WETLANDS ACTION PLAN
for the
GALISTEO WATERSHED

U.S. EPA Cooperative Agreement CD# 976733-01-0(FY2004)
"Planning for Wetlands in the Galisteo Watershed"
And Addendum "Galisteo Pilot Project"

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Surface Water Quality Bureau
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And
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In partnership with
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Santo Domingo Pueblo
US Department of Army, Corps of Engineers
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Executive Summary

In 2003, the NMED Surface Water Quality Bureau (SWQB) Wetlands Program began the development of a wetland restoration program (Wetlands Action Plan Program), which is part of a larger mission to improve and protect the state's watersheds/water quality. Through the CWA Section 319(h) Program, SWQB provides funding for the organization of watershed groups (federal, state and local agencies, non-governmental organizations, and the public including private landowners formed to manage public watersheds) and a planning process (Watershed Implementation Plans) to reduce the total maximum daily loads (TMDL) of pollutants in their watersheds.

The SWQB Wetlands Program provides incentives and support to these existing watershed groups to develop Wetland Action Plans as an addendum to their watershed plans that delineate goals for protection and restoration of wetlands and riparian areas within these same watersheds.

As a demonstration, this Wetlands Action Plan for the Galisteo Watershed, located in central New Mexico was developed. In the Galisteo Watershed, leadership in watershed planning is provided by Earth Works Institute, a non-profit organization dedicated to watershed planning and protection, our primary partner in this Galisteo Wetlands Action Plan, and also principal author of the Galisteo Watershed Restoration Action Strategy produced in 2005 (Earth Works Institute, 2005). The process of developing this Wetlands Action Plan included incorporating wetland issues into the 2005 Galisteo Watershed Restoration Action Strategy document and into the work of the Galisteo Watershed Partnership (GWP). Subsequently, the SWQB Wetlands Program and Earth Works Institute (EWI) established a wetlands steering committee for the Galisteo Watershed under the auspices of the GWP, and helped review and incorporate other community planning initiatives for areas in the watershed that were identified as having wetlands potential. The plan also identifies potential wetland restoration projects, a list of priorities and timeline for implementation.

We have targeted community planning initiatives as the strategic partnerships that will help mainstream wetlands restoration and protection as part of the normal activities in the watershed. These initiatives include Santa Fe County's current planning initiatives for the area, identification of areas of Significant Conservation Value as part of "Green Infrastructure" planning for the Galisteo Watershed (Galisteo Watershed Conservation Initiative), efforts related to tamarisk and other non-native invasive species management, a plan for 24 archeological areas developed by BLM based on recent Federal Legislation, the statewide network New Mexico Wildways, and inclusion in the USFWS Partners for Fish and Wildlife Upper Rio Grande priority area among others. The Wetlands Action Plan takes advantage of the opportunity to coordinate wetland restoration with these planning initiatives as steps to establish a long-term, watershed- wide wetlands restoration and protection program. Included in this planning effort is a strategy to track wetlands gains and losses, documentation of existing on-the-ground restoration of wetlands and a plan for monitoring and adaptive management.

Figure 1. Residents, agency representatives, and conservation organizations have formed a collaborative team to discuss the design for the restoration of riverine wetlands in the Village of Galisteo.

The Galisteo Wetlands Action Plan is a watershed approach to wetlands protection and restoration. Strategic partnerships lie at the heart of the strategy that works in the Galisteo Watershed.

1. INTRODUCTION

The Galisteo Watershed is a 730-square mile sedimentary basin, located just south of Santa Fe, New Mexico (Figure 2). The Galisteo Watershed is named after the Galisteo Creek, which begins its course on the flanks of Thompson Peak and Glorieta Baldy. These peaks form the southernmost reach of the Sangre de Cristo Mountains, officially the southernmost mountain range of the Rocky Mountains. Other headwater creeks include Grasshopper Canyon, Deer and Apache Canyon Creeks. Each mountain creek valley is about eight miles long, and elevation differences between headwaters at Thompson Peak (10,533 ft) and Glorieta Baldy (10,199 ft) and their confluence at Cañoncito (6,937 ft) are significant.

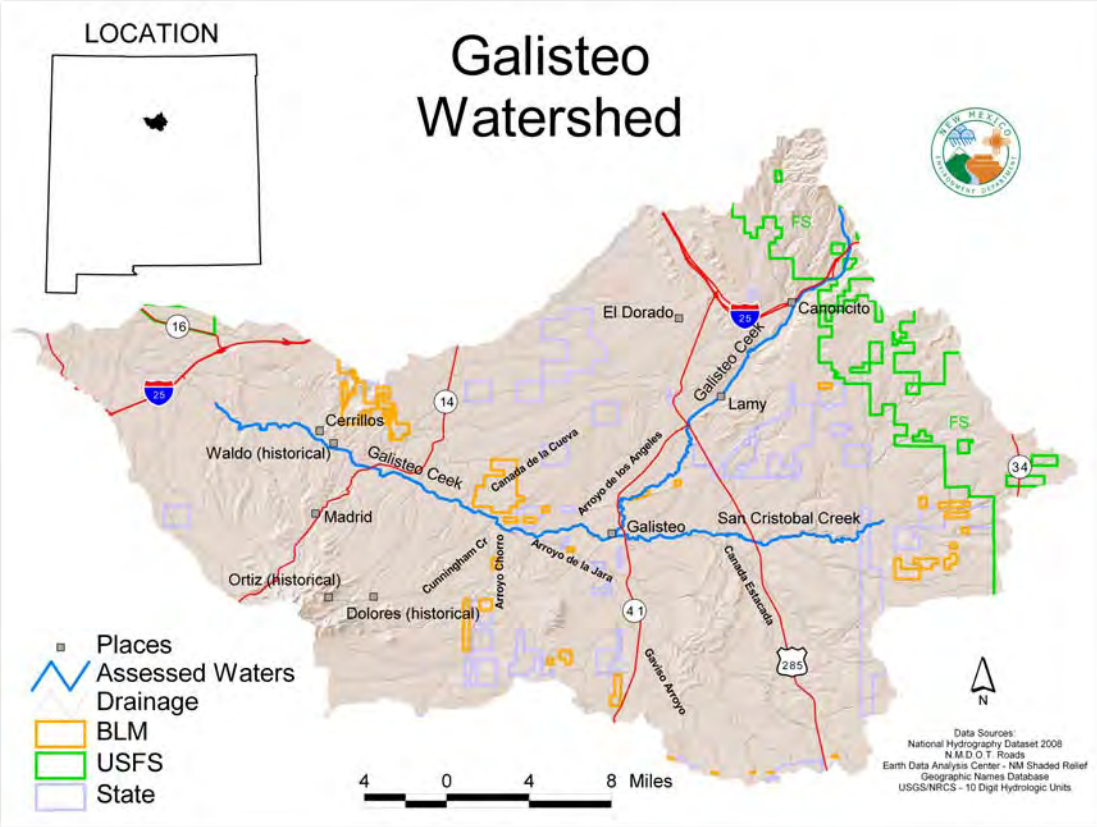

Figure 2. Galisteo Watershed with major perennial drainages, Galisteo Creek water quality assessment reaches, land ownership and geographical features shown.

These headwater creeks merge at upper Cañoncito to form the main stem of the Galisteo Creek, which has a channel grade of 2% or less. Elevation differences over the remaining part of the Galisteo Creek (approximately 46 river miles and 38 valley miles) are relatively small ending at the confluence with the Rio Grande at 5,180 feet (Earth Works Institute, 2005).

1.a Purpose and Need

In the past few decades, the landscape of the Galisteo Watershed has gradually been fragmented as a result of property division, highway and railway construction, and the

gradual conversion of farms and ranches into residential areas. Fragmentation leads to hydro-modification of water courses, isolation of wildlife, and a reduction of minimally disturbed, contiguous habitat, eventually jeopardizing biodiversity and species survival. It is estimated that the Galisteo Watershed has gradually lost approximately 4,000 acres of wetlands due to land degradation and land use conversion. Of the original 5,000 acres of wetlands (1% of land area) in the 1700s, approximately 1,000 acres remain (0.2% of land area).

Past land use and ongoing urban development have led to accelerated storm water runoff and a flow regime of concentrated peak flows in the Galisteo Creek and its tributaries. As a result, soil erosion and sediment accumulation in the stream and the Galisteo reservoir have increased, while adjacent wetland and riparian ecosystems have been compromised. In many locations, tributaries start as steep headcuts and have carved deep gullies that dewater the landscape. The Galisteo Creek is in most locations 10-25 feet incised below the historic floodplain. Riparian floodplain zones with native cottonwood and willow groves have dwindled, while exotic Russian olive and saltcedar have aggressively invaded the riparian habitat (Figure 3). In many places, originally moist flood plains, productive alluvial fans, springs, wetlands and wet meadows have dried up and made place for degraded, dry sediment flats.

Figure 3. Galisteo Creek wetland in the Village of Galisteo (2004). Overhanging vegetation is primarily exotic Russian olive trees. Project activities have led to the removal of this exotic vegetation and the natural regrowth of willows.

Planning for the restoration and protection of wetlands and riparian areas, river corridors, springs and seeps of the Galisteo Watershed are critical to reverse the gradual degradation and loss of wetland ecosystems and their important landscape functions; to address the impacts of gradual fragmentation of landscapes resulting from (ex)urban development, oil, gas and mineral extraction, and construction of transportation lines (highways and railways (Figure 4)); and to guide future development activities that minimize encroachments, impacts and losses of water resources and wildlife habitat in the Galisteo Watershed and its receiving waters of the Rio Grande.

Figure 4. Aerial photograph of Galisteo Creek in the central part of the Galisteo Watershed. The photo shows riparian vegetation patterns that originate from levees constructed by the US Army Corps of Engineers between the 1930s and the 1950s to divert the Galisteo Creek away from the railroad tracks (top of photo). Induced meandering restoration techniques were used to recover stream hydrology, and restore overbank flooding and floodplain function within the confines created by locating railroad tracks adjacent to Galisteo Creek. All land shown in the picture is privately owned.

1.b Wetlands Action Plan Process

The Galisteo Watershed "Wetlands Action Plan" (WAP) is a planning document designed specifically to consider wetland resources within the boundaries of the Galisteo Watershed. Wetlands and riparian areas have ecological, economic, and aesthetic value and serve many vital functions including water purification and storage, and erosion reduction. Riverine wetlands and riparian vegetation store storm water runoff, increasing the duration of stream base flows, reducing flood hazard and peak flows, stabilizing

stream banks, thus reducing erosion, and improving wildlife and fish habitat and overall ecological conditions (Figures 4 and 5). Depressional wetlands store water and contribute to groundwater recharge and provide food and habitat for wildlife (Figure 6).

Figure 5. Typical riverine wetland habitat of the Galisteo Creek mainstem. Note the main channel has been incised and steep erodible banks are exposed.

This WAP provides guidance for protecting and restoring wetlands with an emphasis on water quality benefits and ecological integrity, preserving wildlife corridors, and conserving habitats 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 in the Galisteo Watershed. It can also provide a model for other watersheds and communities because much of this plan is based on findings and lessons learned during the process of restoring and protecting stream corridors, wetlands and riparian areas in the Galisteo Watershed over the past 20 years.

Figure 6. The Galisteo Watershed topography is rarely level because of the complex geology of the area. However, the San Cristobal Playa is present near the center of the Galisteo Basin and in wet winters provides important migratory waterfowl habitat along the Central Flyway.

The Galisteo WAP includes descriptive landscape background information and available information for three major planning components (listed below). These planning components help ensure that watershed planning and any other local planning activities adequately address wetland management issues. Not all information is presently available and part of the planning process and future actions is to fill information gaps. The development and refinement of the Galisteo Watershed WAP will be an ongoing process.

1. Resource Analysis

- Inventory of existing wetlands resources in the watershed, GIS coverage
- Classification of local wetland types
- Wetland functions and ecosystem services
- Baseline assessment of wetland condition
- Location of wetland reference sites
- Identification of threats and impairments (stressors) to local wetlands
- Identification of wetland values and ecosystem markets

2. Resource Management

- Prioritization of sites with potential for restoration of ecological integrity
- Development of measures to protect wetlands
- Development of measures to reduce chronic and cumulative impacts to wetlands
- List of proposed projects to protect and restore wetlands

- Strategizing financing options
- Monitoring component to measure success of implemented projects
- Tracking component to track wetlands gains and losses

3. Local, Public Involvement Strategy

- Technical tools for reaching the public
- Informational programs focusing on wetlands
- Steering Committee and partnerships
- Identification, organization and mobilization of volunteers
- Identification of grant writers and tracking of funding opportunities

This Wetlands Action Plan will become an addendum to the 2005 Galisteo Watershed Restoration Action Strategy (WRAS). The Galisteo Watershed WRAS is a watershed based plan for the development and implementation of actions that abate non-point source water quality impairments. The Galisteo WRAS considers specific surface water quality problems; identifies sources of contamination causing those problems; and includes a schedule of holistic actions that improve watershed conditions and remove or abate non-point sources of water pollution. A WRAS is a non-regulatory, voluntary approach to perform these actions. Over the course of years, we have found that while restoration measures to address water quality also affected associated wetlands and riparian resources, these resources were not the focus of restoration measures, have not been measured for gains or losses, nor were improvements to associated wetlands in the watershed specifically tracked. In addition, in many cases restoration measures that also improved wetlands were not evaluated on that basis. The SWQB Wetlands Program is providing guidance to facilitate watershed groups throughout the State to develop "Wetlands Action Plans" as an additional component of their WRAS in order to more specifically focus on wetland and riparian resource protection, restoration and monitoring as part of comprehensive and holistic watershed-wide planning.

2. THE GALISTEO WATERSHED

The following section provides available background information for the evaluation of wetland resources in the Galisteo Watershed.

2.a Geology

The Galisteo Watershed is situated within the Galisteo Basin, a sub-basin of the Espanola Basin. The Galisteo Basin is part of a series of basins along the Rio Grande Rift which is divided into basins by faults (Bauer et al. 1995). In places, the basins are filled with thousands of feet of sediment eroded from surrounding mountains and land masses that existed millions of years ago and captured by a vast inland sea that stretched from the Arctic to the Gulf of Mexico (Martin 2008). However, the geology of the Galisteo Basin is further complicated by tectonic activity (folding, faulting, and volcanic and seismic activity) that occurred during the Laramide Orogeny (Figure 7).

The Galisteo watershed's surface geology largely consists of sedimentary colluvium and alluvium dating from the late Cretaceous and Tertiary era. Geologic sediments in the area are collectively referred to as the Santa Fe group. Tertiary volcanic intrusions have left clearly visible cones and volcanic dykes throughout the landscape, while intrusive activity has created tilted sandstone layers and rock sills that crisscross the drainage system (Figure 8) and that are responsible for creating many of the seeps and springs found in the watershed. Elevations of the watershed range from over 10,000 feet at the headwaters of Galisteo Creek on Thompson Peak in the southern part of the Rocky Mountains, to approximately 5,000 feet at the confluence with the Rio Grande at Santo Domingo Pueblo. The Galisteo Creek runs in the center of the watershed's valley bottom and supports significant areas of riparian and wetland habitat.

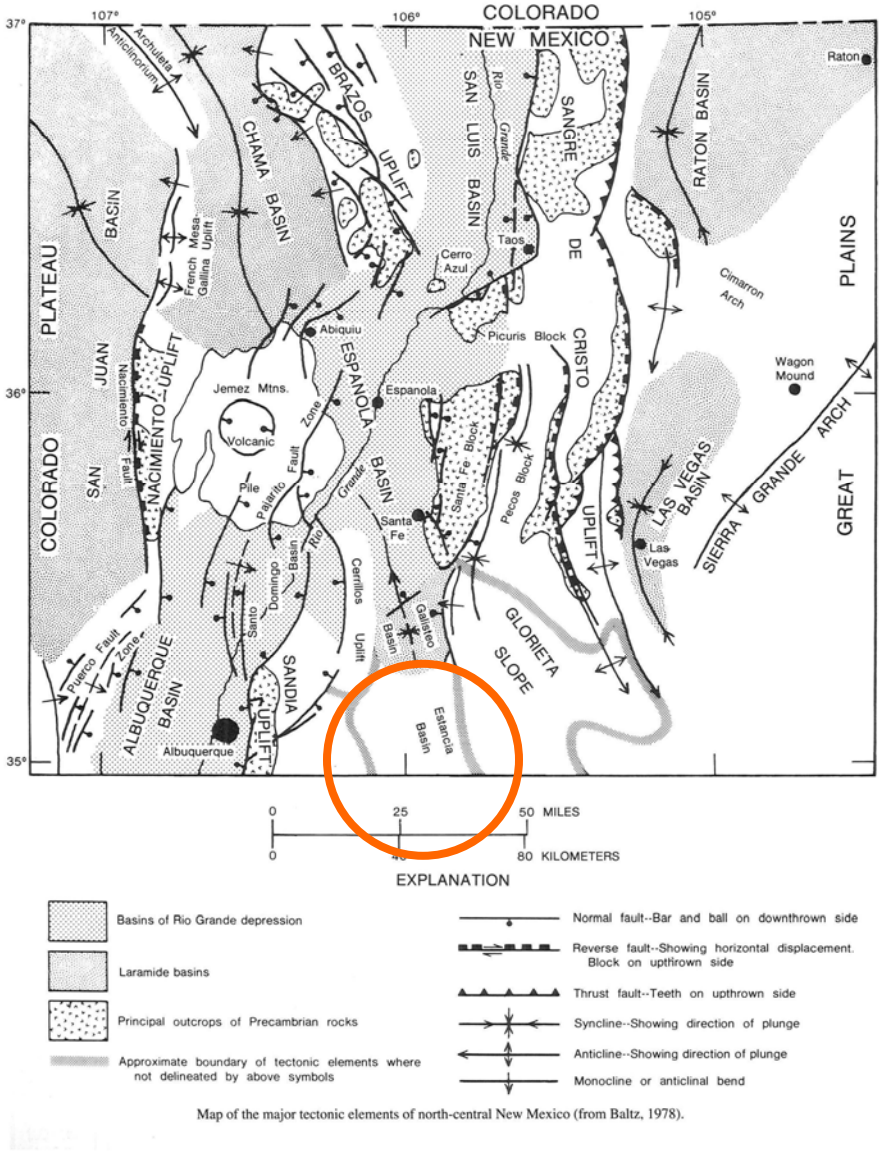

Figure 7. North-Central New Mexico tectonic schematic showing the position of the Galisteo Basin among major tectonic elements (Bauer et al. 1995).

Figure 8. Rock sill diverts the flow of the Arroyo de los Angeles.

2.b Climate

Hot, dry summers and clear, crisp winters are the consequence of the semiarid continental climate that encompasses the Galisteo Watershed (USACE 2006). Information on temperature from the nearest weather station at Cochiti Lake shows an average temperature of 20-30 F at night and 30-50 F during the day in the winter, and 30-60 F at night during the summer and 60-100 F during the daytime summer hours. Because of predominately clear weather, there is considerable daytime warming during the winter, although the nights are usually cold and the temperature often falls below freezing. Cold weather periods are usually brief and are accompanied by brilliant sunshine and low humidity. Consequently during the winter, snowfall melts soon after snow events and except in the high mountains does not have a chance to accumulate. During the summer monsoon season, thunderstorms are generally brief and isolated providing uneven precipitation across the watershed (Figure 9).

Figure 9. Typical summer monsoon isolated thundershower over the Galisteo Watershed.

Average annual precipitation from 1961-1990 for the area shows an average of 10-14 inches per year (USDA NRCS 1998). However, the average annual evaporation rate for the area is about 50 inches per year (Williams 1986). Warm temperatures, moderate winds, large daily solar radiation, and dry air contribute to evaporation rates and conditions that limit infiltration and recharge of stream flow. There can be great variation in annual precipitation due to thunderstorm activity generally occurring during the summer months. Snowfall in the area also varies between the northern and southern boundaries of the watershed due to differences in elevation. The average annual humidity is approximately 43 percent.

2.c Surface Hydrology

The predominant wetland hydrology in the Galisteo Watershed is associated with perennial, intermittent and ephemeral reaches of the Galisteo drainage network. Other hydrologic contributors are seeps and springs and precipitation-fed, depressional wetlands.

Galisteo Creek is predominantly an ephemeral stream. Most of the stream flow is produced by runoff resulting from thunderstorm activity and is characterized by high peaks and relatively small volumes (USACE 2006). Thunderstorm activity, most prevalent during July and August, produces about 70 percent of the annual runoff (Figure 10). Runoff from snowmelt is less significant but important for the Galisteo Watershed. Although measurements have not been taken, observations show that in some years, snowmelt runoff from February through June help saturate the alluvium in the upper and

middle portion of the watershed and in some years the Galisteo flows all the way to the Rio Grande for short periods. The period from April through June is generally dry and produces less than 10 percent of the annual runoff from precipitation events (USACE 2006). Additional flow in the Galisteo Creek is contributed by the permanent springs and seeps (except in very dry years) that occur in various locations along the drainage due to the complex geology of the area.

Figure 10. The lower end of Galisteo Creek flows through Santo Domingo Pueblo. This ephemeral portion of Galisteo Creek is shown flowing here after a summer rainfall event in the upper watershed. This area was previously cleared of exotic Russian olive and is now fenced from grazing as a measure to restore wetlands and the riparian area.

Galisteo Creek flows in a canyon from its headwaters to the community of Cañoncito and then flows along the western edges of the tablelands of Glorieta Mesa to the central grasslands and alluvial bottomlands of the Galisteo Basin. There are major arroyos that merge into Galisteo Creek due to a tributary pattern caused by steep slopes. These include the San Cristobal Creek, Arroyo de los Angeles, Arroyo de la Jara, Arroyo Chorro. Other tributaries to the Galisteo Creek include Cañada Estacada, Gavisco Arroyo, Cañada de la Cueva and Cunningham Creek as well as other un-named drainages (Figure 2). Additionally, there are many areas in the watershed with a high density of springs and small, associated wetlands.

Few internally draining depressional wetlands occur within the Galisteo Watershed. The most prominent example is the playa wetland located on the San Cristobal Ranch south of the town of Galisteo (Figure 6). These playas are ephemeral wetlands that fill during the summer thunderstorm season and support a variety of waterfowl and wildlife.

2.d Water Quality

Technically, Galisteo Creek (perennial reaches above Santo Domingo Boundary) is still included in Water Quality Standards segment 20.6.4.121 NMAC which is classified as a high quality coldwater fishery. It is currently listed for temperature and specific conductance exceedences (2010-2012 State of New Mexico CWA§303(d)/§305(b) Integrated List & Report). Galisteo Creek was previously listed for stream bottom deposits. This assessment unit was intensively sampled as part of the Upper Rio Grande II survey in 2001. Galisteo Creek at the town of Galisteo (59% fines) was used as a reference to determine potential stream bottom deposit impairment. Galisteo Creek at Cerrillos had 76% fines and the benthic macroinvertibrate populations were non-impaired. Therefore, stream bottom deposits were removed as a cause of non-support. The specific conductance criterion of 300 umhos was exceeded in 14 of 14 measurements and is included as a cause of non-support. Five of 14 instantaneous temperature readings taken during site visits were greater than 20 degrees C. A thermograph was deployed at Galisteo Creek at Galisteo summer 2003. The temperature exceeded 23 degrees C and exceeded 20 degrees C for greater than four hours. Therefore, temperature is included as a cause of non-support. In 2002 it was determined from SWQB fish surveys that the Galisteo Creek Assessment Unit does not contain a coldwater fishery and is misclassified as a High Quality Cold Water Fishery according to fisheries data. Presently a Use Attainment Analysis is under preparation at SWQB instead of a TMDL to determine the appropriate classification for the assessment unit.

2.e Vegetation Communities

The University of New Mexico, Natural Heritage New Mexico Program conducted an inventory of wetlands/riparian resources and vegetation communities within the Galisteo Watershed in 2009 (Milford et al. 2009) This study primarily used GIS techniques supported by ground-truthing and includes all but the far northeast corner of the study area which is not covered by color-infrared photography. In addition to the location of wetland resources, dominant vegetation was described and high-quality wetland sites were identified. They recognized 7 wetland communities based on vegetation that include Closed Woodland, Open Woodland, Sparse Woodland with Shrubs, Sparse Woodland with Grasses, Shrubland, Herbaceous Wetland, and Herbaceous. These are principally distinguished by percent canopy cover of trees relative to total vegetative cover. Shrublands comprise the greatest amount of area delineated (416 ha); while Herbaceous Wetland had the least (12 ha). Much of the Shrubland community is dominated by salt cedar, with lesser amounts of coyote willow and minor amounts of rubber rabbitbrush (*Ericameria nauseosa*) (Figure 11). Herbaceous Wetlands often occur near impoundments or, in rare cases, as seeps such as within the Cerrillos Hills Historic Park outside of the town of Cerrillos (Figure 12).

Figure 11. Dense tamarisk shrubland occupies perennial reaches and wetlands of Cañoncito Arroyo. Photo taken before restoration activities in 2009.

Exotics dominate the mapped riparian and wetland areas. Exotic-dominated stands comprise approximately 57% of the total vegetative cover with mixed and native at 29% and 13%, respectively. Salt cedar-dominated stands are the most common exotic type, comprising 81% of the total exotic-dominated area, followed by Russian olive-dominated stands at 19%. Less than 1% of the exotic-dominant area is categorized as Herbaceous Exotic. Among native-dominated stands, cottonwood was the most common dominant, comprising 50% of the total native area. Less commonly dominant were Herbaceous (35%), Coyote Willow (8%), and Herbaceous Wetland (7%) (Figure 13). More information is included in the report (Appendix A).

Figure 12. Devel's Throne Arroyo at Cerrillos Hills Historic Park. Seep supports wetland herbaceous vegetation.

In 2006, an assessment of priority wetlands was undertaken by Earth Works Institute, (Vrooman 2006) as part of this planning process. Wetland plants were identified as part of the assessment of each site and plant species lists are available for several locations in that report (Appendix B).

Figure 13. Herbaceous Wetland vegetation community supported by spring on Thornton Ranch

2.f Wildlife Habitat

The Galisteo Watershed is an important ecological transition zone, because it straddles four of eight ecoregions in New Mexico: the Southern Rockies to the north, the New Mexico/Arizona Mountains to the south, the Arizona/New Mexico Plateau (including the Rio Grande corridor) to the west, and the Southwestern Tablelands to the east (Griffith et al. 2006). As an ecological transition zone, the Galisteo Watershed constitutes a landscape-wide wildlife corridor across the "spine of the continent," as described in the Southern Rockies Wildlands Network Vision (Miller et al. 2003) to the north with the New Mexico Highlands Vision to the south. The Galisteo Creek and its tributaries serve as one of the most important functional wildlife pathways between the ecoregions and as part of a large wildlife migration network between the Southern Rocky Mountains to the north and the New Mexico Mountains to the south. Additionally, wetlands in the Galisteo Watershed constitute a series of stepping stones for migratory water fowl in an alternative eastern flyway route parallel to the Rio Grande corridor. The Galisteo Creek includes several sections of permanent flow. In several permanent and seasonal flow reaches, the Galisteo Creek is habitat to Flathead chub and various kinds of amphibians.

Appendix C lists plant and animal species that are federally endangered, threatened and species of concern. These species are listed by county for each of the counties that are part of the Galisteo Watershed. Of the listed threatened and endangered species, only one - the black footed ferret - may not have a survival or habitat connection during its lifetime

to wetlands and riparian areas typified in the Galisteo Watershed.

2.g Occupational History

The Galisteo Watershed has a rich and complexly layered history of human population. Research indicates that people may have lived in the Galisteo Watershed as early as 14,000 B.P. The first confirmable population living along the Galisteo Creek was the Clovis Culture around 10,500 B.P. Archaeological and historical research data show that during the last 10 millennia the Galisteo Watershed has been a land of many wandering people. The watershed's historical timeline shows that people have often been attracted to the area by some luring promise. Perhaps it was the promise of big game, fertile floodplains and pastures, turquoise and lead, gold or coal, and of beautiful vistas and the proximity of mountains and the river delta that drew people to the Galisteo Watershed. Paradoxically, however, highly variable water resources, disease, and conflicts of various kinds may have been major reasons for the historical down-turns in the watershed's populations.

In the 1300s, about 18 permanent Puebloan settlements with hundreds of homes each gave shelter to as many as 10,000-20,000 people throughout the watershed. This population dwindled to only a few thousand after the Pueblo revolt in 1680. Spanish settlement continued throughout the 1700's. These settlements lead to the discovery of gold in 1821, in Cerrillos and Madrid. By 1840 an estimated 10% of the State's population resided in the Ortiz Mountains, the country's first Gold Rush site in history. Madrid and Cerrillos boomed, attracting thousands of people from around the world looking to make a fortune in gold. The population grew to around 30,000 during the height of the mining days in the mid and late 1800s, with high population concentrations in the Madrid and Cerrillos area. This population was decimated to nearly 3,000 by the 1930s (Earth Works Institute, 2005).

Based on population projections for the Galisteo Watershed, the County Planning Director estimated that the watershed population in 2004 was about 17,000 people spread over about 8,000 households, comprising portions of Santa Fe County and Sandoval and San Miguel Counties.

2.h Land Use

Approximately 69% of the land area in the watershed is privately owned. The San Cristobal Ranch of 81,000 acres is the largest ranch in the watershed, located in the southeastern part of the watershed (17% of the land area of the watershed). Other ranches vary in size from ten-thousands of acres to a few hundred acres.

More than 30% of the land in the watershed is managed by county, state and federal agencies for purposes of public resource management (Figure 2).

- The headwaters of the Galisteo Creek are primarily located on public land managed by the USDA Forest Service (Pecos-Las Vegas Ranger District of the Santa Fe National Forest), and include headwater wetlands, streamside wetlands and springs.
- The Bureau of Land Management (BLM) manages scattered tracts of land

throughout the watershed. The BLM lands are leased to ranches for grazing purposes and are managed for archaeological and open space values. Many archaeological sites are located near springs and seeps, some of which still flow.

- The New Mexico State Land Office owns scattered tracts of lands and mineral rights held in trust, the proceeds of which are used to support the State's infrastructure of roads and public schools.
- The U.S. Army Corps of Engineers (USACE) manages an area of approximately 4.5 square miles around the Galisteo Reservoir for sediment and flood control. This area includes several natural wetlands and wetlands created by the reservoir infrastructure.
- The Bureau of Indian Affairs (BIA) on behalf of the Kiwa (formerly known as Santa Domingo) Tribe manages about 30 square miles in the western part of the watershed, which include lower Galisteo Creek and some unique and exceptional wetlands owing to the complex geology of the area.
- The U.S. National Park Service (NPS) Pecos National Monument manages about 50 acres of land as part of the historic Glorieta Battle Field in Lower Cañoncito, just south of I-25 along Galisteo Creek.
- Santa Fe County owns approximately 6,000 acres of land in five locations as well as a trail along the Santa Fe Southern Railroad tracks for open space conservation and public trail access. Many of the Santa Fe County Open Space sites include wetlands, seeps, springs, riparian areas and buffer.
- The New Mexico State Parks Division manages the Cerrillos Hills State Park (under Santa Fe County Open Space ownership), which includes at least six small springs and wetlands.
- Santa Fe County manages a trail system through several BLM and State Trust Land areas in association with the Thornton Ranch County Open Space Area. These BLM, State and County lands include several small wetlands.

Land use in the watershed also includes (1) residential use in traditional communities, sub-divisions, scattered ranchettes, and individual home sites, (2) small businesses in the arts, hospitality, outdoor recreation, and film production sectors, (3) low-intensity ranching and farming, (4) small scale mining and quarrying, and (5) mine restoration sites. Urban and ex-urban development is concentrated north of Galisteo Creek. In particular, the San Marcos and Gallinas sub-watersheds, covering an area of about 80 square miles, are largely built up in a mosaic of small subdivisions, surrounded by open grassland. Private organizations hold more than 6,000 acres in land under some form of protective easement, such as conservation easements and easements related to archaeological protection.

3. RESOURCE ANALYSIS

3.a Galisteo Watershed Wetlands

Wetlands. Wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Environmental Laboratory, 1987). Wetlands should have one or more of the following attributes: (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The upland limit of a wetland is the boundary between land that supports predominantly hydrophytic cover, soil types that are predominantly hydric, and evidence of hydrology that supports wetlands and land with predominantly mesophytic or xerophytic cover, soil that is non-hydric and land that is not saturated or flooded 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.

Riparian Areas Riparian areas are also included as part of the analysis of wetland areas. Riparian ecosystems are characterized by phreatophytic and mesophytic vegetation and habitats associated with bodies of water and dependent on existence of perennial, intermittent or ephemeral surface and subsurface drainage. The strict water requirements of wetlands are not as drastic in riparian areas. However, they occupy the same areas of the landscape, may contribute to the same functions within the landscape, and are interdependent, and, therefore, are considered together during the assessment phase of the Wetlands Action Plan development.

Buffers For purposes of long-term protection of wetlands, wetland assessments and Wetlands Action Plans must identify wetland buffer zones. Buffers are non-disturbance areas where natural vegetation is maintained to protect wetlands and riparian areas from the impacts of stormwater floods, pollutants, and solid waste from adjacent terrain (Kusler, 2003).

3.b Inventory of Wetland Resources

In New Mexico, many areas and their associated wetlands have not been mapped by the National Wetlands Inventory. Currently National Wetlands Inventory (NWI) digital vector data is not available for the Galisteo Watershed, and 1:100,000-scale scanned (not-geo-referenced) NWI maps 1980's era data do not exist. However a preliminary GIS-based infiltration and runoff model for the Galisteo watershed was developed in 2004 (Earth Works Institute and Santa Fe Conservation Trust, 2007) (Figure 14). This model provided a preliminary estimate of the location of streamside wetlands and riparian resources. However not all wetlands locations are included because of the scale at which

mapping was conducted. The 2009 wetlands study by Natural Heritage New Mexico (Milford et al. 2009) produced a preliminary map of wetlands and riparian areas and mapped broad vegetation communities (Figure 15) (Appendix A). This map and the infiltration/runoff model can provide the basis of a future study to complete mapping of wetlands and riparian resources in the Galisteo Watershed.

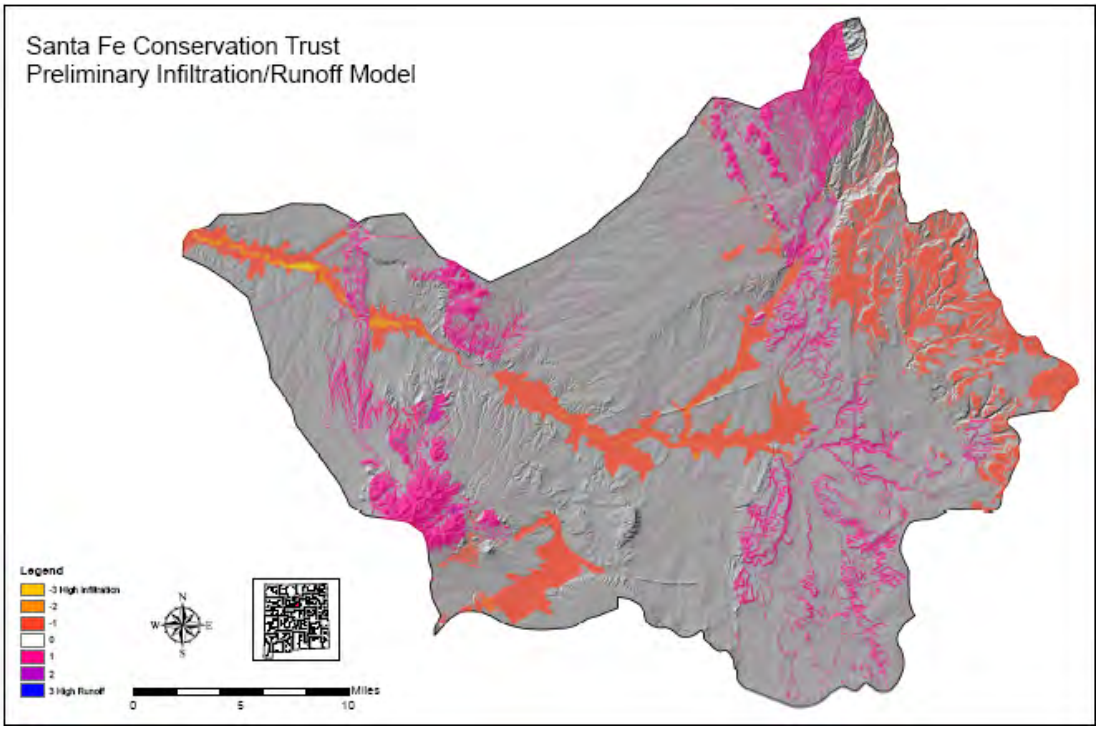

Figure 14. Preliminary Infiltration/Runoff Model. This model was used to produce a Green Infrastructure Plan for the Galisteo Watershed that identified priority areas for conservation, such as wetlands (Earth Works Institute and Santa Fe Conservation Trust 2007).

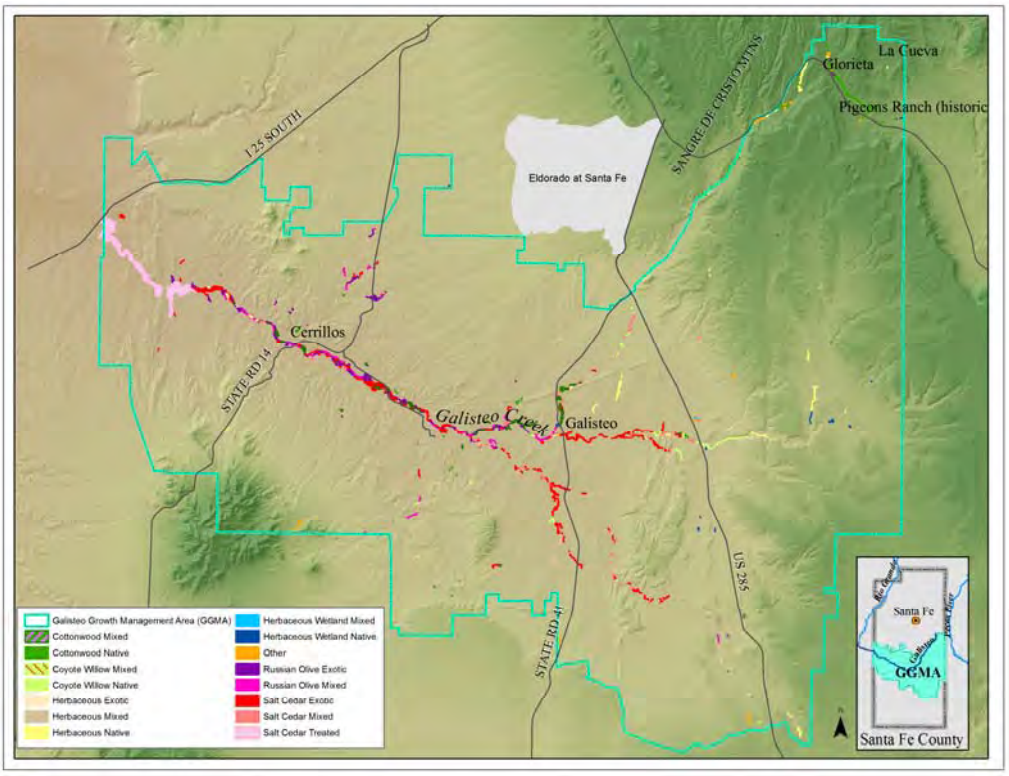

Figure 15. Map of wetland/riparian vegetation communities in the Galisteo Watershed (Milford et al. 2009).

3.c Classification of Local Wetland Types

The SWQB Wetlands Program uses Brinson's Hydrogeomorphic (HGM) wetland classification (Brinson 1993) for the Wetlands Action Plan process. The HGM classification is based on three fundamental factors that influence how wetlands function, including geomorphic setting, water source, and hydrodynamics. At the highest level of hydrogeomorphic classification, wetlands are grouped into hydrogeomorphic wetland classes. Six hydrogeomorphic classes including depression, lacustrine fringe, slope, riverine, mineral flat, and organic flat occur in New Mexico. Four classes are represented in the Galisteo Watershed.

- Depressional wetlands occur in topographic depressions that allow accumulation of surface water (San Cristobal Playa) (Figure 6). On a topographic map these wetlands would occur within a closed elevation contour. Dominant sources of water are precipitation, groundwater discharge, and interflow from adjacent uplands.
- Lacustrine fringe wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. There are no natural lakes in the Galisteo Watershed. Finger Lakes are man-made ponds that support adjacent wetlands (Vrooman 2006).
- Slope wetlands normally are found where there is a discharge of groundwater to the land surface (Figure 16). They normally occur on sloping land; elevation gradients may range from steep hillsides to slight slopes. Hydrodynamics are dominated by downslope unidirectional water flow. Slope

wetlands can occur in nearly flat landscapes if groundwater discharge is a dominant source to the wetland surface. Headwater wetlands and cienegas are examples of slope wetlands. Flowing seeps and springs that support wetland vegetation are also included in this broad class of wetlands.

Figure 16. Slope wetlands in Upper Apache Canyon drainage.

➢ Riverine wetlands occur in floodplains and riparian corridors in association with stream channels, (Figure 17) and are the most common wetland class in the Galisteo Watershed. Dominant water sources are overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. Perennial flow is not required (Numerous examples are located along Galisteo Creek).

Figure 17. Riverine wetlands along the upper reaches of Galisteo Creek.

- Mineral soil flats are most common on interfluves, extensive relic lake bottoms, or large floodplain terraces where the main source of water is precipitation. Organic soil flats differ from mineral soil flats, in part, because their elevation and topography are controlled by vertical accretion of organic matter. They occur commonly on flat interfluves, but may also be located where depressions have become filled with peat to form a relatively large flat surface. Water source is dominated by precipitation. Neither mineral soil flats nor organic soil flats have been recognized in the Galisteo Watershed.

In addition, there are examples throughout the watershed of human-made wetlands. In some areas, these artificially induced wetlands replace, impair or compromise the natural hydrologic regime and associated water and wetland resources. Although these wetlands are the result of anthropogenic activities such as water pumping, impoundment and diversions, they still provide valuable ecological services in an overall arid environment. Examples include wetlands developed or expanded as a result of anthropogenic activities, such as dams, levees, irrigation ditches (acequias), cattle tanks, and mill sites (e.g. Finger Lakes, Galisteo Dam/Reservoir, Arroyo Salado at Beneficial Farm, Galisteo Creek on Cerro Pelon Ranch).

A map showing the classification of all wetlands in the Galisteo Watershed is not available. A classification map would help guide restoration efforts to restore natural wetland attributes to that of the appropriate wetland class.

3.d Wetland Functions and Ecosystem Services

Wetlands can exhibit great variability in terms of their structural characteristics and processes (Mitch and Gosselink 2007). The objective of classification is to identify groups of wetlands that are relatively homogeneous in terms of structure, process, and ultimately function (Smith et al. 1995). Scientific investigations have shown that wetlands unquestionably perform important environmental functions (Mitch et al 2007) and that different types of wetlands perform different functions or the same functions to various degrees (Johnson 2005). Wetland functions are defined as a process or processes that take place in a wetland (Novitski 1993). Ecosystem functions are processes that are necessary for the self-maintenance of an ecosystem. In a wetland, these functions maintain and sustain the wetland and are essential to the existence of the wetland. Examples of wetland ecosystem functions are primary production, nutrient cycling and decomposition (Kleindl 2005). Wetland functions also influence adjacent ecosystems. For example, riverine wetlands can modify flooding along a river's course; or nitrogen, sulfur, methane and carbon cycles in wetlands can affect air quality. Wetlands can also exhibit variability because of climatic conditions, species composition, soil type, biogeochemistry, and other factors. However, regardless of how they are defined, wetlands within a class (or type) share most common functions.

In 2006, the "Planning for Wetlands in the Galisteo Watershed" Steering Committee conducted review of wetland functions common to classes of wetlands in the Galisteo Watershed (Appendix D). Of the many functions that wetlands provide, wetlands functions determined by the committee to be the most important in the Galisteo Watershed are the following:

Hydrologic Functions:

1) Maintenance of Runoff Volume
2) Energy Dissipation
3) Groundwater Recharge

Water Quality and Biogeochemistry Functions:

4) Sediment Retention
5) Phosphorus Retention
6) Nitrogen Removal
7) Heavy Metals and Hydrocarbon Removal
8) Carbon Cycling and Sequestration

Biological Functions:

9) Vascular Plant Production
10) Macroinvertebrate and Fish Production
11) Wildlife Habitat
12) Waterfowl Habitat
13) Biodiversity

Wetlands and wetland functions are of value to people and society. Each wetland function and/or the aggregate of functions can constitute specific values for humans. Wetland ecosystems deliver a wide range of valuable ecosystem services that contribute to human well-being. Linking ecosystem condition and function to services and human

well-being, predicting the effects of changes in ecosystem services on human well-being, and improving the identification, quantification, and communication related to functions and ecosystem services was the goal of the Steering Committee review.

3.e Baseline Assessment of Wetland Condition

In order to make informed decisions about protecting and restoring wetland acreage, quality and function, data that describes the baseline conditions at a wetland site is needed. Baseline conditions can represent a starting point in time for trend analyses (e.g., long-term successional studies or impact analysis on a group of wetlands). Baseline data increases in value if the types of data and data collection techniques are standardized and comparable among sites. In addition, goals for the data collection are developed so that the information collected can be used to evaluate parameters that lead to improved wetlands restoration and protection. Baseline assessment of wetland condition gives a starting point in which to determine whether the resource is on an upward, declining trend or if conditions are stable.

In 2006, Earth Works Institute completed an inventory and assessment of a number of wetland areas in the Galisteo Watershed (Vrooman 2006) (Appendix B). The goal of this study was to determine the restoration potential of these sites. The selection of these preliminary sites was based on access considerations. These areas include:

1) Rowe Mesa Wetlands and Springs
2) Eldorado Wilderness along CR 51
3) Arroyo de Los Angeles at the Galisteo Basin Preserve
4) Village of Galisteo down to the Junction with San Cristobal Arroyo
5) Finger Lakes and Galisteo Creek at Tingle and Barclay Ranches
6) San Marcos Arroyo and the Cerrillos Hills Historic Park
7) Galisteo Reservoir downstream to the Rio Grande

Additionally, several smaller wetlands and springs were identified and assessed in the headwaters area of the Galisteo watershed as part of this study. Subsequently, a series of isolated wetlands along the I-25 corridor between Glorieta and Cañoncito, along the Padre Springs drainage on Glorieta Mesa, on the Galisteo Basin Preserve, and isolated wetlands along Highway 14 between the “Garden of the Gods” (east of Cerrillos) and the community of Madrid have been assessed in 2007 (Appendix B).

The SWQB Wetlands Program is in the process of developing standardized rapid ecological assessment methods of wetland condition, the New Mexico Rapid Assessment Method (NMRAM) (Muldavin et al. In Press). A future goal is to use this methodology to establish reference sets and assess the overall condition of each class of wetlands in the Galisteo Watershed. In addition, presently there is no central repository of wetlands data collected in the watershed. A central repository should be formed where data can be accessed and available for potential restoration and protection activities. Additional inventory and assessment is needed to complete a baseline assessment of all wetland resources in the Galisteo Watershed.

3.f Wetlands Reference Sites

The primary reason for identifying reference standard sites is the need to compare impacted or degraded sites to a standard set of reference conditions. Reference standard sites typically refer to sites in natural or least-disturbed condition that are used to assess and compare the ecological conditions at other sites. Accurate wetland assessments require that the assessed sites be matched with appropriate reference conditions to establish credible comparisons (Hawkins et al. 2010). Reference sites can also serve as alternatives to standard experimental controls that are seldom available. They provide the assessment criteria used for site evaluations. They can be used to set design standards for mitigation plans or to provide performance criteria to measure project success.

A study to locate wetlands reference standard sites statewide was conducted in 1998 (Bradley). No wetlands reference standard sites were identified in the Galisteo Watershed during that study. Natural Heritage New Mexico identified and mapped wetland sites where native vegetation was dominant in 2009 (Milford et al. 2009). They recommended that stands designated as native dominated should receive the highest conservation priority, particularly considering that they occupy a small fraction of the wetland/riparian sites in the watershed. Additional information is needed to determine if these sites can also be considered reference standard sites for restoration of similar sites (Figure 18). Reference wetlands information should include wetland class and natural setting (context), an assessment of the overall condition of wetland hydrology, contiguous wetland area, floristic quality, buffer area and buffer condition, wildlife assemblages, habitat and use, and sustainability based on known threats and stressors.

Figure18. A potential location for identifying reference wetland conditions may exist on the Cerro Pelon Ranch, where there are extensive riverine wetlands along main stem of the Galisteo Creek and at the confluence with the San Cristobal Arroyo.

3.g. Threats to Wetlands

External and internal sources of stress contribute to the overall condition of a wetland area and its ability to perform its associated functions (Collins et al. 2003). Preserving the ecological condition of wetlands so that they can perform their critical functions plays an important role in planning certain land-uses, but also in securing public health conditions, safety and welfare. One of the most prominent threats to water resources in the Galisteo Watershed is development and subdivision of large tracts of private land, mainly ranches. In the past few decades, the landscape of the Galisteo Watershed has gradually been fragmented as a result of property division, highway and railway construction, and the gradual conversion of farms and ranches into residential areas. Fragmentation causes forms of external and internal stress resulting the decline and disappearance of wetland ecosystems. Fragmentation of the landscape leads to hydro-modification of water courses and drying of water sources, isolation of wildlife, and a reduction of minimally disturbed, contiguous habitat, eventually jeopardizing biodiversity and species survival. Additionally, fragmentation degrades potential recreation and view shed qualities of the landscape and its associated wetlands.

Past land use and ongoing urban development have led to accelerated storm water runoff and a flow regime of concentrated peak flows in the Galisteo Creek and its tributaries. As a result, soil erosion and sediment accumulation in the stream and the Galisteo reservoir

have increased. In many locations, tributaries start as steep headcuts and have carved deep gullies that dewater the landscape. The Galisteo Creek is in most locations 10-25 feet incised below the historical floodplain (Figure 5). Riparian floodplain zones with native cottonwood and willow groves have dwindled, while Russian olive and saltcedar have aggressively invaded the riparian habitat. In many places, originally moist flood plains, productive alluvial fans, springs, wetlands and wet meadows have dried up and made place for degraded, dry sediment flats.

Railway and highway construction in particular have impacted watershed health. The construction of the railway across the watershed from Glorieta to the Rio Grande in 1880 was in many places installed in or just next to the stream channel of the Galisteo Creek. In many places, the floodplain of the Galisteo creek was cut in half lengthwise, which destroyed the creek morphology and ecosystem. In subsequent flood events the concentrated flood waters caused severe damage to the railway structure, and the Railroad sought to stabilize undercuts and erosion of the railway with concrete bank revetments and large stream modification structures, such as levees and dams. In addition, highway widening, drainage structures, culverts, bridges and other hard infrastructure design have concentrated stormwater runoff throughout the watershed. In many locations, poorly installed culverts have contributed to headcutting and lowering of gully and stream channel levels and contributed to accelerated erosion (Figure 19).

Figure 19. Headcut caused by nearby road culvert dewaters and dries out local wetland in the Galisteo Watershed.

Another consequence of property development is ground water pumping. Ground water is the principal source of fresh water for homes and businesses and most homes are serviced by private wells. Some communities, such as the Village of Cerrillos, have a community well. Cerrillos water users have a senior water right in the basin. Flows into the San Marcos Springs and its discharge area upstream to the Village of Cerrillos, require protection from up-stream groundwater pumping. In some cases, ground water is pumped from shallow wells and the effects are localized and/or seasonal drops in the local water table. This in turn affects water levels in local wetlands and flow from springs and seeps, as is the case at San Marcos Springs. It also affects the duration of growing season moisture in wetlands that recharge during wet periods and from snow melt.

Figure 20 The Upper San Marcos Arroyo has been severely degraded as a result of uncontrolled development, poor grazing practices, off road vehicle use, stream modification, and groundwater extraction by individual wells.

The number of private wells in the Galisteo Watershed is unknown, but may be more than one thousand. The principal shallow aquifers that are affected by ground water pumping are the alluvial aquifer of the Galisteo Creek from Upper Cañoncito down to Cerrillos, and the Ancha formation below it.

Potentially degrading activities in the watershed also include off-road vehicle use, trails and pedestrian access, mowing, landscaping, solid waste dumping, domesticated animal

access and resultant wildlife decimation, herbivory, vegetation trampling, soil compaction, and other local activities (Figure 20).

One indication of wetland decline is the increasing encroachment of exotic invasive species as wetland conditions change with external and internal sources of stress. Overall, the encroachment of salt cedar is pervasive. Only in the northeastern portion of the study area, as Galisteo Creek flows southwest from Glorieta prior to its westward flow at Galisteo, are natives more abundant than exotics. Combined with the results of historical land degradation, the contemporary impacts of poor runoff management and fragmentation are likely to cause an ongoing decline of wetland acreage in the watershed along with habitat for water-dependent plants and animals.

3.h Wetland Values and Ecosystem Markets

Placing a monetary value on wetlands as a function of the services they provide is a challenging and controversial task, and economists have often been criticized for trying to put a "pricetag" on nature (www.ecosystemvaluation.org/essentials.htm). Many of these goods and services are traditionally viewed as free benefits to society, or "public goods" - wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes, for example. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate, and individual decision-making (Figure 21). As a result, both in our study area and in the United States, resource challenges associated with globalization and urbanization, and the impacts of climate change, pollution, over-exploitation, and land-use change on ecosystem loss and/or the degradation of wetland functions and their values, are poorly translated into monetary losses (www.fs.fed.us/ecosystemservices). However, spending decisions and allocating resources for protecting and managing wetlands must be justified to the community and stakeholders that these resources benefit, and that "pay" for the protection and management of these resources. These types of decisions are based, either explicitly or implicitly, on society's values. Therefore, economic valuation can be useful, by providing a way to justify and set priorities for programs, policies, or actions that protect or restore wetlands, their functions and ecosystem services. Such values can in some cases be expressed in a dollar amount, while in many cases they do not constitute marketable or monetary values, but rather personal, social, and spiritual ones.

Figure 21. Loss of wetlands and their flood control functions allows for severe bank erosion in this section of the Galisteo Creek. Bank erosion threatens nearby homes and property value.

Wetland functions and their values in specific markets can be expressed as marketable ecosystem services. "Ecosystem services" are natural assets that offer a full suite of goods and services that are vital to human health and livelihood. The "2005 Millennium Ecosystem Assessment" www.maweb.org/en/index.aspx, (Watson et al. 2005) a four-year United Nations assessment of the condition and trends of the world's ecosystems - categorizes ecosystem services as:

- **Provisioning Services** *or the provision of food, fresh water, fuel, fiber, and other goods;*
- **Regulating Services** *such as climate, water, and disease regulation as well as pollination;*
- **Supporting Services** *such as soil formation and nutrient cycling; and*
- **Cultural Services** *such as educational, aesthetic, and cultural heritage values as well as recreation and tourism.*

In their book "Rivers for Life," Sandra Postel and Brian Richter (2003) emphasize the central ecological role of water bodies such as flood plains and wetlands, and cite Vermont researcher Robert Costanza's (1997) estimate that the annual ecological value of floodplains at a world market value is about $8,000 per acre, which translates into more than $11,000 per acre per year at present values in 2010. This would mean that the

1,000 acres of present wetlands and streams in the Galisteo Watershed represent an annual value of at least $11 million to society, while about 4,000 acres of historical wetlands and floodplain in the watershed have disappeared, at an annual value of $44 million (based on 2010 values). In contrast, the average cost of a wetlands restoration project funded by EPA to restore approximately 30 acres of New Mexico wetlands (SWQB Wetlands Action Plan Program) is about $500,000 using low-tech restoration practices, and including the value of in-kind match donations to complete the work and associated planning and outreach activities. This would value restoration of "restorable" wetlands at approximately $16,700 per acre. Restoring highly degraded wetlands, using high-tech practices, and including future monitoring, maintenance and management would cost considerably more (Figure 22).

Figure 22. Tamarisk removal at Cañoncito Arroyo. Tamarisk is pulled with heavy equipment and then stacked and hauled out of the open-space area by hand.

Wetland functions that may lead to marketable ecosystem services in the Galisteo Watershed address all four categories of ecosystem services identified by the 2005 Millennium Ecosystem Assessment. Wetland functions and values considered important to the community by the Steering Committee for the Galisteo Watershed are summarized in Appendix D. The following wetland functions appear currently to have the highest likelihood for future payment for ecosystem services:

- Production of specialty products for local or regional markets – a provisioning service: once wetlands are well-established and well-managed, it is possible that stewards can occasionally sell wildlife harvesting (hunting) permits and plant product collection permits (example: edible cattail tubers and pollen).

- Water quality improvements – a provisioning and regulating service: for development projects or road improvement projects that require CWA Section 404 compliance, in some cases, existing wetlands or potential restoration sites may assist these projects in achieving compliance. The projects could potentially be charged to pay for wetland improvements and stewardship that help ensure their compliance (wetlands banking or In Lieu Fee).
- Flood control (as required by the SF County flood plain management code) – a regulating service: for projects that require County flood plain management compliance. In some cases, existing protecting and restoring wetlands may assist these projects in achieving compliance. The projects could potentially be charged to pay for wetland improvements and stewardship that help ensure natural flood management and their compliance.
- Alluvial aquifer recharge (as encouraged by SF County SLDP) – a supporting service: once alluvial aquifer recharge can be modeled and estimated, it may be possible to value the deferred costs to downstream well owners for investments in well production improvements. Likewise, for downstream property owners it may be possible to calculate their savings on maintenance of structures and land due to reduced erosion damage from flows and flooding.
- Biodiversity (habitat protection or creation for listed threatened and endangered species) – a supporting service: once wetlands are well-established and well-managed, it may be possible to identify newly created critical habitat for threatened and endangered species that may offset biodiversity losses elsewhere in the State. Hence, local, voluntary markets for biodiversity or wetland offsets, or official trading schemes of ("banked") biodiversity or wetland values (biodiversity or wetland mitigation) may lead to funds for wetland stewardship and further restoration or development in the Galisteo Basin.
- Carbon sequestration (carbon trading) – a supporting service: once wetlands are well-established and well-managed, it may be possible to identify carbon stored in the wetland soils and any values associated with additional carbon that can be stored in the wetlands as part of local, voluntary carbon banking/trading initiatives or even (inter)national carbon trading markets.
- Cultural heritage, recreational and educational values – a cultural service: it is conceivable that in the near future private and public entities associated with wetland stewardship can charge fees from users or request in-kind support from certain interested parties for recreational or educational tours, information sources, educational workshops, research projects, arts projects, etc.

The University of North Carolina Environmental Finance Center offers several workshops and manages an informative website on sustainable financing strategies for wetlands. Although this information is geared to State and tribal wetland programs, there are also innovative tools, strategies and informative messages that can be used by watershed stakeholders such as in the Galisteo Watershed.

4. RESOURCE MANAGEMENT

Sustainable, healthy and productive landscapes are critical for providing essential functions and ecosystem services, and for sustaining and supporting rural and urban communities that rely on these functions and benefits. Resource management includes collection, interpretation and distribution of comprehensive information to community leaders and agencies that will help support efforts to prevent and reverse land practices that exploit, degrade and destroy wetlands. Resource management also involves a set of actions and decision-making concerned with the conservation, restoration and protection of wetland resources. Of particular importance in wetland management are the understanding of the nature, extent, vulnerabilities, and services of the resource and the processes that help conserve and appropriately allocate the resource when necessary. In the Galisteo Watershed, wetland resources are not common and are dwindling from past land use practices. Potential threats and continuing pressure have the ability of eliminating existing wetlands further. It is therefore critical that sustainable development and environmental protection are major goals of a good management strategy. The probable consequences of human interaction with wetlands must be considered to restrict and prevent environmental damage. Resources should be managed with local, regional and nationwide affects in mind, such as the case of migratory bird flyways and wildlife corridors. Sustainability of the resource and its functions and services is the management goal for the Galisteo Watershed.

4a. Resource Needs

The need for basic information that can help with managing wetlands resources is a recognized outcome of this planning process. It is also important to understand where threats and potential impairments are likely to have the greatest consequences to wetlands and riparian resources including the loss of functions and the impacts to flora and wildlife that depend on the resource. Information gaps have been identified in Section 3 that make it problematic to systematically prioritize, protect and restore wetlands. These important information gaps are basic and include mapping, baseline assessment and classification of existing wetlands, and identification of reference sites. An immediate priority is to fill the information gaps as future funding or opportunities become available.

4.b Reducing Impacts to Wetlands

Despite the recent initiatives, wetlands and any other surface waters receive very little attention in the form of active management, protection, restoration, and code enforcement throughout Santa Fe County. As a result, wetlands are still subject to erosion from flashfloods and impacts from nearby roads, trails and buildings, degradation by four-wheel vehicle access, livestock and horse grazing, and encroachment of invasive plant species.

This planning initiative also revealed that wetland degradation is potentially related to groundwater extraction in relation to (sub)urban development in upstream aquifers. Residents in the Village of Galisteo have repeatedly expressed concerns about ongoing and/or planned groundwater extraction from wells upstream from the Village. Water

wells in Lamy, planned wells at Saddleback Ranch, Vista Clara Ranch, and the Galisteo Basin Preserve (former Thornton Ranch) are cases in point for Galisteo. Similarly, residents in the San Marcos and Cerrillos area as well as several professional hydrologists share a concern for gradual groundwater depletions and well degradation in the San Marcos and Cerrillos area as a result of the ongoing groundwater usage in the Eldorado subdivision. The County's moratorium on new water drilling in Eldorado and the severe concerns expressed about the Galisteo Basin Preserve's water sources are directly related to the anticipated water shortages – and experienced already during dry years - in the western part of the Galisteo Watershed. These observations have led to a special geohydrological study in a follow-up project "Comprehensive Wetland Restoration and Protection in Santa Fe County" (2007).

A wetlands condition assessment helps identify stressors that are impacting or are responsible for wetland degradation. Watershed wide chronic sources of stress have been identified in section 3.g of this plan. Additional direct identification of stressors on an individual wetland can be made by the use of a stressor checklist that includes all potential direct or indirect sources of stress to the ecological condition of the wetland. The result is the present state or condition of a wetland and cumulative list of known stressors to help predict the causes of degradation or the potential affects that a future land use or activity may have on the wetland in question. Restoration measures can then be focused on reduction of sources of stress as well as corrective actions that will help the wetland area become more resilient to future traditional and new sources of stress.

4c. Prioritization of Wetland Restoration Sites

The Steering Committee for the "Planning for Wetlands in the Galisteo Watershed" conducted a prioritization procedure for potential wetlands restoration sites. This prioritization process was applied to wetlands that were likely to be of high value to the local communities, to receive community support for restoration, and to be most accessible for restoration. The prioritization process was not applied to all wetland resources since not enough information was available watershed–wide. The prioritization process followed a flow decision model (Appendix E). The Steering Committee developed a spreadsheet with basic information for each wetland, such as acreage, expected restoration costs and costs per acre. The spreadsheet also included a set of primary criteria in order to rank wetland sites by order of priority for treatment. These criteria included:

1. Wetland function – The functions identified as having high priority were considered, not including the phosphorus retention function since not enough data was available to rank this function.
2. Estimated wetland value to society (of wetland ecosystem services); expressed in high-medium-low
3. Cumulative, landscape wide value of restoration (i.e. the impact value of any local restoration work)
4. Landowner interest and support
5. Community preferences/support
6. Feasibility of implementation

7. Protection and buffer zone development (e.g. through conservation easements or a local government ordinance)
8. Maintenance and follow-up feasibility/likelihood
9. Financial self-sufficiency of wetlands over time

To determine the final prioritization of each wetland site a qualitative scoring of three categories (high, medium, low) was applied to express the sum of values for the nine prioritization criteria for each site. Additional considerations were listed below the evaluation of priorities to describe additional conditions of the wetlands and their restoration potential. These considerations included cumulative landscape-wide values, such as:

- Threatened conditions of the wetland
- Presence of threatened and endangered plant/animal species
- Habitat contiguity with other riparian areas
- Entry experience
- Rarity of conditions
- Buffer function (enhancing open space adjacent to development)

Additionally, project implementation related considerations and conclusions were listed:

- Field monitoring accomplished with schools
- Potential to include the project as a pilot site in the Galisteo Watershed Conservation Initiative (GWCI)
- Proposed action steps and partners
- Suggested sources of funding

The spreadsheet and analysis for prioritization of wetlands restoration sites is included in an Appendix E.

During the restoration process of priority wetland sites the project steering committee learned that two other criteria regarding project feasibility should be included in the lists above:

- Legal status of the property and property title. Any wetland restoration project will run into delays or legal complications if the property title is disputed or encumbered in someway and/or if the property (or its owner) is in litigation over the property.
- Landowner and stakeholder understanding and agreement about their responsibilities, and the expected outcomes in relation to personally held values regarding, for example, increased wildlife use, responsibilities for ongoing monitoring and potential maintenance, or the perceptions of the wetland restoration by neighbors and downstream water users.

Figure 23. Earth Works Institute's 4C crew chip branches of invasive Russian olive harvested from the Escalante Spring area in the Cerrillos Hills State Park in the spring of 2010.

4.d Wetland Restoration Design for Selected Sites

The project "Planning for Wetlands in the Galisteo Watershed" includes the design of several sites (Vrooman 2006) (Appendix B) and implementation of three demonstration wetland restoration sites. The selection of the demonstration restoration wetland sites was based on the prioritization exercise described in the Section 4.c. In addition to the demonstration restoration sites that were part of the project "Planning for Wetlands in the Galisteo Watershed," Earth Works Institute collaborated with several third party partners to pursue implementation of all additional wetlands projects that were identified in the wetland assessment report of 2006.

Wetland restoration designs were completed and many already implemented for the following sites. Table 1 gives restoration and buffer acreage.

1. Cañoncito Arroyo (Eldorado Community Preserve; a.k.a. Eldorado Wilderness) – implemented in 2007-2010 (including work completed and scheduled for completion under the New Mexico River Ecosystem Restoration Initiative)
2. Galisteo Creek (in the Village of Galisteo) – implementation pending outcome of a land dispute (work scheduled to be implemented in 2010-2011 under the New Mexico River Ecosystem Restoration Initiative)

3. San Marcos Arroyo (San Marcos Pueblo archaeological site) – implementation cancelled due to insufficient funds to produce the desired outcome at this very sensitive archaeological and wetland site.
4. Galisteo Dam reservoir – restoration implemented in 2007 by the US Army Corps of Engineers
5. Southwest Arroyo (Galisteo Basin Preserve) – restoration implemented in 2007-2008 with funding from Commonweal Conservancy and the State of New Mexico through Santa Fe Conservation Trust
6. Oxbow wetland on Cerro Pelon Ranch (Village of Galisteo) – thinning of invasive species implemented by the landowner in early 2008 with a follow-up removal treatment in May 2009. Follow-up treatment will be necessary to reduce re-sprouting from remaining root systems.
7. Miners' Spring (Cerrillos Hills State Park) – restoration implemented in 2008 with funding from Santa Fe County
8. Shooting Gallery Arroyo (Cerrillos Hills State Park) – restoration implemented in 2009-2010 with funding from Santa Fe County
9. Escalante Spring (Cerrillos Hills State Park) – demonstration restoration scheduled for 2010 with funding from Santa Fe County and Wetlands Program Development Grant.
10. Arroyo de los Angeles wetlands and Galisteo Spring wetlands (Galisteo Basin Preserve) – restoration implemented in summer 2008 with funding from the State of New Mexico River Ecosystem Restoration Initiative
11. San Marcos Arroyo (private land west of Highway 14) – removal of invasive species and planting of native trees implemented in 2008 with funding from the US Fish & Wildlife Service; demonstration channel rehabilitation scheduled in 2010 with funding from Wetlands Program Development Grant.
12. Finger Lakes wetlands (on 3-Horse Ranch, near Cerrillos, New Mexico) – arroyo channel, wetland and wet meadow rehabilitation completed in 2009 with funding from the State of New Mexico River Ecosystem Restoration Initiative
13. Padre Springs wetlands and wet meadows (on the Holian property, as part of the Ranch at Padre Springs on Glorieta Mesa, Glorieta, New Mexico) – upland road, arroyo and pond restoration work completed in 2008 with private funds. Further stream, wetland, and wet meadow rehabilitation and wildlife drinker systems installation scheduled for 2010-2011 with private funding and state and federal grants.
14. Romero Springs and Arroyo (Community of Valencia, along I-25, west of Glorieta, New Mexico) – spring and stream restoration scheduled for 2010-2011 with funding from the State of New Mexico River Ecosystem Restoration Initiative.

Wetland Site:	Bene-ficial Farm	Eldorado Wilder-ness	Galisteo Basin Preserve all areas	Galisteo Village	Finger Lakes	San Marcos West	Galisteo Dam	CHHP project area	**TOTAL**
Wetland and riparian area in 2005	0.24	0.60	1.00	9.42	0.33	1.00	0.30	0.1	**12.99**
Wetland/riparian area gained after treatment	N/A	0.31	1.20	1.50	1.95	2.50	65.70	1	**74.16**
Wetland/riparian area improved, protected	N/A	0.91	2.20	10.92	2.28	3.50	66.00	1.1	**86.91**
Buffer in 2005	N/A	4000.00	0.00	0.00	0.00	0.00	**?**	0	**4000.00**
Buffer area gained or improved/protected	N/A	4.00	300.00	17.00	400.00	4.50	2500.00	2	**3227.50**
Wetland area affected	0.00	0.91	2.20	10.92	2.28	3.50	66.00	1.1	**86.91**
Total area affected	0.00	4.91	302.20	27.92	402.28	8.00	2566.00	3.1	**3314.41**

Table 1. Initial wetland sites identified in 2005/2006 and protected and restored between 2006 and 2010 through various projects (table has been updated in 2010 from the original version of 2007). All figures are estimates based on best available data (in acres).

Figure 24. "Pole baffle" (back) and "wicker weirs" (front) installed to capture sediment and recreate riffle/pool sequence and meanders in Galisteo Creek.

4.e Measures to Protect Wetlands

Between 2005 and the present, the "Planning for Wetlands in the Galisteo Watershed Project" facilitated and expanded efforts to create, restore, and protect wetlands in the Galisteo Watershed. Already during its lifetime, the project succeeded in bringing wetland protection under the attention of the public, incorporating wetland planning and protection in local (County) planning initiatives, in generating a broad variety of spin-off initiatives and helped accomplish the restoration and protection of a large number of wetlands, riparian areas, and buffer zones in the Galisteo Watershed and in other locations throughout Santa Fe County (more than 100 acres in total). In dialogue with various partners, Earth Works Institute identified several protection measures as a result of the process of implementing the "Planning for Wetlands in the Galisteo Watershed Project." partners such as Commonweal Conservancy, Santa Fe Conservation Trust, Santa Fe County government, and private landowners have established conservation easements, imposed deed restrictions on development, established buffer zones, and purchased properties for conservation purposes.. Additional measures include:

- Incorporating wetland issues into the work of the Galisteo Watershed Partnership.
- Inclusion of wetland planning in the Santa Fe County 2010 Sustainable Land Development Plan and Code and the 2008 "Oil and Gas Element" to the Land Use Code.
- Inclusion in a watershed-wide Green Infrastructure plan and prioritization plan for open space and wetland restoration and protection (This plan also provides for the protection of buffers around wetlands).
- Development of wetland outreach and education programs and materials that inform the public of the functions and values of wetlands and ways to get involved in wetlands protection (Jewels of the Southwest booklet) (Appendix F).
- Creating community consensus on how existing and potential wetlands might be protected and how a protective buffer zone around these wetlands might be established through conservation easements
- Postponement through a County-wide moratorium and possible abandonment of oil and gas drilling in and around wetlands in the Galisteo Watershed, and the establishment of a County Oil & Gas ordinance that regulates and restricts oil and gas development throughout Santa Fe County.
- Leverage of nearly $650,000 for wetland restoration in the Galisteo Watershed and more than $500,000 in other parts of Santa Fe County between 2007 and 2012 that includes additional protection measures through establishment of buffers, landowner agreements and conservation easements.
- Ongoing discussions with floodplain managers regarding wetlands and riparian areas and the need to restore and protect natural ecosystems in floodplains through local development ordinances.
- Inclusion of New Mexico Department of Transportation in the design and implementation of restoration projects near transportation corridors.
- "Watchdog" involvement that assures that appropriate regulatory tools such as CWA Section 404 permitting process is adequately used, includes conditions that restricts inappropriate activities, and is enforced.

Other direct protection measures are through the use of best management practices and can be implemented by local government, homeowners associations, concerned citizens groups, private landowners, school groups and others. For example, off-road vehicle access can be prevented by using post and cable barriers (Zentner 1994). Pedestrian and pet access can be directed, discouraged, or eliminated through placement of fences or signage. Common use boardwalks can be constructed over marshlands and in-stream restoration structures can serve dual uses as low water crossings to reduce degradation of streambank and river channel wetlands from recreational activities (Buchsbaum 1994).

Regulatory measures also provide protection of wetlands such as permit requirements of Clean Water Action Section 404 and Section 401 Certification, and Santa Fe County Ordinances. Permits issued for development around wetlands and buffers should include conditions requiring the permittee to inform future lot owners of restrictions on the use of wetlands and buffers located on or abutting their lots. Deed restrictions can be placed on lots, and permit conditions should require similar disclosure to subsequent lot owners (Osmond et al. 1995).

Figure 25. Approximately 12,000 acres of open space is being gradually protected in the Galisteo Basin Preserve, a conservation and stewardship development project in the heart of the Galisteo Watershed. Each year, new conservation easements are added to assure the protection of open land and night sky in the Preserve, while community members are invited to educational events, such as this campfire story telling event in July 2010.

4.f. Strategizing Financing Options

The project "Planning for Wetlands in the Galisteo Watershed" was funded through a wetlands grant from the US Environmental Protection Agency and managed by the New Mexico Environment Department, Surface Water Quality Bureau. The federal funding amount of $140,230 was awarded in 2005. However, the project, its partnerships and its products leveraged more than 8 times this amount (over $1 million) through many

additional local, state, private and federal funding sources and in-kind and matching contributions. Funding sources and funds leveraged to date included:

- State of New Mexico – Galisteo Watershed Conservation Initiative (through Santa Fe Conservation Trust) – Southwest Arroyo on Galisteo Basin Preserve: $50,000
- State of New Mexico – River Ecosystem Restoration Initiative (RERI) – Arroyo de los Angeles and Galisteo Spring: $167,094
- State of New Mexico – River Ecosystem Restoration Initiative (RERI) – Restoring Riparian Health in Critical Ecological Areas in the Galisteo Creek Watershed:$27,464
- Santa Fe County (Open Space and Trails Division) – Cerrillos Hills springs: $17,500
- Commonweal Conservancy for the completion of Southwest Arroyo Wetlands:$2,000
- US Army Corps of Engineers – Galisteo Dam reservoir: amount unknown
- US Fish & Wildlife Service – Partners for Wildlife Program (through EWI) – in the Cañoncito area: $6,000, and at San Marcos Arroyo: $16,450.
- Los Alamos National Laboratories Foundation (through EWI) – for Cañoncito Arroyo area: $15,000
- Eldorado Community Improvement Association: $6,500
- UNM students and faculty: $31,000
- EWI staff in-kind contributions: more than $9,000
- Private individuals, businesses and landowners' in-kind contributions: more than $5,500
- State of New Mexico - Galisteo Springs Conservation Easement through Natural Heritage Conservation Act (awarded to New Mexico Department of Cultural Affairs and Santa Fe Conservation Trust): $350,000.
- EPA Wetlands Program Development Grant for Wetlands Protection and Restoration in Santa Fe County: Federal and matching funds including $100,000 Santa Fe County match for restoring Open Space wetlands: $465,930
- EPA Region 6 Galisteo Pilot: $10,000

Potential future match sources for federal funds include:

<u>Committed or awarded matching funds:</u>

- State of New Mexico – River Ecosystem Restoration Initiative (RERI) – Finger Lakes, Valencia wetlands, Cañoncito Arroyo wetlands, and Village of Galisteo wetlands: more than $385,000 in 2009-2012
- Santa Fe County wetland restoration work in 2009 in the Cerrillos Hills ($19,755) and ongoing Russian olive removal (amount unknown)

<u>Potential matching funding sources:</u>

- New Mexico State Legislature
- New Mexico Department of Transportation (wetland mitigation funds for Galisteo Village)
- New Mexico Water Trust Board

- State Parks Division protection of wetlands in the Cerrillos Hills
- School and college programs
- Landowner contributions and value of conservation easements donated to protect wetlands
- An innovative program called "Green Burial" at the Galisteo Basin Preserve where participants can buy burial or cremation rights with a portion of the costs earmarked for conservation easements and restoration projects on the remainder of the open space land.

Future Funding Opportunities for Wetland Development, Restoration and Protection

Future funding opportunities for wetland development, restoration, and protection in the Galisteo Watershed include:

1. Grants and contracts (as part of Federal, State, and local government, conservation and restoration programs)
2. Internal government agency funds (add-on or matching funds)
3. Mitigations funds (USACE or other governmental mitigation funds)
4. Developer funding (as part of an urban development project)
5. Private investments
6. Payment for ecosystem services schemes
7. Memorials and foundation funds

1. Grants and contracts (as part of Federal, State, local government, conservation and restoration programs)

Funds acquired for wetlands in the Galisteo Watershed to date (2000-2010):

- EPA – NMED/SWQB – Wetland Program Development Grants
- State of NM – NMED/SWQB – River Ecosystem Restoration Initiative grants
- State of NM – YCC grant
- State of NM – appropriation to OSE/ISC for GWCI demo project
- USFWS – Partners for Fish and Wildlife grants
- Santa Fe County Open Space Division – Professional Services PO
- National Association of Counties – 5 Star Restoration grant

Additional funding sources for future consideration:

- NM Water Trust Fund (Water Trust Board) / NM Finance Authority: only if certain conditions are met, such as the possibility to repay a 20% loan as part of the financing; the possibility for public agencies to manage WRB/NMFA funding; the availability of an approved "water conservation plan" at the applicant agency (State of NM, SF County, or Soil & Water Conservation District)
- New NMEMNRD funding from NM Cultural Heritage & Land Conservation Act of 2010
- A County Special Overlay District, along with specific financial allocation clauses
- State and/or Federal Legislative appropriations

2. Internal government agency funds for wetlands in the Galisteo Watershed (add-on or matching funds)

Funds acquired to date

- USACE – internal funds for Galisteo Dam restoration
- SF County Open Space Division – internal funds for matching contributions to wetland restoration
- SF County Land Use Division – internal funds for wetland study
- New NMEMNRD funding from NM Natural Heritage Conservation Act of 2010

Additional funding sources for future consideration

- Internal NMED funds
- Internal NMDOT funds

3. Mitigations funds (USACE or other government mitigation funds)

Funds acquired to date: None

Additional funding sources for future consideration:

- USACE mitigation funds in relation to NMDOT bridge building in Galisteo and other projects in the region.

4. Developer funding (as part of an urban development project)

Funds acquired to date

- Commonweal Conservancy

Additional funding sources for future consideration: TBD

5. Private investments

Funds acquired to date

- Individual private landowners

Additional funding sources for future consideration: TBD

6. Payment for Ecosystem Services

Funds acquired to date: None

Additional funding sources for future consideration: TBD

7. Memorials and Foundations

Funds acquired to date: None

Additional funding sources for future consideration:

- Galisteo Basin Preserve Green Burial Program

Considering wetland ecosystems, and their ecological functions, as natural assets with economic and social value can help promote conservation and more responsible decision-making. Additionally, conservation and planning of highly functioning wetland ecosystems that are used by design to fulfill a broad spectrum of ecosystem services that contribute to economic returns and community well-being has the potential to stimulate market-based conservation and stewardship.

4.g. Monitoring

Monitoring wetland restoration work helps identify wetlands impacts, degradation and stressors, and measures success of implemented wetland restoration and protection projects. Additionally, monitoring data can be analyzed to be used in data to action reports for educational purposes, for adaptive management, and in future wetland restoration and protection actions.

Project monitoring initiatives for wetland restoration projects in the Galisteo Watershed include those developed for "Planning for Wetlands in the Galisteo Watershed" project:

- Monitoring plan
- Project Quality Assurance Project Plan (PQAPP) written and approved
- Monitoring findings, report to date, and photo series
- Findings and observations by students

The SWQB has established three water quality monitoring sites on Galisteo Creek as part of an intensive water quality survey of the Upper Rio Grande Watershed conducted in 2002. The survey results were assessed with respect to State of New Mexico water quality standards. Relevant survey data and the assessment are available from the SWQB.

Future monitoring needs include:

- GIS analysis of wetland extent using satellite imagery comparing change from images taken in 1995, 2000, 2005 and 2010. This would give us ideas of the historic trends in increasing or decreasing extent of wetlands in the basin.

- A GIS analysis of key wetland sites such as reference standard sites and those based on criteria such as rare, unique in key corridors for migratory birds or other species of wildlife.

- Rapid assessment of wetland condition of a representative sample of all classes and subclasses of wetlands in the Gailisteo Watershed. This would provide information about which wetland subclasses are the most impaired and help select potential sites for restoration.

- Intensive vegetation sampling at key wetlands and reference standard sites to support the GIS image analysis. These data would provide more detailed information on the types and distribution of wetland plants and plant communities found at these sites.

- Fluvial geomorphology data that shows the trends on increased or decreased access of arroyo and stream flows to overbank flooding. Looking at movement of headcuts below and in wetlands will help pinpoint where restoration interventions will have the greatest impact.

- Uploading photos and reports with monitoring data for wetland locations on a statewide water or wetlands data collection website such as www.Watershedwiser.org.

Figure 26.
Students assist with field assessments and monitoring of project accomplishments. This student from Charter School 37 participated in field monitoring of the Southwest Arroyo on the Galisteo Basin Preserve in 2007.

4.h Tracking Wetlands Gains, Losses and Condition

Tracking wetlands gains, losses and condition is a real need not only in the Galisteo Watershed but statewide. The Santa Fe County Sustainable Land Development Plan (Santa Fe County 2010) is a guiding document incorporating local community values, goals and strategies on how to best manage and sustainably utilize the County's limited natural, economic, and cultural resources, and serves as a guide for smart growth and development for all residents and businesses in the County. The reason that tracking wetlands gains and losses is critical is primarily to prevent further losses of wetland acreage and their associated ecosystem services and functions. In addition, historic loss of wetlands precludes allowing the status quo or simply the remaining wetlands as the

sustainable condition. Rather the long-range sustainable goal would include annual gains in wetland acreage. Losses or gains in turn affect other initiatives, such as NM Wildways, an initiative to preserve wildlife and migration corridors that are of national as well as regional significance, and the protection of all aquatic systems in the watershed. A potential strategy for tracking wetlands trends includes the division of subsheds or geographic subregions and tracking wetlands trends in these areas, then local types and then subclasses within each type. Baseline for tracking would include GIS coverage and intensive ground-truthing. This is especially critical since many spring-fed wetlands, wetlands associated with arroyos and confined drainages will be too small (<0.1 acre) to pick up using GIS methods. Yet these small wetlands serve as "watering holes" and sustain local flora and fauna and their losses would substantially affect the local ecosystem. In order to develop and maintain a Wetlands Tracking System for the Galisteo Watershed, the following list of needs must be met.

- Tracking Project Design - A design for tracking that could be incorporated into the SLDP implementation. This would include GIS capabilities along with a strategy for ground-truthing and including wetlands not visible remotely.

- Web-based Database - for entering wetlands data, sharing with stakeholders and the public and for creating and publishing tracking reports.

- Entity to Manage and Implement the Design – This could be Santa Fe County or an environmental non- profit such as Earth Works Institute in combination with local citizen's groups and volunteers and the NMED Wetlands Program.

- Landowner agreements - to enter land to ground-truth especially the more important and significant wetlands in the landscape

Small wetlands are harder to pick up, whereas for wildlife, landscape diversity and ecological value the smaller wetlands are significant across the landscape. In general the bigger wetlands are located on private and tribal lands. Ground-truthing should not only include size but condition of the wetland areas. Condition assessment is discussed in Section 4.b.

5. PUBLIC INVOLVEMENT STRATEGY

Public Involvement and Education/Outreach have long been at the heart of environmental success and sustainable management in the Galisteo Watershed. Earth Works Institute (EWI) has been a community leader and provided direction and guidance in the Galisteo Watershed for coordination and support of these efforts (Figure 27). Community planning initiatives are targeted as the strategic partnerships that will help mainstream wetlands restoration and protection as part of the normal activities in the watershed. Coordination of these initiatives with wetland restoration and protection efforts are the stepping stones to establish a long-term, watershed-wide wetlands restoration and protection program.

Figure 27. Kina Murphy of Earth Works Institute explains the objectives of wetland restoration in the Shooting Gallery Arroyo in the Cerrillos Hills State Park during a tour for community members in 2009.

Other initiatives include the creation and use of technical tools to increase the knowledge base and availability of wetland information, and the use of a number of platforms and initiatives to increase understanding of the benefits of wetlands restoration and protection.

Activities for wetland restoration and protection in the Galisteo Watershed have included:

- Public outreach and education through signage, a brochure, website information, preparations for a technical field guide, conference presentations, workshops, media relations, and associated activities for wildlife conservation;

- Student involvement and formal, outdoor education in area schools;
- Mobilization, organization, technical support to, and motivation of Community Stewardship Teams;
- Volunteer involvement in the project steering committee, monitoring, volunteer restoration initiatives, and matching support; and
- Broad-based institutional support.

Figure 28. Students from Eldorado Elementary School have been participating for many years in outdoor classroom learning in the Eldorado Community Preserve, where they adopted the wetland area and surrounding buffer zones.

5.a. Technical Tools for Reaching the Public

Watershed signs and interpretive wetland signs

In 2008, SWQB Wetlands Program's contractor Earth Works Institute (EWI) initiated the placement of educational road-side signs throughout the Galisteo watershed that indicate stream crossings and watershed boundaries. EWI received support for the signage from Santa Fe County and NMDOT. In the near future more signs are expected to be placed along the Interstate 25 through the services of the New Mexico Energy, Minerals and Natural Resources Department's Forestry Division (NMEMNRD), which is replicating

the initiative statewide.

The watershed sign project is a state-wide collaborative initiative. Initially spearheaded by the Santa Fe Watershed Association and EWI in 2007, other partners included the Santa Fe Conservation Trust, City of Santa Fe, Santa Fe County, SWQB, and later the NMEMNRD and NMDOT. SWQB produced the standardized, striking, blue-white sign imagery. Sign production was contracted to P&M Signs in Mountainair. Funding for the signs in the Galisteo watershed was shared between EWI, Santa Fe County, and NMDOT.

In 2009, an interpretive sign (Figure 29) was installed at the Cañoncito Arroyo wetlands in the Eldorado Wilderness as part of the Galisteo Pilot Project (EPA Pilot Project awarded to SWQB Wetlands Program). The sign offers visitors a summary of wetland functions and values, restoration techniques and suggestions how to get involved in wetland stewardship initiatives. The sign also includes a map of the Eldorado Community Preserve. The sign is mounted in a kiosk which has additional space for other information, such as student work in the area or activities of the Eldorado Community Improvement Association (ECIA).

Figure 29. Kiosk and interpretive sign placed along a trail in the Eldorado Community Preserve in the fall of 2009.

Wetland Brochure

SWQB Wetlands Program and EWI jointly developed an 8-page, full-color information brochure which describes wetland functions, wetland values, threats to wetlands, and wetland protection strategies for the Galisteo Watershed (Appendix F). It also lists government agencies and conservation organization that provide assistance with wetland restoration and protection. The brochure was printed in late 2008, broadly disseminated throughout 2009, and reprinted in 2010 through the "Planning for Wetlands in the Galisteo Watershed" Project.

Web info

In 2008, EWI rebuilt its website and included descriptions of wetlands projects in the Galisteo Watershed. EWI also included wetland project announcements in the website for the Galisteo Watershed Partnership and in its monthly electronic newsletters and activity bulletins. The Galisteo Wetlands Restoration Project is also described on the SWQB Wetlands website.

Technical Field Guide

An educational Technical Field Guide about wetland restoration and stewardship is currently under production. The field guide will complement a technical field guide for wetland and bosque vegetation management in New Mexico produced by NMED-SWQB in early 2010 as well as a series of land stewardship documents produced by Earth Works Institute.

5.b. Informational Programs Focusing on Wetlands

Events and Workshops

Community outreach and involvement relies on an assortment of events to get the word out to the public, to potential supporters and funders, and to local community organizations and interested citizens. In 2005, EWI and NMED-SWQB Wetlands Program hosted a Wetland Delineation workshop for staff from local, state and federal agencies and conservation organizations involved with wetland protection. This effort showed to participating agencies the interest and commitment within the Galisteo Watershed for restoring and protecting wetlands. EWI and NMED Wetlands Program staff regularly give presentations, poster sessions and manage booths at conferences, festivals and workshops to distribute information to stakeholders and the general public. Some of these local venues include the biennial New Mexico Watershed Forum and the annual Quivira Coalition Conferences and venues such as Santa Fe River Festival, Earth Day and the local farmer's market. NMED Wetlands Program also presents nationally at EPA and other group sponsored conferences. EWI also provides project outreach via meetings of the Galisteo Watershed Partnership and in connection to the wildlife conservation efforts in the Galisteo watershed.

Figure 30. Participants at Wetland Delineation Training at Galisteo Creek.

Between 2006 and 2010, annually EWI organized a series of walks, workshops and work days at various wetland sites, such as at the Eldorado Community Preserve (Cañoncito Arroyo), Galisteo Village, Galisteo Basin Preserve (Arroyo de los Angeles), San Marcos Arroyo, 3-Horse Ranch, and in the Cerrillos Hills. The walks, workshops and work days were crucial in mobilizing local Community Stewardship Teams of residents, school groups, and conservation organizations. The events helped educate people about wetland functions and needed wetland restoration work. Workshops focused on wetland botany, planting techniques, removal of non-native species, wetlands monitoring, open space functions, wildlife, and hands-on restoration work. Currently a number of these teams conduct wetlands monitoring, planting days, plant maintenance and watering and other restoration efforts on a regular basis.

Public News Media

Since the inception of the project, news about the wetlands assessment, planning, and pilot restoration work in the Galisteo Watershed has been shared with the media. This has generated several articles about wetlands in local newspapers as well as radio interviews on local radio networks.

Wildlife Conservation Initiatives

In 2008, EWI coordinated the development of a Galisteo Watershed Wildlife Corridor Group under the auspices of the Galisteo Watershed Partnership. The Wildlife Corridor

group and the Galisteo Watershed Partnership included many residents, community groups and conservation organizations that are also part of the community groups described above. This watershed-wide wildlife conservation initiative led to a statewide coalition of partners, the New Mexico Wildways coalition, which seeks to protect existing wildlife habitat and migration pathways through the Galisteo Watershed as part of a wildlife corridor along the spine of the continent from Alaska to Mexico. The Galisteo Creek and its associated wetlands play a crucial role in this continental wildlife corridor. EWI and the Galisteo Watershed Partnership will continue to collaborate with partners to restore and protect wetland functions to enhance wildlife habitat and corridor functions in the watershed.

5.c. Student Involvement and Formal Outdoor Education

Outdoor Education in Area Schools

Three local schools have been involved in outdoor education in association with wetland restoration and protection in the Galisteo Watershed. EWI provided outdoor education services to El Dorado Community School in Eldorado, Turquoise Trail Elementary School in the San Marcos District and Charter School 37 (Tierra Encantada Charter School) in Santa Fe. Other educational organizations in the area, such as the Santa Fe Botanical Garden, will continue to offer outdoor education in association with wetlands in the Galisteo Watershed to area schools in the future.

Eldorado Community School and Eldorado Community Preserve

El Dorado Community School (ECS) developed a Green Team for environmental awareness education and the development of outdoor classroom areas. The school's fifth grade class adopted the Cañoncito Arroyo Wetlands in the Eldorado Wilderness (community open space area) as one of its outdoor classroom areas. Students participated in outdoor environmental education events, tree planting, bird identification, and installation of bird boxes.

Turquoise Trail Charter School

Turquoise Trail Elementary has been involved with Santa Fe County and the Cerrillos Hills Park Coalition in outdoor classroom events and the production of educational outdoor signage in the Cerrillos Hills State Park. Additionally, students from this school received outdoor education in the Santa Fe River wetlands west of the municipal sewage treatment facility as part of EWI's Earth Action Education program.

Tierra Encantada Charter School

Under supervision of EWI staff, high school students from Charter School 37 (now Tierra Encantada Charter School) participated in restoration work of trails stream banks, and road sides at several sites upstream of the wetlands along the Arroyo de los Angeles drainage on the Galisteo Basin Preserve.

University of New Mexico

As of 2001, annually, the UNM Community & Regional Planning program supported the SWQB Wetlands Program/EWI to engage students in field learning through site assessments at various riparian and wetland sites, followed by a public presentation of

their findings. Students have conducted assessments of the riparian and wetland areas in Cañoncito, Galisteo, San Marcos Arroyo, and the Cerrillos Hills.

5.d. Community Stewardship Teams

EWI has played a leadership role in the area for the organization of residents, landowners, community groups, schools, and conservation organizations in Community Stewardship Teams (CST). These CSTs are designed to engage in a variety of activities as public service to protect wetlands and open space resources. CSTs in various forms are in place for wetlands in the Eldorado Wilderness (Cañoncito Arroyo Wetlands), Galisteo Creek in the Village of Galisteo, springs and wetlands in the Cerrillos Hills State Park, and the 3-Horse Ranch (Finger Lakes area). There is also community engagement for the San Marcos Arroyo wetlands, but not in the form of a CST.

Eldorado

The Eldorado Community Improvement Association's (ECIA) Conservation Committee serves as the CST for the wetlands in the Eldorado Wilderness. EWI staff participates on the committee and interacts with the committee for workshops and workdays. EWI, in association with the ECIA Conservation Committee, conducted workshops and workdays on trail maintenance and repair and restored a trail crossing at the bottom of the wetlands area to protect the wetland resource. In collaboration with the committee, EWI also organized botany and restoration workshops to motivate the local community to contribute to long-term wetland health.

Galisteo Basin Preserve

EWI has an ongoing collaborative relationship with Commonweal Conservancy, a non-profit conservation development organization in Santa Fe which is developing 12,000-acre land conservation program around a concentrated new village development project in the Arroyo de los Angeles drainage, called the Galisteo Basin Preserve (GBP). EWI and Commonweal Conservancy developed a conceptual plan for the development of a Community Stewardship Organization (CSO) which will be in charge of the long-term, landscape wide management of the GBP. In 2008, the conceptual CSO consisted of Commonweal Conservancy staff and EWI staff, working in conjunction with contractors for road management, erosion control, drainage planning, and managed grazing.

Galisteo

In 2007, EWI organized residents in the Village of Galisteo form a CST as a sub-committee of the Galisteo Community Association. This CST has been meeting monthly throughout 2008 and addressed issues related to the wetlands, trails along the Galisteo Creek, wildlife habitat along the Creek, and local educational events. The CST continued working on these issues in 2009 and 2010.

Cerrillos Hills State Park

EWI collaborated with Santa Fe County's Open Space and Trails Division, which owns the Cerrillos Hills Historic Park (now Cerrillos Hills State Park), and members of the Cerrillos Hills Park Coalition to coordinate spring and wetland restoration projects in that area. EWI, County officials, and Coalition members participated in numerous meetings

and walks to plan and review wetland restoration projects and reach agreement on restoration techniques, trail alignments, and public education. In mid 2009, the State Parks Division assumed daily management responsibilities for the park. The local Coalition will continue to operate in an advisory capacity to the State Parks and County Open Space agencies. Restoration and stewardship work has been completed for the Miner Spring. Projects are underway for the Shooting Gallery Arroyo wetlands and the Escalante Spring.

3-Horse Ranch

In 2009, EWI organized a local CST for the new 3-Horse Ranch and Cash Ranch subdivisions, which surround and include the wetlands and wet meadows of the Finger Lakes along the Galisteo Creek. The community is still developing after a series of land sales in 2006-2007 that created the subdivisions. The emerging community initially bonded in its successful fight against exploratory oil and gas drilling on their land in 2007-2008. However, the once looming oil and gas exploration also scattered the interest of many of the new property owners. Only three of more than ten have pursued construction projects and may eventually move to this land. Many others have begun searching for buyers for their properties. Despite these adverse circumstances, EWI has mobilized the landowners in a fledgling CST, strengthened by initiatives regarding wildlife habitat conservation.

San Marcos Arroyo

The wetland sites in the San Marcos Arroyo are owned by several private landowners. The arroyo wetlands upstream from the Highway 14 bridge, which runs across the San Marcos Arroyo, are owned and managed by The Archaeological Conservancy (with partial ownership by the State of New Mexico) as part of the San Marcos Pueblo site. The wetlands downstream from the bridge are owned by private individuals. EWI worked with all parties involved, including the NMDOT, the USFWS and WildEarth Guardians (contractor), to work out details for planned Russian olive thinning on both sides of the bridge. The State of New Mexico has received funding for channel reconstruction work on the west side of the bridge with the purpose of increasing water retention in the wetlands downstream. This work is scheduled to be implemented in late 2010.

5e. Steering Committee and Partnerships

Project Steering Committee

At the start of the project "Planning for Wetlands in the Galisteo Watershed", SWQB Wetlands Program and EWI formed a project steering committee including representatives from Santa Fe County, Santa Fe Conservation Trust, Santo Domingo Pueblo, US Army Corps of Engineers, and several private landowners. Between 2005 and 2008, the steering committee met several times per year to coordinate project activities. The goal of having a steering committee is to involve representatives from interested groups in the decision-making for project implementation.

Voluntary Restoration Actions

Several landowners have stepped forward to request assistance with voluntary restoration and stewardship activities. This has led to add-on projects funded through the NM River

Ecosystem Restoration Initiative, USFWS Partners for Wildlife grants, and private funding. Voluntary restoration initiatives included those on the Galisteo Basin Preserve, 3-Horse Ranch, San Marcos Arroyo (west of Highway 14), Romero Arroyo (Valencia), and in the Padre Springs on the Holian property (part of the Ranch at Padre Springs subdivision). Additionally, the US Army Corps of Engineers voluntarily restored and protected several wetlands in the Galisteo Dam reservoir as part of an initiative to remove tamarisk in the reservoir between 2007 and 2010.

Matching Support

Most of the education and outreach activities, voluntary restoration actions, and school-based projects have provided significant matching support to the initial EPA/NMED investments in planning and restoring wetlands in the Galisteo watershed. Matching contributions, both in-kind and through grants and other funds, have been nearly 8 times the initial federal investment of $140,000. Matching contributors are then able to spread the word about project activities.

Institutional Support

The wetland restoration and protection planning activities in the Galisteo watershed have mobilized a large number of parties. The project received institutional support from:

- Santa Fe County
- UNM
- USACE
- NMDOT
- NMED – River Ecosystem Restoration Initiative
- NM State Parks Division
- NM Department of Cultural Affairs, Historic Preservation Division
- Archaeological Conservancy
- Santa Fe Conservation Trust
- Commonweal Conservancy
- State Land Office
- BLM
- US Forest Service
- USFWS – Partners for Wildlife Program

6. ACCOMPLISHMENTS, FUTURE GOALS AND NEEDS, TIMETABLE

6.a. Accomplishments

Several protection measures were identified and put into place as a result of the process of creating this Wetlands Action Plan. These measures include:

- Inclusion of wetland planning in the Santa Fe County 2010 Sustainable Land Development Plan and Code and the 2008 "Oil and Gas Element" to the Land Use Code.
- Completion of report Wetland Assessment and Plan
- Completion of a watershed-wide Green Infrastructure plan and prioritization plan for open space and wetland restoration and protection
- Completion of an analysis of wetland functions and wetland values
- Completion of the development of wetland outreach and education programs and materials
- Completion of detailed assessments and designs for three pilot restoration sites
- Completion of restoration work on one pilot site
- Completion of many spin-off sites identified in the assessment and plan
- Postponement or possible abandonment of oil and gas drilling in and around wetlands in the Galisteo Watershed
- Leverage of nearly $650,000 for wetland restoration in the Galisteo Watershed and more than $500,000 in other parts of Santa Fe County between 2007 and 2012.

6.b. Future Goals and Needs

- Ongoing restoration and protection of wetlands according to prioritization in the Green Infrastructure plan for the Galisteo Watershed and in the Santa Fe County Sustainable Land Development Plan/Code and the County's Open Space plan updates
- Continued work with private landowners and NMDOT on wetland restoration and conservation easements to create protective buffers
- Expected wetland protection acreage by 2013 may reach more than 40,000 acres, including all conservation easement lands to date (more than 21,000 acres, not including Galisteo Basin Preserve), the Cerrillos Hills State Park (potentially 3,000 acres), the Eldorado Community preserve (4,000 acres) and the Galisteo Basin Preserve (12,000 acres). The expected acreage of protected and restored wetlands will reach over 100 acres.
- Detailed wetland assessment and mapping for the Galisteo Watershed
- Development and implementation of a monitoring and trends network of stream, springs and wetlands across the Galisteo Watershed
- Support for ongoing monitoring through Community Stewardship Teams at project sites
- Financial assistance for ongoing wetland restoration, development and protection on private and public lands
- Ongoing institutional and community support for wetland stewardship

6.c. Timeline

2010

- Complete restoration of 30 acres of wetlands and riparian areas throughout the Galisteo watershed (Cañoncito Arroyo, Shooting Gallery Arroyo, Escalante Spring, Galisteo Creek in the Village of Galisteo, Padre Springs area)
- Success monitoring of restored sites
- Application for financial support for ongoing stewardship work and monitoring
- Participate in Use Attainment Analysis for Galisteo Watershed
- Outreach to build capacity among Community Stewardship Teams

2011-2012

- Restoration of 10-30 acres of wetlands and riparian areas throughout the Galisteo watershed (Galisteo Creek in the Community of Valencia and in the Village of Galisteo; more work in Padre Springs area)
- Success monitoring of restored sites
- Application for financial support for ongoing stewardship work and monitoring: Development of pilot projects for Payment for Ecosystem Services (PES)
- Explore development of an "In Lieu Fee Program" in collaboration with Earth Works Institute and the Corps of Engineers
- Explore ways to complete mapping and classification of wetland resources. Participate in statewide mapping consortium.
- Outreach to build capacity among Community Stewardship Teams
- Complete Technical Guide for Wetlands

2013 and Beyond

- Restoration of more acres of wetlands and riparian areas throughout the Galisteo watershed (sites TBD)
- Success monitoring of all restored sites
- Application for financial support for ongoing stewardship work and monitoring: Implementation of pilot projects for Payment for Ecosystem Services (PES)
- Testing and implementation of an In Lieu Fee Program
- Identification of key wetland sites for reference standard, rare and endangered species, waterfowl and other important habitat features
- Condition assessment of wetland sublasses in the watershed
- Development of trends monitoring initiative involving County and private citizens
- Training volunteers to monitor wetland sites
- Development of database and website
- Continue to promote and add conservation easement acreage for wetlands and buffers
- Continue to participate in local community palnning iniatives that help protect wetland resources

- Continue to work with County and city floodplain managers to coordinate activities that protect and resore floodplains
- Continue groundwater studies for affects on local springs and seeps
- Outreach to build capacity among Community Stewardship Teams
- Contiue to define and safeguard wetland buffers through conservation easements or by local government ordinance to maintain their function and permanence.

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APPENDIX A
GALISTEO WATERSHED:
WETLANDS MAP FOR SANTA FE GROWTH MANAGMEMENT STRATEGY

Galisteo Watershed: Wetlands Map for the Santa Fe Growth Management Strategy

Final Report

2009

Natural Heritage New Mexico Publ. No. 09-GTR-336

The University of New Mexico

Santa Fe County

NATURAL HERITAGE NEW MEXICO

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Elizabeth Milford, Teri Neville, and Esteban Muldavin[3]

2009

Introduction

The Galisteo Growth Management Area (GGMA) is one of four areas defined by Santa Fe County for developing growth strategies. The GGMA is principally defined by the Galisteo watershed, is physiographically situated on the upland plateau south of Santa Fe and covers approximately 120,713 ha. The Galisteo Creek cuts through this upland region with its headwaters in the southern portion of the Sangre de Cristo Mountains and drains west into the Rio Grande (Figure 1). Any landuse planning strategy must account for wetlands associated with springs and streams such as the Galisteo and its tributaries Accordingly, the purpose of this project was to produce a suite of map layers in Geographical Information System (GIS) to support the determination of significant wetland and riparian areas within the GGMA as part of Santa Fe County's growth planning process.

Methods

Photo Interpretation and GIS Development

We used photo interpretive techniques in a GIS combined with field data acquired in the fall of 2008 and spring of 2009 to develop GIS layers indicating significant wetland and riparian areas within the GGMA. In addition to the wetland/riparian vegetation layer, we augmented existing GIS layers from Santa Fe County (SFCO) and the U.S. Geological Survey (USGS) representing physical features of the landscape and manmade structures. Color-infrared and natural-color aerial photography acquired in August of 2005 were used in the photo interpretive process (New Mexico GDACC 2007). An area covering approximately 1,052 ha (2599 ac) in the far northeast corner of the study area is not covered by the color-infrared photography and was therefore excluded from the map. Digital orthophoto quarter quads (DOQQs) derived from the aerial photography were used in the mapping. These had a one-meter spatial resolution and were produced to meet National Map Accuracy Standards (NMAS) requirements for 1:12,000-scale products. However, the quality of the imagery allowed for visual interpretations at a

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[1] Throughout this document the term wetlands is defined as both jurisdictional wetlands and vegetated riparian zones.

[2] Work submitted in fulfillment of Agreement No. 28-0150-GM/JS between the University of New Mexico and Santa Fe County. Suggested citation: Milford, E., T. Neville, and E. Muldavin. 2009. Galisteo Watershed: Wetlands Map for the Santa Fe Growth Management Strategy. Natural Heritage New Mexico Publ. No. 09-GTR-336. Natural Heritage New Mexico, University of New Mexico, Albuquerque, NM. 12 p.

[3] Elizabeth Milford, Associate Ecologist, Teri Neville, GIS Coordinator, and Esteban Muldavin, Ecologist and Ecology Group Leader for Natural Heritage New Mexico, Museum of Southwestern Biology, Department of Biology, University of New Mexico, Albuquerque, NM.

higher resolution scale of 1:3,000. Color infrared was particularly useful in separating wetland from upland areas, even when these areas were dry.

We used the USGS National Hydrography Dataset (NHD) Flowline layer as a guide for finding potential wetland and riparian areas. The dataset comprises approximately 2,175 linear kilometers of perennial and ephemeral reaches within the study area (Figure 1). Each segment was surveyed in the GIS and annotated. The USGS Geographic Names Information System (GNIS) was also used as a guide to indicate where known reservoirs, dams, and springs were located within the study area. As a result, this layer was augmented with over 200 additional point features during the desktop survey, principally to better represent impediments such as earthen dams and tanks within the drainages that affect the natural hydrology.

The SFCO GGMA Structures GIS layer was also augmented, with 67 new locations. Most of these new structures were small trailers and buildings. In addition to augmenting existing GIS layers, NHNM created and populated a new GIS layer for larger structures and other areas of disturbance within the drainages. This new feature class is the GGMA PolyFeatures layer and contains 127 labeled polygons. These augmented and new layers were created to be used in spatial analyses to determine potential impacts to riparian/wetland areas. These layers can now be used in a GIS-based assessment of wetland condition, which can aid the planning process in both identifying existing wetlands of high quality for conservation, and in targeting wetland areas in need of restoration.

Field Collection

We conducted three field trips in 2008 (October 24, November 7, and November 14) and one trip in 2009 (June 3) to identify dominant wetland types and improve the accuracy of the photo interpretation process (Figure 1). Prior to field reconnaissance, we selected the most promising photo-interpreted polygons and generated maps from the GIS for field use. Since the majority of lands within the watershed were privately owned, most field data was collected at or near roads. Privately owned lands were only visited if direct permission had been obtained from the landowner or manager. If new riparian/wetland areas were seen in the field that had not yet been photo-interpreted, we recorded these data on field data sheets, marked approximate locations on maps, and collected GPS position data. We recorded dominant species and relative percent of vegetation comprised of exotic species. We collected a total of 36 field plots for the study area.

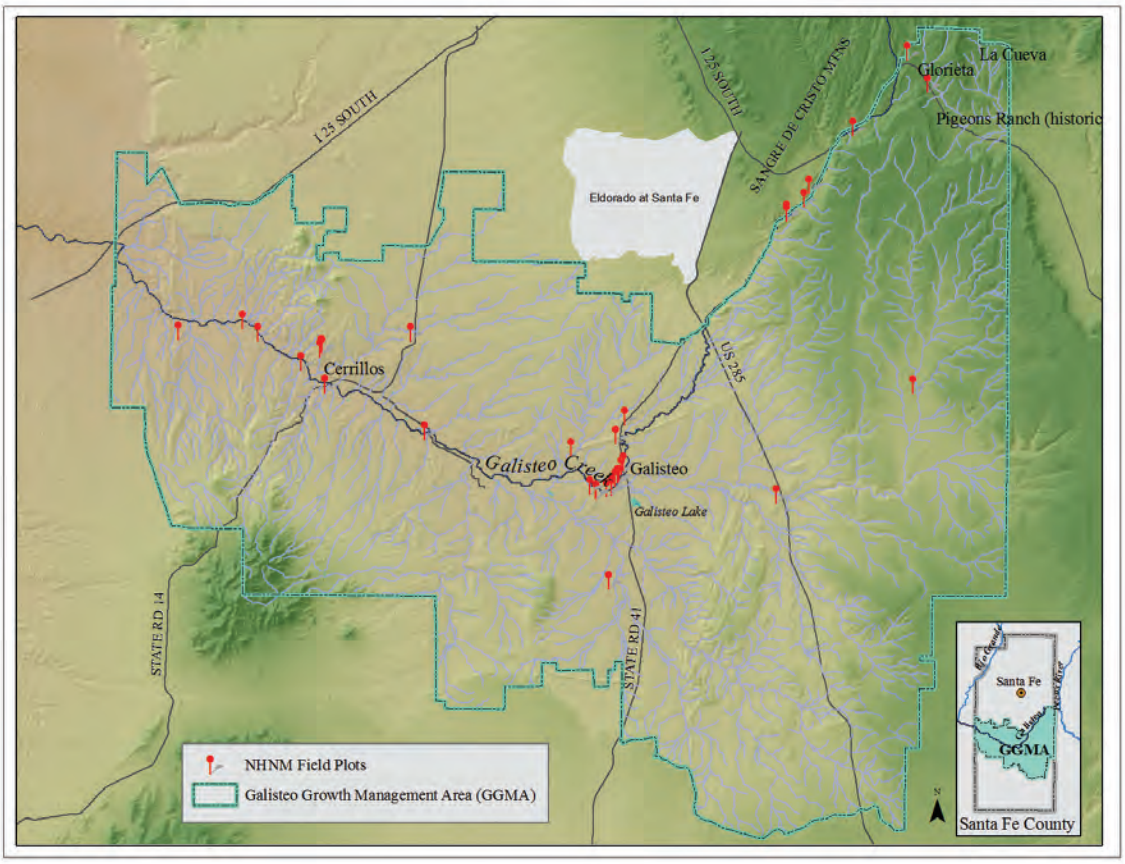

Figure 1. The Galisteo Growth Management Area and location of field plots.

Results

Photo Interpretation and GIS Development

Photo interpretation to determine species composition was based on differences in texture and color of the images and context, based on knowledge of individual reaches from field visits. Trees, shrubs and herbaceous vegetation can generally be distinguished from one another based on texture. Color, used in concert with texture, allows for the differentiation of the dominant woody species from one another. Salt cedar (*Tamarix ramosissima*) is generally distinguishable from coyote willow (*Salix exigua*), cottonwood (*Populus deltoides* ssp. *wislizeni*) and Russian olive (*Elaeagnus angustifolia*) based on color in the near infrared, while Russian olive can best be distinguished from cottonwood using natural color. However, photo interpretation is a somewhat qualitative process as the range of color on the photos differs within and between DOQQs. This occurs because of date and time of day differences in the acquisition of the photo and/or physiognomic differences related to maturity, or seasonality for the plants. For example, a young, dense stand of Russian olive can appear much the same as a young, dense stand of cottonwood; field data are particularly useful in these cases. At times, the young, moderately dense stands of salt cedar can also be confounding and appear similar to coyote willow stands. These apparent similarities may be due to varied reflectance attributed to stand age and substrate saturation. More often, these stands are differentiated on infrared color, salt cedar being a darker red. Vegetation in towns and residences adjacent to the riparian

areas were not delineated. However, within the Glorieta area at the northeast corner of the study area, much of the development was within the current floodplain and therefore included in the interpretation.

A total of 651 polygons comprising approximately 858 ha were generated, representing potentially significant riparian and wetland areas within the study area. Small, isolated impoundments due to earthen dams or tanks were not considered significant riparian or wetland areas. Polygons were attributed with broad to specific categories based on taxonomy and native versus exotics. The higher physiognomic category, labeled "Class," contains seven subsets, and they are: Closed Woodland, Open Woodland, Sparse Woodland with Shrubs, Sparse Woodland with Grasses, Shrubland, Herbaceous Wetland, and Herbaceous. These are principally distinguished by percent canopy cover of trees relative to total vegetative cover (Table 1). Shrublands comprise the greatest amount of area delineated (416 ha); while, not surprisingly, Herbaceous Wetland had the least (12 ha). Much of the Shrubland class is dominated by salt cedar, with lesser amounts of coyote willow and minor amounts of rubber rabbitbrush (*Ericameria nauseosa*). Herbaceous Wetlands often occur near impoundments or, in rare cases, as seeps within the Cerrillos Hills Historic Park outside of the town of Cerrillos.

Table 1. Classification based on percent cover of trees.

%Cover Trees	Class	Ha
>60	Closed Woodland	101
25-60	Open Woodland	111
10-25	Sparse Woodland with Shrubs	92
10-25	Sparse Woodland with Grasses	40
<10	Shrubland	416
<10	Herbaceous Wetland	12
<10	Herbaceous	56

Each polygon contains numerous species. However, we limited attributing the GIS layer to the three most dominant species we could interpret and placed them into categories: Species1, Species2, and Species3, with dominance in descending order. The choices were limited to the following species/vegetation group subsets: Cottonwood, Russian olive, Salt cedar, Salt cedar Treated, Coyote willow, Herbaceous, Herbaceous Wetland, Juniper, Rubber rabbitbrush, and Other. The subset Other was typically a species not in our subset list either because it was an upland species or because it rarely occurred as a dominant. Siberian elm (*Ulmus pumila*), often found near or within drainages of towns, such as Cerrillos, is an example of one species grouped in the 'Other' category.

For each polygon we attributed a percent 'Exoticness' which combines cover of all exotic species into percent of exoticness relative to total vegetative cover. Values range from 0-100%. Examples of 100% cover can be found near the Galisteo Dam where mechanical removal is currently taking place. Since the aerial photography was acquired in 2005, any removal or active management occurring within the study area after August 2005 was not captured, but after field visits we delineated areas of treatment.

Map Units

Vegetated wetlands and riparian areas for the GGMA are delineated by dominant species and relative exotic species composition. The outcome is a GIS layer attributed with a higher-order physiognomic category, dominant-species composition, percent exotics, and a map-unit classification for each polygon. The map, containing over 650 polygons, is not limited to native-dominated wetlands, but comprises the full range of native to exotic.

The map legend is based on dominant species and percent of exotic encroachment (Table 2). We developed a scale of exoticness (EScale) based partially on restoration potential. The three scales are: 0-25, 26-65, and 66-100. The 0-25% scale is considered 'Native' with 26-66% considered 'Mixed', and greater than 66% 'Exotic'. These were: cottonwood, the most common native riparian tree; Russian olive, the most common exotic tree; coyote willow, the most common native shrub; and salt cedar, the most common exotic shrub. Other riparian trees and shrubs, both native and exotic, occur within the GGMA, but are not commonly stand dominants. Herbaceous stands are difficult to differentiate to species using digital aerial photography and were thus grouped into two broad, general subsets of either Herbaceous Wetland or Herbaceous. The subset Herbaceous Wetland included areas composed primarily of emergent or obligate wetland species with perennial to seasonal flooding, while Herbaceous consisted of all other herbaceous types. Polygons that were dominated by upland or arroyo riparian species were assigned to the "Other" map unit and were mostly dominated by juniper (*Juniperus* sp.), rubber rabbitbrush, or Siberian elm.

Table 2. Map legend.

Species 1	Exotic Scale (EScale)	Legend Name
Cottonwood	0-25	Cottonwood Native
Cottonwood	26-65	Cottonwood Mixed
Russian olive	26-65	Russian Olive Mixed
Russian olive	66-100	Russian Olive Exotic
Salt cedar	26-65	Salt Cedar Mixed
Salt cedar	66-100	Salt Cedar Exotic
Salt cedar treated	26-100	Salt Cedar Treated
Coyote willow	0-25	Coyote Willow Native
Coyote willow	26-65	Coyote Willow Mixed
Herbaceous Wetland	0-25	Herbaceous Wetland Native
Herbaceous Wetland	26-65	Herbaceous Wetland Mixed
Herbaceous	0-25	Herbaceous Native
Herbaceous	26-65	Herbaceous Mixed
Herbaceous	66-100	Herbaceous Exotic
Other*	various	Other
**Combined dominates of: Other or Juniper or Rubber rabbitbrush*		

Wetland/Riparian Vegetation Distribution

Exotics dominate the 858 ha of mapped riparian and wetland areas within the GGMA. Exotic-dominated stands comprise approximately 57% of the total vegetative cover with mixed and native at 29% and 13%, respectively. Considering the overall distribution of native-to-exotic (Figure 2), exotics comprise 493 ha. Salt cedar-dominated stands are the most common exotic type, comprising 81% of the total exotic-dominated area, followed by Russian olive-dominated stands at 19%. Less than 1% of the exotic-dominant area is categorized as Herbaceous Exotic.

Mixed-dominance stands comprised 251 ha, or nearly one-third of the mapped wetland area. Mixed-native dominated stands make up 59% of the total mixed-dominance area, with Cottonwood-dominated stands being the most common native-dominated mixed-stand type at 28% of the total mixed-dominance area, followed by Coyote willow (10%), Herbaceous (10%), Other (9%) and Herbaceous Wetland(2%). Mixed exotic stands were dominated by either Russian olive or Salt cedar, with 21% and 20% of the total mixed-dominance area, respectively.

Native-dominated stands (114 ha) comprised approximately one-eighth of the total mapped wetland area. Among native-dominated stands, cottonwood was the most common dominant, comprising 50% of the total native area. Less commonly dominant were Herbaceous (35%), Coyote willow (8%), and Herbaceous Wetland (7%).

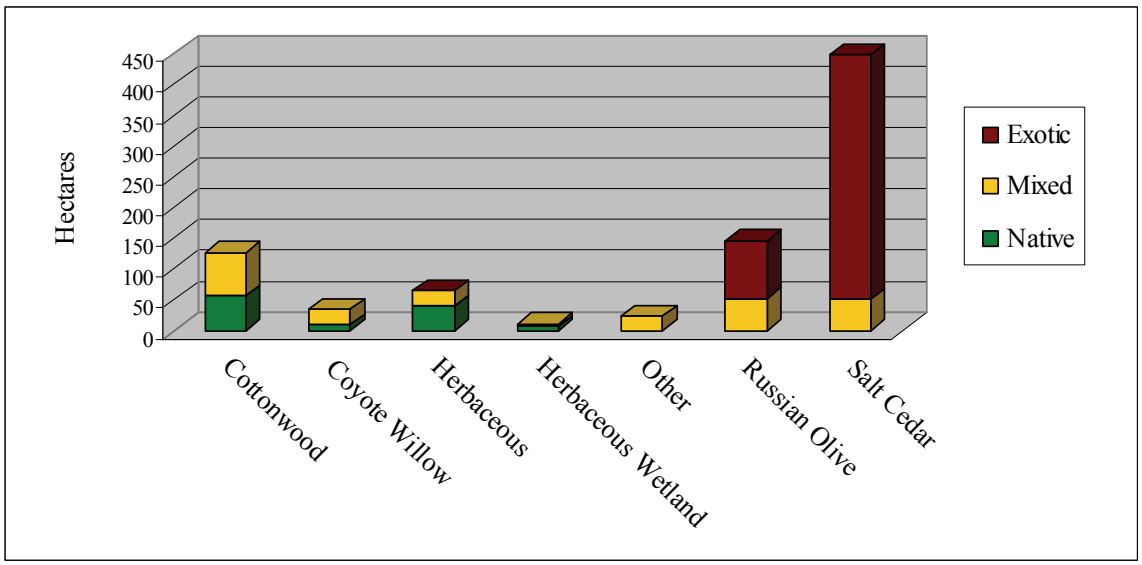

Figure 2. Distribution of dominant species categories and native-to-exotic characterization.

Overall, the encroachment of salt cedar is pervasive within the GGMA (Figure 3). Only in the northeastern portion of the study area, as Galisteo Creek flows southwest from Glorieta prior to its westward flow at Galisteo, are natives more abundant than exotics. Additionally, within Galisteo Creek, adjacent to the towns of Cerrillos and Galisteo, lie some of the best native woodlands. An example of the map at higher spatial resolution (Figure 4) shows an area of considerable ground control and access to the riparian areas at Galisteo. The Cottonwood Mixed stands within this reach contain

coyote willow, scattered tree willow and Russian olive with a diversity of herbaceous vegetation.

As a first level of analysis, to identify the high-quality wetland areas within the GGMA, we created a map of the native-dominated stands (Figure 5). Because native-dominated stands only comprised about one-eighth of the total riparian/wetland area mapped, we also included native-dominated mixed stands due to their potential for restoration. Three major areas stand out as having potential high-quality riparian/wetland areas. The first is in the lower Sangre de Cristos and includes the areas along Glorieta Creek and the headwaters of Galisteo Creek. The second is a series of sites along lower Galisteo Creek, divided into three sub reaches: (a) around the town of Galisteo, extending both to the north and west from Galisteo; (b) along Galisteo Creek between Chorro Arroyo and Arroyo de la Vaca; and (c) along Galisteo Creek around the town of Cerrillos. The third major area of potential high-quality wetlands is along San Cristobal Arroyo to the east of Cañada Estacada. Because this area is on private land, it was mapped based on imagery, with only one field point taken from a bridge on State Road 285. Therefore, additional field visits are needed for validation and inclusion into a group of potential high-quality wetland sites.

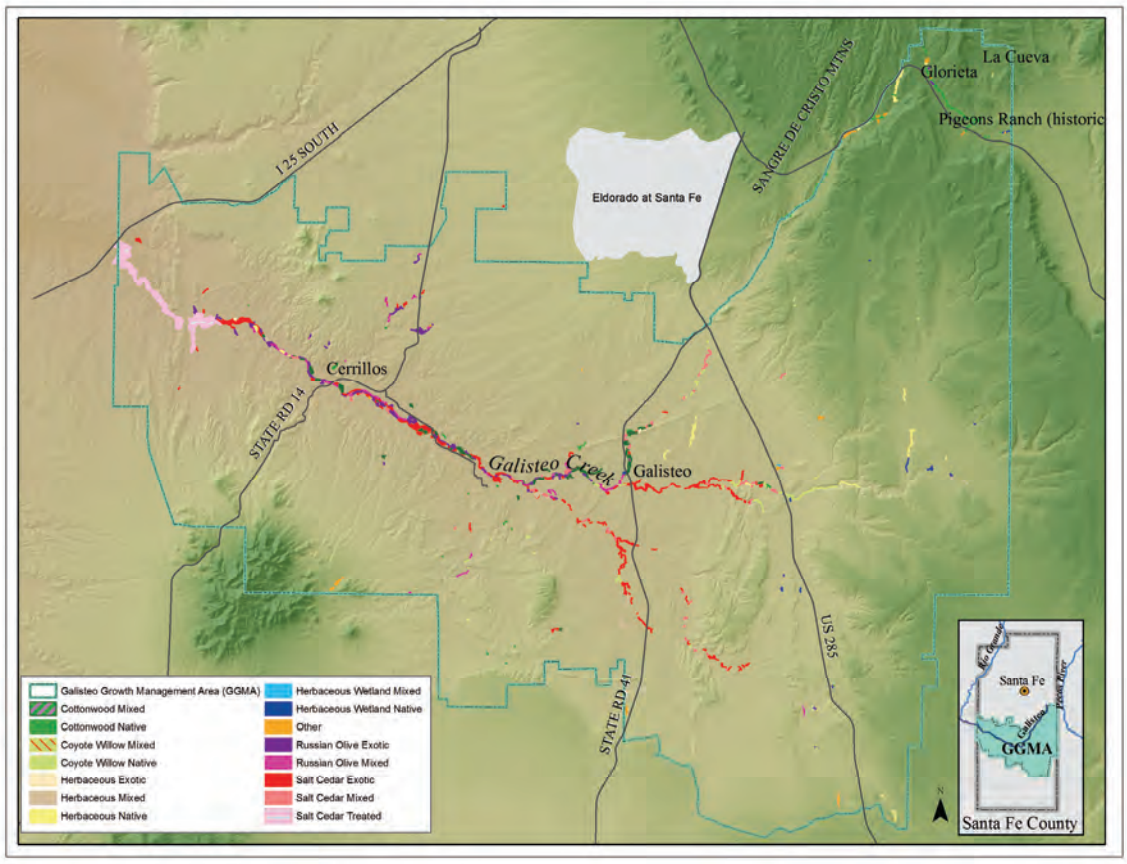

Figure 3. Final Riparian/Wetland vegetation map for the GGMA.

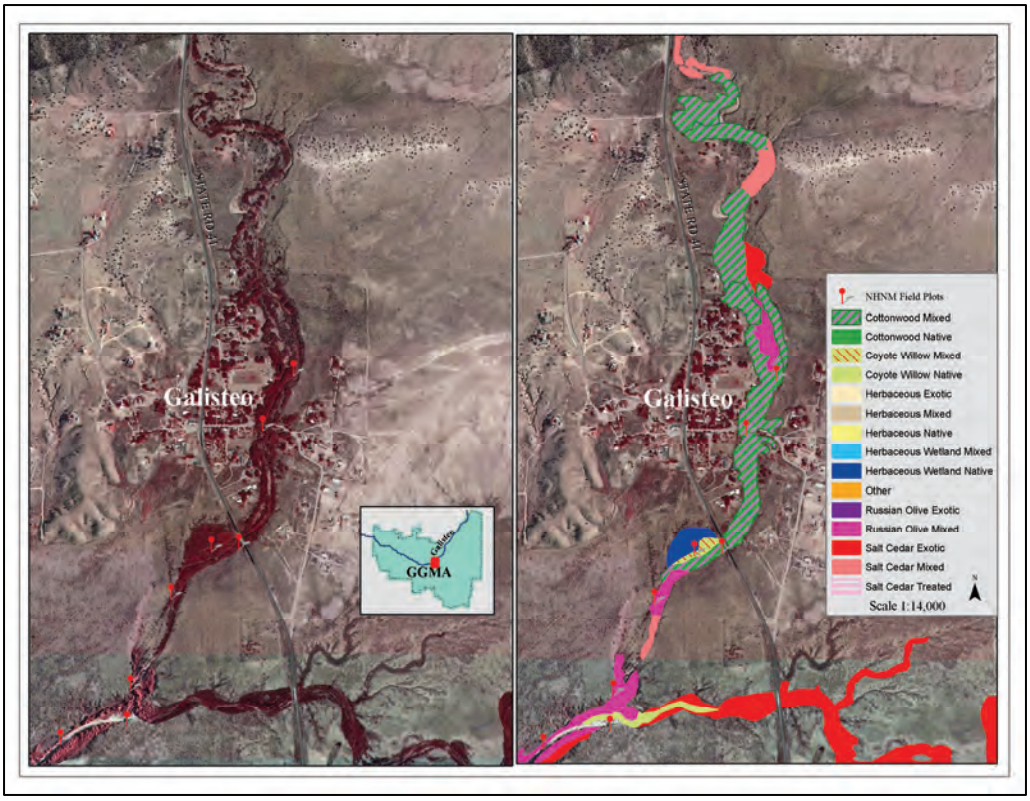

Figure 4. Color infrared orthophotography (left) and an overlay of the wetland/riparian map units (right).

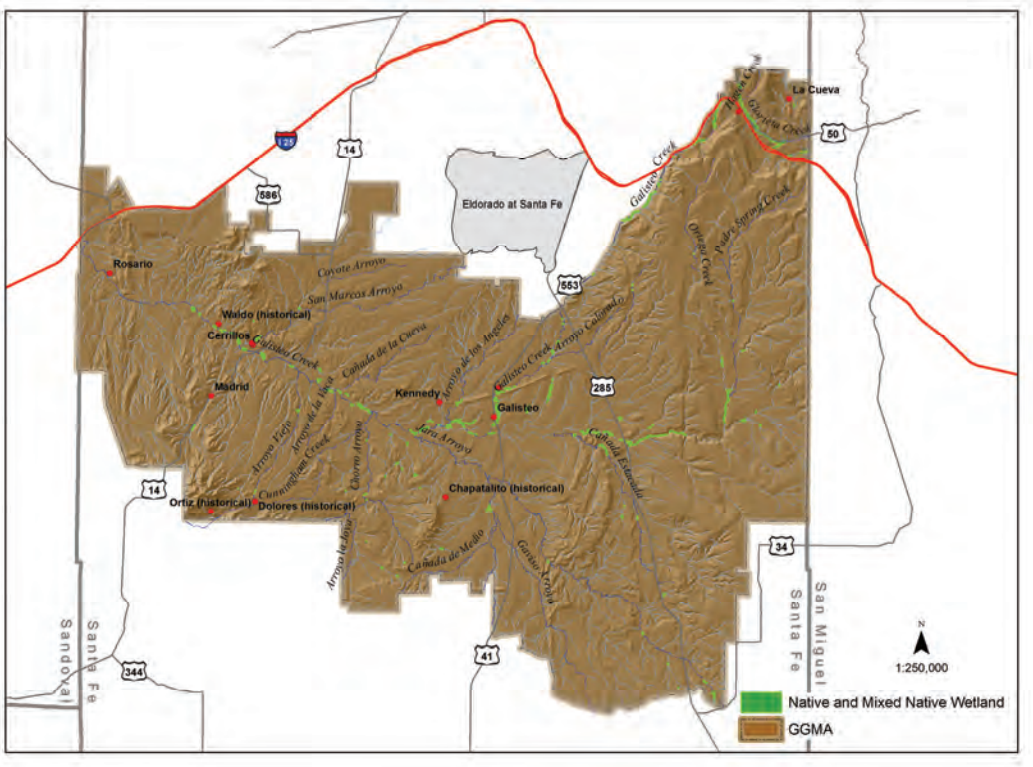

Figure 5. Map of native and mixed-native-dominated riparian/wetland stands.

Discussion

Stands designated as native dominated should receive the highest conservation priority, particularly considering their minor contribution to the overall wetland/riparian area within the GGMA. Due to large areas of encroachment by exotics, stands that are mixed but native dominated may also be good conservation targets. Ultimately, addressing the question of where the highest-quality wetland and riparian sites exist within the GGMA should include further GIS analysis to assess stands at a landscape level. This analysis may include an assessment of contiguous wetland area, dominance, and sustainability based on known threats derived from the layers of physical features and manmade structures developed under this contract. Additional data that may be available on wildlife use, threats such as planned development, and cultural or recreational value could be used to identify wetland quality and conservation priority.

Mixed stands may provide areas for potential restoration when taken in the context of the surrounding landscape and plant-species dominance. Mixed stands with a relatively intact hydrologic system and/or relatively substantial nearby communities of native-dominated vegetation would be priority restoration sites. Further analysis of the map will be required to identify the mixed sites most suitable for restoration.

Stands that are exotic dominated would most likely be lowest on the conservation and restoration priority list. However, in some cases, exotic-dominated sites might have high restoration potential based on hydrology, surrounding wetland vegetation communities for connectivity, and a lack of major stressors. Both mixed- and exotic-dominated riparian/wetland sites may also be providing significant habitat for wildlife, and are still part of the rare wetland resources within the GGMA that should be given consideration during county planning.

Based on the maps created for this project, it is clear that there are limited wetland/riparian areas within the Galisteo Growth Management area, most of which are concentrated around Galisteo Creek. However, the wetland and riparian areas of the GGMA currently have significant upland natural areas and largely intact hydrology. This provides the county with a window of opportunity to carefully plan growth to manage and preserve the unique biological and cultural resource that these riparian/wetlands provide.

Acknowledgements

Our thanks to Steve and Amy Tremper, Managers of the Cerro Pelon Ranch, for providing access to portions of the ranch for mapping purposes. Additionally, Jan-Willem Jansens of Earth Works Institute provided valuable feedback on the draft map.

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APPENDIX

Deliverables

The map and associated legend provides the first step toward understanding the existing diversity and exotic encroachment issues within the GGMA. Other GIS products developed and augmented as part of this project can be utilized to further our understanding of the status of the surface hydrological system within the basin. With this final deliverable, we provide a CD that contains the report and GIS feature class layers in a geodatabase (geodb folder, Version ArcGIS 9.3) along with associated files including the legend and metadata. A list of items on the CD:

1. Report: *GalisteoWetlandsFinalMapReport.pdf*. Final report in Adobe Acrobat format.
2. Point feature class: *WetlandFieldPlotsFinal.* This layer contains plot locations from field visits attributed with notes and percent cover of dominant species. Note: Plots on private land are not included in the deliverable.
3. Polygon feature class: *GGMAWetlandFinal.* This is the final wetland/riparian area delineation for the study area. The principal legend is based on the attribute 'LegSpExotic', however, other attributes can be used to further analyze the composition of the map unit and amount of encroachment by exotics.
4. Point feature class: *GGMA_GNISSelect*. This is the USGS Geographic Names Information System (GNIS) layer derived from the on-line dataset in 2007. NHNM added over 200 point features to this layer representing earthen dams, dams, springs, and tanks observed during the photo interpretive process.
5. Polygon feature class: *GGMA_Structures*. Derived from the SFCO Structure point layer, NHNM added 67 locations that mostly include small structures, trailers, and buildings. These were categorized by type of structure and a buffer attribute assigned to them according to their estimated size.
6. Polygon feature class: *GGMA_PolyFeatures*. NHNM digitized 127 polygons representing diverse disturbances within and upland of drainages. These polygons include agricultural fields, fields, mining areas, sewage ponds, borrow pits, large buildings and ranch facilities, and other diverse disturbances that may impact the function of the hydrology of the basin.
7. Layer Files: *GGMA_WetlandFinalJune2009solid.lyr* and *GGMA_WetlandFinalJune2009outline.lyr*. These can be used to apply symbology seen in the report (…solid.lyr) or an additional symbology layer providing just an outline of the map units. Symbology/legend is based on the attribute LegSPExotic.
8. Metadata: .xml and .html format.
9. Photos: .jpg format labeled with PlotID to match GIS feature class FieldPlots. There may be more than one photo per PlotID which is followed by the cardinal, inter-cardinal direction, or description of an observation. Photos are organized in separate folders by collection date. Note: Photos taken on private land are not included in the deliverable.

APPENDIX B
ASSESSMENT AND PLAN FOR THE CREATION, RESTORATION AND PROTECTION OF WETLANDS IN THE GALISTEO WATERSHED

Assessment and Plan for the Creation, Restoration and Protection of Wetlands in the Galisteo Watershed

Planning for Wetlands in the Galisteo Watershed

As part of U.S. Environmental Protection Agency Cooperative Agreement
with the New Mexico Environment Department
#C976733-01-0 (FY2004)

Steven S. Vrooman
Earth Works Institute

July, 2006

Introduction

The "**Planning for Wetlands in the Galisteo Watershed**" project is funded through the United States EPA Clean Water Act Section 104(b)(3), and managed by the New Mexico Environment Department's Surface Water Quality Bureau. This report satisfies tasks 2 and 3 of this project. Task 2 of this project is to develop wetland creation, restoration and protection plans for seven high priority wetland areas. Task 3 involved identifying and assessing additional wetlands and historic wetlands in the Galisteo Watershed.

The seven high priority wetland areas include:

1) Rowe Mesa Wetlands and Springs
2) Eldorado Wilderness along CR 51
3) Arroyo de Los Angeles at the Galisteo Basin Preserve
4) Village of Galisteo down to the Junction with San Cristobal Arroyo
5) Finger Lakes and Galisteo Creek at Tingle and Barclay Ranches
6) San Marcos Arroyo and the Cerrillos Hills Historic Park
7) Galisteo Reservoir downstream to the Rio Grande

Additionally, several smaller wetlands and springs were identifies and assessed in the headwaters area of the Galisteo watershed.

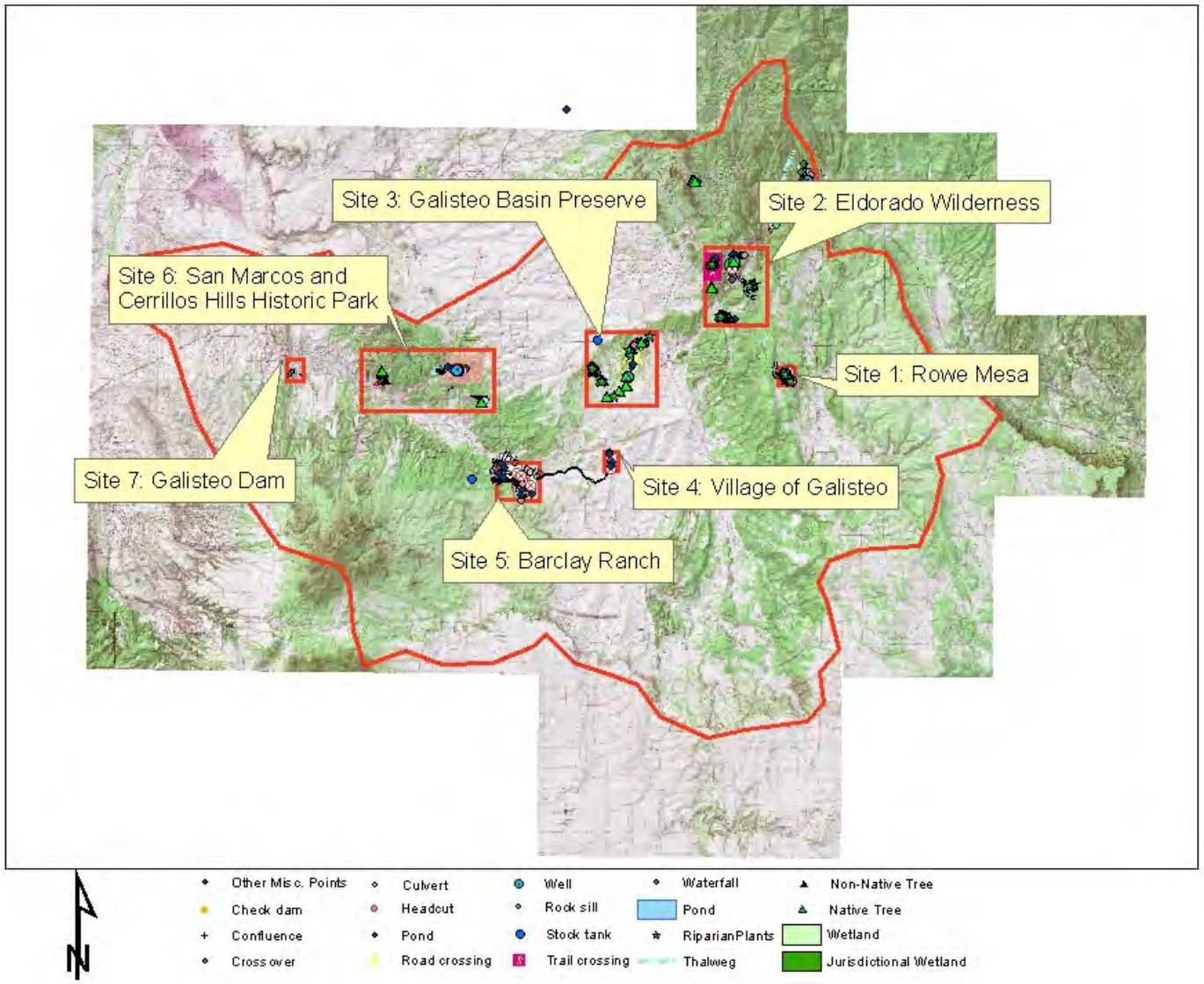
Watershed Background

The Galisteo Watershed is a 730 square mile watershed to the east and south of Santa Fe, NM. The Galisteo Creek originates at 9,500 feet at Thompson Peak in the Sangre de Cristo Mountains and meets the Rio Grande at 5,000 feet at Santo Domingo Pueblo. The Galisteo Creek is classified as a perennial-interrupted or intermittent stream with a flashy flow regime. At the present time, only about 10 percent of the 54 mile stream length is perennial. The upper watershed above the Village of Galisteo is primarily fed by snowmelt, while the Galisteo Creek downstream from Galisteo to the Rio Grande is ephemeral and primarily fed by rain storms.

In many places, the Galisteo Creek is incised into the landscape, which has dried out former wet meadows and wetlands which were fed by stream water and shallow groundwater. This incision has been a relatively recent phenomenon that has occurred over the last 120 years. One major factor which began this incision was the construction of the Atchison-Topeka & Santa Fe (AT&SF) Railway in the 1880s, which ran for much of its length down the old streambed, displacing the Galisteo Creek and reducing the width of the floodplain. The introduction of the railroad also greatly changed the economy of the region, and large scale grazing of sheep, goats, and cattle began soon after the railroad was built.

By 1920, the open range had ended, and cattle were being increasingly concentrated into ranches and the bottomlands of the creek. Grass cover was greatly reduced, and overgrazing was common throughout the watershed. The 1920's Dust Bowl drought caused increased desertification and continued incision of the Galisteo Creek. The Galisteo Creek incised about 15 feet into the landscape, drying out many old wetland areas and wet meadows. Another major drought in the 1950s brought with it large flooding events which washed out the bridge in Cerrillos and probably caused greater down-cutting and incision of the Creek.

Galisteo Wetlands Planning Project Overview Map



Prior to the building of the AT&SF Railway and large-scale grazing and resource use, the Galisteo Watershed may have contained as many as 5,000 acres of wetlands or riparian areas. While this was about 1 % of the total watershed area, this was the most biologically productive part of the landscape. Due to the landscape degradation that has occurred over the last 120 years, the Galisteo Watershed may now contain less than 1,000 acres of wetland, wet meadow, or riparian ecosystems.

Project Purpose: Planning for Wetlands in the Galisteo Watershed

The Galisteo Watershed has lost about 80% of its wetland areas in the last 100 years. This is a loss of the most productive and biologically important lands in this desert landscape. Wetlands, riparian areas, and wet meadow ecosystems are among the most productive ecosystems in the Southwest. They provide food, water, and cover for wildlife and in some areas forage for livestock. In addition, they sustain a great variety of hydrologic and ecologic functions vital to ecosystem integrity. These functions include flood abatement, sediment retention, groundwater recharge, nutrient capture, and plant and animal diversity.

A large portion of the land in the Galisteo Watershed (69%) is privately owned and large ranches are gradually being converted for residential development. This rapid rate of urbanization at four times the national average underscores the urgency of wetland planning and conservation actions in the area. In addition, a long-term drought began in 1996, and water resources for wildlife and vegetation are more at a premium than ever before.

The NMED Surface Water Quality Bureau Wetlands Program developed in 2003 aims at producing and implementing Wetlands Action Plans in New Mexico watersheds. Earth Works Institute (EWI) identified the restoration of wetlands as a major goal in the 2005 draft update of its Watershed Restoration Action Strategy (WRAS). Since 1998, EWI has implemented a number of riparian restoration projects, some of which included wetland restoration (oxbow wetlands).

The purpose of the "**Planning for Wetlands in the Galisteo Watershed**" Project is to begin an expanded effort to create, restore, and protect wetlands in the Galisteo Watershed. The project will begin with a focus on seven high priority wetland areas spread throughout the watershed. Wetland Assessment and Protection plans have been created for these seven areas, and two of the areas will be chosen for wetland restoration projects. In addition, the project involves mapping other wetland and potential wetland areas in the watershed to begin the process for their recognition and protection.

Area 1: Rowe Mesa Wetlands and Springs

Site: Beneficial Farm
Owner: Steve Warshauer
Date: July-August 2005

Description of Site

Beneficial Farm is an Organic Community Supported Agriculture Farm on Rowe Mesa. The Arroyo Salado runs through the farm and contains several potential wetland areas and several springs. The Arroyo runs through a wide grassland and then enters a forested area where it enters a box canyon. The owner of Beneficial Farm has built a dam at the head of the box canyon to prevent any incision of the arroyo upstream of the dam.

Steve Vrooman, Mark Kaltenbach, and David Petrie performed the site investigation during July and August of 2005. The Arroyo Salado was investigated for wetland areas from the upstream to the downstream end of the Beneficial Farm property. One moderately sized wetland area was found near an old windmill and a well in the grassland portion of the Arroyo. Two small spring pools with wetland vegetation were investigated in the box canyon portion of the property. Other small areas of wetland vegetation were also mapped along the Arroyo.

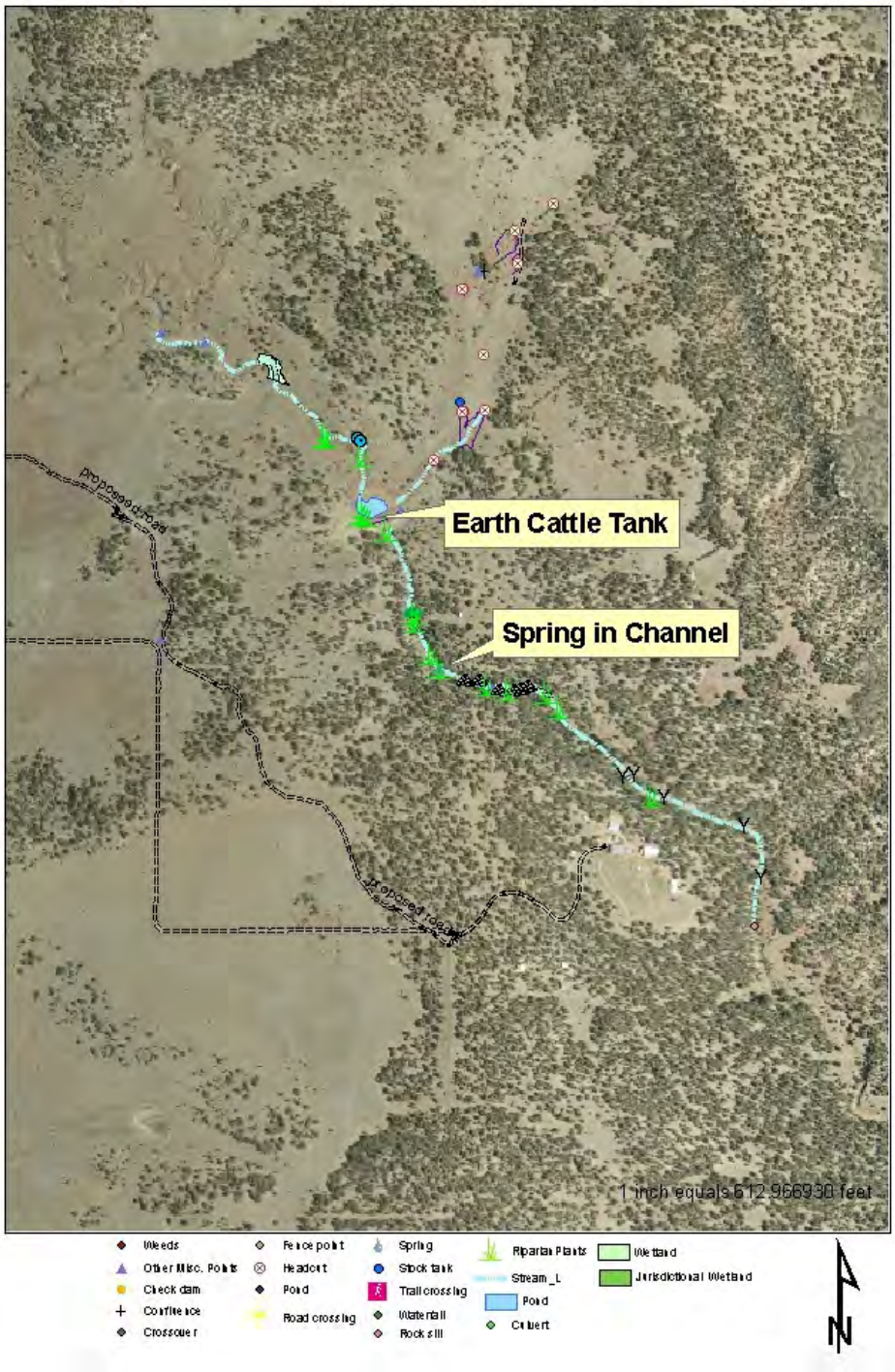
Site Assessment for Beneficial Farm:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Wetlands, ponds, vegetation, thalweg, headcuts	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species in channel	Assessment of diversity
Line-Point Intercept	One transect across upper wetland near well	Monitor condition of wetland community
Geomorphology cross-section	One transect at riffle between upper wetland and cattle tank	Bankfull cross-sectional area, monitoring elevation

GPS Mapping:

The thalweg of the Arroyo Salado, as well as other important geomorphic features such as headcuts were mapped using a Trimble sub-meter GPS. Areas of wetland vegetation, ponds, and confluences with other drainages were mapped. The locations of other monitoring techniques were also mapped. The accuracy of the mapping techniques is high enough to allow for future re-mapping to compare any changes in the area of wetland vegetation between the two measurements. All data from the GPS was used to create the overview map of the area using ArcView 9.1.

Beneficial Farm



Routine Wetland Determination Results for Beneficial Farm

We chose the upper windmill wetland site on Arroyo Salado as the most likely site to be a wetland, due to the vegetation and the presence of a shallow well.

Vegetation: Seventy percent of the dominant species at the upper wetland had a wetland indicator status of Obligate, Facultative Wet or Facultative, therefore wetland vegetation was present.

Hydrology: The soil was not saturated until 2 feet down. While the wetland held water in the spring of 2005, it was decided that wetland hydrology was not present.

Hydric soil indicators: There was no indication of gleyed or reduced soil, and no sulfur odors. Hydric soil was not present. While this area has many indicators of a wetland, the permanent water table appears to be too low to meet the criteria for wetland delineation.

Species List for Beneficial Farm:

Scientific name	Common name	Wetland indicator status
Agrostis stolonifera	Redtop	Fac+
Bouteloua gracilis	Blue grama	Upl
Carex nebrascensis	Nebraska sedge	Obl
Conyzia canadensis	Horseweed	Facu
Cylindropuntia imbriata	Cholla	Upl
Distichlis spicata	Salt grass	Fac+
Eleocharis palustris	Creeping spikerush	Obl
Elymus delgado	Slender wheat	Facu
Elymus smithii	Western Wheat	Fac-
Erigeron coulteri	Fleabane	Facw
Glandularia bipinnatifida	Verbena	Upl
Grindelia squarrosa	Gumweed	Facu
Melilotus officinalis	Yellow sweet clover	Facu+
Muhlenbergia asperifolia	Scratchgrass	FacW
Poa pratensis	Kentucky bluegrass	Facu
Prunus virginia	Choke cherry	Fac, Fac-
Ratibida tagetes	Mexican hat	Upl
Ribes cereum	Wax currant	Facu
Rumex crispus	Curly dock	Upl
Schizachyrium scoparium	Little bluestem	Facu
Sporobolus contractus	Spike dropseed	Upl
Xanthium strumarium	Cocklebur	Facw-

Line Point Intercept at Beneficial Farm, upper wetland by windmill:

Scientific Name	Common Name	Percent cover (all canopy layers included)
Elymus smithii	Western wheat	45
Melilotus officinalus	Yellow sweet clover	45
Muhlenbergia asperifolia	Alkali muhly	14
Ratibida tagetes	Coneflower	12
Distichlis spicata	Inland saltgrass	8
Bouteloua gracilis	Blue grama	4
Grindelia squarrosa	Gumweed	4
Eleocharis palustris	Creeping spikerush	2

Vegetation Results for Beneficial Farm

The upper wetland near the windmill was chosen as the most likely to be a wetland, but the hydrology and soil indicators were not present. The vegetation found here is typical of areas just uphill from a wetland, such as saltgrass and Western wheat. This area has recently come under Beneficial Farm's management, and improvement of the upstream conditions (more grass cover) may gradually cause this area to become wetter.

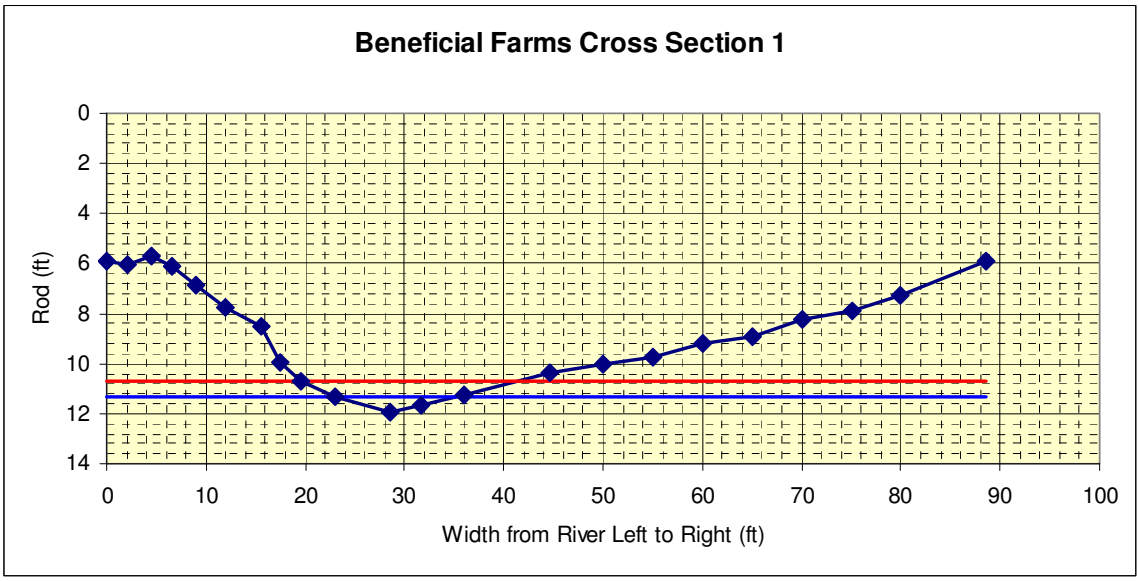
The dirt pond at Beneficial Farm has water for much of the year, but did not have either the vegetation or soil characteristics of a wetland. There is one unknown *Eleocharis* species (large), which indicates a high water table. The other species around the pond were weedy, due perhaps to a fluctuating water table that prevents longer-lived species from surviving.

Two small springs were found downstream in the Arroyo Salado canyon. Both springs had wetland species such as *Juncus balticus*, *Eleocharis palustris*, and *Salix exigua*. The upper spring also had a large patch of *Carex nebrascensis*. Small patches of *Eleocharis palustris* were found at several places downstream.

Spring in the Box Canyon of the Arroyo Salado.

Geomorphology Results for Beneficial Farm

The upper portion of the Arroyo Salado has gullied in the past, and is now incised into the broad valley floor. However, it appears to be in a stable condition and is not losing elevation and may be aggrading over the long term. The entrenchment ratio for the Cross-Section was 1.9, which indicates that the Arroyo has a floodplain and may be developing from an "F" channel (Meandering Gully) towards a more stable state with continuing proper land management. The proper condition for a wide valley such as this is probably an un-channeled valley floor. There is a thick stand of Western Wheatgrass over the entire valley floor, which may stabilize the valley with continuing proper grazing management.



Cross Section 1, Beneficial Farm

Wetland Restoration at Beneficial Farm

The upper channel above the dam is fairly stable, with a thick stand of Western Wheatgrass. This channel will probably continue to widen and perhaps gain elevation over time. There are a few scour holes at the meander bends of the channel; these can be fixed by building One-Rock dams slightly downstream to raise the beginning of the riffle cross-over.

The upper wetland near the windmill has a properly built road crossing just downstream using porous rock material. This will catch sediment over time and increase the area of the wetland. The downstream portion of the channel below this road crossing should be monitored visually to assure that the elevation change created by the road crossing doesn't cause cutting below the road. If this happens, the riffle downstream can be raised in a similar fashion as the road crossing, with small rubble fill.

The dam on the Arroyo Salado has the positive attributes of being a near-permanent source of water as well as preventing a headcut from moving upstream. However, the dam also catches sediment and prevents the Arroyo Salado from filling in behind the check dams. There is no easy way to allow sediment to pass through and the dam to remain. This

"sediment trap" may prevent the channel downstream in the box canyon from healing very quickly, as there are very few sources of sediment other than the main Arroyo channel.

This dam should be planted with Vine mesquite, Alkali muhly, Saltgrass and other grasses that can be flooded. Vine mesquite is common on the grassland to the west and can be planted as cuttings from the runners. Muhly and Saltgrass can be taken as plugs from the windmill wetland upstream.

Downstream, the two springs can be made deeper by raising the lip (glide) at the end of the pools with One-Rock dams. There are many One-Rock dams in the channel, it is not known if they are at the proper location (cross-over) in the channel. The rocks used are very large, and the One-Rock dams should be made lower (1 foot or less), and the spaces between the rocks filled in with fist-sized rocks to catch sediment and cause the dams to fill in. Once a proper meander pattern has been determined, baffles and vanes can be used to lengthen the channel, store water, and grow vegetation.

Area 2: Eldorado Wilderness along CR 51

Sites: Apache Ridge Wetland (Site B), Cañoncito Arroyo Wetland (Site A), Bird Canyon, and Hidden Canyon (Site C)
Owner: Eldorado Community Improvement Association
Date: September-October 2005

Description of Sites

Four separate valleys were surveyed in the Eldorado Wilderness: Apache Ridge Wetland, Cañoncito Arroyo Wetland , Bird Canyon and Hidden Canyon. Apache Ridge Wetland and Cañoncito Arroyo Wetland were found to have significant wetland areas with surface water and wetland plant species. Bird Canyon and Hidden Canyon both have intermittent areas of wetland vegetation. Each area is named on the Eldorado Wilderness Overview Map.

GPS Mapping:

The thalweg of Cañoncito Arroyo, as well as other important geomorphic features such as headcuts, were mapped using a Trimble sub-meter GPS. Areas of wetland vegetation, ponds, and confluences with other drainages were also mapped. The sub-meter accuracy of the GPS is high enough to allow for future re-mapping to compare the areas of wetland vegetation over time. All data from the GPS was used to create the overview map of the area using ArcView 9.1.

Bird Canyon, Hidden Canyon, and Apache Ridge Wetland areas were each mapped with the Trimble GPS, and important features and areas of wetland vegetation were also mapped.

Area 2, Site A: Cañoncito Arroyo Wetland

Cañoncito Arroyo Wetland (our name) was chosen for intensive measurements. It was chosen because it is closest to the most heavily used area of the Wilderness and it is actively eroding due to trail crossings and recent Santa Fe County road work downstream (two years ago). One headcut moving upstream towards this wetland is estimated to have moved eighty feet in the last two years, most likely due to the road work.

Site Assessment for Cañoncito Arroyo Wetland:

Monitoring Techniques	**Measurements taken**	**Purpose of measurements**
GPS mapping	wetlands, ponds, vegetation, thalweg, headcuts	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species in channel	Assessment of diversity
Line-Point Intercept	One transect across wetland chosen for maximum diversity	Monitor condition of wetland community
Geomorphology Longitudinal Profile	From upper edge of wetland to below culvert downstream	Design of treatments, observing erosion

Routine Wetland Determination Results for Cañoncito Arroyo Wetland

Vegetation: Sixty percent of the dominant species at Cañoncito Arroyo Wetland were Obl, FacWet or Fac in their wetland indicator status, therefore wetland vegetation was present.

Hydrology: There is 2-6 inches of surface water over the site, the downstream edge of the wetland is an active spring. Wetland hydrology is present.

Hydric soil indicators: There is some amount of gleyed soil at 6 inches, at 12 inches it is all gleyed soil. This area meets the criteria for a wetland.

Species List for Cañoncito Arroyo Wetland:

Scientific name	Common name	Wetland indicator status
Agropyron delgado	Slender wheat	Upl
Agrostis stolonifera	Redtop	Fac+
Apocynum cannabinum	Dogbane	Fac+
Artemesia filifolia	Sand sage	Fac
Carex aquatilis	Creek sedge	Obl
Cirsium undulatum	Wavy leaf thistle	Fac-
Descurainea incanna ssp incisa	Tansy mustard	Fac-
Eleocharis palustris	Creeping spikerush	Obl
Elymus canadensis	Canadian wild rye	Fac
Elymus smithii	Western wheat	Facu
Festuca arundinacea	Tall fescue	N
Festuca pratensis	Meadow fescue	Facu
Hordeum murinum	Wall barley	Upl
Juncus balticus	Baltic rush	Obl
Melilotus alba	White sweet clover	Facu
Poa pratensis	Kentucky bluegrass	Facu
Ratibida tagetes	Mexican hat	Upl
Schizachyrium scoparium	Little bluestem	Facu
Solidago canadensis	Showy goldenrod	Facu
Spheralcea coccinea	Globe mallow	Upl
Thelesperma filifolium	Cota	Upl
Typha latifolia	Cattail	Obl

Canyoncito Arroyo Wetland

Line Point Intercept at Cañoncito Arroyo Wetland:

Scientific Name	Common Name	Percent cover (all canopy layers included, does not add to 100 %)
Juncus balticus	Baltic rush	47
Festuca arundinacea	Tall fescue	17
Agrostis stolonifera	Redtop	17
Festuca pratensis	Meadow fescue	14
Hordeum murinum	Wall barley	14
Typha latifolia	Cattail	13
Elymus smithii	Western wheat	8
Eleocharis palustris	Creeping spikerush	7
Sonchus oleraceus	Sow thistle	3
Melilotus alba	White sweet clover	2
Agropyron delgado	Slender wheat	2

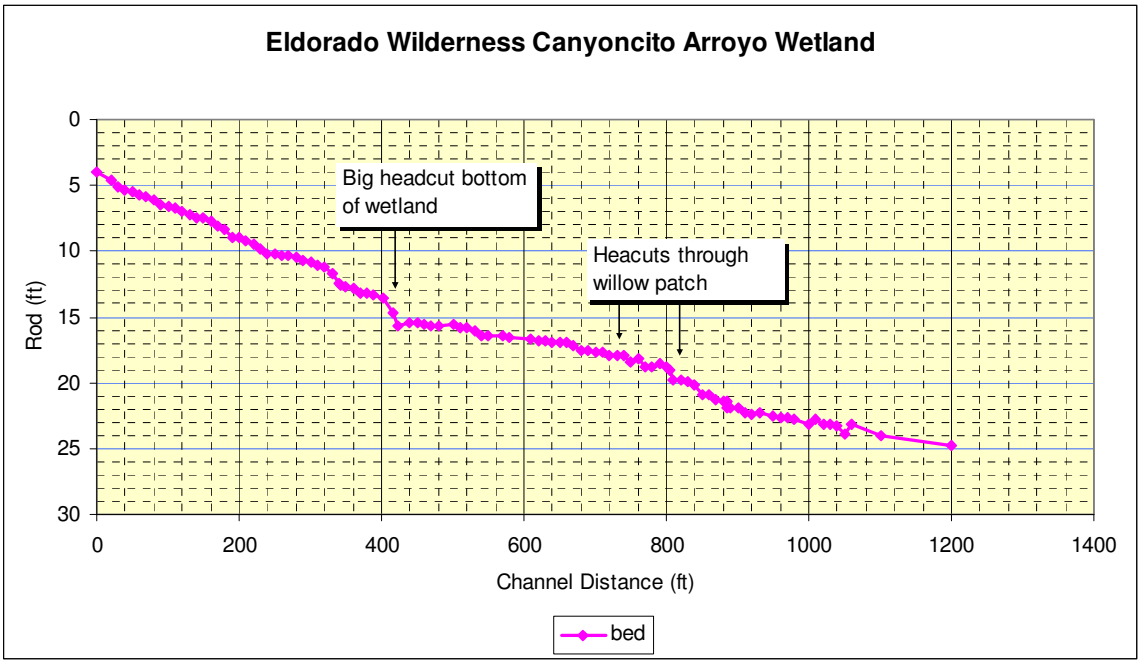
Vegetation results for Cañoncito Arroyo Wetland

This wetland has a large number of wetland species as well as many weedy introduced grasses, such as Redtop, Tall and Meadow Fescue, and Slender Wheat. There are many large Tamarisk trees on the western bank of the wetland that are encroaching into the wetland itself, and 10-20 smaller trees growing in the wettest part of the wetland. The banks of the wetland are moist and very salty, indicating that there could be a high salt content in the water. While no saltgrass and few plants of any type are found growing on the banks of the wetland, saltgrass could be introduced and planted along the banks. The banks should also be mulched to prevent evaporation and accumulation of the salts left behind when the water evaporates.

Geomorphology Results for Cañoncito Arroyo Wetland

There are three large headcuts in this profile: the first is just below the wetland at the distance of 430 feet. The second and third headcuts are at 750 and 805 along the longitudinal profile. The headcut at 805 was at 890 last year, and has cut through an entire patch of coyote willow.

This wetland is being held up by an outcrop of rock at the downstream edge of the wetland. As this rock has eroded, the water table in the area has dropped, as can be seen by a layer of gleyed, wetland soil now left exposed and dry 8 feet above the present water table. This entire area was most likely a large, wet meadow, and evidence can be seen on the map of an old dam created to prevent head-cutting upstream through the historic meadow. Presently, the channel has cut through to the west of the dam, leaving the dam high and dry and the old channel not in use.



Longitudinal Profile at Cañoncito Arroyo Wetland

Wetland restoration at Cañoncito Arroyo Wetland

This wetland is in danger of being eroded and cut through. The first headcut is just below the wetland and is a waterfall about 1 foot high. This could be fixed with a Rock Bowl structure to stabilize the headcut and create a permanent pool. Above this structure is a small headcut in the wetland which could be treated with a One-Rock dam. There is an indistinct trail which is helping this to erode, so the top of the bowl should be made strong enough to be walked upon.

The most active erosion is coming upstream from the culvert. This headcut is estimated to have moved 100 feet in 1-2 years (it can be seen from the County Road). A grove of Coyote Willow has been cut through and may die out. Two Rock Bowl structures (one for each headcut) could be installed here, and the trail crossing downstream should be re-enforced with a filter dam structure for a dry trail crossing. This would also help fill in the headcuts upstream and stabilize the willow patch.

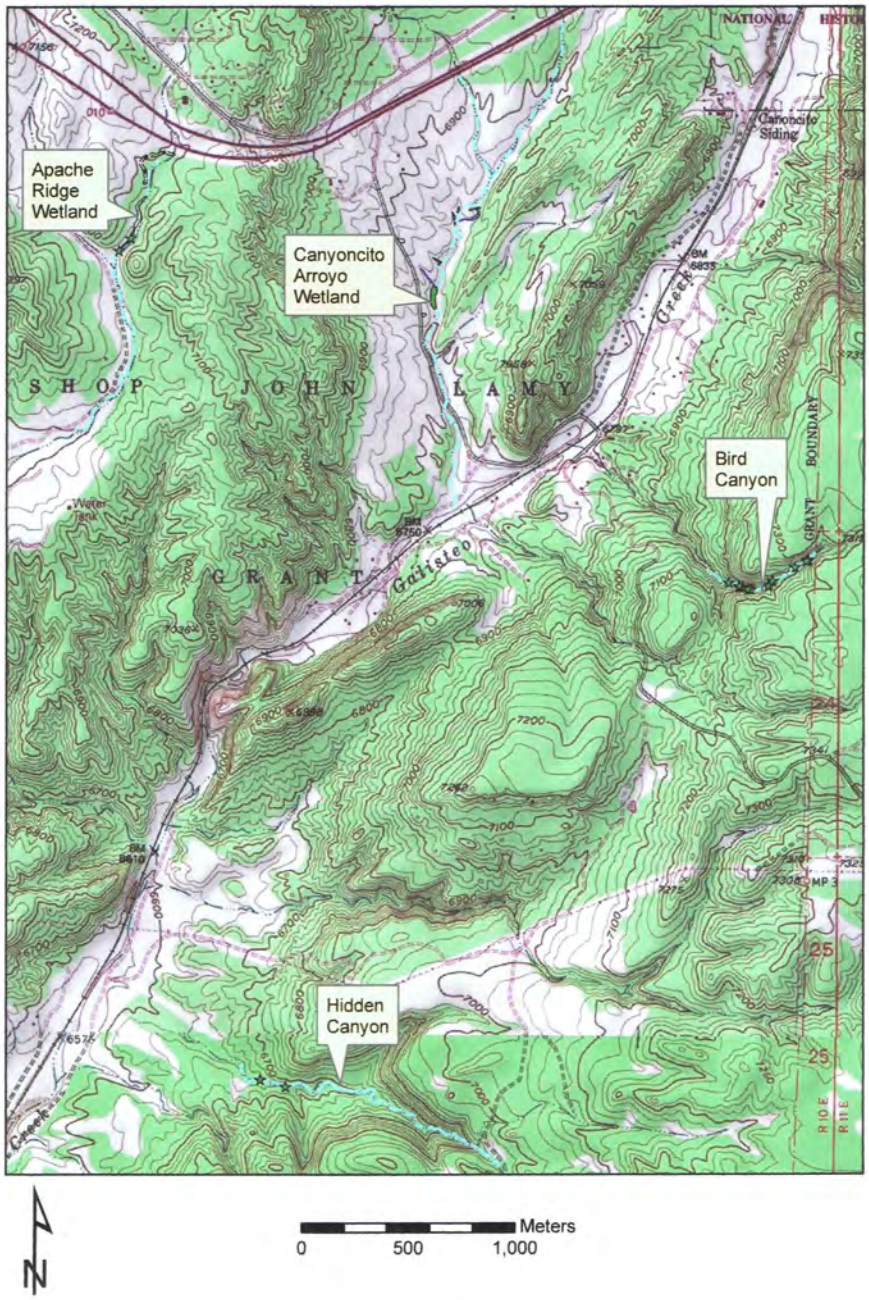
The culvert work resulted in the installation of a number of gabion structures to protect the road. The base of the gabion could be planted with coyote willows and a picket vane installed to ensure that the main flow stays away from the gabions. A One-Rock dam downstream could help raise the grade (still below culvert level) to stabilize the area and keep it wet.

Headcut moving upstream through coyote willows towards Cañoncito Arroyo Wetland.

There are many *Tamarisk* trees in this drainage, both upstream and downstream from the wetland. It appears that they are growing in number and filling the wetland with small trees. It would be beneficial to remove the *Tamarisk* in the drainage to prevent their continual spread both downstream and throughout the wetland. The main stem of the Galisteo River nearby has very few *Tamarisk* trees, and the Cañoncito Arroyo appears to have the largest number in the area.

Cañoncito Arroyo Wetland showing Tamarisk Trees.

Eldorado Wilderness Overview



Area 2, Site B: Apache Ridge Wetland

Description of Site:

This wetland is in the major arroyo in the western portion of the Eldorado Wilderness area, and is uphill from the Los Vaqueros subdivision. The upper portion of the wetland is on private property, with access from private land in Cañoncito to the east. The wetland flows downhill for hundreds of yards before it dries out below a rock sill.

Site Assessment for Apache Ridge Wetland:

Monitoring Techniques	Measurements taken	Purpose of measurements
GIS	Vegetation, headcuts, thalweg of channel, waterfalls, pools, wetlands	Assessment of present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Plant Species List at Apache Ridge Wetland:

Scientific Name	Common name	Wetland indicator status
Carex aquatilis	Creek sedge	Obl
Distichlis spicata	Inland saltgrass	Facw
Eleocharis palustris	Creeping spikerush	Obl
Elymus canadensis	Canadian Wild Rye	Fac
Hordeum murinum	Wall barley	Upl
Juncus balticus	Baltic rush	Obl
Poa pratensis	Kentucky bluegrass	Facu
Sporobolus aeroides	Alkali sacaton	Fac
Tamarisk ramosissima	Salt Cedar	Facw
Thelesperma filifolium	Cota	Upl
Typha latifolia	Cattail	Obl
Xanthium strumarium	Cocklebur	Fac

Wetland Restoration at Apache Ridge Wetland

This wetland is stable and healthy, with a wide diversity of wetland species. Like many wetlands in the Galisteo watershed, it is incised into its valley in a gully. One issue we noticed were 4-wheeler tracks in the channel uphill on the private land portion of the area. A cattle tank is preventing sediment from entering the uphill end of the wetland from box culverts under Interstate 25, and it also prevents the wetland from filling in and aggrading back to its former level. A few locations have sediment flowing in from the old ranch road on the west bank.

Management of 4-wheelers would involve fencing out the property to the North of the Eldorado Wilderness (private land) which is how the 4-wheelers are accessing the wetland. A long fence between private land and the Eldorado Wilderness may be difficult, so a wooden fence could be used just around the wetland to prevent vehicle access. The cattle tank upstream from the wetland is stable and should not be removed to allow more sediment into the wetland. There are a few exotic tree species such as Russian Olives and Tamarisk, and these could be removed, but require continual maintenance cutting to prevent re-sprouting.

Tank at top of Apache Ridge Wetland with ATV tracks

Apache Ridge Wetland

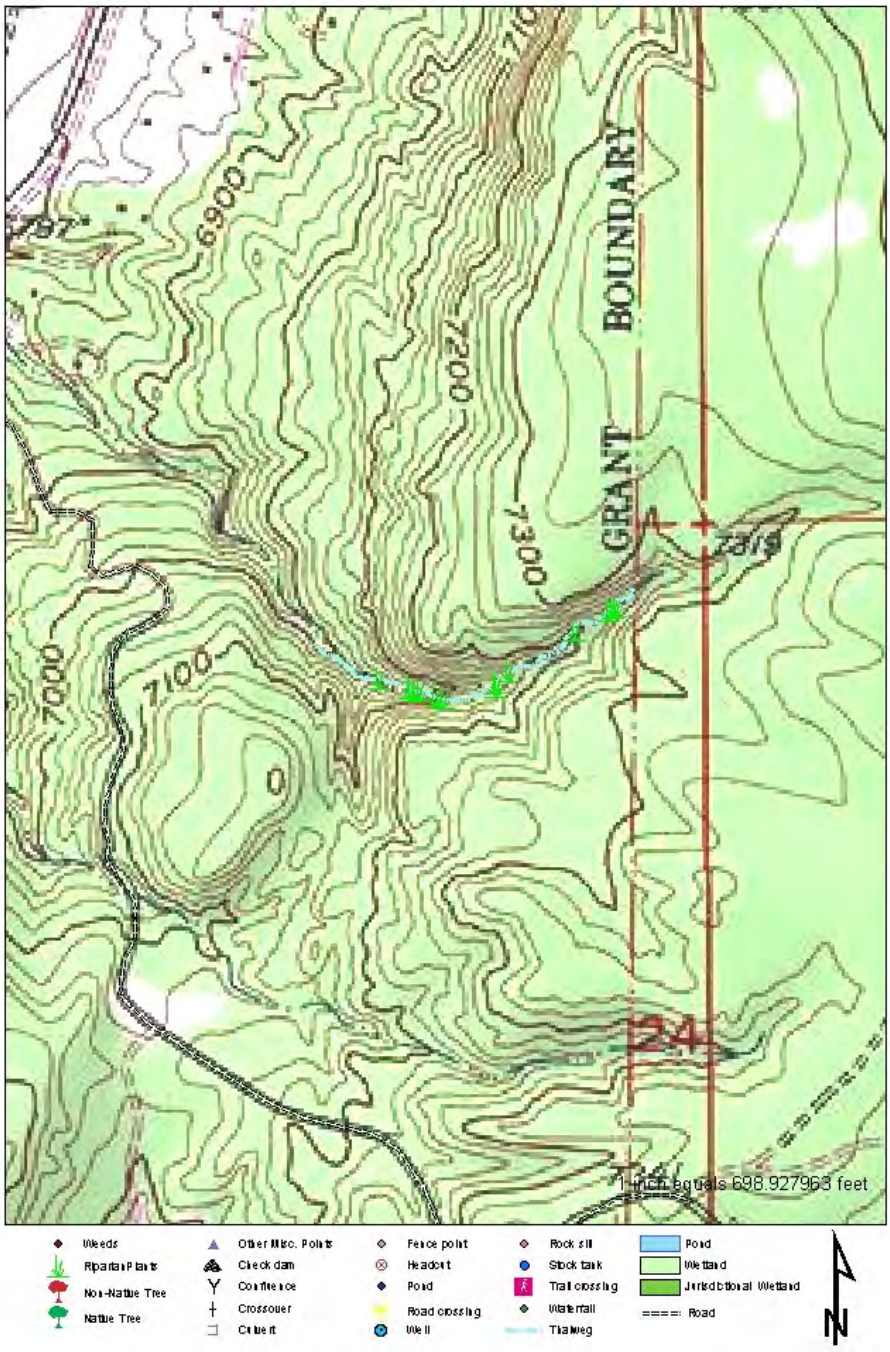
Area 3, Site C: Bird Canyon and Hidden Canyon

Species List for Bird Canyon:

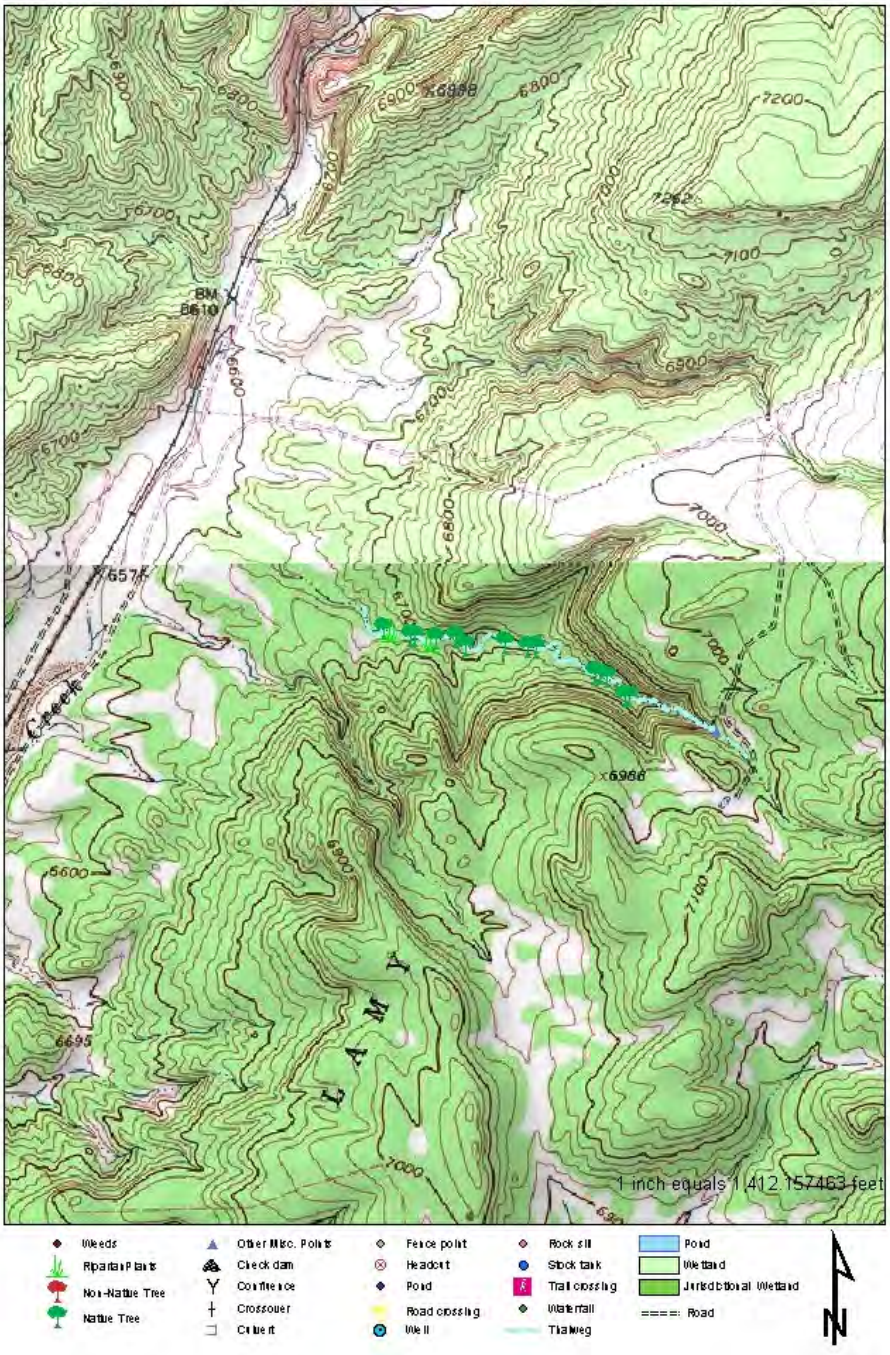
Scientific Name:	**Common Name:**	**Wetland indicator status**
Brickellia californica	Brickelbush	
Bromus japonicus	Japanese brome	Upl
Carex aquatilis	Water sedge	Obl
Eleocharis palustris	Creeping spikerush	Obl
Erigeron divergens	Tall fleabane	Facw
Melilotus officinalus	Yellow clover	Facu
Muhlenbergia asperifolia	Alkali muhly	Facw
Phleum pratense	Timothy	Facu
Phlox nana	Santa Fe phlox	Upl
Ribes aureum	Golden currant	Facw

Wetland Vegetation in Bird Canyon.

Bird Canyon, Eldorado Wilderness



Hidden Canyon, Eldorado Wilderness



Area 3: Galisteo Basin Preserve

Site: Windmill 1 on the Arroyo de Los Angeles (Site A), Galisteo Spring (Site B)
Owner: Commonweal Conservancy
Date of Visit: August – September 2005

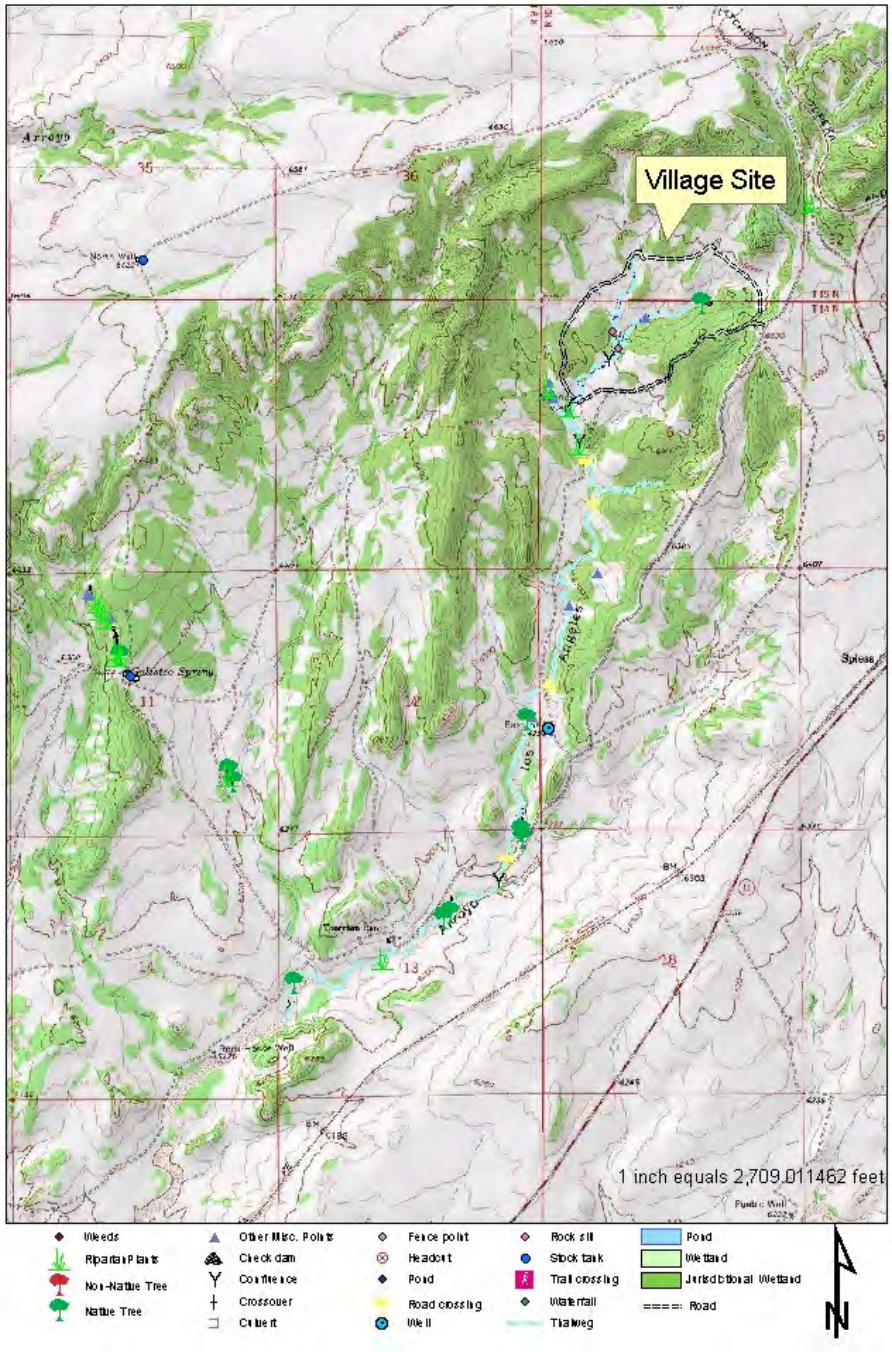
Description of Sites

The Galisteo Basin Preserve Project of Commonweal Conservancy is a conservation development project south-west of Lamy on the Thornton Ranch. A survey of the area around the proposed Village Site was performed to determine the potential for wetlands in the area. The Arroyo de Los Angeles was surveyed from the headwaters at the Village Site downstream to Gene Thornton's house. The area around Galisteo Spring was also surveyed, which is about one mile to the west of the Village Site.

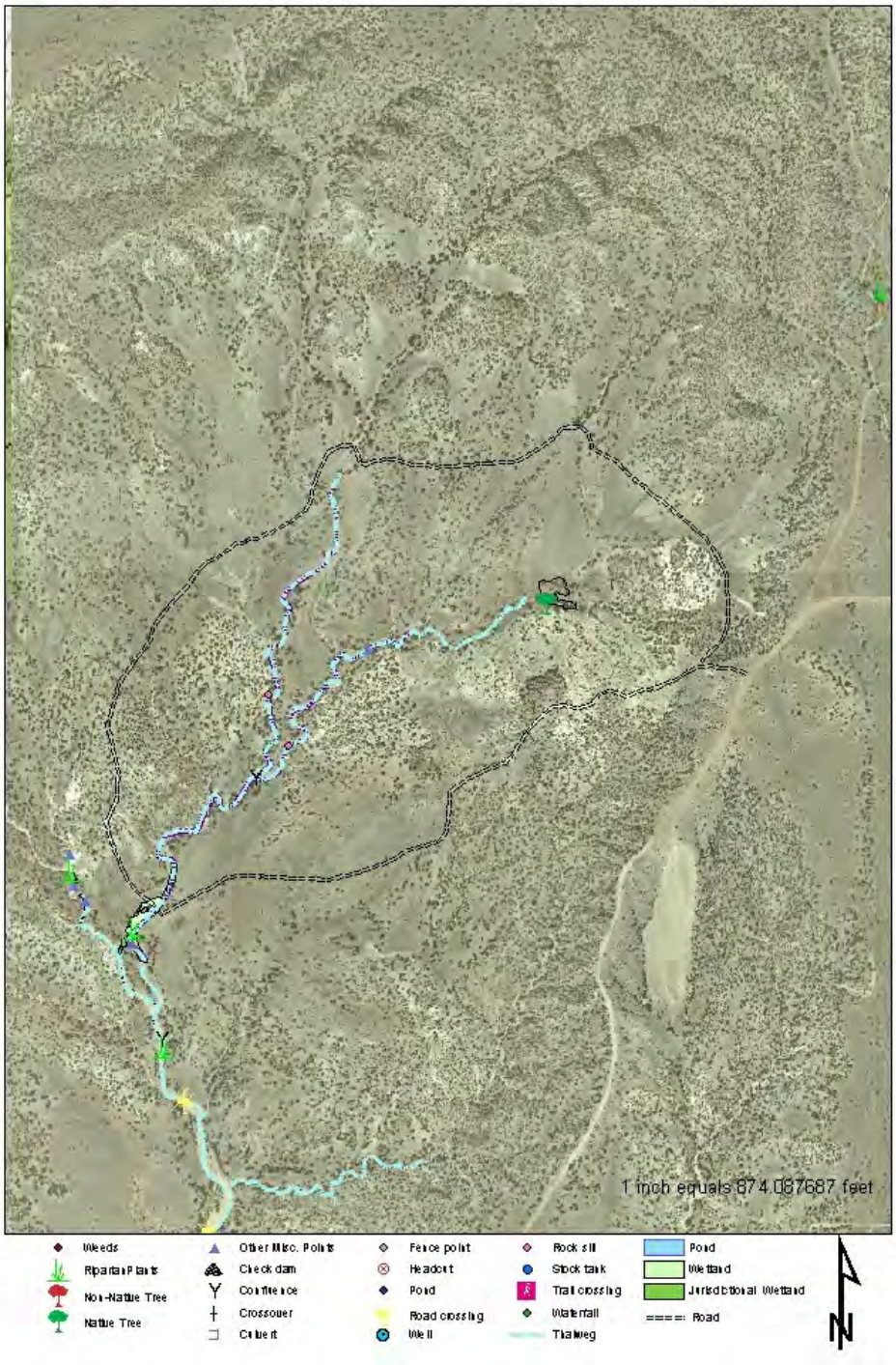
An area of wetland vegetation around the Windmill and Ranch Cabin at the southern end of the village site was named 'Windmill 1'. This area was chosen for intensive measurements, as it has a large area of wetland vegetation and may be affected (positively or negatively) by the development of the Village Site.

GPS Mapping:
The thalweg of the Arroyo de Los Angeles, as well as other important geomorphic features such as headcuts and confluences were mapped using a Trimble sub-meter GPS. Areas of wetland vegetation, ponds, and confluences with other drainages were also mapped. The sub-meter accuracy of the GPS is high enough to allow for future re-mapping to compare the areas of wetland vegetation over time. All data from the GPS was used to create the overview map of the area using ArcView 9.1.

Galisteo Basin Preserve



Galisteo Basin Preserve, Village Site



Area 3, Site A: Cowboy Shack

Site Assessment for Cowboy Shack:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Wetlands, ponds, vegetation, thalweg, headcuts	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species in channel	Assessment of diversity
Line-Point Intercept	Two transects at cross-sections	Monitor condition of wetland community
Geomorphology Longitudinal Profile	From upper edge of wetland to end of wetland vegetation	Design of treatments, observing erosion
Geomorphology Cross Sections	One above windmill, one below	Design of treatments, observing erosion

Routine Wetland Determination Results for Cowboy Shack

Vegetation: 50% of the dominant species at the wetland had a wetland indicator status of Obl, Facw or Fac, therefore wetland vegetation was present.

Hydrology: The windmill overflows into the Arroyo and creates a wet area, however, there is also saturated soil upstream from the windmill. Wetland hydrology is present.

Hydric soil indicators: There is strong mottling below 4 inches, as well as concentrations of gleyed soil. There is hydric soil. This area meets the criteria for a wetland.

Species List for Cowboy Shack:

Scientific name	Common name	Wetland indicator status
Bouteloua gracilis	Blue grama	Upl
Carex praegracilis	Clustered field sedge	Obl
Caltha leptosepala	Marsh marigold	Obl
Distichlis spicata	Inland saltgrass	Facw
Eleocharis rostellata	Beaked spikerush	Obl
Eleocharis quinqueflora	Few-Flowered spikerush	Obl
Elymus trachycaulus	Slender wheatgrass	Fac
Hillaria jamesii	Galleta	Upl
Hordeum murinum	Wall barley	Upl
Juncus balticus	Baltic rush	Obl
Muhlenbergia asperifolia	Scratch muhly	Fac
Ranunculus cymbalaria	Shore buttercup	Obl
Ranunculus gmelinii	Water crowfoot	Obl
Rumex acetosella	Sheep sorrel	Facw
Scirpus pungens	Threesquare bullrush	Obl
Sporobolus aeroides	Alkali sacaton	Fac
Tamarisk ramosissima	Salt cedar	Facw
Xanthium strumarium	Cocklebur	Fac

Line-Point Intercept at Cowboy Shack:

Cross Section 1: Across Windmill pond at Cowboy Shack

Scientific Name	Common Name	Percent cover (all canopy layers included, does not add to 100 %)
Sporobolus aeroides	Alkali Sacaton	30
Carex praegracilis	Clustered field sedge	26
Eleocharis rostellata	Beaked spikerush	20
Muhlenbergia asperifolia	Scratch muhly	19
Caltha leptosepala	Marsh marigold	6
Scirpus pungens	Threesquare bullrush	4

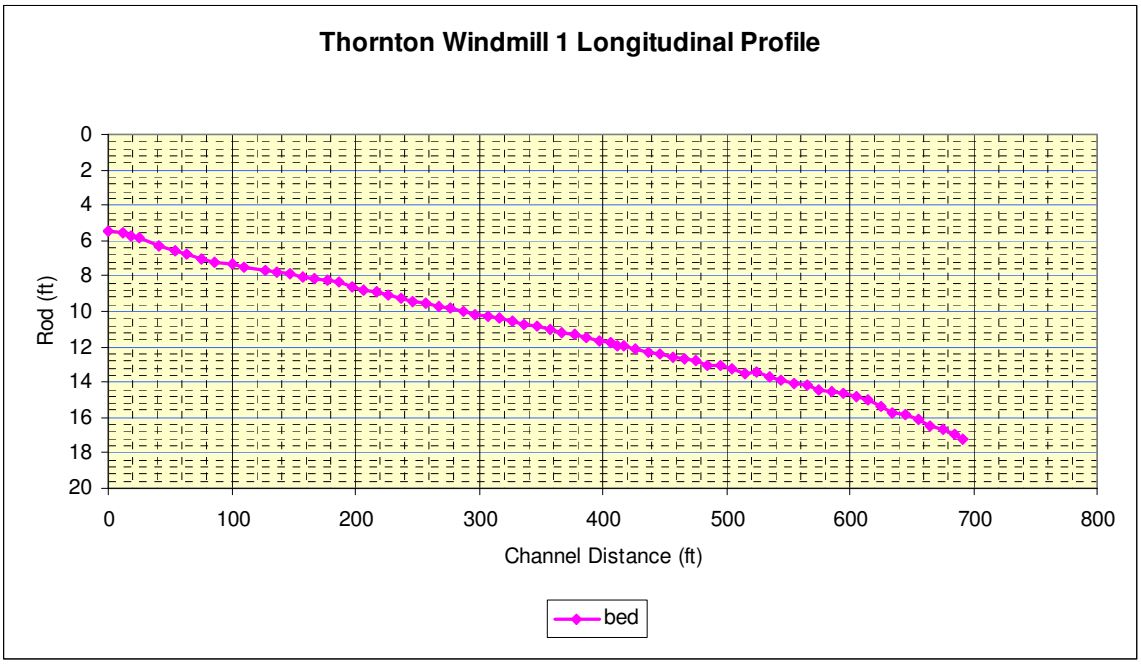
Cross Section 2, Upstream from Windmill at Cowboy Shack

Scientific Name	Common Name	Percent cover (all canopy layers included, does not add to 100 %)
Muhlenbergia asperifolia	Scratch muhly	76
Sporobolus aeroides	Alkali sacaton	60
Elymus trachycaulus	Slender wheatgrass	26
Bouteloua gracilis	Blue grama	18
Hillaria jamesii	Galleta	9

Vegetation Results for Cowboy Shack

This wetland has a high diversity in the pond immediately below the windmill, with many wetland species. Outside the pond area, *Juncus balticus* and *Distichlis spicata* are the primary wetland species. The tank at the windmill is leaking and flowing directly into the Arroyo rather than into the pond. A simple fix to patch the tank and clean out the overflow pipe could ensure the survival of the unique wetland species found here.

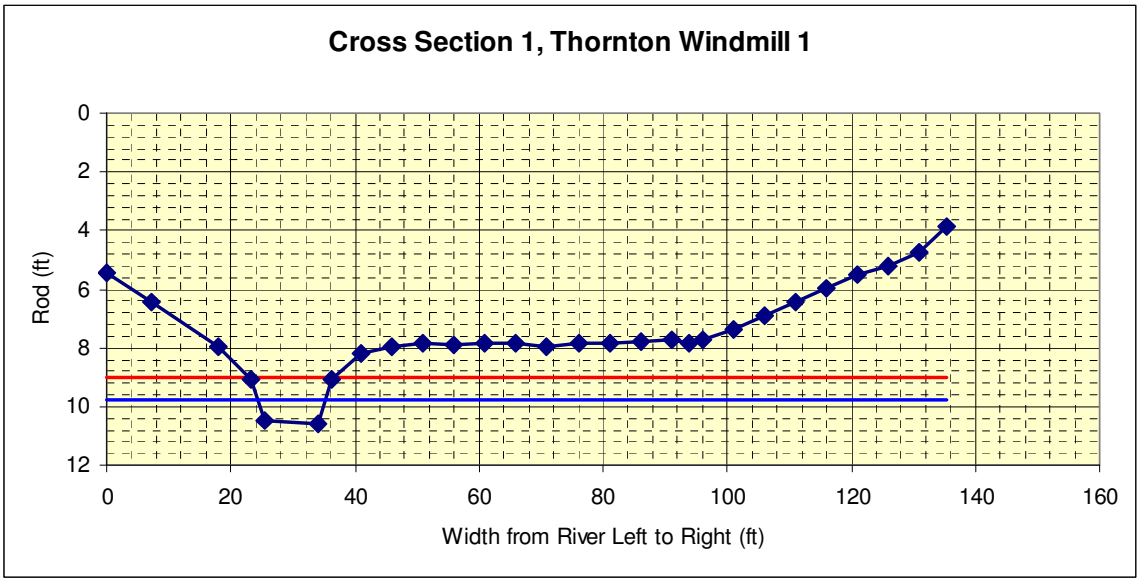
Upstream from the windmill, areas of wetland vegetation such as *Juncus balticus* and *Scratchgrass* were found, but the area is somewhat dry. As in many wetlands in the Galisteo Watershed, the original height of the water table can be seen on the bank of the gully and was 6 to 8 feet higher than the present height. Because of the presence of wetland vegetation and soils, this area was considered to be a wetland even without the presence of the windmill.



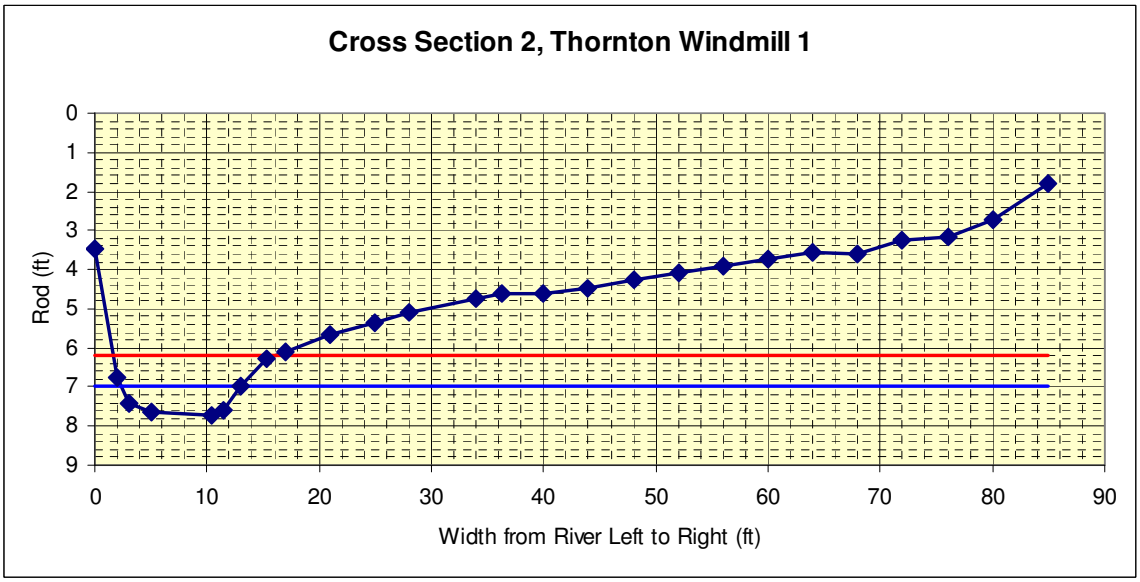
Longitudinal Profile at Thornton Cowboy Shack

Geomorphology Results for Cowboy Shack

The longitudinal profile shows an even profile with a slight dip at the end of the profile. The wetland vegetation in the channel appears to be holding the channel up and where the vegetation disappears, the channel grade steepens. Both cross sections show an entrenched channel, Cross Section 2 is upstream; it is less entrenched, Cross Section 1, downstream, is more entrenched. A power-line pole has been placed in the stream to attempt to hold the grade at the road crossing, it is now suspended in the air and the water flows underneath it. This data will be very interesting to follow over time; in the 1.5 year period that the author has been on-site, there has been substantial degradation just downstream from the windmill, and a loss of several feet of elevation in the channel thalweg.



Cross Section 1 at Thornton Cowboy Shack



Cross Section 2 at Thornton Cowboy Shack

Wetland Restoration for Arroyo de Los Angeles Cowboy Shack

The upper watershed of the Arroyo de Los Angeles is highly eroded and will be the site of a high density, mixed-use, conservation development. Any solutions to increase the area of the wetlands will depend upon the development patterns upstream and how they affect runoff and sediment transport. The upper watershed of the Arroyo de Los Angeles was formerly a wetland area, as there is a layer of gley (grey clay formed by hydric conditions) underneath much of the area. The gley at the Cowboy Shack site is 6-8 feet higher than the current channel height, indicating that the channel here was once much higher.

Upstream from the wetland is an area of sandstone outcrops across both branches of the Arroyo. One solution to help with upstream erosion would be to build a Filter Dam at both of the outcrops to raise the grade of the channel as much as possible. Any solution on such a large scale would need a village-wide geomorphological design, engineering review of the design, and involvement of the geomorphologist in oversight of the construction process.

Looking Upstream at Cowboy Shack Wetland, Headcut begins at bottom of Picture.

Grade Control at Cowboy Shack:

There is a headcut moving upstream towards the wetland areas at the Cowboy Shack. This has dried out the channel and caused death of the vegetation on the banks downstream from the windmill. In addition, the road crossing at the windmill has become barely passable due to degradation and channel lowering.

A possible solution to this problem is to build grade control structures to lift the channel elevation back to the original level (where the road crossing at the wetland was passable to a vehicle). We have prepared an estimate of the number of structures and their locations. If the channel were lifted, the wetland area at the site (about a ½ acre) could expand downstream and the vegetation could help prevent the head-cutting that is now moving upstream towards the windmill.

Another possible restoration project could occur on the tributary entering the Arroyo de Los Angeles from the West just below the windmill. This long, sinuous arroyo defines the south-west boundary of the site, and has small areas of wet soil and wetland vegetation. Raising the grade in this arroyo could prevent head-cutting into the Village Site as well as create a larger area of wetland plants and wet soil. No estimate of the costs for restoration on this arroyo was prepared for this project.

Thornton Ranch windmill at Cowboy Shack

Area 3, Site B: Galisteo Spring on Thornton Ranch

Description of Site

The Galisteo Spring is on the western portion of the Thornton Ranch south of the North Well and New Moon Overlook homesites. The spring comes out from the top of a small ridge as a 10 foot pool, the overflow from the pool flows into a cattle tank and then into an earthen tank downhill. We followed the line of spring flow uphill to the north and located hundreds of yards of seep areas flowing out of the same formation and marked by Baltic rush plants. At the top of this line of springs is a larger wet area with a mature cottonwood tree, surface water, and a broken cattle tank.

Site assessment for Galisteo Spring:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Vegetation, headcuts, pools, wetlands	Assessment of present conditions

Wetland Restoration at Galisteo Spring

The Galisteo spring area itself is in fine condition with a highly diverse wetland community. The best treatment for this spring would be to leave it alone and prevent disturbance to the immediate area. There is a road nearby, which facilitates access to the area, but this is easily accessible only from the north. The road continues south through Gene Thornton's property, and portions of this road are highly eroded and barely passable in a vehicle.

The line of seeps to the north are all extremely eroded, with small patches of *Juncus balticus* preventing the erosion from continuing upstream into the upland areas. Each small arroyo has a spring at the transition point from the uplands to the arroyo. Rock filter dams and upland rock structures could be used to protect these areas, increase plant growth, and build a long line of wetland areas.

The spring at the northern end of the area is also highly eroded, with an empty cattle tank that doesn't hold water any more. There is a deep headcut at the bottom of this area that is moving upstream and draining the wetlands. There is a lot of potential for induced meandering and uplands restoration work at this site to prevent any further damage. We observed a spadefoot toad at the site, so there is some water deep enough for breeding.

Galisteo Spring on Thornton Ranch.

Galisteo Spring and Vicinity

Area 4: Village of Galisteo

Site: Galisteo Creek in Village Area
Owner: Private Ownership, various landowners
Date: October - November 2005

Description of Site

The Village of Galisteo was founded at one of the few perennial reaches of the Galisteo River. The Galisteo Creek flows in an incised channel about 15 feet below the original floodplain where the village sits now. A large, one-month long flood event in the spring of 2005 filled the incised valley from bank to bank, and deposited over 1 foot of soil in many places. Many large changes happened as a result of this flooding, including the disappearance of a 3-foot waterfall as the waterfall headcut moved upstream and the channel slope "evened out".

We performed a site assessment to investigate the causes of bank erosion at the site and to propose a solution to this erosion. A primary goal of the restoration would be to ensure access of the river to its floodplain and prevent further down-cutting. Another goal of the proposed solution would be to ensure the health of a large oxbow wetland just downstream on the Cerro Pelon Ranch.

Site Assessment for Galisteo Creek:

Monitoring Techniques	**Measurements taken**	**Purpose of measurements**
GPS mapping	Wetlands, ponds, vegetation, thalweg, headcuts	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species	Assessment of diversity
Geomorphology Longitudinal Profile	From bridge to bridge	Design of treatments, observing erosion


Village of Galisteo
Possible new channel
1 inch equals 350.961272 feet
Weeds
Riparian Plants
Non-Native Tree
Native Tree
Other Misc. Points
Check dam
Confluence
Crossover
Culvert
Fence point
Headcut
Pond
Road crossing
Well
Rock sill
Stock tank
Trail crossing
Waterfall
Thalweg
Pond
Wetland
Jurisdictional Wetland
Road
N

Routine Wetland Determination Results for Galisteo Creek

The area downstream from the bridge in the village was assessed for wetland potential[1].

Vegetation: One hundred percent of the dominant species at the upper wetland had a wetland indicator status of Obl, Facw or Fac, therefore wetland vegetation was present.

Hydrology: The area has permanent water flow in the creek. An area about 50 feet wide to either side of the creek is saturated with a water table within 6 inches of the surface. Once the river becomes incised at 600 feet on the longitudinal profile, the band of wet soil becomes narrower, about 20 feet wide. Wetland hydrology is present.

Hydric soil indicators: The soil at present was deposited last winter in a 1-month long flood that covered the entire valley. This fresh sandy silt has had little time to develop hydric soil features. However, there are streaks of organic matter and sulfurous odor at the site. Hydric soil is present. This area meets the criteria for a wetland.

Species List for the Galisteo Creek:

Scientific Name	Common Name	Wetland Status
Anemopsis californica	Yerba mansa	Obl
Carex praegracilis	Clustered field sedge	Obl
Distichlis spicata	Inland saltgrass	Facw
Eleocharis rostellata	Beaked spikerush	Obl
Eleocharis quinqueflora	Few-Flowered spikerush	Obl
Equisetum arvense	Horsetail	Obl
Glycyrrhiza lepidota	Licorice	Fac+
Muhlenbergia asperifolia	Alkali muhly	Fac
Juncus balticus	Baltic rush	Obl
Scirpus pungens	Threesquare bullrush	Obl
Scirpus tabernaemontani	Softstem bulrush	Obl
Sisyrinchrium demissum	Blue-Eyed grass	Obl
Sporobolus airoides	Alkali sacaton	Fac
Tamarix ramosissima	Salt cedar	Fac
Typha latifolia	Cattail	Obl

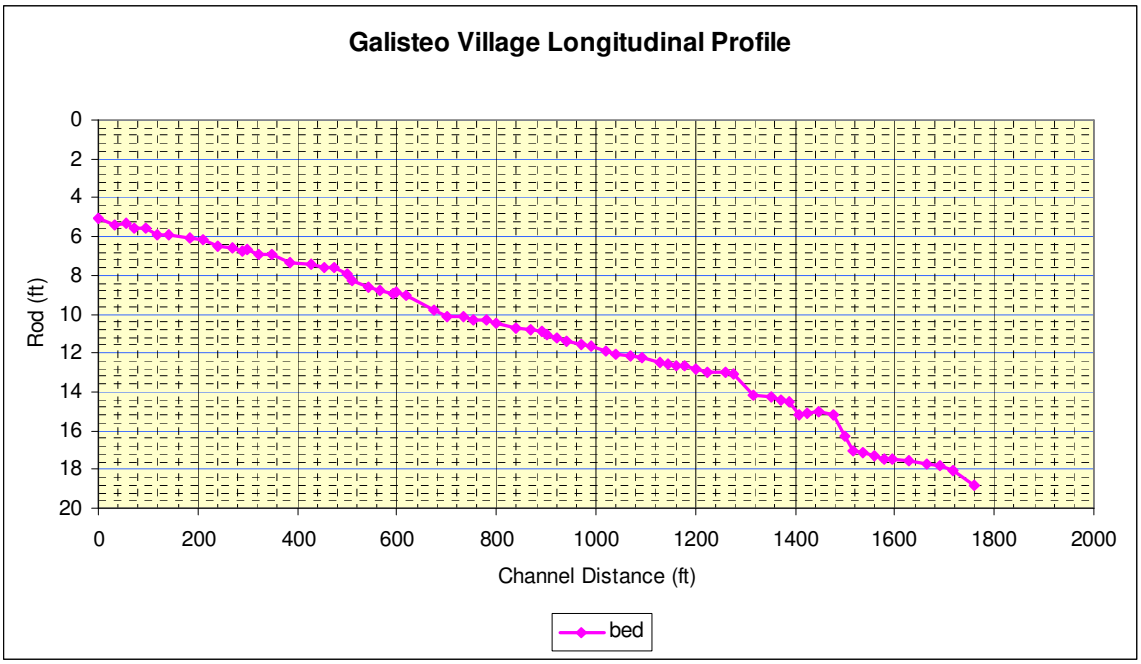
Geomorphology Results for Galisteo Creek

The channel of the Galisteo Creek through the Village remains wide and shallow for about 600 feet downstream from the bridge. Before the flooding last winter, the channel could spill out over the floodplain to the west at this point. However, one to two feet of deposition has occurred over much of the valley bottom and the channel is now stuck in its present course. At about 600 feet on the profile, the channel turns left and is stuck between the bank and a dense grove of willows. Not surprisingly, the channel steepens and narrows at this point.

[1] See photo on cover page of this report. Galisteo Creek in the Village of Galisteo viewing south (downstream).

For the next 800 feet, the channel runs basically straight and narrow against the left (east) bank. For several years, there was a waterfall at the point where the channel ran up against a steep eroding bank below the King property. Last winter, this waterfall blew out and the channel deepened several feet. This point, at about 1200 feet, still is somewhat steep, as can be seen in the profile above. This headcut area could continue upstream and incise the channel if not treated.

At about 1480 feet on the profile, there is a short, steep section held up by willow roots. This area is another place where a headcut could begin and migrate upstream.



Longitudinal Profile

Wetland and Stream Restoration at Galisteo Creek

The Galisteo Creek begins to entrench itself about 600 feet downstream from the bridge on Via del Puente. During the last several years, the narrowing of the channel by willows and the movement of headcuts upstream have concentrated the force of the water against the eastern bank of the valley. This concentration has led to high rates of bank erosion and sediment pollution in the Creek.

This concentration could also be responsible for the deposition of large amounts of sediment last winter, as the channel of the Creek incised, the water on the floodplain became shallower and shallower and the force to move sediment was reduced. If no actions are taken, the headcut (at 1480) at the bottom of the reach could begin to move upstream and entrench the river 4 to 6 feet below the floodplain.

One solution is to re-meander the River channel back onto the floodplain at the 600 foot location on the longitudinal profile. There is still only a one or two foot difference in the

elevation between the Thalweg and the floodplain at this point. Downstream, the floodplain is still mostly uncolonized sediment with no vegetation, and a new channel could easily be carved out with a small bulldozer. A meander pattern appropriate to the size of the river could be chosen, and the banks planted with willows.

This solution would ensure that the Galisteo River would be flowing under the middle of the bridge on State Highway 41. The River would have access to the oxbow wetland and floodwaters could spread across this area. A solution would have to be formulated to ensure that the river could re-enter its channel near the end of the oxbow wetland downstream. The Village of Galisteo, the private landowners who own the property on the floodplain, the New Mexico Highway Department, and the Cerro Pelon Ranch would have to be consulted in this matter.

The costs associated with this are dependent upon a more detailed design, but an estimate of $20,000 for design, permitting, construction, willow planting, and post-implementation monitoring might be appropriate.

Looking Downstream at 600 feet at New Deposition on Floodplain.

Looking upstream we see how the river is trapped against the eroding bank on the King property.

Area 5: County Road 55-A

Site: Finger Lakes on Barclay Ranch, Central Galisteo Creek (Ford Ranch and Tingle Ranch)
Owner: Leslie Barclay
Date: October 2005

Description of Site

The Finger Lakes are human-created ponds dug into a large delta above the Galisteo River between Galisteo and Cerrillos. Formerly, the lakes stayed full of water, were used for swimming, and had a diving board. Presently, they fill up rarely and do not stay wet for very long. An investigation was performed to determine the geomorphic cause of the drying of the lakes. The Finger Lakes were previously filled by a combination of sheet flow from three arroyos from the south and a large swale that captured water from the east and brought it to the lakes.

Site Assessment for Finger Lakes:

Monitoring Techniques	Measurements taken	Purpose of measurements
GIS	wetlands, ponds, vegetation, thalweg, headcuts, swales	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species in Lakes	Assessment of diversity

Routine Wetland Determination Results for Finger Lakes

The South Pond of Finger Lakes, by the goat pens, was assessed for wetland conditions.

Vegetation: 100% of the dominant species at the South Pond had a wetland indicator status of Obligate, therefore wetland vegetation was present.

Hydrology: The area was saturated at the surface and therefore wetland hydrology was present.

Hydric soil indicators: All the vegetation was obligate, and the wetland is less than 5 acres, therefore no soil survey is needed. This area meets the criteria for a wetland.

Species List for the Finger Lakes (All lakes):

Scientific name	Common name	Wetland indicator status
Carex canescens	Hoary sedge	Obl
Conyzia coulteri	Horsetail	Facw-
Eleagnus angustifolia	Russian Olive	Facw-
Elymus smithii	Western wheat	Facu
Glycyrrhiza lepidota	Licorice	Fac+
Juncus balticus	Baltic rush	Obl
Muhlenbergia thurberens	Sand muhly	Obl
Polypogon monspeliensis	Rabbit foot grass	Facw+
Salix exigua	Coyote willow	Obl
Sporobolus airoides	Alkali sacaton	Fac
Sporobolus contractus	Spike dropseed	Facu
Tamarix ramosissima	Salt cedar	Fac

South Pond at Finger Lakes, Headcut into Pond.

Wetland Restoration at the Finger Lakes

Eastern Swale System:

A large arroyo is diverted into a swale at the east end of the Barclay Ranch. This swale flows until it is stopped by a cattle tank (see map, next page). This tank is one of two on the swale system that appear to be blocking the effective transport of water towards the lakes. The overflow from this tank flows both across the grassland and back into the swale below the dam. There is an active headcut moving upstream where the water re-enters the swale.

The grassland below this tank is sparse and poorly vegetated compared to similar grasslands closer to the Finger Lakes. One solution to this could be to build a structure out of rubble or earth (rubble preferred) to act as a berm and force the water that flows out of the tank across the grassland. The location of this diversion is shown on the map (next page). The influx of sediment and water would irrigate this area and may help heal the large scalded areas with little or no vegetation. If the water is not spread out, it will continue to run into the swale and the headcut at the top of the swale will continue to advance uphill towards the cattle tank.

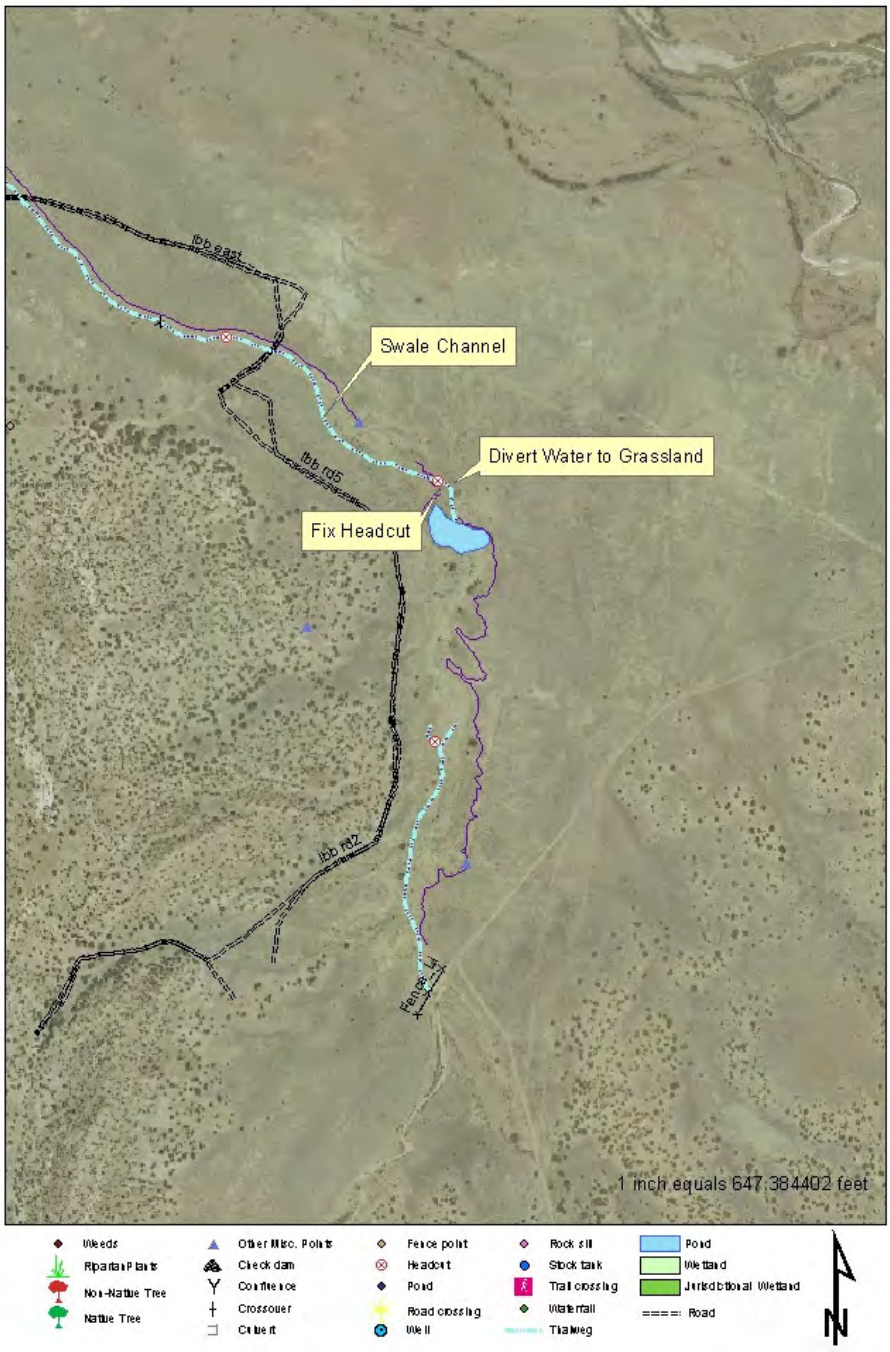
Swale System Near Lakes:

The same swale system continues to run many hundreds of yards to the west towards the Finger Lakes. One small headcut where the swale narrows could be easily fixed by lining the headcut with rocks. Once the swale crosses the pasture fence, it runs towards the Finger Lakes and then into another cattle tank. The location of this tank is somewhat mysterious and the swale begins again downstream on the other side of the cattle tank dam. This tank may have been added as an afterthought to the swale system. The overflow from this tank runs to the North, and never again has a chance to enter the Finger Lakes. It finally enters a tank on the eastern edge of the Finger Lakes' berm, and then enters a deep 20 foot headcut into the Galisteo River.

A hole could be cut in the dam to allow the water from the swale to flow westward and continue towards the Finger Lakes. This cut would be made the same width as the swale, which is wide enough to carry its flow without cutting or erosion. The swale system continues after the dam and runs towards the Finger Lakes, but stops before it reaches them. A berm of rock or earth should be built to encourage this flow to enter the lakes, rather than towards the cattle tank and headcut into the Galisteo River.

The cattle tank to the east of the Finger Lakes has a headcut moving upstream towards it from the Galisteo River. A culvert could be installed at the end of this tank to divert the water back into the Finger Lakes, and to starve the large headcut.

Barclay Ranch, East Swale



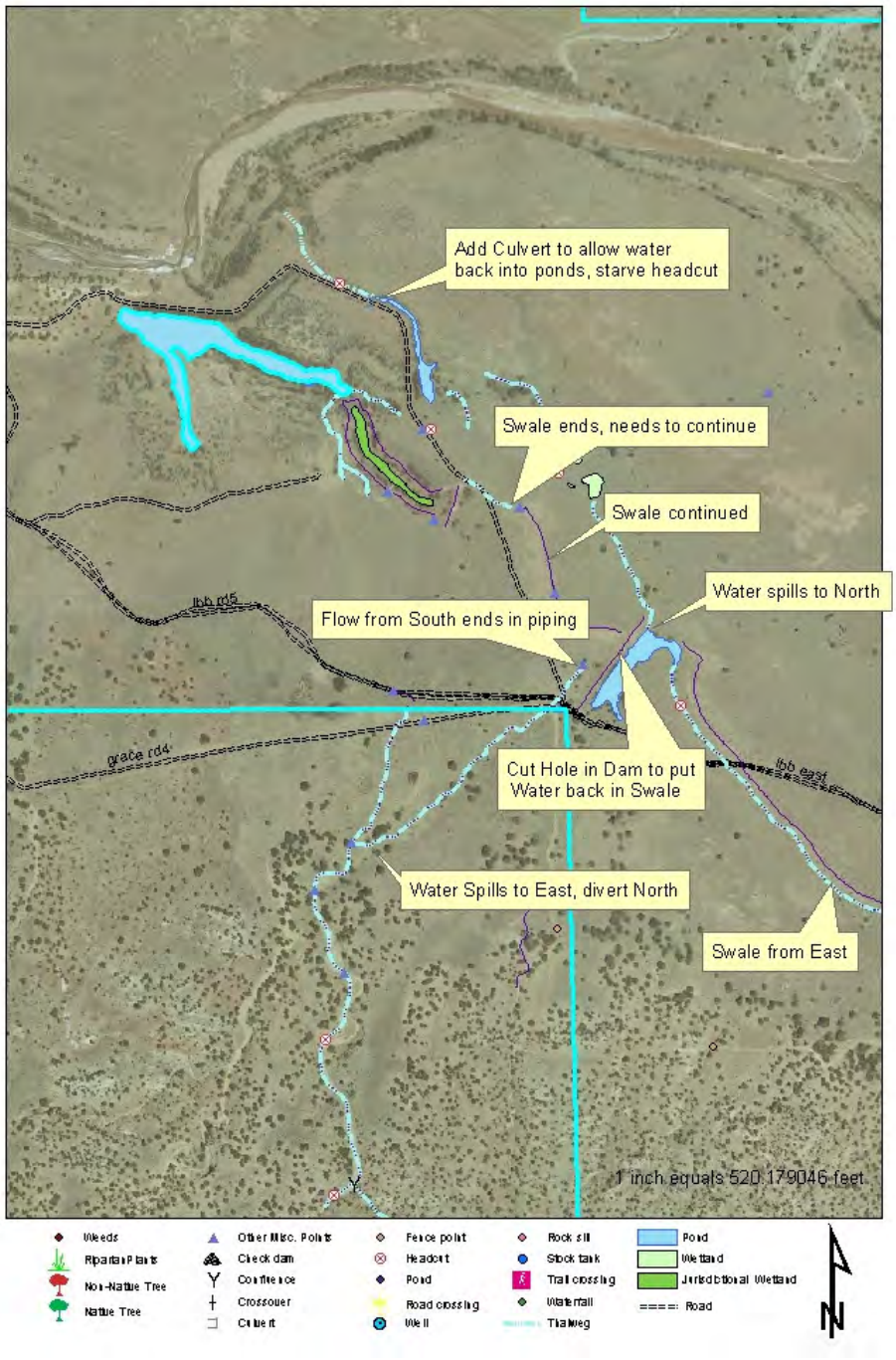
Arroyo System to South on Grace Ranch:

These three Arroyos flow from the south and form a delta just over the property line from the EWI Ranch. The delta fan was investigated, and it appears as if the biggest flow from the central arroyo is not flowing towards the Finger Lakes anymore. It flows northeast towards the cattle tank and property corner, crosses the fence, and is caught in a soil pipe (erosion feature). The outlet of the pipe is unknown, if there is any. Recent road work on the Grace Ranch has complicated this situation by carving a channel along the road which will catch more sheet flow and divert it towards this eastern corner.

Changing the flow of this branch of the arroyo could be a simple matter of using a shovel, chainsaw and brush. There is a line of Juniper trees which could act to force the water back to the north, rather than northeast. The recent road work would have to be modified to ensure that the road doesn't capture this sheet flow and divert it back to the east.

A good source of dirt for fixing swales, plugging pipes, building berms etc. is the berms around the Lakes themselves. The earth removed to create the lakes was piled up in berms around the lakes, where it now is infested with *Tamarisk*. The *Tamarisk* could be removed, the Alkali sacaton grass salvaged, and the earth used for berms without much effect to the lakes themselves. The most likely area would be the upstream edge of the Southern Lake, which could then have a wider entry point to water flowing overland from these Arroyos.

Barclay Ranch, Finger Lakes Meadow



Area 5b: Central Galisteo Creek

Site: Central Galisteo Creek (Ford Ranch and Tingle Ranch)
Owner: Tom Ford and Ralph Tingle
Date: No on-ground assessment

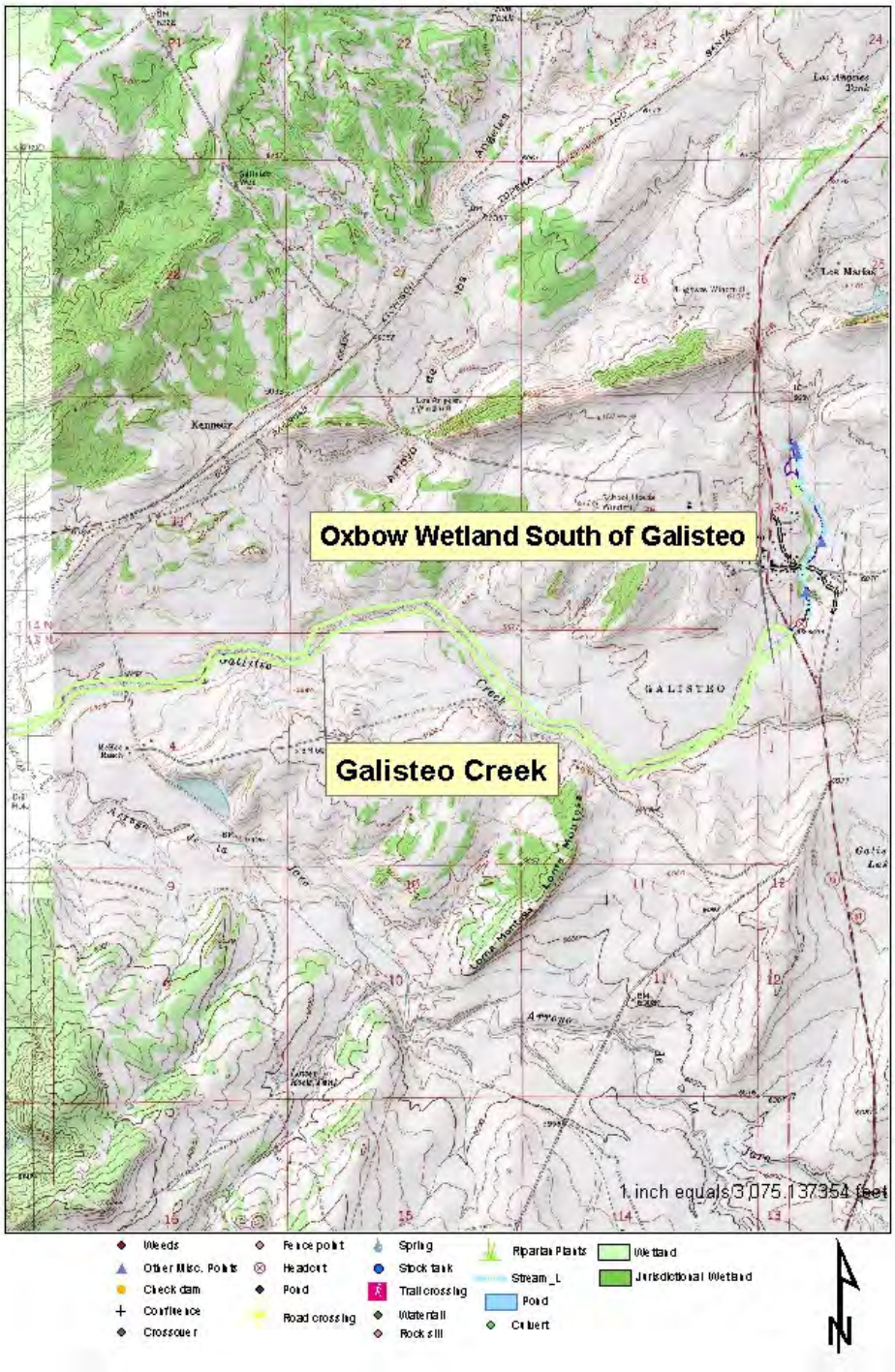
Description of Site

The Central portion of Galisteo Creek flows south-west from the Village of Galisteo towards the Village of Cerrillos. This portion of the creek is on two large private ranches, the Cerro Pelon Ranch, owned by Tom Ford, and the Tingle Ranch, owned by Ralph Tingle. We did not perform an on-ground assessment on either Ranch.

The Galisteo Creek just south of the Village flows by an oxbow wetland, which can be seen from the Highway bridge. This area is healthy and is most likely a jurisdictional wetland under U.S. Army Corps jurisdiction. By anecdotal accounts from individuals in the Village of Galisteo, the area downstream from the Village has very healthy wetland vegetation and a large riparian corridor.

The land ownership patterns of two large private ranches make this area one of the most undisturbed in the watershed. In addition, an irrigation take-out for the Tingle Ranch has maintained the Galisteo Creek from down-cutting and eroding upwards towards the village. The only management suggestions that can be offered are to keep this area undisturbed, with as few river crossings and roads in the riparian area as possible. With continuing excellent management, this area will remain the “crown jewel” of the Galisteo Watershed.

Galisteo Creek, Ford Ranch and Tingle Ranch



Area 6: San Marcos Area

Site A: San Marcos Wetland (Site A), Garden of the Gods (Site B), Dozema Arroyo (Site C), Cerrillos Hills Park (Site D)
Owner: Archaeological Conservancy and Private Landowners
Date: October-November 2005

Description of Site

The San Marcos Arroyo contains a large wetland which has been used and appreciated by people for thousands of years. Highway 14 runs through the middle of the wetland. The upstream area is owned by the Archaeological Conservancy and is adjacent to San Marcos Pueblo. To the west, across Highway 14, the wetland belongs to several private landowners and has two small ponds.

Site Assessment for San Marcos:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Wetlands, ponds, vegetation, thalweg, headcuts, swales	Assessment of present conditions
Routine Wetland Determination	Plants, hydrology, soils.	Wetland delineation
Wetland Species List	Identification of all species	Assessment of diversity

Routine Wetland Determination Results

The area downstream from the bridge was chosen for wetland assessment. The Archaeological Conservancy has stringent requirements on excavation to protect the resources at their site; no holes could be dug upstream from Highway 14.

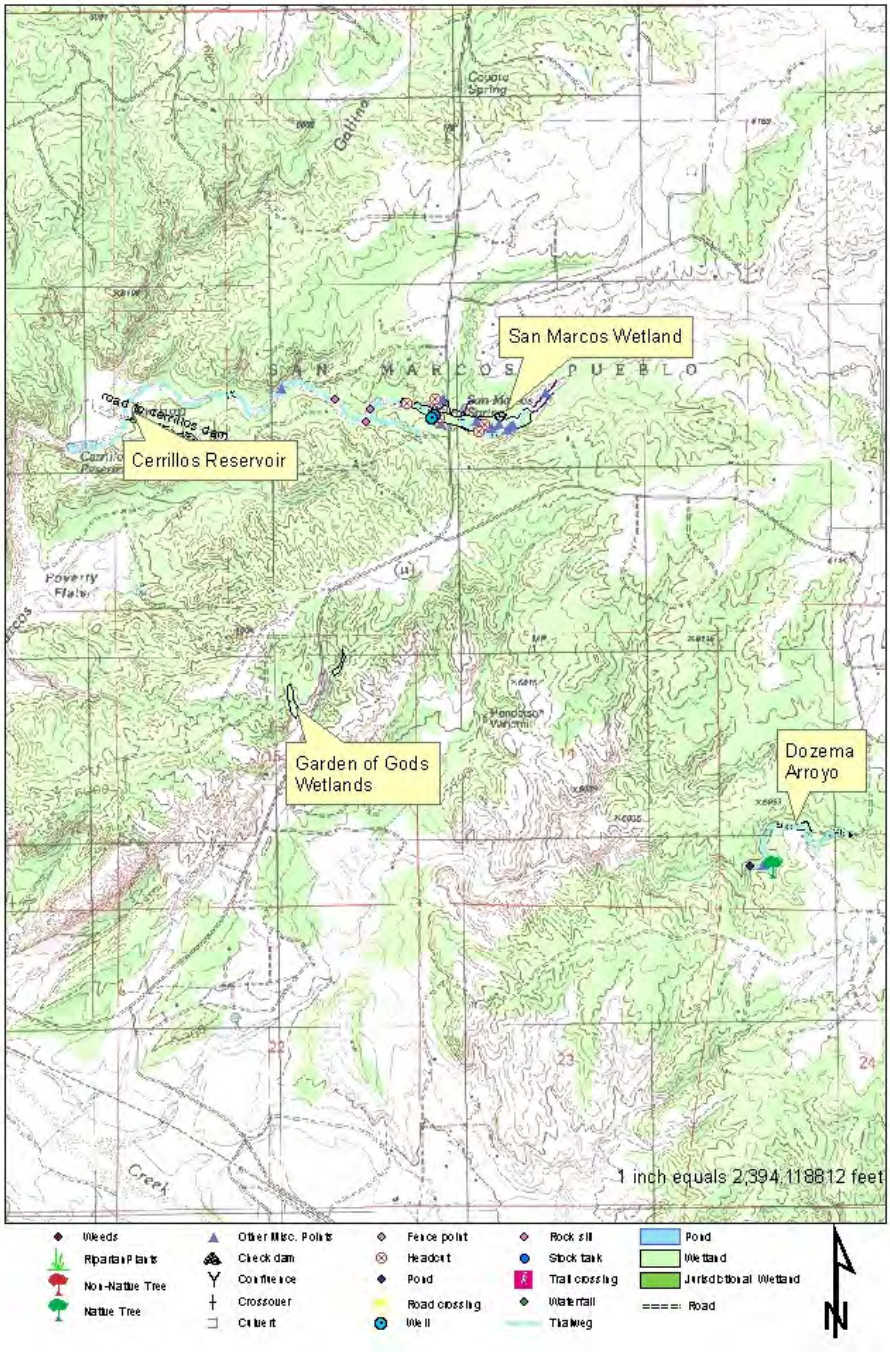
Vegetation: 86% of the dominant species had a wetland indicator status of Obl, Facw or Fac, so the vegetation met the wetland criteria.

Hydrology: The area was moist, not saturated at the surface, surface water was quite deep (greater than 2 feet), and the hydrology criteria was not met.

Hydric soil indicators: The soil did not meet the criteria for wetland soil.

There are spotty areas within San Marcos wetlands which meet all the criteria for formal wetland delineation. The wettest areas with hydric vegetation are downstream from the pools (spring) and the pond. These areas probably meet the criteria, but most of San Marcos Wetland does not meet the criteria for formal wetlands delineation.

San Marcos Area



San Marcos Wetland

Species List at San Marcos Wetland, Upstream from Highway 14:

Scientific Name	Common Name	Wetland indicator status
Anemopsis californica	Yerba mansa	Obl
Bromus tectorum	Cheat grass	Upl
Curcurbita foetidissima	Coyote gourd	Fac-
Cylindropuntia imbricata	Cholla	Upl
Eleagnus angustifolia	Russian Olive	Facw-
Equisetum arvense	Horsetail	Obl
Ericameria nauseosus	Chamisa	Upl
Fallugia paradoxa	Apache plume	Facu
Forestiera neomexicana	New Mexico Olive	Facu
Juncus balticus	Baltic rush	Obl
Juniperus monosperma	Juniper	Upl
Poa pratensis	Kentucky bluegrass	Facu
Rumex crispus	Yellow dock	Facu
Salix exigua	Coyote willow	Obl
Salix gooddingii	Black willow	Obl
Sporobolus contractus	Spike dropseed	Facu-
Tamarix ramosissima	Salt cedar	Fac
Ulmus pumila	Siberian elm	Upl

Species List at San Marcos Wetland, Downstream from Highway 14:

Scientific name	Common name	Wetland indicator status
Berberis hematacarpa	Algerita/ barberry	Upl
Bromus japonica	Cheat grass	Facu
Dactylis glomerata	Orchardgrass	Facu
Fallugia paradoxa	Apache plume	Fac-
Forestiera neomexicana	N.M. privet, N.M. Olive	Facu
Glycyrrhiza lepidota	Licorice	Fac+
Poa pratensis	Kentucky bluegrass	Facu
Populus deltoides	Cottonwood	Facw-
Ribes aureum	Golden currant	Facw
Rorippa nasturtium-aquaticum	Water cress	Obl
Rumex crispa	Yellow dock	Fac-
Salix exigua	Coyote willow	Obl
Scirpus pungens	Threesquare bullrush	Obl
Scirpus tabernaemontani	Softstem bulrush	Obl
Tamarix ramosissima	Salt cedar	Fac
Typha latifolia	Cattail	Obl

Wetland Restoration at San Marcos Wetland

Upstream from Highway 14
There are two berms created to protect the Pueblo just upstream from the start of the wetland. The effect of these berms has been to force the Arroyo to flow down the center of the Valley and then get stuck on the valley left (South) downstream until the bridge. Prior to human intervention, the Arroyo probably meandered back and forth across the valley, and perhaps didn't even have a channel in some places and acted as a delta or alluvial fan.

While there is little likelihood that the berms could be removed, there are several places in the channel where the flow could be diverted back out into the wetland as sheet flow with One-Rock dams while leaving much of the flow in the present channel.

There are several "springs" which are caused by head-cutting in the wetland. These form long, shallow pools which drain into the ground after 10-20 feet. Simple rock structures could be placed at the end of these pools to catch sediment and deepen the pool by raising the water table. This would have an additional benefit of increasing the water table nearby.

Downstream from Highway 14
The area downstream from Highway 14 has multiple small channels with small headcuts that can be treated with rock cobble liners. These flow into a headcut with a pond in it. The upstream side of the pond appears stable, the downstream edge should be built up with a One-Rock dam structure to deepen the pond and raise the water table.

Downstream from this is another headcut with a pond that is unstable and moving upstream. This headcut should be treated with a cross-vane structure. The downstream edge of the pond should be raised with a One-Rock dam. About 30 feet downstream is a faint trail crossing, a large filter dam here could anchor the entire wetland and move the wetland boundary downstream.

Thinning:
San Marcos wetland has a huge number of Russian Olive (*Eleagnus angustifolia*) trees which have grown up in recent years. Their density and number continue to increase. Thinning Russian Olives is backbreaking, difficult work, and they sprout from their roots unless treated with poison or continual trimming (four times a year for three years). Several innovative, natural herbicide techniques are being tested in La Cieneguilla at the Service Learning Center Property by William Barnes. He will be measuring re-sprouts this year against treatment with a salt solution and a strong vinegar solution.

Pros of removing Russian Olives:

1) If not removed, they will continue to spread, making access and enjoyment difficult.
2) Is it thought that they use significant amounts of ground water, although this may not be the (only) reason for the anecdotal decrease in spring flow (probably wells).
3) The vegetation under Russian Olive trees is weedy (mostly cheatgrass), and removing them may increase native wetland vegetation.
4) Increase in wetland vegetation may stabilize the ground and prevent erosion.

5) Increase in native vegetation leads to an increase in native animals which need native species (insects, small mammals).
6) Many olives are large enough to be used for woodworking. The Santa Fe Community College woodshop would take logs for student projects.

Cons of Removing Russian Olives:

1) Difficult at best, will need continual maintenance.
2) Without poison, maintenance may be too expensive and difficult.
3) Shade cast by olives prevents cattails and other vegetation from filling ponds.
4) Olives make food for wildlife (however, there are olives elsewhere).

Upper Pond at San Marcos Wetland in wintertime, West of Highway 14.

Area 6, Site B: Garden of the Gods Wetlands off of Highway 14

Owner: Private Ownership
Date of Visit: November 2005

Description of Site

This site includes two spring-fed wetlands, one on the west side and one on the east side of Highway 14, at the "Garden of the Gods" rock formations just north of Cerrillos. The wetland on the west side of the highway is uphill from the highway in a small arroyo and has a flowing spring at the top of the arroyo. This wetland has a few large Gooddings willows as well as a good diversity of wetland plants. The wetland on the east side of the highway is a 40 yard long area of the arroyo with some *Juncus balticus* and common reeds, as well as many Algeritas and New Mexico Olives. Both wetlands were accessed from Highway 14.

Site Assessment for Garden of Gods West and East:

Monitoring Techniques	**Measurements taken**	**Purpose of measurements**
GPS mapping	Thalweg, channel features, vegetation	Assessment of current conditions
Wetland Species List	Identification of all species	Assessment of wetland health and diversity

Plant list for Garden of Gods wetlands:
(Note: most diversity in West wetland. Plants also found in East wetland marked with an 'E'.)

Scientific name	**Common name**	**Wetland indicator status**	**"E" indicates species were also found in east wetland**
Baccharis sp.(?) not flowering	Seep willow (uncertain)	N	
Carex praegracilis	Clustered field sedge	Obl	
Carex simulata	Analogue sedge	Obl	
Cicuta maculatum	Water hemlock	Obl	
Eleocharis palustris	Common spikerush	Obl	
Eleocharis rostellata	Beaked spikerush	Obl	
Elymus elmoides	Squirreltail	Upl	
Equisetum arvense	Field horsetail	Facw	
Equisetum laevigatum	Smooth horsetail	Facw	
Glycyrrhiza lepidota	Licorice	Fac+	
Juncus balticus	Baltic rush	Obl	E
Muhlenbergia asperifolia	Alkali muhly	Fac	
Phragmites australis	Common reed	Obl	E

Poa pratensis	Ky. Blue grass	Facu	
Populus deltoides	Rio Grande Cottonwood	Facw-	
Rorippa nasturtium-aquaticum	Bank buttercup	Obl	
Salix exigua	Coyote willow	Obl	
Tamarix ramosissima	Salt cedar	Fac	
Typha latifolia	Cattail	Obl	

Geomorphology Results at Garden of the Gods Wetlands

West:
The western wetland has a small headcut at the lower end (up from the highway). The culvert is set a little too low to maintain the natural slope of the wetland, and the headcut is a result of this elevation change. There has been an attempt recently to build an earth dam over the wetland like a cattle tank. It has killed quite a few wetland plants by smothering them. A rough dirt road installed during the 1980s by the landowner runs up the south side of the drainage, and traps the runoff from the main drainage to the west and an eroding southwest drainage and runs them around the wetland. This road may be preventing a significant source of sediment from polluting the wetland, but it is also preventing natural aggradation of the channel.

The entire wetland is in a headcut, and the small drainage from the Northwest is actively head-cutting and calving soil into the wetland, while both the western drainage (main channel) and the southwestern drainage are diverted by the road. The earthen dam downstream in the wetland may be preventing any flow from reaching the highway, as the headcut by the highway appears to be moving very slowly. While the earthen dam is not a good wetland restoration strategy, removing it may cause more damage than the harm it causes.

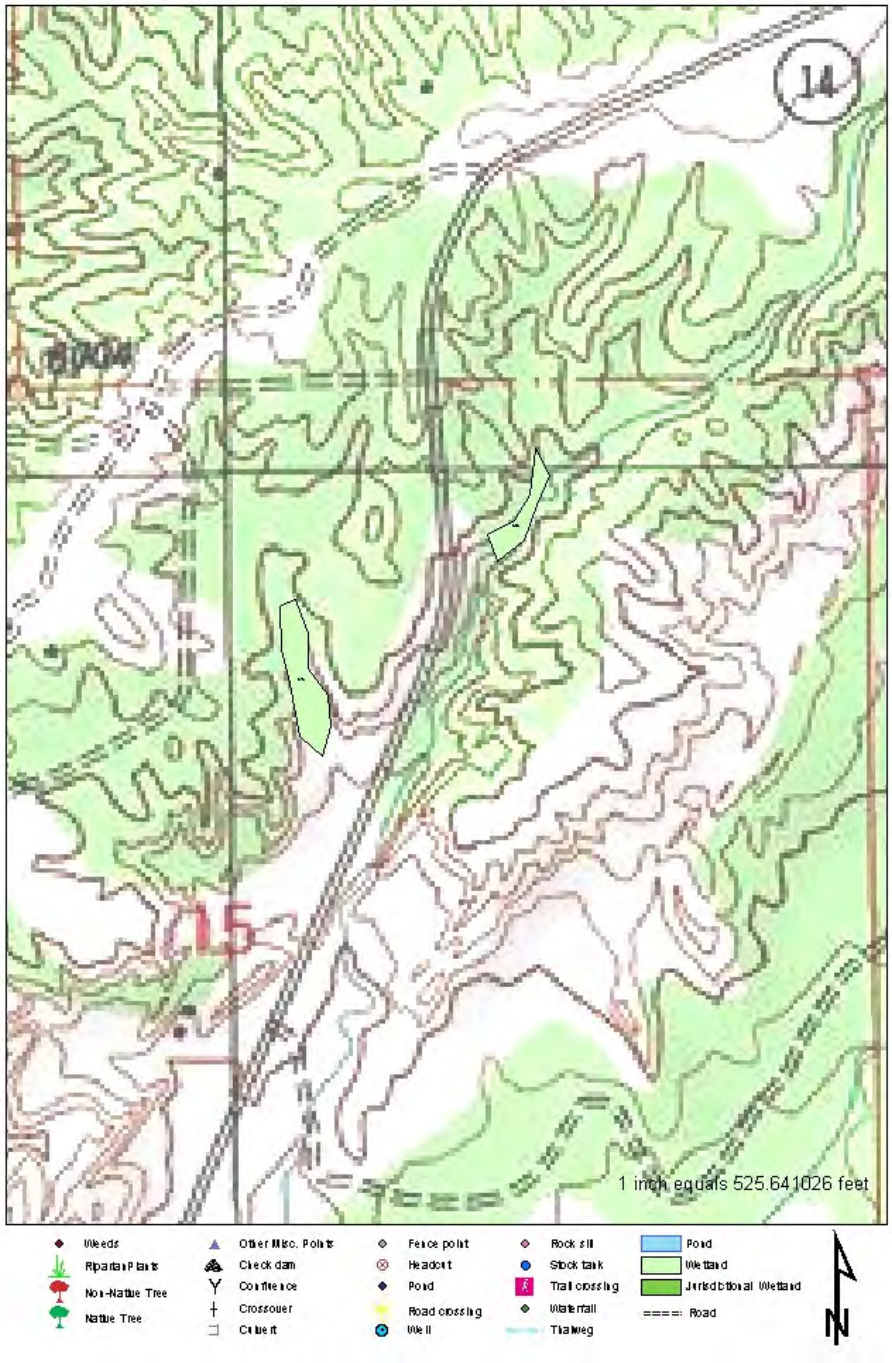
There are many invasive trees in the wetland such as Siberian elm, Russian Olives, and a few *Tamarisk*. Because of the high biological diversity at the site, it may be worth removing these trees to prevent them from overgrowing the wetland, allowing the native Goodding's Willow and Rio Grande Cottonwood to flourish.

East:
The eastern wetland at Garden of the Gods has head-cutting at two places at the bottom and middle of the wetland. There are also two channels flowing in from the west that are actively eroding and adding sediment. The channel entering from the Northwest, uphill of the wetland is receiving extra water from the highway and may receive more runoff water once the highway is widened in 2006.

This wetland could be improved greatly by induced meandering techniques to fix the headcuts mentioned above. Thinning of the dense One-Seed Juniper canopy could also encourage the growth of more wetland plants to hold the soil in place. A One-Rock dam at

the bottom of the wetland could create a small water source without drying out the wetland or starting a headcut.

Garden of Gods Wetlands, East and West of HWY 14



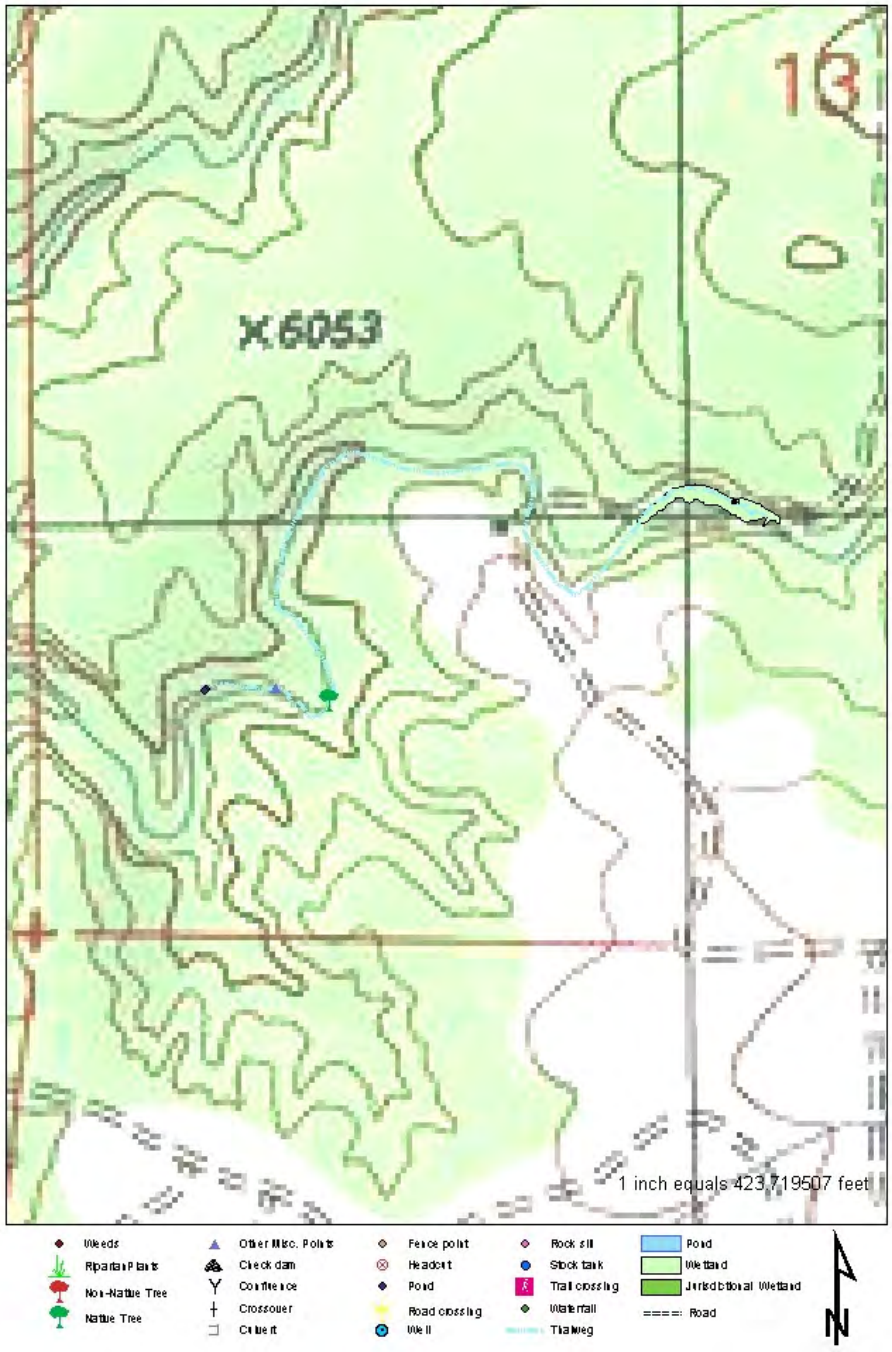
Earth Dam at Garden of Gods East Wetland.

Old Road at Garden of Gods East Wetland.

Area 6, Site C: David Dozema Arroyo

This Arroyo belongs to David Dozema and has several small areas with wetland vegetation. A geomorphic assessment was not performed on the site.

David Dozema Arroyo



Area 6, Site D: Cerrillos Hills Historic Park

Sites: Mineral Spring, Miner's Spring, Coyote Spring, Escalante Spring, Devil's Throne Arroyo, Shooting Gallery Arroyo
Ownership: Santa Fe County (Open Space & Trails Division)
Date: November 2005

Description of Site

The Cerrillos Hills Historic Park is part of the Santa Fe County Open Space program. There are six major spring areas in the park. For each area, the location of wetland vegetation, springs, headcuts, and other important features were mapped with a GPS. A species list and assessment of current conditions was written up for each spring.

Site Assessment for Cerrillos Hills:

Monitoring Techniques	Measurements taken	Purpose of measurements
GIS	Wetlands, ponds, springs, vegetation, thalweg, headcuts	Assessment of present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Devil's Throne Arroyo, Wetland Plants on Bedrock.

Species Lists for Shooting Gallery Arroyo:

Scientific Name:	Common Name:	Wetland indicator status
Brickellia californica	Bricklebush	Facu+
Carex aquatilis	Creek sedge	Obl
Eleagnus angustifolia	Russian Olive	Facw-
Forestiera neomexicana	New Mexico Olive	Facu
Juncus balticus	Baltic rush	Obl
Muhlenbergia asperifolia	Alkali muhly	Facw
Panicum obtusum	Vine mesquite	Fac
Salix exigua	Coyote willow	Obl
Sisyrinchrium demissum	Blue Eyed grass	Obl

Species Lists for Devil's Throne Arroyo:

Scientific Name:	Common Name:	Wetland indicator status
Eleagnus angustifolia	Russian Olive	Facw-
Fallugia paradoxa	Apache plume	Facu
Juncus balticus	Baltic rush	Obl
Muhlenbergia asperifolia	Alkali Muhly	Facw
Poa pratensis	Kentucky Bluegrass	Facu
Populus deltoides	Cottonwood	Facw
Rhus trilobata	Three Leaf Sumac	Fac
Schizachyrium scoparium	Little bluestem	Facu

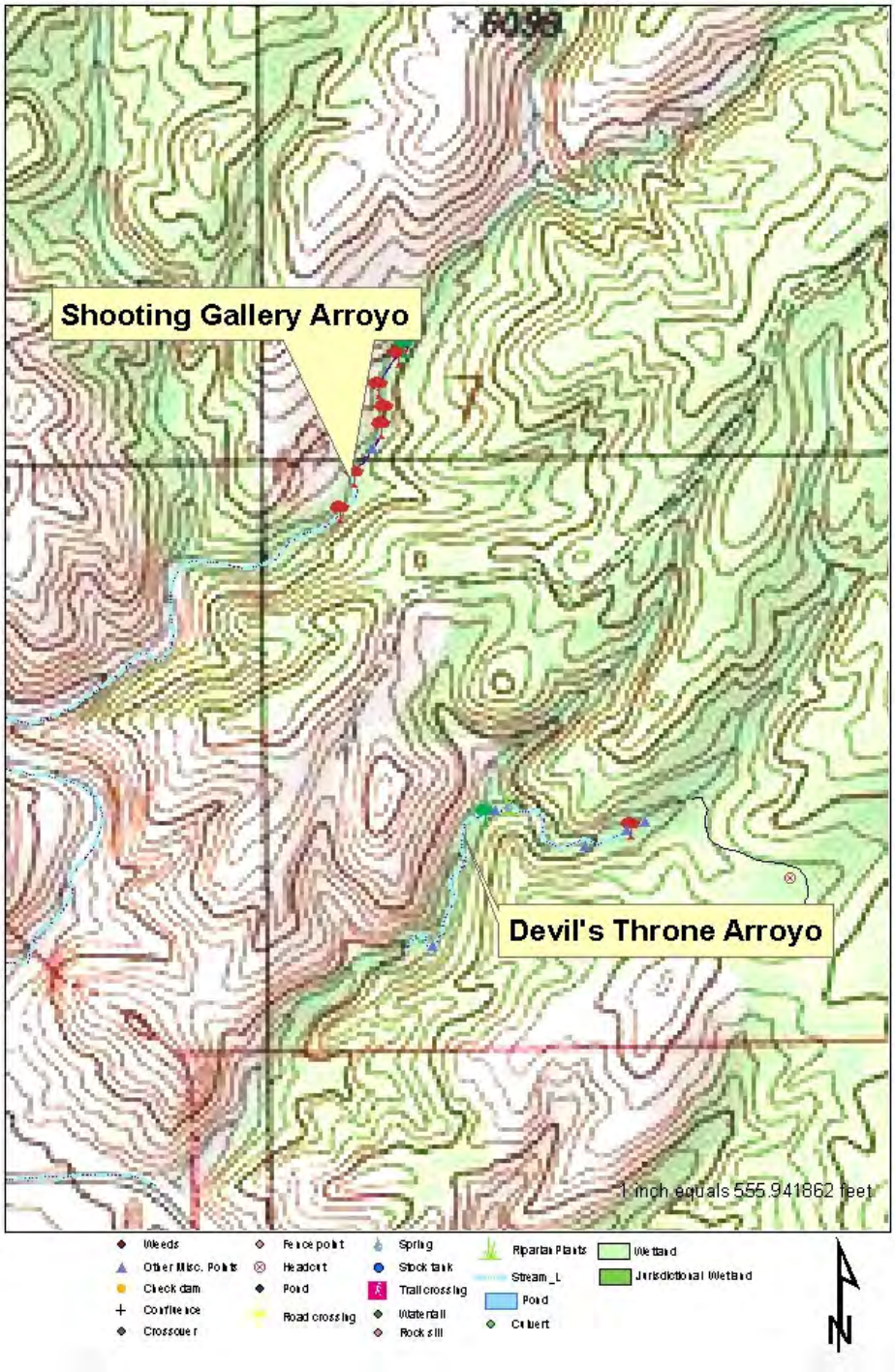
Assessment: Shooting Gallery Arroyo and Devil's Throne Arroyo

Both of these arroyos are in long valleys on the western side of the Cerrillos Hills Historic Park. As is typical throughout the park, there is extensive erosion and the valleys have incised down to bedrock. Wetland plants are found in small areas of remnant soils between areas of exposed bedrock.

Small rock structures such as One-Rock dams and rock baffles can be used to lengthen the channels and to catch sediment. Larger rock structures such as rock-cross vanes and filter dams could be placed at bedrock areas to catch sediment and increase the size of the wetland areas.

There are many large Russian Olives in these arroyos. These may be transpiring and evaporating water that would feed the wetlands below. Russian Olives also shade out native understory vegetation and prevent wetland plants and willows from growing well. Native wetland plants such as Baltic rush, scratchgrass (*Muhlenbergia*), and coyote willows have dense root systems that can withstand floods and prevent erosion. If these species are out-grown and shaded out by Russian Olives, there is less resistance to erosion in flood events and the channel will incise and dry out.

CHHP: Devil's Throne and Shooting Gallery Arroyos



Species List, Mineral Spring:

Scientific Name:	Common Name:	Wetland indicator status
Bouteloua curtipendula	Blue Grama	Upl
Carex aquatilis	Water sedge	Obl
Conyzia canadensis	Horseweed	Facu
Eleagnus angustifolia	Russian Olive	Facw-
Fallugia paradoxa	Apache plume	Fac-
Forestiera neomexicana	New Mexico Olive	Facu
Juncus balticus	Baltic Rush	Obl
Mentzelia albicaulis	Stickleaf	Upl
Muhlenbergia asperifolia	Scratch Muhly	Fac
Poa pratensis	Kentucky bluegrass	Facu
Polypogon monspeliensis	Rabbitsfoot grass	Facw+
Populus deltoides	Cottonwood, Rio Grande	Facw-
Sporobolus airoides	Alkali sacaton	Fac
Tamarix ramosissima	Tamarix	Fac
Typha latifolia	Cattail	Obl

Site Assessment, Mineral Spring:

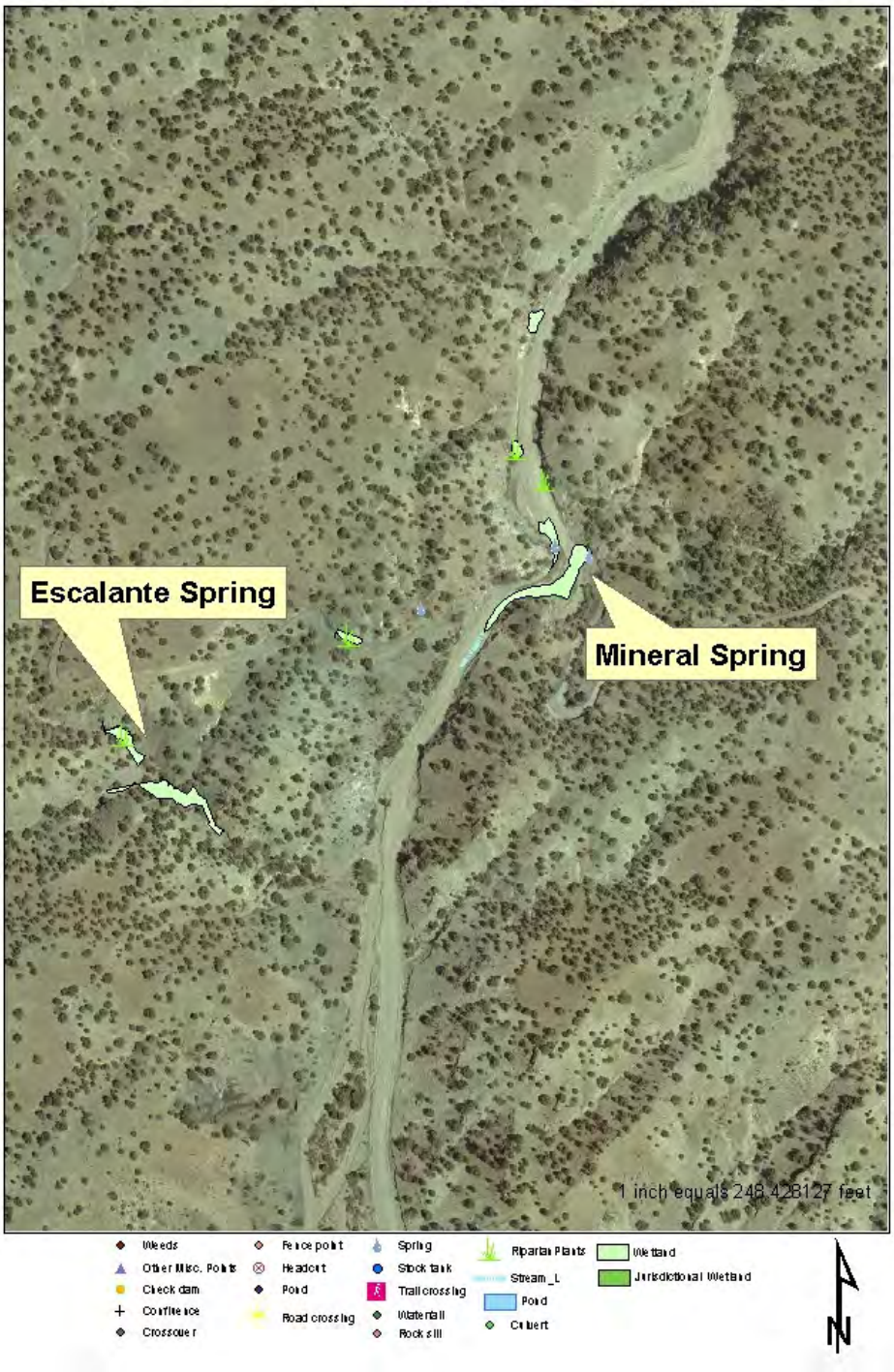
This large spring flows along both sides of the road to the gravel mine. The spring has been fenced off, and there is a need for a hardened crossing where the trail crosses the spring, as horse hoof prints have captured the main flow and diverted some of it into the road, rather than the pool downstream. This crossing should be created with 12 inch rocks (6 inch narrow side), which could be used to cobble the crossing for horses.

The west side of the road was flowing strongly this winter, but it appears to dry up every summer. There is little parking along the road, and cars park on the top of the main flow. This should be blocked off by boulders to prevent parking, and a parking area should be created 20-40 feet uphill with rubble. Creating this parking area could also help force the flow of floods (down the road) into the old channel on the west side of the canyon.

This side of the canyon (west) could also be planted with cottonwoods and Goodding's willows to create a tree canopy where there are presently no trees. As with every spring area in the Cerrillos Hills, there are many large Russian Olives that are spreading in number and taking over the spring area.

Mineral Spring Trail Crossing: needs protection from trampling.

CHHP: Escalante and Mineral Springs



Species List, Escalante Spring:

Scientific Name:	Common Name:	Wetland indicator status
Artemesia ludoviciana	Taragon	Fac-
Eriogonum corymbosum	Buckwheat brush	Upl
Fallugia paradoxa	Apache plume	Fac-
Forestiera neomexicana	N.M. Olive	Facu
Glycyrrhiza lepidota	Licorice	Fac+
Juncus balticus	Baltic rush	Obl
Lactuca serriola	Prickly lettuce	Fac
Muhlenbergia asperifolia	Alkali Muhly	Facw
Panicum obtusum	Vine mesquite	Fac
Phacelia heterophylla	Scorpion weed	Fac
Populus deltoides	Cottonwood	Facw-
Quercus undulata	Wavyleaf oak	Upl
Sporobolus airoides	Alkali sacaton	Fac

Assessment, Escalante Spring:

This spring flows through a small watershed just downstream from the Mineral Springs, and is mostly dry, with a few wet spots. Two small arroyos join and form a larger arroyo which empties out onto the Mineral Spring road. There were a few areas of wetland plants, larger areas of wet soils, and a very large number of Russian Olives. This area could be thinned of Russian Olive trees for the reasons mentioned in the assessment above.

This wetland appears to have cut down 5-6 feet since historic times. There are relict areas of wetland soils that have dried out as the area around them has incised. Restoration could involve building cross-vanes or large riffle structures to raise the grade back up and capture sediment in the wetland areas of the two arroyos. Both arroyos could benefit from restoration work in the channel upstream from the wetlands as well.

There have been upland restoration treatments on a tributary channel to the wetland. Straw bales have been installed to capture sediment and prevent erosion. The straw bales have captured a lot of sediment, but they are breaking down and will not last much longer, and then the sediment will be re-released into the wetland. The rock structures (One-Rock dams) are performing well.

Species Lists for Coyote Spring:

Scientific Name:	Common Name:	Wetland indicator status
Eleagnus angustifolia	Russian Olive	Facw-
Juncus balticus	Baltic rush	Obl
Muhlenbergia asperifolia	Scratchgrass	Fac
Tamarix ramosissima	Tamarix	Fac

Assessment, Coyote Spring:
This valley has many smaller Russian Olives, some *Juncus balticus*, some scratchgrass (*Muhlenbergia*), and water on some bedrock areas.

Like many arroyos in the Cerrillos Hills Historic Park, there is evidence of large flooding events in the past that have lowered the valley bottom, in some places by six feet. There are a few areas with native wetland vegetation, but most of the valley is washed down to bedrock. All of the water in this area comes from a shale layer that seeps out along the valley bottom. Building restoration structures to raise the cross-overs (artificial riffles) as well as a cross-vane, could capture sediment and wet a much greater area.

This area has a lot of unplanned horse trails upstream from the arroyo with the spring in it. These trails may be adding sediment and preventing the upland areas from absorbing water and contributing to spring flow.

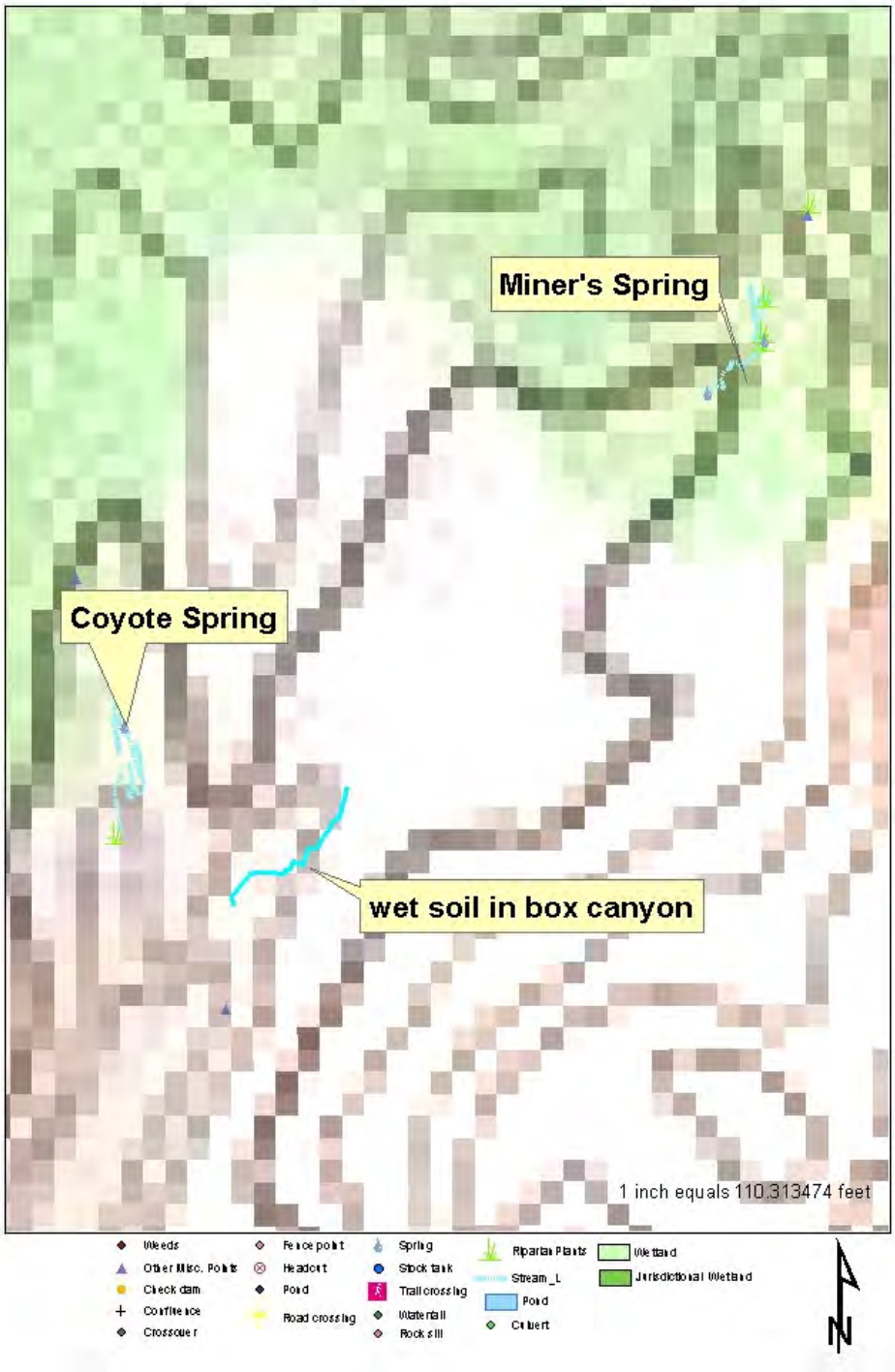
Species Lists for Miner's Spring:

Scientific Name:	Common Name:	Wetland indicator status
Eleagnus angustifolia	Russian Olive	Facw-
Juncus balticus	Baltic rush	Obl
Muhlenbergia asperifolia	Scratchgrass	Fac
Populus deltoides	Cottonwood, Rio Grande	Facw-
Tamarix ramosissima	Tamarix	Fac

Assessment, Miner's Spring:
This spring is larger and wetter than the coyote spring. It flows in a box canyon area uphill from several old miner's campsites and trash deposits. This canyon is also cut down, about four feet, as inferred from the large clump of *Juncus balticus* that is "hanging" on the left bank. This site has *Juncus balticus*, scratchgrass, coyote willows, cottonwoods, and a few other wetland plants.

There is a good location for a cross-vane below the main spring and the clump of *Juncus balticus*, and several locations for One-Rock dams upstream. This site has Russian Olives upstream from the spring (6-8 of them), which could be removed. There is potential for wetland restoration by using induced meandering techniques upstream from the spring.

CHHP: Coyote and Miner's Springs



Miner's Spring, Elevation of *Juncus Balticus* Clump was Old Channel Elevation.

Area 7: Galisteo Dam

Site: Wetland Pond at Galisteo Dam (Site A), Mailbox Road Arroyo (Site B)
Owner: U.S. Army Corps of Engineers
Date: November 2005

Area 7, Site A: Galisteo Dam

Description of Site

The Galisteo Dam is a sediment control structure built to prevent excessive sediment deposition and flooding at Santo Domingo Pueblo and the Rio Grande River. The area behind the dam is large and wet, with thick Tamarisk groves and Alkali Sacaton grasslands. Since this area has been created by human agency, it is not suitable for formal wetland delineation. However, a small pond was found just east of the dam which appears to be groundwater fed. After the sites assessment, Army Corps staff mentioned also a second pond that exists along the Galisteo Creek in the upstream part of the reservoir. No site assessment has been performed for this pond.

Site Assessment of Galisteo Dam:

Monitoring Techniques	**Measurements taken**	**Purpose of measurements**
GPS mapping	ponds	Assessing present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Plant Species List for Galisteo Dam:

Scientific name	**Common name**	**Wetland indicator status**
Aristida purpurea	Red three awn	Upl
Atriplex canescens	Four wing salt bush	Facu
Bouteloua gracilis	Blue grama	Upl
Chenopodium album	White goosefoot	Facu
Cirsium undulate	Wavyleaf thistle	Fac-
Ericameria nauseosus	Chamisa	Facu
Heterotheca villosa	Hairy golden aster	Upl
Hillaria jamesii	Galleta	Upl
Muhlenbergia pungens	Sandhill Muhly	Upl
Opuntia clavata	Dagger cholla	Upl
Oryzopsis hymenoides	Indian rice grass	Upl
Panicum obtusum	Vine mesquite	Fac
Populus deltoids	Cottonwood	Facw-

Ratibida tagetes	Mexican hat	Upl
Rhus trilobata	Three leaf sumac	Fac
Sporobolus contractus	Spike dropseed	Fac
Tamarix ramosissima	Salt cedar	Fac
Typha latifolia	Cattail	Obl

Galisteo Dam Site

Wetland Restoration at Galisteo Dam Pond

The pond is highly utilized by cattle, and at least twenty cattle departed the area during our investigation. The cattle have trampled the banks and there is no vegetation left on any bank areas. There were many cattails in the middle of the pond, and we observed Red-Winged Blackbirds and Mallard Ducks.

Fencing the uphill (inlet) portion of the bank off from cattle could have a large effect on vegetation and wildlife. Wetland vegetation should rebound quickly (could be seeded), and this vegetation could provide cover for frogs, insects and other animals.

After further investigation, we discovered from the Army Corps that no cattle should be grazing on the Galisteo Dam property. It appears as if trespass cattle are a large problem on the site.

Wetland pond at Galisteo Dam.

Area 7, Site B: Mailbox Road Arroyo

Ownership: Various private landowners
Date: October-November 2005

Description of Site

This site is off of Red Rock Road and Mailbox road south of Madrid. About two hundred yards upstream from the road crossing on the main channel was a narrow area with *Tamarisk* and Russian Olives on the banks. This wet area was about thirty yards long, and had several *Juncus balticus* clumps.

Upstream it was dry for about one hundred yards, then a box canyon and bedrock lying close to the surface create a fair sized wetland much larger than the downstream wetland. This wet zone is one hundred yards long and has several areas of wet soil that are cut through with headcuts. One unique thing about this site was the presence of several small, old, Netleaf Hackberry (*Celtis reticulata*) trees on the north bank below the box canyon. These were the only Hackberry trees found during our assessment.

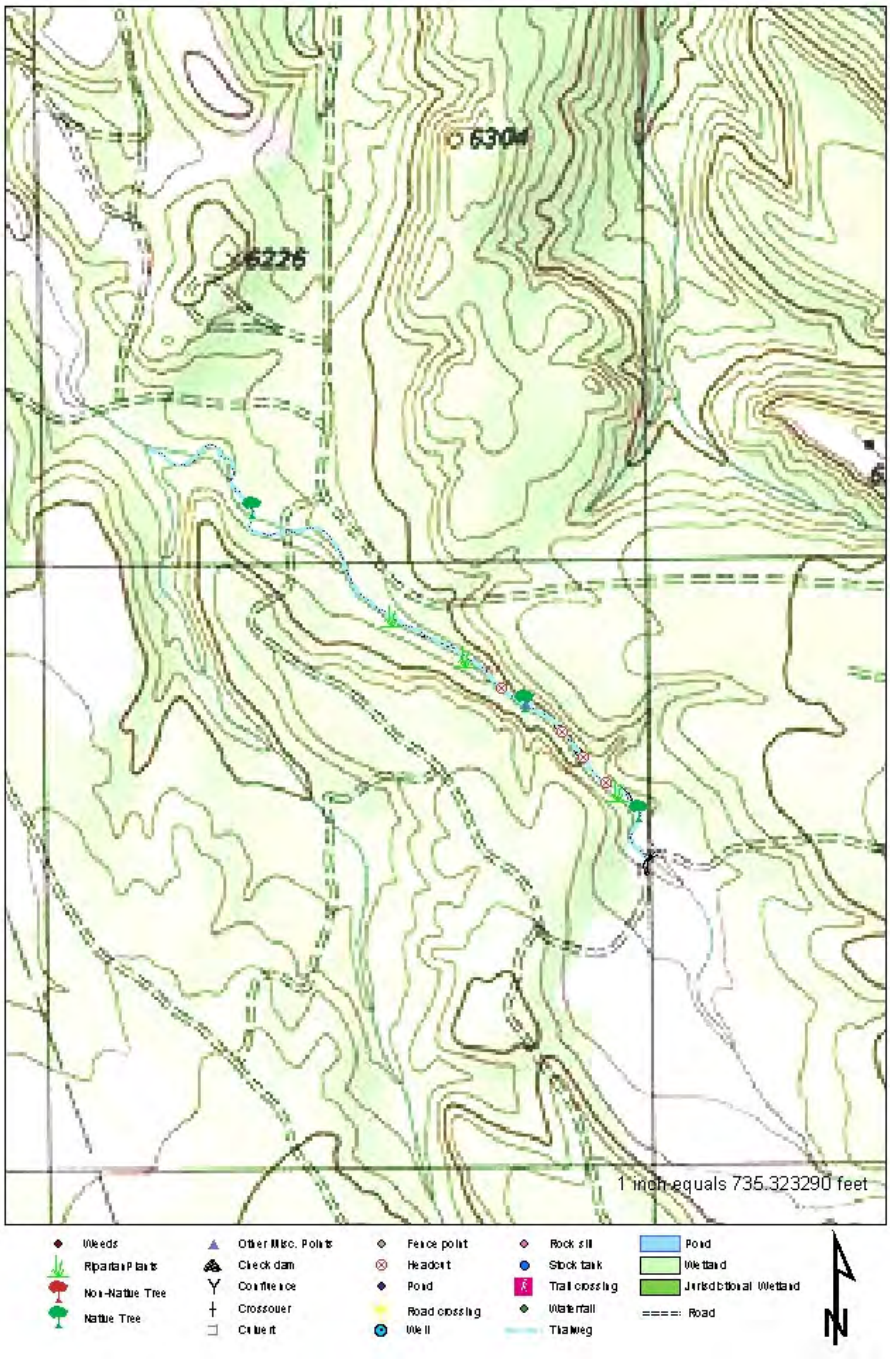
Site assessment at Mailbox Road Arroyo:

Monitoring Techniques	**Measurements taken**	**Purpose of measurements**
GPS mapping	Vegetation, headcuts, thalweg of channel, waterfalls	Assessment of present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Plant list at Mailbox Road Arroyo:

Scientific name	**Common name**	**Wetland indicator status**
Agropyron delgado	Slender wheat	Upl
Berberis hematacarpa	Barberry / Algerita	Upl
Brickellia californica	Brickelbush	Facu+
Celtis reticulata	Hackberry	Facu
Fallugia paradoxa	Apache plume	Fac-
Glycyrrhiza lepidota	Licorice	Fac+
Juncus balticus	Baltic rush	Obl
Muhlenbergia thurberens	Sand muhly	Obl
Ptelia trifoliate	Hop tree	Fac
Rhus trilobata	Three leaf sumac	Fac
Tamarix ramosissima	Salt cedar	Fac

Mailbox Road Arroyo



Wetland Restoration at Mailbox Road

The lower wet area has many *Tamarisk* and Russian Olive trees on the banks. It appears as if they have narrowed and straightened the channel, and there is very little sinuosity in this section. Removing these weedy trees and initiating a meander pattern with induced meandering could cause aggregation and the *Juncus balticus* patch to spread downstream.

Upstream at the box canyon are several larger areas with wetland vegetation and active erosion through them. These areas are cut through to bedrock and much of the wetland vegetation appears to be drying out. There is a good chance for a grade control upstream at a driveway road crossing to stabilize the upstream portion above the box canyon. The canyon itself could be fixed with Cross Vanes and baffles to increase sinuosity, catch sediment and wet the banks.

Additional Wetland Sites:

Site 8: Upper Galisteo Creek near Glorieta Pass

Ownership: Private owner(s) and U.S. Forest Service - Santa Fe National Forest
Date: November 2005

Description of Site

The upper Galisteo Creek is the eastern-most tributary of the Galisteo River, and flows out of the Sangre de Cristo Mountains near Glorieta Pass and the Glorieta Conference Center. Access was obtained by parking at the fire station at the Conference Center, and following a road through a ropes course area over the watershed divide.

Two areas were investigated during this visit, the Galisteo Creek upstream from Interstate-25, and a short section of the creek downstream from I-25. The upstream portion had very little wetland vegetation, and the downstream portion had much more wetland vegetation in a headcut above the Village of Valencia.

Site Assessment Galisteo Creek near Glorieta Pass:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Vegetation, headcuts, thalweg of channel, waterfalls	Assessment of present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Plant species list for Upper Galisteo Creek:

Scientific name	Common name	Wetland indicator status
Carex nebrascensis	Nebraska sedge	Obl
Juncus balticus	Baltic rush	Obl
Populus angustifolia	Narrow-leaf cottonwood	FacW
Salix exigua	Coyote willow	Obl

Glorieta Pass Area

Wetland Restoration for Upper Galisteo Creek

Above I-25
The lower portion of the creek starts out in a deep headcut through a clay valley. There is one rocky portion of the creek that has cottonwoods and some wetland vegetation, which we mapped. Upstream from the headcut, the creek comes out of a densely forested area with Ponderosa Pine (*Pinus ponderosa*) and Douglas Fir (*Pseudotsuga menziesii*). This portion of the creek was very dry, but had a small area of coyote willows.

The valley upstream was one continuous thicket of Gambel Oak and Mountain Mahogany, without any sign of wet soil or wetland plants. We hiked over the hill and came down a tributary to the east, which had no wet areas. Other than the few areas we identified with wetland vegetation, it appears as if this branch of the creek is ephemeral and has no permanent flow. There is little chance for restoration, and the creek appears to have cut as deeply as possible and is held up by the highway underpass downstream (it won't cut any deeper).

Below I-25
Downstream from the interstate, the creek entered a wide, well-vegetated valley with no channel that ended in an earth cattle tank. This tank was cutting through, and draining the wide valley. There was another ten foot headcut downstream in the channel, then a twenty foot headcut being held up by rubble fill (concrete). At the bottom of this headcut, a spring flowed out and led to a wide wetland area in the creek bottom. We performed only a cursory investigation. There were likely many more wetland plants than we noticed. We turned back at a sign marking private property; permission must be obtained to survey further.

Any restoration of this area would be a monumental task, as the creek is twenty to thirty feet incised into its valley bottom. This incision continues downstream through Valencia, then further downstream to the confluence with Deer Creek. Through much of this area, the creek flows alongside the BNSF Railway, and culvert and roads to access the railway contribute to flashy runoff and poor conditions in the creek.

Several easily fixed headcuts can be found near the cattle tank upstream, where the flow could be diverted to the south to a rocky area, and the wide, vegetated valley could be saved from the active erosion that is threatening it. The ten foot headcut downstream could be fixed by laying back the channel and lining it with rock. The large headcut would be a much larger task to fix and an easy solution is not immediately available.

Access to this area would be from the highway borrow pit to the south of I-25.

Headcut at Upper Galisteo Creek above Valencia.

Site 9: Deer Creek and Confluence with Galisteo Creek

Ownership: U.S. Forest Service – Santa Fe National Forest, and private ownership
Date of Visit: November 2005

Description of Site

Deer Creek is one of three perennial tributaries to the Galisteo Creek, including the Galisteo Creek from Valencia, Deer Creek, and Apache Creek. The lower portion of Deer Creek is private property, but the landowner allows access to hikers who park on the side of I-25. Deer Creek leads upstream to some deep pools (the waterfalls) which are used for swimming. We investigated Deer Creek upstream to several hundred yards above the waterfalls, as well as downstream to the confluence with Galisteo Creek.

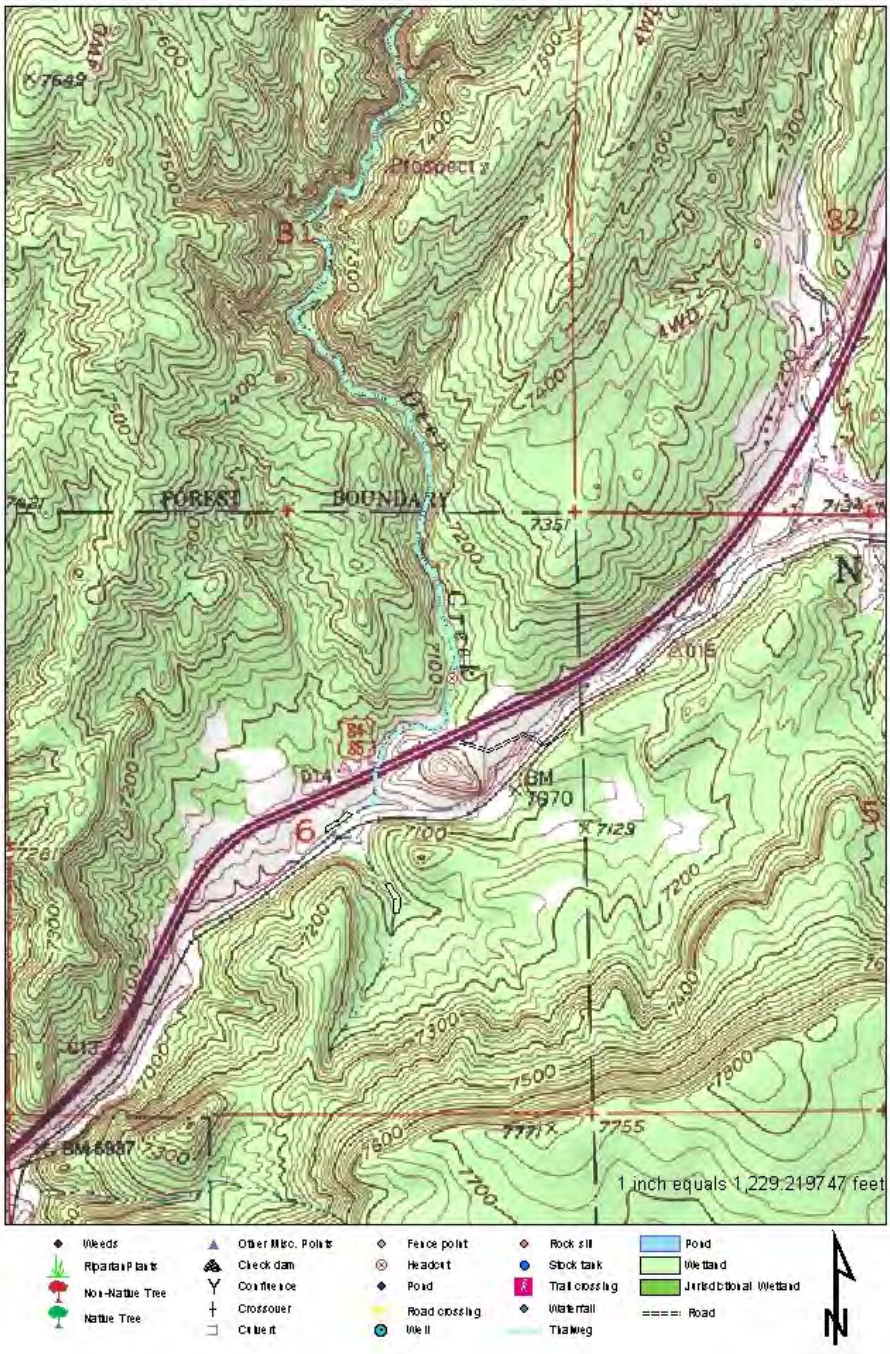
Site Assessment of Deer Creek:

Monitoring Techniques	Measurements taken	Purpose of measurements
GPS mapping	Vegetation, headcuts, thalweg of channel, waterfalls	Assessment of present conditions
Wetland Species List	Identification of all species	Assessment of diversity

Plant List for Deer Creek:

Scientific name	Common name	Wetland indicator status
Bromus japonica	Cheat grass	Facu
Carex aquatilis	Water sedge	Obl
Carex nebrascensis	Nebraska sedge	Obl
Cyperus esculentus	Chufa flatsedge	Obl
Eleocharis palustris	Common spikerush	Obl
Glycyrrhiza lepidota	Licorice	Fac+
Juniperus scopulorum	Rocky Mountain juniper	N
Muhlenbergia asperifolia	Alkali muhly	Fac
Poa pratensis	Kentucky bluegrass	Facu
Populus angustifolia	Narrowleaf cottonwood	Facw
Prunella vulgaris	Selfheal	Facw
Rumex crispa	Yellow dock	Fac-
Salix exigua	Coyote willow	Obl
Scirpus pungens	Threesquare bullrush	Obl
Tamarix ramosissima	Salt cedar	Fac
Typha latifolia	Cattail	Obl

Deer Creek, Confluence with Galisteo Creek



Wetland Restoration at Deer Creek

Upstream from Trail:
Deer Creek is perennial, with permanent small flows all year round. There is an informal (unplanned trail) up the creek which causes erosion at many creek crossings. One section of the creek has an old road on the east bank, which runs upstream to an old mine area. This section is highly incised with almost no available floodplain. Above the mine area, the creek has more ability to meander and flood. Much of the creek could benefit from stream restoration to catch sediment and re-connect the creek with its floodplain, however, this may adversely affect the trail. One small spring appears on the east side of the creek about one-half mile up the stream, and is trampled by hikers.

Restoration of Deer Creek (with the landowner's permission) would begin by re-locating the trail out of the most obvious wetland areas and off of the floodplain. Once the floodplain is clear of the trail, many cross-vanes could be installed to raise the water table and encourage water storage in the banks. Many areas also have a potential for increased meandering by means of vanes or rock baffles.

All of the materials for the restoration of Deer Creek are on-site, as there are many boulders of various sizes on the hillsides.

Downstream from Trail:
There is an active head-cutting area just upstream from I-25, and downstream from the trail access to the creek. This erosion is drying out the banks, and there are large, dead cottonwoods on both banks. A Cross Vane or Filter Dam could hold the Creek from advancing upstream any more. The banks are also covered with Rocky Mountain Juniper. Judicious thinning could encourage more shade-intolerant wetland vegetation which could help stabilize the banks. Downstream from this are several patches with high wetland plant diversity.

The confluence with the Galisteo Creek is cut down to bedrock, but there is still a high diversity of wetland plants on both banks. Downstream from the confluence is a wetland spring area on the right bank (North) that is about 50 yards long. The reason the creek is down-cut to bedrock is a culvert upstream at a road crossing used by the BNSF railway. Access to this is through private property which has a Glorieta Battlefield Memorial on the side of the interstate. The culvert is too small and rusting through; it should be replaced with a larger culvert. The stream upstream of the culvert is much healthier, has well vegetated banks and is not incised down to bedrock.

Another spring area can be found up a tributary across the railroad tracks to the south. There is a fifty yard long spring area in this tributary. An old road or trail runs along the hillside and crosses the spring, which has a large amount of coyote willow, wild licorice and Baltic rush.

Headcut on Deer Creek: Creek incised for 100 yards downstream.

Conclusions and Recommendations

The purpose of the "Planning for Wetlands in the Galisteo Watershed" Project is to begin an expanded effort to create, restore, and protect wetlands in the Galisteo Watershed. Wetland Assessment and Protection plans have been created for each of these seven areas, and two of the areas will be chosen for demonstration wetland restoration projects.

Many of the wetlands identified in this project are suffering from the effects of erosion and drought, and they are suffering from the death of wetland vegetation caused by the lowering of the water table. The heavy winter runoff in the spring of 2005 caused additional erosion on top of that from the drought, as many wetlands were in poor condition and could not handle this large amount of water. While currently grazing by cattle and other domestic livestock is not a major factor in the wetlands we studied, the erosion caused by grazing and other land management practices in the past continues to damage these wetlands to the present day.

The wetland assessments prepared for this project include restoration solutions for many of the erosion problems identified in these wetlands. Some solutions are simple and could be implemented by volunteers with professional oversight. Other solutions involve moving many tons of large rocks and building structures with heavy equipment. While only two areas will be chosen for restoration at this time, we have proposed restoration solutions for many wetland areas in the watershed. We hope that we can involve our partners and the public in performing restoration projects at every area which needs restoration, as many solutions are simple and can be built by hand.

The wetlands in the Galisteo Watershed are a valuable resource for people and wildlife, and provide oases of water in our desert environment. They also sustain a great variety of hydrologic and ecological functions vital to ecosystem integrity. Lastly, they help store water and recharge our surface aquifers that sustain the flow in the Galisteo River. Restoring and protecting our wetlands is an important task that we can all work on together.

APPENDIX C
FEDERALLY THREATENED, ENDANGERED AND SPECIES OF CONCERN BY COUNTY GALISTEO WATERSHED

APPENDIX C
Federally Endangered, Threatened and Species of Concern by County
Galisteo Watershed

Listed and Sensitive Species in San Miguel County

Number of species: 21

Common Name	Scientific Name	Group	Status
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	Candidate
Rio Grande cutthroat trout	*Oncorhynchus clarki virginalis*	Fish	Candidate
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	Mammal	Candidate
Southwestern willow flycatcher	*Empidonax traillii extimus*	Bird	Endangered
Black-footed ferret [2]	*Mustela nigripes*	Mammal	Endangered
Holy Ghost ipomopsis	*Ipomopsis sancti-spiritus*	Plant	Endangered
Mexican spotted owl Designated Critical Habitat	*Strix occidentalis lucida*	Bird	Threatened
Arkansas River shiner	*Notropis girardi*	Fish	Threatened

San Miguel County Species of Concern - Species of Concern are included for planning purposes only.

Common Name	Scientific Name	Group	Status
New Mexico silverspot butterfly	*Speyeria nokomis nitocris*	Arthropod - Invertebrate	Species of Concern
American peregrine falcon	*Falco peregrinus anatum*	Bird	Species of Concern
Arctic peregrine falcon	*Falco peregrinus tundrius*	Bird	Species of Concern
Baird's sparrow	*Ammodramus bairdii*	Bird	Species of Concern
Black tern	*Chlidonias niger*	Bird	Species of Concern
Mountain plover	*Charadrius montanus*	Bird	Species of Concern
Northern goshawk	*Accipiter gentilis*	Bird	Species of Concern
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	Species of Concern
Black-tailed prairie dog	*Cynomys ludovicianus*	Mammal	Species of Concern
Pecos River muskrat	*Ondatra zibethicus ripensis*	Mammal	Species of Concern
Swift fox	*Vulpes velox*	Mammal	Species of Concern
Townsend's big-eared bat	*Corynorhinus townsendii*	Mammal	Species of

			Concern
Dwarf milkweed	*Asclepias uncialis var. uncialis*	Plant	Species of Concern

Listed and Sensitive Species in Sandoval County

Number of species: 22

Common Name	Scientific Name	Group	Status
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	Candidate
Rio Grande cutthroat trout	*Oncorhynchus clarki virginalis*	Fish	Candidate
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	Mammal	Candidate
Southwestern willow flycatcher	*Empidonax traillii extimus*	Bird	Endangered
Rio Grande silvery minnow Designated Critical Habitat	*Hybognathus amarus*	Fish	Endangered
Black-footed ferret [2]	*Mustela nigripes*	Mammal	Endangered
Mexican spotted owl Designated Critical Habitat	*Strix occidentalis lucida*	Bird	Threatened

Sandoval County Species of Concern - Species of Concern are included for planning purposes only.

Common Name	Scientific Name	Group	Status
Jemez Mountains salamander	*Plethodon neomexicanus*	Amphibian	Species of Concern
New Mexico silverspot butterfly	*Speyeria nokomis nitocris*	Arthropod - Invertebrate	Species of Concern
American peregrine falcon	*Falco peregrinus anatum*	Bird	Species of Concern
Arctic peregrine falcon	*Falco peregrinus tundrius*	Bird	Species of Concern
Baird's sparrow	*Ammodramus bairdii*	Bird	Species of Concern
Mountain plover	*Charadrius montanus*	Bird	Species of Concern
Northern goshawk	*Accipiter gentilis*	Bird	Species of Concern
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	Species of Concern
Rio Grande sucker	*Catostomus plebeius*	Fish	Species of Concern
Goat Peak pika	*Ochotona princeps nigrescens*	Mammal	Species of Concern
Townsend's big-eared bat	*Corynorhinus townsendii*	Mammal	Species of Concern
Gypsum phacelia	*Phacelia sp. nov.*	Plant	Species of

			Concern
Gypsum townsendia	*Townsendia gypsophila*	Plant	Species of Concern
Knight's milk-vetch	*Astragalus knightii*	Plant	Species of Concern
Parish's alkali grass	*Puccinellia parishii*	Plant	Species of Concern

Listed and Sensitive Species in Santa Fe County

Number of species: 16

Common Name	Scientific Name	Group	Status
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	Candidate
Rio Grande cutthroat trout	*Oncorhynchus clarki virginalis*	Fish	Candidate
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	Mammal	Candidate
Southwestern willow flycatcher	*Empidonax traillii extimus*	Bird	Endangered
Rio Grande silvery minnow [3]	*Hybognathus amarus*	Fish	Endangered
Black-footed ferret [2]	*Mustela nigripes*	Mammal	Endangered
Mexican spotted owl Designated Critical Habitat	*Strix occidentalis lucida*	Bird	Threatened

Santa Fe County Species of Concern - Species of Concern are included for planning purposes only.

Common Name	Scientific Name	Group	Status
American peregrine falcon	*Falco peregrinus anatum*	Bird	Species of Concern
Arctic peregrine falcon	*Falco peregrinus tundrius*	Bird	Species of Concern
Baird's sparrow	*Ammodramus bairdii*	Bird	Species of Concern
Mountain plover	*Charadrius montanus*	Bird	Species of Concern
Northern goshawk	*Accipiter gentilis*	Bird	Species of Concern
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	Species of Concern
Rio Grande sucker	*Catostomus plebeius*	Fish	Species of Concern
Townsend's big-eared bat	*Corynorhinus townsendii*	Mammal	Species of Concern
Santa Fe cholla	*Opuntia viridiflora*	Plant	Species of Concern

APPENDIX D
STEERING COMMITTEE REVIEW OF WETLAND FUNCTIONS

APPENDIX D
STEERING COMMITTEE REVIEW OF WETLAND FUNCTIONS

The following pages describe each potential wetland function, monitoring indicators, and the potentially associated values of each wetland function.

Hydrologic Functions

1. Maintenance of Runoff Volume

FUNCTION: The volume of surface water runoff (i.e., landscape input) is diminished when water evaporates or is transferred to long-term or permanent storage in aquifers. Many wetlands in the Galisteo Watershed reduce runoff partly by efficiently evaporating (and transpiring) water and/or transferring it to underground (alluvial) storage.

Despite the importance of wetlands for reducing stormwater runoff volume, their landscape-wide effects vary. While surface runoff in the Galisteo Creek from the Galisteo Dam reservoir is not a serious problem, peak runoff during floods occasionally lead to severe erosion and losses of potential infiltration (alluvial storage) at the wetland and downstream. The capacity for large runoff volume evaporation and/or storage at the wetlands is variable, and probably decreasing in the following order of main wetlands areas: Galisteo Creek in the Village of Galisteo, San Marcos Arroyo, Arroyo de los Angeles sub-watershed, Finger Lakes, Canoncito Arroyo, Galisteo Dam ponds, and Arroyo Salado.

Monitoring: It will be costly to measure this function, because it requires long-term measurement of inflow and outflow of water at the wetland sites. It might be easier to estimate the function based on the surface area of the floodplain of the wetland sites, combined with the infiltration capacity of non-saturated floodplain areas.

VALUE: Maintenance of runoff volume is of value to landowners and owners and managers of infrastructure, such as roads, bridges and water source (wells) and conveyance structures (pipelines). Runoff peaks in the Galisteo Watershed typically lead to flooding of low water crossings and culverts and may occasionally damage bridges, wells, home sites, and roads along the drainages. The runoff absorption capacity of wetlands decreases the time of concentration of stormwater (see below) and, hence, the risk of flooding and all associated safety hazards and the risk of scouring damage from the energy of concentrated water flows. As a result, wetlands constitute buffer that helps landowners and managers save money in land and infrastructure

maintenance and repair.

No exact monetary data are available regarding this value. Occasional occurrences have shown the cost of a well (or its replacement) to be at least $10,000. The restoration of a stream site for home site protection at one occasion was approximately $120,000. Railroad grade protection over 600 feet in the Galisteo Creek in 2001 had an estimated cost of $450,000.

2. Maintenance of Runoff Timing

FUNCTION: Surface water runoff (i.e. landscape input) is delayed in its down gradient journey when water is retained in wetlands and riparian areas. This broadens the storm hydrograph and reduces streamflow peaks. Increases in the time of concentration and subsequent hydrograph flattening and broadening are in particular to be expected at the wetlands of Finger Lakes, Galisteo Village, San Marcos, Galisteo Dam ponds, and Arroyo de los Angeles (Galisteo Basin Preserve), because of the broadness of the floodplain and the backing up of water behind bridge openings and dams. This effect will be present to a lesser extent in the channels of the Galisteo Creek on Cerro Pelon Ranch and in the arroyo wetlands of Canoncito Arroyo (Eldorado Wilderness) and the Arroyo Salado canyon.

Monitoring: Like with the previous function, it will be costly to measure this function directly, because it requires long-term measurement of inflow and outflow of water at the wetland sites, combined with the timing of the flows. It might be easier to estimate this function based on the width and surface area of the floodplain of the wetland sites, combined with the infiltration capacity of non-saturated floodplain areas and the flow-through capacity of the bridge openings, spillways and natural outflow points of the wetlands.

VALUE: Delayed runoff downstream due to runoff retention in wetlands and the related reduction in concentrated flows and scouring water energy leads typically to lower costs in repairs and maintenance on infrastructure, homes, wells, and ecologically valuable sites along drainages. As mentioned above, no exact monetary data are available for these values.

3. Groundwater Recharge

FUNCTION: Surface water runoff (i.e., landscape input), when delayed in storage areas during its down gradient journey, can move downward into underlying aquifers, recharging the

groundwater. This function applies to all wetlands in the watershed, and particularly so for those with deep, unsaturated, sandy infiltration zones. These wetlands typically occur on broad floodplains with few, if any, rock or clay layers that confine the bottom and sides of the channel. As described above, the capacity for large runoff volume storage at the wetlands is variable, and probably decreasing in the following order: Galisteo Creek in the Village of Galisteo, San Marcos Arroyo, Arroyo de los Angeles, Finger Lakes, Canoncito Arroyo, Galisteo Dam ponds, and Arroyo Salado.

Monitoring: It is difficult to measure groundwater recharge, unless we install piezometers and perform long-term monitoring on all sites in varying conditions of soil moisture (after floods, etc). Soil data (esp. for infiltration capacity) may help us understand infiltration speed and capacity and local well and/or geological data may also help us understand and interpret the level of confinement of the alluvium.

VALUE: The groundwater recharge function of wetlands is of importance to landowners with alluvial wells that are dependent in their long-term operation on recharge of the alluvial aquifer. At the same time the New Mexico Office of the State Engineer and Interstate Stream Commission may be interested in groundwater recharge data to estimate whether water is diverted or detained in ways that are illegal or undesirable under the State's compact obligations to Texas, or whether groundwater recharge contributes to underground flows to the Rio Grande and contributes positively to the State's compact requirements. Groundwater recharge functions are also of value to Santa Fe County and the Jemez y Sangre Water Planning Council in their efforts to increase groundwater recharge for reuse by consumers and for regulatory purposes. Finally, recharge is of considerable value to downstream ecosystems where the water surfaces in springs and seeps, and where it is used by farmers and ranchers.

Water Quality and Biogeochemistry Functions

4. Sediment Retention

FUNCTION: Sediment retention is the process by which sediment carried by overland runoff (e.g., sheet flow) and incoming surface waters is deposited (sedimentation) and retained. Wetlands in the Galisteo Watershed retain sediments by (a) anchoring sediments with plant roots, and (b) intercepting and reducing erosional energies (e.g., wind, waves). To be stabilized over long periods of time, sediment entering wetlands must either be deposited in deep permanent waters, or be stabilized by encrusting precipitates or roots of wetland vegetation.

This function is very applicable to all wetlands in the Galisteo Watershed, especially in circumstances where flood waters are allowed to spread. Restored wetlands and streams are so effective in retaining sediment that they have starved downstream areas of sediment to the point of net degradation of the channel bottom. Sediment retention, largely enhanced by dams and other engineered stream modifications, has lead to a significant lack of sediment downstream in the Rio Grande. This has increased the effectiveness of the streams and the Rio Grande to convey water downstream to Elephant Butte reservoir in support of water needs in the southern part of the State and its compact obligations to Texas. However the lack of sufficient sediment in the Rio Grande has also severely degraded habitat for fish species which are now considered endangered, such as the Rio Grande silvery minnow. The sediment retention function is most likely effective in decreasing order in Canoncito Arroyo (Eldorado Wilderness), Arroyo de los Angeles (Galisteo Basin Preserve), San Marcos Arroyo, Finger Lakes, Galisteo Dam ponds, and Arroyo Salado.

Monitoring: This function can be monitored easily by measuring stream channel dimensions through continued longitudinal and cross sectional transects and comparing findings in time series, and by conducting pebble counts and photopoint observations.

VALUE: Sediment may have positive and negative values for different constituents at different locations downstream (and upstream) along the water system. In some cases, sediment retention may lead to the ecological degradation of wetlands and their other functions (we have seen this in Galisteo Village and on Cerro Pelon Ranch), where it covers healthy wetland vegetation and chokes and dries up floodplain wetlands. In other cases, sediment retention has positive values due to the increase of alluvial material in the wetland that may enhance other wetland functions (and their associated values), such as increased retention capacity of runoff volume and increased time of concentration (reduction of the hydrograph peaks) and increased groundwater recharge, and reduce the chance of active headcutting in the channel to undermine healthy wetlands upstream. When sediment retention leads to downstream sediment starvation of the system, stream side wetlands may dry up and lose their functions and values, while increased water conveyance increases the values associated with water delivery downstream.

5. Phosphorus Retention

FUNCTION: Phosphorus retention is the process by which phosphorus is held for long periods

within the sediment, water column or biota of a wetland. Excess phosphorus can originate for example from agricultural fields, horse pastures, and mines, and is carried by overland runoff (e.g., sheet flow), incoming surface waters, and perhaps groundwater. While Phosphorus is being retained within a wetland, it can be converted from one form to another, e.g., from organic to inorganic form, or from oxidized to reduced form. However, because wetlands in the Galisteo Watershed are open wetlands with outflows, and because there is relatively little geologic phosphorus in the environment, the relative importance of this function is limited. If and where phosphorus is intercepted, the retention will largely take place in sediments and to some extent in plants, and depends on the effectiveness of function 4 (see above). In freshwater aquatic ecosystems phosphorus has been described as the major limiting nutrient. Under undisturbed natural conditions, phosphorus is in short supply. The natural scarcity of phosphorus is demonstrated by the explosive growth of algae in water receiving heavy discharges of phosphorus-rich wastes. Because phosphorus does not have an atmospheric component as does nitrogen, the phosphorus cycle can be characterized as closed. The removal and storage of phosphorus from wastewater can only occur within the constructed wetland itself. According to Mitsch and Gosselink phosphorus may be sequestered within a wetland system by the following:

1. The binding of phosphorus in organic matter as a result of incorporation into living biomass,
2. Precipitation of insoluble phosphates with ferric iron, calcium, and aluminium found in wetland soils.

Monitoring: This function can be monitored by soil sampling for phosphorus. Measuring kits for water samples will measure phosphorus content in the water

VALUE: The value of phosphorus retention may be of importance if and when phosphorus levels in surface water are too high and cause algal blooms. However, at present, the value of this function is limited.

6. Nitrogen Removal

FUNCTION: Nitrogen removal is the process by which dissolved Nitrogen (a) disappears from the immediate landscape as a result of being converted to gaseous forms, or (b) is retained for long periods within the sediments, water column, or biota of a wetland. While nitrogen is being retained within a wetland, it can be converted from one form to another, e.g., from organic to inorganic.In the Galisteo Watershed, dissolved nitrogen is rapidly converted to gas or retained in plants, water and sediments. Nitrogen levels in the creeks are only high near horse pastures and

can potentially cause algal blooms.

Monitoring: Nitrogen removal can be measured relatively easily with kits that measure dissolved nitrogen in water and sediments.

VALUE: Nitrogen removal helps improve water quality for fisheries, irrigation, and biological diversity. This enhances the productive use of the water and its odor and visual quality. As mentioned above, its relative importance in the Galisteo Watershed is limited.

7. Heavy Metals and Hydrocarbon Removal

FUNCTION: For purposes of this Wetlands Action Plan, detoxification is the process by which xenobiotic contaminants, including synthetic hydrocarbons and atypical concentrations of heavy metals, are converted from forms toxic to plants or animals to forms that are relatively harmless. This function is only applicable to mining sites, high-stakes horse breeding operations, and locations with unexplained high concentrations of mercury, aluminum, and other metals (in Canoncito, Lamy, and near Cerrillos). All soils contain at least a low concentration of metals but in some locations human activities have resulted in metal levels high enough to cause health or ecological risks in water resources. Metals may exist in wetland soils or enter wetlands through surface or ground water flow.

Wetlands can remove metals from surface and ground water as a result of the presence of clays, humic materials (peats), aluminum, iron, and/or calcium (Gambrell 1994). Metals entering wetlands bind to the negatively ionized surface of clay particles, precipitate as inorganic compounds (includes metal oxides, hydroxides, and carbonates controlled by system pH), complex with humic materials, and adsorb or occlude to precipitated hydrous oxides. Iron hydroxides are particularly important in retaining metals in salt marshes. Wetlands remove more metals from slow flowing water since there is more time for chemical processes to occur before the water moves out of the wetland. Burial in the wetland substrate will keep bound metals immobilized. Neutral pH favors metal immobilization in wetlands (Gambrell 1994). With the exception of very low pH peat bogs, as oxidized wetland soils are flooded and reduced, pH

converges toward neutrality (6.5 to 7.5) whether the wetland soils were originally acidic or alkaline (Ponnamperuna 1972). www.water.ncsu.edu/watershedss/info/**wetlands**/function.html

VALUE: Detoxification helps increase water quality for fisheries, irrigation, and biological diversity. This enhances the productive use of the water. As mentioned above, its relative importance in the Galisteo Watershed is limited.

Biological Functions

8. Vascular Plant Production and Carbon Cycling

DESCRIPTION: Wetland plants produce large quantities of carbon as they grow. Carbon production per unit area is particularly great among emergent vascular plants, and to a lesser extent among woody and aquatic bed species.

There is inadequate information available on this function for wetlands in the Galisteo Watershed. The relative volumes of carbon production (sequestration) in wetlands in the Galisteo watershed are probably relatively low due to the small acreage of wetlands, harsh climate conditions, and soil fertility limitations.

Monitoring: Monitoring should consist of annual assessments of vascular plants and woody and aquatic bed species biomass, volume, weight, and carbon estimate. This, however, is very labor intensive and costly work.

VALUE: Vascular plant production and carbon cycling may become of more particular importance if carbon sequestration credits can be obtained for wetlands restoration, especially as part of a State-wide wetlands restoration program. This value may be reduced by the reported greenhouse gas (methane) emissions from wetlands.

9. Macroinvertebrate Production

FUNCTION: Wetlands in the Galisteo Watershed sustain a wide variety of aquatic and semi-aquatic insects and possibly crustaceans. Individual taxa that apply in the area can be grouped as follows (after Jeffries 1989, McLachlan 1970, 1975, 1985, Wiggins et al. 1980):

- Overwintering Spring Recruits: reproduction depends on water availability; include most midges, mayflies, some beetles.
- Overwintering Summer Recruits: reproduce independent of surface water availability, requiring only saturated sediment; include phantom midges and some dragonflies, mosquitoes.
- Non-wintering Spring Migrants: mostly require surface water for overwintering, adults leave temporary water before it disappears in spring or summer; includes most water bugs, some water beetles.

The function of macroinvertebrate production applies particularly to more (semi)permanent streams and pools, and little to ephemeral streams and pools. Therefore, it is of descending importance for the following areas: Galisteo Creek in the Village of Galisteo, Cerrillos Hills Springs (those with permanent water), Galisteo Dam ponds, Finger Lakes (spring), Galisteo Spring (Galisteo Basin Preserve), Arroyo Salado, San Marcos Arroyo, and Canoncito Arroyo.

Monitoring: We can monitor these functions relatively easily by conducting seasonal insect assessments. Some of these assessments can even be done with school classes.

VALUE: Macroinvertebrate production is of value to biologists, resource management agencies, and the general public interested in a balanced insect life that supports fish, birds, and larger animals. As macroinvertebrate production is at the bottom of the food web of a diverse ecosystem, there is a general value related to biodiversity functions in this specific value.

10. Fish Production

FUNCTION: This function is applicable only to the Galisteo Creek in the Village of Galisteo and in the main stem of the Galisteo Creek between Galisteo and Cerrillos. These reaches have Flathead chub and occasionally trout that has escaped from the Apache Canyon hatcheries and ponds (or released by individuals in Canoncito).

Monitoring: Fish production can be monitored by conducting seasonal fish shocking assessments, in collaboration with NMED and/or local schools.

VALUE: The value of fish production is of importance to educational and recreational (scenic) uses of the stream and wetlands. It will help connect people to the stream and wetlands and may

help grow people's interest in stewardship actions to preserve stream and wetland health conditions and processes.

11. Waterfowl Habitat

FUNCTION: In the Galisteo Watershed, this function is limited to the capacity of wetlands to provide alternative stopover sites for migrating waterfowl (ducks, geese, plovers, egrets, herons, and sand pipers). Additionally, the riparian woodlands are of importance to raptors and songbirds, and potential habitat for endangered species such as yellow-billed cuckoo and southwestern willow flycatcher (see below under Biodiversity).

Monitoring: We can monitor water fowl populations by conducting seasonal bird counts with local birders, schools, or engaging regional bird watching organizations.

VALUE: Waterfowl serve a limited but important role in recreational uses of the landscape and the scenic values of the Galisteo Watershed. More importantly, the wetlands in the Galisteo Watershed serve as a stepping stone in an alternative fly route of migratory waterfowl on their way to crucial wintering places such as Bosque del Apache, which has important tourist values in the State.

12. Winter Wildlife Shelter

FUNCTION: This function consists of the capacity of wetlands to reduce thermal stress to non-aquatic birds and mammals during winter. Most of the species that benefit from this function are year-round residents of the region, but not necessarily of wetlands, such as bear, mountain lion, bobcat, coyote, foxes (gray, red, and kit), weasels, badger, mule deer, pronghorn, many rodent species, and wild turkey. More wildlife studies are necessary to gage the importance of this function.

Monitoring: We can monitor wildlife populations by conducting seasonal wildlife observations and counts with local amateurs, schools, or by engaging regional wildlife watching and conservation organizations.

VALUE: Winter wildlife shelter is essential for wildlife population maintenance in the Galisteo Watershed as the area constitutes a crucial link in a continent-wide passage way of wildlife from

Alaska to Mexico. Additionally, this function of wetlands is important for many local species. Wildlife is considered of great value to the area for purposes of outdoor recreation (wildlife viewing), maintaining a rural, open space character to the landscape, and for purposes of maintaining general biodiversity and ecological resilience in a fragile landscape. For some people, wildlife shelter adds to the value of the area for hunting.

13. Biodiversity

FUNCTION: Biodiversity consists of the capacity of wetlands both individually and cumulatively to support a large variety of plants, invertebrates, and vertebrates. Biodiversity concerns the variety of genotypes, species, biotic communities, and trophic groups. For purposes of this Wetlands Action Plan, biodiversity will be considered synonymous with species richness (per unit). It is recognized that wetland or landscape types capable of supporting a large number of species of one phylum (e.g. plants) are not always optimal for supporting maximum diversity of another phylum (e.g. aquatic insects). Also, it is recognized that **genetic** diversity is an intrinsic part of biodiversity, and is not always associated with great **species** diversity or richness. Despite its potential importance, genetic diversity is not considered in this Wetlands Action Plan because no information is available on genetic diversity of wetland in the Galisteo Watershed. An overview of plan species diversity is included in the Assessment and Plan (see above). No information is available about insect, avian or mammalian diversity in wetlands in the Galisteo Watershed.

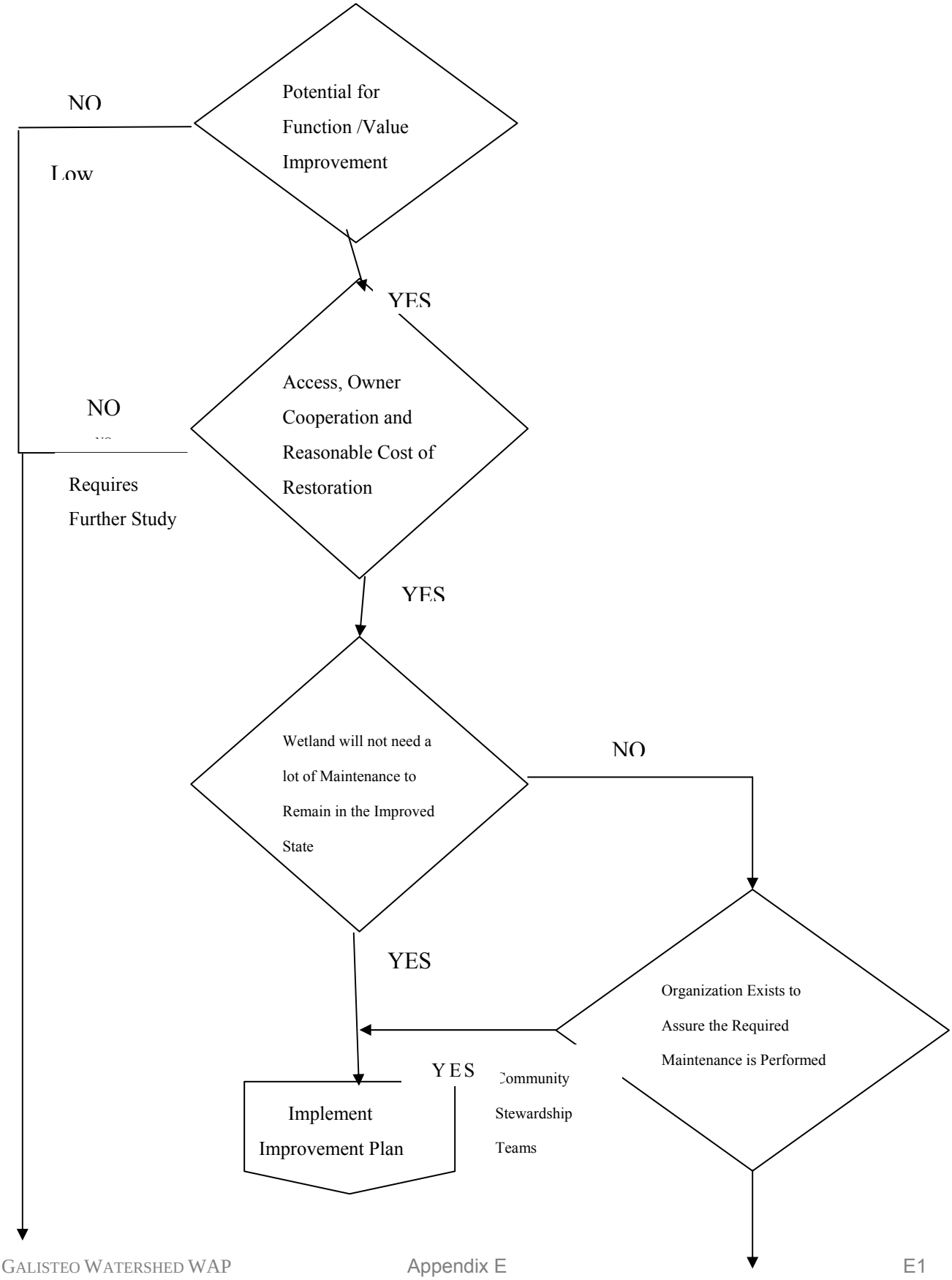
Monitoring: Monitoring should begin with conducting good baseline assessments of focal species or species of concern.

VALUE: Biodiversity is of value to residents for their enjoyment of the area. It is of value to local business, Santa Fe County and the State of New Mexico for purposes of outdoor recreation and eco-tourism development, and outdoor public and school education. Biodiversity is by many also considered of value to maintain ecological integrity and resilience of this fragile and changing landscape.

APPENDIX E
DECISION TREE FOR WETLAND RESTORATION PRIORITIZATION PROCESS

APPENDIX E

Wetlands Selection Decision Tree



APPENDIX F
JEWELS OF THE SOUTHWEST
WETLANDS OF THE GALISTEO WATERSHED
OUTREACH BROCHURE

What Can You Do?

We can all contribute to the protection, restoration and preservation of wetlands.

1. **Learn about wetlands.** Learn about their ecology and ecological functions and the environmental services wetlands offer us. Learn and identify what values wetlands offer our community and society, and how we can protect wetlands, legally and physically.

2. **Monitor and reduce your water consumption** and collaborate with organizations that protect nearby wetlands from drying up.

3. **Join a community association or stewardship team** to collaborate with government agencies, experts, and conservation groups on local and regional wetland protection and restoration projects. Such work will also benefit the preservation of wildlife and water resources.

4. **Join the local and state political process** for public education about wetlands, for greater protection of wetlands, for the creation of buffer zones in the land use planning processes of the county and local developers, and for regulations that reduce the pollution of surface water and wetlands.

5. **Be a conscientious wetland steward** by keeping your land adjacent to a wetland covered under native vegetation and mulch, preventing erosion, and allowing as much precipitation to infiltrate the soil as possible, and by preserving a buffer zone of undeveloped and undisturbed land for at least 300 feet around a wetland or along a stream corridor.

6. **Eliminate future development in and around wetlands** on your property by entering into a voluntary land protection agreement (a.k.a. conservation easement), while reaping possible tax benefits from such an agreement and potentially increasing your property values.

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Jewels Of The Southwest

Wetlands of the Galisteo Watershed

What Are Wetlands?

Wetlands are areas where soils, plant growth, and animal life are permanently influenced by watery conditions at the surface of the land. Wetlands in the Galisteo Watershed include:

> Areas along streams that are kept wet by permanent or frequent flows of water that inundate the land or irrigate it from below due to a shallow groundwater table. Such areas include, for example, many wet patches along the Galisteo Creek and its tributaries.

> Areas that are wet due to springs and seeps at the head of a stream, on the sides or in the walls of arroyos and canyons, such as those of the Galisteo Spring, springs in the Cerrillos Hills, San Marcos Pueblo Spring, Arroyo de los Angeles, San Marcos Arroyo, Arroyo Salado canyon, and in drainages near the Garden of the Gods.

> Natural depressions in the landscape that are supported either by precipitation or by a high water table. An example within the Galisteo Watershed is the playa near the rodeo grounds south of the Village of Galisteo.

Wet areas can also develop into wetland habitat with the help of dams, levees, cattle tanks, and mill sites – for example at the Galisteo Dam reservoir, the Arroyo Salado at Beneficial Farm, on the Galisteo Creek on Cerro Pelon Ranch, and at the Finger Lakes on 3-Horse Ranch.

DEFINITION:

Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of plants that are typically adapted for life in saturated soils. (US ACOE, 1987).

Why Are They Important?

As part of the natural system of land and water, wetlands help make human communities livable by keeping both land and water conditions healthy.

We call land or water ecosystems healthy if they can recover from sudden shocks, such as periods with very little or no precipitation, severe floods, fire, wind storms, or pollution events. An ecosystem recovers if it regains its capacity to support the plant and animal species that used to live there and helps increase the diversity of species over time. Healthy wetlands help control flooding and reduce damage from storm surges. Riverine wetlands absorb and filter out pollutants and sediment from the water that might otherwise enter waterways. Wetlands help to recharge groundwater in some areas and provide habitat for birds, amphibians, and other wildlife. We call the ability of wetlands to provide such ecosystem services the "functions" of wetlands.

One of the most critical threats to wetlands, especially in New Mexico, is the gradual drying up of wetland water sources. This drying process is a result of a combination of changes in the landscape, such as past and present land use, development, infrastructure, water pumping from wells, combined with periodic droughts.

Another critical threat is the pollution of wetlands caused by sediment flowing in from eroded land, and chemical emissions and waste dumps from intensive agricultural operations, mining, and industrial or urban development. Sediment and chemical pollutants can choke plant and animal life of the wetlands, change the chemical composition of the water and soils, and change water temperature to the point that the wetland ecosystem is unable to absorb and process these pollutants. These types of pollution are especially detrimental to depressional wetlands that have no outlet for overloading of chemicals and too much sediment.

Finally, many wetlands succumb to the conversion of the wetlands into development sites. Over time many wetlands have disappeared as a result of infrastructure construction and urban, industrial, or agricultural development. Wetlands need a buffer area around them to perform all of their important functions. Even development that is too close to a wetland area will reduce the ecological condition and the capacity for that wetland to perform certain functions.

Wetland Protection

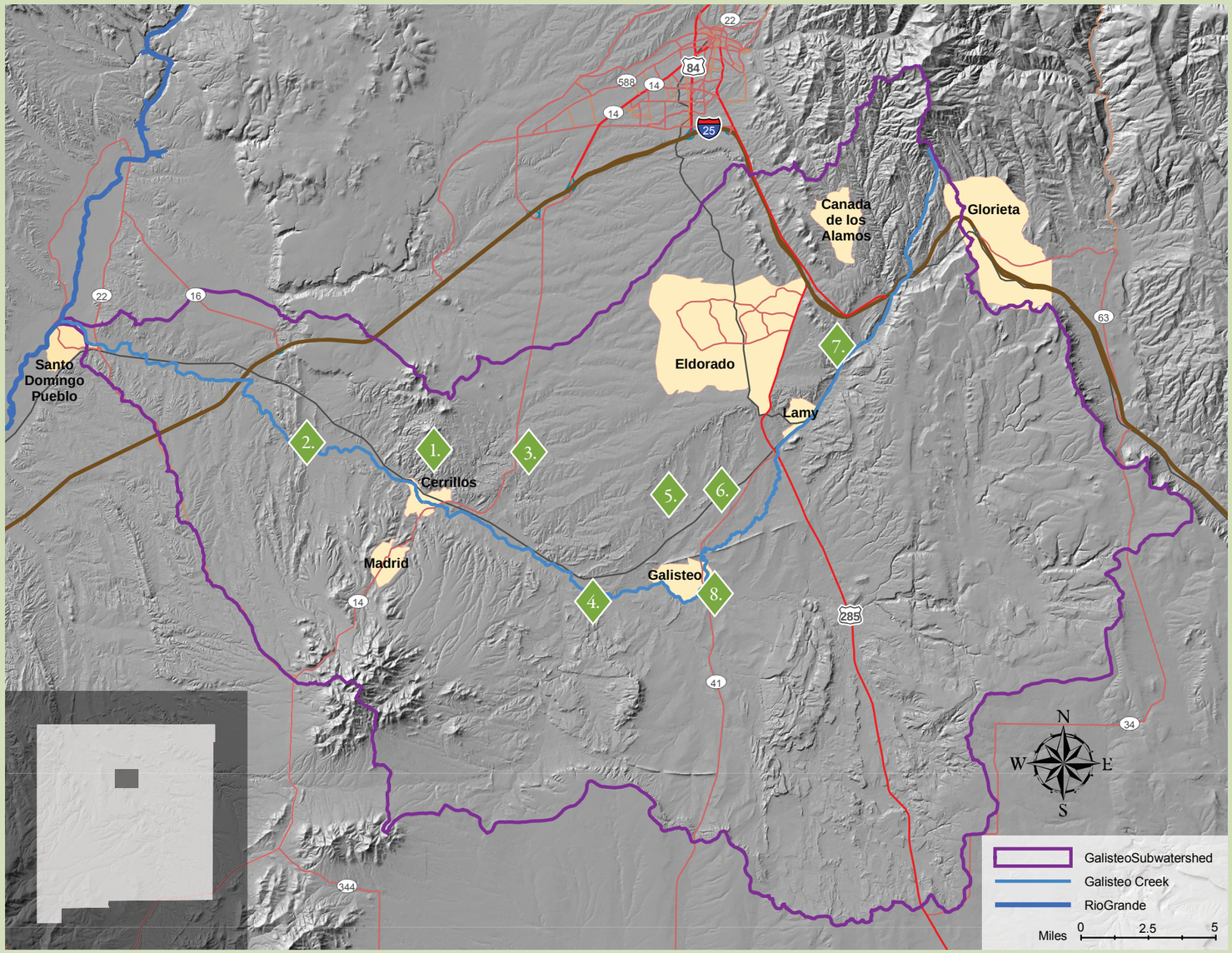
Wetlands protection is legally mandated under the Clean Water Act. However, in recent years, protective provisions of the Clean Water Act have been challenged in court.

In New Mexico, several federal, state and local government agencies, along with conservation organizations and community groups are increasingly paying attention to the functions and values of wetlands. Preserving the ecological condition of wetlands so that they can perform their critical functions plays an important role in planning certain land uses, but also in securing public health conditions, safety and welfare. As transitional zones, wetlands are dependent on the conditions of adjacent uplands and water bodies. Although wetlands have the capacity to cleanse water and absorb sediment and pollutants from adjacent areas, wetlands are also fragile and must be protected with buffer zones that balance out the extremes of influences from outside the wetlands.

At a county level, local governments are making an effort to develop and implement open space planning programs and growth management programs that include the protection of wetlands. Locally, many land and natural resource conservation and stewardship organizations, consulting firms, and community organizations collaborate with government agencies to implement wetland protection and restoration work. An increasing number of individual landowners protect wetlands by placing conservation easements on their land and participating in collaborative restoration efforts.

Wetlands of the Galisteo Watershed

1. Cerrillos Hills: Escalante spring and wetland
2. Galisteo Dam: Reservoir wetlands in the distance after saltcedar removal
3. San Marcos Arroyo: Arroyo wetland pond in the winter
4. Finger Lakes: South pond after a flood
5. Galisteo Spring: Structure placement to help restore arroyo with seeps
6. Arroyo de los Angeles: Streamside wetlands
7. Canoncito Arroyo: Arroyo wetlands restoration underway
8. Galisteo Village: Large bosque wetland on perennial reach of Galisteo Creek



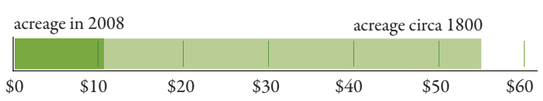
Wetland Importance *(cont.)*

bobcat, coyote, foxes (gray, red, and kit), weasels, badger, mule deer, pronghorn, many rodent species, and wild turkey.

Winter wildlife shelter is essential for wildlife population maintenance in the Galisteo Watershed. The Galisteo Watershed is a crucial link in a continental wildlife corridor from Mexico to Alaska as well as a transition zone between four major Ecoregions in New Mexico. Wildlife is considered of great value to the area for purposes of outdoor recreation (wildlife viewing), maintaining a rural, open space character to the landscape, and for purposes of maintaining general biodiversity and ecological resilience in a fragile landscape. For some people, wildlife shelter adds to the value of the area for hunting.

Ecological wetland functions are of value to people and society. While many wetland values are immaterial and are related to the history of the place or educational or spiritual values, some values translate directly into money. Scientists have tried to calculate the importance of wetland functions. According to one estimate the ecological value of freshwater wetlands and floodplains is probably more than $11,000 per acre per year at present values in 2008. There are about 1,000 acres of floodplains and wetlands in the Galisteo Watershed, which, according to this estimate, represent a value of $11 million per year* to society. It is estimated that around 1800, there was about 5,000 acres of wetlands in the watershed, which means that 4,000 acres have been lost with benefits estimated at an annual value of $44 million.

Estimated annual value of wetland ecological functions in the Galisteo Watershed (millions of dollars as valued in 2008*)



* *Based on global estimates by Robert Costanza and others (University of Vermont) in: Sandra Postel and Brian Richter. 2003. Rivers of Life. Managing Water for People and Nature. Island Press.*

Threats To Wetland Health

Until a few decades ago, little was known about the functions of wetlands. People liberally used the water in wetlands for local water supplies or for cattle, leading to pollution and drying up of many wetlands. Often, wetlands were considered a nuisance, because they were in the way of planned development, they were seen as a breeding ground for mosquitoes, and a hazard for livestock. As a result, wetland ecosystems have disappeared and the condition of many remaining wetlands has declined. Wetlands continue to be threatened by:

1. Lack of public awareness and support
2. Drying up of water sources
3. Pollution
4. Development

In many instances, wetlands are still overlooked and under-appreciated in our daily lives. Many lay people as well as many decision makers and professionals have limited knowledge of wetlands and how important they are for our health and well-being. As a result, wetlands suffer from inadequate legal and physical protection.

Three important groups of wetland functions include:

1. Maintenance of Natural Stream Channels

Wetlands often consist of a thick packet of sediment and plant material, which can absorb sudden flows of water. As the flow of water is slowed down by the vegetation and infiltrates into the soil or pools on top of the wetlands, concentrated high flows are reduced, both on the land and into stream channels. When flow peaks are reduced, the water has less energy to erode sensitive sites and more time to gradually sink into the soil over a larger area of land. This leads to increased storage of water in the soil, also called "groundwater recharge." Finally, wetlands also absorb dirt, or sediment, which flows down with the storm water.

The natural functions of wetlands to buffer floods and prevent stream channels from eroding or choking with sediment are of great importance in the Galisteo Watershed and of great value to many people. These functions ensure that stream crossings and bridges, but also homes, fields, and well sites, are safer and less prone to flood damage. As a result, land-owners and government agencies have to spend less time and money on repairs and maintenance.

2. Maintenance of Water Quality

Wetlands serve an important, natural role in water purification. Wetland plants have the capacity to use nitrogen and phosphorus. Additionally, wetlands can help keep water temperature down and absorb small particles in the water that make water cloudy. Nitrogen and phosphorus removal in wetlands is a valuable wetland function that, if it remains undone, can lead to unwanted algal blooms that change the oxygen content of the water and poison fish and aquatic life.

3. Maintenance of Biological Diversity

Wetlands support vigorous growth of plant communities that prefer wet soil conditions. In fact, wetlands often produce great amounts of plant material, both in roots, stems, leaves and flowers. The production of plant biomass in wetlands absorbs significant quantities of carbon out of the atmosphere.

In addition, when plant material dies within a wetland its carbon content is stored within the wetland soils. Therefore, wetlands serve an important role in carbon cycling and sequestration, which affects green house gas buildup. Besides biomass accumulation, wetlands typically support a great richness of plant and animal species. According to the US Fish and Wildlife Service, more than 70% of the species in southwestern landscapes are dependent on wetlands during some part of their life cycle.

The large amount of plant production and the richness in plant species in wetlands provides opportunities for many other life forms to flourish. Sheltered by the plants in the water, wetlands produce great quantities of invertebrates, such as midges, mayflies, beetles, dragonflies, mosquitoes, and water beetles. These critters, in turn, provide food for fish and waterfowl. In addition, wetland plants and the water bodies of wetlands also provide shelter for fish and waterfowl, either just as temporary retreat places or as permanent habitat. Wetlands in the Galisteo Watershed serve as important stepping stones for migratory waterfowl as part of the Central flyway route along the Rio Grande.

Most importantly in the Galisteo Watershed, wetlands also provide shelter to many non-aquatic birds and mammals during winter. Most of the species that benefit from this function are year-round residents of the region, but not necessarily of wetlands, such as bear, mountain lion,