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.

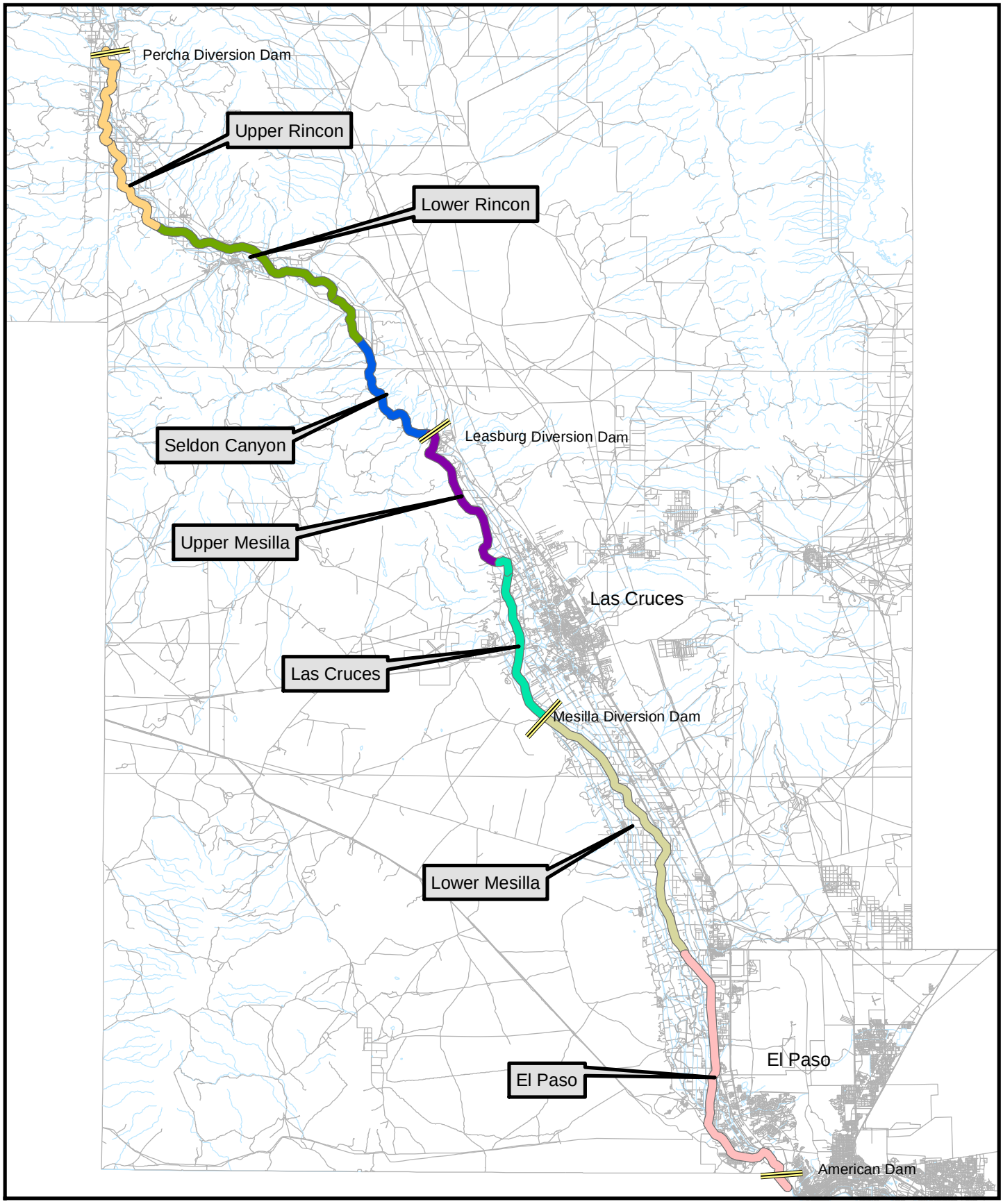
Levees are inspected regularly at the beginning of each flood season and immediately after each flood event. Maintenance includes encouraging grass growth on the levee slopes for erosion control, cutting brush and tall weeds from the slopes, and repairing levee slopes. Levee slopes are mowed to prevent 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)



North

SCALE = 1 : 570,000 or 1 INCH = 47,500 FEET
UTM Zone 13 N / NAD 83

0 5 10 20 30 40 Kilometers

0 2.5 5 10 15 20 Miles

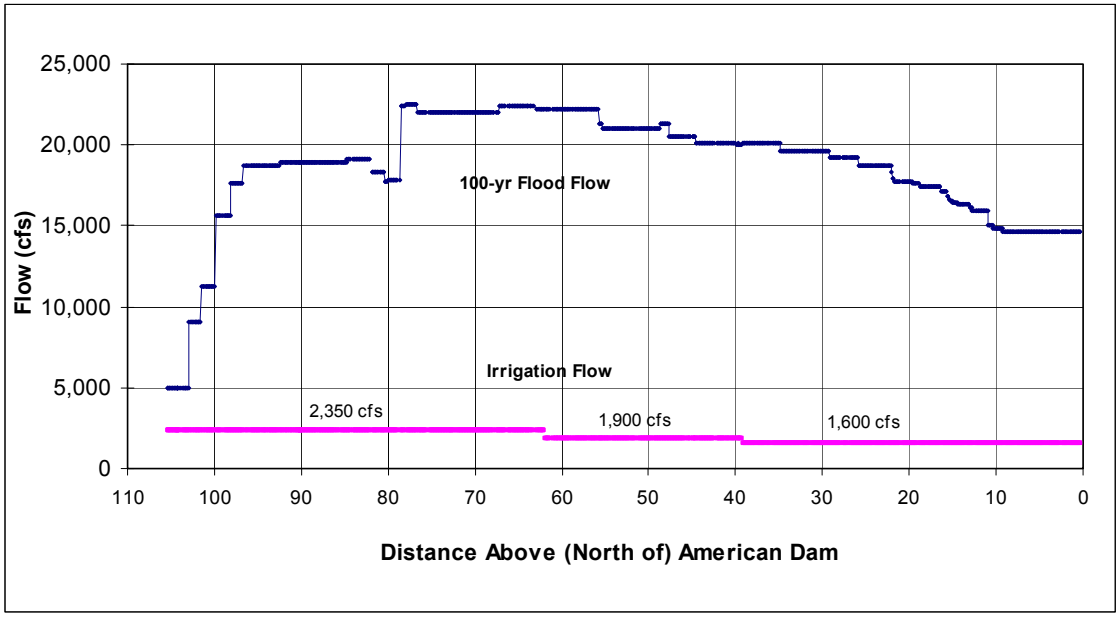
Figure 2-1
Location of River Management Units (RMU's)

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.

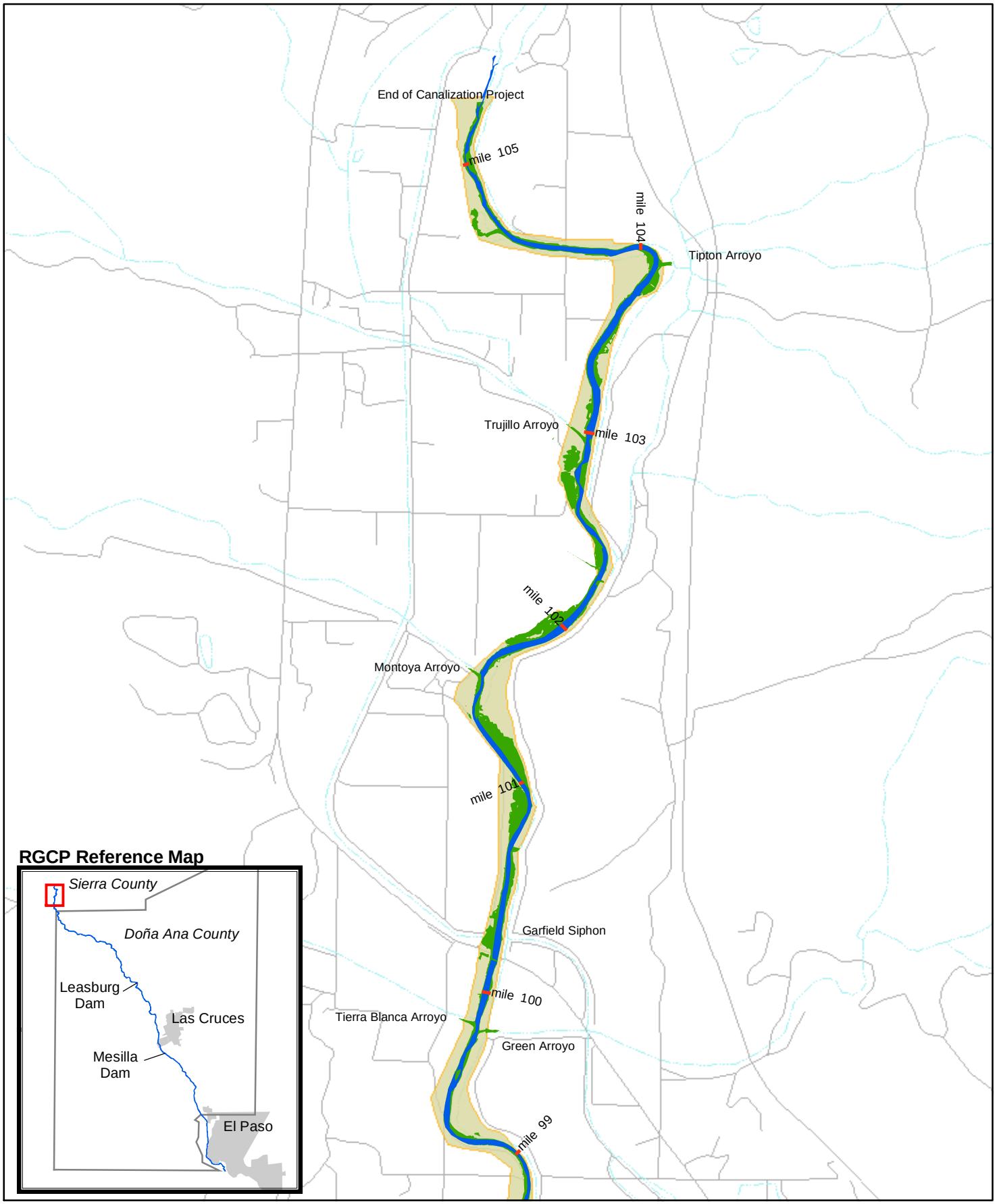


Figure 2-3
Overbank Flow in the Upper Rincon Valley by Controlled Releases from Caballo Dam

United States Section,
International Boundary Water Commission
December 2003

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

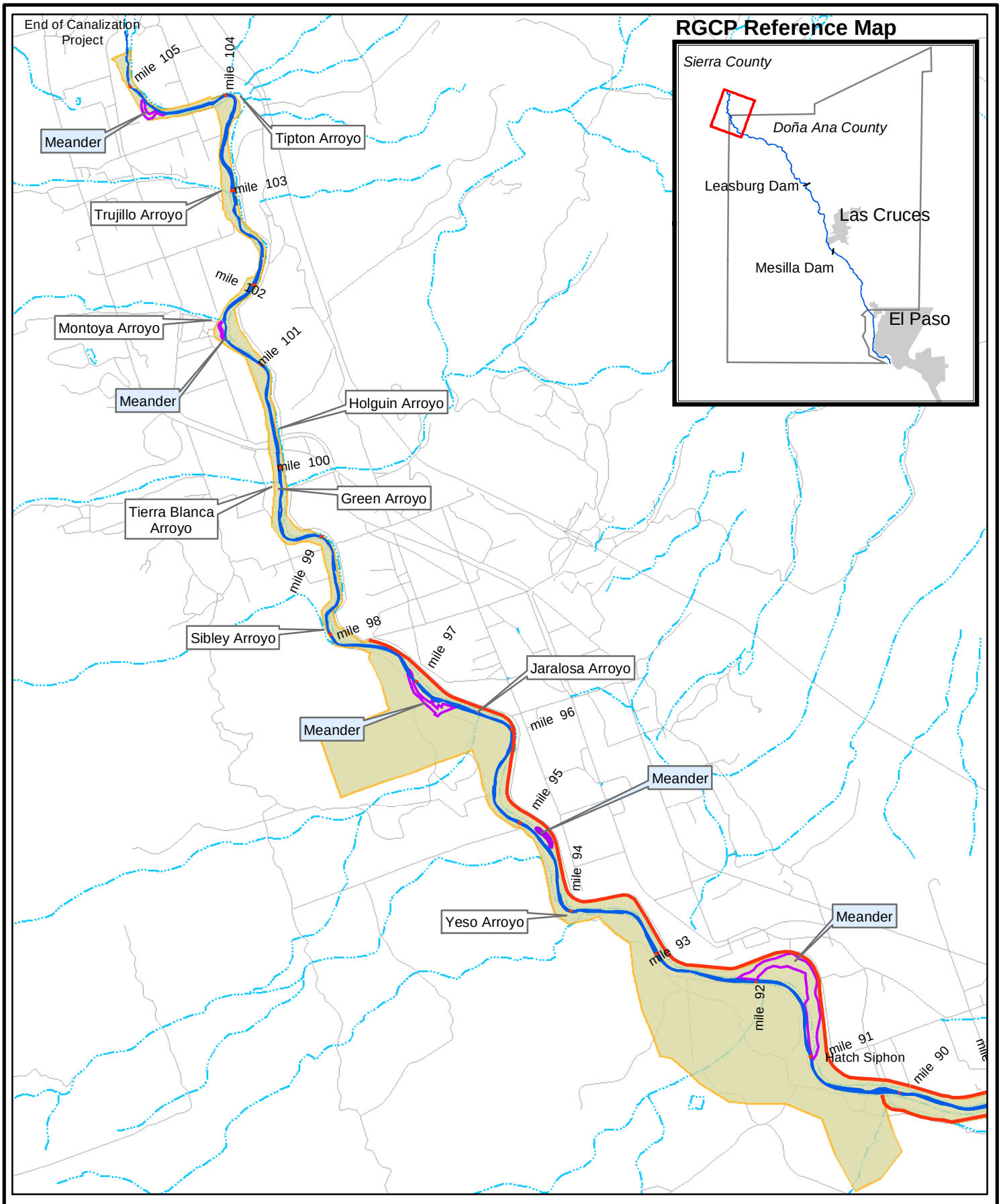


Figure 2-4
Aquatic Habitat Diversification of the Upper Rincon Valley

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.

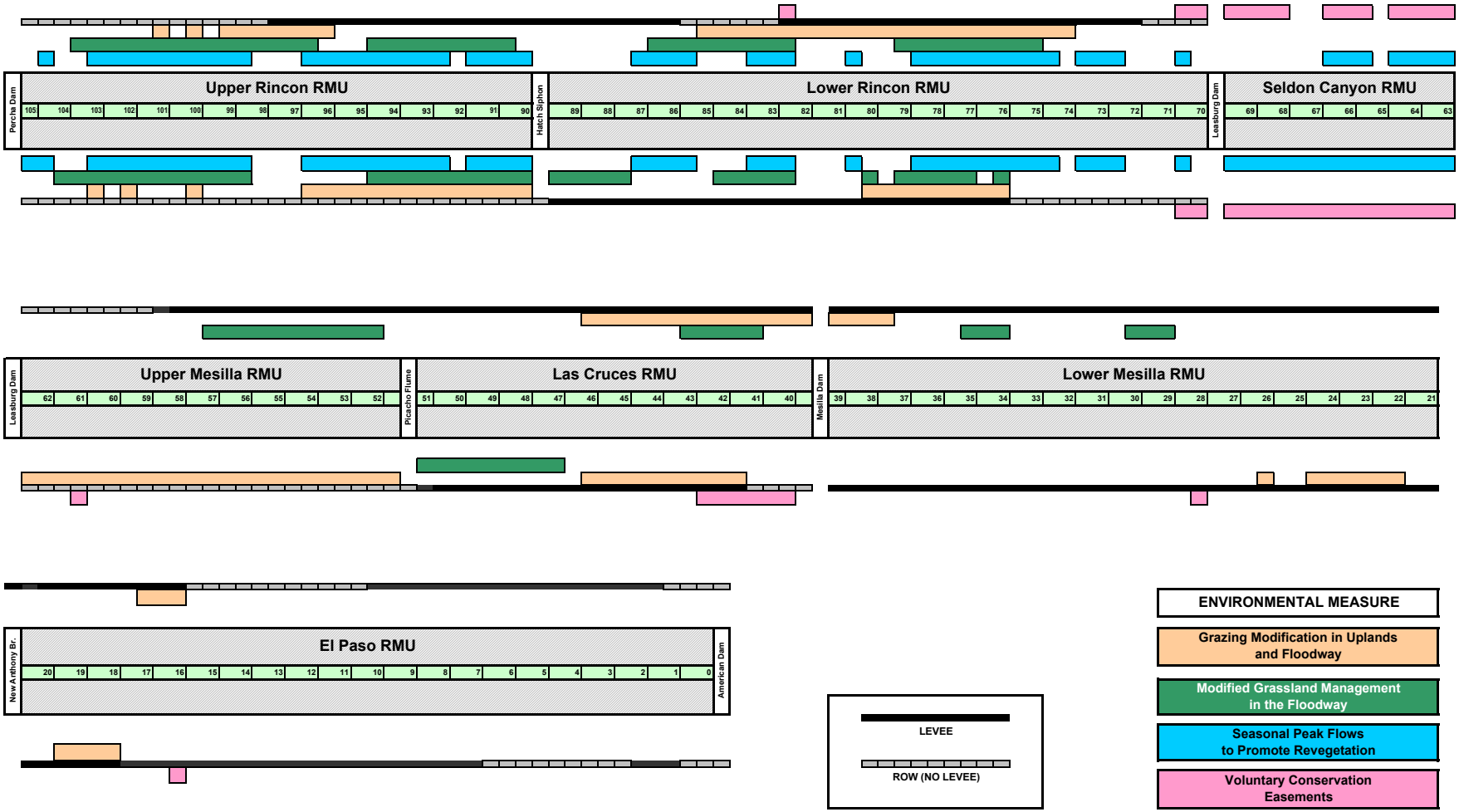
Figure 2-5 shows the geographical distribution of linear projects along the RGCP, and Figure 2-6 illustrates point project distribution along the Rincon and Mesilla Valleys. A graphical description of individual point projects is provided in Figure 2-7 through Figure 2-24. Each figure presents a summary 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

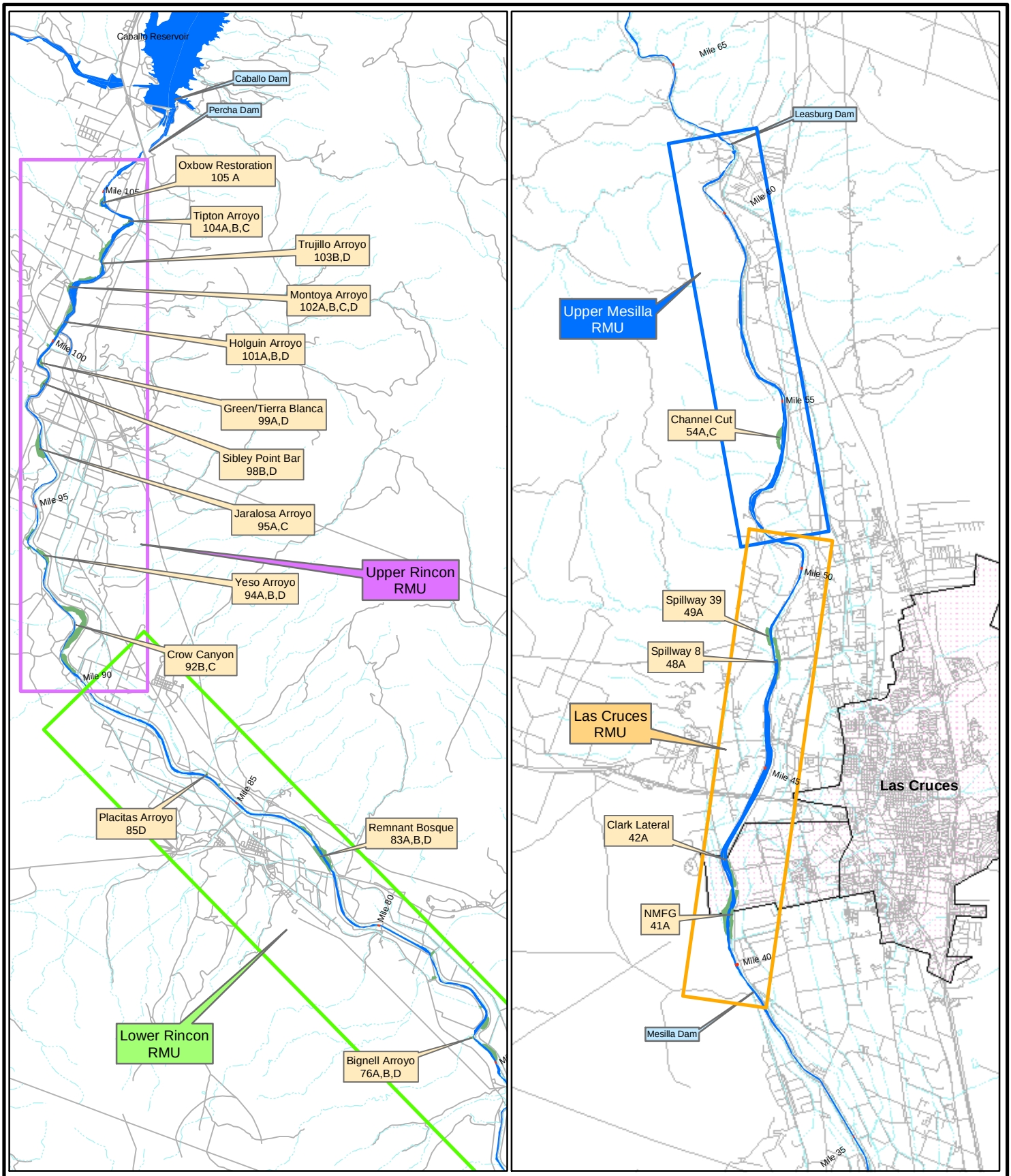
		Alternative*		
Environmental Measure	**Project List**	**FCI**	**IULM**	**TRR**
Floodway Management				
Modified grazing leases (erosion control)	UR-1, LR-1, UM-1, LC-1, LM-1, EP-1	X	X	X
Modified grassland management	UR-2, LR-2, UM-2, LC-2, LM-2		X	X
Vegetation planting and bosque enhancement	104A to 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



North 30

SCALE = 1 : 500,000 or 1 INCH = 41,667 FEET
UTM Zone 13 N / NAD 83

0 1.25 2.5 5 7.5 10 Kilometers

0 1.25 2.5 5 7.5 10 Miles

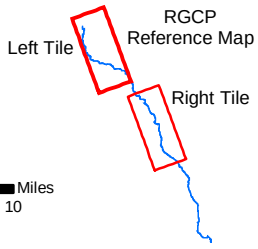


Figure 2-6
Distribution of Point Projects
in the Rincon and Mesilla Valleys

United States Section,
International Boundary Water Commission
December 2003

j:\736\736620\IBWC_drive\projects\point_projects_locations.mxd

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

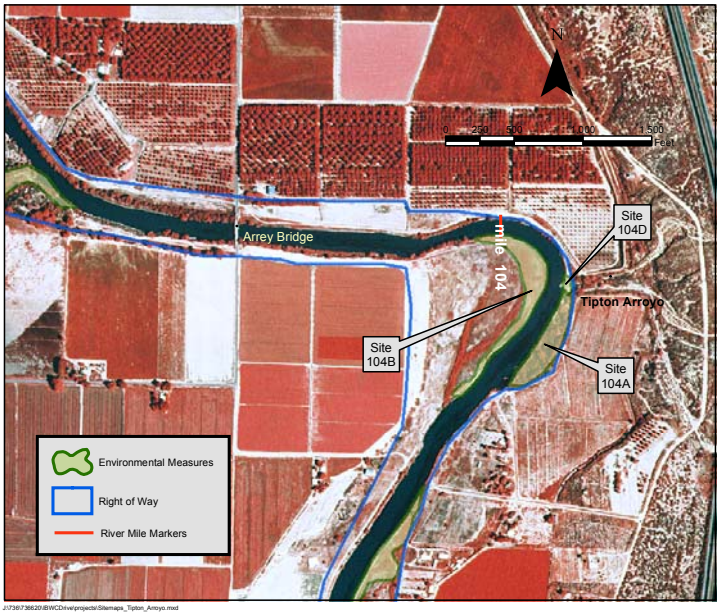


Figure 2-8: Mile 104 Tipton Arroyo

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".

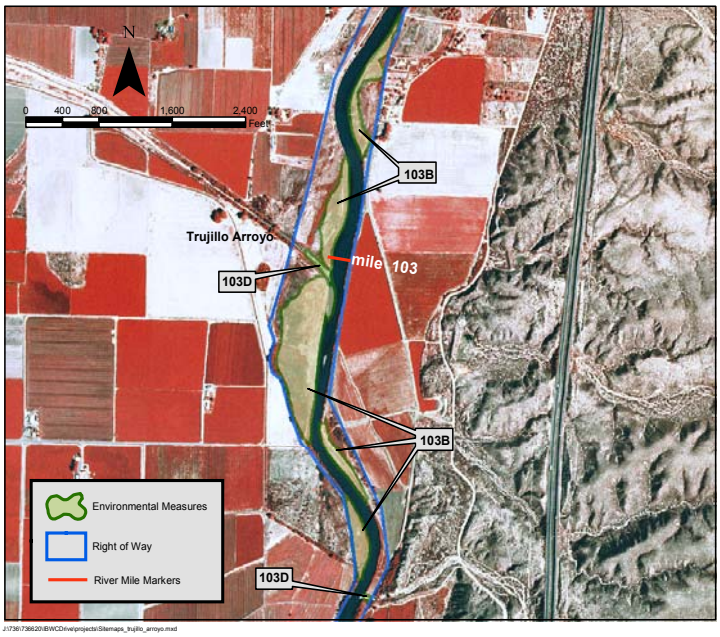


Figure 2-9: Mile 103 Trujillo Arroyo

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".

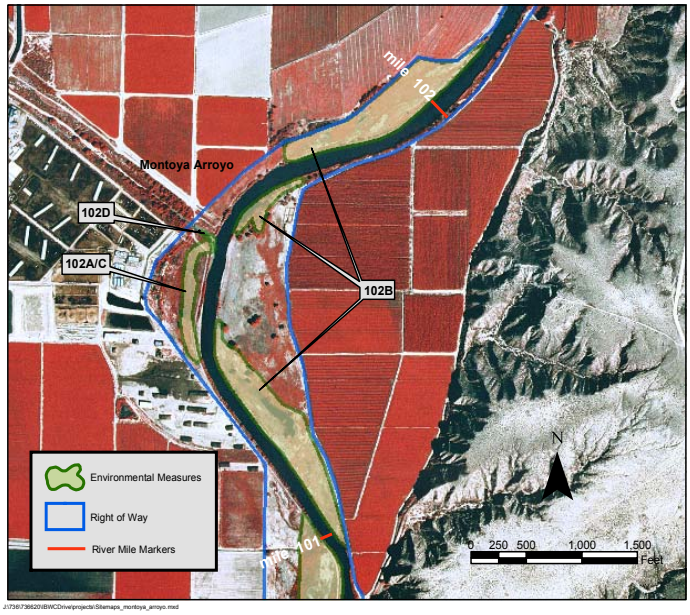


Figure 2-10: Mile 102 Montoya Arroyo

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".

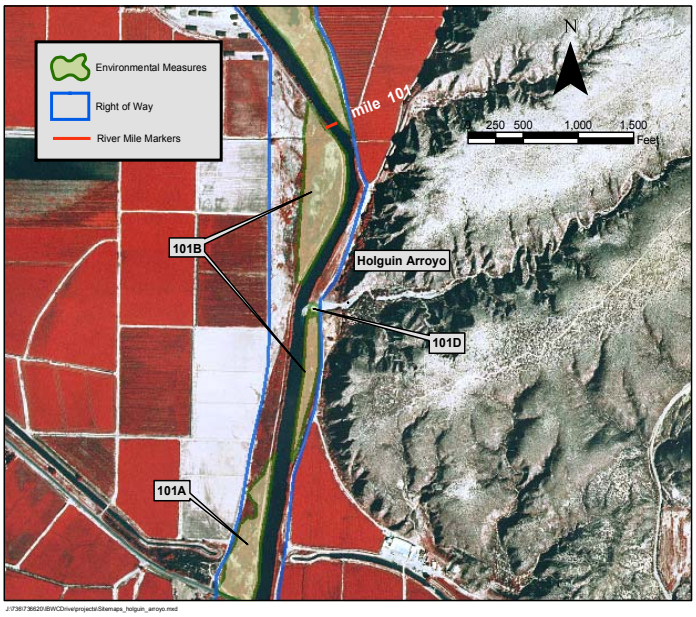


Figure 2-11: Mile 101 Holguin Arroyo

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".

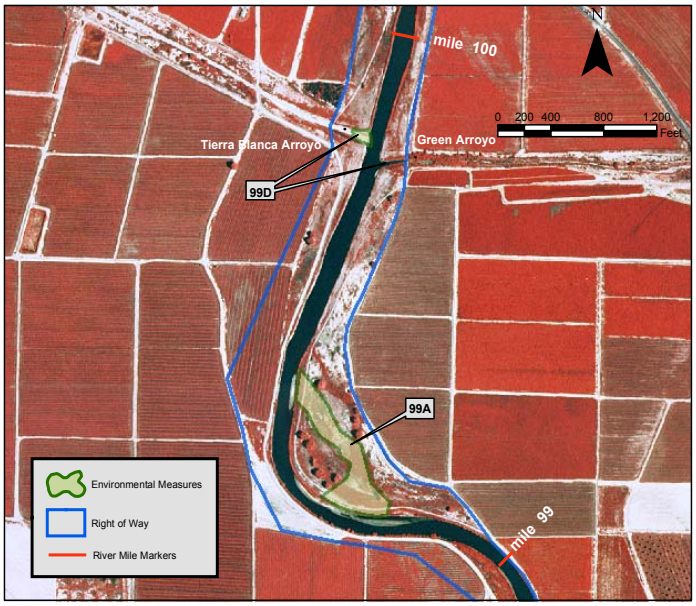


Figure 2-12: Mile 99 Green-Tierra Blanca

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".

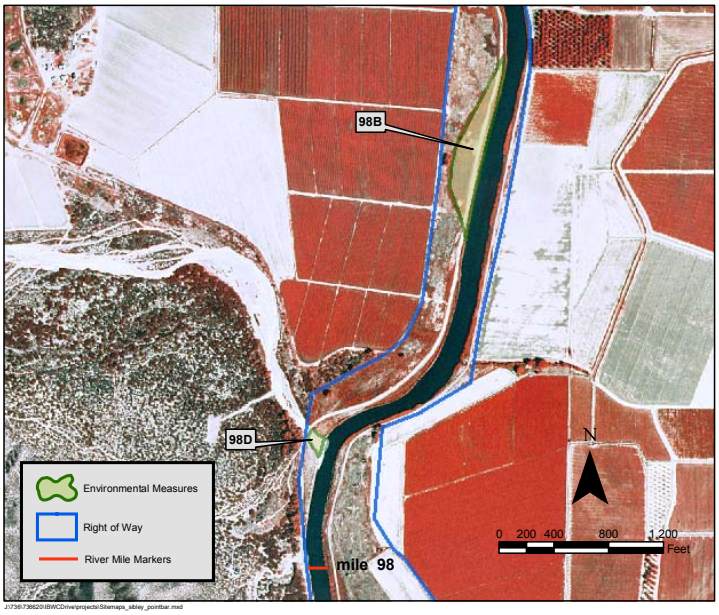


Figure 2-13: Mile 98 Sibley Point Bar

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".

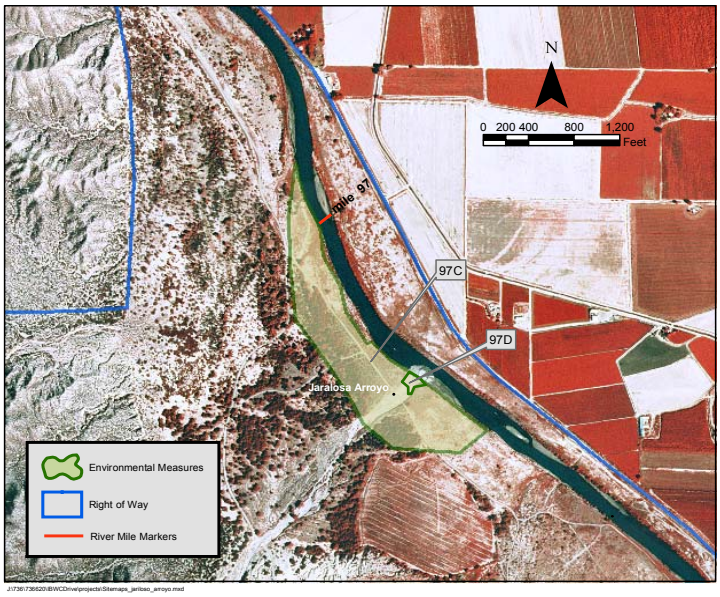


Figure 2-14: Mile 97 Jaralosa Arroyo

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

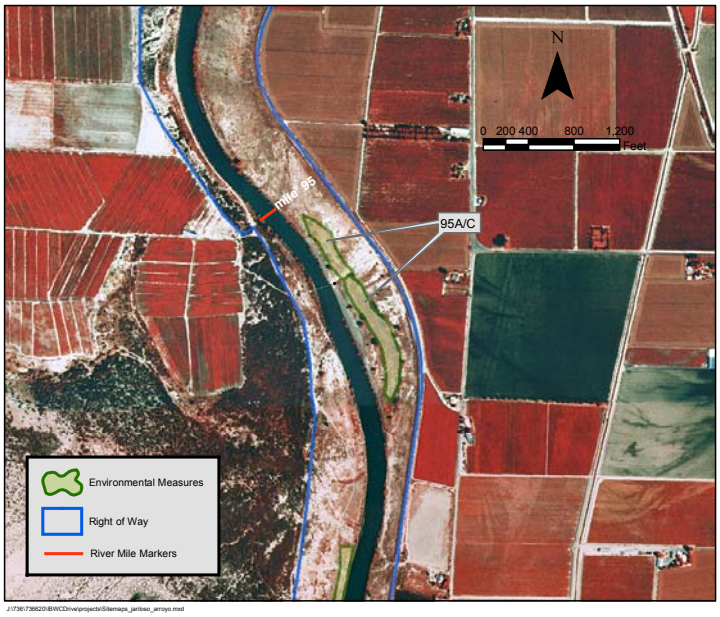


Figure 2-15: Mile 95 Jaralosa South

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

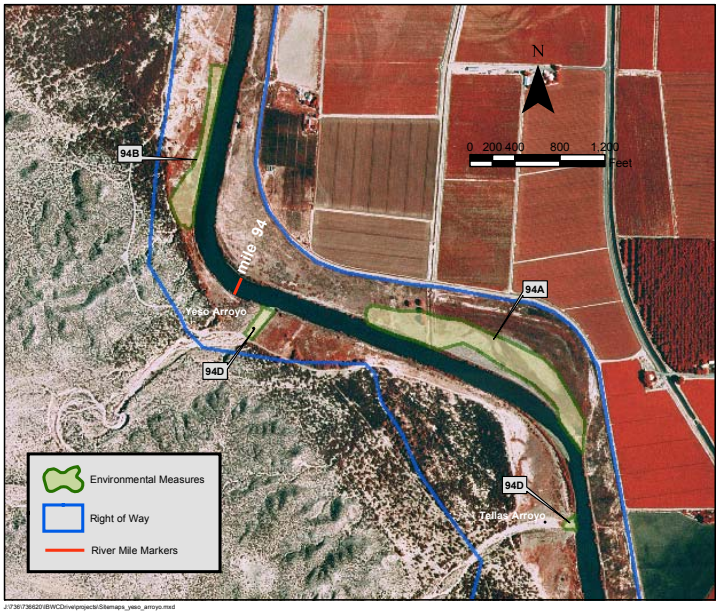


Figure 2-16: Mile 94 Yeso Arroyo

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".

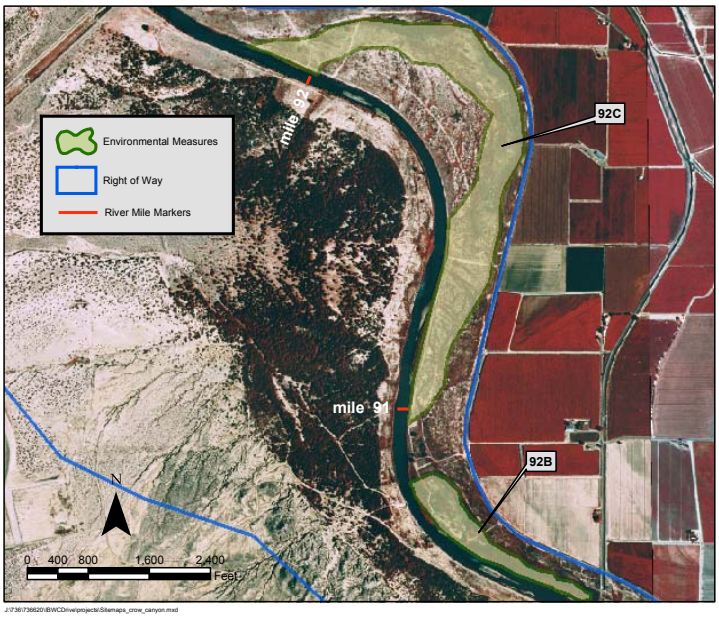


Figure 2-17: Mile 92 Crow Canyon

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)

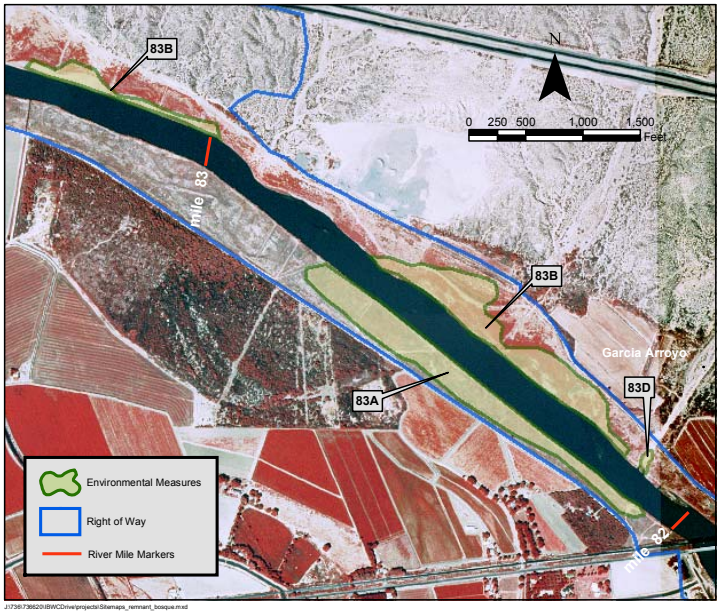


Figure 2-18: Mile 83 Remnant Bosque

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".

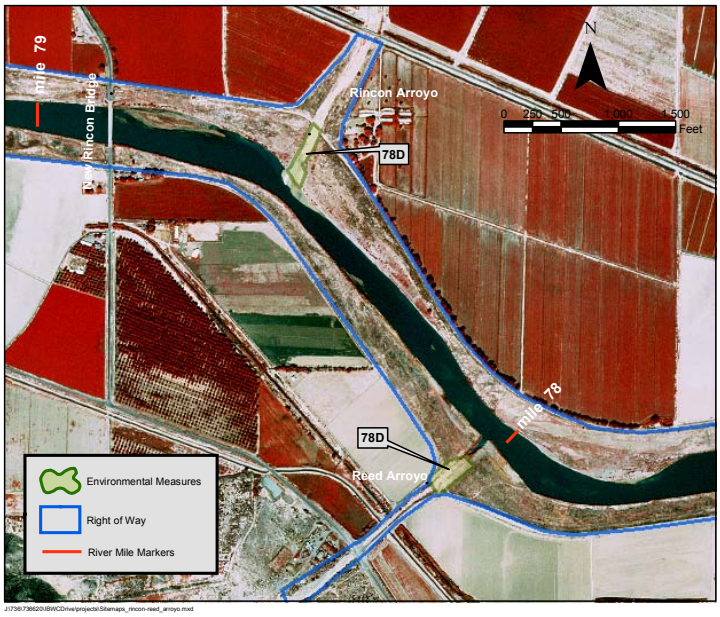


Figure 2-19: Mile 78 Rincon/Reed Arroyo

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

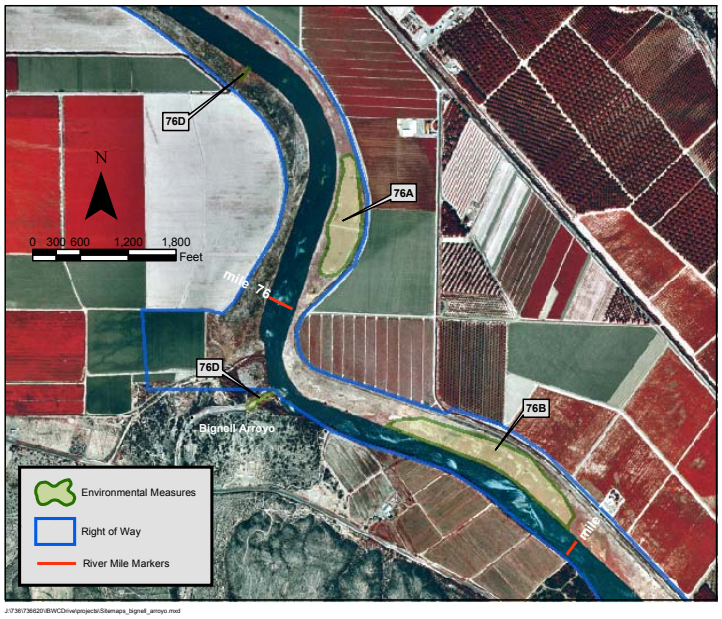


Figure 2-20: Mile 76 Bignell Arroyo

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".

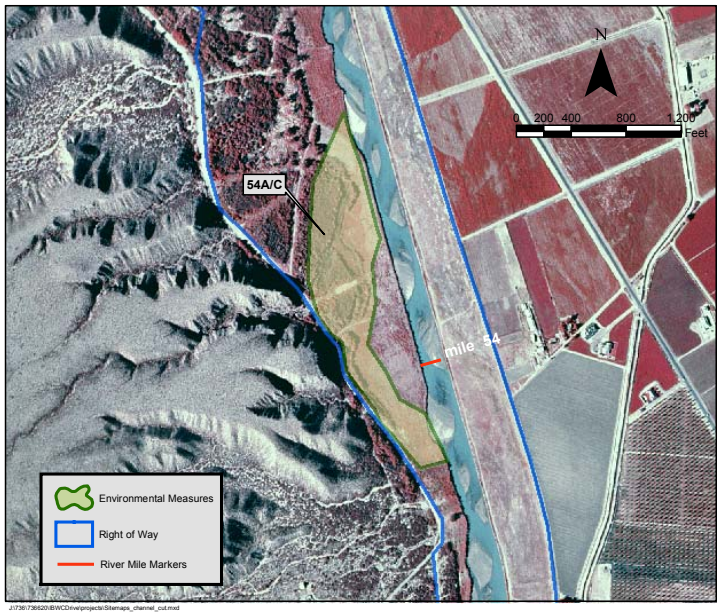


Figure 2-21: Mile 54 Channel Cut

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

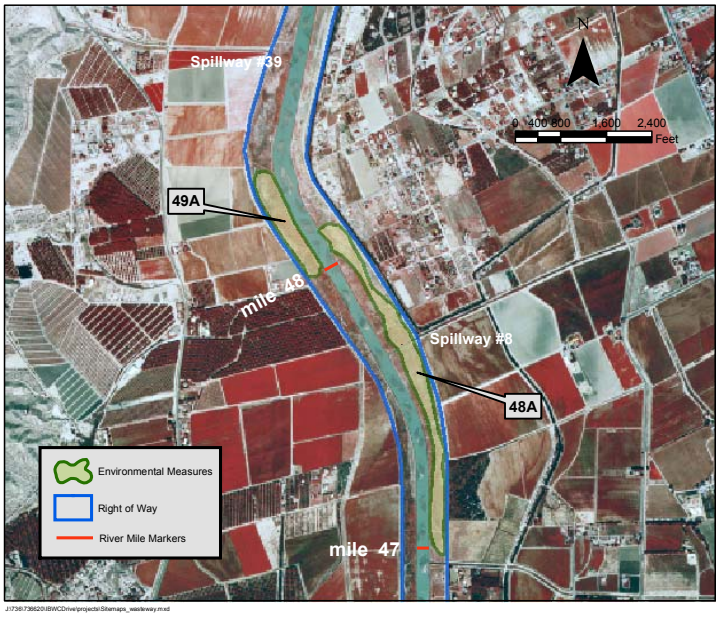


Figure 2-22: Miles 49 & 48 spillways

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

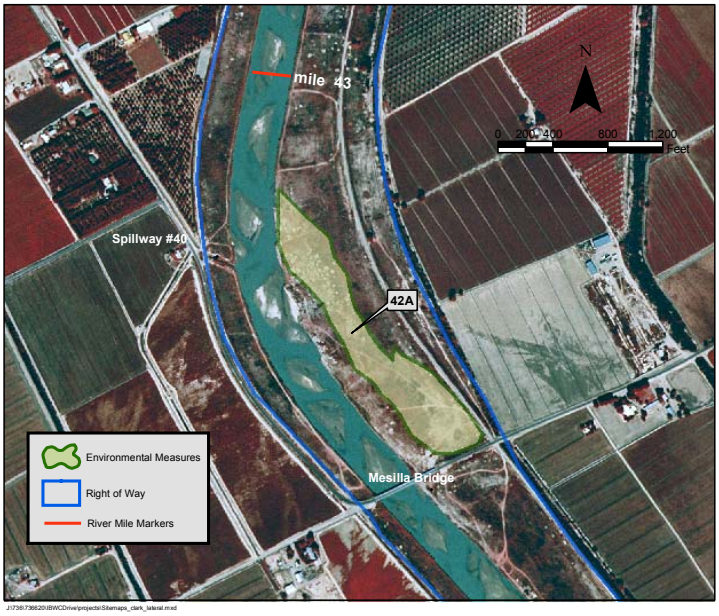


Figure 2-23: Mile 42 Clark Lateral

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

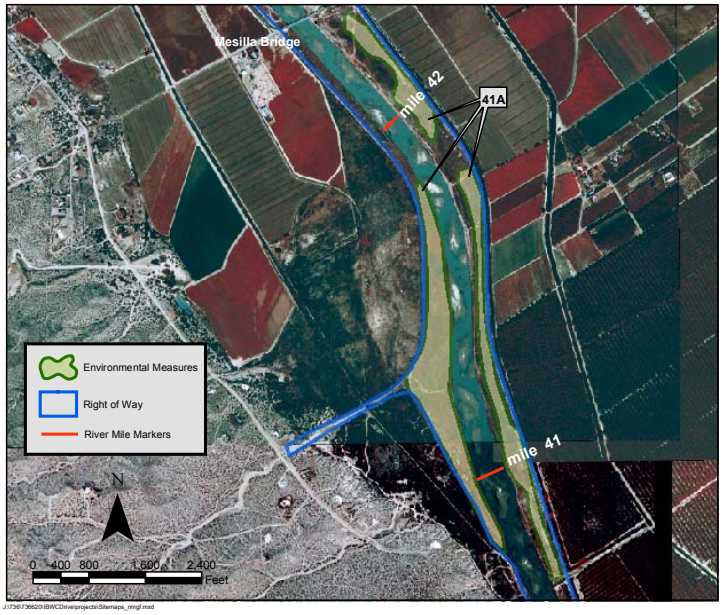


Figure 2-24: Mile 41 Picacho and NMGF

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). 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. No impacts on water delivery are anticipated for 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.	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). 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. 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. 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. 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. 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. 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. Mowing by USIBWC would be reduced by 1,983 acres. 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. Wetland areas would increase by 13 acres.	Effects of modified grazing leases and levee construction would be similar to the Flood Control Improvement Alternative. Mowing by USIBWC would be reduced by 2,434 acres. 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. Wetland areas would increase by 96 acres. 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. Construction associated with levee rehabilitation would be a short minor effect. 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. Construction associated with levee rehabilitation and environmental measures would be a short minor effect. 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. Construction associated with levee rehabilitation and environmental measures would be a short minor effect 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 . 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. 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. Development of native bosque along meanders could potentially create suitable southwestern willow flycatcher habitat and benefit some SOCs. 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. 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. 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. Beneficial effects are expected from ongoing recreational initiatives. 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. 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. 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). 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. Without a water conservation program, environmental measure implementation could result in 3,154 acres of cropland retirement (16.6 percent of farmland in the area of influence). 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. 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. 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.