# DRAFT ENVIRONMENTAL IMPACT STATEMENT

# River Management Alternatives for the Rio Grande Canalization Project

*Prepared for:*

**United States Section International Boundary and Water Commission**
El Paso. Texas

*Cooperating Agency:*

**U.S. Department of the Interior Bureau of Reclamation**

**December 2003**

*Prepared by:*

**PARSONS**
Austin, Texas

# DRAFT ENVIRONMENTAL IMPACT STATEMENT

# River Management Alternatives for the Rio Grande Canalization Project

*Prepared for:*

**UNITED STATES SECTION,**
**INTERNATIONAL BOUNDARY AND WATER COMMISSION**
The Commons, Building C, Suite 100
4171 North Mesa Street
El Paso, TX 79902-1441

*In Cooperation with:*

**U.S. DEPARTMENT OF THE INTERIOR,**
**BUREAU OF RECLAMATION, ALBUQUERQUE AREA OFFICE**
Albuquerque, New Mexico

*Prepared by:*

**PARSONS**
Austin, Texas

**December 2003**

# Cover Sheet

**RIVER MANAGEMENT ALTERNATIVES FOR THE RIO GRANDE CANALIZATION PROJECT**

**(X) Draft ( ) Final**

**Lead Agency**

United States Section, International Boundary and Water Commission, United States and Mexico (USIBWC)
El Paso, Texas

**Cooperating Agency**

U.S. Department of the Interior, Bureau of Reclamation (USBR)
Albuquerque Area Office, Albuquerque, New Mexico

**Abstract**

The USIBWC is evaluating long-term river management alternatives for the Rio Grande Canalization Project (RGCP), a 105.4-mile narrow river corridor that extends from below Percha Dam in Sierra County, New Mexico to American Dam in El Paso, Texas. The RGCP, operated and maintained by the USIBWC since its completion in 1944, facilitates water deliveries and provides flood control.

The No Action Alternative and three action alternatives are evaluated in the Draft EIS. The alternatives were developed in a manner that enhances and restores the riparian ecosystem while maintaining the flood control and water delivery requirements of the RGCP. Alternatives formulation was the result of a three-year public consultation process that included regulatory agencies, irrigation districts, and environmental organizations.

Measures under consideration as part of the alternatives include grazing leases modification to improve erosion control, changes in floodway vegetation management, riparian restoration and aquatic habitat diversification. The USIBWC will select a preferred alternative following the public comment period on the Draft EIS.

**Other Requiremnets Served**

This Draft EIS is intended to serve other environmental review and consultation requirements pursuant to:
40 CFR 1502.25(a)

**Comments Submittal**

Comments on this Draft EIS should be directed to:

Mr. Douglas Echlin, Lead
Environmental Protection Specialist
Environmental Management Division, USIBWC
4171 North Mesa Street, C-310
El Paso, Texas 79902

**Date Draft EIS available to EPA and the Public:**

December 26, 2003

**Date by Which Comments on the Draft EIS Must be Received to be Considered in the Preparation of the Draft EIS:**

February 10, 2004

# EXECUTIVE SUMMARY

### *Purpose of and Need For Action*

The United States Section of the International Boundary and Water Commission (USIBWC) is evaluating long-term river management alternatives for the Rio Grande Canalization Project (RGCP), a narrow river corridor that extends 105.4 miles along the Rio Grande, from below Percha Dam in Sierra County, New Mexico to American Dam in El Paso, Texas. The RGCP, operated and maintained by the USIBWC since its completion in 1943, was constructed to facilitate water deliveries to the Rincon and Mesilla Valleys in New Mexico, El Paso Valley in Texas, and Juárez Valley in Mexico, and provide flood control. A levee system for flood control extends 57 and 74 miles over the right and left stream banks, respectively. Figure ES-1 shows the RGCP location.

The USIBWC currently implements operation and maintenance procedures to enhance ecosystem functions within the RGCP. However, the river and floodway will remain highly altered from events pre-dating RGCP construction. Thus, the USIBWC recognizes the need to accomplish flood control, water delivery, and operation and maintenance activities in a manner that enhances or restores the riparian ecosystem.

River management alternatives under consideration address practices such as stream bank stabilization, erosion reduction, and flood control as well as environmental measures intended to support restoration of native riparian vegetation and diversification of aquatic habitats along the RGCP. Potential effects of the alternatives are evaluated in this Draft Environmental Impact Statement (DEIS) prepared for agency and public review.

### *Alternatives Considered in Detail*

Throughout an extended public consultation process, an interdisciplinary team considered several river management alternatives and selected four for detailed analysis. Features of these alternatives are described below. Alternatives were initially formulated in a March 2001 report issued following an 18-month stakeholder consultation period, and subsequently modified to address further input from representatives of regulatory agencies, irrigation districts, environmental organizations and the general public. A Reformulation of River Management Alternatives Report documenting those modifications and the rationale for their adoption was completed in August 2003 as the basis for the DEIS. The USIBWC will select an alternative for implementation after the public comments on the DEIS.

Table ES-1 presents a comparison of measures by management category for the No Action Alternative and three action alternatives. Levee rehabilitation is the core action of the Flood Control Improvement Alternative, along with changes in grazing leases to improve erosion control. These two measures apply to all action alternatives. Most other measures under consideration are associated with floodway management under the Integrated USIBWC Land Management Alternative and Targeted River Restoration Alternative. The latter alternative also considers measures for aquatic habitat diversification such as modified dredging of arroyos and reopening of meanders, as well as riparian vegetation development by induced overbank flows.

### No-Action Alternative

The No Action Alternative consists of continuing RGCP operation and maintenance activities as currently conducted by the USIBWC. Those activities are directed toward flood protection and water delivery, with some activities involving environmental improvements. Key features of this alternative are management of the levee system, floodway maintenance through mowing and grazing leases, maintenance of pilot channel and irrigation facilities, and sediment control and disposal.

Mowing of the floodway is conducted annually, or as circumstances warrant, to control weeds, brush, and tree growth, including salt cedar. The USIBWC administers a land lease program that covers approximately 43 percent of the RGCP floodway. Pilot channel maintenance is performed during non-irrigation periods when water levels are lowest by removing debris and deposits, including sand bars. The USIBWC is also responsible for maintaining five NRCS sediment control dams in tributary arroyos and associated access roads. The agency conducts dredging at the mouth of arroyos to maintain grade of the channel bed and ensure the channel conveys irrigation deliveries.

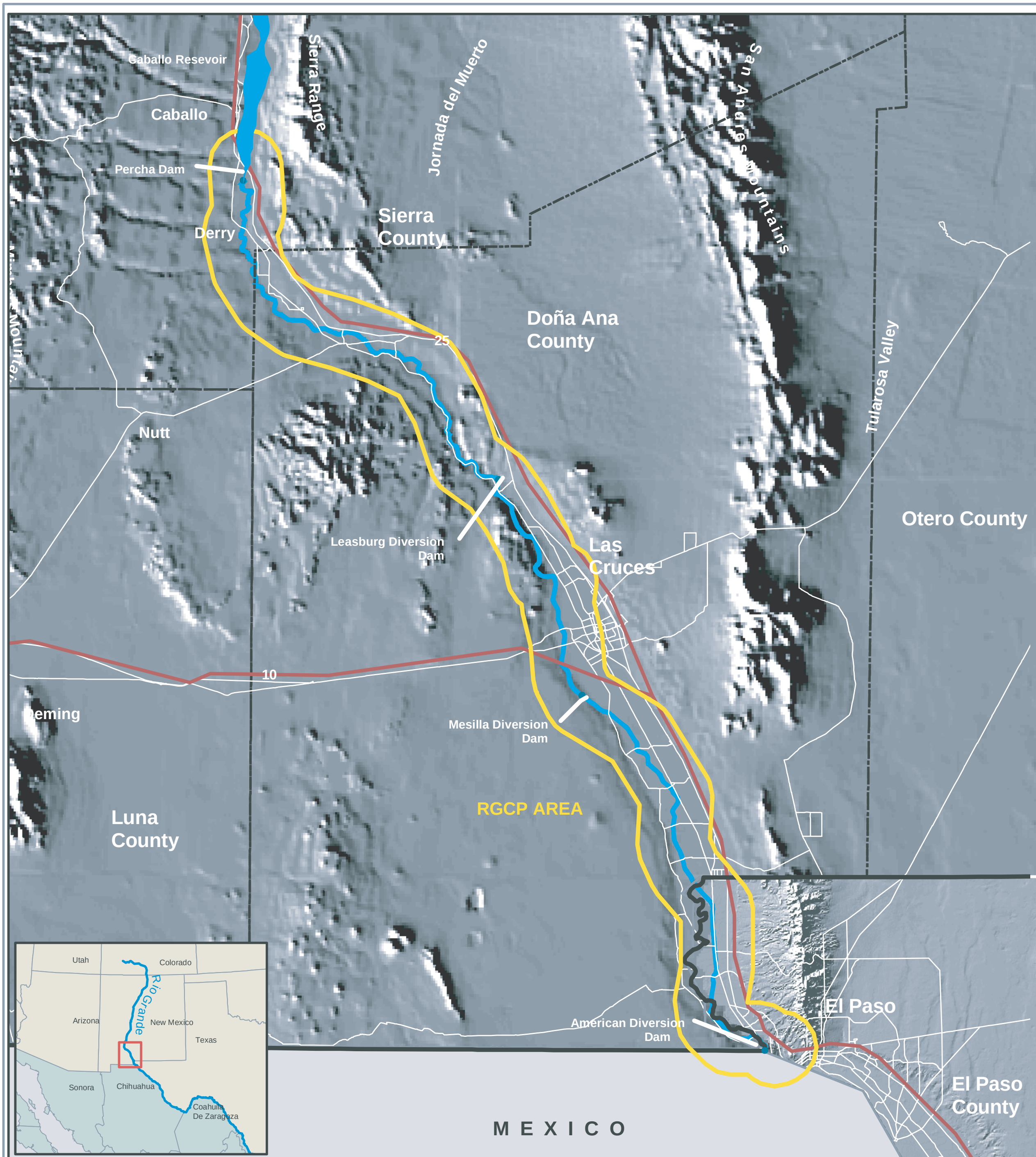
### Flood Control Improvement Alternative

This alternative takes into consideration a potential increase in flood containment capacity. A 1996 hydraulic modeling study by the U.S. Army Corps of Engineers (USACE) identified a number of potential deficiencies in the RGCP in the event of the 100-year storm event. Those findings were partially re-evaluated as part of the DEIS to include potential effects of environmental measures such as additional vegetation growth in the floodway. Most of the potential levee deficiencies were identified within urbanized reaches of the RGCP.

The assumption used for the DEIS was that existing levees would be raised to meet freeboard design criteria, and new levees would be constructed in unconfined areas where flood levels could extend past the ROW boundary. Based on this assumption, levee rehabilitation included 60.1 miles of levees needing a 2 feet average height increase, 6 miles of new levees, and a 2.8 mile floodwall in the Canutillo area. As part of this alternative the grazing lease management program would be modified to improve erosion control. The modified program would include a variety of vegetation treatments to control salt cedar in lease areas.

### Integrated USIBWC Land Management Alternative

In addition to measures for flood control improvement and erosion protection, this alternative incorporates environmental measures within the floodway. All environmental measures would be limited to lands under USIBWC jurisdiction. A key feature of the Integrated USIBWC Land Management Alternative is the development of a riparian corridor for bank stabilization and wildlife habitat by planting and stream bank reconfiguration at selected locations. Stream bank reconfiguration would allow overbank flows within the floodway to provide conditions suitable for establishment of native riparian species, particularly cottonwoods. Under this alternative, some currently mowed floodway vegetation would be managed to promote native grass development in combination with salt cedar control treatments.




SCALE = 1 : 1,000,000 or 1 INCH = 83,333 FEET
UTM Zone 13 N / NAD 83

0 5 10 20 30 40 Kilometers

0 3 6 12 18 24 Miles

**Figure ES-1**
**Location of the Rio Grande Canalization Project (RGCP)**

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\GIS-Mapping\USIBWC_location_map_fig1.mxd

## Table ES-1 Comparison of Alternative Features

| Management Category | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Levee System Management | Routine levee and road maintenance | No change | No change | No change |
| | n/a | Levee system improvements | Levee system improvements | Levee system improvements |
| Floodway Management | Unmodified grazing leases | Modified leases for erosion control (3,552 ac) | Modified leases for erosion control (3,552 ac) | Modified leases for erosion control (3,493 ac) |
| | Continue seasonal mowing (4,657 ac) | No change | Continued mowing (2,674 ac) | Continued mowing (2,223 ac) |
| | | | Modified grassland management (1,641 ac) | Modified grassland management (1,641 ac) |
| | | | Native vegetation planting (223 ac) | Native vegetation planting (189 ac) |
| | | | Stream bank reconfiguration (127 ac) | Seasonal peak flows / bank preparation (516 ac) |
| | n/a | n/a | n/a | Voluntary conser-vation easements (1,618 ac) |
| Channel and Irrigation Facilities Management | Debris removal and channel protection | No change | No change | No change |
| | American Dam and irrigation structures maintenance | No change | No change | No change |
| | n/a | n/a | n/a | Reopening of six former meanders (147 ac) |
| Sediment Management | NRCS sediment dam maintenance | No change | No change | No change |
| | Sediment removal from arroyos / mitigation actions | No change | No change | Modified arroyo dredging for aquatic habitat (12 arroyos) |
| | Disposal from dredging channel within ROW* | Disposal mainly outside ROW* | Disposal mainly outside ROW* | Disposal mainly outside ROW* |
| | n/a | n/a | Disposal from environmental measure excavation inside ROW* | Disposal from environmental measure excavation inside ROW* |

* Right-of-way of the Rio Grande Canalization Project (lands under USIBWC jurisdiction)

### *Targeted River Restoration Alternative*

This alternative emphasizes environmental measures associated with partial restoration of the RGCP, such as pulse flows to promote riparian corridor development, and opening of meanders and modification of arroyos to increase aquatic habitat diversification. This alternative includes measures previously identified for flood control improvement and modification of grazing leases.

Vegetation management for this alternative includes planting and enhancement of existing native woody vegetation, and modified grassland management, as previously indicated for the Integrated USIBWC Land Management Alternative. These measures would be complemented by use of seasonal peak flows to promote natural regeneration of riparian bosque, and the use of conservation easements.

Seasonal peak flows are controlled water releases from Caballo Dam during high storage conditions in Elephant Butte Reservoir. Environmental measures would extend beyond the ROW through the use of voluntary conservation easements to preserve existing wildlife habitat and encourage native bosque development.

Re-establishment of six former meanders eliminated during construction of the RGCP would be conducted to diversify aquatic habitat, required for breeding and spawning of native fish species. In addition, dredging of some arroyos would be modified to create backwaters for additional diversification of aquatic habitats.

### *Implementation Strategy*

*Program Management*. Use of adaptive management is anticipated in implementing river management alternatives. Adaptive management is a science-based decision process that will lead to better management through a systematic process of prediction, application, monitoring, feedback, and improvement.

It is envisioned that adaptive management would be implemented through coordination with the Paso del Norte Watershed Council established by the New Mexico-Texas Water Commission. The Council would serve in an advisory capacity regarding selection, planning, and implementation of environmental measures. It would also recommend policies for cooperation and sharing information concerning planning and management activities of other projects potentially affecting the operation and management of the RGCP. Guidance for future project needs and measures would be provided by an External Advisory Committee to obtain impartial, scientifically informed evaluations based on a long-term monitoring and evaluation program.

*Water Acquisition and Cooperative Programs*. Because a number of measures under consideration would result in water consumption, water rights acquisition and cooperation with the irrigation districts become critical elements in the viability and long-term sustainability of environmental measures. Given that the USIBWC does not likely have any water rights within the RGCP, options for acquisition were evaluated. Support of water conservation by financing on-farm water conservation programs was identified as the most viable strategy to secure water. Conservation programs would not only be consistent with stated interests and ongoing programs of the irrigation districts, but would also facilitate seeking funds from high-priority state and federal programs. Cooperation agreements would be established with other agencies for increased sediment control at a watershed level, and to secure and manage voluntary conservation easements.

*Implementation Timetable*. Levee rehabilitation, improvements in erosion control, establishment of a riparian corridor and diversification of aquatic habitats are envisioned as long-term processes that will evolve as the effectiveness of individual projects are documented. A 20-year timeline was adopted for implementation of alternatives under consideration. During an initial 5-year phase, implementation plans would be developed and funded, agreements would be reached for interagency cooperation and water acquisition, selected projects would be tested at a pilot scale and monitoring conducted. Priority projects would be implemented during a second 5-year phase. A 10-year final phase would be used for implementation of the remaining projects.

### *Potential Effects of the Alternatives*

Thirteen resource areas were evaluated to assess potential effects of the river management alternatives. For each resource area, evaluation criteria were identified and applied to the various measures under consideration. Table ES-2 presents a comparison of alternatives in terms of potential effects.

## Table ES-2 Summary Comparison of the Effects of the Alternatives

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Water Resources | No-mow zones would be maintained, with a potential consumption of up to 35.3 ac-ft/yr (0.62 ft/yr water use over 57 acres).<br>No effects on water delivery or water quality are anticipated as current practices would be maintained. | A potential 1,078 ac-ft/yr increase in water consumption due to environmental measures. Water consumption would increase 0.17 percent of the combined diversions of Rio Grande Project water along the RGCP.<br>No impacts on water delivery are anticipated for levee system rehabilitation, or changes in grazing leases in uplands.<br>Water quality could decrease in terms of total suspended solids during construction, but it would improve in the long-term by a reduced sediment load and lower nutrient input from grazing areas with improved vegetative cover. | A potential water consumption increase of 2,203 ac-ft/yr at the completion of the 20-year implementation period (0.36 percent of the combined water diversions along the RGCP).<br>Development of riparian vegetation on stream banks would have a long-term positive effect on water delivery as cottonwood, once established, would provide stability to the stream bank. Short-term increases in debris and sediment in the river would be expected prior to establishment of vegetative cover.<br>Water quality is likely to improve as more extensive vegetative cover on the RGCP floodway and uplands improve erosion control and nutrient release from grazing areas. | A potential for a water consumption increase of approximately 9,461 ac-ft/yr at the completion of the 20-year implementation period. This value would be equivalent to 1.55 percent of the combined water diversions along the RGCP.<br>Effects on water delivery and water quality would be similar to those of the Integrated USIBWC Land Management Alternative. |
| Flood Control | The risk of flooding and overtopping the levees from the 100-year flood would remain as currently quantified. | Additional protection would be provided to life and public and private property beyond that which is already provided by the existing levee system. | Similar to the Flood Control Improvement Alternative. There would also be a potential for a small reduction in flood containment capacity due to increased vegetation growth along the floodway. | Similar to the Flood Control Improvement Alternative. There would also be a potential for a small reduction in flood containment capacity due to increased vegetation growth along the floodway. |
| Soils | No change from baseline condition. | Levee rehabilitation would mobilize 898 ac-ft of soil for construction. Modified grazing leases would reduce uplands erosion 0.45 ac-ft annually and improved riparian conditions by reducing bank erosion and increasing ground cover. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>An additional 157 ac-ft of soil would be displaced as a result of bank shave-downs. Mitigation procedures were established to reduce erosion. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>An additional 300 ac-ft of soil would be displaced as a result of opening former meanders, excavating arroyos and scour during seasonal peak flows. Mitigation procedures were established to reduce erosion. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Vegetation and Wetlands | No change from baseline condition. | Modified grazing in uplands and riparian zones would affect 3,552 acres increasing plant species, richness and structural diversity. Levee construction would have a minor effect on vegetation communities.<br><br>Mowing by USIBWC would continue at the same level as the No Action Alternative. | Effects of modified grazing leases and levee construction would be similar to the Flood Control Improvement Alternative.<br><br>Mowing by USIBWC would be reduced by 1,983 acres.<br><br>Restoration of 350 acres of native bosque by bank shavedowns and plantings, and development of native grasslands (1651 acres) would increase the amount of native vegetation within the ROW.<br><br>Wetland areas would increase by 13 acres. | Effects of modified grazing leases and levee construction would be similar to the Flood Control Improvement Alternative.<br><br>Mowing by USIBWC would be reduced by 2,434 acres.<br><br>Restoration of 1,549 acres of native bosque by seasonal peak flows, opening meanders, plantings and development of native grasslands (1,029 acres) would increase the amount of native vegetation within and outside the ROW.<br><br>Wetland areas would increase by 96 acres.<br><br>Conservation easements would add 1,601 acres under management. |
| Wildlife Habitat | No change from baseline condition. | Wildlife habitat quality would increase 30% due to modified grazing in 3,552 acres of uplands and riparian areas. However, the majority of the ROW would continue to be considered as below average to poor wildlife quality due to mowing of vegetation.<br><br>Construction associated with levee rehabilitation would be a short minor effect.<br><br>Modification of salt cedar management in grazing leases methods would result in long-term beneficial effects. | Wildlife habitat quality would increase 51% due to modified grazing in 3,552 acres of uplands and riparian areas, and development of 350 acres of native bosque and 1,641 acres of native grassland.<br><br>Construction associated with levee rehabilitation and environmental measures would be a short minor effect.<br><br>Modification of salt cedar management in grazing leases methods would result in long-term beneficial effects. | Wildlife habitat quality would increase 72% due to modified grazing in 3,493 acres of uplands and riparian areas, and development of 1,549 acres of native bosque and 1,929 acres of native grassland.  A total of 1,618 acres of conservation easements significantly increases the amount of high quality wildlife habitat.<br><br>Construction associated with levee rehabilitation and environmental measures would be a short minor effect<br><br>Modification of salt cedar management methods for grazing leases would result in long-term beneficial effects. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Endangered and Other Special Status Species | No change from baseline condition. | Levee construction activities would not affect endangered and other special status species .<br>Modified grazing in uplands and riparian would benefit some species of concern (SOCs). | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>Development of native bosque using bank shavedowns could potentially create suitable southwestern willow flycatcher habitat and benefit some SOCs. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>Development of native bosque along meanders could potentially create suitable southwestern willow flycatcher habitat and benefit some SOCs.<br>Suitable habitat for listed species may exist within conservation easements outside the ROW. Adverse effects would be entirely mitagable. |
| Aquatic Biota | No change from baseline condition. | No significant change from baseline condition would occur.<br>The RGCP would continue to be characterized as poor aquatic habitat, however modified grazing in the riparian area would beneficially effect stream bank stability, water quality and stream side vegetation. | No significant change from baseline condition would occur.<br>The RGCP would continue to be characterized as poor aquatic habitat, however modified grazing in the riparian area in conjunction with bosque development would beneficially effect stream bank stability, water quality and stream side vegetation. | Aquatic biota would be beneficially affected as a result of diversifying aquatic habitat through modified dredging of arroyos and opening former meanders. A total of 59 acres of backwater habitat would be developed. In addition, modified grazing in the riparian area and bosque development would beneficially effect stream bank stability, water quality and stream side vegetation. |
| Land Use | Land use in the potential area of influence would remain unaffected relative to current conditions.<br>Beneficial effects are expected from ongoing recreational initiatives.<br>The RGCP operation and maintenance would not change from the current practices. | Levee rehabilitation would be the only action with potential effects on land use adjacent to the RGCP. Up to 50 acres of the approximately 149 acres of borrow sites would be likely located in agricultural areas. Land use change would not be significant relative to 19,020 acres of farmlands in the potential area of influence.<br>Beneficial effects are expected from ongoing recreational initiatives. | Up to 50 acres of agricultural land would be needed as borrow sites. With implementation of an on-farm water conservation program, no other changes in land use are anticipated.<br>With direct purchase of water rights, environmental measure implementation could result in 734 acres of cropland retirement (3.9 percent of the potential 19,020 acres in the area of influence).<br>Beneficial effects are expected from ongoing recreational initiatives. | Conservation easements would affect up to 288 acres of cropland in addition to 50 acres of borrow sites. Current use would be maintained for another 1,330 acres of remnant bosques.<br>Without a water conservation program, environmental measure implementa-tion could result in 3,154 acres of cropland retirement (16.6 percent of farmland in the area of influence).<br>Beneficial effects are expected from ongoing recreational initiatives. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Socioeconomics and Environmental Justice | There would be no changes in population and housing, employment, or a disproportionate number of minority population affected | Similar to the No Action Alternative, except there would be additional short-term jobs as a result of levee rehabilitation activities. | Similar to the No Action Alternative, with the addition of short-term jobs as a result of an increase in construction activities. With on-farm conservation, no adverse effects on agricultural communities are anticipated.<br><br>For direct water acquisition, the potential annual loss in crop value would be approximately $900,000. | Similar to the No Action Alternative, except there would be additional short-term jobs by increase in construction activities. With on-farm conservation, no adverse effects on agricultural communities are anticipated.<br><br>For direct water acquisition, the potential annual loss in crop value would be approximately $4 million. |
| Cultural Resources | The No Action Alternative will not affect, or adversely affect, any architectural resources, traditional cultural properties or archaeological resources. | Similar to the No Action Alternative. | Similar to the No Action Alternative, except there would be a potential for undiscovered sites at two locations near shavedown projects. | Similar to the No Action Alternative, except there would be a potential for undiscovered sites at three sites located near arroyo or meander projects. |
| Air Quality | Emissions generating activities would be the same as the current ongoing activities. | Criteria pollutant increases in the Air Quality Control Region (AQCR) would range from 0.05 to 0.93 percent and would not be regionally significant. | Criteria pollutant increases in the AQCR would range from 0.01 to 1.25 percent and would not be regionally significant. | Criteria pollutant increases in the AQCR would range from 0.12 to 1.62 percent and would not be regionally significant. |
| Noise | Noise levels from existing maintenance and operation activities would not change relative to current conditions. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. |
| Transportation | There would be no increases in traffic or adverse affect on a roadway's existing level of service (LOS). | The LOS of all listed roadways would not change from existing conditions. | The LOS of all listed roadways would not change from existing conditions. | The LOS of all listed roadways would not change from existing conditions. |

# TABLE OF CONTENTS

**APPENDICES:**

# LIST OF FIGURES

# LIST OF TABLES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg/m3 | Micrograms per cubic meter |
| ac | Acre |
| ac-ft | Acre-feet (of water or sediment) |
| ac-ft/yr | Acre-feet per year |
| AQCR | Air Quality Control Region |
| ARPA | Archaeological Resources Protection Act |
| BLM | Bureau of Land Management |
| BMP | Best Management Practices |
| CAAA | Clean Air Act Amendments |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | Cubic feet per second |
| CO | Carbon monoxide |
| cy | Cubic yards |
| dBA | Air-weighted sound level (decibels) |
| DNL | Day-night average sound level |
| EBID | Elephant Butte Irrigation District |
| EIFS | Economic Impact Forecast System |
| EIS | Environmental Impact Statement |
| EPCWID#1 | El Paso County Water Improvement District No. 1 |
| EPWU/PSB | El Paso Water Utilities/Public Service Board |
| ESA | Endangered Species Act |
| ft/yr | Feet of water (acre-feet per acre) per year |
| FWCA | Fish and Wildlife Coordination Act |
| HEP | Habitat Evaluation Procedure |
| HQ | Habitat Quality |
| HSI | Habitat Suitability Index |
| HU | Habitat Units |
| lbs | Pounds |
| LOS | Level of service |
| Lp | Sound pressure level |
| MOU | Memorandum of Understanding (MOU) |
| MUSLE | Modified Universal Soil Loss Equation |
| MVEDA | Mesilla Valley Economic Development Alliance |
| NAAQS | National Ambient Air Quality Standards (NAAQS) |
| nc | No change |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NMDGF | New Mexico Department of Game and Fish |

| | |
|---|---|
| NMED | New Mexico Environment Department |
| NMOSE | New Mexico Office of the State Engineer |
| $NO_2$ | Nitrogen dioxide |
| NOX | Nitrogen oxides |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| O&M | Operation and maintenance |
| $PM_{10}$ | Particulate matter less than or equal to 10 micrometers in diameter |
| RGCP | Rio Grande Canalization Project |
| RMU | River Management Unit |
| ROD | Record of Decision |
| ROW | Right-of-way |
| SHPO | State Historic Preservation Officer |
| RTV | Rational Threshold Value |
| SOC | Species of Concern |
| SOX | Sulfur oxides |
| spp | Species |
| SWEC | Southwest Environmental Center |
| T&E | Threatened and endangered |
| TCEQ | Texas Commission on Environmental Quality |
| TPWD | Texas Parks and Wildlife Department |
| tpy | Tons per year |
| TSP | Total suspended particulates |
| URGWOM | Upper Rio Grande Water Operations Model |
| USACE | U.S. Army Corps of Engineers |
| USBR | United States Bureau of Reclamation |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USIBWC | United States Section, International Boundary and Water Commission |
| VOC | Volatile organic carbohydrates |
| WHAP | Wildlife Habitat Appraisal Procedure |

# SECTION 1
# PURPOSE OF AND NEED FOR ACTION

This section introduces the Draft Environmental Impact Statement (DEIS), discusses the purpose and need, gives the basis for preparing the DEIS, reviews prior environmental evaluations relevant to the DEIS, details the background organization and mission of the United States Section, International Boundary and Water Commission (USIBWC), describes the function and history of the Rio Grande Canalization Project (RGCP), and summarizes the permits and licenses under authority and institutional involvement for this proposal. It concludes by outlining the structural organization of the DEIS.

## 1.1 PURPOSE OF AND NEED FOR ACTION

### 1.1.1 Proposed Action and Need

The USIBWC is evaluating long-term river management alternatives for the RGCP, a narrow river corridor that extends 105.4 miles along the Rio Grande, from below Percha Dam in Sierra County, New Mexico to American Dam in El Paso, Texas. The RGCP was constructed from 1938 to 1943 to provide flood control and facilitate water deliveries to the Rincon and Mesilla Valleys in New Mexico, El Paso Valley in Texas, and Juárez Valley in Mexico.

Since its completion the RGCP has been operated and maintained by the USIBWC based in El Paso, Texas. The agency is currently evaluating river management alternatives for future operation and maintenance of the RGCP to enhance ecosystem restoration while accomplishing its flood control and water delivery mission. Potential environmental effects of implementing these alternatives are evaluated in this DEIS.

The USIBWC currently implements operation and maintenance procedures to enhance ecosystem functions within the RGCP. Although current procedures will continue to improve ecological conditions, the river and floodway will remain altered from the native riparian and aquatic conditions that existed before the RGCP was constructed unless additional ecosystem restoration actions are undertaken. Thus, the USIBWC recognizes the need to accomplish flood control, water delivery, and operations and maintenance activities in a manner that restores, if possible, and enhances the restoration of native habitat conditions in the RGCP.

The USIBWC proposes to implement expanded ecosystem enhancing river management strategies for its RGCP operation and maintenance activities, while continuing to deliver water and provide flood control in accordance with the existing convention, treaty, and agreements between the United States and Mexico. The potential for reestablishing native ecosystem conditions with actions that would be implemented under the new river management alternatives would be greater than that which can be achieved under the current operation and maintenance practices. The river management strategies being considered include measures such as in-stream structures and other river alternatives to improve riparian wildlife habitat, and the use of watershed-oriented and non-structural operational practices that support restoration of riparian and aquatic habitats. The river management strategies also include construction activities such as raising and strengthening existing levees, and widening or armoring the channel. Under these expanded management strategies, the USIBWC would take a leadership role in promoting environmental enhancement of the Rio Grande corridor from Percha Diversion Dam to American Diversion Dam.

### 1.1.2 Criteria for Alternatives Formulation

The criteria for selecting this strategy would be based on opportunities and constraints dictated by the RGCP functional requirements and river conditions. Over a three year period the USIBWC formulated alternatives through extensive review of river restoration methods and techniques, modeling of river conditions, scoping and consulting with various stake holders and regulatory agencies. The compilation of these activities resulted in overall criteria used as guidance for alternative management strategies proposed in this DEIS. These criteria are described below.

- Consider ecosystem restoration and environmental improvements based on post Canalization project construction. The challenge is not restoring the river to historic conditions but to make environmental improvements to a river that now functions as a water conveyance and delivery system. Baseline conditions used for restoration considerations will be the 1938 time period.
- Develop environmental measures that would take advantage of existing hydrologic conditions and the ability to manage river flows from upstream reservoirs within certain reaches of the river. Management of river flows from upstream reservoirs would be constrained by infrastructure limitations, water delivery requirements and water availability. Partially restoring riparian ecosystem within these hydrologic constraints has been demonstrated in other reaches of the Rio Grande.
- Modify USIBWC management practices within the right-of-way (ROW) that would enhance ecosystem improvements for wildlife while allowing the USIBWC to meet proper flood control requirements. Past USIBWC vegetation management practices within the ROW may be changed to further improve ecosystem conditions within the RGCP.
- Evaluate flood control issues including non-structural methods in conjunction with river restoration potential. The effects of restoration or habitat improvements must be consistent with USIBWC mission requirements.
- Identify and evaluate environmental measures that would consider restoration within and outside of the USIBWC ROW. Opportunities for environmental improvements exist adjacent to the ROW on lands not managed by the USIBWC.
- Consider channel morphology changes that would enhance riparian and aquatic habitats. Meanders and arroyos entering the RGCP have been modified in the past to enhance water conveyance.

- Review the benefits of in-stream structures for improving aquatic habitat and consider expanding in-stream structures within the RGCP . In stream structures have been added to the RGCP as mitigation to improve aquatic habitats.

These criteria above were used to establish a suite of alternatives for evaluating in the DEIS. All alternatives are evaluated and given the same level of consideration. After comments have been received on the DEIS the USIBWC will then select a preferred alternative. The preferred Alternative will be identified in the final Environmental Impact Statement.

### 1.1.3 Authority

Changes under consideration for RGCP operation and maintenance and implementation of environmental measures constitute a major federal action requiring preparation of an Environmental Impact Statement as stipulated by:

- The National Environmental Policy Act (NEPA) of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, and Pub. L. 94-83, August 9, 1975);
- The Council on Environmental Quality, Executive Office of the President, Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508), and
- The USIBWC Operational Procedures for Implementing Section 102 of NEPA as published in the Federal Register on September 2, 1981 (46 CFR 44083-44094).

The USIBWC is the lead federal agency for preparation of this Environmental Impact Statement. The United States Bureau of Reclamation (USBR, Albuquerque Area Office, New Mexico) is a cooperating agency.

## 1.2 BACKGROUND

### 1.2.1 USIBWC Organization and Mission

The International Boundary and Water Commission was created by the Convention of 1889 to apply the rights and obligations that the Governments of the United States and Mexico assumed under the numerous boundary and water treaties and related agreements. Application of the rights and obligations is to be accomplished in a way that benefits the social and economic welfare of the peoples on each side of the boundary and improves relations between the two countries. The agency, which before 1944 was known as the International Boundary Commission, consists of a United States Section and a Mexican Section.

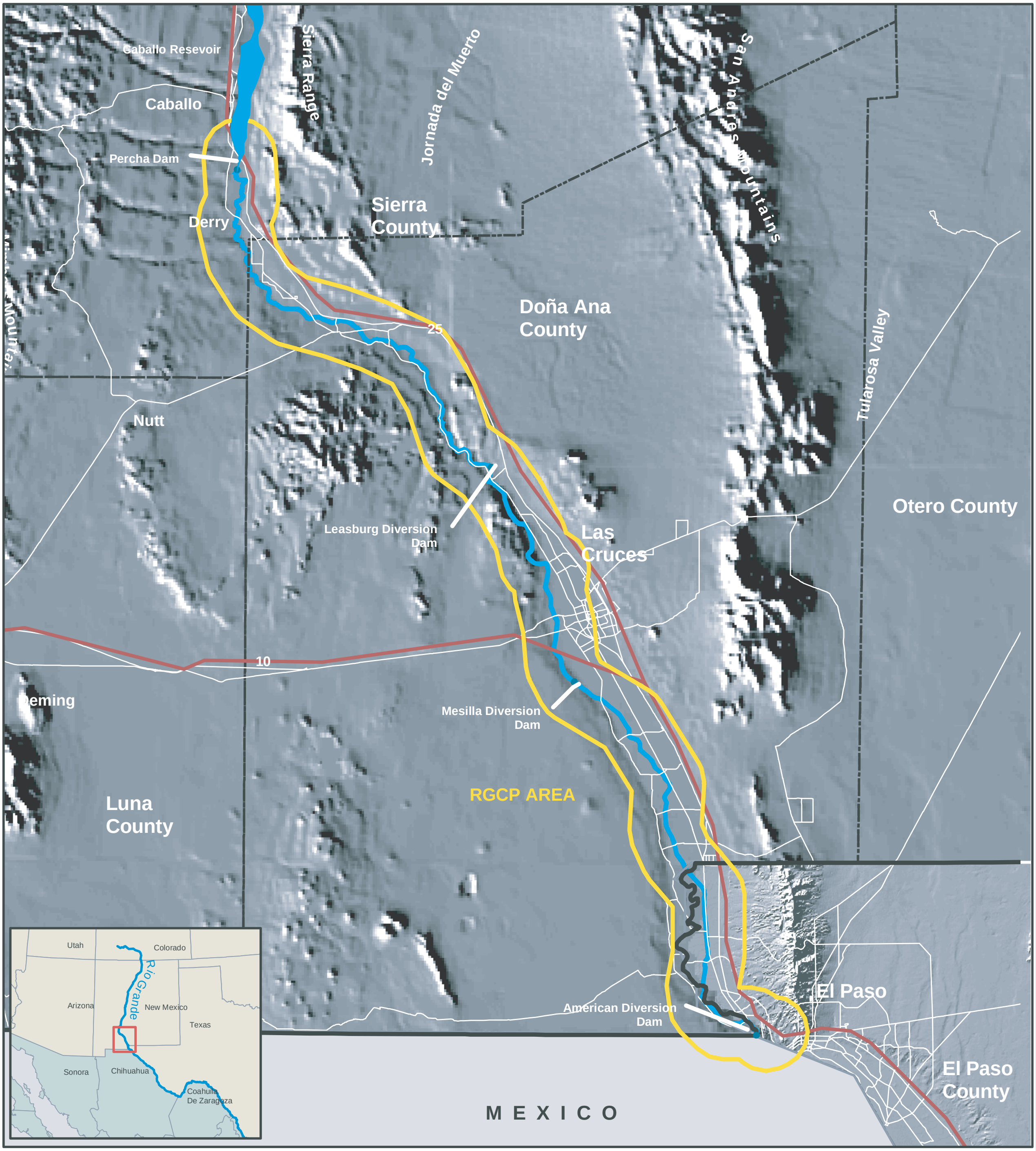
The Convention of 1906 provided for the distribution between the United States and Mexico of waters of the Rio Grande above Fort Quitman, Texas for the 89-mile international boundary reach of the Rio Grande through the El Paso-Juárez Valley. This Convention allotted waters of the Rio Grande to Mexico in the amount of 60,000 acre-feet annually of the waters of the Rio Grande to be delivered in accordance with a monthly schedule at the headgate to Mexico's Acequia Madre just above Ciudad Juárez, Chihuahua. To facilitate the water deliveries, the United States constructed the Elephant Butte Dam in its territory in 1916. The agreements include the provision that, in case of extraordinary drought or a serious accident to the irrigation system in the United States, the amount of water delivered to the Acequia Madre shall be diminished in the same proportion as the water delivered to lands under the irrigation system in the United States downstream of Elephant Butte Dam.

The rights and obligations established in the conventions, treaties, and agreements between the United States and Mexico include:

- Distribution between the two countries of waters of the Rio Grande and of the Colorado River;
- Regulation and conservation of waters of the Rio Grande for use by the two countries through joint construction, operation and maintenance of international storage dams and reservoirs and plants for generating hydroelectric energy at the dams; and regulation of the Colorado River waters allocated to Mexico;
- Protection of lands along the river from floods through levee and floodway projects; and solution of border sanitation and other border water quality problems;
- Preservation of the Rio Grande and the Colorado River as the international boundary; and
- Demarcation of the land boundary.

The mission of the United States Section of the International Boundary and Water Commission (referred to as the USIBWC in this document) is "… to provide environmentally sensitive, timely, and fiscally responsible boundary and water services along the United States and Mexico border region." The USIBWC " …pledges to provide these services in an atmosphere of binational cooperation and in a manner responsive to public concerns." By this, the USIBWC is committed to protecting and enhancing riparian and aquatic habitat in the RGCP.

To accomplish its mission in this reach of the Rio Grande, the USIBWC has: constructed, operated, and maintained the RGCP; implemented a Rio Grande Management Plan for Sediment Control; signed an agreement for improving the environmental quality of the RGCP; implemented environmental enhancement actions; and developed a river management plan for the overall management of the RGCP. Figure 1-1 depicts the RGCP location.




SCALE = 1 : 1,000,000 or 1 INCH = 83,333 FEET
UTM Zone 13 N / NAD 83

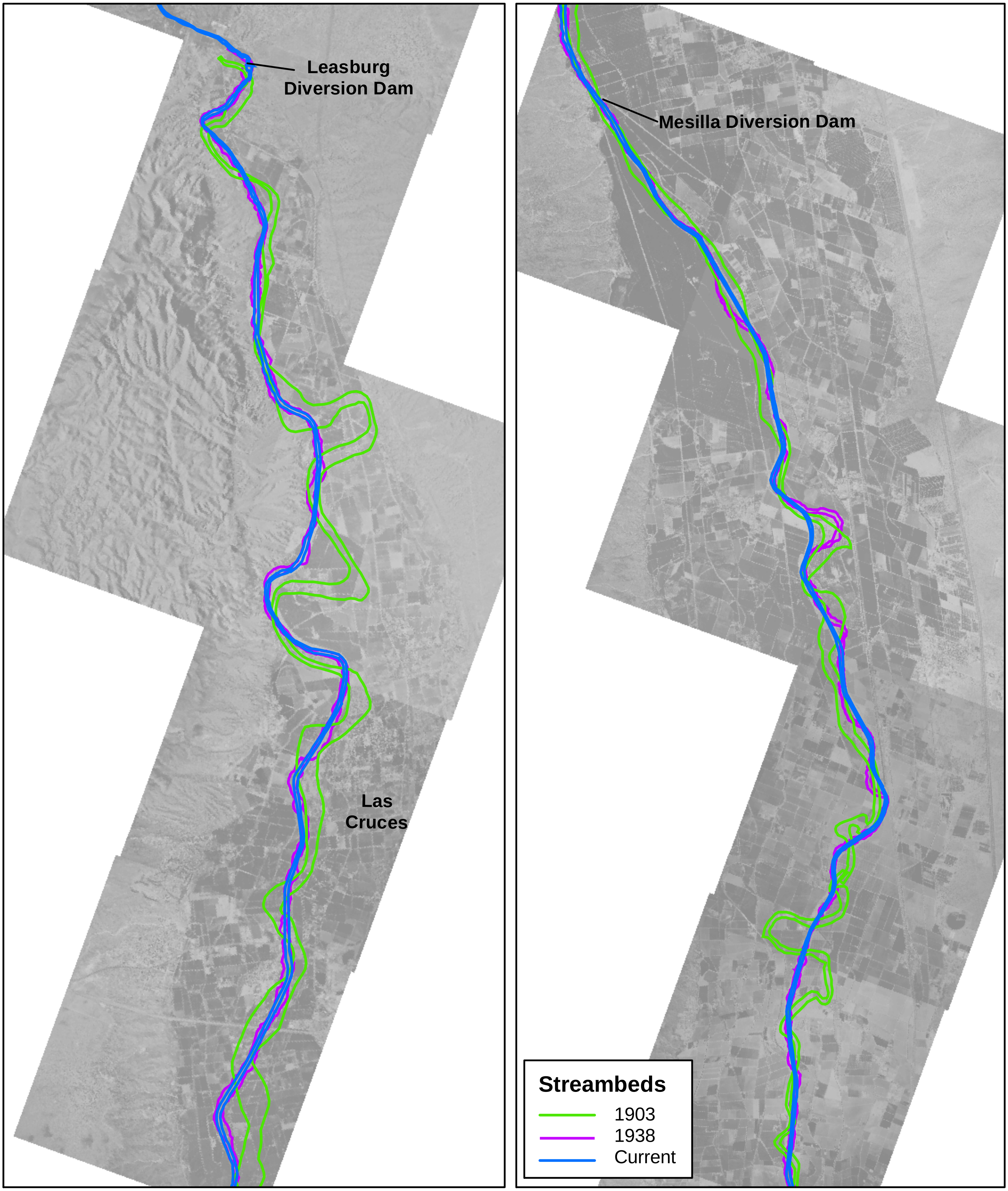
0 5 10 20 30 40 Kilometers

0 3 6 12 18 24 Miles

**Figure 1-1**
**Location of the Rio Grande Canalization Project (RGCP)**

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\GIS-Mapping\USIBWC_location_map_fig1.mxd




North 20
SCALE = 1 : 135,000 or 1 INCH = 11,250 FEET
UTM Zone 13 N / NAD 83

0 0.5 1 2 3 4 Kilometers

0 0.5 1 2 3 4 Miles

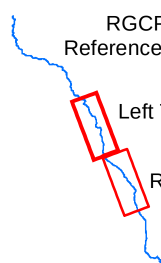



**Figure 1-2**
**Comparison of Current Channel and Pre-RGCP Conditions in Rincon and Mesilla Valleys**

United States Section,
International Boundary Water Commission
December 2003

### 1.2.2 Rio Grande Canalization Project

The RGCP was constructed between 1938 and 1943, as authorized by an Act of Congress approved June 4, 1936 (49 Stat. 1463) to facilitate compliance with the 1906 Convention and to properly regulate and control, to the fullest extent possible, the water supply for use in the two countries as provided by the treaty. The RGCP includes the river channel and adjoining right-of-way for which the USIBWC has legal control. The RGCP extends for about 105.4 miles along the Rio Grande from the Percha Diversion Dam, located downstream from Caballo Dam in Sierra County, New Mexico, to the vicinity of the American Diversion Dam in El Paso County, Texas (Figure 1-1).

The 1936 Act authorized the construction and operation and maintenance (O&M) of the RGCP in agreement with the Engineering Record Plan of December 14, 1935 (Baker 1943). Major elements of the plan were acquisition of ROW for the river channel and adjoining floodways; improvement of the alignment and efficiency of the river channel conveyance for water delivery; and flood control measures that extend through the Rincon and Mesilla Valleys of New Mexico and El Paso Valley in Texas.

#### *Channel Construction*

As part of the RGCP, a deeper main channel was dredged for a length of 95 miles to facilitate water deliveries for irrigation. The river varies in width from 175 to 300 feet with a depth of 2 to 3 feet in the lower reaches and 7 to 10 feet in the upper reaches. Sections of the river bank are armored with rock revetment to reduce erosion and help maintain a consistent channel alignment. The canalization process removed a number of meanders, reducing the overall RGCP length by approximately 10 miles due to channel cutoffs (Baker 1943). Figure 1-2 illustrates current river alignment in the Rincon and Mesilla Valleys relative to the 1938 configuration at the beginning of the RGCP construction (New Mexico Resource Geographic Information System data, http://rgis.unm.edu/intro.cfm). Stream alignment in 1903 is also presented to illustrate extensive changes in stream configuration, largely associated with upstream flow control, that preceeded by several decades construction of the RGCP.

Improvement in the river channel conveyance efficiency was required to deliver irrigation waters both to Mexico, in compliance with the Convention of 1906, and to the USBR Rio Grande Project in the Las Cruces and El Paso region. The USBR Rio Grande Project is a regional water initiative that furnishes irrigation water for about 178,000 acres of land, and electric power for communities and industries in south-central New Mexico and west Texas. Elephant Butte Reservoir, constructed from 1912 to 1916, provides most of the storage for the USBR Rio Grande Project, while three diversion dams route stored water to the irrigation canals: Leasburg Dam, completed in 1908, and Percha and Mesilla Dams, constructed between 1914 and 1919 (USBR 2002).

#### *Flood Control*

Flood control levees were placed along 131 miles of the RGCP, nearly two-thirds of its length. Associated flood control activities included clearing and leveling of approximately 3,400 acres on the floodplain, diverting arroyo outlets, and construction of sediment control dams. The total sediment volume moved during the original canalization project was over 13 million cubic yards (Baker 1943). Additional features included installation of pipe culverts and drainage gates, removal and construction of bridges, building of access roads, and placement of miles of fence revetment to prevent erosion and create new channel banks.

Since completion of the RGCP, a significant operational change was the construction of sediment/flood control dams in tributary arroyos in the early 1970s by the United States Natural Resources Conservation Service (NRCS). A combination of flood control dams at Broad Canyon, Green Canyon, Arroyo Cuervo, and Berrenda Arroyo, controls discharges over 300 square miles of the RGCP tributary basin, and reduce the flood peak by an estimated 40 percent (USACE 1996).

#### *Operations and Maintenance*

The USIBWC has been responsible for maintaining the flood control and water delivery capabilities of the RGCP since its completion in 1943. To accomplish this mission the agency performs O&M activities that include sediment removal from the channel and lower end of the arroyos; leveling of the floodway; vegetation management along channel banks, floodway, and levees; replacement of channel bank riprap; care of dams on arroyos; and maintenance of infrastructure such as levee roads, bridges, and gates at the American Diversion Dam.

Throughout the years, the USIBWC has strived to incorporate environmental measures and operate and maintain the RGCP to enhance ecosystem restoration while complying with the Congress-mandated mission of flood control and efficient water deliveries to the States of New Mexico and Texas, and to Mexico. Environmental measures included limited planting of cottonwood trees, selective mowing to retain native vegetation and control salt cedar, test areas of limited mowing, and use of artificial in-stream structures to diversify aquatic habitat as required by a Section 404 dredging permit issued by the USACE.

## 1.3 DEIS PREPARATION

### 1.3.1 Memorandum of Understanding

In 1998 the Southwest Environmental Center (SWEC), an environmental advocacy organization based in Las Cruces, New Mexico, stated its belief that an updated, comprehensive Environmental Impact Statement was required for continued operation and maintenance of the RGCP, and alleged violations of the Endangered Species Act and NEPA in correspondence addressed to the USIBWC Commissioner, the U.S. Secretary of State, and the U.S. Secretary of the Interior. On March 22, 1999 the USIBWC and SWEC signed a Memorandum of Understanding that established the terms for the preparation of the Environmental Impact Statement and called for continued flood control while improving the environmental quality of the RGCP. The Memorandum of Understanding also established provisional green zones where mowing would be minimized, a limited tree-planting program, and the Rio Grande Citizens' Forum, a quarterly public meeting that provides interested stakeholders the opportunity to learn and discuss Environmental Impact Statement developments.

### 1.3.2 Agency and Public Participation

The USIBWC issued a Notice of Intent for preparation of the Environmental Impact Statement in August 1999, and conducted two public scoping meetings during October 1999 in Las Cruces, New Mexico, and El Paso, Texas. Preliminary alternatives were then developed and presented for stakeholder review during two technical workshops conducted in September 2000 in El Paso, Texas, and a public meeting in Las Cruces, New Mexico in October 2000. An Alternatives Formulation Report was issued in March 2001 as the basis to determine potential effects associated with river management alternatives for the RGCP (Parsons 2001a).

Following preparation of the Alternatives Formulation Report, the USIBWC conducted additional meetings and focused workshops with representatives of regulatory agencies, irrigation districts, and environmental organizations. These additional meetings were conducted to address comments and concerns expressed to the USIBWC by stakeholders after review of the Alternatives Formulation Report posted on the USIBWC website. Based on input from additional stakeholder contacts, river management alternatives and associated environmental measures were modified to further address stated concerns and recommendations. The Reformulation of River Management Alternatives for the RGCP (Reformulation Report) was completed in August 2003 to document modifications to the alternatives since preparation of the Alternatives Formulation Report, and the rationale for these modifications (Parsons 2003a).

The USIBWC followed an extensive public consultation process for development of the alternatives to be evaluated in the DEIS, and subsequent reformulation. The consultation process followed in the development of alternatives for the DEIS is described in detail in Section 5, Consultation and Coordination. Key issues raised during the consultation process are described below.

### 1.3.3 Significant Issues by Resource Category

Issues identified during the scoping process and formulation of alternatives were organized by resource category. Key concerns are discussed below and a summary is presented in Table 1.3-1. This table also provides cross-references to sections of this DEIS where those issues are addressed.

#### *Water Resources*

A number of issues associated with water resources were presented during the scoping meetings, and were a major consideration in the formulation of alternatives. Concerns were stated by the EBID and EPCWID#1 on the effects of modified river management alternatives on water rights and water availability. A particular concern to the irrigation districts was the possibility that environmental measures such as increased vegetation growth in the floodway, would further reduce water availability during drought conditions. Questions were also raised on effects on water delivery efficiency and changes in water quality that would affect downstream uses.

#### *Flood Control*

Evaluation of changes in flood control management approach were suggested by environmental organizations during scoping to emphasize overall floodway management. This approach would include levee relocation as non-structural flood control measure that would support river restoration by expanding the floodway and allowing reopening of meanders. This recommendation was based on the expectation that potential solutions to RGCP levee deficiencies could be coupled with those environmental improvements. Another suggested measure was the control of developments in the floodplain outside the USIBWC jurisdiction by changes in land use planning. A flood control concern expressed by the irrigation districts was the potential for a significant reduction in RGCP flood containment capacity by increased riparian vegetation growth.

#### *Soils*

A key issue identified during scoping was the control of erosion, and thus sediment load to the river. Some stakeholders recommended erosion control by increased vegetative cover and watershed management as opposed to the use of structural measures such as construction of sediment dams in triburaty basins.

#### *Vegetation*

Development of native riparian vegetation along the RGCP was a central issue in the scoping and alternatives formulation. Cottonwood-willow bosque establishment by planting and lowering of stream bank (shavedowns) were recommended. Controlled releases from upstream reservoirs were also suggested to induce over-bank flows. Other measures proposed during scoping were the restablishment of wetlands and control of salt cedar and other invasive plant species in the floodway. A key issue dicussed during alternative formulation was the adoption of reference conditions for stream restoration

#### *Wildlife Habitat and Endangered and Special-Status Species*

The need to promote wildlife habitat and monitor overall improvement of biological conditions, as well as Fish and Wildlife Coordination Act Report preparation, was stated during scoping meetings. Concerns were also expressed on potential effects on state and federal listed endangered and threatened species.

#### *Aquatic Biota*

Aquatic habitat and biota improvements were identified as key issues during scoping and development of alternatives. Promoting meandering for habitat improvement was suggested, including land acquisition to promote stream widening (move back or breach levees) and other changes in channel structure and geometry. Targeting the mouth of arroyos for habitat improvement was also suggested during scoping, as well as establishment of in-stream flows.

## Table 1.3-1 Summary of Issues Identified During Public Scoping and Alternatives Formulation

| Resource Category | Related Issues | Section Cross-References |
|---|---|---|
| Water Resources | Effects on water rights and water availability | 4.1.1 – 4.1.6 |
| | Promotion of more efficient water usage and water conservation | 2.9.2 |
| | Effects on water quality | 4.1.5, 4.1.6 |
| | Potential loss in water delivery capability | 4.1.1 – 4.1.6 |
| | Concern of implementation during drought conditions | 2.9.2, 3.1.1 |
| Flood Control | Effects of riparian vegetation growth on flood control | 4.2.5 |
| | Change emphasis from flood control to floodplain management | 2.7.3, 2.9.3 |
| | Expand floodplain to manage floodwaters and sediment: and non-structural flood control | 2.7.3, 2.9.3 |
| Soils | Watershed management to reduce erosion | 2.3.2, 2.9.3 |
| | Control erosion through vegetative rather than the use of structural methods | 2.3.2 |
| Vegetation | Riparian habitat restoration by development of a native forested strip along the river | 2.4.2, 2.5.2, 4.4 |
| | Remove salt cedar and other invasive species | 2.4.2, 2.5.2, 4.4.1 |
| | Overbank flooding to restore historic habitat and fluvial processes | 2.5.2, 4.4.6 |
| | Re-establish wetland systems for water quality and habitat | 4.4 |
| Wildlife Habitat | Promote environmental protection and enhancement | 4.5 |
| | Monitor improvements in overall ecosystem health | 2.9.1, 2.10 |
| Endangered Species | Consider the potential effects to state and federal listed endangered and threatened species | 4.6 |
| Aquatic Biota | Target arroyo mouths for channel and riparian improvements | 2.5.4 |
| | Need for modfication of channel structure/geometry | 2.5.3 |
| | Promote meandering and habitat improvement; acquire adjacent property to promote widening | 2.5.3, 2.7.1 |
| | Establish in-stream flows | 2.7.2, 3.7.2 |
| Land Use | Floodplain widening could be incompatible with existing land uses | 4.8 |
| | Effects of management changes on recreation opportunities | 4.8 |
| | Need to expand recreational areas and improve access for hunting | 3.8, 4.8 |
| Socioeconomics and Environmental Justice | Adverse effects in local communities, including water supply | 4.9 |
| | Need to protect vulnerable capital improvements | 4.2, 4.9 |
| Cultural Resources | Potential effects to cultural resources | 4.10 |
| Transportation | Potential adverse effects on transportation facilities in the area | 4.13 |

### *Land Use*

Concerns were expressed on the potential encroachement of an expanded floodplain on existing land uses, particularly agriculture. A number of suggestions were made on the desirability to expand recreational areas and facilitate access to the RGCP for recreational purposes.

### *Other Resources*

Concerns were expressed that changes in the river management approach could have adverse socioeconomic effects in local communities and water supply. Concerns were also expressed during scoping on potential effects on cultural resources and transportation facilities in the area.

## 1.3.4 Opportunities and Constraints

Opportunities and constraints were identified for changes in river management to develop realistic goals for development of environmental measures. Tables 1.3-2 and 1.3-3 list opportunities and constraints associated with RGCP functionality (continued flood control and water issues, respectively); those related to river restoration potential are summarized in Tables 1.3-4 and 1.3-5. Restoration potential addresses two key objectives used in the formulation of alternatives: development of a riparian corridor along selected reaches of the RGCP, and diversification of aquatic habitats.

**Table 1.3-2 Opportunities and Constraints Related to RGCP Continued Flood Control**

| Issues | Opportunities | Constraints |
|---|---|---|
| Potential deficiencies in flood containment capacity | Increase in containment capacity could include non-structural measures such as levee relocation and flood easements in addition to levee construction or rehabilitation. | Most potential deficiencies are located in Las Cruces-El Paso reaches where easements or levee relocations are not desirable or feasible. Bridges and irrigation infrastructure limit the potential use of non-structural measures. |
| Management of recurrent flooding | Coupling of flood control and riparian habitat improvements has been achieved in riverine systems with recurrent floods that overtop or damage the levee system. | Recurrent floods are fully contained within the RGCP levee system due to prevalent semi-arid conditions and extensive upstream flow control. |
| Floodway vegetation | Best restoration conditions exist within the hydrological floodplain which is largely within the ROW. Riparian vegetation stabilizes stream banks and increases erosion control. | Vegetation development decreases flood containment capacity. Current mowing of the floodway controls salt cedar. |
| Structural integrity of the levees | Additional opportunities for use of non-structural flood control in non-urbanized reaches of the RGCP might be identified by the ongoing structural condition evaluation. | Levees represent a sizable federal investment that will be rehabilitated and maintained unless alternative actions are warranted by technical or economic reasons. |

### Table 1.3-3 Opportunities and Constraints Related to Water Issues

| Issues | Opportunities | Constraints |
|---|---|---|
| Flow regime | Changes in flow regime (i.e. controlled pulse releases from reservoirs) could support development of riparian habitats. | Irrigation needs, and to a lesser extent flood storage capability, dictate the timing and extent of flow releases. The USIBWC does not have control over those releases. |
| Water rights | Water can be acquired using various strategies that include water banking and financing on-farm water conservation. Rio Grande Project water uses other than irrigation are allowed under the 1920 "Sale of Water for Miscellaneous Purposes Act." | The USIBWC does not own any water rights within the Rio Grande Project. A water acquisition strategy must be developed in concert with the USBR, irrigation districts, and New Mexico Office of the State Engineer. |
| Water availability | Water losses by evaporation can be reduced by on-farm water conservation programs. Financing these programs addresses a pressing need of the farming community, and is supported by state and federal incentive programs. | The Rio Grande Project water is fully allocated; farmers do not receive a full allocation during drought conditions. Upgraded on-farm irrigation systems are costly. |
| Water delivery | Riparian vegetation stabilizes stream banks, reducing erosion potential. | There is a potential for increase in plant debris into the channel. |

### Table 1.3-4 Opportunities and Constraints for Riparian Corridor Development

| Issues | Opportunities | Constraints |
|---|---|---|
| Increase vegetative structural diversity (patch and edge habitat) | Reduced vegetation control (mowing) would have positive effects for wildlife habitat thoroughout much of the floodway. In addition, 3,552 acres of ROW are leased for grazing. | Flood control must be maintained throughout the RGCP, requiring floodway maintenance activities. Potential levee deficiencies in urban areas are a limitation to changes in floodway management. |
| Increase riparian corridor width (Buffer zone) | Lands adjacent to RGCP are available for conservation easements or interagency cooperative management. Some privately owned lands are potentially available for cooperative management. | RGCP adjacent lands are predominantly cropped or urbanized. Concern has been expressed by the agriculture community concerning the conversion of productive farm lands. |
| Improve upland and floodplain connectivity | 35 linear miles of floodway and uplands are adjacent to lands owned by other agencies. | Land use adjacent to the ROW corridor is only 18% government owned. |
| Increase native woody vegetation component | Land within the ROW cover 8,332 acres, the majority of which (89%) is considered below average to poor quality habitat. | Invasive species are prevalent throughout the RGCP and complete eradication is not feasible. |
| Increase amount of riparian habitat | More than 350 acres of ROW are within hydrologic floodplain. | Potential deficiencies in the levee system limit allowable vegetation growth. |
| Maintain a sustainable native riparian community | Work at the Bosque del Apache and Middle Rio Grande Bosque Restoration Project suggests techniques are available for sustainment of riparian restoration. | Requires acquisition of water and/or agreements with New Mexico and Texas irrigation districts. |
| Mimic the natural hydrograph | Modeling of various flow releases from Caballo Dam shows opportunities for overbank flows throughout the Rincon Valley. In addition, periodic storm events in conjunction with irrigation flows occur every 2-3 years and increase flow rates during early spring. | Flows are tightly controlled by upstream dams, which release water primarily in response to irrigation demands. Water delivery regimes must convey normal irrigation flows to the EBID, EPCWID#1, and Mexico. Flow increases over irrigation rates could cause flooding in lands outside USIBWC jurisdiction (Seldon Canyon). |

**Table 1.3-5 Opportunities and Constraints for Aquatic Habitat Diversification**

| Issues | Opportunities | Constraints |
|---|---|---|
| Increase river sinuosity, provide for lateral migration, and increase channel width | A total of eight meanders were cut off during RGCP construction and are currently within the ROW. Extensive floodway ROW is found in the Rincon Valley and Upper Mesilla Valley. Some bank incision and erosion is occurring in sections of the RGCP suggesting some lateral migration is occurring under current flow regimes. | Decreases in water delivery efficiencies would require compensation for water use. Several significant meanders were severed before project construction (i.e. Vinton cutoff) and are currently in private ownership and/or developed. Current or future induced bank erosion would likely result in transport and accumulation of sediment at diversion dams and could require periodic dredging to assure water delivery functions. |
| Increase streambed diversity such a pools, riffles and backwaters | Multiple arroyos are present in the Upper Rincon Valley. | Infrastructure such as bridges, irrigation flumes, siphons, and utilities must be maintained. Use of artificial structures have shown little environmental benefit. |
| Diversify river/terrestrial edge | Modifications to current vegetation control (mowing and grazing leases) would have positive effects to wildlife habitat. | Potential deficiencies in the levee system and need to control salt cedar limit allowable vegetation growth, particularly in urban areas. |
| Enhance surface water quality | The majority of 1,891 square miles of contributing watershed are managed by federal and state government. | The vast majority of the contributing watershed is not controlled by the USIBWC. |
| Create conditions for a connected river and floodway | The RGCP is characterized by a disconnected floodplain rarely extending beyond the ROW. Approximately 350 acres of floodway are located within the hydrologic floodplain and present opportunities for overbank flows. | The amount of sediment "nourishing" the Rio Grande has been greatly modified and has altered the current and potential river form. The narrow channel and incised banks reflect RGCP construction, but more importantly the overriding influences of hydrologic modifications. |

## 1.3.5 Prior Environmental Evaluations and Support Documents

### *Environmental Evaluations*

The USIBWC recognizes the need to accomplish flood control, water delivery, and operation and maintenance activities in a manner that improves and, if possible, partially restores the native ecosystem conditions in the RGCP. To support this goal, the agency previously prepared an environmental evaluation document for operation and maintenance of the RGCP (USIBWC 1977), as well as evaluations of potential effects associated with proposed structural improvements (USIBWC 1975, 1985) and dredging activities (USIBWC 1994).

As a result of these evaluations the USIBWC implemented a number of operation and maintenance procedures to enhance ecosystem conditions both in the river channel and the floodway. Some of these procedures are:

- Limited planting of cottonwood and willows at selected locations to increase riparian habitat for wildlife. This effort was initiated in the early 1970s using nursery stock, and has been continued in recent years using pole plantings.
- Partially modifying annual mowing of the floodway at some locations to selectively retain saplings of native tree species while controlling development of salt cedar and other invasive species of high-water consumption.

- Sediment removal, when required, is conducted according to the guidelines and mitigation requirements specified in the Section 404 permits issued by the United States Army Corps of Engineers (USACE). Dredging of the main channel has not been required since 1996.
- Conduct a 3-year monitoring program to determine the effectiveness of artificial in-stream structures such as groins, vortex weirs and embayments in enhancing fish habitat.
- Encourage development of park areas within the RGCP ROW, but without compromise to flood control purposes, through cooperative efforts with local interests and long-term lease contracts.

#### *Support Documents*

Three types of technical documents were prepared in support of the alternatives formulation and the DEIS:

- Analysis of threatened, endangered, and special-status species along the RGCP based on field surveys conducted during the spring and fall of 2000 (Parsons 2000a, 2001c).
- Mapping and analysis of suitability of terrestrial and aquatic habitats along the RGCP using USFWS-approved field methods habitat evaluation procedures and wildlife habitat appraisal procedures) (Parsons 2001b)
- Assessment of cultural resources from literature search, field reconnaissance, and a geo-archaeological study at selected locations (EMI and Parsons, 2001).

Environmental and technical information for the RGCP relevant to the Environmental Impact Statement was also obtained from the following documents:

- Environmental evaluation documents regarding RGCP operation and maintenance (USIBWC 1977), proposed improvements (USIBWC 1975, 1985), and dredging activities (USIBWC 1994; USFWS 2000a).
- River management plan for sediment control (USIBWC 1994).
- Engineering reports for the RGCP construction (Baker 1943) and improvement of the levee system (USACE 1996).
- Technical documentation prepared in support of the Environmental Impact Statement for El Paso-Las Cruces Regional Sustainable Water Project (USIBWC & EPWU/PSB 2000).

## 1.4 AUTHORITY AND INSTITUTIONAL INVOLVEMENT

Permits and licenses that may be required to implement the alternatives are summarized in Table 1.4-1 for federal agencies and Table 1.4-2 for state agencies and local agencies or organizations. These requirements are necessary to complete the NEPA process and to obtain project approval before action can be initiated.

## 1.5 SCOPE OF THE IMPACT ANALYSIS

The resource areas selected for effects evaluation in Sections 3 and 4 of this DEIS correspond to those previously identified by significant issues in Section 1.3.3. This isssue analysis served as the basis for selecting the resource categories. Air quality and noise are also considered in the effects evaluation due to emissions caused from construction-related activities.

## 1.6 DOCUMENT ORGANIZATION

This DEIS contains the following sections:

Section 1 introduces the USIBWC and provides background information; states the purpose of and need for action; discusses scoping and issues of concern; and lists the potentially required federal permits, licenses, or entitlements.

Section 2 describes the alternatives under consideration and presents those alternatives considered in detail; describes the alternatives eliminated from detailed study; presents the implementation plan; and summarizes potential effects of all alternatives.

Section 3 is a general description of the affected environment. It includes biophysical resources that the alternatives could potentially affect.

Section 4 is an analysis of the environmental consequences of the alternatives. A summary of this analysis is provided in tabular form at the end of Section 2.

Section 5 provides information on the consultation and coordination for preparation of this DEIS, contributors to the document, and distribution list.

Section 6 contains a glossary and the references cited in this DEIS.

Appendices A-H provide support technical information. Appendix I (CD attached to the inside cover of this DEIS) is a copy of the Reformulation of Alternatives Report (Parsons 2003a) that is provided here as a reference.

## Table 1.4-1 Potentially Required Federal Permits, Licenses or Entitlements

| Agency or Organization | Actions, Permits and Licenses Required | Description |
|---|---|---|
| United States Section, International Boundary and Water Commission (USIBWC) | National Environmental Policy Act (NEPA) | USIBWC is lead agency for preparation of the Environmental Impact Statement, will approve the alternative selected, and sign a Record of Decision (ROD) for the project. |
| | Upholding provisions of applicable conventions and treaties between the United States and Mexico | USIBWC is the designated federal agency responsible for meeting the United States obligation to annually deliver 60,000 acre-feet of water to Mexico. |
| | Archaeological Resources Protection Act (ARPA) permit | USIBWC issues an ARPA Permit for any excavation and/or removal of archaeological resources from Federal land it administers. |
| U.S. Department of the Interior - Fish and Wildlife Service (USFWS) | Endangered Species Act (ESA) Section 7 consultation | Consultation under Section 7 of the ESA is required to determine if the project will affect threatened or endangered species. The USFWS will prepare a Biological Opinion based on the Biological Assessment. |
| | Fish and Wildlife Coordination Act (FWCA) Report | The USFWS must prepare a FWCA Report that evaluates the effects on fish and wildlife and recommends ways to avoid or mitigate effects. |
| U.S. Army Corps of Engineers (USACE) | Section 404 of the Clean Water Act (CWA) Permit | A 404 Permit will be required for excavation in, or discharge of fill material into waters of the United States, including wetlands. |
| | CWA Section 401 Water Quality Certificate | The USACE coordinates the water quality certification process with the states of New Mexico and Texas. |
| | Wetland Mitigation Plan | USACE must approve the delineation, impact analysis, and wetland mitigation plan for jurisdictional wetlands impacted by the project on nonagricultural lands for the 404 permit. |
| Natural Resources Conservation Service (NRCS) | Wetlands delineation on agricultural lands | NRCS will delineate wetlands on agricultural lands, if needed, in accordance with the Food Security Act |
| U.S. Environmental Protection Agency (USEPA) | Oversight authority for Section 404 Permit | USEPA will review 404 permit applications and recommend approval or denial of permits. EPA has authority to veto USACE permit approvals. |
| | Stormwater runoff from construction sites | The USEPA regulates discharge of water from construction sites pursuant to the National Pollutant Discharge Elimination System (NPDES) phase I and II stormwater permits. |
| U.S. Bureau of Reclamation (USBR) | National Environmental Policy Act (NEPA) | The USBR is the cooperating agency that will participate in the NEPA process and assist in preparation of the DEIS. |
| | Approval of water use conversion and third-party contracts | The USBR approves project-related changes in operating procedures for the delivery of water pursuant to the 1920 Sale of Water for Miscellaneous Purposes Act in coordination with the appropriate irrigation district. |
| U.S. Bureau of Land Management (BLM) | Right-of-ways for use of BLM-administered lands | The BLM will issue a ROW and ARPA permit for any activities on its land. |

**Table 1.4-2 Potentially Required Permits, Licenses or Entitlements from State and Local Agencies or Organizations**

| Agency or Organization | Actions, Permits and Licenses Required | Description |
|---|---|---|
| New Mexico Department of Game and Fish (NMDGF) | Fish and wildlife consultation | Managing and consulting on fish and wildlife in New Mexico. Review of Fish and Wildlife Coordination Act Report. |
| Texas Parks and Wildlife Department (TPWD) | Fish and wildlife consultation | Managing and consulting on fish and wildlife in Texas. Review of Fish and Wildlife Coordination Act Report. |
| New Mexico Historic Preservation Division, State Historic Preservation Officer (SHPO) | New Mexico Antiquities Permit | Approval of survey and recovery of any cultural resources prior to project construction. The SHPO and the Advisory Council on Historic Preservation will determine if the proposed action will impact culturally or historically sensitive sites, or if sites are eligible for listing on the National Register of Historic Places. |
| Texas Historical Commission (THC) | Texas Antiquities Permit | Approval of survey and recovery of any cultural resources prior to project construction. The SHPO and the Advisory Council on Historic Preservation will determine if the proposed action will impact culturally or historically sensitive sites, or if sites are eligible for listing on the National Register of Historic Places. |
| New Mexico Environment Department (NMED) | Section 401 Water Quality Certificate | NMED will work with the USACE to issue Water Quality Certificates., and will also coordinate and have review authority for any Section 404 Dredge and Fill Permits. |
| | Stream alteration permit | Issues permits for any work in river beds within the state. |
| Texas Commission on Environmental Quality (TCEQ) | Section 401 Water Quality Certificate | TCEQ will work with the USACE to issue Water Quality Certificates. The agency will coordinate and have review authority for any Section 404 Dredge and Fill Permits. |
| | Stream alteration permit | TCEQ issues permits for any work in river beds in the state. |
| | Water rights and uses | TCEQ is responsible for Texas water rights issues. |
| New Mexico Office of the State Engineer (NMOSE) | Water rights and uses | The State Engineer is responsible for New Mexico water rights issues. |
| Governments of Las Cruces, Hatch, Doña Ana County and El Paso County | ROWs, miscellaneous permits and approvals | Coordination and input concerning construction, operation and maintenance activities for affecting local roads, drainage structures and utilities in their communities. |
| Elephant Butte Irrigation District (EBID) | Cooperative agreements for water acquisition | EBID operates and maintains irrigation division through contract with USBR. |
| El Paso County Water Improvement District No. 1 (EPCWID#1) | Cooperative agreements for water acquisition | EPCWID#1 operates irrigation division through contract with the USBR. |
| El Paso Water Utilities/Public Service Board (EPWU/PSB) | Facility construction and operation in Texas | Responsible for operation and maintenance of its facilities, including any agreements with water management agencies. |

# SECTION 2
# DESCRIPTION OF ALTERNATIVES

The following section describes the river management alternatives whose potential effects are evaluated in this Draft Environmental Impact Statement (DEIS). The description is presented in the following sequence:

- A summary of the alternatives.
- Description of the No Action Alternative and three action alternatives: Flood Control Improvement Alternative; Integrated USIBWC Land Management Alternative; and Targeted River Restoration Alternative.
- Comparative summary of alternatives and associated implementation projects.
- Alternatives considered but not carried forward.
- Project and actions with potential cumulative effects.
- Implementation timetable.
- Summary of potential effects.

## 2.1 ALTERNATIVES SUMMARY

Table 2.1-1 presents a comparison of river management alternatives under consideration in terms of four management categories: levee system, floodway, channel and irrigation facilities, and sediment management. Most changes under consideration are associated with floodway management under the Integrated USIBWC Land Management and Targeted River Restoration Alternatives. The Targeted River Restoration Alternative also includes measures for diversification of the aquatic habitat (modified dredging of arroyos and reopening of meanders). Improvements to the levee system and sediment disposal apply to all action alternatives.

A description of individual alternatives is presented below. In the description, references are made to seven distinct geographic reaches of the RGCP identified as River Management Units (RMUs). Features of each RMU are discussed in Appendix A, and their location is illustrated in Figure 2-1.

## 2.2 THE NO ACTION ALTERNATIVE

The No Action Alternative consists of continuing operation and maintenance (O&M) activities currently conducted at the RGCP by the USIBWC. Those activities are directed toward flood protection and water delivery, with some activities involving environmental improvements. The No Action is "no change" from current management direction or level of management intensity.

Maintenance activities are accomplished to ensure that the flood control and water delivery objectives of the RGCP can be met. The two primary locations where O&M activities are carried out are El Paso, Texas and Las Cruces, New Mexico. The USIBWC regularly patrols the RGCP from these locations and conducts inspections prior to the flood and irrigation season of early March through September. Engineering surveys are performed regularly to identify potential problem areas due to sediment accumulation. The channel is inspected for bank sloughing, washing, or erosion during and after all flood events. Corrective actions are taken if problems are identified.

Key features of the No Action Alternative are:

- Levee system management.
- Floodway management through mowing and grazing leases.
- Maintenance of pilot channel and irrigation facilities.
- Sediment management.

### 2.2.1 Levee System Management

The RGCP flood control system was constructed in conjunction with the canalization from 1938 to 1943. The system was designed to provide protection from a storm of large magnitude with a very low probability of occurrence, the 100-year storm (probability of one event every 100 years). Flood control in the RGCP relies largely on upstream flow regulation, as well as the use of levees, to contain high-magnitude flooding in areas with insufficient natural terrain elevation.

The flood control levees extend for 57 miles along the west side of the RGCP, and 74 miles on the east side for a combined total of 131 miles. Naturally elevated bluffs and canyon walls contain flood flows along portions of the RGCP that do not have levees. The levees range in height from about 3 feet to about 18 feet and have slopes of about 3:1 (length to width) on the river side and 2.5:1 on the "land" side. The levees have a gravel maintenance road along the top.

The levees are positioned on average about 750 to 800 feet apart north of Mesilla Dam and 600 feet apart south of Mesilla Dam. The floodway between the levees is generally level or uniformly sloped toward the channel. The floodway contains mostly grasses, some shrubs, and widely scattered trees. The bank of the channel at the immediate edge of the floodway is typically vegetated with a narrow strip of brush and trees. Levees were originally built to provide 3 feet of freeboard during the design flood in most reaches.

Levees are inspected regularly at the beginning of each flood season and immediately after each flood event. Maintenance includes encouraging grass growth on the levee slopes for erosion control, cutting brush and tall weeds from the slopes, and repairing levee slopes. Levee slopes are mowed to prevent growth of brush and trees that could obstruct flows, or cause root damage to the structure itself.

Levee roadways are generally unpaved gravel roads designed for passage of O&M personnel and equipment. Levee maintenance includes road grading and road resurfacing with gravel as needed. The entire levee road system for RGCP is resurfaced within a 20-year cycle.

## Table 2.1-1 Comparison of Alternative Features

| Management Category | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Levee System Management | Routine levee and road maintenance | No change | No change | No change |
| | n/a | Levee system improvements | Levee system improvements | Levee system improvements |
| Floodway Management | Unmodified grazing leases | Modified leases for erosion control (3,552 ac) | Modified leases for erosion control (3,552 ac) | Modified leases for erosion control (3,493 ac) |
| | Continue seasonal mowing (4,657 ac) | No change | Continued mowing (2,674 ac) | Continued mowing (2,223 ac) |
| | | | Modified grassland management (1,641 ac) | Modified grassland management (1,641 ac) |
| | | | Native vegetation planting (223 ac) | Native vegetation planting (189 ac) |
| | | | Stream bank reconfiguration (127 ac) | Seasonal peak flows / bank preparation (516 ac) |
| | n/a | n/a | n/a | Voluntary conser-vation easements (1,618 ac) |
| Channel and Irrigation Facilities Management | Debris removal and channel protection | No change | No change | No change |
| | American Dam and irrigation structures maintenance | No change | No change | No change |
| | n/a | n/a | n/a | Reopening of six former meanders (147 ac) |
| Sediment Management | NRCS sediment dam maintenance | No change | No change | No change |
| | Sediment removal from arroyos / mitigation actions | No change | No change | Modified arroyo dredging for aquatic habitat (12 arroyos) |
| | Disposal from dredging channel within ROW* | Disposal mainly outside ROW* | Disposal mainly outside ROW* | Disposal mainly outside ROW* |
| | n/a | n/a | Disposal from environmental measure excavation inside ROW* | Disposal from environmental measure excavation inside ROW* |

* Right-of-way of the Rio Grande Canalization Project (lands under USIBWC jurisdiction)

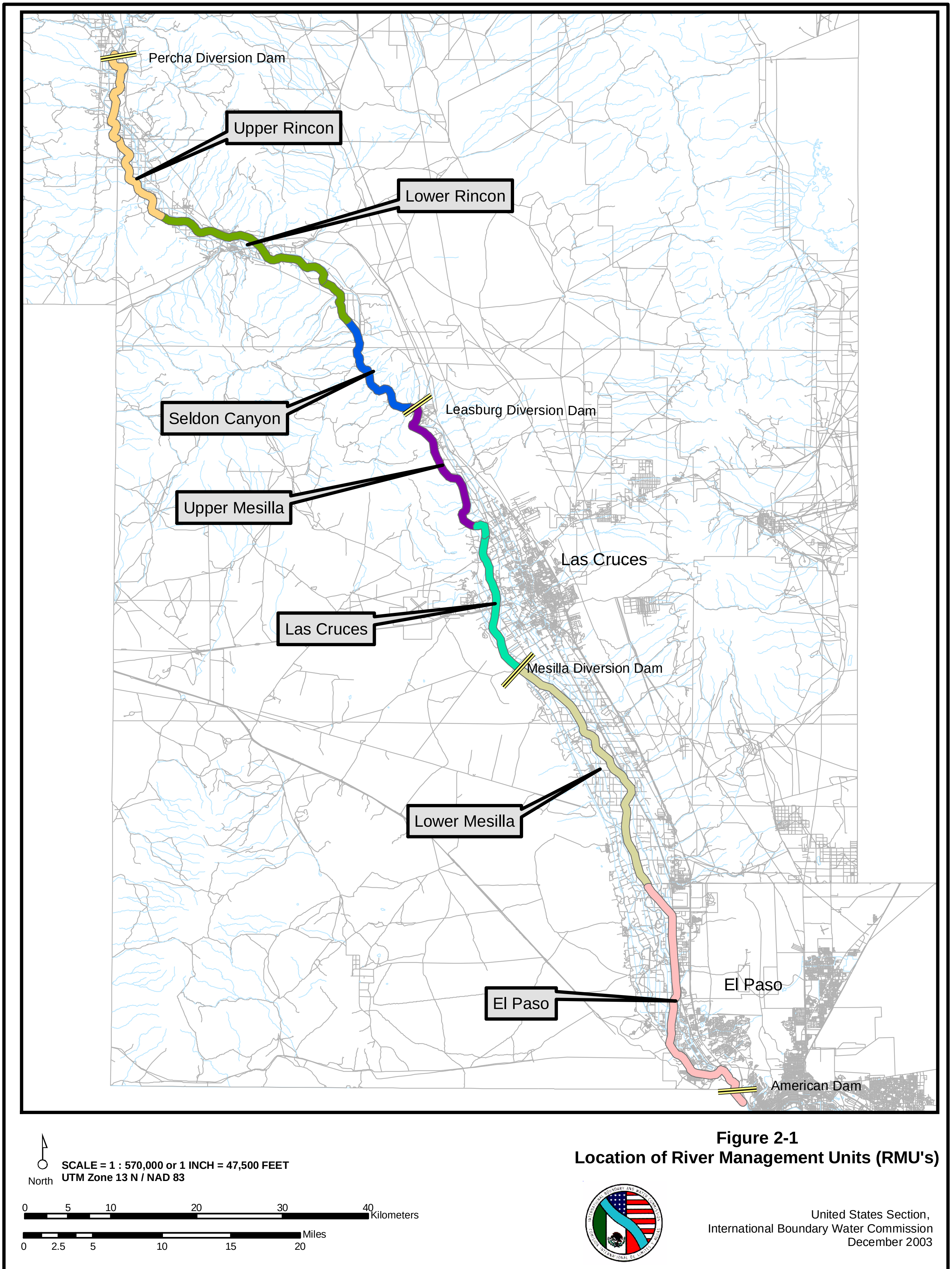


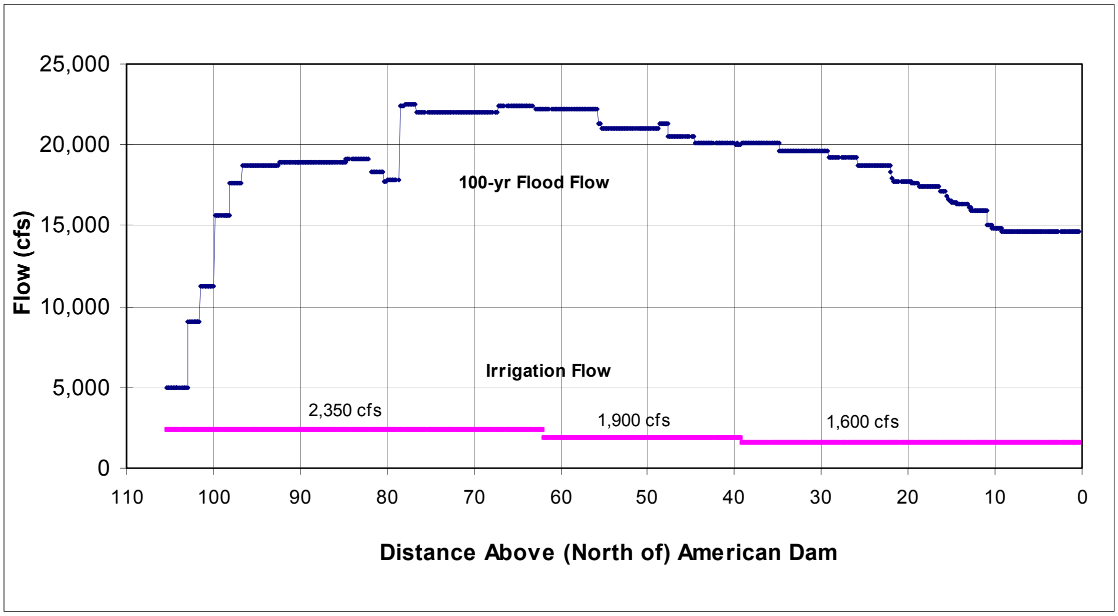

**Figure 2-1**
**Location of River Management Units (RMU's)**

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\IBWC_Drive\Projects\Management_units.mxd

Figure 2-2 illustrates the design flood flow of the RGCP, which ranges from 5,000 cubic feet per second (cfs) at the upstream reach of the RGCP, south of Percha Dam, to 22,400 cfs south of Leasburg Dam, reaching a value of 14,300 cfs at American Diversion Dam in El Paso. The maximum irrigation flow (channel capacity), ranging from 1,600 to 2,350 cfs, is also presented as a reference. During the main irrigation season the RGCP typically operates at about one half or less of the design flow capacity.

**Figure 2-2 Magnitude of the 100-Year Flood along the RGCP Relative to Design Flow**




## 2.2.2 Floodway Management

### *Mowing of the Floodway*

Mowing of the floodway outside the main channel but between the flood control levees is maintained to remove obstructions. Mowing of the floodway controls weed, brush, and tree growth, and is conducted at least once each year prior to July 15. Farm tractors with rotary slope mowers are generally used to mow the floodways. Slope mowers are used for vegetation maintenance on the channel banks. Some areas with dense vegetation require a second late summer mowing.

Since 1999 the USIBWC has conducted limited tree planting and maintained provisional test areas ("no-mow" zones) intended to evaluate effects of additional vegetation growth on RGCP functions. Tree planting has been limited to approximately 800 non-irrigated cottonwood poles planted individually at 100-foot intervals. Due to drought conditions in recent years, only a fraction of the poles remain.

Three no-mow zones are currently maintained. The first no-mow zone extends 5 miles on each side of the river, from Percha Dam to the Doña Ana County line, and ranges in width from 10 to 35 feet. At an average 20-foot width, it covers approximately 24 acres. A second no-mow zone extends 5 miles on each side of the river, from Shalem Bridge to Picacho Bridge, where vegetation is allowed to grow for a width of 35 feet. The extent of this no-mow zone is approximately 33 acres. Regular mowing is maintained in areas adjacent to bridges (400 feet upstream and downstream from the structure) and access points to the river (100-foot long segments located at 800-foot intervals). In combination, the two no-mow zones previously described cover less than 1 percent of the 8,332 acre floodway within the ROW. A third no-mow zone corresponds to Seldon Canyon where USIBWC historically has not conducted mowing operations as the agency's jurisdiction is limited to the channel bed and the stream bank.

#### *Grazing Leases*

The USIBWC administers a land lease program in the RGCP. Currently, approximately 43 percent of a total of 8,332 acres of the RGCP floodway are leased. No permanent structures may be constructed. By leasing land within the floodway, the need for mowing by the USIBWC is reduced (USIBWC 2000).

### 2.2.3 Maintenance of Pilot Channel and Irrigation Facilities

#### *Channel Maintenance*

Maintenance of the pilot channel is performed during non-irrigation periods when water levels are lowest. The RGCP main channel is maintained by removing debris and deposits, including sand bars, weeds, and brush that grow along the bed and banks. Any major depositions or channel closures caused by sediment loads from arroyo flows are removed. Channel excavation is performed with bulldozers, excavators, front end loaders and scrapers either from the channel bank or from within the channel. Normal maintenance work on the main channel is conducted during the non-irrigation and non-flood seasons from September 15 to March 1. Islands and sandbars with vegetation may remain in place as long as the river's carrying capacity is not significantly affected. If required, annual maintenance includes placement of additional riprap to protect meandering channel and stream banks. Any scouring or gouging of the banks due to flooding is repaired immediately.

Because the 1970 dams in tributary basins control over one-third of the upper RGCP basin north of Leasburg Dam (USACE 1996), dredging of the main channel has been conducted infrequently. A study on the scour and deposition of sediments within the main RGCP channel was conducted by the USACE (1996) as part of an evaluation of the RGCP functionality. The extent of bed elevation changes in the channel was evaluated for low, high, and 100-year flows.

The USACE study estimated that consecutive years of low flow conditions would result in only minor scour and deposition along the river. A more significant scour (maximum of 2.6 feet) and deposition (maximum of 1 foot) were estimated for a 10-year period of consecutive elevated flows, for a 100-year flood, changes ranged from a maximum deposit of 0.7 feet to maximum scour of 1.7 feet. A more significant deposition (greater than 5 feet of sediment) was predicted for a limited number of channel cross sections downstream from Rincon Arroyo, Trujillo Canyon, Tierra Blanca Canyon, Placitas Arroyo, and Faulkner Arroyo (USACE 1996).

#### *Maintenance of Irrigation Facilities*

Drainage and irrigation structures in the RGCP are licensed to other entities by the USIBWC. The USIBWC Project Manager must confirm that the licensee adequately maintains the structures, and that all inlet and outlet channels to the structures are kept open and free of debris.

The Hatch and Rincon Siphons, operated and maintained by the USIBWC and EBID, are subject to erosive forces that, if not controlled, would impact the integrity of the structures. The USIBWC and EBID protect the siphons by maintaining slow-moving backwater with riprap dams across the channel at the siphon crossings. Boulders are added periodically to reinforce the dams when excessive flows cause damage. The USIBWC has completed engineering construction for erosion protection of the two siphons and has completed preliminary design of the Picacho flume.

#### *Maintenance of American Diversion Dam*

American Diversion Dam, defining the southern boundary of the RGCP, is operated by the USIBWC. The USIBWC Project Manager cooperates and coordinates dam operations with the USBR to ensure that water delivery objectives are met. Normal maintenance of the American Diversion Dam is performed during the non-irrigation season. Three other diversion dams associated with the RGCP (Percha Dam, Leasburg Dam and Mesilla Dam) are operated and maintained by EBID.

### 2.2.4 Sediment Management

#### *Maintenance of NRCS Dams*

Under an agreement with the EBID and Caballo NRCS District (IBM 65-356 dated December 10, 1965 and Supplement No. 1 dated February 15, 1974), the USIBWC is responsible for maintaining five NRCS sediment control dams and associated access roads. This maintenance includes mowing discharge canal slopes; cleaning and maintaining trash racks, intakes and outlets; repairing fences; and grading access roads. The USIBWC monitors the level of sediment in the dams to ensure that the outlet gates on the discharge structure are set to the proper level. This maintenance allows dams to perform effectively in reducing sediment load to the river and reducing flood potential. Public Law 93-126; Stat. 451, approved October 18, 1973, limits the USIBWC maintenance expenditures to $50,000 per year. Maintenance work is generally done annually following joint inspections by the USIBWC, NRCS, and EBID personnel.

#### *Sediment Removal from the Mouth of the Arroyos*

The USIBWC conducts dredging at the mouth of the arroyos to maintain grade of the channel bed and ensure the channel conveys irrigation deliveries. Channel excavation is performed with bull dozers, excavators, front end loaders and scrapers either from the channel bank or from within the channel between September and March.

In 1998, artificial fish habitat structures were placed at 13 locations within the RGCP channel as a mitigation action required by the USACE Clean Water Act Section 404 permit for dredging sediments from the mouth of several arroyos. Three types of structures providing variable water velocity habitat for aquatic organisms were tested in the Upper Rincon Valley: vortex weirs (two structures), embayments (three structures), and rock groins (seven structures). These structures, built to test their performance as fish habitat, were monitored over a 3-year period. Most of those test structures are currently silted and no longer functional.

#### *Sediment Disposal*

Sediment collected from channel excavation, arroyo mouth maintenance, and other sediment control efforts is deposited on the floodway, on upland spoil areas, or on other federal or private lands approved for this purpose.

## 2.3 FLOOD CONTROL IMPROVEMENT ALTERNATIVE

The primary focus of this alternative is to address known or potential flood control deficiencies in the RGCP. Key features of this alternative are to:

- Improve the levee system in terms of flood containment capacity (potential for peak water levels to reach the levees); and
- Improve erosion control in uplands and floodway to reduce sediment load to the RGCP and improve water quality.

Although the actions described below are primarily intended to improve RGCP functionality, they offer opportunities for environmental improvements in the river and floodway. For instance, backwaters associated with erosion protection structures provide a valuable fish habitat, while sediment management practices could lead to reduced dredging.

### 2.3.1 Levee System Management

#### *Current Practices*

The Flood Control Improvement Alternative would retain the routine maintenance of the levee system in terms of inspections, erosion, and vegetation control, and levee road maintenance.

#### *Flood Containment Capacity Evaluation*

In addition to routine levee maintenance, the alternative takes into consideration a potential increase in flood containment capacity. The flood containment capacity, as evaluated in 1996 by the USACE, identified a number of potential deficiencies in the RGCP on the basis of hydraulic modeling of the 100-year storm. Those findings were re-evaluated as part of the development of the DEIS to include potential effects of environmental measures such as vegetation growth in the floodway (Parsons 2001a, 2003).

Table 2.3-1 presents current estimates of the need to increase the levee height or build new levees in the RGCP. Data are presented for the entire length of the RGCP, and subdivided geographically by RMU.

This report also indicates that up to 60.1 additional miles of levees could require an increase in height, up to 2 feet, to meet the freeboard design criterion for protection against a 100-year flood (Table 2.3-1). Construction of a 2.8 mile floodwall in the Canutillo area to replace a discontinuous railroad berm would be a priority action for flood control (USACE 1996). Most of the potential levee deficiencies were located largely in the southern, mostly urbanized reaches of the RGCP (El Paso RMU). Potential deficiencies were also identified for 8.8 miles of unconfined RGCP sections where simulated flood levels could extend past the ROW. Approximately 2.8 miles of unconfined ROW fall within government controlled land where extending the floodplain past the ROW boundary is acceptable. Therefore, only 6 miles of new levee are projected.

**Table 2.3-1 Potential Need for Levee Rehabilitation for the Flood Control Improvement Alternative**

| | | BY RIVER MANAGEMENT UNIT (RMU) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Entire RGCP** | **Upper Rincon** | **Lower Rincon** | **Seldon Canyon** | **Upper Mesilla** | **Las Cruces** | **Lower Mesilla** | **El Paso** |
| **River Mile:** | **105 - 0** | **105 - 90** | **90 - 72** | **72 - 63** | **63 - 51** | **51 - 40** | **40 - 21** | **21 - 0** |
| **Current Flood Control (miles)** | | | | | | | | |
| Unconfined ROW length | 81.6 | 24.0 | 9.6 | 18.0 | 14.0 | 1.9 | 0.0 | 14.1 |
| Existing levees | 13 | 8.0 | 30.4 | 0.0 | 8.0 | 20.5 | 38.0 | 24.7 |
| Total for RGCP (east and west side) | 211 | 32.0 | 40.0 | 18.0 | 22.0 | 22.4 | 38.0 | 38.8 |
| **Rehabilitation Measures (miles)** | | | | | | | | |
| New levee (6 ft. height) | 6.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 5.4 |
| Floodwall (8 ft, Canutillo area) | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 |
| Raise levee (2 ft. average) | 60.1 | 0.0 | 9.0 | 0.0 | 5.4 | 18.2 | 10.2 | 17.3 |
| Riprap cover (for edge velocities >4 ft/sec) | 3.2 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.9 | 1.1 |

***Preliminary Flood Control Improvement Estimates***

The Flood Control Improvement Alternative incorporates levee height increase and building of additional levees or floodwalls as the two measures to be considered in the DEIS to increase flood containment capacity of the RGCP. These measures were adopted only as a work assumption to estimate effects of potential construction activities because of the potential overestimation of levee deficiencies in terms of flood containment capacity, and incomplete information on the structural integrity of the levee system. The assumption adopted in the Environmental Impact Statement to quantify construction activities for potential effects is that existing levees would be raised to meet freeboard design criteria or new levees would be constructed in unconfined areas where flood levels would extend past the ROW boundary.

Results of this evaluation are required to ascertain the need for a levee rehabilitation program, and to re-assess the overall flood control strategy for the RGCP. Such strategy might incorporate addition of non-structural flood control measures such as flood easement acquisitions, limited levee setbacks to increase flood dissipation in the floodway, and/or removal of sediment within the floodplain that was deposited from dredging operations since project inception.

In areas where rebuilding of levees would be required, existing levee material would be re-engineered with clay material to meet specifications for the new levee. Additional material would be obtained from sediment removed from the active river channel as a result of maintaining channel capacity or from new borrow sites. Other sources of levee material would be from implementation of environmental measures such as lowering the bank in the form of successively low benches to promote establishment of cottonwood/willow seedlings, and reopening of old meanders.

### 2.3.2 Floodway Management

#### *Mowing of the Floodway*

No changes are proposed relative to the No Action alternative.

#### *Modified Grazing Practices*

A management program would be developed and implemented in coordination with the NRCS to improve erosion control in areas within the ROW currently leased for grazing. Those areas include the floodway and uplands where the sloped terrain is more susceptible to erosion during storm events. The program would adopt additional best management practices according to conditions at each specific location. These practices would include physical methods such as placement of erosion control blankets in areas not yet vegetated, modified guidelines for livestock grazing leases, and monitoring to ensure vegetation is properly maintained.

Currently livestock grazing is allowed on 3,552 acres of RGCP land through leases (USIBWC 1994). Grazing can impact riparian areas leading to a higher weed cover, or trampling and creation of trails which are susceptible to erosion due to over-concentration of cattle (Kaufman and Krueger 1984; Krueper 1996). Best management practices identified would be implemented within the framework of the USIBWC directive for management of grazing leases (USIBWC 2002). This directive assigns responsibilities for monitoring grazing leases, and requires lease renewals to be in compliance with USEPA's guidance for grazing in public lands (USEPA 1994), as well as the Pollution Prevention / Environmental Impact Reduction Checklist for Grazing [*http://es.epa.gov/oeca/ofa/pollprev/graze.html*].

Details concerning the modified grazing program would be developed in concert with regulatory agencies. However, it is assumed that uplands grazing regime would be modified to promote forage production for the purposes of wildlife and watershed protection. Subsequent vegetative response would result in increased vegetative cover and reduced soil erosion. The grazing program could include vegetative treatments such as seeding, prescribed burns and mechanically thinning woody vegetation. The purpose of the treatments is to increase species and structural diversity, reduce soil erosion and increase the amount of cool season grasses.

It is anticipated that floodway grazing in some leases could temporally be suspended until the vegetation responds at the appropriate level at which time grazing will be instituted to manage forage production. Cessation of grazing from riparian areas until riparian function is restored is consistent with current BLM guidelines (USDI, BLM 1991). Modification of the floodway grazing regime would be adjusted based on site-specific conditions to achieve the desired community.

Based on vegetation response, salt cedar control and or mowing could be implemented to reduce recruitment of invasive vegetation. The USIBWC would implement additional Best management practices for erosion control that could include 1) reducing mowing frequency and/or increasing mowing height to allow some vegetation recovery; 2) rotating mowing between grazing leases; 3) reducing frequency and extent of grading operations within the floodway; 4) mulching and seeding graded areas to minimize erosion; and 5) using erosion control fabric, silt fences, hay bales, and other measures to prevent erosion.

### 2.3.3 Maintenance of Pilot Channel and Irrigation Facilities

No changes are proposed relative to the No Action alternative.

### 2.3.4 Sediment Management

No changes are anticipated with respect to the No Action alternative in maintenance of sediment control dams and sediment removal from arroyos. Sediment disposal, however, would be conducted primarily outside the ROW.

## 2.4 INTEGRATED USIBWC LAND MANAGEMENT ALTERNATIVE

This alternative incorporates environmental measures within the floodway in combination with actions for flood control improvement, erosion protection, and reassessment of sediment management practices as previously identified for the Flood Control Improvement Alternative. The Integrated USIBWC Land Management Alternative restricts all environmental measures to RGCP lands under USIBWC jurisdiction. Key features of this alternative are to:

- Develop a riparian corridor for bank stabilization and wildlife habitat using shavedowns of stream banks overbank flows and plantings; and
- Promote development of native grasses in combination with salt cedar control to create “beads” surrounding and connecting riparian bosque.

### 2.4.1 Levee System Management

#### *Current Practices*

This alternative retains routine maintenance of the levee system in terms of levee erosion and vegetation control, and levee road maintenance.

#### *Flood Containment Capacity Evaluation*

The alternative incorporates a re-evaluation of the RGCP flood containment capacity as previously described for the Flood Control Improvement Alternative, with an increase in floodway vegetation. Use of levee rehabilitation by height increase and additional levee / floodwall construction were incorporated into the alternative as a work assumption in the DEIS to estimate potential effects of construction activities. Input data for the Targeted River Restoration Alternative which incorporates moderately smaller floodway vegetation growth were used in the simulation, and the results applied without modification to the Integrated USIBWC Land Management Alternative. Modeling results indicated an increase in levee rehabilitation due to a greater amount of vegetation on the floodway relative to the Flood Control Improvement Alternative (Table 2.4-1).

**Table 2.4-1 Potential Levee Rehabilitation for the Integrated USIBWC Land Management and Targeted River Restoration Alternatives**

| | | BY RIVER MANAGEMENT UNIT (RMU) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Entire RGCP | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso |
| River Mile: | 105 - 0 | 105 - 90 | 90 - 72 | 72 - 63 | 63 - 51 | 51 - 40 | 40 - 21 | 21 - 0 |
| **Current Flood Control (miles)** | | | | | | | | |
| Unconfined ROW length | 81.6 | 24.0 | 9.6 | 18.0 | 14.0 | 1.9 | 0.0 | 14.1 |
| Existing Levees | 130 | 8.0 | 30.4 | 0.0 | 8.0 | 20.5 | 38.0 | 24.7 |
| Total for RGCP | 211 | 32.0 | 40.0 | 18.0 | 22.0 | 22.4 | 38.0 | 38.8 |
| **Rehabilitation Measures (miles)** | | | | | | | | |
| New levee (6' height) | 6.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 5.4 |
| Floodwall (8 ft, Canutillo area) | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 |
| Raise levee (2 ft. average) | 63.1 | 0.0 | 10.5 | 0.0 | 5.7 | 18.7 | 10.5 | 17.3 |
| Riprap cover (for edge velocities >4 ft/sec) | 3.2 | 0.2 | 1.0 | 0.0 | 0.0 | 0.0 | 0.9 | 1.1 |

### 2.4.2 Floodway Management

Two measures considered under the No Action Alternative are modified under the Integrated USIBWC Land Management Alternative, namely management of grazing leases and annual vegetation mowing. For grazing leases, additional best management practices would be incorporated into a management program to improve erosion control within the RGCP floodway as previously described in subsection 2.3.2. For vegetation management, four measures described below are incorporated to partially replace mowing in various reaches of the RGCP:

- Modified grassland management;
- Native vegetation planting;
- Bosque enhancement; and
- Reconfiguration of stream banks for regeneration of native woody vegetation.

### *Modified Grassland Management*

Currently both floodways and levee slopes in the RGCP are mowed at least once a year prior to July 15. The purpose of mowing is to control growth of shrubs and trees, primarily salt cedar. Salt cedar can reach up to 9 feet in height in a single growing season, as such it must be controlled annually. The modified grassland management would replace current mowing regime in selected areas to improve wildlife habitat by 1) increasing vegetation diversity, 2) develop native herbaceous vegetation, and 3) improve the riparian corridor and upland/riparian interface. In order to continue to provide salt cedar control, control methods such as herbicide, mechanical (mowing), manual and/or burning would be instituted. Site specific condition would dictate method or combination of methods used. Measure implementation would include:

- Site preparation, salt cedar treatments (e.g. mowing followed by herbicide) and shallow disking to prepare soil and chemical treatments (salinity management),
- Seeding of native vegetation, and
- Maintenance and monitoring. Maintenance would include continued salt cedar control using treatments specific to site conditions and vegetation treatments which would promote the establishment and sustainment of native species. Monitoring would be in place to assess treatment results and modify methods as appropriate.

The modified grassland management areas are outside the hydrologic floodplain and would be dominated by intermediate and xeric native species. Depressions and shallow groundwater interspersed within these areas would support mesic and hydric vegetation, potentially creating additional diversity and improved wildlife habitat.

### *Native Vegetation Planting*

In areas not in proximity to the river, planting is the environmental measure used to establish native riparian vegetation. Restoration by planting may be accomplished through seeding, transplants, and pole planting. Depending on the planting method, establishment could require irrigation or micro-irrigation to increase probability of success (Dressen *et al.,* 1999).

***Seeding***. Seeds of native plants can be purchased from suppliers or collected from nearby areas and distributed in the floodway. Success of seedling establishment must be accompanied by clearing of competing vegetation, particularly invasive species.

***Transplants***. Trees, shrubs, and herbaceous plants may be transplanted into riparian zones. A few well established individuals can help contribute seeds to the site as well as provide immediate wildlife benefits.

***Pole Planting*.** This technique involves obtaining long poles, or branches, from live trees and planting them in holes. Cottonwoods and willows are two species which can be successfully grown from poles. Areas would be planted with trees that are approximately 3 years old, placing the poles directly in contact with the shallow ground water. This is accomplished by digging a hole with an auger to the water table. Poles are then pushed through so that the root system is in contact with the water and the hole is refilled with dirt. Poles must be planted while they are dormant (i.e., from January through April of each year). Poles are usually wrapped with chicken wire to protect them from girdling by beavers.

Researchers have increased pole planting success through such methods as 1) using very long poles inserted into holes drilled to the groundwater; 2) drilling holes to groundwater, backfilling with soil or mulch, and planting poles on top of the backfilled hole; 3) irrigating poles until their roots have reached groundwater; and 4) promoting root growth by applying rooting hormone compounds.

Site specific condition would dictate method or combination of methods used. Measure implementation would include:

- Detailed site survey to include soil analyses, groundwater level assessment, micro topography survey *etc*.,
- Site preparation including removal of established salt cedar and treatment of suppressed (recently mowed) salt cedar,
- Soil preparation including physical (i.e. disking) and chemical treatments (salinity management),
- Seeding or planting of native vegetation.

A maintenance and monitoring plan would be implemented. Maintenance would include continued salt cedar control using treatments specific to site conditions. Salt cedar control would be required to reduce invasive species competition with native plants and reduce fuel loads. Monitoring would be in place to assess treatment results and modify methods as appropriate.

#### *Bosque Enhancements*

This measure involves selective removal of invasive vegetation in existing bosques to allow native vegetation establishment (SWEC 2002). Sites selected for bosque enhancement include wooded areas within the hydrologic floodplain. The process of selective removal would likely be extended to other restored areas as a long-term practice once riparian vegetation became established. Site specific condition would dictate method or combination of methods used. Measure implementation would include:

- Detailed site survey to include soil analyses, groundwater level assessment, micro topography survey *etc*.,
- Site preparation including removal of established salt cedar,
- Hauling and disposal of salt cedar (burning, chipping or piled as slash),
- Soil preparation including salinity management,

- Seeding or planting of native vegetation, and
- Maintenance and monitoring.

Maintenance would include continued salt cedar control using treatments specific to site conditions. Salt cedar control would be required to reduce invasive species competition with native plants and reduce fuel loads. Monitoring would be in place to assess treatment results and modify methods as appropriate.

### *Reconfiguration of Stream Banks for Native Woody Vegetation Regeneration (Shavedowns)*

This measure would allow overbank flooding within the floodway by lowering the stream bank ("shavedown") to within 1 foot of the irrigation flows to promote inundation during moderately-high storm flows. The process of shaving down would reconnect portions of the river and former floodplain. Overbank flooding within the floodway would provide conditions suitable for establishment and maintenance of native riparian species, particularly cottonwoods, whose seeds have a short period of viability and will only germinate in moist soil (Stromberg and Patton 1991). Implementing this environmental measure would sufficiently lower the floodway at selected locations and allow for potential inundation during the months of March and April.

Table 2.4-2 illustrates average monthly flows (based on monitoring data) that are exceeded with a 10 percent frequency for any given month and RGCP reach.

**Table 2.4-2 Potential Flow Exceedance Along the RGCP Based on Historical Data**

| Month | Estimated 10 Percent Exceedance Flow (cubic feet per second)* | | | | | |
|---|---|---|---|---|---|---|
| | Percha Dam to Seldon Canyon | Seldon Canyon to Leasburg Dam | Leasburg Dam to Las Cruces (I-10) | Las Cruces to Mesilla Dam | Mesilla Dam to Anthony, NM | Anthony, NM to Americam Dam |
| October | 884 | 921 | 696 | 703 | 397 | 503 |
| November | 46 | 83 | 92 | 100 | 104 | 148 |
| December | 37 | 66 | 67 | 74 | 77 | 101 |
| January | 90 | 51 | 53 | 59 | 63 | 79 |
| February | 636 | 693 | 610 | 598 | 382 | 411 |
| March | 1,946 | 1,910 | 1,458 | 1,469 | 742 | 1,046 |
| April | 1,497 | 1,524 | 1,175 | 1,202 | 624 | 912 |
| May | 1,970 | 2,011 | 1,537 | 1,551 | 815 | 1,154 |
| June | 2,732 | 2,884 | 2,496 | 2,540 | 1644 | 2,113 |
| July | 2,308 | 2,377 | 1,827 | 1,845 | 1068 | 1,499 |
| August | 1,736 | 1,821 | 1,360 | 1,387 | 728 | 1,114 |
| September | 1,507 | 1,612 | 1,243 | 1,264 | 626 | 904 |
| Channel design value (USACE 1996) | 2,350 | 2,350 | 1,900 | 1,900 | 1,600 | 1,600 |

* Flow exceedance indicates an average monthly value that is exceeded with a 10 percent probability based on historical gage data. Values from Appendix C of Water Resources Technical Report, El Paso-Las Cruces Regional Sustainable Water Project (CH2M-Hill 2000).

Table 2.4-2 illustrates the fact that monthly average flows can be expected to reach or surpass channel design values with some relative frequency. A greater frequency can be expected for average flows calculated on a weekly and daily basis.

***Lowering of Stream Banks***. Cottonwood regeneration through overbank flows would require land preparation including disking, shavedowns, and partial excavation of areas which would be inundated at peak flow levels. Excavation would be performed in selected locations of the floodway to re-shape the bank, forming a series of low terraces subject to intermittent overflows and allow the establishment of vegetation adapted for those patterns. This measure is based on the partial stream restoration concept successfully implemented in the Middle Rio Grande at the Overbank Flow Project near Albuquerque, New Mexico, and the Bosque del Apache National Wildlife Reservation (Crawford *et al*. 1999).

Site specific condition would dictate method or combination of methods used. Measure implementation would be include:

- Detailed site survey to include soil analyses, groundwater level assessment, micro topography survey etc.,
- Site shavedown and move soil to levee and floodway,
- Hauling and disposal of salt cedar (burning, chipping or piled as slash),
- Soil preparation including salinity management, and
- Seeding or planting of native vegetation.
- Maintenance and monitoring.

Maintenance would include continued salt cedar control using treatments specific to site conditions. Salt cedar control would be required to reduce invasive species competition with native plants and reduce fuel loads. Monitoring would be in place to assess treatment results and modify methods as appropriate.

***Best Management Practices***. Best management practices would be applied for bank protection and increase the probability of vegetation development as bank shavedowns exposed to high water velocities may not support a diverse riparian habitat. Three strategies for bank protection that would be utilized are back flooding, bench reconfiguration, and land grading. A maintenance and monitoring plan would also be implemented.

Back flooding would be used to minimize water velocity over cut banks permanently or until vegetation has been established. River water would enter cut bank area from downstream section opening (back flooding). A drainage channel length-wise through the cut bank, possibly below river elevation, would be used to minimize the runoff distance when the river recedes. This construction method would create a habitat similar to only opening a former meander to the river on the downstream end. For bank shavedown areas located on the outer bend of the river, a river diversion barrier parallel to the river and between the bank shavedown area and the river would be used to slow overbank flows [*http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm*].

For bench reconfiguration, stream bank would be lowered in the form of up to three successively low benches, and then a few broad and shallow side channels would run through the benches to promote better seedling establishment.

For land grading, a plan would be prepared that establishes which areas of the site will be graded, how drainage patterns will be directed, and how runoff velocities will affect receiving waters. The grading plan would also include information regarding when earthwork will start and stop, establish the degree and length of finished slopes, and dictate where and how excess material will be disposed. Berms, diversions, and other storm water practices that require excavation and filling would also be incorporated into the grading plan.

### 2.4.3 Maintenance of Pilot Channel and Irrigation Facilities

No changes are expected relative to the No Action alternative.

### 2.4.4 Sediment Management

No changes are expected associated with the No Action Alternative in maintenance of sediment control dams and sediment removal from arroyos. Sediment disposal, however, would be conducted primarily outside the ROW.

## 2.5 TARGETED RIVER RESTORATION ALTERNATIVE

Relative to the previous alternatives, the Targeted River Restoration Alternative emphasizes environmental measures associated with partial restoration of the RGCP, such as various methods for riparian corridor development, and opening of meanders and modification of arroyos to increase aquatic habitat diversification. Native vegetation establishment by overbank flows would be induced by controlled water releases from Caballo Dam during high storage conditions in Elephant Butte Reservoir. Environmental measures would also extend beyond the ROW through voluntary conservation easements to preserve wildlife habitat and encourage bosque development. This alternative also includes actions previously identified for flood control improvement. Key features of this alternative are to:

- Develop a riparian corridor for bank stabilization and wildlife habitat;
- Increase opportunity of overbank flows using controlled water releases;
- Manage grasslands in combination with salt cedar control to “connect” riparian bosque locations in the floodway and river/upland ecotone;
- Reopen low-elevation meanders, in addition to arroyo habitat, to provide backwater habitat and associated riparian vegetation; and
- Establish voluntary conservation easements outside the ROW to preserve remnant bosques and wetlands, create bosque and grassland habitat, and increase width of the river corridor.

### 2.5.1 Levee System Management

#### *Current Practices*

The alternative retains routine maintenance of the levee system in terms of levee erosion and vegetation control, and levee road maintenance.

#### *Flood Containment Capacity Evaluation*

The alternative incorporates a re-evaluation of the RGCP flood containment capacity as previously described for the Integrated USIBWC Land Management Alternative. Use of levee rehabilitation by height increase and additional levee / floodwall construction was incorporated into the alternative as a work assumption to estimate effects of potential construction activities in the DEIS.

### 2.5.2 Floodway Management

Management of grazing leases and annual vegetation mowing, as currently conducted under the No Action Alternative, are modified under the Targeted River Restoration Alternative. For grazing leases, additional best management practices would be incorporated into a management program to improve erosion control within the RGCP floodway as previously described in Subsection 2.3.2.

For vegetation management, development of a riparian corridor would be accomplished by the planting and enhancement of native woody vegetation, as well as modified grassland management, as previously described in Subsection 2.3.2. Under the Targeted River Restoration Alternative these measures would be complemented by use of seasonal peak flows to promote natural regeneration of riparian bosque, and use of conservation easements outside the ROW for connectivity with uplands. These two additional measures are described below.

#### *Controlled Water Releases for Overbank Flooding*

This measure would temporarily modify stream flows, allowing flood surges over the floodway to simulate historical overbank flows. Controlled releases from Caballo Dam up to a maximum flowrate of approximately 3,600 cubic feet per second above typical irrigation levels, would be scheduled to simulate spring/summer overbank flooding in the upper reaches of the RGCP. These discharges would be a combination of coordinated irrigation deliveries and additional water releases from the purchase of water rights, and would be limited to high water storage conditions in Elephant Butte Reservoir.

Due to a greater availability of potentially inundated floodway and proximity to the water release point (Caballo Dam), regeneration of native woody vegetation would take place largely in the Rincon Valley. Figure 2-3 presents an example of overbank flow limits within the ROW in low-elevation terrain of the north Rincon Valley. A total of 516 acres have been identified as potentially inundated areas within the RGCP. The acreage is subsequently presented in the description of linear projects (Section 2.6.1).

Land preparation would include disking to remove vegetation, and partial shavedowns of stream banks. The ability to control the timing and intensity of flows has two primary advantages over shavedowns alone:

- Timed releases would ensure inundation during optimum cottonwood seed germination periods rather than by chance through storm events. This would ensure that bank preparation would not be in vain if a storm event did not occur; and
- Bank preparation (soil disturbance) in many locations could be conducted by disking rather than excavating since relatively higher water levels would be achieved through controlled releases.

#### *Voluntary Conservation Easements Outside ROW*

This measure would incorporate lands outside the ROW for environmental improvements through conservation easements sponsored by federal agencies. Available programs include the National Parks Service Land and Conservation Fund, the USACE Continuing Authorities Program (Sections 206 and 1135 for ecosystem restoration), and NRCS programs for conservation reserves, wetlands reserves, wildlife habitat incentives, and environmental quality incentives. Areas identified for potential easements include remnant bosques and uplands, as well as some croplands. A total of 1,618 acres of potential conservation easements have been identified in areas adjacent to the RGCP. The acreage by RMU is subsequently presented in the description of the alternatives' linear projects.

The main function of easements would be to enhance the connectivity of riparian communities with upland areas, provide buffer zones, and increase corridor width. For existing bosques and undeveloped lands, the main purpose for easements would be to control their conversion to an alternate use. Management options for easements in agricultural lands include development of native grasslands in combination with salt cedar control, and reducing maintenance along sections of irrigation drains or canals to extend riparian vegetation and wetlands.

Along Seldon Canyon, where USIBWC has no land ownership, conservation easements were identified primarily in association with controlled water releases from Caballo Dam for overbank flows.

### 2.5.3 Maintenance of Pilot Channel and Irrigation Facilities

#### *Current Practices*

Under this alternative pilot channel routine maintenance would be continued as indicated for the No Action Alternative (Subsection 2.2.3), as well as maintenance of American Diversion Dam and irrigation facilities. Limited changes in RGCP channel geometry would be introduced in the Rincon Valley by reopening of former meanders.

### *Reopening of Meanders Within the ROW*

Re-establishment of six former meanders eliminated during construction of the RGCP (five in the Upper Rincon and one in the Upper Mesilla) would be conducted for diversification of aquatic habitat and native riparian vegetation development. The reopened meanders would provide slow-moving waters during the late spring and early summer, a required condition for breeding and spawning of various native fish species. Such condition is uncommon in the RGCP because that period coincides with high flows of the main irrigation season. Figure 2-4 indicates locations of meanders and other sites identified for aquatic habitat diversification in the Upper Mesilla Valley. It is anticipated that backwaters would be available in an excavated downstream section of the meander to facilitate fish reproduction during the entire irrigation season, including the late spring and early summer. Water diversions through the upstream section as a high-flow channel, controlled by a mechanically-controlled intake structure, would be used periodically to avoid stagnant water conditions.

Availability of backwaters would be limited by the extent and cost of the excavation and actual benefits as determined by long-term monitoring data from pilot studies. In general, it is anticipated that significant excavation would be required to develop the gradually sloping banks of the meander channel to provide aquatic and riparian habitat. In the DEIS evaluation it was assumed that six former meanders, with a combined surface area of 147 acres, would be converted to a 30 percent open water and 70 percent native bosque. Site specific condition would dictate method or combination of methods used. Measure implementation would include:

- Detailed site survey,
- Excavation,
- Hauling and disposal of salt cedar (burning, chipping or piled as slash),
- Soil preparation including salinity management,
- Seeding or planting of native vegetation, and
- Maintenance and monitoring. Maintenance would include continued salt cedar control using treatments specific to site conditions. Salt cedar control would be required to reduce invasive species competition with native plants and reduce fuel loads. Monitoring would be in place to assess treatment results and modify methods as appropriate.

## 2.5.4 Sediment Management

### *Current Practices*

Under this alternative maintaining five NRCS sediment control dams and associated access roads would be conducted as indicated for the No Action Alternative, while sediment disposal would be conducted primarily outside the ROW. Changes would also be introduced for sediment removal from the mouth of the arroyos.

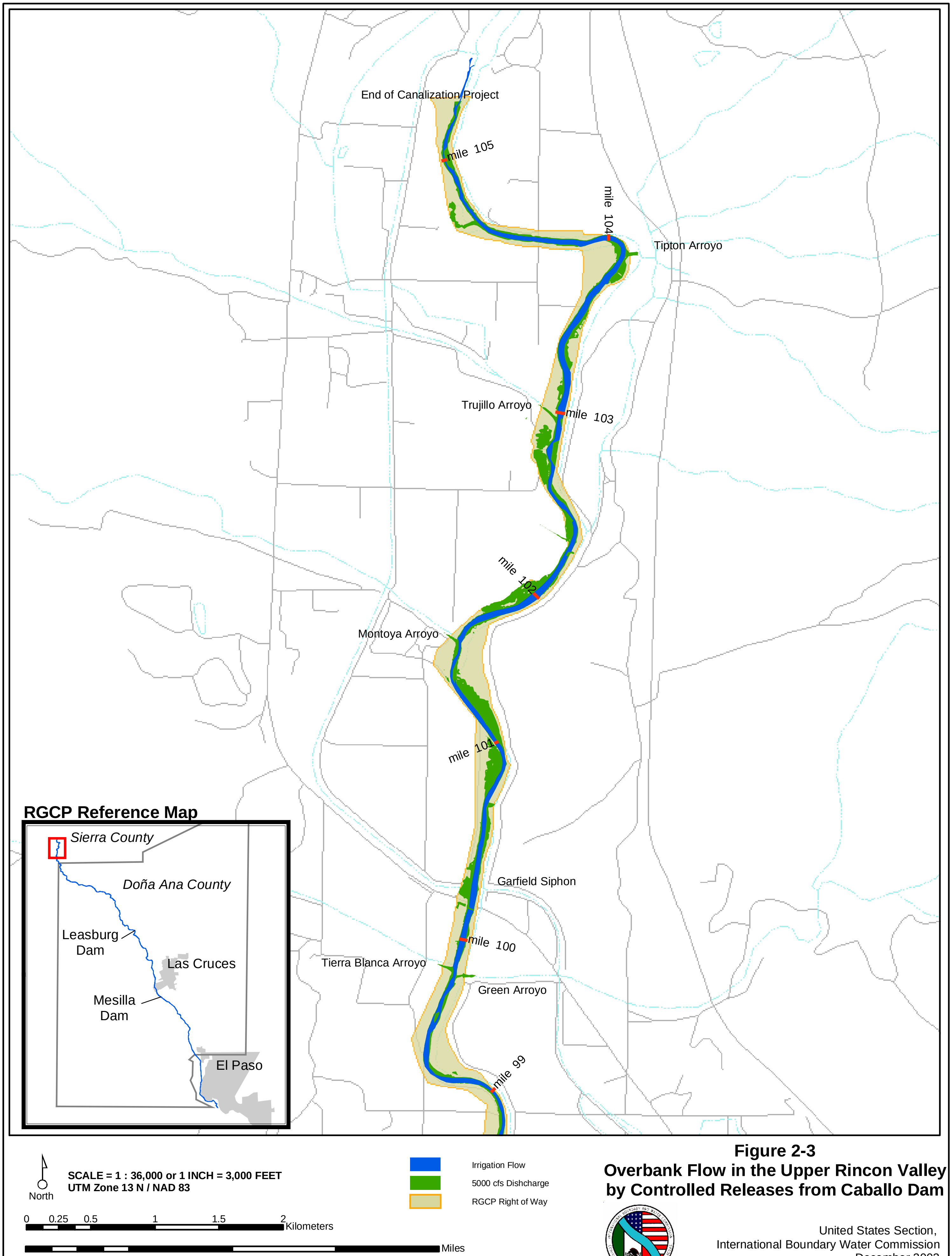



**Figure 2-3**
**Overbank Flow in the Upper Rincon Valley by Controlled Releases from Caballo Dam**

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\IBWCDrive\projects\flow_models_intext.mxd

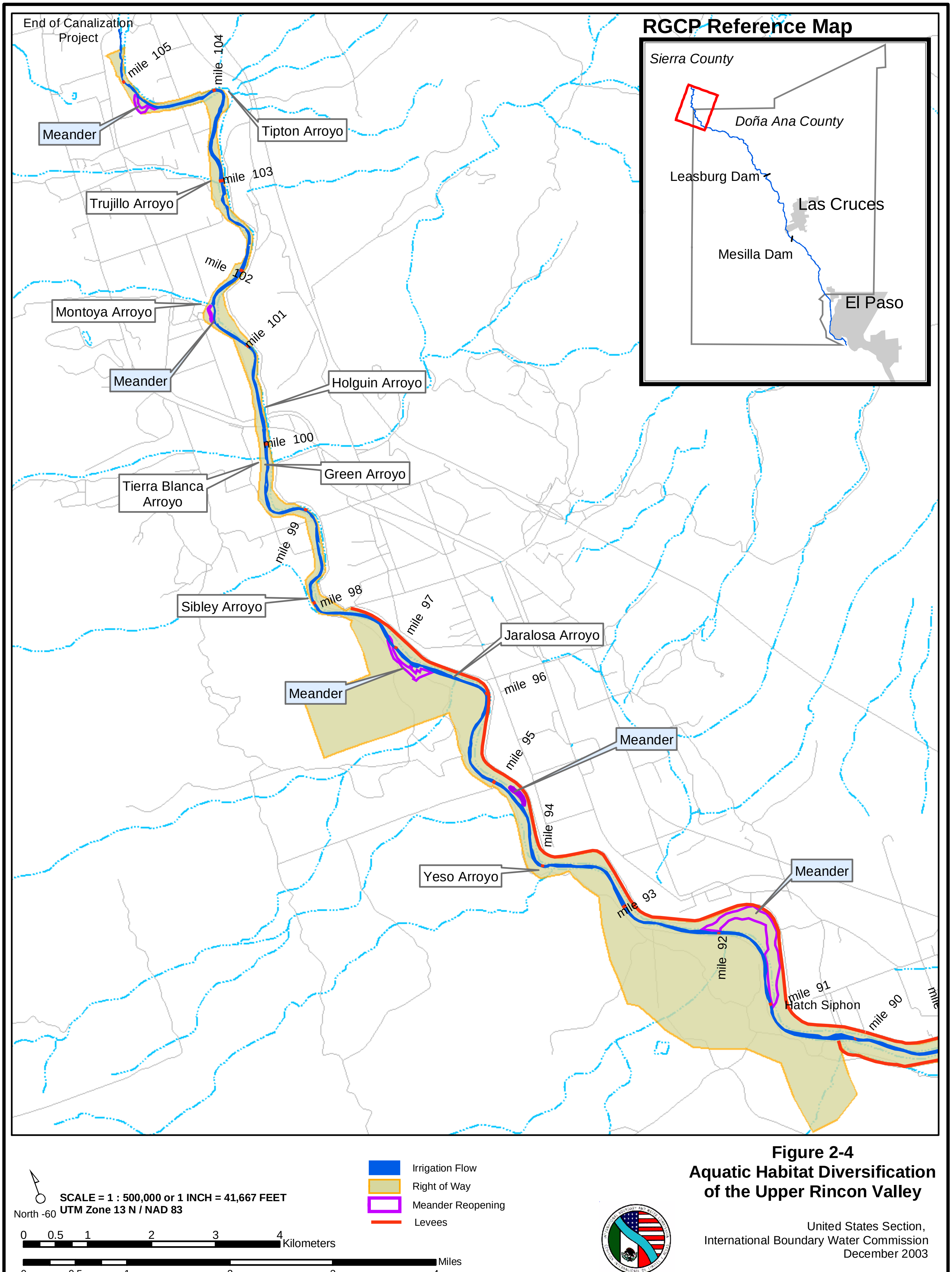



**Figure 2-4**
**Aquatic Habitat Diversification of the Upper Rincon Valley**

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\IBWCDrive\projects\aquatic_habitat_12-9.mxd

***Arroyo Dredging for Habitat Diversification***

Changes in sediment removal from the mouth of the arroyos would be introduced in this alternative for diversification of fish habitat. This measure entails excavating the entrances of selected arroyos to increase the amount of backwater and bottom variation to increase the amount of slow-moving waters during the late spring and early summer. Twelve major arroyos in the Rincon Valley have been identified as having the most significant potential for diversification of aquatic habitat (Subsection 2.6.2).

## 2.6 PROJECTS ASSOCIATED WITH THE ALTERNATIVES

Environmental measures represent river restoration techniques to foster development of riparian corridor and/or diversify aquatic habitat. Environmental measures were arranged as individual projects for a given site or reach of the RGCP. Projects were classified as either linear or point projects based on their geographic coverage along the RGCP.

### 2.6.1 Linear Projects

Linear projects, each extending over several miles of the RGCP, were organized by distinct geographic reaches (RMUs). Four environmental measures are described as linear projects:

- Modification of grazing practices in the floodway and uplands to control erosion and reduce sediment load;
- Modification of grassland management practices (mowing regimes) in the floodway;
- Use of seasonal peak flows to promote regeneration of native riparian vegetation (cottonwoods and willows); and
- Voluntary conservation easements (agriculture and preservation easements).

Each linear project is identified by the two initial letters of the RMU in which they are located, followed by a number that represents a proposed measure. Table 2.6-2 presents the alternatives and identification of associated linear projects..

The Flood Control Improvement Alternative includes six linear projects that entail modification of grazing practices to further reduce erosion in leased areas. Most of the leased areas are located in the Rincon Valley and upper Mesilla Valley (Table 2.6-2).

The Integrated USIBWC Land Management Alternative includes 11 linear projects that are associated with changes in grazing leases as well as modified management of floodway vegetation.

The Targeted River Restoration Alternative includes linear projects associated with four types of environmental measures, modified grazing leases, modified grassland management, seasonal peak flows, and voluntary conservation easements.

### Table 2.6-2 Linear Project Identification and Acreage

| RMU | Measure 1: Modified Grazing in Uplands and Floodway | | Measure 2: Modified Grassland Management in the Floodway | | Measure 3: Controlled Releases from Caballo Dam for Overbank Flows* | | Measure 4: Voluntary Conservation Easements | |
|---|---|---|---|---|---|---|---|---|
| | Project: | *Acres:* | Project: | *Acres:* | Project: | *Acres:* | Project: | *Acres:* |
| Upper Rincon | UR-1 | *1911* | UR-2 | *639* | UR-3 | *214* | | |
| Lower Rincon | LR-1 | *473* | LR-2 | *611* | LR-3 | *302* | LR-4 | *536* |
| Seldon Canyon | | | | | | | SC-4 * | *808* |
| Upper Mesilla | UM-1 | *638* | UM-2 | *22* | | | UM-4 | *28* |
| Las Cruces | LC-1 | *136* | LC-2 | *301* | | | | |
| Lower Mesilla | LM-1 | *256* | LM-2 | *68* | | | LM-4** | *202* |
| El Paso | EP-1 | *138* | | | | | EP-4 | *44* |
| All RMUs | | *3,552* | | *1,641* | | *516* | | *1,618* |
| *Associated with Alternative:* | *All Action Alternatives* | | *Integrated USIBWC Land Management and Targeted River Restoration* | | *Targeted River Restoration* | | *Targeted River Restoration* | |

* Seldon Canyon conservation easements are associated with measure 3, controlled releases from Caballo Dam.
**Overlaps with the Las Cruces RMU. The majority of potential estimates are in the vicinity of current restoration project, the "Picabo Wetlands Restoration Project" (CESWEC 2003).

## 2.6.2 Point Projects

Point projects are limited to site specific locations offering unique opportunities for implementation of environmental measures. Point projects are identified by a number that represents the approximate river mile where they are located, followed by a letter that identifies a specific measure to be implemented. Table 2.6-3 presents all point projects included in the alternatives. The following measures were developed as point projects:

- Planting of native cottonwood and willows within the hydrologic floodplain for riparian corridor development, and/or enhancement of existing bosque;
- Bank shavedowns to promote regeneration of native vegetation;
- Opening of former meanders to diversify aquatic habitat; and
- Modification of dredging at arroyos by creating embayments.

Point projects for the Integrated USIBWC Land Management Alternative focused on the improvement and restoration of riparian vegetation. Projects are listed separately for vegetation planting within the hydrologic floodplain and for shavedown of stream banks to promote overbank flooding during moderately high storm flows. Point projects 105A and 104A, while listed under vegetation planting in Table 2.6-3, are predominantly enhancement of already existing bosques.

Point projects for the Targeted River Restoration Alternative are focused on restoration of the riparian corridor and diversification of the aquatic habitat by reopening low-elevation meanders and modifying arroyo habitat.

# Table 2.6-3 Point Projects Associated with the Integrated USIBWC Land Management and Targeted River Restoration Alternatives

| | | | Integrated USIBWC Land Management Alternative | | Targeted River Restoration Alternative | | |
|---|---|---|---|---|---|---|---|
| **River Mile ID** | **Site Name** | | **Measure A: Native Vegetation Planting** | **Measure B: Stream Bank Shavedowns** | **Measure A: Native Vegetation Planting** | **Measure C: Open Former Meanders** | **Measure D: Modify Dredging at Arroyos** |
| **105** | Oxbow Restoration | Project *(acres)* | 105A *(6.6)* | | | 105C *(6.6)* | |
| **104** | Tipton Arroyo | Project *(acres)* | 104A *(2.5)* | 104B *(3.4)* | 104A *(2.5)* | | 104D *(0.20)* |
| **103** | Trujillo Arroyo | Project *(acres)* | | 103B *(26.5)* | | | 103D *(0.80)* |
| **102** | Montoya Arroyo | Project *(acres)* | 102A *(2.8)* | 102B *(24.7)* | | 102C *(2.8)* | 102D *(0.17)* |
| **101** | Holguin Arroyo | Project *(acres)* | 101A *(6.0)* | 101B *(12.5)* | 101A *(6.0)* | | 101D *(1.16)* |
| **99** | Green/Tierra Blanca Arr. | Project *(acres)* | 99A *(5.1)* | | 99A *(5.1)* | | 99D *(0.27)* |
| **98** | Sibley Point Bar | Project *(acres)* | | 98B *(4.1)* | | | 98D *(0.27)* |
| **97** | Jaralosa Arroyo | Project *(acres)* | | | | 97C *(28.0)* | 97D *(0.44)* |
| **95** | Jaralosa South | Project *(acres)* | 95A *(5.1)* | | | 95C *(5.1)* | |
| **94** | Yeso Arroyo | Project *(acres)* | 94A *(11.5)* | 94B *(3.9)* | 94A *(11.5)* | | 94D *(0.44)* |
| **92** | Crow Canyon | Project *(acres)* | | 92B *(17.9)* | | 92C *(84.6)* | |
| **85** | Placitas Arroyo | Project *(acres)* | | | | | 85D *(0.52)* |
| **83** | Remnant Bosque | Project *(acres)* | 83A *(16.2)* | 83B *(17.9)* | 83A *(16.2)* | | 83D *(0.30)* |
| **78** | Rincon/Reed Arroyos | Project *(acres)* | | | | | 78D *(2.74)* |
| **76** | Bignell Arroyo | Project *(acres)* | 76A *(10.3)* | 76B *(16.3)* | 76A *(10.3)* | | 76D *(0.52)* |
| **54** | Channel Cut | Project *(acres)* | 54A *(19.6)* | | | 54C *(19.6)* | |
| **49** | Spillway No. 39 | Project *(acres)* | 49A *(15.9)* | | 49A *(15.9)* | | |
| **48** | Spillway No. 8 | Project *(acres)* | 48A *(34.6)* | | 48A *(34.6)* | | |
| **42** | Clark Lateral | Project *(acres)* | 42A *(15.4)* | | 42A *(15.4)* | | |
| **41** | Picacho and NMGF | Project *(acres)* | 41A *(71.3)* | | 41A *(71.3)* | | |
| | | ***Total Acreage:*** | ***223*** | ***127*** | ***189*** | ***147*** | ***6.8*** |

### 2.6.3 Summary of Projects

Table 2.6-4 provides a project list by management category and environmental measure. The applicability of those projects to each of the action alternatives is also indicated.

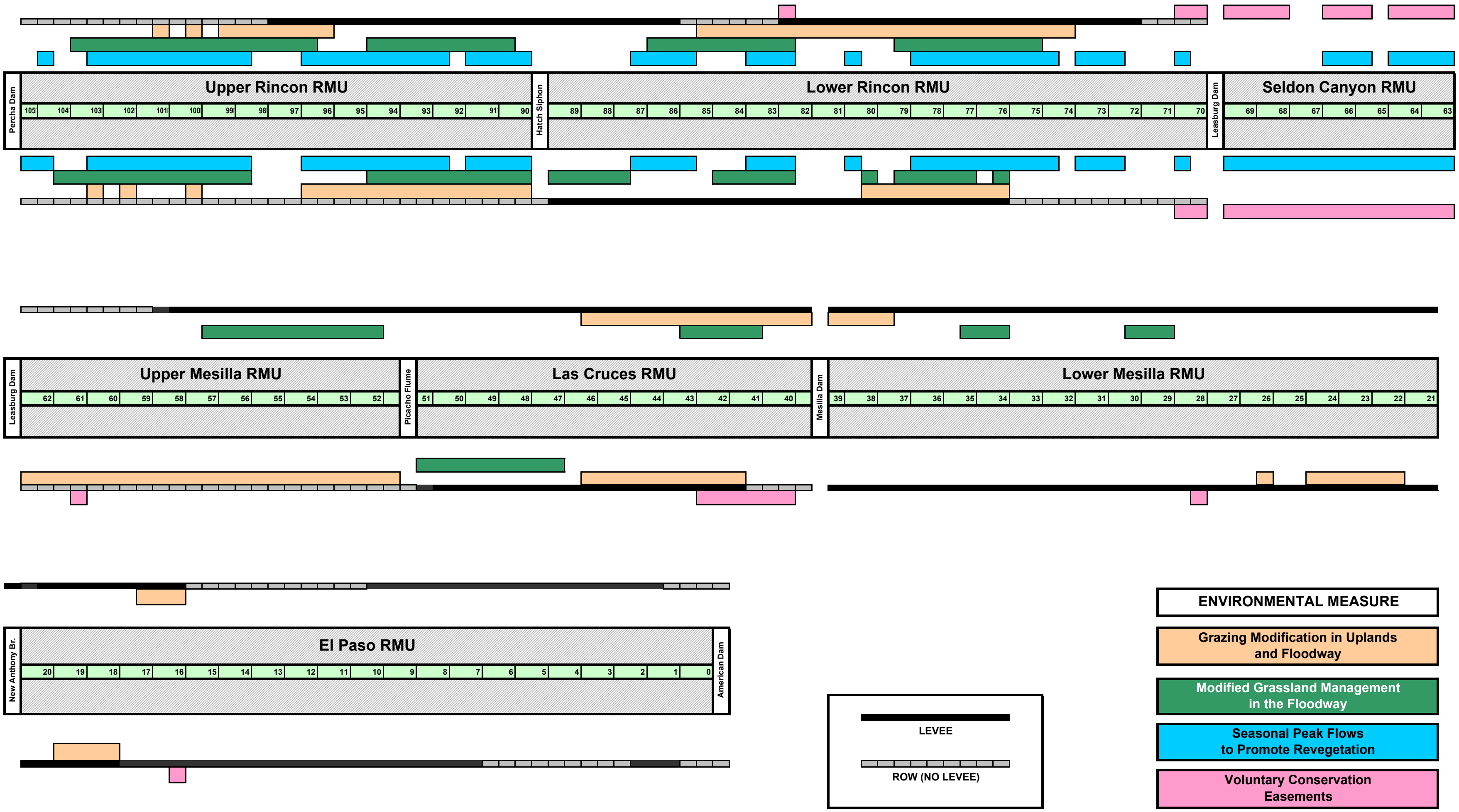
Figure 2-5 shows the geographical distribution of linear projects along the RGCP, and Figure 2-6 illustrates point project distribution along the Rincon and Mesilla Valleys. A graphical description of individual point projects is provided in Figure 2-7 through Figure 2-24. Each figure presents a summary of point projects and acreage by alternative, and aerial photography indicating the RGCP channel, ROW limits, extent of the project area, and adjacent land use.

**Table 2.6-4 Summary of Projects by Measure and Alternative**

| | | Alternative* | | |
|---|---|---|---|---|
| **Environmental Measure** | **Project List** | **FCI** | **IULM** | **TRR** |
| *Floodway Management* | | | | |
| Modified grazing leases (erosion control) | UR-1, LR-1, UM-1, LC-1, LM-1, EP-1 | X | X | X |
| Modified grassland management | UR-2, LR-2, UM-2, LC-2, LM-2 | | X | X |
| Vegetation planting and bosque enhancement | 104A to 48A (14 Projects) | | X | X |
| Stream bank shavedowns | 104B to 76B (9 Projects) | | X | |
| Seasonal peak flows / bank preparation | UR-3, LR-3 | | | X |
| Conservation easements | LR-4, SC-4, UM-4, LM-4, EP-4 | | | X |
| *Pilot Channel Management* | | | | |
| Reopening of former meanders | 105C to 54C (6 Projects) | | | X |
| *Sediment Management* | | | | |
| Modified arroyo dredging for habitat | 104D to 76D (12 Projects) | | | X |

* FCI, Flood Control Improvement; IULM, Integrated USIBWC Land Management;
TRR, Targeted River Restoration

## Figure 2-5 Environmental Measures to be Implemented as Linear Projects






EIS in-text Figures.xls\Figure 2-6 - 10/22/2003

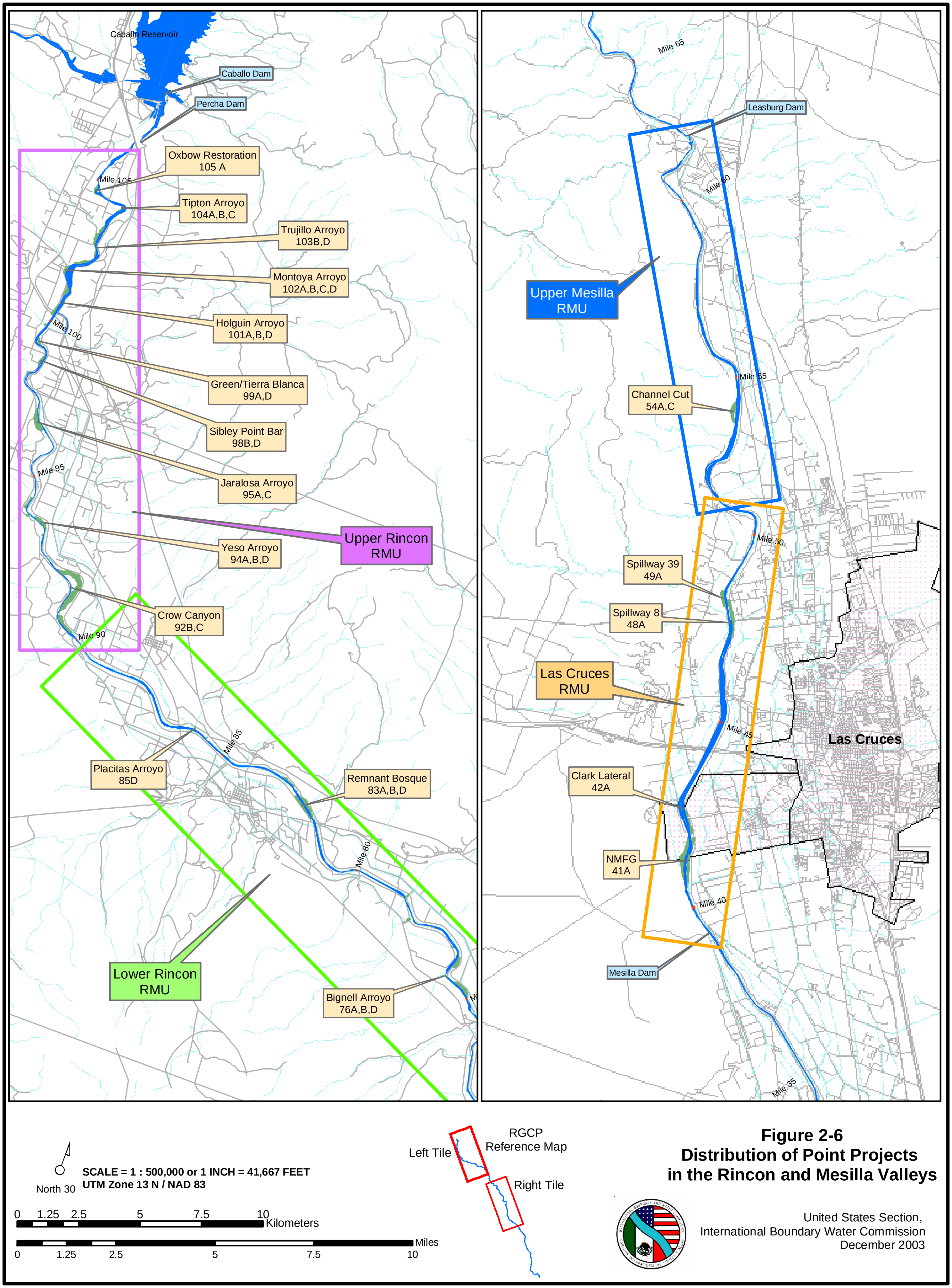



**Figure 2-6**
**Distribution of Point Projects in the Rincon and Mesilla Valleys**

United States Section,
International Boundary Water Commission
December 2003


## Figure 2-7: Mile 105 Oxbow Restoration

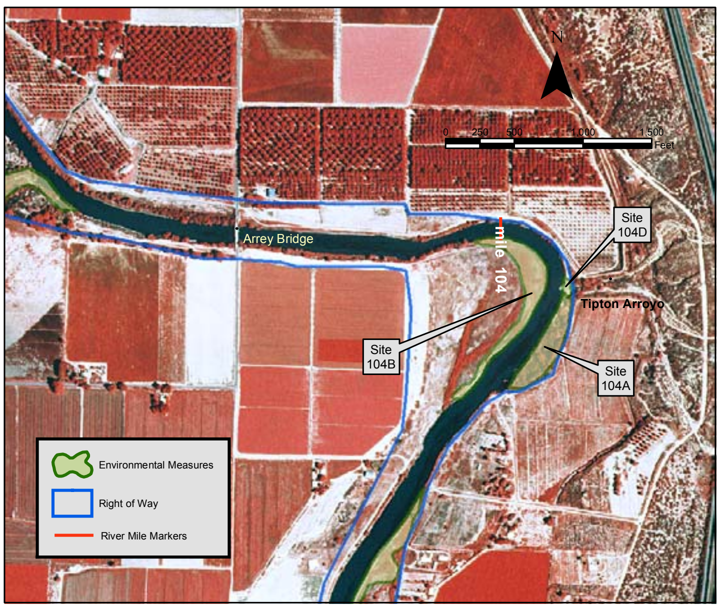
South of Percha Dam is a 6.6 ac former meander diked off during RGCP construction. This oxbow was originally the main channel of the river until the current channel was excavated. The oxbow is heavily vegetated.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native Vegetation Planting/enhancement | 105A | 1 | 6.6 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Open former meander | 105C | 1 | 6.6 |




## Figure 2-8: Mile 104 Tipton Arroyo

On the eastern shore, opposite a point bar, is the mouth of Tipton Arroyo. The mouth of the arroyo has been excavated to remove the “fan” of sediments entering the river. The watershed draining to Tipton Arroyo (identified as Misc.2 by USCOE) encompasses 2.2 square miles with numerous drainage channels leading from uplands to the east. The channels flow under U.S. Interstate 25 and combine into Tipton Arroyo near the Rio Grande.

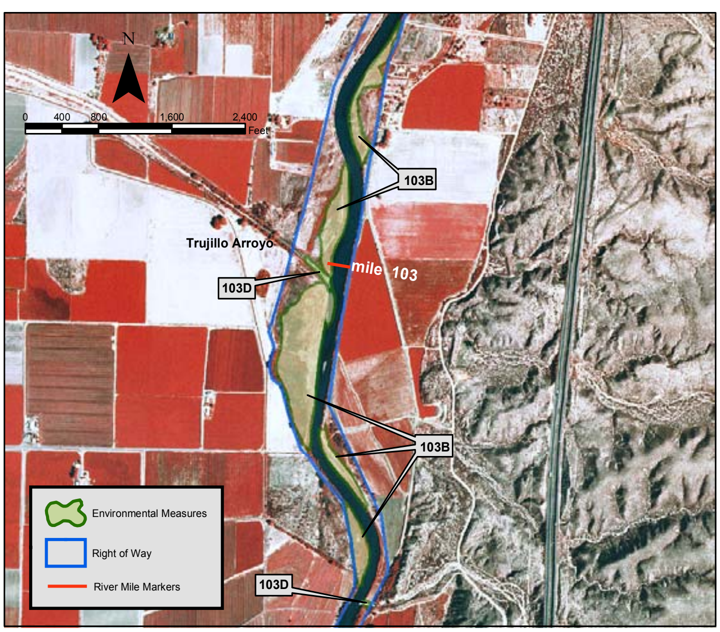
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native Vegetation Planting/enhancement | 104A | 1 | 2.52 |
| Bank shavedowns* | 104B | 1 | 3.4 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Planting/enhancement | 104A | 1 | 2.52 |
| Modify dredging at arroyos by creating embayments | 104D | 1 | 0.2 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure “Seasonal peak flows”.




## Figure 2-9: Mile 103 Trujillo Arroyo

The mouth of Trujillo Arroyo is on the western bank of the river at mile 103. The channel for Nordstrom Arroyo, which is north of Trujillo Arroyo, has been diverted south to combine with Trujillo Arroyo prior to passing over the Arrey Canal Siphon and entering the floodway. Trujillo Canyon covers 52.9 square miles and extends for 29.5 miles to the west from the Rio Grande into the Black Range Mountains of the Gila National Forest.

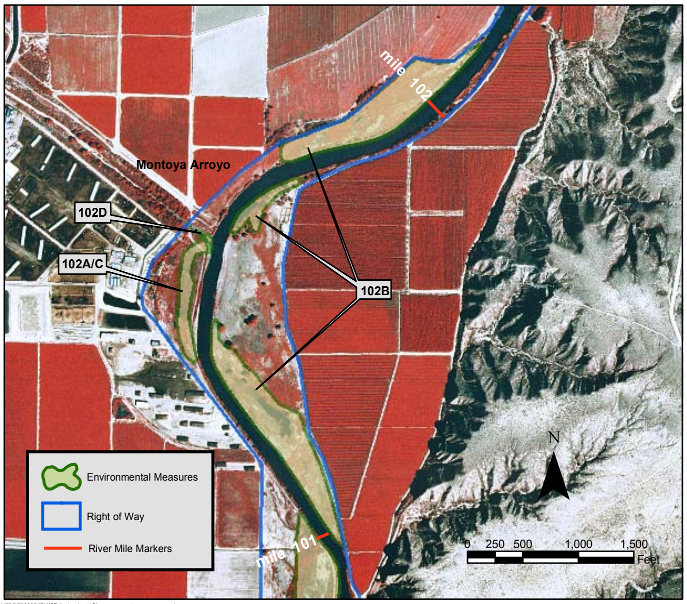
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Bank shavedowns* | 103B | 5 | 26.5 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Modify dredging at arroyos by creating embayments | 103D | 2 | 0.8 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure “Seasonal peak flows”.




J:\736\736620\IBWCDrive\projects\Sitemaps_montoya_arroyo.mxd

## Figure 2-10: Mile 102 Montoya Arroyo

The mouth of Montoya Arroyo is on the western bank of the river at mile 101.5. The watershed covers 23 square miles and does not have a sediment control dam. The banks of the arroyo outside the ROW are heavily vegetated. This part of the ROW was originally a part of the river channel with an island separating two channels. The western channel was diked off and filled in during the RGCP construction.

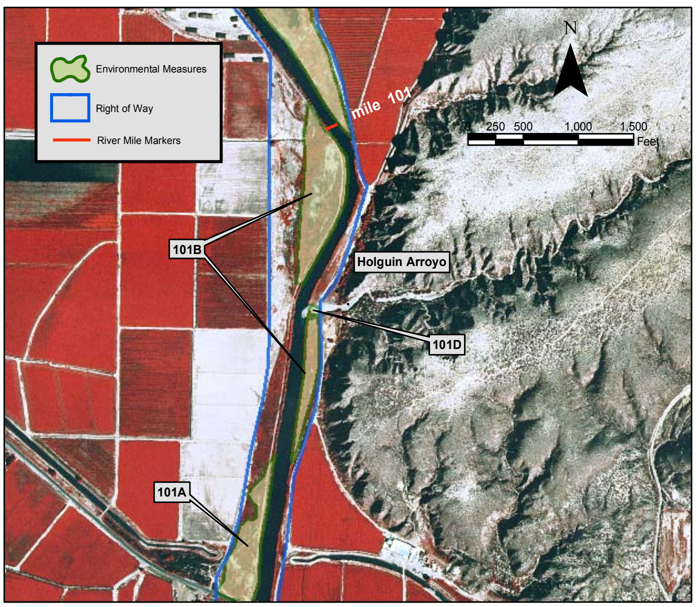
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 102A | 1 | 2.8 |
| Bank shavedowns* | 102B | 3 | 24.7 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Area (ac) |
|---|---|---|---|
| Open former meanders | 102C | 1 | 2.8 |
| Modify dredging at arroyos by creating embayments | 102D | 1 | 0.17 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




J:\736\736620\IBWCDrive\projects\Sitemaps_holguin_arroyo.mxd

## Figure 2-11: Mile 101 Holguin Arroyo

Point measures are located on the western and eastern edge of the river between Montoya and Holguin Arroyos at mile 101. Wetlands are interspersed throughout the site.

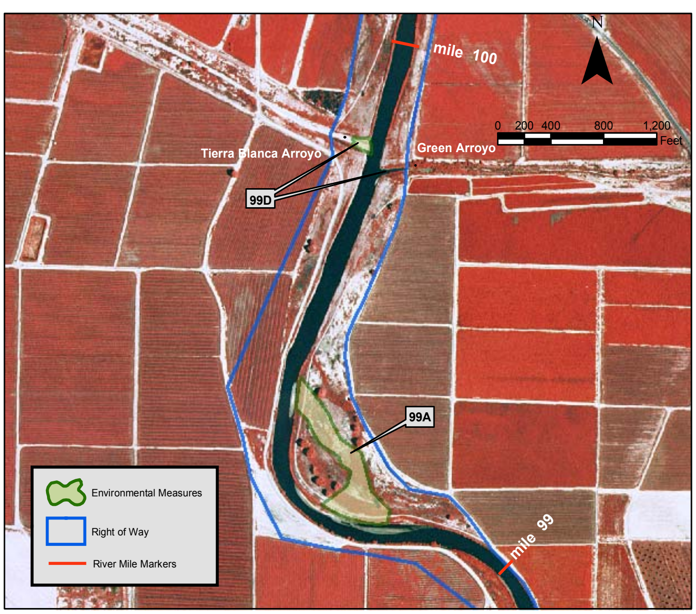
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 101A | 1 | 6.0 |
| Bank shavedowns* | 101B | 2 | 12.5 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 101A | 1 | 6.0 |
| Modify dredging at arroyos by creating embayments | 101D | 1 | 0.16 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




J:\736\736620\IBWCDrive\projects\Sitemaps_green-tierra_blanca.mxd

## Figure 2-12: Mile 99 Green-Tierra Blanca

Tierra Blanca Arroyo enters the river on the west bank opposite Green Arroyo south of mile 100. Green Arroyo has an erosion control dam designated SCS Dam 1A and a watershed of 68.2 square miles and extending westward a distance of 30.2 miles. Tierra Blanca Arroyo deposits sediment within the river that must be periodically dredged.

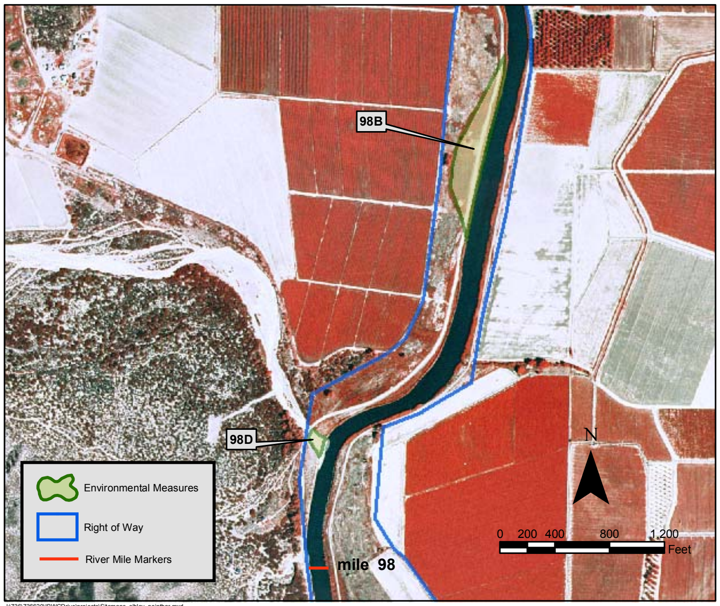
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 99A | 1 | 5.05 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 99A | 1 | 5.05 |
| Modify dredging at arroyos by creating embayments | 99D | 2 | 0.27 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




## Figure 2-13: Mile 98 Sibley Point Bar

Sibley Arroyo deposits sediment within the river that has been periodically dredged. The eastern side of the river supports a point bar opposite the mouth of Sibley Arroyo at mile 98.

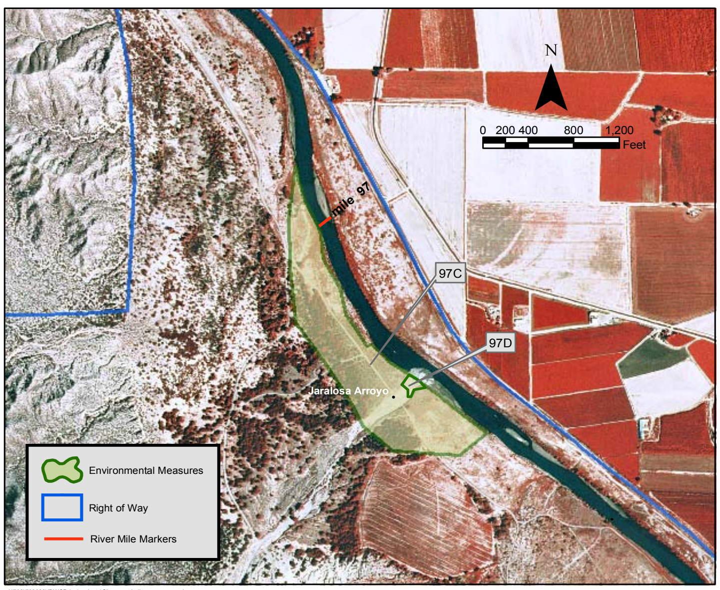
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Bank shavedowns* | 98B | 1 | 4.1 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Modify dredging at arroyos by creating embayments | 98D | 1 | 0.27 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".

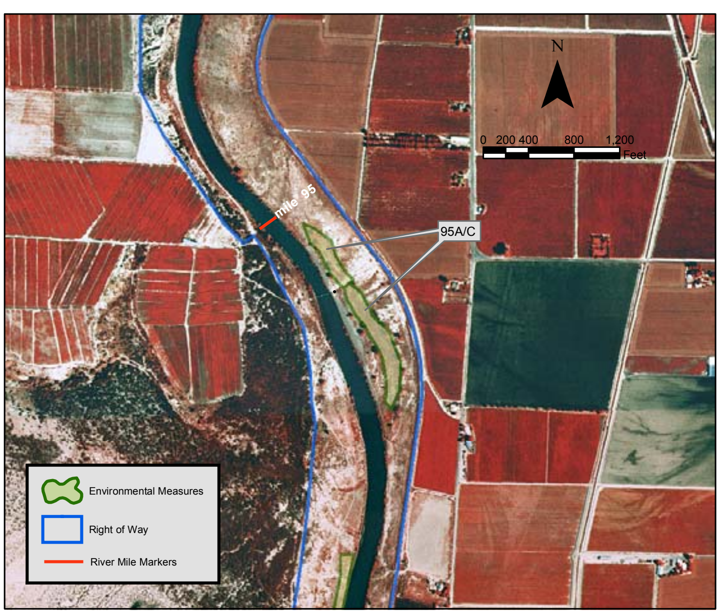



## Figure 2-14: Mile 97 Jaralosa Arroyo

Jaralosa Arroyo enters the west side of the river near mile 96.5 through a channel, which diverted flow from its original route. The channel conveys the combined flow of Jaralosa Arroyo and Berrenda Creek both of which have dams. Despite the dams, the arroyo deposits sediment that creates islands in the river. Part of the ROW is leased for cultivation (approximately 60 ac). A former meander is on the west side of the river. Although the meander is outside the hydrologic floodplain, it presents a restoration opportunity (through excavation) due to ROW width.

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Open former meander | 97C | 1 | 28.0 |
| Modify dredging at arroyos by creating embayments | 97D | 1 | 0.44 |




## Figure 2-15: Mile 95 Jaralosa South

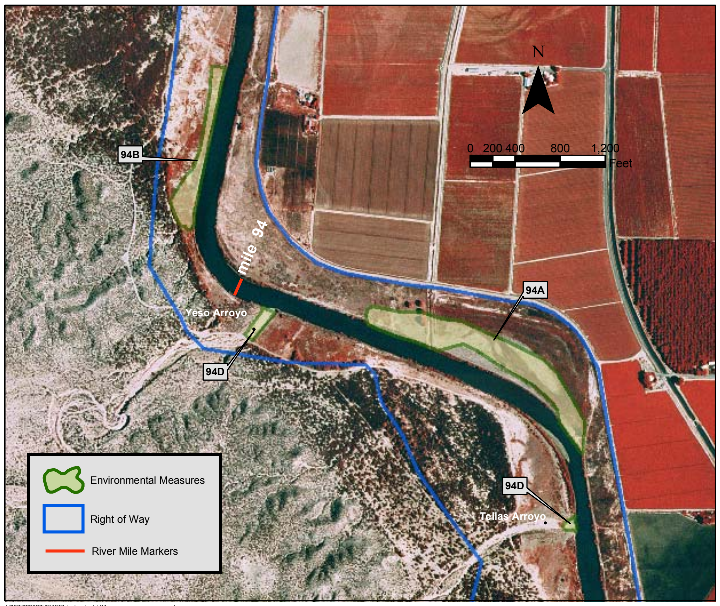
Jaralosa Arroyo enters the west side of the river near mile 96.5 through a channel, which diverted flow from its original route. The channel conveys the combined flow of Jaralosa Arroyo and Berrenda Creek both of which have dams. Despite the dams, the arroyo deposits sediment that creates islands in the river. A former meander is located on the east side.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 95A | 2 | 5.1 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Open former meander | 95C | 1 | 5.1 |




## Figure 2-16: Mile 94 Yeso Arroyo

BLM lands abut the ROW to the west. A large remnant bosque is present on the western side of the river. The west bank contains mature scattered cottonwoods and understory mesquite and salt cedar. Salt cedar dominates the east bank. Yeso Arroyo has a watershed of 9.5 square miles and extends 6.1 miles to the west.

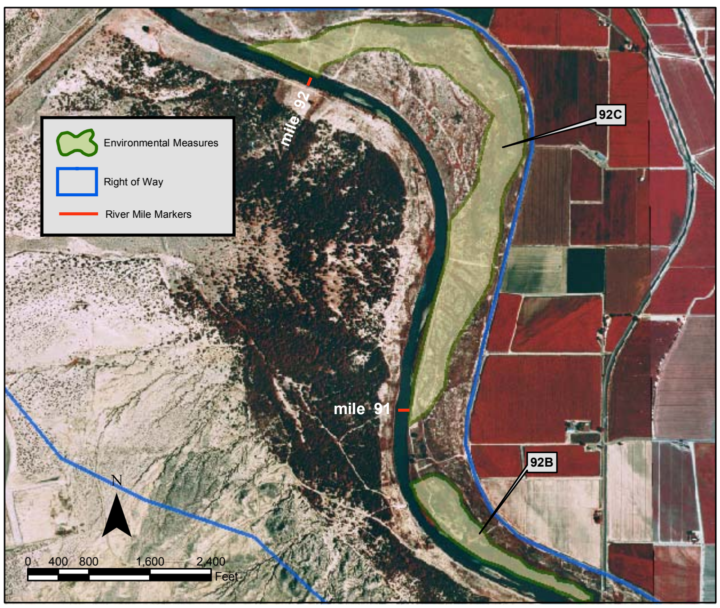
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 94A | 1 | 11.5 |
| Bank shavedowns* | 94B | 1 | 3.9 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 94A | 1 | 11.5 |
| Modify dredging at arroyos by creating embayments | 94D | 2 | 0.44 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




## Figure 2-17: Mile 92 Crow Canyon

The majority of the bosque was cleared during RGCP construction and is now dominated by herbaceous vegetation and salt cedar. A straight, stepped channel extends from Crow Canyon dam to the west side of the river channel south of mile 93. The ROW on the west side of the river abuts land owned by BLM. A large area of ROW on the eastern side of the river is mowed but not grazed. A few mature and young cottonwoods are growing in this area. Isolated areas contain wetland vegetation indicating a high water table.

**Integrated USIBWC Land Management Alternative**

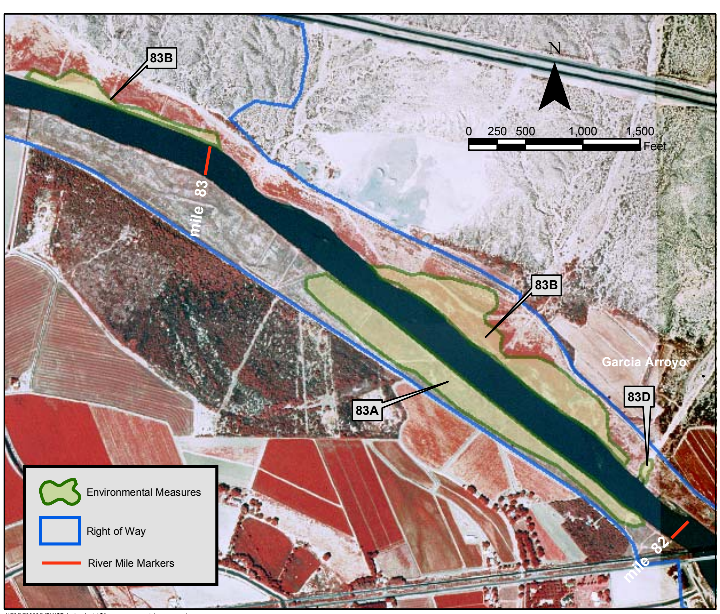
| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Bank shavedowns* | 92B | 1 | 17.9 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Open former meander** | 92C | 1 | 84.6 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".

* *The meander is outside the hydrologic floodplain but considered a potential measure due to relative elevation. However, due to elevation, not considered a location for planting measures (Alternative 3)




## Figure 2-18: Mile 83 Remnant Bosque

The Rincon Siphon portion of the site includes Garcia Arroyo on the eastern side of the river upstream of the Rincon Siphon at mile 82. The arroyo deposits sediments in the river up stream of the bridge. The siphon is protected by a grade control dam consisting of bolders that creates a low velocity backwater to minimize erosion of the siphon bedding material. The high water elevation has created wetlands in the floodway north of the bridge.

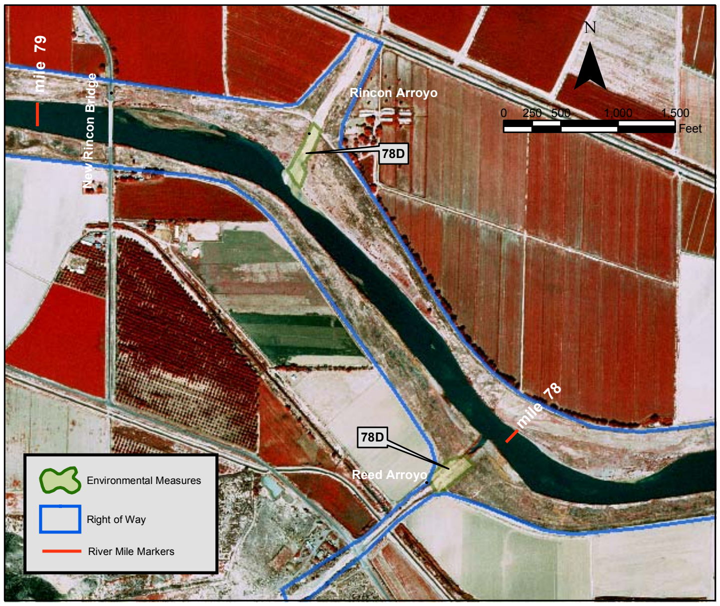
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 83A | 1 | 16.2 |
| Bank shavedowns* | 83B | 2 | 17.9 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 83A | 1 | 16.2 |
| Modify dredging at arroyos by creating embayments | 83D | 1 | 0.3 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




J:\736\736620\IBWCDrive\projects\Sitemaps_rincon-reed_arroyo.mxd

## Figure 2-19: Mile 78 Rincon/Reed Arroyo

Rincon Arroyo enters the river from the north bank near mile 78.5. The Arroyo has a watershed of 124.7 square miles and extends for 30 miles to the north with numerous tributaries. This is the largest arroyo along the RGCP with no sediment control dam. An island created by the sediment deposits is heavily vegetated with willow. Reed Arroyo enters the river on the south bank at mile 78. The arroyo has a watershed of 9.6 square miles and is 6.6 miles long. No sediment control dams are located on the arroyo.

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Modify dredging at arroyos by creating embayments | 78D | 2 | 2.74 |


J:\736\736620\IBWCDrive\projects\Sitemaps_bignell_arroyo.mxd

## Figure 2-20: Mile 76 Bignell Arroyo

Bignell Arroyo enters the river on the south bank near mile 76. The arroyo extends for 7.6 miles from the river and is not controlled by a sediment dam. Woody vegetation is found in drains and along river banks.

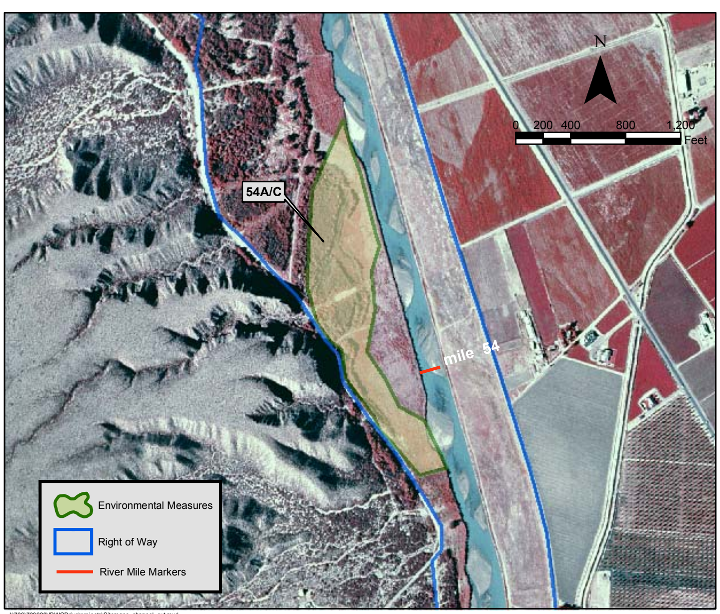
**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 76A | 1 | 10.3 |
| Bank shavedowns* | 76B | 1 | 16.3 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 76A | 1 | 10.3 |
| Modify dredging at arroyos by creating embayments | 76D | 2 | 0.52 |

* Bank shavedowns acreage is included in the Targeted River Restoration Alternative as a linear measure "Seasonal peak flows".




J:\736\736620\IBWCDrive\projects\Sitemaps_channel_cut.mxd

## Figure 2-21: Mile 54 Channel Cut

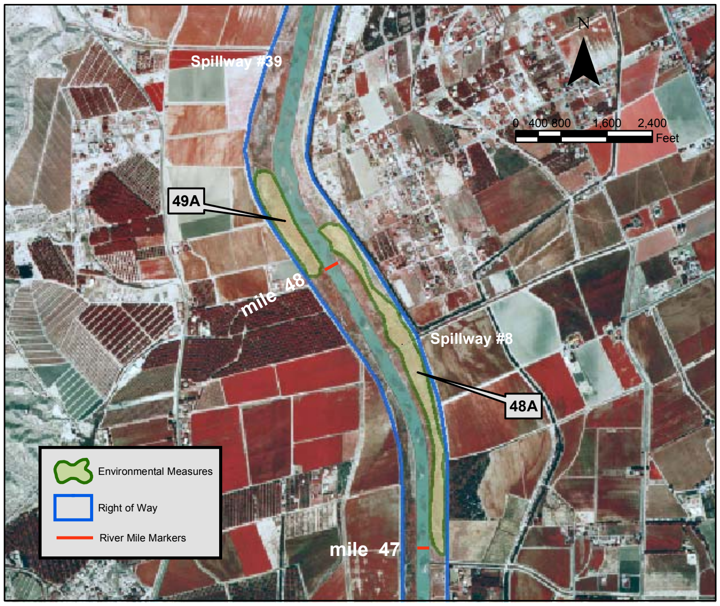
Between mile 54 and 55, the river channel was straightened during RGCP construction. The site includes extensive ROW on each side of the river. The riparian and upland sites are mowed but provide good opportunities for riparian enhancements.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 54A | 1 | 19.6 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Open former meander | 54C | 1 | 19.6 |




## Figure 2-22: Miles 49 & 48 spillways

Spillway No. 39 flows from the Picacho Lateral to the west bank north of river near mile 48.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 49A | 1 | 15.9 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 49A | 1 | 15.9 |

Spillway No. 8 is enters the east bank of the river at mile 48.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 48A | 1 | 34.6 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 48A | 1 | 34.6 |


## Figure 2-23: Mile 42 Clark Lateral

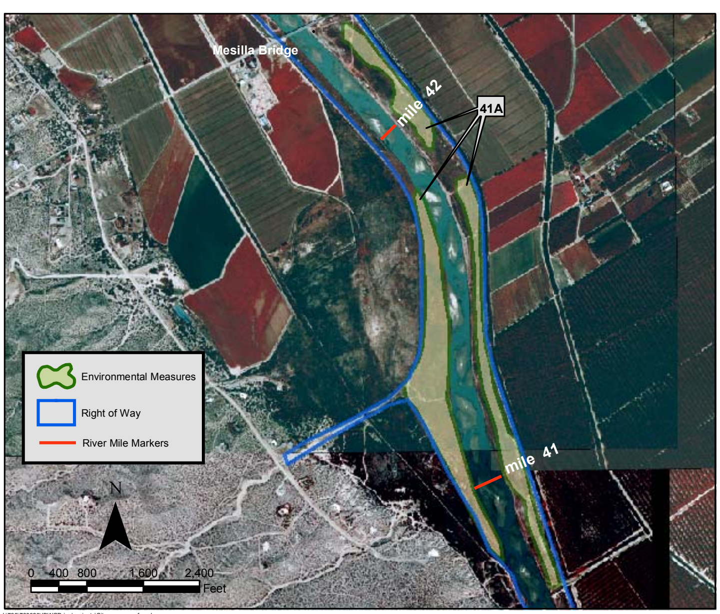
The ROW extends past the levee to the Clark Lateral on the east side of the river at mile 42. Grass and shrubs dominate the area due to mowing although some mature acacia and cottonwoods are present at the south end.

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 42A | 1 | 15.4 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 42A | 1 | 15.4 |




## Figure 2-24: Mile 41 Picacho and NMGF

A privately-owned tract of land on the west side of the river near mile 41.5 has been identified by SWEC as the potential site of a Bosque Park. The presence of an old channel through the tract is evident from vegetation and from historical maps. Undeveloped land south of this tract, owned by New Mexico Game and Fish, is a project planned for bosque enhancement (Picacho Wetlands Project).

**Integrated USIBWC Land Management Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 41A | 3 | 71.3 |

**Targeted River Restoration Alternative**

| *Point Project Measures* | ID | # | Acres |
|---|---|---|---|
| Native vegetation planting | 41A | 3 | 71.3 |

## 2.7 ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

### 2.7.1 RGCP Partial Decommissioning Alternative

During the scoping process, partial decommissioning of the RGCP was suggested as an alternative to be considered in the DEIS. Under this alternative, actions would be limited to those associated with current maintenance of existing levees. Other practices would be discontinued, such as placement of river training works to protect infrastructure, bank stabilization, vegetation control, and sediment removal from the main channel to allow changes in stream configuration. This alternative was reviewed in the Alternatives Formulation Report and excluded from the Environmental Impact Statement analysis because the alternative:

- Fails to meet the congressionally mandated commitment to U.S.-Mexico water delivery treaties.
- Would produce extensive changes in channel geometry that significantly reduce water delivery capabilities of the RGCP.
- Compromises the effectiveness of the flood control system by allowing uncontrolled vegetation growth along the floodway.
- Is conducive to the development of invasive plant species in the floodway, particularly salt cedar.

Management of floodway vegetation for development of a riparian corridor and controlled changes in stream configuration along the RGCP are considered under two action alternatives evaluated in the Environmental Impact Statement (the Integrated USIBWC Land Management Alternative and the Targeted Restoration Alternative).

### 2.7.2 Multipurpose Watershed Management Alternative

This alternative was evaluated during the March 2001 formulation of alternatives (Parsons 2001a). The alternative is not evaluated as such in the DEIS because in the reformulation its most relevant features –those associated with development of a riparian corridor and aquatic habitat diversification– were incorporated into the Integrated USIBWC Land Management and Targeted River Restoration Alternatives. The rationale for those changes in river management alternatives was described in the Reformulation of Alternatives Report (Appendix I, attached CD).

As initially formulated in the March 2001 Alternatives Formulation Report, the Multipurpose Watershed Management Alternative incorporated most of the environmental measures included in the other action alternatives, plus the following measures:

- Sediment control in tributary basins, outside of the immediate area of the river and the ROW. In the DEIS, cooperative agreements address sediment control in tributary basins as part of the implementation strategy (Subsection 2.9.3).

- Flow regime modifications, namely changes in peak flow magnitude or seasonality, and in-stream flows. In the reformulation, induced peak flows for overbank flooding were incorporated into the Targeted River Restoration Alternative. In-stream flows, however, were not retained as a significant RGCP management issue as the opposite condition –high irrigation flows— were identified as the key limiting condition for aquatic habitats (Subsection 3.7.2).
- Initiatives related to a multipurpose use of the RGCP right-of-way (parks and recreational uses). Multiple ongoing initiatives by the USIBWC for increased RGCP recreational use by cooperative agreements –a long-term goal of the USIBWC– were incorporated into all river management alternatives under consideration.

### 2.7.3 Restoration Alternative Based on Non-Structural Flood Control

As part of the river management alternatives formulation, flood control in the RGCP was evaluated in the context of river restoration potential. In particular, potential opportunities for implementation of environmental measures were evaluated considering non-structural flood control measures such as levee relocation to increase the active floodplain size. This alternative was evaluated as part of the reformulation but excluded for further analysis based on two main considerations that are discussed below:

- Because stream configuration along the RGCP is largely dictated by upstream reservoir operation, levee relocation would offer few significant additional opportunities for riparian corridor development or aquatic habitat diversification relative to other alternatives under consideration.
- Potential levee deficiencies have been identified mostly in urbanized areas of El Paso and Las Cruces RMUs where levee relocation is not desirable and has a very limited potential to address those deficiencies.

#### *Potential Role of Non-Structural Flood Control in RGCP Restoration*

The configuration of natural streams is largely dictated by the extent and frequency of flooding events. In most North American streams, however, flows have been heavily regulated by upstream reservoir operation. This is the case of the RGCP where multiple reservoirs were constructed over the last century for flood control and irrigation water storage.

Coupling non-structural flood control measures with riparian ecosystem restoration has been successful in riverine systems with large recurrent flood events, such as the Missouri River (Rasmussen 1999a) and Ohio River (Parsons 2000b). In these systems, many reaches with levees designed for high magnitude floods had actually been subject to frequent flooding. For example, following analysis of the devastating flooding in the Midwest in 1993 the Interagency Floodplain Management Review Committee reported that many districts with protection levees had actually been flooded five to 10 times during the previous 50 years (Cunniff 1997). A significant factor in the flooding was the extensive uncoordinated and/or unregulated placement of levees by agencies and landowners (Rasmussen 1999b). Under these conditions, levee relocation and use of other non-structural flood control measures offer numerous opportunities to combine flood control and river restoration measures.

Flood conditions in the Midwest differ radically from those in the RGCP where the levee system was built as a single, planned project, and its operation for over 60 years has been conducted entirely by a single agency, the USIBWC. In the RGCP, where low precipitation is prevalent and flooding is infrequent and tightly controlled by upstream reservoirs, flood control needs and stream restoration opportunities differ substantially from those applicable to the Missouri and Ohio Rivers. In addition to Elephant Butte Dam, completed in 1916, flood regulation upstream of the RGCP was increased by four reservoirs constructed under the Flood Control Act of 1941: Jemez Canyon Dam (1953), Abiquiu Dam (1963), Galisteo Dam (1970), and Cochiti Dam (1975). These dams have effectively controlled floods originating in the upper Rio Grande Basin (Winter *et al*. unpublished manuscript). Additional flood control is expected as a result of the Upper Rio Grande Water Operations Model (URGWOM), a multi-agency initiative to optimize water storage and delivery operations throughout the Rio Grande from Colorado to Texas (www.spa.usace.army.mil/urgwom). Improved flood routing through the RGCP is a component of the simulation model.

Given the tightly regulated upstream flow, few significant flood events, all contained within the levee system, have been registered in 60+ years of RGCP operation. Unlike non-structural flood control programs implemented for rivers with recurrent high flood events where non-structural methods could provide both flood protection and environmental improvement opportunities, the use of non-structural methods in the RGCP is primarily an economic and risk-management flood control decision. Table 2.7-1 illustrates the reduction in peak floods at El Paso, Texas, following completion of Elephant Butte Dam in 1916 and Caballo Dam in 1938 (USACE 1996).

**Table 2.7-1 Peak Floods of Record at El Paso, Texas**

| Year | Date | Peak Discharge (cubic feet per second) |
|---|---|---|
| **Prior to Elephant Butte Construction** | | |
| 1897 | May 27 | 18,200 |
| 1903 | June 21 | 18,100 |
| 1904 | October 15 | 17,100 |
| 1905 | June 12 | 24,000 |
| **Prior to Caballo Dam Construction** | | |
| 1925 | September 3 | 13,500 |
| 1933 | August 5 | 5,010 |
| 1935 | August 31 | 7,120 |
| **After Caballo Dam Construction** | | |
| 1950 | July 14 | 7,740 |
| 1957 | July 26 | 4,730 |
| 1958 | September 14 | 11,600 |

The active RGCP floodplain is largely controlled by irrigation flows and low-magnitude floods regulated by upstream reservoirs, not by the large and rare 100-year flood events the levees are intended to control. As a result, the existing levee system does not dictate the active floodplain in the RGCP, or current river configuration. Under these conditions non-structural measures such as levee relocation remain an option for flood control in some segments of the RGCP but, unlike the flow regime, is not a key consideration in riparian corridor development or aquatic habitat diversification.

### *Potential for Levee Relocation as a Non-Structural Flood Control Measure*

The potential use of non-structural flood control measures was evaluated on a conceptual basis for the RGCP. This evaluation was not intended to be a flood control study, but an assessment of additional opportunities for riparian and aquatic habitat restoration. Reevaluation of flood control strategies is an ongoing task conducted by the USIBWC as part of its mission.

Levee relocation was evaluated as a potential non-structural flood control measure for the RGCP. The evaluation was performed by identifying reaches of the levee system with potential flood containment deficiencies, in conjunction with adjacent land use categories. The conceptual evaluation was based on the following criteria:

- As a sizable federal investment, relocation of levees would be justified only at locations where a significant potential for flood containment deficiencies is identified (inadequate freeboard).
- Levee deficiencies adjacent to residential or urbanized areas must be addressed by levee rehabilitation at their current location (structural measures).
- Deficient levees adjacent to large rural areas would offer a potential for establishing flood easements and/or partial modification of the levee system.

Hydraulic model simulations of the 100-year flood, subsequently discussed in the flood control baseline conditions (Subsection 3.2.2; Figure 3-4; Appendix E), identified 13 miles of levees with potentially significant deficiencies in terms of height. Most of the potential deficiencies identified are located largely in the southern, mostly urbanized reaches of the RGCP (Las Cruces and El Paso RMUs).

Overall, the combined evaluation of potential levee deficiencies and adjacent land use in the RGCP showed a very limited potential for levee relocation as a non-structural flood control measure and its use in support of river restoration. Under conditions simulated by the hydraulic model, an analysis of levee relocation would be warranted in only two RGCP reaches where significant levee deficiencies are adjacent to agricultural lands:

- The downstream end of the Rincon Valley, from river miles 72 to 76, where model results indicate that the east (left) levee elevation might be inadequate for control of the 100-year flood; and
- The downstream end of Las Cruces RMU, north of Mesilla Dam, from river miles 40 to 41 (left levee).

In the Environmental Impact Statement, lands along these two reaches were identified as potential conservation easements as part of the Targeted River Restoration alternative. If warranted, the USIBWC could incorporate such easements into a future modified flood control strategy.

## 2.8 PROJECTS AND ACTIONS WITH POTENTIAL CUMULATIVE EFFECTS

Complete environmental impact analysis of proposed or alternative actions must consider cumulative impact analysis due to other actions. A cumulative impact, as defined by the NEPA is the impact to the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or non-federal) or person undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. Two actions with potential cumulative effects have been identified: regional water management plans and the ongoing analysis of the levees' structural condition.

### 2.8.1 Regional Water Management Plans

#### *El Paso-Las Cruces Regional Sustainable Water Project*

The New Mexico-Texas Water Commission proposed securing future drinking water supplies from surface water sources for the El Paso-Las Cruces region through the construction and operation of water treatment plants, aqueducts and diversion structures, aquifer storage and recovery, water acquisitions, water conservation, and water banking. This project is known as the El Paso-Las Cruces Regional Sustainable Water Project. The USIBWC and El Paso Water Utilities/Public Service Board (EPWU/PSB) were co-lead agencies for project planning and evaluation of potential effects. The project has not entered the implementation phase as agreements have not been reached on water acquisition. The City of El Paso has developed plans for use of groundwater treated by desalination.

#### *Upper Rio Grande Bsin Water Operations Review*

A multi-agency task force is currently evaluating more reliable and effective management strategies for the Upper Rio Grande basin through comprehensive hydraulic and hydrological simulation of stream flows, storage, and water demands. Only flood control operations are being addressed in the review for Elephant Butte and Caballo Dams.

### 2.8.2 Analysis of Structural Condition of the Levees

The need for levee rehabilitation due to structural deficiencies is not currently known. The extent of such rehabilitation would be dependent on findings of an ongoing investigation to verify levee condition. The three-step investigation entails aerial geophysical surveys, followed by surface geophysical surveys, and a geotechnical drilling program. The goal of aerial geophysical surveys is to identify the regions of levee that yield questionable electrical conductivity values as related to soil composition. Resulting electrical conductivity values would then be correlated to known soil properties and characteristics, thus providing a regional representation of levee composition (i.e., sand, clay, voids).

Levee regions identified in the aerial geophysical surveys as questionable or inappropriate for flood control purposes would be re-surveyed using surface geophysics methods. Surface geophysical surveys would generate detailed resistivity/conductivity data to more accurately quantify integrity of the levee. Results of the surface geophysical survey would determine the sites that require geotechnical investigations (i.e., analysis of soil borings). Combined results of the geophysical and geotechnical drilling program would conclude where levees must be completely replaced (using new material) or rehabilitated (replace some material and re-compact). The USIBWC plans to complete the geotechnical investigations during the Fiscal Year 2004.

## 2.9 IMPLEMENTATION STRATEGY

### 2.9.1 Program Management

The use of adaptive management is anticipated in implementing river management alternatives selected for the RGCP. Adaptive management is a science-based decision process that will lead to better management through a systematic process of prediction, application, monitoring, feedback, and improvement.

The adaptive management scheme lays out specific, measurable goals to be achieved but allows for continuing evaluation and adjustment to cope with unexpected results or changing conditions. The adaptive management approach also allows for development of new management techniques through experimentation (USBR 2000). An adaptive management strategy has been adopted because of the following factors:

- The large scale and resources needed for ecosystem restoration and habitat improvements;
- Implementation of environmental measures would occur over an extended period of time; and
- Uncertainties in projecting hydrologic, geomorphic, and ecosystem responses, and those associated with future conditions of weather, streamflow, and channel morphology.

It is envisioned that adaptive management would be implemented through coordination with the Paso del Norte Watershed Council established by the New Mexico-Texas Water Commission. The Council, established to oversee implementation of enhancements for the El Paso-Las Cruces Regional Sustainable Water Project, would serve in an advisory capacity regarding selection, planning, and implementation of environmental measures. The Paso del Norte Watershed Council would also recommend policies for cooperation and sharing information concerning planning and management activities of other projects potentially affecting the operation and management of the

RGCP. Membership to the Council is open to all municipalities, water agencies, researchers, educators, businesses, volunteer organizations, and concerned citizens.

It is anticipated that guidance for future project needs and actions would be provided by an External Advisory Committee to obtain impartial, scientifically informed evaluations, and that a long-term monitoring and evaluation program would be established. The program would document changes in river flow regime, groundwater depth, vegetation communities, and other predetermined aspects of the biological diversity of designated restoration and control sites.

### 2.9.2 Water Acquisition

While a number of measures under consideration as part of the RGCP management alternatives would result in water consumption, the USIBWC does not own water rights in the RGCP. All river water and agricultural return flows are fully allocated for irrigation of about 178,000 acres of land in New Mexico and Texas as part of the USBR's Rio Grande Project in operation since 1905 (www.usbr.gov/riogrande.html). Because the USIBWC does not have any water rights within the RGCP, water rights acquisition in cooperation with EBID and EPCWID#1 becomes a critical element in the viability and long-term sustainability of several environmental measures. Any thrid-party water conversion contracts would need USBR approval pursuant to the 1920 Sale of Water for Miscellaneous Purposes Act.

A detailed analysis of potential USBR Rio Grande Project water use for river restoration was recently completed by the World Wildlife Fund (King and Maitland 2003). The study evaluated current water uses and options for collaboration between the agricultural community and environmental water users (available online at http://cagesun.nmsu.edu/~jpking/wwf/reportdownload.htm). Water acquisition options evaluated for implementation of RGCP river management alternatives are described below.

#### *Water Rights Acquisition*

Direct acquisition of water rights from the agricultural community was considered in the March 2001 Alternatives Formulation Report as the primary method to secure water for environmental measures. Because direct water rights acquisition on a large scale would likely lead to retirement of existing farm lands, two options for water rights acquisition were considered in the reformulation of alternatives: acquisition by supporting water conservation programs within irrigation districts, and water banking.

Support of water conservation by financing on-farm water conservation programs was identified as a viable strategy to secure water for use in environmental measures. A review study on irrigation efficiency published in the Fall 2001 issue of NMOSE's Waterline indicated that a flood irrigation efficiency typically ranges from 40% to 60%, 65% for high-pressure center-pivot sprinklers, 60% to 65% for side-roll sprinklers, and 85% to 90% for drip irrigation. Potential on-farm irrigation efficiency increases up to 80% for high-pressure center-pivot sprinklers were listed for the use of partial-length drop-down tubes and 95% for full-length drop-down tubes (Wilson 2001). On farm application efficiency for individual districts have been recently reported in the 50 to 82 percent range for EBID, and 50 to 75 percent range for EPCWID#1 (King and Maitland 2003).

Supporting water conservation would not only be consistent with ongoing programs and stated interests of the irrigation districts (EBID 1998; EPCWID#1 2000), but would also facilitate seeking funds from high-priority state and federal programs. Such conservation programs would focus on financing on-farm irrigation system improvements that represent a substantial investment for individual farmers. Along the RGCP, individual farmers at present do not have a clear economic incentive for investing in more water-efficient but expensive on-farm irrigation systems. Economic incentives to compensate for water rights attached to any saved water are likely needed to foster such on-farm water conservation programs. As stated by EBID (1998) General Data and Information booklet:

> "*In the future some form of economic incentives for both (1) helping reduce the capital outlay for the conversion to a more water conservative irrigation system than is presently in use and (2) by far perhaps the more important from the farmer's standpoint, an economic incentive to compensate for the water right attached to any 'saved' water, will most probably need to be implemented in order to foster a purpose of conservation with broader range and benefits to a greater number of users than is already in place within the agricultural community*."

Water banking is a water management strategy that speeds up the temporary transfer of water from those willing to lease it to those willing to pay to use it. Farmers and other water rights holders can deposit some or all of their allotted water into a "water bank" where users pay the going market rate to borrow it for a limited period of time. The lessor retains ownership of the water rights, and rights placed in the bank cannot be forfeited for non-use (Salem 2002).

The water banking concept is gaining support in the State of New Mexico. In November 2002, the State Engineer's Office issued draft regulations for water banking in the Lower Pecos River Basin (NMOSE 2002). While this is a very restricted program for a specific basin, in the future it could lead to a broader application of such programs in the state.

Both strategies, supporting water conservation programs and water banking, would allow gradual implementation of measures under consideration over a 20-year horizon. The implementation timetable, described in Subsection 2.10, considers an initial development period during which financial/cooperative agreements can be reached, and pilot-scale projects tested in terms of viability, environmental benefit, and potential water use prior to the implementation of projects on a larger scale.

#### *Recurrent Flood Cycles*

Riparian vegetation can be developed along low-elevation areas by shaving of stream banks to increase the possibility of recurrent flooding. The method is based on small-scale flood cycles likely to occur at 1 to 3-year intervals. The method relies on natural overbank flow conditions during storm events. There are two considerations in the use of this method. First, there is no certainty that soil preparation activities would always coincide with adequate overbank flow conditions. Second, any water arriving into the RGCP either through the reservoirs or as runoff downstream of the dams constitutes Rio Grande Project water, thus requiring agreements with EBID and EPCWID#1 prior to use. Application of this measure is discussed in Subsection 3.3 as part of the Integrated USIBWC Land Management Alternative.

#### *Salt Cedar Removal*

Extensive salt cedar growth, an invasive species with high water consumption, is found along the RGCP. Estimates of annual water use, summarized by Weeks *et al.* (1987) range up to 11 ft/yr, a value that is more than twice the typical water use reported for native cottonwoods. Given the elevated water consumption, salt cedar removal was considered in the Alternatives Formulation Report to reduce water consumption in the floodway, and for subsequent transfer of the saved water for riparian vegetation development and other environmental measures. In the Environmental Impact Statement evaluation, salt cedar removal was not considered a currently viable approach to offset surface water use due to its high cost, difficulty to reliably quantify actual water use reduction, and uncertainty in obtaining New Mexico Office of the State Engineer (NMOSE) authorization for trading saved ground water for surface water use.

#### *Groundwater Use*

Groundwater is used by farmers in the Rincon and Mesilla Valleys to supplement reduced surface water allocations during severe droughts. In New Mexico, this use must comply with the State's comprehensive groundwater regulatory system based on the doctrine of prior appropriation. In Texas, groundwater use requirements are more flexible as they are based on the right-of-capture rule (EPCWID#1 2000).

Groundwater could be used for establishment of riparian vegetation along the RGCP. Experimental plots supported by groundwater use, tested by the U.S. Department of Agriculture, Natural Resources Center, have proven successful in promoting regeneration of Rio Grande cottonwood seedlings using micro-irrigation systems (Dressen *et al*., 1999).

### 2.9.3 Cooperation Agreements

Cooperation agreements were identified as a viable strategy for increased sediment control at a watershed level, and for acquisition and management of conservation easements.

#### *Watershed Management for Increased Sediment Control*

While an increased erosion control program to be implemented within the ROW is proposed as part of the RGCP river management alternatives, the need for additional sediment load reduction might be identified in the future once that program is implemented. In the near future, the need for sediment removal along the RGCP channel has been identified only for the Seldon Canyon RMU.

If additional sediment control were needed beyond proposed improvements, erosion control programs at a watershed level would be evaluated for individual tributary basins. Those evaluations, as well as their implementation, would be conducted through cooperative agreements with agencies such as NRCS and Bureau of Land Management (BLM) that have the expertise, extensive land control, and resources for implementation of large-scale soil protection programs. Emphasis for those erosion control programs will be placed on tributary basins identified in the 1996 USACE study as major sources of the RGCP sediment load where erosion control could be an alternative to construction of sediment control dams. Those basins are located in the Rincon Valley, and include Rincon, Trujillo, Bignell, Placitas, Sibley and Montoya Arroyos, as well as Tierra Blanca Creek. Sediment loads to the RGCP are discussed in Subsection 3.1.2.

### *Easement Acquisition and Management*

Flood easements, as well as conservation easements, could be incorporated in the future as part of the RGCP management alternatives. Flood easements, while their acquisition is not anticipated in the short-term, could be acquired in the future by the USIBWC as part of a revised flood control strategy. Easements would add flood protection beyond that already provided by a levee system that has been in place for over 60 years. Under these conditions flood easements would cover areas without recurrent flooding and in relatively elevated terrain with little potential for riparian corridor development.

Conservation easements outside the ROW would provide connectivity with undeveloped areas and provide a buffer to riparian vegetation. These objectives do not fall within the Congress-mandated mission for the RGCP and, thus, they would not be operated under USIBWC jurisdiction. Easement acquisition and management would be done through cooperative agreements with other agencies with natural resources management capabilities and funding, and environmental organizations placing high priority on habitat conservation by land acquisition. Cooperative agreements could include USFWS, USACE, USBR, NRCS, National Park Service, New Mexico Department of Game and Fish (NMDGF), New Mexico State Parks Department, and Texas Parks and Wildlife Department, county/local conservation/recreational agencies, and organizations such as the Nature Conservancy.

Implementation of such initiatives by other agencies and organizations would be independent of the management strategy and timetable selected by the USIBWC for the RGCP. An example of such initiatives is the leasing of USBR-owned lands at Percha Dam to the New Mexico State Parks Department for recreation management.

## 2.10 IMPLEMENTATION TIMETABLE

Establishing a riparian corridor and aquatic habitat diversification are envisioned as long-term processes that will progress as water is secured and the effectiveness of projects is documented. Direct intervention measures such as pole planting, micro-irrigation, and induced overbank flooding for seedling germination by bank re-shaping and/or controlled water releases, will be initially required to induce development of the riparian corridor over selected areas in the upper reaches of the RGCP. Dredging will be initially required for reopening meanders and for embayments in arroyos, and after a number of years to maintain their functionality.

Once established, riparian vegetation could be sustained through continued use of agricultural practices such as flood irrigation or micro-irrigation and, in some areas, controlled discharges from Caballo Dam during high runoff years. Given the physical limitations for potential releases and available floodable land, overbank flooding appears to be practical mostly in the Rincon Valley. In this area controlled discharges would be gradually increased, as dictated by the success of previous releases, until a selected maximum target for release is achieved. In all areas where expansion of the riparian corridor is anticipated, routine tracking of groundwater depth will be required to ensure adequate conditions for establishment of riparian vegetation (typically less than 10 feet for cottonwoods and willows). Long-term species control would likely be required to limit the amount of invasive species competition and reduce the loads in native bosques.

Monitoring of measures is applied to all alternatives. Monitoring includes observing the area and/or collecting data for a period of time after conducting measures to determine if it is achieving its intended functions. Regulatory agencies are generally moving in the direction of requiring monitoring. For example, the USACE requires at least 3 years of monitoring of mitigation wetlands, including submittal of written progress reports.

A 20-year timeline was adopted for project implementation. The timeline was divided into three phases. During the 5-year Phase 1, implementation plans would be developed and funded, agreements would be reached for interagency cooperation and water use, and selected projects would be tested at a pilot scale. Project performance would be monitored to determine their success, water use, and need for modification, and to conduct an environmental benefit versus investment analysis. Priority projects, as determined by the potential environmental benefit, would be implemented during a 5-year, Phase 2. Remaining projects would be implemented in the subsequent 10 years, in Phase 3. Site prioritization would be conducted according to an adaptive management approach previously discussed. Following Phase 3, environmental measures would be maintained in the long run and, to the extent possible, expanded to sustain the riparian corridor and ensure functionality of aquatic habitat diversification projects. Timetables for linear and point projects, presented in Tables 2.10-1 and 2.10-2, respectively, are described below.

### 2.10.1 Linear Projects

***Grazing Modifications***. All projects would be completed during Phase 1 and would include development of guidelines, compliance policies, projects implementation and monitoring programs. Subsequent phases would involve continued implementation, monitoring and revision of the guidelines as necessary. These projects are the least complex to implement because the measure is limited to change in practices within ROW. The projects would be conducted throughout most of the RGCP.

***Grassland Management.*** Phase 1 includes a single pilot project in the upper Rincon Valley. The remaining four projects would be implemented in Phase 2 followed by monitoring and modifications to the guidelines as necessary. The projects would be conducted primarily in the Rincon and Mesilla Valleys.

***Peak Flows.*** Phase 1 concentrates on water acquisition and agreements for water use by controlled releases from Caballo Dam. Peak flows would be implemented during Phase 2 and 3 coupled with monitoring and modifications as necessary. The projects would be conducted in the Rincon Valley.

***Conservation Easements.*** Phase 1 would include development easement agreements and target remnant bosques in the Lower Rincon and Seldon Canyon projects. Phase 1 easements coincide with areas identified for induced overbank flows by controlled water releases. Phase 2 would include easement agreements and project implementation in the Mesilla Valley and El Paso. Target areas are located in the Rincon and Mesilla Valleys.

**Table 2.10-1 Implementation Timetable for Linear Projects**

| Measure | Phase 1 (Years 1-5) | Phase 2 (Years 6-10) | Phase 3 (Years 11-20) | Alternative* |
|---|---|---|---|---|
| Grazing modifications | Guidelines, Implementation *Projects UR-1, LR-1, UM-1, LC-1, LM-1, EP-1* | Guidelines revision, monitoring | | FCI IULM, TRR |
| Grasslands management | Guidelines, pilot tests and monitoring *Project UR-2* | Implementation, monitoring *Projects LR-2, UM-2, LC-2, LM-2* | Monitoring | IULM, TRR |
| Peak flows | Agreements, water acquisition | Implementation, monitoring *Projects UR-3, LR-3* | Monitoring | TRR |
| Conservation easements | Agreements; target remnant bosques *Projects LR-4, SC-4* | Implementation *Projects LM-4, EP-4, UM-4* | Secure additional easements | TRR |

* FCI, Flood Control Improvement; IULM, Integrated USIBWC Land Management; TRR, Targeted River Restoration

## 2.10.2 Point Projects

***Planting and Bosque Enhancement.*** Phase 1 includes pilot projects in the Rincon Valley and south of Las Cruces. Pilot projects include 2 small sites (9.1 acres) and a larger site (71 acres) coinciding with a planned restoration projects, the Picacho Wetlands Pilot Project (SWEC 2002). Implementation throughout the RGCP would begin in Phase 2 and 3 after site specific monitoring and potential modifications are made to the measure. Phase 2 emphasizes the Rincon Valley and Phase 3 completes the Rincon Valley and the remaining RGCP projects.

***Stream Bank Shavedowns.*** Phase 1 includes a single, 3.4-acre pilot project in the Rincon Valley. Implementation throughout the Rincon Valley would begin in Phase 2 and 3 after site specific monitoring and potential modifications are made to the measure.

Phase 2 includes five projects north of Yeso Arroyo and Phase 3 includes the remaining three projects. Selection of projects was based on a representative example of the measure to test and provide several years of monitoring before larger scale implementation. The projects would be implemented in the Rincon Valley.

***Reopening of Meanders.*** Phase 1 includes a single, 6.6-acre pilot project in the Rincon Valley. After site specific monitoring and potential modifications are made to the measure, the remaining projects would be conducted. Phase 2 includes two projects (22.4 acres) and Phase 3 includes three projects including the largest restoration project (84.6 acres at mile 54). The largest and potentially more water consumptive projects are planed for Phase 2 and 3 after water acquisition agreements can be put in place. Pilot testing would provide several years of monitoring before larger scale projects are implemented.

***Modified Dredging of Arroyos.*** Phase 1 includes a single pilot project in the Rincon Valley. The project coincides with the location other measures involving construction/earth moving. Implementation throughout the RGCP would begin in Phase 2 and 3 after site specific monitoring, water use agreements and potential modifications are made to the measure. As with Phase 1, these projects would coincide with other measures involving construction/earth moving. Selection of projects would be based on a representative test implementation and would provide several years of monitoring before larger scale implementation. All arroyo dredging modification projects would be conducted in the Rincon Valley.

**Table 2.10-2 Implementation Timetable for Point Projects**

| Alternative / Measure | Measure ID | Projects by River Mile | | |
|---|---|---|---|---|
| | | Phase 1 Pilot Testing (Years 1-5) | Phase 2 (Years 6-10) | Phase 3 (Years 11-20) |
| **Integrated Land Management Alternative** | | | | |
| Planting and bosque enhancement | A | 105, 104, 41 | 102, 101, 99, 94, 95, | 83, 76, 54, 49, 48, 42 |
| Stream bank shavedowns | B | 104 | 103, 102, 101, 98, 94 | 92, 83, 76 |
| **Targeted River Restoration Alternative** | | | | |
| Planting and bosque enhancement | A | 104, 41 | 101, 99, 49, 48, 42 | 94, 83, 76 |
| Reopening meanders | C | 105 | 102, 54 | 97, 92, 95 |
| Modified arroyo dredging | D | 104 | 103, 102, 101, 99, 98, 97, 94 | 85, 83, 78, 76 |

## 2.11 CAPITAL COST EVALUATION

Preliminary capital cost estimates of the river management alternatives were prepared for effects evaluation in the DEIS. Costs were developed for three separate components: improvements to the levee system, implementation of environmental measures, and water acquistion. Table 2.11-1 summarizes calculated costs.

**Table 2.11-1 Preliminary Capital Cost Evaluation**

| Basis for Calculation | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alt. | Targeted River Restoration Alt. |
|---|---|---|---|
| Capital Costs (millions) | | | |
| Levee system Improvements | 55.9 | 55.9 | 55.9 |
| Environmental measure Implementation | 1.0 | 10.7 | 21.4 |
| Water rights acquisition ($3,000/ac-ft) | 3.2 | 6.6 | 28.4 |
| **Total Investment** | **60.1** | **72.2** | **105.7** |
| *Estimated water consumption (from Section 4.1) used in the water acquisition calculation* | *1,078 ac-ft/yr* | *2,203 ac-ft/yr* | *9,461 ac-ft/yr* |

## 2.11.1 Flood Control Improvements

A preliminary cost of $55.9 million was used for flood control improvements. This estimate was prepared for the 2001 Alternatives Formulation Report (see Appendix I of this DEIS). The estimate was developed at a conceptual planning level given the need to use global construction assumptions –as site-specific conditions have not been determined-- and uncertainties on rehabilitation needs for levee structural integrity.

## 2.11.2 Environmental Measure Implementation

Appendix G presents estimates at a conceptual-design level prepared for the DEIS. Those estimates supercede those developed in 2001, as multiple measures considered in the AFR preparation were modified, excluded, or transferred between alternatives during the reformulation process (Section 5). Estimates were based on unit costs per acre obtained from river restoration projects (Taylor and McDaniel 1997; South Dakota Partners for Fish and Wildlife 2001), or calculated by addition of individual subtasks.

## 2.11.3 Water Acquisition

A water acquistion cost was calculated by multiplying consumption estimates per alternative, presented in Subsection 4.1, by a water right purchase cost based on financing on-farm water conservation programs. An typical investment of $3,000 was used to secure 1 acre-foot of water annually over 20 years, the river management alternatives implementation period. The unit cost was obtained from water use data recently compiled for the Rio Grande Project area by King and Maitland (2003: Table 30). The estimate assumes a water conservation potential of 0.8 ac-ft per acre with the installation of a drip irrigation system with a cost per acre ranging from $1,700 to $2,800.

# 2.12 SUMMARY COMPARISON OF ALTERNATIVES AND EFFECTS

Table 2.12-1 presents a summary of alternatives and effects identified for each of the resource areas evaluated in the DEIS. A detailed analysis of potential effects is presented in Section 4.

## Table 2.12-1 Summary Comparison of the Effects of the Alternatives

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Water Resources | No-mow zones would be maintained, with a potential consumption of up to 35.3 ac-ft/yr (0.62 ft/yr water use over 57 acres).<br>No effects on water delivery or water quality are anticipated as current practices would be maintained. | A potential 1,078 ac-ft/yr increase in water consumption due to environmental measures. Water consumption would increase 0.17 percent of the combined diversions of Rio Grande Project water along the RGCP.<br>No impacts on water delivery are anticipated for levee system rehabilitation, or changes in grazing leases in uplands.<br>Water quality could decrease in terms of total suspended solids during construction, but it would improve in the long-term by a reduced sediment load and lower nutrient input from grazing areas with improved vegetative cover. | A potential water consumption increase of 2,203 ac-ft/yr at the completion of the 20-year implementation period (0.36 percent of the combined water diversions along the RGCP).<br>Development of riparian vegetation on stream banks would have a long-term positive effect on water delivery as cottonwood, once established, would provide stability to the stream bank. Short-term increases in debris and sediment in the river would be expected prior to establishment of vegetative cover.<br>Water quality is likely to improve as more extensive vegetative cover on the RGCP floodway and uplands improve erosion control and nutrient release from grazing areas. | A potential for a water consumption increase of approximately 9,461 ac-ft/yr at the completion of the 20-year implementation period. This value would be equivalent to 1.55 percent of the combined water diversions along the RGCP.<br>Effects on water delivery and water quality would be similar to those of the Integrated USIBWC Land Management Alternative. |
| Flood Control | The risk of flooding and overtopping the levees from the 100-year flood would remain as currently quantified. | Additional protection would be provided to life and public and private property beyond that which is already provided by the existing levee system. | Similar to the Flood Control Improvement Alternative. There would also be a potential for a small reduction in flood containment capacity due to increased vegetation growth along the floodway. | Similar to the Flood Control Improvement Alternative. There would also be a potential for a small reduction in flood containment capacity due to increased vegetation growth along the floodway. |
| Soils | No change from baseline condition. | Levee rehabilitation would mobilize 898 ac-ft of soil for construction. Modified grazing leases would reduce uplands erosion 0.45 ac-ft annually and improved riparian conditions by reducing bank erosion and increasing ground cover. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>An additional 157 ac-ft of soil would be displaced as a result of bank shave-downs. Mitigation procedures were established to reduce erosion. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>An additional 300 ac-ft of soil would be displaced as a result of opening former meanders, excavating arroyos and scour during seasonal peak flows. Mitigation procedures were established to reduce erosion. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Vegetation and Wetlands | No change from baseline condition. | Modified grazing in uplands and riparian zones would affect 3,552 acres increasing plant species, richness and structural diversity. Levee construction would have a minor effect on vegetation communities.<br><br>Mowing by USIBWC would continue at the same level as the No Action Alternative. | Effects of modified grazing leases and levee construction would be similar to the Flood Control Improvement Alternative.<br><br>Mowing by USIBWC would be reduced by 1,983 acres.<br><br>Restoration of 350 acres of native bosque by bank shavedowns and plantings, and development of native grasslands (1651 acres) would increase the amount of native vegetation within the ROW.<br><br>Wetland areas would increase by 13 acres. | Effects of modified grazing leases and levee construction would be similar to the Flood Control Improvement Alternative.<br><br>Mowing by USIBWC would be reduced by 2,434 acres.<br><br>Restoration of 1,549 acres of native bosque by seasonal peak flows, opening meanders, plantings and development of native grasslands (1,029 acres) would increase the amount of native vegetation within and outside the ROW.<br><br>Wetland areas would increase by 96 acres.<br><br>Conservation easements would add 1,601 acres under management. |
| Wildlife Habitat | No change from baseline condition. | Wildlife habitat quality would increase 30% due to modified grazing in 3,552 acres of uplands and riparian areas. However, the majority of the ROW would continue to be considered as below average to poor wildlife quality due to mowing of vegetation.<br><br>Construction associated with levee rehabilitation would be a short minor effect.<br><br>Modification of salt cedar management in grazing leases methods would result in long-term beneficial effects. | Wildlife habitat quality would increase 51% due to modified grazing in 3,552 acres of uplands and riparian areas, and development of 350 acres of native bosque and 1,641 acres of native grassland.<br><br>Construction associated with levee rehabilitation and environmental measures would be a short minor effect.<br><br>Modification of salt cedar management in grazing leases methods would result in long-term beneficial effects. | Wildlife habitat quality would increase 72% due to modified grazing in 3,493 acres of uplands and riparian areas, and development of 1,549 acres of native bosque and 1,929 acres of native grassland. A total of 1,618 acres of conservation easements significantly increases the amount of high quality wildlife habitat.<br><br>Construction associated with levee rehabilitation and environmental measures would be a short minor effect<br><br>Modification of salt cedar management methods for grazing leases would result in long-term beneficial effects. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Endangered and Other Special Status Species | No change from baseline condition. | Levee construction activities would not affect endangered and other special status species .<br>Modified grazing in uplands and riparian would benefit some species of concern (SOCs). | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>Development of native bosque using bank shavedowns could potentially create suitable southwestern willow flycatcher habitat and benefit some SOCs. | Levee rehabilitation and modified grazing leases would result in similar effects as the Flood Control Improvement Alternative.<br>Development of native bosque along meanders could potentially create suitable southwestern willow flycatcher habitat and benefit some SOCs.<br>Suitable habitat for listed species may exist within conservation easements outside the ROW. Adverse effects would be entirely mitagable. |
| Aquatic Biota | No change from baseline condition. | No significant change from baseline condition would occur.<br>The RGCP would continue to be characterized as poor aquatic habitat, however modified grazing in the riparian area would beneficially effect stream bank stability, water quality and stream side vegetation. | No significant change from baseline condition would occur.<br>The RGCP would continue to be characterized as poor aquatic habitat, however modified grazing in the riparian area in conjunction with bosque development would beneficially effect stream bank stability, water quality and stream side vegetation. | Aquatic biota would be beneficially affected as a result of diversifying aquatic habitat through modified dredging of arroyos and opening former meanders. A total of 59 acres of backwater habitat would be developed. In addition, modified grazing in the riparian area and bosque development would beneficially effect stream bank stability, water quality and stream side vegetation. |
| Land Use | Land use in the potential area of influence would remain unaffected relative to current conditions.<br>Beneficial effects are expected from ongoing recreational initiatives.<br>The RGCP operation and maintenance would not change from the current practices. | Levee rehabilitation would be the only action with potential effects on land use adjacent to the RGCP. Up to 50 acres of the approximately 149 acres of borrow sites would be likely located in agricultural areas. Land use change would not be significant relative to 19,020 acres of farmlands in the potential area of influence.<br>Beneficial effects are expected from ongoing recreational initiatives. | Up to 50 acres of agricultural land would be needed as borrow sites. With implementation of an on-farm water conservation program, no other changes in land use are anticipated.<br>With direct purchase of water rights, environmental measure implementation could result in 734 acres of cropland retirement (3.9 percent of the potential 19,020 acres in the area of influence).<br>Beneficial effects are expected from ongoing recreational initiatives. | Conservation easements would affect up to 288 acres of cropland in addition to 50 acres of borrow sites. Current use would be maintained for another 1,330 acres of remnant bosques.<br>Without a water conservation program, environmental measure implementa-tion could result in 3,154 acres of cropland retirement (16.6 percent of farmland in the area of influence).<br>Beneficial effects are expected from ongoing recreational initiatives. |

| Resource Area | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Socioeconomics and Environmental Justice | There would be no changes in population and housing, employment, or a disproportionate number of minority population affected | Similar to the No Action Alternative, except there would be additional short-term jobs as a result of levee rehabilitation activities. | Similar to the No Action Alternative, with the addition of short-term jobs as a result of an increase in construction activities. With on-farm conservation, no adverse effects on agricultural communities are anticipated.<br><br>For direct water acquisition, the potential annual loss in crop value would be approximately $900,000. | Similar to the No Action Alternative, except there would be additional short-term jobs by increase in construction activities. With on-farm conservation, no adverse effects on agricultural communities are anticipated.<br><br>For direct water acquisition, the potential annual loss in crop value would be approximately $4 million. |
| Cultural Resources | The No Action Alternative will not affect, or adversely affect, any architectural resources, traditional cultural properties or archaeological resources. | Similar to the No Action Alternative. | Similar to the No Action Alternative, except there would be a potential for undiscovered sites at two locations near shavedown projects. | Similar to the No Action Alternative, except there would be a potential for undiscovered sites at three sites located near arroyo or meander projects. |
| Air Quality | Emissions generating activities would be the same as the current ongoing activities. | Criteria pollutant increases in the Air Quality Control Region (AQCR) would range from 0.05 to 0.93 percent and would not be regionally significant. | Criteria pollutant increases in the AQCR would range from 0.01 to 1.25 percent and would not be regionally significant. | Criteria pollutant increases in the AQCR would range from 0.12 to 1.62 percent and would not be regionally significant. |
| Noise | Noise levels from existing maintenance and operation activities would not change relative to current conditions. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. | Similar to the No Action Alternative. Noise from additional construction activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. |
| Transportation | There would be no increases in traffic or adverse affect on a roadway's existing level of service (LOS). | The LOS of all listed roadways would not change from existing conditions. | The LOS of all listed roadways would not change from existing conditions. | The LOS of all listed roadways would not change from existing conditions. |

# SECTION 3
# AFFECTED ENVIRONMENT

Baseline information for the RGCP was collected from field investigation during 2000/2001 and from the most current information sources. The information was used to determine current conditions of the RGCP to be affected or created by the river management alternatives. The following resource areas are used to describe baseline conditions:

1. Water resources
2. Flood control
3. Soils
4. Vegetation and wetlands
5. Wildlife habitat
6. Endangered and other special status wildlife species
7. Aquatic biota
8. Land use
9. Socioeconomic and environmental justice
10. Cultural resources
11. Air quality
12. Noise
13. Transportation

## 3.1 WATER RESOURCES

### 3.1.1 Water Consumption

#### *Availability*

Low precipitation conditions are prevalent in central New Mexico, severely restricting water availability in the RGCP. The semi-arid climate area receives an average of 8 to 9 inches of rain annually. Climatological data for Elephant Butte reservoir north of the RGCP, and Las Cruces, in the central area of the RGCP, are summarized in Table 3.1-1. Rainfall is heaviest July through September, and occurs mostly in intense thunderstorms. Long-term data for the Las Cruces area indicate that the average annual precipitation in the area is approximately 10 inches, most of which falls from May through September. Precipitation is in the form of brief, and often heavy, thunderstorms, which can cause local flooding and soil erosion from levee slopes and river banks (Bulloch and Neher 1980; NRCS 2003).

## Table 3.1-1 Climatological Data for the North and Central Portions of the RGCP

| Month | Elephant Butte Reservoir, Sierra County (1948-2002)* | | | Las Cruces, Doña Ana County New Mexico State University (1959-2002)* | | | |
|---|---|---|---|---|---|---|---|
| | Average Precip (in) | Daily Temperature Max (°F) | Daily Temperature Min (°F) | Average Precip (in) | Average Evapo (in)** | Daily Temperature Max (°F) | Daily Temperature Min (°F) |
| January | 0.42 | 54.3 | 28.9 | 0.54 | 2.9 | 58.2 | 28.4 |
| February | 0.30 | 60.2 | 32.8 | 0.32 | 4.4 | 63.6 | 31.8 |
| March | 0.32 | 67.2 | 38.5 | 0.21 | 7.6 | 70.2 | 37.2 |
| April | 0.15 | 75.2 | 45.4 | 0.23 | 10.0 | 77.2 | 43.4 |
| May | 0.48 | 83.7 | 54.5 | 0.36 | 12.3 | 85.6 | 52.1 |
| June | 0.72 | 93.1 | 63.6 | 0.70 | 13.2 | 94.4 | 61.2 |
| July | 1.68 | 93.5 | 67.3 | 1.46 | 12.0 | 94.7 | 67.1 |
| August | 2.25 | 90.5 | 65.4 | 2.37 | 13.4 | 91.7 | 65.2 |
| September | 1.68 | 84.9 | 59.0 | 1.37 | 8.4 | 86.9 | 58.4 |
| October | 1.25 | 75.4 | 47.9 | 1.06 | 6.1 | 78.1 | 46.2 |
| November | 0.71 | 63.1 | 36.6 | 0.48 | 3.7 | 66.5 | 34.3 |
| December | 0.75 | 53.8 | 29.1 | 0.78 | 2.64 | 57.8 | 28.4 |
| **Annual** | **10.71** | **74.6** | **47.4** | **9.89** | **93.7** | **77.1** | **46.2** |

* NRCS 2003. [*ftp://ftp.wcc.nrcs.usda.gov/support/climate/wetlands/nm*]

** 1918-1965 data (Bulloch and Neher, 1980); Class A Pan-evaporation

The annual water release from Elephant Butte Dam averages 682,000 acre-feet. There is, however, a wide inter-annual variation in water availability. Since the operation of the RGCP, the region has experienced multi-year cycles illustrated by the water storage levels in Elephant Butte Reservoir (Figure 3-1). Based on the historical record, low storage conditions at the reservoir were prevalent for nearly 4 decades, until significant water storage levels were recorded during the mid 1980s and 1990s (NMOSE 2001). High rainfall precipitation over the past 2 decades, however, appears to be atypical based on the long-term rainfall record for New Mexico (Figure 3-2). The New Mexico Office of the State Engineer identified a trend toward drier conditions in recent years (NMOSE 2003).

Water storage in Elephant Butte Reservoir has experienced a sharp and steady decline as a result of severe drought conditions in the Upper Rio Grande Basin. The USBR (2003) reported a reservoir water storage of 147,300 ac-ft for September 15, 2003, the lowest level since December 1978. This storage level represents 7.5 percent of full reservoir conditions in Elephant Butte Reservoir. Seven of the eight years between 1996 and 2003 have been below average runoff due to poor snow pack conditions in the mountains of northern New Mexico and southern Colorado (USBR 2003).

### *Allocation*

Water allocation is a key consideration for river management alternatives because flow regime modifications, riparian corridor development, and aquatic habitat diversification are likely to require water rights acquisition. All river water and agricultural return flows along the RGCP are fully allocated as part of the Rio Grande Project.

**Figure 3-1 Historic Storage Levels in Elephant Butte Reservoir (NMOSE 2001)**

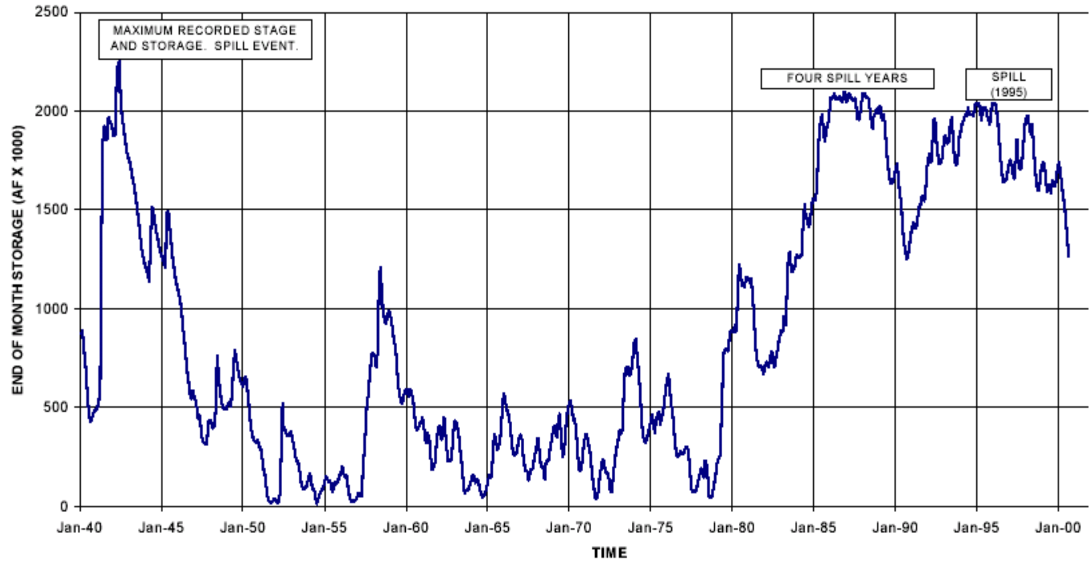
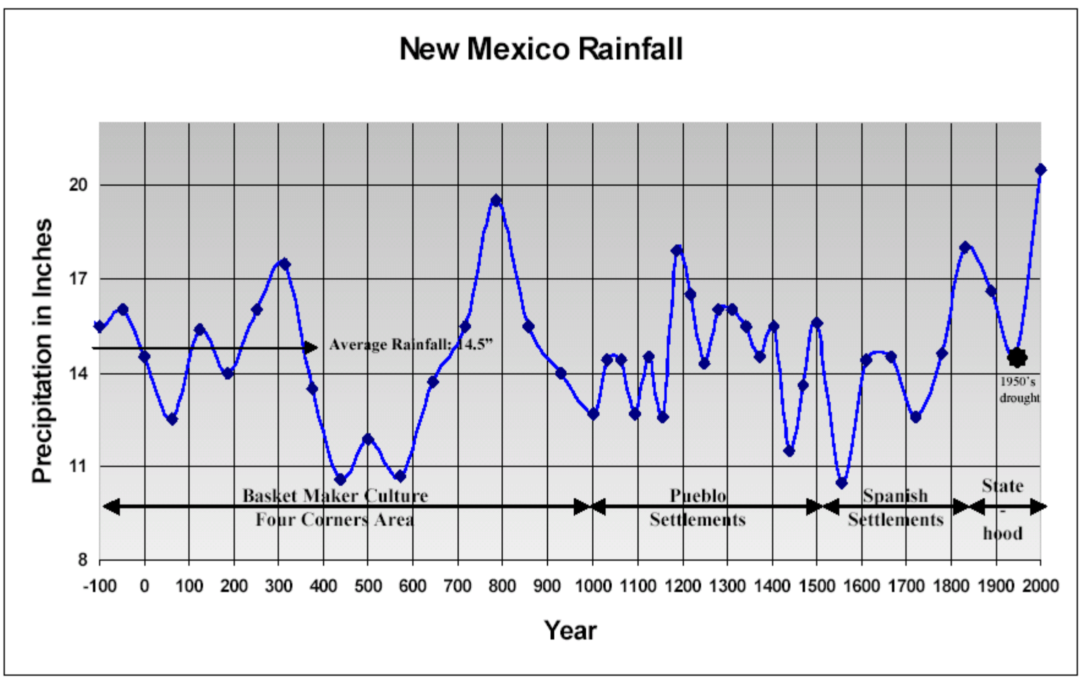



**Figure 3-2 Long-Term Record of New Mexico Rainfall (NMOSE 2001)**



## Figure 3-3 Flow Distribution Along the RGCP

| Inflow / Outflow | Location | Average Flow (cfs) Mar-Oct | Nov-Feb | Annual |
|---|---|---|---|---|
| | *Caballo Dam Release*[b] | 1,301 | 167 | 923 |
| Percha Lateral/Arrey Canals (350 cfs)[a] | Water Diversion at Percha Dam | *(160)* | *(20)* | *(114)* |
| | *Downstream Release*[c] | 1,141 | 147 | 809 |
| Garfield, Hatch, Angostura and Rincon Drains | Return Flows[d] | 78 | 16 | 58 |
| | Seldon Canyon Flow[b] | 1,219 | 163 | 867 |
| Leasburg Canal (625 cfs)[a] | Water Diversion at Leasburg Dam[b] | *(265)* | *(13)* | *(181)* |
| | *Downstream Release*[c] | 954 | 150 | 686 |
| Seldon & Picacho Drains | Return Flows[e] | 80 | 4 | 54 |
| East and West Canals (950 cfs)[a] | Water Diversion at Mesilla Dam[b] | *(455)* | *(27)* | *(312)* |
| | *Downstream Release*[c] | 579 | 127 | 428 |
| Del Rio, La Mesa, Anthony, East, Montoya Drains, other | Return Flows[d] | 196 | 97 | 163 |
| | *Upstream of Amer. Dam*[b] | 774 | 224 | 591 |
| American Canal (1,200 cfs)[a] | Water Diversion at American Dam[b] | *(595)* | *0* | *(397)* |
| | *Downstream Release*[c] | 179 | 224 | 194 |
| Acequia Madre | Water Diversion at International Dam[b] | *(102)* | *0* | *(68)* |

a. Maximum diversion capacities, in parenthesis, from U.S. Bureau of Reclamation (www.usbr.gov)

b. Highlighted values indicate stream flows. Values as reported in the Draft EIS, El Paso-Las Cruces Regional Sustainable Water Project (USIBWC & EPWU/PSB, 2000: Table 3.3-17).

c. Releases from dams were calculated as the difference between upstream flow and diverted flow.

d. Return flows were calculated as the difference between upstream and downstream flows.

e. Mesilla Valley return flows represent 30% of the diverted flow (USIBWC & EPWU/PSB, 2000, p. 3-10)

***Rio Grande Project***. This USBR project, in operation since 1905, furnishes irrigation water supply for about 178,000 acres of land in New Mexico and Texas, as well as electric power. The RGCP, that serves as a conveyance for water delivery to irrigated areas, is located entirely within the Rio Grande Project geographic coverage area. The Rio Grande Project is integral to implementing the Rio Grande Compact between the states of Colorado, New Mexico, and Texas. The compact was ratified by the states and approved by Congress in 1939.

Physical features of the Rio Grande Project include Elephant Butte and Caballo Dams, 457 miles of canals, and Percha, Leasburg, Mesilla, and American diversion dams. The Riverside Diversion Dam (approximately 15 miles south of of El Paso) was part of the original Rio Grande Project, but failed during a large flood event in 1987 [*www.usbr.gov/dataweb/html/riogrande.html*]. The Rio Grande Project has a maximum width of 6 miles and extends 200 miles from Elephant Butte Reservoir in Socorro County, through Sierra and Doña Ana Counties, New Mexico, and El Paso County, Texas. The irrigable lands are mostly contiguous, from 100 miles northwest to 40 miles southeast of the City of El Paso, with an area of 159,700 acres; 90,690 acres are in New Mexico and 69,010 acres are in Texas. The riverbed serves as the principal conveyance channel to all major diversions (Figure 3-3).

The Rio Grande Project water supply is provided through storage and regulated release of the waters of the Rio Grande, return flows to the river, wastewater flows into the river, and stormwater runoff. The Rio Grande drainage basin above Elephant Butte contains 25,923 square miles and has an average 79-year runoff of 904,900 acre-feet (ac-ft). The combined maximum storage possible for the two reservoirs is 2,396,520 ac-ft.

All Rio Grande Project lands in the State of New Mexico are included in the Elephant Butte Irrigation District (EBID), while all lands in the State of Texas are included in the El Paso County Water Improvement District No. 1 (EPCWID#1). The EBID receives approximately 53 percent, Mexico receives approximately 7 percent, and and EPCWID#1 receives 40 percent. Drainage water from EBID is included in the share received by EPCWID#1 (USBR 1982; USBR 1995).

The two irrigation districts have taken over operation of the Rio Grande Project canals, laterals, and drains, or any structures not on the river. The USBR, in conjunction with irrigation district personnel, operates the two storage dams and the diversions on the river, while the irrigation districts operate the rest of the Rio Grande Project facilities

***Water Releases***. The annual water release from Elephant Butte Dam averages 682,000 acre-feet. With normal yearly releases from Caballo Dam, coupled with return flows and rainfall runoff, water availability for agriculture is as follows:

- 494,979 ac-ft at EBID's headings in New Mexico;
- 376,862 ac-ft at EPCWID#1's headings in Texas, and
- 60,000 ac-ft at Mexico's Acequia Madre heading.

The original Rio Grande Project water allotment for irrigation district farmers was 3 ac-ft per acre per year (ft/yr). The water supply was allocated between the two irrigation districts based on the amount of land that each district had under irrigation.

The USBR regularly evaluates hydrologic parameters including reservoir storage, snow pack, and forecast precipitation to establish water allocation for the primary irrigation season. The allocation is set at the beginning of the primary irrigation season and (if less than a full allocation) is adjusted during the irrigation season based on updated information. Each irrigation district determines water allotment for lands within its boundaries (*www.usbr.gov/dataweb/html/riogrande.html*).

Since the beginning of the Rio Grande Project, some of the land originally under irrigation has been removed from agricultural use and is no longer irrigated. This has allowed additional water to be used on crops that require more than 3 ft/yr for adequate growth. Also, the Rio Grande Project water supply is not evenly distributed over a fixed number of acres. Farmers can fallow some fields to free up additional water for high use crops or lease their water to other farmers for their use. From 1979 through 1998 the average allotment for irrigated project lands in EPCWID#1 was 3.63 ft/yr (EPCWID#1 2000). In recent years, the allotment has been 4 ft/yr.

### 3.1.2 Water Delivery

#### *RGCP Main Channel*

The RGCP main channel was designed with a hydraulic capacity that ranges from 2,500 to 3,000 cfs in the Upper Rincon Valley, to less than 2,000 cfs in the Lower Mesilla and El Paso Valleys (Parsons 2001a).

Figure 3-3 is a schematic of the Rio Grande showing diversion and drain return points in the RGCP, and operational average flows during irrigation season, non-irrigation season, and for both seasons combined. Throughout the RGCP, drain flows that return to the river above American Diversion Dam are reused to supply demands lower in the system. The typical average flow ranges from 600 cfs to 1,100 cfs during the March to October irrigation season, and decreases to less than 200 cfs from November to February (Figure 3-3).

Caballo Dam discharges are initially diverted upstream of the RGCP, at Percha Dam. Water flow is subsequently rerouted for irrigation at three diversion dams that pre-date the RGCP: Leasburg Dam, Mesilla Dam, and American Diversion Dam. Most of the flow past American Diversion Dam is diverted south of the RGCP, at the International Dam, to meet United States-Mexico Treaty agreements. Along the RGCP the combined annual diversion is 645,000 ac-ft/yr based on average annual diversions of 181, 312 and 397 cfs at Leasburg, Mesilla Dam, and American Dam, respectively (Figure 3-3).

Diversion dams contain gate structures to route irrigation water from the RGCP to adjacent canals. Excess water overtops the dams and continues downstream. The canals leading from the diversion dams provide irrigation water to surrounding agricultural land through a network of canals and laterals.

### *Irrigation Distribution System*

Water is removed from the agricultural land by a series of drainage canals and spillways that eventually flow back into the RGCP. The drains and spillways enter the ROW by passing through the flood protection levees. Some drains are equipped with gate valves or control structures at the levee crossing that which regulates water level in the drains. The gate valves and control structures are designed to be closed during a flood to prevent water from backing into the canal system and flooding land outside the levees.

In addition to the diversion dams and canals, there are six water-conveyance structures that cross the RGCP channel and ROW. Four siphons, the Rincon, Montoya, Hatch, and Garfield siphons, convey water from canals on one side of the river to the other. A fifth siphon, the Nemexas Drain, carries drainage water and runoff under the river to the drainage canal flowing through El Paso. The siphons were constructed to pass below the bed of the river. The sixth structure, the Picacho flume, consists of two elevated 42-inch diameter half pipes supported by concrete piers on top of timber piles that cross the floodway and channel to convey irrigation water from east to west.

Two of the siphons, Hatch and Rincon, are protected from erosion by boulder dams across the RGCP channel. New erosion protection structures have been constructed for both siphons. Siphon erosion protection structures provide a diversified aquatic habitat with backwater areas of low velocity water behind the dams, and white-water habitat created by water flowing over and down the energy dissipation structures.

### *Sediment Deposition*

***Tributary Basin***. The total watershed area draining to the RGCP below Percha Dam is 823 square miles at Leasburg Dam, 875 square miles at Mesilla Dam, and 921.6 square miles at American Diversion Dam (USACE 1996). The upper watershed was characterized by USACE as a high-bed load sediment system associated with multiple steep arroyos (Type D4 in the Rosgen classification). In addition to contributing to channel flow, arroyos deposit sand, gravel, and boulders, providing a major constituent of the Rio Grande sediment budget. Between 1969 and 1975, the NRCS, at the request of the USIBWC, constructed sediment control dams at Broad Canyon, Crow Canyon, Green Arroyo, and Jaralosa Arroyo to decrease the sediment load into the river. In combination, these four tributaries drain over 300 square miles of the upper RGCP watershed. Additional sediment control dams and flood control dams have been built on smaller arroyos draining into the RGCP.

The 1996 USACE study also evaluated the sedimentation rate from tributary basins to the RGCP. Table 3.1-2 lists major arroyos, size of the drainage area, location of their confluence with the Rio Grande, and the presence of sediment control dams. The table gives the average annual computed total sediment load for major arroyos sorted by volume. The most significant sediment loads (greater than 5 ac-ft per year) are generated in the Rincon Valley, and are largely associated with tributary basins without control dams such as Rincon, Bignell, Placitas, and Montoya Arroyos; Tierra Blanca Creek; and Trujillo and Faulkner Canyons.

## Table 3.1-2 Significant Sediment Loads Reaching the RGCP (USACE 1996)

| Name | Drainage Area (sq. miles) | Confluence (miles above American Dam) | Average Annual Total Sediment Load (ac-ft) |
|---|---|---|---|
| **Without Sediment Control Dam** | | | |
| Rincon Arroyo | 124.7 | 78.9 | 33.52 |
| Tierra Blanca Creek | 68.2 | 100.4 | 22.09 |
| Trujillo Canyon | 52.9 | 103.1 | 18.88 |
| Bignell Arroyo | 8.9 | 76.2 | 16.88 |
| Placitas Arroyo | 34.6 | 85.7 | 14.91 |
| Sibley Arroyo | 27.2 | 98.9 | 13.22 |
| Faulkner Canyon | 25 | 63.8 | 12.70 |
| Montoya Arroyo | 23 | 101.8 | 12.22 |
| Foster Canyon | 11 | 64.5 | 9.06 |
| Reed Arroyo | 9.6 | 78.5 | 8.64 |
| Yeso Arroyo | 9.5 | 94.9 | 8.60 |
| Angostura Arroyo | 8.9 | 80.2 | 8.41 |
| Buckle Bar Canyon | 2.12 | 67.6 | 5.41 |
| **With Sediment Control Dam** | | | |
| Arroyo Cuervo | 126.2 | 93.5 | 3.38 |
| Berrenda Creek | 87.4 | 97.4 | 2.60 |
| Broad Canyon | 68 | 67.6 | 2.20 |
| Green Canyon | 35.6 | 100.4 | 1.51 |
| Nordstrom Arroyo | 16.7 | 103.1 | 1.06 |
| McLeod Arroyo | 14.2 | 93.9 | 1.00 |
| Box Canyon | 8.7 | 49.8 | 0.83 |
| Apache Canyon | 7.8 | 49.8 | 0.80 |
| Spring Canyon | 7.4 | 80.2 | 0.79 |
| Jaralosa Arroyo | 6.8 | 95.2 | 0.77 |
| Doña Ana Arroyo | 6.9 | 51.2 | 0.77 |
| Reed-Thurman Dam Drain | 3.3 | 83.0 | 0.61 |
| Ralph Arroyo | 2.5 | 80.2 | 0.56 |

***RGCP Channel.*** The main channel of the RGCP is maintained to remove debris and deposits, including sand bars, weeds, and brush growing along the bed and banks. Any major depositions or channel closures caused by sediment loads from arroyo flows are removed. The USIBWC also maintains the grade of the channel bed at the mouth of the arroyos to ensure the channel conveys irrigation deliveries. Sediment collected from channel excavation, arroyo mouth maintenance, and other sediment control efforts is deposited on the floodway, on upland spoil areas, or on other federal or private lands approved for this purpose.

The RGCP has largely retained its original configuration since its completion in 1943. Stream banks were routinely stabilized, primarily by riprap placement, until the mid-1970s when construction of NRCS flood control dams in tributary streams, in combination with upstream flow control, provided greater stability to the channel.

Because dams in tributary basins control runoff over one-third of the upper RGCP basin north of Leasburg Dam (USACE 1996), dredging of the main channel has been conducted infrequently over the last 30 years. A study on the scour and deposition of sediments within the main RGCP channel was conducted by the USACE (1996) as part of an evaluation of the RGCP functionality. The extent of bed elevation changes in the channel was evaluated for low, high, and 100-year flows. For the 100-year flood, changes ranged from a maximum deposit of 0.7 feet to maximum scour of 1.7 feet. For limited channel cross sections downstream from Rincon Arroyo, Trujillo Canyon, Tierra Blanca Canyon, Placitas Arroyo, and Faulkner Canyon, a more significant deposition (greater than 5 feet of sediment) was predicted. Relative to the 100-year storm, a more significant scour (maximum of 2.6 feet) and deposition (maximum of 1 foot) were estimated for a 10-year period of consecutive high flows, while 10 years of sustained low flow conditions would result in only minor scour and deposition along the RGCP (USACE 1996).

### 3.1.3 Water Quality

Water quality along the RGCP is defined by New Mexico and Texas on the basis of individual reaches for which designated uses have been defined. On a yearly basis both states submit to the USEPA a 303b surface water quality report in the degree to which those uses are being attained, and identify potential concerns in terms of water quality.

***State of New Mexico.*** The RGCP segment in New Mexico is contained entirely by Assessment Unit NM-2102 that covers a 107-mile reach of the Rio Grande, from Percha Dam to the Texas border. The reach is subdivided into Unit NM-2101_00 from the Texas border to Leasburg Dam, and Unit NM-2101_10 from Leasburg Dam to Percha Dam. For the year 2002, the NMED reported that both reaches were fully supporting the following state-designated uses (NMED 2002, www.nmenv.nm.us/swqb/305b):

- Irrigation;
- Wildlife habitat;
- Limited warmwater fishery;
- Secondary contact; and
- Livestock watering.

***State of Texas.*** The Texas reach of the RGCP is contained in Segment 2314 of the Rio Grande Basin. The 21-mile segment is located in El Paso County and covers from International Dam to the New Mexico State line. For 2002, the TCEQ reported that the following 5 designated uses:

- Aquatic life use;
- Contact recreation use;
- General use;
- Fish consumption use; and
- Public water supply use.

The state reported that these uses were fully supported with the exception of contact recreation use (TCEQ 2002). The standard was not met in 2002 due to bacterial levels above the designated use. Concerns were also indicated for algal growth and nutrient enrichment. (Table 3.1-3). Monitoring data for this determination was obtained from monitoring stations located in the Rio Grande confluence with Anthony Drain (Station 13276), and Rio Grande at Courchesne Bridge, 1.7 miles upstream from American Dam (Station 13272). A March 2000 to August 2002 summary of Rio Grande monitoring data for nutrients and suspended solids at El Paso (Station USGS 8364000) is presented in Table 3.1-4.

### Table 3.1-3 Water Quality Concerns for Segment 2314 of the Rio Grande Basin (TCEQ 2002)

| Assessment Area | Concern | Description of Concern |
|---|---|---|
| New Mexico State line to upstream of Anthony Drain | Algal growth | Excessive growth |
| Upstream of Anthony Drain to International Dam | Nutrient enrichment | Ammonia |
| Upstream of Anthony Drain to International Dam | Algal growth | Excessive growth |

Source: TCEQ 2002

### Table 3.1-4 Rio Grande Monitoring Data at El Paso from March 2000 to August 2002

| Parameter | Number of Samples Reported* | Average Concentration (mg/L) | Lowest Concentration (mg/L) | Highest Concentration (mg/L) |
|---|---|---|---|---|
| Ammonia plus organic nitrogen, as N | 20 | 0.349 | 0.22 | 1.1 |
| Nitrite plus nitrate, as N | 29 | 0.480 | 0.11 | 1.41 |
| Nitrite, as N** | 29 | 0.030* | <0.006 | 0.162 |
| Phosphorus | 20 | 0.069 | 0.008 | 0.171 |
| Total suspended solids | 29 | 481 | 34 | 2,350 |

* At monitoring station USGS 8364000.
** Nitrite values below the detection limit were not included in the average.

## 3.2 FLOOD CONTROL

### 3.2.1 Existing Flood Control

#### *Levee System*

The RGCP flood control system was constructed in conjunction with the canalization from 1938 to 1943. The system was designed to provide protection from a storm of large magnitude with a very low probability of occurrence, the 100-year storm.

The flood control levees extend for 57 miles along the west side of the RGCP and 74 miles on the east side, for a combined total of 131 miles. Naturally elevated bluffs and canyon walls contain flood flows along portions of the RGCP that do not have levees. The levees range in height from about 3 feet to about 18 feet and have slopes of about 3:1 (length to width) on the river side and 2.5:1 on the "land" side. The levees have a gravel maintenance road along the top.

The levees are positioned on average about 750 to 800 feet apart north of Mesilla Dam and 600 feet apart south of Mesilla Dam. The floodway between the levees is generally level or uniformly sloped toward the channel. The floodway contains mostly grasses, some shrubs, and widely scattered trees. The bank of the channel at the immediate edge of the floodway is typically vegetated with a narrow strip of brush and trees. Levees were originally built to provide 3 feet of freeboard during the design flood in most reaches.

#### *Upstream Flood Control*

Flood control in the RGCP relies on upstream flow regulation, as well as the use of levees, to contain high-magnitude flooding in areas with insufficient natural terrain elevation. In the RGCP flooding is largely controlled by upstream reservoirs that include Elephant Butte Dam, completed in 1916, and Caballo Dam, completed in 1938. Caballo Reservoir has storage capacity of 331,500 ac-ft (top of flood capacity), of which 100,000 ac-ft must be available during the months of July, August, and September for flood control (USIBWC 1994). During the non-irrigation season, that capacity is used for storage and regulation of winter flows.

In addition to flow regulation by Elephant Butte and Caballo Dam, flow regulation upstream of the RGCP is provided by a series of four reservoirs constructed under the Flood Control Act of 1941: Jemez Canyon Dam (1953), Abiquiu Dam (1963), Galisteo Dam (1970), and Cochiti Dam (1975). These dams have effectively controlled floods originating in the upper Rio Grande Basin (Winter *et al*. unpublished manuscript). Additional flood control is expected as a result of the Upper Rio Grande Water Operations Model (URGWOM), a multi-agency initiative to optimize water storage and delivery operations throughout the Rio Grande from Colorado to Texas. Improved flood routing through the RGCP is a component of the URGWOM simulation model [*www.spa.usace.army.mil/urgwom*].

### 3.2.2 Flood Containment Capacity Evaluation

In 1996 the Hydrology and Hydraulics Section of the USACE Albuquerque District completed an evaluation of potential flood containment capacity of the RGCP, the Rio Grande Canalization Improvement Program (USACE 1996). Hydrologic and hydraulic analyses of the 100-year flood were performed for the 105.4 miles of floodway between Percha Dam and American Diversion Dam. The study also included an evaluation of sedimentation in RGCP tributary basins, as well as a scour and deposition analysis. Findings of the Rio Grande Canalization Improvement Program are summarized in Appendix B.

#### *Hydrologic Modeling*

The USACE generated the 100-year flood discharges at selected locations along the Rio Grande using standard hydrologic procedures and the USACE program HEC-1.

The 100-year storm developed for the study area represented a summer thunderstorm rain flood, which generated the greatest peak flows in the study reach of the river. A storm centered below Caballo Dam was assumed. A 100-year 24-hour duration uniform rainfall of 2.39 inches and a NRCS Type IIa distribution were used. The USACE report provides detailed analysis of the methods used in generating the 100-year flood discharges.

Table 3.2-1, adopted from the USACE report, lists these peak discharges at the selected stations between Percha Diversion Dam and American Diversion Dam. Irrigation design flows, listed as reference values, represent the maximum capacity of the pilot channel (design value).

#### *Hydraulic Modeling*

The USACE generated the 100-year flood water surface elevations at selected locations along the Rio Grande using standard hydrologic procedures and the USACE computer program HEC-2. Modeling results, summarized in Table 3.2-2 identified various reaches of the RGCP with freeboard values potentially below the 3 feet design criteria, and in some reaches overtopping could occur or in unconfined areas the flood plain would extend past the ROW. The geographic distribution of potential deficiencies is shown in Figure 3-4 along with adjacent land use.

The most significant deficiency identified by the USACE study was located along eastern portion of Canutillo, Texas, only partly protected from flooding by a railroad embankment which acts as the east levee. While the railroad embankment extended for about 5 miles, the protection was discontinuous due to uncontrolled openings in the railroad embankment. To address this deficiency, the USACE (1996) recommended a structural solution that would involve both an earthen levee and concrete floodwall.

***East levee at Canutillo***. The proposed floodwall, beginning approximately at river mile 9.9 above American Dam and extending to river mile 11.3, is necessary due to the constricted flow area that exists; the levee-to-levee width in this reach is only 310 feet to 350 feet. This river section currently represents the hydraulic constriction in the RGCP reach where the levee-to-levee width cannot be reduced by the use of a new earthen levee

## Table 3.2-1 Design Flows for Irrigation and 100-Year Flood

| Miles Above American Dam | Irrigation Design Flow (cfs) | 100-Year Flood Flow (cfs) |
|---|---|---|
| 105.4 | 2,350 | 5,000 |
| 102.9 | 2,350 | 9,100 |
| 101.4 | 2,350 | 11,300 |
| 99.8 | 2,350 | 15,600 |
| 98.1 | 2,350 | 17,600 |
| 96.6 | 2,350 | 18,700 |
| 92.4 | 2,350 | 18,900 |
| 84.4 | 2,350 | 19,100 |
| 81.8 | 2,350 | 18,300 |
| 80.4 | 2,350 | 17,700 |
| 80.0 | 2,350 | 17,800 |
| 78.5 | 2,350 | 22,400 |
| 78.0 | 2,350 | 22,500 |
| 76.6 | 2,350 | 22,000 |
| 67.2 | 2,350 | 22,400 |
| 63.3 | 2,350 | 22,400 |
| 63.0 | 2,350 | 22,200 |
| 57.7 | 1,900 | 21,300 |
| 55.3 | 1,900 | 21,000 |
| 48.7 | 1,900 | 21,300 |
| 47.6 | 1,900 | 20,500 |
| 44.6 | 1,900 | 20,100 |

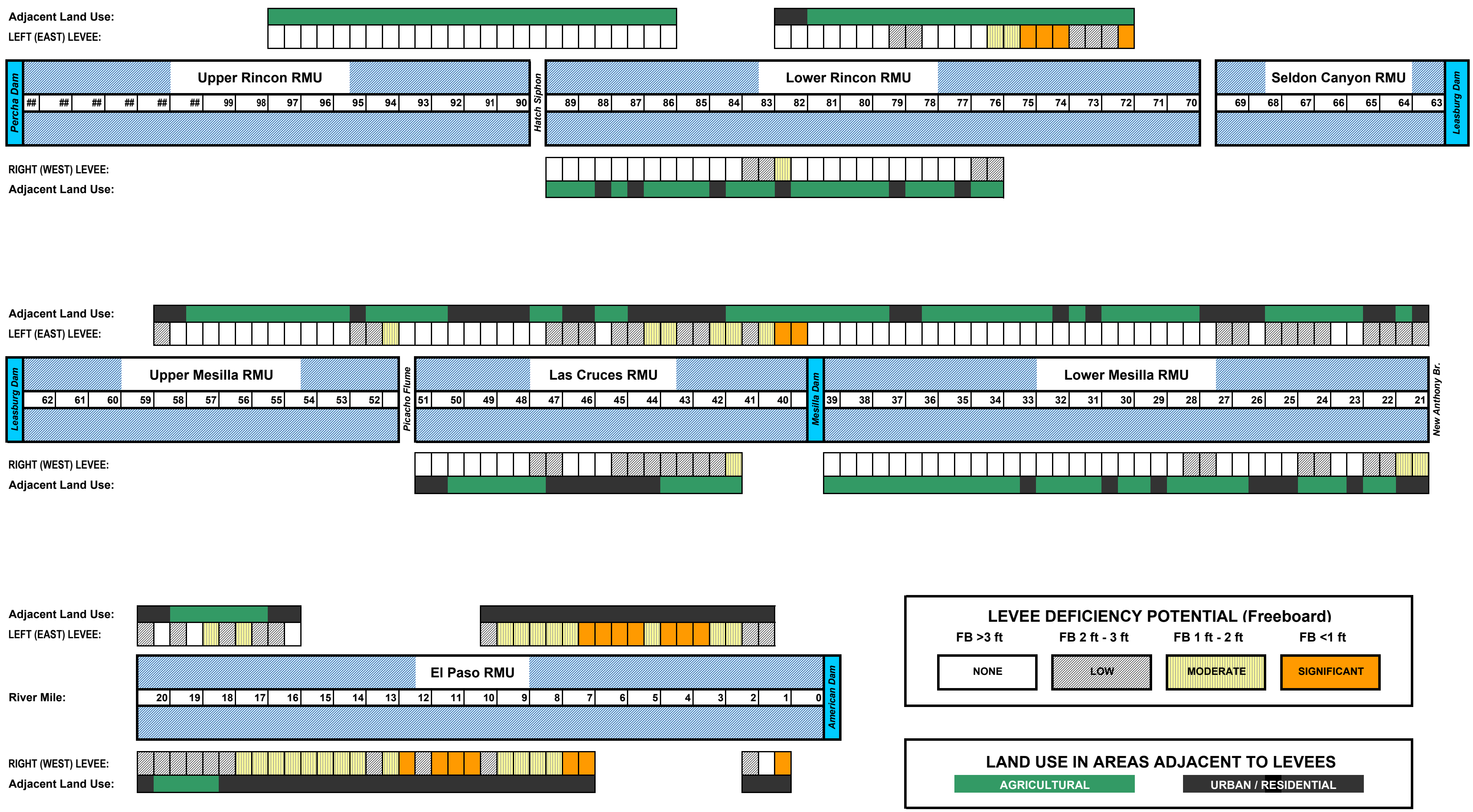
| Miles Above American Dam | Irrigation Design Flow (cfs) | 100-Year Flood Flow (cfs) |
|---|---|---|
| 39.9 | 1,900 | 20,000 |
| 39.3 | 1,600 | 20,100 |
| 34.8 | 1,600 | 19,600 |
| 29.2 | 1,600 | 19,200 |
| 25.9 | 1,600 | 18,700 |
| 22.1 | 1,600 | 18,300 |
| 22.0 | 1,600 | 17,900 |
| 21.8 | 1,600 | 17,700 |
| 19.6 | 1,600 | 17,600 |
| 18.8 | 1,600 | 17,400 |
| 16.4 | 1,600 | 17,100 |
| 15.7 | 1,600 | 16,800 |
| 15.4 | 1,600 | 16,600 |
| 15.2 | 1,600 | 16,500 |
| 15.0 | 1,600 | 16,400 |
| 14.4 | 1,600 | 16,300 |
| 13.1 | 1,600 | 16,100 |
| 12.8 | 1,600 | 15,900 |
| 10.9 | 1,600 | 15,000 |
| 10.3 | 1,600 | 14,800 |
| 9.2 | 1,600 | 14,600 |
| 0.2 | 1,600 | 14,300 |

## Table 3.2-2 Hydraulic Model Results for the 100-Year Flood Conditions

| River Management Unit | Potential Deficiency (Combined length of right and left banks in miles) | | |
|---|---|---|---|
| | No Freeboard* | Freeboard Less Than 1 foot | Freeboard Less Than 3 feet |
| Upper Rincon RMU | 0.0 | 0.5 | 3.9 |
| Lower Rincon RMU | 1.7 | 1.7 | 4.7 |
| Seldon Canyon RMU | 2.6 | 0.2 | 1.3 |
| Upper Mesilla RMU | 1.2 | 0.9 | 3.4 |
| Las Cruces RMU | 0.0 | 0.0 | 3.5 |
| Lower Mesilla RMU | 1.3 | 0.6 | 15.4 |
| El Paso RMU | 6.4 | 2.8 | 22.1 |
| ***Total Length*** | *13.2* | *6.7* | *54.3* |

*Levee potentially overtopped or water surface extending beyond right-of-way

# Figure 3-4 RGCP Characterization in Terms of Potential Levee Deficiencies and Adjacent Land Use



section without adversely increasing the water surface elevation upstream. The recommended 7,500-foot-long floodwall would vary in height from 8 to 10 feet, without freeboard, and the structure would be located riverside and immediately adjacent to the existing east river levee provided by the railroad embankment. To accommodate local drainage, the flood wall must tie into the drainage control structures at appropriate locations. Downstream of river mile 10.8 and upstream of river mile 12.2, the levee-to-levee width expands to approximately 500 feet, allowing the floodwall to transition to an earthen levee.

***West levee at Canutillo***. The west-side levee would incorporate a flood wall extension for the same constricted area (river mile 10.8 to river mile 12.2) to contain the increased water surface elevation resulting from the decrease in effective flow area with the east-side flood wall in place. The west-side flood wall would consist of a vertical wall partially embedded in the existing levee crown. A floodwall extension is possible on the west side because, unlike the east-side levee, the west-side levee does not serve the dual propose of railroad embankment and flood control levee. The existing levee section should be checked for through seepage and underseepage and for embankment and foundation stability. Some methods of controlling seepage and improving embankment stability could eliminate the economic advantage of the flood wall in comparison to an earthen levee enlargement.

***Other Recommendations***. The flood containment capacity study (USACE 1996) also recommended inspections of levee closure devices to ensure they would operate correctly in case of flood emergencies, and replacement of five bridges (Brickplant, Courchesne, Borderland, Canutillo, and Tonuco) in which the 100-year flood could overtop the roadway elevation.

## 3.3 SOILS

Intermontane sediments known locally as bolson deposits underlie most of the RGCP. These sediments washed down from nearby mountains and filled the basin that formed during the Rocky Mountain Orogeny and faulting that occurred in the Tertiary period, continuing through the Quaternary. The basin in El Paso County, known as the Hueco Bolson, was initially enclosed, but as the Rio Grande channel meandered through the area, the basin was drained. Since then, water action has leached carbonates from the parent material and formed layers of caliche at various depths below the surface (USDA 1971).

### 3.3.1 Soil Characterization

Soils on the Rio Grande floodplain formed in alluvium recently deposited by the river. At the landscape level, the NRCS characterizes these floodplain soils as the Glendale-Harkey map unit and the Glendale-Gila-Brazito map unit (USDA 1980).

*Glendale-Harkey Map Unit*: soils are deep, well drained, and formed in alluvium. This map unit is composed of Glendale soils (21 percent), Harkey soils (19 percent), Brazito soils (10 percent), Adelino, Agua, Anapra, Anthony, Armijo, Belen, Vinton, Agua Variant, Belen Variant, and Vinton Variant make up the remainder of the map unit. Slope within this map unit typically range from 0 –1 percent. Surface soils are typically silty clay loams over stratified layers of loamy soils and fine sand. Locally, the RGCP soils are classified as Made land, Gila soil material. This series consists of soil materials, chiefly from Gila soils, which are silty clay loam, fine sandy loam, and sand in texture. The soil is made of recently deposited alluvial material, which has been moved and shaped for construction of levees and for relocation and straightening of the river channel.

*Glendale-Gila-Brazito Map Unit*: soils are deep, nearly level to gently sloping. Slopes range from 0 to 5 percent. Formed in mixed alluvium, these soils are found along the Rio Grande in Sierra County. Typically, the surface layer is a fine loamy sand or clay loam, and extends to a depth of 2 feet. The many arroyos that cut through the area are a source for sedimentation.

Along the perimeter of the floodplain, soils are typically formed in alluvium, alluvium modified by wind, and eolian material. The NRCS characterize these soils as the following three map units: Nickel-Bluepoint, Bluepoint, Caliza-Bluepoint-Yturbide, and Nickel-Upton (USDA 1980). Upland soils are calcareous and with a potentially low availability of phosphorus, iron, copper, zinc and manganese. Salinity is related to permeability and irrigation practices, but in general is much lower than in the clayey soils along the valley (USIBWC & EPWU/PSB 2000).

*Nickel-Bluepoint Map Unit*: soils are well drained, nearly level to extreme sloping. Slopes may range from 1 to 75 percent. These soils are found on alluvial fans, terraces, and piedmonts, and are formed in mixed alluvium modified by wind action. This map unit exhibits some characteristics of badlands, where extreme erosion is evident.

*Bluepoint Map Unit*: soils are deep, gently undulating to moderately rolling along the Rio Grande and associated tributaries. Slopes range from 1 to 15 percent. Typically, the surface layer is a fine, loamy sand, overlying a loamy fine sand. The many arroyos that cut through the area are a source for sedimentation.

*Caliza-Bluepoint-Yturbide Map Unit*: soils are deep, gently undulating to very steep, and are found on ridges and terraces. Slopes range from 1 to 40 percent. The Caliza soils that compose 24 percent of this map unit are typically a very gravelly sandy loam. The Bluepoint soils are typically a loamy sand at the surface, overlying a loamy fine sand. The Yturbide soils are found on side and terminal fans of arroyos and river deposits, and are typically a loamy sand overlying gravels and sands.

*The Nickel-Upton Map Unit*: composed of undulating to moderately rolling soils on fans, terraces, ridges, and piedmonts. Slopes range from 3 to 15 percent. The Nickel soils are deep and well drained, and are formed in gravelly alluvium on terraces. Typically, the surface layer is a gravelly fine sandy loam. The Upton soils are shallow and well drained. They formed in gravelly alluvium and are on piedmont slopes and ridges. Typically, the surface layer is a gravelly sandy loam, overlying indurated caliche.

### 3.3.2 Soil Distribution within the RGCP

Table 3.3-1 presents the distribution of soils along the RGCP by RMU, indicating acreage associated with each type of soil. Values were obtained by superposition of the ROW and geographic soil distribution obtained from New Mexico Resource Geographic Information System (GIS).

**Table 3.3-1 Soil Distribution Along the RGCP**

| RMU | Map Unit | Percent Within RMU |
|---|---|---|
| Upper Rincon | Glendale-Gila-Brazito | 33.5% |
| | Glendale-Harkey | 28.8% |
| | Nickel-Upton (uplands) | 10.3% |
| | Nickel-Bluepoint (uplands) | 13.6% |
| | Caliza-Bluepoint-Yturbide (uplands) | 13.8% |
| Lower Rincon | Glendale-Harkey | 95.1% |
| | Caliza-Bluepoint-Yturbide (uplands) | 2.8% |
| | Nickel-Bluepoint | 1.2% |
| | Bluepoint | 1.0% |
| Upper Mesilla | Glendale-Harkey | 57.1% |
| | Bluepoint | 20.5% |
| | Nickel-Upton | 22.4% |
| Las Cruces | Glendale-Harkey | 100% |
| Lower Mesilla | Glendale-Harkey | 82.8% |
| | Bluepoint | 17.2% |
| El Paso | Glendale-Harkey | 90.5% |
| | Bluepoint | 9.5% |

### 3.3.3 Soil Erosion

Soil erosion is a function of plant cover, grade and length of slope, management practices, and climate. High grazing intensity (high numbers of stock over a long period of time) can alter plant species composition (Chaney *et al*., 1990), can affect soil infiltration rates, and can increase soil erosion (Platts 1989). Soil erosion occurs in the highly sloped uplands as well as the floodway (riparian zone). Uplands soils typically have higher soil erodibility factors and lower soil-loss tolerance factors than floodplain soils. This is due in part to the higher slope grades that are exhibited by upland soils, as well as land cover characteristics.

#### *Uplands*

Soil erosion is influenced primarily by soil cover. Cover intercepts precipitation, reducing raindrop impact, restricting overland flow resulting in less runoff and erosion

Research indicates that cover value between 30-40 percent are needed to control sheet and rill erosion (BLM 1994). Sufficient cover requires adequate vegetation basel cover foliar cover and natural litter (BLM 2000). Estimated annual soil loss of RGCP uplands is presented in Table 3.3-2.

**Table 3.3-2 Potential Sediment Load from Upland Erosion**

| | Watershed Size (sq. miles) | Sediment Load of watershed (ac-ft/yr) | Estimated Percent Vegetative Cover | Amount of Uplands within the RGCP (acres) | Potential Load Generated in RGCP Uplands (ac-ft/yr) |
|---|---|---|---|---|---|
| UPPER RINCON RMU | | | | | |
| Berrenda Creek | 87.4 | 2.60 | 15% | 530 | 0.02 |
| Miscellaneous Area 3 (Yeso Arroyo) | 9.5 | 8.60 | 15% | 40 | 0.06 |
| Arroyo Cuervo | 126.2 | 3.38 | 13% | 850 | 0.04 |
| Miscellaneous Area 4a* | | | 13% | 220 | 0.31 |
| LOWER RINCON RMU | | | | | |
| Angustora Arroyo | 8.9 | 8.41 | 18% | 100 | 0.15 |
| Reed Arroyo | 9.6 | 8.64 | 18% | 40 | 0.06 |
| Miscellaneous Area 6 (Bignell Arroyo) | 8.9 | 16.88 | 14% | 25 | 0.07 |
| *Total* | | | | *1805* | *0.71* |

* Values estimated using adjacent arroyo cover values and soil classification

### *Riparian*

Grazing in riparian areas may have long-lasting, often irreversible effects on riparian areas. Overgrazing of riparian areas can result in erosion due to hoof action and reduced vegetative cover. In addition, overgrazing in riparian areas can lead to a decline in aquatic habitat by reducing or eliminating the number of bank undercuts and cause a decline in water quality due to increased turbidity and fecal contamination (Platts 1989). During field surveys, cattle were observed grazing along the banks and in the river at several locations.

Riparian areas have higher quality forage (higher proportion of green to dead plant material and a higher proportion of leaves to stems), and greater amounts of water and shade (Briggs 1996). Vegetation surveys conducted by Parsons (2001), indicated that grazed areas appeared to be overgrazed and varied from very little vegetative cover (0 on a scale of 5) to good coverage (3 on a scale of 5). The amount of sediment entering the river as a result of hoof- action and reduced vegetative cover are unknown. However, the below-average to poor wildlife quality (discussed further in section 3.4) is indicative of reduced vegetative cover and increased soil erosion potential.

## 3.4 VEGETATION AND WETLANDS

This section describes the vegetation communities within the RGCP. It includes a definition of riparian communities, vegetation community classification, background information on invasive species that dominate the RGCP, and a discussion of regeneration strategies of native and invasive species. A more detailed discussion of the current environmental conditions can be found in previously published technical reports (Parsons 2000a, 2001b, 2001c).

### 3.4.1 Ecological Region

The Chihuahuan Desert can be subdivided into three regions, the northern Trans-Pecos region, the middle Mapimian region, and the southern Saladan region (MacMahon 1988). The RGCP is included in the northern Trans-Pecos region of the Chihuahuan Desert. This region includes all sections of the Chihuahuan Desert in the U.S. and the northernmost sections of the desert of Mexico.

The Trans-Pecos region of the Chihuahuan Desert is a mosaic of grasslands and desert shrublands (Burgess 1995, MacMahon 1988, McClaran 1995) with grassland dominated by Tobosa and black grama. The desert shrub species are typically creosote bush or tarbush with other shrub species and succulents present. Vegetation along the Rio Grande and streams is dominated by willows, cottonwood, and mesquites. Other species such as ash and desert willow are often present.

Historically, the vegetation along the Rio Grande was composed of cottonwoods and willows, with Berlandier ash, netleaf hackberry, and little walnut. Fossil evidence traces this community back 2 million years. The Rio Grande vegetation communities were dynamic, growing, and spreading when weather was favorable, and dying off during periods of prolonged drought or prolonged floods. A wide range of age classifications, from old growth to pioneer communities, provided a varied and diverse habitat (Crawford *et al*., 1996).

The current dominance of invasive vegetation such as salt cedar and subsequent decline of species characteristic of historic bosques is in response to anthropomorphic factors including altered hydrology and landuse changes among others (Everitt 1998; DeBano and Schmidt 1989; Schmidly and Ditton 1978).

### 3.4.2 Riparian Communities

#### *Riparian Community Characterization*

Riparian is generally defined as land occurring along a water body transitioning between permanently saturated wetlands and upland areas (BLM 1993, Briggs 1996). Older and more classical riparian interpretations identify primarily woody vegetation associated only with stream or river systems. Recent interpretations include a broader view involving, surface and subsurface water influences, and natural forces and human-induced activities that affect woody and emergent vegetation (Dall *et al.,* 1997). For classification purposes, lands within the floodway (including wetlands) are classified as riparian.

Riparian areas are often more productive then surrounding lands due to the availability of water and nutrients. Vegetation is generally taller and denser, providing a food base and cover for wildlife. Riparian areas provide numerous environmental functions, including the following (Briggs 1996):

- Riparian areas can serve as transition zones between two very different ecosystems, e.g., desert scrub and aquatic. Density and diversity of wildlife and plant species are higher in this ecotone.
- Riparian vegetation provides bank stabilization and moderates water temperature (e.g., by shading).
- Riparian areas serve as major corridors for wildlife movement
- Riparian areas, like wetlands, provide groundwater recharge and flood hazard reduction and nutrient sinks.

The functioning condition of a riparian system is a result of the interaction of geology, soils, water, and vegetation. Research indicates that water exchange through periodic or seasonal inundation strongly influences riparian functional properties (Gregory *et al*., 1991). The effect of regulated river flows and the subsequent long-term effects on riparian function is not fully known, however, recent studies suggest that periodic flooding is required for establishment and maintenance of native vegetation communities (Molles *et al.,* 1998, Crawford *et al.,* 1996). Cottonwood and willow trees disperse seeds from about May 25 to June 20, peaking in early June (U.S. Department of Interior, Bureau of Reclamation 2000). Freshly deposited or reworked alluvium is required to provide substrate for seedling establishment (Auble and Scott 1998). This alluvium is generally produced by scour of the riverbank during floods.

A "healthy" riparian system normally exhibits an active floodplain with diverse channel characteristics providing varied aquatic habitat for fish production, waterfowl breeding, and other wildlife uses. These channel characteristics are formed by periodic flooding and high velocity flows, which may be accompanied by some erosion, bank scouring, and local loss of vegetation. Healthy riparian systems are characterized by an interaction between the aquatic and riparian zone (Molles *et al*., 1998).

#### *Riparian Communities Within the RGCP*

There has been limited research conducted about the riparian communities in the RGCP (Watts 1998). To develop baseline information for the RGCP, field studies documenting vegetation and habitat quality were conducted by Parsons (2001).

Field studies showed that periodic mowing maintains a large portion of the riparian community in disturbed, or early seral state characterized by herbaceous vegetation and shrubland re-growth. Riparian areas not mowed or otherwise maintained, can rapidly become dominated by non- native salt cedar. The control of woody vegetation through mowing is a major O&M activity within the floodway and is conducted to reduce woody vegetation for flood control and water delivery purposes.

The floristic composition of riparian vegetation is related to river proximity. A border of hydrophytic vegetation, generally 10 to 15 feet wide, occurs on the riverbank forming the sloped side of the channel. This narrow woody zone is dominated by salt cedar with occasional seep willow, willow, or herbaceous vegetation, including common reed, sedges, and rushes. Isolated wetlands are found along the river channel, spillways, and low-lying areas within the floodplain. Salt grass is the common grass occurring in wetland sites. Riparian vegetation is for the most part disconnected from surface water sources.

The majority of the RGCP floodway is rarely flooded and disassociated from the river channel. Natural channel characteristics formed through periodic flooding and high velocity flows are largely absent. The widespread absence of young and mid-aged cottonwood within the RGCP (Parsons 2001a) suggests that the irrigation driven hydrologic regime has greatly influenced riparian native species composition.

In terms of native cottonwood regeneration, there is little evidence of new seedling establishment among the scattered and declining cottonwood remnants. Natural propagation appears to be limited to isolated, new growth trees propagated through root suckers with little successful seed germination observed (Parsons 2001a).

### *Hydrologic Connectivity of Riparian Communities*

Riparian communities can be categorized as connected or disconnected based on their hydrologic connectivity to the river (Crawford *et al*., 1996). Disconnected communities are isolated from the river influence and rarely inundated by overbank flows. The vast majority of the RGCP is considered disconnected from the river. In contrast, connected communities are influenced by the river through periodic inundation, flushing and potential scouring. Connected communities often exhibit a forest floor covered by few leaves and debris, and large well separated trees with dense canopy. Periodic inundation and flushing removes leaf litter and create moist soil conditions suitable for seed regeneration. Connected communities have highly productive soil and have more rapid biochemical cycling then disconnected communities (Crawford *et al.,* 1996).

Identification of hydrological connected areas was conducted to determine the location of potential riparian restoration projects (Parsons 2003a). The hydrologic floodplain was defined as areas inundated from the highest average monthly flow in record for the RGCP (Table 3.4-1). It was assumed that the recorded water elevation associated with the highest average month is indicative of the hydrologic floodway, or active floodway.

The hydrologic floodplain set the bounds (areal extent) for shavedowns and plantings. The assumption was that areas outside the hydrologic floodplain would require extensive shavedowns and/or large flow releases for development of native vegetation. In the case of plantings, sites outside the hydrologic floodplain would be too high above the water table for success. Details concerning the selection of restoration areas is found in Section 2.

### Table 3.4-1 Reference Flows Used to Identify Hydrologic Floodplain

| Flow (cfs) | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso |
|---|---|---|---|---|---|---|---|
| *River Mile* | *105 – 90* | *90 - 72* | *72 - 63* | *63 - 50* | *50 - 40* | *40 - 21* | *21 - 0* |
| Irrigation season average * | 1,150 | 1,150 | 1,200 | 1,000 | 1,000 | 650 | 650 |
| Design flow (USACE 1996) | 2,350 | 2,350 | 2,350 | 1,900 | 1,900 | 1,600 | 1,600 |
| Flows selected as a reference for riparian habitat development ** | 3,561 | 3,470 | 3,470 | 3,035 | 3,270 | 2,545 | 2,586 |

* Approximate values from El Paso-Las Cruces Regional Sustainable Water Project (USIBWC and EPWU/PSB, 2000)

** Highest average monthly flow on record (July 1987) during a 10-consecutive year period with the highest precipitation from USACE 1996, Vol. 4, Tables 2-2, 2-4 and 2-6.

Approximately 350 acres of ROW were calculated within the hydrologic floodplain and met the criteria for riparian restoration. An additional 771 acres of lands outside the ROW, primarily within or adjacent to Seldon Canyon were also identified (Table 3.4-2). Note: the table does not reflect floodway inundation by raising the river elevation above the hydrologic floodplain through increasing flow as identified in the targeted river restoration alternative.

### Table 3.4-2 Lands Within the Hydrologic Floodplain and Meeting Criteria for Potential Environmental Measures

| | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| *River Mile* | *105 - 90* | *90 – 72* | *72 - 63* | *63 - 50* | *50 - 46* | *40 - 21* | *21 - 0* | *105-0* |
| Within RGCP ROW | 137 | 60 | 0 | 20 | 137 | | 0 | 350 |
| Outside RGCP ROW | | 208 | 324 | | 168 | 27 | 44 | 771 |
| Total | 137 | 268 | 324 | 20 | 305 | 27 | 44 | 1121 |

#### *Wetlands*

Wetlands have undergone considerable modification in recent history. Wetlands were found throughout the Rio Grande floodplain created by a dynamic river system responding to heavy snow melt or storm generated runoff. The presence of abundant and mosaiced wetlands interspersed among riparian vegetation was driven by seasonal rain and basin hydrology (Crawford et al., 1996). By some accounts, wetlands extent increased in response to widespread landuse changes which modified river hydrology, raised water tables and created saturated soil conditions (Wozniak 1995).

As recently as the early 1900s, high water tables in the floodplain created many wet meadows, marshes and ponds providing habitat for wildlife and subsequently reducing its value as cropland. In response to saturated soil conditions, extensive drainage canals were built in the 1920's to remove water and improve agricultural productivity. The drainage eliminated the majority of wetlands by the 1930s thereby increasing the importance of the remaining wetlands found among the irrigation network and river margin (Wozniak 1995).

Within the RGCP, wetlands are largely restricted to narrow margins and former oxbows within the floodway. High water tables during irrigation season have created pockets of emergent marsh and wet meadow sites within the floodway and on private lands adjacent to the ROW. The two most significant wetlands on private lands adjacent to the ROW are found at the entrance to Seldon Canyon and south of Las Cruces. Not coincidently, both areas area also mapped as being within the hydrologic floodplain.

Wetlands estimate within the RGCP is heavily influenced by the classification system and classification methodology employed. Table 3.4-3 compares wetland estimates developed for this Environmental Impact Statement (from Parsons 2001a) with an earlier inventory conducted by the USFWS National Wetland Inventory program (from CH2M-Hill and GeoMarine 2000a). Analyses of representative areas suggest that much of the wetland previously identified by the National Wetland Inventory are currently classed as riparian herbaceous or shrubland (in areas south of Las Cruces), and riparian shrubland/woodland in the Rincon Valley. As a result, wetlands mapped by Parsons (2001a) typically reflect the locations of "wetter" wetlands.

**Table 3.4-3 Wetland Inventory from Two Sources**

| Source | Upper Rincon | Lower Rincon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|
| 1979 National Wetland Inventory | 18 | 100 | 20 | 164 | 59 | 236 | 597 |
| Parsons 2001a | 54 | 51 | 2 | 15 | 9 | 35 | 166 |

The difficulty of separating wetlands from riparian areas has resulted in some mapping efforts not distinguishing between wetlands and riparian habitat. For instance riparian areas mapped by the Colorado Division of Wildlife, are inclusive of wetland areas and no mapping distinction is made between riparian vegetation and wetland vegetation (Colorado Division of Wildlife 1997). The variability of mapping wetlands from remotely sensed imagery underscores the importance of conducting on-site wetland determination for future regulatory compliance. The definition of jurisdictional wetlands follows:

Jurisdictional wetlands (waters of the United States) are defined in the Clean Water Act and the Code of Federal Regulations. Waters of the United States are delimited by the "ordinary high water mark," a term defined as that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas (33 CFR part 328).

Wetlands are categorized as waters of the United States and defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (Federal Register 1980, 1982).

Wetlands determination and delineation methods are described in the United States Army Corps of Engineers 1987 Wetlands Delineation Manual (USACE 1987). This manual with amendments provide guidance for determine the extent of jurisdictional wetlands. On-site jurisdictional wetland determinations might or might not correspond to existing wetlands maps.

### 3.4.3 Vegetation Communities Descriptions

USIBWC ROW lands encompass 11,062 acres of terrestrial and open water. Table 3.4-4 presents the distribution of vegetation communities. The system used for mapping vegetation was a modified version of the Texas Parks and Wildlife Department vegetation classification system (Hinson and Pulich 1995).

**Table 3.4-4 Vegetation Communities and Open Water Habitat Within the RGCP**

| Vegetation Community | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Totals |
|---|---|---|---|---|---|---|---|---|
| **Riparian (floodway)** | | | | | | | | |
| Herbaceous | 303 | 542 | 14 | 289 | 459 | 399 | 555 | 2551 |
| Herbaceous – on levees | 46 | 154 | | 46 | 131 | 217 | 154 | 748 |
| Woodland | 380 | 196 | 8 | 242 | 195 | 264 | 160 | 1,445 |
| Shrubland | 302 | 305 | 4 | 117 | 38 | 49 | 24 | 839 |
| Exposed ground | 276 | 101 | 0 | 138 | 36 | 111 | 40 | 702 |
| Croplands | 40 | 26 | 0 | 0 | 0 | 0 | 0 | 66 |
| Wetlands - Emergent marsh | 42 | 31 | 2 | 15 | 11 | 29 | 10 | 140 |
| Wetlands – Palustrine Woodland | 12 | 20 | 0 | 0 | 3 | 1 | 1 | 37 |
| *Total Riparian (acres)* | *1,401* | *1,375* | *28* | *836* | *873* | *1,070* | *944* | *6,527* |
| **Uplands** | | | | | | | | |
| Herbaceous | 789 | 83 | 0 | 0 | 0 | 0 | 0 | 872 |
| Woodland /Shrubland | 721 | 51 | 0 | 0 | 0 | 0 | 0 | 772 |
| Exposed ground | 131 | 30 | 0 | 0 | 0 | 0 | 0 | 161 |
| *Total Upland (acres)* | *1,641* | *164* | *0* | *0* | *0* | *0* | *0* | *1,805* |
| **Total Land Acreage** | **3,042** | **1,539** | **28** | **836** | **873** | **1,070** | **944** | **8,332** |
| **Open Water** | 271 | 541 | 263 | 292 | 420 | 498 | 445 | 2730 |
| **Total Acreage for the RGCP** | **3,313** | **2,080** | **291** | **1,128** | **1,293** | **5,168** | **989** | **11,062** |

A detailed discussion of the classification process was presented in a separate technical report documenting status of RGCP habitats (Parsons 2001b). In brief, the classification process used a combination of supervised and unsupervised image processing techniques to classify color infrared orthoimagery. The primary benefit of using image processing techniques for vegetation classification is its capability to efficiently classify extensive areas. Limitations can include potential error between spectrally similar classes (referred to as omission or commission error) and subsequent under or over representation of some classes. Despite potential limitations, the resulting maps provided the most accurate estimate of vegetation communities available for the RGCP to date.

Vegetation communities are classified as either riparian (the floodway) or upland vegetation (Table 3.4-4). Wetlands are part of the riparian community. Within each class, more detailed physiognomic classes are defined. Within the riparian community, the wetter areas are classified as wetlands. Some riparian areas are cropped within the ROW.

#### *Riparian Communities and Wetlands*

***Herbaceous.*** Due to mowing, much of the riparian community is maintained in an early successional state and classified as herbaceous. Herbaceous communities include non-woody vegetation such as grasses, sedges, and forbs with less than 20 percent cover in trees and shrubs. This community corresponds to Hink and Ohmart Type VI open grassland or emergent community. Although the herbaceous community is diverse (87 species documented), many non-native, invasive, and noxious species such as Russian thistle, red bladderpod, and jimson-weed occur. Many of the plant species are opportunistic, early successional species which are often indicators of disturbance. With the exception of Seldon Canyon, the herbaceous class is abundant throughout the RGCP.

Within the floodway, herbaceous lands are normally characterized as intermediate to xeric grasslands. Xeric grasslands are located on the levees and higher sites within the floodway. Approximately 748 acres of grasslands are part of the levee. Isolated lower sites are composed of mesic vegetation at times transitioning into Hydric (wetland) communities. In the absence of mowing, herbaceous areas would likely convert to a woody salt cedar community.

***Woodlands***. Woodlands are dominated by woody vegetation over 9 feet tall and with a minimum canopy cover of 20 percent. This community corresponds to Hink and Ohmart Type III woodland, and is also referred to in this document as bosques. Woodlands consist of native and non-native woody species, with native species rarely dominating. The dominant species in this community is invasive salt cedar. Common native species include honey mesquite, littleleaf sumac, peachleaf willow, and occasional cottonwood.

***Shrublands***. Shrublands are characterized as areas dominated by woody vegetation less than 9 feet with a canopy cover less than 20 percent. This community corresponds to Hink and Ohmart Type V dense shrub community. Within the RGCP, the dominant species in the shrubland is salt cedar. The shrubland class is similar in species composition of the woodland community. Common native species in this class include apache plume, aromatic sumac, baccharis, fourwing saltbush, and pale wolfberry. Shrublands dominated by willow/seepwillow often transition into palustrine wetlands. Due to the changes in vegetation as a result of the mowing there is a significant overlap between shrubland and herbaceous communities. Permanent shrubland habitat is found closer to the river or in other areas more difficult to mow.

***Exposed Ground***. This land cover classification is characterized by the absence of vegetation and includes bare soil, sand, silt, and gravel and vegetation, if present, is very sparse. Bare ground accounts for a significant amount of the floodway. A recent study in the RGCP using a transect sampling method found that in over half of survey sites (18 of

35 sites), bare ground was actually the dominant land cover type and in 11 sites, it was the second most dominant land cover type (Watts 1998).

***Cropland***. Croplands include alfalfa, chili, corn, cotton, pecan and a number of other crops. These agricultural areas make up a small percentage of the land cover within the floodway.

***Wetlands***. Wetlands are those areas where water saturation is the dominant factor determining soil development and the types of plants and animal communities present (Cowardin *et al.,* 1979). Wetlands are found on sandbars near the center of the channel, river margins or in proximity to the mouths of arroyos (Parsons 2001c). Wetlands are also found in the floodway where groundwater is at or just below the surface. These wetlands are classified as palustrine woodlands or emergent marsh.

- The emergent marsh class is dominated by herbaceous vegetation such as bulrush, cattail, and horsetail. Non-native, or noxious species include Johnsongrass, downy brome, and careless weed. Hydrology is a function of rainfall, episodic flooding, and depth of water table. The majority of wetlands in the RGCP are classed as emergent marsh. Emergent marshes are primarily found in the Upper Rincon, Lower Rincon and Lower Mesilla RMUs. Two fairly significant emergent marsh areas are located on private property north of Seldon Canyon and south of Las Cruces. Both areas are within potential conservation easements.
- Palustrine woodlands are dominated by facultative to obligate woody wetland vegetation. The class is characterized by mixtures of native and non-native plant species found in moist soil conditions. Willow/seepwillow cover types found in saturated soil conditions fall within this category. Depending on hydrologic regime, cottonwood bosques can be classified as palustrine woodlands or riparian woodland. Palustrine woodlands characterized by native species are rare, and when found, occur as narrow isolated pockets. The majority of native dominated palustrine woodland sites are found in the Upper Rincon RMU. Palustrine woodlands can include species such as New Mexico olive, baccharis, false indigo bush, and wolfberry (Scurlock 1998).

### *Uplands*

The uplands represent lands outside the historic floodplain and are dominated by xeric plant species. Grazing in the uplands has reduced populations of some grasses, and the grass communities with grazing tolerant forbs and shrubs. These communities include less palatable species such as snakeweed and shrubs such as saltbush and salt cedar (Scurlock 1998; Stotz 2000).

***Woodland/shrubland***. The woodland/shrubland community includes non-agricultural trees but will occasionally include drier former agricultural lands dominated by woody vegetation (over 20 percent woody coverage). Shrublands are mostly less than 9 feet in height and over 20 percent canopy cover. The majority of the woody upland sites are shrubland class.

***Herbaceous***. Herbaceous lands include all non-woody vegetation including grasses and forbs. Herbaceous areas are composed of less than 20 percent woody cover. Recent studies of upland vegetation suggest that ground coverage is often less then 20 percent within this and other uplands classes (USACE 1997).

***Exposed Ground***. Exposed lands are relatively abundant in the northern reach of the RGCP and include bare soil, sand, silt, and gravel. This land cover classification is defined by the absence of vegetation (<5 percent coverage). Vegetation, if present, is sparser than in vegetated land use classifications. Exposed ground is often interspersed within herbaceous and woodlands.

### 3.4.4 Invasive Species

#### *Salt Cedar*

Several species of salt cedar were introduced into the United States from southern Europe and the eastern Mediterranean region in the late 1800s. Many of these species escaped cultivation, and spread rapidly throughout the riparian areas of the southwest. Salt cedar has several characteristics that make it well suited to the desert regions of the southwest.

Salt cedar is considered a facultative phreatophyte able to survive in conditions where groundwater is depleted and the soil is unsaturated (DiTomaso 1998). Salt cedar can survive drought conditions longer than cottonwoods and willows, and can then rapidly respond to the presence of water (Devitt *et al*., 1997) and may desiccate watercourses (Vitousek 1990; DiTomaso 1998). In addition to the ability of salt cedar to tolerate drought and saline conditions, there is some evidence that the fire regime of these riparian areas may be altered by the presence of salt cedar (Bock and Bock 1990; Smith *et al*., 1998). Salt cedar is relatively tolerant of fire, while most native riparian species are not.

Salt cedar is the dominant woody species found in the riparian and wetland vegetation communities of the RGCP. It would likely dominate the majority of the floodplain replacing herbaceous communities if mowing ceased. Salt cedar tends to release seeds later in the season than cottonwood or willow, starting about the middle of July (Gladwin and Roelle 1998), but salt cedar release seeds for a much longer period of time (up to 5 months) and the seeds are viable for up to 3 months after release (USBR 2000). Salt cedar requires bare moist soil for germination, similar to the conditions required by cottonwood and willow. However, the longer period of release provides salt cedar with the ability to germinate later in the season when water flows are declining, including after late summer monsoonal rains (USBR 2000).

Salt cedar removal is a labor intensive process often requiring a combination of mechanical, manual and chemical treatments (Sudbrock 1993). Seasonal, long-term flooding can be a successful alternative when the salt cedar seedlings are small and they can be completely inundated (Gladwin and Roelle 1998).

#### *Russian Olive*

The Russian olive has also become established within many riparian areas of the southwest. Russian olive was introduced into the United States in the late 1800s, and subsequently escaped cultivation (Olson and Knopf 1986). Russian olive is a rapidly growing plant with a deep taproot and extensive lateral branching (Borell 1971). The Russian olive can effectively compete with native species for space and water, and is a superior competitor on bare mineral substrates due to nitrogen fixing root nodules (Plant Conservation Alliance 1997). Russian olive is considered relatively salt tolerant, although not as salt tolerant as salt cedar (Olson and Knopf 1986; Vines 1960), and is often found as a co-dominant species with willow. It is generally considered inferior wildlife habitat to native riparian species (Olson and Knopf 1986).

Russian olive is most prevalent in the northern reaches of the RGCP. Generally, the easiest way to control Russian olive is with a regime of mowing and removing the cut material. However, the seeds of the Russian olive are readily dispersed by many birds, so if mowing were reduced in some areas, this plant may become more abundant.

#### *Russian Thistle*

Russian thistle (*Salsola kali*), also known as tumbleweed, was introduced into the United States in the late 1800s. It has colonized extensive areas within the RGCP, particularly in disturbed sites in response to grazing and mowing. The seeds of Russian thistle are dispersed when the plant dries and wind tumbles the dried plant to a new location. Russian thistle is a particular problem in agricultural areas because of its extensive seed bank and water use. Research in croplands indicates that Russian thistle may be able to extract water from deep in the soil profile (Schillinger and Young 1999), potentially lowering the water table.

Control of Russian thistle is primarily through chemical controls and occasionally with mechanical controls (e.g., tilling). Chemical control is preferred because of the seed bank that is often exposed when mechanical control methods are used.

### 3.4.5 Vegetation Management within the ROW

Vegetation management affects the floristic and structural characteristics of vegetation communities. Vegetation management is conducted to reduce the amount of vegetation and potential obstructions within the ROW. The USIBWC manages the floodway vegetation primarily by mowing and grazing. Table 3.4-5 presents vegetation management by habitat type.

#### *Leased Areas*

***Grazing Leases***. Grazing allotments are leased to private ranchers, the grazing animals on these allotments are cattle and horses. Agricultural and grazing leases require that brush and vegetation be removed or mowed annually within portions of the lease. Additionally, no permanent structures may be constructed. Table 3.4-6 lists the acreage leased by RMU (Smith 2000).

### Table 3.4-5 Vegetation Management Within the ROW

| Current Vegetation Management | Acres for Entire RGCP | Acres by Habitat Type | | |
|---|---|---|---|---|
| | | Wetlands* | Riparian (excluding wetlands) | Uplands |
| No mow zones | 57 | 0 | 57 | 0 |
| Crop leases | 66 | 0 | 66 | 0 |
| Annual mowing** | 4,657 | 124 | 4,533 | 0 |
| Grazing leases | 3,552 | 53 | 1,694 | 1,805 |

* Boundaries of grazing and mowing zones are not clearly delineated; therefore wetland area was proportionally assigned to vegetation management type.
** Includes areas used for recreational purposes (Section 3.8.3)

### Table 3.4-6 Acreage Leased in the RGCP

| RMU | Habitat Type | Leased Area (acres) |
|---|---|---|
| Upper Rincón | Upland and Riparian | 1,911 |
| Lower Rincon | Upland and Riparian | 473 |
| Upper Mesilla Valley | Riparian | 638 |
| Las Cruces | Riparian | 136 |
| Lower Mesilla Valley | Riparian | 256 |
| El Paso | Riparian | 138 |
| ***Total Area Leased*** | ***Upland and Riparian*** | ***3,552*** |

***Crop Easements***. An estimated 66 acres of floodway is leased for crop production in the Rincon Valley. The majority of the land is in row crops, however pecans are grown in the Lower Rincon Valley within the east floodway.

#### *Mowed Areas*

***Annual Mowing of Floodway***. Mowing of the riparian zone controls weed, brush, and tree growth, and is conducted at least once each year prior to July 15. Farm tractors with rotary slope mowers are generally used to mow the floodways. Slope mowers are used for vegetation maintenance on the channel banks. Some areas with dense vegetation may require a second late summer mowing. Approximately 4,657 acres are potentially mowed within the floodway (Table 3.4-7). However, the actual area mowed is less because some areas within the ROW are either inaccessible or heavily wooded. Based on field observations conducted during the mowing season, mowers frequently work around well-established woodland patches in designated mow area and have been directed to avoid some native stands. The actual acreage cut by Slope mowers, is estimated at 80 percent of the potential area mowed or approximately 3,725 acres.

***No-Mow Zones***. Approximately 57 acres of no mow zones are located in the Upper Rincon and Las Cruces RMU. Since 1999 the USIBWC has conducted limited tree planting and maintained provisional test areas (“no-mow” zones) intended to evaluate effects of additional vegetation growth on RGCP functions.

## Table 3.4-7 Salt Cedar Control Within the Floodway

| Method | Acreage | Comments |
|---|---|---|
| Grazing Leases | 1,747 | Based on a review of aerial imagery, potentially 30% of leased riparian areas are woodlands dominated by salt cedar. As such, active salt cedar control is estimated at 1,222 acres of floodway by lease holders. The remaining areas are grazed woodlands. |
| Mowing | 4,657 | Based on a review of aerial imagery, potentially 20% of mowed areas are woodlands mostly dominated by salt cedar. As such, mowing for the purpose of salt cedar control is estimated at approximately 3,725 acres of floodway. The remaining areas are unmanaged woodlands or areas otherwise avoided due to lack of accessibility or protection for designated areas. |

### *Salt Cedar Control Methods*

***Mowing of Floodway***. The USIBWC manages salt cedar through mowing by USIBWC staff or as part of lease agreements in which lessees agree to mow/control salt cedar on leased property. Table 3.4-7 lists acreage of salt cedar control efforts for the floodway. Additional discussion concerning vegetation management is found in subsequent sections.

***Other Removal Methods***. A variety of salt cedar treatment techniques have been developed. The preferred method is site-specific and often involves a combination of techniques. Techniques include fulmination (prescribed burning), mechanical removal (bulldozers and other machinery), manual (chain saws) and chemical applications. Descriptions of the common methods of salt cedar removal are listed below (SWEC 2002):

*Cut-Stump/Herbicide Method*. The cut-stump/herbicide removal method involves using hand crews to remove the salt cedar stands with chainsaws. Immediately after cutting the tree, an herbicide such as Garlon-4 (triclopyr) is applied with a paintbrush directly to the exposed stump. This allows the exposed vascular system of the plant to carry the herbicide throughout the root system. This method is only effective from April through October, when the salt cedar trees are actively storing nutrients.

*Bull Dozer and Root Plow/Rake*. This method involves removing the vegetation by prying, pulling, or pushing the salt cedars out of the ground with a bull dozer. The area is then root plowed and raked to remove the root crowns and lateral roots. In order to ensure adequate root removal, two passes with both the root plow and root rake are recommended.

*Boss Tree Extractor*. This removal method involves the use of a large tracked machine with a claw-type boom arm attachment. The claw is used to grasp the tree and pull the tree and the root crown vertically from the soil. The machine can stack debris in piles as it clears a 60-foot swath in a single pass.

*Prescribed Burn/Herbicide Method*. This method involves the foliar application of herbicide (aerial or manual). The resulting dead vegetation is allowed to desiccate for 2 years before a prescribed burn is used to remove the standing snags.

## 3.5 WILDLIFE HABITAT

Riparian areas constitute less than one percent of the land area in the arid southwestern landscape yet provide habitat to a greater number of wildlife species than any other ecological community in the region. They are also critical corridors for migratory species (USACE 2003). Hink and Ohmart (1984) found that riparian areas are used extensively by most bird species in New Mexico and at various times of the year riparian areas support the highest bird densities and species numbers in the Middle Rio Grande. To quantify wildlife value for the RGCP, habitat was characterized using the Wildlife Habitat Appraisal Procedure (WHAP) developed by TPWD (1995).

### 3.5.1 Quantification of Habitat Value

Habitat quality was based on the concept of Habitat Quality (HQ). The process of calculating HQ and Habitat Units (HU) are described in the WHAP technical report (Parsons 2001a). In brief, HQ is an index between 0-1 with 0 the lowest value and 1 the highest. The HU is value calculated by multiplying the HQ index of a landcover class by the area of the landcover class. Typically WHAP is used for quantitatively determining effects to wildlife habitat quality and is used as a comparative tool to assess habitat quality effects and changes in HU for a given area. Table 3.5-1 (modified from CH2M-Hill and Geomarine, 2000a) shows relationship between HQ and habitat quality.

**Table 3.5-1 WHAP Ranking System Used in the RGCP**

| Habitat Quality Category | Habitat Quality |
|---|---|
| Poor | 0.00 - 0.20 |
| Below Average | 0.21- 0.40 |
| Average | 0.41 - 0.60 |
| Good | 0.61 - 0.80 |
| Excellent | 0.81 - 1.00 |

The WHAP scores are based on the physical characteristics and associated vegetation and not intended to evaluate habitat quality in relation to specific wildlife species. Based in WHAP scores, overall wildlife habitat quality can be estimated for an area. Areas consisting of diverse, native communities in wetland like conditions are considered the best wildlife habitat (TPWD 1995). The poorest wildlife values are characterized by sites with low species diversity, little structure and in an early seral stages. Table 3.5-2 lists HQ scores for each vegetation community.

#### *Wildlife Value of Wetlands*

Wetland classes represent less than 2 percent of RGCP, but are characterized by the highest wildlife habitat scores. The palustrine woodland class, average 0.59 HQ value, is the highest HQ of all physiognomic classes. Native vegetation component, varied structure and saturated soil conditions is reflected in the relatively high score. The emergent marsh class (HQ value of 0.54) is indicative of average quality for wildlife. Average HQ scores are mostly due to low species diversity and small size.

**Table 3.5-2 Habitat Units for the RGCP**

| Habitat Class | Average HQ Score | Habitat Quality | Area (acres) | Percent of the Floodway | Percent of ROW | Habitat Units |
|---|---|---|---|---|---|---|
| **Riparian** | | | | | | |
| Woodland | 0.52 | Average | 1,445 | 22% | 16% | 751 |
| Shrubland | 0.56 | Average | 839 | 13% | 9% | 469 |
| Herbaceous | 0.32 | Below average | 3,298 | 51% | 37% | 1,055 |
| Exposed* | 0.01 | Poor | 702 | 11% | 8% | 7 |
| Cropland | 0.20 | Poor to average | 66 | 1% | 1% | 13 |
| Wetland emergent marsh | 0.54 | Average | 140 | 2% | 2% | 75 |
| Palustrine woodland | 0.59 | Average | 37 | 1% | 0% | 21 |
| **Upland** | | | | | | |
| Herbaceous | 0.32 | Below average | 872 | N/A | 10% | 279 |
| Woodland/shrubland | 0.35 | Below average | 772 | N/A | 9% | 270 |
| Exposed* | 0.01 | Poor | 161 | N/A | 2% | 1 |
| **Total** | **0.35** | | **8,332** | **100%** | **100%** | **2,945** |

*Surveys were conducted for exposed areas. All exposed lands assigned a value of 0.01 for calculation of the overall RGCP totals.

### *Wildlife Value of Riparian Lands*

Riparian is the predominate vegetation class in the RGCP, accounting for over 76 percent of the total acreage within the ROW. Riparian areas represent areas with the most potential for environmental improvements and currently over 63 percent are below average to poor wildlife habitat quality.

Riparian woodlands and shrublands are widely distributed and characterized by average wildlife quality. The herbaceous class is the most common vegetation class with an average HQ score of 0.32 (considered of below average quality). The exposed class is found throughout the RGCP. Croplands are typically low wildlife habitat as a result of clean farming practices.

### *Wildlife Value of Uplands*

Uplands account for nearly 22 percent of the total land cover and considered below average to poor. Upland areas are located outside the floodplain. The upland exposed class is intermixed within other upland classes. The upland herbaceous class has an average HQ score of 0.32 representing below average quality. The upland herbaceous class is intermixed with the upland woodland/shrubland class. Woodland/Shrubland wildlife habitat is below-average (HQ score of 0.35).

# 3.6 ENDANGERED AND OTHER SPECIAL STATUS WILDLIFE SPECIES

## 3.6.1 Threatened and Endangered Species

In preparation of this Environmental Impact Statement, four surveys were conducted, two terrestrial surveys and two aquatic surveys. A review of Threatened and Endangered (T&E) species was completed in separate biological survey reports (Parsons 2000a and 2001c). A Biological Assessment (Parsons 2003b) was also prepared. The reports concluded that suitable habitat for listed species is largely absent within the RGCP. The findings are consistent with previous studies of T&E species for the RGCP and adjacent areas (Ohmart 1994, USIBWC and EPWU/PSB 2000, CH2M-Hill & Geomarine 2000b, City of Las Cruces 2003, Parsons 2001). Table 3.6-1 lists habitat requirements for federally-listed T&E species potentially occurring in the Doña Ana, Sierra and El Paso Counties.

Most suitable habitat was found in areas adjacent to, but outside, the USIBWC ROW, such as Seldon Canyon (southwestern willow flycatcher) and on state property near Leasburg Dam. Sandbars and beaches along the river, more of which become exposed during periods of low flow, provide small amounts of habitat for waterfowl and the interior least tern. Table 3.6-2 shows the preferred habitat, and the potential for suitable habitat within the RGCP for the interior least tern, southwestern willow flycatcher, bald eagle, and whooping crane. The interior least tern is the only listed species to have been documented within the RGCP.

## 3.6.2 Species of Concern

Table 3.6-3 shows the species of concern (SOC) that occur in the area, and the potential for suitable habitat within the RGCP. To obtain the informal status of species of concern, a species must exhibit at least one of the following criteria (Biota Information System of New Mexico):

- Species considered to be in jeopardy in the RGCP counties and are species for whom habitat in these counties is critical for their overall existence;
- Species considered to be in jeopardy in RGCP counties and are generally declining throughout their range;
- Species believed to be in jeopardy in RGCP counties, but are not considered to be at risk overall; and
- Species not believed to be at risk in RGCP counties, but should be considered for conservation because of their ecological or social importance.

### *Migratory Birds and SOC*

Little suitable habitat for the majority of migratory birds occurs in the RGCP. Two SOCs, the western burrowing owl and the white-faced ibis, were observed during the biological surveys. Both mature and immature owls were observed within the RGCP during field surveys. The burrows were located in the side of the levee road and in the

## Table 3.6-1 Habitat Requirements for Federally-Listed T&E Species and Potential Presence within the RGCP

| | | Listing Status* | | | | | |
|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Federal Listing** | **El Paso Co.**** | **Doña Ana Co.**** | **Sierra Co.**** | **Required Habitat** | **Potential Presence** |
| Interior least tern | *Sterna antillarum* | E | E | E | --- | River sandbars and beaches. Requirements correspond with unconsolidated shore/sandbars found within RGCP. | Potential habitat present |
| Northern aplomado falcon | *Falco femoralis septentrionalis* | E | E | E | E | Brushy prairie and yucca flats. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| Southwestern willow flycatcher | *Empidonax traillii extimus* | E | E | E | E | Prefers brushy fields and thickets along streams. Has been documented in areas outside of and adjacent to the RGCP. Requirements correspond with Riparian Shrubland/Woodland and Palustrine Woodland found within RGCP | Potential habitat present |
| Sneed pincushion cactus | *Coryphantha sneedii var. sneedii* | E | E | E | --- | Limestone ledges in the Chihuahuan desert and grassland at 4,300-5,400 feet. Habitat not present based on literature review and vegetation community maps. | Habitat not present |
| Mexican spotted owl | *Strix occidentalis lucida* | E | T | S | S | Dense coniferous forest. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| Bald eagle | *Haliaeetus leucocephalus* | T | --- | T | T | Prefers timbered areas along coasts, large lakes, and rivers. Requirements correspond with Riparian Shrubland/Woodland and Palustrine Woodland found within RGCP. Has been documented in northern reaches of the RGCP (southern Sierra County). Potential habitat in the form of snags, are most common in northern reaches of the RGCP. | Potential habitat present |
| Black-footed ferret | *Mustela nigripes* | E | --- | S | S | Mixed shrub; associated w/ prairie dogs. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| Whooping crane | *Grus americana* | E | --- | E | E | Prefers marshes and prairie potholes in summer and winters in coastal marshes. Documented north of the RGCP at Bosque del Apache NWR (experimental population). | Potential habitat present |
| Chiricahua leopard frog | *Rana chiricahuensis* | C | --- | --- | S | Rocky slopes of springs, streams and rivers. Invades stock tanks. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| American peregrine falcon | *Falco peregrinus anatum* | E | --- | --- | --- | Cliffs, high river banks, large trees, tall buildings. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| Arctic peregrine falcon | *Falco peregrinus tundrius* | E | --- | --- | --- | Cliffs, high river banks, large trees, tall buildings. Rests at Texas coast during migration. Habitat not present based on literature review and detailed vegetation community maps. | Habitat not present |
| Piping plover | *Charadrius melodus* | T migratory | --- | --- | --- | Beaches, sand dunes, sparsely vegetated areas along oceans, rivers and streams. | Potential habitat present |
| Gila trout | *Oncorhynchus gilae* | E | --- | --- | T | Small, high mountain streams. Habitat not presents based on literature review and detailed vegetation community maps. | Habitat not present |
| Todsen's pennyroyal | *Hedeoma todsenii* | E | --- | --- | E | Pinion juniper woodland, sandy gypsum soil, north-facing slopes. Habitat not presents based on literature review and detailed vegetation community maps. | Habitat not present |

*USFWS. 1998. Threatened and Endangered Species of New Mexico. Albuquerque, New Mexico. pp 93. T- threatened; E - endangered; S – sensitive; C – candidate;

** County-specific state listings for El Paso County, Texas; Sierra and Doña Ana Counties, New Mexico. or El Paso County, Texas; Sierra and Doña Ana Counties, New Mexico.

embankment associated with concrete irrigation ditches. The white-faced ibis was observed on a vegetated sandbar at one location in the RGCP (Parsons 2001a).

### *Aquatic Species*

Habitat for listed aquatic species does not occur within the RGCP. The Chiricahua leopard frog inhabits rivers and other aquatic habitats at elevations of 3,281 to 8,890 feet. The Rio Grande drainage is occupied by these frogs only in Alamosa Creek in Socorro County, New Mexico and Cuchillo Negro Creek in Sierra County, New Mexico. The Gila trout occurs in small, high mountain stream habitats, which do not occur in the RGCP (Table 3.6-1).

**Table 3.6-2 Presence/Absence of Federally-Listed Species Habitat Based on Field Surveys**

| Species | Presence/ Absence Habitat Determination | Comments |
|---|---|---|
| Interior least tern | Limited habitat present | At least one interior least tern was observed during fall surveys in September 2000, presumably in the process of migrating south. The interior least tern is the only listed species to have been documented within the RGCP during field surveys. The tern was initially sighted in the Lower Mesilla Valley RMU, south of Mesilla Dam, in 2000. The solitary individual was observed in flight over the river and resting on unvegetated sand bars. Five additional sightings were made on the same date within 5 miles south of the first sighting, and may have been the same individual. Altered flow conditions in the river have eliminated any suitable nesting habitat in the RGCP; however, interior least terns may use the area for feeding or resting during migration. |
| Southwestern willow flycatcher | Habitat not present | Suitable habitat is nonexistent within the RGCP. The thickets of willow and/or salt cedar are not dense enough and do not meet the 10 m (30 feet) wide criteria. Vertical structure of thickets in un-mowed areas is not suitable and the current hydrologic regime does not provide for saturated soils. Potential habitat does occur in areas adjacent to the USIBWC ROW (Seldon Canyon, Leasburg State Park and Picacho wetlands restoration pilot project). |
| Bald eagle | Limited habitat present | Only marginal habitat (large trees) was found in the northern most portions of the RGCP near Percha Dam. Bald eagles have been sighted in previous studies in the northern portions of the RGCP. |
| Whooping crane | Habitat not present | The whooping crane's preferred habitat of marshes and prairie potholes is rare to non-existent in the RGCP. There are no prairie potholes, and marsh vegetation is generally confined to small sand bar islands, arroyo mouths, and spillways. In addition, the migratory path of the whooping crane has been extensively documented, and the crane has never been observed to use the RGCP area. |
| Piping plover | Limited habitat present | Suitable habitat for migrating birds potentially exists on sandbars, however, this plover is known only as a rare spring (April) migrant, having been verified at Springer Lake (Colfax County) and reliably reported at Bosque del Apache National Wildlife Refuge in Socorro Canyon. No sightings have occurred in the RGCP |

## Table 3.6-3 Summary of SOC Potentially Associated with Vegetation Communities in the RGCP

| Species | Vegetation Community | Comments |
|---|---|---|
| Desert pocket gopher *Geomys bursarius arenarius* | Riparian herbaceous | Found in sandy river bottomland soils near irrigation ditches. This habitat is common throughout the floodway, however clayey soils are not tolerated. |
| Occult little brown bat *Myotis lucifugus occultus* | River | Forages over water, so may use river as foraging area. Arroyo areas for nesting may be of importance, as well. |
| Black tern *Chlidonias niger* | Emergent marsh | A small amount of emergent marsh habitat occurs in the project area. Gravelly areas for nesting are more common. |
| Loggerhead shrike *Lanius ludovicianus* | Riparian and upland | The shrike occurs in a variety of habitats, particularly where thorny shrubs or trees occur. Sites near arroyos may comprise suitable habitat. |
| Northern gray hawk *Buteo nitidus maximus* | Riparian woodland, palustrine woodland | Very little suitable riparian woodland habitat exists in project area, however, shrubland may provide an adequate prey base. |
| Western burrowing owl *Athene cunicularia hypagaea* | Riparian herbaceous, upland herbaceous, upland exposed | Suitable habitat exists in floodway, especially along grassland and open areas with suitable prey species. |
| Yellow-Billed Cuckoo *Coccyzus americanus* | Riparian woodland | Riparian woodlands do not have sufficient patch size and density to provide suitable nesting habitat. |
| White-faced ibis *Plegadis chihi* | Emergent marsh | Limited amount of suitable habitat, mostly on sandbars, islands, mouths of arroyos. |
| Texas horned lizard *Phrynosoma cornutum* | Riparian herbaceous, upland herbaceous, upland exposed | Suitable habitat exists in floodway and adjacent upland areas. Exposed uplands are favored, especially with bunchgrasses. |
| Arizona southwestern toad *Bufo microscaphus microscaphus* | Riparian woodland | Limited amount of suitable habitat in project area. Preferred habitat includes small streams and rivers, and temporary woodland pools. Adjacent arroyos may provide suitable habitat. |
| Anthony blister beetle *Lytta mirifica* | Croplands | Small amount of suitable habitat may occur in wetland margins and islands. |
| Desert viceroy butterfly *Limenitis archippus obsoleta* | Palustrine woodland, riparian woodland | Host genus is willow; therefore, potential habitat only occurs in limited areas where willow is still found. Also adjacent areas such as Seldon Canyon. |
| Pecos River muskrat *Ondatra zibethicus ripensis* | Emergent marsh | Small amount of suitable habitat may occur in wetland margins and islands. Preferred habitat is wetland or lowland riparian areas. |

## 3.7 AQUATIC BIOTA

Aquatic biota was evaluated on the basis of field data obtained at multiple locations throughout the RGCP on September 2000 and January 2001 to document physical characteristics of the habitat and its potential supports fish and invertebrate species, and data on fish species composition (Parsons 2001c). Habitat quality was also evaluated on a theoretical basis using empirical indexes indicative of potential suitability for fish species, and a depth-velocity matrix that illustrates available conditions in the RGCP for reproduction of Rio Grande fish species.

### 3.7.1 Habitat Characterization

#### *Field Survey Data*

Data on physical characteristic of RGCP aquatic habitat were obtained from 10 sampling sites selected as representative of conditions on each of the seven RMUs. Two sites were surveyed at the Upper Rincon, Lower Rincon and Lower Mesilla RMUs. Table 3.7-1 characterizes sampling sites in terms of 6 physical features of the habitat and 7 attributes quantified on a 0 to 4 scale. Survey guidelines were obtained from (TCEQ 2001).

Instream habitat in the RGCP was characterized by low diversity in lotic habitat types. The river was characterized as an undifferentiated run with little pool/riffle structure. Instream cover, which provides essential habitat for different life stages of invertebrate and vertebrate life was very limited. The river channel has little to no sinuosity except in the upper reaches of RGCP that provides variation in velocity. Substrate was relatively unstable, predominantly silt and sand, which is generally considered the least favorable for supporting aquatic organisms both in terms of number of species and individuals. River banks were moderately stable to unstable. There was little overhanging riparian vegetation to filter light and lower instream temperatures. Livestock grazing was also observed in some sections of the floodway potentially impacting the aquatic habitat by increasing siltation and sedimentation. Greater aquatic habitat diversity, diversity of bottom types, backwater or low flow areas, and greater riparian vegetation were found at natural arroyos or agricultural spillways. Table 3.7-1 illustrates habitat characterization of representative areas within the RGCP.

### 3.7.2 Habitat Suitability

#### *Depth-Velocity Matrix*

Habitat preference in terms of water velocity and depth is an indicator of suitability for fish species, particularly as it applies to reproductive success of native species. Figure 3-5 illustrates data compiled in an USIBWC-sponsored study to assess habitat availability for native Rio Grande fish species (CH2M-Hill and GeoMarine 2000). The diagram represents a summary of native fish species reproduction preferences compared with water-velocity combinations likely to be found in the RGCP. Two flows regimes are illustrated representative of the main irrigation and non-irrigation seasons (1,000 cfs and 50 cfs, respectively). The comparison indicated that while depth requirements can be met in the canalized river, fast-moving water conditions prevalent in the RGCP during the irrigation season do not coincide with habitat preferences for reproduction.

#### *Habitat Suitability Index*

A Habitat Evaluation Procedure (HEP) developed by the USFWS was used to evaluate aquatic habitat. HEP can be used to document the quality and quantity of available habitat for selected fish and wildlife species. HEP provides information for two general types of habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same area at future points in time, facilitating "before" and "after" comparisons. HEP methodology information, support data, and findings for the RGCP are summarized in Appendix C. A more detailed discussion concerning HEP is found in Parsons (2001b).

The HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a Habitat Suitability Index (HSI). This index value, ranging from 0.0 to 1.0, is multiplied by the area of available habitat to obtain Habitat Units that serve as the basis for comparison.

Limited availability of HSI models for species present within the RGCP led to the selection of two species for HEP analysis: largemouth bass and flathead catfish. Table 3.7-2 lists applicable HEP values for these species in the RGCP. Of three cover types available for the HSI calculations (riffle, pool and main river run), main river run was used as the basis for index calculation for the RGCP.

Index data indicated that RGCP conditions were more suitable for the flathead catfish than for the largemouth bass, but HSI values underscored the paucity of aquatic habitat available for both species in the RGCP (Table 3.7-2). For largemouth bass, (HSI ranging from 0.05 to 0.17), a large proportion of the RGCP is sub-optimal for species development. Physical conditions contributing to the largemouth bass reproductive success include percentage of total habitat represented by pools and backwaters and a possibly correlated variable, velocity of water in the pools. Most of the RGCP, percent pool values is less than or equal to 10 percent, significantly limiting the availability of optimal bass habitat. The highest HSI values for largemouth are downstream from diversion dams and siphons where pools or slow-moving waters are present. Little suitable habitat is in the main river run (HSI <0.1).

Calculated HSI values for the flathead catfish, while higher than those calculated for the largemouth bass, are also indicative of sub-optimal habitat conditions. Index values ranged from 0.10 to 0.55 depending on the location (Table 3.7-2). As with largemouth bass, locations downstream from diversion dams and siphons have the highest HSI values, indicating a positive relationship between the index and percent coverage of pools. For the main river run HSI values for the catfish were generally low, from 0.10 and 0.25. Results of the habitat suitability models suggest that augmenting pool habitat will likely be beneficial for both largemouth bass and flathead catfish.

## Figure 3-5. Comparison Between Fish Habitat Preference and RGCP Habitat Availability at Two Reference Flows (modified, from CH2M-Hill & GeoMarine 2000a)

### HABITAT PREFERENCE BY LIFESTAGE [a]

| Lifestage: Sub-Yearling | | VELOCITY (feet per second) | | | |
|---|---|---|---|---|---|
| | | Quiet [c] (0 - 0.25) | Slow (0.26 - 0.75) | Moderate (0.76 - 1.5) | Fast (>1.51) |
| DEPTH (feet) | Shallow (0.0 - 1.0) | **21%** | **13%** | 6% | 0% |
| | Moderate (1.1 - 3.0) | **21%** | **13%** | 7% | 0% |
| | Deep (> 3.0) | **11%** | 6% | 1% | 0% |

| Lifestage: Yearling + | | VELOCITY (feet per second) | | | |
|---|---|---|---|---|---|
| | | Quiet (0 - 0.25) | Slow (0.26 - 0.75) | Moderate (0.76 - 1.5) | Fast (>1.51) |
| DEPTH (feet) | Shallow (0.0 - 1.0) | 6% | 3% | 4% | 3% |
| | Moderate (1.1 - 3.0) | **13%** | **11%** | **10%** | 6% |
| | Deep (> 3.0) | **14%** | **15%** | **10%** | 5% |

### HABITAT AVAILABILITY BY FLOW [b]

| Flow: 50 cfs | | VELOCITY (feet per second) | | | |
|---|---|---|---|---|---|
| | | Quiet (0 - 0.25) | Slow (0.26 - 0.75) | Moderate (0.76 - 1.5) | Fast (>1.51) |
| DEPTH (feet) | Shallow (0.0 - 1.0) | **16%** | **42%** | **19%** | 3% |
| | Moderate (1.1 - 3.0) | 0% | **12%** | 6% | 0% |
| | Deep (> 3.0) | 0% | 0% | 0% | 0% |

| Flow: 1,000 cfs | | VELOCITY (feet per second) | | | |
|---|---|---|---|---|---|
| | | Quiet (0 - 0.25) | Slow (0.26 - 0.75) | Moderate (0.76 - 1.5) | Fast [d] (>1.51) |
| DEPTH (feet) | Shallow (0.0 - 1.0) | 0% | 1% | 8% | 3% |
| | Moderate (1.1 - 3.0) | 0% | 0% | 5% | **79%** |
| | Deep (> 3.0) | 0% | 0% | 0% | 4% |

NOTES

a. Habitat preference is defined as the percentage of species/lifestages that prefer a given hydraulic category
b. Habitat availability is defined by the amount of a given hydraulic category as a percent of the total habitat available.
c. Habitat preference for spawning is largely restricted (nearly 60%) to quiet water at depths greater than 1 foot.
d. Velocities greater than 3 ft., unsuitable habitat at any depth, account for 18% of the total.

Values equal or greater than 10% for a given velocity-depth combination.

## Table 3.7-1 Aquatic Habitat Characterization at Selected RGCP Sampling Sites

| | Upper Rincon RMU | | Lower Rincon RMU | | Seldon Canyon RMU | Upper Mesilla RMU | Las Cruces RMU | Lower Mesilla RMU | | El Paso RMU |
|---|---|---|---|---|---|---|---|---|---|---|
| **Habitat Type** | **Site 1** | **Site 2** | **Site 1** | **Site 2** | **Site SC** | **Site UMV** | **Site LC** | **Site 1** | **Site 2** | **Site EP** |
| **Pool / Backwater Area** | 20% | 0% | 20-30% | 10% | <10% | 20% | <10% | <10% | 30% | 10% |
| **Estimated Area >2m Deep** | <10% | 0% | <10% | 0% | 0% | 15% | <10% | 20% | 10% | 0% |
| **Bottom Cove** | 30% | 10% | 0% | 0% | <10% | <10% | <10% | <10% | 0% | 0% |
| **Riparian Vegetation Type** | Grasses, willow, seep-willow, salt cedar | Grasses, willow, seepwillow | Willow, cattails | Willow, Russian olive | Willow, salt cedar | Willow | Grasses, Willow | Grasses, willow, salt cedar | Willow | Grasses, willow |
| **General Stream Type** | Riffle, Pool | Run | Run | Run | Run | Pool, run | Run | Run | Run, backwater | Run |
| **Instream Cover Types** | All | Edge | Edge | Debris, rocks | Overhang | Veg., debris, rocks | Edge, overhang, rocks | Overhang, rocks, pools | Edge, pools | Rocks |
| **Instream Cover** | 30-50% | 10-30% | 0% | 10-30% | 0% | 10-30% | 10-30% | 10-30% | 10-30% | 0% |
| **Riffles** | Rare | Occasional | Occasional | Occasional | Rare | Rare | Rare | Rare | Rare | Rare |
| **Pool Depth** | 2-4 ft | 2-4 ft | 2-4 ft | 2-4 ft | 2-4 ft | 2-4 ft | >1 ft | 2-4 ft | 2-4 ft | >1 ft |
| **Bank Stability** | Moderately stable | Moderately stable | Moderately stable | Moderately unstable | Stable | Moderately stable | Moderately unstable | Moderately stable | Stable | Moderately stable |
| **Riparian Cover** | Wide | Moderate | Moderate | Moderate | Wide | Moderate | Narrow (<15 ft) | Narrow (<15 ft) | Moderate | Moderate |
| **Bottom Substrate** | Moderately stable | Moderately stable | Moderately stable | Moderately stable | Moderately stable | Moderately unstable | Unstable (silt, clay) | Unstable (silt, clay) | Unstable (silt, clay) | Unstable (silt, clay) |
| **Channel Sinuosity** | Moderate | None | Low | Low | Low | Low | Low | Low | None | Low |

**Table 3.7-2 Habitat Suitability Indices for Largemouth Bass and Flathead Catfish**

| River Management Unit* | Site Condition | Location (River mile) | Largemouth Bass HSI | Flathead Catfish HSI |
|---|---|---|---|---|
| Upper Rincon - site 1 | Downstream from Diversion Dam | 104.3 | 0.14 | 0.40 |
| Upper Rincon - site 2 | Main River Run | 100.2 | 0.06 | 0.10 |
| Lower Rincon - site 1 | Downstream from Siphon | 82 | 0.17 | 0.45 |
| Lower Rincon - site 2 | Main River Run | 79 | 0.06 | 0.25 |
| Seldon Canyon | Main River Run | 71.8 | 0.06 | 0.25 |
| Upper Mesilla | Main River Run | 51.3 | 0.14 | 0.40 |
| Las Cruces | Main River Run | 45.8 | 0.05 | 0.25 |
| Lower Mesilla – site 1 | Downstream from Diversion Dam | 40.2 | 0.17 | 0.55 |
| Lower Mesilla – site 2 | Main River Run | 42.5 | 0.05 | 0.25 |
| El Paso | Main River Run | 5.0 | 0.05 | 0.25 |

Similarly to the methodology used for vegetation, habitat units were calculated for the aquatic habitat on the basis of acreage and HSI data. Table 3.7.3 presented the summary of HU analysis.

**Table 3.7-3 Habitat Units by River Management Unit**

| River Management Unit | Area of Surface Water (acres) | Largemouth Bass HSI | Largemouth Bass HU | Flathead Catfish HSI | Flathead Catfish HU |
|---|---|---|---|---|---|
| Upper Rincon | 271 | 0.05 | 14 | 0.25 | 68 |
| Lower Rincon | 541 | 0.05 | 27 | 0.25 | 135 |
| Seldon Canyon | 263 | 0.05 | 13 | 0.25 | 66 |
| Upper Mesilla | 292 | 0.05 | 15 | 0.25 | 73 |
| Las Cruces | 420 | 0.05 | 21 | 0.25 | 105 |
| Lower Mesilla | 498 | 0.05 | 25 | 0.25 | 125 |
| El Paso | 445 | 0.05 | 22 | 0.25 | 111 |
| Total | 2,730 | 0.05 | 126 | 0.25 | 628 |

### 3.7.3 Fish Species Composition

***Field Surveys Conducted in Support of the DEIS Preparation***

The Rio Grande between Caballo Dam and the City of El Paso supports a fish community of at least 22 species that includes channel catfish, white crappie, blue gill, common carp, river carpsucker, gizzard shad, black bullhead, flathead catfish, largemouth bass, green sunfish, and longear sunfish (Sublette *et al*., 1990). A total of 12 species were collected during September 2000 and January 2001 surveys of the RGCP (Parsons 2001b). Table 3.7-4 lists fish species collected an sampling location

## Table 3.7-4 Fish Species Collected During Biological Surveys of the RGCP

| Common Name | Scientific Name | Capture Location (Transect Series) | |
|---|---|---|---|
| | | September 2000 | January 2001 |
| Western mosquitofish | *Gambusia affinis* | DA, MDD | MDD |
| Channel catfish | *Ictalurus punctatus* | UR, H, DA, SC, SP, EP | EP, DA |
| Green sunfish | *Lepomis cyanellus* | DA | |
| Bluegill | *Lepomis macrochirus* | UR | |
| Longear sunfish | *Lepomis megalotis* | UR, SP, EP | |
| Largemouth bass | *Micropterus salmoides* | UR, H, DA | H, UR |
| Fathead minnow | *Pimephales promelas* | H, DA, EP, UR | BM, DA, SA |
| Bullhead minnow | *Pimephales vigilax* | MDD | EP, BM |
| Flathead catfish | *Pylodictis olivaris* | H, SC, SP, EP | |
| Red shiner | *Cyprinella lutrensis* | H | |
| Common carp | *Cyprinus carpio* | H | H |
| River carpsucker | *Carpiodes carpio* | UR | |

BM = Black Mesa, DA = Doña Ana, EP = El Paso, G = Garfield, H = Hatch, LC = Las Cruces, MDD = Mesilla Diversion Dam, SA = Sierra Alta, SC = Seldon Canyon, UR = Upper Rincon

### *Fish Species Collected at Artificial Structures*

A 3-year monitoring program sponsored by the USIBWC was conducted to determine the effectiveness of the artificial in-stream structures constructed as mitigation for a Section 404 permit. Sampling was conducted at two vortex weirs, three embayments, and nine groins. Fish species collected by USFWS are listed in Table 3.7-5. At most of these locations, cyprinids were the majority of fish species encountered during sampling, and the numbers of fish were also low. Most fish were repeatedly encountered near the banks and overhanging vegetation.

## Table 3.7-5 Fish Species Collected at USFWS Mitigation Sites

| Common Name | Scientific Name |
|---|---|
| Bluegill | *Lepomis macrochirus* |
| Bullhead minnow | *Pimephales vigilax* |
| Channel catfish | *Ictalurus punctatus* |
| Fathead minnow | *Pimephales promelas* |
| Gizzard shad | *Dorosoma cepedianum* |
| Green sunfish | *Lepomis cyanellus* |
| Largemouth bass | *Micropterus salmoides* |
| Longnose dace | *Rhinichthys cataractae* |
| Red shiner | *Cyprinella lutrensis* |
| Spotted bass | *Micropterus punctulatus* |
| Threadfin shad | *Dorosoma petenense* |
| Western mosquitofish | *Gambusia affinis* |
| White bass | *Morone chrysops* |
| Yellow perch | *Morone americana* |

## 3.8 LAND USE

This section summarizes existing land use within a 0.25 mile corridor outside the ROW within El Paso, Texas and Doña Ana County and Sierra County, New Mexico. The land use corridor assesses land potentially affected by river management alternatives found outside the ROW.

### 3.8.1 Land Use Analysis

Land use data was created using data from city, state, and federal agencies. Ownership information, aerial photograph interpretation, and fieldwork were utilized to augment and verify the land use information from the various agencies.

Digital land use layers were acquired from Doña Ana County. Doña Ana County's digital land use data contains information for the entire county. Areas that were designated vacant by Doña Ana County or not designated by either the county or city data were reclassified into one of the eleven land use categories through cross-referencing ownership information and/or interpreting aerial photographs.

El Paso County's digital land use data only contains information for portions of El Paso County that are not incorporated. Zoning was utilized for the area encompassed by the City of El Paso since the city was not included in the El Paso County land use data, and the City of El Paso has not completed the creation of digital land use data.

Sierra County does not have digital land use data; therefore fieldwork and ownership information obtained from the USIBWC archives was utilized to determine land use in Sierra County.

Other sources contacted for land use information include EBID, USBR, Rio Grande Council of Governments, SWEC, Mesilla Valley Economic Development Alliance (MVEDA), Paso Del Norte Watershed Council and the BLM. Three ownership databases were acquired and utilized during the land use classification process: Doña Ana County, BLM and USIBWC. The remaining vacant and unidentified land not included in the above databases, were determined through aerial photograph interpretation.

General land use categories were established based on the available agency data categories. The land use categories utilized by county and city agencies and the corresponding generalized land use categories are defined below.

***Agricultural Lands.*** Specific land uses within this classification include agricultural farming, such as croplands and pastures, livestock, and orchards. Livestock includes areas used for the production of milk, eggs, or meat and areas utilized for grazing. Orchards were identified through aerial photograph interpretation. Orchards and other planted areas are maintained for the production of fruits or nuts. Land within this classification may be irrigated or non-irrigated.

Prime farmlands, protected under the Farmland Protection Policy Act, are not present in the anticipated area of direct influence of the RGCP.

***Commercial Lands.*** Land uses within this classification include commercial office parks, shopping centers, wholesale and retail trade, central business districts, and areas of planned commercial use. Churches and cemeteries are also included in this category. Commercial lands are typically concentrated in central urban cores along major streets and highways, adjacent to residential or industrial areas.

***Government.*** Government lands include city, county, state, and United States government owned land. Land owned or occupied by transportation authorities, solid waste, water, and/or sanitation facilities are also classified as government lands. For purposes of this project, state-owned parks are classified in a separate category.

***Institutional.*** This land use class includes lands owned or occupied by schools, state universities, not-for-profit organizations, associations, and/or lodges.

***Industrial Lands.*** Industrial lands include quarries, light and heavy manufacturing, construction, warehousing, and areas of planned industrial uses. These areas are also typically concentrated in central urban cores along major streets and highways, adjacent to residential areas or commercial lands.

***Residential Lands.*** Residential areas comprise single-family and multi-family occupancy. The city and county land use designations and aerial photograph interpretation were utilized for the division of the residential areas within the land use corridor into three classifications: low intensity residential, moderate intensity residential, and high intensity residential.

- *Low Intensity Residential Areas*. This category includes areas with a mixture of residential units and vegetation, including crops. These areas most commonly include single-family housing units. Population density would be lower than in moderate and high residential areas.
- *Moderate Intensity Residential Areas*. This category is also a mixture of residential units and vegetation. These areas most commonly include single-family housing units and some row housing. Population density would be lower than in high residential areas.
- *High Intensity Residential Areas*. This category includes highly developed areas where people reside in large numbers. These areas have a high concentration of residential units. High intensity residential areas commonly include apartment complexes, mobile home parks, row housing, and subdivisions.

***State Parks.*** State parks include recreational areas owned by state agencies. These parks have been established for various recreational activities, but are also used for flood control, scenic, historic, and wildlife management. The natural areas are valued for their aesthetic qualities and minimal urban development.

### 3.8.2 Land Use Corridor

Land use within the RGCP corridor was identified using major features including canals, laterals, irrigation ditches, and roadways as geographic boundaries. A land use corridor was then selected as the potential area of influence applicable to measures under consideration. The corridor was defined by the area that extends 0.25 of a mile beyond each side of the ROW. The corridor was then analyzed geographically quantifying acreage by land use in each RMU. In the Seldon Canyon RMU, where there is no ROW, the 0.25 mile land use corridor was measured from the river centerline. Land use information was available in GIS format for 92% of the corridor surface.

A total of 30,289 acres make up the 0.25 mile land use corridor along each side of the RGCP. Land uses include well-developed urban centers of commerce and residential areas, particularly in the regions of El Paso and Las Cruces. Areas of intensive agricultural activities, government lands parks also lie within the project area. The total acreage by land use category and percent cover by RMU are presented in Table 3.8-1. Land use maps in areas surrounding the RGCP are presented in Figures 3-6 through 3-9.

Agriculture is the largest land use category, accounting for approximately 63 percent of the land use corridor. Farming is the dominant agricultural land use, comprising 39 percent of the land use corridor. Orchards comprise 15 percent of the land use corridor while livestock make up 9 percent. Dairy products, cattle, and cotton are the principal agriculture in El Paso County. Cotton, pecans, chili and livestock are the principal agriculture for Doña Ana and Sierra counties (U.S. Department of Agriculture 1997).

Government lands comprise approximately 13 percent of the land use corridor, with the greatest proportion in the Upper Mesilla Management Unit. These areas contain city, county, state, and federal lands. City parks were also included in this category. La Llorona Park is located within the land use corridor in Doña Ana County. In addition, Mesilla Valley Bosque Park is in the initial development stages for this County. State parks comprise less than 1 percent of the land use corridor. Leasburg Dam State Park in New Mexico is the only state park located within the land use corridor.

Residential areas comprise approximately 18 percent of the land use corridor, with the greatest proportion in Las Cruces. The majority of residential lands are low intensity areas where apartments, mobile homes, housing developments and special residencies are dispersed along the project area. The moderate and high intensity residential areas are more commonly located near the cities of Las Cruces and El Paso.

Together, commercial, institutional, and industrial lands comprise less than 6 percent of the land use corridor. The majority of these areas surround the Cities of El Paso and Las Cruces; however, Seldon Canyon ranks highest in institutional lands among the seven management units.

### 3.8.3 Recreational Use

#### *State and Private Recreational Areas*

Due to the relatively restricted access to the Rio Grande, recreational opportunities have been available primarily at state and city parks such as La Llorona Park in Las Cruces, New Mexico. Two state parks are located within the project area. Percha Dam State Park, an 80-acre New Mexico state park, is approximately 60 miles north of the City of Las Cruces on the Rio Grande. Grassy space surrounded by cottonwoods, salt cedar, and Russian olive trees provide park visitors outdoor activities such as camping and bird-watching (State of New Mexico, 2003). Bird-watching at Percha Dam State Park is considered the best in the area with a variety of bird species in great numbers. Other recreational activities include fishing and swimming along the river.

Leasburg Dam State Park in New Mexico is located approximately 15 miles north of the City of Las Cruces. The dam was constructed in 1908 to channel water from the Rio Grande for irrigation into the Mesilla Valley. The 240-acre park offers fishing, canoeing, and kayaking along the river. Picnic areas, campsites, and a playground are located along the river bank (State of New Mexico, 2003).

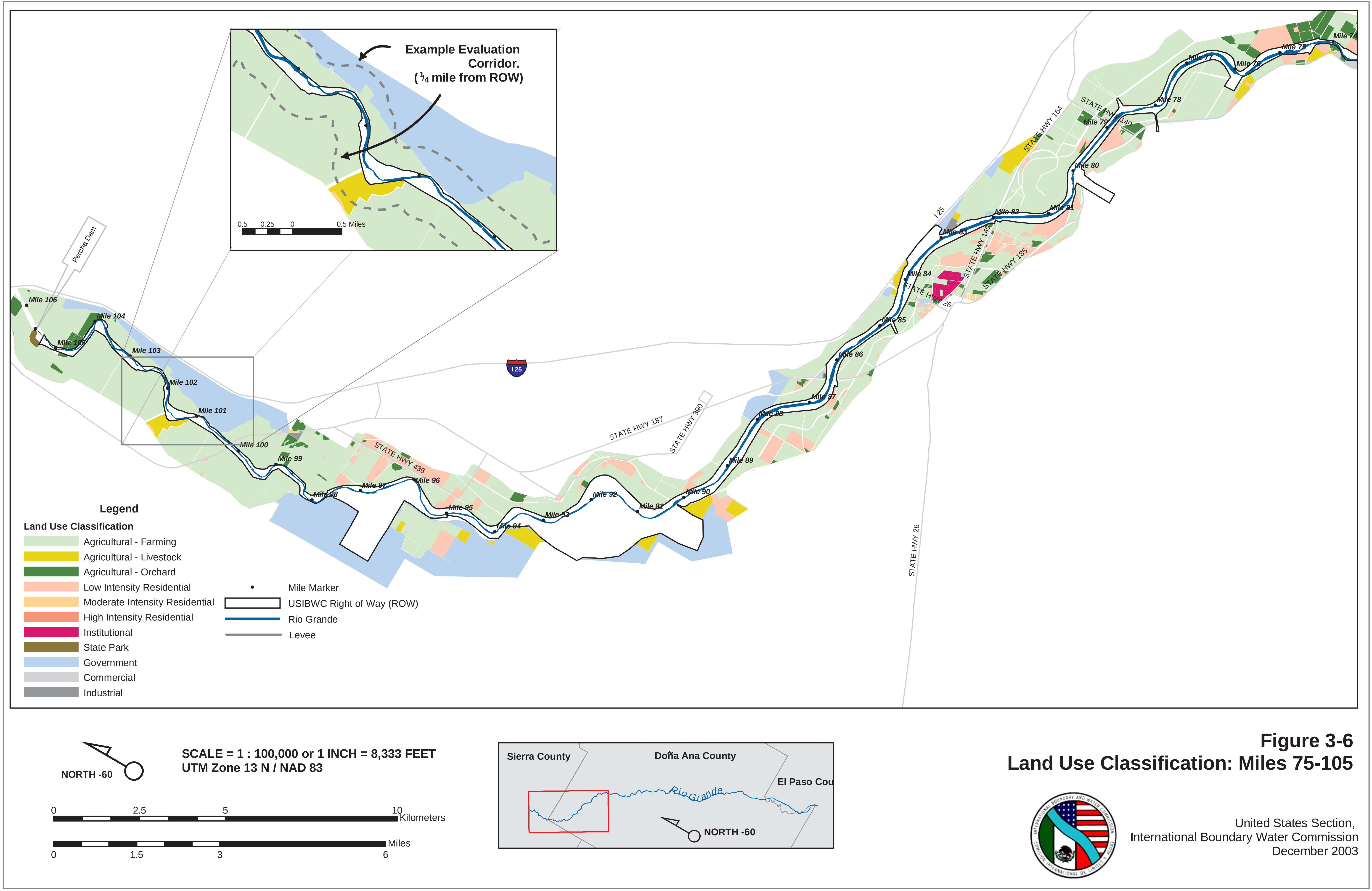
The privately-owned Anthony Country Club in Anthony, Texas borders the Rio Grande and offers visitors recreational golfing. The 62-acre, 9-hole golf course is located on the east bank of the river; approximately 33 acres utilizes the river floodway [*http://thegolfcourses.net/golfcourses/NM/4045.htm*].

### *Cooperative Initiatives Within the ROW*

The USIBWC is participating in various initiatives, proposed or currently underway, to increase recreational opportunities and expand public access to the RGCP natural resources.

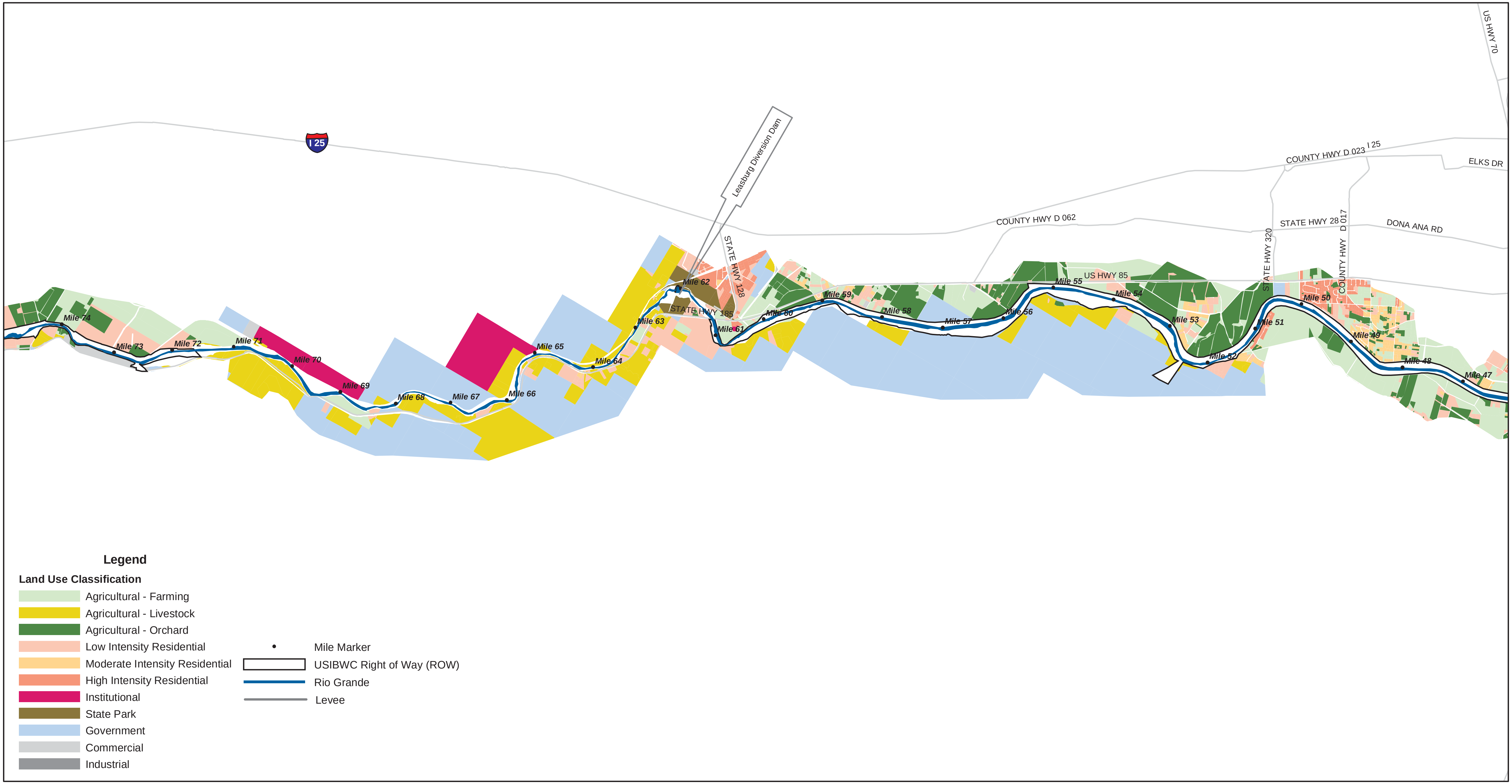
***Rio Grande Riparian Ecological Corridor Project***. In June 2000, the City of Las Cruces received an award from the USEPA Sustainable Development Challenge Grant program to create the Rio Grande Corridor Project (City of Las Cruces 2003). The Project encompasses a distance of 11 linear miles, from the Shalem Colony Bridge to the Mesilla Dam, and is envisioned for both the western and eastern banks of the southern Rio Grande. The extent of RGCP leased lands is 475 acres. The projects would involve cooperative agreements from the USIBWC and a number of other agencies which operate and maintain projects along the Rio Grande. Some of the projects include sites within the floodway identified in the AFR as potential areas for environmental improvements (Parsons 2001a). The project is the proposed site of the Mesilla Valley Bosque State Park that will include a multi-use trail along the east bank of the river (Schurtz, 2002).

***Rio Grande River Park***. The Rio Grande River Park is a project proposed for construction in phases as part of redevelopment of downtown El Paso, Texas. The National Park Service Rivers and Trails Program provided planning assistance, and the USIBWC provides access to a portion of the trail corridor. It would include an approximately 80-acre linear park and a trail for hiking, running, biking, and roller blading along the Rio Grande adjacent to downtown El Paso. The park would extend from the eastern edge of the Chihuahuita neighborhood adjacent to the international border crossing area at Santa Fe Street, to the Hart's Mill and Old Fort Bliss approximately 1.5 miles upstream. The river park was supported by the 1998 designation of the Texas portion of the Rio Grande as an American Heritage River, a White House initiative to help communities alongside their waterfronts preserve the rivers' histories and support natural resources and environmental protection. The extent of RGCP lands leased for the Rio Grande River Park is 101 acres.




# Figure 3-6
# Land Use Classification: Miles 75-105

United States Section,
International Boundary Water Commission
December 2003

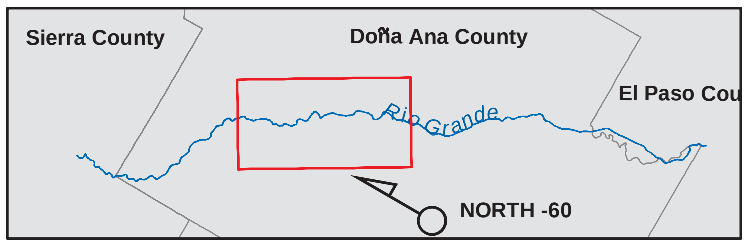



NORTH -60

**SCALE = 1 : 100,000 or 1 INCH = 8,333 FEET**
**UTM Zone 13 N / NAD 83**

0 2.5 5 10 Kilometers

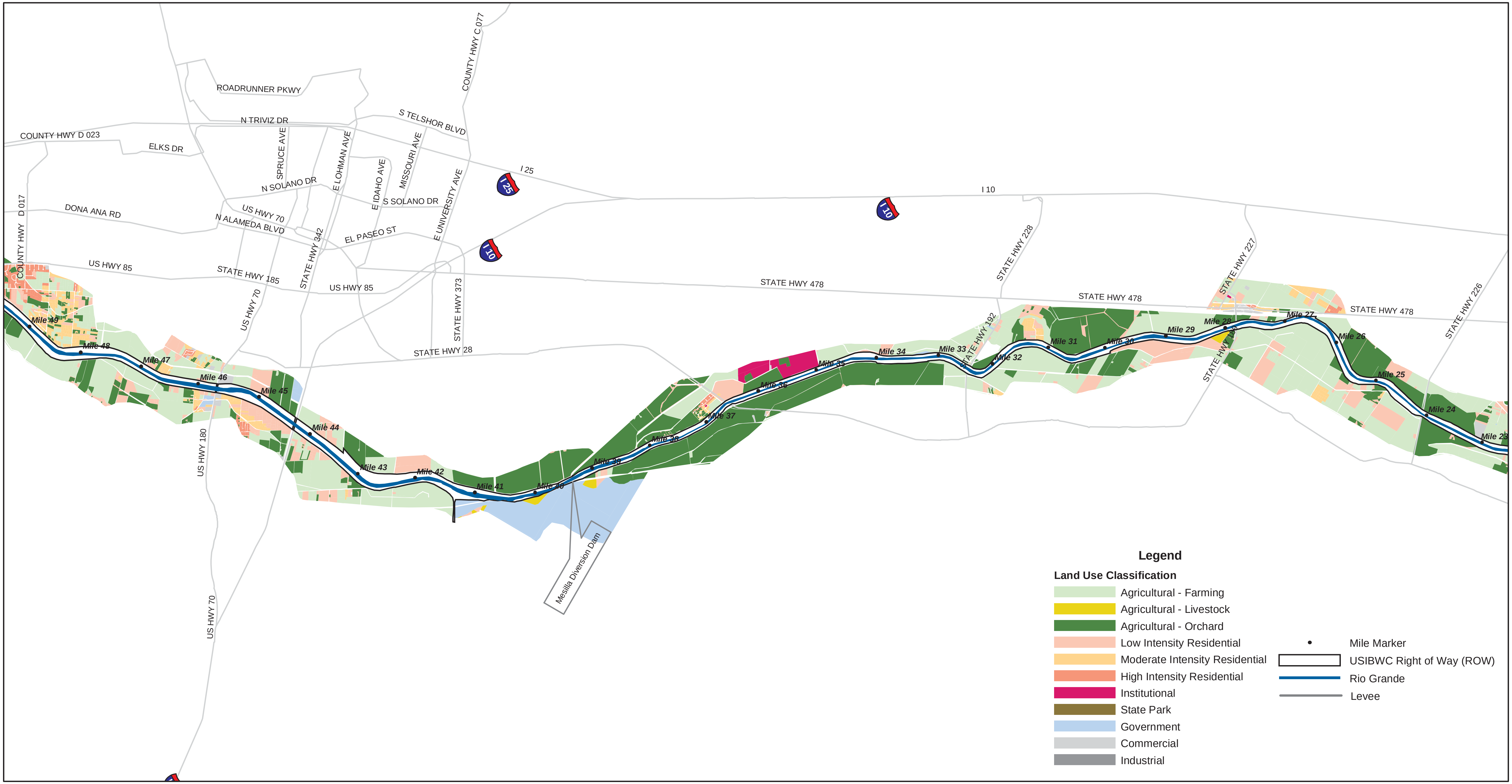
0 1.5 3 6 Miles




# Figure 3-7
# Land Use Classification: Miles 47-75

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\GIS-Mapping\land_use.mxd

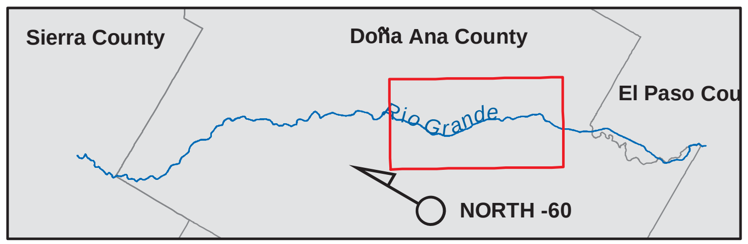



NORTH -60

**SCALE = 1 : 100,000 or 1 INCH = 8,333 FEET**
**UTM Zone 13 N / NAD 83**

0 2.5 5 10 Kilometers

0 1.5 3 6 Miles




# Figure 3-8
# Land Use Classification: Miles 25-50

United States Section,
International Boundary Water Commission
December 2003

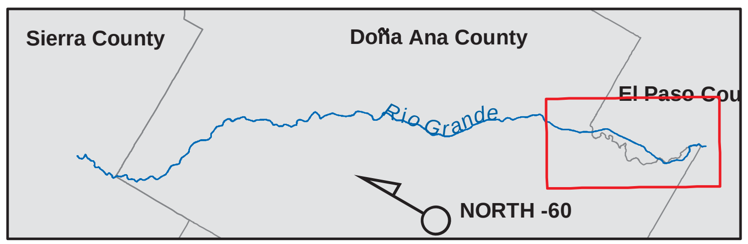
J:\736\736620\GIS-Mapping\land_use.mxd


NORTH -60

**SCALE = 1 : 100,000 or 1 INCH = 8,333 FEET**
**UTM Zone 13 N / NAD 83**

0 2.5 5 10 Kilometers

0 1.5 3 6 Miles




# Figure 3-9
# Land Use Classification: Miles 0-25

United States Section,
International Boundary Water Commission
December 2003

J:\736\736620\GIS-Mapping\land_use.mxd

**Table 3.8-1**
**Land Use Acreage Within 0.25 Mile Outside and Adjacent to the RGCP Right-of-Way**

| Land Use | Upper Rincon | | Lower Rincon | | Seldon Canyon* | | Upper Mesilla | | Las Cruces | | Lower Mesilla | | El Paso | | Total for RGCP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| **Agriculture** | | | | | | | | | | | | | | | | |
| Farming | 2,906 | 61 | 3,185 | 67 | 219 | 8 | 544 | 17 | 1,563 | 45 | 2,141 | 37 | 1,323 | 24 | 11,881 | 39 |
| Livestock | 244 | 5 | 171 | 4 | 1,090 | 41 | 511 | 16 | 30 | 1 | 26 | 0 | 539 | 10 | 2,611 | 9 |
| Pecan Orchard | 145 | 3 | 271 | 6 | 5 | 0 | 684 | 21 | 773 | 22 | 2,531 | 43 | 118 | 2 | 4,527 | 15 |
| *Subtotal Agriculture* | 3,296 | 69 | 3,627 | 76 | 1,314 | 50 | 1,740 | 54 | 2,366 | 68 | 4,699 | 80 | 1,979 | 36 | 19,020 | 63 |
| **Residential** | | | | | | | | | | | | | | | | |
| Low Intensity | 181 | 4 | 785 | 17 | 253 | 10 | 388 | 12 | 460 | 13 | 786 | 13 | 603 | 11 | 3,457 | 11 |
| Medium Intensity | 0 | 0 | 0 | 0 | 4 | 0 | 57 | 2 | 191 | 5 | 145 | 2 | 638 | 12 | 1,035 | 3 |
| High Intensity | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 1 | 98 | 3 | 27 | 0 | 723 | 13 | 864 | 3 |
| *Total Residential* | 181 | 4 | 785 | 17 | 257 | 10 | 462 | 14 | 749 | 21 | 959 | 16 | 1,963 | 35 | 5,356 | 18 |
| **Government** | | | | | | | | | | | | | | | | |
| Federal Government | 1,277 | 27 | 210 | 4 | 1,034 | 39 | 1,025 | 32 | 336 | 10 | 21 | 0 | 72 | 1 | 3,976 | 13 |
| State Park | 23 | 0 | 0 | 0 | 17 | 1 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 0 |
| *Total Government* | 1,299 | 27 | 210 | 4 | 1,051 | 40 | 1,039 | 32 | 336 | 10 | 21 | 0 | 72 | 1 | 4,030 | 13 |
| **Institutional** | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 112 | 2 | 45 | 1 | 161 | 1 |
| **Industrial** | 0 | 0 | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 421 | 8 | 446 | 1 |
| **Commercial** | 2 | 0 | 100 | 2 | 13 | 0 | 7 | 0 | 32 | 1 | 67 | 1 | 1,056 | 19 | 1,276 | 4 |
| ***Total*** | **4,778** | **100** | **4,746** | **100** | **2,635** | **100** | **3,251** | **100** | **3,484** | **100** | **5,858** | **100** | **5,537** | **100** | **30,289** | **100** |

* There is no USIBWC right-of-way in Seldon Canyon; the land use corridor extends 1/4 mile from each side of the river centerline.

***El Paso County River Park***. The USIBWC has an existing lease with the County of El Paso for a river park and trail extending from Country Club Bridge to Vinton Bridge on the west floodway. The county is currently developing the approximately 150-acre area. The county plans to extend the park at a latter date from Vinton Bridge to the Texas / New Mexico state line. The extension is planned to be about 75 acres on the east floodway. The county park plans include trails to accommodate pedestrians, bike and horse activities, park benches, green areas, historic interest signs, and small bridges to cross the drains.

***City Park of Sunland Park, New Mexico***. The 57-acre Sunland Park, New Mexico river park is located upstream from Anapra Bridge within the flood plain on the east side of the river. It includes picnic tables, grills, portable restrooms, and a playground for day use. The cities of El Paso and Sunland Park are proposing to eventually connect their respective river parks to the existing El Paso County river park. Master plans indicate connecting all existing and proposed city parks adjacent to the Rio Grande along the RGCP as well as the Rectification Project.

## 3.9 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

This section describes the socioeconomic resources and environmental justice issues within the RGCP potential region of influence. The river management alternatives under consideration would affect areas located within Sierra County and Doña Ana County, New Mexico and El Paso County, Texas (potential region of influence). Though countywide data are presented, only the southern most reaches (5-6 miles) of Sierra County and about half of El Paso County lie within the RGCP area.

The socioeconomic activity examined included population, employment, and characteristics of local industries, housing, and community infrastructure. Environmental justice issues are discussed in the final subsection.

### 3.9.1 Socioeconomic Criteria

#### *Population*

Table 3.9-1 presents total population in the potential area of influence, along with population trends from 1980 to 2000, and 20-year projections corresponding to the timeframe adopted for implementation of the river management alternatives.

The total population within the three-county region is estimated at 867,574, approximately 78 percent are located in El Paso County, 20 percent in Doña Ana County, and 2 percent in Sierra County (U.S. Census Bureau 2000). Historical population growth within the region has been accelerated since 1980, with a 48 percent increase by the year 2000. Doña Ana County had the largest population increase, approximately 81 percent, while Sierra County and El Paso County had 57 percent and 42 percent increase, respectively (U.S. Census Bureau 1998).

**Table 3.9-1 Population in El Paso, Doña Ana and Sierra Counties**

| | 1980 Total Population[a] | 1980-2000 Increase | 2000 Total Population[b] | Projected Increase | 2020 Total Population Projection |
|---|---|---|---|---|---|
| El Paso County | 479,899 | 42% | 679,622 | 36% | 926,760[c] |
| Doña Ana County | 96,340 | 81% | 174,682 | 62% | 282,152[d] |
| Sierra County | 8,454 | 57% | 13,270 | 0.8% | 13,380[d] |
| Combined three- county region | 584,693 | 48% | 867,574 | 41% | 1,222,292 |

a U.S. Bureau of the Census, USA Counties, 1998
b U.S. Bureau of the Census, Census 2000.
c Texas State Data Center, 2001
d University of New Mexico, Bureau of Business and Economic Research, 1997

Projections for the year 2020 give a 1,222,292 population, representing a 41 percent increase from 2000 for the three-county region. El Paso County population is projected to grow approximately 36 percent to 926,760 (Texas State Data Center 2001) while Doña Ana County is expected to have a 62 percent population increase from 2000 (University of New Mexico 1997). Sierra County is projected to grow 0.8 percent for the same period (University of New Mexico 1997).

### *Employment*

In the year 2000, counties within the potential region of influence reported 331,498 total employment, with 79 percent within El Paso County (Texas Workforce Commission 2000), followed by Doña Ana County with 20 percent and Sierra County with approximately 1 percent (New Mexico Department of Labor 2000). Approximately 98 percent of employment within these counties encompasses the non-agricultural sector of the economy, with only about 2 percent employment in agricultural-related services (U.S. Department of Labor 2000).

Between 1980 and 2000, employment within the potential region of influence increased 62.3 percent Doña Ana County experienced the greatest employment increase of 90.6 percent, followed by Sierra County at 87.9 percent and El Paso County at 56.2 percent (U.S. Census Bureau 2000; U.S. Census Bureau 1998). Table 3.9-2 presents 1980 and 2000 employment data and percent changes for the three-county region.

The 2000 unemployment rate in the region was 7.8 percent, a slight decrease from 8.0 percent in 1980 (U.S. Census Bureau 1998). These values are higher than the United States national average (4 percent) and the state average for New Mexico and Texas (4.9 percent and 4.2 percent, respectively). El Paso County had the highest rate of unemployment at 8.2 percent, followed by Doña Ana County at 6.5 percent. Unemployment in Sierra County was lower than the national average, at 2.9 percent (New Mexico Department of Labor, 2000; Texas Workforce Commission 2000). Unemployment rates for each county and the region of impact are presented in Table 3.9-2.

### Table 3.9-2 Employment Data for El Paso, Doña Ana and Sierra Counties

| | | 1980 Census[a] | 2000 Census[b] | Percent Change |
|---|---|---|---|---|
| El Paso County | Labor Force | 181,867 | 284,758 | 56.6% |
| | Total Employment | 167,344 | 261,318 | 56.2% |
| | Unemployment Rates | 8.0% | 8.2% | --- |
| Doña Ana County | Labor Force | 37,816 | 70,923 | 87.5% |
| | Total Employment | 34,768 | 66,278 | 90.6% |
| | Unemployment Rates | 8.1% | 6.5% | --- |
| Sierra County | Labor Force | 2,219 | 4,017 | 81.0% |
| | Total Employment | 2,077 | 3,902 | 87.9% |
| | Unemployment Rates | 6.4% | 2.9% | --- |
| Region of Impact | Labor Force | 221,902 | 359,698 | 62.1% |
| | Total Employment | 204,189 | 331,498 | 62.3% |
| | Unemployment Rates | 8.0% | 7.8% | --- |

[a] U.S. Census Bureau, USA Counties Data, 1998
[b] U.S. Census Bureau, Census 2000

A majority of employment within the region lies in the service, trade, and government sectors. Each of these industries individually comprise approximately 24 percent of the non-agriculture employment in the region. In El Paso County, employment is also high in the manufacturing and transportation industries, 5.3 percent and 5.9 percent, respectively (Texas Workforce Commission 2000). Employment is relatively high in the construction industries in Doña Ana County and Sierra County, at 6.1 percent and 6.9 percent, respectively (New Mexico Department of Labor 2000). Table 3.9-3 presents 2000 employment data for the major industries in each county and the combined area.

### Table 3.9-3 Major Non- Agricultural Employment Sectors in El Paso, Doña Ana and Sierra Counties

| | El Paso County | | Doña Ana County | | Sierra County | | Combined Region | |
|---|---|---|---|---|---|---|---|---|
| Employment Sector | Employed | % | Employed | % | Employed | % | Employed | % |
| Construction | 12,597 | 5.0 | 3,270 | 6.1 | 186 | 6.9 | 16,053 | 5.3 |
| Manufacturing | 38,069 | 15.3 | 3,219 | 6.1 | 43 | 1.6 | 41,331 | 13.5 |
| Transportation | 14,812 | 5.9 | 2,058 | 3.9 | 82 | 3.0 | 16,952 | 5.6 |
| Trade | 61,370 | 24.6 | 11,847 | 22.3 | 710 | 26.4 | 73,927 | 24.2 |
| Finance, Insurance & Real Estate | 9,334 | 3.7 | 1,860 | 3.5 | 106 | 3.9 | 11,300 | 3.7 |
| Services | 58,392 | 23.4 | 14,870 | 28.0 | 637 | 23.7 | 73,899 | 24.2 |
| Federal, State & Local Government | 54,888 | 22.0 | 16,069 | 30.2 | 929 | 34.5 | 71,886 | 23.5 |
| **Total[c]** | **249,462** | | **53,193** | | **2,693** | | **305,348** | |

a Texas Workforce Commission, 2000
b New Mexico Department of Labor, 2000
c Total employment within major industries, not data for total employed labor force

Many colonia residents are employed as migrant or seasonal workers. A seasonal worker is an individual whose principal employment (51 percent or more) occurs on a seasonal basis. The definition of a migrant worker is similar; however, a migrant worker establishes a temporary abode for the purpose of employment (Larson 2000). There are an estimated 2,378 migrant and seasonal farm workers in El Paso County. Of the colonia residents in El Paso County, approximately 30 percent are agricultural workers and approximately 24 percent are construction workers. This type of work is often seasonal, resulting in fluctuating unemployment rates within these communities (Border Low Income Housing Coalition 2001).

### *Agriculture*

Approximately 19,020 acres of private agricultural land lie in the 1/4-mile wide land use corridor on each side of the ROW. Though agriculture is not considered a major industry within the three counties, the majority of land adjacent to the RGCP is used for agriculture. Table 3.9-4 presents agricultural data for the three counties and the potential region of influence. Data were obtained from the U.S. Department of Agriculture (1997) and includes the number of farms, their acreage, number of workers per farm, and estimated market value.

**Table 3.9-4 Agricultural Data for El Paso, Doña Ana and Sierra Counties**

| | Number of Farms | Acres of Farms | Number of Farm Workers | Market Value (in thousands) |
|---|---|---|---|---|
| El Paso County | 415 | 243,684 | 1,216 | $76,673 |
| Doña Ana County | 1,290 | 581,436 | 4,330 | $235,484 |
| Sierra County | 180 | 1,286,887 | 453 | $15,766 |
| Region of Impact | 1,885 | 2,112,007 | 5,999 | $327,923 |

Source: U.S. Department of Agriculture, 1997 Census of Agriculture

Total reported acreage for the three-county region for 1997 was 2,122,007, with more than half located in Sierra County (60.8 percent), and 27.5 percent in Doña Ana County. The total estimated market value was approximately $328 million. Doña Ana County had the highest number of farms (1,290), farm workers (4,330) and market value ($235.5 million), followed by El Paso County. The average number of workers per farm for the three-county area was 3.2.

### *Income*

***Per Capita Income***. The U.S. Census Bureau defines per capita income as the average income computed for every man, woman, and child in a particular group. Per capita income within the potential region of influence is lower than both the national and state averages. In 1999 per capita income among the three counties averaged $17,828, 62 percent of the $28,546 national average. Sierra County had the highest per capita income of $19,265, 67 percent of the national average and 88 percent of New Mexico's $21,836 average. With an average of $17,003, Doña Ana County per capita income stood at 78 percent of New Mexico's average and approximately 60 percent of the national average. Similar to Doña Ana County, El Paso County per capita income averaged $17,216 in 1999, 64 percent of the Texas $26,834 average and 60 percent of the national average (U.S. Department of Commerce 1999).

***Median Household Income***. This criterion, as defined by the U.S. Census Bureau, is based on individual households, including families and unrelated resident individuals of 15 years or older with an income. The median household income in the region of impact was estimated at $24,323 for 1997. This is approximately 66 percent of the national median household income and approximately 70 percent and 79 percent of the Texas and New Mexico averages, respectively. Doña Ana County led with a median household income of $26,379 followed by El Paso County at $25,866 and Sierra County at $20,724 (U.S. Census Bureau 2000).

#### *Housing*

The total number of housing units within the three-county region was reported as 298,384 in 2000 (U.S. Census Bureau 2000). Among the total housing units, 275,691 (approximately 92 percent) were occupied, leaving an 8 percent vacancy rate within the region of impact. Sierra County, with the least population, had the highest vacancy rate of 30 percent. Vacancy rates in Doña Ana County and El Paso County were lower at 8.7 percent and 6.4 percent, respectively (U.S. Census Bureau 2000). Total housing units and vacancy rates for each county and the region of impact are presented in Table 3.9-5.

**Table 3.9-5 Housing Data for El Paso, Doña Ana and Sierra Counties**

| | Total Housing Units | Occupied Housing Units | Percent of Vacant Housing Units |
|---|---|---|---|
| El Paso County | 224,447 | 210,022 | 6.4% |
| Doña Ana County | 65,210 | 59,556 | 8.7% |
| Sierra County | 8,727 | 6,113 | 30.0% |
| Potential region of influence | 298,384 | 275,691 | 7.6% |

Source: U.S. Bureau of the Census, Census 2000.

### 3.9.2 Environmental Justice

Under Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, dated February 11, 1994), federal agencies are required to address disproportionately high and adverse human health and environmental effects on minority and low-income populations. The environmental justice section of this document is reported in compliance with Executive Order 12898.

Relevant demographic data is provided to assess any disproportionately high minority or low income populations within El Paso County, Texas and Doña Ana County, and Sierra County, New Mexico. Because the project area is located in both Texas and New Mexico, demographic data for these two states are combined, and together these states will represent the geographical unit of comparison. Demographic data for El Paso County, Doña Ana County, and Sierra County are compared with the combined data for Texas and New Mexico. For purposes of impact analysis, the combined data for Texas and New Mexico will be referred to as the region of comparison.

### *Demographic Data*

Executive Order 12898 considers a minority as an individual belonging to one of the following population groups: Hispanic, Black (not of Hispanic origin), American Indian or Alaskan Native, or Asian or Pacific Islander. Under this Executive Order, minority populations are to be identified if (i) the minority population within the affected area exceeds 50 percent or (ii) if the minority population age is meaningfully greater than the age in the general population (Executive Order 12898 1994).

El Paso County and Doña Ana County both have a disproportionately high minority population, exceeding 50 percent. Minority populations comprise 83.2 percent in El Paso County and 67.4 percent in Doña Ana County. The minority population in the region of comparison is 79.2 percent.

Sierra County does not have a disproportionately high minority population with a 28.6 percent minority rate. Therefore, it will not be necessary to address any effects on minority populations in Sierra County.

Minority populations of Hispanic nationality dominate in both El Paso and Doña Ana Counties with 78.2 percent and 63.4 percent, respectively. Hispanic populations in Sierra County are lower than the region of comparison. Table 3.9-6 presents 2000 population data by ethnicity for El Paso County, Doña Ana County, Sierra County and the region of comparison.

**Table 3.9-6 Minority Populations for El Paso County, Doña Ana County, Sierra County and Poverty Rates**

| | El Paso County | Doña Ana County | Sierra County | Region of Comparison |
|---|---|---|---|---|
| White | 17.0% | 32.5% | 70.5% | 20.9% |
| Hispanic | 78.2% | 63.4% | 26.3% | 74.4% |
| Black | 3.1% | 1.6% | 0.5% | 2.8% |
| Asian[a] | 1.1% | 0.9% | 0.3% | 1.0% |
| American Indian[b] | 0.8% | 1.5% | 1.5% | 1.0% |
| Total Minority | 83.2% | 67.4% | 28.6% | 79.2% |
| Poverty Rates[c] | 27.8% | 26.6% | 23.4% | 27.5% |

Source: U.S. Bureau of the Census, 2000
a Asian includes Pacific Islander and Non-Hawaiian
b American Indian includes Eskimo and Aleut
c Poverty rates from U.S. Bureau of Census 2000, 1997 model-based estimate

### *Poverty Rates*

The U.S. Census Bureau official poverty assessment weighs income before taxes and excludes capital gains and noncash benefits (such as public housing, Medicaid, and food stamps). Poverty rates indicate low-income populations are relatively high within all three counties (U.S. Census Bureau 2000). Such counties along the U.S.-Mexico

Border are often havens for colonias (refer to socioeconomic section), where significant low-income populations reside (Texas Department of Human Resources 1988).

The population percentage living below poverty in all three counties is greater than the 16.9 percent in the region of comparison. El Paso County has a poverty rate of 27.5 percent, followed by Doña Ana County and Sierra County at 26.6 percent and 23.4 percent, respectively (U.S. Census Bureau 2000). El Paso County, Doña Ana County, and Sierra County all have disproportionately high low-income populations in relation to the region of comparison.

## 3.10 CULTURAL RESOURCES

Cultural resources include three elements: architectural resources, archaeological resources and traditional cultural properties. Cultural resources information was collected through a records search and literature review, field reconnaissance and location verification, and consultations with Native American tribes (EMI 2001). Site files in New Mexico and Texas, resource listings in the National Register of Historic Places (NRHP), and listings in the New Mexico State Register of Cultural Properties (SRCP) and, the Texas State Register were reviewed. A 2-mile wide corridor that extends for 105.6 miles of the Rio Grande from Percha Dam to American Dam (one mile on each side of the river centerline) was defined as the cultural resources study area for the records search. This large area was used to define the regional context of the cultural resources in the area. The Canalization Project right-of-way (ROW), or lands administered by the USIBWC, is a narrow corridor encompassing only those lands between the left and right flood control levees and represents approximately 8 percent of the total cultural resources study area.

### 3.10.1 Architectural Resources

A field reconnaissance was conducted to note historic structures within the RGCP (EMI 2001). No historic buildings or structures, other than bridges and facilities associated with irrigation facilities, were observed during the field reconnaissance. Two buried canals were revealed during the trenching for the geoarchaeological field work at river mile 91 (site LA 131868) and river mile 94 (LA 131869). Site LA 131869 appears to be a former segment of the Palmer Lateral that was relocated during the canalization work during the 1930s and 1940s. Site LA 131868 is an undetermined cobble-line canal that was dug 27.6 inches into the underlying deposits. It also was probably abandoned and buried during the canalization work during the 1930s and 1940s. Table 3.10-1 lists the architectural resources in the RGCP.

A field reconnaissance was conducted to identify additional historic structures within the RGCP ROW (EMI 2001). No historic buildings or structures, other than bridges and facilities associated with irrigation facilities, were observed during the field reconnaissance.

**Table 3.10-1 Known Architectural Resources in the RGCP ROW**

| Site Number | Period | Date | Site Type | NRHP-Status |
|---|---|---|---|---|
| LA106782 | Historic | A.D. 1908-1995 | House, outbuildings, water catchment device, water control device | Undetermined, associated with the Leasburg Diversion Dam, New Mexico State Register |
| LA120257 | Historic | A.D. 1915-1925 | Irrigation Ditch | Undetermined |
| LA131868 | Historic | A.D. 1846-1945 | Irrigation Ditch | Undetermined |
| LA131869 | Historic | A.D. 1846-1945 | Irrigation Ditch, Palmer Lateral | Undetermined |

### *Bridges*

The RGCP has at least 26 bridges or vehicular crossings between Percha Dam in the north and the American Dam in the south. Rae *et al.* (1987) identified three bridges in Sierra County and 10 bridges in Doña Ana County as historic resources constructued in the 1930s. Those structures reportedly exhibited characteristic engineering or design qualities of the *New Mexico Historic Bridge Survey*. Several of those bridges have been reconstructed or replaced over the last two decades. Original structures remain at Radium Springs (US 85) and at New Mexico highways 28, 226, 227, and 228 (located at Arrey, Berino, Vado and Shalem, respectively).

### *Irrigation Structures*

The Rio Grande Valley has been modified by Native American and Euro American occupants for the past millennium. Numerous irrigation features have been constructed throughout the valley. Four major irrigation feature types occur and include dams, siphons, flumes, and acequias.

***Dams.*** Three diversion dams are in the RGCP area that serve the USBR Rio Grande Project and are operated and maintained by non-federal irrigation districts. These include the Percha Dam (T16S, R5W, Section 36), the Leasburg Dam (T21S, R1W, Section 10), and the Mesilla Dam (unplatted, at about T24S, R1E, Section 13, UTM coordinates 330591E and 3566876N). These dams have associated siphons and gates that are the origins for numerous acequias. A fourth dam, the American Dam (T29S, R4E, Section 15), is operated and maintained by the USIBWC to regulate United States and Mexican waters and provides the last point of allocated river diversion for the RGCP.

The NRCS has constructed 38 dams near or within the RGCP area. All of the dams, with the exception of the Leasburg Diversion Dam, were constructed primarily for flood control purposes. Five of the dams are in Sierra County and 33 structures are in Doña Ana County. Most structures have been transferred to flood control organizations, the EBID, or local communities. Most of these structures are less than 50 years of age. Two dams constructed by the NRCS are more than 50 years of age: Leasburg Diversion Dam, built in 1907, and Spring Canyon Flood Detention Dam, owned by the Village of Hatch, built in 1940.

The American Diversion Dam and the Leasburg Dam are listed on the New Mexico SRCP. The Percha Diversion Dam is listed on both the New Mexico SRCP and the NRHP.

***Siphons.*** Several siphons—Hatch Siphon, Rincon Siphon, and Garfield Siphon on the Arrey Canal—were constructed in the early 1900s. The USIBWC has designed long-term measures for protection of those siphons.

***Flumes.*** The Picacho Flume is located nine miles south of the Leasburg Diversion Dam and is a steel truss structure carrying water on the Leasburg canal over the Rio Grande. It was constructed prior to 1950.

***Acequias.*** The present study has identified six acequia types in the project area: canals, ditches, drains, spur drains, laterals and spurs. None of the irrigation features occur within the RGCP. These features are within 1 mile on each side of the present Rio Grande channel. Irrigation features include ten canals, one ditch, 30 drains, one spur drain, 66 laterals, and one spur. These features irrigate and drain thousands of acres in the Lower Rio Grande Valley.

### 3.10.2 Traditional Cultural Properties

Traditional cultural properties are locations that embody beliefs, customs or practices of a living community. Native American resources are sites, areas and material important to Native Americans for religious or heritage reasons. Resources may include prehistoric sites and artifacts, contemporary sacred areas, traditional use areas (e.g., native plant or animal habitat), and sources for materials used in the production of sacred objects or traditional implements.

Fundamental to Native American religions is the belief in the sacred character of physical places such as mountain peaks, springs, rivers, and burials. Deities are often described as inhabiting specific locations and specific geographic areas may be identified as points of tribal origin or as central axes of the physical universe.

Traditional cultural properties or sensitive resources that may occur in the study area include pictographs and burials. One of the four sacred mountains of the Mescalero Apache is located northeast of Las Cruces in the San Augustin Mountains (Carmichael 1994:90) and within view of the Rio Grande River Valley. Correspondence with Native American Tribes has not identified any traditional cultural properties within the RGCP ROW. Letters were sent in December 2000 to the six tribes that may have concerns regarding management changes of the RGCP, and follow-up phone calls were subsequently made. Table 3.10-2 summarizes findings of the consultation.

### 3.10.3 Archaeological Resources

Archaeological resources consist of both prehistoric and historic sites and may include such site types as lithic and ceramic scatters, pithouses, roomblocks, hearths, trails, foundations, and refuse scatters. The cultural resource records and literature search identified 186 sites (including both archaeological and architectural resources) recorded in the 3.2 km-wide (2 mi) study area: 176 in New Mexico and 10 in Texas (EMI 2001). The records search identified 55 reports pertaining to cultural resource investigations within 1 mile of the Rio Grande channel. An additional 16 reports regarding cultural resources in proximity to the RGCP were also examined.

## Table 3.10-2 Summary of Consultation on Traditional Cultural Properties

| Native American Tribe | Comments |
|---|---|
| Pueblo of Isleta in Valencia County, New Mexico | No concerns, but wishes to be informed about project |
| Mescalero Apache Tribe | Plans to review EIS records prior to commenting |
| White Mountain Apache Tribe in Whiteriver, Arizona | Indicated that information was under review but no response has been received |
| Pueblo of Zuni | No response to letter or follow-up call |
| Ysleta del Sur Pueblo | No response to letter or follow-up call |
| Fort Sill Apache Tribe in Apache, Oklahoma | No response to letter or follow-up call |

Of the 186 sites identified, 130 were prehistoric sites and 56 were historic sites. The 130 prehistoric resources include artifact scatters, hearths, roomblocks, pithouses, depressions, petroglyphs, pictographs, and burials. Fifty-six historic archaeological and architectural resources were recorded and included nine major site types: irrigation facilities, artifact scatters and refuse dumps, structural remains, railroad grades and tracks, trails, forts, a cemetery, a mining facility and an orchard (EMI 2001: 31).

### *Known Sites*

Of the 186 sites, only 19 have been recorded within the RGCP ROW. A field reconnaissance was conducted to verify the locations of these 19 sites locations in reference to the RGCP ROW. The field reconnaissance determined that 9 of the sites are or may be within the ROW and include 7 prehistoric sites and two multicomponent sites (both prehistoric and historic period occupations) (Table 3.10-3). The prehistoric sites date to the Archaic period (5500 B.C.-A.D. 900), the Mogollon Late Pithouse (Jornada) (A.D. 750-1100), and the Mogollon Late Pueblo (Jornada) to Late Pueblo (Jornada) (A.D. 1175-1400). The historic sites include a trail and corral dating post A.D. 1539 and an unknown occupation dating pre A.D. 1880. None of these sites have been formally evaluated for eligibility to the NRHP.

## Table 3.10-3 Known Archaeological Resources in the RGCP ROW

| Site Number | Period | Date | Site Type | NRHP-Status |
|---|---|---|---|---|
| LA1646 | Prehistoric | A.D. 1175-1400 | Artifact Scatter | Undetermined |
| LA1671 | Prehistoric/Historic | A.D. 1175-1400; A.D. 1539-1993 | Roomblock; trail, corral | Undetermined |
| LA2410 | Prehistoric | A.D. 750-1100 | Artifact scatter | Undetermined |
| LA2800 | Prehistoric | A.D. 750-1100 | Artifact scatter | Undetermined |
| LA2895 | Prehistoric | A.D. 1100-1400 | Artifact scatter | Undetermined |
| LA2931 | Prehistoric | A.D. 1175-1400 | Mound | Undetermined |
| LA72703 | Prehistoric | 5500 B.C.-A.D. 900 | Pictograph | Undetermined |
| LA107943 | Prehistoric/Historic | Unknown | Artifact scatter | Undetermined |
| LA131204 | Prehistoric | Archaic; Mogollon | Artifact scatter | Undetermined |

### Undiscovered Sites

***Background***. There is a potential for undiscovered archaeological sites to occur within the RGCP ROW. Particular landforms appear to have a greater likelihood of containing surface and subsurface cultural deposits (EMI 2001). During the Puebloan period, the reliance on farming probably resulted in decreased use of active floodplain areas for more permanent residence. Repeated floods and continued new channel alignments would be a threat to permanent habitation structures. Under these conditions a minimal archaeological record might be expected, with most land use in the floodplain limited to brief temporary camps associated with agricultural field maintenance or hunting and gathering activities.

Earlier landscapes in the valley floodplain and in the valley margins are preserved in the fluvial deposits not visible on the surface. The shallow floodplain soils bordering nineteenth century river channels have the potential to contain well-preserved archaeological deposits dating to at least 2500 years. Historic use of the area can be found in silted-in river channels that were active during the nineteenth century, and has been demonstrated by the discovery of buried irrigation canals predating canalization work. Examination of the deeper deposits exposed in alluvial fans indicates the presence of buried soil surfaces dating to the mid-Holocene. Older landforms are located along the Rio Grande Valley margins. In the side canyons and areas containing alluvial fans, site density should be higher as a result of the limited space available for occupation.

***Potential for Surface Cultural Resources.*** Areas within the RGCP with a higher potential to contain surface cultural resources are those ground surfaces that are elevated above the floodplain (EMI 2001). These areas are also less likely to have been silted over or scoured away by seasonal flooding. Several qualitative factors also contribute to the selections. Prehistoric peoples permanently occupied areas that were less subject to spring season flood damage. Elevated areas in the Rio Grande Valley were attractive for settlement because they were generally warmer during winter months as a result of climatic inversion and cooler during summer months because of breezes in open areas. There is a tendency for people to occupy such areas since they can provide a good visual overview of the surrounding terrain for observing potential game and personal protection. Since most elevated surfaces within the Rio Grande Valley were formed within the last 4000 years, they are well within the time span of human occupation in the region.

***Potential for Subsurface Cultural Deposits***. Archaic period, middle- to late-Holocene hunter-gatherer groups occupying point bars or areas near active stream channels probably established limited activity temporary camps. In these floodplain environments, artifact densities can be expected to be small and of low archaeological visibility. As the Rio Grande channel shifted, these briefly occupied areas became buried. New temporary camps would be continually created in response to accompanying the lateral shift in the Rio Grande channel. These temporary camps on the floodplain would be expected to be dispersed. In contrast, camps along the Rio Grande Valley margin were probably more stable and less likely to be eroded and destroyed by lateral channel movement. Canyon outlets or alluvial fan toe slopes would have provided small areas for human occupation. Repeated occupations of these areas would result in greater accumulations of occupation debris that would become buried by hillslope or alluvial fan deposition. Higher site densities and greater artifact concentrations could be anticipated in these settings.

A total of 27 high potential areas were identified in the RGCP ROW that displayed landform characteristics suitable for the preservation of undiscovered surface and subsurface archaeological sites (EMI 2001). Some archaeological sites are likely to occur in these areas and some may be considered NRHP-eligible.

### 3.10.4 Summary of Findings

***Architectural Resources.*** An evaluation of a 2-mile corridor along the Rio Grande from American Dam to Percha Dam indicated the presence of 13 bridges, 4 dams, 3 siphons and a flume that are older than 50 years. Only the timber trestle bridge near Radium Springs (No. 2591) is listed on the New Mexico SRCP (Rae *et al.* ,1987:56). The American Diversion Dam and the Leasburg Dam are listed on the New Mexico SRCP. The Percha Diversion Dam is listed on both the New Mexico SRCP and the NRHP. The Spring Canyon Flood Detention Dam, owned by the Village of Hatch, is also a historic resource, built in 1940.

Cultural resources recorded in previous field surveys indicated four resources associated with the RGCP ROW: standing buildings and structures associated with the Leasburg diversion dam (outside USIBWC jurisdiction), and three buried canal segments. The location of these sites along the RGCP are listed by river mile in Table 3.10-4.

***Traditional Cultural Properties.*** No traditional cultural properties in the RGCP or viewshed have been identified through correspondence with Native American Tribes.

***Archaeological Resources.*** Of a total of 19 known sites identified in the RGCP, 9 were located within or close to the ROW. The location of these 9 sites along the RGCP is listed by river mile and RMU in Table 3.10-4.

A total of 27 areas with a higher potential for undiscovered archaeological sites were identified along the RGCP (EMI 2001). These locations are listed by river mile and RMU in Table 3.10-4.

**Table 3.10-4 Historical and Archaeological Sites, and Areas with a Higher Potential for Preservation of Cultural Resources**

| River Management Unit | River Mile | Historical Sites from Previous Surveys | Archaeological Sites Along the RGCP | Areas with a Higher Potential for Undiscovered Sites |
|---|---|---|---|---|
| Upper Rincon RMU | 105-90 | 91, 94 | 92 | 91, 94, 96, 97 |
| Lower Rincon RMU | 72-90 | 74 | 82 | 73, 74, 80, 83, 84, 85 |
| Seldon Canyon RMU | 63-72 | | 66, 67, 68, 71 | 64, 65, 66, 68 |
| Upper Mesilla RMU | 51-63 | 62 | 56 | 52, 54, 57 |
| Las Cruces RMU | 40-51 | | | 40 |
| Lower Mesilla RMU | 21-40 | | | 23, 24, 28, 30 |
| El Paso RMU | 0-21 | | 5 (2) | 5, 7, 14, 15, 16 |
| *Total Number* | | *4 sites* | *9 sites* | *27 locations* |

## 3.11 AIR QUALITY

### 3.11.1 Air Pollutants and Regulations

Air quality in any given region is measured by the concentration of various pollutants in the atmosphere, typically expressed in units of parts per million (ppm) or in units of micrograms per cubic meter (μg/m3). Air quality is not only determined by the types and quantities of atmospheric pollutants, but also by surface topography, the size of the air basin, and by the prevailing meteorological conditions.

The Clean Air Act Amendments of 1990 (CAAA) directed the USEPA to develop, implement, and enforce strong environmental regulations that would ensure cleaner air for all Americans. The promulgation of the CAAA was driven by the failure of nearly 100 cities to meet the National Ambient Air Quality Standards (NAAQS) for ozone and carbon monoxide and by the inherent limitations in previous regulations to effectively deal with these and other air quality problems.

The USEPA established both primary and secondary NAAQS under the provisions of the CAAA. Primary standards define levels of air quality necessary to protect public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to protect public welfare (i.e., soils, vegetation, and wildlife) from any known or anticipated adverse effects from a criteria air pollutant. The CAAA also set emission limits for certain air pollutants for new or modified major sources based on best demonstrated technologies, and established health-based national emissions standards for hazardous air pollutants.

NAAQS are currently established for six air pollutants (known as “criteria air pollutants”) including carbon monoxide (CO), nitrogen oxides (NOx, measured as nitrogen dioxide, $NO_2$), ozone ($O_3$), sulfur oxides (SOx, measured as sulfur dioxide, $SO_2$), lead (Pb), and particulate matter equal to or less than 10 microns in aerodynamic diameter ($PM_{10}$). There are many suspended particles in the atmosphere with aerodynamic diameters larger than 10 microns, collectively referred to as total suspended particulates (TSP).

In 1997 USEPA promulgated two new standards: a new 8-hour ozone standard (which could eventually replace the existing 1-hour ozone standard) and a new standard for $PM_{2.5}$, which are fine particulates (with diameters less than 2.5 microns) that have not been previously regulated. In addition, USEPA revised the existing $PM_{10}$ standard. The two new standards were scheduled for implementation over a period of several years, as monitoring data became available to determine the attainment status of areas in the U.S. However, USEPA was challenged in court on these new and revised standards, and in May 1999, the U.S. District of Columbia Court of Appeals issued a ruling stating that the CAA as applied and absent further clarification "effects an unconstitutional delegation of legislative power." Furthermore, the court stated that the new 8-hour ozone standard was remanded back to USEPA for further consideration and "cannot be enforced." It also stated that the new $PM_{2.5}$ standard was allowed to remain in place - but affected parties can apply to have this standard vacated under certain condition - and that the revised $PM_{10}$ standard was vacated and replaced by the pre-existing $PM_{10}$ standard.

The case was appealed to the U.S. Supreme Court, and in February 2001, the court upheld the 8-hour ozone standard and instructed the USEPA to develop a reasonable interpretation of the nonattainment implementation provisions. The Supreme Court has validated the USEPA's standard setting authority and procedures and in March 2002, the remaining challenges to the $PM_{2.5}$ standard were rejected. USEPA is seeking promulgation of the new ozone and PM2.5 standards by December 2004.

The CAAA does not make the NAAQS directly enforceable, but requires each state to promulgate regulatory requirements necessary to implement the NAAQS. The CAAA also allows states to adopt air quality standards that are more stringent than the federal standards. The ambient air quality standards for New Mexico are contained in the Environmental Improvement Act, NMSA 1978, Section 74-1-8(A)(4) and Air Quality Control Act, NMSA. The ambient air quality standards for Texas are contained in the Texas Administrative Code, Title 30, Section 101.21, as amended. Table 3.11-1 contains the national and Texas ambient air quality standards. New Mexico has state standards in addition to the federal NAAQS. Table 3.11-2 lists the New Mexico standards.

**Table 3.11-1 National and Texas Ambient Air Quality Standards**

| Criteria Pollutant | Averaging Time | National and Texas Primary NAAQS[a,b,c] | Secondary NAAQS[d] |
|---|---|---|---|
| Carbon Monoxide | 8-hour<br>1-hour | 9 ppm (10,000 μg/m3)<br>35 ppm (40,000 μg/m3) | No standard<br>No standard |
| Lead | Quarterly | 1.5 μg/m3 | 1.5 μg/m3 |
| Nitrogen Oxides (measured as $NO_2$) | Annual | 0.053 ppm (100 μg/m3) | 0.053 ppm (100 μg/m3) |
| Ozone[e] | 8-hour<br>1-hour | 0.08 ppm (157 μg/m3)<br>0.12 ppm (235 μg/m3) | 0.08 ppm (157 μg/m3)<br>0.12 ppm (235 μg/m3) |
| Particulate Matter (measured as $PM_{10}$) | Annual<br>24-hour | 50 μg/m3<br>150 μg/m3 | 50 μg/m3<br>150 μg/m3 |
| Particulate Matter (measured as PM2.5)e | Annual<br>24-hour | 15 μg/m3<br>65 μg/m3 | 15 μg/m3<br>65 μg/m3 |
| Sulfur Oxides (measured as sulfur dioxide) | Annual<br>24-hour<br>3-hour | 0.03 ppm (80 μg/m3)<br>0.14 ppm (365 μg/m3)<br>No standard | No standard<br>No standard<br>0.50 ppm (1,300 μg/m3) |

a. National and state standards, other than those based on an annual or quarterly arithmetic mean, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to one.

b. The NAAQS and Texas standards are based on standard temperature and pressure of 25 degrees Celsius and 760 millimeters of mercury.

c. National Primary Standards: The levels of air quality necessary to protect the public health with an adequate margin of safety. Each state must attain the primary standards no later than three years after the state implementation plan is approved by the USEPA.

d National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the state implementation plan is approved by the USEPA.

e. The ozone 8-hour standard and $PM_{2.5}$ standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which the USEPA proposed in 1997. In March 2002 the D.C. Circuit Court rejected the remaining challenges to the 1997 $PM_{2.5}$ standard. USEPA is seeking promulgation of the new ozone and $PM_{2.5}$ standards by December 2004.

**Table 3.11-2 New Mexico Ambient Air Quality Standards**

| Pollutant | Averaging Time | Maximum Concentration |
|---|---|---|
| Carbon Monoxide | 1-hour<br>8-hour | 13.1 ppm<br>8.7 ppm |
| Nitrogen Dioxide | 24-hour average<br>Annual average | 0.10 ppm<br>0.05 ppm |
| Total suspended particles (TSP) | 24-hour average<br>7- day average<br>30-day average<br>Annual average | 150 μg/m3<br>110 μg/m3<br>90 μg/m3<br>60 μg/m3 |
| Sulfur Dioxide | 24-hour average<br>Annual average | 0.10 ppm<br>0.02 ppm |
| Hydrogen Sulfide | 1-hour average* | 0.01 ppm |
| Total Reduced Sulfur | ½-hour average | 0.003 ppm |

*Not to be exceeded more than once per year. Source: New Mexico 2002a.

Federal actions must comply with the USEPA Final General Conformity Rule published in 40 CFR 93, subpart B (for federal agencies) and 40 CFR 51, subpart W (for state requirements). The Final Conformity Rule, which took effect on January 31, 1994, requires all Federal agencies to ensure that proposed agency activities conform with an approved or promulgated State or Federal implementation plans. Conformity means compliance with a State or Federal implementation plan for the purpose of attaining or maintaining the NAAQS. Specifically, this means ensuring the Federal activity does not: 1) cause a new violation of the NAAQS; 2) contribute to an increase in the frequency or severity of violations of existing NAAQS; 3) delay the timely attainment of any NAAQS; or 4) delay interim or other milestones contained in the State implementation plan for achieving attainment.

The Final General Conformity Rule only applies to Federal actions in designated nonattainment or maintenance areas, and the rule requires that total direct and indirect emissions of subject criteria pollutants, including ozone precursors, be considered in determining conformity. The rule does not apply to actions that are not considered regionally significant and where the total direct and indirect emissions of nonattainment criteria pollutants do not equal or exceed *de minimis* threshold levels for criteria pollutants established in 40 CFR 93.153(b). The State of New Mexico *de minimis* threshold levels are the same as the Federal standards (New Mexico 2002b). A Federal action would be considered regionally significant when the total emissions from the proposed action equal or exceed 10 percent of the nonattainment or maintenance area's emissions inventory for any criteria air pollutant. If a Federal action meets *de minimis* requirements and is not considered a regionally significant action, then it does not have to go through a full conformity determination. Ongoing activities currently being conducted are exempt from the rule so long as there is no increase in emissions equal to or greater than above the *de minimis* levels as the result of the Federal action. Table 3.11-3 lists the *de minimis* levels for nonattainment areas.

**Table 3.11-3 *De minimis* Thresholds in Nonattainment Areas**

| Criteria Pollutant | Degree of Nonattainment | *De minimis* Level (tons per year) |
|---|---|---|
| Ozone ($VOC$ and $NO_x$) | Serious<br>Severe<br>Extreme<br>Other ozone nonattainment areas outside ozone transport region | 50<br>25<br>10<br>100 |
| | Marginal or moderate nonattainment within ozone transport region | 50 (VOC)<br>100 ($NO_x$) |
| Carbon Monoxide (CO) | All | 100 |
| Particulate Matter ($PM_{10}$) | Moderate<br>Serious | 100<br>70 |
| Sulfur Dioxide | All | 100 |
| Lead | All | 25 |

Sources: 40 CFR 93 1999, New Mexico 2002b.

## 3.11.2 Regional Air Quality

The USEPA classifies the air quality within an air quality control region (AQCR) according to whether or not the concentration of criteria air pollutants in the atmosphere exceeds primary or secondary NAAQS. All areas within each AQCR are assigned a designation of either attainment or nonattainment for each criteria air pollutant. An attainment designation indicates that the air quality within an area is as good or better than the NAAQS. Nonattainment indicates that air quality within a specific geographical area exceeds applicable NAAQS. Unclassifiable and not designated indicates that the air quality cannot be or has not been classified based on available information as meeting or not meeting the NAAQS and is therefore treated as attainment. Before a nonattainment area is eligible for reclassification to attainment status, the state must demonstrate compliance with NAAQS in the nonattainment area for three consecutive years and demonstrate, through extensive dispersion modeling, that attainment status can be maintained in the future even with community growth.

The NMED Air Quality Bureau has regulatory authority for air pollution control in the State of New Mexico, while the TCEQ regulates air pollution in the State of Texas. The El Paso-Las Cruces-Alamogordo Interstate AQCR 153 includes Doña Ana, Lincoln, Sierra, and Otero counties in New Mexico, and Brewster, Culbertson, El Paso, Hudspeth, Jeff Davis, and Presidio counties in Texas. Table 3.11-4 lists the air quality status for the counties in the AQCR.

## 3.11.3 Baseline Air Emissions

An air emissions inventory is an estimate of total mass emissions of pollutants generated from a source or sources over a period of time, typically a year. Accurate air emissions inventories are needed for estimating the relationship between emissions sources and air quality. The quantities of air pollutants are generally measured in pounds (lbs) per year or tons per year (tpy). All emission sources may be categorized as either mobile or stationary emission sources. Stationary emission sources may include boilers, generators, fueling operations, industrial processes, and burning activities, among others. Mobile emission sources include activity such as on and off highway vehicle operations, waste disposal and recycling, and miscellaneous sources.

**Table 3.11-4 Air Quality Status for Counties in Air Quality Control Region 153**

| Carbon Monoxide (CO) | Nitrogen Oxides ($NO_2$) | Sulfur Dioxide ($SO_x$) | Particulate Matter ($PM_{10}$) | Ozone |
|---|---|---|---|---|
| Part of El Paso County--designated nonattainment, classification—moderate; all other counties unclassifiable or attainment | All counties—cannot be classified or better than national standards | El Paso County—cannot be classified; all other counties—better than national standards | Part of Doña Ana county designated nonattainment, classification, moderate; all other counties unclassifiable | El Paso County designated nonattainment, classification, serious; part of Doña Ana county designated nonattainment, classification, marginal; all other counties unclassifiable or attainment |

Sources: 40 CFR 81.332 and 81.344 (Air data updated 9/26/03)

Table 3.11-5 lists the most recent air emissions for Sierra and Doña Ana counties in New Mexico and El Paso County in Texas. Although there are seven other New Mexico and Texas counties within AQCR 153, only the emissions data for Sierra, Doña Ana, and El Paso counties are listed because the activity associated with the alternatives would be localized in the narrow area along the river, and emissions from the activities would not be likely to affect the more distant AQCR counties in New Mexico and Texas.

**Table 3.11-5 Baseline Air Emissions for Sierra, Doña Ana, and El Paso Counties**

| County | Emissions (tons per year, tpy) | | | | | |
|---|---|---|---|---|---|---|
| | Carbon Monoxide (CO) | Volatile Organic Carbon (VOC) | Nitrogen Oxides ($NO_2$) | Sulfur Dioxide ($SO_x$) | Particulate Matter ($PM_{10}$) | Particulate Matter ($PM_{25}$) |
| Sierra | 16,676 | 2,085 | 1,781 | 83 | 7,907 | 1,700 |
| Doña Ana | 89,488 | 11,413 | 14,158 | 1,246 | 63,654 | 10,997 |
| El Paso | 138,253 | 21,095 | 24,073 | 1,986 | 7,478 | 3,024 |
| CY99 Totals: | 244,417 | 34,593 | 40,012 | 3,315 | 79,039 | 15,721 |

Note: VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. $PM_{2.5}$ data are included for information only.
Source: AIRData 1999. USEPA 2003.

Specific information describing the types of equipment required for a specific task, the hours the equipment is operated, and the operating conditions vary widely. Emissions from the current RGCP operation and maintenance activities were calculated using established estimating methodologies for equipment operation (Means 2002). Combustive emissions from equipment exhausts were estimated by using USEPA approved emissions factors for various equipment types that would be used for the RGCP operation, maintenance, and mowing activity (USEPA 1985). The emissions presented in Table 3.11-6 include the estimated annual emissions from equipment exhaust associated with RGCP operation and maintenance activity.

**Table 3.11-6 Estimated Air Emissions from Current RGCP Operation and Maintenance Activity**

| Emissions (tons per year, tpy) | | | | | |
|---|---|---|---|---|---|
| Carbon Monoxide (CO) | Volatile Organic Carbon (VOC) | Nitrogen Oxides ($NO_2$) | Sulfur Dioxide ($SO_x$) | Particulate Matter ($PM_{10}$) | Particulate Matter ($PM_{25}$) |
| 68 | 14 | 170 | 19 | 97 | 0 |

Note:VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant. $PM_{2.5}$ data are included for information only. Data calculated based on current RGCP operation and maintenance activity.

## 3.12 NOISE

### 3.12.1 Guidelines

Noise is defined as sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying. Noise levels often change with time. To compare sound levels over different time periods, several descriptors have been developed that take into account this time-varying nature. These descriptors are used to assess and correlate the various effects of noise on humans.

The day-night average sound level (DNL) is a measure of the total community noise environment. DNL is the average A-weighted sound level over a 24-hour period, with a 10 dBA adjustment added to the nighttime levels (between 10:00 p.m. and 7:00 a.m.). This adjustment is an effort to account for increased human sensitivity to nighttime noise events. DNL was endorsed by the USEPA for use by federal agencies. DNL is an accepted unit for quantifying annoyance to humans by general environmental noise, including aircraft noise. The Federal Interagency Committee on Urban Noise developed land use compatibility guidelines for noise (U.S. Department of Transportation 1980). Potential adverse effects of noise include annoyance, speech interference and hearing loss.

#### *Annoyance*

Noise annoyance is defined by the USEPA as any negative subjective reaction to noise by an individual or group. Typically 15 to 25 percent of persons exposed on a long-term basis to DNL of 65 to 70 dBA would be expected to be highly annoyed by noise events, and over 50 percent at DNL greater than 80 (NAS 1977).

#### *Speech Interference*

In a noisy environment, understanding speech is diminished when speech signals are masked by intruding noises. Based on a variety of studies, DNL 75 dBA indicates there is good probability for frequent speech disruption. This level produces ratings of “barely acceptable” for intelligibility of spoken material. Increasing the level of noise to 80 dB reduces the intelligibility to zero, even if the people speak in loud voices.

#### *Hearing loss*

Hearing loss is measured in decibels and refers to a permanent auditory threshold shift of an individual’s hearing. The USEPA (USEPA 1974) has recommended a limiting daily equivalent energy value of equivalent sound level of 70 dBA to protect against hearing impairment over a period of 40 years. Hearing loss projections must be considered conservative as the calculations are based on an average daily outdoor exposure of 16 hours.

### 3.12.2 Baseline Noise Levels

Areas along RGCP sites include two distinctly different settings for noise purposes. One setting is rural and the other setting is urban.

Noise sources in the rural setting include operation of RGCP maintenance equipment, as well as farming and ranching equipment. Additionally there is sporadic vehicular traffic on gravel roads adjacent to the RGCP and on bridges crossing the RGCP. The background noise levels in the rural areas when tractors and equipment are not operating would be approximately DNL 45 dBA based on a typical noise environment in a rural area away from highways (USEPA 1974). The area adjacent to the RGCP is used for ranching and farming. Therefore, residences are scattered and there are no populated centers. Sierra County, New Mexico is predominantly rural and has no urban area and has population density of 3.2 persons per square mile (USBC 2002c). It is estimated that the population density in the rural areas of the RGCP in Doña Ana County, New Mexico and El Paso County, Texas would be the same as Sierra County based on comparison of aerial photographs of the rural areas of all three counties.

The area along the RGCP in Las Cruces, Doña Ana County and El Paso, El Paso County are typical of an urban setting. Noise sources in these areas include vehicle and construction equipment operation as well as numerous other sources. The noise levels in urban areas would be expected to range from about DNL 50 dBA for a quiet daytime setting to approximately DNL 80 dBA for a typical noisier condition. Doña Ana and El Paso counties have both urban and rural areas. Therefore, the Las Cruces and El Paso urban areas influence the overall population density of Doña Ana and El Paso counties, which are 45.9 and 670.9 persons per square mile, respectively (USBC 2002a, USBC 2002b). Since these population densities include both the rural and urban areas of the counties, the population density in the areas adjacent to the RGCP in the Las Cruces and El Paso areas likely would be greater than the overall county density.

## 3.13 TRANSPORTATION

Local, state, and interstate roadways are located throughout the project area. Many of these roadways run parallel and or adjacent to the Rio Grande. The roadways within the project area that could compromise routes to and from the levees during project construction are discussed in this section.

The transportation system for the three county area is served by a network of federal and state highways which includes Interstates 10 and 25. U.S. Highway 85 generally parallels the Rio Grande from Las Cruces to Hatch and U.S. Highways 20 and 478 run just east of the river and connects El Paso to Las Cruces. U.S. Highway 20 changes to U.S. Highway 478 near Anthony, Texas and then connects to U.S. Highway 85 in Las Cruces. The project site is also well served by numerous other state and farm to market (FM) highways throughout the valley.

There are 26 bridges that cross the Rio Grande from the American Dam to the Percha Dam. Approximately 70 percent of them are located in the Mesilla Valley area and the remaining 30 percent are located in the Rincon Valley. These bridges provide good access across the entire project area and to access roads that lead to property owners adjacent to the Rio Grande.

Approximately 85 percent of the Rio Grande between El Paso and the Percha Dam is considered to be in rural areas and the remaining 15 percent is considered urban. The urban areas are near Las Cruces and El Paso. The roadways that run parallel, across, or adjacent to the levees of the Rio Grande are described below.

Approximately 8 miles of the Rio Grande is located in Sierra County, which is considered entirely rural. The Rio Grande flows along urban areas adjacent to the western portion of El Paso County for approximately 20 miles. However, the majority of the project area, 78 miles, is located in Doña Ana County, which is mostly rural except for an approximate 2-mile area near the western portion of Las Cruces.

Interstate 10 (I-10) and I-25 are the main throughways in the project area, traveled by visitors to the area as well as by those who reside in the three counties. The western boundary of Las Cruces extends to the Las Cruces Regional Airport along I-10. The northern border of the city extends north of the U.S. Highway 70 and I-25 interchange and the southern border from the I-10 and I-25 interchange. The Rio Grande runs northwest to southeast along the western edge of the city and parallel to State Highways 28, 185 and 292. Numerous feeder roads connect to these highways and service the areas parallel to the Rio Grande.

Interstate 10 runs south and parallel to the Rio Grande from Las Cruces to El Paso, Texas. Along the western portion of El Paso, State Highway 20 runs parallel to the river and then connects to I-10 and US Highway 85. Similar to Las Cruces, El Paso has numerous feeder roads that cross over or run parallel to the levees along the river.

State Highway 185 runs parallel to the Rio Grande from Las Cruces to Hatch where the highway changes to State Highway 187 at the junction of State Highways 26, 154, and 185 near mile marker 84. State Highway 187 continues along the Rio Grande to mile marker 100 where it crosses the river.

Table 3.13-1 lists the roadways expected to be accessed during construction and maintenance activities on the project along the Rio Grande from the American Dam to the Percha Dam. The 1997 average daily traffic volumes on those roadways, roadway characteristics, and associated level of service (LOS) are also included in the table (CH2M-Hill 2000b).

Driver satisfaction can be measured quantitatively during different levels of traffic congestion. This classification, LOS, measures the congestion on a roadway on a continuum from LOS "A" (free flow) to LOS "F" (traffic jam) conditions. For the areas along the Rio Grande from El Paso to the Percha Dam, LOS "A", "B", and "C" are considered to be acceptable roadway operating conditions in urban areas. LOS "D" is considered marginally acceptable; LOS "E" is undesirable; and LOS "F" is considered to be unacceptable congestion levels.

The LOS standard for Texas is C while the LOS for New Mexico is B. The New Mexico Department of Transportation allows lowering the existing LOS of a particular roadway one level during construction of roadway projects, but requires maintaining at least a LOS of D at all times (CH2M-Hill 2000b).

**Table 3.13-1 Roadway Characteristics, Average Daily Traffic and Existing Level of Service**

| Roadway | Proximity to the Rio Grande | Characteristics | Average Daily Traffic (ADT) | Average Daily Truck Traffic | Existing Level of Service (LOS) |
|---|---|---|---|---|---|
| SH 62/180 | South of American Dam | 4 lanes, paved, 40 mph | 53,062 | 5,306 | D |
| I 10 | Parallels river | 4 lanes interstate, paved, 65 mph | 40,000 | 4,000 | C |
| SH 375 | Mile 12 | 4 lanes, paved, 60 mph | 40,000 | 4,000 | C |
| SH 20 | Mile 16.5 | 4 lanes, paved, 60 mph | 9,220 | 922 | A |
| SH 478 | Parallels river | 2 lanes, paved, 55 mph | 12,151 | 1,215 | B |
| Vinton Rd. | Mile 15.75 | 2 lanes, paved, 40 mph | 5,500 | 550 | A |
| SH 225 | Mile 19.5 | 2 lanes, paved, 40 mph | 4,359 | 436 | A |
| Levee Road | Parallels river | < 2 lanes, gravel | Data not available | Data not available | Data not available |
| SH 404 | Mile 21 | 2 lanes, paved, 55 mph | 5,496 | 550 | A |
| SH 226 | Mile 24 | 2 lanes, paved, 55 mph | 3,749 | 375 | A |
| SH 227 | Mile 28 | 2 lanes, paved, 50 mph | 2,000 | 200 | A |
| SH 28 | Parallels river | 2 lanes, paved, 40 mph | 3,586 | 359 | A |
| SH 192 | Mile 32.5 | 2 lanes, paved, 40 mph | 4,518 | 452 | A |
| SH 228 | Mile 32.5 | 2 lanes, paved, 40 mph | 3,110 | 311 | A |
| I 25 | Near Mesilla parallels river | 4 lanes interstate, paved, 75 mph | 18,379 | 1,838 | B |
| SH 185 | Parallels river starting at mile 45 | 2 lanes, paved, 55 mph | 18,313 | 1,831 | B |
| SH 154 | Mile 82 near Hatch | 2 lanes, paved, 40 mph | 1,497 | 150 | A |
| SH 26 | Mile 84.5, Franklin Street in Hatch | 2 lanes, paved, 30 mph | 5,478 | 548 | A |
| SH 187 | Mile 85, Hall Street parallels river | 2 lanes, paved, 40 mph | 16,307 | 1,631 | D |

# SECTION 4
# ENVIRONMENTAL CONSEQUENCES

This section addresses the direct, indirect and cumulative effects of the No Action Alternative and the three action alternatives as they affect the 13 resource areas. These resource issues were raised during the scoping and consultation process. This section is organized by resource issues and provides the scientific, analytical, and technical basis for assessing the effects on those resources.

Direct impacts and indirect are those that occur primarily within RGCP. These impacts occur over a 20 year implementation period. While some effects are negative or adverse, the long term effects are beneficial. The environmental consequences discussion combines both kinds of effects.

Cumulative impacts occur when the USIBWC action has an incremental impact when analyzed in light of "past, present, and reasonable foreseeable future actions regardless who causes or is responsible for such actions." The USIBWC actions under consideration are unique and confined locally to the RGCP

Most of the other actions are planning actions that might influence river conditions and have been considered from a general perspective. Planning functions such as recreations areas permitted by the USIBWC were considered as ongoing actions as part of the RGCP project.

Mitigation has been addressed in a subsection by resource areas. Most of the actions have been included as part of the project activities for implementation.

Evaluation criteria were identified for resource areas to assess potential effects of environmental measures included under each river management alternative. Effects evaluation criteria were selected by the USIBWC and support technical team taking into consideration issues discussed during the Environmental Impact Statement scoping and alternatives formulation meetings.

For each of the resource areas evaluated, the following sequence of presentation is used:

- Resource and evaluation criteria,
- Method of analysis,
- Comparative summary of effects for all alternatives, and
- Discussion of effects by individual alternative.

Potential cumulative effects associated with other projects and pertinent activities and mitigation measures, are presented in separate subsections following the resources impact analysis.

## 4.1 WATER RESOURCES

The effects of the alternatives on water resources along the RGCP were evaluated using the following evaluation criteria:

- Changes in water consumption;
- Water delivery efficiency; and
- Effects on water quality.

### 4.1.1 Method of Analysis

Water consumption rates were applied on an annual basis to the acreage for each measure. Table 4.1-1 presents 2001 water consumption estimates for various types of plant coverage. Applicable 2001 data for the Rio Grande Basin were obtained from USBR AWARDS System/ET Tool Box Project. Table 4.1-2 lists for each individual measure assumptions used in the calculation of water consumption.

Changes in delivery efficiency and water quality were both evaluated in qualitative terms. Assumptions for changes in water delivery efficiency are listed in Table 4.1-2.

**Table 4.1-1 Water Consumption Estimates for Rio Grande Vegetation**

| Type of Coverage | Annual Water Consumption* (ac-ft/ac) | Start Date | Term Date | Evapotrans-piration (inches) | Annual Forecast (inches) |
|---|---|---|---|---|---|
| Pasture grass | 4.01 | Mar 15 | Oct 20 | 41.3 | 48 |
| Miscellaneous grass | 4.63 | Apr 05 | Oct 20 | 47.7 | 56 |
| Cottonwood | 3.48 | Apr 05 | Nov 21 | 30.4 | 42 |
| Salt cedar | 4.96 | Apr 05 | Nov 21 | 49.5 | 59 |
| Riparian wood/shrub | 5.35 | Apr 05 | Nov 21 | 46.7 | 64 |
| Open water | 8.48 | Jan 01 | Dec 31 | 73.3 | 102 |
| Marsh | 8.85 | Jan 01 | Dec 31 | 76.5 | 106 |

* Annual forecast expressed in feet. Data for 2001 from USBR Rio Grande Basin AWARDS System and ET Toolbox Project (*www.usbr.gov/pmts/rivers/awards/Nm/riogrande.html*)

### 4.1.2 Summary of Potential Effects

Table 4.1-3 presents a comparative summary of potential effects of river management alternatives on water resources.

### 4.1.3 No Action Alternative

No effects are anticipated on water consumption, water delivery or water quality as current practices are maintained.

## Table 4.1-2 Assumptions for Water Consumption Estimates and Changes in Water Delivery Efficiency

| Measure | Assumptions for Water Consumption Estimates | Assumptions for Changes in Water Delivery Efficiency |
|---|---|---|
| Levee rehabilitation | No effect on water consumption. | No effects on water delivery. |
| Modify grazing practices | No net change for uplands. In the floodway, managed grasslands replace grazed areas (4.63 – 4.01 = 0.62 ft/yr increase). | No effect on water delivery (potential positive effect by reduction in erosion and sediment load). |
| Modified grassland management in floodway | Managed grasslands replace currently mowed areas (4.63 – 4.01 = 0.62 ft/yr increase). | No effect on water delivery (potential positive effect by reduction in erosion and sediment load). |
| Plant woody native vegetation | Tree planting areas replace both currently mowed areas (5.35 - 4.01 = 1.34 ft/yr increase), and salt cedar areas (4.96 – 3.48 = 1.48 ft/yr reduction) | Potential bank stabilization (reduced sediment load) by riparian corridor and increase in debris in the pilot channel (interference with irrigation infrastructure). |
| Enhance existing bosques | No water consumption increase as existing bosques are maintained. | No effects on water deliveries as existing bosques are maintained. |
| Bank shavedowns | Bosques replace both currently mowed areas (5.35 - 4.01 = 1.34 ft/yr increase), and salt cedar areas (4.96 – 3.48 = 1.48 ft/yr reduction) | Potential sediment load changes (reduction by vegetative bank stabilization, and short-term increase by soil mobilization). Short-term increase in debris into the pilot channel. |
| Open former meanders | Open water replaces both currently mowed areas (8.48 – 4.01 = 4.47 ft/yr increase) and salt cedar bosque (8.48 – 4.96 = 3.52 ft/yr increase). | Minimum effect on water delivery as meanders would be reopened downstream to create backwaters, not as flow-through channels. |
| Modify dredging at arroyos | No net increase in water surface area exposed to evaporation. | No effect as dredging Is required to prevent pilot channel obstructions. |
| Controlled peak flows | As a conservative scenario, consumption of entire volume of water released (assuming no downstream utilization for irrigation). | Controlled releases would cause overbank flows and potential short-term increase in sediment and debris into the pilot channel. |
| Conservation easements | No increase in current water consumption for remnant bosques (no intervention), or agricultural lands (managed grasslands replace cropped areas). | No effect on water delivery. |

## Table 4.1-3 Summary of Potential Effects on Water Resources

| Evaluation Criteria | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Change in water consumption relative to 645,000 ac-ft annual diversions along the RGCP | No effect | 0.17% | 0.35% | 1.55% |
| Effect on water delivery efficiency | No effect | No effect | Potential adverse short-term effects; long-term improvement | Potential adverse short-term effects; long-term improvement |
| Effect on water quality | No effect | Potential adverse short-term effects; long-term improvement | Potential adverse short-term effects; long-term improvement | Potential adverse short-term effects; long-term improvement |

### 4.1.4 Flood Control Improvement Alternative

Water consumption would be increased by converting 1,739 acres of grazing areas in the floodway into an improved riparian community. The estimated change would be 1,078 ac-ft/yr assuming a rate increase of 0.62 ft/yr. This amount is equivalent to 0.17 percent of the annual combined diversions of Rio Grande Project water at Leasburg, Mesilla and American Dams (645,000 ac-ft/year).

No effects on water delivery efficiency are anticipated as a result of the levee system rehabilitation, or changes in grazing leases in uplands.

Water quality could decrease in terms of total suspended solids during construction, but it would improve in the long-term by a reduced sediment load and lower nutrient input from grazing areas with improved vegetative cover.

### 4.1.5 Integrated USIBWC Land Management Alternative

#### *Water Consumption*

Potential changes in water consumption are listed in Table 4.1-4. The potentially more significant changes in water consumption would be in the change of grazing leases and no-mow areas to managed native vegetation grasslands, each measure representing approximately 0.17 percent of the combined diverted water from Leasburg, Mesilla and American Dams. The net increase for tree planting areas and stream bank shavedowns, taking into account the required removal of salt cedar, is approximately 0.02 percent of the combined annual diversion value. On an annual basis, the potential water use for the Integrated USIBWC Land Management Alternative would represent, at the completion of the 20-year implementation period, approximately 0.35 percent of the combined water diversion from Leasburg, Mesilla and American Dams (Table 4.1-4).

**Table 4.1-4 Water Consumption Estimates for the Integrated USIBWC Land Management Alternative**

| Measure | Area (acres) | Unit Rate (ac-ft/yr) | Consumption at Full Implementation (ac-ft/yr) | Use Relative to 645,000 ac-ft/yr of Diverted Water* |
|---|---|---|---|---|
| Modified grazing leases | | | | |
| Uplands (50.8%) | 1,805 | 0.00 | 0.0 | 0.00% |
| Floodway ( 49.2%) | 1,747 | 0.62 | 1,083 | 0.17% |
| Native grasslands | 1641 | 0.62 | 1,017 | 0.16% |
| Tree planting areas | | | | |
| Currently mowed areas | 146.0 | 1.34 | 196 | 0.03% |
| Salt cedar areas | 77.0 | -1.48 | -114.0 | -0.02% |
| Stream bank shavedowns | | | | |
| Currently mowed areas | 74.0 | 1.34 | 99 | 0.02% |
| Salt cedar areas | 53.0 | -1.48 | -78.4 | -0.01% |
| | | **Total Estimate** | **2,203** | **0.34%** |

* An average diversion of 645,000 ac-ft/yr was based on a combined average of 890 cfs along the RGCP (181 cfs at Leasburg Dam, 312 cfs at Mesilla Dam, and 397 cfs at American Dam; data from Figure 3-3).

### *Water Delivery and Water Quality*

Development of riparian vegetation along the stream banks is likely to have a positive long-term effect on cottonwoods and willows, once established, and would provide stability to the stream bank. In a technical evaluation of the RGCP functionality, vegetative stream bank stabilization with sand bar willow was recommended as a multi-objective technique for bank protection, sediment input reduction, and improved riparian habitat along the RGCP (USACE 1996). The evaluation recommended vegetative stabilization for nearly four miles of stream banks, applied either individually or in combination with riprap or soft armoring technologies.

On the short-term, the bank preparation and seedling establishment could result in a greater release of plant debris into the channel and the need for additional channel maintenance. However, shavedown areas would be designed to provide backflooding and avoid creating free-flow channels over the vegetated area.

Soil preparation, prior to establishment of the vegetative cover, could result in short-term increases of sediment release into the river. This effect would not be considered significant in terms of water quality given that a potential sediment contribution from 127 acres of shavedowns areas would be negligible compared to the RGCP tributary watershed that extends over several hundred square miles. Water quality is likely to improve to some extent as a more extensive vegetative cover on the RGCP floodway and uplands improve erosion control and lessen nutrient release from grazing areas.

## 4.1.6 Targeted River Restoration Alternative

### *Water Consumption*

Potential changes in water consumption are listed in Table 4.1-5. Excluding controlled water releases from Caballo Dam, the potential water consumption would be approximately 0.33 percent of the combined diversions at Leasburg, Mesilla and American Dams. This consumption is similar to the estimated value for the Integrated USIBWC Land Management Alternative, considering both alternatives at full implementation. Controlled water releases would increase water consumption to approximately 1.47 percent of the water diversions along the RGCP.

Water consumption associated with controlled releases from Caballo Dam was estimated as a function of volume released, not of the overbank flow surface area. Appendix F describes the assumptions and basis for the calculation. The potential release calculation took into consideration that 5,000 cfs is the physical limitation of the Caballo Dam outlet work discharge structure, as well as the design value for containment of the 100-year flood in the upper reach of the RGCP. With a typical average irrigation release of 1,300 cfs for the main irrigation season, an additional 3,700 cfs above the average irrigation release would be required to reach the maximum discharge from Caballo Dam as determined by the outlet works capacity.

## Table 4.1-5 Water Consumption Estimates for the Targeted River Restoration Alternative

| Measure | Area (acres) | Unit Rate (ac-ft/yr) | Consumption at Full Implementation (ac-ft/yr) | Use Relative to 645,000 ac-ft/y of Diverted Water* |
|---|---|---|---|---|
| Modified grazing leases | | | | |
| 50.8% in uplands | 1,805 | 0.00 | 0.0 | 0.00% |
| 49.2% in the floodway | 1,747 | 0.62 | 1,083 | 0.17% |
| Native grasslands | 1,641 | 0.62 | 1,017 | 0.16% |
| Tree planting areas | | | | |
| Currently mowed areas | 124.0 | 1.34 | 166 | 0.03% |
| Salt cedar areas | 65.0 | -1.48 | -96.2 | -0.01% |
| Open former meanders | | | | |
| Currently mowed areas | 54.0 | 4.47 | 241 | 0.04% |
| Salt cedar areas | 88.0 | 3.52 | -310 | -0.05% |
| Controlled peak flows** | 516 | n/a | 7,336 | 1.14% |
| | | **Total Estimate** | 9,461 | 1.47% |

* Average diversion of 645,000 ac-ft/yr based on a combined average of 890 cfs along the RGCP (181 cfs at Leasburg Dam, 312 cfs at Mesilla Dam, and 397 cfs at American Dam; data from Figure 3-3).

** Assumes a single 3,700 cfs discharge above average irrigation flows during the early irrigation season. The controlled released would be limited to a maximum of 24 hours (Appendix F).

To estimate the potential extent and duration of controlled releases from Caballo Dam, it was assumed that overbank flows would be induced during the early irrigation season, the most suitable for cottonwood establishment (Crawford *et al.*, 1999). For water consumption estimates, a release period up to 24 hours was assumed to increase soil moisture by overbank flooding and ponding (3,700 cfs over one day, or 7,336 ac-ft per year). Micro-irrigation could be used in subsequent months to support seedling development. Micro-irrigation was effective in cottonwood seedling establishment in Middle Rio Grande arid floodplains during tests conducted by the Rocky Mountain Research Station of the NRCS (Dreesen *et al.*, 1999).

It is anticipated that the maximum Caballo Dam discharge value would be reached by the end of a 20-year implementation period by gradually increasing releases of smaller magnitude. Any increase in water releases over irrigation flows assumes that extended monitoring would indicate that:

- Releases are an ecologically sound and effective approach to support development of the riparian corridor along the RGCP in relation to site-specific techniques such as shavedowns, planting, and seedling development by micro-irrigation.
- Enough water rights are acquired for the releases, and the releases do not to interfere with irrigation water delivery.
- Releases are safe to downstream properties, and agreements are reached for any required conservation easements in areas where induced water releases could extend beyond the ROW.

#### *Water Delivery and Water Quality*

Similarly to the Integrated USIBWC Land Management Alternative the development of riparian vegetation along the stream banks is likely to have a long-term positive effect as cottonwood and willows, once established, would provide stability to the stream bank. On the short-term, bank preparation and seedling establishment could result in a greater release of plant debris into the channel and the need for additional channel maintenance.

Soil preparation, prior to establishment of the vegetative cover could result in short-term increases of sediment release into the river. This effect would not be considered significant in terms of water quality, given that a potential sediment contribution from 127 acres of shavedowns areas would be negligible compared to the RGCP tributary watershed that extends over several hundred square miles. Water quality is likely to improve to some extent, as a more extensive vegetative cover on the RGCP floodway and uplands improve erosion control and nutrient release from grazing areas.

## 4.2 FLOOD CONTROL

Effects on flood control for all alternatives along the RGCP were evaluated using the following evaluation criteria:

- Increase in levee rehabilitation need, and
- Potential deficiencies as a percent of total levee system.

### 4.2.1 Method of Analysis

#### *Analysis of Potential Levee System Deficiencies*

A flood containment capacity analysis was performed using a hydraulic model to compare potential levee deficiencies under the No Action Alternative with those anticipated following implementation of environmental measures under the three action alternatives. The analysis emphasized the potential of extensive vegetation growth on the floodway. Simulations were performed using a HEC-2 model developed for the RGCP by the USACE (1996), converted to a HEC-RAS model (version 2) currently in use by the agency.

The HEC-RAS model, widely used in flood control studies, performs one-dimensional water surface profile calculations for steady-state conditions with gradual changes in flow due to inflows from tributaries and diversion outflows from the Rio Grande for irrigation. For locations where the assumption of steady state flows is valid, HEC-RAS solves the energy equation exclusive of any time-dependent terms. At locations where the flow is rapidly varied (at hydraulic structures such as bridges, culverts, and weirs), the program switches to the momentum equation or other empirical equations. HEC-RAS is a one-dimensional model (i.e., velocity components in directions other than the direction of flow are not accounted for) because the mathematical equations used are based on the premise that the total energy head is the same for all points in a cross section. The program for this study does not have the capability of dealing with movable boundaries (i.e., sediment transport), or hydrograph routing, which would allow varying discharge rates to be calculated as the floodplain cross section varies. The topographic information available is limited to the digital elevation model, which the USACE produced for the 1996 study that typically extends only a very limited distance outside the ROW.

For the analysis of conditions under the No Action Alternative, hydraulic input data files and hydrologic data for the 100-year flood from the 1996 USACE study were used, as well as roughness coefficients applicable to the channel and floodway. Cross section geometry data were modified along a section of the El Paso RMU to incorporate the new Courchesne Bridge as planned by the Texas Department of Transportation.

To evaluate effects of the Integrated USIBWC Land Management and Targeted River Restoration alternatives, 100-year flood conditions were evaluated by modification of the 1996 USACE model to incorporate the effects of vegetation growth on the floodway. Extensive vegetation growth was initially simulated as part of the Alternatives Formulation Report completed in March 2001 (Parsons 2001a), but the extent of the vegetation cover was reduced as part of the alternatives reformulation (Parsons 2003a) when changes were made to the extent and locations of environmental measures as previously discussed in Subsection 2.1. The most extensive reductions in vegetation growth along the floodway were made in the El Paso, Las Cruces, and Lower Mesilla RMUs where a significant potential for increase in deficiencies was anticipated (nearly 75 percent of the increase of freeboard deficiencies as simulated in 2001 were located in the El Paso, Lower Mesilla, and Las Cruces RMUs). Vegetation growth along the floodway was simulated by increasing roughness coefficients (Manning's "n") from a typical value of 0.03 for mowed brush to 0.04 for agriculture, 0.05 for wetlands, 0.10 for shrubs, and 0.15 for trees. Appendix E lists the extent of changes in roughness coefficients included in the evaluation of alternatives for the Environmental Impact Statement as well as calculated water elevations.

### 4.2.2 Summary of Effects

Table 4.2-1 presents a comparative summary of potential effects of river management alternatives on flood control.

**Table 4.2-1 Summary of Potential Effects on Flood Control**

| Evaluation Criteria | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Need for levee improvements | 60.1 miles | None | None | None |
| Average levee height increase for flood control improvement | Not applicable | 24 inches | 24.6 inches* | 24.6 inches* |

* Relative to the Flood Control Improvement Alternative the levee improvement program would require an average height increase (from an assumed average of 24 inches to 24.6 inches).

### 4.2.3 No Action Alternative

Under the No Action Alternative the risk of flooding for the 100-year flood would remain as currently quantified on the basis of the HEC-RAS simulations (Section 3.2).

### 4.2.4 Flood Control Improvement Alternative

The Flood Control Improvement Alternative would address potential deficiencies in the levee system by construction of 2.8 miles of floodwall in the Canutillo area, 6 miles of new earthen levees, and levee rehabilitation along 60.1 miles to increase freeboard to the minimum design value of 3 feet. This measure would provide the additional protection to life and public and private property beyond that already provided by the existing levee system and upstream flow regulation against an extremely high flood event induced by a storm with a 100-year recurrence period.

### 4.2.5 Integrated USIBWC Land Management Alternative

Benefits of an improved flood control system would be obtained under this alternative,. There is, however, a potential for increase in deficiencies due to increase vegetation growth along the floodway. Table 4.2-2 lists changes in levee rehabilitation estimates in the flood control system, as identified in the baseline conditions, compared to potential deficiencies that could result from riparian and floodway vegetation growth at the completion of the 20-year implementation period. The overall difference in estimates for rehabilitation is an increase of 2.29% relative to the baseline conditions. In terms of levee rehabilitation, an average increase of 0.55 inches would be required over the 2-foot assumption used for the flood control improvement alternative.

**Table 4.2-2 Estimates of Levee Rehabilitation Needs for the Integrated USIBWC Land Management Alternative**

| River Management Unit | Estimates for the Alternative | | Estimates for Baseline | | Difference Versus Baseline | Increase In Rehabilitation Height (inches)* |
|---|---|---|---|---|---|---|
| | Miles | % of Levee System | Miles | % of Levee System | % | |
| Upper Rincon | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| Lower Rincon | 10.5 | 34.5 | 9.0 | 29.6 | 4.93 | 1.18 |
| Upper Mesilla | 5.7 | 71.3 | 5.4 | 67.5 | 3.75 | 0.9 |
| Las Cruces | 18.7 | 91.2 | 18.2 | 88.8 | 2.44 | 0.59 |
| Lower Mesilla | 10.5 | 27.6 | 10.2 | 26.8 | 0.79 | 0.19 |
| El Paso | 17.3 | 70.0 | 17.3 | 70.0 | 0.0 | 0 |
| **Total** | 62.7 | 48.1 | 60.1 | 45.9 | 2.29 | 0.55 |
| * Average increase in levee height above a 2 ft rehabilitation average assumed for current floodway conditions | | | | | | |

A low potential for levee deficiency increase as a result of project implementation was identified under current conditions (without flood control improvements). No linear projects and only four locations where identified as having an adverse effect on flood control under current conditions. Those locations correspond to point projects at river miles 42, 48, 76 and 83 (either planting sites and/or stream bank shavedowns) that are under consideration for the Integrated USIBWC Land Management Alternative (Table 4.2-3). Reductions in feeboard below the 3-feet design value as a result of increased vegetation, as simulated by hydraulic modeling, are tabulated in Appendix E, Table E-2.

### Table 4.2-3 Point Projects with a Potential to Reduce Freeboard Below Design Values

| River Mile ID | Site Name | Measure A: Native Vegetation Planting | Measure B: Stream Bank Shavedowns | Measure C: Open Former Meanders | Measure D: Modify Dredging at Arroyos |
|---|---|---|---|---|---|
| **105** | Oxbow Restoration | 105A | | 105C | |
| **104** | Tipton Arroyo | 104A | 104B | | 104D |
| **103** | Trujillo Arroyo | | 103B | | 103D |
| **102** | Montoya Arroyo | 102A | 102B | 102C | 102D |
| **101** | Holguin Arroyo | 101A | 101B | | 101D |
| **99** | Green/Tierra Blanca Arroyos | 99A | | | 99D |
| **98** | Sibley Point Bar | | 98B | | 98D |
| **97** | Jaralosa Arroyo | | | 97C | 97D |
| **95** | Jaralosa South | 95A | | 95C | |
| **94** | Yeso Arroyo | 94A | 94B | | 94D |
| **92** | Crow Canyon | | 92B | 92C | |
| **85** | Placitas Arroyo | | | | 85D |
| **83** | Remnant Bosque | **83A*** | **83B*** | | 83D |
| **78** | Rincon/Reed Arroyos | | | | **83B*** |
| **76** | Bignell Arroyo | **76A*** | **76B*** | | 76D |
| **54** | Channel Cut | 54A | | 54C | |
| **49** | Spillway No. 39 | **49A*** | | | |
| **48** | Spillway No. 8 | **48A*** | | | |
| **42** | Clark Lateral | 42A | | | |
| **41** | Picacho and NMGF | 41A | | | |

* Highlighted locations indicate that, under current conditions, environmental measure implementation would result in a levee freeboard less that 3 feet, or an increase in already existing freeboard deficiencies.

## 4.2.6 Targeted River Restoration Alternative

Potential effects of the levee rehabilitation program under this alternative would be similar to those described for the Integrated USIBWC Land Management. The extent of riparian vegetation growth and floodway management within the levee system would be similar for the two alternatives.

For the Targeted River Restoration Alternative, five locations were identified where point project implementation under current conditions (without flood control improvements) would have an adverse effect on flood control. Those projects are located at river miles 42, 48, 76, 78 and 83 (Table 4.2-3). Reductions in levee feeboard below the 3-feet design value as a result of increased vegetation, as simulated by hydraulic modeling, are tabulated in Appendix E, Table E-2. No linear projects, with exception of those associated with seasonal peak flows, would have an adverse effect on flood control. Developing native bosques through the use of seasonal peak flows would have an adverse effect on flood control at some sites south of river mile 83 to Leasburg Diversion Dam.

## 4.3 SOILS

Effects to soils are a function of direct short-term effects of construction and environmental measure implementation (*i.e.* earthwork, scouring from pulse flows, selective clearing) and long-term effects such as soil erosion in response to grazing. Effects of alternatives to soils were based on the following evaluation criteria:

- Amount of soil displaced or eroded from construction of levees and implementation of environmental measures;
- Amount of soil erosion as a result of grazing practices; and
- Environmental construction for excavation of arroyo, meanders, and earthwork.

### 4.3.1 Method of Analysis

#### *General Assumptions*

A GIS was used to calculate extent and location of measures. The results of the GIS analyses were assessed against baseline values. Assumptions and calculation used for assessing effects to soils through implementation of environmental measures are listed in Tables 4.3-1 – 4.3-5.

#### *Construction Estimates for Levee System Rehabilitation*

All action alternatives include levee construction measures that increase levee height and add additional levees or floodwalls. The assumption adopted in the DEIS to quantify construction activities for potential effects is that existing levees would be raised to meet freeboard design criteria or new levees would be constructed in unconfined areas where flood levels would extend past the ROW boundary.

In areas where rebuilding of levees would be required, existing levee material would be re-engineered with clay material to meet specifications for the new levee. Additional material would be obtained from sediment removed during implementation of environmental measures or from new borrow sites. Increase in levee footprint was used as evaluation criteria.

#### *Soil Excavation Estimate for Environmental Measures*

The Integrated USIBWC Land Management Alternative and Targeted River Restoration Alternative include excavating soil as part of implementing environmental measures (Tables 4.3-3 and 4.3-4). All soil excavated would be placed on existing levees or floodway and revegetated as part of the modified grassland measure. Soil salinity management could be required to facilitate revegetation of desired species.

## Table 4.3-1 Basis for Soil Calculations

| Measure | Loss (ac-ft) | Description |
|---|---|---|
| Levee rehabilitation | 898 | Levee volume estimates (additional material would be hauled from borrow areas outside of ROW; increase in levee footprint. |
| Modified grassland management in uplands | -- | Erosion reduced by >50% in uplands by increasing cover to an average of 40%. The sediment yield analyses equation used was the Modified Universal Soil Loss Equation (MUSLE) (USACE 1996). |
| Modified grassland management in riparian areas | -- | Shallow (<8") soil disturbance during site preparation and native grass planting. Minor soil erosion was assumed as a result of incorporating BMPs during construction and as vegetation reestablishes. Herbicidal treatments would be used to kill woody vegetation in previously mowed areas. Additional soil treatments to manage salinity could be required. Minor soil erosion was assumed during implementation of vegetation maintenance activities such as salt cedar control and fuel reduction. |
| Plant woody native vegetation | -- | Herbicidal treatments would be used to kill woody vegetation in previously mowed areas. In woodland areas selected for planting, implementation could include mechanical clearing, herbicide application, salinity management, and hauling of material. Maintenance using mechanical salt cedar removal methods would avoid the river edge and wetlands locations. Minor soil erosion was assumed for vegetation maintenance activities such as salt cedar control and fuel reduction. |
| Enhance existing bosques | -- | Minor soil erosion during selective removal and hauling of material. Mechanical salt cedar removal methods would avoid the river edge and wetlands locations and cleared using manual methods. Minor soil erosion was assumed as a result of incorporating BMPs during construction and as vegetation reestablishes. |
| Bank shavedowns | 157 | Assumed excavation of 127 acres to within 1 foot of mean irrigation flow. Table 4.3-3 list calculations. Soil would be placed in the floodway. Loss of soil during construction (incidental fill) and due to overbank flows would be minimal through incorporating BMPs and overflow bank design that promotes backflow inundation. Maintenance using mechanical salt cedar removal methods would avoid the river edge and wetlands locations. Minor soil erosion was assumed during maintenance activities such as salt cedar control and fuel reduction. |
| Opening former meanders | 225 | Excavation calculations assumed ½ volume of meander excavation depth (3 ft. below irrigation level). Material would be deposited in floodway. Loss of soil due to opening menders (incidental fill) would be minimal. Minor soil erosion was assumed during implementation of vegetation maintenance activities such as salt cedar control and fuel reduction. Site 105 and 92 listed with additional assumptions:<br>Site 105.– assumed above excavation calculation but for only ½ of meander length. Site is currently riparian woodland.<br>Site 92 assumed above excavation calculation but for only 1/4 of meander length. Site is very high relative irrigation water level and outside hydrologic floodplain. |
| Modify dredging at arroyos | 27.3 | 6.82 acres excavated an average of 4 feet. Material would be deposited in floodway. |
| Seasonal peak flows /bank preparation | 43 | Preparation and clearing of 517 acres. Shallow (<8") soil disturbance during site preparation. Assumes minor soil erosion as vegetation reestablishes. Loss of soil during overbank flows estimated at 1 inch per acre for 517 acres, or 43 ac-ft. Maintenance using mechanical salt cedar removal methods would avoid the river edge and wetlands locations. Minor soil erosion was assumed during maintenance activities such as salt cedar control and fuel reduction. |
| Conservation easements | n/a | Selective removal and clearing by mechanical or manual means. Shallow (<8") soil disturbance during site preparation and native grass planting for 288 ac. Minor soil erosion was assumed as a result of incorporating BMPs during construction and as vegetation reestablishes. Minor soil erosion was assumed during maintenance activities such as salt cedar control and fuel reduction. Maintenance using mechanical salt cedar removal methods would avoid the river edge and wetlands locations. |

## Table 4.3-2 Construction Estimates for Levee System Rehabilitation

| | | BY RIVER MANAGEMENT UNIT | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Entire RGCP** | **Upper Rincon** | **Lower Rincon** | **Seldon Canyon** | **Upper Mesilla** | **Las Cruces** | **Lower Mesilla** | **El Paso** |
| **River Mile:** | **105 - 0** | **105 - 90** | **90 - 72** | **72 - 63** | **63 - 51** | **51 - 40** | **40 - 21** | **21 - 0** |
| Levee volume (ac-ft.) | 898.1 | 0 | 127.7 | 0 | 67.6 | 230.6 | 128.3 | 344 |
| Levee footprint increase (acres) | 114.3 | 0.0 | 15.4 | 0.0 | 7.1 | 24.1 | 13.5 | 54.2 |
| Riprap volume (1,000 c.y.) | 35.5 | 2.2 | 11.0 | 0 | 0.0 | 0.0 | 10.0 | 12.3 |
| Borrow site size (acres) (assumes 6 ft excavation depth) | 149 | 0 | 21 | 0 | 11 | 38 | 22 | 57 |

## Table 4.3-3 Soil Excavation Estimates for Conducting Bank Shavedowns

| Point Projects | Shavedowns for Riparian Vegetation (acres) | Reference Irrigation Flow Elevation (feet) | Average Bank Elevation (feet) | Excavation Volume* (acre-ft) |
|---|---|---|---|---|
| 104B - Total | 3.4 | 4128.8 | 4131.0 | 3.92 |
| *103B* | *3.8* | *4127.7* | *4131.0* | *8.69* |
| *103B* | *4.3* | *4127.0* | *4128.5* | *2.12* |
| *103B* | *14.0* | *4123.8* | *4126.5* | *23.8* |
| *103B* | *2.0* | *4123.5* | *4128.0* | *6.93* |
| *103B* | *2.5* | *4123.1* | *4125.5* | *3.51* |
| 103B - Total | 26.6 | -- | -- | 45.1 |
| 102B | 11.1 | 4122.8 | 4125.0 | 13.3 |
| 102B | 1.9 | 4122.6 | 4125.0 | 2.70 |
| 102B | 11.7 | 4118.7 | 4120.0 | 3.51 |
| 102B - Total | 24.7 | -- | -- | 19.5 |
| *101B* | *9.7* | *4117.9* | *4120.5* | *15.5* |
| *101B* | *2.9* | *4117.4* | *4120.0* | *4.62* |
| 101B -Total | 12.6 | -- | -- | 20.1 |
| 98B Total | 4.1 | 4109.0 | 4112.0 | 8.24 |
| 94B Total | 3.9 | 4089.0 | 4092.0 | 7.78 |
| 92B Total | 17.9 | 4074.0 | 4077.0 | 35.7 |
| 83B Total | 17.9 | 4043.3 | 4044.5 | 3.57 |
| 76B Total | 16.3 | 4012.2 | 4014.0 | 13.0 |
| **Total** | 127 | -- | -- | **157** |

* See Table 4.3-1 for assumptions concerning volume estimates

**Table 4.3-4 Soil Excavation Estimates for Opening Meanders**

| Mile ID | Measure ID | Former Meander | Average Irrigation Flow Elevation | Average Bank Elevation | Average Height Above Irrigation Flow | Volume of Sediment ac-ft |
|---|---|---|---|---|---|---|
| 105 | 105c | 6.6 | 4129.9 | 4133 | 3.1 | 10.1 |
| 102 | 102c | 2.8 | 4121 | 4125 | 4.0 | 9.8 |
| 97* | 97c | 28.0 | 4100.9 | 4106 | 5.1 | 56.7 |
| 95 | 95c | 5.1 | 4090.8 | 4093.5 | 2.7 | 14.5 |
| 92* | 92c | 84.6 | 4077 | 4082 | 5.0 | 84.6 |
| 54 | 54c | 19.6 | 3924 | 3926 | 2.0 | 49.0 |
| **Total** | | | | | | **225** |

*Sites are outside the hydrologic floodplain but selected due to other criteria.

### 4.3.2 Summary of Potential Effects

Table 4.3-5 presents a summary of alternative effects on soils. Levee construction accounts for the majority of soil effects.

**Table 4.3-5 Soils Summary of Potential Effects**

| Evaluation Criteria | No Action | | Flood Control Improvement | | Integrated USIBWC Land Management | | Targeted River Restoration | |
|---|---|---|---|---|---|---|---|---|
| | Acre-feet | % of baseline | Acre-feet | % of baseline | Acre-feet | % of baseline | Acre-feet | % of baseline |
| Erosion from uplands (*Percent values represent a decrease in erosion due to measure)* | 0.71 | No change | 0.45 | 64% | 0.45 | 64% | 0.45 | 64% |
| Construction of levees | 0 | No change | 898 | | 898 | | 898 | |
| Environmental project construction | 0 | No change | 0 | No change | 157 | | 295 | |

### 4.3.3 No Action Alternative

Under the No Action alternative, soil erosion in the uplands and floodway is not expected to change from baseline conditions. Vegetative cover is currently estimated at <20 percent for upland vegetation and would likely remain consistent with baseline conditions under the current grazing regime.

### 4.3.4 Flood Control Improvement Alternative

Under this alternative, 898.1 ac-ft of material would be used for levee construction increasing levee footprint by 114.3 acres (Table 4.3-2). Based on engineering requirements, the soil within the levee footprint could be excavated and replaced by more structurally suitable material or buried and contained within the levee. Modified grazing in 1,805 acres of uplands would reduce sedimentation into the RGCP by 0.45 ac-ft annually (Table 4.3-6). Modified grazing in the riparian areas would likely improve bank stability and reduce potential soil loss due to increased vegetative cover. Table 4.3-6 provides a summary of soil effects of the Flood Control Improvement Alternative by RMU.

**Table 4.3-6 Soil Effects of the Flood Control Improvement Alternative**

| Evaluation Criteria | River Management Unit (acre-feet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
| Erosion from upland | 0.29 | 0.16 | nc | nc | nc | nc | nc | 0.45 |
| Construction of levees | nc | 127.7 | nc | 67.6 | 230.6 | 128.3 | 344 | 898.1 |
| Environmental project construction | nc | nc | nc | nc | nc | nc | nc | nc |

nc= no change

### *Soil Erosion*

Increasing upland vegetative cover to 40 percent would decrease sediment to 0.45 ac-ft annually (Table 4.3-6). It is anticipated vegetation response to modified grazing management would take several years. Beneficial effects for the floodway would include reduced bank erosion and sediment entering the river. It is anticipated that grazing in riparian areas would be reduced or temporally ceased to allow vegetation to recover and fencing constructed to exclude cattle from the river banks and wetlands areas.

### *Construction of Levees and Environmental Projects*

A total of 114 acres of floodway would be affected due to levee rehabilitation (Table 4.3-2). Soils within the levee footprint could be excavated, but would likely be covered with overburden.

Vegetation maintenance activates for grazing leases could include treatments such as re-seeding and woody vegetation control (mechanical and chemical treatments) in order to increase vegetation cover. Maintenance of floodway vegetation within grazing leases would include invasive species control to contain the extent of salt cedar. It is estimated that 30 percent of current grazing areas are riparian woodland dominated by salt cedar. Invasive species treatments would replace or compliment current mowing practice and could include chemical (such as Garlan4®) applications, mechanical treatments and prescribed burns. Details of treatments would be based on site-specific conditions.

Chemicals such as Garlan4® would have no direct effect on soils given the expected short half-life of the compounds in soils. Due to the herbicide’s low toxicity level and relatively short half-life periods (about 100 days for some compounds; most compounds less than 30 days) there would not be a long-term affect to using this product (USEPA 1998). The chemical application would be done in a way to avoid spills and be directed specifically at target areas. The chemical treatment would be applied during dry weather conditions when winds are minimal to prevent broadcast distribution over a larger area.

Use of mechanical equipment can cause soil alterations, compaction and rutting in heavily traveled areas. Alteration of natural drainage patterns within the micro-topography caused by mechanical equipment may locally alter soil topography within the savanna community. Mechanized vehicles would avoid impacting areas larger than necessary. The vehicles would be used in dry weather conditions to avoid soil rutting and compaction that would occur during wet conditions.

Prescribed burns may have various short-term effects on soil conditions. Soil organic matter is often increased by light burns, but can be decreased by intense fires. Nitrogen is often volatilized when vegetation and forest litter are burned. Nitrogen that is not lost by burning often becomes more available to plants, and soil nitrogen increases very much like the increase in organic matter (Agee 1974).

### 4.3.5 Integrated USIBWC Land Management Alternative

Under this alternative, soil effects due to levee rehabilitation and modified grazing would be the same as the Flood Control Improvement Alternative. Bank shavedowns would result in the removal of 157 ac-ft of fluvial soils (see Table 4.3-3 for calculations). Shavedown material would be deposited on existing levee toe and slopes and re-vegetated. Table 4.3-7 provides a summary of potential effects of the Integrated USIBWC Land Management Alternative by RMU and the reduced erosion volume.

**Table 4.3-7 Soil Effects of the Integrated USIBWC Land Management Alternative**

| Evaluation Criteria | River Management Unit (acre-feet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
| Erosion from uplands | 0.29 | 0.16 | nc | nc | nc | nc | nc | 0.45 |
| Construction of levees | nc | 127.7 | nc | 67.6 | 230.6 | 128.3 | 344 | 898.1 |
| Environmental project construction [bank shavedowns] | 140 | 17 | nc | nc | nc | nc | nc | 157 |

nc= no change

#### *Soil Erosion*

Same as Flood Control Improvement Alternative.

#### *Construction of Levees and Environmental Project Construction*

Levee rehabilitation effects are the same as Flood Control Improvement Alternative. Maintenance of grazing leases and levees is the same as Flood Control Improvement Alternative.

Bank shavedowns would displace 157 ac-ft (Table 4.3-3) of fluvial soil in the Rincon valley. Loss of soil due to overbank flows would be minimal through incorporating Best Management Practices (BMPs) and overflow bank design that promotes backflow inundation. Soils placed in floodway would be revegetated as part of the modified grassland measure. The modified grassland measure would replace 1,641 acres of mowing with native grasslands (see Table 2.6-2). The measure would result in minor short-term shallow soil disturbance during site preparation. Effects of invasive species control from chemical, fire and mechanical treatments are similar to the Flood Control Improvement Alternative.

### 4.3.6 Targeted River Restoration

Under this alternative, soil effects due to levee rehabilitation construction and modified grazing would be the same as the Flood Control Improvement Alternative and Integrated USIBWC Land Management Alternative. A total of 252 ac-ft of soil would be displaced due to project construction and 43 ac-ft lost to erosion during overbank flows. Table 4.3-8 provides a summary of potential effects of the Targeted River Restoration Alternative.

**Table 4.3-8 Soil Effects of the Targeted River Restoration Alternative**

| Evaluation Criteria | River Management Unit (acre-feet) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
| Erosion from uplands | 0.29 | 0.16 | nc | nc | nc | nc | nc | 0.45 |
| Construction of levees | nc | 27.7 | nc | 67.6 | 230.6 | 128.3 | 344 | 898.1 |
| Environmental project construction [*opening meanders and modify dredging at arroyos*] | 186 | 17 | nc | 49 | nc | nc | nc | 252 |
| Loss of soil due to scarring [*Seasonal peak flows /bank preparation*] | 17.8 | 25 | nc | nc | nc | nc | nc | 43 |

nc= no change

#### *Soil Erosion*

Same as Flood Control Improvement Alternative and Integrated USIBWC Land Management Alternative.

#### *Construction of Levees and Environmental Measure Implementation*

Levee rehabilitation effects are the same as Flood Control Improvement Alternative and Integrated USIBWC Land Management Alternative. Opening former meanders would result in the removal of 225 ac-ft of fluvial soils (much of if recent overburden fill created during project construction and maintenance). Table 4.3-4 shows totals by meander. Material would be deposited in the floodway or on the toe and slope of the levee. Loss of soil (incidental fill) due to opening menders would be minimal for 6 meanders. Excavation of arroyos would result in the removal of 27.3 acres (Table 4.3-1). Combined meanders and arroyo excavation would equal 252 acres.

Bank preparation for 517 acres of overbank flows would result in the removal of vegetation and shallow soil disturbance in preparation of overbank flows. Direct effects of seasonal peak flows includes erosion of prepared banks and potential bank incisions. Loss of soil due to overbank flows is estimated at 1-inch per acre for 517 acres (43 ac-ft).

The majority of excavation from opening meanders would occur in the Upper Rincon Valley RMU. Excavation associated with aquatic habitat diversification would occur in the Upper and Lower Valley RMUs. Replacement of 1,641 acres of mowing with native grasslands would result in minor short-term shallow soil disturbance during site preparation. Measures conducted in conservation easements would also result in minor soil disturbance assuming BMPs are implemented.

Long-term maintenance of grazing leases and levees is the same as the Flood Control Improvement Alternative. Maintenance of areas inundated by seasonal flows could include re-seeding, planting, and woody vegetation control. Details of treatments would be based on site-specific conditions. Soil disturbance would be minimized through incorporation of BMPs. Effects of invasive species control from chemical, fire and mechanical treatments are similar to the Flood Control Improvement Alternative.

## 4.4 VEGETATION AND WETLANDS

Effects on vegetation and wetlands are a function of direct short-term effects of construction and environmental measure implementation (*i.e.* earthwork, scouring from pulse flows, selective clearing) but more significantly the long-term effects of modifying vegetation management practices and restoring or improving vegetation communities (reference communities). The following evaluation criteria were used for the analyses:

***Changes in the Extent of Vegetation***

- Amount of uplands; and
- Amount riparian vegetation (including wetlands).

***Changes in Community Composition***

- Amount of reference community created.

***Changes in Vegetation Management***

- Amount of salt cedar woodland removed;
- Amount of annual mowing by USIBWC;
- Amount of annual grazing leases ; and
- Amount of crop leases.

### 4.4.1 Method of Analysis

***Extent of Vegetation***

Changes in upland and riparian vegetation were compared to baseline values (Table 3.4-4). A GIS was used to calculate the construction footprint associated with environmental measures to assess changes in vegetation.

### *Community Composition*

Changes in community composition were assessed by calculating the amount of reference community developed as a result of implementing environmental measures. Assumptions concerning changes in community composition include:

- The current anthropomorphic factors would continue to be the dominating influence. Specifically the highly altered hydrologic and sediment regime would remain in place through the analysis period.
- The amount of reference community created assumed successful implementation of environmental measures.
- Habitat improvements would result in a community comparable to the reference communities identified in Section 2. Sites would vary in seral stage, structure and site-specific characteristics, but generally classified as the reference community.
- Native communities would develop over a 20 year implementation period.

*Reference Communities* represent the desired future condition of vegetation communities (Table 4.4-1). The actual process of developing desired future communities is dependent on site-specific characteristic and monitoring to achieve success. Implementation of environmental measures would addresses the following questions USACE (2003):

- What is the best combination of vegetation structures, patch sizes and corridors to create a dynamic mosaic?
- What is the most cost-effective combination of various revegetation strategies to achieve the optimum and sustainable mosaic?
- What are the best strategies to remove debris and vegetation?
- What shall be the timing of removal and re-vegetation to be least likely to disrupt wildlife?

Table 4.4-1 lists four reference communities created as a result of implementing environmental measures. The following section describes each of those communities.

**Table 4.4-1 Reference Communities Associated with Environmental Measures**

| Measure | Habitat Type | Reference Community |
|---|---|---|
| Modified grazing leases (uplands) | Uplands | Improved uplands |
| Modified grazing leases (riparian zone) | Riparian | Improved riparian |
| Modified grassland management | Riparian | Native grasslands |
| Native vegetation planting | Riparian | Native bosque |
| Existing bosque enhancement | Riparian | Native bosque |
| Bank shavedowns | Riparian | Native bosque |
| Seasonal peak flows/bank preparation | Riparian | Native bosque |
| Reopening former meanders within ROW | Riparian | Native bosque |
| Conservation easements | Riparian and uplands | Native bosque, native grasslands and/or remnant bosques |

***Improved Riparian Community***. This community would be developed through modification of floodway grazing lease practices in conjunction with additional salt cedar control methods. Although the primary objective is improved erosion control and bank stability in grazed areas, the improved riparian community would incorporate livestock grazing in a manner more compatible with biological quality and increased forage production. It would develop habitat corridors between patches of bosque, provide increased protection of floodway wetlands, contain the expansion of existing large stands of non-native vegetation, and enhance wildlife habitat. Grazing would be managed to promote regeneration of native vegetation and increase species diversity. Grazing management could include vegetation treatments such as burning, mechanically clearing and re-seeding. Improving and installing fences and water sources would be the responsibility of leaseholder.

Despite the improved habitat quality, the reference community would continue to be disconnected from the river, composed primarily of herbaceous vegetation with woodlands dominated by invasive species. However, the herbaceous vegetation would be structurally and floristically diverse. Salt cedar would be controlled to limit additional expansion. Vegetation along the river and in wetlands locations would be maintained in a manner that improves bank stability and decreases potential sedimentation.

***Improved Uplands Community***. This community would be developed through modification of upland grazing lease practices more compatible with increasing vegetative cover to reduce soil erosion and enhance wildlife habitat. The reference community would be dominated by upland herbaceous vegetation with a percent cover equal to or greater than 40 percent. Leases would be managed to increase the amount of palatable grass species such as grama grass species and other bunch grasses. Modified grazing regimes in conjunction with woody vegetation management would result in a greater contribution of less grazing tolerant grass species, more ground cover and improved soil stabilization.

***Native Grassland Communities***. Grasses have the greatest potential for holding soils, thus decreasing erosion. They also can create open areas, which coupled with densely wooded patches create an edge habitat that is ideally suited for many wildlife species (USACE 2003). Native grasslands would be developed to improve habitat corridors between patches of bosque, provide increased protection of riparian wetlands, and enhance wildlife habitat. This reference community would continue to be disconnected from the river, and be composed primarily of intermediate and xeric native grasses and other herbaceous vegetation. Within isolated mesic and hydric areas, species would include salt grass, cattail, sedges, and rushes.

Grasslands would be established by plantings and maintained through woody vegetation control. A woody component would likely be present, but typically less then a 20 percent aerial coverage. Where appropriate, woody vegetation would be retained for structural diversity and would include native woody vegetation such as screw bean mesquite. More xeric species would become established on higher sites. Salt cedar would be controlled. Vegetation along the river and in wetlands locations would not be maintained, with the exception of salt cedar removal to improve bank stability and decrease potential erosion and sedimentation.

Prescribed burning of grassland may be warranted to improve grass production. Most grasses are relatively tolerant of fire, and the subsequent nutrient pulse would allow grasses to rapidly recover after a fire. If native grasses are well-established, burning would control most woody plants (if they are small) and would promote growth of most herbaceous plants. In addition, if native plants are well established, particularly in the rooting zone, burning would not harm the roots and the soil would remain stabilized (Scurlock 1998; Crawford *et al*., 1996).

***Native Bosque Community***. Developing and sustaining native bosque communities could include clearing, hydrologic modifications, planting/natural regeneration, salt cedar control, fuel reduction, and natural or induced flooding (USACE 2003). This reference community would be floristically and structurally similar to native riparian communities characterized by uneven aged, multi strata woody plants, with interspersed grasslands and isolated wetlands. The community would be considered connected, with the potential for overbank flows and long-term sustainability. Invasive vegetation, particularly salt cedar, would compose less than 50 percent of the community. Dominant woody species would include cottonwood and willow, with other species occurring such as western chokeberry, New Mexico olive, false indigo bush, and wolfberry among others.

Development of this community would require considerable site preparation, salt cedar control, and in some areas removal of Russian olive. Periodic reduction in fuel loads may be required. Fuel load reduction consists of removing dead and fallen trees and excess leaf litter. When the flood disturbance regime was still functional, much of this material would have been removed by periodic flooding (USACE 2003).

#### *Vegetation Management*

Changes in vegetation management were compared to baseline values. Vegetation management primarily includes activities associated with salt cedar control, but also includes crop leases and no-mow zones. It does not include changes to recreational and park leases. Salt cedar reduction estimates were calculated by comparing the construction footprint against vegetation classification maps. Assumptions concerning vegetation management included:

- Woodland communities, croplands and no-mow zones are currently not mowed either by USIBWC or grazing lease holders. All other vegetation communities are mowed by USIBWC or by lease holders.
- Implementing some environmental measures could result in a net decrease in the acreage of invasive species. However, in most cases, no net decrease of invasive species was assumed because mowing of the ROW currently manages salt cedar and the majority of the ROW is mowed.

Table 4.4-2 list assumptions regarding calculations used in assessing changes in vegetation management.

## Table 4.4-2 Assumptions Used to Assess Effects Associated with Vegetation Management

| Measures | Vegetation Management | Salt Cedar Removal and Maintenance |
|---|---|---|
| Levee rehabilitation | Assumed that grazing lease boundaries would be modified to compensate for implementing measure when possible. | Levees would continue to be mowed. No additional salt cedar would be eliminated above the amount removed under current mowing management. |
| Modified grazing in uplands | All uplands vegetation in the Rincon Valley was classified as part of grazed lands (1,805 ac). | Assumed no salt cedar would be removed in addition to the amount currently controlled. Management would shift to improved erosion control. |
| Modified grassland management in floodway | A total of 1,747 acres were classified as riparian. In some cases, riparian leases would be eliminated and converted to native grasslands. | Invasive species maintenance would likely include conducting prescribed burns, soil salinity management, applying herbicide and potentially rotational mowing. Management would emphasize the development of improved wildlife habitat. |
| Plant woody native vegetation | Assumed conversion of mowed areas to native bosque. In some cases, riparian lease acres would be reduced. 223 acres and 189 acres would be planted under the Integrated USIBWC Land Management and Targeted River Restoration alternatives, respectively. | Assumed all invasive vegetation within planting areas would be removed and soil salinity management instituted during site preparation. Salt cedar removal estimated at 77 acres and 65 acres for the Integrated USIBWC Land Management and Targeted River Restoration alternatives, respectively. Long-term invasive species maintenance would include selective removal of invasive species and fuel reduction. |
| Enhance existing bosques | Bosque enhancement would be conducted in areas currently classed as riparian woodland within the hydrologic floodplain. Totals are included in the "plant woody vegetation measure." | Assumed >50% of established woodland in hydrologic floodplain would be removed during site preparation. Long-term maintenance would include selective removal of invasive species and fuel reduction to reduce chance of uncontrolled fire. |
| Bank shavedowns | A total of 127 acres of floodway would be shavedown. Conversion to native bosque from mowed areas. A total of 157 ac-ft of sediment from bank shavedowns would be distributed on floodway an average of 2 foot deep, or 77 surface ac. Shavedowns would be conducted in conjunction with native grassland seeding. 10% of shavedown areas are assumed to become future wetlands | Assumed all woodlands within shavedown areas would be removed during site preparation. Salt cedar removal estimated at 53 ac. Long-term maintenance would include selective removal of invasive species and fuel reduction to uncontrolled fire potential. |
| Opening former meanders | A total of 147 acres of former meanders would be affected. Assumed total excavated lands converted at a proportion 50% native bosque, 20% wetlands and 30% backwater (pool) habitat. A total of 224 ac-ft of sediment from bank shavedowns would be distributed on levees and floodway an average of 2 foot deep or over 112 surface acres. Native grass seeding would be conducted on displaced soil. | Assumed all woodlands within construction footprint would be removed during site preparation. Salt cedar removal estimated at 88 ac. Long-term maintenance would include selective removal of invasive species and fuel reduction to reduce uncontrolled fire potential. |
| Modify dredging at arroyos | A total of 27 ac-ft of sediment from arroyo dredging would be distributed on floodway an average of 2 foot deep or 14 surface acres. Native grass seeding would be conducted on displaced soil. | None |
| Seasonal peak flows / bank preparation | Conversion of 517 ac to native bosque from grazing leases and mowed areas. If possible, lease boundaries would be modified to compensate for implementing measure. | Assumed all woodlands within overbank flows would be removed during site preparation. Salt cedar removal estimated at 217 ac. Long-term maintenance would include selective removal of invasive species and fuel reduction to reduce uncontrolled fire potential. |
| Conservation easements | Assumed lands in hydrologic floodplain (771 ac) used primarily for riparian restoration (some lands <10% classed as wetlands), all croplands (288 ac) converted to native grasslands and remaining conservation easement (559 ac) preserved at current levels. | Assumed 20-25% of established woodland in hydrologic floodplain would be removed during site preparation (salt cedar removal estimated at 173 ac). Maintenance would include selective removal of invasive species and fuel reduction to reduce chance of uncontrolled fire. No salt cedar control would be conducted outside hydrologic floodplain. |

### 4.4.2 Summary of Potential Effects

Table 4.4-3 presents a summary of effects for vegetation and wetland. The extent of upland community is unchanged from baseline irrespective of alternative. The amount of riparian community increases only in the Targeted River Restoration Alternative. Restoration measures under the Integrated Lands Management and Targeted River Restoration alternatives result in increased amounts of wetlands and native communities. Each of the action alternatives includes modification of uplands and riparian grazing regimes and levee rehabilitation.

**Table 4.4-3 Summary of Effects for Vegetation and Wetland**

| Evaluation Criteria | No Action | | Flood Control Improvement | | Integrated USIBWC Land Management | | Targeted River Restoration | |
|---|---|---|---|---|---|---|---|---|
| | Acres | Change | Acres | Change | Acres | Change | Acres | Change |
| *Extent of Vegetation* | | | | | | | | |
| Total lands | 8,332 | nc | 8,332 | nc | 8,332 | nc | 9,933 | 19% |
| Uplands vegetation | 1,805 | nc | 1,805 | nc | 1,805 | nc | 1,805 | nc |
| Riparian vegetation - total | 6,527 | nc | 6,527 | nc | 6,527 | nc | 8,103 | 24% |
| Riparian vegetation - wetlands | 177 | nc | 177 | nc | 190 | 7% | 283 | 60% |
| *Community Composition* | | | | | | | | |
| Improved uplands | nc | nc | 1,805 | | 1,805 | | 1,805 | |
| Improved riparian | nc | nc | 1,747 | | 1,747 | | 1,688 | |
| Native bosque or cottonwood/ willow riparian community | nc | nc | nc | nc | 350 | | 1,549 | |
| Native grasslands | nc | nc | nc | nc | 1,641 | | 1,929 | |
| Salt cedar reduction by initial implementation of environmental measures | nc | nc | nc | nc | 130 | | 543 | |
| *Vegetation Management* | | | | | | | | |
| Modified upland grazing leases | nc | nc | 1,805 | 100% | 1,805 | 100% | 1,805 | (-100%) |
| Vegetation control in the floodway by grazing leases | 1,747 | nc | 0 | (-100%) | 0 | (-100%) | 0 | (-100%) |
| Crop leases | 66 | nc | 66 | nc | 66 | nc | 66 | nc |
| Annual mowing | 4,657 | nc | 4,657 | nc | 2,674 | -43% | 2,223 | -52% |
| No-mow zones | 57 | 1.2% | 57 | 1.2% | 57 | 2.1% | 57 | 2.5% |

nc=no change

### 4.4.3 No Action Alternative

Under the No Action alternative, vegetation communities would remain consistent with baseline conditions.

#### *Extent of Vegetation*

No change in the amount of the upland and riparian vegetation would occur.

### *Vegetation Composition*

Management practices would likely keep the vegetation composition consistent with the baseline condition; however, increases in invasive species could occur in lease areas. An estimated 30 percent of leased areas contain invasive dominated woodland communities. Areas inaccessible to mowers would continue to be dominated by salt cedar. Vegetation reduction through mowing would be a direct and short-term effect. Long-term term effects would be minor as vegetation would re-grow after treatment.

Salt cedar would continue to dominate with the exception of isolated pockets of native vegetation. Mowing would suppress salt cedar for almost 5,000 acres (USIBWC mowing and lease holder agreements); however, salt cedar root crowns regrow vigorously after mowing and can reach a height of 9 feet or more in one season. Existing stands of salt cedar which are not mowed would continue to thrive.

The long-term effects of the No Action Alternative would likely result in the decrease in the number of isolated pockets of cottonwoods. Colonization by native species can be inhibited by the prevalence of salt cedar. Very limited opportunities exist for establishment of native vegetation. The floodway would continue to remain largely disassociated from the river providing little scouring potential. Occasional periodic overbank flows would not likely be sufficient to create suitable cottonwood regeneration conditions. Decline of scattered mature cottonwoods would continue and natural regeneration would be limited to isolated pockets such as Sunland Park in El Paso. Avoidance of these pockets by mowers would continue, however, the lack of salt cedar removal actions would likely result in encroachment by salt cedar.

### *Vegetation Management*

There would be no changes in vegetation management relative to current conditions. Mowing will continue to control salt cedar as indicated in Table 4.4-4. A total of 1,805 acres of uplands are leased in the Rincon Valley. Woody shrubland vegetation within the floodway would be cut back annually. Crop leases would continue for 66 acres in the Rincon Valley.

**Table 4.4-4 Invasive Species Management in the Floodway Under the No Action Alternative**

| Method | Acreage | Comments |
|---|---|---|
| Grazing leases (mowing by lease holders) | 1,747 | Grazing leases require that brush and vegetation be removed or mowed annually within portions of the lease. |
| Mowing by USIBWC | 4,657 | Farm tractors with rotary slope mowers are generally used to mow the floodways. Slope mowers are used for vegetation maintenance on the channel banks. Some areas with dense vegetation may require a second late summer mowing. |

Grazing in the riparian community would continue for 1,747 acres resulting in reduced vegetative cover. The few mature native cottonwoods would decline and not likely be replaced due to lack of favorable recruitment conditions. Mowing would continue to maintain the majority of the floodplain in an early seral state.

### 4.4.4 Flood Control Improvement Alternative

Under this alternative, vegetation would be directly impacted through a modification of grazing leases and the rehabilitation of levees. Decline of scattered mature cottonwoods would continue and natural regeneration would be limited to isolated pockets. Limited opportunities would exist for establishment and maintenance of native vegetation, although modified grazing regimes would potentially result in some recruitment. The floodway would continue to exhibit perched banks and remain largely disassociated from the river.

#### *Extent of Vegetation*

No change in the amount of upland, riparian and wetlands vegetation.

#### *Vegetation Composition*

As the grazing regime is modified, species composition of the uplands would be subject to change. The uplands vegetation community would likely respond by an increase in species intolerant of grazing pressure. Modified grazing regime in the floodway in conjunction with salt cedar control program would increase the amount of herbaceous vegetation. Salt cedar control could include mechanical, chemical, and burning. Table 4.4-5 provides a summary of the effects expected as a result of implementing this alternative.

**Table 4.4-5 Effect Summary of Flood Control Improvement Alternative**

| Vegetation | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| *Extent of Vegetation (acres)* | | | | | | | | |
| Total lands | nc | nc | nc | nc | nc | nc | nc | nc |
| Uplands vegetation | nc | nc | nc | nc | nc | nc | nc | nc |
| Riparian vegetation total | nc | nc | nc | nc | nc | nc | nc | nc |
| Riparian vegetation- wetlands | nc | nc | nc | nc | nc | nc | nc | nc |
| *Community Composition (acres)* | | | | | | | | |
| Improved uplands | 1,641 | 164 | nc | nc | nc | nc | nc | 1,805 |
| Improved riparian | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1,747 |
| Native bosque or cottonwood /willow riparian community | nc | nc | nc | nc | nc | nc | nc | nc |
| Native grasslands | nc | nc | nc | nc | nc | nc | nc | nc |
| *Vegetation Management (acres)* | | | | | | | | |
| Mod. upland grazing leases | 1,641 | 164 | nc | nc | nc | nc | nc | 1,805 |
| Mod. floodway grazing leases | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1,747 |
| Crop lease | nc | nc | nc | nc | nc | nc | nc | nc |
| Annual mowing (by USIBWC) | nc | nc | nc | nc | nc | nc | nc | nc |
| No-mow zones | nc | nc | nc | nc | nc | nc | nc | nc |

nc=no change

Removal of vegetation would be short-term and associated with O&M activities such as mowing and levee construction. Areas inaccessible to mowers would continue to be dominated by salt cedar (Table 4.4-5). The 57 acres of no-mow zones (Table 4.4-3)would be maintained and provide management contrast with other floodway vegetation management strategies (grazing and mowing). Vegetation reduction through mowing would be considered a direct and short-term impact. From a long-term perspective, effects to vegetation would be negligible because existing species would re-grow after treatment. Some adverse direct effects to non-target vegetation could occur such as cottonwood and willow trees. Long-term effects to implementing environmental measures would be beneficial due to conversion of treatment areas to reference communities.

The few mature native cottonwoods would continue to decline and not likely be replaced due to lack of favorable recruitment conditions. Cottonwood regeneration through natural seed dispersal would be unlikely within the floodway. With the exception of isolated pockets of native dominated bosque, the riparian woodland would remain a salt cedar dominated community.

### *Vegetation Management*

A total of 1,805 acres of grazing leases would be modified in the Rincon Valley. A grazing regime would be instituted emphasizing the need for improving erosion control though increased vegetative cover. Details concerning the modified grazing program would be developed in concert with regulatory agencies. However, it is assumed that uplands grazing regime would be modified to promote forage production for the purposes of watershed protection. Subsequent vegetative response would result in increased vegetative cover and reduced soil erosion. Based on reference community description, the uplands vegetation would likely exhibit a greater floristic and structural diversity than current baseline conditions. The grazing program could include vegetative treatments such as seeding, prescribed burns and potentially mechanically thinning woody vegetation. The purpose of treatments is to increase species richness, structural diversity and reduce soil erosion. Burning regimes in the upland areas may increase the forage yield of herbaceous species through nutrient addition and site preparation for seedling establishment.

Crop leases would continue for 66 acres in the Rincon Valley. A modified grazing program would be instituted for riparian leases emphasizing forage production for wildlife and watershed management. It is anticipated that some riparian grazing would cease until the vegetation responds at the appropriate level. The modified grazing program would adjust stocking rates based on lease-specific conditions for the purpose of achieving the desired reference community.

The dominate influence of salt cedar would continue throughout the RGCP. Mowing would suppress 4,657 acres (Table 4.4-2) of floodway and modified riparian leases would be used to manage 1,747 acres (Table 4.5-5). The riparian woodland community would remain dominated by salt cedar. Salt cedar control would be implemented to reduce recruitment of invasive vegetation within the riparian zone. Chemical and mechanical treatments would be considered a direct short-term effect. Repeated treatments would be required.

Salt cedar control through herbicide applications of registered herbicide would introduce chemicals in to the environment. Use of spot application techniques would limit chemical exposure to non-target species and individuals. Incidental effects to non-target plant species would be considered a negligible, indirect, adverse effect because typically registered chemicals applied according to label directions and by qualified and trained personnel are relatively non-hazardous.

Prescribed burns would have varying effects, depending on the vegetative community, burn size and intensity, and post-burn conditions. Short-term, minor to moderate, effects would be expected in the treatment areas. Effects include mortality of juveniles and injury to some adult tree and shrub species. Site recovery would depend on each species' resistance or resilience when exposed to disturbance. Long-term, herbaceous communities would benefit from exposure to prescribed fire. Increased soil nutrients concentrations following fire conditions would encourage rapid re-growth of herbaceous vegetation.

The restrictions on the distribution of herbicide applications to spot treatments, use of mechanical equipment designed to minimize damage to soils and non-target plant communities, and restrictions on the degree of clearing to only the treatment areas, would contribute to minimizing adverse effects to non-target vegetation areas.

**Table 4.4-6 Invasive Species Management in the Floodway Under the Flood Control Improvement Alternative**

| Environmental Measure | Acreage | Initial Site Preparation Activities | Long-Term Maintenance |
|---|---|---|---|
| Grazing management in floodway | 1,747 | Stocking rate evaluation and potential adjustment on a lease by lease basis | Modified - Salt cedar control by chemical or mechanical means (mowing). |
| Mowing by USIBWC | 4,657 | No change from current practices | No Change from current practices. |

### 4.4.5 Integrated USIBWC Land Management Alternative

Under this alternative, 3,552 acres of upland (1,805 ac) and riparian (1,747 ac) grazing leases would be modified. Restoration of riparian (350 acres) and herbaceous vegetation (1,641) represent significant changes in floodway management. Mowing would be reduced by 1,983 acres (Table 4.4-7).

#### *Extent of Vegetation*

No change to the amount of upland vegetation. Wetland vegetation would increase by 13 acres as a result of shavedowns.

#### *Vegetation Composition*

Riparian restoration measures would increase native bosque by 350 acres (127 acres by shavedown and 223 acres by pole planting). With this alternative, the species composition would change from one dominated by salt cedar to include communities of cottonwood and willow. This would require extensive site preparation and invasive plant removal. Native woody vegetation would increase in the Rincon Valley, Las Cruces and Upper Mesilla RMU.

### Table 4.4-7 Effects Summary of Integrated USIBWC Land Management Alternative

| Vegetation | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| *Extent of Vegetation (acres)* | | | | | | | | |
| Total lands | nc | nc | nc | nc | nc | nc | nc | nc |
| Uplands vegetation | nc | nc | nc | nc | nc | nc | nc | nc |
| Riparian vegetation total | nc | nc | nc | nc | nc | nc | nc | nc |
| Riparian vegetation-wetlands | 9 | 3 | nc | nc | nc | nc | nc | 13 |
| *Community Composition (acres)* | | | | | | | | |
| Improved uplands | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Improved riparian | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1747 |
| Native bosque or cottonwood/ willow riparian community | 133 | 61 | nc | 20 | 137 | nc | nc | 350 |
| Native grasslands | 639 | 611 | nc | 22 | 301 | 68 | nc | 1641 |
| *Vegetation Management (acres)* | | | | | | | | |
| Modified upland grazing leases | 1,641 | 164 | nc | nc | nc | nc | nc | 1,805 |
| Modified floodway grazing leases | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1,747 |
| Crop lease | nc | nc | nc | nc | nc | nc | nc | nc |
| Annual mowing (by USIBWC) | -771 | -672 | nc | -39 | -433 | -68 | nc | -1,983 |
| No-mow zones | nc | nc | nc | nc | nc | nc | nc | nc |

nc=no change

Bank shavedowns would remove 127 acres of existing vegetation in the Rincon Valley. Periodic bank preparation would convert shavedown sites to exposed soil until native vegetation becomes established. Based upon assumptions presented in Table 4.4-2, disposal of shavedown material within the floodway would have a short-term effect on 75 acres of woody vegetation (primarily salt cedar). Pole planting would result in vegetation disturbance within planting sites as a result of site preparation (salt cedar removal, salinity management, *etc*.). Long-term effects due to implementing environmental measures would be beneficial due to the conversion of treatment areas to the reference community.

#### *Vegetation Management*

No change would occur from the Flood Control Alternative for upland and floodway grazing. Mowing would be reduced by 1,983 acres. Areas inaccessible to mowers and not targeted for salt cedar removal would continue to be dominated by salt cedar. Crop leases would continue for 66 acres Rincon Valley. The 57 acres of no mow zones would be maintained and provide management contrast with other riparian vegetation management strategies.

Salt cedar control and fuel reduction would likely be required in all 350 acres of riparian restoration areas to assure native vegetation is sustained. The majority of riparian restoration areas would be dominated by young to mid aged cotton/willow vegetation at the end of the 20-year implementation. Outside the hydrologic floodplain, the floodway would remain disassociated from the river.

Native grasslands would be developed for 1,641 acres of ROW with the majority in the Rincon Valley. The reference community would be characterized as native grassland, however up to 20 percent of the area could be composed of woody vegetation. Salt cedar control would likely be required for much of the 1,641 acres and could include periodic mowing, burning and chemical control in order to sustain native herbaceous vegetation.

Invasive species would be managed by mowing (2,674 acres of floodway), grassland management (1,641 acres) and modified grazing (1,747 acres of floodway). An additional 350 acres of salt cedar control would be required in restored riparian areas. Effects of this alternative on salt cedar would be similar to the Improved Flood Control Alternative. Table 4.4-8 summarizes invasive species management.

**Table 4.4-8 Invasive Species Management in the Floodway Under the Integrated USIBWC Land Management Alternative**

| Measure | Acreage | Initial Site Preparation Activities | Long-term Maintenance |
|---|---|---|---|
| Floodway grazing management | 1,747 | Stocking rate evaluation and potential adjustments on a lease by lease basis. | Salt cedar control by chemical (spot) or mechanical means. Mechanical removal would be avoided along river edge and wetlands areas. |
| Native vegetation planting | 223 | Selective removal and clearing through mechanical means. Mechanical means could be required in dense-monotypic stands. | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Stream bank reconfiguration | 127 | Complete removal of vegetation through mechanical means and excavation to within 1 foot of mean irrigation flow. | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Native grasslands | 1,641 | Removal of vegetation by herbicide (aerial or spot), shallow disking. | Salt cedar control by chemical (spot). Periodic mowing could be used in some areas. Mechanical removal would be avoided along river edge and wetlands areas. |
| Mowing | 2,674 | No change from current practices | No change from current practices. |

### 4.4.6 Targeted River Restoration Alternative

Under this alternative, 3,493 acres of upland (1,805 ac) and floodway (1,688 ac) grazing leases would be managed as improved upland riparian communities. A slight decrease in the amount of riparian grazing leases (currently 1,747 ac) would occur as a result of implementing environmental measures. Through a combination of conservation easements and restoration measures, 1,549 acres of restored riparian habitat and 1,929 acres and native herbaceous vegetation would be developed. With the exception of levees, mowing of the floodway would cease in the Rincon Valley.

**Table 4.4-9 Effects Summary of Targeted River Restoration Alternative**

| Vegetation | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| *Extent of Vegetation (acres)* | | | | | | | | |
| Total lands | -42 | 536 | 808 | 22 | nc | 202 | 44 | 1,576 |
| Uplands vegetation | nc | nc | nc | nc | nc | nc | nc | nc |
| Riparian vegetation total | -42 | 536 | 808 | 22 | nc | 202 | 44 | 1,576 |
| Riparian vegetation- wetlands | 25 | 21 | 32 | 4 | 17 | 3 | 4 | 106 |
| *Community Composition (acres)* | | | | | | | | |
| Improved uplands | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Improved riparian | 286 | 242 | nc | 635 | 131 | 256 | 138 | 1,688 |
| Native bosque or cottonwood/ willow riparian community | 303 | 537 | 351 | 10 | 137 | 168 | 44 | 1,549 |
| Native grasslands | 639 | 743 | 128 | 50 | 301 | 68 | nc | 1,929 |
| *Vegetation Management (acres)* | | | | | | | | |
| Modified upland grazing leases | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Mod. floodway grazing leases | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1747 |
| Crop lease | nc | nc | nc | nc | nc | nc | nc | nc |
| Annual mowing (by USIBWC) | -1,021 | -873 | nc | -39 | -433 | -68 | nc | -2,434 |
| No-mow zones | nc | nc | nc | nc | nc | nc | nc | nc |

nc=no change

### *Extent of Vegetation*

No change would occur to the amount of upland community from the baseline. The total amount of riparian vegetation would increase 1,576 acres from incorporating conservation easements. The majority of increase would occur in Seldon Canyon and the Lower Rincon RMU. Riparian vegetation in the Upper Rincon RMU would slightly decrease by 42 acres as meanders are opened and terrestrial habitat is converted to aquatic habitat (Table 4.4-9). An additional 106 acres of wetlands would be created or managed in this alternative. The primary source of wetland increases would be conservation easements (77 acres) and opening of new meanders (28 acres) within the ROW, (Table 4.4-2 shows assumptions for estimates).

### *Vegetation Composition*

A shift in the floristic composition would occur within the RGCP and adjacent conservation easements. Riparian vegetation in the ROW would be developed through seasonal peak flows planting and opening meanders for a total of 705 acres within the ROW (see section alternative description for ROW average details). Periodic bank preparation would convert overbank flow areas to exposed soil until native vegetation becomes established. This would result in a short-term direct effects to 517 acres of riparian vegetation (Table 4.4-2). Once vegetation becomes established, periodic peak flows would be conducted to sustain native communities (e.g. inundate sites, remove excess vegetation *etc*). Opening meanders would result in a short-term direct impact to 147 acres of riparian vegetation (Table 4.4-2). Long-term effects of environmental measure would be beneficial as current communities would convert to reference communities. Restoration within conservation easements would add an additional 771 acres of native dominated bosque (Table 4.4-10).

### *Vegetation Management*

No change would occurr within the ROW to grazing and native grassland development from the Integrated Land Management Alternative. However an additional 288 of conservation easements would be developed as native grasslands.

Mowing would be reduced by 2,434 acres (Table 4.4-9). All mowing in the Rincon valley would be restricted to levees. Crop leases would continue for 66 acres of floodway in the Rincon Valley. The 57 acres of no mow zones would be maintained and provide management contrast with other floodway vegetation management strategies.

The incorporation of conservation easements significantly expands the amount of riparian corridor available for restoration. Table 4.4-10 lists conservation easement measures.

**Table 4.4-10 Potential Restoration for Conservation Easement**

| Conservation Easement Location | Acreage | Measure |
|---|---|---|
| Cropped easements | 288 | Native grasslands management |
| Hydrologic floodplain | 771 | Native bosque enhancement/planting. The majority of conservation easements located within or adjacent to Seldon Canyon and nearby the Picacho wetlands pilot project. |
| Other | 559 | Preservation of corridor width. It includes remnant bosques outside the hydrologic floodplain. |
| Total | 1,618 | |

Mowing would suppress invasive species in 2,223 acres of floodway, grassland management would control 1,929 acres and a modified floodway grazing program would be used to manage 1,747 acres of floodway. An additional 1,549 acres of salt cedar control would be required in restored riparian areas (Table 4.4-11). Effects of implementing the invasive species program on baseline community are presented as two separate actions, initial site preparation and long-term maintenance.

Salt cedar control would be required in all riparian restoration areas to assure a native dominated component is maintained. The majority of riparian restoration areas would be dominated by young to middle aged cottonwood and willow vegetation at the end of the 20-year implementation. Outside the hydrologic floodplain, the floodway would remain disassociated from the river,

Chemical control of salt cedar would be considered a direct short-term impact. Long-term effects to vegetation would be considered negligible because existing species would re-grow after treatment. Some adverse direct effects to non-target vegetation would occur.

**Table 4.4-11 Invasive Species Management in the ROW Under the Targeted River Restoration Alternative**

| Measure | Acreage | Initial Site Preparation Activities | Long-term Maintenance Activities |
|---|---|---|---|
| Grazing management | 1,747 | Stocking rate evaluation and potential adjustment on a lease by lease basis. | Salt cedar control by chemical or mechanical means. |
| Native vegetation planting/enhancement | 960 | Selective removal and clearing. Mechanical means could be required in dense-monotypic stands. Sites within Seldon Canyon will require extensive removal of mature salt cedar. | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along the river edge and wetlands areas. |
| Seasonal peak flows /bank preparation | 516 | Complete removal of vegetation through mechanical means/ bank preparation | Salt cedar control by herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands. |
| Native grasslands | 1,929 | Removal of vegetation by herbicide, shallow disking. Mature woodlands not treated in order to provide structural diversity in floodway. | Salt cedar control by chemical or mechanical means. Periodic mowing could be used in some areas. |
| Reopening of meanders | 142 | Complete removal of vegetation through mechanical means/ bank preparation and excavation | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands. |
| Mowing | 2,223 | None | Continued annual mowing |

## 4.5 WILDLIFE HABITAT

Effects to wildlife habitat were based on changes in habitat quality after implementing environmental measures. The following evaluation criteria were used for the analyses:

- Changes in habitat quality (WHAP) values; and
- Amount of wetlands and reference community created as a result of implementing environmental measures.

Acreage totals and qualitative vegetation changes were assessed with respect to baseline values. Assumptions regarding future conditions of vegetation due to implementation of environmental measures are provided in the following section.

### 4.5.1 Method of Analysis

A GIS was used to calculate the extent and location of habitat types. The results of the GIS analyses were assessed against baseline values. Wildlife habitat measured as HU are used to provide a quantitative measure for comparing alternatives. Actions affecting wildlife habitat are reflected as a change (positive or negative) in HU. Changes in HQ values were calculated by multiplying the HQ difference of the reference community from the baseline community. Although individual wildlife species would respond differently to environmental measures, WHAP provides an overall assessment of the wildlife habitat. To calculate changes in wildlife habitat, the following assumptions were made:

- HQ estimates can be made for reference communities by comparing desired future conditions with WHAP scoring criteria.
- Although there are seral differences in HQ for reference communities, a single HQ value (reference community characteristics after 20 year implementation) is used for assessing changes in baseline values.

Several studies have documented potential increased wildlife value of native communities over invasive salt cedar monocultures (Ellis 1995). Studies at the Bosque del Apache found that reactivation of an abandoned river channel was a key variable in increasing avian richness (Stuart and Farley 1993; Bosque del Apache NWR unpublished biomonitoring program reports). The increase of wildlife response was attributed to developing mesic microhabitats from dryer, less densely vegetated habitats.

Potential WHAP scores were used to reflect the contribution of native plant communities to wildlife habitat quality. Table 4.5-1 presents predicted WHAP values due to implementing environmental measures. The “maximum range” possible column represents the highest hypothetical value for a reference community using the WHAP score sheet. The potential HQ value represents an estimated score for a reference community after 20-year implementation. The potential score is 80 percent of the maximum score. WHAP scoring criteria such as temporal development and uniqueness and relative abundance limit a reference communities’ potential HQ value to scores below the maximum score.

**Table 4.5-1 Potential Wildlife Habitat Quality From Reference Communities**

| Reference Community | Potential HQ Value | Maximum Score Range |
|---|---|---|
| Improved uplands | 0.50 | 0.63 – 0.88 |
| Improved floodway | 0.60 | 0.75 – 1.0 |
| Native grasslands | 0.65 | 080 |
| Native bosque | 0.80 | 1.0 |

Assumptions regarding specific calculations effecting wildlife habitat through implementation of environmental measures are listed in the table 4.5-2.

Table 4.5-3 presents baseline values for assessing effects to wildlife habitat. Values are derived from information presented in Section 3 and calculations based on previous assumptions.

## Table 4.5-2 Basis for Habitat Quality Calculations

| Measure | Effects of ROW Management Categories |
|---|---|
| Levee rehabilitation | Herbaceous vegetation would be unchanged. Woodlands would decrease an average of 0.65 HQ to 0.36 HQ within levee footprint. |
| Modified grazing in uplands | Upland leases would increase from an average of 0.3 HQ to 0.5 HQ. Riparian leases would increase from an average of 0.30 HQ to 0.6 HQ. |
| Modified grassland management in riparian | Riparian vegetation (herbaceous and woody shrub lands) would increase from an average of 0.36 HQ to 0.6 HQ within restoration areas. |
| Plant woody native vegetation | Floodway vegetation (herbaceous and woody shrub lands) would increase from an average of 0.36 HQ to 0.8 HQ within restoration areas. An initial decrease would occur as a result of measure implementation. |
| Enhance existing bosques | Increase an average of 0.65 HQ to 0.8 HQ. HQ would initially decrease during measure construction. |
| Bank shavedowns | Floodway vegetation (herbaceous and woody shrub lands) would increase from an average of 0.36 HQ to 0.8 HQ within restoration areas. HQ would initially decrease during measure construction. |
| Opening former meanders | Assumed total excavated lands converted at a proportion 50% native bosque (0.8 HQ), 20% wetlands (0.8 HQ), and 30% backwater (pool) habitat. An initial decrease in HQ would occur a result of measure implementation. |
| Modify dredging at arroyos | Not applicable |
| Seasonal peak flows /bank preparation | Floodway vegetation (herbaceous and woody shrub lands) would increase from an average of 0.36 HQ to 0.8 HQ within restoration areas. An initial would occur a result of measure implementation. Baseline HQ values were assumed to be comparable to HQ ROW communities. |
| Conservation easements | A total of 1,618 acres of conservation easements. 771 acres added as restored bosque and wetlands (0.8 HQ). HQ would initially decrease during measure construction. 288 acres added as native grasslands (0.65 HQ), and 559 acres added as existing bosque (no change to HQ). |

## Table 4.5-3 Baseline Values Used For Analyses

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| WHAP Habitat Units | 1021 | 574 | 12 | 303 | 178 | 527 | 330 | 2945 |
| Wetlands (ac) | 54 | 51 | 2 | 15 | 14 | 30 | 11 | 177 |
| Improved uplands (ac) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Improved riparian (ac) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native bosque or cottonwood / willow riparian community (ac) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native grasslands (ac) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

### 4.5.2 Summary of Effects

Table 4.5-4 presents a summary of the expected effects of the alternative wildlife habitats. Changes from baseline are presented for each evaluation criteria.

**Table 4.5-4 Summary of Effects**

| Evaluation Criteria | No Action | Modified O&M and Flood Control Improvement | | Integrated USIBWC Land Management | | Targeted River Restoration | |
|---|---|---|---|---|---|---|---|
| WHAP Habitat Units | 2,945 | 3,822 | 130% | 4,452 | 151% | 5,063 | 172% |
| Wetlands (ac) | 177 | 177 | nc | 190 | 107% | 282 | 160% |
| Improved uplands (ac) | nc | 1805 | | 1805 | | 1805 | |
| Improved riparian (ac) | nc | 1747 | | 1747 | | 1688 | |
| Native bosque or cottonwood / willow riparian community (ac) | nc | nc | nc | 350 | | 1549 | |
| Native grasslands (ac) | nc | nc | nc | 1641 | | 1929 | |

nc=no change

### 4.5.3 No Action Alternative

Under the No Action Alternative, the overall composition of vegetation communities types would remain consistent with current conditions. The general condition of the RGCP would continue to provide poor to below average wildlife habitat. Species adapted to current conditions would continue to thrive with little opportunity for reintroduction of less tolerant species. Overall, no change is expected from baseline conditions

#### *Habitat Quality*

No measurable change from the baseline condition would be expected. Decline of isolated native vegetation would not have a measurable effect on total WHAP values. Mowing and grazing would continue to suppress vegetation resulting in limited vegetative structure and HQ scores consistent with poor to below average wildlife quality. Riparian woodlands, invasive dominated or otherwise would provide the highest wildlife habitat quality.

#### *Wetlands and Reference Community Developed*

No expected change in condition or extent of wetlands is likely to occur. Little change to the physiognomic characteristics of riparian and upland vegetation would occur. Removal of vegetation by mowing would keep the majority of the floodplain in an early seral community. Riparian woodland would continue to be dominated by salt cedar.

### 4.5.4 Flood Control Improvement

Under the Flood Control Improvement Alternative, improving lands within grazing leases would increase overall wildlife habitat quality by approximately 30 percent. Continued mowing as a salt cedar control method in areas outside grazing leases would suppress woody growth and maintain a large portion of the floodway in a disturbed or early seral state. The majority of the floodway would be characterized as herbaceous and shrubland (re-growth). Table 4.5-5 presents the Flood Control Improvement Alternative by RMU. Values represent an increase above baseline.

**Table 4.5-5 Wildlife Habitat Effects of the Flood Control Improvement Alternative**

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| WHAP Habitat Units | 401 | 125 | nc | 191 | 41 | 77 | 41 | 877 |
| Wetlands (ac) | nc | nc | nc | nc | nc | nc | nc | nc |
| Improved uplands (ac) | 1,641 | 164 | nc | nc | nc | nc | nc | 1,805 |
| Improved riparian (ac) | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1,747 |
| Native bosque or cottonwood / willow riparian community (ac) | nc | nc | nc | nc | nc | nc | nc | nc |
| Native grasslands (ac) | nc | nc | nc | nc | nc | nc | nc | nc |

nc=no change

#### *Habitat Quality*

Habitat quality would increase 30 percent (Table 4.5-4) from the baseline condition mostly within the Upper and Lower Rincon Valley and Upper Mesilla RMU. The modification of grazing leases would result in an increase of wildlife habitat quality by 877 HU (Table 4.5-5). Mowing would continue to maintain the majority of the ROW as below average quality.

#### *Wetlands and Reference Community Developed*

No expected change in extent of wetlands is likely to occur. However, wetlands condition and potential wildlife quality would improve as modified grazing leases would exclude cattle from wetland areas. Although only 177 acres of wetlands were mapped using Parsons (2001b) methodology. National Wetland Inventory maps suggest up to 600 acres of palustrine emergent wetlands could be present in the RGCP. The modified grazing program could result in improvements in wildlife habitat quality for wetlands within the riparian zone.

Modified grazing in the riparian zone would improve vegetation structure and floristic composition, however, non-native Bermudagrass and invasive Russian thistle would likely remain a dominant component of riparian leases. Most of the woody shrubland vegetation within the riparian zone would be cut back annually. Areas inaccessible to mowers would continue to be dominated by salt cedar. Levee construction activities would temporally disrupt some wildlife but not appreciably change the wildlife habitat condition. Removal of vegetation associated with O&M activities such as mowing would keep the majority of the riparian zone in an early seral state.

### 4.5.5 Integrated USIBWC Land Management Alternative

Under the Integrated USIBWC Land Management Alternative, modifications to grazing leases and development of native bosque and grasslands would result in a 51% increase in HU. Mowing would continue as the primary salt cedar control method in the lower portions of the RGCP. Species adapted to current conditions would continue to thrive with opportunity for reintroduction of less tolerant species. Levee construction activities would temporally disrupt some wildlife but not measurably change the overall wildlife habitat quality. Table 4.5-6 shows the increase in WHAP HU and habitats above baseline. This change is inclusive of the Flood Control Improvement Alternative.

**Table 4.5-6 Wildlife Habitat Effects of the Integrated Land Management Alternative**

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| WHAP Habitat Units | 645 | 329 | nc | 478 | 188 | 97 | 41 | 1,507 |
| Wetlands (ac) | 9 | 3 | nc | nc | nc | nc | nc | 13 |
| Improved uplands (ac) | 1,641 | 164 | nc | nc | nc | nc | nc | 1,805 |
| Improved riparian (ac) | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1,747 |
| Native bosque or cottonwood / willow riparian community (ac) | 133 | 61 | nc | 20 | 137 | nc | nc | 350 |
| Native grasslands (ac) | 639 | 611 | nc | 22 | 301 | 68 | nc | 1,641 |

nc=no change

#### *Habitat Quality*

Wildlife quality would increase over 50 percent (Table 4.5-4). Habitat quality would initially decrease in some locations as environmental measures are implemented, but would increase by 1,507 HU as vegetation develops (Table 4.5-6). Removal of salt cedar may adversely affect wildlife using habitat as food, nesting and /or cover. However, due to the extensive availability of similar woodland (salt cedar) habitat within the RGCP, direct effects would be minor.

Construction activities associated with bank shavedowns would result in the mortality of animals. Such losses would be considered a negligible adverse effect. Levee construction activities would temporally disrupt some wildlife but not appreciably change the wildlife habitat condition.

Salt cedar control and fuel reduction would likely be required in restored bosques to assure native component is sustained. There would be short-term effects due to the disruption or destruction of habitat and foraging areas. However, due to the small acreages treated, in the context of the entire RGCP, the effects would be negligible. Any adverse effects would be minimized or offset by performing treatment (shavedowns, salt cedar control, fuel reduction) out of wildlife breeding seasons. Salt cedar control using licensed herbicides that are applied in conformance with label instructions would unlikely result in wildlife mortality.

Changes in plant structural characteristics from development of native bosque (350 acres) and native grasslands (1,641 acres) would have a noticeable and long-lasting effect on wildlife quality (Table 4.5-6). Some species would benefit from vegetation changes while others would be adversely affected. Overall, modification of salt cedar control would have a long-term beneficial effect for wildlife.

#### *Wetlands and Reference Community Developed*

An increase of 51 percent in HUs would occur due to the development of more structurally diverse vegetation communities including 350 acres of native bosque and 1,641 acres of native grassland (Table 4.5-6). The majority of the change would occur in the Rincon Valley and Upper Mesilla RMU. Wildlife adapted to current conditions would continue to thrive. Long-term wildlife composition would either remain unchanged or would gradually change in response to changes in habitat conditions. The changes would be considered a minor direct effect. Depending on prevailing land management objectives slight shifts in species assemblages could be considered either adverse or beneficial.

A seven percent increase in wetlands would occur due to bank shavedowns (Table 4.5-6). Overall wetlands condition and potential wildlife quality would improve as the majority of the floodway would be managed as modified grazing leases, native grasslands or native bosque. The environmental measures would likely result in improvements of emergent wetlands and subsequent increased wildlife habitat quality.

Modified grazing in the riparian zone would improve vegetation structure and species diversity, however, non-native Bermudagrass and invasive Russian thistle would likely remain a dominant component of 1,747 acres of riparian leases. Most of the woody shrubland vegetation within the floodway would be cut back annually.

### 4.5.6 Targeted River Restoration Alternative

Under this alternative, wildlife habitat quality would increase 72% (Table 4.5-4) as a result of implementing environmental measures and modifying invasive species control methods. The addition of 1,618 acres of conservation easements (Table 4.5-2) would increase the amount of native vegetation and preserve river corridor in the Rincon Valley and Upper Mesilla RMU. The potential development of 1,549 acres of native bosque and 1,929 acres of native grassland would have a positive effect for wildlife (Table 4.5-7).

Mowing would continue as the primary salt cedar control method in the lower portions of the RGCP but restricted to the levees in the Rincon Valley. The majority of the riparian zone would be characterized as grassland with native riparian woodland established in the Rincon Valley, Seldon Canyon and Upper Mesilla RMU. Species adapted to current conditions would continue to thrive with opportunity for reintroduction of less tolerant species. The Rincon Valley, Seldon Canyon and Upper Mesilla RMU would have the greatest potential for reintroduction of wildlife species less tolerant of current management practices. Levee construction activities would temporally disrupt some wildlife but not measurably reduce overall wildlife quality.

Table 4.5-7 shows the increase above baseline for the WHAP HU and increases in area for wetlands and reference habitats. These changes are inclusive of Integrated Land Management Alternative.

### Table 4.5-7 Wildlife Habitat Effects of the Targeted River Restoration Alternative

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| WHAP Habitat Units | 720 | 576 | 192 | 210 | 188 | 170 | 61 | 2,118 |
| Wetlands (ac) | 25 | 21 | 32 | 4 | 17 | 3 | 4 | 106 |
| Improved uplands (ac) | 1641 | 164 | 0 | 0 | 0 | 0 | 0 | 1805 |
| Improved riparian | 286 | 242 | nc | 635 | 131 | 256 | 138 | 1,688 |
| Native bosque or cottonwood/willow riparian community (ac) | 303 | 537 | 351 | 10 | 137 | 168 | 44 | 1,549 |
| Native grasslands (ac) | 639 | 743 | 128 | 50 | 301 | 68 | 8 | 1,929 |

#### *Habitat Quality*

Changes in plant communities would have a noticeable effect on wildlife quality. A 72 percent increase in HUs would occur due to the development of native vegetation communities, modifications in grazing management of conservation easements (Table 4.5-4). The majority of the change would occur in the Rincon Valley, Seldon Canyon and Lower Mesilla Valley. Habitat quality would initially decrease as environmental measures are implemented but would increase as reference communities develop. Long-term wildlife composition would either remain unchanged or would gradually change in response to changes in habitat conditions. Depending on prevailing land management objectives slight shifts in species assemblages could be considered either adverse or beneficial.

Construction associated with environmental measures and removal of salt cedar may adversely affect wildlife using habitat as food, nesting and/or cover. Because of the extensive availability of similar woodland habitat in the RGCP, direct effects would be minor. There would be short-term effects of construction or salt cedar control treatment due to the disruption or destruction of habitat and foraging areas. Any adverse effects would be minimized or offset by performing the treatment actions out of wildlife breeding seasons. Overall, modifications of salt cedar control methods would have a long-term beneficial effect for wildlife.

#### *Wetlands and Reference Community Developed*

A 60 percent increase in wetlands would occur as a result of opening former meanders and management of conservation easements supporting wetlands communities (Table 4.5-4). Overall wetlands condition and potential wildlife quality would improve as the majority of the floodway would be managed as modified grazing leases, native grasslands or native bosque. The environmental measures would likely result in measurable improvements in wildlife quality.

Managed overbank flows in conjunction with bank preparation would slightly increase native vegetation within the Rincon Valley. The addition of conservation easements would extend riparian restoration throughout the RGCP. As a result of overbank flows, planting and conservation easements, the Upper Rincon (720 HU) and Lower Rincon (576 HU) would exhibit the most significant increases in habitat quality of the entire RGCP (Table 4.5-7). Overall, the RGCP would show an increase of 2,118 HU due to the implementation of environmental measures. The replacement of mowed acreage with high quality bosques and grassland is reflected in increase WHAP scores.

Salt cedar control would be required to assure the native dominated component is maintained. Fuel reduction would likely be required in bosque restoration sites. The majority of riparian restoration projects would be dominated by young - mid aged native vegetation. Salt cedar treatments would result in direct minor effects to wildlife in treatment areas. Any adverse effects could be minimized through mitigation measures.

## 4.6 ENDANGERED AND THREATENED SPECIES OF CONCERN

Threatened and endangered species and species of special concern populations would be expected to increase or decrease depending on availability of suitable habitat. Currently, suitable habitat for listed species is largely absent in the RGCP. However, habitat improvements could potentially result in the development of suitable endangered and special status species habitat. The following evaluation criteria were used to evaluate the effects of alternatives on endangered species and species of concern.

- Amount of reference community developed as a result of implementing environmental measures; and
- Construction activities associated with environmental measures and O&M activities.

### 4.6.1 Method of Analysis

Effects to threatened and endangered species were based on assessing species life history requirements with reference community characteristics and construction activities associated with environmental measures. For those species with no potential habitat in the RGCP (as determined from literature review and field survey results) the determination of “no-effect” was applied. For those species with potential habitat in the RGCP, O&M activity and environmental measures associated with alternatives were assessed to determine potential effects. The potential effects of O&M activities and environmental measures on T&E species with a potential habitat in the RGCP are presented in Table 4.6-1.

## Table 4.6-1 Potential Effect of O&M Activities and Environmental Measures on Listed Species

| O&M Activity / Environmental Measure* | Alternative | Potential Effect to Listed Species with a Potential Habitat in the RGCP |
|---|---|---|
| Current O&M activities | NA, FCI, IULM, TRR | Long-term sediment removal/ disposal operations, channel bank protection and road maintenance are conducted. Sediment removal and channel bank protection occurs infrequently (minimal since 1961). Road maintenance occurs on a less then annual basis. Vegetation management by mowing either on USIBWC maintained areas or leased areas is conducted on an annual basis. Maintenance activities could potentially create short-term noise disturbance to interior least terns and bald eagles within RGCP. |
| Levee rehabilitation | FCI, IULM, TRR | Activities could potentially create short-term noise disturbance to infrequent migrant use by the interior least terns and bald eagle. |
| Modify grazing practices | FCI, IULM, TRR | No likely benefit as a result of implementing this measure |
| Modified grassland management in floodway | IULM, TRR | No likely benefit as a result of implementing this measure |
| Plant woody vegetation and/or enhance bosques | IULM, TRR | No likely benefit within 20-year implementation period. |
| Bank shavedowns | IULM | Earthwork and related construction activities could potentially create short-term noise disturbance to interior least terns and bald eagles infrequently over-wintering within RGCP. Development of riparian woodlands in conjunction with potential moist soil conditions as a result of bank shavedowns could create suitable nesting conditions for southwestern willow flycatcher nesting habitat. The lowering of banks would have a potential of creating interspersed wetlands and or moist soil conditions within the restoration areas. This combination of wetlands/wet conditions in conjunction with riparian development could result in long-term beneficial effects to southwestern willow flycatcher habitat. No likely benefit to bald eagles within 20-year implementation period would be expected. |
| Open former meanders | TRR | Earthwork and related construction activities could potentially create short-term noise disturbance to interior least terns and bald eagles infrequently over-wintering within RGCP. Development of riparian woodlands in conjunction with potential moist soil conditions as a result of opening former meanders could create suitable nesting conditions for southwestern willow flycatcher nesting habitat. The opening of meanders would have a potential of creating interspersed wetlands and or moist soil conditions within the restoration areas. This combination of wetlands/wet conditions in conjunction with riparian development could result in long-term beneficial effects to southwestern willow flycatcher habitat. No likely benefit to bald eagles within 20-year implementation period would be expected. |
| Modify dredging at arroyos by creating embayments | TRR | No likely benefit as a result of implementing measure within 20-year implementation period. Dredging activities could potentially create short-term noise disturbance to interior least terns and bald eagles that infrequently over-winter within the RGCP. |
| Seasonal peak flows | TRR | No likely benefit as a result of implementing measure within 20-year implementation period would be expected. |
| Conservation easements | TRR | Management of conservation estimates could potentially benefit listed species. However, if suitable habitat currently exits in some conservation easements (i.e. those located in Seldon Canyon), implementation of measure (*i.e.,* salt cedar reduction) could adversely effect southwestern willow flycatcher habitat. Therefore, surveys would be conducted within conservation easements prior to environmental measure implementation. No likely benefit to bald eagles within 20-year implementation period would be expected. |

* NA- No Action; FCI, Flood Control Improvement; IULM, Integrated USIBWC Land Management; TRR, Targeted River Restoration

Effect determinations were assessed by determining the presence or absence of T&E habitat and if present, analyzing the potential effects of alternative measures. Effect determination for each listed species was based on the following definitions:

"*No effect*" – Either the T&E species habitat was not present in the RGPC and/or the alternative would have no effect on available T&E species habitat.

"*May affect – is not likely to adversely affect*" – T&E species habitat or T&E individuals could potentially be present in the RGPC and the alternative would have beneficial, insignificant or discountable effects.

"*May affect – is likely to adversely affect*" – T&E species habitat or T&E individuals could potentially be present in the RGPC and the adverse effects can not be avoided.

### 4.6.2 Summary of Potential Effects

Table 4.6-2 presents a summary of reference community development for each alternative. Potential effects could be short-term and direct as a result of construction activities and/or long-term as a result of restoring and improving riparian habitats. Currently, suitable habitat for listed species is largely absent in the RGCP. However, environmental measures could potentially result in development of suitable habitat. Specifically, measures associated with the Integrated USIBWC Land Management Alternative and Targeted River Restoration Alternative could potentially result in future vegetation communities consistent with T&E habitat. Assumptions regarding the potential customization of reference community as a result of implementing environmental measures are shown in Table 4.6-3.

**Table 4.6-2 Summary of Reference Community Development for T&E Species**

| Evaluation Criteria | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Improved uplands (ac) | nc | 1805 | 1805 | 1805 |
| Improved riparian (ac) | nc | 1747 | 1747 | 1688 |
| Native bosque or cottonwood/willow riparian community (ac) | nc | 0 | 350 | 1549 |
| Native grasslands (ac) | nc | 0 | 1641 | 1929 |

nc=no change

**Table 4.6-3 Assumptions Regarding T&E Species for Reference Communities**

| Species | Improved Uplands | Improved Riparian | Native Bosque or Cottonwood/Willow riparian community | Native Grasslands |
|---|---|---|---|---|
| Interior Least Tern | No likely benefit | No likely benefit | No likely benefit | No likely benefit |
| Southwestern Willow Flycatcher | No likely benefit | No likely benefit | Potential benefit assuming suitable hydrologic regime | No likely benefit |
| Bald Eagle | No likely benefit | No likely benefit | No likely benefit during the analyses period | No likely benefit |
| Piping Plover | No likely benefit | No likely benefit | No likely benefit | No likely benefit |
| Whooping Crane | No likely benefit | No likely benefit | No likely benefit | No likely benefit |

### 4.6.3 No Action Alternative

Currently, suitable habitat for all but three listed species (piping plover, bald eagle, and interior least tern) is absent from the RGCP. Although piping plover habitat is potentially present, the migrant status of the piping plover and the lack of sighting within the RGCP result in a “no-effect” determination. For the bald eagle and interior least tern, O&M practices associated with the no-action alternative result in a “may affect – is not likely to adversely affect” determination. Current condition do not provide suitable habitat for endangered species.

### 4.6.4 Flood Control Improvement Alternative

Under the Flood Control Improvement Alternative, there would be no direct effects to threatened an endangered species. Suitable habitat for all but three listed species (piping plover, bald eagle, and interior least tern) would continue to be absent from the RGCP. Although piping plover habitat is potentially present, the migrant status of the piping plover and the lack of sighting within the RGCP result in a “no-effect” determination. For the bald eagle and interior least tern, O&M practices associated with the flood control improvement alternative result in a “may affect – is not likely to adversely affect” determination. Direct effects to SOCs known to occur in the area (western burrowing owl and white-faced ibis) or potentially occurring would be negligible. (See Table 3.6.3 for listing of SOCs).

Reference communities developed by this alternative include improved uplands and improved riparian (Table 4.6-4). There would be no indirect effects to threatened and endangered species. The SOCs potentially benefiting from the development of 1,805 acres of improved uplands and improved riparian include the loggerhead shrike (Table 3.6.3). Reference community for improved uplands and improved riparian is consistent with habitat requirements of the loggerhead shrike

**Table 4.6-4 Summary Reference Community Development for Flood Control Improvement Alternative**

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| Improved uplands (ac) | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Improved riparian (ac) | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1747 |
| Native bosque or cottonwood/willow riparian community (ac) | nc | nc | nc | nc | nc | nc | nc | nc |
| Native grasslands (ac) | nc | nc | nc | nc | nc | nc | nc | nc |

nc=no change

### 4.6.5 Integrated USIBWC Land Management Alternative

Under the Integrated USIBWC Land Management Alternative, there would be no direct effects to threatened an endangered species. Suitable habitat for four listed species (piping plover, bald eagle, interior least tern, and southwestern willow flycatcher) would be potentially present within the RGCP. Although piping plover habitat is potentially present, the migrant status of the piping plover and the lack of sighting within the RGCP result in a "no-effect" determination. O&M practices associated with the Integrated USIBWC Land Management alternative may result in a "may affect – is not likely to adversely affect" determination for the bald eagle and interior least tern. Direct effects to SOCs known to occur in the area (western burrowing owl and white-faced ibis) would be negligible.

Reference communities developed by this alternative include improved uplands, improved riparian, native bosque and native grasslands (Table 4.6-4). Development of native riparian woodlands could create conditions suitable for southwestern willow flycatcher nesting habitat. The lowering of banks would have a potential of creating interspersed wetlands and or moist soil conditions within the restoration areas. This combination of wetlands/wet conditions in conjunction with riparian development could result in long-term beneficial effects to southwestern willow flycatcher habitat. As a result a "may affect – is not likely to adversely affect" determination was made for the southwestern willow flycatcher under the Integrated USIBWC Land Management Alternative.

**Table 4.6-5 Summary of Reference Community Development for Integrated USIBWC Land Management Alternative**

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| Improved uplands (ac) | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Improved riparian (ac) | 270 | 309 | nc | 638 | 136 | 256 | 138 | 1747 |
| Native bosque or cottonwood/willow riparian community (ac) | 133 | 61 | nc | 20 | 137 | nc | nc | 350 |
| Native grasslands (ac) | 639 | 611 | nc | 22 | 301 | 68 | nc | 1641 |

nc=no change

Species of concern potentially benefiting from environmental measures include the loggerhead shrike, northern gray hawk, Arizona southwestern toad, and desert viceroy butterfly. The reference community for improved riparian, uplands, and native grasslands is consistent with habitat requirements of the loggerhead shrike. The reference community for native bosque is consistent with habitat requirements of northern gray hawk, Arizona southwestern toad and desert viceroy butterfly (Table 3.6.3).

### 4.6.6 Targeted River Restoration Alternative

Under the Targeted River Restoration Alternative, there would be no direct effects to threatened an endangered species. Direct effects to SOCs known to occur in the area (western burrowing owl and white-faced ibis) would be negligible. Suitable habitat for four listed species (piping plover, bald eagle, interior least tern, and southwestern willow flycatcher) would be potentially present within the RGCP. Although piping plover habitat is potentially present, the migrant status of the piping plover and the lack of sighting within the RGCP result in a "no-effect" determination. O&M practices associated with the Targeted River Restoration Alternative may result in a "may affect – is not likely to adversely affect" determination for the bald eagle and interior least tern. Reference communities developed by this alternative include improved uplands, improved riparian, native bosque and native grasslands (Table 4.6-6). Development of riparian woodlands as a result of opening meanders could create conditions suitable for southwestern willow flycatcher nesting habitat. The opening of meanders would have a potential of creating interspersed wetlands and or moist soil conditions within the restoration areas. This combination of wetlands/wet conditions in conjunction with riparian development could result in long-term beneficial effects to southwestern willow flycatcher habitat.

In addition, implementation of the conservation easements could potentially benefit the southwestern willow flycatcher. However, if suitable habitat currently exits in some conservation easements, measure implementation (i.e., salt cedar reduction) could adversely affect the species habitat. Although there is a potential likelihood of southwestern willow flycatcher habitat within conservation easements (primarily within Seldon Canyon), a determination of "may affect – is not likely to adversely affect" is made under the mitigation conditions dicussed at the end of this chapter.

Species of concern (Table 3.6.3) potentially benefiting from environmental measures include the loggerhead shrike, northern gray hawk, Arizona southwestern toad and desert viceroy butterfly. The reference community for improved uplands/floodway and native grasslands is consistent with habitat requirements of the loggerhead shrike. The reference community for native bosque is consistent with habitat requirements of northern gray hawk, Arizona southwestern toad and desert viceroy butterfly. The status of listed species in potential conservation easements in unknown. Management of construction estimates could potentially benefit listed species. However, if suitable habitat currently exits in some conservation easements, implementation of measure (i.e., salt cedar reduction) could adversely effect listed species habitat. Therefore, surveys would be conducted within conservation easements prior to environmental measure implementation.

**Table 4.6-6 Summary of Reference Community Development for Targeted River Restoration Alternative**

| Evaluation Criteria | Upper Rincon | Lower Rincon | Seldon Canyon | Upper Mesilla | Las Cruces | Lower Mesilla | El Paso | Total |
|---|---|---|---|---|---|---|---|---|
| Improved uplands (ac) | 1641 | 164 | nc | nc | nc | nc | nc | 1805 |
| Improved riparian (ac) | 286 | 242 | nc | 635 | 131 | 256 | 138 | 1688 |
| Native bosque or cottonwood/willow riparian community (ac) | 303 | 537 | 351 | 10 | 137 | 168 | 44 | 1549 |
| Native grasslands (ac) | 639 | 743 | 128 | 50 | 301 | 68 | nc | 1929 |

nc=no change

## 4.7 AQUATIC BIOTA

Alternative effects to aquatic habitats were based upon changes to the amount of in-channel habitat, backwater habitat, and a habitat units of largemouth bass and flathead catfish. These fish are long-lived predators that would only be successful in a river with an adequate food supply and spawning and rearing habitat. The following evaluation criteria were used for the analyses:

- In-channel habitat, a representation of conditions along the overall length of the RGCP.
- Created backwater habitat established as a result of habitat modifications within the RGCP.
- Habitat suitability for indicator two fish species for largemouth bass and flathead catfish, as indicated by HEP evaluation methodology.

### 4.7.1 Method of Analysis

Acreage totals and qualitative habitat changes for each alternative were compared to baseline values. The analyses assessed changes in aquatic habitat as a result of implementing environmental measures. Analysis assumptions included:

- The current anthropomorphic factors would continue to be the dominating influence. Specifically the altered hydrologic and sediment regime would remain in place through the analysis period.
- The location and amount of unconsolidated shore habitat and open water habitat are dynamic and change to reflect flow conditions.
- The calculated HEP scores for two species, largemouth bass and flathead catfish, are reflective of aquatic habitat conditions in the RGCP in terms of availability of suitable, dependable prey source and spawning and rearing habitat.

- Modifications of land management practices would eventually be reflected by increases in the quality of aquatic habitat.

Reference communities are the result of implementing environmental measure and represent the "desired" future condition of aquatic habitat. The two aquatic reference communities identified are 1) back water habitat, and 2) main river run. Table 4.7-1 lists HSI associated with reference communities.

**Table 4.7-1 Habitat Suitability Indices for Largemouth Bass and Flathead Catfish**

| Environmental Measure | Largemouth Bass HSI | Flathead Catfish HSI | Reference Community |
|---|---|---|---|
| Modified grazing leases (riparian zone) | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability for river margin. |
| Modified grassland management | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability for river margin. |
| Native vegetation planting | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability for areas adjacent to river. |
| Bank shavedowns | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability. |
| Existing bosque enhancement | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability. |
| Seasonal peak flows /bank preparation | 0.05 | 0.25 | Main river run with increase riparian cover and bank stability. |
| Excavation of arroyos | 0.15 | 0.45 | Backwater habitat with increased Pool Depth. |
| Reopening former meanders within ROW | 0.15 | 0.45 | Backwater habitat increased Pool Depth and increase riparian cover and bank stability. |

## 4.7.2 Summary of Potential Effects

Table 4.7-2 presents a summary of alternative effects on aquatic habitat. The summary lists acreage of habitat and associated HU for the largemouth bass and flathead catfish.

**Table 4.7-2 Summary of Alternative Effects on Aquatic Habitat**

| Evaluation Criteria | No Action Alternative | | Flood Control Improvement Alternative | | Integrated USIBWC Land Management Alternative | | Targeted River Restoration Alternative | |
|---|---|---|---|---|---|---|---|---|
| | Units | Change | Units | Change | Units | Change | Units | Change |
| In-channel habitat (acres) | 2,513 | nc | 2,513 | nc | 2,513 | nc | 2,513 | nc |
| Created backwater habitat (acres) | nc | nc | nc | nc | nc | nc | 59 | Additional habitat |
| HEP largemouth bass (HU) | 126 | nc | 126 | nc | 126 | nc | 134 | 6.3% |
| HEP flathead catfish (HU) | 628 | nc | 628 | nc | 628 | nc | 654 | 4.1% |

### 4.7.3 No Action Alternative

Under the No Action Alternative, vegetation community and vegetation management would remain consistent with current conditions. Long-term effects are a continued fragmentation of aquatic habitat due to unnatural flow regimes, reduced riparian vegetation, and low physical stream habitat diversity.

### 4.7.4 Flood Control Improvement Alternative

Direct effects due to levee rehabilitation would be short-term resulting in the removal of vegetation and the replacement of effected areas by vegetated levees. Construction of some levees may reduce the amount of runoff into the river. This effect would be localized.

The modification of grazing leases may lead to a reduction of sediment runoff nitrogenous contaminants from livestock. This would represent a localized effect and may improve water quality in some instances. Modification of floodway grazing leases could lead to some increase in bank stabilization and overhanging cover in localized situations. Long-term, this would increase shading along the river, and potentially increase invertebrate production near the river. No change in HU for largemouth bass or flathead catfish would occur.

### 4.7.5 Integrated USIBWC Land Management Alternative

Direct effects due to levee rehabilitation and grazing leases modification would be similar to those indicated for the Flood Control Improvement Alternative.

Bank shavedowns, associated with episodic over bank flows, could potentially influence fish during their spawning periods by providing additional spawning and resting habitats, particularly if small side channels or embayments were created as a result of the activity. Increase in overhanging cover from bosque development and improved river margin vegetation within native grasslands would likely have a long-term beneficial effect to aquatic species.

### 4.7.6 Targeted River Restoration Alternative

Direct effects due to levee rehabilitation and grazing lease modification would be similar to the previous action alternatives.

This alternative offers the greatest opportunity for the improvement of aquatic habitat. Modification of the terrestrial system, and links to the aquatic system would result in long-term beneficial effects to the aquatic system. Specifically, direct effects include the opening of stream meanders within the ROW for 122 acres within the Upper Rincon area and about 20 acres within the Upper Mesilla area (Table 4.7-2). Modified dredging in some arroyos for aquatic habitat diversification would occur within the Upper Rincon area (2.62 acres) and Lower Rincon area (4.2 acres). This activity would create some diversity of aquatic habitat in a localized manner, and provide backwater areas for fish species. A total of 59 acres of aquatic habitat would be developed (Table 4.7-2).

These activities would increase the amount and size of pools within these areas thus increasing resting and feeding habitat. As a result of aquatic habitat diversification, largemouth bass and flathead catfish HEP values show an increase of 6.3% and 4.1%, respectively.

The development of native bosque and native grasslands within the riparian community would likely result in long-term beneficial effects to aquatic resources. Beneficial effects include increased bank stabilization, overhanging cover along the river margin, invertebrates food production, and improved water quality. Improving the terrestrial/aquatic link would result in increased aquatic habitat diversity.

The development of backwater habitat would increase largemouth bass HUs to 134 and flathead catfish to 654 (Table 4.7-2). Improvements within the bosque would directly improve bank stabilization and vegetation establishment, thus providing shading, invertebrate food production, and increased bank overhead cover for aquatic species in these areas. This process, by improving the terrestrial/aquatic link, would result in long-term beneficial effects by increasing habitat diversity.

Habitat is more than a physical place for the fish to occur, there must be areas of suitability for reproduction, rearing of young, and the production of adequate food sources. Environmental measure could increase the amount and size of pools within the RGCP thus increasing resting and feeding habitat for the largemouth and flathead catfish, the HEP evaluated species, as well as other species, particularly if the pools occur near the river bank. Indirectly, increasing the amount and depth of pools, by increasing the diversity of river habitats, will improve aquatic productivity in the areas where the planned meandering and dredging is planned.

## 4.8 LAND USE

The following evaluation criteria were used in the analysis of river management alternatives effects on land use:

- Changes in agricultural land use
- Changes in recreational use

### 4.8.1 Method of Analysis

Land use analysis is limited to lands outside the USIBWC jurisdiction, in terms of agricultural use. Land use changes within the ROW evaluated in this section are those associated with recreational use. For recreational use, the same initiatives apply to all alternatives, so no analysis is conducted for individaul alternatives. Effects on other resources (soils, vegetation, wildlife habitat) were previously evaluated (Subsections 4.3 through 4.7).

Potential changes in land use would be associated with voluntary conservation easements and, to a lesser extent, with material borrow sites needed for levee rehabilitation. A second type of change, farmland retirement, could also result from water acquisition for implementation of environmental measures. For water acquisition two scenarios were evaluated. Under the Scenario 1, water would be acquired by financing on-farm water conservation programs. This approach is the preferred strategy as it would retain farmlands in full production (Subsection 2.2.9).

Under Scenario 2, landfarm retirement would be required for direct water acquisition. The extent of potential farm retirement was calculated based on the alternative estimated water consumption. Acreage of retired farmland was estimated by dividing water consumption (ac-ft/yr) by the typical Rio Grande Project water allocation (3 ft/yr). In this estimate it is assumed that surface water sources would supply the entire water requirement, without a groundwater contribution. This is a conservative approach as established vegetation in the floodway is expected to be sustained primarily by groundwater.

### 4.8.2 Summary of Potential Effects

Table 4.8-1 presents a comparative summary of potential effects of river management alternatives under consideration on land use.

Implementation of either the three river management action alternatives or the No Action Alternative would not result in adverse effects on recreational resources. The USIBWC, along with other agencies who manage and maintain projects along the RGCP, are currently participating in initiatives to create additional recreational opportunities and public access to natural areas within the Rio Grande floodway. As a result, projects currently underway and future ROW enhancements identified would result in the same beneficial effects to recreational resources under all alternatives.

**Table 4.8-1 Summary of Potential Effects on Land Use**

| Evaluation Criteria | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Changes in agricultural land use | No effect | Approximately 50 acres of agricultural land would be needed as material borrow sites to raise or build levees | 50 acres of agricultural land would be needed as borrow sites. Without an on-farm water conservation program, environmental measure Implementa-tion could result in 734 acres of cropland retirement | Voluntary conservation easements would affect up to 288 acres of cropland. Current use would be maintained for another 1,330 acres of remnant bosque easements. Without an on-farm water conservation program, environmental measure implementation could result in 3,154 acres of cropland retirement |
| Changes in recreational use | Beneficial effects on recreational resources | Same as No-Action Alternative | Same as No-Action Alternative | Same as No-Action Alternative |

### 4.8.3 No Action Alternative

Under the No Action Alternative, the RGCP operation and maintenance would not change from the current practices. Agricultural land use in the potential area of influence would remain unaffected relative to current conditions. Beneficial effects on recreational use as ongoing initiatives are implemented.

### 4.8.4 Flood Control Improvement Alternative

Under this alternative, levee rehabilitation would be the only action with potential effects on land use adjacent to the RGCP. While levee construction would take place in government lands, it was estimated that up to 149 acres of material borrow sites would be needed for rehabilitation of the levee system if adequate material were available within the ROW. The estimated depth of excavation is 6 feet.

Rehabilitation estimates include six miles of new levees and increasing levee height up to 2 feet for 60.1 miles. The bulk of the rehabilitation program would take place in the southern reaches of the RGCP, 90 percent of the new levees would be within El Paso RMU, and 64 percent of the height increase would take place in the El Paso and Las Cruces RMUs. Because most of the levee rehabilitation would take place near urban areas, most borrow material would likely to be obtained from commercial sites already in operation. The combined length of levee rehabilitation outside the El Paso and Las Cruces RMUs would be 22.2 miles, or 33.6 percent of the entire rehabilitation program. On this basis, up to 50 acres of the approximately 149 acres of borrow sites would be located in agricultural areas. Relative to the 30,289 acres located within the area of influence (Table 3.8-1), it would not be significant in terms of land use.

### 4.8.5 Integrated USIBWC Land Management Alternative

This alternative would include the same construction activities as the Flood Control Improvement Alternative. In addition to these construction activities, the Integrated USIBWC Land Management Alternative would include habitat enhancement through management of bosque, planting of native vegetation, regeneration of native woody vegetation, and improvement of erosion control. These activities would occur entirely within the RGCP, without changesd in current land use outside the ROW. These activities would be compatible with and would not change existing land use.

No changes in land use would be anticipated under the preferred water acquisition Scenario 1, financing of on-farm conservation programs. Under Scenario 2, direct water acquisition (or groundwater use) would be required to support implementation of environmental measures. For an estimated water consumption of 2,203 ac-ft/yr (Table 4.1-4), and an annual 3 ac-ft/ac allocation, a 734-acre farmland retirement would be required for water consumption under the Integrated USIBWC Land Management Alternative). Relative to 19,020 acres of agricultural lands located within the potential area of influence (Table 3.8-1), retired farmlands would represent 3.9 percent.

Some USIBWC lands near urban areas would be allocated for recreational use. These areas include designated parklands that would be extended under all river management alternatives under consideration. These activities would be compatible with current land uses, and would have the same effects as the No Action Alternative.

### 4.8.6 Targeted River Restoration Alternative

This alternative would include the same construction activities as the Flood Control Improvement Alternative for levee system rehabilitation. The Targeted River Restoration Alternative would also include a total of 1,618 acres of voluntary conservation easements outside the ROW. Of these easements 1,330 acres are existing bosques located primarily in Seldon Canyon that would be preserved as part of the Targeted River Restoration Alternative. The remaining 288 acres are croplands that would be converted to conservation easements. Voluntary easements would be established for a vegetation management program. Ownership of these properties would not change; only the function of the land through voluntary easements.

No additional changes in land use would be anticipated under the preferred water acquisition Scenario 1, financing of on-farm conservation programs. Under Scenario 2, direct water acquisition (or groundwater use) would be required to support implementation of environmental measures. The estimated water consumption for the Targeted River Restoration Alternative would be 9,461 ac-ft, 78 percent of which would be associated with controlled water releases from Caballo Dam in early spring to induce overbank flows (Table 4.1-5). On the basis of a 3 ac-ft/ac annual allocation, a farmland retirement of 3,154 acres would be required for water consumption under the alternative. Relative to 19,020 acres of agricultural lands located within the potential area of influence (Table 3.8-1), retired farmlands would represent 16. 6 percent.

Some USIBWC lands near urban areas would be allocated for recreational use under all river management alternatives under consideration. These areas include designated parklands that would be extended. These activities would be compatible with current land uses, and would have the same effects as the No Action Alternative.

## 4.9 SOCIOECONOMIC RESOURCES AND ENVIRONMENTAL JUSTICE

The following evaluation criteria were used in the analysisof the effects of levee construction and river management alternatives on socioeconomic resources and environmental justice:

- Changes in population and housing;
- Changes in employment;
- Changes in income;
- Changes in business volume;
- Disproportionate number of minority populations affected;
- Cropland lost;
- Value of cropland production lost; and
- Decrease in farm laborers.

### 4.9.1 Method of Analysis

The Economic Impact Forecast System (EIFS) Model was used to project the short-term regional and local economic impacts of levee construction. The EIFS Model was developed by the U.S. Army Construction Engineering and Research Laboratory (CERL) to provide a systematic method for evaluating regional socioeconomic effects of government actions. Using employment and income "multipliers" developed with a comprehensive regional/local database combined with economic export base techniques, the model estimates the direct and indirect economic impacts of a construction activity on changes in the regional/local population and housing; employment; business volume; and income. The Region of Influence (ROI) is considered to be Doña Ana County and Sierra County in New Mexico, and El Paso County in Texas. Since the EIFS economic projections are on an annual basis, the primary model input for levee construction costs ($18.7 million) was pro-rated over a five-year construction period. In addition, an estimate of 42 construction workers was also used as an input into the model. Table 4.9-1 summarizes the economic impacts under each alternative as forecasted by the EIFS Model.

The EIFS Model also includes a RTV (Rational Threshold Value) profile that is used in conjunction with the forecast model to assess the significance of impacts of a construction activity for a specific geographic area or region. For each variable (i.e. population, housing, employment, business volume, income) the current time-series data available from the Bureau of Economic Analysis is calculated along with the annual change, deviation from the average annual change, and the percent deviation for each variable. This calculation defines a "threshold" for significant annual economic impacts for a variable. If the RTV for a particular variable associated with the impacts of the project exceeds the annual regional RTV for that variable, then the economic impact is considered to be significant. If the RTV for a variable is less than the regional RTV for that variable, the regional economic impact is then considered not significant.

The implementation and operational effects of the proposed management activities under each alternative were analyzed using a different methodology. The objective of this analysis was to estimate the impacts on cropland reduction as a result of levee borrow sites, conservation easements, and direct water rights acquisition. These impacts include acreage of cropland lost, annual value of cropland production lost, and associated decrease in farm laborers under each of the alternatives and associated components/scenarios.

This latter analysis was based on estimates of cropland distribution by type, and per acre value of annual production for the project area. Because of cropland similarities, the cropland distribution for the Elephant Butte Irrigation District (EBID), excluding pecans, was used and pro-rated for each alternative and associated component/scenario. Estimates of annual value of production per acre for each crop was obtained from the New Mexico Department of Agriculture, Agricultural Statistics Service; U.S. Department of Agriculture, U.S. Census of Agriculture, 1997; and economic worksheets developed for the El Paso-Las Cruces Regional Sustainable Water Project (CH2M-Hill 2000b). In addition, an estimate was made of the direct impact on farm labor as a result of the removal of cropland from production. This estimate was based on the average number of acres per farm worker in Doña Ana County according to the U.S. Census of Agriculture. This value was subsequently inflated to reflect the more labor-intensive character of some of the crops grown in the affected area.

### 4.9.2 Summary of Potential Effects

#### *Levee System Improvements*

Table 4.9-1 presents a comparative summary of potential effects of river management alternatives under consideration on socioeconomic resources and environmental justice. Table 4.9-1 summarizes the impacts of levee construction under each alternative in respect to changes in population/housing, employment, business sales volume, income and disadvantaged populations. Table 4.9-2 summarizes the implementation/operational impacts of each of the components/scenarios under each alternative on potential cropland removed from production, value of cropland production, and farm labor.

**Table 4.9-1 Summary of Potential Effects on Socioeconomic Resources and Environmental Justice, Levee Construction**

| Evaluation Criteria | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Changes in population and housing | No change | No change | No change | No change |
| Direct/Indirect changes in employment | No change | 104 additional short-term jobs | 104 additional short-term jobs | 104 additional short-term jobs |
| Annual direct/indirect changes in sales volume | No change | $12, 267,200 | $12, 267,200 | $12, 267,200 |
| Direct/Indirect changes in income | No change | $2,194,432 | $2,194,432 | $2,194,432 |
| Disproportionate number of low-income / minority populations negatively affected | No change | No effect | No effect | No effect |

The socioeconomic impacts of levee construction presented in Table 4.9-1 represent the outputs from the EIFS Model. It was assumed that the majority of the expenditures associated with levee construction would be local expenditures. Since the estimated cost of levee construction is the same under each alternative, the socioeconomic impacts are also similar for each alternative. A total of 104 direct and indirect jobs would be created, including the 42 construction jobs associated with the construction of the levee. Other jobs created include those directly or indirectly associated with levee construction, including jobs in the various industry sectors such as retail/wholesale trade, construction, manufacturing. Other impacts include an annual increase of $12,267,200 in direct and indirect business sales volume, and an annual increase of $2,194,432 in direct and indirect income. The RTV values generated from the EIFS Model for each of the economic variables associated with levee construction were significantly below the regional RTV values for each variable. Thus, this construction activity is not considered to have significant regional/local economic impacts.

There would be no changes in population or housing as it is assumed that all of the construction workers would come from the local or regional labor pool. There would be no disproportionate adverse impact on minority or low-income populations. Rather, considering the local and regional population composition, the impacts on such disadvantaged populations would be beneficial as it is assumed that the majority of the construction workers would be minority and lower income.

As indicated in Table 4.9-2 the greatest adverse impacts on cropland and production, and farm labor would be under Component C, Scenario 2, of the Targeted River Restoration Alternative. Under this scenario 3,492 acres of cropland with an annual production value of over $4 million would be taken out of production. It is estimated that this decrease in cropland could result in a reduction of 35-40 farm workers. This would result in an adverse impact on minority/low income populations since the majority or all of the farm laborers represent this population group.

**Table 4.9-2 Summary of Potential Impacts on Socioeconomic Resources and Environmental Justice, Cropland/Farm Labor**

| Scenario / Component | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| **Scenario 1: With Implementation of Water Conservation Program** | | | | |
| Levee material borrow sites (acres) | 0 | 50 | 50 | 50 |
| Conservation easement acreage (from active croplands) | 0 | 0 | 0 | 288 |
| Potential cropland conversion (acres) | 0 | 50 | 50 | 388 |
| *Value of production (annual)* | *No change* | *$58,965* | *$58,965* | *$386,965* |
| *Decrease in farm workers* | *No change* | *1-2* | *1-2* | *4-6* |
| **Scenario 2: With Direct Water Rights Acquisition** | | | | |
| Levee material borrow sites (acres) | 0 | 50 | 50 | 50 |
| Conservation easements (acres from active croplands) | 0 | 0 | 0 | 288 |
| Retirement due to water acquisition | 0 | 0 | 734 | 3,154 |
| Potential cropland conversion (acres) | 0 | 50 | 784 | 3,492 |
| *Value of production (annual)* | *No change* | *$58,965* | *$899,435* | *$4,003,605* |
| *Decrease in farm workers* | *No change* | *1-2* | *7-9* | *35-40* |

The next greatest adverse impacts would also be under Component C, Scenario 2, of the Integrated USIBWC Land Management Alternative. The impacts are greatest under this combined component/scenario for both the Integrated USIBWC Land Management Alternative and the Targeted River Restoration Alternative because of the additional cropland lost through direct water rights acquisition. The least adverse impacts would occur under the Flood Control Improvement Alternative where cropland would be lost only because of borrow sites for levee construction.

#### *Socioeconomics*

No additional equipment or personnel would be required if the current operation and maintenance practices were continued. Thus, the No Action Alternative would not result in any additional construction or operation costs. There would be no impact on cropland and production, or on farm labor.

Since there would not be a need for additional workers, there would be no effects on population or employment rates. The No Action Alternative would not result in relocations to or from the area and, consequently, housing and community services would not be impacted. An EIFS analysis was not performed for this alternative because there would not be any associated costs which could result in socioeconomic changes.

#### *Environmental Justice*

There would be no change from the current maintenance practices under the No Action Alternative. Therefore, the situation for minority and low-income populations would remain unchanged.

### 4.9.3 Flood Control Improvement Alternative

#### *Socioeconomics*

The Flood Control Improvement Alternative includes 6 miles of new levees, 2.8 miles of floodwalls and 60.1 miles of raised levees. It was assumed that the USIBWC would hire contractors to carry out these activities. Based on the necessary equipment and materials for these tasks, a crew of approximately 42 workers was used for an estimate of construction activity requirements. Construction of 6 miles of new levee including labor, equipment and compaction costs was estimated at $2.3 million. Labor, equipment and soil compaction costs for 55 miles of raised levee were estimated at $15.6 million. Approximately 12 miles of levee will be raised per year over a 5 year period. Construction of a floodwall, including materials (concrete, form wood, steel), labor and equipment was estimated at $739,000. In determining the socioeconomic impact of the proposed flood control improvement action, a total construction cost estimate of $18.7 million was used with the conservative assumption that all construction would be completed within 5 years. Costs during the first year would be $2.3 million for the new levee, $739,000 for the floodwall, and $3.12 million for raising the height of existing, which totals $16.6 million.

As a result of the proposed action, the local population would not change. Housing and community structure would be unaffected since relocations are not expected. With an unemployment rate of 7.8 percent, the 42 workers required for construction could be hired within the community, making relocations unnecessary. Direct and indirect employment in the region of impact would increase by 104, or only 0.13 percent, significantly below the regional positive RTV of 3.79 percent for this variable.

Total sales volume is defined as the total change in local business volume due to the proposed action. The proposed action would result in an increase in direct and indirect annual total sales volume of $12,267,200, or 0.05 percent, significantly below the regional positive RTV of 8.0 percent. The total direct and indirect annual income would increase 0.09 percent, again significantly below the regional positive RTV of 7.99 percent for this variable.

There would be minor adverse impacts on cropland as 50 acres, with an estimated annual production value of $58,965, would be removed from production for the purposes of borrow sites for levee construction material in rural areas.

#### *Environmental Justice*

The Flood Control Improvement Alternative would not disproportionately affect low-income or minority populations. An increase in sales volume of 0.78 percent would be contributed to the local economy, providing a positive impact for these populations. The increase in employment and income could also be beneficial. Low-income and minority populations would not be displaced by the proposed alternative. Business sectors that disproportionately employ low-income or minority populations would be positively affected by the implementation of this alternative.

As discussed in Section 3, colonias are dominated by minority and low-income populations. Approximately 24 percent of employed residents of border colonias are construction workers (Border Low Income Housing Coalition 2001). Any rise in employment due to project construction could benefit colonia residents. There would be no adverse impact on minority and low-income populations as a result of the small amount of cropland removed from production.

### 4.9.4 Integrated USIBWC Land Management Alternative

#### *Socioeconomics*

In determining the socioeconomic impact of the Integrated USIBWC Land Management Alternative, a total construction estimate of $19.5 million was used. This includes $18.7 million for flood control improvement (described above) and $768,000 for annual habitat enhancement and vegetation management costs (20-year implementation period). Habitat enhancement includes salt cedar removal and control, cottonwood replacement and regeneration, and modified grazing.

The proposed vegetation management program is expected to span approximately 20 years; however construction of the flood control improvements is assumed to be completed in 5 years. For purposes of this analysis, the initial year of construction and maximum cost of $17.37 million ($16.60 + $0.77) was used for a conservative analysis of effects. USIBWC would implement the vegetation maintenance program with existing staff. An estimated 42 additional workers for construction of flood control improvements would be required.

This alternative would not result in a population change. Therefore, housing and community structure, including public protection, education and medical care, would not be affected. No relocations would be expected; the estimated 42 workers could be hired locally. The annual impacts from levee construction on business sales volume, employment and income would be the same as under the Flood Control Improvement Alternative.

Potential effects with implementation of a water conservation program (Scenario 1), would be similar to those impacts under the Flood Control Improvement Alternative. A potential adverse effect would occur by direct water acquisition (Scenario 2) as 784 acres, with an estimated annual production value of $899,435, would be removed from production. This cropland conversion would consist of 50 acres of borrow sites for levee material in rural areas, and 734 acres associated with direct water rights acquisition.

#### *Environmental Justice*

The Integrated USIBWC Land Management Alternative would not disproportionately affect low-income or minority populations. Though the rise in sale volume, employment and income could benefit low-income and minority populations. Also, a rise in construction employment could benefit colonia residents. No displacements would occur, and the business sectors that disproportionately employ low-income and minority populations could be positively affected.

There could potentially be some adverse effects on low-income and minority population as a result of the implementation and subsequent management operations under this alternative. Under Scenario 2, it is estimated that 7-9 farm labor jobs could be lost because of the removal of cropland from production.

### 4.9.5 Targeted River Restoration Alternative

#### *Socioeconomics*

In determining socioeconomic effects of the Targeted River Restoration Alternative, a total construction cost estimate of $21 million was used. This estimate includes $18.7 million in flood control improvements and $1.1 million for annual habitat improvements and vegetation management (20-year implementation period). Habitat enhancement under this alternative would include salt cedar removal and control, cottonwood planting, meander restoration, and conservation easements. Additional costs would include acquisition of 288 acres of voluntary agricultural easements.

The vegetation management program under consideration is expected to span approximately 20 years; however, construction of the flood control improvements is assumed to be completed in 5 years. For purposes of this analysis, the initial year of construction and maximum cost of $21 million was used for a conservative analysis of effects. The USIBWC would implement the vegetation maintenance program with existing staff. An estimated 42 additional workers for construction of flood control improvements would be required.

The local population is not expected to change as a result of this alternative. Relocations are not expected; therefore housing and community structure would remain unaffected. The annual impacts from levee construction on business sales volume, employment and income would be the same as under the Flood Control Improvement Alternative and the Integrated USIBWC Land Management Alternative.

Adverse socioeconomic effects could be associated with this alternative under both scenarios evaluated due to potential farmland retirement (Table 4.9-2). With implementation of a water conservation program (Scenario 1), potential cropland conversion would be 388 acres. The estimated loss in annual production value would be $386,965. With direct water rights acquisition, approximately 3,492 acres with an estimated annual production value of $4,003,605 would be removed from production. This retired cropland would consist of 50 acres of borrow sites, 288 acres of voluntary conservation easements, and 3,154 acres associated with direct water rights acquisition. This conversion would represent the most adverse effect of all the alternatives under consideration.

***Environmental Justice***

The Targeted River Restoration Alternative would not disproportionately affect low-income or minority populations. Though increases in sales volume, employment and income fall below their respective RTVs, any rise could be potentially beneficial. Low-income and minority populations, particularly colonia residents, could benefit from an increase in construction employment. Low-income and minority populations would not be displaced by the proposed alternative. Business sectors that disproportionately employ low-income and minority populations could be positively affected.

There could potentially be adverse effects on low-income and minority population as a result of the implementation and subsequent management operations under this alternative. Under Scenario 2, it is estimated that 35-40 farm labor jobs could be lost as a result of the removal of cropland from production.

## 4.10 CULTURAL RESOURCES

As defined in Section 106 of the National Historic Preservation Act (NHPA) and in conjunction with NEPA, an adverse effect on a cultural resource could occur due to an action that could 1) physically damage or destroy all or part of the property; 2) isolate the property or alter the character of the property's setting, when that character contributes to the property's qualification for the National Register of Historic Places (NRHP); 3) introduce visual, audible, or atmospheric elements that are out of character with the property or alter its setting; 4) result in neglect of a property leading to its deterioration or destruction; or 5) result in the transfer, lease, or sale of the property without adequate restriction or conditions included to ensure preservation of the property's significant historic features.

Effects to NRHP-eligible archaeological and architectural resources, and traditional cultural properties as a result of the proposed RGCP alternatives may include ground disturbance; increased soil erosion from vegetation removal through burning; reduced maintenance of landscape near architectural resources; and audio or visual intrusions to historic or traditional settings. Ground disturbance and soil erosion may damage or destroy the physical integrity and decrease or destroy research potential of a cultural resource, and subsequently, alter the NRHP eligibility of the resource. Audio or visual intrusions resulting from the short term construction phase of the RGCP may disturb historic settings associated with architectural resources or disrupt the use of sacred or sensitive traditional cultural properties. The following evaluation criteria were used in the analysis for river management alternatives effects on cultural resources:

- Potential adverse effect on architectural resources;
- Potential adverse effects on traditional cultural properties;
- Potential adverse effects on known archaeological sites; and
- Potential adverse effects on undiscovered cultural resources

### 4.10.1 Method of Analysis

The areas of potential effect (APE, as defined by Section 106 of the NHPA) were defined for the cultural resource types. The APE for archaeological and architectural resources consisted of the RGCP ROW corridor and any areas outside the ROW designated for ground disturbing activities. The APE for traditional cultural properties was defined as the broader cultural resources study area which was the 2-mile wide corridor along the length of the RGCP.

The cultural resource impact analysis was based on the comparison of known or potential cultural resources locations with locations of environmental measures under consideration along the RGCP. Assumptions listed in Table 4.10-1 were used in the effects analysis.

**Table 4.10-1 Assumptions for Cultural Resources Effects Analysis**

| Measure | Assumptions for Effects Evaluation |
|---|---|
| Levee rehabilitation | Ground disturbance associated with construction of new levees and floodwall has potential effects.<br>Ground disturbance associated with excavation of materials borrow sites has potential effects.<br>In-place rehabilitation of levees by increase in height has little or no potential effect. |
| Modify grazing practices | Potential beneficial impact through stabilization of landforms by increasing vegetative cover for soil erosion control.<br>Vegetation treatments, such as burns and mechanical thinning, has a potential effect. |
| Modified grassland management in floodway | Mowing and planting limited to surface soil preparation and maintenance has little or no potential effects. |
| Plant woody native vegetation | Planting and/or irrigation limited to surface soil preparation and maintenance has potential effects. |
| Enhance existing bosques | Removal of invasive plants on floodplain limited to surface disturbance and maintenance has little or no potential effect |
| Bank shavedowns | Ground disturbance associated with excavation and soil disposal has potential effects. |

| Measure | Assumptions for Effects Evaluation |
|---|---|
| Open former meanders | Ground disturbance associated with excavation and heavy equipment use has potential effects.<br>Soil disposal activities may decrease accessibility to cultural resources. |
| Modify dredging at arroyos | Ground disturbance associated with excavation and heavy equipment has potential effects.<br>Soil disposal activities may decrease accessibility to cultural resources. |
| Controlled peak flows | Ground disturbance associated with disking and excavation of stream banks has potential effects. |
| Voluntary conservation easements | Potential beneficial effects through converting cultivated lands to natural grasslands.<br>Removal of salt cedar limited to surface disturbance and maintenance has little or no potential effect. |

## 4.10.2 Summary of Potential Effects

Table 4.10-2 presents a summary of potential effects of river management alternatives under consideration on cultural resources.

**Table 4.10-2 Summary of Potential Effects on Cultural Resources**

| Criteria for Potential Effects | No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|---|
| Architectural resources | No effect | No effect | No effect | No effect |
| Traditional cultural properties | No effect | No effect | No effect | No effect |
| Known archaeological sites | No effect | No effect | No effect | Two projects (one meander reopening and one arroyo dredging) would be in the general vicinity of a recorded site |
| Areas with a greater potential for undiscovered cultural resources | No effect | No effect | Two areas with a greater potential for undiscovered sites would be located in the general vicinity of shavedown projects. | The areas with a greater potential for undiscovered sites would be located near arroyo or meander projects. |

## 4.10.3 No Action Alternative

Under this alternative, current operations and maintenance activities would continue. Routine maintenance of three historic dams: the American Diversion Dam (listed on the New Mexico SRCP), the Percha Diversion Dam (NRHP-listed) and the Leasburg Dam (listed on the New Mexico SRCP) will occur. Engineering evaluations for the erosion protection of the Hatch and Rincon Siphons and the Picacho Flume (all historic resources) have been completed by the USIBWC and will be implemented to protect these resources. Continued maintenance would also include other irrigation structures and historic bridges. Operations and maintenance of historic architectural resources will continue to follow existing guidelines and regulations.

The No Action Alternative will not effect or adversely affect any architectural resources, traditional cultural properties or archaeological resources.

### 4.10.4 Flood Control Improvement Alternative

Levee system rehabilitation has the potential for adverse effects on cultural resources due to excavation at the levee or at material borrow locations. Rehabilitation would entail construction of a 2.8 mile floodwall and 6 miles of new levees, and rehabilitation of existing levees by increasing their height and footprint. A low potential for effects on undiscovered sites was assumed for in-place levee rehabilitation. No traditional cultural properties or architectural resources have been identified for project areas under consideration and, thus, no adverse effects are anticipated on these cultural resources.

Floodwall construction has a low potential for adverse effects on undiscovered sites, as it would be constructed in the urban area of Canutillo (river mile 13), in extensively disturbed terrain along an existing railroad berm. None of the 27 areas identified as having potential for undiscovered cultural sites are located in the Canutillo area.

Construction would be primarily in the El Paso RMU (5.4 river miles), to a lesser extent in the Lower Rincon (0.6 river miles). In El Paso RMU, known archaeological sites were identified for river mile 5, and areas with a potential for undiscovered cultural sites at miles 5, 7 in the east bank, and 14, 15 and 16 in the west bank. These areas have existing levees and, consequently, no adverse effects are expected. In the Lower Rincon RMU, new levee construction would not be conducted in areas where a potential for undiscovered cultural resources has been identified.

Modified grazing practices would have a beneficial impact to subsurface archaeological sites by stabilizing landforms through increasing vegetative cover for soil erosion control. However, vegetation treatments, such as burns and mechanical thinning, will adversely effect surface archaeological sites by damaging or destroying artifacts and generate carbon that has the potential to interfere with carbon dating of archaeological sites.

### 4.10.5 Integrated USIBWC Land Management

In addition to the levee system rehabilitation and the modified leases previously discussed, three measures associated with this alternative were identified as potentially having effects on cultural resources: modified grassland management, bosque enhancement, and shavedowns for stream bank reconfiguration. No traditional cultural properties or architectural resources have been identified for project areas under consideration and, thus, no adverse effects are anticipated on these cultural resources.

Mowing and planting native grass in the floodways and levee slopes would have little or no effect on cultural resources. These activities involve minimal surface disturbance and any cultural resources on the floodplains are expected to be subsurface.

Planting of native vegetation and removal of invasive plants in the bosques located on the floodplains would have little or no effect on cultural resources. This activity would involve minimal surface disturbance and any cultural resources on the floodplains are expected to be subsurface.

Table 4.10-3 shows the river mile of shavedown sites relative to the general location of known archaeological sites and areas with a greater potential for undiscovered cultural resources. Two shavedown projects listed in Table 4.10-3 are within the same river mile as recorded archaeological site, but no adverse effect from shavedowns are anticipated. Both sites are either located more than ½ mile from the shavedown projects. Two areas with a greater potential for undiscovered cultural resources are located in the general vicinity of shavedown projects 83B and 94B. If undiscovered cultural resources occur, some are likely to be considered potentially eligible for the NRHP. Implementation of the shavedown projects may have an adverse effect on NRHP-eligible archaeological resources.

**Table 4.10-3 Cultural Resources Locations Relative to Point Projects for the Integrated USIBWC Land Management Alternative**

| River Management Unit | Mile Range | Archaeological Sites Along the RGCP | Areas with a Greater Potential for Undiscovered Sites | Stream Bank Shavedowns by River Mile |
|---|---|---|---|---|
| El Paso | 0-21 | 1 location | 5 locations | |
| Lower Mesilla | 21-40 | | 4 locations | |
| Las Cruces | 40-51 | | 1 location | |
| Upper Mesilla | 51-63 | 2 locations | 3 locations | |
| Seldon Canyon | 63-72 | 4 locations | 4 locations | |
| Lower Rincon | 72-90 | 2 locations | 6 locations | 76, 83 |
| Upper Rincon | 105-90 | 3 locations | 4 locations | 92, 94, 98, 101, 102, 103, 104 |

## 4.10.6 Targeted River Restoration

In addition to the levee system rehabilitation, modified leases, modified grassland management, native vegetation planting/bosque enhancement previously discussed, three measures associated with this alternative were identified as potentially having effects on cultural resources: controlled peak flows, reopening of meanders, and modified dredging of arroyos. No traditional cultural properties or architectural resources have been identified for project areas under consideration and, thus, no adverse effects are anticipated on these cultural resources.

Disking and excavation of stream banks has a potential for adverse effects to archaeological sites.

Excavation of meanders has a low potential for adverse effects since former active channels have a low probability of preserving materials dating before the start of canalization. Spoil disposal locations and practices could result in the burial of unrecorded archaeological sites, protecting them, but also making them inaccessible to researchers. Heavy equipment could also impact surface archaeological remains, damaging or destroying their physical integrity, degrading their research potential and subsequently, their NRHP eligibility.

Table 4.10-4 shows the relative location of meander sites relative to archaeological sites and areas with a higher potential for undiscovered cultural resources. One listed project was identified in the general vicinity of a recorded archaeological site. An area with a higher potential for undiscovered sites was also located near a menader project. If undiscovered cultural resources occur, some are likely to be considered potentially eligible for the NRHP. Excavation of meanders may have an adverse effect on NRHP-eligible archaeological resources.

Spoil disposal locations and practices could result in the burial of unrecorded archaeological sites, protecting them, but also making them inaccessible to researchers. Heavy equipment could also impact surface archaeological remains damaging or destroying their physical integrity, degrading their research potential and subsequently, their NRHP eligibility.

Table 4.10-4 shows arroyo dredging locations relative to the general location of known archaeological sites and areas with a greater potential for undiscovered cultural resources. One listed arroyo project is identified with the same river mile as a recorded archaeological site, but in the opposite bank, so no adverse effect is anticipated. Four areas with a greater potential for undiscovered sites are located in the same river mile as arroyo projects. Two of those areas are in the general vicinity of arroyo projects. If undiscovered cultural resources occur, some are likely to be considered potentially eligible for the NRHP. Implementation of arroyo dredging might have an adverse effect on NRHP-eligible archaeological resources.

**Table 4.10-4 Cultural Resources Locations Relative to Point Projects for the Targeted River Restoration Alternative**

| River Management Unit | Mile Range | Archaeological Sites Along the RGCP | Areas With a Greater Potential for Undiscovered Sites | Reopening of Meanders (river mile) | Modified Arroyo Dredging (river mile) |
|---|---|---|---|---|---|
| El Paso | 0-21 | 1 location | 5 locations | | |
| Lower Mesilla | 21-40 | | 4 locations | | |
| Las Cruces | 40-51 | | 1 location | | |
| Upper Mesilla | 51-63 | 2 locations | 3 locations | 54 | |
| Seldon Canyon | 63-72 | 4 locations | 4 locations | | |
| Lower Rincon | 72-90 | 2 locations | 6 locations | | 76, 78, 83, 85 |
| Upper Rincon | 105-90 | 3 locations | 4 locations | 92, 95, 97, 102, 105 | 94, 97, 98, 99, 101, 102, 103, 104 |

Potential beneficial impacts may occur by the conversion of cultivated lands to natural grasslands. Disturbance of archaeological sites resulting from continuous plowing would cease with this conversion. Planting of native vegetation and removal of invasive plants in the bosques located on the floodplains would have little or no effect on cultural resources. This activity would involve minimal surface disturbance and any cultural resources on the floodplains are expected to be subsurface. However, reduced maintenance along historic irrigation drains or canals may adversely affect these resources through bioturbation resulting in a decrease in physical integrity.

## 4.11 AIR QUALITY

The evaluation criteria considered for measuring effects to air quality were based on whether the net change in pollutant emissions from implementation of environmental measures:

- Caused or contributed to a violation of any national, state, or local ambient air quality standard;
- Increased the frequency or severity of a violation of any ambient air quality standard;
- Delayed the attainment of any standard or other milestone contained in the New Mexico or Texas implementation plan; or
- Increased a nonattainment or maintenance area's emissions inventory by ten percent or more for individual nonattainment pollutants; or exceeded *de minimis* threshold levels established in 40 CFR 93.153(b) for individual nonattainment pollutants.

### 4.11.1 Method of Analysis

Air emissions were calculated for the entire RGCP on the basis of annual releases. Emissions from implementation of the environmental measures would extend over several years; therefore, the emissions were allocated equally by year. As a conservative assumption for the emission calculations, measures were assumed to take place concurrently along the entire RGCP even though gradual implementation throughout a 20-year horizon is anticipated. Calculations were based on assumptions listed in Table 4.11-1 by individual measures.

Emissions for the various measures were calculated on a per-acre, per-mile or per-cubic yard basis, as indicated in Table 4.11-2. Unit emissions for the five priority pollutants were then applied according to specific input data assigned to each of the alternatives under consideration. Unit emissions were calculated based on the amount of soil disturbed, estimated number of hours of equipment operation, and on man-hour labor and equipment production estimates. Estimates followed common construction practices and methodologies (Means 2002), and emission factors reported by USEPA (USEPA 2000).

## Table 4.11-1 Assumptions and Basis for Calculation of Air Emissions

| Type of Measure | General Assumptions | Basis for Calculation |
|---|---|---|
| **Current O&M Practices** | | |
| Sediment removal from the main channel and arroyos | Dredging is conducted infrequently over a several year period and limited to selected reaches; calculations are based on annual removal. | Up to 251, 000 cy and 47,500 cy removed from the channel and arroyos, respectively |
| Riprap placement along the channel | Conducted infrequently at limited reaches. Assume regularly along 20% of stream banks. | 20.3 miles per year. |
| Mowing of floodway | Conducted during the late spring over a 3 month period using mechanical mowers. | 4,657 acres/year. |
| Maintenance of levees and levee/access roads | Entire levee system per year plus 10 miles/year both for levee gravel roads and for access roads. | 131 miles of levee and 20 of roads maintained per year. |
| **Levee System Rehabilitation** | | |
| New levees | Entire construction in 1 year; 7 acres/mile of levee for material borrow sites; excavated to a depth of 3 ft. (36,000 cy/mile). | 6 miles of new levee |
| Levee height increase | 5 year rehabilitation program (60.1 miles), 4 acres/mile for material borrow sites (21,000 cy/mile). | 12 miles of levee rehabilitation per year |
| Floodwall construction | 2.8 miles of floodwall all built in 1 year; 5.5 acres of disturbed area; 645 cy of concrete per mile | 2.8 miles in one year |
| Construction in non-attainment areas | *El Paso County*: a subset of emissions above baseline that apply to El Paso RMU for levee rehabilitation was used. No environmental measures such as planting, shavedowns, or controlled are under consideration for that reach of the RGCP. | 36.8% of RGCP emissions for potential levee rehabilitation (26.5 out of 72.1 miles). |
| | *Las Cruces (Doña Ana County)*: a subset of emissions above baseline that apply to Las Cruces RMU was used. Applicable values are levee rehabilitation (18.1 out of 72.1 miles along the RGCP), as well as environmental measures under the Integrated USIBWC Land Management Alternative (Las Cruces RMU represents 11.2 miles of the 105.4 mile corridor). | 25.1% of emissions for levee rehabilitation, and 10.6% of emissions for environmental measures. |
| **Environmental Measures** | | |
| Modified grazing and management of native grasslands | Soil preparation and associated emissions for exposed soil and mowing/tilling equipment on a per-acre basis assuming a 10% implementation per year. Includes prescribed burning emissions (based on an average of 2.6 ton/acre of grass biomass). | Emissions for 334 ac/yr of prescribed burns. |
| Tree planting/bosque enhancement sites, and controlled overbank flows | Soil preparation by mowing/tilling, with dust and equipment emissions on a per-acre basis. It assumes a 10% implementation per year, with prescribed burning emissions from 25% selective salt cedar removal. Emissions based on an average of 15 ton/acre of biomass removal for burning reported for chaparral vegetation). | Emissions for up to 74 acres per year (10% of 223 acres of planting sites and 516 acres of induced overbank flows). |
| Bank shavedowns and open former meanders | Excavation to an average depth of 2 ft. and soil preparation. Emissions calculated on a per-acre basis from soil exposure and transfer, and associated equipment. An assumed 5-year implementation includes prescribed burning from 25% selective salt cedar removal. | Emissions for up to 55 acres per year (20% of 127 acres of shavedowns and 300 acres of open meanders). |
| Sediment disposal from arroyo dredging | Excavation of 6.8 acres to an average depth of 4 feet with sediment placement on the ROW to a depth of 2 ft. | Emissions from up to 14 acres of exposed soils. |

**Table 4.11-2 Calculated Unit Air Emissions by Measure**

| Measure | Input Data | Unit Emissions per Measure (tons/year) | | | | |
|---|---|---|---|---|---|---|
| | | SOx | NOx | CO | VOC | $PM_{10}$ |
| Sediment removal from main channel | $10^6$ cubic yards | 9.97 | 91.49 | 38.51 | 6.93 | 5.78 |
| Sediment removal from arroyos | $10^6$ cubic yards | 9.81 | 90.05 | 37.90 | 6.82 | 5.69 |
| Mowing of floodways | 1,000 acres | 0.37 | 3.36 | 0.92 | 0.39 | 0.37 |
| Placement of riprap | miles | 0.02 | 0.21 | 0.06 | 0.03 | 0.02 |
| Mowing/brush cutting on levee slopes | 1,000 acres | 1.84 | 16.91 | 4.64 | 1.99 | 1.59 |
| Levee road grading and resurfacing | miles | 0.43 | 3.94 | 1.66 | 0.29 | 4.49 |
| Grading access roads | miles | 0.43 | 3.94 | 1.66 | 0.29 | 2.37 |
| Construction of new levees | miles | 0.91 | 8.44 | 3.52 | 0.67 | 11.09 |
| Increase levee height | miles | 0.55 | 5.05 | 2.10 | 0.40 | 5.61 |
| Construction of new floodwalls | miles | 0.09 | 0.88 | 1.05 | 0.09 | 0.30 |
| Excavation (bank shavedowns) | acres | 0.081 | 0.754 | 0.317 | 0.060 | 1.488 |
| Exposed soils (soil preparation) | 1,000 acres | 0.00 | 0.00 | 0.00 | 0.00 | 1.86 |
| Prescribed burning -grasslands | acres | 0.001 | 0.007 | 0.190 | 0.018 | 0.026 |
| Prescribed burning - salt cedar control | acres | 0.005 | 0.044 | 1.230 | 0.115 | 0.169 |
| Reopen meanders within ROW | acres | 0.08 | 0.75 | 0.32 | 0.06 | 1.49 |

## 4.11.2 Summary of Potential Effects

Table 4.11-3 summarizes air quality effects of the proposed action, alternative actions, and the No Action alternative.

**Table 4.11-3 Summary of Air Quality Effects**

| No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|
| Criteria pollutant levels for criteria pollutants range from 0.03% to 0.56% for AQCR | Criteria pollutant increases in AQCR range from 0.05 to 0.93 percent and are not regionally significant. | Criteria pollutant increases in AQCR range from 0.01 to 1.25 percent and are not regionally significant. | Criteria pollutant increases in AQCR range from 0.12 to 1.62 percent and are not regionally significant |

## 4.11.3 No Action Alternative

Emissions generating activities for the No Action Alternative would be the same as the current ongoing activities. Therefore, the emissions calculated as a result of the current activities (see Table 3.11.6) would apply to the alternative. As mentioned in Subsection 3.11.3, the emissions data for Sierra, Doña Ana, and El Paso counties are used for analysis purposes because the activity associated with the alternative would be localized in the narrow area along the river, and emissions from the activities would not be likely to affect the more distant AQCR counties in New Mexico and Texas.

Table 4.11-4 presents the baseline emissions data for the three counties and the No Action Alternative, and compares the alternative with the baseline condition.

**Table 4.11-4 Estimated Annual Emissions for No Action Alternative**

| Criteria Air Pollutant | Emissions in Tons per Year (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | Sox | $PM_{10}$ |
| Totals for 3 counties (USEPA 2003) | 244,417 | 34,593 | 40 | 3,315 | 79,039 |
| Estimated annual emissions from No Action Alternative | 68.1 | 13.6 | 170.2 | 18.6 | 96.6 |
| No Action Alternative emissions as percent of emissions for 3 Counties | 0.03% | 0.04% | 0.42% | 0.56% | 0.12% |

Note:VOC is not a criteria air pollutant. However, VOC is reported because, as an ozone precursor, it is a controlled pollutant.

Review of the data in Table 4.11-4 indicates that the greatest volume of air emissions No Action Alternative activities would be NOx (170.23 tons), which equates to 0.42 percent of the NOx emissions within the three county area. The effects would be temporary, fall off rapidly with distance from the routine O&M activity construction, and would not result in any long-term effects.

Ongoing activities currently being conducted are exempt from the Final General Conformity Rule so long as there is no increase in emissions equal to or greater than above the *de minimis* levels as the result of the Federal action. The No Action Alternative would be a continuation of the current USIBWC activities and, therefore, emissions would be the same as the baseline. The emissions from these activities would not increase emissions above *de minimis* levels. Therefore, the alternative would be exempt from further conformity requirements specified by the USEPA Final General Conformity Rule and a conformity determination would not be required.

### 4.11.4 Flood Control Improvement Alternative

In addition to the activities anticipated under the No Action Alternative, actions under this alternative generating emissions would include constructing new levees and floodwalls, increasing height of levees, and new floodwalls. Fugitive dust from ground disturbing activities and combustive emissions from equipment operation would be generated as a result of the activities.

#### *Fugitive Dust*

Fugitive dust would be generated from activities associated with soil disturbance and from equipment and vehicular traffic moving over the disturbed site. These emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the construction phase, level of activity, and prevailing weather conditions.

The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of construction activity. The USEPA has estimated that uncontrolled fugitive dust emissions from ground-disturbing activities would be emitted at a rate of 80 lbs of TSP per acre per day of disturbance

(USEPA 1996). In a USEPA study of air sampling data at a distance of 50 meters downwind from construction activities, $PM_{10}$ emissions from various open dust sources were determined based on the ratio of $PM_{10}$ to TSP sampling data. The average $PM_{10}$ to TSP ratios for top soil removal, aggregate hauling, and cut and fill operations is reported as 0.27, 0.23, and 0.22, respectively (USEPA 1988). Using 0.24 as the average ratio for purposes of analysis, the emission factor for $PM_{10}$ dust emissions becomes 19.2 lbs per acre per day of disturbance.

### *Equipment Emissions*

Emissions generated from mowing activities on the levee slopes and within the floodways were calculated by using the emission rate from grain harvesting equipment. Equipment used for the analysis includes rotary disc mowers pulled behind tractors in 20-foot swaths at a speed of 11 feet per second. Mowing is done annually between May and June. The emission factor used in the calculation for $PM_{10}$ dust emissions is 0.027 lbs per hour of tractor operations (USEPA 1996).

The USEPA also assumes that 230 working days are available per year for construction (accounting for weekends, weather, and holidays), and that only half of these working days would result in uncontrolled fugitive dust emissions at the emitted rate described above (USEPA 1996). The emissions presented in Table 4.11-4 include the estimated annual $PM_{10}$ and $PM_{2.5}$ emissions associated with the project activities. These emissions would produce slightly elevated short-term $PM_{10}$ and $PM_{2.5}$ ambient air concentrations. The USEPA estimates that the effects of fugitive dust from construction activities would be reduced significantly with an effective watering program. Watering the disturbed area of the construction site twice per day with approximately 3,500 gallons per acre per day would reduce TSP emissions as much as 50 percent (USEPA 1996).

Specific information describing the types of construction equipment required for a specific task, the hours the equipment is operated, and the operating conditions vary widely from project to project. Emissions were calculated using established cost estimating methodologies for construction and experience with similar types of construction projects (Means 2002). Combustive emissions from construction equipment exhausts were estimated by using USEPA approved emissions factors for heavy-duty diesel-powered construction equipment (USEPA 1985). The emissions presented in Table 4.11-5 include the estimated annual emissions from equipment exhaust associated with the proposed activities. Table 4.11-5 lists the annual emissions and the annual percent of change when compared to the baseline for the alternative action.

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 4.11-6 indicates that the greatest volume of emissions would be NOx (283.9 tons), which equates to 0.71 percent of the NOx emissions within the three county area. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term effects.

### Table 4.11-5 Estimated Annual Emissions for Flood Control Improvement Alternative

| Criteria Air Pollutant | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | SOx | $PM_{10}$ |
| Totals for 3 counties (USEPA 2003) | 224,417 | 35,593 | 40,012 | 3,315 | 79,039 |
| Estimated emissions for Flood Control Improvement Alternative | 117.4 | 22.6 | 283.9 | 30.9 | 231.3 |
| Alternative emissions as percent of emissions for 3 Counties | 0.05% | 0.06% | 0.71% | 0.93% | 0.29% |

Approximately 37 percent of the environmental measure activities would occur in El Paso County and about 25 percent in Doña Ana County. As shown in Table 3.11-4, part of El Paso County is designated nonattainment for CO and $PM_{10}$, classification moderate and nonattainment for Ozone, classification serious. Similarly, part of Doña Ana County is also nonattainment for Ozone and $PM_{10}$, classification marginal and moderate, respectively. Therefore, to show that the emissions presented in Table 4.11-7 are not above *de minimis* levels for nonattainment areas, the values are reduced by the percentage of the work that would be conducted in the respective counties. Therefore, the emissions shown in Table 4.12-6 are reduced accordingly and the values shown in Table 4.12-7 would be more representative of the actual emissions generated from construction activities in El Paso and Doña Ana Counties.

### Table 4.11-6 Estimated Annual Emissions for El Paso and Doña Ana Counties

| Calculation | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | SOx | $PM_{10}$ |
| **El Paso County** | | | | | |
| Flood Control Improvement Alternative emissions | 117.4 | 22.6 | 283.9 | 30.9 | 231.3 |
| Less No Action Alternative | 68.1 | 13.6 | 170.2 | 18.6 | 96.6 |
| Net emissions | 49.3 | 9.0 | 113.7 | 12.3 | 134.7 |
| 37% applicable to El Paso | **18.14** | **3.32** | **41.83** | **4.53** | **49.56** |
| **Doña Ana County** | | | | | |
| Flood Control Improvement Alternative emissions | 117.4 | 22.6 | 283.9 | 30.9 | 231.3 |
| Less No Action Alternative | 68.1 | 13.6 | 170.2 | 18.6 | 96.6 |
| Net emissions | 49.3 | 9.0 | 113.7 | 12.3 | 134.7 |
| 25% applicable to Doña Ana | **12.38** | **2.26** | **28.53** | **3.09** | **33.80** |

Emissions generated as a result of this alternative would fall below the 10 percent level (see Table 4.11-5) that would be considered regionally significant by the USEPA. Additionally, the emissions would not exceed *de minimis* threshold levels for criteria pollutants. Since the net change in potential emissions associated with alternative action activities meet both regional significance and *de minimis* criteria requirements, it is concluded that this Federal action alternative is exempt from further conformity requirements specified by the USEPA Final General Conformity Rule.

### 4.11.5 Integrated USIBWC Land Management Alternative

The methodologies used to calculate emissions for the Flood Control Improvement Alternative were used to estimate the emissions for the Integrated USIBWC Land Management Alternative. Table 4.11-7 lists the annual emissions for the alternative and compares them to the emissions for the three county area.

**Table 4.11-7 Estimated Annual Emissions for Integrated USIBWC Land Management Alternative**

| Criteria Air Pollutant | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | SOx | $PM_{10}$ |
| Totals for 3 counties (USEPA 2003) | 244,417 | 34,593 | 40,012 | 3,315 | 79,039 |
| Estimated emissions for the Integrated USIBWC Land Management Alternative | 237.0 | 37.7 | 382.5 | 41.6 | 431.5 |
| Alternative emissions as percent of emissions for 3 Counties | 0.01% | 0.11% | 0.96% | 1.25% | 0.55% |

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 4.11-7 indicates that the greatest volume of emissions would be NOx (382.5 tons), which equates to 0.96 percent of the NOx emissions within the three county area. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term effects.

Approximately 11 percent of the environmental measure activities for the Integrated USIBWC Land Management Alternative would occur in the Las Cruces area of Doña Ana County. As shown in Table 3.11-4, part of Doña Ana County is nonattainment for Ozone and $PM_{10}$, classification marginal and moderate, respectively. Therefore, to show that the emissions presented in Table 4.11-7 are not above *de minimis* levels for nonattainment areas, the values are reduced by the percentage of the work that would be conducted in the respective counties. Therefore, the emissions shown Table 4.11-7 are reduced accordingly and the values shown in Table 4.11-8 would be more representative of the actual emissions generated from construction activities near Las Cruces.

**Table 4.11-8 Estimated Annual Emissions for Las Cruces Area**

| Doña Ana County | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | SOx | $PM_{10}$ |
| *Basis for Levee Rehabilitation Calculation* | | | | | |
| Integrated Land Management Alternative | 237.0 | 37.7 | 382.5 | 41.6 | 431.5 |
| Less Flood Control Improvement Alternative emissions | 117.4 | 22.6 | 283.9 | 30.9 | 231.3 |
| Net Emissions | 119.6 | 15.1 | 98.6 | 10.7 | 200.3 |
| 10.6% applicable to Las Cruces | **12.68** | **1.6** | **10.45** | **1.13** | **21.23** |

Emissions generated as a result of this alternative would fall below the 10 percent level (see Table 4.11-7) that would be considered regionally significant by the USEPA. Additionally, the emissions would not exceed *de minimis* threshold levels for criteria pollutants. Since the net change in potential emissions associated with alternative action activities meet both regional significance and *de minimis* criteria requirements, it is concluded that this Federal action alternative is exempt from further conformity requirements specified by the USEPA Final General Conformity Rule.

### 4.11.6 Targeted River Restoration Alternative

In addition to the activities anticipated under the Flood Control Improvement Alternatives, actions under this alternative generating emissions would include reopening meanders, removing riprap near arroyos, creating or expanding wetlands, and preparing land for controlled water releases for overbank flooding. The methodologies used to calculate emissions for the Flood Control Improvement Alternative were used to estimate the emissions for the Targeted River Restoration Alternative. Table 4.11-9 lists the annual emissions for the alternative and compares them to the emissions for the three county area.

**Table 4.11-9 Estimated Annual Emissions for Targeted River Restoration Alternative**

| | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| Criteria Air Pollutant | CO | VOC | NOx | SOx | $PM_{10}$ |
| Totals for 3 counties (USEPA 2003) | 244,417 | 34,593 | 40,012 | 3,315 | 79,039 |
| Estimated emissions for Targeted River Restoration Alternative | 283.5 | 46.5 | 493.3 | 53.6 | 650.3 |
| Alternative emissions as percent of emissions for 3 Counties | 0.12% | 0.13% | 1.23% | 1.62% | 0.82% |

The emissions would produce slightly elevated air pollutant concentrations. Review of the data in Table 4.11-9 indicates that the greatest volume of emissions would be NOx (493.3 tons) and $PM_{10}$ (650.3 tons), which equates to 1.23 percent and 0.82 percent of the NOx and $PM_{10}$ emissions within the three county area, respectively. However, the effects would be temporary, fall off rapidly with distance from the proposed construction sites, and would not result in any long-term effects.

Similar to the Integrated USIBWC Land Management Alternative, approximately 11 percent of the environmental measure activities for the Targeted River Restoration Alternative would occur in the Las Cruces area of Doña Ana County. As shown in Table 3.11-4, part of Doña Ana County is nonattainment for Ozone and $PM_{10}$, classification marginal and moderate, respectively. Therefore, to show that the emissions presented in Table 4.11-9 are not above *de minimis* levels for nonattainment areas, the values are reduced by the percentage of the work that would be conducted in the respective counties. Therefore, the emissions shown Table 4.11-9 are reduced accordingly and the values shown in Table 4.11-10 would be more representative of the actual emissions generated from construction activities in Doña Ana County.

**Table 4.11-10 Estimated Annual Emissions for Las Cruces Area**

| Doña Ana County | Emission (tons/year) | | | | |
|---|---|---|---|---|---|
| | CO | VOC | NOx | SOx | $PM_{10}$ |
| *Basis for Levee Rehabilitation Calculation* | | | | | |
| Targeted River Restoration Alternative emissions | 283.5 | 46.5 | 493.3 | 53.6 | 650.3 |
| Less Flood Control Alternative and No Action Alternative emissions | 117.4 | 22.6 | 283.9 | 30.9 | 231.3 |
| Net emissions | 166.1 | 23.9 | 209.4 | 22.7 | 419 |
| 10.6% applicable to Las Cruces | 17.6 | 2.5 | 22.2 | 2.4 | 44.4 |

Emissions generated as a result of this alternative would fall below the 10 percent level (see Table 4.11-9) that would be considered regionally significant by the USEPA. Additionally, the emissions would not exceed *de minimis* threshold levels for criteria pollutants. Since the net change in potential emissions associated with alternative action activities meet both regional significance and *de minimis* criteria requirements, it is concluded that this Federal action alternative is exempt from further conformity requirements specified by the USEPA Final General Conformity Rule.

## 4.12 NOISE

The evaluation criteria considered for measuring effects from noise were based on the following:

- The degree to which noise levels generated by environmental measures would be higher than the ambient noise levels;
- The degree to which there is annoyance and/or activity interference; and
- The proximity of noise-sensitive receptors to the noise source.

### 4.12.1 Method of Analysis

Estimates of noise generated from heavy construction equipment were calculated for the environmental measures based on the type of heavy equipment used and the duration of the construction activity. Predicted noise levels for each type of equipment anticipated to be used for the environmental measures are presented in Table 4.12-1. The noise levels in Table 4.12-1 are probably conservative because additional attenuation would be expected because of atmospheric absorption and the effects of topographic or other features such as hills and buildings that could physically block the transmission of some noise waves. Under most conditions, reflected sound would reduce the attenuation due to distance. In these cases, doubling the distance would result in a decrease of 4 to 5 dBA (American Industrial Hygiene Association, 1986). Calculations were based on assumptions listed in Table 4.12-1 by individual measures.

Assuming that noise from the construction equipment radiates equally in all directions, the sound intensity would diminish inversely as the square of the distance from the source. Therefore, in a free field (no reflections of sound), the sound pressure level decreases 6 dBA with each doubling of the distance from the source. Table 4.12-1 shows the anticipated sound pressure levels at a distance of 50 feet for miscellaneous heavy equipment.

**Table 4.12-1 Heavy Equipment Noise Levels at 50 Feet**

| Equipment Type | Estimated number in use at any time | Generated Noise Levels in dBA (CERL, 1978) |
|---|---|---|
| Bulldozer | 1 | 88 |
| Backhoe (rubber tire) | 1 | 80 |
| Front Loader (rubber tire) | 1 | 80 |
| Concrete Truck | 1 | 75 |
| Concrete Finisher | 1 | 80 |
| Crane | 1 | 75 |
| Asphalt Spreader | 1 | 80 |
| Roller | 1 | 80 |
| Flat Bed Truck (18 wheel) | 1 | 75 |
| Scraper | 1 | 89 |
| Trenching Machine | 1 | 85 |

## 4.12.2 Summary of Potential Effects

Table 4.12-2 summarizes noise effects of the No Action alternative and action alternatives.

**Table 4.12-2 Summary of Noise Effects**

| No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|
| 75 to 89 dBA at 50 feet from the source | Similar to the No Action Alternative | Similar to the No Action Alternative | Similar to the No Action Alternative |

## 4.12.3 No Action Alternative

The existing maintenance and operation activities would continue to occur. The primary source of noise from these activities would be generated by equipment and vehicles used to excavate the channel, remove sediment, mow levees and sediment control dams, and grade levee roads. Noise from these activities would be intermittent and short-term in duration. Typical noise levels generated by these activities range from 75 to 89 dBA at 50 feet from the source. Sensitive receptors in the vicinity of these short-term activities would include persons near the project site in rural areas and residential districts in the urban areas of Las Cruces and El Paso.

For the purposes of this assessment, it is estimated the shortest distance between an equipment noise source and a receptor in a rural area would be a person(s) 100 feet off-site. Given the rural nature and low population density of the area, it is unlikely a person other than a construction worker would be within 100 feet of the site boundary during project activities. However, if a person were within this distance, the person could be exposed to noise as high as 69 to 83 dBA (see Table 4.12-1). Sixty-one percent of the person(s) exposed to noise of 83 dBA could be annoyed. As stated in Subsection 3.12.3, DNL 75 dBA during the noise event indicates there is good probability for frequent speech disruption, producing ratings of "barely acceptable" for intelligibility of spoken material. Increasing the level of noise to 80 dB reduces the intelligibility to zero, even if the people speak in loud voices. The potential for hearing loss involves direct exposure on a regular, continuing, long-term basis to DNL levels above 75 dBA. Hearing loss projections are based on an average daily outdoor exposure of 16 hours over a 40-year period. It is anticipated the construction activities would occur between 7:30 a.m. and 4:00 p.m., five days per week for the duration of the project. Individuals would not be exposed for the entire noise producing period. Under this condition, persons would not be exposed to long-term and regular noise above 75 dBA. Therefore, nearby persons should not experience loss of hearing.

As with the rural area, it is estimated the shortest distance between an equipment noise source and a receptor in an urban setting would be a person(s) or a structure 100 feet from the source. Due to the potential for reflected sound in an urban area, it is estimated sound would attenuate 4 to 5 dBA as the distance doubles. Therefore, a person in an urban area conservatively could be exposed to noise as high as 71 to 85 dBA, or about 2 dBA greater than the rural area noise. An increase of 3 dBA is just perceptible to the human ear (Bies and Hanson, 1988). The difference in noise in the two settings likely would be imperceptible and the discussion and analysis in the pervious paragraph for a rural area applies to the noise condition in an urban setting. Interior noise levels would be reduced from the 71 to 85 dBA level by approximately 18 to 27 dBA due to the noise level reduction properties of the building's construction materials (U.S. Department of Transportation, 1992).

### 4.12.4 Flood Control Improvement Alternative

In addition to the activities anticipated under the No Action Alternative, actions under this alternative requiring equipment operation would include constructing new levees and floodwalls and increasing height of levees. Although the structures and activities that would be constructed and accomplished under this alternative would be different from the No Action Alternative, the equipment that would be used and the distance to a receptor would be the same. Therefore, the analysis and conclusions for the No Action Alternative apply to the alternative.

### 4.12.5 Integrated USIBWC Land Management Alternative

The noise generating activities for this alternative would be the same as the Flood Control Improvement Alternative. Therefore, the analysis and conclusions for the Flood Control Improvement Alternative apply to this alternative.

### 4.12.6 Targeted River Restoration Alternative

In addition to the activities anticipated under the Flood Control Improvement Alternatives, actions requiring equipment operation would include reopening meanders, removing riprap near arroyos, creating or expanding wetlands, and preparing land for controlled water releases for overbank flooding. Although the structures and activities that would be constructed and accomplished under this alternative would be different than the No Action Alternative, the equipment that would be used and the distance to a receptor would be the same. Therefore, the analysis and conclusions for the No Action Alternative apply to this alternative.

## 4.13 TRANSPORTATION

The evaluation criteria considered for measuring effects to transportation were based on whether implementation of environmental measures would:

- Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system;
- Adversely affect a roadway's existing LOS, such that it would not meet agency standards; or
- Adversely affect roadway condition, such as the development of potholes or cracking.

### 4.13.1 Method of Analysis

The following methodology was used in evaluating effects on transportation:

- Expected routes were identified on road maps.
- Existing (1997) average daily traffic levels, percentage of truck traffic, and roadway speeds were obtained.
- The number of construction workers and truck trips required for project construction for each alternative were estimated.
- The project construction period of each alternative was estimated.
- Total expected average daily traffic levels were calculated, considering daily truck trips and construction worker trips plus existing levels to determine expected traffic levels during project construction.
- Calculated project construction average daily traffic levels were compared to existing average daily traffic levels to determine if project construction traffic would result in a substantial increase in existing traffic levels.
- LOS associated with average daily traffic levels for existing and project construction conditions were compared to determine potential changes during project construction.

#### *Table Assumptions for Calculating Effects on Transportation*

For this analysis, the following assumptions were made:

- A construction workday is considered to last 10 hours, from 7:00 a.m. to 5:00 p.m.
- A month was considered to be 22 workdays.
- Work force for the project area would likely come from construction workers residing and commuting from El Paso and Doña Ana Counties

### 4.13.2 Summary of Potential Effects

Table 4.13-1 summarizes transportation effects from the No Action Alternative.

**Table 4.13-1 Summary of Transportation Effects**

| No Action Alternative | Flood Control Improvement Alternative | Integrated USIBWC Land Management Alternative | Targeted River Restoration Alternative |
|---|---|---|---|
| No increase in traffic or affect existing Level of Service (LOS) | The LOS of all listed roadways would not change from existing conditions. | The LOS of all listed roadways would not change from existing conditions | The LOS of all listed roadways would not change from existing conditions |

### 4.13.3 No Action Alternative

No additional construction equipment or vehicles would be required if the current operation and maintenance practices were continued. None of the proposed construction projects would be constructed. The No Action Alternative would not result in any increases in traffic or adversely affect a roadway's existing LOS. Traffic levels on interstate, state, and local roadways would be expected to increase as a result of population growth. This may result in a corresponding increase in traffic congestion and more wear and tear on the roadways. If the LOS on Texas roadways falls below C, and the LOS on New Mexico roadways falls below B, this impact would be considered significant.

### 4.13.4 Flood Control Improvement Alternative

Under the Flood Control Improvement Alternative, construction would include six miles of new levees, three miles for additional floodwalls, and 60 miles for raising of existing levees. All construction activities would occur within the existing USIBWC ROW and within agricultural and government lands. Transportation of construction equipment and the use of personnel vehicles would mainly occur within the levee ROW and along the levee road system within the floodway.

Heavy construction equipment (dump trucks, front-end loaders, graders) would initially be driven to the construction site from larger metropolitan cities like El Paso or Las Cruces using the roadways presented in Table 3.13-1. Implementation of this alternative would be comparable to the No Action Alternative since USIBWC currently provides similar construction and maintenance projects along the Rio Grande.

Construction activities associated with levee rehabilitation are presented in Table 4.13-2. The majority, about 81 percent, of the construction activity would occur within the Lower Mesilla and El Paso RMUs. Of the construction work that would occur in those two RMUs, about half of the work would occur within the El Paso RMU.

The construction duration for each proposed project, the roadways that would be affected during those time periods, and the estimated maximum number of daily worker vehicle trips and truck trips throughout the construction period are presented in Table 4.13-2.

**Table 4.13-2 Construction Duration and Estimated Daily Vehicle Trips**

| Action | Affected Roadways | Construction Period (months) | Maximum Construction Worker Vehicle Trips (one-way)* | Average Truck Trips (one-way)* |
|---|---|---|---|---|
| New Levee (6 ft. height) | I 25, SH 185, SH 187 SH 154, SH 26, levee roads | 16 | 144 | 76 |
| Floodwall (Canutillo area) | I 10, SH 375, SH 20, levee roads | 4.5 | 110 | 14 |
| Raise levee (12 miles per year for 5 years) | I 25, SH 185, SH 187 SH 154, SH 26, SH 28, I 10, SH 478, SH 192, SH 228, SH 227, SH 226, SH 404, SH 225, SH 20, Vinton Rd., SH 375, levee roads | 60 | 178 | 86 |

* Number of trips during the construction period

The maximum number of worker vehicle trips expected during the morning and evening commute hours and the average number of truck trips expected to arrive at and leave the construction sites throughout the work day are shown in Table 4.13-3.

**Table 4.13-3 Expected Additional Traffic During the Construction Period**

| Action | Estimated Average Number of Vehicle[a] Trips Per Day | Average Number of Vehicle Trips During the a.m. and p.m. Commute Hours | Average Number of Vehicle Trips per Hour During the Remaining 6 Hours of Work |
|---|---|---|---|
| New Levee (6 ft. height) | 130 | 65 | 0 |
| Floodwall (Canutillo area) | 99 | 50 | 0 |
| Raise Levee (12 miles per year for 5 years) | 160 | 80 | 0 |

Depending on the construction activities that are occurring at the time, the numbers in Table 4.13-3 could be higher or lower on any given day. Additionally, the majority of vehicle trips that would occur during the commute hours would be construction worker vehicles rather than semi-trucks.

As shown above, the increase in existing hourly traffic during the remaining 6-hour workday from project construction activities, which would consist solely of heavy construction equipment vehicles (dump trucks, flat-bed trailers, *etc.*), would be insignificant.

Table 4.13-4 presents the expected roadway LOS associated with the increased traffic levels during the project construction period. Construction vehicles associated with environmental measures within the floodway (such as erosion protection, sediment management.) would mostly access levee roadways and not the highways listed in Table 4.13-4. As shown in the table, the LOS of all roadways listed would not change from existing conditions, resulting in no significant effect on traffic flow from project construction.

This increased traffic would be an inconvenience to commuters traveling on these roadways during the morning commute (the project construction traffic in the evening would occur before the primary evening commute hour). This impact on traffic and circulation on the affected roadways would be temporary and not considered significant, only lasting during the construction period.

### 4.13.5 Integrated USIBWC Land Management Alternative

This alternative would include the same construction activities as the Flood Control Improvement Alternative. In addition to these construction activities, the Integrated USIBWC Land Management Alternative includes bank shavedowns, soil preparation, prescribed burning, regeneration of native woody vegetation, and improvement of erosion control. These activities cover over 2,000 acres and would occur entirely within USIBWC ROW. These activities would be compatible with and would not change existing land use.

The methodologies used to calculate traffic effect analysis for the Flood Control Improvement Alternative were used to estimate the traffic effects for the Integrated USIBWC Land Management Alternative.

Traffic levels for this alternative would not vary from the Flood Control Improvement Alternative. This alternative would generate the same effects; therefore, the LOS of all affected roadways would not change, resulting in no significant impact on traffic flow from project construction. Mitigation for this alternative would be the same as for the Flood Control Improvement Alternative.

### 4.13.6 Targeted River Restoration Alternative

In addition to flood control improvements and ROW habitat enhancement, the Targeted River Restoration Alternative would also utilize 1,618 acres outside the ROW for the establishment of voluntary conservation easements. Voluntary easements would be established for a vegetation management program. These areas would function to enhance the connectivity of riparian communities with upland areas and provide buffer zones for the protection of wildlife. Ownership of these properties would not change; only the function of the land through voluntary easements.

**Table 4.13-4 Expected Increase in Existing Average Daily Traffic and Expected Level of Service During Construction**

| Action | Roadways Affected | Expected Level of Service (LOS) |
|---|---|---|
| New Levee (6 miles in 1 year) | I 25<br>SH 185<br>SH 187<br>SH 154<br>SH 26<br>Levee Roads | B<br>B<br>D<br>A<br>A<br>NA |
| Floodwall (2.8 miles in 1 year) | I 10<br>SH 375<br>SH 20<br>Levee Roads | C<br>A<br>A<br>NA |
| Raise Levee (12 miles per year for 5 years) | I 25<br>SH 185<br>SH 187<br>SH 154<br>SH 26<br>SH 28<br>I 10<br>SH 478<br>SH 192<br>SH 228<br>SH 227<br>SH 226<br>SH 404<br>SH 225<br>SH 20<br>Vinton Rd.<br>SH 375<br>Levee Roads | B<br>B<br>D<br>A<br>A<br>A<br>C<br>B<br>A<br>A<br>A<br>A<br>A<br>A<br>A<br>A<br>C<br>NA |

The methodologies used to calculate traffic impact analysis for the Flood Control Improvement Alternative and the Integrated USIBWC Land Management Alternative were used to estimate the traffic effects for the Targeted River Restoration Alternative.

Traffic levels for this alternative would increase slightly from the Integrated USIBWC Land Management Alternative. This alternative would generate the same effects; therefore, the LOS of all affected roadways would not change, resulting in no significant impact on traffic flow from project construction. Mitigation for this alternative would be the same as for the Integrated USIBWC Land Management Alternative.

## 4.14 MITIGATION MEASURES

The USIBWC proposes to implement the following mitigation measures to offset or decrease the environmental effects of implementing the alternative actions. Most of these mitigations have been included in the project designs.

Mitigations are organized into two classes: 1) construction activities as a result of implementing environmental measures and levee rehabilitation; and 2) vegetation treatments used to control invasive species and establish desired vegetation. These mitigations are categorized by resource area.

### 4.14.1 Water Resources

Table 4.14-1 lists mitigations measures for protection of aquatic resources. Measures are applicable to construction activities, such as lowering of stream banks, and vegetation management for development of a riparian corridor.

**Table 4.14-1 Mitigation Measures for Water Resources**

| |
|---|
| **Construction Activities** |
| Water-C1. During construction near the river, best management practices and spill control procedures would be emplaced to prevent contamination and increased erosion to the river. Heavy equipment needing servicing (fueling, greasing, repair work) will be done out of the riparian zone. Fuel stored on-site will be in an upland position and in a cleared area with an earthen containment barrier. |
| Water-C2. Sediment would not be placed within the river during shavedowns and bank preparation, rather sediment would be moved to nearby floodway locations and stabilized by revegetation in conjunction with native grassland environmental measure. Design would promote backflow inundation reducing the possibility of sediment eroding and entering the river. |
| Water-C3. Bank shavedowns point projects and other locations inundated by peak flows would be design to promote backflow inundation thereby reducing the possibility of sediment entering the river. In sites where backflow inundation is not feasible, erosion controls would be put in place to limit the amount of sediment entering the river while still providing conditions suitable for native species germination. |
| Water-C4. The USIBWC would create an accounting system that would identify the location(s) and quantity(ies) of water removed from the river, the amount returned to the river as a result of environmental measures. |
| Water-C5. Removal of invasive salt cedar would reduce water consumption. |
| **Vegetation Treatments** |
| Water-V1. Herbicide would be applied directly to targeted plants in a manner to minimize runoff to surface water |
| Water-V2 Herbicides will not be aerially applied over open water. |
| Water-V3 Prescribed burns would incorporate BMPs to limit runoff into the river. |
| Water-V4 Mechanical removal of salt cedar during maintenance or fuel reduction would not be conducted on the river margin; rather material would be cut and removed manually. Avoidance of the river bank by equipment would reduce sediment input into the river. |
| Water-V5. – Woody debris as a result of salt cedar reduction will be burned or removed from the floodway. |

### 4.14.2 Flood Control and Soil Excavation

Table 4.14-2 lists mitigations measures for flood control and soil excavation. Measures are applicable to construction activities, such as lowering of stream banks, and vegetation management for development of a riparian corridor.

**Table 4.14-2 Mitigation Measures for Flood Control and Soil Excavation**

| **Construction Activities** |
|---|
| Flood – C1. Conservation easements in Rincon Valley and Seldon Canyon would be used within locations potentially effected by controlled releases. Controlled releases would be gradual and incremental in order to monitor the predicted extent of over bank flows. |
| Flood – C2. Sediment removed as a result of implementing environmental measures would be placed in the floodway ( no net change in the RGCP flood containtment capacity. |
| Soils-C1. Construction during and after arroyo embankment creation, and opening former meanders will expose unprotected soil to rainfall runoff and wind erosion. USIBWC would consider performing construction during the dry season to limit exposure to rain. |
| Soils-C2. Bank shavedowns exposed to frequent high water velocities would be susceptible to erosion. When bank shavedown areas are located on the outer bend of the river, a river diversion barrier parallel to the river and between the bank shavedown area and the river will slow river course migration. River water should enter bank shavedown areas from a downstream section opening (back flooding). A drainage channel placed length-wise through the bank shavedown area, possibly below river elevation, will minimize erosion by limiting the runoff distance when the river recedes. This construction method will create a habitat similar to only opening a former meander to the river on the downstream end. |
| Soils-C3. Temporary materials and equipment-staging areas at the water diversion facility construction area would be reclaimed and revegetated with suitable native woody trees and shrubs. |
| **Vegetation Treatments** |
| Soils-V1. The heavy equipment used for brush reduction would be wheeled and not tracked. |
| Soils-V2. Oversized wheels would be used to minimize soil compaction and rutting. |
| Soils-V3. Mechanical treatment would be conducted in the late summer and fall, which typically provide for dryer soil conditions, which would minimize soil displacement and compaction. |
| Soils-V4. Signage will indicate that riparian use is limited to designated trails and explaining that the purpose is to limit erosion, minimize damage to vegetation, and provide refuge areas away from trails where wildlife remain undisturbed. |

### 4.14.3 Biological Resources

Table 4.14-3 lists mitigations measures for biological resources. Measures are applicable to construction activities, such as lowering of stream banks, and vegetation management.

## Table 4.14-3 Mitigation Measures for Biological Resources

| |
|---|
| **Construction Activities** |
| Vegetation-C1 Temporary materials- and equipment-staging areas at construction areas would be reclaimed and revegetated with suitable native woody trees and shrubs |
| Vegetation-C3. The USIBWC would restore riparian vegetation in the areas temporarily affected by the levee rehabilitation |
| Vegetation-C4. The USIBWC would monitor all environmental measures. |
| Vegetation-C5. Studies would need to be performed in order to determine locations and specific details for some of the bosque improvements, including: fire prevention through fuel reduction (assess fuel loads and priority areas), bank lowering (determine where low banks exist), channel cutting (determine locations in terrace to promote a better connection between the channel and floodplain), and removal of invasive species (determine areas of most invasion and priority areas) |
| Aquatic-C1. During construction near the river, best management practices and spill control procedures will be emplaced to prevent contamination and increased erosion to the river. |
| Aquatic-C2. When equipment is operating in the river, or arroyo tributaries, if fish are stranded, they will be salvaged and put into the main river channel. |
| Aquatic-C3. During construction in the river, the USIBWC would use BMPs to minimize and contain the discharge of suspended sediments into the Rio Grande. |
| **Vegetation Treatments** |
| Vegetation-V1. Garlan-4® herbicide or equivalent would be sprayed by hand application to targeted species whenever feasible. |
| Vegetation-V2. Vegetation will be monitored (species, composition, abundance and distribution) before and after vegetation treatments. |
| Vegetation-V3. Re-vegetate the upland disturbed areas with native species |
| Vegetation-V4. Herbicides would not be aerially applied on areas where sensitive riparian vegetation such as cottonwoods and willows are extensively intermingled with the salt cedar. |
| Vegetation-V5. Protect revegetation sites for at least one growing season from grazing |
| Vegetation-V6. Prescribed burns would be conducted in accordance to techniques identified in a RGCP River Management Plan. The Plan will be developed by the USIBWC with guidance from resource agencies including the USFWS, BLM and state agencies. |
| Vegetation-V7. Planting would be conducted in accordance to techniques identified in a RGCP River Management Plan. Plantings would be conducted using native species. |
| Vegetation-V8. Degraded or burned areas would be interseeded with native grasses and forbs to further enhance the establishment of desirable browse and forage species. Seeding will be conducted in accordance to techniques identified in a RGCP River Management Plan. |
| Vegetation-V9. Saturated and ponded areas would be avoided during mechanical and chemical treatments. |
| Vegetation-V10. Burning would need to occur when woody plants such as salt cedar are not actively seeding, as burning would create open spaces for seedling establishment of salt cedar. If there are woody plants present on the areas considered for burning, these species would have to be assessed for fire-tolerance. Salt cedar tends to be more tolerant of fire than some native riparian species. |
| Wildlife-V1. Treatments would occur outside the nesting season, which is generally March through August. If construction activity must occur during the migratory bird-nesting season, surveys would be conducted and active nests would be marked and avoided. |
| Wildlife-V2. USIBWC will develop a Fire Management Plan as part of the RGCP River Management Plan. The Fire Management Plan will detail perceived burn methods and BMPs to offset any potential negative effects to wildlife as a result of treatments. |
| T&E Species-V1. Wherever possible, treatments would not be used in known habitats of listed or sensitive species. |
| T&E Species V2. Where treatments would be necessary in proximity to known listed or sensitive species' habitats, the treatment would be selected to minimize the effect. |
| Aquatic Biota-V1. Herbicide would be applied directly to targeted plants in a manner to minimize runoff to surface water. |
| Aquatic Biota-V2 Herbicides will not be aerially applied over open water. |

### 4.14.4 Land Use, Socioeconomics and Cultural Resources

Table 4.14-4 lists mitigations measures for land use, socioeconomics and cultural resources. Measures are applicable to construction activities, such as lowering of stream banks, and vegetation management for development of a riparian corridor.

**Table 4.14-4 Mitigation Measures for Land Use, Socioeconomics and Cultural Resources**

| **Construction Activities** |
|---|
| Land Use-C1. The USIBWC would adhere to project work-hour restrictions (work allowed only between 7 a.m. and 10 p.m.) within 500 feet of residences, hospitals, and schools. |
| Soc-C1 Existing road and utility rights-of-way would be used as much as possible to reduce permitting and land- acquisitions cost and to reduce disruptions to commercial facilities. |
| Soc-C2 Where possible local construction personnel would be hired to build the project. |
| Soc-C3 Local professional or service personnel would be hired and trained to operate and maintain facilities so direct and secondary spending remains in the local economy. |
| Cultural-C1. A cultural resources discovery plan would be prepared and make final through consultation with the SHPO prior to the beginning of construction. |
| Cultural-C2. Precautions would be taken to ensure that archaeological assistance is promptly available in case of a discovery. The discovery plan approved by the SHPO would detail these measures. |
| Cultural-C3. Before ground-disturbing construction work takes place, a preconstruction conference would be held with construction crews to inform them of the potential for disturbing subsurface cultural resources, and the procedures involved in the event that this occurs. |
| Cultural-C4. Any cultural resources found during construction would be documented and evaluated as to their eligibility for listing on the National Register of Historic Places. |
| **Vegetation Treatments** |
| Land Use-V1 Herbicides would not be aerially applied in populated areas or within 500 feet of residence. |
| Land Use-V2 – Prior to any treatments, notices and signage will be placed to assure any nearby communities are aware of upcoming treatments. |
| Cultural-V1. Treatments would avoid deep soil disturbance (i.e. root plowing) whenever possible. In the event, deep soil treatments are required, mitigation measures for construction activities would be used. |

### 4.14.5 Air, Noise and Transportation

Table 4.14-5 lists mitigations measures for for air, noise and trasportation. Measures are applicable to construction activities, such as lowering of stream banks, and vegetation management for development of a riparian corridor.

**Table 4.14-5 Mitigation Measures for Air, Noise and Transportation**

| |
|---|
| **Construction Activities** |
| Air-C1. Dust control measures are applicable to any construction site where dust is created and there is the potential for air and water pollution from dust traveling across the landscape or through the air. Dust control measures are particularly important in arid or semiarid regions, where soil can become extremely dry and vulnerable to transport by high winds. Dust control measures include sprinkling/irrigation, mulch, vegetative cover, and wind breaks. |
| Air-C2. Each construction contractor would be responsible for assuring that construction equipment (especially diesel equipment) meets local community opacity standards for operating emissions. |
| Air-C3 Each construction contractor would acquire excavation, grading, and surface-disturbance permits that specify BMPs to minimize particulate and dust emissions from construction work sites. |
| Air-C4 Mitigation would ensure that mechanized equipment is in good operating condition so that exhaust emissions are kept to a minimum. |
| Noise-C1. Each contractor would adhere to project work hour restrictions (work allowed only between 7 a.m. and 10 p.m.) within 500 feet of residences, hospitals, schools, churches, and libraries. Each contractor would arrange the construction schedule to restrict to 4 the number of days in one work location within 500 feet of the same residence, hospital, school, church, or library. |
| Traffic C-1. Develop and implement traffic protocols and travel routes for all project construction trucks, vehicles, and equipment, including measures for ingress, egress, turning, and back-up movements at all proposed facility sites. |
| **Vegetation Treatments** |
| Air-V1. The amount of vapors would be minimized by dispensing herbicide in a vegetable oil solution limiting airborne particulates. Application of this treatment would not occur during high-wind conditions. |
| Air-V2. Use smoke management techniques that rely on computer models to determine smoke dispersion prior to prescribed burns. |
| Air-V3. Use guidelines established by the National Weather Service; a clearing index of 500 or greater would be required for prescribed burning. |

## 4.15 CUMULATIVE EFFECTS

Cumulative effects are defined as impacts on the environment that result from the incremental impact of the action when added to other past, present and reasonable foreseeable future actions. It does not matter what agency or person undertakes these actions. Cumulative effects can result from individually minor, but collectively significant actions taking place over time.

Several projects and activities are planned or being implemented along the RGCP that would likely have some potential for cumulative impact. This section describes those activities that could contribute to cumulative impacts when combined with environmental measures being implemented within the RGCP. Cumulative effects are described for those resource areas where such effects would reasonably occur. These activities and projects are described below.

## 4.15.1 Regional Plans

### *El Paso-Las Cruces Regional Sustainable Water Project*

The New Mexico-Texas Water Commission proposed securing future drinking water supplies from surface water sources for the El Paso-Las Cruces region through the construction and operation of water treatment plants, aqueducts and diversion structures, aquifer storage and recovery, water acquisitions, water conservation, and water banking. This project is known as the El Paso-Las Cruces Regional Sustainable Water Project. The USIBWC and El Paso Water Utilities/Public Service Board (EPWU/PSB) were co-lead agencies for project planning and evaluation of potential effects. The project has not entered the implementation phase as agreements have not been reached on water acquisition. The City of El Paso has developed plans for use of groundwater treated by desalination.

Cumulative impacts would have been significant for all resource areas. However, it appears that this project is no longer viable.

### *Upper Rio Grande Basin Water Operations*

A multi-agency task force is currently evaluating more reliable and effective management strategies for the Upper Rio Grande basin through comprehensive hydraulic and hydrological simulation of stream flows, storage, and water demands. Timing of flows through the RGCP, as well as potential controlled releases from Caballo Dam, could be influenced by findings of the operations evaluation. As part of an ongoing Environmental Impact Statement, draft alternatives are currently under development for the Upper Rio Grande Basin Water Operations.

A multi-agency task force is currently evaluating more reliable and effective management strategies for the Upper Rio Grande basin through comprehensive hydraulic and hydrological simulation of stream flows, storage, and water demands. Timing of flows through the RGCP, as well as potential controlled releases from Caballo Dam, could be influenced by findings of the operations evaluation. As part of an ongoing Environmental Impact Statement, draft alternatives are currently under development for the Upper Rio Grande Basin Water Operations.

This project could likely improve delivery efficiency which could insure potential water availability for measure implementation.

## 4.15.2 Analysis of Structural Condition of the Levees

The need for levee rehabilitation due to structural deficiencies is not currently known. The extent of such rehabilitation would be dependent on findings of an ongoing investigation to verify levee condition. The three-step investigation entails aerial geophysical surveys, followed by surface geophysical surveys, and a geotechnical drilling program. The goal of aerial geophysical surveys is to identify the regions of levee that yield questionable electrical conductivity values as related to soil composition. Resulting electrical conductivity values would then be correlated to known soil properties and characteristics, thus providing a regional representation of levee composition (i.e., sand, clay, voids).

Levee regions identified in the aerial geophysical surveys as questionable or inappropriate for flood control purposes would be re-surveyed using surface geophysics methods. Surface geophysical surveys would generate detailed resistivity/conductivity data to more accurately quantify integrity of the levee. Results of the surface geophysical survey would determine the sites that require geotechnical investigations (i.e., analysis of soil borings). Combined results of the geophysical and geotechnical drilling program would conclude where levees must be completely replaced (using new material) or rehabilitated (replace some material and re-compact). The USIBWC plans to complete the geotechnical investigations during the Fiscal Year 2004.

If this study shows additional levee deficiencies requiring major construction to correct problems cumulative impacts could result in air quality, soils, cultural, transportation, noise and socioeconomics. Construction could result in possible ground disturbance to archaeological sites in barrow areas and at sites near new levee construction. Additional impacts to noise, transportation and air would be dependent on the amount of new construction. In this EIS the potential effects of levee rehabilitation have been examined under the Flood Control Improvement Alternative.

## 4.16 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are environmental consequences of an action that cannot be avoided either by changing the nature of the action or through mitigation if the action is undertaken. Unavoidable environmental effects would result from implementation of the alternative actions; however, none of the effects would be significant.

The sediment removal activities would have short term unavoidable adverse effects on biological and fisheries resources. However, in the long term biological communities would flourish due to alternative actions. The impact to benthic invertebrates would be localized and not likely effect area populations. Loss of water due to the creation of wetlands and bosque enhancement areas would have a small effect on commercial farming and land use.

## 4.17 RELATIONSHIP BETWEEN THE SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

This analysis investigates the relationship between short-term uses of the environment and the maintenance and possible enhancement of long-term productivity. Improving and adding levees would provide value in improved flood control and water deliveries. Soil would be displaced as a result of bank shave-downs or opening former meanders, excavating arroyos, and scour during seasonal peak flows; however, soil would be deposited within the floodway or on the levee toe and slope as a beneficial use. Restoration of native bosque and development of native grasslands in formally mowed areas would result in direct beneficial effects for environmental improvements. Seasonal peak flows, opening meanders and incorporation of conservation easements would significantly increase the amount of native bosque and native grasslands. There would be no disruptions of short-term uses of the river or known effects on long-term productivity within the river.

## 4.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects the use of these resources would have on consumption or destruction of a resource that could not be replaced in a reasonable period of time. The irreversible environmental changes that could result from implementation of the alternative actions include consumption of material resources, energy resources, and human resources.

Material resources used for the alternative actions include building materials for construction of levees or levee improvements, new floodwalls, or tree planting. The materials that would be consumed are not in short supply and are readily available from suppliers in the region. Use of these materials would not limit other unrelated construction activities and, therefore, would not be considered significant.

Energy resources would be irretrievably lost. These include petroleum-based products such as gasoline and diesel fuel. During construction or dredging activities, gasoline and diesel fuel would be used for operation of equipment and other vehicles. Consumption of these energy resources would not place a significant demand on their availability in the region. Therefore, no adverse impacts would be expected.

The use of human resources for construction or dredging activities is considered an irretrievable loss, only in that it would preclude such personnel from engaging in other work activities. However, the use of human resources for the alternative actions represents employment opportunities and is considered beneficial.

# SECTION 5
# CONSULTATION AND COORDINATION

This section describes the consultation process followed by the USIBWC for development of the DEIS. Key issues discussed by stakeholders were previously listed in Section 2.1. Also included are the list of preparers, indicating level of experience and contribution to the document preparation, and a DEIS distribution list.

## 5.1 DEIS PREPARATION OVERVIEW

The USIBWC issued a Notice of Intent for environmental impact statement preparation in August 1999, and conducted two public scoping meetings during October 1999 in Las Cruces, New Mexico, and El Paso, Texas. Preliminary alternatives were then developed and presented for stakeholder review during two technical workshops conducted in September and October 2000. An Alternatives Formulation Report was issued in March 2001 as the basis to determine potential effects associated with river management alternatives for the RGCP (Parsons 2001a).

Following preparation of the Alternatives Formulation Report, the USIBWC conducted additional meetings and focused workshops with representatives of regulatory agencies, irrigation districts, and environmental organizations. These additional meetings were conducted to address comments and concerns expressed to the USIBWC by stakeholders after review of the Alternatives Formulation Report posted on the USIBWC website. Based on input from additional stakeholder contacts, river management alternatives and associated environmental measures were modified to further address stakeholders' concerns and recommendations. These changes were summarized in the Reformulation of Alternatives Report (Parsons 2003a). A copy of this report, which also includes the Alternatives Formulation Report as an appendix, is provided as a reference in Appendix I (CD attached to the back cover of this DEIS).

The consultation process followed by the USIBWC for preparation of the DEIS is described below.

### 5.1.1 Public Scoping Meetings

Throughout the DEIS development process, the USIBWC has emphasized public involvement. Two public scoping meetings were conducted following publication of the Notice of Intent:

- The first public scoping meeting was held October 5, 1999 from 6:00 to 8:00 p.m., at the Las Cruces Hilton, 705 South Telshor Boulevard, Las Cruces, NM.
- The second meeting was held October 6, 1999 from 6:00 to 8:00 p.m., at the El Paso Airport Hilton, 2027 Airway Boulevard, El Paso, Texas.

Advance notification of the public scoping meetings was provided to two local newspapers (Las Cruces Sun News and El Paso Times) and 112 elected officials, federal/state/local government agencies, and interested organizations and individuals. Each public scoping meeting consisted of an informational presentation by the USIBWC that explained the environmental process as well as features of the alternatives that might be considered. Each person was given the opportunity to make a statement during the second portion of the meeting. Additionally, each person had the opportunity to submit a written statement concerning the proposal. Likewise, individuals who read the advertisements announcing the meetings and did not attend the meeting were given an address to which they could submit written comments. These comments, along with those written and oral statements submitted during and after the meetings, were included in a summary document prepared in November 1999 (Parsons 1999).

Management issues identified by various organizations and the general public during the two public scoping meetings were previously described (Table 2.1-1). Comments received dealt primarily with land use and biological resources issues, particularly vegetation, and to a lesser extent with water resources, recreation, geology and soils.

### 5.1.2 Consultation for Formulation of Alternatives

#### *Alternatives Formulation*

In March 2001 the USIBWC completed the Alternatives Formulation Report to be used as the basis for evaluation of potential effects in the DEIS (Parsons 2001a). Prior to completion of this report, the agency conducted two technical workshops with representatives of the USBR, USFWS and other regulatory agencies, the SWEC, EBID and EPCWD#1 to review the alternatives formulation process. These workshops were held on September 12 and 13, 2000, at the USIBWC offices in El Paso. An additional public meeting was held in Las Cruces on October 12, 2000 to obtain further input on the alternatives. Table 5.1-1 presents a chronology of the consultation process, stakeholder identification, and main topics discussed.

**Table 5.1-1 Stakeholder Consultation for Preparation of the Alternatives Formulation Report**

| Date | Type | Attendees (Location) | Main Topics |
|---|---|---|---|
| Oct 5, 1999 | Public Meeting | Open forum (Las Cruces) | Scoping of actions to be evaluated in Environmental Impact Statement |
| Oct 6, 1999 | Public Meeting | Open forum (El Paso) | Scoping of actions to be evaluated in Environmental Impact Statement |
| Sep 12, 2000 | Presentation | USBR, USACE, NRCS, SWEC, other NGOs (El Paso @USIBWC) | Inter-agency / NGOs review of draft alternatives formulation |
| Sep 13, 2000 | Presentation | USBR, EBID, EPCWID#1 (El Paso @USIBWC) | Irrigation Districts review of draft alternatives formulation |
| Oct 12, 2000 | Public Meeting | Open forum (Las Cruces @ Hilton Hotel) | Discussion of draft alternatives |
| Jan 23, 2001 | Presentation | USIBWC, USBR (El Paso @USIBWC) | Parsons' presentation of draft alternatives to the USIBWC Commissioner & Principal Engineers |

### 5.1.3 Reformulation of Alternatives

Findings of the Alternatives Formulation Report, issued in March 2001 (Parsons 2001a), were subsequently reviewed with representatives of regulatory agencies, irrigation districts and environmental organizations during three presentations and a technical workshop organized by the USIBWC between June 14, 2001 and May 8, 2002. These presentations were attended by representatives of the USBR, USFWS, EBID, EPCWD#1, SWEC, Alliance for the Rio Grande Heritage, and Rio Grande Citizens Forum. Four review meetings with members of the farming community and representatives of various environmental organizations were also held by the USIBWC between October 31, 2001 and December 5, 2002. Written comments were received from representatives of those organizations. Changes to the river management alternatives for the RGCP were summarized in the Reformulation of Alternatives Report (Parsons 2003a). Issues and concerns discussed during presentations and review meetings are summarized in Table 5.1-2.

**Table 5.1-2 Issues and Concerns Discussed with Stakeholders During the Alternatives Reformulation Consultation Process**

| Issues and Concerns |
|---|
| **Water Use and Water Acquisition** |
| Water consumption and mechanisms for rights acquisition |
| Transfer of water gains by salt cedar reduction |
| Viability of proposed water conservation strategy |
| Likely water use by riparian vegetation, channel modifications, test plots |
| Concern of implementation during drought conditions |
| **Changes in River Configuration** |
| Use of pre-canalization conditions as a reference for restoration (1938) |
| Need for additional modifications to channel structure |
| Potential loss in efficiency of water deliveries |
| Greater emphasis on watershed management (coordination with agencies and landowners for erosion control in uplands) |
| **Changes in Project Functionality** |
| Effect of riparian vegetation growth on flood control |
| Recommendation to cease annual mowing and discontinue grazing and agricultural leases |
| Hydraulic modeling reliability and need for a two-dimensional model |
| Need for additional flood control analysis including non-structural measures |
| **Approach to River Restoration** |
| Description of adopted restoration vision |
| Selection criteria for riparian vegetation and aquatic improvement sites |
| Sustainability defined as the need to minimize management / intervention |

Table 5.1-3 presents a chronology of the consultation process, stakeholder identification, and main topics discussed. A listing of correspondence regarding the development of the Reformulation Report is presented in Table 5.1-4.

Following publication of the Reformulation Report, comments on the report were received from the following three organizations:

- World Wildlife Fund. September 12, 2003 correspondence requesting additional information or clarification on 37 issues;
- Elephant Butte Irrigation District. September 13, 2003 correspondence stating their position on two issues. The second issue, "U.S. Section's Proposals to Establish New Zones of Riparian Vegetation along the Rio Grande in New Mexico" addresses the reformulation of RGCP management alternatives; and
- Alliance for the Rio Grande (undated correspondence) stating eight technical concerns regarding the reformulation of alternatives.

The USIBWC provided detailed responses to each organization on November 14, 2003. Appendix H presents correspondence received, as well as USIBWC responses.

**Table 5.1-3 Stakeholder Consultation for Preparation of the Reformulation of Alternatives Report**

| Date | Type | Attendees (Location) | Main Topics |
|---|---|---|---|
| June 14, 2001 | Presentation | USIBWC, USFWS, USBR, SWEC, other NGOs (El Paso @USIBWC) | Discussion of key elements of the Alternatives Formulation Report |
| Oct 22, 2001 | Technical Workshop | USIBWC / SWEC (El Paso @USIBWC) | Presentation of revised river restoration alternative incorporating SWEC's input |
| Oct 31, 2001 | Meeting | USIBWC / SWEC (Albuquerque @Parsons) | Discussion of pending issues from 10/22/01 workshop |
| Nov 30, 2001 | Meeting | USIBWC / Las Cruces area farmers (Anthony, NM @ Dos Lagos Gulf Club) | Discussed project alternatives, and possible implications of proposed measures |
| April 17, 2002 | Presentation | Elephant Butte Irrigation District (Las Cruces @EBID) | Presentation to the Irrigation District regarding the basis for reformulation of alternatives and proposed measures |
| May 8, 2002 | Presentation | El Paso County WID#1 (El Paso @ EPCWID#1) | Presentation of reformulated alternatives incorporating input from EBID's 4/17/02 presentation |
| July 22, 2002 | Meeting | USIBWC-Alliance (El Paso @USIBWC) | Discussion of Environmental Impact Statement scope and reformulation of the restoration alternative with representatives of the Alliance for the Rio Grande Heritage |
| Dec 5, 2002 | Meeting | USIBWC & R. B. Miller (El Paso @ USIBWC) | Environmental Impact Statement development update, discussion of 2001 alternatives formulation, plans to develop reformulation report, and source water to support environmental enhancements |
| August 14, 2003 | Presentation | New Mexico-Texas Water Commissions | Briefing on the Reformulation of Alternatives Report |

## Table 5.1-4 List of Correspondence Regarding Preparation of the Reformulation of Alternatives Report

| Date | Author | Main Topics |
|---|---|---|
| Feb 21, 2001 | Kevin Bixby, E. Director, SWEC | SWEC's comments to USIBWC on Draft Alternatives Report |
| June 13, 2001 | Kevin Bixby, Executive Director, SWEC | Letter to USIBWC reviewing the final Alternatives Formulation Report, with attachment from a May 2001 analysis by K. Craig |
| Aug 29, 2001 | Kevin Bixby, Executive Director, SWEC | Letter to USIBWC describing SWEC vision of a restoration alternative, and components of a preferred alternative |
| Nov 29, 2001 | Kevin Bixby, Executive Director, SWEC | Letter reviewing new formulation of the restoration alternative, acknowledging restoration alternative improvements, and indicating concerns on sustainability and role of flood control measures |
| Jan 11, 2002 | Jack F. Darbyshire | Letter to USIBWC on the need for water conservation and additional analysis of water use, and concerns about project implementation |
| Feb 15, 2002 | Carlos M. Ramirez, P.E., Commissioner, USIBWC | USIBWC 2/15/02 response to J. Darbyshire 1/11/02 letter |
| May 31, 2002 | Kevin Bixby, Executive Director, SWEC | Letter to USIBWC partially restating issues from 11/29/01 letter on preliminary Environmental Impact Statement Sections 1& 2 |
| June 6, and June 13, 2002 | Rebecca B. Miller | Correspondence to USIBWC stating concerns related to compliance with the Farm Protection Policy Act and conservation easement use |
| June 28, 2002 | Gary Arnold, President, Board of Directors, Elephant Butte Irrigation District | Comments on Parsons 4/17/02 presentation regarding water right issues, need for a prior environmental analysis, mandate to proceed, and technical issues on flood control and water conservation analysis |
| July 3, 2002 | Carlos Victoria-Rueda, Project Manager, Parsons | Parsons' reply to SWEC's concerns regarding river restoration alternative reformulation |
| July 23, 2002 (e-mail) | Carlos Victoria-Rueda, Project Manager, Parsons | Correspondence to USIBWC providing documentation on the partial river restoration concept, as adopted by the Bosque Hydrology Group |
| July 23, 2002 (e-mail) | Kevin Bixby, E. Director, SWEC | Reply to 7/23/02 Parsons' e-mail |
| July 25, 2002 (e-mail) | Steve Harris, Rio Grande Restoration | Comments on Parsons' 7/23/02 e-mail to SWEC, and Rio Grande restoration perspective |
| July 31, 2002 (e-mail) | Carlos Victoria-Rueda, Project Manager, Parsons | Parsons reply to S. Harris' 7/25/02 e-mail, pointing out the limited role of flood control measures on Rio Grande restoration |
| Aug 7, 2002 | Sylvia Waggoner, Division Engineer, Environmental Management, USIBWC | USIBWC thanks recipients of participating in extended scoping process and announces pending reformulation report to be provided to them prior to release of draft Environmental Impact Statement |
| Aug 7, 2002 | Carlos Victoria-Rueda, Project Manager, Parsons | Letter to USIBWC addressing concerns, clarifying issues from 4/17/02 presentation to EBID, and stating adoption of recommendations |
| Aug 13,2002 | Lori Robertson, Division Manager, Environment and Lands, USBR | U.S. Bureau of Reclamation's comments to USIBWC on preliminary draft Sections 1&2, confirming 6/28/02 teleconference with A. Coykendall |
| Sep 4, 2002 | Douglas Echlin, Environmental Management Division, USIBWC | USIBWC thanking EBID's Gary Arnold for 6/28/02 comment letter and providing copy of Parsons 8/7/02 letter |
| Sep 25, 2002 | Kevin Bixby, Executive Director, SWEC | The Alliance for the Rio Grande Heritage's comments to USIBWC on some issues discussed in 7/3/02 Parsons letter. |
| Dec 5, 2002 | Sylvia Waggoner, Division Engineer, Environmental Management, USIBWC | USIBWC notification to SWEC of preparation of an Alternatives Reformulation Report incorporating stakeholders' input received since March 2001 |
| Dec 9, 2002 | Carlos Marin, Deputy Commissioner, USIBWC | USIBWC follow-up letter to R. Miller, Rio Grande Citizen Forum Board Member, regarding issues discussed during 12/5/02 meeting |

## 5.2 LIST OF CONTRIBUTORS

Table 5.2-1 and 5.2-2 present a list of persons who prepared various sections of the DEIS or participated to a significant degree in its preparation or that of supporting documents. Documents developed as part of the NEPA process are the biological survey reports (vegetation, habitat and listed species surveys), cultural resources report, and alternatives formulation reports.

### Table 5.2-1 List of DEIS Reviewers

| Name | Degree | Title | Years of Experience | Contribution |
|---|---|---|---|---|
| **United States Section, International Boundary Water Commission (Lead Federal Agency)** | | | | |
| Douglas Echlin | M.S. Biological Science | Acting Chief, Environmental Management Division | 28 | DEIS Coordinator, and Document Reviewer |
| Jim Robinson, P.E. | B.S. Civil Engineering | Engineering Services Division Engineer | 26 | Engineering, Hydraulics and Hydrology and Document Reviewer |
| Daniel Borunda | M.S. Wildlife Science | Environmental Protection Specialist | 7 | Document Reviewer |
| Hector A. Maynes | B.S., Civil Engineering | Project Manager, URGP | 39 | Document Reviewer |
| Rong Kuo, P.E. | Ph.D. Civil Engineering | Civil Engineer | 20 | Engineering, Hydraulics and Hydrology and Document Reviewer |
| Luis Hernandez | B.S., Civil Engineering | Civil Engineer, O&M Division | 14 | O&M and Document Reviewer |
| Susan Daniel | J.D. | Assistant Leval Advisor | 11 | Legal Sufficiency and Document Reviewer |
| Mario Lewis | J.D. | General Counsel | 30 | Legal Sufficiency and Document Reviewer |
| Antonio Solo, P.E. | B.S. | Civil Engineer | 28 | O&M and Document Reviewer |
| **U.S. Department of Interior, Bureau of Reclamation (Cooperating Federal Agency)** | | | | |
| Art Coykendall | M.S. Wildlife Management | Environmental Protection Specialist | 12 | Water Use Review, NEPA Compliance |
| Robert Maxwell | B.S. Botany and Range Management | Environmental Protection Specialist | 25 | NEPA Compliance |
| **Other Technical Reviewers** | | | | |
| Dr. Cliff Crawford | Ph.D., Biology | Professor (ret.) | 40 | Restoration Review and Consultation |

## Table 5.2-2 List of Preparers

| Name | Degree | Title | Years of Experience | Contribution |
|---|---|---|---|---|
| **PARSONS (NEPA Consultant)** | | | | |
| R. C. Wooten | Ph.D., Biology/Ecology | Vice-President and Technical Manager | 34 | Technical Direction and Quality Assurance |
| Carlos Victoria-Rueda | Ph.D., Environ-mental Engineering | Principal Engineer | 19 | Project Management and Technical Review |
| Ron Beisel | M.A. Geography | Principal Scientist | 30 | Socioeconomic Analysis |
| Rick Billings | M.S. Fisheries Science | Senior Biologist | 22 | Aquatic Ecology |
| Brian Crane | Ph.D. Antropology | Principal Scientist | 16 | Archaeology and Cultural Resources |
| Rosemarie Crisologo | M.S., Environmental Engineering | Senior NEPA Specialist | 23 | Scoping and Public Participation |
| Anthony Davis, P.E. | B.S. Civil Engineering | Principal Engineer | 26 | NEPA Compliance |
| April Fitzner | M.S. Water Resources | Principal Scientist | 12 | Technical Support, Water Resources |
| Dave Guggemos | M.S. Civil Engineering | Principal Engineer | 23 | Formulation of Alternatives |
| James Hinson | M.S. Wildlife Science | Principal Biologist | 16 | Biological Analyses, Remote Sensing, GIS |
| Taylor Houston | B.S. Geography | Project Scientist | 3 | GIS Analysis |
| Sherrie Keenan | B.A., Journalism | Technical Editor | 27 | Technical Editing |
| Stephen Manning, P.E. | MBA, B.S. Civil Engineering | Senior Engineer | 20 | Quality Control |
| Namir Najjar | Ph.D. Water Resources | Project Engineer | 7 | Hydraulic Modeling |
| Garner Peterson | B.S., Geology | Project Scientist | 4 | GIS Analysis |
| Steve Schrader | M.S. Civil Engineering | Project Engineer | 16 | Water Resources Analysis |
| John Sigler | Ph.D., Fisheries | Aquatic Biologist | 31 | Fisheries Biology |
| John Wallin | M.S. Management | Principal Scientist | 11 | Air Quality Analysis |
| Chris Westerman | M.S. Botany | Senior Scientist | 9 | Biological Surveys |
| **Lopez-Garcia Group (NEPA Subconsultant)** | | | | |
| Mike Sipos | M.S. Biology | Senior Biologist | 6 | Land Use Analysis, Field Supervision |
| **Ecosystem Management, Inc. (NEPA Subconsultant)** | | | | |
| Kenneth L. Brown | Ph.D. Anthropology | Senior Archaeologist | 25 | Cultural Resources, Archaeological Surveys Supervision |

## 5.3 DISTRIBUTION LIST

This DEIS is being sent to the following federal agencies, state and local governments, libraries, and interested organizations, as listed in Table 5.1-5. Additional copies are being sent to private individuals that provided comments during the development and preparation of the DEIS and support documents.

### Table 5.3-1 Distribution List by Organization

| Affiliation | Position | City | St |
|---|---|---|---|
| **FEDERAL AGENCIES** | | | |
| Environmental Protection Agency | Office of Federal Activities, EIS Filing Section | Washington | DC |
| Environmental Protection Agency, Region VI | – Regional Administrator<br>– Regional Environmental Impact Statement Coordinator | Dallas | TX |
| USDA, Natural Resources Conservation Service | District Conservationist | Las Cruces | NM |
| USDA, Natural Resources Conservation Service | Resource Team Leader | El Paso | TX |
| USDA, Natural Resources Conservation Service | – State Biologist<br>– State Conservationist | Albuquerque | NM |
| U.S. Army Corps of Engineers, Albuquerque District | – District Engineer<br>– Chief, Planning and Reports Section | Albuquerque | NM |
| U.S. Army Corps of Engineers, Albuquerque District | El Paso Regulatory Office Chief | Fort Bliss | TX |
| U.S. Bureau of Reclamation, Rio Grande Project | – Project Supervisor<br>– Assistant Area Manager<br>– Hydraulic Engineer | El Paso | NM |
| U.S. Bureau of Reclamation, Albuquerque Area Office | Area Manager | Albuquerque | NM |
| Bureau of Land Management, Las Cruces Field Office | Field Manager<br>Field Office Environment Coordinator | Las Cruces | NM |
| National Park Service, Southwest Region (Texas, New Mexico) | Regional Director | Santa Fe | NM |
| U.S. Fish and Wildlife Service, Austin Ecological Services Office | – Supervisor<br>– Fish and Wildlife Biologist | Austin | TX |
| U.S. Fish and Wildlife Service, New Mexico Ecological Services State Office | Supervisory Fish and Wildlife Biologist | Albuquerque | NM |
| U.S. Fish and Wildlife Service, Region 2 | Regional Director | Albuquerque | NM |
| Advisory Council on Historic Preservation | Western Office of Project Review Director | Lakewood | CO |
| Texas Rio Grande Water Commission | Texas Commissioner | El Paso | TX |
| Interstate Stream Commission | Commissioner | Las Cruces | NM |

| Affiliation | Position | City | St |
|---|---|---|---|
| **STATE AND LOCAL AGENCIES - NEW MEXICO** | | | |
| New Mexico Department of Game and Fish | – Director<br>– Chief, Conservation Services Division | Santa Fe | NM |
| New Mexico Environmental Department | Chief, Surface Water Quality Bureau | Santa Fe | NM |
| New Mexico Office of Cultural Affairs, Historic Preservation Division | State Historic Preservation Officer | Santa Fe | NM |
| City of Las Cruces | – City Administrator<br>– Planning Department | Las Cruces | NM |
| Las Cruces Chamber of Commerce | | Las Cruces | NM |
| City of Truth or Consequences | Assistant City Manager | TOC | NM |
| **STATE AND LOCAL AGENCIES - TEXAS** | | | |
| Governor's Budget and Planning Office | State Single Point of Contact | Austin | TX |
| Texas Parks and Wildlife Department | – Executive Director<br>– Assistant Director, Resource Protection Division | Austin | TX |
| Texas Commission on Environmental Quality | Regional Manager | El Paso | TX |
| Texas Department of Highways and Public Transportation | District Engineer | El Paso | TX |
| Texas Department of Transportation | El Paso District Design Engineer | El Paso | TX |
| Texas Water Development Board | – Director<br>– Executive Administrator, Office of Planning | Austin | TX |
| Texas Historical Commission | Executive Director and State Historic Preservation Officer | Austin | TX |
| Department of Planning Research and Development | Urban Planner | El Paso | TX |
| Rio Grande Council of Governments and El Paso County Dispute Resolution Center | Executive Director | El Paso | TX |
| City of El Paso | – City Administrator<br>– Planning Department | El Paso | TX |
| El Paso Chamber of Commerce | | El Paso | TX |
| **UTILITIES AND WATER DISTRICTS** | | | |
| El Paso Water Utilities/Public Service Board | – Planning and Development Manager<br>– Environmental Planner | El Paso | TX |
| Anthony Water & Sanitation District | Superintendent | Anthony | NM |
| Elephant Butte Irrigation District | – Treasurer-Manager<br>– District Engineer | Las Cruces | NM |
| El Paso County Water Improvement District No. 1 | General Manager | El Paso | TX |
| **ELECTED OFFICIALS** | | | |
| Village of Hatch | Mayor | Hatch | NM |
| City of Mesilla | Mayor | Mesilla | NM |
| City of Anthony | Mayor | Anthony | TX |
| Village of Vinton | Mayor | Anthony | TX |
| City of El Paso | Mayor | El Paso | TX |
| City of Sunland Park | Mayor | Sunland Park | NM |
| City of Las Cruces | Mayor | Las Cruces | NM |
| Doña Ana County | Chairman | Las Cruces | NM |
| El Paso County Courthouse | El Paso County Judge | El Paso | TX |
| Sierra County | Commission Chairman | Truth or Conseq. | NM |

| Affiliation | Position | City | St |
|---|---|---|---|
| District 33 | New Mexico State Representative | Mesilla | NM |
| Districts 34, 35, 36 and 37 | New Mexico State Representative | Las Cruces | NM |
| 75th and 79th District | Texas State Representative | El Paso | TX |
| 76th and 77th District | Texas State Representative | Austin | TX |
| District 36 (Doña Ana) | New Mexico State Senator | Doña Ana | NM |
| District 38 (Doña Ana) | New Mexico State Senator | Mesilla | NM |
| District 31 (Doña Ana) | New Mexico State Senator | Las Cruces | NM |
| District 37 (Doña Ana, Otero & Sierra) | New Mexico State Senator | Las Cruces | NM |
| 28th District | Texas State Senator | Austin | TX |
| 29th District | Texas State Senator | El Paso | TX |
| State of New Mexico | U.S. Senators and<br>U.S. Representatives | Washington | D.C. |
| State of Texas | U.S. Senators and<br>U.S. Representatives | Washington | D.C. |
| **LIBRARIES** | | | |
| New Mexico State University Library | Reference Desk | Las Cruces | NM |
| Thomas Branigan Memorial Library | Reference Section | Las Cruces | NM |
| El Paso Public Library | Reference Desk | El Paso | TX |
| University of Texas at El Paso Library | Reference Section | El Paso | TX |
| **ORGANIZATIONS** | | | |
| New Mexico State University | – New Mexico Water Resources Research Institute<br>– Dept. of Range Science | Las Cruces | NM |
| University of Texas at El Paso | – Center for Environmental Research and Management<br>– Dept. Biological Sciences<br>– Engineering Department | El Paso | TX |
| Southwest Environmental Center | Director | Las Cruces | NM |
| Paso del Norte Watershed Council | Coordinator | El Paso | TX |
| El Paso Trans-Pecos Audubon Society | | El Paso | TX |
| Doña Ana Mutual Domestic Water Consumers Association | | Doña Ana | NM |
| El Paso Times | Editor | El Paso | TX |
| Chihuahuan Desert Wildlife Restoration | | El Paso | TX |
| Rio Grande Restoration | Executive Secretary | El Prado | NM |
| ASCE Environmental and Water Res. Institute | Director | Mesilla Park | NM |
| RGCC-TX | Engr. Advisor | El Paso | TX |
| Pueblo of Isleta | Governor | Isleta | NM |
| Mescalero Apache Tribe | Tribal Historic Preservation Office | Mescalero | NM |
| Pueblo of Zuni | Governor | Zuni | NM |
| Ysleta del Sur Pueblo | Governor | El Paso | TX |
| El Paso Zoo | Animal Curator | El Paso | TX |
| EPISO | Leader Organizer | El Paso | TX |
| Las Cruces Sun News | | Las Cruces | NM |
| Southwest Consolidated Sportsman | | Las Cruces | NM |
| SWEC/Mesilla Valley Audubon Society | | Mesilla | NM |
| SNMEC | | Las Cruces | NM |
| Sierra Club | Chair, E.P. Group | El Paso | TX |
| Sierra Club, Southern NM Group | Chair | Las Cruces | NM |
| Rio Grande/Rio Bravo Basin Coalition | | El Paso | TX |
| National Audubon Society | Texas Audubon Society | San Antonio | TX |
| Texas Center for Policy Studies | | Austin | TX |
| World Wildlife Fund | Program Officer | Las Cruces | NM |
| Alliance for the Rio Grande Heritage | | El Paso | TX |

# SECTION 6
# GLOSSARY AND REFERENCES

## 6.1 GLOSSARY

**100-year floodplain:** The area along the river corridor that would receive flood waters during a 100-year flood event. This flood event has the probability of occurring 1% of the time during any given year. If a 100-year flood event occurs, the following year will still have the same probability for occurrence of a 100-year event. The 100-year floodplain also includes wetlands and meadows associated with the hydrologic and ecological processes of the river.

### A

**Acre-foot:** A volume of water that would cover 1 acre to a depth of 1 foot (325,850 gallons, 43,560 cubic feet).

**Adaptive management:** A systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. A way for resources managers to proceed responsibly in the face of such uncertainty.

**Affected environment:** Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as the result of a proposed human action. Also, the chapter in an environmental impact statement describing current environmental conditions.

**Alluvium**: A general term for all deposits resulting from the operations of modern rivers, including the sediments laid down in riverbeds, floodplains, lakes, fans at the foot of mountain slopes, and estuaries.

**Alternatives:** Courses of action which may meet the objectives of a proposal at varying levels of accomplishment, including the most likely future conditions without the project or action.

**Aquifer**: A geological formation or structure that stores and/or transmits water, such as to wells and springs.

**Archaeology**: Study of human cultures through the recovery and analysis of their material relics.

**Arroyo:** A gully or channel cut by an intermittent stream.

**Artifact:** A human-made object.

### B

**Backflooding:** Flooding due to backup of excess flow behind a constriction in a major conduit.

**Backwater**: A small, generally shallow body of water attached to the main canal, with little or no current of its own.

**Baseline**: Condition that would prevail if no action were taken.

**Bed material:** Unconsolidated material of which a streambed is composed.

**Benthic:** Bottom of lakes or oceans; organisms that live on the bottom of water bodies.

**Benthos:** Organisms living in or on the bottom of a lake, pond, ocean, or stream.

**Biological diversity**: Number and kinds of organisms per unit area or volume; the composition of species in a given area at the given time.

**Biological Opinion:** Document which states the opinion of the U.S. Fish and Wildlife Service about whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

**Biota:** The types of plant and animal life found in specific regions at specific times.

**Bosque:** Spanish word for forest, used to refer to the riparian forest along the Rio Grande.

**Bypass flow:** Water allowed to flow past a diversion structure or storage facility.

## C

**Candidate species**: Plant or animal species that are candidates for designation as endangered (becoming extinct) or threatened (likely to become endangered).

**Capital costs**: Costs (usually long-term debt) of financing construction and equipment. Capital costs are usually fixed, one-time expenses.

**Channel:** The bed or deepest portion of a stream, river, or other body of water.

**Community:** A group of one or more interacting populations of plants and animals in a common spatial arrangement at a particular point in time.

**Consumptive use**: That part of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. Also referred to as water consumed.

**Contiguous**: Touching or connected throughout in an unbroken sequence.

**Conveyance loss**: Water that is lost in transit from a canal, conduit, or ditch by leakage or evaporation. Generally, leakage from an irrigation ditch an percolate to a groundwater source and be available as groundwater.

**Conservation easement:** A restriction placed on a piece of property to protect the resources (natural or man-made) associated with the parcel.

**Corridor:** Narrow strip of land reserved that extends over several miles.

**Critical habitat**: Areas designated by the Secretary as critical habitat under section 4 of the ESA (16 USC sec. 1533). The term is a legal term which connotes a formal designation that takes place through a rulemaking process.

**Cultural rsource(s):** Sites, structures, landscapes, and objects of some importance to a culture or community for scientific, traditional, religious, or other reasons.

**Colonization:** The successful establishment of a new habitat by a species

## D

**Degradation:** Process wherein the elevation of streambeds, sandbars, and floodplains is lowered by erosion. The opposite of aggradation.

**Depletion:** To permanently remove water from a system for a specific use.

**Deposition**: Material settling out of the water onto the streambed. Occurs when the energy of the flowing water is unable to support the load of suspended sediment.

**Direct impact:** An impact caused by an action that occurs at the same time and place as the [proposed] action (see 40 CFR 1508.8).

**Discharge**: The volume of water that passes a given location within a given period of time. Usually expressed in cubic feet per second.

**Diversion:** The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other method to another body of water or to the land, as in the case of an irrigation system.

**Drainage basin**: The area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel. Also see watershed.

## E

**Easement:** The right to use the real property of another for a specific purpose.

**Ecosystem:** Complex system composed of a community of animals and plants as well as the chemical and physical environment.

**Emergent vegetation**: Aquatic plants having most of the vegetation parts growing above water.

**Embayment**: The formation of a bay.

**Emissions:** Substances dischared into the air.

**Endangered species:** A species in danger of extinction throughout all or a significant portion of its range. As a general rule, the term is used only for species that have been formally listed as endangered under the Endangered Species Act (16 USC sec. 1531-1544)..

**Ephemeral**: Streams that contain running water only for brief periods of time in direct response to precipitation.

**Evaporation**: Water vapor losses from water surfaces, sprinkler irrigation, and other related factors.

**Evapotranspiration**: The combined processes of evaporation and transpiration. It can be defined as the sum of water used by vegetation and water lost by evaporation.

**Environmental consequences**: A section in an Environmental Impact Statement that addresses the alternatives as they affect resource issues; it provides the scientific, analytical, and technical basis for assessing the impacts on those resources.

**Environmental measure**: For this EIS, changes in operation and maintenance procedures or the manipulation of the biological and physical environment to enchance or restore ecosystems along the Rio Grande.

## F

**Facilities**: Structures associated with irrigation projects, municipal and industrial water systems, power generation facilities, including all storage, conveyance, distribution, and drainage systems.

**Fauna:** All animals associated with a given habitat, country, area, or period.

**Federal agency action**: For purposes of the DEIS, actions authorized, funded or carried out by a federal agency and hence subject to Section 7 consultation requirements.

**Flood or flooding:** A general condition of partial or complete inundation of normally dry land areas from the overflow of inland and/or tidal water, or unusual and rapid accumulation of surface waters from any source.

**Floodplain**: A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Floodway:** A shallow reservoir between the levee line and the bank of the river channel.

**Flora:** All plant life associated with a given habitat, country, or period. Bacteria are considered flora.

**Flow**: Volume of water passing a given point per unit of time.

**Flume:** An artifical channel or chute for a stream of water.

**Freeboard:** The designed height between the maximum water level and the crest of the flood control levees.

## G, H

**Gauge or gauging station**: Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.

**Geomorphology:** Geological study of the configuration and evolution of land forms and earth features.

**Global Positioning System (GPS)**: A satellite navigation system used to determine terrestrial position, velocity, and time.

**Gradient:** General slope of rate of change in vertical elevation per unit of horizontal distance of water surface of a flowing stream.

**Greenbelt**: A belt of parkways, parks, or farmlands that encircles or runs through a community.

**Groin**: Structure built from shore into water for protection against erosion, Used in river training as construction works to establish normal channel width; to direct the axis of flow. Also considered a deflector .

**Groundwater:** Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper level of the saturated zone is called the water table. Water stored underground in rock crevices and in the pores of geologic materials that make up the earth's crust. That part of the subsurface water which is in the zone of saturation; phreatic water .

**Habitat:** Area or type of environment where a plant or animal lives.

**Head**: Differential of pressure causing flow in a fluid system, usually expressed in terms of the height of a liquid column (or the vertical distance in feet) that pressure will support.

**Headwater**: The source and upper part of a stream; water upstream of a dam or powerhouse.

**Hydrograph**: A graph of the rate of runoff plotted against time for a point on a channel.

**Hydrologic cycle**: The sequence of conditions through which water passes from vapor in the atmosphere through precipitation upon land or water surfaces, and ultimately, back into the atmosphere as a result of evaporation and transpiration.

**Hydrologic floodplain:** The land adjacent to the baseflow channel residing below bankfull elevation.

**Hydrology**: Scientific study of water in nature-its properties, distribution, and behavior.

**Hydraulic**: Having to do with water in motion, as in the case of channel flow.

**Hydraulic gradient**: The slope of the hydraulic grade line. This is the slope of the water surface in an open channel, the slope of water surface of the groundwater table, or the slope of the water pressure for pipes under pressure.

## I, J, K, L

**Impoundment:** Body of water created by a dam.

**Indirect impacts**: A condition caused by an action through intermediary causal agents. An effect for which the causal linkages to the action are not readily apparent.

**Intermittent (stream):** A stream that flows part of the time, usually after rainstorm, during wet weather, or for only part of the year. Also referred to as an ephemeral stream.

**Invasive species:** Species that evolved elsewhere and have been purposely or accidentally relocated .

**Irretrievable**: Commitments that are lost for a period of time.

**Irreversible**: Commitments that cannot be reversed, except perhaps in the extreme long term.

**Irrigation releases:** Releases of water from the Rio Grande for the purposes of irrigation in accordance with pre-approved agreements, contracts, leases, or charters between the landowner and the USBR.

**Land retirement**: Removing land from irrigated production.

**Lease:** A continuance or opportunity for continuance.

**Levee**: A natural or manmade earthen barrier along the edge of a stream, lake, or river.

**Life cycle**: Various stages through which an animal passes through from egg fertilization to death.

## M

**Main channel**: The deepest or central part of the bed of a stream, containing the main current.

**Maintenance**: All routine and extraordinary work necessary to keep the facilities in good repair and reliable working order to fulfill the intended designed project purposes.

**"May affect, not likely to adversely affect:"** Means that all effects are beneficial, insignificant, or discountable.

**Meander:** A looplike, winding turn occurring in a river or stream that flows across nearly level terrain.

**Measure:** For this EIS, the term is used in place of environmental measure.

**Middle Rio Grande**: The Rio Grande between Cochiti Dam and Elephant Butte Dam in New Mexico (upstream of the RGCP).

**Mitigation**: Action taken to avoid, reduce the severity of, or eliminate an adverse impact.

**Modeling**: Use of mathematical equations to simulate and predict real events and processes.

**Monitoring**: Measuring concentrations of substances in environmental media or in human or other biological tissues.

## N, O

**National Environmental Policy Act (NEPA):** The federal law that requires Federal agencies to include in every recommendation or report on proposals for major Federal actions significantly affecting the quality of the human environment a detailed statement on the environmental impacts of the proposed action, any adverse environmental effects which cannot be avoided should the report be implemented, and alternatives to the proposed action (42 USC sec. 4321-4370e).

**Native:** Originating, grown, or produced in a particular region.

**The National Register of Historic Places:** A federally maintained register of districts, sites, buildings, structures, architecture, archeology , and culture.

**Neotropoical migrant landbirds**: Nest in the United States or Canada and spend the winter primarily south in Mexico, Central or South America, or in the Caribbean.

**No action alternative:** The expected future condition if no action is taken-..:not necessarily the same as the present condition. The effects of action alternatives are measured against this baseline condition.

**No effect**: Means there are absolutely no effects of the project, positive or negative.

## P

**Paleontology**: A science dealing with the life of past geological periods as known from fossil remains.

**Palustrine habitat:** Marsh habitat.

**Passerine:** Of or pertaining to an order of small or medium-sized songbirds having grasping feet with the first toe directed backward.

**Percolation:** The movement of water through openings in rock or soil.

**Phreatophyte:** A deep-rooted plant that obtains its water from the water table or the layer of soil just above it. Commonly used to refer to plants, such as saltcedar or Russian Olive, which consume much water.

**$PM_{10}$**: (Air) particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

**Primary (or main) irrigation season**: The 8-month irrigation season, generally from March through October, when water is released from Elephant Butte and Caballo Reservoirs.

**Public involvement:** Process of obtaining citizen input into each stage of development of planning documents. Required as a major input into any EIS.

## Q, R

**Qualitative:** Descriptive of kind, type, or direction, as opposed to size, magnitude, or degree.

**Quantitative:** Descriptive of size, magnitude, or degree.

**Reach**: Any specified length of a stream, river, channel, or other water conveyance.

**Recharge**: Water added to an aquifer. For instance, rainfall that seeps into the ground.

**Recovery:** Improvements in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act (50 CFR 402.02).

**Recruitment**: Survival of young plants and animals from birth to a life stage less vulnerable to environmental change.

**Reference community:** For this EIS, a desired future condition of vegetation communities that would be created as a result of implementing environmental measures.

**Reservoir**: Artificially impounded body of water; also, or an extra supply of anything.

**Restoration:** Repair or reconstruction of ecosystems damaged by human actions.

**Return flow**: The part of a diverted flow which is not consumptively used and which returns to a water body.

**Riparian:** Living on or adjacent to a water supply such as a riverbank, lake, or pond.

**Riparian area**: The land and vegetation along continuously or intermittently flowing rivers, streams and lake shores.

## S

**Secondary irrigation season**: The 4-month irrigation season, generally from November through February, when water is not released from Elephant Butte and Caballo Reservoirs.

**Scour:** Removing debris and sediments from a channel by the force of water.

**Sediment**: Unconsolidated solid material that comes from weathering of rock and is carried by, suspended in, or deposited by water or wind.

**Sediment load:** Mass of sediment passing through a stream cross section in a given period of time, expressed in millions of tons.

**Sensitive species**: Species not yet officially listed but undergoing status review for listing on the U.S. Fish and Wildlife Service's official threatened and endangered list; species whose populations are small and widely dispersed or restricted to a few localities; and species whose numbers are declining so rapidly that official listing may be necessary.

**Shavedown:** A reduction by mechanical or manual means in the height of a river bank to accommodate water direction and flow.

**Shrubs**: Plants with woody stems, generally less than 20 feet tall, such as willows.

**Siphon:** A piplike spillway for water conveyance.

**Slope**: Change in elevation per unit of horizontal distance

**Species:** Basic category of biological classification intended to designate a single kind of animal or plant.

**Species of concern:** Species for which further biological research and field study are needed to resolve their conservation status. Species of concern have no legal protection under the ESA but are often discussed for planning purposes.

**Snag:** A standing dead tree.

**Special status species:** For this EIS, those Fish and Wildlife Service Species of Concern that may occur within the study area.

**Stakeholder:** An individual or group or individuals who own property along the Rio Grande and who will be affected by the decisions made.

**Storage**: Water held in a reservoir for later use.

**Suspended solids**: Solids that either float on the surface or are suspended in water or other liquids, and that are largely removable by laboratory filtering.

## T

**Threatened species**: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. As a general rule, the term is used only when a species has been formally listed as threatened under the ESA. (Note: States also have endangered species laws and may or may not use the same terms and definitions as the federal ESA).

**Traditional cultural property:** A site or resource that is eligible for inclusion in the *National Register of Historic Places* because of its association with cultural practices or beliefs of a living community.

**Transpiration**: The process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, such as leaf pores.

**Transport capacity:** The capacity of a river to carry sediment in suspension or to move sediment along the riverbed. Usually expressed as mass per unit of time.

**Tributary:** River or stream flowing into a larger river or stream**.**

**Turbidity**: The amount of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Turbidity makes the water cloudy or even opaque in extreme cases.

## U, V, W, X, Y, Z

**Uplands:** Ground elevated above the lowlands along rivers or between hills.

**Velocity:** Rate of flow of water or water-sediment mixture; expressed in feet per second or miles per hour.

**Water allocation:** The amount of water allotted to the Irrigation Districts at the beginning og the irrigation season based on hydrologic parameters and legal agreements.

**Water banking**: A legal mechanism whereby an entity (farmer, company, or individual) who controls rights to water that will not be used can "deposit" those rights in return for compensation from the water bank, and another entity that needs water or additional water can use rights that have been "deposited" in return for compensation to the water bank. Water banking is, in essence, a way to transfer, for a defined period, the rights to water without multiple individual agreements between the various parties.

**Water consumption:** For this EIS, the amount of water designated for consumptive use.

**Water right:** Long-term entitlement to water use for a beneficial purpose. Water management in 13 western states, including New Mexico, falls under the doctrine of prior appropriation. Under this doctrine, the first person to divert water from a river acquires the most senior property right (“first in time, first in right”).

**Watershed:** The land that drains into a stream or a river.

**Water user**: Any individual, district, association, government agency, or other entity that uses water supplied from a Reclamation project.

**Weir:** A wall or obstruction used to control flow (from settling tanks and clarifiers) to ensure uniform flow rate and avoid short-circuiting.

**Wetlands**: Lands including swamps, marshes, bogs, and similar areas such as wet meadows, river overflows, mud flats, and natural ponds. Habitat provided by shallow or deep water (but less than 6-feet deep), with or without emergent and aquatic vegetation in wetlands.

**Wildlife Habitat Appraisal Procedure (WHAP):** Texas Parks and Wildlife Department’s method for evaluating wildlife habitat for particular tracts of land in Texas. This habitat appraisal assumes a positive relationship between vegetation diversity and wildlife species diversity.

**Xeric**: Referring to a habitat characterized by dry conditions.

## 6.2 REFERENCES

33 CFR 328. 33 Code of Federal Regulations, Part 32. Clean Water Act. Jurisdictional wetlands (waters of the United States).

40 CFR 15. 40 Code of Federal Regulations, Part 1500-1508. The Council on Environmental Quality, Executive Office of the President. Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

40 CFR 51. 40 Code of Federal Regulations, Part 51, subpart W. Final Conformity Rule, State Implementation Plan, January 31, 1994.

40 CFR 81. 40 Code of Federal Regulations, Part 81.332, Designation of Areas for Air Quality Planning Purposes, April 18, 2002. [*www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr81_00.html*]

40 CFR 93. 40 Code of Federal Regulations, Part 93, Subpart B: Determining Conformity of General Federal Actions to State or Federal Implementation Plans, May 2, 2002 [*www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr93_00.html*]

40 CFR 93. 40 Code of Federal Regulations, 93.153(b). *De minimis* threshold levels for individual nonattainment pollutants.

46 CFR 170. 46 Code of Federal Regulations, 44083-44094. USIBWC. Operational Procedures for Implementing Section 102 of the National Environmental Policy Act of 1969, Other Laws Pertaining to Specific Aspects of the Environment and Applicable Executive Orders, September 2, 1981.

Agee J. K., 1974. Prescribed fire effects on physical and hydrologic properties of mixed-conifer forest floor and soil. University California Water Resource Center. 143.

American Industrial Hygiene Association, 1986. Noise and Hearing Conservation Manual.

Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer, 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper 964, 28 p.

Army Environmental Policy Institute, 2002. Economic Impact Forecast System. Clark Atlanta University. [*http://205.129.162.28/eifs*]

Baker, W.W., 1943. Final Report on the Construction of the Canalization Feature of the Rio Grande Canalization Project. January 1943.

BHG, 2001. Middle Rio Grande Rehabilitation Concepts. Draft technical memorandum, Bosque Hydrology Group (USFES, USACE, USBR, Middle Rio Grande Conservancy District, University of New Mexico, and New Mexico Institute of Mining and Technology). [*http://bhg.fws.gov/ABQcf.htm*].

Bies, D.A. and B.H. Hanson, 1988. Engineering Noise Control: Theory and Practice. Unwin Hyman, London, pp. 36-37, 1988.

BLM 1994. Rangeland Reform Draft Environmental Impact Statement. Bureau of Land Management.

BLM 2000. New Mexico Standards for Public Land Health and Guidelines for Livestock Management. Bureau of Land Management.

Bock, C.E. and J. H. Bock, 1990. Effects of fire on wildlife in southwestern lowland habitats. Pp. 50-64 in: J.S. Krammes (tech. coord.), Effects of Fire Management in Southwestern Natural

Resources. U.S. Forest Service, General Technical Report RM-191, Fort Collins, Colorado.

Border Low Income Housing Coalition, 2001. Colonia Facts and Statistics. [www.bordercoalition.org]

Borell, A.E., 1971. Russian olive for wildlife and other conservation uses. *Leaflet 292*. U.S. Department of Agriculture, Washington, DC.

Briggs, M.K., 1995. Evaluating degraded riparian ecosystems to determine the potential effectiveness of revegetation. Proceedings: Wildland Shrub and Arid Land Restoration Symposium, 1993 October 19-21, Las Vegas, NV. General Technical Report INT-GTR-315: USDA, Forest Service, Intermountain Research Station.

Briggs, M.K., 1996. Riparian Ecosystem Recovery in Arid Lands: Strategies and References. University of Arizona Press. Tucson, Arizona.

Brown, D.E., 1982. Chihuahuan desert scrub. *Desert Plant* 4: 169-179.

Bulloch, H. E. Jr. and R. E. Neher. 1980. Soil Survey of Doña Ana County Area New Mexico. United States Department of Agriculture, Soil Conservation Service, Washington D.C.

Carmichael, D.L., 1994. Places of Power: Mescalero Apache Sacred Sites and Sensitive Areas. In Sacred Sites, Sacred Places, edited by D.L. Carmichael, J. Hubert, B. Reeves and A. Schanche, pp. 89-98. Routledge Press, New York.

CERL, 1978. *MicroBNOISE*, *A Users Manual*. Construction and Engineering Research Laboratory, United States Army., Technical Report N-86/12, June 1978.

CH2M-Hill, 2000a. Water Resources Technical Report, El Paso-Las Cruces Regional Sustainable Water Project (prepared for USIBWC and EPWU/PUB).

CH2M-Hill, 2000b. Human Resources Technical Report, El Paso-Las Cruces Regional Sustainable Water Project (prepared for USIBWC and EPWU/PUB).

CH2M-Hill and Geomarine, 2000a. Biological Resources Technical Report, El Paso-Las Cruces Regional Sustainable Water Project (prepared for USIBWC and EPWU/PUB).

CH2M-Hill and Geomarine, 2000b. Biological Assessment, El Paso-Las Cruces Regional Sustainable Water Project (prepared for USIBWC and EPWU/PUB).

Chaney, E., W. Elmore and W. S. Platts, 1990. Livestock Grazing On Western Riparian Areas; US Environmental Protection Agency and Northwest Resource Information Center.

City of Las Cruces 2003. A Rio Grande Renaissance: Our Rivers History, Culture and Diversity. City of Las Cruces Rio Grande Riparian Ecological Corridor Project: An EPA Sustainable Development Challenge Grant. Draft Report 4/18/03:

Council on Environmental Quality, 1997. Environmental Justice: Guidance Under the National Environmental Policy Act. Executive Office of the President, Washington D.C.

Cowardin, L. M., V. Carter, F.C. Golet and E.T. La Roe, 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS-79/31

Crawford C.S, L.M. Ellis, M.C. Molles. 1996 The Middle Rio Grande bosque: An endangered ecosystem. *New Mexico Journal of Science* 36:276-299.

Crawford, C.S., L.M. Ellis, M.C. Molles, Jr., and H.M. Valett, 1996. The potential for implementing partial restoration of the Middle Rio Grande Ecosystem. Pp. 93-99. USDA Forest Service, General Technical Report RM-GTR-272. Proceedings of the "Desires

Future Conditions for Southwestern Riparian Ecosystems: Bringing Interests and Concerns Together", Albuquerque, NM, September 18-22, 1995.

Crawford, C.S., L.M. Ellis, D. Shaw and N.E. Umbreit, 1999. Restoration and monitoring on the Middle Rio Grande Bosque: Current status of flood pulse related efforts. Pp. 158-163, USDA Forest Service Proceedings RMRS-P-7.

Cunniff, S.E., 1997. Testimony of Shannon E. Cunnif, Deputy Executive Director, Flood Plain Management Review Committee, to the U.S. House of Representatives Resources Committee, April 10, 1997.

Dall, D., C. Elliott, and D. Peters, 1997. A System for Mapping Riparian Areas in The Western United States. Colorado Division of Wildlife, 1997 [*http://ndis1.nrel.colostate.edu/riparian/riparian.htm*]

DeBano, L.F. and L.J. Schmidt, 1989. Interrelationship between watershed condition and health of riparian areas in southwestern United States. In: R.E. Gresswell, B.A. Barton, and J.L. Kershner (editors) Practical Approaches to Riparian Resource Management. U.S. Bureau of Land Management.

DiTomaso, J.M., 1998. Impact, biology, and ecology of salt cedar (*Tamarix* spp.) in the southwestern United States. *Weed Technology* 12: 326-336.

Dressen, D.R., G.A. Fenchel and J.G. Fraser, 1999. Establishment of Rio Grande cottonwood seedlings using micro-irrigation of xeric flood plain sites. USDA Forest Service Proceedings, RMRS-P-7, 1999.

EBID 1998. Elephant Butte Irrigation District: General Data and Information. October 15, 1998.

Ecosystem Management, 2001. Cultural Resource Class I Survey and Geoarchaeological Study, United States Section, International Boundary and Water Commission, Rio Grande Canalization Project. Ecosystem Management, Inc., March 2001.

Ellis, L.M. *1995* Bird use of salt cedar and cottonwood vegetation in the Middle Rio Grande Valley of New Mexico, U.S.A. *Journal of Arid Environments* 30:339-349.

El Paso Parks and Recreation, 2003. Rio Grande River Park Project. [*www.epcounty.com/parksandrec/riverpark/]*.

EPCWID#1 2000. Water Guide. El Paso County Water Improvement District No. 1.

Everitt, F.L, 1998. Chronology of the spread of Tamarix in the central Rio Grande. *Wetlands* 18:658-668.

Federal Interagency Stream Restoration Group 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. USEPA, USACE, FEMA, TVA, Department of Agriculture (ARS, CSREES, FS, NRCS), Department of Commerce (NOAA/NMFS), and Department of the Interior (BLM, USBR, FWS, NPS, USGS). October 1998.

Federal Register. 1982. Title 33: Navigation and Navigable Waters; Chapter II, Regulatory Programs of the Corps of Engineers. Vol. 47, No. 138, p 31810. Government Printing Office, Washington, DC.

Ferguson, D.J., 2001. *Phemeranthus* and *Talinum (Portulacaceae)* in New Mexico. *The New Mexico Botanist,* No. 20, December 10, 2001.

Fidell, S., T.J. Schultz, and D.M. Green, 1988. A Theoretical Interpretation of the Prevalence Rate of Noise-Induced Annoyance in Residential Populations. *Journal of the Acoustical Society of America*, 84(6).

Greater Las Cruces Chamber of Commerce, 2001. Governmental Institutions in Las Cruces & Doña Ana County. [*www.lascruces.org/html/site_contents.html*]

Gregory, S.V., F.J. Swanson, W.A. Mckee, K.W. Cummins, 1991. An ecosystem perspective on riparian zones. *BioScience* 41:540-551.

Hink V.C. and R.D. Ohmart, 1984. Middle Rio Grande Biological Survey. Report submitted to U.S. Army Corps of Engineers, Albuquerque, NM.

Hinson J.M. and W.M. Pulich, Jr., 1995. Development of coastal wetlands habitat data sets through integration of lands at thematic mapper and land use data. Pp. 303-314 In: Proceedings of third thematic conference on remote sensing for marine and coastal environments, Seattle, Washington, 18-20. September 1995.

Kauffman, J.B. and W.C. Krueger, 1984. Livestock impacts on riparian ecosystems and streamside management implications: A Review. *Journal of Range Management* 37: 430-437.

King, J.P. and J. Maitland, 2003. Water for River Restoration: Potential for Collaboration between Agricultural and Environmental Water Users in the Rio Grande Project. Report prepared for the Chihuahuan Desert Program, World Wildlife Fund. June 2003. [*http://cagesun.nmsu.edu/~jpking/wwf/reportdownload.htm*]

Krueper, D.J., 1996. Effects of livestock management on southwestern riparian ecosystems. In: Desired Future Conditions for Southwestern riparian Ecosystems: Bringing Interests and Concerns Together. U.S. Department of Agriculture, Forest Service, General Technical Report RM-GTM-272.

Larson, A. C., 2000. Migrant and Seasonal Farmworkers Enumeration Profiles Study: Texas. Larson Assistance Services, Vashon Island, WA. [*www.bphc.hrsa.gov/migrant/enumberation/final-tx.pdf]*

Means, R.S., 2002. Building Construction Cost Data, 54th Annual Edition, R.S. Means Company, Incorporated, Kingston, Massachusetts.

NAS 1977. National Academy of Sciences (NAS). 1977. Guidelines for Preparing Environmental Impact Statements on Noise. Report of Working Group on the Committee on Hearing, Bioacoustics, and Biomechanics, National Research Council. Washington, D.C.

New Mexico 2002a. New Mexico Administrative Code Title 20, Environmental Protection, Chapter 2, Air Quality (Statewide), Part 3, Ambient Air Quality Standards, April 29, 2002. [*www.nmenv.state.nm.us/NMED_regs/abq/20NMAC2_03.html*]

New Mexico 2002b. New Mexico Administrative Code Title 20, Environmental Protection, Chapter 2, Air Quality, Part 98, Conformity of General Federal Actions, April 29, 2002. [*www.nmenv.state.nm.us/NMED_regs/abq/20NMAC2_98.html*]

New Mexico Department of Labor, 2000. Economic Research and Analysis. Labor Information Series: Nonagricultural Wage and Salary Employment (Jobs). [*www3.state.nm.us/dol*]

New Mexico State Parks, 2003. Percha Dam State Park. [*www.nmparks.com*].

NRCS 2003. Natural resources Conservation Service. Climatological data for wetland determination: Doña Aña County and Sierra County, New Mexico [*ftp://ftp.wcc.nrcs.usda.gov/support/climate/wetlands/nm/).*

Ohmart, R.D. 1994. Biological Assessement of the U.S. International Boundary and Water Commission's Proposal Spoil Removal in the Rio Grande and Selected Arroyos in the Canalization Project Area. Center for Environmental Studies, Arizona State University, December 1994.

Parsons 2000a. Threatened and endangered species final report, USIBWC Rio Grande Canalization EIS, Parsons, April 2000.

Parsons 2000b: Ohio River Mainstream Ecosystem Restoration Project: Final Feasibility and Concept Reports. Prepared for USACE, Louisville District, St. Louis. Parsons, April 2000.

Parsons 2001a. Alternatives Formulation Report, Rio Grande Canalization Project. Parsons, March 2001.

Parsons 2001b. Technical Report, HEP and WHAP Surveys for Evaluation of Aquatic and Wildlife Habitat, Rio Grande Canalization Project. Parsons, June 2001.

Parsons 2001c. Final Threatened and Endangered Species Survey Technical Report, Rio Grande Canalization Project. Parsons, February 2001.

Parsons 2001d. Biological Assessement, USIBWC Projects: American Dam to Fort Quitman. Parsons, February 2001.

Parsons 2003a. Reformulation of Alternatives Report, Rio Grande Canalization Project. Parsons, August 2003.

Parsons 2003b. Draft Biological Assessement, River Management Alternatives for the Rio Grande Canalization Project. Parsons, December 2003.

Plant Conservation Alliance, 1997. Russian olive (*Elaeagnus angustifolia* L.). Plant Conservation Alliance, Alien Plant Working Group. [*www.nps.gov/plants/alien/fact/elan1.htm*]

Platts, W. S., 1989. Compatibility of livestock grazing strategies with fisheries. In: Practical approaches to riparian resource management: an educational workshop; Billings, MT Billings, MT: U.S. Department of the Interior, Bureau of Land Management: 103-110.

Rae, S.R., J.E. King, and D.R. Abbe, 1987. New Mexico Hitoric bridge Survey. New mexico State Highway and Transportation Department and the Federal Highway Administration – Region 6. Santa Fe.

Rasmussen, J.L., 1999a. Ecosystem Restoration. U.S. Fish and Wildlife Service. 1999. [*www.aux.cerc.cr.usgs.gov/MICRA/Ecosystem%20Restoration%20(2).pdf*]

Rasmussen, J.L., 1999b. Levees and Floodplain Management. U.S. Fish and Wildlife Service. 1999. [*www.aux.cerc.cr.usgs.gov/MICRA/Levees%20and%20Floodplains.htm*]

Rasmussen, J, L., 2000. Riverine Habitat and Floodplain Restoration Concepts for the Missouri River. U.S. Fish & Wildlife, Large Rivers Coordination Office Report prepared for the Missouri River Basin Association.

Schillinger, W.F. and F.L. Young, 1999. Soil water use and growth of Russian thistle after wheat harvest. TEKTRAN, U.S. Department of Agriculture, Agricultural Research Service, Pullman, Washington. [*www.nal.usda.gov/ttic/tektran/data/000010/06/0000100614.html*]

Schmidly, D.J. and R.B. Ditton, 1978. Relating human activities and biological resources in riparian habitats of western Texas. U.S. Department of Agriculture, Forest Service. General Technical Report WO-12.

Schurtz, C., 2002. Wetlands project gets city OK. *Las Cruces Sun News*, March 20, 2002.

Scurlock, D., 1998. From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin. U.S. Department of Agriculture, Forest Service. General Technical Report RMRS-GTR-5. Fort Collins, Colorado.

Smith, S.D., D.A. Devitt, A. Sala, J.R. Cleverly, and D.E. Busch, 1998. Water relations of riparian plants from warm desert regions. *Wetlands* 18: 687-696.

South Dakota Partners for Fish and Wildlife 2001. Tallgrass Prairie Restoration Project. [*http://partners.fws.gov/pdfs/SD-needs.pdf*]

Southwest Environmental Center 2002. Saltcedar Removal Plan, Picacho Wetlands Pilot Project. April 2002.

State of New Mexico, 2003. Leasburg Dam State Park. [*www.emnrd.state.nm.us/nmparks/PAGES/PARKS/LEASBURG/LEASBURG.HTM*].

Stotz, N.G., 2000. *Historic Reconstruction of the Ecology of the Rio Grande/Rio Bravo Channel and Flood plain in the Chihuahuan Desert.* Prepared for the Chihuahuan Desert Program, World Wildlife Fund.

Stromberg, J.C. and D.T. Patton, 1991. *Instream flow requirements for cottonwoods at Bishop Creek, Inyo County, California*. Rivers 2:1-11.

Sublette, J.E. and M.D. Hatch, 1990. *The Fishes of New Mexico*. Albuquerque, NM, University of New Mexico Press.

TCEQ 1999. Water Quality Monitoring Procedures Manual. Water Quality Division, Texas Natural Resources Conservation Commission, GI-252, June 1999.

Taylor, J.P. and K.C. McDaniel 1997. Restoration of Saltcedar Infested Flood Planis on the Bosque del Apache National Wildlife Refuge. New Mexico State University, Department of Animal and Range Science.

Texas Department of Human Resources, 1988. Colonias Factbook Summary: A Survey of Living Conditions in Rural Areas of South West Texas Border Counties. [*http://chud.tamu.edu/colonias/factbook.html*]

Texas State Data Center, 2001. Projections of the Population of Texas and Counties in Texas by Age, Sex and Race/Ethnicity for 2000-2040. Population Estimates and Projections Program, Texas A&M University System.

TPWD 1995. Wildlife Habitat Appraisal Procedure. Texas Park and Wildlife Department.

University of New Mexico, 1997. Bureau of Business and Economic Research. New Mexico Population Projections by the Bureau of Business and Economic Research. [*www.unm.edu/~bber/demo/poproj*]

U.S. Department of Commerce, 1999. BEARFACTS. Bureau of Economic Analysis, Regional Economic Information System. [*www.bea.doc.gov/bea/regional/bearfacts/*]

U.S. Department of Labor, 2000. Bureau of Labor Statistics. State and County Employment and Wages. [*http://stats.bls.gov/cew/home.htm*]

U.S. Department of Transportation, 1980. United States Department of Transportation, Guidelines for Considering Noise in Land Use Planning and Control, Federal Interagency Committee on Urban Noise.

U.S. Department of Transportation, 1992. Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations. United States Department of Transportation.

USACE 1987. Wetlands Delineation Manual. United States Army Corps of Engineers.

USACE 1996. Rio Grande Canalization Improvement Project. Prepared for the U.S. Section, International Boundary and Water Commission, U.S. and Mexico. U.S. Army Corps of Engineers, Albuquerque District.

USACE 2003 U.S. Army Corps of Engineers' Middle Rio Grande Bosque Restoration Project, Middle Rio Grande Bosque Restoration Supplemental Planning Document

USBR 2000. Draft Environmental Impact Statement: Rio Grande and Low Conveyance Channel Modifications, Socorro and Sierra Counties, New Mexico. U.S. Bureau of Reclamation, Upper Colorado Region, Albuquerque Office.

USBR 2002. Rio Grande Project, New Mexico and Texas. U.S. Bureau of Reclamation, Upper Colorado Region, Albuquerque Office. [*http://dataweb.usbr.gov/html/riogrande.html*]

USBR 2003. Reclamation Annonunces the End of the 2003 Irrigation Season for the Rio Grande Project. News Release, U.S. Bureau of Reclamation, Upper Colorado Region, Albuquerque Office. [*www.usbr.gov/uc/albuq/news/nr/irrigation_2003.htm*]

USCB 1998. USA Counties Data. United States Census Bureau. [*http://tier2.census.gov/usac/index.html*]

USCB 2000. Census 2000: State and County QuickFact. United States Census Bureau. [*http://quickfacts.census.gov/qfd/index.html*]

USCB 2002. United States Census Bureau, State and County Quick Facts, El Paso County, Texas, April 24, 2002. [*http://quickfacts.census.gov/qfd/states/48/48141.html*]

USCB 2002a. United States Census Bureau, State and County Quick Facts, Doña Ana County, New Mexico, April 24, 2002. [*http://quickfacts.census.gov/qfd/states/35/35013.html*]

USDA 1980. Soil Survey of Sierra County Area, New Mexico. National Resource Conservation Service.

USEPA 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. NTID 300.1, December.

USEPA 1985. Compilation of Air Pollutant Factors, Volume 2: Mobile Sources (AP-42), 4th edition, Ann Arbor, September 1985.

USEPA 1988. Gap Filling $PM_{10}$ Emission Factors for Selected Open Area Dust Sources. USEPA-450/4-88-003. Research Triangle Park, February 1988.

USEPA 1994. Background for NEPA Reviews: Grazing on Federal Lands, EPA-300-B94-004, February 1994.

USEPA 1996. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources (AP-42). 5th edition with Supplements, USEPA, Research Triangle Park, February 1996.

USEPA 1998. Prevention, Pesticides And Toxic Substances, (7508C). United States Environmental Protection Agency. EPA 738-R-98-011, October. 1998.

USEPA 2001. El Paso Texas: An American Heritage River (AHR) Initiative Success Story. Rio Grande AHR, State of the River 2001. [*www.epa.gov/rivers/sor/sorriogrande.pdf*]

USEPA 2003. Point source emissions inventory data. Office of Air Quality Planning and Standards, AirData web site as updated June 4, 2003. [*www.epa.gov.air/data/geosel.htm*]

USFWS 2000a. Annual Report, Summary of Mitigation Monitoring Studies within the Rio Grande Canalization Project (September 1998 – September 1999). J. Jackson and J. Smith, U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, June 2000.

USFWS 2000b. Fish and Wildlife Coordination Act Report for the El Paso-Las Cruces Regional Sustainable Water Project. U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, September 2000

USIBWC 1975. Final Environmental Statement – Improvements Needed for Rio Grande Canalization Project, New Mexico and Texas. United States Section, International Boundary and Water Commission, August 1975.

USIBWC 1977. Preliminary Draft Environmental Statement. Annual Operation and Maintenance of Rio Grande Canalization Project and American Dam and Canal Project, New Mexico and Texas.

USIBWC 1985. Final Environmental Assessment – Revised Improvements Needed for the Rio Grande Canalization Project, El Paso County, Texas. United States Section, International Boundary and Water Commission, October 1985.

USIBWC 1994. Rio Grande Management Plan. United States Section, International Boundary and Water Commission, July 1994.

USIBWC 2000. Index of Agricultural and Grazing Leases in the Canalization Project. International Boundary and Water Commission, E.J. Smith letter to Parsons dated July 20, 2000.

USIBWC 2001. Rio Grande Canalization Project River Management Plan. United States Section, International Boundary and Water Commission, July 2001.

USIBWC 2002. National Environmental Policy Act (NEPA) Procedures for USIBWC Real Property Actions and Management of Environmental Impacts. United States Section Directive, United States Section, International Boundary and Water Commission., Vol. III, Chapter 501. March 13, 2002.

USIBWC & EPWU/PSB 2000. Final Environmental Impact Statement, El Paso-Las Cruces Regional Sustainable Water Project. United States Section, International Boundary and Water Commission and El Paso Water Utilities/Public Service Board, December 2000.

Vines, R.A., 1960. Trees, Shrubs and Woody Vines of the Southwest. University of Texas Press, Austin, Texas.

Vitousek, P.M., 1990. Biological invasions and ecosystem processes: towards an integration of population biology and ecosystems studies. *Oikos* 57:7-13.

Watts, S.H., 1998. 1998 Survey of Riparian Habitats along the Rio Grande. University of Texas at El Paso Project Number: NR98-4

Weeks, E. P., H. L. Weaver, G. S. Campbell, and B. D. Tanner, 1987. Water Use by Salt Cedar and by Replacement Vegetation in the Pecos River Flood plain Between Acme and Artesia, New Mexico. U.S. Geol. Survey, Prof. Paper 491-G.

Wilson, C.W., 2001: A Short Course on Irrigation Efficiency. *Water Line*, *Fall 2001*. New Mexico Office of the State Engineer,.

Winter C.L., D.M. Fort, C. Keyes, Jr., D. Kreiner, D. Cooper, and R. Greene. (not dated). Water Resources of the Upper Rio Grande Basin: History, Hydrology and Management. Los Alamos National Laboratory, Department of Energy. [*www.lanl.gov/chinawater/documents/wrriogrande.pdf*]

Wozniak F. E., 1995. Human impacts on riparian ecosystems of the Middle Rio Grande Valley during historic times. Pp 33-43 in Shaw DW and Finch DM (technical coordinators), Desired Future Conditions for the Southwestern Riparian Ecosystems: Bringing Interests and Concerns Together. USDA Forest Service General Technical Report RM-GRT-22, Fort Collins, CO.

# APPENDIX A
# RIVER MANAGEMENT UNIT DESCRIPTION

The Rio Grande Canalization Project was divided into seven distinct geographic reaches identified as river management units (RMUs). A summary of each RMU is presented below.

***Upper Rincon RMU***

*Description*- The RMU is a 16.5-mile stretch of river located south of Percha Dam. This is the least populated segment of the river, with large tracts of ROW lands and adjacent BLM lands on the east and west sides of the river. Includes more than 2,830 acres inside the right of way (ROW).

*Structures* - There are no constructed levees north of the Doña Ana County line. A 7-mile long levee on the east side extends from Doña Ana County line south to the end of the RMU boundary. Armored (rip-rap) is present to varying degrees along the channel. Eight aquatic in-stream mitigation sites are present. Structures include the Arrey and Garfield bridges.

*Land Use* - The Upper Rincon above Doña Ana County line is currently managed by USIBWC as a no-mow zone. The RMU is bounded on the east and west sides by agricultural lands within upper portion. On the leveed portion (lower 9.5 mile area) the east side levee separates contiguous agricultural lands with the west side dominated extensively by BLM tracts. USIBWC uplands right of way is leased for grazing.

*Hydrology* -The highest flow rates of the Canalization Project are found below Percha Dam during water delivery periods. The RMU contains 7 tributaries; Trujillo Arroyo, Montoya Arroyo, Tierra Blanca Arroyo, Sibley Arroyo, Green Arroyo, Berrenda Creek, Jaralosa Arroyo, Cuervo Arroyo, and McLeod Draw.

*Erosion and Sedimentation* - Sedimentation occurs at the mouths of the arroyos. This tends to divert the river flow against the opposite bank, which is subject to erosion if not armored. Erosion may also occur on the same bank but downstream from the arroyo as the flow deflects back across the river.

*Vegetation* - Remnant riparian vegetation exists in pockets adjacent to arroyo confluence concentrated in the northern end of the RMU adjacent to Percha Dam State Park. Fringes of vegetation are established in many mowed areas providing bank stabilization.

*Channel Processes* - The riverbanks are generally elevated above the water surface by 5 to 10 feet. Significant sedimentation occurs in this reach due to contributions from large arroyo watersheds. This material has been periodically removed for water conveyance purposes. Sediment disposal outside of the ROW has historically been an issue due to the lack of available space.

*Corridor and ROW Dimension* - The width of the USIBWC ROW varies from 250 feet to about 1,250 feet until Jaralosa Arroyo where extensive uplands are included within the ROW. A second large upland tract is located within the Crow Canyon arroyo on the west side of the river.

*Potential* - The RMU includes old meanders within the ROW, which were cut off by canalization during construction. The large amount of area contained within the ROW's large floodway, while numerous arroyos provide potential for numerous site-specific restoration measures. Seasonal peak flows have a potential to inundate over 200 acres of floodway.

***Lower Rincon RMU***

*Description* – The RMU is a 18-mile stretch dominated by agricultural (primarily row crops) on either side of the river. The RMU is considered marginal for restoration due to potential levee deficiencies, water delivery structures and extensive amount of private lands. The RMU Includes more than 598 acres of potential enhancement sites inside the ROW and 256 acres outside the ROW.

*Structures* – Rincon Siphon, Hatch Siphon, and 31 miles of levees characterize the RMU. Five mitigation sites are present in the RMU. The RMU includes Salem, Hatch (US85 and NM26), Atchison, Topeka and Santa Fe Railroad, Hatch-Rincon (NM140 and HWY 154), and new Rincon Bridge.

*Land Use* – The entire RMU is mowed. Agriculture dominates the landscape with a few areas changing into the BLM tracts. Narrow bands of agriculture separate BLM tracks from the ROW along the unleveed lower west side. Angostura Arroyo provides some connectivity between uplands, arroyo habitat and the river corridor.

*Hydrology* – The RMU contains seven contributing arroyos: Placitas Arroyo. Spring Canyon, Ralph Arroyo, Rincon Arroyo, Angostura Arroyo, Reed Arroyo and Bignell Arroyo. Extensive flooding of agriculture lands is possible along the southerly unleveed west bank, unleveed west bank north of Rincon bridge, and in the east side of Garfield Drain.

*Erosion and Sedimentation* – The arroyos contribute extensive amounts of sediment into the river. Integrity of the siphons due to erosion is a major concern.

*Vegetation* - Remnant riparian vegetation exists on private lands adjacent to the ROW. The majority of the ROW is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee. A diversity of vegetation can be found along the Angostura Arroyo, Reed Arroyo and Bignell Arroyo.

*Channel Processes* – There appears to be little modification in channel sinuosity since project construction. No bends or meanders appear to have been straightened during construction.

*Corridor Dimension* – The width of the ROW varies from about 300 feet to 800 feet. The ROW becomes significantly wider at the confluence of the Angostura Arroyo and extends from the corridor at Reed Arroyo and Bignell Arroyo.

*Potential* - The Lower Rincon has riparian and aquatic enhancement opportunities for improving the riparian corridor between the Upper Rincon and Seldon Canyon and connecting upland habitat with the riparian corridor. Seasonal peak flows potential to inundate over 300 acres of floodway.

***Seldon Canyon RMU***

*Description* - The Seldon Canyon RMU is a 9-mile section bounded by Seldon Canyon ending at Leasburg Dam State Park The RMU is currently managed as a no-mow zone. The RMU is adjacent to southwestern willow flycatcher habitat on private property. The very limited ROW restricts options outside of the channel proper, and as a result, restoration options although listed as a potential goal are largely limited.

*Structures* – Tonuco bridge is the only listed structure.

*Land Use* – Extensive undeveloped lands (BLM, New Mexico State University and private) buttress the river corridor. Considerable topographic relief has restricted agriculture conversion of the area. The RMU is managed as a no-mow zone.

*Hydrology* – The RMU contains 3 major arroyos, Broad Canyon, Foster Canyon and Faulkner Canyon.

*Erosion and Sedimentation* – Sedimentation at Leasburg Dam has widened the river and created extensive islands even at high flows. The process of sediment accumulation followed by vegetation of islands is readily apparent north and west of Leasburg Dam.

*Vegetation* - Extensive and mature salt cedar woodlands are found along the Broad Canyon confluence with the river. The majority of non-uplands property is privately held.

*Channel Processes* - Increasing elevation changes through the canyon result in high flow rates. Increased flows in conjunction with channel blockage can present potential flood management problems north of the canyon.

*Corridor Dimension* – The river corridor ranges between 300 feet and 1500 feet in width. The riparian zone is clearly visible in aerial photographs by the sharp contrast between salt cedar dominated communities and upland shrub scrub areas.

*Potential* - The USIBWC has a limited ROW within the canyon; extensive private lands are adjacent to the river. There is possible habitat for southwestern willow flycatcher located adjacent to the floodway.

***Upper Mesilla RMU***

*Description* - The Upper Mesilla RMU is a 12-mile stretch extending from Leasburg Dam State Park to the outskirts of Las Cruces at Shalem Colony Bridge. Levees on the east side and extensive BLM holdings on the west define the RMU. Sites include a total of 214 acres within the ROW and 56 acres of potential acquisitions.

*Structures* – The east side of the river has over 9-miles of maintained levees. Structures include Leasburg Bridge.

*Land Use* – The entire east side of the river is in agriculture. Extensive pecan orchards dominate the agricultural areas.

*Hydrology* – Other than upstream water flows, the RMU is influenced by Apache Canyon and two spillways (identified as WW 2 and WW 2A).

*Erosion and Sedimentation* – Water velocities are less than in the northern RMU, having been reduced through attenuation and water diversions at Leasburg Dam. The RMU begins a significant departure from previous RMUs which contain numerous arroyos contributing sediment.

*Vegetation* - The majority of the east ROW is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee. Vegetation on the west side ROW has been grazed and appears to be partially mowed along the level flood plain. Several large dense salt cedar bosques are found on the west side with mature and declining cottonwoods found within the bosques. There is little indication of cottonwood re-growth. Pole plantings have been attempted on the east side near spillway WW 2A and across the river from a channel cut site.

*Channel Processes* - The major modification of channel sinuosity is a 0.8 mile meander straightened during project construction.

*Corridor Dimension* - The river corridor ranges between 800 feet and 1500 feet in width.

*Potential* – The most significant attribute of the RMU is the uninterrupted connectivity between BLM lands and the west side of the river corridor. In addition, hydraulic analyses (HEC-RAS modeling) showed no potential deficiencies in the east side levees. This provides restoration opportunities for a previous channel cut (0.8 miles in length) on the west side. In addition, modifying grazing practices along with salt cedar control on the west side could improve wildlife habitat and terrestrial/riverine ecotone. Interagency agreements concerning grazing along the west side would be required. West side ROW provides a unique opportunity to improve the river corridor and uplands connectivity by altering to a large extent grazing and mowing. The west side of the river contains several remnant bosques, mostly dominated by salt cedar but with occasional mature cottonwoods and cottonwood snags.

### *Las Cruces RMU*

*Description*- Urbanization and heightened need for flood control are the major issues. The RMU begins at Shalem Colony Bridge and extends south for 15 miles to Mesilla Dam. The Las Cruces RMU includes both developed and agricultural lands.

*Structures* – Over 18 miles of levees bound the east and west sides of the river. Bridges include Shalem, Picacho (U.S. 70, 80 and 180), and IH 10.

*Land Use* – Land use is composed of an urbanized/agricultural matrix. The levees are used as recreational areas (e.g. access and parking for fishing jogging, nature walks, etc). The upper 5 miles of the RMU are managed as a no-mow zone.

*Hydrology* – Box Canyon is the primary arroyo entering the river. Spillways WW 4, WW 6 and WW 10 provide some opportunities for enhancement.

*Vegetation* – The majority of the ROW is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee.

*Channel Processes* – A 0.6-mile meander was straightened on the east side north of WW 39.

*Corridor Dimension* - The river corridor ranges between 700 feet and 1100 feet in width.

*Potential* - Las Cruces RMU provides significant opportunities for managing in a multiple-use manner. Despite urbanization constraints, considerable improvements in the form of recreation areas and selective habitat are possible. Local agency cooperation is required to fully realize potential. Emphasis is on enhancing and creating habitat associated with spillways and connecting sites within the current no-mow zone. Further mowing reduction and green zone management should include salt cedar control.

### *Lower Mesilla RMU*

*Description* – The Lower Mesilla Valley begins at Mesilla Dam and extends south 19 miles to New Anthony Road. The Lower Mesilla RMU is dominated by agriculture on both sides of the river. The northern portion of the RMU is characterized by extensive pecan orchards and the southern portions are primarily cropped.

*Structures* – Levees bound both sides of the RMU with the exception of a 2-mile stretch located on the west side of the river, north of Mesilla Dam. Bridges include Mesilla, Santo Tomas (NM 28), Mesquite (NM 228), Vado, Berino and Old Anthony Bridge.

*Land Use* – Evidence of overgrazing was observed in several locations within the floodway. A golf course (Anthony Country Club) is located in the floodway. Mowing occurs up to the river bank in several locations.

*Hydrology* – Several spillways feed into the river (WW 104 through WW 115). The water level during irrigation flow is at times less than 1 foot below the incised bank. This is in contrast to water levels in many parts of the northern project area where water levels were observed to be several feet below the bank even at high flows.

*Vegetation* - The majority of the ROW is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee.

*Channel Processes* - Seven old channels cut off by the canalization are located mostly outside the ROW.

*Corridor Dimension* – The corridor is virtually uniform in width, averaging 650 feet. There is remarkably little variability throughout the RMU in overall dimensions.

*Potential* - With the exception of a NMGF site, opportunities are restricted. Due to private landowner involvement and adjacent state property, the NMGF site presents an opportunity for restoration of bosque and wetlands.

***El Paso RMU***

*Description* – The RMU begins at New Anthony Road and extends south 20 miles to American Dam. Urbanization and flood control problems are the major issue.

*Structures* – Levees bound both sides of the river with the exception of a 4.5 mile length on the west side of the river beginning at Anapra Bridge progressing northward. Flood protection is afforded by natural relief along this section.

*Land Use* – Land use is primarily urbanized with a mix of agricultural in the northern section of the RMU. As in the Las Cruces RMU, many of the areas are used as recreational areas. Several bridges in the RMU include, New Anthony, Vinton, Canutillo, Borderland, Artcraft, County Club, Anapra, and Brick Plant.

*Hydrology* – Several spillways (WW 116 through WW 128) provide some opportunities for enhancement.

*Vegetation* - The majority of the ROW is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee

*Channel Processes* - Some of the most extensive changes to the river have occurred in the El Paso area. The Vinton cutoff, completed several decades before the Canalization Project, significantly straightened the river. The old meander, approximately 3.5 miles in length, is mostly situated on Public Utilities Board land.

*Corridor Dimension* – The channel is similar in dimension to that of the Lower Mesilla Valley rarely exceeding 800 feet in width.

*Potential* - El Paso provides significant opportunities for multiple management. Overriding flood control concerns limit actions which could aggravate flooding. Urbanization adjacent to levees reduce future flood control options to raising levees rather than using levee setbacks. Despite urbanization constraints, considerable improvements in the form of recreation areas are possible. Local agency cooperation is required to fully realize potential. Selective mowing over the years has allowed limited natural regeneration of cottonwood stands.

# APPENDIX B
# FLOOD CONTROL IMPROVEMENT PROJECT SUMMARY (USACE 1996)

# RIO GRANDE CANALIZATION IMPROVEMENT PROJECT

PERCHA DIVERSION DAM, NEW MEXICO, TO AMERICAN DIVERSION DAM, TEXAS

# EXECUTIVE SUMMARY

VOLUME 1

JULY 1996

PREPARED FOR:

INTERNATIONAL BOUNDARY AND WATER COMMISSION

UNITED STATES AND MEXICO

UNITED STATES SECTION

PREPARED BY:


US Army Corps
Of Engineers
Albuquerque District

&

Resource Technology, Inc.

CIVIL • ENVIRONMENTAL • WATER RESOURCES • RECREATION • PLANNIN
ENGINEERS AND ENVIRONMENTAL SCIENTISTS
2129 Osuna NE, Suite 200, Albuquerque, NM 87103

RIO GRANDE CANALIZATION IMPROVEMENT PROJECT
PERCHA DIVERSION DAM, NEW MEXICO, TO AMERICAN DIVERSION DAM, TEXAS

# EXECUTIVE SUMMARY

VOLUME 1

JULY 1996

## PREFACE

This volume is part of a multi-volume set prepared for the United States Section of the International Boundary and Water Commission (USIBWC). All documents in the set are listed below.

| | | |
|---|---|---|
| **Volume 1** | | - Executive Summary |
| **Volume 2** | | - Hydrology and Hydraulic Analyses |
| | Appendix A | - Alignment Plan and Cross-Section Locations |
| | Appendix B | - Fixed-Bed Water Surface Profiles |
| | Appendix C | - Fixed-Bed Cross Sections |
| **Volume 3** | | - Sedimentation Analysis of the Rio Grande Tributary Basins |
| | Appendices A- J | |
| **Volume 4** | | - Scour and Deposition Analysis of the Rio Grande |
| | Appendices A - I | (Volume A4.1 of 2) |
| | Appendices J - N | (Volume A4.2 of 2) |

The hydrologic analysis summarized in Volume 2 presents the 100-year flood discharges at selected locations along the Rio Grande computed using standard hydrologic procedures and the U.S. Army Corps of Engineers computer program HEC-1. The hydraulic analysis presented in Volume 2 identifies locations at which the 100-year flood encroaches upon the levee freeboard or overtops the levee and locations at which Caballo Dam low-flow releases overtop the existing low-flow pilot channel. Discharges used in the hydraulic analysis of the low-flow channel were approved by the USIBWC and establish conditions as they exist for standard operation of the Rio Grande below Caballo Dam. The U.S. Army Corps of Engineers computer program HEC-2 computed the water surface profiles. Geometry for the HEC-2 modeling was obtained using digital terrain models with Intergraph's *InRoads* (version 5.1) computer software running in the *Microstation* (version 5.0) environment.

The profiles displayed in Volume 2, Appendix B, show the invert of the Rio Grande, the low-flow water surface elevation, the 100-year water surface elevation, the right-bank elevation, the left-bank elevation, and the existing right and left top-of-levee elevations. The right- and left-bank profiles show limits of the existing low-flow channel.

The cross sections and invert and bank profiles presented in Volume 2, Appendices B and C, show conditions as they existed when the aerial photography was produced (November 1993). No effects of future sediment aggradation or degradation were included in the cross-sectional and profile data.

The U.S. Army Corps of Engineers, Albuquerque District, Hydrology and Hydraulics Section, performed the hydrology and hydraulic analyses for this study. The Albuquerque District produced the plates showing the alignment plan and cross-section locations, the fixed-bed water surface profiles, and the fixed-bed cross sections. Resource Technology, Inc., performed the sedimentation analysis for the tributary arroyos and the main stem of the Rio Grande under contract to the Albuquerque District.

Appendices A, B, and C should be used with this volume to gain a full visual representation of fixed-bed conditions along the Rio Grande.

## TABLE OF CONTENTS

**INTERNATIONAL BOUNDARY AND WATER COMMISSION**
**UNITED STATES SECTION**
**RIO GRANDE CANALIZATION IMPROVEMENT PROJECT**
**PERCHA DIVERSION DAM, NEW MEXICO, TO AMERICAN DIVERSION DAM, TEXAS**

# EXECUTIVE SUMMARY

## INTRODUCTION

The U.S. Army Corps of Engineers, Albuquerque District, evaluated approximately 100 miles of the Rio Grande floodway between Percha Diversion Dam in New Mexico and the American Diversion Dam in El Paso, Texas, to determine the Rio Grande channel capacity and the cause of channel scouring. Channel capacity and scour information is necessary for the United States Section of the International Boundary and Water Commission (USIBWC) to provide adequate flood control protection and channel stabilization in the study reach. The Albuquerque District conducted the study under contract to the USIBWC on a cost-recovery basis under authority of Section 321 of the Water Resources Development Act of 1990.

The USIBWC constructed and maintains the Rio Grande levee system between Percha Diversion Dam and American Diversion Dam as part of the Rio Grande Canalization Project. The levees are generally continuous, except where the river runs against the base of rising ground or bluffs. A sizable unleveed section exists near Canutillo, Texas, where the Atchison, Topeka, and Santa Fe Railroad embankment serves as the east river levee. The low-flow pilot channel within the floodway carries the normal irrigation releases from Caballo Dam.

## HYDROLOGIC ANALYSIS

The hydrologic analysis, presented in Volume 2, involves only the watershed area that contributes directly to the Rio Grande. The flat river-bottom land between the bluffs and the Rio Grande provides a large amount of valley storage where arroyo flood peaks dissipate before flowing to the river via irrigation ditches in the Canalization Project levees. The hydrologic analysis provides the 100-year peak discharges for selected stations on the Rio Grande between Percha Diversion Dam and American Diversion Dam. The Albuquerque District assumed that the existing levees contain the flood flows without overtopping for the entire study reach. Table 1-17 in Volume 2 lists the 100-year flood peak discharges at selected locations on the Rio Grande.

The irrigation canals drain into the Rio Grande by gravity through ungated openings (wasteways) in the levee. Many of the wasteways have closure devices; however, thirty-two in the study reach do not. A majority of these large wasteway openings, with mild invert slopes, would allow Rio Grande flood waters to flow backward through the levee openings and cause localized or generalized flooding behind the levee. Irrigation returns are minimal compared to the 100-year flow in the Rio Grande; therefore, the wasteways have ample capacity to store non-conveying flow. The wasteway diversion and storage of these flood waters in the irrigation canals cause a significant attenuation of the flood peaks on the Rio Grande; consequently, the Albuquerque District modeled the ungated wasteways within the study reach to determine their effect. Table 1-17 in Volume 2 identifies the wasteways where the Rio Grande discharges are reduced to reflect flow diversion and storage in the wasteways.

Computed flood discharges, based on or supported by frequency-discharge relationships developed from local stream gage records, constitute a desirable situation in any hydrologic analysis. The Albuquerque District recommends that the concerned agencies begin recording instantaneous annual peak discharges, as well as mean daily discharges, at the existing stream gages on the Rio Grande. Furthermore, support of cooperative stream gaging programs on the tributary arroyos will provide additional information to further the understanding and interpretation of hydrologic conditions in the watershed.

**HYDRAULIC ANALYSIS**

The hydraulic analysis presented in Volume 2 details the hydraulic evaluation of approximately 100 miles of the Rio Grande floodway between Percha Diversion Dam in New Mexico and the American Diversion Dam in El Paso, Texas. These analyses include: (1) identification of the areas which do not adequately convey the maximum annual irrigation releases from Caballo Dam within the channel banks (low flow) of the Rio Grande; (2) identification of the levee areas where the 100-year computed water surface elevation encroaches upon the freeboard or overtops the levee; and (3) analysis of all ungated wasteways to determine if backwater effects of the Rio Grande, during the 100-year flood, exceed the wasteway bank elevations. General recommendations are provided for containment of the 100-year flood within the levees and in the Canutillo, Texas, area where the Atchison, Topeka, and Santa Fe Railroad embankment forms the east river levee.

The results of the HEC-2 analyses for both the low-flow condition and the 100-year flood condition are listed in Tables 2-3, 2-4, and 2-5 in Volume 2. Table 2-3 lists the centerline station, the HEC-2 section number, the low-flow discharge, the computed water surface elevation, and the left and right low-flow channel bank elevations. Table 2-3 also identifies the cross sections where the computed water surface elevation overtops the bank elevation. Table 2-4 summarizes Table 2-3. Table 2-5 lists the centerline station, the HEC-2 section number, the 100-year discharge, the computed water surface elevation, and the left and right top-of-levee elevations. Table 2-5 also identifies the cross sections where the computed water surface elevation encroaches upon the levee freeboard or overtops the levee. A separate HEC-2 model was created for each ungated wasteway to determine if the backwater effects of the 100-year flood would exceed the wasteway embankments. Table 2-6 in Volume 2 lists the results of the wasteway analysis.

The Albuquerque District originally developed the HEC-2 hydraulic model of the Rio Grande using a channel roughness coefficient (Manning's "n" value) of 0.020 and an overbank roughness coefficient of 0.030. Based on the hydraulic analysis conducted by the Albuquerque District, Resource Technology, Inc., the study contractor for the sediment investigation, also used "n" values of 0.020 and 0.030 for the channel and overbank areas, respectively. Closer examination of the overbank areas, conducted jointly by the Albuquerque District and the USIBWC, revealed that the overbank "n" value should be increased in several areas, particularly in the Selden Canyon region where dense vegetation is present. Consequently, the final HEC-2 model uses a channel "n" value of 0.020 and overbank "n" values that range from 0.030 to 0.080.

The Albuquerque District compared the HEC-2 models developed with the original and revised "n" values. The results of the comparison showed that the computed water surface elevation with the revised "n" values varied by more than 0.5 foot for only 73 of the 1,159 cross sections in the model; a variation in the 1- to 2-foot range occurred at only 18 cross-section locations, and none varied by more than 2 feet. The channel velocity changed by more than 10% at isolated locations at 46 of the 1,159 cross sections. Based on the variations indicated by the comparison, the HEC-6 sediment model was not adjusted to reflect the revised "n" values; the HEC-6 model incorporates the original "n" values of 0.020 for the channel and 0.030 for the overbank areas. If the HEC-6 model were modified to include the revised "n" values, the HEC-6 results would change. However, because the sediment analysis should be used to identify trends as opposed to magnitudes, the Albuquerque District considers the differences based on the revised "n" values insignificant to the analysis. The current HEC-6 model is acceptable to identify areas of scour and deposition.

**GENERAL RECOMMENDATIONS**

All closure devices along the levee should be inspected to insure that they will operate correctly in case of flood emergencies. Several existing closure devices in the study reach have been tampered with such that they remain permanently open.

There are three bridges (Brickplant, Courchesne, and Canutillo) at which the 100-year flood overtops the roadway elevation. These bridges should be replaced in order to pass the 100-year flood without overtopping. The Tonuco Bridge is an abandoned bridge in the northern reach of the study area and should be removed from the floodway.

**CANUTILLO, TEXAS, GENERAL RECOMMENDATIONS**

Flooding in Canutillo, Texas, is currently prevented by the Atchison, Topeka, and Santa Fe Railroad embankment which acts as the east river levee. As denoted by asterisks in Table 2-5 of Volume 2, the railroad embankment extends from Station 575+00 (HEC-2 Section Number 117) to Station 865+00 (HEC-2 Section Number 175); however, the protection is discontinuous due to uncontrolled openings in the railroad embankment. To successfully contain river flood stages within the levee section, the openings must be eliminated. This can be accomplished on an emergency basis by sandbagging the openings or by building stop-log structures at each opening. Both of these methods require extensive manual labor and coordination during an emergency situation; therefore, the measures are not considered viable solutions unless an extensive flood warning system was to be implemented.

A recommended structural solution would involve both an earthen levee and a concrete floodwall. The floodwall, beginning approximately at Station 525+00 and extending to Station 600+00, is necessary due to the constricted flow area that exists; the levee-to-levee width in this reach is only 310 feet to 350 feet. This river section currently represents the hydraulic constriction in the study reach, and the levee-to-levee width cannot be reduced by a new earthen levee section without adversely increasing the water surface elevation upstream. The recommended 7,500-foot floodwall would vary in height from 8 to 10 feet, without freeboard, and the structure would be located riverside and immediately adjacent to the Atchison, Topeka, and Santa Fe Railroad embankment (the existing east river levee). To accommodate local drainage, the floodwall must tie into the drainage control structures at appropriate locations. Downstream of Station 525+00 and upstream of Station 600+00, the levee-to-levee width expands to approximately 500 feet, thus allowing the floodwall to transition to an earthen levee.

The west-side levee should incorporate a floodwall extension for the same constricted area (Station 525+00 to Station 600+00). The floodwall would consist of a vertical wall partially embedded in the existing levee crown. A floodwall extension is possible on the west side because, unlike the east-side levee, the west-side levee does not serve the dual purpose of railroad embankment and flood control levee. The economics of the recommended plan must be investigated before determining whether the floodwall extension should be considered downstream of Station 525+00 or upstream of Station 600+00 or both. The existing levee section should be checked for through seepage and underseepage and for embankment and foundation stability. Some methods of controlling seepage and improving embankment stability could eliminate the economic advantage of the floodwall in comparison to an earthen levee enlargement. The U.S. Army Corps of Engineers Manual EM 1110-2-2502, Engineering and Design of Retaining and Floodwalls (dated 27 September 1989), provides guidance for the safe design and economical construction of floodwalls.

## SEDIMENTATION ANALYSIS - RIO GRANDE TRIBUTARY BASINS

The purpose of this phase of the project is to determine sediment yield estimates from all tributary basins in the study reach between Percha Diversion Dam, New Mexico, and American Diversion Dam, Texas. Detailed hydraulic and sediment analyses were conducted to quantify the sediment yield from twenty selected tributary basins to the Rio Grande within the study reach. The analysis procedure, assumptions, and results are described in Volume 3; the supporting data and calculations are included in the Volume 3 Appendices A through J.

The total drainage area of all tributary basins contributing to the Rio Grande within the study reach is 922 square miles. Fifty-two contributing subareas and many non-contributing subareas were initially delineated by the Albuquerque District. Resource Technology, Inc., (RTI), the study contractor for the sediment analysis, selected twenty of those subareas for detailed hydraulic and sediment analyses. These study basins were selected to represent the entire range of subareas with respect to drainage area, basin slope, and outfall location within the study reach. The reason for selection of twenty study basins was to complete a detailed hydrologic, hydraulic, and sediment yield and transport analysis for each of those basins in order to develop sediment yield prediction equations to be applied to the remaining unstudied contributing subareas. Therefore, the total sediment yield from all tributary arroyo basins could be computed.

The hydrologic analyses for all arroyo subbasins were completed using the HEC-1 computer program. The Albuquerque District developed and provided the 100-year hydrologic model to RTI. The Albuquerque District and RTI jointly developed models for the 2-, 5-, 10-, 25-, and 50-year return period storms. Using surveyed cross sections and the HEC-2 computer program, RTI computed hydraulic data for a short channel segment within each study basin. The peak discharges developed from the HEC-1 models for all return periods were input into the HEC-2 models of each channel segment.

For each of the twenty study basins, RTI computed the sediment yield (wash load) and sediment transport (bed material load) which together equal the total sediment load. The analysis for the total sediment load was completed for the 2-, 5-, 10-, 25-, 50-, and 100-year return period rainfall events for existing watershed conditions. Subsequently, RTI computed the average annual event total sediment load. The representative annual storm is based on the probability of storms of various return periods occurring in any given year.

The total sediment load results for the twenty study basins were then used to develop prediction equations to compute the total sediment load from all tributary basins not studied. To account for the reduction of sediment contribution to the Rio Grande by existing reservoirs, RTI assumed a trap efficiency of 90% based on review of available data for these reservoirs. The total sediment load prediction equations were applied to all subareas, and the results are included in Table 5-10 in Volume 3 which lists subareas which produce the greatest sediment loads descending to the subareas which produce the least sediment loads. RTI used the results of this effort as input into the scour and deposition analysis on the Rio Grande (Volume 4). In addition, Volume 3 results were important in developing the recommendations presented in Volume 4.

## SEDIMENTATION ANALYSIS - RIO GRANDE MAIN STEM

The purpose of this phase of the study is to perform detailed scour and deposition analyses that can be used by the USIBWC to carry out an improvement program to stabilize the river channel from Percha Diversion Dam to American Diversion Dam. The procedures applied in this study were selected to yield the most reliable results to estimate sediment loads and yields. The U.S. Army Corps of Engineers Hydrologic Engineering Center computer program HEC-6, Scour and Deposition in Rivers and Reservoirs was used to model sediment transport in the study reach and to evaluate the efficiency of the proposed improvements. The analysis procedures, assumptions, and results are described in Volume 4; the supporting data and calculations are presented in Appendices A through H in Volume A4.1, and the HEC-6 computer models and output files are included in Volumes A4.1 and A4.2, Appendices I through K. Appendix L, Volume A4.2, presents plan view maps of the HEC-2/HEC-6 cross-section locations and recommended sediment control structures. Appendix M, Volume A4.2, includes the Rio Grande bed profiles from 1958, 1962, 1967, 1972, and 1980. Appendix N, Volume A4.2, presents a summary of problem areas identified during the field survey and recommended improvements.

Four HEC-6 models were developed in order to simulate the river response to three flow scenarios and also to evaluate the effect of recommended sediment control measures. Each of the models includes the entire 105-mile study reach. A brief description of each HEC-6 model follows:

1. An average low-flow year which represents the 10-year lowest flow period, current river geometry and features (November, 1993) HEC-6 model:

   Based on evaluation of the available flow gage data, RTI selected ten years of consecutive lowest flows from the period of record, and an average low-flow year was computed to evaluate the river response to low flows. This analysis is also called the 10-year low-flow period analysis.

2. An average high-flow year which represents the 10-year highest flow period, current river geometry and features (November, 1993) HEC-6 model:

   Based on evaluation of the available flow gage data, RTI selected ten years of consecutive highest flows from the period of record, and an average high-flow year was computed to evaluate the river response to high flows. This analysis is also called the 10-year high-flow period analysis.

3. 100-year return period storm, current river geometry and features (November, 1993) HEC-6 model:

   The 100-year return period storm over the entire study area was modeled by the Albuquerque District using the HEC-1 program (refer to Volume 2). The runoff hydrographs from the HEC-1 model were used as input to the HEC-6 model to evaluate the river response to large flows of short duration. This model includes the 100-year hydrographs and associated sediment loads from most of the contributing basins. Some of the smaller basins were not considered in this analysis because their impact was negligible.

4. 100-year return period storm, current river geometry and features (November, 1993) with recommended sediment control measures HEC-6 model:

   Based on the results from the previous 100-year model, sediment control measures were proposed and incorporated into this model to evaluate the effects of the recommended measures.

**SUMMARY AND CONCLUSIONS OF THE AVERAGE LOW- AND HIGH-FLOW YEARS (BASED ON 10-YEAR PERIODS) HEC-6 MODEL RESULTS FOR CURRENT RIVER GEOMETRY AND FEATURES**

Appendix I in Volume A4.1 presents the average year low- and high-flow model output files. The output files were reviewed and the relatively significant bed changes are summarized in Table 2-9 in Volume 4. Local water discharge rate changes along the study reach are modeled, but tributary water and sediment inflows are not included in the low- and high-flow models.

The average year low-flow model results indicate a maximum scour depth of 1.7 feet at cross-section 925 and a maximum deposition depth of 0.7 feet at cross-section 895. Therefore, it appears that only minor scour and deposition problems would occur during a low-flow year which may be reasonable if local problems from sediment or water inflows from tributary arroyos are not considered.

The average year high-flow model results indicate a maximum scour depth of 2.6 feet at cross-sections 925 and 841, and a maximum deposition depth of 1.0 foot at cross-section 801. Therefore, it appears that significant, but not catastrophic, scour and deposition problems would occur during a high-flow year which again may be reasonable if local problems from sediment or water inflows from tributary arroyos are not considered.

**SUMMARY AND CONCLUSIONS OF 100-YEAR RETURN PERIOD STORM HEC-6 MODEL RESULTS BASED ON CURRENT RIVER GEOMETRY AND FEATURES**

Table 2-10 in Volume 4 summarizes the 100-year return period storm HEC-6 model results based on current river geometry and features. Table 2-10 also presents the computed water surface elevations with respect to the approximate levee or high-bank elevations and the resulting freeboard relative to the lower levee or bank elevation. Tributary water and sediment inflows are included in the model for all major arroyos.

The 100-year model results indicate that maximum deposition depths are found at cross sections located below major tributaries due to the addition of sediment loads. At these locations, deposition depths of 16.2 feet (Rincon Arroyo), 12.0 feet (Trujillo Canyon), 9.2 feet (Tierra Blanca Canyon), 8.6 feet (Placitas and Faulkner Arroyos), and other lesser depths would be expected. These depths are not design depths and are dependent upon the channel distance between cross sections. They do indicate that excessive deposition (over 5 feet) is likely at these locations.

The 100-year model results indicate maximum scour depths generally in the 3- to 4-foot range with a few 4- and 5-foot depths as shown in Table 2-10 (Volume 4). The scouring reaches are mostly downstream from Mesilla Diversion Dam. The maximum scour locations usually occur near bridges or other features which cause additional local effects on hydraulic parameters such as conveyance, slope, depth, and velocity.

The model results for most sections indicate that scour and deposition values are generally less than 1 foot in reaches between either a bridge or a tributary inflow location. Therefore, based on the model results, the river appears to have the capacity to carry high flows without major scour or deposition problems except at bridges or tributary inflow locations. Consequently, these locations will require detailed analyses and evaluation for specific sediment control projects.

Table 1 in this volume compares the results of the HEC-6 moveable-bed sedimentation analysis discussed above with the results of the HEC-2 fixed-bed hydraulic analysis for the 100-year flood on the Rio Grande. The following classification system was used in an effort to provide a means of prioritizing future levee rehabilitation:

| | | |
|---|---|---|
| CLASS: | I | HEC-2 CWSEL > top of levee elevation |
| | II | HEC-2 CWSEL > top of levee elevation minus 3 feet |
| | III | HEC-2 CWSEL < top of levee elevation minus 3 feet |
| SUBCLASS: | A | HEC-6 CWSEL > HEC-2 CWSEL |
| | B | HEC-6 CWSEL ≈ HEC-2 CWSEL (± ½ foot) |
| | C | HEC-6 CWSEL < HEC-2 CWSEL |

For example:

CASE IC would indicate that the levee is in danger of being overtopped, but because of scour or some other moveable-bed phenomenon, the moveable-bed water surface elevation is lower than that of the fixed-bed condition.

CASE IIA would indicate that the water surface encroaches on the levee freeboard, and sedimentation causes an increase in water surface elevation. Potentially, this could be enough to overtop the levee and change the classification.

It should be noted that CLASSES IIIB and IIIC are benign. Also, highlighted data in Table 1 in this volume refer to fixed-bed conditions only.

Caution should be exercised when comparing the results of the HEC-2 and HEC-6 analyses. The models, while sharing many similarities, often employ dissimilar assumptions. HEC-2 assumes steady flow, that is $\partial Q/\partial t=0$. . This assumption is handled by modeling only the peak discharge of an event associated with a specific location. HEC-6 attempts to account for the dynamic processes at work in a moveable bed by modeling a hydrograph as a series of discrete, steady flows of a corresponding duration. As a result of the interaction of the hydrologic, hydraulic, geometric, and sedimentation processes, often the peak water surface elevation does not occur at the same time as the peak discharge. A detailed explanation of the modeling procedures can be found in the HEC-2 and the HEC-6 user's manuals. In addition, the water surface elevations resulting from the moveable bed HEC-6 analysis reported in Table 2-10 in Volume 4 differ from those reported in Table 1 of this volume as a result of different computational methodologies. The water surface elevations reported in Table 1 occur at the time step corresponding to the maximum water surface elevation; however, the water surface elevations reported in Table 2-10 in Volume 4 occur at the time step corresponding to maximum scour.

Under anything less than ideal conditions, any computed water surface profile must be viewed as an estimate only with some inherent degree of uncertainty associated with it. Frequency discharges, hydraulic roughness values, and channel geometry are never exact. They can only represent our best estimates. Traditionally, design engineers dealt with this uncertainty by adding some constant to the profile elevation (freeboard) to account for physical variables which were not always known and phenomena which were not completely understood. The freeboard was often established as a matter of professional judgement, past experience, rule-of-thumb, or agency policy. Recently, there has been a move to more carefully quantify this uncertainty and account for the uncertainty in the design using a risk-based approach. Regardless of the strategy, the designer should set levee elevations with this uncertainty in mind, as well as other variables such as the risk of loss of life associated with levee overtopping or failure, and, of course, economics.

Consequently, the HEC-2 results should be used as the primary basis for hydraulic design. The HEC-6 results are useful in quantifying a large part of the uncertainty associated with hydraulics, namely, that of a moveable bed. The HEC-6 model provides an indication of the typical fluctuations in the water surface profile due to sedimentation, as well as variations related to specific locations. Additionally, the moveable bed model provides a means of assessing the effectiveness of tributary control measures, both those suggested in the report and any formulated in the future. The HEC-6 model also points to areas in need of more maintenance and allows assessment of measures to reduce dredging or assessment of areas in need of armoring or grade control. Finally, it provides a means of prioritizing construction. However, it should be kept in mind that, as with the HEC-2 water surface profile, there is some inherent uncertainty included within the HEC-6 profile. Because of the relative complexity of the moveable bed model, it could be argued that the HEC-6 results have more uncertainly. The HEC-6 results should be viewed as a means to identify trends as opposed to magnitudes. Hence, the Corps of Engineers suggests using the HEC-2 water surface profile primarily during design.

### SUMMARY AND CONCLUSIONS OF 100-YEAR RETURN PERIOD STORM HEC-6 MODEL RESULTS BASED ON CURRENT RIVER GEOMETRY AND FEATURES WITH RECOMMENDED SEDIMENT CONTROL MEASURES

The need for each recommended sediment control measure was based on providing a minimum of three feet of freeboard. Therefore, a sediment control dam is recommended at all tributary arroyos immediately upstream of the cross sections listed in Table 2-10 in Volume 4 that exhibit excessive deposition as a result of a local arroyo inflow and where the freeboard criterion is not met. The procedure used to model a sediment control dam was based on the assumption that the trap efficiency of the dam would be 90 percent. Consequently, the local inflow sediment load rates were reduced to 10 percent of the original values. Local water and sediment inflows are included in the model for all major arroyos, and some local inflow sediment rating curves have been adjusted to simulate the reduction of the total sediment load as a result of a sediment control dam.

The 100-year model results based on the recommended sediment control dams indicate a maximum scour depth of 5.8 feet at cross-section 407 which is located below Mesilla Diversion Dam. Similar to the existing condition model, all closely spaced cross sections as determined by the Albuquerque District for modeling bridges with HEC-2 were removed from the HEC-6 model except the cross section at the upstream face of each bridge. Also, 10 feet was set as the maximum allowable scour depth at all sections excluding structural bed control locations where no erosion was allowed.

The maximum scour locations generally occur near bridges or other features which affect hydraulic parameters such as conveyance, slope, depth, and velocity. All of the scour areas occur in the El Paso subreach which suggests that the proposed sediment control dams in the Mesilla and Leasburg subreaches are appropriate and will not result in undue channel erosion. More detailed analysis is required in subreach R3 (subareas 15 through 20) and subreach R5.1 (Berrenda Creek) to determine the impacts of individual tributaries because it may be desirable not to control sediment inflow from those tributaries.

The maximum deposition depth of 5.2 feet at cross section 563 results from a single basin representing subareas 15 through 20. Therefore, the deposition depth was significantly reduced from the existing condition model by including a sediment control dam on this basin. Once again, detailed analysis of the individual subareas will probably reduce this value. The next highest deposition (4.3 feet) occurs at the Berrenda Creek outfall where a sediment control dam was not recommended because adequate freeboard is available at this location. In general, after sediment control dams are introduced into the HEC-6 model, less than one foot of deposition may be expected.

In addition to the 100-year HEC-6 model results, all arroyos (without dams) and the associated total sediment load results from Volume 3 should be considered for future sediment control dams. It is possible that a minor tributary could create a significant sediment plug. Conversely, it may be desirable to maintain sediment inflow in the lower part of the study reach where erosion tendencies dominate. Detailed HEC-6 modeling of these subreaches, with each tributary modeled separately, may show that the predicted scour depths would be reduced and that it may be desirable to maintain sediment delivery channels to the Rio Grande.

## RECOMMENDED IMPROVEMENTS TO THE RIO GRANDE CHANNEL

### RECOMMENDATIONS BASED ON FIELD OBSERVATIONS

RTI staff conducted field surveys in 1994 to locate sites that indicate erosion, scour, deposition, vegetation (or lack of vegetation), livestock, or maintenance problems. The following is an inventory of areas that may require improvements. In addition to the station-by-station identification of problem areas, the following trends, which extend for varying lengths along the main stem of the river, have been noted:

1. Rio Grande Main Stem between Sibley Arroyo and Hatch Siphon
   (Station 5205+00 to Station 4754+71)
   "Poor" hydrologic range conditions on right-of-way.

2. Rio Grande Main Stem
   Leasburg Dam - North (both banks)
   (Station 3275+99 - Station 3745+00)
   Nemexas Siphon - South (west bank)
   (Station 3655+00 to Station 3640+00)
   Dense salt cedar (*Tamarix ramosissima*) infestation which may restrict channel flow through reduction of conveyance. Flow quantity may also be reduced by phreatophytic root uptake.

3. Non-Continuous Bank Erosion
   Main Stem from Mesilla Diversion Dam to Canutillo Bridge
   (Station 2075+42 to Station 670+98)
   Approximately one-quarter of this reach (35,000 linear feet) shows some degree of bank erosion or failure in an intermittent pattern.

4. Fifteen to twenty percent of the river banks for the entire study reach are dredge material disposal areas which are highly erodible, reduce channel conveyance, and limit vegetative recovery.

Specific recommendations for resolving these problems may be found in the inventory included in Appendix N (Volume A4.2).

Bank stabilization is required for approximately 18,200 linear feet of river bank. Bank failure appears to be caused by two impacts: those from the water flows in the river channel and those from the management of the adjacent floodway areas. Of these management related impacts, the most significant may be unrestricted cattle access to the river. Vegetative condition improvements have been estimated for 667 acres.

At locations requiring bank protection, RTI recommends riprap or the following alternative bank stabilization measures. Where soil salinity levels are favorable for sandbar willow (*Salix exigua*), RTI recommends: (1) willow planting; (2) willow planting in combination with a "soft" technology bank stabilization such as a polymer soil stabilization grid fabric; or (3) willow planting in combination with riprap. In areas where soil salinity is not favorable for willow, planting with certain salt-tolerant sedge species (*Cyperaceae spp.*) may be possible. Site assessment of each overbank area will determine which measure is to be used.

In areas requiring vegetative improvements, RTI recommends a revegetation program with soil-stabilizing native grasses and construction of stabilized cattle access to the river to prevent bank failure which can be caused by hoof action. Vegetation improvement in the form of grass seeding and brush planting along the banks may satisfy multi-objective, cross-agency management goals. These may include: (1) bank protection, (2) reduction of sediment input to the main stem from bank failure and soil erosion, (3) improved pasture forage for leased floodway areas, and (4) creation of additional fish and wildlife habitat. In addition, a potential flooding problem near Canutillo has been discussed by the Albuquerque District and the USIBWC, and a flood wall has been proposed in Volume 2 of this report.

## RECOMMENDATIONS BASED ON HEC-6 SCOUR AND DEPOSITION ANALYSES

The results of the HEC-6 scour and deposition analyses are presented in Tables 2-9 and 2-10 of Volume 4 and are shown graphically on Sheets 1-55 included in Appendix L (Volume A4.2). Tributary arroyos which cause excessive deposition at the confluence with the Rio Grande are identified, and sediment control dams on these tributaries (with at least 90 percent trap efficiency) are proposed. These dams, which are generally located in the upper part of the study reach (the Leasburg and Mesilla subreaches), do not appear to have a significant impact on the lower (El Paso) subreach, which generally tends to be in an erosion mode. RTI did not consider erosion to be a major problem except in localized areas where the levees may be threatened; this type of analysis is beyond the capabilities of the HEC-6 computer program.

The HEC-6 100-year existing river model results were reviewed for scour and deposition bed changes at the Garfield, Hatch, and Rincon siphons; Table 3-1 in Volume 4 presents the results. The Garfield siphon appears to be in a stable reach based on the HEC-6 model results, this also appears to be true upon visual observation. The Rincon and Hatch siphons have both required protection in the past due to bed scour. Protection has been provided by dumping large rip-rap over the siphon. The rip-rap requires monitoring and occasional replacement as a result of transport during high flows. The 100-year HEC-6 model with existing geometry was generated allowing the bed to erode at the Hatch and Rincon siphons to determine the potential scour. The results presented in Table 3-1 of Volume 4 indicate that the Hatch and Rincon siphon locations are expected to scour upstream about 2 feet and 3 feet, respectively, and deposit downstream of the siphons about 2 feet and 3 feet, respectively. The HEC-6 model results do not represent local scour at the siphons which, as noted, has been a very significant problem. A much more detailed design analysis of the scour problems is required to accurately predict the local scour depth in order to design grade control structures.

RTI ran the future condition HEC-6 models by fixing the bed to allow no scour at the siphons by assuming a grade control structure in place. The results presented in Table 3-1 in Volume 4 indicate that scour will occur about 1.0 feet upstream and deposition about 1.0 feet downstream of the Hatch siphon. At the Rincon siphon, scour will occur about 0.5 foot upstream and deposition about 1.0 foot downstream.

Based on these results and field observations, grade control structures are recommended to control scour and protect both siphons. The grade control structures may be constructed just downstream of the siphons. The structures may be constructed with reinforced concrete, sheet piling, or possibly gabions. Bank protection may also be required upstream and downstream of the grade control structures due to increased bank heights, probable bank failure, and lateral migration.

**404 PERMIT REQUIREMENTS**

Structures or work affecting navigable waters of the United States are regulated under Section 10 of the Rivers and Harbor Act of 1899. Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (renamed the Clean Water Act) insures that the biological and chemical quality of the nation's waters is protected from unregulated discharges of dredged or fill material. Section 404 established a permit program to be administered by the U.S. Army Corps of Engineers to regulate the discharge of dredged or fill material. The Act was further amended in 1977 to provide exemptions, general permits, and program turnover to states having approved programs. Other laws which may affect the processing of applications for Corps of Engineers permits include the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, the National Historic Preservation Act, the Federal Power Act, the Wild and Scenic Rivers Act, and the National Fishing Enhancement Act of 1984.

"Waters of the United States" are administratively defined as (1) the traditional "navigable waters of the United States" including adjacent wetlands; (2) all interstate waters including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), prairie potholes, mudflats, playa lakes, wet meadows, wetlands, natural ponds, *etc.*; (4) all impoundments of these waters; (5) tributaries of the above listed waters; and (6) wetlands adjacent to the above waters. "Navigable waters" are defined as waters that have been used in the past, are now used, or are susceptible to use as a means to transport interstate or foreign commerce up to the head of navigation. Navigable waters within the Albuquerque District include Navajo Reservoir and the Rio Grande along the international boundary. "Wetlands" are areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. The landward regulatory limit for non-tidal waters (in the absence of adjacent wetlands) is the ordinary high water mark. The ordinary high water mark is the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of the soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

An individual Section 404 permit is required for placement of dredged or fill material, including excavation, or construction activities in waters of the United States if the project is not exempted from the Section 404 program and does not fall under one of the nationwide or regional permits. This information is directed to those individuals, companies, corporations, and government agencies planning construction activities in a river, stream, lake, or wetland within the jurisdiction of the Corps of Engineers. Examples of regulated activities are materials excavated or placed in a waterway or wetland for any purpose including: commercial, industrial, or recreational construction; roadfills and causeways where portions of the construction are in waters or wetlands; dams and dikes; and protection devices such as levees, groins, riprap, and other bank stabilization.

In some cases, the formal processing of a permit application is not required because of general permits already issued to the public at large by the Corps of Engineers. These permits are issued on a regional or nationwide basis. Regional permits are issued by the District Engineer for a general category of fill activities when (1) the activities are similar in nature and cause minimal environmental impact (both individually and cumulatively) and (2) the regional permit reduces duplication of regulatory control by state and federal agencies. A nationwide permit is a form of general permit authorizing a category of activities throughout the nation. If the conditions of a nationwide permit can not be met, a regional or individual permit is required; the Corps of Engineers is authorized to determine if an activity complies with the terms and conditions of a nationwide permit. Separate applications may not be required for activities authorized by a general permit; however, reporting may be required. For more specific information on general permits, contact the Regulatory Office of the U.S. Army Corps of Engineers, Albuquerque District.

If an individual permit is required, an application form should be completed. A copy of the application form and instructions for the Department of the Army Section 404 permit is included on the following pages; additional permit applications can be obtained from the Albuquerque District. Information needed includes (1) drawings (size 8-1/2" x 11") sufficient to understand the project; (2) locations, purpose, types and quantities of fill, and intended use; (3) expected start and completion dates; (4) names and addresses of adjacent landowners; and (5) location and dimensions of adjacent structures. Photographs of the site of the proposed activity are not required; however, photographs are helpful and may be submitted as part of any application. The Regulatory Office of the Corps of Engineers should be contacted for additional submittal information. The completed permit can be mailed to:

The District Engineer
U.S. Army Corps of Engineers
Attention: CESWACO-OR
4104 Jefferson Plaza Northeast
Albuquerque, New Mexico 87109-3435

Nationwide permit conditions are periodically revised. Contact the Regulatory Office of the Corps of Engineers for a summary of current nationwide permit conditions.

# APPENDIX C
# AQUATIC HABITAT EVALUATION

HEP is a method developed by the U.S. Fish and Wildlife Service to facilitate evaluations of aquatic habitat where changes in ecosystem structure are anticipated. HEP can be used to document the quality and quantity of available habitat for selected fish and wildlife species. HEP provides information for two general types of habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same area at future points in time, facilitating "before" and "after" comparisons.

The HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a Habitat Suitability Index (HSI). This index value, ranging from 0.0 to 1.0, is multiplied by the area of available habitat to obtain Habitat Units that serve as the basis for comparison. The reliability of HEP and the significance of HUs are dependent on the ability to assign a well defined and accurate HSI to the selected evaluation species. The number of HUs is defined as the product of the HSI (quality) and the total area of available habitat (quantity). This appendix summarizes findings and analysis previously reported of HEP surveys conducted in September 2000 and January 2001 at multiple locations along the RGCP (Parsons 2001b). As a comparison, data are presented on September 1999 fish surveys conducted by the USFWS on artificial structures placed at 13 locations in the north reach of the RGCP.

## METHODOLOGY

### Survey Locations

Ten HEP locations were surveyed along the RGCP, one each in the Seldon Canyon, Upper Mesilla, Las Cruces, and El Paso RMUs and two locations in the remaining RMUs (*i.e.,* Upper Rincon, Lower Rincon, and Lower Mesilla). HEP survey locations (transect series) according to RMU are depicted in Table C-1. Two transects were surveyed at one location with the exception of the Upper Rincon and Lower Mesilla locations where three transects were surveyed.

Transects at each survey location were separated by approximately 100 meters and consisted of up to 20 points depending upon channel width. Depth and current velocity measurements were made at each point, allowing the vertical profile and flow to be determined for each site. In addition, water quality measurements were made, namely temperature, salinity, conductivity, pH, dissolved oxygen, and total dissolved solids. The physical variables measured at each location were used for subsequent HSI calculations.

### Delineation of Cover Types

HEP analysis requires the delineation of cover types. Cover types serve to facilitate the selection of evaluation species, the extrapolation of data from sampled areas to non-sampled areas, and the treatment of HEP data. The diversity of cover types in the project area is very limited resulting in the delineation of only one type suitable for the selected evaluation species. The RGCP area's aquatic cover type is characterized as a shallow water stream with little aquatic diversity and productivity.

**Table C-1**
**Transect Location for Aquatic Sampling Sites**

| Management Unit | Transect Series | Transect Identification | Notes |
|---|---|---|---|
| Upper Rincon | Upper Rincon | UR2, UR3, UR4 | At Tipton Arroyo |
| Upper Rincon | Garfield | G1, G2 | Sibley Arroyo |
| Lower Rincon | Hatch | H1, H2 | Downstream of Rincon Siphon |
| Lower Rincon | Sierra Alta | SA1, SA2 | At Rincon Arroyo |
| Seldon Canyon | Seldon Canyon | SC1, SC2 | From Highway 185 at Mile Marker 18 |
| Upper Mesilla | Doña Ana | DA1, DA2 | Downstream Shalem Colony Bridge |
| Las Cruces | Las Cruces | HEP1, HEP2 | Downstream of Picacho Bridge |
| Lower Mesilla | Black Mesa | BM1, BM2 | Downstream of Mesilla Bridge |
| Lower Mesilla | Mesilla Valley | MV, MV2, MV3 | Downstream of Mesilla Diversion Dam |
| El Paso | El Paso | EP1, EP2 | At Cottonwood Bosque Area |

### Aquatic Species Sampling

*Electrofishing*. Electrofishing was completed using a Smith-Root back-pack (battery) operated unit with direct current. At each sampling location, electrofishing was conducted through representative habitat elements. Shoreline lengths of from 164 to 328 feet (50 to 100 meters) were electrofished, as were any other habitat types at the location such as debris or other materials. Fish captured were identified to species, measured for length, and released.

*Seining*. Seining, where it was conducted to supplement electrofishing, was completed with a two-person beach seine. The 3-meter wide seine was pulled rapidly through select habitat types or near specific features such as logs or other debris. Fish captured were identified to species, measured for length, and released.

### Selection of Evaluation Species

The selection of evaluation species form the basis of the HEP analysis and is used to quantify habitat suitability and determine changes in the number of available HUs. Therefore, the HEP assessment is directly applicable only to the evaluation species selected. This is an important distinction between HEP and the WHAP methodology used for terrestrial surveys. Limited availability of HSI models for the species present in the Project area resulted in selection of two species for HEP analysis, largemouth bass *(Micropterus salmoides)* and flathead catfish *(Pylodictis olivaris)* .

### Calculating Total Area of Available Habitat

The total area of available habitat for an evaluation species includes all areas that can be expected to provide some support to the evaluation species. Typically, total area of available habitat is calculated by summing the areas of all cover types likely to be used by the evaluation species. Because only one cover type throughout all RMUs was defined, only one value was used to represent total area of available habitat for each RMU. This number was developed by reclassifying digital orthographic imagery using ERDAS Imagine® and using ArcView GIS to calculate total area for open water in the project area.

## FLATHEAD CATFISH HABITAT EVALUATION

### Specific Habitat Requirements

Flathead catfish habitat requirements vary with age. Young flathead catfish are often found in riffles until they are 5.1 to 10.2 cm (2 to 4.0 inches) in total length. In streams, flatheads from 10.2 to 30.4 cm (4.0 to 12 inches) in total length are generally dispersed, catfish with a total length of 30.4 to 40.6 cm (12 to 16 inches) are typically associated with intermediate depths and cover, and catfish with a total length of over 40.6 cm (16 inches) are solitary and associated with cover in deep pools. Young catfish typically are active only at night.

Flatheads are most common in large, turbid rivers and reservoirs. In large rivers, flathead catfish appear to prefer large, sluggish, deep pools located in low gradient sections. Flathead catfish inhabit a variety of stream types, but tend to avoid streams with high gradients or intermittent flow.

### Flathead Catfish Habitat Suitability Model

*[ From: Lee, L.A., and J.W. Terrell. 1987. Habitat suitability index models: flathead catfish. Fish and Wildlife Service Biological Report 82(10.152). ]*

Lee and Terrell (1987) developed two habitat models for flathead catfish used to assess different types of habitat impacts (*e.g.*, Riverine Cover model and Macrohabitat model). The Riverine Cover model applies to situations where a diversity of cover types exist. Flathead catfish are often closely associated with cover, both for spawning and other activities, however, because cover requirements for the flathead catfish were not observed in the entire study area the Macrohabitat model was chosen for this species. The Macrohabitat model uses the following variables to assess habitat suitability: V1-stream gradient; V2-turbidity; V3-current velocity; V4-percent riffles; V5-percent runs; and V6-percent pools.

For those variables Lee and Terrell (1987) developed Macrohabitat Suitability Index (SI) graphs used to model individual suitability indices from known values of the habitat variables at a given location. These indices (SIs) represent estimates of the limits to average standing crop imposed by individual habitat variables in an entire water body or sample site large enough to encompass an individual's range throughout an entire life cycle. To derive HSI that is a conservative estimate of standing crop limit imposed by all the model variables, HSI is defined as the lowest SI measured for any variable. "The proper interpretation of the HSI is one of comparison. If two riverine habitats have different HSI's the one with the higher HSI should have the potential to support more flathead catfish than the one with the lower HSI, if no unmeasured habitat variables are more limiting than the model variables."

## LARGEMOUTH BASS HABITAT EVALUATION

### Specific Habitat Requirements

Optimal riverine habitat for largemouth bass is characterized by large, slow moving rivers or pools of streams with soft bottoms, some aquatic vegetation, and relatively clear water. First and second order streams generally provide poor habitat. A river with a high percent (≥ 60%) of pool and backwater area is optimal. Also, largemouth bass prefer low gradient streams; abundance declines as gradient increases toward headwater areas. Gradients larger than 4 m/km are assumed to be unsuitable.

The species growth is reduced at dissolved oxygen levels less than 8 mg/l, and a substantial reduction occurs below 4 mg/l. Levels below 1.0 mg/l are considered lethal. Largemouth bass are also considered intolerant of suspended solids (turbidity) and sediment. High levels of suspended solids may interfere with reproductive processes and reduce growth. The optimum suspended solid levels are assumed to be 5-25 ppm, and levels below 5 ppm indicate low productivity. Largemouth bass require a pH between 5 and 10 for a successful reproduction. Optimal pH range is 6.5-8.5 although largemouth bass can tolerate short-term exposure to pH levels of 3.9 and 10.5

Adult largemouth bass are most abundant in areas with vegetation and other forms of cover. Optimal cover corresponds to 40-60% of the pool or littoral area; too much cover may reduce prey availability. Optimal current velocities are less than or equal to 6 cm/sec (2.4 inches/sec), and velocities above 20 cm/sec (7.9 inches/sec) are considered unsuitable. Optimal temperatures for growth of adult bass range from 24-30° C (75 to 86 F). Very little growth occurs below 15° C (60 F) or above 36° C (99 F). Salinity levels above 4 ppt cause sharp declines in abundance.

Optimal current velocities for fry are below 4 cm/sec (1.5 inches/sec), and fry cannot tolerate current velocities above 27 cm/sec (11 inches/sec). Cover, in the form of flooded terrestrial vegetation, is an important requirement for fry suitability, because the amount of cover has been positively correlated to number of fry. However, too much cover constitutes poor spawning habitat. Optimal pools or littoral areas are assumed to contain approximately 40-80% cover. Also, stable to increased summer water level is optimal, because it increases cover availability. It is assumed that decreasing water levels would be suboptimal because fry would be more susceptible to predation with the decrease in available cover

**Habitat Suitability Model**

*[ Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982. Habitat suitability index models: Largemouth bass. U.S. Department of Interior Fish and Wildlife Service FWS/OBS-82/10.16 .]*

Two HSI models exist for the largemouth bass: 1) Riverine HSI Model and 2) Lacustrine HSI Model. The riverine model, applied to the RGCP survey is described below: According to Stuber *et. al.* (1980) the Riverine HSI model has the form:

$$HSI = (C_F \text{ x } C_C \text{ x } C_{WQ} \text{ x } C_R \text{ x } C_{OT})^{1/5}$$

Where each of the five components represent food ($C_F$), cover ($C_C$), water quality ($C_{WQ}$), reproduction ($C_R$), and other ($C_{OT}$).

*Food Component.* Percent bottom cover is assumed to be important because bottom cover provides habitat for aquatic insects, crayfish, and forage fish, which are the predominant food items of largemouth bass. Percent pool and backwater area is included to quantify the amount of food habitat.

*Cover Component.* Percent bottom cover is included because largemouth bass are most abundant in areas with cover. Percent pool and backwater area quantifies the amount of cover habitat. Water level fluctuation is considered to be important because the amount of available cover is dependent on fluctuations.

*Water Quality Component.* The water quality component is limited to dissolved oxygen, pH range, temperature, turbidity, and salinity measurements. These parameters have been shown to affect growth or survival. Variables related to temperature and oxygen are assumed to be limiting when they reach near lethal levels.

*Reproductive Component.* Temperature and salinity during spawning and embryonic development describe water quality conditions which affect reproduction. Maximum water level fluctuation is included because optimal development and survival is dependent on stable water levels during spawning. Current velocity is important because embryos require areas of little or no velocity. Percent pool and backwater area quantifies the amount of low velocity spawning areas.

*Other Components.* The variables which are in the other component are those which also describe habitat suitability for the largemouth bass, yet are not specifically related to the life requisite components already present. Stream gradient is included because largemouth bass prefer slow moving streams.

## HABITAT SUITABILITY INDICES

HSI values were calculated for the largemouth bass and flathead catfish by location (Table C-2). Locations were classified according to three prevailing characteristics to compare HSIs among site attributes: main river run, downstream from diversion dams, and downstream from siphons. Documented physical conditions in the Rio Grande appear to be more suitable for the flathead catfish than for the largemouth bass, but HSI values underscore the paucity of aquatic habitat available for both species in the RGCP area.

For largemouth bass, HSI ranged from 0.05 to 0.17, indicating that a large proportion of the surveyed habitat was sub-optimal for the species development. At all but one site the reproductive component of the index was determined to be the limiting factor. Physical conditions contributing to the largemouth bass reproductive success include percentage of total habitat represented by pools and backwaters and a possibly correlated variable, velocity of water in the pools. At most sites percent pool values were less than or equal to 10 percent, significantly limiting the availability of optimal bass habitat. The highest HSI values for largemouth bass were found at three sites located downstream from diversion dams and siphons where pools or slow-moving waters were present. Little suitable habitat was documented at survey locations in the main river run (HSI < 0.1).

Calculated HSI values for the flathead catfish, while higher than those calculated for the largemouth bass, were also indicative of sub-optimal habitat conditions. Index values ranged from 0.10 to 0.55 depending on the location (Table C-2). As with largemouth bass, locations downstream from diversion dams and siphons had the highest HSI values, indicating a positive relationship between the index and percent coverage of pools. For the main river run HSI values for the catfish were generally low, from 0.10 and 0.25. Results of the habitat suitability models suggest that augmenting pool habitat will likely be beneficial for both largemouth bass and flathead catfish.

## SUPPORT CALCULATIONS

Detailed calculations for HSI data summarized in Table C-2 for flathead catfish and largemouth bass are presented in Tables C-3 and C-4, respectively. Description of model components was previously discussed in the text.

Similarly to the survey data utilized for calculation of habitat suitability indices in seven RMUs along the RGCP, HSI data were calculated for 13 reference locations in the Rincon Valley where artificial habitat structures were placed as mitigation for arroyo dredging as required by the USACE 404 permit. The structures 2 v-notch weirs placed across the RGCP channel, 3 small embayments placed along the river banks, and 7 groins near the mouth of dredge arroyos and two reference arroyos. September 1999 data from an monitoring program conducted by the USFWS for the USIBWC were used in the HSI calculations. These data were selected as potentially representative of more diversified aquatic habitat conditions in the RGCP channel.

**Table C-2. Habitat Suitability Indices for Largemouth Bass and Flathead Catfish**

| Site Attribute | Location (River mi) | Transect Series ID | Largemouth Bass HSI | Flathead Catfish HSI |
|---|---|---|---|---|
| Downstream from Siphon | 82 | Hatch | 0.17 | 0.45 |
| Downstream from Diversion Dam | 40.2 | Mesilla Valley | 0.17 | 0.55 |
| | 104.3 | Upper Rincon | 0.14 | 0.40 |
| Main River Run | 5.0 | El Paso | 0.05 | 0.25 |
| | 42.5 | Black Mesa | 0.05 | 0.25 |
| | 45.8 | Las Cruces | 0.05 | 0.25 |
| | 79 | Sierra Alta | 0.06 | 0.25 |
| | 100.2 | Garfield | 0.06 | 0.10 |
| | 51.3 | Doña Ana | 0.14 | 0.40 |
| | 71.8 | Seldon Canyon | 0.06 | 0.25 |

**Table C-3 Calculation of Flathead Catfish Habitat Suitability Indices***
**(September 2000 and January 2001 Surveys)**

| Site | Model Variable | V1 | V2 | V3 | V4 | V5 | V6 | HSI |
|---|---|---|---|---|---|---|---|---|
| SC, Seldon Canyon | Input | 0.52 | 140 | 0.43 | 10 | 80 | 10 | 0.25 |
| | SI | 1 | 1 | 0.8 | 0.7 | 0.85 | 0.25 | |
| H, Hatch | Input | 1.53 | 140 | 0.58 | 25 | 45 | 30 | 0.45 |
| | SI | 1 | 1 | 0.45 | 1 | 0.95 | 0.55 | |
| UR, Upper Rincon | Input | 0.25 | 140 | 0.26 | 10 | 70 | 20 | 0.4 |
| | SI | 1 | 1 | 1 | 0.7 | 0.875 | 0.4 | |
| G, Garfield | Input | 0.82 | 140 | 0.646 | 25 | 75 | 0 | 0.1 |
| | SI | 1 | 1 | 0.375 | 1 | 0.875 | 0.1 | |
| LC, Las Cruces | Input | 0.625 | 140 | 0.48 | 10 | 80 | 10 | 0.25 |
| | SI | 1 | 1 | 0.6 | 0.7 | 0.85 | 0.25 | |
| BM, Black Mesa | Input | 0.54 | 140 | 0.46 | 10 | 80 | 10 | 0.25 |
| | SI | 1 | 1 | 0.7 | 0.7 | 0.85 | 0.25 | |
| EP, El Paso | Input | 0.54 | 140 | 0.38 | 10 | 80 | 10 | 0.25 |
| | SI | 1 | 1 | 1 | 0.7 | 0.85 | 0.25 | |
| MDD, Mesilla Diversion Dam | Input | 1.86 | 140 | 0.273 | 10 | 60 | 30 | 0.55 |
| | SI | 1 | 1 | 1 | 0.7 | 0.9 | 0.55 | |
| Doña Ana | Input | 0.625 | 140 | 0.484 | 10 | 70 | 20 | 0.4 |
| | SI | 1 | 1 | 0.6 | 0.7 | 0.875 | 0.4 | |
| SA, Sierra Alta | Input | 0.979 | 140 | 0.598 | 25 | 65 | 10 | 0.25 |
| | SI | 1 | 1 | 0.45 | 1 | 0.9 | 0.25 | |

* Parsons' 2000 Surveys Along the USIBWC Rio Grande Canalization Project

**Variable Descriptions:**
V1-Stream Gradient (m/km); V2-Turbidity (JTU); V3-Mean Velocity (m/s); V4-% Riffle; V5-% Run; V6-% Pool.

**HSI: value equivalent to lowest SI of the six physical variables.**

**Input Value Estimation:**
V1- Summer stream surface elevation at beginning and ending mile marker used to estimate stream gradient at each site (Alternatives Formulation Report, Appendix C, Parsons ES, Jan 2001).
V2- Intermediate value, 140 JTU, assumed to reflect average turbidity.
V3- used weighted average velocity measured from cross-sectional data collected at each site, Parsons ES, March 2001.
V4:V6- values from field data collected at each site, Parsons, April 2001.

## Table C-4 Calculation of Largemouth Bass Habitat Suitability Indices

### Parsons Surveys Along the USIBWC Rio Grande Canalization Project (September 2000 and January 2001)

| Site | Model Variable | V1 | V3 | V4 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V17 | V18 | V19 | V20 | V21 | V22 | Cf | Cc | Cwq | *Cr* | Cot | ***HSI*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC | Input | 10 | 10 | 10 | 7.68 | 8.06 | 24.1 | 21.69 | 24.1 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 43 | 22 | 43 | 0.52 | 0.018 | 0.068 | 0.863 | *0.055* | 1 | *0.055* |
| | SI | 0.001 | 0.375 | 0.25 | 0.8 | 1 | 1 | 1 | 0.8 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| H | Input | 30 | 0 | 0 | 8.82 | 8.33 | 21.14 | 19.026 | 21.14 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 58 | 29 | 58 | 1.5 | 0.181 | 0.320 | 0.806 | *0.168* | 0.8 | *0.168* |
| | SI | 0.325 | 0.2 | 0.001 | 1 | 1 | 0.65 | 0.85 | 0.65 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 0.8 | | | | | | |
| UR | Input | 20 | 30 | 30 | 8.33 | 8.01 | 0.65 | 20.6 | 0.65 | 25-100 | 0.2 | 0.2 | 0.2 | Mostly Sand | 0 | 1 | 0 | 26 | 13 | 26 | 0.25 | 0.278 | 0.426 | 0.886 | *0.137* | 1 | *0.137* |
| | SI | 0.1 | 0.8 | 0.75 | 1 | 1 | 0.9 | 1 | 0.7 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| G | Input | 10 | 10 | 10 | 8.36 | 8.26 | 23.5 | 21.2 | 23.5 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 65 | 32 | 65 | 0.8 | 0.018 | 0.068 | 0.888 | *0.055* | 1 | *0.055* |
| | SI | 0.001 | 0.375 | 0.25 | 1 | 1 | 0.95 | 1 | 0.7 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| LC | Input | 10 | 10 | 10 | 7.67 | 8.39 | 21.38 | 19.42 | 21.38 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 48 | 24 | 48 | 0.625 | 0.018 | 0.068 | 0.738 | *0.053* | 1 | *0.053* |
| | SI | 0.001 | 0.375 | 0.25 | 0.8 | 1 | 0.65 | 0.85 | 0.55 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| BM | Input | 10 | 10 | 10 | 7.42 | 8.39 | 20.9 | 18.8 | 20.9 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 46 | 23 | 46 | 0.54 | 0.014 | 0.057 | 0.688 | *0.050* | 1 | *0.050* |
| | SI | 0.001 | 0.375 | 0.001 | 0.8 | 1 | 0.5 | 0.65 | 0.45 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| EP | Input | 10 | 0 | 0 | 8.5 | 8.53 | 19.48 | 17.532 | 19.48 | 25-100 | 0.5 | 0.5 | 0.5 | Mostly Sand | 0 | 1 | 0 | 38 | 19 | 38 | 0.54 | 0.014 | 0.057 | 0.692 | *0.049* | 1 | *0.049* |
| | SI | 0.001 | 0.375 | 0.001 | 1 | 1 | 0.45 | 0.6 | 0.4 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| MDD | Input | 30 | 0 | 0 | 7.67 | 8.34 | 25 | 22.5 | 25 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 27 | 14 | 27 | 1.86 | 0.181 | 0.320 | 0.894 | *0.174* | 0.7 | *0.174* |
| | SI | 0.325 | 0.2 | 0.001 | 0.8 | 1 | 1 | 1 | 0.9 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 0.7 | | | | | | |
| DA | Input | 20 | 10 | 10 | 7.61 | 8.34 | 22.45 | 20.2 | 22.45 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 48 | 24 | 48 | 0.625 | 0.177 | 0.315 | 0.781 | *0.137* | 1 | *0.137* |
| | SI | 0.1 | 0.375 | 0.25 | 0.8 | 1 | 0.75 | 1 | 0.65 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |
| SA | Input | 10 | 0 | 0 | 9.36 | 8.33 | 23.62 | 21.3 | 23.62 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 60 | 30 | 60 | 0.98 | 0.010 | 0.046 | 0.900 | *0.055* | 1 | *0.055* |
| | SI | 0.001 | 0.2 | 0.001 | 1 | 1 | 0.95 | 1 | 0.8 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | 1 | | | | | | |

Notes:

**Variable Descriptions:**

**V1**-% pool, backwater coverage; **V3**-% bottom cover (Adult, Juv); **V4**-% bottom cover (Fry); **V6**-Dissolved O2 (mg/L), pools; **V7**-pH, growing season; **V8**-Temp (°C), growing season (Adult, Juv); **V9**-Temp (°C), spawning season (Embryo); **V10**-Temp (°C), growing season (Fry); **V11**-Turbidity (ppm); **V12**-Max salinity (ppt), summer (Adult, Juv); **V13**-Max salinity (ppt), summer (Fry); **V14**-Max salinity (ppt), spawning season (Embryo); **V15**-Substrate composition; **V16**-Avg water fluctuation (m), growing season (Adult, Juv); **V17**-Max water fluctuation (m), spawning season (Embryo); **V18**-Avg water fluctuation (m), growing season, (Fry); **V19**-Avg current vel (cm/sec), summer (Adult, Juv); **V20**-Max current vel (cm/sec), pools, spawning season, (Embryo); **V21**-Avg current vel (cm/sec), summer (Fry); **V22**-Stream gradient (m/km).

**Terms used for calculating HSI:**

**Cf**-Food component term; **Cc**-Cover component term; **Cwq**-Water quality component term; **Cr**-Reproductive component term; **Cot**-Other component term.

**Calculation of HSI Index:**

See formulas presented in Appendix G.

For variables producing a 0 value for the SI, 0.001 was substituted when calculating terms of the HSI.

*Since the Cr term was below 0.4 the Cr value was used as HSI for all sites.*

**Input value estimation**:

V6-DO measured in the field assumed to approximate pool DO.

V9-Temp during spawning season assumed to be 90% of temp measured in the field during, (Parsons ES March 2001).

V11-Turbity assumed to be intermediate in value, 25-100 ppm

V14-Spawning season salinity assumed to be approximately salinity measured during summer sampling.

V16, V18-Avg water surface elevation variation assumed negligible due to strict summer agricultural demands.

V17-Max water fluctuation during spawning seasoned assumed to not exceed 1m.

V19, V21-used weighted average velocity measured from cross-sectional data collected at each site, (Parsons ES March 2001).

V20-Max current vel in pools assumed to be half the avg current vel (see V19, V21).

V22-Summer stream surface elevation at beginning and ending mile marker used to estimate stream gradient at each site [Alternatives Formulation Report, Appendix C, (Parsons ES, March 2001)].

All other variable values measured directly in the Sept 2000 field sampling event.

**Site Codes:**

UR – Upper Rincon; G – Garfield, H – Hatch; SA – Sierra Alta, SC – Seldon Canyon; DA – Shalem Colony; LC – Las Cruces; MDD– Mesilla Dam; BM – Black Mesa; and EP – El Paso.

**Table C-5 Calculation of Flathead Catfish Habitat Suitability Indices Based on Data from Surveys at Artificial Habitat Structures in the RGCP September 1999 USFWS Sampling Data**

| Site | Model Variable | V1 | V2 | V3 | V4 | V5 | V6 | HSI |
|---|---|---|---|---|---|---|---|---|
| Montoya Weir | Input | <1 | 140 | 0 | 10 | 40 | 50 | 0.7 |
| | SI | 1 | 1 | 1 | 0.7 | 0.95 | 0.8 | |
| Tierra Blanca Green Weir | Input | <1 | 140 | 0 | 10 | 40 | 50 | 0.7 |
| | SI | 1 | 1 | 1 | 0.7 | 0.95 | 0.8 | |
| Trujillo Groin | Input | <1 | 140 | 0.17 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Montoya* Groin | Input | <1 | 140 | 0.13 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Jaralosa* Groin | Input | <1 | 140 | 0 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Yeso Groin | Input | <1 | 140 | 0.12 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Placitas Groin | Input | <1 | 140 | 0.09 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Garcia Groin | Input | <1 | 140 | 0.09 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Angostora Groin | Input | <1 | 140 | 0.09 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Rincon Groin | Input | <1 | 140 | 0.06 | 5 | 70 | 25 | 0.4 |
| | SI | 1 | 1 | 1 | 0.4 | 0.9 | 0.45 | |
| Trujillo Embayment | Input | <1 | 140 | 0.13 | 0 | 0 | 25 | 0.1 |
| | SI | 1 | 1 | 1 | 0.1 | 1 | 0.45 | |
| Jaralosa* Embayment | Input | <1 | 140 | 0.05 | 0 | 0 | 25 | 0.1 |
| | SI | 1 | 1 | 1 | 0.1 | 1 | 0.45 | |
| Rincon Embayment | Input | <1 | 140 | 0.33 | 0 | 0 | 25 | 0.1 |
| | SI | 1 | 1 | 1 | 0.1 | 1 | 0.45 | |

Notes:

**Variable Descriptions:**

V1-Stream Gradient (m/km); V2-Turbidity (JTU); V3-Mean Velocity (m/s); V4-% Riffle; V5-% Run V6-% Pool.

**HSI:**

HSI value equivalent to lowest SI of the six physical variables.

**Input Value Estimation:**

V1- Since the habitat enhancement structures function to create backwater, stream gradient assumed to be less than 1 m/km at each site area of influence.
V2- Intermediate value, 140 JTU, assumed to reflect average turbidity.
V3- Current velocity measured by NMFO adjacent to structure in Sept 1999 or June 1999.
V4- Value assumed to be 10% for weirs, 5% for groins, and 0% for embayments.
V5- Value assumed to be 40% for weirs, 70% for groins and 0% for embayments.
V6- As with Largemouth Bass HSI calculations value assumed to be 50% for weirs, 25% for groins, and 0% for embayments.

# Table C-6 Calculation of Largemouth Bass Habitat Suitability Indices

## Based on Data from Surveys at Artificial Habitat Structures in the RGCP (September 1999 USFWS Sampling Data)

| Site | Model Variable | V1 | V3 | V4 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V17 | V18 | V19 | V20 | V21 | Cf | Cc | Cwq | Cr | Cot | HSI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montoya Weir | Input | 50 | 20 | 20 | 6.39 | >8 | 23.4 | 21.06 | 23.4 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 0 | 0 | 0 | 0.64 | 0.74 | 0.83 | 0.82 | 1 | 0.80 |
| | SI | 0.75 | 0.6 | 0.5 | 0.8 | 1 | 0.9 | 1 | 0.7 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 1 | 1 | 1 | | | | | | |
| Tierra Blanca Green Weir | Input | 50 | 20 | 20 | 5.8 | >8 | 22.4 | 20.16 | 22.4 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 0 | 0 | 0 | 0.64 | 0.74 | 0.79 | 0.82 | 1 | 0.79 |
| | SI | 0.75 | 0.6 | 0.5 | 0.8 | 1 | 0.8 | 1 | 0.65 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 1 | 1 | 1 | | | | | | |
| Trujillo Groin | Input | 25 | 10 | 10 | 7.1 | >8 | 21.2 | 19.08 | 21.2 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 17 | 17 | 17 | 0.24 | 0.39 | 0.73 | 0.15 | 0.10 | 0.15 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 0.65 | 0.85 | 0.5 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.2 | 0.001 | 0.001 | | | | | | |
| Montoya* Groin | Input | 25 | 10 | 10 | 6.86 | >8 | 22.3 | 20.07 | 22.3 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 13 | 13 | 13 | 0.24 | 0.39 | 0.78 | 0.16 | 0.25 | 0.16 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 0.775 | 1 | 0.6 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.5 | 0.001 | 0.001 | | | | | | |
| Jaralosa* Groin | Input | 25 | 10 | 10 | 7.58 | >8 | 24.7 | 22.23 | 24.7 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 0 | 0 | 0 | 0.24 | 0.39 | 0.89 | 0.62 | 1 | 0.56 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 1 | 0.95 | 0.9 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 1 | 1 | 1 | | | | | | |
| Yeso Groin | Input | 25 | 10 | 10 | 6.29 | >8 | 25 | 22.5 | 25 | 25-100 | 0.3 | 0.3 | 0.3 | Mostly Sand | 0 | 1 | 0 | 12 | 12 | 12 | 0.24 | 0.39 | 0.89 | 0.16 | 0.28 | 0.16 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 1 | 0.95 | 0.9 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.55 | 0.001 | 0.001 | | | | | | |
| Placitas Groin | Input | 25 | 10 | 10 | 6.74 | >8 | 25.7 | 23.13 | 25.7 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 9 | 9 | 9 | 0.24 | 0.39 | 0.89 | 0.37 | 0.38 | 0.37 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 1 | 0.7 | 0.95 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.75 | 0.1 | 0.001 | | | | | | |
| Garcia Groin | Input | 25 | 10 | 10 | 6.21 | >8 | 25.4 | 22.86 | 25.4 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 9 | 9 | 9 | 0.24 | 0.39 | 0.89 | 0.38 | 0.38 | 0.38 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 1 | 0.8 | 0.95 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.75 | 0.1 | 0.001 | | | | | | |
| Angostora Groin | Input | 25 | 10 | 10 | 6.9 | >8 | 24.7 | 22.23 | 24.7 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 9 | 9 | 9 | 0.24 | 0.39 | 0.89 | 0.39 | 0.38 | 0.39 |
| | SI | 0.2 | 0.375 | 0.225 | 0.8 | 1 | 1 | 0.95 | 0.9 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.75 | 0.1 | 0.001 | | | | | | |
| Rincon Groin | Input | 25 | 10 | 10 | 3.71 | >8 | 24 | 21.6 | 24 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 6 | 6 | 6 | 0.24 | 0.39 | 0.76 | 0.48 | 0.50 | 0.44 |
| | SI | 0.2 | 0.375 | 0.225 | 0.4 | 1 | 1 | 1 | 0.8 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 1 | 0.25 | 0.001 | | | | | | |
| Trujillo Embayment | Input | 100 | 0 | 0 | 6.9 | >8 | 23.9 | 21.51 | 23.9 | 25-100 | 0.2 | 0.2 | 0.2 | Mostly Sand | 0 | 1 | 0 | 13 | 13 | 13 | 0.32 | 0.46 | 0.86 | 0.22 | 0.25 | 0.22 |
| | SI | 1 | 0.2 | 0.001 | 0.8 | 1 | 0.95 | 1 | 0.8 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.5 | 0.001 | 0.001 | | | | | | |
| Jaralosa* Embayment | Input | 100 | 0 | 0 | 6.95 | >8 | 22.3 | 20.07 | 22.3 | 25-100 | 0.1 | 0.1 | 0.1 | Mostly Sand | 0 | 1 | 0 | 5 | 5 | 5 | 0.32 | 0.46 | 0.79 | 0.68 | 0.50 | 0.52 |
| | SI | 1 | 0.2 | 0.001 | 0.8 | 1 | 0.775 | 1 | 0.65 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 1 | 0.3 | 0.001 | | | | | | |
| Rincon Embayment | Input | 100 | 0 | 0 | 2.56 | >8 | 23.9 | 21.51 | 23.9 | 25-100 | 0.4 | 0.4 | 0.4 | Mostly Sand | 0 | 1 | 0 | 33 | 33 | 33 | 0.32 | 0.46 | 0.76 | 0.22 | 0.001 | 0.22 |
| | SI | 1 | 0.2 | 0.001 | 0.4 | 1 | 0.95 | 1 | 0.9 | 0.7 | 1 | 1 | 1 | 0.5 | 1 | 0.975 | 1 | 0.001 | 0.001 | 0.001 | | | | | | |

Notes:

**Variable Descriptions:**

**V1**-% pool, backwater coverage; **V3**-% bottom cover (Adult, Juv); **V4**-% bottom cover (Fry); **V6**-Dissolved O2 (mg/L), pools; **V7**-pH, growing season; **V8**-Temp (°C), growing season (Adult, Juv); **V9**-Temp (°C), spawning season (Embryo); **V10**-Temp (°C), growing season; V11-Turbidity (ppm); V12-Max salinity (ppt), summer (Adult, Juv); V13-Max salinity (ppt), summer (Fry); V14-Max salinity (ppt), spawning season (Embryo); V15-Substrate composition; **V16**-Avg water fluctuation (m), growing season (Adult, Juv); **V17**-Max water spawning season (Embryo); V18-Avg water fluctuation (m), growing season, (Fry); V19-Avg current vel (cm/sec), summer (Adult, Juv); **V20**-Max current vel (cm/sec), pools, spawning season, (Embryo); **V21**-Avg current vel (cm/sec), summer (Fry); **V22**-Stream gradi

**Terms used for calculating HSI:**

**Cf**-Food component term; **Cc**-Cover component term; **Cwq**-Water quality component term; **Cr**-Reproductive component term; **Cot**-Other component term.

**Calculation of HSI Index:**

See formulas presented in Appendix G.
For variables producing a 0 value for the SI, 0.001 was substituted when calculating terms of the HSI.
Since the Cr term was below 0.4 the Cr value was used as HSI for all sites.

**Input value estimation**:

V1-Embayments may provide 100% backwater, weirs 50%, and groins 25%.
V3&V4-Embayments provide 0% bottom cover, weirs 20%, and groins 10%.
V6-DO measured in the field assumed to approximate pool DO.
V7-pH assumed to be greater than 8 as it was at all transect series during Parsons ES, Sept 2000 sampling
V9-Temp during spawning season assumed to be 90% of temp measured in the field during, Parsons ES, Sept 2000.
V11-Turbity assumed to be intermediate in value, 25-100 ppm.
V14-Spawning season salinity assumed to be approximately salinity measured during summer sampling.
V15-Substrate composition assumed to be mostly sand.
V16, V18-Avg water surface elevation variation assumed negligible due to strict summer agricultural demands.
V17-Max water fluctuation during spawning seasoned assumed to not exceed 1m.
V19, V21-Velocity measurements from NMFRO Annual Report and represents June 1999 sampling event.
V20-Max current vel in pools assumed to be half current vel (see V19, V21).
All other variable values measured directly in the June1999 field sampling event.

# APPENDIX D
# SCIENTIFIC SPECIES LIST

## Table D-1. Index of Scientific Names for Plant Species

| Category | Common Name | Scientific Name |
|---|---|---|
| ***Forb / Herb*** | Buttercup | *Ranunculus cymbalaria* |
| | Cattail | *Typha* spp. |
| | Russian thistle | *Salsola kali* |
| | Saltbush | *Atriplex spp.* |
| ***G rasses*** | Black gama | *Bouteloua eriopoda* |
| | Reed grass | *Pragmites australis* |
| | Rush | *Juncus* spp. |
| | Salt grass | *Distichlis spicatai* |
| | Sedge | *Carex spp.* |
| | Tubosa | *Hilaria mutica* |
| ***Shrub*** | Creosote bush | *Larrea tridentate* |
| | False indigo | *Amorpha fruticosa* |
| | Snakeweed | *Gutierrezia sarothra* |
| | Tarbush | *Flourensia cernua* |
| | Wolfberry | *Lycium berlandieri* |
| | Yucca | *Yucca* spp. |
| ***Tree*** | Acacia | *Acacia* spp. |
| | Ash | *Fraxinus* spp. |
| | Berlandier ash | *Fraxinus berlandieri* |
| | Cottonwood | *Populus fremontii* |
| | Desert willow | *Chilopis linearis* |
| | Little walnut | *Juglans microcarpa* |
| | Mesquite | *Prosopis spp.* |
| | Netleaf hackberry | *Celtis reticulata* |
| | New Mexico olive | *Forestiera pubescens* |
| | Russian olive | *Elaeagnus angustifolia* |
| | Salt cedar | *Tamarix chinensis, Tamarix* spp. |
| | Seep willow | *Baccharis glutinosa* |
| | Western chokeberry | *Prunus virginiana* |
| | Willow | *Salix gooddingii* |

## Table D-2. Index of Scientific Names for Animal Species

| Category | Common Name | Scientific Name |
|---|---|---|
| ***Mammal*** | Desert pocket gopher | *Geomys bursarius* |
| | Jackrabbit | *Lepus calinifornicus* |
| | Occult little brown bat | *Myotis lucifugus occultus* |
| | Pecos River muskrat | *Ondatra zibethicus ripensis* |
| ***Avian*** | Bald eagle | *Haliaeetus leucocephalus* |
| | Black tern | *Chlidonias niger* |
| | Interior least tern | *Sterna antillarum* |
| | Loggerhead shrike | *Lanius ludovicianus* |
| | Mexican Spotted Owl | *Strix occidentalis lucida* |
| | Northern aplomado falcon | *Falco femoralis septentrionalis* |
| | Northern gray hawk | *Buteo nitidus maximus* |
| | Southwest willow flycatcher | *Empidonax traillii extimus* |
| | Western burrowing owl | *Athene cunicularia hypagaea* |
| | White-faced ibis | *Plegadis chihi* |
| | Whooping crane | *Grus americana* |
| | Yellow-Billed Cuckoo | *Coccyzus americanus* |
| ***Reptile*** | Texas horned lizard | *Phrynosoma cornutum* |
| ***Amphibian*** | Arizona southwestern toad | *Bufo microscaphus microscaphus* |
| ***Fish*** | Bluegill | *Lepomis macrochirus* |
| | Bullhead minnow | *Pimephales vigilax* |
| | Channel catfish | *Ictalurus punctatus* |
| | Common carp | *Cyprinus carpio* |
| | Fathead minnow | *Pimephales promelas* |
| | Fathead minnow | *Pimephales promelas* |
| | Flathead catfish | *Pylodictis olivaris* |
| | Gizzard shad | *Dorosoma cepedianum* |
| | Green sunfish | *Lepomis cyanellus* |
| | Green sunfish | *Lepomis cyanellus* |
| | Largemouth bass | *Micropterus salmoides* |
| | Largemouth bass | *Micropterus salmoides* |
| | Longear sunfish | *Lepomis megalotis* |
| | Longnose dace | *Rhinichthys cataractae* |
| | Red shiner | *Cyprinella lutrensis* |
| | Red shiner | *Cyprinella lutrensis* |
| | River carpsucker | *Carpiodes carpio* |
| | Spotted bass | *Micropterus punctulatus* |
| | Threadfin shad | *Dorosoma petenense* |
| | Western mosquito fish | *Gambusia affinis* |
| | Western mosquito fish | *Gambusia affinis* |
| | White bass | *Morone chrysops* |
| | Yellow perch | *Morone Americana* |
| ***Invertebrate*** | Anthony blister beetle | *Lytta mirifica* |
| | Desert viceroy butterfly | *Limenitis archippus obsoleta* |

# APPENDIX E
# FLOOD CONTAINMENT CAPACITY ANALYSIS

Following completion of the Reformulation of Alternatives Report (Parsons 2003), the HEC-RAS hydraulic model was modified to recalculate flood containment capacity of the RGCP. The updated model simulated a floodway vegetation growth that, while greater that current conditions, represents a significant reduction to those conditions simulated during preparation of the Alternatives Formulation Report (Parsons 2001a). Relative to previously simulated conditions, the extent that vegetation would be allowed to grow was minimized in the southern reach of the RGCP.

Table E-1 lists modified roughness coefficients relative to values originally used in the 1996 USACE model. Individual cross-sections used in model are identified by River mile, the distance from American Dam in El Paso. For the banks, coefficient changes were made to simulate development of native grasslands (n=0.04) and cottonwoods (n=0.15) along the riparian corridor at selected RGCP locations. No changes were made in the river channel coefficients (n=0.02) relative to the 1996 simulations. Results of the flood containment analysis are discussed in Section 4.2 of the DEIS.

Table E-2 compares results of the current conditions, as simulated by USACE in 1996), and as modified conditions simulating vegetation growth. A solid bar indicates sections of the RGCO where levees are present. The center column indicates the potential increase in water elevation as a result the increase in vegetation growth (roughness coefficient). Sections of the RGCP where the simulated freeboard is less that 3 feet (the design value above the maximum water elevation for the 100-year flood) are highlighted.

**Table E-1 Changes in Floodway Roughness Coefficients**

| Site | Miles from Am. Dam | Roughness Coefficient (Manning's "n") | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Original Coefficient (USACE 1996) | | | Modified Coefficient (Parsons 2003) | | | | |
| | | Left Bank | Channel | Right Bank | Left Bank | | Channel | Right Bank | |
| **UPPER RINCON RIVER MANAGEMENT UNIT** | | | | | | | | | |
| **Oxbow** | 104.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Restoration** | 104.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 104.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Tripton** | 103.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| **Arroyo** | 103.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 103.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Trujillo** | 103.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Arroyo** | 103.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 103.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 103.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.5 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.3 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.2 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.1 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 102.0 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.9 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.8 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.7 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |

| | | Roughness Coefficient (Manning's "n") | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Miles from** | **Original Coefficient (USACE 1996)** | | | **Modified Coefficient (Parsons 2003)** | | | | |
| **Site** | **Am. Dam** | **Left Bank** | **Channel** | **Right Bank** | **Left Bank** | | **Channel** | **Right Bank** | |
| **Montoya** | 101.6 | 0.035 | **0.02** | 0.035 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Arroyo** | 101.4 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.3 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.2 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 101.1 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Holguin** | 100.9 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| **Arroyo** | 100.9 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 100.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 100.7 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 100.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Green/** | 99.9 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Tierra** | 99.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Blanca** | 99.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Arroyos** | 99.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 99.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 99.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 99.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 99.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 98.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 98.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 98.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 98.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 98.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Sibley** | 98.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| **Arroyo** | 98.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 98.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 98.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 98.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 97.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 97.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 97.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 97.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| **Jaralosa** | 97.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| **Arroyo** | 97.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| | 97.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| | 97.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| | 97.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| | 97.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | |
| | 97.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 96.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 95.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 95.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 95.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 95.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |

| Site | Miles from Am. Dam | Roughness Coefficient (Manning's "n") | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Original Coefficient (USACE 1996) | | | Modified Coefficient (Parsons 2003) | | | | |
| | | Left Bank | Channel | Right Bank | Left Bank | | Channel | Right Bank | |
| | 95.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 95.4 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 95.3 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 95.2 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 95.1 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 95.0 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 94.9 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 94.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 94.7 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 94.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Yeso** | 94.2 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Arroyo** | 94.1 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 94.0 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 93.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.7 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 93.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Crow** | 92.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| **Canyon** | 92.4 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 92.3 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 92.2 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 92.1 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 92.0 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.9 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.8 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.7 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.6 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.5 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.3 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.2 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.1 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 91.0 | 0.03 | **0.02** | 0.03 | 0.15 | 0.15 | **0.02** | 0.15 | |
| | 90.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 90.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 90.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 90.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 90.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | |
| **LOWER RINCON RIVER MANAGEMENT UNIT** | | | | | | | | | |
| **Hatch** | 90.3 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | |
| **Siphon** | 90.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | |
| | 90.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | |
| | 90.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | |
| | 90.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | |
| | 90.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 90.1 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 90.1 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |

| Site | Miles from Am. Dam | Roughness Coefficient (Manning's "n") | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Original Coefficient (USACE 1996) | | | Modified Coefficient (Parsons 2003) | | | | |
| | | Left Bank | Channel | Right Bank | Left Bank | | Channel | Right Bank | |
| | 90.1 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 89.9 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 89.9 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Wetlands** | 88.7 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Unit A** | 88.6 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 88.5 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 88.4 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 88.4 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Wetlands** | 87.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Unit B** | 87.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 87.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 87.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 87.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Garfield** | 86.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Drain** | 86.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 86.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 85.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Placitas** | 85.4 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.03 | 0.03 |
| **Arroyo** | 85.3 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.03 | 0.03 |
| | 85.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.03 | 0.03 |
| | 85.1 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.03 | 0.03 |
| | 85.0 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 84.9 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 84.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| | 84.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| | 84.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| | 84.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| | 84.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| | 84.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.04 | 0.04 |
| **Remnant** | 83.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Bosque/** | 83.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| **Rincon** | 83.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 83.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 82.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 82.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 82.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 82.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.03 | 0.03 |
| | 82.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.03 | 0.03 |
| | 82.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 82.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 82.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| | 82.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |
| **Angostura** | 80.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Arroyo** | 80.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 80.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 80.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 80.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 80.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 80.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 80.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | |

| Site | Miles from Am. Dam | Roughness Coefficient (Manning's "n") | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Original Coefficient (USACE 1996) | | | Modified Coefficient (Parsons 2003) | | | | |
| | | Left Bank | Channel | Right Bank | Left Bank | | Channel | Right Bank | |
| | 80.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 79.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 79.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Rincon/** | 78.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Reed** | 78.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Arroyos** | 78.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 78.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 78.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 78.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 78.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 77.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 77.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Bignell** | 76.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **Arroyo** | 76.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 76.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 76.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 75.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 75.9 | 0.03 | **0.02** | 0.08 | 0.04 | 0.15 | **0.02** | 0.15 | |
| | 75.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 75.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| **SELDON CANYON RIVER MANAGEMENT UNIT** | | | | | | | | | |
| **Dead Man's** | 69.3 | 0.05 | **0.02** | 0.03 | 0.05 | 0.05 | **0.02** | 0.04 | 0.15 |
| **Curve** | 69.2 | 0.05 | **0.02** | 0.03 | 0.05 | 0.05 | **0.02** | 0.04 | 0.15 |
| | 69.1 | 0.05 | **0.02** | 0.03 | 0.05 | 0.05 | **0.02** | 0.04 | 0.15 |
| | 69.0 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | 68.9 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | 68.8 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | 68.8 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | 68.7 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | 68.6 | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| | | 0.08 | **0.02** | 0.03 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| **Broad** | 68.1 | 0.08 | **0.02** | 0.08 | 0.08 | 0.08 | **0.02** | 0.04 | 0.15 |
| **Canyon** | 67.9 | 0.08 | **0.02** | 0.08 | 0.08 | 0.08 | **0.02** | 0.15 | |
| **UPPER MESILLA RIVER MANAGEMENT UNIT** | | | | | | | | | |
| **West Side** | 58.0 | 0.03 | **0.02** | 0.035 | 0.03 | 0.03 | **0.02** | 0.065 | 0.065 |
| | 57.9 | 0.03 | **0.02** | 0.035 | 0.03 | 0.03 | **0.02** | 0.065 | 0.065 |
| **Levee** | 57.4 | 0.03 | **0.02** | 0.035 | 0.04 | 0.15 | **0.02** | 0.065 | 0.065 |
| **Setback** | 57.3 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | 0.065 |
| | 57.2 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | 0.065 |
| | 57.1 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | |
| | 56.9 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | |
| | 56.8 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | |
| | 56.7 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | 0.065 |
| | 56.6 | 0.03 | **0.02** | 0.065 | 0.15 | 0.15 | **0.02** | 0.065 | 0.065 |
| | 56.5 | 0.03 | **0.02** | 0.065 | 0.04 | 0.15 | **0.02** | 0.065 | 0.065 |
| **Channel** | 54.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| **Cut** | 54.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |

| **Site** | **Miles from Am. Dam** | **Roughness Coefficient (Manning's "n")** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Original Coefficient (USACE 1996)** | | | **Modified Coefficient (Parsons 2003)** | | | | |
| | | **Left Bank** | **Channel** | **Right Bank** | **Left Bank** | | **Channel** | **Right Bank** | |
| | 54.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 54.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| | 53.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.04 | **0.02** | 0.15 | 0.15 |
| **Spillway** | 53.0 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| **No. 2A** | 52.9 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.8 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.7 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.7 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.6 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.5 | 0.03 | **0.02** | 0.08 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.4 | 0.03 | **0.02** | 0.035 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| | 52.3 | 0.03 | **0.02** | 0.035 | 0.04 | 0.04 | **0.02** | 0.08 | 0.08 |
| **LAS CRUCES RIVER MANAGEMENT UNIT** | | | | | | | | | |
| | 50.7 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 50.6 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 50.5 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Spillway** | 50.2 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **No. 5** | 50.1 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 50.0 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 49.9 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **Spillway** | 48.9 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| **No. 39** | 48.8 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.04 | 0.04 |
| | 48.7 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.15 | 0.04 |
| | 48.6 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.15 | 0.04 |
| | 48.4 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.15 | 0.04 |
| | 48.3 | 0.03 | **0.02** | 0.03 | 0.03 | 0.03 | **0.02** | 0.15 | 0.04 |
| **Spillway** | 47.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| **No. 8** | 47.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| | 47.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| | 47.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| **Spillway** | 47.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| **No. 39A** | 47.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| | 47.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.04 | 0.04 |
| **NMGF** | 42.1 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.04 |
| | 42.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 42.0 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.9 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.8 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.7 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.6 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.5 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.4 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.3 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.05 |
| | 41.2 | 0.03 | **0.02** | 0.03 | 0.04 | 0.15 | **0.02** | 0.15 | 0.15 |
| | 40.7 | 0.03 | **0.02** | 0.035 | 0.04 | 0.15 | **0.02** | 0.03 | 0.03 |
| | 40.6 | 0.03 | **0.02** | 0.035 | 0.04 | 0.04 | **0.02** | 0.03 | 0.03 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 105.34 | 13.99 | 13.99 | | 0.00 | | 10.85 | 10.85 |
| 105.30 | 11.33 | 11.33 | | 0.00 | | 11.86 | 11.86 |
| 105.20 | 12.37 | 12.35 | | 0.02 | | 13.33 | 13.31 |
| 105.11 | 12.48 | 12.44 | | 0.04 | | 15.08 | 15.04 |
| 105.01 | 12.21 | 12.16 | | 0.05 | | 12.37 | 12.32 |
| 104.92 | 11.91 | 11.84 | | 0.07 | | 11.85 | 11.78 |
| 104.82 | 13.62 | 13.53 | | 0.09 | | 11.49 | 11.40 |
| 104.73 | 14.62 | 14.49 | | 0.13 | | 10.60 | 10.47 |
| 104.64 | 10.08 | 9.91 | | 0.17 | | 7.53 | 7.36 |
| 104.54 | 9.00 | 8.78 | | 0.22 | | 12.52 | 12.30 |
| 104.45 | 6.01 | 5.78 | | 0.23 | | 11.75 | 11.52 |
| 104.35 | 12.60 | 12.35 | | 0.25 | | 12.53 | 12.28 |
| 104.26 | 13.98 | 13.71 | | 0.27 | | 12.51 | 12.24 |
| 104.20 | 11.45 | 11.16 | | 0.29 | | 12.45 | 12.16 |
| 104.20 | 11.48 | 11.18 | | 0.30 | | 12.48 | 12.18 |
| 104.20 | 11.49 | 11.19 | | 0.30 | | 12.49 | 12.19 |
| 104.20 | 11.49 | 11.19 | | 0.30 | | 12.49 | 12.19 |
| 104.07 | 12.60 | 12.29 | | 0.31 | | 9.70 | 9.39 |
| 103.98 | 11.85 | 11.53 | | 0.32 | | 9.97 | 9.65 |
| 103.69 | 6.87 | 6.52 | | 0.35 | | 10.46 | 10.11 |
| 103.60 | 6.04 | 5.74 | | 0.30 | | 9.83 | 9.53 |
| 103.50 | 3.74 | 3.33 | | 0.41 | | 8.92 | 8.51 |
| 103.41 | 4.54 | 4.08 | | 0.46 | | 9.11 | 8.65 |
| 103.31 | 8.01 | 7.52 | | 0.49 | | 9.54 | 9.05 |
| 103.22 | 1.29 | 0.78 | | 0.51 | | 3.44 | 2.93 |
| 103.12 | 2.15 | 1.65 | | 0.50 | | 2.68 | 2.18 |
| 103.03 | 9.36 | 8.76 | | 0.60 | | 1.11 | 0.51 |
| 102.93 | 8.25 | 7.72 | | 0.53 | | 0.27 | 0.26 |
| 102.84 | 9.07 | 8.55 | | 0.52 | | 3.91 | 3.39 |
| 102.65 | 3.15 | 2.60 | | 0.55 | | 8.35 | 7.80 |
| 102.56 | 4.08 | 3.94 | | 0.14 | | 8.28 | 8.14 |
| 102.46 | 4.07 | 3.59 | | 0.48 | | 7.88 | 7.40 |
| 102.27 | 7.07 | 6.65 | | 0.42 | | 2.74 | 2.32 |
| 102.18 | 0.55 | 0.20 | | 0.35 | | 3.45 | 3.10 |
| 102.08 | 7.09 | 6.62 | | 0.47 | | 3.56 | 3.09 |
| 101.99 | 5.40 | 4.98 | | 0.42 | | 3.55 | 3.13 |
| 101.89 | 4.65 | 4.27 | | 0.38 | | 2.32 | 1.94 |
| 101.80 | 5.43 | 5.12 | | 0.31 | | 1.87 | 1.56 |
| 101.70 | 3.03 | 2.62 | | 0.41 | | 1.86 | 1.45 |
| 101.61 | 3.75 | 3.38 | | 0.37 | | 1.49 | 1.12 |
| 101.51 | 3.06 | 2.66 | | 0.40 | | 0.24 | 0.16 |
| 101.32 | 3.37 | 1.87 | | 1.50 | | 3.67 | 2.17 |
| 101.23 | 0.57 | 0.61 | | 1.18 | | 2.17 | 0.99 |
| 101.14 | 3.56 | 2.80 | | 0.76 | | 5.56 | 4.80 |
| 101.04 | 2.07 | 1.42 | | 0.65 | | 2.40 | 1.75 |
| 100.85 | 0.64 | 0.15 | | 0.49 | | 2.44 | 1.95 |
| 100.76 | 8.18 | 7.94 | | 0.24 | | 1.68 | 1.44 |
| 100.66 | 27.27 | 27.20 | | 0.07 | | 2.27 | 2.20 |
| 100.56 | 0.21 | 0.17 | | 0.38 | | 2.93 | 2.55 |
| 100.47 | 24.13 | 23.80 | | 0.33 | | 1.31 | 0.98 |
| 100.38 | 87.77 | 87.50 | | 0.27 | | 2.41 | 2.14 |
| 100.28 | 63.96 | 63.61 | | 0.35 | | 2.43 | 2.08 |
| 100.19 | 32.68 | 32.40 | | 0.28 | | 1.45 | 1.17 |
| 100.09 | 5.85 | 5.68 | | 0.17 | | 7.15 | 6.98 |
| 100.00 | 3.72 | 3.58 | | 0.14 | | 3.62 | 3.48 |
| 100.00 | 3.73 | 3.66 | | 0.07 | | 3.63 | 3.56 |
| 100.00 | 3.74 | 3.69 | | 0.05 | | 3.64 | 3.59 |
| 100.00 | 3.74 | 3.67 | | 0.07 | | 3.64 | 3.57 |
| 99.81 | 1.24 | 1.17 | | 0.07 | | 3.60 | 3.53 |
| 99.72 | 2.60 | 2.68 | | 0.08 | | 3.84 | 3.92 |
| 99.53 | 3.93 | 2.83 | | 1.10 | | 4.33 | 3.23 |
| 99.44 | 2.18 | 1.20 | | 0.98 | | 4.38 | 3.40 |
| 99.34 | 0.80 | 0.36 | | 0.44 | | 3.35 | 2.91 |
| 99.29 | 0.53 | 0.06 | | 0.59 | | 3.93 | 3.34 |
| 99.15 | 2.90 | 2.59 | | 0.31 | | 1.90 | 1.59 |
| 98.96 | 1.06 | 0.51 | | 0.55 | | 0.89 | 0.34 |
| 98.77 | 2.06 | 1.82 | | 0.24 | | 2.26 | 2.02 |
| 98.68 | 3.95 | 3.88 | | 0.07 | | 1.15 | 1.08 |
| 98.58 | 2.99 | 2.64 | | 0.35 | | 0.99 | 0.64 |
| 98.49 | 3.31 | 2.97 | | 0.34 | | 4.48 | 4.14 |
| 98.39 | 2.09 | 1.77 | | 0.32 | | 5.29 | 4.97 |
| 98.30 | 1.49 | 1.21 | | 0.28 | | 12.09 | 11.81 |
| 98.20 | 1.07 | 1.14 | | 0.07 | | 10.32 | 10.39 |
| 98.11 | 1.15 | 1.69 | | 0.54 | | 8.31 | 8.85 |

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 98.01 | 3.81 | 3.30 | | 0.51 | | 7.71 | 7.20 |
| 97.92 | 3.79 | 3.02 | | 0.77 | | 8.18 | 7.41 |
| 97.83 | 2.47 | 2.69 | | 0.22 | | 15.38 | 15.60 |
| 97.73 | 0.91 | 0.89 | | 0.02 | | 27.95 | 27.93 |
| 97.64 | 3.39 | 3.39 | | 0.00 | | 47.91 | 47.91 |
| 97.54 | 4.01 | 3.93 | | 0.08 | | 22.18 | 22.10 |
| 97.45 | 6.45 | 6.32 | | 0.13 | | 13.92 | 13.79 |
| 97.35 | 6.66 | 6.50 | | 0.16 | | 2.81 | 2.65 |
| 97.26 | 7.03 | 6.87 | | 0.16 | | 2.16 | 2.00 |
| 97.16 | 7.33 | 7.12 | | 0.21 | | 1.73 | 1.52 |
| 97.07 | 7.42 | 7.25 | | 0.17 | | 2.22 | 2.05 |
| 96.97 | 6.26 | 6.08 | | 0.18 | | 1.86 | 1.68 |
| 96.88 | 7.46 | 7.32 | | 0.14 | | 0.66 | 0.52 |
| 96.78 | 7.25 | 7.06 | | 0.19 | | 2.05 | 1.86 |
| 96.69 | 7.70 | 7.93 | | 0.23 | | 8.27 | 8.50 |
| 96.50 | 8.75 | 8.62 | | 0.13 | | 3.29 | 3.16 |
| 96.41 | 9.14 | 8.99 | | 0.15 | | 3.26 | 3.11 |
| 96.22 | 8.68 | 8.47 | | 0.21 | | 1.68 | 1.47 |
| 96.12 | 8.44 | 8.19 | | 0.25 | | 4.03 | 3.78 |
| 95.93 | 8.71 | 8.32 | | 0.39 | | 3.29 | 2.90 |
| 95.74 | 7.74 | 7.52 | | 0.22 | | 6.32 | 6.10 |
| 95.65 | 7.14 | 7.08 | | 0.06 | | 6.44 | 6.38 |
| 95.55 | 8.02 | 7.52 | | 0.50 | | 9.08 | 8.58 |
| 95.46 | 7.27 | 6.72 | | 0.55 | | 17.33 | 16.78 |
| 95.36 | 7.54 | 7.18 | | 0.36 | | 12.89 | 12.53 |
| 95.27 | 7.20 | 6.74 | | 0.46 | | 25.18 | 24.72 |
| 95.17 | 7.85 | 7.41 | | 0.44 | | 29.03 | 28.59 |
| 95.08 | 7.90 | 7.45 | | 0.45 | | 24.15 | 23.70 |
| 94.98 | 8.26 | 7.89 | | 0.37 | | 16.89 | 16.52 |
| 94.89 | 7.92 | 7.37 | | 0.55 | | 8.58 | 8.03 |
| 94.80 | 8.53 | 8.37 | | 0.16 | | 6.44 | 6.28 |
| 94.70 | 8.16 | 7.77 | | 0.39 | | 5.28 | 4.89 |
| 94.65 | 8.19 | 7.76 | | 0.43 | | 4.94 | 4.51 |
| 94.51 | 8.51 | 8.13 | | 0.38 | | 7.73 | 7.35 |
| 94.42 | 7.78 | 7.57 | | 0.21 | | 9.81 | 9.60 |
| 94.32 | 7.41 | 7.19 | | 0.22 | | 9.02 | 8.80 |
| 94.23 | 7.22 | 7.08 | | 0.14 | | 8.03 | 7.89 |
| 94.13 | 6.99 | 7.02 | | 0.03 | | 17.16 | 17.19 |
| 94.04 | 7.25 | 7.37 | | 0.12 | | 17.44 | 17.56 |
| 93.94 | 8.26 | 8.08 | | 0.18 | | 13.56 | 13.38 |
| 93.75 | 9.49 | 8.95 | | 0.54 | | 15.18 | 14.64 |
| 93.66 | 8.85 | 8.72 | | 0.13 | | 17.75 | 17.62 |
| 93.56 | 8.83 | 8.74 | | 0.09 | | 6.54 | 6.45 |
| 93.47 | 7.23 | 7.29 | | 0.06 | | 5.84 | 5.90 |
| 93.37 | 6.21 | 6.45 | | 0.24 | | 5.79 | 6.03 |
| 93.28 | 5.94 | 6.13 | | 0.19 | | 5.58 | 5.77 |
| 93.19 | 7.52 | 7.18 | | 0.34 | | 7.16 | 6.82 |
| 93.09 | 8.57 | 8.29 | | 0.28 | | 8.29 | 8.01 |
| 93.00 | 7.74 | 7.79 | | 0.05 | | 7.46 | 7.51 |
| 92.90 | 6.34 | 6.38 | | 0.04 | | 17.43 | 17.47 |
| 92.80 | 6.83 | 6.97 | | 0.14 | | 29.38 | 29.52 |
| 92.71 | 7.74 | 7.59 | | 0.15 | | 44.66 | 44.51 |
| 92.62 | 7.41 | 7.43 | | 0.02 | | 22.01 | 22.03 |
| 92.52 | 6.92 | 7.00 | | 0.08 | | 7.42 | 7.50 |
| 92.33 | 7.16 | 7.09 | | 0.07 | | 2.36 | 2.29 |
| 92.24 | 7.17 | 7.10 | | 0.07 | | 2.07 | 2.00 |
| 92.14 | 7.37 | 7.30 | | 0.07 | | 8.47 | 8.40 |
| 92.05 | 7.21 | 7.13 | | 0.08 | | 8.67 | 8.59 |
| 91.95 | 7.35 | 7.25 | | 0.10 | | 7.15 | 7.05 |
| 91.76 | 7.52 | 7.41 | | 0.11 | | 0.92 | 0.81 |
| 91.67 | 7.12 | 6.92 | | 0.20 | | 2.52 | 2.32 |
| 91.58 | 7.90 | 7.35 | | 0.55 | | 2.81 | 2.26 |
| 91.48 | 7.26 | 6.46 | | 0.80 | | 5.26 | 4.46 |
| 91.39 | 8.43 | 7.06 | | 1.37 | | 6.95 | 5.58 |
| 91.20 | 6.69 | 5.53 | | 1.16 | | 7.69 | 6.53 |
| 91.10 | 6.05 | 4.91 | | 1.14 | | 6.85 | 5.71 |
| 91.01 | 6.96 | 5.18 | | 1.78 | | 5.76 | 3.98 |
| 90.91 | 7.35 | 5.00 | | 2.35 | | 7.91 | 5.56 |
| 90.82 | 6.58 | 4.51 | | 2.07 | | 5.78 | 3.71 |
| 90.63 | 6.80 | 7.36 | | 0.56 | | 23.17 | 23.73 |
| 90.53 | 6.52 | 6.08 | | 0.44 | | 18.77 | 18.33 |
| 90.44 | 7.43 | 7.00 | | 0.43 | | 36.83 | 36.40 |
| 90.34 | 8.60 | 8.53 | | 0.07 | | 2.68 | 2.61 |
| 90.25 | 8.21 | 8.11 | | 0.10 | | 4.17 | 4.07 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 90.16 | 8.38 | 8.28 | | 0.10 | | 5.61 | 5.51 |
| 90.14 | 9.23 | 9.07 | | 0.16 | | 5.83 | 5.67 |
| 90.12 | 9.42 | 9.08 | | 0.34 | | 6.71 | 6.37 |
| 90.10 | 9.28 | 9.11 | | 0.17 | | 7.16 | 6.99 |
| 90.06 | 10.08 | 9.98 | | 0.10 | | 7.02 | 6.92 |
| 90.04 | 10.05 | 9.95 | | 0.10 | | 6.90 | 6.80 |
| 90.01 | 10.34 | 10.31 | | 0.03 | | 6.34 | 6.31 |
| 89.96 | 10.13 | 10.22 | | 0.09 | | 6.53 | 6.62 |
| 89.82 | 10.18 | 10.14 | | 0.04 | | 6.78 | 6.74 |
| 89.78 | 10.73 | 10.73 | | 0.00 | | 6.17 | 6.17 |
| 89.68 | 10.24 | 10.18 | | 0.06 | | 9.24 | 9.18 |
| 89.59 | 11.01 | 11.10 | | 0.09 | | 10.37 | 10.46 |
| 89.49 | 11.45 | 11.47 | | 0.02 | | 6.97 | 6.99 |
| 89.40 | 10.76 | 10.76 | | 0.00 | | 10.16 | 10.16 |
| 89.30 | 9.78 | 9.78 | | 0.00 | | 9.58 | 9.58 |
| 89.21 | 9.98 | 9.98 | | 0.00 | | 8.78 | 8.78 |
| 89.11 | 10.53 | 10.53 | | 0.00 | | 9.73 | 9.73 |
| 89.02 | 9.33 | 9.33 | | 0.00 | | 9.28 | 9.28 |
| 88.92 | 9.53 | 9.52 | | 0.01 | | 8.93 | 8.92 |
| 88.83 | 9.52 | 9.51 | | 0.01 | | 8.07 | 8.06 |
| 88.73 | 9.28 | 9.28 | | 0.00 | | 8.08 | 8.08 |
| 88.64 | 9.94 | 9.94 | | 0.00 | | 9.47 | 9.47 |
| 88.55 | 9.90 | 9.89 | | 0.01 | | 8.91 | 8.90 |
| 88.45 | 10.25 | 10.25 | | 0.00 | | 8.85 | 8.85 |
| 88.36 | 11.28 | 11.27 | | 0.01 | | 8.88 | 8.87 |
| 88.26 | 8.93 | 8.92 | | 0.01 | | 8.33 | 8.32 |
| 88.17 | 8.83 | 8.81 | | 0.02 | | 8.27 | 8.25 |
| 88.07 | 9.26 | 9.24 | | 0.02 | | 8.33 | 8.31 |
| 88.00 | 11.91 | 11.88 | | 0.03 | | 12.60 | 12.57 |
| 87.99 | 11.29 | 11.26 | | 0.03 | | 11.93 | 11.90 |
| 87.99 | 11.36 | 11.33 | | 0.03 | | 12.00 | 11.97 |
| 87.99 | 12.12 | 12.09 | | 0.03 | | 12.81 | 12.78 |
| 87.89 | 9.85 | 9.82 | | 0.03 | | 9.25 | 9.22 |
| 87.79 | 10.13 | 10.08 | | 0.05 | | 9.73 | 9.68 |
| 87.70 | 10.34 | 10.27 | | 0.07 | | 9.34 | 9.27 |
| 87.60 | 9.77 | 9.70 | | 0.07 | | 9.17 | 9.10 |
| 87.51 | 9.99 | 9.90 | | 0.09 | | 8.99 | 8.90 |
| 87.41 | 9.91 | 9.81 | | 0.10 | | 9.48 | 9.38 |
| 87.32 | 8.64 | 8.52 | | 0.12 | | 9.37 | 9.25 |
| 87.22 | 8.64 | 8.51 | | 0.13 | | 9.24 | 9.11 |
| 87.13 | 8.61 | 8.47 | | 0.14 | | 9.21 | 9.07 |
| 87.03 | 8.21 | 8.05 | | 0.16 | | 9.27 | 9.11 |
| 86.94 | 7.34 | 7.17 | | 0.17 | | 8.54 | 8.37 |
| 86.85 | 7.36 | 7.18 | | 0.18 | | 8.36 | 8.18 |
| 86.75 | 6.98 | 6.79 | | 0.19 | | 8.28 | 8.09 |
| 86.66 | 6.81 | 6.61 | | 0.20 | | 7.41 | 7.21 |
| 86.56 | 6.86 | 6.68 | | 0.18 | | 7.06 | 6.88 |
| 86.47 | 7.23 | 7.00 | | 0.23 | | 7.46 | 7.23 |
| 86.37 | 6.57 | 6.32 | | 0.25 | | 7.17 | 6.92 |
| 86.29 | 5.60 | 5.34 | | 0.26 | | 5.78 | 5.52 |
| 86.29 | 5.66 | 5.40 | | 0.26 | | 5.79 | 5.53 |
| 86.29 | 5.69 | 5.42 | | 0.27 | | 5.82 | 5.55 |
| 86.29 | 5.67 | 5.41 | | 0.26 | | 5.85 | 5.59 |
| 86.19 | 0.29 | 0.54 | | 0.25 | | 5.40 | 5.15 |
| 86.09 | 2.16 | 2.33 | | 0.17 | | 5.04 | 4.87 |
| 86.00 | 1.31 | 1.22 | | 0.09 | | 4.47 | 4.38 |
| 85.81 | 0.27 | 0.30 | | 0.03 | | 5.33 | 5.30 |
| 85.71 | 3.50 | 3.50 | | 0.00 | | 4.82 | 4.82 |
| 85.62 | 4.95 | 4.76 | | 0.19 | | 5.55 | 5.36 |
| 85.43 | 20.93 | 20.71 | | 0.22 | | 5.13 | 4.91 |
| 85.34 | 5.53 | 5.22 | | 0.31 | | 5.77 | 5.46 |
| 85.24 | 2.28 | 1.97 | | 0.31 | | 5.29 | 4.98 |
| 85.15 | 0.73 | 0.68 | | 0.05 | | 5.30 | 5.25 |
| 85.05 | 1.06 | 1.03 | | 0.03 | | 5.93 | 5.90 |
| 84.96 | 0.64 | 0.87 | | 0.23 | | 5.41 | 5.64 |
| 84.86 | 4.53 | 4.59 | | 0.06 | | 5.21 | 5.27 |
| 84.77 | 0.21 | 0.21 | | 0.00 | | 4.43 | 4.43 |
| 84.67 | 0.80 | 0.80 | | 0.00 | | 5.71 | 5.71 |
| 84.58 | 0.74 | 0.73 | | 0.01 | | 4.94 | 4.93 |
| 84.48 | 0.92 | 0.92 | | 0.00 | | 4.49 | 4.49 |
| 84.39 | 4.41 | 4.41 | | 0.00 | | 5.28 | 5.28 |
| 84.29 | 5.23 | 5.23 | | 0.00 | | 4.49 | 4.49 |
| 84.20 | 14.05 | 14.04 | | 0.01 | | 13.20 | 13.19 |
| 84.19 | 14.05 | 14.05 | | 0.00 | | 13.20 | 13.20 |

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 84.19 | 14.16 | 14.15 | | 0.01 | | 13.31 | 13.30 |
| 84.19 | 14.17 | 14.16 | | 0.01 | | 13.32 | 13.31 |
| 84.02 | 32.40 | 32.12 | | 0.28 | | 6.20 | 5.92 |
| 83.92 | 10.66 | 10.39 | | 0.27 | | 5.86 | 5.59 |
| 83.83 | 19.08 | 18.82 | | 0.26 | | 4.37 | 4.11 |
| 83.73 | 21.74 | 21.48 | | 0.26 | | 3.94 | 3.68 |
| 83.64 | 19.91 | 19.66 | | 0.25 | | 4.31 | 4.06 |
| 83.54 | 29.38 | 29.13 | | 0.25 | | 3.38 | 3.13 |
| 83.45 | 16.37 | 16.05 | | 0.32 | | 3.87 | 3.55 |
| 83.35 | 24.73 | 24.42 | | 0.31 | | 4.93 | 4.62 |
| 83.26 | 22.02 | 21.67 | | 0.35 | | 4.30 | 3.95 |
| 83.16 | 31.65 | 31.32 | | 0.33 | | 4.65 | 4.32 |
| 83.07 | 20.05 | 19.66 | | 0.39 | | 3.99 | 3.60 |
| 82.97 | 15.16 | 14.76 | | 0.40 | | 3.94 | 3.54 |
| 82.88 | 12.21 | 11.78 | | 0.43 | | 4.23 | 3.80 |
| 82.78 | 16.14 | 15.68 | | 0.46 | | 3.71 | 3.25 |
| 82.69 | 16.54 | 16.05 | | 0.49 | | 3.14 | 2.65 |
| 82.60 | 17.67 | 17.17 | | 0.50 | | 2.79 | 2.29 |
| 82.50 | 6.23 | 5.72 | | 0.51 | | 1.66 | 1.15 |
| 82.41 | 9.61 | 9.10 | | 0.51 | | 1.11 | 0.60 |
| 82.31 | 2.69 | 2.17 | | 0.52 | | 0.88 | 0.36 |
| 82.22 | 1.76 | 1.48 | | 0.28 | | 1.26 | 0.98 |
| 82.12 | 1.68 | 1.52 | | 0.16 | | 1.10 | 0.94 |
| 82.03 | 3.33 | 3.56 | | 0.23 | | 1.07 | 1.30 |
| 81.87 | 6.04 | 5.61 | | 0.43 | | 6.02 | 5.59 |
| 81.87 | 6.33 | 5.80 | | 0.53 | | 6.33 | 5.80 |
| 81.87 | 6.42 | 6.12 | | 0.30 | | 6.42 | 6.12 |
| 81.87 | 6.37 | 6.07 | | 0.30 | | 6.35 | 6.05 |
| 81.86 | 1.68 | 1.39 | | 0.29 | | 0.79 | 0.50 |
| 81.86 | 1.68 | 1.39 | | 0.29 | | 0.79 | 0.50 |
| 81.86 | 3.59 | 3.41 | | 0.18 | | 3.88 | 3.70 |
| 81.86 | 3.85 | 3.71 | | 0.14 | | 3.84 | 3.70 |
| 81.86 | 4.11 | 3.92 | | 0.19 | | 4.10 | 3.91 |
| 81.86 | 4.07 | 3.87 | | 0.20 | | 4.36 | 4.16 |
| 81.83 | 4.38 | 4.28 | | 0.10 | | 4.41 | 4.31 |
| 81.82 | 5.11 | 5.04 | | 0.07 | | 5.10 | 5.03 |
| 81.81 | 5.04 | 5.00 | | 0.04 | | 4.84 | 4.80 |
| 81.80 | 5.94 | 5.96 | | 0.02 | | 5.04 | 5.06 |
| 81.80 | 6.72 | 6.72 | | 0.00 | | 6.58 | 6.58 |
| 81.79 | 7.37 | 7.35 | | 0.02 | | 7.77 | 7.75 |
| 81.79 | 6.91 | 6.90 | | 0.01 | | 7.51 | 7.50 |
| 81.78 | 6.99 | 6.98 | | 0.01 | | 7.59 | 7.58 |
| 81.75 | 6.50 | 6.48 | | 0.02 | | 7.50 | 7.48 |
| 81.66 | 6.84 | 6.82 | | 0.02 | | 7.14 | 7.12 |
| 81.56 | 6.33 | 6.31 | | 0.02 | | 7.13 | 7.11 |
| 81.47 | 6.55 | 6.53 | | 0.02 | | 6.75 | 6.73 |
| 81.37 | 6.77 | 6.74 | | 0.03 | | 7.17 | 7.14 |
| 81.28 | 6.40 | 6.36 | | 0.04 | | 7.07 | 7.03 |
| 81.18 | 6.31 | 6.25 | | 0.06 | | 6.96 | 6.90 |
| 81.09 | 5.19 | 5.11 | | 0.08 | | 6.73 | 6.65 |
| 80.99 | 5.56 | 5.47 | | 0.09 | | 6.76 | 6.67 |
| 80.90 | 5.91 | 5.81 | | 0.10 | | 6.81 | 6.71 |
| 80.80 | 5.77 | 5.68 | | 0.09 | | 6.97 | 6.88 |
| 80.71 | 4.95 | 4.87 | | 0.08 | | 5.65 | 5.57 |
| 80.61 | 5.33 | 5.27 | | 0.06 | | 6.13 | 6.07 |
| 80.52 | 5.24 | 5.17 | | 0.07 | | 5.72 | 5.65 |
| 80.42 | 4.94 | 4.87 | | 0.07 | | 4.74 | 4.67 |
| 80.33 | 5.15 | 5.06 | | 0.09 | | 19.97 | 19.88 |
| 80.24 | 4.43 | 4.33 | | 0.10 | | 19.88 | 19.78 |
| 80.14 | 4.40 | 4.31 | | 0.09 | | 13.23 | 13.14 |
| 79.95 | 5.29 | 5.12 | | 0.17 | | 12.49 | 12.32 |
| 79.86 | 3.15 | 3.01 | | 0.14 | | 10.40 | 10.26 |
| 79.76 | 4.06 | 3.90 | | 0.16 | | 4.75 | 4.59 |
| 79.67 | 5.31 | 5.03 | | 0.28 | | 5.15 | 4.87 |
| 79.57 | 4.09 | 3.77 | | 0.32 | | 6.13 | 5.81 |
| 79.48 | 3.86 | 3.52 | | 0.34 | | 4.20 | 3.86 |
| 79.38 | 3.98 | 3.61 | | 0.37 | | 4.97 | 4.60 |
| 79.29 | 4.20 | 3.79 | | 0.41 | | 4.88 | 4.47 |
| 79.19 | 3.06 | 2.63 | | 0.43 | | 4.30 | 3.87 |
| 79.10 | 3.39 | 2.93 | | 0.46 | | 4.55 | 4.09 |
| 79.00 | 4.26 | 3.72 | | 0.54 | | 4.56 | 4.02 |
| 78.91 | 2.49 | 1.92 | | 0.57 | | 4.09 | 3.52 |
| 78.82 | 7.37 | 6.77 | | 0.60 | | 6.97 | 6.37 |
| 78.82 | 7.40 | 6.80 | | 0.60 | | 7.60 | 7.00 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 78.82 | 7.42 | 6.82 | | 0.60 | | 7.62 | 7.02 |
| 78.82 | 7.42 | 6.81 | | 0.61 | | 7.02 | 6.41 |
| 78.63 | 2.60 | 2.00 | | 0.60 | | 2.60 | 2.00 |
| 78.44 | 5.19 | 5.43 | | 0.24 | | 3.99 | 4.23 |
| 78.35 | 3.45 | 3.07 | | 0.38 | | 3.76 | 3.38 |
| 78.25 | 3.12 | 2.28 | | 0.84 | | 6.32 | 5.48 |
| 78.16 | 3.07 | 2.24 | | 0.83 | | 4.07 | 3.24 |
| 78.06 | 3.60 | 2.82 | | 0.78 | | 3.60 | 2.82 |
| 77.92 | 3.69 | 2.91 | | 0.78 | | 3.69 | 2.91 |
| 77.78 | 3.06 | 3.23 | | 0.17 | | 3.94 | 4.11 |
| 77.68 | 3.42 | 3.64 | | 0.22 | | 4.42 | 4.64 |
| 77.59 | 4.56 | 4.76 | | 0.20 | | 4.73 | 4.93 |
| 77.50 | 4.69 | 4.61 | | 0.08 | | 5.31 | 5.23 |
| 77.40 | 4.99 | 4.81 | | 0.18 | | 4.86 | 4.68 |
| 77.31 | 3.99 | 3.80 | | 0.19 | | 4.18 | 3.99 |
| 77.21 | 4.36 | 4.12 | | 0.24 | | 4.53 | 4.29 |
| 77.12 | 3.43 | 3.15 | | 0.28 | | 4.76 | 4.48 |
| 77.02 | 3.85 | 3.49 | | 0.36 | | 4.84 | 4.48 |
| 76.93 | 4.28 | 3.69 | | 0.59 | | 4.69 | 4.10 |
| 76.83 | 4.23 | 3.58 | | 0.65 | | 4.23 | 3.58 |
| 76.74 | 3.99 | 3.29 | | 0.70 | | 3.86 | 3.16 |
| 76.64 | 2.99 | 2.75 | | 0.24 | | 3.15 | 2.91 |
| 76.55 | 3.70 | 3.60 | | 0.10 | | 2.71 | 2.61 |
| 76.45 | 3.85 | 3.40 | | 0.45 | | 2.88 | 2.43 |
| 76.36 | 3.51 | 2.98 | | 0.53 | | 3.33 | 2.80 |
| 76.26 | 3.07 | 2.52 | | 0.55 | | 2.15 | 1.60 |
| 76.17 | 2.27 | 1.70 | | 0.57 | | 3.30 | 2.73 |
| 76.07 | 2.26 | 2.10 | | 0.16 | | 3.39 | 3.23 |
| 75.98 | 1.83 | 1.60 | | 0.23 | | 2.83 | 2.60 |
| 75.89 | 2.11 | 1.91 | | 0.20 | | 2.91 | 2.71 |
| 75.79 | 3.20 | 3.39 | | 0.19 | | 1.58 | 1.77 |
| 75.70 | 3.37 | 3.23 | | 0.14 | | 11.26 | 11.12 |
| 75.60 | 4.70 | 4.22 | | 0.48 | | 2.70 | 2.22 |
| 75.22 | 1.49 | 1.53 | | 0.04 | | 0.07 | 0.11 |
| 75.13 | 1.01 | 1.06 | | 0.05 | | 15.71 | 15.76 |
| 75.03 | 0.38 | 0.38 | | 0.00 | | 34.45 | 34.45 |
| 74.94 | 0.71 | 0.71 | | 0.00 | | 16.94 | 16.94 |
| 74.84 | 0.86 | 0.86 | | 0.00 | | 8.86 | 8.86 |
| 74.75 | 0.42 | 0.42 | | 0.00 | | 1.00 | 1.00 |
| 74.65 | 0.64 | 0.64 | | 0.00 | | 17.25 | 17.25 |
| 74.56 | 0.38 | 0.38 | | 0.00 | | 11.46 | 11.46 |
| 74.47 | 0.40 | 0.40 | | 0.00 | | 12.23 | 12.23 |
| 74.37 | 0.49 | 0.49 | | 0.00 | | 10.48 | 10.48 |
| 74.28 | 2.12 | 2.12 | | 0.00 | | 5.48 | 5.48 |
| 74.18 | 0.46 | 0.46 | | 0.00 | | 6.47 | 6.47 |
| 74.09 | 0.77 | 0.77 | | 0.00 | | 5.15 | 5.15 |
| 73.99 | 2.05 | 2.05 | | 0.00 | | 6.35 | 6.35 |
| 73.90 | 2.28 | 2.28 | | 0.00 | | 7.22 | 7.22 |
| 73.80 | 3.19 | 3.19 | | 0.00 | | 6.91 | 6.91 |
| 73.76 | 1.43 | 1.43 | | 0.00 | | 0.87 | 0.87 |
| 73.76 | 2.13 | 2.13 | | 0.00 | | 2.69 | 2.69 |
| 73.71 | 3.54 | 3.54 | | 0.00 | | 8.00 | 8.00 |
| 73.61 | 2.79 | 2.79 | | 0.00 | | 17.79 | 17.79 |
| 73.52 | 2.40 | 2.40 | | 0.00 | | 18.98 | 18.98 |
| 73.43 | 2.62 | 2.62 | | 0.00 | | 19.34 | 19.34 |
| 73.33 | 2.29 | 2.29 | | 0.00 | | 15.09 | 15.09 |
| 73.24 | 2.25 | 2.25 | | 0.00 | | 15.10 | 15.10 |
| 73.14 | 3.02 | 3.02 | | 0.00 | | 15.41 | 15.41 |
| 73.07 | 2.87 | 2.87 | | 0.00 | | 9.43 | 9.43 |
| 72.95 | 2.29 | 2.29 | | 0.00 | | 5.83 | 5.83 |
| 72.86 | 1.77 | 1.77 | | 0.00 | | 6.17 | 6.17 |
| 72.76 | 2.34 | 2.34 | | 0.00 | | 4.34 | 4.34 |
| 72.67 | 2.05 | 2.05 | | 0.00 | | 9.65 | 9.65 |
| 72.57 | 1.46 | 1.46 | | 0.00 | | 12.29 | 12.29 |
| 72.48 | 1.07 | 1.07 | | 0.00 | | 11.30 | 11.30 |
| 72.38 | 0.70 | 0.70 | | 0.00 | | 10.54 | 10.54 |
| 72.29 | 1.21 | 1.21 | | 0.00 | | 10.77 | 10.77 |
| 72.19 | 0.76 | 0.76 | | 0.00 | | 11.23 | 11.23 |
| 72.10 | 0.84 | 0.84 | | 0.00 | | 11.56 | 11.56 |
| 72.01 | 1.55 | 1.55 | | 0.00 | | 13.88 | 13.88 |
| 71.91 | 3.56 | 3.56 | | 0.00 | | 21.36 | 21.36 |
| 71.82 | 5.25 | 5.25 | | 0.00 | | 13.65 | 13.65 |
| 71.72 | 4.43 | 4.43 | | 0.00 | | 6.97 | 6.97 |
| 71.63 | 4.22 | 4.22 | | 0.00 | | 4.08 | 4.08 |

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 71.53 | 1.89 | 1.89 | | 0.00 | | 14.61 | 14.61 |
| 71.44 | 4.38 | 4.38 | | 0.00 | | 5.82 | 5.82 |
| 71.34 | 3.60 | 3.60 | | 0.00 | | 17.76 | 17.76 |
| 71.25 | 3.77 | 3.77 | | 0.00 | | 25.33 | 25.33 |
| 71.15 | 4.45 | 4.45 | | 0.00 | | 21.35 | 21.35 |
| 71.06 | 0.99 | 0.99 | | 0.00 | | 15.23 | 15.23 |
| 70.96 | 2.78 | 2.78 | | 0.00 | | 0.58 | 0.58 |
| 70.87 | 2.89 | 2.89 | | 0.00 | | 0.79 | 0.79 |
| 70.77 | 2.58 | 2.58 | | 0.00 | | 0.58 | 0.58 |
| 70.68 | 2.62 | 2.62 | | 0.00 | | 0.94 | 0.94 |
| 70.58 | 1.44 | 1.44 | | 0.00 | | 0.54 | 0.54 |
| 70.49 | 43.10 | 43.11 | | 0.01 | | 16.34 | 16.35 |
| 70.40 | 14.90 | 14.91 | | 0.01 | | 0.70 | 0.69 |
| 70.30 | 15.24 | 15.25 | | 0.01 | | 5.84 | 5.85 |
| 70.21 | 11.42 | 11.43 | | 0.01 | | 2.42 | 2.43 |
| 70.11 | 9.94 | 9.95 | | 0.01 | | 0.72 | 0.73 |
| 70.02 | 12.05 | 12.06 | | 0.01 | | 1.15 | 1.14 |
| 69.92 | 11.17 | 11.18 | | 0.01 | | 1.75 | 1.74 |
| 69.83 | 11.43 | 11.44 | | 0.01 | | 1.77 | 1.76 |
| 69.73 | 10.70 | 10.71 | | 0.01 | | 1.40 | 1.39 |
| 69.64 | 5.35 | 5.36 | | 0.01 | | 1.40 | 1.39 |
| 69.54 | 9.80 | 9.82 | | 0.02 | | 1.10 | 1.08 |
| 69.45 | 12.83 | 12.84 | | 0.01 | | 0.81 | 0.80 |
| 69.35 | 10.13 | 10.15 | | 0.02 | | 11.99 | 12.01 |
| 69.26 | 2.45 | 2.48 | | 0.03 | | 11.45 | 11.48 |
| 69.16 | 4.82 | 4.86 | | 0.04 | | 9.82 | 9.86 |
| 69.07 | 10.37 | 10.43 | | 0.06 | | 10.37 | 10.43 |
| 68.97 | 9.65 | 9.62 | | 0.03 | | 10.55 | 10.52 |
| 68.88 | 10.55 | 10.64 | | 0.09 | | 5.23 | 5.32 |
| 68.79 | 8.55 | 8.63 | | 0.08 | | 7.59 | 7.67 |
| 68.69 | 8.58 | 8.67 | | 0.09 | | 8.58 | 8.67 |
| 68.66 | 8.59 | 8.68 | | 0.09 | | 3.49 | 3.58 |
| 68.55 | 8.64 | 8.74 | | 0.10 | | 1.74 | 1.84 |
| 68.52 | 8.66 | 8.76 | | 0.10 | | 8.66 | 8.76 |
| 68.39 | 7.15 | 7.24 | | 0.09 | | 7.15 | 7.24 |
| 68.31 | 7.75 | 7.84 | | 0.09 | | 6.92 | 7.01 |
| 68.19 | 7.21 | 7.34 | | 0.13 | | 4.99 | 5.12 |
| 68.12 | 14.75 | 14.87 | | 0.12 | | 2.81 | 2.93 |
| 68.04 | 1.97 | 1.95 | | 0.02 | | 25.87 | 25.85 |
| 67.84 | 2.85 | 2.43 | | 0.42 | | 4.12 | 3.70 |
| 67.74 | 15.80 | 15.80 | | 0.00 | | 12.10 | 12.10 |
| 67.55 | 7.03 | 7.03 | | 0.00 | | 13.29 | 13.29 |
| 67.46 | 25.01 | 25.01 | | 0.00 | | 11.75 | 11.75 |
| 67.36 | 20.40 | 20.40 | | 0.00 | | 7.50 | 7.50 |
| 67.27 | 4.14 | 4.14 | | 0.00 | | 8.61 | 8.61 |
| 67.18 | 13.83 | 13.83 | | 0.00 | | 10.36 | 10.36 |
| 67.08 | 22.14 | 22.14 | | 0.00 | | 20.82 | 20.82 |
| 66.99 | 15.61 | 15.61 | | 0.00 | | 9.90 | 9.90 |
| 66.89 | 20.14 | 20.14 | | 0.00 | | 19.06 | 19.06 |
| 66.80 | 18.95 | 18.95 | | 0.00 | | 8.74 | 8.74 |
| 66.70 | 20.30 | 20.30 | | 0.00 | | 10.26 | 10.26 |
| 66.61 | 17.94 | 17.94 | | 0.00 | | 2.76 | 2.76 |
| 66.51 | 26.82 | 26.82 | | 0.00 | | 22.03 | 22.03 |
| 66.09 | 18.33 | 18.33 | | 0.00 | | 13.96 | 13.96 |
| 66.04 | 43.68 | 43.68 | | 0.00 | | 11.57 | 11.57 |
| 65.99 | 34.00 | 34.00 | | 0.00 | | 7.23 | 7.23 |
| 65.94 | 7.28 | 7.28 | | 0.00 | | 1.41 | 1.41 |
| 65.76 | 8.04 | 8.04 | | 0.00 | | 24.69 | 24.69 |
| 65.66 | 2.96 | 2.96 | | 0.00 | | 18.02 | 18.02 |
| 65.57 | 1.84 | 1.84 | | 0.00 | | 31.91 | 31.91 |
| 65.47 | 5.06 | 5.06 | | 0.00 | | 2.43 | 2.43 |
| 65.38 | 8.32 | 8.32 | | 0.00 | | 8.43 | 8.43 |
| 65.28 | 12.82 | 12.82 | | 0.00 | | 14.93 | 14.93 |
| 65.19 | 22.68 | 22.68 | | 0.00 | | 5.34 | 5.34 |
| 65.09 | 12.18 | 12.18 | | 0.00 | | 4.96 | 4.96 |
| 65.00 | 42.76 | 42.76 | | 0.00 | | 26.16 | 26.16 |
| 64.90 | 8.14 | 8.14 | | 0.00 | | 15.15 | 15.15 |
| 64.81 | 6.70 | 6.70 | | 0.00 | | 6.92 | 6.92 |
| 64.71 | 64.31 | 64.31 | | 0.00 | | 3.12 | 3.12 |
| 64.62 | 14.20 | 14.20 | | 0.00 | | 16.86 | 16.86 |
| 64.52 | 19.67 | 19.67 | | 0.00 | | 16.67 | 16.67 |
| 64.43 | 39.68 | 39.68 | | 0.00 | | 25.26 | 25.26 |
| 64.33 | 5.30 | 5.30 | | 0.00 | | 7.97 | 7.97 |
| 64.24 | 47.75 | 47.75 | | 0.00 | | 60.65 | 60.65 |

## Table E-2  Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 64.15 | 46.57 | 46.57 | | 0.00 | | 19.11 | 19.11 |
| 64.03 | 28.23 | 28.23 | | 0.00 | | 6.03 | 6.03 |
| 63.96 | 25.55 | 25.55 | | 0.00 | | 21.13 | 21.13 |
| 63.91 | 4.74 | 4.74 | | 0.00 | | 25.31 | 25.31 |
| 63.67 | 41.55 | 41.55 | | 0.00 | | 30.55 | 30.55 |
| 63.58 | 9.61 | 9.61 | | 0.00 | | 19.61 | 19.61 |
| 63.48 | 11.92 | 11.92 | | 0.00 | | 8.87 | 8.87 |
| 63.29 | 41.11 | 41.11 | | 0.00 | | 10.40 | 10.40 |
| 63.20 | 43.40 | 43.40 | | 0.00 | | 10.67 | 10.67 |
| 62.91 | 15.04 | 15.04 | | 0.00 | | 18.34 | 18.34 |
| 62.82 | 8.82 | 8.82 | | 0.00 | | 25.07 | 25.07 |
| 62.63 | 7.43 | 7.43 | | 0.00 | | 35.25 | 35.25 |
| 62.54 | 10.43 | 10.43 | | 0.00 | | 30.94 | 30.94 |
| 62.44 | 35.52 | 35.52 | | 0.00 | | 12.65 | 12.65 |
| 62.35 | 15.24 | 15.24 | | 0.00 | | 3.54 | 3.54 |
| 62.25 | 2.78 | 2.78 | | 0.00 | | 2.17 | 2.17 |
| 62.16 | 9.55 | 9.55 | | 0.00 | | 4.15 | 4.15 |
| 62.06 | 10.37 | 10.37 | | 0.00 | | 5.77 | 5.77 |
| 61.99 | 1.80 | 1.80 | | 0.00 | | 5.74 | 5.74 |
| 61.89 | 8.37 | 8.37 | | 0.00 | | 9.47 | 9.47 |
| 61.78 | 47.78 | 47.78 | | 0.00 | | 0.90 | 0.90 |
| 61.69 | 41.83 | 41.83 | | 0.00 | | 1.13 | 1.13 |
| 61.55 | 40.62 | 40.62 | | 0.00 | | 5.17 | 5.17 |
| 61.50 | 30.13 | 30.13 | | 0.00 | | 2.23 | 2.23 |
| 61.40 | 5.38 | 5.38 | | 0.00 | | 4.17 | 4.17 |
| 61.31 | 6.53 | 6.53 | | 0.00 | | 3.11 | 3.11 |
| 61.11 | 2.99 | 2.99 | | 0.00 | | 3.09 | 3.09 |
| 61.11 | 3.06 | 3.06 | | 0.00 | | 3.16 | 3.16 |
| 61.11 | 3.08 | 3.08 | | 0.00 | | 3.18 | 3.18 |
| 61.11 | 3.06 | 3.06 | | 0.00 | | 3.16 | 3.16 |
| 60.94 | 0.70 | 0.70 | | 0.00 | | 0.21 | 0.21 |
| 60.84 | 0.66 | 0.66 | | 0.00 | | 0.37 | 0.37 |
| 60.65 | 2.74 | 2.74 | | 0.00 | | 10.94 | 10.94 |
| 60.56 | 4.95 | 4.95 | | 0.00 | | 14.19 | 14.19 |
| 60.46 | 6.53 | 6.53 | | 0.00 | | 11.97 | 11.97 |
| 60.37 | 6.30 | 6.30 | | 0.00 | | 8.90 | 8.90 |
| 60.27 | 6.40 | 6.40 | | 0.00 | | 9.42 | 9.42 |
| 60.08 | 6.71 | 6.71 | | 0.00 | | 11.64 | 11.64 |
| 59.99 | 7.38 | 7.38 | | 0.00 | | 10.18 | 10.18 |
| 59.89 | 7.46 | 7.46 | | 0.00 | | 11.06 | 11.06 |
| 59.80 | 5.96 | 5.96 | | 0.00 | | 10.85 | 10.85 |
| 59.71 | 3.17 | 3.17 | | 0.00 | | 11.17 | 11.17 |
| 59.61 | 6.60 | 6.60 | | 0.00 | | 10.80 | 10.80 |
| 59.52 | 6.05 | 6.05 | | 0.00 | | 5.17 | 5.17 |
| 59.42 | 5.68 | 5.68 | | 0.00 | | 6.38 | 6.38 |
| 59.33 | 5.64 | 5.64 | | 0.00 | | 10.84 | 10.84 |
| 59.23 | 6.10 | 6.10 | | 0.00 | | 10.90 | 10.90 |
| 59.14 | 7.10 | 7.10 | | 0.00 | | 9.92 | 9.92 |
| 59.04 | 6.71 | 6.71 | | 0.00 | | 10.64 | 10.64 |
| 58.99 | 5.35 | 5.35 | | 0.00 | | 10.60 | 10.60 |
| 58.76 | 2.20 | 2.20 | | 0.00 | | 11.19 | 11.19 |
| 58.66 | 2.45 | 2.45 | | 0.00 | | 12.18 | 12.18 |
| 58.57 | 1.51 | 1.51 | | 0.00 | | 12.11 | 12.11 |
| 58.47 | 2.79 | 2.79 | | 0.00 | | 9.99 | 9.99 |
| 58.38 | 2.41 | 2.41 | | 0.00 | | 10.02 | 10.02 |
| 58.28 | 2.25 | 2.25 | | 0.00 | | 10.16 | 10.16 |
| 58.19 | 2.07 | 2.07 | | 0.00 | | 10.87 | 10.87 |
| 58.10 | 2.94 | 2.94 | | 0.00 | | 12.69 | 12.69 |
| 58.00 | 4.51 | 4.51 | | 0.00 | | 15.31 | 15.31 |
| 57.91 | 4.26 | 4.26 | | 0.00 | | 14.66 | 14.66 |
| 57.81 | 4.60 | 4.60 | | 0.00 | | 7.80 | 7.80 |
| 57.72 | 4.38 | 4.38 | | 0.00 | | 3.98 | 3.98 |
| 57.62 | 4.21 | 4.21 | | 0.00 | | 11.22 | 11.22 |
| 57.53 | 3.60 | 3.60 | | 0.00 | | 11.18 | 11.18 |
| 57.43 | 3.09 | 3.09 | | 0.00 | | 11.89 | 11.89 |
| 57.34 | 4.34 | 4.34 | | 0.00 | | 12.35 | 12.35 |
| 57.24 | 4.17 | 4.17 | | 0.00 | | 3.06 | 3.06 |
| 57.15 | 3.50 | 3.50 | | 0.00 | | 2.30 | 2.30 |
| 57.05 | 4.11 | 4.11 | | 0.00 | | 1.49 | 1.49 |
| 56.96 | 5.42 | 5.42 | | 0.00 | | 14.82 | 14.82 |
| 56.77 | 5.04 | 5.04 | | 0.00 | | 13.64 | 13.64 |
| 56.67 | 5.40 | 5.40 | | 0.00 | | 14.37 | 14.37 |
| 56.58 | 5.13 | 5.13 | | 0.00 | | 14.53 | 14.53 |
| 56.49 | 5.09 | 5.09 | | 0.00 | | 13.54 | 13.54 |

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 56.39 | 4.91 | 4.91 | | 0.00 | | 13.91 | 13.91 |
| 56.30 | 5.06 | 5.06 | | 0.00 | | 14.06 | 14.06 |
| 56.20 | 5.17 | 5.17 | | 0.00 | | 14.57 | 14.57 |
| 56.11 | 5.19 | 5.19 | | 0.00 | | 12.99 | 12.99 |
| 56.01 | 4.65 | 4.65 | | 0.00 | | 13.25 | 13.25 |
| 55.92 | 5.27 | 5.27 | | 0.00 | | 13.77 | 13.77 |
| 55.82 | 4.97 | 4.97 | | 0.00 | | 12.97 | 12.97 |
| 55.73 | 5.09 | 5.09 | | 0.00 | | 13.29 | 13.29 |
| 55.59 | 4.52 | 4.52 | | 0.00 | | 8.56 | 8.56 |
| 55.54 | 4.70 | 4.70 | | 0.00 | | 5.00 | 5.00 |
| 55.44 | 4.49 | 4.49 | | 0.00 | | 13.77 | 13.77 |
| 55.35 | 4.29 | 4.29 | | 0.00 | | 12.49 | 12.49 |
| 55.25 | 4.74 | 4.74 | | 0.00 | | 11.74 | 11.74 |
| 55.16 | 4.47 | 4.47 | | 0.00 | | 12.07 | 12.07 |
| 55.06 | 3.81 | 3.81 | | 0.00 | | 11.61 | 11.61 |
| 54.97 | 5.58 | 5.58 | | 0.00 | | 13.38 | 13.38 |
| 54.88 | 5.00 | 5.00 | | 0.00 | | 13.80 | 13.80 |
| 54.78 | 4.81 | 4.81 | | 0.00 | | 10.81 | 10.81 |
| 54.69 | 4.67 | 4.67 | | 0.00 | | 3.81 | 3.81 |
| 54.59 | 4.23 | 4.23 | | 0.00 | | 1.38 | 1.38 |
| 54.50 | 3.96 | 3.96 | | 0.00 | | 0.82 | 0.82 |
| 54.40 | 3.78 | 3.78 | | 0.00 | | 1.21 | 1.21 |
| 54.31 | 4.19 | 4.19 | | 0.00 | | 10.14 | 10.14 |
| 54.21 | 4.35 | 4.35 | | 0.00 | | 0.22 | 0.22 |
| 54.07 | 2.63 | 2.63 | | 0.00 | | 3.33 | 3.33 |
| 54.02 | 2.26 | 2.26 | | 0.00 | | 3.23 | 3.23 |
| 53.93 | 2.67 | 2.67 | | 0.00 | | 3.60 | 3.60 |
| 53.83 | 3.04 | 3.04 | | 0.00 | | 0.44 | 0.44 |
| 53.74 | 2.91 | 2.91 | | 0.00 | | 0.20 | 0.20 |
| 53.64 | 3.56 | 3.56 | | 0.00 | | 11.56 | 11.56 |
| 53.55 | 3.03 | 3.03 | | 0.00 | | 11.63 | 11.63 |
| 53.46 | 4.28 | 4.28 | | 0.00 | | 11.88 | 11.88 |
| 53.36 | 3.79 | 3.79 | | 0.00 | | 12.19 | 12.19 |
| 53.27 | 3.62 | 3.62 | | 0.00 | | 8.82 | 8.82 |
| 53.17 | 3.59 | 3.59 | | 0.00 | | 7.31 | 7.31 |
| 53.08 | 3.38 | 3.38 | | 0.00 | | 10.09 | 10.09 |
| 52.98 | 3.48 | 3.48 | | 0.00 | | 10.29 | 10.29 |
| 52.89 | 2.72 | 2.72 | | 0.00 | | 3.79 | 3.79 |
| 52.79 | 2.08 | 2.08 | | 0.00 | | 1.28 | 1.28 |
| 52.70 | 2.42 | 2.42 | | 0.00 | | 1.98 | 1.98 |
| 52.60 | 1.77 | 1.77 | | 0.00 | | 1.83 | 1.83 |
| 52.51 | 1.54 | 1.54 | | 0.00 | | 2.26 | 2.26 |
| 52.41 | 2.33 | 2.33 | | 0.00 | | 1.07 | 1.07 |
| 52.32 | 2.91 | 2.91 | | 0.00 | | 1.09 | 1.09 |
| 52.22 | 2.83 | 2.83 | | 0.00 | | 1.07 | 1.07 |
| 52.13 | 2.12 | 2.12 | | 0.00 | | 1.88 | 1.88 |
| 51.94 | 1.78 | 1.78 | | 0.00 | | 19.78 | 19.78 |
| 51.85 | 1.08 | 1.08 | | 0.00 | | 19.48 | 19.48 |
| 51.75 | 0.76 | 0.76 | | 0.00 | | 17.96 | 17.96 |
| 51.66 | 1.34 | 1.34 | | 0.00 | | 13.64 | 13.64 |
| 51.56 | 1.28 | 1.28 | | 0.00 | | 14.88 | 14.88 |
| 51.47 | 3.47 | 3.47 | | 0.00 | | 10.77 | 10.77 |
| 51.28 | 7.47 | 7.47 | | 0.00 | | 5.37 | 5.37 |
| 51.16 | 5.08 | 5.08 | | 0.00 | | 4.70 | 4.70 |
| 51.16 | 5.33 | 5.33 | | 0.00 | | 4.95 | 4.95 |
| 51.16 | 5.47 | 5.47 | | 0.00 | | 5.09 | 5.09 |
| 51.16 | 5.43 | 5.43 | | 0.00 | | 5.05 | 5.05 |
| 51.00 | 4.99 | 4.99 | | 0.00 | | 5.79 | 5.79 |
| 50.90 | 4.60 | 4.60 | | 0.00 | | 5.54 | 5.54 |
| 50.81 | 5.07 | 5.07 | | 0.00 | | 5.67 | 5.67 |
| 50.71 | 4.86 | 4.86 | | 0.00 | | 5.37 | 5.37 |
| 50.62 | 3.57 | 3.57 | | 0.00 | | 4.12 | 4.12 |
| 50.52 | 3.97 | 3.97 | | 0.00 | | 4.27 | 4.27 |
| 50.43 | 3.29 | 3.29 | | 0.00 | | 4.03 | 4.03 |
| 50.33 | 3.37 | 3.37 | | 0.00 | | 5.57 | 5.57 |
| 50.24 | 3.68 | 3.68 | | 0.00 | | 5.68 | 5.68 |
| 50.15 | 4.25 | 4.25 | | 0.00 | | 5.85 | 5.85 |
| 50.05 | 4.46 | 4.46 | | 0.00 | | 5.90 | 5.90 |
| 49.96 | 4.90 | 4.90 | | 0.00 | | 5.30 | 5.30 |
| 49.86 | 3.06 | 3.06 | | 0.00 | | 3.44 | 3.44 |
| 49.77 | 4.00 | 4.00 | | 0.00 | | 3.75 | 3.75 |
| 49.67 | 3.49 | 3.49 | | 0.00 | | 4.29 | 4.29 |
| 49.58 | 3.38 | 3.38 | | 0.00 | | 4.68 | 4.68 |
| 49.48 | 3.55 | 3.55 | | 0.00 | | 3.79 | 3.79 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 49.39 | 3.28 | 3.28 | | 0.00 | | 2.87 | 2.87 |
| 49.29 | 2.93 | 2.93 | | 0.00 | | 3.64 | 3.64 |
| 49.20 | 3.63 | 3.63 | | 0.00 | | 4.61 | 4.61 |
| 49.10 | 4.22 | 4.22 | | 0.00 | | 5.09 | 5.09 |
| 49.01 | 3.06 | 3.05 | | 0.01 | | 4.70 | 4.69 |
| 48.91 | 4.08 | 4.08 | | 0.00 | | 4.63 | 4.63 |
| 48.82 | 5.37 | 5.37 | | 0.00 | | 5.74 | 5.74 |
| 48.72 | 4.97 | 4.96 | | 0.01 | | 5.37 | 5.36 |
| 48.63 | 4.48 | 4.47 | | 0.01 | | 5.28 | 5.27 |
| 48.54 | 4.39 | 4.37 | | 0.02 | | 5.49 | 5.47 |
| 48.44 | 4.46 | 4.43 | | 0.03 | | 5.86 | 5.83 |
| 48.35 | 4.04 | 3.97 | | 0.07 | | 5.24 | 5.17 |
| 48.25 | 4.00 | 3.92 | | 0.08 | | 4.68 | 4.60 |
| 48.16 | 3.87 | 3.78 | | 0.09 | | 4.92 | 4.83 |
| 48.06 | 4.49 | 4.39 | | 0.10 | | 4.28 | 4.18 |
| 47.97 | 3.35 | 3.24 | | 0.11 | | 3.94 | 3.83 |
| 47.87 | 3.61 | 3.45 | | 0.16 | | 4.42 | 4.26 |
| 47.78 | 3.94 | 3.72 | | 0.22 | | 4.54 | 4.32 |
| 47.68 | 3.32 | 3.04 | | 0.28 | | 4.32 | 4.04 |
| 47.59 | 3.12 | 2.80 | | 0.32 | | 3.59 | 3.27 |
| 47.49 | 3.31 | 2.97 | | 0.34 | | 3.15 | 2.81 |
| 47.40 | 3.34 | 2.91 | | 0.43 | | 3.74 | 3.31 |
| 47.30 | 2.78 | 2.26 | | 0.52 | | 2.68 | 2.16 |
| 47.21 | 2.18 | 1.61 | | 0.57 | | 2.29 | 1.72 |
| 47.12 | 2.34 | 1.65 | | 0.69 | | 2.45 | 1.76 |
| 47.02 | 2.39 | 1.87 | | 0.52 | | 2.62 | 2.10 |
| 46.93 | 2.03 | 1.51 | | 0.52 | | 2.83 | 2.31 |
| 46.83 | 2.11 | 1.65 | | 0.46 | | 3.27 | 2.81 |
| 46.74 | 2.73 | 2.24 | | 0.49 | | 3.45 | 2.96 |
| 46.64 | 2.46 | 2.30 | | 0.16 | | 3.48 | 3.32 |
| 46.55 | 2.31 | 2.19 | | 0.12 | | 3.25 | 3.13 |
| 46.45 | 2.57 | 2.46 | | 0.11 | | 3.74 | 3.63 |
| 46.36 | 2.62 | 2.32 | | 0.30 | | 3.39 | 3.09 |
| 46.26 | 3.29 | 3.33 | | 0.04 | | 4.17 | 4.21 |
| 46.17 | 2.20 | 2.37 | | 0.17 | | 3.60 | 3.77 |
| 46.07 | 2.70 | 2.70 | | 0.00 | | 3.65 | 3.65 |
| 45.98 | 3.70 | 3.70 | | 0.00 | | 4.15 | 4.15 |
| 45.88 | 3.83 | 3.83 | | 0.00 | | 4.82 | 4.82 |
| 45.79 | 4.43 | 4.43 | | 0.00 | | 4.93 | 4.93 |
| 45.69 | 3.63 | 3.63 | | 0.00 | | 4.12 | 4.12 |
| 45.59 | 8.26 | 8.26 | | 0.00 | | 8.10 | 8.10 |
| 45.59 | 8.28 | 8.28 | | 0.00 | | 8.12 | 8.12 |
| 45.59 | 8.50 | 8.50 | | 0.00 | | 8.34 | 8.34 |
| 45.58 | 8.50 | 8.50 | | 0.00 | | 8.34 | 8.34 |
| 45.43 | 3.97 | 3.97 | | 0.00 | | 2.87 | 2.87 |
| 45.33 | 2.97 | 2.97 | | 0.00 | | 3.27 | 3.27 |
| 45.24 | 3.01 | 3.01 | | 0.00 | | 3.41 | 3.41 |
| 45.14 | 2.95 | 2.95 | | 0.00 | | 3.55 | 3.55 |
| 45.05 | 2.74 | 2.74 | | 0.00 | | 3.34 | 3.34 |
| 44.95 | 2.74 | 2.74 | | 0.00 | | 3.14 | 3.14 |
| 44.86 | 3.06 | 3.06 | | 0.00 | | 2.66 | 2.66 |
| 44.77 | 2.52 | 2.52 | | 0.00 | | 2.82 | 2.82 |
| 44.67 | 2.46 | 2.46 | | 0.00 | | 2.16 | 2.16 |
| 44.58 | 2.03 | 2.03 | | 0.00 | | 2.23 | 2.23 |
| 44.48 | 2.42 | 2.42 | | 0.00 | | 1.92 | 1.92 |
| 44.39 | 1.82 | 1.82 | | 0.00 | | 1.62 | 1.62 |
| 44.29 | 1.40 | 1.40 | | 0.00 | | 1.60 | 1.60 |
| 44.18 | 27.22 | 27.22 | | 0.00 | | 27.00 | 27.00 |
| 44.18 | 27.22 | 27.22 | | 0.00 | | 27.00 | 27.00 |
| 44.18 | 27.32 | 27.32 | | 0.00 | | 27.10 | 27.10 |
| 44.18 | 27.35 | 27.35 | | 0.00 | | 27.13 | 27.13 |
| 44.12 | 1.71 | 1.71 | | 0.00 | | 2.41 | 2.41 |
| 44.03 | 1.35 | 1.35 | | 0.00 | | 1.35 | 1.35 |
| 43.93 | 1.72 | 1.72 | | 0.00 | | 1.82 | 1.82 |
| 43.84 | 2.00 | 2.00 | | 0.00 | | 1.80 | 1.80 |
| 43.75 | 1.81 | 1.80 | | 0.01 | | 2.21 | 2.20 |
| 43.65 | 2.09 | 2.09 | | 0.00 | | 2.59 | 2.59 |
| 43.56 | 2.55 | 2.54 | | 0.01 | | 2.95 | 2.94 |
| 43.46 | 2.02 | 2.02 | | 0.00 | | 3.32 | 3.32 |
| 43.37 | 2.97 | 2.97 | | 0.00 | | 3.57 | 3.57 |
| 43.27 | 2.52 | 2.51 | | 0.01 | | 3.52 | 3.51 |
| 43.18 | 2.38 | 2.38 | | 0.00 | | 3.38 | 3.38 |
| 43.06 | 2.29 | 2.28 | | 0.01 | | 3.39 | 3.38 |
| 42.99 | 2.45 | 2.44 | | 0.01 | | 3.35 | 3.34 |
| 42.89 | 3.01 | 3.00 | | 0.01 | | 3.01 | 3.00 |
| 42.80 | 2.68 | 2.66 | | 0.02 | | 2.98 | 2.96 |
| 42.70 | 2.26 | 2.24 | | 0.02 | | 2.76 | 2.74 |
| 42.61 | 1.47 | 1.44 | | 0.03 | | 1.77 | 1.74 |
| 42.51 | 1.56 | 1.54 | | 0.02 | | 1.86 | 1.84 |
| 42.42 | 2.29 | 2.26 | | 0.03 | | 1.79 | 1.76 |
| 42.26 | 4.49 | 4.42 | | 0.07 | | 3.94 | 3.87 |
| 42.26 | 4.63 | 4.54 | | 0.09 | | 4.08 | 3.99 |
| 42.26 | 4.82 | 4.70 | | 0.12 | | 4.27 | 4.15 |
| 42.26 | 4.81 | 4.69 | | 0.12 | | 4.26 | 4.14 |
| 42.05 | 2.92 | 2.71 | | 0.21 | | 3.42 | 3.21 |
| 41.95 | 2.47 | 2.22 | | 0.25 | | 2.97 | 2.72 |
| 41.86 | 2.97 | 2.64 | | 0.33 | | 3.37 | 3.04 |
| 41.76 | 2.66 | 2.22 | | 0.44 | | 3.16 | 2.72 |
| 41.67 | 1.95 | 1.88 | | 0.07 | | 2.55 | 2.48 |
| 41.57 | 1.75 | 1.69 | | 0.06 | | 2.05 | 1.99 |
| 41.48 | 2.53 | 2.44 | | 0.09 | | 2.13 | 2.04 |
| 41.38 | 2.39 | 2.32 | | 0.07 | | 2.39 | 2.32 |
| 41.29 | 2.69 | 2.65 | | 0.04 | | 2.09 | 2.05 |
| 41.19 | 1.86 | 1.84 | | 0.02 | | 2.69 | 2.67 |
| 41.10 | 2.08 | 2.03 | | 0.05 | | 2.22 | 2.27 |
| 40.91 | 0.82 | 0.78 | | 0.04 | | 9.13 | 9.09 |
| 40.82 | 1.10 | 1.04 | | 0.06 | | 9.60 | 9.54 |
| 40.72 | 1.41 | 1.35 | | 0.06 | | 9.59 | 9.53 |
| 40.63 | 0.72 | 0.80 | | 0.08 | | 2.89 | 2.81 |
| 40.53 | 0.33 | 0.26 | | 0.07 | | 5.11 | 5.04 |
| 40.44 | 0.62 | 0.62 | | 0.00 | | 15.31 | 15.31 |
| 40.34 | 0.52 | 0.52 | | 0.00 | | 12.78 | 12.78 |
| 40.25 | 1.11 | 1.11 | | 0.00 | | 23.77 | 23.77 |
| 40.15 | 1.26 | 1.26 | | 0.00 | | 32.31 | 32.31 |
| 40.06 | 0.38 | 0.38 | | 0.00 | | 27.46 | 27.46 |
| 39.90 | 0.54 | 0.54 | | 0.00 | | 2.26 | 2.26 |
| 39.77 | 0.20 | 0.20 | | 0.00 | | 34.10 | 34.10 |
| 39.68 | 0.67 | 0.67 | | 0.00 | | 12.83 | 12.83 |
| 39.58 | 0.50 | 0.50 | | 0.00 | | 20.10 | 20.10 |
| 39.49 | 2.00 | 2.00 | | 0.00 | | 18.30 | 18.30 |
| 39.40 | 1.75 | 1.75 | | 0.00 | | 20.95 | 20.95 |
| 39.30 | 1.19 | 1.19 | | 0.00 | | 15.11 | 15.11 |
| 39.25 | 2.76 | 2.76 | | 0.00 | | 2.22 | 2.22 |
| 39.21 | 6.20 | 6.20 | | 0.00 | | 6.20 | 6.20 |
| 39.21 | 6.70 | 6.70 | | 0.00 | | 6.70 | 6.70 |
| 39.21 | 6.81 | 6.81 | | 0.00 | | 6.81 | 6.81 |
| 39.21 | 6.69 | 6.69 | | 0.00 | | 6.69 | 6.69 |
| 39.12 | 5.69 | 5.69 | | 0.00 | | 5.19 | 5.19 |
| 39.02 | 5.58 | 5.58 | | 0.00 | | 6.38 | 6.38 |
| 38.93 | 5.67 | 5.67 | | 0.00 | | 6.57 | 6.57 |
| 38.83 | 5.16 | 5.16 | | 0.00 | | 5.76 | 5.76 |
| 38.74 | 5.29 | 5.29 | | 0.00 | | 4.99 | 4.99 |
| 38.64 | 5.06 | 5.06 | | 0.00 | | 4.96 | 4.96 |
| 38.55 | 4.78 | 4.78 | | 0.00 | | 5.68 | 5.68 |
| 38.45 | 5.31 | 5.31 | | 0.00 | | 4.71 | 4.71 |
| 38.36 | 5.44 | 5.44 | | 0.00 | | 4.74 | 4.74 |
| 38.26 | 5.03 | 5.03 | | 0.00 | | 5.03 | 5.03 |
| 38.17 | 4.57 | 4.57 | | 0.00 | | 4.97 | 4.97 |
| 38.07 | 4.23 | 4.23 | | 0.00 | | 5.13 | 5.13 |
| 37.98 | 4.50 | 4.50 | | 0.00 | | 4.90 | 4.90 |
| 37.88 | 3.90 | 3.90 | | 0.00 | | 4.50 | 4.50 |
| 37.79 | 3.68 | 3.68 | | 0.00 | | 4.68 | 4.68 |
| 37.69 | 3.38 | 3.38 | | 0.00 | | 5.08 | 5.08 |
| 37.51 | 3.62 | 3.62 | | 0.00 | | 4.62 | 4.62 |
| 37.41 | 3.86 | 3.86 | | 0.00 | | 5.16 | 5.16 |
| 37.32 | 3.43 | 3.43 | | 0.00 | | 4.93 | 4.93 |
| 37.22 | 3.27 | 3.27 | | 0.00 | | 4.12 | 4.12 |
| 37.13 | 4.14 | 4.14 | | 0.00 | | 5.21 | 5.21 |
| 37.03 | 5.32 | 5.32 | | 0.00 | | 6.01 | 6.01 |
| 36.94 | 5.18 | 5.18 | | 0.00 | | 5.97 | 5.97 |
| 36.84 | 4.38 | 4.38 | | 0.00 | | 4.88 | 4.88 |
| 36.75 | 4.76 | 4.76 | | 0.00 | | 5.71 | 5.71 |
| 36.65 | 4.70 | 4.70 | | 0.00 | | 4.91 | 4.91 |
| 36.56 | 4.26 | 4.26 | | 0.00 | | 4.27 | 4.27 |
| 36.51 | 4.21 | 4.21 | | 0.00 | | 5.26 | 5.26 |
| 36.48 | 9.76 | 9.76 | | 0.00 | | 9.72 | 9.72 |
| 36.48 | 9.78 | 9.78 | | 0.00 | | 9.72 | 9.72 |
| 36.48 | 9.81 | 9.81 | | 0.00 | | 9.75 | 9.75 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) | | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) | |
|---|---|---|---|---|---|---|---|
| | 1996 | 2003 | | | | 1996 | 2003 |
| 36.48 | 9.80 | 9.80 | | 0.00 | | 9.76 | 9.76 |
| 36.38 | 5.18 | 5.18 | | 0.00 | | 6.40 | 6.40 |
| 36.28 | 4.19 | 4.19 | | 0.00 | | 5.49 | 5.49 |
| 36.19 | 3.81 | 3.81 | | 0.00 | | 6.17 | 6.17 |
| 36.09 | 3.58 | 3.58 | | 0.00 | | 5.03 | 5.03 |
| 36.00 | 3.46 | 3.46 | | 0.00 | | 4.66 | 4.66 |
| 35.90 | 3.61 | 3.61 | | 0.00 | | 5.11 | 5.11 |
| 35.81 | 3.48 | 3.48 | | 0.00 | | 5.24 | 5.24 |
| 35.62 | 5.30 | 5.30 | | 0.00 | | 6.20 | 6.20 |
| 35.52 | 4.63 | 4.63 | | 0.00 | | 5.33 | 5.33 |
| 35.43 | 5.19 | 5.19 | | 0.00 | | 5.89 | 5.89 |
| 35.33 | 5.25 | 5.25 | | 0.00 | | 5.35 | 5.35 |
| 35.24 | 4.50 | 4.50 | | 0.00 | | 5.00 | 5.00 |
| 35.15 | 4.04 | 4.04 | | 0.00 | | 4.14 | 4.14 |
| 35.05 | 5.41 | 5.41 | | 0.00 | | 5.41 | 5.41 |
| 34.96 | 5.62 | 5.62 | | 0.00 | | 5.52 | 5.52 |
| 34.86 | 6.04 | 6.04 | | 0.00 | | 5.44 | 5.44 |
| 34.77 | 6.60 | 6.60 | | 0.00 | | 6.00 | 6.00 |
| 34.67 | 5.02 | 5.02 | | 0.00 | | 5.12 | 5.12 |
| 34.58 | 5.36 | 5.36 | | 0.00 | | 5.06 | 5.06 |
| 34.48 | 5.32 | 5.32 | | 0.00 | | 5.12 | 5.12 |
| 34.39 | 5.90 | 5.90 | | 0.00 | | 5.90 | 5.90 |
| 34.29 | 5.35 | 5.35 | | 0.00 | | 5.45 | 5.45 |
| 34.20 | 5.22 | 5.22 | | 0.00 | | 5.82 | 5.82 |
| 34.10 | 4.85 | 4.85 | | 0.00 | | 4.95 | 4.95 |
| 34.01 | 5.41 | 5.41 | | 0.00 | | 5.01 | 5.01 |
| 33.91 | 4.78 | 4.78 | | 0.00 | | 4.28 | 4.28 |
| 33.82 | 4.75 | 4.75 | | 0.00 | | 5.35 | 5.35 |
| 33.72 | 6.20 | 6.20 | | 0.00 | | 5.80 | 5.80 |
| 33.63 | 6.06 | 6.06 | | 0.00 | | 5.66 | 5.66 |
| 33.54 | 5.32 | 5.32 | | 0.00 | | 5.82 | 5.82 |
| 33.43 | 5.67 | 5.67 | | 0.00 | | 5.17 | 5.17 |
| 33.35 | 5.51 | 5.51 | | 0.00 | | 4.71 | 4.71 |
| 33.25 | 5.88 | 5.88 | | 0.00 | | 5.88 | 5.88 |
| 33.16 | 6.36 | 6.36 | | 0.00 | | 6.36 | 6.36 |
| 33.06 | 5.76 | 5.76 | | 0.00 | | 6.26 | 6.26 |
| 32.97 | 5.59 | 5.59 | | 0.00 | | 5.89 | 5.89 |
| 32.87 | 5.77 | 5.77 | | 0.00 | | 5.87 | 5.87 |
| 32.78 | 5.60 | 5.60 | | 0.00 | | 6.20 | 6.20 |
| 32.68 | 5.64 | 5.64 | | 0.00 | | 6.34 | 6.34 |
| 32.59 | 5.56 | 5.56 | | 0.00 | | 5.96 | 5.96 |
| 32.49 | 6.18 | 6.18 | | 0.00 | | 5.78 | 5.78 |
| 32.40 | 5.83 | 5.83 | | 0.00 | | 5.93 | 5.93 |
| 32.35 | 10.87 | 10.87 | | 0.00 | | 10.93 | 10.93 |
| 32.35 | 10.90 | 10.90 | | 0.00 | | 10.96 | 10.96 |
| 32.35 | 10.94 | 10.94 | | 0.00 | | 11.00 | 11.00 |
| 32.35 | 10.93 | 10.93 | | 0.00 | | 10.99 | 10.99 |
| 32.22 | 4.93 | 4.93 | | 0.00 | | 5.73 | 5.73 |
| 32.12 | 4.51 | 4.51 | | 0.00 | | 5.51 | 5.51 |
| 32.03 | 5.20 | 5.20 | | 0.00 | | 5.50 | 5.50 |
| 31.93 | 4.96 | 4.96 | | 0.00 | | 5.56 | 5.56 |
| 31.84 | 5.92 | 5.92 | | 0.00 | | 6.52 | 6.52 |
| 31.75 | 5.16 | 5.16 | | 0.00 | | 5.86 | 5.86 |
| 31.65 | 5.20 | 5.20 | | 0.00 | | 4.90 | 4.90 |
| 31.56 | 5.27 | 5.27 | | 0.00 | | 5.27 | 5.27 |
| 31.46 | 5.67 | 5.67 | | 0.00 | | 5.67 | 5.67 |
| 31.27 | 4.13 | 4.13 | | 0.00 | | 5.13 | 5.13 |
| 31.18 | 4.67 | 4.67 | | 0.00 | | 4.97 | 4.97 |
| 31.08 | 5.44 | 5.44 | | 0.00 | | 5.44 | 5.44 |
| 30.99 | 5.24 | 5.24 | | 0.00 | | 6.04 | 6.04 |
| 30.89 | 5.27 | 5.27 | | 0.00 | | 6.07 | 6.07 |
| 30.80 | 5.53 | 5.53 | | 0.00 | | 5.93 | 5.93 |
| 30.70 | 5.58 | 5.58 | | 0.00 | | 6.28 | 6.28 |
| 30.61 | 5.55 | 5.55 | | 0.00 | | 5.75 | 5.75 |
| 30.51 | 5.19 | 5.19 | | 0.00 | | 5.89 | 5.89 |
| 30.42 | 4.94 | 4.94 | | 0.00 | | 5.64 | 5.64 |
| 30.32 | 5.78 | 5.78 | | 0.00 | | 5.58 | 5.58 |
| 30.23 | 5.56 | 5.56 | | 0.00 | | 6.46 | 6.46 |
| 30.14 | 5.44 | 5.44 | | 0.00 | | 5.94 | 5.94 |
| 30.04 | 4.98 | 4.98 | | 0.00 | | 4.38 | 4.38 |
| 29.95 | 4.86 | 4.86 | | 0.00 | | 4.06 | 4.06 |
| 29.85 | 5.34 | 5.34 | | 0.00 | | 4.34 | 4.34 |
| 29.76 | 5.05 | 5.05 | | 0.00 | | 3.95 | 3.95 |
| 29.66 | 4.25 | 4.25 | | 0.00 | | 3.35 | 3.35 |

| River Mile | LEFT Freeboard (feet) | | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) | |
|---|---|---|---|---|---|---|---|
| | 1996 | 2003 | | | | 1996 | 2003 |
| 29.57 | 4.16 | 4.16 | | 0.00 | | 3.76 | 3.76 |
| 29.47 | 4.47 | 4.47 | | 0.00 | | 3.87 | 3.87 |
| 29.40 | 4.57 | 4.57 | | 0.00 | | 4.27 | 4.27 |
| 29.28 | 4.69 | 4.69 | | 0.00 | | 4.69 | 4.69 |
| 29.19 | 5.19 | 5.19 | | 0.00 | | 4.89 | 4.89 |
| 29.09 | 4.19 | 4.19 | | 0.00 | | 4.29 | 4.29 |
| 29.00 | 4.60 | 4.60 | | 0.00 | | 4.20 | 4.20 |
| 28.90 | 4.98 | 4.98 | | 0.00 | | 4.78 | 4.78 |
| 28.81 | 4.43 | 4.43 | | 0.00 | | 4.53 | 4.53 |
| 28.72 | 4.76 | 4.76 | | 0.00 | | 4.36 | 4.36 |
| 28.62 | 4.62 | 4.62 | | 0.00 | | 4.32 | 4.32 |
| 28.53 | 4.23 | 4.23 | | 0.00 | | 4.23 | 4.23 |
| 28.43 | 3.95 | 3.95 | | 0.00 | | 4.15 | 4.15 |
| 28.34 | 3.87 | 3.87 | | 0.00 | | 3.27 | 3.27 |
| 28.24 | 4.12 | 4.12 | | 0.00 | | 3.52 | 3.52 |
| 28.15 | 3.77 | 3.77 | | 0.00 | | 3.57 | 3.57 |
| 28.05 | 4.30 | 4.30 | | 0.00 | | 4.10 | 4.10 |
| 27.96 | 4.58 | 4.58 | | 0.00 | | 4.08 | 4.08 |
| 27.86 | 3.76 | 3.76 | | 0.00 | | 4.06 | 4.06 |
| 27.82 | 3.41 | 3.41 | | 0.00 | | 3.76 | 3.76 |
| 27.75 | 4.25 | 4.25 | | 0.00 | | 4.25 | 4.25 |
| 27.75 | 4.25 | 4.25 | | 0.00 | | 4.24 | 4.24 |
| 27.75 | 4.30 | 4.30 | | 0.00 | | 4.29 | 4.29 |
| 27.75 | 4.29 | 4.29 | | 0.00 | | 4.28 | 4.28 |
| 27.58 | 2.96 | 2.96 | | 0.00 | | 2.86 | 2.86 |
| 27.49 | 3.01 | 3.01 | | 0.00 | | 2.51 | 2.51 |
| 27.39 | 2.07 | 2.07 | | 0.00 | | 2.47 | 2.47 |
| 27.30 | 2.64 | 2.64 | | 0.00 | | 2.04 | 2.04 |
| 27.20 | 2.09 | 2.09 | | 0.00 | | 2.09 | 2.09 |
| 27.11 | 2.32 | 2.32 | | 0.00 | | 1.32 | 1.32 |
| 26.99 | 1.59 | 1.59 | | 0.00 | | 1.39 | 1.39 |
| 26.83 | 0.01 | 0.01 | | 0.00 | | 2.39 | 2.39 |
| 26.73 | 4.32 | 4.32 | | 0.00 | | 2.32 | 2.32 |
| 26.64 | 4.11 | 4.11 | | 0.00 | | 3.11 | 3.11 |
| 26.54 | 3.74 | 3.74 | | 0.00 | | 3.34 | 3.34 |
| 26.45 | 1.65 | 1.65 | | 0.00 | | 3.85 | 3.85 |
| 26.35 | 3.17 | 3.17 | | 0.00 | | 4.57 | 4.57 |
| 26.26 | 4.26 | 4.26 | | 0.00 | | 3.86 | 3.86 |
| 26.16 | 4.48 | 4.48 | | 0.00 | | 4.18 | 4.18 |
| 26.07 | 4.25 | 4.25 | | 0.00 | | 4.25 | 4.25 |
| 25.97 | 3.50 | 3.50 | | 0.00 | | 4.30 | 4.30 |
| 25.88 | 3.21 | 3.21 | | 0.00 | | 4.51 | 4.51 |
| 25.78 | 3.03 | 3.03 | | 0.00 | | 4.43 | 4.43 |
| 25.69 | 2.02 | 2.02 | | 0.00 | | 4.02 | 4.02 |
| 25.59 | 2.83 | 2.83 | | 0.00 | | 3.83 | 3.83 |
| 25.50 | 4.33 | 4.33 | | 0.00 | | 4.03 | 4.03 |
| 25.41 | 2.81 | 2.81 | | 0.00 | | 3.71 | 3.71 |
| 25.31 | 2.64 | 2.64 | | 0.00 | | 3.84 | 3.84 |
| 25.22 | 2.66 | 2.66 | | 0.00 | | 3.56 | 3.56 |
| 25.12 | 2.22 | 2.22 | | 0.00 | | 3.22 | 3.22 |
| 25.03 | 2.80 | 2.80 | | 0.00 | | 2.90 | 2.90 |
| 24.93 | 2.52 | 2.52 | | 0.00 | | 3.22 | 3.22 |
| 24.84 | 2.12 | 2.12 | | 0.00 | | 2.72 | 2.72 |
| 24.74 | 1.33 | 1.33 | | 0.00 | | 6.63 | 6.63 |
| 24.65 | 1.97 | 1.97 | | 0.00 | | 6.77 | 6.77 |
| 24.55 | 2.43 | 2.43 | | 0.00 | | 6.33 | 6.33 |
| 24.46 | 2.27 | 2.27 | | 0.00 | | 6.37 | 6.37 |
| 24.36 | 2.21 | 2.21 | | 0.00 | | 6.01 | 6.01 |
| 24.27 | 2.45 | 2.45 | | 0.00 | | 6.35 | 6.35 |
| 24.17 | 2.36 | 2.36 | | 0.00 | | 5.36 | 5.36 |
| 24.08 | 1.51 | 1.51 | | 0.00 | | 4.81 | 4.81 |
| 24.02 | 3.96 | 3.96 | | 0.00 | | 3.98 | 3.98 |
| 24.02 | 3.92 | 3.92 | | 0.00 | | 3.91 | 3.91 |
| 24.02 | 4.05 | 4.05 | | 0.00 | | 4.04 | 4.04 |
| 24.02 | 4.95 | 4.95 | | 0.00 | | 4.97 | 4.97 |
| 23.89 | 4.01 | 4.01 | | 0.00 | | 4.71 | 4.71 |
| 23.80 | 3.47 | 3.47 | | 0.00 | | 3.27 | 3.27 |
| 23.71 | 3.00 | 3.00 | | 0.00 | | 3.30 | 3.30 |
| 23.61 | 2.50 | 2.50 | | 0.00 | | 3.10 | 3.10 |
| 23.52 | 3.57 | 3.57 | | 0.00 | | 3.37 | 3.37 |
| 23.42 | 3.25 | 3.25 | | 0.00 | | 3.05 | 3.05 |
| 23.33 | 3.76 | 3.76 | | 0.00 | | 3.76 | 3.76 |
| 23.23 | 4.40 | 4.40 | | 0.00 | | 3.20 | 3.20 |
| 23.14 | 3.36 | 3.36 | | 0.00 | | 3.56 | 3.56 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 23.04 | 2.42 | 2.42 | | 0.00 | | 2.32 | 2.32 |
| 22.95 | 2.46 | 2.46 | | 0.00 | | 2.26 | 2.26 |
| 22.85 | 2.03 | 2.03 | | 0.00 | | 2.23 | 2.23 |
| 22.76 | 2.43 | 2.43 | | 0.00 | | 1.63 | 1.63 |
| 22.66 | 2.75 | 2.75 | | 0.00 | | 1.75 | 1.75 |
| 22.57 | 2.46 | 2.46 | | 0.00 | | 1.66 | 1.66 |
| 22.47 | 1.85 | 1.85 | | 0.00 | | 2.45 | 2.45 |
| 22.38 | 2.98 | 2.98 | | 0.00 | | 3.18 | 3.18 |
| 22.28 | 2.81 | 2.81 | | 0.00 | | 3.21 | 3.21 |
| 22.19 | 2.38 | 2.38 | | 0.00 | | 2.88 | 2.88 |
| 22.10 | 3.23 | 3.23 | | 0.00 | | 3.23 | 3.23 |
| 22.00 | 3.09 | 3.09 | | 0.00 | | 3.69 | 3.69 |
| 21.91 | 2.20 | 2.20 | | 0.00 | | 2.50 | 2.50 |
| 21.81 | 2.40 | 2.40 | | 0.00 | | 4.10 | 4.10 |
| 21.72 | 2.30 | 2.30 | | 0.00 | | 4.20 | 4.20 |
| 21.62 | 1.48 | 1.48 | | 0.00 | | 1.38 | 1.38 |
| 21.53 | 1.26 | 1.26 | | 0.00 | | 1.86 | 1.86 |
| 21.43 | 2.19 | 2.19 | | 0.00 | | 1.69 | 1.69 |
| 21.34 | 4.20 | 4.20 | | 0.00 | | 1.60 | 1.60 |
| 21.24 | 5.03 | 5.03 | | 0.00 | | 1.13 | 1.13 |
| 21.15 | 5.84 | 5.84 | | 0.00 | | 0.94 | 0.94 |
| 21.05 | 4.22 | 4.22 | | 0.00 | | 0.82 | 0.82 |
| 20.94 | 6.46 | 6.46 | | 0.00 | | 7.23 | 7.23 |
| 20.94 | 6.49 | 6.49 | | 0.00 | | 7.22 | 7.22 |
| 20.94 | 6.53 | 6.53 | | 0.00 | | 7.26 | 7.26 |
| 20.94 | 6.53 | 6.53 | | 0.00 | | 7.30 | 7.30 |
| 20.77 | 4.88 | 4.88 | | 0.00 | | 3.58 | 3.58 |
| 20.68 | 3.50 | 3.50 | | 0.00 | | 2.20 | 2.20 |
| 20.59 | 2.30 | 2.30 | | 0.00 | | 2.50 | 2.50 |
| 20.49 | 2.18 | 2.18 | | 0.00 | | 2.18 | 2.18 |
| 20.40 | 2.60 | 2.60 | | 0.00 | | 2.30 | 2.30 |
| 20.30 | 1.89 | 1.89 | | 0.00 | | 2.09 | 2.09 |
| 20.21 | 1.75 | 1.75 | | 0.00 | | 2.05 | 2.05 |
| 20.11 | 4.47 | 4.47 | | 0.00 | | 3.17 | 3.17 |
| 20.02 | 2.47 | 2.47 | | 0.00 | | 3.37 | 3.37 |
| 19.92 | 1.66 | 1.66 | | 0.00 | | 2.86 | 2.86 |
| 19.83 | 1.29 | 1.29 | | 0.00 | | 3.29 | 3.29 |
| 19.73 | 2.01 | 2.01 | | 0.00 | | 4.21 | 4.21 |
| 19.64 | 1.16 | 1.16 | | 0.00 | | 3.66 | 3.66 |
| 19.54 | 1.09 | 1.09 | | 0.00 | | 1.99 | 1.99 |
| 19.45 | 1.93 | 1.93 | | 0.00 | | 1.83 | 1.83 |
| 19.35 | 5.32 | 5.32 | | 0.00 | | 1.92 | 1.92 |
| 19.26 | 5.35 | 5.35 | | 0.00 | | 1.55 | 1.55 |
| 19.16 | 4.54 | 4.54 | | 0.00 | | 2.34 | 2.34 |
| 19.15 | 3.87 | 3.87 | | 0.00 | | 2.34 | 2.34 |
| 19.10 | 5.49 | 5.49 | | 0.00 | | 5.12 | 5.12 |
| 19.10 | 5.94 | 5.94 | | 0.00 | | 5.57 | 5.57 |
| 19.10 | 6.42 | 6.42 | | 0.00 | | 6.05 | 6.05 |
| 19.10 | 6.31 | 6.31 | | 0.00 | | 5.94 | 5.94 |
| 19.01 | 2.79 | 2.79 | | 0.00 | | 3.10 | 3.10 |
| 18.98 | 2.56 | 2.56 | | 0.00 | | 3.26 | 3.26 |
| 18.89 | 2.56 | 2.56 | | 0.00 | | 3.36 | 3.36 |
| 18.76 | 2.05 | 2.05 | | 0.00 | | 2.85 | 2.85 |
| 18.70 | 2.30 | 2.30 | | 0.00 | | 3.10 | 3.10 |
| 18.61 | 2.48 | 2.48 | | 0.00 | | 2.28 | 2.28 |
| 18.51 | 2.23 | 2.23 | | 0.00 | | 2.43 | 2.43 |
| 18.42 | 2.42 | 2.42 | | 0.00 | | 3.02 | 3.02 |
| 18.32 | 2.44 | 2.44 | | 0.00 | | 2.14 | 2.14 |
| 18.23 | 2.58 | 2.58 | | 0.00 | | 2.58 | 2.58 |
| 18.13 | 2.31 | 2.31 | | 0.00 | | 1.51 | 1.51 |
| 18.04 | 3.39 | 3.39 | | 0.00 | | 2.69 | 2.69 |
| 17.94 | 2.71 | 2.71 | | 0.00 | | 2.61 | 2.61 |
| 17.85 | 2.31 | 2.31 | | 0.00 | | 1.71 | 1.71 |
| 17.75 | 3.06 | 3.06 | | 0.00 | | 2.06 | 2.06 |
| 17.66 | 3.15 | 3.15 | | 0.00 | | 2.55 | 2.55 |
| 17.56 | 4.33 | 4.33 | | 0.00 | | 2.73 | 2.73 |
| 17.47 | 4.00 | 4.00 | | 0.00 | | 3.10 | 3.10 |
| 17.37 | 4.51 | 4.51 | | 0.00 | | 3.21 | 3.21 |
| 17.28 | 3.79 | 3.79 | | 0.00 | | 3.29 | 3.29 |
| 17.18 | 3.52 | 3.52 | | 0.00 | | 2.62 | 2.62 |
| 17.09 | 3.26 | 3.26 | | 0.00 | | 2.46 | 2.46 |
| 17.00 | 4.04 | 4.04 | | 0.00 | | 1.94 | 1.94 |
| 16.90 | 3.74 | 3.74 | | 0.00 | | 2.44 | 2.44 |
| 16.81 | 3.82 | 3.82 | | 0.00 | | 2.82 | 2.82 |

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 16.71 | 4.04 | 4.04 | | 0.00 | | 2.24 | 2.24 |
| 16.62 | 4.17 | 4.17 | | 0.00 | | 2.87 | 2.87 |
| 16.52 | 3.45 | 3.45 | | 0.00 | | 2.45 | 2.45 |
| 16.43 | 3.32 | 3.32 | | 0.00 | | 2.42 | 2.42 |
| 16.33 | 1.33 | 1.33 | | 0.00 | | 1.97 | 1.97 |
| 16.26 | 3.53 | 3.53 | | 0.00 | | 1.53 | 1.53 |
| 16.14 | 2.58 | 2.58 | | 0.00 | | 1.58 | 1.58 |
| 16.05 | 5.86 | 5.86 | | 0.00 | | 1.76 | 1.76 |
| 15.95 | 2.40 | 2.40 | | 0.00 | | 2.40 | 2.40 |
| 15.86 | 1.81 | 1.81 | | 0.00 | | 2.51 | 2.51 |
| 15.76 | 0.91 | 0.91 | | 0.00 | | 2.11 | 2.11 |
| 15.71 | 2.58 | 2.58 | | 0.00 | | 2.57 | 2.57 |
| 15.71 | 2.56 | 2.56 | | 0.00 | | 2.25 | 2.25 |
| 15.71 | 2.59 | 2.59 | | 0.00 | | 2.28 | 2.28 |
| 15.71 | 2.65 | 2.65 | | 0.00 | | 2.64 | 2.64 |
| 15.58 | 9.53 | 9.53 | | 0.00 | | 1.73 | 1.73 |
| 15.48 | 8.08 | 8.08 | | 0.00 | | 2.28 | 2.28 |
| 15.39 | 7.48 | 7.48 | | 0.00 | | 2.68 | 2.68 |
| 15.30 | 7.76 | 7.76 | | 0.00 | | 2.16 | 2.16 |
| 15.20 | 10.06 | 10.06 | | 0.00 | | 2.16 | 2.16 |
| 15.11 | 10.11 | 10.11 | | 0.00 | | 1.11 | 1.11 |
| 15.01 | 11.21 | 11.21 | | 0.00 | | 1.21 | 1.21 |
| 14.92 | 10.75 | 10.75 | | 0.00 | | 0.75 | 0.75 |
| 14.82 | 10.55 | 10.55 | | 0.00 | | 2.45 | 2.45 |
| 14.73 | 10.40 | 10.40 | | 0.00 | | 1.00 | 1.00 |
| 14.63 | 6.96 | 6.96 | | 0.00 | | 1.16 | 1.16 |
| 14.54 | 7.05 | 7.05 | | 0.00 | | 1.25 | 1.25 |
| 14.44 | 0.72 | 0.72 | | 0.00 | | 1.72 | 1.72 |
| 14.35 | 10.77 | 10.77 | | 0.00 | | 1.67 | 1.67 |
| 14.25 | 8.65 | 8.65 | | 0.00 | | 1.55 | 1.55 |
| 14.16 | 7.38 | 7.38 | | 0.00 | | 2.08 | 2.08 |
| 14.06 | 8.55 | 8.55 | | 0.00 | | 2.55 | 2.55 |
| 13.97 | 8.28 | 8.28 | | 0.00 | | 2.08 | 2.08 |
| 13.88 | 7.49 | 7.49 | | 0.00 | | 1.79 | 1.79 |
| 13.78 | 2.48 | 2.48 | | 0.00 | | 2.32 | 2.32 |
| 13.69 | 11.40 | 11.40 | | 0.00 | | 1.70 | 1.70 |
| 13.59 | 12.72 | 12.72 | | 0.00 | | 1.32 | 1.32 |
| 13.50 | 13.64 | 13.64 | | 0.00 | | 1.74 | 1.74 |
| 13.40 | 16.24 | 16.24 | | 0.00 | | 1.54 | 1.54 |
| 13.31 | 13.79 | 13.79 | | 0.00 | | 1.49 | 1.49 |
| 13.21 | 7.40 | 7.40 | | 0.00 | | 0.90 | 0.90 |
| 13.12 | 0.71 | 0.71 | | 0.00 | | 0.89 | 0.89 |
| 13.02 | 5.61 | 5.61 | | 0.00 | | 0.21 | 0.21 |
| 12.93 | 1.04 | 1.04 | | 0.00 | | 0.06 | 0.06 |
| 12.83 | 0.22 | 0.22 | | 0.00 | | 0.28 | 0.28 |
| 12.74 | 10.73 | 10.73 | | 0.00 | | 0.03 | 0.03 |
| 12.68 | 1.45 | 1.45 | | 0.00 | | 0.02 | 0.02 |
| 12.66 | 2.64 | 2.64 | | 0.00 | | 2.73 | 2.73 |
| 12.66 | 1.10 | 1.10 | | 0.00 | | 1.19 | 1.19 |
| 12.63 | 2.53 | 2.53 | | 0.00 | | 1.47 | 1.47 |
| 12.56 | 11.81 | 11.81 | | 0.00 | | 1.51 | 1.51 |
| 12.46 | 4.98 | 4.98 | | 0.00 | | 1.48 | 1.48 |
| 12.37 | 7.98 | 7.98 | | 0.00 | | 1.68 | 1.68 |
| 12.27 | 5.21 | 5.21 | | 0.00 | | 1.21 | 1.21 |
| 12.18 | 2.58 | 2.58 | | 0.00 | | 1.38 | 1.38 |
| 12.08 | 0.52 | 0.52 | | 0.00 | | 0.88 | 0.88 |
| 11.99 | 1.29 | 1.29 | | 0.00 | | 0.71 | 0.71 |
| 11.89 | 1.56 | 1.56 | | 0.00 | | 0.94 | 0.94 |
| 11.80 | 1.42 | 1.42 | | 0.00 | | 1.08 | 1.08 |
| 11.70 | 1.35 | 1.35 | | 0.00 | | 0.65 | 0.65 |
| 11.61 | 2.30 | 2.30 | | 0.00 | | 0.30 | 0.30 |
| 11.51 | 2.63 | 2.63 | | 0.00 | | 0.17 | 0.17 |
| 11.42 | 2.49 | 2.49 | | 0.00 | | 0.29 | 0.29 |
| 11.33 | 2.61 | 2.61 | | 0.00 | | 0.81 | 0.81 |
| 11.23 | 3.33 | 3.33 | | 0.00 | | 0.33 | 0.33 |
| 11.14 | 2.18 | 2.18 | | 0.00 | | 0.18 | 0.18 |
| 11.04 | 1.99 | 1.99 | | 0.00 | | 1.39 | 1.39 |
| 10.95 | 2.71 | 2.71 | | 0.00 | | 1.31 | 1.31 |
| 10.85 | 2.51 | 2.51 | | 0.00 | | 1.71 | 1.71 |
| 10.76 | 3.28 | 3.28 | | 0.00 | | 0.78 | 0.78 |
| 10.66 | 3.07 | 3.07 | | 0.00 | | 1.47 | 1.47 |
| 10.66 | 3.15 | 3.15 | | 0.00 | | 1.27 | 1.27 |
| 10.64 | 0.89 | 0.89 | | 0.00 | | 1.15 | 1.15 |
| 10.64 | 1.86 | 1.86 | | 0.00 | | 1.60 | 1.60 |

## Table E-2 Hydraulic Simulation Results

| River Mile | LEFT Freeboard (feet) 1996 | LEFT Freeboard (feet) 2003 | LEVEE | Water Surface Elevation Change (ft) | LEVEE | RIGHT Freeboard (feet) 1996 | RIGHT Freeboard (feet) 2003 |
|---|---|---|---|---|---|---|---|
| 10.62 | 1.82 | 1.82 | | 0.00 | | 1.80 | 1.80 |
| 10.56 | 2.68 | 2.68 | | 0.00 | | 2.88 | 2.88 |
| 10.48 | 2.26 | 2.26 | | 0.00 | | 2.86 | 2.86 |
| 10.38 | 2.12 | 2.12 | | 0.00 | | 3.02 | 3.02 |
| 10.29 | 2.29 | 2.29 | | 0.00 | | 2.29 | 2.29 |
| 10.19 | 2.32 | 2.32 | | 0.00 | | 2.72 | 2.72 |
| 10.10 | 2.54 | 2.54 | | 0.00 | | 2.94 | 2.94 |
| 10.00 | 1.72 | 1.72 | | 0.00 | | 2.32 | 2.32 |
| 9.91 | 2.04 | 2.04 | | 0.00 | | 2.04 | 2.04 |
| 9.81 | 2.11 | 2.11 | | 0.00 | | 2.21 | 2.21 |
| 9.72 | 2.09 | 2.09 | | 0.00 | | 1.59 | 1.59 |
| 9.63 | 1.45 | 1.45 | | 0.00 | | 1.35 | 1.35 |
| 9.53 | 1.90 | 1.90 | | 0.00 | | 1.70 | 1.70 |
| 9.44 | 2.08 | 2.08 | | 0.00 | | 2.08 | 2.08 |
| 9.34 | 2.27 | 2.27 | | 0.00 | | 2.17 | 2.17 |
| 9.25 | 1.51 | 1.51 | | 0.00 | | 1.51 | 1.51 |
| 9.15 | 1.99 | 1.99 | | 0.00 | | 1.79 | 1.79 |
| 9.06 | 1.59 | 1.59 | | 0.00 | | 1.79 | 1.79 |
| 8.96 | 1.51 | 1.51 | | 0.00 | | 1.71 | 1.71 |
| 8.87 | 1.64 | 1.64 | | 0.00 | | 1.84 | 1.84 |
| 8.77 | 1.78 | 1.78 | | 0.00 | | 1.88 | 1.88 |
| 8.68 | 1.62 | 1.62 | | 0.00 | | 1.62 | 1.62 |
| 8.59 | 1.35 | 1.35 | | 0.00 | | 1.75 | 1.75 |
| 8.49 | 1.75 | 1.75 | | 0.00 | | 1.75 | 1.75 |
| 8.39 | 2.05 | 2.05 | | 0.00 | | 1.75 | 1.75 |
| 8.30 | 2.17 | 2.17 | | 0.00 | | 2.07 | 2.07 |
| 8.21 | 1.79 | 1.79 | | 0.00 | | 1.69 | 1.69 |
| 8.11 | 1.86 | 1.86 | | 0.00 | | 1.86 | 1.86 |
| 8.02 | 2.14 | 2.14 | | 0.00 | | 2.04 | 2.04 |
| 7.92 | 2.17 | 2.17 | | 0.00 | | 1.67 | 1.67 |
| 7.86 | 1.58 | 1.58 | | 0.00 | | 1.71 | 1.71 |
| 7.83 | 2.23 | 2.23 | | 0.00 | | 2.12 | 2.12 |
| 7.83 | 2.24 | 2.24 | | 0.00 | | 2.13 | 2.13 |
| 7.83 | 2.42 | 2.42 | | 0.00 | | 2.31 | 2.31 |
| 7.83 | 2.42 | 2.42 | | 0.00 | | 2.31 | 2.31 |
| 7.79 | 1.62 | 1.62 | | 0.00 | | 1.96 | 1.96 |
| 7.74 | 2.09 | 2.09 | | 0.00 | | 1.39 | 1.39 |
| 7.65 | 1.95 | 1.95 | | 0.00 | | 1.65 | 1.65 |
| 7.55 | 2.35 | 2.35 | | 0.00 | | 2.05 | 2.05 |
| 7.46 | 1.17 | 1.17 | | 0.00 | | 1.77 | 1.77 |
| 7.36 | 1.76 | 1.76 | | 0.00 | | 2.06 | 2.06 |
| 7.27 | 1.22 | 1.22 | | 0.00 | | 2.12 | 2.12 |
| 7.17 | 2.65 | 2.65 | | 0.00 | | 2.15 | 2.15 |
| 7.08 | 1.18 | 1.18 | | 0.00 | | 1.28 | 1.28 |
| 6.98 | 1.38 | 1.38 | | 0.00 | | 1.38 | 1.38 |
| 6.89 | 1.33 | 1.33 | | 0.00 | | 8.53 | 8.53 |
| 6.79 | 1.36 | 1.36 | | 0.00 | | 12.06 | 12.06 |
| 6.70 | 1.05 | 1.05 | | 0.00 | | 13.75 | 13.75 |
| 6.66 | 1.12 | 1.12 | | 0.00 | | 18.72 | 18.72 |
| 6.61 | 1.32 | 1.32 | | 0.00 | | 13.92 | 13.92 |
| 6.51 | 1.90 | 1.90 | | 0.00 | | 14.30 | 14.30 |
| 6.42 | 2.20 | 2.20 | | 0.00 | | 14.40 | 14.40 |
| 6.32 | 1.37 | 1.37 | | 0.00 | | 14.57 | 14.57 |
| 6.23 | 1.33 | 1.33 | | 0.00 | | 12.23 | 12.23 |
| 6.13 | 1.59 | 1.59 | | 0.00 | | 11.89 | 11.89 |
| 6.04 | 1.66 | 1.66 | | 0.00 | | 12.16 | 12.16 |
| 5.94 | 0.54 | 0.54 | | 0.00 | | 13.24 | 13.24 |
| 5.85 | 1.61 | 1.61 | | 0.00 | | 15.21 | 15.21 |
| 5.75 | 2.69 | 2.69 | | 0.00 | | 17.59 | 17.59 |
| 5.66 | 1.90 | 1.90 | | 0.00 | | 20.90 | 20.90 |
| 5.56 | 2.92 | 2.92 | | 0.00 | | 12.12 | 12.12 |
| 5.47 | 3.25 | 3.25 | | 0.00 | | 12.05 | 12.05 |
| 5.28 | 2.55 | 2.55 | | 0.00 | | 12.35 | 12.35 |
| 5.18 | 1.91 | 1.91 | | 0.00 | | 10.21 | 10.21 |
| 5.09 | 2.35 | 2.35 | | 0.00 | | 4.55 | 4.55 |
| 5.00 | 1.95 | 1.95 | | 0.00 | | 8.35 | 8.35 |
| 4.90 | 2.13 | 2.13 | | 0.00 | | 14.93 | 14.93 |
| 4.81 | 2.49 | 2.49 | | 0.00 | | 13.29 | 13.29 |
| 4.71 | 2.49 | 2.49 | | 0.00 | | 8.39 | 8.39 |
| 4.62 | 1.57 | 1.57 | | 0.00 | | 14.07 | 14.07 |
| 4.52 | 1.59 | 1.59 | | 0.00 | | 4.29 | 4.29 |
| 4.43 | 1.51 | 1.51 | | 0.00 | | 8.71 | 8.71 |
| 4.33 | 1.08 | 1.08 | | 0.00 | | 15.08 | 15.08 |
| 4.24 | 1.50 | 1.50 | | 0.00 | | 7.80 | 7.80 |
| 4.09 | 1.46 | 1.46 | | 0.00 | | 12.36 | 12.36 |
| 3.95 | 1.17 | 1.17 | | 0.00 | | 3.27 | 3.27 |
| 3.86 | 0.89 | 0.89 | | 0.00 | | 3.89 | 3.89 |
| 3.76 | 2.07 | 2.07 | | 0.00 | | 0.17 | 0.17 |
| 3.67 | 2.15 | 2.15 | | 0.00 | | 13.45 | 13.45 |
| 3.58 | 2.06 | 2.06 | | 0.00 | | 13.76 | 13.76 |
| 3.48 | 1.84 | 1.84 | | 0.00 | | 13.14 | 13.14 |
| 3.39 | 2.06 | 2.06 | | 0.00 | | 13.16 | 13.16 |
| 3.29 | 2.47 | 2.47 | | 0.00 | | 14.17 | 14.17 |
| 3.20 | 2.11 | 2.11 | | 0.00 | | 14.21 | 14.21 |
| 3.10 | 1.28 | 1.28 | | 0.00 | | 14.28 | 14.28 |
| 3.01 | 1.50 | 1.50 | | 0.00 | | 10.50 | 10.50 |
| 2.91 | 1.34 | 1.34 | | 0.00 | | 2.74 | 2.74 |
| 2.82 | 1.00 | 1.00 | | 0.00 | | 5.50 | 5.50 |
| 2.72 | 1.07 | 1.07 | | 0.00 | | 8.97 | 8.97 |
| 2.66 | 7.99 | 7.99 | | 0.00 | | 8.27 | 8.27 |
| 2.66 | 7.99 | 7.99 | | 0.00 | | 8.23 | 8.23 |
| 2.66 | 8.01 | 8.01 | | 0.00 | | 8.25 | 8.25 |
| 2.66 | 8.02 | 8.02 | | 0.00 | | 8.30 | 8.30 |
| 2.45 | 2.16 | 2.16 | | 0.00 | | 12.36 | 12.36 |
| 2.35 | 1.75 | 1.75 | | 0.00 | | 14.65 | 14.65 |
| 2.26 | 1.92 | 1.92 | | 0.00 | | 22.32 | 22.32 |
| 2.16 | 1.67 | 1.67 | | 0.00 | | 22.37 | 22.37 |
| 2.10 | 1.48 | 1.48 | | 0.00 | | 0.98 | 0.98 |
| 1.97 | 1.32 | 1.32 | | 0.00 | | 0.62 | 0.62 |
| 1.88 | 1.36 | 1.36 | | 0.00 | | 0.76 | 0.76 |
| 1.78 | 19.75 | 19.75 | | 0.00 | | 0.95 | 0.95 |
| 1.69 | 21.75 | 21.75 | | 0.00 | | 1.55 | 1.55 |
| 1.66 | 13.56 | 13.56 | | 0.00 | | 18.76 | 18.76 |
| 1.66 | 13.56 | 13.56 | | 0.00 | | 18.76 | 18.76 |
| 1.66 | 13.71 | 13.71 | | 0.00 | | 18.91 | 18.91 |
| 1.66 | 13.71 | 13.71 | | 0.00 | | 18.91 | 18.91 |
| 1.51 | 27.92 | 27.92 | | 0.00 | | 11.62 | 11.62 |
| 1.42 | 12.71 | 12.71 | | 0.00 | | 10.61 | 10.61 |
| 1.32 | 10.98 | 10.98 | | 0.00 | | 10.68 | 10.68 |
| 1.23 | 2.04 | 2.04 | | 0.00 | | 10.84 | 10.84 |
| 1.13 | 28.04 | 28.04 | | 0.00 | | 11.04 | 11.04 |
| 1.04 | 25.30 | 25.30 | | 0.00 | | 0.40 | 0.40 |
| 0.94 | 17.55 | 17.55 | | 0.00 | | 0.05 | 0.05 |
| 0.85 | 3.05 | 3.05 | | 0.00 | | 11.15 | 11.15 |
| 0.75 | 1.44 | 1.44 | | 0.00 | | 10.14 | 10.14 |
| 0.66 | 11.84 | 11.84 | | 0.00 | | 10.84 | 10.84 |
| 0.56 | 16.81 | 16.81 | | 0.00 | | 10.91 | 10.91 |
| 0.47 | 11.18 | 11.18 | | 0.00 | | 11.18 | 11.18 |
| 0.38 | 3.21 | 3.21 | | 0.00 | | 11.41 | 11.41 |
| 0.28 | 4.04 | 4.04 | | 0.00 | | 8.54 | 8.54 |
| 0.20 | 1.48 | 1.48 | | 0.00 | | 1.28 | 1.28 |
| 0.19 | 0.49 | 0.49 | | 0.00 | | 0.43 | 0.43 |
| 0.19 | 0.17 | 0.17 | | 0.00 | | 0.04 | 0.04 |
| 0.09 | 0.80 | 0.80 | | 0.00 | | 10.90 | 10.90 |
| 0.00 | 0.23 | 0.23 | | 0.00 | | 9.17 | 9.17 |

# APPENDIX F
# CONTROLLED WATER RELEASES FOR OVERBANK FLOWS

## ANALYSIS METHODOLOGY

This appendix presents the technical basis and assumptions of the controlled water release evaluation. The measure, included as part of the Targeted River Restoration Alternative, is intended to induce controlled overbank flows for riparian vegetation development. Changes in flow patterns that simulate early spring runoff conditions has been proposed for establishment of cottonwood bosque along the Rio Grande (Crawford *et al*., 1996, 1999).

A simulation of controlled releases from Caballo Dam was conducted to estimate the potential extent of the overbank flows. The simulation was made using the HEC-RAS hydraulic model. While the potential extent of overbank flows was analyzed based on a maximum theoretical value –5,000 cfs discharge– it is important to emphasize that full discharge conditions would be reached only after several years of planning, gradual implementation, and regular monitoring.

### Potential Extent of Overbank Flows

To simulate potential overbank conditions, 5,000 cfs was used as the maximum theoretical value for controlled discharges from Caballo Reservoir. This discharge value is dictated by the rated value of the outlet works that would be possible only when the reservoir reaches maximum water surface elevation (4,182 ft elevation, with a hydraulic head of 78 ft). This elevation is approximately 10 ft above the top of the active conservation elevation (4,172.44), and above typical reservoir operation conditions. Over the last two years, according to the operational records [*www.usbr.gov/uc/elpaso/water/reservoirs*], water surface elevations reached a maximum of 4,152.7 ft. in March 2002 and drop to a minimum of 4,128.3 ft in September 2003. Based on the 2002-2003 operational elevations, the maximum possible discharge would have ranged from approximately 3,500 cfs in March 2002 to less than 2,600 cfs in September 2003.

Table F-1 summarizes the approximate maximum discharge from Caballo Reservoir as a function of water surface elevation. Data were obtained from the outlet works' operational nomograph (both gates fully open). Steady-state flow conditions used in the overbank simulation are listed in Table F-2.

## Table F-1 Theoretical Discharge Capacity of Caballo Dam Outlet Works

| Water Elevation (above Rio Grande Project Datum) | 4,182 ft (maximum elevation) | 4,172 ft (top of active conservation) | 4,162 ft | 4,152 ft | 4,142 ft | 4,132 ft |
|---|---|---|---|---|---|---|
| Approximate discharge (both gates open at 7 ft.) | 5,000 cfs | 4,300 cfs | 3,900 cfs | 3,500 cfs | 3,100 cfs | 2,600 cfs |

## Table F-2 Simulated Flows for Pulse Discharges in the RGCP Northern Reach

Apparent Attenuation (100-Year Flows in a Non-Contributing Reach)
(Table 8.1 Alternatives Formulation Report, Parsons March 2001)

| Mile | Length | Flow Reduction | Change (cfs) | Change (%) | Change per Mile |
|---|---|---|---|---|---|
| 84.8 | | 19,100 | | | |
| 81.8 | 3.0 | 18,300 | 800 | 4.2% | 1.4% |
| 80.4 | 1.4 | 17,700 | 600 | 3.3% | 2.3% |

**Attenuation per mile selected: 1.5%**

| Station | Mile | Delta (miles) | Attenuation | Cumulative | Controlled Release | DESIGN FLOW | HIGHEST MONTH* | 100-YR FLOOD |
|---|---|---|---|---|---|---|---|---|
| 1055 | 105.4 | | | 100.0% | **5,000** | **2,350** | 3,561 | 5,000 |
| 1031 | 102.9 | 2.5 | 3.8% | 96.3% | 4,813 | 2,350 | 3,561 | 9,100 |
| 1018 | 101.4 | 1.5 | 2.3% | 94.1% | 4,704 | 2,350 | 3,561 | 11,300 |
| 1004 | 99.8 | 1.6 | 2.4% | 91.8% | 4,591 | 2,350 | 3,561 | 15,600 |
| 989 | 98.1 | 1.7 | 2.6% | 89.5% | 4,474 | 2,350 | 3,561 | 17,600 |
| 974 | 96.6 | 1.5 | 2.3% | 87.5% | 4,374 | 2,350 | 3,561 | 18,700 |
| 935 | 92.4 | 4.2 | 6.3% | 82.0% | 4,098 | 2,350 | 3,561 | 18,900 |
| 856 | 84.8 | 7.6 | 11.4% | 72.6% | 3,631 | 2,350 | 3,561 | 19,100 |
| 820 | 81.8 | 3.0 | 4.5% | 69.3% | 3,467 | 2,350 | 3,470 | 18,300 |
| 805 | 80.4 | 1.4 | 2.1% | 67.9% | 3,395 | 2,350 | 3,470 | 17,700 |
| 805 | 80.4 | | | 67.9% | 3,395 | 2,350 | 3,470 | 17,700 |
| 802 | 80.0 | 0.4 | 0.6% | 67.5% | 3,374 | 2,350 | 3,470 | 17,800 |
| 789 | 78.5 | 1.5 | 2.3% | 66.0% | 3,298 | 2,350 | 3,470 | 22,400 |
| 784 | 78.0 | 0.5 | 0.8% | 65.5% | 3,274 | 2,350 | 3,470 | 22,500 |
| 770 | 76.6 | 1.4 | 2.1% | 64.1% | 3,205 | 2,350 | 3,470 | 22,000 |
| 675 | 67.2 | 9.4 | 14.1% | 55.1% | 2,753 | 2,350 | 3,470 | 22,400 |
| 637 | 63.3 | 3.9 | 5.9% | 51.8% | 2,592 | 2,350 | 3,470 | 22,400 |
| **Leasburg Dam** | | | | | *-450* | *-450* | | |
| 637 | 63.3 | | | | **2,142** | **1,900** | 3,035 | 22,400 |
| 636 | 63.0 | 0.3 | 0.4% | | 2,136 | 1,900 | 3,045 | 22,200 |
| 568 | 55.7 | 7.3 | 11.0% | | 1,902 | 1,900 | 3,045 | 21,300 |
| 553 | 55.3 | 0.4 | 0.6% | | 1,890 | 1,900 | 3,045 | 21,000 |
| 497 | 48.7 | 6.6 | 9.9% | | 1,703 | 1,900 | 3,045 | 21,300 |
| 486 | 47.6 | 1.1 | 1.7% | | 1,675 | 1,900 | 3,270 | 20,500 |
| 456 | 44.6 | 3.0 | 4.5% | | 1,600 | 1,900 | 3,270 | 20,100 |
| 412 | 39.9 | 8.8 | 13.2% | | 1,388 | 1,900 | 3,270 | 20,000 |
| **Mesilla Dam** | | | | | *-300* | *-300* | | |

* Average value of the month with highest flow on record (July 1987, reported in USACE 1996, Vol. 4 , Tables 2-2, 2-4 & 2-6).

For the flow distribution analysis along the RGCP an attenuation coefficient of 1.5 percent per mile was applied (Table F-2). Water elevations were calculated for a 5,000 cfs discharge using the existing HEC-RAS model, and plotted along the RGCP. Table F-2 also includes three reference flows: RGCP channel design flow (maximum irrigation flow capacity); highest average monthly flow (used as a reference for riparian vegetation development); and 100-year flood values (from USACE 1996 hydrology analysis). The geographic coverage of simulated bank overflows along the northern reach of the RGCP was previously provided with the Reformulation of Alternatives Report (Parsons 20031a: Appendix F). This information is available in electronic format in Appendix I of this DEIS.

## Discharge Characteristics

Under current water releases, advantageous conditions for an increase in early spring flows would be in March when peak weekly irrigation discharges occur. An analysis by King and Maitland (2003) indicated that during that month irrigation releases from Caballo Reservoir peaked at approximately 2,200 cfs (29,000 ac-ft for a week) for both 1957 and 1999, two years selected as representative short- and full-water supply conditions, respectively. For an additional release of 5,000 ac-ft during this period, King and Maitland (2003) estimated that a peak flow of 3,500 cfs could be maintained for two days to simulate a spring runoff flow.

Extending the same rationale, in this DEIS it was assumed that a 3,700 cfs peak discharge above a typical 1,300 cfs irrigation flow could be sustained. The resulting water release above irrigation levels over a 1-day period would be equivalent to 7,336 ac-ft, the value used in the water consumption (Section 4.1.6) and cost calculations (Section 2.11.3). In practice the discharge duration would be limited not by theoretical considerations on the desirable peak duration, but by the water availability and cost. Releases would also be timed to coincide with peak irrigation flows, and likely to be significantly less than 5,000 cfs (given physical limitations of the outlet works). The geographic coverage of overbank flows would also be reduced relative to that calculated in the DEIS (214 acres in the Upper Rincon RMU and 302 acres in the Lower Rincon RMU).

Measures would be required to ensure that river structures are not damaged. In 1995, two months of release in excess of 3,000 cfs, peaking at 4,500 cfs caused scour damage to the siphons under the river in Rincon valley that convey EBID water from one side to the other (King and Maitland 2003).

At some locations, overbank flows would extent past the ROW, particularly in Seldon Canyon. Along this area the USIBWC jurisdiction is limited to the streambed and adjacent banks. This condition is addressed in the EIS by use of conservation easements that would be secured by other agencies or environmental organizations.

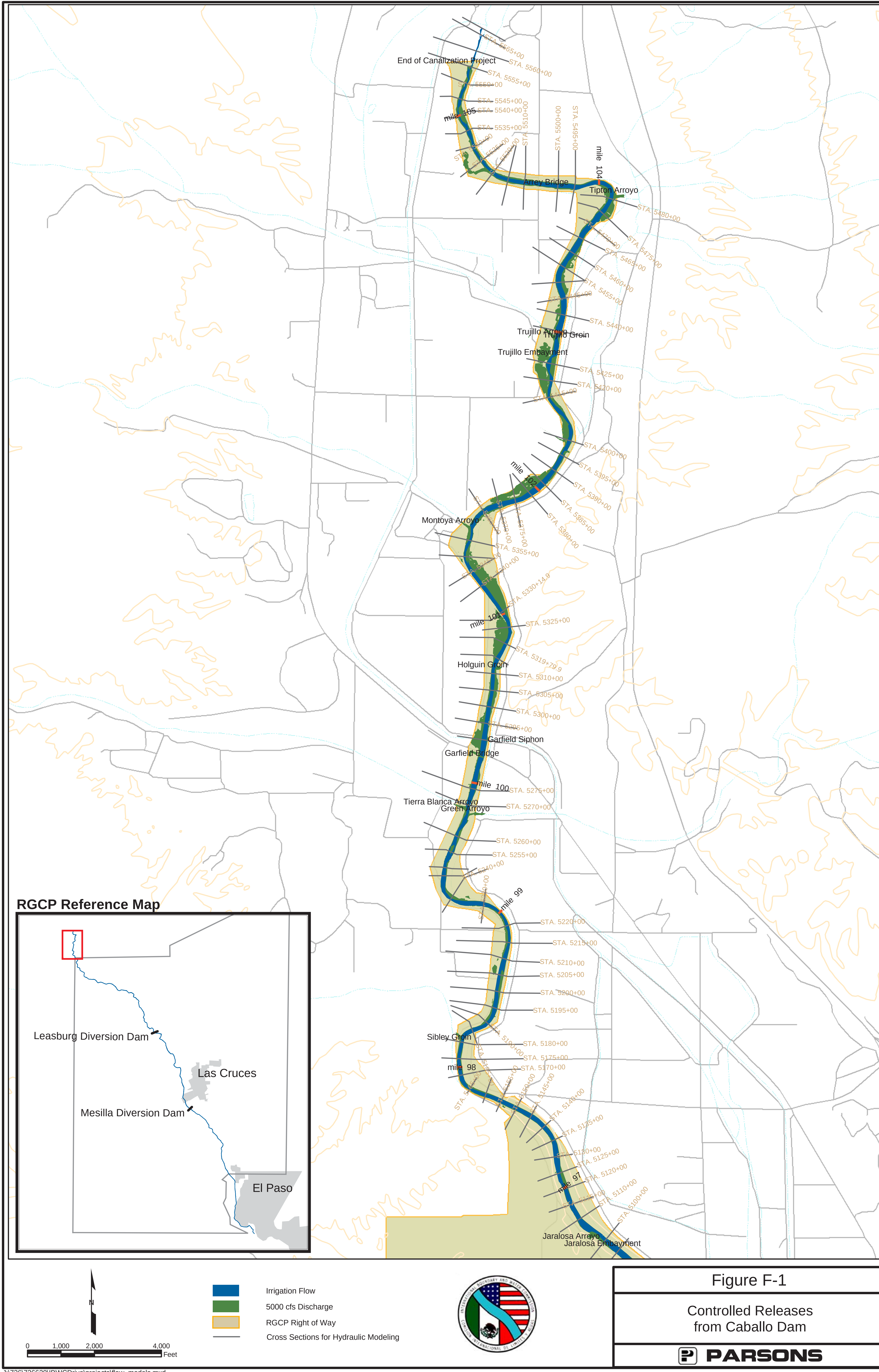



Figure F-1

Controlled Releases from Caballo Dam

J:\736\736620\IBWCDrive\projects\flow_models.mxd

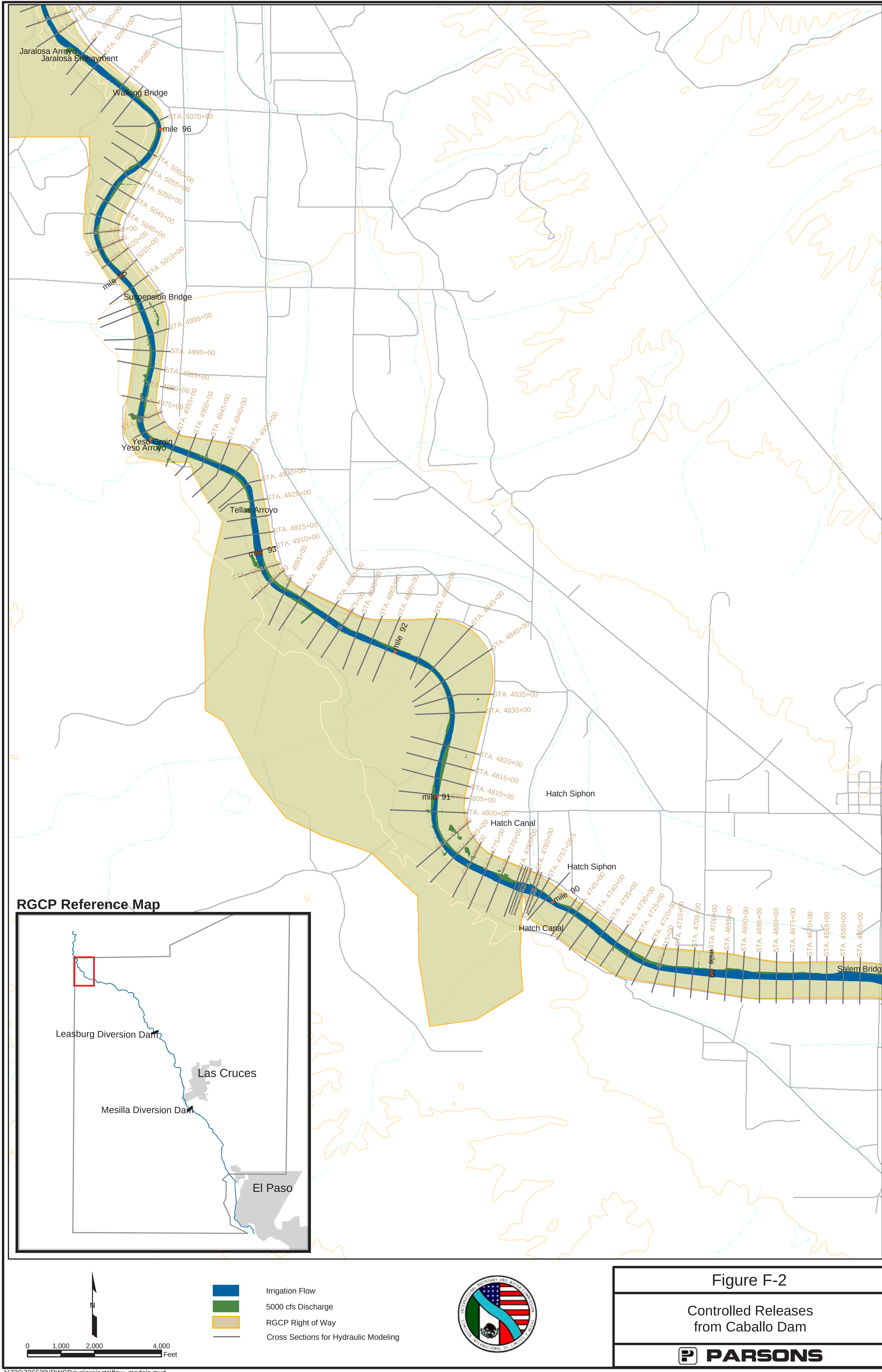



Figure F-2

Controlled Releases from Caballo Dam

J:\736\736620\IBWCDrive\projects\flow_models.mxd

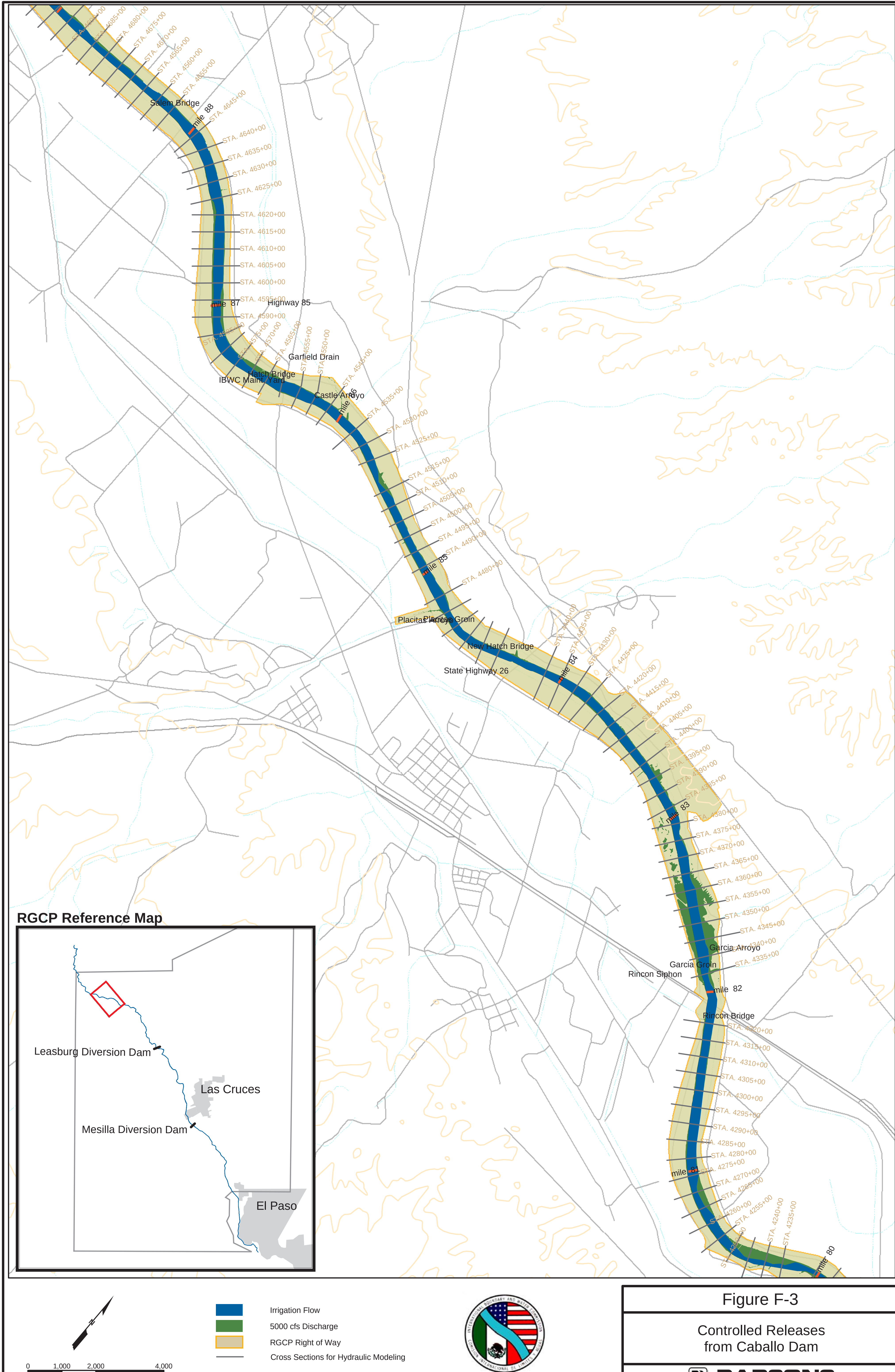
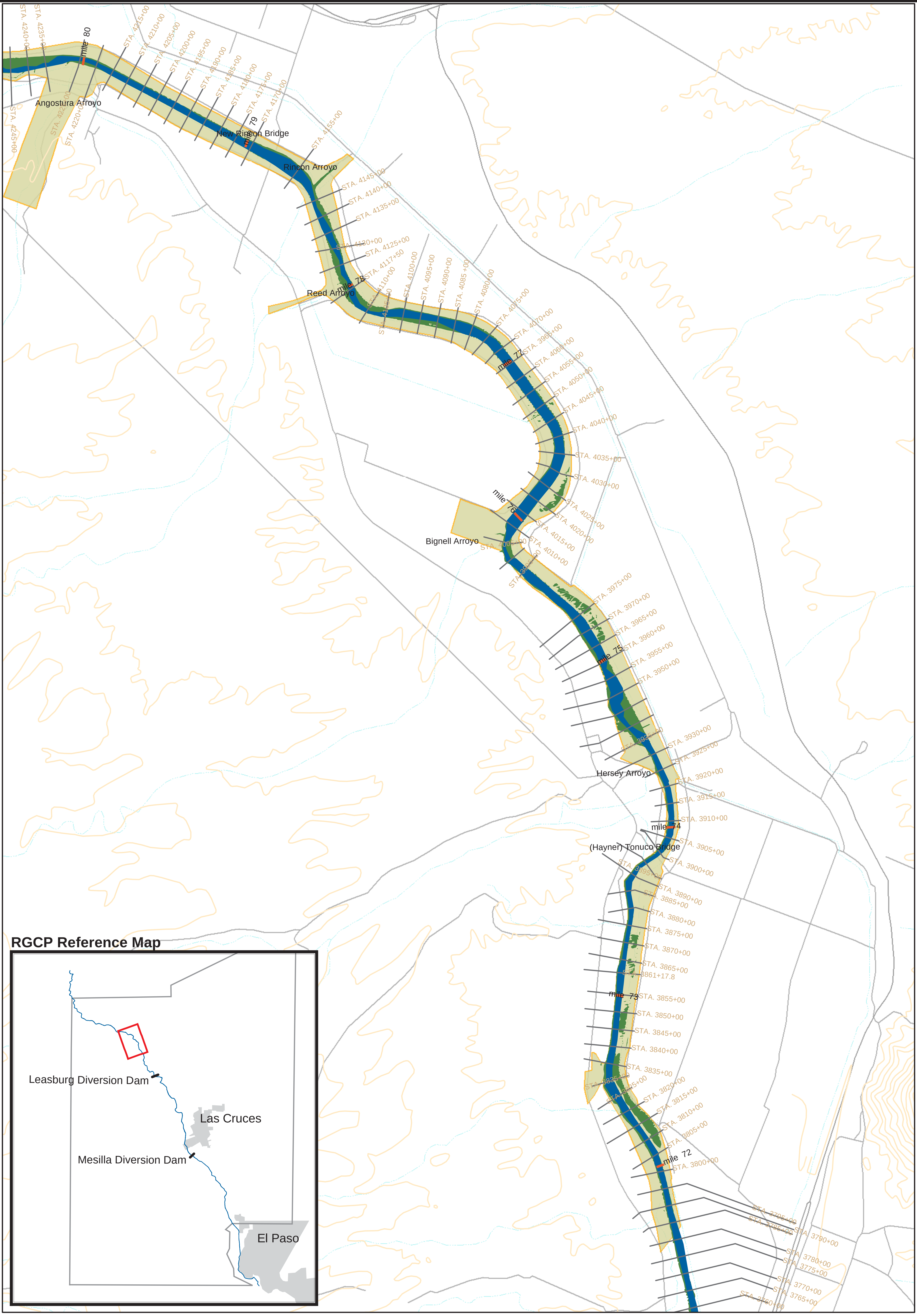



Figure F-3

Controlled Releases from Caballo Dam

PARSONS

J:\736\736620\IBWCDrive\projects\flow_models.mxd




Irrigation Flow

5000 cfs Discharge

RGCP Right of Way

Cross Sections for Hydraulic Modeling

0 1,000 2,000 4,000 Feet

Figure F-4

Controlled Releases from Caballo Dam

PARSONS

J:\736\736620\IBWCDrive\projects\flow_models.mxd

# APPENDIX G
# PRELIMINARY COST ESTIMATES FOR THE ALTERNATIVES

# APPENDIX H
# COMMENTS TO THE REFORMULATION REPORT AND USIBWC RESPONSES

WWF

September 12, 2003

Slyvia Waggoner
Supervisory Environmental Engineer
Environmental Management Division
IBWC US
4171 N. Mesa
Suite C-310
El Paso, Texas 79902

Dear Slyvia:

I want to extend my sincere appreciation for IBWC's willingness to meet the other week and discuss stakeholders' concerns with the current hydrological analyses underlying the Canalization EIS processes.

This past week I have reviewed the Reformulation report and need some points clarified to enhance WWF's understanding of the restoration measures that are being proposed.

I acknowledge that the questions are lengthy and may require a substantial dedication of time on the part of IBWC or Parsons' staff to answer. The additional information provided by these answers will be instrumental in helping WWF and the environmental community at large be a well-informed participant in the EIS process and improve our accuracy in communications on proposed alternatives. Because IBWC staff time may be limited, we understand if a response is not immediately forthcoming. I would be happy to discuss a reasonable time frame for a response with you.

If it would be more efficient for me to talk directly with Parsons' staff, please refer me to the individual to whom I may direct my questions. Also, if my questions are unclear, I would be happy to clarify them in person or by phone.

Below are my questions:

1. What is the correct number of acreage for planting sites within the ROW for Integrated Land Management Alternative? Table 2-4 indicates 149 acres under Integrated Land Management, 141 acres under Targeted River Restoration, Table 4-9 indicates 217 under Integrated Land Management Alternative but 189 under the Targeted River Restoration and the text indicates 223 acres (2-8).

2. What was the basis for reducing the acreage for expanded remnant bosque/riparian veg from 249 to 3 acres in the Integrated Land Management Alternative? (See Table 2-4)

Were they outside the limits of the hydrologic flood plain, outside the ROW or did they result in "relatively" high water consumption?

3. Did Parsons prepare tables in the Reformulation report that breaks down environmental enhancement sites into acreage distribution by physiognomic class and geographic distribution by management unit (see for comparison Table 2.8 in AFR)? The reason I ask is while Parsons claims to have retained the majority of the 48 locations it is difficult to compare where they have been modified and in what respect given the information provided in the Reformulation report.

4. In Integrated Land Management Alternative, what model was used to predict how much acreage would be inundated under reference flows, see discussion 2-7 to 2-8? Which reference flow was the basis for predicting the limits of the hydrologic flood plain? Where in the report can I find the data/evaluation that supports the estimate? Is it also in the handout in the October 22, 2001 presentation (Appendix D)?

5. I wanted to verify whether the additional recreational acres within ROW identified as an environmental enhancement under Integrated land management was limited to 14 acres or 14 sites of unknown acreage? If 14 sites, where are those sites located, what type of recreational use is proposed and how much acreage would be included in each site?

6. What percentage of IBWC lands is currently under lease as recreational areas and can you provide me the name of leaseholders and locations by River Unit?

7. In Integrated Land Management Alternative, what activities are included in the "emphasis on water conservation" (2-8)?

8. Under enhancements by seasonal peak flow, the report states that the "discharge would be a combination of coordinated irrigation deliveries and additional releases from purchase of water rights" (2-8). What is the amount of discharge? What percentage of that would have to come from purchase of water rights?

9. On what basis were "artificial wetlands" deemed unsustainable in this semi-arid region given several managed wetland areas in Socorro (Bosque del Apache NWR), Las Cruces (Picacho Wetland), and El Paso (Rio Bosque and Feather Lake) and their relatively high habitat value? (2-11)

10. What exact measures are being proposed under Land Management restoration measure of modified grassland management? Specifically,

    a. what modifications would occur to the mowing regime,

    b. what types of native grasses are being considered, what percentage of ROW would be planted with native grasses and how would the native grasses be planted and established?

    c. What type(s) of salt cedar control would be used?

**World Wildlife Fund**
**Chihuahuan Desert Program**
**100 E. Hadley Street, Las Cruces, New Mexico 88001**
**505-525-9537 (*phone*) 505-525-9532 (*fax*)**

11. Did Parsons do a WHAP (Wildlife Habitat Appraisal Procedure) analysis to determine the comparative habitat value from two revised measures in the Reformulation report: (1) discontinuation of mowing on 488 acres to managed grasslands on 1641 acres; and (2) cessation of grazing leases on 881 acres to modified grazing leases on 3552 acres?

12. Table 2-7 indicates that "no environmental measures were proposed for sites within urbanized reaches where flood control concerns were potentially significant." Please specify in what river mile are these "urban reaches" located? On what basis/analyses was a decision made that flood control concerns were potentially significant in these urban reaches? How many sites were excluded on this basis and what were the specific locations of the environmental measures in river miles?

13. Why was the amount of land easements/land acquisition reduced from 1183 acres to 999 acres (Table 2-4)?

14. Under the original Formulation report, 1062 acres w/in the ROW and 914 acres outside of ROW were identified for salt cedar control (See AFR Table 2-12). This action was identified as an "implementation action" in the Reformulation report. Are these acreage now included in the acreage count under some other restoration measure such as modified grazing lease, managed grasslands or easements? What does it mean to be called an implementation action as opposed to a "measure"?

15. What was the basis for excluding 47 acres of new meanders outside of the ROW from consideration as a restoration measure under the Targeted River Restoration?

16. What was the basis for excluding minimum in-stream flows from consideration in Targeted River Restoration alternative?

17. Under "Maintenance of Levee System", p.3-1, the report states that the slopes are mowed to prevent growth of bush and trees that could obstruct flows or cause root damage to structure itself." On what basis/analyses was the conclusion drawn that growth of bush and trees could obstruct flows or cause root damage to the structure itself?

18. Under "Mowing of Floodway", p.3-2, the report states "floodway areas outside the main channel are maintained to remove obstructions." What is the justification for removing "obstructions" and on what basis/analyses was the conclusion drawn that vegetation in the floodway could "obstruct" flows?

19. Under the Modified O&M and Flood Control alternative, the report states that modeling and absence of information on structural integrity were insufficient to accurately predict how much levee height increase and building of additional levees will be necessary, but estimates were included anyway as a "work assumption" (3-

5). Can you explain to me what IBWC means by "work assumption?" I am having a difficult time understanding the justification for including it and then failing to complete the necessary analyses to objectively evaluate this alternative, or, alternatively, why the alternative was included at all or especially in light of the language in Section 4.3.4, "Reevaluation of flood control strategies is an ongoing task conducted by the USIBWC as part of its mission, and whose scope is beyond the evaluation of river management alternatives for the RGCP."

20. The report states (4-20) that two reaches successfully met the criteria for levee relocation. Is "levee relocation" a restoration measure incorporated in any alternative? I do not see these measures included in any of the figures detailing point projects, Figure 2-4 through 2-22 or included in Table 2-4 as a measure under the Targeted River Restoration. If levee relocation was not included in any alternative, why not, considering at least two reaches met the criteria established by Parsons?

21. The criteria for levee relocation state that "levee deficiencies adjacent to urbanized areas must be addressed by levee rehabilitation at their current location (structural measures)." How was "urbanized areas" defined? Did Parsons look at adjacent land use to the "deficient" levee in "urbanized areas? What was the justification/basis for the assumption that "levee deficiencies adjacent to urbanized areas must be addressed by levee rehabilitation at their current location (structural measures)?"

22. Are the 127 acres of bank shave-downs included in the estimate of 516 acres of floodway inundated with seasonal peak flows or are they in addition to the 516 acres under the Targeted River Restoration alternative?

23. All 127 acres of the bank shavedown restoration measures occurs in the upper and lower Rincon Valley. Table 3-4 indicates recurrence of peak daily flows during the months of March and April over the past 63 years below Caballo Dam at station 08-3625.00. On what basis was the conclusion made that peak daily flows below Caballo Dam occurred with the same frequency at river miles 104, 103, 102,101,98,94,92,83,76? In other words, was the necessary modeling completed to estimate the presence/absence of attenuation of these flows in the reach between station 08-3625.00 and the above river miles? If so, what model was used and how much attenuation was estimated?

24. What are the estimates of increase in consumptive water use for each of the restoration measures below? (On page 4-4, the report sets out two estimates but it is unclear to me which of the restoration measures below are "riparian vegetation development" and which are "planting sites.") On what basis/justification were these estimates drawn from? Further, there appear to be no estimates for salvage or depletions from seasonal flows, open water areas in reopened meanders or modified dredging at arroyos. Is it estimated that there will be no change in water use from these measures? How much water is estimated to be lost from evapotranspiration from the existing vegetation in the floodway under current management? It is critical

to know this figure as the language on 4-4, specifies the estimates in water consumption are an "increase" over existing use and not "actual" water consumption estimates.

a. 223 acres of native vegetation planting

b. 127 acres of bank shavedowns

c. 516 acres of inundated floodway

d. 141 acres of reopened meanders (25% open water and 75% native cottonwoods)

e. modified dredging at 12 arroyos

23. The Reformulation report states that implementation of native vegetation establishment and localized changes in channel geometry are likely to require significant water acquisition (3-11). How much water does Parson's estimate these measures will consume? On what basis were these estimates computed/prepared?

24. The Reformulation report states that native vegetation establishment under the Targeted River Restoration alternative will occur as a result of controlled water releases from Caballo Dam during "high storage conditions in Elephant Butte Reservoir." (3-11) What is the definition of "high storage conditions?" Based on historical records, with what frequency will these storage conditions occur?

25. With regard to controlled water releases for overbank flooding (3-13), what are the flow values for "typical irrigation levels?"

26. What is the hydrograph for the water releases for overbank flooding, i.e., duration, magnitude, frequency and timing, and rate of change in rising and recessional limbs?

27. The report further states (3-13) that these discharges would be a combination of coordinated irrigation deliveries and additional water releases from the purchase of water rights. How many acre-feet of water does Parson's estimate would have to be purchased to achieve the projected overbank flooding? What analyses have been performed to demonstrate the feasibility of coordinating irrigation flows at desired levels during optimum cottonwood seed germination periods?

28. With regard to reopening of meanders within ROW, the report states that the structures would divert water during "high flow periods" (3-16). What is the definition of "high flow periods" and with what frequency do they occur based on historical records? What data or model was used to determine the frequency of "high flow" occurrence at river miles 105, 102, 97, 95, 92, and 54? For what duration of time and at what water levels does Parsons' estimate "backwater conditions during low flow conditions" would persist in the side channels?

**World Wildlife Fund**
**Chihuahuan Desert Program**
**100 E. Hadley Street, Las Cruces, New Mexico 88001**
**505-525-9537 (*phone*) 505-525-9532 (*fax*)**

29. On what basis/criteria were arroyos identified as having the most significant potential for diversification of aquatic habitat (3-16)?

30. What role did/does IBWC play in the construction and maintenance of sediment retention dams on arroyos in the Canalization Project. The report indicates that USIBWC requested NRCS to construct sediment control dams at 4 arroyos (4-12). Can you provide more information about the nature of these requests and whether IBWC funding/in-kind services were used for their construction?

31. What is the legal basis for saying that environmental water use will require project reauthorization (4-2)?

32. Can you explain the position taken in the report that "use of non-structural flood control methods in the RGCP is primarily an economic and risk-management decision?" (4-17)

33. What role did IBWC play in the construction of Caballo Dam? Was the dam constructed, in part or whole, at the request of IBWC? Did IBWC funding/in-kind services contribute to the cost of construction?

34. What was the basis/justification for not considering reworking of the channel geometry to create low velocity habitat for aquatic habitat diversification?

35. Is it possible to get copies of the following technical reports:

    a. Technical Report, HEP and WHAP Surveys for Evaluation of Aquatic and Wildlife Habitat, Rio Grande Canalization Project, Parsons, June 2001

    b. Threatened and endangered species final report, USIBWC Rio Grande Canalization EIS, Parsons, April 2000

    c. Final Threatened and Endangered Species Survey Technical Report, Rio Grande Canalization Project, Parsons, February 2001

Yours truly,

Beth Bardwell

Program Officer

**World Wildlife Fund**
**Chihuahuan Desert Program**
**100 E. Hadley Street, Las Cruces, New Mexico 88001**
**505-525-9537 (*phone*) 505-525-9532 (*fax*)**

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

NOV 14 2003

Ms. Beth Bardwell
Program Officer
World Wildlife Fund
Chihuahuan Desert Program
100 E. Hadley Street
Las Cruces, New Mexico 88001

Dear Ms. Bardwell:

This responds to your September 12, 2003 letter to me regarding questions you and the World Wildlife Fund have on the Reformulation of River Management Alternatives for the Rio Grande Canalization Project report, dated August 2003. We shared your letter with Parsons, which, by the way, was very glad to receive your substantive comments; and as a result, they were able to strengthen the environmental document we hope to release soon. As you stated in your letter, you anticipated a substantial dedication of time and effort in preparing answers to your questions. It has taken a long time to respond due, not only to the detail of your questions, but also due to project scheduling that included completing and distributing a preliminary draft environmental impact statement for USIBWC staff and cooperating agency review which is still underway.

Attached, please find the responses largely provided by Parsons. Each question is restated, followed by the appropriate response. I hope this adequately responds to your questions, and you and your organization receive an enhanced understanding of the proposed actions and analysis in the upcoming document. We look forward to your comments on the draft environmental impact statement when it is released for public review in the near future. I appreciate your patience in receiving this reply.

Sincerely,

Sylvia A. Waggoner

Sylvia A. Waggoner
Acting Principal Engineer
Engineering Department

Attachment:
Responses to WWF September 2003 Comments

The Commons, Building C, Suite 310 • 4171 N. Mesa Street • El Paso, Texas 79902
(915) 832-4100 • (FAX) (915) 832-4190 • http://www.ibwc.state.gov

cc w/Attachment:

Dr. R.C. Wooten
Vice President
Principal
Parsons Engineering Science, Inc.
8000 Centre Park Drive, Suite 200
Austin, Texas 78754

## Response to WWF September 2003 Comments

*Question 1. What is the correct number of acreage for planting sites within the ROW for Integrated Land Management Alternative? Table 2-4 indicates 149 acres under Integrated Land Management, 141 acres under Targeted River Restoration, Table 4-9 indicates 217 under Integrated Land Management Alternative but 189 under the Targeted River Restoration and the text indicates 223 acres (2-8).*

Planting site estimates were based on individual point projects listed in the reformulated alternative descriptions (Tables 3-6 and 3-8). The before-after reformulation comparison presented in Table 2-4 was not updated to reflect an increase in planting area estimates.

For the Targeted River Restoration Alternative, 189 acres is the correct updated value as listed for 10 projects in Table 3-8. This value is correctly quoted in Table 4-9, but a lower estimate of 141 acres is presented in Table 2-4.

For the Integrated USIBWC Land Management Alternative, 223 acres is the updated value as listed for 14 projects in Table 3-6. This value is correctly quoted in page 2-8 of the text, but a lower estimate of 149 acres is presented in Table 2-4 (in Table 4-9, 217 acres instead of 223 acres is an entry error).

*Question 2. What was the basis for reducing the acreage for expanded remnant bosque/riparian veg from 249 to 3 acres in the Integrated Land Management Alternative? (See Table 2-4) Were they outside the limits of the hydrologic flood plain, outside the ROW or did they result in "relatively" high water consumption?*

"Expand remnant bosques/riparian vegetation" as a single measure in the AFR listed for comparison in Table 2-4, refers to two types of measures in the reformulation: expansion of riparian vegetation and enhancement of bosques. High water consumption was not a consideration in acreage changes.

All riparian vegetation acreage within the hydrologic flood plain in the AFR was retained or expanded as part of planting areas (up to 223 acres), shavedowns (127 acres), or induced overbank flows (516 acres).

Enhancement of existing bosques by selective salt cedar removal, was limited in the reformulation to 3 acres located within the flood plain. Intervention was no longer proposed in the reformulation for other remnant bosques located in uplands (either within or outside the ROW) that are largely dominated by salt cedar. Extensive salt cedar removal in the floodway, however, would be conducted as an implementation action for other measures. Attachment A identifies site-by-site changes to remnant bosque areas as well as other measures.

*Question 3. Did Parsons prepare tables in the Reformulation report that breaks down environmental enhancement sites into acreage distribution by physiognomic class and* *geographic distribution by management unit (see for comparison Table 2.8 in AFR)? The reason I ask is while Parsons claims to have retained the majority of the 48 locations it is difficult to compare where they have been modified and in what respect given the information provided in the Reformulation report.*

Detailed tabulated data by physiognomic class, not presented in the Reformulation Report, will be included in the DEIS as the basis for comparison between baseline conditions and those anticipated for each alternative. [Note: no Table 2.8 was presented in the AFR; tables in the DEIS are structured as those presented by in Section 7 of the AFR (7.2 through 7.6)]

Most sites were retained in the reformulation as point projects or were incorporated into more extensive linear projects, typically native grassland management or bank overflows by seasonal peak flows, that extend beyond the original site boundaries. Sites eliminated from consideration, also identified in the table, are located in the southern section of the RGCP where potential levee deficiencies were identified, or in uplands where intervention of remnant bosques is no longer proposed (as discussed in the previous response). The rationale for changes was described in Section 2.3 of the Reformulation Report, and summarized in Tables 2-6 and 2-7.

Attachment A was prepared to illustrate the point that most acreage for environmental measures was retained as point projects, and often expanded as part of a linear project. Attachment A presents a list of the 48 environmental enhancement sites initially identified in the AFR and their modification in the reformulation.

*Question 4. In Integrated Land Management Alternative, what model was used to predict how much acreage would be inundated under reference flows, see discussion 2-7 to 2-8? Which reference flow was the basis for predicting the limits of the hydrologic flood plain? Where in the report can I find the data/evaluation that supports the estimate? Is it also in the handout in the October 22, 2001 presentation (Appendix D)?*

A HEC-RAS simulation was performed using as steady-state input flows listed by RMU in Table 2-5 of the Reformulation Report (page 2-7). Those flows were derived from long-term flow data from gages in the RGCP. Data for the October 22, 2001 presentation were used in the simulation of water releases from Caballo Dam, but were not used in the hydrologic flood plain estimates.

As indicated in Table 2-5, flows ranging from 2,586 cfs to 3,561 cfs were used to delineate a likely active hydrological flood plain based on average monthly data, and were obtained from the USACE 1996 report (Tables 2-2, 2-4 and 2-6 of Vol. 4 of USACE 1996 report, copies of which are attached to this letter). Resulting water elevation data by cross section were then incorporated into the GIS topographic map to produce the graphical representation by site presented in Figures 2-4 through 2-22. In the DEIS, use of the HEC-RAS model will be specifically indicated, and an appendix will be included presenting copies of USACE 1996 tabulated flow data used as input in the simulation (see Attachment B).

*Question 5. I wanted to verify whether the additional recreational acres within ROW identified as an environmental enhancement under Integrated land management was limited to 14 acres or 14 sites of unknown acreage? If 14 sites, where are those sites located, what type of recreational use is proposed and how much acreage would be included in each site?*

The value refers to acres as listed in Table 2-4 of the Reformulation Report, and originally identified in the AFR (Table 7.1). It applies to two sites, one at river mile 62 near Leasburg Dam (4 acres) and the other at mile 5 in Sunland Park (10 acres on west bank). Site description and proposed uses were identified in the AFR for each location (pages 6-27 and 6-36, respectively).

*Question 6. What percentage of IBWC lands is currently under lease as recreational areas and can you provide me the name of leaseholders and locations by River Unit?*

The Rio Grande Corridor Project by the City of Las Cruces encompass a distance of 11 linear miles, from the Shalem Colony Bridge to the Mesilla Dam, and is envisioned for both the western and eastern banks of the southern Rio Grande. The projects would involve cooperative agreements from the USIBWC, as well as a number of other agencies. The total RGCP lands leased is about 23,200 acres; Rio Grande Corridor Project is about 475 acres or 2 percent of leased RGCP land.

The Rio Grande River Park is an ongoing project as part of redevelopment of downtown El Paso that would include an approximately 80-acre linear park and a trail along the Rio Grande. The USIBWC provides access to a portion of the trail corridor. The extent of RGCP lands leased for Rio Grande River Park is about 101 acres or 0.44 percent.

The USIBWC has an existing lease with the County of El Paso for the El Paso County River Park and trail extending from Country Club Bridge to Vinton Bridge on the west floodway. The county is currently developing the approximately 150-acre area. The county plans a 75-acre extension on the east floodway from Vinton Bridge to the Texas / New Mexico state line. All acreage is planned within the RGCP or about 0.97 percent of leased lands.

The cities of El Paso and Sunland Park, New Mexico operate a 57-acre river park located within the flood plain on the east side of the river, upstream from Anapra Bridge. The cities are proposing to eventually connect their respective river parks to the existing El Paso County river park. Master plans indicate connecting all existing and proposed city parks adjacent to the Rio Grande along the Canalization and Rectification projects.

At Anthony, New Mexico a 62-acre golf course is operated and maintained by the Anthony Country Club. Part of the course (eight tees and greens, about 33 acres or about 0.14 percent of leased RGCP lands) utilizes the flood plain on the right bank of the river.

*Question 7. In Integrated Land Management Alternative, what activities are included in the "emphasis on water conservation" (2-8)?*

Salt cedar control remains the key action for water conservation. In addition, sponsoring on-farm water conservation programs (instead of direct water rights acquisition previously emphasized in the AFR) was adopted as the primary water acquisition strategy proposed for both the Integrated USIBWC Land Management and Targeted River Restoration alternatives (Section 3.8.2).

*Question 8. Under enhancements by seasonal peak flow, the report states that the "discharge would be a combination of coordinated irrigation deliveries and additional releases from purchase of water rights" (2-8). What is the amount of discharge? What percentage of that would have to come from purchase of water rights?*

Typical releases from Caballo Dam during the March-October irrigation period have an average of 1,300 cfs as indicated in Figure 4-4, with daily releases changing from week to week for any given year to meet irrigation needs, based on water availability. Water releases above irrigation values at any given time (assuming this action receives authorization by the USBR Rio Grande Project) require water acquisition. For a theoretical maximum discharge of 5,000 cfs from Caballo Dam, up to 3,700 cfs acquisition would be required over the selected discharge period (in this case up to 74% of the total). A 3,700 cfs release sustained over a 1-day period represents an approximate 7,400 ac-ft discharge that needs to be multiplied by the number of days (or fraction of a day).

*Question 9. On what basis were "artificial wetlands" deemed unsustainable in this semi-arid region given several managed wetland areas in Socorro (Bosque del Apache NWR), Las Cruces (Picacho Wetland), and El Paso (Rio Bosque and Feather Lake) and their relatively high habitat value? (2-11)*

Construction of artificial wetlands were not considered a priority measure to be included in the river management alternatives for two reasons:

- First, artificial wetlands have a high water consumption (greater evapotranspiration than open water) whose construction would come at the expense of other measures proposed for riparian corridor development (riparian bosque and native grasslands). This was a key consideration since no water rights are currently available for any environmental measure. Managed areas listed in the question are not necessarily applicable to large scaled restoration of the RGCP. For example, the Rio Bosque Wetland Refuge, was constructed by the USIBWC as a USFWS required mitigation measure, and placed downstream from a steady, controlled water source, a wastewater treatment plant.

- Second, the long-term success of artificial wetlands has often been questioned. We agreed on this point with the SWEC opinion replied to in a June 13, 2001 correspondence to the USIBWC (page 3 of Interim Report) that stated "Proposed artificially constructed wetlands have questionable merit in terms of long-term success (See Malakoff, D. 1998. 'Restored Wetlands Flunk the Real World Test')... Better the USIBWC cooperate with the NRCS apply its resources to establishing continuous *strands* or buffer *strip* vegetation along a restored channel capable of conveying hydrologic pulses." Riparian corridor development is a core action adopted for the Targeted River Restoration alternative.

*Question 10. What exact measures are being proposed under Land Management restoration measure of modified grassland management? Specifically,*

a. *what modifications would occur to the mowing regime,*

b. *what types of native grasses are being considered, what percentage of ROW would be planted with native grasses and how would the native grasses be planted and established?*

c. *What type(s) of salt cedar control would be used?*

Question 10.a Currently both floodways and levee slopes in the RGCP are mowed at least once a year prior to July 15. The purpose of mowing is to control growth of shrubs and trees, primarily salt cedar. Salt cedar can reach up to 9 feet in height in a single growing season, as such must, it be controlled annually. The modified grassland management would replace current mowing regime in selected areas to improve wildlife habitat by 1) increasing vegetation diversity, 2) develop native herbaceous vegetation, and 3) improve the riparian corridor and upland/riparian interface. In order to continue to provide salt cedar control, control methods such as herbicide, mechanical (mowing), manual and/or burning would be instituted. Site-specific condition would dictate method or combination of methods used. Measure implementation would include:

- Site preparation, salt cedar treatments (e.g. mowing followed by herbicide) and shallow disking to prepare soil and chemical treatments (salinity management),
- Seeding of native vegetation, and
- Maintenance and monitoring. Maintenance would include continued salt cedar control using treatments specific to site conditions and vegetation treatments that would promote the establishment and sustainability of native

species. Monitoring would be in place to assess treatment results and modify methods as appropriate.

The modified grassland management areas are outside the hydrologic flood plain and would be dominated by intermediate and xeric native species. Depressions and shallow groundwater interspersed within these areas would support mesic and hydric vegetation, potentially creating additional diversity and improved wildlife habitat.

Question 10.b Grasses have the greatest potential for holding soils, thus decreasing erosion. They also can create open areas, which coupled with densely wooded patches create an edge habitat that is ideally suited for a number of small mammal and bird species (USACE 2003). Native grasslands would be developed to improve habitat corridors between patches of bosque, provide increased protection of riparian wetlands, and enhance wildlife habitat. However, this reference community would continue to be disconnected from the river, and would be composed primarily of intermediate and xeric native grasses and other herbaceous vegetation. Within isolated mesic and hydric areas, species would include salt grass, cattail, sedges, and rushes.

Grasslands would be established by plantings and maintained through woody vegetation control. A woody component would likely be present, but typically less then a 20 percent aerial coverage. Where appropriate, woody vegetation would be retained for structural diversity and would include native woody vegetation such as screw bean mesquite. More xeric species would become established on higher sites. Salt cedar would be controlled. Vegetation along the river and in wetlands locations would not be maintained, with the exception of salt cedar removal to improve bank stability and decrease potential erosion and sedimentation.

Question 10.c Prescribed burning of grassland may be warranted to improve grass production. Most grasses are relatively tolerant of fire, and the subsequent nutrient pulse will allow grasses to rapidly recover after a fire. If native grasses are well established, burning will control most woody plants (if they are small) and will promote growth of most herbaceous plants. In addition, if native plants are well established, particularly in the rooting zone, burning will not harm the roots and the soil will remain stabilized. However, burning would need to occur when woody plants such as salt cedar are not actively seeding, as burning will create open spaces for seedling establishment of salt cedar. If there are woody plants present on the areas considered for burning, these species would have to be assessed for fire-tolerance. Salt cedar tends to be more tolerant of fire than some native riparian species (Scurlock 1998; Crawford *et al.*, 1996).

*Question 11. Did Parsons do a WHAP (Wildlife Habitat Appraisal Procedure) analysis to determine the comparative habitat value from two revised measures in the Reformulation report: (1) discontinuation of mowing on 488 acres to managed grasslands on 1641 acres; and (2) cessation of grazing leases on 881 acres to modified grazing leases on 3552 acres?*

Potential WHAP scores reflect the contribution of native plant communities to wildlife habitat quality. WHAP data are used as a basis for evaluation of impacts and, as such, are included in the DEIS evaluation, not the Reformulation Report. The table below illustrates criteria used for WHAP in the DEIS. The table presents predicted WHAP values due to implementing environmental measures. The "maximum range" possible column represents the highest hypothetical value for a reference community using the WHAP score sheet. The potential HQ value represents an estimated score for a reference community after 20-year implementation. The potential score is 80 percent of the maximum score. WHAP scoring criteria such as temporal development and uniqueness and relative abundance limit a reference communities' potential HQ value to scores below the maximum score.

| Reference Community | Potential HQ Value | Maximum Score Range |
|---|---|---|
| Improved uplands | 0.50 | 0.63 – 0.88 |
| Improved floodway | 0.60 | 0.75 – 1.0 |
| Native grasslands | 0.65 | 0.80 |
| Native bosque | 0.80 | 1.0 |

*Question 12. Table 2-7 indicates that "no environmental measures were proposed for sites within urbanized reaches where flood control concerns were potentially significant." Please specify in what river mile are these "urban reaches" located? On what basis/analyses was a decision made that flood control concerns were potentially significant in these urban reaches? How many sites were excluded on this basis and what were the specific locations of the environmental measures in river miles?*

Residential areas (low, medium and high intensity) are defined in the Doña Ana County digital land use map. Copies of the land use maps are included as the baseline to evaluate potential impacts in the Preliminary DEIS currently under evaluation by the USIBWC. A summary of this land use was provided in the Reformulation Report as the simplified diagram shown in Figure 4-9. This figure identifies predominant agricultural vs. residential/urban areas in ½ mile intervals along with potential levee deficiencies.

Potential levee deficiencies in hydraulic simulations are defined by freeboard availability relative to the simulated peak water elevation. Since the design criterion is a 3 feet freeboard, potential levee deficiencies were qualified as significant when estimated water elevations resulting in levees without freeboard or a freeboard less than 1 foot, and moderate for levee sections with freeboards from 1 foot to 2 feet. Freeboards in the 2 to 3 feet range were considered a low deficiency potential considering the conservative nature of the HEC-RAS flood simulations. Figure 4-9 shows that most significant or moderate deficiencies (less than 2 ft freeboard) are located in reaches adjacent to urban areas in Las Cruces and El Paso. Attachment A indicates changes from the AFR to the reformulated alternatives on a site-by-site basis.

*Question 13. Why was the amount of land easements/land acquisition reduced from 1183 acres to 999 acres (Table 2-4)?*

Conservation easements were actually increased to 1,618 acres in the reformulation as listed by RMU in the description of the reformulated Targeted River Restoration alternative (Section 3.4.5 and Table 3-7). However, as indicated in question No. 1, the reformulated alternatives before-after comparison presented in Table 2-4 was not updated to reflect the 1,618 acres indicated in Section 3. The distribution of conservation easement estimates to be used in DEIS is as follows:

| Conservation Easement Location | Acreage | Restoration |
|---|---|---|
| Cropped CE | 288 | Native grasslands management |
| Hydrologic Floodplain | 771 | Native bosque enhancement/planting. The majority of CE within or adjacent to Seldon Canyon and nearby Picacho wetlands pilot project. |
| Other | 559 | Preservation of corridor width. Includes remnant bosques outside the hydrologic floodplain. |
| Total | 1,618 | |

*Question 14. Under the original Formulation report, 1062 acres w/in the ROW and 914 acres outside of ROW were identified for salt cedar control (See AFR Table 2-12). This action was identified as an "implementation action" in the Reformulation report. Are these acreage now included in the acreage count under some other restoration measure such as modified grazing lease, managed grasslands or easements? What does it mean to be called an implementation action as opposed to a "measure"?*

Salt cedar control is required for implementation of various measures (bosque enhancement, cottonwood establishment sites, management of grazed areas and native grasslands) but is no longer considered a river management objective (as it was in the AFR). For this reason all salt cedar removal acreage is included as part of other measures.

Environmental measures are composed of various activities. For instance the environmental measure "opening former meanders" would include activities such as 1) site survey and design, 2) vegetation clearing and disposal, 3) excavation and sediment disposal, 4) planting and site preparation, 5) monitoring and maintenance, among others. Salt cedar control activities would be captured in task 2 and 5, and assessed as an effect/result of implementing the environmental measure. In our opinion, it is best to assess salt cedar control as an "effect" rather then an environmental measure.

That said, salt cedar control is a fundamental aspect of a broader RGCP vegetation management program. Vegetation management is conducted to reduce the amount of vegetation (primarily salt cedar) and potential obstructions within the ROW. The

USIBWC manages salt cedar through mowing by USIBWC staff or as part of lease agreements in which lessees agree to mow/control salt cedar on leased property. Implementation of environmental measures results in a change of vegetation management practices. This change in vegetation management was one the indicators used in the DEIS analyses.

The following tables, included in the DEIS, list salt cedar control methods for riparian areas (upland areas represent an additional 1,805 ac not shown in table) within and outside (conservation easements) the ROW by alternative.

### Flood Control Improvement Alternative

| Environmental Measure | Acreage | Initial Site Preparation Activities | Long-Term Maintenance |
|---|---|---|---|
| Floodway Grazing Management | 1,747 | Stocking rate evaluation and potential adjustment on a lease by lease basis | Modified - Salt cedar control by chemical or mechanical means (mowing). |
| Mowing by USIBWC | 4,657 | No change from current practices | No Change from current practices. |

### Integrated USIBWC Land Management Alternative

| Measure | Acreage | Initial Site Preparation Activities | Long-term Maintenance |
|---|---|---|---|
| Floodway Grazing Management | 1,747 | Stocking rate evaluation and potential adjustments on a lease by lease basis. | Salt cedar control by chemical (spot) or mechanical means. Mechanical removal would be avoided along river edge and wetlands areas. |
| Native vegetation planting | 223 | Selective removal and clearing through mechanical means. Mechanical means could be required in dense-monotypic stands. | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Stream bank reconfiguration Existing bosque enhancement | 127 | Complete removal of vegetation through mechanical means and excavation to within 1 foot of mean irrigation flow. | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Native Grasslands | 1,641 | Removal of vegetation by herbicide (aerial or spot), shallow disking. | Salt cedar control by chemical (spot). Periodic mowing could be used in some areas. Mechanical removal would be avoided along river edge and wetlands areas. |
| Mowing by USIBWC | 2,674 | No Change from current practices | No Change from current practices. |

### Targeted River Restoration Alternative

| Measure | Acreage | Initial Site Preparation Activities | Long-term Maintenance Activities |
|---|---|---|---|
| Floodway Grazing Management | 1,688 | Stocking rate evaluation and potential adjustment on a lease by lease basis. | Salt cedar control by chemical or mechanical means. |
| Native vegetation planting/enhancement | 960 | Selective removal and clearing. Mechanical means could be required in dense-monotypic stands such as in sites within Seldon Canyon which would require extensive removal of mature salt | Salt cedar control by spot application of herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |

| Measure | Acreage | Initial Site Preparation Activities | Long-term Maintenance Activities |
|---|---|---|---|
| | | cedar. | |
| Seasonal peak flows /bank preparation Existing bosque enhancement | 516 | Complete removal of vegetation through mechanical means/ bank preparation | Salt cedar control by herbicide or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Native grasslands | 1,929 | Removal of vegetation by herbicide, shallow disking. Mature woodlands not treated in order to provide structural diversity in floodway. | Salt cedar control by chemical or mechanical means. Periodic mowing could be used in some areas. |
| Reopening of meanders | 142 | Complete removal of vegetation through mechanical means/ bank preparation and excavation | Salt cedar control by spot application of herbicide control or cut-stump methods. Mechanical removal would be avoided along river edge and wetlands areas. |
| Mowing by USIBWC | 2,223 | None | Continued annual mowing |

*Question 15. What was the basis for excluding 47 acres of new meanders outside of the ROW from consideration as a restoration measure under the Targeted River Restoration?*

With the exception of meander 41.5 NMFG, levees did not exhibit potential overtopping during a 100-year flood event as calculated using HEC-RAS. Removal of levees for the sole purpose of environmental enhancement was eliminated during reformulation. In the case of a 20-acre meander at 41.5 NMFG, the opening of this meander was eliminated because of the potential loss of wetland/wet meadow habitat from meander excavation. Meander 41.5 NMFG is identified within a larger conservation easement.

*Question 16. What was the basis for excluding minimum in-stream flows from consideration in Targeted River Restoration alternative?*

Minimum in-stream flow is not a consideration for the RGCP as the opposite condition, high stream flows during the 8-month irrigation season (that includes critical fish reproduction periods), is the key concern identified. Elevated flows associated with water delivery create a high water velocity habitat with areas of slow-moving waters more suitable for fish reproduction. Minimum in-stream flows, unlike the case of the Middle Rio Grande, have not been documented by any technical study as a priority issue for the RGCP.

*Question 17. Under "Maintenance of Levee System", p.3-1, the report states that the slopes are mowed to prevent growth of bush and trees that could obstruct flows or cause root damage to structure itself." On what basis/analyses was the conclusion drawn that growth of bush and trees could obstruct flows or cause root damage to the structure itself?*

Both flow obstruction by vegetation (in the sense of increased roughness coefficients) and soil levees weakening by tree roots (particularly of existing 60-year old soil structures) are basic design concepts. USACE levee design guidelines limit vegetation on a levee embankment to sod-forming grasses of 2 to 12 in. in height to provide for structural integrity, inspectability, and unhindered flood-fight access to levees (USACE Design and Construction of Levees, Engineer Manual 1100-2-1913). Obstructions in the channel usually refer to unstable or fallen trees, and it's a judgment call by the USIBWC Project Manager.

*Question 18. Under "Mowing of Floodway", p.3-2, the report states "floodway areas outside the main channel are maintained to remove obstructions." What is the justification for removing "obstructions" and on what basis/analyses was the conclusion drawn that vegetation in the floodway could "obstruct" flows?*

As indicated for question 17, increase in floodway vegetation results in increased roughness coefficients, again a basic design concept, and the reason –along with salt cedar control— that annual mowing is conducted. Typical roughness coefficients increase (and thus potential flow obstruction) ranges from 0.03 for short grass (Manning's "n"), to 0.10 for medium to dense brush, and up to 0.15 for dense willows (values from Table 2.1 of HEC-RAS River Analysis System, Version 2.2, September 1998).

The relevant question is to which extent that increase is significant in terms of flood control protection relative to current conditions. This is a critical issue that is evaluated in the DEIS, as many stakeholders have expressed their opposition to expansion of floodway vegetation due to the possibility of reducing flood control potential within the levee system.

*Question 19. Under the Modified O&M and Flood Control alternative, the report states that modeling and absence of information on structural integrity were insufficient to accurately predict how much levee height increase and building of additional levees will be necessary, but estimates were included anyway as a "work assumption" (3-5). Can you explain to me what IBWC means by "work assumption?" I am having a difficult time understanding the justification for including it and then failing to complete the necessary analyses to objectively evaluate this alternative, or, alternatively, why the alternative was included at all or especially in light of the language in Section 4.3.4, "Reevaluation of flood control strategies is an ongoing task conducted by the USIBWC as part of its mission, and whose scope is beyond the evaluation of river management alternatives for the RGCP."*

The question indicates that clarification is needed in two areas, why is flood control evaluated as part of the EIS and why include this action as an alternative.

<u>Extent of the Flood Control Evaluation in the EIS</u>

A detailed evaluation of flood control system improvements was completed in 1996 by the USACE. The study encompassed detailed hydrology and hydraulic evaluations, sedimentation analysis from the Rio Grande tributary basins, and a scour and deposition analysis along the RGCP. Findings of this extensive study are not being reevaluated as part of the EIS, as estimates of levee freeboard and sediment transport are already available and supported by appropriate technical evaluations. Thus the statement *"Reevaluation of flood control strategies is an ongoing task conducted by the USIBWC as part of its mission, and whose scope is beyond the evaluation of river management alternatives for the RGCP."*

USIBWC is currently gathering additional data for flood control system improvements in an area not covered by the 1996 study, structural condition of the levees. Results of the structural analysis could indicate a need to replace limited sections of the levee system, but it will not modify current levee freeboard estimates or findings of the sediment transport analyses.

The specific issue under evaluation in the EIS is that of potential effects of environmental measures on the flood control system given findings of the 1996 RGCP improvement study. To that effect, the same analytical tool used in the 1996 study was used to assess potential changes in flood control if environmental measures were incorporated as part of revised river management alternatives within a 20-year horizon.

Inclusion of the Flood Control Improvement Alternative

The USIBWC will implement a number of recommendations from the USACE 1996 improvement study for the RGCP and ongoing levee system structural evaluation according to priorities that are determined for each fiscal year budget.

Since it is possible for Congress to provide separate funding (and in different years) for measures associated with a modified river management strategy from those of a flood control improvement program, individual evaluation of potential effects of this program in the EIS is in USIBWC (and the taxpayers) benefit. Separate evaluation of the flood control improvement program effects is also useful in the EIS because it is clear that effects of environmental measures need to be assessed within the framework of a future levee rehabilitation program likely be implemented within the same 20-year horizon. This analysis is particularly needed to assess effects from construction activities associated with potentially extensive levee rehabilitation activities on resources such as air quality, land use, soils, socioeconomics, noise and transportation.

Since targets for flood control improvement and timing of implementation are not presently fully defined, a conservative approach was adopted in the EIS for evaluation of potential effects. The approach was to assume (thus "a work assumption for the EIS") that all potential freeboard increases identified by the 1996 hydraulic modeling simulation will be eventually addressed by in-place rehabilitation. This simply implies that construction for levee system improvement could be extensive (a conservative assumption for effects evaluation), and implemented concurrently with environmental measures.

*Question 20. The report states (4-20) that two reaches successfully met the criteria for levee relocation. Is "levee relocation" a restoration measure incorporated in any alternative? I do not see these measures included in any of the figures detailing point projects, Figure 2-4 through 2-22 or included in Table 2-4 as a measure under the Targeted River Restoration. If levee relocation was not included in any alternative, why not, considering at least two reaches met the criteria established by Parsons?*

Page 4-20 of the Reformulation Report indicates that at those two locations (representing less than 5% of the levee system) an analysis of levee relocation would be warranted as part of a revised flood control strategy. The rephrasing "the two reaches met the criteria for levee relocation" is incorrect as in-place rehabilitation is the preferred course of action to preserve the federal investment in the levee system. Current technical data indicates that, excluding a limited reach in Canutillo, there is not a need or advantage in reconstructing or relocating any sections of the levee system. This conclusion could be modified in the future if flood easement use and/or levee relocation prove advantageous for those two levee sections based on a cost-benefit and risk analysis, or identification of structural deficiencies.

*Question 21. The criteria for levee relocation state that "levee deficiencies adjacent to urbanized areas must be addressed by levee rehabilitation at their current location (structural measures)." How was "urbanized areas" defined? Did Parsons look at adjacent land use to the "deficient" levee in "urbanized areas? What was the justification/basis for the assumption that "levee deficiencies adjacent to urbanized areas must be addressed by levee rehabilitation at their current location (structural measures)?"*

For definition of urbanized areas, see response to Question 12. Flood control strategy is discussed at length in Section 4.3 of the Reformulation report (Flood Control Evaluation) that presents a comparison of potential levee deficiencies and adjacent land use. The detailed land use analysis used in preparation of Figure 4-9 is included in the DEIS as baseline conditions of potential effects evaluation for that resource area, as previously indicated in the response to Question 12.

USIBWC flood control strategy relies on the use of existing levees along urban areas, largely in Las Cruces and El Paso. To modify that strategy a valid rationale must be provided a) to justify relocation of existing levees (6 to 10 feet tall) that can be rehabilitated in place by an average 2 feet height increase, and b) to incorporate into the RGCP floodway urban areas that the levee system are intended to protect. No such justification exists as the need for levee reconstruction has not been identified (see response to Question 19).

*Question 22. Are the 127 acres of bank shave-downs included in the estimate of 516 acres of floodway inundated with seasonal peak flows or are they in addition to the 516 acres under the Targeted River Restoration alternative?*

Yes, shavedown areas under the Integrated Land Management Alternative would be inundated by peak flows and part of the 516 acres listed for the Targeted River Restoration Alternative. Under the latter alternative, lowering of the stream bank to induce overbank flows (shavedowns) would not be required.

*Question 23. All 127 acres of the bank shavedown restoration measures occurs in the upper and lower Rincon Valley. Table 3-4 indicates recurrence of peak daily flows during the months of March and April over the past 63 years below Caballo Dam at station 08-3625.00. On what basis was the conclusion made that peak daily flows below Caballo Dam occurred with the same frequency at river miles 104, 103, 102,101,98,94,92,83,76? In other words, was the necessary modeling completed to estimate the presence/absence of attenuation of these flows in the reach between station 08-3625.00 and the above river miles? If so, what model was used and how much attenuation was estimated?*

Table 3-4 was included to illustrate that daily peak releases from Caballo Dam can be reasonably expected to exceed the channel design value of 2,300 cfs at least one day every other year. That information is not used for estimates of shavedown areas as random occurrences of a daily peak flow are not likely to develop or support a riparian corridor. A different approach to facilitate understanding of the concept is tabulated data showing average monthly flows (based on monitoring data) that are exceeded with a 10 percent frequency for a given month and RGCP reach. The table below illustrates the fact that flows above channel design values can be expected (as a monthly average) with some relative frequency. Average monthly flows selected as a guideline for riparian vegetation development are also listed as a reference.

| | Estimated 10 Percent Exceedance Flow (cfs)* | | | | | |
|---|---|---|---|---|---|---|
| **Month** | **Percha Dam to Seldon Canyon** | **Seldon Canyon to Leasburg Dam** | **Leasburg Dam to Las Cruces (I-10)** | **Las Cruces to Mesilla Dam** | **Mesilla Dam to Anthony, NM** | **Anthony, NM to American Dam** |
| October | 884 | 921 | 696 | 703 | 397 | 503 |
| November | 46 | 83 | 92 | 100 | 104 | 148 |
| December | 37 | 66 | 67 | 74 | 77 | 101 |
| January | 90 | 51 | 53 | 59 | 63 | 79 |
| February | 636 | 693 | 610 | 598 | 382 | 411 |
| March | 1,946 | 1,910 | 1,458 | 1,469 | 742 | 1,046 |
| April | 1,497 | 1,524 | 1,175 | 1,202 | 624 | 912 |
| May | 1,970 | 2,011 | 1,537 | 1,551 | 815 | 1,154 |
| June | 2,732 | 2,884 | 2,496 | 2,540 | 1644 | 2,113 |
| **July** | **2,308** | **2,377** | **1,827** | **1,845** | **1068** | **1,499** |
| August | 1,736 | 1,821 | 1,360 | 1,387 | 728 | 1,114 |

| | | | | | | |
|---|---|---|---|---|---|---|
| September | 1,507 | 1,612 | 1,243 | 1,264 | 626 | 904 |
| **Reference flows**** a. Channel design value | 2,350 | 2,350 | 1,900 | 1,900 | 1,600 | 1,600 |
| b. Riparian vegetation development | **3,561** | **3,470** | **3,035** | **3,270** | **2,545** | **2,586** |

*10 percent exceedance indicates an average monthly value that is exceeded with a 10 percent probability based on historical gage data. For example, 10 percent of monthly flows estimated for the Percha Dam-Seldon Canyon reach exceeded 884 cfs, and 90 percent were below that number (Data from El Paso-Las Cruces Regional Sustainable Water Project, Water Resources Technical Report (2000, Appendix C)

** Channel design values and flows to estimate extent of riparian vegetation development were ontained from USACE (1996).

Quantification of a 127 acres target for shavedowns was based on an empirical reference flows for riparian habitat development along the RGCP. These flows are listed in Table 2-5 and discussed in the rationale for Integrated Land Management Alternative reformulation in Section 2.2.2. As previously indicated in the response to Question 4, the reference flow is based on a sustained flow obtained from monthly historical flow data summarized by USACE (1996) and presented in Attachment B. Monthly data represent the 10-year high flow period on record for various reaches of the RGCP. HEC-RAS modeling was used to simulate water elevation for each reach from the flow input data.

*Question 24. What are the estimates of increase in consumptive water use for each of the restoration measures below? (On page 4-4, the report sets out two estimates but it is unclear to me which of the restoration measures below are "riparian vegetation development" and which are "planting sites.") On what basis/justification were these estimates drawn from? Further, there appear to be no estimates for salvage or depletions from seasonal flows, open water areas in reopened meanders or modified dredging at arroyos. Is it estimated that there will be no change in water use from these measures? How much water is estimated to be lost from evapotranspiration from the existing vegetation in the floodway under current management? It is critical to know this figure as the language on 4-4, specifies the estimates in water consumption are an "increase" over existing use and not "actual" water consumption estimates.*

a. *223 acres of native vegetation planting*
b. *127 acres of bank shavedowns*
c. *516 acres of inundated floodway*
d. *141 acres of reopened meanders (25% open water and 75% native cottonwoods),*
e. *modified dredging at 12 arroyos*

Water use is an effect for any given measures and, as such, it is evaluated in the DEIS not in the Reformulation Report. Values listed in page 4-4 were obtained from the 2001 AFR that included a water use analysis and support documentation (Section 9, Table 9.5). The following support tables have been included in the Preliminary DEIS currently under evaluation by the USIBWC:

**Water Consumption Estimates for Rio Grande Basin Vegetation**

| Type of Coverage | Annual Water Consumption* (ac-ft/ac) | Start date | Term Date | Evapotrans-piration (inches) | Annual Forecast (inches) |
|---|---|---|---|---|---|
| Pasture grass | 4.01 | Mar 15 | Oct 20 | 41.3 | 48 |
| Miscellaneous grass | 4.63 | Apr 05 | Oct 20 | 47.7 | 56 |
| Cottonwood | 3.48 | Apr 05 | Nov 21 | 30.4 | 42 |
| Salt cedar | 4.96 | Apr 05 | Nov 21 | 49.5 | 59 |
| Riparian wood / shrub | 5.35 | Apr 05 | Nov 21 | 46.7 | 64 |
| Open water | 8.48 | Jan 01 | Dec 31 | 73.3 | 102 |
| Marsh | 8.85 | Jan 01 | Dec 31 | 76.5 | 106 |

* Annual forecast expressed in feet. Data for 2001 from USBR Rio Grande Basin AWARDS System and ET Toolbox Project (www.usbr.gov/pmts/rivers/awards/Nm/riogrande.html)

**Assumptions for Water Consumption Estimates**

| Type of Measure | Assumptions |
|---|---|
| Levee rehabilitation | No effect on surface water consumption. |
| Modify grazing practices | No net change for uplands. In the floodway, managed grasslands replace grazed areas (4.63 – 4.01 = 0.62 ft/yr increase). |
| Modified grassland management in floodway | Managed grasslands replace currently mowed areas (4.63 – 4.01 = 0.62 ft/yr increase). |
| Plant woody native vegetation | Tree planting areas replace both currently mowed areas (5.35 - 4.01 = 1.34 ft/yr increase), and salt cedar areas (4.96 – 3.48 = 1.48 ft/yr reduction) |
| Enhance existing bosques | No water consumption increase as existing bosques are maintained. |
| Bank shavedowns | Bosques replace both currently mowed areas (5.35 - 4.01 = 1.34 ft/yr increase), and salt cedar areas (4.96 – 3.48 = 1.48 ft/yr reduction) |
| Open former meanders | Open water replaces both currently mowed areas (8.48 – 4.01 = 4.47 ft/yr increase) and salt cedar bosque (8.48 – 4.96 = 3.52 ft/yr increase). |
| Modify dredging at arroyos | No net increase in water surface area exposed to evaporation. |
| Controlled peak flows | As a conservative scenario, consumption of entire volume of water released assuming no downstream utilization for agricultural irrigation. |
| Conservation easements | No increase in current water consumption for remnant bosques (no intervention), enhanced bosques (selective salt cedar removal), or agricultural lands (managed grasslands replace cropped areas). |

**[Note: this and subsequent questions, listed in the letter as 23 through 35, were renumbered to follow previous numbering of the questions].**

*Question 25. [listed as 23] The Reformulation report states that implementation of native vegetation establishment and localized changes in channel geometry are likely to require significant water acquisition (3-11). How much water does Parson's estimate* *these measures will consume? On what basis were these estimates computed/prepared?*

The basis for water use was presented in the previous response. Water consumption estimates are presented in the Preliminary DEIS currently under evaluation by the USIBWC and are presented in the following two tables.

### Water Consumption Estimates for the Integrated USIBWC Land Management Alternative

| Type of Measure | Area (acres) | Unit Rate (ac-ft/yr) | Water Consumption at Full Implementation (ac-ft/yr) | Use Relative to 645,000 ac-ft/yr of Diverted Water* |
|---|---|---|---|---|
| Modified grazing leases | | | | |
| Uplands (50.8%) | 1,805 | 0.00 | 0.0 | 0.00% |
| Floodway (49.2%) | 1,747 | 0.62 | 1,083 | 0.17% |
| Native grasslands | 1641 | 0.62 | 1,017 | 0.16% |
| Tree planting areas | | | | |
| Currently mowed areas | 146.0 | 1.34 | 196 | 0.03% |
| Salt cedar areas | 77.0 | -1.48 | -114.0 | -0.02% |
| Stream bank shavedowns | | | | |
| Currently mowed areas | 74.0 | 1.34 | 99 | 0.02% |
| Salt cedar areas | 53.0 | -1.48 | -78.4 | -0.01% |
| | | Total Estimate | 2,203 | 0.34% |

* An average diversion of 645,000 ac-ft/yr was based on a combined average of 890 cfs along the RGCP (181 cfs at Leasburg Dam, 312 cfs at Mesilla Dam, and 397 cfs at American Dam; data from Figure 3-3).

### Water Consumption Estimates for the Targeted River Restoration Alternative

| Type of Measure | Area (acres) | Unit Rate (ac-ft/yr) | Water Consumption at Full Implementation (ac-ft/yr) | Use Relative to 645,000 ac-ft/yr of Diverted Water* |
|---|---|---|---|---|
| Modified grazing leases | | | | |
| 50.8% in uplands | 1,805 | 0.00 | 0.0 | 0.00% |
| 49.2% in the floodway | 1,747 | 0.62 | 1,083 | 0.17% |
| Native grasslands | 1,641 | 0.62 | 1,017 | 0.16% |
| Tree planting areas | | | | |
| Currently mowed areas | 124.0 | 1.34 | 166 | 0.03% |
| Salt cedar areas | 65.0 | -1.48 | -96.2 | -0.01% |
| Open former meanders | | | | |
| Currently mowed areas | 54.0 | 4.47 | 241 | 0.04% |
| Salt cedar areas | 88.0 | 3.52 | -310 | -0.05% |
| Controlled peak flows** | 516 | n/a | 7,336 | 1.14% |
| | | Total Estimate | 9,461 | 1.47% |

* Average diversion of 645,000 ac-ft/yr based on a combined average of 890 cfs along the RGCP (181 cfs at Leasburg Dam, 312 cfs at Mesilla Dam, and 397 cfs at American Dam; data from Figure 3-3).

** Assumes a maximum potential discharge of 3,700 cfs above irrigation once a month for 4 months during the early irrigation season. Each monthly water release would be limited to a 6-hour period.

*Question 26. [listed as 24] The Reformulation report states that native vegetation establishment under the Targeted River Restoration alternative will occur as a result of controlled water releases from Caballo Dam during "high storage conditions in Elephant Butte Reservoir." (3-11) What is the definition of "high storage conditions?" Based on historical records, with what frequency will these storage conditions occur?*

A reservoir storage near normal water surface elevation is considered "high storage conditions" which in the case of Elephant Butte has only occurred a few times over the last 60 years as indicated in Figure 4-1 (in the early 40s and from late 80s to mid 90s).

In Caballo Dam that condition is seldom reached not only because of drought conditions but also due to the operational regime that maintains relatively low water levels most of the year for flood water storage and to reduce evaporative losses. The USBR site indicates reservoir storage in 2003 has ranged from 10,000 to 70,000 ac-ft, a small fraction of the 300,000 ac-ft reservoir capacity. Given the extended drought conditions, the USBR website reported water elevations that fluctuated from 4130 ft to 4154 ft for the period January 2002 to September 2003, well below the 4177.44 normal water surface elevation (the dam hydraulic height is 78 ft.). The nominal outlet works capacity of 5,000 cfs is based on a water elevation of 4182 ft.

*Question 27. [listed as 25] With regard to controlled water releases for overbank flooding (3-13), what are the flow values for "typical irrigation levels?"*

Typical irrigation flows are the long-term averages that are summarized in Figure 4-4 of the Reformulation Report for various reaches of the RGCP. Data were obtained for the El Paso-Las Cruces Regional Sustainable Water Project EIS.

*Question 28. [listed as 26] What is the hydrograph for the water releases for overbank flooding, i.e., duration, magnitude, frequency and timing, and rate of change in rising and recessional limbs?*

A maximum theoretical 5,000 cfs steady-state discharge from Caballo Dam was modeled using the HEC-RAS model assuming typical irrigation flows (no input from tributaries), and a 1.5%/mile linear attenuation as indicated in the October 22, 2001 presentation (Appendix D). The discharge would be induced so, by definition, duration, frequency and timing would be defined by restoration targets and, more critical in practical terms, by water rights acquisition to support those discharges.

*Question 29. [listed as 27] The report further states (3-13) that these discharges would be a combination of coordinated irrigation deliveries and additional water releases from the purchase of water rights. How many acre-feet of water does Parson's estimate would have to be purchased to achieve the projected overbank flooding?*

*What analyses have been performed to demonstrate the feasibility of coordinating irrigation flows at desired levels during optimum cottonwood seed germination periods?*

Flows along the RGCP are fully controlled by irrigation requirements, so any releases for overbank flows will be superimposed on any scheduled irrigation flows. Smart use of water for overbank flows would take advantage of the highest scheduled irrigation flows near the time of the desired discharge and, thus the need for coordination.

For the DEIS preparation a target water use of 7,336 ac-ft/yr was calculated on the basis of one 6-hour discharge of 3,700 cfs (which added to an average 1,300 cfs irrigation would result in the theoretical 5,000 cfs discharge) on a monthly basis. In theory, longer or more frequent discharges would be possible to the extent that:

- Enough water rights are acquired for the releases, and the releases do not to interfere with irrigation water delivery.
- Releases are safe to downstream properties, and agreements are reached for any required conservation easements in areas where induced water releases would extend beyond the ROW.
- Extended monitoring indicate that releases are an ecologically sound and effective approach to support development of the riparian corridor along the RGCP in relation to site-specific techniques such as shavedowns, planting, and seedling development by micro-irrigation.

Feasibility of coordinating irrigation flows with controlled releases is an implementation issue to be decided each year according to water availability and by agreement with the irrigation districts that have legal ownership of the water and whose needs determine the timing and magnitude of the releases. At present the feasibility of any releases is questionable as 1) the irrigation districts have expressed opposition to those releases, a situation aggravated by the fact that farmers are facing one of the most severe droughts on record; 2) water releases would the measure with the greatest need for water acquisition (see Question 25) and currently no water rights are available for any environmental measure; and 3) Caballo Dam operational regime –maintained at the low water levels for flood control and to minimize evaporation as indicated in the response to Question 26— would not support peak discharges near the 5,000 cfs theoretical maximum value.

*Question 30. [listed as 28] With regard to reopening of meanders within ROW, the report states that the structures would divert water during "high flow periods" (3-16). What is the definition of "high flow periods" and with what frequency do they occur based on historical records? What data or model was used to determine the frequency of "high flow" occurrence at river miles 105, 102, 97, 95, 92, and 54? For what duration of time and at what water levels does Parsons' estimate "backwater conditions during low flow conditions" would persist in the side channels?*

The use of "high flow periods" as stated in page 3-16 is misleading and it will be changed in the DEIS. In terms of aquatic habitat diversification high flow periods refer to normal irrigation flow conditions when water velocities are far too excessive for reproduction relative to habitat preference by native fish species, as illustrated in page 4-23, Figure 4-10. The main objective of the meanders as adopted in the reformulation is to provide backwaters; such objective would be achieved by water entering into an excavated downstream section of the meander during the entire irrigation season, including the late spring and early summer, to facilitate fish reproduction. Diversions through the upstream section as a high-flow channel (as originally proposed in the AFR) would be used only once or twice a year to avoid stagnant water conditions, and would be controlled by a mechanically controlled intake structure. In this configuration, backwater availability would be limited not by the flow regime but by the extent/practicality/cost of the excavation and actual benefit as determined by long-term monitoring data from pilot studies.

*Question 31. [listed as 29] On what basis/criteria were arroyos identified as having the most significant potential for diversification of aquatic habitat (3-16)?*

Aquatic habitat diversification was evaluated taking into account the need for relatively deep and slow moving waters during the irrigation season as a preferred reproduction condition for native Rio Grande fish species, as illustrated in page 4-23, Figure 4-10. Monitoring data for a 3-year study of in-stream artificial structures such as V-notch weirs, embayments, and groins waters indicated that such structures were not particularly effective in increasing the diversity or abundance of fish species. That was the reasoning to focus on former meanders, and arroyos where deeper, slow-moving waters can be achieved by excavation over more extensive areas.

*Question 32. [listed as 30] What role did/does IBWC play in the construction and maintenance of sediment retention dams on arroyos in the Canalization Project. The report indicates that USIBWC requested NRCS to construct sediment control dams at 4 arroyos (4-12). Can you provide more information about the nature of these requests and whether IBWC funding/in-kind services were used for their construction?*

The Sediment Control Dams at tributary arroyos were constructed to reduce flood peaks and sediment inflows into the Rio Grande, thereby reducing the average annual maintenance cost for the Canalization Project. These structures are authorized by: Public Law 88-600, September 18, 1964, 78 Stat. 956; 22 U.S.C. 277d-29, amended by Act of October 18, 1973, Public Law 93-126, 87 Stat. 451.

The USIBWC requested the Soil Conservation Service (SCS, now the Natural Resource Conservation Service), Department of Agriculture, in 1960 to make reconnaissance studies of means of controlling the sediment inflow from tributary streams into the Canalization Project in the Rincon Valley and into the Selden Canyon in order to reduce project maintenance costs to economic levels. The SCS found that flood and sediment retention dams could be considered under its Public Law 566 program for 11 arroyos tributary to the Rio Grande between Caballo and Leasburg Diversion Dams.

In recognition of the savings in maintenance cost for sediment removal from the Canalization Project, by virtue of construction of the dams, the Congress by Public Law 88-600 authorized the USIBWC to enter into contracts with local organizations for maintenance of such dams. The SCS then proceeded under its program with surveys and construction as found justified.

Between 1969 and 1975, five dams were completed on four arroyos. They are designed, with one exception, to provide sufficient storage capacity to contain an estimated 100 years of sediment inflow and to control the estimated 100-year flood. The exception (Broad Canyon) is designed to contain 100 years of sediments and control an estimated 50-year flood. These dams control flood runoff to the Canalization Project from 39 percent of the watershed upstream from Leasburg Dam.

Soil Conservation Service, PL 566 Projects, 1975 Conditions

| | | DRAINAGE AREA | CAPACITY IN ACRE-FEET | | | HEIGHT |
|---|---|---|---|---|---|---|
| ARROYO/DAM | COMPLETED | REGULATED, SQ.MI. | SEDIMENT | FLOOD | TOTAL | FEET. |
| BROAD CANYON, NO. 1 | 1969 | 64 | 2,625 | 3,405 | 6.030 | 70.5 |
| CROW CANYON. NO. 2A | 1971 | 120 | 3.945 | 7,384 | 11,329 | 65.5 |
| GREEN ARROYO. NO. 1A | 1972 | 31 | 1,320 | 1,612 | 2,932 | 90.2 |
| JARALOSA ARROYO NO. 4 | 1975 | 86 | 3,427 | 2,891 | 6.318 | 91.5 |
| JARALOSA ARROYO NO. 5 | 1975 | 6 | 389 | 327 | 716 | 27.5 |
| TOTAL | | 307 | 11,706 | 15,619 | 27,325 | - |

The Local interests sponsoring the SCS projects are the Elephant Butte Irrigation District and the Caballo Natural Resource Conservation Service District. The USIBWC in cooperation with the two local interest districts maintains the dams, outlet works, and access roads.

Under an agreement with the Elephant Butte Irrigation District and Caballo Natural Resource Conservation Service District, IBM 65-356 dated December 10, 1965, and Supplement No. 1 dated February 15, 1974, the USIBWC performs maintenance of the constructed works. A joint annual inspection including the Caballo Natural Resources Conservation District, Elephant Butte Irrigation District, New Mexico State Engineer's Office, and USIBWC is made for the purpose of reviewing the maintenance needs. Public Law 93-126; 87 Stat. 451, approved October 18, 1973, limits the USIBWC maintenance activities to $50,000 per year.

*Question 33. [listed as 31] What is the legal basis for saying that environmental water use will require project reauthorization (4-2)?*

The statement in page 4-2 reads "Authorization changes are also likely for Rio Grande Project water use in habitat improvements " not "*environmental water use will require project reauthorization.*"

Changes in Rio Grande Project water use do require authorization by USBR and agreements with the irrigation districts. Under a Congressional Law (Sale of Water for Miscellaneous Purposes Act) enacted February 25, 1920, the Secretary of the Interior can sell Rio Grande Project water for purposes other than irrigation as long as the following three criteria are met (2000 Water Resources Technical Report, page 3-49, El Paso-Las Cruces Regional Sustainable Water Project):

- The affected irrigation districts must approve the sale
- Sale cannot be detrimental to the Rio Grande Project
- There can be no other practicable source of water

There is a 1998 authorization by the USBR to EPCWID#1 for water rights conversion from irrigation to water supply for the City of El Paso and the Lower Mesilla Water District (that supersedes a 1941 agreement). However, there is no precedent of an USBR authorization for Rio Grande Project water use in environmental measures.

*34. [listed as 32] Can you explain the position taken in the report that "use of non-structural flood control methods in the RGCP is primarily an economic and risk-management decision?" (4-17)*

(see also response to Q 19).
As indicated in page 4-17, and discussed at length in Section 4.3.3 and previous correspondence RGCP conditions, unlike other types of riverine systems, offer few opportunities to combine non-structural flood control (namely levee relocation) and river restoration measures. Under these conditions use of in-place levee rehabilitation versus levee relocation is simply an engineering decision based on 1) economic considerations as determined by a cost-benefit analysis (structure condition, options for relocation), and 2) a risk management analysis for protection against flood for given the probability of flood occurrence.

*Question 35. [listed as 33] What role did IBWC play in the construction of Caballo Dam? Was the dam constructed, in part or whole, at the request of IBWC? Did IBWC funding/in-kind services contribute to the cost of construction?*

A Memorandum of Agreement was signed October 9, 1935 between Department of State and Department of Interior, pursuant to the provisions of the Act approved May 21, 1930 (U.S.C., Title 31, Sec. 686) as amended by Section 601 of the Act approved June 30, 1932 (U.S.C., Suppl. VII, Sec. 686), and the Convention for the Rectification of the Rio Grande of February 1, 1933, between the United States and Mexico (48 Stat. 1621).

Provision was made by the Convention and attached annexes for the Rio Grande Rectification Project in the El Paso-Juarez Valley for construction by the United States, under the direction and inspection of the International Boundary Commission, United States and Mexico, of a flood control and channel stabilization project including a flood control detention dam and reservoir of not less than 100,000 acre feet capacity at Caballo, New Mexico. The cost of construction of the dam and reservoir was estimated to be $1,500,000, and these funds were allotted to the Department of State pursuant to the provisions of Title II of the Act approved June 16, 1933.

The Bureau of Reclamation, needing a high dam rather than the low dam envisioned by the IBWC, applied for and received an allotment of funds under Title II of the Act approved June 16, 1933 in the sum of $100,000 and under the Relief Appropriation Act of 1935, approved April 8 1935, an allotment of funds in the sum of $900,000 for the construction of a high dam for the creation of a reservoir for development of hydroelectric power.

Caballo Dam was constructed from 1936 to 1938 as part of the Rectification Project. The dam, located 25 miles downstream from Elephant Butte, was included as a flood control unit in the Rio Grande Rectification Project and part of its cost was allocated to that purpose. This is an earth fill, rock faced structure 96 feet high and 4,590 feet long. It made year-round power generation at Elephant butte Dam possible and part of the cost was allocated to that purpose, but it also provided replacement for storage lost at Elephant Butte due to silt deposition.

Elephant Butte power plant was constructed between 1938 and 1940. Water used for winter generation of power at Elephant Butte is held in Caballo Reservoir in storage for irrigation use during the summer. Construction of the power transmission system, begun in 1940, was completed in 1952 (Dept. of Int. 1981. Water and Power Resources Service, Project Data. pp. 1049-1062. USGPO, Denver; Bureau of Rec. 1970. Factual Data about the Rio Grande Project. Reg. Dir. Region 5, Amarillo.)

Since completion of construction in 1938, as agreed in the 1935 MOA, Caballo Dam and Reservoir have been operated and maintained by the Bureau of Reclamation.

*Question 36. [listed as 34] What was the basis/justification for not considering reworking of the channel geometry to create low velocity habitat for aquatic habitat diversification?*

Reworking of the channel to create low velocity habitat leads to inefficiency in water delivery, a measure that is in conflict with the Congress-mandated RGCP mission. For this reason the inclusion of such a measure in the alternatives (partial decommissioning of the RGCP) was removed from further consideration in the EIS.

As an alternative, off-channel changes are under consideration to create relatively deep habitats with low velocity waters during the irrigation season in arroyos and meanders (see response to Questions 30 and 31). Shallow habitat with slow-moving water and ponding is widely available in the main channel during the four-month non-irrigation season.

*Question 37. [listed as 35] Is it possible to get copies of the following technical reports:*

a. *Technical Report, HEP and WHAP Surveys for Evaluation of Aquatic and Wildlife Habitat, Rio Grande Canalization Project, Parsons, June 2001*

b. *Threatened and endangered species final report, USIBWC Rio Grande Canalization EIS, Parsons, April 2000*

c. *Final Threatened and Endangered Species Survey Technical Report, Rio Grande Canalization Project, Parsons, February 2001*

Copies of those reports will be provided in CD format.

## ATTACHMENT A

The following table lists the 48 environmental enhancement sites initially identified in the AFR and modifications made in the reformulation.

| | AFR Site Name within ROW | Project | AFR Measures Revised in Reformulation of Alternatives |
|---|---|---|---|
| 1 | Oxbow Restoration Site (6 acres) | Retained as a point project (6.6 ac) | Meander restoration project unchanged from AFR. A 1-acre wetland enhancement identified in AFR contained within meander opening. No-mow zones replaced with native grasslands and modified grazing. In stream aquatic structures deleted. Creation of wetlands during meander construction increased from 1 ac in AFR to an estimated 2 ac (20% of meander) in reformulated measure. |
| 2 | Tipton Arroyo (14 acres) | Retained as a point project (5.9 ac) and linear project component | Shave down project unchanged, however the extent of the project modified (reduced from 5 ac to 3.4) to be contained within hydrologic floodplain. No-mow zones replaced with native grasslands and modified grazing. Expansion of remnant Bosque (east side of river) replaced with Bosque enhancement and project size reduced from 8 ac to 2.5 ac to be consistent with hydrologic floodplain boundary. Creation of wetlands as a result of shave downs reduced from 1 ac proposed in AFR to an estimated 0.2 ac (10% of shave downs) in reformulated measure. AFR actions of instream aquatic structures and widening channel replaced by modified dredging in arroyos. Purchasing of 74 ac identified in AFR eliminated during reformulation. |
| 3 | Trujillo Arroyo (12 acres) | Expanded to 26.5 ac | Project measure changed from plantings to shave downs and expanded from 10 ac proposed in AFR to 26.6 ac under reformulation. Creation of wetlands as a result of shave downs increased from 2 ac proposed in AFR to an estimated 2.6 ac (10% of shave downs) in reformulated measure. No-mow zones replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures and widening channel replaced by modified dredging in arroyos. Purchasing of 55 ac identified in AFR eliminated during reformulation. |
| 4 | Montoya Arroyo (12 acres) | Expanded to 27.5 ac | Project measure changed from plantings to shave downs and expanded from 10 ac proposed in AFR to 24.7 ac under reformulation. A 2.83 ac meander opening replace the 5 ac channel split identified in AFR. Creation of wetlands as a result of shave downs increased from 2 ac proposed in AFR to an estimated 2.5 ac (10% of shave downs) in reformulated measure. Creation of additional wetlands as a result of meander opening estimated at 0.5 ac (20% of meander opening) in reformulated measure. Native grasslands and modified grazing replace AFR action of discontinuing leases and enhancing wetlands. AFR actions of instream aquatic structures and widening channel replaced by modified dredging in arroyos. Land purchases eliminated. |
| 5 | Holguin Arroyo (22 acres) | Retained as a point project but reduced to 18.5 ac | Project measure changed from plantings to a combination of shave downs and plantings and reduced from 20 ac proposed in AFR to 18.6 ac under reformulation in order to be contained within hydrologic floodplain. Native grasslands and modified grazing replace AFR action of discontinuing leases and 2 acres of enhancing wetlands. AFR actions of instream aquatic structures replaced by modified dredging in arroyos |
| 6 | Green / Tierra Blanca (23 acres) | Retained as a point project but reduced to 5.1 ac | Original project reduced from 23 ac (20 ac planting and 3 ac of bosque enhancement) to 5 ac in order to remain within hydrologic floodplain. A 5.1 ac meander opening replace the 3-ac channel split identified in AFR Native grasslands and modified grazing replace AFR action of discontinuing leases and 2 acres of enhancing wetlands. AFR actions of instream aquatic structures replaced by modified dredging in arroyos. |

| | | | |
|---|---|---|---|
| 7 | Sibley Arroyo Point Bar (12 acres) | Retained as a point project (4.1 ac) and linear project component | Original project reduced from 10 ac of planting to a 4.1 ac shave down. Native grasslands and modified grazing replace AFR action of discontinuing leases and 2 acres of enhancing wetlands. AFR actions of in stream aquatic structures replaced by modified dredging in arroyos. The 2-ac channel split identified in AFR eliminated. |
| 8 | Jaralosa Arroyo (75 acres) | Retained as a point project (28 ac) and linear project component | Original project reduced from 70 ac (60 ac of planting and 20 ac of bosque enhancement) to 5.1 ac of plantings under the reformulation (in order to be contained within hydrologic floodplain). A 20 ac channel spilt identified in AFR was replaced by 2 opening of meanders projects for a total of 33.1 ac. The opening of meanders would result in 6.6 ac of wetlands. Native grasslands and modified grazing replaced AFR action of discontinuing leases and 5 acres of enhancing wetlands. AFR actions of instream aquatic structures was replaced by modified dredging in arroyos. Purchasing of 355 ac identified in AFR eliminated during reformulation. |
| 9 | Yeso Arroyo (22 acres) | Retained as a point project (15.4 ac) and linear project component | Original 20 ac bosque enhancement project reduced to a 3.9 ac shave down under the reformulation (in order to be contained within hydrologic floodplain). A 10 ac channel spilt identified in AFR was replaced by 11.5 ac of plantings. Native grasslands and modified grazing replaced AFR action of discontinuing leases and 2 acres of enhancing wetlands. AFR actions of instream aquatic structures were replaced by modified dredging in arroyos. |
| 10 | Crow Canyon ( 52 acres) | Expanded to 102.5 ac | Original project reduced from 50 ac (20 ac of planting and 30 ac of bosque enhancement) to 17.9 ac shave down under the reformulation (in order to be contained within hydrologic floodplain). A 40 ac channel spilt identified in AFR was replaced by an 84.6 ac opening of meanders project. The opening of meanders would result in 16 ac of wetlands. Native grasslands and modified grazing replaced AFR action of discontinuing leases and 2 acres of enhancing wetlands. AFR actions of instream aquatic structures were eliminated. |
| 11 | Hatch Siphon (3 acres) | Retained as a linear project component | Native grasslands and modified grazing replaced AFR action of discontinuing leases and 3 acres of enhancing wetlands. |
| 12 | Wetlands Unit B (10 acres) | Retained as a linear project component | 10 ac wetland enhancement identified in AFR replaced with native grasslands and modified grazing. |
| 13 | Wetlands Unit A (10 acres) | Retained as a linear project component | 10 ac wetland enhancement identified in AFR replaced with native grasslands and modified grazing. |
| 14 | Garfield Drain (5 acres) | Retained as a linear project component | Bosque enhancement replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures were eliminated. Native grasslands and modified grazing replaced AFR action of no mow zones. |
| 15 | Placitas Arroyo (12 acres) | Retained as a linear project component | Bosque enhancement within arroyo drain replaced with native grasslands. Conservation easement replaced acquisition of 132 of farmland. Native grasslands and modified grazing replaced AFR action of no mow zones 2 acres of enhancing wetlands. |
| 16 | Remnant Bosque/Rincon (22 acres) | Expanded to 34.1 ac | Original project increased from 20 ac (10 ac of planting and 10 ac of bosque enhancement) to 34.1 ac (17.9 ac shave down and 16.2 ac planting under the reformulation). Conservation easement used in place of acquisition of a 91-ac remnant bosque tract. The purchase of two small cropped tracts (18 ac) eliminated. Native grasslands and modified grazing replaced AFR action of no mow zones and 2 acres of enhancing wetlands. Modified dredging in arroyos added as a measure. |

| | | | |
|---|---|---|---|
| 17 | Angostura Arroyo (10 acres) | Retained as a linear project component | Original project of enhancing 10 acres of bosque eliminated (outside hydrologic floodplain). AFR actions of instream aquatic structures were eliminated. Native grasslands and modified grazing replaced AFR action of no mow zones. Conservation easement replaced acquisition of 43 ac of adjacent lands. |
| 18 | Rincon/Reed Arroyo (7 acres) | Retained as a point project (2.74 ac) and linear project component | Original 5-ac project eliminated (outside hydrologic floodplain). Native grasslands and modified grazing replaced no-mow zones and 2 acres of enhancing wetlands. AFR actions of instream aquatic structures were replaced by modified dredging in arroyos. |
| 19 | Bignell Arroyo (17 acres) | Expanded to 26.6 ac | Original project increased from 5 ac to 26.6 ac (16.3 ac shave down and 10.3 ac planting under the reformulation). A 26 ac conservation easement added. Native grasslands and modified grazing replaced AFR action of no mow zones and 12 acres of enhancing wetlands. AFR actions of instream aquatic structures were replaced by modified dredging in arroyos. |
| | Bufford Property (0 acres) | Added as a linear project component | Not part of the AFR. Conservation easements added during reformulation. A total of 219 ac with a large amount of wetlands 20-40 ac located in conservation easements. |
| 20 | Dead Man's Curve ( 59 acres) | Retained as conservation easement and expanded | Retained as a conservation easement. Conservation easements expanded in the Seldon Canyon RMU from 106 ac to 808 ac |
| 21 | Broad Canyon (47 acres) | Retained as conservation easement and expanded | Retained as a conservation easement. Conservation easements expanded in the Seldon Canyon RMU from 106 ac to 808 ac |
| 22 | Leasburg Dam ( 4 acres) | Retained | The addition of a 4 ac park identified in AFR reformulated retained as part of an overall agency cooperative agreement program. |
| 23 | West Side ( 64 acres) | Retained as a linear project component | Original 60-ac bosque enhancement projects deleted as a result of being outside hydrologic floodplain. Modified grazing replaced AFR action of discontinued grazing and 4 acres of enhancing wetlands. AFR actions of instream aquatic structures eliminated. |
| 24 | Levee Setback (11 acres) | Retained as a linear project component | Original 10 ac planting project deleted as a result of being outside hydrologic floodplain. Modified grazing replaced AFR action of discontinued grazing and 1 acre of enhancing wetlands. AFR actions of instream aquatic structures eliminated. Levee set back and subsequent opening meander outside the ROW no longer considered in the reformulation. The current levee exceeds 100-year flood containment capacity as calculated from hydraulic modeling and fully functional levees (structural integrity analyses not withstanding) would not be removed for the sole purpose of environmental enhancement. |
| 25 | Seldon Drain (3 acres) | Retained as a linear project component | 3 acre wetland enhancement replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. |
| 26 | Channel Cut ( 20 acres) | Retained as a point project (19.6 ac) | Original 20-ac bosque enhancement project deleted as a result of being outside hydrologic floodplain. The original 23-ac channel split changed to a 19.6 ac meander opening (or planting) in the reformulation. Native grasslands and modified grazing replaced the AFR action of discontinued leases. |

| | | | |
|---|---|---|---|
| 27 | Wasteway No. 2A ( 3 acres) | Retained as a linear project component | Original no-mow zone, 2 acre of enhancing wetlands and 1 acre of planting replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. |
| 28 | Wasteway No. 5 (7 acres) | Retained as a linear project component | Original 5 ac planting and 2 ac wetland enhancement project deleted as a result of being outside hydrologic floodplain. Native grasslands and modified grazing replaced AFR action of additional no mow zones. Reduced maintenance of drains retained as part of a native grasslands/modified grazing measure. AFR actions of instream aquatic structures eliminated. |
| 29 | Wasteway No. 39 (8 acres) | Expanded to 15.9 ac | Original 6 ac planting and 2 ac wetland enhancement project increased to 15. 9 ac planting under reformulation. Native grasslands and modified grazing replaced AFR action of additional no mow zones. Reduced maintenance of drains retained as part of a native grasslands/modified grazing measure. AFR actions of instream aquatic structures eliminated. |
| 30 | Wasteway No. 8 (8 acres) | Expanded to 34.6 ac | Original 5 ac planting (and 3 ac wetland enhancement) project increased to 34.6 ac planting under reformulation. Native grasslands and modified grazing measure added. Reduced maintenance of drains retained as part of a native grasslands/modified grazing measure. AFR actions of instream aquatic structures eliminated. |
| 31 | Wasteway No. 39A (1 acres) | Retained as a linear project component | 1-acre wetland enhancement and No-mow zones replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. Reduced maintenance of drains retained as part of a native grasslands/modified grazing measure. Land acquisition eliminated in favor of a conservation easement of remnant bosque on east side. |
| 32 | Clark Lateral (10 acres) | Expanded to 15.4 ac | 15.4 ac of woody plantings added under reformulation. Native grasslands added as a measure and replaced 10 ac wetland enhancements. Reduced maintained of nearby drain as part of a native grasslands measure. |
| 33 | NMGF Bosque (Picacho Bosque) ( 9 acres) | Expanded to 71.3 ac | 71 ac of plantings added under reformulation. 9 ac wetland enhancement replaced with native grasslands. Native grasslands replaced 40 ac of reduced maintenance under AFR. Original 114 ac of land acquisition eliminated in favor of 181 ac of conservation easements and 19-ac agency cooperative agreement (NMGF). Levee set back and the subsequent opening of a former meander outside the ROW was eliminated in reformulation for two reasons, 1) the majority of the levee in the vicinity of the meander currently contain the 100 year flood within 3 feet for freeboard and 2) significant amounts of wetlands (wet meadow community) are located in the former meander site and represent a fairly unique and limited community in the RGCP. |
| 34 | Mesilla Dam (10 acres) | Retained | Backwater habitat will still be created as a result of siphon/structure protection; no longer considered a measure, but rather an effect. |
| 35 | Pole Planting Area (5 acres) | Retained as a linear project component | Original 5 ac of pole plantings and no- mow zones identified in AFR replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. |
| 36 | Wasteway No. 18 (5 acres) | Retained as a linear project component | Original 5 ac of pole plantings and no- mow zones identified in AFR replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. Reduced maintained of drains retained as part of a native grasslands/modified grazing measure. Levee set back and subsequent opening meander outside the ROW eliminated in reformulation. Levee freebooard is adequate for 100-year flood containment capacity as calculated from hydraulic modeling and fully functional levees (structural integrity analyses not withstanding) would not be removed for the sole purpose of environmental enhancement. |

| | | | |
|---|---|---|---|
| 37 | Old Channel Cut (7 acres) | Retained as a linear project component | Original 5 ac of pole plantings, 2 ac of wetland enchantment and 16 acres of no- mow zones identified in AFR replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. Reduced maintained of drains retained as part of a native grasslands/modified grazing measure. Land acquisition not longer under consideration. Levee set back and subsequent opening meander outside the ROW eliminated in reformulation. Levee freebooard is adequate for 100-year flood containment capacity as calculated from hydraulic modeling and fully functional levees (structural integrity analyses not withstanding) would not be removed for the sole purpose of environmental enhancement. |
| 38 | Del Rio drain (5 acres) | Retained as a linear project component | Original 5 ac of pole plantings and no- mow zones identified in AFR replaced with native grasslands and modified grazing. AFR actions of instream aquatic structures eliminated. Reduced maintained of drains retained as part of a native grasslands/modified grazing measure. Levee set back and subsequent opening meander outside the ROW eliminated in reformulation. Levee freebooard is adequate for 100-year flood containment capacity as calculated from hydraulic modeling and fully functional levees (structural integrity analyses not withstanding) would not be removed for the sole purpose of environmental enhancement. |
| 39 | Wasteway No. 19 (4 acres) | Retained as a linear project component | Original 3 ac of wetland creation and 1 ac of wetland enhancement identified in AFR replaced with native grasslands and modified grazing. Reduced maintained of drains retained as part of a native grasslands/modified grazing measure. |
| 40 | Wasteway Nos. 31 and 20 (5 acres) | Retained as a linear project component | Original 5 ac of wetland creation identified in AFR replaced with native grasslands and modified grazing. Reduced maintained of drains retained as part of a native grasslands/modified grazing measure. |
| 41 | Jimenez and Three Saints Lateral (2 acres). | Retained as a linear project component | Modified grazing replaced no-mow zones and 2 ac of wetland enhancement. Reduced maintenance of drains/laterals retained as part of modified grazing measure. AFR actions of instream aquatic structures eliminated. |
| 42 | East Drain (12 acres) | Retained as a linear project component | Planting of 10-ac site identified in AFR not longer under consideration due to potential levee deficiencies. Modified grazing replaced no-mow zones and 2 ac of wetland enhancement. Reduced maintained of drains/laterals part of modified grazing measure. Land purchase eliminated in favor of conservation easement. |
| 43 | Wasteway No. 34 (1 acres) | Not retained | Planting of 1-ac site identified in AFR not longer under consideration due to potential levee deficiencies. AFR actions of instream aquatic structures eliminated. Continued avoidance of native vegetation by mowers maintained. |
| 44 | Wasteway No. 35 (5 acres) | Not retained | Planting of 4-ac site and 1 acre wetland enhancement identified in AFR not longer under consideration due to potential levee deficiencies. AFR actions of instream aquatic structures eliminated. Continued avoidance of native vegetation by mowers maintained. |
| 45 | Nemexas Drain (1 acres) | Not retained | AFR actions of in-stream aquatic structures and 1 acre wetland enhancement eliminated. Continued avoidance of native vegetation by mowers maintained. |
| 46 | Sunland Park (10 acres) | Not retained | Planting of 10-ac site identified in AFR not longer under consideration due to potential levee deficiencies. Continued avoidance of native vegetation by mowers maintained. |
| 47 | Cottonwood Grove | Not retained | Project identified in AFR not longer under consideration due to potential levee deficiencies. Continued avoidance of native vegetation by mowers |

| | | | |
|---|---|---|---|
| | (3 acres) | | maintained. |
| 48 | Anapra Bridge (0 acres) | Not retained | Land purchase outside ROW not longer under consideration. |

ATTACHEMENT B

Flow Data Used for Selection of Reference Conditions for Riparian Corridor Development

**TABLE 2-2**

**10-YR. HIGH FLOW PERIOD MEAN MONTHLY FLOW DATA FOR THE LEASBURG SUBREACH**

| WATER YEAR | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (FROM SECTION 628 TO SECTION 861) | | | | | | | | |
| 1983 | 56 | 48 | 47 | 38 | 178 | 1185 | 1050 | 1263 | 1512 | 1702 | 1556 | 1168 |
| 1984 | 139 | 61 | 41 | 31 | 267 | 1339 | 1303 | 1415 | 1498 | 1892 | 1052 | 1277 |
| 1985 | 214 | 54 | 64 | 46 | 47 | 1104 | 1177 | 1430 | 1742 | 1855 | 1542 | 1067 |
| 1986 | 484 | 79 | 66 | 515 | 1401 | 1870 | 1596 | 2020 | 2363 | 2978 | 2206 | 1401 |
| 1987 | 2049 | 1490 | 2337 | 1961 | 1942 | 2496 | 2364 | 3189 | 2699 | 3470 | 1696 | 972 |
| 1988 | 510 | 133 | 114 | 111 | 354 | 2163 | 1983 | 1638 | 1995 | 1929 | 1548 | 1038 |
| 1989 | 356 | 80 | 50 | 34 | 303 | 1841 | 1190 | 1419 | 2027 | 2061 | 1538 | 1030 |
| 1990 | 100 | 66 | 51 | 43 | 170 | 1601 | 1078 | 1283 | 2013 | 1836 | 1190 | 1164 |
| 1991 | 151 | 66 | 40 | 34 | 157 | 1549 | 1025 | 1207 | 2048 | 2289 | 1539 | 1136 |
| 1992 | 552 | 281 | 389 | 347 | 580 | 1746 | 1464 | 1700 | 2048 | 2289 | 1539 | 1136 |
| AVERAGE | 461 | 236 | 320 | 316 | 540 | 1689 | 1423 | 1656 | 1995 | 2230 | 1541 | 1139 |
| | | | | (FROM SECTION 861 TO SECTION 1050) | | | | | | | | |
| 1983 | 1 | 1 | 1 | 1 | 192 | 1202 | 985 | 1230 | 1485 | 1678 | 1526 | 1014 |
| 1984 | 23 | 1 | 1 | 2 | 299 | 1352 | 1203 | 1328 | 1319 | 1791 | 832 | 1212 |
| 1985 | 51 | 2 | 2 | 2 | 60 | 1078 | 1136 | 1320 | 1637 | 1705 | 1379 | 929 |
| 1986 | 266 | 25 | 18 | 473 | 1330 | 1759 | 1530 | 1912 | 2263 | 2763 | 2032 | 1264 |
| 1987 | 1917 | 1384 | 2379 | 1893 | 1779 | 2413 | 2319 | 3071 | 2694 | 3561 | 1555 | 823 |
| 1988 | 348 | 73 | 72 | 66 | 326 | 2418 | 1929 | 1488 | 1926 | 1780 | 1225 | 916 |
| 1989 | 176 | 2 | 2 | 2 | 242 | 1780 | 1092 | 1308 | 1950 | 1889 | 1236 | 813 |
| 1990 | 3 | 2 | 2 | 2 | 175 | 1602 | 999 | 1237 | 1959 | 1651 | 1099 | 939 |
| 1991 | 7 | 2 | 2 | 1 | 166 | 1507 | 980 | 1208 | 1692 | 1367 | 1010 | 723 |
| 1992 | 281 | 2 | 2 | 173 | 391 | 1484 | 1156 | 1093 | 1629 | 1787 | 1340 | 1131 |
| AVERAGE | 307 | 149 | 248 | 262 | 496 | 1660 | 1333 | 1520 | 1855 | 1997 | 1323 | 976 |
| | | | CALCULATED DATA (cfs) FOR HEC-6 INPUT ON Q CARDS - DIFFERENCES FROM ABOVE - REQUIRED TO CHANGE DISCHARGE AT SECTION 861 | | | | | | | | | |
| AVERAGE | 154 | 86 | 72 | 54 | 44 | 30 | 90 | 137 | 139 | 233 | 217 | 163 |

See Appendix D for supporting computations.

TABLE 2-4

10-YR. HIGH FLOW PERIOD MEAN MONTHLY FLOW DATA FOR THE MESILLA SUBREACH (LOCATED BETWEEN MESILLA DIVERSION DAM AND LEASBURG DIVERSION DAM)

| WATER YEAR | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (FROM SECTION 405.4 TO SECTION 499) | | | | | | | | | | | | |
| 1983 | 47 | 48 | 51 | 39 | 160 | 985 | 777 | 997 | 1203 | 1422 | 1254 | 876 |
| 1984 | 118 | 61 | 45 | 32 | 235 | 1083 | 1061 | 1140 | 1248 | 1639 | 893 | 957 |
| 1985 | 171 | 54 | 71 | 47 | 42 | 934 | 937 | 1140 | 1469 | 1602 | 1286 | 801 |
| 1986 | 407 | 79 | 72 | 451 | 1078 | 1573 | 1308 | 1687 | 2174 | 2805 | 1891 | 1075 |
| 1987 | 1983 | 1487 | 2566 | 2016 | 1507 | 2142 | 2060 | 2816 | 2455 | 3270 | 1382 | 655 |
| 1988 | 379 | 133 | 125 | 114 | 226 | 1873 | 1717 | 1300 | 1664 | 1618 | 1254 | 744 |
| 1989 | 264 | 77 | 55 | 35 | 229 | 1488 | 893 | 1075 | 1670 | 1742 | 1320 | 801 |
| 1990 | 102 | 66 | 56 | 45 | 153 | 1340 | 852 | 1000 | 1717 | 1614 | 979 | 890 |
| 1991 | 141 | 66 | 44 | 35 | 86 | 1285 | 766 | 910 | 1346 | 1147 | 956 | 618 |
| 1992 | 253 | 77 | 81 | 176 | 291 | 1240 | 965 | 989 | 1437 | 1627 | 1164 | 868 |
| AVERAGE | 387 | 215 | 317 | 299 | 401 | 1394 | 1134 | 1305 | 1638 | 1846 | 1238 | 828 |
| (FROM SECTION 499 TO SECTION 626) | | | | | | | | | | | | |
| 1983 | 47 | 48 | 47 | 38 | 178 | 988 | 757 | 993 | 1136 | 1320 | 1200 | 882 |
| 1984 | 116 | 61 | 41 | 31 | 262 | 1086 | 1034 | 1136 | 1179 | 1521 | 855 | 963 |
| 1985 | 168 | 54 | 65 | 46 | 47 | 936 | 913 | 1136 | 1387 | 1487 | 1231 | 806 |
| 1986 | 400 | 79 | 66 | 439 | 1201 | 1577 | 1275 | 1680 | 2053 | 2604 | 1810 | 1082 |
| 1987 | 1948 | 1490 | 2337 | 1961 | 1678 | 2148 | 2008 | 2805 | 2319 | 3035 | 1323 | 659 |
| 1988 | 372 | 133 | 114 | 111 | 252 | 1878 | 1674 | 1295 | 1572 | 1502 | 1200 | 749 |
| 1989 | 259 | 77 | 50 | 35 | 255 | 1492 | 870 | 1071 | 1577 | 1617 | 1263 | 806 |
| 1990 | 100 | 66 | 51 | 43 | 170 | 1343 | 830 | 996 | 1622 | 1498 | 937 | 895 |
| 1991 | 139 | 67 | 40 | 34 | 96 | 1288 | 747 | 906 | 1271 | 1037 | 915 | 622 |
| 1992 | 249 | 77 | 74 | 171 | 324 | 1243 | 941 | 985 | 1357 | 1510 | 1114 | 874 |
| AVERAGE | 380 | 215 | 288 | 291 | 446 | 1398 | 1105 | 1300 | 1547 | 1713 | 1185 | 834 |
| CALCULATED DATA (cfs) FOR HEC-6 INPUT ON Q CARDS - DIFFERENCES FROM ABOVE - REQUIRED TO CHANGE DISCHARGE AT SECTION 499 | | | | | | | | | | | | |
| AVERAGE | 7 | 0 | 28 | 8 | -46 | -4 | 29 | 5 | 91 | 132 | 53 | -5 |

See Appendix D for supporting computations.

## TABLE 2-6

### 10-YR. HIGH FLOW PERIOD MEAN MONTHLY FLOW DATA FOR THE EL PASO SUBREACH (LOCATED BETWEEN AMERICAN DIVERSION DAM AND MESILLA DIVERSION DAM)

| WATER YEAR | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (FROM SECTION 1 TO SECTION 217) | | | | | | | | | | | | |
| 1983 | 192 | 124 | 131 | 86 | 165 | 556 | 517 | 606 | 658 | 879 | 877 | 624 |
| 1984 | 286 | 142 | 81 | 68 | 187 | 547 | 594 | 718 | 765 | 897 | 892 | 616 |
| 1985 | 345 | 148 | 147 | 110 | 85 | 509 | 568 | 646 | 765 | 885 | 866 | 675 |
| 1986 | 509 | 185 | 129 | 378 | 921 | 1097 | 917 | 1127 | 1589 | 2265 | 1533 | 1035 |
| 1987 | 2159 | 1696 | 2602 | 1978 | 1785 | 1852 | 1883 | 2592 | 2108 | 2586 | 1325 | 807 |
| 1988 | 477 | 263 | 183 | 175 | 238 | 1409 | 1347 | 1041 | 1222 | 1241 | 1226 | 753 |
| 1989 | 407 | 188 | 151 | 121 | 183 | 886 | 687 | 799 | 1084 | 1173 | 985 | 631 |
| 1990 | 263 | 140 | 110 | 85 | 133 | 823 | 608 | 624 | 1030 | 1092 | 696 | 736 |
| 1991 | 336 | 178 | 126 | 91 | 97 | 738 | 552 | 589 | 839 | 1003 | 876 | 675 |
| 1992 | 314 | 181 | 178 | 280 | 304 | 944 | 777 | 834 | 940 | 1031 | 967 | 779 |
| AVERAGE | 529 | 325 | 384 | 337 | 410 | 936 | 845 | 958 | 1100 | 1305 | 1024 | 733 |
| (FROM SECTION 217 TO SECTION 405.2) | | | | | | | | | | | | |
| 1983 | 69 | 44 | 44 | 45 | 94 | 508 | 360 | 462 | 573 | 850 | 892 | 469 |
| 1984 | 103 | 51 | 27 | 36 | 107 | 499 | 413 | 548 | 667 | 867 | 908 | 463 |
| 1985 | 124 | 53 | 50 | 29 | 35 | 360 | 365 | 461 | 582 | 768 | 523 | 313 |
| 1986 | 215 | 69 | 43 | 281 | 745 | 1033 | 755 | 1132 | 1628 | 2178 | 1234 | 419 |
| 1987 | 1743 | 1430 | 2392 | 1870 | 1339 | 1572 | 1496 | 2373 | 1764 | 2545 | 627 | 203 |
| 1988 | 116 | 100 | 119 | 107 | 121 | 1526 | 1295 | 655 | 981 | 806 | 739 | 341 |
| 1989 | 138 | 85 | 64 | 54 | 86 | 805 | 376 | 587 | 1010 | 1033 | 895 | 354 |
| 1990 | 126 | 82 | 66 | 47 | 154 | 848 | 414 | 483 | 933 | 1048 | 553 | 365 |
| 1991 | 120 | 70 | 52 | 38 | 28 | 735 | 357 | 446 | 763 | 808 | 658 | 307 |
| 1992 | 82 | 81 | 80 | 143 | 136 | 742 | 483 | 556 | 624 | 855 | 685 | 414 |
| AVERAGE | 284 | 206 | 294 | 265 | 284 | 863 | 631 | 770 | 953 | 1176 | 771 | 365 |
| CALCULATED DATA (cfs) FOR HEC-6 INPUT ON Q CARDS - DIFFERENCES FROM ABOVE - REQUIRED TO CHANGE DISCHARGE AT SECTION 217 | | | | | | | | | | | | |
| AVERAGE | 245 | 118 | 90 | 72 | 125 | 73 | 214 | 187 | 147 | 129 | 253 | 368 |

See Appendix D for supporting computations.

EBID

ELEPHANT BUTTE IRRIGATION DISTRICT

Elephant Butte Irrigation District
Of New Mexico
P.O. DRAWER 1509
LAS CRUCES, NEW MEXICO 88004-1509
(OFFICE AT 530 SOUTH MELENDRES)
TELEPHONE
(505) 526-6671
FAX (505) 523-9666
DISPATCH FAX 526-8391
WAREHOUSE FAX 526-1530



9-006

September 13, 2003

Ms. Debra Little, Acting U.S. Commissioner
International Boundary and Water Commission
4171 North Mesa Street
El Paso, Texas 79902-1441

Dear Acting Commissioner Little,

Over the years the Elephant Butte Irrigation District has sought to cooperate and to work with the International Boundary and Water Commission (IBWC). Often in the past we have joined together on shared interests and our history of common concerns goes back almost 100 years. It has been a fruitful and valuable association.

Our view of the U.S. Section of the International Boundary and Water Commission is that it is a federal commission, within the U.S. State Department, that has specific, limited responsibilities. We believe that the activities of the U.S. Commission should be carried out in a fair and even handed style and that, within the continental U.S., that the Commission should be neutral, and should not take sides or give aid to any party when there is an adversarial disagreement between two U.S. parties that share common responsibilities with respect to the management of the water resources of the Rio Grande.

During the past year or so the U.S. Section has been involved in to two activities that we believe are prejudicial to best interests of the Elephant Butte Irrigation District (EBID) and to the State of New Mexico. I have asked our staff to prepared an "Issue" paper on each and have attached them to this letter. We believe both to be serious and both to be related to the U.S. Section's view of the Agency's "environmental" authority. We understand that the U.S. Section's environmental duties stem from the U.S. – Mexico Treaty of 1944 and subsequent agreements between the two countries as recorded in IBWC minutes.

We understand that the IBWC "environmental" powers are based on Article 3 of the 1944 Treaty that states that uses of international waters "shall be subject to any sanitary measures or works which may be mutually agreed upon" and that the IBWC should "give preferential attention to the solution of border sanitation problems." We find that the activities presented in our "Issue" papers go well beyond "border sanitation problems." We believe that the Agency's actions in these cases pose a potential detriment to the interests of the District and to New Mexico and that these actions verge on being violations of the intent of a provision of the U.S. Senate in the ratification of the Treaty of 1944. Condition (c) in the Senates ratification resolution states that:

> "nothing contained in the treaty or protocol shall be construed as authorizing the Secretary of State of the United States, the Commissioner of the United States Section of the International Boundary and Water Commission, or the United States Section of said Commission, directly or indirectly, to alter or control the distribution of water to users within the territorial limits of any of the individual states".

We believe that the U.S. Section activities outlined in our two Issue papers may have, and will continue to have the potential effect of directly and/or indirectly altering the distribution of the water supply of the Rio Grande in Texas and New Mexico. Clearly, this is a serious concern and one that we believe can best be resolved by a fundamental reordering of some of the environmental activities of the U.S. Section. After you and your staff have had an opportunity to review our Issue papers, we will be pleased to schedule a meeting with you. As we believe that treaty ratification conditions of the U.S. Senate are at risk, we will also invite New Mexico Congressional staff to join us.

Sincerely

Gary Arnold, President
Elephant Butte Irrigation District

Copies To: The Honorable Pete Domenici, U.S. Senator from New Mexico
The Honorable Jeff Bingaman, U.S. Senator from New Mexico
The Honorable Steve Pearce, U.S. Representative,
2nd Congressional District
The Honorable Patricia Madrid, New Mexico Attorney General

# ISSUE I

## U.S. Section's Representation For The State Of Texas

### U.S. Section Activity

In October 1998 the U.S. Section of the International Boundary Commission (IBWC) entered into a contract with the State of Texas to implement the Texas Clean Rivers Program (TCRP) on the Pecos River and on the Rio Grande in Texas. The authority of the Texas Clean River Program has been extended up the Rio Grande to Anthony, Texas, the point where the river first crosses into Texas. The Rio Grande moves back and forth between states four or five times before reaching the end of river for the purpose of New Mexico's stream standards; that is, at the International Dam. Acting for the State of Texas, under the aegis of the TCRP, the U.S. Section has issued a publication and held public meetings that site activities in New Mexico as being responsible for salinity in the Rio Grande. In representing the State of Texas and it taking these actions, the U.S. Section has put itself in a potentially adversarial position, pitting a federal commission against the interests of the State of New Mexico and the Elephant Butte Irrigation District. We believe that by contracting to represent the State of Texas, that the U.S. Section can not meet the test of being "fair and even-handed" with all parties, and that it may have acted, directly and/or indirectly, to prejudice threatened litigation dealing with water quality issues between the State of Texas and the State of New Mexico.

### Authority For U.S. Section Actions

The IBWC environmental and water quality responsibilities are based on Article 3 of the 1944 Treaty between the U.S. and Mexico. Article 3 states that the International Boundary and Water Commission "may be called upon to make provisions for joint use" of water. The Treaty language continues with an ordered list of "preferences" for the use of "international waters". This set of preferences is to serve as a guide for IBWC actions. Article 3 continues with the statement that all of the "foregoing uses shall be subject to any sanitary measures or works which may be mutually agreed upon" and that the IBWC should "give preferential attention to the solution of border sanitation problems."

The IBWC has authorized further water quality investigations and activities on the Rio Grande in the El Paso-Juarez area by agreements in Commission Minutes as follows:

- Minute No. 261 of September 24, 1979 defined the term "border sanitation problems" to include "sanitary conditions that present a hazard to the health and well-being of the inhabitants of either side of the border or impair the beneficial uses of these waters".

- Minute No. 289 of November 13, 1992 dealt with water quality monitoring for the purpose of determining the presence of toxic substances in the Rio Grande from El Paso-Juarez to the Gulf of Mexico.
- Minute No. 294 of November 24, 1995 dealt with relations with the Border Environment Cooperation Commission (BECC) and planning for domestic water systems and wastewater treatment infrastructure.
- Minute No. 299 of December 3, 1998 again dealt with BECC sanitation projects and noted that "all activities taken" pursuant to this minute are subject "to applicable laws and standards in each country".

None of these minutes authorize the issuance of critical commentary dealing with water quality related to non-toxic dissolved-ion concentrations (salinity) in the Rio Grande in New Mexico, nor in the El Paso-Juarez area.

**Rational For EBID Concerns**

The Elephant Butte Irrigation District has been threatened with litigation with entities in the State of Texas where water quality (salinity) or, more specifically the dissolved solids content (TDS) of the water in the Rio Grande, may be an issue. The U.S. Section has published technical information, that has not been subject to peer review, that could directly or indirectly result in the redistribution of the water resources of the Rio Grande. The emphasis placed on salinity concerns in the Rio Grande at El Paso in the U.S. Section's publication can give support not only to Texas claims to lower TDS water, but to similar demands by other parties using the river as a supply. The Elephant Butte Irrigation District is concerned about the lack of sensitivity on the part of the U.S. Section to this issue.

**Specific EBID Concerns**

In July 2003 the Texas Clean Rivers Program and the U.S. Section of the IBWC published a report titled: **2003 Regional Assessment Of Water Quality In The Rio Grande Basin**. The following excerpts from the **Assessment** represent a few of the statements in the report about salinity that are a concern to the Elephant Butte Irrigation District as the District believes that intensive salinity monitoring in the El Paso-Juarez area, and the interpretation of this TDS data in the **Assessment**, are not within the scope of the 1944 Treaty or of the Minutes issued by the IBWC. The page numbers and quotes in the comments that follow refer to the page numbers and statements in the **Assessment**:

- Page xvi in **Executive Summary:** "The Upper Rio Grande Basin sub-basin extends from the Texas/New Mexico line to Amistad Reservoir. Primary concerns in the sub-basin include ......salinity (chloride, sulfate, TDS)...." "High salinity is attributed primarily to current irrigation practices."
- Page 1, **Introduction:** The Rio Grande as it flows into Texas from New Mexico exceeds the criterion established for salinity ..." NOTE: This statement is in conflict with that on page 52 to the effect that at Station 13276 on the Rio Grande near Anthony, Texas that water quality in the river meets the Texas Water Quality Standards. It is also at odds with statements on page 102 and 103 as follows:
  - Page 102, **Segment 2314, Station 13276 at Anthony:** Lists sulfates, chlorides, and TDS and the Texas Water Quality Standards, followed by the words "meets designated uses" for each of these constituents.
  - Page 103, **Segment 2314, Station 113272 at Courchesne Bridge upstream of the International Dam:** Lists sulfates, chlorides, and TDS and the Texas Water Quality Standards, followed by the words "meets designated uses" for each of these constituents; and
- Page 1, **Introduction:** "High salt levels in the Rio Grande limit its use for agriculture and municipal use."
- Page 51, **Rio Grande above International Dam:** "Irrigated agriculture ..... impacts this area."
- Page 62, **Upper Rio Grande Sub-basin Salinity:** "Salinity has been a concern in the upper basin for many years primarily due to the extensive water use for agriculture and as a drinking water supply. Water from the Rio Grande picks up salt from the soil after it has been used for irrigation from one community to another to point where it does not meet the standards for a public waster supply." (Note: El Paso is the only significant surface water supply in the Upper Basin)
- Page 63, **Excerpts from a paper on salt accumulation**: "The salinity of the soil appears to be increasing from upstream site in New Mexico compared to downstream sites in and below the El Paso and Hudspeth counties".
- Page 85, **Conclusions and Recommendations; Upper Rio Grande Sub-basin** ". Water quality concerns in the Rio Grande consists of elevated levels of ..... dissolved salts ...". "High levels of salt of salt are due to return flows that carry dissolved salts from irrigated agriculture and runoff from soil that is high in salinity."

## ISSUE II

### U.S. Section's Proposals to Establish New Zones Of Riparian Vegetation along the Rio Grande in New Mexico

**U.S. Section Activity**

The U.S. Section has proposed new additional areas for the establishment of riparian vegetation in and along the Rio Grande in New Mexico under the agency's Reformulation of River Management Alternatives for the Rio Grande Canalization Project. The current documentation and the U.S. Section's proposed alternatives are part of an Environmental Impact Assessment under the NEPA requirements. These proposals are in addition to past Agency permitted channel vegetation programs. In March 1999, the U.S. Section of the IBWC entered into a Memorandum of Understanding (MOU) with the Southwest Environmental Center (SWEC) under which certain physical actions were taken by the U.S. Section, specifically the establishment of "green zones" and test areas along substantial stretches of the Rio Grande. Additionally, the U.S. Section cooperated with SWEC in planting trees in IBWC-controlled areas from 1999 on.

**Authority For U.S. Section Actions**

The documentation for the Reformulation of River Management Alternatives is noticeably absent in explaining the Agency's mandate and motivation in proceeding in the direction of the 2003 EIS. This does not appear to be an EIS on the full scope of the environmental operations of the U.S. Section. None of the treaty or statutory Agency mandates include environmental enhancement, or riparian restoration. There is little or nothing in the documentation for the Reformulation of River Management Alternatives that discusses the primary functions and duties of the U.S. Section nor is an evaluation of these functions found or proposed in the EIS documentation. The 2003 EIS does not appear to be motivated by concerns under the Endangered Species Act, nor by any action taken or proposed to be taken by the U.S. Fish and Wildlife Service. Similarly, there is little or no discussion in the existing documentation as to the amount of financing and the source of financing for the activities sought to be undertaken for riparian restoration.

**Rational For EBID Concerns**

In the past the Elephant Butte Irrigation District has registered its concerns about the U.S. Section's efforts to establish new vegetation in the Rio Grande channel and flood plains. This was done formally in an extensive (six page) letter dated June 17, 2002 to Mr. Douglas Echlin, an environmental protection specialist with the U.S. Section. The comments of the District appear to have been totally disregarded as many of the same issues reappear and are unanswered in the Agency's 2003 Reformulation of River Management Alternatives for the Rio Grande Canalization Project. A major District concern is the illegal taking of Project water resources by the planting of new vegetation by the U.S. Section and its MOU partner. The Agency's actions in permitting the planting of vegetation in the river channel could , directly or indirectly, alter the distribution of water to users in Texas and New Mexico.

## Specific EBID Concerns

The basic EBID concerns remain the same as those outlined in our letter of June 17, 2002 to the U.S. Section of the IBWC. Some of these are:

- The absence of good hydrologic studies of the effects of new riparian vegetation on the water supply in the Rio Grande particularly the situation that will prevail during long-term drought situations. The tree planting actions, and the resulting increase in depletions of stream flows as a result of riparian evapotranspiration, have obviously effected the availability of water in the Rio Grande system. A realistic estimate of the annual water use by all trees planted within the IBWC right-of-way must be made and an environmental analysis is needed of the water use by these newly introduced trees.
- The lack of a sound program for the retirement of existing farm lands to provide water that riparian vegetation will consume, particularly off-setting the consumptive effects of new vegetation during prolonged droughts. Any new water-use created by actions of the U.S. Section of the IBWC must be offset, minimally, by the acquisition of water rights in an equal amount by the Agency. Failure to legally acquire off-setting water-rights constitutes a taking property rights (water rights) which belong to others and for which no compensation has yet been paid. An analysis of property takings under applicable executive orders should also be undertaken.
- The U.S. Section's failure to prepare an all inclusive EIS remains a concern. The U.S. Section's MOU with the Southwest Environmental Center should have been the subject of environmental documentation at the time of origin. The fact that it was not does not excuse evading a comprehensive environmental review at this time. All federal agencies subject to NEPA know that just because effects of a federal action may be considered positive to the environment, does not preclude the need for a full environmental review. NEPA requires not only the review of environmental effects, but also consideration social and economic effects

as well. The U.S. Section considers all actions taken under the 1999 MOU as the environmental baseline for consideration of future effects. This is a false presumption and must be corrected. NEPA requires a federal agency to analyze all of its actions, not just those incremental actions recently undertaken. The environmental baseline must be the situation that preceded the 1999 MOU and any 2003 and future NEPA review must include consideration of all of the actions taken by the U.S. Section as past actions will be part of any alternative selected by the Agency in its Record of Decision.

- There is little or no discussion in the existing documentation as to the financing and the sources for funding the activities sought to be undertaken for riparian restoration. The capital costs for the alternatives, except the no action alternative, range from $65 million to $204 million. Discussion of the financial base for various alternatives would seem to be essential, as well as a full discussion of the annual maintenance expenses that Agency anticipates. To be feasible alternatives they must be economically feasible. If the U.S. Section finds these alternatives to be economically feasible, then appropriate source of funds should be identified.
- Some, if not all, of the alternatives to be examined in the Agency's EIS constitute substantial deviations from the primary purpose and duty of the U.S. Section of the IBWC. The EIS should properly analyze and evaluate how substantial these deviations will be from the statutory duties of the agency. The deviations from the duties of the agency should in turn be evaluated for their environmental, economic and social effects upon the people and land in southern New Mexico and western Texas that will be affected. EBID believes that these effects will be substantial, and they cannot be ignored or understated in the EIS.
- The Agency's documents fail to recognize the conservation effort of the District. The Reformulation report states that "The agricultural community along the RGCP, at present, does not have a clear incentive for investing in water conservation." The farmers in EBID have invested large sums of their own resources to install high-flow turnouts and to laser-level virtually all of the large fields in the District. Miles of ditch laterals have been concrete lined. The District has implemented a flow measurement program from the diversion to farm delivery, and return flows to the river. The District has experimented with alternate-row irrigation. The District and its members have, and have always had, the incentive to conserve water, and have always done so. Research by New Mexico State University has shown in at least two studies that District farmers achieve irrigation efficiencies as high as 85 percent using modern surface irrigation, rather than the 40 to 65 percent quoted in the report. This is indicative of the lack of site-specific conditions conveyed in the report.

- The Reformulation report also proposes use of groundwater to establish riparian vegetation. While it is the responsibility of the New Mexico State Engineer to permit groundwater use in New Mexico, it seems highly unlikely that this new depletion would be permitted.
- The only acceptable alternative in the 2003 EIS is maintaining current situation; that is, the "no action alternative". As the NEPA process continues, it is proposed that the U.S. Section of the IBWC arrive at the same conclusion.

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

NOV 14 2003

Mr. Gary Arnold
Board President
Elephant Butte Irrigation District
P.O. Drawer 1509
Las Cruces, New Mexico 88004-1509

Dear Mr. Arnold:

This responds to both your September 13, 2003 and November 3, 2003 letters to me. The first letter provides an issue paper on two issues you claim are prejudicial to the best interests of the Elephant Butte Irrigation District and to the State of New Mexico. The second letter included an invitation to the November 19, 2003 meeting of the Board of Directors to discuss the issues.

First, however, I am compelled to respond to your misunderstanding stated in the first letter of the environmental authority of the United States Section, International Boundary and Water Commission (USIBWC). You state that it is your understanding that the USIBWC's "environmental duties stem from the U.S.-Mexico Treaty of 1944 and subsequent agreements between the two countries as recorded in IBWC minutes."

For your information, the USIBWC is a United States governmental agency in every way similar to the United States Army Corps of Engineers, United States Bureau of Reclamation and United States Fish and Wildlife Service; agencies with which I know you are very familiar. The international body, or International Boundary and Water Commission, United States and Mexico (IBWC), is designated by Executive Order (E.O.) 12467 issued March 2, 1984 as a public international organization entitled to enjoy the privileges, exemptions, and immunities conferred by the International Organizations Immunities Act (59 Stat. 669, 22 U.S.C. 288). Section 2 of the E.O. does not extend these rights and privileges to the USIBWC. That is to say, the USIBWC, established to carry out the work in the United States of the agreed upon actions of the IBWC, like any other federal agency, is required to follow the laws of the United States, including the National Environmental Policy Act (NEPA) of 1969. It is NEPA and subsequent Council on Environmental Quality regulations that dictate the authority of USIBWC's environmental compliance.

That established, allow me now to respond specifically to the two issues you raised.

**Issue I: USIBWC's Representation for the State of Texas**

The USIBWC has the authority to enter into an agreement with Texas Commission on Environmental Quality (TCEQ) in furtherance of the TCEQ Clean Rivers Program (CRP), and did so pursuant to 22 United States Code Section 277h (Authority of the International Boundary and Water Commission to assist State and local governments). This law states in part:

"The Commissioner of the United States Section of the International Boundary and Water Commission may provide technical tests, evaluations, information, surveys, or other similar services to State or local governments upon the request of such State or local government on a reimbursable basis."

The agreement between TCEQ and USIBWC requires the USIBWC to conduct data collection for basin-wide monitoring, special studies project planning, and quality assurance project planning for the Texas portion of the Rio Grande. The Rio Grande originates in the headwaters of the San Juan Mountains of southern Colorado, and flows southward for approximately 600 miles through New Mexico and into Texas. Along the Texas portion, the Rio Grande forms a 1260-mile international boundary between the United States and Mexico. The TCEQ initiated the agreement with the USIBWC for the reasons that data collection for the CRP could more efficiently be achieved by using manpower stationed at USIBWC headquarters and field offices and because data collection would be facilitated in the international river where jurisdiction is divided between the United States and Mexico. Administration of the CRP program in the Rio Grande Basin ideally requires a coordinated effort between two states and two countries.

The work product and report, "2003 Regional Assessment of Water Quality in the Rio Grande Basin," was funded and is wholly owned by TCEQ. As a general condition of the TCEQ state-funded grant agreement, the USIBWC has granted an intellectual property license to TCEQ covering all work produced in the course of fulfilling the scope of work of the agreement.

Specific Concerns in Issue I:

Page xvi in Executive Summary: "The Upper Rio Grande Basin sub-basin extends from the Texas/New Mexico line to Amistad Reservoir. Primary concerns in the sub-basin include ... salinity (chloride, sulfate, TDS) .... High salinity is attributed primarily to current irrigation practices."

Response 1: The three concerns addressed in the assessment: salinity, bacteria and nutrients represent the analysis of data that has been collected over the past five years. The data indicates that below El Paso, return flows from Mexico and the United States contain high levels of chloride and sulfate (which influence the TDS value), resulting in an increase that causes exceedances when compared to the Texas Surface Water Quality Standards (TSWQS) under the General Use Criteria and the Public Water Supply use. The exceedances continue from below El Paso until tributary flows below Big Bend National Park dilute the concentration of TDS, chloride and sulfate to meet the TSWQS. The return flows consists of Publicly Owned Treatment Works (POTWs) effluents, irrigated agriculture and industrial return discharges that re-enter the Rio Grande at various points in this part of the Rio Grande.

Page 1, Introduction: The Rio Grande as it flows into Texas from New Mexico exceeds the criterion established for salinity ...."

Response 2: The salinity levels are exceeded as the Rio Grande flows into Texas from New Mexico at certain times of the year (November-February) for a public water supply. During this time, water would require additional treatment or blending in order to be used for drinking water purposes. This segment is also impaired due to high bacteria levels that exceed TSWQS. The primary flows in the Rio Grande during the November-February time period, in this reach, are mostly from POTWs (from Texas and New Mexico) and from agricultural returns at the confluence of the Montoya drain and the Rio Grande.

Page 1, Introduction: "High salt levels in the Rio Grande limit its use for agriculture and municipal use."

Response 3: Data from the CRP monitoring stations indicate (from upstream to downstream) that as drains from irrigation runoff, industry and POTWs located in Texas and Chihuahua, flow back into the Rio Grande, the concentration of chloride, sulfate, and TDS increase to the point where the TSWQS for general criteria and the Public Water Supply uses are exceeded. The water in the river could not be used as a public water supply without advanced water treatment technologies, i.e. reverse osmosis below El Paso to downstream of Big Bend National Park. All segments below El Paso are designated as a public water supply source in order to protect water users not only in the Upper Rio Grande Basin, but communities below Amistad Reservoir who utilize the Rio Grande as their only source of drinking water. Previous reports on soil salinity, soil type, and water quality indicate that as chloride, sulfate, and sodium increase, it will affect crop selection and crop yield. Please refer to Response 6.

Page 51, Rio Grande above International Dam: "Irrigated agriculture ... impacts this area."

Response 4: The data from stations in Segment 2314 shows an increase in chloride, sulfate, EC and TDS during the winter months, November-February primarily. Although the annual average meets the TSWQS, there is still a concern that above average chloride, sulfate, EC and TDS concentrations occur during the winter months and impacts this part of the Rio Grande. The public water supply use regarding salinity (TDS, chloride, sulfate) would exceed the criteria for this designated use in Segment 2314 during this time period. Bacterial levels above the TSWQS have also been identified in this reach not only in the mainstem of the Rio Grande, but in the Montoya drain as well. The source of the impairment for bacteria appears to be downstream of Station 13276 and upstream of Station 13272. Segment 2314 exceeds the criterion for fecal coliform and *E. coli* and has been listed on the state of Texas 303(d) list as an impaired segment. During this time period, November-February, the majority of the flow is comprised of return flows from POTWs, runoff and baseflow from irrigation drains.

Page 62, Upper Rio Grande Sub-basin Salinity: "Salinity has been a concern in the upper basin for many years primarily due to the extensive water use for agriculture and as a drinking water supply. Water from the Rio Grande picks up salt from the soil after it has been used for irrigation from one community to another to point [sic] where it does not meet the standards for a public waster [sic] supply."

Response 5: The primary concerns, expressed during public forums and among water work groups, have identified salinity and public water supply as two of the top concerns regarding water quality in the Upper Rio Grande Basin. Refer to Response #3.

Page 63, Excerpts from a paper on salt accumulation: "The salinity of the soil appears to be increasing from upstream sites in New Mexico compared to downstream sites in and below the El Paso and Hudspeth counties."

Response 6: The objective of this research is to determine the salt accumulation and release processes and their impact to the increased salinity levels at Amistad Reservoir. This report along with previous studies indicate that additional information is needed to better understand salt storage and its contribution to in-stream salinity fluctuation. The reason for the increase in salinity is not known. Analysis of the data shows that soil salinity in the riparian section increases from upstream to downstream, from New Mexico into Texas, based on the sampling sites. The highest soil salinity values occur in El Paso and Hudspeth counties. Please refer to an additional report entitled, "*Salinity Problems of the Middle Rio Grande Basin: An Overview*," S. Miyamoto.

Report summary: Salinity of project water from Elephant Butte, the main reservoir for the middle Rio Grande Project, has ranged typically from 400 to 500 mg/L. However, quality of the river water deteriorates downstream; 700 to 1000 mg/L at El Paso and 1100 to 2000 mg/L when entering Hudspeth District. . Sodicity expressed in SAR is also low at the reservoir, averaging 2.5, but increases to 3 to 6 at El Paso, and 6 to 18 when entering the Hudspeth District. The use of this water source has caused soil salinization and sodification, mainly in the Hudspeth District, and in some clayey soils of the El Paso Valley. Soil salinization led to cropping constraints in the Hudspeth District, and significant yield reductions of high value crops such as pecans and vegetable crops in the El Paso Valley. In urban sectors, relatively high salinity of potable water caused salinization of recreational turf established on clayey alluvial soils, and to a lesser extent, in upland soils consisting of poorly permeable caliche. Salinity and sulfate concentrations of the river water reaching El Paso during non-irrigation seasons exceed the Texas Standard for Drinking Water Supply, thus limiting the full-utilization of this surface water resource. Reuse of reclaimed municipal effluent began for maintaining large landscape areas, but indiscriminate use of sprinkler irrigation is inducing considerable foliar salt damage. Salinity problems could increase with increasing utilization of all types of water resources for crop irrigation and for municipal purposes, unless appropriate salt management is incorporated. The progressive salinization of the river flow is caused largely by the inflow of saline drainage water back into the river stream. Therefore, any measures which will reduce diversion and/or return flow have potentially a positive impact on downstream salinity. There are indications that river banks are undergoing salinization, and riparian vegetation except for the reach with mowing activities has shifted largely to salt cedars. The salts stored in the bank and flood plains are subject to flushing during spills or high flow. Salt flushing from the middle Rio Grande into Amistad International Reservoir occurred during 1986/87, and it could be occurring above Elephant Butte as well. Vegetation management in riparian zones and flood plains may become an increasingly important salinity control strategy in this basin.

Page 85, Conclusions and Recommendations; Upper Rio Grande Sub-basin: "Water quality concerns in the Rio Grande consists of elevated levels of ... dissolved salts ...." "High levels of salt of salt [sic] are due to return flows that carry dissolved salts from irrigated agriculture and runoff from soil that is high in salinity."

Response 7: This is similar to Response #1. Data from the CRP monitoring stations in the Upper Rio Grande Sub-basin indicate that the primary source of increased levels of chloride, sulfate, and TDS are from agricultural return flows. Dilution of these flows below Big Bend National Park from springs and tributaries help to reduce the salinity prior to reaching Amistad Reservoir.

**Issue II: USIBWC's Proposals to Establish New Zones of Riparian Vegetation Along the Rio Grande in New Mexico**

The USIBWC responded to a June 28, 2002 (not June 17, 2002 as stated by EBID) letter from EBID on September 4, 2002. The USIBWC's response included an attachment of Parsons letter dated August 7, 2002. The Parsons letter provided detailed responses to the same concerns raised in Issue II of the current letter. Notwithstanding, a reiteration of the responses provided by Parsons follows.

Regarding the USIBWC activity of riparian vegetation establishment and extent of "green zones," the general issues are the concern that the three "green zones" and limited tree planting since 1999 represent significant water consumption. In reality the no-mow zones represent limited provisional test plots intended to evaluate effects of additional vegetation growth on the Rio Grande Canalization Project (RGCP) functions. Under current conditions those zones have a very limited potential for water consumption because they are not irrigated and, given the extended drought, only scattered vegetation growth has occurred to date in the no-mow zones.

The acreage of the no-mow zones is as follows: the first zone extends 5 miles from Percha Dam to the Doña Ana County line, and ranges in width from 10 to 35 feet. At an average 20-foot width, it covers approximately 24 acres. The second zone corresponds to Seldon Canyon where USIBWC historically has not conducted mowing operations since the agency's jurisdiction is limited to the channel bed and stream banks. The third zone, extending for 5 miles from Shalem Bridge to Picacho Bridge, vegetation is allowed to grow for a width of 35 feet. Regular mowing is maintained in areas adjacent to bridges (400 feet upstream and downstream from the structure) and access points to the river (100-ft long segments located at 800-ft intervals). The extent of this no-mow zone is approximately 19 acres. In combination, no-mow zones outside Seldon Canyon cover less than 1 percent of the 8,332 acres of project right of way.

Tree planting since 1999 has been limited to approximately 800 cottonwood poles planted individually at 100-foot intervals, and only a fraction remains alive since they are not irrigated. In combination, and if and when they reach maturity, all plantings would cover less than 5 acres at their typical density under natural conditions.

Another issue is the need for an environmental evaluation for the no-mow zones. Given their small magnitude, it becomes obvious why actions such as temporary test plots fall under a categorical exclusion.

Another issue related to "green zones" is whether they should be part of the baseline condition (which in NEPA is defined as the current condition). While that scattered vegetation growth currently present in the no-mow zones could be considered an individual action, albeit a very small one, in the EIS analysis those zones are being evaluated as part of the more comprehensive and substantial action of future areas in the floodway with full vegetation growth. This larger action is part of the alternatives under evaluation, and was presented in tabular form in the handout provided to EBID during the April 17, 2002 meeting.

Regarding the USIBWC authority for the environmental analysis see my lead paragraph to this letter regarding the USIBWC environmental analysis authority.

Regarding the statement that the reformulation of alternatives report does not appear to be an EIS is correct. This document is a step in the process of developing alternatives for analysis in the EIS. In addition, in Section 1 of the draft EIS the purpose and need for the project is discussed. Further discussion on this issue follows later.

Regarding EBID's rational for concerns on water rights and the statement that USIBWC totally disregarded responding to the issue, in fact, the Parsons August 7, 2002 letter answered this concern. Regarding whether there are actual water savings by salt cedar removal, Parsons responded that while very high water consumption by this introduced species is a fact fully supported by extensive scientific data, there is agreement that it would be very difficult to reach a consensus as to the actual potential for reduction in water consumption.

The district also questioned whether any saved water could be used in other environmental improvement actions, such as opening of meanders, since all surface water is allocated to the Rio Grande Project. In response to EBID's concerns, Parsons modified the formulation of the proposed action. Initially they presented the action simply as removal of salt cedar to offset water losses by other environmental actions. In the reformulation of alternatives, salt cedar control partially offsets water consumption by the new riparian vegetation on a site by site basis. For other environmental actions that need additional water, acquisition would be required.

Finally, the need for evaluation of socioeconomic impacts was stated. We fully understand this point and for that reason socioeconomic and water use issues are major components of the draft EIS. In fact, Parsons presentation identified water conservation programs and not decommissioning agricultural lands as two key elements in the implementation strategy.

Specific Concerns in Issue II:

Bullet #1 - The specific estimates of water use by new riparian vegetation is addressed in the draft EIS.

Bullet #2 - Here EBID requests a program for existing farmland retirements and water rights acquisition. This ignores that not retiring farmlands is a goal of the alternatives, and need for water acquisition is clearly indicated in multiple sections of the reformulation of alternatives report (including those sections from which EBID is taking rephrased quotes).

Bullet #3 - EBID continues to label the reformulation of alternatives report as an EIS despite an explicit indication in the document's introduction and a statement in the USIBWC September 4, 2002 letter with attached Parsons August 7, 2002 letter to the contrary. To reiterate, the reformulation of alternatives report is not an EIS. The report provides the background and reasons for changing the alternatives from those developed in the March 2001 alternative formulation report to be analyzed in the EIS. It is the purpose of the EIS to discuss the potential impacts of future operation of the RGCP, not the reformulation of alternatives report. The draft EIS will be available for public review soon. This point was stated in previous meetings with and correspondence to EBID. This misunderstanding explains why EBID lists a number of impacts they believe have not been adequately addressed. Several of those impacts are relevant and will be included in the EIS analysis. Once the Draft EIS becomes available, all stakeholders will have the opportunity to comment as to whether potential impacts were adequately evaluated.

Bullet #4 - Costs of the alternatives can be included as information in the EIS (although it is not in the preliminary draft now under review by USBR and USIBWC staff). Cost can be a factor as with the environmental analysis and other considerations for the USIBWC to make the final decision on selection and implementation of the alternatives.

Bullet #5 - See response to USIBWC authority for environmental analysis and purpose and need statement above.

Bullet #6 - Regarding recognition of water conservation, a paragraph on EBID's conservation practices is presented in the reformulation of alternatives report that specifically addresses on-farm conservation. The lack of incentives to individual farmers for on-farm conservation was quoted from an EBID document and is now quoted verbatim in the preliminary draft EIS, along with the New Mexico Office of the State Engineer irrigation efficiency numbers in the preliminary draft EIS, as follows:

> "Support of water conservation by financing on-farm water conservation programs was identified as a viable strategy to secure water for use in environmental measures. A review study on irrigation efficiency published in the Fall 2001 issue of NMOSE's Waterline indicated that a flood irrigation efficiency typically ranges from 40% to 60%, 65% for high-pressure center-pivot sprinklers, 60% to 65% for side-roll sprinklers, and 85% to 90% for

drip irrigation. EBID's on-farm irrigation efficiency was quoted at 60% (Wilson 2001). Potential on-farm irrigation efficiency increases up to 80% for high-pressure center-pivot sprinklers were listed for the use of partial-length drop-down tubes and 95% for full-length drop-down tubes (Wilson 2001).

"Supporting water conservation programs would not only be consistent with stated interests of the irrigation districts (EBID 1998; EPCWID#1 2000), but would also facilitate seeking funds from high-priority state and federal programs. Such conservation programs would focus on financing on-farm irrigation system improvements that represent a substantial investment for individual farmers. Along the RGCP, individual farmers at present do not have a clear economic incentive for investing in more water-efficient but expensive on-farm irrigation systems. Economic incentives to compensate for water rights attached to any saved water are likely needed to foster such on-farm water conservation programs. As stated by EBID (1998) General Data and Information booklet: *'In the future some form of economic incentives for both (1) helping reduce the capital outlay for the conversion to a more water conservative irrigation system than is presently in use and (2) by far perhaps the more important from the farmer's standpoint, an economic incentive to compensate for the water right attached to any 'saved' water, will most probably need to be implemented in order to foster a purpose of conservation with broader range and benefits to a greater number of users than is already in place within the agricultural community.'*

"Water banking is a water management strategy that speeds up the temporary transfer of water from those willing to lease it to those willing to pay to use it. Farmers and other water rights holders can deposit some or all of their allotted water into a 'water bank' where users pay the going market rate to borrow it for a limited period of time. The lessor retains ownership of the water rights, and rights placed in the bank cannot be forfeited for non-use (Salem 2002).

"The water banking concept is gaining support in the State of New Mexico. In November 2002, the State Engineer's Office issued draft regulations for water banking in the Lower Pecos River Basin (NMOSE 2002). While this is a very restricted program for a specific basin, in the future it could lead to a broader application of such programs in the state.

"Both strategies, supporting water conservation programs and water banking, would allow gradual implementation of measures under consideration over a 20-year horizon. The implementation timetable, described in Subsection 2.10, considers an initial development period during which financial/cooperative agreements can be reached, and pilot-scale projects tested in terms of viability, environmental benefit, and potential water use prior to the implementation of projects on a larger scale."

Bullet #7 - We agree, groundwater use is an option that is characterized as highly unlikely.

Bullet #8 - We recognize EBID's selection of the No Action Alternative as the only acceptable alternative. However, we would prefer that they review the draft EIS in its entirety before making their selection since such a conclusion can only be reached once the evaluation of impacts is completed.

The USIBWC and the CRP hold annual public meetings along the border to present information derived from the ongoing routine water quality monitoring program and special studies that are conducted in the Rio Grande Basin. Over the past four years, the CRP has invited staff from the EBID office to all of it's public meetings and coordinated monitoring events and has solicited their input into the program. Input from the public is welcomed and encouraged in order to help steer the program and address issues that are of concern to the community. Ongoing efforts include participation in the United States Environmental Protection Agency (EPA) Border 2012 initiative as part of the water workgroup. Under the Border 2012, the USIBWC and the CRP will focus on improving water quality monitoring by attempting to include additional monitoring in a binational setting to include agencies and groups from Mexico actively participating in the program. The CRP staff has also provided water quality data to the New Mexico Environment Department for use in assessment of the Rio Grande Basin in New Mexico to fulfill its state and federal mandates. The USIBWC and the CRP will continue to provide water quality data, technical support, and strive to collaborate with New Mexico entities to achieve the goals of both states in addressing water quality issues in our region.

I hope this adequately responds to your concerns. We look forward to your comments on the draft environmental impact statement when it is released to the public. Regarding your invitation to speak at the Board meeting on November 19, 2003, I have prior commitments; therefore, I will not be able to attend your meeting. However, the USIBWC welcomes the opportunity to meet you to discuss any further concerns you might have. You may contact me at (915) 832-4147.

Sincerely,

Debra J. Little

Debra J. Little
Acting Commissioner

cc:

Senator Pete V. Demenici
New Mexico
United States Senate
Washington, DC 20510-3101
Attn: Mr. Kristopher T. Schafer

R.C. Wooten, Principal, Parsons, Austin

THE ALLIANCE FOR THE RIO GRANDE HERITAGE

Acting Commissioner Debra Little
International Boundary and Water Commission, U.S. Section
4171 N. Mesa, Suite C-310
El Paso, TX 79902-1441

RE: Reformulation of River Management Alternatives and Draft Canalization EIS

10-005

Dear Commissioner Little:

IBWC has taken great strides this past decade to begin to address the environmental impact of its boundary and water services along the United States and Mexico border region. We applaud these efforts because our border rivers provide tremendous benefits and habitat for wildlife and support large-scale ecological processes as migratory pathways and wintering grounds for waterfowl and shorebirds. Proper ecological management of these rivers can also, of course, be of great benefit for the quality of life in communities along the watershed.

IBWC took a significant step in fulfilling its role as an environmental steward when it undertook evaluation of long-term river management alternatives for the Rio Grande Canalization Project. Although the Canalization EIS addresses only a limited reach of the Rio Grande, it has far reaching implications for environmental sensitivity by your agency along the length of the Rio Grande and the Colorado River. This is one reason, among others, that the Canalization EIS is of such concern for many national and regional environmental groups. Another reason is this reach of the Rio Grande has experienced some of the greatest impacts on its geomorphology, hydrology and biology of the entire 873-mile Upper Rio Grande basin. Further, this reach may prove instrumental to enhancing flows to the Forgotten Reach and reversing the hydrologic disjunction between the upper and lower Rio Grande basins.

The Alliance greatly appreciates IBWC's efforts to date to make the Canalization EIS a transparent and inclusive process. As recently as August 22nd, members of the Alliance, along with Phil King, representing the Elephant Butte Irrigation District, met with your staff to discuss major concerns shared by both the environmental and agricultural community with flood modeling analyses that are integral to the EIS.

While we are encouraged by IBWC's efforts to meet with us, it is becoming increasingly clear that the proposed alternatives are not being modified to address our primary concerns. We wanted to make certain that you were aware that this was happening. These concerns are both technical and legal in nature. The technical issues are detailed in the attachment to this letter. Most of these have been raised with Parsons and your staff previously. The legal issues were raised in our September 25, 2002 letter to Commissioner Ramirez.

We feel strongly that it is not in the best interests of the environmental community or IBWC to resolve these issues through litigation. Moreover, we feel that through further refinement of sources of environmental water and flood modeling, it is conceivable that an alternative could be developed that garners both agricultural and environmental support and reduces IBWC maintenance costs. But, such an alternative will take time and further negotiations. We recognize that IBWC is operating under severe fiscal and staffing constraints, and are concerned that these constraints will militate against further exploration of alternatives and result in a November release of the Draft EIS. We would urge IBWC to not let such short-term considerations outweigh the overwhelming benefits of a collaborative resolution of these issues.

We have requested a meeting with you on October 24 at 10 a.m. to discuss the Canalization EIS further. We remain hopeful that a solution can be found that meets the needs of all stakeholders, even if it delays issuance of the draft EIS further. We renew our offer to help make this outcome a reality.

Sincerely,

Kevin Bixby, Executive Direcotor
Southwest Environmental Center
(for the Alliance)

Enclosure

The following is a summary listing of the Alliance's major technical concerns related to the alternatives formulation for the Canalization Project.

1. **Definition of Restoration**

The definition of restoration used in the EIS is critical as a starting point for complying with the Memorandum of Understanding (MOU) signed with the Southwest Environmental Center, which requires the EIS to include an analysis of:

> "flood protection measures and alternatives to current management, including watershed-oriented and non-structural alternatives, and including collaborative measures with other agencies and landowners, to determine to what extent project management can support restoration of native riparian and aquatic habitats, as well as the restoration of natural fluvial processes such as channel meanders and overbank flooding."

The Alliance is guided by the definition of river restoration put forward by the National Academy of Sciences (*Restoration of Aquatic Ecosystems: Science Technology, and Public Policy*, 1992) and the U.S. Environmental Protection Agency. This definition embodies the following concepts:

- Looks to the predisturbance state for reference (pre-1870 in this case, but certainly pre-Elephant Butte Dam)
- Seeks to address causes not just symptoms of disturbance
- Seeks to replace hydrologic conditions as well as structure
- Is holistic and multi-faceted
- Is sustainable because it requires a minimum of human intervention
- Considers specific biotic elements.

We do not believe the definition of restoration used by Parsons is scientifically defensible or adequate to meet the requirements of the MOU or the National Environmental Policy Act (NEPA). The concept of "partial restoration" relied upon by Parsons is unnecessarily and arbitrarily limited. Because it lacks the above elements, it has resulted in the inclusion of "restoration" measures within the alternatives that are neither holistic nor sustainable. Parsons has not given adequate consideration to the following key river restoration objectives:

- provide a greater range of flow regimes
- enhance river dynamic behavior
- remove constraints on natural channel processes
- expand the active floodplain
- increase the channel/floodplain hydrologic connectivity
- enhance sediment loading to support channel functions
- ensure channel forming flows will sustain restoration measures.

Lest our idea of restoration seem unrealistic, we encourage IBWC to consider the restoration effort currently underway on the middle Rio Grande by the Save Our Bosque Task Force (SOBTF), a group comprised of federal agency personnel and other stakeholders. SOBTF's vision of restoration is:

> *A riparian ecosystem that functions as natural as possible within the confines of 21st Century infrastructure and political limitations while respecting the traditional customs and cultures of the citizens of Socorro County.*

Two objectives have been defined to achieve this goal: 1) enhance natural river functions; and 2) increase habitat diversity. The general approach used by SOBTF is to create riparian restoration opportunities by establishing favorable hydrogeomorphic conditions, i.e. to let the river do as much of the work of restoration as possible, to save money and to ensure sustainability. We endorse this approach.

**2. Adequacy of modeling**

A continuing concern is the exclusive reliance by Parsons on a one-dimensional hydraulic model, which in our opinion does not allow for the kind of analysis needed to comply with NEPA and the MOU. Specifically, this kind of modeling does not provide accurate or credible answers to the following key questions that are central to all the alternatives:

- the fate of the design flood event as it travels downstream, and hence,
- the quantitative need for flood protection at each point within the project
- the extent to which vegetation can be allowed to occupy the floodway
- the extent to which flood protection requirements could potentially be met by non-structural means
- the amount of floodplain that could be wetted by design restoration flows of various sizes
- the amount of water consumed by restoration features, such as riparian vegetation or sloughs

Accurately predicting channel and floodplain interaction with flow attenuation and infiltration/evaporative losses cannot be accomplished with a single discharge, one-dimensional HEC-2 or HEC-RAS model.

In its evaluation of levee freeboard deficiencies, Parsons relies on the 100-year flood event estimated by a HEC-1 Corps watershed model. Floodwave attenuation in the arroyos and the Rio Grande channel due to overbank storage flows is probably underpredicted resulting in relatively narrow high peaks at various locations in the RGCP. The conservative estimates of the flood peaks in the RGCP may result in a recommendation that the RGCP levee system was deficient in some areas when in reality the levee was not impacted by flooding. A conservative estimate of the design flood peak discharges will result in higher costs associated levee flood protection improvements.

We have suggested on numerous occasions that two-dimensional flood routing modeling is needed to provide the kind of analysis called for by the EIS. It would certainly seem to be in the interest of IBWC to do this kind of modeling since it could help the agency avoid wasting potentially a great deal of money on restoration and/or flood control measures that may not be needed or sustainable. We have offered to help secure the resources needed to undertake such modeling. To date, our suggestions and offer have gone unheeded.

### 3. Selection and analysis of channel-forming flows

Parsons has failed to consider the central role of channel forming flows in creating and sustaining restoration efforts, and in maintaining flood conveyance capacity. Channel forming flow may be defined as the flow at which the bed material is mobilized and the banks begin to erode.

The outlet at Caballo Dam currently limits the maximum discharge to 5000 cfs. Unless the system is completely full or the outlet works are restructured, 5,000 cfs will be the peak discharge that limits the channel morphology. The potential to retrofit the outlet works has not been addressed by Parsons.

In lieu of increasing the outlet works peak discharge, the channel restoration components and proposed channel morphology should be designed to accommodate the 5,000 cfs release. Releasing 5,000 cfs with the frequency, duration and timing to sustain the restored channel morphology will maximize opportunities to enhance aquatic and riparian habitat and sustain dynamic river functions.

It will also provide the greatest channel conveyance capacity to limit flooding during project design flood events (~100 year flood). If a seasonal peak discharge less than 5,000 cfs is provided on frequent basis, the river will gradually adjust to the lower flow regime with channel narrowing, vegetation encroachment and sediment deposition.

### 4. Frequency and timing of restoration flows.

Parsons does not give adequate consideration to the timing, frequency and duration of restoration flows. The restoration flow should occur with a prescribed frequency to sustain channel function and eliminate vegetation growth within the active channel.

A channel forming flow frequency on the order of four out of ten years with no more that two consecutive years without the channel forming flow is necessary to sustain the active channel geometry over the long term. This frequency of channel forming flows is also conducive to native vegetation regeneration for mixed stands of vegetations and will reduce the need for mowing in the floodway (one of the objectives for restoration of natural river functions). In the absence of channel-forming flows on a frequent basis, IBWC will be required to continue mechanical techniques (mowing) and dredging to maintain channel flood conveyance capacity.

The timing of restoration flows is critical. The abundance and diversity of native species in the Rio Grande riparian ecosystem is strongly linked to the river's natural hydrograph (Crawford, et al., 1993). Both the rising and recessional limbs are documented to affect the reproductive strategies of many aquatic and riparian species. The decline of the river functions and biological diversity of the system can be primarily attributed to the reduction in peak flow magnitude, frequency and duration.

Releases of restoration flows should be orchestrated to mimic the shape and timing of historic hydrographs. The spring peak flushing flow should be timed to occur the last two weeks of May and it should reflect the shape of the typical pre-1900 hydrograph in terms of the rate of change in the rising and recessional limbs. This peak discharge timing will encourage regeneration of native riparian vegetation.

Parsons has not done the necessary analysis to design a restoration target flow. The product of this analysis would be a series of flow hydrograph scenarios for a restoration channel design that would relate peak discharge, duration, frequency to flow volume and area of inundation. Selection of an appropriate restoration discharge hydrograph and timing would then be based a knowledge of required water volume, costs and constraints.

The Parsons report has presented a number of disconnected hydrologic concepts that were formulated with the single discharge, one-dimensional HEC-RAS model. The targeted restoration flow is poorly defined. The analysis does not provide the opportunity to review various flow scenarios or apply any selection criteria to varying levels of restoration alternatives. There was no iterative analysis of restoration options provided by the report. The reader cannot determine that 3,600 cfs for five days every five years is better than 2,250 cfs for 14 days every other year on the basis of the area of inundation, required volume of water, or cost associated channel restoration.

Both channel and floodplain restoration activities require flows that will equal or exceed the bankfull discharge. Long term sustainability is contingent on designing restoration activities to the channel forming flow.

Parsons recognizes the importance of using seasonal peak flows to promote regeneration of riparian vegetation. However, in the supporting documentation, there is no mention of how these flows relate to existing bankfull conditions or channel forming discharge. There is no discussion of the hydrograph associated with restoration target flows or the required frequency, duration or timing of these flows for sustaining the channel restoration activities. Without knowing the prescribed frequency of the restoration flows, it is impossible to assess whether the restoration components can be sustained over the long term without mechanical intervention.

### 5. Analysis of sediment loading and transport

One of the keys to designing self-sustaining restoration activities in the RGCP is an accurate estimate of long term sediment loading. The success or failure of restoration activities will depend on channel response to variable sediment yields. Sediment supply and sediment transport capacity will dictate whether the restored channel geometry will be self-sustaining with managed flows or will require continual mechanical maintenance.

There are several key linkages between the hydrology, sediment load and channel morphology analyses in the Parsons report that are missing. Parsons reports on the sediment load estimates from the arroyos based on the 1996 Corps of Engineers report. The Corps report also indicated the potential sediment deposition or scour associated with the 100-year flood and a 10-year period of high flows. Critically missing from the Parsons' report is an analysis of the whether the existing sediment load will sustain a restored channel morphology, a determination of the impacts of continued load term sediment dredging at the arroyos on channel restoration and an analysis of the relationship between future sediment loading and the proposed restoration plan.

Several important questions related to channel morphology and restoration have yet to be addressed:

- What has been the historical change in bed material size?
- Will the restoration components be sustained over the long term without sediment dredging?
- Can future arroyo sediment loading enhance channel dynamics and stimulate channel migration?
- Would sediment loading sustain a higher width to depth ratio for the channel geometry?
- What is the relationship between the potential sediment loading and RGCP channel conveyance capacity and tributary hydrology?
- If tributary experiences a 100-year flood event, will the proposed channel restoration be positively or adversely impacted?

The relationships between the tributary hydrology, sediment loading, tributary bed material size and channel bed material size and restoration channel morphology must be understood to select a restoration flow.

The Parsons report does not quantify the progressive decline in sediment supply to RGCP. The current channel response to variations in sediment supply has been limited by bank stabilization methods. Bank erosion and channel migration are two components of an active wide channel that have been thwarted by the RGCP and tributary sediment retention facilities.

### 6. Channel restoration

One of the primary concerns is the failure of the Parsons' Reformation Report to identify reworking the channel geometry as a restoration technique to improve aquatic habitat diversity. The Report acknowledges that instream habitat diversity is low. (4-26). There are many methods available to rework channel morphology and create low velocity habitat. Failure to consider this environmental measure unduly limits in scope the management alternatives for the Canalization EIS.

## 7. Sources of environmental water

The Report erroneously implies that restoration measures that consume water will have little or no political viability (4-4, 4-22, 4-26). Our experience suggests that if the dominant source of environmental water is voluntary water transfers, either through the marketplace or by donation, the agricultural community will be supportive of restoration measures. If the irrigation districts play an administrative role in overseeing these transfers, through, for example, an environmental water user's bank, the districts can ensure their farm constituents are not injured by environmental water transfers. For further discussion of this approach, we refer you to Phil King and Julie Maitland's report, "Water for River Restoration: Potential for Collaboration between Agriculture and Environmental Water Users in the Rio Grande Project, available on the web at http://cagesun.nmsu.edu/~jpking/wwf/reportdownload.htm. There may be other viable sources that could be agreed upon with further negotiations between agricultural water users and the environmental community. To avoid further unnecessary conflict on this point, we strongly recommend that the EIS sections on the source of environmental water be drafted collectively by the environmental and agricultural community for review by Parsons and IBWC for incorporation into the Draft EIS.

## 8. Dramatic reduction or exclusion of restoration measures

We are concerned that environmental measures were dramatically minimized or excluded in the Reformulation report and those that remained were lumped into the Targeted River Restoration alternative despite the fact that the report states 89% of the project is considered below average to poor quality habitat. (Table 4-5). We are concerned that environmental measures were selected to minimize consumptive use of water and not on the basis of habitat value.

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

NOV 14 2003

Mr. Kevin Bixby
Executive Director
Southwest Environmental Center
275 North Downtown Mall
Las Cruces, New Mexico 88001

Dear Mr. Bixby:

This responds to your undated letter to me, on behalf of The Alliance for the Rio Grande, regarding the Reformulation Report of River Management Alternatives and Draft Canalization Project EIS. You stated your disappointment that, "the proposed alternatives are not being modified to address [Southwest Environmental Center's (SWEC)] primary concerns." There are many stakeholders the EIS must respond to, including your organization, United States Bureau of Reclamation, Elephant Butte Irrigation District, El Paso County Water Improvement District No. 1, etc. The National Environmental Policy Act (NEPA) of 1969 encourages public participation in the process of analyzing proposed project impacts on the human environment. The issues you summarized: definition of restoration, adequacy of modeling, selection and analysis of channel-forming flows, frequency and timing of restoration flows, analysis of sediment loading and transport, channel restoration, sources of environmental water, and dramatic reduction or exclusion of restoration measures have been addressed largely in prior correspondence and meetings, including the most recent meeting on October 24, 2003. Notwithstanding, my reiteration follows.

Regarding the stream restoration definition for the Canalization Project, the United States Section, International Boundary and Water Commission (USIBWC) and consultants met and corresponded numerous times with stakeholders between October 1999 and December 2002, during an extended (over 3-year) scoping process, to receive input for alternatives development. Meetings included open forums, public meetings, presentations, and technical workshops with federal, state, and local agencies, organizations, individuals (farmers), and outside SWEC consultants as well as peer reviewers regarding Parsons alternatives formulation methodologies. As a result of this extended scoping process, the EIS, in accordance with the March 1999 Memorandum of Understanding, will analyze alternatives that are viable and implementable and will respond to the stated concerns of the various stakeholders, including the Alliance and SWEC.

Regarding a pre-disturbance state for restoration, are you suggesting that USIBWC is now supposed to remove the dams and reservoirs as an alternative of our project? The challenge is not restoring a river to historic conditions, but improving the environmental conditions of a river that for all practical purposes now functions as a water conveyance and delivery system. The USIBWC is not responsible for what occurred in the project reach prior to the Canalization Project. The pre-project condition is not our baseline condition, nor should it be. Over the past century, flow regime control and physical modifications to the streambed have drastically changed the configuration of the Rio

Grande along the project reach. Nearly all major changes pre-date the Canalization Project by decades. Understanding the extent of upstream flow control, historical changes in stream configuration, and sediment transport give a realistic view of the ecosystem restoration potential along the project reach.

You state that modeling is inadequate. In fact, as Parsons responded on July 3, 2002 to a similar criticism in your May 31, 2002 letter, current estimates of levee deficiencies and potential flood risk will be reduced with the use of two-dimensional models because they account for the attenuation of flood peaks as they spill into the floodway. The lesser the need to address flood control problems, the lesser the opportunity and practical justification to relocate levees or incorporate other non-structural control measures. As we understand, the 2-D model you want used is best for project design of environmental measures, when we get to that phase.

Also, regarding hydraulic modeling of the project, flood control is one of the USIBWC 's major responsibilities; the other is water delivery. Both HEC-2 and HEC-RAS are models that have been developed by the United States Army Corps of Engineers (USACOE) and are accepted nationwide as a standard for flood plain management and flood insurance studies to evaluate floodway encroachments. The HEC-2 model developed in 1995 by the USACOE for the USIBWC and the HEC-RAS model developed in 2002 for the USIBWC are one-dimensional and steady state flow models. Both models analyze the water surface elevations at each cross-section (500 feet apart) based on different design flood flows. The design flood peak flows were developed by the USACOE as the 100-year flood event for different reaches of the project. The USIBWC believes that both models are appropriate for the flood control, channel improvement purposes, and for completion of the hydraulic studies associated with the EIS.

Regarding selection and analysis of channel-forming flows, you allege that channel-forming flows are those that mobilize bed material and create bank erosion. You also advocate retrofitting the outlet works of Caballo Dam to allow for greater discharge. As you know, flows are tightly controlled by a series of upstream dams as evidenced by the small number of documented significant flood events in the 65 years of project operation. The smaller, more frequent (1- to 5-year recurrence) overbank flows are most favorable for riparian development. These are the flows the project management alternatives exploit.

Flow regime (magnitude, frequency, duration, timing, and rate of change of hydraulic conditions) within the project reach was a primary consideration for virtually all environmental measures. Regulation of the stream flow has had little change since the early 1900's. Average discharges downstream of Elephant Butte Reservoir during summer conditions remained near 2,000 cfs until 1940, fluctuated from 500 cfs to 2,000 cfs during low-precipitation conditions prevalent for the following four decades, and experienced greater fluctuations during high-precipitation periods of the mid 1980s and 1990s. Consider, also, that current O&M activities require relatively little control of bank geometry given the upstream flow regulation. Since 1961 there has been little need for additional bank stabilization using riprap.

Regarding the retrofitting of Caballo Dam outlet works, it is not within the scope of our EIS. The proposed action you recommend should be explored with the United States Bureau of Reclamation, Rio Grande Project in whose jurisdiction is the dam.

Regarding frequency and timing of restoration flows, you say that Parsons does not give adequate consideration to timing, frequency and duration of restoration flows. Further hydraulic studies are anticipated to assist in the design of mitigation projects after the completion of the EIS.

Regarding analysis of sediment loading and transport, you say that one of the keys to designing self-sustaining restoration activities in the project reach is an accurate analysis of sediment loading and transport. Sediment load and channel morphology analyses are not a part of the reformulation report since the USACOE's HEC-6 Sediment Transport models for the USIBWC are still applicable. The USACOE four models are: 1) Average low-flow year which represents the 10-year lowest flow period, current river geometry and features; 2) Average high-flow year which presents the 10-year highest flow period, current river geometry and features; 3) 100-year return period storm, current river geometry and features; and 4) 100-year return period storm, current river geometry and features with recommended sediment control measures.

Regarding channel restoration, you say a main concern is failure to identify reworking channel geometry. You indicate that there are many methods to rework channel morphology, but fail to suggest what you are contemplating. The reformulation of alternatives report suggests several channel morphology treatments, including: open former meanders, modification of dredging at arroyos by creating embayments, whitewater/backwater habitat conditions created by erosion control protection structures at siphons and flumes, and channel bank shavedowns (more for riparian regeneration).

Regarding sources of environmental water, you say that the reformulation of alternatives report incorrectly states that water for environmental enhancement has "little or no political viability." You also recommend water banking. Low precipitation conditions prevalent in the Middle Rio Grande watershed severely restrict water availability in the project reach. As all river water and agricultural return flows in the project are fully allocated, water acquisition becomes a requirement for implementation of environmental measures for riparian corridor development, aquatic habitat diversification, and changes in flow regime. Such acquisition faces competing interests of municipal entities, making water acquisition a critical element in a river restoration program.

For nearly a century, flows along the project have been tightly controlled by a series of upstream dams which release water primarily to meet the needs of agricultural lands in New Mexico, Texas, and Mexico. As a result, water delivery needs control the flow regime along the project and limit the type and extent of environmental measures that can be implemented. The door on the concept of water banking is <u>not</u> closed by the alternatives under analysis. The reformulation report recognizes that water is a limited resource in the project reach but goes on to say that a viable restoration program will require cooperation with irrigation districts, compensation for water use, and incorporation of water conservation measures.

Regarding reduction or exclusion of restoration measures you are concerned about a perceived minimization or lumping of environmental measures into the Targeted River Restoration alternative. The project reach upstream from Leasburg Diversion Dam is the most likely candidate for emphasizing environmental measures associated with partial restoration of the Canalization Project. As the project extends downstream from Leasburg Dam it becomes more and more constrained by urban development as well as loss of pulse flow effects due to attenuation. This does not, however, mean that if the opportunity presents itself the environmental measures applied in the upper reach could not be used in the lower reaches also. Levee removal, as you advocate, is a very real possibility in the upper reach once a full understanding of structural deficiencies from ongoing studies is completed in 2004.

The assumption that the levee system dictates the extent of the active flood plain in the project reach is incorrect. The narrowing of the flood plain was actually induced by upstream flow regulation, not by the presence of the levees. With few exceptions the active flood plain is well within the levee system and, under the current flow regime, will retain its current configuration even if the levees were repositioned farther away from the stream for flood control purposes.

Unlike non-structural flood control programs implemented for rivers such as the Mississippi-Missouri with recurrent flood events - in which use of non-structural methods provides flood protection as well as environmental benefits - the use of non-structural flood control methods in the Canalization Project is primarily an economic and risk-management decision. Since flows are tightly controlled by a series of upstream dams, only a handful of significant flood events have been documented in the over-60 years of Canalization Project operation.

I hope this adequately responds to your concerns. We look forward to your comments on the draft environmental impact statement when it is released to the public soon.

Sincerely,

Debra J. Little

Debra J. Little
Acting Commissioner

copy of letter sent to:
R.C. Wooten, Principal, Parsons, Austin