DEVELOPMENT OF ALTERNATIVES FOR CANUTILLO FLOOD CONTROL IMPROVEMENTS

RIO GRANDE CANALIZATION PROJECT

VOLUME 1

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Section 1 – Introduction

1.1 Introduction

In October 2005, the report study "Upper Rio Grande Water Operations Model" (URGWOM) was prepared for the USIBWC and USACE using FLO-2D Model Development. The model described the Rio Grande Canalization Project (RGCP) from Caballo Dam to American Dam (105 river miles). The report indicated that, for a 100-year flood event, on the east side, a total of 14,000 ft of the railroad embankment will be either overtopped or encroached. This included 2,500 ft of the Railroad embankment located upstream of the Canutillo bridge and 11,500 feet of the railroad embankment downstream of the Canutillo bridge. The report also concluded that on the west side, about 8,000 ft of the existing levee located downstream of the Canutillo bridge will be either overtopped or encroached. The Canutillo study area is approximately 4.17 miles of the Rio Grande Canalization Project (RGCP).

This report presents a conceptual level analysis to develop alternatives for Canutillo Flood Control Improvements to eliminate current flooding problems using a 100-year design storm. Canutillo, Texas is a town located in far west El Paso County along the Rio Grande Canalization Project. The project study area is from Clayton Rd. to Los Mochis Dr. along the Rio Grande, the east boundary is 5th Street and Doniphan, and the west boundary is Strahan, as shown in **Figure 1**, "Canutillo and Vicinity Map." Within the study area, the Rio Grande is approximately one m ile west of I-10, runs from north to south, and includes bridge crossings at SH 178 / Artcraft, Borderland Road, and FM 259 (Canutillo bridge).

This study used the results from the 2005 FLO-2D model, completed in October 2005, to develop potential flood control alternatives and to evaluate the economic benefits of construction of any proposed alternative. The tasks included a site investigation, a flood damage assessment for existing conditions, development of construction alternatives to contain the 100-year flood with three (3) feet of freeboard, and environmental considerations within the study boundary. Damage dollar amounts and construction costs were developed for each alternative. This report concludes with a description of advantages and disadvantages for each alternative and the preferred option.

1.2 Authorization and Scope

International Boundary and Water Commission, United States Section (USIBWC), authorized S&B to perform this study under Task Order Number IBM06T0009 of Contract Number IBM05-D0001. A notice to proceed was issued on August 28, 2006.

The Scope of Work for the "Development of Canutillo Flood Control Improvements" consisted of the following elements:

- Perform a site visit to identify locations for construction of flood control improvements within the study area described in **Figure 1**, "Canutillo and Vicinity Map."
- Develop four Alternatives which include a "No-Action, No-Build;" "Action, No-Build;" and two "Build" options to contain the 100-year flood with three (3) feet of freeboard.
- Provide economic analyses using the FLO-2D simulation results to estimate the extent of the area of inundation due to the 100-year flood event and current information of land use, property value, crop value, residential and commercial values.
- Develop schematic and typical section drawings for each alternative on 24" by 36" sheets.
- Prepare a preliminary cost estimate for construction and operation and maintenance for each alternative including impact to USIBWC's right-of-way.
- Address the environmental considerations of the proposed alternatives.

Section 2 – Site Investigation

S&B performed a site visit during the week ending on Friday, October 20th, 2006 and determined the following conditions for the Canutillo Study Area.

2.1 Location of Existing Flood Control Improvements

The west levee is an earthen structure, and the top of levee is generally 6 to 7 feet above natural ground. Although very minor rills were observed, the levee was in very good condition. The top is approximately 14-feet wide and has a gravel maintenance road throughout in good condition.

West Levee Downstream of Canutillo Bridge

A park is located between the west levee and west bank of the Rio Grande. The park includes a sidewalk and aesthetic stone fencing. The sidewalk is adjacent to the levee near the intersections of Borderland Road and FM 259. Raising the levee at these locations may require slope paving or a retaining wall to maintain the condition of the sidewalk. Farm land adjacent to the west levee is irrigated and the pump station for the Canutillo Lateral is located adjacent to the levee approximately 2,800 feet north of Borderland Road. An open drainage ditch is observed 2,600 feet north of the pump station. This outfall crosses the levee with a pipe culvert which will need to be extended if the levee is raised. Elevating the levee profile at its current horizontal alignment appears to be the best option for flood control.

West Levee Gravel Roadway

The east levee is an earthen berm from the southern limits of the study area to Borderland Road, and it is in excellent condition. The railroad serves as the east levee from approximately 680 feet north of Borderland Rd. to the northern limit of the study area. The east levee from Borderland Rd. to the railroad is an existing maintenance road within IBWC property. It appears that the berm serves as a levee, but the 2005 study does not indicate a levee at this location.

Stream tributaries, originating in the Franklin Mountains, outfall into the Rio Grande within our study area. The outfalls are located along the Atchison Topeka and Santa Fe (AT&SF) railroad and enter the Rio Grande without any inlet/outlet control. Existing railroad bridges are located approximately 1,500 feet north of Borderland, immediately upstream of the Canutillo Bridge (FM 259), and 2,250 feet north of Canutillo Bridge. The railroad is located on the east bank of the Rio Grande from 1,600 feet north of Borderland Road to 4,800 feet south of Canutillo bridge. A potential location for an east floodwall is adjacent to the railroad. Since the railroad right-of-way is 100 feet, the minimum distance between the outside edge of the floodwall foundation and the center of rail is 50 feet. Placement of a floodwall in the area where the railroad is the east bank of the river requires a horizontal re-alignment of the railroad or elevating the rail profile.

Railroad (East Levee) at Canutillo Bridge

The main channel appeared to be relatively shallow with significant amounts of sediment deposit throughout the study area. Removing the sediment, or dredging the Rio Grande, was analyzed as a possible flood control alternative.

Additional photos from the site investigation are included in **Appendix E**, Site Photos.

2.2 Conditions of Land and Improvements within the Floodplain

Canutillo has mixed development with commercial property mainly located along Doniphan (SH 20). Houses in the area generally had a finished floor elevation of six inches above natural ground. Mobile home floors were estimated to be 3 ½ feet above ground level. Land along the west levee was primarily agriculture consisting of pima cotton, alfalfa, and pecans. The field observations were used in combination with El Paso County appraisal records for the tax year 2006 to determine values.

Section 3 – Design Parameters

In 1996, the U.S. Army Corps of Engineers (USACE) conducted hydrologic and hydraulic analyses (HEC-2) for the Rio Grande Canalization Project (105 river miles). The report identified levee deficiencies and recommended that the USIBWC build a 7,500 ft concrete floodwall on the east side and raise a portion of the west side levee in the Canutillo area to contain the 100-year flood event. In October 2005, Tetra Tech, Inc. completed for the USACE hydrologic / hydraulic analysis and issued a final study report entitled, "FLO-2D Model Development Below Caballo Dam" for the USACE and the USIBWC. The report indicated that, for a 100-year flood event, on the east side, a total of 14,000 ft of the railroad embankment will be either overtopped or encroached which included 2,500 feet along the railroad embankment located upstream of the Canutillo Bridge and 11,500 feet along the railroad embankment downstream of the Canutillo Bridge. The report also concluded that on the west side, about 8,000 ft of the existing

levee located downstream of the Canutillo bridge will be either overtopped or encroached.

S&B developed the methodology described below for the analysis of four alternatives. The alternatives are: 1) "No-Action, No-Build," 2) "Action, No-Build," 3A) "Raise West Levee Profile; Realign Section of Railroad Profile, and Construct East Floodwall," 3B) "Raise West Levee Profile; Raise Section of Railroad Profile, and Construct East Floodwall," and 4) "Raise West Levee Profile; Realign Section of Railroad Profile, Construct East Floodwall, and Channel Improvements."

3.1 No-Action, No-Build Alternative

The "No-Action, No-Build" alternative was a base condition that determined the dollar damage for an existing 100-year flood inundation area, as shown in **Figure 2**, "Flood Inundation Area Alternatives No. 1 & No. 2." The El Paso County appraisal records, from the tax year 2006, were used in combination with depth-to-damage functions to quantify the partial flood damage in dollars based on maximum water surface depth. An electronic copy of the depth-to-damage functions and the appraisal records in the Canutillo study area are included in **Appendix A**. The damage was based on structures, contents, vehicles, and crop losses. Land values were not considered in the "No-Action, No-Build Alternative."

The crops impacted in the study area, as determined by the site visit, were pima cotton, alfalfa, and pecans. The flood damage crop loss was based on unit costs obtained from tables developed by the Agriculture Research and Extension Center (El Paso) and Agricultural Economics, Texas A&M University as shown in **Appendix A**. Damages associated with residential and commercial buildings included improvement costs, content values, and vehicle costs.

For residential structures, damage functions for improvement costs were derived from the Army Corps of Engineers, Institute for Water Resources ("CECW-PG Economic Guidance Memorandum (EGM) 04-01, Generic Depth Damage Relationships for Residential Structures with Basements," 10 October 2003). Damage for each one-foot increment of flooding was calculated as a percentage of the assessed value of the structure. The tables applicable to Canutillo, Texas were "Structure One Story" (with Basement), "Content One Story" (with Basement), "Structure One Story" (no Basement), "Structure Two or More Stories" (no Basement), "Content One Story" (no Basement), and "Content Two or More Stories" (no Basement). These tables can be found in **Appendix A**. For residential structures excluding mobile homes, content value was assumed to be 50% of structure value. During the site visit, it was noted that the homes were approximately 6 inches (0.5 ft) above existing ground. The damage table used 6 inch flood depth as the first monetary damage, and then increased in one foot (1 ft) increments up to 16.5 ft.

Mobile homes damage functions used the FIA "Depth-Damage Data" (January 2005) to determine percent structure damage. Mobile home content value was estimated to be

67% of structure value as determined by the "Pearl River Study." The Depth-Damage Functions for mobile home contents were obtained from the same study and are included in **Appendix A**. As previously mentioned, the finished floor was estimated to be 3.5 feet above natural ground.

Depth-to-damage functions for commercial structures were derived from two major studies. The "Pearl River Study" determined the average percent contents-to-structure value for various businesses. A study in Galveston, Texas developed "Table B-1: Depth-Damage Functions for Commercial and Public Structures." The two studies were included as Attachment A and Attachment B of the USACE report titled "Dredged Material Management Plan and Environmental Impact Statement: McNary Reservoir and Lower Snake River Reservoirs, Appendix C Economic Analysis" and are noted in the references of this report. A summary of these findings for commercial and public structure depth to damage functions applicable in this study is included in **Appendix A**. Commercial structure values were obtained from El Paso County appraisal records for the tax year 2006. Public structures are not appraised by the county; therefore, S&B contacted the facilities and obtained structure values via telephone conversation.

The estimated dollar damages to residential vehicles were based on guidance from the USACE. It was assumed that most homeowners have more than one vehicle, but that only one would be subject to flood damage. It was also assumed that the average value of the flooded vehicle is $8,000. Auto damages were estimated at 10 percent for a flood depth of 1.5 foot, 20 percent for 2.5 feet, 30 percent for 3.5 feet, and 80 percent for 4 feet and higher.

S&B used the FLO-2D program to duplicate existing model results from the October 2005 study. This data was used as a base model for development of a flood damage assessment. The process required creating a polygon shape file (ARC-GIS) which defined the boundaries of buildings and agriculture land. This file had an ID (identification number) related to each building that correlated to a depth-damage table of functions which were imported into the program. The depth-to-damage table described the dollar damage for each improved property in one foot increments. Since the finished floor elevations were determined to be 6 inches above natural ground, this was the first value in the damage table. The damage table proceeds in one foot increments as shown on Table 1-1, "Depth / Damage Relationship" and is included in **Appendix A**.

The polygon shape file, named joined_info.shp, contains all of the structures and crop land in the project study area. It is associated with a geographical information system (GIS) database file called joined_info.dbf. The database file has two sets of information for each polygon: 1) FLO-2D_ID and 2) El Paso County Appraisal District account number (PIDN). The El Paso County Appraisal District account numbers were used to pull the improvement values for the properties within the flood area and ultimately developed a depth-damage relationship for each location.

3.2 Action, No-Build Alternative

These "Action, No-Build Alternative," or Alternative No. 2, included buyout of properties within the flooded area and damage costs associated with the railroad. This option used the data from the first alternative to determine which properties were affected by the 100-year flood event. All properties, including residential, commercial, and croplands were included in the buyout cost. The cost only took into account the land value, structure value, and affected agricultural land area for one flooding event. The value did not include contents or vehicles. The railroad property included a damage cost of $38.78 per square foot of flooded area. Since the railroad was generally 3.5 feet above natural ground, the damage was not included unless the depth exceeded 3.5 feet. For a summary of property acquisition, refer to Table 2-1, "Summary of Property Buyout," in **Appendix B**.

3.3 Build Alternatives

The alternatives include levee and floodwall improvements to contain the 100-year flood with three (3) feet of freeboard. Upon evaluating the existing 2005 analysis data, it is determined that the freeboard is less than 3 feet within the entire study area, as shown in **Figure 3**, Levee Deficiency Map, Alternatives No. 1 & No. 2. The model reports levee freeboard deficit as four possible levels as follows:

- Level 4 – Levee is overtopped,
- Level 3 – Available Freeboard is less than one foot,
- Level 2 – Available Freeboard is greater than one foot and less than two feet,
- Level 1 – Available Freeboard is greater than two feet and less than three feet,
- Level 0 – Available Freeboard is greater than three feet.

Although the USACE October 2005 report states that overtopping or encroaching of the existing west levee is about 8,000 ft downstream of the Canutillo Bridge, the project limits were extended in order to comply with the project requirements warranting a three (3) foot freeboard. This extended the west levee design area from 8,000 ft to 21,938 ft. The channel limits of study are set at our area boundary. Beginning upstream, the study area is from grid numbers 36794 to grid numbers 38649. The east levee limits for improvement are increased to include the entire study area as well. On Table 1-2, "Existing Maximum Water Surface Elevations, Grid Number 36794 to Grid Number 38649," the 100-year peak water surface elevations are listed, and Table 1-3, "Existing Cross Section Data, Grid Number 36794 to Grid Number 38649" provides the X and Y coordinates for surveyed and interpolated cross sections. These values constitute the base model conditions.

In order to determine the "Action-Build" alternatives, the 2005 model was revised to include a proposed raised levee condition. The main component in the model was raising the levee elevations to contain the 100-year flood with 3 feet of freeboard. An effort was made to minimize the increase in levee profile while still meeting freeboard requirements. The resulting flood inundation after levee improvements is shown in

Figure 5, "Flood Inundation Area Alternatives No. 3A & No. 3B East Levee / Floodwall & West Levee Improvements." The respective levee deficiencies are shown in **Figure 6**, "Levee Deficiency Map Alternatives No. 3A & No. 3B East Levee / Floodwall & West Levee Improvements," indicating three grids with levee deficiency; however, these locations have exactly 3.0 feet of freeboard; therefore, the model is determined to be correct. Table 3-2, "West Levee Freeboard Summary," and Table 3-3, "East Levee Freeboard Summary" are the freeboard summaries for the west levee and east levee, respectively.

As mentioned, the "Action-Build" alternatives involve construction of a floodwall and improvements to the existing levees, or dredging the Rio Grande. A condition that needs to be considered when evaluating these alternatives is that the railroad is located on the east bank of the Rio Grande from Sta. 1105+00 to Sta. 1145+00, approximately. The railroad will require relocation from this area in order to provide adequate room for a floodwall. The new floodwall alignment would be along the east bank, and would be situated at the edge of the repositioned railroad right-of-way. The railroad 100-ft right-of-way corridor would be shifted approximately twenty feet to the east. Another option considered was to raise the railroad profile in this area and eliminate the need for a floodwall. A third option, which was not analyzed, could be to fill in the Rio Grande 20-feet where the railroad conflict occurs on the east bank and mitigate the impact to jurisdictional waters at another location of the river.

Section 4 – Description of Alternatives

4.1 Alternative 1 – No-Action, No-Build

Alternative 1 assessed the impact for taking no action on the existing flooding problems in the Canutillo study area. The flood inundation area, shown in **Figure 2** "Flood Inundation Area Alternatives No. 1 & No. 2," was obtained from the FLO-2D study completed on October 2005. The levee deficiencies map, shown in **Figure 3**, "Levee Deficiency Map Alternatives No. 1 & No. 2," depicts the locations where the 100-year water surface elevation was either overtopping or within 3 feet or less of the top of levee. An economic analysis for existing flooding conditions was calculated using FLO-2D, 2006, modeling software. A sample of results is shown in **Figure 4**, "Partial Flood Damage Area Map with Polygon ID and Dollar Amount." **Figures 4-1 to 4-8**, "Flood Damage Area Map with Polygon ID and Dollar Amount," provide a 24" by 36" detailed key map to display the dollar damage for each individual polygon.

The damage cost associated with Alternative No. 1, No–Action, No-Build was $27,417,805. Table 1-4, "Building Damage Listing" in **Appendix A**, provided a list of damages that summarize the information in the 24" X 36" maps, **Figure 4-1 through 4-8**, "Flood Damage Area Map with Polygon ID and Dollar Amount."

4.2 Alternative 2 - Action, No-Build

The "Action, No-Build Alternative," or Alternative No. 2, included buyout of properties within the flooded area and damage costs associated with the railroad. This value is approximately $71,266,108. Table 2-1, "Summary of Property Buyout" in **Appendix B**, provides a summary of property costs. The buyout is further described by category as follows:

1) Residential $18,035,397
2) Agriculture $ 1,702,988
3) Commercial $48,791,077
4) Other $ 2,736,646

4.3 Alternative 3A – Raise West Levee Profile; Realign Section of Railroad Profile and Construct East Floodwall

The "Raise West Levee Profile; Realign Section of Railroad Profile and Construct East Floodwall," or Alternative No. 3A, consists of raising the earth levees to the minimum required elevation and maintaining the same horizontal alignment. Proposed conditions include raising the earth levee on the west side of the Rio Grande for approximately 21,938 feet and raising the earthen levee on the east side for approximately 8,200 feet at the beginning the project and constructing a concrete floodwall for the remaining 12,972 feet.

A typical section for the raised levee is shown in **Figure 7**, "Typical Section Proposed Raised Levee**."** The proposed earthen levee has 3:1 side slopes with a 14 foot maintenance road on top. An exception is along the public park, near the intersection of Borderland Road and FM 259, where the side slope is steepened to 2:1 and be concrete rip-rap. The slope paving is meant to preserve the existing park and the walking trail along the west overbank of the Rio Grande. Pipe extensions would be added to the culvert crossing the west levee. A temporary flood gate along the west levee is required at the Canutillo bridge (FM 259). In addition, about 5.73 acres of additional right of way is required for the construction of the proposed levee. The opinion of probable cost, shown in Exhibit 3A-1, for the west levee is $1,910,689.87 including construction cost, right of way acquisition, and engineering and construction management fees.

West Levee Project Cost (3A & 3B)

Description	**Amount**
Total Construction w/ contingencies	$1,545,695.06
Right of Way	$42,975.00
Engineering, Design, and CMS	$322,019.81
Total West Levee Project Cost	$1,910,689.87

The Canutillo Bridge (FM 259) is an obstruction to flood flows. The Texas Department of Transportation prepared bridge replacement plans for FM 259 signed December 13, 2004. The proposed bridge is a crest curve over the Rio Grande. Although the low chord

at the center of the proposed bridge is above the 100-yr water surface elevation, the east levee bridge abutment cannot be raised above the flood elevation due to the railroad at-grade crossing. At the time of the field visit on October 2006, the existing bridge was still in place. The FLO-2D model was not revised to account for the proposed FM 259 bridge replacement. The existing bridge is overtopped during the 100-year storm event, and temporary flood gates are required to prevent flooding at the bridge abutments. Construction of the floodgates should be coordinated with the proposed Canutillo bridge replacement project.

Flood gates are adjustable gates to control water flow in the levee system, and they are designed to stop water flow entirely as part of the levee system. The west levee requires a temporary floodgate from Sta. 1192+87.40 to Sta. 1194+45.31 which shall be closed during the Rio Grande maximum flood stage and be placed across FM 259. The required length is 158 feet and the minimum height is 4.64 ft to maintain a 3-foot freeboard for a 100 year storm event. A removable multi-panel lip seal flood barrier is proposed at this location. Side by side multiple panel flood barriers are generally used to keep the panel size and weight manageable. For larger panels that may be difficult to lift, panel mounted rollers allow larger panels to be positioned and installed with ease. Bracing is required to provide structural support between panels. The braces are usually pinned bars mounted diagonally from the front of the panel.

The east levee improvement is a combination of an earth levee and a concrete floodwall. The earth levee has the same configuration as the levee typical section shown in **Figure 7**, "Typical Section Proposed Raised Levee." The proposed east floodwall, as shown in **Figure 8**, "Typical Section Proposed East Floodwall," is a vertical, 18-inch thick reinforced concrete wall with concrete piling for foundation support. This configuration is used as a basis for estimating costs associated with this alternative. The actual wall thickness and foundation support will need to be determined in final design. The alignment of the east floodwall from Sta. 1105+00 to Sta. 1145+00 conflicts with the existing Atchison Topeka and Santa Fe (AT&SF) Railroad, which is currently acting as the east levee. Approximately 5,630 feet of new railroad track is proposed to allow room for the floodwall between the east bank of the Rio Grande and the railroad as shown in **Figure 9**, "Typical Section Proposed East Floodwall and Rail Relocation."

The east levee requires a temporary floodgate crossing the Canutillo Bridge (FM 259) from Sta. 1192+66.43 to Sta. 1193+27.33. The required length is 61 feet and the minimum height is 4.27 ft to maintain a 3 foot freeboard for the 100 year storm event. A removable Multi-Panel Lip Seal Flood Barrier, as previously discussed on the west levee, is proposed at this location. Sluice gate structures are proposed on three tributary streams which outfall to the Rio Grande along the proposed floodwall. The three locations are described as follows:

1) From Sta. 1099+70 to Sta. 1101+85 – Length = 215 ft, Height = 13.5 ft
2) From Sta. 1193+27 to Sta. 1193+90 – Length = 63 ft, Height = 8.22 ft
3) From Sta. 1215+36 to Sta. 1216+02 – Length = 66 ft, Height = 2.77 ft

The proposed height is required to maintain 3-foot of freeboard during a 100-year event. To construct the sluice gate, concrete structures consisting of a reinforced concrete pile cap / footing and a vertical supporting wall are required to be formed and poured prior to driving sheet piling. Sections of the sheet piling will be embedded in the concrete structure and act as terminus points for the steel pile wall. Sluice gates are bolted through the wall after the concrete has attained sufficient strength to support the dead load. The sluice gates will be operated with an electric wrench. Power for the wrench should be provided at an electric power drop/pole proximate to each gate.

In addition, about 6.19 acres of additional right of way is required for the construction of the proposed floodwall. The opinion of probable cost, shown in Exhibit 3A-1, for the east levee is $11,730,730.44 including construction cost, right of way acquisition, engineering and construction management fees.

East Levee Project Cost (3A)

Description	**Amount**
Total Construction w/ contingencies	$9,669,770.00
Right of Way	$46,425.00
Engineering, Design, and CMS	$2,014,535.42
Total East Levee Project Cost	$11,730,730.44

Plan and profiles with cross sections are prepared for Alternative 3A on 24”x36” sheets and are included as an attachment to this report. Earthwork calculations were performed for the west and east levee. (Refer to **Appendix C**.) A detailed cost breakdown is described in Exhibit 3A-1, “Opinion of Probable Cost” in **Appendix C**. The opinion of total probable cost for Alternative 3A, “Raise West Levee Profile; Realign Section of Railroad Profile and Construct East Floodwall,” is $13,641,420.31.

4.4 Alternative 3B - Raise West Levee Profile; Raise Section of Railroad Profile and Construct East Floodwall

Alternative 3B, “Raise West Levee Profile; Raise Section of Rail Profile and Construct East Floodwall,” is an option to raise the railroad profile to reduce the length of floodwall. The railroad will maintain the current horizontal alignment, but the vertical profile will be elevated as shown in **Figure 10**, “Typical Section Proposed Raised Railroad.” The adjusted profile begins just north of the at-grade railroad crossing at Borderland Road and ends approximately 945 feet south of the at-grade railroad crossing at Park St. The railroad section is two tracks at the Park St railroad crossing. A temporary rail track would be required to keep the railroad in operation during construction. The opinion of probable cost, shown in Exhibit 3B-1, “Opinion of Probable Cost,” for the east levee is $12,484,544.92 including construction cost, right of way acquisition, and engineering and construction management fees.

Additional plan and profiles, and cross sections were prepared for Alternative 3B and are included as an attachment to this report. Earthwork calculations were performed for the higher profile and taken into account for the probable cost estimate. (Refer to **Appendix**

C.) A detailed cost breakdown is described in Exhibit 3B-1, "Opinion of Probable Cost" in **Appendix C**. The Opinion of Total Probable Cost for Alternative 3B, "Raise West Levee Profile; Raise Section of Railroad Profile and Construct East Floodwall," is $14,395,234.79.

East Levee Project Cost (3B)

Description	**Amount**
Total Construction w/ contingencies	$10,332,037.18
Right of Way	$0.00
Engineering, Design, and CMS	$2,152,507.74
Total East Levee Project Cost	$12,484,544.92

4.5 Alternatives 4 – Raise West Levee Profile; Realign Section of Railroad Profile, Construct East Floodwall, and Channel Improvements

Alternative 4, "Raise West Levee Profile; Realign Section of Railroad Profile, Construct East Floodwall, and Channel Improvements," considered the option of removing the sediment from the main channel. The existing bed elevation is maintained; however, the channel section is excavated to match the bed elevations shown in Table 4-2, "Cross Section Data After Channel Improvements, Grid Number 36794 to Grid Number 38649" provided in **Appendix D** and the Alternative 4 Cross Sections. Table 4-1, "Maximum Water Surface Elevations After Channel Improvements by Grid Number (Alt 4)" describes the resulting maximum water surface elevations after channel improvements. The flood inundation areas and levee deficiencies are shown in **Figure 11**, "Flood Inundation Area Alternative No. 4 (Channel Improvements)" and **Figure 12**, "Levee Deficiency Map Alternative No. 4 (Channel Improvements)." The model results indicate channel grading still requires raising the east and west levees to contain the 100 year flood breaches and maintain three (3) feet of freeboard. The east and west freeboard summaries are described in Tables 4-3, "West Levee Freeboard Summary (Alt 4)," and "Table 4-4, East Levee Freeboard Summary (Alt 4)," respectively.

Alternative 4 was revised to determine the levee improvements required in combination with channel dredging. Table 4-5, "Maximum Water Surface Elevations After Channel and Levee Improvements By Grid Number (Alt 4)" describes the resulting maximum water surface elevations after channel improvements. The resulting flood inundation areas and levee deficiencies are shown in **Figure 13**, "Flood Inundation Area Alternative No. 4 (Channel and Levee Improvements)" and **Figure 14**, "Levee Deficiency Map Alternative No. 4 (Channel and Levee Improvements)." Levees were raised to contain the 100 year flood with three feet of freeboard. The east and west levees' freeboard summaries are described in Tables 4-6, "West Levee Freeboard Summary With Channel and Levee Improvements (Alt 4)," and Table 4-7, "East Levee Freeboard Summary With Channel and Levee Improvements (Alt 4)," respectively.

Plan and profiles and cross sections were prepared for Alternative 4 and are provided as an attachment to this report. Earthwork calculations were performed for the channel and levee improvements, and they are provided in **Appendix D**. The Opinion of Total

Probable Cost for Alternative 4, Raise West Levee Profile; Realign Section of Railroad Profile, Construct East Floodwall, and Channel Improvements is $16,900,149.33.

4.6 Alternative 5

A fifth alternative was considered, but not analyzed. This would involve reclaiming a portion of the channel between east levee Sta. 1105+00 to Sta. 1145+00 in lieu of relocating the railroad. This option includes the use of steel sheet piling in the channel offset from the east bank. This could be filled and used as a location for the floodwall. The fill area would need to be mitigated at another location, since it is an impact to jurisdictional waters of the U.S.; however, the option would provide a significant railroad cost savings. A detailed analysis of Alternative 5, "Channel Fill," was not performed in this report.

Section 5 – Environmental Considerations

5.1 Discussion of Alternatives

The project was divided into four alternatives that will be evaluated to determine a preferred alternative. The four alternatives will be evaluated for impacts to the human environment, natural environment, cost, and engineering constraints.

The parameters used for each evaluation category include:

- Human Environment Impacts: land use (including residential and commercial business), agricultural resources (farmland displaced), cultural resources (potential historic sites), hazardous material sites, and environmental justice;

- Natural Environmental Impacts: ecological resources (waters of the U.S.), threatened and endangered species, 100-year floodplain;

- Costs: Construction cost for each of the proposed build alternatives.

The four alternatives include:

Alternative 1, No-Action, No-Build

This alternative would result in no changes to the current human or natural environment.

Alternative 2, Action, No-Build

This alternative proposes that the land would be used primarily as flood areas and would result in no significant changes to the natural environment. If the adjacent lands are currently being used for agriculture then this alternative may have a minimal affect on the human environment by changing the land use.

Alternative 3A / 3B, Raise West Levee Profile; Realign / Raise Section of Railroad Profile and Construct East Floodwall (Increase levee height on the west and east sides and add a floodwall on the east side.)

This alternative proposes to raise the existing west earth embankment type levee. On the east side of the levee the proposed improvements would include raising the concrete levee and relocating the railroad.

Land between the west bank and west Levee of the Rio Grande is designated as the Rio Grande River Regional Park sponsored by the City and County of El Paso, Texas with funding from Texas Parks and Wildlife Department. Construction improvements in this area would require a Section 6F permit.

Waters of the U.S. may be affected or impacted by the proposed project. The Rio Grande and the adjacent wetlands are waters of the U.S. If any dredged or fill material is placed below the ordinary high water mark of the Rio Grande and/or placed in adjacent wetlands a U.S. Army Corps of Engineer's permit would be required. In accordance with Section 401 and 402 of the Clean Water Act coordination, certification and/or permits may be required from the Texas Commission on Environmental Quality (TCEQ) for this alternative.

In compliance with the Endangered Species Act this alternative may require an endangered and/or threatened species habitat assessment may be required project. The proposed project may require an endangered and/or threatened species presence/absence survey. In addition, this alternative may require coordination through Section 7 or Section 10 of the Endangered Species Act with the U.S. Fish and Wildlife Service.

Coordination for historic structures and archeological remains would be required for the proposed project. Coordination and/or assessments and surveys of Publicly Owned Parks, Recreational Lands, Wildlife and Water Fowl Refuses and Historic Sites may be required to comply with Section 4 (f) U.S. Department of Transportation Act of 1966. In addition, a hazardous materials survey and or analysis may be required in order to move the railroad.

Alternative 4, Channel and Levee Improvements; Realign Section of Railroad Profile, and Construct East Floodwall

This alternative proposes to remove sediment from the Rio Grande main channel. Waters of the U.S would be affected and/or impacted by dredged or fill material for this alternative. The Rio Grande is a water of the U.S. and would requires permits under the Clean Water act for activities that require the placement of dredged or fill material below the ordinary high water mark of the Rio Grande and all other waters of the U.S..

In accordance with Section 401 and 402 of the Clean Water Act coordination, certification and/or permits may be required from the Texas Commission on Environmental Quality (TCEQ) for this alternative. Coordination and/or permits may be

required from the Texas Commission on Environmental Quality (TCEQ) regarding the impaired waters designation for the Rio Grande on the 303(d) Impaired Waters List.

In compliance with the Endangered Species Act this alternative may require an endangered and/or threatened species habitat assessment may be required project. The proposed project may require an endangered and/or threatened species presence/absence survey. In addition, this alternative may require coordination through Section 7 or Section 10 of the Endangered Species Act with the U.S. Fish and Wildlife Service.

Coordination for historic structures and archeological remains would be required for the proposed project. Coordination and/or assessments and surveys of Publicly Owned Parks, Recreational Lands, Wildlife and Water Fowl Refuses and Historic Sites may be required to comply with Section 4 (f) U.S Department of Transportation Act of 1966. In addition, a hazardous materials survey and/or analysis may be required for this proposed alternative.

5.2 Parameters Considered

Air Quality

The boundaries of a non-attainment area are defined by EPA, areas determined to be non-attainment are given classifications based on the magnitude of the area's problem. Non-attainment classifications are used to specify certain regulatory requirements, establish deadlines for states to submit air quality plans, and determine when an area must be in compliance (attainment) with the NAAQS. For ozone the non-attainment classifications are: Marginal, Moderate, Serious, Severe, and Extreme. The City of El Paso is a moderate classification of non-attainment for Carbon Monoxide and Particulate Matter and in attainment for Ozone.

Waters of the U.S.

According to the U.S. Fish and Wildlife Service's 1990 National Wetlands Inventory map the Rio Grande is classified as a riverine intermittent streambed semipermanently flooded excavated (R4SBFx). This reach of the Rio Grande is braded with a wide, deep, floodplain. Within the project corridor is the Rio Grande River with adjacent wetlands. The adjacent wetlands are primarily palustrine emergent, unconsolidated shoreline, and scrub shrub. The adjacent wetlands are primarily outside of the ordinary high watermark of the Rio Grande these wetlands are located adjacent to the existing levees.

Water Quality

In accordance with Section 401 and 402 of the Clean Water Act coordination, certification, and/or permits may be required from the Texas Commission on Environmental Quality (TCEQ) for one or more of the proposed alternatives.

Floodplain

El Paso County and the City of El Paso are participants in the National Flood Insurance Program. According to the Federal Emergency Management Agency Flood Insurance Rate Map Community Panel 480212 0025 B dated September 4, 1991. Route 259 at the

Rio Grande River is located at Zone A (100-year floodplain in which the base flood elevation and flood hazard factors have not been determined). Minimal to no impact to these water features or flood zone are anticipated by this proposed project. The proposed project would not increase the base flood elevation to a level that would violate the applicable floodplain regulations or ordinances. Coordination with the local floodplain administrator would be required.

Soils

1971 El Paso County Soil Survey by the United States Department of Agriculture Soil Conservation Services found within the project area includes Made Land, Gilia soil material (Mg). Made Land, Gilia soil material lie on the Rio Grande Floodplain and consist of soil material primarily from the Gila soils which are silty clay loam, fine sandy loam and sand in texture. On both sides of the river are levees constructed about 200 to 400 feet back from the main channel. These levees were built to prevent the river from flooding in populated areas as well as flooding adjacent farmlands.

Vegetation

Trans Pecos region has diverse habitats and vegetation varying from desert valleys and plateaus to wooded mountain slopes. There are many vegetation types in this region that include creosote-tarbush, dessert scrub, grama grass land, yucca, and juniper savannas, pinyon pine, and oak forest with very little ponderosa pine forest (Texas Plants, Frank Gould 1975).

Historic/Archeological

In accordance with the National Historic Preservation Act (Section 106), the proposed project may require coordination for historic structures and archeological remains for one or more of the proposed alternatives.

Publicly Owned Parks, Recreational Lands, Wildlife and Water Fowl Refuses and Historic Sites

Coordination and/or assessments and surveys may be required to comply with Section 4 (f) U.S. Department of Transportation Act of 1966 if Publicly Owned Parks, Recreational Lands, Wildlife and Water Fowl Refuses and Historic Sites exist with in the proposed project area.

Texas Water Quality Inventory and 303(d) List in compliance with the Clean Water Act

The portion of the Rio Grande near Canutillo is defined as Segment 2314-Rio Grande above International Dam. This reach of the Rio Grande is on the 2004 303(d) List for not meeting the contact recreation use. Bacteria levels were elevated above the surface water quality standard.

Hazardous Materials

In accordance with the Resource Conservation and Recovery Act a hazardous materials survey and/or analysis may be required for one or more of the proposed alternatives.

Threatened and Endangered Species

According to Texas Parks and Wildlife Department's annotated County Lists of Rare Species for El Paso County as of July 2006 the species listed in the table below have been observed in El Paso County.

Type	Common Name	Genus Species	Federal Status	State Status
AMPHIBIANS	Northern leopard frog	*Rana pipiens*		
BIRDS	American Peregrine Falcon	*Falco peregrinus anatum*	DL	E
	Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	T
	Baird's Sparrow	*Ammodramus bairdii*		
	Ferruginous Hawk	*Buteo regalis*		
	Interior Least Tern	*Sterna antillarum athalassos*	LE	E
	Mexican Spotted Owl	*Strix occidentalis lucida*	LT	T
	Montezuma Quail	*Cyrtonyx montezumae*		
	Peregrine Falcon	*Falco peregrinus*	DL	ET
	Prairie Falcon	*Falco mexicanus*		
	Snowy Plover	*Charadrius alexandrinus*		
	Southwestern Willow Flycatcher	*Empidonax traillii extimus*	LE	E
	Western Burrowing Owl	*Athene cunicularia hypugaea*		
	Western Snowy Plover	*Charadrius alexandrinus nivosus*		
	Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	C;NL	
FISHES	Bluntnose shiner	*Notropis simus*		T
	Rio Grande silvery minnow	*Hybognathus amarus*	LE	E
	Bluntnose shiner	*Notropis simus*		T
INSECTS	A Royal moth	*Sphingicampa raspa*		
	A tiger beetle	*Cicindela hornii*		
	Barbara Ann's tiger beetle	*Cicindela politula barbarannae*		
	Poling's hairstreak	*Fixsenia polingi*		
MAMMALS	Big free-tailed bat	*Nyctinomops macrotis*		
	Black bear	*Ursus americanus*	T/SA;NL	T

Section 6 – Evaluation of Alternatives

Advantages and disadvantages, qualitative cost, and opinion of probable cost assessments are listed in Table 6-1.

Table 6-1 Evaluation of Alternatives

Alt No.	Flood Control Improvements	Advantages and Disadvantages	Opinion of Probable Cost
1	No Action, No Build	Advantages • No construction cost Disadvantages • Possibility of flooding not eliminated • FEMA, insurance providers, and Landowners will continue to pay damages on recurring flood events Note: Opinion of Probable Cost is for a single 100-year event.	$27,417,805
2	Action, No Build	Advantages • FEMA, insurance providers, and Landowners will not incur damages from possible flooding • No construction cost Disadvantages • High property buyout cost • Difficult and time consuming to acquire properties	$71,266,108
3A	Raise West Levee Profile; Realign Section of Railroad Profile and Construct East Floodwall	Advantages • Contains the 100-year flood with 3 feet of freeboard • FEMA, insurance providers, and Landowners will not incur flood damages • Minimizes the length of railroad relocation and downtime to rail line through construction phasing • Minimal impacts to the environment Disadvantages • Encroaches into railroad right-of-way • Requires purchase of additional right-of-way • Requires coordination with Railroad officials	$13,641,420.31
3B	Raise West Levee Profile; Raise Section of Railroad Profile and Construct East Floodwall	Advantages • Lower cost • Contains the 100-year flood with 3 feet of freeboard • FEMA, insurance providers, and Landowners will not incur damages from flood events • No encroachment into railroad right-of-way • Raises Rail Bridge for Rio Grande Tributary Disadvantages • Increased impact to railroad operations during construction due to limited phasing options. • Temporary rail may be required for construction	$14,395,234.79

Alt No.	Flood Control Improvements	Advantages and Disadvantages	Opinion of Probable Cost
4	Channel & Levee Improvements, Realign Section of Railroad Profile and Construct East Floodwall	Advantages • Lowers the 100-yr Water Surface Elevation Disadvantages • A combination of raised levees and channel grading is required to contain the 100-yr flood and maintain 3 feet of freeboard • Removal of sediment is temporary. • Maintaining channel grade will have high maintenance cost • River and west overbank is designated as Rio Grande Regional Park under jurisdiction of Texas Parks & Wildlife. Section 6f Permit required.	$16,900,149.33

Section 7 – Recommendation of Alternative

The evaluation of alternatives indicates that the cost for constructing an east floodwall and raising the west levee profile (Alternative 3A) is significantly less cost than the estimated 100 year event flood damage costs (Alternative 1), the property buyout costs (Alternative 2), and performing channel and levee improvements (Alternatives 4). Channel improvements alone will neither contain the levee breaches caused by the 100-year flood event nor maintain 3 feet of freeboard. The channel excavation will also create adverse environmental impacts to existing wildlife habitat. Channel excavation would also only be a temporary remedy and continued maintenance of the channel grade would be required. Further analysis of action/build alternatives reveals that relocation of rail road should be kept to a minimum due to construction costs. Alternative 3B requires more coordination with Atchison Topeka and Santa Fe (AT&SF) railroad than Alternative 3A. The recommended, or preferred, alternative is Alternative 3A, which entails a raised west and east levee and the construction of an east floodwall and floodgates.