Final Detailed Project Report and Environmental Assessment for Bottomless Lakes State Park, Roswell, New Mexico

12 December 2006

US Army Corps of Engineers
Albuquerque District

U.S. Army Corps of Engineers Albuquerque District

New Mexico State Parks Division

Energy, Minerals, and Natural Resources Department

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U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

FINDING OF NO SIGNIFICANT IMPACT
for
Bottomless Lakes State Park

The U.S. Army Corps of Engineers (Corps), Albuquerque District, in cooperation with the New Mexico Energy, Minerals, and Natural Resources Department - State Parks Division (State Parks), is proposing restoration of approximately 43 acres of wetland habitat at Bottomless Lakes State Park, Chaves County, New Mexico, by implementing the following elements: 1) increasing the Lea Lake outlet channel capacity from 15 cfs to 25 cfs; 2) removing all salt cedar from the approximately 43-acre project area; 3) removing all solid waste debris from the project area; 4) constructing three open water habitats totaling approximately 2.2 acres; 5) planting supplemental wetland vegetation in solid waste debris removal areas and around the margins of open water habitats (approximately 7.32 acres); and 6) constructing a 0.5-acre gravel parking lot, a 3,786-ft gravel loop trail, a 517-ft raised boardwalk trail, and four wildlife viewing blinds. The approximate cost of the project is $2,190,700. Combinations of the elements mentioned above were considered as alternatives as well as the No Action alternative.

All Best Management Practices described in Section 5.2 will be adhered to during project implementation including: 1) management of sediments, 2) inspection of equipment, 3) compliance with all water quality permits, 4) adherence to the schedule and best management practices discussed in order to avoid impacts to endangered or protected species, or avian nesting species, and 5) oversight by a qualified biologist to monitor adherence to these conditions during construction. These and all other conditions listed in the Detailed Project Report/Environmental Assessment would be adhered to during construction.

The Clean Water Act (CWA) provides for the protection of waters and wetlands of the United States from impacts associated with discharges or placement of dredged or fill material in Waters of the U.S., including wetlands, as defined under Section 404 of the CWA. Since no dredged or fill material would be placed within wetlands or other waters of the U.S., a 404 (b)(1) evaluation will not be performed. A 401 water quality certification would not be obtained from the New Mexico Environment Department. Additionally, the project would require National Pollutant Discharge Elimination System (NPDES) permitting under Section 402 of the Clean Water Act. The project would be covered under the NPDES General Permit for Discharges from Large and Small Construction Activities (permit number NMR150000).

Section 7 Endangered Species Act consultation was conducted for this project. A Biological Assessment (BA) was produced and concurrence on this BA was obtained from the U.S. Fish and Wildlife Service (Appendix 5). A cultural resources inventory was conducted for the project and submitted to the State Historic Preservation Officer (SHPO). Concurrence from the SHPO was received (Technical Appendix C).

The planned action would result in only minor and temporary adverse impacts on soils, water quality, air quality and noise levels, aesthetics, vegetation, floodplain, fish and wildlife, and recreational resources during construction. The long-term benefits of the proposed project including increased size and quality of wetlands, increase in quality vegetation and fauna, improved aesthetics, and an increase in habitat for the Federally endangered Pecos sunflower, State threatened Pecos pupfish, and least shrew, would outweigh these short-term adverse impacts. The following elements have been analyzed and would not be significantly affected by the planned action: socioeconomic environment, hydrology and geomorphology, wetlands, waters of the United States, biological resources, endangered and threatened species, Indian Trust Assets, prime and unique farmland, cultural resources, geology, water temperature, water use, water rights, environmental justice, and HTRW.

The planned action has been coordinated with Federal, State, and local agencies with jurisdiction over the biological and cultural resources of the project area. Based upon these factors and others discussed in detail in the Detailed Project Report/Environmental Assessment, the proposed project will not have a significant effect on the human environment. Therefore, an environmental impact statement will not be prepared for the proposed aquatic habitat restoration at Bottomless Lakes State Park.

12 Dec 06
Date

Bruce Estok
B.A. Estok
Lieutenant Colonel, U.S. Army
District Commander

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

TECHNICAL APPENDICES (Volume II)

ACRONYMS AND ABBREVIATIONS

BLM	(U.S. Department of Interior) Bureau of Land Management
CFR	Code of Federal Regulations
CWA	Clean Water Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
DPR	detailed project report
EA	environmental assessment
ft	feet
HEP	habitat evaluation procedures
HSI	habitat suitability index
HTRW	hazardous, toxic, and radiological waste
HU	habitat unit
H:V	horizontal to vertical
ICA	incremental cost analysis
LERRD	lands, easements, rights-of-way, relocations, disposal/borrow areas
MCACES	micro-computer aided cost engineering system
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMISC	New Mexico Interstate Stream Commission
NPDES	National Pollutant Discharge Elimination System
OMRR&R	operations, maintenance, repair, replacement, and rehabilitation
PM_{10}	airborne particulates
ppm	parts per million
SHPO	State Historic Preservation Office
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1.0 PURPOSE AND NEED

The U.S. Army Corps of Engineers (USACE), in cooperation with the New Mexico Energy, Minerals, and Natural Resources Department - State Parks Division (State Parks), is studying the feasibility of restoring aquatic habitat at Bottomless Lakes State Park in Chaves County, New Mexico.

1.1 Study Authority

The Bottomless Lakes State Park Aquatic Habitat Restoration Feasibility Study documented in this Detailed Project Report/Environmental Assessment (DPR/EA) was conducted under the authority of Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303 Section 22 U.S. C. 2330). This law provides the U.S. Army Corps of Engineers (USACE) with the authority to undertake aquatic ecosystem restoration and protection projects provided that each project: 1) will improve environmental quality; 2) is in the public interest; and 3) is cost-effective. The authority requires that a non-federal sponsor initiate each project. The non-federal sponsor for this project is the State Parks Division of the New Mexico Energy, Minerals, and Natural Resources Department. The non-federal sponsor is responsible for 35% of the project costs, which include planning and construction of the project. The USACE provides 65% of the project costs up to $5,000,000.

1.2 Study Area

The feasibility study area ("study area") consists of Lea Lake Marsh and the outlet channel that conveys surface water from Lea Lake to the marsh. The study area comprises approximately 43 acres and is situated entirely within the boundary of Bottomless Lakes State Park. The study area is bordered on the south and west by private land and the Bureau of Land Management Overflow Wetlands (Figure 1).

Bottomless Lakes State Park is located about 12 miles southeast of Roswell, New Mexico and was established as New Mexico's first state park in 1933. The park includes seven sinkhole lakes formed in gypsum deposits (State Parks Division, 2001). Lea Lake, the largest of the seven lakes, has a surface area of about 15 acres and a maximum depth of about 90 feet. Although modest camping developments are provided at all of the lakes, Lea Lake has the most extensive developed recreation facilities, including a swimming beach, a recreational vehicle campground with hookups, showers, a large tent camping and day-use area with covered picnic tables and sports areas, and a historic building constructed by the Civilian Conservation Corps. Unlike the other seven sinkhole lakes at Bottomless Lakes State Park, Lea Lake has an outflow that sustains about 715 acres of wetlands to the south (Bureau of Land Management, 2003). Most of the wetlands are on lands that are privately-owned or managed by the Bureau of Land Management (BLM), but approximately 43 acres of wetland sustained by Lea Lake outflow are located within the park boundary south of NM Highway 409 (NM 409; Figure 2).

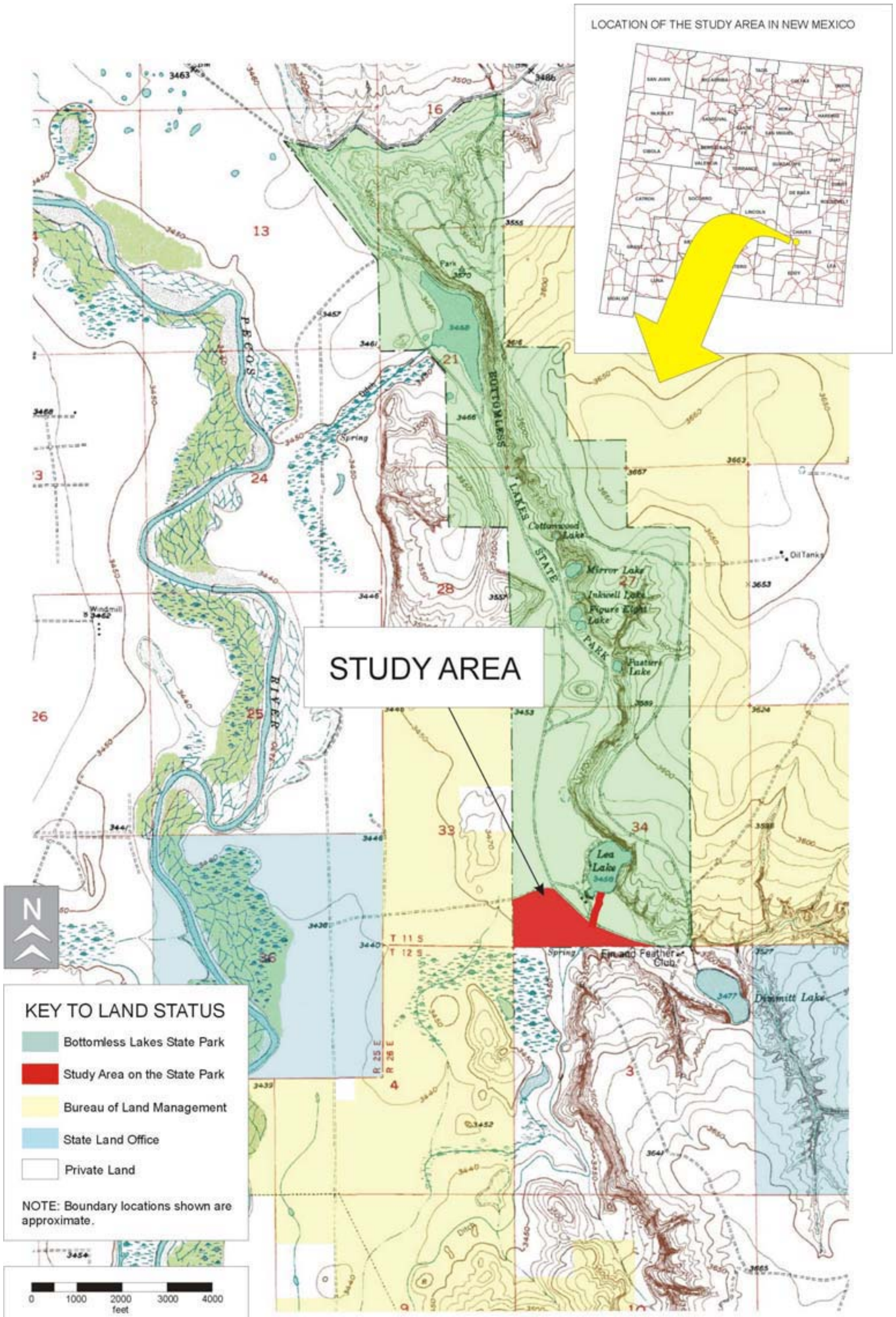
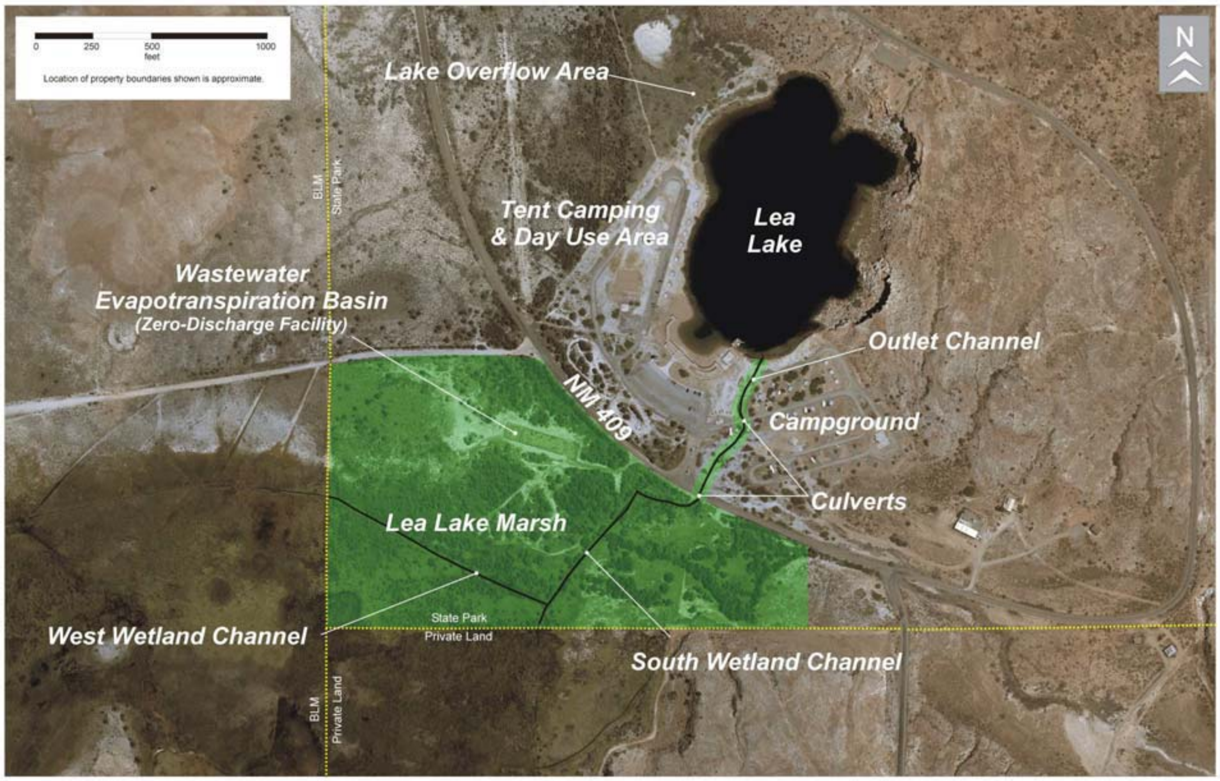


Figure 1. Location of the feasibility study area at Bottomless Lakes State Park near Roswell, Chaves County, New Mexico.

Figure 2. Aerial photograph of the study area showing salient features.



1.3 Problem and Opportunity Identification

Problems at the Bottomless Lakes State Park study area include the following.

1) There has been a dramatic loss of spring-fed wetland habitats in the lower Pecos River drainage in New Mexico and Texas.
2) Non-native salt cedar has invaded Lea Lake Marsh and formed dense, monotypic stands that have replaced native wetland vegetation.
3) Flow patterns and hydrologic regimes in the wetland have been altered.
4) Solid waste debris (including cut brush, concrete, scrap metal, fence posts, and scrap lumber) has been placed in the wetland.
5) Outflow from Lea Lake often overflows the outlet channel and lake banks, resulting in flooding and damage of campgrounds, historic structures, and roads.

There are opportunities in the study area to do the following.

1) Restore native wetland plant communities in Lea Lake Marsh.

2) Improve the diversity of hydrologic regimes within the wetland and the consistency of water delivery from Lea Lake to the wetland.
3) Improve habitat for native fishes including the state-listed Pecos pupfish and Mexican tetra.
4) Improve habitat for the federal threatened Pecos sunflower.
5) Improve habitat for the state-listed least shrew.
6) Improve habitat for the species-rich community of dragonflies and damselflies found in the park.
7) Provide increased interpretation of wetland habitats and recreational opportunities for park visitors.

Restoration of aquatic and wetland habitat at Bottomless Lakes State Park and interpretation of these important resources are identified as high-priority management goals for the park (State Parks Division, 2001). Aquatic and wetland habitats are relatively rare in New Mexico, yet they support a high diversity of native plants and wildlife. For example, over 55% of the vertebrate species that occur in the state rely wholly, or in part, on aquatic or wetland habitat for their survival. Wetland and aquatic habitats are particularly critical in the restoration and management of special-status species, as well over half of the species listed as threatened or endangered in the state are associated with wetland or aquatic habitats (New Mexico Department of Game and Fish, 2001). However, it is estimated that fully one-third of the wetlands that once existed in the state have been lost (Dahl, 1990), with only about 482,000 acres of these habitats now remaining in the State, most of which are located in the northern third of New Mexico (Fretwell *et al.* 1996). Desert wetland systems such as Lea Lake Marsh are relatively rare. Although Lea Lake Marsh is only about 43 acres in size, it is part of a larger desert wetland complex that encompasses about 715 acres and serves as the headwaters for this wetland ecosystem.

Wetlands in the lower Pecos River drainage that are maintained by outflow from springs, such as Lea Lake Marsh, have declined dramatically since the turn of the century. Lea Lake Marsh is one of the few remaining spring-fed wetland systems in the Chihuahuan desert region of the Pecos River drainage. Aside from Lea Lake, other major springs in the Roswell Basin historically included North Spring, South Spring, North Berrendo Spring, Middle Berrendo Spring, and South Berrendo Spring. Prior to extensive groundwater pumping in the basin, discharge from each of these springs ranged from about 15,600 to 61,500 acre-feet of water per year (Fiedler and Nye, 1933). For comparison, the current annual outflow from Lea Lake is about 9,200 acre-feet per year. The first artesian wells in the Roswell Basin were constructed in 1896 and by 1905 there were at least 2,185 artesian wells in operation. By 1925 all five of these formerly large spring systems were reduced to almost zero flow and were completely dry by 1931 (Fiedler and Nye, 1933; U.S. National Resources Planning Board, 1942). Groundwater use increased in the 1940s and 1950s and the artesian pressure of the aquifer was largely exhausted by 1953 (Thomas, 1959; Jones and Balleau, 1996). Metering of groundwater pumping began in 1967, and the decline in groundwater levels began to slow. However, the level of the artesian aquifer continued to decline and reached the lowest level in 1970, which was about 70 ft below the historic level (Jones and Balleau, 1996). Wetlands associated with these artesian springs disappeared with loss of outflow.

Similarly, spring systems downstream from the project area have also declined dramatically due to groundwater pumping. In Pecos County, Texas, pumping of groundwater in the Pecos River valley lowered groundwater levels as much as 394 ft from the late 1940s into the late 1970s (Brune, 1981: 356), resulting in the loss of “nearly all” of the springs in the area (Brune, 1981: 356, 360). For example, Leon Springs historically flowed at a rate of 2,540 gal/min. Flow from Leon Springs declined steadily from 1920 to 1958, at which time discharge ceased completely and the spring was lost (Brune, 1981: 359). Flow from Comanche Spring, which historically measured about 24,305 gal/min, was completely eliminated by 1954 by groundwater pumping (Scudday, 1974: 515).

Outflow from Lea Lake has increased since flow measurements began in 1976 (Technical Appendix A). Outflow from the lake began to exceed the capacity of the outlet channel in winter 1999-2000 and overflow on the northwest side of the lake occurred (Figure 2). Lake overflow spread through the tent camping and day-use area on the northwest side of the lake in late 2000 and resulted in temporary closure of these facilities. The following winter, flood waters again inundated or saturated the tent camping and day-use area. During this flood event, water damaged the foundation of the Civilian Conservation Corps structure near the beach and NM 409 west of Lea Lake. About 0.1 miles of the road were damaged to the extent that the road was temporarily closed for repair. Emergency work was conducted by Bottomless Lakes State Park in January 2002 to increase flow capacity of the old ditch system downstream from NM 409 culvert crossing. The emergency work temporarily stopped the overflow and subsequent flooding on the northwest side of the lake and directed all outflow into the wetland. However, discharge from Lea Lake continues to overflow the outlet channel at times. Also, localized flooding and soil saturation continue to occur at the NM 409 and campground access road culvert crossings of the outlet channel.

In the spring of 2005, State Parks and the New Mexico Department of Transportation combined forces to reduce overflow at the southwest side of Lea Lake that was causing damage to NM 409. State Parks dug a shallow trench from the southwest corner of Lea Lake west to the culvert crossing at NM 409. An 18-inch culvert was buried in the trench to accommodate overflows from Lea Lake. Two new culverts were placed under NM 409 to move flows into the earthen ditch along the south side of the gravel road leading to the BLM wetlands.

An important constraint in wetland restoration planning for the study area is to maintain existing surface water yields and flow patterns from Lea Lake Marsh to avoid potential adverse affects on adjacent wetlands and stream flows in the Pecos River. Other constraints include locations of underground utilities, endangered species, and the location of the wastewater treatment facility (see Chapter 4).

1.4 Study Purpose and Scope

The purpose of a USACE feasibility study is to "identify, evaluate and recommend to decision makers an appropriate, coordinated, implementable solution to the identified water resources problems and opportunities" (U.S. Army Corps of Engineers, 2000: G-19). Consequently, the purpose of the Bottomless Lakes State Park Aquatic Habitat Restoration Feasibility Study is to: 1) determine the extent of aquatic habitat degradation in Bottomless Lakes State Park south of Lea Lake; and 2) develop a plan for restoration of the existing aquatic and wetland habitats in this area. The scope of analysis in this DPR/EA is limited to those activities proposed at Bottomless Lakes State Park by the USACE under the Section 206 Program.

Scoping was performed during this period with a public meeting being held on October 9, 2003 at the Eastern New Mexico University campus in Roswell, NM. The scoping letter, dated September 18, 2003 was mailed to Federal, state, and local agencies and interested parties. The mailing list and responses to scoping are in Appendix 1a.

1.5 Regulatory Compliance

This DPR/EA was prepared in compliance with all applicable federal and state statutes, regulations, and executive orders, including, but not limited to:

- National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 *et seq.*) as implemented by the Council on Environmental Quality regulations (40 CFR 1500, *et seq.*);
- U.S. Army Corps of Engineers Procedures for Implementing NEPA (33 CFR 230);
- Clean Air Act, as amended (42 U.S.C. 1251 *et seq.*);
- Clean Water Act, as amended (33 U.S.C. 1344 *et seq.*);
- Endangered Species Act, as amended (16 U.S.C. 1531 *et seq.*);
- Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*);
- Floodplain Management (Executive Order 11988):
- Protection of Wetlands (Executive Order 11990);
- Federal Noxious Weed Act (7 U.S.C. 2801-2814 *et seq.*);
- Resource Conservation and Recovery Act of 1976 and amendments of 1984;
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980;
- Section 106 of the National Historic Preservation Act, as amended (16 U.S.C. 470 *et seq.*);
- Protection of Historic and Cultural Properties (36 CFR 800 *et seq.*);
- Protection and Enhancement of the Cultural Environment (Executive Order 11593);
- American Indian Religious Freedom Act (42 U.S.C. 1996); and
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq.*).

2.0 EXISTING ENVIRONMENTAL SETTING

This chapter summarizes an inventory of critical resources relevant to the problems and opportunities under consideration in the study area. The purpose of presenting this information is to further define and characterize the problems and opportunities (U.S. Army Corps of Engineers, 2000: 2-3). It is important to note that only those resources that are relevant to proposed wetland restoration in the study area are discussed and that the discussion focuses on aspects of those resources that are applicable to the planning process.

2.1 Physiography, Geology, and Soils

The study area is located at the base of an escarpment along the east side of the Pecos River valley. It is situated between latitudes 33° 12'10" and 33° 16'07" north and longitudes 104° 19' 22" and 104° 22' 15" west. Elevation in the study area ranges from about 3,440 feet to 3,477 feet above mean sea level. Land surface slopes gradually to the west and south.

The lower Pecos River valley, which includes Bottomless Lakes State Park, is largely covered with Quaternary-age alluvium. The eastern side of the valley, however, exposes carbonate and evaporite deposits of the Artesia Group of Permian age, which consists of the Seven Rivers, upper Grayburg, and Queen Formations. Beneath the rocks of the Artesia Group (primarily Seven Rivers Formation) is the San Andres Formation of Permian-age, which also contains evaporites. The rocks of the Artesia Group and the San Andres Formation include limestone, dolomite, gypsum, and anhydrite that are susceptible to solution by groundwater.

Uplift of the Sacramento Mountains to the west of the river valley has tilted the formations down to the east, forming the Roswell Artesia Basin, which consists primarily of a carbonate aquifer of the San Andres Formation. The confining layer of the San Andres aquifer primarily consists of slightly to moderately permeable rocks of the Seven Rivers Formation. The leaky confining layer (Seven Rivers Formation) that overlays the carbonate aquifer creates an artesian condition to the east and an unconfined water-table to the west where the formation outcrops (Figure 3). In addition, a shallow, unconfined alluvial aquifer exists above the confining layer, which is hydraulically connected to the Pecos River (Land, 2003).

Soils in the study area are classified as Holloman-Gypsum land complex (Hodson *et al.*, 1980). Holloman-Gypsum land complex is not included in the national list of hydric soils or in the New Mexico list of hydric soils (Natural Resources Conservation Service, 2003).

2.2 Climate

The study area has a mild, arid to semiarid continental climate. Average total annual precipitation at nearby Bitter Lake National Wildlife Refuge is 12.44 inches; and average annual snowfall is about 7.3 inches. Average total annual precipitation at the Roswell Airport is 12.31 inches; average annual snowfall there is about 10.5 inches. Summer rainfall typically occurs in brief, intense thunderstorms that generate as moist air from the Gulf of Mexico moves over the heated surface of the state. Almost 40% of the annual precipitation occurs during the summer months (Western Regional Climate Center, 2003).

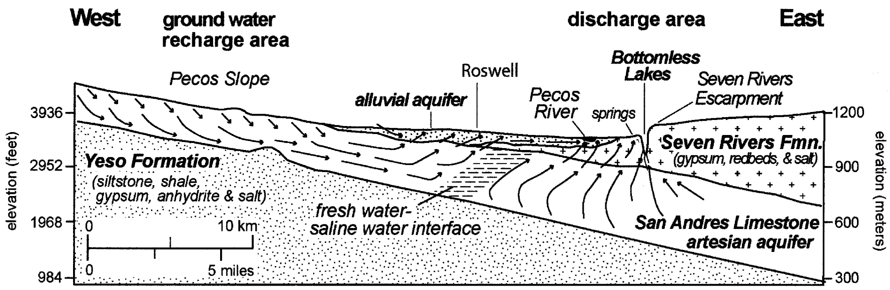


Figure 3. Geological cross-section through the Pecos River Valley illustrating regional groundwater flow patterns within the San Andres artesian aquifer. Arrows indicate general direction of groundwater flow (figure from Land, 2003).

2.3 Hydrology and Geomorphology

2.3.1 Hydrology

Subsurface flow is a significant component of the hydrologic cycle in the Bottomless Lakes area. Groundwater dynamics in the Roswell basin also plays an important role in development of sinkholes in Bottomless Lakes State Park. Surface water originating primarily from precipitation in the Sacramento Mountains west of Roswell infiltrates through unsaturated porous material to the water table. As groundwater travels east in the direction of the downward sloping strata in response to the hydraulic gradient (Figure 3), it becomes confined in the artesian aquifer. This confined aquifer continues to extend east of Roswell, below the Pecos River and beyond Bottomless Lakes State Park. Dissolution of rock in the vicinity of Bottomless Lakes creates a hydraulic connection between the confined aquifer and the sinkhole lakes, which allows the discharge of water up into the lakes.

Measurement of discharge from Lea Lake began in 1976, at which time outflow from the lake was delivered to the study area wetland via a buried pipe. The present open outlet channel was constructed in 2002. Maximum annual discharge from Lea Lake has increased steadily from 1976 to the present time. Maximum discharge measured in 1976 was about 4.5 cfs, compared to a maximum discharge in 2003 of about 16 cfs (Technical Appendix A) Increased discharge from the lake is most likely a result of increased water levels in the artesian aquifer in the Roswell Artesian basin (Technical Appendix A). Mean monthly discharge from Lea Lake in 2002 varied from 9.5 cfs in August to 16.2 cfs in January (Figure 4). Average annual discharge from Lea Lake into the study area wetland during 2002 and 2003 was about 9,211 acre-feet (Technical Appendix A). Seasonal fluctuations in the discharge are a direct response to seasonal changes in the aquifer due primarily to spring and summer irrigation (Land, 2003).

Almost two-thirds of the inflow to the wetland from Lea Lake exits the study area via the South and West wetland channels. The remainder of the inflow to Lea Lake Marsh flows through the study area via sheet flow in the wetland (Technical Appendix B). About 11.7 acres of Lea Lake Marsh, or 27%, are perennially inundated (Technical Appendix B). Overland and channel flow exits the state park onto private lands and lands administered by the BLM, and then to the Pecos River.

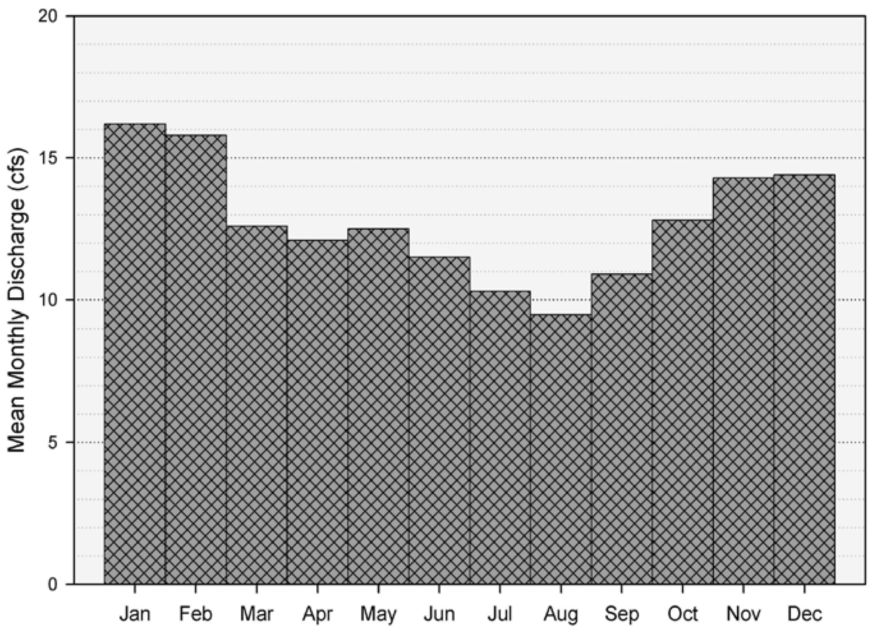


Figure 4. Mean monthly discharge (in cubic feet per second) from Lea Lake into the study area, January through December 2002 (source: Technical Appendix A).

2.3.2 Geomorphology and Hydraulics

The primary feature of the Bottomless Lakes area is the chain of eight lakes that, with other nearby features, forms karst topography. This type of topography occurs in areas of carbonate rocks and evaporites due to weathering and solution of the rocks. Land forms associated with karst topography include blind valleys, caves, and other solution features. In the Bottomless Lakes area, the important karst features are the lakes, which are sinks or sinkholes that, in karst terminology, are called dolines. There are two types of dolines that are relevant to the Bottomless Lakes area: solution dolines and collapse dolines.

Water infiltration into joints and other pathways enlarge these passageways by solution, which eventually creates a closed-surface depression. Collapse dolines differ from solution dolines because they form by major solution pathways beneath the surface. When a subsurface cavern enlarges, eventually the overlying rocks collapse. The irregularity of Lea Lake suggests that it is comprised of several interconnected collapse dolines. Solution at depth leads to collapse doline formations (Sweeting, 1973). The rockslide that occurred at Lea Lake in 1975, as well as others prior to 1975, was the response to removal of material underground to form a void into which overlying rocks collapsed. Therefore, it is unlikely that the rockslide itself opened new passageways for water migration. Rather, the rockslide was triggered by the slow underground solution of soluble rocks, which formed a void into which the overlying rocks collapsed.

Outflow from Lea Lake is conveyed to Lea Lake Marsh via a man-made outlet channel that is about 700 feet long (Figure 2). The cross-section of the outlet channel has a trapezoidal shape with a flat bottom and 45° side-slopes (denoted as 1H:1V, meaning one unit of unit of horizontal distance for each unit of vertical rise). The side-slopes of the channel are composed of articulated concrete blocks. The bottom of the channel is about three feet wide and the channel is approximately nine feet wide at the top. The bed of the outlet channel is lined with small cobbles. At about 14 cfs, wetted-width of the outlet channel was about 7.0 feet and average depth was 1.49 feet, with a maximum depth of 2.21 feet (Appendix B). The maximum capacity of the existing outlet channel appears to be about 15 cfs (Technical Appendix F).

There are two culvert crossings of the outlet channel: one in the campground and the other at the NM 409 crossing (Figure 2). A localized rise in the bed profile of the outlet channel downstream from the N.M. 409 crossing significantly increases the surface water elevations at and upstream from the NM 409 crossing (Technical Appendix F). Additionally, the NM 409 culverts are undersized and contribute to creation of a backwater upstream from the culverts, which exacerbates flooding of the campground.

Outflow from Lea Lake is controlled both by the lake level and a concrete weir structure in the outlet channel. A buried, 18-in diameter corrugated metal pipe was installed from the southwest bank of Lea Lake to the bar ditch draining to the BLM Overflow Wetlands in March 2005 in an attempt to further alleviate potential flooding at high lake levels.

The two wetland channels are also man-made. They have very low sinuosity and a relatively consistent trapezoidal shape. The South Wetland Channel near the south boundary had a wetted-width of 13.5 feet at a flow of 6.34 cfs, with a mean depth of 0.81 feet and a maximum depth of 1.32 feet. The West Wetland Channel near the west boundary was substantially smaller and had a wetted-width of 3.83 feet at a flow of 1.59 cfs, a mean depth of 0.56 feet, and a maximum depth of 0.78 feet. Banks of the wetland channels are densely vegetated and aquatic vegetation growth is abundant within the channels. Channel substrate consists of silts, clays, and sapropel (“muck”). Water surface slope in the South Wetland Channel was 0.0022 ft/ft, while the slope of the water surface in the West Wetland Channel was substantially steeper at 0.0067 ft/ft (Technical Appendix B).

2.4 Water Quality

Water flowing from Lea Lake into the study area is slightly alkaline, moderately saline, and has very low concentrations of suspended sediments. Field measurements of surface water salinity in Lea Lake Marsh ranged from 6.6 to 6.7 parts per thousand in 2003 (Technical Appendix B). Hydrogen-ion concentration (*p*H) in Lea Lake shows an annual variation from about 8.2 during the fall, through winter, and into early spring, to a low of about 6.4 in the middle of the summer. Surface water temperature in Lea Lake Marsh varies seasonally, from a low of about 55^{o}F in January to a high of about 80^{o}F in July (Brandenburg and Farrington, 2003).

Suspended sediment concentration in surface waters of Lea Lake Marsh is low, as indicated by the clarity of the water (*i.e.* it has very low turbidity). Specific conductance ranges from about 9,850 to 11,700 µmhos/cm. The extensive gypsum deposits in the area result in relatively unusual anion composition in water, with sulphate as the major anion, followed by chloride, then carbonate. Typically, carbonate is the major anion in surface waters in North America.

The outflow from Lea Lake and Lea Lake Marsh are not classified waters with respect to New Mexico Water Quality Standards (§20.6.4.7.H of the New Mexico Administrative Code [NMAC]). Consequently, the New Mexico Water Quality Control Commission has not adopted a stream segment description or defined designated uses and applicable water quality standards for Lea Lake Marsh. However, the Antidegradation

Policy of the New Mexico Water Quality Standards does apply to Lea Lake Marsh and the Lea Lake outflow. This policy states that "existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state" (§20.6.4.8.A.[1] NMAC).

2.5 Air Quality

The Clean Air Act of 1970, as amended, established National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants: ozone, airborne particulates (PM_{10}), carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. If the concentrations of any of these six pollutants exceeds the standard, the area where the exceedance occurs is considered nonattainment for that pollutant. No violations of the NAAQS have occurred in Chaves County, which is classified as attainment for all six criteria air pollutants by the Environmental Protection Agency (U.S. Environmental Protection Agency, 2005).

2.6 Ecological Setting

2.6.1 Vegetation

Vegetation in the study area can be classified as alkali sink riparian (Dick-Peddie, 1993) and was characterized by few dominants and relatively low species diversity (Technical Appendix B). Ten vegetation communities were defined in the study area based on dominant plant species and hydrologic conditions (Figure 5; Technical Appendix B). Saltgrass wet meadow was the most extensive vegetation, composing 25.4% or 10.90 acres of the study area. Salt cedar invasion was widespread in this community, with *Tamarix* cover averaging about 50%. Saltgrass wet meadow was fairly variable in the study area, ranging from areas with nearly 100% saltgrass cover to areas heavily overgrown with salt cedar. Saltgrass marsh was the second most extensive vegetation, and covered 8.04 acres or 18.7% of the study area. This community type had standing water, which was often obscured by a thick mat of saltgrass.

The salt cedar thicket community was the third most abundant vegetation, covering 7.16 acres (16.7%) of the study area. This community was typically characterized by very dense growth of salt cedar seedlings, saplings, and small trees. Barren ground was the fourth most common cover type, composing 12.6% or 5.40 acres of the study area. Barren ground was classified as areas with no more than 20% plant cover. The iodinebush flats community type covered 9.7% of the study area and comprised 4.17 acres. This vegetation had a fairly high bare ground component, with iodinebush and alkali sacaton sharing dominance in the plant community.

About 8.4% of the study area, or 3.63 acres, was covered by the alkali sacaton flats community. Cattail marsh occurred at nine locations in the study area. This community type composed 3.9% of the study area, or 1.69 acres. Saltgrass-iodinebush marsh typically occurred as a transition community between saltgrass marsh and iodinebush flats or saltgrass wet meadow. This community type covered 1.32 acres and comprised 3.1% of the study area. Bulrush marsh was only found at two locations in the study area. This community type occurred at sites that were perennially inundated, where chairmaker's bulrush formed very dense stands. This community type covered 0.9% of the study area, or 0.38 acres. Only 0.6% of the study area consisted of wetland channel habitat. This community type covered 0.27 acres.

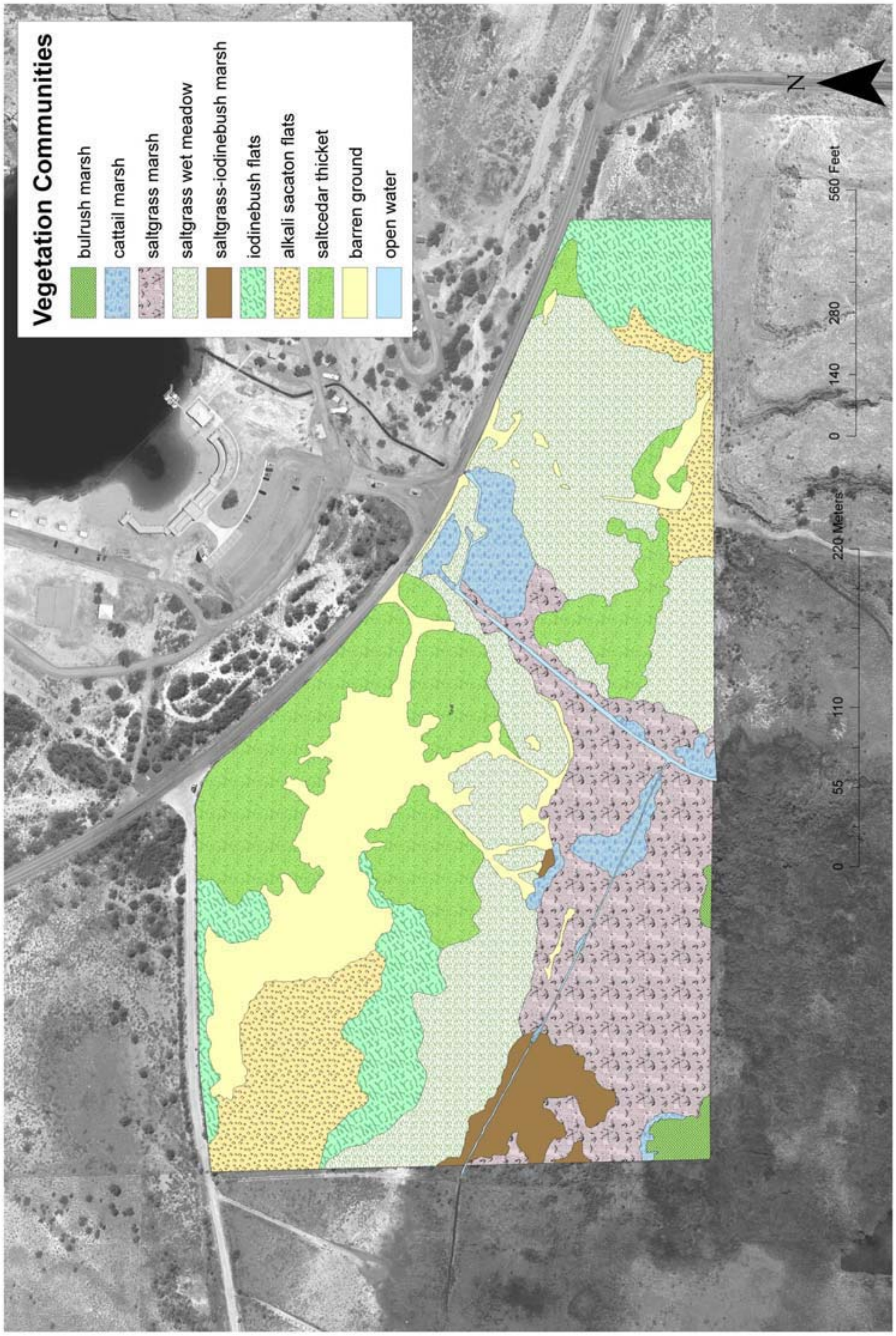


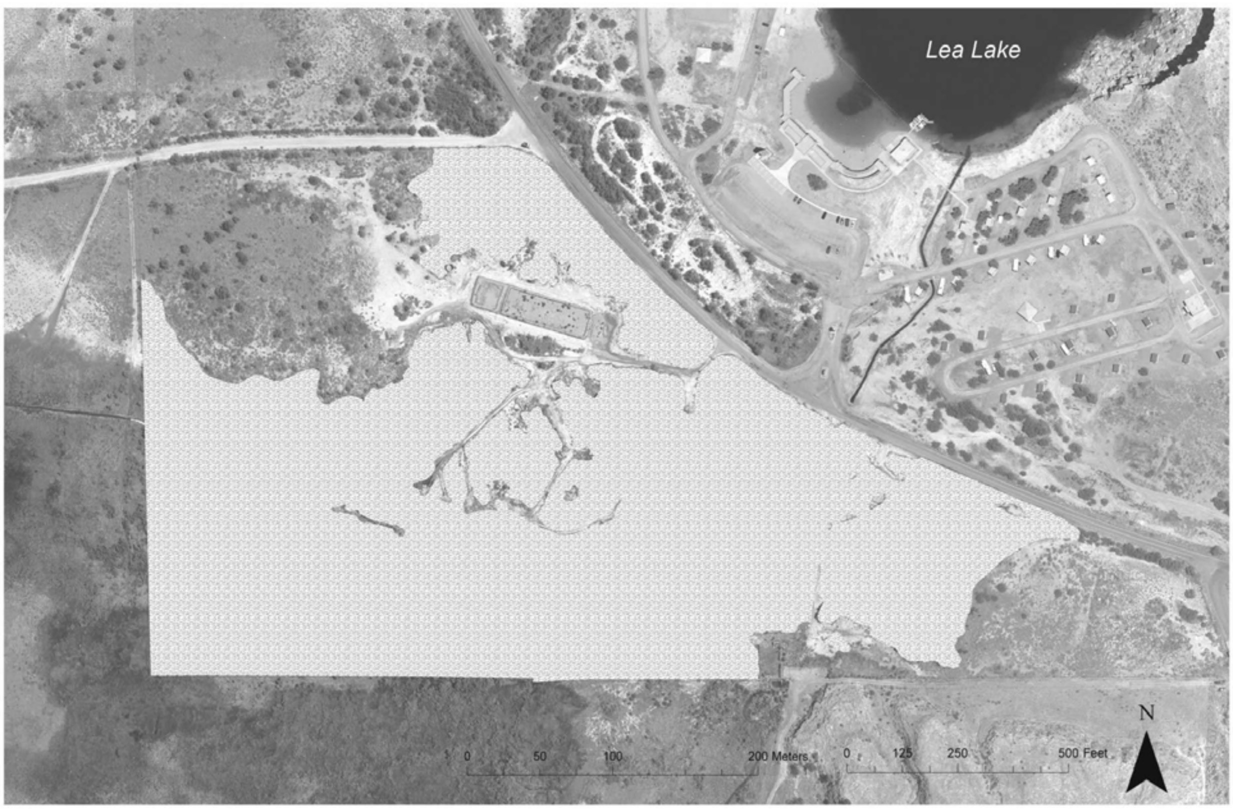
Figure 5. Vegetation communities in the study area.

2.6.2 Wetlands and Floodplains

About 33.92 acres of the study area, or 79%, was jurisdictional wetland (Figure 6; Technical Appendix B). Wetlands consisted of eight of the ten mapped community types (Technical Appendix B).

Excluding the non-native salt cedar, Lea Lake Marsh was characterized by a dominance of native herbaceous plants. Most of the dominant plant species in the wetland (8%) were classified as facultative, facultative wetland, or obligate wetland plants (Technical Appendix B).

Figure 6. Extent of wetlands in the study area. Shaded area depicts jurisdictional wetlands.



2.6.3 Fauna

Wetlands in the study area support a rich assemblage of vertebrate and invertebrate animals, including some endemic or otherwise rare species. Wetlands and aquatic habitats in Bottomless Lakes State Park provide habitat for 41 species of dragonflies and 22 species of damselflies (Technical Appendix B). This level of odonate species richness is among the highest in the continental United States. Amphibians and reptiles observed in the study area from July through October 2003 included plains leopard frog (*Rana blairi*), slider turtle (*Tracemys scripta*), and checkered garter snake (*Thamnophis marcianus*). Northern cricket frog (*Acris crepitans*) was heard throughout the southern portion of the study area during the wetland determination and delineation field work conducted in October 2003.

Fishes known to occur in the study area include red shiner (*Cyprinella lutrensis*), plains minnow (*Hybognathus placitus*), Pecos pupfish (*Cyprinodon pecosensis*), plains killifish (*Fundulus zebrinus*), rainwater killifish (*Lucania parva*), western mosquitofish (*Gambusia affinis*), and green sunfish (*Lepomis cyanellus*; Brandenburg and Farrington, 2003). Hoagstrom and Brooks (1998: 44) also reported Mexican tetra (*Astyanax mexicanus*) from the Lea Lake outflow wetland. Plains minnow, western mosquitofish, and green sunfish are introduced species; the other four fishes are native to the Pecos River drainage (Sublette *et al.*, 1990). Pecos pupfish and western mosquitofish were found throughout in all marsh habitats, even into very shallow water, in the study area in October 2003. Both species were also found in the two outflow channels in the study area. Deep pool habitat in the two channels provides important winter refuge habitat for Pecos pupfish (Brandenburg and Farrington, 2003).

Eighty-one species of birds have been recorded from Bottomless Lakes State Park, including 26 year-round residents, 18 spring or summer residents, and 37 winter residents (Technical Appendix B). Only two species of mammals were observed in the study area in October 2003: muskrat (*Ondatra zibethicus*) and mule deer (*Odocoileus hemionus*). Least shrew (*Cryptotis parva*) was recently documented from Lea Lake Marsh (Frey, 2005).

2.7 Endangered and Protected Species

Endangered, threatened, or federal species of concern considered to occur in the study area (Technical Appendix B) include:

- Pecos sunflower (*Helianthus paradoxus*, federal threatened, state endangered);
- Mexican tetra (*Astyanax mexicanus*, state threatened, federal species of concern);
- Pecos pupfish (*Cyprinodon pecosensis*, state threatened, federal species of concern);
- Arid land ribbon snake (*Thamnophis proximus diabolicus*, state threatened, federal species of concern);
- Least shrew (*Cryptotis parva*, state threatened);
- Wright's marsh thistle (*Cirsium wrightii*, federal species of concern); and
- Pecos River muskrat (*Ondatra zibethicus ripensis*, federal species of concern).

Plant and animal species may be protected under federal or state law. Protection from harm, harassment, or destruction of habitat is afforded to species protected under the federal Endangered Species Act. The New Mexico Wildlife Conservation Act and New Mexico Endangered Plant Species Act protects state-listed species by prohibiting take without a permit from the New Mexico Department of Game and Fish or New Mexico Forestry and Resources Conservation Division. No legal protection is afforded to state or federal species of concern. Project proponents are encouraged to consider species of concern in project planning and to attempt to avoid implementing projects that would adversely affect population persistence or distribution.

2.7.1 Pecos Sunflower

Pecos sunflower was found in the study area during the field investigations (Technical Appendix B). Pecos sunflower is a salt-tolerant annual plant. The species was listed as threatened under the federal Endangered Species Act on 20 October 1999 (64 FR 56582). The main threat to continued existence of Pecos sunflower is loss or alteration of wetland habitat.

The known distribution of Pecos sunflower consists of six population centers, two of which are in Texas and the four in New Mexico (U.S. Fish and Wildlife Service, 2004: 5). The species is known from locations in Cibola, Valencia, Socorro, Guadalupe, and Chaves counties in New Mexico and from Pecos and Reeves counties in Texas (New Mexico Rare Plant Technical Council, 2005). Habitat of Pecos sunflower is saturated, saline soils of desert wetlands associated with rivers and spring systems from 3,300 to 6,600 feet elevation. The species is restricted to saline wetland habitats and requires saturated soils for seed germination; adult plants grow well in standing water (New Mexico Rare Plant Technical Council, 2005).

2.7.2 Mexican Tetra

Hoagstrom and Brooks (1998) collected Mexican tetra in the study area from 1994 through 1998 and the species was observed in Lea Lake and the South Wetland Channel during field investigations conducted in 2003 (Technical Appendix B). Habitat suitable for the species is present in the outflow channels and adjacent inundated wetland.

Mexican tetra is native to the lower Rio Grande, Pecos River, and Nueces River drainages in southern Texas and the lower Rio Grande and Pecos River in New Mexico (Sublette *et al.*, 1990). The species also occurs south into Mexico (Lee *et al.*, 1980). Mexican tetra is the only native characin fish in the United States. This tetra moves seasonally between habitats to avoid low winter water temperatures (Edwards, 1977). Mexican tetra spawns in late spring to early summer and lays adhesive eggs. Habitats used by Mexican tetra include stenothermal springs, often with abundant vegetation cover. Mexican tetra is typically carnivorous, feeding on small fishes and insects (Sublette *et al.*, 1990).

2.7.3 Pecos Pupfish

Pecos pupfish has been collected at Lea Lake Marsh in the past (Hoagstrom and Brooks, 1998; Brandenburg and Farrington, 2003) and it was observed in inundated emergent herbaceous wetland habitat and channel habitat in the study area in 2003 (Technical Appendix B). Suitable habitats for the species in the study area include bulrush marsh, cattail marsh, saltgrass marsh, saltgrass-iodinebush marsh, and wetland channels. Lea Lake Marsh provides important over-wintering habitat for Pecos pupfish in the BLM Overflow Wetlands and adjacent wetlands on private land (Brandenburg and Farrington, 2003).

Males are territorial and breeding occurs from May through June. Pecos pupfish is omnivorous, feeding primarily on diatoms and detritus (Sublette *et al.*, 1990). The main threats to Pecos pupfish include hybridization with sheepshead minnow (*Cyprinodon variegatus*) and habitat loss (Hoagstrom and Brooks, 1998; Brandenburg and Farrington, 2003). A fish barrier was constructed on the largest of the four surface water connections between the BLM Overflow Wetland and the Pecos River; however, the barrier was considered ineffective during high flows and fish movement from the river into the wetlands was also determined to be possible in the other three connecting channels (Brandenburg and Farrington, 2003: 36).

2.7.4 Arid Land Ribbon Snake

Arid land ribbon snake has been collected in the vicinity of the project area (Degenhardt *et al.*, 1996). Suitable habitats for arid land ribbon snake in the study area include bulrush marsh, cattail marsh, saltgrass marsh, and wetland channel community types (Technical Appendix B). In New Mexico this semiaquatic species is known only from two disjunct areas in the eastern portion of the state (Schmitt *et al.*, 1985). These two areas are along Ute Creek in Harding and Union counties and in the Pecos Valley north to Roswell in Chaves and Eddy counties. These are areas of key habitat for this species in the state.

Arid land ribbon snake is found from 3,000 to 5,000 feet elevation where permanent water is present, including streams, ponds, marshes, and even some stock tanks. Vegetation in such areas consists of riparian and emergent aquatic types, including willows (*Salix*), cattails, and bulrushes. The species forages in and along the water and on the adjacent land (Degenhardt *et al.*, 1996; New Mexico Department of Game and Fish, 1988).

2.7.5 Least Shrew

Suitable habitat for least shrew is found throughout the study area (Technical Appendix B) and the species was recently collected at Lea Lake Marsh (Frey, 2005). The species also occurs in the BLM Overflow Wetlands (Frey, 2005).

Least shrew is most often found in mesic habitats, including marshy areas (Fitzgerald *et al.*, 1994:86). Least shrew may construct burrows. Nests are constructed of loosely piled grass or leaves. Nesting is communal and breeding likely occurs mainly in spring and summer. Litter size ranges from three to seven. Young reach near adult size about 30 days after birth. Main food items of least shrew are insects, arthropods, and earthworms. Least shrew forage mainly at night, but may be active all day (Fitzgerald *et al.*, 1994: 87).

2.7.6 Wright's Marsh Thistle

Wright's marsh thistle was not found at Lea Lake Marsh during the field investigations. However, the species has been documented from the Pecos River valley, where it occurs in alkaline wetlands (New Mexico Rare Plant Technical Council, 2005). Suitable habitat for the species occurs in the study area.

Wright's marsh thistle is a biennial or perennial obligate wetland species that occurs in saturated alkaline soils associated with springs, seeps, streams, and ponds from about 3,450 to 8,500 feet elevation (New Mexico Rare Plant Technical Council, 2005). It flowers from August through October.

2.7.7 Pecos River Muskrat

Muskrat and signs of muskrat foraging were observed in the study area during the field investigations (Technical Appendix B). The bulrush marsh, cattail marsh, and wetland channel community types are suitable habitats for Pecos River muskrat in the study area.

Muskrats live in burrows in stream banks or in cone-shaped houses made of leafy vegetation in marsh habitats (Fitzgerald *et al.*, 1994: 287). Muskrats are primarily herbivorous. Both sexes are territorial and competition for breeding territories is intense. However, territories are typically quite small with most activity being confined to an area within about 50 feet of the nest. Breeding commences in early spring, gestation takes 25 to 30 days, and litter size ranges from four to eight. Young are weaned about four weeks after birth. Several litters may be produced each year. Population density in good quality habitat may reach 22 individuals/ac before food resources are rapidly depleted. Populations often undergo five- to ten-year cyclical, density-dependent fluctuations (Fitzgerald *et al.*, 1994: 288).

2.8 Cultural Resources

A cultural resource survey of the study area was conducted for the study area and several associated areas adjacent to Lea Lake. A copy of the cultural resource survey report is included in Technical Appendix C. The survey included a search of the state archaeological records database for an approximately three-mile radius centered on the study area. Six previously-recorded archaeological sites were identified within the search area.

A pedestrian survey of 55-acres, including the study area, was conducted in February 2004. Three archaeological sites and two isolated occurrences were located during the pedestrian survey (Technical Appendix C). Only one of these, site LA 142878, was located in the study area. This site consisted of two drainage ditches south of Lea Lake that were both full and active at the time of survey. Site LA 142879 was a single ditch that drained into a natural basin to the northwest of the lake. All of the ditches were most likely built when the park was constructed between 1933 and 1938.

The third site was a structural foundation and its associated features outside of the study area. This site, LA 142877, was a historic site dating between 1880 and 1920 consisting of a dump, hearth feature, house foundation, outbuilding remains, and an undefined rock alignment. All three sites are considered having the ability to yield additional information and are designated as eligible for recommendation to the National Register of Historic Places under criterion "d" of 36 CFR 50.4.

2.9 Land and Water Use, Recreation Resources, and Aesthetics

The study area is entirely within the boundaries of Bottomless Lakes State Park and abuts the southern boundary of the park south of Lea Lake (Figure 2). Land adjacent to the park boundary at the study area is either public land managed by the BLM as part of their Overflow Wetlands Area or private ranch land.

2.9.1 Water Rights

Water use at Bottomless Lakes State Park includes evaporation from the open water surface of the lakes and transpiration from wetland and riparian vegetation. No water rights are associated with these uses as there are no diversions of water from man-made works (Technical Appendix A). Water uses for domestic, sanitary and landscape purposes at Bottomless Lakes State Park are provided by the City of Roswell municipal water system.

Numerous private individuals hold water rights for domestic, commercial and agricultural purposes in the vicinity of Bottomless Lakes State Park. Water uses under these rights are supplied by diversion from the artesian and shallow groundwater aquifers. Water rights associated with agricultural and domestic uses in the immediate vicinity of Bottomless Lakes State Park are supplied by diversion from groundwater sources (artesian and shallow) and surface water from the Hagerman Canal supplemented by groundwater pumping (Technical Appendix A).

On 25 March 2003, the State of New Mexico, the United States, the Carlsbad Irrigation District and the Pecos Valley Artesian Conservancy District filed a motion with the Pecos River Adjudication Court (*State of New Mexico, ex rel. Office of the State Engineer, and Pecos Valley Artesian Conservancy District v. L. T. Lewis et al. and the*

United States of America, Nos. 20294 and 22600 Consolidated) requesting entry of a Partial Final Decree which would settle the surface water claims of the Carlsbad Irrigation District and the United States. The Partial Final Decree established the maximum allowable annual diversion and storage right of the United States and the Carlsbad Irrigation District, and the Carlsbad Irrigation District's right to deliver surface water to the members of the District (Technical Appendix A).

The Partial Final Decree became effective upon compliance with the terms of the Settlement Agreement entered into between the State Engineer, the New Mexico Interstate Stream Commission (NMISC), the United States Department of the Interior - Bureau of Reclamation, the Carlsbad Irrigation District and the Pecos Valley Artesian Conservancy District. The Settlement Agreement, among other items, calls for the Interstate Stream Commission to purchase up to 6,000 water right acres in the Carlsbad Irrigation District, up to 11,000 water right acres in the Roswell artesian basin (of which, 8,000 acres will be water rights from the artesian aquifer) and up to 1,000 acres from the Fort Sumner Irrigation District area. The water rights acquired by the Interstate Stream Commission will be transferred to an augmentation well field developed and operated by the Interstate Stream Commission. The augmentation well field will be operated to deliver water to the Pecos River in accordance with criteria established in the Settlement Agreement to enhance the water supply of the Carlsbad Irrigation District and to comply with the provisions of the Pecos River Compact and the U. S. Supreme Court's Pecos River Decree. The augmentation well field could potentially affect groundwater levels in the vicinity of the project area, depending on the location and depth of the wells. This, in turn, could influence outflow from Lea Lake.

2.9.2 Recreation Developments and Resources

The park consists of about 1,600 acres emphasizing a chain of seven sinkhole lakes. Although some land within the park boundaries is leased State Trust land under the jurisdiction of the New Mexico State Land Office and some is privately-owned, all land within the study area is owned by State Parks.

The mission of the park is "to provide a quality outdoor recreation experience to all visitors through the protection of the natural environment, preservation of historic resources, and educational programming" (State Parks Division, 2001). Common recreational activities offered at the park include swimming, boating, scuba diving, fishing, hiking, bird watching, camping, and picnicking. The first three of these activities are offered only at Lea Lake and its associated facilities. Lea Lake has the largest array of developed recreation facilities of any of the lakes in the park. These facilities include: 1) a swimming beach, bathhouse with showers and toilets, a small dock, pedal boat rentals, vending machines, and a gift shop; 2) an RV campground with hook-ups, dump station, flush toilets, and showers; and 3) a tent campground and day-use picnic area with volleyball courts, playground, and covered picnic tables. Facilities at the other lakes are limited to developed camp sites with vault toilets and a centralized water system.

The Lea Lake recreation area is serviced by two above-ground septic tanks and a lined wastewater evapotranspiration basin located in the study area (Figure 2). This facility receives waste from the bathhouse, campground, and RV dump station at the Lea Lake recreation area. Solids settle in the above-ground septic tanks and wastewater effluent is allowed to evaporate in the lined pond at the site. There is no leach field associated with the facility. Groundwater and the septic tanks are monitored on a quarterly basis (S. Patterson, Bottomless Lakes State Park Superintendent, pers. comm., 21 March 2006).

Throughout the year, special recreational events take place at the park, such as a fishing tournament, triathalons, a sand sculpture contest, and paddleboard races. Additionally, the park hosts a series of interpretive programs at the Lea Lake beach every Saturday evening from Memorial Day through Labor Day generally featuring nature-oriented topics (State Parks Division, 2001).

Natural lakes are in limited supply in New Mexico and quite rare at low elevations. Thus, park visitation for day-use is highest during summer months when recreationists flock to the pleasant aquatic setting to enjoy the swimming, boating, scuba diving, and picnicking. Camping has historically been most popular in spring months, but year-round use has been steadily increasing due to increased capacity for RV hook-ups. The total number of annual visitors to the park has been steadily increasing in recent years, but the park's highest visitor count of more than 162,000 occurred in 1998, the year that coincided with the fiftieth anniversary of the “Roswell incident" (State Parks Division, 2001).

Recreation use in the study area is relatively low, given that the majority of the area is too wet and choked with salt cedar to make it enjoyable for hiking, picnicking, or fishing. The greatest use of the area is by bird watchers, but the area is also becoming more popular with persons interested in observing dragonflies and damselflies (S. Patterson, Bottomless Lakes State Park Superintendent, pers. comm., 15 September 2003).

2.9.3 Aesthetics

The clear, deep lakes and steep bluffs in the park are visually appealing features in an otherwise fairly homogeneous landscape. In contrast, at least part of the study area south of NM 409 is relatively visually unappealing due to use as a storage and disposal area for discarded park materials, including scrap lumber and metal, portable toilets, rusting vehicles, concrete, asphalt, brush piles, and wood parking posts. Park personnel believe that this debris was discarded at least 50 years ago and is a solid waste issue (S. Patterson, Bottomless Lakes State Park Superintendent, pers. comm., 23 March 2006; refer to section 2.12 for further discussion). This solid waste debris can be found spread throughout the degraded wetland area, which contributes to the habitat degradation. In addition, the thick salt cedar stands that characterize the degraded wetland area are not visually inviting for the average recreationist.

2.10 Socioeconomic Environment and Environmental Justice

Bottomless Lakes State Park is located in rural Chaves County. The closest community is Dexter, population 1,235 (U.S. Census Bureau, 2003), located approximately seven miles to the southwest. The closest full-service community is Roswell (population 45,293), approximately 12 miles northwest of the park. No homes, businesses, or community services are located in the study area. Residences nearest the study area are two park employee houses located off NM 409 southeast of the Lea Lake recreation facilities. Two other park employee homes are located near the park visitor center in the middle of the park.

With exception of the state park headquarters, the nearest schools, emergency services, government offices, churches, retail shops, restaurants, and other services are in Roswell.

The study area is located in Chaves County Census Tract 12, Block Group 2 (U.S. Census Bureau, 2003). Some population demographics of this census tract are compared to those of Chaves County and the State of New Mexico in Table 1.

The data show that the population of Chaves County Census Tract 12 has a higher percentage of white persons, and conversely, fewer ethnic minorities, than are found in Chaves County and the State of New Mexico. Census Tract 12 also has a lower percentage of persons identifying themselves as Hispanic or Latino than either Chaves County or the State of New Mexico. Chaves County has a slightly higher percentage of individuals living below the poverty level than the statewide average. No data regarding income levels is available for Census Tract 12.

Table 1. Comparison of selected race and income demographics for the State of New Mexico, Chaves County, and Chaves County Census Tract 12 which includes the study area.

	New Mexico	Chaves County	Chaves County Census Tract 12
total population	1,819,046	61,382	1,808
white	66.8%	72.0 %	79.5%
American Indian	9.5%	1.1%	0.9%
black or African American	1.9%	2.0%	0.1%
Asian	1.1%	0.5%	0.1%
Native Hawaiian and Other Pacific	0.1%	0.1%	0%
Some Other Race	17%	21.2%	16.3%
Two or More Races	3.6%	3.1%	3.0%
Hispanic or Latino (regardless of race)	42.1%	43.8 %	36.4%
persons below poverty level	18.4%	21.3 %	11%

Source: U.S. Census Bureau, 2003.

2.11 Noise

In considering potential effects of increased noise levels, sensitive noise receptors are identified in a project area. Sensitive receptors include, but are not limited to, homes, lodging facilities, hospitals, parks, and undeveloped natural areas. Several employee residences are located within the park boundaries, but none are within or adjacent to the study area boundaries. No other man-made sensitive noise receptors are within or near the park boundaries. Existing noise levels in the study area are relatively low due to the nature of the setting (*i.e.* rural state park). Noise in the study area is currently generated mainly in the day time from the following sources:

- vehicles traveling on NM 409, other park roads, or Dexter (Wichita) Road;
- recreationists using Lea Lake and its associated facilities;
- dispersed recreation uses (*e.g.* hunters, fishers, hikers); and
- park staff operation and maintenance activities.

2.12 Hazardous, Toxic, and Radiological Waste

A Phase I Environmental Site Assessment for Hazardous Toxic Radioactive Waste (HTRW) was conducted for the study area in November 2003. The findings in the final Environmental Site Assessment report, dated 27 February 2004, were based upon an evaluation of data collected by review of records, site reconnaissance, and personal interviews. A regulatory agency search revealed no recognized HTRW occurrences associated with the study area. The full HTRW report is contained in Technical Appendix D.

At the time of the study, portions of the study area were in use for storage of solid waste debris, salvage, wastewater treatment, and a maintenance shop. Land use nearby the study area included state park functions, such as the Lea Lake campground, residences, and a maintenance shop. The park "bone yard" area was located in degraded wetland area south of NM 409. The bone yard had been used to store debris and salvage resulting from operation and maintenance activities in the park dating back to the 1930s (Technical Appendix D).

Waste materials observed during site reconnaissance included concrete rubble, lumber, abandoned latrines, steel cable, a metal pedestrian bridge, cement block, used RV electrical hookup boxes, bolts, outhouses, fence posts, pressure-treated bollards, an empty water storage tank, used camp stoves, and an empty 500-gallon gasoline tank. The bone yard area was fenced and secure.

The park wastewater treatment facilities were located next to the bone yard, as was a single monitoring well for the package plant. The package plant included a covered and lined pond raised approximately four feet above grade. The wastewater treatment area was fenced and secure.

There was no visible evidence of spill or stained areas in the park or the study area that could be attributed to an HTRW activities. The following were recognized as potential HTRW occurrences within the study area (Technical Appendix D):

- Two areas were observed where pressure-treated bollards were stored on the ground. Chromium copper arsenate is the most common substance used to pressure-treat wood and could have leached out over time. Interviews indicate that these areas have been used to store bollards for long periods of time prior to 1965. Groundwater was at shallow depths, and the bollards were in direct contact with the ground. Bollard storage areas were subject to flooding as recently as 1999. In addition, the presence of these materials in contact with the ground where flooding has occurred was a recognized environmental condition and may have impacted the soils in the study area.

- The presence of two piles of construction debris that included roofing and insulation material and painted wooden surfaces were observed in the study area. Based on the age of the buildings that may have been the potential source of the material, the roofing and insulation materials could contain asbestos and the painted debris could contain lead.

Within several months of identification of these potential hazards, the pressure-treated bollards were removed from the site (S. Patterson, Bottomless Lakes State Park Superintendent, pers. comm., 27 November 2005). Since completion of the HTRW inventory in 2003, no additional solid waste debris has been placed in the study area (S. Patterson, Bottomless Lakes Sate Park Superintendent, pers. comm., 6 February 2006).

3.0 FUTURE CONDITIONS WITHOUT PROJECT

This section discusses conditions of pertinent resources that would likely be affected if no plan is developed and implemented to restore aquatic habitat in the study area portion of Bottomless Lakes State Park. Other resources discussed in Chapter 2 are analyzed only for their potential to be affected as a result of implementation of a proposed project (Chapter 6).

3.1 Hydrology and Geomorphology

On average, Lea Lake discharges have been increasing since 1976. However, based on recent discharge measurements of the Lea Lake outflows by the NMISC, the temporal trend shows that flows are reduced, but continue, during summer months as the aquifer levels are lowered due to irrigation.

A significant relationship between Lea Lake outflows and the artesian aquifer levels has been identified (Technical Appendix A). Lea Lake outflows are primarily dependent upon the hydraulic head within the artesian aquifer. Therefore, an understanding of the causes of recharge and discharge in the Roswell Artesian basin is necessary to predict future conditions of the aquifer, and hence Lea Lake outflows.

Future characteristics within the Roswell region such as well pumping rates, irrigation practices, and retirement of water rights could potentially affect the hydraulic head in the aquifer. According to the New Mexico Office of the State Engineer in Roswell, metering of all wells was imposed in 1963 and is still required. Because the water rights of farmers are currently metered, it is unlikely that water use for current farmland would vary significantly. The issue that has the largest potential for affecting aquifer water levels in the near future is planned purchase of around 12,000 acres of land and water rights by NMISC, as mentioned above. If NMISC simply retires the wells, water levels in the aquifer could rise. If any of the purchased water rights were previously dormant, and NMISC activates those water rights in order to augment flows to the Pecos River, the additional pumping could possibly cause a lowering of aquifer levels.

Due to uncertainty in predictions of future flows, three scenarios were evaluated to assess possible future discharges from Lea Lake into the adjacent wetland area (Technical Appendix A). The three scenarios included stabilization of Lea Lake outflows at approximately their current levels, a continued increase of Lea Lake outflows, and a future decrease in Lea Lake outflows. The impact of each of these possibilities may be considered in the future design alternatives for the project. The analysis of historical and existing conditions suggests that the Lea Lake outflows would probably somewhat stabilize or slightly increase as more wells are retired. No evidence exists that suggests either a large increase or large decrease in discharges in the future.

Based upon the assumption that flows from Lea Lake would remain similar or slightly higher than existing conditions, discharges would likely continue to exceed the capacity of the existing outlet channel. Without changes to the channel size and constant maintenance (which the Bottomless Lakes State Park personnel have been managing, to-date), growth of aquatic vegetation would continue to further diminish the limited capacity of the outlet channel. High lake levels and continued flooding conditions in the park that have been experienced since the construction of the existing outlet channel in 2002 would likely occur.

3.2 Ecological Setting

Analysis of future ecological conditions in the study area without the project was conducted by first evaluating changes that have occurred over the last 50 years (1954 to 2003). This evaluation involved comparing aerial photographs taken on 5 February 1954 and 23 July 2003 (see Technical Appendix B), assessing trends and patterns of vegetation change, and inferring the processes likely responsible for those changes. The resulting information on changes that occurred over the last 50 years was then used as a basis for projecting future changes in ecological conditions with no action.

Vegetation changed considerably in the study area over the last 50 years, apparently due primarily to changing hydrological conditions. In 1954, the study area was drier than it is currently. The South and West wetland channels existed in their current alignments in 1954. The South Wetland Channel apparently was well-maintained, as evidenced by bare soils along the channel banks. The West Wetland Channel, although faint in the 1954 aerial photograph, appeared to convey flow all the way to the Pecos River. Interpretation of the 1954 aerial photograph indicated that inundated areas with dense stands of emergent wetland vegetation were small and limited to the southwest portion of the study area. A relatively large stand of dense, emergent wetland vegetation occurred south of the study area on private lands, where the South Wetland Channel became indistinct and surface water likely spread out over the land.

It appears that most of the study area was dominated by saltgrass, with just a few small patches of dense, emergent hydrophytic vegetation (*i.e.* sedges or cattail) in the southwest portion of the study area in 1954. Salt cedar occurred mostly along NM 409, with the stand extending southwest into the center of the study area. Two large trees (possibly cottonwoods, based on the size and shape of the crowns) occurred in the eastern portion of the study area. A presumptive delineation of dominant vegetation was made from the 1954 aerial photograph and compared to the results of the vegetation mapping conducted in 2003. This comparison indicates an increase in salt cedar cover from about 15% of the study area in 1954 to 54% in 2003. Also, emergent marsh habitat increased in coverage from about 7% in 1954 to 27% in 2003.

Freshwater wetlands with relatively constant hydrological regimes may have stable vegetation assemblages over long periods of time (Mitsch and Gosselink, 1986: 157). Wetland vegetation dynamics are influenced by allogenic factors such as disturbance regime, colonization patterns, differential species tolerance to environmental conditions, and inhibition (Harris and Marshall, 1963; Millar, 1973; Hamilton, 1984; Grace, 1987; van der Valk and Welling, 1988). Autogenic factors, such as accumulation of organic sediments, may also lead to vegetation change (*i.e.* the facilitation model of Connell and Slayter, 1977). Anecdotal information suggests that perennially inundated emergent marshes were a feature of the landscape since at least the late 1500s (Hammond and Rey, 1967). These wetlands were probably relatively stable because disturbances such as fire, scour, and regularly-fluctuating water levels would have been infrequent, if not absent. However, lowering of groundwater levels from pumping, coupled with ditching and redirection of surface water flows, changed hydrological conditions in the study area. These changes in hydrology constituted a "disturbance," with respect to vegetation dynamics.

The increase in salt cedar cover from 1954 to 2003 indicates that the species may continue to spread in the study area. Following is an hypothesized scenario for the development and dynamics of salt cedar vegetation in the study area over the last 50 years and into the future, with no restoration actions.

1) The study area was drier in 1954 than it is currently and salt cedar was established along NM 409 in 1954.
2) From 1954 to 2003, salt cedar continued to spread south and west into the study area, with wet years likely resulting in high rates of seedling establishment (Horton *et al.*, 1960).
3) As outflow from Lea Lake gradually increased since at least the late 1970s (Technical Appendix A), overflow from the wetland channels in the study area began to occur, resulting in increasing areas subject to frequent or perennial inundation.
4) Salt cedar establishment in inundated areas was arrested and mortality of established trees in these areas began to occur (Warren and Turner, 1975; Busch and Smith, 1995).
5) Salt cedar continued to spread on moist-soil sites not subject to prolonged inundation, resulting in gradual conversion to salt cedar monoculture stands on those sites.

Construction of a sewage treatment facility, solid waste debris disposal, and clearing and grading of small areas were other disturbance factors that may have affected wetland vegetation dynamics in the study area. These impacts created bare-soil sites available for colonization by species such as salt cedar, kochia, and ragweed.

In the absence of any restoration actions, wetlands in the study area are likely to continue to change. Much of the study area (ca. 54%) consists of moist-soil sites that have a salt cedar component ranging from dense stands to scattered seedlings or saplings. These stands are likely to continue to develop into dense, mature monoculture stands of salt cedar with very low plant species diversity over time. An example of such a mature, monoculture stand is the area along NM 409 northwest of the South Wetland Channel. It is apparent that this salt cedar stand has developed since 1954 to its current condition. This trajectory of salt cedar development is likely to occur over much of the study area, with the exception of the drier alkali sacaton flats and the inundated marsh areas. However, autogenic processes in the marsh areas may provide suitable sites for salt cedar establishment. Tussocks of alkali sacaton, although not common, were observed scattered throughout the inundated marsh areas in 2003 (a tussock is a hummock or tuft of grass in a marsh that is bound together by plant roots). These tussocks appear to have formed through a process of accumulation of wind-blown sediments and litter resulting in localized increase in elevation. Minor increases in elevation may provide a suitable site for establishment of alkali sacaton, which tolerates occasional flooding but is intolerant of perennial inundation (Bowman *et al.*, 1985; Brotherson, 1987). Continued accumulation of sediments may provide ideal sites for germination of salt cedar seeds and establishment of seedlings.

In summary, ecological conditions in the study area would likely decline in the future with no restoration action. Salt cedar is likely to continue to spread and increase in density throughout most of the study area. Depending on channel maintenance activities and induced drainage, inundation levels in the study area may remain the same or decrease in the future. If the latter occurs, salt cedar would likely colonize drained areas. Increasing dominance of salt cedar would reduce habitat diversity in the study area and would result in conversion of emergent marsh and wet meadow habitats with woody riparian habitats. Salt cedar stands are generally poor habitat for most native vertebrate and invertebrate species (Lovich and De Gouvenain, 1998). Some species of birds may benefit from an increase in salt cedar, but habitat for other species, such as shorebirds and waterfowl, would decline (Horton and Campbell, 1974; Hunter *et al.*, 1988; Livingston and Schemnitz, 1996; Anderson, 1998). Also, while salt cedar may support a relatively diverse assemblage of invertebrates (Anderson, 1998), species associated with emergent wetlands and open water areas, such as dragonflies and damselflies, would be negatively affected by conversion of these habitats to salt cedar stands.

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4.0 PLAN FORMULATION

4.1 Formulation of Alternative Plans

This section describes the process used to develop alternatives plans, evaluate alternative plans based on costs and outputs, and select a preferred plan. The plan formulation process followed USACE guidance (Yoe and Orth, 1996). The major steps in plan formulation are: 1) identifying problems and opportunities; 2) inventorying and forecasting resources; 3) formulating alternative plans: 4) evaluating alternative plans; 5) comparing alternative plans; and 6) selecting a recommended plan.

4.1.1 Formulation Process

The planning process began with the USACE and State Parks identifying the feasibility study goal, which was to develop and implement a plan to restore aquatic and wetland habitats in the study area. In order to formulate alternative plans to meet the study goal, an examination of current conditions was undertaken to determine existing problems and potential opportunities in the study area. These problems and opportunities, described in Section 1.3, led to development of several objectives to address the problems and opportunities and, thereby, achieve the study goal. Constraints to choosing solutions to solve existing problems were also recognized at this step in the planning process.

Following development of objectives and identification of constraints , a range of solutions, or management measures, were created to specifically address one or more objectives. Development of management measures for restoration of Lea Lake Marsh was based on a reference model that included published information on the vegetation dynamics of inland saline marshes, an analysis of historic conditions in the study area, and an assessment of changes in vegetation and hydrologic conditions that have occurred at Lea Lake Marsh (Technical Appendix B). Using the USACE software IWR-PLAN, various management measures were combined into a range of alternative plans.

4.1.2 Objectives and Constraints

4.1.2.1 Objectives

Based on the problems and opportunities identified for the study area (Chapter 1), the USACE study team defined the following objectives for restoration of aquatic and wetland habitats.

- Increase the extent of spring-fed wetland habitat in Lea Lake Marsh that has natural ecosystem structure and function.
- Restore naturally-occurring native plant communities to the wetland.
- Reclaim habitat for Pecos sunflower, Pecos pupfish, Mexican tetra, Pecos River muskrat, and least shrew.
- Improve habitat diversity for dragonflies and damselflies.
- Provide consistent water delivery to Lea Lake Marsh.
- Create opportunities for environmental education.

4.1.2.2 Constraints

Constraints to developing alternatives to achieve these objectives were also identified. These constraints are listed below.

- Prohibit any increase in consumption or loss of surface water in the study area.

- Protect the pattern of water flow from Lea Lake Marsh to adjacent wetlands on BLM and private land.
- Maintain the existing sewage treatment facility location for the Lea Lake recreation complex (Figure 2).
- Avoid buried utility lines located in and across the study area.
- Conserve an open area twice the size of and adjacent to the existing sewage treatment facility for expansion or replacement of the current facility.
- Do not increase the potential for flood damage to historic structures and recreation facilities surrounding Lea Lake.

4.1.2.3 Water Budget

A major constraint in restoration planning for Lea Lake Marsh was to ensure that water yield from the wetland was not reduced. Consequently, a water budget was developed to provide a mechanism for analyzing the effects of alternative plans on water yield from Lea Lake Marsh (Technical Appendix A). The water budget compared total inflows to Lea Lake Marsh with total outflows to the Pecos River (Table 2). A correction or balancing term was applied to ensure that the water budget balanced on a monthly basis. Total inflow to the marsh (9,900 acre-feet) is nearly identical to total outflow (9,956 acre-feet) on an annual basis, excluding the balancing term. This indicates that the important components of the water budget have been considered.

Inflow to the wetland from Lea Lake varied seasonally and ranged from 587 acre-feet in late summer to 999 acre-feet in winter (Table 2). Evapotransporation from the wetlands between Lea Lake and the Pecos River was greatest in summer (364 acre-feet) and lowest in winter (Table 2). The water budget considered evaporation and evapotranspiration losses from the entire 715-ac wetland area between Lea Lake and the Pecos River (Technical Appendix A). Evapotranspiration rates for each dominant plant species occurring at Lea Lake Marsh were estimated from available data. These rates were then used in estimating water losses following implementation of management measures such as salt cedar removal, creation of open water habitats, and supplemental planting.

4.2 Management Measures

4.2.1 Management Measures Considered But Eliminated From Detailed Study

Construction of a second outlet channel from Lea Lake was given cursory consideration in early planning stages (2003-2004) but eliminated from further study. A second channel would allow the entire Lea Lake outflow to be diverted into only one channel at a time, thus providing an easier work environment for channel maintenance. By providing an alternate route for the entire outflow, the construction of a second channel might also reduce the construction costs of temporarily dewatering the existing outlet channel during reconstruction. However, there are several disadvantages that outweigh the benefits of constructing a second channel:

1) The presence of a high water table in the area would likely result in a significant amount of water seepage into whichever channel is not in use. This would promote vegetation growth, that when combined with the original outlet channel, would effectively double the amount of channel to maintain (including vegetation removal and culvert and structure maintenance).

2) Widening the existing outlet channel to increase the discharge capacity, combined with construction of a second outlet channel equal in size, would require a significant amount of additional space.

Table 2. Water budget for wetlands between Lea Lake and the Pecos River, including the study area (source: Technical Appendix A).

MONTH	WETLAND INFLOWS			WETLAND OUTFLOWS				
	INFLOW FROM LEA LAKE (acre-feet)	PRECIP. (acre-feet)	TOTAL INFLOW (acre-feet)	SURFACE-WATER EVAPORATION (acre-feet)	WETLAND EVAPO-TRANSPIRATION (acre-feet)	UNMEASURED OUTFLOW (acre-feet)	BALANCING TERM (acre-feet)	TOTAL OUTFLOW (acre-feet)
JAN	999	26	1024	31	38	157	-16	1024
FEB	875	25	900	46	46	73	-70	900
MAR	775	28	802	81	77	101	-90	802
APR	721	33	754	113	86	317	-206	754
MAY	769	77	845	133	149	-89	283	845
JUN	681	100	782	149	339	1	-51	782
JUL	635	111	746	140	364	64	-16	746
AUG	587	129	716	121	345	8	28	716
SEP	649	113	761	94	257	5	133	761
OCT	787	73	860	69	126	47	130	860
NOV	848	31	879	42	54	120	-141	879
DEC	885	34	919	29	45	202	-78	919

3) The considerable costs associated with the construction of a second channel would include excavation, a control structure and possible bridge, and at least two additional culverts to convey water to the wetland. These costs may equal or exceed any temporary dewatering method that would be incurred under a single-channel alternative.

In the spring of 2005, however, after the wettest winter on record and with funding for completion of this feasibility study stalled, State Parks created another outlet on the southwest side of Lea Lake. An 18-inch culvert was installed to direct overflow from the lake that could not be carried by the outlet channel away from recreation facilities. State Parks has indicated that, with any action alternative, the culvert would remain in place, but the inlet would be covered. This would ensure that outflows from Lake would be directed to the permanent channel leading southeast from the lake into the wetland. The culvert inlet would only be opened during extreme flooding situations (*i.e.* outlet channel overtopped).

4.2.2 Management Measures Considered in Detail

Broad actions required to move the wetland towards the reference condition were identified as: removing salt cedar and controlling its re-growth; removing solid waste debris piles from the wetland; diversify hydrologic regime in the wetland; and planting disturbed areas with native species. These actions were used as a basis for developing specific management measures that could then be combined into various alternative plans.

The management measures were developed to be spatially explicit, which means that locations of management measure boundaries in the study area affects the environmental outputs associated with those measures. This spatial component results from the Habitat Suitability Index (HSI) model developed for the study which assigns a habitat unit score to each existing vegetation community type (Technical Appendix B). A composite HSI model was developed to quantify the expected environmental outputs of the various management measures. This model combines individual HSI models for slider turtle, muskrat and Yellow-headed Blackbird, which together serve as indicator species for overall ecological integrity of the study area (Technical Appendix B).

Additionally, an initial outlet channel design (Technical Appendix F) recommended approximately doubling the channel width to accommodate excessive winter flows. This would increase the channel capacity from 15 cfs to 25 cfs and aid in moving overflow into the park wetland and away from park facilities.

Various scales of each management measure were defined, associated with the area where each management measure was applied. Each management measure was assigned one or more letter codes. More than one letter code was used for a single management measure to accommodate combinability and contingency relationships in the incremental cost analysis. Scales were assigned numeric codes. Thus, the combination of a specific management measure and scale was designated by an alphanumeric code, such as A1, as described below.

4.2.2.1 Modify Outlet Channel - Management Measure A

The purpose of this measure is to direct all outflow from Lea Lake into the study area wetland. Currently, water regularly over-tops the outlet channel and overflows the northwest side of the lake in the winter months because the existing outlet channel and culverts have insufficient capacity (Technical Appendix F). Modification of the outlet channel would increase capacity and capture this overflow water, which floods campgrounds, recreational facilities, historic structures, and other non-wetland areas, and deliver it to the study area wetland. This increased volume of water delivered to the wetland would ensure a consistent supply of water to and flow rate through open-water and inundated habitats of Lea Lake Marsh. This additional water volume would augment total annual flow to adjacent wetlands on BLM and private lands from Lea Lake Marsh, thereby helping to ensure that their hydrologic conditions would not be negatively affected by ecosystem restoration in the study area.

The volume of water that would be directed to the study area by modification of the outlet channel has not been quantified but is likely to be considerable. Overflow events are variable in terms of their duration and magnitude and data are not currently available to develop accurate estimates of water volumes that would be captured and delivered to the study area wetland by modifying the outlet channel. However, anecdotal and qualitative information suggests that modification of the outlet channel would substantially augment the volume of water delivered to the wetland on an annual basis. Winter flooding from Lea Lake overflow has occurred every year since 1999 (see section 1.3). In the winter of 2000-2001, overflow flooding was extensive enough to damage a 0.1 mile-long segment of NM 409 and inundate most of the tent camping and day-use area on the west side of the lake (Figure 2). During this prolonged overflow event, at least 20 acres of land west of the lake were inundated. Modification of the outlet channel would capture this overflow water and direct it into the study area wetlands.

Modification of the outlet channel is necessary to ensure a consistent supply of water for creation of open water habitats in the study area wetland (see the description of management measures J, K, and L below). The added volume of water provided to the wetland by modification of the outlet channel would guarantee an adequate flow through the open water habitats and prevent them from becoming stagnant pools. Additionally, the increased volume of water supplied to the wetland would flush fine sediment that may accumulate in the feeder channels for the open water habitats during low-flow periods. This hydrologic function provided by modification of the outlet channel would preclude the need for extensive maintenance of the feeder channels.

This management measure has two scales: A0 = no modification of the outlet channel; and A1 = modification of the outlet channel (Figure 7). The goal of outlet channel modification would be to increase the capacity of the channel and associated culverts to convey 25 cfs. The design of the inlet to the channel at Lea Lake would be such that the lake level would not drop below 3,459.2 feet nor would it rise above 3,459.7 feet. This would ensure that recreational values in the lake are maintained while preventing over-topping of the channel and overflow of the lake. Additionally, the design would minimize impacts to buried infrastructure in the vicinity of the outlet channel. Major features of outlet channel modification (see Technical Appendix F) are summarized below.

- The concrete control structure in the channel would be moved upstream 32 feet and widened to 6 feet.
- The outlet channel would be graded to a uniform slope from the concrete control structure at Lea Lake downstream for a distance of 994 feet to match with the existing channel bed at Station 7+66 (Figure 7).
- The reconstructed channel would have a bottom width of 6 feet and 1.5H:1V side slopes lined with interlocking block.
- The corrugated metal culverts on the Access Road would be replaced with a single 6-foot wide by 3-foot high concrete box culvert.
- The corrugated metal culverts on NM 409 would be replaced with two 3-foot wide by 2-foot high concrete box culverts (Figure 7).

4.2.2.2 Remove Salt Cedar - Management Measures B, C, and D

The purpose of these measures is to restore native wetland plant communities in the study area and reduce or eliminate the evapotranspiration water loss from the wetland that is attributable to salt cedar. Salt cedar, a non-native plant introduced by man for stabilization of stream banks, was first reported in the Pecos River basin in New Mexico in 1912 (Robinson, 1958). Since then, salt cedar has spread rapidly throughout riparian and wetland habitats in the Pecos River basin.

Currently, salt cedar covers much of the wetland habitat in the study area. In many locations it is the dominant plant and often occurs in very dense stands as the only plant species. The presence of salt cedar as a dominant plant lowers habitat suitability for indicator species (see analysis of habitat suitability in Technical Appendix B). Salt cedar is likely to continue to spread in the study area and provide a vigorous headwater seed source for continued, active spread of the species in downstream wetland and riparian habitats.

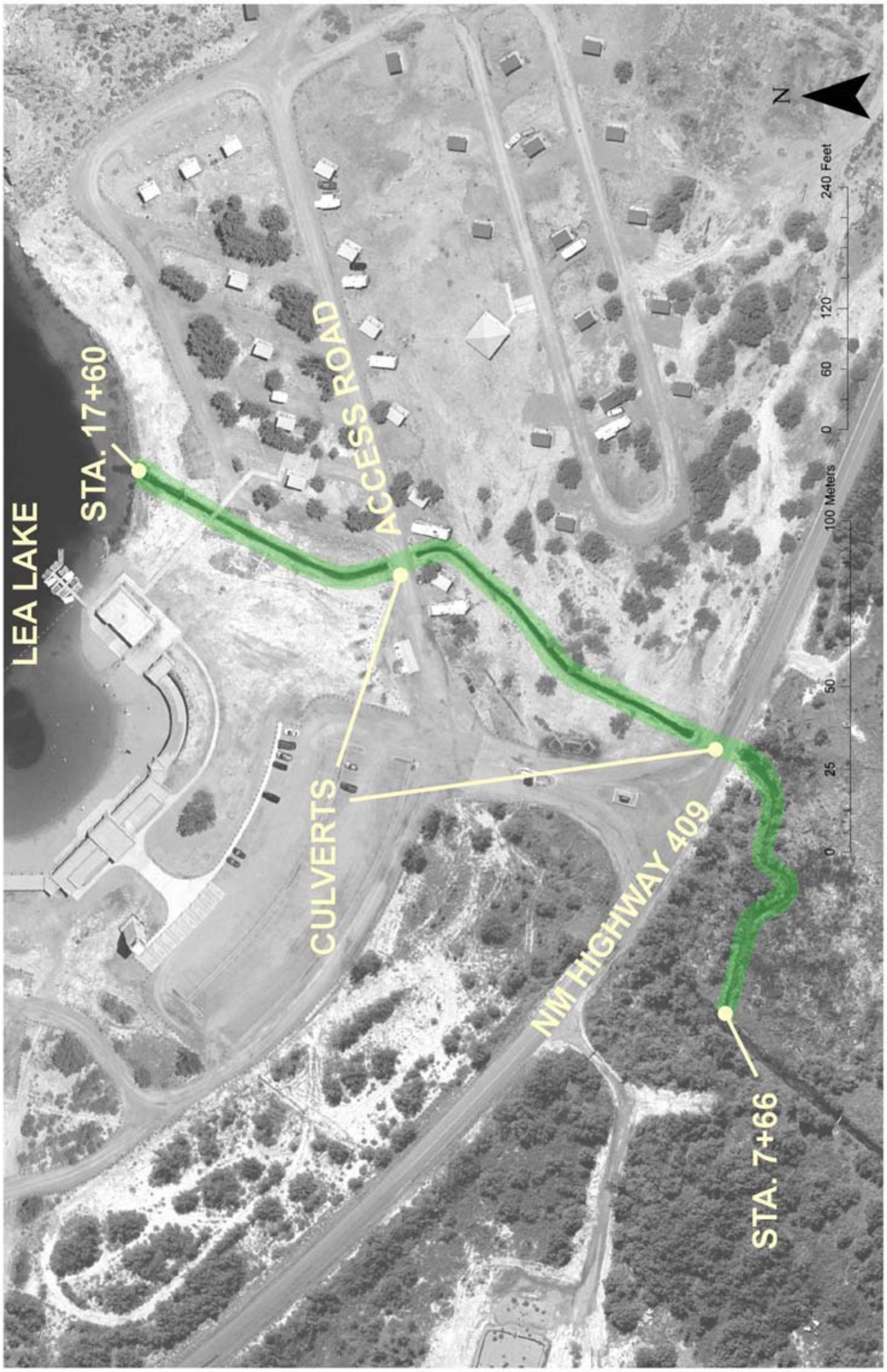


Figure 7. Outlet channel modification management measure. The segment of the outlet channel proposed for modification is highlighted in green.

Removal of salt cedar from part or all of the study area is considered to be central to restoration of the wetland. The role of non-native species such as salt cedar in present-day ecosystems, and the necessity of control of these species, is the subject of much debate (*e.g.* Anderson, 1998; Gould, 1998; Janzen, 1998). A reasonable approach regarding the necessity of non-native plant control and the role of native plant species in ecological restoration is application of a sustainability standard (Del Tredici, 2004). Application of this standard results in identifying plants species suitable for ecological restoration as those that: 1) tolerate site conditions; 2) require minimal use of pesticides, herbicides, and fertilizers; 3) tolerate prevailing soil moisture and climate conditions; and 4) will not aggressively spread into surrounding natural areas. Non-native plants may meet these criteria in cases where underlying ecosystem processes no longer support a native plant community and such processes cannot realistically be restored. However, the underlying ecological processes at Lea Lake Marsh are intact (see Technical Appendix B) and the occurrence of salt cedar at the site is a result of that plant's ability to actively spread and out-compete native plants. If salt cedar is removed, the native plant community could thrive at the site with minimal human intervention.

Native plants occurring at Lea Lake Marsh are adequately adapted to the local environment and grow in balance with each other, whereas salt cedar spreads aggressively and causes major changes in plant community structure and function. Restoration and preservation of the native plant community at Lea Lake Marsh is biologically prudent because, as Stephan Jay Gould (1998) explained:

> "At least we know what natives will do in an unchanged habitat, for they have generally been present for a long time and have therefore stabilized and adapted. We never know for sure what an imported interloper will do, and our consciously planted exotics have 'escaped' to disastrous spread and extirpation of natives (the kudzu model) as often as they have supplied the intended horticultural or agricultural benefits."

Salt cedar has indeed "escaped" and spread aggressively throughout the American West. Its detrimental ecological impacts are at least partly known and include changes in plant community structure, nutrient cycling, animal species diversity, surface and ground water hydrology, stream geomorphology, and fire regime (DeLoach *et al.*, 2000; Levine *et al.*, 2003).

The management measures developed for removal of salt cedar consist of treatment of three geographically specific areas (Figure 8). These areas were delineated based on their importance in continued growth and spread of the species in the study area. Management measure B1 would remove salt cedar from the area labeled SC-1, which encompasses 24.88 acres or 57 percent of the study area (Figure 8). This area has the highest density of salt cedar and the largest, densest stands of salt cedar seedlings and saplings. It is the area with the most extensive, active spread of salt cedar in the wetland. Therefore, area SC-1 was considered the highest priority for removal of salt cedar. Management measure C1 would remove salt cedar from area SC-2, located in the eastern portion of the study area and comprising 12.39 acres or 29 percent of the study area (Figure 8). This area had much less active expansion of salt cedar stands than area SC-1, but did have fairly extensive, mature stands that produce an abundance of seed. Consequently, area SC-2 was considered to be the second highest priority for removal of salt cedar. Finally, area SC-3, covering 5.68 acres or 14 percent of the study area, had the lowest salt cedar density and included several stands that appeared to be dying out due to permanent inundation. However, there were still patches of mature trees with vigorous growth that likely produce substantial volumes of seed. Therefore, area SC-3 was considered to be the third highest priority for removal of salt cedar.

Salt cedar removal from the entire study area (*i.e.* areas SC-1, SC-2 and SC-3) was considered to be necessary before any debris removal or creation of open water habitats could be conducted. This rationale consisted of two parts. First, debris removal and creation of open water habitats would create relatively large areas of bare, disturbed soil that would constitute an ideal seed bed for establishment of salt cedar. While natural revegetation, particularly by rhizomatous spread of saltgrass, would likely occur, this effect would initiate at the margins of disturbed areas and proceed inward. However, salt cedar establishment by seed germination would occur throughout the disturbed areas and would likely proceed rapidly, overwhelming the establishment of other plant species. Therefore, it was considered necessary to remove all of the salt cedar and greatly reduce the seed source before any bare-ground creating activities were conducted.

Secondly, the water budget analysis was premised on eliminating evapotranspiration water use by salt cedar in the study area to allow for creation of open water habitats. Under this framework, no open water habitats could be created without first gaining the water liberated by salt cedar removal. The water budget analysis (see section 4.3) indicated that removal of all salt cedar would more than offset the incremental change in evapotranspiration from the wetland resulting from creation of the open water habitats. Moreover, capture and conveyance of the overflow water volume to the study area (see management measure A) would further guarantee that total water yield from the wetland would stay the same or increase compared to existing conditions.

Salt cedar removal in the three management measure treatment areas would be conducted as follows. Salt cedar would be removed mechanically using a 23-ton excavator fitted with a special bucket used for extracting whole salt cedar plants, including roots. This method has been employed successfully on adjacent marsh habitats with similar vegetation, soils, and hydrologic regimes in the BLM Overflow Wetland (*e.g.* Bureau of Land Management, 2002). Salt cedar trees would be hauled out of the marsh and chipped. In areas that are too wet for the excavator to operate, salt cedar would be cut with a chainsaw and the stumps would be treated by immediately brushing the cut surface of the stump thoroughly with a full strength (28.7% by volume) solution of isopropylamine salt of Imazapyr (Habitat® herbicide) mixed with a water-soluble dye, such as RIT® liquid clothing dye, to track treated stems. Habitat® is registered for use in aquatic habitats. The herbicide specimen label and Material Safety Data Sheets for the herbicide and water-soluble dye are provided in the Appendix. Potential effects of the herbicide and dye on the environment are discussed in Chapter 6 of this document.

Cut-stump herbicide application is an effective method for controlling salt cedar (Sudbrock, 1993). Cut-stump treatments would preferably be conducted late in the growing season to improve translocation of the herbicide from the cut stump surface to the plant roots). Follow-up maintenance of salt cedar treatment areas would involve hand-pulling of sprouts and seedlings and continued removal of larger trees not killed by the first treatment. This would be conducted by removing trees using a chainsaw and treating the cut stumps immediately with an herbicide, as previously described. For the purposes of analysis, it was assumed that the full effect of salt cedar removal would take five years to be realized.

Scales of the three salt cedar removal management measures are defined as: B0, C0, and D0 = no salt cedar removal; B1 = remove salt cedar from area SC-1 (24.88 acres); C1 = remove salt cedar from area SC-2 (12.39 acres); and D1 = remove salt cedar from area SC-3 (5.68 acres).

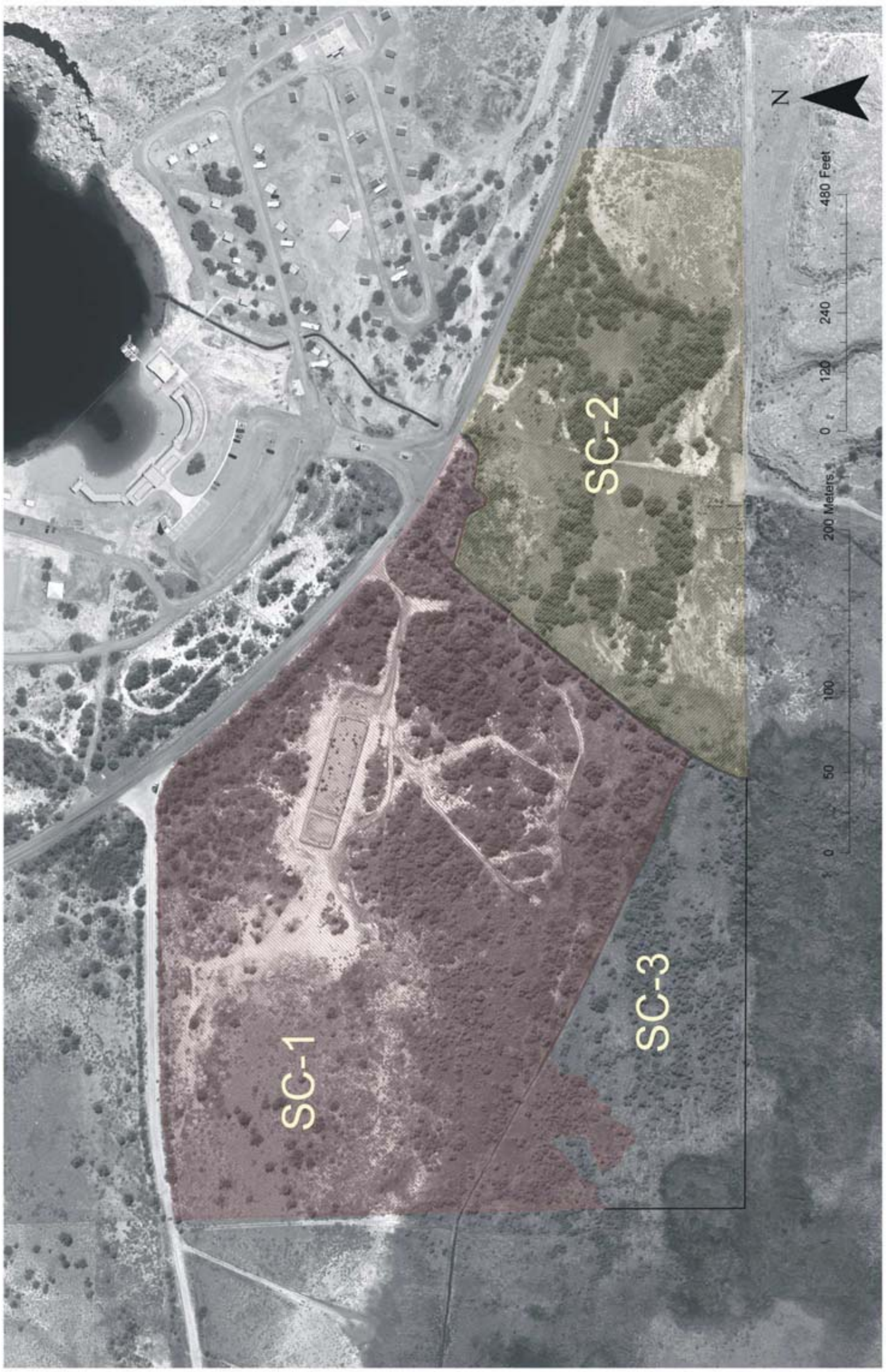


Figure 8. Treatment areas for the salt cedar removal management measures. The treatment areas are indicated by the polygons labeled SC-1 through SC-3.

4.2.2.3 Remove Solid Waste Debris - Management Measures E, F, G, H, and I

The purpose of these measures is to restore areas currently covered with solid waste debris to wetland habitat and native vegetation. Substantial portions of the study area with wetland hydrologic regimes and hydric soils are occupied by piles of solid waste debris and associated access paths that are devoid of vegetation (Figure 9). Solid waste debris in the study area includes cut brush, concrete, scrap metal, fence posts, construction debris, and scrap lumber.

Solid waste debris piles change the wetland from a naturally functioning condition by precluding vegetation growth and providing novel habitat structure. This in turn influences plant and animal species composition in the wetland. For example, many of the solid waste debris piles occupy potential wetland that would otherwise be vegetated with saltgrass (either wet meadow or marsh). This habitat is particularly important for species such as least shrew, which is a state-endangered species (see Chapter 2). Instead, the solid waste debris piles provide habitat for other species, such as western diamondback rattlesnake which preys on species such as least shrew, thereby altering the balance among species in the wetland. Solid waste debris piles also have an aesthetic impact that is contrary to the concept of "restoration." Removing this material and allowing wetland vegetation to establish would restore these sites.

Five solid waste debris removal areas were defined by delineating major areas of waste concentration in the study area (Figure 10). Prior to removal, all debris would be classified. Solid waste debris piles would be removed using an excavator or front-end loader to pick up the material and place it in dumpsters, which would then be hauled to and emptied at the county landfill. Removal of solid waste debris is considered to be dependent upon first removing all of the salt cedar in the study area. This is considered necessary in order to reduce the seed source for potential colonization of disturbed-soil areas, as described above in the discussion of the salt cedar removal management measures. Removal of solid waste debris from area DB-1 is necessary to construct open water habitats WC-1 or WC-2 because these areas overlap spatially.

Scales of the solid waste debris removal management measures are defined as: E0, F0, G0, H0, and I0 = no solid waste debris removal; E1 = remove debris from area DB-1 (2,344 yd^3, 2.07 acres); F1 = remove debris from area DB-2 (3,344 yd^3, 2.67 acres); G1 = remove debris from area DB-3 (329 yd^3, 0.10 acres); H1 = remove debris from area DB-4 (1,710 yd^3, 0.30 acres); and I1 = remove debris from area DB-5 (187 yd^3, 0.03 acres). Solid waste debris removal areas are shown in Figure 10.

Figure 9. Piles of solid waste debris and cleared access paths in area DB-1.

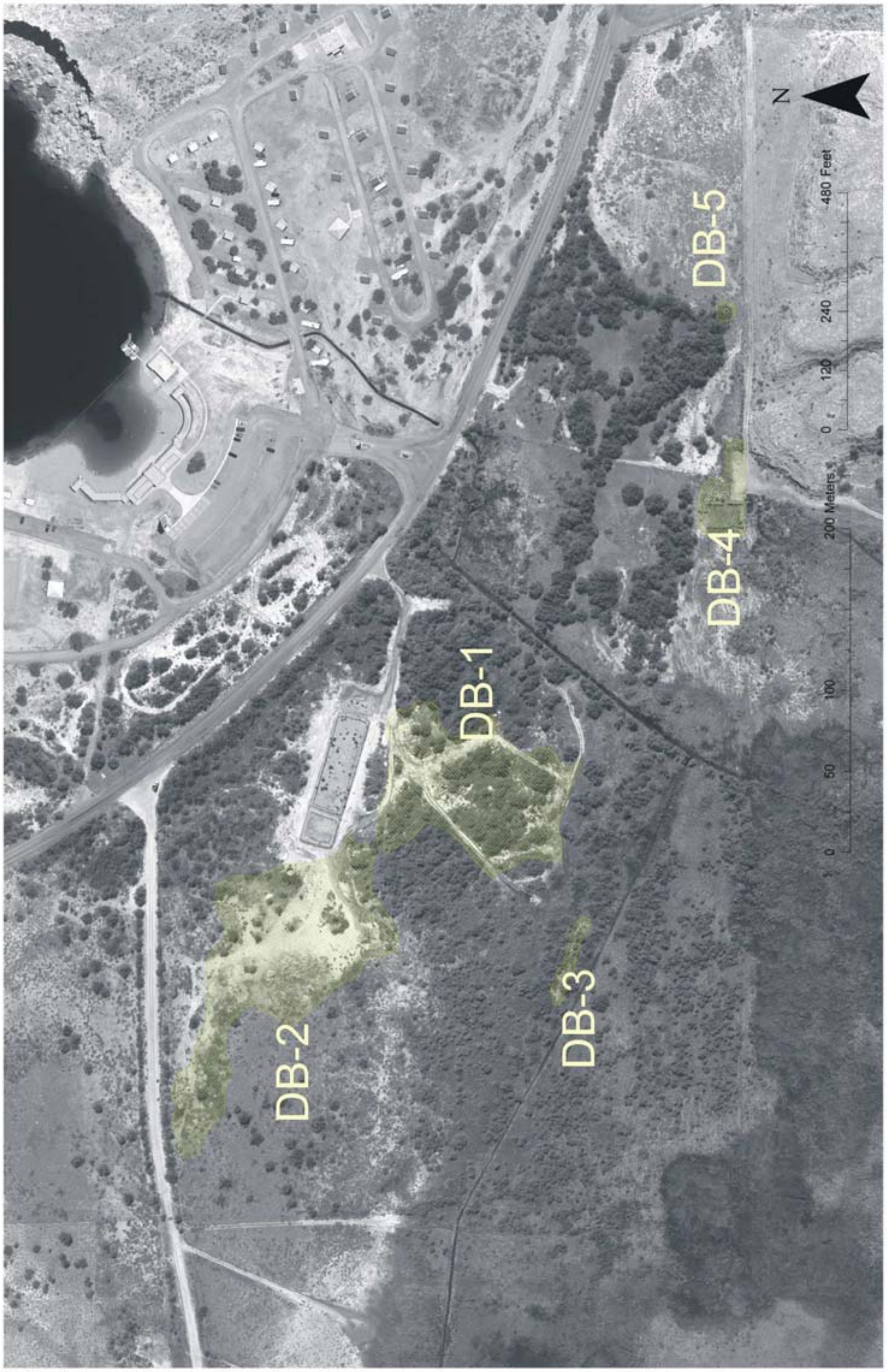


Figure 10. Treatment areas for the solid waste debris removal management measures. The treatment areas are indicated by the polygons labeled DB-1 through DB-5.

4.2.2.4 Diversify Hydrologic Regime - Management Measures J, K, and L

The purpose of these management measures is to restore diversity in hydrologic regimes in the study area wetland. The hydrologic gradient in Lea Lake Marsh and resulting hydrologic regimes in the wetland have been altered by ditching, which occurred some time prior to 1954 (see section2.3.1). Currently, water depths are quite shallow (typically less than 6 inches) and relatively homogeneous throughout the perennially inundated habitats in Lea Lake Marsh. The only exception to this pattern are the wetland channels, which occupy only a small percentage (0.6%) of the total marsh area.

Relatively deep open water areas are part of the reference conditions for restoration of Lea Lake Marsh (Appendix B1: 59) and are an important habitat component for many species in the study area. For example, open water areas with sufficient depth provide essential over-wintering habitat for Pecos pupfish and year-round habitat for Mexican tetra. Open water habitats with sufficient depth are a central habitat component for both muskrat and slider turtle, which are two of the three species used in the composite Habitat Suitability Index (HSI) model for the project (see section 4.3 below). Similarly, the ecotone between open water areas and emergent marsh vegetation is a primary component in the HSI model for Yellow-headed Blackbird, which is the third species used in the composite HSI model for the project (Technical Appendix B). The vegetated margins of open water habitats, characterized by a dominance of emergent herbaceous species, are important habitat for damselflies (suborder Zygoptera) and many species of dragonflies found in the study area, including the genera *Aeshna*, *Anax*, *Epitheca*, *Celithemis*, *Erythrodiplax*, and *Sympetrum* (Westfall, 1996). Saturated soils adjacent to open water areas are a primary habitat component for Pecos sunflower, a plant listed as threatened under the federal Endangered Species Act, which occurs at Lea Lake Marsh (Technical Appendix B).

Open water areas with a diversity of water depths would be increased in the study area by excavating shallow depressions at selected sites where there currently is no standing water. An excavator would be used to dig the shallow depressions to create open water habitats. Excavation spoil would be temporarily stockpiled on bare ground and then transported in dump trucks to an approved, non-wetland location within the park boundaries.

Excavation of open water areas was considered to be dependent first on modifying the outlet channel (management measure A) and secondly on removing all of the salt cedar in the study area. Modification of the outlet channel is necessary to ensure consistent delivery of water to the excavated areas, as described above in the discussion of management measure A. The salt cedar removal dependency relationship is based on two factors, as described above in the discussion of the salt cedar removal management measures. The first factor is the need to minimize salt cedar colonization of disturbed soil areas by reducing the seed source. The second factor is the requirement to maintain the existing water yield from the wetland. Removal of salt cedar from the study area would result in a reduction in evapotranspiration water loss, which would allow for restoration of up to 2.07 acres of open water habitat. Additionally, solid waste debris would have to be removed from area DB-1 before construction of either open water habitat WC-1 or WC-2 because this debris overlaps spatially with the location of these two open water habitat areas.

Figure 11. Diversifying hydrologic regime management measures. The open water habitats are indicated by the polygons labeled WC-1 through WC-3.

Open water habitats were configured to maximize the amount of "edge" habitat while providing a maximum depth of three to four feet, assuming that side slopes of the habitats would be no steeper than 2H:1V. Open water habitats were also sited relative to existing topography to ensure adequate gravity flow of water through the excavated areas to avoid impounding water and to prevent development of stagnant pools. Finally, the length of inlet and outlet channel connecting excavated areas to existing wetland channels was maximized because channel habitat was also of high "value" in the project area. Application of these conceptual design criteria resulted in identification of three open water habitat areas, ranging in size from 0.66 to 0.72 acres (Figure 11).

Scales of diversifying hydrologic regime are defined as: J0 = do not construct open water habitat WC-1; J1 = construct open water habitat WC-1 (0.69 acres; Figure 10); K0 = do not construct open water habitat WC-2; K1 = construct open water habitat WC-2 (total 0.72 acres); L0 = do not construct open water habitat WC-3; L1 = construct open water habitat WC-3 (total 0.66 acres).

4.2.2.5 Supplement Wetland Vegetation - Management Measures M through T

The purpose of these measures is to promote establishment of diverse, native wetland plant species in areas subject to soil disturbance. Planting of live material and sowing seeds of native wetland species adapted to saline marshes in the study area, such as chairmaker's bulrush, saltgrass, baccharis, and other species that are available either as live material or seed, would help to ensure that desired vegetation becomes established. Planting is important because initial species composition of saline marsh sites is a strong determinant of the final plant community (*e.g.* van der Valk 1981; Smith and Kadlec, 1985). Planting would significantly contribute to establishment of an abundant and diverse assemblage of wetland and aquatic vascular plants at disturbed sites in the study area. Increasing the diversity and abundance of wetland and aquatic vascular plants would have beneficial effects such as improving habitat for aquatic macroinvertebrates (*e.g.* Campeau *et al.*, 1994; Mittlebach, 1998). Only areas where the ground surface has been disturbed (*i.e.* open water habitats and debris removal areas) would be planted. Seeding rates and live material planting rates would be determined in the detailed restoration design plans according to the actual species used. The measures of supplementing wetland vegetation correspond to and depend upon solid waste debris removal and hydrologic regime diversification measures described above.

Scales of supplementing wetland vegetation are defined as: M0 = no supplemental wetland planting in debris removal area DB-1; M1 = supplemental wetland planting in debris removal area DB-1 (2.07 acres); N0 = no supplemental wetland planting in debris removal area DB-2; N1 = supplemental wetland planting in debris removal area DB-2 (2.68 acres); O0 = no supplemental wetland planting in debris removal area DB-3; O1 = supplemental wetland planting in debris removal area DB-3 (0.10 acres); P0 = no supplemental wetland planting in debris removal area DB-4; P1 = supplemental wetland planting in debris removal area DB-4 (0.29 acres); Q0 = no supplemental wetland planting in debris removal area DB-5; Q1 = supplemental wetland planting in debris removal area DB-5 (0.03 acres); R0 = no supplemental wetland planting of the margins of open water habitat area WC-1; R1 = supplemental wetland planting of the margins of open water habitat area WC-1 (0.69 acres); S0 = no supplemental wetland planting of the margins of open water habitat area WC-2; S1 = supplemental wetland planting of the margins of open water habitat area WC-2 (0.72 acres); T0 = no supplemental wetland planting of the margins of open water habitat area WC-3; T1 = supplemental wetland planting of the margins of open water habitat area WC-3 (0.66 acres).

4.2.2.6 Construct Interpretive Facilities - Management Measure U

The purpose of this measure is to provide interpretation of wetland and aquatic resources on Bottomless Lakes State Park and the Pecos River. Currently, there are no interpretive facilities in the study area and public use of the study area is low to nonexistent. Interpretive facilities could include walking trails, raised boardwalks, wildlife viewing blinds, and a parking area. No ecosystem restoration outputs are associated with this management measure.

Walking trails would consist of a six-foot wide compacted gravel surface on a six-inch deep bed of compacted soil. The gravel-surfaced parking area would be constructed similar to the walking trail. Raised boardwalk would be eight feet wide, constructed from 2-inch by 6-inch Trex (composite plastic) decking screwed to treated 2-inch by 10-inch wood joists spaced 16 inches on center. Individual Trex deck boards would be gapped one-half inch. Screws for attaching the Trex decking to joists would be three-inch number 7, stainless steel, ceramic-coated, or hot-dipped galvanized. Joists would rest on treated wood ledgers (comprised of two 2-inch by 10-inch boards) placed perpendicular across each pier set. A 42-inch high Trex "Traditional Railing" would be constructed along each side of the boardwalk per the Trex installation guide. All wood would be treated with an appropriate preservative (*e.g.* waterborne preservatives that will not leach or bleed). Hardware (nails, screws, and other fasteners) would be ceramic-coated, stainless steel, or hot-dipped galvanized. The walking trails and wildlife viewing blinds would be constructed on dry ground. The raised boardwalk trail would be constructed through wet areas, with water depths up to 10 inches. The gravel parking area would be constructed on dry ground.

Wildlife-viewing blinds would be 12 feet long by eight feet wide. The floor of the blinds would be constructed as described above for the raised boardwalk, except with no railing. Framing above the deck would be post-and-beam construction using 4-inch by 4-inch treated wood posts placed at 4-foot intervals with an 8-foot ceiling height. Horizontal 4-inch by 4-inch beams would be constructed at 4-foot and 8-foot levels to tie the vertical members together and serve as an anchor point for the wall sheathing. The roof and three walls of the viewing blind would be sheathed with latillas salvaged from salt cedar cut on site. The fourth wall would remain open. A bench constructed of 2-inch by 4-inch treated wood framing and surfaced with 2-inch by 6-inch Trex decking would be constructed along each of the two 8-foot sides of the blind.

Scales of this management measure are: U0 = no interpretive facilities constructed; U1 = construct a 2,800-ft long gravel-bed loop trail with four wildlife viewing blinds (IF-1; Figure 12); U2 = construct IF-1 plus a 450-feet long raised boardwalk trail with a wildlife viewing blind (IF-2); and U3 = construct trails IF-1 and IF-2, plus a 0.5-ac gravel-surfaced parking lot (IF-3) at the north side of the study area (Figure 12).

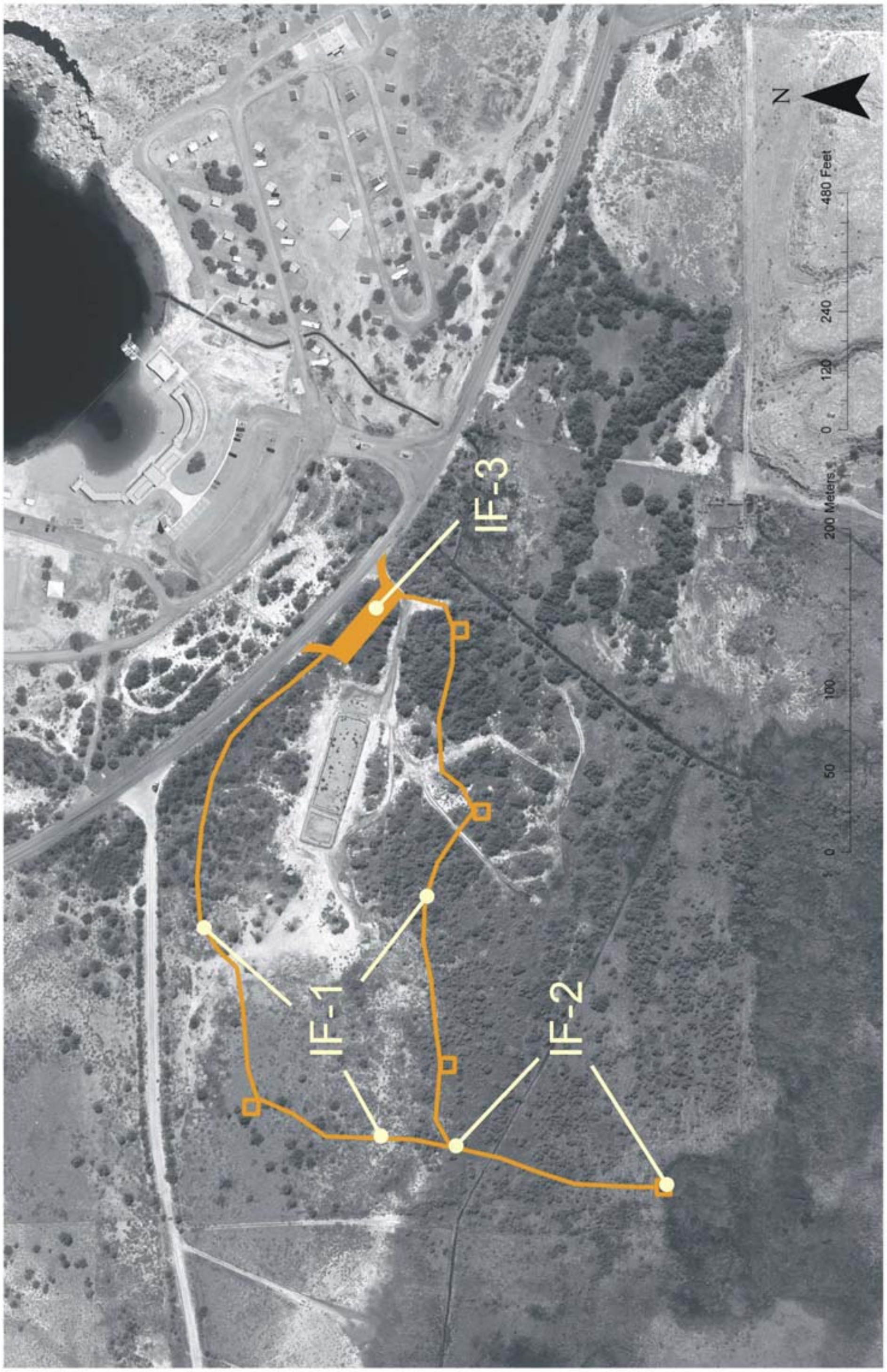


Figure 12. Construct interpretive facilities management measure. See text for explanation of components labeled IF-1 through IF-3.

4.2.3 Relationship Between Management Measures and Objectives

Management measures were developed to address specific objectives. Table 3 shows that all objectives are met wholly or in part by one or more of the broad management categories (*e.g.* remove salt cedar, remove debris).

The table also shows that all management measures contribute towards meeting one or more objectives. Construction of interpretive facilities is the only action that contributes to just one objective. All of the other management measures contribute to meeting at least three study objectives (Table 3).

Table 3. Relationship between management measures and the study objectives that they address. The relative contribution of each management measure toward meeting the corresponding study objective is indicated by percentages.

Management Measures / Objectives	Modify Outlet Channel (A)	Remove Salt Cedar (B, C, D)	Remove Solid Waste Debris (E, F, G, H, I)	Diversify Hydrologic Regime (J, K, L)	Supplement Wetland Vegetation (M through T)	Construct Interpretive Facilities (U)
Increase naturally-functioning wetland habitat at Lea Lake Marsh	10%	40%	30%	10%	10%	
Restore native wetland plant communities at Lea Lake Marsh		40%	30%		30%	
Reclaim habitat for special status species	5%	20%	20%	35%	20%	
Improve habitat diversity for dragonflies and damselflies	10%	10%		50%	30%	
Provide consistent water delivery to Lea Lake Marsh	100%					
Reduce potential for flood damage to historic structures and facilities at	100%					
Create opportunities for environmental education						100%

4.3 Incremental Cost Analysis and Plan Selection

A cost-effectiveness analysis and an incremental cost analysis (ICA) of possible environmental restoration alternatives for the Bottomless Lakes State Park aquatic habitat restoration study were conducted as part of the study for the purpose of selecting the preferred plan. The cost-effectiveness analysis identified the least-cost solution for each level of environmental output. The ICA showed the incremental changes in costs for increasing levels of environmental outputs. These analyses were conducted using the USACE software program IWR-PLAN. Detailed methodology, assumptions, and results of the IWR-PLAN analysis are contained in Technical Appendix E.

4.3.1 Incremental Cost Analysis

Management measures developed to restore aquatic and wetland habitat in the study area consist of channel modification, salt cedar removal, solid waste debris removal, open water habitat construction, and planting open water habitat margins at geographically-specific portions of the study area. These measures are summarized in Table 4. Management measures were combined in alternative plans and the plans were evaluated based on their environmental output, expressed as a habitat unit score, relative to their cost.

HSI values for both existing and restored vegetation community types in the study area were computed and multiplied by the acreage of that community type to obtain a habitat unit score. The net increase in habitat units over the existing condition for each management measure served as the environmental output in the cost effectiveness and incremental cost analyses (Technical Appendix B). However, it should be noted that the HSI values are only an index of the environmental benefits associated with alternative plans. Ecological systems are extremely complex and accurate, unbiased measurement of all of the benefits of a particular action is impossible. Therefore, it should be recognized that the HSI values are a gross simplification of a complex, variable ecological system and do not represent an absolute measure of benefits. The HSI values do provide an objective means of comparing the relative effect of alternative plans, but they do not accurately measure the real benefits that would accrue with individual management measures such as solid waste debris removal or supplemental planting. For the purpose of this analysis, the existing condition was assumed to represent the future-without-project condition. Costs associated with each management measure were developed using the micro-computer aided cost estimating software (MCACES; Technical Appendix G). These costs include operation and maintenance, all of which are paid by the sponsor.

The plans reflect certain dependencies, meaning that some management measures cannot be implemented unless other measures are implemented first. Table 5 indicates the dependencies that were established for the cost effectiveness and incremental cost analyses.

The cost effectiveness analysis identified 85 cost-effective plans (Figure 13; Technical Appendix E). These plans represent the least-cost way to achieve various levels of relative environmental output. Moving from lower to higher costs, the cost-effective plans consist of increasing amounts of salt cedar removal. The next set of cost-effective plans involve the maximum amount of salt cedar removal with increasing amounts of solid waste debris removal and supplemental planting of solid waste debris removal areas. The next set of cost-effective plans combine the maximum amount of salt cedar removal with varying levels of solid waste debris removal, creation of open water habitats, and supplemental planting. The plans containing creation of open water habitats are dependent upon modification of the outlet channel, as described in section 4.2.2.4.

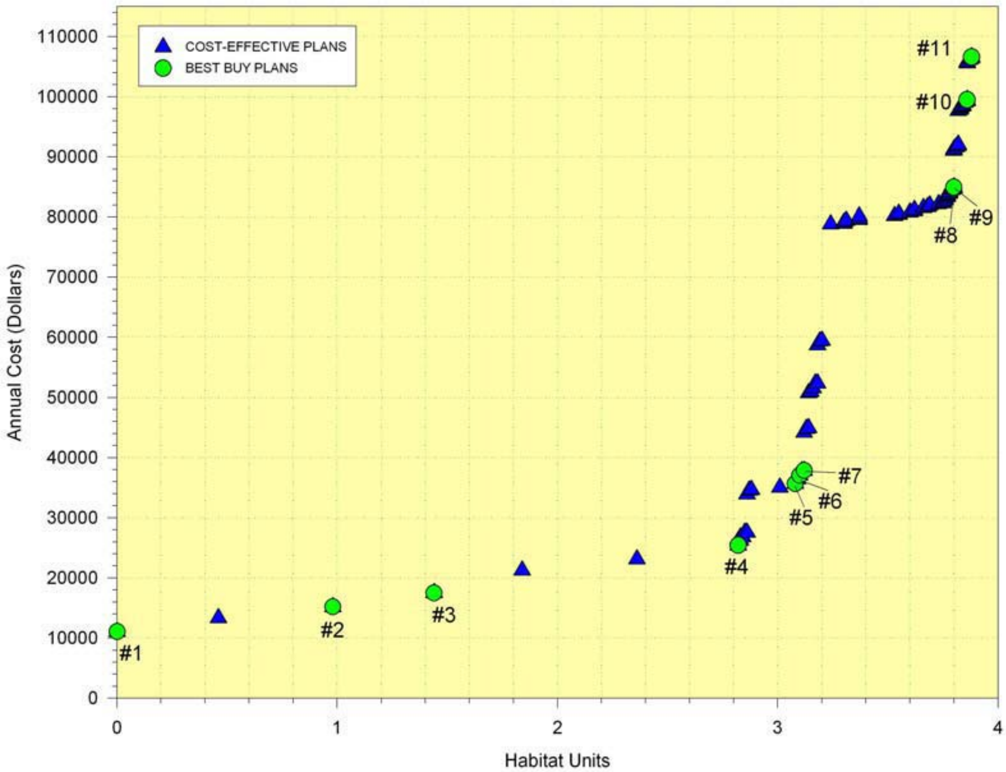
Table 4. Management measures, costs, and associated increases in habitat units for the Bottomless Lakes State Park aquatic habitat restoration feasibility study.

Management Measure Code	Management Measure Description	Average Annual Cost (Dollars)	Increase in Average Annual Habitat Units	Total HUs in Place After 5 Years
A	Channel modification	$53,546	0.000	0.00
B	Remove salt cedar from area SC-1	$7,929	1.377	3.65
C	Remove salt cedar from area SC-2	$4,134	0.981	3.21
D	Remove salt cedar from area SC-3	$2,298	0.459	2.63
E	Remove solid waste debris from area DB-1	$9,618	0.190	5.40
F	Remove solid waste debris from area DB-2	$13,722	0.040	5.25
G	Remove solid waste debris from area DB-3	$1,349	0.017	5.22
H	Remove solid waste debris from area DB-4	$7,015	0.010	5.22
I	Remove solid waste debris from area DB-5	$768	0.005	5.22
J	Construct open water habitat WC-1	$1,344	0.130	5.47
K	Construct open water habitat WC-2	$1,396	0.290	5.50
L	Construct open water habitat WC-3	$1,279	0.230	5.44
M	Plant debris removal area DB-1	$632	0.068	5.46
N	Plant debris removal area DB-2	$818	0.020	5.27
O	Plant debris removal area DB-3	$31	0.010	5.23
P	Plant debris removal area DB-4	$91	0.010	5.22
Q	Plant debris removal area DB-5	$9	0.010	5.22
R	Plant margin of open water habitat WC-1	$211	0.010	5.48
S	Plant margin of open water habitat WC-2	$219	0.001	5.50
T	Plant margin of open water habitat WC-3	$203	0.020	5.46

Table 5. Management measure dependencies and combinability.

Management Measure		Is Dependent On ...	But Is Not Combinable With ...
A	Channel modification	---	---
B	Remove salt cedar from area SC-1	---	---
C	Remove salt cedar from area SC-2	---	---
D	Remove salt cedar from area SC-3	---	---
E	Remove solid waste debris from area DB-1	B, C, D	---
F	Remove solid waste debris from area DB-2	B, C, D	---
G	Remove solid waste debris from area DB-3	B, C, D	---
H	Remove solid waste debris from area DB-4	B, C, D	---
I	Remove solid waste debris from area DB-5	B, C, D	---
J	Construct open water habitat WC-1	A, B, C, D, E	---
K	Construct open water habitat WC-2	A, B, C, D, E	---
L	Construct open water habitat WC-3	A, B, C, D	---
M	Plant debris removal area DB-1	E	---
N	Plant debris removal area DB-2	F	---
O	Plant debris removal area DB-3	G	---
P	Plant debris removal area DB-4	H	---
Q	Plant debris removal area DB-5	I	---
R	Plant margin of open water habitat WC-1	J	---
S	Plant margin of open water habitat WC-2	K	---
T	Plant margin of open water habitat WC-3	L	---

Figure 13. Cost effective and best buy plans for restoration of Lea Lake Marsh.



Best Buy Plans definitions are:

#1 (A0B0C0D0E0F0G0H0I0J0K0L0M0N0O0P0Q0R0S0T0), no action;

#2 (A0B0C1D0E0F0G0H0I0J0K0L0M0N0O0P0Q0R0S0T0), salt cedar removal from SC-2;

#3 (A0B0C1D1E0F0G0H0I0J0K0L0M0N0O0P0Q0R0S0T0), salt cedar removal from SC-2 and SC-3;

#4 (A0B1C1D1E0F0G0H0I0J0K0L0M0N0O0P0Q0R0S0T0), salt cedar removal from SC-1, SC-2, and SC-3;

#5 (A0B1C1D1E1F0G0H0I0J0K0L0M1N0O0P0Q0R0S0T0), salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, plant area DB-1;

#6 (A0B1C1D1E1F0G1H0I0J0K0L0M1N0O0P0Q0R0S0T0), salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1 and DB-3, plant areas DB-1 and DB-3;

#7 (A0B1C1D1E1F0G1H0I1J0K0L0M1N0O0P0Q1R0S0T0), salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, DB-3, and DB-5, plant areas DB-1, DB-3, and DB-5;

#8 (A1B1C1D1E1F0G1H0I1J1K1L1M1N0O1P0Q1R1S0T1), modify outlet channel, salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, DB-3, and DB-5, construct open water habitats WC-1, WC-2, and WC-3, plant areas DB-3, DB-5, WC-1, and WC-3;

#9 (A1B1C1D1E1F0G1H0I1J1K1L1M1N0O1P0Q1R1S1T1), modify outlet channel, salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, DB-3, and DB-5, construct open water habitats WC-1, WC-2, and WC-3, plant areas DB-1, DB-3, DB-5, WC-1, WC-2, and WC-3;

#10 (A1B1C1D1E1F1G1H0I1J1K1L1M1N1O1P0Q1R1S1T1), modify outlet channel, salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, DB-2, DB-3, and DB-5, construct open water habitats WC-1, WC-2, and WC-3, plant areas DB-1, DB-2, DB-3, DB-5, WC-1, WC-2, and WC-3;

#11 (A1B1C1D1E1F1G1H1I1J1K1L1M1N1O1P1Q1R1S1T1), modify outlet channel, salt cedar removal from SC-1, SC-2, and SC-3, solid waste debris removal from DB-1, DB-2, DB-3, DB-4, and DB-5, construct open water habitats WC-1, WC-2, and WC-3, plant areas DB-1, DB-2, DB-3, DB-4, DB-5, WC-1, WC-2, and WC-3.

The incremental cost analysis identified 11 "best-buy" plans from among the 85 cost-effective plans (Figure 13). These plans are the most efficient in generating environmental outputs; they have the lowest incremental costs per unit of environmental output. The initial best-buy plan is the "no action" alternative. This plan does not contribute to meeting any of the project's ecosystem restoration objectives (Table 6).

Best-buy plans #2 through #4 include salt cedar removal from one or more of the three treatment areas identified for this management measure. Approximately 73 percent of the incremental increase in habitat units in the HSI analysis can be realized by salt cedar removal alone. However, salt cedar removal alone contributes to, but does not fully meet, any of the project's ecosystem restoration objectives and two of the objectives are not addressed at all by these plans (Table 6).

Best buy plans #5 through #7 include removal of solid waste debris from treatment areas DB-1, DB-3 and DB-5 and supplemental planting of the removal areas, in addition to salt cedar removal from the entire study area. These combinations achieve a modest incremental increase in habitat units. As with salt cedar removal, these plans do not contribute to two of the project's ecosystem restoration objectives and only partially contribute to meeting the remaining ones (Table 6).

Best buy plan #8 introduces the construction of open water habitats, with the required modification of the outlet channel, and supplemental planting of disturbed ground in treatment areas DB-1, DB-3, DB-5, WC-1 and WC-3. While the incremental cost in dollars is high because of the cost of outlet channel modification, this alternative achieves a relatively large incremental increase in habitat units. This is the first best buy plan that addresses, at least in part, all of the project's ecosystem restoration objectives (Table 6).

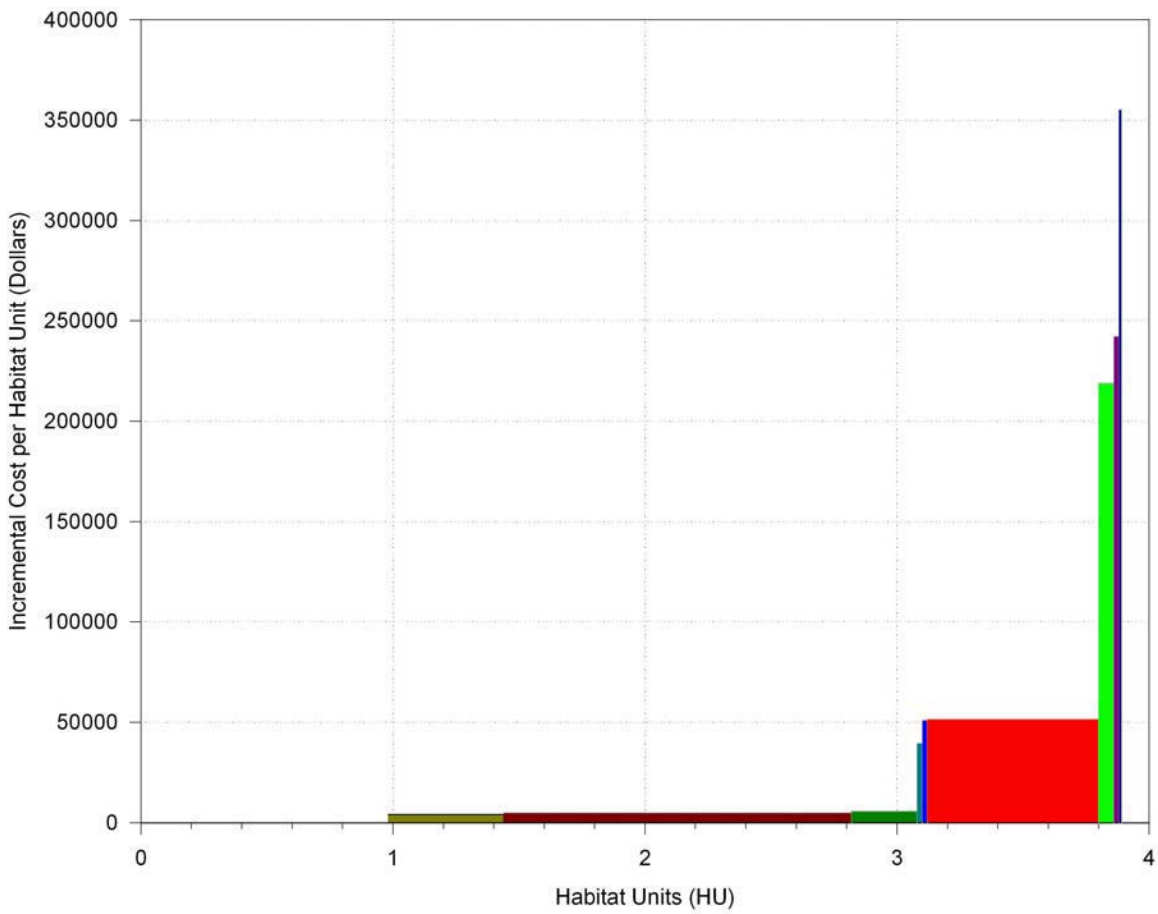
Best buy plan #9 adds supplemental planting of open water habitat area WC-2, which contributes a very small incremental increase in habitat units to the project but increases the contribution to meeting objectives (Table 6). The total incremental cost of this management measure is low, but the incremental cost per unit of environmental output is very high. Best Buy plans #10 and #11 add the removal of solid waste debris from areas DB-2 and DB-4 and supplemental planting of these areas. These management measures have a high cost per unit and increase the contributions to meeting ecosystem restoration objectives, to the point that best-buy plan #11 fully meets all of the project's ecosystem restoration objectives (Table 6).

Figure 14 shows the incremental cost per habitat unit for the best buy plans. The annual cost of the no-action alternative is $11,076, which is the cost of maintaining the existing outlet channel. The incremental cost per habitat unit for the second best buy plan is $4,134. This figure jumps to $40,000 when the first level of solid waste debris removal is introduced and to $69,000 when modification of the outlet channel and construction of open water habitats are included. The final three plans have incremental cost per habitat unit of over $200,000 because of the relatively low incremental increase in habitat units resulting from removing solid waste debris from areas DB-4 and DB-5 and planting those areas.

Table 6. Relative contributions of best-buy plans to meeting ecosystem restoration objectives. Relatively contributions were estimated based on area of effect and overall contribution of each category of management measure to meeting project objectives, as shown in Table 3.

Project Objective	Best-Buy Plan										
	1	2	3	4	5	6	7	8	9	10	11
Increase naturally-functioning wetland habitat at Lea Lake Marsh	0%	10%	20%	40%	48%	61%	62%	84%	92%	99%	100%
Restore native wetland plant communities at Lea Lake Marsh	0%	10%	20%	40%	52%	67%	70%	76%	88%	97%	100%
Reclaim habitat for special status species	0%	5%	10%	20%	28%	38%	40%	85%	93%	99%	100%
Improve habitat diversity for dragonflies and damselflies	0%	3%	5%	10%	16%	19%	22%	90%	96%	99%	100%
Provide consistent water delivery to Lea Lake Marsh	0%	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%
Reduce potential for flood damage to historic structures and facilities	0%	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%

Figure 14. Incremental cost analysis results for the best buy plans for restoration of Lea Lake Marsh.



4.3.2 Plan Selection

Plan selection was based on evaluation of the following criteria:

1) plan contributions to planning objectives;
2) functioning of plan within planning constraints;
3) significance of outputs;
4) cost effectiveness and incremental cost analysis; and
5) acceptability, completeness, effectiveness, and efficiency of the plan.

Application of these criteria resulted in selection of best-buy plan #11 (which includes the following management measures: A1B1C1D1E1F1G1H1I1J1K1L1M1N1O1P1Q1R1S1T1U3). This plan includes modification of the outlet channel, removal of salt cedar from the entire study area, remove of all solid waste debris piles from the study area, creation of three open water habitats, planting native wetland species in solid waste debris removal areas and the margins of open water habitats, and development of interpretive facilities including a walking trail and boardwalk, wildlife viewing blinds, and a parking area.

Best-buy plan #11, or the "full-implementation plan," is the locally-preferred plan which fully meets all of the planning objectives (Table 6) and functions within the planning constraints. Implementation of the plan would result in significant ecosystem outputs including substantial contributions to conservation of federal- and state-listed species, improving habitat for a nationally significant area of high dragonfly and damselfly species richness, and restoring habitat for migratory birds along an important migration route (Technical Appendix B). The full-implementation plan would contribute significantly to restoration and conservation of one of the few large *cienega* (*i.e.* spring-fed desert marsh) systems left in the lower Pecos River drainage of New Mexico and Texas.

Outputs of some of the management measures, particularly removal of solid waste debris and supplementing wetland vegetation, were not well represented in the composite HSI model used in the ICA. Consequently, these measures show little environmental benefit for their associated costs. However, they do make significant contributions to the planning objectives. For example, solid waste debris piles are almost entirely situated in locations that would naturally have saltgrass wet meadow vegetation, which is a key habitat component for the state-listed least shrew. Removal of the solid waste debris piles would increase the amount of suitable habitat for least shrew in the study area by about 47% (an increase of 5.17 acres). Also, removal of solid waste debris piles would augment habitat for establishment of new aggregations of the federal-threatened Pecos sunflower in the study area.

Similarly, the effect of supplementing wetland vegetation by planting disturbed solid waste debris removal areas and the margins of open water habitats was difficult to capture in the HSI model. Available HSI models applicable to the study area were limited and the best three were selected and used in the ICA. However, separating the habitat unit effects of the ground disturbing activities from subsequent planting or lack of planting was complicated and speculative. In practice, planting of wetland species can have a major influence on the composition and structure of the vegetation in restored areas due primarily to the effect of preemption (J. Pittenger, pers. obs.; Grubb, 1977; van der Valk, 1981; Grace, 1987). This is especially true in cases where aggressive, invasive species such as salt cedar are an issue. Consequently, the composite HSI model underestimated the real benefits of supplementing wetland vegetation following ground disturbing activities. The study team concluded that the costs associated with the planting measures were commensurate with the ecological benefits that would occur, despite the under-representation of those benefits in the composite HSI model. Planting of disturbed ground was considered to be an integral component of restoring natural vegetation structure, plant species composition, and ecological function to the wetland.

Alternatives developed in planning ecosystem restoration projects must meet minimum standards of acceptability, completeness, efficiency, and effectiveness to qualify for further analysis (U.S. Army Corps of Engineers, 2000: E-162). The full-implementation plan meets standards of these four evaluation criteria. The plan is fully supported by State Parks, the non-federal cost-share sponsor. Public participation activities conducted during the planning process indicate that the full-implementation plan is also acceptable to federal, state, tribal, local entities, and the public. It is compatible with existing laws, regulations, and policies. The full-implementation plan is complete in that it does not depend on implementation of actions outside the plan. All relevant factors including real estate, operations and maintenance, monitoring, and sponsorship have been considered. Adaptive management has been planned to address uncertainties in wetland restoration measures such as vegetation development and channel function. Outputs from the full-implementation plan could not be produced more cost-effectively by another agency or institution.

The full-implementation plan is a cost-effective solution to the stated problems, opportunities and objectives and it would function within the planning constraints. No other plan produces the same level of output more cost effectively. Plans that could produce similar ecosystem benefits would be extremely costly and would not function within planning constraints. For example, the sewage treatment facility in the study area could potentially be relocated to another site outside of the area, and the vacated site could be restored. However, this would involve relocation of existing recreational facilities, construction of a new sewage treatment facility, and excavation and reconstruction of new underground utilities. This was not considered to be a feasible alternative by the local sponsor. Another alternative that could potentially provide similar ecosystem benefits to the full-implementation plan would be construction of a berm along the study-area boundary to impound water and increase the diversity of hydrologic regimes. This alternative would not function within planning constraints to maintain water yield and flow patterns from Lea Lake Marsh to adjacent wetlands. Additionally, such a scheme would likely have serious ramifications regarding water rights and interstate compact issues. Similarly, other management measures that would achieve equivalent ecosystem benefits are not feasible in the study area. Aerial spraying of herbicide to remove salt cedar was not considered to be appropriate in a state park due to the level of human activity adjacent to the study area and the desire to minimize herbicide use and its introduction into aquatic and wetland habitats. Open water habitats could potentially be created using explosives, but this method was considered infeasible because of adjacent recreational use and potential adverse impacts to special-status species such as least shrew and Pecos pupfish.

The full-implementation plan would result in significant improvement through restoration of ecological structure and function at Lea Lake Marsh. Non-native, invasive salt cedar would be removed, solid waste debris would be removed, hydrologic diversity would be restored, and native emergent marsh vegetation would be re-established at the site. The plan would benefit the federal-threatened Pecos sunflower and state-listed species including Pecos pupfish, Mexican tetra, arid land ribbon snake, and least shrew. It would improve habitat for invertebrate species. Water quality and water yield from the marsh would be maintained. The plan would provide benefits to the larger marsh ecosystem situated between Lea Lake and the Pecos River. In conclusion, the full-implementation plan is the plan recommended for detailed analysis of potential project effects. Potential effects of implementing this plan are described in Chapter 6.

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5.0 RECOMMENDED PLAN

5.1 Description of Recommended Plan

The recommended plan would include restoration of approximately 43 acres of wetland habitat by implementing the following elements:

- increasing the Lea Lake outlet channel capacity from 15 cfs to 25 cfs;
- removing all salt cedar from the approximately 43-acre study area;
- removing all solid waste debris from the study area;
- constructing three open water habitats totaling approximately 2.07 acres;
- planting supplemental wetland vegetation in solid waste debris removal areas and around the margins of open water habitats (approximately 7.32 acres); and
- constructing a 0.5-gravel parking lot, a 3,768 gravel loop trail, a 517-ft raised boardwalk trail, and four wildlife viewing blinds.
- constructing a 0.5-acre gravel parking lot, a 3,786-ft gravel loop trail, a 517-ft raised boardwalk trail, and four wildlife viewing blinds.

A draft design for the outlet channel modification, described in detail in Technical Appendix F, is summarized here.

- The outlet-control weir from Lea Lake would be moved 32 feet upstream from its current location, placed at an elevation of 3,457.8 feet, and widened to 6 feet.

- Modification of the outlet channel would be conducted in dry conditions. This would be accomplished by dewatering the outlet channel and diverting outflow from Lea Lake around the work area and into Lea Lake Marsh.

- The channel bed would be re-graded to a uniform slope from the outlet-control structure to match with the existing channel bed approximately 300 feet downstream from the NM 409 crossing. This would eliminate a hump in the existing bed profile below the road crossing and would result in a maximum bed cut upstream of NM 409 of approximately 0.5 feet.

- The new channel would be trapezoidal with a bottom width of 6 feet, 1.5H:1V side slopes and a top width of about 15 feet.

- Two 24-inch corrugated metal pipe culverts at NM 409 would be replaced with two 3-ft wide by 2-ft high concrete box culverts.

- Two 24-inch corrugated metal pipe culverts at the campground access road crossing would be replaced with a single 6-ft wide by 3-ft high concrete box culvert.

- Similar to the existing channel, the new channel would be lined with articulated concrete blocks and river cobbles for its entire approximately 280-foot length between the lake outlet and the campground access road as well as in the vicinity of each culvert.

- The walking bridge near the campground would be replaced with a structure that would span the wider channel.

Construction of the open water habitats in the recommended plan would not involve construction of a structure that would impound water. The recommended plan does not require a change in the place or purpose of use of water in the study area, nor does it require any new point of diversion or change in an existing point of diversion. No fill material would be placed below the ordinary high water mark or in wetlands.

Salt cedar would be removed mechanically using a 23-ton excavator fitted with a special bucket used for extracting whole salt cedar plants, including roots (*e.g.* Bureau of Land Management, 2002). Salt cedar trees would be hauled out of the marsh and chipped. In areas that are too wet for the excavator to operate, salt cedar would be cut with a chainsaw and the stumps would be treated immediately by brushing the cut surface thoroughly with a full strength solution of isopropylamine salt of Imazapyr (Habitat®) mixed with water-soluble RIT® fabric dye to track treated stems. Habitat® is registered for use in aquatic habitats. Cut-stump treatments would preferably be conducted late in the growing season to improve translocation of the herbicide from the cut stump surface to the plant roots.

Solid waste debris piles would be removed using an excavator to pick up the solid waste debris and place it in dumpsters, which would then be hauled to the county landfill where the solid waste debris would be dumped.. Salvageable material would be removed first and stored at the park equipment yard. About 8,000 yd^3 of solid waste debris would be removed. An excavator would also be used to dig shallow depressions for construction of the open water habitats. Excavation spoil (approximately 12,300 yd^3) would be temporarily stockpiled on bare ground in the study area before being transported in dump trucks to an upland site within the park boundaries that is devoid of any significant cultural or ecological resources. Supplementing wetland vegetation would be conducted by planting live material and sowing seeds of native wetland species adapted to saline marshes in the study area.

Construction of the various plan elements is expected to last about eight months. Timing of construction is critical to allow channel work to be conducted during low-flow periods (*i.e.* summer and fall) and yet also avoid migratory bird breeding and nesting seasons (*i.e.* spring to mid-summer). The Park's fenced and paved maintenance lot would be used for the construction staging area. Details of the construction schedule would be clarified prior to issuing a contract.

Construction of the various elements associated with the recommended plan would require a Clean Water Act Section 404 permit from the USACE Regulatory Branch. Additionally, the project would require National Pollutant Discharge Elimination System (NPDES) permitting under Section 402 of the Clean Water Act. Estimated area of ground disturbance for the recommended plan is approximately 5.17 acres. The recommended plan would be covered under the NPDES General Permit for Discharges from Large and Small Construction Activities (permit number NMR150000).

5.2 Best Management Practices

The following measures would be undertaken with implementation of the recommended plan to reduce effects on ecological, cultural, and social resources.

5.2.1 Water Quality and Wetlands

- Feeder channels connecting the excavated open water habitats to the wetland channels would be dug from the cells outward to the channels. The feeder channel connections to the wetland channels would not be breached until sediments have settled in the excavated areas. This would prevent flushing of turbid water into downstream or down-gradient areas.

- All equipment would be inspected at least twice a day to ensure that oils, fuels, or lubricants are not leaking. All servicing and fueling of equipment would be conducted in a designated area hydrologically isolated from surface waters. Additionally, emergency spill kits would be placed in the designated fueling area to absorb and contain any accidental spills of fuels, lubricants, or other chemical contaminants.

- All herbicides would be applied according to manufacturer's specifications and label instructions. Cut-stump herbicide treatment for removing salt cedar would only be conducted in areas with deeper standing water where the whole-tree extractor cannot be used. Only the herbicide Habitat® would be used. Habitat® would be mixed with water-soluble RIT® fabric dye to allow visual tracking of application. The herbicide would be applied to stumps immediately after cutting using a paint brush or similar method by an experienced, licensed pesticide applicator.

- The Corps, or their representatives, would monitor and inspect any contractor's compliance with project specifications regarding the conditions set forth under the water quality certification (under Section 401 of the Clean Water Act, see Section 6.3.1) and any best management practices employed to conform to those permit conditions. The NPDES permit and Storm Water Pollution Prevention Plan (SWPPP) would also be adhered to during construction.

5.2.2 Air Quality

Construction-related effects to air quality would be minimized by: 1) requiring the contractor to have emission control devices on all equipment; and 2) employing the use of Best Management Practices to control wind erosion, including wetting of soils within the construction zone and compliance with local soil sedimentation and erosion-control regulations. Construction and operation of the recommended plan would conform with air quality control regulations as established by the Clean Air Act and the New Mexico Air Quality Control Act.

5.2.3 Fauna

- Salt cedar removal would be conducted outside (*i.e.* September through March) of the bird breeding season to avoid destruction of active nests and mortality of young birds.

5.2.4 Endangered and Protected Species

- Endangered Species Act section 7 consultation would be initiated with the U.S. Fish and Wildlife Service regarding potential impacts of the proposed action on the federal threatened Pecos sunflower.

- The boundaries of all aggregations of Pecos sunflower in the study area would be marked with a continuous band of brightly-colored tape flagging attached to wooden lathe stakes. A biologist would be present on site during project implementation to ensure that no Pecos sunflower are disturbed.

- Operation of the tree extractor would be restricted as much as possible to salt cedar stands and moved as little as possible to minimize the chance of crushing an occupied communal nest of least shrew.

- A qualified biologist would be periodically present on site during project implementation to monitor work, inspect work areas before construction activity begins, and provide guidance on areas to avoid to prevent or minimize impacts to Pecos sunflower and least shrew.

5.2.5 Cultural Resources

- If any previously-unrecorded cultural resources are encountered during construction, work at that location would stop and the USACE and State Parks archaeologists would be contacted.

5.2.6 Noise

- Construction contracts would require that construction equipment and activities comply with state and local noise control ordinances to minimize noise increases.

5.2.7 HTRW

- A visual HTRW survey would be repeated in the project area within 60 days prior to any construction being undertaken to verify if conditions described in the 2003 survey are still the same.

5.2.8 Public Safety

- The boundary of the project area adjacent to NM 409 and the BLM access road would be flagged or delineated with temporary construction fencing to prevent public access during implementation of the project.

5.3 Operation and Maintenance Considerations

For purposes of analyzing costs of operation and maintenance, a 20-year "project life" was used. During the 20 years after project construction is completed, several features of the project would require operation, maintenance, repair, replacement, and/or rehabilitation (OMRR&R) with associated costs for labor and materials. Major items that would require consideration of OMRR&R are clearing vegetation from the channel, suppressing salt cedar reestablishment, and maintaining recreation facilities.

Growth of aquatic vegetation would continue to be a problem in the widened channel and in the new "feeder channels" that would provide water to new open water habitats. Currently, vegetation is manually removed (*i.e.* pulled by hand or extracted with shovels and rakes) from the outlet channel approximately eight times per year. To reduce hand-pulling, equipment such as a small backhoe or excavator may be used upstream from NM 409, although special care would be necessary to avoid damaging the channel lining. Downstream from NM 409, such mechanical equipment would not be feasible in order to avoid impacting the restored wetland. A possible option may be a battery-powered aquatic weed cutter, typically about the size of a large rake, which cuts vegetation near its base. Manual labor would still be required to remove cut vegetation from the channel. Cost for channel maintenance would be approximately $22,400 annually.

Follow-up maintenance of salt cedar treatment areas would involve annual hand-pulling of sprouts and continued removal of larger trees not killed by the first treatment. Removal of larger trees would be conducted by chainsaw and treating the cut stumps immediately with an herbicide, as described in section 5.1. Estimated maximum cost of salt cedar maintenance is $20,000/year. However, this cost is expected to decrease substantially after the third year following completion of the project, with the assumption that salt cedar would have largely been controlled in the marsh by that time. If an accidental spill occurs in the wetland that may impact public land, the Corps will notify the Authorized Officer of the BLM Roswell Field Office immediately.

Wildlife viewing blinds, trails, and the trail-head parking lot would need to be routinely maintained throughout the 20-year project life. Painting and staining, replacement of worn-out or damaged facilities, and grading and replacement of gravel in the parking area are some of the maintenance considerations for these facilities.

The USACE would prepare an Operations and Maintenance manual for the project upon completion of construction. This manual would provide a summary of all OMRR&R needs for 20 years. It is anticipated that State Parks would be responsible for undertaking labor and associated costs for all maintenance during this period.

5.4 Project Implementation Procedures and Schedule

From release of the draft DPR/EA for public review and comment, several actions remain for completion of the DPR/EA and implementation of the proposed project. Pertinent comments on the draft DPR/EA would be incorporated into the final DPR/EA. After review and approval of the DPR/EA by the South Pacific Division of the USACE, a project cooperation agreement would be signed between the federal government and the local sponsor. The USACE Albuquerque District would issue a contract for final project design and construction specifications.

When the construction plans and specifications are approved by USACE, the plans and specifications would be released to construction contractors for bidding purposes, bids would be received and reviewed, and a construction contractor would be selected. A contract for construction would be issued and construction would be undertaken. It is anticipated that the activities described to implement the project would follow the approximate schedule shown below.

July 2006	Public Review
November 2006	Final DPR/EA Approved
December 2006	Final Plans & Specifications
Winter 2007	Begin Construction
Fall 2008	End Construction

Construction components would be scheduled to optimize effectiveness of herbicide cut-stump treatments and minimize impacts to nesting birds.

5.5 Monitoring and Adaptive Management

If the recommended plan is implemented by the sponsor, an adaptive management plan would be developed and implemented for five years to ensure that the desired restoration objectives are achieved. Adaptive management is a continual learning process involving planning, implementation, monitoring, and evaluation to achieve desired results (Holling, 1978; Walters, 1986). Adaptive management for this restoration project would involve monitoring of key indicators, evaluating the response of the indicators with respect to restoration actions, and then planning and implementing additional actions based on the knowledge gained from monitoring to achieve the restoration objectives. Key indicators that could be monitored in the study area following implementation of the proposed plan may include density and distribution of salt cedar, vegetation composition in the wetland (particularly the margins of open water habitats), fish fauna, odonate diversity, and abundance and distribution of Pecos sunflower and other special-status species.

The newly-enlarged outlet channel would also be monitored to ensure its proper function. This would primarily involve monitoring of the discharge capacity and condition of the channel.

Channel capacity would be monitored by measuring the discharge on a regular basis and observing the water-surface elevations in the lake and key areas along the outlet channel. It is also recommended that four to six cross sections be established and permanently monumented in the reach downstream from NM 409. These cross sections should be periodically re-surveyed to monitor changes in the channel geometry, which could indicate potential changes in both channel capacity and stability.

5.6 Real Estate Requirements

All land required for implementation of the proposed plan is currently owned by the State of New Mexico and managed by State Parks Division of the Energy, Minerals and Natural Resources Department as part of Bottomless Lakes State Park. No additional lands, easements, or rights of way would need to be acquired for restoration of aquatic habitat with any of the project alternatives. No lands outside the state park would be required for borrow material or disposal of excavated material. No residential or commercial relocations would be required as none exist in the project area.

5.7 Project Costs

Cost of implementing the recommended plan, including interpretive facilities, planning, design, construction, and land costs, is estimated at $2,190,700. This includes costs for:

Lands and Damages	$ 36,000
Planning, Engineering, and Design	$ 540,000
Ecosystem Restoration Construction	$1,199,900
Interpretive Facilities Construction	$ 315,100
Construction Management	$ 99,700
Total	$2,190,700

Construction costs were developed using the USACE cost-estimating program MCACES (microcomputer - aided cost estimating system). The detailed MCACES report, including estimate assumptions, is provided in Technical Appendix G.

5.8 Cost Sharing Requirements

The proposed aquatic habitat restoration would be conducted under Section 206 of the Water Resources Development Act of 1996. This section of the Act provides for cost-sharing between the federal government (USACE) and the local sponsor (State Parks) as shown in Table 7.

Following these requirements, USACE would provide approximately $1,195,740 for planning, design, construction, and construction oversight costs. State Parks would contribute approximately $679,860 for planning and design, lands, construction, and construction management. Because the cost of interpretive facilities ($315,100) exceeds ten percent of the total project cost ($2,190,700), the USACE share would only be 50 percent of those facilities up to ten percent of the total project cost. Therefore, USACE would contribute $109,535 for interpretive facilities while State Parks would be responsible for the remainder ($205,565).

This would result in USACE contributing a total of $1,305,275 and State Parks contributing $885,425 to the entire project cost (Table 7). All costs for operation and maintenance of various elements of the plan and post-construction monitoring would be borne by State Parks.

Table 7. Cost-sharing requirements for Section 206 water projects and associated project cost allocation.

Participant	Federal Agency	Local Sponsor	Total
Planning and Design[1]	65% $351,000	35% $189,000	$540,000
Lands[2]	0% $0	100% $36,000	$36,000
Construction[3]	65% $715,130	35% $385,070	$1,299,600
Construction Management	65% $64,805	35% $34,895	$99,700
Interpretive Facilities	50%[4] $109,535	50%[4] $205,565	$315,100
Total	$1,305,275	$885,425	$2,190,700
Annual OMRR&R[5]	$0	$42,400	$42,400

[1] Design would include an HTRW survey and debris classification prior to construction.
[2] Includes lands, easements, rights of way, relocations, and disposal/borrow sites (LERRD).
[3] Excludes interpretive facilities.
[4] Federal agency contributes half of interpretive costs not exceeding 10% of total project cost; local sponsor pays 100% of interpretive costs that exceed 10% of total project cost.
[5] Annual OMRR&R costs for salt cedar maintenance are expected to decrease after first three years, thereby decreasing annual total.

5.9 Consistency with Project Purpose

The recommended plan is consistent with the Section 206 study purpose to develop a plan for restoration of the existing aquatic and wetland habitats in this area. The plan also capitalizes on the opportunity to redirect overflows from Lea Lake into the degraded state park wetland.

Implementation of the recommended plan would allow restoration of historic wetland vegetation while protecting developed recreation facilities from high water levels. The plan is consistent with State Parks' current management for Bottomless Lakes State Park (State Parks Division, 2001).

6.0 ENVIRONMENTAL EFFECTS

This section analyzes potential effects on physical, biological, cultural, and socioeconomic resources if the recommended plan is implemented. Effects of taking no action are discussed in Chapter 3.

6.1 Geology and Soils

Implementation of the management measures within the study area would have no effect on the surrounding geologic features. Soils would in the study area would be impacted by operation of the tree extractor equipment to remove salt cedar, removal of solid waste debris, and excavation of open water habitats. Salt cedar removal using the 23-ton tree extractor would cause soil disturbance to a depth of about six to 12 inches below the surface. This would result from tire action on the soil during equipment operation. Additionally, tree extraction would leave a depression in the ground created by removal of the tree root mass.

Removal of solid waste debris would result in incidental excavation of soils with collection of the waste material. No more than about three inches of soil are likely to be incidentally excavated from solid waste debris removal areas. Consequently, up to about 2,000 yd^3 of soil would be excavated and removed along with solid waste debris. These incidentally excavated soils would be deposited at the county landfill along with the solid waste debris removed from the study area.

Creation of open water habitats in the study area would entail excavation of about 12,300 yd^3 of soil (Technical Appendix G). Soils would be temporarily stockpiled on bare ground sites adjacent to the excavation site and allowed to drain. Temporarily stockpiled soils would then be loaded into dump trucks and hauled to an upland site within the park boundaries that is devoid of any significant cultural or ecological resources.

6.2 Hydrology and Geomorphology

If the recommended plan is implemented, lining approximately 280 feet of the new channel above NM 409 with articulated concrete blocks and river cobbles would prevent bank erosion from occurring after construction is completed. Downstream from NM 409, the channel would continue to remain unlined. The channel stability analysis (Technical Appendix F) shows that the channel velocities and bed shear stresses downstream from NM 409 do not exceed the critical range; thus erosion would also not be an issue along this channel segment. Sediment deposition is also unlikely since the outflow from Lea Lake is essentially sediment-free. Therefore, based on the existing characteristics of the channel and the design itself, there would be no net impact on the geomorphology of the channels within the study area.

Although the flow exiting Lea Lake is fed by a hydraulic connection to the confined aquifer, subsurface flow would not be affected by implementation of the management measures within the study area. The design of the outlet channel is intended to increase the capacity of the channel and eliminate flooding in the portion of Bottomless Lakes State Park north of NM 409. Eliminating flooding would reduce flow loss and result in a more efficient conveyance of water from Lea Lake to the study area wetland downstream from NM 409.

Downstream of NM 409, water currently overflows the wetland channels and spreads throughout the wetland in the form of both surface water and shallow groundwater. It is possible that the addition of open water habitats and the associated feeder channels in the recommended management plan would redirect a portion of the surface flow within the wetland. However, management measures comprising the recommended plan are designed to prevent a net increase in water loss within Bottomless Lakes State Park.

The methodology used to develop the water budget (Technical Appendix A) was applied to the modifications proposed in the recommended plan to analyze effects on water consumption. The recommended plan balances the increase in surface water evaporation (about 11 acre-feet annually) associated with the addition of the open water habitats with a decrease in the amount of evapotranspiration (about 15 acre-feet annually) by the removal of salt cedar. Table 8 shows that, on an annual basis, the recommended plan would slightly decrease net water use in the study area.

The recommended feeder channels that would maintain a hydraulic connection between the new open water habitats and the outlet channel would be designed to maintain water-surface elevations that are similar to those under existing conditions, thereby maintaining similar groundwater conditions throughout the wetland. In addition, the purpose of excavating each of the open water habitats not to create a deep storage pond but to simply remove surface material to provide areas of open water for habitat. These actions would not lower adjacent water-surface elevations. Rather, it is possible that the new open water habitats and associated feeder channels may allow water to reach more extensive areas of the existing wetland. In summary, the volume of water flowing from Lea Lake Marsh to adjacent wetlands on private and BLM land and the pattern of those flows would not change as a result of the proposed action.

Table 8. Effects of the recommended plan on water yield from Lea Lake Marsh.

	Surface Water Evaporation (acre-feet)	Wetland Evapo-transpiration (acre-feet)	Groundwater Outflow (acre-feet)	Surface Outflow to Pecos River (acre-feet)	Balancing Term** (acre-feet)	Total Output (acre-feet)
Existing Condition	1,049	1,926	1,007	5,973	34	9,990
Recommended Plan*	1,060	1,911	1,007	5,973	34	9,984

* Refer to section 6.6 for details on vegetation changes resulting from the recommended plan
** Technical Appendix A

6.3 Water Quality

6.3.1 Suspended Sediments and Turbidity

Implementation of the recommended plan may affect water quality by disturbance of soils in or adjacent to areas with surface water during modification of the outlet channel, salt cedar removal, solid waste debris removal, and excavation of the open water habitats. Direct effects of these activities would consist of short-term increases in suspended sediment loads and turbidity. Indirect effects could include increased turbidity and suspended sediment levels downstream and off-site (*e.g.* in the BLM Overflow Wetlands).

Impacts to water quality would be minimized in several ways. First, modification of the outlet channel would be conducted in dry conditions. This would be accomplished by dewatering the outlet channel and diverting outflow from Lea Lake around the work area and into Lea Lake Marsh. Consequently, impacts to water quality from channel modification would be short-term and of low magnitude. There may be a visible increase in turbidity immediately following resumption of outflow in the reconstructed outlet channel. However, this increase in suspended sediments would likely persist only for up to about two hours. Also, increased turbidity levels are likely to lessen with downstream distance as a result of dilution. Therefore, noticeable changes in suspended sediments and turbidity are likely to be absent at the park boundary.

Removal of solid waste debris and salt cedar are proposed in areas that are shallowly inundated with very low current velocity. Treatment areas for these two management measures that have standing water include cattail marsh, saltgrass marsh, saltgrass wet meadow, saltgrass-iodinebush marsh, iodinebush flats, alkali sacaton flats, salt cedar thicket, and barren ground community types. Only the cattail marsh, saltgrass marsh, saltgrass wet meadow, and saltgrass-iodinebush marsh community types have standing surface water (Technical Appendix B).

Average flow velocity in all of these communities except cattail marsh is 0 ft/sec. Flow velocity in these communities is not expected to change following salt cedar or solid waste debris removal (Technical Appendix B). Therefore, due to the low flow velocity, suspended sediments would not be transported in surface water. Accordingly, the result of salt cedar or solid waste debris removal on water quality would be localized, short-term increases in suspended sediments in saltgrass marsh, saltgrass wet meadow, and saltgrass-iodinebush marsh communities.

Because of the low flow velocity and shallow water depth (up to 5 inches; Technical Appendix B), sediments suspended in surface water by solid waste debris removal would likely settle quickly. Turbid conditions would therefore be expected to last during solid waste debris removal and persist for only a matter of hours following completion of solid waste debris removal.

Average flow velocity in cattail marsh habitat is 0.4 ft/sec (Technical Appendix B). While no solid waste debris piles are located in this community type, salt cedar removal would occur. Salt cedar removal in cattail marsh habitat would be conducted by hand using chainsaws. Increases in turbidity and suspended sediments would result from workers walking in the marsh. These increases in turbidity and suspended sediment would occur in small areas measuring several square feet and would persist during salt cedar removal and for an hour or two following completion of the work.

Excavation of open water habitats to diversify hydrologic regime would be conducted in areas with no standing water or in areas with shallow standing water but with no or very low flow rates (Technical Appendix B). Consequently, effects on water quality would be the same as those described above for salt cedar and solid waste debris removal. Connection of the excavated open water habitats to the wetland channels would require digging small feeder channels. These channels would be dug from the open water habitats outward to the channels. The feeder channel connections to the wetland channels would not be breached until sediments settled in the excavated areas. This would prevent flushing of turbid water into downstream or down-gradient areas, thereby avoiding impacts to the BLM Overflow Wetlands and wetlands on adjacent private lands.

Section 402(p) of the Clean Water Act (CWA) regulates point source discharges of pollutants into water of the United States and specifies that storm water discharges associated with construction activity be conducted under NPDES guidance. Ground disturbance would take place in order to construct the project. Therefore, a NPDES permit would be required. A Notice of Intent would be filed, and a Storm Water Pollution Prevention Plan for the project would be developed and kept on file at the construction site and become part of the permanent project record.

Section 401 of the CWA, (CWA; 33 U.S.C. 1251 et seq.) as amended, requires that a water quality certification be obtained prior to initiating any proposed construction. For projects located on public or private lands in New Mexico, the New Mexico Environmental Department (NMED) administers the water quality certification. A water quality certification is required and would be obtained from NMED and all requirements would be adhered to during construction of this project.

Water quality would be monitored throughout the project. Silt fence would be installed prior to construction in all areas. Compliance with the regulations listed above and implementation of these best management practices (as well as those listed in Section 5.2) would ensure that the Proposed Action would have limited effects on the water quality in the area. There may be a short-term adverse effect on water quality during construction of the channel and removal of salt cedar (as discussed above).

6.3.2 Water Temperature

Excavation of open water habitat would create about 2.07 acres of open surface water exposed to direct sunlight. These areas would be expected to have the same water temperature regimes as existing inundated areas at Lea Lake Marsh.

6.3.3 Chemical Contaminants

Use of an excavator, dump trucks, and chain saws in the marsh and herbicide treatments of freshly cut salt cedar stumps in deeper-water areas of the marsh pose the potential for release of chemical contaminants into surface water. All equipment would be inspected at least twice a day to ensure that oils, fuels, or lubricants are not leaking. All servicing and fueling of equipment would be conducted in a designated area hydrologically isolated from surface waters. Additionally, emergency spill kits would be placed in the designated fueling area to absorb and contain any accidental spills of fuels, lubricants, or other chemical contaminants.

The recommended plan involves cut-stump herbicide application for removal of large trees. Herbicide would be applied per the manufacturer's specifications and label instructions. The herbicide proposed for cut-stump treatments is Habitat® (Imazapyr), which is registered for use in aquatic habitats. Habitat® consists of 28.7% of the active ingredient, isopropylamine salt of Imazapyr (2-[4,5-dihydro-4-methyl-1(1-methylethyl)-5-oxo-1H-imidazol-2-y]-3-pyridinecarboxylic acid, CAS# 81510-83-0) and 71.3% inert ingredients (Appendix 4). A dilute solution consisting of 12 ounces of Habitat® mixed with one gallon of water would be used.

Red or blue RIT® water-soluble fabric dye would be mixed with the dilute herbicide solution to provide an indicator of stems treated with herbicide. The dyed herbicide solution would be painted on cut stumps immediately following cutting. Care would be taken to avoid over-application that would result in run-off from the cut surface. Also, care would be taken to ensure that the dyed herbicide solution thoroughly wets the entire cambium area of the stump. Cut-stump herbicide treatments would only be conducted in areas with deeper standing water where the whole-tree extractor cannot be used

These deeper-water areas encompass approximately 12 acres in the study area (Technical Appendix B: 15). This would be the maximum area subject to hand-removal of salt cedar using chainsaws and cut-stump herbicide treatments. Average salt cedar density in the inundated area is 22.6 stems/10,000 ft^2 (n = 5, s.d. = 9.86, min. = 13/10,000 ft^2, max. = 38/10,000 ft^2). Average stump diameter of salt cedar trees in the hand-cutting area is about 4 inches, which would require a maximum of 0.10 ounces (oz) of herbicide (*i.e.* one ounce of dyed, dilute herbicide solution) to completely coat the cut surface. Using the average density of 22.6 salt cedar trees per 10,000 ft^2, there are approximately 1,200 salt cedar trees that would require hand cutting in the 12-acre inundated portion of the study area. Accordingly, approximately 120 oz, or roughly one gallon of Habitat® herbicide would be required.

Use of water-soluble RIT® fabric dye would provide a means to visually control application of the herbicide to only cut-stump surfaces and minimize the amount of herbicide that could potentially enter surface water. A conservative estimate of accidental herbicide spills into surface water during cut-stump application is 1% of the total volume applied. Consequently, about 0.01 oz (0.30 milliliters) of herbicide could potentially enter surface water adjacent to any given cut stump.

Habitat® is water soluble and therefore would readily mix with water. Because surface water velocity of inundated habitats is very low, most mixing of any accidentally spilled herbicide would occur in the immediate vicinity of a cut stump. If it is assumed that the herbicide would mix within a 2-ft diameter area around the stump in standing water and average water depth is about 4 inches (Technical Appendix B), resulting concentration of Habitat® in surface water would be about 0.30 mL/30 liters, or 10 parts per million (ppm). The concentration in flowing water would be less because of rapid dilution.

Habitat® is not known to have any genetic toxicity, carcinogenicity, reproductive toxicity, or developmental toxicity effects in animals (Appendix 4). A 10-ppm concentration of the herbicide is well below the reported acute toxicity levels for rainbow trout (*Oncorhynchus mykiss*), the zooplankter *Daphnia magna*, Mallard Duck, and honey bee (Appendix 4).

6.3.4 Cumulative Effects on Water Quality

For the purpose of cumulative effects analysis of impacts to water quality, the resource boundary is the study area. This was determined to be appropriate because the recommended plan is not expected to have any indirect impacts on water quality beyond the study area, as described in sections 6.3.1 through 6.3.3.

The existing quality of surface water of Lea Lake Marsh indicates that past and present actions in the study area have not resulted in any lasting degradation of water quality. Proposed future actions in the study area that may impact water quality are limited to annual salt cedar maintenance, which may result in additional releases of herbicide, as described above. However, Habitat® decomposes to inert compounds. Complete decomposition of herbicide residues occurs within 120 days of application (Appendix 4), so there would not be any overlap of impacts either in time or space from the cut-stump herbicide application.

No future ground-disturbing activities are proposed within Lea Lake Marsh. Periodic maintenance of the Lea Lake outlet channel is likely to result in suspension and transport of sediments into the marsh. However, these effects are short-term (*i.e.* diminishing to background conditions within several hours after completion of maintenance) and therefore would not overlap in time or space with water quality impacts that are likely to occur from implementation of the recommended plan.

6.4 Air Quality

The recommended plan would result in a temporary decrease in local air quality. An increase in particulates (dust) would be expected as a result of vegetation removal and topsoil disturbance. A localized increase in concentrations of carbon monoxide would result from equipment operation during construction.

Increased carbon monoxide emissions would subside when heavy equipment use ends. Air quality degradation from increased particulates would persist until ground cover is reestablished. Due to the moist condition of soils in much of the project area, the increase in dust particulates is not expected to result in a noticeable decrease in air quality. Increased emissions during construction would not significantly change air quality in the project area.

For the purpose of assessing cumulative effects to air quality, effects from implementation of the recommended plan were considered in relation to air quality in Chaves County. The increase in particulates caused by the recommended plan would contribute temporarily to cumulative effects to air quality degradation in Chaves County. Particulate matter from other past, present, and future soil-disturbing actions, including construction projects, farming practices, and natural erosion, combined with the recommended plan, would slightly decease ambient air quality in Chaves County. However, increase in particulates would not result in significant deterioration in air quality in the county.

Construction-related effects to air quality would be minimized by: 1) requiring the contractor to have emission control devices on all equipment; and 2) employing the use of Best Management Practices to control wind erosion, including wetting of soils within the construction zone and compliance with local soil sedimentation and erosion-control regulations. Construction and operation of the recommended plan would conform with air quality control regulations as established by the Clean Air Act and the New Mexico Air Quality Control Act.

6.5 Ecological Setting

6.5.1 Vegetation

Effects of the recommended plan on vegetation were estimated by overlaying the treatment areas of proposed management measures on existing vegetation, applying the expected changes in vegetation described in Technical Appendix B to the treatment areas, then calculating the new areas of the vegetation community types. This analysis was carried out using the ESRI ArcMap™ 9.1 Geographic Information System software.

Implementation of the recommended plan would result in changes in areal extent of each community type in the study area (Table 9). Most notably, the salt cedar thicket community type would be converted to saltgrass wet meadow vegetation by implementing the recommended plan. Coverage of bare ground would be markedly reduced by supplemental planting in the study area. Cattail marsh vegetation would decrease slightly from excavation of open water habitats, solid waste debris removal, and supplemental planting.

The areal extent of saltgrass marsh, saltgrass-iodinebush marsh, and iodinebush flats would not change with implementation of the recommended plan (Table 9). Substantial increases in the areal extent of wetland channel (open water) habitat, saltgrass wet meadow, bulrush marsh, and alkali sacaton flats vegetation would result from implementation of the recommended plan (Table 9). Species composition within community types is also expected to change with implementation of the recommended plan (Technical Appendix B). Removal of salt cedar from existing vegetation communities would result in increased coverage by native species such as saltgrass, chairmaker's bulrush, cattail, willow baccharis, and alkali sacaton.

The 715 acres of wetlands between Lea Lake and the Pecos River, including the study area, comprise a functioning, interconnected ecological unit. Therefore, this was used as the resource boundary for considering cumulative effects to vegetation from the recommended plan. Furthermore, the cumulative aggregate impact of past actions on vegetation in the study area was considered to be represented by the existing condition.

Ongoing and proposed future actions affecting vegetation in the analysis area consist of continued salt cedar removal and control by State Parks and the BLM. The BLM proposes to conduct salt cedar removal and control on the BLM Overflow Wetlands (ca. 670 acres) using mechanical, hand removal, and herbicide techniques (Bureau of Land Management, 2003). This action would overlap temporally with the proposed wetland restoration at Lea Lake Marsh. These combined actions would markedly decrease salt cedar density in the 715 acres of wetlands between Lea Lake and the Pecos River, possibly by as much as 80%. This is expected to result in a concordant increase in native wetland vegetation.

Table 9. Effect of recommended plan on areal extent of vegetation communities in the study area.

Community Type	Areal Extent (acres)		Percent Change
	Before	After	
Bulrush Marsh	0.38	0.61	+ 60.5%
Cattail Marsh	1.69	1.64	- 2.9%
Saltgrass Marsh	8.04	8.04	----
Saltgrass Wet Meadow	10.90	19.51	+ 78.9%
Saltgrass-Iodinebush Marsh	1.32	1.32	----
Iodinebush Flats	4.17	4.17	----
Alkali Sacaton Flats	3.63	5.25	+ 44.6%
Salt Cedar Thicket	7.16	0.00	- 100.0%
Barren Ground	5.40	0.41	- 92.4%
Wetland Channel (Open Water)	0.27	2.00	+ 640.1%

6.5.2 Wetlands and Floodplains

The areal extent and character of the study area wetland are likely to change with implementation of the recommended plan. Continued increases in outflow from Lea Lake, coupled with the recommended plan of directing all of the outflow to Lea Lake Marsh by modifying the outlet channel, are likely to increase the areal extent of wetland in the study area. The magnitude of this change is uncertain. The only available data applicable to predicting changes in wetland area are the increases in wetland from 1954 to 2003 as interpreted from aerial photography (*cf.* section 3.2). Based on this photo interpretation, an increase in emergent marsh habitat of 8.6 acres can be inferred. It is likely that most of this increase occurred since ground water levels began to recover in the late 1970s (section 2.4).

Assuming that the expansion of emergent wetland occurred between 1976 and 2003, a rate of increase in wetland per unit increase in discharge from Lea Lake can be estimated. Outflow from Lea Lake increased by about 17 cfs while emergent marsh increase in extent by 8.6 acres. If a linear relationship between the two variables is assumed, the a rate of increase of 0.49 acres of wetland/cfs increase in outflow from Lea Lake can be assumed. Furthermore, if it is assumed that outflow from Lea Lake will plateau at about 25 cfs (an increase of about 4 cfs above existing conditions), then an increase in wetland extent of 1.96 acres can be inferred for the study area.

Average water depth and hydroperiod in several of the wetland vegetation communities are expected to change with implementation of the recommended plan (Technical Appendix B). Average depth of inundation would increase from 7 to 18 inches in bulrush marsh, 2.4 to 12 inches in saltgrass marsh, 0.4 to 4 inches in saltgrass wet meadow, 1.2 to 8 inches in saltgrass-iodinebush marsh, and 0 to 1.2 inches in converted salt cedar thicket vegetation (Technical Appendix B). Hydroperiod would change in saltgrass marsh habitat from semi-permanently flooded to intermittently exposed and from seasonally flooded to semi-permanently flooded in saltgrass wet meadow. Also, hydroperiod in converted salt cedar thicket vegetation would change from saturated to semi-permanently flooded (Technical Appendix B).

Jurisdictional wetlands (relative to Section 404 of the Clean Water Act) do occur adjacent to and within the project area (see section 2.6.2). Executive Order 11990 (Protection of Wetlands) requires the avoidance, to the extent possible, of long- and short-term adverse impacts associated with the destruction, modification, or other disturbance of wetland habitats. The proposed action would benefit wetlands in the project area, as described above. Since no dredged or fill material would be placed within the wetlands or other waters of the U.S., a Department of the Army permit under Section 404 would not be needed for this work.

Executive Order 11988 (Floodplain Management) provides federal guidance for activities within the floodplains of inland and coastal waters. Preservation of the natural values of floodplains is of critical importance to the nation and the State of New Mexico. Federal agencies are required to "ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management." The proposed action is located more than a mile from the Pecos River and is not part of the floodplain. Therefore, the proposed action would have no effects on floodplains.

Impacts of the recommended plan on wetlands are limited to the boundaries of the study area. Therefore, the study area is the appropriate boundary for consideration of cumulative impacts.

As discussed in the analysis of impacts to vegetation, the cumulative aggregate impact of past actions on wetlands in the study area was considered to be represented by the existing condition. No other actions are planned in the future for the study area that would have impacts on wetlands. Consequently, there would be no impacts to wetlands that overlap spatially or temporally with the recommended plan.

6.5.3 Fauna

Operation of tree-extractor and excavation equipment for removing salt cedar and solid waste debris and excavating open water habitats would cause direct impacts. There would be an unknown amount of direct mortality of relatively immobile organisms such as aquatic invertebrates. Other more mobile organisms such as birds and fish would be disturbed and flushed from work areas.

Another direct impact of the recommended plan would be removal of salt cedar trees from the marsh, which may serve as nesting sites for birds. In order to avoid destruction of active nests and mortality of young birds, salt cedar removal would be conducted outside of the breeding season (*i.e.* September through March).

Cut-stump herbicide treatment of salt cedar may result in some accidental introduction of Rodeo® into surface water. Introduction of Rodeo® into surface water would be minimized by carefully applying the herbicide by hand directly to cut stumps using a brush. No aerial herbicide spraying would be conducted.

As described in section 6.3.3, concentrations of the herbicide in localized areas are not expected to exceed 25 ppm, which is below the acute toxicity limit for most organisms. The total amount of herbicide accidentally spilled is unlikely to exceed 3 oz over the entire 43-ac study area, or 0.07 oz/ac.

Implementation of the recommended plan would change wildlife habitat characteristics at Lea Lake Marsh in several important ways. First, the recommended plan would eliminate the only trees (salt cedar) from the marsh. Second, the recommended plan would create more diversity in water depths and increase open water habitat. Third, the recommended plan would increase the area covered by native herbaceous wetland vegetation.

In order to assess the indirect effects of these changes in habitat conditions on fauna of the marsh, two indicator species groups were used. These indicator groups were: 1) the 18 species of birds known to occur at Lea Lake Marsh during the breeding season; and 2) dragonflies and damselflies (the taxonomic Order Odonata in the Class Insecta) known to occur in the marsh (*cf.* section 2.7.3 and Technical Appendix B). Consequences of the recommended plan on endangered and protected species, which are discussed below in section 6.6, provide another index of effects on fauna in general.

Of the 18 spring/summer bird species known to occur at or in the vicinity of Lea Lake Marsh, eight nest in trees or shrubs (Table 10). Two of these species are unlikely to nest at Lea Lake Marsh. Osprey uses large stick nests, none of which were found in the study area. House Sparrow nests in cavities of trees, but cavity-nesting birds rarely use salt cedar (Hunter *et al.*, 1988; Lovich and DeGouvenain, 1998). The remaining six species may potentially have nest sites reduced or eliminated by removal of salt cedar trees and shrubs from Lea Lake Marsh. However, abundance of baccharis, a native shrub, is expected to increase following implementation of the recommended plan. This shrub may provide suitable nesting habitat for Black-headed Grosbeak and White-crowned Sparrow (Table 10).

Dragonflies and damselflies occur in aquatic habitats such as ponds, streams, and marshes with open water (Westfall and Tennessen, 1996). All of the 62 species documented from Lea Lake Marsh are known to occur in standing or flowing water habitats. Many of the genera known to occur in the marsh are also associated with vascular hydrophytic plants. Increasing the diversity of water depths, area of open water, and emergent wetland vegetation such as bulrush marsh would create additional habitat for dragonflies and damselflies in the study area. Consequently, this group would be expected to benefit in the long term from implementation of the recommended plan.

Table 10. Nesting characteristics of birds occurring in the vicinity of Lea Lake Marsh in spring and summer. (Source: Erlich *et al.*, 1988).

COMMON NAME	SCIENTIFIC NAME	NEST LOCATION	NEST TYPE
Turkey Vulture	*Cathartes aura*	Cliff	No nest
Osprey	*Pandion haliaetus*	Tree, Snag (10-60 ft)	Stick nest
Killdeer	*Charadrius vociferus*	Ground	Scrape nest
Inca Dove	*Columbina inca*	Shrub (10-12 ft)	Saucer nest
Common Nighthawk	*Chordeiles minor*	Ground	No nest
Black-chinned Hummingbird	*Archilochus alexandri*	Tree (4-8 ft)	Cup nest
Rufous Hummingbird	*Selasphorus rufus*	Tree (1-15 ft)	Cup nest
Say's Phoebe	*Sayornis saya*	Cliff, Rock wall	Cup nest
Barn Swallow	*Hirundo rustica*	Structure, Rock wall	Cup nest
Cactus Wren	*Campylorhynchus brunneicapillus*	Cactus	Spherical nest
Northern Mockingbird	*Mimus polyglottos*	Tree (3-10 ft)	Cup nest
Wilson's Warbler	*Wilsonia pusilla*	Ground	Cup nest
Black-headed Grosbeak	*Pheucticus melanocephalus*	Shrub (4-12 ft)	Cup nest
White-crowned Sparrow	*Zonotrichia leucophrys*	Shrub (1-5 ft)	Cup nest
Red-winged Blackbird	*Agelaius phoeniceus*	Reeds	Cup nest
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Reeds	Cup nest
Brown-headed Cowbird	*Molothrus ater*	Variable	Parasite
House Sparrow	*Passer domesticus*	Structure, Tree	Cavity

Up to six genera of mosquitoes may occur at Bottomless Lakes State Park: *Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Mansonia*, and *Psorophora* (Walker and Newson, 1996). The proposed action would not substantially alter the quality or quantity of habitat suitable for the mosquitoes. However, creation of open water habitats and diversification of hydrologic regime in the study area would likely benefit species that prey on mosquito larvae including dragonfly naiads, damselfly nymphs, and fishes, such as Pecos pupfish and Mexican tetra. Fish predation, in particular, may significantly alter the composition and abundance of aquatic invertebrate communities (*e.g.* Batzer *et al.*, 2000; Zimmer *et al.*, 2001). The proposed action would, therefore, be unlikely to result in any measurable increase in mosquitoes in the vicinity of the project area.

Because many species of wildlife are relatively mobile, the appropriate boundary for analysis of cumulative effects is the 715-ac wetland complex supported by outflow from Lea Lake. Existing fauna conditions were assumed to represent the cumulative aggregate impact of past actions in the study area. Planned future actions that may affect wildlife habitat in the analysis area and which may overlap temporally with the recommended plan consist of salt cedar removal in the BLM Overflow Wetlands.

The recommended plan would contribute to a net loss of salt cedar in the analysis area, which would have a cumulative impact on nesting birds that use salt cedar. It is unlikely that this cumulative impact would reach a biologically meaningful threshold, such as a decrease in population size, of any of the bird species known to occur at Lea Lake Marsh that may nest in salt cedar. All of these species are relatively widespread and abundant and use other trees and shrubs besides salt cedar as nest sites.

6.6 Endangered and Protected Species

6.6.1 Pecos Sunflower

Pecos sunflower would not be directly affected by the recommended plan. All Pecos sunflower plants would be avoided during implementation of the recommended plan. Aggregations of plants would be flagged to delineate areas where no work is to be performed and restoration activities would be monitored to ensure that no Pecos sunflower plants are disturbed.

Pecos sunflower may be indirectly affected by the recommended plan. Excavation of open water habitats that are hydrologically connected to the wetland channels may provide suitable sites for establishment of Pecos sunflower by seed. Seed may be carried by surface water flow into the open water habitats and deposited along the margins of the ponds, which could lead to establishment of additional aggregations of plants in the study area. Colonization of disturbed ground by Pecos sunflower in areas subject to mechanical removal of salt cedar was observed immediately south of the study area (Technical Appendix B). Also, sites along the South Wetland Channel subject to past ground disturbance from channel maintenance activities were also colonized by Pecos sunflower. Therefore, it seems likely that the species would also colonize the margins of the open water habitats.

Pecos sunflower is restricted to the margins of Lea Lake and Lea Lake Marsh; no occurrences of the species have been documented from the BLM Overflow Wetlands (Bureau of Land Management, 2003). Therefore, the appropriate analysis area for assessing cumulative impacts to Pecos sunflower from the recommended plan is the study area. The cumulative aggregate effect of past actions in the study area on Pecos sunflower was assumed to be represented by existing conditions.

Current and planned actions in the study area that may affect Pecos sunflower consist of ongoing hand-clearing of aquatic vegetation and sediment from small segments of the South and West wetland channels. This action creates sites suitable for colonization by Pecos sunflower. Thus, there would be an overall beneficial cumulative effect on Pecos sunflower through an increase in area suitable for establishment of plants in the study area.

In conclusion, the proposed action may affect but is not likely to adversely affect Pecos sunflower. Initiation of section 7 consultation under the Endangered Species Act with the U.S. Fish and Wildlife Service would be required.

6.6.2 Mexican Tetra

The recommended plan is unlikely to have any measurable direct or indirect effects on Mexican tetra in the study area. The recommended plan would directly impact the Lea Lake outlet channel. Channel modification work would involve dewatering of the channel and diverting flow around the work area into Lea Lake Marsh. Fish occurring in the outlet channel would be moved downstream as flows recede following plugging of the upstream end of the channel. The temporary increases in turbidity following resumption of flow in the modified channel are unlikely to be of sufficient magnitude or duration to cause mortality of fish.

6.6.3 Pecos Pupfish

Operation of mechanized equipment to remove salt cedar and excavate open water habitats in the study area may cause direct mortality of some Pecos pupfish, especially young-of-year fish inhabiting very shallow water. This level of mortality is likely to be very small, perhaps on the order of 10 to 20 individuals, because mechanized equipment operation would be restricted to areas with no surface water or with only extremely shallow surface water (*e.g.* up to 1 inch depth). Impacts to water quality from the recommended plan are unlikely to measurably affect Pecos pupfish because they are of small magnitude and short duration (*cf.* section 6.3).

The recommended plan is likely to increase suitable habitat for Pecos pupfish in the project area by at least 2 acres, associated with excavation of the open water habitats. Open water habitats would provide important over-wintering habitat for the population of Pecos pupfish that inhabits Lea Lake Marsh and the BLM Overflow Wetlands (*cf.* Technical Appendix B).

Pecos pupfish in the study area are part of a larger population that inhabits the 715-ac wetland supported by outflow from Lea Lake. Therefore, this is the appropriate boundary for analysis of cumulative effects. The cumulative aggregate effect of past actions in the study area on Pecos pupfish was assumed to be represented by existing conditions.

Current and planned future actions that may potentially affect Pecos pupfish in the analysis area are construction of fish barriers in the BLM Overflow Wetlands at outflow points to the Pecos River. The purpose of the fish barriers are to prevent movement of non-native sheepshead minnow (*Cyprinodon variegatus*) into the wetland. Sheepshead minnow hybridization is considered a major threat to Pecos pupfish (Technical Appendix B). The recommended plan, when combined with the effect of fish barrier construction, is likely to result in beneficial cumulative effects to Pecos pupfish. The overall status of the population would be markedly improved by preventing invasion of the wetland by sheepshead minnow and increased availability of over-wintering habitat.

6.6.4 Arid Land Ribbon Snake

The recommended plan is unlikely to have any measurable effect on arid land ribbon snake, as this species is almost always associated with permanent water (Degenhardt *et al.*, 1996). In the study area, arid land ribbon snake would most likely be found along the wetland channels, which would not be affected by the recommended plan.

6.6.5 Least Shrew

The recommended plan would directly impact saltgrass marsh and saltgrass wet meadow habitat east of the South Wetland Channel that is occupied by least shrew (Frey, 2005). Operation of mechanized equipment for removing salt cedar may potentially result in mortality of some least shrew by crushing. The tree extractor exerts a force of approximately 5 lbs/in^2 and the tracks have a surface area of about 52 ft^2 (Bureau of Land Management, 2003).

Mortality of least shrew would be minimized by moving the salt cedar extractor as little as possible and restricting movement of the machine to salt cedar stands as much as possible. This would reduce operation of the equipment in suitable saltgrass wet meadow and saltgrass marsh habitat.

The tree extractor has a reach of about 30 feet (Bureau of Land Management, 2003), so any given position of the machine would allow for treatment of a 2,820 ft^2 (0.06 acres). Each position of the tree extractor would have a tread impact area of 52 ft^2, which is about 2% of the treated area. If movement of the machine is also considered, then it can be assumed that tread impacts would occur to about 10% of the treated area.

The area on the east side of the South Wetland Channel comprises about 12.4 acres, of which about 25% is covered with salt cedar (3.1 acres). If it is assumed that the tree extractor tread impact is about 10% of the treated area, then about 0.3 acres of occupied habitat would be impacted.

Four individual least shrew were captured in the 12.4-ac area east of the South Wetland Channel (Frey, 2005). If least shrew is uniformly distributed, a minimum density of 0.3 least shrew/ac could be assumed. However, least shrew is gregarious and nests communally (Fitzgerald *et al.*, 1994). Least shrew likely breed throughout the year in the study area but with most breeding occurring in spring and summer (Fitzgerald *et al.*, 1994: 87). Therefore, operation of the tree extractor could incidentally crush several individuals because distribution of least shrew is aggregated and not uniform.

In order to minimize the chance of crushing an occupied communal nest of least shrew, operation of the tree extractor would be restricted as much as possible to salt cedar stands. Additionally, a qualified biologist would be on site to inspect work areas and provide guidance on areas to avoid. These measures would reduce incidental take of least shrew so that measurable impacts to the population would not occur.

The recommended plan is consistent with the following management recommendations developed by Frey (2005: 35) for the study area:

- Protect the saltgrass wetland meadow system from infrastructure development and changes to hydrology.
- Enhance habitat through aggressive control of salt cedar.
- Create additional saltgrass meadow habitat by aggressively controlling salt cedar in areas with adequate soil moisture.
- Promote plans to enhance ground water resources.

In the long term, habitat in the study area would be improved for least shrew.

Least shrew occurring in the study area appear to be part of a larger population that inhabits the 715-ac wetland complex between Lea Lake and the Pecos River. Therefore, the entire wetland complex is the appropriate boundary for analysis of cumulative effects on the species from the recommended plan. The current status of the species in the wetland is considered to represent the cumulative aggregate effect of all past actions in the analysis area.

Ongoing and planned future actions in the analysis area consist of salt cedar removal actions proposed on the BLM Overflow Wetlands. These treatments may overlap temporally with the recommended plan. Consequently, the cumulative effect of the recommended plan may be a slight decrease in the abundance of least shrew in the analysis area. However, the decrease in abundance is not likely to result in any measurable affect on the persistence or viability of the population in the analysis area.

6.6.6 Wright's Marsh Thistle

Wright's marsh thistle has not been found in the study area (Technical Appendix B). Therefore, the species would not be affected by the recommended plan. The recommended plan would improve potential habitat for the species in the study area.

6.6.7 Pecos River Muskrat

Suitable habitat for Pecos River muskrat in the study area is limited primarily to the wetland channels. Because these habitats would not be affected by the recommended plan, this species is unlikely to be directly affected by implementation of the recommended plan. The recommended plan is likely to increase the amount of suitable habitat for Pecos River muskrat in the study area through excavation of the open water habitats.

Pecos River muskrat likely occur throughout the 715-ac wetland supported by outflow from Lea Lake. This area is the appropriate boundary for analysis of cumulative effects on the species from the recommended plan. The cumulative aggregate effect of past actions in the study area on Pecos River muskrat was assumed to be represented by existing conditions.

Current and planned future actions that may potentially affect Pecos River muskrat in the analysis area consist of salt cedar removal actions in the BLM Overflow Wetlands. These actions would improve habitat conditions for muskrat by creating more emergent marsh habitat. The recommended plan would cumulatively contribute to this beneficial effect.

6.7 Cultural Resources

No prehistoric archaeological sites or traditional cultural properties would be affected by the proposed facility development as none occur in the project area. One historic site, the Lea Lake outlet channel, would be altered by widening the channel bottom from approximately 3 feet to 6 feet to accommodate greater flow volumes. No other historic sites occur in the project area.

In compliance with Section 106 of the Historic Preservation Act, consultation with the State Historic Preservation Officer regarding potential effects to cultural resources from the proposed project has been initiated by USACE and would be completed prior to construction. No further investigations are necessary. If any previously-unrecorded cultural resources are encountered during construction, work at that location would stop and the USACE and State Parks archaeologists would be contacted.

6.8 Land and Water Uses, Recreation Resources, and Aesthetics

6.8.1 Water Use and Water Rights

The recommended plan would have no affect on regional artesian aquifer levels. Consequently, discharge from Lea Lake, which is a function of artesian aquifer levels, would not be affected. Implementation of the recommended plan would not increase evapotranspiration water loss at Lea Lake Marsh (Table 7; see section 6.2 - Hydrology and Geomorphology). Existing water yield from Lea Lake Marsh to adjacent wetlands on private lands and BLM land would not be diminished. Therefore, there would be no change in computed inflow to the Sumner Dam to Artesia reach of the Pecos River. New Mexico delivery obligations under the Pecos River Compact and the U. S. Supreme Court Decree in *Texas v. New Mexico* would not be affected because the recommended plan would not change the flood inflow computation.

Restoration of the aquatic habitat in the study area would not cause adverse impacts to water right holders in the vicinity of the study area. The recommended plan would not affect the water uses for domestic, sanitary and landscape uses in Bottomless Lakes State Park.

Because the recommended plan does not involve the construction of new man-made structures, and because there is no new point of diversion or change in place or purpose of use, there would be no need for State Engineer administrative action regarding the implementation of the recommended plan.

6.8.2 Land Use, Recreation, and Aesthetics

Restoration of the Lea Lake Marsh aquatic habitats would change the use of the land in the study area in that it would no longer be used for material or solid waste debris storage by the park. A new location would be selected in the park for storage of extra construction and related materials as well as a place to store solid waste debris. General land use (i.e. management as a state park) would not change as a result of recommended plan implementation.

Removal of the solid waste debris and salt cedar, creating small areas of open water, and planting native wetland vegetation would improve the aesthetic appeal of the study area. Coupled with the new raised trails, interpretive signs, and viewing blinds, the area would become more appealing to visitors. This is likely to increase recreation use of the study area by providing a maintained trail for persons wishing to view wildlife or just take a leisurely stroll. Although the new facilities are unlikely to draw large numbers of new visitors to the park, development of the trail would provide additional recreation and educational experiences for visitors coming to the park for other reasons (*e.g.* camping). Group educational use of the study area is likely to rise as school groups would have an easily-accessible site which provides a dry path into a wetland for learning about these important habitats, studying plants or water, and with viewing blinds for students to observe wildlife.

6.9 Socioeconomic Environment and Environmental Justice

Implementation of the recommended plan would not directly affect residences, businesses, community facilities or services, churches, or other community resources as none are located in the project area. These social and economic resources would not be indirectly affected, either, as they are removed in space or time from the proposed project.

No jobs would be created or lost as a direct result of the recommended plan. There would be a small economic advantage to local area businesses (*e.g.* Roswell) generated by expenditures for construction materials, fuel, and possibly some local labor and equipment, needed to implement the recommended plan. These potentially-beneficial effects would be temporary in nature, ceasing when the project construction is completed.

Regulations for implementing NEPA require analysis of social effects when they are interrelated with effects on the physical or natural environment (40 CFR §1508.14). Federal agencies are also required to "*identify and address disproportionately high and adverse human health or environmental effects*" of their programs and actions on minority populations and low-income populations, as directed by Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations).

The study area is located in a census tract that has lower percentage of ethnic minorities than found overall in Chaves County or the state of New Mexico (Table 1). No data are available on the percentage of persons living below poverty level in the study area, so no comparison can be made to the state and county percentages. However, since there are no high or adverse human health or environmental effects from the recommended plan, there would be no disproportionate adverse effects on any specially-protected populations (*i.e.* minority or low-income).

Since there would be no adverse effects from the proposed project in regards to socioeconomic factors or environmental justice issues, there would be no adverse cumulative effects on these elements. The small increase in purchases at local businesses resulting from this project, combined with increases in retail sales from any other temporary source (*e.g.* construction projects) in the Roswell area occurring simultaneously, would temporarily provide a beneficial cumulative effect on the local economy.

6.10 Noise

If the recommended plan is implemented, there would be temporary increases in noise levels from the operation of heavy equipment and increased presence of humans in the study area. Because ambient noise levels are generally low and the construction noise would be quite loud at times, the increase in noise may disturb wildlife and recreationists in the vicinity of Lea Lake and Lea Lake Marsh. The noise would be limited to day time hours and would occur during intermittent periods during the approximately eight-month construction schedule. No disturbances would occur at night to disrupt sleeping campers.

Noise level changes from implementation of the recommended plan were assessed in relation to noise level changes approximately within a mile of the study area. Routine park maintenance activities, vehicles traveling on NM 409 and adjacent roads, Lea Lake recreationists (*e.g.* campers, swimmers, picnickers), aircraft passing overhead, and land management activities on adjacent lands (*i.e.* private and public) all contribute to past, present, and future ambient noise levels. Although the preferred plan would contribute incrementally to cumulative noise levels within a mile of the project area, the increase would not be significant.

To reduce temporary construction noise, construction contracts would require that construction equipment and activities comply with state and local noise control ordinances. No permanent increases in noise levels are anticipated as a result of construction or operation of the proposed project.

6.11 Hazardous, Toxic, and Radiological Waste

Several potentially-hazardous materials were identified within the study area during the HTRW survey in 2003. Two piles of construction materials containing roofing, insulation, and painted wood still remain in the project area. It is unlikely that asbestos or lead, if present in the waste materials, would leach out of this solid waste debris during flood events and effect soils. However, disturbance of asbestos- or lead-containing materials could cause these hazardous substances to become airborne and expose people in the study area. In addition, asbestos- and lead-containing materials may be subject to federal and state regulations with respect to handling, transport, and disposal. An HTRW survey would be repeated in the project area within 60 days prior to any construction being undertaken to ensure that conditions described during the 2003 survey are still the same.

7.0 RECOMMENDATIONS

I propose that the recommended plan described in this DPR/EA be authorized for implementation under the authority of Section 206 of the WRDA of 1996, Public Law 104-303 (Section 22 U.S.C. 2330), as a federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable. The initial cost of this project is estimated to be $2,190,700.

Prior to the commencement of construction, local interests must agree to meet the requirements for local sponsor responsibilities as outlined in this report and future legal documents. New Mexico State Parks Division has demonstrated that they have the authority and the financial capability to provide all local sponsor requirements for the implementation, operation, and maintenance of the project.

Prior to construction, the local sponsor agrees to the following:

1. Provide all lands, easements, rights-of-way, dredged material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project.

2. Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors.

3. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses, incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20.

4. Operate, maintain, rehabilitate, repair, and replace all the works after completion in accordance with the regulations prescribed by the Secretary of the Army.

5. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the proposed restoration project. However, for lands that the Government determines to be subject to navigation servitude, only the Government shall perform such investigations unless the Federal Government provides the non-federal sponsor with prior specific written direction, in which case, the non-federal sponsor shall perform such investigations in accordance with such written direction.

6. Assume complete financial responsibility, as between the Federal Government and the non-federal sponsor, for all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for

the construction, operation, or maintenance of the general navigation features.

7. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

8. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

9. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

10. Provide, during the period of construction, a cash contribution and/or in-kind services equal to 35 percent of the total cost of pre-construction engineering and design, and construction, or total implementation costs of a multiple purpose project allocated to ecosystem restoration. Pay all costs beyond the Federal limit of $5,000,000 for Section 206 projects.

11. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government.

The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation of individual projects. They do not reflect the program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

B. A. Estok
Lieutenant Colonel, U.S. Army
District Commander

12 Dec 06
Date

8.0 PREPARATION, COORDINATION, AND CONSULTATION

8.1 Preparation

The DPR/EA was prepared by the Albuquerque District project delivery team, including Blue Earth & Mussetter, LLC and their subconsultants. Members of the team included:

Albuquerque District, Corps of Engineers

Fritz Blake	Civil Project Management Branch
Patricia Phillips	Civil Project Management Branch
Lynette Giesen	Plan Formulation Section
Ondrea Linderoth-Hummel	Environmental Resources Section
Gregory Everhart	Environmental Resources Section
Armando Najera	Hydrology and Hydraulics Section

Consultants

Karen Yori	Principal Planner, Project Manager
John Pittenger	Ecologist
Jennifer Mullins	Biologist
Terry Schlaht, P.E.	Quality Control
Robert Mussetter, Ph.D, P.E.	Principal Engineer
Chad Morris, P.E.(Colorado)	Hydrologist
Jon Balis	Estimator
Randy Baccadutre	Estimator
Phyllis Taylor	Economist
William Miller, P.E.	Water Resource Engineer
Jarrett Airhart	HTRW Specialist

The University of New Mexico, Office of Contract Archeology, prepared the cultural resource survey report (Technical Appendix C) under separate contract to the Albuquerque District.

The Albuquerque District Interdisciplinary Technical Review Team consisted of the following individuals:

William DeRagon	Environmental
Greg Everhart	Archaeology
F. Terry Weeks	General
Alan C deBaca	Cost Engineering
Cecilia Horner	HTRW
Suzanne Hess	Geotechnical
Charles Wilson	Planning
Robert Browning	Economics
Patrick Montoya	Hydraulic Engineering

8.2 Coordination and Consultation

The following agencies and organizations were consulted during the planning process for the Bottomless Lakes Aquatic Habitat Restoration Feasibility Study:

U.S. Army Corps of Engineers, Albuquerque District Regulatory Branch
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service - New Mexico Ecological Services Office
U.S. Fish and Wildlife Service - Dexter National Fish Hatchery
U.S. Fish and Wildlife Service - Bitter Lake National Wildlife Refuge
USDA Natural Resource Conservation Service
USDI Bureau of Land Management - Roswell Field Office
New Mexico Department of Energy, Minerals, and Natural Resources - Rare Plants Division
New Mexico Department of Energy, Minerals, and Natural Resources - State Parks Division
New Mexico Department of Game and Fish - Conservation Services Division
New Mexico Department of Transportation
New Mexico Environment Department - Surface Water Quality Bureau
New Mexico Interstate Stream Commission
New Mexico State Engineer
New Mexico State Historic Preservation Officer
Apache Tribe of Oklahoma
Comanche Indian Tribe
Kiowa Tribe
Mescalero Apache Tribe
Ysleta del Sur Pueblo
Chaves County Extension Service
Chaves County Soil and Water Conservation District
Fin and Feather Club
Friends of Bottomless Lakes

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