently include the Sierra Club, and to continue work with Acoma SCC. Hunting is popular in the area, as numerous hunting groups set up camps in the canyon, and through the Game and Fish Department hunting groups should be engaged. More stakeholders can also be engaged through the efforts of the Rio Puerco Management Committee and their 35+ organizations that are represented.

14.3 INFORMATIONAL PROGRAMS AND ACTIVITIES

14.3.1 BLM Ranger Station on NM117

As part of the outreach associated with RERI and SWQB Wetlands Program funding, a display at the BLM Ranger Station was created showing the work done and discussing the Summer Academy. A future display will be discussed that will include monitoring results, adaptive management and future restoration needs.

14.3.2 Interpretive Display at the Multiagency Visitor Center

An interpretive display for the Multiagency Visitor Center located in Grants is also being planned. The display is to reach area children to introduce them to wetlands and the need for their restoration.

14.3.3 Wetlands Academy

On July 21st and 22nd of 2013, the Summer Academy/Cebolla Outdoors Classroom took place in Cebolla Canyon and Thoreau, NM. The event involved a two-day workshop, including an overnight at the Cottonwood Gulch (CG) basecamp. RPA and partners recruited 7 students from the community of Grants – the target population we were trying to reach – and 19 students from one of the CG summer programs.

The participants ranged from 7th to 10th grade and had a wonderful time learning about land and water management in the high riparian habitat of Cebolla Canyon, building 12 one-rock dams under the guidance of Southwest Urban Hydrology (SUH) owner Aaron Kauffman. The day dawned bright and sunny for an early morning pickup in Grants, and thankfully as the Grants participants joined the Trekkers from Cottonwood Gulch, a cool cloud cover favored the group, allowing for a comfortable day of outdoor activities.

The group then moved on to the beautiful, shady Cottonwood Gulch base camp in Thoreau, NM. Trekkers and Grants youth got to dine together and enjoy fun group activities around camp, and OSM/VISTA Emily Wolf and BLM Ranger Jen Cutillo joined the next day! Emily and Jen led the group in exploration of the Cottonwood riparian area, including a riparian scavenger hunt and a group rainmaking activity.

This program was the second-annual Cebolla Summer Classroom – the first was arranged by former RPA OSM/VISTA Nikolis Gualco, and took place July 1st and 2nd, 2012. The classroom brought out Keystone Restoration owner Steve Vrooman, who took the group out to tour the canyon. He highlighted all of the different restoration techniques used and showed us some really effective examples. After the tour, the group visited a nearby Student Conservation Association (SCA) project site to see an ongoing example of rock-work-based restoration. SCA presented a rock structure they were currently building. This program went a long way to foster important partnerships between the Grants Ranger Station at El Malpais, Los Alamitos Middle School in Grants, Cottonwood Gulch Foundation, and various RPA restoration contractors such as Steve Vrooman and Aaron Kauffman. Not only did the group get to aid in the empowering process of restoration and see the effects of erosion control at work, they got to explore the outdoors and spend time with other peers from very different parts of the world!

The programs were funded under an RPA contract with the SWQB Wetlands Program, which has been providing funds to restore Cebolla Canyon for four years, and has seen amazing results. Already the treated reaches in Cebolla Canyon are showing marked signs of improvement, and are serving as important tools for any visitors to the site, who can see successful restoration in action!

Funding is being sought to continue this program, but thus far requests have not been successful.

15. FUNDING SOURCES

Cebolla Canyon is not eligible for Clean Water Act 319 (non-point source) funding, as it is not listed on the 303d list. - We have tried to get further restoration funding from:

- the National Fish and Wildlife Foundation;
- the North American Wetlands Conservation Act program (NAWCA);
- the Frost Foundation; and
- the National Environment Education Foundation (NEEF).

Thus far, this area has been overlooked for further funding. The New Mexico Legislature is funding a River Stewardship Initiative in 2014. That may give us another opportunity for restoration funding. We received a $25,000 grant from the New Mexico Community Foundation in 2012 which provided valuable work by the Acoma SCC in restoring Cebolla canyon wetlands. They will be contacted again. Other foundations will be contacted as well.

16.MONITORING

Monitoring of ongoing wetland restoration efforts will help identify impacts specific to the restoration and protection measures being used on the wetland. The monitoring of the wetland will show how successful different measures and techniques are and will help in determining whether measures have to be adjusted or redesigned. In addition, data that is produced through the monitoring process can be used in reports and for educational purposes and will influence future wetland restoration and protection actions.

Several monitoring reports have already been produced and are listed below. The wetlands are expected to be monitored continuously if funding is available, to evaluate the short and long-term effects that restoration and protection measures have. Specifically, monitoring will determine wetland expansion through changes in wetland vegetation, geomorphology, and groundwater as well as in soils. Additionally, photomonitoring will help visually display how the wetland is expanding and vegetation cover is changing.

Specific monitoring techniques that have been applied and are recommended to be used are:

- Wetlands delineation
- Site photography (photo points)
- Vegetation transects
- Installation of piezometers to determine whether the hyporheic zone and wetland areas expand as intended.
- Development of a Quality Assurance Project Plan (QAPP)
- Training of monitoring volunteers

16.1 PAST MONITORING EFFORTS

There have been project specific monitoring efforts in Cebolla Canyon. Below is a list of the reports on these efforts:

- Restoring Cebolla Canyon Monitoring Report
  Keystone Restoration Ecology, December, 2013
  Prepared for the Rio Puerco Alliance and the New Mexico Environment

- Restoring and Protecting Wetlands in Cebolla Canyon Closed Basin
  Monitoring Report
  Keystone Restoration Ecology, January, 2011

- Cebolla Creek Wetland Restoration Monitoring:
  Status Report, December, 2009. Geomorphology Monitoring
  Steve Vrooman Restoration Ecology, December 9, 2009

- *Hydrologic and topographic monitoring of wetland restoration effectiveness in Cebolla Canyon Closed Basin*
  Final Report, December 2011, Prepared by Ellen Soles

- Cebolla Canyon Restoration Area
  Ablquerque Resource Area
  Bureau of Land Management, New Mexico
  Preliminary Small Mammal Survey
  Prepared by:
  Katherine M. Thibault, Travis W. Perry
  Department of Biology, Furman University

- Cebolla Canyon
  Restoration Treatment Photomonitoring
  2011-2012

17. APPENDIX

17.1 LIST OF PROFESSIONALS AND EXPERTS INTERVIEWED

Name	Title/Profession
Bill Zeedyk	Land, Biologist / Ecologist, Riparian Wildlife and Wetlands Specialist.
Steve Fischer	Former Retired BLM
Matthew Schultz	Surface Water Quality Environmental Scientist, New Mexico Environmental Department
Steve Vrooman	Professional Ecologist
Gretchen Obenaus	BLM Archeologist Rio Puerco Field Office Cebolla Canyon/Malpais
Craig Sponholtz	Riparian and Watershed Restoration Expert
Dave Mattern	BLM Hydrologist
Ed Singleton	Retired BLM District Manager
Brian Gleadle,	Chief of NW Area Operations, NM Department of Game Fish and Fish Game Albuquerque
Gene Tatum	Retired BLM, Albuquerque Wildlife Federation
Joe Lally	BLM Archaeologist Cebolla Canyon/Malpais Rio Puerco Field Office

17.2 LIST OF PHOTOPOINTS

17.2.1 Photopoint Identification Sheet

The following is a collection of photopoints gathered by Matt Schultz in order to document the restoration in the Cebolla Canyon.

Site Name: Cebolla Canyon; El Malpais National Conservation Area, BLM	**Date of survey:** 11/5/09
Recorder's name: Matt Schultz	**Photographer's name:** Matt Schultz
Camera description (focal length of lens, digital or print camera, is it same as last one used for monitoring?) If digital, what is the resolution setting of the camera? Canon Powershot SX100 IS Digital Camera 6.0-60.0mm 1:2.8-4.3 8.0 Mega Pixels	
Speed of film (ASA) if shooting print film: NA	
Height from ground to eye of the photographer. Approximately 5 feet	
Declination of compass: 10 degrees E	

17.2.2 Data

Number on roll or file image number	Time of day & Direction of photograph (compass bearing)	Photopoint label/code, height of photo from ground level and location description (see map and photo captions)
2508	11:48AM / 1°	PP1; DD 34.675683° -107.846786° (Datum WGS 1984)
2509	11:48 AM / 49°	PP1; DD 34.675683° -107.846786° (Datum WGS 1984)
2503	11:32 AM / 170°	PP2; DD 34.673793° -107.845555° (Datum WGS 1984)
2505	11:35 AM / 40°	PP2; DD 34.673793° -107.845555° (Datum WGS 1984)
2506	11:36 AM / 85°	PP2; DD 34.673793° -107.845555° (Datum WGS 1984)
2511	12:17 PM / 125°	PP3; DD 34.670636° -107.846576° (Datum WGS 1984)
2512	12:18 PM / 85°	PP3; DD 34.670636° -107.846576° (Datum WGS 1984)
2515	12:43 PM / 205°	PP4; DD 34.667518° -107.848185° (Datum WGS 1984)
2516	12:44 PM / 165°	PP4; DD 34.667518° -107.848185° (Datum WGS 1984)
2517	12:46 PM / 115°	PP4; DD 34.667518° -107.848185° (Datum WGS 1984)
2518	12:46 PM / 75°	PP4; DD 34.667518° -107.848185° (Datum WGS 1984)

2519	12:48 PM / 55°	PP4; DD 34.667518° -107.848185° (Datum WGS 1984)
2521	1:31 PM / 65°	PP5; DD 34.67845° -107.85429° (Datum WGS 1984)
2522	1:33 PM / 325°	PP5; DD 34.67845° -107.85429° (Datum WGS 1984)

2524	2:08 PM / 295°	PP6; DD 34.682755° -107.864503° (Datum WGS 1984)
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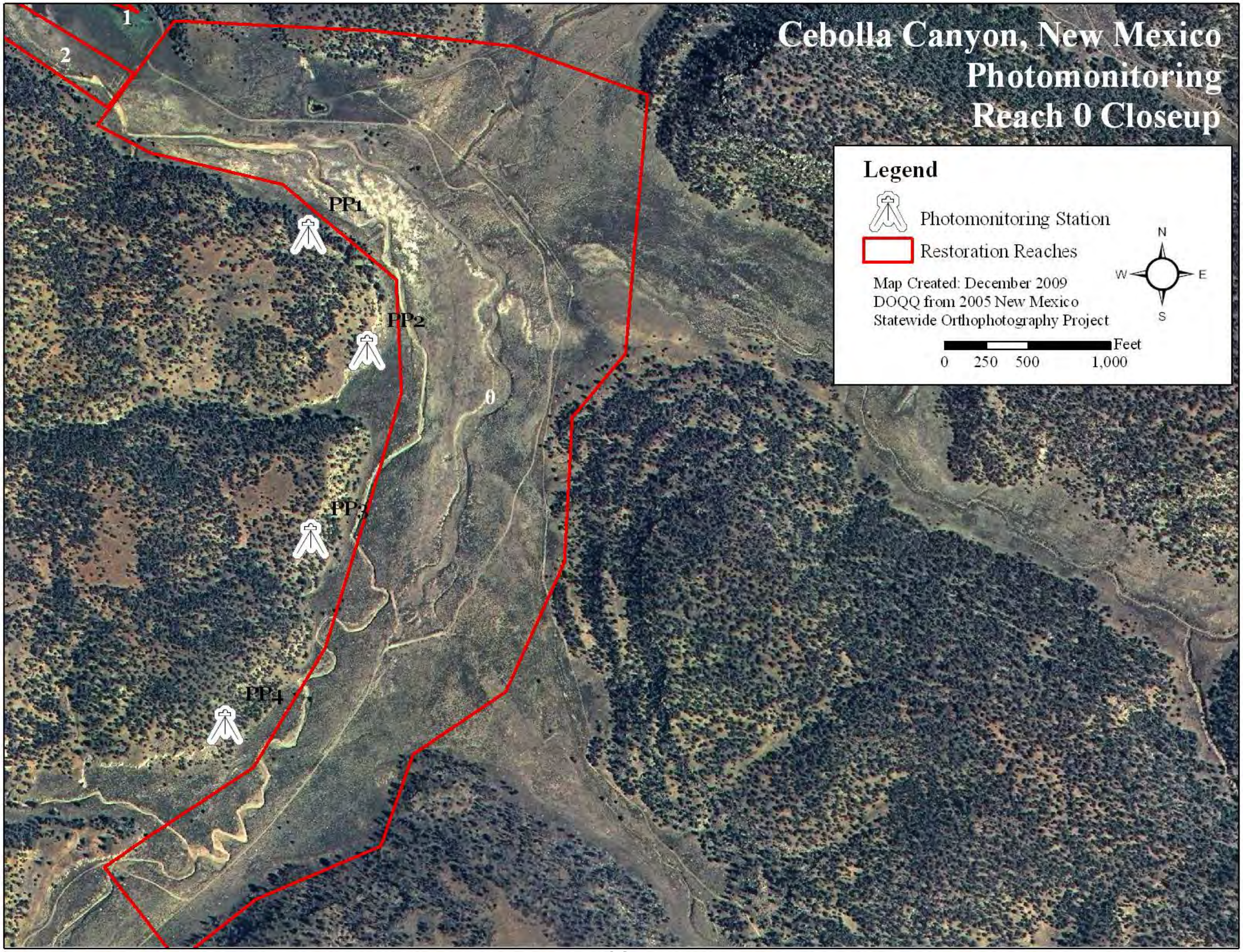
2527	2:13 PM / 65°	PP6; DD 34.682755° -107.864503° (Datum WGS 1984)
2529	2:48 PM / 260°	PP7; DD 34.692409° -107.879531° (Datum WGS 1984)
2530	2:49 PM / 225°	PP7; DD 34.692409° -107.879531° (Datum WGS 1984)
2531	2:50 PM / 190°	PP7; DD 34.692409° -107.879531° (Datum WGS 1984)
2532	2:51 PM / 160°	PP7; DD 34.692409° -107.879531° (Datum WGS 1984)


Cebolla Canyon, New Mexico
Photomonitoring
Reach 0 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
Statewide Orthophotography Project
Feet
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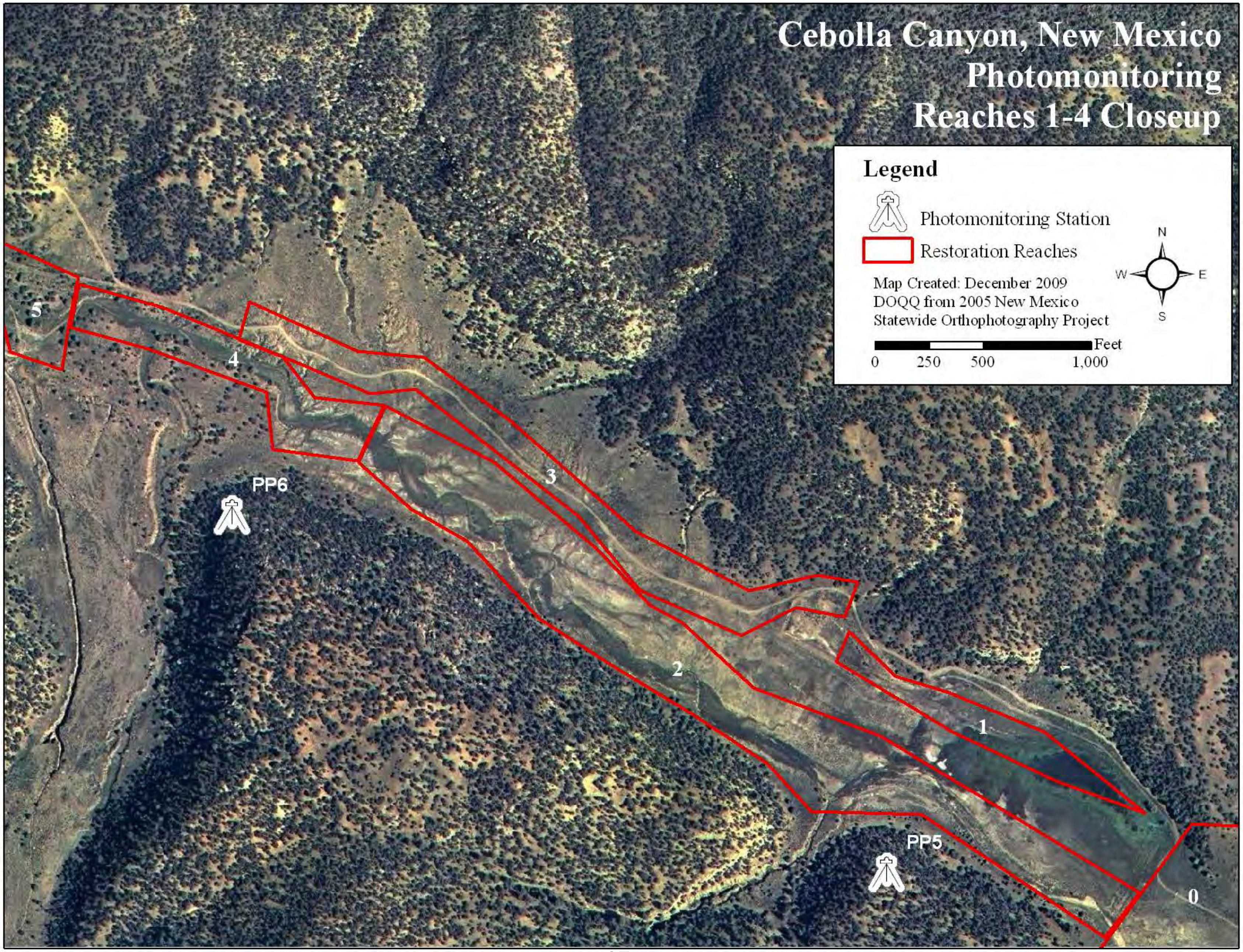
Cebolla Canyon, New Mexico
Photomonitoring
Reaches 1-4 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
Statewide Orthophotography Project
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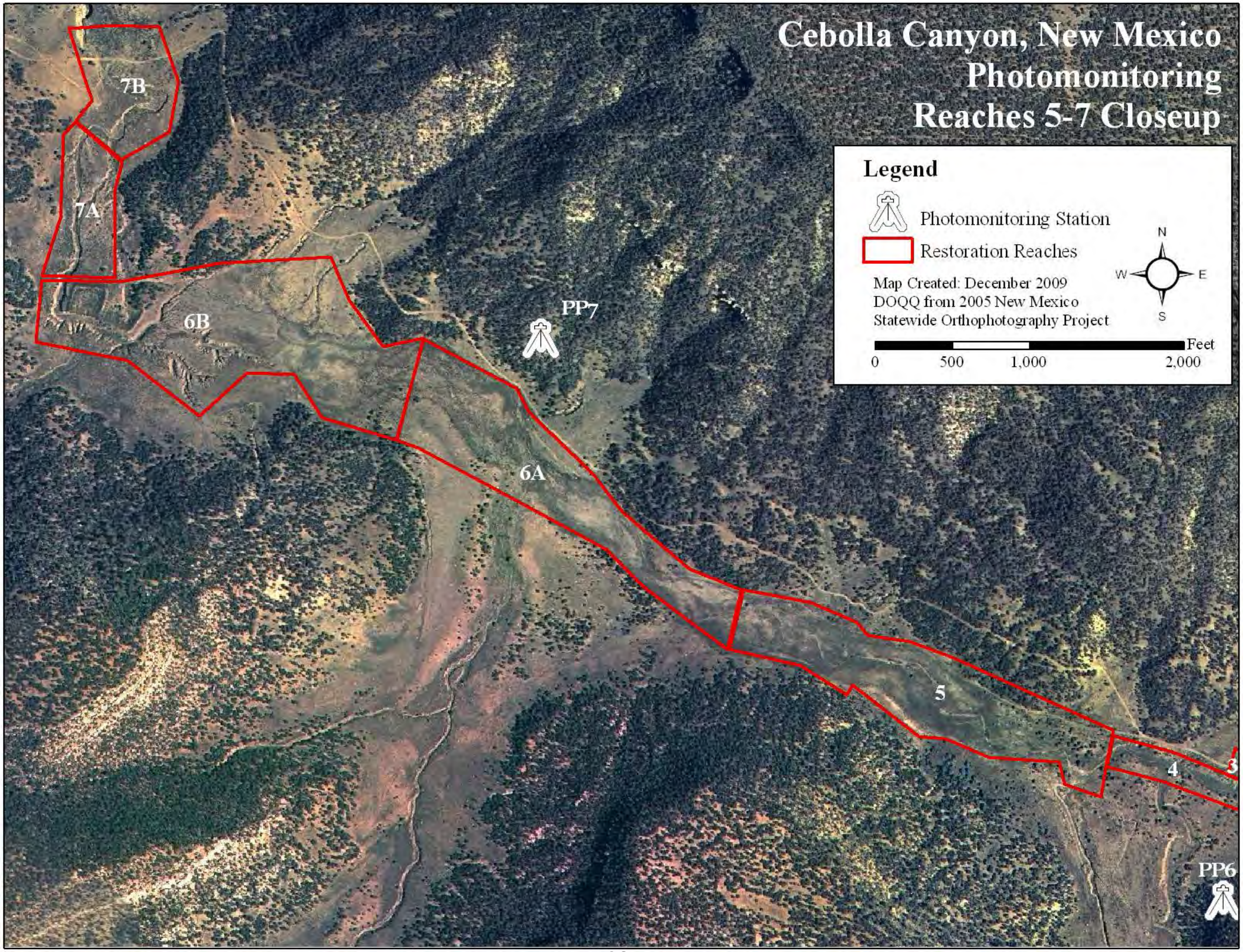
Cebolla Canyon, New Mexico
Photomonitoring
Reaches 5-7 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
Statewide Orthophotography Project
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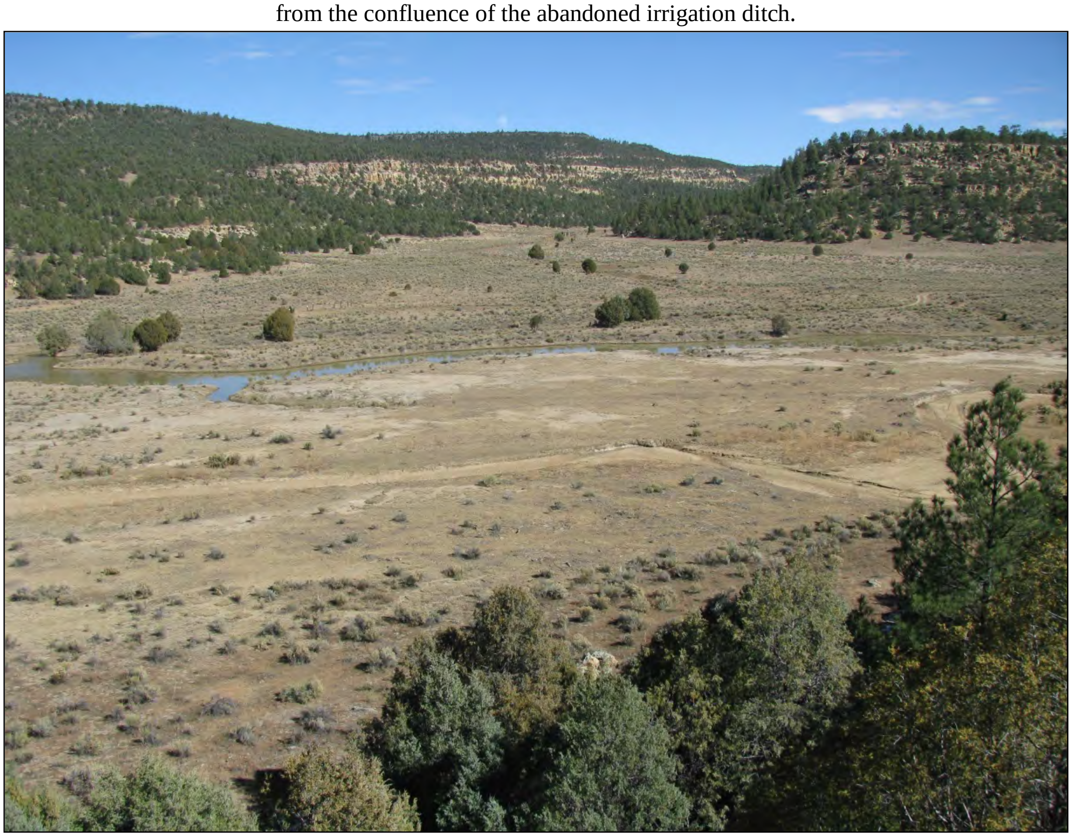
2,000
Feet
7B
7A
6B
6A
5
4
PP7
PP6

Photopoint 1 – 1 degrees – Reach 0: View of Little Cebolla Springs and Lake Cebolla as well as the sediment plug resulting from the confluence of the abandoned irrigation ditch.



Photopoint 1 – 49 degrees – Reach 0: View of Lake Cebolla in the center with Side Valley Right #3 in the background and the abandoned irrigation ditch in the foreground.

Photopoint 2 – 170 degrees – Reach 0: View upstream of Cebolla valley in the center with Side Valley Right #1 in the background and the abandoned irrigation ditch in the foreground.

Photopoint 2 – 40 degrees – Reach 0: View downstream of Cebolla natural channel in the center with Side Valley Right #2 and 3 in the background and the abandoned irrigation ditch in the foreground.

Photopoint 2 – 85 degrees – Reach 0: View of Cebolla natural channel in the center with Side Valley Right #2 in the background and the abandoned irrigation ditch in the foreground.

Photopoint 3 – 125 degrees – Reach 0: View of Cebolla natural channel and diversion berm in the center with Side Valley Right #1 in the background and the abandoned irrigation ditch in the foreground.


Photopoint 3 – 85 degrees – Reach 0: View of Cebolla natural channel and road in the center and the abandoned irrigation ditch in the foreground.


Photopoint 4 – 205 degrees – Reach 0: View upstream of Cebolla valley with Side Valley Left #1 to the right.


Photopoint 4 – 165 degrees – Reach 0: View across Cebolla valley with tortured meanders and road in center.


Photopoint 4 – 115 degrees – Reach 0: View across Cebolla valley with channel and road visible in center.

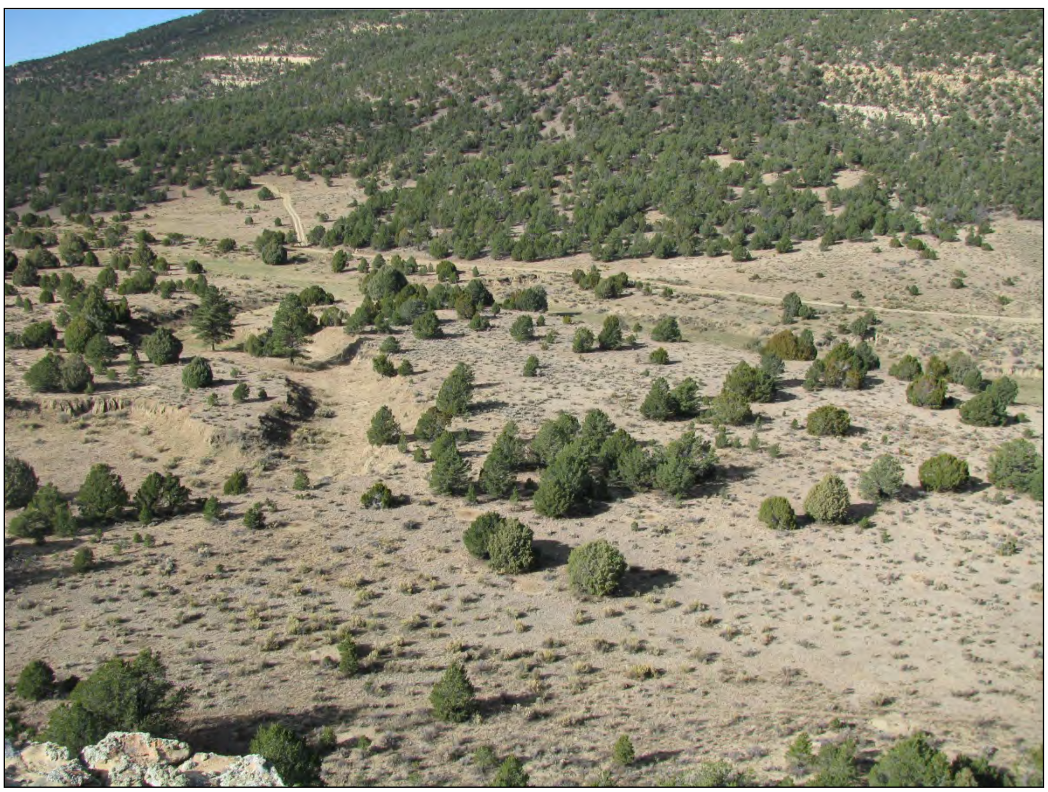
Photopoint 4 – 75 degrees – Reach 0: View across Cebolla valley with channel and road visible in center and Side Valley Right #1 in the background.

Photopoint 4 – 55 degrees – Reach 0: View downstream of Cebolla valley with channel and road visible in center and Side Valley Right #1 and #2 in the background.

Photopoint 5 – 65 degrees – Reach 1: View upstream of Cebolla Springs.

Photopoint 5 – 325 degrees – Reaches 2 and 3: View downstream of Cebolla valley with the road (Reach 3) visible on valley right and the irrigation ditch on valley left. A fenceline is located in the center.

Photopoint 6 – 295 degrees – Reaches 4 and 5: View downstream of Cebolla valley with Side Valley Left #4 in the foreground.



Photopoint 6 – 335 degrees – Reach 4: View slightly downstream of Cebolla valley with Side Valley Left #4 in the foreground and the road visible in the background.

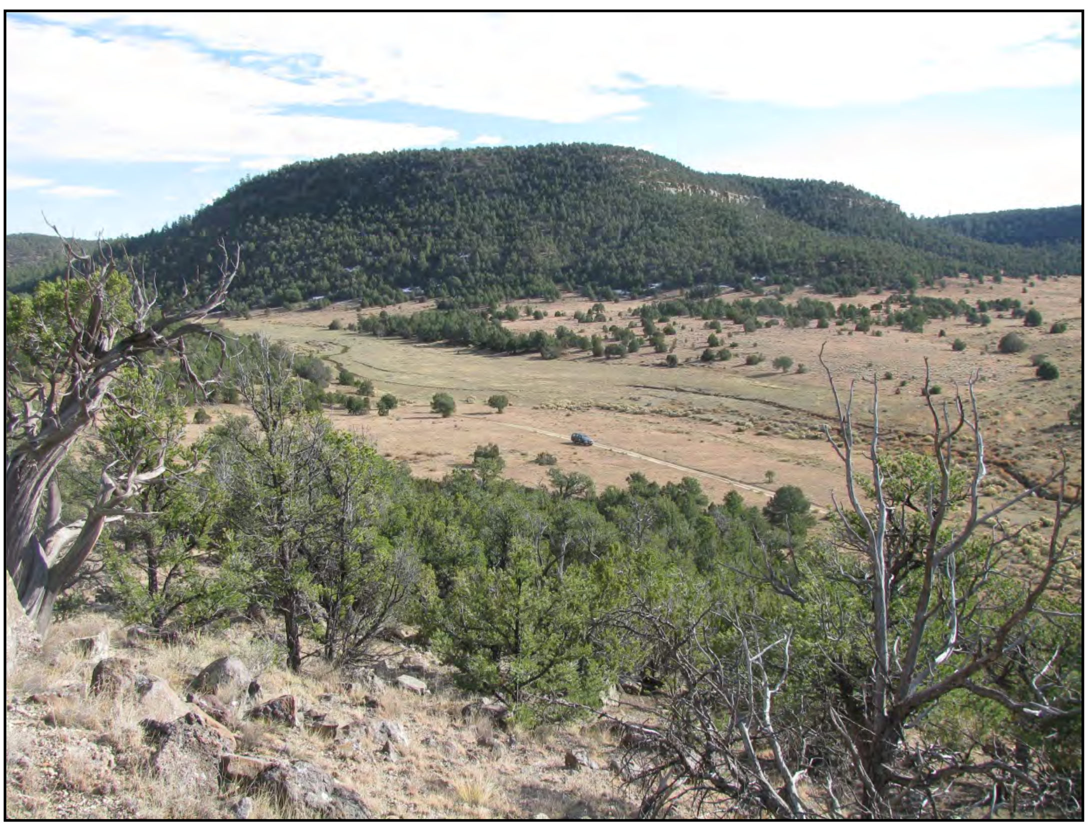
Photopoint 6 – 40 degrees – Reaches 4 and 3: View across Cebolla valley with the road (Reach 3) visible in the background.

Photopoint 6 – 65 degrees – Reaches 4, 3, and 2: View across Cebolla valley with the junction of reaches 4 and 2 in the center, and the road (Reach 3) visible in the background.

Photopoint 7 – 260 degrees – Reaches 6A and 6B: View downstream Cebolla valley with the massive headcuts in the center.

Photopoint 7 – 225 degrees – Reach 6A: View across Cebolla valley.

Photopoint 7 – 190 degrees – Reach 6A: View across Cebolla valley into Side Valley Left #5.



Photopoint 7 – 160 degrees – Reach 6A: View upstream of Cebolla valley with Side Valley Left #5 at the upper right

17.3 2013 MONITORING REPORT

Restoring Cebolla Canyon
Monitoring Report
Keystone Restoration Ecology, December, 2013

Prepared for the Rio Puerco Alliance and the New Mexico Environment Department's SWQB Wetlands Program

Table of Contents

Introduction

Steve Vrooman of Keystone Restoration Ecology was contracted to lead the geomorphology and monitoring efforts for the Cebolla Creek Wetland Restoration Project. This project is funded through two separate grants. One grant is through the EPA's 319 clean water act program, called: "Restoring Cebolla Canyon," which is being funded through NMED CD # (FY2008). The second grant is through the State of New Mexico's River Ecosystem Restoration Initiative (RERI) and called "Restoring and Protecting Wetlands in Cebolla Canyon Closed Basin," which is being funded through NMED CD #966857-01-0C (FY2008). The two grants were used to fund separate reaches of the total project. The RERI grant funding ended on June 30, 2012. The NMED wetlands program funding was extended to Dec 31st, 2013, and the monitoring for the wetlands grant was re-taken in 2013 with this funding.

Land Use History and Purpose of Restoration

Past channel manipulations for agriculture included cattle tank dams, irrigation diversions, headcut protection dams, cattle trails, and road building. All of these manipulations together caused gullying in the main Cebolla Canyon and the associated tributaries, loss of the historic wetland community, and drying out of the area. These manipulations occurred in the 1930s to 1950s.

After the last homesteaders left, their land mostly became Bureau of Land Management property, and the agricultural works were not maintained. The area was grazed heavily as part of the King Ranch, and most recently the York Ranch. Heavy grazing pressure was the norm for 50 years, and the gullying and headcutting became worse. When the first restoration activities were begun by Gene Tatum, the BLM and the Albuquerque Wildlife Federation under Bill Zeedyk's supervision, the Cebolla Spring was a 100 foot wide mud hole with little or no riparian vegetation. Simple actions such as plugging a gully with sandbags started a chain reaction that filled a 200 foot gully and created a 10 acre wetland that continues to expand today.

These treatments applied were selectively designed by Bill Zeedyk and other resource experts to undo the historic manipulations of the watershed and use the resource of flowing water and sediment transport to restore the historic wetland areas, fix the gullies and eliminate headcutting. Most of these treatments involved earth moving activities such as plug and pond, removing or repairing old cattle tank dams, and road drainage. Where necessary, smaller headcuts were treated with Zuni bowls and one rock dams. Due to the fact of water flowing downhill, all of the downhill treatments are the beneficiaries of the upstream treatments, the storage of water upstream in Reach 0 can be said to have an effect downstream in Reach 5.

Wetland Delineation at Cebolla Creek

A wetland delineation was performed at Cebolla Creek with Matt Schultz of the NM Environment Department. A polygon was mapped with GPS (sub-meter Trimble) to delineate the boundaries of the wetland. The wetland delineation was re-surveyed in October 2013 to show how the wetland conditions have responded to the restoration treatments.

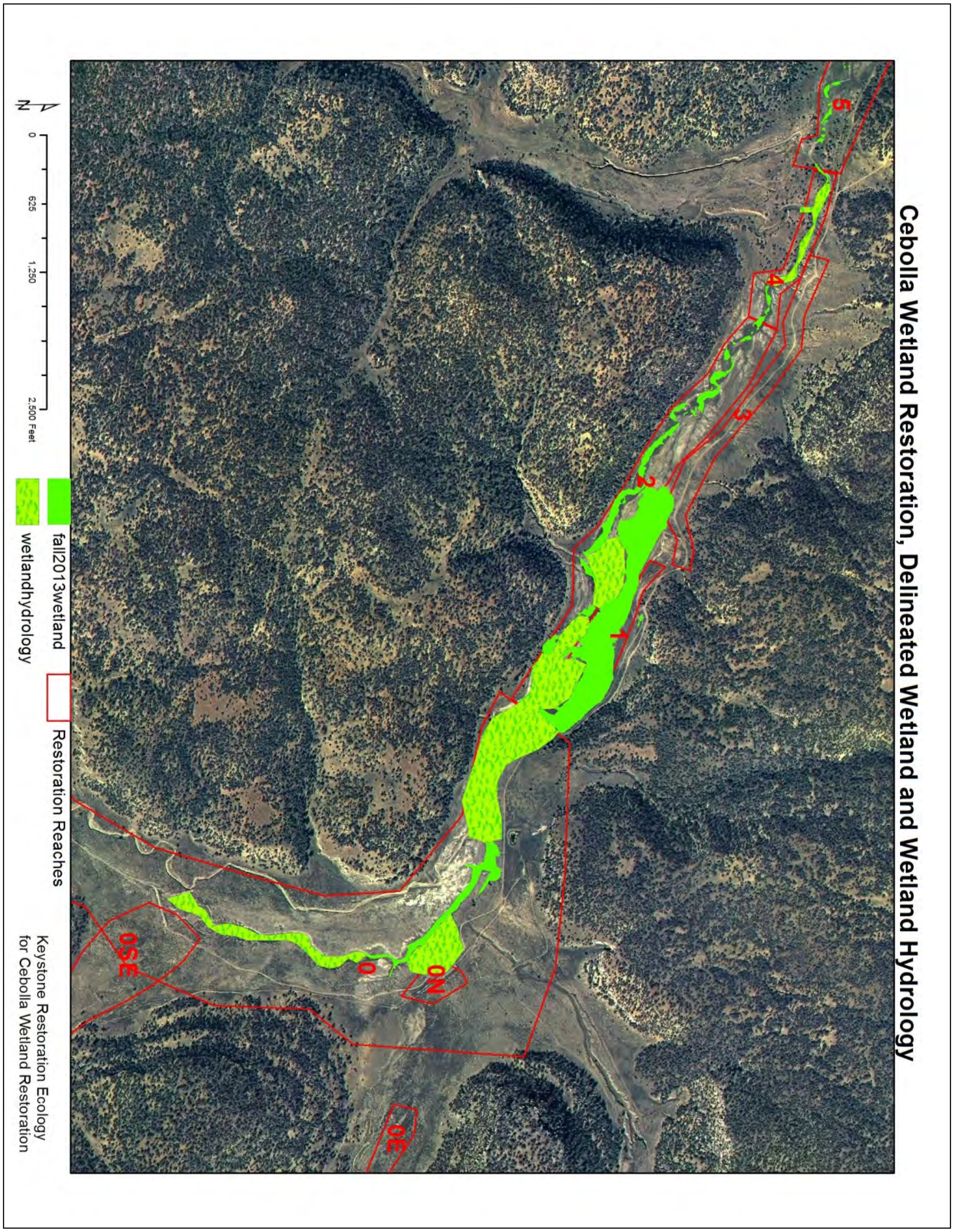
This data was also used to create a wetland vegetation gradient and is presented in a state-transition model format.

A summary of the findings:

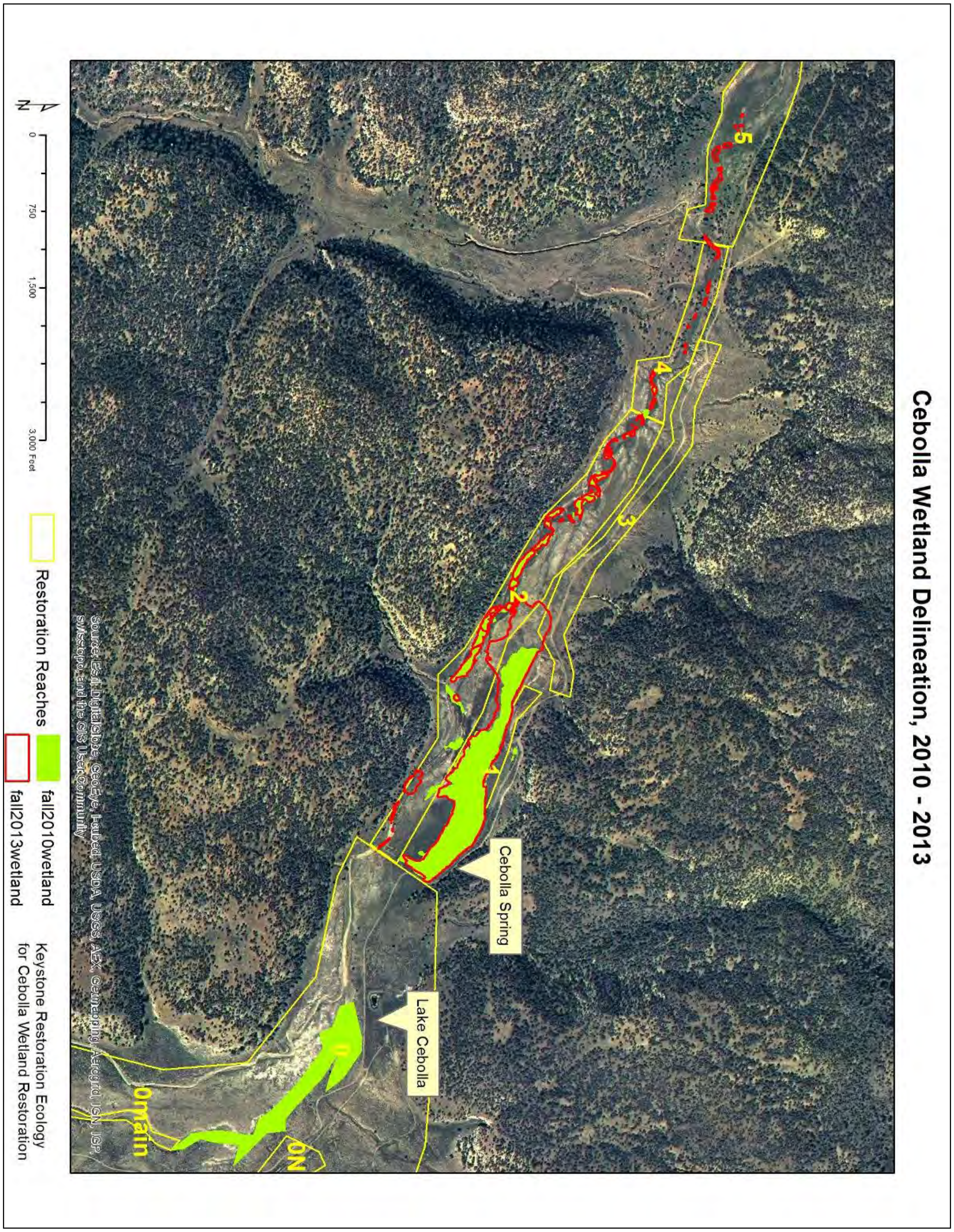
1. Wetland vegetation must be over 50% of the herb/grass stratum. When western wheatgrass is present, the area is not inundated enough to be wetland, and the vegetation is not hydrophytic. When these areas get wetter, the western wheatgrass dies off and is replaced by more foxtail barley and smartweed polygonum.
2. None of the soils surveyed were hydric soils, there was no layering or redox reactions, and the only sign of wetland soil was oxidized rhizospheres (rust along roots), which is a secondary hydrology wetland hydrology indicator on the worksheet.
3. Most of the surveyed areas have wetland hydrology, due to either surface water, regular flooding, or secondary indicators such as water marks and sediment and drift deposits. DUE TO THIS, we delineated an area as wetland when wetland vegetation was present in addition to the wetland hydrology indicators. Lake Cebolla was unique due to the presence of water throughout the growing season and a fringe of Baltic rush.
4. Areas that had wetland hydrology but did not have wetland vegetation were shown separate as "wetland hydrology" polygons. These areas were buried in 1-4 feet of sand in 2013, burying any evidence of any vegetation present. Wetland plants will be able to sprout through the sand in 2014, and their presence in the future would make these areas delineated wetland.

Wetland Areas in Cebolla Creek, Reaches 0-5

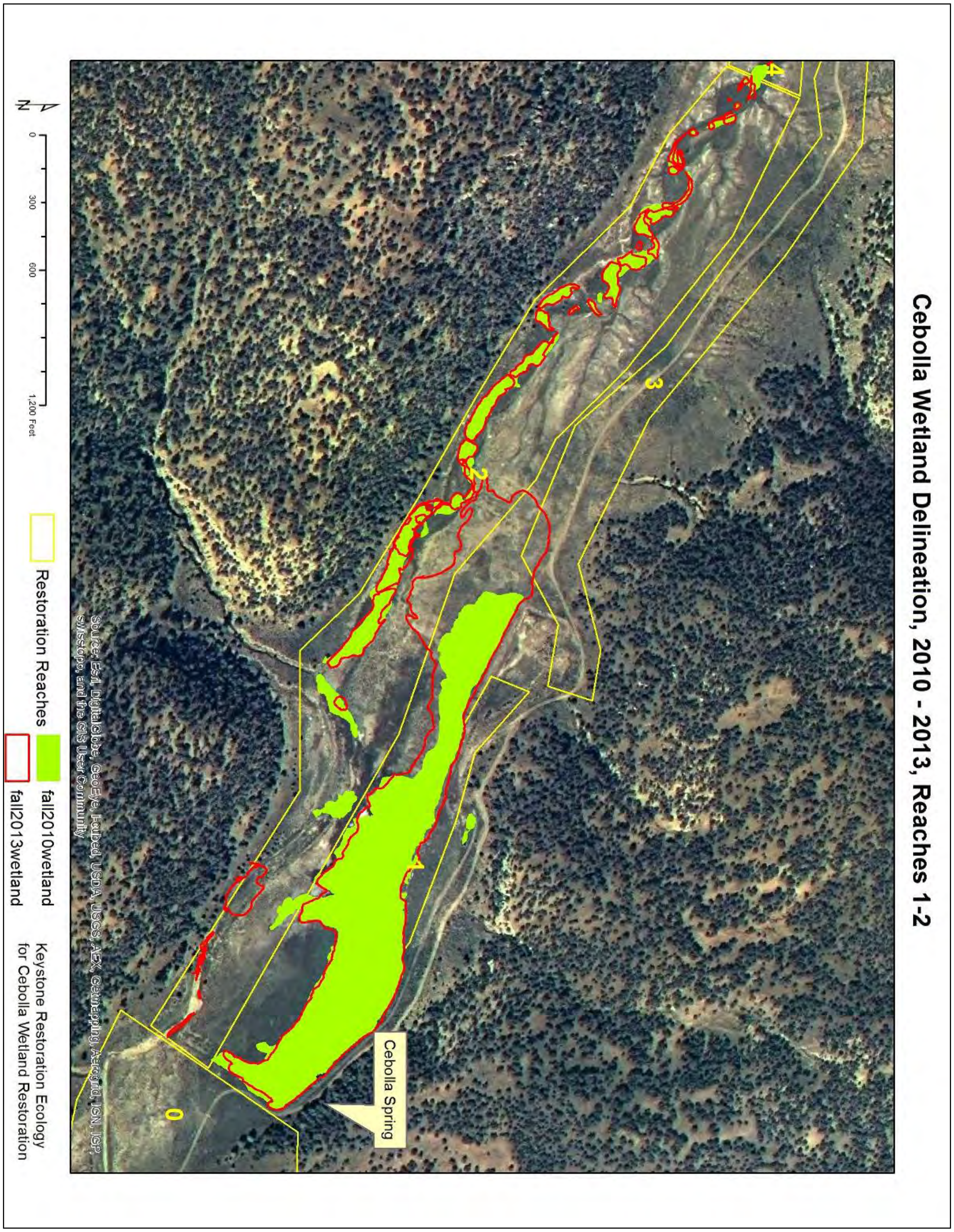
Location	Delineated wetland in acres 2010	Delineated wetland in acres 2013	Wetland hydrology in 2013
Lake Cebolla (Reach 0)	2.9	2.9	
Reaches 1-2	13.33	16.9	
Reaches 4-5	0.37	0.7	
Total acres	16.6 acres	20.5 acres	29.4 acres



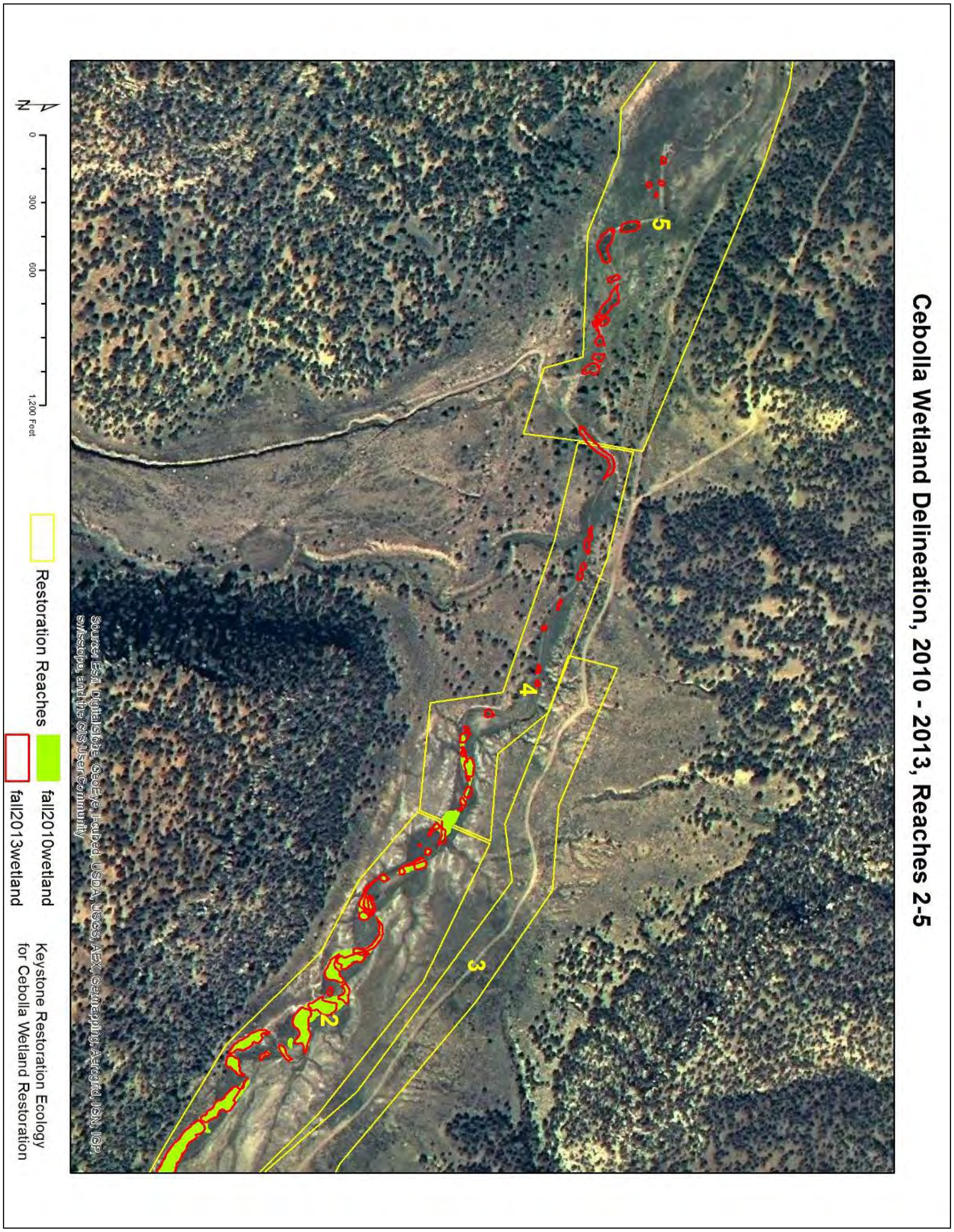
Comparison between areas with wetland hydrology and areas with wetland hydrology and vegetation (delineated wetland) in 2013. A large portion of these areas were covered with several feet of sand, burying any vegetation present when surveyed in Oct 2013.



Overview of wetland areas in Cebolla Wetland, a comparison between 2010 and 2013.



Close-up on Reaches 1 and 2 at Cebolla wetland. Wetland areas were identified up-channel to the large exclosure fence between reaches 0 and 1. Most of the area near Cebolla Spring had been buried in sand and litter after the large floods in September, 2013. This caused some areas that had been identified as wetland in 2010 to be missed in 2013, as they were buried under sand and had not yet sprouted new growth, one month after the flood.



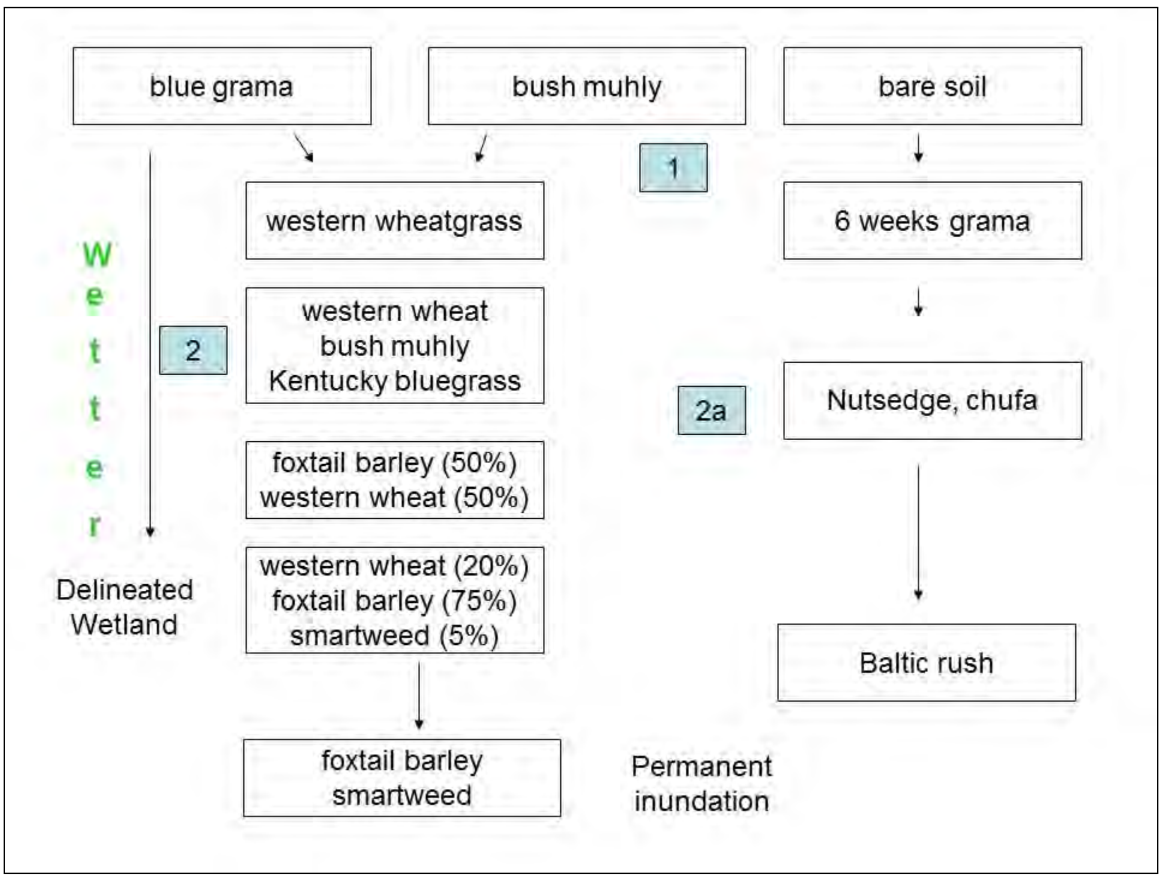
Close-up on Reaches 4 and 5 at Cebolla wetland. Wetland areas had advanced down-channel into reach 5 from the upstream reaches. A large alluvial fan from Savage Canyon to the south has filled the valley bottom and caused water to spread and soak into the ground, creating conditions appropriate for wetland vegetation, in this case, Baltic rush.

Two photos taken from different locations on the south side of Cebolla Canyon fall 2010 and fall 2013, looking at end of wetland. Upper photo has wetland ending near pond, in lower photo; wetland extends downstream 500 feet or so to bend in road and white truck to left of picture.

Wetland Vegetation Indicator Gradient

An assessment was performed and a proposed wetland gradient was proposed for Cebolla Creek. As areas change from dry to wet, the vegetation community responds. Once an area is completely inundated, the successional gradient proceeds from common spikerush (*Eleocharis palustris*) to cattail and bulrush.

LARGE CHANGES FROM 2010 TO 2013: this wetland vegetation indicator gradient model was created in 2010-2011. Over the last three years, the numbers of cattails in the main Cebolla wetland has dropped to almost none, as bulrush has taken over the main wetland area at Cebolla Spring. The cattails may have been a relic of a burning of the wetland that occurred years before and created open water at the spring.



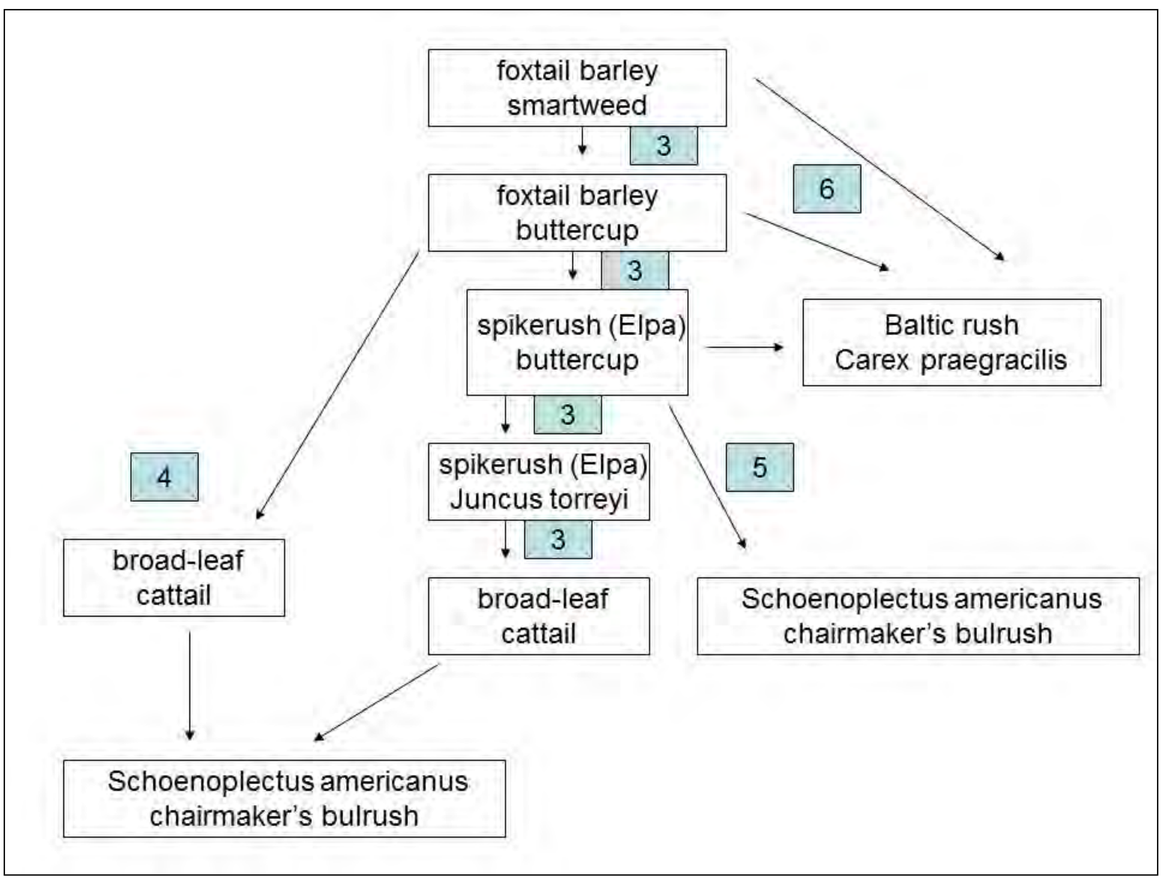
State-transition stages

1. Community becomes wetter through brief flood events from main channel or tributary channels. Extra water during growing season grows more vigorous vegetation and plant community changes to wet meadow (Western Wheatgrass) community. Bare Soil is colonized by Six-weeks grama if flooding is present.
2. Area becomes inundated for a significant time, either by pooling in the channel or tributaries of Cebolla Creek, or by expansion of Cebolla Spring wetland. Vegetation

responds by becoming more hydric until it becomes a delineated wetland community with Foxtail Barley, Western Wheatgrass, and Polygonum smartweed.

2a. Areas that are slightly drier and have deposition of wet sand can be colonized by nutsedge or Chufa (*Cyperus esculentus*). This plant is a vigorous grower and is most common at the end of Reach 0 near Little Cebolla Spring (lower exclosure) and the end of Reach 4. These areas progress to Baltic rush over time as they stay saturated and become delineated wetland. Due to the position in the channel and lack of permanent surface water, this stage ends at Baltic rush.

3. This is a successional stage from early to late successional species. In the absence of disturbance and continual inundation, this stage proceeds. The vegetation transects 1-1, 1-2, 1-3 will study this effect through several years.
4. This transition occurs when elk or cattle wallow in the spikerush and create large open pools (6 feet across). The open space allows for cattails to colonize the thick spikerush (Eleocharis palustris) vegetation.
5. The spikerush (Elpa) can quickly change to bulrush if the seeds of bulrush get established, otherwise, the change proceeds more slowly through Juncus torreyi.
6. If the spikerush areas dry out seasonally, they can become colonized by Juncus balticus and Carex praegracilis (Baltic rush and field sedge). These areas are saturated, but have no surface moisture. This community is found along the edges of the Cebolla Spring area, between the spring and the channel, and not found (yet) to the west where the wetland is advancing.



Indicator vegetation species list for State-transition model for wetland creation, species at top of table are dry, wetness increases down the list from top to bottom.

Vegetation species	Common name	habitat	wetness
Bouteloua gracilis	blue grama	Slopes, flats	dry
Muhlenbergia repens	creeping muhly	Valley bottoms with some additional moisture	dry/mesic
Pascopyrum smithii	western wheatgrass	Slopes, flats, valley	mesic, additional moisture
Poa pratensis	Kentucky bluegrass	All	mesic
Cyperus esculentus	nutsedge, chufa	Wet sand deposition	mesic
Hordeum jubatum	foxtail barley	Valley bottoms	wetland
Polygonum puncatatum	smartweed	Valley bottoms	wetland
Ranunculus sceleratus	cursed buttercup	Valley bottoms	wetland
Eleocharis palustris	common spikerush	Valley bottoms	wetland
Juncus balticus	Baltic rush	Valley bottoms	wetland, not inundated
Juncus torreyi	Torrey rush	Valley bottoms	wetland
Carex praegracilis	field sedge	Valley bottoms	wetland, not inundated
Typha latifolia	broad-leat cattail	Valley bottoms	wetland
Schoenoplectus americanus	chairmaker's bulrush	Valley bottoms	wetland

Rabbitbrush Mortality Experiment

Rabbitbrush (*Ericameria nauseosa, Chrysothamnus nauseosa*) is a large, common shrub found all over the Western U.S. It is known locally as Chamisa, it Spanish name, as well. This shrub grows in seasonally flooded areas, and quickly becomes the dominant shrub species. On former wetland areas at Cebolla, such as Reach 0, it is very common.

An experiment was set up to study the effects of inundation and flooding on rabbitbrush survival. Bill Zeedyk, the noted restorationist who is the designer of this project, has proposed that rabbitbrush is quickly eliminated from areas where it is common by saturated or seasonally saturated soils.

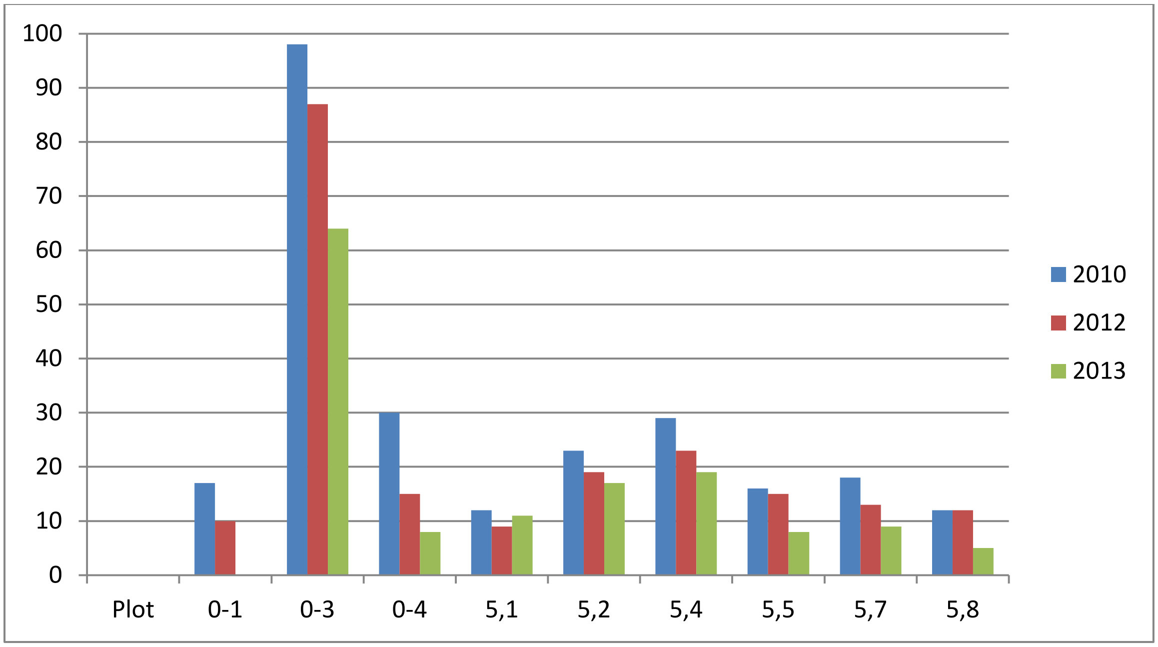
Nine treatment plots and three control plots were set up to study rabbitbrush survivorship. Each plot was a 30 foot radius circle around a single rebar centerpoint. Only reaches 0 and 5 to 6 had significant rabbitbrush cover, so the experiment was located in these reaches.

	2010	2012	2013	2010	2012	2013	2010	2012	2013
Plot	mature	mature	mature	seedling	seedling	seedling	all plants	all plants	all plants
0-1	17	10	0	12	1	0	29	11	0
0-3	98	87	64	13	14	19	111	101	83
0-4	30	15	8	20	8	12	50	23	20
5,1	12	9	11	1	0	0	13	9	11
5,2	23	19	17	4	4	1	27	23	18
5,4	29	23	19	3	0	1	32	23	20
5,5	16	15	8	0	0	0	16	15	8
5,7	18	13	9	1	0	1	19	13	10
5,8	12	12	5	1	0	0	13	12	5
0-2 control	62	40	50	21	19	16	83	59	66
5-3 control	21	21	21	6	3	0	27	24	21
5-6 control	18	17	20	9	15	1	27	32	21

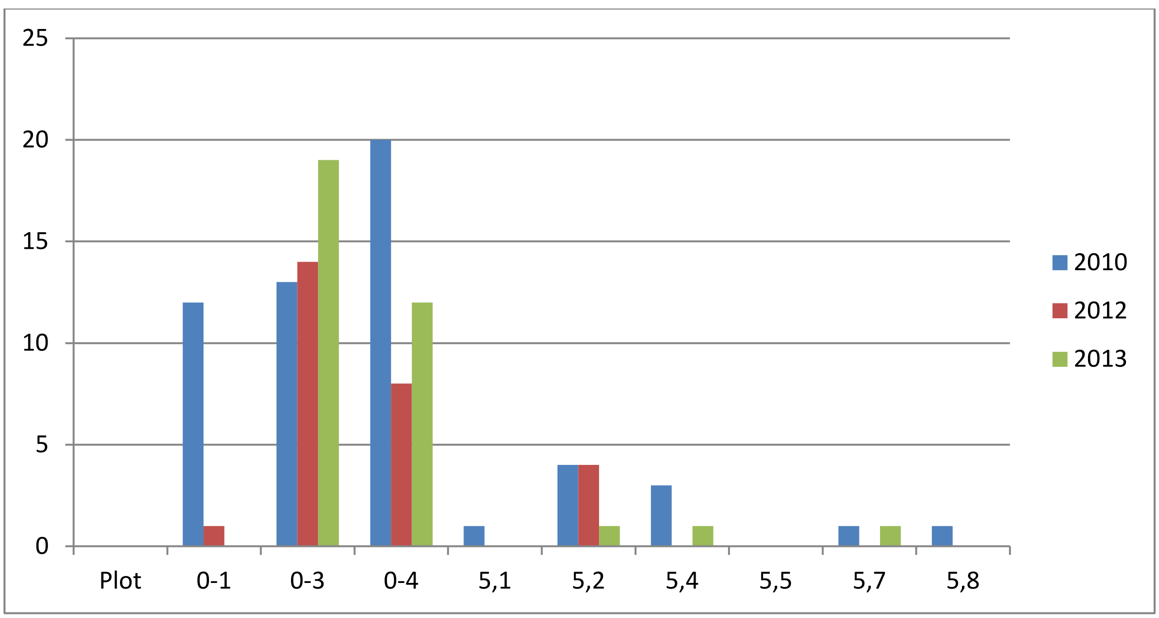
Table of Rabbitbrush counts (live plants) for 2010 (pre-treatment), 2012, and 2013.

The data was tested with a Wilcoxon signed-rank test to determine the significance of differences between each year. The Wilcoxon test assumes that the pairs tested are correlated, and that the distribution is not a normal distribution, among other assumptions.

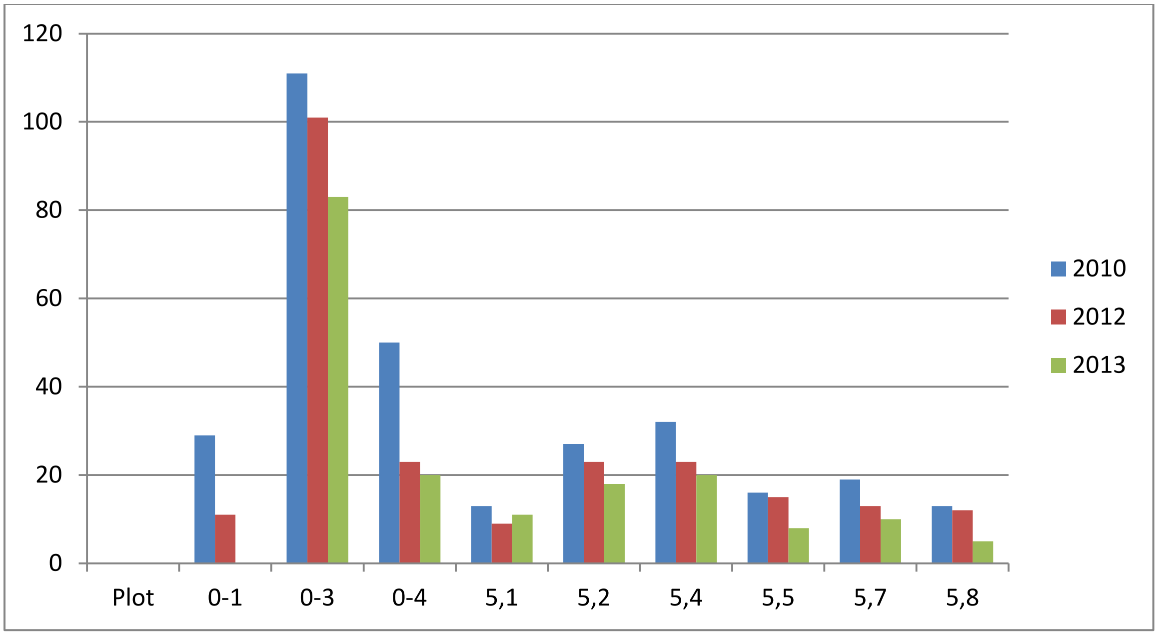
The number of control samples was limited to three, due to the lack of locations that had rabbitbrush, were in a similar location and were not in the valley bottom and responding to treatment. Because of this limited number, the test was insignificant and not performed on this data.



Bar chart of mature rabbitbrush counts from three years. The trend was towards less rabbitbrush from year to year, with a significant difference of 0.01 between 2010 and 2012. The significance of the difference bewteen 2010 and 2013 was also 0.01.



Bar chart of rabbitbrush seedling counts from three years of sampling. There was a significant difference between the counts of seedlings from 2010-2012 and 2010-2013, at 0.01.



This bar chart shows the comparisons for all three years for all rabbitbrush counted (seedlings and adults summed). There was a a significant difference between 2010 and 2012, as well as 2010 and 2013, with the trend being a decrease in rabbitbrush numbers.

Interpretation:
The Wilcoxon signed-rank test determines if a pair of samples are significantly different, and it appears as if the number of rabbitbrush in the "treatment" plots were significantly less over time from 2010 to 2013. Whether this was due to the treatment or another factor such as rainfall can be determined by comparison with the control, however, the three control plots were not enough samples to run this test.

One interesting observation is that the control plots also showed some pattern of a reduction in rabbitbrush numbers from 2010 to 2013. This was most marked in the numbers of seedlings, which saw a large reduction in numbers (see table above). The adult rabbitbrush in the control plots showed no pattern of increase or decrease, but there was a change in number, which may be due to the difficulty of counting a species that "suckers" from its roots and grows in large clumps.

If the numbers of seedlings was less, but the adults were the same in the control plot samples, this could be evidence of drought mortality on the weaker, less rooted seedlings.

The most probable result is that there is an effect of both flooding (strong) and drought (weak) on rabbitbrush mortality over the last three years. In reach 5, the effects of flooding were huge, and at least 2 large, valley-wide floods left 1-2 feet of flood debris pushed up against the rabbitbrush stems. Any dead adults appear to have washed away quickly as they died and became un-rooted.

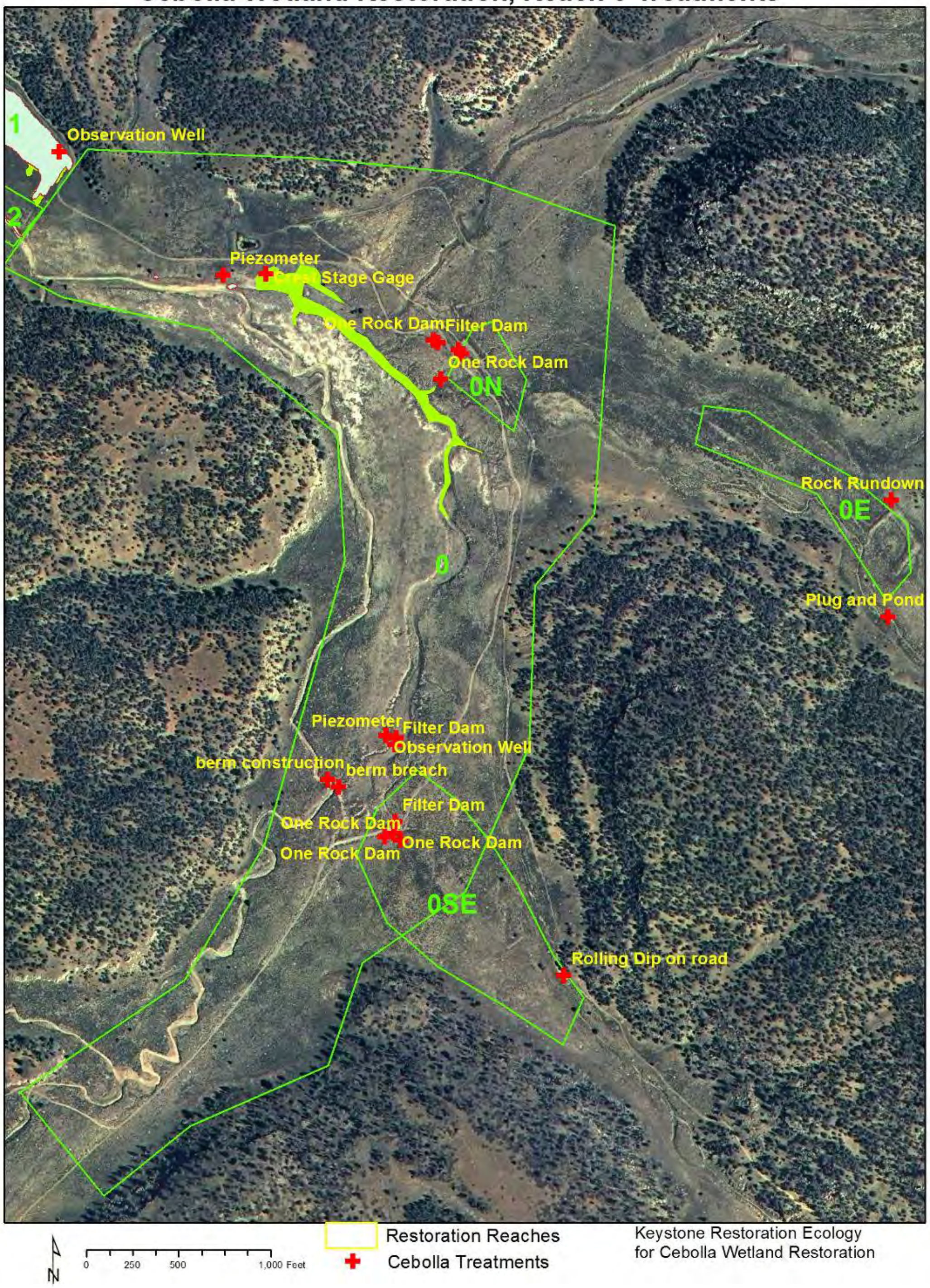
Treatment and Monitoring Reach 0, Cebolla Creek

A large number of treatments were constructed in Reach 0, which is at the confluence of three major canyons and the main valley of Cebolla Creek. The three tributaries were identified as SE trib, E trib, and N tributaries.

The major treatment in Reach 0 was the irrigation dam removal and the return of Cebolla Creek to its original channel from an irrigation ditch which had captured the channel. This has led to some major changes in the channel morphology and hydrology which should lead to benefits for both reach 0 and all the downstream reaches of Cebolla Creek.

Treatment	Location	Expected results	Monitoring
Rolling dip road drain, Reconstruction of Main Access roads	SE tributary	Wetland expansion, flooding of large area, elimination of rabbitbrush	Veg transects 0-1, 0-1a, 0-2, rabbitbrush circle 0-3
Plug and Pond , Rock Rundown	E tributary	Wetland expansion, flooding of large area, fixing of cattle tank	Veg transect 0-4
Four one rock dams, filter dam, berm repair, mini-exclosure	N tributary	Wetland expansion, flooding of large area, restoration of natural channel flow	Veg transect 0-3
Road drainage, three one rock dams, one filter dam, berm removal and channel construction, earthen plug, mini-exclosure	Main channel of Cebolla Canyon	Wetland expansion, filling of old and new channels of Cebolla Creek, creation of wet meadow communities, elimination of Rabbitbrush	Valley Cross Section 0-2, Channel Cross section 0-2 Veg Circle 0-1. Longitudinal Profile 0-2

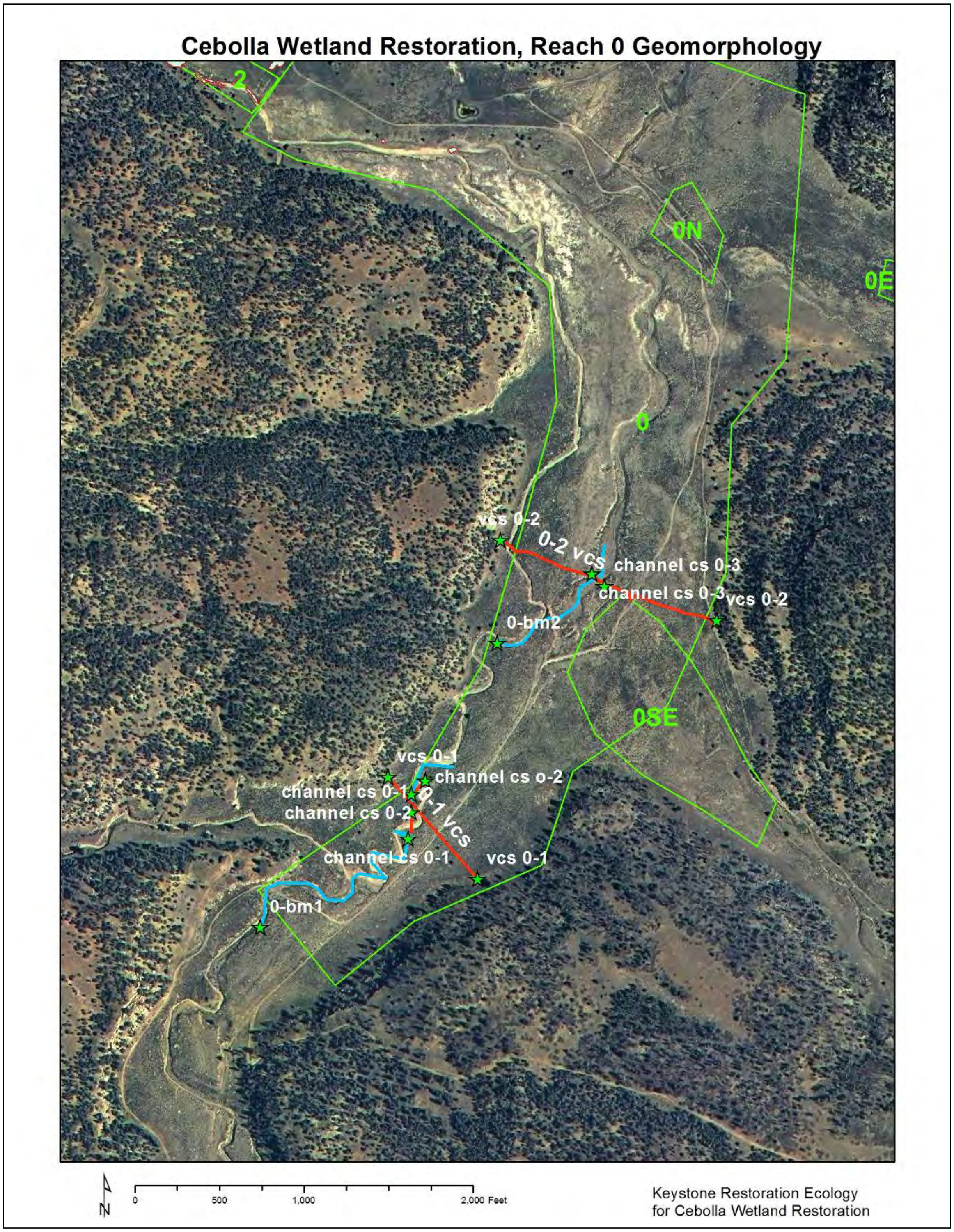
Cebolla Wetland Restoration, Reach 0 Treatments



Geomorphology Monitoring in Reach 0

A list of geomorphology monitoring performed is presented in the table below. Much of this reach was re-surveyed in 2012, and Reach 0-2 was re-surveyed in 2013 as well.

Name	Length	Notes,
Longitudinal profile 0-1	2100 feet	No work done in this reach, begins above road crossing over Cebolla Creek
Longitudinal Profile 0-2	1100 feet	Profile through removed irrigation dam and return of Cebolla Creek to original channel, taken 3X
Channel Cross Section 0-1	171	Reference cross section, potential diversion site
Channel Cross Section 0-2	109	Reference cross section, no work performed in this reach
Channel Cross Section 0-3	101	Cross section on top of filter dam
Valley Cross Section 0-1	867	Reference, taken at location of potential diversion site
Valley Cross Section 0-2	1437	Lines up with Channel Cross Section 0-3 on top of filter dam (just upstream)

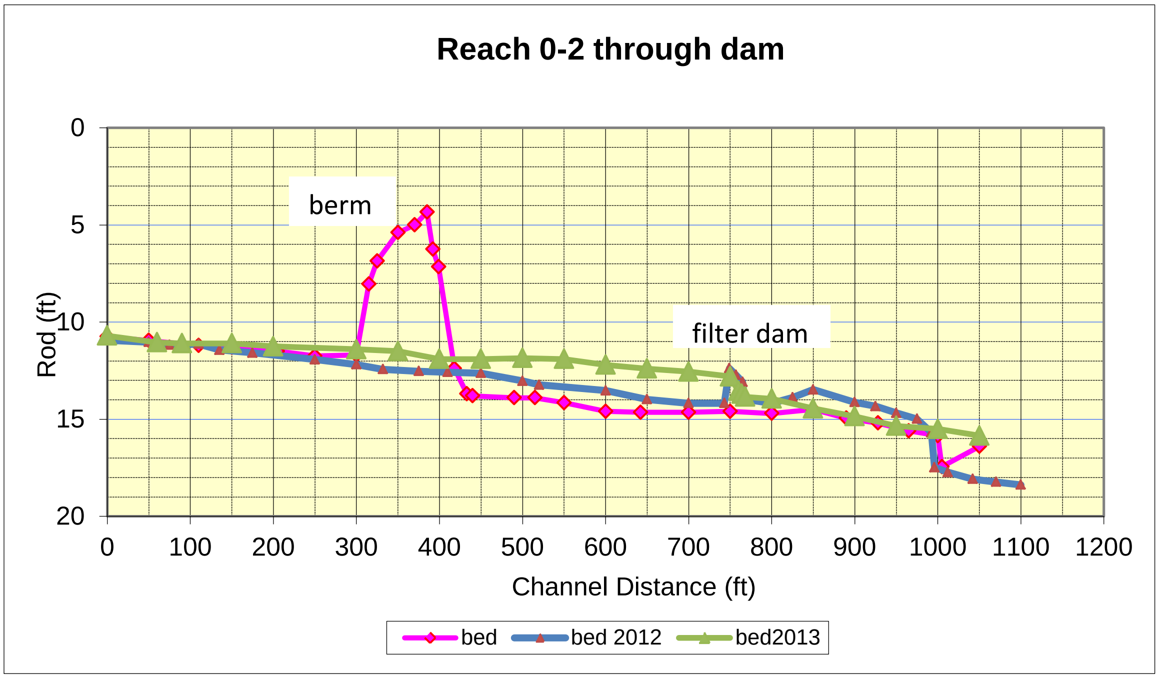

Cebolla Wetland Restoration, Reach 0 Geomorphology
2
0N
0E
0
vcs 0-2
0-2 vcs
channel cs 0-3
channel cs 0-3
vcs 0-2
0-bm2
0SE
vcs 0-1
channel cs o-2
channel cs 0-1
channel cs 0-2
0-1 vcs
channel cs 0-1
vcs 0-1
0-bm1
N
0
500
1,000
2,000 Feet
Keystone Restoration Ecology
for Cebolla Wetland Restoration

The major work performed in Reach 0 was the removal of an irrigation dam and installation of a berm to return Cebolla Creek to its original channel. Downstream from the berm, a large filter dam was constructed to capture sediment and water and create wetland.

A list of possible results from the treatment:

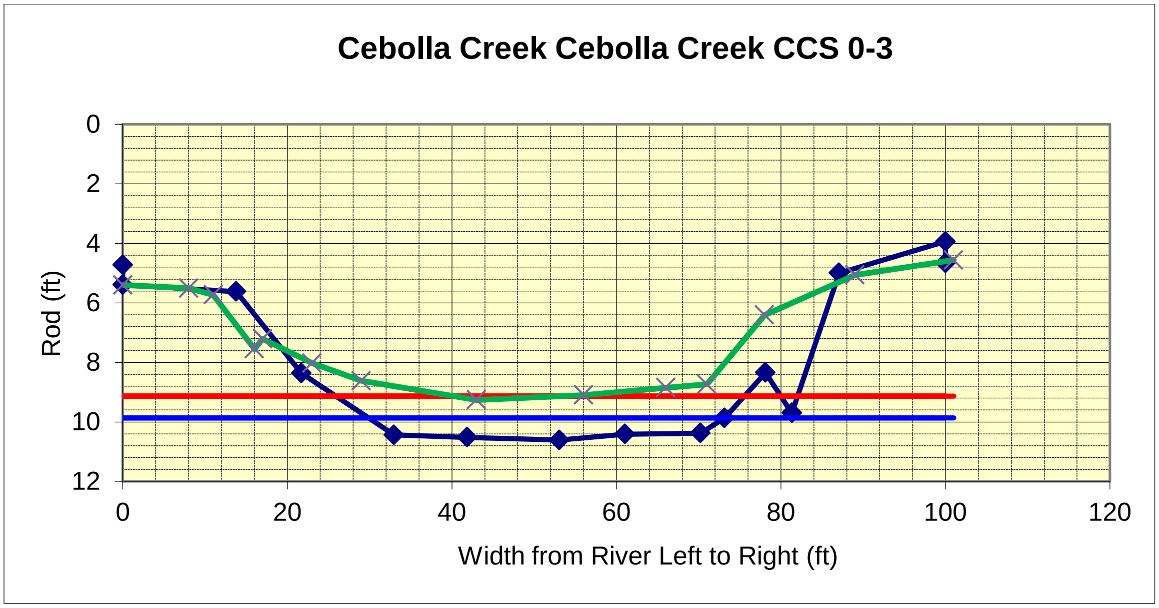
- Irrigation of former channel including the entire Lake Cebolla area
- Lengthening of channel and reduction of slope of channel, as former channel is much longer than the irrigation ditch
- Capture of sediment in channel as it is much wider than irrigation ditch with a lesser slope
- Filling in of Lake Cebolla with water and sediment

Reach 0-2 longitudinal profile is presented below:

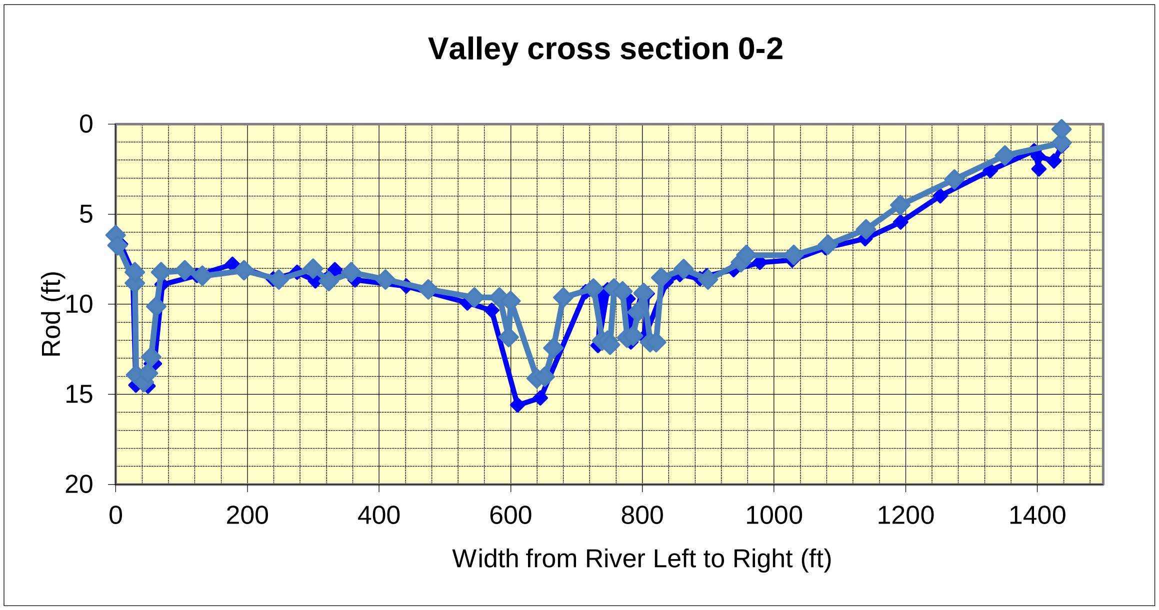


Three years of longitudinal profile survey at Cebolla Creek. Over that time, the filter dam has filled in with sediment, mostly sand, over 2 feet deep. This area has the potential to capture and store a great deal of water underneath the sand, which also acts as a mulch to prevent the stored water from evaporating.

In addition, the lower end of the profile had a 2 foot headcut which was enlarging from the effects of returning water to this channel and the capture of sediment above the filter dam. This increase in size and depth of the headcut can be seen in the difference between the pink 2010 profile and the blue 2012 profile. Once the filter dam filled in with flooding in the summer of 2013, sand was deposited down the entire channel of Cebolla Creek, even filling in the bed of Lake Cebolla. This has eliminated the headcut at 1000 feet on the longitudinal profile.



The green line is the 2012 survey of the channel cross section 0-3 at the Filter Dam. The blue line is the 2010 survey. The elevation has increased by more than 2 feet, the height of the filter dam.



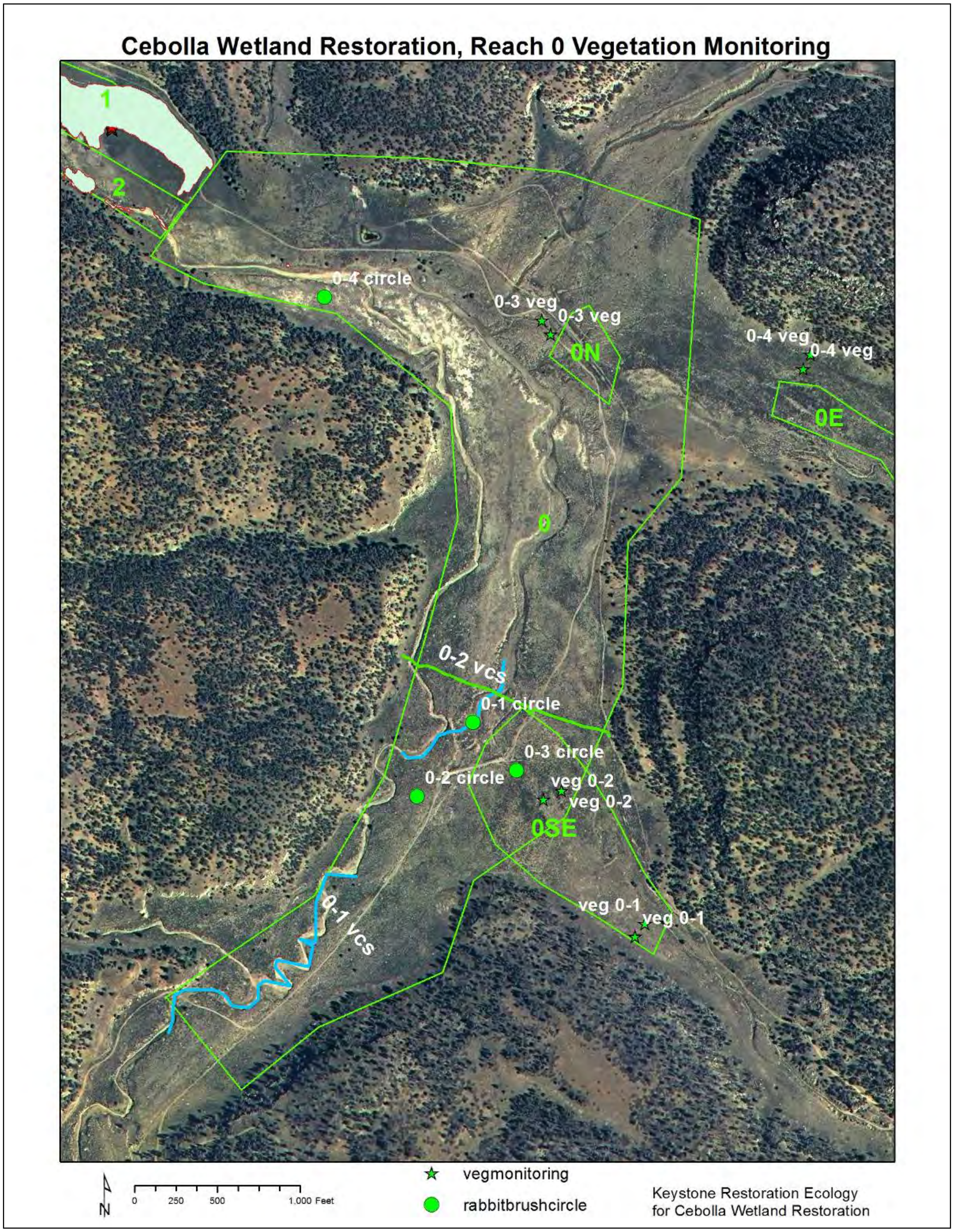
Valley Cross Section 0-2 runs across the filter dam and spans the entire valley. Few changes have happened over the length of the cross section, but the filter dam at 660 has raised the grade locally.

Filter Dam below Berm breach and channel reconstruction, spring 2012

Filter Dam in October 2013, filled in with sand

Vegetation Monitoring in Reach 0, Cebolla Creek

Treatment	Location	Expected results	Vegetation Monitoring
Rolling dip road drain, Reconstruction of Main Access roads	SE tributary	Wetland expansion, flooding of large area, elimination of rabbitbrush	Veg transects 0-1, 0-1a, 0-2, rabbitbrush circle 0-3
Plug and Pond , Rock Rundown	E tributary	Wetland expansion, flooding of large area, fixing of cattle tank	Veg transect 0-4
Four one rock dams, filter dam, berm repair, mini-exclosure	N tributary	Wetland expansion, flooding of large area, restoration of natural channel flow	Veg transect 0-3
Road drainage, three one rock dams, one filter dam, berm removal and channel construction, earthen plug, mini-exclosure	Main channel of Cebolla Canyon	Wetland expansion, filling of old and new channels of Cebolla Creek, creation of wet meadow communities, elimination of Rabbitbrush	Rabbitbrush Circle 0-1, Valley cross-section 0-2



Cebolla Wetland Restoration, Reach 0 Vegetation Monitoring
1
2
0-4 circle
0-3 veg
0-3 veg
0N
0-4 veg
0-4 veg
0E
0
0-2 vcs
0-1 circle
0-3 circle
0-2 circle
veg 0-2
veg 0-2
0SE
0-1 vcs
veg 0-1
veg 0-1
N
0
250
500
1,000 Feet
vegmonitoring
rabbitbrushcircle
Keystone Restoration Ecology
for Cebolla Wetland Restoration

Vegetation Results, Reach 0, Main Channel of Cebolla Creek

Channel Cross Section 0-3 was placed directly across the filter dam structure. While this transect will continue to be an excellent monitoring point for geomorphology, the use of filter fabric under the structure will prohibit any vegetation from establishing. Because of this, this transect will no longer be used for vegetation monitoring.

Valley Cross Section 0-2
This cross section was taken on top of the Valle CS 0-2 geomorphology cross section. This cross section is monitoring in a broad scale much of the work done upstream in SE Trib, the BLM road realignment and drainage work, as well as the one rock dams and filter dams done near the berm breach and channel realignment. This cross section runs over the top of the filter dam.

This line-point transect has 211 monitoring points.

Species	Common Name	cover 2010	cover 2012	Percent difference
Artemisia dracunculus	tarragon	0%	1%	1%
Artemisia species	sagewort	0%	0%	0%
Bouteloua barbata	six weeks grama	0%	23%	23%
Bouteloua gracilis	blue grama	12%	5%	-8%
Chrysothamnus nauseosus	Rabbitbrush	16%	25%	9%
Elymus smithii	Western wheatgrass	32%	16%	-16%
Grindelia squarosa	gumweed	1%	2%	1%
Gutierrezia sarothrae	snakeweed	0%	1%	1%
Kochia scoparia	kochia	9%	14%	5%
Muhlenbergia repens	creeping muhly	1%	6%	5%
Muhlenbergia wrightii	spike muhly	0%	1%	1%
Plantago patagonica	Wooly plantain	0%	0%	0%
Rock		0%	3%	3%
Soil		31%	15%	-16%
litter		5%	2%	-3%

The most notable changes are an increase in six-weeks grama, which was not present previously on the site. This annual grass spread over some of the bare soil areas, which accounted for the increase. Kochia also invades these areas, and this saw an increase as well. Both of these plants provide cover on otherwise bare, old wetland soils that are heavy clays and difficult for many plant species to establish on.

There was a decrease in Western Wheatgrass, which is of concern, as this species is an effective forage grass that spreads by runners and seed. However, the 2010 data was taken in the fall, when Western wheatgrass may have been at its full growth potential, and cover more soil.

This may be the same for blue grama, another very important grass, it only grows and blooms in the summer months, and may have more cover in the fall.
There was an increase in rabbitbrush, which may be due to the irrigation of these shrubs by the restoration work done. While one goal is to eliminate rabbitbrush through flooding, partial flooding will only irrigate it and encourage its growth.

Vegetation Circle 0-1
This rabbitbrush vegetation circle was sampled as part of an experiment in rabbitbrush survivorship (see above). Each 60 foot diameter circle was placed in a clump of rabbitbrush to monitor the response to flooding. The number of adults and juvenile rabbitbrush were counted. Juvenile rabbitbrush were under two feet tall.

Age class of rabbitbrush	2010	2012	2013
0-1 adults	17	10	0
0-1 juveniles	12	1	0

There is a large difference between 2010 and 2012, with a large decrease in the numbers of mature and juvenile rabbitbrush. This site was impacted by the berm breach, a foot of sand was deposited, and most of the existing vegetation was drowned out.

Rabbitbrush Circle 0-1, Aaron Kauffman in middle of circle, taken in 2012, some rabbitbrush remain in channel.

Vegetation Results, SE tributary, Reach 0

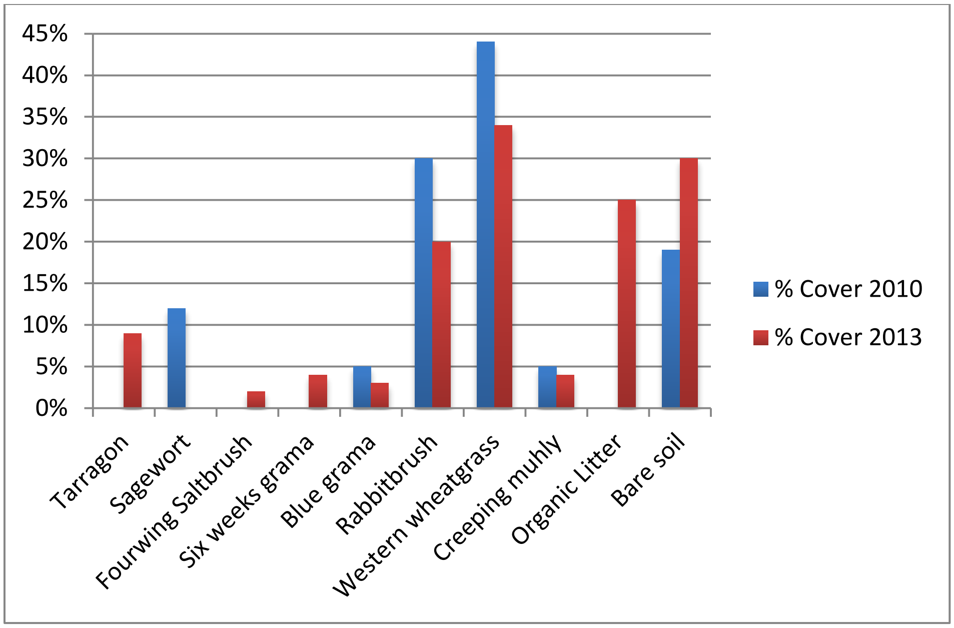
This tributary formerly flowed down the road to the north, and was trapped in a gully for most of its length. This gully was fed by the road up the SE trib valley, which captured the entire flow. The construction of a rolling dip road drain in the valley, as well as the BLM road work, has ensured that floodwaters from this valley are spreading across the largest area possible and are flowing in center of the valley.

Vegetation transect 0-1
This transect was lost to the effects of a large flood event in September 2013. Both endpoints were washed away in the flood event, which even over-topped the rolling dip road drain. Because of this, this transect was not re-monitored in 2013.

Vegetation transect 0-2
This transect was placed in a very thick patch of Rabbitbrush (*Chrysothamnus nauseosus*), a mid-sized shrub that invades overgrazed rangelands. Rabbitbrush can be eliminated by watering, its roots die in saturated soils. Vegetation transect 0-2 is monitoring the response of the rolling dip in the SE tributary and its effect on the downstream vegetation, once the floodwaters are spreading again.

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisia dracunculus	Tarragon	0%	9%	9%
Artemisia frigida	Sagewort	12%	0%	-12%
Atriplex canescens	Fourwing Saltbrush	0%	2%	2%
Bouteloua barbata	Six weeks grama	0%	4%	4%
Bouteloua gracilis	Blue grama	5%	3%	-2%
Chrysothamnus nauseosus	Rabbitbrush	30%	20%	-10%
Elymus smithii	Western wheatgrass	44%	34%	-10%
Muhlenbergia repens	Creeping muhly	5%	4%	-1%
Organic Litter	Organic Litter	0%	25%	25%
Bare soil	Bare soil	19%	30%	11%

A column chart showing the data can be seen below, most species showed a decline in cover from 2010 to 2013. There is some decrease in rabbitbrush cover, perhaps due to flooding and reduction of growth from saturation of the root zone. There was an increase in bare soil (due to less vegetation overall), however there was also an increase in organic litter. This material has been deposited in a very large flood event in September 2013, and shows that this area does flood after the installation of the rolling dip treatment upstream.



Rabbitbrush Circle 0-3
This circle was located just above the berm removal/channel reconstruction and filter dam. Over time, this area should be saturated from the work below, such as the three one rock dams. However, it also will receive more water from SE tributary.

Age class of Rabbitbrush	2010	2012	2013
Young	98	87	64
Mature	13	14	19

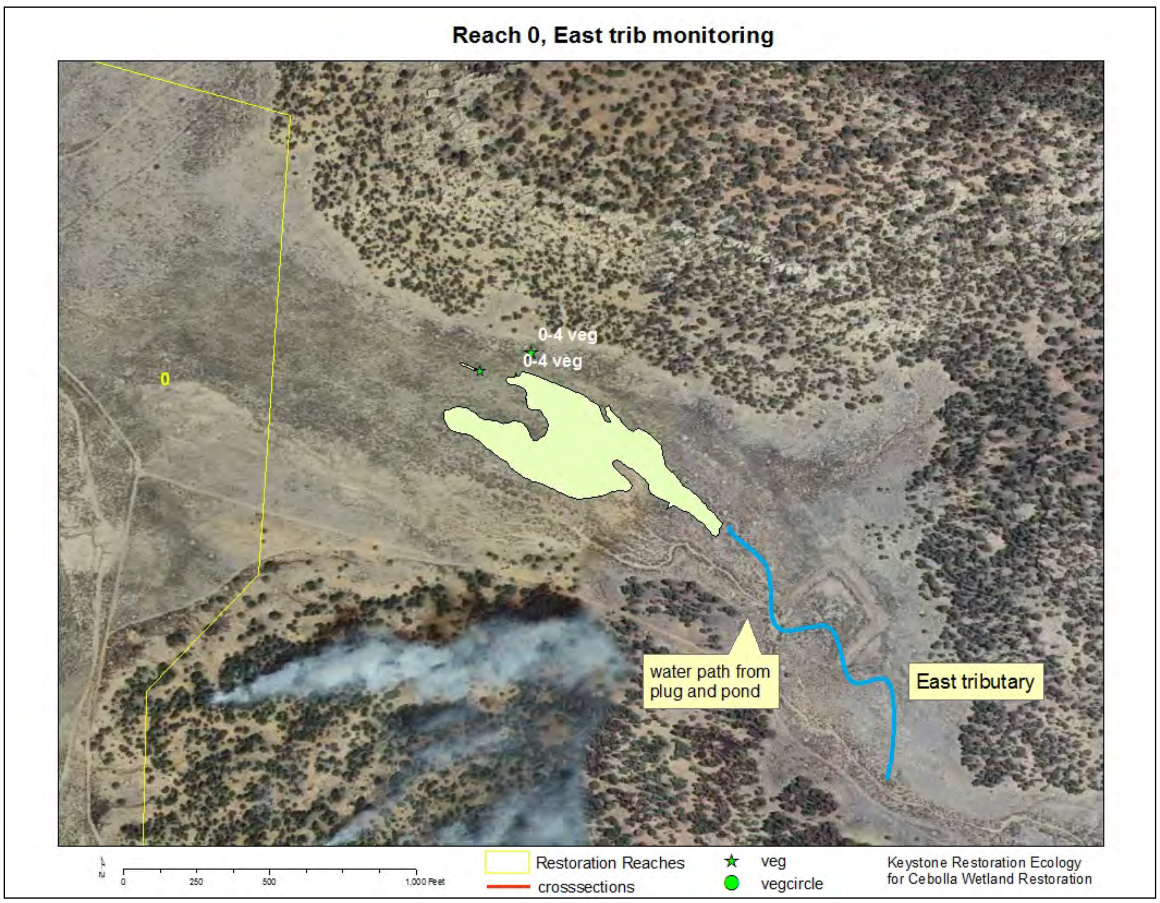
There was a small increase in the number of seedlings and a noticeable decrease in the number of adults.

Vegetation Results, East tributary, Reach 0

The treatment in the East tributary involved the plug and ponding of a gully that was carrying water past a stock tank and out of the valley. The plug and pond drained into the stock tank, and a rock-lined rundown channel carried water out of the tank into the old valley bottom. Vegetation transect 0-4 was placed to monitor the effects of this treatment.

Visually, the floodwaters and deposition of sand from this treatment stopped just before the transect, so no results were seen. The sand deposition caused the growth of a large number of Rocky Mountain beeplant (*Cleome serrulata*). This plant has been seen to colonize newly deposited wet sands, over time, that area has become wet meadow habitat with vigorous grasses. This was seen only in 2012, with good spring/winter moisture, in 2013, the winter and spring moisture was poor and very little beeplant was seen in the canyon.

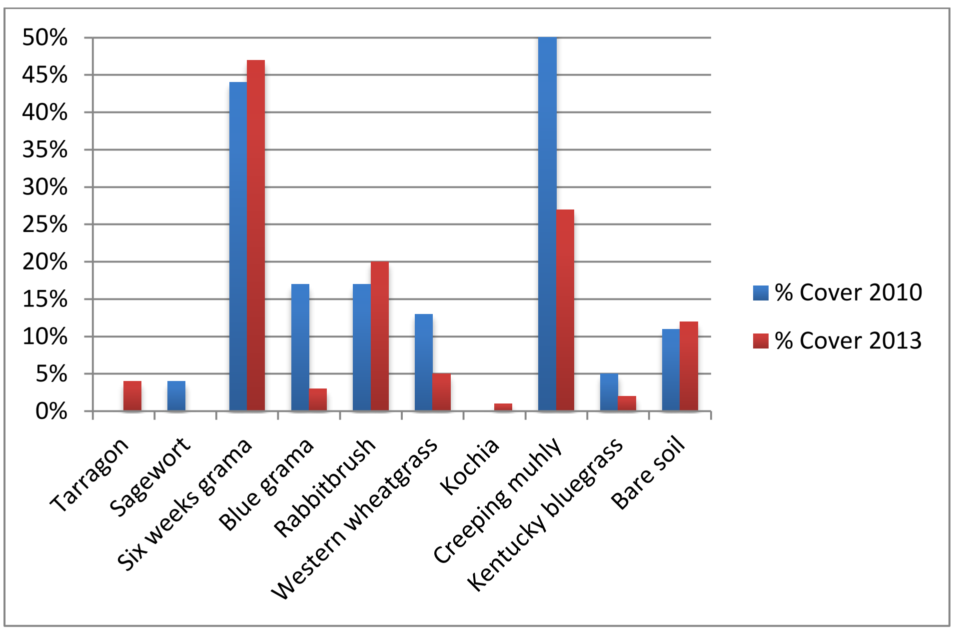
When this area was re-monitored in October of 2013, there was a herd of cattle living around the pond and grazing the area, which may have had an effect on vegetation cover.



East trib flooding, green boundary is sand and beeplant.

Results, Vegetation transect 0-4

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisia dracunculus	Tarragon	0%	4%	4%
Artemisia spp.	Sagewort	4%	0%	-4%
Bouteloua barbata	Six weeks grama	44%	47%	3%
Bouteloua gracilis	Blue grama	17%	3%	-14%
Chrysothamnus nauseosus	Rabbitbrush	17%	20%	3%
Cleome serrulata	Beeplant	0%	0%	0%
Elymus smithii	Western wheatgrass	13%	5%	-8%
Kochia scoparia	Kochia	0%	1%	1%
Muhlenbergia repens	Creeping muhly	52%	27%	-25%
Poa pratensis	Kentucky bluegrass	5%	2%	-3%
Bare soil	Bare soil	11%	12%	1%



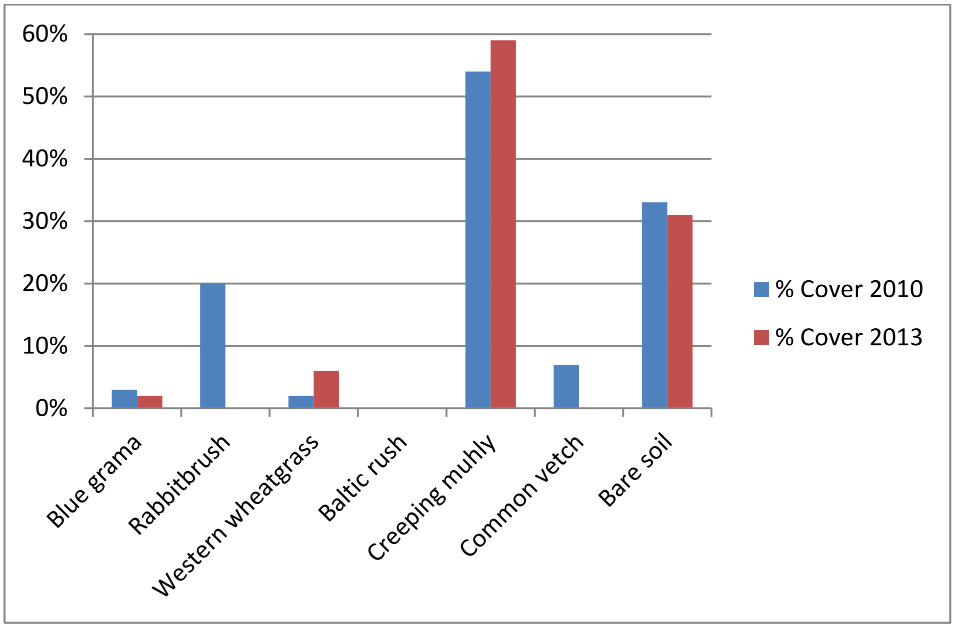
Results from vegetation transect 0-4 indicate a decrease in cover of desirable species, and a small increase in weeds such as Tarragon and Six-weeks grama. This site was grazed heavily in fall of 2013.

Detail of plug and pond at top of project, gully became a pond
with overflow to left of picture. Pic October 2011.

Results, North tributary, Reach 0

The treatments in this area included road relocation, berm repair, filter dams, two one rock dams and a mini-exclosure. The vegetation transect 0-3 was just upstream from the filter dam, and the area was flooded during fall of 2011, just after implementation.

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Bouteloua gracilis	Blue grama	3%	2%	-1%
Chrysothamnus nauseosus	Rabbitbrush	20%	0%	-20%
Elymus smithii	Western wheatgrass	2%	6%	4%
Juncus balticus	Baltic rush	0%	0%	0%
Muhlenbergia repens	Creeping muhly	54%	59%	5%
Vicia americana	Common Vetch	7%	0%	-7%
Bare soil	Bare Soil	33%	31%	-2%



The vegetation in plot 0-3 changed somewhat due to the treatment. There was a decrease in rabbitbrush due entirely to the machine installation of the filter dam. Western wheatgrass increased its cover, probably due to the wetting of the soil. One Baltic rush was identified, this wetland plant may be invading this area. This area also is grazed heavily by the same herd of cattle as seen in Trib 0-E.

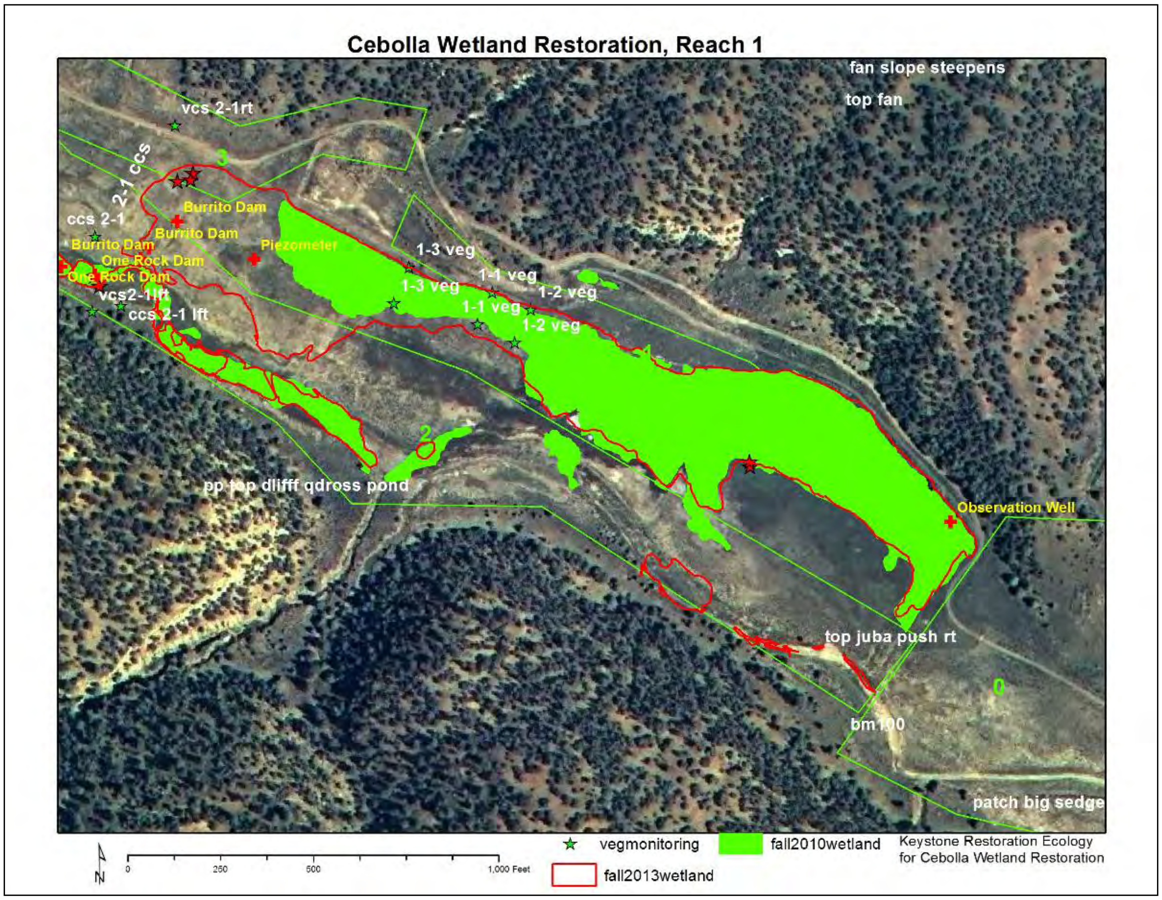
Filter dam, reach 0-N, transect is by Aaron Kauffman in top of picture

Vegetation Results, Reach 1 Cebolla Creek

Reach 1 was created to encompass the main wetland at Big Cebolla Spring. This area has increased in size over the last 10 years due to simple plugging techniques with sandbags, rock and brush. These "burrito dams" plugged a man-made gully created to water cattle from the spring, and caused the wetland to expand to the north-west. The main channel of Cebolla Creek was formerly a 6-foot deep gully, over time, this has filled in entirely, most recently due to a large flood in September of 2013.

Water that previously flowed in the gully past Big Cebolla Spring is now spreading across the entire valley bottom. In fact, the last flood event was so large that it did serious damage to the fenceline exclosure surrounding the spring.

Treatment	Location	Expected results	Monitoring
Return of Cebolla Creek to historic channel	Reach 0, main channel	Capture of sediment in Lake Cebolla, increased sub-surface water	Wetland delineation
Tributary treatments in reach 0	Tribs 0-E, 0-N and 0-SE	Spread of water across large area, more sub-surface water downstream	Wetland delineation
Exclusion of cattle, burrito dams downstream, flooding in main channel	Reach 2 (main channel) and reach 1	Expansion of wetland downstream, successional advance of wetland vegetation	Vegetation transects 1-1, 1-2,1-3



Wetland delineation results

A complete description of the acreages and areas of delineated wetland can be found at the beginning of this report. A comparison of the wetland delineation of 2010 versus 2013 shows that some areas described as wetland in 2010 were not delineated in 2013. This was due to the large amount of sand deposited through this portion of Cebolla Creek, which can be seen in more detail in the Reach 2 geomorphology below. This sand buried the Baltic Rush, however, it should grow through this sediment in Spring 2014 and respond positively to the increased water and sediment.

Due to the construction of burrito dams in Reach 2, the wetland area has expanded about 3 acres to the west. The burrito dams raise the water table and prevent it from flowing into the channel of Cebolla Creek at the south of the aerial photo. Water can spread to the west as sheet flow and this sheet flow creates more wetland area.

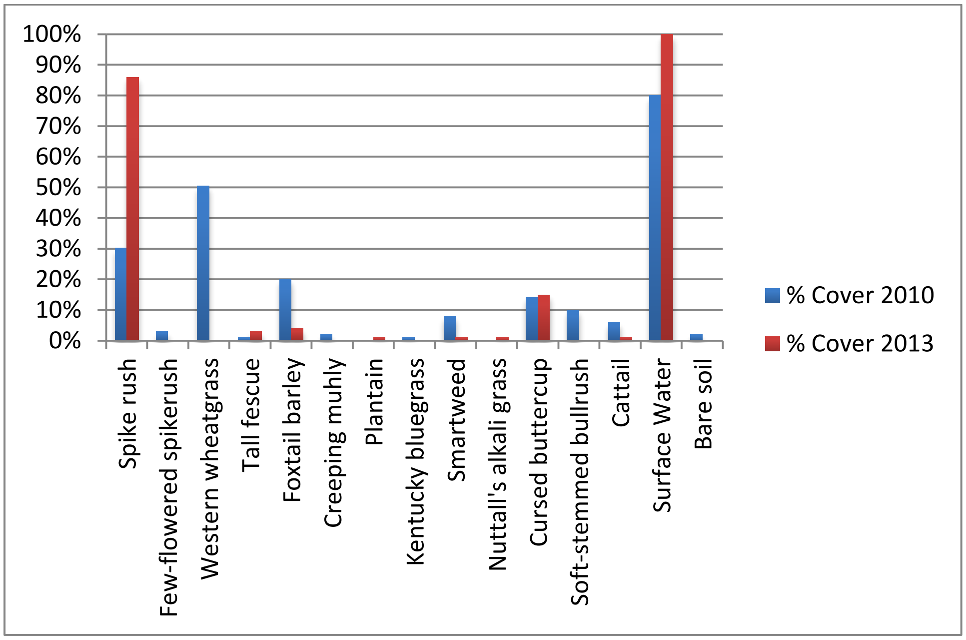
Vegetation Results, transects 1-1, 1-2, 1-3.

These three transects are 100 foot long line-point intercept transects that monitor the development and successional changes in the wetland at Big Cebolla Spring. The composition of vegetation over time should show the successional sequence in flooded areas in Big Cebolla Spring.

Results, Transect 1-1

The results of transect 1-1 show development of the wetland from a foxtail barley early-successional community to a common spikerush community. The amount of the transect under water is now 100% (formerly 80%). Some species, such as western wheatgrass and foxtail barley have decreased in cover as they have been replaced by spikerush.

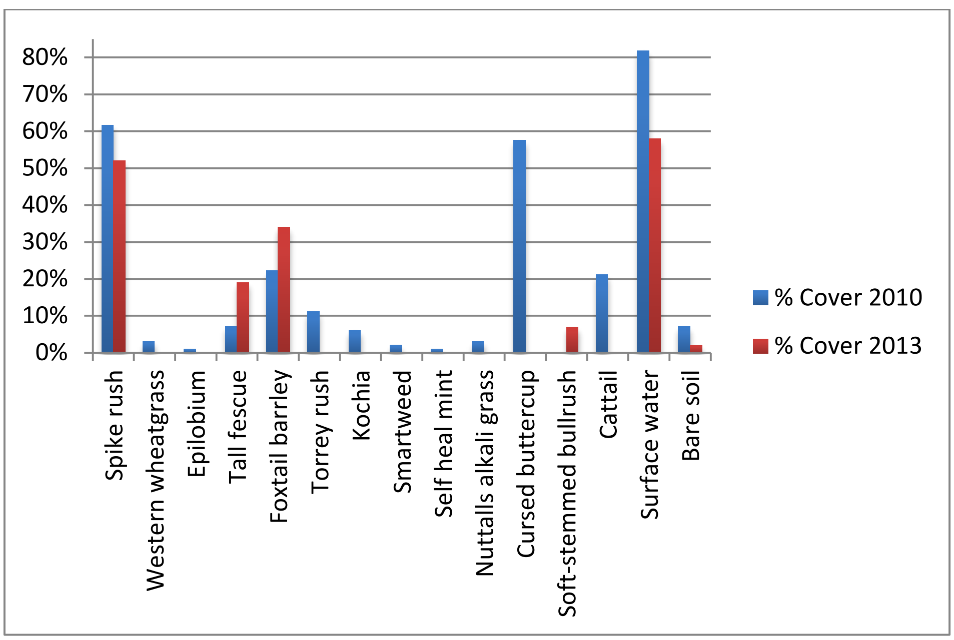
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Eleocharis palustris	Spike rush	30%	86%	56%
Eleocharis quinqueflora	Few-flowered spikerush	3%	0%	-3%
Elymus smithii	Western wheatgrass	51%	0%	-51%
Festuca arudinacea	Tall fescue	1%	3%	2%
Hordeum jubatum	Foxtail barley	20%	4%	-16%
Muhlenbergia repens	Creeping muhly	2%	0%	-2%
Plantago spp.	Plantain	0%	1%	1%
Poa pratensis	Kentucky bluegrass	1%	0%	-1%
Polygonum puncatatum	Smartweed	8%	1%	-7%
Puccinellia airoides	Nuttall's alkali grass	0%	1%	1%
Ranunculus sceleratus	Cursed buttercup	14%	15%	1%
Scirpus tabernaemontana	Soft-stemmed bullrush	10%	0%	-10%
Typha latifolia	Cattail	6%	1%	-5%
Surface Water	Surface Water	80%	100%	20%
Bare soil	Bare soil	2%	0%	-2%



Results, Transect 1-2

This transect shows a reduction in the cover of nearly all species found. There is some increase in foxtail barley and tall fescue, both early-successional weeds. There was also an increase in Chairmaker's bulrush from 0 to 7%, which may be invading and replacing the spikerush vegetation. There is a decrease in surface water, probably due to trampling by the herd of cattle that was present and grazing the wetland edge in October 2013. Many species that were reduced in cover may have been eaten by cattle.

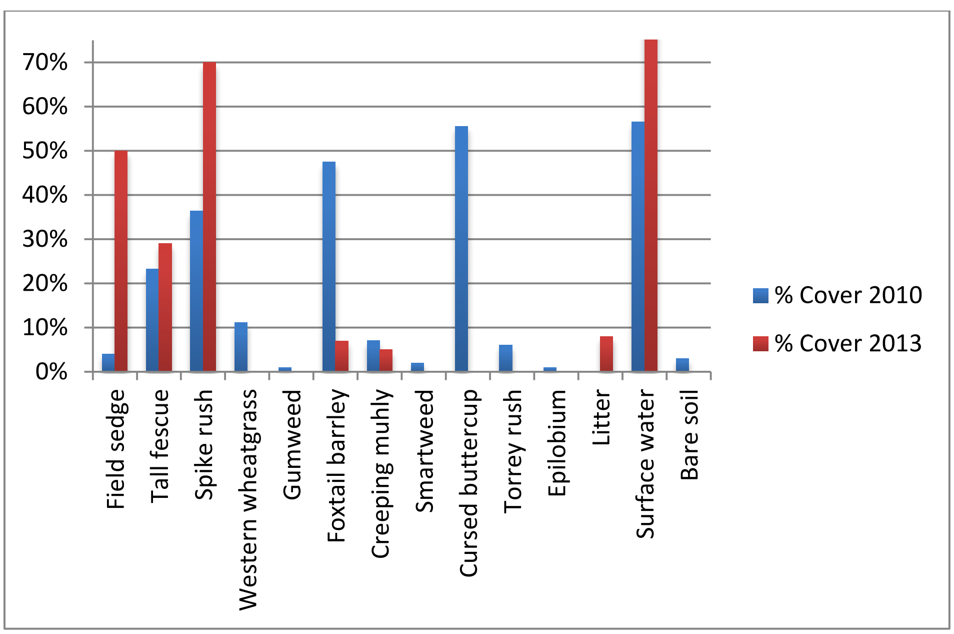
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Eleocharis palustris	Spike rush	62%	52%	-10%
Elymus smithii	Western wheatgrass	3%	0%	-3%
Epilobium ciliatum	Epilobium	1%	0%	-1%
Festuca arudinacea	Tall fescue	7%	19%	12%
Hordeum jubatum	Foxtail barley	22%	34%	12%
Juncus torreyi	Torrey rush	11%	0%	-11%
Kochia scoparia	Kochia	6%	0%	-6%
Polygonum puncatatum	Smartweed	2%	0%	-2%
Prunella vulgaris	Self heal mint	1%	0%	-1%
Puccinellia airoides	Nuttalls alkali grass	3%	0%	-3%
Ranunculus sceleratus	Cursed buttercup	58%	0%	-58%
Scirpus tabernaemontan	Soft-stemmed bullrush	0%	7%	7%
Typha latifolia	Cattail	21%	0%	-21%
Surface water	Surface water	82%	58%	-24%
Bare soil	Bare soil	7%	2%	-5%



Results, Transect 1-3

This transect was the furthest downstream (to the west). The most notable increase in species cover was in Field sedge and spikerush. These two species replace the Western wheatgrass, Foxtail barley, and Cursed buttercup that are found as early-succesional species in Big Cebolla Wetland. The introduction of Field sedge provides another link in the successional sequence, which appears to reach a climax as Chairmaker's bulrush. There is also a much larger amount of surface water, from 57% to 89% from 2010 to 2013.

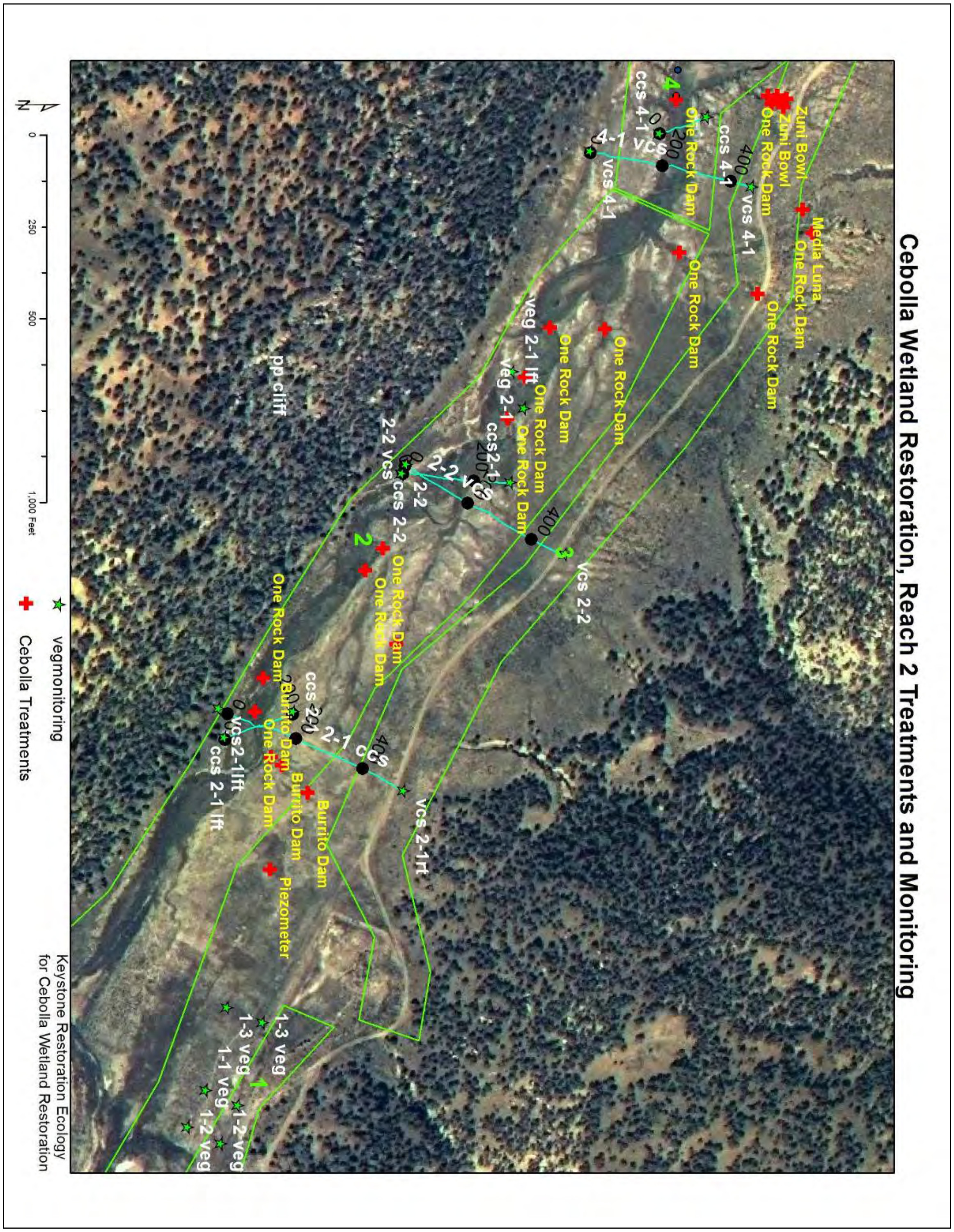
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Carex praegracilis	Field sedge	4%	50%	46%
Eleocharis palustris	Spike rush	36%	70%	34%
Elymus smithii	Western wheatgrass	11%	0%	-11%
Epilobium ciliatum	Epilobium	1%	0%	-1%
Festuca arudinacea	Tall fescue	23%	29%	6%
Grindelia squarosa	Gumweed	1%	0%	-1%
Hordeum jubatum	Foxtail barley	47%	7%	-40%
Juncus torreyi	Torrey rush	6%	0%	-6%
Muhlenbergia repens	Creeping muhly	7%	5%	-2%
Polygonum puncatatum	Smartweed	2%	0%	-2%
Ranunculus sceleratus	Cursed buttercup	56%	0%	-56%
Organic matter litter	Litter	0%	8%	8%
Surface water	Surface water	57%	89%	32%
Bare soil	Bare soil	3%	0%	-3%



Treatment and Monitoring Reach 2, Cebolla Creek

A large number of treatments were constructed in Reach 2, which is the main channel of Cebolla Creek as it flows past Big Cebolla Spring. The purposes of these treatments were to continue to fill the main channel of Cebolla Creek with sediment and expand the wetland downstream.

Treatment	Location	Expected results	Monitoring
3 burrito dams	End of wetland	Increased flooding, capture of sediment, change in vegetation	Valley Cross Section 2-1, Channel cross section 2-1, both geomorphology and vegetation
3 one rock dams	Below cross sections	Capture of sediment, raised water table, more wetland	Valley Cross Section 2-1, Channel cross section 2-1, both geomorphology and vegetation, VCS 2-2, CCS 2-2, both geomorphology and vegetation
One rock dam	Near bottom of reach 2, just below veg transect 2-1	Capture of sediment, raised water table, more wetland	Veg transect 2-1, 100 foot line-point intercept
One rock dams, burrito dams	Throughout reach	Capture of sediment, raised water table, more wetland	Wetland delination through reach, longitudinal profile

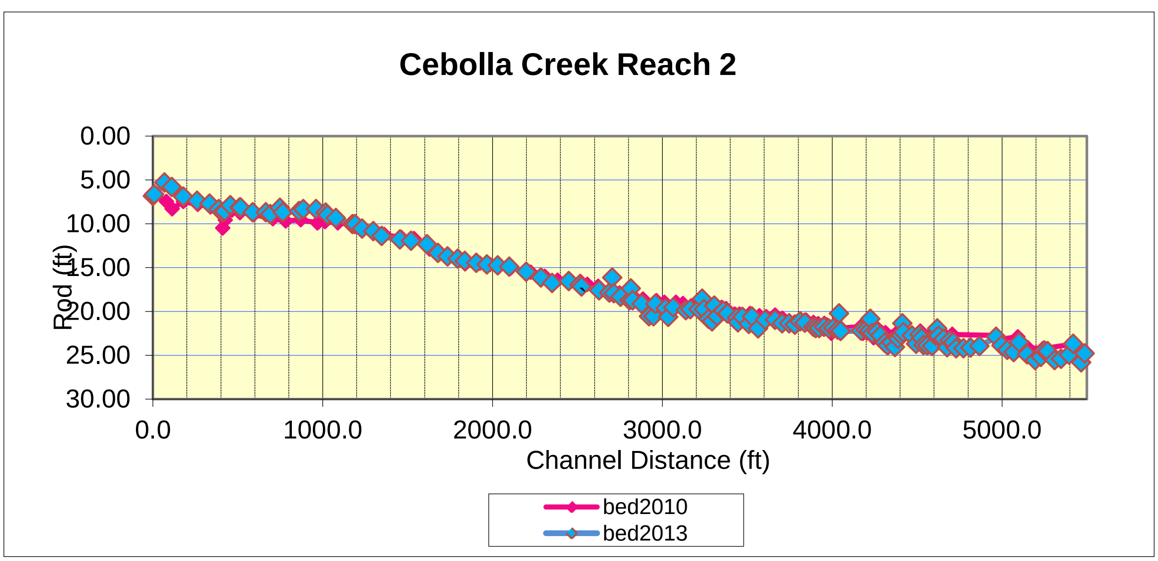

Cebolla Wetland Restoration, Reach 2 Treatments and Monitoring
Zuni Bowl
One Rock Dam
Media Luna
One Rock Dam
vcs 4-1
ccs 4-1
4-1 vcs
veg 2-1 lft
veg 2-1
ccs2-1
2-2 vcs
2-2 vcs
ccs 2-2
vcs 2-2
pp cliff
Burrito Dam
Piezometer
2-1 ccs
vcs 2-1rt
vcs2-1lft
ccs 2-1 lft
1-3 veg
1-1 veg
1-2 veg
vegmonitoring
Cebolla Treatments
Keystone Restoration Ecology
for Cebolla Wetland Restoration
0
250
500
1,000 Feet

Reach 2 Geomorphology Monitoring, using Trimble sub-meter GPS
One unique challenge was the more than 9500 feet of longitudinal profile to be measured in Reaches 1-6. This challenge was met by a new technique involving the use of the Trimble Geo XT sub-meter GPS and a laser level. Rather than laying out 9500 feet of measuring tape in 300-foot intervals, the project involved using the GPS to survey the location of each surveying point, and using the comments field to enter the elevation. This involved taking a large number of points, especially to measure any sinuosity in the stream channel.

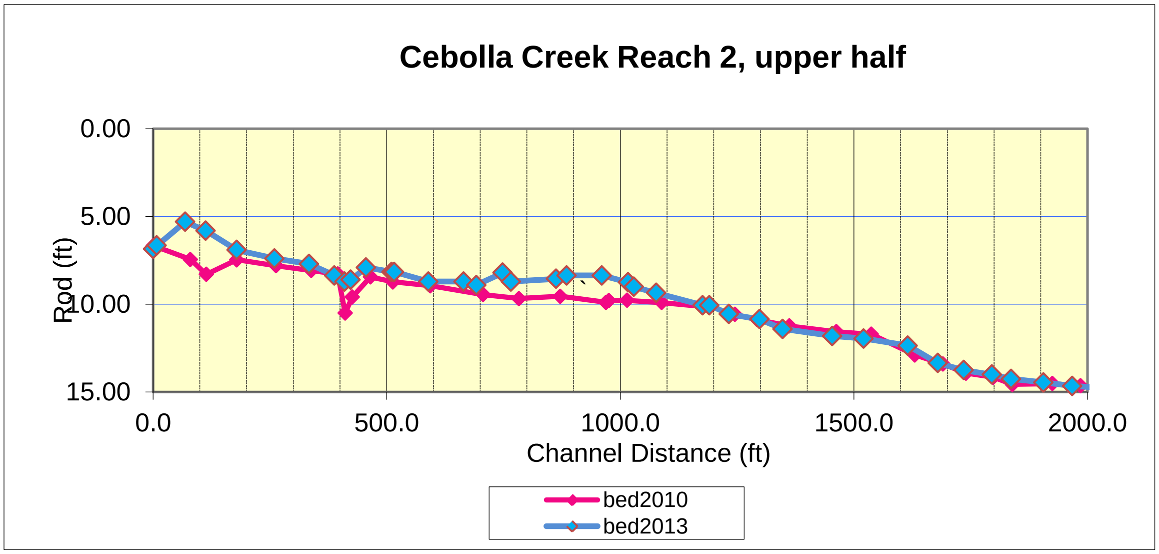
This data was tied together with the creation of a route feature in ArcGis 9.2 to assign a longitudinal profile "distance" to the elevation point features. Using the tool "Locate features along route" ArcGis was able to draw a line through the points that has a measureable length, and then use this line to assign profile locations to the elevation measurements. When this data was re-surveyed in 2013, two Trimble Geo XT sub meter GPSs were used, one to find the survey point, and another to re-take the data.

The very useful portion of this process is that the data can be displayed on top of the aerial photo and the longitudinal seen in 2D. The usual process is to create a GIS map with unique features and the location of proposed structures, but to leave the longitudinal profile in Excel or another graphing program. The designer goes back and forth between the map and the excel file to measure and calculate slopes and dimensionless ratios for stream geomorphology. With this new advance, the slope between any two points can be determined on the map with the scale.

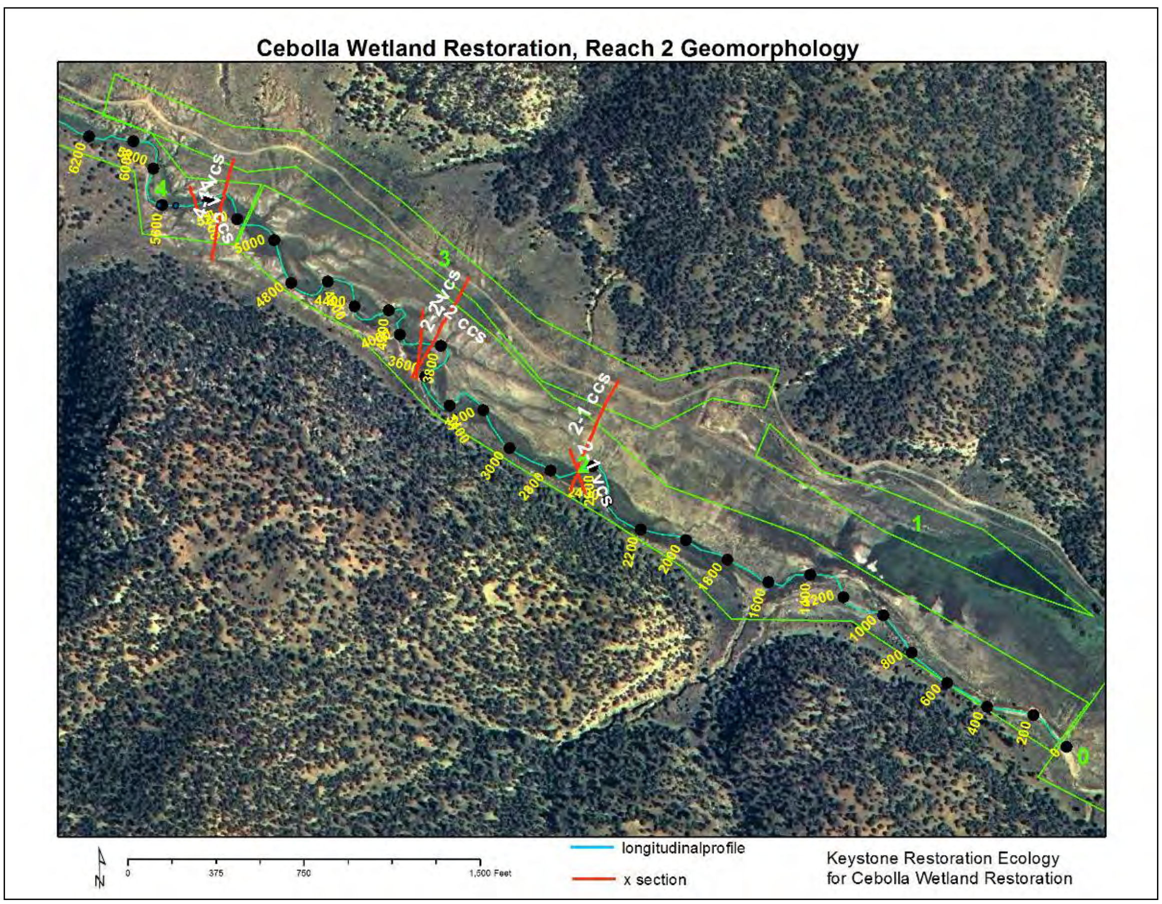
This advance is especially important for Cebolla Canyon. The portion of Cebolla Creek near Reach 1 and Big Cebolla Spring is geomorphically very active and aggrading rapidly. Because of this, the course of the Creek changes yearly or less, and repeating a longitudinal profile over three years with a measuring tape would have been very difficult. With this GIS mapping, the elevation of the channel can be re-mapped each year, no matter how deposition and flooding have changed the course of the channel.

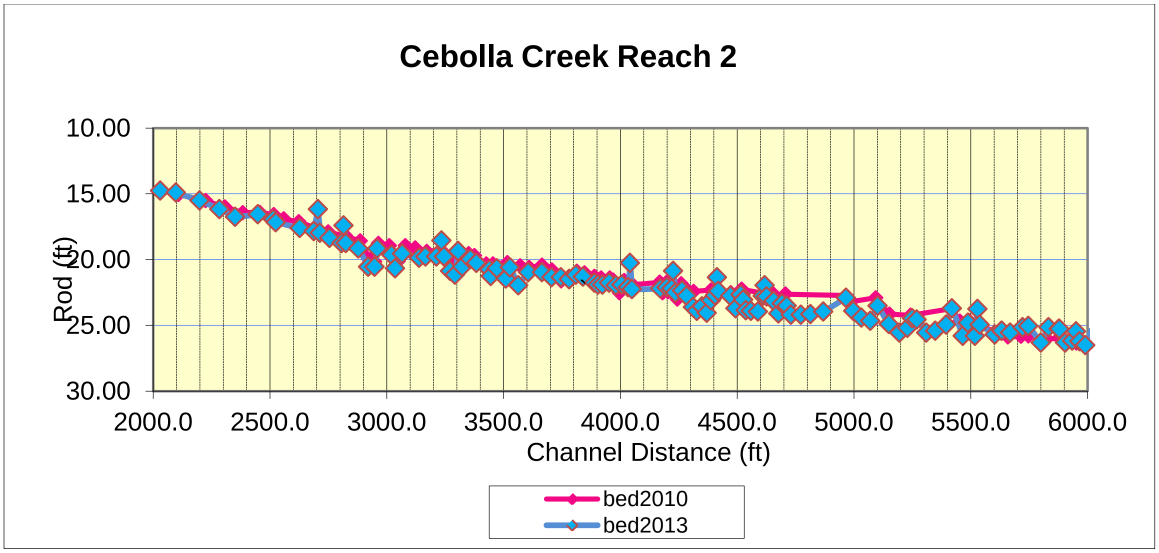


This scale shows very little detail, it is the entire Reach 2.



This portion of the longitudinal profile shows the elevation difference between 2010 and 2013 for the upper 2000 feet. There is a large amount of deposition in the first 1000 feet, the channel has been covered by sand from Cebolla Creek, and flows as sheet flow.

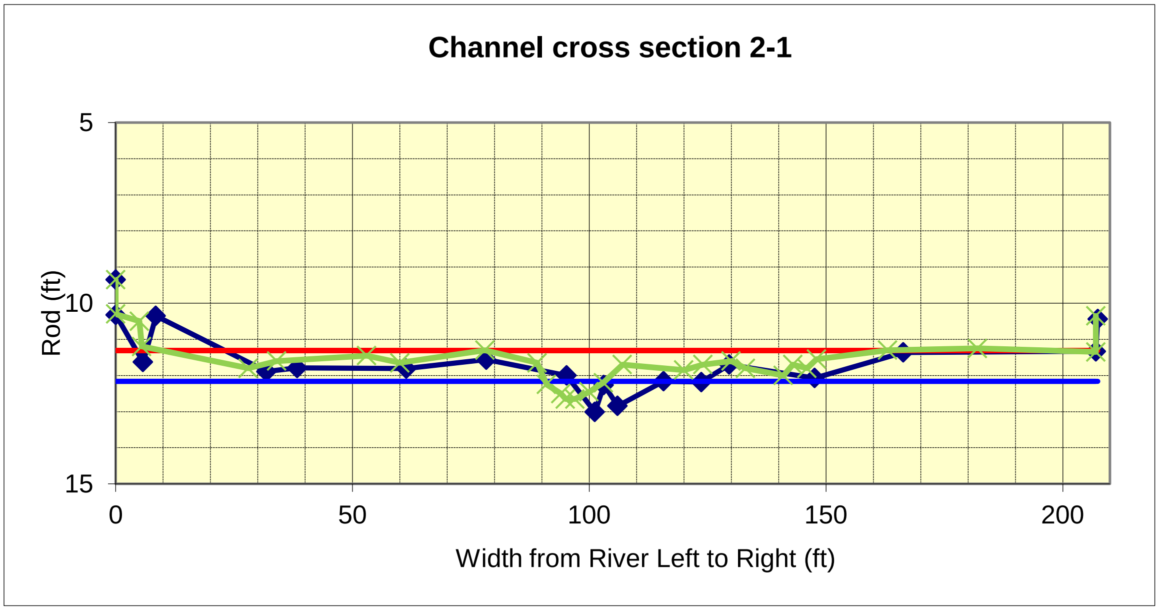




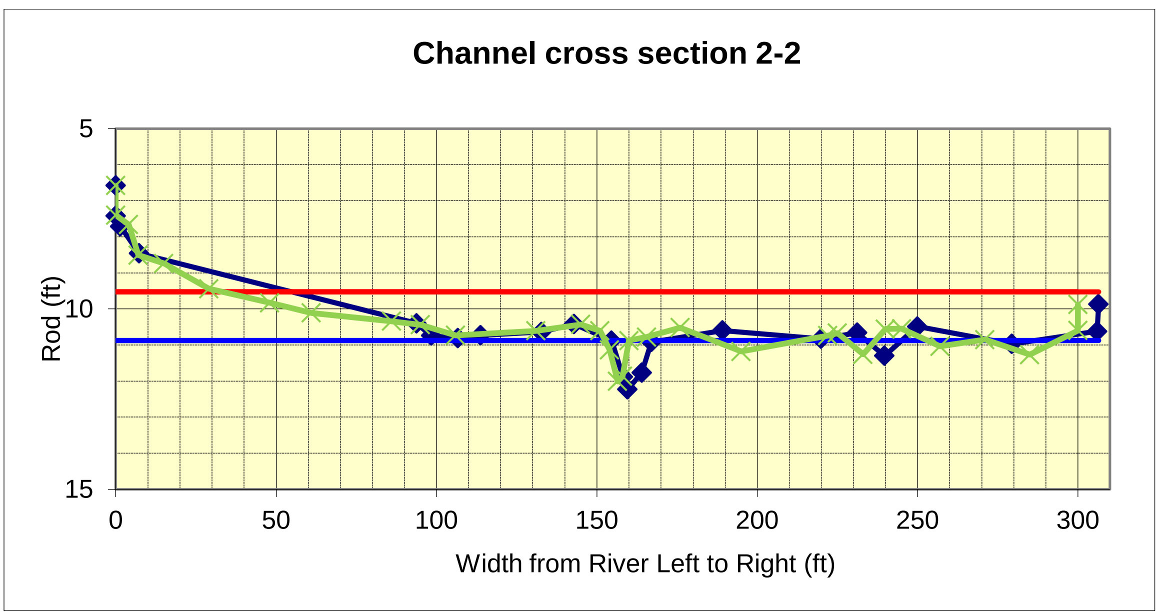
The lower half of reach 2 longitudinal profile. The changes seen between 2010 and 2013 indicate a lack of data, the graph is a straight line. Very little change has happened between these two profiles, the “spikes” in the 2013 profile are one rock dams installed by the Albuquerque Wildlife Federation and others in 2012.

There is a large one rock dam at 5500 on the profile, which was originally designed as a filter dam. As the deposition proceeds downstream from the top of reach 2, these one rock dams should fill in with sediment and the channel form become sheet-flow wetland with no defined channel.

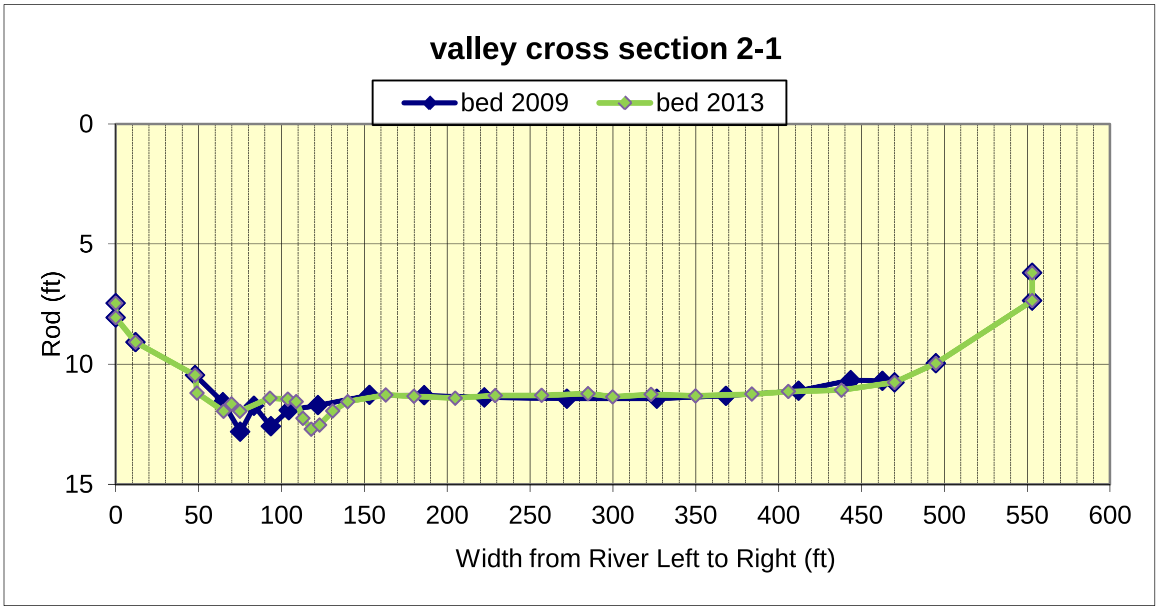
Cross Section Results, Reach 2



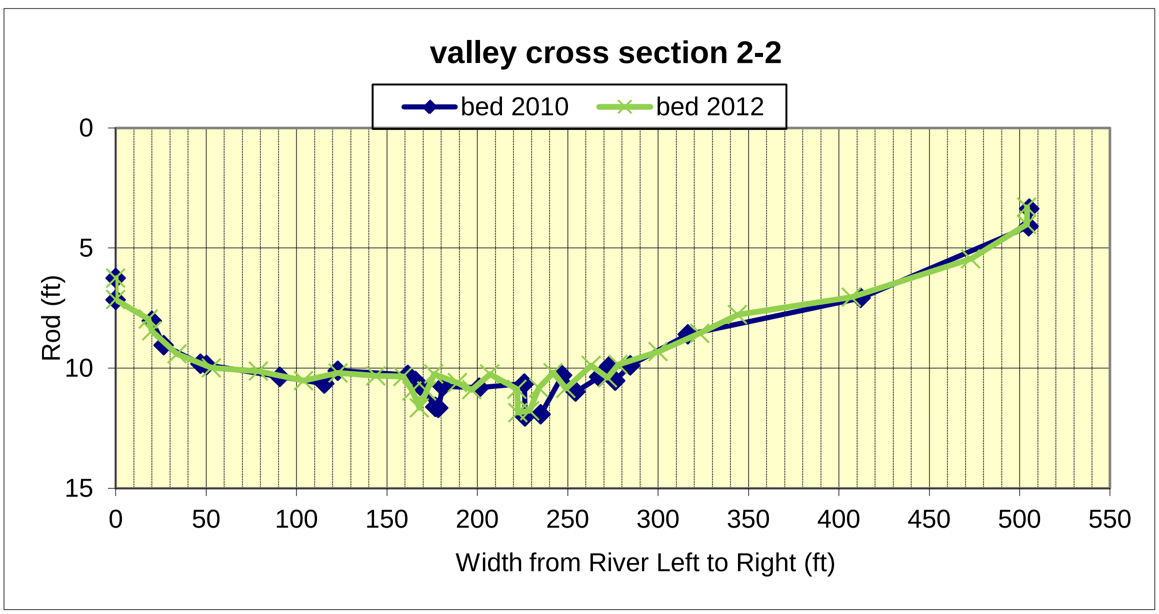
The green line is the 2012 survey. The channel has moved to the left somewhat, as the growth of Juncus balticus captures sediment. There has been a large one rock dam built below this cross section that will fill the channel entirely, moving the channel over to distance 140 on the cross section, the old valley channel before agriculture.



This cross section is downstream from 2-1, and it also has a one rock dam that will fill the channel over time. The channel in this cross section has narrowed somewhat, as more of the flow moves to the right into the old valley bottom before agriculture.



This valley cross section shows a small change in the location of the thalweg, most likely due to deposition and re-channelization in a large flood event.



This valley cross section shows little change across the entire valley. This portion of Reach 2 is further downstream from any source of sediment and may not change due to deposition as Valley Cross Section 1 changed.

Vegetation Monitoring Results, Reach 2

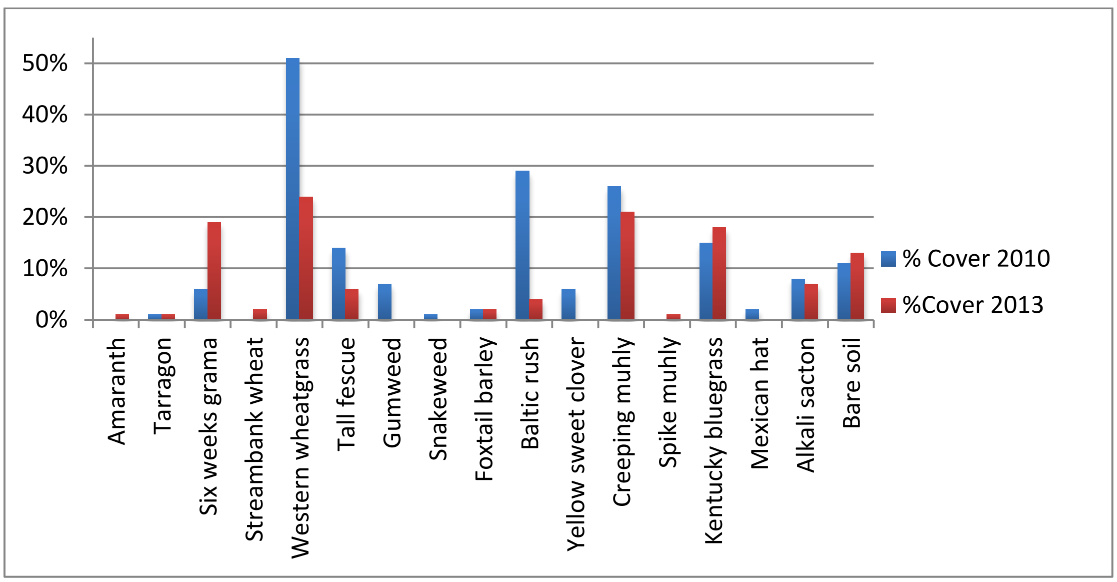
Vegetation monitoring was performed in reach 2 at four cross sections and one vegetation transect. The monitoring transects are described below:

Monitoring transect	Treatment	Expected results
Valley cross section 2-1	Burrito dams, one rock dams	Expansion of wetland from Big Cebolla Spring
Channel cross section 2-1	One rock dams	Capture of sediment in main channel, expansion of wetland
Valley cross section 2-2	One rock dams in channel upstream and downstream	Capture of sediment in main channel, little change expected in rest of valley
Valley cross section 2-2	One rock dams in channel upstream and downstream	Capture of sediment in main channel, expansion of wetland
Veg transect 2-2	One rock dam downstream in channel	Capture of sediment in main channel, expansion of wetland
Wetland delineation in reach 2	Burrito dams, one rock dams	Expansion of wetland


Cebolla Wetland Restoration, Reach 2 Vegetation Monitoring
vcs 2-2
2-2 vcs
veg 2-1
veg 2-1 lft
ccs2-1
2-2 ccs
ccs 2-22-2
2-2 vcs
vcs 2-1rt
2-1 ccs
ccs 2-1
2-1 vcs
vcs2-1lft
ccs 2-1 lft
pp cliff
N
0
187.5
375
750 Feet
longitudinalprofile
x section
fall2013wetland
Keystone Restoration Ecology
for Cebolla Wetland Restoration

Channel Cross Section 2-1

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Amaranthus spp.	Amaranth	0%	1%	1%
Artemisia dracunculus	Tarragon	1%	1%	1%
Bouteloua barbata	Six weeks grama	6%	19%	13%
Elymus	Streambank wheat	0%	2%	2%
Elymus smithii	Western wheatgrass	51%	24%	-27%
Festuca arudinacea	Tall fescue	14%	6%	-8%
Grindelia squarosa	Gumweed	7%	0%	-7%
Gutierrezia sarothrae	Snakeweed	1%	0%	-1%
Hordeum jubatum	Foxtail barrley	2%	2%	0%
Juncus balticus	Baltic rush	29%	4%	-25%
Melilotus offinalis	Yellow sweet clover	6%	0%	-6%
Muhlenbergia repens	Creeping muhly	26%	21%	-5%
Muhlenbergia wrightii	Spike muhly	0%	1%	1%
Poa pratensis	Kentucky bluegrass	15%	18%	3%
Ratibida tagetes	Mexican hat	2%	0%	-2%
Sporobolus airoides	Alkali sacton	8%	7%	-2%
Bare soil	Bare soil	11%	13%	2%

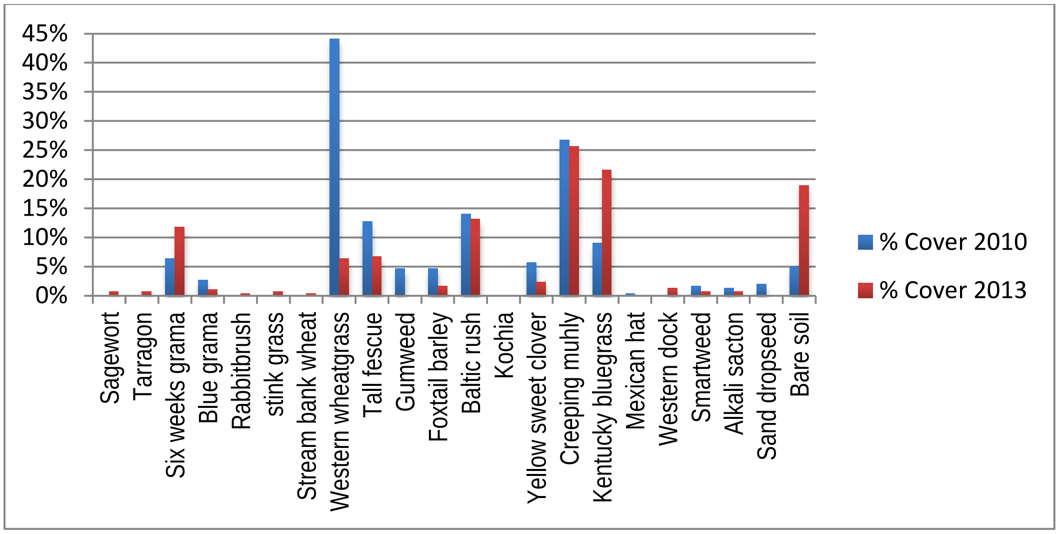


The results of vegetation monitoring at channel cross section 2-1 show a decrease in many important species. Western wheatgrass, Baltic rush, and tall fescue are all species along the wetland gradient, and they all decreased in percent cover. There was a hole in the exclosure fence on this side of Big Cebolla wetland, and this transect was grazed heavily in

2013 due to its proximity to this access bewtween the larger pasture area and the exclosure around the spring.

Channel cross section 2-2

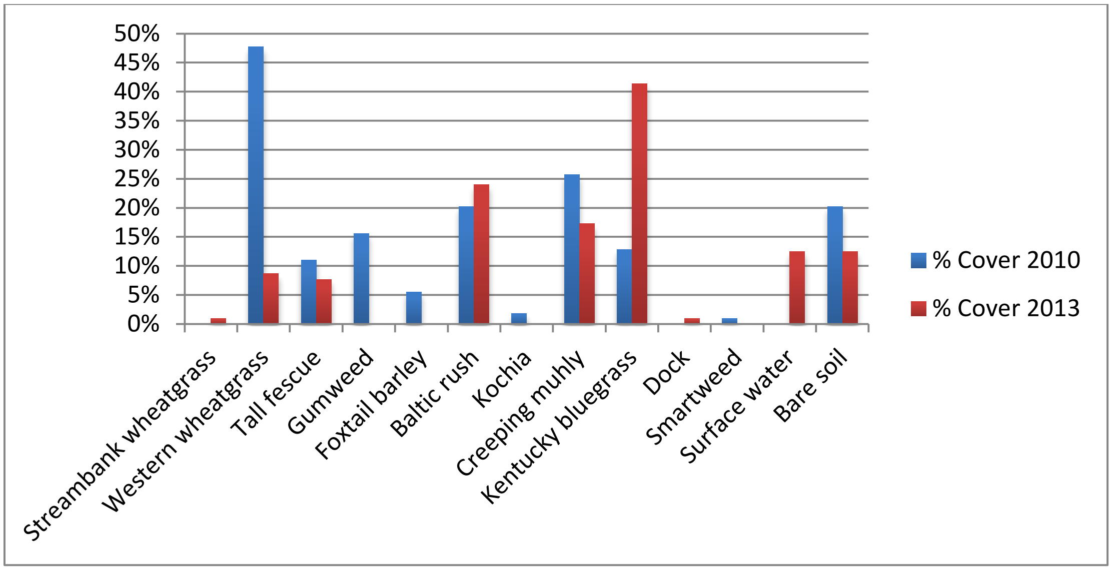
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisa frigida	Sagewort	0%	1%	1%
Artemisia dracunculus	Tarragon	0%	1%	1%
Bouteloua barbata	Six weeks grama	6%	12%	5%
Bouteloua gracilis	Blue grama	3%	1%	-2%
Chrysothamnus nauseosus	Rabbitbrush	0%	0%	0%
Eragrostis cilianensis	Stink grass	0%	1%	1%
Elymus lanceolatus	Streambank wheat grass	0%	0%	0%
Elymus smithii	Western wheatgrass	44%	6%	-38%
Festuca arudinacea	Tall fescue	13%	7%	-6%
Grindelia squarosa	Gumweed	5%	0%	-5%
Hordeum jubatum	Foxtail barley	5%	2%	-3%
Juncus balticus	Baltic rush	14%	13%	-1%
Kochia scoparia	Kochia	0%	0%	0%
Melilotus offinalis	Yellow sweet clover	6%	2%	-3%
Muhlenbergia repens	Creeping muhly	27%	26%	-1%
Poa pratensis	Kentucky bluegrass	9%	22%	13%
Ratibida tagetes	Mexican hat	0%	0%	0%
Rumex aquaticus L.	Western dock	0%	1%	1%
Rumex species	Smartweed	2%	1%	-1%
Sporobolus airoides	Alkali sacton	1%	1%	-1%
Sporobolus cryptandrus	Sand dropseed	2%	0%	-2%
Bare soil	Bare soil	5%	19%	14%



The effects of heavy grazing activity were also seen at cross section 2-2, however it seemed less pronounced. There was little decrease in Baltic rush, an important wetland indicator, but a large decrease in western wheatgrass, which is an important species that colonizes wet sites. Kentucky bluegrass increased in cover from 9 to 22%, it is a perrenial sod-forming grass species that is grazing tolerant, which may be a reason for its expansion. There was more bare soil in 2013 as well, a decrease in the % cover of many forb species may be linked to this increase in bare soil.

Vegetation transect 2-1

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Elymus lanceolatus	Streambank wheatgrass	0%	1%	1%
Elymus smithii	Western wheatgrass	48%	9%	-39%
Festuca arudinacea	Tall fescue	11%	8%	-3%
Grindelia squarosa	Gumweed	16%	0%	-16%
Hordeum jubatum	Foxtail barley	6%	0%	-6%
Juncus balticus	Baltic rush	20%	24%	4%
Kochia scoparia	Kochia	2%	0%	-2%
Muhlenbergia repens	Creeping muhly	26%	17%	-8%
Poa pratensis	Kentucky bluegrass	13%	41%	29%
Rumex crispus	Dock	0%	1%	1%
Rumex species	Smartweed	1%	0%	-1%
Surface water	Surface water	0%	13%	13%
Bare soil	Bare soil	20%	13%	-8%



There was a large decrease in western wheatgrass, again probably due to grazing. Grazing-tolerant Kentucky bluegrass increased greatly. A positive result was seen in some increase in Baltic rush, as more of this transect became delineated wetland (from 20% to 24%) of a 100 foot transect.

Valley Cross section 2-1, 91 points

Species	Common Name	cover 2010	cover 2012	Percent difference
Artemisia dracunculus	tarragon	2%	1%	-1%
Bouteloua barbata	six weeks grama	7%	7%	0%
Bouteloua gracilis	blue grama	13%	9%	-4%
Festuca arudinacea	tall fescue	5%	4%	-1%
Elymus smithii	Western wheatgrass	44%	20%	-24%
Grindelia squarosa	gumweed	5%	1%	-4%
Gutierrezia sarothrae	snakeweed	2%	0%	-2%
Hordeum jubatum	foxtail barley	22%	34%	12%
Juncus balticus	baltic rush	4%	4%	0%
Kochia scoparia	kochia	3%	2%	-1%
Muhlenbergia repens	creeping muhly	8%	10%	2%
Muhlenbergia wrightii	spike muhly	4%	1%	-3%
Sporobolus airoides	alkali sacton	5%	8%	2%
Soil		5%	9%	3%

The vegetation results were taken at different times of year, so different grasses and plants may be expected to dominate the plot. There was a large decrease in Western Wheatgrass and an increase in Foxtail barley, the two may be related. Foxtail barley invades on saturated soils, and soon after, Western Wheatgrass dies out from too much water. More on this can be seen in the State-Transition Wetland Model in this report.

Valley Cross Section 2-2, 84 points

Species	Common Name	cover 2010	cover 2012	percent difference
Bouteloua barbata	six weeks grama	2%	2%	0%
Bouteloua gracilis	blue grama	10%	5%	-5%
Festuca arudinacea	tall fescue	5%	4%	-1%
Elymus smithii	Western wheatgrass	14%	14%	0%
Grindelia squarosa	gumweed	6%	2%	-4%
Hordeum jubatum	foxtail barley	0%	13%	13%
Juncus balticus	baltic rush	5%	5%	0%
Kochia scoparia	kochia	39%	25%	-14%
Melilotus offinalis	yellow sweet clover	0%	0%	0%
Muhlenbergia asperifolia	scratchgrass muhly	2%	0%	-2%
Muhlenbergia repens	creeping muhly	6%	11%	5%
Poa pratensis	Kentucky bluegrass	5%	10%	5%
Soil		18%	24%	6%

These data indicate a small increase in foxtail barley, which is spreading downstream onto the saturated soils. There was a decrease in Kochia, which was very small this time of year June, about 1 inch high. Higher cover of Kochia would be expected in the fall when it has sprouted up and flowered.

Overall monitoring results for Reach 2

Geomorphology

The uppermost portion of Reach 2 had some aggradation of sediment from flood events, and the channel was eliminated due to filling in with sand. This positive result will spread floodwaters across the Big Cebolla Wetland area, and increase the water table at the site, as the spreading floodwaters soak into the soil. The channel and valley cross sections show some changes (narrowing) due to vegetation growth and capture of sediment, but it is not yet very pronounced.

Vegetation

The vegetation at the site shows both positive and negative changes over time. There was heavy grazing in almost all year since the start of the project, as cattle find their way to the wetland and jump the fence. The year 2013, however, appeared to have the heaviest grazing intensity. Since 2009, there has been grazing, but the cattle have not yet eaten the less palatable Baltic rush, which is thick and fibrous. In 2013, however, the Baltic rush was eaten to the nub, and most stems were 2-3 inches above ground. This is compared with the

thick sward of Baltic rush which persisted in Reach 2 for many years, and is usually 2 feet tall.
The positive changes were an increase in Kentucky bluegrass, which requires a wetter site than upland vegetation, and provides good ground cover. In addition, the area covered by Baltic rush and considered delineated wetland appeared to increase over the last three years (see wetland delineation portion of report).

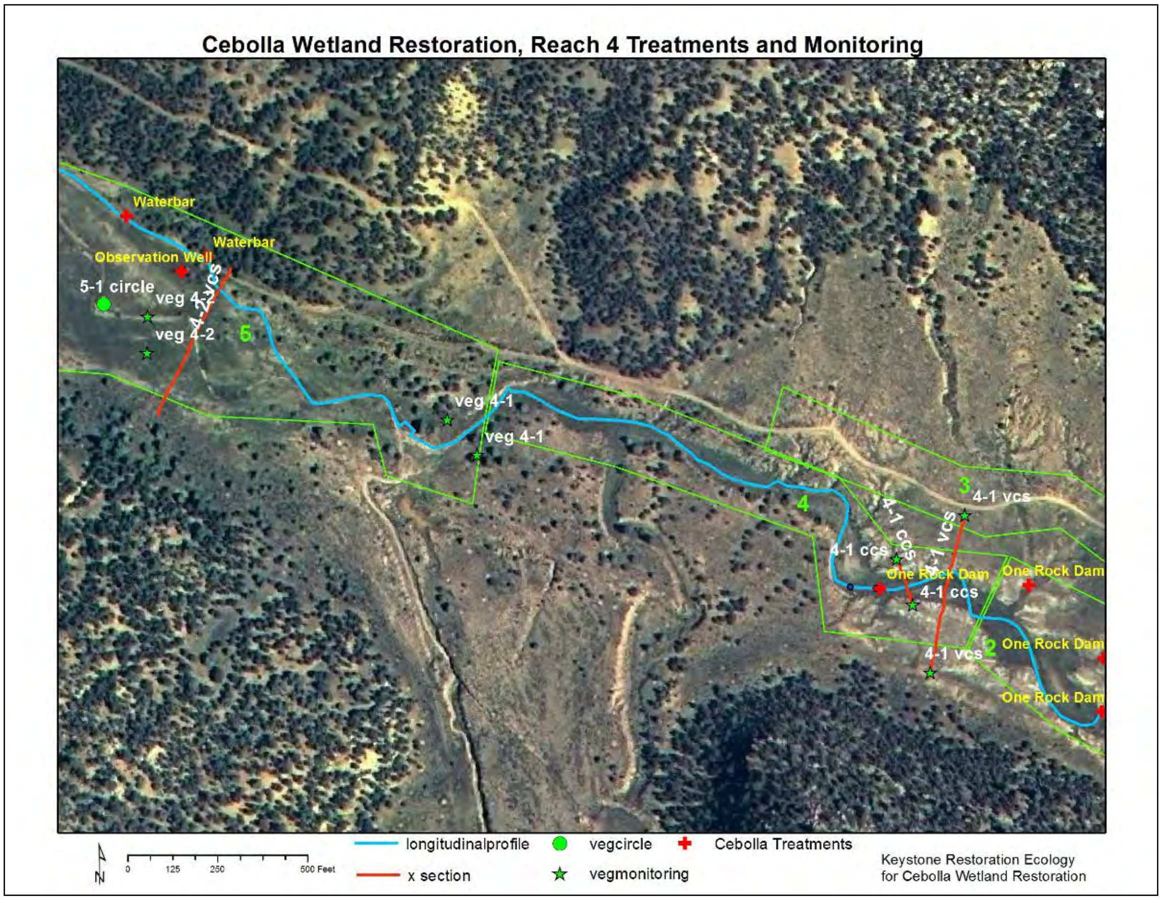
This increase was not large in area, however Baltic rush is now continuous downstream through the reach, even as a narrow fringe of vegetation along the channel. As the one rock dams installed in 2012 begin to capture sediment and raise the water table, this fringe should spread across the valley bottom and increase wetland area. This tough-rooted wetland plant will also buffer the channel from floods, and if left to grow to its natural height of 2 feet or so, capture sediment and litter from upstream, and fill the channel.

Reach 2 vegetation, Baltic Rush fringe along channel in 2013

Treatment and Monitoring Reach 4, Cebolla Creek

Reach 4 actually begins at the end of Reach 2, as Reach 3 is a gully treatment area on the hillslopes to the North near the road. The monitoring transects downstream were originally believed to be in Reach 4, but are actually in Reach 5. This data will be presented as data for Reach 4, to have consistency with the orginal names of the transects.

Treatment	Location	Expected results	Monitoring
One large one rock dam (originally planned as filter dam)	End of valley, beginning of narrow Reach 4	Increased flooding, capture of sediment, change in vegetation	Valley cross section 4-1, Channel cross section 4-1, Channel cross section 4-1 vegetation
Savage Canyon alluvial fan from south, LACK OF TREATMENT as management to provide sediment source	Between Reach 4 and Reach 5	Capture of sediment, raised water table, more wetland	Veg transect 4-1, 4-2 Valley cross section 4-2 geomorphology


Cebolla Wetland Restoration, Reach 4 Treatments and Monitoring
Waterbar
Waterbar
Observation Well
5-1 circle
veg 4-2
veg 4-2
5
veg 4-1
veg 4-1
4
3
4-1 vcs
4-1 ccs
4-1 ccs
4-1 ccs
One Rock Dam
One Rock Dam
One Rock Dam
One Rock Dam
2
4-1 vcs
longitudinalprofile
vegcircle
Cebolla Treatments
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0 125 250 500 Feet
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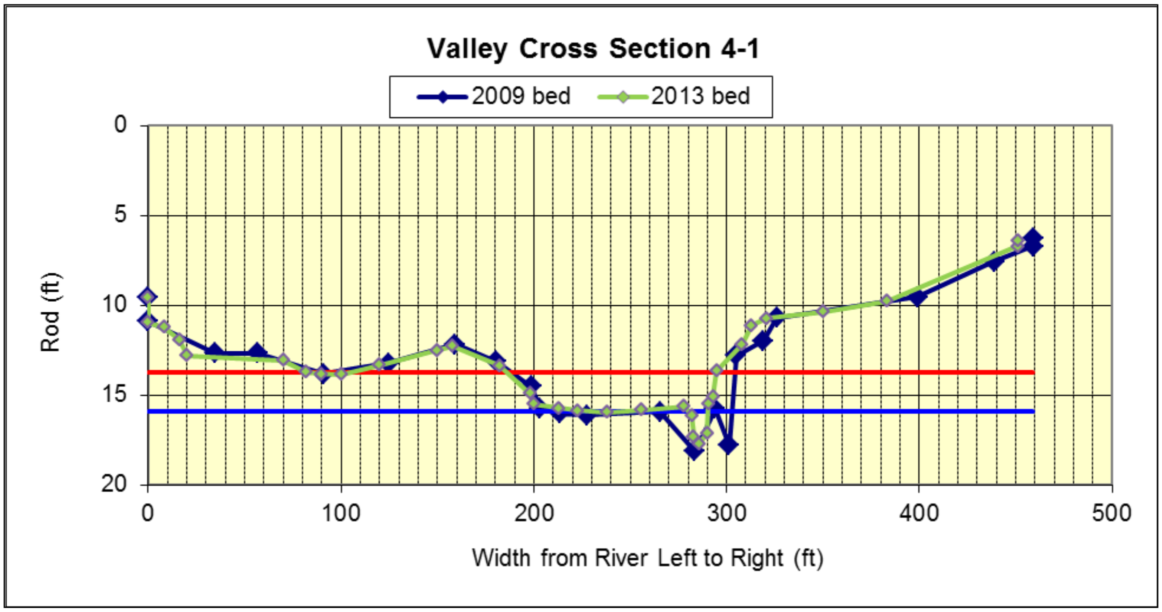
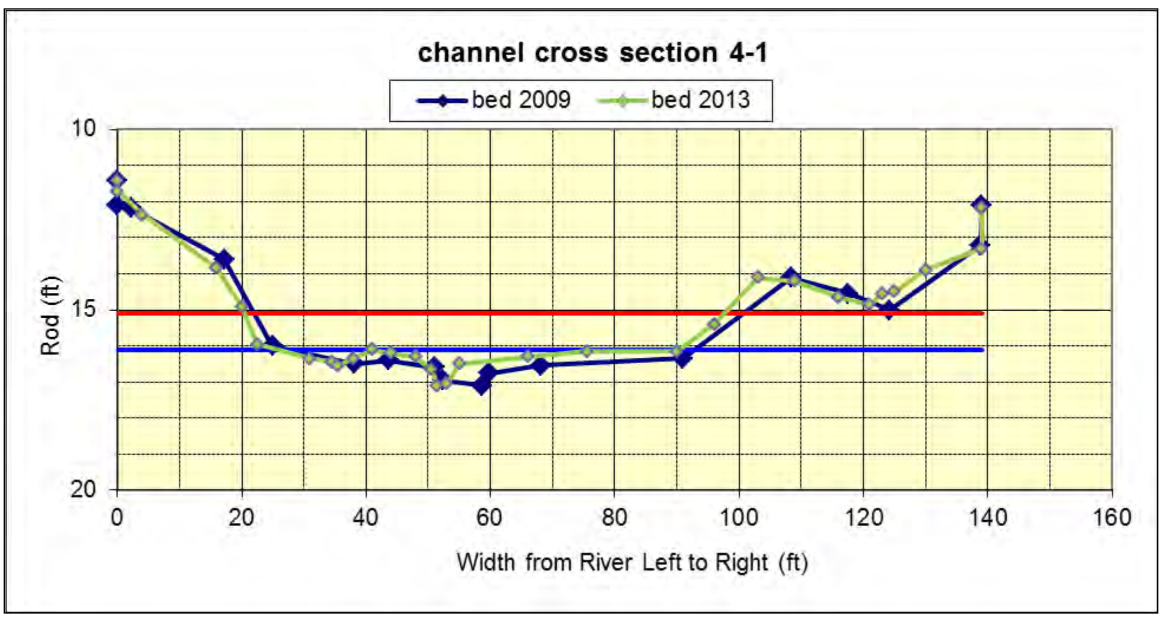
Keystone Restoration Ecology
for Cebolla Wetland Restoration

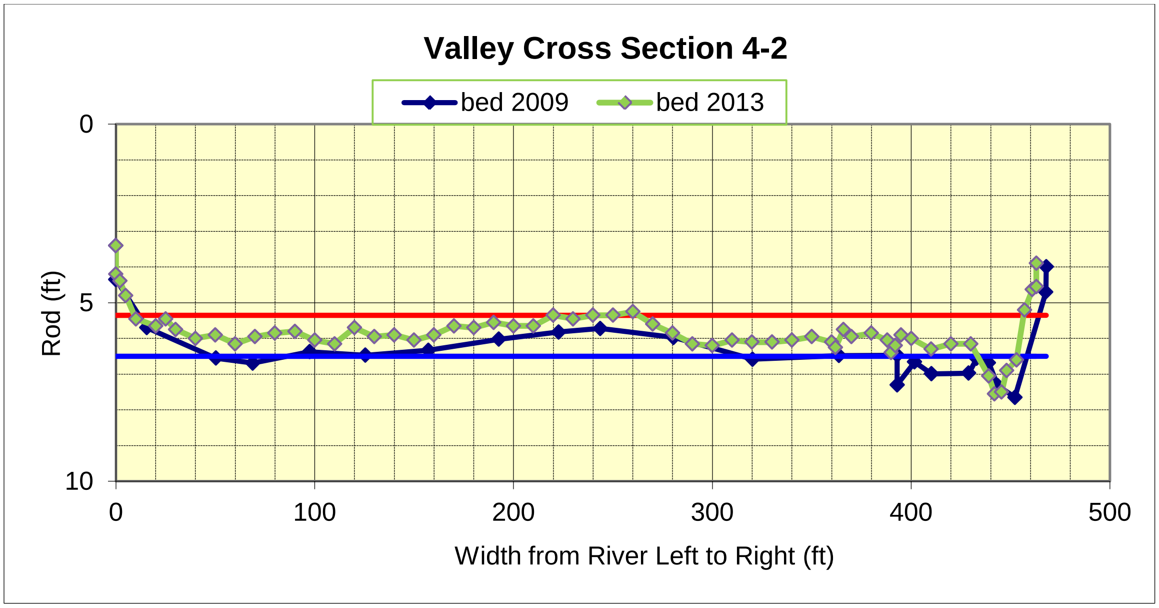
Geomorphology Results, Reach 4



There were small changes in valley cross section 4-1, but only in the bed of the channel, which filled in with sediment and narrowed to a single channel. This transect was installed to monitor the changes from installation of a 2 foot high filter dam, this was changed to a one rock dam that is one foot high, less change is expected.



Channel cross section 4-1 is downstream from the valley cross section 4-1 and closer to the one rock dam (which replaced the designed filter dam). As seen in the valley cross section, the channel narrowed and gained elevation due to the capture of sediment behind the one rock dam.

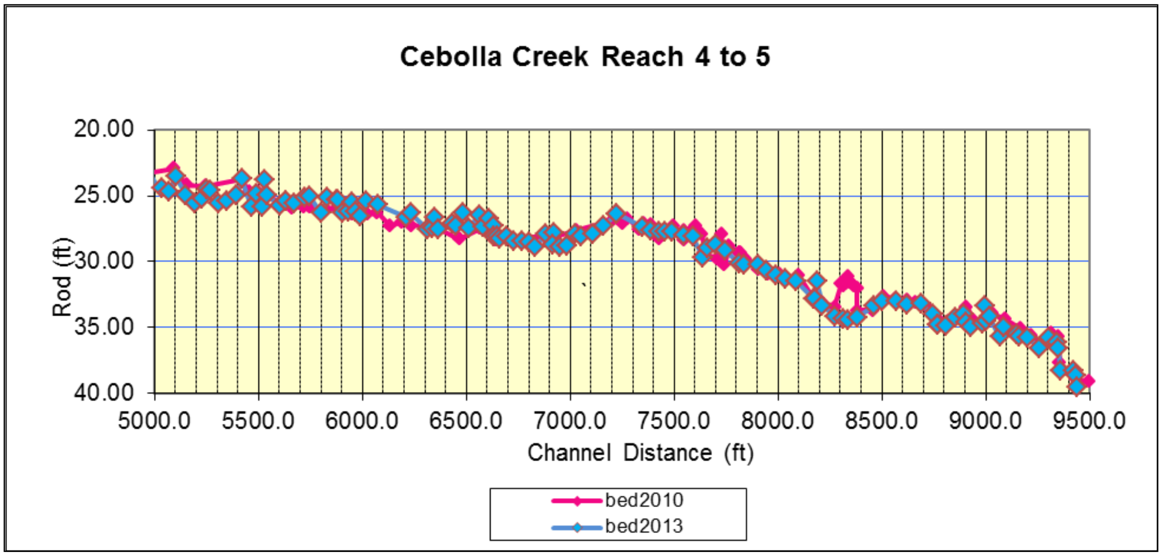


This valley cross section is just downsream from the boundary between Reaches 4 and 5, but was orginally named 4-2, so the name remains. A large amount of sediment from Savage Canyon, a tributary canyon to the south, spills into the channel of Cebolla Creek, causing braiding and an alluvial fan form.

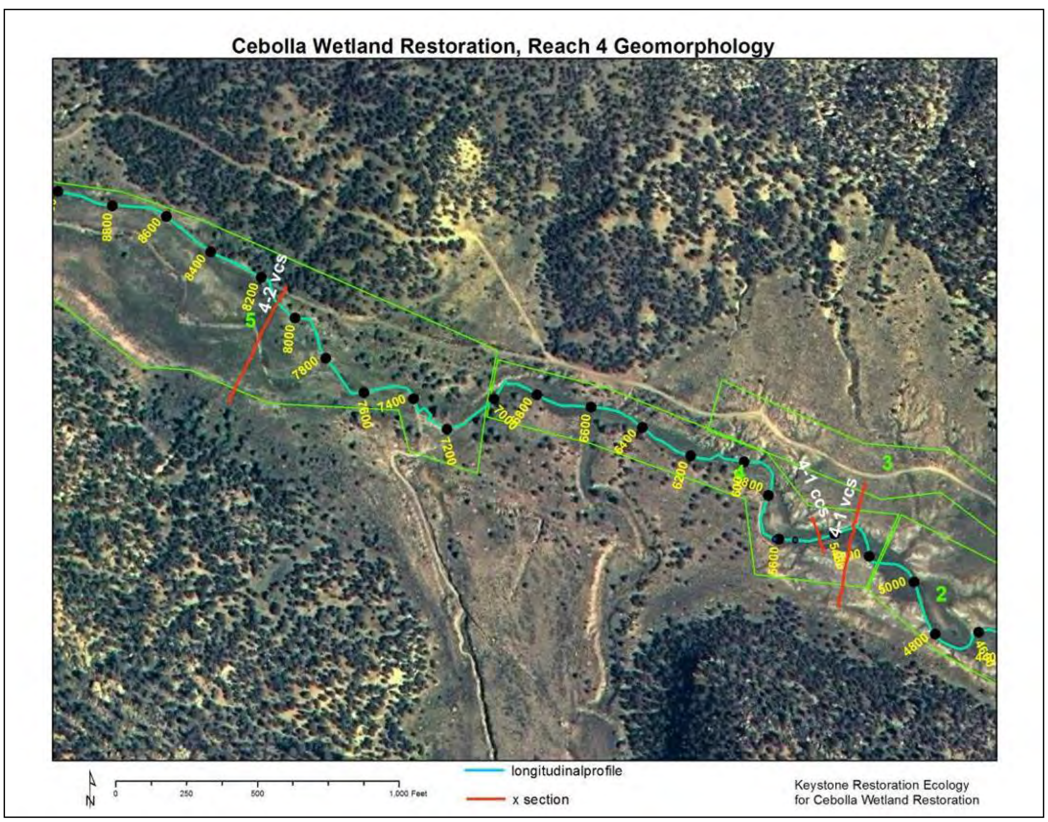
As seen in a typical alluvial fan, the middle of the fan is the highest elevation, with lower channels on both sides of the valley. The deep channel to the right of the valley is the old road, which formed a gully. This gully is filling in due to the installation of a rolling dip/one rock dam downstream from this transect.

Rolling dip road drain looking upstream at valley cross section 4-2

Cebolla Longitudinal Profile, Reach 4-5



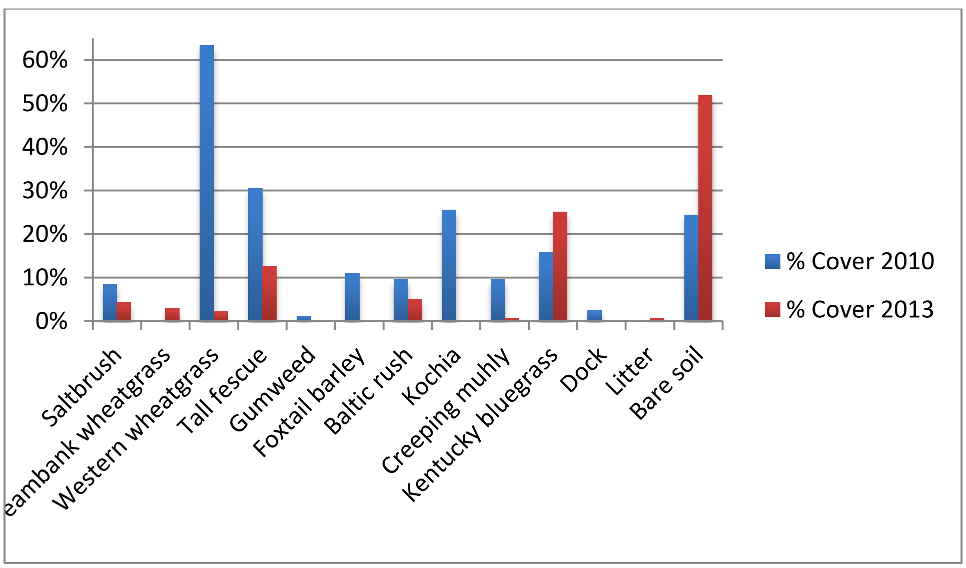
This profile runs from upstream of Reach 4 through Reach 5. The most notable portion of this graph is the area around 7200 on the longitudinal profile. This reach runs "uphill", as the sediment plume from Savage Canyon fills the valley. The large "hump" at 8400 is the rolling dip/one rock dam. The channel has cut around it to the left and needs repair and extension of the one rock dam.



Vegetation Results, Reach 4

Channel cross section 4-1

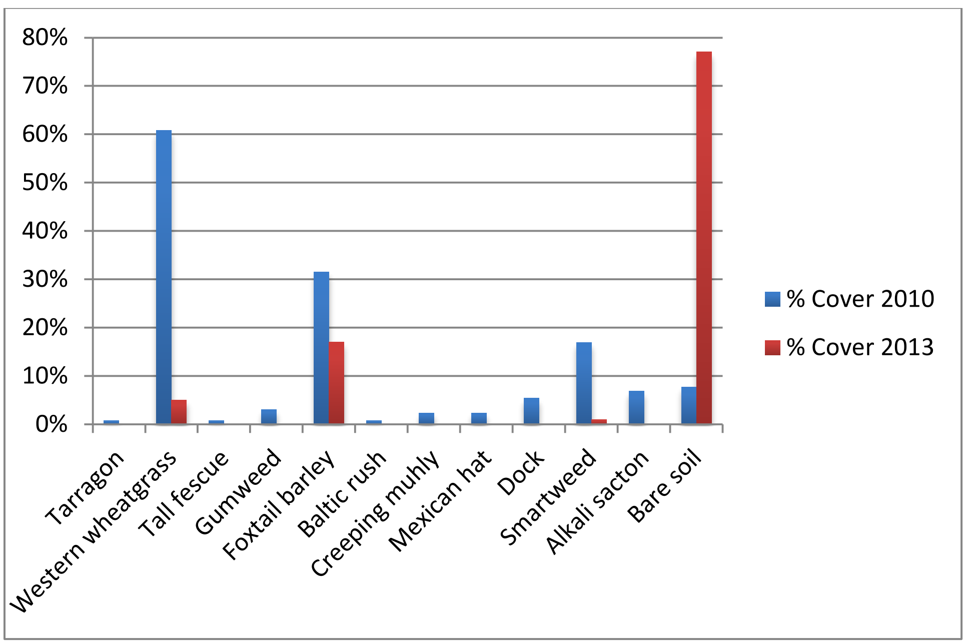
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Atriplex canescens	Saltbrush	9%	4%	-4%
Elymus	Streambank wheatgrass	0%	3%	3%
Elymus smithii	Western wheatgrass	63%	2%	-61%
Festuca arudinacea	Tall fescue	30%	13%	-18%
Grindelia squarosa	Gumweed	1%	0%	-1%
Hordeum jubatum	Foxtail barley	11%	0%	-11%
Juncus balticus	Baltic rush	10%	5%	-5%
Kochia scoparia	Kochia	26%	0%	-26%
Muhlenbergia repens	Creeping muhly	10%	1%	-9%
Poa pratensis	Kentucky bluegrass	16%	25%	9%
Rumex crispus	Dock	2%	0%	-2%
Organic Matter	Litter	0%	1%	1%
Bare Soil	Bare soil	24%	52%	27%



The results from channel cross section 4-1 show a decrease in the cover of many important species. This transect is very close to Reach 2, and the same patterns can be seen in the data. Western wheatgrass decreased in cover, as did Baltic rush, tall fescue, and foxtail barley. There was also an increase in bare soil on the transect. All of these results can be explained by the heavy grazing pressure in 2013 at the site.

Vegetation transect 4-1

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisia dracunculus	Tarragon	1%	0%	-1%
Elymus smithii	Western wheatgrass	61%	5%	-56%
Festuca arudinacea	Tall fescue	1%	0%	-1%
Grindelia squarosa	Gumweed	3%	0%	-3%
Hordeum jubatum	Foxtail barley	32%	17%	-15%
Juncus balticus	Baltic rush	1%	0%	-1%
Muhlenbergia repens	Creeping muhly	2%	0%	-2%
Ratibida tagetes	Mexican hat	2%	0%	-2%
Rumex crispus	Dock	5%	0%	-5%
Rumex species	Smartweed	17%	1%	-16%
Sporobolus airoides	Alkali sacton	7%	0%	-7%
Bare soil	Bare soil	8%	77%	69%

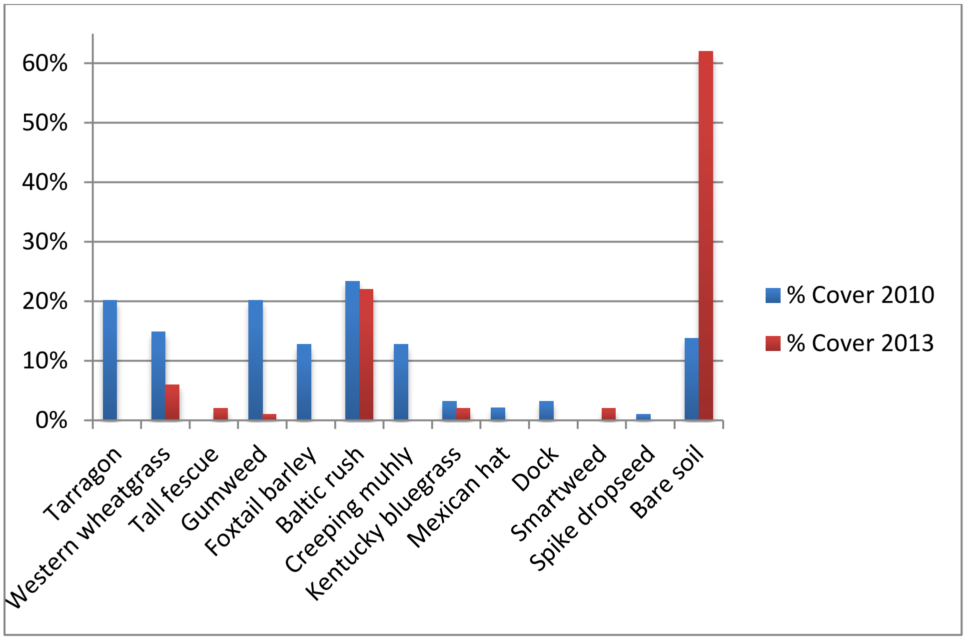


Vegetation transect 4-1 was just upstream from the sediment plug from Savage Canyon. This causes this transect to be in a ponded area, and a large amount of sedimetn from Cebolla Canyon and Savage Canyon drops out of suspension. There was a decrease in almost every species, as this transect was mostly sand deposited a foot deep on top of vegetation seen in 2010.

Vegetation transect 4-1 buried under new sediment

Vegetation transect 4-2

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisia dracunculus	Tarragon	20%	0%	-20%
Elymus smithii	Western wheatgrass	15%	6%	-9%
Festuca arudinacea	Tall fescue	0%	2%	2%
Grindelia squarosa	Gumweed	20%	1%	-19%
Hordeum jubatum	Foxtail barley	13%	0%	-13%
Juncus balticus	Baltic rush	23%	22%	-1%
Muhlenbergia repens	Creeping muhly	13%	0%	-13%
Poa pratensis	Kentucky bluegrass	3%	2%	-1%
Ratibida tagetes	Mexican hat	2%	0%	-2%
Rumex crispus	Dock	3%	0%	-3%
Rumex species	Smartweed	0%	2%	2%
Sporobolus contractus	Spike dropseed	1%	0%	-1%
Bare soil	Bare soil	14%	62%	48%



Vegetation transect 4-2 is just downstream from Valley transect 4-2, which had ½ to 1 feet of sediment deposition from Savage Canyon. The amount of bare soil increased greatly, as did the percent cover of most species. However, Baltic rush, which is a wetland species that thrives under the deposition of wet sediment, decreased by only 1% cover, despite the large amount of sand on top of it. Baltic rush may already be growing up through the new deposition that has buried the rest of the plants in the transect.

Overall monitoring results for Reach 4

Geomorphology

Transects valley cross section 4-1 and channel cross section 4-1 both had similar results, with the channel narrowing and gaining elevation slightly. This is due to the growth of Baltic rush along the banks, as well as sediment deposition from upstream. Valley cross section 4-2 had ½ to 1 feet of deposition from Savage Canyon across the entire transect, which should flatten the grade of the channel upstream.

Vegetation

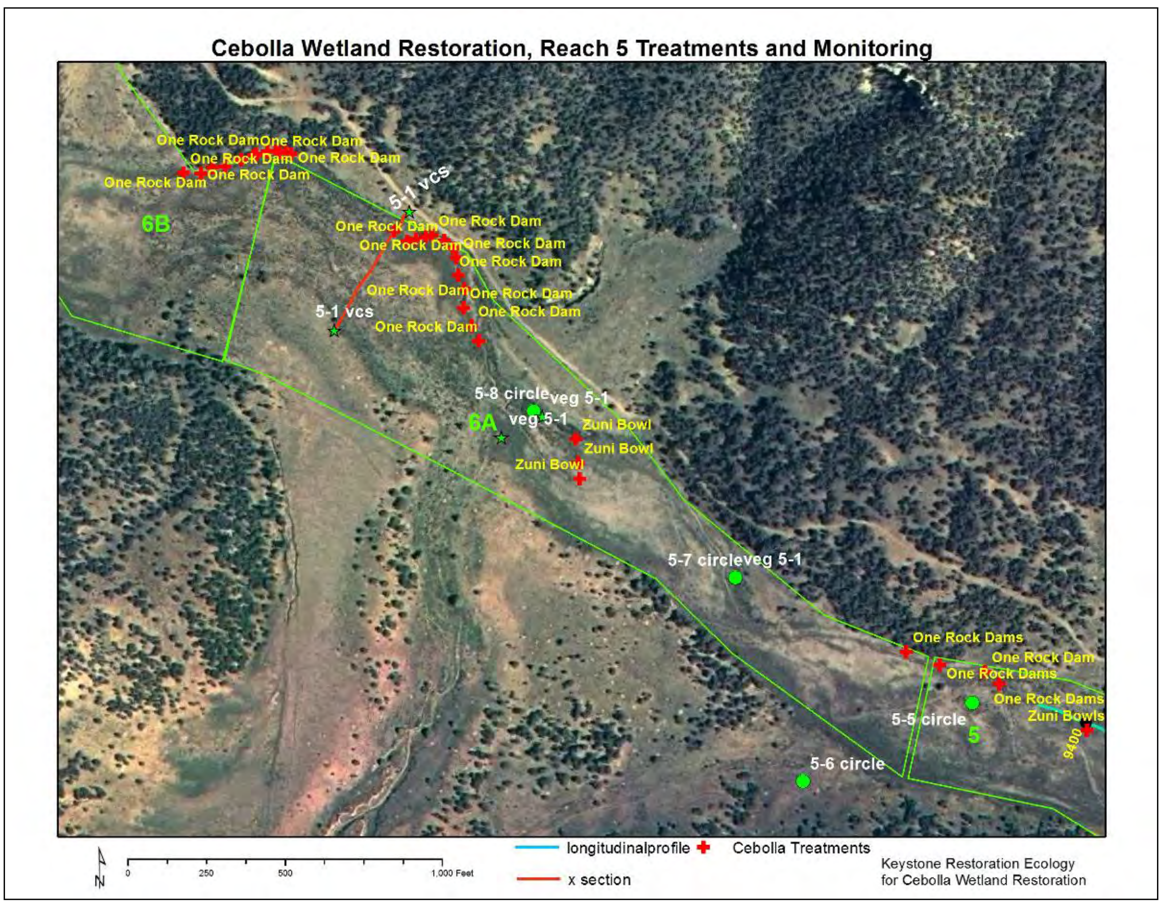
The vegetation at the site shows both positive and negative changes over time. There was heavy grazing in almost all year long since the beginning of the project. The year 2013, however, appeared to have the heaviest grazing intensity due to the heavy grazing on Baltic rush. Channel cross section 4-1 had the most grazing intensity and showed a marked reduction in species cover. Vegetation transects 4-1 and 4-2 were covered by sediment and also had a decrease in plant cover, however, the effects of sedimentation are positive for the channel of Cebolla Creek.

The results of the wetland delineation portion of this report show that Baltic rush is moving downstream and colonizing Reach 5. This will anchor the sediment spilling out from Savage Canyon, and in the future, most of Reach 4 should fill in as well with sediment from the main channel of Cebolla Creek.

Treatment and Monitoring Reach 5-6a, Cebolla Creek

Reach 5 extends into Reach 6a, and an old road/cattle trail captures the channel of Cebolla Creek in a gully. A large number of one rock dams were built by youth and volunteers in the channel of this gully.

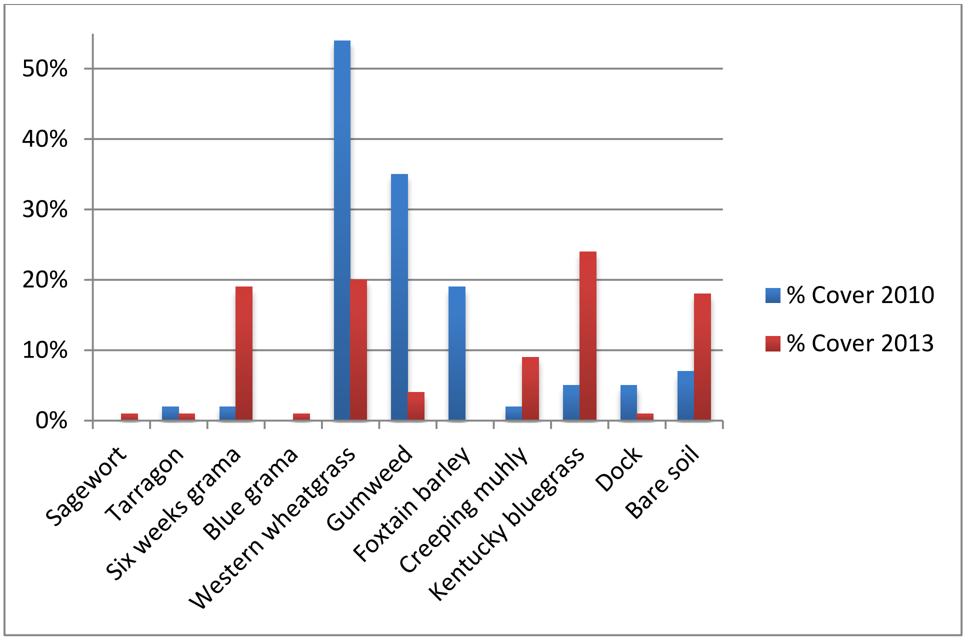
Treatment	Location	Expected results	Monitoring
Large Zuni Bowls to prevent headcutting of gully up valley	Above vegetation transect 5-1	Increased flooding, spreading of water across vallely	Vegetation transect 5-1
Thirteen one rock dams in gully		Raised water table, increased flooding across valley bottom	Valley cross section 5-1, geomorphology and vegetation



Zuni bowl to prevent gullying upstream, upstream of vegetation transect 5-1

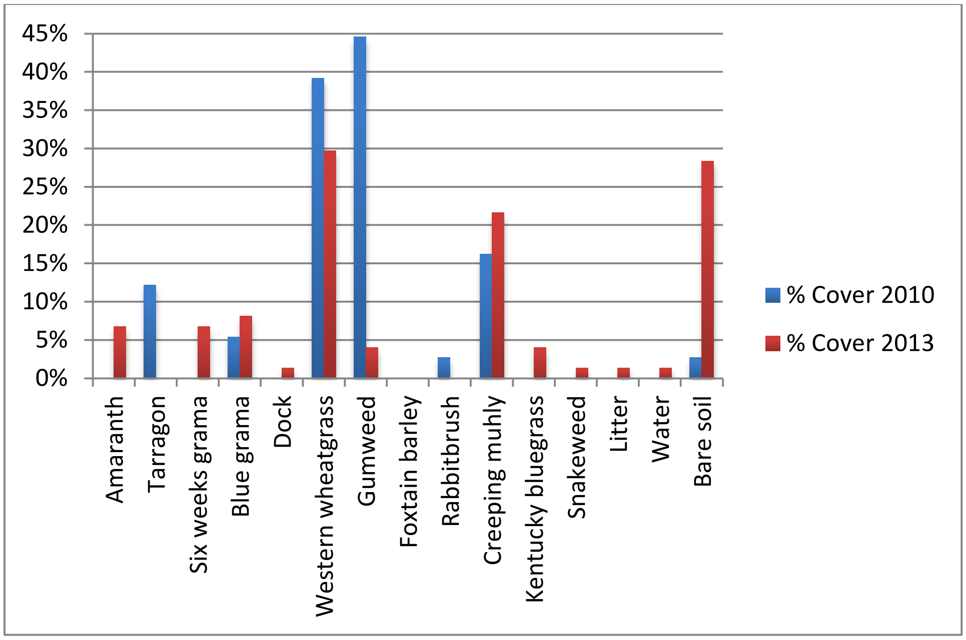
Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Artemisia frigida	Sagewort	0%	1%	1%
Artemisia dracunculus	Tarragon	2%	1%	-1%
Bouteloua barbata	Six weeks grama	2%	19%	17%
Bouteloua gracilis	Blue grama	0%	1%	1%
Elymus smithii	Western wheatgrass	54%	20%	-34%
Grindelia squarosa	Gumweed	35%	4%	-31%
Hordeum jubatum	Foxtain barley	19%	0%	-19%
Muhlenbergia repens	Creeping muhly	2%	9%	7%
Poa pratensis	Kentucky bluegrass	5%	24%	19%
Rumex crispus	Dock	5%	1%	-4%
Bare soil	Bare soil	7%	18%	11%

Vegetation transect 5-1 had a decrease in many important species over the time of the study. This area had heavy grazing pressure and a herd of cattle at the site during the montoring session. The positive results seen are in the increase in cover of creeping muhly and Kentucky bluegrass. Both species prefer moderately wet soil and increase at sites that begin as upland species and then are irrigated by additional water.



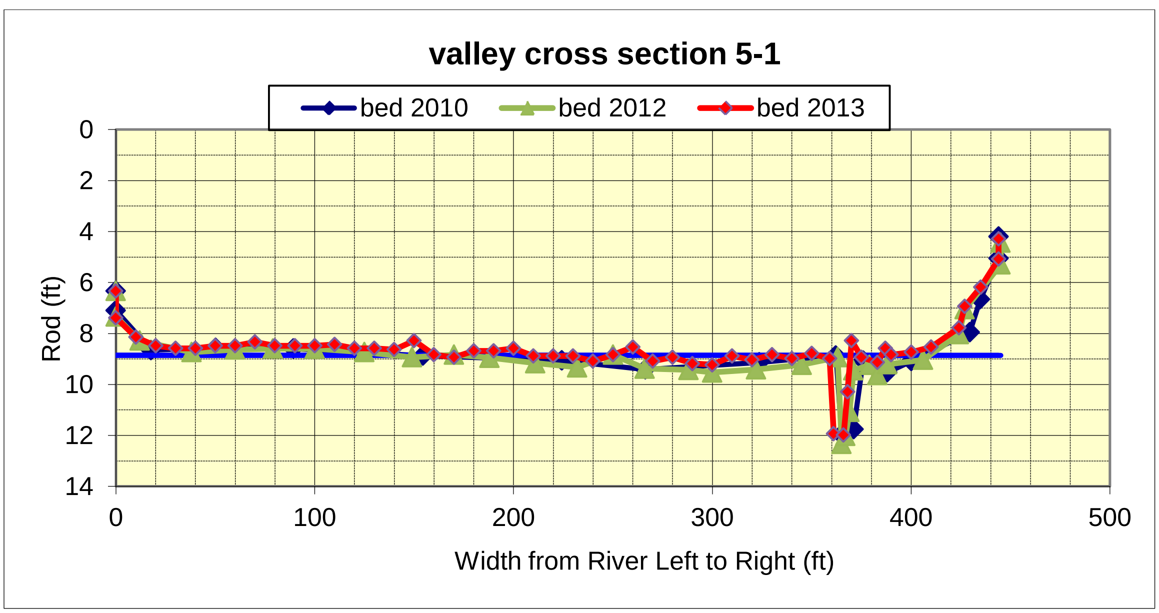
Valley Cross Section 5-1

Vegetation Species	Common Name	Percent of Cover 2010	Percent of Cover 2013	Percent Difference
Amaranthus spp.	Amaranth	0%	7%	7%
Artemisia dracunculus	Tarragon	12%	0%	-12%
Bouteloua barbata	Six weeks grama	0%	7%	7%
Bouteloua gracilis	Blue grama	5%	8%	3%
Rumex crispus	Dock	0%	1%	1%
Elymus smithii	Western wheatgrass	39%	30%	-9%
Grindelia squarosa	Gumweed	45%	4%	-41%
Hordeum jubatum	Foxtail barley	0%	0%	0%
Chrysothamnus nauseosus	Rabbitbrush	3%	0%	-3%
Muhlenbergia repens	Creeping muhly	16%	22%	5%
Poa pratensis	Kentucky bluegrass	0%	4%	4%
Gutierrezia sarothrae	Snakeweed	0%	1%	1%
Organic matter litter	Litter	0%	1%	1%
Water	Water	0%	1%	1%
Bare soil	Bare soil	3%	28%	26%



The results of valley transect 5-1 show a decrease in the cover of many species of plants, as well as an increase in bare soil. This may be due to heavy grazing pressure, as is seen in the rest of Cebolla Wetland. However, the slight increase in Kentucky bluegrass and creeping muhly may indicate an increase in the moisture at the site.

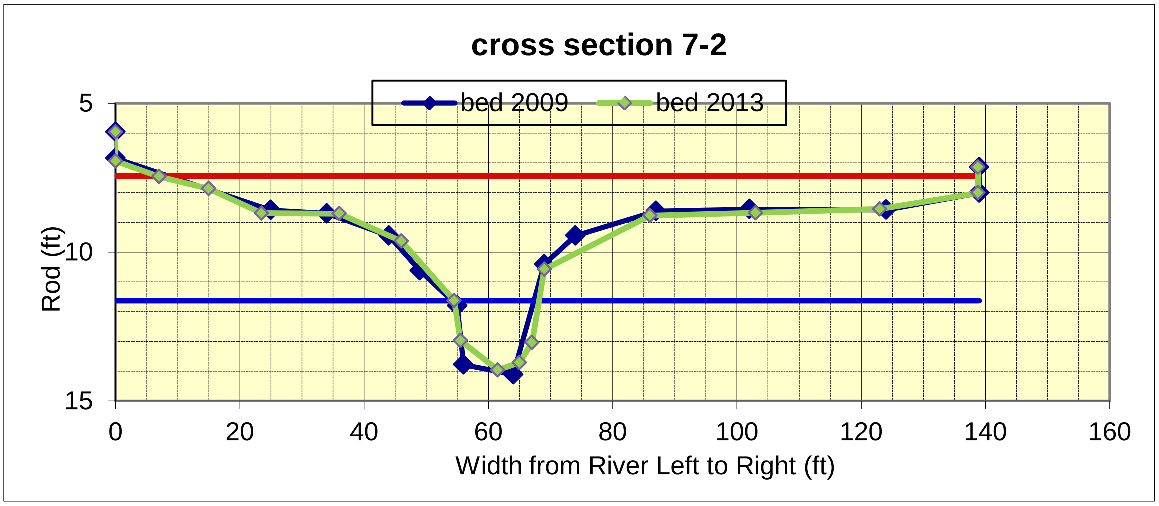
Geomorphology Monitoring in Reach 5-6



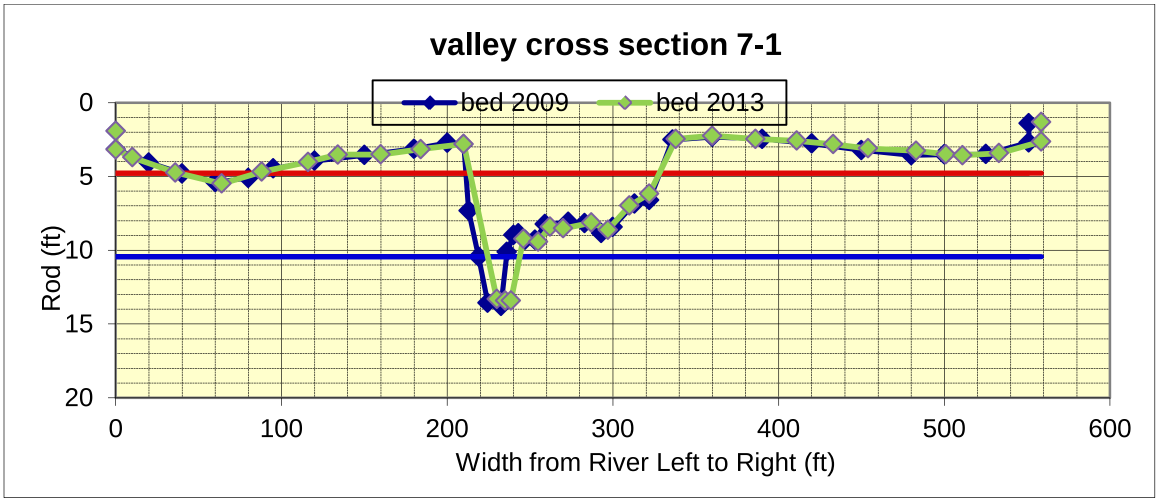
Little changes were seen in valley cross section 5-1 between 2010 and 2013. Small "humps" in the profile are piles of litter (pine needles) from flooding in September 2013.

Cebolla Reach 7 Monitoring

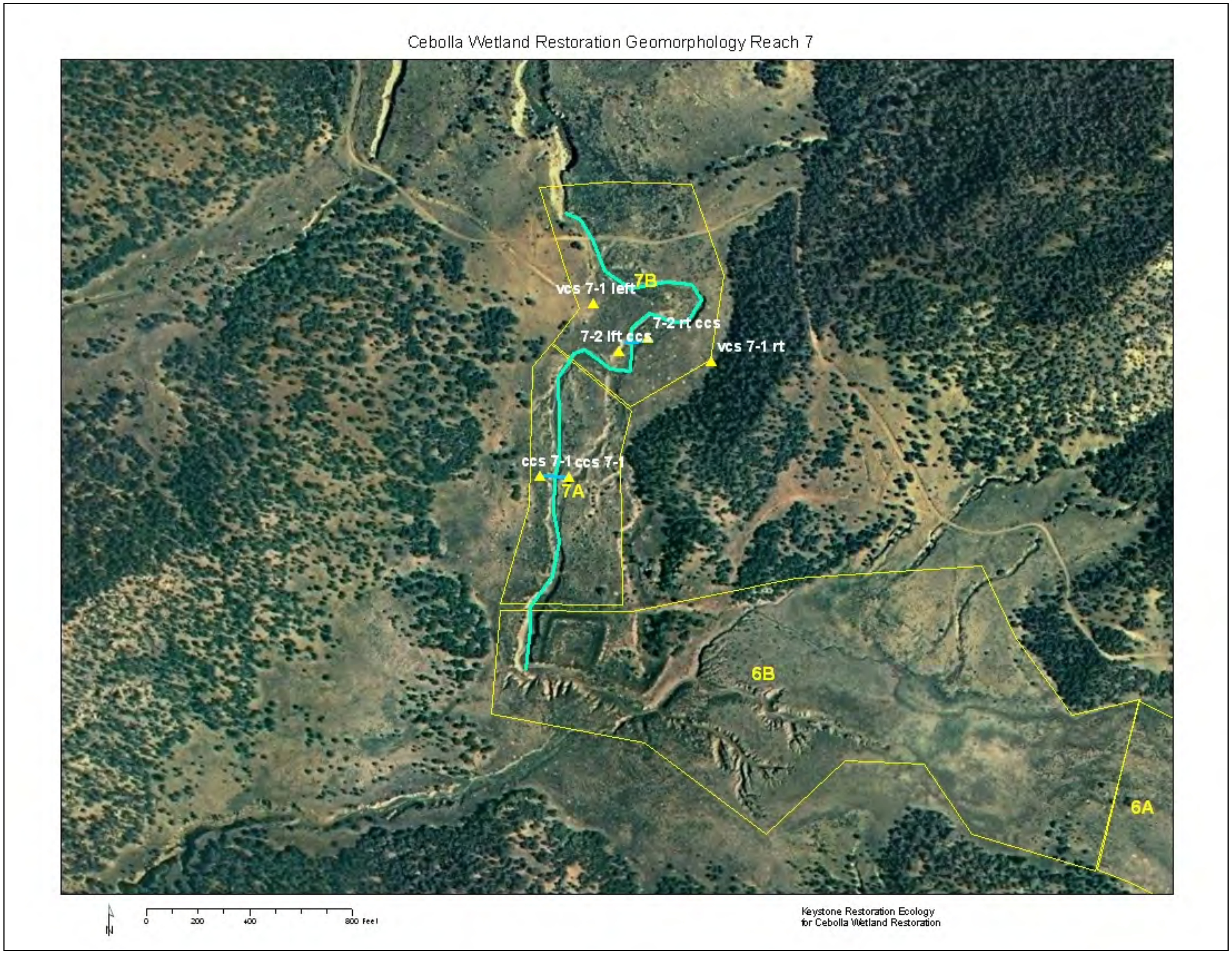
A longitudinal profile was taken through the entire reach 7 in late fall 2009. This profile was not repeated, as very few treatments were constructed in Reach 7. Two channel cross sections and one valley cross section were taken. Channel cross section 7-2 and valley cross section 7-1 were re-surveyed in 2013.



Very little changes were observed over the four years, indicating that this is a stable channel shape.



There appears to be some movement of the channel to the right over the four years, this could be an artifact of the survey itself. No treatments were constructed nearby.


Cebolla Wetland Restoration Geomorphology Reach 7
vcs 7-1 left
7B
7-2 rt ccs
7-2 lft ccs
vcs 7-1 rt
ccs 7-1 ccs 7-1
7A
6B
6A
0
200
400
800 feet
Keystone Restoration Ecology
for Cebolla Wetland Restoration

Monitoring at Cebolla Wetland, Final Results and Recommendations

Geomorphology

The geomorphology of Reach 0 saw some of the largest changes, as could be expected from a project of over 20,000 foot length. Sediment from Cebolla Creek upstream will fill Reach 0 first, and then move downstream through Reaches 2, 4 5, and 6.

Reach 0, Channel re-location and longitudinal profile 0-2

Due to the enormous floods in September 2013 that saw flooding throughout the Front Range of Colorado, a huge plume of sand came downstream and filled in the channel of Cebolla Creek for thousands of feet. This historic channel is wide and shallow, and now has about 3 feet of sand deposition in it. A healthy meander pattern is developing in this sand, and any headcutting or erosion in this channel is now buried and “fixed”.

This deposition of sand washed out two exclosures, at the top and bottom of the Lake Cebolla. These should be repaired (planned for January 2014), and planted with both western wheatgrass seed (cheap and effectively scratched into the sand). Bulrush planting has proven to be successful as well, but it is difficult and stinky work. It is also possible that coyote willows could thrive in this habitat of deep sand over wet clay.

Buried exclosure fence at top of Lake Cebolla in 3 feet of sand, this channel is now only 4 feet from the former wide wetland surface of the valley and may proceed to fill in with no additional treatment, creating 10-20 acres of additional wetland area.

Downstream end of Lake Cebolla

The large plug of sediment that created a shallow, 1500 foot long pond that was named "Lake Cebolla", is head-cutting through the bulrush plantings. This appears to be an artifact of the enormous September 2013 flooding. Extremely large events can cause erosion in a channel that can easily carry floods from year to year. Lake Cebolla itself has filled with sand, and remains wetland due to the saturation of the clays below the sands. The exlcosure fence around the bulrush also needs repair; both "break-away" fences at the water gaps broke, as they were designed to.

Bottom of Lake Cebolla in 2013, note channel filled in with wet sand upstream, headcut in picture should be repaired with rock, smaller flood events may fill this in with sand with no treatment. Break-away exclosure fence in middle of picture.

Plug and Pond in Tributaries of Reach 0

A NACWA grant has been applied for by the RPA for building plug and pond structures in Reach 0's tributaries and upstream. Some issues were noted that may have an effect on these projects.

1. The main channel of Cebolla Creek should not be plugged for some time, this sediment source is too valuable in Reaches 2-6. In addition, the area around Lake Cebolla is experiencing large, positive changes due to this sediment.
2. Reach 0-SE has a large watershed and flooded much more than Reaches 0-N or 0-SE. There is also evidence of large willows in one of its two tributaries upstream, and this area may be a wetland.
3. Reach 0-E was designed to fill a cattle tank with water, due to the large floods in Sep 2013, it has filled in ½ with sediment, and may need to be dug out by the permittee. In addition, the plug and pond was constructed at the upstream end of the gully (first chance) rather than the lower end (last chance to plug). This has allowed the sediment to fan out, and cause the water from this trib to flow back into the gully. Another small plug could be built in ½ day with a tracked loader to repair this problem.
4. The issue noted in Reach 0-E indicates that plug and ponds should be built from the bottom up, with the lower portion of a gully plugged first, the gully filled with sand, then another plug built at the upstream end of the sediment. The surprising results in this tributary were just how much sediment there was, it filled in the "pond" in one flood, filled in the cattle tank, and caused some of the water to divert back into the gully.

Reach 2 geomorphology

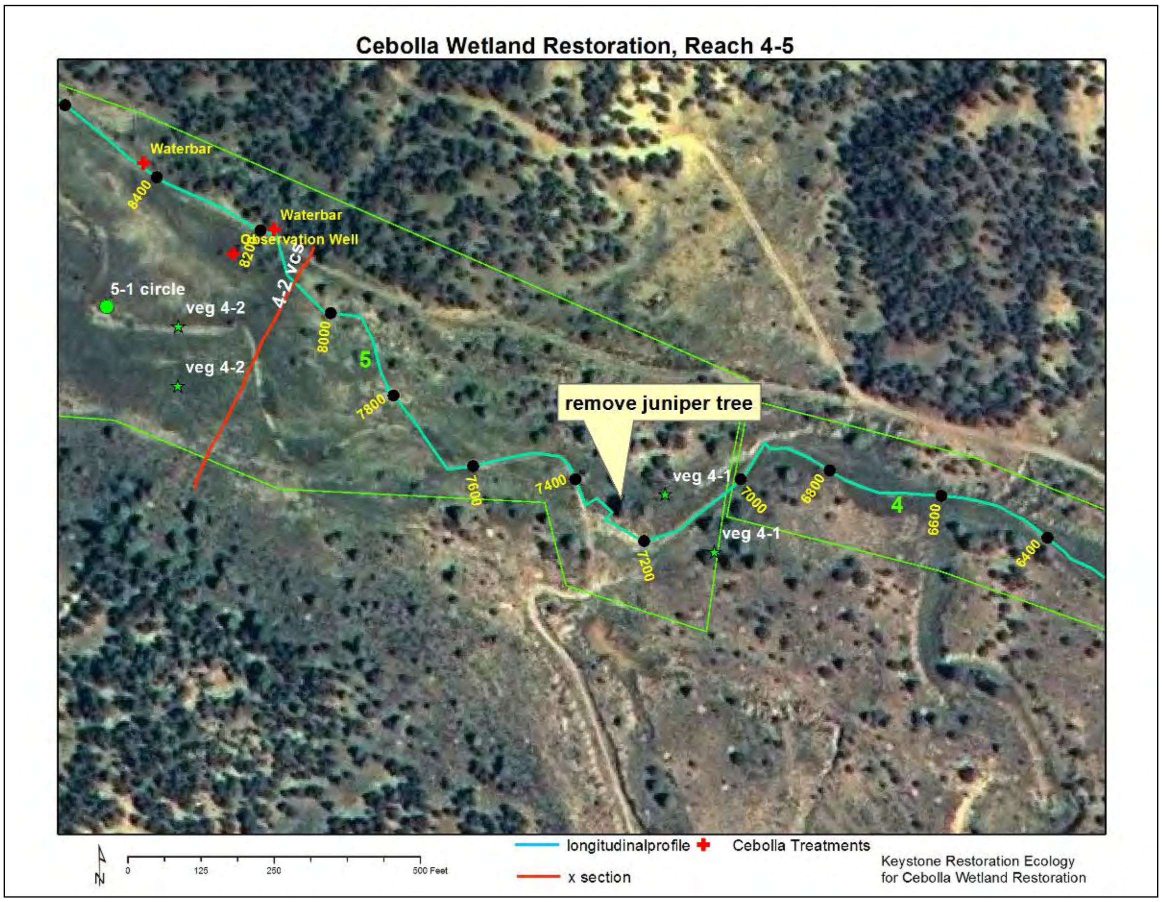
The large flood events in September 2013 caused damage to both the pasture fence at the beginning of Reach 2 and the exclosure fence around the Big Cebolla Wetland. Each fence needs almost complete rebuilding. The sediment plume from this plug moved about 1000 feet into Reach 2, and should move downstream through Reach 2 in one or two years, depending upon precipitation and flood events. Reach 2 has a large number of large one rock dams that should fill in and become sheet flow rather than a narrow, meandering channel.

Reach 2 one rock dams should be plugged with clay and packed tight to raise the water table six inches to a foot and spread it across the floodplain.

Reach 4 geomorphology

As this sediment moves into Reach 4, it will fill in behind the sediment plug at Savage Canyon (seen on longitudinal profile). This should change all of Reach 4 into a wetland area as it fills in the channel and water from Big Cebolla Spring saturates this area.

One particular area in Reach 4/5 is channelizing the flow from Cebolla Creek and preventing deposition of sediment from Savage Canyon. There is a large Rocky Mountain Juniper tree that is nearly dead from flooding, but continues to shade out the wetland vegetation that would plug the channel. Removal of this tree should cause large changes both upstream and downstream and eliminate the channel entirely in this area.



Monitoring at Cebolla Wetland, Final Results and Recommendations

Vegetation Monitoring

Wetland Delineation

The wetland areas at Cebolla Canyon increased over the timeline of the two grant-funded projects. About 4 acres of wetland were gained, in addition, the areas of wetland extended downstream into Reaches 4 and 5, for almost another 1000 feet downstream.

The potential for more expansion is huge, especially around Lake Cebolla. This area was formerly a sheet-flow valley and has filled rapidly from below, near the Big Cebolla Spring. It is possible that a geomorphic threshold has been crossed, and more aggradation will continue to fill the channel and spread water across the valley, however, only time will tell.

Rabbitbrush Mortality Experiment

This experiment proved our hypothesis that the areas of Cebolla Creek with rabbitbrush cover would decrease over time as the valley becomes flooded and saturated. These areas may become wetland over a longer time frame, it is possible that the first noticeable change is the mortality of adult and juvenile rabbitbrush.

Vegetation transects in Reaches 0-6

There were poor results for most of the vegetation transects. The only area that showed an increase in wetland plants were the transects in Reach 1, Big Cebolla Wetland. The other sites, from Reach 0, Reach 2, Reach 4, and Reaches 5-6 all experienced poor to middling results.

The year 2013 had an especially dry winter and early spring, with good rainfall in late summer and early fall. September 2013 had damaging floods across New Mexico and Colorado, and there was a large amount of rainfall and flooding in Cebolla Creek as well. This pattern of rainfall may have some role in the reduction in cover for many species, especially forbs such as Rocky Mountain beeplant (*Cleome serrulata*), which can be dominant on freshly deposited sandy soils, but needs springtime moisture to germinate. The vast fields that were seen in Reaches 0 and 2 in 2010, 2011 and 2012 were missing in 2013, either spring or fall.

Grazing

The year 2013 appeared to have a large amount of grazing pressure. While there has been some presence of cattle during almost every year in Cebolla Canyon, this year there were about 50 cattle in Reach 5 and 6 that also grazed in the wetland areas in Reaches 0, 2 and 4. The intensity of grazing pressure was noticeable in the cover of Baltic Rush, which had never before (from 2010 to 2012) been grazed “to the nub”. While other, more palatable plant species had been grazed down, Baltic Rush had remained ungrazed until 2013.

Plant Interactions with Geomorphology

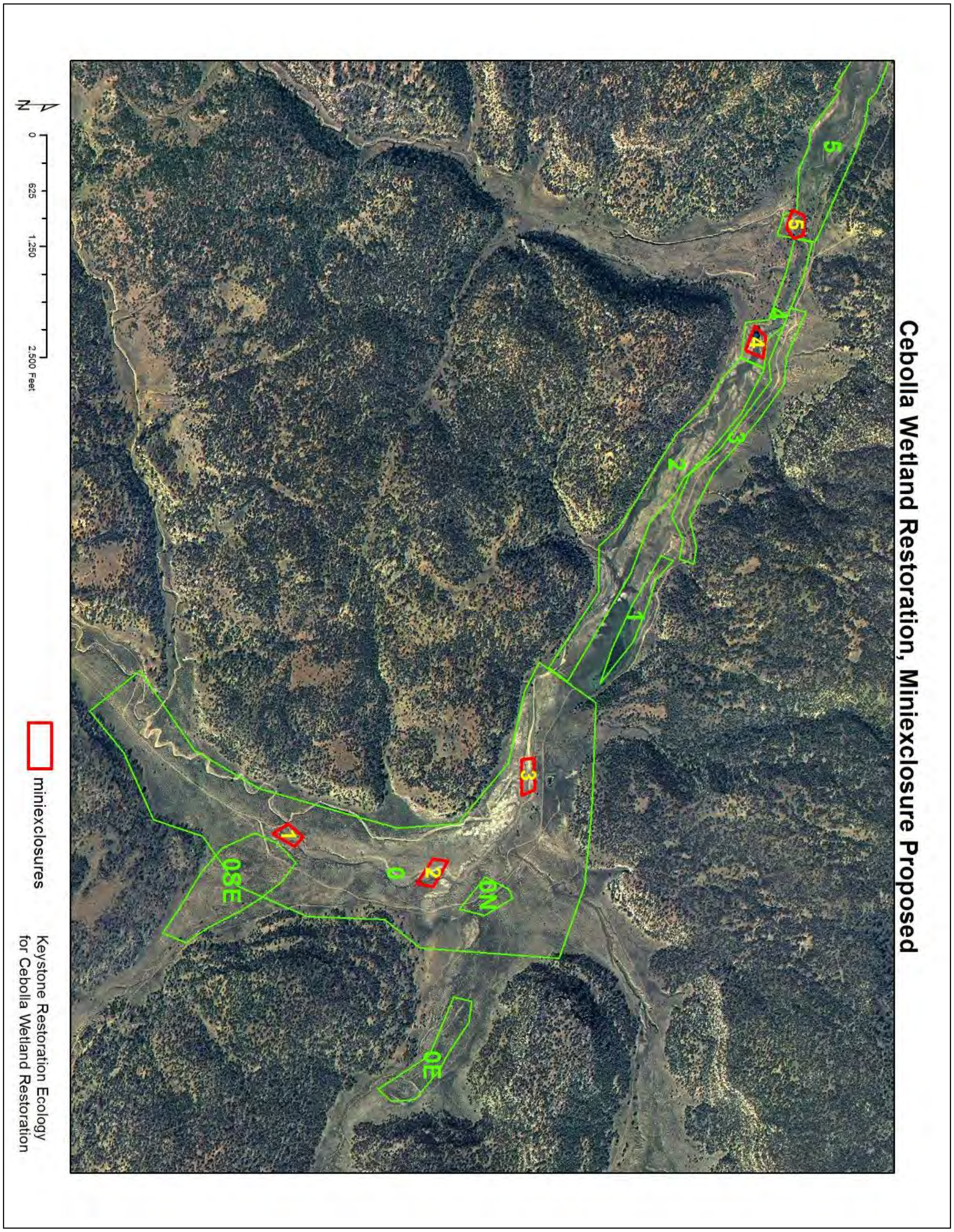
The growth of grass-like plants plays and important role in form and health of wetlands. The expansion of wetland areas at Cebolla Creek are very much dependent on the capture of sediment from Cebolla Crek, which spreads floodwaters, soaks them into the ground, and raises the water table. The channel of Cebolla Creek has almost been eliminated for 1500 feet, between Reach 0 and 2. This creates the potential for wetlands in this area.

Grass-like plants that grow from runners such as western wheatgrass, Baltic rush, common spikerush, Kentucky bluegrass, and chairmaker's bulrush have the ability to capture wet sediment that has been freshly deposited and hold it in place. The wetland plants above can actually growth through even several feet of sediment and hold it in place before the next flood event washes it away. This function of wetland plants is the major reason that wetlands are expanding at Cebolla Canyon.

Heavy, year-long grazing by cattle has the effect of removing these species and preventing their spread. Western wheatgrass, Baltic rush, and nutsedge are the early-successional invaders of wet, freshly deposited sediment. They are also preferred grazing species for cattle.

Three suggestions for managing the effects of grazing at Cebolla Crek

1. A grazing plan for the permittees that excludes cattle from the important areas in Reaches 0, 2, and 4 during the spring. This will allow these cool-season species to green-up and spread. Less grazing in the late-summer and fall would let them go to seed, which is important for western wheatgrass and nutsedge especially.
2. Repair the fences around Cebolla Spring that have been damaged by flooding, cut by members of the public or buried by sediment from Cebolla Creek. This protects the "core" of the wetland and provides seeds and pieces of rhizomes for colonization downstream.
3. Continue to focus on "trigger point" areas that store sediment and water with small exclosures to allow for the growth of vegetation that can capture sediment and fill the channel of Cebolla Creek. Two exclosures were damaged in the September 2013 floods and are planned to be repaired in January 2014 by the BLM.
    1. Mini exclosure around Filter dam and berm breach in Reach 0. This will create wetland area due to the storage of water and sediment. Healthy, un-grazed vegetation will accelerate this process.
    2. Mini exclosure at top of Lake Cebolla, needs repair.
    3. Mini exclosure at bottom of Lake Cebolla, needs repair.
    4. Mini exclosure at large one rock dam between Reaches 2 and 4, this trigger point will fill the valley upstream if allowed to fill in with sediment
    5. Mini exclosure at boundary of Reaches 4 and 5, will grow wetland vegetation and capture more sediment.


Cebolla Wetland Restoration, Miniexclosure Proposed
5
5
4
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2
0
6N
0SE
0E
miniexclosures
Keystone Restoration Ecology
for Cebolla Wetland Restoration
0
625
1,250
2,500 Feet
N

Species List for Cebolla Wetland

Achillea millefolium	ACMI	yarrow
Achnatherum hymenoides	ACHY	indian ricegrass
Achnatherum robustum	ACRO	sleepygrass
Artemisia dracunculus	ARDR	tarragon
Artemisia frigida	ARFR	sagewort
Atriplex canescens	ATCA	fourwing saltbush
Bouteloua barbata	BOBA	6-weeks grama
Bouteloua gracilis	BOGR	Blue grama
Bromus tectorum	BRTE	cheatgrass
Carex praegracilis	CAPR	Field sedge
Chrysothamnus nauseosus	CHNA	rabbitbrush
Cleome serrulata	CLSE	beeplant
Conyza canadensis	COCA	horseweed
Descurainia pinnata	DEPI	Western tansy-mustard
Eleocharis palustris	ELPA	spikerush
Eleocharis quinqueflora	ELQU	Few-flowered spikerush
Elymus smithii	ELSM	western wheatgrass
Epilobium ciliatum	EPCI	Epilobium
Erigeron divergens	ERDI	margarita
Euphorbia sp.	EUSP	Euphorbia species(spurge)
Euphorbia spathulata	EUSP	warty spurge
Festuca arundinacea	FEAR	tall fescue
Grindelia squarosa	GRSQ	gumweed
Gutierrezia sarothrae	GUSA	Snakeweed
Hackelia hirsuta	HAHI	stickseed
Hordeum jubatum	HOJA	Foxtail barley
Juncus balticus	JUBA	Baltic rush
Juncus torreyi	JUTO	Torrey's rush
Kochia scoparia	KOSC	Kochia
Lycopus asper	LYAS	bugleweed
Lycurus phleoides	LYPH	wolf tail
Melilotus officinalis	MEOF	yellow sweet clover
Muhlenbergia asperifolia	MUAS	scratchgrass
Muhlenbergia montana	MUMO	mountain muhly
Muhlenbergia repens	MURE	Creeping Muhly

Opuntia sp.	OPSP	prickly pear
Plantago patagonica	PLPA	wooly plantain
Poa pratensis	POPR	Kentucky bluegrass
Polygonum puncatatum	POPU	smartweed
Portulaca oleracea	POOL	Purslane
Prunella vulgaris	PRVU	“self-heal mint”
Puccinellia airoides	PUAI	Nuttall’s alkali grass
Ranunculus sceleratus	RASC	Cursed butter-cup
Ratibida tagetes	RATA	Mexican hat
Rumex crispus	RUCR	Dock
Salsola kali	SAKA	Russian thistle
Schoenoplectus tabernaemontani	SCTA	bullrush
Sporobolis aeroides	SPAI	Alkali sacaton
Sporobolus contractus	SPCO	Spike dropseed
Taraxacum officinale	TAOF	dandelion
Thelesperma subnudum	THSU	cota
Thermopsis Montana	THMO	goldenpea
Tragopogon dubius	TRDU	salsify
Typha latifolia	TYLA	cattail
Unknown		parsley
Vicia americana	VIAM	American vetch
Vulpia octoflora	VUOC	fescue

Species missing from Cebolla Wetland, Cebollita Spring Visit

One particular interest of this project is to identify which plant or animal species are missing due to the erosion and manipulation of the Cebolla Spring. A visit was taken with Steve Fischer of the BLM to Cebollita Spring, which is about 12 miles north on BLM and Acoma Pueblo land. Cebollita Spring was much larger, with a stronger flow of many cubic feet per second. This flow spilled down a mountainside for thousands of feet, a much different situation than Cebolla Spring, which is in a flat valley.

One notable Carex species was Carex pellita, wooly sedge. This species is mesic, and occupies the habitat taken up by Kentucky bluegrass on the edge of Cebolla Spring. Large areas of Carex pellita make up acres at Cebollita.

In terms of shrub species, there were a large number of barberry (Berberis fendleri), a clonal species that creates clumps of many square yards. This species was growing together with wild rose (Rosa woodsii) on the edge of the Cebollita Spring.

Transplanting these two species may have large ecological effects. Wooly sedge should colonize a large area of habitat that is now being colonized slowly by Kentucky blugrass, Western Wheat, and other mesic species. Planting this species near the Cebolla Spring will allow it to be spread downstream by flooding.

The barberry should be introduced into alluvial fans, where it will capture sediment and cause the fan to aggrade. This landform/vegetation combination has been seen before in Cuba, NM, on sandstone derived soils like Cebolla Canyon.

Vigorous Sedges:
There were no vigorous sedges at either Cebolla, Little Cebolla, or Cebollita Spring. A species such as Carex nebraskensis or Carex aquatilis would be able to colonize deeper water habitats now occupied by bulrush or cattails and provide forage and another habitat component.

Wooly Sedge (Carex pellita)

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