RIPARIAN HABITAT RESTORATION AT FOUR SITES IN DOÑA ANA COUNTY, NEW MEXICO: JARALOSA, YESO EAST, YESO WEST, AND CROW CANYON C

FINAL MONITORING REPORT

CONTRACT # IBM15D0005/TASK ORDER # IBM16T0019

JULY 2018

PREPARED FOR

U.S. International Boundary and Water Commission

PREPARED BY

Gulf South Research Corporation

and

SWCA Environmental Consultants

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ABSTRACT/EXECUTIVE SUMMARY

The U.S. International Boundary Water Commission (USIBWC) committed to restoring riparian habitat and implementing invasive species management within the Rio Grande Canalization Project. Gulf South Research Corporation (GSRC) and SWCA Environmental Consultants (SWCA) were contracted to implement restoration activities at four sites (Jaralosa, Yeso East, Yeso West, and Crow Canyon C) totaling 19.2 acres located north of Hatch, in Doña Ana County, New Mexico.

The target habitats for the selected sites include open riparian woodland and dense riparian shrub. The purpose of the restoration project is to improve the riparian zone through increasing suitable feeding, breeding, and sheltering habitat for the southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) and the yellow-billed cuckoo (*Coccyzus americanus*). To increase habitat for these key species, plans call for removing non-native vegetation and planting native trees and shrubs. Habitat restoration consists of creating willow (*Salix sp*.)–dominated stands, Rio Grande cottonwood (*Populus deltoids* spp. *wislizeni*) gallery forests, and buffer areas planted with native riparian shrubs and native herbaceous vegetation typical of the surrounding floodplain.

Restoration activities implemented for this project include invasive species management, floodplain and swale excavation, and planting coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and cottonwood poles and native shrubs at each site. GSRC was the prime contractor and as such was responsible for program management and ensuring that contract requirements were fulfilled. SWCA oversaw the implementation of restoration activities, monitoring, and reporting. Under subcontract to SWCA, Restoration Solutions and High Desert Native Plants (HDNP) assisted with project execution. Restoration Solutions provided site preparation, invasive species control, and planting assistance. HDNP provided and installed all plant material and performed follow-up watering and maintenance activities.

Saltcedar (*Tamarix spp*.) was the dominant non-native woody species present on the four sites. The entire tree/shrub was extracted along with its root crown and masticated at designated areas. Follow-up resprout control consisted of a low-volume basal bark application of Garlon 4. Shallow swales were excavated at Jaralosa and Yeso East in abandoned meander channels to reduce the depth to groundwater and create more favorable planting conditions. An experimental inset floodplain was excavated at Yeso West to create inundated conditions to create wetlands and improve habitat for the flycatcher.

Across all sites, 5,010 coyote willow poles, 634 Goodding's willow poles, 689 cottonwood poles, and 623 tall pot shrubs were planted. A native grass/forb seed mix was seeded in disturbance areas. Final survival rates across all sites, accounting for replacement plantings were 76.5% for coyote willow, 83.4% for Goodding's willow, 79% for cottonwood, and 96.5% for native shrubs.

Challenges included disturbances that affect planting survival, including off-road vehicle disturbance, livestock damage, invertebrate herbivory, beaver herbivory, herbicide drift from nearby agricultural operations, and heat stress. Variable depths to groundwater, sometimes exceeding 10 feet, at the time of planting also created challenges in finding suitable planting conditions. Rapid groundwater drawdown following the end of the irrigation season in fall 2017 further stressed planted poles. The Yeso West site was inundated throughout the irrigation season and was subject to scour during a monsoonal rain event.

Despite the challenges, the plantings showed resiliency and rebounded in spring 2018. Many of the pole plantings exhibited top-growth dieback with resprouting at the base. This condition was especially prevalent with both willow species, but was also documented for cottonwood. Resprouting occurred throughout the first-year growing season, but was most evident in the spring 2018 monitoring sessions. At the Yeso West site native wetland vegetation and willow resprouting was evident during the spring 2018 monitoring sessions.

Management recommendations include 1) installing nested piezometers to supplement existing groundwater data and document groundwater flow; 2) creating swales to reduce depth to groundwater; 3) continue to acquire water rights to provide supplemental water in strategic locations; 4) improving signage and outreach to neighbors, and 5) conducting additional hydraulic modeling using updated surveys to establish cut elevations and identify target inundation discharge prior to initiating inset floodplain features.

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1 INTRODUCTION

The U.S. International Boundary Water Commission's (USIBWC's) 2009 *Record of Decision for River Management Alternatives for the Rio Grande Canalization Project* commits the agency to implement invasive species management and riparian habitat restoration within the Rio Grande Canalization Project. Gulf South Research Corporation (GSRC) and SWCA Environmental Consultants (SWCA) were under contract to implement restoration activities at four sites (Jaralosa, Yeso East, Yeso West, and Crow Canyon C) totaling 19.2 acres located north of Hatch, in Doña Ana County, New Mexico (Figure 1).

The target habitats identified in the Conceptual Restoration Plan (U.S. Army Corps of Engineers [USACE] 2009) and the Site Implementation Plan (TRC Environmental Corporation [TRC] 2011) for the selected sites are open riparian woodland and dense riparian shrub (Table 1). The restoration activities outlined and implemented will help improve the riparian zone, increasing suitable feeding, breeding, and sheltering habitat for the southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) and the yellow-billed cuckoo (*Coccyzus americanus*). To increase habitat for these key species, plans call for removing non-native vegetation and planting native trees and shrubs. Habitat restoration consists of creating willow (*Salix sp*.)–dominated stands, cottonwood (*Populus deltoids* spp. *wislizeni*) gallery forests, and buffer areas planted with native riparian shrubs typical of the surrounding floodplain.

Table 1. Summary of Restoration Sites

Site	Acres	Target Habitat	Restoration Work Type
Jaralosa	4.5	Open riparian woodland	Old river meander
Yeso East	9.7	Open riparian woodland	Old river meander
Yeso West	1.6	Dense riparian shrub (flycatcher)	Creation of inset floodplain
Crow Canyon C	3.4	Dense riparian shrub (flycatcher)	Existing inset floodplain in need of enhancement

Restoration activities implemented for this project include invasive species management, floodplain and swale excavation, and planting coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and Rio Grande cottonwood poles and native shrubs at each site. Restoration techniques are described in the Restoration Plan (SWCA 2017).

This report describes monitoring activities at four riparian habitat restoration sites. SWCA/GSRC biologists completed six post restoration monitoring sessions, four sessions in 2017 (March, June, September, and November) and two sessions in 2018 (April and May). Monitoring of the Yeso West site was limited to surveillance from the east bank of the river during the June and September monitoring sessions due to high river depth and deeply washed-out access roads. The biologists were again able to access Yeso West and conducted monitoring in November 2017 and the two monitoring sessions in spring 2018.

The monitoring of restoration success consisted of completing qualitative field assessments to document the general health and viability of native plantings and the existence of both native and non-native species within the project area. The biologists also measured depth to groundwater at the seven USIBWC monitoring wells in order to document any trends or fluctuations in depth-to-groundwater conditions experienced by the new plantings at the sites.

The field data sheets are presented in Appendix A. Photographs were recorded at permanent photo points established by SWCA in order to provide a chronological display of site conditions and restoration success (Appendix B).

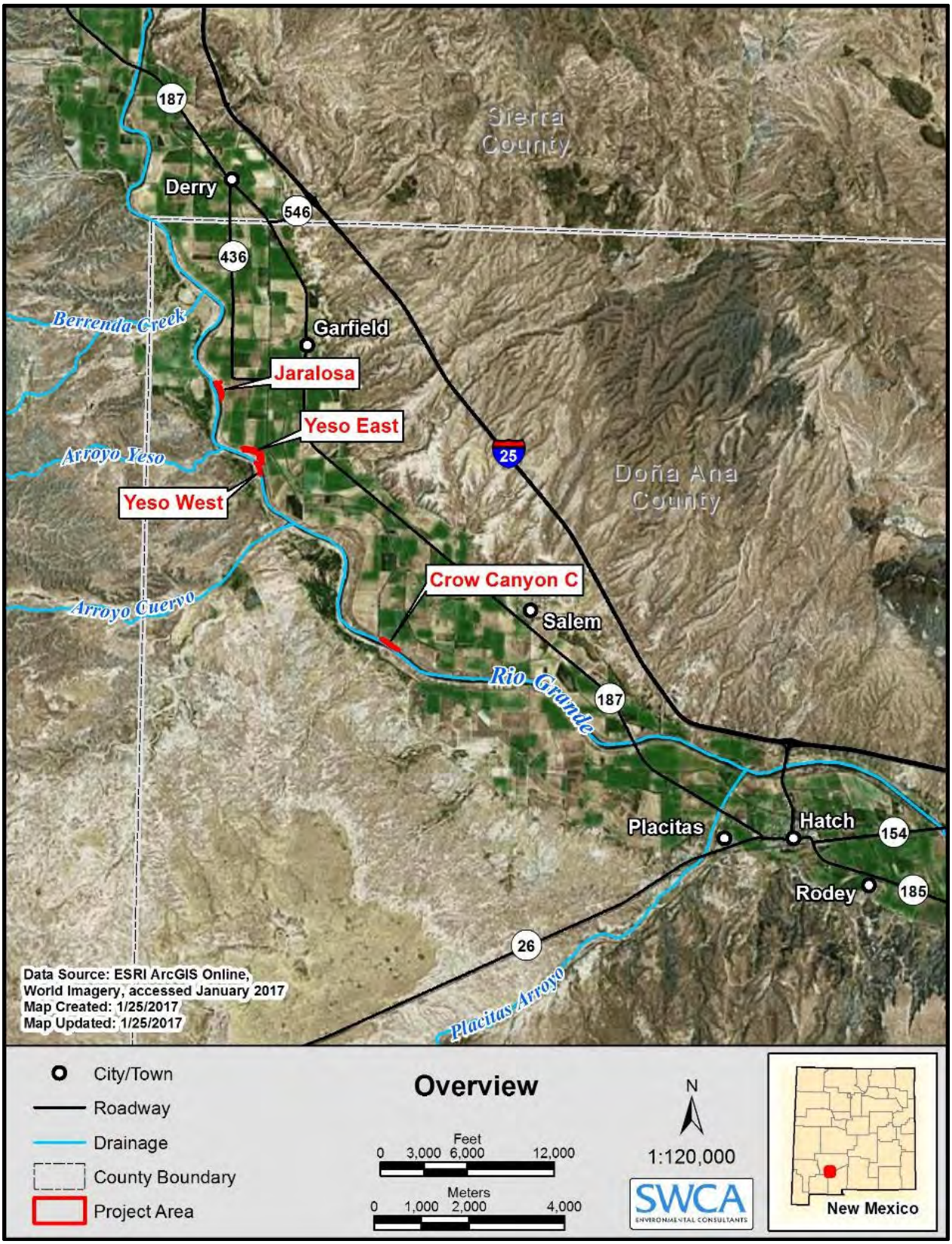

Figure 1. Overview of the four restoration sites.

2 RESTORATION ACTIVITIES

2.1 Site Preparation

Site preparation included non-native plant removal and excavating swales and creating an inset floodplain. Subcontractor to SWCA, Restoration Solutions completed all site preparation activities from late February through mid-March 2017.

2.1.1 Non-Native Plant Removal

Saltcedar (*Tamarix spp*.) was the dominant non-native woody species present on the four sites. An excavator fitted with a clasping thumb attachment removed the entire shrub/tree along with its root crown and placed the extracted biomass in windrows where it was masticated on-site (Figure 2).

Figure 2. Saltcedar extraction (left) and chipped masticated material (right).

Follow-up herbicide treatments of saltcedar resprouts were completed on April 18, 2018, using a low-volume basal bark application of Garlon 4.

2.1.2 Excavation

At the Jaralosa and Yeso East sites, SWCA's subcontractor excavated 1 to 2 feet of soil to create swales (Figure 3) in abandoned meanders (Appendix C, Figures C-1 and C-2). The purpose of the swale excavation was to decrease the depth to groundwater and increase the area suitable for planting native vegetation. Cottonwood and Goodding's willow plantings were concentrated in these areas.

Figure 3. Swale excavation at Jaralosa, near well JARMW-1; view facing south.

An experimental inset floodplain was created at the Yeso West site (Figure 4). The floodplain was excavated to an elevation that was just above the ordinary high-water mark (OHWM). Bankline vegetation was left intact to provide bank stabilization. An inlet and outlet channels were excavated above the OHWM to connect the excavated inset floodplain. The purpose of this experimental technique was to create riparian willow habitat that contained moist soil conditions during the flycatcher breeding season.

Figure 4. Yeso West inset floodplain; view facing west from across the river.

No excavation occurred at the Crow Canyon C site.

2.2 Native Plantings

Initial planting of cut poles was conducted between March 14 and 30, 2017, by SWCA, GSRC, and subcontractors to SWCA: High Desert Native Plants (HDNP) and Restoration Solutions. To plant cottonwood and Goodding's willow poles, an auger mounted on the excavator bucket was used to auger holes to moist soil indicating the depth of groundwater (Figure 5). Coyote willow poles were planted

either using the auger method or trenching (Figure 6). The goal for either method was to locate moist soil conditions, indicative of the groundwater level. Due to variability in depth to groundwater, it was often necessary to drill several holes to find suitable soil conditions.

Figure 5. Goodding's willow pole planting using auger mounted to an excavator.

Figure 6. Coyote willow planted in a trench excavated to moist soil conditions indicating the depth to groundwater.

HDNP grew out Goodding's willow and cottonwood poles in their facilities near El Paso, Texas. All poles are of local genotypes. Due to warm conditions in January and February 2017, HDNP stored poles in a refrigerated trailer covered with moist mulch (Figure 7). Field crews harvested coyote willow poles on-site and stored in the trailer. Prior to planting, field crew took the poles out of storage and soaked them in a water tank.

Figure 7. Poles stored in a refrigerated trailer.

2.2.1 Planting Summary

The planting activity generally followed the planting plan presented in the Restoration Plan (SWCA 2017), which is provided in, Appendix D. The project team proposed and implemented changes from the specifications listed in the Statement of Work (SOW). The USIBWC approved the following project changes:

- Changes in the number of specified poles at a given site. The project team requested transferring a number of Goodding's willow and coyote willow poles from the Crow Canyon C site to the Yeso West and Yeso East sites. The project team requested the changes in an effort to plant poles in suitable locations based on depth to groundwater at the time of planting and existing soil conditions.
- Change in native shrub planting schedule and shrub size. Based on the recommendations from HDNP, the project team requested a change in schedule for planting the long-stem shrubs to fall. The requested change allowed HDNP to grow out shrubs in a tall pot form, which would result in a greater root mass. Fall planting was also believed to be a more suitable time to plant the shrubs.
- Over planting. The project team planted additional poles at each site to compensate for potential mortalities.

Table 2 summarizes planting quantities of coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*) poles at each of the sites, including replanted quantities. Please see Appendix C for planting area maps.

Table 2. Planting Quantities at Each Restoration Site

Site	Coyote Willow Poles		Goodding's Willow Poles		Cottonwood Poles		Long-Stem Riparian Shrubs	
	SOW Specification	Actual Planted	SOW Specification	Actual Planted	SOW Specification	Actual Planted	SOW Specification	Actual Planted
Jaralosa	1,000*	1,260	100	110	60	72	50	60
Yeso East	800	820	50	59	485	490	485	518
Yeso West	1,000	1,790	50	50	20	20	0†	0
Crow Canyon C	2,100	1,140	400	415	100	107	35	45
Total	**4,900**	**5,010**	**600**	**634**	**665**	**689**	**570**	**623**

* Coyote willow planting at Jaralosa approved by USIBWC.

† The approved planting plan specified that there would be no long-stem riparian shrubs planted at the Yeso West site.

2.2.1.1 JARALOSA

The project team completed planting at Jaralosa on March 22, 24, and 28, 2017 (see Figure C-1). In total, 1,260 coyote willows were planted along the bank line, filling in gaps exposed by saltcedar (*Tamarix* sp.) removal and where native vegetation was absent. The excavated swale was planted with 110 Goodding's willow poles and 72 cottonwood poles. Planting was conducted with a 5-foot by 6-inch auger with a 5-foot extension and a 10-foot by 4-inch continuous flight auger.

2.2.1.2 YESO EAST

Planting at Yeso East was conducted between March 17 and March 23, 2017 (see Figure C-2). In total, 820 coyote willow poles were planted along the bank line. The upland swale was planted with 490 cottonwood and 59 Goodding's willow poles. Seeding and long-stem shrubs were planted in the fall in September 2017 when conditions were more favorable. Planting was conducted with a 5-foot by 6-inch auger with a 5-foot extension and a 10-foot by 4-inch continuous flight auger.

2.2.1.3 YESO WEST

Planting at Yeso West was conducted between March 15 and 29, 2017 (see Figure C-2). In total, 1,790 coyote willow poles were planted along the bank and within the excavated area. In addition to the coyote willows, 59 Goodding's willow and 20 cottonwood poles were planted within the excavated area. Planting was conducted with a 5-foot by 6-inch auger with a 5-foot extension.

2.2.1.4 CROW CANYON C

Crow Canyon C was planted between the dates of March 14 and 29, 2017 (see Figure C-3). In total, 1,140 coyote willow poles were planted along the bank and upland intermixed with 415 Goodding's willow and 107 cottonwood poles. Planting was conducted with a 5-foot by 6-inch auger with a 5-foot extension and a 10-foot by 4-inch continuous flight auger.

2.2.1.5 REPLANTING

The GSRC/SWCA team was required to replant cottonwood and Goodding's willow poles to replace mortality. The USIBWC established a 15% mortality (85% survival) threshold for acceptable survival of planted poles and shrubs. The November 2017 monitoring session provided the baseline for the number of replacement plants. Due to conditions beyond the project team's control at Yeso West, the USIBWC approved eliminating replacement coyote willow plantings at Yeso West. GSRC/SWCA agreed to replant 173 Goodding's willow and 184 cottonwood poles across all sites, allowing the contractor flexibility to determine the most appropriate sites/locations to replant. GSRC/SWCA elected to plant all Goodding's willow and cottonwood poles at Jaralosa, Yeso East, and Crow Canyon C. We did not replant any Goodding's willow and cottonwood poles at Yeso West. In November 2017, the survival rate at all sites, excluding Yeso West, exceeded 98% (3,835 survived out 3900 specified in the SOW). Therefore, we were not required to replace coyote willow poles. HDNP completed replanting on March 16, 2018. Table 3 summarizes the quantities of each species replanted by site.

Table 3. Replanting Summary

Species	Site	Jaralosa	Yeso East	Yeso West	Crow Canyon C	Total	Notes
Coyote Willow Poles	**Revised SOW**	1,260	800	1,700	1,140	**4,900**	
	# Survived (Revised SOW)	1,100	788	847	1,100	**3,835**	
	% Mortality	**12.7%**	**1.5%**	**50.2%**	**3.5%**	**21.7%**	
	Total Replanted	**0**	**0**	**0**	**0**	**0**	
Goodding's Willow Poles	**SOW**	100	50	50	400	**600**	
	# Survived (Revised SOW)	69	14	4	340	**427**	
	% Mortality	**31.0%**	**72.0%**	**92.0%**	**15.0%**	**28.8%**	
	Total Replanted	**54**	**59**	**0**	**60**	**173**	46 dead poles at Yeso West, 50% planted at Jaralosa, 50% planted at Yeso East
Cottonwood Poles	**SOW**	60	485	20	100	**665**	
	# Survived (Revised SOW)	40	370	2	69	**481**	
	% Mortality	**33.3%**	**23.7%**	**90.0%**	**31.0%**	**27.7%**	
	Total Replanted	**38**	**115**	**0**	**31**	**184**	18 dead poles at Yeso West, all planted at Jaralosa
Native Shrubs	**SOW**	50	485	0	35	**570**	
	# Survived (Revised SOW)	60	518	0	45	**623**	
	% Mortality	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**	
	Total Replanted	0	0	0	0	**0**	
Total Native Planting	**SOW**	1,470	1,820	1,770	1,675	**6,735**	
	# Survived (Revised SOW)	1,269	1,690	853	1,554	**5,366**	
	% Mortality	**13.7%**	**7.1%**	**51.8%**	**7.2%**	**20.3%**	
	Total Replanted	**92**	**174**	**0**	**91**	**357**	

2.2.2 Native Shrub Plantings

HDNP completed planting native shrubs in late September and early October 2017 using the tall pot planting method (Figure 8 through Figure 10). Four species were planted: baccharis willow (*Baccharis salicina*), fourwing saltbush (*Atriplex canescens*), skunkbush sumac (*Rhus trilobata*), and desert willow (*Chilopsis linearis*). Table 2 provides the total number of shrubs planted at each site.

Figure 8. Tall pot shrubs.

Figure 9. Tall pot shrub showing root mass.

Figure 10. A newly planted baccharis willow shrub.

2.2.3 Native Grass and Forb Seeding

Seeding of native grasses and forbs was completed in September 2017 following a period of monsoonal rain events that created moist soil conditions. Table 4 identifies the species and quantities planted. Planting areas are indicated in the Planting Area Maps found in Appendix C. Seeding was completed using an imprinter. The imprinter (Figure 11) is a drop seeder with a large, wedged roller drum that deposits seed in patterned depressions, or dimples created in the soil surface. The dimples create microhabitat conditions where moisture, organic matter, and wind-blown silt and clay are collected and conserved, aiding in seed germination. Soil imprinting is a technique developed for revegetating barren, arid soils (Permaculture Research Institute 2018)

Table 4. Seed Mix Specifications

Common Name	Scientific Name	Area (acres)	Total Seed (PLS)*	Total PLS/ acre
Desert marigold	*Baileya multiradiata*	15	4	0.27
Common sunflower	*Helianthus annuus*	15	15	1.00
Woolly paperflower	*Psilostrophe tagetina*	15	8	0.53
Redwhisker clammyweed	*Polanisia dodecandra*	15	8	0.53
Wooly prairie clover	*Dalea lanata*	15	8	0.53
Penstemon	*Penstemon* sp.	15	8	0.53
Indian ricegrass	*Achnatherum hymenoides*	15	30	2.00
Saltgrass	*Distichlis spicata*	15	15	1.00
Scratchgrass	*Muhlenbergia asperifolia*	15	3	0.20
Tobosagrass	*Pleuraphis mutica*	15	8	0.53
Alkali sacaton	*Sporobolus airoides*	15	15	1.00
Salt bush	*Atriplex canescens*	15	8	0.53

Common Name	Scientific Name	Area (acres)	Total Seed (PLS)*	Total PLS/ acre
Sand dropseed	*Sporobolous cryptandrus*	15	15	1.00
TOTAL pls			**145**	**9.67**

*PLS – Pure Live Seed, in pounds

Figure 11. Seed imprinter, high desert native plants.

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3 RESULTS

3.1 General Site Conditions

Native shrubs and grasses generally dominate vegetation regrowth in the project area. Honey mesquite *Prosopis glandulosa*) is a dominant species at Jaralosa with an estimated cover of 50%. It is found less commonly at the Yeso East and Crow Canyon C sites and is absent from the Yeso West site. Arrowweed (*Pluchea sericea*) is common at the Yeso East and Crow Canyon C sites, with an estimated cover of 40% and 45%, respectively. At Yeso West, there was a significant recruitment of willow baccharis (*Baccharis salicina*) and several wetland species such as narrowleaf cattail (*Typha latifolia*), Baltic rush (*Juncus balticus*), and hardstem bulrush (*Schoenoplectus acutus*).

The most common non-native species documented within the project area were saltcedar (*Tamarix chinensis*), Bermudagrass (*Cynodon dactylon*), and Russian thistle (*Salsola tragus*) (see field data sheets in Appendix A). These species were particularly prevalent in the recently disturbed areas of the sites. Table 5 provides a summary of the dominant species observed. We used the May 2018 data for the cover estimates.

Table 5. Dominant Vegetation Observed at the Four Restoration Sites, May 2018

Common Name	Scientific Name	Site Estimated Cover (%))			
		Jaralosa	Yeso East	Yeso West	Crow Canyon C
Native Species					
Honey mesquite	*Prosopis glandulosa*	50	20		15
Fourwing saltbush	*Atriplex canescens*	10			
Pale-desert thorn (pale wolfberry)	*Lycium pallidum*	10	10		
Sand dropseed	*Sporobolus cryptandrus*	5			
Willow baccharis	*Baccharis salicina*		5	40	
Arrowweed	*Pluchea sericea*		40		45
Narrowleaf cattail	*Typha latifolia*			40	
Hardstem bulrush	*Schoenoplectus acutus*			10	
Saltgrass	*Distichlis spicata*			10	
Single whorl burrobush	*Hymenoclea monogyra*				30
Rio Grande cottonwood	*Populus deltoides* ssp. *wislizeni*				10
Non-Native Species					
Saltcedar	*Tamarix chinensis*	0	0	0	1
Barnyardgrass	*Echinochloa crus-galli*			1	
Prickly Russian thistle	*Salsola tragus*	5	1		
Bermuda grass	*Cynodon dactylon*	5			

SWCA/GSRC biologists observed evidence of wildlife herbivory on planted poles, including American beaver (Figure 12) and mule deer (Figure 13). Other wildlife observed included kestrel, northern harrier, osprey, red-wing black bird, house finch, red-tail hawk, chipping sparrow, white-crowned sparrow, Gambel's quail, and cottontail rabbit.

Figure 12. Evidence of beaver herbivory at Yeso East.

Figure 13. Evidence of damage caused by mule deer on a Goodding's willow plant at Jaralosa.

SWCA/GSRC biologists observed evidence of activities that created disturbance or otherwise affected the restoration sites. These include herbicide drift, off-road vehicle use, and livestock grazing. In March 2017, SWCA and GSRC observed herbicide applied onto the levee road slopes adjacent to new pole plantings at Yeso East (Figure 14). A video taken by SWCA biologist Ian Dolly shows herbicide mist drifting over the levee road onto the habitat restoration site. Upon inquiry, GSRC biologist John Ginter stopped the operator, asked what herbicide was being applied, and was informed that it was Roundup. It is likely that additional unobserved herbicide applications may have occurred along the levee slopes adjacent to the new plantings. Biologists observed evidence of off-road vehicle disturbance at Jaralosa (Figure 15). Evidence of livestock damage was limited to the Yeso West site where livestock were able to access the site despite repair of the fence following excavation and planting (Figure 16 and Figure 17).

Figure 14. View of herbicide spraying incident at Yeso East, facing southeast, March 2017. Note herbicide drift across the levee onto the site.

Figure 15. View of off-road vehicle disturbance on the bank of Jaralosa, facing west, November 2017.

Figure 16. View of fence at the southern end of Yeso West showing new strand of barbed wire installed after the high-flow event, November 2017.

The Yeso West site remained inundated throughout much of the growing season, with estimated water depths of approximately 3 feet or greater. Site inundation, during the June (Figure 17) and September monitoring sessions hampered access and monitoring activities. Estimated water depths were 3 feet or greater and salt crusts resulted as the site dried (Figure 18). Additionally, extreme high-water events associated with monsoonal rain events scoured the site and deposited debris lines throughout the site (Figure 19). High flow events were confirmed by a review of the hydrograph, which indicated a monsoonal event on July 24 that resulted in a discharge of 104 cubic meters per second (cms) (3,677 cubic feet per second [cfs]) (USIBWC, 2018).

Figure 17. Yeso West inundation; June 2017 discharge = 48.35 cms (1,707 cfs). Note livestock presence.

Figure 18. View of Yeso West showing high-water event damage and salt crusts, facing northeast, November 2017.

Figure 19. View of Yeso West showing woody debris accumulated at thesouthern end of the site, facing southeast, November 2017.

3.2 Native Planting Survival

At each monitoring event, SWCA/GSRC biologists inspected the pole and long-stem shrub plantings to evaluate their health status and document survival of all poles and shrubs planted. Individuals that appeared to be dead or dormant were examined for any signs of resprouting or regrowth at the base, and a "snap test" was applied to outer stems. This test consisted of flexing branches to the point of breaking. Plants that showed no signs of regrowth and easily cracked or broke during snap tests were recorded as mortalities (Figure 20). Many of the plants that showed signs of stress or top growth dieback displayed some signs of regrowth, often at the base (Figure 21).

Figure 20. The outer stems of a willow (Salix sp.) pole planting snap easily when dead. Some of these plantings that have dead upper growth may still survive with growth of tissues at the base of the pole planting.

Figure 21. Some plantings displayed partial or complete dieback of aboveground growth with vigorous resprouting at the base, such as this Rio Grande Cottonwood, April 2018.

Table 6 documents the observed mortality at each site for each monitoring event. Coyote willow mortality generally occurred shortly after planting at all sites. Extensive resprouting occurred at Crow Canyon C, which suggests that the initial conditions were too dry for planting the species; however, with increased moisture resulting from increased flows, the plants successfully grew basal resprouts. These resprouts persisted over winter into the 2018 growing season, as indicated by the minimal mortality observed in the April and May monitoring sessions. SWCA/GSRC reported a large coyote willow dieback at Yeso West in the November monitoring session, likely due to the extended inundation and scour resulting from the monsoonal rain event.

Mortality of Goodding's willow and cottonwood poles gradually increased throughout the 2017 growing season, with one exception. Cottonwood experienced a large dieback at the Yeso East site as reported in the September monitoring session, perhaps in response to the herbicide drift event.

Table 6. Total Number of Dead Stems Counted at Each Site per Monitoring Event

Sampling Period	Site	Total Dead Stems Counted			
		Cottonwood	Goodding's Willow	Coyote Willow	Native Shrubs
Mar-17	Jaralosa	0	0	0	N/A
	Yeso East	0	0	0	N/A
	Yeso West	0	0	0	N/A
	Crow Canyon C	0	0	0	N/A
Jun-17	Jaralosa	18	20	160	N/A
	Yeso East	49	35	96	N/A

Sampling Period	Site	Total Dead Stems Counted			
		Cottonwood	Goodding's Willow	Coyote Willow	Native Shrubs
Jun-17 (Continued)	Yeso West	11	18	20	N/A
	Crow Canyon C	17	37	39	N/A
Sep-17	Jaralosa	32	31	160	N/A
	Yeso East	120	40	30	N/A
	Yeso West	N/A	N/A	N/A	N/A
	Crow Canyon C	38	75	40	N/A
Nov-17	Jaralosa	32	41	160	0
	Yeso East	120	45	32	0
	Yeso West	18	46	943	N/A
	Crow Canyon C	38	75	40	0
Apr-18	Jaralosa	32	51	160	0
	Yeso East	129	50	34	12
	Yeso West	18	46	943	N/A
	Crow Canyon C	38	75	40	0
May-18	Jaralosa	33	51	160	3
	Yeso East	131	50	34	14
	Yeso West	18	46	943	N/A
	Crow Canyon C	38	75	40	5

SWCA/GSRC prepared summaries of planting survival rates based on the total number of poles planted (Table 7) and planting mortality (Table 8) based on the quantities specified in the SOW. Because the mortality exceeded the specifications, due to resprouting and replanting, the result is presented as a survival percentage. To meet contract requirements, the survival rate would be greater than 85% (15% acceptable mortality). We present the November 2017 and the May 2018 monitoring results. The May 2018 results include the replanted poles.

Table 7. Species Survival at Each Site Based on Actual Poles Planted*

Site	Results		Jaralosa	Yeso East	Yeso West	Crow Canyon C	Total
Coyote Willow Poles	**2017 Results**	**SOW**	1,000	800	1,000	2,100	**4,900**
		Revised SOW	1,260	800	1,700	1,140	**4,900**
		Planted	1,260	820	1,790	1,140	**5,010**
		2017 Mortality	160	32	943	40	**1,175**
		Total Survived	1,100	788	847	1,100	**3,835**
		% survival	**87.3%**	**96.1%**	**47.3%**	**96.5%**	**76.5%**
	2018 Results	**Replanted**	0	0	0	0	**0**
		2018 Mortality	0	2	0	0	**2**
		Resprout	0	2	0	0	**2**
		Total Survived	1,100	788	847	1,100	**3,835**
		Revised % survival	**87.3%**	**96.1%**	**47.3%**	**96.5%**	**76.5%**

Site	Results		Jaralosa	Yeso East	Yeso West	Crow Canyon C	Total
Goodding's Willow Poles	**2017 Results**	**SOW**	100	50	50	400	**600**
		Planted	110	59	50	415	**634**
		2017 Mortality	41	45	46	75	**207**
		Total Survived	69	14	4	340	**427**
		% survival	**62.7%**	**23.7%**	**8.0%**	**81.9%**	**67.4%**
	2018 Results	**Replanted**	54	59	0	60	**173**
		2018 Mortality	10	5			**15**
		Resprout	22	37		29	**88**
		Total Survived	135	105	4	429	**673**
		Revised % survival	**82.3%**	**89.0%**	**8.0%**	**90.3%**	**83.4%**
Cottonwood Poles	**2017 Results**	**SOW**	60	485	20	100	**665**
		Planted	72	490	20	107	**689**
		2017 Mortality	32	120	18	38	**208**
		Total Survived	40	370	2	69	**481**
		2017 % survival	**55.6%**	**75.5%**	**10.0%**	**64.5%**	**69.8%**
	2018 Results	**Replanted**	38	115	0	31	**184**
		2018 Mortality	1	11	0	0	**12**
		Resprout	16	1	0	20	**37**
		Total Survived	93	475	2	120	**690**
		Revised % survival	**84.5%**	**78.5%**	**10.0%**	**87.0%**	**79.0%**
Native Shrubs	**2018 Results**	**SOW**	50	485	0	35	**570**
		Planted	60	518	0	45	**623**
		2018 Mortality	3	14	0	5	**22**
		Total Survived	57	504	0	40	**601**
		% survival	**95.0%**	**97.3%**	**%**	**88.9%**	**96.5%**

*Survival percentage based on total number poles planted.

Table 8. Mortality at Each Site Based on Planting Specifications†

Site	Results		Jaralosa	Yeso East	Yeso West	Crow Canyon C	Total
Coyote Willow Poles	**2017 Results**	**SOW**	1,000	800	1,000	2,100	**4,900**
		Revised SOW	1,260	800	1,700	1,140	**4,900**
		Planted	1,260	820	1,790	1,140	**5,010**
		Mortality	160	32	943	40	**1,175**
		Total Survived	1,100	788	847	1,100	**3,835**
		% Survival	**87.3%**	**98.5%**	**49.8%**	**96.5%**	**78.3%**
	2018 Results	**Replanted**	0	0	0	0	**0**
		Additional Mortality	0	2	0	0	**2**
		Resprout	0	2	0	0	**2**

Site	Results		Jaralosa	Yeso East	Yeso West	Crow Canyon C	Total
		Total Survived	1,100	788	847	1,100	**3,835**
		Revised % Survival	**87.3%**	**98.5%**	**49.8%**	**96.5%**	**78.3%**
Goodding's Willow Poles	**2017 Results**	**SOW**	100	50	50	400	**600**
		Planted	110	59	50	415	**634**
		Mortality	41	45	46	75	**207**
		Total Survived	69	14	4	340	**427**
		% Survival	**69.0%**	**28.0%**	**8.0%**	**85.0%**	**71.2%**
	2018 Results	**Replanted**	54	59	0	60	**173**
		2018 Mortality	10	5	0	0	**15**
		Resprout	22	37	0	29	**88**
		Total Survived	135	105	4	429	**673**
		Revised % Survival	**135.0%**	**210.0%**	**8.0%**	**107.3%**	**112.2%**
Cottonwood Poles	**2017 Results**	**SOW**	60	485	20	100	**665**
		Planted	72	490	20	107	**689**
		Mortality	32	120	18	38	**208**
		Total Survived	40	370	2	69	**481**
		% Survival	**66.7%**	**76.3%**	**10.0%**	**69.0%**	**72.3%**
	2018 Results	**Replanted**	38	115	0	31	**184**
		2018 Mortality	1	11	0	0	**12**
		Resprout	16	1	0	20	**37**
		Total Survive	93	475	2	120	**690**
		Revised % Survival	**155.0%**	**97.9%**	**10.0%**	**120.0%**	**103.8%**
Native Shrubs	**2018 Results**	**SOW**	50	485	0	35	**570**
		Planted	60	518	0	45	**623**
		2018 Mortality	3	14	0	5	**22**
		Total Survived	57	504	0	40	**601**
		% Survival	**114.0%**	**103.9%**	**%**	**114.3%**	**105.4%**

† Mortality based on specified quantities in the SOW or revised scope.

During the April and May 2018 monitoring sessions, the biologists observed relatively good survival of the new plantings for all species. Many plants previously counted as mortalities showed signs of life, often resprouting at the base (see Figure 21). All sites experienced significant numbers of rebounding pole plantings, with Jaralosa showing 16 rebounding cottonwoods and 22 Goodding's willow poles. Yeso East experienced an increase in rebounding Goodding's willow, with 37 plants and 1 cottonwood resprouting. Crow Canyon C experienced rebounding pole plantings, with 20 cottonwoods and 29 Goodding's willow resprouting.

Biologists observed additional mortalities during the spring 2018 monitoring sessions. The majority of new mortalities occurred at Yeso East, where an additional 11 cottonwood, five Goodding's willow, and 2 coyote willow were observed. Biologists observed 14 shrub mortalities, mostly desert willow. At Jaralosa, biologists observed 10 Goodding's willow mortalities and one cottonwood mortality.

Pole planting survival was variable by species and across sites. New cottonwood and Goodding's willow pole resprouting at Jaralosa, Yeso East, and Crow Canyon C was observed. Resprouts are in the form of basal sprouts. This was offset somewhat by additional mortality for Goodding's willow observed at Jaralosa and Yeso East and additional cottonwood mortality at Yeso East.

Table 9 compares the November 2017 and May 2018 survival and mortality rates for all sites (including Yeso West). Survival rates are based on the total number of poles planted. Mortality rates are based on the SOW quantities and approved changes. The result is presented as a survival percentage. To meet contract requirements, the survival rates would be greater than 85% (15% acceptable mortality).

Table 9. Planting Survival and Contract Mortality Compliance Summary

Species	Survival Summary		Contract Mortality Summary	
	Nov-17	May-18	Nov-17	Mar-18
Coyote Willow	76.5%	76.5%	78.3%	78.3%
Goodding's willow	67.4%	83.4%	71.2%	112.2%
Cottonwood	69.8%	79.0%	72.3%	103.8%
Native Shrubs	100.0%	96.5%	100.0%	105.4%

The final survival rates take into account replanting, additional resprouting, and mortalities. The number of additional resprouts exceeded the number of additional mortalities between November 2017 and May 2018.

The November 2017 mortality rate for all sites (including Yeso West) did not exceed the 85% survival threshold for pole plantings. The May 2018 overall mortality rate for all sites (including Yeso West) exceeded the 85% survival threshold for all species, except for coyote willow.

At Jaralosa, Yeso East, and Crow Canyon C, there are more surviving Goodding's willow and cottonwood poles and native shrubs than the planting quantities specified in the SOW. This is due to overplanting during the initial planting, replanting, and greater resprouts than additional mortalities in spring 2018. Because our team replaced the number of dead stems counted in November 2017, contract mortality survival greater than 100% may be due entirely to additional resprouting of stems previously recorded as dead. For the project as a whole, including Yeso West, there are still more surviving poles than the planting quantities specified in the SOW. The USIBWC approved a replanting plan that excluded replanting coyote willow at the Yeso West site and at other sites.

3.3 Non-Native Species

Saltcedar resprouting was documented across all four sites and was particularly notable at the Crow Canyon C and Jaralosa sites (Figure 22). GPS mapping of the densest saltcedar patches was conducted during the November 14 and 15, 2017, monitoring session, which yielded an approximate retreatment acreage of 2.5 acres, not including the sporadic occurrence of resprouts throughout each project area. Saltcedar chemical treatment was conducted April 16, 2018, using a brush cutter and Garlon 4 applied as a basal bark application (Figure 23 and Figure 24). This treatment method is regarded as effective and was approved by the USIBWC. Saltcedar resprouts missed during the April retreatment period were hand-pulled in May.

Figure 22. Saltcedar resprouts at Crow Canyon C, June 2017.

Figure 23. View of treated saltcedar resprouts at Crow Canyon C, April 2018.

Figure 24. View of treated saltcedar resprouts at Jaralosa, facing southwest, April 2018.

3.4 Native Grass and Forb Seeding

SWCA/GSRC did not conduct surveys to document quantitatively seeding success. Species noted anecdotally as present include inland saltgrass, alkali sacaton, saltbush, sand dropseed, wooly prairie clover, penstemon, and common sunflower. This list should not be considered inclusive. Cover for seeded species remains low through all sites.

3.5 Groundwater Monitoring

SWCA and GSRC biologists measured the depth to groundwater at six groundwater monitoring wells at the Jaralosa and Yeso East sites during all field monitoring events. The Yeso East wells included YE-MW-1, YE-MW-2, and YE-MW-3. The Jaralosa wells included JAR-MW-1, JAR-MW-2, and JAR-MW-3. The single groundwater monitoring well at Crow Canyon C was previously collapsed and unusable; however, USIBWC repaired the well in spring 2018, allowing biologists to measure the depth to groundwater in April and May 2018. The Yeso West site does not have any groundwater monitoring wells.

Depth to groundwater was recorded pre-implementation and during project implementation, and has been measured five times post-implementation. A Solinst water-level meter was used to collect water elevations to the nearest tenth of a foot. Figure 25 shows the typical wellhead structure and Solinst measuring equipment.

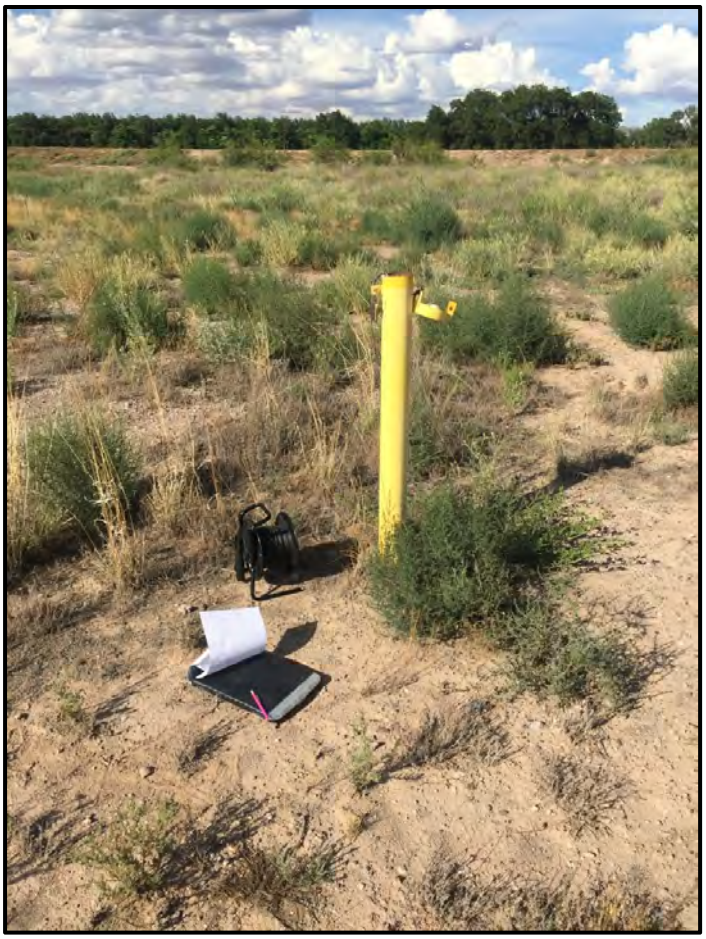

Figure 25. Typical wellhead with locking cap removed and ready for a depth-to-groundwater measurement.

After removal of the locked wellhead cap, a cable was slowly lowered into the well casing. When the probe contacts water it emits an audible signal. The cable is marked in 0.1-foot delineations, and this value was noted and recorded. This value was then rectified with the known length of the top of the casing to the ground surface to get a true reading for surface to depth of groundwater. Table 10 summarizes water depths recorded to date at each site. Well monitoring field data sheets are provided in Appendix A.

Depth to groundwater varied in response to water deliveries. The greatest groundwater depths occurred during the winter months when there was no water in the channel. Conversely, the depth to groundwater was least during the growing season when there was water in the channel. The average variance in depth to groundwater was 3.65 feet. The greatest variance recorded was 4.30 feet at the JAR-MW-3 well. The lowest variance recorded was 3.30 feet at the YE-MW-1 well. SWCA/GSRC did not analyze the variance in groundwater depths at the CCB-MW-3 well due to the lack of data, which was limited to spring flows during the irrigation season.

Table 10. Groundwater Monitoring Well Data

Site	Well ID	Site Visit Dates and Water Depth Below Surface Measured in Feet											Variance
		Baseline	Implementation				Post-Implementation						
		2016	2017				2017				2018		
		15-Nov	15-Feb	23-Feb	27-Feb	28-Mar	12-Jun	25-Jul	28-Sep	14-Nov	17-Apr	29-May	
Jaralosa	JAR-MW-1	6.79	7.06	6.39	6.39	7.19	3.89	4.04	3.39	6.59	5.09	4.89	3.80
	JAR-MW-2	6.59	6.60	6.64	6.69	6.19	3.19	4.29	3.59	6.19	5.09	2.59	3.50
	JAR-MW-3	5.78	5.78	5.68	5.73	7.08	3.38	3.33	2.78	6.98	4.38	3.88	4.30
Yeso East	YE-MW-1	7.88	7.63	7.48	7.38	7.28	4.78	4.93	4.58	5.88	5.98	5.38	3.30
	YE-MW-2	8.60	7.75	8.30	8.34	8.45	5.05	5.70	5.05	8.20	6.40	5.40	3.55
	YE-MW-3	7.72	7.82	5.67	7.42	7.52	4.47	4.37	4.12	8.02	5.72	4.52	3.45
Crow Canyon C	CCB-MW-3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.4	4.7	N/A
Average		**7.23**	**7.11**	**6.69**	**6.99**	**7.29**	**4.13**	**4.44**	**3.92**	**6.98**	**5.44**	**4.44**	**3.65**

Red highlighted values represent the highest depth to groundwater; green highlighted values represent the lowest depth to groundwater. Variance is the difference between the highest and lowest depths to groundwater.

3.6 Repeat Photography

As part of the restoration success monitoring, SWCA/GSRC established a series of permanent repeat photo points to document visually invasive species control and revegetation success. Appendix B provides the photo log and select repeat photo point series for each site to illustrate the site changes throughout the project. SWCA provided all photographs to the USIBWC on DVD.

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4 CONCLUSIONS AND DISCUSSION

4.1 General Observations

Many of the pole plantings exhibited some dieback of the upper stems with resprouting at the base. This condition was especially prevalent in the willow species but was also documented for some cottonwood plantings. This result is not atypical of results for similar willow pole planting projects implemented in the Rio Grande valley. The SWCA/GSRC biologists observed some volunteer seedlings of cottonwood, willow, and other native species within the newly planted areas of the restoration sites.

SWCA/GSRC biologists observed disturbances that can affect planting survival including evidence of off-road vehicle disturbance at Jaralosa, livestock damage at Yeso West, evidence of invertebrate herbivory, American beaver herbivory, and heat stress at all sites. Herbicide drift from adjacent farming operations may have contributed to mortality observed at the Jaralosa and Yeso East sites.

Soil conditions may also affect the success of the pole plantings. Soil conditions varied across the restoration sites and within each of the sites. The pole plantings that display the greatest vigor are located in areas with increased quantities of gravel and sand content. In areas with clay- and silt-dominated soils, the pole plants appear to display less success and vigor. Soils at the Yeso West site appear to have a higher clay and silt content. This site has heavy salt crusts over much of the newly exposed excavated surfaces. The heavy salt content is likely the result of parent soil composition and high evaporation, exacerbated by the historic dense stands of saltcedar. These highly saline and poorly drained soil conditions likely reduced willow and cottonwood establishment success and hamper future restoration efforts that use less salt-tolerant species.

Multiple saltcedar resprouts and seedlings were observed throughout all of the sites, but particularly at the Jaralosa site. SWCA/GSRC biologists GPS mapped the densest saltcedar patches during the November monitoring session, which totaled approximately 2.5 acres of treatment area. Russian thistle is well established at all sites, especially in the areas disturbed during clearing and planting.

Depth to groundwater varied across time and across sites. The depth to groundwater, as measured in the groundwater monitoring wells, varied an average of 3.65 feet. The average depth to groundwater during planting in March 2017 was 7.29 feet. The average depth to groundwater during the 2017 growing season was 4.16 feet. These depths are within the range of groundwater depths that can support pole plantings for cottonwood, Goodding's willow, and coyote willow, although the depths during the planting are at the threshold that can support coyote willow. However, the depth to groundwater varied within sites. During planting, SWCA/GSRC biologists observed depths to groundwater greater than 10 feet at some locations, especially at Crow Canyon C. The site-specific variation was not captured in the groundwater monitoring well data. There appears to be a rapid drawdown in groundwater depths following the end of the irrigation season. The groundwater depth decreased to an average of 6.98 feet in November, a period of less than one month. The rate of groundwater drawdown may exceed the ability of roots to follow. Coupled with warm, dry conditions, this could explain some of the mortality recorded in the November 2017 monitoring session.

Overall, the survival of planted poles and shrubs exceeded the mortality thresholds specified in the SOW. However, planting success and development of each site should be expected to vary over time. A summary of each site follows.

4.2 Site Analysis

4.2.1 Jaralosa

Development of the Goodding's willow and cottonwood stands would benefit from vegetation management and irrigation. Honey mesquite is showing signs of recolonizing cleared areas. Selectively mowing honey mesquite would reduce competitive pressure during the establishment period. Biologists noted signs of heat stress throughout the summer of 2017. Supplemental water in the form of acquiring water rights and irrigating planted areas would increase long-term cottonwood and Goodding's willow survival. Hand watering would not likely provide sufficient water to benefit pole plantings. The planting strategy focused on identifying abandoned meander swales. However, these are quite a distance from the river. The impacts of hyporheic water from the river channel may be minimal. While there was a clear rebound in the depth to groundwater, this site had the greatest variance in groundwater depths, which may affect plant vigor. Coyote willow poles planted near the water's edge showed good vigor and should be expected to continue to expand and create flycatcher habitat.

4.2.2 Yeso East

Plant vigor for cottonwood and Goodding's willow poles varied across the site. The northern planting, planted in an excavation area, showed good plant vigor (Figure 26). In the remaining areas, the vigor of the planted poles was not great. This site also experienced a high mortality for cottonwood and Goodding's willow poles, which may have resulted from the herbicide drift documented in the June monitoring session. Similar to the Jaralosa site, SWCA/GSRC focused planting in abandoned meander swales located some distance from the river. The northern planting is closest to the irrigation return and may benefit from hyporheic water. The remaining planting areas may not receive the same benefit. The plantings would benefit from supplemental irrigation. The USIBWC recently acquired water rights and is currently designing a supplemental irrigation system. SWCA/GSRC recommends a system to provide water to the southern, downstream planting areas. Similar to the Jaralosa site, coyote willow poles display good vigor and should continue to expand, providing good flycatcher habitat.

Figure 26. Cottonwood trees showing excellent vigor at Yeso East; repeat photo Y1, looking northwest, May 2018. Trees were planted in a swale excavated in an abandoned meander.

4.2.3 Crow Canyon C

Deep groundwater levels and dry sugar sand characterized planting conditions at the time of planting. The site was difficult to plant, with limited depths to groundwater that would support coyote willow. Following an initial coyote willow dieback, the site stabilized in response to hyporheic water from the full channel. This site is narrow and the sandy conditions would promote the transmission of groundwater throughout the growing season. The vigor of the surviving and replanted poles during the May 2018 monitoring session was good. The planting area focused on the southern, downstream portion to take advantage of existing willow stands. This site is expected to continue to develop into good flycatcher and cuckoo habitat without further intervention.

4.2.4 Yeso West

The extreme high-water events were likely responsible for much of the heavy losses of pole plantings. Excavating an inlet and outlet to the OHWM created a flow-through channel where the discharge and velocities were too great for the willows to survive. Evidence of the high flows with high velocities consist of the debris lines evident in Figure 18. The inset floodplain concept is experimental and lacked the requisite planning and analysis to identify a suitable excavation depth. SWCA/GSRC recommends conducting additional hydraulic modeling, such as HEC-RAS or Flo-2D modeling, to determine the excavation elevations at a range of discharge. Analysis of the hydrograph for the Hayner's Bridge site indicates that while the discharge throughout the 2017 irrigation season was overall a little higher than previous years, it does not appear to be significantly higher. The discharge in 2017, with the exception of the monsoonal flows, generally ranged from 32 cms (1,130 cfs) to approximately 67 cms (2,366 cfs) (USIBWC 2018). The discharge on June 12, 2017, the date the photo in Figure 17 was taken, was

48.35 cms (1,707 cfs) (USIBWC 2018). The Conceptual Plan states that the site would inundate at 3,500 cfs at a 4-foot excavation depth (USACE 2009). The excavation at the site did not exceed 4 feet and followed the requirements in the SOW. This indicates that the modeling may be inaccurate, due to lack of good topographic data and/or geomorphic changes in the channel since the original survey. It should be noted that the OHWM appears to be below the 3,500 cfs inundation threshold indicated in the Conceptual Restoration Plan.

SWCA/GSRC recommends no further planting or manipulation of the site. Preliminary observations in May 2018 indicate that the site is developing into a riparian wetland. Much can be learned to guide future planning and management from monitoring the site for the next 3 to 5 years. There are coyote willows that surround the site and based on previous experience there is a strong possibility that natural regeneration will occur, especially if there are reduced flows during the irrigation season. Additionally, there may be resprouting from some of the planted coyote willows. As the vegetation becomes established, roughness will increase in the site, which should result in slowing water velocities, increasing sedimentation, which would eventually result in an increase in riparian woody vegetation. The site should be monitored annually to assess changes in vegetation composition. Additional management of non-native species may be required.

4.3 Management Recommendations

The SWCA/GSRC team recommends the following:

- The available depth to groundwater data is inadequate to support the warranty requirements in the SOW. The depth to groundwater varied greatly within sites. For example, at Crow Canyon C, SWCA/GSRC biologists observed depths ranging from 5–6 feet to over 10 feet. Site-specific variability may be due to changes in soil type, presence of clay lenses, distance from the river channel, or other factors. Establishing a piezometer grid would provide additional samples to model groundwater flow within sites. Additional sampling locations could provide better data and identify locations where suitable planting conditions exist.
- Consider scraping soil to create swales to reduce the depth to groundwater and using existing microtopographic variation. Reducing the depth to groundwater by as little as 1 foot can yield results. To minimize costs, focus excavation in abandoned meander scars or areas near the river channel where plantings would be concentrated rather than excavating across the entire site. Improved groundwater monitoring data and modeling would also support locating suitable planting locations.
- Continue to acquire water rights and irrigate project areas. Irrigation could focus on the establishment period and during nesting seasons for the flycatcher and cuckoo.
- Consider soil salinity or electroconductivity sampling to identify areas where soil salinity is high and therefore unsuitable for planting riparian species.
- Improve outreach to neighbors. The herbicide drift across the levee was particularly troublesome and undoubtedly contributed to the mortality. Establish visible signage and consider implementing a newsletter or other announcement.
- Prior to initiating additional inset floodplain sites, consider conducting additional hydraulic modeling, such as HEC-RAS. Hydraulic modeling is used to identify the target discharge and corresponding water surface elevations. Modeling would be improved by increasing survey cross-sections or the development of a digital elevation model using technologies such as Light Detecting and Radar (LiDAR). LiDAR technology is now becoming available on unmanned

aerial vehicles ("drones"), which would facilitate the acquisition of high-quality topographic data that can then be used to develop the HEC-RAS models.

- Planning and design should include a provision for surveying to identify the cut depths and the excavated elevation. This elevation would be tied to the elevation at which the site would inundate. Excavation elevations should likely be considerable above the OHWM, so the site would not remain inundated throughout the growing season but would be inundated during spike flows. This would provide the best opportunity to provide willow habitat for the listed species. The bankline excavation requirement at Jaralosa and Yeso West would have benefited from appropriate surveys and identification of cut depths and excavation quantities. The Conceptual Restoration Plan (USACE 2009) inaccurately identified these parameters, resulting in a scope modification.

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APPENDIX A

Field Data Forms

Pre-Implementation Qualitative Monitoring Field Sheet

Site Jaralosa Date 10.20.2016

Participants C. Flynn Target habitat Open Riparian Woodland

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Honey Mesquite	High	Large patches
Saltbush	Moderate	
Sand dropseed	Moderate	Uplands
Screwbean Mesquite	Sporadic	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	Abandoned meander and along river bank

General Site Conditions: Deep abandoned meander with thick mesquite, saltbush, and saltcedar. Uplands are relatively thicky vegetated w/ perennial grasses and forbs.

Observed Wildlife: Barn Swallow, American Kestrel, Chipping Sparrow, White-crown sparrow Rattlesnake..

Photos Taken: Repeat photos at J1 - J6

max height of native vegetation 35'

max height of non-native vegetation 30'

Planting Field Sheet

Site: Jaralosa — Date Planted: 3/23, 3/24, 3/28/2017

Participants: I. Dolly, HDNP — Auger Depth: 10'

Species	# Planted	Stock/Origin	Comments
Coyote Willow	1260	Local	
Goodding's Willow	110	HDNP	
Cottonwood	72	HDNP	
Long Stem Shrub (specify in comments)	0	—	TBP in Fall.
Other			

General Location of trees planted: Alog bank, W. thin Swale — Area (acres): 3.47

Provide GPS coordinates of planting locations or a sketch of the site:

Planting Field Sheet

Site: VESO East — Date Planted: 3/17, 3/20, 3/21, 3/22, 3/23/2017

Participants: I. Dolly, HDNP — Auger Depth: 10' – 15'

Species	# Planted	Stock/Origin	Comments
Coyote Willow	820	Local	
Goodding's Willow	59	HDNP	
Cottonwood	490	HDNP	
Long Stem Shrub (specify in comments)	0	—	TBP in Fall
Other			

General Location of trees planted: Alog bank, W. thin Swale — Area (acres): 3.86

Provide GPS coordinates of planting locations or a sketch of the site:

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Jaralosa Date: 6/12/17

Participants: T. Dolly J. Gutierrez Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	40	
4wing Saltbush	Moderate	00	
Pale Wolfberry	Moderate	15	
Sand dropseed	low	5	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Moderate	10	
Russian thistle	Moderate	10	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 60

Success of plantings: Fair

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead; Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	Dead		6-12'	A	A	A		
					D	D	D		
Goodding's Willow	20	Dead			A	A	A		
					D	D	D		
Cottonwood	18	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	N/A				A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Fairly successful plantings. Tamarix is slowly recolonizing the site.

Observed Wildlife: Mule deer, Northern Mockingbird, Western Diamond back rattlesnake, Gambels Quail, Redwinged Blackbird

Photos Taken: 1 – 26

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Javalosa Date: 9/28/2017

Participants: I. Dolly Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	50	
Yerba Saltbush	Moderate	10	
Pale Wolfberry	Moderate	10	
Sad Dropseed	Low	5	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Moderate	10	
Russian thistle	Moderate	10	
Bermuda Grass	Low	5	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 60%

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	Dead			A	A	A		
					D	D	D		
Goodding's Willow	31	Dead			A	A	A		
					D	D	D		
Cottonwood	32	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	30	Normal			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Increased mortality since June Monitoring. Honey mesquite recruitment is very high.

Observed Wildlife: Mule deer, Peregrine Falcon, White-crowned sparrow, Verdin, Ladder-backed woodpecker, Blue Grosbeak

Photos Taken: 1 – 24.

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Jaralosa Date: 11/14/2017

Participants: I. Dolly, J. Lanter Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	50	
Four-wing Saltbush	Moderate	10	
Pale Wolfberry	Moderate	10	
Sand dropseed	Low	5	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Moderate	10	
Russian thistle	Moderate	10	
Bermuda Grass	Low	5	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	Dead			A / D	A / D	A / D		
Goodding's Willow	41	Dead			A / D	A / D	A / D		
Cottonwood	32	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	30	Normal			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: 10 new meanderities (Goodding's willows)

Observed Wildlife: Mule deer, White-crowned Sparrow

Photos Taken: 1-24

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Jaralosa Date: 4-16-18

Participants: I. Dolly, J. Shuck Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	50	
Four-wing Saltbush	Moderate	10	
Pale Wolfberry	Moderate	10	
Sand dropseed	Low	5	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Moderate	10	
Russian thistle	Low	1	
Bermuda grass	Low	5	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead; Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	Dead			A / D	A / D	A / D		
Goodding's Willow	29	Dead			A / D	A / D	A / D		
Cottonwood	16	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	30	normal			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: 16 new resprouts from previously deceased Goodding's Willow.

Observed Wildlife: White-crowned Sparrow, brewer's Sparrow. Desert cottontail, Mule deer, Pyrrhuloxia.

Photos Taken: 1-24

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Jaralosa Date: 5/29/18

Participants: T. Dolly, A. McArdle Target Habitat: YBCN

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	50%	
Fourwing saltbush	Moderate	10%	
Pale Publ Berry	Moderate	10%	
Sand Dropseed	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar		0%	
Bermuda Grass	Low	5%	
Russian Thistle	Low	5%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	Dead			A	A	A		
					D	D	D		
Goodding's Willow	29	Dead			A	A	A		
					D	D	D		
Cottonwood	17	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	3	Dead			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: 1 new Cottonwood resprout. 10 new Goodings willow resprouts.

Observed Wildlife: Mule Deer Sign

Photos Taken: 1-24

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Figure A-1. Jaralosa Field Data Sheets.

Pre-Implementation Qualitative Monitoring Field Sheet

Site Yeso West Date 10.20.2016

Participants C. Flynn Target habitat Dense riparian shrub

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Cattail	Low	Some patches
Baccharis	Moderate	Band along low bank
Vine mesquite grass	Moderate	Covers low floodplain
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	Large trees in thick,
		continuous band

General Site Conditions: A low bench at OHWM contains native grass and shrubs, while the higher bench behind is covered in a thick continuous band of Saltcedar. A fence runs around outside of PA.

Observed Wildlife: Red tail, Chipping Sparrow, Cottontail.

Photos Taken: Repeat Y5, photos of riverbank and back fence area

max height of native vegetation 12'

max height of non-native vegetation 40'

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso East Date: 6/12/17

Participants: I. Dolly, J. Gates Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Honey Mesquite	Moderate	20%	
Wolfberry	Moderate	10%	
Baccharis	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	5%	
Russian Thistle	Moderate	20%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited): 60

Success of plantings: Fair

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead, Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	96	Dead		6-12'	A	A	A		
				"	D	D	D		
Goodding's Willow	35	Dead		"	A	A	A		
				"	D	D	D		
Cottonwood	49	Dead		"	A	A	A		
				"	D	D	D		
Long Stem Shrub (specify in	N/A	—			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Fair. Tamarix is beginning to recolonize the site.

Observed Wildlife: Gambel's Quail, Mourning dove, Red-winged blackbird.

Photos Taken: 27 – 47

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Veso East Date: 9/28/2017

Participants: J. Dolly Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Hairy Marguerite	Moderate	20%	
Wolfberry	Moderate	10%	
Baccharis	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	5%	
Russian thistle	Moderate	20%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 40%

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	30	Dead			A / D	A / D	A / D		
Goodding's Willow	40	Dead			A / D	A / D	A / D		
Cottonwood	120	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	0	—			A / D	A / D	A / D		
Other	—	—			A / D	A / D	A / D		

General Site Conditions: Approx. 7/ more Cottonwood deaths. Since last monitoring session.

Observed Wildlife: White-crowned Sparrow, Gambel's Quail.

Photos Taken: 25 – 38

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso East Date: 11/14/17

Participants: I. Daly, J. Carter Target Habitat: Yellow-billed Cuckoo

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Honey Mesquite	Moderate	20%	
Wolfberry	Moderate	10%	
Bebbs's willow	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	5%	
Russian thistle	Moderate	20%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 40%

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	32	Dead			A / D	A / D	A / D		
Goodding's Willow	45	Dead			A / D	A / D	A / D		
Cottonwood	120	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	105	Normal			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: 2 new Coyote willow mortalities and 5 more goodding's willow

Observed Wildlife: Gambel's quail

Photos Taken: 25-38

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso East Date: 4-17-18

Participants: I. Dolly, J. Shuck Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Honey mesquite	Moderate	20%	
Wolfberry	Moderate	10%	
Buckbrush willow	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low/Moderate	5%	
Russian thistle	Low	5%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	32	Dead			A / D	A / D	A / D		
Goodding's Willow	13	Dead			A / D	A / D	A / D		
Cottonwood	129	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	12	Dead			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: 9 new Cottonwood Mortalities.

Observed Wildlife: Gambel's quail, Brewers Sparrow.

Photos Taken: 25-38

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso East Date: 5/29/18

Participants: J. Dolly, A. McArdle Target Habitat: YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Honey mesquite	Moderate	20%	
Wolfberry	Moderate	10%	
Baccharis Willow	Low	5%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	None	0%	
Russian thistle	Low	10%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	32	Dead			A	A	A		
					D	D	D		
Goodding's Willow	13	Dead			A	A	A		
					D	D	D		
Cottonwood	130	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	14	Dead			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: 2 new Coyote willow resprouts, 1 new cottonwood resprout, 5 new gooding willow resprouts.

Observed Wildlife: Desert Cottontail, Pyrrhuloxia

Photos Taken: 25-38

Figure A-2. Yeso East Field Data Sheets.

Planting Field Sheet

Site Vejo West Date Planted 3/5, 3/16, 3/17, 3/22, 3/29/2014

Participants I.Dolly, HDNP Auger Depth 5'

Species	# Planted	Stock/Origin	Comments
Coyote Willow	1790	Local	
Goodding's Willow	50	HDNP	
Cottonwood	20	HDNP	
Long Stem Shrub (specify in comments)	0		
Other			

General Location of trees planted within excavated area Area (acres) 1.37

Provide GPS coordinates of planting locations or a sketch of the site:

Planting Field Sheet

Site Cow C Date Planted 3/14, 3/15, 3/29, 3/30

Participants I.Dolly, HDNP Auger Depth 10'

Species	# Planted	Stock/Origin	Comments
Coyote Willow	1140	Local	
Goodding's Willow	415	HDNP	
Cottonwood	107	HDNP	
Long Stem Shrub (specify in comments)	0		
Other			

General Location of trees planted Bankline, Swale Area (acres) 1.44

Provide GPS coordinates of planting locations or a sketch of the site:

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso West — Date: 6/12/17

Participants: F. Dolly, J. Lowder — Target Habitat: SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Baccharis	High	30%	
Cattail	Moderate	25%	
White Horn Acacia	low	14%	
Honey Mesquite	Moderate	20%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	10%	
African Rue	low	1%	Found on Road near Site.

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 40%

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead. Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	20	Dead		6-12"	A	A	A		
				"	D	D	D		
Goodding's Willow	18	Dead		"	A	A	A		
				"	D	D	D		
Cottonwood	11	Dead		"	A	A	A		
				"	D	D	D		
Long Stem Shrub (specify in	N/A	–			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Good. Cows are present, but do not appear to be eating the plantings.

Observed Wildlife: Western Kingbird, Red-winged blackbird.

Photos Taken: 61 – 69

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Vera west Date: 11/14/17

Participants: T. Daily, J. Baker Target Habitat: Willow fly catcher

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Baccharis	Low	10%	
Lycium	Low	10%	
Screw bean	Low	10%	
Typha latifolia	High	55%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	10%	
Barnyard Grass	Moderate	5%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	943	Dead			A / D	A / D	A / D		
Goodding's Willow	46	Dead			A / D	A / D	A / D		
Cottonwood	18	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	N/A	N/A			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: Site has been devastated by a large flood event

Observed Wildlife: Scaled Quail, Beaver, Mule deer, Domestic Cow

Photos Taken: 39, 40, 62, 63

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso West Date: 4-17-18

Participants: F. Dolly, J. Schuck Target Habitat: SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Baccharis willow	Moderate	20%	
Pale wolfberry	Moderate	15%	
Honey mesquite	Low	10%	
Broadleaf Cattail	High	65%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low	10%	
Barnyard grass	Low	1%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	943	Dead			A / D	A / D	A / D		
Goodding's Willow	46	Dead			A / D	A / D	A / D		
Cottonwood	18	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	N/A	N/A			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: Increased recruitment of cattails, Baccharis willow, and hard-stem bullrush.

Observed Wildlife: None

Photos Taken: 39-42

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso West Date: 5/29/18

Participants: F. Dolly, A. McArdle Target Habitat: SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Baccharis willow	High	40%	
Broad-leaf Cattail	High	40%	
Hardstem bulrush	Moderate	10%	
Salt Grass	Moderate	10%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	None	0%	
Barnyard Grass	Low	1%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	943	Dead			A	A	A		
					D	D	D		
Goodding's Willow	46	Dead			A	A	A		
					D	D	D		
Cottonwood	18	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	N/A	N/A			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Increased recruitment of Baccharis and Cattails. Inundation prevalent.

Observed Wildlife:

Photos Taken: 39–42

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Figure A-3. Yeso West Field Data Sheets.

Pre-Implementation Qualitative Monitoring Field Sheet

Site: Crow Canyon C Date: 10·20·2016

Participants: C. Flynn Target habitat: Dense riparian shrub

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Cottonwood	Few Individuals	
Wolfberry	Scattered groups - Low	
Coyote Willow	Few Stands - Low	
Arrow weed	Scattered groups - Low	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	

General Site Conditions: Few medium-height cottonwoods along back bench, coyote willow stands at N and S ends of site. Monotypic Saltcedar in interior of site, with taller Saltcedar along river and back bank.

Observed Wildlife: Kestrel, N. Harrier, Osprey, Red wing blackbird, House Finch

Photos Taken: Repeat monitoring photos C1, C2, C3

max height of native vegetation 30 Ft

max height of non-native vegetation 30 Ft

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Cross Canyon Date: 6/12/17

Participants: I. Dolly, J. Gomez Target Habitat: YBCU, SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Single-wood burrobush	High	40	
Macheeranthera Sp.	Moderate	20	
Rio Cottonwood	Low	10	
Honey Mesquite	Low	10	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low	10	
Russian thistle	Low	10	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited): 40%

Success of plantings: Good

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead. Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	39	Dead		6-12"	A	A	A		
				"	D	D	D		
Goodding's Willow	37	Dead		"	A	A	A		
				"	D	D	D		
Cottonwood	17	Dead		"	A	A	A		
				"	D	D	D		
Long Stem Shrub (specify in	N/A	Dead			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Good. Tamarix is recolonizing the site

Observed Wildlife: Redwinged blackbird, mourning dove.

Photos Taken: 48-59

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Crow Canyon C Date: 9/29/17

Participants: I. Dolly Target Habitat: YBCU, SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Sngle-whorl burrobush	High	20	
Arrowweed	Moderate	40	
R.G. Cottonwood	Low	10	
Honey Mesquite	Low	10	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low	10	
Russian thistle	Low	10	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	40	Dead			A / D	A / D	A / D		
Goodding's Willow	75	Dead			A / D	A / D	A / D		
Cottonwood	38	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	45	Normal			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: More mortalities since last time. Significant Arrowweed recruitment.

Observed Wildlife: White-crowned Sparrow, Gambels Quail

Photos Taken: 41-49

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Crow Canyon C Date: 11/15/17

Participants: J. Dolly, J. Winter Target Habitat: YBCU, SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Hymenoclea Monogyra	High	40%	
Arrow weed	Moderate	20%	
R.G. Cottonwood	Low	10%	
Honey Mesquite	Low	10%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low	10%	
Russia thistle	Moderate	10%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	40	Dead			A / D	A / D	A / D		
Goodding's Willow	75	Dead			A / D	A / D	A / D		
Cottonwood	38	Dead			A / D	A / D	A / D		
Long Stem Shrub (specify in	45	Normal			A / D	A / D	A / D		
Other					A / D	A / D	A / D		

General Site Conditions: No new mortalities.

Observed Wildlife: Scaled Quail

Photos Taken: 41-49

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Cow Canyon C Date: 4-17-18

Participants: I. Dolly, J. Sluck Target Habitat: YBCU, SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Sycamore broadleaf	Moderate	30%	
Arrowweed	High	40%	
Rio Cottonwood	Low	10%	
Honey Mesquite	Low	20%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	40%	
Russian thistle	Moderate	10%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	40	Dead			A	A	A		
					D	D	D		
Goodding's Willow	75	Dead			A	A	A		
					D	D	D		
Cottonwood	38	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	045	Normal			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Increased recruitment of arrowweed.

Observed Wildlife: Gambel's quail

Photos Taken: 43 - 51

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Crow Canyon C Date: 5/29/18

Participants: F. Dolly, A McArdle Target Habitat: YBCU, SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Burrowbush	Moderate	3%	
Arrowweed	High	45%	
Cottonwood	Low	10%	
Honey Mesquite	Low	15%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Low	1%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	40	Dead			A	A	A		
					D	D	D		
Goodding's Willow	75	Dead			A	A	A		
					D	D	D		
Cottonwood	38	Dead			A	A	A		
					D	D	D		
Long Stem Shrub (specify in	5	Dead			A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: A few Salt Cedar resprouts were removed by hand. 5 Shrubs (chilopsis) Dead.

Observed Wildlife: none

Photos Taken: 43-51

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Figure A-4. Crow Canyon C Field Data Sheets.

Participants Conor Flynn + Cody Strapki Date 11/15/2016

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30	11-15-2016	12:30	NA		obstructed
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31		10:30	9.1	6.79	
	JAR-MW-2	4097.23	4094.32	2.91		10:30	9.5	6.59	
	JAR-MW-3	4095.86	4093.04	2.82		10:30	8.6	5.78	
Yeso East	YE-MW-1	4093.98	4090.86	3.12		11:30	11.0	7.88	
	YE-MW-2	4094.18	4090.68	3.50		11:30	12.1	8.6	
	YE-MW-3	4093.01	4090.13	2.88		11:30	10.6	7.72	

Participants I. Dolly C. Slupski Date 2-15-17 **Groundwater Levels Monitoring Field Sheet**

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30	2/15				
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	"	1:10	9.37	7.06	
	JAR-MW-2	4097.23	4094.32	2.91	"	1:15	9.6	6.69	
	JAR-MW-3	4095.86	4093.04	2.82	"	1:20	8.6	5.78	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	"	1:35	10.75	7.63	
	YE-MW-2	4094.18	4090.68	3.50	"	1:40	11.25	7.75	
	YE-MW-3	4093.01	4090.13	2.88	"	1:45	10.7	7.82	

Participants I Dolly Date 2-23-17

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	~~CCR-MW-3~~	~~4074.22~~	~~4070.92~~	~~3.30~~					
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	2/23	2:30	8.7	6.39	
	JAR-MW-2	4097.23	4094.32	2.91	2/23	2:20	9.55	6.64	
	JAR-MW-3	4095.86	4093.04	2.82	2/23	2:15	8.5	5.68	
Yesc East	YE-MW-1	4093.98	4090.86	3.12	2/23	2:00	10.6	7.48	
	YE-MW-2	4094.18	4090.68	3.50	2/23	2:05	11.8	8.3	
	YE-MW-3	4093.01	4090.13	2.88	2/23	2:10	8.55	5.67	

Participants F. Dolly Date 2/27

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crew Canyon C	CCR-MW-3	4074.22	4070.92	3.30	2/27				
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	"	1400	8.7	6.39	
	JAR-MW-2	4097.23	4094.32	2.91	"	1420	9.6	6.69	
	JAR-MW-3	4095.86	4093.04	2.82	"	1425	8.55	5.73	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	"	15:05	10.5	7.38	
	YE-MW-2	4094.18	4090.68	3.50	"	15:20	11.84	8.34	
	YE-MW-3	4093.01	4090.13	2.88	"	15:10	10.3	7.42	

Groundwater Levels Monitoring Field Sheet

Participants E.D.L Date 3/28

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30	3/28				
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	"	1100	9.5	7.19	
	JAR-MW-2	4097.23	4094.32	2.91	"	1115	9.1	6.19	
	JAR-MW-3	4095.86	4093.04	2.82	"	1130	9.9	7.08	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	"	1145	10.4	7.28	
	YE-MW-2	4094.18	4090.68	3.50	"	1215	11.95	8.45	
	YE-MW-3	4093.01	4090.13	2.88	"	1230	10.4	7.52	

Participants ED, JG Date 6/12/17 **Groundwater Levels Monitoring Field Sheet**

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30	6/12				
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	"	10:00	6.2	3.89	
	JAR-MW-2	4097.23	4094.32	2.91	"	10:15	6.1	3.19	
	JAR-MW-3	4095.86	4093.04	2.82	"	10:30	6.2	3.38	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	"	11:15	7.9	4.78	
	YE-MW-2	4094.18	4090.68	3.50	"	11:30	8.55	5.05	
	YE-MW-3	4093.01	4090.13	2.88	"	11:45	7.35	4.47	

Participants Ian Dolly Date 9/28/17

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon	~~CCB-MW-3~~	~~4074.22~~	~~4070.92~~	~~3.30~~					
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	9/28	9:00a	5.7	3.39	
	JAR-MW-2	4097.23	4094.32	2.91	"	8:30a	6.5	3.59	
	JAR-MW-3	4095.86	4093.04	2.82	"	8:45a	5.6	2.78	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	"	9:30	7.7	4.58	
	YE-MW-2	4094.18	4090.68	3.50	"	10:00	8.55	5.05	
	YE-MW-3	4093.01	4090.13	2.88	"	9:45	7	4.12	

Participants T. Dalley, J. Gibbs Date 11/14/17

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	~~CCB-MW-3~~	~~4076.22~~	~~4078.92~~	~~3.30~~					
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	11/14	9:00	8.9	6.59	
	JAR-MW-2	4097.23	4094.32	2.91	11/14	9:30	9.1	6.19	
	JAR-MW-3	4095.86	4093.04	2.82	11/14	10:00	9.8	6.98	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	11/14	10:30	9.0	5.88	
	YE-MW-2	4094.18	4090.68	3.50	11/14	10:45	11.7	8.2	
	YE-MW-3	4093.01	4090.13	2.88	11/14	11:00	10.9	8.02	

Participants FD, JS Date 4-17-15

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	~~3.00~~ 3.38	4/17	9Am	8.4	5.4	
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	4/16	5pm	7.4	5.09	
	JAR-MW-2	4097.23	4094.32	2.91	4/16	5pm	8.0	5.09	
	JAR-MW-3	4095.86	4093.04	2.82	4/16	5pm	7.2	4.38	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	4/17	11Am	9.1	5.98	
	YE-MW-2	4094.18	4090.68	3.50	4/17	11Am	9.9	6.4	
	YE-MW-3	4093.01	4090.13	2.88	4/17	11Am	8.6	5.72	

Participants I.D. AM Date 5-29-18

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.0	5/29	4:05	7.7	4.7	
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	5/29	1:57	7.2	4.89	
	JAR-MW-2	4097.23	4094.32	2.91	5/29	1:39	5.5	2.59	
	JAR-MW-3	4095.86	4093.04	2.82	5/29	1:50	6.7	3.88	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	5/29	2:32	8.5	5.38	
	YE-MW-2	4094.18	4090.68	3.50	5/29	2:40	8.9	5.40	
	YE-MW-3	4093.01	4090.13	2.88	5/29	2:51	7.4	4.52	

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program

last updated May 10, 2016

Figure A-5. Groundwater Well Data

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site Jaralosa Date 26 July 2017

Participants J. Cutler Target Habitat YBCU

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	High	40 %	site much greener since last visit
Four wing saltbush	Moderate	20 %	
Pale wolfberry	Moderate	15 %	
Sand dropseed	low	5 %	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	Moderate	10 %	
Russian thistle	Moderate	20+ %	especially in disturbed areas
silver leaf nightshade	Moderate	20 %	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 70%

Success of plantings: Good

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	160	possibly dead		2'-10'	A	A	A		
					D	D	D		
Goodding's Willow	20				A	A	A		
					D	D	D		
Cottonwood	18				A	A	A		
					D	D	D		
Long Stem Shrub (specify in	NA				A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Saltcedar resprouts observed, silver leaf nightshade & Salt cedar abundant; No ATV or livestock damage. Some Bfr showing insect herbivory

Observed Wildlife: Redwing Blkbird, YB chat, Mocko, CB Hawk, Am. Kestrel, RR runner, Lark buntings, desert cottontail, Gambels Quail, Blue grosbeak, desert king snake (No new mortality observed) Heart shaped

Photos Taken: IMG - 6285 → Img 6341

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso East — Date: 26 July 2017

Participants: J. Ginter — Target Habitat: YBCu

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Arrowweed	High	40%	
Honey Mesquite	Moderate	20%	Site much
Pale wolfberry	Moderate	10%	greener than previous
Baccharis sp.	Low	5%	visit
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	5%	
Russian thistle	moderate	20%	especially in disturbed areas
Silverleaf nightshade	moderate	20%	

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 70%

Success of plantings: Good

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead; Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	96	possibly dead		2-10'	A	A	A		
					D	D	D		
Goodding's Willow	35				A	A	A		
					D	D	D		
Cottonwood	49				A	A	A		
					D	D	D		
Long Stem Shrub (specify in	NA				A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: TAMARISK resprouts
No new mortality observed, increase in nightshade & russian thistle
No ATV or livestock damage; some cottonwoods with heat stress & invert. herbivory

Observed Wildlife: RWBK bird, YB chat, side blotched lizard, lesser gold finches, Kestrel, Barnlk Owl! white wing dove

Photos Taken:

IMG-6343 to IMG-6357

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Yeso West Date: 26-July 2017

Participants: J. Ginter Target Habitat: GWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Cattail			
Wht thorn Amaranth			
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar			

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead; Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow					A	A	A		
					D	D	D		
Goodding's Willow					A	A	A		
					D	D	D		
Cottonwood					A	A	A		
					D	D	D		
Long Stem Shrub (specify in	NA				A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: Plantings looked good from opposit bank. No evidence of livestock or ATV disturbance.

Observed Wildlife: * Unable to access site due to Rd Washouts

Photos Taken: Photos taken from Yeso Pt #5 IMG-6355 to IMG 6357

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site: Crow Canyon C Date: 26 July 2017

Participants: J. Ginter Target Habitat: YBCu & SWFL

Identifiable Native Species	Abundance (None, Sporadic individuals, Low, Moderate, High)	Percent Cover (Estimate)	Comments
Honey Mesquite	Low	10%	site much greener than previous visits
burrow brush	High	40%	
Marestail	Moderate	20%	
Cottonwood	Low	10%	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar	low	10%	
Russian thistle	Mod	20%	↑ since last visit especially in disturbed areas

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) 50%

Success of plantings:

Species	General Planting Area (s)	Vigor (stressed, normal, thriving)	Density (stems /acre)	Height Range	Survival Rate (average of 3 subplot counts) A = Alive, D = Dead, Average = Sum A/ (Sum D + Sum A)				Comments
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow	39	Possibly dead		2-10'	A	A	A		
					D	D	D		
Goodding's Willow	37				A	A	A		
					D	D	D		
Cottonwood	17				A	A	A		
					D	D	D		
Long Stem Shrub (specify in	NA				A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: No evidence of ATV or livestock disturbance, invertebrate herbivory noted on cottonwoods, Saltcedar resprouts observed

Observed Wildlife: Great blue heron, RW Blkbird, YB chat, Ave. Kestrel, side whitled (Pearl), MODO, Hoary finch,

Photos Taken: IMG - 6358 to IMG 6371

Participants J. Ginter Date 25 July 2017

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30					Non-functional
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31	25 July 2017	1700	6.35	4.04	
	JAR-MW-2	4097.23	4094.32	2.91	25 July 2017	1540	7.20	4.29	
	JAR-MW-3	4095.86	4093.04	2.82	25 July 2017	1550	6.15	3.33	
Yeso East	YE-MW-1	4093.98	4090.86	3.12	25 July 2017	1720	8.05	4.93	
	YE-MW-2	4094.18	4090.68	3.50	25 July 2017	1735	9.20	5.70	
	YE-MW-3	4093.01	4090.13	2.88	25 July 2017	1728	7.25	4.37	

APPENDIX B

Repeat Photo Points

Table B-1. Repeat Photo Point Log

Site	Photo Point Code	View Direction	Latitude	Longitude	Description
Jaralosa	J1	210	32.749202	-107.28416	Jaralosa Repeat J1
	J1	285			
	J1	31			
	J2	330	32.749307	-107.28445	Jaralosa Repeat J2
	J2	50			
	J2	165			
	J2	245			
	J3	320	32.747912	-107.28344	Jaralosa Repeat J3
	J3	55			
	J3	162			
	J3	245			
	J4	308	32.747763	-107.28319	Jaralosa Repeat J4, USIBWC Sign
	J4	180			
	J4	255			
	J5	310	32.74683	-107.28324	Jaralosa Repeat J5, USIBWC Sign
	J5	245			
	J5	185			
	J6	60	32.747147	-107.28326	Jaralosa Repeat J6, USIBWC Sign
	J6	335			
	J6	145			
	J6	243			
	J7	90	32.749472	-107.28521	Jaralosa Repeat J7
	J7	180			
	J7	225			
Yeso East	YE1	120	32.737246	-107.27705	Yeso East Repeat YE1, USIBWC Sign
	YE1	185			
	YE1	245			
	YE2	180	32.735728	-107.27372	Yeso East Repeat YE2, Levee Road Monument
	YE2	310			
	YE2	250			
	YE3	353	32.736131	-107.27459	Yeso East Repeat YE3, YE-MW-3 Well
	YE3	68			
	YE3	165			
	YE3	244			
	YE4	310	32.734541	-107.27425	Yeso East Repeat YE4, YE-MW-2 Well
	YE4	60			
	YE4	130			
	YE4	215			

Site	Photo Point Code	View Direction	Latitude	Longitude	Description
Yeso West	YW1	220	32.734006	-107.27431	Yeso West Repeat YW1, View From Yeso East, Looking Across River
	YW1	290			
	YW2	270	32.732125	-107.27413	Yeso West Repeat YW2, Along River Bank
	YW3	110	32.734603	-107.27612	Yeso West Repeat YW3, Along Back Fence
Crow Canyon C	C3	110	32.701382	-107.24558	Crow Canyon C3, Northernmost Photo Point
	C3	165			
	C3	220			
	C2	165	32.70081	-107.24447	Crow Canyon Repeat C2, Middle Photo Point
	C2	110			
	C2	220			
	C1	110	32.700068	-107.24321	Crow Canyon Repeat C1, Southernmost Photo Point
	C1	165			
	C1	220			

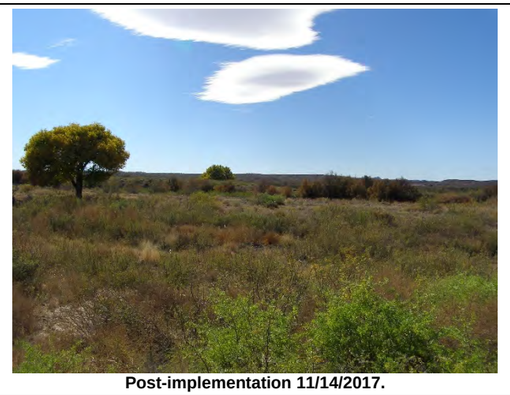
 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-1. Jaralosa Photo Point: J1, facing 210 degrees.

 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-2. Jaralosa Photo Point: J5, facing 185 degrees.

 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-3. Jaralosa Photo Point: J6, facing 145 degrees.

 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-4. Yeso East Photo Point: YE-MW-2, facing 215 degrees west.

 Pre-implementation 2016.	 Post-implementation 03/28/2017.	 Post-implementation 06/12/2017.
 Post-implementation 09/28/2017.	 Post-implementation 11/14/2017.	 Post-implementation 04/17/2018.
 Post-implementation 05/29/2018.		

Figure B-5. Yeso East Photo Point: YE-MW-3, facing 353 degrees north.

 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-6. Yeso East Photo Point: YE-2, facing 180 degrees south.

 Pre-implementation 2016.	 Post-implementation 03/28/2017.	 Post-implementation 06/12/2017.
 Post-implementation 09/28/2017.	 Post-implementation 11/14/2017.	 Post-implementation 04/17/2018.
 Post-implementation 05/29/2018.		

Figure B-7. Yeso West Photo Point: YW-1, facing 220 degrees, from across the river channel.

 Pre-implementation 2016.	 Post-implementation 03/28/2017.	 Post-implementation 06/12/2017.
 Post-implementation 05/29/2018.		

Figure B-8. Yeso West Photo Point: YW-2, facing 270 degrees along river bank.

Pre-implementation 2016.

Post-implementation 03/28/2017.

Post-implementation 06/12/2017.

Post-implementation 04/17/2018.

Post-implementation 05/29/2018.

Figure B-9. Yeso West Photo Point: YW-3, facing 110 degrees south, along back fence.

 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-10. Crow Canyon C Photo Point: C1, facing 110 degrees southeast.

 Pre-implementation 2016.	 Post-implementation 03/28/2017.	 Post-implementation 06/12/2017.
 Post-implementation 09/28/2017.	 Post-implementation 11/14/2017.	 Post-implementation 04/17/2018.
 Post-implementation 05/29/2018.		

Figure B-11. Crow Canyon C Photo Point: C2, facing 165 degrees.

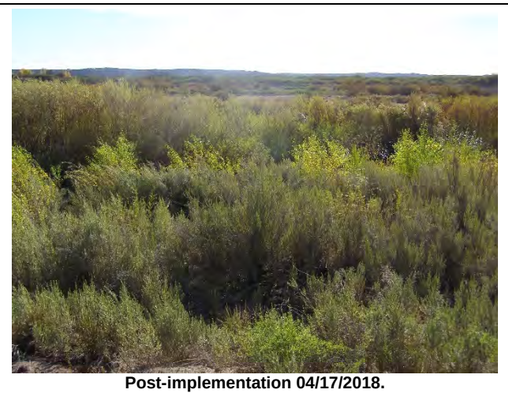
 **Pre-implementation 2016.**	 **Post-implementation 03/28/2017.**	 **Post-implementation 06/12/2017.**
 **Post-implementation 09/28/2017.**	 **Post-implementation 11/14/2017.**	 **Post-implementation 04/17/2018.**
 **Post-implementation 05/29/2018.**		

Figure B-12. Crow Canyon C Photo Point: C3, facing 165 degrees.

APPENDIX C

Planting Area Maps

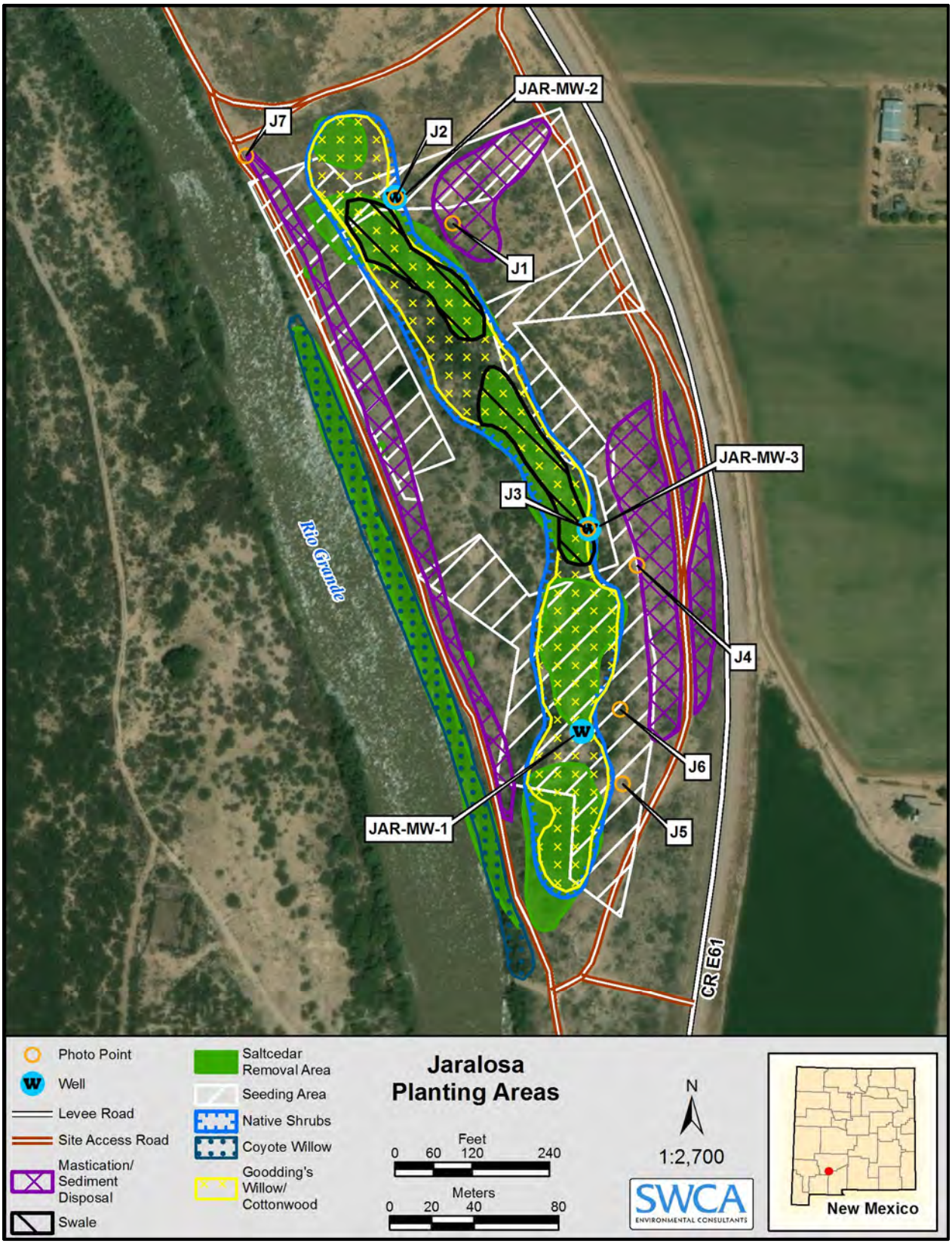


Figure C-1. Jaralosa Planting Areas.

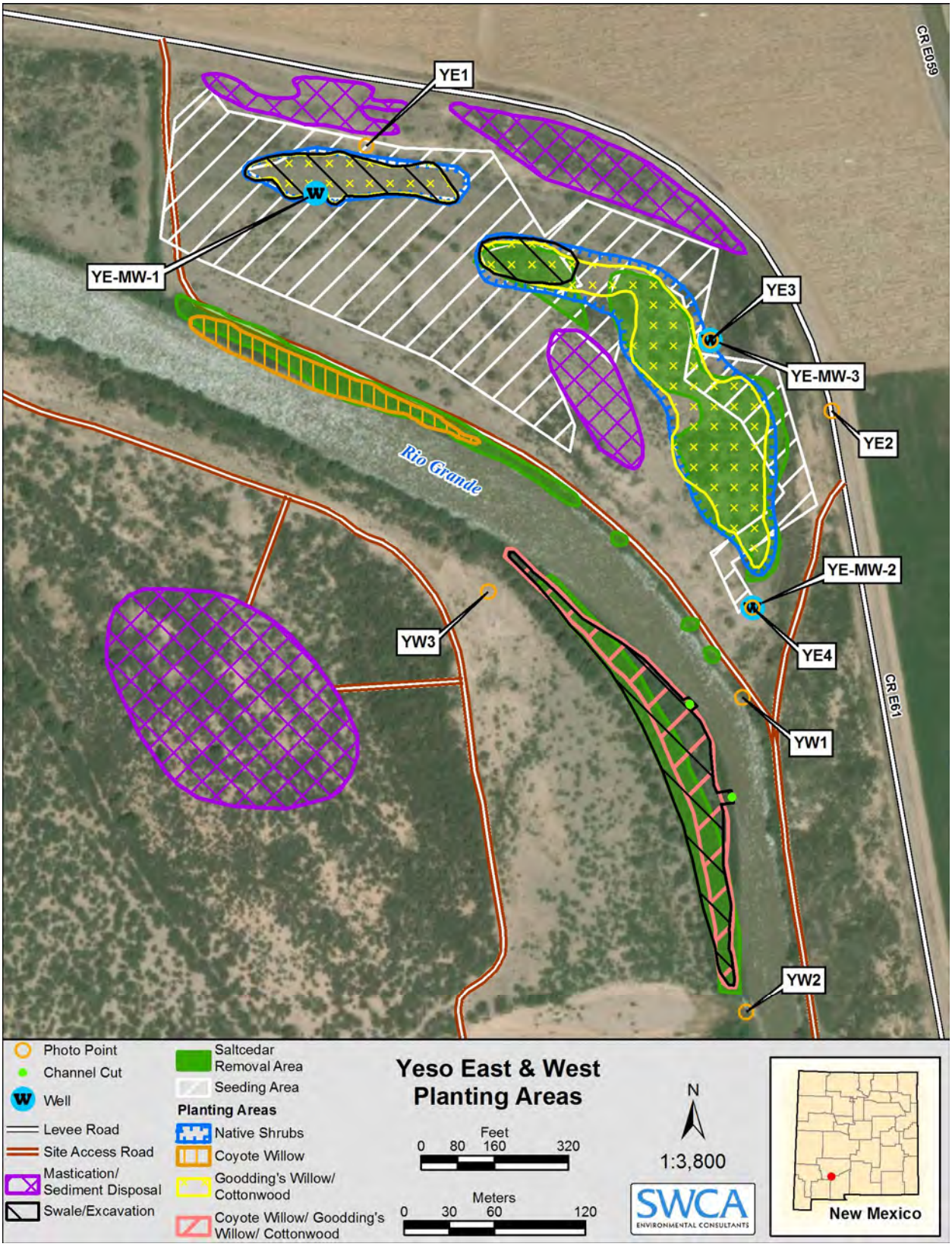


Figure C-2. Yeso East and West Planting Areas.

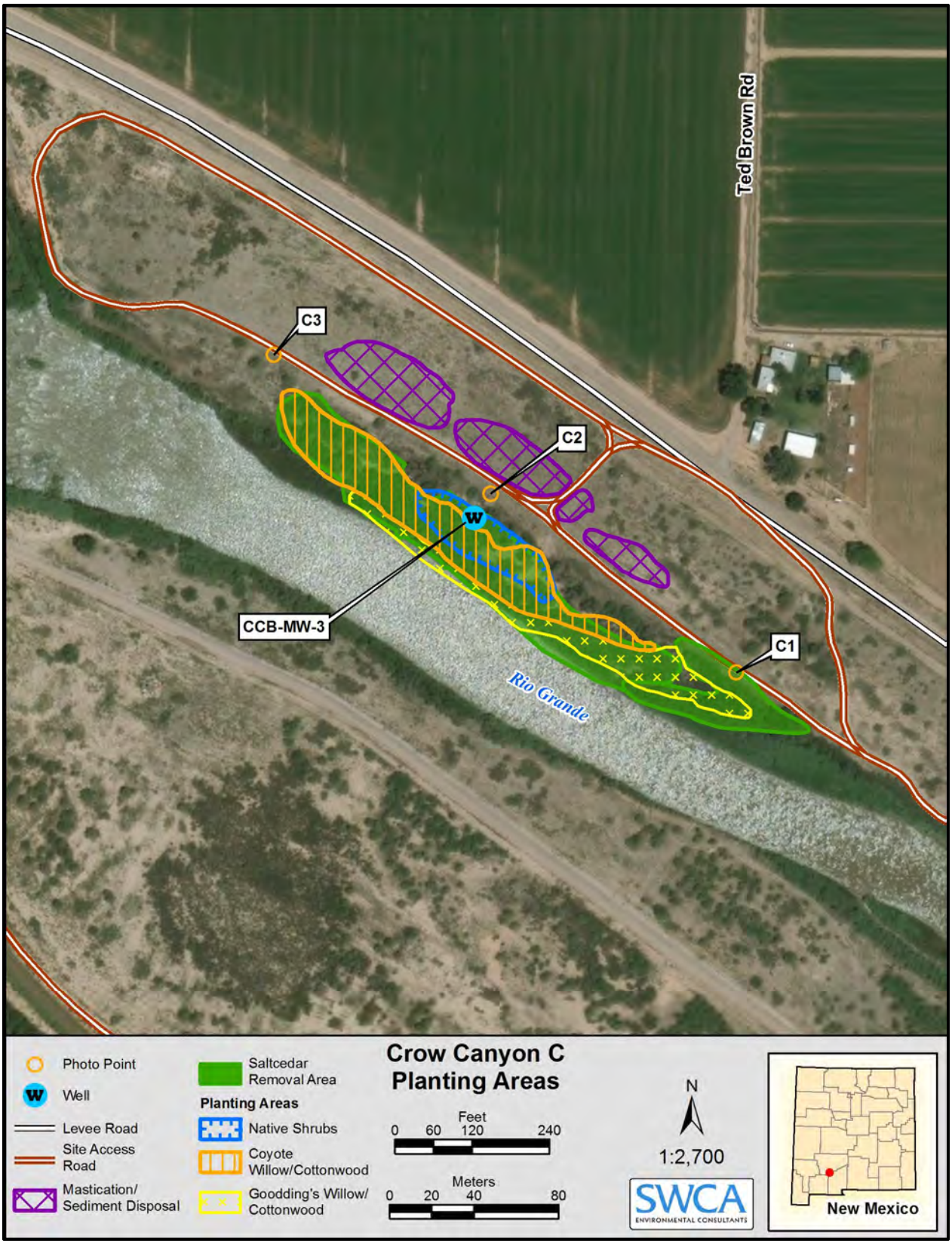


Figure C-3. Crow Canyon C Planting Areas.

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APPENDIX D

Restoration Plan

Riparian Habitat Restoration at Four Sites in Doña Ana County, New Mexico: Jaralosa, Yeso East, Yeso West, and Crow Canyon C

Restoration Plan

Prepared for:

U.S. International Boundary and Water Commission

Prepared by:

SWCA Environmental Consultants

January 2017

RIPARIAN HABITAT RESTORATION AT FOUR SITES IN DOÑA ANA COUNTY, NEW MEXICO: JARALOSA, YESO EAST, YESO WEST, AND CROW CANYON C

RESTORATION PLAN

Prepared for:

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January 27, 2017

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INTRODUCTION

This plan describes the activities required to implement invasive species management and riparian habitat restoration at four sites totaling 19.2 acres within the U.S. International Boundary Water Commission's (USIBWC's) Rio Grande Canalization Project area. The four sites (Jaralosa, Yeso East, Yeso West, and Crow Canyon C) are located north of Hatch, in Doña Ana County, New Mexico (Figure 1).

The target habitats identified in the Conceptual Restoration Plan (U.S. Army Corps of Engineers [USACE] 2009) and the Site Implementation Plan (TRC Environmental Corporation [TRC] 2011) for the selected sites are open riparian woodland and dense riparian shrub (Table 1). The restoration activities outlined and implemented will help improve the riparian zone, increasing suitable feeding, breeding, and sheltering habitat for the southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) and the yellow-billed cuckoo (*Coccyzus americanus*).

Table 1. Summary of Restoration Sites

Site	Acres	Target Habitat	Restoration Work Type
Jaralosa	4.5	Open riparian woodland	Old river meander
Yeso East	9.7	Open riparian woodland	Old river meander
Yeso West	1.6	Dense riparian shrub (flycatcher)	Creation of inset floodplain
Crow Canyon C	3.4	Dense riparian shrub (flycatcher)	Existing inset floodplain in need of enhancement

To increase habitat for these key species, non-native vegetation will be removed, and native trees and shrubs will be planted. Habitat restoration will consist of creating willow (*Salix* sp.)–dominated stands, a cottonwood (*Populus deltoids* spp. *wislizeni*) gallery forest, and a buffer area planted with native riparian shrubs typical of the surrounding floodplain. All of the plantings will be located in strategic locations in order to maximize the footprint of the existing native vegetation (see Site-Specific Restoration Plans, below).

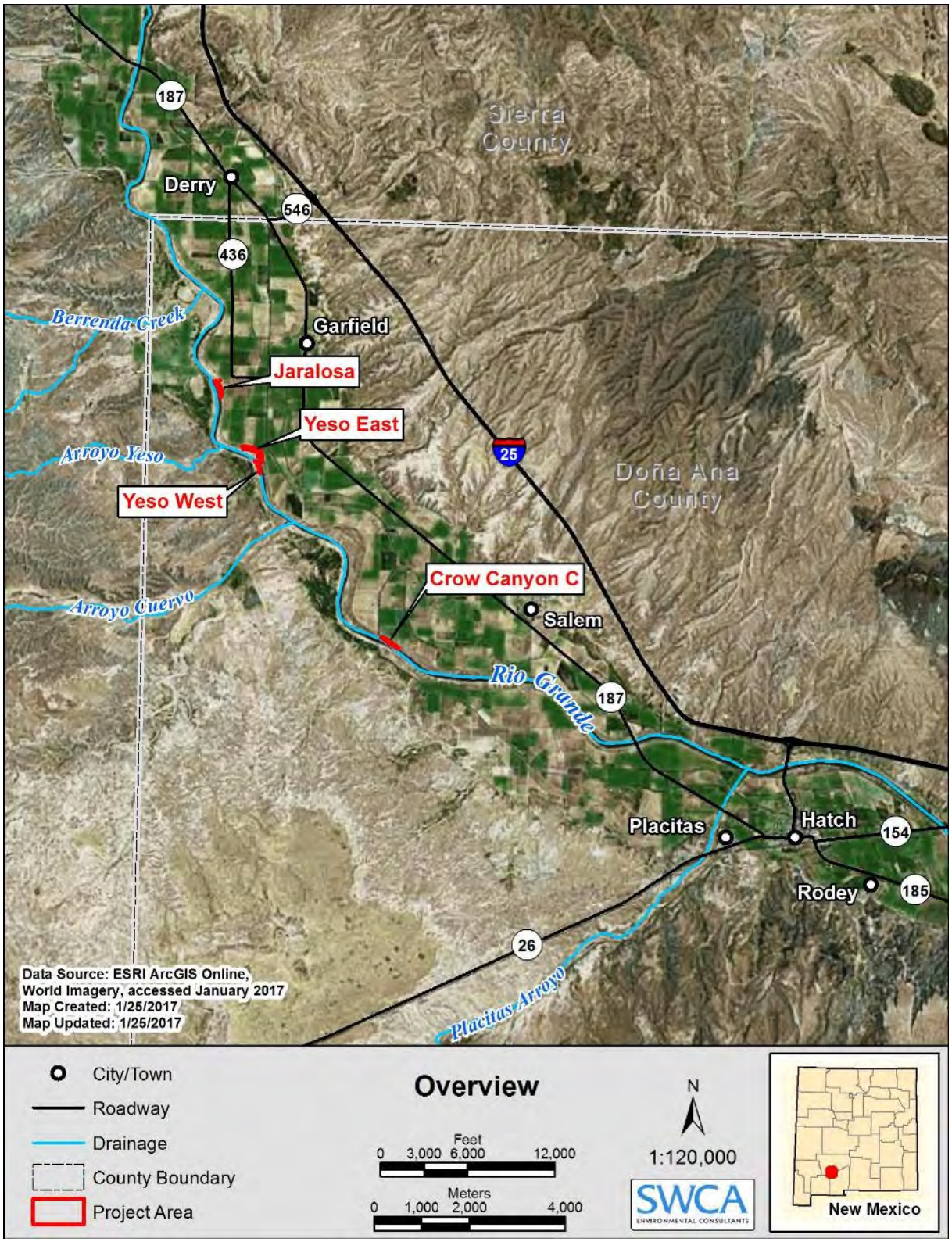

Figure 1. Overview of the four Rio Grande Canalization Project restoration sites: Jaralosa, Yeso East, Yeso West, and Crow Canyon C.

SITE HISTORY

All four restoration sites are within the historical floodplain of the Rio Grande, and two of the sites (Jaralosa and Yeso East) contain abandoned meanders from before the Rio Grande was channelized. The Rio Grande Canalization Project straightened and channelized the river, armored the riverbanks, constructed levees, and cleared the floodplain of the existing mosaic of riparian plant communities and wetlands (USIBWC 2016). These activities, coupled with the water demand for irrigated agricultural and municipal use, have resulted in lowering of the groundwater levels and disconnecting the floodplain from the river. Lowered groundwater levels and lack of overbank flooding has limited the extent of the native riparian and wetland habitat throughout the Rio Grande Canalization Project area, including the four selected restoration sites.

EXISTING SITE CONDITIONS

JARALOSA

The Jaralosa site (see Figure 1 and Figures A-1 and A-2 in Appendix A) contains a large, deep, abandoned river meander and an abandoned irrigation return canal, along with over 1,400 feet of river bank. Historically, this site has been mowed clean of all vegetation; however, mowing ceased in 2011, which has allowed for both native and non-native species to colonize the area.

Three groundwater monitoring wells were established in 2013. Site visits to the wells have recorded groundwater as shallow as 5 feet below ground surface (bgs) and as deep as 12 feet bgs, with the greatest depth to groundwater recorded annually in May prior to irrigation releases. Well JAR-MW-1 typically shows groundwater levels approximately 0.5 – 1 foot deeper than the other two wells (USIBWC 2016).

Soils consist of Brazito loamy fine sand in the uplands and Anapra clay loam in the old meander (TRC 2010). The upland soil is composed of loamy fine sand from 0 to 5 inches bgs, underlain by deep, well drained sand grading to mixed alluvium. Due to the high sand content there is very low available water capacity and very high soil blowing hazard. The root zone is from 10 to 24 inches bgs. The old meander soil is composed of clay loam from 0 to 28 inches bgs, underlain by deep, well drained sand grading to mixed alluvium. Due to the higher clay and loam content in the surface horizons, the soil has moderate water capacity and moderate soil blowing hazard. The root zone is 0 to 60 inches bgs.

Soils in the Jaralosa site are expected to be non-saline as classified by the Natural Resources Conservation Service (NRCS) (Table 2), although some measurements border on the slightly saline. As reported in HDR EOC (2014), non-saline soils have electrical conductivity (EC) less than 2.0 microSiemens per centimeter (mS/cm), slightly saline soils range from 2.1 – 4.0 mS/cm. Deeper profiles did not reveal elevated salinity, indicating that the moderate surface soil salinity is primarily due to evaporation. TRC (2010) analyzed two samples in the project area, although the exact locations were not reported. EC ranges from 2.23 to 4.70 mS/cm in the top 6 inches, and 0.02 to 5.06 mS/cm from 6 to 24 inches bgs.

These levels are near the lower end of Natural Resources Conservation Service (NRCS) moderate soil salinity and would not be expected to affect plants with medium salt tolerance. Deeper profiles

did not reveal elevated salinity, indicating that the moderate surface soil salinity is primarily due to evaporation. Localized elevated salinity in the surface layers resulting from evaporation which may impact surface seeding for saline intolerant species. Soil salinity should not impact the health or vigor of deeper-rooted species.

Table 2. Jaralosa Soil Electrical Conductivity (HDR EOC 2014)

Sample Location	Depth Interval bgs (inches)	EC (mS/cm)
JAR-MW-1	0 – 6	1.641
	7 – 24	1.711
	25 – 48	0.047
JAR-MW-2	0 – 6	0.389
	7 – 24	0.403
	25 – 48	0.459
JAR-MW-3	0 – 6	1.651
	7 – 24	1.893
	25 – 48	0.390

The deep, abandoned meander contains thick vegetation. Patches of saltbush (*Atriplex canescens*), honey mesquite (*Prosopis glandulosa*), southern goldenbush (*Isocoma pluriflora*), and sand dropseed (*Sporobolus cryptandrus*) grow along the banks of the meander, while the bottom of the meander has dense to sparse patches of honey mesquite and saltcedar (*Tamarix* sp.). There is a small area of saltgrass (*Distichlis spicata*), but other native herbaceous growth is sparse in the old meander. A thick stand of saltcedar grows along the river bank, along with forbs such as canaigre dock (*Rumex hymenosepalus*), rough cocklebur (*Xanthium strumarium*), and Chinese thorn-apple (*Datura quercifolia*). Grasses such as thin paspalum (*Paspalum setaceum*) and barnyardgrass (*Echinochloa crus-galli*) also grow along the river bank. Coyote willow (*Salix exigua*) and baccharis (*Baccharis salicina*) are present in low densities along the bank. Vegetation observed at the Jaralosa site on the October 20, 2016, site visit is presented in Table 4.

No riprap was observed within the Jaralosa project reach, although it seems likely that riprap is present on the old outlets to the meander.

YESO EAST

The Yeso East site contains a large, shallow, abandoned river meander along with over 1,750 feet of river bank. Historically this site has been mowed of all vegetation; however mowing ceased in 2011, which has allowed for both native and non-native species to colonize the area. A single large cottonwood tree has collapsed but is still living south of the old meander.

Three groundwater monitoring wells were established in 2013 at the Yeso East site (USIBWC 2016). Site visits to the wells have recorded groundwater as shallow as 3 feet bgs and as deep as 11 feet bgs, with the greatest depth to groundwater typically recorded in May prior to the irrigation season. The depth to groundwater was variable between the three monitoring wells, but generally Well YE-MW-2 typically shows groundwater levels approximately 1 foot deeper than YE-MW-1, which is about 1 foot deeper than YE-MW-3. These groundwater depths appear to correlate with

the relative ground-surface elevation of the old meander, which is lowest near the middle at YE-MW-3.

Soils consist of Brazito loamy fine sand throughout the project area (TRC 2010). The soil is composed of loamy fine sand from 0 to 5 inches bgs, underlain by deep, well drained sand grading to mixed alluvium. Due to the high sand content there is very low available water capacity and very high soil blowing hazard. The root zone is 10 to 24 inches bgs.

Soils in this project have low soil salinity. EC ranged from 0.034 mS/cm to 0.321 mS/cm (HDR EOC 2014) (Table 3). One soils sample was analyzed in the project area, although the exact location was not reported (TRC 2010). EC is 0.39 mS/cm in the top 6 inches, 0.66 mS/cm from 6 to 24 inches bgs, and 2.56 mS/cm from 24 to 39 inches bgs. The deeper profile test result is problematic because it indicates that, at least in one location in the project area, elevated salinity occurs in the rooting zone of shrubs and trees. However, the test result of 2.56 mS/cm is at the lower end of salinity that may impact willow and cottonwood (Beauchamp et al. 2009).

Table 3. Yeso East Soil Electrical Conductivity (HDR EOC 2014)

Sample Location	Depth Interval bgs (inches)	EC (mS/cm)
YE-MW-1	0 – 6	0.321
	7 – 24	0.145
	25 – 48	0.289
YE-MW-2	0 – 6	0.135
	7 – 24	0.898
	25 – 48	0.131
YE-MW-3	0 – 6	0.072
	7 – 24	0.078
	25 – 48	0.034

Weedy annuals, such as Palmer amaranth (*Amaranthus palmeri*) and annual grama grass (*Bouteloua barbinoides*), cover large portions of the Yeso East site, with patches of arrowweed (*Pluchea sericea*), saltbush, saltcedar, and bare ground. A few scattered honey mesquite are also present. The perennial grass sand dropseed occurs in some areas, although most grasses are annuals. Saltbush and Mormon tea (*Ephedra torreyana*) grow along the levee side of the site. A few cottonwood trees occur in the middle of the site, between the river and the old meander. Saltcedar grows in a thick band along the northern two-thirds of the riverside bank, with scattered individuals throughout. A few velvet ash (*Fraxinus velutina*) and Siberian elm (*Ulmus pumila*) are present interspersed in the saltcedar. Baccharis and thin paspalum grow at and just above the ordinary high-water mark (OHWM). Vegetation observed during an October 20, 2016, site visit is presented in Table 4.

We found no evidence of riprap on the upstream portion of the Yeso East site, although riprap is present along the bank south of the site.

YESO WEST

The Yeso West site occurs as an inset floodplain at a wide bend in the river. The site is dominated by tall saltcedar and dense native riparian vegetation. Sedges and thin paspalum occur along the low bank at the OHWM, while baccharis and saltcedar grow at higher elevations. Honey mesquite and bare ground occur beyond the fence to the west of the site. A complete list of all vegetation observed during an October 20, 2016, site visit is presented in Table 4.

No groundwater wells have been installed or soil tests performed at the Yeso West site.

Sections of a fence along the western boundary of the site will need to be temporarily removed to facilitate access for saltcedar extraction and soil excavation.

CROW CANYON C

The Crow Canyon C site is on a river bench immediately downstream of the Hatch Siphon. Historically, most of the site has been mowed of all vegetation; however mowing ceased in 2011, which has allowed for both native and non-native species to colonize the site. The southern portion of the site is on a lower bench that was not mowed, as evidenced by the thick riparian vegetation there, which includes coyote willow, saltcedar, and Russian olive (*Elaeagnus angustifolia*).

A single groundwater monitoring well (CCB-MW-3) was established at the Crow Canyon C site in 2013. Site visits to the well have recorded groundwater as shallow as 5.5 feet bgs and as deep as 10.5 feet bgs (USIBWC 2016).

Although no soil tests were conducted at Crow Canyon C, it is likely that the soils in the area are similar to the soils in Crow Canyon B, immediately upstream. Soils there consist of Agua variant soils on lower benches along the river, and Brazito loamy fine sand on upper benches (TRC 2010). The lower bench soil is composed of fine sandy loam from 0 to 28 inches bgs, underlain by deep, somewhat poorly drained sand grading to mixed alluvium. Due to the high sand content, there is very low available water capacity and high soil blowing hazard. The root zone is 25 to 35 inches bgs. The upland soil is composed of loamy fine sand from 0 to 5 inches bgs, underlain by deep, well drained sand grading to mixed alluvium. Due to the high sand content, there is very low available water capacity and very high soil blowing hazard. The root zone is 10 to 24 inches bgs. Boring logs for CCB-MW-3 indicate a silty sand from 0 – 1 feet, silty clay from 1 – 8 feet, and poorly graded fine sand below 8 feet.

Soil EC measurements (HDR EOC 2014) at CCB-MW-3 indicate non-saline soils. EC ranged from 0.101 mS/cm at 0 – 6 inches, 0.094 at 7 – 24 inches, and 0.926 at 25 – 48 inches. Soil tests at Crow Canyon B showed slightly elevated EC, 1.47 mS/cm in the top 6 inches of soil, but no elevated test results in deeper layers, indicating that these high surface salinities are primarily due to evaporation (TRC 2010). The low level of salinity is not likely to significantly affect seeding efforts or willow and cottonwood pole establishment.

A thick coyote willow stand occurs along the return drain and the river bank at the north end of the site. A large, sparsely vegetated area containing only annual weeds occurs between the willow growth and the upland bench to the east of the site. The upland bench contains a diverse mix of

annual weeds including tanseyleaf tansyaster (*Machaeranthera tanacetifolia*), Cuman ragweed (*Ambrosia psilostachya*), stinkgrass (*Eragrostis cilianensis*), and needle grama (*Bouteloua aristoides*), along with patches of saltcedar, saltbush, singlewhorl burrobush (*Hymenoclea monogyra*), and honey mesquite. Most of the river bench is covered by saltcedar in patches and dense stands. Streambed bristlegrass (*Setaria leucopila*) occurs through the saltcedar stands, along with Palmer amaranth (*Amaranthus palmeri*), feather fingergrass (*Chloris virgata*), and scattered individual alkali sacaton (*Sporobolus airoides*). Individual saltcedar also grow along the river bank, interspersed with baccharis and American licorice (*Glycyrrhiza lepidota*). A few mature cottonwoods trees occur along the back bench, although they have not recovered from drought and/or frost damage. A dense stand of coyote willow is present on a lower bench on the southern end of the site. Along the end of this bench, saltcedar trees grow up to 35 feet tall. Vegetation observed during an October 20, 2016, site visit is presented in Table 4.

Table 4. Vegetative Species Observed during Site Visits on October 20, 2016 across all 4 sites

Common Name	Scientific Name	Family	Native Status*
Palmer amaranth	*Amaranthus palmeri*	Amaranthaceae	I
Skunkbush sumac	*Rhus trilobata*	Anacardiaceae	N
Fringed twinevine	*Funastrum cynanchoides*	Asclepiadaceae	N
Cuman ragweed	*Ambrosia psilostachya*	Asteraceae	N
Willow baccharis	*Baccharis salicina*	Asteraceae	N
Desert marigold	*Baileya multiradiata*	Asteraceae	N
Broom snakeweed	*Gutierrezia sarothrae*	Asteraceae	N
Singlewhorl burrobrush	*Hymenoclea monogyra*	Asteraceae	N
Southern goldenbush	*Isocoma pluriflora*	Asteraceae	N
Texas skeleton plant	*Lygodesmia texana*	Asteraceae	N
Tanseyleaf tansyaster	*Machaeranthera tanacetifolia*	Asteraceae	N
Lemonscent	*Pectis angustifolia*	Asteraceae	N
Arrowweed	*Pluchea sericea*	Asteraceae	N
Hopi tea greenthread	*Thelesperma megapotamicum*	Asteraceae	N
Golden crownbeard	*Verbesina encelioides*	Asteraceae	N
Rough cocklebur	*Xanthium strumarium*	Asteraceae	N
Tulip pricklypear	*Opuntia phaeacantha*	Cactaceae	N
Fourwing saltbush	*Atriplex canescens*	Chenopodiaceae	N
Burningbush	*Bassia scoparia*	Chenopodiaceae	I
Prickly Russian thistle	*Salsola tragus*	Chenopodiaceae	I
Desert seepweed	*Suaeda nigra*	Chenopodiaceae	N
Missouri gourd	*Cucurbita foetidissima*	Cucurbitaceae	N
Hardstem bulrush	*Schoenoplectus acutus*	Cyperaceae	N
Russian olive	*Elaeagnus angustifolia*	Elaeagnaceae	I
Torrey's jointfir	*Ephedra torreyana*	Ephedraceae	N
Whitethorn acacia	*Acacia constricta*	Fabaceae	N
White prairie clover	*Dalea candida*	Fabaceae	N

Common Name	Scientific Name	Family	Native Status*
Woolly prairie clover	*Dalea lanata*	Fabaceae	N
American licorice	*Glycyrrhiza lepidota*	Fabaceae	N
Honey mesquite	*Prosopis glandulosa*	Fabaceae	N
Screwbean mesquite	*Prosopis pubescens*	Fabaceae	N
Broom dalea	*Psorothamnus scoparius*	Fabaceae	N
Bristly nama	*Nama hispidum*	Hydrophyllaceae	N
Manystem blazingstar	*Mentzelia multicaulis*	Loasaceae	N
Copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	N
Fivewing spiderling	*Boerhavia intermedia*	Nyctaginaceae	N
Velvet (Arizona) ash	*Fraxinus velutina*	Oleaceae	N
Velvetweed	*Gaura mollis*	Onagraceae	N
New Mexico evening primrose	*Oenothera neomexicana*	Onagraceae	N
Giant reed	*Arundo donax*	Poaceae	I
Needle grama	*Bouteloua aristidoides*	Poaceae	N
Sixweeks grama	*Bouteloua barbata*	Poaceae	N
Feather fingergrass	*Chloris virgata*	Poaceae	I
Low woollygrass	*Dasyochloa pulchella*	Poaceae	N
Saltgrass	*Distichlis spicata*	Poaceae	N
Barnyardgrass	*Echinochloa crus-galli*	Poaceae	I
Stinkgrass	*Eragrostis cilianensis*	Poaceae	I
Vine mesquite	*Panicum obtusum*	Poaceae	N
Thin paspalum	*Paspalum setaceum*	Poaceae	N
Streambed bristlegrass	*Setaria leucopila*	Poaceae	N
Alkali sacaton	*Sporobolus airoides*	Poaceae	N
Spike dropseed	*Sporobolus contractus*	Poaceae	N
Sand dropseed	*Sporobolus cryptandrus*	Poaceae	N
Mesa dropseed	*Sporobolus flexuosus*	Poaceae	N
Flaxflowered ipomopsis	*Ipomopsis longiflora*	Polemoniaceae	N
Abert's buckwheat	*Eriogonum abertianum*	Polygonaceae	N
Canaigre dock	*Rumex hymenosepalus*	Polygonaceae	N
Kiss me quick	*Portulaca pilosa*	Portulacaceae	N
Rio Grande cottonwood	*Populus deltoides* ssp. *wislizeni*	Salicaceae	N
Chinese thorn-apple	*Datura quercifolia*	Solanaceae	N
Pale desert-thorn	*Lycium pallidum*	Solanaceae	N
Silverleaf nightshade	*Solanum elaeagnifolium*	Solanaceae	I
Five-stamen tamarisk	*Tamarix chinensis*	Tamaricaceae	I
Narrowleaf cattail	*Typha angustifolia*	Typhaceae	I

Note: The four restoration sites have similar species composition.
* I=Non-native, N=Native.

RESTORATION TECHNIQUES

Restoration work will consist of removing and disposing of invasive vegetation; bank destabilization and excavation to improve planting area depth to groundwater; and planting native tree poles, long-stem native riparian shrubs, and a native grass/forbs seed mix.

SITE PREPARATION – PHASE 1

The USIBWC *Rio Grande Canalization Project River Management Plan* (USIBWC 2014) calls for USIBWC to "help ensure the long-term persistence of riparian habitats and associated species by removing and controlling invasive species, primarily saltcedar" (USIBWC 2014:2-11).

Invasive Species Management. Saltcedar will be removed through excavation with the disposal of the woody biomass done by mastication. Extraction will be performed using a clasping thumb attachment fitted on an excavator to completely remove the entire shrub/tree along with its root ball (SWCA Environmental Consultants [SWCA] 2011 and USIBWC 2014). Care will be taken to remove as much of the root crown and lateral roots as possible while avoiding damage to existing native plants. In some areas, aerial stems of baccharis or honey mesquite may be damaged by extraction efforts; however, these species regrow quickly following disturbance. There may be some cases where extraction of neighboring native shrub root crowns may be unavoidable when extracting saltcedar root crowns.

The extracted saltcedar will be placed in windrows and masticated on-site. Mastication involves grinding woody biomass to a coarse wood chip consistency using a specially designed machine. Mastication will be conducted in specified areas to avoid smothering native vegetation or impeding planting efforts. Specified areas will include areas with low total vegetative cover to provide a moisture-retaining and erosion-inhibiting mulch.

Heavy equipment will be used to accomplish extraction of the saltcedar. Best management practices (as described in SWCA 2011) and informed by SWCA's and the contractor's extensive experience conducting riparian restoration, will include:

- Water Resources Protection: All woody debris, as a result of saltcedar reduction, will be mulched and removed from the floodway.

- Soil Protection: Heavy equipment used for brush reduction will minimize impacts to native brush.

- Soil Protection: Mechanical treatment, including extraction, mastication, and excavation, will be conducted in weather conditions that provide for drier soil conditions to avoid creating ruts and compacting soil. (Due to the sandy soils present in the project area, compaction is not expected to present a serious problem.)

Foliar or basal application of herbicide may be employed in follow-up treatments in subsequent years. Field surveys in October 2016 noted the presence of saltcedar beetle (*Diorhabda carinulata*) in the project area, which should facilitate resprouting saltcedar control via defoliation. SWCA recommends monitoring saltcedar beetle defoliation of resprouting saltcedar in the first growing

season following project implementation, followed by herbicide application in subsequent years if needed.

A total of 9.7 acres of saltcedar, according to field delineation and geographic information system (GIS) calculation, will be removed from the four restoration sites (see Figure 5, Figure 6, and Figure 8).

Floodplain and Swale Excavation

Simultaneous with saltcedar removal, the contractor will excavate swales in the old meanders at the Jaralosa and Yeso East sites to decrease the depth to groundwater to approximately 8 to 9 feet bgs and increase the area suitable for planting native vegetation. An inset floodplain will be created at the Yeso West site. No excavation will occur at the Crow Canyon C site. Table 5 summarizes the excavation and bank destabilization quantities at each site.

At the Yeso East site, a swale could be constructed to enable future flood irrigation via the existing Palmer Lateral Wasteway, which traverses the upstream end of the site. The Conceptual Restoration Plan (USACE 2009) calls for a simple check dam in the wasteway to raise the water surface and allow inundation of the swale via a turnout). The swale could be excavated to connect to the wasteway to facilitate gravity water movement from the northern end at the wasteway turnout to the southern end of the excavated area. Some of the spoil from the swale excavation could be used to construct the check dam, as well as raise the banks of the wasteway, if needed. The exact design of the check dam and turnout will be determined in consultation with the USIBWC.

The USACE has issued a preliminary jurisdictional determination (Action No. SPA-2012-00529-LCO). Excavation will not result in any discharge of dredged or fill material into Waters of the U.S, including wetlands, nor will it affect navigable waterways. No excavation equipment will operate in the river. Therefore, the Project will not require Department of Army authorization under Section 404 of the Clean Water act and Section 10 of the rivers and Harbors Act of 1899.

Table 5. Excavation and Bank Destabilization at Restoration Sites

Site	Estimated Volume (cubic yards)	Dimensions (feet)	Type of Work	Erosion Control BMPs
Jaralosa	650	1.7 acres × 4.2 feet deep	Excavation of swales within old river meander	Flag perimeter, leave native vegetation, maintain buffer from river, install silt fence when working along water interface
Yeso East	800	3.25 acres × 6.5 feet deep	Excavation of swales within old river meander	Flag perimeter, leave native vegetation, maintain buffer from river, install silt fence when working along water interface
Yeso West	6,000	40 × 1,000 × 4 feet (width × length × depth)	Floodplain excavation	Flag perimeter and OHWM, leave native vegetation, maintain

				buffer from river, install silt fence when working along water interface
Crow Canyon C	N/A	N/A	N/A	Flag perimeter, leave native vegetation, maintain buffer from river.

Modifications from the Implementation Plan

Bank destabilization will not be completed at the Yeso East and Jaralosa sites, as was called for in the Conceptual Restoration Plan (USACE 2009). The original purpose of bank destabilization was to encourage channel migration. However, the excavation specifications recommended in the Conceptual Restoration Plan (25 × 1,400 × 0.05 feet) along the bankline are insufficient to encourage channel migration. This was recognized in the *Rio Grande Canalization Project River Restoration Implementation Plan* (TRC 2011), which recommended grading to a 4:1 slope over 25 feet instead. After consultation with the USIBWC, this requirement was changed to decrease the depth to groundwater as described above.

NATIVE PLANTINGS – PHASE 2

Following invasive species removal, native trees, long-stemmed riparian shrubs, and a native grass/forb seeds will be used to revegetate disturbed areas at all sites. SWCA will follow the preferred methods for planting native trees and shrubs established by the Los Lunas Plant Materials Center (Dreesen et al. 2002; NRCS 2009a, 2009b, 2009c). These methods have the advantage of minimizing watering requirements leading to successful establishment. The key to successful establishment of native riparian trees and shrubs is establishing a connection to the groundwater table (Figure 2).

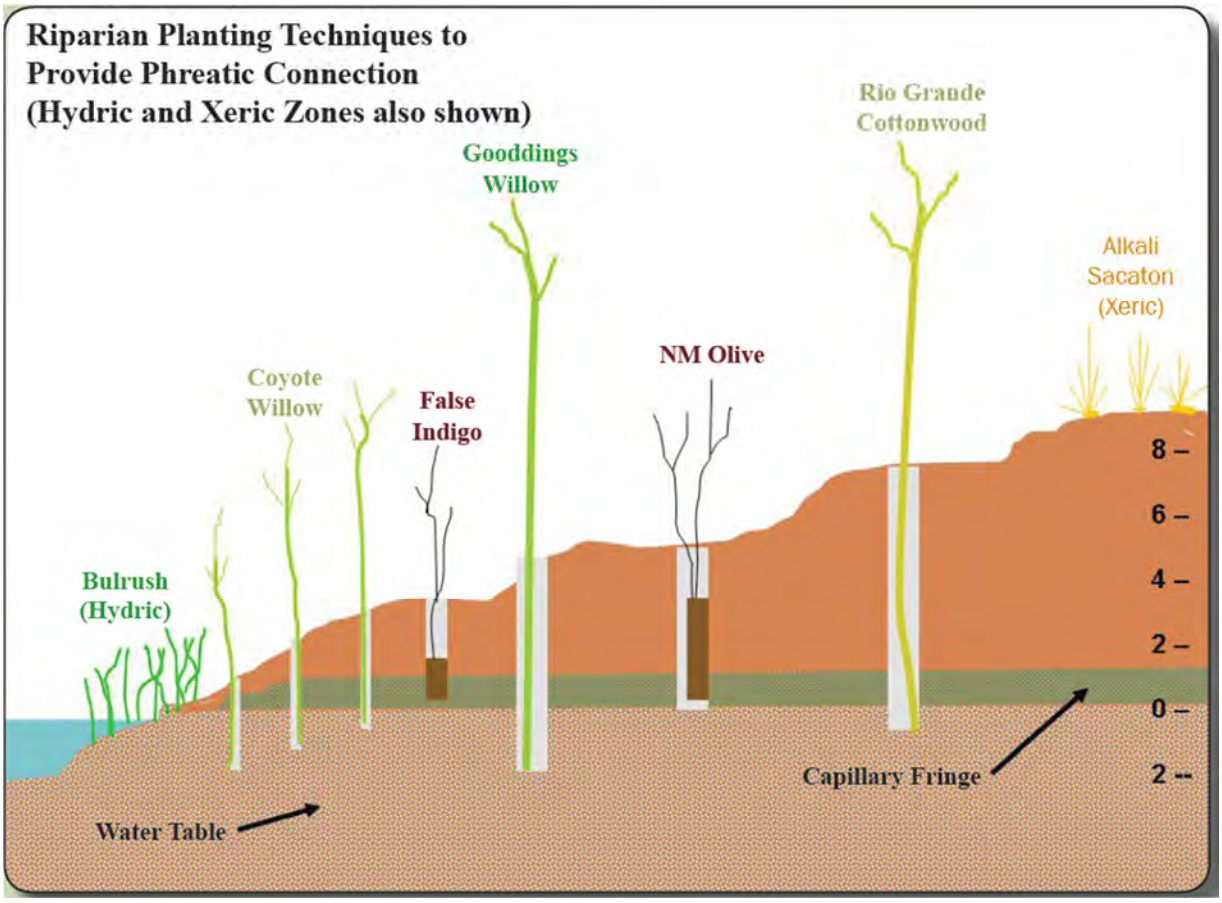

Figure 2. The conceptual planting design that will be used at all restoration sites (USDA 2007).

Planting is scheduled to be completed in late February – early March 2017. Planting depth will be informed by the documented variability (2013–2015) of groundwater depth; groundwater depth has been observed to drop through May when flow in the river resumes. Poles will be watered at least once in the first season after planting during the critical leafing-out period (March 15 to April 15), but prior to irrigation releases, in order to promote root growth and plant vigor. At least 5 gallons of water will be used per tree or planting hole.

Coyote willow patches for the flycatcher should be at least 0.25 acre in size, or about 200 × 200 feet, interspersed with herbaceous/low shrub growth. Patches should not be less than 30 feet wide. Flycatchers forage within and above the canopy, along patch edges, in openings within the territory, above water, and glean from tall trees as well as herbaceous ground cover (U.S. Fish and Wildlife Service [USFWS] 2002). Therefore, shrubs and forbs that attract pollinator insects will be selected to provide foraging opportunities for the flycatcher.

Moore (2015) has shown that higher tree-stem density is better for nesting (i.e., 1,100 stems/acre). Both low- and mid-canopy density is important; nesting is correlated with the presence of larger trees (10 to 20 centimeters diameter at breast height [DBH]) that reach into the mid-canopy. Coyote willows rarely exceed 5 cm DBH and are restricted to the lower canopy, so the presence of Goodding's willow (*Salix gooddingii*) or other mid-stature trees interspersed with coyote willow is critical.

Breeding success and fecundity (number of eggs) is greatest at sites that are flooded. In general, nesting sites with more soil moisture and less distance to water are more productive for flycatcher nesting (USFWS 2002).

Mixed cottonwood and Goodding's willow copses or swales are designed to benefit yellow-billed cuckoos, which prefer to nest in open woodlands with an understory of dense vegetation (Wiggins 2005). In the desert Southwest, nesting habitat is invariably riparian woodlands, particularly those with an intact (i.e., ungrazed) understory. The nests are typically placed in dense patches of broad-leaved deciduous trees, usually with a relatively thick understory.

Coyote willow poles will be placed in excavated swales using the trenching technique. Trenches would be selectively excavated to reach the desired depth to groundwater. Coyote willow poles would be placed at a density of approximately 1 pole/stem per foot. Coyote willows will colonize the site through clonal growth to form dense patches.

Cottonwood and Goodding's willow will also be planted with the use of an auger at the end of an excavator arm in a patchy distribution, to avoid an orchard appearance. Some poles may be planted into existing shrub communities (e.g., mesquite, arrowweed), which may result in incidental damage to the existing shrubs during the planting process. However, established native shrubs can regrow quickly following non-lethal damage. Existing native shrubs will be flagged during planting to prevent excess damage. Augured holes will be filled to almost level with the soil surface, leaving a basin surrounding the pole to facilitate directed watering. Planting quantities are specified in Table 6.

Table 6. Minimum Planting Quantities at Each Site

Site	Grass and Forb Seeding (acres)	Coyote Willow Poles	Goodding's Willow Poles	Cottonwood Poles	Longstem Riparian Shrubs	Coyote Willow Bankline
Jaralosa	4.5	0	100	60	50	1000
Yeso East	9.7	800	50	485	485	
Yeso West	0	1,000	50	20	0	
Crow Canyon C	0	2,100	400	100	35	
Total	**14.2**	**3,900**	**600**	**665**	**570**	

Long-stem shrubs will be planted in and around the margins of constructed swales to create a thick understory, using an auger attached to an excavator or small skid steer. Native long-stem riparian shrubs will be planted with dri-water, terra-sorb, or equivalent product to maintain moisture around the roots during the critical establishment period. Watering will be conducted twice from March 15 to July 15, with at least 2 gallons of water per shrub per visit. Access roads will be maintained to facilitate watering with a water truck.

Long-stem shrubs will be planted in and around the margins of constructed swales to create a thick understory. Shrubs will also be planted in association with cottonwood and Goodding's willow trees, with preference given to species that can survive drier or shaded sites, depending on planting location (Table 7). All planted long-stem shrubs will be flagged (with a different color than existing shrubs) to facilitate monitoring.

Table 7. Long-stem Shrub/Tree Species Planting Recommendations

Common Name	Scientific Name	Family
Baccharis	*Baccharis salicifolia/salicina*	Asteraceae
Desert willow	*Chilopsis linearis*	Bignoniaceae
Fourwing saltbush	*Atriplex canescens*	Chenopodiaceae
Skunkbush sumac	*Rhus trilobata*	Anacardiaceae
Velvet (Arizona) Ash*	*Fraxinus velutina*	Oleaceae

*If available

Seeding with native grass and forb species will be accomplished using an imprinter to create favorable microsites for germination and establishment, according to protocols developed successfully by High Desert Native Plants (Figure 3). Seeding will occur immediately following pole and long-stem shrub planting, and will be focused on areas with disturbed soil created by saltcedar removal and planting earthmoving. The seeding plan does not currently call for mulch use although this may be included, if warranted. Seeds may also be scattered directly into swales and basins and other areas not reachable by the imprinter. These areas can create "islands" of favorable conditions, from which rhizomatous or self-seeding species can spread out across the project area (Dreesen et al. 2006).

Figure 3. High Desert Native Plants imprinter.

Native grass and forb species will be selected for vigor, pollinator suitability, and local seed availability. Table 8 provides a list of suggested species.

Table 8. Grass and Forb Species Recommendations

Common Name	Scientific Name	Family
Desert marigold	*Baileya multiradiata*	Asteraceae
Common sunflower	*Helianthus annuus*	Asteraceae
Woolly paperflower	*Psilostrophe tagetina*	Asteraceae
Redwhisker clammyweed	*Polanisia dodecandra*	Cleomaceae
Wooly prairie clover	*Dalea lanata*	Fabaceae
Indian ricegrass	*Achnatherum hymenoides*	Poaceae
Saltgrass	*Distichlis spicata*	Poaceae
Scratchgrass	*Muhlenbergia asperifolia*	Poaceae
Tobosagrass	*Pleuraphis mutica*	Poaceae
Alkali sacaton	*Sporobolus airoides*	Poaceae
Penstemon	*Penstemon sp.*	Scrophulariaceae

SITE-SPECIFIC RESTORATION PLANS

JARALOSA AND YESO EAST

Access will be through the levee road. Access roads along the bank will be left intact, unless otherwise directed to remove by the US IBWC. Saltcedar will be removed in the abandoned meander and along the river bankline. Extracted biomass will be windrowed in specified areas and masticated on-site to create mulch and promote moist soil conditions. Selected areas within the abandoned meander will be excavated to create a swale. By decreasing the depth to groundwater, the swale will facilitate planting success for cottonwood trees and Goodding's willow poles. This

swale in the abandoned meander will reduce depth to groundwater and facilitate planting phreatophytes into deep groundwater. Phreatophytes are plants, like cottonwood and willow that require contact with groundwater. Existing native shrub patches will be retained by auguring single cottonwood and Goodding's willow poles into these areas.

Trees and shrubs will be planted according to the quantities listed in Table 6. Long-stemmed riparian shrub species will be selected from the species recommended in Table 7. All disturbed areas will be imprinted and seeded with the grass/seed mix specified in Table 8.

Planting will be designed to create structural habitat elements and structural diversity. Goodding's willow and cottonwood will be planted using trenching in the excavated swale habitats. Plantings will be determined by location of plantable-depth water table via test auger holes. High spots (not visible on LIDAR) will be avoided; however, shrubs that are more drought-tolerant will be planted on the on-swale slopes. Coyote willow (1,000 stems) will be planted along the river bankline in the area disturbed by saltcedar extraction at the Jaralosa site. Planting plans are presented in Figure 5 and Figure 6.

YESO WEST

Access will be along levee roads on the western side of the river, accessed from Road 391. (Drive 5 miles north and across the Yeso arroyo to enter the area west of the project area [Figure 7]). The fence line along the western boundary of the site will need to be removed to facilitate access. The site will be cleared of invasive saltcedar, and the extracted biomass windrowed in specified areas (west of the existing fence line) and masticated. Soil within the site will be excavated approximately 4 feet and graded to create an inset floodplain. The perimeter of the inset floodplain will be graded to an approximately 3:1 or 4:1 slope. See Figure 4 for a schematic design of the inset floodplain. Excavation will not be conducted below the OHWM. Coyote willow and Goodding's willow will be planted on the inset floodplain. Planting will be accomplished according to Table 6. No grass/forb seeds or long-stem shrubs will be planted. The Yeso West site planting plan is illustrated in Figure 6.

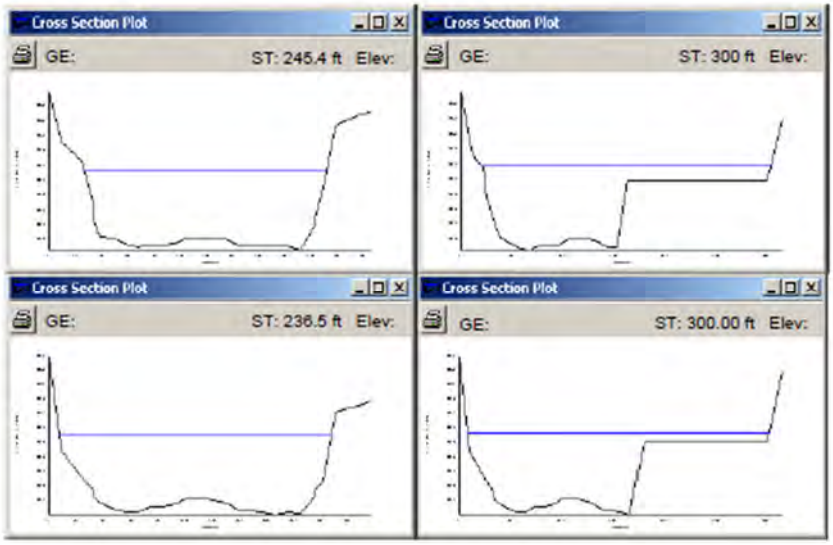

Figure 4.6. Existing (left) and restored (right) Inset floodplain cross sections.

Figure 4. Inset floodplain conceptual design (USACE 2009).

CROW CANYON C

Access roads will be left intact. Saltcedar will be removed throughout the site. Extracted biomass will be windrowed in specified areas on the bench to the east of the project area and then masticated. Trees and shrubs will be planted according to the quantities listed in Table 6. Species will be selected from the species planting recommendations (see Table 7). All disturbed areas will be imprinted and seeded with the grass/seed mix specified in Table 8.

Planting will be designed to create structural habitat elements and structural diversity. Plantings will grade from the southern end of the site where swales will be trenched to plant coyote willow and Goodding's willow, to the drier northern end of the site where Goodding's willow and cottonwood will be planted in augered holes. Plantings will be determined by location of plantable-depth water table via test auger holes. High spots (not visible on LIDAR) will be avoided. Shade-tolerant shrubs will be located under the existing cottonwood canopy. The Crow Canyon C planting plan is presented in Figure 8.

EROSION AND SEDIMENT CONTROL MEASURES

In compliance with the Clean Water Act Section 402 – National Pollutant Discharge Elimination System (NPDES) and other federal regulations, SWCA and GSRC have prepared a Stormwater Pollution Prevention Plan (SWPPP). The goals of the SWPPP include:

1. Identify potential sources of pollutants that affect storm water discharges from the site;

2. Implement best management practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent storm water contamination; and

3. Create an implementation schedule to ensure that the practices described in this SWPPP are in fact implemented and to evaluate the plan's effectiveness in reducing the pollutant levels in storm water discharges.

The following BMPs will be implemented:

- Demarcating the perimeter of all areas to be disturbed and limiting the area of disturbance
- Preserving Natural Vegetation
- Maintaining buffer areas around waterways
- Installing silt fence when working along the water interface
- Revegetating disturbed areas with native vegetation
- Refueling and conducting equipment maintenance a minimum of 100 feet from waterways
- Maintaining spill kits in excavation equipment
- Staff training
- Monitoring

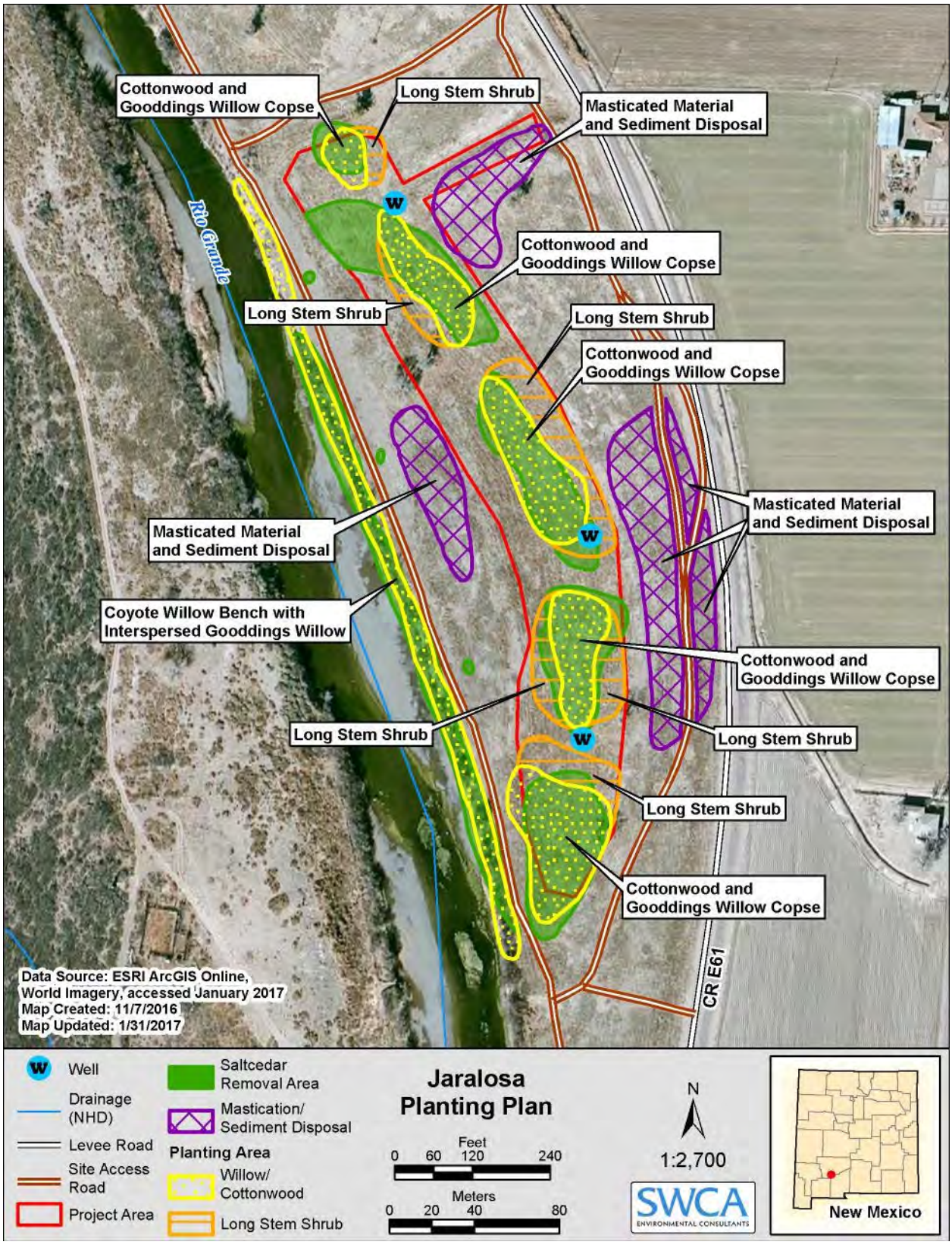

Figure 5. Jaralosa site planting plan.

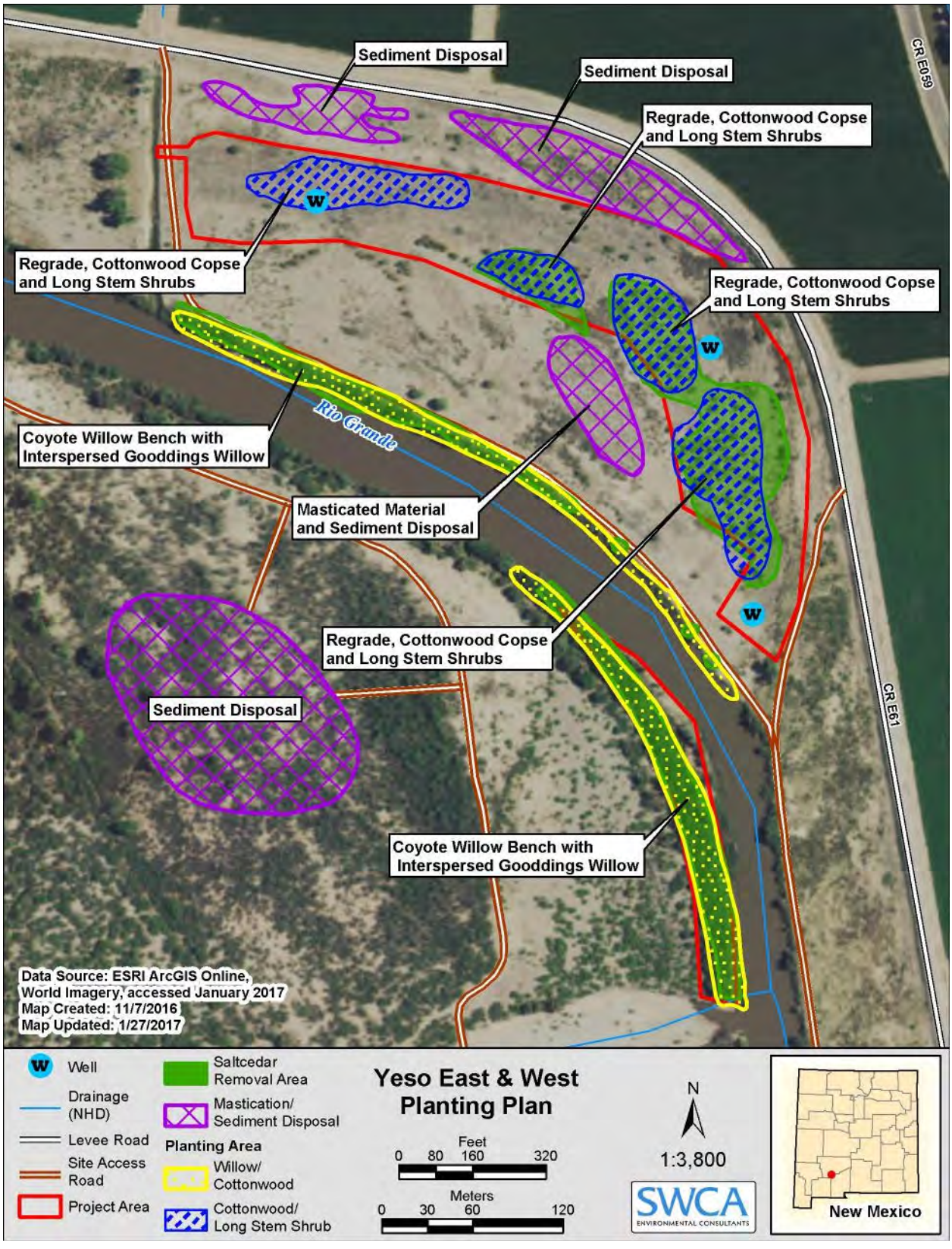

Figure 6. Yeso East and Yeso West site planting plan.

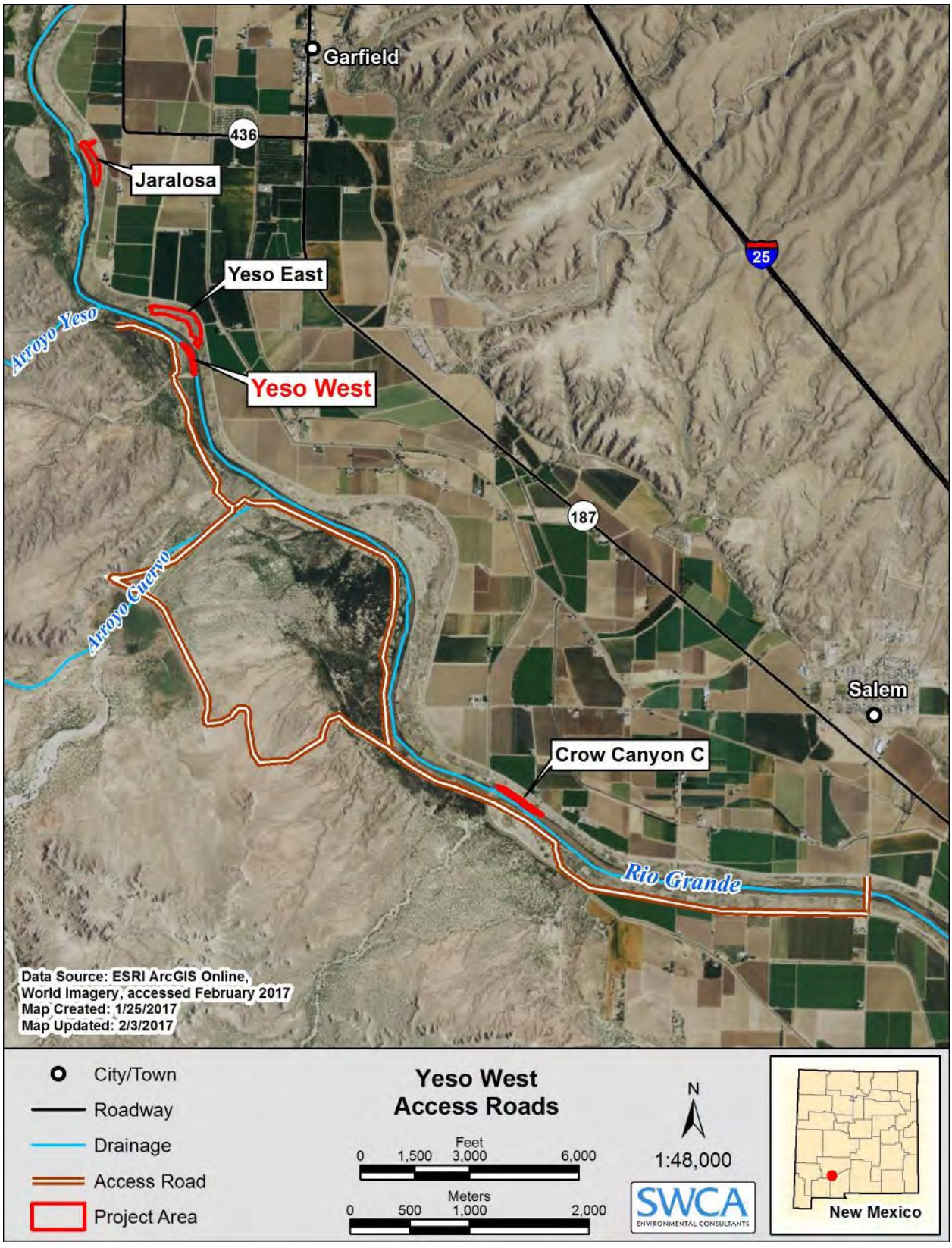

Figure 7. Access roads to the Yeso West site.

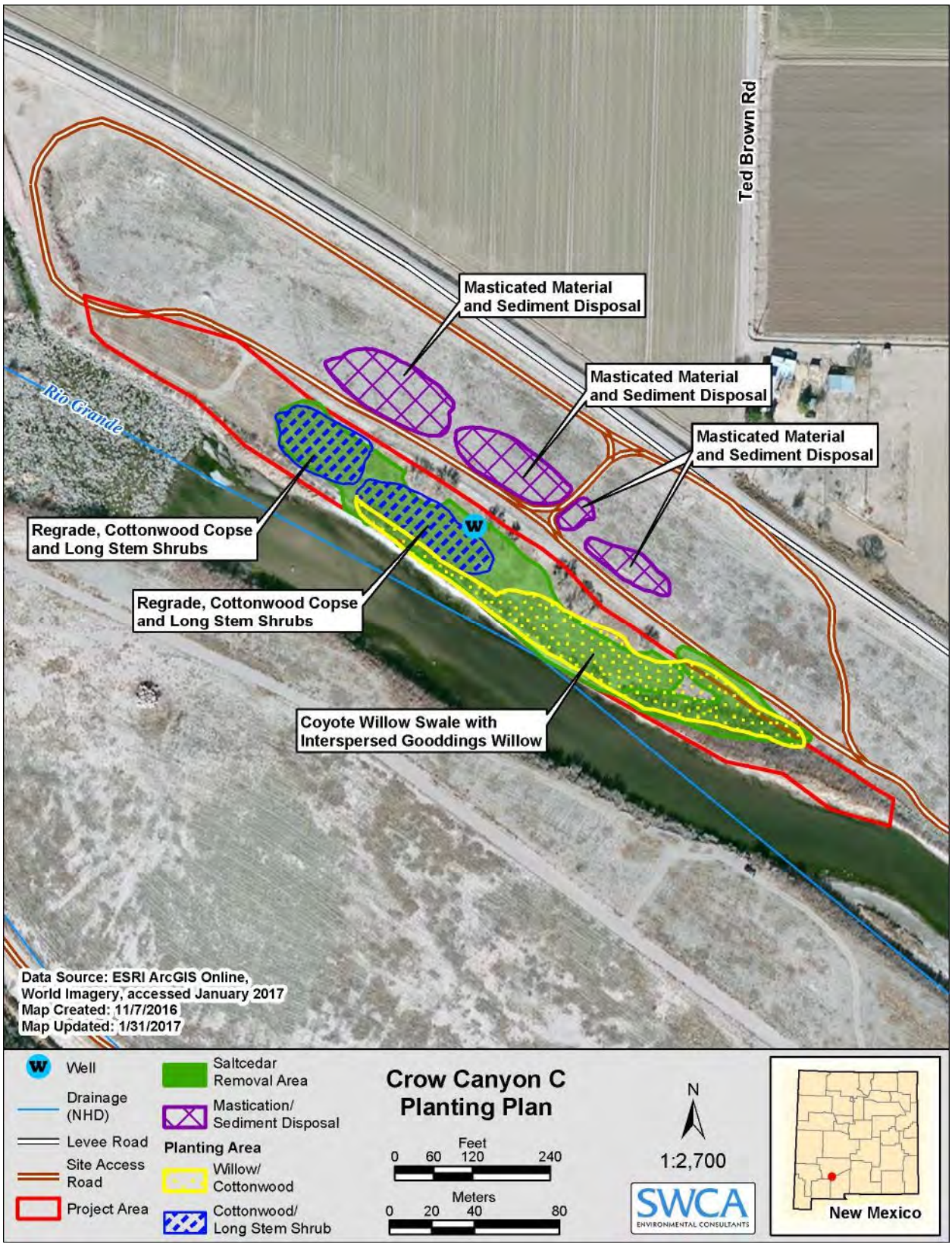

Figure 8. Crow Canyon C site planting plan.

MONITORING AND MAINTENANCE

MONITORING PLAN

Pre-construction monitoring was conducted on October 19 and 20, 2016 with the groundwater wells being measured on November 16, 2016. Monitoring consisted of establishing repeat photodocumentation points, qualitatively assessing the existing vegetation present at each site, and collecting groundwater data at UWIBWC groundwater monitoring wells.

Repeat photodocumentation points were established near monitoring wells and/or USIBWC delineator posts during pre-construction monitoring (Table 9). Appendix A contains some of the photographs taken at the photo monitoring points in October 2016. Repeat photos will be collected at each site visit (described below) and transmitted to USIBWC with appropriate file names and metadata.

Table 9. Repeat Photodocumentation Coordinates

Site	Latitude	Longitude	Location Notes
Jaralosa	32.749202	-107.284163	
	32.749307	-107.284453	JARMW-2
	32.747912	-107.283437	JARMW-3
	32.747763	-107.28319	IBWC Sign
	32.74683	-107.283244	IBWC Sign
	32.747147	-107.283258	IBWC Sign
	32.749467	-107.285196	
Yeso East	32.737246	-107.277046	IBWC Sign
	32.735728	-107.273723	Levee Road (survey monument)
	32.736131	-107.27459	YEMW-3
	32.734541	-107.27425	YEMW-2
Yeso West	32.732125	-107.274127	Along river bank
	32.734603	-107.276119	Along back fence
	32.734006	-107.27431	View from Yeso East looking across the river
Crow Canyon C	32.701382	-107.245578	
	32.70081	-107.244467	
	32.700068	-107.243206	

Vegetation monitoring will be conducted during and after planting in order to document success of native species plantings and identify any regrowth of invasive species. Each site will be revisited a minimum of six times following completion of restoration work, with the exact schedule of visits to be coordinated with USIBWC. The preliminary schedule suggested by the USIBWC includes April, July, and October 2017, and February, April, and July 2018. USIBWC datasheets (Appendix B) will be used to ensure standard data collection methods.

Groundwater monitoring wells will also be measured during each site visit. A Solinst water level meter will be used to collect water elevations to the nearest tenth of a foot. Data will be collected on IBWC data sheets and transmitted to USIBWC.

Pre-Construction monitoring field data are presented in Appendix C.

POST RESTORATION MAINTENANCE

In accordance with the Statement of Work, post-restoration maintenance will consist of the following:

- Replanting if mortality exceeds 15% of the total number of poles and shrubs planted.
- Treating saltcedar resprouts.

Replanting will be based on the results of the vegetation monitoring. If the results of the October monitoring suggest a mortality of greater than 15% for all planted poles and longstem shrubs, GSRC along with SWCA and High Desert Native Plant Nursery will coordinate with the UW IBWC. One option to be explored may include planting the longstem shrubs in the fall. The advantage of this planting period for the longstem shrubs includes higher groundwater table and lower temperatures, which results in reduced transpiration stress.

Saltcedar resprouts will be noted during monitoring. Prior to treating as described above, GSRC and SWCA will coordinate with the US IBWC.

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APPENDIX A SITE PHOTOGRAPHS

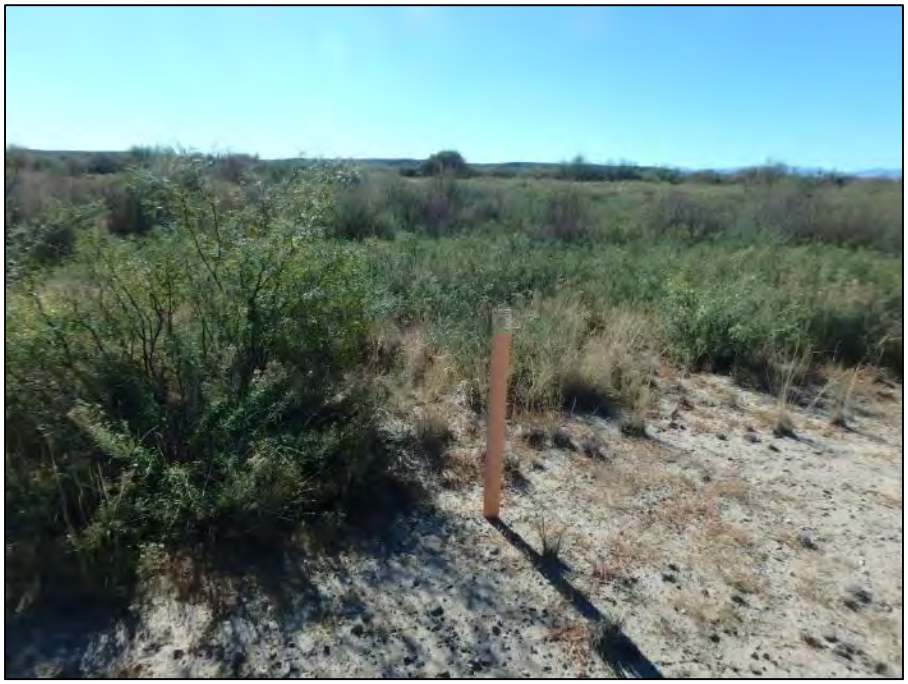

Figure A.1. Jaralosa repeat photo point J4. Looking west, this photo point overlooks the old meander.

Figure A.2. Jaralosa bankside, looking upstream (north) from the southern end of the site.

Figure A.3. Yeso East repeat photo point Y1 looking west at USIBWC sign and old meander. River bankline visible in the background.

Figure A.4. Yeso East repeat photo point Y2 from levee road looking west at old meander.

Figure A.5. Yeso West repeat photo point Y5 looking west from the east bank of the Rio Grande.

Figure A.6. Yeso West looking south along back fence on west side of the site.

Figure A.7. Crow Canyon C repeat photo point C2 looking west at monitoring well and planting area.

Figure A.8. Crow Canyon C repeat photo point C3 looking south.

APPENDIX B IBWC MONITORING DATA FIELD SHEETS

Planting Field Sheet

Site _____ Date Planted _____

Participants _____ Auger Depth _____

Species	# Planted	Stock/Origin	Comments
Coyote Willow			
Goodding's Willow			
Cottonwood			
Long Stem Shrub (specify in comments)			
Other			

General Location of trees planted _____ Area (acres) _____

Provide GPS coordinates of planting locations or a sketch of the site:

Planting Field Sheet

Site _____ Date Planted _____

Participants _____ Auger Depth _____

Species	# Planted	Stock/Origin	Comments
Coyote Willow			
Goodding's Willow			
Cottonwood			
Long Stem Shrub (specify in comments)			
Other			

General Location of trees planted _____ Area (acres) _____

Provide GPS coordinates of planting locations or a sketch of the site:

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Pre-Implementation Qualitative Monitoring Field Sheet

Site _____ Date _____

Participants _____ Target habitat

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	**Abundance (Sporadic individuals, Low, Moderate, High)**	**Comments**
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar		

General Site Conditions: _____

_____

Observed Wildlife : _____

_____

_____

Photos Taken: _____

_____

max height of native vegetation _____

max height of non-native vegetation _____

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Restoration Work Effectiveness - Qualitative Monitoring Field Sheet

Site _____ Date _____

Participants _____ Target Habitat _____

Identifiable Native Species	**Abundance (None, Sporadic individuals, Low, Moderate, High)**	**Percent Cover (Estimate)**	**Comments**
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Percent Cover (Estimate)**	**Comments**
Saltcedar			

OVERALL PERCENT COVER OF VEGETATION AT SITE (planted and naturally recruited) _____

Success of plantings:

Species	**General Planting Area (s)**	**Vigor** (stressed, normal, thriving)	**Density** (stems /acre)	**Height Range**	**Survival Rate** (average of 3 subplot counts) A = Alive, D = Dead Average = Sum A/ (Sum D + Sum A)				**Comments**
					Plot 1	Plot 2	Plot 3	Average	
Coyote Willow					A	A	A		
					D	D	D		
Goodding's Willow					A	A	A		
					D	D	D		
Cottonwood					A	A	A		
					D	D	D		
Long Stem Shrub (specify in					A	A	A		
					D	D	D		
Other					A	A	A		
					D	D	D		

General Site Conditions: _____

Observed Wildlife: _____

Photos Taken: _____

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated April 21, 2015*

Groundwater Levels Monitoring Field Sheet

Participants _____ Date _____

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30					
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31					
	JAR-MW-2	4097.23	4094.32	2.91					
	JAR-MW-3	4095.86	4093.04	2.82					
Yeso East	YE-MW-1	4093.98	4090.86	3.12					
	YE-MW-2	4094.18	4090.68	3.50					
	YE-MW-3	4093.01	4090.13	2.88					

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated May 10, 2016*

APPENDIX C PRE-CONSTRUCTION MONITORING DATA FIELD SHEETS

Pre-Implementation Qualitative Monitoring Field Sheet

Site Yeso West Date 10-20-2016

Participants C. Flynn Target habitat Dense riparian shrub

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Cattail	Low	Some patches
Baccharis	Moderate	Band along low bank
Vine mesquite grass	Moderate	Covers low floodplain
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	Large trees in thick,
		continuous band

General Site Conditions: A low bench at OHWM contains native grass and shrubs, while the higher bench behind is covered in a thick continuous band of Saltcedar. A fence runs around outside of PA.

Observed Wildlife: Red tail. Chipping Sparrow. Cottontail.

Photos Taken: Repeat Y5, photos of riverbank and back fence area

max height of native vegetation 12'

max height of non-native vegetation 40'

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated June 11, 2013*

Pre-Implementation Qualitative Monitoring Field Sheet

Site Jaralosa Date 10·20·2016

Participants C. Flynn Target habitat Open Riparian woodland

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Honey Mesquite	High	Large patches
Saltbush	Moderate	
Sand dropseed	Moderate	Uplands
Screwbean Mesquite	Sporadic	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	Abundant meander and along river bank

General Site Conditions: Deep abandoned meander with thick mesquite, saltbush, and saltcedar. Uplands are relatively thicky vegetated w/ perennial grasses and forbs.

Observed Wildlife: Barn swallow, American kestrel, Chipping sparrow, White-crown sparrow Rattlesnake..

Photos Taken: Repeat photos at J1 - J6

max height of native vegetation 35'

max height of non-native vegetation 30'

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated June 11, 2013*

Pre-Implementation Qualitative Monitoring Field Sheet

Site Yeso East Date 10.20.2016

Participants C. Flynn Target habitat Open Riparian Woodland

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Arrow weed	Moderate	large patches
honey mesquite	Sporadic	
Salt bush	Sporadic	
Sand dropseed	Low	Scattered throughout
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	Along bank and abandoned meander

General Site Conditions: Abandoned meander contains much bare ground and annual weeds; Saltcedar occurs, but not in dense stands. However, saltcedar does occur as a dense stand along the river bank.

Observed Wildlife: Lincoln Sparrow, Northern Harrier, Osprey, Black Phoebe, Ruby crowned kinglet, Mourning Dove

Photos Taken: Repeat photos at 41 - 4

max height of native vegetation 30'

max height of non-native vegetation 30'

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated June 11, 2013*

Pre-Implementation Qualitative Monitoring Field Sheet

Site Crow Canyon C Date 10·20·2016

Participants C. Flynn Target habitat Dense riparian shrub

Document conditions at restoration site prior to restoration work implementation:

Identifiable Native Species	Abundance (Sporadic individuals, Low, Moderate, High)	Comments
Cottonwood	Few Individuals	
Wolfberry	Scattered groups - Low	
Coyote Willow	Few Stands - Low	
Arrow weed	Scattered groups - Low	
Identifiable Exotic (Non-Native) Species	**Abundance (None, Sporadic individuals, Low, Moderate, High, Monotypic)**	**Comments**
Saltcedar	High	

General Site Conditions: Few medium-height cottonwoods along back bench, coyote willow stands at N and S ends of site. Monotypic saltcedar in interior of site, with taller salt cedar along river and back bank.

Observed Wildlife : Kestrel, N. Harrier, Osprey, Red wing blackbird, House finch

Photos Taken: Repeat monitoring photos C1, C2, C3

max height of native vegetation 30 ft

max height of non-native vegetation 30ft

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated June 11, 2013*

Site: Jaralosa page _____

Photo Point Records

Date mm/dd/yy	Photo Point Code	Cam.Photo Number	View Dir. (compass)	GPS Coordinates (Lat. / Long.)	Description
10-19-2016	J1	1	180	32°44'57.1284 N	South @ PA mesquite and saltcedar
		2	270	107°17'03.0140W	West @ PA " "
		3	340		North @ PA note dead cottonwood
		4	90		East @ PA mesquite and dead cottonwood
	J2	5	N	32°44'57.9994 N	JARMW-2
		6	E	107° 17'04.0595 W	
		7	S		
		8	W		
	J3	10	N	32°44'52.4966 N	JARMW-3
		11	E	107°17'00.4007 W	
		12	S		
		13	W		
	J4	14	SW	32°44'51.9376 N IBWC	Construction sign w/ J PA swale in background
		15	W	107°16'59.5403 W	"
		16	NW	32°44'48.5748 N	"
	J5	17	SW	107°16'59.7281 W	
		18	W		
		19	NW		
	J6	2321	N	32°44'49.7300 N IBWC	construction sign
		2422	E	107°17'02.2533 W	
		2523	S		
		2624	W		bankline
	J7	28	E	32° 44'58.0854 N	PA swale
		29	S	107°17'06.7132 W	PA
		30	SW		PA - river bank
10-20	J1	31	S	See Trimble	IBWC construction sign & View E project area - New
		32	W		"
		33	N		"
	J2	34	S	See Trimble	From IBWC Survey Monument on top of levee road
		35	W		Overlooking View E PA
		36	N		

Site: Yess E

Photo Point Records

page _____

Date mm/dd/yy	Photo Point Code	Cam.Photo Number	View Dir. (compass)	GPS Coordinates (Lat. / Long.)	Description
10-20-2016	Y3 - YEMW3	37	N	See Trimble	YEMW3
		38	E		"
		39	S		"
		40	W		"
	Y4	41	N		YEMW2
		42	E		"
		43	S		"
		44	W		"
	—	45	N		From river looking at Yess West
	—	46	SE		backside of Yess West
	Y5	47	S		View from Yess East looking across
		48	W		river at Yess West
		49	NW		
	C1	50	S		overlooking N end of Crow Canyon C
		51	W		
		52	NW		
	C2	53	S		overlooking CCBMW3
		54	W		
		55	NW		
	C3	56	S		overlooking S end of Crow Canyon C
		57	W		
		58	NW		

Participants Conner Flynn + Cody Strapki Date 11/15/2016

Groundwater Levels Monitoring Field Sheet

Site	Well ID	TOC Elevation	Ground Surface Elevation	Casing Height	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Crow Canyon C	CCB-MW-3	4074.22	4070.92	3.30	11-15-2016	12:30	NA		obstructed
Jaralosa	JAR-MW-1	4095.74	4093.43	2.31		10:30	9.1	6.79	
	JAR-MW-2	4097.23	4094.32	2.91		10:30	9.5	6.59	
	JAR-MW-3	4095.86	4093.04	2.82		10:30	8.6	5.78	
Yeso East	YE-MW-1	4093.98	4090.86	3.12		11:30	11.0	7.88	
	YE-MW-2	4094.18	4090.68	3.50		11:30	[redacted]12.1	8.6	
	YE-MW-3	4093.01	4090.13	2.88		11:30	[redacted]10.6	7.72	

USIBWC Rio Grande Canalization Project Restoration Site Monitoring Program *last updated May 10, 2016*