

GENERAL REEVALUATION REPORT AND
SUPPLEMENTAL ENVIRONMENTAL
IMPACT STATEMENT II:

RIO GRANDE FLOODWAY,
SAN ACACIA TO BOSQUE DEL APACHE UNIT,
SOCORRO COUNTY, NEW MEXICO

APPENDIX C
ENDANGERED SPECIES
ACT CONSULTATION

BIOLOGICAL ASSESSMENT



DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE NM 87109-3435

May 8, 2012

Planning, Projects and Program Management Division
Planning Branch

Mr. Wally Murphy
U.S. Fish and Wildlife Service
Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113

Dear Mr. Murphy:

As a follow-up to your office's comments dated January 26, 2012, the U.S. Army Corps of Engineers, Albuquerque District (Corps) is providing clarifying background information for the ongoing consultation with the U.S. Fish and Wildlife Service (Service) on the San Acacia to Bosque del Apache Unit of the Rio Grande Floodway Project. To this end, enclosed is the updated *Programmatic Biological Assessment of U.S. Army Corps of Engineers' Rio Grande Floodway, San Acacia to Bosque del Apache Unit, Socorro County, New Mexico*.

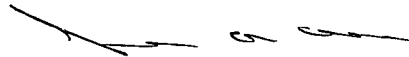
The Biological Assessment (BA) provides supplemental information to clarify project design and the Corps' effects determination of the proposed action on federally listed species and designated and/or proposed critical habitat occurring from the San Acacia Diversion Dam downstream along the Rio Grande to San Marcial.

The Corps appreciates the Service's discussion on our BA provided during our meeting on January 31, 2012. We concur that a programmatic Biological Opinion (BO) is appropriate for the proposed action to provide flexibility for project implementation and species protection over the approximately twenty-year construction period. The Corps has included sections for annual monitoring and reporting to support the programmatic BO, and addressed other comments to the extent possible in the updated BA.

Formal Section 7 consultation on the proposed action was initiated on December 7, 2011, with the submittal of a Biological Assessment. With the submittal of the enclosed clarifying information, the Corps agrees to extend the formal consultation period. The Corps requests that Service provide a draft programmatic Biological Opinion no later than June 11, 2012, in order to stay on schedule to award a construction contract for the project during next fiscal year.

If you have any questions, please contact me at 505-342-3281 or Mr. William DeRagon, Biologist, at 505-342-3358.

Sincerely,



Julie A. Alcon
Acting Chief, Planning Branch

Enclosure

Copies Furnished:

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COMMENTS & RECOMMENDATIONS
On the
U.S. ARMY CORPS OF ENGINEERS BIOLOGICAL ASSESSMENT
For the
SAN ACACIA TO BOSQUE DEL APACHE UNIT
SOCCORO COUNTY, NEW MEXICO

General information: The Corps has revised the BA to include the clarifying information requested; and we took the opportunity to edit it for general readability and clarity. The text within a given chapter (especially Chs. 1, 2, and 5) have been rearranged. We attempted to preserve all edits through MS-Word's track-change feature; however, the results quickly became more of a disservice to the reader than a help. Despite substantive revisions in the text, the effects determination regarding the proposed action remains the same. Appendix A has been updated with more detailed information; and Appendix B (floodplains) has been added.

May 4, 2012

- 1) The BA contains no executive summary. However, this is not a hard and fast requirement, and the introduction includes all of that information.

Response: The Introduction and the summary of effects section provide a brief summary of the document. An executive summary was not considered in a document of this rather small size and pointed topic.

- 2) If there were an executive summary, it would include the table on page 86, so suggest adding a sentence to the end of the last paragraph in the introduction to let the reader know that it is there.

Response: A sentence referring to the summary table was added to end of the Introduction.

- 3) The table on page 86 needs to be revised to be consistent with the NLAA conclusion on page 78.

Response: The Table has been revised.

- 4) The conclusions on page 85 need to be revised consistent with the conclusions on page 78.

Response: The text has been revised.

- 5) Maps of the 14 individual reaches would be helpful in supporting the mitigative value of staged construction, and give the reader a better understanding of the project.

Response: Table 2.2 describes the six segments of phased construction.

- 6) Habitat restoration proposed as a conservation measure is not described sufficiently to assess the aggregate effect after considering offsetting measures. A generalized location, total acreage and general habitat type is provided, but more detail is necessary to assess the adequacy in offsetting effects of the proposed action.

Response: The descriptions of riparian vegetation effects and mitigative plantings has been revised.

January 26, 2011

- 7) Timing of construction needs to be clear. Not clear whether all construction activities except vegetation management will occur year-round.

Response: The text has been revised accordingly.

- 8) Duration of the consultation is not clear. What is the life of the project? The non-federal O&M extends to perpetuity or when?

Response: The following was added to Section 2.2.1: The Corps regularly considers 50 years as the functional life of flood control structures. Non-Federal operations and maintenance requirements extend to perpetuity.

- 9) How long will the temporary river crossing be deployed? Discussion of placing it is included but no discussion of how it will be removed.

Response: See revised text in Sections 2.2.2 and 5.1.1.

- 10) The heart of the BA should be analysis of effects of the action on endangered species. Section 5 reads like a summary and covers some aspects of effects but is not comprehensive.

Response: The text has been revised accordingly.

- 11) Why are 3 LFCC pumping stations going to be made permanent through the levee? Wouldn't it be better to say there is flexibility depending on the next Water Ops BO and/or future adaptive management?

Response: Concur. See revised text in Section 2.2.7.

- 12) There still does not seem to be sufficient detail on some aspects to assess effects – how far are flycatcher territories from construction areas/ from habitat to be removed? Still no description of the effect on the side channel abutting the spoil levee in the refuge reach.

Response: Additional detail on the location of flycatcher territories was included in Section 5.1.3, and in GIS shapefiles provided under separate cover. The ephemeral channel is discussed in Section 5.1.4.

- 13) No effect determinations were made for sunflower, falcon, and least tern. This is an action agency responsibility and we generally don't spend time on these species unless we have overwhelming reason to believe there are effects that should be considered.

[No response necessary.]

- 14) Candidate species NM meadow jumping mouse and Yellow billed cuckoo were not assessed. This will be a trigger for reinitiation in the future when/if the species are listed. This may occur before construction is completed. While candidate species are not afforded protection under the ESA, and need not be included in the BA, it would be helpful to state that should they become listed species the project would re-initiate consultation for them, if necessary.

Response: Section 2.2.13 mentions the criteria for reinitiation, including the listing of new species.

- 15) Difficult to understand if the San Marcial railroad bridge is a limiting factor on flood releases or not. First sentence Section 3.3.3 seems to mean that Corps flood operations are affected by the presence of the bridge but this is followed by lots of narrative of why the Corps did not replace it, and it contradicted by last sentence of this same section.

Response: The text was revised to clarify that the bridge is a restriction to unregulated flood flows, but does not restrict the regulated flow from upstream reservoirs.

- 16) Table 2.2 on page 17 is hard to interpret. Does it mean that with the new levee that there will be almost ½ less overbanking flow?

Response: This table (now Table 5.3) indicates that the new levee would eliminate inundation of lands west of the spoil bank / new levee alignment. The Corps refers to this area as the “floodplain”, and uses “overbank” to refer to the out-of-channel area within the floodway.

- 17) There is no mention of the PCEs for the flycatcher. A discussion of their presence or absence in areas where woody vegetation is necessary in the analysis of effects.

Response: Chapters 4 and 5 have been revised to include discussion of flycatcher PCEs.

- 18) There is no monitoring plan.

Response: Monitoring is now described Section 2.2.13.

- 19) There is no reporting plan.

Response: Annual reporting is now described Section 2.2.13.

- 20) The Collaborative Program deserves a discussion of its own.

Response: As a long standing participant in the Collaborative Program, the Service is fully informed about the breadth of activities on the Middle Rio Grande. The BA references numerous reports funded by the Program that contribute directly to the baseline and analysis.

- 21) There is no mention of any coordination with the New Mexico Department of Game and Fish.

Response: The NM Dept of Game and Fish has been requested to review and comment on the proposed plan, specifically the General Reevaluation Report / Supplemental EIS (GRR/SEIS). There was no specific coordination for Section 7 consultation.

- 22) The discussion on the placement of riprap states that it will be when the area is dry and should conclude NLAA or no effect to the minnow.

Response: Concur. See revised text in Section 5.1.5.

- 23) Relocation of fish from construction areas is a form of take and is adverse.

Response: Agree. The following text was added to Section 2.2.2: “Cofferdams and silt curtains would be deployed to minimize disturbance to fish in the immediate area. These barriers

would be deployed by Corps biologists from the shoreline into the current to exclude fish from the area where the temporary ramp is constructed. These barriers also would be deployed to exclude fish from the construction activities when the ramp is removed.” Service determines effects and take.

- 24) The analysis for the soils cement/riprap states that water velocities at SADD are too high for the minnow. The riprap would reduce the velocity of water and create some backwater refugia that could be used by the minnow at lower flows. Since some PCEs are lacking, why the adverse modification conclusion? [There are plenty of minnow near SADD, so perhaps that discussion was an oversimplification. Adverse modification could result from the soil cement and/or the temporary road placed in the river?]

Response: PCEs for minnow habitat are described in Section 4.1.1. PCE iii is specific to substrate type. The text in Section 5.1.2 has been revised regarding loss of aquatic habitat area, conversion of sand substrate (PCE) to soil cement. Riprap will not be used at this site based on more recent design.

- 25) 2.1, p. 7: “Prior to LFCC construction, the channel into Elephant Butte Reservoir was obstructed with sediment and vegetation such that no surface flows entered the reservoir...”. Does this mean no flows ever, or just under some or most conditions?

Response: The latter condition is implied. The text in Section 1.2 was revised to read: “Prior to LFCC construction, the channel into Elephant Butte Reservoir was obstructed with sediment and vegetation such that surface flows entered the reservoir were reduced, resulting in an estimated water loss of 140,000 acre-feet per year.”

- 26) 2.1, p. 8: “Average annual water salvage ranges from 35,000 to 66,000 acre-feet during full operation.” We were told on the field trip that the LFCC and this is verified by other sources that the LFCC is no longer used to divert flows but only captures drainage. Please expand the description of the operation of the LFCC to clarify its current management. Are any of the water saving actually being achieved these days, perhaps consisting of water drained from the agricultural areas?

Response: The text states accurately that the Bureau of Reclamation does not currently operate the LFCC for its intended purpose. The state water savings refer to the “when-operated” period between 1962 and 1985 (approximately). The LFCC does passively function as an riverside drain currently.

- 27) 2.1, p. 8: “Elephant Butte Reservoir storage increased in the early to mid-1980s, inundating and burying the last 15 miles of the channel above the reservoir with sediment.” Clarify that this, along with difficulties with maintenance of alternate reentry points for the LFCC, are the reasons that diversions into the LDCC have largely or entirely stopped.

Response: The text in Section 1.2 was revised accordingly.

- 28) 2.1.1, p. 9: “The new levee cross section is narrower than the existing non-engineered spoil bank...”. This is mostly true but not always true. Also, should point out that the new levee is higher than spoil bank. New levee is expected to prevent the spoil bank overtopping or other failure issues that are expected without it.

Response: The description of the proposed levee was revised accordingly.

January 26, 2011

- 29) 2.2.1, p. 11: Text states: "Error! Reference source not found". Please provide reference.

Response: The erroneous links to tables and figures have been corrected.

- 30) 2.1.1, p. 12: Clarify vegetation and habitat characteristics of Tiffany Basin disposal site. These are not discussed elsewhere in the document. There needs to be a discussion of impacts, or lack thereof as the case may be, for this component of the project at the appropriate locations in the document. This is 300 acres that will receive spoil. It needs to be clear what habitat will be lost and restored or where nearest flycatcher territories are.

Response: The revised BA addresses these topics in Section 5.1.8.

- 31) 2.2.4, p. 14: Provide more information on the vegetation management zone and levee management. Mowing will be required once or twice a year, forbs will need to be controlled (see below), and rodents will be controlled which will probably mean using poison bait.

Response: More information has been provided within Section 2.2.6 for clarity and understanding.

- 32) 2.2.7, p. 15: Presumably no vegetation would grow on the soil cement areas. If true, this should be made explicit.

Response: Vegetation would not grow on or within the soil-cement slope after construction. See revised text in Section 2.2.4.

- 33) 2.2.9, p. 17, Conservation measure 2: Consider rerouting major construction traffic that would travel close to occupied flycatcher nests where this is practical. In some areas alternate access routes are available.

Response: This conservation measure has been reworded and clarified.

- 34) 2.2.9, p. 17, Conservation measure 3: Please clarify what is meant by flycatchers being present. Does this mean just a sighting of a bird or does it mean nesting activity as on page 77? (also on page 76)

Response: This has been reworded and clarified to indicate that it means any bird present, migrant or territorial.

- 35) 2.2.9, p. 17, Conservation measure 5: Change "the watercourse" to "any watercourse"; otherwise, specify the Rio Grande if that is the only intended watercourse.

Response: Corrected as suggested.

- 36) 3.3.2, p. 28: State why flooding of Tiffany Basin is a concern if there are no facilities or farmland within the basin (for example, that water ponded there after a flood would be lost to downstream use).

Response: Section 3.3.2 has been revised accordingly.

- 37) 4.2.3, p. 56, Flycatcher Breeding Habitat: Provide affiliations for D. Ahlers and M. Sogge.

Response: Corrected as suggested.

- 38) 4.2.3, p. 63: The lower incidence of cowbird parasitism on flycatcher nests in the Elephant Butte habitat areas may be due to greatly reduced riparian habitat fragmentation in this area due to more favorable conditions for denser and more continuous riparian growth. See Morrison and Hahn (2002). This has implications for the evaluation of both impacts and mitigation.
- 39) 5.1, p. 71: It would be helpful to include typical cross sections to show the differences between the work upstream and downstream of Highway 380. It would be helpful to include a variety of cross sections of the current spoil levee and the future levee at that location and assess the encroachment.

Response: Typical cross-sections are contained in Appendix A, Sheet C-141.

- 40) 5.1, p. 71-72: It is not clear how Action 1 and Action 2 are different as described. Both descriptions of the actions primarily address the encroachment of the levee on the floodway. It would make more sense to consolidate encroachment effects under one discussion and construction effects (noise, traffic, temporary disturbance, etc.) under the other.

Response: Chapter 5 has been revised to more clearly describe the effects of different project features and activities.

- 41) 5.1, P. 73: The NLAA determination needs further rationale. It appears that there are net gains in the floodway area and potential long-term gains in nesting habitat, but some nesting habitat is still lost in the short term. The quality of the habitats lost and gained are not detailed. Generally, if there are losses of habitat occupied by breeding flycatchers, that is an adverse determination; if suitable but unoccupied habitat is lost and is re-created elsewhere that could be not adverse; if there is a drop in groundwater elevation in riparian areas that causes loss in native vegetation (we see this when the river bed elevation drops), this could be adverse if it affects territories. The bigger picture potential effect is the future effect of continuing the river's confinement. The BA acknowledges the negative effects that dams, levees and drains, diversions, and flow regulation have had. This project perpetuates part of those effects.

Response: The discussion of affected vegetation has been clarified in Section 5.1.1. Regarding the 'future condition: Should the existing spoil bank be breached or damaged, it would be immediately rebuilt on the same alignment. The future condition is the same for the with- and without-Corps-project conditions for discharges less than the breaching/ damaging flow (of approx. 11,800 cfs). The differential effect of the Corps proposed action relates to the confinement of flows greater than 11,800 cfs with the floodway.

- 42) 5.1, P. 74: ETL 1110-2-571 allows only perennial grasses (paragraphs 4-8), not "grasses and most herbaceous plant species". This implies removal of forbs by means of herbicides, and also negates planting of forbs in the vegetation-free zone.

Response: Section 2.2.6 has been revised accordingly.

- 43) 5.1, p. 75: Would any of the riparian forest plantings in Tiffany Basin be close enough to water to potentially serve as willow flycatcher habitat? This piece of information is essential to determining whether any of these plantings may qualify as mitigation for project impacts to this species.

Response: The location and type of plantings in Tiffany Basin are discussed in Section 5.1.8. These would consist of upland vegetation and would not likely be utilized by the flycatcher.

- 44) 5.1, p. 76: Why is the amount of riparian forest to be removed by the project exactly equal to the amount of space that is *suitable* for riparian forest mitigation?

Response: Their numeric similarity was coincidental.

- 45) 5.1, Action 5, p. 77: Text states that “This offset would replace...” does not explain what the offset is. Presumably this refers to the excavation work on the east bank discussed lower on the page; if so, this work should be referenced here. Also, the reference to water velocities should compare these to the no-action condition. I also note that the habitat removed by the excavation of about 12.4 acres is not described. For minnow, the construction of this excavation is very important for determining potential take of minnow. Needs details.

Response: The text clarifies this discussion in Sections 2.2.2 and 2.2.4, and in Sections 5.1.1 and 5.1.2.

- 46) 5.1, Rio Grande Silvery Minnow, p. 77: The statement that the west bank for 0.75 mile downstream of the SADD is “generally unsuitable for silvery minnows and other fish species because of very high water velocities in this area” seems to refer to flood flows. This bank currently has riparian forest along its entire length and may provide habitat for this species under low-flow conditions. Habitat conditions here under varying flow conditions and their relationship to the vertical location of proposed channel modifications should be clarified. (also on page 79)

Response: This analysis focuses on in-channel baseflow along vertical bankline. The aquatic habitat where the soil cement wall would be installed has high water velocities as a function of river width, local slope, etc. The high water velocity is why a soil cement wall is appropriate for bank protection, and why this area is unsuitable as minnow habitat.

The comment is correct in stating that as flow increases, there will be increased area of low-velocity habitat in other areas of the channel. There is an area of low velocity habitat across the channel.

- 47) 5.1, Action 7, p. 79: The discussion of the 1% and 10% floods does not adequately address the effects under the no-action alternative of such a flood (or any flood large enough to cause the spoil bank to fail). In such an event, the river would flood the agricultural lands normally protected by the spoil bank. This would leave large amounts of sediment on these lands, and in the downstream reaches large amounts of water unable to return to the floodway. The flow predictions are confusing – a quick online search reveals that there have been no discharges above 9,500 cfs at San Acacia at least since 1959 (the plot downloaded).

Response: The revised text in Section 5.1.6 discusses these topics.

Regarding flow predictions: The flood discharges and frequencies (Table 3.1) were based on standard Corps methodology, including the annual peak discharge series, and certified hydrology. These are explained in detail in the GRR/SEIS and its appendices.

- 48) Breaches in the spoil bank and resulting flooding could have a variety of effects, including temporary scouring, down-cutting, and loss of riparian forest near breaks in the spoil bank, stranding of fish in the agricultural area, channel avulsion from the floodway into the agricultural area (at least until corrected by Reclamation), habitat impacts due to prolonged flooding on the BDANWR, or abandonment of some agricultural lands after an extreme flood event due to soil and infrastructure damage. Such effects could have both negative and positive impacts on listed species.

January 26, 2011

Response: The revised text in Section 5.1.6 discusses these topics.

- 49) The proposed project would not eliminate the potential for these flooding effects and their potential impacts on listed species. However, it would greatly decrease their probability in any one year and the number of times they occur over the life of the project, relative to the no-action alternative.

Response: This has been acknowledged in Section 4.2.3.

- 50) Another consideration is the extent to which this change in flood regime could affect river and floodplain morphology and dynamism. While upstream dams and reservoirs reduce flood peaks, keeping more of the remaining flood flows within the remaining floodway and habitat area through levee construction may partially compensate for this condition. The return of somewhat higher flood peaks may result in a more dynamic river channel and floodplain. Losses of riparian vegetation due to floods may increase but this could also mean greater regeneration and development of more of the young age classes of riparian vegetation which can provide nesting habitat for the willow flycatcher.

Response: The revised text in Section 5.1.6 discusses these topics.

- 51) There is also the question of the long-term sustainability of the current and future project area. Is sediment accumulation in the floodway expected to continue, worsening the problem of the elevation differential between the floodway and the agricultural area and the drain in downstream areas? In the long term this would be expected to make the existing floodplain on the west bank of the river less and less suitable for riparian forest due to the ground surface continuing to elevate in relation to the water table which is controlled by the LFCC. This also might or might not affect the amount of surface flow in the river, depending on whether infiltration would increase or not in response to the water table being deeper.

Responses: The information for this comment has been updated and can be found within Section 3.03.2.

- 52) The discussion of effects on the silvery minnow should relate the <2 feet/second criterion used in the discussion with known responses of the silvery minnow to water velocities. I am not convinced that the flood flows will occur enough to cause high velocities often enough to even be considered as an effect on silvery minnow. Plus I thought it was stated that there are plenty of low velocity habitats available even at the highest peaks. Similarly, the increase in river stage due to high flow is so infrequent that it probably cannot be considered of any benefit to riparian vegetation.

Response: Concur. High water velocities occur within the normal range of flow at this site. See Section 5.1.2 and 5.1.6.

- 53) 5.4, p. 85: Discussion of Pecos sunflower should address the potential for this species to be found in the impact area. Given the lowered water table caused by the LFCC this is very unlikely, but this reason should be stated.

Editorial Clarifications and Corrections

General

- 1) Suggest that the indicative mood (will, etc.) or subjunctive mood (would, etc.) be used consistently throughout the document as appropriate rather than interchangeably.

January 26, 2011

Response: "Will" has been replaced with "would" throughout the document for consistency.

Specific

- 1) 1.4, P. 5: Change the name of NEPA to National Environmental *Policy* Act.

Response: Corrected as suggested.

- 2) 2.1, p. 7, line 36: insert "to" in front of "the Rio Grande".

Response: Corrected as suggested.

- 3) 2.2.7, p. 15, line 22: Text states "2.5 to 1 foot side slopes". Does this mean 2.5 to 1 side slopes, or side slopes that are 1 to 2.5 feet tall?

Response: 2.5 ft horizontal to 1 ft vertical, corrected in text.

- 4) 2.2.8, p. 15: Text states "This condition exists from approximately the city of Socorro and increases in the downstream direction...". Insert "downstream" after Socorro. Also, text states "For the 1% chance flood, depth in the floodway floodplain averages approximately 3 feet with some low lying areas reaching depths of up to 10 feet." Please reword to show this is the future condition with the project, not the present condition.

Response: The text in Section 5.1.6 has been revised accordingly.

- 5) 2.2.9, p. 17, Conservation measure 9: Insert "would" before "include".

Response: Corrected as suggested.

- 6) 2.2.9, p. 18, Conservation measure 10: Text states "...no leaks or discharges or lubricants, hydraulic fluids, ...". Is this supposed to read "...no leaks or discharges of lubricants..."?

Response: Corrected as suggested.

- 7) 3.3.2, p. 27: "The existing spoil bank limits meandering to the areas within the spoil banks...". The significant spoil bank is on only on one side of the river so this does not make sense. Suggest rewording to "limits meandering to the area east of the spoil bank". Corrected as suggested.

- 8) 4.2.3, p. 64: "Levees drains have greatly restricted..." Please clarify text.

Response: Sentence was revised to read: "Spoil banks have restricted the extent of floodplain inundation from discharges up to 7,000 or 10,000 cfs and, along with their attendant riverside drains, have functionally separated the river from most of the historical floodplain."

- 9) 4.5.2, p. 69: Correct *Sporobolus airoide* to *Sporobolus airoides*.

Response: Corrected as suggested.

January 26, 2011

10) 5.1, P. 74: Change “with the Tiffany Basin” to “within Tiffany Basin”.

Response: Corrected as suggested.

11) 5.1, p. 79: Change “29.900 cfs” to “29,900 cfs”.

Response: Corrected as suggested.

Reference used in Comments

Morrison and Hahn (2002) Geographic Variation in Cowbird Distribution, Abundance, and Parasitism, IN Effects of Habitat Fragmentation on Birds in Western Landscapes: Contrasts with Paradigms from the Eastern United States, T. Luke George and David S. Dobkin, ed. Studies in Avian Biology No. 25, Cooper Ornithological Society.



**US Army Corps
Of Engineers**
Albuquerque District

**PROGRAMMATIC
BIOLOGICAL ASSESSMENT OF
U.S. ARMY CORPS OF ENGINEERS
RIO GRANDE FLOODWAY,
SAN ACACIA TO BOSQUE DEL APACHE UNIT,
SOCORRO COUNTY, NEW MEXICO**

November 28, 2011

With clarifying information added on May 4, 2012

Prepared by
U.S. Army Corps of Engineers
Albuquerque District, New Mexico

CONVERSION FACTORS

| | From | Multiplier | To |
|-----------------|---------------------------------|-------------|--------------------------------------|
| Distance: | inches (in) | 25.4 | millimeters (mm) |
| | feet (ft) | 0.3048 | meters (m) |
| | miles (mi) | 1.6093 | kilometers (km) |
| Area: | acres (ac) | 0.0407 | hectares (ha) |
| | square miles (mi ²) | 2.590 | square kilometers (km ²) |
| Volume: | cubic yards (CY) | 0.7646 | cubic meters (m ³) |
| | acre-feet (ac-ft) | 1,233.5 | cubic meters (m ³) |
| | acre-feet (ac-ft) | 325,851 | gallons (gal) |
| Discharge: | cubic feet/second (cfs) | 0.0283 | cubic meters/second (cms) |
| Mass (weight) : | tons [short] | 0.9072 | metric tons [long] |
| Velocity: | feet/second (fps) | 0.3048 | meters/second (cms) |
| Salinity: | μSiemens/cm | 0.32379 | parts/million NaCl |
| | or μmhos/cm | | or mg/liter NaCl |
| Temperature: | ° Fahrenheit (°F) | (°F-32)/1.8 | ° Celsius (°C) |

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1. Introduction

1.1 Scope of the Biological Assessment

The U.S. Army Corps of Engineers (Corps) is submitting this Programmatic Biological Assessment (BA) to the U.S. Fish and Wildlife Service (Service) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA). This BA evaluates the effects of the Corps' Rio Grande Floodway, San Acacia to Bosque del Apache Unit actions on federally listed species and designated critical habitat in the proposed action area within the Middle Rio Grande valley of New Mexico.

Because of the relatively long duration of anticipated construction (approximately 20 years), this consultation is being conducted programmatically. During the construction period, changes in design, construction methods, or the condition of ecological resources could alter the determinations of effects made by the Corps or Service at the present time. Should there be a change in the determination of effects, or in the suitability of stipulations of the Biological Opinion or Incidental Take Statement, the Corps would provide to the Service a supplemental BA tiered to this Programmatic BA. The Corps also will provide annual reports on progress to the Service during the construction period.

When determining the proposed action for this consultation, the Corps carefully considered the water management activities of non-Federal and other Federal entities in the action area. Activities appropriate for inclusion as a proposed action are those that are discretionarily authorized, permitted, funded, or implemented by the Corps. Additionally, activities that are interdependent or interrelated (as defined in 50 CFR §402.02) with our primary actions could be included as a proposed action in this BA. None of the water management activities of other entities met these criteria for inclusion. Therefore, the proposed action in this Section 7 consultation includes construction, operation and maintenance of the Rio Grande Floodway, San Acacia to Bosque del Apache Unit. The proposed action is described in detail in Chapter 2 of this BA.

This BA considers the effects of the Corps' proposed action on Federally listed species and their designated critical habitat occurring from the San Acacia diversion dam (SADD) downstream along the Rio Grande to the area referred to as Tiffany Junction just north of San Marcial, New Mexico. A detailed description of the action area is provided in Section 2.1 of this document. The BA focuses on the endangered Rio Grande silvery minnow (*Hybognathus amarus*) (minnow), the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (flycatcher), the endangered Interior Least Tern (*Sternula antillarum athalassos*) (tern), the endangered Northern Aplomado Falcon (*Falco femoralis*) (falcon), and the threatened Pecos sunflower (*Helianthus paradoxus*) (sunflower).

The remainder of this chapter summarizes the general location, description of the project authorization, and purpose and need for the action. Chapter 2 includes a detailed description of the proposed action. Chapter 3 describes historic and existing conditions. Chapter 4 contains detailed information regarding the status of listed species. Chapter 5 includes the analysis of proposed action. Table 5.4 summarizes the Corps' determination of effects.

1.2 Study Area Location and Description

The study area comprises a stretch of the Rio Grande extending from the San Acacia diversion dam (SADD), near the historic community of San Acacia, south through the Bosque del Apache National Wildlife Refuge (BDANWR) to the headwaters of the U.S. Bureau of Reclamation's (Reclamation) Elephant Butte Reservoir, south of the former village of San Marcial. The action area is largely contained within Socorro County, New Mexico. The City of Socorro, New Mexico is the largest population center within the county. The study area is shown on Figure 1.1

The Rio Grande stretches approximately 2,000 miles from its headwaters in the San Juan Mountains of southwestern Colorado to its terminus in the Gulf of Mexico near Brownsville, Texas. The Rio Grande is the fifth longest river in North America and the 20th longest in the world. The watershed measures approximately 336,000 square miles (mi^2), although only about half of the total area, 176,000 mi^2 , contributes to the river's flow. The Rio Grande passes through three states in the United States (Colorado, New Mexico, and Texas) and four in the Republic of Mexico (Chihuahua, Coahuila, Nueva Leon, and Tamaulipas). The Rio Grande, known as the Rio Bravo in Mexico, forms the international boundary between Texas and Mexico. In 1997, the U.S. Environmental Protection Agency designated the Rio Grande as an American Heritage River.

The Albuquerque District maintains jurisdiction over what is known as the Upper Rio Grande Basin, which is defined as that part of the river upstream of Fort Quitman, Texas. Within this reach, the river measures approximately 700 miles in length with a drainage area of approximately 30,000 mi^2 . The Continental Divide forms the western boundary of the Upper Rio Grande Basin while the Sangre de Cristo, Sandia, and Manzano Mountains, and a series of north-south mountain ranges form the eastern boundary.

The major Upper Rio Grande tributaries in Colorado and New Mexico are, from north to south, the Conejos River (watershed area: 821 mi^2), Rio Chama (watershed area: 3,150 mi^2), Galisteo Creek (watershed area: 670 mi^2), Jemez River (watershed area: 1,038 mi^2), Rio Puerco (watershed area: 6,057 mi^2), and Rio Salado (watershed area: 1,394 mi^2). The Rio Grande watershed upstream of El Paso, Texas, also contains five closed basins: San Luis in Colorado (watershed area: 2,884 mi^2), the Llano de Albuquerque (watershed area: 147 mi^2), North Plains (watershed area: 1,373 mi^2), San Agustin Plains (watershed area: 1,990 mi^2), and Jornada del Muerto (watershed area: 3,316 mi^2) in New Mexico.

The Middle Rio Grande refers to the portion of the Upper Rio Grande Basin that passes through central New Mexico and is typically defined as extending from Cochiti Dam downstream approximately 160 miles to San Marcial and the head of Elephant Butte Reservoir. The Middle Rio Grande Valley extends across four New Mexican counties (from north to south: Sandoval, Bernalillo, Valencia, and Socorro) and six Pueblos (Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta). The Pueblos of Jemez, Santa Ana, and Zia are located along the Jemez River, a tributary to the Rio Grande. The cities and towns of Bernalillo, Rio Rancho, Corrales, Albuquerque, Los Lunas, Belen, and Socorro are located within the Middle Rio Grande Valley.

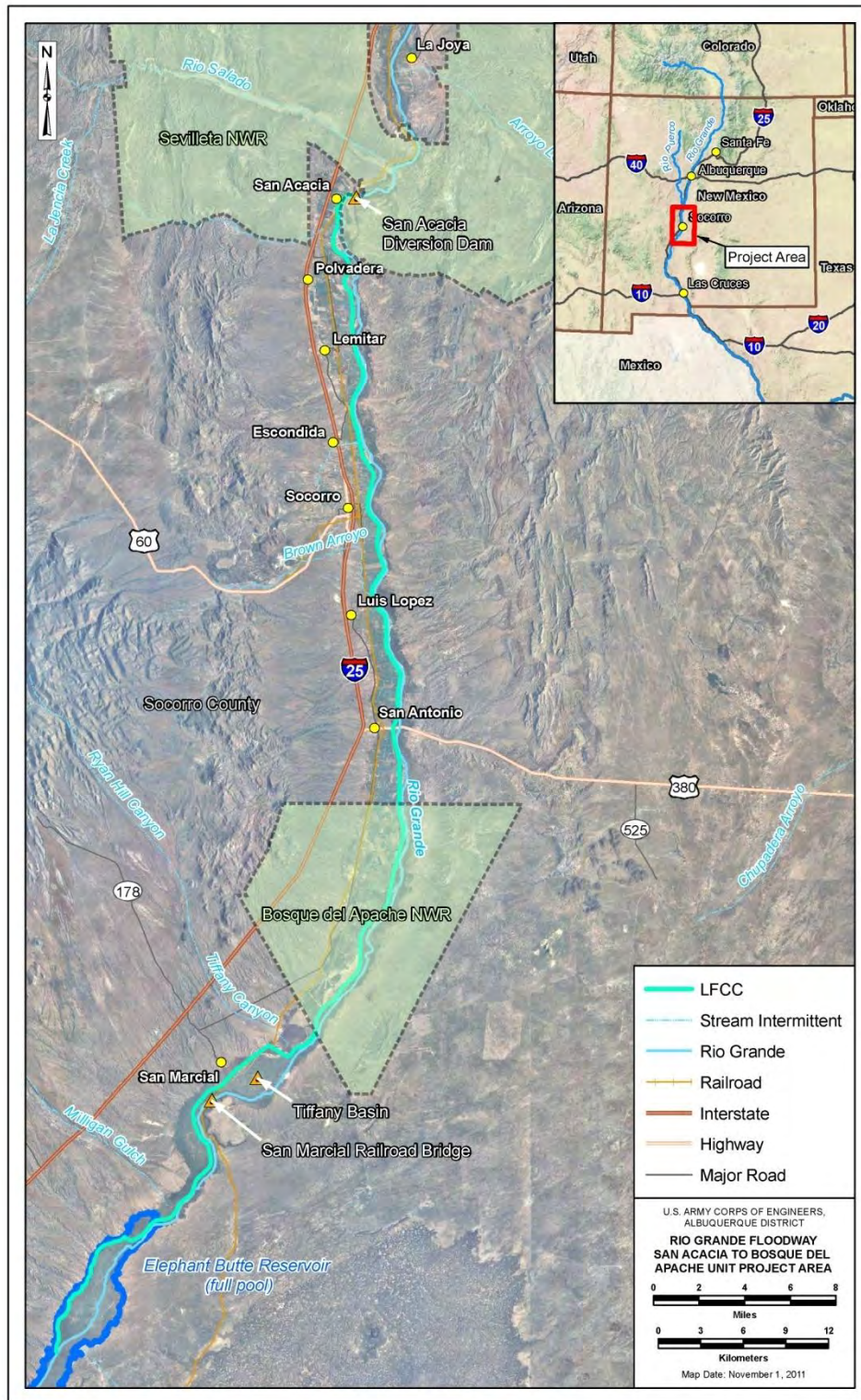


Figure 1.1. Map of study area.

The San Acacia to Bosque del Apache Unit is the southern-most section of the Middle Rio Grande Valley, comprising the 58 miles between the SADD and the northern end of Elephant Butte Reservoir just below the San Marcial Railroad Bridge. The principal city in this reach is Socorro with a 2010 census population of 9,051 (U.S. Census Bureau 2011). In addition, six small agricultural villages occur on the flood plain: Polvadera, Lemitar, Escondida, Luis Lopez, San Antonio, and San Marcial. The western boundary of this section of the river basin is marked by the Magdalena, Chupadera and Lemitar Mountains and the eastern boundary by a series of lower ranges.

In the San Acacia to Bosque del Apache Unit, the principal land and facility managers in the valley include the Middle Rio Grande Conservancy District (MRGCD), Reclamation, and the Service. The New Mexico Office of the State Engineer (NM OSE) and the New Mexico Interstate Stream Commission (NM ISC) administer water rights and address Rio Grande Compact compliance. Elephant Butte Reservoir, immediately downstream of the action area, is the largest reservoir in New Mexico, storing water for irrigation, hydroelectric power, and recreation. Three major Federally owned facilities within the area of consideration are the Service's Bosque del Apache and Sevilleta National Wildlife Refuges, and Reclamation's Low Flow Conveyance Channel (LFCC) (Figure 1.1).

BDANWR encompasses 57,191 acres straddling the Rio Grande within the project area between the towns of San Antonio and San Marcial. The heart of the BDANWR is about 12,900 acres of moist bottomlands--3,800 acres are active flood plain of the Rio Grande and 9,100 acres are areas where water is diverted to create extensive wetlands, farmlands, and riparian forests. The goal of refuge management is to provide habitat and protection for migratory birds and endangered species and provide the public with a high quality wildlife and educational experience (USFWS 2010). BDANWR cooperates with local farmers to grow crops for wintering waterfowl and cranes. Farmers plant alfalfa and corn, harvesting the alfalfa and leaving the corn for wildlife. The refuge staff grows corn, winter wheat, clover, and native plants as additional food.

In addition to farming, natural and created habitats are managed to provide wildlife habitat. Prescribed burning, exotic plant control, moist soil management, and water level manipulation are used to maintain these habitats. Wetlands within created impoundments are managed via irrigation and water level manipulation. Marsh management is rotated so that varied habitats are always available for resident and migratory wildlife. Wildlife foods grown this way include smartweed, millets, chufa, bulrush, and sedges. Irrigation canals ensure critical water flow. Daily monitoring, along with occasional mowing and clearing, keeps them functioning. Controlling the water enables refuge staff to manage the habitat (USFWS 2010).

The LFCC, completed in 1959, is an artificial channel that runs parallel to the Rio Grande between San Acacia, New Mexico, and Elephant Butte Reservoir. Reclamation built the LFCC as part of the 1948 Rio Grande Basin authorization for the purpose of reducing consumption of water, providing more effective sediment transport, and improving valley drainage. Operation and maintenance of the LFCC are continuing Reclamation responsibilities.

The LFCC was constructed by Reclamation to aid the State of New Mexico in the delivery of water obligated to Texas under the Rio Grande Compact (Compact). Prior to LFCC construction, the channel into Elephant Butte Reservoir was obstructed with sediment and vegetation such that

surface flows entered the reservoir were reduced, resulting in an estimated water loss of 140,000 acre-feet per year. Historically, the LFCC conveyed up to 2,000 cfs to Elephant Butte Reservoir, saving considerable amounts of water that would otherwise have been lost to evapotranspiration. The LFCC has been credited with assisting New Mexico to significantly decrease its Compact compliance deficit (which was 325,000 acre-ft in 1951). Average annual water salvage ranges from 35,000 to 66,000 acre-feet during full operation.

Elephant Butte Reservoir storage increased in the early to mid-1980s, inundating and burying the last 15 miles of the channel above the reservoir with sediment. As a result, the channel was shortened to 58 miles. Reclamation has proposed moving the LFCC west in the flood plain, away from the floodway, for a distance of approximately 15 miles upstream of the Elephant Butte Reservoir (Reclamation 2000). Since no structures, irrigation infrastructure, or agricultural fields exist here, the LFCC is the only facility subject to damage from flooding in this reach. The uncertainty of the future location of the LFCC prompts the elimination of this reach from the flood risk management considerations at this time. Thus, the reach under current consideration is 43 miles long, extending from the SADD only as far as San Marcial, and not including the segment from San Marcial to Elephant Butte Reservoir.

Difficulties with maintenance in the Elephant Butte Headwaters and endangered species considerations are among the reasons that Reclamation is not currently operating the LFCC as designed. The LFCC currently provides valley drainage benefits, water for pumping to benefit the Rio Grande silvery minnow, and supplemental irrigation water supplies to the BDANWR and irrigators of the Middle Rio Grande Conservancy District. Various rehabilitation or relocation strategies would potentially increase water deliveries to Elephant Butte Reservoir, a primary interest of the Compact states.

1.3 Description of the Authorized Project

The Rio Grande Floodway, San Acacia to Bosque del Apache Unit Project was authorized for construction by the Flood Control Act of 1948 (Public Law 80-858, Section 203), in accordance with the recommendation of the Chief of Engineers, as found in House Document No. 243, 81st Congress, 1st Session, dated 5 April 1948, which reads as follows:

The comprehensive plan for the Rio Grande Basin as set forth in the report of the Chief of Engineers, dated April 5, 1948, and in the report of the Bureau of Reclamation, dated November 21, 1947, all in substantial accord with the agreement approved by the Secretary of the Army and the Acting Secretary of the Interior on November 21, 1947, is hereby approved except insofar as the recommendations in those reports are inconsistent with the provisions of this Act and subject to the authorizations and limitations set forth herein.

The approval granted above shall be subject to the following conditions and limitations:

- a) Construction of the spillway gate structure at Chamita Dam shall be deferred so long as New Mexico shall have accrued debits as defined by the Rio Grande Compact and until New Mexico shall consistently accrue credits pursuant to the Rio Grande Compact;*
- b) Chiflo Dam and Reservoir on the Rio Grande shall be excluded from the Middle Rio Grande Project authorized herein without prejudice to subsequent consideration of*

Chiflo Dam and Reservoir by the Congress;

- c) The Bureau of Reclamation, in conjunction with other interested federal agencies, is directed to make studies to determine feasible ways and means of reducing non-beneficial consumption of water by native vegetation in the flood plain of the Rio Grande and its principle tributaries above Caballo Reservoir; and*
- d) At all times when New Mexico shall have accrued debits as defined by the Rio Grande Compact, all reservoirs constructed as a part of the project shall be operated solely for flood control except as otherwise required by the Rio Grande Compact, and at all times all project works shall be operated in conformity with the Rio Grande Compact as it is administered by the Rio Grande Compact Commission.*

The comprehensive plan for development for flood control in the Middle Rio Grande broke the river into separate units, many of which have already been constructed. The proposed action, levee construction in the San Acacia to Bosque del Apache Unit, is one of the last units required for comprehensive flood control in the Middle Rio Grande.

Additional language was provided in WRDA 1992, Section 102 regarding the equitable cost share portioning due to the large amount of Federal properties to be protected by the proposed project:

(s) RIO GRANDE FLOODWAY, NEW MEXICO.--Notwithstanding any other provision of law, the project for flood control, Rio Grande Floodway, San Acacia to Bosque del Apache Unit, New Mexico, authorized by section 203 of the Flood Control Act of 1948 (Public Law 80-858) and amended by section 204 of the Flood Control Act of 1950 (Public Law 81-516), is modified to more equitably reflect the non-Federal benefits from the project in relation to the total benefits of the project by reducing the non-Federal contribution for the project by that percentage of benefits which is attributable to the Federal properties; except that, for purposes of this subsection, Federal property benefits may not exceed 50 percent of the total project benefits.

1.4 Purpose and Need for Action

The study area has a long history of flood damage (Scurlock 1998). Recorded flood history in the study area dates back to the 1920s. Before that time, newspaper accounts identify major floods that occurred in July 1895 and September 1904. Recorded major floods, which would have exceeded the estimated protection afforded by the existing levee in the study area, occurred twice in 1929 (August 12, with Rio Salado flows of 27,400 cfs, and September 23, with Rio Puerco flows of 37,000 cfs); as well as in 1936 (August 4, with Rio Puerco flows of 24,000 cfs); in 1941 (September 23, with Rio Puerco flows of 18,800 cfs); and in 1965 (July 31, with Rio Salado flows of 36,200 cfs). A recurrence of any of these floods would have devastating effects downstream in the study area. In addition, there have been numerous flood events in recent years, more specifically, 1976, 1979, 1995, and 2005, when the Middle Rio Grande Conservancy District (MRGCD) and Reclamation had to conduct flood fights to prevent levee failure. Without these actions, the existing spoil bank would have failed several times in the past 35 years. It has been estimated that a 1%-chance flood event (colloquially referred to as the 100-year flood) occurring today would result in \$241.4 million (2010 price level) in damages in the study area.

Start of damages is estimated to be between the 20%- and 14%-chance flood events. Thus, the study area would suffer large economic losses during a flood, beginning with a small flood event.

As a result, the Corps has received numerous requests from Federal and State agencies, local municipalities and agencies, and individuals to address the flood problems of the Middle Rio Grande Basin. These requests resulted in the U.S. Congress directing the Corps to define the problems of the basin, formulate and evaluate various solutions to these problems, evaluate their applicability under existing Federal programs, and recommend a corrective course of action. The discharge for the 10%-chance exceedance flow is 15,400 cfs at the SADD, which exceeds the minimum discharge of 800 cfs required for study under Corps authorities. Thus, several analyses have been conducted with the objective of addressing the water resource problems of the watershed.

The Flood Control Act of 1948 concluded that the flood problems of the Rio Grande Basin were severe and could be addressed under the Corps' flood risk management program. Due to changes within the basin over the years, including budgetary requirements, real estate constraints, flood risk management features implemented in the upper watershed, and environmental concerns, the features of the project have changed several times. Preparation of updated environmental compliance documents became necessary due to these changes and specifically those that have occurred since 1993, when the San Acacia to Bosque del Apache Unit Project was last reaffirmed to be implementable, as previously approved, in a Limited Reevaluation and Supplemental EIS (U.S. Army Corps of Engineers [Corps] 1992). Currently, a draft General Re-evaluation Report/Supplemental Environmental Impact Statement (GRR/SEIS; Corps 2012) is available for public review and comment. The GRR/SEIS is the final response to the project authority with respect to the San Acacia to Bosque Del Apache unit.

The major purposes for the flood control phase of the comprehensive plan described in the 1948 authorization, House Document 243, Appendix E, Project Planning are:

- a. Provide protection against inundation by flash floods
- b. Provide a stable channel having a lower river bed so that controlled releases of 5,000 cfs could be efficiently carried
- c. Provide a lower river bed so that the channel effectively drains the river valley lands and results in a lower water table

Items b and c were intended to be performed by the Bureau of Reclamation through channel rectification and dredging. Flood control, now referred to as flood risk management, was to be performed by the Corps of Engineers through construction of dams and levees. Alternative methods for accomplishing flood risk management in the study area have been evaluated for compliance with Corps planning policy as well as the National Environmental Policy Act (NEPA), both of which were established after 1948.

2. Description of Proposed Action

2.1 Action Area

The action area comprises a the reach of the Rio Grande extending from the San Acacia Diversion Dam (SADD), near the historic community of San Acacia, south through the Bosque del Apache National Wildlife Refuge (BDANWR) to the Burlington Northern Santa Fe railroad near Tiffany Junction (where the railroad crosses the Low Flow Conveyance Channel (LFCC)).

2.2 Description of the Proposed Action

Eleven total alternatives as well as the no-action alternative were considered and are presented in detail in the GRR/SEIS (Corps 2012). That document provides details as to the plan formulation process, the entire array of alternatives considered, alternatives not considered, and why the proposed plan was chosen. The following sections provide a description of the proposed plan and its various features (generally, from the north to south).

2.2.1 General Description

The proposed action consists of replacing approximately 43 miles of non-engineered spoil banks with engineered levees along the west bank of the Rio Grande from the SADD to Tiffany Junction. The spoil banks were constructed in the late 1960s by Reclamation using the spoil excavated from the adjacent LFCC and generally cannot withstand erosive flows. The spoil bank is estimated to fail at flows in the range of 11,800 to 13,240 cfs at San Acacia. The proposed engineered levees would be designed such that they would convey the 1%-chance event with a 98.9% level of confidence of not failing. The proposed levee would reduce potential flood-damage to inhabitants of the western flood plain, the LFCC, and numerous railroad, irrigation, drainage, transportation, and agricultural improvements within the length of the project area.

The levee alignment would follow that of the existing spoil bank between the LFCC and the Rio Grande. The levee design height is equivalent to the water surface elevation corresponding to the 1% chance flood, plus an additional 4 vertical feet. The discharge for the 1% chance flow is 29,900 cfs at the upstream end, attenuating to 15,000 cfs at the downstream end of the project.

The Corps regularly considers 50 years as the functional life of flood control structures. Non-Federal operations and maintenance requirements extend to perpetuity.

Appendix A to this BA contains plates showing the preliminary layout for the proposed action and will be referenced in the following sections. Appendix B depicts the with- and without-project floodplains of the 1%-chance flood event.

2.2.2 East Side Excavation

The floodway of the Rio Grande is constricted between higher ground on either side of the river at the San Acacia Diversion Dam. Special design features are required in this area to provide bank protection and to decrease the velocity and erosive potential of the design flood. To provide a wider corridor for flood flows, excavation of approximately 9.3 acres of the east bank would create a terrace at the 10%-chance exceedance water surface elevation along approximately 300

yards (Appendix A, Sheet C-111). At the base of the proposed terrace, an additional 3.1 acres of the existing bank would be excavated to the approximate 50%- exceedance water surface, sloping downward to the existing channel. Overall, the excavation and widening would increase the cross-sectional flow area and proportionally decrease the velocity. In addition, overbank lowering would allow river flows into higher-roughness areas, causing an overall reduction in velocity. Excavation would be scheduled for four months during fall and winter when river flow is relatively low and reliably stable.

During construction, a temporary river crossing would be required to access the east bank from the LFCC service road on the west bank of the Rio Grande. The temporary crossing would consist of an earthen ramp approximately 300 feet long, with a 15 foot top width and 2.5 horizontal to 1 vertical side slopes. Six 60-inch corrugated metal pipes would allow low flows through the crossing to maintain a wet river channel during construction. Conservation Measures would be used to minimize impacts to water quality for this feature and include the use of rubber cofferdams and silt curtains for the reduction of turbidity, ease of construction, provide a barrier between construction activities and river waters (and fish), slope protection for the culverts, and specialized grading to prevent runoff or sediment from entering the river at the location of the ramps. Rubber coffer dams also would be employed along the east bank to minimize contact between construction activities and the river waters.

Cofferdams and silt curtains would be deployed to minimize disturbance to fish in the immediate area. These barriers would be deployed by Corps biologists from the shoreline into the current to exclude fish from the area where the temporary ramp is constructed. These barriers also would be deployed to exclude fish from the construction activities when the ramp is removed.

2.2.3 Floodwall

In the vicinity of the Sana Acacia Diversion Dam, the corridor between the western bank of the river and the railroad track is too narrow to accommodate an earthen levee. Therefore, a cement floodwall would be constructed on top of the bank beginning at a point about 400 feet upstream of the diversion dam and extending 650 feet downstream (Appendix A, Sheet C-111). The floodwall would be approximately 4 feet high and would be flanked by a roller-compacted concrete apron along the downstream portion. Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Approximately 0.25 acres of honey mesquite and fourwing saltbush would be removed to accommodate the floodwall at its upstream terminus.

2.2.4 Soil Cement Embankment

Although the East Side Excavation decreases the velocity of the design flood, there still would be a high potential for bank erosion along the eastern bank, especially in the large bend downstream from the SADD. Therefore, a soil-cement embankment would be constructed along 5,700 feet of the west bank immediately downstream from the SADD (Appendix A, Sheet C-112 – C-112). Soil cement would be placed in a series of horizontal lifts resulting in a stepped wall with an overall slope of 1:1 (Appendix A, Sheet C-142). The river bank is sufficiently high within this reach that a floodwall or levee would not be required to contain flood flows; however, the soil-cement embankment would be required to prevent erosion and undermining of the railroad track.

Vegetation would not grow on or within the soil-cement slope after construction.

Vertically, the soil-cement embankment begins at the base of railroad embankment and would be buried approximately 12 feet below the existing base of the riverbank slope¹. The base of the soil-cement wall would fill approximately 0.56 acres of the present river channel. During excavation and placement of the soil-cement embankment, construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish.

2.2.5 Earthen Levee Construction

The new earthen levee would follow the alignment of the existing spoil bank throughout the reach. The earthen levee would begin where the soil-cement embankment ends (at 1.2 river-miles downstream from SADD). The proposed levee would terminate at the railroad embankment near Tiffany Junction, approximately 43.6 river-miles from the SADD.

The construction of the proposed levee would entail removing the existing spoil bank with heavy machinery, processing the material removed to obtain suitable fill material for new construction. All sorting and material mixing would occur within the footprint of the existing spoil bank during construction. Selected materials required for construction (*i.e.*, riprap and bentonite) would be acquired from commercial sources or borrowed at approved sites.

The landward toe of the proposed levee would be separated from LFCC maintenance road by an 18-foot-wide drainage ditch. Generally, the base of the proposed levee would be narrower than that of the existing spoil bank north of U.S. Highway 380, and would be equal to or greater than the base width of the spoil bank south of Highway 380. Positioning the landward toe as close as practicable to the maintenance road in order to minimize floodway encroachment by the structure was one of the design objectives for the new levee.

The proposed levee would remain trapezoidal in cross-section with a 15-foot-wide crest (Appendix A, Sheet C-141). Side slopes would vary between 1 vertical to 2.5 horizontal and 1 vertical to 3 horizontal, depending on the height of the levee. Levee height would range from 4 to 14 feet. Perforated pipe toe drains, discharge pipes into the LFCC, and risers would be required for levee heights greater than 5 feet. An 8-foot-wide by 4-foot-high inspection trench, with 1V:1H side slopes, would also be required for levee heights greater than 5 feet. In addition, a 2-foot-wide bentonite slurry trench extending downward from the design water surface elevation to the bottom of the inspection trench would be required for levee heights greater than 5 feet. The slurry trench would extend from 2 feet below the levee embankment crest to 5 feet into the foundation material. The slurry trench and toe drain system decrease the likelihood of the levee becoming saturated during long-duration floods.

Turnarounds would be located on the levee or existing disturbed locations used for spoil bank and LFCC maintenance. Specific locations would be determined after further coordination with all parties using the levee.

¹ In the 30 November 2011 version of this BA, this feature was described as a combination of soil cement and riprap. Rather, the entire embankment would consist of soil cement.

The contractor would not be allowed to construct any new haul roads for the construction of this project. The existing haul road adjacent to and between the existing spoil bank and the LFCC would be used for the construction of the levee. A relatively small amount of surplus material would be stockpiled during construction of a given levee segment. Short-term stockpiles would be located within the disturbed footprint during construction of a given segment. Long-term stockpiles will only be located at staging areas or previously disturbed sites outside of the floodway.

2.2.6 *Vegetation-free Zone*

The Corps' Engineer Technical Letter 1110-2-571 (10 April 2009) provides guidelines to assure that landscape planting and vegetation management provide aesthetic and environmental benefits without compromising the reliability of levees. The vegetation-free zone requires that no vegetation, other than approved grass species be allowed to grow on the levee or within 15 feet of the riverward or landside toes of the levee. During construction, existing vegetation would be removed adjacent to the riverward and landside toes by clearing and grubbing, and root-plowing where salt cedar occurs. Since the landward side of the levee is currently maintained as an access road very little vegetation exists. Following construction, disturbed soils including the levee side slopes would be seeded with native grass species to prevent wind and water erosion. A 15-foot-wide vegetation-free zone would be permanently maintained to be devoid of any vegetation other than grasses. Vegetation-free zones would be mowed, when dry, at any time the grass reaches a height of 12 inches. Mowing would be triggered by grass heights of less than 12 inches if important to the health maintenance of the particular grass species.

2.2.7 *Structures to Accommodate Tributary Flow*

Three tributary arroyos in the project area empty into the Rio Grande from the west, crossing the LFCC and existing spoil bank: 1) San Lorenzo Arroyo enters the Rio Grande approximately 2.9 river-miles downstream of the SADD; 2) the Socorro Diversion Channel captures flows from the Socorro Canyon Arroyo, Nogal Canyon Arroyo, and several smaller arroyos, and empties into the Rio Grande just upstream of the city of Socorro, at 13.7 river-miles downstream from SADD; and 3) Brown Arroyo enters the Rio Grande approximately 22.2 river-miles downstream from SADD. Each of these tributaries was evaluated in order to determine if closure structures were needed to prevent flood flows on the Rio Grande from escaping the floodway.

Closure structures were determined not to be needed at San Lorenzo Arroyo and the Socorro Diversion Channel. Instead, levee tie-backs were designed to prevent overtopping of the interior drainage facilities at these places. It was determined that a closure structure was needed at Brown Arroyo (Appendix A, Sheets C-138 – C-139) to prevent the 1%-chance flood event from backing into Brown Arroyo for a distance of approximately 7,500 feet and a depth of up to 9 feet. Brown Arroyo is confined by non-engineered spoil banks that have a high risk of failure at high flood stages. This gated closure structure would be designed to pass Brown Arroyo flood flows while preventing longer-duration Rio Grande flood flows from potentially breaching the existing interior drainage facilities and is described below. The gated floodwall structure would be located where the new levee intersects the outfall channel of Brown Arroyo. The gate structure would consist of 10 sluice gates. Brown Arroyo inlet is skewed to the Rio Grande Floodway, so the gates are aligned in a zigzag configuration which would allow for flows from Brown Arroyo

to enter directly into the gates.

Approximately 11.7 river-miles downstream from SADD, the "Nine-mile Outfall" consists of three large conduits that direct flow from the LFCC to the river when the canal is operated. The Corps would replace these with conduits equipped with flap gates to prevent flood flow from entering the LFCC.

There currently are three locations along the proposed levee alignment where Reclamation pumps water from the LFCC through the levee to the river when required to benefit endangered species. Currently, pumps are located approximately 3 miles north of Highway 380, and at both the north and south boundaries of BDANWR. The pumps provide flexibility for future water operations and adaptive management tools. The Corps would install permanent conduits through the proposed levee to accommodate these pumps at their current locations (or at alternate locations agreed to by Reclamation and the Service). Appropriate measures to ensure levee performance would be incorporated to the conduit design, including concrete encasement, appropriate filter materials, and slope protection.

2.2.8 Placement of Riprap along the Toe of the Levee

Ten portions of the new levee would require toe protection based on hydraulic analysis of scour velocities and proximity of the river channel to the proposed levee. The proposed locations of riprap protection are noted on the plans and profile plates in Appendix A (Sheets C-112 – C128). The protected portions range from 500 to 4,850 feet long, and the total length of erosion protection is approximately 31,700 linear feet (6.0 miles). Riprap protection would blanket the riverward slope of the levee from crest to toe, and would be buried to a depth of 6.5 to 12 feet beneath the levee toe (Appendix A, Sheet C-142). Self-launching riprap would be buried below the ground surface at the toe of the levee for potential scour depths greater than 12 feet but not exceeding 17 feet. Rock sizes used for riprap would vary from 0.75 to 3.5 feet in diameter depending of the velocities at potential scour locations. Coloration for rock used for riprap would vary; however, suitable material in the local area consists of dark colored basalt or grey metamorphic rock. Jetty jacks are currently located in and around the proposed project area and would continue to provide erosion protection to the proposed project.

2.2.9 Material Quantities and Waste Spoil

The existing spoil bank was built from material excavated for the LFCC rather than being designed relative to a specific flood discharge. The height of the proposed levee was initially designed to accommodate the mean water surface elevation of the 1%-chance flood event. After construction of the new levee, a large amount of excavated spoil material would remain unused. Hauling the waste spoil to a disposal location can be more expensive than incorporating that material into a larger levee structure. As required for all Corps-built flood risk management projects, the proposed levee was designed to maximize National Economic Development (NED) benefits. The cost of increasing the levee's height in one-foot increments was evaluated relative to the increment benefit of reduced flood damages afforded by the taller levee. NED benefits were maximized by a levee structure 4 feet taller than the 1%-chance event structure. Still, a significant amount of spoil material requiring disposal results from the proposed levee's design.

Table 2.1 summarizes the amount of excavation, usable soil material, and disposal requirements

of the proposed action. The proposed levee would use approximately 44% of the excavated material, resulting in approximately 3 million cubic yards (1,881 acre-feet) of spoil material requiring disposal.

Three potential alternatives for the disposal of spoil waste would be employed in the proposed action. A number of existing borrow areas occur near the project area and could be used as disposal locations for the spoil waste generated during levee construction. The Corps would evaluate the cost effectiveness of utilizing these disturbed areas as disposal locations. Only locations that are devoid of significant ecological or cultural resources would be utilized.

Secondly, where the proposed levee would be narrower than the existing spoil bank, there may be opportunities to slightly shift the base of the new levee riverward while remaining within the disturbed footprint of the spoil bank. In these instances, some waste spoil (up to 656,000 cubic yards) could be deposited on the landward slope of the new levee structure.

The default location for the disposal of spoil waste evaluated in this BA is within the undeveloped Tiffany Basin at the south end of the project area. Although the ground surface in the basin is lower than the current riverbed, the basin would only be inundated due to failure of the spoil bank along its eastern edge. A spoil deposition area of up to 300 acres would accommodate the waste material from the proposed levee (3 million cubic yards, or 1,881 ac-ft). The area considered for spoil deposition is currently vegetated by salt cedar.

Table 2.1. Excavation and disposal quantities for the proposed action.

| Item | Volume (bank cubic yards) |
|--|---|
| Excavated from spoil bank | 5,233,730 |
| Excavated from East Side Excavation | <u>152,650</u> |
| <i>Excavation subtotal</i> | <i>5,386,380</i> |
| Used as random fill in new levee | 2,176,901 |
| Used in rip rap toe protection (screened oversized waste) | <u>174,152</u> |
| <i>Used subtotal</i> | <i>2,351,053</i> <i>(43.7% of excavated)</i> |
| Disposal total | 3,035,327 (1,881 ac-ft) |

2.2.10 Project Schedule

Based on anticipated Federal funding, the total construction period for the project entails 20 years. The current levee plan has been divided into 6 segments to provide manageable pieces of the project to construct in phases (Table 2.2). The first segment anticipated to be constructed is at

Socorro, extending from the Socorro Diversion Channel downstream to Brown Arroyo. The two segments north of Socorro would be next in order. Thereafter, phasing of the levee construction would occur from north to south beginning at Brown Arroyo. The Plans and Specifications for segment 1 of the levee plan would be initiated upon the completion and approval of the GRR/SEIS, expected in 2012. Construction for this segment is anticipated to begin in October 2012. Subsequent segments would be constructed annually as funding is received. Depending on the timing and seasonality of construction or presence of species of concern, construction of levee portions within a given segment may not be contiguous. Construction of concrete structures may occur prior to or after earthwork has been completed in a particular levee segment.

Table 2.2. Construction Schedule for the proposed action.

| Segment | Location | Levee length (mi) | Number of annual contracts | Fiscal Years |
|---------|--|-------------------|----------------------------|--------------|
| 1 | Socorro North. Channel to Brown Arroyo | 7.3 | 3 | FY13 – 15 |
| 2 | San Lorenzo Arroyo to Socorro North Channel | 9.4 | 4 | FY16 – 19 |
| 3 | San Acacia Diversion Dam to San Lorenzo Arroyo | 2.6 | 1 | FY20 |
| 4 | Brown Arroyo to US Hwy 380 | 4.7 | 2 | FY21 – 22 |
| 5 | US Hwy 380 to LFCC-weir at BDANWR | 11.9 | 5 | FY23 – 27 |
| 6 | LFCC-weir at BDANWR to end | 6.8 | 4 | FY28 – 31 |
| Total | | 42.7 | 19 | |

2.2.11 Conservation Measures

The following is a list of conservation measures and stipulations that would be complied with during construction of the proposed action to protect water resources and endangered species habitat from degradation:

1. Beginning with the breeding season prior to the initiation of each phase of construction, the Corps would perform or fund annual Southwestern Willow Flycatcher protocol surveys (5 visits per site per season) along the western bank of the floodway, eventually extending from San Acacia to San Marcial. Annual surveys would continue until the completion of construction and would continue for five years following the phased construction of each levee segment.
2. Levee and floodwall construction may occur throughout the calendar year; however, no construction would be performed within 0.25 mile of occupied flycatcher breeding territories (generally, late May through August 15). Traffic associated with construction

activities may continue along the construction alignment adjacent to occupied flycatcher breeding territories. All construction equipment and large trucks would be restricted to the maintenance roads adjacent to the LFCC. The levee and/or spoil bank would serve as a buffer between this traffic and flycatchers within the floodway. Small vehicles (*e.g.*, pickup trucks and SUVs) would occasionally travel along the top of the spoil bank / levee, as they do currently.

3. Vegetation removal and clearing-and-grubbing activities would be performed between August 15 and April 15. If needed, vegetation removal between April 15 and August 15 would only be performed if inspection by a qualified biologist determines that flycatchers (including both migrant and territorial birds) are not present within 500 feet of the vegetation patch to be removed.
4. If stream flow exists, it would be maintained during construction and the streambed contoured so that fish can migrate through the project area during and after construction.
5. Silt curtains, cofferdams, dikes, straw bales and other suitable erosion control measures would be employed to prevent sediment-laden runoff or contaminants from entering any watercourse.
6. Work would be performed below the elevation of the ordinary high water mark only during low-flow periods. This includes placement of the lower portions of the soil-cement wall, riprap blankets, and excavation along the east bank downstream from the SADD. No erodible fill materials would be placed below the elevation of the ordinary high water mark.
7. Qualified fisheries biologists would evaluate measures to exclude fish from in-channel construction areas. Cofferdams and silt curtains would be deployed by Corps biologists from the shoreline into the channel to exclude fish from construction areas where possible. If appropriate, biologists would coordinate with Service personnel to seine areas prior to placement of barriers in the construction area.
8. Concrete would be poured in forms and would be contained to prevent discharge into the river. Wastewater from concrete batching, vehicle washdown, and aggregate processing would be contained, and treated or removed for off-site disposal.
9. Fuels, lubricants, hydraulic fluids and other petrochemicals would be stored outside the 1%-chance floodplain, if practical. At the least, staging and fueling areas would be located west of the LFCC and would include spill prevention and containment features.
10. Construction equipment would be inspected daily to ensure that no leaks or discharges of lubricants, hydraulic fluids or fuels occur in the aquatic or riparian ecosystem. Any petroleum or chemical spills would be contained and removed, including any contaminated soil.
11. Only uncontaminated earth or crushed rock for backfills would be used.
12. Water quality would be monitored during construction to ensure compliance with state water quality standards for turbidity, pH, temperature, and dissolved solids.

2.2.12 Operation and Maintenance

Upon completion of each functional segment of the new levee, that portion of the project would be turned over to the local sponsor for operations and maintenance (O&M). The Corps would provide the sponsor with a manual describing the duties necessary for proper O&M of the segment, and the entire project.

In general, O&M would consist of maintaining the vegetation management zone free of woody vegetation larger than 0.5-inch-diameter stems or trunks. The sponsor would be responsible for maintaining levee integrity by repairing runoff erosion, eliminating rodent burrows in the levee, replacing riprap lost in flow events, and inspecting and cleaning seepage infrastructure regularly. The Corps and the sponsor also would perform annual inspections of the levee system.

2.2.13 Monitoring and Reporting

During the relatively long construction period (up to 20 years) for the proposed action, changes in design, construction methods, or the condition of ecological resources could alter the determinations of effects to listed species that are made by the Corps or Service at the present time. Therefore, this Section 7 consultation is being conducted programmatically to adapt proposed activities to changed conditions. The Corps, in conjunction with other concerned agencies, will monitor the condition of listed species, hydrology, and ecological resources in the action area throughout the construction period.

The criteria for reinitiation of formal consultation are contained in 50 CFR §402.16:

"Reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in the biological opinion; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action."

Should any of these conditions arise, the Corps would reinitiate Section 7 consultation by providing the Service with a supplemental BA tiered to this Programmatic BA.

Several of the Conservation Measures in Section 2.2.11 of this BA include construction and monitoring activities that would avoid or minimize the potential for adverse effects to water quality during construction and would serve to avoid or minimize direct effects to the silvery minnow. Qualified fisheries biologists would monitor all construction activities within or adjacent to the Rio Grande channel and its tributaries.

Conservation Measure 1 provides that the Corps would perform or fund annual protocol surveys for the flycatcher in the action area, beginning with the breeding season preceding construction and continuing for five years following the phased construction of each levee segment. Flycatcher surveys for each anticipated segment of construction (see Table 2.2) would be conducted on the west bank of the Rio Grande one breeding season prior to the anticipated

construction. Additional survey areas will be added for each segment as overall construction progresses. Information resulting from these surveys would be used to update resource conditions, avoid direct effects from construction activities, and to revise the determination of effects of the proposed project, if needed.

Construction contracts will include warranties or performance standards for the establishment of vegetation. For seeding, the requirements will specify that planted areas will exhibit vigorous growth after a one-year establishment period. Requirements typically will include stem density or percent cover measures which the Contracting Officer Representative will use to verify that the performance standards have been, or have not been, met. Any additional planting activities to meet the performance standard will be performed at the contractor's expense. The stem density or percent cover criteria included in each contract will vary depending on location-specific soil and moisture conditions, as well as the specified seed mix. For woody plantings (trees and shrubs), the performance standard will require at least 85% survival of planted material at the end of the third growing season following planting. If survival is less than this criterion, the contractor will install additional plantings to assure at least 85% living trees or shrubs.

The success of mitigative revegetation measures will be based on the acceptable development of vegetation and its likelihood of continued development into a mature stand. The exact criteria for success will be determined during ongoing ESA consultation with the Service and coordination with the Sevilleta and Bosque del Apache NWRs. Monitoring will be conducted by the Corps once each year during the summer growing season for five years following planting. Monitoring requirements beyond five years (to be determined during ongoing consultation and coordination) would be conducted by the project sponsor.

Avian utilization of revegetated areas will be documented through variable-distance point counts (Ralph et al., 1993; Martin et al., 1997; Bibby et al., 2000; Buckland et al., 2001), and vegetation characteristics will be measured using commensurate methods (James and Shugart, 1970; Noon, 1981; Martin et al., 1997). Photographs will be taken at permanently established photo points.

The Corps will provide an annual report on progress to the Service during the construction period of the proposed action. Copies of the report will be furnished to the project sponsors, and pertinent Federal and local resource agencies. Annual reports will include:

- A summary of construction activities performed during the preceding year.
- A description of construction activities anticipated in the upcoming year.
- A description of refinements in design or construction activities, if any.
- A description and evaluation of Conservation Measures employed.
- A summary of the status of listed species, including the results of species-specific surveys.
- A description and evaluation of compliance with Reasonable and Prudent Alternatives in the Programmatic Biological Opinion, and with stipulations in its associated Incidental Take Statement.
- The status and success of mitigative revegetation measures and associated results of monitoring activities.

2.3 Consideration of Related Actions

In addition to activities authorized, funded, or carried out by Federal agencies, Section 7 consultation regulations also require agencies to consult on interrelated and interdependent actions. Interdependent actions are those having no independent utility apart from the proposed action (defined in 50 CFR §402.02). Interrelated actions are those actions that are part of a larger action and depend on the larger [proposed] action for their justification (defined in 50 CFR §402.02).

Both Reclamation and the Corps received the primary Congressional authorization for their actions in the Middle Rio Grande from the Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). The responsibilities of each agency were defined in these acts and in a Joint Agreement² signed by the Corps, Reclamation, and the Department of Interior in 1947. The Corps is responsible for the construction, operation, and maintenance of:

- Abiquiu Dam and Reservoir
- Cochiti Dam
- Jemez Canyon Reservoir
- Levees for local flood protection.

Reclamation is responsible for:

- El Vado Reservoir
- Channel rectification
- Irrigation and project rehabilitation
- Drainage rehabilitation and extension

The Corps has determined that Reclamation's activities and the operation of Corps dams are not interrelated or interdependent with the proposed action evaluated in this BA. El Vado Reservoir, irrigation, channel rectification, flood-control operation, and drainage actions each have an independent utility separate from levee rehabilitation; and they do not singly or collectively depend on a new engineered levee for their justification or implementation.

The principal non-Federal water-management actions in the Middle Rio Grande are summarized in Section 3.2 of this BA. Additionally, several non-Federal signatories in the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program) have compiled summaries of their water management and depletion-related activities. The Corps has evaluated these activities and determined that they each have an independent utility separate from the Corps' proposed action; and they do not singly or collectively depend on Corps actions for their justification or implementation.

² Joint Agreement Between the Secretary of the Interior and the Secretary of the Army on a Unified Plan for the Control of Floods, Irrigation, and use of Water in the Middle Rio Grande Basin in New Mexico, July 25, 1947.

3. Environmental Baseline

Under Section 7(a)(2) of the ESA, when considering the effects of the action on Federally listed species, agencies are required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR 402) define the environmental baseline as the past and present impacts of all Federal, State, Tribal, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early Section 7 consultation; and the impacts of State and private actions that are contemporaneous with the consultation in progress. For each species, the environmental baseline describes its current status and its habitat in the action area as a point of comparison to assess the effects of the action now under consultation.

This chapter outlines the environmental baseline for this Section 7 consultation. The environmental baseline describes a “snapshot in time” that includes the effects of all past and present federal and non-federal human activities. All existing facilities and all previous and current effects of construction and operation of the dams, as well as all ongoing, Federal actions, non-Federal irrigation activities and existing physical features such as diversion dams, storage dams, and flood control dikes are part of the environmental baseline.

3.1 Recent and Contemporary Federal Actions

This list is not intended to be a comprehensive list of all recent and ongoing Federal actions, but rather to be a selection of recent actions located near or within the San Acacia to Bosque del Apache Unit.

3.1.1 U.S. Army Corps of Engineers

Reservoir Operations

The Corps of Engineers is currently preparing a biological assessment (BA) that evaluates the effects of the Corps’ continuing, discretionary reservoir operation actions on Federally listed species and designated critical habitat within the middle Rio Grande valley of New Mexico. These activities include discretionary flood control operation of reservoirs, delivery of “carryover” floodwater, San Juan Chama water storage at Abiquiu Reservoir, delivery of Cochiti recreation pool water, maintenance actions at Corps-managed reservoirs, and temporary deviation for spawning and recruitment flows. It is expected that formal consultation would begin sometime during the winter of 2011.

3.1.2 Bureau of Reclamation

River Mile 111 Priority Site Project

In March 2008, Reclamation submitted a BA to the Service evaluating the effects of relocation of the Low Flow Conveyance Channel and the associated levee on the endangered flycatcher and minnow and designated critical habitat. The project would allow the Rio Grande more freedom to move within its historic floodplain. Reclamation determined that the project “may affect, is not likely to adversely affect” the minnow and its designated habitat. The Service concurred with

this determination (Consultation #22420-2008-I-0067), provided the following conditions were met: 1) all construction of woody debris piles would occur under dry working conditions or during low flow conditions; 2) recent surveys of the Low-Flow Conveyance Channel (LFCC) downstream of the proposed construction area did not find any minnows; 3) the Lemitar radial gate structure would be closed during the construction operations; 4) cottonwood root wads would be placed on the bank near river mile (RM) 111 and would cascade into the river as it migrates west; and 5) the mitigation plan described in the BA would be fully implemented and the Conservation Measures described in the BA would also be fully implemented by Reclamation.

Rio Grande Sediment Plug Removal Project at Bosque del Apache National Wildlife Refuge

In August 2008, Reclamation submitted a BA to the Service addressing potential impacts of removal of a sediment plug, which had formed within the Rio Grande at the BDANWR during spring runoff 2008, on the endangered minnow and its designated critical habitat and on the endangered flycatcher. Reclamation's environmental commitments for the Sediment Plug Removal Project include: 1) construction of at least four embayments (each approximately 30 to 50 feet in width and 50 to 70 feet in length) on the west side of the pilot channel to promote channel widening to be completed during Phase I(b); 2) collection of data for four years following excavation of the pilot channel to monitor channel degradation/aggradation and overbanking patterns, including *i.* cross-section data of the river channel from the north boundary of the BDANWR to the San Marcial Railroad Bridge; *ii.* at least two inspections of the river channel by boat when overbanking begins during runoff; and *iii.* at least once during the four years, cross-section data of the river channel and floodplains that extend between endpoints for these rangelines; 3) data collected as above will be analyzed and compared to 2002 and 2005 cross-section data to assess changes to the riverbed thalweg and channel geometry, including width/depth ratio, and data and analysis will be provided to the Service (New Mexico Ecological Service Field Office and the BDANWR); and 4) in-depth analysis of alternatives to pilot channel construction within the aforementioned reach of river to be initiated within six months of completion of Phase I(b) of the project. This included: at least three strategies to address sediment transport through the reach; maintenance of connected unvegetated river bars; opportunities for river realignment following sand plug formation; river connectivity during low flows; river/floodplain surface connectivity; surface water supplies to adjacent wetlands; and effects on threatened, endangered, or candidate species. This analysis must be conducted in coordination with the Service, and the final report must be completed within three years and will be used in all future sediment plug removal or maintenance activities within the BDANWR.

Drain Unit 7 Extension River Maintenance Priority Site Project

On June 13, 2008, Reclamation submitted a BA, along with a letter formally requesting consultation reinitiation, to the Service for the proposed Drain Unit 7 (DU7) Extension River Maintenance Priority Site Project. The project will reinforce the bankline and protect the adjacent access road and drain by placing riprap along the bank within the active river channel. Reclamation determined that this action may affect, and is likely to adversely affect, the endangered minnow during construction; and may affect, and is not likely to adversely affect, designated minnow critical habitat. The Service concluded that the proposed action is not likely

to jeopardize the continued existence of the minnow and that there is likely to be short-term adverse effects on a very small portion of designated critical habitat at the construction site.

Environmental commitments associated with the proposed DU7 Project include: implementing construction Best Management Practices (BMPs) and dust abatement during construction; re-vegetating the site; and performing construction outside minnow spawning periods (construction exclusion period of April 15 through July 1).

3.2 Recent and Contemporary Non-Federal Actions

The past and present impacts of non-Federal actions which are contemporaneous with the consultation in process are included in the environmental baseline. Future impacts of these same non-Federal actions will be considered as cumulative effects in the analysis of effects discussion in Chapter 5 of this BA. The following is considered a non-exhaustive list of non-Federal actions.

3.2.1 Rio Grande Compact

Water uses on the Middle Rio Grande must be conducted in conformance with the Compact administered by the Rio Grande Compact Commission. The four-member Commission is composed of Commissioners from Colorado, New Mexico, and Texas, as well as a Federal representative who chairs Commission meetings. Colorado is prohibited from accruing a debit, or under-delivery to the downstream States, of more than 100,000 ac-ft, while New Mexico's accrued debit to Texas is limited to 200,000 ac-ft. These limits may be exceeded if caused by holdover storage in certain reservoirs, but water must be retained in the reservoirs to the extent of the accrued debit. Any deviation from the terms of the Compact requires unanimous approval from the three state Commissioners.

In order to meet delivery obligations under the Compact, depletions within New Mexico are carefully controlled. Allowable depletions above Otowi gage (located outside of Santa Fe, near the Pueblo of San Ildefonso) are confined to levels defined in the Compact. Allowable depletions below Otowi gage and above the headwaters of Elephant Butte Reservoir are calculated based on the flows passing through Otowi gage. The maximum allowable depletions below Otowi gage are limited to 405,000 ac-ft in addition to tributary inflows. In an average year, when 1,100,000 ac-ft of water passes the gage, approximately 393,000 ac-ft of water is allowed to be depleted below Otowi gage, in addition to tributary inflows. Depletion volumes are lower in dry years. For instance, in 1977, allowable depletions were 264,600 ac-ft in addition to tributary inflows. No Indian water rights may be impaired by the State's Compact management activities.

3.2.2 State of New Mexico

The State of New Mexico has a wide range of agencies that actively represent different aspects of the State's interest in water management:

New Mexico Office of the State Engineer

The New Mexico State Engineer has general supervision of the waters of the State and of the measurement, appropriation, and distribution thereof (N.M. Stat. Ann. 72-2-1 Repl. Pamp. 1994). The Office of the State Engineer (OSE) grants state water rights permits, ensures that applicants

meet state permit requirements, and enforces the water laws of the State. The OSE is responsible for administering water rights, including changing points of diversion and places or purposes of use. The OSE uses the “Middle Rio Grande Administrative Area Guidelines for Review of Water Right Applications” to assess the validity and transfer of pre-1907 water rights.

New Mexico Interstate Stream Commission

The New Mexico Interstate Stream Commission (NMISC) is authorized to develop, conserve, protect and to do any and all things necessary to protect, conserve, and develop the waters and stream systems of the State. It is responsible for representing New Mexico’s interests in making interstate stream deliveries, as well as for investigating, planning, and developing the State’s water supplies. The State cooperates with Reclamation to perform annual construction and maintenance work under the State of New Mexico Cooperative Program. In the past, this work has included some river maintenance on the Rio Chama, maintenance of Drain Unit 7, drain and canal maintenance within the BDANWR, similar work at the state refuges, and temporary pilot channels into Elephant Butte Reservoir.

New Mexico Department of Game and Fish

The New Mexico Department of Game and Fish (NMDGF) administers programs concerned with conservation of endangered species and of game and fish resources. It also manages the La Joya Wildlife Management Area and Bernardo Wildlife Area.

New Mexico Environment Department

The New Mexico Environment Department (NMED) administers the State’s water quality program including compliance with various sections of the Clean Water Act. Section 303 of the Clean Water Act allows NMED to establish water quality standards for water bodies and total maximum daily loads for each pollutant. Section 402 of the Clean Water Act includes the National Pollutant Discharge Elimination System Storm Water Permit Program.

3.2.3 Counties

All counties that border the Rio Grande and Rio Chama and their respective tributaries perform actions or can perform actions that may at least indirectly affect these rivers. The primary area in which county actions may influence water management is providing for general development and infrastructure of these counties, and activities may include pumping of wells or land-use regulations within the immediate Middle Rio Grande watershed.

3.2.4 Villages, Towns, and Cities

Citizens in a multitude of villages, towns, and cities are served with municipal and industrial water systems. While most use groundwater exclusively, Santa Fe also uses surface water supplies, and both the cities of Albuquerque and Santa Fe use San Juan-Chama surface water in addition to groundwater. To the extent that future groundwater pumping or use of surface water depletes the river, the New Mexico State Engineer requires that these depletions be offset, either by acquiring other water rights or with San Juan-Chama Project water. Many of these contractors have voluntarily entered into annual lease programs with Reclamation to enhance Middle Rio

Grande valley water management. Municipalities also manage wastewater treatment systems that are point source discharges into the Rio Grande. Municipalities also release storm water discharge into the Rio Grande.

3.2.5 Irrigation Interests

Irrigation interests include a variety of the acequias, pueblos, individual irrigators, and ditch associations, as well as the MRGCD, which have water rights to divert the natural flow of the Rio Grande for beneficial use and then return unused water to the Rio Grande. Many of these irrigation interests have existed for hundreds of years. The MRGCD was established under state law in 1928, to address issues such as valley drainage and flooding, and currently operates the diversion dams of the Middle Rio Grande Project to deliver irrigation water to lands in the middle valley, including areas on six pueblos.

3.3 General Environmental Setting

The proposed project is located in the Middle Rio Grande, a 219-mile-long reach of the river in New Mexico extending from Velarde to Elephant Butte Reservoir. In this reach, the floodplain is entrenched in an alluvium-filled rift valley that ranges from less than 1 mile to about 12 miles wide. Principal tributaries to the Rio Grande below Cochiti Dam are Galisteo Creek, Rio Jemez, Rio Puerco, and Rio Salado. The latter two tributaries are located approximately 10 and 2 miles upstream of the project area, respectively.

The project area extends from the SADD, located 12 miles north of the City of Socorro, New Mexico, downstream to the railroad bridge over the LFCC at the northern end of Tiffany Junction. Several of the alternatives considered extended south to include the railroad crossing at San Marcial. This area includes the southern-most section of the Middle Rio Grande. River channel, off-channel wetlands, riparian woodlands, floodplain farmland, river terraces and piedmont (bajada) surfaces covered in grasses and shrubs, basalt-capped mesas, and nearby mountains characterize a cross-section of the rift from the river to the adjoining uplands. The floodplain and bordering terraces are mostly rural and used for irrigated farmland, livestock grazing, and wildlife conservation. The City of Socorro is the only urban center in the region. Smaller communities are scattered throughout the project area. Elephant Butte Reservoir, downstream of the project area, is the largest reservoir in New Mexico; it stores water for irrigation and recreation. The project area runs through BDANWR, which provides habitat for wintering waterfowl, cranes, other wading birds, endangered species, and a rich diversity of resident and migrant wildlife (Corps 1992).

Historically, the segment of the Rio Grande in the proposed project area was a large, braided, and meandering river system with a diversity of channels, oxbows, and marshes, influenced by cycles of frequent floods and periodic channel desiccation. Conversion of riparian areas to farmland and diversion of water for irrigation began as early as AD 1350, and peaked about 1880, when an estimated 125,000 acres in the Middle Rio Grande Valley were in cultivation (Scurlock 1998). Tree harvest for fuelwood and building materials, first by the Pueblo people and later by early European settlers, further depleted the larger woody riparian vegetation. The introduction of exotic (non-native) trees and shrubs, including Russian olive, saltcedar, and Siberian elm, which started during the late nineteenth century, created habitat competition for the

native species. Large-scale grazing has been important in the valley since the 18th Century. Collectively, these activities narrowed the bosque, reduced and altered the species composition of its woodlands, and increased the sediment yield from the watershed (Crawford *et al.* 1993). There is evidence that drier climatic conditions also affected the watershed's sediment yield by reducing vegetation ground cover (Lagasse 1980), a phenomena that may increase with climate change.

The ecology of the valley is conditioned by the Great Basin Grassland, Semidesert Grassland, and Chihuahuan Desert Scrub biotic communities through which the river flows (Crawford *et al.* 1993). The major plant communities in the active floodplain of the Middle Rio Grande Valley include woodlands, shrublands, grasslands, and emergent wetlands (Tetra Tech 2004). Vegetation mapping produced by Parametrix (2008) has been used to quantitatively characterize the vegetation composition and is the most complete digitized coverage available to date.

The proposed action area has an arid to semi-arid continental climate characterized by light precipitation, abundant sunshine, low relative humidity, and wide diurnal and annual range of temperature (Crawford *et al.* 1993). Summer daytime temperatures can exceed 100 degrees Fahrenheit (°F). Average maximum temperatures in January range from the upper 30°F range to the upper 40°F range. Temperatures below freezing are common during the winter. Relative humidity is usually low, mitigating considerably the effects of the temperature extremes in both winter and summer. Humidity during the warmer months is below 20% much of the time. Wind speeds are usually moderate; however, relatively strong winds often accompany frontal activity in late winter and spring, and may exceed 30 miles per hour for several hours. Sources of these moisture-laden air masses are the Pacific Ocean and the Gulf of Mexico. Average annual precipitation is less than 10 inches throughout the proposed action area. Approximately 50% of the annual precipitation occurs during the three-month period of July through October, usually as brief, intense thunderstorms. Winter precipitation, most of which comes from the Pacific Ocean, falls primarily in connection with frontal activity associated with the general movement of storms from west to east. In winter and spring, moisture transported from the Pacific by westerly winds can be amplified by the El Niño/La Niña phenomenon, which ties regional precipitation to global climate (Crawford *et al.* 1993).

3.3.1 Geology and Soils

The project area lies within the San Marcial structural basin in central New Mexico, which extends from San Acacia to the upper end of Elephant Butte Reservoir. This basin is bounded to the west by the Socorro, Magdalena, and San Mateo mountains. The eastern boundary of the San Marcial basin is the San Pasqual Platform, which is a north-south trending block of Mesozoic sedimentary rocks overlain by Santa Fe Formation alluvium.

Rifting (extension and uplifting) began in the region approximately 36 million years ago resulting in a central valley surrounded on both sides by faulted, upthrown mountain ranges. The rift valley itself is segmented by faults, with different structural basins (half grabens) tilted strongly to the east or west depending on the location of the master structural faults (Keller and Cather 1994). The Tertiary Datil Volcanic Field borders the project area to the west. Silic and andesitic volcanic rocks of the Datil field overlie older Mississippian, Pennsylvanian, and Permian sedimentary rocks (Keller and Cather 1994). The Socorro, Magdalena, and San Mateo

mountains that bound the western part of the study area are composed of uplifted, faulted blocks of Datil volcanic and older sedimentary rocks (Keller and Cather 1994).

As uplift and volcanism occurred, sediment eroded from the highlands was washed into the basin producing a complex sequence of gravel, sand, silt, clay, and volcanic deposits known as the Santa Fe Formation. Much of the Santa Fe Formation is overlain by unconsolidated Quaternary alluvium and locally thick piedmont detritus. The thickness of the deposits in the deeper parts of the basin is estimated at 15,000 feet. Soils within the proposed action area are generally silty sands and sandy clays.

A subsurface investigation was conducted within the proposed project area at the LFCC and Rio Grande for the Rio Grande Floodway: Feature Design Memorandum. San Acacia to Bosque del Apache Unit, NM, which was published in 1991 by the Corps (Corps 1991). The borings for the Feature Design Memorandum were drilled to a maximum depth of 25 feet and indicate that the foundation soils in these areas are composed of alluvium consisting of predominantly fine silty sand and sand with traces of silt, clay, and gravel. The soils are typically very loose to medium dense with corrected blow counts ranging from a low of 6 to a high of 22.

In 2006, 2008, and 2010, additional subsurface investigations were conducted along the proposed levee alignment in accordance with ETL 1110-2-563 *Engineering and Design: Design Guidance for Levee Underseepage*. Drill log data indicates the foundation materials were predominantly poorly sorted sand and silty sand. Relative densities, determined from correlation to Standard Penetration Tests, varied from soft/loose at shallower depths with generally increasing relative density to hard/very dense to 50 feet. Drill log data indicates the existing spoil bank was constructed of sands, silty sands, and clayey sands, with random layers of clay. Drill log data indicates the majority of the materials are very loose to loose. Materials in the existing spoil bank are layered, potentially indicating that construction was phased. No identifiable zoning or seepage control measures were noted.

Typical alluvial deposits and soils are quite variable and discontinuous. Foundation materials along the proposed levee alignment are generally sands, silty sands, and sandy clays. These foundation soils are generally considered suitable provided adequate preparation is provided at locations of identified low-density material. Weak clay layers composed of high-plasticity clay are also present in the foundation. Exploration indicates that the layers are generally randomly located, are relatively thin, and have sand layers above and below that allow dissipation of excess pore pressures upon construction of new levee, leading to consolidation and increased strength. During construction of the new levee, soft clay layers near the foundation surface can be over-excavated and removed. Lower layers of existing spoil bank foundations have been previously consolidated by the upper layers placed on the existing spoil bank; therefore, only the weight of fill required to increase the height of the existing spoil bank would contribute to additional consolidation and settlement of the foundation. Since in most cases the new levee would be smaller than the existing spoil bank, consolidation and settlement of the foundation is considered to be minimal for the project. Areas where the new levee height is greater than the spoil bank would be evaluated for potential consolidation or settlement issues by analysis of the boring logs at those locations. The levee section would be overbuilt at locations where consolidation or settlement is deemed an issue by further analysis.

3.3.2 *Hydrology and Hydraulics*

There are more than 8,500 square miles (mi²) of contributing, uncontrolled drainage upstream of the project area. The two largest ephemeral tributaries are the Rio Puerco (7,350 mi²) and Rio Salado (1,395 mi²). These tributaries meet the Rio Grande approximately 10 miles and 2 miles upstream of the project area, respectively. In combination, these two tributaries can produce flows far greater than the protection provided by the existing spoil banks. Flows from these two tributaries, coinciding with high flows on the mainstem of the Rio Grande, would create the most severe flooding condition possible through the proposed action reach. Other contributing tributary drainages east of the river provide small flood potentials in comparison to the Rio Puerco and Rio Salado.

River Geomorphology and Sedimentation

Present water management in the Middle Rio Grande valley implemented as a result of the 1948 authorization for the Rio Grande Floodway includes flood risk and sediment management dams and reservoirs, irrigation storage reservoirs, levees, channel maintenance, irrigation diversions, drainage systems, and runoff conveyance systems. In addition, the river has been laterally stabilized in the floodplain by the installation of jetty jacks in the 1950s and 1960s (Crawford *et al.* 1993). River sediment loads and debris settled in the jacks, creating stable banks and a riparian zone of cottonwood, Russian olive, willow, and saltcedar (Crawford *et al.* 1993). All these activities affect channel morphology through alterations in discharge and sediment load. The river discharge influences the size of the channel, whereas the type of material transported influences the character of the channel. The existing spoil bank limits meandering to the area east of the spoil bank and controls the degradation/aggradation process. The increased vegetation hastens aggradation in the overbanks through increased roughness and lowered velocities and energy. The current status of the channel morphology is a result of these earlier and ongoing activities and water management.

In the San Acacia to Bosque del Apache Unit, stream channel incision has been pronounced from immediately upstream of the San Acacia diversion dam extending downstream of the SADD to approximately 4 miles above a point on the river parallel to the intersection between US 60 and Interstate 25. Localized geologic uplift is a major contributor to stream channel incision in this reach. Below this point, for a distance of less than 10 miles, the river is neither incising nor aggrading, and below this, the river channel is in a long-term aggradation pattern (Massong *et al.* 2006). Aggradation is occurring within the floodway, raising it as much as 10 to 12 feet above the adjacent, sediment-starved historical floodplain (Figure 3.1).

With individual years' average sediment concentrations as high as about 200,000 mg/L the Middle Rio Grande is one of the more heavily sediment-laden streams on earth (Baird 1999). The combination of high sediment loading coupled with confinement of the floodway by spoil banks has resulted in a perched channel, whereby the active channel and adjacent overbanks are elevated above the historic floodplain lying outside the leveed floodway. The elevation differences on either side of the spoil bank are becoming worrisome, with disparities on the order of 10 to 15 feet in downstream reaches.

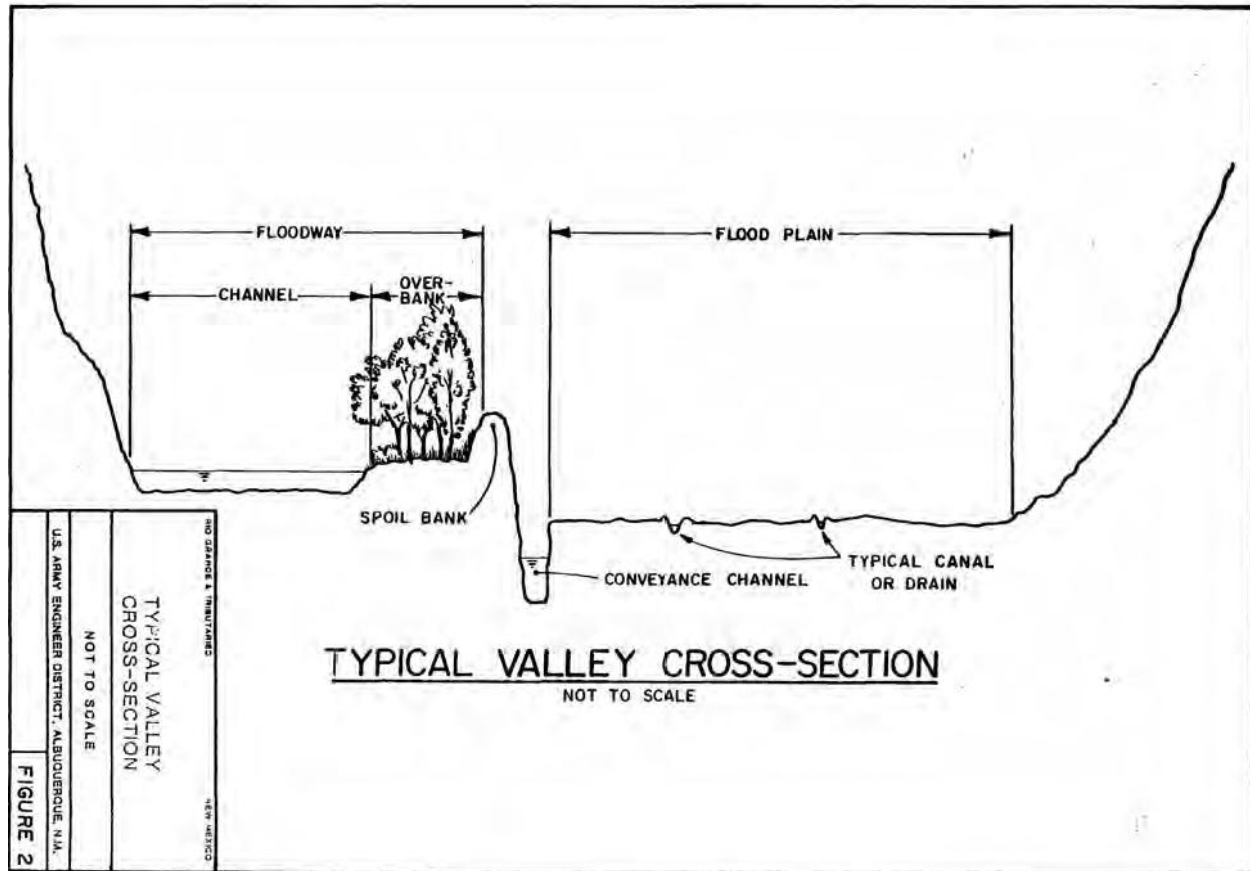


Figure 3.1. Typical cross-section of perched channel where the river channel is significantly higher than the floodplain landward of the spoil bank.

One area of particular concern is Tiffany Basin, located on the west side of the river channel, near the Tiffany Junction railroad siding, immediately upstream of the San Marcial Railroad Bridge. Tiffany Basin has an areal extent of roughly 2,053 acres, is bounded on all sides by either spoil banks or railroad embankment, and is normally isolated from sediment-laden river flows. The absence of frequent deposition has left this basin at a significantly lower elevation than the adjacent river floodway. Separated from spring runoff and flashy peaks by the non-engineered spoil bank, the probability for flooding of this area is greater than its historical frequency would suggest because this flood frequency has been reduced due to flood-fighting efforts by Reclamation. During floods larger than the 20%-chance event (11,800 cfs), the spoil bank would likely fail and could induce a significant headcut in the Rio Grande channel and threatening portions of the spoil bank upstream from the breach. Additionally, this closed basin would capture approximately 10,000 to 15,000 acre-feet of water and, after flood flows recede, all fish that have entered.

Sediment is primarily provided by uncontrolled, ephemeral tributary flows from the Rio Puerco and Rio Salado, which contribute large volumes of sediment due to their large drainage areas, arid climate, and sparse vegetation cover throughout most of their drainages. These high sediment loads have contributed to the high aggradation rate in the San Marcial Reach, which historically has been greater than in any other reach in the Middle Rio Grande. For example, from approximately 1880 to 1924, the riverbed aggraded 9 feet at the San Marcial Railroad Bridge. These high sediment loads also contributed to a history of sediment plug formation in the reach often forming approximately 1.5 miles upstream of the San Marcial Railroad Bridge, near RM 70. Four plugs have formed in this area in the last 18 years in 1991, 1995, 2005, and 2008.

There are indications of plugs forming in years prior to 1991, but they were apparently removed as part of Reclamation's routine river dredging program of that era. The 1991 plug caused a breach of the spoil bank on the west side of the river. The 1995 plug grew to a length of approximately 5 miles and the 2005 plug to 3 miles. Both of these plugs caused a significant rise in the water surface against the spoil bank and prompted emergency levee work during periods of high runoff.

During the 2008 spring runoff, a fourth sediment plug formed in the main channel of the river within BDANWR, immediately downstream of RM 81. The main channel was completely plugged with sediment for a length of 0.5 miles and partially plugged upstream of that for a distance of over a mile. After the spring runoff, a pilot channel, approximately 25 feet in width, was excavated through the plug and excavated spoil material was placed on the west side of the channel to form a spoil bank. The length of the pilot channel was 1.4 miles. The river widened the excavated pilot channel quickly. Within three months, most of the pilot channel returned to the pre-plug width, with only two short sections of spoil banks remaining, totaling 600 linear feet.

Sediment plug formation is a symptom of the larger problem of aggradation due to channel confinement due to constructed spoil banks, jetty jacks, channel rectification, and other factors. When the channel and floodplain inside the spoil banks aggrade, the river channel becomes "perched" above the former floodplain. This perched channel condition exacerbates the consequences from flooding since water entering the former floodplain has no way to drain back into the river. Flood water remains on the floodplain until it infiltrates or evaporates.

In addition to being affected by the high sediment loads, the geomorphology of the San Marcial reach and the lower part of the proposed action area also have been affected by the pool level in Elephant Butte Reservoir since its construction in 1916. During wet periods with a full reservoir, slower flows in the river reach immediately upstream of the reservoir leads to high rates of sedimentation and channel aggradation. During dry periods and recession of the reservoir, base level fall leads to channel incision and degradation.

During high reservoir stages, a delta typically forms where the river enters Elephant Butte Reservoir, and sometimes a temporary channel must be cut into this delta to facilitate stream flow. Following the drought-induced drawdown of Elephant Butte Reservoir that began in 2003, a headcut developed near RM 58 within the upper reach of the temporary channel that had been cut through the reservoir delta that had formed during preceding wet years. By September 2009 this headcut had migrated north into BDANWR. As this reach has historically been rapidly aggrading, this incision is presumed to be temporary (Massong *et al.* 2008). The aggraded

overbanks, which occupy a large proportion of the floodway capacity, are largely unaffected by this localized and transient headcut. From a design perspective, any capacity added through this headcut is ephemeral and could not be relied upon to add meaningful longer-term flood protection within the reach.

Hydrology and Flooding

Surface flows of the Middle Rio Grande are of two general types: snowmelt runoff and stormwater runoff. Snowmelt runoff generally occurs from April through June as a result of snowmelt, which may be augmented by general precipitation (Corps *et al.* 2007). Spring flows are characterized by gradual rises to moderate discharge rates, large runoff volumes, and approximately two-month-long flow durations, with shorter duration peak flows included. Since it was completed in 1975, flow regulation upstream at Cochiti Dam substantially limits potential for spring flooding through the proposed action area. Stormwater runoff is typified by summer monsoonal flash flows that may occur from May through October. Summer monsoon flows are characterized by sharp, high peak flows that recede quickly and generally contain smaller runoff volumes (Corps *et al.* 2007). However, most of the floods producing the greatest damage within the proposed action area have been flows from summer storms entering the Rio Grande through tributary inflows from the Rio Puerco and Rio Salado. The potential for significant floods within the proposed action area originating through either of these tributary watersheds remains largely unaltered from historical flood potentials. Currently, flows above 7,000 cubic feet per second (cfs) through the Middle Rio Grande valley are considered flood flows. During years of low snowmelt runoff and precipitation, surface flows in the main channel of the river can be eliminated for extended periods because of irrigation or water delivery diversions. The river channel below San Acacia can be dry for several months due to upstream diversions during the irrigation season (Corps *et al.* 2007).

There are two different methods commonly used for referring to the likelihood or frequency of a flood event of a specific magnitude. In the past, the Corps has used periods of time (*e.g.*, the 100 year-event) to describe a flooding event that is expected to happen on the order of once every 100 years. However, this convention is somewhat misleading because a 100-year-event can happen multiple times within a single century. For that reason, the Corps has started describing these flooding events by the percent chance that these events have of being equaled or exceeded in any given year. For example, the 100-year-event has a 1% chance of occurring or being exceeded any given year. The Corps used hydrologic routing models to predict flood routing and magnitudes at various cross-sections in the action area without construction of the proposed levee. A discussion on how these discharges are derived is presented in Appendixes F2-F4 (Hydrology, Hydraulics, and Sedimentation) of the GRR/SEIS (Corps 2012) and events referred to in this BA are presented in Table 3.1.

Table 3.1. Discharge frequency, return interval, and projected peak flow at San Acacia Diversion Dam.

| Percent chance event (%) | Return period flood event (year event) | Projected peak flow at San Acacia diversion dam without proposed action (cfs) |
|--------------------------|--|---|
| 0.2 | 500 | 43,500 |
| 1 | 100 | 29,900 |
| 2 | 50 | 25,000 |
| 10 | 10 | 15,400 |
| 14 | 7.1 | 13,240 |
| 20 | 5 | 11,800 |
| 50 | 2 | 7,380 |
| 80 | 1.25 | 4,770 |
| 99 | 1.01 | 2,420 |

The existing west bank spoil levee in the project area provides the current level of flood risk management and corresponding degree of active channel restriction. Analysis performed by the Corps (see Corps 2012 for a complete list of references) indicates that with maintenance such as described in the previous subsection, the existing spoil bank would potentially fail at a flood magnitude equal to the 20%- to 14%-chance event or at flows between 11,800 and 13,240 cfs.

The area subject to major flood damage from inundation, scour, and sediment deposition by the Rio Grande, prior to placement of the existing spoil bank, was the floodplain on the west side of the river from San Acacia to the upstream end of the Elephant Butte Reservoir pool. The east side of the river is largely undeveloped, with few improvements susceptible to flood damage from the Rio Grande, although there are a couple of rural communities across the river from Socorro (Corps *et al.* 2007).

3.3.3 San Marcial Railroad Bridge

The existing San Marcial Railroad Bridge, originally constructed in 1929, is a significant restriction that limits the capacity of the channel to pass unregulated flood flows originating downstream from Cochiti Dam. This, in turn, enhances the deposition of sediment and aggradation of the river channel and floodplain. The bridge alignment is skewed with an angle of approximately 30 degrees with respect to the river channel. The existing bridge crossing consists of five modified Warren through trusses, each spanning nearly 150 feet. The reinforced concrete bridge piers with timber crib wall abutments supporting these spans are wide, flat-nosed, and inefficient at passing flows. The lower chord of the bridge has been as little as 5 feet above the river bottom in the recent past. The combination of poor bridge alignment and inefficient pier design causes the flow of Rio Grande to slow drastically through the area, dropping much of its sediment load, which backs-up upstream of the bridge.

Sedimentation in the immediate vicinity of the existing San Marcial Railroad Bridge have been significant, and increasing as time goes on, in terms of reductions in conveyance capacity and increases in maintenance effort. The Corps examined the sedimentation impacts and determined that the sediment would continue to deposit and that the floodway would continue to aggrade at historic rates. For conditions 50 years into the future, the Corps assumed that the BNSF will replace the bridge at some point during the intervening years.

In May 1996, the Corps initiated formal consultation (Consultation #2-22-95-F-180) on the *Rio Grande Floodway, San Acacia to Bosque del Apache* project, which entailed the replacement of 42 miles of existing spoil bank with a superior and competent engineered levee. The Service issued a draft Biological Opinion BO (USFWS 1996) in November 1996 that determined the proposed project would likely jeopardize the continued existence of both the Southwestern Willow Flycatcher and the Rio Grande silvery minnow, and would likely result in destruction and adverse modification of proposed critical habitat for the minnow. The attendant Reasonable and Prudent Alternative (RPA) included, in part, the “management of the Middle Rio Grande to mimic timing of the historic hydrograph with sufficient flows to provide adequate overbank flooding to meet flycatcher needs.”

During continuing plan formulation for the *San Acacia to Bosque del Apache* project, hydraulic analyses indicated that the proposed levee would sufficiently increase water surface elevations in the Rio Grande to result in an increased probability and frequency of damage to the railroad bridge, and that the railroad bridge would sustain damages that it normally would not sustain under existing (pre-construction) conditions. The Corps does not have the authority to routinely improve or replace private property that can potentially be physically or economically damaged by regulated flood flows. However, the increased probability and frequency in damage to the San Marcial Railroad Bridge as a result of proposed levee construction was determined to represent a compensable taking under the Fifth Amendment of the Constitution. In such cases, the Federal Government has the responsibility and is authorized to provide compensation for actions which negatively affect private property rights. In this case, it was determined that the least expensive compensation alternative was to replace the bridge in-kind, at a height and location where it would no longer be subject to damage. The replacement and relocation of the railroad bridge was incorporated as a justified feature of the Corps reevaluation study for the *San Acacia to Bosque del Apache* flood protection project.

In 2003, the Corps consulted on the operation of its Middle Rio Grande reservoirs relative to the Endangered Species Act (Consultation # 2-22-03-F-0129). The Biological Opinion (BO) issued in March 2003 (USFWS 2003) found that the proposed action would likely jeopardize the continued existence of the endangered Rio Grande silvery minnow and the endangered Southwestern Willow Flycatcher, and would likely adversely modify designated critical habitat for the silvery minnow. The Corps proposed the replacement of the San Marcial Railroad Bridge as an environmental commitment that would facilitate increased discharges and subsequently benefit the listed species. Element U of the RPA of the 2003 BO therefore states, in part: "Action agencies ... shall collaborate on the river realignment and proposed relocation of the San Marcial Railroad Bridge project, which is necessary to increase the safe channel capacity within the Middle Rio Grande." This inclusion in the 2003 BO was, at the time, consistent with the scope of the Corps' legal authority and jurisdiction.

Subsequently, analyses based on updated hydro-meteorological data resulted in a significant (30%) decrease in the magnitude of the 1%-chance flood event; that is, from 43,000 cfs to approximately 30,000 cfs at San Acacia. Based on these new evaluations, construction of an engineered levee along the west bank of the Rio Grande would have minimal effect on the potential for damaging the San Marcial Railroad Bridge. In essence, the probability of damages to the bridge is the same for both the with- and without-levee project condition. Therefore, there are no induced flood damages to the Bridge that can be attributed to construction of the levees, which means there is no compensable taking under the 5th Amendment, and as a result, the Federal Government would bear no responsibility, nor would it be in the Federal interest to relocate the bridge under the auspices of the *San Acacia to Bosque del Apache* project.

The railroad bridge has not functioned to curtail the regulated flood releases (*i.e.*, 7,000 cfs as measured at Albuquerque) from Corps reservoirs since 1997. High storage in Elephant Butte Reservoir—a few miles downstream from the railroad bridge—was a factor in the channel's reduced capacity at the bridge during the mid-1980s to mid-1990s. These years were a period of unprecedented storage in the reservoir. The only previous time such storage was reached was for a brief period following a major flood event in 1941. Storage levels in Elephant Butte Reservoir have been very low for the past few years, and, as a result, channel capacity has increased in the headwaters area. Specifically, the river bed at the San Marcial Railroad Bridge has incised approximately three feet. The railroad bridge has not substantively limited flood-control operations of reservoirs since 1997, including the extended, above-average runoff experienced in 2005.

3.3.4 Water Quality

Section 404 of the Clean Water Act provides for the protection of "waters of the United States" from impacts associated with irresponsible or unregulated discharges of dredged or fill material in aquatic habitats, including wetlands as defined under Section 404(b)(1). For the proposed action three activities relating to proposed work below the ordinary high water mark (OHWM) are: 1) earthen levee construction; 2) placement of riprap along the riverward slope and toe of the levee; and 3) a temporary river crossing (to access the east side of the river to excavate a terrace above the OHWM). Portions of the proposed work below the OHWM would be located on Sevilleta and Bosque del Apache National Wildlife Refuges. The Corps would obtain a Determination of Compatibility from the respective refuge managers for the proposed construction; and would minimize potential impacts to these lands and resources. In 1993, a Record of Decision (ROD) was signed for the 1992 Supplemental EIS (Corps 1992), and the ROD and EIS were submitted to Congress. An appendix in the 1992 SEIS included an evaluation of effects and a Finding of Compliance relative to Section 404(b)(1) of the Clean Water Act; therefore, meeting the requirements for an exemption under §1344(r) of the Act. The current GRR/SEIS updates this evaluation and compliance with §1344(r).

Section 401 of the Clean Water Act requires that a Water Quality Certification Permit be obtained for anticipated discharges associated with construction activities or other disturbance within waterways in the project area. Water quality certification is the responsibility of the New Mexico Environment Department, Surface Water Quality Bureau.

New Mexico's Water Quality Control Commission has designated stream uses and standards in the proposed action area (NMED 2007). Designated uses for the reach from San Marcial at the US Geological Survey (USGS) gage to the Rio Puerco include irrigation, habitat for marginal warm water aquatic life, wildlife habitat, livestock watering, and secondary contact recreation (fishing, boating). Based on a 2007 water quality review by the New Mexico Environmental Department Surface Water Bureau, designated uses for marginal warm water aquatic life and secondary contact recreation were not fully supported. The survey concluded that aluminum and *Escherichia coli* were the probable cause of the impaired uses, with the probable sources of impairments including avian sources (waterfowl and/or other); impervious surface/parking lot runoff; municipal (urbanized high density area); municipal point source discharges; natural sources; on-site treatment systems (septic systems and similar decentralized systems); and wastes from pets.

Although the Rio Grande has a well-defined channel throughout the proposed action area, flows in portions of the area frequently exceed the bank elevation and inundate the overbank area adjacent to the channel. For the purposes of evaluation, the OHWM relative to Section 404 was estimated to be the water surface elevation of the 50%-exceedance discharge based on mean-daily-discharge values at the USGS stream flow gage at San Acacia for the period 1974 through 2002. This discharge was determined to be 5,660 cfs by Parametrix (2008).

The Parametrix (2008) study also used two-dimensional hydraulic modeling to map the extent of these flows throughout the proposed action area. The modeled 5,660-cfs discharge intersects with the existing spoil bank and proposed construction areas in three small areas in the northern portion of the project area. Beginning at approximately 1.5 miles upstream from BDANWR, the modeled flows inundate the riverward toe of the spoil bank (and proposed levee construction zone) for the entire downstream portion of the proposed action area.

No wetlands, as defined in Section 404(b)(1) of the Clean Water Act, have been identified within the affected area for the final array of levee construction alternatives.

4. Species Status and Life History

4.1 Rio Grande Silvery Minnow

4.1.1 Status and Distribution

Until the late 1950s, the silvery minnow was distributed throughout many of the larger order streams of the Rio Grande Basin upstream of Brownsville, Texas , with a range extending to northern New Mexico (about 2000 miles) in water lying primarily below 5500 ft elevation (1676 m). This elevation coincides with the approximate vicinities of Abiquiu on the Chama River, Velarde on the Rio Grande, and Santa Rosa on the Pecos River. Today the silvery minnow is restricted to a variably perennial reach of the Rio Grande in New Mexico, from the vicinity of Bernalillo downstream to the head of Elephant Butte Reservoir, a distance that fluctuates as the size of the pool of water in storage in Elephant Butte Reservoir changes, but that approximates 150 river miles (241 km).

Historically, the silvery minnow was distributed throughout the Rio Grande Basin over a broad range of environmental parameters (including chemical, physical, hydrological, climatic, and biological attributes) that are typical of the arid southwest. Sublette *et al.* (1990) describe the taxonomic characteristics of the silvery minnow and provides an overview account of the life history and species distribution. Bestgen and Propst (1996) provide a detailed morphometric study of the silvery minnow and document the distinctiveness of the species. The silvery minnow is currently listed as endangered on the New Mexico State list of endangered species, having first been listed May 25, 1979 as an endangered endemic population of the Mississippi silvery minnow (*Hybognathus nuchalis*; NMDGF 1988). On July 20, 1994, the Service published a final rule to list the silvery minnow as an endangered species with proposed critical habitat (Federal Register 1994). The Service issued the final rule for silvery minnow critical habitat on February 19, 2003 (Federal Register 2003).

The primary constituent elements (PCE) for silvery minnow critical habitat include: (i) a hydrologic regime capable of forming and maintaining a diversity of aquatic habitats, including backwaters, shallow side channels, pools, eddies, and runs to support all silvery minnow life-history stages; (ii) the presence of eddies created by debris piles, pools, backwaters, or other refuge habitat within reaches of sufficient length to provide a variety of habitats with a wide range of depths and velocities; (iii) substrates of predominantly sand or silt; (iv) water temperatures that vary on a daily, seasonal and annual basis, and that annually range no lower than 1°C and no greater than 30°C; and (v) water with reduced degraded conditions, such as decreased dissolved oxygen and increased pH.

Designated critical habitat for the Middle Rio Grande extends through Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico, from Cochiti Lake downstream to the utility line crossing the Rio Grande at the upstream end of the Elephant Butte Reservoir. The designation includes the tributary Jemez River from Jemez Canyon Dam to the upstream boundary of Santa Ana Pueblo, Sandoval County, but excludes the tribal lands of Santo Domingo, Santa Ana, Sandia, and Isleta Pueblos. The Service considered the Lower Rio Grande around Big Bend National Park, and the Pecos River between Ft. Sumner Dam and Brantley Reservoir for critical

habitat but elected not to so designate these areas even though they are essential to silvery minnow conservation (*e.g.*, possible re-introduction). For all of these reaches, the lateral extent of critical habitat includes those areas bounded by existing levees. In areas without levees, the lateral extent of critical habitat is defined as 300 feet (91.4 m) of riparian zone adjacent to each side of the river.

Population monitoring for silvery minnows has been conducted at twenty sites between Angostura Diversion Dam and the Elephant Butte Reservoir pool since 1993 (Dudley and Platania 2008). Population monitoring provides information for the October population index (Figure 4.1), and yields trends in recruitment and population centers. The October population index has rebounded starting in 2004 with spring runoff flows greater than 2000 cfs (Dudley and Platania 2007a), indicating the importance of overbanking floods in creating suitable habitat for population recruitment.

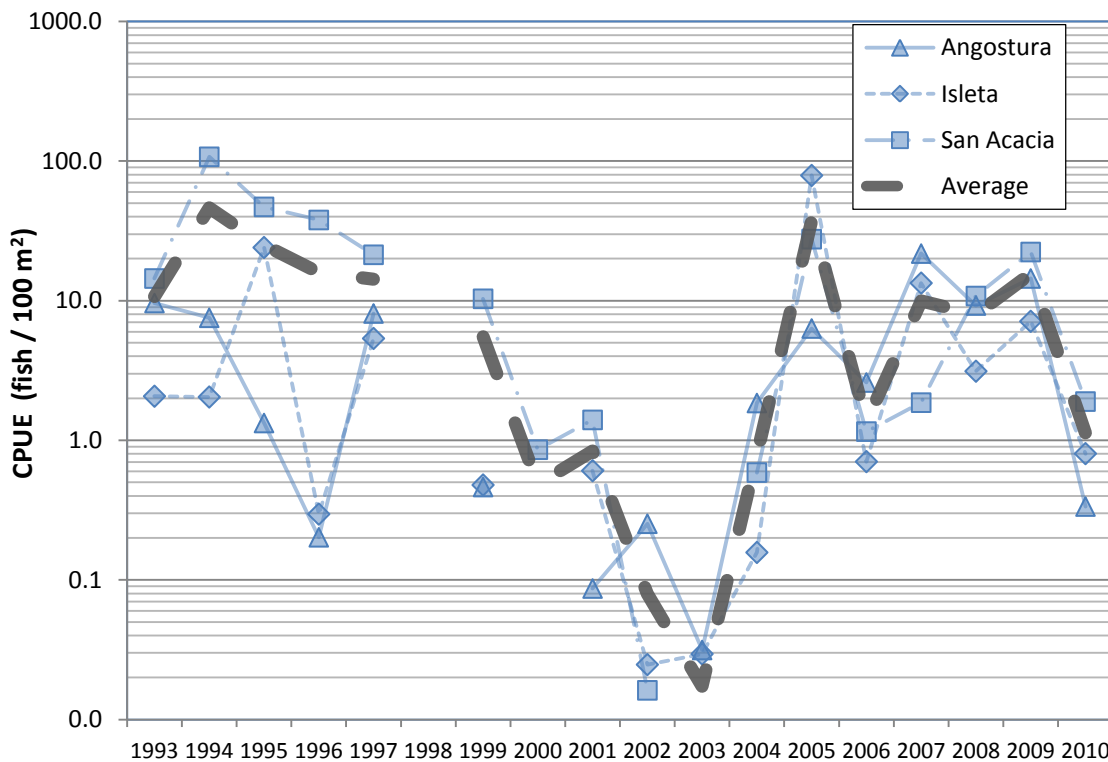


Figure 4.1. Average estimated October density catch per unit effort (CPUE) of Rio Grande silvery minnow by river reaches for the period 1993–2010.

4.1.2 Life History and Ecology

Rio Grande Silvery Minnow Habitat

Floodplain habitat appears important for supporting silvery minnow recruitment (Porter and Massong 2004a, b; Fluder *et al.* 2007; SWCA 2008; Hatch and Gonzales 2008), and habitat fragmentation is likely a major mechanism for extirpation of the silvery minnow from most of its range (Dudley and Platania 2007b). Silvery minnow habitat is typically described as shallow (0.7- 2.6 ft) water bodies with fine grained substrate (silt, sand) and slow water velocities (<1 ft/sec) (USFWS 2010). Silvery minnows are most commonly collected in shallow water (<1.3 ft) with low water velocities (<0.32 ft/sec), primarily over silt and sand substrate (Dudley and Platania 1997). Silvery minnows are capable of moving through narrower incised channels with faster water velocities by remaining in the boundary layer adjacent to the bank to avoid the main current (Porter and Massong 2004b). Surveys in 1977-1978 collected large numbers of silvery minnows in adjacent aquatic habitats connected to the Rio Grande main channel (C. Painter (New Mexico Department of Game and Fish [NMDGF]), unpublished data, 1977-1978), such as the Albuquerque Oxbow, Elephant Butte Marsh (headwaters), the Low Flow Conveyance Channel, and various irrigation drains and canals.

The Rio Grande and Pecos River have been fragmented by dams and reservoirs, resulting in a total of 82 disconnected sub-reaches (Dudley and Platania 2007b). Barriers restricting upstream fish movement between sub-reaches reduce the ability of fish species to re-colonize upstream sub-reaches following downstream movement. While large dams and reservoirs prevent dispersal of fish upstream and downstream, smaller diversion dams may allow limited movement of some fish. The diversion dams on the Middle Rio Grande were designed to pass sediment, allowing passage of fish in both directions during the winter when no irrigation was occurring. Silvery minnow populations (Figure 4.1) also persist in shorter reaches that are unsuitable for other pelagic spawning fishes with semi-buoyant eggs (Dudley and Platania 2007b; Hoagstrom *et al.* 2008). The role of silvery minnow dispersal and habitat connectivity within reaches may benefit from additional research (Rodriguez 2010).

In addition to forming barriers to silvery minnow movement, large reservoirs trap sediment, resulting in channel incision extending downstream from the dam. The extent of downstream incision is a function of scouring flows, time and sediment contribution from downstream tributaries (Massong *et al.* 2006; Schmidt *et al.* 2003). Channel incision increases the depth of turbid water reducing primary productivity within the river (J. Lusk (USFWS) personal communication, 2010). Channel incision also reduces annual connectivity to floodplain and riparian areas for many fish species (Coutant 2004). The loss of inundated riparian habitat for nursery areas limits recruitment by fish species with life histories that are dependent on this habitat. The correlation of October catch rates with spring flow above 2000 cfs ($r^2 = 0.83-0.91$) supports recruitment as a function of inundated habitat for the silvery minnow (Dudley and Platania 2007a). Loss of riparian connectivity within the Rio Grande floodplain has decreased the amount of critical habitat for the silvery minnow.

The USGS modeled silvery minnow habitat availability as a function of instream flow in the lower Isleta Reach between the Rio Puerco confluence and San Acacia diversion dam (Bovee *et al.* 2008). The study focused on hydraulic and structural habitat for juveniles (young-of-year,

YOY) and adults at the lower range of flows typical of dry and normal summers in this reach of the river. The maximum area of suitable hydraulic habitat for adults was at flow between 40 to 80 cfs. The area of suitable adult habitat declined rapidly as flow increased above 150 cfs, shifting the preferred shallow, low velocity habitat to the margins of the river.

The MRGCD irrigation system may provide habitat for silvery minnows, particularly as refugia during river drying, with fish returning to the river as flow increases (Cowley *et al.* 2007). Because of this, declines in the occurrence of silvery minnows in the irrigation system since the 1970s (C. Painter (NMDGF), unpublished data, 1977-1978; Lang and Altenbach 1994) indicate the need for more information about how irrigation practices affect minnow survivorship in the ditches. Cowley *et al.* (2007) suggests several concepts for managing the irrigation system to enhance habitat values for native fish species.

Ecologically, the silvery minnow appears to be a physiological generalist with specific habitat requirements for completion of its life cycle to support recruitment, persistence and abundance of the species. Silvery minnow primarily consume diatoms, cyanobacteria, and green algae associated with sand or silt substrates in shallow areas of the river channel (Propst 1999; USFWS 1999; Shirey *et al.* 2007). Dudley and Platania (1997) studied habitat preferences of the silvery minnow in the Middle Rio Grande at Rio Rancho and Socorro. They characterize habitat preference and habitat availability in terms of water depth, water velocity and stream substrate. Both juvenile and adult silvery minnows primarily use mesohabitats with moderate depths (15-40 cm), low water velocities (4-9 cm/sec) and silt/sand substrates. Avoidance of swift water velocities by the silvery minnow is one means of conserving energy, a general life strategy shared by many lotic fish species (Facey and Grossman 1992). Young-of-year (YOY) silvery minnows are generally captured in shallower and lower velocity habitats than adult individuals. Silvery minnows used low velocity habitat with instream debris (cover) more frequently during winter months (Dudley and Platania 1996). At near-freezing water temperatures, silvery minnow become less active and seek habitats with cover such as debris piles and low water velocities.

Rio Grande Silvery Minnow Spawning and Recruitment

Age and body length analyses by Cowley *et al.* (2006) indicate silvery minnows had a maximum longevity of 4-6 years in the late 1800s. Data from minnow rescue in 2006 (USFWS 2007a) indicates five possible classes (Age 0-4) based on standard length size distribution. More recent age-at-length studies using silvery minnow scales and otoliths show four age classes (Age 0-3) (Horwitz *et al.* 2011). The majority of spawning individuals are Age 1 fish (1-year old) with older, larger fish (Age 2+) constituting less than 10% of the spawning population (Platania and Altenbach 1996). Reproductively mature females are typically larger than males. Each female may produce several clutches of eggs during spawning ranging from 2000-3000 (Age 1) to 5000+ eggs (Age 2) per female (Platania and Altenbach 1996). Few adult silvery minnows are captured by late summer, suggesting that spawning adults may either experience high post-spawning mortality or reduced catchability.

Silvery minnows spawn from late April through June and over a relatively narrow range of water temperature 20-25C (Platania and Dudley 1999, 2001). Peak egg production occurs in mid to late-May and generally coincides with high spring discharge produced by snowmelt. Silvery minnows produce numerous semi-buoyant, non-adhesive eggs typical of the genus *Hybognathus*

(Platania and Altenbach 1998). The specific gravity of silvery minnow eggs ranges from 1.012 – 1.00281 as a function of time post-fertilization (Cowley *et al.* 2005). Eggs produced by related species, such as *H. regius* (Raney 1939) and *H. hankinsoni* (Copes 1975), are non-adhesive and considered demersal. More data on the specific gravity of related species of *Hybognathus* may provide useful insights for understanding spawning behavior and site selection among silvery minnow species. Egg hatching time is temperature-dependent, occurring in 24-48 hours at water temperatures of 20-30°C (Platania 2000). Recently hatched silvery minnow larvae are about 3.7 mm in length. Environmental variables that influence silvery minnow spawning include photoperiod, degree days (average temperature multiplied by the number of days), and water turbidity. Additional research should improve our understanding of environmental factors on the timing and duration of silvery minnow spawning.

The summer catch rates (July catch per unit effort [CPUE]) are correlated with spring flow (mean cfs from April 15th – June 15th: adjusted $r^2 = 0.7588-0.7763$) and overbank area (inundated acres adjusted $r^2 = 0.7594-0.835$), supporting recruitment as a function of spring flow (Figure 4.2) and inundated habitat (Figure 4.3) (D. Goodman (University of Montana), personal communication, 2010; Dudley and Platania 2007a). Nursery habitat consists of shallow inundated surfaces with low water velocities where eggs hatch without downstream displacement, and larval fish can readily find food (Pease *et al.* 2006; Porter and Dean 2007). Shallow water areas provide the productive habitats required by larval fishes to successfully complete their early life history (Dudley and Platania 2007a; Turner *et al.* 2010). Creating additional shallow water habitats in the Middle Rio Grande is an objective of temporary deviations of flow from Cochiti and Jemez Canyon Dams (Grand *et al.* 2006; Corps 2009).

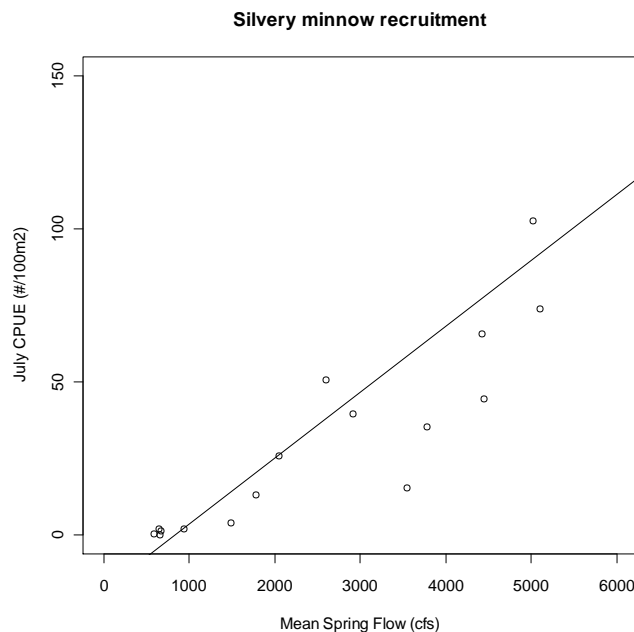


Figure 4.2. Relationship of Rio Grande silvery minnow July catch per unit effort (CPUE) as a function of spring runoff from 1993-2010 based on different linear models ($r^2 = 0.7588-0.7763$).

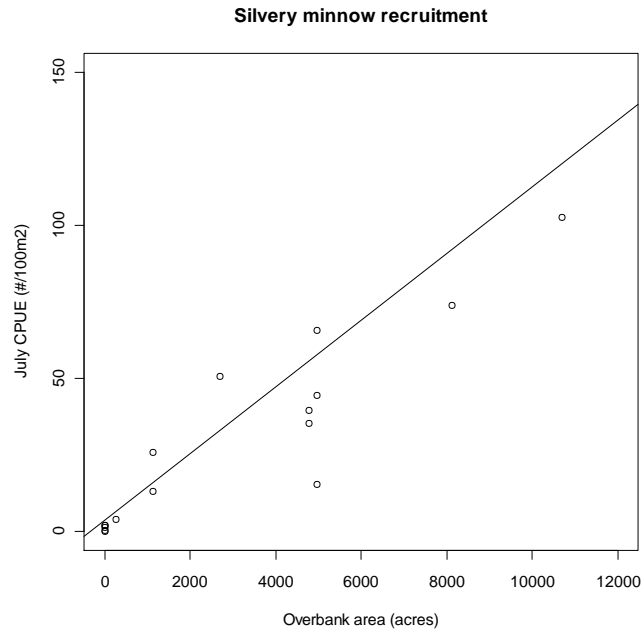


Figure 4.3. Relationship of Rio Grande silvery minnow July catch per unit effort (CPUE) as a function of inundated area during spring runoff from 1993-2010 based on different linear models ($r^2 = 0.7594-0.835$).

Platania and Altenbach (1998) discussed the difficulty for explaining the persistence of the silvery minnow in the Rio Grande while other minnow species with semi-buoyant eggs were extirpated from the system. Dudley and Platania (2007b) observed that many silvery minnow eggs incubate as they drift downstream through channelized reaches and they suggest that adult silvery minnows migrate upstream to complete their life cycle.

Egg retention from the current into inundated riparian zones favorable for larval fishes provides a mechanism for silvery minnow recruitment in the Middle Rio Grande (Widmer *et al.* 2007, 2010). Egg retention is consistent with the interactions of channel incision and hydrology leading to egg drift, declining recruitment and populations (Porter and Massong 2004b, 2005; Dudley and Platania 2007a, 2007b; Widmer *et al.* 2007, 2010). Larval silvery minnow have been associated with low water velocity habitat including inlets, shelves, and side channels (Pease *et al.* 2006; Turner *et al.* 2010). Higher silvery minnow densities, measured as catch per unit effort (CPUE), appear to be spatially associated with reaches with higher egg retention (Widmer *et al.* 2007).

Rio Grande silvery minnow spawning is closely tied to the annual spring flood. During the ascending limb of the hydrograph, silvery minnows appear to move into flooded riparian areas and backwaters to spawn. Habitat monitoring has documented silvery minnow adults (Hatch and Gonzales 2008; SWCA 2008), and eggs (SWCA 2008) on constructed nursery habitat sites. Similar habitat use by silvery minnows, razorback suckers (*Xyrauchen texanus*; Valdez and Wick 1983; Tyus 1987; Tyus and Karp 1990; Modde *et al.* 1996; Modde and Irving 1998), and

Colorado pikeminnow (*Ptychocheilus lucius*, Grand *et al.* 2006) suggests that nursery habitat is important for population management (USFWS 2007b).

There has been annual monitoring of silvery minnow egg drift (Table 4.1) since 2002 (Platania and Dudley 2002, 2003, 2004, 2005, 2008, 2009, 2010, 2011) to evaluate recovery goals. These samples provide information on the magnitude of reproduction carried downstream of nursery habitat in the channelized San Marcial reach (at River Mile (RM) 58.8). The duration of high flows during the April-June spawning season were positively correlated with silvery minnow mean October densities, while extended low-flow periods were negatively correlated with silvery minnow mean October densities (Dudley and Platania 2008). Elevated flows in 7 of the past 10 years (2001-2010) have contributed to silvery minnow recruitment compared with the 2002-2003, 2006 year-classes (Dudley *et al.* 2008; Dudley and Platania 2010).

Table 4.1. Results of monitoring for silvery minnow eggs at irrigation diversion structures and at San Marcial. Values are absolute number of eggs collected.

| Date | Albuquerque Main | Peralta Main | Belen Highline | Socorro Main | Totals | San Marcial ^d |
|---------------------|------------------|--------------|----------------|--------------|--------|--------------------------|
| 2002 ^b | 0 | 729 | 826 | 28 | 1,583 | 92,000 |
| 2003 ^{a,b} | 3 | 26 | 48 | - | 77 | 13,292 |
| 2004 ^{a,b} | 0 | 3 | 3 | - | 6 | 5 |
| 2005 ^{a,b} | 1 | 1 | 3 | - | 4 | - |
| 2006 ^{a,b} | 0 | 1 | 8 | 8 | 17 | 7,900 |
| 2007 ^{a,b} | 0 | 49 | 43 | 2 | 94 | 10,995 |
| 2008 ^{a,c} | 0 | 1 | 0 | 9 | 10 | 155 |
| 2009 ^{a,c} | 0 | 12 | 3 | 29 | 44 | 645 |
| 2010 ^{a,c} | - | 11 | 1 | 0 | 12 | 364 |
| 2011 ^{a,c} | - | 8 | 4 | 13 | 25 | 96,266 |

^a Diversions managed to minimize entrainment of silvery minnow eggs.

^b Porter and Dean 2007.

^c Data provided to Reclamation by the Service. Monitoring for the Albuquerque Main was discontinued after 2009.

^d Estimated number of eggs collected from Platania and Dudley 2002-2011.

Reclamation has contracted egg entrainment monitoring from 2002 through 2011 (Table 4.1) as part of RPA elements in the BO (USFWS 2001, 2003b). After 2002, MRGCD has managed diversions to minimize entrainment during peak egg drift. Higher spring flows since 2003 have inundated riparian areas, providing nursery habitat for spawning and rearing. The availability of nursery habitat probably reduces entrainment of silvery minnow eggs into the current, reducing the number of eggs drifting downstream.

Rio Grande Silvery Minnow Population Trends 1994-2010

Long-term monitoring of fish populations is fundamental for evaluating how management affects riverine fish communities and silvery minnow populations. Fish community surveys have been conducted since 1993 (with the exception of 1998) in the Rio Grande of New Mexico between Angostura Diversion Dam (RM 209.7) and Elephant Butte Reservoir (RM 58.8). Survey methodology consists of single-pass seine samples (Dudley *et al.* 2008) with results reported as count data, such as catch per unit effort (CPUE) or catch per area sampled. Although the statistical properties of these indices (*e.g.*, measures of bias, capture or detection probabilities, and variance) are unknown, these surveys document silvery minnow density (fish per 100 m²) variability over time and space.

The 2001 and 2003 Biological Opinions (USFWS 2001, 2003) included several Reasonable and Prudent Alternative elements for maintaining minimal wetted silvery minnow habitat in the Angostura, Isleta, and San Acacia reaches. It also provided for a one-time increase in flows (spawning spike) between April 15 and June 15 of each year to cue spawning if needed (USFWS 2001, 2003b). This action has been transformed into recruitment flows based on the predictions of nursery habitat and silvery minnow population trends following riparian habitat inundation from 2004-2008 (Corps 2007, 2008a). Though recruitment was highly variable both annually and longitudinally, the 2007 fish community monitoring results show June-July YOY recruitment throughout all three reaches.

Over the period 1993-2010, October counts were conducted in the Angostura, Isleta, and San Acacia reaches (Table 4.1). The data show that the density of silvery minnows was generally lower (CPUE < 35 / 100 m²) for the October surveys (1993-2010) in the Angostura Reach. The density of silvery minnows (CPUE < 0.1 – 118 / 100 m²) during October has a broader range in the Isleta Reach. Silvery minnow fall abundance (CPUE < 0.1 – 207 / 100 m²) has fluctuated the greatest in the San Acacia Reach.

4.1.3 Reasons for Rio Grande Silvery Minnow Decline

Understanding the effects of habitat degradation, connectivity and fragmentation on different fish species' life history patterns provides clues for analyzing future actions (Koster 1955). The range of the Rio Grande silvery minnow has contracted significantly since the 1950s. The Federal Register (Federal Register 1993) proposal to list the silvery minnow as an endangered species discusses many factors that have led to the decline of the species. The silvery minnow has several common factors for extinction prone species including specialized habitat requirements, restricted geographic distribution with limited opportunities for dispersal, and small but demographically-variable populations (Brown and Lomolino 1998).

Habitat Modification

Factors currently affecting silvery minnow habitat include loss of habitat due to: water impoundment; channel drying; channel straightening and other geomorphic channel alterations; and water pollution (Federal Register 1994; Schmidt *et al* 2003; USFWS 2007b). Impoundment of water in the Rio Grande by mainstem dams has affected the flow regime of the river, fragmented habitat, and resulted in geomorphological changes to the channel (Federal Register 1994; USFWS 2007b). Habitat fragmentation and degradation (resulting from dams) may be a

factor in the decline of the silvery minnow, including the sequential decline and loss of fish from upstream to downstream (Platania and Altenbach 1998, Porter and Massong 2004a).

The conversion of riverine habitat into reservoirs creates barriers to silvery minnow movement. Silvery minnows are generally obligate riverine species that have not been documented using limnetic habitat. The unsuitability of reservoir habitat creates barriers to silvery minnow dispersal and does not provide refugial habitat for maintaining populations.

Flows in the Middle Rio Grande are extreme and highly erratic, including episodic flooding and, at times, intermittence (Corps 2007, 2009). Reservoir operations may reduce the size of the flood peaks, extend or decrease the duration of the snowmelt runoff (depending on the size of the runoff), and increase the volume of water entering the Middle Rio Grande valley during normal natural low flow periods (USFWS 2007b). Managed flow regimes can alter silvery minnow habitat by reducing the frequency and magnitude of overbank flooding, trapping nutrients, altering sediment transport regimes, prolonging summer base flows, and creating reservoir habitats that favor non-native fish species. The changes in hydrology may reduce silvery minnow food supplies, alter its habitat, prevent dispersal, and provide non-native fish with a competitive advantage.

River engineering projects have variable effects on silvery minnow habitat quality and area depending on how they are implemented. Traditional river engineering activities have confined the Rio Grande to a narrower channel and reduced the connectivity with adjacent riparian habitat. Channels have been straightened and deepened, and aquatic plants and snags have been removed to lessen hydraulic resistance. Sediment retention by upstream reservoirs results in channel incision, reducing surface water inundation. Conventional river engineering projects have reduced the retention time of water and organic matter, surface area and physical complexity of the habitat, and refugial habitats.

Channelization of the Middle Rio Grande has resulted from the placement of Kellner jetty jacks along the river to protect levees by retarding flood flows, trapping sediment, and promoting vegetation (Federal Register 1994; USFWS 2007b). Meanders, oxbows, and other components of silvery minnow habitat have been eliminated in order to pass water as efficiently as possible for agricultural irrigation and downstream deliveries. The loss of low-velocity nursery habitat (inundated riparian vegetation, backwaters, etc.) has likely reduced silvery minnow larval and juvenile recruitment.

River Diversions and Dewatering

Dewatering (channel drying) is caused primarily by agricultural water diversion and by climatic drought. For minnows, these actions result in a fragmented range with reduced habitat area and connectivity (Federal Register 1994; USFWS 2007b). The impacts of water diversion may not be severe in years when an average or above average amount of water is available (Federal Register 1994; USFWS 2007b). In years of below-average water availability river channel drying may be extensive from Isleta Diversion Dam downstream to Elephant Butte Reservoir (111 mi).

Dewatering is implicated in many studies of silvery minnow range contraction from its historic extent. For example, Trevino-Robinson (1959) documented the early 1950s “cosmopolitan” occurrence of silvery minnows in the Rio Grande downstream of its confluence with the Pecos

River where, for “the first time in recorded history,” a portion of this reach of river went dry in 1953. Although Trevino-Robinson (1959) could not document any “apparent undesirable or severe after effects” from the drought, silvery minnows have not been documented from this lower portion of the Rio Grande since the mid-1950s (in part, USFWS 1999). Edwards and Contreras-Balderas (1991) confirm the absence of the silvery minnow from the Rio Grande below Falcon Dam, which is downstream of the Pecos confluence at Amistad Lake.

Drought leading to channel drying has also been implicated in the extirpation of the silvery minnow from upstream reaches of the Rio Grande. Hubbs *et al.* (1977) documented the “inexplicable” absence of silvery minnow from the Rio Grande in Texas between El Paso and its confluence with the Pecos River where Hubbs (1958) had earlier documented the species to occur. However, Chernoff *et al.* (1982) noted that much of this stretch, particularly the Rio Grande between El Paso and the mouth of the Rio Conchos, is at times dry. Sublette *et al.* (1990) documented the former occurrence of the silvery minnow in the Rio Grande from Caballo Reservoir, NM downstream to El Paso, TX, another stretch that is now often dry and from which the silvery minnow has been extirpated. Thus, between 1950 and 1991, the Rio Grande silvery minnow was extirpated from that portion of its historic range lying downstream of Caballo Reservoir to the Gulf of Mexico.

Observations suggest that during periods of such extreme water scarcity, the silvery minnow seeks out cooler pool habitats associated with overhead cover, irrigation return flow, and shallow groundwater (Federal Register 1994; USFWS 2007b). During periods of no flow, the silvery minnow is thought to have survived in the irrigation ditches and drains, the reaches above the diversions, and in channels maintained by irrigation return flows or leakage from the diversion dams. River drying increases silvery minnow mortality rates due both to decreasing water quality in temporary pools and the eventual disappearance of such pools as water seeps into the substrate.

It has been proposed that the entrainment of silvery minnows (primarily eggs and larvae) in the infrastructure of irrigation systems that derive water directly from the Rio Grande could be a factor contributing to the decline of the species (*e.g.*, USFWS, 1999). Egg entrainment in irrigation canals has been monitored since 2001 (*e.g.*, Reclamation 2003). These studies show that recent management actions have minimized egg entrapment in irrigation infrastructure.

Water Quality for Rio Grande Silvery Minnow Habitat

Water quality in the Middle Rio Grande varies spatially and temporally throughout its course primarily due to inflows of groundwater, as well as surface water discharges and tributary delivery to the river. Factors that are known to cause poor fish habitat include temperature changes, sedimentation, runoff, erosion, organic loading, reduced oxygen content, pesticides, and an array of other toxic and hazardous substances. Both point source pollution (*e.g.*, pollution discharges from a pipe) and non-point source pollution (*i.e.*, diffuse sources) affect Rio Grande water quality.

Changes in water quality from increasing agriculture and urbanization along the Rio Grande during the last century have been suggested as a factor in declining silvery minnow populations (USFWS 1999). A screening level risk assessment based on two Middle Rio Grande datasets suggests that while there may be locally poor water quality, the analysis does not indicate that

human activities have adversely impacted silvery minnow populations (Marcus *et al.* 2010). Though there are many natural and anthropogenic factors that affect water quality in the Middle Rio Grande, a 2006-2008 water quality study concluded that water chemistry may be a contributing factor, it is not likely to be the most critical issue affecting the silvery minnow especially compared to a lack/timing of adequate flows to maintain the needed habitat (NMED 2009:). Further downstream the International Boundary and Water Commission (IBWC 2003) and the Texas Natural Resources Conservation Commission (TNRCC 1994) have documented water quality impairment from toxic chemicals at sites along the international border.

The expansion of cities and agriculture along the Middle Rio Grande may have adverse effects on river water quality (Federal Register 1994; USFWS 2007b). During low flow periods, the increased proportion of municipal and agricultural discharge to native flow may allow pollutants to significantly degrade water quality. Agricultural water use appears to reduce nutrient availability in return flows to the river (Van Horn and Dahm 2008). Recent water-quality data have not identified limiting factors for silvery minnows or habitat (NMED 2001, 2009; USFWS 2004; Marcus *et al.* 2005).

Major point sources include wastewater treatment plants and dairy cattle feedlots. The US Environmental Protection Agency (USEPA) conducted endocrine disruption testing of wastewater treatment plant effluents from Rio Rancho, Bernalillo, Albuquerque, Bosque Farms, Los Lunas, Belen, and Socorro in 2007 (NMED 2009). Effluent from Los Lunas and Socorro during the summer (low flow volumes) could make endocrine disruption a seasonal water quality concern for silvery minnow in the Isleta and San Acacia reaches respectively. In 1999, water quality in the Angostura reach (RM 203.3 – 178) was found to not be adversely affecting aquatic life (NMED 2001, 2009). Nitrogen and phosphorous concentrations were less than 2 mg/L, with increasing specific conductance (calcium bicarbonate) in the downstream direction (Langman and Nolan 2005). Diatom species from the late 1800s are indicators of high nutrient loads in the Rio Grande (Shirey *et al.* 2007). Though wastewater treatment plants are a major nutrient source (Van Horn and Dahm 2008), it appears that there is significant removal of nutrients (nitrate and phosphate) from water diverted for irrigation (Peterson *et al.* 2001). These observations are consistent with the low overall gross primary productivity in the Rio Grande (USFWS 2004). There have been no longitudinal studies bracketing wastewater treatment plants to examine the aquatic primary productivity and fish community response to the effluent (*e.g.*, Lewis *et al.* 1981).

Potential major non-point sources include agricultural activities (*e.g.*, fertilizer and pesticide application, livestock grazing), urban stormwater run-off, and mining activities (Ellis *et al.* 1993). Large precipitation events wash sediment and pollutants into the river from surrounding lands through storm drains and intermittent tributaries. Contaminants of concern to the silvery minnow that are frequently found in stormwater include the metals aluminum, cadmium, lead, mercury, and zinc; organics such as petroleum products; the industrial solvents trichloroethene and tetrachloroethene; and the gasoline additive methyl tert-butyl ether (USGS 2001). However, chronic aluminum and *E. coli* are the only water quality impairments in the Middle Rio Grande identified by recent studies (NMED 2009).

Pesticide contamination may originate from agricultural, residential and commercial landscaping activities. Nine pesticides were identified as constituents of concern (Tier II risk) in the Middle

Rio Grande (Marcus *et al.* 2010). The presence of pesticides in surface water depends on the amount applied, timing, location, and method of application. Water quality standards have not been set for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time. Pesticide degradation products have been detected in whole body fish collected throughout the Rio Grande (Roy *et al.* 1992).

Semi-volatile organic compounds including polycyclic aromatic hydrocarbons, phenols, and phthalate esters, were analyzed in sediment collected by the USGS (Levings *et al.* 1998). The analysis of the polycyclic aromatic hydrocarbon data by Levings *et al.* (1998) shows that one or more polycyclic aromatic hydrocarbon compounds were detected at 14 sites along the Rio Grande, with the highest concentrations found below Albuquerque and Santa Fe. More recent studies reported the absence of detectable organic chemicals (despite urbanization) in the Middle Rio Grande (NMED 2009). These compounds likely result from past water-quality or stormwater-runoff events, and may pose a greater risk to aquatic life when attached to the sediment on the stream bed or sediment suspended in the water column than as waterborne compounds (Marcus *et al.* 2010).

Sediment-borne contaminants present greater risks to the silvery minnow as they graze on benthic algae in the Middle Rio Grande (Marcus *et al.* 2010). Ong *et al.* (1991) recorded the concentrations of trace elements and organochlorine pesticides in suspended sediment and bed sediment samples collected from the Middle Rio Grande between 1978 and 1988. Available water quality data do not support a conclusion that sediment toxicity has produced population-level impacts to silvery minnows in the Middle Rio Grande (Marcus *et al.* 2010).

Rio Grande Silvery Minnow Population Genetics

While population size (N) is an important variable for endangered species survivorship, the effective population size (N_e) of an endangered species is also crucial because it describes the genetic diversity of the population (Minckley *et al.* 2003). Genetic diversity determines the ability of species to cope with environmental variability (Gilpin and Soulé 1986). The effective size (and therefore genetic diversity) is reduced by genetic drift and inbreeding. Small effective population size can negatively impact long-term survival because reduced genetic variability can translate into a reduced ability to adapt to environmental changes. These values are poorly understood for most species (Minckley *et al.* 2003). The silvery minnow N_e is moderately low based on different estimators (PBS&J 2011).

Due to the increased efforts in captive propagation, recent studies by the Collaborative Program have focused on the genetic composition of the silvery minnow. Several studies since 2003 have demonstrated a decline in overall mitochondrial mtDNA and gene diversity in the silvery minnow (*e.g.*, Osborne *et al.* 2005; Turner *et al.* 2006). The results are consistent with smaller overall population numbers and/or increasing relatedness of the females. In addition, studies need to be conducted on the genetic effects of stocking hatchery fish. Currently, these fish are artificially spawned in groups, where fish are assumed to form pairs. However, competition between males and gametic competition could produce effective numbers far smaller than those that are assumed. The effect of communal spawning on effective number must be assessed so the genetic consequences of stocking hatchery fish can be accurately measured and a true effective population number can be determined.

Finally, the changes in gene frequency caused by fish culture practices must be assessed (Minckley *et al.* 2003). Osborne *et al.* (2006) reported that genetic heterozygosity in captive-reared fish and wild fish were the same, with a loss only in allelic diversity. They also stated that hatchery-reared fish stocked into the wild will cause a lower effective breeding number and could cause a reduction in fitness of the entire population. However, the effects of domestication and inadvertent selection have not been studied in the silvery minnow. Additional problems may occur due to the increased survival in wild genotypes brought into the hatchery that would have died in the wild. These fish survive due to lack of predation and to increased care, and then are stocked back into the river as brooders and are still considered to be “wild fish.” This is critical because captive-reared fish could affect the natural population’s level of fitness.

Competition, Predation, Disease

Accidental or intentional releases of fishes outside of their native ranges (including bait and aquarium sources) have established numerous exotic fish species in the Rio Grande Basin (Sublette *et al.* 1990), representing potential competitors or predators of the silvery minnow. The silvery minnow evolved sympatrically with about 90 other fish species, including those with similar feeding habitats. Competition among fish species often evokes resource partitioning through selective and interactive segregation.

Predation and competition with other fish species has been cited as a factor possibly contributing to the decline of the species (*e.g.*, USFWS 1999). Predation by piscine and avian predators upon silvery minnows has not been quantified, but probably has a minor role in declining silvery minnow populations (Federal Register 1994; USFWS 2007b). Swimming performance of silvery minnows may provide a reasonable capability for escaping predators (Bestgen *et al.* 2003). Experiments using brassy minnows (*H. hankinsoni*) exhibited a change in habitat use when predators are present (Schlosser 1988). The turbidity of the Rio Grande serves to lessen the impacts of would-be predators on silvery minnows because the effective predatory strike zone is shortened.

Fish confined to pools during periods of low flow may experience outbreaks of *Ichthyophthirius multifiliis* (caused by a protozoan and commonly called “ick”) or *Lernaea* (a parasitic copepod, Federal Register 1994; USFWS 2007b). Ongoing studies are examining the impact of disease and parasites on silvery minnows (USFWS unpublished data).

4.1.4 U.S. Fish and Wildlife Service Actions to Avoid Jeopardy

Rio Grande Silvery Minnow Population Augmentation

In 2000, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow. Captive propagation is designed to preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations. Augmentation of endangered fish species on the lower Colorado River has documented improved survival and recruitment from rearing wild fish larvae in off-channel habitats (Minckley *et al.* 2003; Mueller and Carpenter 2008).

Since 2000, over a million propagated silvery minnows (Table 4.2) have been released into the Angostura Reach (2002-2007) to ensure downstream repopulation (Remshardt 2008).

Augmented fish are marked with a visible fluorescent elastomer tag and released in large numbers at a few locations. Marked fish have been released by the Service since 2002 under a formal augmentation effort funded by the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program). The percentage of recaptured (marked) silvery minnows (Table 4.2) provides an index of the contribution of augmented fish to the overall population (Annual Recapture) and recruitment (April-May Recapture).

Table 4.2. Summary of augmented (marked), recaptured, and salvaged silvery minnows.

| Year | Stocked | Annual recapture (USFWS) | | | April-May recapture (fish community monitoring) | | | Salvaged silvery minnows | |
|-------|-----------|--------------------------|--------|--------------------|---|--------|--------------------|--------------------------|----------------------------|
| | | Total captured | Marked | Percent recaptured | Total captured | Marked | Percent recaptured | Total salvaged | Ratio (salvaged / stocked) |
| 2002 | 43,582 | 53 | 7 | 13.20% | 270 | 0 | 0.00% | 3,662 | |
| 2003 | 83,384 | 141 | 32 | 22.70% | 48 | 14 | 29.20% | 713 | 0.86% |
| 2004 | 180,651 | 450 | 99 | 22.00% | 566 | 22 | 3.90% | 12,865 | 7.12% |
| 2005 | 255,217 | 31,457 | 264 | 0.84% | 280 | 5 | 1.80% | 207,746 | 81.40% |
| 2006 | 418,851 | 8,375 | 298 | 3.60% | 2,058 | 9 | 0.44% | 69,889 | 16.69% |
| 2007 | 133,154 | 10,172 | 53 | 0.52% | 123 | 35 | 28.50% | 13,953 | 10.47% |
| 2008 | 0 | 9,666 | 5 | 0.05% | 455 | 2 | 0.44% | N/A | N/A |
| 2009 | 0 | | N/A | | | N/A | | 18,473 | N/A |
| 2010 | 5,715 | | N/A | | | N/A | | 10,273 | 189% |
| Total | 1,114,839 | 50,648 | 753 | 1.49% | 3,800 | 87 | 2.30% | 308,828 | 27.70% |

Ongoing research by the Service is designed to document the movement of silvery minnows. Initial studies had crews sample upstream and downstream from the release site in an attempt to capture the marked fish. Preliminary results indicate that the majority of silvery minnows disperse a few miles downstream. Recent studies are using passive injected transponder (PIT) tags implanted in silvery minnows to document individual fish movement (Remshardt 2008; Archdeacon *et al.* 2009).

Rio Grande Silvery Minnow Rescue and Salvage

During river drying periods, the Service's silvery minnow salvage crew capture and relocate silvery minnows upstream to the perennial reaches. Since 2002, over 300,000 silvery minnows (Table 4.2) have been salvaged and relocated to wet reaches. The contribution of salvaged fish to the population is about 28% of the total augmented fish. Silvery minnows were repatriated into the Angostura Reach (2002-2007) of the river near Alameda Bridge. Starting in 2008, silvery

minnows were released in flowing water within the reach in which they were captured to minimize handling stress (Remshardt 2008).

4.2 Southwestern Willow Flycatcher

4.2.1 Status and Distribution

The USFWS listed the Southwestern Willow Flycatcher (flycatcher) as endangered in February 1995 (Federal Register 1995). The flycatcher also is classified as endangered (Group I) by the State of New Mexico (NMDGF 1987). The current range of the flycatcher includes Arizona, New Mexico, southern California, extreme western Texas, southwestern Colorado, and southern portions of Nevada and Utah (USFWS 2002). In New Mexico, flycatchers are known to breed along the Rio Grande, and in the Zuni, San Francisco, and Gila River drainages. A recovery plan for the flycatcher has been completed (USFWS 2002).

Critical habitat for the flycatcher was designated in July 1997 (USFWS 1997); however, pursuant to an order from the U.S. District Court of Appeals Tenth Circuit, the USFWS conducted an economic analysis and re-designated critical habitat in October 2005 (Federal Register 2005). Most of the defined critical habitat includes areas outside of the Middle Rio Grande and outside of New Mexico. Critical habitat along the Middle Rio Grande includes, in part, the Rio Grande floodway from the southern boundary of the Pueblo of Isleta downstream to the headwaters of Elephant Butte Lake at RM 62 (approximately 104 river miles), except for lands within Sevilleta and Bosque del Apache NWRs. Within the proposed action area, designated critical habitat for the flycatcher encompasses the entire floodway from the SADD to the headwaters of Elephant Butte Reservoir, except for the portions of the floodway on the two National Wildlife Refuges.

On August 15, 2011, the Service proposed to revise critical habitat for the Southwestern Willow Flycatcher (USFWS 2011). Chapter 5 of this BA also evaluates potential effects of the proposed actions on proposed critical habitat for the flycatcher. The only difference between proposed and designated critical habitat within the action area is the addition of Sevilleta and Bosque del Apache NWRs to the proposed critical habitat.

The Primary Constituent Elements (PCEs) of both designated and proposed flycatcher critical habitat are similar. The following description is taken from the proposed critical habitat notice (USFWS 2011):

1. Primary Constituent Element 1— Riparian vegetation. Riparian habitat in a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Goodding's willow, coyote willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, velvet ash, poison hemlock, blackberry, seep-willow, oak, rose, false indigo, grape, Virginia creeper, and Siberian elm³) and some combination of:

³ Only tree and shrub species likely to occur in the action area for this consultation were included in this list.

- a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 m to 30 m (about 6 to 98 ft). Lower-stature thickets (2 to 4 m [6 to 13 ft] tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests; and/or
 - b. Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or
 - c. Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground); and/or
 - d. Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 ha (0.25 ac) or as large as 70 ha (175 ac); and
2. Primary Constituent Element 2— Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

The flycatcher is an obligate riparian species and nests in thickets associated with rivers, streams and wetlands where dense growth of willow, buttonbush, boxelder, Russian olive, saltcedar, or other plants are present (Finch and Stoleson 2000). Nests are frequently associated with an overstory of scattered cottonwood. Throughout the flycatcher's range, these riparian habitats are now reduced, widely separated, and occur in small and/or linear patches. Flycatchers nest in thickets of trees and shrubs approximately 6 to 23 feet in height or taller, with a densely vegetated understory approximately 12 feet or more in height. Surface water or saturated soil is usually present beneath or adjacent to occupied thickets (Phillips *et al.* 1964; Muiznieks *et al.* 1994). At some nest sites, surface water may be present early in the breeding season with only damp soil present by late June or early July (Muiznieks *et al.* 1994; Sferra *et al.* 1995; Finch and Stoleson 2000). Habitats not selected for nesting include narrow (less than 30 feet wide) riparian strips, small willow patches, and stands with low stem density (USFWS 2002). Suitable habitat adjacent to high gradient streams does not appear to be used for nesting. Areas not utilized for nesting may still be used during migration (Yong and Finch 1997).

Flycatchers begin arriving in New Mexico in early May and spring migration of the Southwestern and more northerly subspecies continues into early June (Yong and Finch 1997). Breeding activity in New Mexico begins immediately and young may fledge as soon as late June. Late nests and re-nesting attempts may not fledge young until late summer (Sogge and Tibbitts 1992; Sogge *et al.*, 1993; Reclamation 2005). Fall migration in New Mexico occurs from early August through mid-September (Yong and Finch 1997).

Six general locations of flycatcher populations have been established throughout the Middle Rio Grande (Figure 4.4). These areas have consistently held several territories; however, the number of territories, pairs, nest attempts, and successful nests has varied through the years.

Formal surveys for breeding flycatchers in the proposed action area were begun by the New Mexico Natural Heritage Program in 1994 (Mehlhop and Tonne 1994) and 1995 (Henry *et al.* 1996) in the San Marcial area, and have been conducted annually by Reclamation throughout the proposed action area.



Figure 4.4. Six general locations of flycatcher populations along the Rio Grande of New Mexico.

Table 4.3 summarizes the locations of known territories (that is, occupied by a male or pair of flycatchers) within the floodway of the proposed action area during 2004 through 2011.

Table 4.3. Known Southwestern Willow Flycatcher territories in the action area, 2004-2011.

| Reach | Reach length (river-miles) | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|----------------------------|---------------|--------------|--------------------|---------------|---------------|----------------|----------------|----------------|
| San Acacia Diversion Dam to US Hwy. 380 | 29 | 0 | 0 | 1 (0) ² | 0 | 3 (2) | 1 (0) | 1 (0) | 3 (0) |
| US Hwy. 380 to south boundary of BDANWR | 13 | 1 (1) | 0 | 4 (2) | 7 (5) | 5 (2) | 20 (11) | 37 (27) | 54 (40) |
| South boundary of BDANWR to River Mile 68 | 6 | 16 (4) | 3 (0) | 9 (3) | 4 (1) | 8 (4) | 6 (3) | 5 (2) | 4 (0) |
| TOTAL | 48 | 17 (5) | 3 (0) | 14 (5) | 11 (6) | 16 (8) | 27 (14) | 43 (29) | 61 (40) |

¹ The term "territories" includes pairs or single males detected throughout the breeding season.

² Values in parentheses indicate the number of territories on the west bank of the Rio Grande.

Spring migrant flycatchers have been regularly observed in a variety of riparian vegetation types throughout the Rio Grande floodway in the proposed action area. Occupied breeding habitat in the proposed action area is composed of dense riparian shrubs, chiefly Goodding's willow, coyote willow, and saltcedar. At least a partial canopy of Rio Grande cottonwood or Goodding's willow may be present. The majority of flycatcher nests have been found to be situated within 150 feet of the river bank or other water bodies (Reclamation 2005).

Relatively few flycatchers (0 to 3 territories) have nested between the SADD and U.S. Highway 380 near San Antonio since 2004. Also, the locations of territorial birds have changed from year-to-year throughout this 29-mile-long reach.

In the 13 river-mile reach from Highway 380 to the south boundary of BDANWR, flycatcher occupation has increased dramatically from 1 territory in 2004 to 54 in 2011. In 2008, a sediment plug in the Rio Grande channel near the middle of BDANWR caused the majority of the flow to inundate riparian vegetation adjacent to the channel. Flycatchers were attracted to this area, presumably, by the resultant increased willow growth and wetter substrate. In 2010, 27 of the flycatcher territories in this reach were located on the west bank of the river, adjacent to the alignment of the current spoil bank and proposed engineered levee. The number of territorial birds increased to 54 in 2011, and their distribution has spread to the north along the banks of the river.

Flycatchers have nested less numerously, but more consistently, in the 6-mile-long reach south of BDANWR to River Mile 68 (Table 4.3). The largest breeding population of flycatchers along the Rio Grande in New Mexico occurs in the upper reaches of Elephant Butte Reservoir, approximately 5 miles downstream from the San Marcial Railroad Bridge. Receding lake levels

allowed the establishment of riparian shrub species that were quickly colonized by the flycatcher. The number of territories has grown from 12 in 1999 to 298 in 2010 (Reclamation 2011). This colony could very well serve as a source for birds which nest in the San Marcial and upstream areas.

4.2.2 Reasons for Flycatcher Decline

During the last two centuries, human induced hydrological, geomorphological, and ecological changes have heavily influenced the composition and extent of floodplain riparian vegetation along the Middle Rio Grande (Bullard and Wells 1992; Dick-Peddie 1993). Introduction of exotic species, such as saltcedar, has decreased the availability of dense willow and associated desirable vegetation and habitat important to flycatchers. Fragmentation of forested breeding habitat may also play a role in population reduction of migratory birds (Lynch and Whigham 1984; Wilcove 1988). In addition, the rapid rate of deforestation in tropical areas has been cited as a possible reason for population declines in forest-dwelling migrant land birds (Lovejoy 1983; Robbins *et al.* 1989; Rappole and McDonald 1994).

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*), has been implicated in the decline of songbirds including those found in the western riparian habitats (Gaines 1974, 1977; Goldwasser *et al.* 1980; Laymon 1987). Brown-headed Cowbirds have increased their range with the clearing of forests and the spread of intensive grazing and agriculture. Flycatchers are particularly susceptible to Brown-headed Cowbird nest parasitism because of the ease of egg laying in the flycatcher's open-cup nest design. Habitat fragmentation and forest openings allow cowbirds easy access to host nests located near these edges. Nest parasitism, combined with declining populations and habitat loss, has placed this species in a precarious situation (Mayfield 1977; Rothstein *et al.* 1980; Brittingham and Temple 1983; Laymon 1987).

4.2.3 Life History and Ecology

Flycatcher Breeding Chronology

The flycatcher is a late spring/summer breeder that builds nests and lays eggs in late May and early June, and fledges young in late June or early July (Sogge *et al.* 1993, Tibbitts *et al.* 1994). If re-nesting or second broods occur, they will fledge into mid-August (USFWS 2002). Based on data from flycatcher survey and nest monitoring along the Middle Rio Grande, particularly in the San Marcial reach, flycatchers have been found in the area as early as May 6; however, actual nest initiation has been documented to occur later in May (Ahlers *et al.* 2002). Flycatchers that re-nest or produce a second brood can remain in the nesting area through the end of August.

Flycatcher breeding chronology in the lower portion of the Middle Rio Grande is presented in Figure 4.5 and falls within the generalized breeding chronology of Southwestern Willow Flycatchers (based on Unitt 1987; Brown 1988; Whitfield 1990; Maynard 1995; Sogge 1995; Skaggs 1996; Sferra *et al.* 1997; Sogge *et al.* 1997). Extreme dates for any given stage of the breeding cycle may vary as much as a week from the dates presented. Egg laying begins as early as late May but more often starts in early to mid-June. Chicks can be present in nests from mid-June through early August. Young typically fledge from nests from late June through mid-August but remain in the natal area 14 to 15 days. Adults depart from breeding territories as early as mid-August, but may stay until mid-September in later nesting efforts. Fledglings probably

leave the breeding areas a week or two after adults.

Each stage of the breeding cycle represents a greater energy investment in the nesting effort by the flycatcher pair and may influence their fidelity to the nest site or their susceptibility to abandon if the conditions in the selected breeding habitat become adverse.

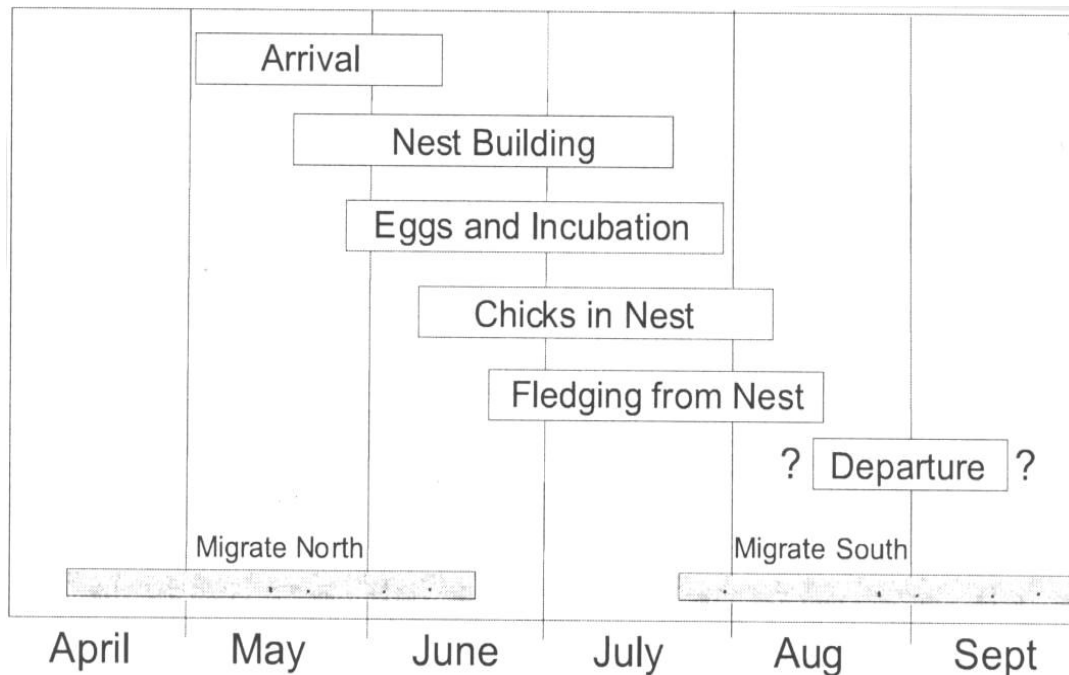


Figure 4.5. Generalized breeding chronology of the Southwestern Willow Flycatcher (from Sogge *et al.* 1997).

Flycatcher Breeding Habitat

The flycatcher is an obligate riparian species occurring in habitats adjacent to rivers, streams, or other wetlands characterized by dense growths of willows (*Salix* sp.), seep-willow (*Baccharis* sp.), arrowweed (*Pluchea* sp.), saltcedar (*Tamarix* sp.), or other species (Federal Register 1995). Flycatchers may utilize areas without surface water, but if suitable habitat goes without water for several years, substrate plants may die and habitat quality may decline. The presence of surface water may also affect nesting success and food availability.

Nesting habitat for the flycatcher varies greatly by site and includes plant species such as willow, saltcedar, box elder (*Acer negundo*), and Russian olive (*Elaeagnus angustifolia*). Species composition, however, appears less important than plant and twig structure (D. Ahlers, U.S. Bureau of Reclamation, personal communication, 2005), as slender stems and twigs are important for nest attachment. Nest placement is highly variable: nests have been observed at heights ranging from 2 to 33 feet and generally occur adjacent to or over water (M. Sogge, U.S.

Geological Survey, personal communication, 2005). Along the Middle Rio Grande, breeding territories have been found in young and mid-age riparian vegetation dominated by dense growths of willows at least 15 feet high, as well as in mixed native and exotic stands dominated by Russian olive and saltcedar.

A majority of the birds within the Middle Rio Grande have selected habitat patches dominated by native species, usually dense willows, for nesting. Within these willow patches, nests have been found on individual saltcedar plants, especially in older, taller willow patches where an understory of saltcedar provides suitable nesting substrate. It appears that younger trees in the understory having more slender vertical stems and twigs are selected for nest placement. Most recently, nests located at the Sevilleta NWR and La Joya State Wildlife Management Area (WMA) have been established in areas adjacent to the river dominated by saltcedar and Russian olive; however, the overall vegetation type of most of the flycatcher territories established in the Middle Rio Grande is dominated by native species and not saltcedar (Moore and Ahlers 2005, 2008).

A critical component for suitable nesting conditions is the presence of water, usually provided by overbank flooding or some other hydrologic source. Along the Rio Grande, nests have been consistently found within 150 feet of surface water, usually a flowing channel (Moore and Ahlers 2005, 2008). Reclamation has found that 95% of all flycatcher nests in the Reclamation-surveyed areas of the Middle Rio Grande occur within 100 m of surface water, and 91% occur within 50 m (Moore and Ahlers 2008). The presence of surface water at the onset of nest site selection and nest initiation is likely critical, though not absolutely necessary. In rare cases in Arizona, birds have nested over 300 feet from water (Sogge *et al.* 2001). Nesting appears to be initiated only after high flows and groundwater levels have created and maintained at least moist soil conditions underneath the nest tree.

Many flycatcher breeding sites are composed of spatially complex habitat mosaics, often including both exotic and native vegetation. Within a site, flycatchers often use only a part of the patch, with territories frequently clumped or distributed near the patch edge. Therefore, the vegetation composition of individual territories may differ from the overall composition of the patch (Sogge *et al.* 2002).

Generally, four broad categories have been developed to describe species composition at breeding sites and include the following:

- Native: >90% native vegetation
- Mixed: >50% native (50-90% native vegetation)
- Mixed: >50% exotic (50-90% exotic vegetation)
- Exotic: >90% exotic vegetation

Habitat patches comprised of native vegetation account for approximately half (48%) of the known flycatcher territories in the Southwest. As of the 2007 breeding season, range-wide, 19% of breeding territories occurred in patches >50% exotic and 4% in patches >90% exotic (Durst *et al.* 2007). Although only 9% of territories occur at exotic sites, another 39% are located within sites where the habitat includes native and exotic mixtures. In many cases, exotics are contributing significantly to the habitat structure by providing the dense lower-strata vegetation that flycatchers prefer (Sogge *et al.* 2002).

In the Middle Rio Grande, the degree to which flycatchers breed in habitat dominated by a particular tree species was summarized from nest data collected in 1999-2001. Over 76% (n = 119) of territories are found at sites where native species (*Salix* spp.) are the dominant tree species and 12% (n = 19) of the nests are in patches where saltcedar is the most common habitat component.

Data collected and analyzed on nest substrate and surrounding habitat patch communities in the Middle Rio Grande (specifically in the Sevilleta NWR/La Joya State WMA, and San Marcial river reaches) indicate that flycatchers may key in on areas dominated by native vegetation, but often select exotic vegetation, particularly saltcedar, as a nest substrate. Saltcedar may actually be the flycatchers' substrate of choice due to its dense and vertical twig structure. From 1999-2002, approximately 49% of 156 nests located in these river reaches were on exotic plants (Russian olive and saltcedar). In the Middle Rio Grande, between 1999 and 2007, 63 nests (6.3 %) were in saltcedar-dominated territories, 793 (79.5 %) were in *Salix*-dominated territories and 141 (14.1 %) were in mixed-dominance territories (Moore and Ahlers 2008).

Evidence gathered during multi-year studies of color-banded populations shows that, although most male flycatchers return to former breeding areas, they regularly move among sites within and between years (Ellis *et al.* 2008). Between 1996 and 1997, 29% of banded flycatchers in Arizona returned to the breeding site of the previous year, while 11% moved to other breeding areas within the same major drainage (Paxton *et al.* 1997). The remaining 60% of flycatchers were not relocated in 1997 and may have died or moved to undiscovered breeding sites. Distance moved ranged from 66 to 2,950 feet (20 to 900 m). There were also two cases of movement (>1,640 ft [500m]) within a breeding site during the course of a breeding season. The mechanism controlling the decision to return or move, as well as the adaptive value of movement between sites, is unknown.

In two different situations, flycatchers were forced to move because of catastrophic habitat loss by fire. Occupied flycatcher habitat was destroyed because of fire along the San Pedro River in Arizona (Paxton *et al.* 1996) and along the Gunnison River in Colorado (Owen and Sogge 1997). In Arizona, occupied habitat was destroyed as nesting was underway on seven flycatcher territories. All flycatchers abandoned the site and were not seen again in the burned area. Displaced flycatchers had moved to unburned areas within the breeding site or to other breeding areas within 1.2 to 3 miles (1.9 to 4.8 km) of the original site. In Colorado, after a fire destroyed flycatcher habitat, some flycatchers returned to the burned area and attempted to breed even in an area without any live vegetation.

These situations demonstrate that some flycatcher pairs will return to the general breeding area to nest in subsequent years if previously occupied sites become unavailable.

Riparian Habitat Description

Riparian habitat within all the reaches of the Middle Rio Grande where flycatcher population sites occur includes dense stands of willows and other woody riparian plants adjacent to or near the river channel.

Within the San Acacia reach, several major riparian plant communities exist (Table 4.4). Riparian woodlands have a canopy of Rio Grande cottonwood and, less extensively, Goodding's willow (Parametrix 2008). These bosque habitats comprise about 3,885 acres (31%) of the

riparian vegetation in the proposed action area. An understory of native shrub species (primarily coyote willow and seep-willow) occurs in only a small percentage of woodland stands. The majority (approximately 3,290 acres) of bosque has an understory dominated by saltcedar and, secondarily, by Russian olive. Riparian shrublands are the most abundant plant community in this reach, occupying over 7,700 acres (61% of all vegetated area). Again, exotic shrub species, primarily saltcedar, dominate this plant community type (Parametrix 2008). The structure of shrub stands can vary widely depending on age and species composition. Young stands or those in relatively dry areas may be short (less than 5 feet in height) and sparsely distributed. The majority of shrub stands in the proposed action area consist of moderately to very dense stands of 5- to 15-foot-tall saltcedar. Native shrub species (coyote willow, seep-willow, and screwbean mesquite) occupy only about 1,600 acres (13% of all vegetated types). Small areas of emergent wetlands are scattered throughout the floodway. These consist of marshes dominated by broad-leaved cattail and hardstem bulrush along the riverbank or in poorly drained depression within the overbank area. Wet meadows consisting primarily of saltgrass also occur. Together, these comprise only 440 acres in the floodway of the proposed action area (3.6% of all vegetation types).

Table 4.4. Vegetation and open water types within the floodway of the proposed action area (Parametrix 2008).

| Plant community or open water type | Acres | Percent of vegetated area |
|---|---------------|--------------------------------------|
| Riparian Woodland: | | |
| Native understory | 599 | 4.7 |
| Mixed understory | 1,656 | 13.1 |
| Exotic understory | <u>1,630</u> | <u>12.9</u> |
| <i>Woodland Subtotal</i> | <i>3,885</i> | <i>30.7</i> |
| Riparian Shrubland: | | |
| Native | 1,581 | 12.5 |
| Mixed native and exotic | 236 | 1.9 |
| Exotic | <u>5,887</u> | <u>46.5</u> |
| <i>Shrubland Subtotal</i> | <i>7,704</i> | <i>60.8</i> |
| Emergent wetland: | 459 | 3.6 |
| Dry grassland and open areas | 625 | 4.9 |
| <i>Subtotal - All Vegetation</i> | <i>12,672</i> | <i>100.0</i> |
| Pond and small channel | 138 | |
| Rio Grande channel | 1,343 | |
| TOTAL | 14,153 | |

Modeling Habitat Characteristics

Development of a Geographic Information System (GIS)-based flycatcher habitat suitability model was initiated in 1998 by members of the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program) for the Middle Rio Grande basin and continues

to be refined based on changes in hydrology and updated vegetation maps. The model is currently limited to the Middle Rio Grande from Belen south to Elephant Butte.

Riparian vegetation in the Middle Rio Grande basin between the SADD and Elephant Butte Reservoir had been classified using the Hink and Ohmart (1984) classification system. This system identifies vegetation polygons based on dominant species and structure. Plant community types are classified according to the dominant and/or co-dominant species in the canopy and shrub layers.

During the summer and fall of 2002, as part of the Collaborative Program's efforts, Reclamation personnel updated vegetation maps from Belen to San Marcial using a combination of ground-truthing and aerial photography analysis. In summer of 2004, the conservation pool of Elephant Butte Reservoir was again aerially photographed (true color) and vegetation heights were remotely-sensed using Light Detection and Ranging (LiDAR) methods. The area was ground-truthed during the summer of 2005. In 2008, the conservation pool of Elephant Butte Reservoir was reviewed and habitat mapping was updated based on ground-truthing and aerial photography flow in late summer of 2007. These areas are continually being reviewed as vegetation matures and develops in new areas so that components of the flycatcher habitat suitability model remain current.

In the model, breeding habitat suitability was refined by identifying all areas that are within 328 feet (100 m) of existing watercourses, ponded water, or in the zone of peak inundation. The five categories of flycatcher habitat that lie within 328 feet of water are defined as:

- *Highly Suitable Native Riparian* - Stands dominated by willow and/or cottonwood.
- *Suitable Mixed Native/Non-native Riparian* - Includes stands of natives mixed with non-natives.
- *Marginally Suitable Non-native Riparian* - Stands composed of monotypic saltcedar or stands of saltcedar mixed with Russian olive.
- *Potential with Future Riparian Vegetation Growth and Development* - Includes stands of very young sparse riparian plants on river bars that could develop into stands of adequate structure with growth and/or additional recruitment. This category requires regular monitoring to ascertain which areas contain all the parameters to become flycatcher habitat.
- *Low Suitability* - Includes areas where native and/or non-native vegetation lacks the structure and density to support breeding flycatchers or exceeds the hydrologic parameter of greater than 100 meters from water. The presence of low suitability habitats may be important for migration and dispersal in areas where riparian habitats have been lost (*i.e.*, agricultural and urban areas).

Currently, the Service groups the first three categories listed above as equally suitable habitat for the flycatcher, because a large number of sites are currently occupied in all three categories. Suitable habitats with non-native vegetation are often defined as being less suitable for flycatchers than native habitat when native habitat is available in quantity and in the proper context (*i.e.*, with the proper density and structure and in close proximity to surface water at the onset of territory development and nest initiation). Ultimately, the structure and density of

habitat is likely what is most attractive to flycatchers, rather than the plant species composition (Moore and Ahlers 2008, 2009)

Current Availability of Breeding Habitat for Flycatchers within the Proposed Action Area

Breeding habitat in the proposed action area is composed of dense riparian shrubs, chiefly Goodding's willow, coyote willow, and saltcedar. At least a partial canopy of Rio Grande cottonwood or Goodding's willow may be present. The majority of breeding habitat has been found to be situated within 150 feet of the river bank or other water bodies (Reclamation 2005).

Within the proposed action area, designated critical habitat for the flycatcher encompasses the entire floodway from the SADD to the headwaters of Elephant Butte Reservoir, except for the portions of the floodway on the two National Wildlife Refuges. Therefore, suitable breeding habitat exists through the proposed action area. Based on the categories listed above, breeding habitat can be considered either suitable or highly suitable through the project reach.

Flycatcher Habitat Use During Migration

Flycatchers and many other species of Neotropical migrant land birds also use the Rio Grande riparian corridor as stop-over habitat during migration. Studies have shown that during the spring and fall migration, flycatchers are more commonly found in willow habitats than in other riparian vegetation types (Yong and Finch 1997). These birds utilize a variety of vegetation types during migration, many of which are classified as "low suitability" for breeding habitat (Ahlers and White 1997).

The San Acacia reach contains a mosaic of native woody vegetation and dense stands of saltcedar. Flycatchers (and many other species of Neotropical migrant land birds) use the Rio Grande riparian corridor as stop-over habitat during migration. Studies have shown that during the spring and fall migration, flycatchers are more commonly found in willow habitats than in other riparian vegetation types, including the narrow band of coyote willows that line the LFCC (Finch and Yong 1997). Recent presence/absence surveys during May have detected migrating flycatchers throughout the project area in vegetation types that are classified as "low suitability" for breeding habitat (Ahlers and White 1997).

Flycatcher Population Trends 1994-2010

In general, the flycatcher population of the Middle Rio Grande has increased since regular surveys began in 1994. Territories are more abundant in the southern half of the Middle Rio Grande (from the Sevilleta NWR south) than north of this area. Table 4.3 summarizes the locations of known territories (that is, occupied by a male or pair of flycatchers) within the floodway of the proposed action area during 2004 to 2010. The San Marcial reach of the Middle Rio Grande has been surveyed for flycatchers regularly since 1994 (Mehlhop and Tonne 1994; Henry *et al.* 1996; Ahlers and White 1995, 1996, 1997, 1999, 2000; Ahlers *et al.* 2001, 2002; Ahlers and Moore 2003; Moore and Ahlers 2004, 2005, 2006, 2008; Reclamation 2010, 2011). The population in this area has steadily increased and expanded since the initial surveys. In 1994, the only 11 flycatcher territories that were known were located south of the BDANWR (all near the railroad bridge above San Marcial). The population in this river reach remained between 9 and 12 territories through 1999. By 2000, the birds had dispersed and expanded southward following the development of new riparian vegetation in the receding pool of Elephant Butte

Reservoir. This new population has experienced steady growth, with approximately 319 territories were located in the delta area in 2009.

North of the San Marcial reach, portions of the BDANWR have been surveyed for flycatchers annually since 1993. The wetland areas within the inactive floodplain outside of the levees have variably attracted between one and seven territories annually during this period. When the active floodplain channel, or river corridor within the refuge, was surveyed in 2005, no territories were detected. However, in 2009 there were 20 territories detected within this same area.

Development of Suitable Flycatcher Breeding Habitat within the Middle Rio Grande

It is commonly recognized that one of the primary causes for the decline of Neotropical migrants, along with numerous other terrestrial species, is the decrease in the abundance of riparian vegetation over the past hundred years. The reason for this decline in riparian vegetation is due to the removal of the dynamic components of river systems.

The Rio Grande and associated riparian areas have historically been a dynamic system in constant change and, without this change, the plant diversity and productivity has decreased. Sediment deposition, scouring flows, inundation, and irregular flows are natural dynamic processes that occurred frequently enough in concert to shape the characteristics of the Rio Grande channel and floodplain. Through the development of dams, irrigation systems, and controlled flows, the dynamics of the river system have been significantly reduced except at localized areas such as the reservoirs where water storage levels frequently change with releases and inflows.

The interaction of river discharge (timing and magnitude), river channel morphology, and floodplain characteristics are vital components that can favor the establishment of native vegetation and enhance the development of suitable Willow Flycatcher breeding habitat within the Middle Rio Grande. To recreate these dynamic processes in a very static river system, man-made procedures have been developed and implemented including mechanical disturbance, herbicide treatments, prescribed fire, channel realignment, operational flows, avulsions, and river realignment. These man-made processes manipulate the river and floodplain in an attempt to restore the diversity of a healthy river system. It is no coincidence that flycatchers have expanded and dispersed within the delta of the Elephant Butte Reservoir. In the previous several years, this area has had the most dynamic components within the Middle Rio Grande as a result of changing reservoir elevations. Since cottonwoods and willows are aggressive colonizers of disturbed sites (Reichenbacher 1984), the dynamic scouring and deposition process provides the potential for the development of new habitat.

Successful cottonwood and willow recruitment has been shown to coincide with the descending limb of the spring runoff hydrograph. The timing and rate of decline of surface-water inundation, such as that occurring in the headwaters of Elephant Butte Reservoir, have been documented as important factors affecting seedling survival (Sprenger *et al.* 2002).

Several years of prolonged inundation have killed many saltcedar stands within the Elephant Butte Reservoir pool. The receding reservoir pool has exposed new areas for establishment of native vegetation. Newly scoured areas of the river channel or floodplain and areas where sediment has been deposited also provide conditions for regeneration of native species.

In the San Marcial reach, as part of ongoing reviewed and approved projects, Reclamation is conducting non-native vegetation clearing, floodplain expansion, riparian vegetation plantings, channel avulsions, channel widening, and bank destabilization, all of which are man-induced processes to provide the dynamic conditions to enhance the recruitment of cottonwoods and willows, and indirectly increasing the quantity of available flycatcher habitat.

Cowbird Parasitism and Breeding Flycatchers

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) may be a contributing factor to the decline of the flycatcher, as well as other Neotropical migrant land birds. Reclamation implemented a cowbird control program from 1996 through 2001 in the San Marcial area. This was an effort to reduce brood parasitism on the endangered Southwestern Willow Flycatcher as mitigation for the presence of cattle within Elephant Butte public lands. From 1997 through 2001, approximately 3,599 cowbirds were captured in the San Acacia reach in the absence of cattle (except trespass cattle). During this time, the number of cowbirds trapped during the summer resident period remained constant, which appeared to indicate that trapping did not reduce the breeding population of cowbirds at Elephant Butte Reservoir over time. However, the number of cowbirds was reduced on a seasonal basis.

Factors influencing cowbird density include host nest availability, habitat quality, presence of livestock, and availability of forage areas such as grain fields (Morrison and Hahn 2002). Cowbird and Neotropical bird observations along the riparian corridor of the Middle Rio Grande were compared between sites with different land-use practices using the point-count methodology. These counts indicate that Sevilleta NWR attracted the highest number of nesting Neotropical bird species likely to provide host nests for cowbirds. This reach is also characterized by the narrowest riparian corridor of the four reaches. Point counts indicate that Sevilleta NWR and BDANWR attracted the highest number of cowbirds. Both of these refugees are not grazed. Increased cowbird numbers may be in response to better habitat or the availability of Neotropical bird host nests.

The effects of cowbird trapping on the success of breeding flycatchers and other Neotropical birds on Elephant Butte public lands was assessed for the period 1999–2001. In the Elephant Butte public lands study area, parasitism was observed in 31% of nests of all Neotropical bird species, but was only 5% in flycatcher nests, according to data sets combining nests monitored from 1999 through 2001 (D. Ahlers, U.S. Bureau of Reclamation, personal communication, 2001). These data indicate that, possibly, factors other than trapping may be responsible for the low incidence of parasitism on the flycatcher nests. Within the reservoir delta, a dramatic increase in the number of breeding flycatchers occurred since 1999. In 2001, nest success for the breeding flycatchers in the delta was 75% in comparison to a 50% nest success of Neotropical birds in the same area. No parasitism had occurred in the flycatcher nests from 1999 through 2001. The increase of breeding pairs and the absence of parasitism in this specific area most likely is a response to high quality habitat. When comparing the Neotropical bird nest data between Elephant Butte public lands with cowbird trapping, and San Acacia and BDANWR reaches where no trapping occurs, there was no statistical difference between nest success observed within the trapped *versus* untrapped areas. These data indicate that trapping cowbirds does not affect Neotropical bird nest success in the Middle Rio Grande, and, therefore, cowbird trapping was stopped.

Addling or removal of Brown-headed Cowbird eggs from parasitized flycatcher nests is a practice that was begun in 2002 and continued through 2005. Of the 79 flycatcher nests parasitized during that period with known outcomes, cowbird eggs were addled or removed from 38 nests, 7 of which successfully fledged flycatcher young (18.4% success). Parasitized nests during 1999 through 2005 in the Middle Rio Grande that were unaltered were as successful. Of 41 parasitized nests monitored, 32 failed, and 9 successfully fledged young (a 22% success rate).

Other Factors Potentially Affecting Flycatchers and Critical Habitat

In the Middle Rio Grande, past and present Federal, State, and private activities that may affect the flycatcher include irrigated agriculture, river maintenance, flood control, dam operation, water diversions, and downstream Rio Grande Compact deliveries. The Rio Grande and associated riparian areas are a dynamic system in constant change. Without this change, the riparian community will decrease in diversity and productivity. Sediment deposition, scouring flows, inundation, base flows, and channel and river realignment are processes that help to maintain and restore the riparian community diversity. Habitat elements for the flycatcher are provided by thickets of riparian shrubs and small trees and adjacent surface water, or areas where such suitable vegetation may become established (Federal Register 2005).

The Rio Grande historically had highly variable annual and seasonal discharge patterns (Platania 1993). Since 1973, flows in the Middle Rio Grande have been determined mainly by regulation of dam facilities and irrigation diversions. The highest flows generally result from snowmelt (April-May), irrigation water releases from the upstream reservoirs, and variable thunderstorms. Lowest flows generally occur from July to October, when most of the available river flow is diverted for irrigation. Summer monsoons can elevate river flows during this time period depending on their frequency and intensity. Water and sediment management have resulted in a large reduction of suitable habitat for the flycatcher, as a result of the reduction of peak flows that helped to create and maintain habitat for this species. Overbank flooding is needed to create shallow, low-velocity backwaters and to maintain and restore native riparian vegetation for flycatcher habitat. Overbank flooding is also currently restricted by the safe channel capacity at the San Marcial Railroad Bridge and for Isleta reach spoil bank levees.

Spoil banks have restricted the extent of floodplain inundation from discharges up to 7,000 or 10,000 cfs and, along with their attendant riverside drains, have functionally separated the river from most of the historical floodplain. A comparison of river habitat changes between 1935 and 1989 shows a 49% reduction of river channel habitat from 22,023 acres (8,916 ha) to 10,736 acres (4,347 ha) (Crawford *et al.* 1993). Between Cochiti Dam and Elephant Butte Reservoir headwaters, there are 235 miles (378 km) of levees including distances on both sides of the river (Federal Register 2005).

The Middle Rio Grande channel width has narrowed over the last century. The trend can be attributed to reduced peak flows, channelization, and reduced sediment supply. Channelization in the 1950s and 1960s is primarily responsible for the elimination of thousands of acres of the shallow, low-velocity habitats required by the flycatcher. Flow regulation below Abiquiu Reservoir and Cochiti Dam has further decreased channel capacity and reduced peak flows. Flood events greater than 10,000 cfs have not occurred since the 1940s. The lack of large peak flows combined with the effects of channelization contributes significantly to channel narrowing and the reduction of overbank flooding. These factors severely limit the development of

backwater habitats essential to the survival of the flycatcher (Federal Register 2005).

4.3 Interior Least Tern

4.3.1 Status and Distribution

The Interior Least Tern (*Sternula antillarum athalassos*) was listed as endangered by the Service in 1985 (Federal Register 1985). This subspecies historically bred along the Colorado River (in Texas), Red River, Rio Grande (in Texas), Arkansas River, Missouri River, Ohio River, and Mississippi River systems and has been found on braided rivers of southwestern Kansas, northwestern Oklahoma, and southeastern New Mexico (American Ornithologists' Union 1957). In New Mexico, the Interior Least Tern was first recorded (including nesting) at Bitter Lake National Wildlife Refuge in 1949, and since then, it remained present essentially annually (Marlatt 1984). The species also occurs as an occasional breeder in Eddy County, New Mexico (Doster 2007). The Interior Least Tern is a vagrant elsewhere in New Mexico, including locations such as Española, Sumner Lake, BDANWR, and in wetlands near Glenwood, Las Cruces, and Alamogordo (NMDGF 1988).

4.3.2 Life History and Ecology

Habitat requirements for this species include the presence of bare or nearly bare ground on alluvial islands, shorelines, or sandbars for nesting; the availability of food (primarily small fish); and the existence of favorable water levels during the nesting season so nests remain above water (Ducey 1981). Breeding colonies contain from 5 to 75 nests. Although most nesting occurs along rivers, the tern also nests on barren flats of saline lakes and ponds.

4.3.3 Reasons for Decline

Loss of nesting areas through permanent inundation or destruction by reservoir and channelization projects was identified as the major threat to the species (Federal Register 1985). Alteration of natural river or lake dynamics has caused unfavorable vegetation succession on many remaining islands, curtailing their use as nesting sites by terns. Releases of water from upstream reservoirs and annual spring floods often inundate nests. Recreational use of sandbars may cause destruction of nesting habitat, nests, and eggs by trampling.

4.4 Northern Aplomado Falcon

4.4.1 Status and Distribution

The Northern Aplomado Falcon (*Falco femoralis*) was listed as endangered by the Service in 1986 (Federal Register 1986). The species was historically distributed in the United States across grasslands from southeastern Arizona, southern New Mexico, and western and southern Texas and southward through Mexico to Nicaragua (Macias-Duarte *et al.* 2004). It is a medium-sized falcon, approximately 14-18 inches (35-45 cm) in length. These birds have lead-gray underparts with a dark gray band separating a cinnamon belly from a white upper breast, yellow legs, a banded tail, and a distinct facial stripe.

This species was reported to be fairly common throughout their range but by the early 1900s in New Mexico they were restricted to the southwestern corner of the state (Young and Young

2010). The last documented nest in New Mexico was reported in 1952 and although there have been sporadic sightings, the species was considered extirpated in the state (Meyer and Williams 2005). However, in 2001 and 2002, a nesting pair (presumably from Chihuahua) was confirmed in Luna County (Meyer and Williams 2005). In 2006, an experimental non-essential population was introduced on the privately-owned Armendaris Ranch in Socorro County.

Over the past few years, captive Aplomado Falcons have been released, and have successfully bred, on the Armendaris Ranch, located southeast of San Marcial. During fall and winter, Aplomado Falcons have been occasionally sighted foraging in sparsely vegetated areas of Bosque del Apache NWR.

4.4.2 Life History and Ecology

Northern Aplomado Falcons are associated with grassland habitats with a sparse canopy of woody vegetation. Territories in northern Chihuahua, Mexico, are known to be flat, open grasslands with less than 10% shrub cover consisting of yucca (*Yucca* spp.), longleaf ephedra (*Ephedra trifurca*), honey mesquite (*Prosopis glandulosa*), creosotebush (*Larrea tridentata*), and tarbush (*Flourensia cernua*) (Meyer and Williams 2005). The diet of this species consists primarily of small birds and insects and less so of small mammals, reptiles, and amphibians (Young and Young 2010).

This species is a secondary nester and relies on stick nests previously constructed by other raptors or ravens (Young and Young 2010). They nest from February to June with an incubation period lasting approximately 31-33 days (Young and Young 2010). In northern Chihuahua, clutch size is approximately 2 to 3 eggs (Macias-Duarte *et al.* 2004). Nestlings fledge four to five weeks after hatching (Young and Young 2010).

4.4.3 Reasons for Decline

The major threats to the species are primarily habitat degradation due to brush encroachment caused by fire suppression and over-grazing (Federal Register 1986), agricultural development of grasslands (Hector 1987; Keddy-Hector 2000) secondarily egg and specimen collecting and continued pesticide application (DDT) within the range.

4.5 Pecos Sunflower

4.5.1 Status and Distribution

Pecos sunflower (*Helianthus paradoxus* Heiser) was listed as a threatened species by the Service on October 20, 1999 (Federal Register 1999). Critical habitat for the species was designated effective May 8, 2008 (Federal Register 2008). The State of New Mexico lists Pecos sunflower as endangered under the regulations of the New Mexico Endangered Plant Species Act (19 NMAC 21.2). This species is also listed as threatened by the State of Texas (31 TAC 2.69(A)).

Pecos sunflower is a wetland plant that was known only from a single population near Fort Stockton, Pecos County, Texas, when it was proposed as a candidate for listing as endangered under the ESA on December 15, 1980 (Federal Register 1980). Subsequent field surveys for this plant found additional populations in New Mexico and Texas. It is presently known to occur in two widely separated locations in the Pecos River valley in eastern New Mexico, two locations

on the Rio San Jose, two locations on the Rio Grande in west-central New Mexico, and at two desert springs in west Texas. Little is known about the historic distribution of Pecos sunflower. The plant is associated with spring seeps and wet meadow (cienega) habitats, which are very rare in the dry regions of New Mexico and west Texas. There is evidence these habitats were originally more widespread, but have been historically reduced or eliminated by aquifer depletion, or severely impacted by agricultural activities and encroachment by alien plants (Hendrickson and Minckley 1984; Poole 1992; Sivinski 1996). Existing Pecos sunflower populations occur on a variety of State and Federal lands and several private land holdings, and face a moderate degree of threat. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of Pecos sunflower (Poole 1992; Sivinski 1996; USFWS 2005). In addition, the Southwestern United States is currently experiencing a period of prolonged drought that is exacerbating this habitat degradation. The trend of decreasing habitat availability and suitability justified listing Pecos sunflower as a threatened species. Recovery actions to reverse or stabilize this trend and ensure the long-term sustainability of this species include identifying the ecological parameters of Pecos sunflower habitat, and enlisting the cooperation of the various habitat owners in the long-term conservation of the species (USFWS 2005).

Pecos sunflower is presently known from only seven naturally occurring populations, two in west Texas and five in New Mexico (Figure 4.6), and one reintroduced population in New Mexico. The type locality (the location at which the species was first described) is near Fort Stockton in Pecos County, Texas. Here a large population with several hundred thousand plants currently exists at the Nature Conservancy's Diamond Y Spring Preserve, with a smaller group of plants downstream at a nearby highway right-of-way. A second Texas population occurs at the Nature Conservancy's Sandia Spring Preserve in the Balmorhea area of Reeves County, Texas.

In New Mexico, the six Pecos sunflower populations are located in the Roswell/Dexter region, Santa Rosa, two locations in the Rio San Jose valley, and two on the Middle Rio Grande. In the Roswell/Dexter region of the Pecos River valley in Chaves County, Pecos sunflower occurs at 11 spring seeps and cienegas. Three of these wetlands support many thousands of Pecos sunflowers, but the remaining are smaller, isolated occurrences. Springs and cienegas within and near the town of Santa Rosa in Guadalupe County have eight wetlands with Pecos sunflower, one of which consists of several hundred thousand plants in good years. Two widely separated areas of spring seeps and cienegas in the Rio San Jose valley of western New Mexico each support a population of Pecos sunflower. One occurs on the lower Rio San Jose in Valencia County and the other is in Cibola County in the vicinity of Grants. Neither are especially large populations.



Figure 4.6. Distribution of naturally occurring populations of Pecos sunflower (USFWS 2005).

In the Middle Rio Grande, the only known naturally occurring population of Pecos sunflower exists within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex (Figure 4.6).. It

represents one of the largest populations of *H. paradoxus* in the range of the species (USFWS 2005), consisting of 100,000 to 1,000,000 plants. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for *H. paradoxus*. The site was determined to be essential to the conservation of the species resulting from encroachment of non-native species, degradation of habitat, or a catastrophic event because it is occupied by a very large, stable population, that is sufficiently distant (over 40 mi, 64 km) from other populations to serve as an additional locality that contributes to the conservation of genetic variation (USFWS 2005). As such, it may contain genetic variation not found anywhere else in the range of the species. This naturally occurring population of Pecos sunflower contains all of the Primary Constituent Elements (PCEs) in the appropriate spatial arrangement and quantity, but is threatened by encroachment of non-native vegetation. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year.

With the exception of the La Joya population, most Pecos sunflower habitats are limited to less than five acres (two hectares) of wetland. Some are only a small fraction of a hectare; however, one near Fort Stockton and another near Roswell are more extensive. The number of sunflowers per site varies from less than 100 to several hundred thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to groundwater. Stands of Pecos sunflower can change location within the habitat as well (Sivinski 1992; Bush 2006; Grunstra and Van Auken 2007). This sunflower is completely dependent on water-saturated soil conditions within the soil root zone. If a wetland habitat dries out permanently, even a large population of Pecos sunflower would disappear (USFWS 2005).

In 2008, seeds from the La Joya population were used to establish a reintroduced population on private property approximately 25 miles (40 km) to the south in Socorro County. This reintroduced population was established as a cooperative effort between the landowner, the U.S. Fish and Wildlife Service, and the New Mexico Energy, Minerals and Natural Resources Department, Forestry Division. The State of New Mexico and the Service consider this to be a reintroduction within the historic range of Pecos sunflower. After identifying suitable habitat on the property, biologists planted seeds obtained from the La Joya population in several 1- or 2-m² patches. Although a current population estimate is unavailable, some of the original seeded patches have expanded in numbers and area. The population is protected from grazing by an exclosure, and the landowner is conducting habitat management work in cooperation with the Service (R. Sivinski (New Mexico Forestry Division [NMFD]), personal communication, 2010). Due to its recent establishment, the population's long-term viability has not been assessed. This habitat and sunflower population belong to the landowner and neither have ESA protection from the actions of the landowner, unless an action is proposed that would have a Federal nexus (R. Sivinski (NMFD), personal communication, 2010). This population was not considered for critical habitat designation because it became established after the rulemaking process was complete. This reintroduced population must also demonstrate an ability to persist under current land use and environmental conditions.

4.5.2 Life History and Ecology

Pecos sunflower is an annual, herbaceous plant. It grows 3.3 to 10 feet (1 to 3 m) tall and is branched at the top. The leaves are opposite on the lower part of the stem and alternate at the top. Each leaf is lance-shaped with three prominent veins and up to 6.9 inches (17.5 cm) long by 3.3 inches (8.5 cm) wide. The stem and leaf surfaces have a few short, stiff hairs. Flower heads are 2.0 to 2.8 inches (5 to 7 cm) in diameter with bright yellow rays around a dark purplish brown center (the disc flowers). Pecos sunflower looks much like the common sunflower (*Helianthus annuus*) seen along roadsides throughout the West, but differs from common sunflower by having narrower leaves, fewer hairs on the stems and leaves, smaller flower heads, and narrower bracts (phyllaries) around the bases of the heads. The prairie sunflower (*Helianthus petiolaris*) also has narrow leaves and phyllaries, but is distinguished from Pecos sunflower by having white cilia in the dark center of the flower head and a branching pattern from the base of the plant that imparts a bushy appearance. Common sunflower and prairie sunflower usually bloom earlier in the season (May to August depending on location) than Pecos sunflower (September and October) and neither occupies the wet, saline soils that are typical of Pecos sunflower habitats. Pecos sunflower has a highly disjunctive distribution, yet there appears to be very little phenotypic variation between populations.

Pecos sunflower grows in areas with permanently saturated soils in the root zone. These wet soil areas are most commonly associated with desert springs and seeps that form wet meadows called cienegas. Such wetland habitats are rare in the arid southwest region and have decreased historically (Hendrickson and Minckley 1984). This sunflower also can occur around the margins of lakes, impoundments, and creeks. When Pecos sunflowers grow around lakes or ponds, these are usually impoundments or subsidence areas within natural cienega habitats. The soils of these desert wetlands are typically saline or alkaline because the waters are high in dissolved solids, and high rates of evaporation leave deposits of salts, including carbonates, at the soils surface. Soils in these habitats are predominantly silty clays or fine sands with high organic matter content. Studies by Van Auken and Bush (1995) and Van Auken (2001) showed that Pecos sunflowers grow in saline soils, but seeds germinate and establish best when precipitation and high water tables reduce salinity near the soil's surface. Like all sunflowers, this species requires open areas that are not shaded by taller vegetation.

Plants commonly associated with Pecos sunflower include saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), common reed (*Phragmites australis*), chairmaker's bulrush (*Schoenoplectus americanus*), Baltic rush (*Juncus balticus*), alkali muhly (*Muhlenbergia asperifolia*), southwestern sea lavender (*Limonium limbatum*), clasping yellowtops (*Flaveria chloraefolia*), Wright's marsh thistle (*Cirsium wrightii*), saltcedar (*Tamarix sp.*), and Russian olive (*Elaeagnus angustifolia*) (Poole 1992; Sivinski 1996). All of these species are indicators of wet, saline, or alkaline soils. Pecos sunflowers often occur with saltgrass between the saturated soils occupied by bulrush and the relatively drier soils with alkali sacaton (Van Auken and Bush 1998).

4.5.3 Reasons for Decline

Spring seeps and wet meadow (*cienega*) habitats are rare in the dry regions of New Mexico and Texas. There is evidence these habitats have historically, and are presently, being reduced or

eliminated by aquifer depletion, or severely impacted by agricultural activities and encroachment by alien plants (Poole 1992; Sivinski 1996). The Southwestern United States is currently experiencing a period of prolonged drought that is exacerbating this habitat degradation. The trend of decreasing habitat availability and suitability justified listing Pecos sunflower as a threatened species. Recovery actions to reverse or stabilize this trend and ensure the long-term sustainability of this species include identifying the ecological parameters of Pecos sunflower habitat, and enlisting the cooperation of the various habitat owners in the long-term conservation of the species (USFWS 2005).

5. Analysis of Effects of Proposed Action

This chapter provides an analysis of the effects of proposed Corps' actions on listed species and their designated and proposed critical habitat. "Effects of the action" refers to the direct and indirect effects of the proposed action on listed species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline to determine the overall effects on the species (50 CFR § 402.02). For purposes of this BA, effects on listed species and critical habitat are analyzed individually with respect to the proposed action. The historic and existing conditions discussed previously (*i.e.*, hydrology, geomorphology, aquatic and riparian habitat, and species distribution and abundance) are the basis upon which the proposed action was assessed.

This chapter first addresses the analysis of effects on the Rio Grande silvery minnow (silvery minnow), the Southwestern Willow Flycatcher (flycatcher), and designated and/or proposed critical habitat for each species in Section 5.1. This is followed by three sections addressing effects on the Pecos sunflower, the Interior Least Tern, and the Northern Aplomado Falcon (Sections 5.2 through 5.4, respectively), and a final summary of all effect determinations (Section 5.5).

In Section 5.1, the discretionary activity associated with each component feature of the proposed action is briefly summarized. This brief summary is intended as a reminder to the reader, and does not supplant the formal description of the proposed action in Chapter 2 of this BA.

5.1 Rio Grande Silvery Minnow, Southwestern Willow Flycatcher, and Their Critical Habitats

5.1.1 East Side Excavation

Immediately downstream from the San Acacia Diversion Dam (SADD), approximately 12.4 acres along the east bank of the river would be excavated to provide a wider corridor for flood flows and decrease the velocity and erosive potential of the design flood (Appendix A, Sheet C-111). Excavation would create a level terrace at the 10%-chance exceedance water surface elevation. At the base of the proposed terrace, the existing bank would be excavated to slope downward to the existing channel. Excavation would be scheduled for four months during fall and winter when river flow is relatively low and reliably stable. During excavation of the east bank near the SADD, the existing river bankline would be maintained until all other excavation is completed to minimize sedimentation of the river. Construction would be scheduled during low-flow conditions and no impoundment of water would occur.

Currently, the area to be excavated is not inundated until the discharge measured at the San Acacia gage exceeds 25,000 cfs. Vegetation consists of relict riparian shrubs: 5.0 acres of relatively dense salt cedar, 6.0 acres of short sparse salt cedar, and a narrow band of sparse coyote willow along the bankline. This upland area is not suitable habitat for the flycatcher.

Following excavation, the lowest 3.1 acres would become part of the active Rio Grande channel (that is, would be excavated to an elevation below that of the 50%-chance flow event). A 1.1-acre band of coyote willow and seep-willow would be planted along the new bank-line within

this 3.1 acres. The upper 9.3 acres would entail a bench that would be inundated by the 10%-chance flow event (15,400 cfs at the San Acacia gage), and would be revegetated by upland grasses, forbs, and shrubs (e.g., fourwing saltbush).

For the 1%-chance flood event (29,900 cfs) without the proposed project, water velocities along the western bankline immediately downstream from the San Acacia Diversion Dam may reach 17 fps. The East Side Excavation would reduce flood velocities along the west bank to approximately 14 fps. Still, these velocities are considerably higher than quality silvery minnow habitat.

In order to complete the east-side excavation immediately below SADD, a temporary crossing would be constructed to facilitate the movement of equipment. The crossing would be 300 feet long with a top-width of 15 feet. The crossing would entail 1,000 CY of earthen material (from a portion of the excavated spoil bank) and six 60-inch-diameter, 30-feet-long corrugated metal pipes. The majority of these materials would be below the OHWM. The construction and removal of the temporary crossing as well as the east bankline may create a minor and temporary increase in turbidity.

Rio Grande Silvery Minnow

Construction of the temporary crossing would entail moving and placing soil and pipes in the river channel below the Ordinary High Water Mark (OHWM) elevation (5,660 cfs at SADD). Qualified fisheries biologists would be present to seine and remove as many fish from the immediate work area as possible. However, this action may affect and is likely to adversely affect silvery minnows in the immediate vicinity. Because the crossing is only temporary in nature, it would not affect the hydrologic regime (i), instream habitat (ii), fine sediments for substrate (iii), or water temperature (iv). The temporary crossing would temporarily affect local water conditions (v), therefore it may affect but would not adversely modify silvery minnow critical habitat.

Following excavation, an additional 3.1 acres of active river channel would be created, which would be beneficial to the silvery minnow.

Southwestern Willow Flycatcher

The proposed excavation would be conducted during late fall and winter when flycatchers are not present in New Mexico. No migrant or breeding flycatchers have been detected in this reach of the Rio Grande during protocol surveys conducted in 1994 through 2011 (see references in Section 6.1). The excavated area lies entirely within the Sevilleta NWR and is not currently designated critical habitat for the flycatcher; however, the area may be included in currently proposed critical habitat (USFWS 2011). The area to be excavated entails a portion of Reclamation flycatcher site "LF-38," which has been classified as unsuitable flycatcher habitat (Ahlers *et al.* 2010). The proposed East Side Excavation would not affect the Southwestern Willow Flycatcher or adversely modify proposed critical habitat for the flycatcher.

5.1.2 Installation of Floodwall and Soil Cement Embankment

The floodwall and its roller-compacted concrete apron would be installed within a disturbed, upland portion of the terrace west of the Rio Grande. Approximately 0.05 acres of honey

mesquite and fourwing saltbush would be removed at the upstream end of the proposed floodwall during construction.

Along 1.1 miles of the western bankline downstream from the SADD, a soil cement embankment would be installed to protect the vertical bankline and railroad. This embankment would replace high velocity habitat along the steep embankment with lower velocity habitat along a terrace-point bar feature. Flow conditions on the south/east bank are likely more conducive for silvery minnow transit. Installation of this feature would fill 0.56 acres of the active channel. Placement of soil cement in this 0.56-acre area would require partial dewatering of the adjacent river channel. Conservation Measures listed in Section 2.2.11—particularly numbers 4 through 8—would minimize the potential for soil erosion, water quality degradation, and entrapment of fish.

Because of the incised condition of the river channel downstream from the SADD, the eastern overbank area is not currently inundated until flows exceed 15,400 cfs. Vegetation largely consists of relatively short and moderately dense salt cedar. Installation of the soil cement embankment would permanently remove 3.5 acres of this vegetation growing on the terrace slope. A 10 to 40-foot-wide band of vegetation closest to the bankline consists of moderately dense salt cedar, coyote willow, and seep-willow, plus several scattered, mature cottonwood trees. Approximately 0.04 acres of this vegetation would be displaced by the soil cement structure.

Vegetation would be temporarily removed from a 20-foot-wide strip bordering the base of the soil cement to accommodate construction access. Vegetation consists of 1.4 acres of salt cedar and 0.4 acres of moderately dense coyote willow and seep-willow. Following construction, this 1.8-acre area would be replanted with coyote willow and seep-willow.

Rio Grande Silvery Minnow

The 1.1 miles of the western bankline downstream from the SADD is generally unsuitable for silvery minnows and other small fish species because of very high water velocities (Figure 5.1, Figure 5.2) in this area. The proposed soil cement embankment to protect the vertical bankline and railroad would result in the loss of 0.56 acres of river channel and critical habitat. The area of silvery minnow critical habitat that would be affected by the placement of soil cement below the 5,660-cfs Ordinary High Water Mark (OHWM) immediately downstream of the SADD would be more than compensated by the channel excavation on the east bank which increases the area below the OHWM by approximately 3.1 acres (Section 5.1.1). The 3.1 acres of created habitat lies immediately across the channel from the 0.56 acres filled by the soil cement embankment (Appendix A, Sheet C-111).

Placement of soil cement for erosion protection on the western bankline below the SADD may affect, and is likely to adversely affect, silvery minnows in the river. Conservation Measures (Section 2.2.11) would be implemented during in-channel construction to minimize adverse effects to the silvery minnow and other fish species. This erosion control embankment may likely adversely modify silvery minnow critical habitat constituent elements ii and iii (instream habitat and fine sediments for substrate). The soil cement would not modify the hydrologic regime (i), water temperature (iv) or water conditions (v).

While the loss of 0.56 acres of aquatic and critical habitat may likely adversely affect the minnow, this effect would be more than offset in the proposed action by the creation of 3.1 acres of channel habitat during east side terrace excavation

Southwestern Willow Flycatcher

The proposed floodwall and soil cement construction would be conducted during late fall and winter when flycatchers are not present in New Mexico. No migrant or breeding Southwestern Willow Flycatchers have been detected in the affected area during protocol surveys conducted in 1994 through 2011 (see references in Section 6.1).

Approximately 0.6 miles of the 1.1-mile-long soil cement embankment lies within the Sevilleta NWR and is not currently designated critical habitat for the flycatcher; however, the area may be included in currently proposed critical habitat (USFWS 2011). Approximately 2.3 acres of the footprint of the proposed soil cement embankment at its downstream end lies within currently designated critical habitat.

The area to be excavated entails a portion of Reclamation flycatcher site "LF-108," the majority of which has been classified as unsuitable flycatcher habitat (Ahlers *et al.* 2010). A 0.3-mile long portion of Reclamation's flycatcher site LF-10 immediately downstream from the SADD was classified as moderately suitable flycatcher habitat (Ahlers *et al.* 2010); however, field inspection by the Corps in 2012 determined that this area is unsuitable nesting habitat for the flycatcher.

To install soil cent, vegetation growing on the 15-foot-tall slope of the terrace embankment would be removed, along with that in a narrow strip at its base. Affected vegetation largely consists of sparse to moderately dense saltcedar that is 15-foot-tall or shorter. As stated, a narrow (10 to 40 feet) band along the riverbank consists of sparse coyote willow and seep-willow, also less than 15 feet tall, mixed with salt cedar. Vegetation throughout the footprint of the soil cement embankment lacks sufficient height and dense branching that characterizes suitable flycatcher nesting habitat.

Therefore, due to its location and the low quality of flycatcher habitat affected, this feature of the proposed action may affect, but would not likely adversely affect the flycatcher, and would not likely adversely modify flycatcher designated critical habitat. (The cumulative effect on riparian vegetation and flycatcher PCEs is discussed in Section 5.1.3.)

5.1.3 Earthen Levee Construction

Vegetation removed due to levee footprint

The basal extent of the proposed levee was superimposed on geo-referenced aerial photography from 2010 and on riparian vegetation coverage mapped in 2007 (Parametrix, 2008). This was used to estimate potential changes to the riparian vegetation bordering the riverward toe of the levee.

From the north end of the proposed levee downstream to the northern boundary of BDANWR, the footprint of the new levee structure would fit entirely within that of the existing spoil bank (once it is removed). No riparian vegetation would be removed to accommodate the earthen structure.

Through BDANWR, the proposed levee would extend beyond the riverward toe of the existing spoil bank, and 8.7 acres riparian vegetation within the floodway would be permanently removed. Of these 8.7 acres, 8.6 acres are dominated by salt cedar. Along the levee alignment on the north end of Tiffany Basin, less than one acre of vegetation would be similarly affected, all of which is sparsely vegetated or occupied by relatively short salt cedar.

Vegetation removal and clearing-and-grubbing activities for all proposed construction would only occur between August 15 and April 15 to avoid disturbance of nesting migratory birds. If needed, vegetation removal outside of that period would only be performed after a survey by a biologist confirms that disturbance to nesting migratory bird species would be avoided.

Vegetation altered to accommodate the Vegetation-free Zone

The Corps Engineer Technical Letter 1110-2-571 (10 April 2009) requires that no vegetation other than grasses be allowed to grow on the levee or within 15 feet of either toe of the levee. This prevents root penetration into the levee that can compromise its structural integrity and allows for unobstructed visual inspections on a periodic basis. Vegetation removal in preparation of construction would include the removal of above-ground stems, root crowns, and roots greater than 0.5-inch in diameter. Removal methods may include clearing and grubbing, scraping, or root-plowing and raking. Following construction, a 15-foot-wide zone along the riverward toe of the levee would be permanently maintained to be devoid of all vegetation except grass.

During construction, existing vegetation would be removed adjacent to the riverward toe of the proposed levee to create the Vegetation-free Zone. This would only be necessary where the new levee toe is within 15 feet westward of the existing spoil bank toe, or where the new levee footprint extends riverward (eastward) of the existing toe. No vegetation removal would be required where the basal width of the new levee is sufficiently narrower than that of the existing spoil bank.

For the proposed action a total of 27.5 acres of existing riparian vegetation would be removed to establish the Vegetation-free Zone. The majority of that affected acreage (21.6) would occur within the BDANWR where the proposed levee is wider than the existing spoil bank. Most (72%) of the riparian vegetation to be removed is dominated by salt cedar; 10% is principally native woody species, about 14% is a mixture of native and non-native species, and about 4% is open or grassy. Along the 1.3-mile portion of the levee at the downstream end, about 2 acres of sparse saltcedar would be removed within the Tiffany basin.

Summary of affected vegetation

Table 5.1 summarizes the area of extent and type of vegetation affected by the proposed earthen levee, soil cement embankment and floodwall, as well as the vegetation types that would be converted to grassland within the Vegetation-free Zone. (This table does not include non-riparian vegetation affected by the East Bank Excavation and spoil deposition area which are discussed in Sections 5.1.1 and 5.1.8, respectively.)

Table 5.1. Vegetation affected by the proposed project, and area revegetated (acres).

| Habitat type | Affected areas | | | Revegetated areas | | |
|--------------------------------|--|--|-------|--|-----------------------------|-------|
| | Vegetation altered in Vegetation-free Zone | Vegetation removed for footprint of levee, soil cement & floodwall | Total | Area exposed after spoilbank removal (exclusive of Veg.-free Zone) | Other revegetated locations | Total |
| <u>Riparian vegetation:</u> | | | | | | |
| Native-dominated shrub/tree | 2.8 | 0.9 | 3.7 | 7.7 | 8.7 | 16.4 |
| Mixed native/exotic shrub/tree | 3.7 | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 |
| Exotic-dominated shrub | 19.8 | 12.1 | 31.9 | 0.0 | 0.0 | 0.0 |
| Herbaceous | 1.3 | 0.0 | 1.3 | 27.8 | 75.9 | 103.7 |
| Subtotal | 27.6 | 13.0 | 40.6 | 35.5 | 84.6 | 120.1 |
| <u>Upland vegetation:</u> | | | | | | |
| Native-dominated shrub/tree | 0.0 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| Mixed native/exotic shrub/tree | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Exotic-dominated shrub | 0.9 | 15.2 | 16.0 | 0.0 | 0.0 | 0.0 |
| Herbaceous | 1.1 | 1.0 | 2.1 | 0.1 | 1.9 | 2.0 |
| Subtotal | 1.9 | 16.4 | 18.3 | 0.1 | 1.9 | 2.0 |
| Total | 29.5 | 29.4 | 58.9 | 35.6 | 86.5 | 122.1 |

Mitigative Vegetation Establishment

All areas disturbed by construction activities would be revegetated following construction. These areas include staging and access areas, levees side-slopes, the Vegetation-free Zone, and additional locations within the floodway. Table 5.1 summarizes the extent and type of proposed vegetation plantings.

A total of 77.9 acres would be planted and maintained as grassland within the riverside corridor of the Vegetation-free Zone. Approximately 29.5 acres of existing vegetation (Table 5.1) would be converted to grassland to accommodate this. The remainder of the Vegetation-free Zone would entail grass plantings in areas exposed after removal of the spoil bank.

Following construction, the Corp's operation and maintenance manual would require the local sponsor to maintain the Vegetation-free Zone (the levee itself and the 15-foot-wide strip adjacent to each toe) to preclude the establishment of all vegetation except grass. The Vegetation-free Zone would be periodically mowed, when dry. If required, spot-application of approved herbicides would be used to prevent colonization by invasive weed species.

As discussed in Section 5.1.7 below, removal of the spoil bank would increase the floodway area by approximately 75.0 acres. Of that area, approximately 35.5 acres would not be devoted to the Vegetation-free Zone adjacent to the riverward levee toe. Based on current vegetation types and the potential inundation frequency, approximately 7.7 acres of this area would be suitable for planting with native riparian shrub species (coyote willow, seep-willow, New Mexico olive). The remaining drier, or higher sites (27.8 acres) would be revegetated with native grass and forb species.

In addition to the woody plantings mentioned above, the Corps would establish 8.7 acres of native shrubs and trees (up to 30% tree canopy cover) on or in close proximity to BDANWR. The Corps is currently coordinating with the BDANWR staff on the location and composition of revegetated areas. The Corps would receive guidance from the BDANWR as to where the establishment of native riparian habitat would be most practicable on lands managed by BDANWR.

Rio Grande Silvery Minnow

The areas affected by the levee footprint and establishment of the Vegetation-free Zone are within the Rio Grande floodway but are not regularly inundated by river flows. All vegetation removal activities would occur on dry ground and therefore these activities may affect but are not likely to adversely affect silvery minnow. Establishment of the Vegetation-free Zone would preclude the establishment of any native woody riparian vegetation, but would not preclude inundation during periods of higher flows. Silvery minnows can still use these areas for refugial habitat and foraging. Therefore, the proposed action may affect but is not likely to adversely modify any of the critical habitat PCEs elements hydrologic regime (i), instream habitat (ii) and fine sediments for substrate (iii), water temperature (iv), or water conditions (v).

Southwestern Willow Flycatcher

As described in Section 4.2.1, Relatively few flycatchers (0 to 3 territories) have nested between the SADD and U.S. Highway 380 near San Antonio since 1994 (Table 4.3 and references in Section 6.1). The location of these isolated, territorial birds has changed from year-to-year throughout this 29-mile-long reach. From Highway 380 downstream to the San Marcial railroad bridge, territorial flycatchers have been present consistently and more numerous (up to 54 in 2001).

While all woody riparian habitat is generally valuable to the flycatcher, not all tree and shrub stands possess the pertinent characteristics (*e.g.*, stature, density, cover) identified as primary constituent elements (PCEs) of critical habitat (Federal Register 2005, USFWS 2011). Considering these PCEs, along with the known distribution of breeding flycatchers in 2006 through 2009, Reclamation has determined the flycatcher habitat suitability of all riparian vegetation in the action area (Ahlers *et al.* 2010). The “Suitable” and “Moderately suitable” classifications included vegetation types that included all or most of the PCEs for flycatcher habitat. Other categories also mapped included “Unsuitable” habitat and “Non-habitat” (the latter including upland, grassland, and Unvegetated areas).

From the detailed maps produced by Ahlers *et al.* (2010), the Corps determined the flycatcher habitat suitability of all vegetation affected by the proposed action.⁴ Approximately 86% of the vegetation altered or removed by the proposed action entails habitat types unsuitable for breeding flycatchers (Table 5.2). Throughout the action area, approximately 8.4 acres of Suitable or Moderately Suitable flycatcher habitat would be altered or removed. The proposed action includes 16.4 acres of dense riparian shrub plantings which, along with natural germination, would develop into, at least, Moderately Suitable flycatcher habitat.

Table 5.2. Flycatcher habitat suitability (Ahlers *et al.* 2010) of affected vegetation.

| Reach | Vegetation altered in Vegetation-free Zone | | | Vegetation removed for footprint of levee, soil cement & floodwall | | |
|--------------------------|--|---------------------|---------------------------|--|---------------------|---------------------------|
| | Suitable | Moderately suitable | Unsuitable or Non-habitat | Suitable | Moderately suitable | Unsuitable or Non-habitat |
| SADD to Brown Arroyo | 0 | 0 | 1.2 | 0 | 0 | 20.7 |
| Brown Arroyo to Hwy. 380 | 0 | 0.9 | 2.3 | 0 | 0 | 0 |
| Highway 380 to BDANWR | 0 | 0.6 | 0.6 | 0 | 0 | 0 |
| BDANWR | 0 | 2.4 | 19.2 | 0 | 2.7 | 6.0 |
| BDANWR to Tiffany Basin | 1.8 | 0 | 0.5 | 0 | 0 | 0 |
| Total | 1.8 | 3.9 | 23.8 | 0 | 2.7 | 26.7 |

All riparian habitat affected by the proposed action occurs in a narrow strip immediately adjacent to the riverward toe of the existing spoil bank. Geo-referenced locations of flycatchers associated with surveys conducted by Reclamation (see references in Section 6.1) indicate that breeding birds have a propensity to establish territories along or near the bank of the active channel, ranging from 50 to 1,300 feet of the spoil bank alignment. Territorial flycatchers are rarely observed immediately adjacent to the existing spoil bank (Gina DelloRusso, Biologist, BDANWR, March 2012).

Given these considerations, and the incorporation of Conservation Measures (see Section 2.2.11), earthen levee construction may affect, but would not likely adversely affect the flycatcher, and would not likely adversely modify designated or proposed critical habitat for the species.

⁴ The precise location and community-structure type of all vegetation affected by the proposed action is detailed in a spreadsheet provided to the Service with this BA.

5.1.4 Ephemeral Channels Adjacent to the Spoil Bank

An ephemeral channel runs along the existing spoil bank from Highway 380 through BDANWR. As is often the case throughout the middle Rio Grande valley, the overbank area tends to slope from the riverbank downwards toward the spoil bank toe. When inundated, flow becomes concentrated along the spoil bank, and, over time, has formed a small channel paralleling the toe. During proposed levee construction, the Corps would fill such depressions within 15-feet of the riverward toe, grade the surface to that of the adjacent overbank, and re-vegetate it with grass species in order to minimize the potential for erosion of the levee toe. During detailed design for specific levee segments, the drainage patterns adjacent to the levee would be evaluated by a Corps biologist, and measures would be included in the design to avoid the creation of depressions that could trap silvery minnows. Such measures may include local contouring, or the creation of small channels to direct receding overbanking flows back to the Rio Grande channel.

Rio Grande Silvery Minnow and Southwestern Willow Flycatcher

Filling the ephemeral channels to the same level with contiguous floodplain would not result in loss of terrestrial or aquatic habitat area for either flycatchers or silvery minnows. A floodplain that generally slopes to the river will continue to function as floodplain habitat for both flycatchers and silvery minnows. Replacing the ephemeral channels with floodplain may affect, but is not likely to adversely affect the minnow or flycatcher, and would not adversely modify critical habitat PCEs for either flycatchers or silvery minnows.

5.1.5 Placement of Riprap Along the Levee

Riprap would be used for erosion protection along a total of 31,700 linear feet (approx. 6.0 miles) of the riverward slope and toe of the proposed levee. Riprap would be installed in the areas most susceptible to scour during large flood events and would be buried at depths of between 6.5 and 12 feet. This riprap would be placed during levee construction activities when the area is dry. Should any portions of the riprap fail in the future, the Corps' operation and maintenance manual would require the project sponsor to repair these areas.

Rio Grande Silvery Minnow

Although minnow critical habitat extends up to the levee (including riprap) during higher flows, water velocities during such flows are above suitable values for the minnow. Therefore, levee erosion-control features may affect but are not likely to adversely affect any constituent elements of silvery minnow critical habitat as the placement of riprap is entirely within the overbank terrace.

Riprap may partially reduce water velocities at the normal range of flows, but would create turbulence which is unsuitable for silvery minnows and velocities are likely to remain above the threshold for silvery minnow use. The current design for riprap would not create quantifiable backwater habitat. Riprap along the bankline toe may provide a solid substrate supporting attached algae, but would otherwise provide little usable habitat.

Riprap would be buried at the levee toe to a depth of 1 to 12 feet. Buried riprap may be inundated at higher flows, but would not contribute to, or adversely affect, aquatic habitat. Buried riprap may be partially exposed by erosion in the future. Changes in aquatic habitat

quality caused by exposing riprap at the levee toe would be offset by corresponding geomorphic processes forming point bars on the opposite bank. The buried riprap at most sites would not affect the hydrologic regime (i), instream habitat (ii), fine sediments for substrate (iii), water temperature (iv), or water conditions (v). Therefore riprap may affect, but is not likely to adversely modify critical habitat. Placement of riprap would have no effect of the silvery minnow.

Southwestern Willow Flycatcher

Riprap would be placed during earthen levee construction activities. As a result of this erosion control feature, an additional 5.4 acres of vegetation would be converted to grassland to accommodate the widened Vegetation-free Zone along the riverward toe of the levee. This effect is evaluated in Section 5.1.3 along with vegetation effects resulting from earthen levee construction.

5.1.6 Altered Floodplain Inundation

The existing spoil bank has been estimated to fail at discharges in the range of the 20%- to 14%-chance event (11,800 to 13,240 cfs, respectively) at the San Acacia gage. Currently, spoil bank failure would periodically result in inundation throughout the floodplain west of the LFCC. Breached or damaged spoil banks would be quickly repaired or rebuilt along the existing alignment. Flow conditions within the floodway up to the breaching or failure discharge would be the same with or without the proposed action. The principal effect of the proposed action is that higher discharges that would be contained within the floodway. The following discussion focuses on those differential effects. The differential extents of inundation are first described, then changes in water depth and velocity are discussed specific to the minnow and flycatcher.

1%-Chance-Event Floodplain

The existing spoil bank has been estimated to fail at discharges in the range of the 20%- to 14%-chance event (11,800 to 13,240 cfs, respectively) at San Acacia. Currently, spoil bank failure would result in inundation both within the current floodway and throughout the floodplain west of the LFCC. Breached or damaged spoil bank would be quickly repaired or rebuilt along the existing alignment.

Without the proposed project, damages to ecological resources from the 1%-chance flood event (29,900 cfs at San Acacia) are expected to occur both within the current floodway and throughout the floodplain west of the spoil bank. The estimated inundated area of the 1%-chance flood totals approximately 38,800 acres (see Table 5.3). Affected plant communities in the floodplain west of the spoil bank include: rural and suburban yards; agricultural fields and edges; upland Chihuahuan desertscrub; and wetland and riparian communities managed at Bosque del Apache NWR. These plant communities may be subjected to substrate scouring or extensive sediment deposition. Additional stress may result from extended inundation, depending on the tolerance of plant species within each community.

Table 5.3. With and without-project flood plain inundation (acres).

| Alternative | 10%-chance-event floodplain (15,400 cfs) | 1%-chance-event floodplain (29,900 cfs) |
|-----------------------------------|---|--|
| Future condition, Without project | 36,200 | 38,800 |
| Proposed action | 18,300 | 20,200 |

Although periodic floodplain inundation outside of the existing floodway has the potential for providing allocthonous material to the Rio Grande, historic and existing land uses west of the spoil bank alignment also present potential threats to water quality. Following a spoil bank breach, floodwaters would likely be of low quality and could result in the introduction of potential contaminants (sewage, petroleum products) to the river, and, therefore, may not be considered beneficial to aquatic habitat and organisms.

With the proposed action, all flow for the 1%-chance event would be contained within the current floodway, and is estimated to inundate approximately 20,200 acres. Flooding, and potential ecological damages, would be eliminated from approximately 18,600 acres of the floodplain west of the spoil bank alignment.

Within the floodway, however, potentially adverse impacts to riparian and aquatic communities would still occur following levee construction. Currently, the 1%-chance flood event has the potential to scour the substrate and remove, or otherwise damage, vegetation within the Rio Grande floodway. This process is inherent in sand-bed river systems of the Southwestern U.S., and one to which riparian plant species are adapted. After construction of Alternatives A or A+4ft in the study area, the water surface of the 1%-chance event would increase in the Rio Grande floodway by approximately 2.5 feet near Escondida to nearly 5 feet near Tiffany Junction. Water depths would decrease downstream from there, largely due to transit storage afforded by the 2,000-acre Tiffany Basin and areas of Elephant Butte Reservoir outside of the active floodway.

Because of the rarity of the 1%-chance event, quantitative data on ecological impacts are not available for the Southwestern United States. Potential impacts likely include the physical destruction of vegetation from high flow velocities, soil erosion, and/or sediment deposition; the temporary displacement of non-aquatic animals; and the death (primarily through drowning) of animals that cannot escape floodwaters. Qualitatively, we believe that ecological effects within the floodway following construction of any of the levee alternatives would be as extensive and similar to the without-project condition. Although inundation, scouring and sediment accretion are natural processes of sand-bed rivers such as the Rio Grande, the recovery of plant and animal communities following the 1%-chance flood would be slow.

10%-Chance-Event Floodplain

Currently, the more probable 10%-chance flood event (approximately 15,400 cfs at San Acacia) also is expected to result in spoil bank failure and extensive inundation—about 36,200 acres—of

the valley (Table 5.3). Because spring runoff floods would be regulated by upstream reservoirs, this event would most likely result from rainstorm activity, and, therefore, would be of short duration. Therefore, resultant ecological damage from scouring, deposition, and inundation would be significantly less than for the 1%-chance event.

After construction of a new levee, the 10%-chance event would be contained to about 18,300 acres of the floodway. The with- *versus* without-project differential in depths and velocities of the 10%-chance events are nominal; therefore, the extent of adverse effects would be similarly small. The magnitude of the event is within the range of unregulated snowmelt and thunderstorm flows recorded in the Middle Rio Grande over the past 100 years, and is well within the flow regime to which native riparian species (cottonwood, willow) have adapted.

Rio Grande Silvery Minnow

Because the Rio Grande channel throughout much of the study area has aggraded to elevations of up to 15 feet above the historical floodplain outside of the existing spoil bank, any breach of the spoil bank during flood flows, under future without-project conditions, would discharge silvery minnows and other fish onto the floodplain. Most of these fish would likely be stranded, and eventually die on the floodplain outside the levees.

Rio Grande silvery minnow are small fish that cannot swim against high velocities for extended periods. Post-construction water depths and velocities determined by Corps hydraulic modeling were reviewed to evaluate potential effects on silvery minnow. Average with-project water depth in the overbank area would increase by 2.5 to 5 feet for the 1%-chance flood, and 1 to 2 feet for the 10%-chance flow. For both events, extensive shallow (2 feet or less) areas would still occur within the floodway. Likewise, with-project velocities (Figure 5.1, Figure 5.2, and Figure 5.3 indicate that relatively slow-flowing (<2 ft/sec) areas are extensive enough to provide refugia for the silvery minnow during the 1%-chance flood, as well for more frequent discharge events. The proposed construction would reduce the risk of silvery minnow stranding outside of the floodway due to a spoil bank breach. Therefore, sufficient slackwater areas would remain after levee replacement to avoid flushing silvery minnow from the San Acacia reach. Therefore, the proposed action may affect but is not likely to adversely affect silvery minnow. It would not affect the hydrologic regime (i), instream habitat (ii), fine sediments for substrate (iii), water temperature (iv) or water conditions (v). Therefore the proposed action may affect but is not likely to adversely modify designated critical habitat.

Southwestern Willow Flycatcher

With-project water depths within the proposed action area were reviewed to evaluate potential effects to the flycatcher from changes in hydrologic characteristics. After construction of a new levee in the proposed action area, the water surface of the 1%-chance event was similar to the without-project conditions within most of the proposed action area. The largest increase in depth occurs within the BDANWR. Under with-project conditions, the water depth of the 1%-chance event averaged approximately 6-7 feet and reached as high as 8 feet. Under without-project conditions, the water depth of the 1%-chance event averaged approximately 5 feet, but reached 7-8 feet near the outer edge of the floodway. The with-*versus* without-project differential in depths and velocities of the 10%-chance events are nominal; therefore, the extent of adverse

effects would be similarly small. The magnitude of this event is within the range of unregulated snowmelt and thunderstorm flows recorded in the Middle Rio Grande over the past 100 years, and is well within the flow regime to which native riparian species (cottonwood, willow) have adapted. Retaining flood flows within the floodway would be expected to increase scouring and sediment accretion. These dynamic processes have the potential to increase the loss of older riparian habitat patches while supporting the regeneration of new riparian habitat patches. The net result would be a continually changing mosaic of suitable riparian habitat for the flycatcher.

At BDANWR, where the biggest difference in water depth for the 1%-chance event occurs between the with- and without project conditions, flycatchers are regularly nesting in the riparian zone and the number of territories has significantly increased within the last several years. In the 1%-chance event, within the BDANWR, adult and flighted young flycatchers would be capable of avoiding drowning; however, eggs and nestlings would be susceptible to drowning due to rising floodwaters. The probability of inundation is dependent on the height of the nest above the substrate. At Elephant Butte Reservoir during 2004 through 2008, the average flycatcher nest height in stands with a dry substrate was 10.7 ft (3.27 m; n = 31), but was lower, 8.2 feet (2.49 m; n = 52), at nest sites with saturated substrate (Ahlers and Moore 2009). Generally, flycatcher nest height appears to be lower in stands with dense vegetation closer to the ground (Ahlers and Moore 2009; Paxton *et al.* 2007). In a review of recent literature, the minimum flycatcher nest height that was reported was 4.6 ft (1.40 m) at Roosevelt Lake in Arizona (Graber *et al.* 2007). Assuming that future flycatcher nests within the project area are a minimum of 4 feet above the ground surface, the probability of inundating eggs or nestlings is only somewhat likely in a 1%-chance event for both with- and without-project conditions. The average maximum water depths for with- and without project conditions for a 1%-chance event is approximately 3 to 5 feet throughout most of the project area. The only reach within the project area where the change in depth would most likely inundate eggs or nestlings is within BDANWR. However, even without-project conditions for a 1%-chance event would have similar results. Therefore, the changes due to altered floodplain inundation may affect, but not likely to adversely affect the flycatcher and may affect, but not likely to adversely modify flycatcher designated or proposed critical habitat.

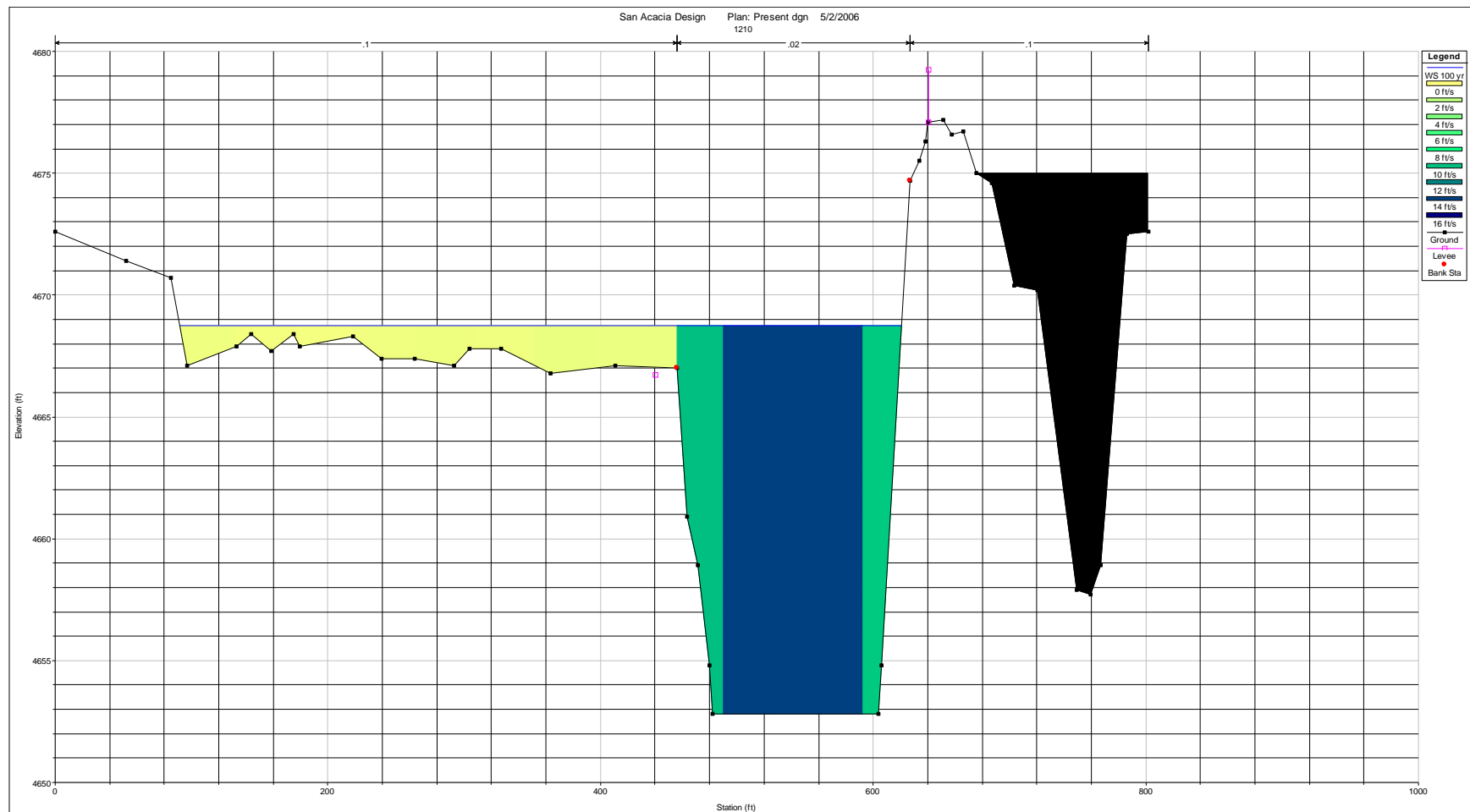


Figure 5.1. RAS cross-section immediately downstream of San Acacia diversion dam without proposed action.

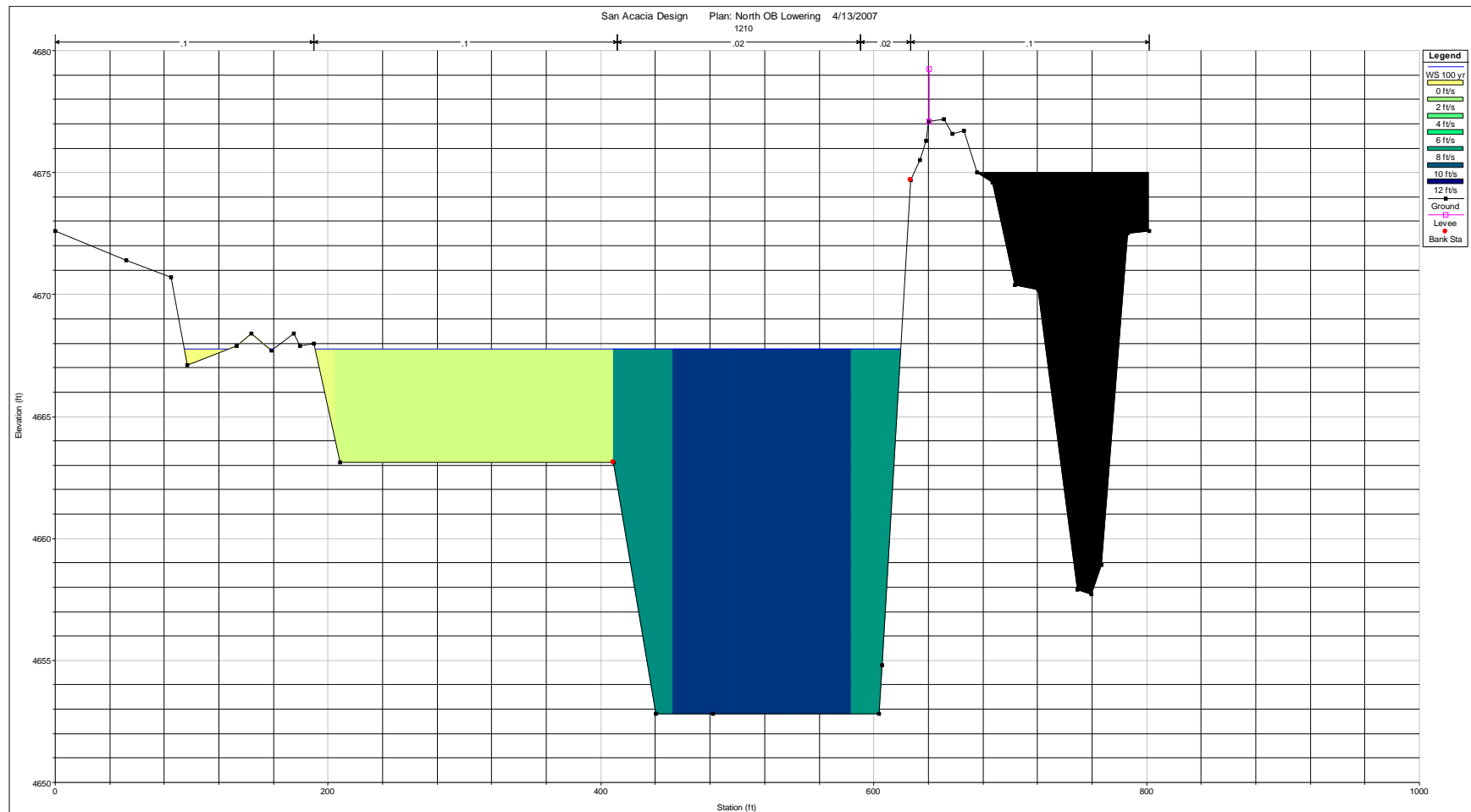


Figure 5.2. RAS cross-section immediately downstream of San Acacia diversion dam with proposed action.

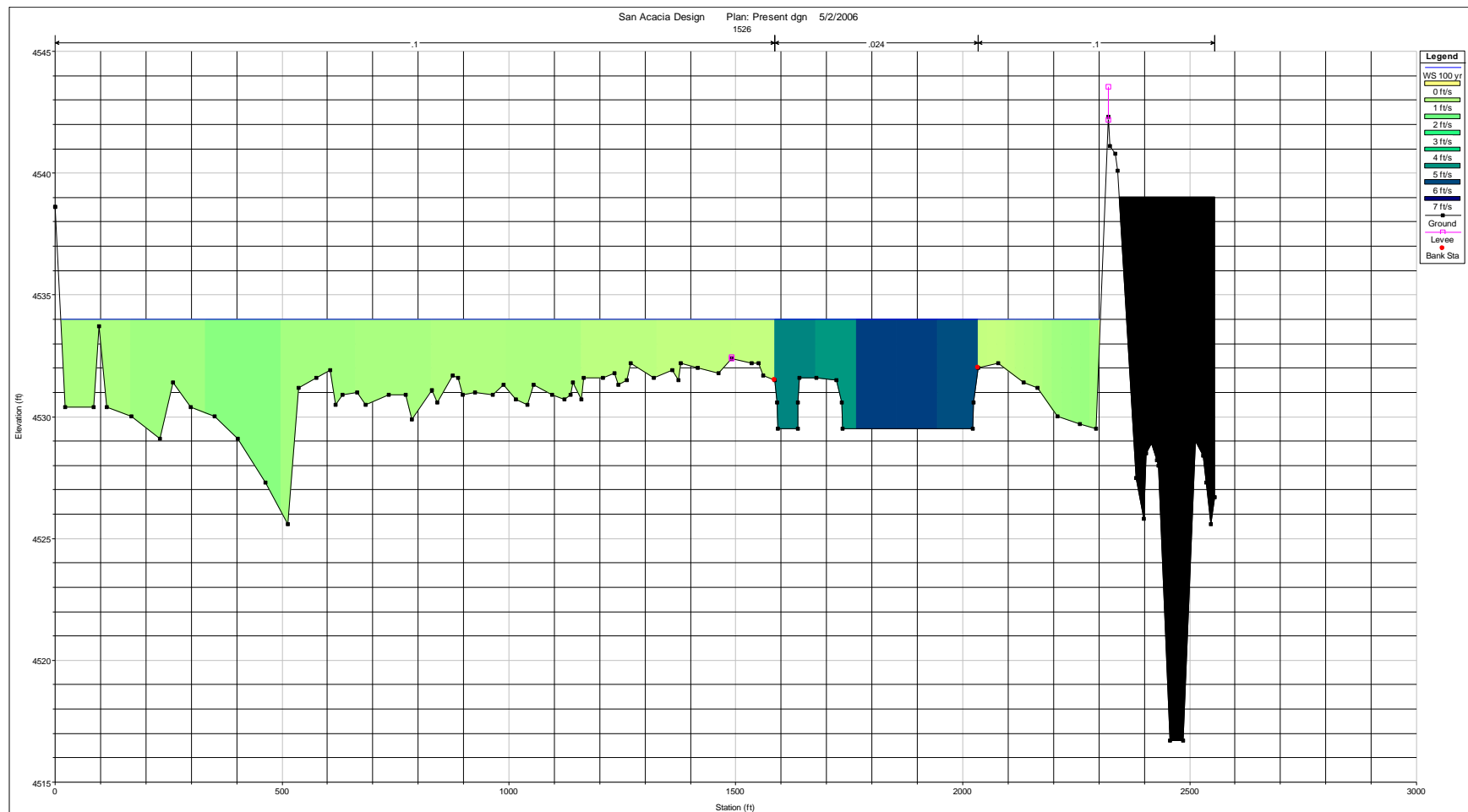


Figure 5.3. RAS cross-section at Bureau of Reclamation aggradation/degradation line 1526 with proposed action.

5.1.7 Change in Floodway Area Due to Physical Footprint of Levee

The basal extent of the proposed levee and associated features was superimposed on geo-referenced aerial photography from 2010. The location of the riverward toe of the proposed levee relative to the current riverward toe of the spoil bank was estimated throughout the reach. Similarly, the location of the riverward extent of the soil-cement embankment was estimated relative to the current bankline. The differential extent of the proposed levee was calculated and formed the basis for the evaluation of potential changes to the floodway area.

From the northern end of the action area to the Highway 380 bridge at San Antonio (approx. 24.9 miles), the landward toe of the proposed levee was aligned on the landward toe of the existing spoil bank. This landward toe is frequently 10 to 20 feet east (riverward) of the maintenance road between the levee and the Low Flow Conveyance Channel. South of Highway 380, the base width of the proposed frequently levee equals or exceeds the existing spoil bank width. Therefore, to minimize encroachment of the levee footprint upon the riparian zone south of Highway 380, the landward toe of the proposed levee was shifted landward to abut the eastern edge of the maintenance road.

From the northern end of the proposed earthen levee to BDANWR, the base width of the proposed levee is equal to or less than that of the existing spoil bank (by an average difference of about 25 ft; range 0-80 ft). Therefore, following construction, upstream from BDANWR, the area of the floodway would increase by approximately 82.3 acres due to the smaller footprint of the proposed levee (Table 5.4).

Through BDANWR, the footprint of the proposed levee would encroach on an additional 8.7 acres of the current floodway. Due to variation in the alignment of the existing spoil bank, the proposed levee would occasionally fall landward of the existing riverward toe, resulting in a minor gain of about 0.6 acres. Therefore, throughout BDANWR, the proposed levee would result in a net loss of 8.1 acres of the floodway.

Within the 1.5-mile reach immediately downstream from BDANWR, the riverward toe of the proposed levee would remain to the west (landward) of the existing spoil bank toe. This would result in a small gain of about 0.8 acres to the floodway area.

Table 5.4 summarizes the expected changes to the existing floodway and floodplain areas. Throughout the entire length of the proposed levee, the net change in area as a result of levee construction would be a gain of approximately 83.1 acres. Considering this net gain in active floodway area, and the distance that the levee alignment is set back from the channel, construction of the levee along the proposed alignment would have no direct effect on aquatic habitat within the proposed action area.

Table 5.4. Net change in floodway and 10%-chance floodplain area due to construction of new levee.

| Reach | Reach length (mi.) | Net change in area (acres) | Type |
|-------------------------------|---------------------------|-----------------------------------|-------------|
| Start (40+00) to BDANWR | 28.3 | +82.3 | Floodway |
| BDANWR | 11.3 | -8.1 | Floodway |
| BDANWR to 2133+00 | 1.5 | +0.8 | Floodway |
| <i>Net change in floodway</i> | <i>41.1</i> | <i>+75.0</i> | |
| East Side Excavation (bench) | -- | +9.3 | 10%-chance |
| Sta. 2133+00 to RR track | 1.1 | -1.2 | floodplain |
| Total (net) | 42.2 | +83.1 | |

Rio Grande Silvery Minnow

When inundated, these areas of additional floodway would provide additional foraging, spawning, and nursery habitat for the silvery minnow, and improve critical habitat constituent elements (instream habitat, substrate). Hydraulic modeling indicates that even during the 1%-chance flow (29,900 cfs) there will be refugial areas in the floodway providing lower velocity habitat for silvery minnows. The proposed action may affect but is not likely to adversely affect the Rio Grande silvery minnow. The proposed action would not affect the hydrologic regime (i), instream habitat (ii), fine sediments for substrate (iii), water temperature (iv) or water conditions (v). Therefore the change to the floodway footprint may affect but is not likely to adversely modify critical habitat for the silvery minnow.

Southwestern Willow Flycatcher

Throughout the entire length of the proposed levee, the net change to floodway area as a result of levee construction would be a gain of approximately 75.0 acres. Of these 75.0 acres, approximately 38.2 acres would be planted with grasses as part of the Vegetation-free Zone, and 35.5 acres would be suitable for planting, or otherwise establishing, herbaceous and woody riparian vegetation. The area suitable for woody planting would occur between the upstream end of the levee alignment and BDANWR. The only loss in floodway would occur at BDANWR, where the footprint of the proposed levee would encroach on 8.7 acres of the current floodway. (Vegetation effects within the floodway from the levee footprint are discussed and analyzed in Section 5.1.3). Considering the net gain in active floodway area (in which about half would be areas suitable for establishing native riparian habitat), and the distance that the levee alignment is set back from the channel, construction of the levee along the proposed alignment may affect, but would not likely adversely affect the flycatcher and may affect, but would not likely adversely modify flycatcher designated critical habitat.

5.1.8 Waste Spoil Disposal

Excess soil material from the excavated spoil bank would be deposited within a 300-acre area located at Tiffany Basin (Table 5.4). The area is currently vegetated with salt cedar of varying density, and is not inundated by flows smaller than the 10%-chance event. Spoil will be deposited up to 6.5 feet deep throughout this area, rendering it suitable for upland, rather than riparian, vegetation. The fill material would be revegetated to minimize erosion, to decrease the potential for colonization by invasive weeds, and to replace shrubby wildlife habitat. Following fill deposition, the disturbed area would be seeded with a mixture of grass, herbaceous and shrub species (e.g., four-winged saltbush, with winterfat and Woods' rose).

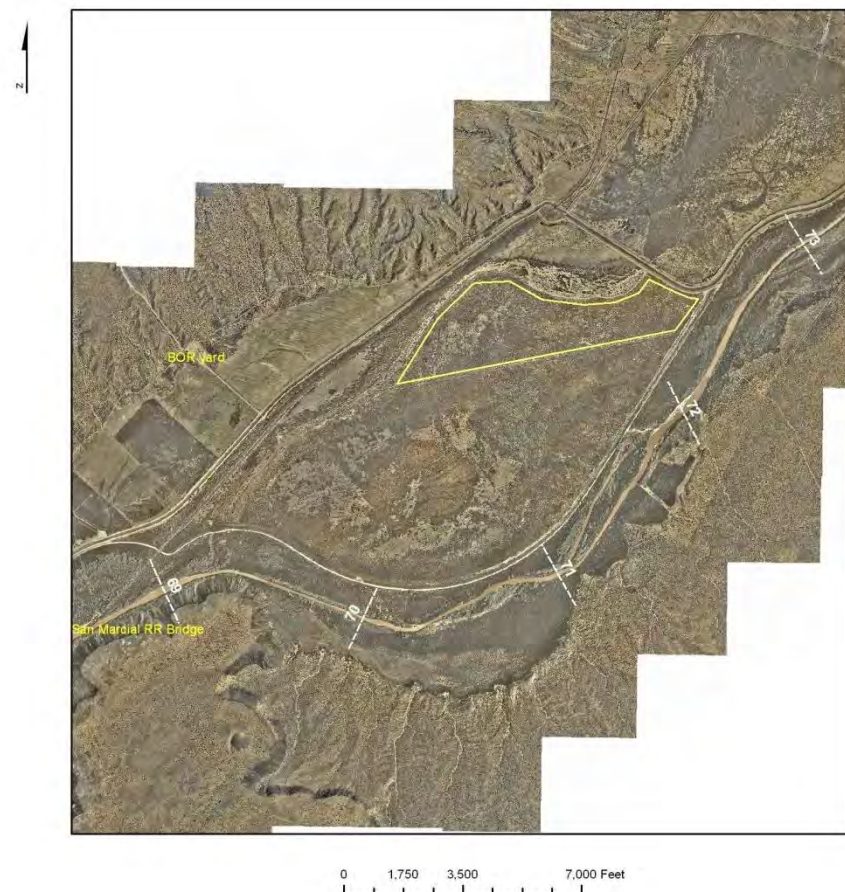


Figure 5.4. Waste disposal location in Tiffany Basin.

Rio Grande Silvery Minnow

The deposition of spoil material in the Tiffany Basin would not affect the silvery minnow or its designated critical habitat.

Southwestern Willow Flycatcher

Willow flycatchers have not been detected within the Tiffany Basin during annual protocol surveys conducted from 1994 through 2011 (see references in Section 6.1). Flycatchers have regularly established breeding territories in the riparian vegetation bordering the Rio Grande channel east of the Tiffany Basin. The basin lies within the 10%-chance floodplain behind a continuation of the spoil bank, and soil conditions are relatively dry in comparison with the riparian zone adjacent to the river channel. Except for a small portion near its western edge, the basin includes designated and proposed critical habitat for the flycatcher. However, all vegetation within the basin has been classified as Unsuitable habitat for the flycatcher (Ahlers *et al.* 2010), lacking the PCEs that constitute high quality habitat. The deposition of spoil material in the Tiffany Basin would not affect the flycatcher and would not adversely modify its designated and proposed critical habitat.

5.2 Interior Least Tern

The Interior Least Tern is a vagrant in the proposed action area, occasionally present along the Rio Grande in central and southern New Mexico. Its principal foraging and resting areas would be along the river channel, or, perhaps, at managed areas of BDANWR.

The majority of the construction activities associated with the proposed action and the various alternatives would be limited to the current spoil bank alignment. Should a tern occur within the project area, the alignment is sufficiently far from the river channel that active construction and related traffic would not interfere with the bird's foraging or resting activities. Construction along the immediate bank of the channel would only occur in the northernmost mile of the alignment, and would take place during the winter, low-flow period, when terns are not present in New Mexico.

Given the relatively rare occurrence of terns in the proposed action area, and the low disturbance factor of the potential construction activities, the implementation of the proposed action is not likely to affect the Interior Least Tern.

5.3 Northern Aplomado Falcon

Northern Aplomado Falcons are known to nest on the Armendaris Ranch, which is adjacent to the proposed action area. However, Northern Aplomado Falcons inhabit desert grasslands and are infrequent visitors to riparian areas. Given the relatively rare occurrence of falcons in the action area, the low disturbance factor of the potential construction activities, the implementation of the proposed action is not likely to affect the Northern Aplomado Falcon.

5.4 Pecos Sunflower

The privately-owned land where the artificially seeded stand of Pecos sunflower occurs is located on the east side of the Rio Grande; that is, on the opposite side of the river from all

proposed or alternative levee construction activities. The stand is located near the eastern extent of the 1%-chance floodplain and would not be subject to measurably difference inundation during inundation by the rare and larger flood discharges. The proposed action would not affect the Pecos sunflower.

5.5 Summary of Effects, and Endangered Species Act Consultation

The following, and Table 5.5, summarizes the findings in the sections above and the Corps' determination of effects for the proposed action:

- May affect, and likely to adversely affect, the Rio Grande silvery minnow
- May modify, and likely to adversely modify, designated critical habitat for the Rio Grande silvery minnow
- May affect, but not likely to adversely affect, the Southwestern Willow Flycatcher
- May modify, but not likely to adversely modify, designated and proposed critical habitat for the Southwestern Willow Flycatcher
- Would not affect the Interior Least Tern, Northern Aplomado Falcon, and Pecos sunflower.

Table 5.5. Summary of analysis of effects of the proposed action.

| Feature or effect of the proposed action | Rio Grande silvery minnow | | Southwestern Willow Flycatcher | | Interior Least Tern | Northern Aplomado Falcon | Pecos sunflower |
|--|-------------------------------------|-------------------------------------|---|---|----------------------------|---------------------------------|------------------------|
| | Species | Critical habitat | Species | Critical habitat | | | |
| East Side Excavation | May affect, likely adversely | May modify, not likely adversely | No effect | May modify, not likely adversely | No effect | No effect | No effect |
| Floodwall | No effect | No effect | No effect | No effect | No effect | No effect | No effect |
| Soil Cement Embankment | May affect, likely adversely | May modify, likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |
| Earthen Levee Construction | May affect, not likely adversely | May modify, not likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |
| Ephemeral Channels Adjacent to the Spoil Bank | May affect, not likely adversely | May modify, not likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |
| Placement of Riprap Along the Levee | May affect, not likely adversely | May modify, not likely adversely | (see Earthen Levee Constr.) | (see Earthen Levee Constr.) | No effect | No effect | No effect |
| Altered Floodplain Inundation | May affect, not likely adversely | May modify, not likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |
| Change in Floodway Area Due to Physical Footprint of Levee | May affect, not likely adversely | May modify, not likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |
| Waste Spoil Disposal | No effect | No effect | No effect | May modify, not likely adversely | No effect | No effect | No effect |
| Overall | May affect, likely adversely | May modify, likely adversely | May affect, not likely adversely | May modify, not likely adversely | No effect | No effect | No effect |

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Appendix A

Plans for San Acacia Levee Improvements, Jan. 2012

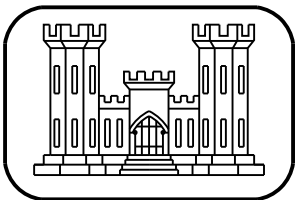
SOCORRO COUNTY, NEW MEXICO

RIO GRANDE FLOODWAY

PLANS FOR

SAN ACACIA LEVEE IMPROVEMENTS STUDY

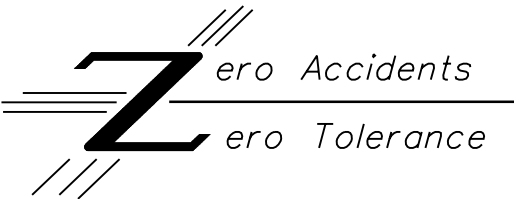
DATED : JANUARY, 2012



United States Army
Corps of Engineers

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Albuquerque District



THE DESIGN, ASSOCIATED DETAILS, AND PRESENTATION CONCEPTS IN THIS SET OF DRAWINGS WERE ASSEMBLED AND REVIEWED BY THE FOLLOWING ALBUQUERQUE DISTRICT DESIGN TEAM. THIS DOCUMENT MEETS OUR HIGH STANDARDS OF QUALITY AND PROFESSIONALISM.

| TEAM MEMBER | SIGNATURE | FUNCTION |
|--------------------------|-----------|------------------------|
| CIVIL | | |
| CORINA V. CHAVEZ | _____ | CIVIL ENGINEER INTERN |
| GARY EDWARDS | _____ | CIVIL ENGINEER TECH |
| RONNIE CASAUS | _____ | CIVIL ENGINEER TECH |
| GEOTECH | | |
| BRUCE JORDAN, EIT | _____ | CIVIL ENGINEER-GEOTECH |
| WILLIAM SHUTER, PE | _____ | CIVIL ENGINEER-GEOTECH |
| ENVIRONMENTAL | | |
| GREGORY EVERHART | _____ | ARCHAEOLOGIST |
| WILLIAM DERAGON | _____ | BIOLOGIST |
| H & H | | |
| RYAN GRONEWOLD, PE | _____ | HYDRAULIC ENGINEER |
| DARRELL EIDSON, PE | _____ | HYDRAULIC ENGINEER |
| PLANNING AND FORMULATION | | |
| MARK DOLES | _____ | PLANNER |
| STRUCTURAL | | |
| JOHN STAGES, PE | _____ | STRUCTURAL ENGINEER |
| COST ENGINEERING | | |
| MIKE PRUDHOMME, EIT | _____ | ESTIMATOR |
| BRYSE DAVIS, PE | _____ | ESTIMATOR |
| PABLO GONZALEZ | _____ | ENGINEER INTERN |
| SPECIFICATIONS | | |
| PAUL GENDRON, PE | _____ | SPECIFICATIONS |
| PROJECT MANAGEMENT | | |
| JERRY NIETO, PE | _____ | PROJECT MANAGER |

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDEXED.

| | |
|-------------------------------|---|
| SUBMITTED: | APPROVED: |
| _____ CHIEF, DESIGN BRANCH | _____ CHIEF, ENGINEERING AND CONSTRUCTION DIVISION |

THIS PROJECT WAS DESIGNED BY THE U.S. ARMY CORPS OF ENGINEERS ALBUQUERQUE DISTRICT. THE INITIALS OR SIGNATURES AND REGISTRATION DESIGNATIONS OF GOVERNMENT INDIVIDUALS APPEAR ON THESE PROJECT DOCUMENTS WITHIN THE SCOPE OF THEIR EMPLOYMENT AS REQUIRED BY ER 1110-1-8152.

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| 2 | G002 | INDEX OF SHEETS |
| 3 | G003 | PROJECT LOCATION AND VICINITY MAP |

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| 45 | C-142 | EROSION CONTROL DETAILS |
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| 61 | C-216 | CROSS SECTIONS 589.00 TO 625.00 |
| 62 | C-217 | CROSS SECTIONS 627.00 TO 641.00 10-00A TO 28-00A (NORTH SOCORRO) |
| 63 | C-218 | CROSS SECTIONS 29-16A TO 29-35.59B NORTH SOCORRO STA. 649.00 TO 661.00 |
| 64 | C-219 | CROSS SECTIONS 663.00 TO 688.00 |
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| 67 | C-222 | CROSS SECTIONS 746.00 TO 772.00 |
| 68 | C-223 | CROSS SECTIONS 774.00 TO 800.00 |
| 69 | C-224 | CROSS SECTIONS 804.00 TO 840.00 |
| 70 | C-225 | CROSS SECTIONS 842.00 TO 868.00 |
| 71 | C-226 | CROSS SECTIONS 870.00 TO 906.00 |
| 72 | C-227 | CROSS SECTIONS 908.00 TO 934.00 |
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| 81 | C-236 | CROSS SECTIONS 1158.00 TO 1184.00 |
| 82 | C-237 | CROSS SECTIONS 1186.00 TO 1212.00 |
| 83 | C-238 | CROSS SECTIONS 1214.00 TO 1240.00 |
| 84 | C-239 | CROSS SECTIONS 1242.00 TO 1268.00 |
| 85 | C-240 | CROSS SECTIONS 1270.00 TO 1296.00 |
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| 87 | C-242 | CROSS SECTIONS 1326.00 TO 1352.00 |
| 88 | C-243 | CROSS SECTIONS 1354.00 TO 1380.00 |
| 89 | C-244 | CROSS SECTIONS 1382.00 TO 1408.00 |
| 90 | C-245 | CROSS SECTIONS 1410.00 TO 1436.00 |
| 91 | C-246 | CROSS SECTIONS 1438.00 TO 1464.00 |
| 92 | C-247 | CROSS SECTIONS 1466.00 TO 1492.00 |
| 93 | C-248 | CROSS SECTIONS 1494.00 TO 1520.00 |
| 94 | C-249 | CROSS SECTIONS 1522.00 TO 1464.00 |
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| 112 | C-267 | CROSS SECTIONS 2078.00 TO 2104.00 |
| 113 | C-268 | CROSS SECTIONS 2106.00 TO 2132.00 |
| 114 | C-269 | CROSS SECTIONS 2134.00 TO 2160.00 |

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| | | <u>CIVIL</u> |
| 115 | C-270 | CROSS SECTIONS 2162-00 TO 2188-00 |
| 116 | C-271 | CROSS SECTIONS 2188-00 TO 2216-00 |
| 117 | C-272 | CROSS SECTIONS 2218-00 TO 2244-00 |
| 118 | C-273 | CROSS SECTIONS 2246-00 TO 2271-00 |



S Army Corps
Engineers
buquerque District

[illegible]

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|--|----------------------------|
| Plot Scale: 1:1 | Plot Date: January 2012 |
| CWIS NO. P2 NO. | |
| Zero Accidents Zero Tolerance | |

SEE COVER
DRAWN BY:
SEE COVER
REVIEWED BY:
SEE COVER

CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM

כחול לבן

SHEET NO.
G-002
2 OF 3

SEQUENCE NO.
2

SAN ACACIA LEVEE HORIZONTAL CONTROL

| | | | |
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| POB | N=1185473.11 | E=1448753.68 | STA. 0+00 |
| PI-1 | N=1185457.80 | E=1445763.01 | STA. 29+90.71 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 52° 29'54"L 5° 43'46" 1000.00 493.13' 916.27' | PC-1- PI-1- PT-1- | STA. 13+87.44 STA. 18+80.57 STA. 23+03.71 |
| PI-2 | N=1184635.23 | E=1445138.45 | STA. 39+53.54 |
| PI-3 | N=1182291.13 | E=1443588.99 | STA. 67+63.45 |
| PI-4 | N=1181987.13 | E=1443843.87 | STA. 71+60.16 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 39° 06'26"R 7° 09'43" 800.00 284.14' 546.04' | PC-4- PI-4- PT-4- | STA. 68+76.02 STA. 71+60.16 STA. 74+22.06 |
| PI-5 | N=1179019.17 | E=1443888.90 | STA. 101+06.22 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 16° 11'07"R 5° 43'46" 1000.00 142.19' 282.49' | PC-5- PI-5- PT-5- | STA. 99+64.04 STA. 101+06.22 STA. 102+46.52 |
| PI-6 | N=1178539.87 | E=1443757.64 | STA. 106+01.28 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 4° 18'57"R 2° 51'53" 2000.00 75.36' 150.65' | PC-6- PI-6- PT-6- | STA. 105+25.91 STA. 106+01.28 STA. 106+76.57 |
| PI-7 | N=1176060.06 | E=1442873.07 | STA. 132+34.07 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 20° 40'52"L 2° 17'31" 2500.00' 456.15' 902.38' | PC-7- PI-7- PT-7- | STA. 127+77.91 STA. 132+34.07 STA. 136+80.30 |
| PI-8 | N=1172840.31 | E=1442932.04 | STA. 164+44.42 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 61° 21'32"L 2° 17'31" 2500.00' 1483.18' 2677.29' | PC-8- PI-8- PT-8- | STA. 149+61.24 STA. 164+44.42 STA. 176+38.53 |
| PI-9 | N=1171357.77 | E=1445768.87 | STA. 193+56.22 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 41° 23'09"R 3° 49'11" 1500.00' 566.59' 1083.48' | PC-9- PI-9- PT-9- | STA. 187+89.63 STA. 193+56.22 STA. 198+73.10 |
| PI-10 | N=1169447.26 | E=1446503.11 | STA. 213+53.26 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 19° 27'13"R 3° 49'11" 1500.00' 257.12' 509.29' | PC-10- PI-10- PT-10- | STA. 210+96.14 STA. 213+53.26 STA. 216+05.43 |
| PI-11 | N=1167138.43 | E=1446566.34 | STA. 236+58.01 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 52° 44'33"R 4° 14'39" 1350.00' 669.30' 1242.72' | PC-11- PI-11- PT-11- | STA. 229+88.71 STA. 236+58.01 STA. 242+31.42 |

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| PI-12 | N=1165699.18 | E=1444777.96 | STA. 247+47.57 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 88° 25'31"L 3° 28'21" 1650.00' 1605.27' 2546.47' | PC-13- PI-13- PT-13- | STA. 231+42.30 STA. 247+47.57 STA. 256+88.77 |
| PI-13 | N=1163058.69 | E=1446785.95 | STA. 285+10.91 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 28° 02'38"R 3° 49'11" 1500.00' 374.60' 734.19' | PC-13- PI-13- PT-13- | STA. 281+36.31 STA. 285+10.91 STA. 288+70.49 |
| PI-14 | N=1159275.72 | E=1447399.19 | STA. 323+28.25 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 14° 15'54"R 3° 49'11" 1500.00' 187.70' 373.46' | PC-14- PI-14- PT-14- | STA. 321+40.55 STA. 323+28.25 STA. 325+14.01 |
| PI-15 | N=1152049.05 | E=1446759.68 | STA. 395+81.21 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 27° 28'43"L 0° 15'13" 22600.00' 5525.73' 10838.82' | PC-15- PI-15- PT-15- | STA. 340+55.48 STA. 395+81.21 STA. 448+94.30 |
| PI-16 | N=1143787.74 | E=1450168.38 | STA. 483+05.49 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 50° 18'57"R 1° 28'09" 3900.00' 1831.70' 3424.89' | PC-16- PI-16- PT-16- | STA. 464+73.79 STA. 483+05.49 STA. 498+98.68 |
| PI-17 | N=1136795.23 | E=1446466.94 | STA. 559+78.73 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 46° 39'35"L 0° 45'50" 7500.00' 3234.64' 6107.74' | PC-17- PI-17- PT-17- | STA. 527+44.09 STA. 559+78.73 STA. 588+51.82 |
| PI-18 | N=1131385.28 | E=1448304.99 | STA. 613+30.85 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 8° 01'13"R 2° 17'31" 2500.00' 175.26' 349.96' | PC-18- PI-18- PT-18- | STA. 611+55.59 STA. 613+30.85 STA. 615+05.54 |
| PI-19 | N=1125377.94 | E=1449444.98 | STA. 674+44.83 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 22° 02'06"L 1° 54'35" 3000.00' 584.09' 1153.75' | PC-19- PI-19- PT-19- | STA. 668+60.74 STA. 674+44.83 STA. 680+14.49 |
| PI-20 | N=1120909.35 | E=1452322.58 | STA. 727+45.36 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 47° 40'20"R 5° 43'46" 1000.00' 441.81' 832.04' | PC-20- PI-20- PT-20- | STA. 723+03.56 STA. 727+45.36 STA. 731+35.59 |
| PI-21 | N=1114865.90 | E=1450715.41 | STA. 789+47.29 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 17° 50'17"L 1° 54'35" 3000.00' 470.81' 934.00' | PC-21- PI-21- PT-21- | STA. 784+76.48 STA. 789+47.29 STA. 794+10.48 |

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| PI-22 | N=1112374.23 | E=1450843.63 | STA. 814+34.64 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 36° 17'31"L 2° 12'13" 2600.00' 852.12' 1646.87' | PC-22- PI-22- PT-22- | STA. 805+82.52 STA. 814+34.64 STA. 822+29.40 |
| PI-23 | N=1109039.58 | E=1453566.96 | STA. 856+82.67 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 48° 53'43"R 4° 46'29" 1200.00' 545.55' 1024.06' | PC-23- PI-23- PT-23- | STA. 851+37.12 STA. 856+82.67 STA. 861+61.18 |
| PI-24 | N=1105358.01 | E=1452940.46 | STA. 893+50.13 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 16° 45'15"L 1° 38'13" 3500.00' 515.41' 1023.46' | PC-24- PI-24- PT-24- | STA. 888+34.72 STA. 893+50.13 STA. 898+58.18 |
| PI-25 | N=1103395.47 | E=1453184.79 | STA. 913+20.46 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 12° 14'15"L 1° 08'45" 5000.00' 536.00' 1067.93' | PC-25- PI-25- PT-25- | STA. 907+84.46 STA. 913+20.46 STA. 918+52.38 |
| PI-26 | N=1099060.97 | E=1454705.62 | STA. 959+09.95 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 53° 28'07"R 5° 12'31" 1100.00' 554.07' 1026.52' | PC-26- PI-26- PT-26- | STA. 953+55.88 STA. 959+09.95 STA. 963+82.40 |
| PI-27 | N=1094568.80 | E=1451660.28 | STA. 1012+55.46 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 44° 02'24"L 2° 02'24" 2800.00' 1132.41' 2152.20' | PC-27- PI-27- PT-27- | STA. 91001+23.05 STA. 1012+55.46 STA. 1022+75.25 |
| PI-28 | N=1090890.21 | E=1452302.67 | STA. 1048+77.10 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 32° 50'49"L 2° 17'31" 2500.00' 736.90' 1433.22' | PC-28- PI-28- PT-28- | STA. 1041+40.19 STA. 1048+77.10 STA. 1055+73.41 |
| PI-29 | N=1088009.81 | E=1454965.54 | STA. 1087+59.21 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 41° 49'21"R 3° 49'11" 1500.00' 573.13' 1094.91' | PC-29- PI-29- PT-29- | STA. 1081+86.08 STA. 1087+59.21 STA. 1092+80.99 |
| PI-30 | N=1081069.09 | E=1455078.25 | STA. 1156+49.50 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 21° 56'48"L 1° 54'35" 3000.00' 581.69' 1149.13' | PC-30- PI-30- PT-30- | STA. 1150+67.80 STA. 1156+49.50 STA. 1162+16.93 |
| PI-31 | N=1079158.49 | E=1455884.42 | STA. 1177+08.95 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 7° 02'27"L 0° 22'55" 15000.00' 922.80' 1843.29' | PC-31- PI-31- PT-31- | STA. 1167+86.14 STA. 1177+08.95 STA. 1186+29.43 |

| | | | |
|--|--|----------------------------|---|
| PI-32 | N=1074619.06 | E=1458496.60 | STA. 1229+43.99 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 41° 06'56"R 3° 49'11" 1500.00' 562.55' 1076.40' | PC-32- PI-32- PT-32- | STA. 1223+81.44 STA. 1229+43.99 STA. 1234+57.84 |
| PI-33 | N=1071327.87 | E=1457845.07 | STA. 1262+50.34 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 10° 39'02"L 0° 34'23" 10000.00' 932.12' 1858.87' | PC-33- PI-33- PT-33- | STA. 1253+18.22 STA. 1262+50.34 STA. 1271+77.09 |
| PI-34 | N=1064723.08 | E=1457782.01 | STA. 1328+50.06 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 27° 03'05"R 4° 46'29" 1200.00' 288.66' 566.56' | PC-34- PI-34- PT-34- | STA. 1325+61.40 STA. 1328+50.06 STA. 1331+27.96 |
| PI-35 | N=1062954.77 | E=1456857.62 | STA. 1348+34.65 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 20° 06'49"L 1° 54'35" 3000.00' 532.05' 1053.14' | PC-35- PI-35- PT-35- | STA. 1343+02.60 STA. 1348+34.65 STA. 1353+55.74 |
| PI-36 | N=1061212.68 | E=1456628.74 | STA. 1365+80.76 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 18° 21'29"L 1° 38'13" 5000.00' 565.56' 1121.43' | PC-36- PI-36- PT-36- | STA. 1360+15.20 STA. 1365+80.76 STA. 1371+36.62 |
| PI-37 | N=1057757.40 | E=1457292.45 | STA. 1400+89.51 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 6° 23'33"L 0° 28'39" 12000.00' 670.12' 1338.85' | PC-37- PI-37- PT-37- | STA. 1394+19.39 STA. 1400+89.51 STA. 1407+58.24 |
| PI-38 | N=1054933.13 | E=1458170.26 | STA. 1430+45.66 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 17° 39'39"R 1° 38'13" 3500.00' 543.73' 1078.85' | PC-38- PI-38- PT-38- | STA. 1425+01.92 STA. 1430+45.66 STA. 1435+80.77 |
| PI-39 | N=1044900.70 | E=1458101.06 | STA. 1530+69.71 |
| PI-40 | N=1042295.41 | E=1458023.90 | STA. 1556+76.14 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 21° 48'38"L 0° 49'07" 7000.00' 1348.66' 2664.66' | PC-40- PI-40- PT-40- | STA. 1543+27.48 STA. 1556+76.14 STA. 1569+92.15 |
| PI-41 | N=1039772.08 | E=1458948.02 | STA. 1583+30.72 |
| DELTA- DEGREE- RADIUS- TANGENT- LENGTH | 18° 37'43"R 1° 08'45" 5000.00' 820.06' 1625.65' | PC-41- PI-41- PT-41- | STA. 1575+10.66 STA. 1583+30.72 STA. 1591+36.30 |



| | | |
|-----------------------------|--|-------------------------------------|
| File Name: | Project: | Date: |
| 1102C-01.dgn | San Acacia Levee | January 2012 |
| Plot Scale: | Plot Date: | Plot No.: |
| 10:1 | January 2012 | P2 NO. |
| DESIGN BY: | SEE COVER | REVIEWED BY: |
| SEE COVER | SEE COVER | SEE COVER |
| U.S. ARMY ENGINEER DISTRICT | CORPS OF ENGINEERS | ALBUQUERQUE, NEW MEXICO |
| RIO GRANDE FLOODWAY | SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | SAN ACACIA LEVEE HORIZONTAL CONTROL |
| SHEET NO. | C-101 | 1 OF 116 |
| SEQUENCE NO. | 4 | |

SAN ACACIA LEVEE HORIZONTAL CONTROL CONT.

PI-42 N=1037015.25 E=1459019.51 STA. 1610+74.00

DELTA= 16° 26'49"R PC-42= STA. 1603+51.40
DEGREE= 1° 08'45" PI-42= STA. 1610+74.00
RADIUS= 5000.00' PT-42= STA. 1617+86.66
TANGENT= 722.60'
LENGTH = 1435.27'

PI-43 N=1028206.58 E=1456665.61 STA. 1701+81.82

DELTA= 4° 04'51"L PC-43= STA. 1687+56.78
DEGREE= 0° 08'36" PI-43= STA. 1701+81.82
RADIUS= 40000.00' PT-43= STA. 1716+05.66
TANGENT= 1425.04'
LENGTH = 2848.88'

PI-44 N=1020564.56 E=1455196.67 STA. 1779+62.53

DELTA= 38° 18'58"R PC-44= STA. 1759+47.51
DEGREE= 0° 59'16" PI-44= STA. 1779+62.53
RADIUS= 5800.00' PT-44= STA. 1798+26.22
TANGENT= 2015.01'
LENGTH = 3878.71'

PI-45 N=1015231.38 E=1449018.84 STA. 1859+72.61

DELTA= 50° 03'19"L PC-45= STA. 1833+57.99
DEGREE= 1° 01'23" PI-45= STA. 1859+72.61
RADIUS= 5600.00' PT-45= STA. 1882+50.33
TANGENT= 2614.62'
LENGTH = 4892.33'

PI-46 N=1005969.38 E=1449157.65 STA. 1948+98.75

DELTA= 50° 06'11"R PC-46= STA. 1921+87.82
DEGREE= 0° 59'16" PI-46= STA. 1948+98.75
RADIUS= 5800.00' PT-46= STA. 1972+59.70
TANGENT= 2710.93'
LENGTH = 5071.87'

PI-47 N=1002453.93 E=1445078.59 STA. 1999+33.66

DELTA= 19° 02'03"L PC-47= STA. 1987+60.12
DEGREE= 0° 49'07" PI-47= STA. 1999+33.66
RADIUS= 7000.00' PT-47= STA. 2010+85.57
TANGENT= 1173.54'
LENGTH = 2325.45'

PI-48 N=999303.53 E=1443244.26 STA. 2035+57.55

DELTA= 28° 08'31"R PC-48= STA. 2025+54.97
DEGREE= 1° 25'57" PI-48= STA. 2035+57.55
RADIUS= 4000.00' PT-48= STA. 2045+19.65
TANGENT= 1002.58'
LENGTH = 1964.68'

PI-49 N=997669.83 E=1440593.69 STA. 2066+30.68

DELTA= 25° 58'20"L PC-49= STA. 2059+38.84
DEGREE= 1° 54'35" PI-49= STA. 2066+30.68
RADIUS= 3000.00' PT-49= STA. 2072+98.74
TANGENT= 691.84'
LENGTH = 1359.90'

PI-50 N=994760.42 E=1438748.74 STA. 2100+51.97

DELTA= 38° 15'41"L PC-50= STA. 2091+50.07
DEGREE= 2° 12'13" PI-50= STA. 2100+51.97
RADIUS= 2600.00' PT-50= STA. 2108+86.32
TANGENT= 901.89'
LENGTH = 1736.25'

PI-51 N=992682.13 E=1438962.84 STA. 2120+73.72

DELTA= 30° 18'40"R PC-51= STA. 2112+61.14
DEGREE= 1° 54'35" PI-51= STA. 2120+73.72
RADIUS= 3000.00' PT-51= STA. 2128+48.22
TANGENT= 812.58'
LENGTH = 1587.09'

PI-52 N=990687.12 E=1438056.62 STA. 2142+26.83

DELTA= 17° 25'31"R PC-52= STA. 2137+67.08
DEGREE= 1° 54'35" PI-52= STA. 2142+26.83
RADIUS= 3000.00' PT-52= STA. 2146+79.47
TANGENT= 459.74'
LENGTH = 912.39'

PI-53 N=988727.45 E=1436301.09 STA. 2168+50.73

DELTA= 36° 29'59"R PC-53= STA. 2159+93.39
DEGREE= 2° 12'13" PI-53= STA. 2168+50.73
RADIUS= 2600.00' PT-53= STA. 2176+49.69
TANGENT= 857.34'
LENGTH = 1656.30'

PI-54 N=988267.84 E=1434071.03 STA. 2190+69.28

DELTA= 45° 51'08"L PC-54= STA. 2180+11.89
DEGREE= 2° 17'31" PI-54= STA. 2190+69.28
RADIUS= 2500.00' PT-54= STA. 2200+12.58
TANGENT= 1057.39'
LENGTH = 2000.68'

PI-55 N=985714.60 E=1432444.30 STA. 2219+82.62

DELTA= 89° 24'44"R PC-55= STA. 2208+93.84
DEGREE= 5° 12'31" PI-55= STA. 2219+82.62
RADIUS= 1100.00' PT-55= STA. 2226+10.44
TANGENT= 1088.77'
LENGTH = 1716.59'

PI-56 N=988298.38 E=1428295.62 STA. 2264+09.14

DELTA= 47° 31'52"L PC-56= STA. 2263+65.11
DEGREE= 57° 17'45" PI-56= STA. 2264+09.14
RADIUS= 100.00' PT-56= STA. 2264+48.07
TANGENT= 44.03'
LENGTH = 82.96'

PI-57 N=988142.53 E=1427738.04 STA. 2269+82.98

DELTA= 68° 13'31"R PC-57= STA. 2268+06.86
DEGREE= 22° 02'13" PI-57= STA. 2269+82.98
RADIUS= 260.00' PT-57= STA. 2271+16.46
TANGENT= 176.12'
LENGTH = 309.60'

POE N=989212.14 E=1426920.52 STA. 2282+86.60

GENERAL NOTES:

1. MAPPING SHOWN ON THESE DRAWINGS WAS OBTAINED IN FEBRUARY 2007 BY INTEGRAPH SERVICES COMPANY (ISC). COORDINATES ARE NEW MEXICO STATE PLANE GRID COORDINATES, CENTRAL ZONE, NAD 83. ELEVATIONS REFERENCE NAVD 88. COORDINATES AND ELEVATIONS ARE EXPRESSED IN SURVEY FEET. GRID TO GROUND COMBINED FACTOR = 0.9999

BENCH MARK DATA

| BM No. | ELEV. | COORDINATE | DESCRIPTION |
|------------|----------|-------------------------------------|-------------------------|
| TSC10 | 4729.261 | N = 1185759.340 E = 1448133.992 | BRASS CAP |
| BM-1 | 4679.486 | N = 1185041.139 E = 1447870.020 | TOP OF DAM BRASS CAP |
| BM-2 | 4679.462 | N = 1184718.712 E = 1447944.357 | TOP OF DAM BRASS CAP |
| TBM1 | 4673.462 | N = 1174850.452 E = 1442916.451 | 2X2 WD STAKE |
| TBM2 | 4689.151 | N = 1173904.131 E = 1440108.089 | 2X2 WD STAKE |
| TBM3 | | N = 1167178.836 E = 1446124.979 | 2X2 WD STAKE |
| TBM4 | 4645.235 | N = 1163225.087 E = 1446373.536 | 2X2 WD STAKE |
| TBM5 | 4624.893 | N = 1128359.435 E = 1447789.866 | 2X2 WD STAKE |
| TBM6 | 4618.611 | N = 1128131.976 E = 1448820.963 | 2X2 WD STAKE |
| TBM7 | | N = NA E = NA | 2X2 WD STAKE |
| TBM8 | | N = 988222.120 E = 1427672.469 | 2X2 WD STAKE |
| TBM9 | | N = 1044681.676 E = 1458091.622 | 2X2 WD STAKE |
| V-3 | 4628.531 | N = 1146829.038 E = 1448756.200 | BRASS CAP |
| D356 | 4623.710 | N = 1128213.645 E = 1446982.408 | BRASS CAP |
| TBM R356 | 4591.325 | N = 1114295.504 E = 1448565.992 | ALUM CAP |
| RLP-1397 | 4591.060 | N = 1098399.938 E = 1454370.717 | ALUM CAP |
| V-11 | 4585.660 | N = 1092901.509 E = 1451818.348 | BRASS CAP |
| R-1420 | 4582.190 | N = 1088410.331 E = 1454657.422 | ALUM CAP |
| RLP-1437.9 | 4576.395 | N = 1079738.138 E = 1455715.975 | ALUM CAP |
| R-1456 | 4565.440 | N = 11072297.902 E = 1458086.065 | ALUM CAP |
| TBM V-17 | 4562.882 | N = 1062461.262 E = 1457493.037 | BRASS CAP |
| R-1491 | 4555.510 | N = 1054809.602 E = 1458208.349 | ALUM CAP |
| SD-1502WIP | 4541.160 | N = 1049566.320 E = 1459418.249 | ALUM CAP |
| R-1502 | 4552.490 | N = 1049814.907 E = 1458207.502 | ALUM CAP |
| V-23 | 4534.360 | N = 1044618.096 E = 1458043.186 | BRASS CAP |
| R-1536 | 4535.600 | N = 1033283.931 E = 1458059.772 | ALUM CAP |
| R-1550 | 4528.566 | N = 1026447.859 E = 1456387.754 | ALUM CAP |
| SD-1566REP | 4516.380 | N = 1018968.241 E = 1454264.879 | ALUM CAP |
| 1585R-417 | 4509.578 | N = 1011167.789 E = 1451054.695 | ALUM CAP |
| SD-1585RLP | 4517.920 | N = 10111527.256 E = 1449161.278 | ALUM CAP |
| WIPI-1600 | 4504.910 | N = 1005199.809 E = 1448616.734 | ALUM CAP |
| RLP-1600 | 4510.860 | N = 1005438.416 E = 1448231.050 | ALUM CAP |
| R-1641 | 4504.230 | N = 989897.828 E = 1437432.134 | ALUM CAP |
| V-47 | 4497.790 | N = 986551.442 E = 1432997.580 | BRASS CAP |
| RLP-1660 | 4491.840 | N = 983625.180 E = 1431211.759 | ALUM CAP |
| CP-1 | 4578.951 | N = 988051.633 E = 1425729.366 | BRASS CAP |



US Army Corps
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Albuquerque District

File Name:
sanc-102.dgn
Plot Date:
01-Jan-2012
Plot Scale:
1"=100'

Sheet No.
C-102
P.2 OF 116
C-102
P.2 OF 116

Drawn By:
SEE COVER
Reviewed By:
SEE COVER

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO
GENERAL ENGINEERING SECTION

RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM
SAN ACACIA LEVEE
HORIZONTAL CONTROL CONT.
AND BENCH MARK DATA

SHEET NO.
C-102
2 OF 116
SEQUENCE NO.
5

Appr.
Date

Description

Work

Accidents
Tolerance

NORTH SOCORRO ARROYO

TIE BACK ALIGN 2

TIE BACK ALIGN 2

| | | | |
|----------|--------------|--------------|----------------|
| PI-1 | N=1174696.41 | E=1442897.97 | STA. 10+50.468 |
| DELTA- | 90° 31'43" | PC-1- | STA. 10+00.008 |
| DEGREE- | 114° 35'30" | PI-1- | STA. 10+50.468 |
| RADIUS- | 50.00' | PT-1- | STA. 10+79.008 |
| TANGENT- | 50.46' | | |
| LENGTH - | 79.00' | | |
| PI-2 | N=1174691.72 | E=1442731.63 | STA. 11+94.948 |
| DELTA- | 67° 11'00" | PC-2- | STA. 11+61.738 |
| DEGREE- | 114° 35'30" | PI-2- | STA. 11+94.948 |
| RADIUS- | 50.00' | PT-2- | STA. 12+20.368 |
| TANGENT- | 33.21' | | |
| LENGTH - | 58.63' | | |
| PI-3 | N=1174586.94 | E=1442690.98 | STA. 12+99.558 |
| DELTA- | 113° 42'22" | PC-3- | STA. 12+22.988 |
| DEGREE- | 114° 35'30" | PI-3- | STA. 12+99.558 |
| RADIUS- | 50.00' | PT-3- | STA. 13+22.218 |
| TANGENT- | 76.56' | | |
| LENGTH - | 99.23' | | |
| PI-4 | N=1174694.31 | E=1442583.27 | STA. 13+97.748 |
| DELTA- | 47° 16'57" | PC-4- | STA. 13+53.968 |
| DEGREE- | 57° 17'45" | PI-4- | STA. 13+97.748 |
| RADIUS- | 100.00' | PT-4- | STA. 14+36.498 |
| TANGENT- | 43.77' | | |
| LENGTH - | 82.52' | | |
| PI-5 | N=1174688.13 | E=1442434.20 | STA. 15+41.918 |
| DELTA- | 15° 08'37" | PC-5- | STA. 15+02.038 |
| DEGREE- | 190° 05'55" | PI-5- | STA. 15+41.918 |
| RADIUS- | 300.00' | PT-5- | STA. 15+81.328 |
| TANGENT- | 39.88' | | |
| LENGTH - | 79.29' | | |
| PI-POE | N=1174466.03 | E=1441730.54 | STA. 22+79.328 |

| | | | |
|----------|--------------|--------------|----------------|
| PI-1 | N=1128140.73 | E=1448902.75 | STA. 10+33.91B |
| DELTA= | 48° 39' 37" | PC-1= | STA. 10+00.00B |
| DEGREE= | 76° 23' 40" | PI-1= | STA. 10+33.91B |
| RADIUS= | 75.00' | PT-1= | STA. 10+63.70B |
| TANGENT= | 33.91' | | |
| LENGTH = | 63.70' | | |
| PI-2 | N=1128116.80 | E=1447380.70 | STA. 25+52.03B |
| PI-3 | N=1128110.81 | E=1447211.72 | STA. 27+21.10B |
| PI-POE | N=1128088.43 | E=1446998.41 | STA. 29+35.59B |

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

DESIGN BY:
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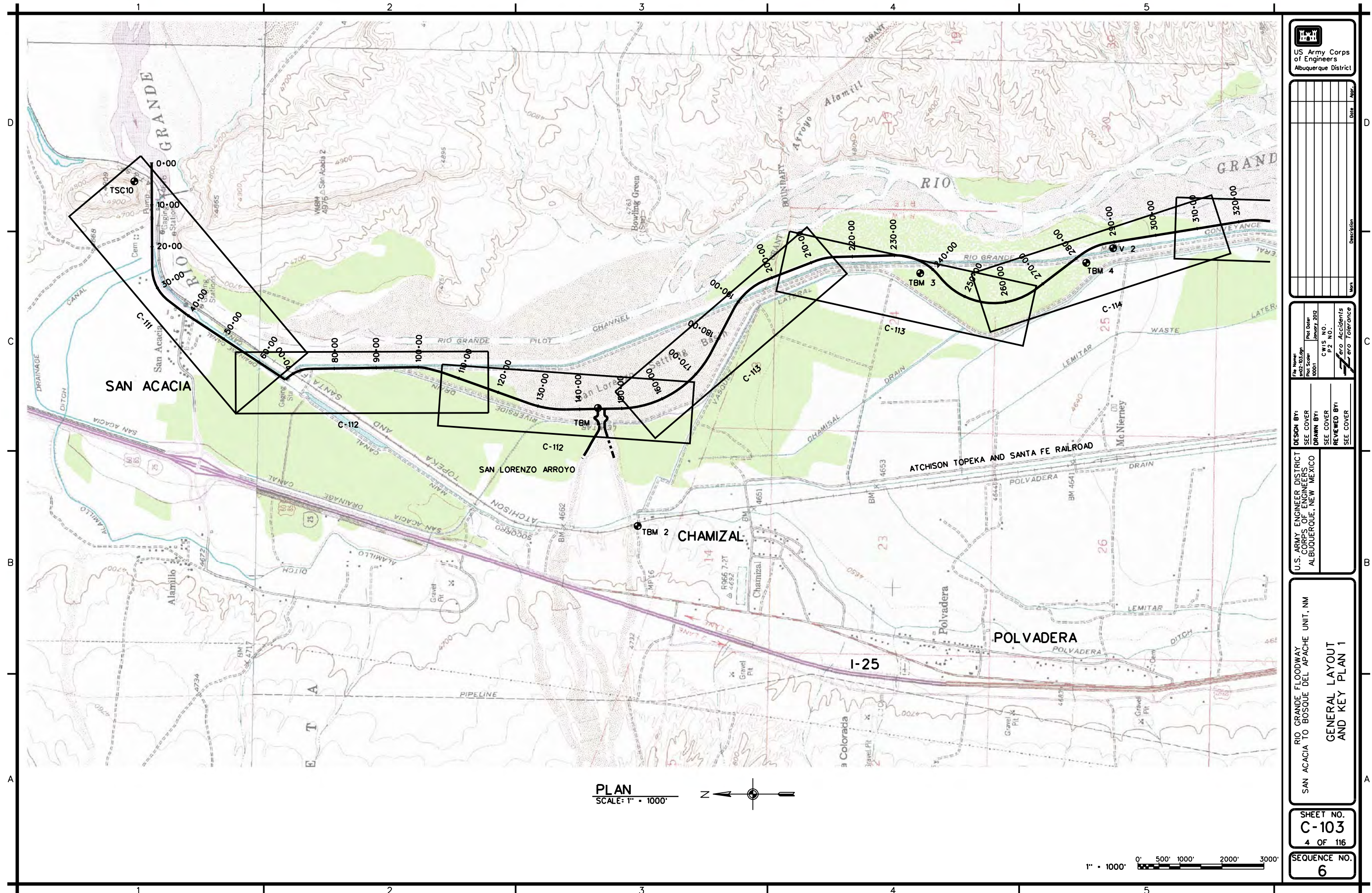
DRAWN BY:
SEE COVER

REVIEWED BY:
SEE COVER

RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM
HORIZONTAL CONTROL
SAN LORENZO AND NORTH
SOCORRO ARROYO


SHEET NO.
C-102A
3 OF 116

SEQUENCE NO.
5A



US Army Corps
of Engineers
Albuquerque District

[illegible]

| | | |
|--|--------------------|----------------------------|
| sn02-103.dgn | | Plot Date: January 2012 |
| Plot Scale: 1000:1 | CWIS NO. P2 NO. | |
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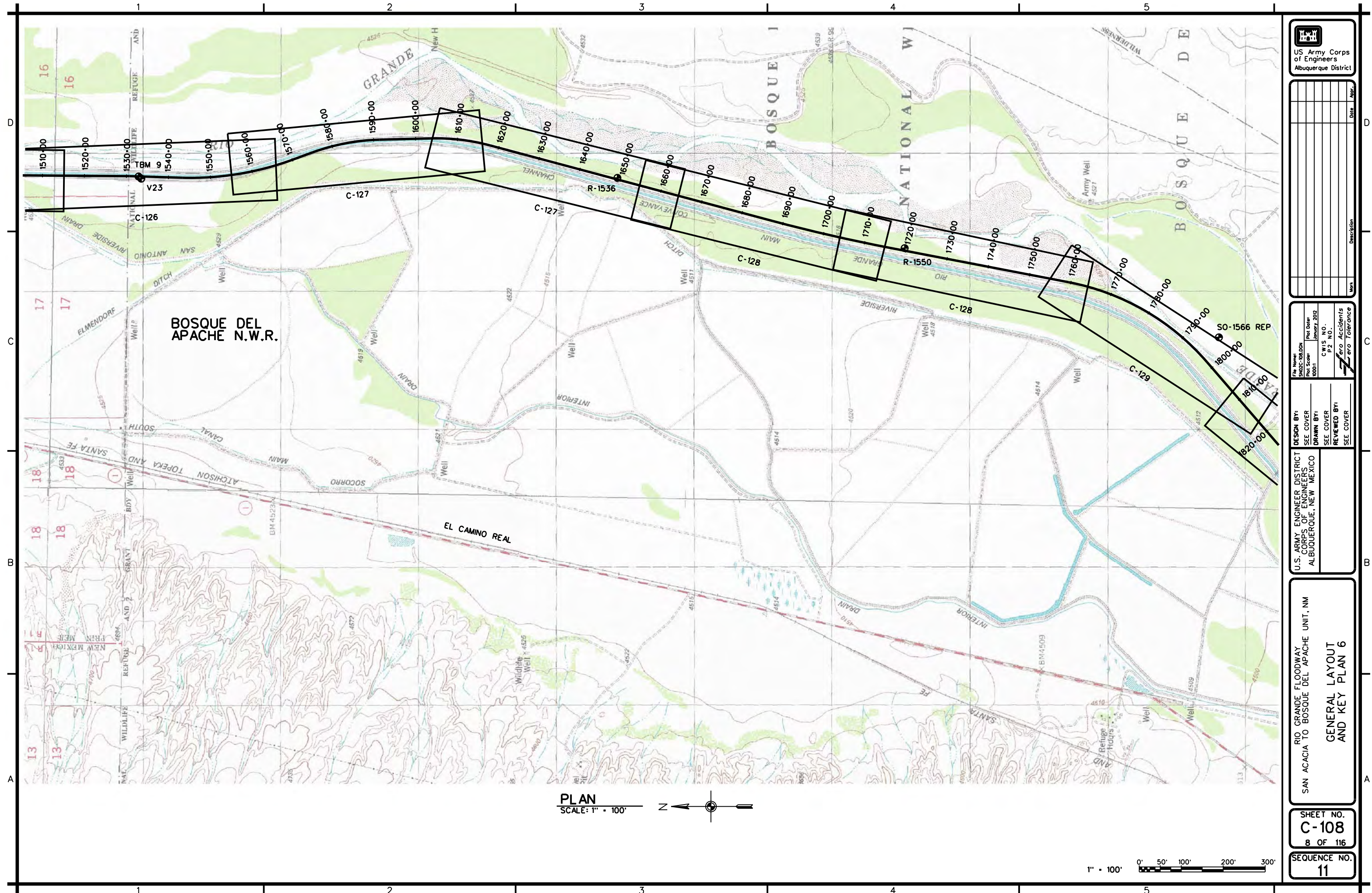
DESIGN BY:
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DRAWN BY:
SEE COVER
REVIEWED BY:
SEE COVER

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

GENERAL LAYOUT
AND KEY PLAN 1


SHEET NO.
C-103
4 OF 116

SEQUENCE NO.
6



US Army Corps
of Engineers
Albuquerque District

[illegible]

| | |
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| SN02C-108.DGN | |
| Plot Scale: 1000:1 | Plot Date: January 2012 |
| CWIS NO. P2 NO. | |
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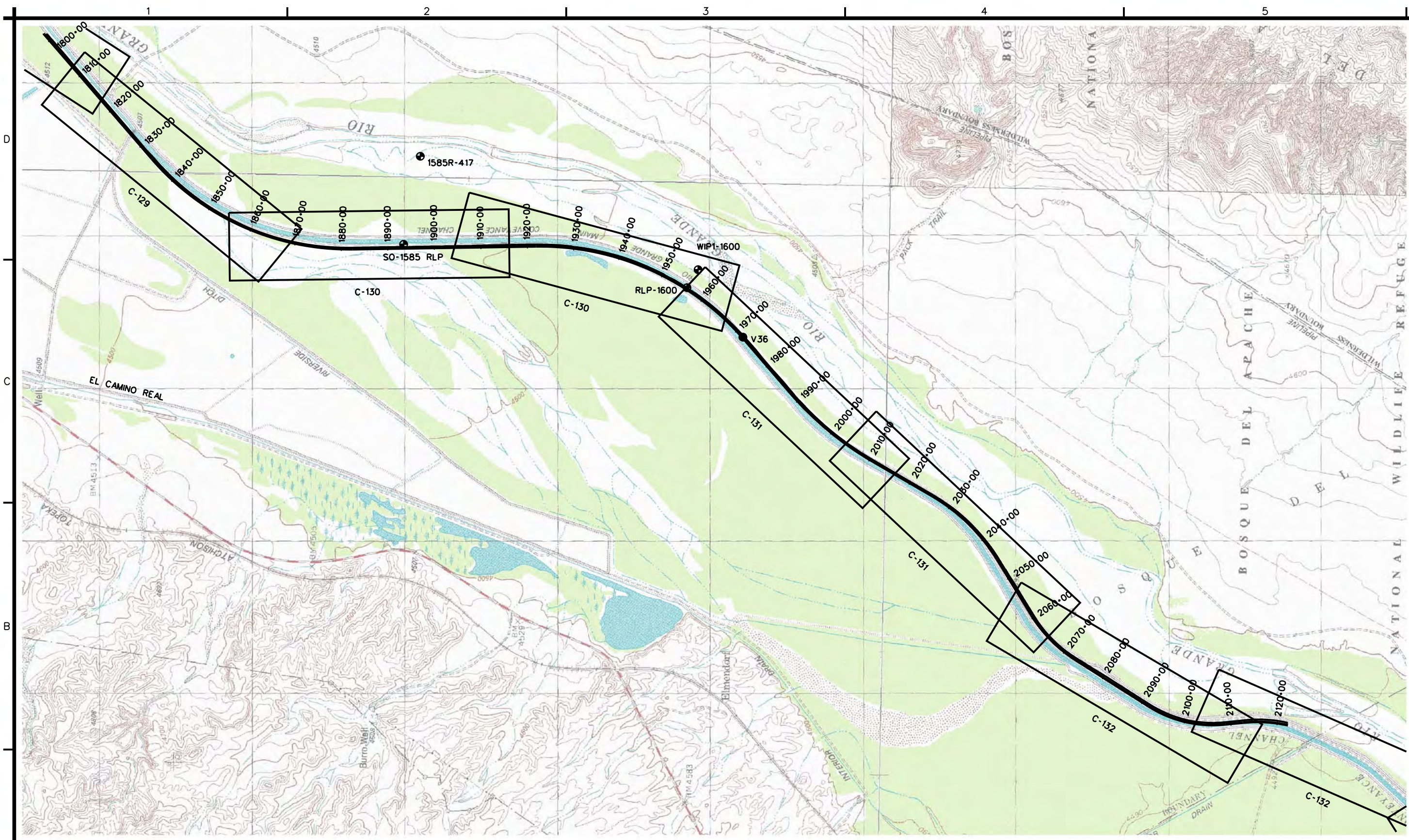
DESIGN BY:
SEE COVER
DRAWN BY:
SEE COVER
REVIEWED BY:
SEE COVER

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

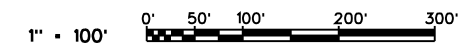
GENERAL LAYOUT
AND KEY PLAN 6

SHEET NO.
C-108
8 OF 116

SEQUENCE NO.
11



PLAN
SCALE: 1" = 100'



US Army Corps
of Engineers
Albuquerque District

| Work | Date | Appr. |
|------|------|-------|
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File Name: SWD2C-00A.DGN
Plot Scale: 1000:1
Plot Date: January, 2012

CWIS NO.
P2 NO.

Zero Accidents
Zero Tolerance

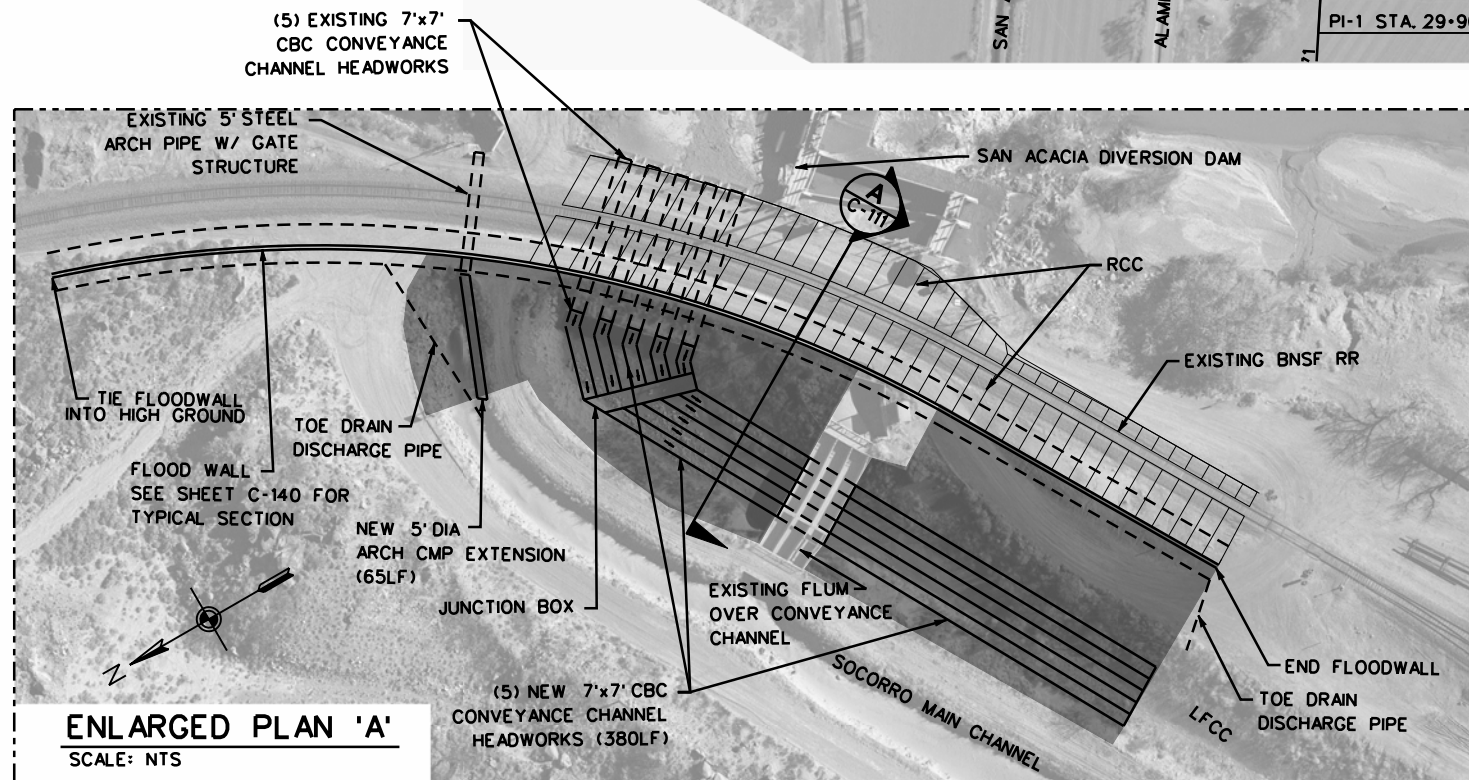
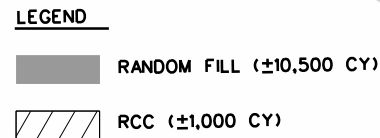
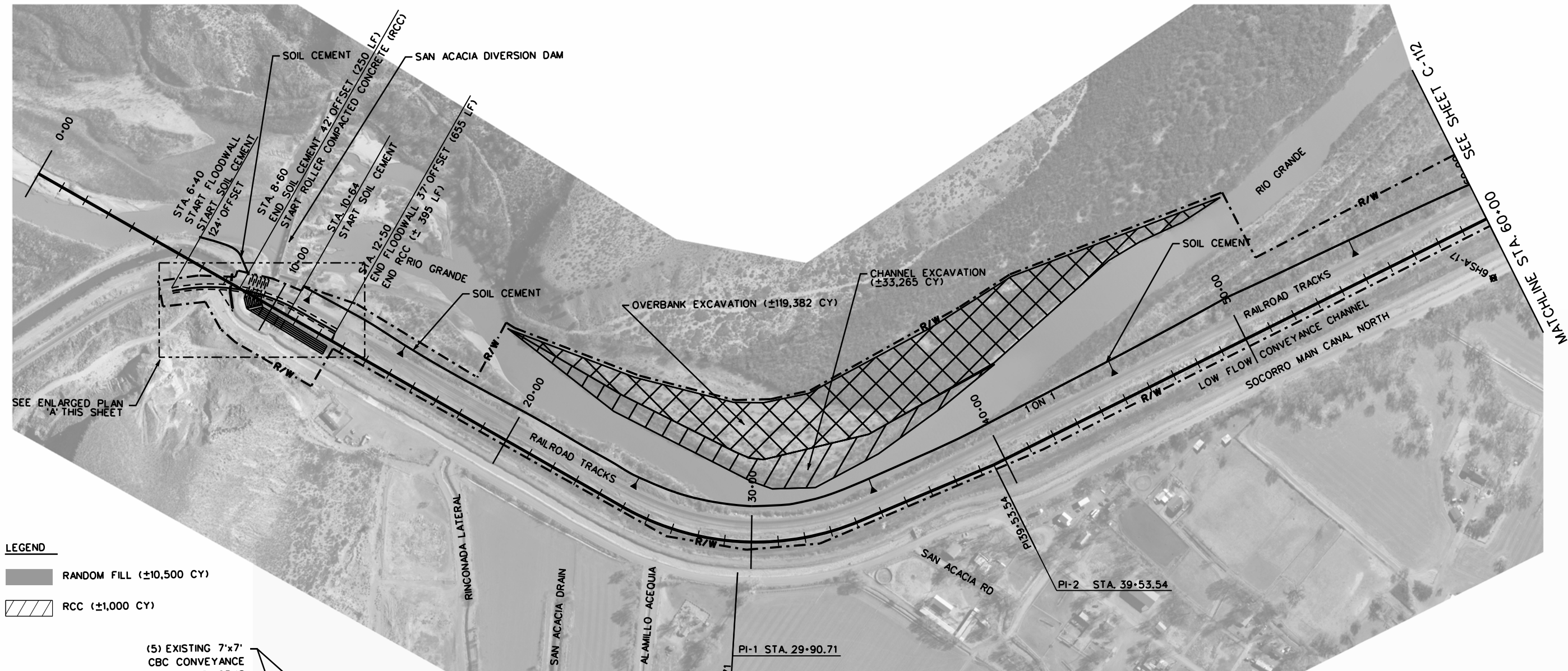
| DESIGN BY: | U.S. ARMY ENGINEER DISTRICT |
|--------------|-----------------------------|
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| DRAWN BY: | ALBUQUERQUE, NEW MEXICO |
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| REVIEWED BY: | |
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RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM

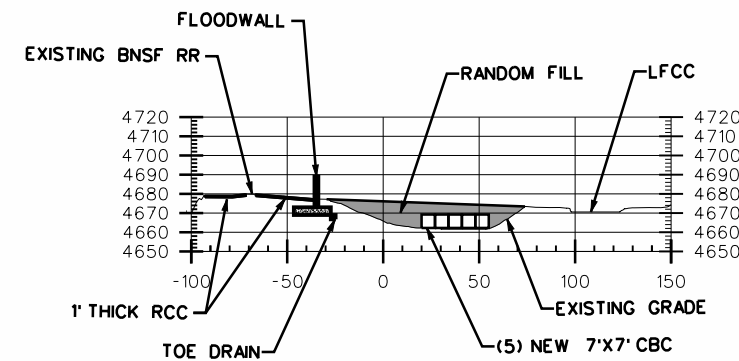
**GENERAL LAYOUT
AND KEY PLAN 7**

SHEET NO.
C-109
10 OF 119

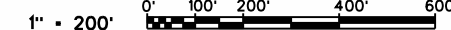
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12

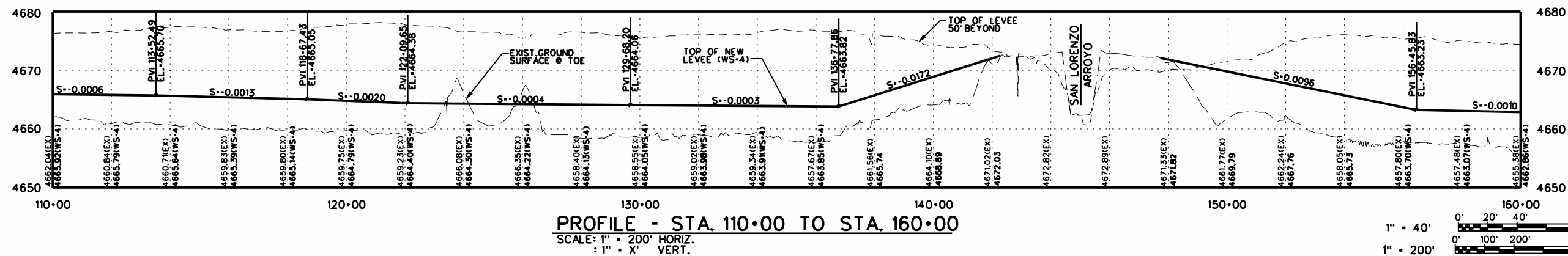
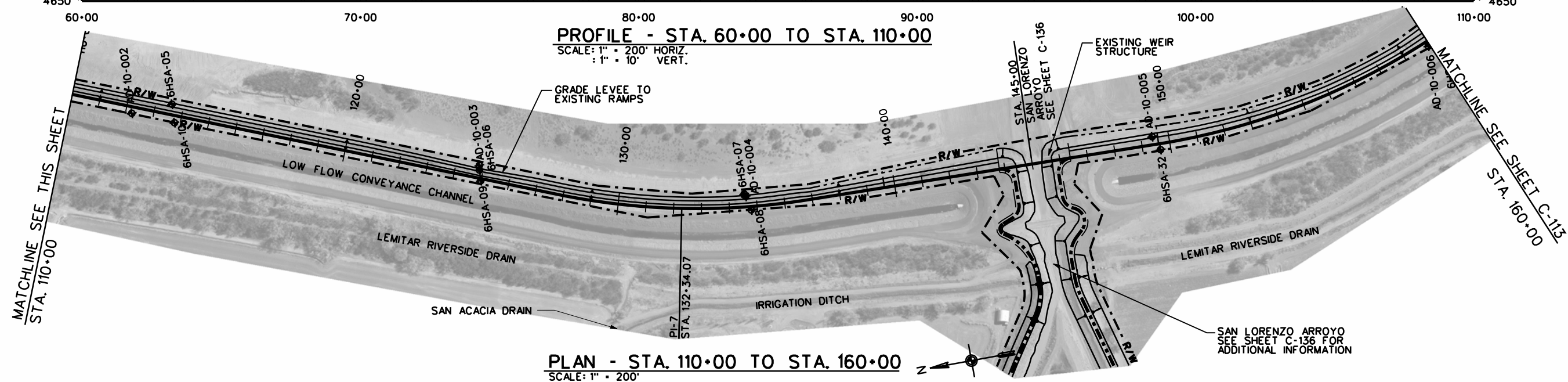
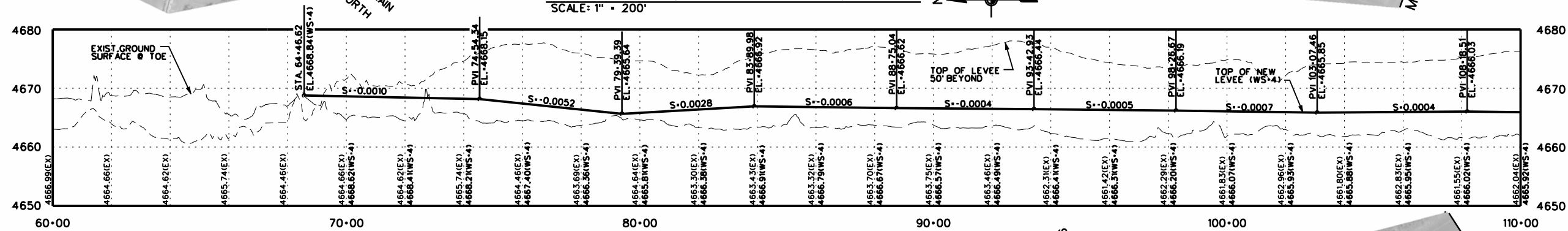
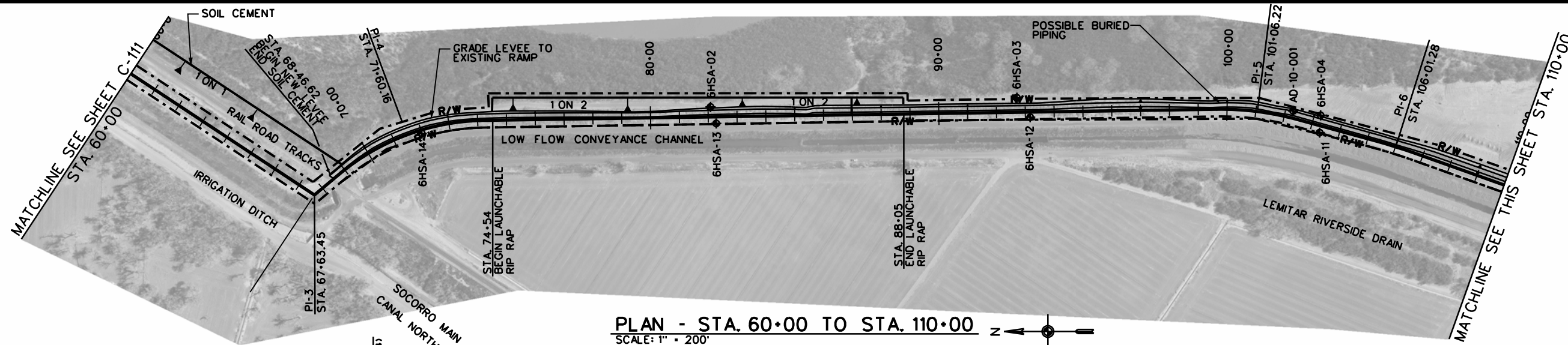


SITE PLAN -SAN ACACIA DIVERSION DAM
SCALE: 1" = 200'



SECTION- A
SCALE: NTS





US Army Corps
of Engineers
Albuquerque District

[illegible]

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| File Name: FSN02C-112.DGN | Plot Date: January 2012 |
| Plot Scale: 200:1 | CWIS NO. P2 NO. |

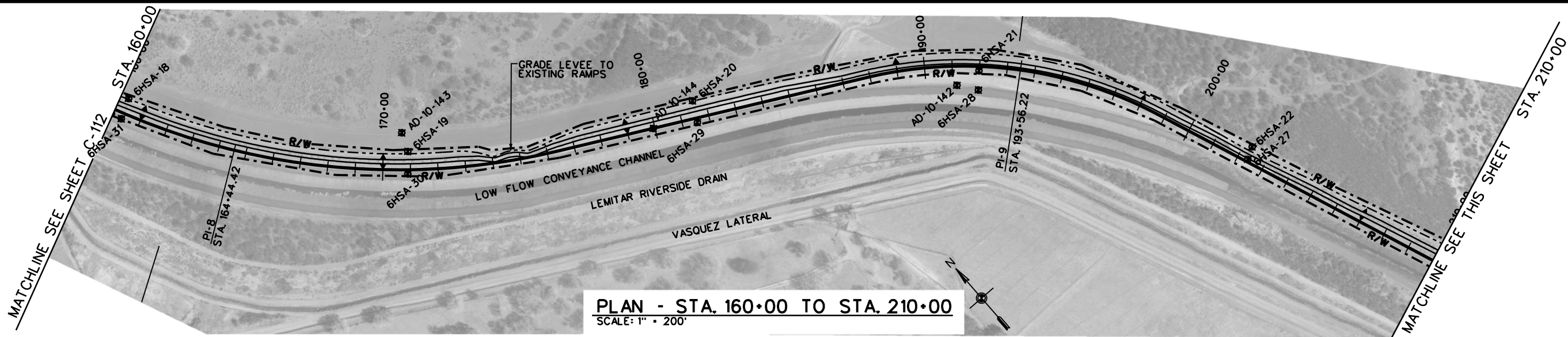
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| DESIGN BY: | |
| SEE COVER | |
| DRAWN BY: | |
| SEE COVER | |
| REVIEWED BY: | |
| SEE COVER | |

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

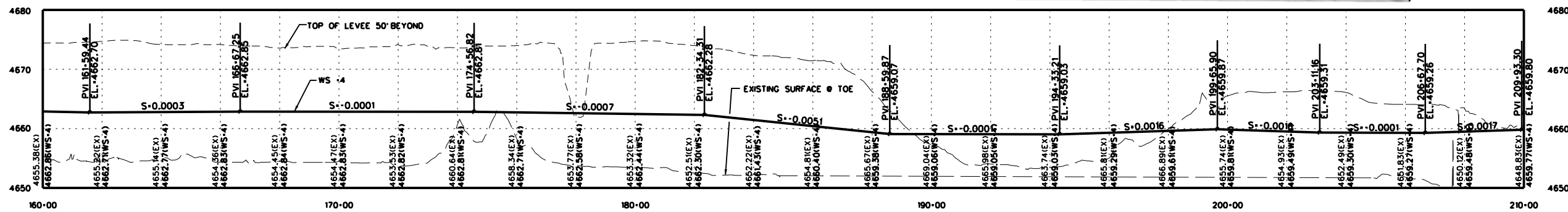
RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM
PLAN AND PROFILE
STA. 60+00 TO STA. 160+00

SHEET NO.
C-112
13 OF 116

SEQUENCE NO
15



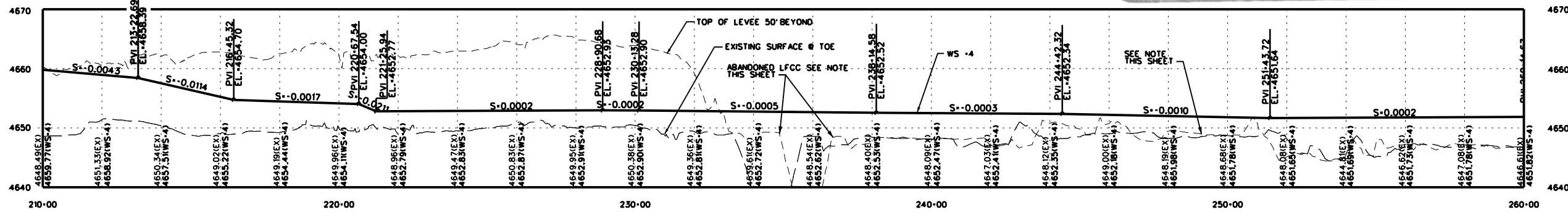
PLAN - STA. 160+00 TO STA. 210+00
SCALE: 1" = 200'



PROFILE - STA. 160+00 TO STA. 210+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.



PLAN - STA. 210+00 TO STA. 260+00
SCALE: 1" = 200'



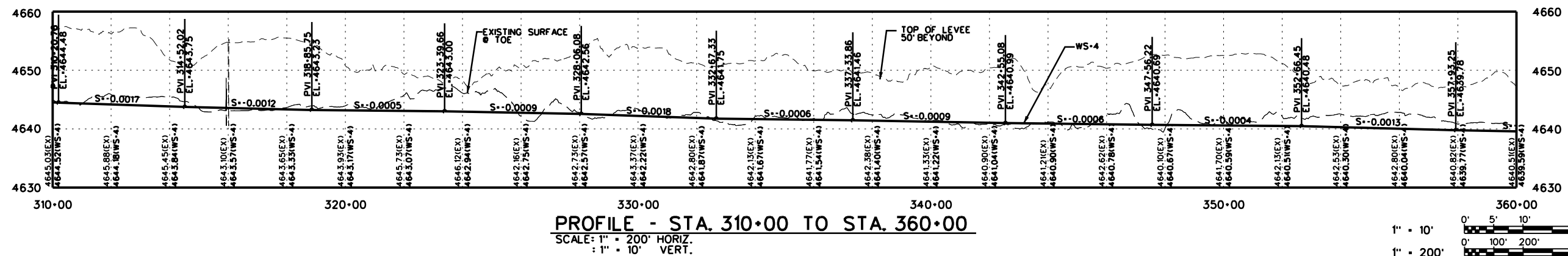
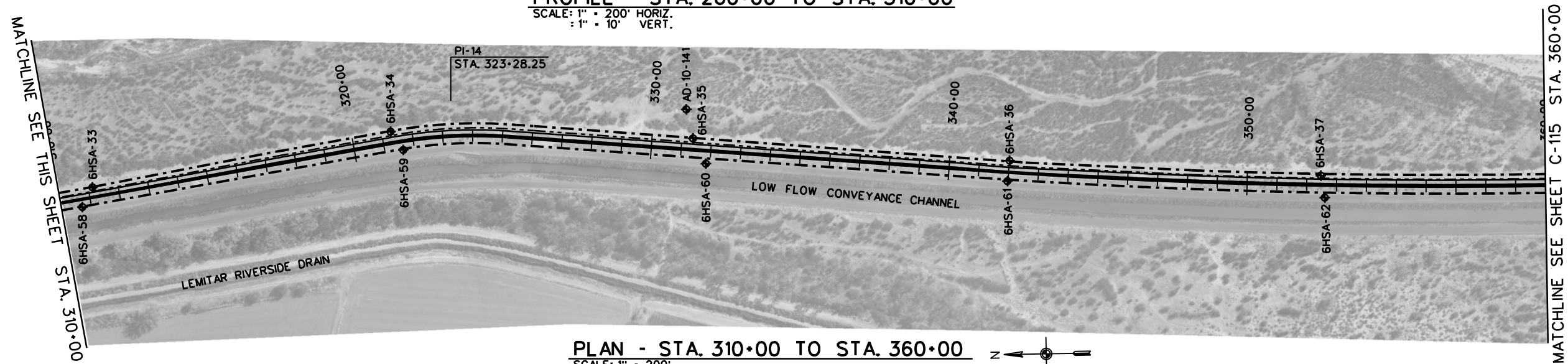
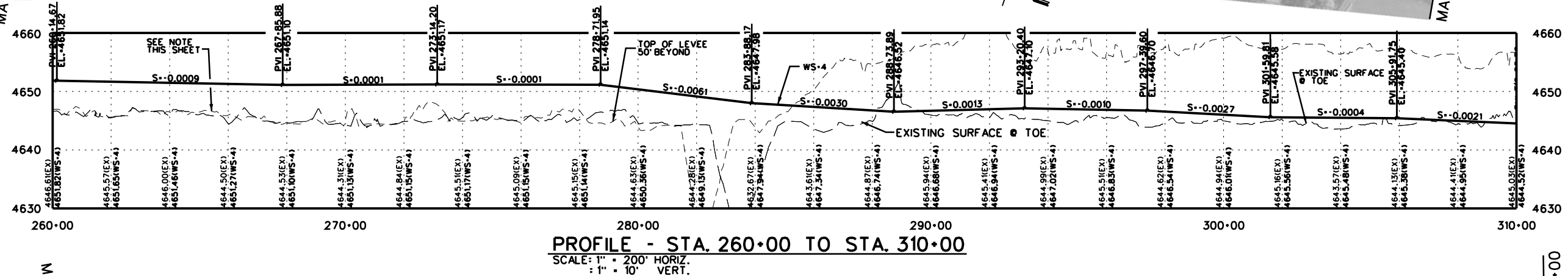
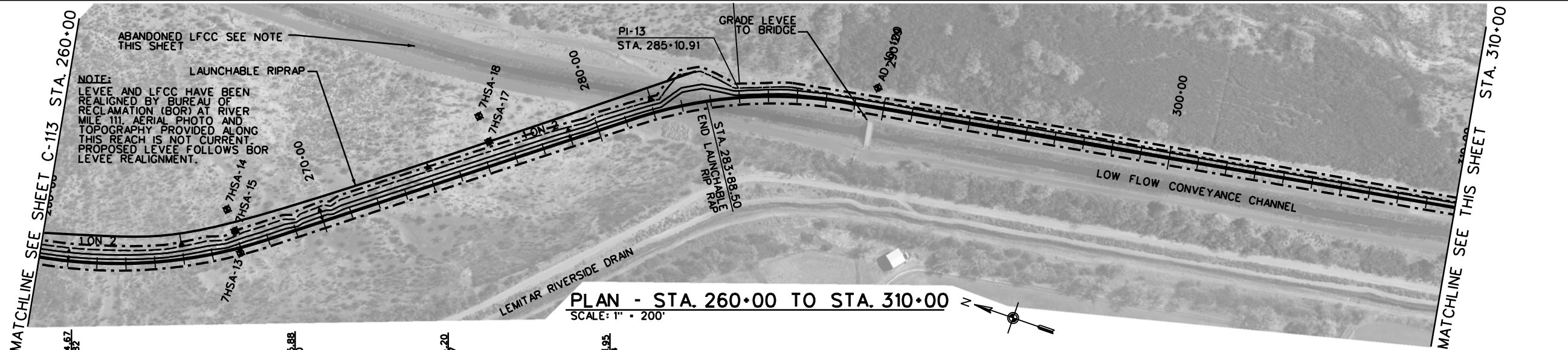
PROFILE - STA. 210+00 TO STA. 260+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.

| File Name | Scale | Plot Date | Plot No. | Work |
|--------------|-------|--------------|----------|------|
| SMC2-113.DGN | 2001 | January 2012 | 1 | |

| DESIGN BY: | SEE COVER |
|--------------|-----------|
| DRAWN BY: | SEE COVER |
| REVIEWED BY: | SEE COVER |

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| U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO | FILE NAME SMC2-113.DGN PLOT SCALE 2001 PLOT DATE January 2012 C.W.I.S. NO. P.2 NO. Aero Accidents Tolerance |
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| RIO GRANDE FLOODWAY SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | PLAN AND PROFILE STA. 160+00 TO STA. 260+00 |
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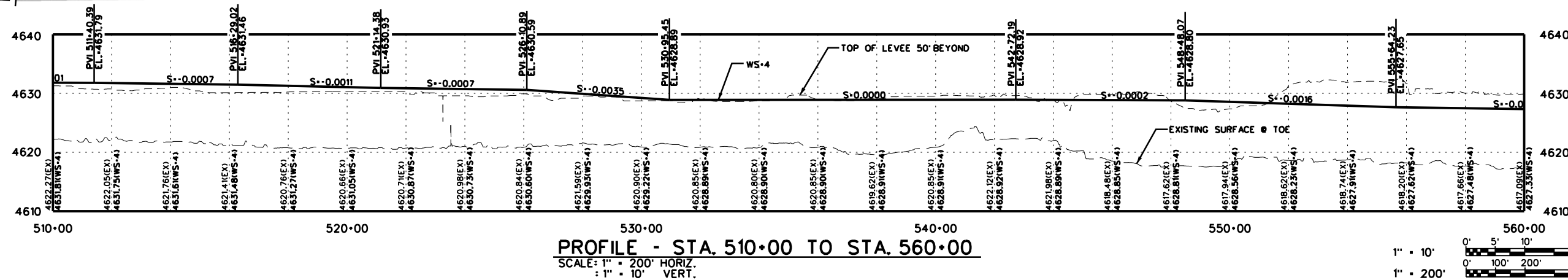
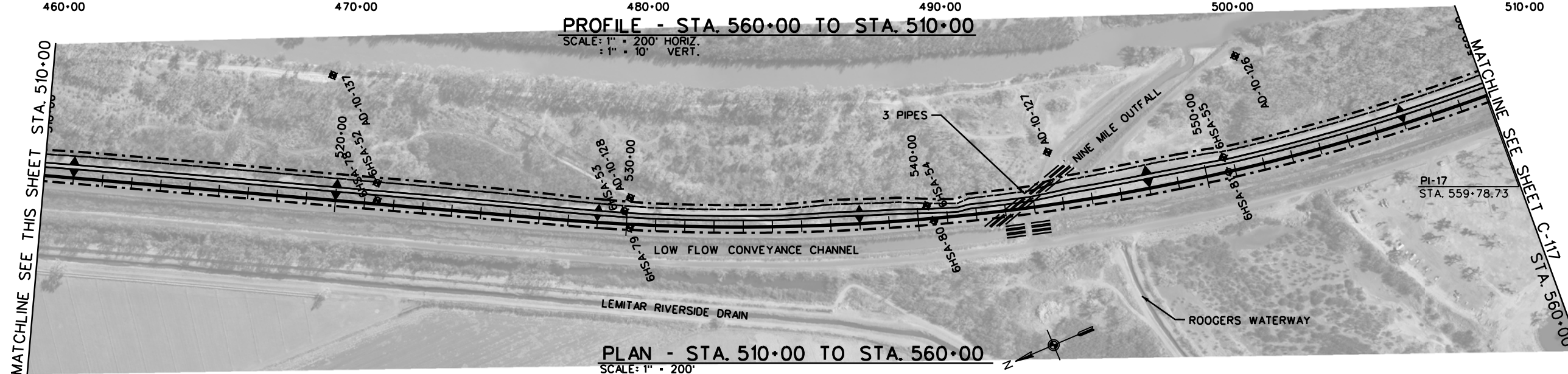
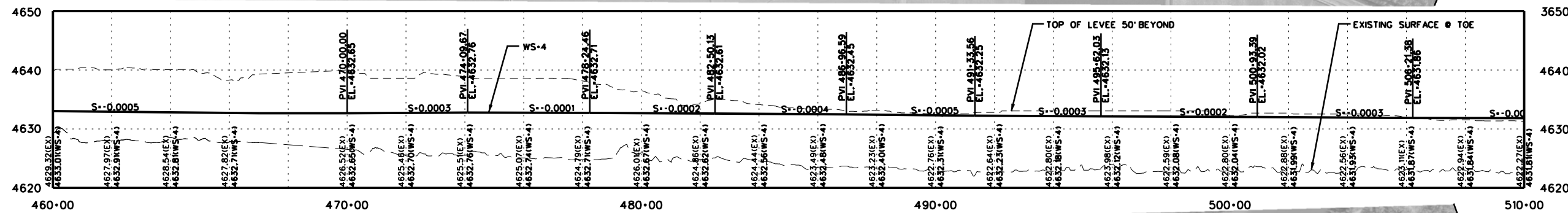
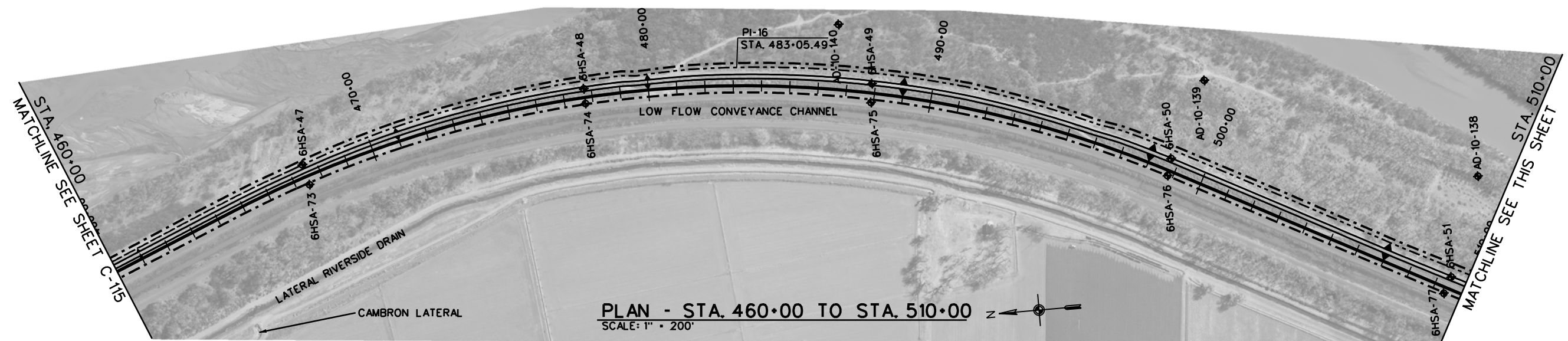
5 Army Corps
Engineers
Bouquet District

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| Plot Scale: 200:1 | Plot Date: January 2012 |
| CWIS NO. P2 NO. | |
| Zero Accidents Zero Tolerance | |


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DRAWN BY:
SEE COVER
REVIEWED BY:
SEE COVER

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| CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO | |
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US Army Corps
of Engineers
Albuquerque District

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| File Name: | SN02C-116.DGN | |
| Plot Scale: | 200:1 | Plot Date: January 2012 |
| CWIS NO. P2 NO. | | |
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DESIGN BY:
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DRAWN BY:
SEE COVER

REVIEWED BY:
SEE COVER

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

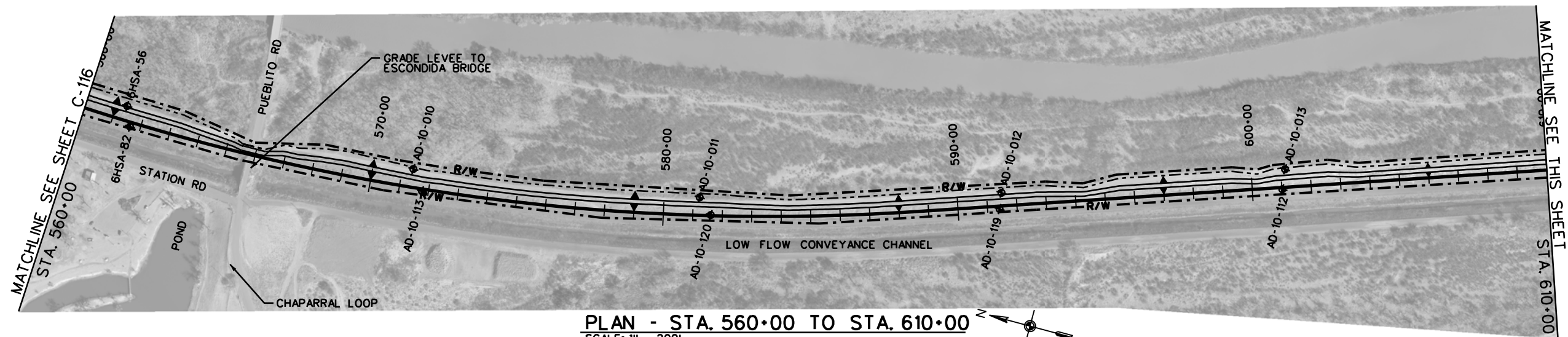
RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM

PLAN AND PROFILE
STA. 460+00 TO STA. 560+00

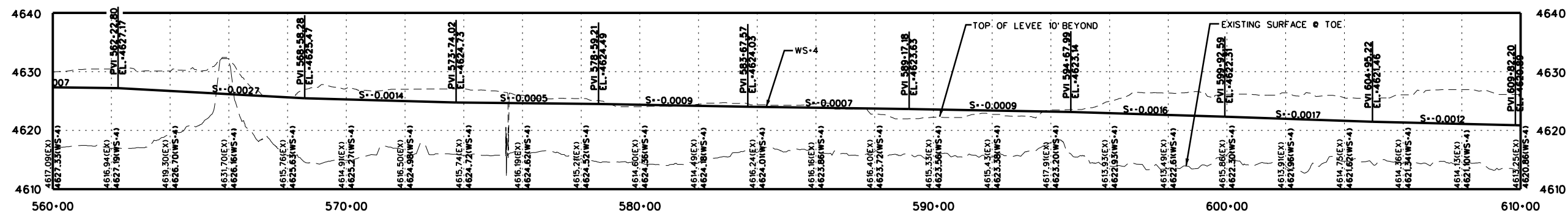
SHEET NO.
C-116
17 OF 116

SEQUENCE NO.
19

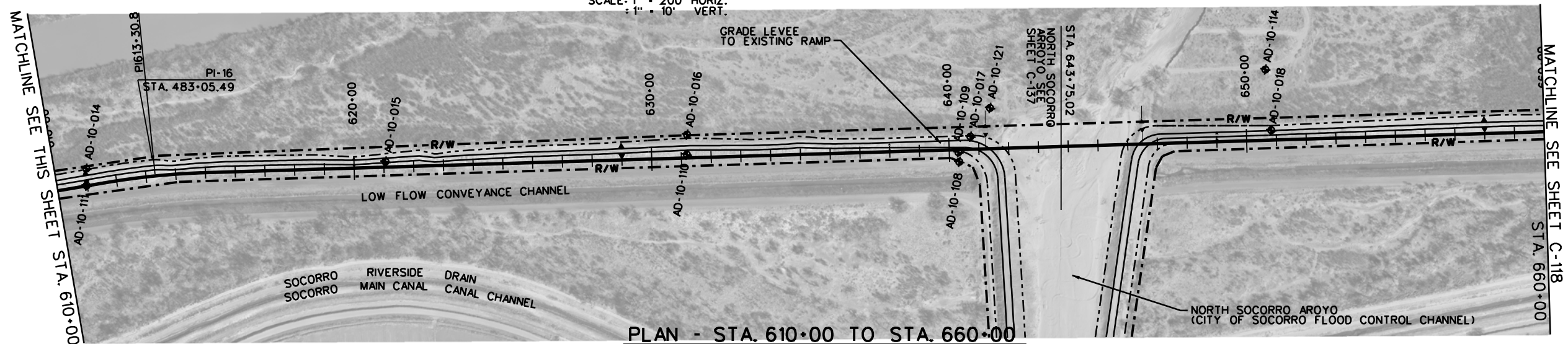
PLAN AND PROFILE
460+00 TO STA. 560+00



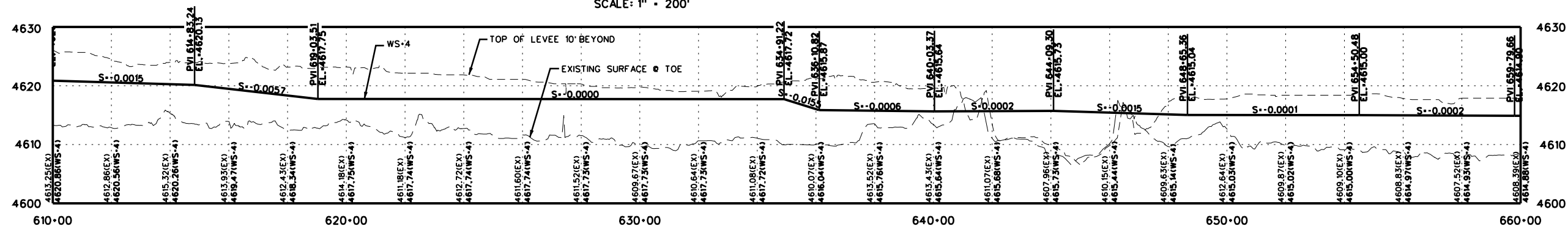
PLAN - STA. 560+00 TO STA. 610+00
SCALE: 1" = 200'



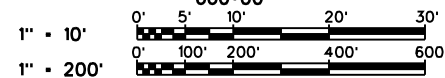
PROFILE - STA. 560+00 TO STA. 610+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.



PLAN - STA. 610+00 TO STA. 660+00
SCALE: 1" = 200'



PROFILE - STA. 610+00 TO STA. 660+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.



| File Name | Plot Date | Plot Scale | CWIS NO. | P2 NO. | Accidents | Tolerance |
|-------------|--------------|------------|----------|--------|-----------|-----------|
| SWC-117.DGN | January 2012 | 2001 | | | | |

| DESIGN BY: | SEE COVER | DRAWN BY: | SEE COVER | REVIEWED BY: | SEE COVER |
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| U.S. ARMY ENGINEER DISTRICT | | CORPS OF ENGINEERS | | ALBUQUERQUE, NEW MEXICO | |

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| RIO GRANDE FLOODWAY | PLAN AND PROFILE |
| SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | STA. 560+00 TO STA. 660+00 |

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| SHEET NO. | 18 OF 116 |
| SEQUENCE NO. | 20 |

1 2 3 4 5

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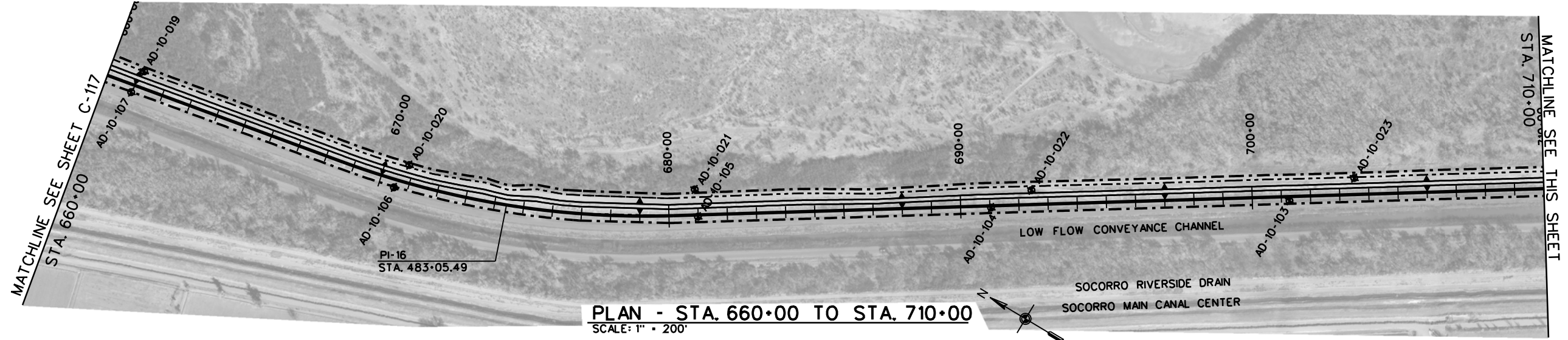
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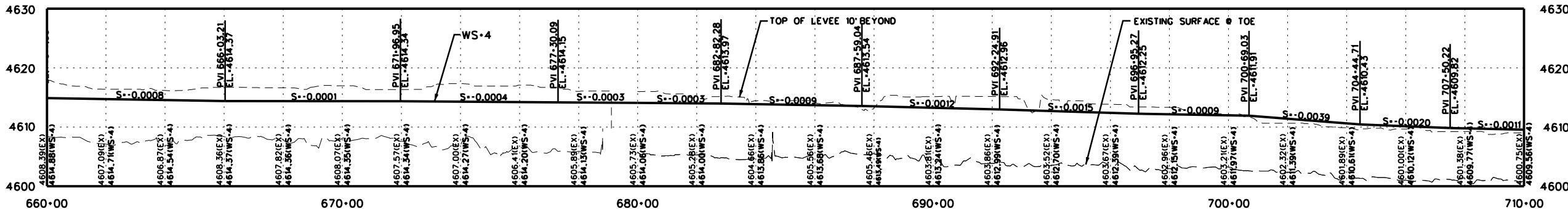
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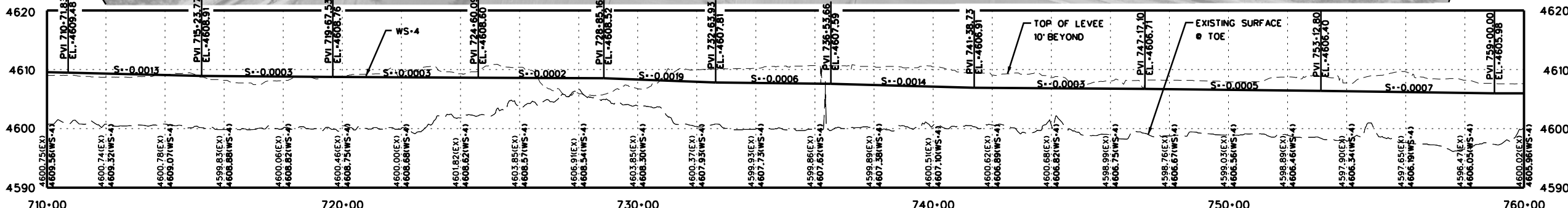
PLAN - STA. 660+00 TO STA. 710+00
SCALE: 1" = 200'



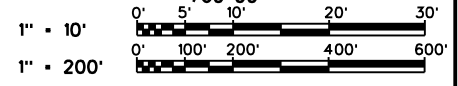
PROFILE - STA. 660+00 TO STA. 710+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.



PLAN - STA. 710+00 TO STA. 760+00
SCALE: 1" = 200'



PROFILE - STA. 710+00 TO STA. 760+00
SCALE: 1" = 200' HORIZ.
1" = 10' VERT.



| File Name | Proj. No. | Proj. Date | Proj. Scale | CWIS No. | P2 No. | Proj. Title | Description | Date | Appr. |
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| SRD-C-118.DGN | 2001 | January 2012 | | | | | | | |

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

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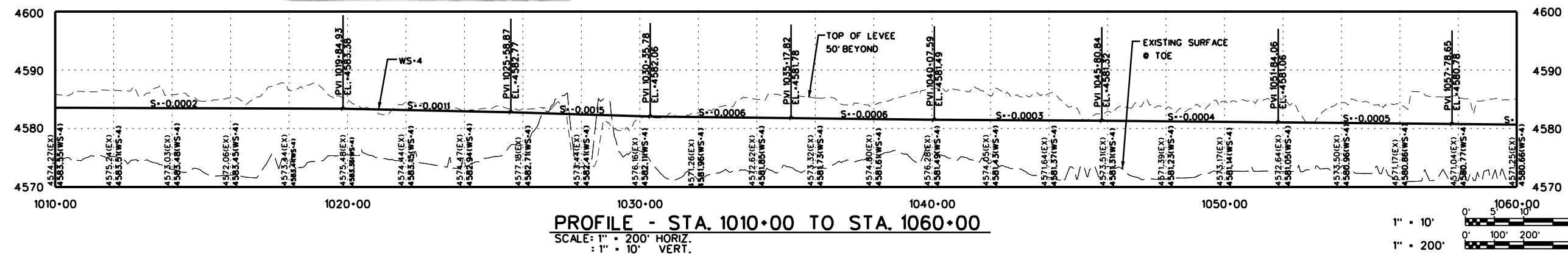
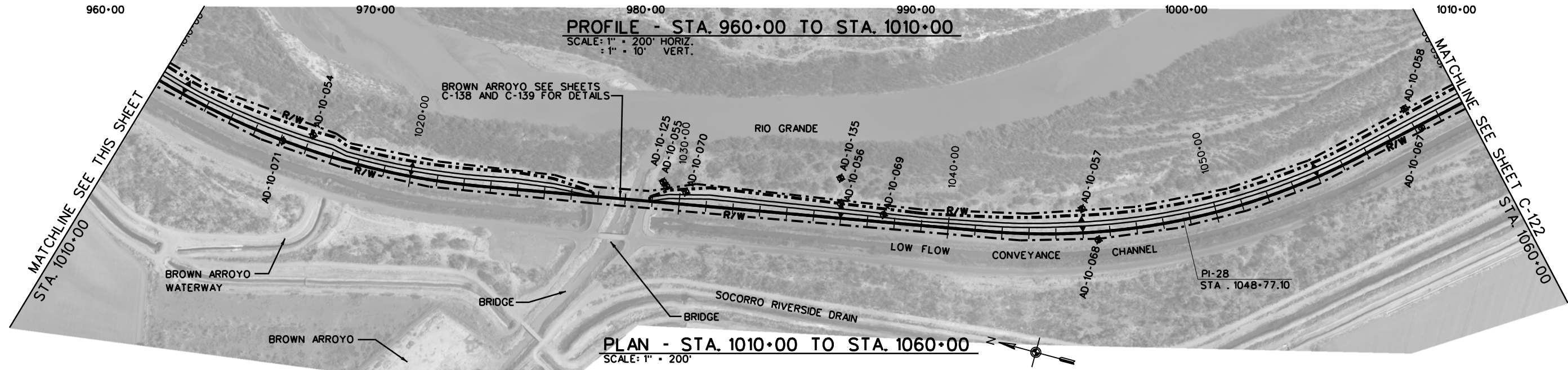
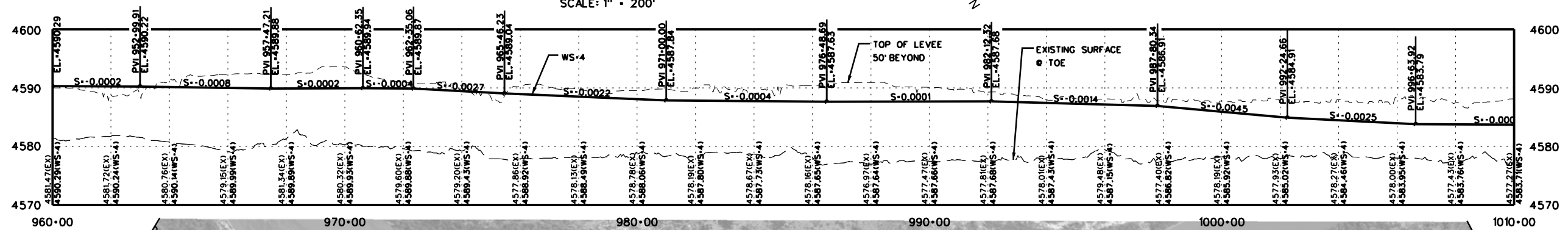
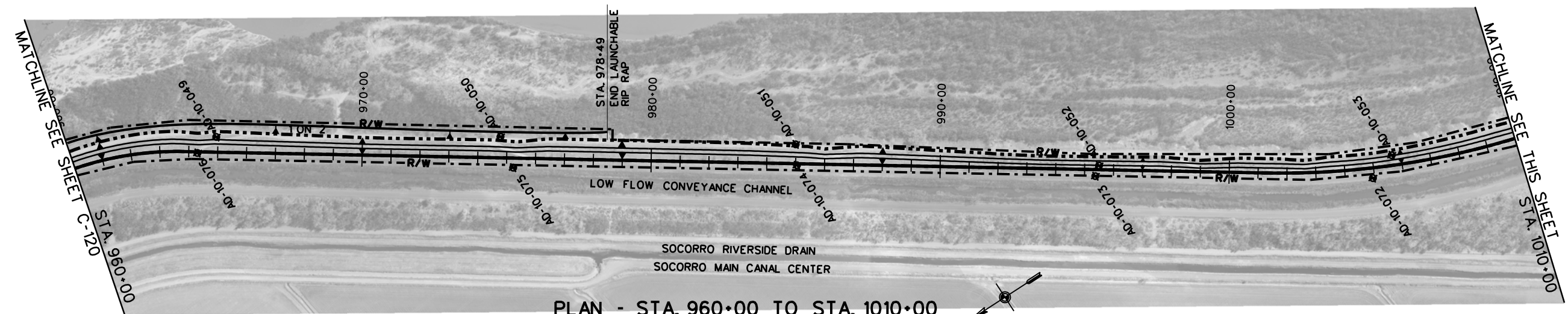
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SEE COVER

RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM

PLAN AND PROFILE
STA. 660+00 TO STA. 760+00

SHEET NO.
C-118
19 OF 116

SEQUENCE NO.
21



S Army Corps
Engineers
buquerque District

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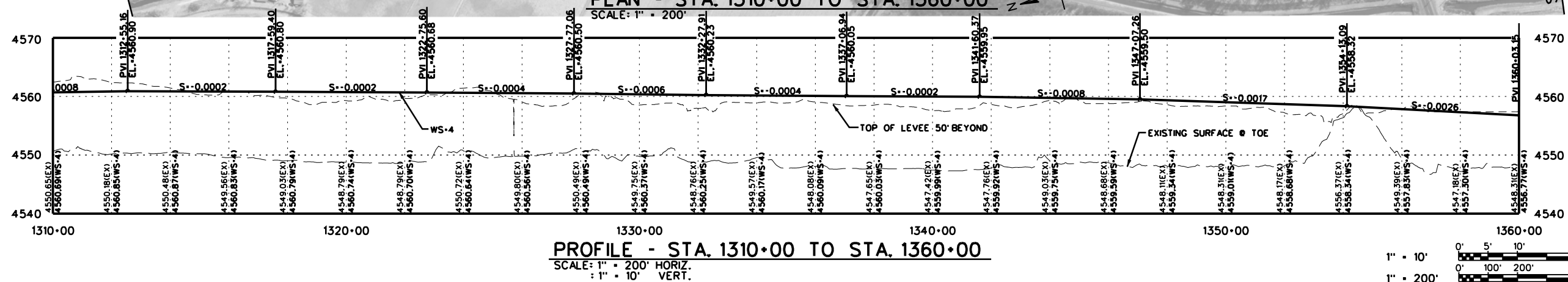
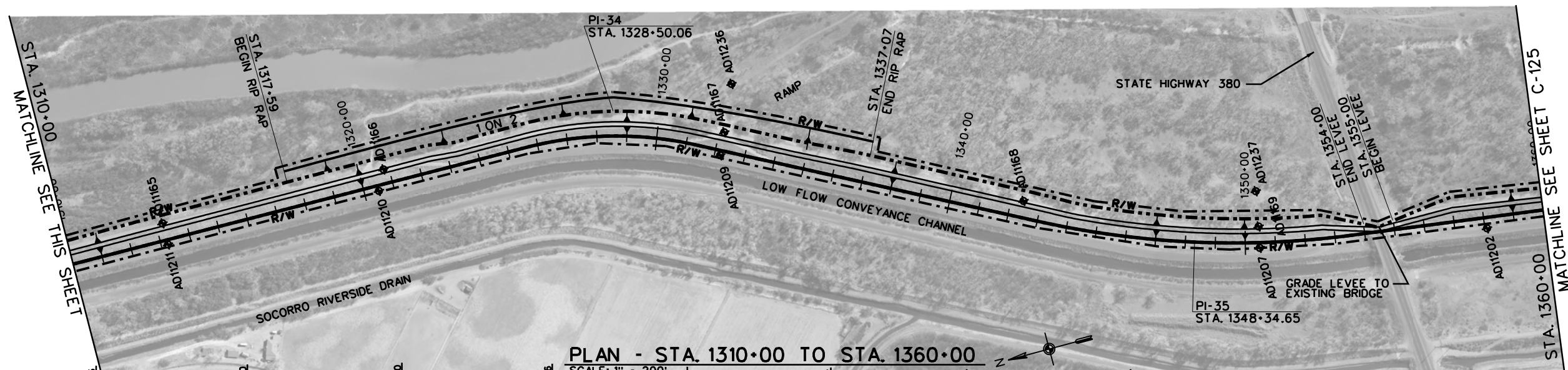
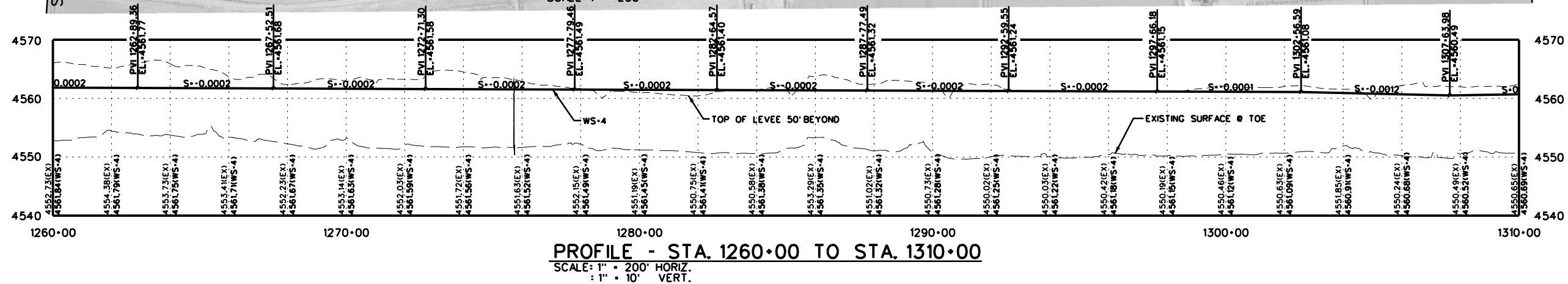
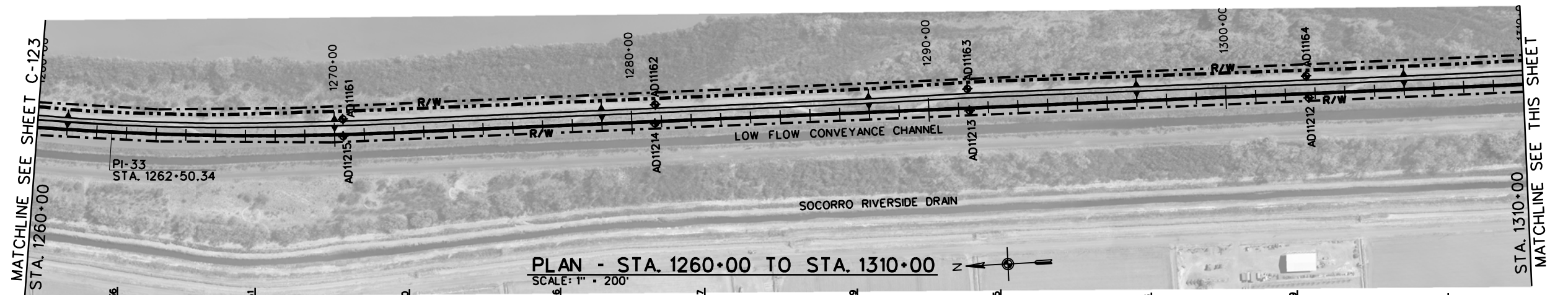
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| Plot No. | Plot Date: |
| 200:1 | January 2012 |
| CWIS NO. | |
| P2 NO. | |
| Zero Accidents | |
| Zero Tolerance | |

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| SEE COVER DRAWN BY: | SEE COVER REVIEWED BY: | SEE COVER |
| CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO | | |

PLAN AND PROFILE
STA. 960+00 TO STA. 1060+00

SHEET NO.
C-121
22 OF 116

SEQUENCE NO.
24



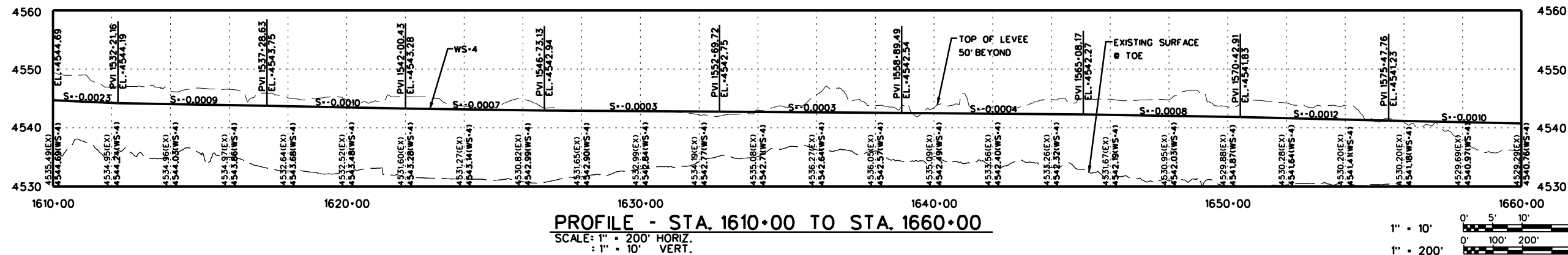
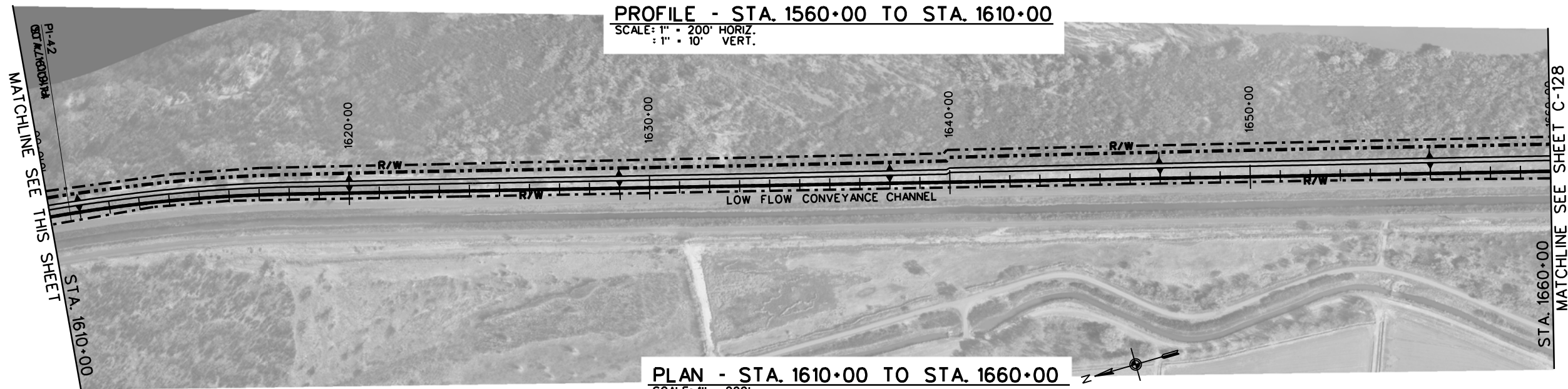
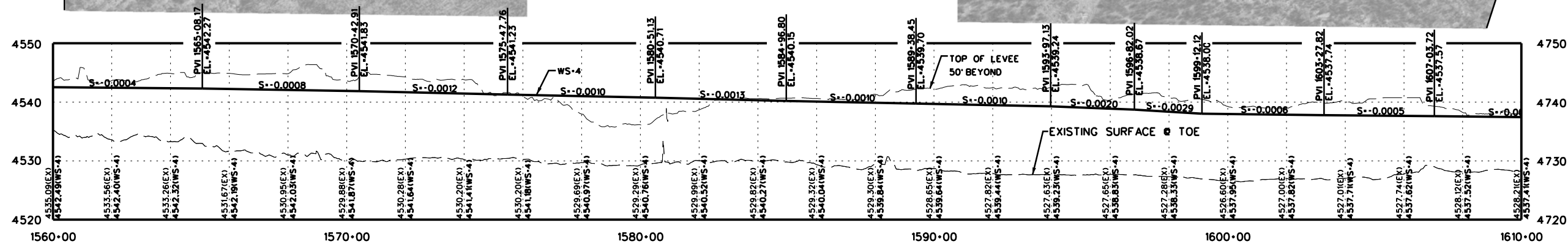
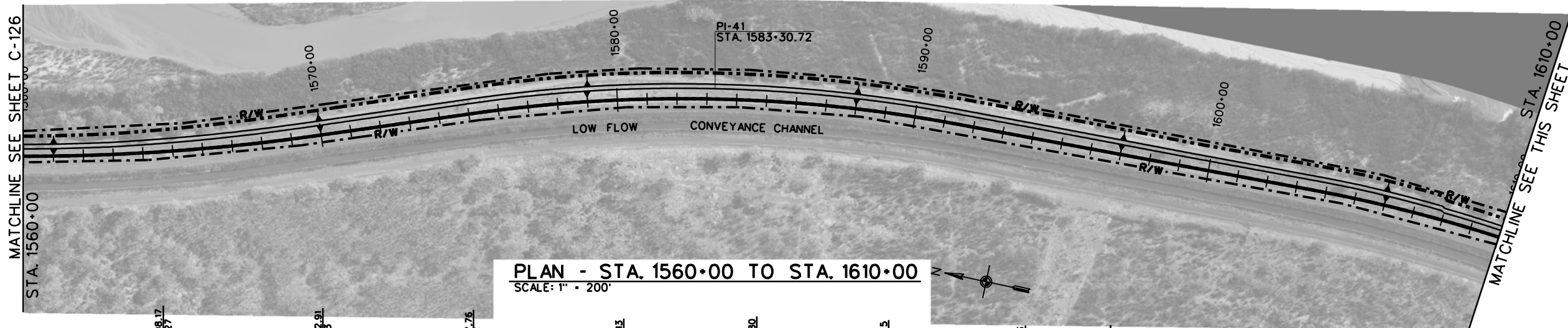
| Work | Date | Appr. |
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| File Name: S:\C-124.DGN | Plot Date: January 2012 |
| Plot Scale: 2001 | CWIS NO. P2 NO. |
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| DESIGN BY: SEE COVER | U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO |
| DRAWN BY: SEE COVER | |
| REVIEWED BY: SEE COVER | |

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| RIO GRANDE FLOODWAY SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | PLAN AND PROFILE STA. 1260+00 TO STA. 1360+00 |
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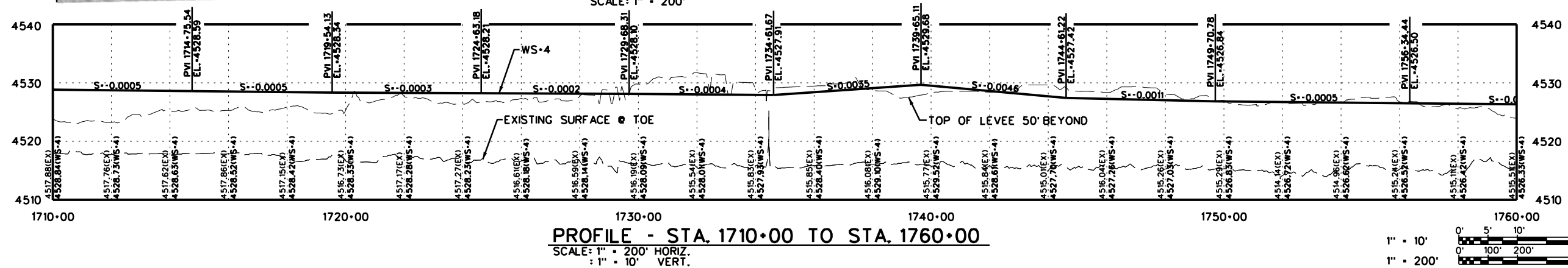
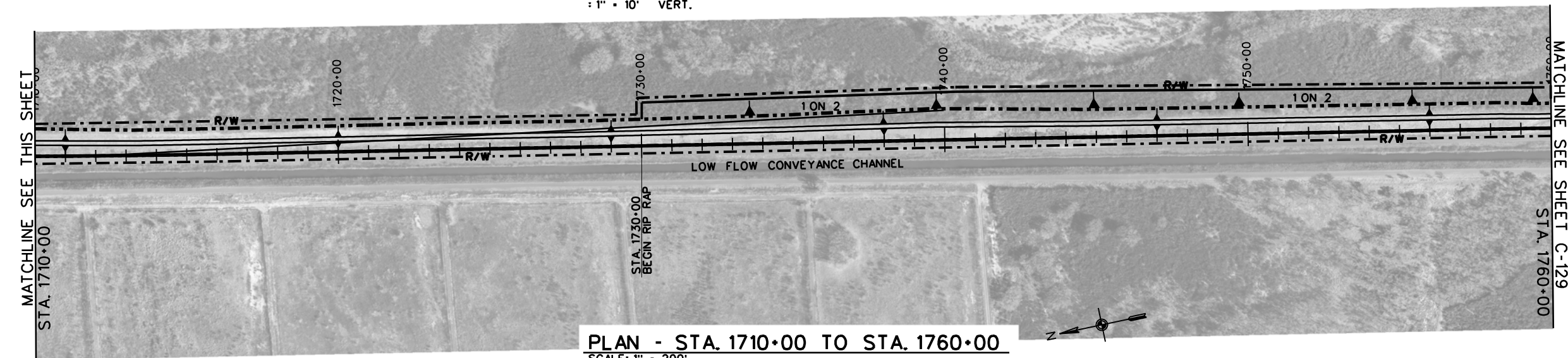
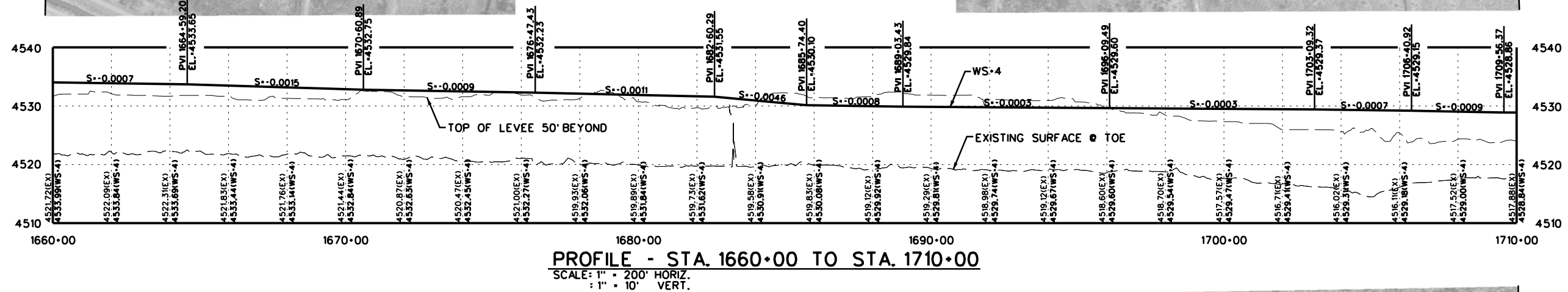
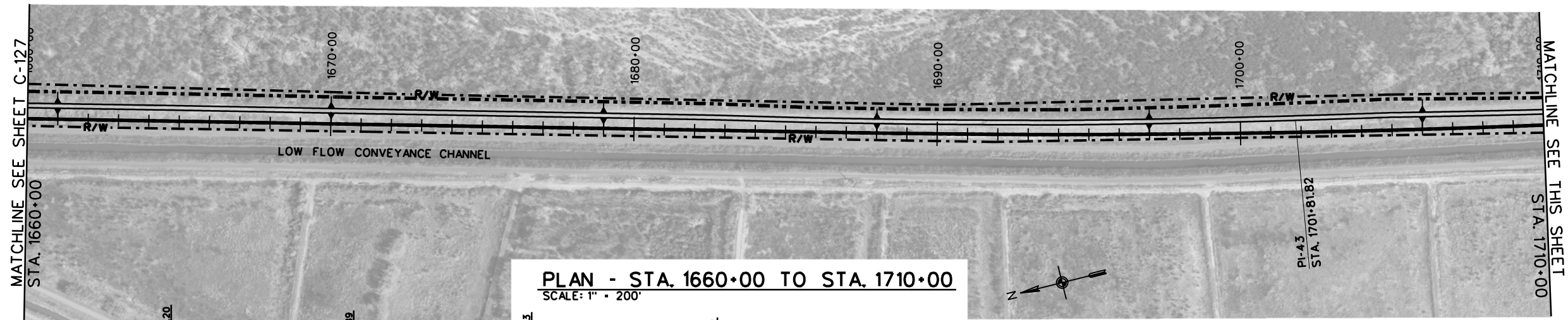
| File Name | Sheet | Plot Date | Plot Scale | CWIS NO. | P2 NO. | ero Accidents | ero Tolerance |
|---------------|-----------|--------------|------------|----------|--------|---------------|---------------|
| SR02C-127.DGN | 28 OF 116 | January 2012 | 2001 | | | | |

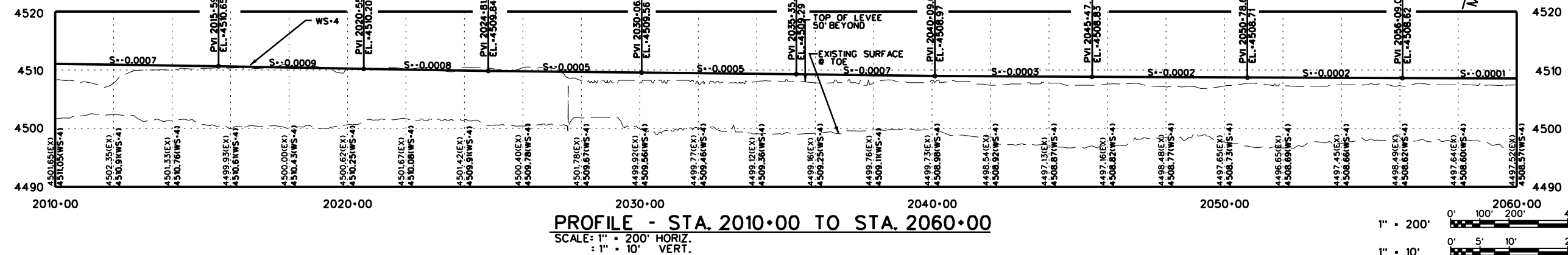
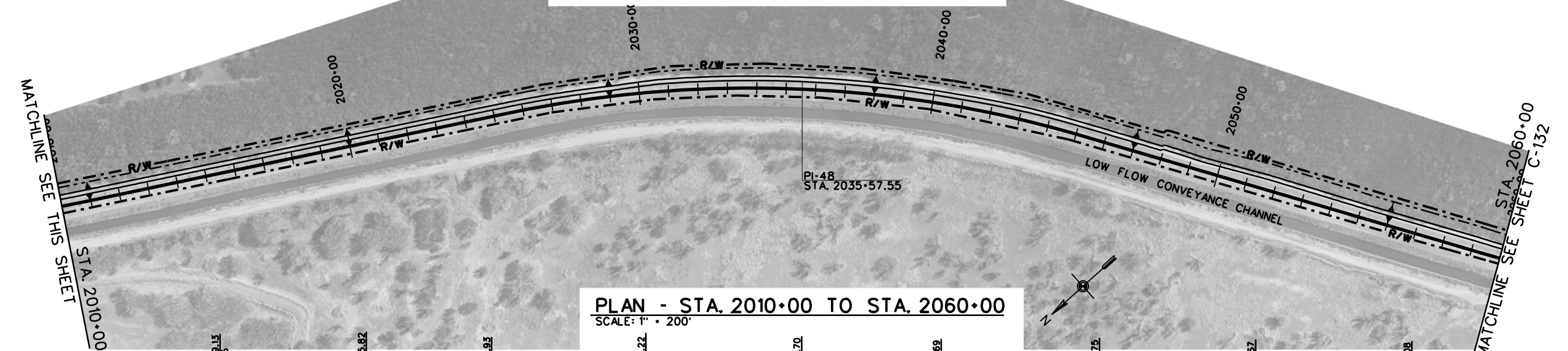
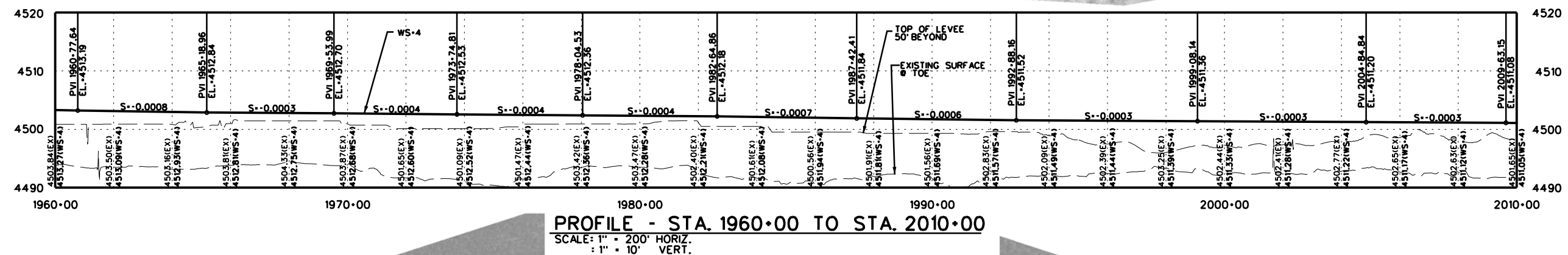
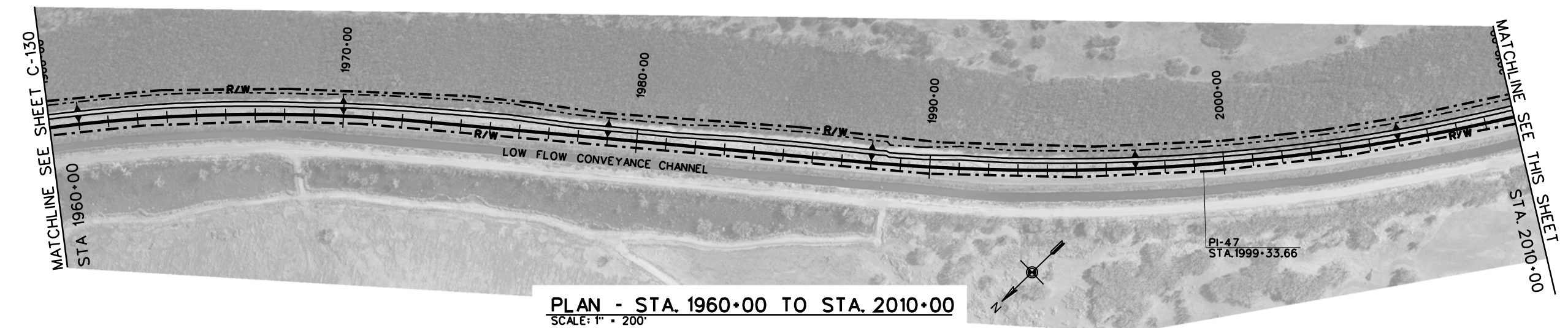
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| DESIGN BY: | SEE COVER |
| DRAWN BY: | SEE COVER |
| REVIEWED BY: | SEE COVER |

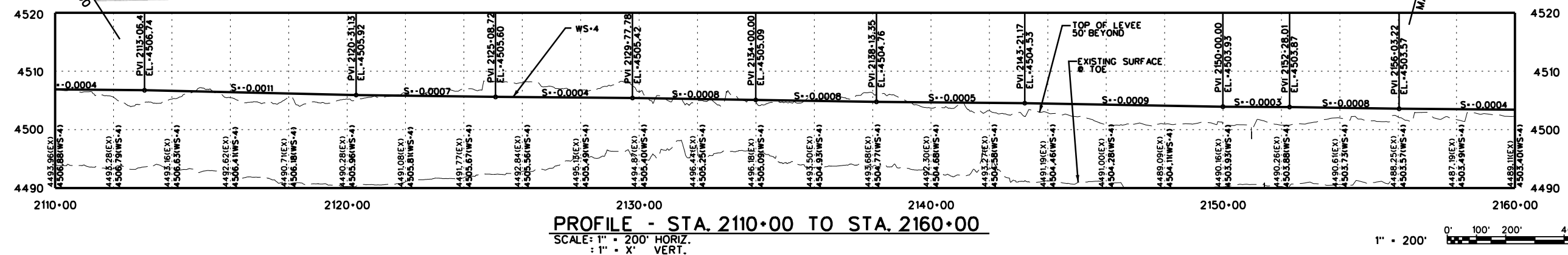
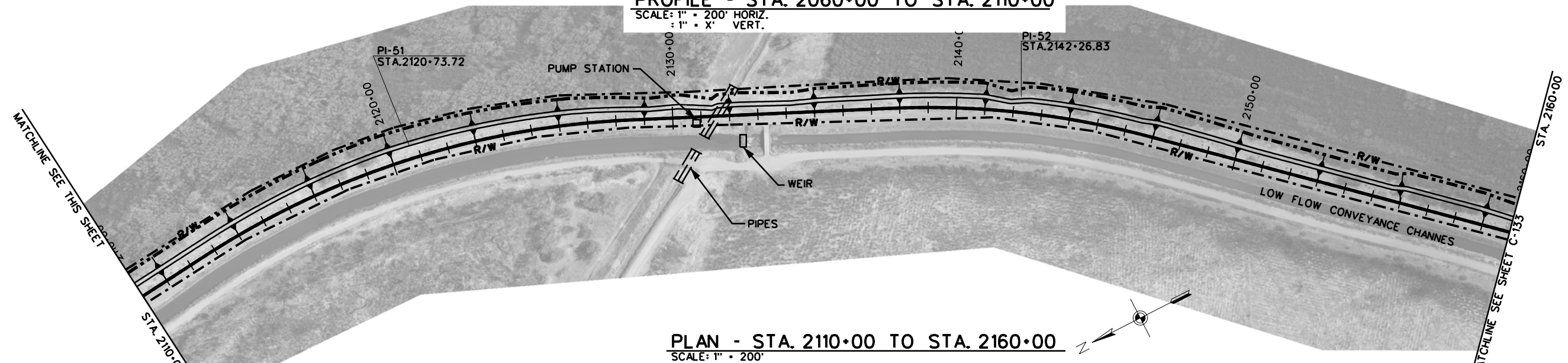
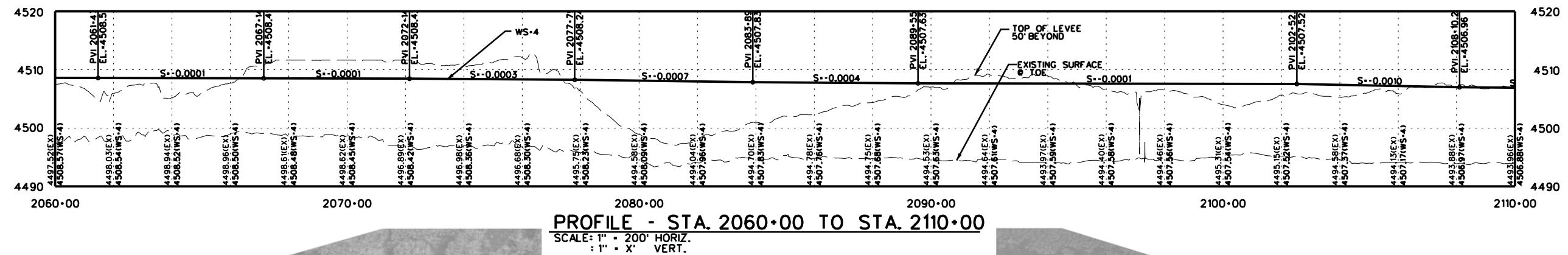
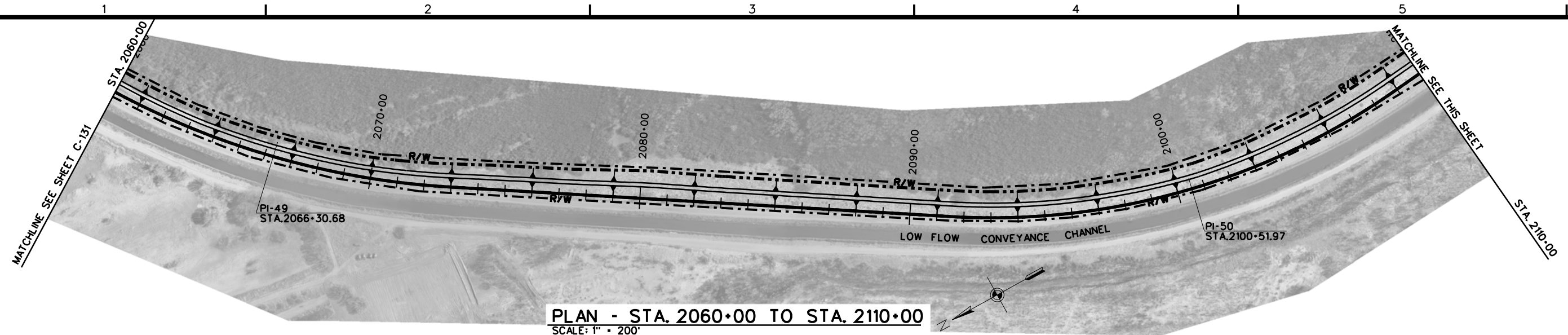
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|--|---|
| U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO | RIO GRANDE FLOODWAY SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM |
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| SHEET NO. C-127 28 OF 116 | PLAN AND PROFILE STA. 1560+00 TO STA. 1660+00 |
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| SEQUENCE NO. 30 |
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S Army Corps
f Engineers
buquerque District

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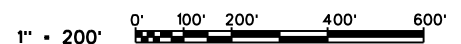
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| SNO2C-132.DGN | Plot Scale: | Plot Date: |
| | 200:1 | January 2012 |
| CWIS NO. | | |
| P2 NO. | | |
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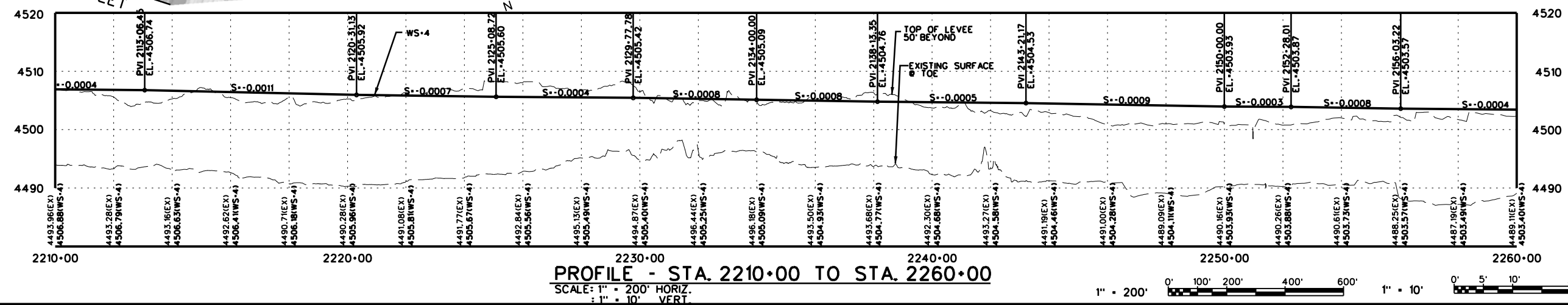
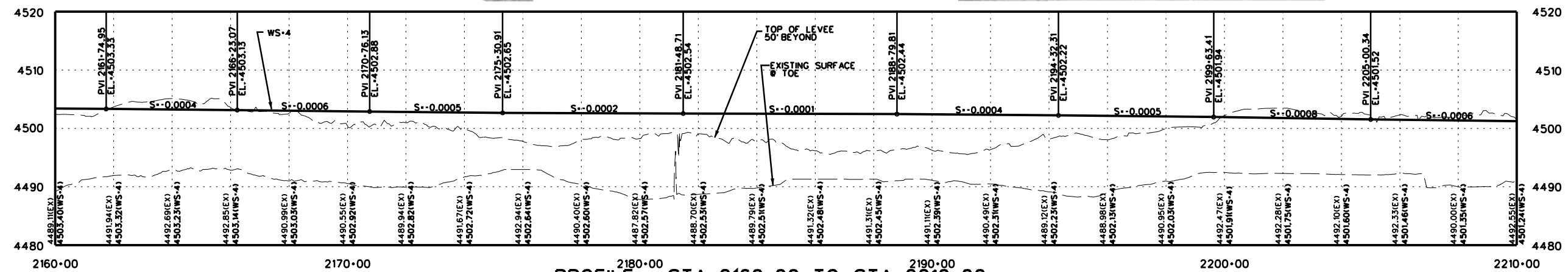
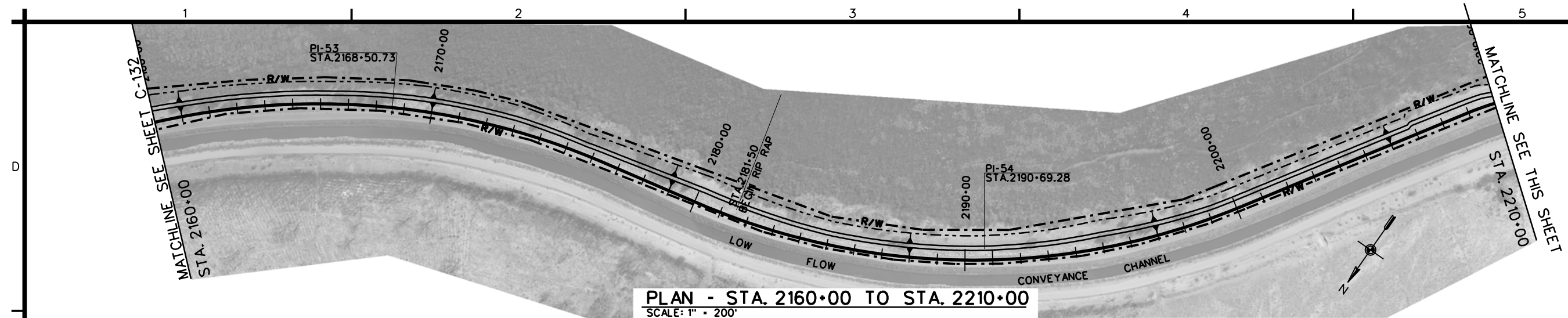
SEE COVER
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SEE COVER
REVIEWED BY:
SEE COVER

CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

PLAN AND PROFILE
STA. 2060+00 TO STA. 2160+00

SHEET NO.
C-132
33 OF 116

SEQUENCE NO.
35

[illegible]

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| File Names: SN02C-133.DGN | Plot Dates: January 2012 | CWIS NO. P2 NO. | Zero Accidents Zero Tolerance |
|------------------------------|-----------------------------|--------------------|--|

DESIGN BY:
SEE COVER

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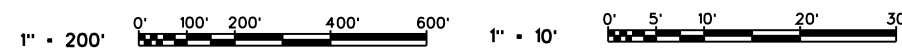
REVIEWED BY:
SEE COVER

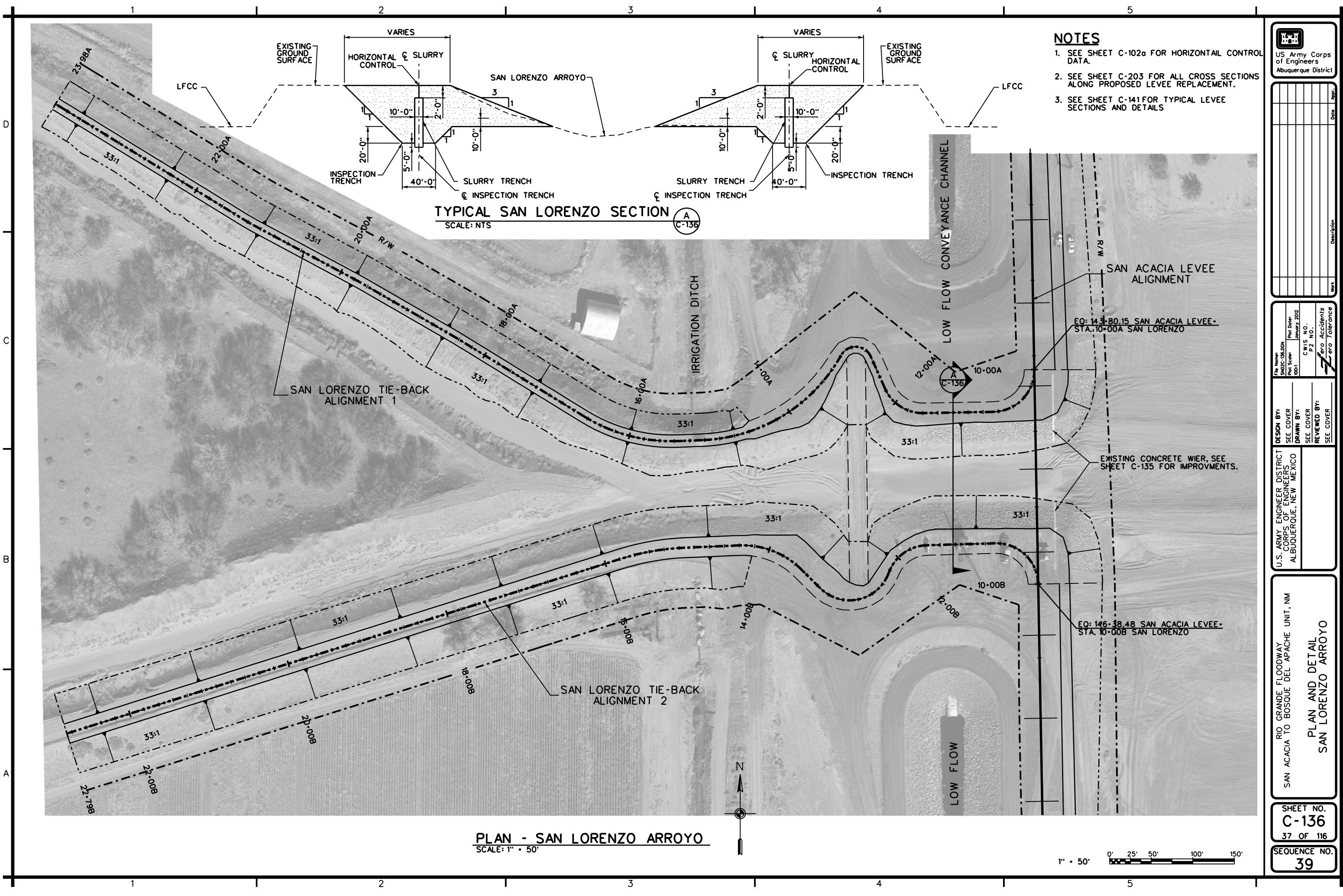
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM
PLAN AND PROFILE
STA. 2160+00 TO STA. 2260+00

SHEET NO.
C-133
34 OF 116

SEQUENCE NO.
36





NOTES

1. SEE SHEET C-102a FOR HORIZONTAL CONTROL DATA.
2. SEE SHEET C-203 FOR ALL CROSS SECTIONS ALONG PROPOSED LEVEE REPLACEMENT.
3. SEE SHEET C-141 FOR TYPICAL LEVEE SECTIONS AND DETAILS


TYPICAL SAN LORENZO SECTION

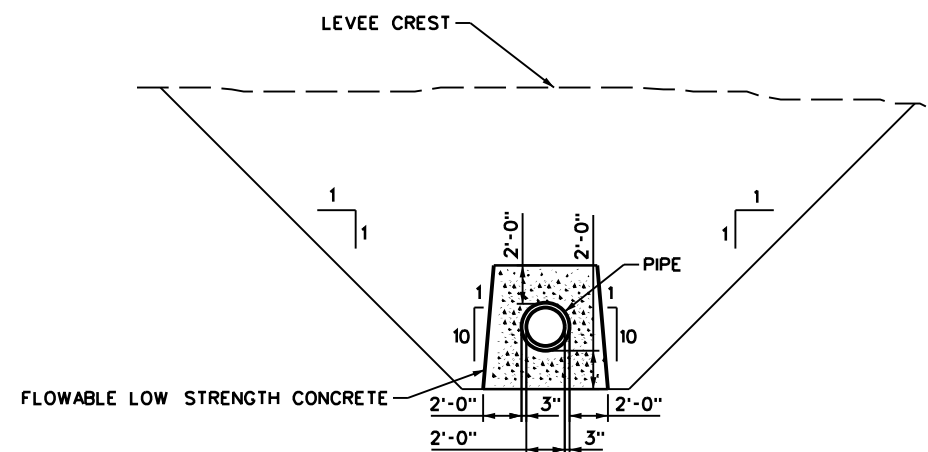
SCALE: NTS

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C-136

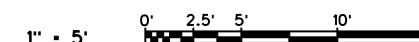
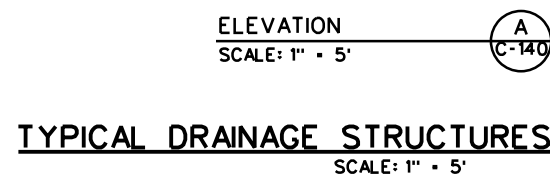
PLAN - SAN LORENZO ARROYO

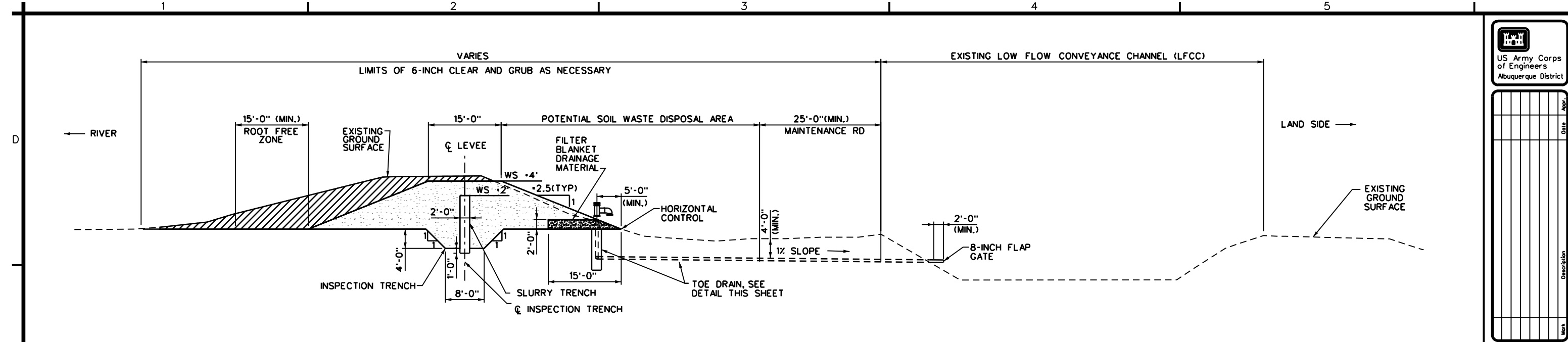
SCALE: 1" = 50'

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|  US Army Corps of Engineers Albuquerque District | |
| File Name: SWDC-136.DGN | Plot Date: January 2012 |
| Plot Scale: 1001 | CWIS NO. P2 NO. |
| DESIGN BY: SEE COVER | DRAWN BY: SEE COVER |
| REVIEWED BY: SEE COVER | U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO |
| RIO GRANDE FLOODWAY SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | |
| PLAN AND DETAIL SAN LORENZO ARROYO | |
| SHEET NO. C-136 37 OF 116 | |
| SEQUENCE NO. 39 | |



SECTION A
SCALE: 1" = 5' C-140

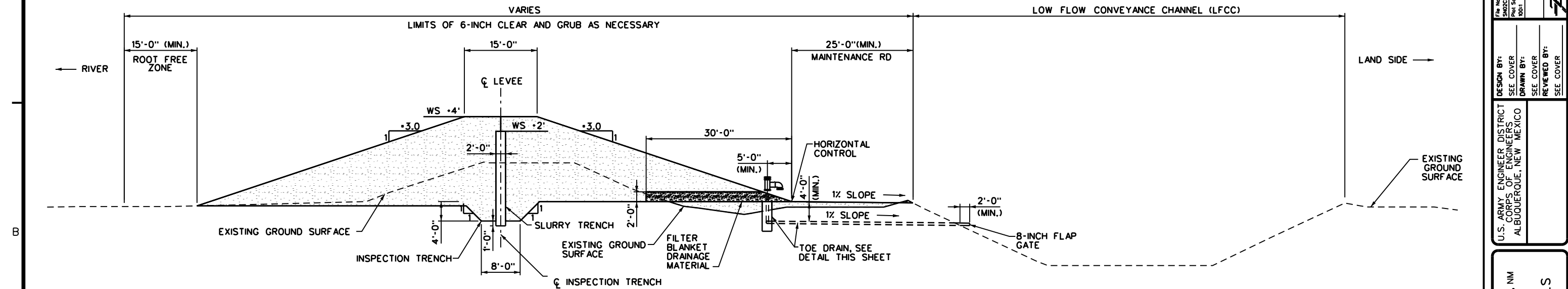




TYPICAL LEVEE REPLACEMENT SECTION-A

SCALE: 1" = 10'

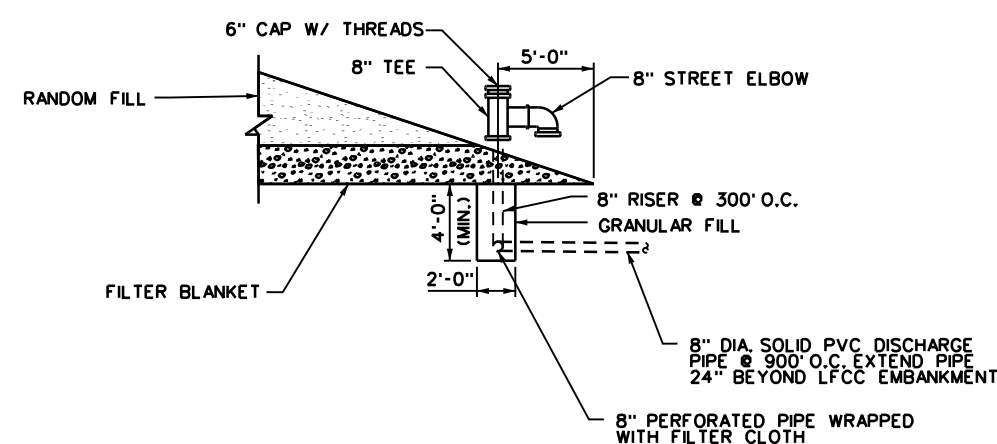
• SEE GENERAL NOTE NO. 1



TYPICAL LEVEE REPLACEMENT SECTION-B

SCALE: 1" = 10'

• SEE GENERAL NOTE NO. 1



TYPICAL TOE DRAIN DETAIL

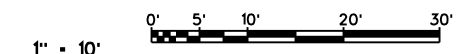
SCALE: NOT TO SCALE

GENERAL NOTES

1. A LEVEE HEIGHT OF 12' OR LESS WILL REQUIRE THE SLOPE ON THE NEW LEVEE TO BE 1 VERTICAL TO 2.5 HORIZONTAL. A LEVEE HEIGHT OVER 12' WILL REQUIRE THE SLOPE TO BE 1 VERTICAL TO 3 HORIZONTAL.
2. DELETE TOE DRAIN, SLURRY TRENCH AND INSPECTION TRENCH WHEN HEIGHT OF LEVEE IS 5' OR LESS.
3. EXISTING SPOIL BANK WILL BE DEMOLISHED TO CONSTRUCT NEW LEVEE.
4. GRADING REQUIREMENTS ARE AS SHOWN AND DEPEND ON LEVEE HEIGHT.
5. HORIZONTAL CONTROL WILL BE SET AT THE EXISTING LAND SIDE LEVEE TOE WHEN LEVEE HEIGHT IS SMALLER OR EQUAL TO THE EXISTING LEVEE HEIGHT. HORIZONTAL CONTROL WILL SHIFT TOWARDS LFCC AS LEVEE HEIGHT INCREASES. NEW LEVEE LAND SIDE TOE WILL BE AT MINIMUM 25' FROM LFCC BANK.
6. "TYPICAL LEVEE REPLACEMENT SECTION-A" IS TYPICAL OF THE NEW LEVEE APPROXIMATELY THE SAME HEIGHT OF THE EXISTING LEVEE OR SMALLER, APPROXIMATELY STA. 80+00 (BOR 1219) TO STA. 1900+00 (BOR 1588).
7. "TYPICAL LEVEE REPLACEMENT SECTION-B" IS TYPICAL OF THE NEW LEVEE AT A HEIGHT LARGER THAN THE EXISTING LEVEE, APPROXIMATELY STA. 1900+00 (BOR 1588) TO STA. 2260+00 (BOR 1654).

LEGEND

- CUT
- RANDOM FILL
- FILTER BLANKET
- EXISTING GROUND SURFACE



US Army Corps of Engineers
Albuquerque District

| Description | Date | Appr. | Work |
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DESIGN BY: SEE COVER

DRAWN BY: SEE COVER

REVIEWED BY: SEE COVER

File Name: SWDC-141.DGN
Plot Scale: 100:1
Plot Date: January 2012
CWIS NO.: P.2 NO. 1
Aero Accidents Tolerance

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

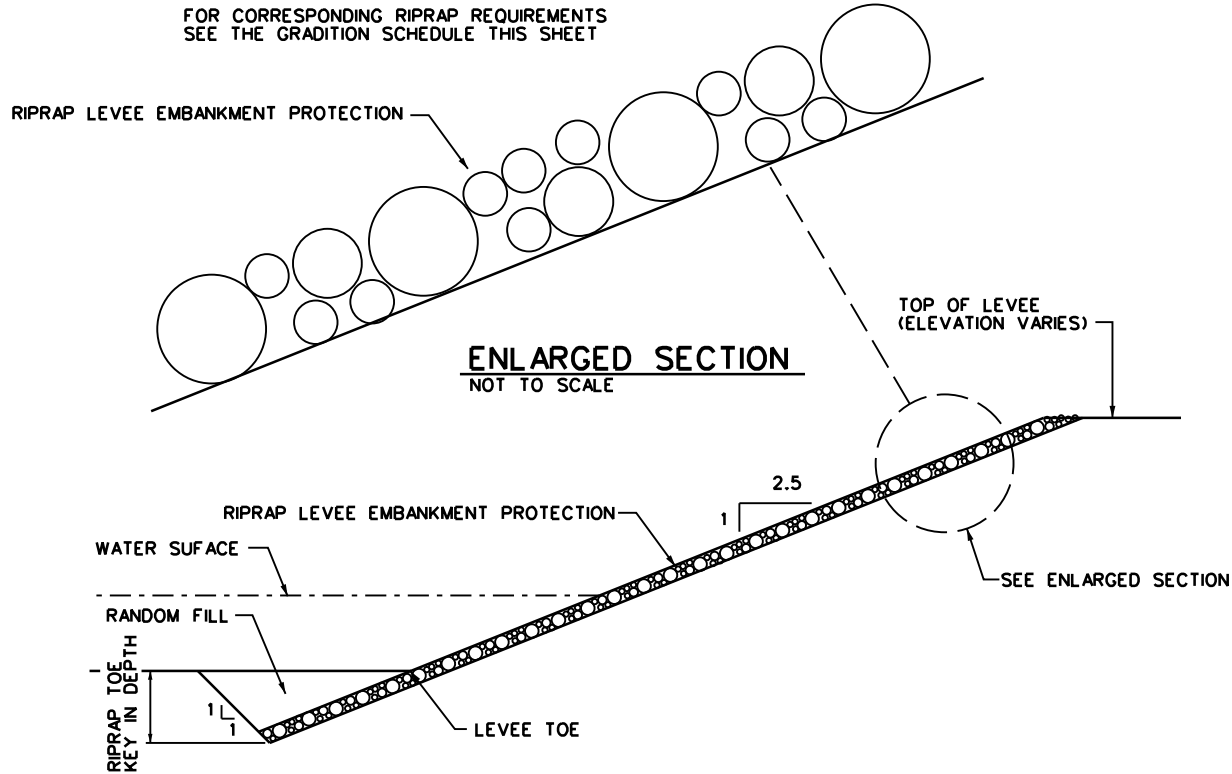
RIO GRANDE FLOODWAY
SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM

LEVEE SECTIONS AND DETAILS

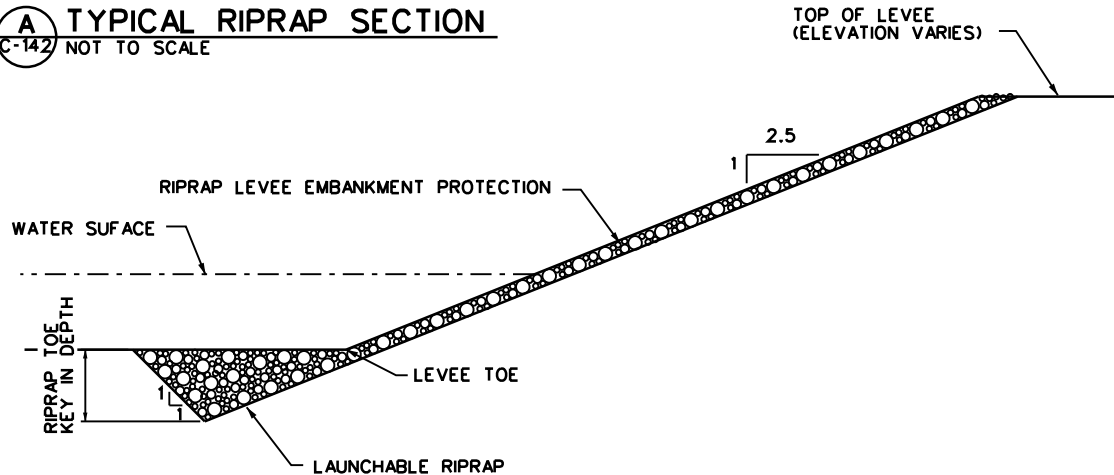
SHEET NO.
C-141
42 OF 116

SEQUENCE NO.
44

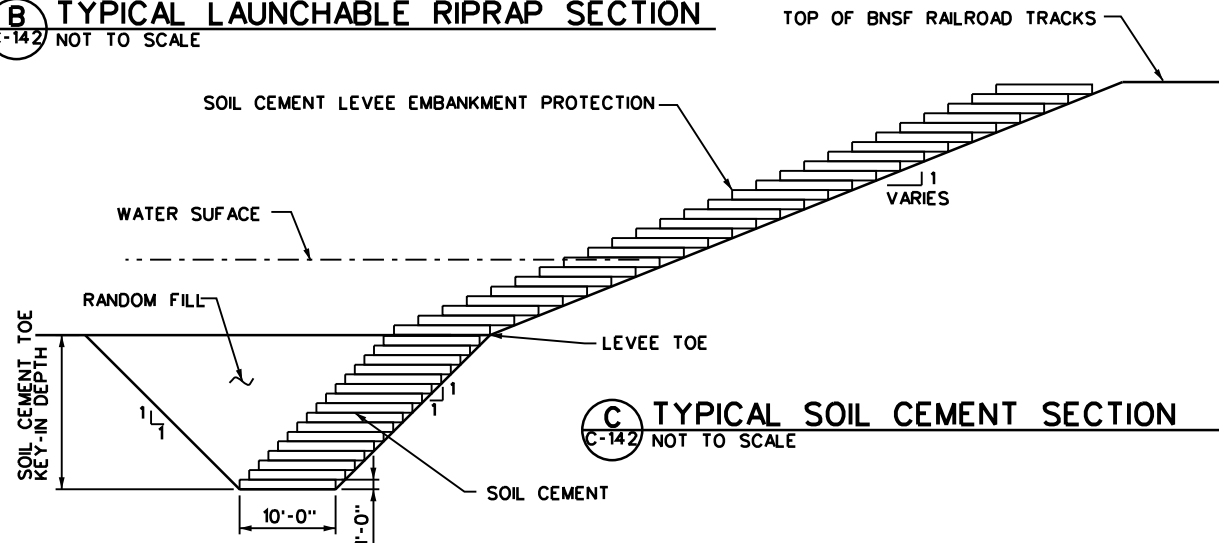
FOR CORRESPONDING RIPRAP REQUIREMENTS
SEE THE GRADATION SCHEDULE THIS SHEET



A TYPICAL RIPRAP SECTION
C-142 NOT TO SCALE



B TYPICAL LAUNCHABLE RIPRAP SECTION
C-142 NOT TO SCALE



C TYPICAL SOIL CEMENT SECTION
C-142 NOT TO SCALE

GRADATION SCHEDULE

STA. 6+40 - BEGIN STA. 8+60 - END
STA. 12+50 - BEGIN STA. 68+00 - END

RL 1206.3 - RL 1213 SOIL CEMENT
D100 (MAX) = 3.5'
D90 (MIN) = 2.47'
D50 (MIN) = 2.047'
D30 (MIN) = 1.67'
D15 (MIN) = 1.39'
RIPRAP THICKNESS = 3.5'
TOE KEY-IN DEPTH = 17'
ELEVATION = 4635.00

STA. 74+54 - BEGIN STA. 88+05 - END
LAUNCHABLE RIPRAP

RL 1218 - RL 1221
D100 (MAX) = 3.5'
D90 (MIN) = 2.47'
D50 (MIN) = 2.047'
D30 (MIN) = 1.67'
D15 (MIN) = 1.39'
RIPRAP THICKNESS = 3.5'
TOE KEY-IN DEPTH = 17'
ELEVATION = 4633.00

STA. 244+42 - BEGIN STA. 283+88.50 - END
LAUNCHABLE RIPRAP

RL 1252 - RL 1258
D100 (MAX) = 4.00'
D90 (MIN) = 2.82'
D50 (MIN) = 2.34'
D30 (MIN) = 2.02'
D15 (MIN) = 1.59'
RIPRAP THICKNESS = 4.00'
TOE KEY-IN DEPTH = 14'
ELEVATION = 4619.50

STA. 770+55 - BEGIN STA. 802+44 - END
RIPRAP

RL 1356 - RL 1362
D100 (MAX) = 3.5'
D90 (MIN) = 2.47'
D50 (MIN) = 2.047'
D30 (MIN) = 1.67'
D15 (MIN) = 1.39'
RIPRAP THICKNESS = 3.5'
TOE KEY-IN DEPTH = 10'
ELEVATION = 4582.00

STA. 927+30 - BEGIN STA. 978+49 - END
LAUNCHABLE RIPRAP

RL 1388 - RL 1399
D100 (MAX) = 2.5'
D90 (MIN) = 1.77'
D50 (MIN) = 1.46'
D30 (MIN) = 1.20'
D15 (MIN) = 1.099'
RIPRAP THICKNESS = 2.5'
TOE KEY-IN DEPTH = 12'
ELEVATION = 4562.00

STA. 1098+07 - BEGIN STA. 1133+27.50 - END
RIPRAP

RL 1424 - RL 1431
D100 (MAX) = 1.75'
D90 (MIN) = 1.23'
D50 (MIN) = 1.03'
D30 (MIN) = 0.81'
D15 (MIN) = 0.70'
RIPRAP THICKNESS = 1.75'
TOE KEY-IN DEPTH = 7.50'
ELEVATION = 4558.50

STA. 1202+75 - BEGIN STA. 1207.75 - END
RIPRAP

RL 1444 - RL 1445
D100 (MAX) = 0.75'
D90 (MIN) = 0.53'
D50 (MIN) = 0.43'
D30 (MIN) = 0.35'
D15 (MIN) = 0.29'
RIPRAP THICKNESS = 0.75'
TOE KEY-IN DEPTH = 7.50'
ELEVATION = 4551.50

STA. 1317+59 - BEGIN STA. 1337+07 - END
RIPRAP

RL 1469 - RL 1473
D100 (MAX) = 0.75'
D90 (MIN) = 0.53'
D50 (MIN) = 0.43'
D30 (MIN) = 0.35'
D15 (MIN) = 0.29'
RIPRAP THICKNESS = 0.75'
TOE KEY-IN DEPTH = 8'
ELEVATION = 4538.00

STA. 1370+57 - BEGIN STA. 1376+46.50 - END
RIPRAP

RL 1479 - RL 1481
D100 (MAX) = 0.75'
D90 (MIN) = 0.53'
D50 (MIN) = 0.43'
D30 (MIN) = 0.35'
D15 (MIN) = 0.29'
RIPRAP THICKNESS = 0.75'
TOE KEY-IN DEPTH = 8'
ELEVATION = 4537.50

STA. 1522+18.50 - BEGIN STA. 1554+70 - END
RIPRAP

RL 1510 - RL 1516
D100 (MAX) = 0.75'
D90 (MIN) = 0.53'
D50 (MIN) = 0.43'
D30 (MIN) = 0.36'
D15 (MIN) = 0.29'
RIPRAP THICKNESS = 0.75'
TOE KEY-IN DEPTH = 8'
ELEVATION = 4527.00

STA. 1730+00 - BEGIN STA. 1801+50 - END
RIPRAP

RL 1552 - RL 1567
D100 (MAX) = 0.75'
D90 (MIN) = 0.53'
D50 (MIN) = 0.43'
D30 (MIN) = 0.36'
D15 (MIN) = 0.29'
RIPRAP THICKNESS = 0.75'
TOE KEY-IN DEPTH = 7'
ELEVATION = 4503.50

STA. 2181+50 - BEGIN STA. 2200+00 - END
LAUNCHABLE RIP RAP

STA. 2200+00 - BEGIN STA. 2230+00 - END
RIP RAP
RL 1647 - RL 1654
D100 (MAX) = 1.25'
D90 (MIN) = 0.88'
D50 (MIN) = 0.73'
D30 (MIN) = 0.65'
D15 (MIN) = 0.51'
RIPRAP THICKNESS = 1.25'
TOE KEY-IN DEPTH = 15' (STA 2181+50 - 2220+00)
TOE KEY-IN DEPTH = 10' (STA 2220+00 - 2230+00)
ELEVATION = 4474.00



U.S. Army Corps
of Engineers
Albuquerque District

| File Name | Sheet No. | Plot Date | Plot No. | Work |
|-----------------------------|-------------------------|--------------|-----------|--------------|
| SWD2C-142.DGN | 001 | January 2012 | | |
| DESIGN BY: | SEE COVER | DRAWN BY: | SEE COVER | REVIEWED BY: |
| U.S. ARMY ENGINEER DISTRICT | ALBUQUERQUE, NEW MEXICO | | | |

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| RIO GRANDE FLOODWAY | EROSION CONTROL DETAILS |
| SAN ACACIA TO BOSQUE DEL APACHE UNIT, NM | |

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| SHEET NO. | C-142 |
| 43 OF 116 | |
| SEQUENCE NO. | 45 |

Appendix B

With- and Without-Project Floodplains for the 1%-chance Event

Figures 5.3 through 5.9 from: *Draft General Reevaluation Report and Supplemental Environmental Impact Statement II: Rio Grande Floodway, San Acacia to Bosque del Apache Unit, Socorro County, NM*. U.S. Army Corps of Engineers, Albuquerque District, April, 2012.

Figure 5.3 Without- and With-Project Floodplains Index

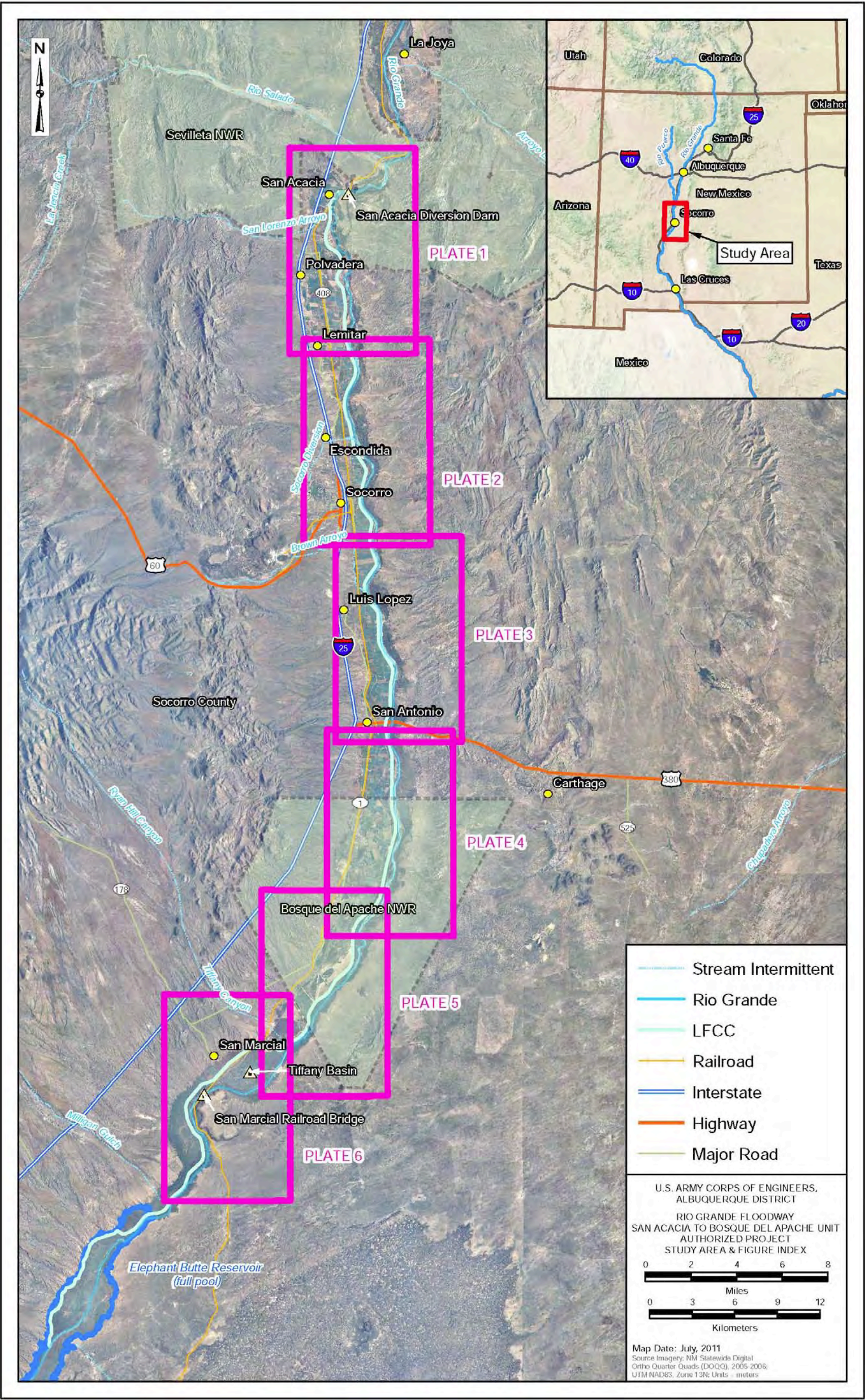


Figure 5.4 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

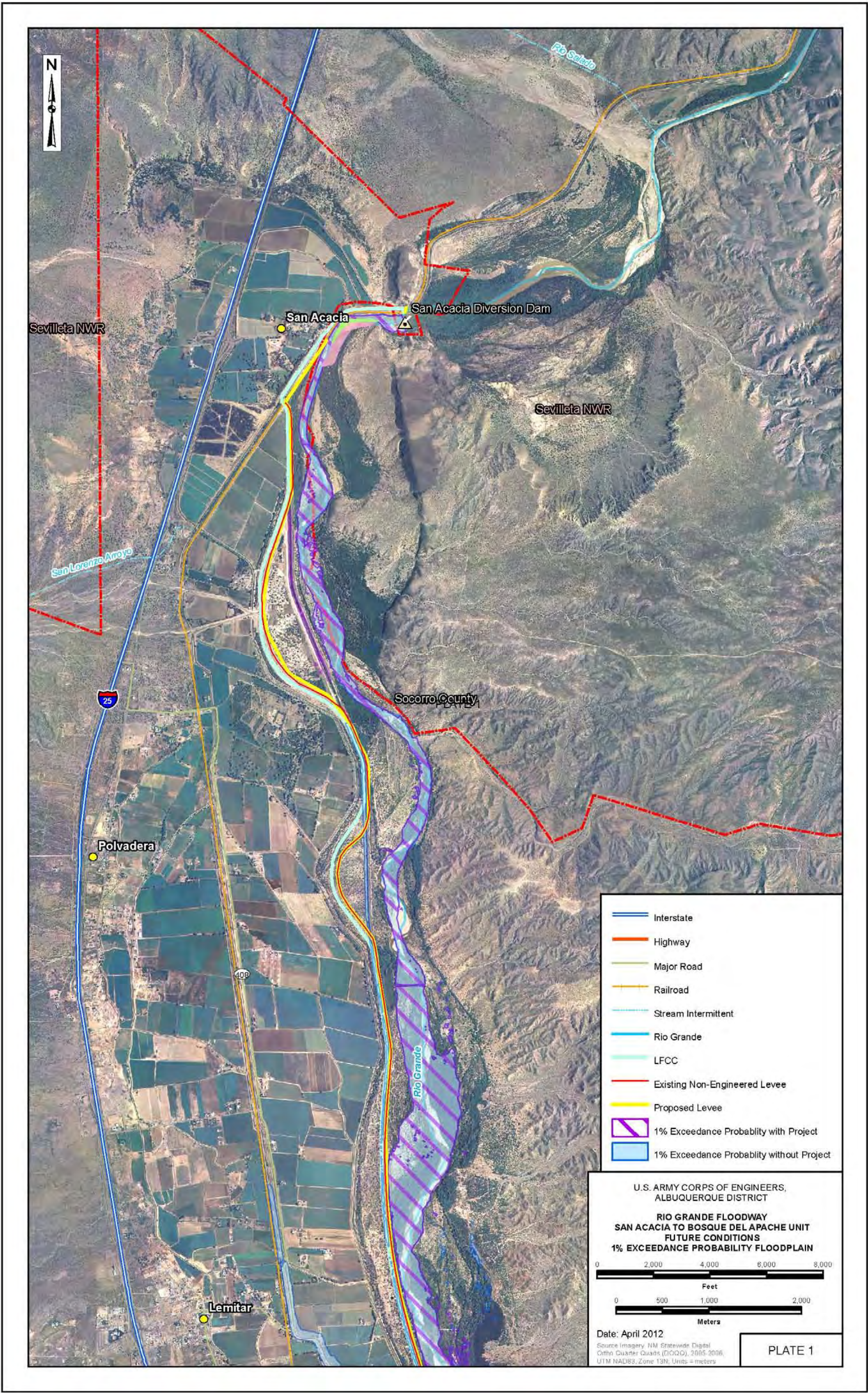


Figure 5.5 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

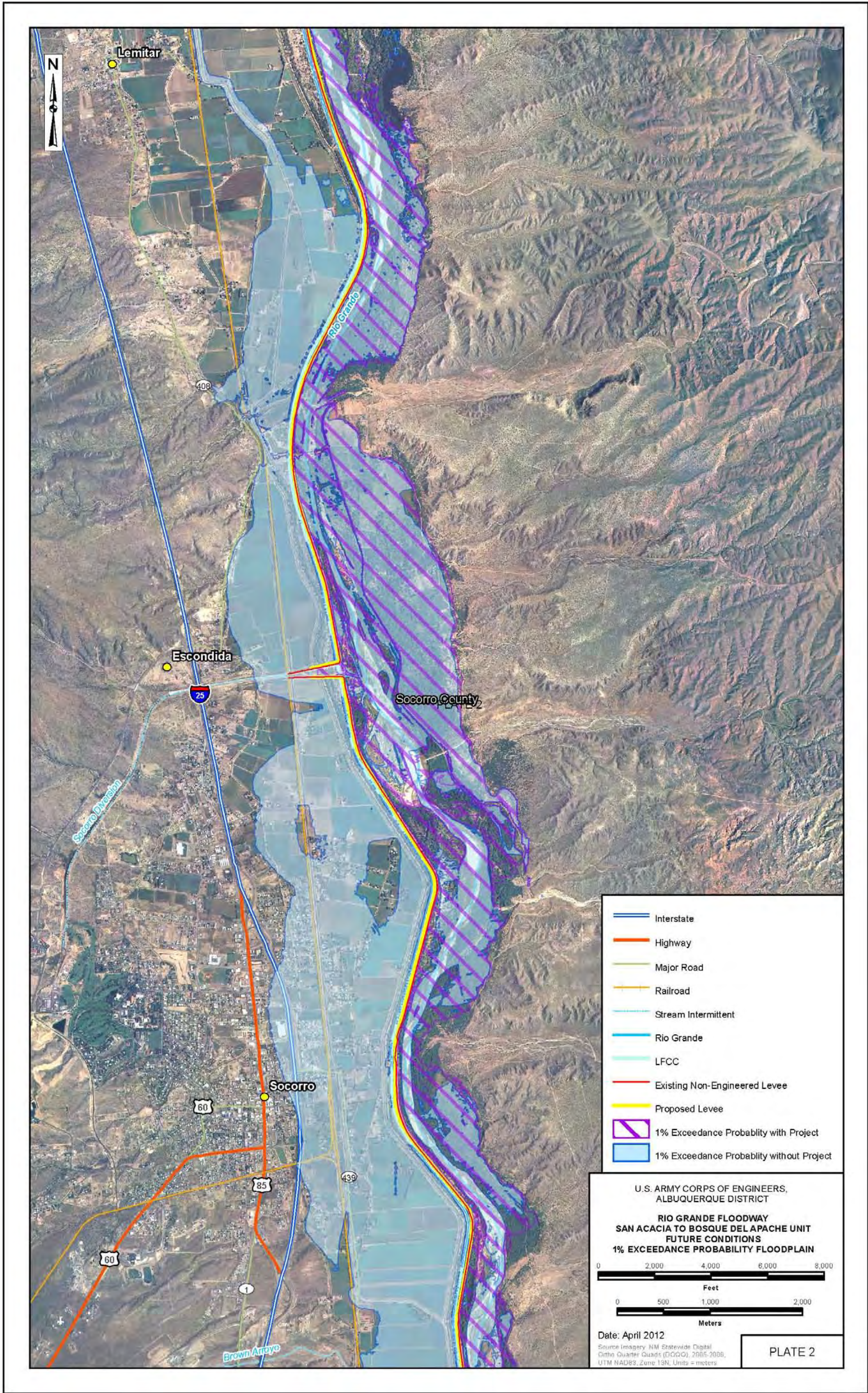


Figure 5.6 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

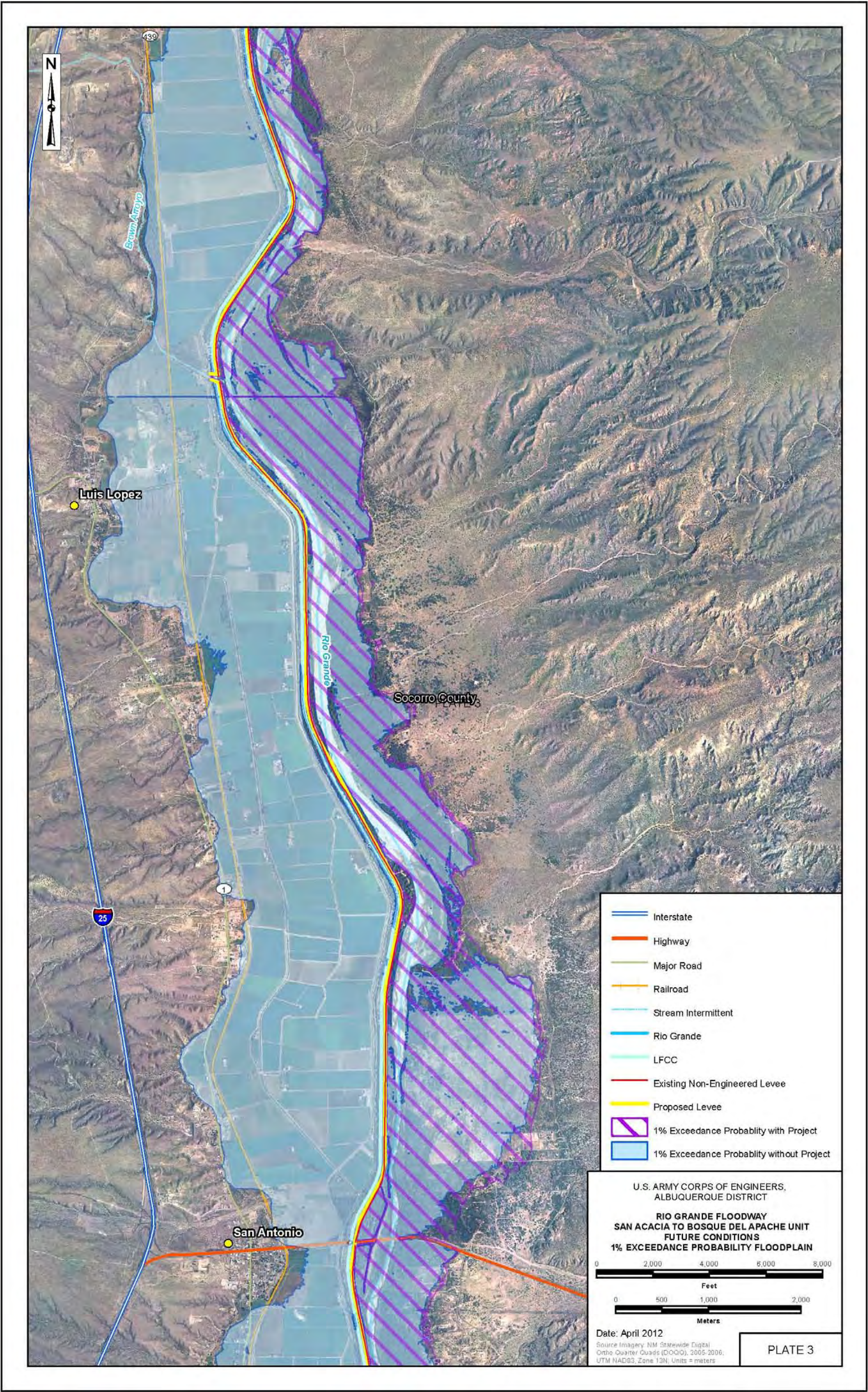


Figure 5.7 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

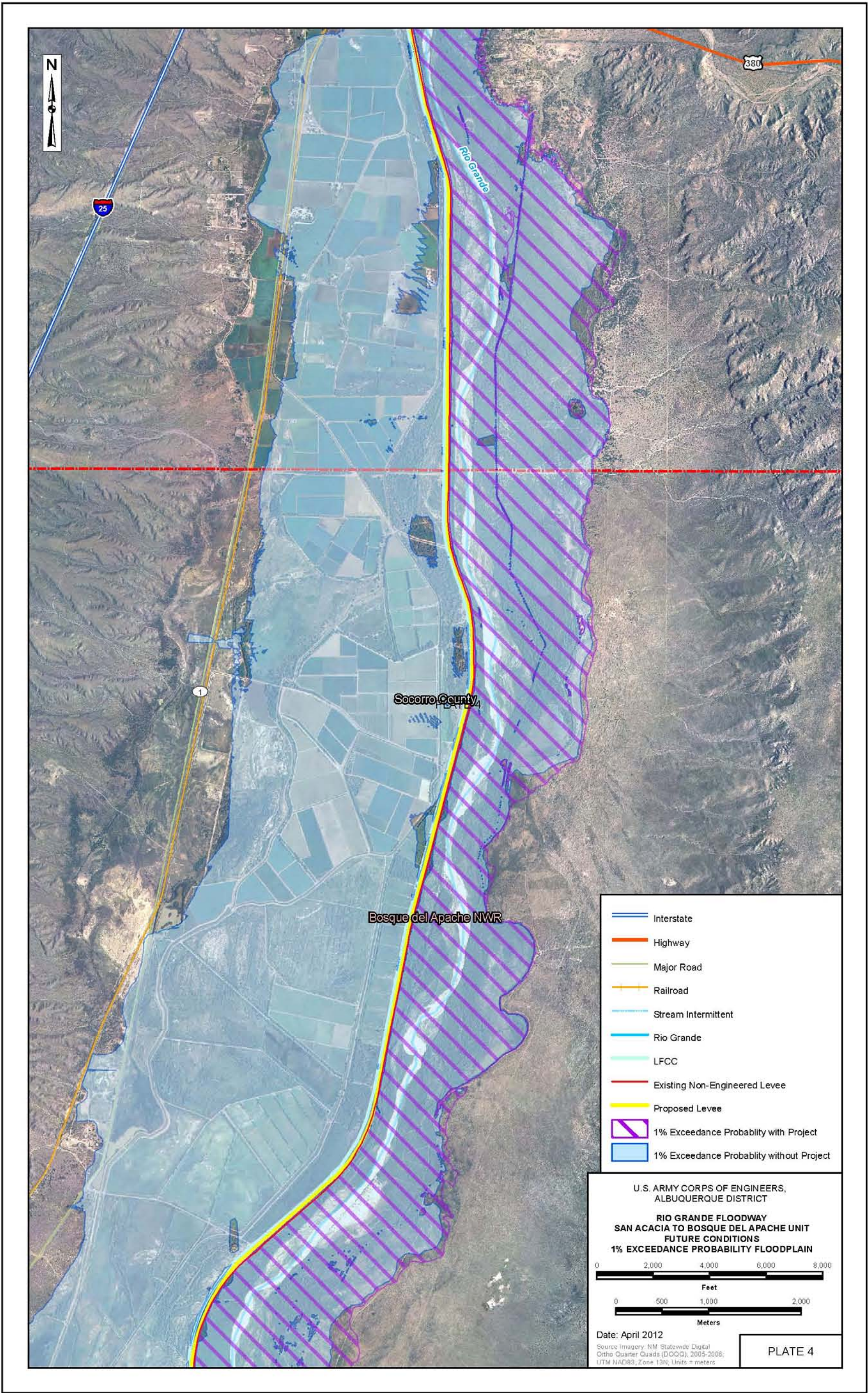


Figure 5.8 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

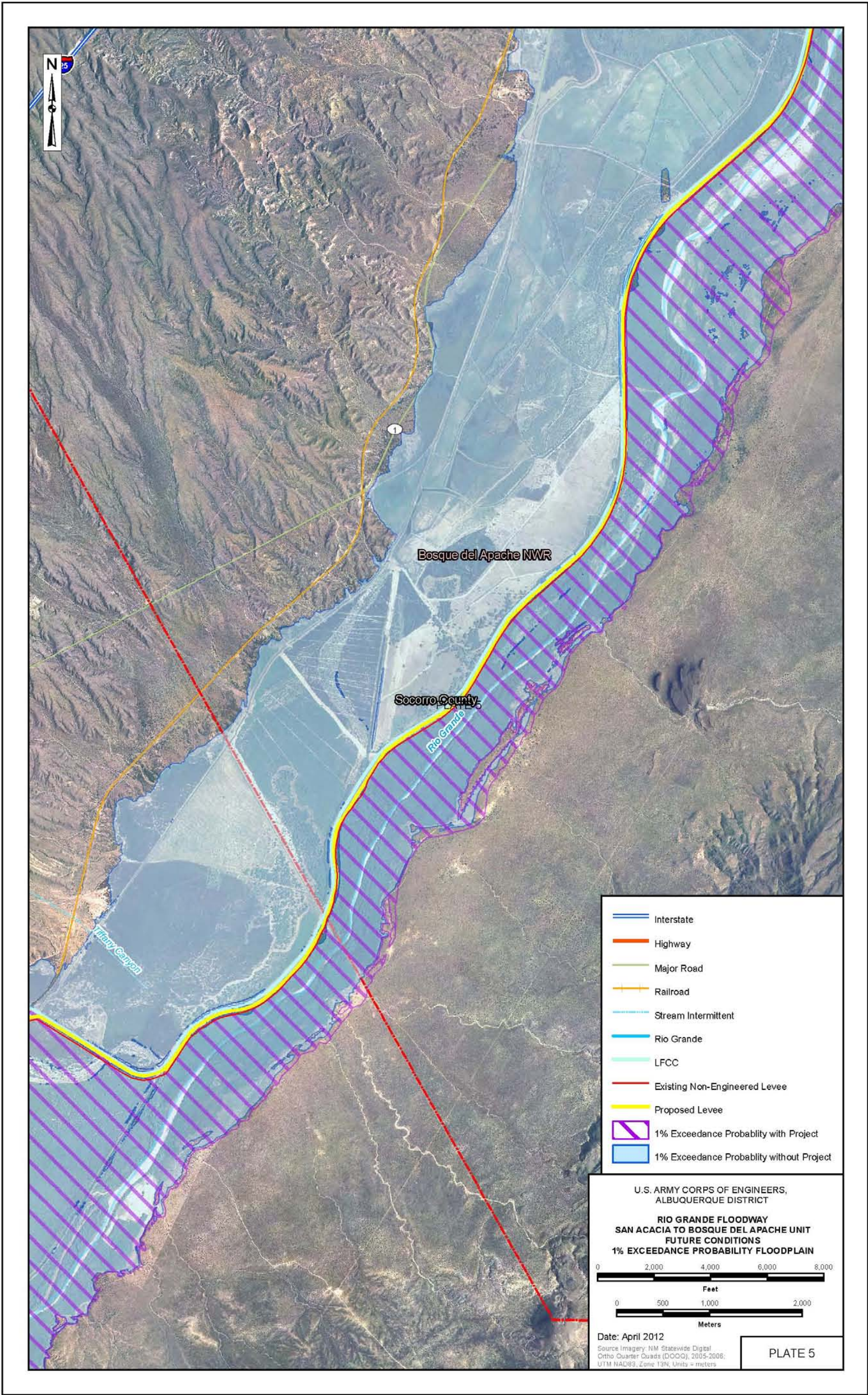
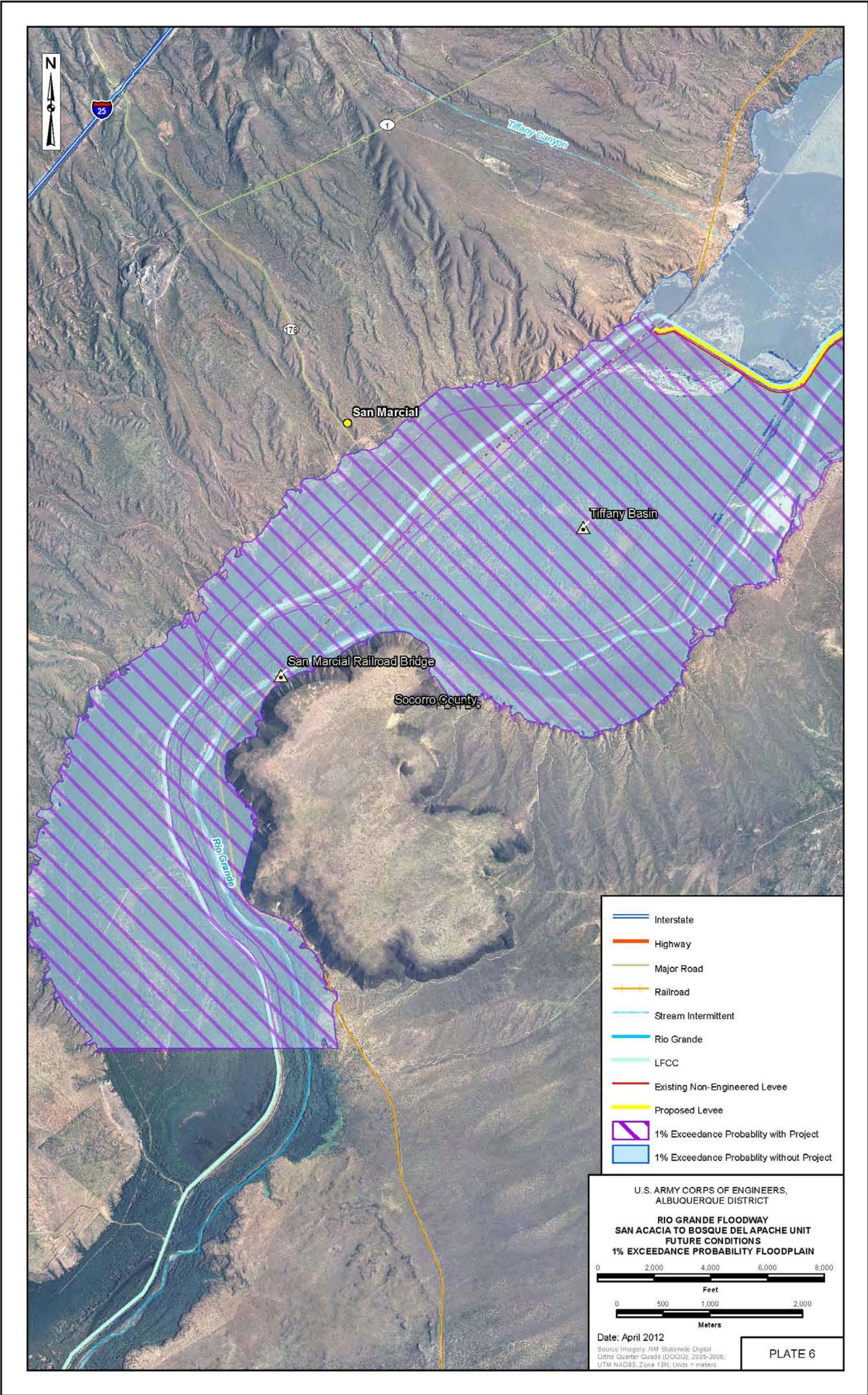


Figure 5.9 Without-Project Floodplains and With-Project Floodplains (Alternative at Base Levee + 4 ft levee height)



Additional Information
provided to the USFWS
(Nov. 17, 2012)

Additional information on the Corps of Engineers' San Acacia to Bosque del Apache Unit Project

November 27, 2012

The following provides additional information on the U.S. Army Corps of Engineers' (Corps') proposed *Rio Grande Floodway, San Acacia to Bosque del Apache Unit Project*. Also included are additional comments on the draft Biological and Conference Opinion (USFWS 2012; Draft BO) which was transmitted to the Corps by the U.S. Fish and Wildlife Service (Service) on August 16, 2012. Comments also address additional analysis information provided by the Service: *Nov 2012 Analysis of San Acacia Levee Project Impacts to SWFL Habitat*.

A. ENVIRONMENTAL BASELINE CONSIDERATIONS

The Service has attributed future degradation of 293 acres of flycatcher habitat to the Corps' proposed action. This attribution was apparently caused by a misunderstanding of the existing environmental baseline condition and current geomorphic processes in the action area. Additional explanatory information is therefore provided to distinguish the impacts that are solely the result of the Corps' proposed action as opposed to the effects of future aggradation due to confinement of the floodplain attributable to the environmental baseline.

As early as 1917, earthen flood protection works were constructed in the action area (Berry and Lewis 1997). Protective works were constructed in San Marcial in 1928 and maintained through 1941. A (still existing) spoil bank and attendant riverside drain were constructed along the western bank of the river from San Marcial to Bosque del Apache National Wildlife Refuge (33 miles; BDANWR) by the Middle Rio Grande Conservancy District between 1930 and 1935 (Berry and Lewis 1997). Eastward of these flood protection structures, the U.S. Bureau of Reclamation (Reclamation) later constructed the Low-Flow Conveyance Channel (LFCC) and its attendant spoil bank in 1951-58. (This latter spoil bank is the one proposed to be replaced with an engineered levee by the Corps.)

Between 1951 and 1974, Reclamation canalized the Rio Grande channel in the action area, straightening the channel and confining it by jetty-jack fields where necessary. Extensive invasion and development of dense exotic woody vegetation, primarily saltcedar, since the 1950s also has contributed to armoring of the banks and limiting channel meandering.

Regulations (50 CFR §402) implementing the Endangered Species Act (ESA) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early Section 7 consultation; and the impacts of State and private actions that are contemporaneous with the consultation in progress. ESA regulations also clearly state that projects constructed prior to November 10, 1978, are not subject to consultation on their past and ongoing effects, and that these effects must be considered part of the environmental baseline.

Past and current effects of the confinement of the Rio Grande channel due to construction of the spoilbank associated with the LFCC and river canalization are clearly part of the environmental

baseline. Additionally, the potential future effects of these projects have already been the subject of past and current consultations. The maintenance of the current channel alignment and repairs to threatened portions of the existing spoilbank are conducted through Reclamations' River Maintenance Program. This program has been consulted upon in 2001 and 2003 (USFWS 2001, 2003), and is included as an action in informal consultation conducted by Reclamation over the past three years. Reclamation's draft Biological Assessment (Reclamation 2012) includes activities and an adaptive management process to alleviate the potential jeopardy of listed species and minimize adverse modification of critical habitat in the action area.

In our project decision document (USACE 2012b) and Biological Assessment (BA; USACE 2012a) for the proposed San Acacia levee reconstruction, the Corps has determined that the expected future aggradation of sediment within the existing floodway is similar both with and without the Corps' proposed action. The analysis supporting this conclusion is summarized in a later section of this document. The Service has stated that it concurs with this determination. The additional information provided herein is intended to enable the Service to assess the potential effects attributable solely to the Corps' project.

The ESA and its supporting regulation (50 CFR §402) state that the effects of the agency's proposed action form the basis for determining incidental take, not the effects of the environmental baseline or non-related ongoing Federal actions. This is described most clearly in the Endangered Species Act Consultation Handbook (USFWS and NMFS 1998, page 4-47) when discussing the amount or extent of take anticipated:

“In determining whether the proposed action is reasonably likely to be the direct or indirect cause of incidental take, the Services use the simple causation principle; i.e., 'but for' the implementation of the proposed action and its direct or indirect degradation of habitat, would actual injury or mortality to individuals of a listed wildlife species be reasonably likely to occur? If the take would not occur but for the proposed action, then the Services must describe the amount or extent of such anticipated incidental take.”

The fact that the ESA expressly exempts projects that pre-date November 10, 1978, from the consultation requirements is not only supported by the Services' own regulations and policy, but also by case law. Under the Services' joint consultation regulations, the past and present impacts of federal projects that have already undergone Section 7 consultation or that pre-date the ESA become part of the environmental baseline. Baseline effects are not considered as part of the proposed federal action. Courts have consistently upheld the appropriateness of included pre-ESA projects as baseline (*See Idaho Department of Fish and Game v. National Marine Fisheries Service*, 850 F. Supp. 886, 894 (D. Ore. 1994)).

For the reasons outlined, and with the additional information provided herein, the Corps anticipates that the Service can now conclude that the Corps' proposed action will not be responsible for the take (in the form of harassment) due to the future degradation of flycatcher suitable habitat as a result of sediment accretion within the floodway.

B. COMMENTS ON THE SERVICE'S EFFECTS ANALYSIS

In their analysis of potential future effects, the Service has assumed that sediment aggradation would increase the depth to the water table within the floodway and result in the deterioration of suitable breeding habitat for the flycatcher. We believe that this analysis is based on the assumption that aggradation of the overbank area would elevate the root zone above the water table. The following information is provided to clarify the future conditions in the action area.

1. Sedimentation and Long-term Aggradation Processes

The above premise consigns aggradational response of the floodway elevation to the levee project, while discounting the associated channel aggradation, the groundwater's response to the channel's aggradation, and numerous additional processes and conditions that interact with the groundwater table and influence its behavior. The premise, considered within the context of USFWS' conceptual illustration, reproduced below as Figure 1, appears formulated on the assumption that the channel invert (and groundwater elevation) remains static or does not increase as part of the aggradation process. The Rio Grande channel, and therefore the local water table level, is expected to increase in elevation concomitant with the channel/overbank in the aggradational regime. For overbank aggradation to occur (from riverine flows) the active channel capacity must first be exceeded (by water and/or sediment), and the aggradation process raises both the channel and overbank elevations over time. There is no hydrologic or geomorphic support for the assertion that aggradation would result in an increase in depth to groundwater, absent other influences.

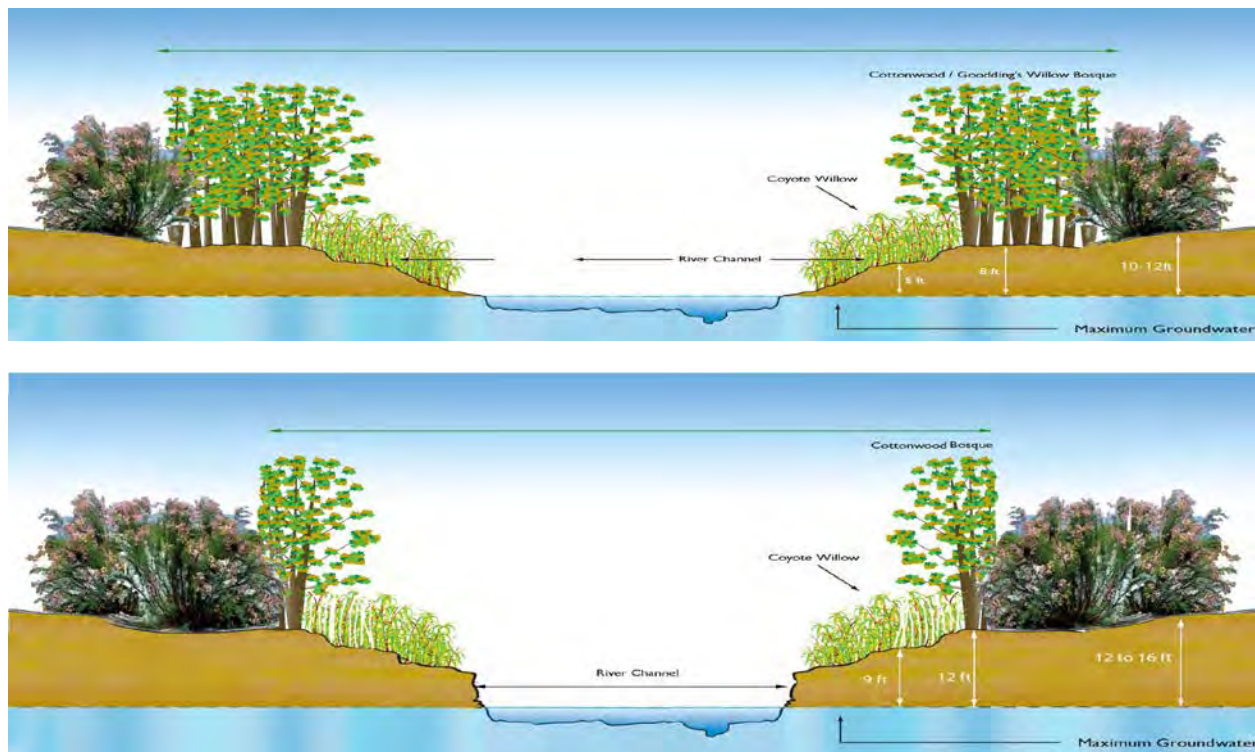


Figure 1. Service's conceptual depiction of static groundwater/surface water accompanied by floodplain (overbank area) elevation increase.

Within the avulsing system of the Rio Grande, channel aggradation typically precedes overbank aggradation. The active channel's bed rises over time as the sediment load exceeds the channel's sediment transport capacity, partially filling it. As this process progresses, flows greater than the active channel's capacity spill out to the floodway and distribute the river's sediment load, where deposition results in vertical accretion. As flow leaves the stream channel, the velocity is checked abruptly, and vertical accretion deposits can form natural berms adjacent to the channel. Thus, at modest flows, these may primarily deposit sediment adjacent to the active channel, thereby maintaining a relatively constant flow capacity within the channel even though the channel bed and water surface elevations are increasing. When the main channel becomes heavily charged with bed load it can fill to nearly the top of its banks, yet the flow can remain within and travel along a path that is elevated relative to portions of the floodplain, flanked by the confining natural berm deposits (Vanoni 2006).

At higher flows, avulsion to an adjacent, lower elevation flow path can occur, thereby abandoning the previously active channel. This can occur through formation of a sand plug, leaving behind an elevated ridge of relatively coarser bed material adjacent to the typically finer overbank flood water deposits. During flood flows, sediment-laden water is widely distributed throughout the floodway, though sediment transport capacity is not uniformly distributed and deposition occurs in less-energetic zones, such as more densely vegetated overbank areas. In these ways, excess sediment of varying characteristic sizes are distributed both laterally and vertically within the floodway, and channel planforms and cross-sectional geometries adjust and conform to the flow regime. Figure 2a serves to illustrate several of these aggradational processes — vertical accretion, natural berms, lateral distribution of sediment — over time at Rangeline 1523, roughly a mile downstream of the northern boundary of BDANWR.

This general aggradational trend is not uniform through time, and can be accompanied by other processes that can interact with it in complex ways. Figure 3, below, is reproduced from *Fluvial Processes in Geomorphology* (Leopold *et al.* 2006) and displays the low-water surface (2,000 cfs) elevation measured on the Rio Grande near San Marcial between 1895 and 1935. Note that though this is a plot of the water surface, it illustrates the relationship of the riverine water surface with the aggrading trend of the floodplain. It was widely assumed that aggradation within the San Marcial area was primarily attributable to the backwater influence of Elephant Butte Reservoir, but examination of the figure makes apparent the upward trend that predates the reservoir. What is also apparent is the non-uniformity of this upward trend, with its fits and starts, and temporary retreats. The large jumps in the elevations in Figure 3 are coincident with years of high runoff volume or large floods. The figure also includes an extended period of diversion of approximately half of the natural flow prior to 1915, accelerated erosion of tributary streams, and the influence of the railroad embankment built in 1880 diagonally across the valley that served to restrict sediment distribution over the river's floodplain and function as a dam during flood flows. All of these factors, natural and otherwise, combined within this short reach of the river to modify the conditions, and subordinate the importance of the reservoir pool of Elephant Butte as a controlling factor in the aggradation (Leopold *et al.* 2006).

RL 1523

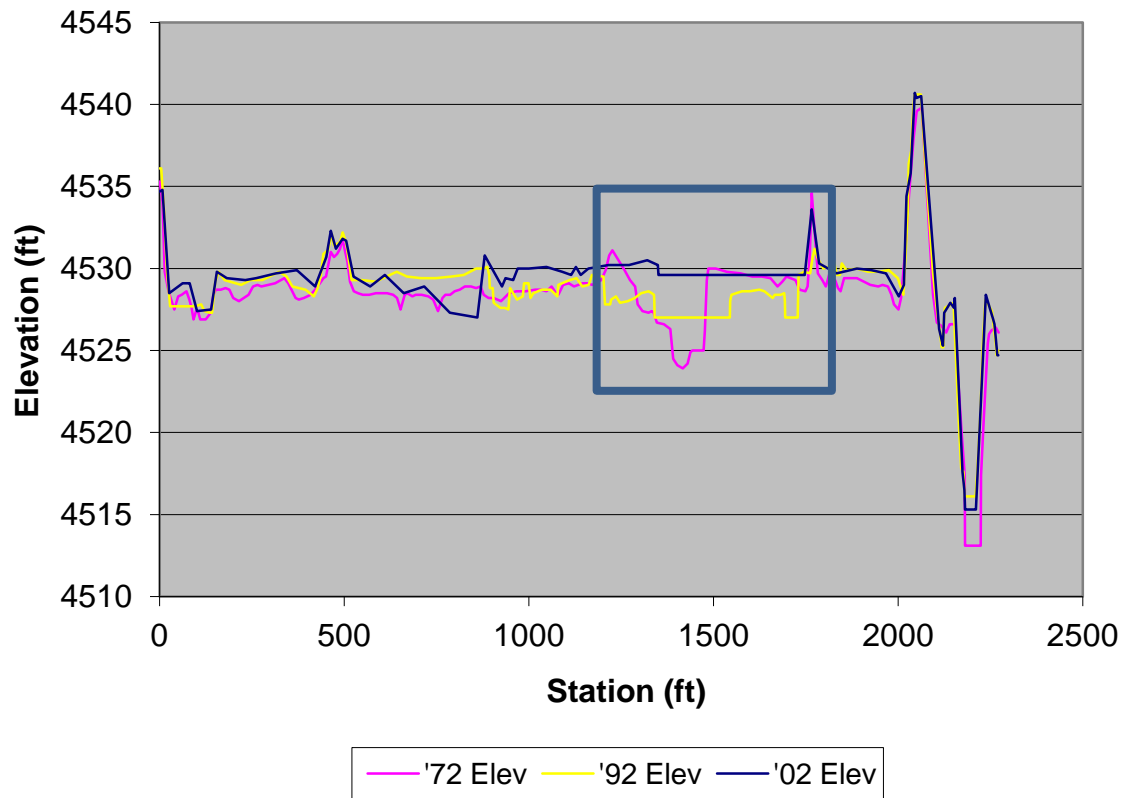


Figure 2a. Three periodic surveys at Rangeline 1523, approximately one mile downstream from the north boundary of BDANWR. For orientation, the floodway occupies roughly stations 0 - 2000, with the spoil bank and LFCC to the right (looking downstream). The box outlines the cross section of the aggrading river channel within the floodway at this location.

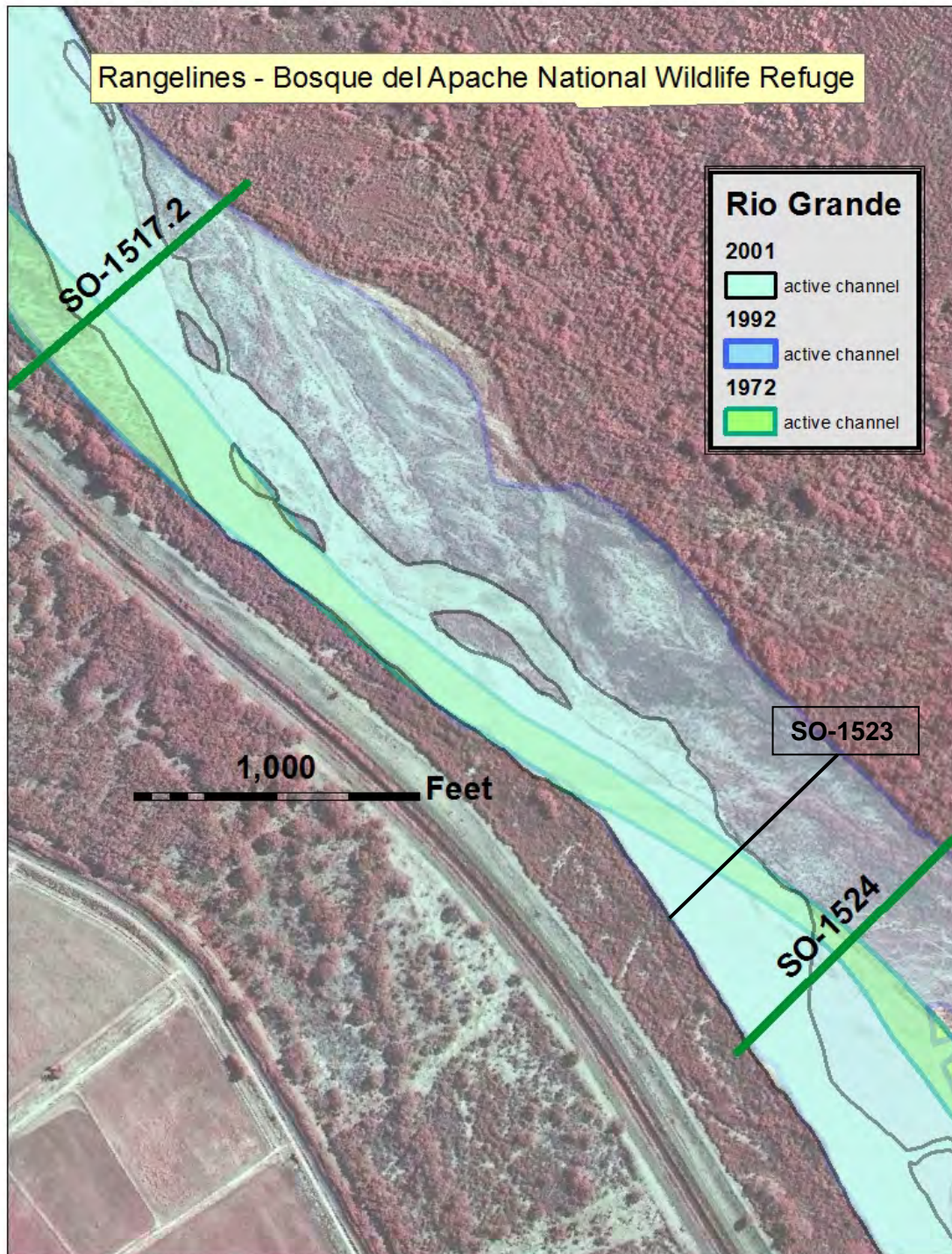


Figure 2b. Location of Rangeline 1523 (depicted in Fig. 2a). This map also illustrates the concomitant increase in channel width between 1972 and 1992, and the decreasing width through 2011, as a function of changing trends in annual water volume.

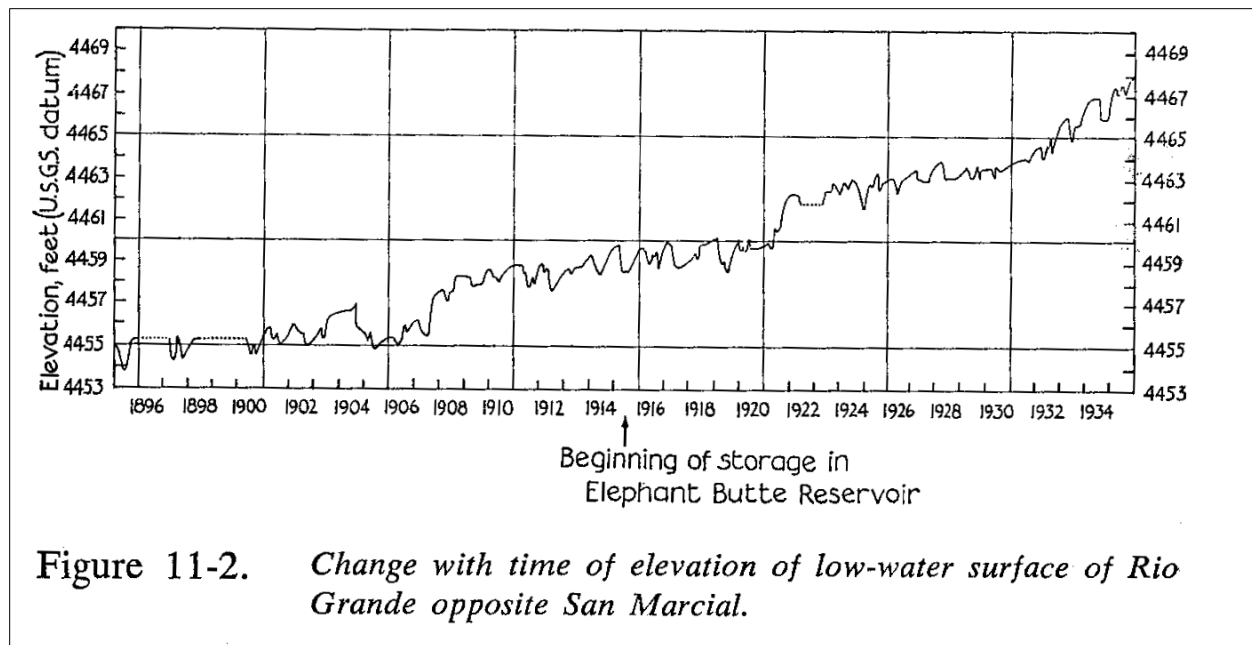


Figure 3. A figure from Leopold *et al* 2006.

As described previously, deposition of excess sediment within the floodplain overbank area through fluvial processes requires first filling the volume available within the channel. Whether through gradual filling of the active channel through bed deposition, or episodic overwhelming of the active channel's capacity during higher flows, this volume must be consumed first before river-borne sediment can proceed to the remainder of the floodplain and deposit. For the case of gradual channel bed aggradation, there is typically an accompanying increase in water surface elevation. For a case where there is channel bed lowering within the overall aggradational environment, the channel capacity is increased in the process, resulting in an increased volume that must be first satisfied before overbank deposition takes place. Since higher magnitude discharges are associated with decreasing probability of occurrence, there is a corresponding lower likelihood of overbank deposition that would also manifest as the irregular progress of the longer-term trend depicted in Figure 3.

2. Groundwater-Surface Water Interaction

There is clearly a link between the local water table elevation and the open channel water surface within the floodway as it interacts with the groundwater. This is partially illustrated, as it relates to a (presumably fixed) floodway elevation, by the "Exhibit 2-26" illustration provided by USFWS, and reproduced below as Figure 4. At a conceptual level this makes sense; increased river discharge normally leads to higher river stage within the channel, further increases in discharge produce broader areal flow extents for flows exceeding the active channel capacity. The first of these, higher stage, correlates with a higher head condition interacting with the adjacent groundwater. The latter broader surface area provides more area over which surface water can infiltrate and augment the groundwater. Both of these would serve to raise the water table, correspondingly decreasing the depth to groundwater. As seen in the exhibit, lower depths

to groundwater are coincident with the highest peak discharges in 2004 and 2005 (with some amount of time shift displayed), though there are other apparent influences implied by the out-of-phase responses in 2003 and 2006. This exhibit makes clear that the interaction between groundwater and surface water is one of complexity, and that depth to groundwater is dependent on many more variables than river discharge alone.

Shafike (2007) describes the general groundwater behavior within the project region as moving from the east and west to the center of the basin where it discharges to the surface water features. Shafike includes background information on the LFCC, noting that it was designed to be the lowest point within the valley, with a bed elevation significantly below that of the river channel. The modeling described within this document links surface water and groundwater, and models riparian and agricultural evapotranspiration. The Rio Grande, LFCC and drains are modeled as head dependent flow boundaries of the aquifer system. Steady state calibration of the model clearly depicts seepage from the (higher elevation) Rio Grande and gain to the LFCC. This infers the significance of the lower elevation LFCC's water surface on the groundwater behavior.

Exhibit 2-26

Depth to Groundwater Versus Discharge – Bosque del Apache

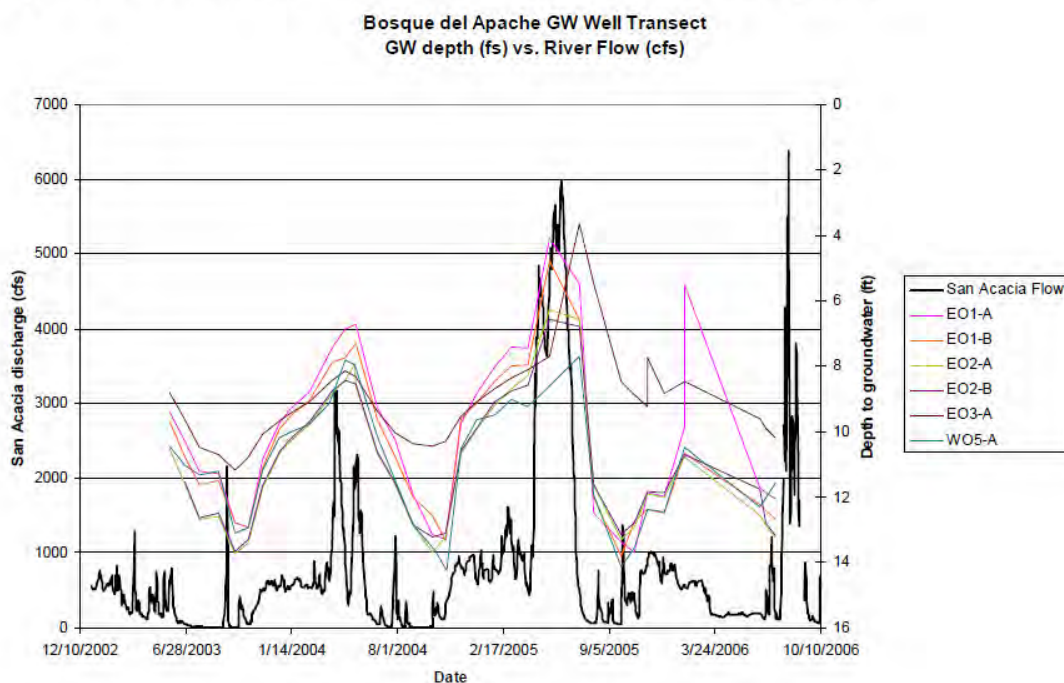


Figure 4. Service Exhibit 2-26.

Given the positive correlation between increasing mean water surface elevation within an aggradational regime depicted by Figure 3, above, there is certainly potential for the depth to local ground water to change in response to floodway aggradation. By itself, an increase in the mean water surface of the river would be expected to incur an increase in the local groundwater elevation through its influence as a higher-head flow boundary of the aquifer. (This can be seen in the project area, for example, when the local water table rises in response to the active river bed's rise, and wetlands along the eastern bluff are formed as the water table approaches and

intersects the floodway topography. Under that development scenario, this would be expected to occur as a *decrease* in depth to groundwater, at least until less-frequent surface water events carry river sediment into the overbank areas and increase their elevations through deposition, catching up with the surface water rise.) In isolation, the aggradation process would be expected to result in a neutral-to-positive net change (*i.e.*, decrease) in the depth to groundwater. The influence of numerous other factors, most notably the surface water elevation within the LFCC, however is seen to exhibit significant influence over the depth to groundwater, outside of the floodway aggradation.

3. Concomitant Channel Incision

The discussion in Section 1 above illustrates some of the complexities of the surface water behavior of the historic Rio Grande within the project area in the context of a long-term aggradational response. Scaling down to a shorter-term perspective adds to the complexity further still. While some of the drops in water surface elevation seen in Figure 3 could be the result of channel avulsions, which often result in a lowering of the channel water surface elevation, this water surface lowering can also result from channel incision. Variations in both the sediment load and transport capacity of the river over time and space manifest as changes in the channel, and would produce similar fluctuations to those displayed intermediately within the overall upward trend seen in Figure 3 above. Channel bed lowering can and does occur from temporal changes in the generally sediment-rich river's flow, but can also result from other perturbations to the system that may not be related to the overall aggradational state. Examples of such disturbances would include headcutting and dredging.

Figure 2a clearly demonstrates that aggradation of the overbank areas and river channel occur concurrently in the BDANWR reach (consistent with the fundamental principles of fluvial geomorphology). However, beginning in 2000, the water surface elevation of Elephant Butte Reservoir has declined rapidly, resulting in headcutting (channel incision) within the action area (USBR 2012). It is estimated that the channel bed elevation at the San Marcial railroad bridge has lowered approximately 5 feet over the past seven years (pers. comm., Robert Padilla, USBR, Nov. 26, 2012). The river channel downstream from River-mile 78 (near mid-BDANWR) is influenced by the changing pool elevations of Elephant Butte Reservoir (Makar and AuBuchon 2012). Reclamation's 2012 BA (USBR 2012) specifically identifies bed degradation, channel incision, and increasing bank height as current trends in this reach. This geomorphic condition will persist until the reservoir storage again approaches its upper capacity limit.

Summarizing, the long-term condition of aggradation of sediment within the floodway is continuing while the relatively short-term incision of the channel effectively increases the local depth to the water table. Rather than aggradation, the Service's analysis focused on the potential effects of channel incision. Incision lowers the elevation of the bed and the water surface for a given discharge. Therefore, water seeping from the incised channel is deeper relative to the unchanged ground surface in the overbank areas.

Short-term incision also results from periodic dredging of pilot channels as part of Reclamation's river management activities. Over the past 20 years, Reclamation and the New Mexico Interstate Stream Commission have regularly dredged pilot channels in the headwaters of the reservoir to facilitate water delivery (USBR 2012). These activities are localized to areas where sediment

gradually accumulates within the channel to result in adverse bed slopes, and also in areas of episodic accretion that form sediment plugs (USBR 2012). Specific activities, such as dredging through the 2008 sediment plug at BDANWR (USBR 2008), have been, and will continue to be, consulted upon by Reclamation.

4. Current Condition of Vegetation

The Service has stated that cottonwoods within the BDANWR reach have been recently observed to be dying, and has attributed this as an effect of accretion of sediment in the overbank areas. However, there are many potential causes for vegetation stress and local groundwater levels effects within that area.

As described above, the long-term condition of aggradation of sediment within the floodway is continuing while the relatively short-term (*e.g.*, sediment plug remediation) and more protracted (headcut from Elephant Butte Reservoir) incision of the channel effectively increases the local depth to the water table.

Drought conditions in New Mexico since 2000 have resulted in below average precipitation (Figure 5) and river flow (Figure 6) in the action area for years. Both conditions can result in poor rates of growth for riparian vegetation.

In addition to lower annual volume of river flows, the pattern of low flows in the action area has been altered. Since implementation of flow targets in the 2003 BO (USFWS 2003), the channel in the action area has been dry for an average of nearly 40 days per year (range: 1 to 65). Based on a frost-free period of 191 days from mid-April through late October in Socorro County (Johnson 1988), this represents an average of 20.2% of the growing season (range: 0.5% to 34.0%; Table 1). River drying has been most severe in 2010 and 2011, representing 31% and 34% of the growing season, respectively. The BDANWR reach is the first portion of the river to dry in any given year, and vegetation in that reach has likely endured the most stress from dry channel conditions.

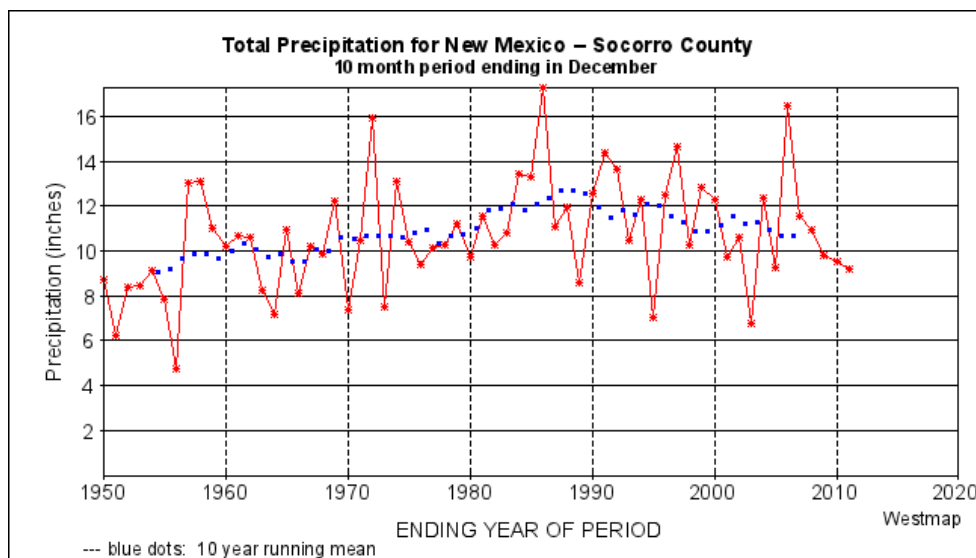


Figure 5. Annual precipitation in Socorro County, NM, 1950 through October 2012. (Source: Western Climate Mapping Initiative [WestMap], [www.cefa.dri.edu/ Westmap/](http://www.cefa.dri.edu/Westmap/), based on interpolated PRISM data.)

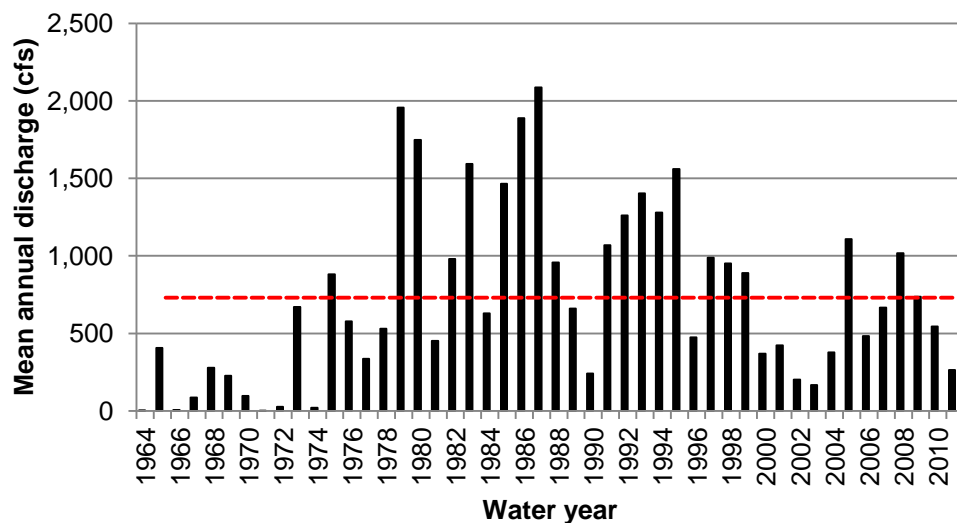


Figure 6. Average annual discharge (cfs) for water years 1964 through 2011 at the San Marcial gage. The dashed red line depicts the average (730.1 cfs) for the period of record.

(Source: USGS Water Resources information for New Mexico,

http://waterdata.usgs.gov/nm/nwis/annual?site_no=08358400&agency_cd=USGS&referred_module=sw&format=sites_selection_links.)

Table 1. Annual days of river-drying, and percentage of growing season, in the San Acacia reach (USBR 2012).

| Year | Days dry | % of growing season (191d) |
|---------|----------|----------------------------|
| 2003 | 6 | 3.1% |
| 2004 | 57 | 29.8% |
| 2005 | 48 | 25.1% |
| 2006 | 33 | 17.3% |
| 2007 | 36 | 18.8% |
| 2008 | 1 | 0.5% |
| 2009 | 42 | 22.0% |
| 2010 | 59 | 30.9% |
| 2011 | 65 | 34.0% |
| Average | 38.6 | 20.2% |
| Minimum | 1 | 0.5% |
| Maximum | 65 | 34.0% |

5. Conclusions

The overall complexity of the numerous factors depicted herein and their influence on the future groundwater table support the conclusion that it would be unreasonable to ascribe an increase in the depth to groundwater to a levee project that, in essence, maintains the status quo of the future trajectory of the floodway aggradation, and does not directly include any action by USACE that can be attributed to a departure from the ongoing processes, as they are understood within the context of the uncertainties inherent in prediction of future states.

C. EFFECTS OF THE CORPS' PROPOSED ACTION

In our BA (USACE 2012a) and GRR/SEIS (USACE 2012b), the Corps provided information regarding the expected sediment aggradation within the floodway of the San Acacia reach of the Rio Grande. (The Rio Grande floodway includes the river and the floodplain to the east of the existing spoilbank.) To characterize the future conditions of the floodway which would affect changes in the flood risk of the system, the Corps evaluated historic measured cross-sectional information spanning a 30-year period and developed a regression relationship to project this measured aggradation rate to a future state. These cross-sectional changes were then incorporated into numerical models to arrive at estimated water surface profiles for evaluation of various alternatives, including the without-project alternative, and estimate alternative performance at a future state (Figure 7).

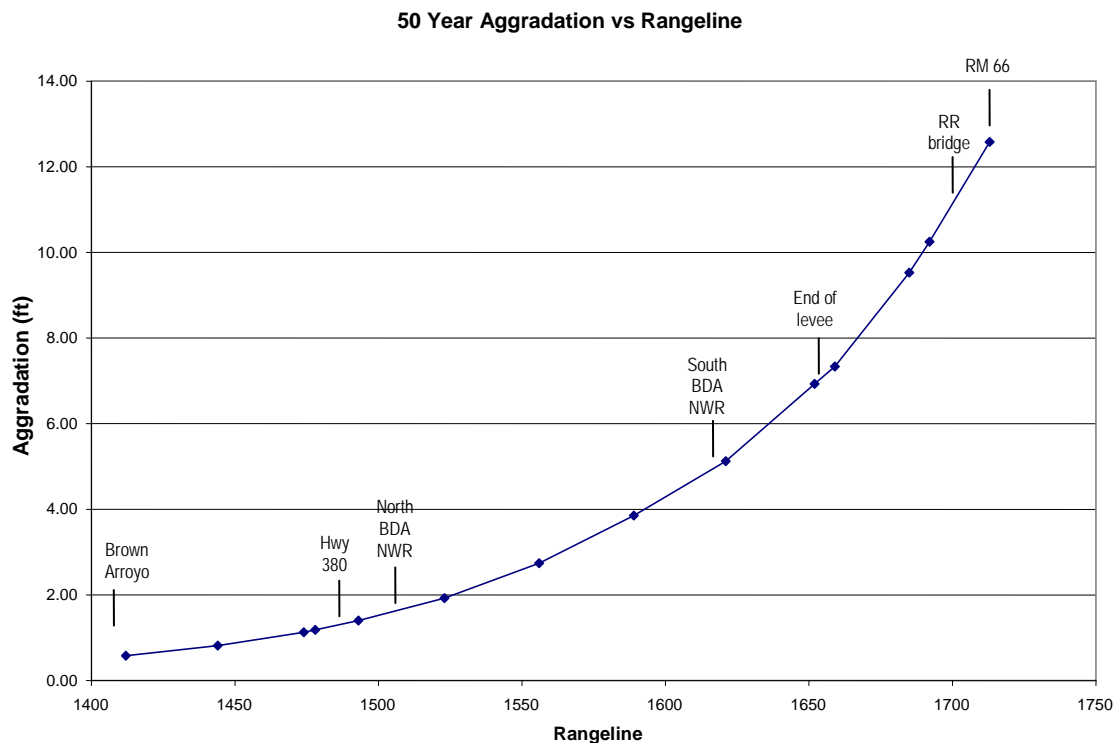


Figure 7. Predicted 50-year aggradation for selected range lines along the project reach.

At the conceptual level, it was recognized early on that the pronounced sedimentation within the study area has exhibited a significant influence on historical channel profiles and river stages. The recent historic (last 30 years) aggradation, on which the Corps based its future projections, has been accompanied by breaches to the spoilbanks on several occasions, but continues to be exhibited overwhelmingly within the floodway confined by the spoilbank. When breaches have occurred, sediment and large volumes of water have escaped the floodway to flood areas of the historic floodplain. It is flood risks associated with these relatively brief, but potentially catastrophic, events that the Corps is focused on minimizing through the implementation of the proposed action.

While these episodic events resulted in a decrease in the volume of sediment within the floodway, over the long-term, the associated volumes of lost sediment are insignificant when compared with the ongoing depositional environment. Since damage to the spoilbank that normally confines the river to the floodway has always been repaired in short order, the confined state has been the defining condition. It has been established that any damage in the future to the existing spoilbank would also be quickly repaired, restoring the normal state that governs the long-term aggradational trend.

During such a breaching event, flows that remained within the floodway would be substantially reduced, with correspondingly less sediment transport energy, which would result in localized deposition near the area of a breach. This temporal increase in deposition within the floodway, along with the loss of material through a breach described above, was discounted for the purpose of projecting future conditions for the hydraulic performance evaluations. Given that they would be expected to exhibit secondary influences, in markedly opposing directions (*i.e.*, adding / removing sediment volume), in terms of the long-term sediment budget, they were assumed to not affect the expected performance of the alternatives evaluated within the context of the uncertainties clearly present when estimating out into the future.

As discussed above, effects due to the existence of spoilbank are part of the environmental baseline in this consultation. The dynamics and volume of sediment accretion within the floodway will be the same both with and without the Corps' proposed action; therefore, it is not appropriate to assign take of listed species as an effect of the proposed action.

The proposed action does entail a direct effect to riparian vegetation during construction. As summarized in Table 5.2 of our BA, a total of 39.3 acres of woody riparian vegetation — of which 31.9 acres is dominated by saltcedar — would be removed or otherwise altered by the proposed action. Table 5.4 in the BA summarizes the flycatcher habitat suitability of the affected riparian zone and upland vegetation as mapped and classified by Reclamation (USBR 2010): 1.8 acres of Suitable habitat and 6.6 acres Moderately Suitable habitat (totaling 8.4 acres). Using the Service's index of 2.7 acres per flycatcher territory, the resulting take anticipated from modifying 8.4 acres of suitable (or nearly so) habitat would be 3 territories.

D. PROPOSED MITIGATIVE ACTIVITIES

Suitable flycatcher breeding habitat is classified as Resource Category 2 by the Service, which includes vegetation of regional importance. To compensate for the temporal loss of vegetation structure while mitigative plantings are maturing, a mitigation ratio of 4:1 this resource category is commonly applied in USFWS Region 2.

The Corps' BA (USACE 2012a), the Service's Draft BO (USFWS 2012), and the preceding discussion in this document all acknowledge that many factors will continue to stress the riparian vegetation in the action area. Additionally, the presence of tamarisk leaf beetle (*Diorhabda* spp.) has recently been recognized to be advancing in the direction of the action area from the north (Albuquerque) and south (El Paso). There is a highly likely chance of extensive defoliation of saltcedar throughout the San Acacia reach. Although it is an exotic species, saltcedar is a significant structural component of many areas classified as Suitable and Moderately Suitable flycatcher habitat (USBR 2010). The Corps recognizes that the relative value of suitable flycatcher breeding habitat will increase in the near future. Accordingly, the Corps proposes to establish dense woody plantings in the action area at a replacement ratio of 6:1, or 50.4 acres.

The Corps further commits to the following Term and Condition for Reasonable and Prudent Measure 3 in the Draft BO:

Prepare and implement a flycatcher habitat mitigation and adaptive management plan for the San Acacia Reach. The plan will include Best Management Practices for construction to minimize effects to the flycatcher, and its critical habitat. The plan will identify specific areas for habitat management with a schedule for completing construction of up to 50.4 acres of dense riparian shrub habitat possessing primary constituent elements of critical habitat. The habitats shall be constructed prior to, or immediately following, the loss of critical habitat due to specific construction activities of to the proposed action. The plan will be reviewed by the Service and should be completed by December 31, 2014.

Additionally, the Corps offers the following term and condition relative to Reasonable and Prudent Measure 1:

The Corps will monitor groundwater-surface water interaction and dynamics in the San Acacia reach; and will assist resource management agencies in the analysis, modeling, planning, and adaptive management of activities relating to future sediment, habitat, and flow issues.

During the relatively long construction period (up to 20 years) for the proposed action, changes in the condition of ecological resources could alter the determinations of effects to listed species that are made by the Corps or Service at the present time. Therefore, this Section 7 consultation is being conducted programmatically to adapt proposed activities to changed conditions. The Corps, will monitor the condition of listed species, channel morphology, hydrology, and ecological resources in the action area throughout the construction period, and reinitiate consultation as appropriate.

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BIOLOGICAL OPINION



United States Department of the Interior

FISH AND WILDLIFE SERVICE

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February 28, 2013

Consultation No. 02ENNM00-2012-F-0015

Previous Consultation No. 2-22-95-F-0180

Julie A. Alcon, Acting Chief
Planning Branch, Albuquerque District
Department of the Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109-3435

Dear Ms. Alcon:

This document transmits the U.S. Fish and Wildlife Service's (Service) final programmatic biological opinion (Opinion) on effects of the U.S. Department of the Army, Corps of Engineers, Albuquerque District (Corps) proposed action of construction, operation and maintenance of the Rio Grande Floodway, San Acacia to Bosque del Apache Unit, in Socorro County, New Mexico (i.e., proposed action or San Acacia Levee Project). The Corps proposes construct a new 43-mile levee by replacing an existing, earthen spoil bank in order to better protect nearby communities from a 100-year flood. The levee plan was divided into six segments, with construction occurring within those segments at approximately two miles per year, over a period of 20 years. Some of the excavated spoil bank material will be used in the construction of the new levee, but a large amount of excavated material will be transported and disposed on a 300-acre location at the south end of the project area. With continued operations and maintenance, the new levee will have a functional regional flood control life of 50 years. Construction is estimated to occur over the next 20 years, so this project will continue to at least 2082.

This Opinion addresses the effects of the San Acacia Levee Project on the endangered Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow), its designated critical habitat, the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) (flycatcher), and its designated critical habitat. Your request for formal consultation, in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), was received as complete on May 8, 2012. A draft Opinion was issued by the Service on August 16, 2012. A request to extend the deadline to allow Corps to comment on the draft Opinion was received on September 20, 2012. The Corps and Service met multiple times and exchanged information regarding the project and analysis of effects to endangered species. No permit or license applicants (16 U.S.C. 1532 and 1536(3)) were identified by Corps as part of this ESA consultation.

This Opinion is based on information submitted in the May 8, 2012, San Acacia Levee Project Biological Assessment (BA; USACE 2012a), the draft General Reevaluation Report and Supplemental Environmental Impact Statement II (USACE 2012b), Geographic Information System (GIS) files and information from Restoration Analysis and Recommendations for the San Acacia Reach of the Middle Rio Grande, New Mexico (Parametrix 2008), and the Conceptual Restoration Plan for the Active Floodplain of the Rio Grande San Acacia – San Marcial, New Mexico (Tetra Tech EM Inc. 2004), conference calls, e-mails, and meetings between Corps and the Service, supplemental information provided electronically (USACE 2012d,e), and other sources of information available to the Service. The administrative record for Consultation No. 02ENNM00-2012-F-0015 is on file at the Service's New Mexico Ecological Services Field Office in Albuquerque, New Mexico.

The Service concurs with Corps' findings that the proposed action "may affect, but is not likely to adversely affect" Aplomado falcon (*Falco femoralis*) (falcon) or least tern (*Sternula antillarum*) (tern). As documented in Corps BA (USACE 2012a), the timing and location of Corps activities are unlikely to disturb foraging or resting behavior of the falcon or the tern and therefore, are discountable. No critical habitat is designated for the falcon or the tern in the project area and therefore, none is affected by the proposed action.

Critical habitat is currently designated for flycatcher and silvery minnow within the San Acacia Levee Project area. This Opinion assesses effects of the proposed action on designated flycatcher critical habitat, and designated silvery minnow critical habitat. The Service does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, the Service relied upon the statute and August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. USDI Fish and Wildlife Service (CIV No. 03-35279) to complete the following analysis with respect to designated critical habitat. This consultation analyzes the effects of the action and its relationship to the function and conservation role of the physical and biological features of critical habitat to determine whether the current proposed action adversely affects or adversely modifies silvery minnow or flycatcher designated critical habitat.

The Service is unable to concur with Corps findings that the San Acacia Levee Project "may affect, is not likely to adversely affect" flycatcher, or flycatcher designated critical habitat because effects of the proposed action are not wholly beneficial, discountable, or insignificant. As described in this Opinion, direct and indirect effects of the proposed action to flycatchers and flycatcher habitat are likely to adversely affect flycatchers, and their designated critical habitat. Additionally, Corps found that the proposed action, "may affect, likely adversely affect" silvery minnow and silvery minnow designated critical habitat. Therefore, this Opinion describes adverse effects to silvery minnows, flycatchers, and their designated critical habitats.

BIOLOGICAL OPINION

I. DESCRIPTION OF PROPOSED ACTION

Structural Flood Control

Historically, the predominant approach to flood control in the United States has been the use of engineered structures, such as levees, floodwalls, and dams. Human development within the historical floodplain near Socorro, New Mexico, has resulted in the need for structural flood control measures including engineered levees to limit the area over which the Rio Grande can move (USACE 2012b). Twelve alternatives were considered and presented in the Draft General Reevaluation Report/Supplemental Environmental Impact Statement II (GRR/SEIS) by the Corps (USACE 2012b). The GRR/SEIS provides details as to the plan formulation process, the entire array of alternatives considered, alternatives not considered, and why the proposed action considered in this Opinion was chosen. The BA (USACE 2012a) also described the purpose and need for the proposed action, details of the proposed action, the environmental consequences, details of the Corps conservation measures for fish and wildlife, and Corps findings of effects of the proposed action on silvery minnows, flycatchers, and their critical habitats. Corps (USACE 2012d, 2012e, 2013) provided supplemental material specifying additional conservation measures for silvery minnow and flycatcher.

The purpose of the proposed action is provision of improved flood control to the portion of the Middle Rio Grande Valley (MRGV) extending from San Acacia, New Mexico downstream to San Marcial, New Mexico (Figure 1). The proposed action includes construction, operation and maintenance of engineered levees and other associated activities associated with the Corps Rio Grande Floodway, San Acacia to Bosque del Apache Unit (San Acacia Levee Project or Project or proposed action). The Project area specifically occurs in the southern most section of the MRGV, from approximately one-half mile upstream of the San Acacia Diversion Dam (SADD) and the Rio Grande to just below the Burlington Northern Santa Fe Railroad crossing of the Low Flow Conveyance Channel near Tiffany and San Marcial, New Mexico, and next to the Low Flow Conveyance Channel (LFCC) (Figure 1).

The design limits of engineered, earthen levees must be considered in river valleys because variations in flow and the sinuosity of the river channel can result in uncertainty in flow trajectory within a valley under high river flow conditions as well as levee integrity. The Corps refers to the probabilities of a particular flow or flood event as a percentage exceeded in any one year, such as, 0.2%, 1%, 5%, 10%, 14 %, 20%, and so on (USACE 2012b). The previous nomenclature often referred to the “100-year flood,” but is more properly defined as the flood having a 1 percent chance of being exceeded in any one year (USACE 2012b). Similarly, the 5% flood was previously called the “20-year” flood, the 2% flood was previously called the “50-year” flood, and the 0.2% flow was called the “500-year” flood (USACE 2012b).

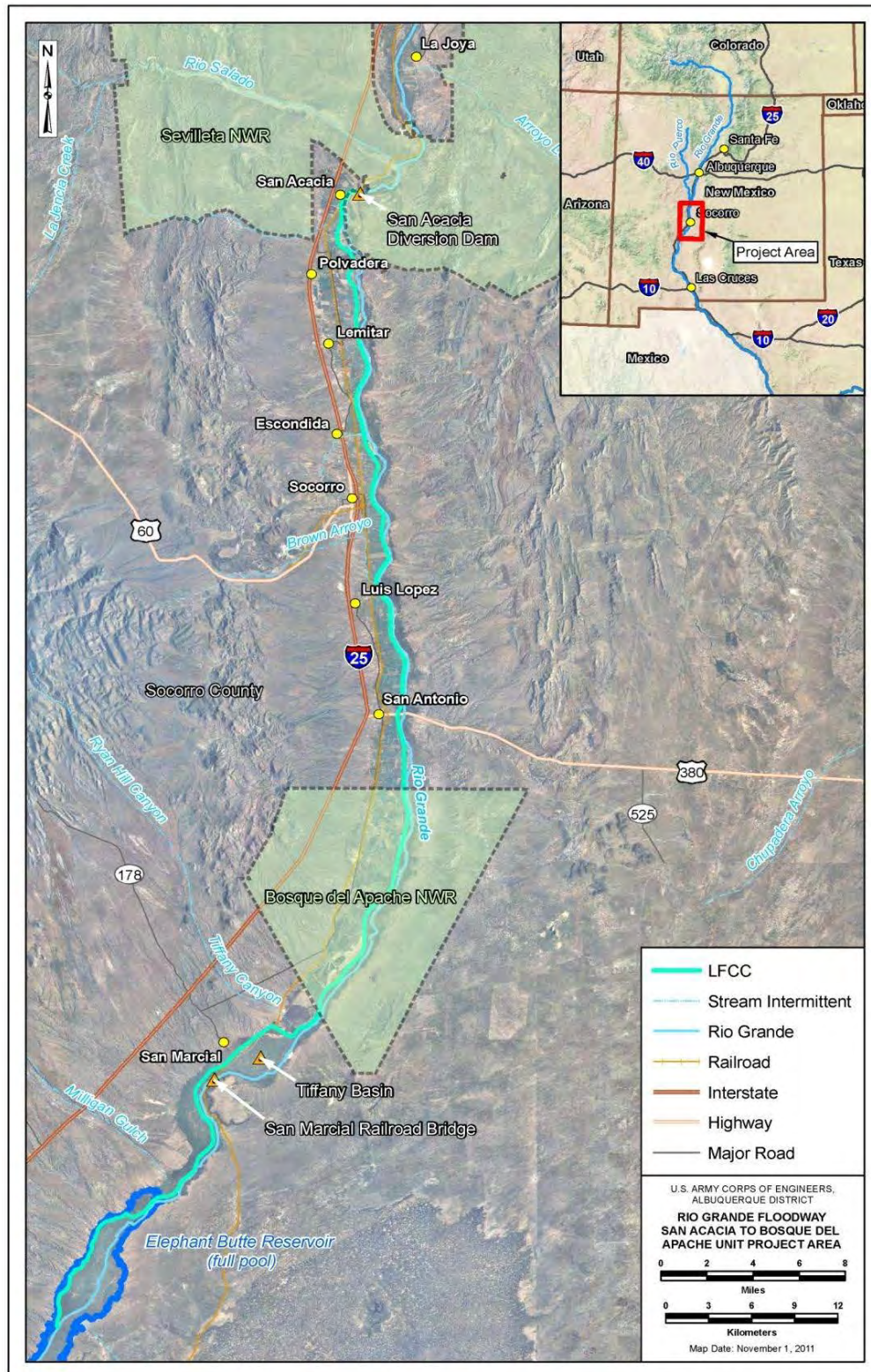


Figure 1. Map of the San Acacia Levee Project area. (Source: USACE 2012a)

The proposed levees would be designed such that they would convey the 1%-chance flood event with a high level of confidence of not failing during flows as high as 29,900 cfs measured at SADD. The proposed action would further reduce potential flood-damage to inhabitants of the historical floodplain, the LFCC, open space, historic and archaeological sites, natural vegetation and trees, agricultural land and facilities, residential and commercial development, recreation, and numerous railroad, irrigation, drainage, transportation, industrial, and municipal facilities within the historical floodplain west of the levee and in the San Acacia Levee Project area.

The proposed action consists of replacing approximately 43 miles of non-engineered spoil banks with engineered levees along the west bank of the Rio Grande from the SADD to Tiffany, New Mexico. The spoil banks range from 3 to 19 feet tall and were constructed in the late 1960s by the United States Bureau of Reclamation (Reclamation) using spoil (i.e., soil and materials removed from an excavation) excavated from the adjacent river valley to create the LFCC (USACE et al 2007; USACE 2012b). The spoil bank is not an engineered structure and is estimated to fail at river flows in the range of 11,800 to 13,240 cubic feet per second (cfs) measured at the gage at the SADD (USACE 2012a). Without replacement the spoil bank would not contain future flood events, even with “flood fighting” activities and maintenance, and which would result in significant hydrological and environmental impacts (USACE 2012b,c; MRGCD and NMISC 2012). There are no spoil banks or engineered levees on the east side of the Rio Grande floodway in the San Acacia Levee Project area.

The proposed levee alignment would generally follow that of the existing spoil bank that is between the LFCC and the Rio Grande. The new levee design height is equivalent to the water surface elevation corresponding to the 1% chance flood event, plus an additional 4 vertical feet (i.e., levee height ranging from approximately 4 to 14 feet; BA, page 10). The discharge for the one percent chance flow is 29,900 cfs at the upstream end, attenuating to 15,000 cfs at the downstream end of the project (USACE 2012b). After construction is complete, Corps requires agreement on operation, maintenance, repair, and rehabilitation of the levee by local governments or sponsors. If structural protection is not maintained, over time the levee may fail to provide the level of protection it was designed for, increasing the flood risk. The proposed construction action is scheduled to take up to 20 years, or until 2032, and Corps (USACE 2012b) considers 50 years as the functional life of flood control, or until 2082.

The Corps (2012a) refers to the river channel and its overbank areas between the spoil banks (and soon levee) and the high ground on the east side of the river as the “floodway.” The term “floodplain” or “historical floodplain” typically refers to those areas outside of the floodway (and currently associated with a one percent chance flow event), to the west of the spoil banks or levee (Figure 2).

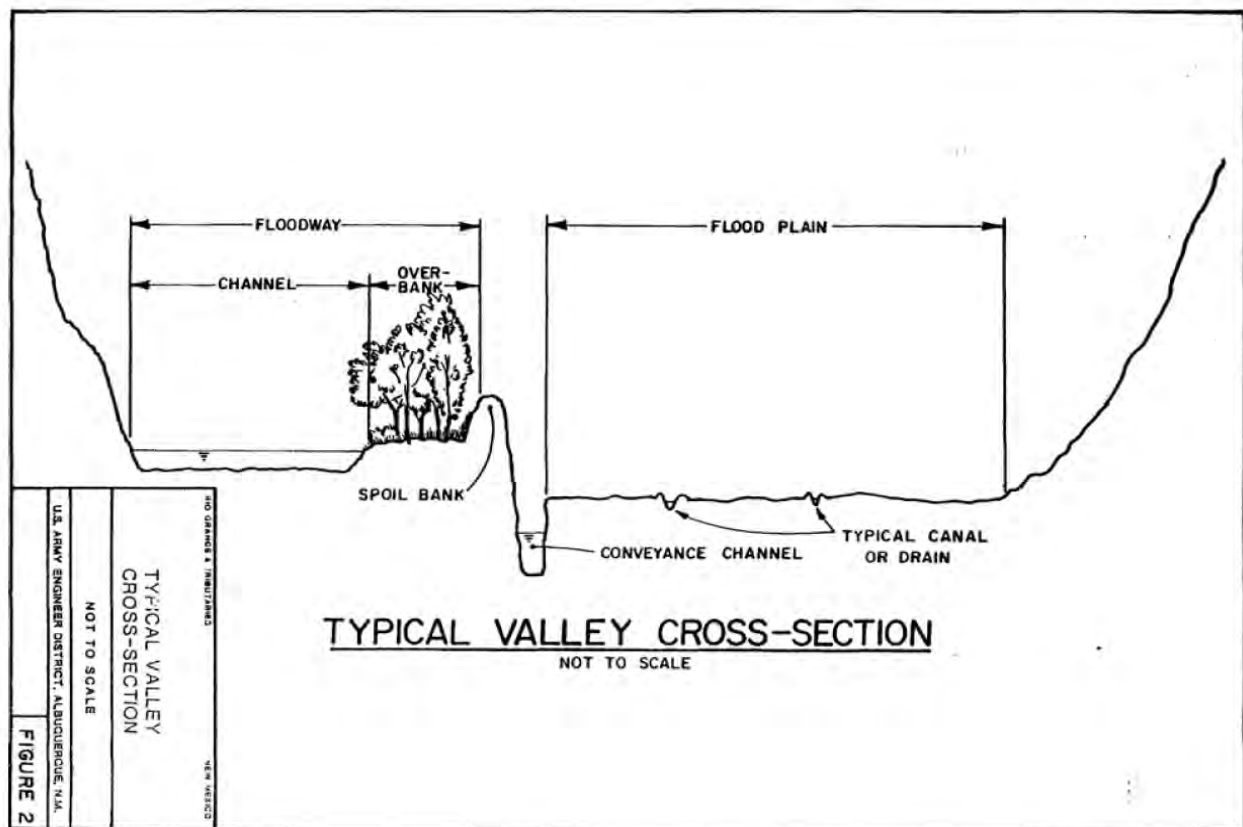


Figure 2. Typical Middle Rio Grande Valley cross section depicting the floodway with river channel and overbank areas and the floodplain in the San Acacia Levee Project area.

Appendix A of the BA contains plates showing the preliminary layout for the proposed action. Appendix B of the BA depicts the MRGV floodplain affected by the one percent chance flood event with and without the San Acacia Levee Project. The Service has identified the action area for this Opinion as all floodplains and proposed levee areas as depicted in six plates in Appendix B of the Corps BA (USACE 2012a) (Opinion, Appendix A). Additional phases of the San Acacia Levee Project in the floodway and historical floodplain are discussed below, by topic.

East Side Excavation, Temporary River Crossing, and Floodwall Installation

The floodway of the Rio Grande is constricted between higher grounds on either side of the river at the SADD (USACE 2012a). Special design features are required in this area of the levee to provide west side bank protection and excavation on the east side is necessary to decrease the velocity and erosive potential of the design flood (USACE 2012a). To provide a wider corridor for flood flows, excavation of approximately 9.3 acres of the east bank would create a terrace at the 10 percent-chance (10-year) flood event water surface elevation along approximately 300 yards of the channel's east edge. At the base of the proposed terrace, an additional 3.1 acres of the existing bank would be excavated to the approximate 50 percent-exceedance (2-year) water surface elevation, sloping downward to the existing channel. Overall, the excavation and widening would increase the cross-sectional flow area and proportionally decrease the velocity

(USACE 2012a). Corps would plant up to 1.1 acres of willows (*Salix* spp.) along the edge of the new bank line within the 3.1 acres and the 9.2-acre terrace. Excavation would be scheduled for four months during fall and winter when river flow is relatively low.

During construction, a temporary river crossing would be required to access the east bank from the LFCC service road on the west bank of the Rio Grande. The temporary crossing would consist of an earthen ramp approximately 300 feet long, with a 15-foot top width and 2.5 horizontal to 1 vertical side slopes. Six, 60-inch corrugated, metal pipes would be installed below the crossing to allow low flows to pass through the crossing to maintain a wet river channel during construction. Conservation measures would be used to minimize impacts to water quality for this temporary crossing. These include the use of rubber cofferdams and silt curtains for the reduction of turbidity, ease of construction, and to provide a barrier between construction activities and river waters (and fish). Other conservation measures would include slope protection for the culverts and specialized grading to prevent runoff of sediment from entering the river at the location of the ramps. Rubber cofferdams would be employed along the east bank to minimize contact between construction activities and the river waters.

Cofferdams and silt curtains would be deployed to minimize disturbance to fish in the immediate area. These barriers would be deployed by Corps biologists from the shoreline into the current to exclude fish from the area where the temporary ramp is constructed. These barriers also would be deployed to exclude fish from the construction activities when the ramp is removed. Near the SADD, the corridor between the western bank of the river and the railroad track is too narrow to accommodate an earthen levee. Therefore, a concrete floodwall would be constructed on top of the bank beginning at a point about 400 feet upstream of the diversion dam and extending 650 feet downstream. The floodwall will be approximately 4 feet high and would be flanked by a roller-compacted concrete apron along the downstream portion (see Soil Cement Embankment below). Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Approximately 0.25 acres of upland vegetation would be removed to accommodate the floodwall at its upstream terminus.

Soil Cement Embankment and Riprap Blankets

Although the East Side Excavation decreases the velocity of the design flood, there still would be a high potential for bank erosion along the west bank, especially in along the river bank where the channel and flow bends westward downstream from the SADD for about one mile. Corps proposes installation of a soil-cement embankment along 5,700 feet of the west bank immediately downstream from the SADD. Soil cement would be placed in a series of horizontal lifts resulting in a stepped (terraced) wall with an overall slope of 1:1 varying to the crest of the levee supporting the railroad tracks. The riverbank is sufficiently high within this reach that a floodwall or levee would not be required to contain flood flows; however, the soil-cement embankment would be required to prevent erosion and undermining of the railroad track. Vegetation would not grow on or within the soil-cement slope after construction and any soil accumulation would likely be thin. Vertically, the soil-cement embankment begins at the base of railroad embankment and would be buried approximately 12 feet below the existing base of the riverbank slope. The base of the soil-cement wall would fill approximately 0.6 acres of the

present river channel. During excavation and placement of the soil-cement embankment, construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish.

It is estimated that the cofferdam will be in place for approximately 3 months to include time for setup and teardown and completion of the soil-cement armoring work. It is estimated that the construction of the soil cement armoring requires the clearing and grubbing trees and small brush. Trees are chipped and disposed of at a local landfill, within a thirty-mile radius of the job site. Clearing and grubbing activities are accomplished using a crew consisting of hydraulic excavator, bulldozer, front-end loader, chipper, dump trucks, and laborers. It is assumed that 314,247 cubic yards of excavation is required in order to place the soil cement at the required scour depth. The material is removed using a bulldozer and temporarily stockpiled adjacent to the work area.

Ten portions of the levee would require riprap toe protection based on hydraulic analysis of scour velocities and proximity of the river channel to the proposed levee. The protected portions range from 500 to 4,850 feet long, and the total length of erosion protection with riprap blankets is approximately 31,700 linear feet (6.0 miles). Riprap protection would blanket the riverward slope of the levee from crest to toe, and would be buried to a depth of 6.5 to 12 feet beneath the levee toe. Self-launching riprap (i.e., launchable stones are proposed to be placed along areas expected to erode or scour. As flood events result in erosion below the stone, the stone is undermined and rolls or slides down the slope, stopping the erosion (USACE 1994)), would be buried below the ground surface at the toe of the levee for potential scour depths greater than 12 feet but not exceeding 17 feet. Rock sizes used for riprap would vary from 0.75 to 3.5 feet in diameter depending of the velocities at potential scour locations. Coloration for rock used for riprap would vary; however, suitable material in the local area consists of dark colored basalt or grey metamorphic rock. Jetty jacks are currently located in and around the proposed project area and would continue to provide erosion protection to the proposed project.

It is estimated that construction of the deep toe portions of the soil-cement embankment and riprap protection require groundwater excavation and dewatering for their proper placement. The toe key for the riprap slope protection will have a minimum depth of 5 feet and a maximum depth of 17 feet. The water table in the area of excavation was estimated at 8' below the levee toe. The dewatering is accomplished using a deep well type system consisting of wells placed at 50' on center. The depth of the wells is varied based on the depth of the construction excavation. Each well will have an electric submersible pump and discharge piping. Power is estimated to be supplied by a skid-mounted generator, which can power a line of pumps up to 500 ft long. It is estimated that the pumps are operated continuously for the duration of the toe riprap placement from 1 to 8 months.

Engineered Earthen Levee, Trenches, and Levee Drainage Features

The new earthen levee would generally follow the alignment of the existing spoil bank throughout the reach. The earthen levee would begin where the soil-cement embankment ends (at 1.2 river-miles downstream from SADD). The proposed levee would terminate at the railroad embankment near Tiffany, New Mexico, approximately 43.6 river-miles from the SADD. The construction of the proposed levee would entail removing the existing spoil bank with heavy machinery and processing the material removed to obtain suitable fill material for new construction. All sorting and material mixing would occur within the footprint of the existing spoil bank during construction. Selected materials required for construction (i.e., riprap and bentonite) would be acquired from commercial sources or borrowed at approved sites. The landward toe of the proposed levee would be separated from LFCC maintenance road by an 18-foot-wide drainage ditch (the LFCC). Generally, the base of the proposed levee would be narrower than that of the existing spoil bank north of U.S. Highway 380, and would be equal to or greater than the base width of the spoil bank south of Highway 380. Positioning the landward toe as close as practicable to the maintenance road in order to minimize floodway encroachment by the structure and the required vegetation-free zone was one of the design objectives for the new levee.

The proposed levee would remain trapezoidal in cross-section with a 15-foot-wide crest (USACE 2012b, Appendix A, Sheet C-141). Side slopes would vary between 1 vertical (V) to 2.5 horizontal (H) and 1 V to 3 H, depending on the height of the levee. Levee height would range from 4 to 14 feet, increasing gradually from north to south. Perforated-pipe toe drains with discharge pipes into the LFCC, and risers would be required for levee heights greater than 5 feet. An 8-foot-wide by 4-foot-high inspection trench, with 1V:1H side slopes, would be installed under the levee and is required for levee heights greater than 5 feet.

In addition, a 2-foot-wide bentonite (i.e., fine earth having small particle size and a clayey consistency) slurry trench extending downward from the design water surface elevation to the top inspection trench and would be required for levee heights greater than 5 feet. The slurry trench would extend from 2 feet below the levee embankment crest to 5 feet into the foundation material. The slurry trench and toe drain system decrease the likelihood of the levee becoming saturated during long-duration floods. For levee heights greater than 5 feet, 6-inch perforated-pipe, toe drain that, discharges into the LFCC, and risers as well as an 8-foot-wide by 4-foot-high inspection trench with 1V:1H side slopes would be required. Because the proposed levee embankment would be constructed on thick deposits of pervious materials overlain with little or no impervious material, foundation seepage is a serious problem. A method of protecting the levee embankment toe from seepage and a method of intercepting shallow foundation seepage is required (USACE 2012b, Appendix F).

Several seepage control measures were considered during design and it was determined that a network of subsurface seepage collector pipes and a landside drainage blanket would be the best alternative. The new levees embankment would include a landside foundation drainage blanket, extending approximately one-third the foundation width, and a network of toe collector pipes and

drains to control seepage and eliminate sloughing. The toe drain system required for seepage control consists of a perforated main line with risers and clean-outs every 300 feet and outlets every 900 feet throughout the entire alignment. (USACE 2012b, Appendix F, page 203).

The contractor would not be allowed to construct any new haul roads for the construction of this project. However, vehicle turnarounds would be located on the levee or existing disturbed locations used for spoil bank and LFCC maintenance. Specific locations would be determined after further coordination with all parties using the levee. The existing haul road adjacent to and between the existing spoil bank and the LFCC would be used for the construction of the levee. A relatively small amount of surplus material would be stockpiled during construction of a given levee segment. Short-term stockpiles would be located within the disturbed footprint during construction of a given segment. Long-term stockpiles will be located at staging areas or previously disturbed sites outside of the floodway.

Vegetation-Free Zone

The Corps' Engineer Technical Letter 1110-2-571 (10 April 2009) provides guidelines to assure that landscape planting and vegetation management provide aesthetic and environmental benefits without compromising the reliability of levees. The vegetation-free zone requires that no vegetation, other than approved grass species be allowed, to grow on the levee or within 15 feet of the riverward or landside toes of the levee. During construction, existing vegetation would be removed adjacent to the riverward and landside toes by clearing and grubbing, and root-plowing where salt cedar occurs. Since the landward side of the levee is currently maintained as an access road very little vegetation exists in that area, but riparian vegetation may occur along the LFCC. Following construction, disturbed soils including the levee side slopes would be seeded with native grass species to prevent wind and water erosion. A 15-foot-wide vegetation-free zone would be permanently maintained to be devoid of any vegetation other than grasses. Vegetation-free zones would be mowed, when dry in fall or winter, any time the grass reaches a height of 12 inches. Mowing would be triggered by grass heights of less than 12 inches if important to the health maintenance of the particular grass species.

Structures to Accommodate Tributary Flow

Three tributary arroyos in the project area empty into the Rio Grande from the west, crossing the LFCC and existing spoil bank: 1) San Lorenzo Arroyo enters the Rio Grande approximately 2.9 river-miles downstream of the SADD; 2) the Socorro Diversion Channel captures flows from the Socorro Canyon Arroyo (approximately at decimal degree coordinates 34.061100,-106.887618), Nogal Canyon Arroyo (approximately at decimal degree coordinates 34.064100,-106.887890), and several smaller arroyos, and empties into the Rio Grande just upstream of the city of Socorro, at 13.7 river-miles downstream from SADD; and 3) Brown Arroyo (approximately at decimal degree coordinates 34.002619, -106.871334) enters the Rio Grande approximately 22.2 river-miles downstream from the SADD. Each of these tributaries was evaluated in order to determine if closure structures were needed to prevent flood flows on the Rio Grande from escaping the floodway. Closure structures were determined not to be needed at San Lorenzo Arroyo and the Socorro Diversion Channel. Instead, levee tiebacks were designed to prevent

overtopping of the interior drainage facilities at these places. It was determined that a closure structure was needed at Brown Arroyo to prevent the one percent-chance flood event from backing into Brown Arroyo for a distance of approximately 7,500 feet and a depth of up to 9 feet. Brown Arroyo is confined by non-engineered spoil banks that have a high risk of failure at high flood stages. This gated closure structure would be designed to pass Brown Arroyo flood flows while preventing longer-duration Rio Grande flood flows from potentially breaching the existing interior drainage facilities and is described below. The gated floodwall structure would be located where the new levee intersects the outfall channel of Brown Arroyo. The gate structure would consist of 10 sluice gates. The Brown Arroyo inlet is skewed relative to the Rio Grande Floodway, so the gates are aligned in a zigzag configuration that allows for flows from Brown Arroyo to enter directly into the gates.

Approximately 11.7 river-miles downstream from SADD, the "Nine-Mile Outfall" consists of three large conduits that direct flow from the LFCC to the river when the LFCC is operated. The Corps would replace these with conduits equipped with flap gates to prevent flood flows from entering the LFCC. There currently are three locations along the proposed levee alignment where Reclamation pumps water from the LFCC through the levee to the river when required to benefit endangered species. Currently, pumps are located approximately 3 miles north of Highway 380, and at both the north and south boundaries of BDANWR. The pumps provide flexibility for future water operations and adaptive management tools. The Corps would install permanent conduits through the proposed levee to accommodate these pumps at their current locations (or at alternate locations agreed to by Reclamation and the Service). Appropriate measures to ensure levee performance would be incorporated to the conduit design, including concrete encasement, appropriate filter materials, and slope protection.

Material Quantities and Waste Spoil

The existing spoil bank was built from material excavated for the LFCC rather than being designed relative to a specific flood discharge. The height of the proposed levee was initially designed to accommodate the mean water surface elevation of the one percent-chance flood event. According to Corps (USACE 2012b, Appendix F, Table F-61), the existing spoil bank provides no protection from any of the flood events evaluated. After construction of the new levee, a large amount of excavated spoil material would remain unused. Hauling the waste spoil to a disposal location can be more expensive than incorporating that material into a larger levee structure. As required for all Corps-built flood risk management projects, the proposed levee was designed to maximize National Economic Development (NED) benefits. The cost of increasing the levee's height in one-foot increments was evaluated relative to the increment benefit of reduced flood damages afforded by the taller levee. NED benefits were maximized by a levee structure 4 feet taller than the 1percent-chance event structure. Still, a significant amount of spoil material requiring disposal results from the proposed levee's design. Table 1 summarizes the amount of excavation, usable soil material, and disposal material, showing that there would be approximately 3 million cubic yards (1,881 acre-feet) of spoil material requiring disposal.

Table 1. Excavation and disposal quantities for the proposed action.

| Item | Material Volume (cubic yards) |
|--|---|
| Excavated from spoil bank | 5,233,730 |
| Excavated from East Side Excavation | 152,650 |
| <i>Excavation subtotal</i> | <i>5,386,380</i> |
| Used as random fill in new levee | 2,176,901 |
| Used in rip rap toe protection (screened oversized waste) | 174,152 |
| <i>Used subtotal</i> | <i>2,351,053 (43.7percent of excavated)</i> |
| Disposal total | 3,035,327 (1,881 acre-feet) |

Three potential alternatives for the disposal of spoil waste would be employed in the proposed action. A number of existing borrow areas occur near the project area and could be used as disposal locations for the spoil waste generated during levee construction. The Corps would evaluate the cost effectiveness of utilizing these disturbed areas as disposal locations. Only locations that are devoid of significant ecological or cultural resources would be utilized. Secondly, where the proposed levee would be narrower than the existing spoil bank, there may be opportunities to slightly shift the base of the new levee riverward while remaining within the disturbed footprint of the spoil bank. In these instances, some waste spoil (up to 656,000 cubic yards) could be deposited on the landward slope of the new levee structure. The default location for the disposal of spoil waste evaluated in this Opinion is within the undeveloped Tiffany Basin at the south end of the project area.

Although the ground surface in the Tiffany Basin is lower than the current riverbed, the basin would only be inundated due to failure of the spoil bank along its eastern edge. Corps estimated that a 10 percent chance exceedance flow (15,400 cfs at SADD; or over 10,000 cfs near San Marcial, New Mexico) would not be contained in the floodway (USACE 2012b, Appendix F). A spoil deposition area of up to 300 acres would accommodate the waste material from the proposed levee (3 million cubic yards, or 1,881 acre-feet). At the higher discharge 10.0%-chance exceedance probability, breaching in the two, modeled potential locations does occur and reaches a point sufficient to divert all of the river flow into the Tiffany Basin (USACE 2012b, Appendix F, page 44). The area considered for spoil deposition is currently vegetated by species of tamarisk (*Tamarix* sp.), a nonnative, riparian shrub (USACE 2012a).

Conservation Measures

The Corps proposes to implement the following conservation measures as part of its proposed action.

1. Corps proposes to establish 50.4 acres of dense woody plantings in the action area due to footprint effects of the San Acacia Levee Project (USACE 2013).

2. Beginning with the breeding season prior to the initiation of each phase of construction, the Corps will perform or fund annual flycatcher protocol surveys (five visits per site per season) along the western bank of the floodway, eventually extending from San Acacia to San Marcial. Annual surveys would continue until the completion of construction and would continue for five years following the phased construction of each levee segment. (USACE 2012a)
3. Levee and floodwall construction may occur throughout the calendar year; however, no construction would be performed within 0.25 mile of occupied flycatcher breeding territories (generally, late May through August 15). Traffic associated with construction activities may continue along the construction alignment adjacent to occupied flycatcher breeding territories. All construction equipment and large trucks would be restricted to the maintenance roads adjacent to the LFCC. The levee and/or spoil bank would serve as a buffer between this traffic and flycatchers within the floodway. Small vehicles (*e.g.*, pickup trucks and SUVs) would occasionally travel along the top of the spoil bank / levee, as they do currently. (USACE 2012a)
4. Vegetation removal and clearing-and-grubbing activities would be performed between August 15 and April 15. If needed, vegetation removal between April 15 and August 15 would only be performed if inspection by a qualified biologist determines that flycatchers (including both migrant and territorial birds) are not present within 500 feet of the vegetation patch to be removed. (USACE 2012a)
5. If stream flow exists, it would be maintained during construction and the streambed contoured so that fish can migrate through the project area during and after construction. (USACE 2012a)
6. Silt curtains, cofferdams, dikes, straw bales and other suitable erosion control measures would be employed to prevent sediment-laden runoff or contaminants from entering any watercourse. (USACE 2012a)
7. Work would be performed below the elevation of the ordinary high water mark only during low-flow periods. This includes placement of the lower portions of the soil-cement wall, riprap blankets, and excavation along the east bank downstream from the SADD. No erodible fill materials would be placed below the elevation of the ordinary high water mark (USACE 2012a)
8. Qualified fisheries biologists would evaluate measures to exclude fish from in-channel construction areas. Cofferdams and silt curtains would be deployed by Corps biologists from the shoreline into the channel to exclude fish from construction areas where possible. If appropriate, biologists would coordinate with Service's Fisheries personnel to seine areas prior to placement of barriers in the construction area. (USACE 2012a)
9. Concrete would be poured in forms and would be contained to prevent discharge into the river. Wastewater from concrete batching, vehicle wash down, and aggregate processing would be contained, and treated or removed for off-site disposal. (USACE 2012a)

10. Fuels, lubricants, hydraulic fluids and other petrochemicals would be stored outside the 1%-chance floodplain (i.e., not within the floodway), if practical. At the least, staging and fueling areas would be located west of the LFCC and would include spill prevention and containment features. (USACE 2012a)
11. Construction equipment would be inspected daily to ensure that no leaks or discharges of lubricants, hydraulic fluids or fuels occur in the aquatic or riparian ecosystem. Any petroleum or chemical spills would be contained and removed, including any contaminated soil. (USACE 2012a)
12. Only uncontaminated earth or crushed rock for backfills would be used. (USACE 2012a)
13. Water quality would be monitored during construction to ensure compliance with state water quality standards for turbidity, pH, temperature, oxygen, and dissolved solids. (USACE 2012a)

II. STATUS OF THE SPECIES

The proposed action considered in this BO may affect the silvery minnow and the flycatcher that is provided protection as an endangered species under the ESA. A description of these species, its status, and designated critical habitat are provided below and informs the effects analysis.

RIO GRANDE SILVERY MINNOW (SILVERY MINNOW)

Description

The silvery minnow currently occupies a 170-mile reach of the Rio Grande, from Cochiti Dam in Sandoval County, to the headwaters of Elephant Butte Reservoir in Socorro County (Service 2010). This includes a small section of the lower Jemez River, a tributary to the Rio Grande north of Albuquerque. The silvery minnow's current habitat is limited to approximately seven percent of its former range, and is split into four discrete reaches by three river-wide dams (Figure 3).

Silvery minnows are a stout fish, with a small, subterminal mouth, with long pharyngeal dentition with a distinct grinding surface and a pointed snout that projects beyond the upper lip (Sublette et al. 1990). The back and upper sides of silvery minnow are silvery to olive, the broad middorsal stripe is greenish, and the lower sides and abdomen are silver. The fins are moderate in length and variable in shape, with the dorsal and pectoral fins rounded at the tips. The body is fully scaled, with breast scales slightly embedded and smaller. The scales about the lateral line are sometimes outlined by melanophores, suggesting a grid pattern. The eye is small and orbit diameter is much less than gape width or snout length (Bestgen and Propst 1996). Maximum total length attained in New Mexico specimens is about 3.5 inches (90 mm) (Sublette et al. 1990). The only readily apparent sexual dimorphism is the expanded body cavity of ripe females

prior to spawning (Bestgen and Propst 1994); however, there are some notable differences. The pectoral fins of males flare broadly from their base to a triangular fan shape, while those of females are shorter, narrower, and oval shaped. The pectoral rays of breeding males are thickened, while those of females are slender, and the pectoral fin length in males is also significantly greater.

In the past, the silvery minnow was included with other species in the genus *Hybognathus* due to morphological similarities, including a distinct, convex jaw. Phenetic and phylogenetic analyses corroborate the hypothesis that *Hybognathus amarus* is a distinct valid taxon, and separate from other species of *Hybognathus* (Cook et al. 1992; Bestgen and Propst 1994), particularly the placement of its subterminal mouth. It is now recognized as one of seven species in the genus *Hybognathus* in the United States and was formerly one of the most widespread and abundant minnow species in the Rio Grande basin of New Mexico, Texas, and Mexico (Pflieger 1980; Bestgen and Platania 1991). Currently, *Hybognathus amarus* is the only remaining endemic, pelagic-spawning minnow in the Middle Rio Grande. The speckled chub (*Macrhybopsis aestivalis*), Rio Grande shiner (*Notropis jemezianus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus simus*) are either extinct or have been extirpated from the Rio Grande (Bestgen and Platania 1991).

Legal Status

The silvery minnow was federally listed as endangered under the ESA on July 20, 1994 (58 Federal Register [FR] 36988, see USFWS 1994). Primary reasons for listing the silvery minnow are described below in the *Reasons for Listing/Threats to Survival* section. The Service designated critical habitat for the silvery minnow effective March 21, 2003 (68 FR 8088, USFWS 2003b). See description of designated critical habitat below. The species is also listed as an endangered species by the state of New Mexico (19 NMAC 33.1), the state of Texas (sections 65.171–65.184 of Title 31 Texas Annotated Code), and the Republic of Mexico (SDS 1994). Silvery minnows were also introduced into the Rio Grande near Big Bend, Texas, in December 2008 as an experimental, nonessential population under section 10(j) of the ESA.

Habitat

Silvery minnows travel in schools and tolerate a wide range of habitats (Sublette et al. 1990), yet

are commonly found in waters with low velocity (less than 10 centimeters per second [cm/s] (0.33 feet per second [ft/s])) in areas over silt or sand substrate associated with aquatic habitats such as shallow braided runs, backwaters, or pools (Dudley and Platania 1997, Watts et al. 2002). Habitat for silvery minnows includes stream margins (i.e., shoreline or shoal), side channels, and off-channel pools where water velocities are low or reduced. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by silvery minnows (Sublette et al. 1990; Bestgen and Platania 1991). This preference for low velocity habitat, especially for survival and recruitment of larval and juvenile silvery minnows, characterizes the habitat use and recruitment conditions of most common native Rio Grande fishes (Pease et al. 2006).

Passively drifting eggs and larvae are found throughout all habitat types, whereas adult silvery minnows are most commonly found in backwaters, pools, and habitats associated with debris piles, and young of year (YOY) (age-0) fish occupy shallow, low velocity backwaters with silt substrates (Dudley and Platania 1997). Dudley and Platania (1997) reported that silvery minnows were most commonly found in habitats with depths less than 50 cm (19.7 in). Over 85 percent were collected from low-velocity habitats (less than 10 cm/s [0.33 ft/s]) (Dudley and Platania 1997; Watts et al. 2002). During winter, silvery minnows tend to concentrate in low velocity areas in conjunction with vegetation or debris for cover, (Dudley and Platania 1996; Dudley and Platania 1997; Bixby and Burdett 2009). Silvery minnows are generally not found associated with cool water, cobble substrates, strong velocities, high salinity, highly channelized reaches, low oxygen conditions, or dry river bed areas (USFWS 2003a, 2003b; 2010, 2011a).

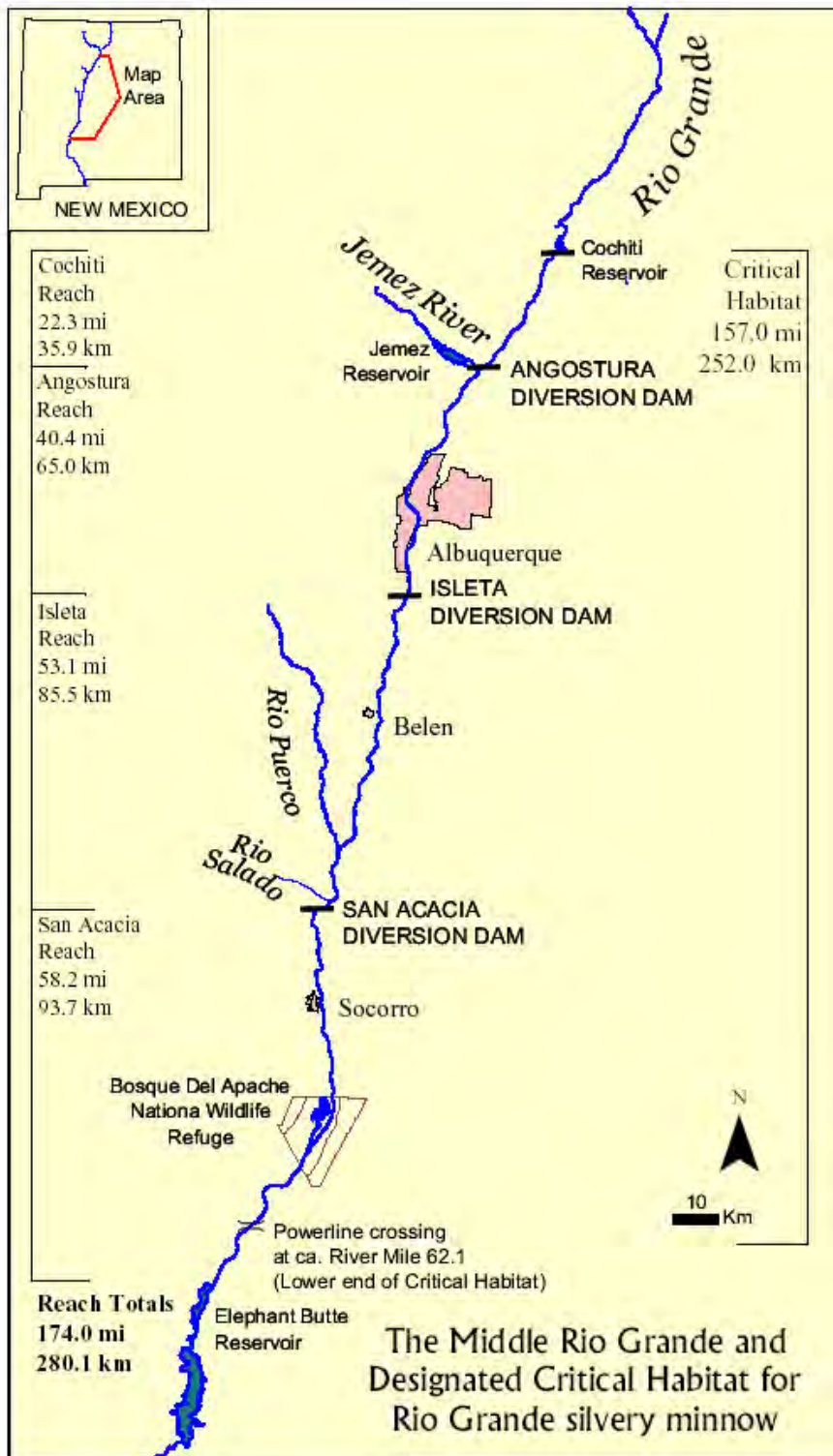


Figure 3. Location of the Cochiti, Angostura, Isleta, and San Acacia Reaches and selected major features in the Middle Rio Grande, New Mexico.

Designated Critical Habitat

Silvery minnow critical habitat designation extends approximately 157 miles from Cochiti Dam in Sandoval County, New Mexico, downstream to the utility line crossing the Rio Grande just east of the Bosque Well demarcated on USGS (1980) Paraje Well 7.5-minute quadrangle map at the Universal Transverse Mercator coordinates in Zone 13, 311474 meters East by 3719722 meters North. The utility line crossing is a permanent, identified landmark in Socorro County, New Mexico, just north of Elephant Butte Reservoir at River Mile 62.1 (USFWS 2003b). The interior boundaries of the Pueblos of Sandia, Santo Domingo, Santa Ana, and Isleta within the MRGV are not included in designated critical habitat because each Pueblo has management plans to protect their own silvery minnows. The remaining portion of the silvery minnow's occupied range in the Middle Rio Grande is designated as critical habitat (USFWS 2003b).

The critical habitat designation defines the lateral extent (width) as those areas including the Rio Grande and riparian zone bounded by existing levees or, in areas without levees, 300 feet of riparian zone adjacent to each side of the bankfull stage of the Rio Grande. Some developed lands within the riparian zone are not considered designated critical habitat, as they do not contain the appropriate the primary constituent elements (PCEs), and are therefore not essential to the conservation of the silvery minnow. Lands located within the lateral boundaries of the critical habitat designation, but not considered critical habitat include: developed flood control facilities, existing paved roads, bridges, parking lots, dikes, levees, diversion structures, railroad tracks, railroad trestles, water diversion and irrigation canals outside of natural stream channels, the Low Flow Conveyance Channel, active gravel pits, cultivated agricultural land, and residential, commercial, and industrial developments that existed at the time critical habitat designation became effective (i.e., March 21, 2003; USFWS 2003b).

The Service (USFWS 2003b) recognized that the lateral width of riparian area along the river channel provides an important function for the protection and maintenance of the PCEs and is essential to the conservation of the species. The Service selected the 300-ft (91.4-m) lateral extent, rather than some other delineation, for three reasons: 1) The biological integrity and natural dynamics of the river system are maintained within this area. The floodplain and its riparian vegetation provide space for natural flooding patterns and latitude for necessary natural channel adjustments to maintain appropriate channel morphology and geometry, store water for slow release to maintain base flows, provide protected side channels and other protected areas for larval and juvenile silvery minnow, allow the river to meander within its main channel in response to large flow events, and recreate the mosaic of habitats necessary for the conservation of the silvery minnow; 2) Conservation of the adjacent riparian zone also helps provide essential nutrient recharge and protection from sediment and pollutants, which contributes to successful spawning and recruitment of silvery minnows; and, 3) vegetated lateral zones are widely recognized as providing a variety of aquatic habitat functions and values (e.g., aquatic habitat for fish and other aquatic organisms, moderation of water temperature changes, and detritus for aquatic food webs) and help improve or maintain local water quality (USFWS 2003b). Riparian areas are seasonally flooded habitats that are major contributors to a variety of vital functions within the associated stream channel (Federal Interagency Stream Restoration Working Group 1998, Brinson et al. 1981). They are responsible for energy and nutrient cycling, filtering runoff,

absorbing and gradually releasing floodwaters, recharging groundwater, maintaining streamflow, protecting stream banks from erosion, and providing shade and cover for fish and other aquatic species. Healthy riparian areas help ensure watercourses maintain the habitat components essential to the silvery minnow (USFWS 2003b).

The Service determined the PCEs of silvery minnow designated critical habitat based on studies on silvery minnow habitat and population biology. Critical habitat containing these PCEs provide for the physiological, behavioral, and ecological requirements essential to the conservation of the silvery minnow. These PCEs include:

1. a hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats, such as, but not limited to the following: backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels (anabranches), pools (that portion of the river that is deep with relatively little velocity compared to the rest of the channel), and runs (flowing water in the river channel without obstructions) of varying depth and velocity, all of which are necessary for each of the particular silvery minnow life history stages in appropriate seasons (e.g., the silvery minnow requires habitat with sufficient peak flows from early spring (March) to early summer (June) to trigger spawning, flows in the summer (June) and fall (October) that do not increase prolonged periods of low or no flow, and relatively constant winter flow (November through February));
2. the presence of eddies created by debris piles, pools, or backwaters, or other refuge habitat within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities;
3. substrates of predominantly sand or silt; and,
4. water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 degree Celsius (C) (35 degrees Fahrenheit [°F]) and less than 30 °C (85 °F) and reduce degraded conditions (e.g., decreased DO, increased pH).

These PCEs provide for the physiological, behavioral, and ecological requirements essential to the conservation of the silvery minnow. While all of these PCEs are found in each of the four reaches of the MRGV, it does not imply that optimal conditions for silvery minnow occur equally throughout this designated critical habitat. Therefore, it should not be assumed that silvery minnows will occur in all portions of this critical habitat at all times.

Significantly and detrimentally altering the characteristics of the 300-ft (91.4-m) lateral width (e.g., parts of the floodplain) in the designated critical habitat of the middle Rio Grande can include vegetation manipulation, timber harvest, road construction and maintenance, prescribed fire, livestock grazing, off-road vehicle use, power line or pipeline construction and repair, mining, and urban and suburban development with a Federal nexus. Significantly and

detrimentally altering the channel morphology (e.g., depth, velocity) of any of the river reaches within the designation can include channelization, impoundment, road and bridge construction, deprivation of substrate source, reduction of available floodplain, removal of gravel or floodplain terrace materials, reduction in stream flow, and excessive sedimentation from mining, livestock grazing, road construction, timber harvest, off-road vehicle use, and other watershed and floodplain disturbances with a Federal nexus.

Federal actions that are found likely to destroy or adversely modify critical habitat may often be modified, through development of reasonable and prudent alternatives, in ways that will remove the likelihood of destruction or adverse modification of critical habitat. Such project modifications may include such things as adjustment in timing of projects to avoid sensitive periods for the species and its habitat; replanting of riparian vegetation; minimization of work and vehicle use in the main river channel or the 300-ft (91.4-m) lateral width; restriction of riparian and upland vegetation clearing in the 300-ft (91.4-m) lateral width; fencing to exclude livestock and limit recreational use; use of alternative livestock management techniques; avoidance of pollution; minimization of ground disturbance in the 300-foot lateral width; use of alternative material sources; storage of equipment and staging of operations outside the 300-foot lateral width; use of sediment barriers; access restrictions; and use of best management practices to minimize erosion.

Life History

Silvery minnow is a pelagic spawner and a female may produce as many as 3,000 to 6,000 semibuoyant, nonadhesive eggs during a spawning event (Platania 1995; Platania and Altenbach 1998; Dudley and Platania 2008a). The majority of adults in the wild spawn in about a 1-month period in late spring to early summer (May to June) in association with spring runoff. Platania and Dudley (2000) found that the highest numbers of silvery minnow eggs collected from the river channel occurred in mid- to late May. These data suggest silvery minnow spawning events during the spring are concurrent with peak flows. Artificial flow spikes in spring have apparently induced silvery minnows to spawn (Platania and Hoagstrom 1996; USACE 2009).

High spring flows, high water levels, and turbidity (i.e., particles preventing observation depth or spectra in the water column) generally preclude direct observations of silvery minnow spawning behavior and location(s) in the wild (Platania and Altenbach 1998; Caldwell 2003). In captivity, silvery minnows have been induced to spawn up to four times in a year (Altenbach 2000); however, it is unknown if individual silvery minnows spawn more than once per year in the wild or if multiple spawning events during spring and summer represent same or different individuals. The spawning strategy of releasing semibuoyant eggs can result in the downstream displacement of eggs, especially in years or locations where overbank-flooding opportunities are limited. The presence of irrigation water diversion dams (Angostura, Isleta, and San Acacia Diversion Dams) prevents the movement of adults to recolonize habitats upstream of these dams (Platania 1995) and has reduced the species' effective population size to critically low levels (Alò and Turner 2005; Osborne et al. 2005). Adults, eggs, and larvae may also be transported downstream and into Elephant Butte Reservoir. It is believed that few to none of these fish survive because of poor habitat conditions and predation from reservoir fishes (USFWS 2010a). Also, silvery

minnow eggs that enter Elephant Butte Reservoir may settle out along with substrate as velocity decreases in the delta area (i.e., where the river meets the reservoir) and subsequently suffocate as they are buried with silt and sediment (Platania and Altenbach 1998, p. 55).

Platania (2000) found that development of larval fish and hatching of eggs are correlated with water temperature. Eggs of silvery minnows raised in water at 30 °C (86 °F) hatched in approximately 24 hr while eggs reared in 20 to 24°C (70 to 75 °F) water hatched within 50 hr. Eggs were 1.52 mm (0.06 in) in diameter upon fertilization, but quickly swelled to 3.05 mm (0.12 in) during water exposure. Salinity and suspended sediment may affect the specific gravity of silvery minnow eggs, potentially affecting their survival and rate of downstream transport (Cowley et al. 2009).

Recently hatched larval fish are about 3.81 mm (0.15 in) in standard length and grow about 0.13 mm (0.005 in) per day during development through various larval stages. Eggs and larvae have been estimated to remain in the drift for 3 to 5 days, and could be transported from 216 to 359 km (134 to 223 mi) downstream depending on river flows, obstructions to flow, and availability of nursery habitat (Platania and Dudley 2000; Fluder et al. 2007). Approximately 3 days after hatching the larvae move to low velocity habitats where food (mainly algae (i.e. phytoplankton) and small animals (i.e. zooplankton)) is abundant (Pease et al. 2006). The Age-0 fish attain lengths of 39 to 41 mm (1.53 to 1.61 in) by late autumn (USFWS 2010a). Age-1 fish are approximately 46 mm (1.8 in) by the start of the spring spawning season. Most growth occurs between June (post spawning) and October, but there is some growth during the winter months. Maximum longevity is about 30 months for wild fish (inferred from length-frequency), or up to 36 months based on findings from a study of otolith and scale examinations on wild fish (Horwitz et al. 2011), and up to 36 months for hatchery-released fish (USFWS 2010a).

In laboratory experiments, Bestgen et al. (2010) found that adult silvery minnow are capable of relatively high-speed and long-distance swimming. Mean critical swimming speed for silvery minnows was 51.5 cm/s, with faster sustained swimming speeds for larger fish. Silvery minnow were capable of swimming for longer durations at lower water velocities and warmer water temperatures. Endurance is a function of significant effects of water velocity, water temperature, and fish total length. Individual have the ability to swim several kilometers is just a few hours (up to 125 km) and are capable of moving long distances upstream as part of their life history. In 2006, the Service's New Mexico Fish and Wildlife Conservation Office conducted an experimental study of stocking success for silvery minnows reared in captive propagation facilities and released throughout their current range. The data from this study provided additional information on movement of hatchery reared silvery minnows following their release. The recapture data indicated that movement was generally downstream, with the majority of recaptures within 16 to 24 km (10 to 15 mi) downstream of the release site. The maximum distance traveled from release to recapture was 59.4 km (36.9 mi) downstream 300 days following release. Upstream movement was minimal; however, some individuals were documented upstream from their release sites. The maximum upstream distance traveled was 37.7 km (23.4 mi) 246 days following release (Remshardt and Archdeacon 2011).

Based on estimated length groups for assigning an age class, it is possible that some individuals in the wild survive to be Age-3 fish; however greater than 95 percent of the population in any given year is estimated to comprise Age-0 and Age-1 fish (USFWS 2010a). In the wild, the silvery minnow is a very short-lived species that exhibits similar patterns of growth, survival, and longevity as compared with several other closely related species of *Hybognathus* (Horwitz et al. 2011). In comparison to longevity in the wild, it is common for captive-reared, silvery minnows to live beyond 4 years, especially at lower water temperatures. For example, the USGS Columbia Environmental Research Center research station in Yankton, South Dakota, has several silvery minnows in captivity with a maximum age of 11 and that range in size from 46 to 73 mm (1.8 to 2.9 in) standard length (USFWS 2010a).

Silvery minnow foraging strategies are often demersal (feeding along or near the river substrate) and primarily herbivorous (largely feeding on algae and other plant materials); this is indicated indirectly by the elongated and coiled gastrointestinal tract (Sublette et al. 1990); also Shirey (2004) and Magaña (2009) found diatoms (algae with cell walls made of silica) were a main component of their identifiable gut contents. Silvery minnows reared in a laboratory have been directly observed grazing on algae in aquaria (Platania 1995; Magaña 2009; USFWS 2010a). Additionally, in wild silvery minnows, organic detritus, larval insect exuvia, and small invertebrates, as well as sand, and silt are often filtered from the bottom and ingested (Sublette et al. 1990; USFWS 1999; Magaña 2009). The presence of this sand and silt in the gut of wild-captured specimens suggests that epipsammic algae (i.e., algae growing on surface of sand, such as species of diatoms) is an important food (Magaña 2009; USFWS 2010a). As silvery minnows age and grow, their feeding can include more prey variety (Pease et al. 2006; Magaña 2007).

Population Dynamics

Generally, a population of silvery minnows consists of only two age classes: Age-0 and Age-1 fish (USFWS 2010a; Horwitz et al. 2011). The majority of spawning silvery minnows is 1 year in age, with 2 year-old fish and older estimated to comprise less than 5 percent of the spawning population (USFWS 2010a). High mortality of silvery minnows occurs during or subsequent to spawning, consequently fewer adults have been found in late summer and fall. By December, in general, the majority of surviving silvery minnows are represented by Age-0 fish, those that hatched during the previous spring (Dudley and Platania 2007; Remshardt 2007, 2008a,b).

Platania (1995a) found that a single female in captivity could broadcast 3,000 eggs in 8 hr. Females produce 3 to 18 clutches of eggs in a 12-hr period. The mean number of eggs in a clutch is approximately 270 (Platania and Altenbach 1998). In captivity, silvery minnows have been induced to spawn as many as four times in a year (Altenbach 2000). It is not known if they spawn multiple times in the wild. The high reproductive potential of this fish appears to be one of the primary reasons that it has not been extirpated from the Middle Rio Grande. However, the short life span of silvery minnows and environmental variation in their habitat increases the instability of the population. For example, when two below-average flow years occur consecutively, a short-lived species such as the silvery minnow can be impacted, if not eliminated from drying reaches of the Rio Grande (USFWS 1999, 2003a, 2010a).

Distribution and Abundance

Historically, the silvery minnow likely occurred in 3,967 km (2,465 mi) of rivers in New Mexico and Texas and was one of the most abundant and widespread species in the Rio Grande Basin (Bestgen and Platania 1991). The species was known to have occurred upstream to Española, New Mexico (upstream from Cochiti Lake); in the downstream portions of the Rio Chama and Jemez River; throughout the Middle and Lower Rio Grande to the Gulf of Mexico; and in portions of the Pecos River from Sumner Reservoir downstream to the confluence with the Rio Grande (Sublette et al. 1990; Bestgen and Platania 1991). The current distribution of the silvery minnow is limited to the Rio Grande between Cochiti Dam and Elephant Butte Reservoir, which amounts to approximately 7 percent of its historical range. In December 2008, 2009, and 2010, silvery minnows were introduced into the Rio Grande near Big Bend, Texas, as a nonessential, experimental population under section 10(j) of the ESA (73 FR 74357, USFWS 2008a). The success of these efforts is evaluated through monitoring of the silvery minnows reintroduced into that portion of the Rio Grande and is ongoing. In 2010, the Service found evidence of successful reproduction with the detection of silvery minnow eggs, larval and juvenile fish. In 2011, silvery minnows had distributed 70 miles further downstream and 15 miles upstream of their distribution in 2010. Success of the Big Bend 10(j) population will continue to be evaluated and relevant information incorporated into the assessment for potential reintroductions in additional locations.

The Rio Grande, prior to widespread human influence, was a wide, perennially flowing, aggrading river characterized by a shifting sand substrate (Biella and Chapman 1977). The river freely migrated across a wide floodplain and was limited only by valley terraces and bedrock outcroppings. Throughout much of its historic range, the decline of the silvery minnow can be attributed in part to destruction and modification of its habitat due to dewatering and diversion of water, water impoundment, and modification of the river (channelization). The construction of mainstem dams, such as Cochiti Dam and several irrigation diversion dams, have contributed to the decline of the silvery minnow (USFWS 2010a). Cochiti Dam was constructed on the main stem of the Rio Grande in 1973 for flood control and sediment retention (Julien et al. 2005). The construction of Cochiti Dam affected the silvery minnow by reducing the magnitude and frequency of peak flow events and floods that help to create and maintain habitat for the species (Dudley and Platania 1997; Julien et al. 2005). In addition, the construction of Cochiti Dam has resulted in degradation of silvery minnow habitat within the Cochiti Reach downstream of the Cochiti Dam. Water released through Cochiti Dam is now generally clear, cool, and free of sediment. Below Cochiti Dam, there is relatively little channel braiding, and areas with reduced velocity and sand or silt substrates are now uncommon (Julien et al. 2005). Cochiti Dam also created a barrier for movement upstream by silvery minnows (USFWS 2010a). As recently as 1963, silvery minnows were collected upstream of Cochiti, New Mexico; however surveys since 1983 suggest that silvery minnows are now extirpated from in or above Cochiti Reservoir (USFWS 2010a).

Substrate immediately downstream of Cochiti Dam is often composed of gravel and cobble (rounded rock fragments generally 8 to 30 cm [3 to 12 in] in diameter). Farther downstream, the riverbed is gravel with some sand and silt substrate. Tributaries including Galisteo Creek and Tonque Arroyo introduce sand and silt during stormwater runoff to the lower sections of the Cochiti Reach, and some of this sediment is transported further downstream along with flows (Salazar 1998; USFWS 1999, 2001).

Long-term monitoring of silvery minnows in the Middle Rio Grande began in 1993 and has continued annually, with the exception of 1998 (Dudley et al. 2012a). The long-term monitoring of silvery minnows has recorded dramatic annual fluctuations in density, measured in October, over time (Figure 3). For example, silvery minnow catch rates declined two to three orders of magnitude between 1993 and 2003, but then increased three to four orders of magnitude by 2005 and continue to fluctuate (Figure 3). Catch rate data suggest that the population of silvery minnows declined through early 2000, increased by 2005, and during 2010 and 2011, were below their levels at the time of their listing as an endangered species in 1994. The recent capture of zero wild silvery minnows during October 2012 population monitoring indicated that silvery minnow populations are not stable and have declined precipitously (Dudley et al. 2012). Catch of silvery minnow, in October, was positively correlated with the magnitude and duration of the spring runoff (Dudley and Platania 2008b). However, errors associated silvery minnow catch and distribution appears to complicate direct comparisons of catch rates (Goodman 2012).

Augmentation with hatchery-reared silvery minnows has likely sustained the silvery minnow population throughout its range over the last decade (Remshardt 2008b). Nearly 1,750,000 silvery minnows have been released since 2002. Hatchery-propagated and released fish supplement the native adult population, most likely prevented extinction during the extremely low water years of 2002, 2003, and 2012, and allowed for quicker and more robust population response in all reaches due to improved water conditions observed in recent years (USFWS 2010a). Since 2008, augmentation has only occurred in the Isleta and San Acacia Reaches in order to monitor the success of previous stocking efforts in the Angostura Reach (USFWS 2011a).

Dudley et al (2012a) reported the catch rate of silvery minnows from 0 per 100 m² in the San Acacia Reach, whereas, average catch rate was 0.03 per 100 m² in September 2012. Population monitoring efforts from February 1993 to September 2011, had an average density of silvery minnows in the San Acacia Reach of 15.9 (±82.2) per 100 m² and ranging from 0 to 1,742 per 100 m² (without considering silvery minnow density in isolated pools, n=1,217). Approximately 144,000 hatchery-reared silvery minnows were released at sites in the San Acacia Reach during November 2012 (T. Archdeacon, Service, 26 November 2012, written communication). However, the low number of wild silvery minnow collected during September 2012 and their absence in October 2012 confirms that there was very poor survival and recruitment following spawning earlier in 2012 (Dudley et al. 2012a).

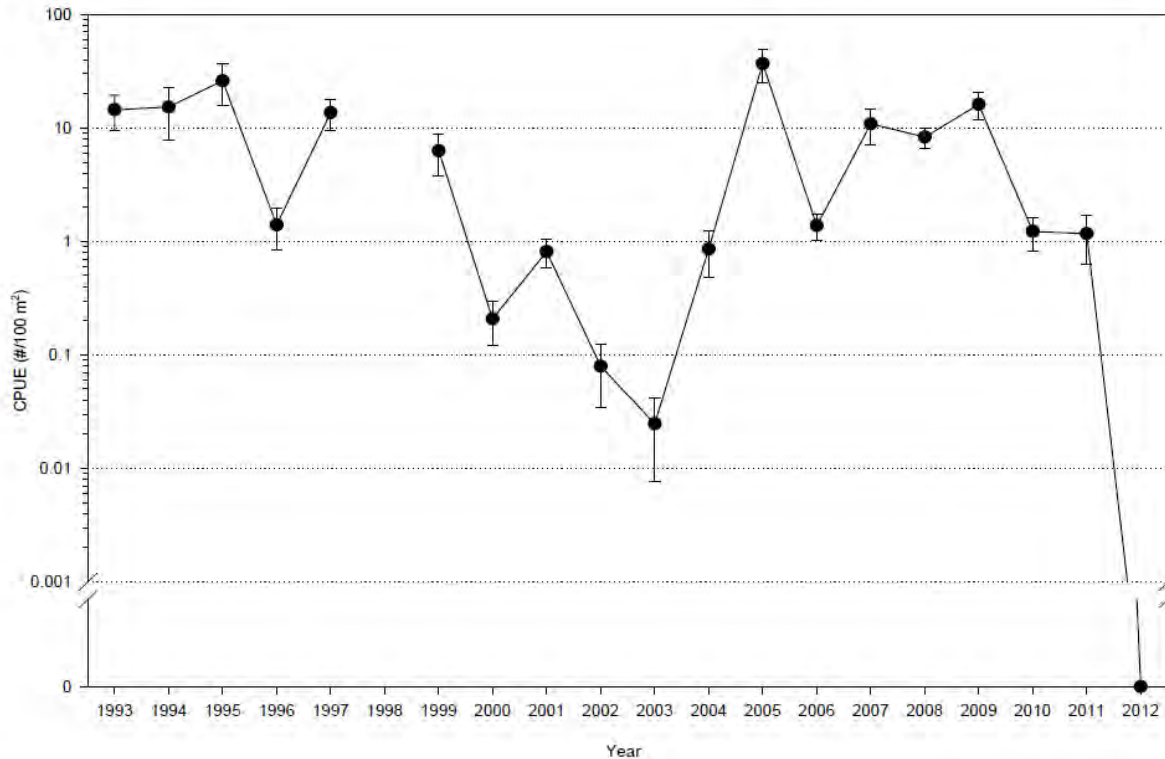


Figure 4. Annual October monitoring summary of silvery minnow catch per unit effort (number of fish per 100 square meters during 1993 to 2012 (Dudley et al 2012a).

Middle Rio Grande Distribution Patterns

During the early 1990s, the catch rates of silvery minnows generally increased from upstream (Angostura Reach) to downstream (San Acacia Reach). During surveys in 1999, over 98 percent of the silvery minnows captured were downstream of SADD (Dudley and Platania 2002). This distributional pattern can be attributed to downstream drift of eggs and larvae and the inability of adults to repopulate upstream reaches because of diversion dams. For this reason, an absence of continuous flow in the San Acacia Reach would likely have a disproportionately greater negative effect on silvery minnows when there is a large portion of the silvery minnow population affected by drying events. The San Acacia Reach is often the first of the four reaches of the Middle Rio Grande to experience drying (Platania and Dudley 2003).

This pattern shifted in several recent years. In 2004, 2005, and 2007, catch rates were highest in the Angostura Reach and lower in the Isleta and San Acacia Reaches. Routine augmentation of silvery minnows in the Angostura Reach (the focus of augmentation efforts started in 2001) may partially explain this pattern. Transplanting of silvery minnows (approximately 802,700 through 2009) rescued from drying reaches has also occurred since 2003. It is not possible to quantify the effects of those rescue efforts on the silvery minnow population distribution patterns (Remshardt 2010b). Good recruitment conditions (high and sustained spring runoff) throughout the Middle Rio Grande during April and May followed by wide-scale drying in the Isleta and

San Acacia Reaches from June to September may also explain the shift. High spring runoff greater than $86 \text{ m}^3/\text{s}$ (3,000 cubic feet per second [cfs]) for 7 to 10 days and perennial flow tends to lead to increased nursery habitat and survivorship. In recent times, portions of the Rio Grande south of the Isleta and San Acacia Diversion Dams have had large stretches of river (0.8 to 93.5 miles, average 34.7 miles (USBR 2012) routinely dewatered. Silvery minnows in these areas were subjected to poor recruitment conditions (lack of nursery habitats during low flows) or were trapped in drying pools where many perished (USFWS 2010a).

Reports for 2008 indicated high recruitment, at all 20 sampling sites along the Middle Rio Grande, and strong runoff over an extended duration from May to July lead to elevated numbers of this species. Sampling in October 2009, indicated high recruitment, at 19 of the 20 sampling sites. The highest densities were noted to persist in the San Acacia Reach during the population monitoring in October of 2008, 2009, 2010, and 2011. The lack of extensive river drying in 2008 and 2009, and favorable spring peak flows, was likely an important factor in this distribution shift from highest densities in the Angostura Reach in 2007 to the San Acacia Reach in 2008 and 2009 (Dudley and Platania 2008a, 2008b, 2009). During 2010, the silvery minnow was the most common fish species caught in the San Acacia Reach and the least common in the Angostura Reach during monitoring (Dudley and Platania 2010). In late 2010, the Isleta and San Acacia Reaches were stocked with hatchery-raised silvery minnows, and this activity was apparently the primary cause for increased silvery minnow catch rates in those reaches (Dudley and Platania 2011).

Even though densities of silvery minnows have shown a tendency to track hydrological patterns, site occupancy data has determined that there has been about a 2% decline since 2005 in the number of occupied sampling units (Dudley et al. 2011a,b,c). This reduced site occupancy has indicated a cumulative loss of about 10% occupied sites in 5 years (Dudley et al. 2011a,b,c).

Population Estimate

Since 2006, the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP) has funded studies to investigate methods for estimating population size for the Rio Grande silvery minnow (Dudley et al. 2011a,b,c, 2012b). This study was structured to provide estimation for the population of Rio Grande silvery minnow based on data collected from 20 sampling units in the study area. Sampling units were selected randomly using a spatially balanced statistical design to maintain an unbiased probability of sampling at localities that support differing densities of silvery minnow. The 2008 estimate incorporated sampling efficiencies by habitat and is considered the most reliable estimate to date. In 2008, silvery minnow numbers were highest in the Isleta Reach ($N = 1,027,489$) and lowest in the San Acacia Reach ($N = 404,864$). In October 2009, population estimates were highest in the Isleta Reach ($N = 1,602,348$) and lowest in the San Acacia Reach ($N = 923,352$). The total population estimate

for all three reaches was 3,476,873 (Dudley et al. 2011b). In October 2010, the overall population estimate decreased to 267,272 for all three reaches (Dudley et al. 2011c). The 2011 population estimation data suggested that the silvery minnow population declined as compared with 2010 (Dudley et al. 2012b) and undoubtedly declined further in 2012 as indicated by the lack of detection during population monitoring of silvery minnows in the San Acacia Reach (Dudley et al. 2012a).

Genetics

The ability of a species to persist long term is determined in part by the amount of genetic variation that is retained by a species. As a population declines, genetic variation is lost and can lead to reduced viability and reproductive capability (Falconer 1981, Ralls and Ballou 1983), affect a species' ability to adapt and respond to environmental changes, and can ultimately heighten the risk of extinction (Frankham 1995, Higgins and Lynch 2001). Evaluations of genetic data collected for the Rio Grande silvery minnow indicate that overall, mitochondrial (mt) DNA diversity declined nearly 18 percent between 1987 and 2005. There have been two sharp declines in mt DNA diversity in the "wild" Rio Grande silvery minnow population. The first occurred in 1999, the second in 2001 (Alò and Turner 2005, Turner et al. 2006, Turner and Osborne 2007). The losses of diversity followed a sharp decline in abundance of Rio Grande silvery minnow between 1995 and 1997, and again between 1999 and 2000, as catch rates declined by an order of magnitude (Dudley et al. 2005). These declines in diversity coincided with extensive drying in the San Acacia Reach of the Rio Grande. Mitochondrial DNA diversity has continued to decline between 2004 and 2007 (Turner and Osborne 2007).

Declines in heterozygosity were also recorded for silver minnow from 1987 to 1999 and between 2000 and 2002, but increased between 2002 and 2005. Supplemental stocking with captive reared minnows from wild-caught eggs between 2001 and 2003 is thought to have temporarily alleviated loss of alleles and heterozygosity in the wild during this period (Turner and Osborne 2004). Heterozygosity again declined in 2007 (Turner and Osborne 2007).

Genetic studies have also demonstrated that the effective population size (N_e) for the Rio Grande silvery minnow is a fraction of the census size (Alò and Turner 2005). The effective population size is defined as the number of adult individuals that successfully contribute genes to subsequent generations (Frankham 1995). Alternatively, put into other words, the effective population size is a measure that allows predictions about the rate of loss of genetic variation in a population and is generally equivalent to the number of individuals that contribute genes to subsequent generations. In natural population, N_e is less than the census population size, which is the actual number on individuals that can be counted (Frankham 1995). For the Rio Grande silvery minnow, the presence of diversion dams prevents the recolonization of upstream habitats (Platania 1995) and has reduced the species' effective population size to critically low levels (Alò and Turner 2005). The N_e for the silvery minnow is estimated to be approximately 100 and calculated from measured genetic changes (due to genetic drift) across nine generations. Although the Service does not know the direct impacts of small genetic effect size in silvery minnow, the rate at which genetic diversity is lost is inversely proportional to effective population size. There is ample indication that populations of species that have limited diversity

are at increased extinction risk. In conservation genetics literature, an N_e of 500 has been recommended to conserve neutral genetic variation (Frankel and Soule 1981) and an N_e of 5000 has been recommended to maintain the normal adaptive potential in important traits, such as size, that are determined by multiple genes (Lande 1995). Estimates of genetic effective size for the Rio Grande silvery minnow have consistently fallen well below the lower of these numbers, and the current effective size is not sufficient to rule out genetic consequences of small N_e for the species.

Reasons for Listing and Threats to Survival

The silvery minnow was federally listed as endangered for the following reasons:

1. regulation of stream waters, which has led to severe flow reductions, often to the point of dewatering extended lengths of stream channel;
2. alteration of the natural hydrograph, which impacts the species by disrupting the environmental cues the fish receives for a variety of life functions, including spawning as well as food availability during larval fish development;
3. both the stream flow reductions and other alterations of the natural hydrograph throughout the year can severely impact habitat availability and quality, including the temporal availability of habitats;
4. actions such as channelization, bank stabilization, levee construction, and dredging result in both direct and indirect impacts to the silvery minnow and its habitat by severely disrupting natural fluvial processes throughout the floodplain;
5. construction of diversion dams fragment the habitat and prevent upstream migration;
6. introduction of nonnative fishes that directly compete with, and can totally replace the silvery minnow, as was the case in the Pecos River, where the species was totally replaced in a time frame of 10 years by its congener the plains minnow (*H. placitus*); and,
7. degraded water quality caused by industrial, municipal, or agricultural discharges also affects the species and its habitat (USFWS 1994).

These reasons for listing continue to threaten the species throughout its currently occupied range in the Middle Rio Grande. The decline in abundance of the silvery minnow in association with the much-reduced range of the species is a great concern to its continued existence. Any species, restricted to as small a portion of its natural range is susceptible to a variety of local perturbations that may lead to its extinction (PBS&J 2011).

Recovery Efforts

Recovery efforts are currently guided by the First Revision of the Rio Grande Silvery Minnow Recovery Plan, which was finalized and issued on February 22, 2010 (75 FR 7625, USFWS 2010a). The revised Recovery Plan describes recovery goals for the silvery minnow and actions to complete these (USFWS 2010a). The three goals identified for the recovery and delisting of the silvery minnow are:

1. prevent the extinction of the silvery minnow in the Middle Rio Grande of New Mexico;
2. recover the silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting); and
3. recover the silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).

Downlisting (Goal 2) of the silvery minnow may be considered when the criteria have been met resulting in three populations (including at least two that are self-sustaining) that have been established within the historical range of the species and have been maintained for at least 5 years.

Delisting (Goal 3) of the species may be considered when the criteria have been met resulting in three self-sustaining populations have been established within the historical range of the species and have been maintained for at least 10 years (USFWS 2010a).

Conservation and recovery efforts targeting the silvery minnow are also summarized in the revised Recovery Plan and elsewhere (Tetra Tech EM Inc. 2004; USFWS 2010a). These efforts have included habitat restoration activities; research and monitoring of the status of the silvery minnow, its habitat, and the associated fish community in the Middle Rio Grande; and programs to stabilize and enhance the species, such as tagging fish and egg monitoring studies, salvage operations, captive propagation, fish health monitoring, and augmentation efforts (for more information see www.middleriogrande.com). In addition, specific water management actions in the Middle Rio Grande valley over the past several years have been used to meet river flow targets and the 2003 BO requirements for silvery minnow (USFWS 2003a).

Propagation and Augmentation

In 2000, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow. Captive propagation is conducted in a manner that will, to the maximum extent possible, preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations.

Facilities at Dexter National Fish Hatchery and Technology Center and the City of Albuquerque's BioPark conduct captive propagation of silvery minnows. Silvery minnows are also held at the Service's New Mexico Fish and Wildlife Conservation Office, the Interstate Stream Commission Refugium in Los Lunas, New Mexico, and USGS Columbia Environmental Research Center Laboratory in Yankton, South Dakota.

Since 2002, over 1 million silvery minnows have been propagated and released into the Rio Grande (Remshardt 2010b). Wild gravid adults are successfully spawned in captivity at the City of Albuquerque's propagation facilities. Eggs are raised and released as larval fish. Marked fish have been released into the Middle Rio Grande by the Service's New Mexico Fish and Wildlife Conservation Office, and others, since 2002 under an augmentation effort funded by the Middle

Rio Grande Endangered Species Collaborative Program. Eggs left in the wild have a very low survivorship, and captive propagation ensures that an adequate number of spawning adults are present to repopulate the river each year. Wild eggs are also collected and reared to maximize the genetic diversity of the minnows released (Remshardt 2008b; Osborne et al. 2012).

Silvery Minnow Salvage and Relocation

During river drying, staff from the Service's New Mexico Fish and Wildlife Conservation Office often captures and relocates silvery minnows to nearby perennial water (Remshardt 2010a,b). Through 2009, approximately 800,000 silvery minnows have been rescued and relocated to wet river reaches, the majority of which were released in the Angostura Reach. Studies have been conducted to determine survival rates for salvaged fish. Caldwell et al. (2010) reported on studies that assessed the physiological responses of wild silvery minnows subjected to collection and transport associated with salvage. The authors examined primary (plasma cortisol), secondary (plasma glucose and osmolality), and tertiary indices (parasite and incidence of disease) and concluded that the effects of stressors associated with river intermittency and salvage resulted in a cumulative stress response in wild silvery minnows. They also concluded that fish in isolated pools experienced a greater risk of exposure and vulnerability to pathogens (parasites and bacteria), and that the stress response and subsequent disease effects were reduced through a modified salvage protocol that applied specific criteria to determine which wild fish are to be rescued from pools during river intermittency (Caldwell et al. 2010).

SOUTHWESTERN WILLOW FLYCATCHER

The terms “territory” and “site” are used below to help describe flycatcher population biology and breeding habitat. A territory is an area occupied by a single male or pair of flycatchers throughout the breeding season. Territories are the unit of measurement used by the Service in determining population numbers. A site may include a single territory or a cluster of territories. When used alone, the term “habitat” is used to describe those areas that provide food, shelter, and protection from predators during long-distance migration and short-distance stopover habitat. The term “breeding habitat” is used to describe those habitats that also provide resources for nest support, extra food for raising young, and protection from nest predators.

Species and Subspecies Description

The willow flycatcher is a widespread species that breeds across much of the contiguous United States. There are four commonly recognized subspecies of willow flycatcher; *Empidonax traillii traillii*, *Empidonax traillii brewsteri*, *Empidonax traillii adastus*, and *Empidonax traillii extimus*. Each subspecies occupies a distinct breeding range (Figure 4), though there is an interbreeding or gradation zone in the northern boundary area between *E. t. extimus* and *E. t. adastus*, making the delineation of a precise boundary between these two subspecies difficult (Sedgwick 2001 and Paxton et al. 2008). All subspecies of willow flycatcher are neotropical migrants that breed in the U.S. and migrate to Mexico, Central America, and South America during the wintering season, returning to the U.S. to breed in the spring (Phillips 1948; Stiles and Skutch 1989; Browning 1993; Ridgely and Tudor 1994; Howell and Webb 1995; Paxton et al. 2011a).

The willow flycatcher is a small passerine bird (Family Tyrannidae) measuring approximately 5.75 in (14.6 cm) in height (USFWS 1995). It has drab plumage; often including grayish-green feathers on its back and wings, a pale, white-colored throat, a light gray-olive breast, and a pale yellow-colored belly. Two white wingbars are often visible (juveniles have buff-colored wingbars). The eye ring is faint or absent in many individuals. (Unitt 1987 and Browning 1993). Plumage color can vary on observer bias, and feather wear and fading can affect color and lightness (Paxton et al. 2010a). The upper portion of the flycatcher’s beak is often dark, with the lower portion light yellow in color and grading to black at the tip. A flycatcher’s song is not particularly melodious, and has been characterized as a sneezy “fitz-bew” and their call is a repeated, but soft, “whitt” (Howell and Webb 1995).

The southwestern subspecies, *E. t. extimus*, was described by Phillips (1948), and its taxonomic status has been accepted by most authors (USFWS 1995, 2002). Morphological differences among the four flycatcher subspecies is mostly based on difference in plumage coloration (Unitt 1987). Generally, the southwestern subspecies has a lighter and more yellowish plumage coloration compared with other flycatcher subspecies. The remainder of this document will focus on the southwestern subspecies of willow flycatcher, *E. t. extimus* (flycatcher).

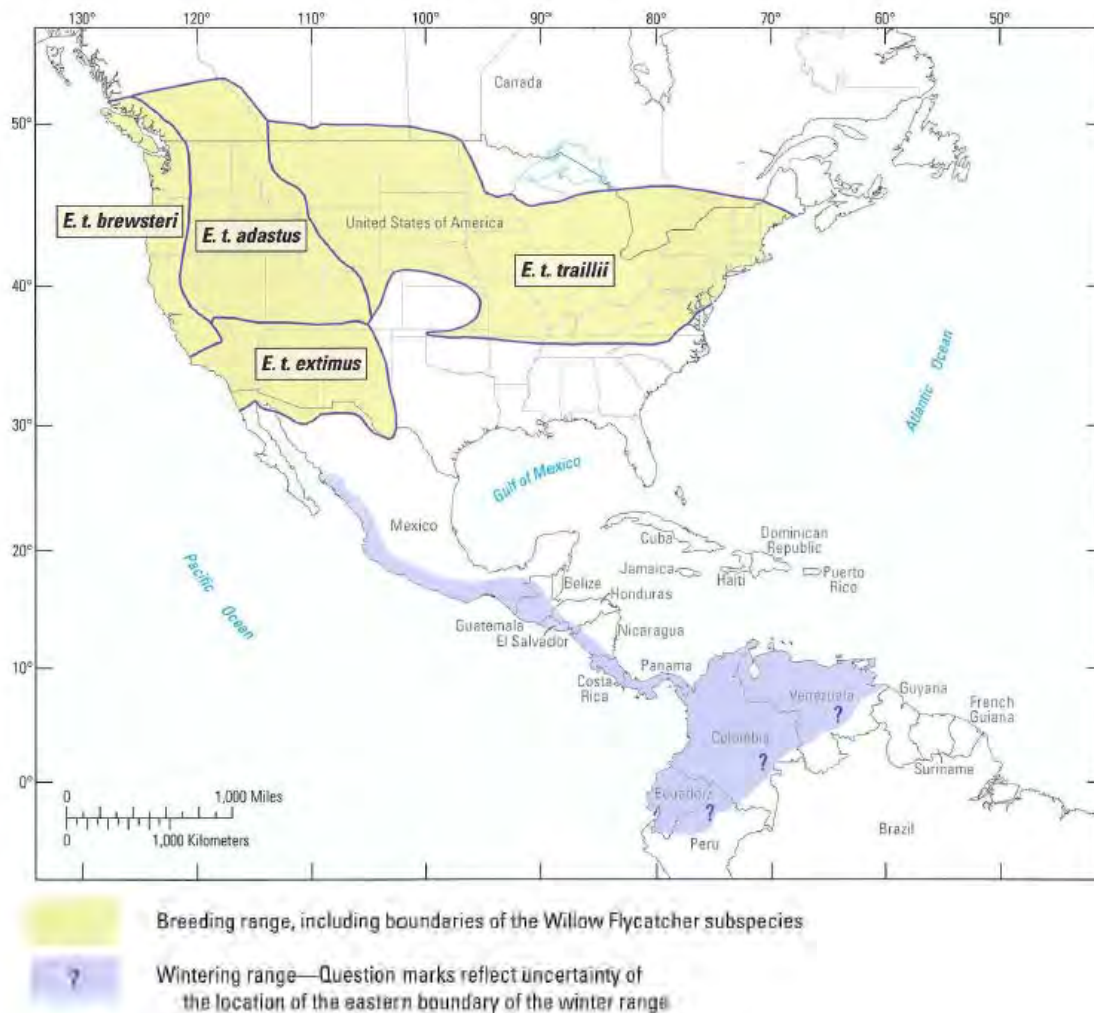


Figure 4. Approximate range distribution of willow flycatcher subspecies (Sogge et al. 2010) adapted from Unitt (1987), Browning (1993), and Paxton et al (2008).

Listing and Critical Habitat

The final rule that listed the flycatcher as an endangered species was published in the Federal Register (FR) on February 27, 1995, without critical habitat designation (USFWS 1995). A 5-year review of the flycatcher was initiated on March 20, 2008 (USFWS 2008c) and did not include a recommendation to the endangered listing status, however, a final decision as to the flycatcher's status has yet to be issued (USFWS 2013). In addition to its federal status, the flycatcher is also listed as an endangered species or species of concern in California (California Department of Fish and Game 1991), New Mexico (NMDGF 1996), Utah (Utah Division of Wildlife Resources 1997), and Arizona (Arizona Game and Fish Department 2006).

Critical habitat was designated for the flycatcher on July 22, 1997 along 599 river miles in Arizona, California, and New Mexico (USFWS 1997a). A correction notice was later published in the Federal Register on August 20, 1997, to clarify the lateral extent of the designation (USFWS 1997b). In May 2001, citing a faulty economic analysis, the 10th Circuit Court of Appeals vacated the designation of critical habitat and instructed the Service to issue a new flycatcher critical habitat designation. On, October 19, 2005, critical habitat was re-designated on approximately 48,896 ha (120,824 acres) or 1,186 km (737 mi) within Arizona, California, Nevada, New Mexico and Utah (USFWS 2005). On July 13, 2010, the Service agreed to revise critical habitat for the flycatcher; while the 2005 critical habitat designation remained in place. On January 3, 2013, a final rule to designate revised critical habitat was published in the Federal Register (USFWS 2013) for the flycatcher on approximately 1,975 stream km (1,227 mi) on a combination of Federal, State, tribal, and private lands in California, Nevada, Utah, Colorado, Arizona, and in New Mexico. In determining which areas within the geographical area are occupied by the flycatcher, the Service considered physical or biological features essential to the conservation of the flycatcher in accordance with sections 3(5)(A)(i) and 4(b)(1)(A) of the ESA and regulations at 50 CFR 424.12. These areas included:

the specific areas within the geographic area occupied by flycatchers on which are found those physical or biological features essential to the conservation of the flycatcher; and,

specific areas outside the geographical area occupied by the flycatcher at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential to the conservation of the species.

Proposed critical habitat areas included, but were not limited to:

1. Space for individual and population growth and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, or rearing (or development) of offspring; and
5. Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

The specific physical or biological features required for the flycatcher from studies of its habitat, ecology, and life history was described by the Service (USFWS 2013). In general, the physical or biological features of critical habitat for nesting flycatchers are found in the riparian areas within the 100-year floodplain or flood-prone areas. Flycatchers use riparian habitat for feeding, sheltering, and cover while breeding, migrating, and dispersing. It is important to recognize that flycatcher habitat is ephemeral in its presence, and its distribution is dynamic in nature because riparian vegetation is prone to periodic disturbance (such as flooding). The PCEs of critical habitat proposed for the flycatcher included:

1. Primary Constituent Element 1— Riparian vegetation. Riparian habitat in a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Gooddings willow (*Salix gooddingii*), coyote willow (*S. exigua*), Geyers willow (*S. geyerana*), arroyo willow (*S. lasiolepis*), red willow (*S. laevigata*), yewleaf willow (*S. taxifolia*), pacific willow (*S. lasiandra*), boxelder (*Acer negundo*), tamarisk (*Tamarix ramosissima*; also known as salt cedar), Russian olive (*Elaeagnus angustifolia*), buttonbush (*Cephalanthus occidentalis*), cottonwood (*Populus fremontii*), stinging nettle (*Urtica dioica*), alder (*Alnus spp.*), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus ursinus*), seep willow (*Baccharis salicifolia*, *B. glutinosa*), oak (*Quercus agrifolia*, *Q. chrysolepis*), rose (*Rosa californica*, *R. arizonica*, *R. multiflora*), sycamore (*Platanus wrightii*), false indigo (*Amorpha californica*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), and walnut (*Juglans hindsii*)).
2. and some combination of:
 - a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 meters (m) to 30 m (about 6 to 98 feet (ft)). Lower-stature thickets (2 to 4 m or 6 to 13 ft tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests; and/or
 - b. Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or
 - c. Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground); and/or
 - d. Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 hectares (ha) (0.25 acres (acres)) or as large as 70 ha (175 acres); and
3. Primary Constituent Element 2— Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and cicada (Homoptera).

The PCEs of flycatcher critical focused on the end result of all the components that culminate in the development of flycatcher breeding habitat. The Service (USFWS 2005) described those components (e.g., broad floodplain, surface water, fine sediments, hydrologic regime, channel-floodplain connectivity, elevated groundwater, etc.) in detail in the supporting text for the PCEs (69 FR 60712–60715). The methodology used for designating critical habitat for the flycatcher was based around nesting territories. Riparian habitat is dependent on the location of river channels, floodplain soils, subsurface water, floodplain shape, and is driven by the wide variety of high, medium, and low flow events. Rivers normally can and do move from one side of the floodplain to the other. Flooding occurs at periodic frequencies that recharge aquifers, deposit, and moisten fine floodplain soils that create seedbeds for riparian vegetation germination and growth within these boundaries. All the PCEs of critical habitat for the flycatcher are found in the riparian ecosystem within the 100-year floodplain or flood prone area. Pre-existing data sources were used by the Service (USFWS 2005) to assist in the process of delineating the lateral extent of the riparian zones for this designation included: (1) National Wetlands Inventory (NWI) digital data from the mid 1980's, 2001, 2002; (2) Federal Emergency Management Agency (FEMA) 1995, Q3 100 year flood data; (3) U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing; and (4) (TIGER) 2000 digital data. Where pre-existing data may not have been available to readily define riparian zones, visual interpretation of remotely sensed data was used to define the lateral extent.

The flycatcher may be dependent upon habitat components beyond the immediate areas where individuals of the species occur if they are important in maintaining ecological processes such as hydrology; stream flow; hydrologic regimes; plant germination, growth, maintenance, regeneration (succession); sedimentation; groundwater elevations. However, floodplains may be productive environments because flooding makes them so. The location of breeding sites, foraging locations, or areas used for migration or dispersal, can change over time (sometimes within a year or over a few years). Changes can occur due to flooding, drought, fire, or choices in land management. Thus, habitat that is not currently suitable for nesting at a specific time, but useful for foraging and/or migration can be essential to the future conservation of the flycatcher.

Within the State of New Mexico, revised critical habitat was designated along 402 stream km (250 mi) on a combination of Federal, State, Tribal and private lands. The majority of these lands are located within the Rio Grande Recovery Unit, which primarily includes the Rio Grande watershed from its headwaters in southern Colorado downstream to the Pecos River confluence in Texas and is made up of the San Luis Valley Management Unit in Colorado, and the Upper Rio Grande, Middle Rio Grande, and Lower Rio Grande Management Units in New Mexico.

Within the Upper Rio Grande Management Unit, a 46.8km (29.1 mi) segment of the Rio Grande is being proposed that extends from the Taos Junction Bridge (State Route 520) downstream to the northern boundary of the San Juan (Ohkay Ohwingeh) Pueblo, plus a 1.1 k, (0.4 mi) portion of the Rio Grande between San Juan Pueblo and Santa Clara Pueblo, an 11.9 km (7.4-mi) segment of the Rio Grande del Rancho is being proposed from Sarco Canyon downstream to the Arroyo Miranda confluence, and a 10.7 km (6.6-mi) segment of Coyote Creek is being proposed from above Coyote Creek State Park downstream to the second bridge on State Route 518, upstream from Los Cocas. Additionally, a 0.4 km (0.2 mi) segment of the Rio Fernando is designated upstream of Rio Lucero confluence.

Within the Middle Rio Grande Management Unit, a 180.4 km (112.1 mi) segment of the Rio Grande was designated from below the Isleta Pueblo and the Bernalillo and Valencia County line downstream past Bosque del Apache and Sevilleta National Wildlife Refuges and into the upper portion of Elephant Butte Reservoir in Valencia and Socorro Counties, New Mexico. Within the Lower Rio Grande Management Unit, no critical habitat was designated.

Reasons for Endangerment

The historic breeding range of the flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987). Declining flycatcher numbers have been attributed to loss, modification, and fragmentation of riparian habitat, breeding habitat, loss of wintering habitat, and brood parasitism by the brown-headed cowbird (*Molothrus ater*) (Sogge et al. 1997, McCarthy et al. 1998). Changes to riparian ecosystems such as reductions in water flow, alteration of flood flows, physical modifications to watersheds and streams, and removal of riparian vegetation have occurred because of dams and reservoirs, groundwater pumping, channelization of streams for flood control, livestock overgrazing, agriculture developments, urbanization and other modifications.

Fire is also responsible for changes to riparian ecosystems, and is a threat to willow flycatcher habitat (Paxton et al. 1997), especially in monotypic tamarisk vegetation (DeLoach 1997) and where water diversions and/or groundwater pumping desiccate riparian vegetation (Sogge et al. 1997).

Flycatcher nests are parasitized by brown-headed cowbirds, which lay their eggs in the flycatcher nests. Feeding sites for cowbirds are enhanced by the presence of livestock and range improvements such as waterers and corrals, agriculture, urban areas, golf courses, bird feeders, and trash areas. When these feeding areas are in close proximity to flycatcher breeding habitat, especially coupled with habitat fragmentation, cowbird parasitism of flycatcher nests may increase (Hanna 1928; Mayfield 1977a,b; Tibbitts et al. 1994). An increase in nest parasitism by cowbirds and predation of flycatcher nests affects populations, especially those in smaller numbers and at more isolated locations.

Modification and loss of wintering habitat as well as loss of migratory “stopover” habitat used by flycatchers to replenish energy reserves during their long-distance migration may also contribute to the decline of flycatcher survival and reproduction. The widespread distribution, accumulation, or continued use of agrichemicals and pesticides in North, Central, and South America as well as the legacy of previous chemical use, storage, leaks, spills and atmospheric redistribution also likely contributed to the decline of the flycatcher.

Recently, a new threat to the flycatcher has been introduced that was not previously identified in the reasons for listing. The U.S. Department of Agriculture facilitated a biological control effort to eradicate nonnative tamarisk vegetation by releasing tamarisk beetles in the southwestern United States. These leaf beetles act by defoliating tamarisk trees during the growing season, with repeated defoliation over multiple years until the tree is killed. The use of tamarisk beetles was predicted to have large net positive benefits and minimal negative effects, however tamarisk beetles have dispersed from original release sites in Colorado and Utah much faster than predicted (Bean et al. 2007), and have the potential to spread widely and defoliate large expanses of tamarisk habitat, which is often utilized by flycatchers. In June 2010, the U.S. Department of Agriculture issued a moratorium on the release of tamarisk beetles in response to concerns over its potential effects on flycatcher critical habitat. Tamarisk beetle has become established in multiple watersheds in the southwest and will likely continue to expand its range (Paxton et al. 2011b).

Recovery Plan

A final recovery plan for the flycatcher was issued by the Service on August 30, 2002 (USFWS 2002). The Recovery Plan describes the reasons for endangerment, current status of the flycatcher, addresses important recovery actions, includes detailed papers on management issues, and provides recovery goals.

Because the breeding range of the flycatcher encompasses a broad geographic area with much site variation, management of its recovery is approached in the Recovery Plan by dividing the flycatcher’s range into six Recovery Units, each of which are further subdivided into Management Units (USFWS 2002). This provides an organizational strategy to “characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground” (USFWS 2002). Recovery goals are recommended for most Management Units. Recovery Units are defined based on large watershed and hydrologic units.

Within each Recovery Unit, Management Units are based on watershed or major drainage boundaries at the Hydrologic Unit Code Cataloging Unit level. The “outer” boundaries of some Recovery Units and Management Units were defined by the flycatcher’s range boundaries. Flycatcher habitat within Recovery and Management Units is expected to expand, contract, or change as a result of flooding, drought, inundation, and changes in floodplains and river channels (USFWS 2002) that result from natural occurrences and water or land management choices. The Recovery Plan (USFWS 2002) provides recommendations to recover the flycatcher and provides two alternatives, either of which can be met, in order to consider downlisting the

species to threatened. The first alternative for downlisting requires reaching a total population of 1,500 flycatcher territories geographically distributed among all Recovery Units and maintained for 3 years with habitat protections. Habitat protections include a variety of options such as conservation plans, conservation easements, or safe harbor agreements. The second alternative approach for downlisting calls for reaching a population of 1,950 territories also strategically distributed among all Recovery and Management Units for 5 years without additional habitat protection. In order to delist this flycatcher subspecies (to remove it from the List of Endangered and Threatened Wildlife and Plants), a minimum of 1,950 territories are geographically distributed among all Recovery and Management Units, and that twice the amount of habitat is provided to maintain these territories over time. Twice the amount of suitable habitat is needed to support the numerical territory goals, because the long-term persistence of flycatcher populations cannot be assured by protecting only those habitats in which flycatchers currently breed. Second, these habitats must be protected from threats to assure maintenance of these populations and habitat for the foreseeable future through development and implementation of conservation management agreements. Third, all of these delisting criteria must be accomplished and their effectiveness demonstrated for a period of 5 years.

The amount of additional habitat needed may vary in each Management Unit, based on local and regional factors that could affect the rate of occupied habitat loss and change. Until these factors can be better quantified, the Service believes that conserving, within each Management Unit, double the amount of breeding habitat needed to support the target number of flycatchers assures that displaced flycatchers will have habitats in which to settle, given even a catastrophic level of local habitat loss.

Based on a range-wide review of riparian patch sizes and flycatcher population sizes presented in published and unpublished literature, a patch has an average of 1.1 ha (2.7 acres) (± 0.1 acres Standard Error) of dense, riparian vegetation for each flycatcher territory found within the patch. Therefore, delisting would require that twice this amount of breeding habitat (i.e., 5.4 acres) be protected for each flycatcher territory that is part of the recovery goal within a Management Unit. For example, a Management Unit with a recovery goal of 100 territories would need to assure the protection of 540 acres (220 ha) (i.e., 100 territories \times 5.4 acres for each territory) of suitable breeding habitat. This total amount of available and protected breeding habitat includes: (a) habitat occupied by flycatchers meeting the population target (100 territories), (b) flycatchers in excess of the population target, and (c) suitable but unoccupied habitat. The factor of 5.4 acres/2.2 ha of breeding habitat per flycatcher territory can be modified based on more local data on patch sizes and population numbers. For example, if the average amount of dense, riparian vegetation per flycatcher territory were higher or lower for a given Management Unit, the amount of breeding habitat required, within that unit, to meet delisting criteria would change accordingly. Suitable breeding habitat conditions may be maintained over time through natural processes and active human manipulation.

The Service (USFWS 2002) identified several key strategies tied to flycatcher conservation in the Recovery Plan such as: 1) populations should be distributed close enough to each other to allow for movement; 2) maintaining/augmenting existing populations is a greater priority than establishing new populations; and, 3) a population's increase improves the potential to disperse and colonize. Breeding habitat objectives are incorporated into the delisting criteria because of the importance of providing replacement habitat for dispersing flycatchers after natural stochastic destruction of existing breeding habitat, and suitable breeding habitat for future population growth.

Essential to the survival and recovery of the flycatcher is a minimum size, distribution and spatial proximity of habitat patches that promotes metapopulation stability. The current size of occupied breeding habitat patches is skewed heavily toward small patches and small population sizes; this situation inhibits recovery. Recovery will be enhanced by increasing the number of larger populations and by having populations distributed close enough to increase the probability of successful immigration by dispersing flycatchers. For example, decreasing the proportion of small breeding groups can be achieved by striving for a minimum patch size that supports 10 or more territories. Available data indicate that current populations with 10 or more territories occupy patches with a mean size of 24.9 ha/61.5 acres. Alternatively, along the lower San Pedro River and nearby Gila River confluence in Arizona, smaller, occupied habitat patches show substantial between-patch movement by flycatchers and function effectively as a single site. Thus, to promote recovery, land managers and other conservation entities should strive to protect larger breeding habitat patches (about 25 ha/62 acres or more) within Management Units to minimize the distance between smaller occupied patches so that they function ecologically as a larger patch.

Breeding Biology

Throughout their range, the generalized breeding chronology of flycatchers begins with the arrival at breeding grounds in late April and May (Sogge and Tibbitts 1992; Sogge et al. 1993; Muiznieks et al. 1994; Sogge and Tibbitts 1994; Maynard 1995; Sferra et al. 1995, 1997; USFWS 2002; Sogge et al. 2010), though extreme or record dates for any given stage of the flycatcher breeding cycle may occur slightly earlier or later than the dates presented. Nesting and egg laying may begin as early as late May, but more often starts in early to mid-June. Flycatchers typically lay three to four eggs per clutch (range = 1 to 5). Eggs are laid at one-day intervals and are incubated by the female for approximately 12 days (Bent 1960, Walkinshaw 1966, McCabe 1991). Chicks can be present in nests from mid-June through early August and will typically fledge approximately 12 to 13 days after hatching (King 1955, Harrison 1979), from late June through mid-August. Young will remain in the natal area for up to 15 days (Brown 1988a,b; Sogge and Tibbitts 1992; Muiznieks et al. 1994; Maynard 1995). Adults depart from breeding territories as early as mid-August, but may stay until mid-September in later nesting efforts. Fledglings likely leave the breeding areas a week or two after adults. Most flycatchers only live one or two years as adults, but there have been rare occurrences of flycatchers living at least 9 years of age (Paxton et. al 2007a). Typically, one brood is raised per year, but birds have been documented raising two broods during one season and re-nesting after a failure (Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993, Sogge and Tibbitts 1994,

Muiznieks et al. 1994, Whitfield 1994, Whitfield and Strong 1995). The entire breeding cycle, from egg laying to fledging, is approximately 28 days. Each stage of the breeding cycle represents a greater energy investment in the nesting effort by the flycatcher pair and may influence their fidelity to the nest site or their susceptibility to quickly abandon if the conditions in the selected breeding habitat become adverse, decadent, or result in nest failure.

Flycatcher nests are small (3.2 inches tall and wide) and are commonly placed in a shrub or tree. Nests are open cup structures, and are typically placed in the fork of a branch. Nests have been found against the trunk of a shrub or tree (in monotypic tamarisk and mixed native broadleaf/tamarisk vegetation) and on limbs as far away from the trunk as 10.8 feet (Spencer et al. 1996). Typical nest placement is in the fork of small-diameter (e.g., 0.4 in), vertical or nearly vertical branches (USFWS 2002). Occasionally, nests are placed in down-curving branches. Nest height varies considerably, from 1.6 to 60 feet, and may be related to height of nest plant, overall canopy height, and/or the height of the vegetation strata that contain small twigs and live growth. Most typically, nests are relatively low, 6.5 to 23 feet above ground. Flycatcher nests in box elder dominated habitats are highest at almost 60 feet (USFWS 2002).

A breeding site is simply an area along the river that has been described while surveying for flycatcher territories (USFWS 2002; Sogge et al. 2010). A breeding site can contain none, only one, or many territories, however breeding sites are areas where flycatcher territories were detected. A territory is defined as a discrete area defended by a resident single flycatcher or pair of flycatchers within a single breeding season (Sogge et al. 2010). This is usually evidenced by the presence of a singing male, and possibly one or more mates (Sogge et al. 2010). Flycatchers have been recorded nesting in riparian habitat patches as small as 0.1 ha (0.25 acres) along the Rio Grande, and as large as 70 ha (175 acres) in the upper Gila River, New Mexico (USFWS 2002). The mean reported size of flycatcher breeding patches was 8.6 ha (21.2 acres), with the majority of sites toward the smaller end, as evidenced by a median patch size of 1.8 ha (4.4 acres) (USFWS 2002). Mean patch size of breeding sites supporting 10 or more flycatcher territories was 25 ha (62 acres). Aggregations of occupied breeding patches within a breeding site may create a riparian mosaic as large as 200 ha (494 acres), such as areas like the Kern River, Alamo Lake, Roosevelt Lake (Paradzick et al. 1999), and Lake Mead (McKernan 1997).

Flycatcher territory size likely fluctuates with population density, habitat quality, and nesting stage. Territories are established within a larger patch of appropriate habitat sufficient to contain several nesting pairs of flycatchers; flycatchers appear to be semi-colonial nesters. Estimated territory sizes are 0.59 to 3.21 acres for monogamous males and 2.7 to 5.7 acres for polygynous males at the Kern River (Whitfield and Enos 1996), 0.15 to 0.49 acres for birds in a 1.5 to 2.2 acre patch of habitat on the Colorado River (Sogge et al. 1995a), and 0.5 to 1.2 acres in a 3.7 acre patch on the Verde River (Sogge 1995b).

Flycatchers can cluster their territories into small portions of riparian sites (Whitfield and Enos 1996; Sogge et al. 2010), and major portions of the site may only be used briefly or not at all in any given year. Habitat modeling based on remote sensing and GIS data has found that breeding site occupancy at reservoir sites in Arizona is influenced by vegetation characteristics of habitat adjacent to the actual nesting areas (Hatten and Paradzick 2003); therefore, areas adjacent to nest

sites can be an important component of a breeding site. The continued exploration into the use of satellite imagery combined with associated predictive modeling techniques, whether it is suitability of flycatcher nesting habitat (Hatten and Paradzick 2003, Hatten and Sogge 2007) or to evaluate possible habitat changes associated with the tamarisk beetle (Dennison et al. 2009), may become an even more important tool in future management and recovery. How size and shape of riparian patches relate to factors such as flycatcher nest-site selection and fidelity, reproductive success, predation, and brood parasitism remains as areas for further research (USFWS 2002).

Reproductive Success

Using the information derived from tracking banded flycatchers over multiple years, Paxton et al. (2007a) estimated the average minimum lifetime productivity (the total number of young fledged per individual over their estimated lifetime) at 3.3 offspring per female, but it varied by site and year. Over a third of nesting birds did not fledge young that were detected, and over 50 percent of the young fledged were contributed by just 16 percent of the breeding adults (Paxton et al. 2007a). Average seasonal fecundity for females ranged from 1.6 at Roosevelt Lake to 2.0 at the San Pedro and Gila River confluence area. Older females had higher seasonal productivity than second-year females (Paxton et al. 2007a).

In New Mexico, breeding success has been studied in the Gila River sites, and along the Rio Grande. In 2001, 133 nests were monitored in the Gila River near Gila-Cliff Valley, New Mexico. Data indicated that 34.4 percent of the nesting attempts were successful (Broadhead et al. 2002). Along the Rio Grande, in 2000, the nest success along the Rio Grande was 65 percent of 26 monitored nests (Ahlers et al. 2001). In 2001, 45 nesting attempts were documented, and 73 percent of these were successful (Ahlers et al. 2002). In 2002, 80 nests were monitored and success was 55 percent (Ahlers et al. 2003). Since 1999, the overall nest success rate along the Middle Rio Grande has been 50 percent, with a brood parasitism rate of 14 percent, nest predation rate of 33 percent, and a nest abandonment rate of 8 percent (Moore and Ahlers 2012). Nest success has greatly decreased since 2009 and has been below 50 percent since, with 2010 being the lowest success rate observed in 12 years. This is believed to be attributed to a large increase in predation rates (Moore and Ahlers 2012). Nest success decreased to 31% in 2012 and was below the 10-year average and the parasitism rate was the highest observed in the past 13 years. The San Marcial Reach was similarly less productive in 2012, with 223 nests detected and only 65 nests successful with young fledged (i.e., $65/223=29$ percent successful) (Moore 2012).

In 2001, 426 nesting attempts were documented in Arizona at 40 sites (Smith et al. 2002). The outcome from 329 nesting attempts was determined (not every nesting attempt was monitored). Of the 329 nests monitored, 58 percent ($n=191$) were successful, 35 percent failed ($n=114$), and 7 percent ($n=24$) had an outcome which could not be determined. Causes of nest failure were predation ($n=82$), nest desertion ($n=10$), brood parasitism ($n=6$), infertile clutches ($n=12$), weather ($n=2$), and unknown causes ($n=2$). Cowbirds may have contributed to other abandoned nests, but no direct evidence was detected. Three parasitized nests fledged flycatchers along with cowbird young.

Intensive nest monitoring efforts in California, Arizona, and New Mexico have shown that cowbird parasitism and/or predation can result in failure of the nest, reduced fecundity in subsequent nesting attempts, delayed fledging, and reduced survivorship of late-fledged young. Cowbirds have been documented at more than 90 percent of sites surveyed (Sogge and Tibbitts 1992, Sogge et al. 1993, Muiznieks et al. 1994, Sogge and Tibbitts 1994, Whitfield 1994, Tomlinson 1997, Griffith and Griffith 1995, Holmgren and Collins 1995, Kus 1995, Maynard 1995, McDonald et al. 1995, Sferra et al. 1995, Sogge 1995b, c, San Diego Natural History Museum 1995, Stransky 1995, Whitfield and Strong 1995, Griffith and Griffith 1996, Skaggs 1996, Spencer et al. 1996, Whitfield and Enos 1996, Sferra et al. 1997, McCarthey et al. 1998). The probability of a flycatcher successfully fledging its own young from a cowbird parasitized nest is low (< 5 percent). In addition, nest loss due to predation appears consistent from year to year and across sites, generally in the range of 30 to 50 percent.

Cowbird trapping has been demonstrated to be an effective management strategy for increasing reproductive success for the flycatcher in certain areas as well as for other endangered passerines (e.g., least Bell's vireo [*Vireo bellii pusillus*], black-capped vireo [*V. atricapillus*], golden-cheeked warbler [*Dendroica chrysoparia*]). It may also benefit juvenile survivorship by increasing the probability that parents fledge birds early in the season. Expansion of cowbird management programs may have the potential to not only increase reproductive output and juvenile survivorship at source populations, but also to potentially convert small, sink populations into breeding groups that contribute to population growth and expansion.

Flycatcher Habitat

Flycatchers utilize riparian habitats that are generally dense, shrubby, moist, and that have abundant flying insects. Flycatchers use riparian corridors throughout their range as stopover habitat during their long-distance migration. Historical species' descriptions often describe the flycatcher's widespread use of native willow (*Salix* spp.) for habitat and nesting (Phillips 1948, Phillips et al. 1964, Hubbard 1987, Unitt 1987, San Diego Natural History Museum 1995).

Flycatcher Breeding Habitat

The flycatcher currently breeds in areas from near sea level to over 2,600 m (8,500 ft) (Durst et al. 2008b) in vegetation alongside rivers, streams, or other wetlands (riparian habitat). It establishes nesting territories, builds nests, and forages where mosaics of relatively dense and expansive growths of trees and shrubs are established, near, adjacent to surface water, or underlain by saturated soil (Sogge et al. 2010). Vegetation characteristics of flycatcher breeding habitat generally include dense tree or shrub cover that is greater than 3 meters high, with dense twig structure and abundant live, green foliage (Allison et al. 2003). Riparian habitat characteristics such as dominant plant species, size and shape of habitat patches, tree canopy structure, vegetation height and density, hydrology, and insects are important parameters of flycatcher breeding habitat, although they may vary widely at different sites (USFWS 2002).

The accumulating knowledge of flycatcher breeding sites reveals important areas of similarity, which constitute the basic concept of what is suitable breeding habitat (USFWS 2002). These features are generally discussed below. Flycatchers nest in thickets of trees and shrubs ranging in height from 2 m to 30 m (6 to 98 ft) (USFWS 2002). Lower-stature thickets (2 to 4 m (6 to 13 ft) tall) tend to be found at higher elevation sites, with tall-stature habitats at middle- and lower-elevation riparian forests (USFWS 2002). Nest sites typically have dense foliage (greater than 1000 stem density) greater than at least from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low, dense tree canopy (USFWS 2002). Breeding habitat is often associated with dense, riparian scrub-shrub wetlands.

Regardless of the plant species' composition or height, breeding sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings creating a mosaic that is not uniformly dense (USFWS 2002). Canopy density (the amount of cover provided by tree and shrub branches measured from the ground) at various nest sites ranges from 50 to 100 percent (USFWS 2002). Flycatchers primarily use Geyer willow (*Salix geyeriana*), Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), boxelder (*Acer negundo*), tamarisk (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolius*), cottonwood (*Populus* spp.), and live oak (*Quercus agrifolia*) for nesting. Other plant species less commonly used for nesting include buttonbush (*Cephalanthus* sp.), black twinberry (*Lonicera involucrata*), white alder (*Alnus rhombifolia*), blackberry (*Rubus ursinus*), and stinging nettle (*Urtica* spp.). Other plant species used for nesting may become known over time as more studies and surveys occur.

Most flycatcher breeding sites are comprised of spatially complex habitat mosaics, often including both exotic (mostly tamarisk) and native vegetation. Within a site, territories are frequently clumped or distributed near the patch edge. Thus, the vegetative composition of individual territories may differ from the overall composition of the patch. Flycatchers may move extensively within a breeding patch, travel between patches, or exploit resources outside of a patch (Cardinal and Paxton 2005; Cardinal et al. 2006). Therefore, an area much larger than a territory or even a patch may be important to flycatcher breeding success and persistence at a particular site (Hatten and Paradzick 2003).

The habitat at flycatcher breeding sites can be broadly characterized by proportion of native and exotic habitats into four broad categories (Sogge et al. 2010). Most commonly, tamarisk is the exotic plant species (Russian olive has also been used). Those categories are based on species composition of the tree/shrub layer(s) of the site:

1. Native = >90% native vegetation.
2. Mixed (>50% native) = 50 to 90% native vegetation.
3. Mixed (>50% exotic) = 50 to 90% exotic vegetation.
4. Exotic = >90% exotic vegetation.

Though an exotic species, tamarisk is an important component of the flycatchers' nesting and foraging habitat in Arizona and New Mexico. In 2001 in Arizona, 323 of the 404 (80 percent) known flycatcher nests (in 346 territories) were built in a tamarisk tree (Smith et al. 2002). Durst et al (2008b) broadly characterized the use of native and exotic habitats by flycatchers as of the 2007 breeding season, and found that habitat patches comprising mostly of native vegetation accounted for 44% of the known flycatcher territories range wide, 4% of territories occurred within exotic vegetation, and approximately 50% were located within sites where the habitat included a mixture of native and exotic vegetation. In 2010, along the Middle Rio Grande in New Mexico, about 43 percent of nests ($n = 110$) were found in vegetation dominated by tamarisk (Moore and Ahlers 2011). In 2011, flycatcher nests were physically placed in tamarisk substrate 58 percent of the time, even though 57 percent of the nesting territories were dominated by native vegetation (Moore and Ahlers 2012). Although the quality of tamarisk as nesting habitat for flycatchers has been debated, comparisons of reproductive performance and physiological conditions of flycatchers breeding in native and exotic vegetation has revealed no difference, and tamarisk may be ecologically suitable and equivalent to native vegetation in some areas (Service 2002, Owen and Sogge 2002, Sogge et al 2008, Moore and Ahlers 2012). Paxton et al. (2011b) suggests that species with restricted distributions, such as the flycatcher, that utilize habitat dominated by tamarisk may be negatively affected both in the short and long term by defoliation by tamarisk beetles. There are currently no large, monotypic stands of tamarisk in the Middle Rio Grande that are occupied by flycatchers, however flycatchers in the Middle Rio Grande do nest in exotic substrate and establish territories in exotic dominated vegetation (14 percent in 2011) which would be adversely impacted by beetle defoliation (Moore and Ahlers 2012).

Hydrology and Breeding Habitat

Flycatchers are closely associated with water. An affinity for moist or wet, shrubby areas, often with standing or running water, has been noted throughout the West (Sedgwick 2004). The riparian vegetation that constitutes breeding habitat requires substantial water (USFWS 2002). Because breeding habitat is associated, where there is slow moving or still water, these slow and still water conditions may be important in influencing production of an insect prey base for flycatcher food (USFWS 2002). Flycatcher breeding habitat is largely associated with persistent water during breeding and water flow that supports dense vegetation and insect prey needed by breeding flycatchers, nesting conditions, and flycatcher fledglings. Productivity of successful flycatcher nests appeared greater near water or saturated soils (Moore and Ahlers 2012).

Over 13 studies have identified a positive association with water or saturated soils and flycatcher breeding habitat use, sites, territories, and nesting (ERO Resources Corporation 2009). Of 33 sites with breeding flycatchers along the lower Colorado River from 2003 to 2007, 80% had surface water or saturated soils nearby (McLeod et al. 2008). At Elephant Butte, 95% of all nests were within 100 m and 91% were within 50 m of water or saturated soil (Moore and Ahlers 2008). Other hydrologic conditions that flycatchers have selected include sites with large floodplains (Hatten and Paradzick 2003, Paxton et al. 2007a) and patches with a high percentage of riparian forest (Brodhead 2005). The range and variety of stream flow conditions (frequency, magnitude, duration, and timing) (Poff et al. 1997) that will establish and maintain breeding

habitat can arise in different types of both regulated and unregulated flow regimes throughout its range (USFWS 2002). In addition, flow conditions that will establish and maintain breeding habitat can be achieved in regulated streams, depending on scale of operation and the interaction of the physical characteristics of the landscape (USFWS 2002).

Flowing streams with a wide range of discharge conditions that create and support expansive riparian vegetation and insect prey are essential physical and biological features of flycatcher habitat (USFWS 2011c). The most common stream flow conditions are largely perennial (persistent) stream flow with a natural hydrologic regime (frequency, magnitude, duration, and timing). However, in the Southwest, hydrological conditions can vary; causing some flows to be intermittent, but the floodplain can retain surface moisture conditions favorable to expansive and flourishing riparian vegetation. These appropriate conditions can be supported by managed water sources and hydrological cycles that mimic components of the natural hydrologic cycle.

Low water availability and earlier drying of soils, such as during dry years, may affect the number of breeding SWFLs (McLeod et al. 2008, 2009), demographics (ERO Corporation 2009) and reproductive success (Johnson et al. 1999, Brodhead et al. 2002, Paxton et al. 2007a, Ellis et al. 2008). Flycatcher nesting habitat can persist on intermittent (ephemeral) streams that retain local hydrologic conditions favorable to riparian vegetation and insect prey (USFWS 2002). In the Southwest, hydrological conditions at a flycatcher-breeding site can vary remarkably within a season and between years (USFWS 2002). At some locations, particularly during drier years, water or saturated soil may only be present early in the breeding season (May and part of June) (USFWS 2002). In the MRGV, few nest attempts were made by flycatchers during the dry year of 1996 and birds migrated south between mid-June and early July (Johnson et al. 1999). In 2006, flycatchers established territories in areas previously occupied, even though the areas were dry, but then birds moved to wetter areas later in season (Smith and Johnson 2008).

In some areas, natural or managed hydrologic cycles can create temporary breeding habitat, but may not be able to support it for an extended amount of time, or may support varying amounts of breeding habitat at different points during its maturation and succession phases. Some dam operations create varied situations that allow different plant species to thrive when water is released below a dam, held in a lake, or removed from a lakebed, and consequently, varying degrees of breeding habitat are available because of dam operations (USFWS 2002). Slow-moving water situations can also be managed or mimicked through manipulated supplemental water originating from sources such as agricultural returns or irrigation canals (USFWS 2002).

Habitat Dynamics and Restored Habitat

The hydrologic regime (stream flow pattern) and supply of (and interaction between) surface and subsurface water is a driving factor in the long-term maintenance, growth, recycling, and regeneration of flycatcher habitat (USFWS 2002). As streams reach the lowlands, their gradients typically flatten and surrounding terrain opens into broader floodplains (USFWS 2002). In these geographic settings, the stream-flow patterns (frequency, magnitude, duration, and timing) will provide the necessary stream-channel conditions (wide configuration, high sediment deposition, periodic inundation, recharged aquifers, lateral channel movement, and elevated groundwater

tables throughout the floodplain) that result in the development of flycatcher habitat (Poff et al. 1997; USFWS 2002). Allowing the river to flow over the width of the floodplain, when overbank flooding occurs, is integral to allow deposition of fine moist soils, water, nutrients, and seeds that provide the essential material for plant germination and growth. An abundance and distribution of fine sediments extending farther laterally across the floodplain and deeper underneath the surface retains much more subsurface water, which in turn supplies water for the development of the vegetation that provides flycatcher habitat and micro-habitat conditions (USFWS 2002). The interaction between groundwater and surface water contributes to the quality of riparian vegetation community (structure and plant species) and will influence the germination, density, vigor, composition, and the ability of vegetation to regenerate and maintain itself (Arizona Department of Water Resources 1994).

Flycatcher habitat can quickly change and vary in suitability, location, and occupancy over time (Finch and Stoleson 2000). Flycatcher nesting habitat comprised of willows can grow out of suitability; tamarisk habitat can develop from seeds to suitability in five years; heavy runoff can remove or reduce habitat suitability in a day; and river channels, floodplain width, location, and vegetation density may change over time. The development of flycatcher habitat is a dynamic process involving, maintenance, recycling, and regeneration of habitat. Due to its dynamic and cyclic nature, flycatcher “habitat” is often defined as either suitable or potential (Service 2002). Thus, areas other than occupied locations can be considered flycatcher “habitat” and are essential to the survival and recovery of the flycatcher (USFWS 2002).

It is important to recognize that most flycatcher breeding habitats are susceptible to future changes in site hydrology (natural or human-related), impacts from development activities or fire, and natural catastrophic events such as flood or drought (USFWS 2002). Flycatcher habitat can quickly change and vary in suitability, location, use, and occupancy over time (Finch and Stoleson 2000). For example, suitable habitat dominated by tamarisk can develop in five years, heavy runoff can create velocities or sediment deposition that may reduce or remove habitat within in a day, or river flow and channel topology may also change quickly. Flycatcher breeding habitat can mature beyond that suitable for nesting. Flycatcher use of breeding habitat in different successional stages may also be dynamic. For example, over-mature or young riparian vegetation may not be suitable for breeding habitat and instead can be used for foraging and shelter by migrating, dispersing, or non-territorial individuals (McLeod et al. 2005). Similarly, early successional riparian habitat may subsequently mature over time and later become suitable for breeding habitat. These and other factors can destroy or degrade breeding habitat, such that one cannot expect any given breeding site to remain suitable in perpetuity (USFWS 2002). Thus, in order to manage flycatcher-breeding habitat over time, it is necessary to have additional suitable habitat available to which flycatchers, displaced by such habitat loss or change, can readily move into and breed (USFWS 2002).

In many instances, flycatcher-breeding sites occur along streams where human impacts are minimized enough to allow more natural processes to create, recycle, and maintain flycatcher habitat. However, there are also breeding sites that are supported by various types of supplemental water including agricultural and urban run-off, treated water outflow, irrigation or diversion ditches, reservoirs, and dam outflows (USFWS 2002). Although the waters provided to these habitats might be considered “artificial,” they are often important for maintaining the habitat in appropriate condition for breeding flycatchers within the existing environment.

Sites for Germination or Seed Dispersal of Riparian Vegetation

Subsurface hydrologic conditions may be equally important to surface water conditions in determining riparian vegetation vigor and landscape patterns (Lichivar and Wakely 2004). Where groundwater levels are elevated to the point that riparian forest plants can directly access those waters, it can be an area for breeding, non-breeding, territorial, dispersing, foraging, or migrating flycatchers. Elevated groundwater helps create moist soil conditions believed to be important for nesting conditions and prey populations (USFWS 2002).

Depth to groundwater plays an important part in the distribution of riparian vegetation (Arizona Department of Water Resources 1994; USFWS 2012b) and consequently, flycatcher habitat. The greater the depth to groundwater below the land surface, the less abundant the riparian vegetation (Arizona Department of Water Resources 1994). Flow regulation also affects the integrity of riparian zones by lowering water tables, reducing lateral fluxes of water and materials, accelerating and modifying the processes of plant succession, and stopping the formation of new riparian habitats (Ward and Stanford 1995; Decamps et al. 2008). The vertical accumulation of sediment in a floodplain, exacerbated by the lateral confinement of flooding, can also result in a physical separation of riparian vegetation from groundwater necessary for flycatcher habitat (Dufour et al 2007; USFWS 2012b). During this process of “terrestrialization,” productive pioneer species such as willows or poplars tend to be replaced by either invasive or upland plant species that invade the floodplain under artificially enhanced conditions of environmental stability (Friedman and Auble 2000; Decamps et al 2008). Localized, perched aquifers (a saturated area that sits above the main water table) can and do support some riparian habitat, but these systems are not extensive (Arizona Department of Water Resources 1994).

The abundance and distribution of fine sediment deposited on floodplains is critical for the development, abundance, distribution, maintenance, and germination of the plants that grow into flycatcher habitat (USFWS 2002). Fine sediments provide seed beds to facilitate the growth of riparian vegetation for flycatcher habitat. In almost all cases, moist or saturated soil is present at or near breeding sites during wet and non-drought years (USFWS 2002). The saturated soil and adjacent surface water may be present early in the breeding season, but only damp soil is present by late June or early July (USFWS 2002). Microclimate features (temperature and humidity) facilitated by moist or saturated soil, are believed to play an important role where flycatchers are detected and nest, their breeding success, and availability and abundance of food resources (USFWS 2002).

Riparian vegetation also provides the flycatcher cover and shelter while migrating and nesting. Placing nests in dense vegetation provides cover and shelter from predators or nest parasites that would seek out flycatcher adults, nestlings, or eggs. Similarly, using riparian vegetation for cover and shelter during migration provides food-rich stopover areas, a place to rest, and shelter or cover along migratory flights (USFWS 2002). Riparian vegetation used by migrating flycatchers can sometimes be less dense and abundant than areas used for nesting (USFWS 2002). However, migration stopover areas, even though not used for breeding, may be critically important resources affecting local and regional flycatcher productivity and survival (USFWS 2002, 2011c).

Nutritional and Physiological Requirements

The flycatcher is somewhat of an insect generalist (USFWS 2002), taking a wide range of invertebrate prey including flying, and ground- and vegetation-dwelling species of terrestrial and aquatic origins (Drost et al. 2003). Wasps and bees (Hymenoptera) are common food items, as are flies (Diptera), beetles (Coleoptera), butterflies, moths and caterpillars (Lepidoptera), and spittlebugs (Homoptera) (Beal 1912; McCabe 1991). Plant foods such as small fruits have also been reported (Beal 1912; Roberts 1932; Imhof 1962), but are not a significant food during the breeding season (McCabe 1991). Diet studies of adult flycatchers (Drost et al. 1998; DeLay et al. 1999) found that major prey items ranged from small (flying ants) (Hymenoptera) to large (dragonflies) (Odonata) flying insects, with Diptera and Hemiptera (true bugs) comprising half of the prey items. From an analysis of the flycatcher diet along the South Fork of the Kern River, California (Drost et al. 2003), flycatchers consumed a variety of prey from 12 different insect groups. Flycatchers have been identified targeting seasonal hatchings of aquatic insects along the Salt River arm of Roosevelt Lake, Arizona (Paxton et al. 2007a).

Flycatcher food availability may be largely influenced by the density and species of vegetation, proximity to and presence of water, saturated soil levels, and microclimate features such as temperature and humidity (USFWS 2002). Flycatchers forage within and above the tree canopy, along the patch edge, in openings within the territory, over water, and from tall trees as well as herbaceous ground cover (Bent 1960; McCabe 1991). Flycatchers employ a “sit and wait” foraging tactic, with foraging bouts interspersed with longer periods of perching (Prescott and Middleton 1988).

Parasitism and Predation

Brown-headed cowbird parasitism of flycatcher broods has been documented throughout its range (Brown 1988a,b; Whitfield 1990; Muiznieks et al. 1994; Whitfield 1994; Hull and Parker 1995; Maynard 1995; Sferra et al. 1995; Sogge 1995a). Where studied, high rates of cowbird parasitism have coincided with flycatcher population declines (Whitfield 1994; Sogge 1995a,c; Whitfield and Strong 1995) or, at a minimum, resulted in reduced or complete nesting failure at a site for a particular year (Muiznieks et al. 1994; Whitfield 1994; Maynard 1995; Sferra et al. 1995; Sogge 1995a,c; Whitfield and Strong 1995). Cowbird eggs hatch earlier than those of many passerine hosts, thus giving cowbird nestlings a competitive advantage (Bent 1960; McGeen 1972; Mayfield 1977a,b; Brittingham and Temple 1983). Flycatchers can attempt to

renest, but this often results in reduced clutch sizes, delayed fledging, and reduced nest success (Whitfield 1994). Whitfield and Strong (1995) found that flycatcher nestlings fledged after July 20 had a significantly lower recruitment rate; cowbird parasitism was often the cause of delayed fledging. In the Middle Rio Grande in recent years, parasitism of nests appears to be a non-factor in the growth of the Middle Rio Grande population (Moore and Ahlers 2011).

Predation of flycatcher eggs and nestlings has been documented for the common king snake (*Lampropeltis getulus*), gopher snake (*Pituophis melanoleucus affinis*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), western screech owl (*Otus kennicottii*), yellow-breasted chat (*Icteria virens*), and Argentine ants (*Linepithema humili*) (Paxton et al. 1997a, McKernan and Braden 2001, Whitfield and Lynn 2001, Stoleson and Finch 1999, Smith et al. 2002, Paradzick et al. 2000, Famolaro 1998, USFWS 2002). Other potential predators include various snakes, lizards, chipmunks, weasels, raccoons, ringtailed cats, foxes, and domestic cats (McCabe 1991, Sogge 1995c, Langridge and Sogge 1997, Paxton et al. 1997a, Sferra et al. 1997, McCarthey et al. 1998, Paradzick et al. 2000, USFWS 2002). There are wide varieties of flycatcher nest predators. Flycatcher nest success can be greatly affected by predation, and may often be the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In 2010, the predation rate on nests in the Middle Rio Grande increased to 49% (125 out of 257 nests), compared to an average of approximately 30% for the previous eight years (Moore and Ahlers 2011). These high predation rates may be explained by a drier hydrologic regime, leading to reduced foliage density, reduced nest concealment and/or easier access by a wider range of potential predators (Moore and Ahlers 2011).

Movements, Long-Distance Migration, and Stopover Flight Distance

Flycatchers have higher site fidelity (to a local area) than nest fidelity (to a specific nest location) and can move among sites within stream drainages and between drainages (Kenwood and Paxton 2001). Within-drainage movements are more common than between-drainage movements (Kenwood and Paxton 2001). Evidence gathered during studies of banded populations shows that although most male willow flycatchers return to former breeding areas, flycatchers regularly move among sites within and between years (Ellis et al. 2008). Juvenile flycatchers were the group of flycatchers that moved (dispersed) the farthest to new and distant breeding sites from the area where they hatched (Paxton et al. 2007a).

The USGS's 10-year flycatcher study in central Arizona (Paxton et al. 2007a) is the key movement study that has generated these conclusions, augmented by other flycatcher banding and re-sighting studies (Sedgwick 2004; McLeod et al. 2008). Between 1997 and 2005, of the 1,012 relocated banded flycatchers, 595 (59%) banded flycatchers in Arizona returned to the breeding site of the previous year, while 398 (39%) moved to other breeding areas within the same major drainage, and 19 (2%) moved to a completely different drainage (Paxton et al. 2007a). Overall distance moved amongst adults and returning nestlings ranged from 0.03 to 444 km with mean distance moved by adults (9.5 km) being much less than the mean natal dispersal distance (20.5 km). Movement patterns are strongly influenced by reproductive success, and the age class of habitat patches may also be of consideration (Paxton et al. 2007a).

Flycatchers showed a high degree of movement, with movements common among breeding sites that were 30 to 40 km (18 to 25 mi) apart and within the same drainage (Paxton et al. 2007a). Therefore, the idea of a biologically meaningful breeding site has shifted from considering every habitat patch as a distinct site, to a network of patches within the same drainage as a site. At a larger geographic scale, infrequent movements that connect different drainages allow for metapopulation-scale processes to occur. Along the Lower Colorado River and its major drainages, flycatchers demonstrated similar patterns of movement (MacLeod et al. 2008). Thus, consideration of drainage and regional breeding habitat connectivity when planning flycatcher recovery and management will be more effective.

The USGS concluded that rapid colonization and increased metapopulation stability could be accomplished by establishing breeding sites within 30 to 40 km (18 to 25 mi) of each other (Paxton et al. 2007a). Flycatchers at breeding sites configured in this way would be able to regularly disperse or move between new or known breeding sites within the same year or from year-to-year. This proximity of sites would increase the connectivity and stability of the metapopulation, as well as support migratory stopover activity. Therefore, distances between patches for flycatcher breeding (30 to 40 km or 18 to 25 mi) in a stable metapopulation within an area may need to occur more closely than the proximity of riparian habitats used for stopovers during their long-distance migration (35 to 46 mi or 56 to 74 km, see migration section above).

Flycatchers migrate through the Rio Grande and arrive in breeding habitat between early May and early June; whereas autumn migration can occur anywhere from late July to mid September (Finch et al. 2000). Additionally, autumn flycatcher migration may vary from year to year, from site to site, and especially, in response to environmental conditions that affect nesting success or fledgling survival, such as drying events, fire, weather patterns or a combination of factors (Finch et al. 2000).

Flycatchers that breed in the Rio Grande Valley likely stopover along the Rio Grande during long-distance migration to Central America (Paxton et al. 2011a). During migration, flycatchers use a greater variety and distribution of habitats, including non-riparian vegetation than during breeding (Finch et al. 2000). Stopover habitats may lack some of the components important for breeding birds such as the presence of standing water or moist soils and suitable riparian patch size and structure. However, Yong and Finch (1997) and Finch et al. (2000) reported that capture rates and body mass of flycatchers were often highest in flycatchers captured in willow than in cottonwood, tamarisk, agricultural edge, or mowed willow.

Flycatchers do not deposit large amounts of fat in their bodies in order to prepare them for the high energy demands of long-distance migration as do migratory waterfowl (Finch et al. 2000). Alerstam and Lindstrom (1990) proposed that flycatchers may maintain low fat stores to minimize the energetic costs of flying with unnecessary weight. Owing to low fat stores, flycatchers may be constrained to feed at stopover habitats in order to make progress toward their breeding or wintering destination. Yong and Finch (1997) reported that the average body mass of migrant flycatchers on the middle Rio Grande was 12.7 grams (g) and ranged from 10.3 to 15.9 g. About 70% of the spring and fall migrant flycatchers captured along the Middle Rio Grande were captured between the hours of 0700 and 0900 (Yong and Finch 2002). After that

period, migrant flycatchers had apparently stopped for an average of one day and were then recaptured. Yong and Finch (1997) reported an average increase of 1.6 percent body mass per day after their recapture, generally increasing with time of day. DeLay et al. (1999) found a positive association between the relative abundance of migrant willow flycatchers and the relative abundance of aerial insects, suggesting that flycatchers migrate briefly in the morning, and stopover in habitats containing abundant insects sufficient to gain body mass and fat reserves before their next segment of their long-distance migratory journey.

Alerstam et al. (2007) suggested that maximum potential flight distance is the product of the potential hours of flight based on available flight energy from fat multiplied by flight speed. Therefore, based on the average flycatcher weight, and using the Alerstam et al. (2007) estimator, the average flight speed of a flycatcher is likely 18 to 23 mph (8 to 10 meters per second (mps)). If 70 percent of flycatchers migrate 2 hours per day, then the distance travelled would range from 35 to 46 mi per day (56 to 74 km per day). Since flycatcher wintering habitat is approximately 1,700 to 1,800 mi (2,736 to 2,897 km), and flycatchers spend approximately 12 percent of the year migrating (or 44 days; based on Yong and Finch 2002), then the average migration distance per day would be approximately 40 mi (64 km). Based on flight speeds, and distance travelled by flycatchers during 2 hours of flight, flycatchers would be able to reach their wintering grounds in fall or breeding grounds in spring, if adequate stopover habitats occurred at no less than every 40 miles. Since the average sized flycatcher likely flies approximately 9 mps (20 mph) for approximately 2 hours per day, migratory flycatcher habitats at distances greater than 65 km (40 mi) apart would likely stress flycatchers by reducing their fat and protein reserves necessary for survival and their long-distance migration. While the maximum average distance flycatchers could potentially fly in a day is larger, perhaps as far as 140 mi (225 km; see Finch et al. 2000), such distances may come at high energetic cost, as indicated by the lack of fat reserves in nearly 50 percent of migrant flycatchers captured, and potentially resulting in protein metabolism, reduced flight performance, and an inability to overcome obstacles.

Migrant flycatchers face a variety of obstacles and threats during migration including inclement weather, landscape barriers, predators, limited food and water, and discontinuity of stopover habitat (Finch et al. 2000, citing Moore 2000). If migrating flycatchers cannot periodically replenish their fat stores and do so quickly, the probability of a successful migration is reduced. If food supply varies among habitats during migration periods, fat stores, and body mass may depend on how successfully migrant flycatchers select foraging habitats with plentiful food during stopover (Finch et al. 2000). During flights, birds metabolize not only fat but also protein. Because there is no storage form of protein, protein metabolism may entail a structural or functional loss in flight performance, particularly if breast muscle is lost. Therefore, the probability of a successful migration is likely to be increased when stopover habitats are managed with distances between stopovers minimized as well as having stopover habitat contain willow vegetation and abundant insects (Finch et al. 2000; Yong and Finch 2002). Whenever stopover habitats become degraded, diminished, or fragmented, migrating flycatchers will likely experience stress, a reduction of fitness, reduced mating or nesting success, increased time and energy expenditures, or an impaired ability to defend nesting or wintering sites, which could ultimately result in a population reduction. However, specific features associated with riparian habitats that support migratory flycatchers require further study (Yong and Finch 2002).

Range Wide Distribution and Abundance

Overall, the flycatcher's current range is similar to the historical range, but the quantity of suitable habitat within that range has been significantly reduced from historical levels (USFWS 2002, 2011c). The flycatcher's current range includes distribution over six Southwestern states (Arizona, New Mexico, southern California, extreme southern Nevada, southern Utah, and southwestern Colorado). Though part of its historical range, Texas is not included in the flycatcher's current distribution as there is no survey data or other records to determine its current status within the state. Durst et al. (2008a) reported that since 1993, extensive survey efforts in the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah have greatly increased the number of known flycatcher breeding sites and territories. Between 1993 and 2007, the number of known flycatcher breeding sites grew from less than 50 to 288 sites. This increase was also reflected in the number of estimated flycatcher territories, growing from less than 200 territories in the 1990s to 1,299 in 2007. However, from 2005 to 2007, Durst et al. (2008a) estimated that the number of territories range wide increased only modestly from 1,214 to 1,299, and breeding sites from 275 to 288.

Across the flycatcher's range, certain river drainages have more territories than others do. More flycatcher territories are found along the Gila River Basin in New Mexico and Arizona than any other major drainage. Elsewhere in New Mexico and in southwest Colorado, territories are mostly found along the Rio Grande. The primary drainages in California with territories are the Kern, Owens, San Luis Rey, Santa Ana, and Santa Margarita Rivers. In Arizona, most flycatchers are found along the Gila, San Pedro, and Salt Rivers (particularly, at Roosevelt Lake). The Gunnison River drainage supports the majority of flycatchers in Colorado, while the Virgin and Pahrangat Rivers support the most territories in Nevada (Durst et al 2008a).

There are four general locations across the flycatcher's breeding range that has the most number of territories. Breeding locations along the Middle Rio Grande and Cliff-Gila Valley in New Mexico, and Roosevelt Lake (Salt River/Tonto Creek confluence) and the lower Gila River/San Pedro river confluence in Arizona fluctuate in numbers, but each can have about 200 territories in a single season (sometimes increasing to over 300 along the Middle Rio Grande). As a result, those four locations, can account for about 60 percent (approximately 800 out of 1,299 range wide territories) of all known territories. These sites create great colonization potential and opportunities to accomplish the Recovery Plan's goal of developing many breeding sites spread across the landscape (USFWS 2002). However, having that high of a proportion of territories in few locations increases concern for the subspecies from catastrophic events. Additionally, two of these locations (Roosevelt Lake in Arizona and Elephant Butte Reservoir in New Mexico) are associated with water storage. Therefore, while these locations are anticipated to maintain the dynamic nature of habitat, those cycles could be altered by water demand and climate change.

Tracking the distribution and abundance of the flycatcher has become increasingly challenging as the compilation of flycatcher survey data forms, database entry, and reporting is becoming more difficult to coordinate and accomplish across six states without dedicated funding (USFWS 2011c). Synthesizing the information of these sites and territories is also difficult due to the lack of standardized data collection and survey reporting range wide (Durst et al 2008a). There

have been annual statewide reports from Arizona and range wide reports completed between the mid-1990s to 2007, but none since. Because of current limitations in database management, the ability to estimate populations and detect changes is becoming more difficult. Recently, Reclamation has compiled flycatcher data for New Mexico (Carstensen et al. 2012).

Due to the variety of habitat and breeding site characteristics, potential threats, and management responsibilities across the broad geographic area utilized by the flycatcher, its range is divided into 6 Recovery Units, with each Recovery Unit further divided into Management Units.

Coastal California Recovery Unit

The Coastal California Recovery Unit extends along the coast of southern California from north of Point Conception south to the Mexico Border and encompasses the Santa Ynez, Santa Clara, Santa Ana, and San Diego Management Units. The most recent range wide assessment of this Recovery unit in 2007 estimated that the number of territories had declined to 120, representing 9 percent of the range wide total (Durst et al. 2008a, USFWS 2011c).

Basin and Mohave Recovery Unit

The Basin and Mohave Recovery Unit represents a broad geographic area, which includes the arid interior of southern California and a small portion of extreme southwestern Nevada. This area encompasses the Owens, Kern, Mohave, Salton, and Amargosa Management Units. Since 2002, the number of known territories has decline from 69 to 51(Durst et al. 2008a), and with the exception of breeding sites on the Owens and Kern Rivers, all other known sites have fewer than five territories (USFWS 2002, 2011c).

Lower Colorado Recovery Unit

The Lower Colorado Recovery Unit is a geographically large and ecologically diverse unit, and includes the Colorado River and its major tributaries from the high elevation streams of East-Central Arizona and Central Western New Mexico to the main stem Colorado River through the Grand Canyon and downstream along the lower Colorado River to the Mexico Border (USFWS 2002, 2011c). The Lower Colorado Recovery Unit encompasses the Little Colorado, Middle Colorado, Virgin, Pahrnagat, Bill Williams, Hoover to Parker Dam, and Parker Dam to Southerly International Border Management Units. Durst et al. (2008) estimated that as of 2007, 150 territories occurred in this Recovery Unit, representing 11 percent of the range wide total, with most sites containing fewer than five territories.

Upper Colorado Recovery Unit

The Upper Colorado Recovery Unit comprises another broad geographic area including much of the Four Corners area of southeastern Utah and southwestern Colorado, and smaller portions of northwestern Arizona and northeastern New Mexico, and encompasses the Powell and San Juan Management Units (USFWS 2002, 2011c). Only five breeding sites are known to occur in this Recovery Unit, representing an estimated high of 10 territories as of 2007 and less than 1 percent

of the range wide total (Durst et al. 2008a). These low numbers however may be due to a relatively low survey effort rather than an accurate reflection the flycatcher numbers and distribution (USFWS 2002, 2011c).

Gila Recovery Unit

The Gila Recovery Unit includes the Gila River watershed from its headwaters in southwestern New Mexico and downstream across Arizona toward the confluence with the Colorado River, and encompasses the Verde, Hassayampa and Agua Fria, Roosevelt, San Francisco, Upper Gila, Middle Gila and San Pedro, and Santa Cruz Management Units (USFWS 2002, 2011c). The latest range wide estimates from 2007 indicate the number of known territories to have increased to 659, representing 50 percent of the range wide total (Durst et al. 2008a).

Rio Grande Recovery Unit

The Rio Grande Recovery Unit includes the Rio Grande watershed from its headwaters in southern Colorado downstream to the Pecos River confluence in Texas and to a lesser extent the Rio Grande in Texas and the Pecos watershed in New Mexico and Texas. This Recovery Unit encompasses the San Luis Valley, Upper Rio Grande, Middle Rio Grande, and Lower Rio Grande Management Units (USFWS 2002, 2013). Large increases in the number of estimated and known territories have occurred within this Recovery Unit, primarily due to increasing numbers with the Middle Rio Grande Management Unit. In 2002, a total of 197 territories were known to occur within the Recovery Unit, mostly along the main stem Rio Grande (Sogge et al. 2003), representing 17 percent of the range wide total. By 2007, this number had increased to an estimated 230 territories (Durst et al. 2008a).

Reclamation (e.g., Moore and Ahlers 2011) has conducted presence/absence surveys within the Middle Rio Grande Management Unit since 1995 and there are currently eight distinct reaches that are surveyed along 300 km of the Rio Grande between Bandelier National Monument and Elephant Butte Reservoir (Figure 5). In 2011, the Middle Rio Grande Management Unit had approximately 399 territories detected (Moore and Ahlers 2012). In 2012, Moore (2012; Appendix B) reported 581 flycatchers observed, 348 flycatcher territories, 283 nests found, and 88 successful nesting attempts by flycatchers in the Middle Rio Grande Management Unit. Since 1999, most territories within the Middle Rio Grande Management Unit (~72 percent in 2012) have been located within the San Marcial Reach near and within Elephant Butte Reservoir (Moore and Ahlers 2012; Moore 2012). In the Middle Rio Grande Management Unit, the numerical territory goal is 100 territories, which has been far surpassed in the most recent years (Moore and Ahlers 2010).

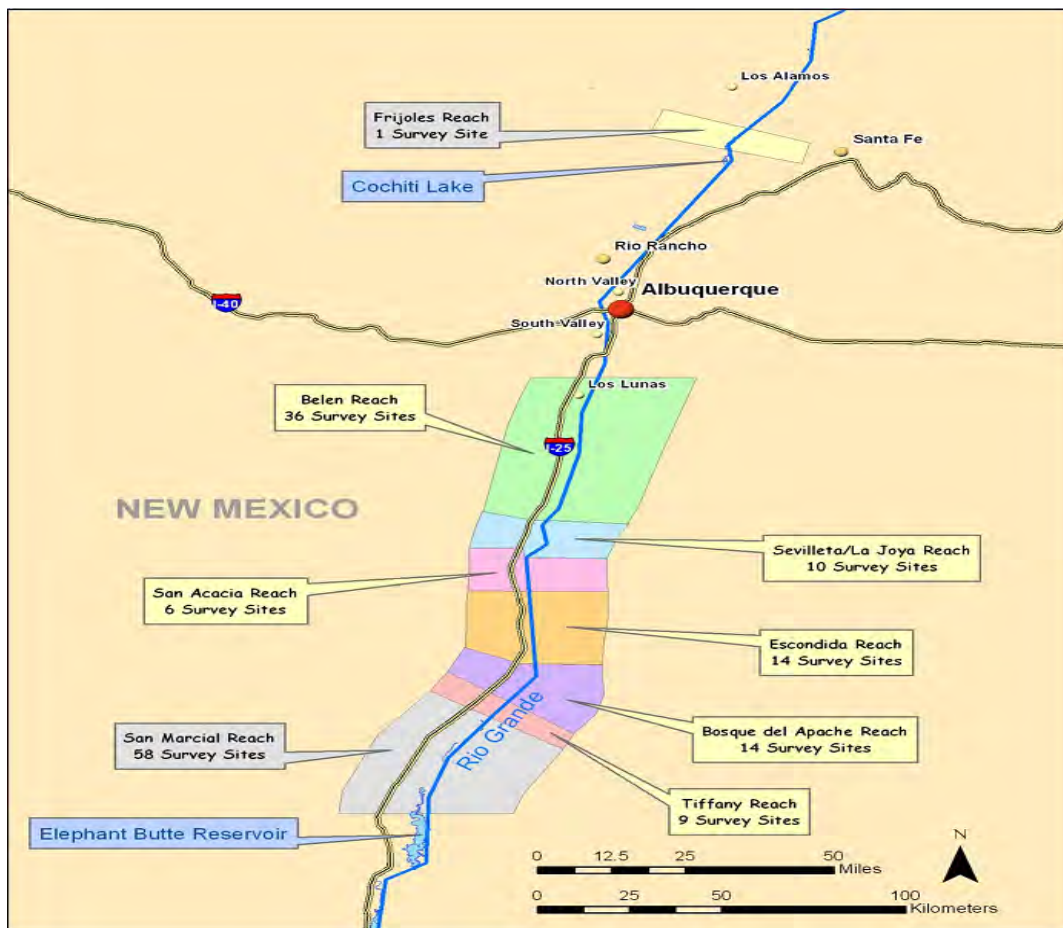


Figure 5. General locations of flycatcher survey sites conducted by the U.S. Bureau of Reclamation (Moore and Ahlers 2011, 2012)

New Mexico Distribution and Abundance

In New Mexico, surveys and monitoring since 1993 have documented approximately 173 to 400 flycatcher territories in 8 drainages and have been observed at 34 sites along the Rio Grande, Chama, Canadian, Gila, San Francisco, San Juan, and Zuni drainages. Unitt (1987) considered New Mexico as the state with the greatest number of flycatchers remaining. After reviewing the historical status of the flycatcher and its riparian habitat in New Mexico, Hubbard (1987) concluded, “[it] is virtually inescapable that a decrease has occurred in the population of breeding flycatchers in New Mexico over historical time. This is based on the fact that wooded sloughs and similar habitats have been widely eliminated along streams in New Mexico, largely as a result of the activities of man in the area.” Unitt (1987), Hubbard (1987), and more recent survey efforts have documented very small numbers and/or extirpation in New Mexico on the San Juan River (San Juan County), near Zuni (McKinley County), and Blue Water Creek (Cibola County).

There are varying reasons why there have been changes in the number of territories in specific Management or Recovery units since completion of the Recovery Plan. In general, riparian habitat is dynamic due to it being subjected to river flooding, water storage, dam releases, river diversion, fire, agricultural return flow, drought, and so on. As a result, breeding habitat quality and distribution can rapidly change in quality and quantity (Paxton et al. 2007a), which will be reflected by the number of breeding territories observed. For example, nesting habitat can grow out of suitability; vegetation can develop from seeds to nesting suitability within five years; heavy river flow can remove or reduce habitat suitability in a day; and water storage can inundate habitat within conservation pools of lakes, and recede during or after the breeding season (USFWS 2002). Flycatcher’s use of breeding habitat in different successional stages can also be dynamic. There is little doubt that changes to breeding habitat quality and quantity, and possibly increased survey efforts, have led to increases in flycatcher territories detected in the Middle Rio Grande (Moore and Ahlers 2010), Middle Gila and San Pedro River (Ellis et al. 2008, Graber and Koronkiewicz 2009), and Upper Gila Management Unit (Dockens et al. 2006), and decreased territories in Roosevelt Lake after reservoir elevation changes (Ellis et al. 2008).

Recent flycatcher breeding site reports show increases and maintenance of some of the largest populations in New Mexico. Along the Middle Rio Grande Management Unit, the number of known flycatcher territories has increased from 51 territories in 2002 (USFWS 2002) to 319 in 2009 (Moore and Ahlers 2010) and to 348 in 2012 (Moore 2012; Appendix B). During the 2010 breeding season, a total of approximately 400 flycatcher territories were found within the entire Rio Grande Basin in New Mexico (USBR 2012) and 617 were detected range wide in New Mexico (D. Carstensen, Reclamation, written comm., Jan 30, 2012), though numbers declined in 2012 (Moore 2012).

Throughout the San Acacia Levee Project area, there have been as many as 550 flycatchers or flycatcher territories detected from 1994 through 2012. Nearly all flycatcher pairs, or pairs with nests occur between River Mile 72 to River Mile 83 along the Rio Grande near the Refuge. However, in 2012, 4 pairs with nests were detected near Escondida, New Mexico.

Approximately 75% of the total known territories found within the Rio Grande Basin during the 2010 season were within the conservation pool of Elephant Butte Reservoir. The distribution of flycatcher territories within Elephant Butte Reservoir has shifted with the development of younger riparian habitats at lower elevations within the conservation pool as its elevation has receded over time. Fluctuating reservoir levels, reminiscent of the once-frequent scouring peak flood events of major rivers in pre-dam times, can create large swaths of dense riparian shrub habitat at relatively young successional stages suitable as flycatcher breeding habitat. When this occurs, the riparian habitat is quickly colonized by wildlife, particularly by vagile species such as birds, and can become important for the period that it exists (Hatten et al. 2010). However, although flycatchers are utilizing breeding habitat at elevations associated with the changing conservation pool, some of the greatest densities remain in those areas supported by groundwater seepage and some of the outflows from the LFCC. Breeding habitat availability in this area appears to have been a key component to the increasing population trend in the Middle Rio Grande Management Unit. .

III. ENVIRONMENTAL BASELINE

Under section 7(a)(2) of the ESA, when considering the effects of the action on federally listed species, the Service is required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR 402.02) define environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation; and the impact of State and private actions that are contemporaneous with the consultation in process. Given that the scale of environmental baseline information available on silvery minnows is generally associated with the four reaches of Middle Rio Grande (Figure 3), in this case, San Acacia Reach, the Service will evaluate the environmental baseline of the silvery minnow in the San Acacia Reach as part of the action area, which does not include the historical floodplain (Figure 2). However, the action area for the flycatcher does include the historical floodplain, as well as all areas of effect associated with the San Acacia Levee Project area including within the MRGV and along the west side of the Rio Grande Floodway from just upstream of SADD downstream to San Marcial, New Mexico. Therefore, the Service will refer to the action area for the flycatcher as the San Acacia Levee Project area versus the action area for the silvery minnow, which the Service will refer to as the San Acacia Reach. The Service will include environmental baseline information on the silvery minnow in the San Acacia Reach and on the flycatcher within the current 1% flow event floodplain and the floodway of the San Acacia Levee Project area. These species environmental baselines will help define the effects of the proposed action and other activities in the action area on the status of the species and its habitat to provide a platform to assess the effects of the action now under consultation.

To make this determination, the Service considered the regulations at 50 CFR 402.02 and 402.14(h)(2) which define "effects of the action" as including both direct and indirect effects of an action, and the "environmental baseline" as including "the past and present impacts of all Federal, State or private actions and other human activities in the action area" and "the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation."

Status of the Silvery Minnow in the Action Area

Status of the Silvery Minnow in the San Acacia Reach of the Middle Rio Grande

Several activities have contributed to the status of the silvery minnow and its habitat in the action area, and are believed to affect the survival and recovery of silvery minnows in the wild. These include the current weather patterns, changes to the natural hydrology of the Rio Grande, changes to the morphology of the channel and floodplain, water quality, storage of water and release of spike flows, captive propagation and augmentation, silvery minnow salvage and relocation, ongoing research, and past projects in the San Acacia Reach.

From 1993 until 2010, the catch rate of silvery minnows ($n=1153$) ranged from 0 to 2653 per 100 m² in the San Acacia Reach, and averaged 17.8 per 100 m². Since the Services 2003 Opinion was issued (USFWS 2003a), that is, since 2003, the catch rate has dropped, averaging 9.8 silvery minnow per 100 m² and ranging from 0 to 32.2 per 100 m² in the San Acacia Reach. More recently, in June 2012, Dudley et al (2012a) reported the catch rate of silvery minnows from 0 to 2.7 per 100 m² in the San Acacia Reach, with an average catch rate of 0.5 per 100 m². Based on their lengths, silvery minnows collected in the San Acacia Reach appeared to be primarily Age 1 individuals. Dudley et al. (2012a) sampled an area of 4,080.8 m² of water in the San Acacia Reach during June 2012. The highest number of silvery minnows was observed at Site 15 (i.e., near the middle of the Refuge; Dudley et al. 2012a).

FACTORS AFFECTING SILVERY MINNOWS IN THE ACTION AREA

Changes in Hydrology

There have been two primary changes in hydrology because of the construction of dams on the Rio Chama and Rio Grande that affect the silvery minnow: 1) loss of water in silvery minnow habitat, and 2) changes to the magnitude and duration of peak flows.

Loss of Water in Silvery Minnow Habitat

Prior to measurable human influence on the system, up to the 14th century, the Rio Grande was a perennially flowing, aggrading river with a shifting sand substrate (Biella and Chapman 1977). There is now strong evidence that the Middle Rio Grande first began drying up periodically after the development of Colorado's San Luis Valley in the mid- to late 1800s (Scurlock 1998). After humans began exerting greater influence on the river, there are two documented occasions when the river became intermittent during prolonged, severe droughts in 1752 and 1861 (Scurlock 1998). The silvery minnow historically survived low-flow periods because such events were infrequent and of lesser magnitude than they are today. There were also no diversion dams to block repopulation of upstream or downstream areas, the fish had a much broader geographical distribution, and there were oxbow lakes, cienegas, lagoons, and sloughs associated with the Rio Grande that supported fish until the river became connected again.

Water use and flood management has resulted in a large reduction of suitable habitat for the silvery minnow. Total water use (surface and groundwater) by agriculture may range from 28 to 37 percent (S. S. Papadopoulos & Associates, Inc. 2000; Bartolino and Cole 2002). However, agriculture accounts for up to 90 percent of surface water consumption historically in the Middle Rio Grande (Bullard and Wells 1992). The average annual diversion of water in the Middle Rio Grande by the Middle Rio Grande Conservancy District (MRGCD) was 0.7×10^7 m³ (535,280 acre-feet [af]) for the period from 1975 to 1989. Since 2001, improvements to physical and operational components of the irrigation system have contributed to a reduction in the total diversion of water from the Middle Rio Grande by the MRGCD. Total net diversions by the MRGCD have more recently dropped to 292,000 acre-feet (USBR 2012). A portion of the water diverted by the MRGCD returns to the river (through drains) and may be diverted from the river again for other uses, sometimes more than once (Bullard and Wells 1992). MRGCD diversions

from SADD are much lower, approximately 6,000 acre-feet (USBR 2012). In the San Acacia Reach, some lands are also irrigated using a combination of surface and groundwater (Landsford 1993a, 1993b, 1996).

Groundwater withdrawals also affect flow in the Middle Rio Grande. In 1990, total water withdrawal (groundwater and surface water) from the Rio Grande Basin in New Mexico was $2.3 \times 10^9 \text{ m}^3$ (1,830,628 af), significantly exceeding input (Schmandt 1993). Whipple (1996) identified enormous water losses to infiltration in the San Acacia Reach ranging from 17 to 77% and averaging 55% of surface flow. However, under New Mexico State law, the municipal and industrial users are now required to offset the effects of groundwater pumping on the surface water system (USBR 2003, 2012). Water withdrawals have not only reduced overall flow quantities, but also caused the river to become locally intermittent or dry for extended reaches. Irrigation diversions and drains, riparian evapotranspiration, as well as a declining water table, significantly reduce water volumes in the river.

The state has legally acknowledged the connection between surface flow and groundwater (USBR 2012). Where potential exists for groundwater pumping to deplete a stream system of surface water, the state may prohibit or limit groundwater withdrawals. Thereafter, surface rights must be purchased and “retired” in exchange for what is pumped from the new well. The rule applies only to large wells; domestic wells are considered *de minimus* depletions of groundwater and are exempt from the offset requirement and many groundwater permits are issued annually by the State of New Mexico Office of the State Engineer. However, due to the proximity of the City of Socorro well fields to the MRG, the future expected drawdown of the aquifer by 14.6 feet by 2022 and 17.1 feet by 2042, could potentially result in relatively immediate stream depletions that must be considered (S.S. Papadopoulos & Associates 2002). Metering of groundwater use in Socorro County is not compulsory and the cumulative impact of domestic wells on Rio Grande surface flows has not been fully characterized in the San Acacia Reach.

River reaches particularly susceptible to river drying occur at an extended 58-km (36-mi) reach from near Brown Arroyo (downstream of Socorro, New Mexico) to Elephant Butte Reservoir. Extensive fish kills, including tens of thousands of silvery minnows, have occurred in these lower reaches when the river has dried (USFWS 2003a, 2010a). It is assumed that mortalities during river intermittence are likely greater than those documented, for example, due to predation by birds in isolated pools (USFWS 2010a). From 1996 to 2007, an average of 51 km (32 mi) of the Rio Grande dried each year, mostly in the San Acacia Reach. The most extensive drying occurred in 2003 when 70 miles was dewatered. In contrast, 2008 was considered a wet year, with above average runoff and an average monsoon season. As a result, there was no river intermittency (though 0.8 miles were purposely dewatered) and no salvage of silvery minnow that year, which was the first time there has been no river drying since 1996. Intermittent river conditions in 2009, 2010, and 2011 resulted in 20, 28 and 40 miles of dewatered channel (USBR 2012); large sections of the San Acacia Reach are also drying currently in 2012. Dudley et al (2005) reported a strong negative correlation between low flow days less than 100 cfs and mean October catch rate of silvery minnows in the San Acacia Reach.

Changes to Magnitude and Duration of Peak Flows

Water management has resulted in a loss of peak flows that historically triggered the initiation of silvery minnow spawning. The reproductive cycle of the silvery minnow is tied to the natural river hydrograph. A reduction in peak flows or altered timing of flows may inhibit reproduction. Since completion of Elephant Butte Dam in 1916, additional dams have been constructed on the Middle Rio Grande (Scurlock 1998). Construction and operation of these dams, which are either irrigation diversion dams (Angostura, Isleta, San Acacia) or flood control and water storage dams (Elephant Butte, Cochiti, Abiquiu, El Vado), have modified the natural flow of the river. Mainstem dams store spring runoff and summer inflow, which would normally cause flooding, and release this water back into the river channel over a prolonged period.

Surface flows of the Middle Rio Grande are of two general types: snowmelt runoff and stormwater runoff (USACE 2012a). Snowmelt runoff generally occurs from April through June as a result of snowmelt, which may be augmented by general precipitation (Corps et al. 2007). Spring flows are characterized by gradual rises to moderate discharge rates, large runoff volumes, and approximately two-month-long flow durations, with shorter duration peak flows included. Since it was completed in 1975, flow regulation upstream at Cochiti Dam substantially limits potential for spring flooding through the San Acacia Levee Project area (USACE 2012a,b). However, most of the floods producing the greatest damage within the San Acacia Levee Project area have been flows from summer storms entering the Rio Grande through tributary inflows from the Rio Puerco and Rio Salado.

The Corps has consulted with the Service on the variations of releases of water. For example, from November 1995 to March 31, 1996, during which time $0.1 \times 10^7 \text{ m}^3$ (98,000 af) of water was released at a rate of $9.2 \text{ m}^3/\text{s}$ (325 cfs). Such releases depart significantly from natural, historical winter flow rates, and can substantially alter the habitat for silvery minnows. In spring and summer, artificially low flows may limit the amount of habitat available to silvery minnows (USFWS 2003a). The Corps (USACE 2009) has proposed to implement a temporary deviation from its water control plans for the Cochiti Lake Project to facilitate spawning and recruitment flows for silvery minnows and to provide seasonal overbank flooding opportunities to create flycatcher habitat.

In the spring of 2002, 2003, and 2012, an extended drought raised concerns that silvery minnows would not spawn because of a lack of spring runoff. Except in 2012, river discharge was artificially elevated through short-duration reservoir releases during May to induce silvery minnow spawning (USACE 2009). In response to the releases, significant silvery minnow spawning occurred in all reaches except the Cochiti Reach (USACE 2009).

By contrast, natural spring runoff in 2005 was above average, leading to a peak of over $170 \text{ m}^3/\text{s}$ (6,000 cfs) at Albuquerque and sustained high flows greater than $85 \text{ m}^3/\text{s}$ (3,000 cfs) for more than 2 months. These flows improved conditions for both spawning and recruitment (Dudley et al. 2005). The October 2005 monitoring indicated a significant increase in silvery minnow densities in the Middle Rio Grande compared to 2003 and 2004. In 2006, however, October numbers declined again after an extremely low runoff period and channel drying in June and July

(Dudley et al. 2006). October samples that year yielded no age-0 silvery minnows, indicating poor recruitment in the spring. Runoff conditions in 2007 to 2009 were average or above average and maintained a high catch rate (Dudley and Platania 2009). In addition to providing a cue for spawning, flood flows can help maintain a channel morphology to which the silvery minnow is adapted. Despite periodic and sometimes sustained declines in the abundance of silvery minnow, the species can apparently rebound quickly following years with good spawning and recruitment conditions (Dudley et al. 2006). The dramatic increase in the abundance of silvery minnow from 2006 to 2007 (nearly an order of magnitude) is indicative of the ability of the species to rebound following favorable conditions.

Mainstem dams and altered flow regimes can affect aquatic and riparian habitat by preventing overbank flooding, trapping nutrients, altering sediment transport and temperature regimes, reducing and dewatering main channel habitat, modifying or eliminating native riparian vegetation, and creating reservoirs that favor nonnative fish species. Wesche et al (2005) evaluated the hydrologic alterations by compare 33 different hydrologic parameters between gage stations and times in the MRGV. Overall, hydrologic alteration was highest at SADD (0.47). For example, the 1, 3, 7, 30 and 90-day maximum flow parameters at SADD were highly altered, but positive, indicating high flows were occurring more frequently within the RVA target range than would be expected. Likewise, several low flow parameters (e.g. December and January median flows, 3, 7, and 30-day minimums) were found to be highly altered at SADD and negative. These changes may affect the silvery minnows by reducing increasing winter flows and decreasing summer minimum flows, thereby altering its preferred habitat, especially in summer and winter, and affecting the fishes' metabolism, increases stress, and affecting health. Dams and reservoirs also fragment habitat, affect dispersal and provide a continual supply of nonnative fish that may compete with or prey upon silvery minnows. Altered flow regimes may also result in improved conditions for other native fish species that occupy the same habitat, causing those populations to expand at the expense of the silvery minnow (USFWS 1999).

Changes in Channel and Floodplain Morphology, Geomorphology, and Sedimentation

Historically, the Rio Grande was slightly sinuous, braided, and freely migrated across the valley floodplain. Changes in natural flow regimes, narrowing and deepening of the channel, and restraints (levees, jetty jacks) to channel migration adversely affected the silvery minnow. These effects result directly from constraints placed on channel capacity by structures built in the floodplain. These anthropogenic changes have and continue to degrade and eliminate spawning, nursery, feeding, resting, and refugia areas required for species' survival and recovery (USFWS 1993; 2003a). Structural flood control also prevents natural channel avulsions within the MRGV to which silvery minnows (and flycatchers) are adapted and benefit from the dynamic habitat, even at when such avulsions can lead to local mortalities and habitat destruction.

Present water management in the Middle Rio Grande implemented because of the 1948 authorization for the Rio Grande Floodway includes flood risk and sediment management dams and reservoirs, irrigation storage reservoirs, levees, channel maintenance, irrigation diversions, drainage systems, and runoff conveyance systems (USACE et al. 2007). In addition, the river has been laterally stabilized in the floodplain by the installation of jetty jacks in the 1950s and

1960s (Crawford et al. 1993). River sediment loads and debris settled in the jacks, creating stable banks and a riparian zone of cottonwood, Russian olive, willow, and saltcedar (Crawford et al. 1993). All these activities affect channel morphology through alterations in discharge and sediment load. The river discharge influences the size of the channel, whereas the type of material transported influences the character of the channel. The existing spoil bank limits meandering to the historic floodplain and controls the degradation/aggradation process (USACE 2012a). The increased vegetation hastens aggradation in the overbank areas of the floodway through increased roughness and lowered velocities and energy. The status of the channel morphology is a result of these earlier and ongoing activities and water management and is predicted to continue to degrade over time (USBR 2012).

In the San Acacia Levee Project area, stream channel incision has been pronounced from immediately upstream of the SADD extending downstream of the SADD to approximately 4 miles above a point on the river parallel to the intersection between United States Highway 60 and Interstate 25 (USACE 2012a). Localized geologic uplift may be a major contributor to stream channel incision in this reach. Below this point, for a distance of less than 10 miles, the river is neither incising nor aggrading, and below this, the river channel is in a long-term aggradation pattern (Massong et al. 2007). Aggradation has occurred within the floodway, raising it as much as 10 to 12 feet above the adjacent, sediment-starved historical floodplain (Figure 2). With individual years' average sediment concentrations as high as about 200,000 mg/L the Middle Rio Grande is one of the more heavily sediment-laden streams on earth (Baird 1998). The combination of high sediment loading coupled with confinement of the floodway by spoil banks (and soon engineered levees) exacerbate the already-perched channel, whereby the active channel and adjacent overbanks are elevated above the historical floodplain lying outside the floodway. Potential effects on silvery minnow habitat by spoil bank confinement of the active floodplain into the floodway have not been evaluated.

As a result of the lateral confinement of floods within the floodway by the spoil bank, vertical accumulation of sediment deposition along the channel and the floodway has resulted in a raised water and sediment surface elevation, by as much as 11 to 24 feet in some locations, but mostly below Highway 380 (Crawford et al. 1993, USACE 2012b). This process of vertical sediment accumulation within the floodway will continue at a rate of approximately 0.5 ft per year and is predicted to accumulate over 10 to 15 feet into the future (USACE 2012b) for as long as the spoil bank lasts. Corps (2012b, Appendix F, page 126, Tables F-2A, F-2B, F-61) describe the water surface elevation exceeding the height of the spoil bank and causing damages and flow into the historical floodplain (Table 3). Flood protection greater than that provided by the spoil bank is the purpose of San Acacia Levee Project (USACE 2012a,b). Floods that are not contained by the spoil bank will result in sediment accumulation outside the floodway, with various environmental and societal consequences (USACE 2012b).

Corps (USACE 2012b) developed a relationship between the rates of aggradation to the position in the river (as defined by cross section or range lines) that predicted sediment accumulation continuing over the next 50 years (Figure 6). The Corps plotted these aggradation (or degradation) values against range lines to determine where the reach had a general aggradation or degradation trend. The Corps (USACE 2012b,e) analysis showed that the San Acacia Levee

Project area had a general degradation trend upstream of the Escondida Bridge (near range line/cross section 1412) and an aggradation trend 10 miles downstream of the Escondida Bridge at approximately at the Brown Arroyo and Rio Grande confluence, south of Socorro, New Mexico (Figure 6).

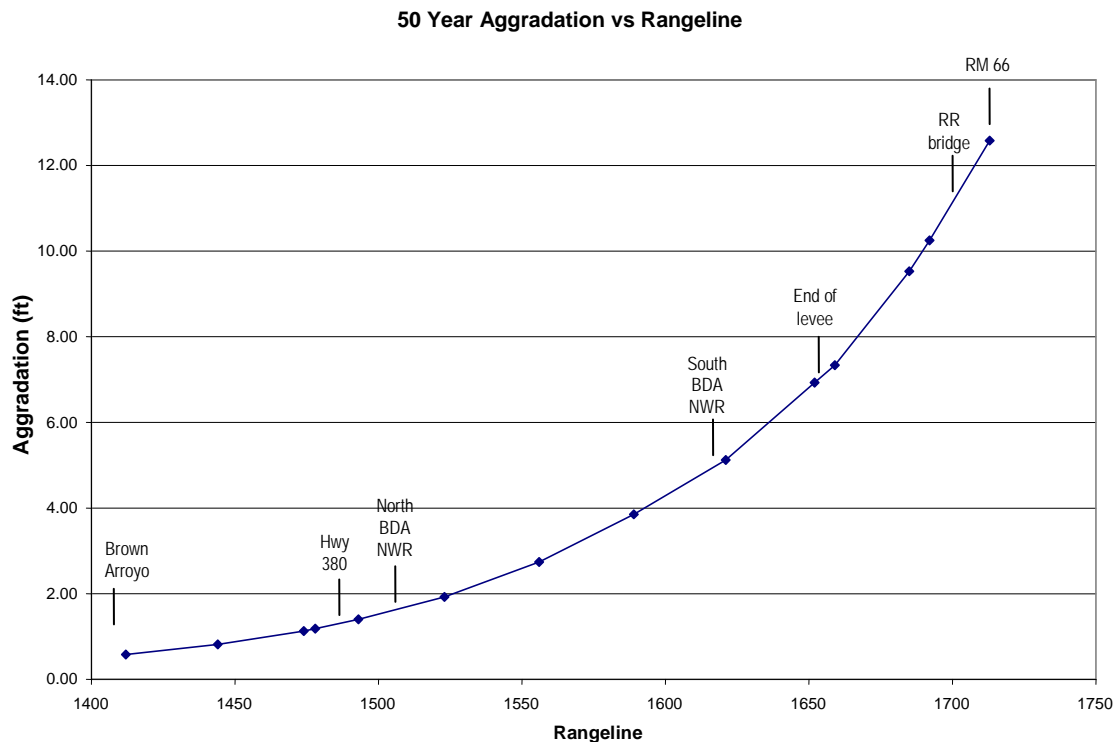


Figure 6. Corps (2012b,e) predicted 50-year sediment accumulation (aggradation) for selected Rangelines (cross sections) along the San Acacia Reach of the Middle Rio Grande.

The active river channel within the floodway is also being narrowed by the encroachment of vegetation, resulting from continued flow reductions and the lack of overbank flooding. The lack of flood flows has allowed nonnative riparian vegetation, such as tamarisk and Russian olive, to encroach on the river channel (USBR 2001; 2012). These nonnative plants are very resistant to erosion, resulting in channel narrowing and a subsequent increase in water velocity. Higher velocities result in fine sediment (e.g., silt and sand) being swept into the water column and redeposit downstream to form sediment plugs or be transported further away, which leaves coarser bed materials such as gravel and cobble as the predominant substrate. Habitat studies (Dudley and Platania 1997), demonstrated that a wide, braided river channel with low velocities resulted in higher catch rates of silvery minnows, and narrower channels with higher velocities resulted in fewer fish captured. The availability of wide, shallow habitats that are important to the silvery minnow is decreasing. Narrow channels have few backwater habitats or frequently flooded overbank areas with low velocities that are important for silvery minnow fry and age-0 fish.

Within the current range of the silvery minnow, human development and use of the floodplain have greatly restricted the width available to the active river channel. A comparison of river area between 1935 and 1989 shows a 52 percent reduction, from 10,764 ha (26,598 acres) to 5,626 ha (13,901 acres) (Crawford et al. 1993). These data refer to the Rio Grande from Cochiti Dam downstream to the “Narrows” in Elephant Butte Reservoir. Analysis of aerial photography taken by Reclamation in February 1992, shows that of the 290 km (180 mi) of river, only 0.6 percent of the floodplain has remained undeveloped. Development in the floodplain also makes it difficult, if not impossible, to send large quantities of water downstream that would create adequate low velocity habitat that the silvery minnow prefers. As a result, reduced releases have decreased available habitat for silvery minnows and allowed encroachment of nonnative vegetation and human development in the floodplain.

Habitat Fragmentation

In addition to altering peak flows, and contributing to reductions of water in silvery minnow habitat and alterations of river morphology, the dams constructed along the MRG have resulted in fragmentation of existing silvery minnow habitat, and are believed to be a significant causal factor for the 90 to 95% reduction of the species range compared to its historical range (USFWS 1994; Platania and Altenbach 1998). By changing the flow of water, sediment, nutrients, energy, and biota, dams interrupt and alter most of a river's important ecological processes (Ligon et al 1995). In the San Acacia Levee Project area, dams have fragmented silvery minnow habitat. For the silvery minnow, two of the major deleterious effects from the presence of dams in the Middle Rio Grande include the inability of fish to move to upstream reaches and repopulate those portions of the Middle Rio Grande without human intervention, and effects on the genetics of the existing silvery minnow population (USFWS 2010).

Water Quality

Many natural and anthropogenic factors affect water quality in the Middle Rio Grande. Water quality in the Middle Rio Grande varies spatially and temporally throughout its course primarily due to inflows of groundwater, as well as surface water discharges and tributary deliveries to the river (Ellis et al. 1993). Factors that are known to contribute to degraded fish habitat include temperature changes, sedimentation, runoff, erosion, organic loading, reduced oxygen content, pesticides, and an array of other toxic or hazardous substances (USFWS 2003; NMED 2009; Lusk et al 2012). Both point source pollution (pollution discharges from a pipe or other discreet conveyances) and nonpoint source pollution (from diffuse sources such as urban stormwater runoff) affect the MRGV (NMED 2007, 2009, 2010). Major point sources include discharges from wastewater treatment plants (WWTPs) and potentially from confined animal feeding operations (i.e., feedlots). Major nonpoint sources include agricultural activities, such as, fertilizer and pesticide application, excessive grazing; urban stormwater; atmospheric deposition; and mining activities (Ellis et al. 1993).

Effluents from WWTPs contain pollutants such as ammonia that may affect the water quality of the Rio Grande and adversely affect silvery minnows (Passell et al. 2007). Since 1989, ammonia and chlorine have been discharged unintentionally at concentrations that exceed protective levels for silvery minnows (Passell et al. 2007) as recently as 2011 (Chwirka 2011; Lusk 2011a). In addition to ammonia and chlorine, WWTP effluents may also include cyanide, chloroform, pesticides, semivolatile compounds and hydrocarbons, volatile compounds, heavy metals, and pharmaceuticals and their derivatives, which can pose a health risk to silvery minnows when discharged in concentrations that exceed the water quality criteria or guidelines (Lusk 2003; NMED 2010). Additionally, even if the concentration of a single chemical compound is not harmful by itself, chemical mixtures can be additive in their toxicity to silvery minnows (Buhl 2002). Marcus et al. (2010) described the concentrations of chemicals in the Middle Rio Grande that may affect fish health or produce localized mortalities. However, the long-term effects and population-level impacts of toxic chemical discharges or other degraded water quality conditions in the Middle Rio Grande on silvery minnow over time have not been fully evaluated and often fail to address uncertainties.

Dissolved Oxygen and Oxygen Demanding Substances

DO is the amount of oxygen as measured dissolved in the water column (Benson and Krause 1980). The amount of DO in water depends upon the water temperature, atmospheric pressure, the surface area of water exposed to the atmosphere, and the oxygen byproduct of photosynthesis by aquatic plants (Odum 1956; Bott 1996). The capacity of water to hold oxygen in solution is inversely proportional to the water temperature (Benson and Krause 1980). DO is critical to the aquatic community and for the breakdown of organic matter in the Rio Grande. DO, at appropriate saturation, is essential to keeping fish and other aquatic organisms alive, and for sustaining their reproduction, development, vigor, immune capacity, behavior, movement, and predator response actions (Hughes 1973; Kramer 1987; Breitburg 1992; Pörtner and Peck 2010). DO can be lost from the water column because of aquatic life respiration and the oxygen demand created by substances oxidizing in the water or sediment (Odum 1956; Bott 1996). Diurnal fluctuations in DO concentrations result from photosynthesis as a source of oxygen in excess of saturation during the day, and at night, when photosynthesis ceases and respiration consumes oxygen and reduces the DO concentrations in the water column (Ignjatovic 1968; Bott 1996). Hypoxia occurs when DO concentrations are below those expected at 100 percent saturation of oxygen between the air and water. Critically low DO levels (below 2 mg/L), are often termed anoxic. DO can be reduced from its maximum saturation within the water column because of aquatic life respiration and the oxygen demand of substances oxidizing in the water or in sediment (Odum 1956; Bott 1996).

Fish can attempt to compensate for low DO conditions by their behavioral responses, such as increased use of ventilation of oxygenating water at the aquatic surface, by changing their activity level or habitat use, and by avoidance behaviors; though these activities are known to come at a higher energy cost for fish (Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending excess energy to maintain homeostasis and some degree of physiological stress will occur (Heath 1995). For example, ventilation rates are often increased, reduced feeding and movement activity are decreased and increased glycolysis and

cortisol release can be induced even by short-term low DO conditions (Kramer 1987; Heath 1995; BCME 1997). Eventually fish suffocate at critically low DO concentrations and may begin to die. Additionally, hypoxic conditions may also cause a wide range of chronic effects and behavior responses in fish (Downing and Merkens 1957; Davis 1975; Kramer 1987; Breitburg 1992).

The depletion of oxygen from the water overlying the bottom sediment is primarily caused by the decomposition of organic matter in sediments. For example, Bexfield (2010) reported that the groundwater at shallow depths below and near the Rio Grande channel tends to have low concentrations of dissolved oxygen, which probably reflects a greater organic-carbon content for sediments within the Rio Grande inner valley and, therefore, greater oxygen reduction. Sediment oxygen demand (SOD) has been defined as the rate of oxygen consumption, biologically or chemically, on or in the sediment at the bottom of a water body (Veenstra and Nolen 1991). The primary sources of SOD are often reduced or recalcitrant compounds (e.g., iron, manganese, ammonia, sulfides, anoxic groundwater, etc.) in the sediments as well as algae, bacteria, and other sources of organic matter that settle out of the water column, or are resuspended with increased flow (Fillos and Molof 1972; Kreutzberger et al. 1980; Wang 1980; Walker and Snodgrass 1986, Caldwell and Doyle 1995).

The sources of these oxygen demanding compounds includes erosion from stream banks, from bed sediment and as attached to suspended sediment, attached particulate organic matter, or associated with anoxic, alluvial groundwater, and from the addition of chemicals added from point and nonpoint sources, including biotic deposits (e.g., debris, feces), or as the result biotic activity (e.g., colonies of bacterial growth). Kreutzberger et al. (1980) reported that low DO in the Milwaukee River was due to sediment oxygen demanding substances that were churned up by stormwater discharges scouring sediment into the water column. Several researchers have reported low oxygen events in the Middle Rio Grande associated with storm water runoff events from urban areas, natural tributaries, and fire burn scar areas (Van Horn and Dahm 2008, USFWS 2011a, Lusk et al. 2012, Dahm and Candelaria-Ley 2012). Another important consequence of low DO conditions is that organic matter and sediments can then also release ammonia, which can affect fish and their prey, thereby reducing the quality of suitable habitat (Merkens and Downing 1957; Fillos and Molof 1972; Thurston et al. 1981; Caldwell and Doyle 1995).

Precipitation events of sufficient intensity can result in increased turbidity, increased or decreased water temperatures, and increased input of oxygen demanding substances (Huggins and Anderson 2005). Conditions in the Rio Grande that have led to increased erosion and sedimentation including natural or anthropogenic-induced variation in water and sediment discharge due to high and low flows, poor land management, flooding, catastrophic wildfires, or other activities (Graf 1994; Scurlock 1998; Julien et al. 2005; Massong et al. 2007). When tributaries and riverbeds are scoured by stormwater runoff or other events of sufficient velocity, and sediments are redistributed, the actions of sedimentation and elevated SSC likely creates mixing zones that may scour or smother sessile organisms (algae, bacteria, some invertebrates), and turbidity that shades light levels and reduces algae production, and creates stressful or suffocating conditions for fish at least temporarily until the sediment-water interface is stabilized

and DO again increases (Huggins and Anderson 2005; Bixby and Burdett 2009). Moderate to large changes in any one of these factors because of a single or multiple events that can affect the level of DO in the Rio Grande and potentially adversely affect silvery minnows.

Infrequent Overbank Flooding and Hypoxic Water Return

Flooding of the overbank areas during spring runoff is beneficial to the development and recruitment of silvery minnows as the flooded habitats provide cover, food, and low velocity nursery habitat. However, in the Middle Rio Grande, Valett et al. (2005) found that flooding of the riparian forest soils (Rio Grande floodplain or “bosque”) increased the rates of respiration during the flood pulse. Ellis et al. (1999) suggested that a decade of annual flooding of riparian forest may be used to return forest floor organic debris levels to pre-disturbance levels. In floodplains that were *infrequently* flooded, inundation of the forest resulted in widespread low DO in the floodwaters capable of affecting fish. For example, Abeyta and Lusk (2004b) reported a fish kill due to low DO in a large stagnant floodplain pool after flooding along the Middle Rio Grande. Contributions from the stagnant floodwaters into the main channel would also be expected to decrease the DO content within the Rio Grande downstream. Depending on how the annual cycle of the flood pulse influences primary productivity, plant respiration, decomposition of woody and other vegetation, and water residence time, floodplains may produce and retain enough organic matter to reduce the DO of floodwaters on an annual basis (Valett et al. 2005; DBS&A 2009). However, these flood events are not necessarily a “natural phenomena” as the flood frequency and depositional character of the Rio Grande floodplain has been substantially changed, and frequently flooded areas did not experience low DO conditions to the same extent as did infrequently flooded areas (Ellis et al. 1998; Valett et al. 2005).

Petroleum, Hydrocarbons, and Spills

There are concerns about the potential petroleum spills (and other chemicals) from pipelines or during transportation in vehicles or by rail along and across the Rio Grande. Based on information reported in the National Response Center database (<http://www.nrc.uscg.mil> Accessed April 27, 2011). PAHs are known to occur during petroleum spills and may persist in contaminated sediments. These may be transported to fish tissues through foraging on contaminated sediments or prey where they can be toxic to fish (Eisler 1987; Schein et al. 2009). A petroleum pipeline break, if it were to spill into the Rio Grande, has the potential to reduce DO in the water column as well as contaminate the water, sediment and habitats of fish and wildlife, and could contribute to adverse effects on downstream water quality and silvery minnow habitat (Lusk 2010). However, the lack of available information on past spill events does not allow the estimation of these effects to silvery minnow or to forecast future frequency of spill events. In the action area, high potential risk may include rail spills near San Marcial Railroad Bridge.

PAHs can be associated with petroleum spills, parking lot runoff, but wet and dry atmospheric deposition from combustion activities is often a predominant source in the environment (Eisler 1987). To understand the potential effects of polycyclic aromatic hydrocarbons (PAHs) on sediment, the data on PAHs in Rio Grande sediments can be compared to numerical sediment quality criteria (such as Threshold Effect Concentrations or Probable Effect Concentrations

[PECs]) such as those proposed by MacDonald et al. (2000). Using sediment PAH concentrations in the Middle Rio Grande compared with guidelines similar to PECs, Marcus et al. (2010) identified heavy metal- and PAH-contaminated sediment as posing the greatest toxicity threat to silvery minnow. PAH compounds have been detected in sediment for decades, and are widespread in the Rio Grande (Levings et al. 1998; NMED 2009; Marcus et al. 2010). PAHs in sediment are often toxic to aquatic life and may reduce prey populations, and when incorporated into prey or through sediment ingestion can become carcinogenic to fish and other predators (Eisler 1987). Concentrations of naphthalene, an indicator PAH, ranged up to 17 µg/kg wet weight were found in silvery minnows collected from the Middle Rio Grande (Lusk 2012). Except for evaluating the PAH concentrations in sediment using quality criteria (e.g., PECs), there are few diagnostic criteria for the evaluation of PAHs in silvery minnows or methods of evaluation for potential effects to their prey, and how specifically silvery minnow behaviors, habitat, feeding, or health may be affected by their widespread exposure to PAHs in the Middle Rio Grande.

Sediment Quality

Sediment is an important component of silvery minnow habitat in the Rio Grande (USFWS 1999, 2003a). Sediment suspended in the water column, from erosion and other processes, can be described in terms of suspended sediment concentration (SSC) or as total suspended solids (TSS), but these measurements are not identical (Gray et al. 2000). Sediment concentrations and suspended sediment loads are important sources of sediment contamination often conveyed by stormwater (Harwood 1995; USEPA 2002). USEPA (2002) identified a number of pollutants that are more likely to partition into sediment than remain dissolved in the water column, such as heavy metals, certain semivolatile organic compounds such as PAHs, PCBs, and organochlorine pesticides. Large precipitation events wash sediment and pollutants that adhere to sediment into the river from surrounding lands through storm drains and intermittent tributaries. Stormwater produces high levels of SSC and TSS, and consequently high levels of contaminants for those constituents that commonly bound to sediment particles, for example, metals, radionuclides, and PCBs (NMED 2009, 2010).

Heavy Metals

The USEPA (USEPA 2010a) reported lead and zinc in urban stormwater exceeded applicable water quality standards. In their Biological Evaluation, the USEPA (2010a) reviewed the accumulation of lead and zinc in fish tissue and sediment. Numerous researchers (Roy et al. 1992; Schmitt et al. 2004; Buhl 2011b; Lusk 2012) have reported high zinc concentrations in fish collected from the Rio Grande. However, zinc in silvery minnows rarely exceed concentrations associated with adverse effects in those fish used in laboratory studies, but additional study on elevated zinc burdens in silvery minnows may be warranted (Buhl 2011b; Lusk 2012).

PCBs

The chemicals known as PCBs are mixtures of synthetic organic chemicals with the same basic chemical structure and similar physical properties that range from oily liquids to waxy solids (USEPA 2011). There are no known natural sources of PCBs in the San Acacia Reach. While the production of PCBs was banned in 1979, there are many PCB containing applications still in use, which can become sources for PCBs in the environment (USEPA 2011). PCBs enter aquatic environments from wet and dry atmospheric deposition, river inflows, groundwater flow, and discharges from industrial facilities. Deposition may be the most important source to water bodies such as large lakes, reservoirs and rivers (Wenning et al. 2010).

PCBs have been detected in suspended sediments (0.09 µg/g) in urban stormwater entering the Rio Grande (NMED 2010). The NMED (2010) noted a correlation between the concentrations of PCBs in suspended sediment and stormwater discharges, suggesting that management techniques that reduce suspended sediment in stormwater may reduce sediment contamination loads to the Rio Grande. Lusk (2012) reported that silvery minnows collected from the Middle Rio Grande contained detectable concentrations ranging from 4.7 to 38.2 ng/g wet weight. Olsson et al. (1999) reported skeletal deformities associated with fish injected with 360 ng/g PCBs on a lipid basis. Lusk (2012) reported that silvery minnows had PCBs concentrations lower than 36 ng/g on a per lipid basis. This suggests that PCB-induced deformity would be unlikely in silvery minnows unless they were more sensitive to PCBs than were the test fish and that concentrations detected do not exceed current known toxic effect levels (Wenning et al. 2011) within the silvery minnow.

Pesticides and Pesticide Use

Pesticide contamination can occur from agricultural activities, as well as from the cumulative impact of residential and commercial landscaping and other activities (Anderholm et al. 1995). Stormwater runoff, irrigation return, and riverside drain return flows and windblown dust and drift likely contribute a portion of pesticides to the Rio Grande. The presence of pesticides in surface water can depend on the amount applied, timing, location, and method of application. Water quality standards have not been established for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time or as part of the food chain. Ong et al. (1991) recorded the concentrations organochlorine pesticides in water, suspended sediment and bed sediment samples between 1978 and 1988. Several researchers (Roy et al. 1992; Anderholm et al. 1995; Abeyta and Lusk 2004a; Langman and Nolan 2005; NMED 2009; Marcus et al. 2010) have all reported various pesticide residues detected in water, fish tissues, or sediment samples in the Middle Rio Grande, including in the San Acacia Reach.

Roy et al. (1992) reported that DDE, a degradation product of DDT, was detected in whole body fish collected throughout the Rio Grande. They suggested that fish in the lower Rio Grande were accumulating DDE in concentrations that may be harmful to fish and their predators. Lusk (2012) analyzed silvery minnows collected in the Rio Grande for DDT residues and found that the sum of DDT residues and metabolites ranged from 8.8 to 30.7 micrograms per kilogram (µg/kg) wet weight. The concentrations of DDT residues in silvery minnows, while elevated,

were not above concentrations of concern for lethality (890 µg/kg wet weight), but may be associated with sublethal effects (greater than 5 µg/kg wet weight) particularly if similar DDT residues are found in silvery minnow eggs (Beckvar and Lotufo 2011).

Pesticide use may occur throughout Socorro County, New Mexico (USEPA 1991). For example, a number of Federal and non-Federal agencies use herbicide applications in association with nonnative vegetation removal and riparian restoration projects in or near the floodway (NMSLO 2010, USFWS 2011b). A variety of herbicides (e.g., Arsenal, Roundup, Garlon 4) have been used to control salt cedar and Russian olive along roadways, dikes, and in areas undergoing riparian vegetation restoration; particularly on new sprouts in previously treated areas using a backpack sprayer application methods to foliage or onto cut-stumps. Some herbicides have been used to control Eurasian water milfoil (*Myriophyllum spicatum*) or pepperweed (*Lepidium latifolium*) and other weeds in or along irrigation return drains and roadways. The Service (White 2004) identified a number of conservation measures that prescribe pesticide use applications, timing and formulations in or near flycatchers or silvery minnows that seek to reduce the potential for adverse effects on flycatchers or silvery minnows and their habitat that have been implemented by Federal agencies to reduce effects (NMSLO 2010, USFWS 2011b).

Salinity and Other Chemical Stressors

In addition to the compounds and conditions discussed above, several other constituents are present and may affect the water quality of the Rio Grande. These include nutrients such as forms of nitrates and phosphorus, total dissolved solids (salinity), and radionuclides. Salinity levels in the MRGV are elevated in the San Acacia Reach (Cowley et al. 2009), but are not known to be levels likely to adversely affect silvery minnow (<4400 mg/L as total dissolved solids; Hoagstrom (2009)). However, information on toxicity of salinity on silvery minnow is generally lacking, or difficult to quantify (Cowley et al. 2009), presenting a substantial gap in predicting effects without additional information on ion composition and additional study is warranted. Pollutants and physical stressors have the potential to affect the aquatic ecosystem as well as silvery minnow health, silvery minnow prey and prey quality (Lusk et al 2012). Other physical stressors can also affect silvery minnows, particularly during river drying events. As the river dries, pollutants and temperatures tend increase in isolated pools (Caldwell et al. 2010). Toxic pollutants have been documented within the Middle Rio Grande and likely associated with localized mortalities of silvery minnows was suggested by Marcus et al. (2010). Papoulias et al. (2009) suggested the amount and variety of stressors in the Middle Rio Grande, combined, may nonetheless be affecting the health of silvery minnows as observed in their tissues.

Climate Change

“Climate” refers to an area's long-term average weather statistics (typically for at least 20- or 30-year periods), including the mean and variation of surface variables such as temperature, precipitation, and wind. “Climate change” refers to a change in the mean and variability of climate properties that persists for an extended period (typically decades or longer), whether due to natural processes or human activity (Intergovernmental Panel on Climate Change [IPCC] 2007a). Although changes in climate occur continuously over geological time, changes are now

occurring at an accelerated rate. For example, at continental, regional, and ocean basin scales, recent observed changes in long-term trends include: a substantial increase in precipitation in eastern parts of North American and South America, northern Europe, and northern and central Asia, and an increase in intense tropical cyclone activity in the North Atlantic since about 1970 (IPCC 2007a); and an increase in annual average temperature of more than 1.1 °C (2 °F) across U.S. since 1960 (Karl et al. 2009). Examples of observed changes in the physical environment include: an increase average sea level, declines in mountain glaciers and declines in average snow cover in both hemispheres (IPCC 2007a); substantial and accelerating reductions in Arctic sea-ice (e.g., Comiso et al. 2008), and a variety of changes in ecosystem processes, the distribution of species, and the timing of seasonal events (e.g., Karl et al. 2009).

The IPCC used Atmosphere-Ocean General Circulation Models and various greenhouse gas emissions scenarios to make projections of climate change globally and for broad regions through the 21st century (Meehl et al. 2007; Randall et al. 2007), and reported these projections using a framework for characterizing certainty (Solomon et al. 2007). Examples include: 1) it is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas; 2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will increase over most areas; and 3) it is likely that increases will occur in the incidence of extreme high sea level (excluding tsunamis), intense tropical cyclone activity, and the area affected by droughts (IPCC 2007b, Table SPM.2). More recent analyses using a different global model and comparing other emissions scenarios resulted in similar projections of global temperature change across the different approaches (Prinn et al. 2011).

All models (not just those involving climate change) have some uncertainty associated with projections due to assumptions used, data available, and features of the models; with regard to climate change this includes factors such as assumptions related to emissions scenarios, internal climate variability and differences among models. Despite this, however, under all global models and emissions scenarios, the overall projected trajectory of surface air temperature is one of increased warming compared to current conditions (Meehl et al. 2007; Prinn et al. 2011). Climate models, emissions scenarios, and associated assumptions, data, and analytical techniques will continue to be refined, as will interpretations of projections, as more information becomes available. For instance, some changes in conditions are occurring more rapidly than initially projected, such as melting of Arctic sea ice (Comiso et al. 2008; Polyak et al. 2010), and since 2000 the observed emissions of greenhouse gases, which are a key influence on climate change, have been occurring at the mid- to higher levels of the various emissions scenarios developed in the late 1990's and used by the IPCC for making projections (Raupach et al. 2007, Figure 1; Pielke et al. 2008; Manning et al. 2010, Figure 1). The best scientific and commercial data available indicates that average global surface air temperature is increasing and several climate-related changes are occurring and will continue for many decades even if emissions are stabilized soon (Meehl et al. 2007; Church et al. 2010; Gillett et al. 2011).

Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing “climate change” as a single threat in and of itself, the Service examined the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. For example, climate-related changes to habitats, the quality, availability, and timing of prey to developing fish and wildlife, predator-prey relationships, disease and disease vectors, or conditions that exceed the physiological tolerances of a species, or that alter the rate of metabolic and biochemical processes within organisms, the occurring individually or in combination, may affect the status of a species. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007a; Glick et al. 2011). As described above, in evaluating the status of a species, the Service uses the best scientific and commercial data available, and this includes consideration of direct and indirect effects of climate change. If a species is listed as threatened or endangered, knowledge regarding its vulnerability to, and impacts from, climate-associated changes in environmental conditions can be used to help evaluate expected effects of the action for this BO, as well as to help devise appropriate strategies for species recovery.

While projections from global climate model simulations are informative and in some cases are the only or the best scientific information available, various downscaling methods are being used to provide higher-resolution projections that are more relevant to the spatial scales used to assess impacts to a given species (see Glick et al. 2011). With regard to the area of analysis for the silvery minnow, the following downscaled projections are available.

The New Mexico Office of the State Engineer report (NMOSE 2006) made the following observations about the impact of climate change in New Mexico:

1. warming trends in the Southwest exceed global averages by about 50 percent;
2. modeling suggests that even moderate increases in precipitation would not offset the negative impacts to the water supply caused by increased temperature;
3. temperature increases in the Southwest are predicted to continue to be greater than the global average;
4. there will be a delay in the arrival of snow and acceleration of spring snow melt, leading to a rapid and earlier seasonal runoff; and
5. the intensity, frequency, and duration of drought may increase.

Most of the upper Rio Grande basin is arid or semiarid, generally receiving less than 25 cm (10 in) of precipitation per year (USBR 2011). In contrast, some of the high mountain headwater areas receive on average over 100 cm (40 in) of precipitation per year. Most of the total annual flow in the Rio Grande basin results, ultimately, from runoff from mountain snowmelt (BOR 2011b). In the Middle Rio Grande, there is expected earlier peak streamflow, reduced total streamflow, and more water lost to evaporation (Hurd and Coonrod 2007).

Climate change is predicted to affect silvery minnow habitat in four areas: 1) increased water temperature; 2) decreased streamflow; 3) a change in the hydrograph; and 4) an increased occurrence of extreme events (fire, drought, and floods). These impacts may affect the amount and qualities of silvery minnow habitat, silvery minnow physiology, phenology (the timing and availability of resources necessary for silvery minnow growth to maturity), and biological interactions with other aquatic and terrestrial species.

Increased water temperature

Kundzewicz et al. (2007) found that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change. Small changes in water temperature are known to have considerable effects on freshwater fishes by affecting a variety of life history, behavioral, and physiological aspects (Morgan et al. 2001; Carveth et al. 2006). Alterations in the temperature regime from natural background conditions negatively affect population viability, when considered at the scale of the watershed or individual stream (McCullough 1999). Both silvery minnow hatching and larval development are affected by high temperatures (Platania 2000). The density, type and seasonal availability of prey available to developing larvae and maturing silvery minnow, the amount of primary productivity and oxygen saturation are also affected by higher temperatures. As such, the silvery minnow may be adversely affected by increased water temperature due to climate change.

Decreased streamflow

Consistent with the outlook presented for New Mexico, Hoerling and Eischeid (2007) states that, relative to 1990 through 2005, simulations indicate that a 45 percent decline in streamflow will occur from 2035 through 2060 in the Southwest. Current models suggest a decrease in precipitation in the Southwest (Kundzewicz et al. 2007; Seager et al. 2007) that would lead to reduced streamflow and a reduced amount of habitat for silvery minnows. Streamflow is predicted to decrease in the Southwest even if precipitation were to increase moderately (NMOSE 2005; Hoerling and Eischeid 2007). Winter and spring warming causes an increased fraction of precipitation to fall as rain, resulting in a reduced snow pack, an earlier snowmelt, and decreased summer base flow (Regonda et al. 2005; Stewart et al. 2005). Earlier snowmelt and warmer air temperatures can lead to a longer dry season. Warmer air temperatures lead to increased evaporation, increased evapotranspiration, and decreased soil moisture. These factors could lead to decreased streamflow even if precipitation increased moderately.

The effects of decreased streamflow on the Rio Grande include smaller wetted area; more frequent intermittent or dry conditions; and greater conflicts among water users (Hurd and Coonrod 2007). As such, there will be reduced habitat available for aquatic species. As the river becomes more intermittent, fish isolated in pools may be subject to increased stress and predation.

Change in the hydrograph

Another documented effect of climate change is that warming in the Southwest has resulted in a shift of the timing of spring snowmelt (BOR 2011b). Stewart et al. (2005) show that timing of spring streamflow in the Southwest during the last 5 decades has shifted so that the major peak now arrives 1 to 4 weeks earlier, resulting in less flow in the spring and summer. They conclude that almost everywhere in North America, a 10 to 50 percent decrease in spring-summer streamflow fractions will accentuate the seasonal summer dry period with important consequences for water supplies, ecosystems, and wildfire risks (Stewart et al. 2005). Enquist et al. (2008) found that 93 percent of New Mexico's watersheds have become relatively drier from 1970 to 2006 and that snowpack in New Mexico's major mountain ranges has declined over the past 2 decades. The timing of peak streamflow from snowmelt in New Mexico is an average of 1 week earlier than in the mid-20th century (Enquist et al. 2008). Watersheds with the greatest declines in snowpack are those that have experienced the greatest drying from 1970 to 2006. Dust storms, associated with drought-stricken or poorly managed land can also influence snow albedo (reflectance), which can affect snowpack and the timing of snowmelt (Breed and Reheis 1999; Yasunari et al. 2011). Increased winter temperatures can cause more precipitation to fall as rain instead of snow resulting in earlier spring peak streamflow (Regonda et al. 2005). Rauscher et al. (2008) suggest that with air temperature increases of 3 to 5 °C (37 to 41 °F), snowmelt runoff in the Southwest could occur as much as 2 months earlier than present. Changes in the hydrograph could potentially alter the native fish assemblages, prey availability, and affect the reproductive success of the silvery minnow that is dependent on river flow pulses to spawn (Platania and Hoagstrom 1996).

Increased occurrence of extreme events

It is anticipated that an increase in extreme events (droughts, floods, fires) will most likely affect populations living at the edge of their physiological tolerances. The predicted increases in extreme temperature and precipitation events may lead to dramatic changes in the distribution of species or to their extirpation or extinction (Parmesan and Matthews 2006). Of these extreme events, drought intensity may be most important to the silvery minnow. The formation of an ice dam in 2011, in the San Acacia Reach, may have been an extreme event, and the ice dam resulted in blockage of the river and overbank flooding for several days until it thawed.

Overall, the predicted effects of climate change are expected to result in degradation of the remaining silvery minnow habitat, with potential adverse consequences on species viability.

Ongoing and Past Projects in the Middle Rio Grande including those in the San Acacia Reach

The Service has issued permits authorizing take for scientific research and enhancement purposes under ESA section 10(a)(1)(A), and for incidental take under section 7 for Federal actions. Applicants for ESA section 10(a)(1)(A) permits must also acquire a permit from the State of New Mexico to “take” or collect silvery minnows. Many of the section 10 permits issued by the Service allow take for the purpose of collection and salvage of silvery minnows and their eggs for captive propagation. Eggs, larvae, and adults are also collected for scientific studies to further our knowledge about the species and how best to conserve the silvery minnow.

Low Flow Conveyance Channel (LFCC)

Federal agencies have conducted numerous ESA section 7 consultations on flood control activities, water operations, LFCC and other projects in the Middle Rio Grande that inform the environmental baseline of the San Acacia Reach.

Floods in the early 1940s and the drought of the 1950s created a condition where the Rio Grande river channel below the Refuge had become a series of disconnected segments separated by sediment plugs and delta deposits (USBR 2012). To reduce provide more effective sediment and water transport to meet water obligations downstream, Reclamation constructed a 54-mile long artificial channel, the LFCC, running alongside the Rio Grande between San Acacia, New Mexico and Elephant Butte Reservoir. Operation and maintenance of the LFCC are ongoing Reclamation responsibilities.

The LFCC was designed to reduce depletion of water by diverting some or all of the river’s flow into a narrower, deeper, and more hydraulically efficient channel. The LFCC exposes relatively less water surface area to evaporation and is less prone to loss of water by seepage than the natural river channel. The higher flow velocities in the low flow channel can also move more sediment than the river, especially at lower discharges. Currently, at its upper end, the LFCC behaves as a canal conveying water downstream, but downstream from Escondida, New Mexico, the LFCC transitions in function to that of a drain. The LFCC can discharge to the Rio Grande, under certain conditions at the 9-mile outfall near Escondida; however, there is typically little or no flow in the LFCC at that point. The MRGCD returns surface water from its canals directly to the LFCC at four wasteway points. The MRGCD then may re-divert this LFCC water into its canal system at three locations. There is a single, small MRGCD wasteway that can return water directly to the Rio Grande by discharging to the Brown Arroyo, which crosses over the LFCC to enter the Rio Grande. The LFCC is protected by spoil banks, and is the subject of complex hydrologic interactions between the Rio Grande and irrigated lands (USBR 2012). The LFCC has a nominal capacity of 2,000 cfs, and the maximum-recorded mean daily discharge of the LFCC at San Acacia is 1,950 cfs.

In the 1990s and early 2000s, the Service consulted with Reclamation on the diversion of water from the Rio Grande into the LFCC and vice versa, including studying the effects of channel gradient and sedimentation on water delivery (USBR 2001, 2003, 2012; USFWS 2003a). Experimental diversions into the LFCC resulted in the entrainment of silvery minnow eggs and

subsequent detections of silvery minnows in the LFCC. Reclamation may perform some operations associated with the LFCC in conjunction with its supplemental water management program including pumping activities (USBR 2012). Reclamation also uses LFCC water in response to requests by the MRGCD or the Refuge to check up flows in the channel at existing check structures, thus increasing the head on the water so that diversions by the MRGCD and the Refuge from the LFCC are more easily made. Occasionally, the entrainment of silvery minnow eggs and adults may become entrained in the LFCC (USBR 2012), however, long-term occupancy by silvery minnows in the LFCC is not anticipated as flow velocities (> 7 fps; USACE 2012a,b) would create unfavorable conditions for silvery minnows.

River Mile 111 Priority Site Project

In March 2008, Reclamation submitted a BA to the Service evaluating the effects of relocation of the Low Flow Conveyance Channel (LFCC) and the associated levee on flycatcher and silvery minnow and their designated critical habitat. The project would allow the Rio Grande more freedom to move within its historical floodplain. Reclamation determined that the project “may affect, is not likely to adversely affect” the minnow and its designated habitat. The Service concurred with this determination (Consultation #22420-2008-I-0067), provided the following conditions were met: 1) all construction of woody debris piles would occur under dry working conditions or during low flow conditions; 2) recent surveys of the LFCC downstream of the proposed construction area did not find any minnows; 3) the Lemitar radial gate structure would be closed during the construction operations; 4) cottonwood root wads would be placed on the bank near river mile (RM) 111 and would cascade into the river as it migrates west; and 5) the mitigation plan described in the BA would be fully implemented and the Conservation Measures described in the BA would also be fully implemented by Reclamation.

Flood Control Activities and Water Operations

In 2001 and 2003, the Service issued jeopardy biological opinions resulting from programmatic section 7 consultations with Reclamation (USBR 2001, 2003; USFWS 2003a) and Corps (USBR 2003; USFWS 2003a), which addressed water operations and management on the Middle Rio Grande and the effects on the silvery minnow and flycatchers (USFWS 2001, 2003a). Incidental take of listed species was authorized associated with the 2001 programmatic BO (USFWS 2001), as well as consultations that were tiered off of that BO.

In the 2003 ESA consultation, a jeopardy Opinion was issued on March 17, 2003 (USFWS 2003a), and is the current programmatic Opinion on water operations for the Middle Rio Grande, and contains one RPA with multiple elements (USFWS 2003a). These elements set forth a flow regime in the Middle Rio Grande and describe habitat improvements necessary to alleviate jeopardy to both the silvery minnow and flycatcher. In 2005, the Service revised the incidental take statement (ITS) for the 2003 Opinion using a formula that incorporates October monitoring data, habitat conditions during silvery minnow spawn (spring runoff), and augmentation. Incidental take of silvery minnows is authorized with the 2005 BO revised ITS, and now fluctuates on an annual basis relative to the total number of silvery minnows found in October across the 20 population monitoring locations. Incidental take is authorized through consultations tiered off of the programmatic Opinion and on projects in the Middle Rio Grande.

In 2007, the Corps and others (USACE et al. 2007) evaluated the effects of a number of alternative water operations in the Middle Rio Grande. In particular, the “no action” alternative described in the Final Environmental Impact Statement (FEIS) helps inform the environmental baseline of silvery minnow habitat in the San Acacia Reach. Changes in magnitude and duration of peak flows by water operations and flood control activities were the most pronounced in the San Acacia Reach. Silvery minnow habitat in the San Acacia Reach was characterized as intermediate (USACE et al 2007, Table L-3.20, page L-161), as operations result in velocities surpassing the threshold velocity 62% of the time resulting in only 511,468 square feet (11.7 acres). San Acacia Reach peak flows of 3,578 cfs, and peak flow durations of up to 39 days per year, were expected to inundating 201 acres of overbank areas within the floodway during as many as 33 days per year. Additionally, flows less than 100 cfs were expected to occur for over 98 days per year (USACE et al 2007, Table L-3.20, page L-161). Discharges of less than 100 cfs and zero discharge are currently experienced in the San Acacia Reach and are detrimental to silvery minnow. Drought, diversions, and seepage into the LFCC contribute to low-flow conditions. Operations and flood control may not provide low-flow augmentation during the spring and summer months due to storage and release conditions and limitations at Abiquiu, Cochiti and other reservoirs (USACE et al. 2007). Storage of the spring runoff in upstream reservoirs is characterized as locked until late fall, when release of reservoir storage is least beneficial biologically. The Corps (USACE 2012c) and Reclamation (USBR 2012) have more recently been preparing BAs to reinitiate ESA consultation effects of flood control activities, reservoir and water operation and associated actions on Federally listed species and designated critical habitat within the MRGV of New Mexico. These activities include discretionary flood control operation of reservoirs, delivery of “carryover” floodwater, San Juan Chama water storage at Abiquiu Reservoir, delivery of Cochiti recreation pool water, maintenance actions at Corps-managed reservoirs, and temporary deviation for spawning and recruitment flows, to name a few. It is expected that formal consultation would begin sometime in 2012, and therefore, no more formal evaluation of those activities are conducted in this San Acacia Levee Project Opinion than is described above.

Bosque del Apache National Wildlife Refuge (Refuge) Water Management Plan

The Refuge completed an intra-Service section 7 consultation in May 2001, for the use of 8,691 acre feet of consumptive water use from the Rio Grande for the years 2001 through 2004, with 869 acre feet being used to aid in maintenance of habitat for the silvery minnow if: (1) data indicating that the addition of the water will foster survival of the silvery minnow or flycatcher; (2) an equal or greater percentage of water by other water users in the MRGV is also contributed; and (3) legal permitting from the Office of the State Engineer is obtained prior to the emergency transfer request. The Refuge maintains a consumptive water right of 12,417 acre feet and has initiated ESA consultation with the Service for its future use. Consumptive use of water at the Refuge may also affect flow, duration, and during drying events as well as silvery minnow and flycatcher habitat conditions in the San Acacia Reach.

Sediment Plug Removal Project at the Refuge

In August 2008, Reclamation submitted a BA to the Service addressing potential impacts of removal of a sediment plug, which had formed within the Rio Grande at the BDANWR during spring runoff 2008, on silvery minnow and its designated critical habitat and on the flycatcher. Reclamation's environmental commitments for the Sediment Plug Removal Project include: 1) construction of at least four embayment habitats (each approximately 30 to 50 feet in width and 50 to 70 feet in length) on the west side of the pilot channel to promote channel widening to be completed during Phase I(b); 2) collection of data for four years following excavation of the pilot channel to monitor channel degradation/aggradation and overbanking patterns, including i) cross-section data of the river channel from the north boundary of the BDANWR to the San Marcial Railroad Bridge; ii) at least two inspections of the river channel by boat when overbanking begins during runoff; and iii) at least once during the four years, cross-section data of the river channel and floodplains that extend between endpoints for these rangelines; 3) data collected as above will be analyzed and compared to 2002 and 2005 cross-section data to assess changes to the riverbed thalweg and channel geometry, including width/depth ratio, and data and analysis will be provided to the Service; and 4) in-depth analysis of alternatives to pilot channel construction within the aforementioned reach of river to be initiated within six months of completion of Phase I(b) of the project. This included: at least three strategies to address sediment transport through the reach; maintenance of connected unvegetated river bars; opportunities for river realignment following sand plug formation; river connectivity during low flows; river/floodplain surface connectivity; surface water supplies to adjacent wetlands; and effects on threatened, endangered, or candidate species. This analysis was conducted and a report titled Channel Conditions and Dynamics on the MRG was issued (Makar and AuBuchon 2012). Based on the study, Reclamation adopted river maintenance goals described in Middle Rio Grande Maintenance Program Comprehensive Plan and Guide (USBR 2012). Reclamation's strategy and goals seek to address trends in channel narrowing, vegetation encroachment, aggradation, channel plugging with sediment, and perched channel conditions.

Drain Unit 7 Extension River Maintenance Priority Site Project

On June 13, 2008, Reclamation submitted a BA, along with a letter formally requesting consultation reinitiation, to the Service for the proposed Drain Unit 7 (DU7) Extension River Maintenance Priority Site Project. The project will reinforce the bankline and protect the adjacent access road and drain by placing riprap along the bank within the active river channel. Reclamation determined that this action may affect, and is likely to adversely affect, the endangered minnow during construction; and may affect, and is not likely to adversely affect, designated minnow critical habitat. The Service concluded that the proposed action is not likely to jeopardize the continued existence of the minnow and that there is likely to be short-term adverse effects on a very small portion of designated critical habitat at the construction site. Environmental commitments associated with the proposed DU7 Project include: implementing construction Best Management Practices (BMPs) and dust abatement during construction; re-vegetating the site; and performing construction outside minnow spawning periods (construction exclusion period of April 15 through July 1).

Vegetation and Sand Bar Removal Project Upstream of San Acacia Diversion Dam (SADD)

The Vegetation and Sand Bar Removal Project consisted of removing vegetation from approximately 11 acres of an in-channel sand bar in order to encourage mobilization of the sediment. Immediately upstream of the SADD, in the small reservoir pool, an 11-acre sand bar has developed, filling the channel with sand and narrowing the channel width. The presence of this sand bar has reduced the pool volume upstream of the Dam to less than 35 percent of the intended design, and channel width above the SADD is about 25 percent of original. This reduced capacity and physical narrowing of the channel has caused significant negative impact to Dam operations and has increased risk to the SADD structure itself. Over time, vegetation has established on the sand bar and has further contributed to stabilization of the sand bar. The Middle Rio Grande Conservancy District planned to implement the Vegetation and Sand Bar Removal Project as part of its operation and maintenance responsibilities at the SADD, and Reclamation undertook ESA Section 7 consultation on its behalf because it owns the SADD. In this area, approximately 6.5 acres of suitable flycatcher habitat would be destroyed. The Vegetation and Sand Bar Removal Project was mostly conducted in the dry and expected to indirectly benefit the silvery minnow by increasing available aquatic habitat above SADD, when inundated. Along with timing restrictions, habitat restoration to create 6.5 acres of suitable flycatcher habitat was proposed as a conservation measure by Reclamation. Construction of the habitat restoration project will be completed by April 15, 2014.

Recent and Contemporary Non-Federal Actions

The past and present impacts of non-Federal actions, which are contemporaneous with the consultation in process, are included in the environmental baseline. Future impacts of these same non-Federal actions will be considered as cumulative effects in the analysis of effects discussion in this Opinion. The following is considered a non-exhaustive list of non-Federal actions.

Rio Grande Compact

Water uses on the Middle Rio Grande must be conducted in conformance with the Compact administered by the Rio Grande Compact Commission. The four-member Commission is composed of Commissioners from Colorado, New Mexico, and Texas, as well as a Federal representative who chairs Commission meetings. Colorado is prohibited from accruing a debit, or under-delivery to the downstream States, of more than 100,000 acre-feet, while New Mexico has accrued debit to Texas is limited to 200,000 acre-feet. These limits may be exceeded if caused by holdover storage in certain reservoirs, but water must be retained in the reservoirs to the extent of the accrued debit. Any deviation from the terms of the Compact requires unanimous approval from the three state Commissioners.

In order to meet delivery obligations under the Compact, depletions within New Mexico are carefully controlled. Allowable depletions above Otowi gage (located outside of Santa Fe, near the Pueblo of San Ildefonso) are confined to levels defined in the Compact. Allowable depletions below Otowi gage and above the headwaters of Elephant Butte Reservoir are

calculated based on the flows passing through Otowi gage. The maximum allowable depletions below Otowi gage are limited to 405,000 acre-feet in addition to tributary inflows. In an average year, when 1,100,000 acre-feet of water passes the gage, approximately 393,000 acre-feet of water is allowed to be depleted below Otowi gage, in addition to tributary inflows. Depletion volumes are lower in dry years. For instance, in 1977, allowable depletions were 264,600 acre-feet in addition to tributary inflows. No Indian water rights may be impaired by the State's Compact management activities.

State of New Mexico

The State of New Mexico has a wide range of agencies that actively represent different aspects of the State's interest in water management. The New Mexico State Engineer has general supervision of the waters of the State and of the measurement, appropriation, and distribution thereof (N.M. Stat. Ann. 72-2-1 Repl. Pamp. 1994). The New Mexico Office of the State Engineer (NMOSE) grants state water rights permits ensures that applicants meet state permit requirements, and enforces the water laws of the State. The OSE is responsible for administering water rights, including changing points of diversion and places or purposes of use. The OSE uses the "Middle Rio Grande Administrative Area Guidelines for Review of Water Right Applications" to assess the validity and transfer of pre-1907 water rights.

The New Mexico Interstate Stream Commission (NMISC) is authorized to develop, conserve, protect and to do any and all things necessary to protect, conserve, and develop the waters and stream systems of the State. It is responsible for representing New Mexico's interests in making interstate stream deliveries, as well as for investigating, planning, and developing the State's water supplies. The State cooperates with Reclamation to perform annual construction and maintenance work under the State of New Mexico Cooperative Program. In the past, this work has included some river maintenance on the Rio Chama, maintenance of Drain Unit 7, drain and canal maintenance, similar work at the state refuges, and temporary pilot channels into Elephant Butte Reservoir. The NMISC, along with the New Mexico Office of the Attorney General, the New Mexico Department of Agriculture, and the New Mexico Department of Game and Fish, represents the State of New Mexico as part of the Middle Rio Grande Endangered Species Collaborative Program.

Summary of the Silvery Minnow Environmental Baseline

The remaining population of the silvery minnow in the Middle Rio Grande is restricted to approximately 7 percent of its historical range. With the exception of 2008, every year since 1996 has exhibited at least one drying event that has negatively affected silvery minnows. The species is unable to expand its distribution because of poor habitat quality and Cochiti Dam prevents upstream movement and Elephant Butte Reservoir blocks downstream movement (USFWS 1999; 2010a). Silvery minnow habitat is limited by reduced peak flow magnitude and duration, water diversions, diversion dams, and climate change that contributing to river drying. Increasing demands for water have altered the normal hydrologic and ecological processes in the San Acacia Levee Project area.

The consumption of surface water and shallow groundwater for municipal, industrial, and agricultural uses continues to reduce the flow in the Rio Grande and degrade habitat for the silvery minnow (USBR 2003, 2012). Stormwater discharges and high velocities appear to contribute to low DO conditions in the Rio Grande that can harm the feeding and sheltering activities of silvery minnows. In addition, a variety of organic chemicals, heavy metals, and pesticides have been documented in the Rio Grande and that cumulatively contribute to the overall degradation of water and sediment quality in silvery minnow habitat.

Population monitoring indicates that densities of this species are the lowest on record (Figure 4; Dudley et al 2012a), lower than catch rates at the time of the silvery minnow listing as an endangered species (USFWS 1994). Norris et al (2008) reported that the fifty-year projections for simulated populations of silvery minnows occupying the Middle Rio Grande were associated with decreased water availability, increased reliance on captive propagation, and the degraded, fragmented, and isolated nature of occupied habitat, and the absence of the silvery minnow throughout most of its historical range. Various conservation efforts have been undertaken in the past and others are currently being carried out in the Middle Rio Grande for the benefit of the silvery minnow. Augmentation of silvery minnows with captive-reared fish has been ongoing, and monitoring and evaluation of these fish provide information regarding the survival and movement of individuals (USFWS 2010a). However, the threat of extinction for the silvery minnow continues because of decreased water availability, increased reliance on captive propagation, the degraded, fragmented, and isolated nature of occupied habitat, and the absence of the silvery minnow throughout most of its historical range.

FACTORS AFFECTING FLYCATCHERS IN THE ACTION AREA

Physical Modification of the Channel, Floodplain, Riparian Vegetation, and Watershed

The watersheds and rivers of the southwestern United States (Southwest) are the physical foundation of habitat for the willow flycatcher (Graf et al. 2002). Hatten et al. (2010) also described the importance of riparian habitats in the Southwest for wildlife. For example, over 50 percent of southwestern bird species are directly dependent on riparian habitat even though it only covers about 1 percent of the landscape (Knopf et al. 1988; Skagen et al. 1998). According to Hatten et al. (2010), riparian habitat has declined by as much as 90 percent as in historical times, and is generally considered a habitat of great conservation and management concern. Many stressors have contributed to the decline of riparian habitat, but one of the most wide-scale stressors to riparian systems is due to dams, diversions, and other modifications of rivers in the Southwest (Graf et al. 2002, Graf 2006). Dams disrupt the natural flood cycle that riparian systems have adapted to, creating rivers that flood infrequently, lose their meanders, and generally become more channelized (Graf 2006; Webb and Leake 2006).

Dams, Operations, and Diversions

The headwaters of the Rio Grande are fed by far away mountain snowpack or tropical monsoon rains and provide water important to people living in a climate that is semi-arid in the Lower Rio Grande (Scurlock 1998; Stotz 2000; Schmandt 2010). Upstream river water is captured in

reservoirs by dams, thus making human settlements possible, with irrigated agriculture providing the local economy with food and jobs (Schmandt 2010). Eventually villages and cities were built or expanded, and their communities increasingly relied on the Rio Grande for drinking water and other demands (USBR 2012).

While dams and reservoirs provide societal benefits including urban water supply, irrigation, hydroelectric power, flood control, and recreation, they also cause changes in river riparian environments that include adjustments in potential habitat for the willow flycatcher (Graf et al. 2002). Dams are the most pervasive and significant changes to flycatcher habitat because they are the primary cause of altered flows of water, energy, and sediment throughout the Rio Grande (Graf et al. 2002). Dams have stored an amount of water equal to almost four times the mean annual runoff in the Rio Grande, which has reduced floods, and the amount and timing of flow in the Middle Rio Grande (Graf et al. 2002, USACE et al. 2007).

In the Rio Grande, “operations” of the river have included the engineering tasks of water management, construction and maintenance of dams, diversions, channeling water to irrigation districts and bringing return flow back to the mainstem, leveling and clearing of flood plains, alterations of the stream and watershed, and allocation of water between New Mexico, Texas, and Mexico. The Middle Rio Grande also experiences periodic droughts during which water allocations are reduced. The specific hydrologic changes downstream from dams depend on the inflows to the reservoir, the engineering characteristics of the dam, and its operating rules (Graf et al. 2002). Dam operating rules often involve the release of water from a reservoir or through the dam according to a variety of agreements by various entities and maintenance conditions. River flows and diversions to irrigation systems, municipal water supplies, or other facilities and levels of water within a reservoir can be increased or decreased depending on how the dam is operated and to meet societal needs.

However, the operating rules of dams can often modify, reduce, destroy, or increase riparian habitat both downstream and upstream of the dam (Graf et al. 2002). Below dams, natural hydrological cycles are modified. Peak and low flow events both can be altered in time, duration and magnitude. Peak flows are reduced in size and frequency below many dams (Graf 2006). The cycle of base flow punctuated by short duration floods is often lost. In so doing, dams inhibit the natural cycles of flood-induced sediment deposition, floodplain hydration and flushing, and timing of seed dispersal necessary for establishment and maintenance of native riparian habitats (USFWS 2002).

Upstream of dams, previous river channels and near-channel surfaces that are in the reservoir area are often inundated, either permanently or periodically, so that the riparian habitat associated with them is lost (Graf et al. 2002). However, the shoreline of the newly formed reservoir may create new riparian habitats where the stream enters the lake, is a dynamic zone where deposition of sediment creates a delta because the lake reduces the energy gradient of flow (Graf et al. 2002). These areas typically support flycatchers when the riparian vegetation becomes suitable at the edges of the reservoir pool (Behle and Higgins 1959; Graf et al. 2002; USFWS 2002).

Historically, the Middle Rio Grande has been used for agriculture (Scurlock 1998; Stotz 2000). Pueblo people were utilizing small diversions and ditch irrigation on a limited scale at the time of Spanish exploration in 1591. The Spanish expanded irrigation greatly, including diverting the main stem at low flow, and the area of irrigated farming steadily increased in New Mexico until it reached a peak of 127,800 acres (50,500 ha) in 1880 (Scurlock, 1998). Stotz (2000) estimated that more than half the summer stream flow from the Rio Grande between 1890 and 1893 was consumed by irrigation or was lost to seepage and evapotranspiration. Water loss due to agriculture was also associated with irrigation in the San Luis Valley (SLV) of Colorado (Scurlock 1998; Stotz 2000). Between 1936 and 1953, the average annual depletion in the SLV was approximately 802,600 acres ft ($9.9 \times 10^8 \text{ m}^3$) and annual depletions ranged from about 502,600 acres ft ($6.2 \times 10^8 \text{ m}^3$) in dry years to more than 997,200 acres ft ($12.3 \times 10^8 \text{ m}^3$) in wet years. The effect of these SLV depletions was primarily reflected in the shorter duration of the median snowmelt flood as far down as El Paso (Stotz 2000).

Peak flow or floods are the primary natural disturbance in riparian ecosystems (Poff et al. 1997). The components of flow, including its amplitude, magnitude, frequency, duration, timing, and rate of change of hydrologic conditions, strongly influenced the structure and function of riparian habitat below dams (Poff et al. 1997; USFWS 2002; USACE et al. 2007). Many of the riparian plant species in the southwest such as Goodding willow are pioneer species that depend on periodic winter and spring flood disturbance for regeneration. Cottonwoods and willows release small, windborne seeds timed to the distributional patterns of flows common to the Rio Grande (Moss 1938; McBride and Strahan 1984; Graf 1994). For example, cottonwood seeds are released coinciding with higher flows, while willow seeds are released during lower flows when sandier substrates are exposed and are wet enough to allow for germination (McBride and Strahan 1984). Other plant species regenerate in response to periodic flooding in the Lower Rio Grande (Stotz 2000).

Infrequent but very large floods reset riparian habitat succession and can rejuvenate large stands of the riparian habitat upon which flycatchers depend (Graf et al 2002). Smaller floods that inundate, but do not destroy riparian vegetation, help to maintain a diversity of herbaceous plant species that may also play important roles in maintaining the food base of the flycatcher. Floods exert important physical and biological controls on riparian habitats, because they inundate and moisten floodplain soils, raise water tables, and recharge aquifers, mobilize and deposit sediment on flood plains creating seed beds for riparian plants, flush salts and redistribute nutrients, cause river channels to relocate or meander, create abandoned channels and backwaters, disperse and scarify plant propagules, scour and relocate vegetation, and deposit organic materials that have higher water-holding capacity than the inorganic materials in the substrate (USFWS 2002).

Scurlock (1998) determined that there were at least 50 major floods exceeding 280 cms in New Mexico between 1849 and 1942. Twice as many of these floods occurred in the 1800's than in the 1600's or 1700's, although the record of large floods improves with time. Scurlock (1998) and Stotz (2000) suggested that environmental degradation may have contributed to the increase in flood frequency in the 1800's. The largest flood occurred in 1828 and had an estimated discharge of about 2830 cms. The entire Rio Grande valley was inundated from Albuquerque to El Paso, Texas. Natural floods large enough to destroy riparian vegetation and flycatcher habitat

operate at regional and local scales in the Rio Grande (USFWS 2002). Extensive flooding can result in widespread loss of riparian habitat. In the intervening years, the riparian habitat recovers and matures. On the time scale of decades, therefore, it is reasonable to expect regional changes in the amount of available riparian habitat for flycatchers due to natural flooding (Graf et al. 2002). The existing hydrology and flood control operations created by dams, diversions, and provisions for safe channel capacity now make flood events large enough to destabilize the current vegetation and change the channel pattern extremely unlikely in the Rio Grande.

Reduced annual flow shrinks both peak and low flows, which increases channel stability, and decreases water tables that can reduce riparian habitat (Graf et al. 2002). Construction of Cochiti Dam significantly reduced the floods and high flow pulses in the action area (USACE 2012b). The width of riparian habitat and biomass decreases with decreased mean and median annual flow volume and drainage size in alluvial river channels (Stromberg 1993). Reduced peak flow shrinks the high flow channel from braided to single thread and thereby reduces riparian habitat dynamics (Stotz 2000). With reduced low flows, or during drought or extended loss of surface flow during drying events, the alluvial groundwater levels also decline often resulting in mortality of riparian vegetation.

Operations of dams have decreased annual fluctuations in flow, which contributed to the simplification of the channel system, reduced the size and amount of beaches, sand bars, or floodplains, and reduced or simplified riparian vegetation, thereby reducing river function and processes, and increasing conditions that favored tamarisk replacement of native vegetation in the action area (Everitt 1993; Graf et al. 2002). These flood-driven fluvial processes maintain high species diversity, productivity, and habitat complexity in riparian ecosystems, all of which benefit habitat for the willow flycatcher. Loss and alteration of surface flows reduced vegetation and insect productivity, reduce the flooding, inundation, or saturation of breeding habitat soils, reduced native riparian habitat quality, as well as affected the production and biomass of insects important to flycatcher breeding habitat in the action area.

Flood Control Activities and Water Operations

(See discussion of flycatcher baseline associated with Flood Control Activities and Water Operations in the “Factors Affecting Silvery Minnows in the Action Area” environmental baseline section).

Changes to the Floodplain, Floodway and Riparian Habitat

Spoil banks currently extend through the project area on the west side of the Rio Grande demarking the edge of the floodway. The spoil banks effectively reduced the historical floodplain area to the floodway. High ground, (naturally elevated bluffs and canyon walls contain flood flows along portions west side of the floodway that does not have spoil banks or levees. Roadways are atop the spoil banks and are generally unpaved gravel roads designed for passage of personnel and equipment.

Pre-canalization channel conditions were characterized by Stotz (2000) as wide and shallow with some meanders in the stream configuration. Once channel capacity was reduced, floods from tributaries created flows that affected communities nearby, and accumulated sediment and vegetation. Changes to the flow and channel described previously have resulted in a current channel pattern that is a narrower, single channel that supports less native riparian vegetation than historically (Stotz 2000; Everitt 1993; USBR 2001). Bank heights have increased in the upper and lower portions of the San Acacia Levee Project area due to channel incision and/or channel bed degradation in reaches below Escondida Bridge, aggradation begins below Socorro, although a recent incision has occurred near San Marcial and traveled northward.

As a result of the lateral confinement of floods within the floodway by the spoil bank, vertical accumulation of sediment deposition along the channel and in the floodway has resulted in a raised sediment surface elevation compared to the historical floodplain. In the San Acacia Reach, below Highway 380, floodway elevation relative to the historical floodplain elevation has been raised by as much as 11 to 24 feet in some locations (Crawford et al. 1993, USACE 2012b). On average, lateral floodplain confinement results in approximately 0.5 ft per year of vertical sediment accumulation within the floodway (USACE 2012b). The USACE (2012b) predicted sediment accumulation within the floodway for as long as the spoil bank lasts. However, Corps (2012b, Appendix F, page 126, Tables F-2A, F-2B, F-61) described the water surface elevation rapidly exceeding the height of the spoil bank or breaching it and causing damages and flow into the historical floodplain (Table 3). Sediment accumulation due to the lateral confinement of the floodplain may increase the depth to groundwater that plays an important part in the health and distribution of riparian vegetation (Arizona Department of Water Resources 1994; USFWS 2012b) and consequently, flycatcher habitat. The greater the depth to groundwater below the land surface, the less abundant the riparian vegetation (Arizona Department of Water Resources 1994, USFWS 2012b). Vertical accumulation of sediment in a floodplain, exacerbated by the lateral confinement of the floodplain, results in a physical separation of riparian vegetation from groundwater necessary for flycatcher habitat (Dufour et al 2007; USFWS 2012b). Accumulation of sediment within a floodway which increases the depth to water results in productive pioneer species such as willows or poplars being replaced by either non-native (e.g., tamarisk) or upland plant species (Friedman and Auble 2000; Dufour et al. 2007; Decamps et al 2008).

As the Rio Grande Valley began to be developed by settlers and the agricultural lands were expanded, water was taken from the river for irrigation, resulting in a slowing of the river flow rate. As river water slows, silt begins to drop and increases the height of the river channel. More than half the Rio Grande silt comes from stormwater tributaries below the mouths of the Rio Puerco and the Rio Salado. These tributaries bring 55% of the total sediment into this portion of the Rio Grande and only 4 to 6% of the surface water yield (USACE 1972). In addition, they run during the summer storm season when the Rio Grande flow is at its lowest. Water is being taken out of the river upstream, and a considerable source of silt is being added just before the San Marcial area. This silt is being added at a time of low flow, which encourages silt to drop out of the flow and accumulate. Sediment can accumulate, the channel aggrades, and vegetation encroachment, mainly by salt cedar, will tend to armor the channel banks thereby simplifying the channel. Reclamation operates and maintains the channel in the floodway within the action area (USACE 2012). Maintenance includes dredging sediment out of the river channel in order to maintain hydraulic efficiency for floodwater conveyance and water distribution (USBR 2012).

As a river channel narrows or incises, it deepens and the adjoining overbank is inundated less frequently, which fosters conditions favoring vegetation growth on or near the banks, and thereby reducing the width of the active channel. This vegetation encroachment is likely the result of decreased peak flows and increased low flow duration. Increased low flow duration provides water more consistently and encourages vegetation growth near the channel. Since riparian vegetation has been shown to provide geotechnical strength to the soil (Simon and Collison 2002; Pollen and Simon 2005; Pollen 2007; Pollen-Bankhead et al, 2009), it can effectively stabilize channel banks and bars (Thorne 1990; Abernethy and Rutherford, 2001; Gran and Paola 2001; Simon and Collison 2002; Griffin and Smith 2004), and reduce channel-margin flow velocities and shear stresses (Carollo et al. 2002, Tal et al. 2004; Griffin et al. 2005; Tal and Paola 2007), and induce sedimentation (Tooth and Nanson 2000; Schultz et al. 2003). As a result, channel width is often decreased. The San Acacia Section suffers the highest infestation of exotic plant species of MRG. Thus, riparian vegetation can exacerbate processes of channel narrowing during low flow periods by promoting sediment deposition within the channel and on the condition of the floodplain.

In New Mexico, floodplain riparian vegetation has probably been impacted more by human activities than any other type of riparian vegetation (Dick-Peddie 1993). Current Rio Grande floodplain vegetation greatly differs in both composition and extent from that described by Van Cleave (1935; cited in Finch et al. 1995). Cottonwood and willow were, and remain, primarily restricted to the floodway. The bosque, though much reduced in extent, is still represented by some individual cottonwood trees of extremely large size. With some notable exceptions, the historic cottonwood and willow forests have been reduced to a narrow band of mid- to old-age forest stands between levees in the floodway. Many cottonwood/willow communities were lost to expanding agriculture, the demand for fuel and wood products, channelization and flood control projects, urbanization, transportation systems, inundation by large impoundments, and the introduction and escape of exotic plants (Finch et al. 1995).

The specific role of tamarisk in floodplain aggradation and channel narrowing is a matter of debate. Tamarisk was not common on the floodplain until the 1930's, after channel narrowing had begun in the Lower Rio Grande (Everitt 1998). The spread of tamarisk throughout the Rio Grande may have taken place due to the decreased flows, aggradation, and channel narrowing. Nevertheless, tamarisk may play a role in limiting the ability to reconnect the river channel with its overbank. Under stress, dense tamarisk patches can be prone to fire that can directly affect flycatcher habitat (Paxton et al. 2008a).

The Middle Rio Grande and associated riparian habitat has historically been a very dynamic system in constant change and without this change, the diversity and productivity decreased. Sediment deposition, scouring flows, inundation, and irregular flows, are natural dynamic processes that occurred frequently enough in concert to shape the characteristics of the river channel, floodplain, and riparian vegetation in the action area. Flycatcher habitat has historically developed in conjunction with this dynamic system where habitat was created and destroyed at various time scales and locations. It was this type of dynamic, successional system that flycatchers depended upon for the establishment and development of breeding habitat. Through the development of dams, reduced flow, channelization, water withdrawal, and development, the

dynamics of the river system have been eliminated except for localized areas such as the reservoirs where water storage levels frequently change with releases and inflows, where the river is wide and connects to the floodplain, or where riparian vegetation and flycatcher prey is maintained by seepage and high water tables.

Still Waters, Water Table, and Groundwater Interactions

The Middle Rio Grande interacts with groundwater in its alluvial sediment. Additionally, the timing, location, and rate of these exchanges between groundwater and surface water are constantly changing and are often unmeasured making specific observations limited. These alluvial groundwater aquifers are often much wider than the stream channel and can be shaped by aquifer geology. Precipitation on the uplands can infiltrate soils, and depending on elevation and surface geology, it can contribute to the alluvial groundwater. It can also be affected by drought. Recharge to the groundwater aquifer below the Middle Rio Grande can occur from mountain-front seepage, tributary seepage, community wastewater and septic return flow, urban stormwater seepage, or irrigation seepage. Deeper groundwater levels, below, near and associated with the spoil banks have been observed (Parametrix 2008).

The elevation of the water table in riparian areas within the floodway correlates with the surface water elevation in the channel and the drawdown effects of the LFCC functioning as a drain (USACE et al. 2007). The duration of high flows is an indicator of inundation frequency of riparian areas located on islands and in the overbank areas. The reduction in the frequency and magnitude of flow at Cochiti is likely to reduce the frequency, duration, or extent of inundation in wetlands within the floodway below SADD. The duration of high flows also contributes to groundwater recharge and the stability of groundwater elevations. Groundwater elevation maps along the action area show less stable groundwater elevations and decreases in the areal extent of high water table conditions generally during the April to September period (USACE et al. 2007). Water table elevations below the ground surface vary from 4 to 5 feet at Escondida, and from 5 to 10 feet near San Antonio, New Mexico (USACE et al. 2007). Groundwater pumping for agricultural, mining, industrial, and municipal uses has resulted in water table declines along many rivers and is a major factor in the quality of flycatcher habitat (Briggs 1996; USFWS 2002). The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation. Topography, drainage patterns, soil types, depth to groundwater, groundwater flow direction and gradient, and other factors can affect the transport of water on and beneath the ground surface. Locally, manufactured conduits such as sewers, water lines, drains, trenches, or wells can divert subsurface transport. These impacts are expected to be exacerbated as the river aggrades up to 12 ft, over time in the action area (USACE et al. 2007; USACE 2012b).

The effect of activities that alter groundwater can lead to the reduction of water tables in or below riparian habitats that may support flycatchers (USFWS 2002). The floodplain of the Middle Rio Grande historically contained numerous marshes, swamps, meanders, oxbows and pools (Stotz 2000). In addition to providing evidence of channel shifting and flooding, such features also suggest a high water table within the floodplain (Graf et al. 2002). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that

provide breeding habitat for flycatchers. These waters and high water tables associated with alluvial aquifers are essential for flycatchers as they foster abundant insects necessary for breeding habitat and are associated with productive nesting (Moore and Ahlers 2012).

Agricultural Development

The availability of relatively flat land, rich soils, high water tables, and water for flood irrigation has fostered agricultural development in the Middle Rio Grande. Conversion of floodplains to agricultural fields reduced the areas covered by native vegetation and certain types of vegetation were more susceptible to conversion than others. These areas often contained extensive grassland, riparian, and wetland vegetation (Stotz 2000). Agricultural development sometimes cleared riparian vegetation, or drained and protected floodplains using spoil banks and other engineering techniques. Agricultural development can also increase the likelihood or severity of cowbird parasitism, by creating foraging sites (e.g., short-grass fields, grain storage, livestock concentrations) in proximity to breeding habitat. However, riparian vegetation that supports flycatcher habitat can also be sustained by agricultural seepage and return flows.

Urbanization, Recreation, and Human Disturbance

Urban development can result in many impacts to riparian ecosystems and flycatcher habitat. Urbanization near flycatcher habitat provides the catalyst for a variety of indirect effects, which can adversely affect flycatchers or contribute to habitat loss. Urban development fosters demand for domestic, municipal, and industrial water use. These demands are satisfied by diverting water from streams and groundwater pumping, which can reduce flow and groundwater aquifers. Urbanization can favor domestic cat predation as well as other predators or competitors of flycatchers (e.g., cowbirds, blackbirds). Urban areas have transportation systems that include bridges, roads, and vehicles that can be detrimental to riparian habitat (Marshall and Stoleson 2000). Some communities may desire to remove riparian vegetation to reduce fire risk or control insect populations. Stormwater management can involve construction of settling basins, reservoirs, and other structures necessary to control floods, alter flow velocity, native riparian habitat, and groundwater infiltration patterns. Urban development can also concentrate pollutants and non-native species in riparian habitats. Riparian vegetation that supports flycatcher habitat can also be sustained by urban stormwater and wastewater. Streams where flow is desiccated that receive some wastewater can increase water tables and water in channels to support riparian vegetation suitable for flycatcher habitat (Stromberg 1993, USFWS 2002). However, the chemical quality of riparian habitat and insects associated with urban water may affect breeding habitat and may need further research. Continued use of chemicals and certain pesticides as well as a legacy of previous chemical use, spills, and atmospheric re-deposition may also affect flycatchers.

Urban development also tends to increase recreational use of riparian habitat. Recreation can occur in riparian habitat because of the shade, water, aesthetic values, as well as its association with opportunities for fishing, boating, swimming, and other activities in surface waters. As developed areas and human populations grow, the magnitude and cumulative effects of these activities often increase. Effects may include: reduction in vegetation through trampling,

clearing, woodcutting and prevention of seedling germination due to soil compaction; bank erosion; increased incidence of fire; promoting invasion by exotic plant species; promoting increases in predators and scavengers due to discarded food and solid waste (e.g., ravens, jays, grackles, skunks, squirrels, domestic cats, etc.); promoting increases in brood parasitism by cowbirds; and noise disturbance. Recreational development also tends to promote an increased need for foot and vehicle access, roads, pavement, trails, boating, and structures that fragment habitat. Effects of these activities on flycatchers may vary with frequency, intensity, and management actions. Reductions in density and diversity of bird communities, including flycatchers, have been associated with recreational activities (USFWS 2002).

Human disturbance in the action area may include flycatcher science and research as well as flycatcher surveys affect flycatchers (USFWS 2002). Temporary, short-term impacts to wildlife from noise, dust, and the presence of workers and machinery during project construction where activities occur near flycatchers or within flycatcher breeding season. Accidental spills of fuels, lubricants, hydraulic fluids and other petrochemicals, although unlikely, could be harmful to aquatic insect prey or riparian habitat vigor.

Livestock Grazing

Overgrazing by domestic livestock has been a significant factor in the modification and loss of riparian habitats in Southwest (USFWS 2002). If not properly managed, livestock grazing can significantly alter plant community structure, species composition, relative abundance of species, and alter stream channel morphology. The primary mechanism of effect is by livestock feeding in and on riparian vegetation. Overutilization of riparian vegetation by livestock also can reduce the overall density of vegetation that provides flycatcher-breeding habitat. Palatable broadleaf plants like willows and cottonwood saplings may also be preferred by livestock, as are grasses and forbs comprising the understory, depending on season and the availability of upland forage. Though rare, livestock may also physically contact and destroy nests (USFWS 2002). Livestock also physically degrade nesting habitat by trampling and seeking shade and by creating trails that nest predators and people may also use for recreation. Furthermore, improper livestock grazing in watershed uplands above riparian systems can cause bank destabilization, increased runoff, increased sedimentation, increased erosion, and reduced capacity of soils to hold water. Because the impact of grazing can be highly variable both geographically and temporally, proper management strategies must be developed locally (USFWS 2002).

Feral Hogs

Feral hogs (*Sus scrofa*) also have potential to degrade riparian habitat and native animal populations through soil disturbance, uprooting of native plants, competition for foraging resources, particularly acorns, predation on small animals, and disease transmission. Feral hogs degrade wildlife habitat and compete directly with native wildlife for food. Hogs are omnivorous, primarily consuming vegetation, mast, roots and tubers, and to a lesser degree a wide range of animal species including invertebrates, reptiles, amphibians, small mammals and birds (Davis and Schmidley 1994, Ditchkoff and Mayer 2009). Their rooting habits create severely disturbed areas, which may lead to a localized shift in plant succession and increase the

potential for soil erosion (Davis and Schmidley 1994). Feral hogs also destabilize wetland areas, springs, creeks and other riparian areas through excessive rooting and wallowing. They also pose a threat to humans and livestock through the spread of disease (USDA 2010).

Fire

Fire is an imminent threat to flycatcher breeding habitat (USFWS 2002). Although fires occurred to some extent in riparian habitats historically, many native riparian plants are neither fire-adapted nor fire-regenerated. Thus, fires in riparian habitats are typically catastrophic, causing immediate and drastic changes in plant density and species composition. Busch (1995) documented that the current frequency and size of fires in riparian habitats is greater than historical levels because reduced floods have allowed buildup of fuels, and because of the expansion and dominance of the highly flammable tamarisk. Tamarisk and arrowweed tend to recover more rapidly from fire than do cottonwood and willow. Riparian fires have destroyed nesting flycatcher sites along the Middle Rio Grande and elsewhere in New Mexico (USFWS 2002).

The Refuge maintains fuel breaks at strategic locations on the Rio Grande floodway on Refuge lands, due to the high recurrence interval and risk of wildfires in the Middle Rio Grande. Most wildfires in this reach of the Middle Rio Grande are human caused (USFWS 2010b). The most recent wildfire on the Refuge floodplain was the Marcial Fire of 2006. The largest wildfire (most acres burned) in recent history that affected the Refuge (and other landowners) was the San Pedro Wildfire of 1996. The San Pedro Wildfire of 1996 burned approximately 4,000 acres on the Refuge floodplain including 2,000 acres of gallery cottonwood forest. This Refuge has installed and widened “fuel breaks” along the floodway. Fires in the floodway have shown that riparian wildfires can “jump” long distances and access to the floodway in this area to utilize heavy equipment to fight these fires is very limited (USFWS 2010b). As a result, the Refuge has created large fuel breaks (approximately 0.25 river miles on average and encompassing the width of the floodway). The Refuge has removed of approximately 43.6 acres of non native woody plant species on the east side of the Rio Grande. This reduced vegetated area is maintained yearly to assure that dense woody vegetation does not become reestablished in the fuel break to the point of creating a fire hazard.

Predators, Predation, Parasites, and Disease

Flycatcher nesting success may be influenced by predation, but predation rates are within the range typical for other open-cup nesting passerine birds (Newton 1998). However, for an endangered species “normal” predation rates may exert disproportionately greater effects on the populations. Predation has been reported as the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In a New Mexico, Stoleson and Finch (1999) attributed 37 percent of nest failures to predation. Predation of flycatcher eggs and nestlings has been documented by the common king snake (*Lampropeltis getulus*) (Paxton et al. 1997; McKernan and Braden 2001; Smith et al. 2003), gopher snake (*Pituophis* spp.) (Paradzick et al. 2000, McKernan and Braden 2001), Cooper’s hawk (*Accipiter cooperii*) (Paxton et al. 1997), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*) (Stoleson and Finch

1999), western screech owl (*Megascops kennicottii*) (Smith et al. 2003), yellow-breasted chat (*Icteria virens*) (Paradzick et al. 2000), and Argentine ants (*Linepithema humili*) (Famolaro 1998). Other potential predators of flycatcher nests include other snakes, lizards, chipmunks, weasels, raccoons, ringtailed cats, foxes, and domestic cats (McCabe 1991; Paxton et al. 1997; Sferra et al. 1997; Langridge and Sogge 1998; McCarthy et al. 1998; Paradzick et al. 2000). Predatory birds such as crows, ravens, hawks, roadrunners, or owls may hunt in flycatcher habitat.

Brown-headed cowbirds (*Molothrus ater*), and to a lesser extent, bronzed cowbirds (*M. aeneus*) effectively function as predators if they remove flycatcher eggs during their parasitism. The cowbird lays its eggs in the nests of several bird species. The “host” bird species will then incubate the cowbirds eggs and raise the young. Because cowbird eggs hatch after relatively short incubation and hatchlings develop quickly, they often outcompete the hosts’ own young for parental care. Cowbirds may also remove eggs and nestlings of host species from nests (or injure nestlings in nests), thereby acting as nest predators (Beane and Alford 1990; Scott and McKinney 1994; USFWS 2002). Cowbirds can therefore have negative effects on reproductive success of flycatcher females and populations.

Several factors influence the degree to which cowbird parasitism is a problem to nesting flycatchers, including: parasitism rate; flycatcher response to parasitism (e.g., nest abandonment); and net reproductive success per female flycatcher. Various factors have increased the range and numbers of the brown-headed cowbird, and potentially its impacts on hosts, including expansion of suburban and agricultural areas into and near riparian habitats, and increases in cowbird access into riparian habitats through narrowed riparian habitat and increased fragmentation. Stumpf et al. (2011) examined whether temporal and habitat characteristics were associated with risk of predation and probability of brood parasitism by cowbirds on flycatcher nests. They found that date of parasitism and an interaction between parasitism status and nesting stage affected the overall nestling survival rates. Additionally, of the variables modeled, distance to habitat edge decreased the odds of parasitism 1 percent for every 1 m from the habitat edge. Nests greater than 100 m from an edge were 50 percent less likely to be parasitized as those on an edge, however, only 22 percent of nests were found at that distance. Stumpf et al. (2011) found that where management and conservation goals include reducing nest losses due to parasitism, restoration of habitat patches that minimize edge and maximize breeding habitat further from edges was recommended. At sites where cowbirds have been documented as important nest predators, controlling cowbirds may be one option, but further study of the link between parasitism and nest predation and the identification of major nest predators at specific sites was warranted (Stumpf et al. 2011). Similarly, the USFWS (2002) recommended that cowbird impacts on some (but not all) populations may be sufficiently large to warrant management efforts. However, rates of cowbird removal efficiencies and nest predation have often not declined significantly in response to cowbird control efforts (Ahlers et al. 2009).

Although all wild birds are exposed to disease and various internal and external parasites, little is known of the role of disease and parasites on most species or populations. Disease and parasites may be significant factors in periods of environmental or physiological stress, during certain portions of a life cycle, or when introduced into a new or naive host (Karstad 1971, Atkinson and

van Riper 1991, van Riper 1991). Flycatcher subspecies are known to be a host to a variety of internal and external parasites. These include blood parasites such as *Leucocytozoon*, *Microfilaria*, *Tyrpanosoma* and *Plasmodium* (Bennett et al. 1982, USFWS 2002); blow fly (*Protocalliphora* sp.) (Boland et al. 1989, Sabrosky et al. 1989, McCabe 1991); and nasal mites (Pence 1975). Most bird species, flycatchers, are susceptible to viral pox (Karstad 1971) and may be susceptible West Nile virus (Flaviviridae) and avian influenzas (Orthomyxoviridae). Although these parasites likely occur in flycatchers, there is no information on what impact they have on infected birds or populations.

Tamarisk Leaf beetles

Threats to flycatchers and flycatcher breeding habitat now include introduced tamarisk leaf beetles (tamarisk beetles; *Diorahbda* spp.). The tamarisk beetles have been and continue to be released in Texas to eradicate tamarisk in the Rio Grande (Knutson 2010). Tamarisk beetles have the potential to spread widely and defoliate large expanses of tamarisk-dominated flycatcher breeding habitat, but the effects of such a widespread loss of riparian vegetation on flycatcher remains unknown. Tamarisk is widely used as breeding habitat by flycatchers without negative consequences to their physiology, immunology, site fidelity, productivity, and survivorship (Sogge et al. 2005). Tamarisk-dominated habitats also vary with respect to breeding habitat quality as do cottonwood and willow dominated habitat (Sogge et al. 2005).

Release of tamarisk beetles within 200 mi (322 km) of the occupied flycatcher breeding range is currently prohibited (USFWS 2002). Initial presumptions that tamarisk beetles would only move “tens of feet per year” and could not survive in the range of flycatcher breeding habitat have proven specious (USFWS 1999, 2011c). In addition to tamarisk beetles moving on their own, they may also be transported accidentally or deliberately by people. Due to the variety of tamarisk beetles being introduced, transported by people, or introduction through biocontrol programs, it is predicted that tamarisk beetles will spread throughout the western United States and into Mexico (Tracy et al. 2008).

The tamarisk beetle however, has become established in multiple watersheds in the southwest, including the at several locations along the Rio Grande, including along the Jemez River, on the Rio Grande on Pueblo of Santa Ana, along Hwy 313 from Tramway Boulevard to Algodones, New Mexico, and along Interstate 25 from Bernalillo, New Mexico, to the Highway 14 bridge over Galisteo Creek in Cerrillos, New Mexico (ISC 2011), along the Rio Grande below and in the City of Albuquerque, New Mexico (A. White, USDA, written comm., 2012), and will likely continue to expand its range (Paxton et al. 2011b). In 2010, tamarisk beetles were released near Presidio, Texas and they have defoliated approximately 20 mi (32 km) of tamarisk along the Rio Grande (Knutson 2010). Tamarisk beetles have been reported along the 45 river miles of the Pecos River, near Pecos, Texas (Knutson 2010). Additionally, tamarisk beetles have also been reported in the Middle Rio Grande near Santa Ana Pueblo, New Mexico (ISC 2011).

Tamarisk beetles have dispersed approximately 30 to 50 mi (50 to 80 km) per year, based on a 200 mi (322 km) expansion over four years in the Colorado River Basin (Tamarisk Coalition 2011). Given the occurrence of tamarisk beetles to the east, north, and south, all within approximately 150 mi (400 km) of occupied flycatcher breeding habitat in the action area, and the apparent long-distance dispersal ability of released tamarisk beetles, it is likely that tamarisk beetles will spread into the action area within one to five years and begin defoliation of tamarisk-dominated flycatcher habitat. Tamarisk beetles' dispersal speed and distance may also increase due to the activities of people.

Tamarisk beetle invasion of tamarisk that supports flycatcher breeding habitat has high potential to negatively affect flycatcher breeding success by changing food abundance, vegetation structure, nest temperature and site humidity (Paxton et al. 2010b). Breeding flycatchers within areas dominated by tamarisk may be negatively affected both in the short and long term. The rate of regeneration or restoration of native cottonwoods and willows relative to the rate of tamarisk loss will be critical in determining the effects of this large-scale ecological experiment.

Drought and Climate Change

Climate change is a long-term shift in the statistics of the weather (including its averages). In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) defines climate change as, "a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer" (Solomon et al. 2007). Changes in climate already are occurring. Examples of observed changes in the physical environment include an increase in global average sea level and declines in mountain glaciers and average snow cover in both the northern and southern hemispheres (IPCC 2007a). At continental, regional and ocean basin scales, observed changes in long-term trends of other aspects of climate include: a substantial increase in precipitation in eastern parts of North American and South America, northern Europe, and northern and central Asia; declines in precipitation in the Mediterranean, southern Africa, and parts of southern Asia; and an increase in intense tropical cyclone activity in the North Atlantic since about 1970 (IPCC 2007a).

Projections of climate change globally and for broad regions through the 21st century are based on the results of modeling efforts using state-of-the-art Atmosphere-Ocean General Circulation Models and various greenhouse gas emissions scenarios (Meehl et al. 2007; Randall et al. 2007). As is the case with all models, there is uncertainty associated with projections due to assumptions used and other features of the models. However, despite differences in assumptions and other parameters used in climate change models, the overall surface air temperature trajectory is one of increased warming in comparison to current conditions (Meehl et al. 2007; Prinn et al. 2011). Among the IPCC's projections for the 21st century are the following:

- (1) It is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas;
- (2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will increase over most areas; and
- (3) it is likely that increases will occur in the incidence of extreme high sea level (excludes tsunamis), intense tropical cyclone activity, and the area affected by droughts in various regions of the world (IPCC 2007b).

Changes in climate can have a variety of direct and indirect ecological impacts on species, and can exacerbate the effects of other threats. Climate-associated environmental changes to the landscape, such as decreased stream flows, increased water temperatures, reduced snowpack, and increased fire frequency, affect species and their habitats. The vulnerability of a species to climate change impacts is a function of the species' sensitivity to those changes, its exposure to those changes, and its capacity to adapt to those changes. Future climate change may present a particular challenge evaluating habitat conditions for species like the flycatcher because the additional stressors may push species beyond their ability to survive in their present locations.

Streams such as the Rio Grande will likely be damaged by a combination of lower water flows, higher water temperatures, silting from erosion and non-native plant invasions (Schmandt 2010). Riparian habitat will likely contract and will be less tolerant of stress. The combination of increased droughts and floods, land use and land cover change, and human water demand will amplify these impacts and promote sedimentation (U.S. Department of Agriculture 2008). Flow and riparian habitat will also be affected by precipitation and evaporation and their seasonality (CCSP 2008; Seager et al. 2007; U.S. Global Change Research Program 2000b, 2000c, 2001). Compared to years before 1950, the snowpack is melting earlier in the year, rain is replacing some snowstorms, and the April snow pack is containing less water (Schmandt 2010). Quantifiable data for water losses due to changes in snowpack still contain much uncertainty; however, riparian habitat losses due to evaporation and salinity or other stressors can be calculated with more confidence. Observed changes in droughts are influenced by climate variability and, increasingly, climate change (Guido 2008; Hidalgo 2009; Nemec 1982; Nitze 2004).

In the recent past, drought has had both negative and positive effects on breeding flycatchers and their habitat, which can provide insight into how climate change may affect flycatchers and flycatcher habitat. For example, the extreme drought of 2002 caused near complete reproductive failure of the 146 flycatcher territories in central Arizona (Smith et al. 2003), and caused a dramatic rise in the prevalence of non-breeding and unpaired flycatchers (Paxton et al. 2007a). While extreme drought during a single year can generate impacts to breeding success, drought can also have localized short-term benefits in some regulated environments. For instance at some reservoirs, drought led to reduced water storage, which increased the exposure of wet soils at the lake's perimeter (USFWS 2011c). Continued drought in those areas allowed the exposed areas to grow vegetation and become new flycatcher nesting habitat (Ellis et al. 2008). These

short-term and localized habitat increases are not likely sustainable with persistent drought or long-term predictions of a drier environment, because of the overall importance of the presence of surface water and elevated groundwater needed to grow dense riparian forests for flycatcher habitat. As a result, long-term climate trends associated with a drier climate will likely have an overall negative effect on flycatcher habitat range-wide.

The future predictions of impacts associated with climate change are similar, and in some respect, an extension or exacerbation of the effects of drought, diversions, and surface and groundwater withdrawal. The potential habitat impact to river flow is similar to the negative effects associated with the water and land management actions that have altered river surface and subsurface flow. Some of the negative impacts to the abundance and distribution of flycatcher habitat were caused by the alteration of peak flow, or the reduction of surface flow, raising floodplains through aggradation and increasing depth to groundwater, and/or lowering of groundwater tables. These impacts, which were key factors in shaping the distribution and abundance of flycatcher habitat, contributed to its listing as an endangered species.

Therefore, it is reasonable to conclude in the Southwest, based upon past negative effects from drought and water or land management actions that the flycatcher and its habitat will be impacted when future drought or low water conditions, including shortages, continue or re-occur. These conditions can be expected to be exacerbated by climate change or future reductions in water supplies and shortages with continued negative impacts to the flycatcher and its habitat.

Exactly how climate change will affect precipitation in the specific areas with flycatcher habitat is uncertain. However, consistent with recent observations of regional effects of climate change, the projections presented for the Southwest predict warmer, drier, and more drought-like conditions (Hoerling and Eischeid 2007; Seager et al. 2007). For example, climate simulations of the Palmer Drought Severity Index (PDSI) (a calculation of the cumulative effects of precipitation and temperature on surface moisture balance) for the Southwest for the periods of 2006 to 2030 and 2035 to 2060 show an increase in drought severity with surface warming. Additionally, drought still increases even during wetter simulations because of the effect of heat-related moisture loss through evaporation and evapotranspiration (Hoerling and Eischeid 2007). Annual mean precipitation is likely to decrease in the Southwest, as is the length of snow season and snow depth (IPCC 2007b). Most models project a widespread decrease in snow depth in the Rocky Mountains and earlier snowmelt (IPCC 2007b). In summary, climate change will result in a warmer, drier climate, and reduced surface water across the flycatcher's range in the Middle Rio Grande as well as in the action area.

V. EFFECTS OF THE ACTION

Regulations implementing the ESA (50 FR 402.02) define the *effects of the action* as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, which will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the proposed action.

The proposed project would remove approximately 43 miles of existing levee (non-engineered spoil bank) adjacent to the Rio Grande Floodway and replace it with engineered levees capable of containing at least the 1%-chance flood event. The current levee plan has been divided into 14 phases and 6 segments that would be constructed over a 20-year period (2012-2032). The functional life of the project is considered 50 years (until 2082). Many aspects of the project are not expected to result in effects on the endangered species and their habitats, and those will not be discussed. The following sections describe the anticipated effects on silvery minnows and silvery minnow designated critical habitat, on flycatchers, on flycatcher designated critical habitat, and on flycatcher proposed critical habitat resulting from the proposed action.

Effects of the Proposed Action on Silvery Minnows and Silvery Minnow Designated Critical Habitat

Summary of the Proposed Action Effects to Silvery Minnows and Designated Critical Habitat

Table 2. Summary of the Proposed Action Effects to Silvery Minnows and Critical Habitat

| Corps BA Proposed Activity | Estimated Incidental Take of Individual Silvery Minnows | Temporary Impacts to Silvery Minnow Critical Habitat (Acres) | Long term Impacts to Silvery Minnow Critical Habitat (Acres) |
|---|---|--|--|
| Temporary River Crossing | 79 | 0.2 | 0 |
| East Side Excavation | 0 | 9.9 | 0 |
| Floodwall Installation and Soil Cement Embankment | 238 | 0.6 | 2.3 |
| Riprap Blanket Installation | 0 | 4.4 | 10.9 |
| Sluice Gates at Brown Arroyo | 119 | 0.3 | 0.3 |
| Earthen Levee and Vegetation Free Zone | 0 | 42.5 | 0 |
| Tiffany Basin Fill | 0 | 0 | 0 |
| Corps Conservation Measures | 0 | 3.1 | (3.1) |
| Column Totals | 436 | 64.0 | 13.5 |

Earthen Levee and Vegetation-Free Zone

The proposed activities associated with this aspect of the project will occur in the dry and will remove 58.9 acres of vegetation, converting 29.5 acres to grasslands, and replanting 16.4 acres riparian vegetation (BA, Table 5.1, page 74). Therefore, the Service estimates that there is a loss of (58.9 acres – 16.4 acres) up to 42.5 acres riparian vegetation within the floodway.

Modification 42.5 acres of a silvery minnow critical habitat PCEs will occur. Removal of vegetation from the installation of the earthen levee and from the levee toe plus 15 ft into the floodway adversely affects vegetation that contributes to silvery minnow PCE water of sufficient quality. The loss of riparian vegetation will change water temperatures during periods when soil and riparian vegetation cooling should normally occur that help maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 C and less than 30 C. Such reduced shade effects may be particularly pronounced when the river channel width is much larger than river depth, and/or during periods of low flow during summer months. Additional effects due to lack of shading, reduction or removal of riparian organic matter for food and substrate will be removed, and use of herbicides and pesticides during operation and maintenance of the levee may adversely affect silvery minnow critical habitat PCEs.

Gains in the floodway near River Mile 111 and River Mile 113 are currently not adequately revegetated with native riparian vegetation to provide shading. The area near River Mile 113 is especially degraded by vehicle access that is expected to continue without additional management. Over time, the quality of shade contributed by the revegetated riparian and upland areas should again contribute to this silvery minnow critical habitat PCE wherever the channel moves further to the East Side, or by natural reestablishment or installation of additional riparian vegetation near the channel edge would contribute to this PCE. Thus, it is currently estimated that this PCE (i.e., supporting water of sufficient quality) would be temporarily adversely affect 42.5 acres of designated critical habitat, until channel edges are recolonized by riparian vegetation of sufficient shading to reduce and/or moderate water temperatures.

Temporary River Crossing

To reach the East Side Excavation from the maintenance road on the west bank, Corps proposes to temporarily cross the Rio Grande on the downstream side of the SADD between the eastern and western banks of the river channel. The crossing would be constructed on one-half of the river at a time. The temporary river crossing will consist of an earthen ramp approximately 300 feet long, with a 15-foot top width and 2.5 horizontal to 1 vertical side slopes. The temporary river crossing would require the placement of six, 60-inch-diameter, 30-foot-long, corrugated metal pipes would allow low flows through the crossing area to maintain a wet river channel. Added to top of the pipes will be approximately 1,000 cubic yards of random fill ranging in depth from two to eight feet.

Assuming the final width of the crossing is equivalent to pipe length, and then the area filled would be approximately 9,000 square feet (0.2 acres). Corps standard best management practices (BMPs) would be followed during dewatering, and placement and then removal of temporary fill. Construction activities in or immediately adjacent the river channel would be

scheduled during low-flow conditions and no impoundment of water would occur. The construction and removal of the temporary crossing may create a minor and temporary increase in turbidity and decreases in oxygen content. Construction of the temporary ramps and road with the temporary river crossing will occur in the dry and small amounts of vegetation will be removed.

Prior to installing the access ramps and temporary river crossing, an estimated 700 linear feet of silt curtains or coffer dam will be installed to exclude silvery minnows from the construction and access areas. The cofferdam will be installed with the bottom secured to the riverbed. Installation of the silt curtain or coffer dam during the temporary crossing and is expected to occur in the river, and will protect against any influx of river water into the project area that could expose silvery minnows to the construction. Corps will coordinate with the Service to ensure that prior to construction activities, any remaining pools of water between the silt curtain or coffer dam and the SADD will be seined or electro-fished by the Service or biologists who have obtained Section 10(a)(1)(A) permits for research to remove silvery minnows captured by the silt curtains or cofferdams.

Short-term adverse effects on silvery minnows may occur due to disturbance during installation of the silt curtains and cofferdams and exclusion of fish species. The Service expects silvery minnows will be present during the closure of the silt curtain area and will be harassed temporarily as a direct effect of the proposed activities (e.g., installation of the silt fences and cofferdams). Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured. Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance.

The Service estimates that harassment during the temporary river crossing will affect up to the average density of silvery minnows reported in the San Acacia Reach since 2003 (see page 25), or as many as 9.8 silvery minnows per 100 m² (equivalent to 9.8 per 0.0247 acres) (or 9.8 RGSM/0.0247acre *0.2 acre = 79) or 79 silvery minnows may be harassed. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and those silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not continue to access the area, silt curtains (or as necessary, cofferdams) should be inspected daily to verify connection between bottom of the BMP used (i.e., silt curtain, coffer dam) and the river substrate.

The Service expects that up to 0.2 acres of silvery minnow critical habitat will be temporarily lost when the road is in place, but its conservation value will return after the temporary crossing is removed.

East Side Excavation

Approximately 12.4 acres along the east bank of the river will be excavated by Corps to provide a wider corridor for flood flows and decrease the velocity and erosive potential of the design flood. Excavation would be scheduled for four months during fall and winter when river flow is relatively low and reliably stable. Terraces would be excavated and the existing bank would be excavated to slope downward to the existing channel. Construction would be scheduled during low-flow conditions and no impoundment of water would occur. Following excavation, the lowest 3.1 acres would become part of the active Rio Grande channel (that is, would be excavated to an elevation below that of the 50%-chance flow event). Silt curtains and cofferdams are not expected to be installed in the water column, and therefore no silvery minnows are expected to be taken.

Modification 12.4 acres of silvery minnow critical habitat will occur. Approximately 1.1 acres of the bankline will be revegetated with willows, and 3.1 acres of lower terrace overbank area will be created, and revegetation with grasses and terrestrial shrubs will occur, resulting in the loss of 9.9 acres of riparian shrub (11 riparian - 1.1 acres revegetated = 9.9 acres riparian vegetation lost) within silvery minnow critical habitat. Silvery minnow habitat qualities on the 3.1 acre floodable terrace were not quantified, and without routine maintenance silvery minnow habitat are not expected to be maintained over the duration of the project. We expect unquantifiable changes in relative shading by vegetation types, and changes in organic matter contributions. This will temporarily affect the PCE of water of sufficient quality. Thus, 9.9 acres of silvery minnow critical habitat will temporarily lose shading. Over time, perhaps as long as two years, the quality of shade contributed by the revegetated riparian and upland area should again contribute to the silvery minnow critical habitat PCEs of water of sufficient quality.

Floodwall Installation and Soil Cement Embankment

On the west side of SADD, the corridor between the western bank of the river and the railroad track is too narrow to accommodate an earthen levee. Therefore, a cement floodwall would be constructed on top of the bank beginning at a point about 400 feet upstream of the SADD and extending 650 feet downstream (~1,000 feet total, minus 50 feet around SADD). The floodwall would be approximately 4 feet high and would be flanked by a roller-compacted concrete or soil cement apron along the downstream portion. Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Riparian vegetation of dense salt cedar does occur along the 1.1 mile area to be constructed as the Soil Cement Embankment.

According to the BA, there is a high potential for bank erosion along the western bank, especially in the large bend area downstream from the SADD. Therefore, a soil-cement embankment would be constructed by the Corps along 5,700 feet of the west bank immediately downstream from the SADD. The soil-cement embankment is not required to prevent flood flows into the floodplain west of the levee, but is required to prevent erosion and undermining of the railroad track (USACE 2012a, page 10). The soil cement embankment will armor the entire slope from levee crest to toe, removing all vegetation and topsoil. The Soil Cement Embankment, together with the soil apron associated with the Floodwall will cover 6,700 feet. The Corps estimates that 0.6 acres of the Soil Cement Embankment will occur in river channel.

During excavation, dewatering, and placement of the soil-cement embankment, conservation measures and construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish. Short-term adverse effects on silvery minnows may occur due to disturbance during reconnaissance, and installation of silt curtains and cofferdams. The Service expects silvery minnows will be present during the closure of the silt curtain area and will be harassed temporarily as a direct effect of the proposed activities (e.g., installation of the silt fences and cofferdams) in approximately 0.6 acres below the ordinary high water mark. Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured.

Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance. The Service estimates that harassment over the project duration will affect up to the average density of silvery minnows reported in the San Acacia Reach since 2003 (page 25), or as many as 9.8 silvery minnows per 100 m² (equivalent to 9.8 per 0.0247 acres) (or $9.8 \text{ RGSM}/0.0247 \text{ acre} \times 0.6 \text{ acre} = 238$) or 238 silvery minnows may be harassed. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not continue to access the area, silt curtains or cofferdams should be inspected daily to verify connection with bottom of BMP and substrate.

During construction, up to 0.6 acres of silvery minnow critical habitat will be temporarily disturbed, but its conservation value will return after the construction is complete and silt curtains are removed. However, during the life of the project, flood flows may overbank in the floodway up to the design elevation of the water surface, at approximately 6 feet above the bottom of the river channel, as indicated in the BA (USACE 2012a, Appendix A, Sheet C-142, C). The width of soil cement embankment that is within those 6 feet depth of inundation is approximately 15 feet. Over the project duration, 70 years, the river channel may migrate within the floodway and widen directly onto the soil cement embankment section, though such migration may be limited by ongoing channel degradation and incision occurring near the SADD. The 70-year project duration prevents a complete understanding of any future channel

alignment with respect to the soil cement embankment. Therefore, the Service assumed that the 6,700 feet in length of the soil cement embankment, with a 15 foot width, and 6 foot depth could be part of the river channel or part of the overbank area subject to flood flows at any time. Therefore, the total area that may occur within silvery minnow habitat, even when such habitat occurs only during flood flows, is equal to, or less than, 6 foot deep, and is 2.3 acres (6,700 feet long x 15 feet wide = 100,500 square feet).

Therefore, the Service estimates that 2.3 acres of Soil Cement Embankment could be inundated with water during flood flows, overbank flows, or associated with channel migration. Substrate of the Soil Cement is largely carbonates of lime, clay, gypsum, silica, alumina, and various oxides and alkalis that are mixed stone and sand to form large slabs and is described by the Corps as having coarse textures (min D50 > 2 feet; BA, Appendix A, Sheet C-142). The predominant bed-material size material in the San Acacia Reach is naturally fine to medium sand with gravel found at confluences with eastside tributaries. The bed material has coarsened somewhat since the early 1970s in the reach downstream from the San Acacia Diversion Dam, although the median bed-material size remains in the medium sand range throughout most of the reach. Silvery minnow critical habitat PCE only includes substrates of sand or silt. Unless completely covered for the duration of the project with sand and silt (D50 = 0.01 to 0.1 mm), which is not expected given the water velocities of up to 17 fps, soil cement installation will permanently change substrate PCE of silvery minnow critical habitat for up to 2.3 acres. When inundated or exposed, soil cement embankment exceed silvery minnow critical habitat PCE for fine substrate.

Soil Cement Embankment may also adversely affect the quality of river runs, in that the velocities associated with it are fast (up to 17 fps) and will likely be relatively uniform, unlike runs of varying depth and velocity. Silvery minnow critical habitat extends up to the existing spoil bank toe (including soil cement embankment) during higher flows (10% occurrence, ~5500 cfs water velocities during such flows are not well known, but are depicted anywhere from 1 to 17 fps, some of which are not suitable flow velocity values for the minnow (at or less than 30 cm/s). Silvery minnow does have a positive association with channel shorelines and high velocities associated with the Soil Cement Embankment may preclude silvery minnow use of shorelines that are in direct contact for approximately 1.2 miles.

Additionally, potential water quality effects by pH (below), the lack of shading after removal of riparian vegetation, loss of riparian organic matter for food or substrate may also adversely affect silvery minnows in this area. The function of topsoil previously on the slope of the soil banks that helps process wastes, pesticides, or chemicals associated with the railroad tracks and its right-of-way, as well as the quality of its runoff may be substantially altered. The number of minnows that may be affected by these water quality changes cannot be accurately estimated.

The addition of cement can produce elevated changes in the pH of waters that flow over it (Steffes 1999). The soil cement should be allowed to cure at least a month before contact with water is allowed, to reduce these effects (Steffes 1999). However, water that has been in contact with the soil cement feature for sufficient time periods should be monitored sufficiently to determine if elevated pH (compared to pH measurements upstream, at SADD, or is above pH = 9

for any period of time) conditions exist or persist over time along the soil cement embankment. If the soil cement embankment is found to elevate pH, then the area affected would reduce the water of sufficient quality PCE of silvery minnow critical habitat and must be quantified.

Riprap Blankets

Corps will install riprap blankets only in the dry. During construction, up to 4.4 acres of silvery minnow critical habitat will be temporarily disturbed, but its conservation value will return after the construction is complete and silt curtains are removed. However, during the life of the project, flood flows may overbank in the floodway up to the design elevation of the water surface, at approximately 6 feet above the bottom of the river channel up the riprap blanket, as indicated in the BA (USACE 2012a, Appendix A, Sheet C-142, B). The width of riprap blanket that is within those 6 feet depth of inundation is approximately 15 feet. Over the project duration, 70 years, the river channel may migrate within the floodway and widen directly onto the riprap section. The 70-year project duration prevents a complete understanding of any future channel alignment with respect to the riprap blankets. Therefore, the Service assumed that the 31,700 feet in length of the riprap blankets, with a 15 foot width, and 6 foot depth could be part of the river channel or part of the overbank area subject to flood flows at any time. In addition, riprap blankets are often deployed in areas subject to flood flows. Additionally, the launchable portion of riprap is designed to erode during flooding to protect the levee toe. Therefore, the total area that may occur within silvery minnow habitat, even when such habitat occurs only during flood flows, is equal to, or less than, 6 foot deep, and is 10.9 acres (31,700 feet long x 15 feet wide = 475,500 square feet).

Therefore, the Service estimates that 10.9 acres of Riprap Blanket could be inundated with water during flood flows, overbank flows, or associated with channel migration. Substrate of the Riprap blanket is largely dark basalt rocks and is described by the Corps as having coarse textures (min D50 > 2 feet; BA, Appendix A, Sheet C-142). The predominant bed-material size material in the San Acacia Reach is naturally fine to medium sand with gravel found at confluences with eastside tributaries. The bed material has coarsened somewhat since the early 1970s in the reach downstream from the San Acacia Diversion Dam, although the median bed-material size remains in the medium sand range throughout most of the reach. Silvery minnow critical habitat PCE only includes substrates of sand or silt. Corps will place small earthen berms in the vegetation maintenance zone adjacent to the riprap to increase sand and silt in the area and contribute to slack water features when the area is inundated. However, unless completely covered for the duration of the project with sand and silt (D50 = 0.01 to 0.1 mm), riprap blankets may permanently change substrate PCE of silvery minnow critical habitat for up to 10.9 acres. When inundated or exposed, riprap blanket construction materials exceed silvery minnow critical habitat PCE for fine substrate. Additionally, when launchable riprap is eroded, it will contribute large sized cobble and boulders to the silvery minnow critical habitat downstream, and levee maintenance operations will require additional installation of launchable riprap to again protect the levee toe.

Additionally, during higher flows, flow velocities along the riprap are depicted from 1 to 3 fps (30 to 90 cm/s) but not all suitable flow velocity values for the minnow (at or less than 30 cm/s). Silvery minnow does have a positive association with channel shorelines. When exposed, the riprap blanket will possibly exceed silvery minnow critical habitat PCE water velocities associated with the riprap materials. The riprap blanket will armor the entire slope from levee crest to toe, removing most vegetation and topsoil and a vegetation free zone will be maintained over the project duration. Additional effects due to heat transfer by riprap blanket, lack of shading, reduction or removal of riparian organic matter for food and substrate will be removed may also adversely affecting silvery minnow critical habitat. The function of topsoil previously on the slope of the spoil banks to process nutrients and wastes, and its runoff, may also be substantially reduced.

Areas containing riprap composed of dark basalt rock may have significantly different heat capacity than the previous soil and riparian vegetated conditions (Ingham 1999). Such dark basalt would be expected to absorb radiant heat during the day and radiant that heat during the night. Such dark basal material, when inundated by water, will warm that water (Ingham 1999). The change in substrate will change the surface water temperatures during periods when soil and riparian vegetation cooling should occur in the silvery minnow critical habitat PCEs for water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1C and less than 30 C. Such effects may be particularly pronounced when the river channel width is much larger than river depth, and during periods of low flow during summer months. The area expected to experience elevated water temperatures associated with the riprap blankets is the same determined as above, 10.9 acres.

Additionally, it is estimated that construction of the deep toe portions of the riprap protection require dewatering for placement. No information regarding the potential effects or magnitude of groundwater excavation by pumping was provided in the BA. The Service estimated that the levee toe would have a maximum depth of 17 feet. For the estimate, the water table in the excavation exists 8' below the levee toe and may need to be evacuated by as much as 20 feet for construction. The depth of the wells is varied based on the depth of the construction excavation. The dewatering is accomplished using a deep well type system consisting of wells placed at 50' on center, therefore, such wells may number as many as 100 per mile of the levee installation. Each well will have an electric submersible pump and discharge piping that will convey excavated groundwater to the riparian area on the overbank or to the LFCC. Approximately 31,700 feet of riprap blankets are to be installed, and groundwater depths will be lowered as much as 12 feet. If the Service assumes the average distance from any pump is approximately 25 feet, based on their spacing, then the minimum volume of water to be evacuated in the riparian area will be approximately 9,525,000 cubic feet (31,750 long * 25 wide * 12 deep =), which is approximately 71,251,948 gallons or 219 acre feet of water.

The depletion of oxygen from the water overlying the bottom sediment is primarily caused by the decomposition of organic matter in sediments. For example, Bexfield (2010) reported that unlike groundwater throughout most of the basin, the water at shallow depths below and near the Rio Grande channel tends to have concentrations of DO near or below detection limits, which probably reflects a greater organic-carbon content for sediments within the Rio Grande inner

valley and, therefore, greater oxygen reduction. Similarly, flooding or sprinkling the riparian area with its organic matter accumulations with excavated groundwater can also result in anoxic water conditions when the runoff discharges into the Rio Grande. Valett et al. (2005) found that flooding of the riparian forest soils (Rio Grande floodplain or “bosque”) increased the rates of respiration during the flood pulse. In floodplains that were *infrequently* flooded, or where the volume of floodwater was inadequate to flush and dilute the area, the inundation of the forest resulted in widespread low DO in the floodwaters that are capable of adversely affecting fish. Contributions from any low oxygen floodwaters into the main channel would be expected to decrease the DO content within the Rio Grande downstream. Flooding by groundwater pumping discharges are not necessarily a “natural phenomena” that should be compared with the natural flood events described by Ellis et al. (1998) and Valett et al. (2005). Groundwater pumping that discharges directly to the Rio Grande or that discharge into the riparian forest and subsequently runoff into Rio Grande may adversely affect silvery minnow within the mixing zone.

The 219 acre feet of groundwater in the MRGV that is excavated and pumped during riprap installation will likely contain very low (<1 mg/L) oxygen (Bexfield 2010). Water that is pumped from anoxic groundwater sources into the Rio Grande could have adverse effects on silvery minnows. When exposed to low oxygen conditions, fish can attempt to compensate by behavioral responses, such as increased use of ventilation of the aquatic surface, change their activity level or habitat use, and avoidance behaviors, though these activities are known to come at a higher energy cost due to physiological stress (Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending excess energy to maintain homeostasis and that some degree of physiological stress will occur (Heath 1995). For example, ventilation rates are often increased, feeding is reduced, movement activity is decreased and increased glycolysis and cortisol release (i.e., a protein associated with physical stress in silvery minnow) can be induced by even short-term, low DO conditions (Kramer 1987; Heath 1995; BCME 1997). Eventually at critically low DO concentrations, fish suffocate and may begin to die. Such hypoxic conditions may also cause a wider range of chronic effects and behavioral responses in fish (Downing and Merckens 1957; Davis 1975; Kramer 1987; Breitburg 1992) that are not fully characterized for silvery minnow.

However, Buhl (2007, 2011a) reported that 50 percent of the test population of silvery minnow larvae (6-days post-hatch in age) died when exposed to water containing DO at 0.7 mg/L (8.7 percent oxygen saturation) during 24- to 96-hr exposures, even when allowed access to the water surface. Buhl (2011a) reported that 50 percent of the test population of adult silvery minnows dies when exposed to water containing DO from 0.8 mg/L (6.7 to 13.2 percent oxygen saturation) after a 3-hr exposure. Buhl (2011a) reported that the highest DO concentration observed without acute mortality to larval silvery minnows (that had no access to the water surface) was 2.4 mg/L (i.e., at 29.8 percent saturation). Buhl (2011a) reported that the highest DO concentration observed without acute mortality to adult silvery minnows (that had no access to the water surface) was 4.4 mg/L (i.e., at 54.3 percent saturation). Those data suggest that larval silvery minnow may be more tolerant than adult silvery minnow to low DO.

Also from the Buhl (2011a) data, the Service expects that adult silvery minnows in water at 25.7 °C (78.3 °F) with DO less than or equal to 4.4 mg/L (i.e., at 54.3 percent saturation) will begin to experience mortality as well as experience adverse effects such as changes in ventilation rates, increased surface water respiration, lack of feeding activity, metabolism changes, or the condition or position of the silvery minnow in the water column will change such that they are at an increased risk of predation. Temperature and pressure can affect the solubility of DO in surface water, and as the activities occur in the winter months, the likelihood of low DO excavated groundwater in mixing zones is reduced in the Middle Rio Grande due to cold water.

Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to aerate groundwater to eliminate impacts to aquatic life, riparian vegetation and river levels to the extent possible. The Corps would immediately confer with the Service if hypoxic conditions occur in the Rio Grande as a consequence of groundwater pumping to the river (including runoff across the floodplain). Therefore, while the Service would expect that silvery minnow could exhibit a stress response due to the loss of oxygen by any excavated hypoxic groundwater discharges; Corps conservation measures assure that such discharges to the Rio Grande will be routinely monitored, and if any discharges to the Rio Grande are found to contain inadequate oxygen below 54.3 percent, or 4.4 mg/L (at 25°C), then immediate management actions shall be taken by Corps to increase aeration or diversion away from river channel. Sprinkling hypoxic discharges onto the riparian zone might not adequately result in sufficient aeration, especially if organic matter continues to depress the oxygen content of such discharges and therefore, these conditions too shall be monitored by Corps. As necessary, with additional information about the volume, timing, location, oxygen content and temperature of the excavated groundwater discharges the mixing zone of such discharges with the Rio Grande could be estimated to minimize the area of the temporary impacts.

Sluice Gate Installation at Brown Arroyo

Brown Arroyo enters the Rio Grande approximately 22.2 river-miles downstream from SADD. Corps determined that a closure structure (consisting of 10 sluice gates in a zigzag pattern) was needed at Brown Arroyo. This gated closure structure would be designed to pass Brown Arroyo flood flows while preventing longer-duration Rio Grande flood flows from potentially breaching the existing interior drainage facilities and is described below.

During excavation and placement of the additional riprap blankets along Brown Arroyo and sluice gates, conservation measures and construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish. Short-term adverse effects on silvery minnows may occur due to disturbance during reconnaissance, and installation of any silt curtains and cofferdams deployed in the water column. The Service expects silvery minnows will be present during the closure of the silt curtain area in approximately 0.3 acres below the ordinary high water mark. The Service anticipates that silt curtains or cofferdams will be used in the river and arroyo channel will reduce turbidity impacts and reduce fish access to construction area. Total acreage affected is estimated at 0.3 acres. Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured.

Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance. The Brown Arroyo confluence is a natural stormwater return with the Rio Grande and may be favored by silvery minnows (USFWS 2011a). The Service estimated that harassment over the project duration will affect up to the average of silvery minnows reported in the San Acacia Reach since 2003 (page 21), or as many as 9.8 silvery minnows per 100 m² (equivalent to 9.8 per 0.0247 acres) (or 9.8 RGSM/0.0247acre *0.3 acres = 119) or 119 silvery minnows may be harassed associated with installation of the Brown Arroyo sluice gates. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not access the area, silt curtains or cofferdams should be inspected daily to verify connection between the bottom of BMP and the substrate.

The gated floodwall structure would be located where the new levee intersects the outfall channel of Brown Arroyo and will permanently remove 0.3 acres of silvery minnow habitat PCEs with installation of additional riprap blankets as well as remove inundated area away from the access by silvery minnows that, at times, contains the hydrologic regime supporting backwaters with fine substrates and water of sufficient quality.

Ephemeral Channels Fill within 15 Feet of Levee Toe

All ephemeral channel runs along the existing spoil banks will be filled in areas within 15 feet of the new levee by the Corps. The overbank area within the floodway tends to slope from the riverbank downwards toward the spoil bank toe. When inundated, flow becomes concentrated along the spoil bank, and, over time, has formed a small channel paralleling the toe. During proposed levee construction, the Corps would fill such depressions within 15-feet of the riverward toe, grade the surface to that of the adjacent overbank, and re-vegetate it with grass species in order to minimize the potential for erosion of the levee toe. This activity will also intentionally and directly contribute to the vertical accumulation of sediment within the floodway. Non-federal local sponsors who assume operation and maintenance activities during the project duration would be expected to do this same ephemeral channel filling activity. The Corps identified local contouring of the ephemeral channels to direct receding overbanking flows back to the Rio Grande channel. All activities would be conducted in the dry and therefore no silvery minnows would be directly affected. This fill is not expected to change the hydrologic regime, affect aquatic habitat, substrates, and provided no fill occurs within or affects the water quality of the river channel, no silvery minnow critical habitat should be affected.

Tiffany Basin Fill

Tiffany Basin Fill activities occur in the dry. Silvery minnow critical habitat is outside the area of the Tiffany Basin and any associated truck routes. Fill does not change the hydrologic regime of the Rio Grande (as Tiffany Basin is currently protected by a spoil bank), affect aquatic habitat, substrates, and provided no fill occurs within or affects the water quality of the river channel, no silvery minnow critical habitat should be affected.

Effects of the Proposed Action on Flycatchers and Flycatcher Designated Critical Habitat**Summary of Project Effects to Flycatchers and Flycatcher Critical Habitat**

Table 3. Summary of the Proposed Action Effects to Flycatcher and Critical Habitat PCEs

| Corps BA Proposed Activity | Estimated Incidental Take of Flycatcher Territories | Temporary Impacts to Flycatcher Critical Habitat (Acres) | Long Term Impacts to Flycatcher Critical Habitat (Acres) |
|--|---|--|--|
| Temporary River Crossing | 0 | 0.2 | 0 |
| East Side Excavation | 0 | 1.1 | 0 |
| Soil Cement Embankment | 0 | 0 | 0 |
| Noise and Traffic Disturbance | 6 | 0 | 0 |
| Riprap Blanket Installation | 2 | 18 | 2.45 |
| Sluice Gates at Brown Arroyo | 0 | 0.1 | 0 |
| Tiffany Basin Fill | 0 | 0 | 0 |
| Earthen Levee Footprint and Vegetation Free Zone ¹ | 3 | 58.9 | 8.41 |
| Levee exacerbated sediment accumulation in floodway ² | Uncertain | 0 | 50-200 |
| Riparian just West of Levee | 0 | 32 | 0 |
| Column Totals | 11 | 94.8 | 60.1-200 |

¹Number of flycatchers estimated to be affected by habitat losses due to levee construction (approx. 8.41 acres/2.7 acres/flycatcher territory = 3 flycatcher territories) yet the establishment of 50.4 acres of flycatcher habitat as proposed by the Corps would minimize this effect.

²Number of flycatchers estimated to be affected by habitat losses due to the increased sediment accumulation and increasing depth to groundwater is relatively certain by 2029 (approx. 53 acres/2.7 acres/flycatcher territory=20) yet the establishment of 50.4 acres of flycatcher habitat as proposed by the Corps would minimize this effect. Estimates are more uncertain by 2079 and require additional study before the Service would be able to issue an incidental take statement. Acreages of critical habitat affected by the increased sediment accumulation and increasing depth to groundwater is uncertain, but currently estimated to range between 50 and 200 acres.

Temporary River Crossing

Corps seasonal and geographic restrictions (along with flycatcher surveys) should limit any effects to flycatchers in the area of the Temporary River Crossing. A portion (0.2 acres) of the temporary river crossing area does occur within the location of flycatcher designated critical habitat (Figure 7). Therefore, 0.2 acres of flycatcher critical habitat PCEs, insect prey populations, will be disturbed temporarily, but its conservation value for flycatchers will return after the temporary crossing is removed and area is wetted and aquatic insects associated with the water and saturated substrate will again emerge to become prey for flycatchers.

East Side Excavation

Corps seasonal and geographic restrictions (along with flycatcher surveys) should limit any effects to flycatchers. Currently, the east side excavation is not inundated until the discharge measured at the San Acacia gage exceeds 25,000 cfs. Vegetation currently consists of riparian shrubs: 5.0 acres of relatively dense salt cedar, 6.0 acres of short sparse salt cedar and coyote willow along the bankline. Following excavation, the lowest 3.1 acres would become part of the active Rio Grande channel (that is, would be excavated to an elevation below that of the 50%-chance flow event). A 1.1-acre band of coyote willow and seep-willow will be planted by the Corps along the new bank-line within these 3.1 acres. The upper 9.3 acres would entail a bench that would be only inundated by the 10%-chance flow event (15,400 cfs at the San Acacia gage), and would be revegetated by upland grasses and native forbs and shrubs. (see Figure 7)

Flycatcher designated critical habitat does occur in the area of the East Side Excavation. However, revised critical habitat is identified only on the 3.1-acre portion of the East Side Excavation, and on the 5.0 acres of relatively dense tamarisk on the bench. The 3.1 acres will continue to provide moist soils that contribute insect prey populations and revegetation with willows will restore 1.1 acres to the value of the PCEs in the critical habitat areas with no net gain or loss in the 3.1 acre area. However, the proposed action would remove a total of 5 acres proposed critical habitat PCEs that include areas of dense riparian foliage and replant it with upland grasses and shrub, thereby removing the PCEs (Figure 7). However, Ahlers et al. (2010) indicated that this bench containing dense tamarisk vegetation is unsuitable as flycatcher habitat. Therefore, no loss of flycatcher critical habitat occurs in the bench area. The 1.1 acres of willows lost and subsequent gains by replanting willows along the edge of the 3.1-acre excavated area do not permanently modify flycatcher critical habitat.

Floodwall Installation and Soil Cement Embankment

Seasonal and geographic restrictions and flycatcher surveys should limit any effects to flycatchers. The cement floodwall and soil cement embankment will be constructed on top of the bank beginning at a point about 400 feet upstream of the SADD and extending 650 feet downstream (~1,000 feet total, minus 50 feet around SADD) and then soil cement embankment will travel 1.1 miles south approximately 20 feet wide. Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Riparian vegetation in the form of dense salt cedar occurs along the 1.1-mile area to be constructed as the Soil Cement

Embankment. Only migrant flycatchers have been detected near there and the river channel nearby (Moore and Ahlers 2011). Flycatcher designated critical habitat is only designated along the southernmost portion of the Soil Cement Embankment area for approximately 0.4 miles, and with a 20 foot width, in 1 acre (2,112 feet long by 20 feet wide). Flycatcher designated critical habitat occurs along the entire length of the Soil Cement Embankment, for 1.1 miles, and with a 20 foot width, in approximately 2.7 acres (5,808 feet long x 20 feet wide). However, the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat (Ahlers et al. 2010).

East Side Excavation and Flycatcher critical habitat

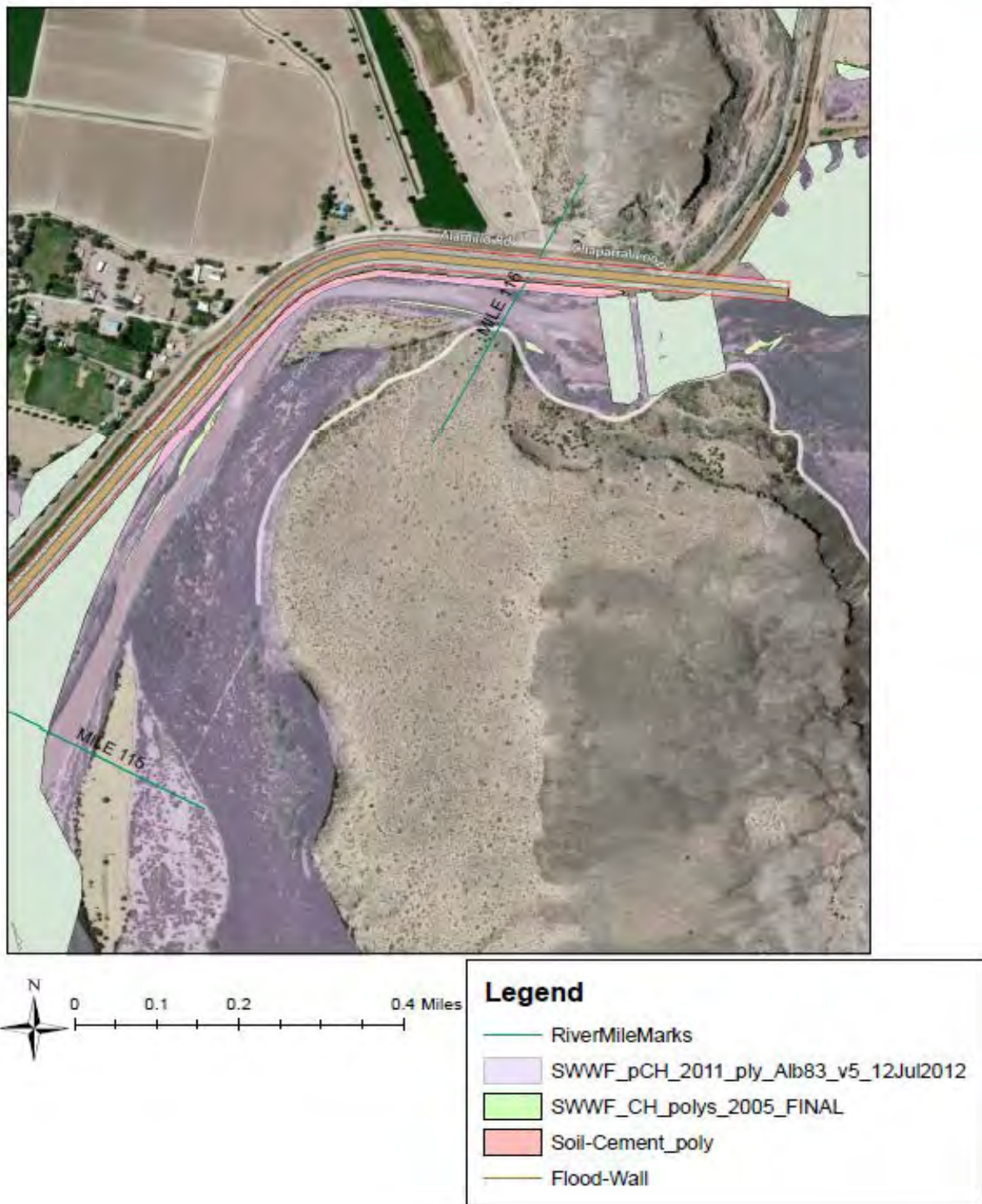


Figure 7. Location of the Temporary River Crossing and East Side Excavation below SADD and 2005 designated critical habitat and recently revised 2013 flycatcher designated critical habitat (i.e., SWWF_pCH_2011_ply_Alb83_v5_12_Jul2012).

Noise and Traffic Disturbance

Levee construction measures may not adequately minimize effects of disturbance (e.g., noise, dust, human activities or traffic) to flycatchers. The effect of the proposed action on traffic patterns along the spoil bank road or LFCC road were not quantified and are expected to increase significantly for the duration of the project (USACE 2012b). The effects of the proposed action on noise in the environment were not quantified and are expected to increase significantly for the duration of the project. The use of the spoil bank, levee, or riparian vegetation to provide adequate buffers between heavy equipment or other traffic and noise along roads within 0.25 miles was not quantified in the BA. Many flycatchers have routinely paired and nested in this area from River mile 77 through River mile 87, and many territories occur within 300 ft of the spoil bank. After consultation with the Service, Corps was able to provide additional information on strict disturbance prohibitions for heavy truck traffic and noise reductions necessary to protect flycatcher breeding behaviors.

Habib et al. (2007) assessed the impacts of noise on ovenbird (*Seiurus aurocapillus*) pairing success and found a significant reduction in pairing success at breeding sites affected by noise and disturbance compared with noiseless areas. Habib et al. (2007) hypothesized that noise interferes with a male's song, such that females may not hear the male's song at greater distances and/or females may perceive males to be of lower quality because of distortion of song characteristics. Therefore, chronic noise pollution could be an important factor affecting bird population distributions including those of flycatchers in the MRGV. The Service assumed that one flycatcher territory would not successfully establish a pair with nest in the area between River-mile 77 to 89, during each year that disturbances were not further ameliorated. As earthen levee installation will occur at a rates of approximately 2 miles per year, total disturbance impacts were estimated to affect at least one female pairing per year, that would not successfully pair with a territorial male due to noise and disturbance in the area between River-mile 77 to 89, or up to 6 flycatcher territories could be disturbed by activity in that 12 miles. While adhering to seasonal and geographic disturbance restrictions for flycatchers to the maximum extent, additional temporal restrictions on heavy truck traffic noise and disturbance during flycatcher breeding season should further minimize impacts to breeding flycatchers. However, flycatchers may nonetheless be adversely affected by traffic noise and disturbance. Therefore, flycatcher surveys will be necessary to determine the effectiveness of Corps conservation measures for heavy truck traffic.

Riprap Blankets

Seasonal and geographic restrictions and flycatcher surveys should limit effect on flycatchers. The loss of suitable flycatcher critical habitat PCEs in 4.9 acres (as described below) may adversely affect up to 2 flycatcher territories (based on 2.7 acres/territory and rounded up— see flycatcher status above). Corps calculated the area of suitable breeding habitat that would be affected by installation of riprap blankets (at 0.42 acres), as well as suitable habitat adversely affected by the vegetation free zone (at 2.03 acres) (i.e., combined total for riprap blanket installation and vegetation free zone is 2.45 acres).

The Service estimated that construction of the deep toe portions of the riprap would require dewatering of groundwater for approximately 6 miles for riprap blanket placement. The Service expects that as much 9,525,000 cubic feet (31,750 long * 25 wide * 12 deep), which is approximately 71,251,948 gallons or 219 acre feet of groundwater will be pumped from the ground below the riparian habitat. The width and length of groundwater extraction area totals 18.2 acres (31,750 * 25 = 793,750 square feet). Replenishment of groundwater and water tables may not be fast, resulting in the dehydration stress of riparian vegetation that may support breeding flycatchers. The duration and distance of the groundwater depletion effects in flycatcher breeding habitat were not estimated by Corps. Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to eliminate or reduce impacts to riparian vegetation to the extent possible. Therefore, the Service identified the area affected (2.45 acres) by installation of the riprap blankets and a similar area (based on width) associated with an initial area groundwater excavation associated riparian stress as estimated by the Service (2.5 acres) for the first riprap installation, along with Corps monitoring to determine effectiveness of their groundwater pumping plan.

The total affected area would be 4.9 acres and the breeding habitat flycatcher PCEs of dense riparian vegetation and insect prey populations may be temporarily adversely affected by groundwater excavation until such adverse effects are quantified and reduced by Corps groundwater pumping plan. If Corps groundwater pumping plan is found not effective, then as many as 18.2 acres could be adversely affected. The Service anticipates that only the initial riprap installation area (~2.5 acres) would be temporarily adversely affected by groundwater pumping, and expect Corps groundwater pumping plan to quantify and ameliorates adverse effects to the remaining areas potentially affected (18.2 – 2.5 acres = 15.7 acres). Therefore, 2.5 acres due to groundwater pumping will be temporarily adversely affected, and as described by Corps, 2.45 acres will be permanently adversely affected by riprap installation and vegetation free zone areas associated with riprap blankets.

The effect of activities that alter groundwater can lead to the reduction of water tables in or below riparian habitats that may support flycatchers (USFWS 2002, Parametrix 2008). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that provide dense riparian habitat for flycatchers and insect prey populations. Receding water levels will likely stress or kill willows, depending on the extent or time they are dewatered by project dewatering activities and including any exacerbation by an ongoing drought. Groundwater pumping has resulted in water table declines along many rivers and can be a major factor in the quality of flycatcher habitat (Briggs 1996; USFWS 2002). The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation. Under stress, dense tamarisk patches can be prone to fire that can directly affect flycatcher habitat (Paxton et al. 2008a). Reduced groundwater and water tables could affect riparian vegetation vigor, quality, and flycatcher survival and therefore, the proposed action may adversely affect flycatchers, flycatcher breeding habitat and potentially result in nest failure or flycatcher egg, nestling or fledgling death and breeding habitat abandonment in areas where substantial groundwater excavation occurs. Whenever flycatcher-breeding habitats become degraded, diminished, or fragmented, flycatchers will likely experience stress, a reduction of

fitness, reduced mating or nesting success, increased time and energy expenditures, or an impaired ability to defend nesting or wintering sites, which could ultimately result in a population reduction. As described above, up to 2 flycatcher territories may be adversely affected by modification of flycatcher breeding habitat. These critical habitats should be reviewed for any changes to the PCEs prior to initiation of construction phases that are associated with riprap installation and groundwater pumping through the year 2032.

Sluice Gate Installation at Brown Arroyo

Seasonal and geographic restrictions and flycatcher surveys should limit effects on flycatchers. The sluice gates and riprap blanket placement along Brown Arroyo occurs in 0.3 acres of designated critical habitat. Riparian vegetation in the form of salt cedar occurs there now. Only migrant flycatchers have been detected near there and the river channel nearby (Moore and Ahlers 2011). While the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat, the inundated area (~0.1 acres) may provide insect prey populations. Temporary construction disturbance of 0.1 acres of inundated area are expected. However, permanent losses of inundated areas providing insect prey populations to flycatchers are not expected by installation of sluice gates at Brown Arroyo. These critical habitats should be reviewed for changes to the PCEs prior to initiation of construction in 2014.

Tiffany Basin Fill

Seasonal restrictions and flycatcher surveys will limit disturbance of flycatchers. However, heavy machinery may nonetheless affect flycatchers through noise and disturbance impacts as described in the Noise and Traffic Disturbance above. No flycatchers have been detected in the Tiffany Basin, although a few surveys have been conducted. Lone male flycatcher territories were detected within 0.25 miles of the edge of the Tiffany Basin Fill in 2006 and 2008, and six other similar territories were detected within 0.5 miles at approximately river-mile 72.5. If a flycatcher territory were to become established within 0.25 mi of the Tiffany Basin, there may be disturbance effects of year round trucking activity if spoil bank is an insufficient buffer.

Spoil from removal of the spoil banks and various excavations will be deposited up to 6.5 feet deep throughout this the Tiffany Basin, permanently rendering it suitable for upland, rather than riparian, vegetation for the duration of the project. The 300-acre spoil deposition area within the Tiffany Basin is currently vegetated by relatively dense stands of salt cedar but is currently unsuitable as flycatcher breeding habitat (Ahlers et al. 2010). The basin lies within the 10%-chance floodplain behind a continuation of the spoil bank. Any floods that may occur would likely affect the riparian vegetation in the Tiffany Basin. Riparian vegetation conditions would also be expected to change in ways described below over the 70-year project duration. For example, invasion by tamarisk beetles, effects of droughts, and potentially, fires, or floods are likely to change quantity and quality of riparian vegetation in the Tiffany Basin (also, see cumulative effects below). Conversion to uplands permanently removes 300 acres from flycatcher critical habitat designated critical habitat. However, the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat (Ahlers et al. 2010). These critical habitats should be reviewed for changes to the PCEs routinely during the duration of activities until 2032.

Earthen Levee Installation, Footprint, Vegetation Free Zone, and Levee Hydrology Impacts

Seasonal and geographic restrictions and flycatcher surveys during levee installation should guarantee no physical disturbance of flycatchers. Corps Operation and Maintenance (O&M) manuals provided to project sponsors that integrate endangered species monitoring and measures protective of endangered species and their habitats during O&M activities should guarantee no physical disturbance of flycatchers or additional habitat impacts in the future. Removal of vegetation by levee footprint and after levee installation, from the vegetation free zone 15 feet into the floodway would adversely affect vegetation that contributes to flycatcher critical habitat PCEs within the floodway. The proposed action removes 58.9 acres of riparian vegetation during levee installation and in vegetation free zone, ultimately converting 29.5 acres of riparian vegetation into grasslands. Corps identifies the revegetation of 16.4 acres riparian habitat as a conservation measure in the BA (Table 5.1, page 74), and the Service assumed these 16.4 acres were part of the 50.4 total acres later identified by Corps (2012e). Corps estimates that a total of 8.41 acres is currently suitable for flycatcher breeding habitat and provides the entire flycatcher critical habitat PCEs. Of those 8.4 acres, 5.7 acres of suitable flycatcher habitat are adversely affected by the vegetation free zone and 2.7 acres are adversely affected by the area of installation of the new levee in an area called the footprint. Permanent removal of suitable flycatcher habitat without offsetting measures, minimization and/or mitigation of PCEs modify flycatcher critical habitat. Corps proposed action (USACE 2013) will provide 50.4 acres of suitable flycatcher habitat to offset levee installation footprint and vegetation free zone impacts.

The effects of the levee, the inspection and slurry trenches, the levee drainage features, the levee interception of precipitation, and the subsequent reduction of riparian areas inside the floodway on groundwater levels, if any, were not quantified in the BA (USACE 2012a) or in the SEIS (USACE 2012b). Changes in groundwater levels or changes in hydrology can be detrimental to riparian vegetation and riparian vegetation establishment (USFWS 2002; Parametrix 2008). Whether the slope of the new levee, including its riprap blankets, and soil cement embankment, or vegetation free zones alter the amount of precipitation or infiltration under, on, or around the levee, and extent those hydrological changes may have on groundwater levels are unknown.

Levee Exacerbation of Sediment Accumulation and Impacts to Riparian Vegetation

Over the duration of the San Acacia Levee Project, the accumulation of sediment in the floodway exacerbated by the levee will result in a further increase in the physical separation of riparian vegetation from groundwater that is necessary for flycatcher habitat. The existing spoil bank, as well as the proposed San Acacia Levee Project levee, both restrict the lateral extent of the floodplain into the Floodway by approximately 50 percent its former width below Highway 380. With the floodable area approximately reduced by half (i.e., into the managed floodway) and with a historically similar sediment load, dynamics, and deposition by the Rio Grande and its tributaries, the vertical accumulation of sediment approximately doubles in elevation/height. Over the last 50 years, floodway elevations have raised by up to 12 feet as exacerbated by the spoil bank. However, once replaced, the proposed San Acacia Levee Project will continue to raise it up to 11 feet more in the San Acacia Levee Project area (USACE 2012b). Note that wherever the spoil bank remains, and for however long it lasts, the spoil bank would continue to

exacerbate sediment accumulation within the floodway into the future (USACE 2012d, e). Nonetheless, the functional life of the spoil bank, given its current height, and the height of flood flows, suggests that the spoil bank is not likely to last beyond 2040. Spoil bank integrity is currently maintained by Reclamation and MRGCD (USBR 2001; 2012), but heroic measures are inadequate to prevent its likely breaching or eventual overtopping (USACE 2012b and Table 3).

Even with an entirely unobstructed or unconstrained floodplain (i.e., both the historical and active floodway), the natural mass load of sediment delivered by the Middle Rio Grande would likely spread out, aggrade, and accumulate in vertical height approximately half (0.25 feet/year) that of the projected accumulation depth of approximately (0.5 feet per year) of the spoil bank/levee (USACE 2012b). The Service discounted the natural vertical accumulation of floodway height (Table 4) from its effects analysis. Nonetheless, with average depth to groundwater ranging from 8 to 12 feet below the average height of the floodway elevation, it suggested that riparian vegetation was currently stressed (Table 5) and increasing the height of the floodway would continue to stress riparian vegetation and result in flycatcher habitat loss in the future. Service estimates of sediment accumulation in the San Acacia Project Area by 2079, suggested high sediment accumulation (Figure 8).

The effect of earthen levees indirectly adversely affects the depth to groundwater in or below riparian habitats that may support flycatchers (Van Cleave 1935; Crawford et al. 1993; USFWS 2002, 2013; Parametrix 2008; Isaacson 2009; Gunning 2010; Merritt and Bateman 2012). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that provide dense riparian shrub habitat for flycatchers and insect prey populations. Receding groundwater levels will likely stress or kill willows, depending on the extent or time they are dewatered and including any exacerbation by an ongoing drought and the effects of water operations and flood control activities upstream. The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation and reduced seedling establishment and survival of native riparian vegetation.

Assuming an average increase in the depth to groundwater in the future (Table 4) and an average increase in floodway sediment accumulation resulting terrace heights that may no longer be able to be colonized by riparian vegetation that constitutes of flycatcher habitat, the Service estimated the total future flycatcher habitat loss to be approximately 2,010 acres, and attributed between 195 to 460 acres of that flycatcher habitat loss due to specifically to the San Acacia Levee Project and the remainder to the spoil bank (Table 7). (See USFWS 2013 for additional information). Corps (2012e; Corps 2013) and the Service have identified uncertainties associated with these analyses and have described a method of analysis to arrive at a more certain estimate of flycatcher habitat impacts due to sediment accumulation. Corps and the Service (Corps 2013) agreed that the likely range of impacts to flycatcher habitat would range from 50.4 to 200 acres, subject to additional analyses to reduce the uncertainties associated with these estimates.

In addition, there are an uncertain number of flycatchers and flycatcher habitats affected by levee exacerbated sediment accumulation, for the duration of the project. We have estimated that the continued accumulation of sediment in the floodway will result in the loss of flycatcher habitat over time. Though we can estimate this loss, it there are many factors affecting sediment

accumulation which are uncertain. The sediment accumulation is not anticipated to result in the loss of flycatcher habitat until (1% by 2019, 3% by 2029, or 28% by 2079), and it is reasonably certain to result in the loss of habitat that would sufficiently support 20 flycatcher territories by 2029 (i.e., 3%, ~53 acres/2.7 acres/flycatcher territory). As a proposed conservation measure for this project, the Corps is proposing to create between 50.4 acres of replacement habitat that would partially offset the 2029 loss. The Corps has also proposed additional scientific analysis, monitoring and modeling to increase certainty in the loss expected by 2079 with offsetting measure equal to that loss described and to support further ESA consultation.

In summary, sediment accumulation in the floodway, particularly in the southern reaches below Highway 380, is exacerbated by levees' constriction of the floodable area, and will raise the floodway elevations above the water table that is necessary to sustain and establish robust riparian vegetation throughout the floodway that is used by flycatchers. Over the San Acacia Levee Project duration, the floodway elevation will increase up to 12 feet in some locations but the range of sediment accumulation and subsequent estimates of impacts to flycatcher habitat in the future were uncertain. Additionally, sediment accumulation and groundwater levels will likely be influenced by regional droughts, groundwater withdrawals, and by land use, water operations and flood control activities in the upstream watershed. Nonetheless, the potential loss of up to 200 acres of suitable flycatcher habitat, identified as critical to its long term survival and recovery (USFWS 2005, 2011c) within the floodway could adversely affect flycatcher survivorship and recovery in the San Acacia Reach.

Riparian vegetation as it currently exists will likely change over the duration of the proposed action. Therefore, the qualities of riparian habitat that may be affected and would be expected to change over the next 70 years. The current flycatcher habitat suitability determinations used by the Service in this Opinion (Ahlers et al. 2010) would be expected to change over time.

Table 4. Corp (2012b) estimate of sediment accumulation in the San Acacia Levee Project Area, amount of sediment accumulation exacerbated by spoil bank/levee, and Service estimates of ground water depths currently and as compared to expected sediment accumulation heights in the future.

| San Acacia Reach Sites as listed in Table 3.1 of the USACE (2012b) GRR/SEIS II, Page 3.8, which quantifies changes in sediment accumulation in the action area. | Service <i>discounted</i> 50 percent of sediment accumulation as was described by USACE (2012b) to 1/2 height of increase over next 50 years due to natural conditions. This column reflects only half of the sediment accumulation, in feet. | Using groundwater levels in the San Acacia Reach as described by SSP&A (2002), Parametrix (2008), Beman (2012), the Service estimated groundwater levels (in feet below surface) and extrapolated that range for depth to water for the average Floodway elevation (Note: ground water fluctuations, drought, & reduced flow would increase depth to GW) (feet). | Service added column 2 (left) for 50% of sediment accumulation to the average depth to ground water below the Floodway to estimate its depth within 50 years, in feet. |
|---|---|--|--|
| 17 BdA | 0.9 | 8 to 12 | 9 to 13 |
| 18 BdA | 1.3 | 8 to 12 | 9.3 to 13.3 |
| 19 BdA RM 78 | 2.2 | 8 to 12 | 10.2 to 14.2 |
| 20 BdA | 3.1 | 8 to 12 | 11.1 to 15.1 |
| 21 Tiff | 3.8 | 8 to 12 | 11.8 to 15.8 |
| 22 SM | 5.6 | 8 to 12 | 13.6 to 17.6 |

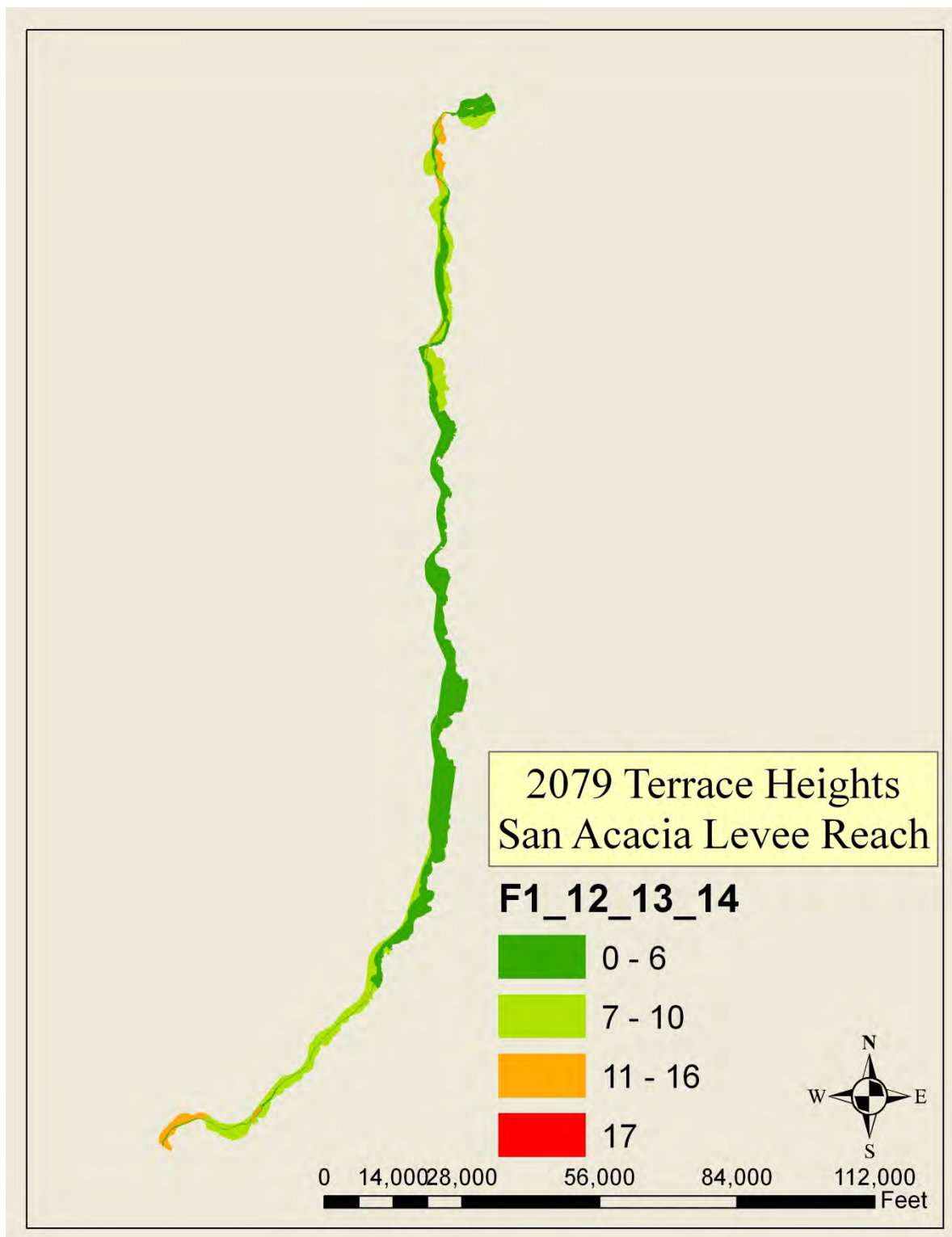


Figure 8. Service estimate of sediment accumulation by location and height over 50 years. Note: 'F1_12_13_14' legend means elevation in feet, with colors representing ranges of floodway terrace height elevations in feet due to sediment accumulation.

Table 5. Depth to groundwater for native and nonnative riparian vegetation in the Middle Rio Grande resulting in healthy, stressed, crown dieback or mortality, in feet.

| Riparian species & separation from groundwater effect | Healthy (feet) | Stressed (feet) | Crown dieback (feet) | Mortality (feet) |
|--|----------------|-----------------|----------------------|------------------|
| willows | 0 – 6.5 | 6.6 – 7.4 | 7.5 – 9.8 | > 10 |
| cottonwood | 0 – 7.4 | 7.5 – 9.8 | 9.9 – 16.4 | > 16 |
| tamarisk | 0 – 7.4 | 7.5 – 8.2 | > 8.2 | > 100 |
| (Sources: Horton et al. 2001, Parametrix 2008, Caplan et al. 2012) | | | | |

Table 6. Average (and 95% confidence interval) of Percentage of flycatcher habitat 50 m near channel areas or in overbanking areas (see Ahlers et al. 2010 for methods, description, subreach site locations and names)

| Amounts of suitable and moderate flycatcher habitat (Ahlers et al. 2010) for each subreach within San Acacia Reach | Percentage Suitable or Moderate flycatcher habitat outside 50 m or during overbanking | Percent Suitable or Moderate Habitat within 50 m near channel or during overbanking | Percentage flycatcher habitat outside 50 m of river channel or overbanking areas |
|--|---|---|--|
| SV/LJ-Suitable (S) | 7 | 2 | 71 |
| SV/LJ-Moderate (M) | 19 | 8 | 56 |
| San Acacia S | 2 | 1 | 50 |
| San Acacia M | 9 | 4 | 56 |
| Escondida M | 7 | 5 | 29 |
| BdA S | 1 | 1 | 0 |
| BdA M | 16 | 16 | 0 |
| Tiffany S | 4 | 3 | 25 |
| Tiffany M | 5 | 2 | 60 |
| San Marcial S | 16 | 10 | 25 |
| San Marcial M | 14 | 6 | <u>57</u> |
| Average and 95 percent confidence interval of suitable or moderate flycatcher habitat outside of 50m and outside of overbanking. | | | 40% (95%CI = 195 to 460 acres) |

Riparian Areas West of Levee

Flycatchers are known to use riparian areas in and near the LFCC for migratory stopover habitat (Yong and Finch 1997). Extension of the levee toe and the vegetation free zone toward the LFCC on the west side is expected to affect riparian vegetation there. The Service estimates that approximately 32 acres of riparian vegetation may be adversely affected and could affect flycatchers that utilize the area. Corps has committed to flycatcher surveys along this west edge to determine the potential effects to nesting flycatchers in this area.

The Service (USFWS 2013) designated approximately 9,333 acres of critical habitat for the flycatcher in the historical floodplain west of the levee. With construction of the engineered levee, the historical floodplain is effectively removed west of the levee by the proposed action from any flood events greater than 1 percent chance event (e.g., a 500-year flood). Therefore, the proposed action potentially removes all possible flooding or avulsion events contributing to flycatcher critical habitat and may foster development, including groundwater pumping, on the historical floodplain west of the levee. Substantial increases in urban and residential development within the historical floodplain may lead to additional groundwater wells, as such individual wells are often not monitored, and cumulative effects of individual wells to groundwater levels are unknown. Riparian critical habitat in this area was dependent on the location of the nearby river channel, floodplain soils, subsurface water, floodplain shape, and was driven by the wide variety of high, medium, and low flow events. Flooding was part of flycatcher critical habitat there as it occurred at periodic frequencies that recharged aquifers, deposited and moisten fine floodplain soils, which conditions created seedbeds for riparian vegetation germination and growth within the critical habitat boundaries. Soils from historic flooding still contribute to the nutrients, minerals, and substrate used by riparian vegetation and agricultural crops that grow there today. Reduction or elimination of flooding has the potential for impoverishing flood recession cropping, groundwater recharge, natural vegetation, wildlife and livestock population in the flood plain that are adapted to the natural flood cycles.

Critical habitat areas to the west of the levee were based upon data sources including delineating the lateral extent of the riparian zones for using the National Wetlands Inventory (NWI) digital data from the mid 1980's, 2001, 2002; and (2) Federal Emergency Management Agency (FEMA) 1995, Q3 100 year flood data, and other data. With construction of the engineered levee, the historical floodplain is effectively removed west of the levee by the proposed action from any flood events greater than 1%. In addition, development will progress without the burden of individual flood insurance or implementing regulations. Therefore, the proposed action removes the majority of all possible flooding or avulsion events, and fosters development, including groundwater pumping, that may affect flycatcher critical habitat on the agricultural floodplain west of the levee. The current status of flycatchers in the Middle Rio Grande Management Unit, its abundance (>300 territories) and suitable habitat (Ahlers et al. 2010) within the floodway suggests that the lack of flooding in the historical floodplain and its critical habitat are not, at this time, critical to the recovery of the flycatcher regionally. Additionally, flycatcher critical habitat in the historical floodplain may be sustained by other sources of water or groundwater.

San Acacia Levee Project Effects Summary:

Construction, operation and maintenance of the levee project are expected to result in adverse effects to silvery minnow and 13.5 acres of its designated critical habitat. Adverse effects to individual silvery minnow (436 individuals estimated to be affected) in the form of harassment are anticipated. In addition, the Service has predicted adverse changes to PCEs of designated critical habitat will result from the earthen levee, vegetation free zone, soil cement embankment, riprap blanket, sluice gates at Brown Arroyo, the East Side Excavation, and the temporary river crossing, some of which are temporary and 13.5 acres others permanent. The Corps is proposing to create 2.2 acres of in-channel silvery minnow habitat.

Construction, operation and maintenance of the levee project are expected to result in adverse effects to 11 flycatcher territories and between 60 to 200 acres of its suitable and designated critical habitat. The Corps has proposed to create 50.4 acres of flycatcher breeding habitat which will assist in minimizing adverse effects of the levee project. Traffic near flycatcher territories is estimated to adversely affect 6 territories. The loss of habitat due to groundwater effects resulting from the riprap blanket installation is anticipated to adversely affect 2 flycatcher territories and permanently impact 2.45 acres of designated flycatcher critical habitat.

Construction of the levee and the vegetation-free zone will result in the temporary loss of 58.9 of critical habitat and permanent loss of 8.41 acres. The Service's analysis predicted the potential of the levee to alter flycatcher critical habitat PCEs of up to 460 acres as a result of the sediment accumulation in the floodway and riparian vegetation separation from groundwater. However, the uncertainty associated with this analysis in attempting to predict effects of the proposed levee that are decades into the future calls for a monitoring, modeling and continued scientific analysis. The effect of the levee-induced sediment accumulation on flycatcher critical habitat to the year 2029 is more certain and is within an estimated range of 50 to 200 acres.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. This Opinion summarizes, in general terms, the types of activities that are likely to occur, based on continuation of existing actions and likely future development.

Human Population, Land, and Water Use Changes

Population in the Middle Rio Grande Valley (including Socorro) has doubled every twenty years since the 1950s and will continue to grow. Growth has been driven by high birth rates, higher infant survival rates, and immigration. Other factors include increased border and military installation activities, increased manufacturing in a free trade zone, and increased availability of agricultural and industrial jobs, as well as affordable housing, a high standard of living, and availability of freshwater (Schmandt 2010). Increasing urbanization and development within the historic floodplain would continue to eliminate remnant riparian areas located outside the levees, while putting increased pressure on the riparian habitat and wildlife (USFWS 2001, 2011c).

Irrigated land will likely shrink in the MRGV due to market forces and urbanization. Because irrigation uses over 75 percent of surface river water a reduction in agricultural land use may have important impacts on future water demands. Changes in irrigation use may also have significant impacts on surface and groundwater hydrology, agricultural economic activities, and population growth. Drought resistant or less water-intensive crops and improved irrigation techniques (e.g., lining of canals, use of modern sprinkler systems, floodwater capture) may result in substantial surface water conservation without economic loss (Schmandt 2010). Municipalities will also likely increase water conservation, reuse, recycle, and improve water quality, as well as repair of leaky distribution systems (Schmandt 2010). Regional water markets may be developed to facilitate the transfer of water rights from agricultural to municipal uses (Schmandt 2010), particularly during multiyear droughts (Schmandt 2010). Overall water quality may continue to decline and salinity increase such that riparian habitats may be further imperiled. Methodologies for developing flow recommendations and managing rivers could result in some improvements to salinity levels and sustained riparian vegetation. Desalinization of water may also become cost effective or agricultural production may also be severely constrained and reduce salt load in the future (Schmandt 2010).

General cumulative effects will likely continue to include:

- Increases in development and urbanization in the historical floodplain that result in reduced peak flows because of the flooding threat. Development in the floodplain makes it more difficult, if not impossible, to transport large quantities of water that will overbank and create low velocity habitats for silvery minnows and flycatchers.
- Increased urban use of water, including municipal and private uses. Further use of surface water from the Rio Grande will reduce river flow and decrease available habitat for the silvery minnow and flycatcher.
- Human activities that may adversely impact the flycatcher by decreasing the amount and suitability of habitat include dewatering the river for irrigation; increased water pollution from non-point sources; habitat disturbance from recreational use, and urban development.
- Wildfires and wildfire suppression in the riparian areas along the Lower Rio Grande may have an adverse effect on flycatchers. Wildfires can be common occurrence in the bosque (riparian area) along the Rio Grande. The increase in wildfires has been attributed to increasingly dry, fine fuels and ignition sources. The spread of the highly flammable plant, tamarisk, and drying of river areas due to river flow regulation, water diversion, lowering of groundwater tables, and other land practices is largely responsible for these fuels. Wildfires have the potential to injury silvery minnow and destroy flycatcher habitat.

- The removal of non-native vegetation, such as salt cedar by tamarisk beetles will adversely affect the amount of available flycatcher habitat in the short term. In areas where non-native trees are removed and replaced with native vegetation as part of a restoration project, habitat may be created. Where phreatophyte removal or tamarisk beetle defoliation is not followed by restoration, habitat for the flycatcher and support of the PCEs of silvery minnow critical habitat will be reduced.
- The effect global warming may have on the flycatcher and silvery minnow is still unpredictable. Higher temperatures lead to higher evaporation rates that may reduce the amount of runoff, groundwater recharge, and lateral extent of rivers such as the Rio Grande. Increased temperatures may also increase the extent of area influenced by drought (Lenart 2003). Increased temperatures will directly affect silvery minnow development (Davis and Lusk 2012)

The Service anticipates that these conditions and types of activities will continue to threaten the survival and recovery of the silvery minnow and flycatcher by reducing the quantity and quality of habitat through the continuation and expansion of habitat degrading actions.

VI. CONCLUSION

After reviewing the current status of the silvery minnow and the flycatcher, the environmental baseline for the action area, the anticipated effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Corps proposed action of construction, operation and maintenance of the Rio Grande Floodway, San Acacia to Bosque del Apache Unit, as proposed in the May 8, 2012 BA and subsequent correspondence with the Service during this consultation, is not likely to jeopardize the continued existence of the silvery minnow or the flycatcher. In addition, the project is not likely to adversely modify or destroy designated silvery minnow critical habitat or designated flycatcher critical habitat. We expect the level and type of take associated with the project is unlikely to appreciably diminish the population of the silvery minnow or the flycatcher in the San Acacia reach or for the species as a whole.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Corps so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The action agency has a continuing duty to regulate the activity covered by this incidental take statement. If Corps (1) fails to assume and implement the terms and conditions or (2) fails to require adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)].

Amount or Extent of Take Anticipated

The Service anticipates incidental take of 436 silvery minnows (79+238+119) in the form of harassment during installation of silt curtains or cofferdams for construction of the temporary river crossing, the floodwall and soil cement embankment, and the sluice gates at Brown Arroyo.

The Service anticipates take of 6 flycatcher territories in the form of disturbance due to traffic within 0.25 mile of flycatcher territories, and take of 2 territories in the form of disturbance caused by loss of suitable habitat due groundwater changes during riprap blanket installation. Loss of 8.41 acres of flycatcher critical habitat due to construction of the levee and the vegetation-free zone will result in an additional loss of 3 flycatcher territories. Between 50 and 200 acres of additional flycatcher critical habitat is projected to be lost due to levee-exacerbated sediment accumulation in the floodway, but this effect is minimized by the creation of 50.4 acres of flycatcher breeding habitat. Therefore, no incidental take was assigned to this loss of habitat.

Effect of Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the silvery minnow or the flycatcher. The proposed action is likely to have adverse effects on individual silvery minnows but those effects are not anticipated to result in any long-term consequences on the population. Incidental take of silvery minnows will result from harassment and harm of any individuals that may occupy habitats disturbed by deployment of silt curtains or cofferdams or even heavy equipment or that may occupy critical habitat that becomes permanently or temporarily lost. The proposed action is likely to have adverse effects on individual flycatcher territories but those effects are not anticipated to result in any long-term consequences on the population. Incidental take of flycatchers will result from disturbance of territories caused by the noise and dust created by heavy equipment and other traffic on adjacent dirt roadways and degradation or loss of suitable habitat over the duration of the proposed action.

Reasonable and Prudent Measures

The Service believes the following Reasonable and Prudent Measures (RPMs) are necessary and appropriate to minimize impacts of incidental take of flycatcher and silvery minnow due to activities associated with the proposed action.

1. Conduct flycatcher and flycatcher habitat surveys and monitor flycatcher critical habitat.
2. Minimize take of flycatchers due to construction activities occurring within 0.25 mile of occupied habitat.
3. Minimize take of flycatchers due to habitat degradation or loss caused by the proposed action.
4. Minimize take of silvery minnows due to construction activities.
5. Reduce likelihood of take of silvery minnow and flycatcher for project duration (currently until 2082).

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the RPMs described above. These terms and conditions are non-discretionary.

To implement RPM 1, Corps shall:

- 1.1. Conduct flycatcher protocol surveys covering the floodway west of the Rio Grande channel from 0.5 mile north of San Acacia Diversion Dam to the San Marcial railroad bridge. These surveys shall commence in the breeding season prior to anticipated construction in a given segment of the action area, and shall continue annually through the third breeding season following construction in each given segment (USACE 2012d).
- 1.2. Conduct flycatcher protocol surveys performed by biologists that possess a Section 10(a)(1)(A) permit, and report to the Service in accordance with the permit. (USACE 2012d).
- 1.3. Monitor groundwater pumping for construction activities in the floodway to determine its effect on riparian habitats. (USACE 2012d).
- 1.4. Conduct flycatcher protocol surveys within critical habitat located within 0.25-mile west of the Low Flow Conveyance Channel canal, from the San Acacia Diversion Dam to Tiffany Junction. These surveys will be conducted for a single breeding season, and should be commensurate in time to flycatcher surveys within the floodway for a given construction-segment of the action area. (USACE 2012d).
- 1.5. The Corps will monitor groundwater-surface water interaction and dynamics in the San Acacia reach per 3.5 below; and will assist resource management agencies in the analysis, modeling, planning, and adaptive management of activities relating to future sediment, habitat, and flow issues.

To implement RPM 2, Corps shall:

- 2.1 Construction may occur throughout the calendar year; however, no construction would be performed within 0.25 mile of occupied flycatcher territories during the breeding season; that is, from the date of the second protocol survey of the season through August 15. Construction traffic may continue year-round along the LFCC maintenance roads.
- 2.2 Each Corps construction contract will include requirements that ensure the contractor's compliance with all pertinent terms and conditions of the Service's Incidental Take Statement; pertinent information on the presence or locations of flycatchers; and requisite work restrictions. As needed, the Corps will formally update pertinent information and requirements throughout the duration of the contract. (USACE 2012d).
- 2.3 If traffic or other proposed action activities do occur within the 0.25-mile radius of a breeding territory, then those territories/nests will be monitored according to standard protocols, but at least every two weeks to determine continued occupancy.

To implement RPM 3, Corps shall:

- 3.1 Coordinate development of 50.4 acres of flycatcher habitat with the Service's NMESFO prior to implementation. If habitat is proposed to be developed on National Wildlife Refuge lands, the Corps will also coordinate with the Service's Refuges. If applicable, the Corps will obtain Refuges approval before proceeding.
- 3.2 Prepare and implement a flycatcher habitat mitigation and adaptive management plan for the San Acacia Reach. The plan will include Best Management Practices to minimize effects to the flycatcher, and its critical habitat. The plan will identify specific areas for habitat management with a schedule for completing development of 50.4 acres of dense riparian shrub habitat possessing primary constituent elements of critical habitat. The habitats shall be developed prior to, or immediately following, the loss of critical habitat due to specific construction activities of the proposed action. The plan will be reviewed and approved by the Service and should be completed by December 31, 2014. (USACE 2012e).
- 3.3 Assure that the water used for dust suppression will not harm nesting or migrating flycatchers. (USACE 2012d).
- 3.4 Utilize results obtained during implementation of RPM 1 to limit effects on flycatcher habitat.
- 3.5 The uncertainty surrounding the impact of the levee project-exacerbated sediment accumulation on flycatcher habitat will be clarified through a program of monitoring, modeling, and scientific analysis conducted by the Corps once construction has started. Methods for calculating the habitat area that may be at risk due to aggradation follow:
 - 3.5.1 Mitigation of habitat is described as creating or managing the number of acres to provide a functioning flycatcher habitat for the duration of the project. Creation of newly built habitat is not necessarily required.
 - 3.5.2 Calculation Methods: Corps, in coordination with the Service's New Mexico Ecological Services Field Office shall determine distance from levee that vegetation may be affected by increased depth to the water table.
 - 3.5.3 Corps shall project surface aggradation from USACE's 50 yr projections and estimate the future ground elevations.
 - 3.5.4 Corps shall compare information gained from 3.5.1 and 3.5.2 with most current suitable and moderately suitable habitat information.
 - 3.5.5 Based on a program of monitoring, modeling, and scientific analysis, the Corps shall determine and develop commensurate mitigation for the duration of the project.

To implement RPM 4, Corps shall:

- 4.1 Coordinate development of silvery minnow habitat with the Service's NMESFO prior to implementation. If habitat is proposed to be developed on National Wildlife Refuge lands, the Corps will also coordinate with the Service's Refuges. If applicable, the Corps will obtain Refuges approval before proceeding.

- 4.2 For bankline construction, the Corps, in coordination with the Service, will establish and implement a design standard applicable to deployment of erosion control screens (e.g., silt curtains or wattles, etc.) that insure protection of water quality. For in-river construction, the Corps, in coordination with the Service, will establish and implement a coffer dam design standard applicable to prevent fish access to the construction site and insure protection of water quality. Cofferdams and erosion protection screens will be inspected daily to maintain the connection to the substrate and will be removed following construction. (USACE 2012d).
- 4.3 Prepare and implement a silvery minnow habitat mitigation and adaptive management plan for the San Acacia Reach. The plan will include Best Management Practices for construction to minimize effects to the silvery minnow, and its critical habitat. The adaptive management section will provide recommendations for silvery minnow and habitat monitoring focused on reproduction and recruitment. The plan will identify specific areas for habitat management with a schedule for completing construction of a minimum of 13.5 acres of silvery minnow critical habitat possessing the primary constituent elements. The habitats shall be constructed prior to, or immediately following, the loss of critical habitat due to specific construction activities in the proposed action. The plan will be reviewed and approved by the Service and should be completed by December 31, 2014. (USACE 2012d,e).
- 4.4 Fish sampling will be conducted by biologists that possess a Section 10(a)(1)(A) permit, and report to the Service in accordance with the permit. (USACE 2012d).
- 4.5 Monitor groundwater pumping for construction activities in the floodway to determine its effect on aquatic habitats (USACE 2012d). Oxygen content in excavated groundwater will be measured to ensure no hypoxic conditions occur. The Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to aerate groundwater to eliminate impacts to aquatic life, riparian vegetation and river levels to the extent possible. The Corps would immediately confer with the Service if hypoxic conditions occur in the Rio Grande as a consequence of groundwater pumping to the river (including runoff across the floodplain). (USACE 2012d).
- 4.6 Assure that water used for dust suppression does not reduce water availability for silvery minnow; assure the quality of water used for dust suppression; use water from sources other than those used by silvery minnow; if water must be removed from the low flow conveyance channel, assure no impact to the low flow conveyance channel pumping program. (USACE 2012d).
- 4.7 Monitor pH as part of the soil cement construction. Samples from the river channel, within the coffer dam, and on the soil cement to detect changes due to soil cement through the curing process. Monitoring data will be reported to the Service to demonstrate complete curing of the soil cement will not alter river pH upon contact with the surfaces. (USACE 2012d).
- 4.8 Prepare and implement a study to document water temperature daily and seasonally upstream and downstream where river is in contact with riprap. Water temperature conditions associated with the riprap blankets will be monitored upstream and downstream daily and seasonally to determine the water temperature effects associated with the riprap in silvery minnow habitats. The Corps will evaluate the

thermal effects of riprap and slackwater habitat on river water temperature to ensure no detrimental effects to silvery minnow occur.

- 4.9 Each Corps construction contract will include requirements that ensure the contractor's compliance with all pertinent terms and conditions of the Service's Incidental Take Statement; pertinent information on the presence or locations of silvery minnow; and requisite work restrictions. As needed, the Corps will formally update pertinent information and requirements throughout the duration of the contract. (USACE 2012d).
- 4.10 Report to the Service finding of any injured, rescued, or dead silvery minnows associated with project activities (USACE 2012d).

To implement RPM 5, Corps shall:

- 5.1 Develop an Operation and Maintenance (O&M) manual, in coordination with the Service's NMESFO, prior to turning the project over to the project sponsors
- 5.2 Include in the O&M manual requirements that the project sponsor integrates endangered species monitoring and measures protective of endangered species and their habitats during its O&M activities; recommendations to coordinate with Service's NMESFO regarding any emergency repair work; and coordinates with and reports to the Service's NMESFO on its O&M activities. These requirements will include standard Corps' best management practices (BMPs), the BMPs developed specifically for this project, and avoidance periods. (USACE 2012d).

For all RPMs, Corps shall monitor the implementation of the RPMs and their associated terms and conditions, and report their status to the Service's NMESFO annually, no later than February 20 for the previous calendar year's report. Ensure that the Service receives electronic copies of all reports and plans related to implementation of these RPMs and terms and conditions, including but not limited to species monitoring/surveying, habitat and water quality monitoring, flycatcher habitat management plan, silvery minnow habitat management plan, and site specific construction and mitigation designs. These reports should reference Consultation # 02ENNM00-2012-F-0015 and should be sent to the email address nmesfo@fws.gov or by mail to the New Mexico Ecological Services Field Office, 2105 Osuna Road NE, Albuquerque, New Mexico 87113.

Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following conservation activities:

1. Encourage adaptive management of flows and conservation of water to benefit silvery minnow, flycatcher, New Mexico jumping mouse, and yellow-billed cuckoo habitat in the Middle Rio Grande.
2. Enhance spring flows in the Middle Rio Grande.
3. Return LFCC low flows to the river channel.
4. Increase the frequency and duration of flooding events in the floodway.
5. Time high flow with native plant species seed dispersal.
6. Implement recommendations for the San Acacia Reach (Parametrix 2008).
7. Increase groundwater storage (focus on east side of the Floodway).
8. Establish management tools to work within climatic variation of water availability expected within the life of the San Acacia Levee Project.
9. Work to secure long-term water sources to support habitat restoration activities in the Middle Rio Grande.
10. Restore channel function, form, and processes.
11. Maintain the cottonwood bosque and re-establish cottonwood regeneration.
12. Address floodplain structural encroachment.
13. Monitor groundwater levels, as needed
14. Create wetlands and marshes within the Floodway.
15. Lower abandoned terraces within the Floodway.
16. Enhance groundwater storage and interaction.
17. Remove jetty jacks.
18. Eliminate structural limitations on flooding.
19. Manage future development in the floodplain.
20. Conduct surveys for Pecos sunflower in advance of construction cycles and use the information to support its conservation.
21. Investigate opportunities to transplant Pecos sunflower into project area.

RE-INITIATION NOTICE

This concludes formal consultation on the action(s) described in the May 9, 2012 Biological Assessment of Rio Grande Floodway, San Acacia to Bosque del Apache Unit. As provided in 50 CFR § 402.16, re-initiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or designated critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or designated critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any activities causing such take must immediately cease pending re-initiation.

Julie A. Alcon, Acting Chief

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In future correspondence on this project, please refer to consultation number 02ENNM00-2012-F-0015. If you have any questions or would like to discuss any part of this Opinion, please contact Lori Robertson at (505) 761-4710 or Joel D. Lusk of my staff at (505) 761-4709.

Sincerely,

A handwritten signature in black ink, appearing to read 'Wally Murphy', with a long horizontal flourish extending to the right.

Wally Murphy

cc:

Assistant Regional Director, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM
Regional Section 7 Coordinator, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM

Middle Rio Grande Conservancy District, Albuquerque, NM (Attn: Subhas Shah)

New Mexico Interstate Stream Commission, Santa Fe, NM (Attn: Estevan Lopez)

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Julie A. Alcon, Acting Chief

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In future correspondence on this project, please refer to consultation number 02ENNM00-2012-F-0015. If you have any questions or would like to discuss any part of this Opinion, please contact Lori Robertson at (505) 761-4710 or Joel D. Lusk of my staff at (505) 761-4709.

Sincerely,

A handwritten signature in black ink, appearing to read 'Wally Murphy', with a long horizontal flourish extending to the right.

Wally Murphy

cc:

Assistant Regional Director, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM
Regional Section 7 Coordinator, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque,
NM

Middle Rio Grande Conservancy District, Albuquerque, NM (Attn: Subhas Shah)

New Mexico Interstate Stream Commission, Santa Fe, NM (Attn: Estevan Lopez)

U.S. Fish and Wildlife Service,
New Mexico Ecological Services Field Office
San Acacia Levee Project
Biological Opinion

Appendix A. San Acacia Levee Project Action Area. Source: USACE 2012b. With- and Without-Project Floodplains for the 1%-chance Event. Figures 5.3 through 5.9 in, Draft General Reevaluation Report and Supplemental Environmental Impact Statement II: Rio Grande Floodway, San Acacia to Bosque del Apache Unit, Socorro County, NM. U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, New Mexico.

Figure 5.3 Without- and With-Project Floodplains Index

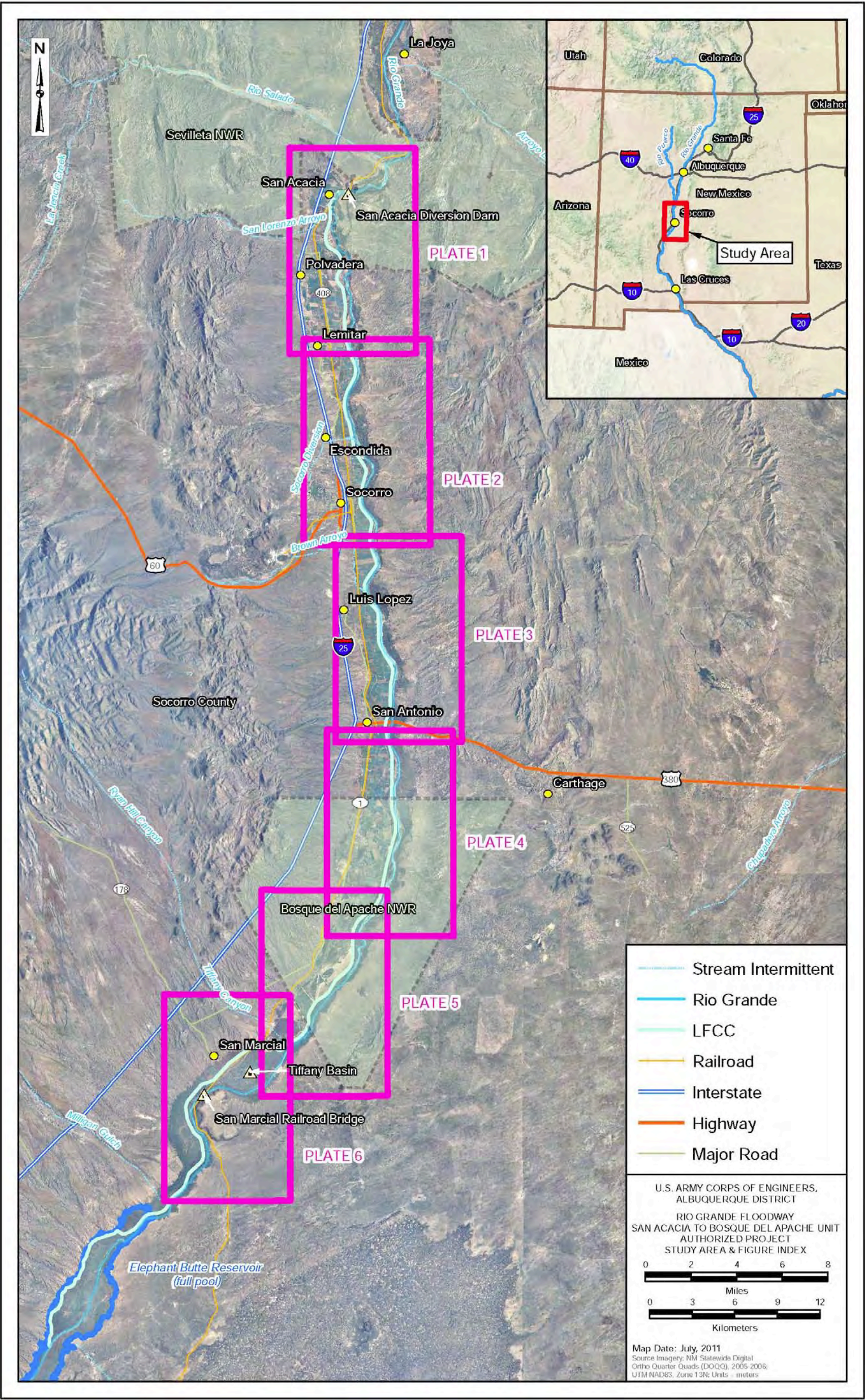


Figure 5.4 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

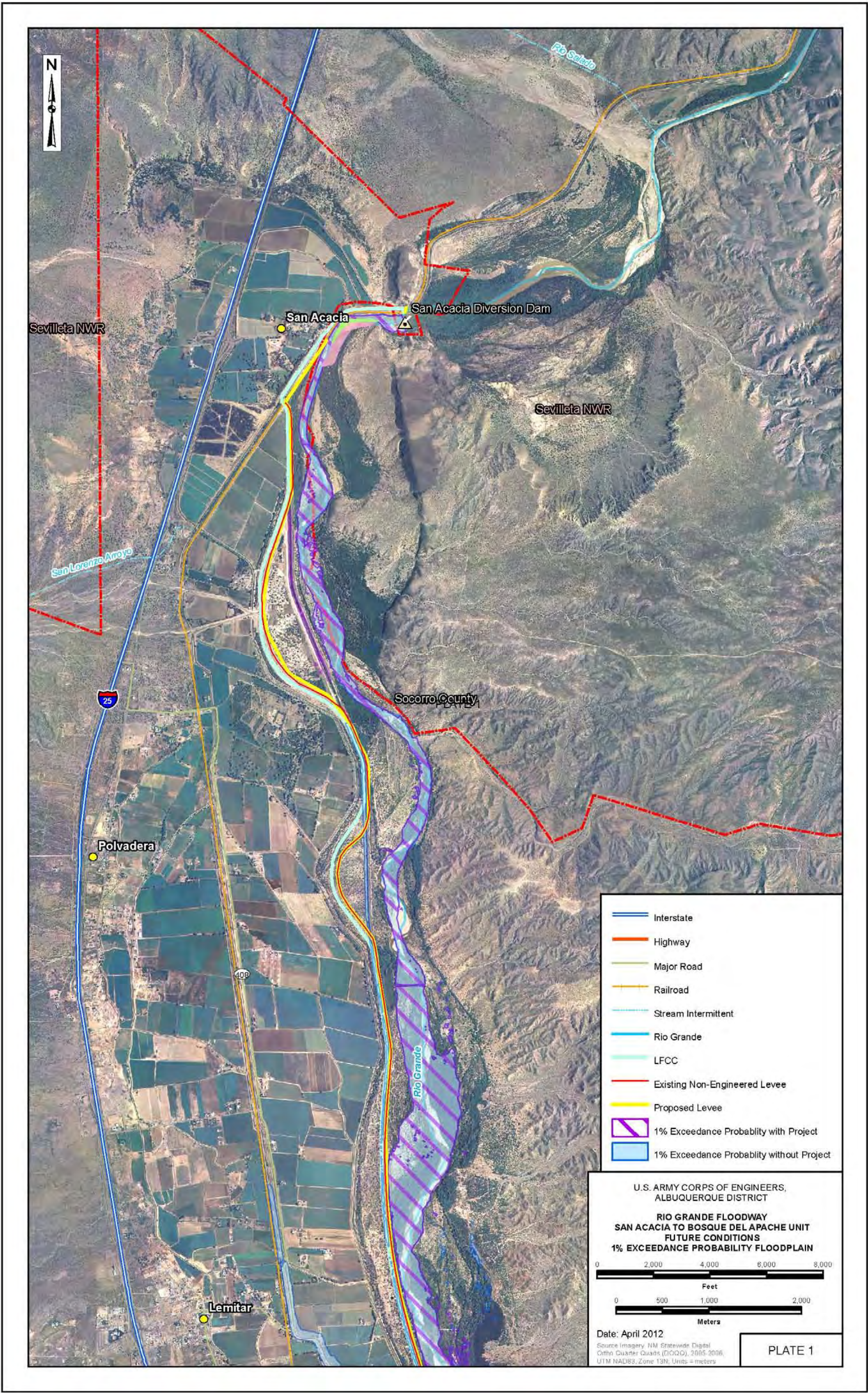


Figure 5.5 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

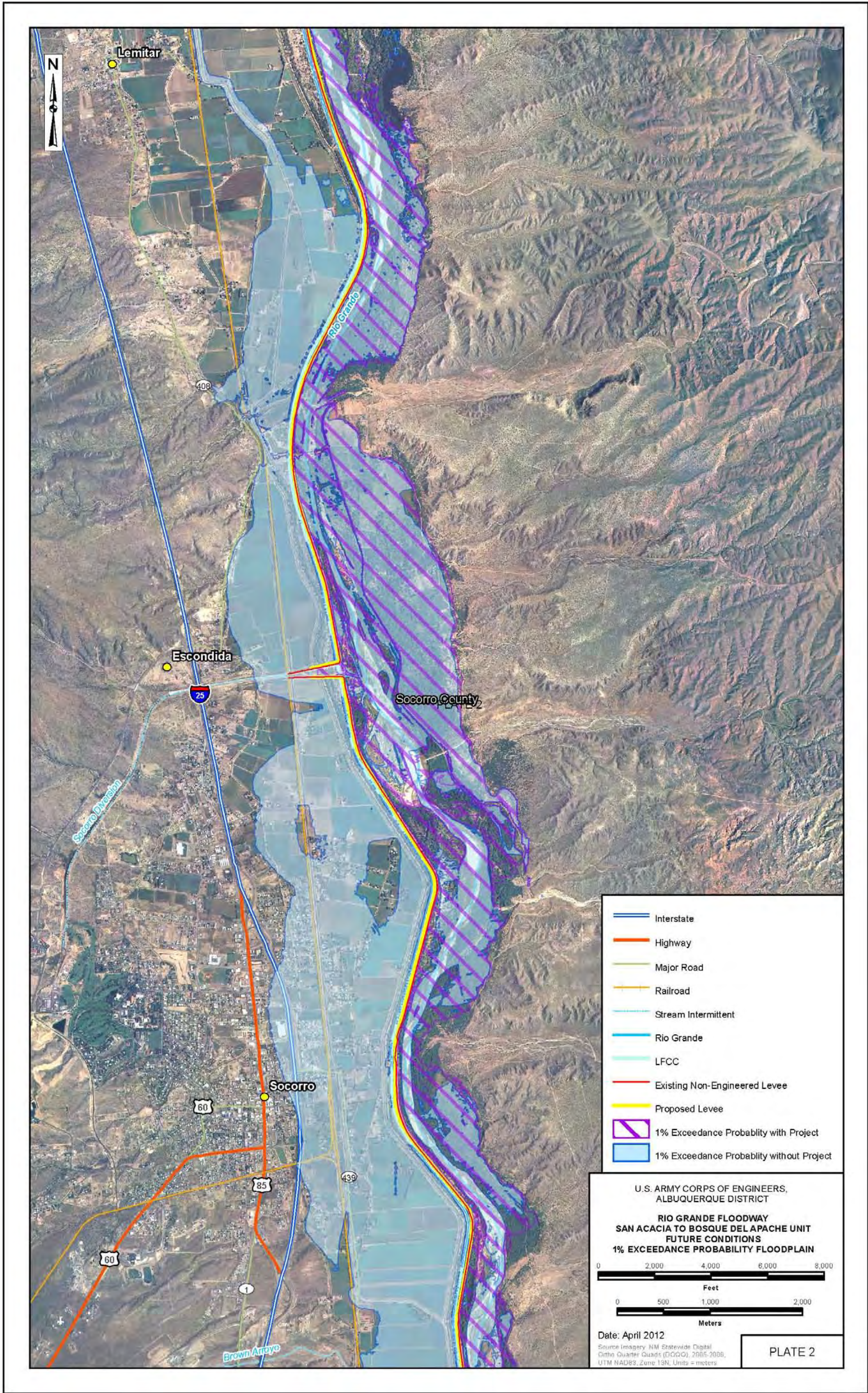


Figure 5.6 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

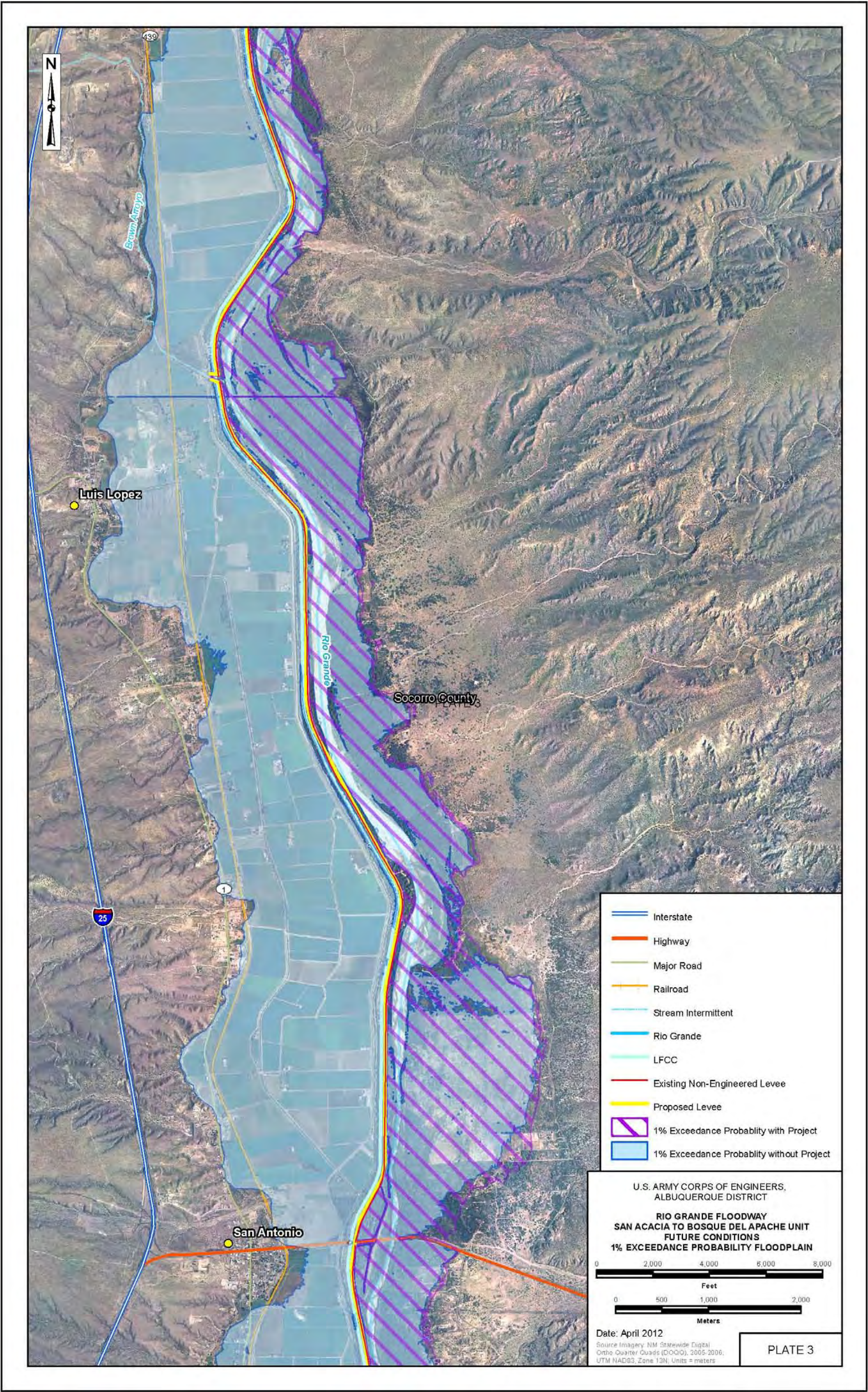


Figure 5.7 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

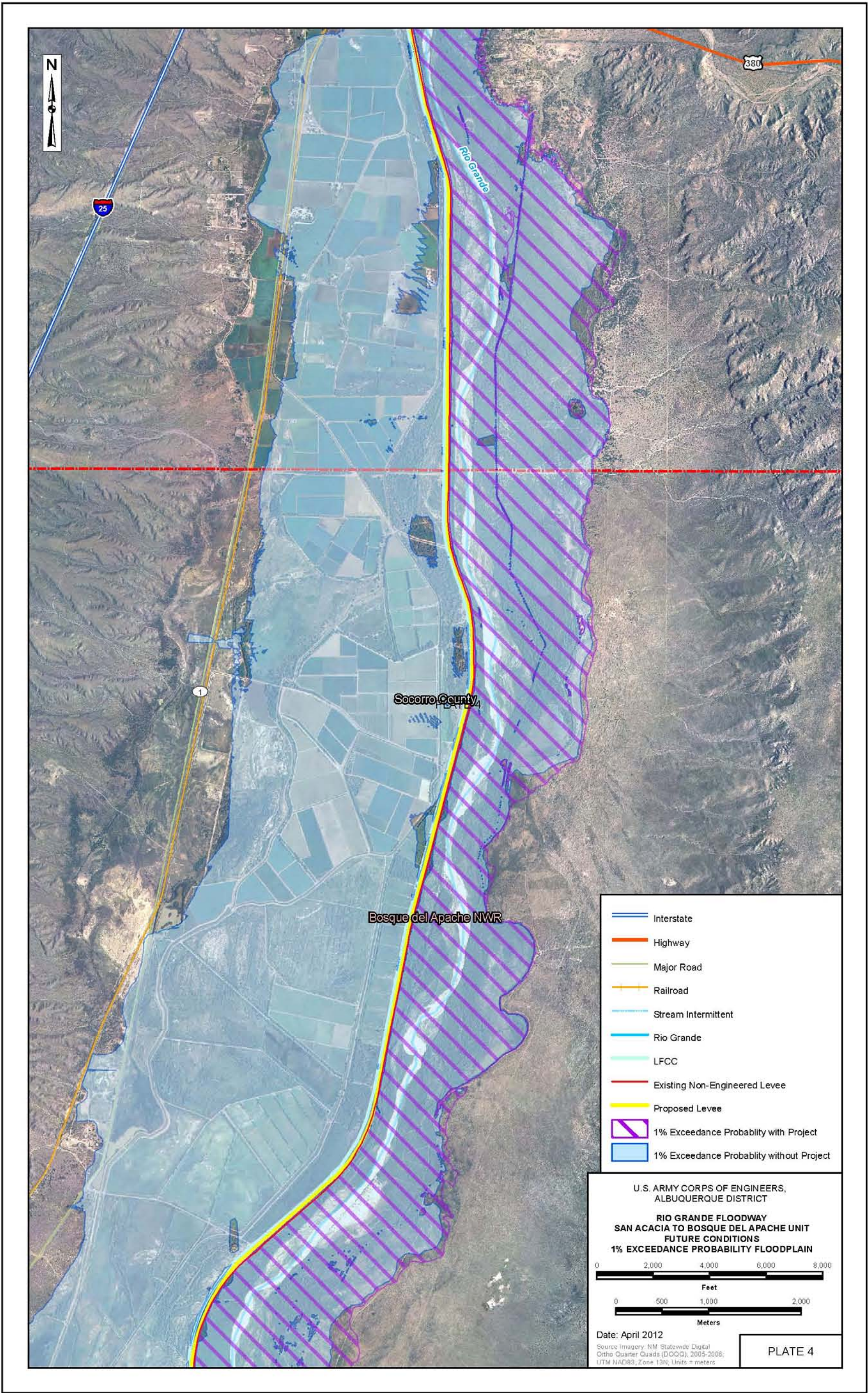


Figure 5.8 Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

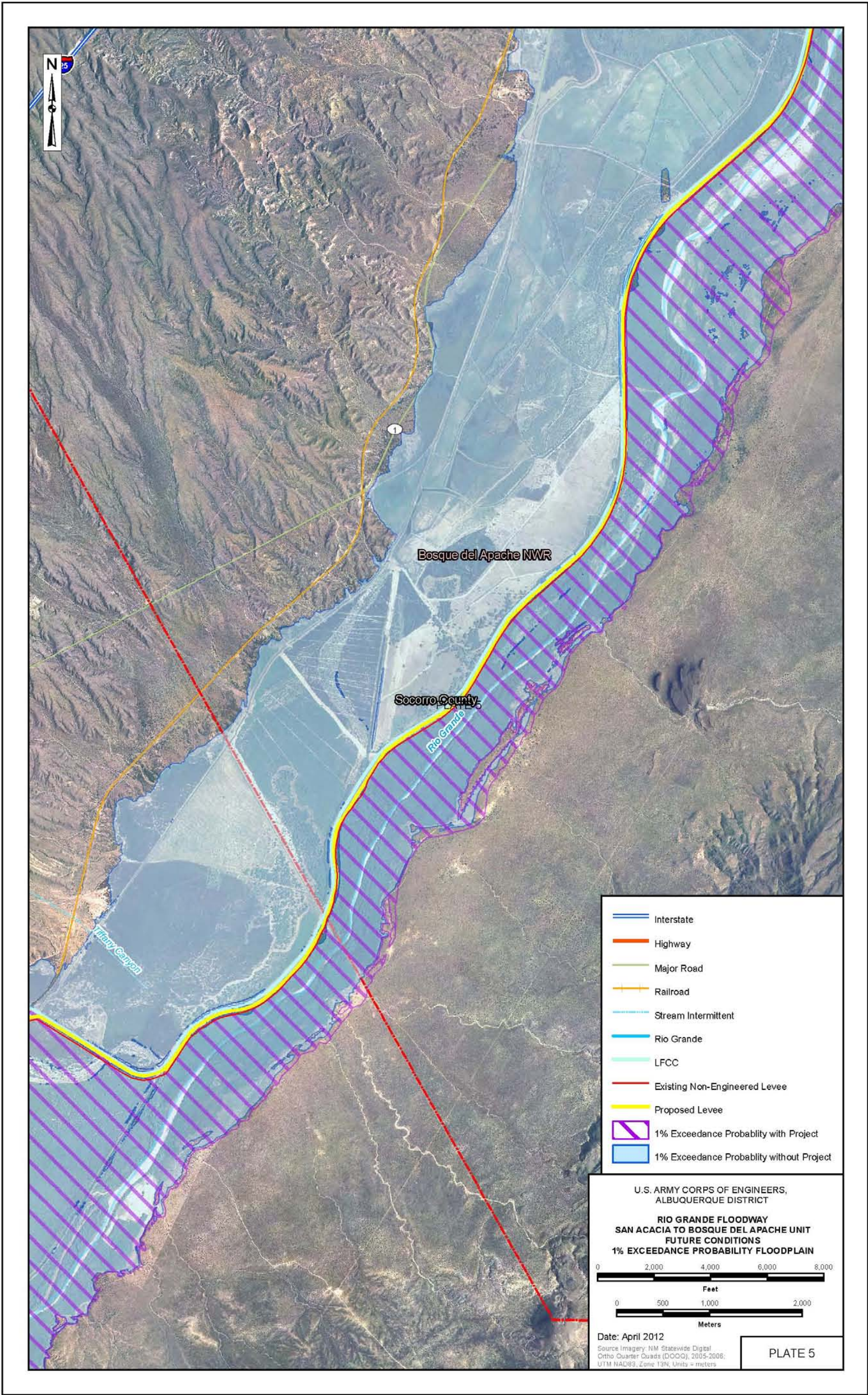
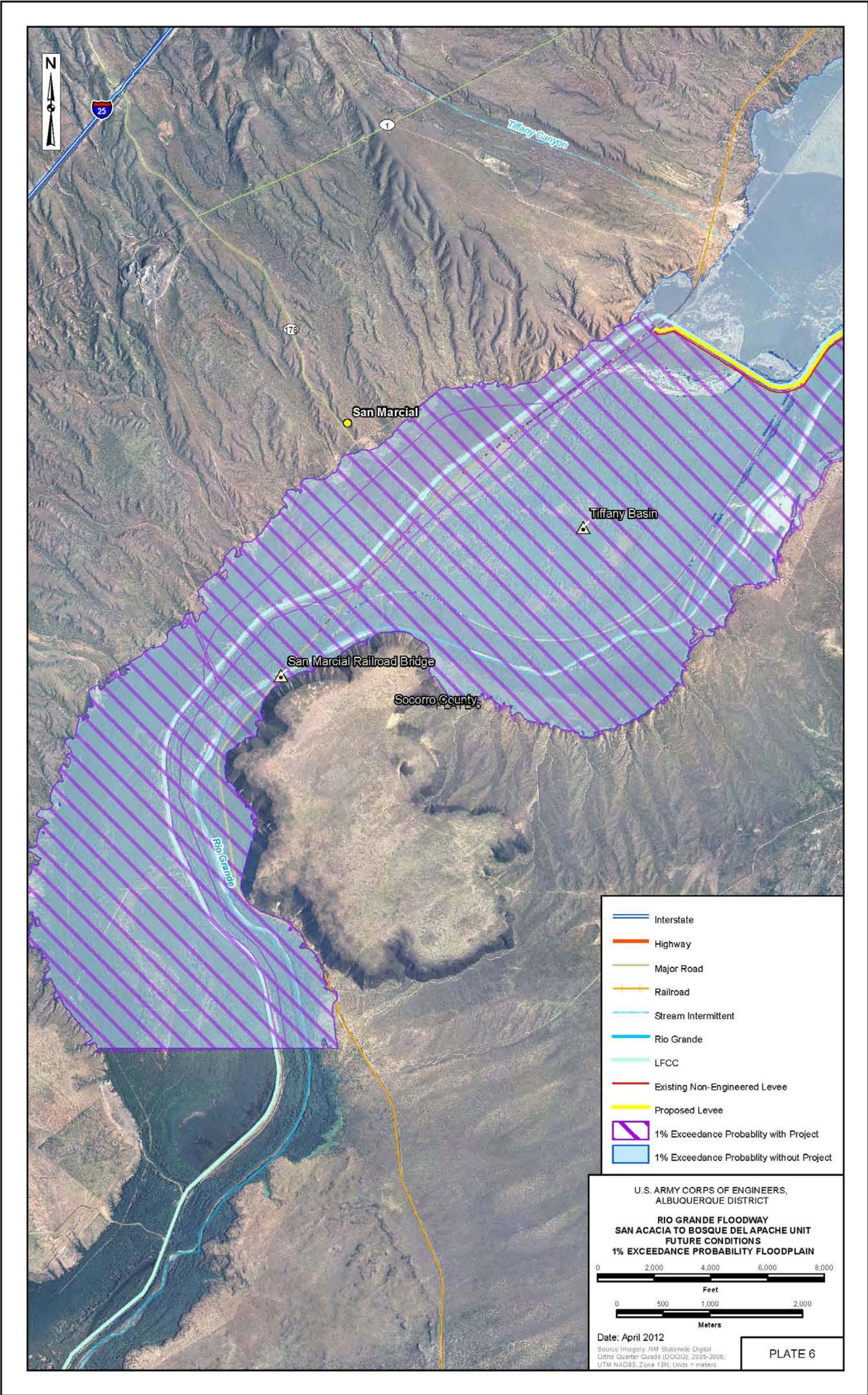


Figure 5.9 Without-Project Floodplains and With-Project Floodplains (Alternative at Base Levee + 4 ft levee height)



U.S. Fish and Wildlife Service,
New Mexico Ecological Services Field Office
San Acacia Levee Project
Biological Opinion

Appendix B. 2012 Status of the Southwestern Willow Flycatcher in the Middle and Lower Rio Grande Management Units. Moore, S. D. 2012. WIFL Survey Site Summary Table 2012. November 8, 2012, 3:48AM, email with attachment titled, "WIFL Survey Site Summary Table 2012," from S.D. Moore, U.S. Bureau of Reclamation, Denver, Colorado, to D. Hill, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Bureau of Reclamation Summary of 2012 WIFL Detections within the Rio Grande, NM.

| Site Name | WIFLs Observed ⁽¹⁾ | Est. | | | Est. | | | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|---------------------------------------|----------------------------------|--------------------|--|--------------------------|--------------------|--|--------------------------|----------------------------------|---------------|--|----------|
| | | Number of Pairs | Number of E.t. <i>extimus</i> ⁽²⁾ | Number of Territories | Number of Pairs | Number of E.t. <i>extimus</i> ⁽²⁾ | Number of Territories | | | | |
| La Cienega | 4 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | Santa Fe |
| BLM Survey Sites | 4 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | |
| Frijoles Reach | 7 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 7 Migrants | Sandoval |
| BL-05 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| BL-06 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| BL-09 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Valencia |
| BL-10 | 18 | 4 | 12 | 8 | | | | Yes (4) | 4 Successful | 6 Migrants; 4 Unpaired males; 4 Pairs w/ nests | Valencia |
| BL-11 | 9 | 3 | 6 | 3 | | | | Yes (4) | 4 Successful | 3 Migrants; 3 Pairs w/ nests | Valencia |
| BL-12 | 5 | 0 | 0 | 0 | | | | N/A | N/A | 5 Migrants | Valencia |
| BL-13 | 6 | 0 | 0 | 0 | | | | N/A | N/A | 6 Migrants | Valencia |
| BL-14 | 6 | 0 | 1 | 1 | | | | N/A | N/A | 5 Migrants; 1 Unpaired male | Valencia |
| BL-15 | 7 | 0 | 0 | 0 | | | | N/A | N/A | 7 Migrants | Valencia |
| BL-16 | 3 | 0 | 0 | 0 | | | | N/A | N/A | 3 Migrants | Valencia |
| BL-17 | 9 | 0 | 0 | 0 | | | | N/A | N/A | 9 Migrants | Valencia |
| BL-19 | 1 | 0 | 0 | 0 | | | | N/A | N/A | 1 Migrant | Valencia |
| BL-21 | 1 | 0 | 0 | 0 | | | | N/A | N/A | 1 Migrant | Valencia |
| BL-22 | 3 | 0 | 0 | 0 | | | | N/A | N/A | 3 Migrants | Valencia |
| BL-24 | 5 | 0 | 0 | 0 | | | | N/A | N/A | 5 Migrants | Valencia |
| BL-25 | 2 | 0 | 0 | 0 | | | | N/A | N/A | 2 Migrants | Valencia |
| BL-26 | 2 | 0 | 0 | 0 | | | | N/A | N/A | 2 Migrant | Valencia |
| BL-27 | 3 | 1 | 2 | 1 | | | | Yes (2) | 2 Successful | 1 Migrant; 1 Pair w/nest | Valencia |
| BL-28 | 2 | 0 | 0 | 0 | | | | N/A | N/A | 2 Migrants | Valencia |
| BL-29 | 5 | 0 | 0 | 0 | | | | N/A | N/A | 5 Migrants | Valencia |
| BL-30 | 1 | 0 | 0 | 0 | | | | N/A | N/A | 1 Migrant | Valencia |
| SV-11 | 4 | 1 | 2 | 1 | | | | No | N/A | 2 Migrants; 1 Pair | Socorro |
| SV-12 | 3 | 0 | 0 | 0 | | | | N/A | N/A | 3 Migrants | Socorro |
| SV-13 | 1 | 0 | 0 | 0 | | | | N/A | N/A | 1 Migrant | Socorro |
| SV-14 | 1 | 0 | 0 | 0 | | | | N/A | N/A | 1 Migrant | Socorro |
| Belen Reach ⁽⁴⁾ Summary | 104 | 9 | 23 | 14 | | | | 10 | 10 Successful | 81 Migrants; 5 Unpaired males; 1 Pair; 8 Pairs w/nests | |

| Site Name | WIFLs Observed ⁽¹⁾ | Est. Number of Pairs | Est. Number of <i>E.t. extimus</i> ⁽²⁾ | Est. Number of Territories | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|--|-------------------------------|----------------------|---|----------------------------|-------------------------------|--------------------------|--|---------|
| SV-02 | 5 | 0 | 0 | 0 | N/A | N/A | 5 Migrants | Socorro |
| SV-03 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| SV-04 | 5 | 0 | 0 | 0 | N/A | N/A | 5 Migrants | Socorro |
| SV-06 | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| SV-07 | 4 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | Socorro |
| SV-09 | 11 | 5 | 11 | 6 | Yes (5) | 4 Failed 1 Successful | 1 Unpaired male; 1 Pair; 4 Pairs w/ nests | Socorro |
| SV-10 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| Sevillaleta/ La Joya ⁽⁵⁾ Reach Summary | 31 | 5 | 11 | 6 | 5 | 4 Failed 1 Successful | 20 Migrants; 1 Unpaired male; 1 Pair; 4 Pairs w/nests | |
| LF-01 | 7 | 0 | 0 | 0 | N/A | N/A | 7 Migrants | Socorro |
| LF-02 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LF-38 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LF-39 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LF-40 | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| San Acacia Reach ⁽⁶⁾ Summary | 18 | 0 | 0 | 0 | N/A | N/A | 18 Migrants | |
| LF-03 | 9 | 1 | 3 | 2 | Y (1) | 1 Successful | 6 Migrants; 1 Unpaired male; 1 Pair w/ nest | Socorro |
| LF-04 | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| LF-06 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LF-07 | 9 | 0 | 0 | 0 | N/A | N/A | 9 Migrants | Socorro |
| LF-08 | 21 | 4 | 16 | 12 | Yes (1) | 1 Unknown | 5 Migrants; 8 Unpaired males; 3 Pairs; 1 Pair w/ nest | Socorro |
| LF-33 | 10 | 3 | 8 | 5 | Yes (4) | 2 Failed 2 Successful | 2 Migrants; 2 Unpaired males; 3 Pairs w/ nests | Socorro |
| LF-34 | 4 | 0 | 3 | 3 | N/A | N/A | 1 Migrant; 3 Unpaired males | Socorro |
| LF-42 | 6 | 0 | 0 | 0 | N/A | N/A | 6 Migrants | Socorro |
| LF-43a | 4 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | Socorro |
| LF-43b | 8 | 0 | 0 | 0 | N/A | N/A | 8 Migrants | Socorro |
| LF-44a | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LF-45 | 5 | 0 | 1 | 1 | N/A | N/A | 4 Migrants; 1 Unpaired male | Socorro |

| Site Name | WIFLs | | Est. Number of Pairs | Est. Number of Territories | | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|--|-------------------------|----|----------------------|-----------------------------|----------|--|--|----------|--------|
| | Observed ⁽¹⁾ | | | E.t. extimus ⁽²⁾ | | | | | |
| Escondida Reach ⁽⁷⁾ Summary | 84 | 8 | 31 | 23 | 6 | 2 Failed 3 Successful 1 Unknown | 53 Migrants; 15 Unpaired males; 3 Pairs; 5 Pairs w/ nests | | |
| BA-01 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| BA-03N | 5 | 1 | 2 | 1 | Yes (1) | 1 Unknown | 3 Migrants; 1 Pair w/ nest | Socorro | |
| BA-03S | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro | |
| BA-04N | 9 | 0 | 1 | 1 | N/A | N/A | 8 Migrants; 1 Unpaired male | Socorro | |
| BA-04S | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro | |
| BA-05 | 13 | 3 | 9 | 6 | Yes (3) | 1 Failed 2 Successful | 4 Migrants; 3 Unpaired males; 3 Pairs w/ nests | Socorro | |
| BA-06N | 21 | 6 | 18 | 12 | Yes (8) | 6 Failed 1 Successful 1 Unknown | 3 Migrants; 6 Unpaired males; 1 Pair; 5 Pairs w/ nests | Socorro | |
| BA-06S | 22 | 9 | 21 | 12 | Yes (11) | 10 Failed 1 Successful | 1 Migrant; 3 Unpaired males; 3 Pairs; 6 Pairs w/ nests | Socorro | |
| BA-07 | 7 | 1 | 3 | 2 | Yes (2) | 2 Failed | 4 Migrants; 1 Unpaired male; 1 Pair w/ nest | Socorro | |
| BA-08 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| BA-09 | 9 | 0 | 5 | 5 | N/A | N/A | 4 Migrants; 5 Unpaired males | Socorro | |
| BA-10 | 26 | 9 | 21 | 12 | Yes (13) | 8 Failed 5 Successful | 5 Migrants; 3 Unpaired males; 1 Pair; 8 Pairs w/nests | Socorro | |
| Bosque del Apache Reach ⁽⁸⁾ Summary | 119 | 29 | 80 | 51 | 38 | 27 Failed 9 Successful 2 Unknown | 39 Migrants; 22 Unpaired males; 5 Pairs; 24 pairs w/nests | | |
| LF-21 | 2 | 0 | 1 | 1 | N/A | N/A | 1 Migrant; 1 Unpaired male | Socorro | |
| LF-25 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| LF-35 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| LF-36 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro | |
| Tiffany Reach ⁽⁹⁾ Summary | 7 | 0 | 1 | 1 | N/A | N/A | 6 Migrants; 1 Unpaired male | | |
| LF-10 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| LF-12 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro | |
| LF-13 | 4 | 0 | 2 | 2 | N/A | N/A | 2 Migrants; 2 Unpaired males | Socorro | |

| Site Name | Est. | | | | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|------------|----------------------------------|----------------------------|---|----------------------------------|----------------------------------|--|---|---------|
| | WIFLs Observed ⁽¹⁾ | Est. Number of Pairs | Number of <i>E.t.</i> <i>extimus</i> ⁽²⁾ | Est. Number of Territories | | | | |
| LF-14 | 7 | 1 | 4 | 3 | No | N/A | 3 Migrants; 2 Unpaired males; 1 Pair | Socorro |
| LF-15 | 5 | 0 | 0 | 0 | N/A | N/A | 5 Migrants | Socorro |
| LF-16 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| LF-17 | 37 | 15 | 37 | 22 | Yes (21) | 16 Failed 4 Successful 1 Unknown | 7 Unpaired males; 15 Pairs w/ nests | Socorro |
| LF-17a | 43 | 21 | 43 | 22 | Yes (32) | 23 Failed 6 Successful 3 Unknown | 1 Unpaired male; 1 Pair; 20 Pairs w/ nests | Socorro |
| LF-17b | 5 | 1 | 4 | 3 | Yes (1) | Successful | 1 Migrant; 2 Unpaired males; 1 Pair w/ nest | Socorro |
| LF-18 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| LF-19 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| LF-27 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| LF-28 | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro |
| LF-31 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| LF-32 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LFCC-01 | 11 | 4 | 8 | 4 | Yes (3) | 3 Failed | 3 Migrants; 2 Pairs; 2 Pairs w/ nests | Socorro |
| LFCC-02 | 2 | 0 | 2 | 2 | N/A | N/A | 2 Unpaired males | Socorro |
| LFCC-03 | 7 | 2 | 7 | 5 | Yes (2) | 1 Failed 1 Unknown | 3 Unpaired males; 2 Pairs w/ nests | Socorro |
| LFCC-04 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro |
| LFCC-05b | 4 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | Socorro |
| DL-01 | 26 | 12 | 26 | 14 | Yes (8) | 8 Failed | 2 Unpaired males; 6 Pairs; 6 Pairs w/ nests | Socorro |
| DL-01a | 20 | 7 | 19 | 12 | Yes (6) | 5 Failed 1 Unknown | 1 Migrant; 5 Unpaired males; 3 Pairs; 4 Pairs w/ nests | Socorro |
| DL-02 | 59 | 21 | 51 | 30 | Yes (22) | 13 Failed 9 Successful | 8 Migrants; 9 Unpaired males; 3 Pairs; 18 Pairs w/ nests | Socorro |
| DL-03 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Socorro |
| DL-04 & 4a | 5 | 0 | 0 | 0 | N/A | N/A | 5 Migrants | Socorro |

| Site Name | WIFLs | | Est. Number of Pairs | | Est. Number of Territories | | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|---|-------------------------|-----|----------------------|-----|----------------------------|---|--|--------------|----------|--------|
| | Observed ⁽¹⁾ | | | | | | | | | |
| DL-06 | 14 | 3 | 8 | 5 | Yes (4) | 3 Failed 1 Successful | 6 Migrants; 2 Unpaired males; 1 Pair; 2 Pairs w/ nests | Socorro | | |
| DL-07 | 22 | 5 | 19 | 14 | Yes (5) | 4 Failed 1 Successful | 3 Migrants; 9 Unpaired males; 1 Pair; 4 Pairs w/ nests | Socorro | | |
| DL-08 | 30 | 9 | 20 | 11 | Yes (7) | 3 Failed 4 Successful | 10 Migrants; 2 Unpaired males; 3 Pairs; 6 Pairs w/ nests | Socorro | | |
| DL-09 | 31 | 13 | 28 | 15 | Yes (16) | 9 Failed 3 Successful 4 Unknown | 3 Migrants; 2 Unpaired males; 2 Pairs; 11 Pairs w/ nests | Socorro | | |
| DL-10 | 11 | 2 | 8 | 6 | Yes (3) | 3 Failed | 3 Migrants; 4 Unpaired males; 2 Pairs w/ nests | Socorro | | |
| DL-11 | 2 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | Socorro | | |
| DL-12 | 62 | 29 | 59 | 30 | Yes (50) | 33 Failed 15 Successful 2 Unknown | 3 Migrants; 1 Unpaired male; 29 Pairs w/ nests | Socorro | | |
| EB-01 | 32 | 13 | 28 | 15 | Yes (23) | 10 Failed 11 Successful 2 Unknown | 4 Migrants; 2 Unpaired males; 13 Pairs w/ nests | Socorro | | |
| EB-03 | 3 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | Socorro | | |
| EB-04 | 7 | 0 | 4 | 4 | N/A | N/A | 3 Migrants; 4 Unpaired males | Socorro | | |
| EB-06 | 1 | 0 | 0 | 0 | N/A | N/A | 1 Migrant | Sierra | | |
| EB-07 | 13 | 5 | 13 | 8 | Yes (8) | 4 Failed 3 Successful 1 Unknown | 3 Unpaired males; 5 Pairs w/ nests | Sierra | | |
| EB-08 | 1 | 0 | 1 | 1 | N/A | N/A | 1 Unpaired male | Sierra | | |
| EB-09 | 31 | 12 | 27 | 15 | Yes (12) | 4 Failed 7 Successful 1 Unknown | 4 Migrants; 3 Unpaired males; 3 Pairs; 9 Pairs w/nests | Sierra | | |
| EB-13S | 3 | 0 | 2 | 2 | N/A | N/A | 1 Migrant; 2 Unpaired males | Sierra | | |
| EB-14 | 1 | 0 | 1 | 1 | N/A | N/A | 1 Unpaired male | Sierra | | |
| EB-15 | 6 | 3 | 6 | 3 | No | N/A | 3 Pairs | Sierra | | |
| EB-16 | 6 | 3 | 6 | 3 | No | N/A | 3 Pairs | Sierra | | |
| San Marcial Reach ⁽¹⁰⁾ Summary | 527 | 181 | 433 | 252 | 223 | 142 Failed 65 Successful 16 Unknown | 94 Migrants; 71 Unpaired males; 32 Pairs; 149 Pairs w/nests | | | |

| Site Name | WIFLs | | | Est. | | Est. Number of Territories | Nest (s) Found ⁽³⁾ | Nest Success | Comments | County |
|---|-------------------------|-----------------|--|-----------------|-----------------------|----------------------------|---|---|---|----------|
| | Observed ⁽¹⁾ | Number of Pairs | Number of <i>E.t. extimus</i> ⁽²⁾ | Number of Pairs | Number of Territories | | | | | |
| Caballo Delta | 2 | 1 | 2 | 1 | 1 | Y (1) | Unknown | 1 Pair w/ nest | 1 Pair w/ nest | Sierra |
| HA-01 | 18 | 8 | 18 | 10 | 10 | Y (8) | 1 Failed 7 Unknown | 2 Unpaired males; 8 Pairs w/ nests | 2 Unpaired males; 8 Pairs w/ nests | Dona Ana |
| HA-02 | 18 | 7 | 17 | 10 | 10 | Y (6) | 1 Failed 2 Successful 3 Unknown | 1 Migrant; 3 Unpaired males; 1 Pair; 6 Pairs w/ nests | 1 Migrant; 3 Unpaired males; 1 Pair; 6 Pairs w/ nests | Dona Ana |
| HA-03 | 2 | 1 | 2 | 1 | 1 | Y (1) | Failed | 1 Pair w/ nest | 1 Pair w/ nest | Dona Ana |
| HA-04 | 7 | 3 | 7 | 4 | 4 | Y (3) | 2 Failed 1 Unknown | 1 Unpaired male; 1 Pair; 2 Pairs w/ nests | 1 Unpaired male; 1 Pair; 2 Pairs w/ nests | Dona Ana |
| HA-05 | 3 | 0 | 0 | 0 | 0 | N/A | N/A | 3 Migrants | 3 Migrants | Dona Ana |
| HA-06 | 4 | 0 | 0 | 0 | 0 | N/A | N/A | 4 Migrants | 4 Migrants | Dona Ana |
| Selden Canyon | 2 | 0 | 0 | 0 | 0 | N/A | N/A | 2 Migrants | 2 Migrants | Dona Ana |
| Radium Springs | 10 | 2 | 4 | 2 | 2 | No | N/A | 6 Migrants; 2 Pairs | 6 Migrants; 2 Pairs | Dona Ana |
| Lower Rio Grande ⁽¹¹⁾ Summary | 64 | 21 | 48 | 27 | 27 | 18 | 5 Failed 2 Successful 11 Unknown | 16 Migrants; 6 Unpaired males; 4 Pairs; 17 Pairs w/ nests | 16 Migrants; 6 Unpaired males; 4 Pairs; 17 Pairs w/ nests | |
| 2012 TOTALS | 967 | 254 | 629 | 375 | 301 | | 180 Failed 90 Success 31 Unknown | 338 Migrants; 121 Unpaired males; 46 Pairs; 208 Pairs w/ nests | | |
| The line below contains summary data for the Middle Rio Grande Management Unit only. Modified by J. Lusk, USFWS, February 2013. | | | | | | | | | | |
| 2012 Totals for MRG Management Unit (Only) | 903 | 242 | 581 | 348 | 283 | | 175 Failed 88 Success 20 Unknown | 322 Migrants; 115 Unpaired males; 42 Pairs; 191 Pairs w/ nests | | |

¹ When a single WIFL responded to the tape playback, and there was no evidence of pairing, it was considered to be an unpaired male. It is possible that some WIFLs counted as males may have been females, especially during the migration period.

² A WIFL was considered to be a resident *Empidonax traillii extimus* if it was documented on or after June 10 and exhibited behavioral characteristics typical of a territorial WIFL or nesting activity could be confirmed.

³ A second brood occurs after a SWFL pair has had a successful nesting attempt (i.e., young are fledged). A re-nest commonly occurs after an unsuccessful first nesting attempt.

⁴ Belen Reach = From south boundary of Pueblo of Isleta, downstream to confluence of Rio Puerco and Rio Grande.

⁵ Sevilleta/La Joya Reach = From confluence of Rio Puerco and Rio Grande, downstream to San Acacia Diversion Dam

⁶ San Acacia Reach = From San Acacia Diversion Dam, downstream to Escondida Bridge

⁷ Escondida Reach = From Escondida Bridge, downstream to north boundary of Bosque del Apache NWR

⁸ Bosque del Apache NWR Reach = From north boundary of NWR, downstream to southern boundary of NWR.

⁹ Tiofany Reach = From south boundary of BDA NWR, downstream to railroad trestle.

¹⁰ San Marcial Reach = From railroad trestle, downstream through the narrows to Elephant Butte Reservoir Pool (Monticello Bay)

¹¹ Lower Rio Grande = From Caballo Dam to the Mexican border

Migrant – any WIFL detected only during the period prior to June 10th, and where breeding was neither confirmed nor suspected.

Unpaired Male – a resident SWFL that was documented on or after June 10th and exhibited behavioral characteristics typical of a territorial flycatcher, however breeding was neither suspected nor confirmed

Pair – a SWFL territory where breeding was confirmed or behavioral evidence strongly suggested that pairing had occurred

Pair w/ nest – a SWFL territory where breeding was confirmed by the discovery of an active nest.