Maverick County / City of Eagle Pass

Flood Protection Study

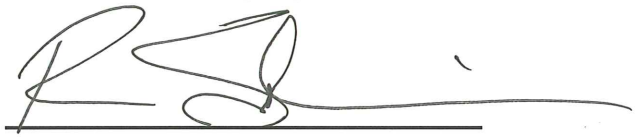
Prepared for:

City of Eagle Pass

Maverick County

Texas Water Development Board

FINAL COPY



Robert Solari, P.E.

September 2009

AVO 25413

Halff Associates

300 East Sonterra, Suite 230
San Antonio, Texas 78258

TABLE OF CONTENTS

APPENDIX A - TABLES

1.0 EXECUTIVE SUMMARY

1.1 Introduction

The purpose of the Maverick County/City of Eagle Pass Flood Protection Study is to develop flood reduction alternatives for five streams flowing into the Rio Grande within the City of Eagle Pass and Maverick County. Past large rainfall events within the project area, specifically the floods of 1998, caused road closures, residential, commercial and business inundations. The five streams flowing into the Rio Grande analyzed (from west to east) are: Seco Creek, Rio Grande Tributary 1, 3 and 4, and Rosita Creek. Most of these streams, excluding Rosita Creek, collect flows from developed industrial, commercial and residential areas. Rosita Creek collects flows from rural, wooded and forest land. A total of 58.51 square miles encompassed the study area. The watersheds size range from 1.4 square miles for Rio Grande Tributary 1 to 35 square miles for Rosita Creek. ***Appendix G, Exhibits 1, 11, 20, 29 and 38*** depict the watershed map for each stream.

Based on the Flood Insurance Rate Map developed by the Federal Emergency Management Agency (FEMA), all of the streams in this study have a 100 year (1% annual event) floodplain designated as Zone A. The watersheds contain a series of irrigation channels crossing a few of the flow paths within the streams being studied. The irrigation channels and associated laterals are design to "siphon" under or cross the channel bed approximately 10 to 15 feet above so as to not interrupt the natural storm water flow path.

This project was funded by the Texas Water Development Board (TWDB), The City of Eagle Pass and Maverick County.

1.2 Existing and Fully Urbanized Conditions

1.2.1 Hydrology and Hydraulic Analysis

The Flood Protection Study consists of hydrologic and hydraulic components. The hydrologic component estimates the peak flows collected in the watershed and the hydraulics component estimates the characteristics of the peak flow conveyance. The hydrology was developed utilizing

TR55 methodology and peak flows determined for the 2, 5, 10, 25, 50 and 100-Year storm events. A total of two Hydrologic Modeling System (HEC-HMS) models were created to establish a baseline for comparison purposes between the Existing, Fully Urbanized and relative alternatives. The Existing Conditions analysis was based on discharges generated by the current land use while the Fully Urbanized (FU) conditions model reflected fully developed conditions, therefore in most instances generating higher flows. The HEC-HMS peak flow tables are located in ***Appendix B.***

The hydraulic component was developed using the US Corps of Engineering (USACE) HEC RAS software, version 4.0. USGS, LIDAR and topographic field survey data was utilized to develop surface terrain models to utilize in developing the HEC-RAS models. Two hydraulic models, Existing and Fully Urbanized Conditions, were developed to establish a baseline and utilized for comparison purposes with the relative stream alternatives. The HEC-RAS summary tables are located in ***Appendix C.***

1.3 Criteria

In the development of the Existing/Fully Urbanized conditions the TR-55/SCS methodology was utilized as mentioned in the **Hydrology and Hydraulics Analysis** section. For localized drainage, proposed storm sewer facilities located within the City of Eagle Pass, the criteria utilized was in compliance with the City of Eagle Pass Drainage Ordinance.

A preliminary analysis was developed to determine the most economical approach in regards to which storm event should be evaluated. The criterion was based on a preliminary analysis of all floodplain mappings for all streams (excluding Rosita Creek). The mappings for the 2, 5, 10, 25, 50 and 100 year were laid on top of each other and by inspection the **10-year** storm event covers the most flooded area relative to all other storms. Although the analysis was developed for 2, 5, 10, 25, 50 and 100-year storm events, the comparisons made between proposed alternatives on each stream and both Existing and Fully Urbanized Conditions are solely based on the **10-year**, excluding Rosita Creek.

Two factors were taken into consideration in developing the criteria for Rosita Creek, land use and road access. The Rosita Creek watershed consists mainly of rural, farm and ranch land;

therefore existing damages due to flooding are minimal. During higher flood events road closures occur on FM 1021 within the Rosita Creek watershed; this leaves FM 1021 inaccessible to emergency vehicles responding to calls from the farm and ranch lands located east of the city. Being a TxDOT road, any improvements recommended for FM 1021 need to be in compliance with Texas Department of Transportation Hydraulic Design Manual criteria. According to this criterion, the 25-year storm frequency is the storm to target for design.

1.4 Alternatives

In general, there were five alternative concepts developed for each stream identified for study. Depending on the extents of the study stream, some of these concepts did not apply because of available space, economic reasons and current conditions (existing flooding problems). The following are the list of concepts that were considered for alternative development:

- Property Buyouts in Flood Prone Areas
- Do nothing Alternative
- Detention Pond Facility
- Channel Modifications
- Culvert/Bridge Structure Upgrade

The set of alternatives explored for all study streams can be found in of this report. ***Section 4*** ***Section 4*** includes a detailed description of each alternative explored as well as the probable construction costs and the benefit cost analysis results. ***Table 6.0*** in ***Appendix A*** summarizes the probable construction costs for alternatives considered for each study stream.

1.5 Conclusion and Recommendations

Seco Creek: The limits of the Seco Creek study extend from approximately 4,400 feet to the east of Union Pacific Railroad on the upstream boundary to 750 feet west of FM 277 on the downstream boundary. The 8.49 square miles that encompassed this study collects 6,660 cfs of runoff for the 10-Year Fully Urbanized conditions. The findings depict a very low benefit/cost ratio for all alternatives explored. Alternative 1, a 577 Acre-Foot Detention Pond, and

Alternative 3, channel modifications between US 277 and Union Pacific Railroad, have a very low reduction in damages. Alternative 2, detention pond and channel modifications, alleviates most of the current flooding problems associated with the 10-Year event but the costs associated with the high amount of excavation for the detention pond do not justify it as a viable solution.

The recommended solution is Alternative 4 which consists of property buyouts within the 10-Year floodplain. See ***Exhibit 6*** in ***Appendix G*** for property buyouts location. The City and the County can utilize the purchased land for green space after any existing structures are removed from the properties. The preliminary construction cost estimates for Alternative 3 is $1.3 million. The approximate cost of buyouts is $2.5 million. See ***Tables 6.0 and 7.1*** in ***Appendix A***.

Rio Grande Tributary 1: The limits of the Rio Grande Tributary 1 study extend from approximately 3,000 feet north of Eidson Road on the upstream boundary to 7,700 feet south of Eidson Road on the downstream boundary. The 1.44 square miles that encompassed this study collects 1,500 cfs of runoff for the 10-Year Fully Urbanized conditions.

The recommended solution for the Rio Grande Tributary 1 study is Alternative 2, channel modifications. This alternative consists of channel modifications from the Eidson Road/La Herradura intersection to 2,500 feet downstream. There will be three proposed drops for this alternative, ranging in depth from 1.5 to 3.70 feet. The channel modifications will consist of a grassed, trapezoidal channel, with a 12 foot bottom width and 4:1 side slopes. ***Exhibit 18*** in ***Appendix H*** depicts the channel modifications for Alternative 2 of Rio Grande Tributary 1.

The benefit/cost economic analysis indicated Alternative 2, channel modifications, ratio as higher than the other two alternatives. The greatest reduction in impacts (parcels within the floodplain) is from Alternative 3 but when comparing the parcel reduction difference between Alternative 2 and 3 the results are minimal. The preliminary construction cost estimates for Alternative 2 is $590,000. See ***Tables 6.0, 7.2 and 12.0*** in ***Appendix A***.

Rio Grande Tributary 3: The limits of the Rio Grande Tributary 3 study extend from approximately 2,000 feet north of El Indio Highway (FM 1021) on the upstream boundary to 4,400 feet southeast of El Indio Highway (FM 1021) on the downstream boundary. The 11.53 square miles that encompassed this study generate 6,600 cfs of runoff for the 10-Year Fully Urbanized conditions.

The recommended solution for the Rio Grande Tributary 3 study is Alternative 2. This alternative consists of channel modifications from approximately 1,400 upstream of El Indio Highway to 2,600 feet downstream of El Indio Highway. There are four proposed drops for this alternative, ranging from 0.5 to 3 feet. The channel modifications will consist of a grassed, trapezoidal channel, ranging from a bottom width of 40 to 55 feet and 4:1 side slopes. In addition to having the highest benefit/cost ratio, this alternative compared to the others, minimizes the depth of water flowing over El Indio Highway. The preliminary construction cost estimates for Alternative 2 is $1.90 million. See ***Tables 6.0, 7.3 and 15.0*** in ***Appendix A.*** ***Exhibit 27*** in ***Appendix G*** depicts the channel modifications for Alternative 2 of Rio Grande Tributary 3.

Rio Grande Tributary 4: The limits of the Rio Grande Tributary 4 study extend from approximately 200 feet north of FM 1021/Rosita Valley Road intersection on the upstream boundary to 600 feet east of the High Noon Drice/Latigo Circle on the downstream boundary. The 2.01 square miles that encompassed this study generate 1,500 cfs of runoff for the 10-Year Fully Urbanized conditions.

The recommended solution for the Rio Grande Tributary 4 study is Alternative 1. This alternative consists of a retention/detention pond to the north of FM 1021 and channel modifications. Channel modifications will start at the outfall of the detention pond and end at 450 feet south of FM 1021. From this point water will be captured via a 6:1 sloped grate inlet and taken underground through a single box culvert that will run along Chuck Wagon Road to outfall at 400 feet south of Loma Linda Drive. This alternative also consists of another segment of channel modifications from just south of the Rosita Valley/Loma Linda intersection and

ending at approximately 1,100 feet south of the Ghost Rider Drive/Wagon Wheel Road intersection. This proposed channel will also capture water via two proposed 6 feet by 4 feet (2 - 6'X4') multiple box culvert structure taking water from the north side of Rosita Valley Road to the south side of Rosita Valley Road. A small proposed ditch running on the north side of Rosita Valley road will help in capturing most of the water being generated by the vacant area north of Rosita Valley Road. This proposed ditch will outfall on the upstream portion of the aforementioned multiple box culvert structure. ***Exhibit 35*** in ***Appendix G*** depicts the channel modifications for Alternative 1, Rio Grande Tributary 4.

Although in the economic analysis the benefit/cost ratio is higher for **Alternative 2**, the greatest reduction in impacts (parcels within the floodplain) is for **Alternative 1**. **Alternative 1** removes 93 more parcels than **Alternative 2** and 26 more parcels than **Alternative 3** from the 10 Year floodplain. **Alternative 1** is the only alternative to remove water currently overtopping Rosita Valley Road which would otherwise be overtopped with the improvements made from **Alternatives 2** and **3**. The preliminary construction cost estimates for **Alternative 1** is $2.86 million. See ***Tables 6.0, 7.4 and 17.0*** in ***Appendix A***.

Rosita Creek: The limits of the Rosita Creek study extend from approximately 5,000 feet north of El Indio Highway (FM 1021) on the upstream boundary to 12,000 feet south of El Indio Highway (FM 1021) on the downstream boundary. The 35.04 square miles that encompassed this study generate 7,600 cfs of runoff for the 10-Year Fully Urbanized conditions.

The main focus of this analysis was to find a solution that reduces the amount of water overtopping FM 1021. Two alternatives were explored and both solutions minimize the amount of flow overtopping the road. The recommended solution is Alternative 2 which will take the majority of the flow for the 25 year Fully Urbanized conditions under FM 1021. The resulting depth of flow from this alternative over FM 1021 is less than 1inch. The existing 60 foot span bridge will be replaced with a 120' span bridge. The 2 – 6' by 4' MBC relief structure will remain in place without any modifications. The 3 – 6' by 6' Multiple Box Culvert structure located 2,400 feet east of the main conveyance will be upgraded to 16 – 6' by 6' boxes, therefore

13 – 6' by 6' boxes will be added to the existing structure. The probable construction cost estimate for this Alternative is approximately $819,000. In comparing Alternative 2 to Alternative 1, the probable construction estimates results are similar. Therefore, the recommended alternative is to replace this bridge. See ***Tables 6.0, 7.5 and 21.0*** in ***Appendix A***. ***Exhibit 45*** in ***Appendix G*** depicts the channel modifications and bridge structure for Alternative 2, Rosita Creek.

2.0 EXISTING AND FULLY URBANIZED CONDITIONS

The current regulatory Flood Insurance Rate Maps published by FEMA show all streams floodplains designated as *Zone A.* A *Zone A* floodplain indicates that it was delineated using a limited analysis and no official base flood elevations determined or provided.

To establish a baseline for the entire study, consideration was given to several factors, for example, extents of study, land use type, habitable structures located in the floodplain, potential damages, etc. When establishing the baseline, two models were created, Existing and Fully Urbanized Conditions. A table was created depicting Existing and Fully Urbanized Conditions property values located in the 10 and 100-year floodplain. This table can be found in ***Appendix A*** as ***Table 1.0***. ***Exhibits 2, 12, 21, 30*** and ***39*** in ***Appendix G*** show the overlay of the Existing Conditions for the 100-Year (1% Annual) floodplain over the most recent publication of the Zone A FEMA FIRM floodplain. .

2.1 Seco Creek

The Seco Creek watershed encompasses approximately 5,437 acres (8.5 square miles). Seco Creek collects stormwater runoff from a section of Maverick County generally located north of the City of Eagle Pass stretching from just east of US Highway 57 to North US Highway 277. Flow in Seco Creek drains towards the west and eventually outfalls into the Rio Grande River. The Seco Creek watershed is approximately 10 percent developed with a combination of open space and single family residential land use types. The Seco Creek watershed is divided by the Maverick County Irrigation Canal. ***Exhibit 1*** in ***Appendix G*** depicts the watershed and sub-watershed boundaries, including the overall project location.

Seco Creek is an earthen channel which intersects a total of three crossings within the study area. These crossings from upstream to downstream are: Union Pacific Railroad (UPRR), Barrera Street, and North US Highway 277. The crossings at UPRR and North US Highway 277 are bridges, while the crossing at Barrera Street consists of 5 – 5-ft x 3-ft box culverts. The limits of the Seco Creek study extend from approximately 4,400 feet to the east of Union Pacific Railroad

on the upstream boundary to 750 feet west of FM 277. The entire length of the Seco Creek study is approximately 8,000 feet or 1.50 miles and the existing channel consists primarily of open natural channel sections.

2.2 Rio Grande Tributary One

The Rio Grande Tributary One (RGT1) watershed encompasses approximately 918 acres (1.44 square miles) and is bounded by Avenida Linares to the north, Eidson Road to the east and Venesas to the south. RGT1 drains towards the south and eventually outfalls into the Rio Grande River. This watershed is approximately 70 percent developed with a combination of orchards, open space, and single family residential land use types. In addition, this watershed is divided by the Maverick County Irrigation Canal Lateral Channels. ***Exhibit 11*** in ***Appendix G*** depicts the watershed and sub-watershed boundaries, including the overall project location.

The limits of the Rio Grande Tributary 1 study extend from approximately 3,000 feet north of Eidson Road on the upstream boundary to 7,700 feet south of Eidson Road on the downstream boundary. An approximate segment length of 1,700 feet on the upstream portion of the existing channel consists of a 5 foot bottom width concrete channel and 4:1 side slopes. The rest of the study extent for RGT1 is composed of an earthen channel which intersects one road crossing within the study area. This road crossing is a 36-in corrugated metal pipe (CMP) culvert located at Eidson Road. Downstream of Eidson Road, the channel follows parallel to La Herradura Road on the west side; in addition, within this area the channel captures water from the area east of La Herradura via a series of culvert structures. The entire length of the Rio Grande Tributary One channel analyzed as part of this study is approximately 10,700 feet (2.03 miles).

2.3 Rio Grande Tributary Three

The Rio Grande Tributary Three (RGT3) watershed encompasses approximately 7380 acres (11.53 square miles). RGT3 collects stormwater runoff from a section of Maverick County generally located in the eastern portion of the City of Eagle Pass, along El Indio Highway (FM 1021). The RGT3 watershed drains towards the southeast and eventually outfalls into the Rio

Grande River. This watershed is approximately 35 percent developed with a combination of orchards, open space, and single family residential land use types. In addition, this watershed lies between RGT1 and the Rio Grande Tributary 4 (RGT4) watersheds. Maverick County Irrigation Canals and Lateral Channels cut through the RGT3 watershed. ***Exhibit 20*** in ***Appendix G*** depicts the watershed and sub-watershed boundaries, including the overall project location.

RGT3 is a concrete and earthen channel which intersects a series of road crossings and private drive crossings within the study area. These crossings from upstream to downstream are: South Veterans Boulevard (FM 3443), Laura Street pedestrian bridge, El Indio Highway (FM 1021), 7 private drives between FM 1021 and Jardines Verdes, Jardines Verdes and 2 private drives. All private drives consist of small driveway bridges (piers and concrete slabs). South Veterans Boulevard (FM 3443), El Indio Highway (FM 1021) and Jardines Verdes are Multiple box culvert bridge class structures. The upstream portion of RGT3 consists of approximately 4,700 feet of open concrete channel with an average 40 foot bottom width and 165 Ac-Ft storm water detention pond located north of Cherry Leaf Road. This pond is currently being built and has been incorporated into the "existing conditions" analysis. Immediately downstream of this pond is where the 40 foot bottom width concrete channel begins and ends at 700 feet downstream of the Laura Street pedestrian bridge. From this point to the study boundary, the channel is earthen. Downstream of El Indio Highway (FM 1021), the channel makes a 90 degree bend, following parallel to FM 1021 and on the south side. The entire length of the RGT3 channel analyzed as part of this study is approximately 16,300 feet (3.1 miles).

2.4 Rio Grande Tributary Four

The Rio Grande Tributary Four (RGT4) watershed encompasses approximately 1285 acres (2.01 square miles). The RGT4 watershed collects stormwater runoff from a section of Maverick County generally located in the southeastern portion of the City of Eagle Pass, crossing El Indio Highway (FM 1021). Flow in Rio Grande Tributary Four drains towards the southwest and eventually outfalls into the Rio Grande River. The Rio Grande Tributary Four watershed is approximately 60 percent developed with a combination of open space and single family

residential land use types. This watershed is bounded by Karen and Ruela Drive to the north, Chula Vista Road to the east and Wagon Wheel Road to the south. The RGT4 watershed is divided by the Maverick County Irrigation Canal Lateral Channel (Lateral #50- WCID). ***Exhibit 29*** in ***Appendix G*** depicts the watershed and sub basins boundaries; including the overall project location.

The RGT4 channel is an earthen channel which intersects a total of eight road crossings within the study area. These crossings from upstream to downstream are: Alamo Road, Fresno Street, El Indio Highway (FM 1021), Chuck Wagon Road, Wagon Wheel Road, Lomalinda Drive and High Noon Drive. The existing conveyance structures along the channel range from the smallest being a 15 inch CMP at a private drive to the largest being 3 – 30-in Reinforced Concrete Pipe (RCP) culverts for El Indio Highway (FM 1021). The entire length of the RGT4 channel analyzed as part of this study is approximately 11,000 feet (2.04 miles) and consists primarily of open natural channel sections. There is an existing retention pond located approximately 100 feet north of Alamo Road, this retention pond serves no hydraulic function and holds water through out the year. For a large portion of the area studied there is no channel defined, the street (Chuck Wagon Road) is being utilized for conveyance which in turn all properties on Chuck Wagon Road end up getting flooded.

2.5 Rosita Creek

The Rosita Creek watershed encompasses approximately 22,428 acres (35.04 square miles). Rosita Creek collects stormwater runoff from a section of Maverick County generally located east of the City of Eagle Pass stretching from just north of US Highway 57 to south of the El Indio Highway (FM 1021). Flow in Rosita Creek drains towards the south and eventually outfalls into the Rio Grande River. The Rosita Creek watershed is approximately 5 percent developed with a combination of open space and single family residential land use types. The Rosita Creek watershed is divided by the Maverick County Irrigation Canal. ***Exhibit 38*** in ***Appendix G*** depicts the watershed and sub basin boundaries, including the overall project location.

Rosita Creek is an earthen channel which intersects one road crossing within the study area at El Indio Highway (FM 1021). There are currently three multiple openings at the Rosita Creek/FM 1021 crossing, these three openings consists of (starting with the most westerly structure): a 60' span bridge, a 2–6 feet span by 4 feet high multiple box culvert (MBC) structure and a 3 – 6' by 6' MBC structure. The existing, most easterly 3 – 6' by 6' MBC structure is undersize and during heavy frequency storm events, FM 1021 gets overtopped and road closures occur within this vicinity. The entire length of the Rosita Creek channel analyzed as part of this study is approximately 17,500 feet (3.4 miles) and consists primarily of open natural channel sections.

2.6 Methodology

2.6.1 Hydrologic Analysis

A hydrologic analysis was conducted to estimate the peak discharges of each watershed within the study using the U.S. Army Corps of Engineers' Hydrologic Modeling System (HEC-HMS), Version 3.2.0. TR-55 and the Soil Conservation Service (SCS) methodologies were utilized for all streams analyzed. The TR-55 method was used to calculate time of concentration and lag time based on slope/flow characteristics for sheet flow, shallow concentrated flow and channel flow. The SCS method was used in the Hydrological (HEC-HMS) models to develop discharges using curve numbers and lag time. Two baseline models were developed for each stream, Existing and Fully Urbanized conditions. The Existing conditions model reflects current land use conditions within each watershed, while the Fully Urbanized conditions reflects each watershed as a 100% developed area. Due to the lack of previous developed hydrologic models for the project area, calibration of the hydrologic model results considered flows calculated using Regional Regression Methodologies. ***Table 3.1*** in ***Appendix A*** displays the results of the calibration process.

There are five total watersheds in the entire study. All of these watersheds were subdivided to form sub-basins. Utilizing 2 foot contours, the sub-basin delineation was drawn at the high point boundaries within the watershed; certain strategic areas were also utilized for drainage divides; for example: roads, highway, crossings, etc. The drainage areas for each watershed range from 1.44

square miles for Rio Grande Tributary 1 to 35.04 square miles for Rosita Creek. Once the delineations for all watersheds were developed, the next step was to compute the time of concentration for each sub-basin. The general definition of Time of Concentration is the time it takes a drop of water to travel from the uppermost part of the watershed to the lowest point within the watershed. As discussed in the first paragraph of this section, the time of concentration has three different phases, sheet (overland) flow, shallow concentrated flow, and channel flow. All of these phases are dependent on velocity of flow in which the velocities are a function of slope and terrain characteristics and the hydraulic length. Once those velocities have been determined, the travel time associated with each phase is the hydraulic length divided by velocity.

Rainfall depths were computed using W.H. Asquith interface program, which performs the computational procedures documents in Depth-Duration Frequency of Precipitation for Texas 1998. Coordinates were extrapolated from the center of the watershed and the depths were determined. The calculation of sheet flow time of concentration used the 2-year 24 hour rainfall of 3.04 inches. The calculation of channel flow assumed a flow velocity of 5.0 feet per second, which is considered to be conservative and sufficient for the purpose of this project.

The time of concentration is the summation of these phases, where:

$$t_c = t_{sheet} + t_{shallow\ concentrated} + t_{channel}.$$

The empirical relationship between lag time and time of concentration is $L = 0.6\ t_c$. The time for travel depends on the type of conveyance, surface type, channel, pipes, etc. The watershed exhibits are located in ***Appendix G, Exhibits 1, 11, 20, 29,*** and ***38.*** ***Table 3.0*** in ***Appendix A*** displays the computations and results for all sub-basin Lag Times.

In addition, runoff curve numbers were developed using the NRCS Runoff Curve Number method. The soil types found in this area were determined to be hydrologic soil groups B, C, and D as defined by the Hydrologic Soil Category. The sub-basins were further subdivided for each corresponding land use category and soil types within the watershed. Using the land use and soil types for each sub-basin; a weighted Curve Number (CN) was determined for each of the

watershed sub-basins. ***Table 2.0*** in ***Appendix A*** shows the breakdown of the weighted Curve Numbers for each sub-basin.

Ultimately, utilizing all the parameters aforementioned, (i.e. sub-basins, rainfall, Lag Times, Land Use and Curve Numbers) the flows for the 2, 5, 10, 25, 50 and 100-year storm events in cubic feet per second (cfs) were determined. The flows computed for Existing and Fully Urbanized Conditions can be found in ***Appendix B,*** which lists the HMS output tables.

2.6.2 Hydraulic Analysis

A hydraulic analysis was conducted to estimate the water surface elevations for all frequency storms on analyzed streams. The sources for the terrain data utilized to develop the hydraulic models for the entire study was sets of two-foot interval contours created for each stream. These contours were created from their respective Triangulated Irregular Network (TIN) files. These TIN files were generated from a combination of LIDAR data from the IBWC, ten-foot interval contours from the USGS, and two-foot interval contours obtained from Tetra Tech.

Manning's "n" values were assigned primarily from aerial photography, as well as from photographs taken in the field. The streams in this study are mixed with some in natural floodplain conditions (undeveloped channels and overbanks), while portions are in developed areas. Areas of this study consists of concrete open trapezoidal channels, this roughness differential was accounted for in those areas.

The hydraulic component was created using the US Corps of Engineering (USACE) HEC-RAS software. Two HEC-RAS baseline models were developed for each stream, Existing and Fully Urbanized conditions. The Existing conditions model reflects current conditions within each watershed, while the Fully Urbanized conditions reflects each watershed as a 100% developed area. The HEC-RAS summary tables are located in ***Appendix C***.

The extents of these limits, comparisons between the Existing and Fully Urbanized Conditions; and all HEC-RAS cross sections utilized in the analysis can be found in ***Appendix G***, ***Exhibit 3, 13, 22, 31 and 40*** .

2.6.3 Hydrologic and Hydraulic Criteria

In order to maximize damage control and minimize construction costs, a hydrologic and hydraulic criterion was developed. The criterion was based on a preliminary analysis of all floodplain mappings for all streams (excluding Rosita Creek). The mappings for the 2, 5, 10, 25, 50 and 100 year were laid on top of each other and by inspection the **10-year** storm event covers the most flooded area relative to all other storms. Although the analysis was developed for 2, 5, 10, 25, 50 and 100-year storm events, the comparisons made between proposed alternatives on each stream and both Existing and Fully Urbanized Conditions are solely based on the **10-year**, excluding Rosita Creek.

The criterion developed for Rosita Creek was based on The Texas Department of Transportation (TxDOT) Hydraulic criteria. The focus of the flooding problems for Rosita Creek is localized to the FM 1021 (El Indio Highway) crossing, a TxDOT facility. To be in compliance with TxDOT criteria, ***The Texas Department of Transportation Hydraulic Design Manual***, Recommended Design Frequencies (years) Table was referenced for criteria (***Chapter 5, page 5-12***). FM 1021 is a Principal Arterial; therefore the **25-year** is desirable for design.

3.0 ENVIRONMENTAL PERMITTING

An investigation was conducted regarding environmental, social, and cultural factors for existing watershed conditions in the study area for each proposed alternative, and factors were identified that need to be considered for proposed solutions. Particular attention was paid to the identification of permits that may need to be obtained from governmental regulatory agencies. The proposed alternative solutions could be subject to review by the United States Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), the United States Fish and Wildlife Service (USFWS), the Texas Commission on Environmental Quality (TCEQ), the Texas Parks and Wildlife Department (TPWD), and the Texas Historical Commission (THC).

Under Section 404 of the Clean Water Act (CWA), and Section 10 of the Rivers and Harbors Act of 1899, the Secretary of the Army is responsible for administering a regulatory program that requires permits for the discharge of dredged or fill material into waters of the United States, including wetlands (33 CRF Part 323). Other environmental laws must be addressed in the evaluation of all permit applications, including the Endangered Species Act (ESA) and the National Historic Preservation Act (NHPA). The Secretary operates the CWA regulatory program through USACE.

3.1 Wetlands and Waters of the United States

3.1.1 Jurisdictional Determination

The term "waters of the United States" as defined in 33 CFR 328.3 (a) includes: all waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; waters such as lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds; all impoundments and tributaries of waters of the United States; and wetlands adjacent to waters of the United States. Isolated waters such as old river scars, cutoff sloughs, and abandoned construction and mining pits may also be waters of the United

States if they meet certain criteria. Waters of the United States may also include areas that are man-made, or man-induced.

For waterbodies and tributaries that are not relatively permanent waters, including adjacent wetlands if present, an evaluation must be made to determine if the feature has a significant nexus to traditionally navigable water. A significant nexus exists if the tributary has more than a speculative or insubstantial effect on the chemical, physical, and/or biological integrity of a traditionally navigable water. According to the USACE – Fort Worth District list of navigable waters of the United States, the Rio Grande River is considered a navigable water from the Zapata-Webb county line upstream to the point of intersection of the Texas-New Mexico state line and Mexico. Because all of the tributaries described in **Section 2.0** flow directly into the Rio Grande River, a traditionally navigable water, a significant nexus exists. Because of this significant nexus, USACE jurisdiction under the CWA would extend to the tributaries of the Rio Grande River, in addition to the Rio Grande River itself.

3.1.2 Section 404 Permitting Responsibilities

Permits issued by USACE may be in one of three primary forms: general permits, letters of permission, and standard individual permits. Activities requiring authorization that are similar in nature and would cause only minimal individual and cumulative environmental impacts may qualify for general permits. These general permits may be either nationwide of regional in scope, and may be used to authorize specific activities as long as the impact of the work on the aquatic ecosystem is minor and the agency responsible for the work meets certain conditions. Some general permits require that USACE be notified before begins. This is called "preconstruction notification," and is usually abbreviated as "PCN."

The letter of permission is another USACE permit option. This is a form of individual permit issued through an abbreviated process that includes coordination with federal and state fish and wildlife agencies and a public interest evaluation, but without the publication of individual public notice.

If the proposed activity does not meet the requirements of a general permit and cannot be authorized by a letter of permission, a standard individual permit is required. The project evaluation process for this type of permit includes: pre-application consultation (for larger projects); submittal of a completed application form; a public notice (if needed) and comment period on the permit application; preparation of permit decision documents, including a discussion of the environmental impacts of the project; the findings of the USACE public interest review process, and compliance determinations with the Section 404(b) (1) Guidelines; and the permit decision.

As stated in 40 CFR 230.10, "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." An alternative is considered practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Based on a preliminary review of the project alternatives, it appears many of the project alternatives would exceed thresholds established by any NWP, and result in more than minimal adverse impacts to waters of the United States, thus requiring a Section 404 individual permit. Nationwide Permit 39 *Commercial and Institutional Developments* and Nationwide Permit 43 *Stormwater Management Facilities* could be applicable for the proposed project alternatives whose impacts fall below the thresholds of the NWPs. Both NWP 39 and NWP 43 can authorize projects whose discharges would not exceed 0.5 acre or 300 linear feet of permanent impacts to waters of the United States. The 300-linear foot threshold can be waived in writing by the district engineer, but because many of the project alternatives would impact 1,000 linear feet or greater of stream channel, the possibility of a written waiver is highly unlikely. With the exception of Seco Creek Alternative 1 and Rosita Creek Alternative 2, which would fall below the thresholds for NWP 39 or NWP 43, all project alternatives would require a Section 404 individual permit.

Table A contains a summary of potential impacts to waters of the United States by the project alternatives.

TABLE A - SUMMARY OF PROPOSED IMPACTS TO WATERS OF THE UNITED STATES BY ALTERNATIVE

Feature Name	Alternative	Impacted Length	OHWM (average)	Acres
Rio Grande Tributary 1	1	2,700	10	0.62
Rio Grande Tributary 1	2	2,800	10	0.64
Rio Grande Tributary 3	1	3,300	20	1.50
Rio Grande Tributary 3	2	4,400	20	2.0
Rio Grande Tributary 3	3	4,400	20	2.0
Rio Grande Tributary 3	4	5,000	20	2.30
Rio Grande Tributary 4	1	3,800	8	0.70
Rio Grande Tributary 4	2	2,600	8	0.50
Rio Grande Tributary 4	3	1,300	8	0.25
Seco Creek	1	100	18	0.05
Seco Creek	2	3,000	18	1.25
Rosita Creek	1	1,200	10	0.25
Rosita Creek	2	200	10	0.05

The individual permit application must include a detailed analysis of project alternatives to ensure the least environmentally damaging practicable alternative is selected. The application process also includes a 30-day public comment period, an interagency review and a compensatory mitigation plan. Processing time for individual permits is typically 12 to 18 months.

Under Section 401 of CWA, certification of compliance with state water quality standards by the State Water Quality Agency is required for any discharge of pollutants into waters of the United States. Section 401 water quality certification is conducted by TCEQ. All Section 404 individual or nationwide permits require Section 401 water quality certification.

The TCEQ and the USACE have developed a tiered system of review for all Section 404 permit applications based on project size and the area of waters in the state affected. Generally, for small projects (Tier I) that affect less than three-acres of waters in the state, or less than 1,500 linear-feet of streams, the TCEQ has determined that incorporating certain best management practices and other requirements into the project will sufficiently address the likelihood that water quality will remain at the desired level. Any project that does not qualify for a Tier I review or for which the applicant elects not to incorporate Tier I criteria or prefers to use alternatives will be considered a Tier II project. Tier II projects are subject to a certification review by TCEQ.

3.1.3 Compensatory Mitigation

Currently undeveloped stream resources are considered valuable resource commodities by USACE. With the continued expanding development along stream corridors, and the shifting focus of USACE to a watershed approach to permitting, the focus of the project should be avoidance and minimization measures to the fullest extent practicable in order to protect stream resources from unnecessary degradation. Per a 1990 Memorandum of Agreement with USACE and EPA, avoidance measures include evaluating project alternatives which would not result in adverse impacts to the aquatic environment and minimization measures include taking appropriate and practicable steps to minimize adverse impacts to the aquatic environment through project modifications such as relief channels which would not result in discharges into waters of the United States and permit conditions such as restoration of temporary disturbances. Minimization measures appropriate for this project could include maintaining existing stream channels and keeping construction activities above the plane of the OHWM wherever possible.

For unavoidable adverse impacts to the aquatic environment which remain after all appropriate avoidance and minimization measures have been exhausted, compensatory mitigation would be

required. Per recent USACE guidance regarding compensatory mitigation, the use of a mitigation bank or in-lieu fee program is preferred over permittee responsible mitigation. However, there are currently no mitigation banks whose service areas would include the Rio Grande River basin, thus permittee responsible mitigation would be considered the appropriate compensatory measure for the proposed project. USACE requires in-kind compensatory mitigation for stream resource impacts and this should also be considered when developing project alternatives.

The compensatory mitigation plan must include a description of mitigation activities, which may include the establishment of woody or herbaceous vegetation for stream or habitat restoration along modified channels, or the rehabilitation of a degraded local stream in the same watershed. The compensatory mitigation plan must also establish a monitoring period for the mitigation area(s), with annual reports to USACE detailing what activities have occurred in the mitigation areas, including the success of mitigation plantings and any required replanting necessary to meet success criteria. The establishment of a protective covenant, typically by deed restriction or by third-party conservation easement would also be necessary to ensure the ongoing protection and success of the mitigation area(s).

Additionally, the compensatory mitigation plan must include a description of temporary erosion control devices which would be implemented and maintained until construction is complete. Erosion control devices to be used may include, but are not limited to, temporary vegetation, blankets/matting, mulch, sod, interceptor swales, and diversion dikes. In addition, at least one sedimentation control device would be maintained and remain in place until completion of the project. Sedimentation control devices which could be used include, but are not limited to, sand bag berms, silt fences, triangular filter dikes, rock berms and hay bale dikes, brush berms, stone outlet sediment traps, or sediment basins.

3.2 Floodplains

According to the FEMA Flood Insurance Rate Map (FIRM) Number 4804710002 C, dated October 19, 2005, (Seco Creek); FIRM Number 4804710005 C, dated October 19, 2005, (upper portion of Rio Grande Tributary 3); and FIRM Number 4804700010 A, dated December 20, 1977, (Rio Grande Tributaries 1, 4 and lower portion of 3); the proposed build solutions could

impact the 100-year floodplain. Modifications to the 100-year floodplain would have to be coordinated with the local floodplain administrator (City of Eagle Pass) once a project design alternative is selected. Prior to construction, a request for a Conditional Letter of Map Revision (CLOMR) would be submitted to FEMA describing the proposed changes to the 100-year floodplain. To officially change the 100-year floodplain, after the project has been constructed a Letter of Map Revision (LOMR) would be submitted to FEMA.

3.3 Threatened and Endangered Species

The ESA declares the intention of the Congress to conserve threatened and endangered species and the ecosystems on which those species depend. The ESA requires that federal agencies, in consultation with USFWS, use their authorities in furtherance of its purposes by carrying out programs for the conservation of endangered or threatened species, and by taking such action necessary to ensure that any action authorized, funded, or carried out by the Agency is not likely to jeopardize the continued existence of such endangered or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary of the Interior or Commerce, as appropriate, to be critical.

If a proposed project includes the discharge of dredged or fill material into waters of the United States, and/or work in, or affecting, a navigable water of the United States, and if federally-listed threatened or endangered species, or its critical habitat, may be affected by the proposed activity, then USACE must consult with the appropriate federal agency. USACE must consider all the direct and indirect impacts of the proposed project on the federally-listed species or its critical habitat. For the purpose of evaluating Department of the Army applications, the scope of analysis under the ESA is the permit area, which includes all waters of the United States affected by activities associated with the project, as well as any additional area of non-waters of the United States in the immediate vicinity of, directly associated with, and/or affected by, activities in waters of the United States where there is sufficient federal control and responsibility.

Standard Individual Permit applications are reviewed on a case-by-case basis by USACE for potential effects to threatened or endangered species. Permit applicants should provide

information to USACE that addresses whether proposed project may affect federally listed endangered or threatened species.

Letter of Permission procedure general conditions provide that no authorization will be granted for an activity that is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Endangered Species Act, or for an activity that is likely to destroy or adversely modify the critical habitat of such species. Applicants must notify USACE if any listed species or critical habitat might be affected by, or is in the vicinity of, the project and must not begin work until notified by the District Engineer that the requirements of the Endangered Species Act have been satisfied and that the activity is authorized.

For authorization under nationwide, regional, or programmatic general permits, prospective permittees must submit a pre-construction notification to USACE (even if pre-construction notification is not otherwise required) if the project may affect, or is in the vicinity of, federally-listed endangered or threatened species. The PCN must include the name(s) of the endangered or threatened species that may be affected by the proposed work, located in the vicinity of the proposed activity, or utilize the designated critical habitat as well as any other information required by the general permit. As a result of formal or informal consultation with USFWS, USACE may add species-specific regional endangered species conditions to general permits. No activity can be authorized by a general permit if the continued existence of a federally-threatened or endangered or proposed threatened or endangered species would be jeopardized or its critical habitat destroyed or adversely modified by the proposed project.

TPWD maintains special species lists through the Biological Conservation Data System (BCD). The BCD identified several threatened or endangered species that may occur within or migrate through Maverick County. ***Appendix H*** contains a summary of the listed status of each of these species. Coordination with the Texas Parks and Wildlife Department revealed that no known state- or federal-listed threatened or endangered species have been observed in or around the

proposed project area, though recent detailed studies are not available. A search of the Texas Natural Diversity Database (TNDD) recorded observations of the indigo snake in the vicinity of Rio Grande Tributary 1, Rio Grande Tributary 3, and Seco Creek, but the last recorded observations were in 1972. The TNDD search also reported observations of the black bear in 1981. There is potential for suitable habitat for several of the listed species and it should be noted that presence of suitable habitat for a threatened or endangered species is not necessarily indicative that the species will be present, however, if suitable habitat for a particular species is recognized, a survey for those species should be conducted prior to construction.

The proposed project area may provide habitat for the following state-listed threatened or endangered species: Amphibian species – South Texas siren; Bird species – American Peregrine Falcon (potential migrant), Arctic Peregrine Falcon (potential migrant), interior least tern, and Peregrine Falcon (potential migrant); Fish species – Proserpine shiner, Rio Grande darter, and Rio Grande silvery minnow (extirpated); Mammal species – Gray Wolf (extirpated), Jaguarundi, Ocelot, black bear, and White-nosed coati; and Reptile species – Indigo snake. The proposed project area should be surveyed for the listed species during appropriate times of species occupation by qualified wildlife biologists. Additionally, coordination with the USFWS and TWPD is recommended prior to construction of the proposed flood control project.

3.4 Historical and Archeological Sites

3.4.1 Historic Resources

Section 106 of NHPA requires a federal agency with jurisdiction over a federal, federally assisted, or federally licensed undertaking to take into account the effects of the agency's undertakings on properties included in, or eligible for listing in the National Register of Historic Places. The National Register of Historic Places (NRHP) is a register of historic and prehistoric sites, buildings, districts, structures, and objects significant in American history, architecture, archeology, engineering, and culture that is maintained by the Secretary of the Interior. Sites that are prehistoric (prior to 1542 in the United States) or are historic are eligible for listing in the NRHP.

Section 106 and its implementing regulations, 36 CFR Part 800: Protection of Historic Properties, effective January 11, 2001, also require that federal agencies consult with federally recognized Native American tribes in all phases of the Section 106 process when an agency undertaking may have the potential to affect Native American historic properties on or off tribal lands. Because some of the alternatives for Rio Grande Tributaries 1 and 3 are within the area of the Kickapoo Traditional Tribe of Texas, tribal coordination will be required for these alternatives.

36 CFR 800 Appendix A sets forth the criteria that will be used by the Advisory Council on Historic Preservation to determine whether to begin a Section 106 review. The Advisory Council on Historic Preservation may choose to exercise its authorities under Section 106 of the NHPA to participate in an individual project. The Advisory Council on Historic Preservation is likely to enter the Section 106 process when an undertaking has substantial impacts on important historic properties; presents important questions of policy or interpretation; has the potential for presenting procedural problems; and presents issues of concern to Indian tribes or Native Hawaiian organizations.

The lead federal agency must afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on undertakings on properties included in or eligible for listing in the NRHP. The Advisory Council on Historic Preservation is an independent federal agency charged with advising the President and Congress on historic preservation matters and administering the provisions of Section 106 of the NHPA. The State Historic Preservation Officer (SHPO) is an official appointed by the Governor to administer the state historic preservation program. The SHPO consults and assists federal agencies in identifying historic properties, assessing effect upon them and considering alternatives to avoid or reduce those effects.

Individual Permit applications are reviewed on a case-by-case basis by USACE for potential effects to prehistoric or historic properties. Permit applicants should provide information to

USACE that addresses whether proposed project may affect historic properties listed, determined to be eligible, or which the prospective permittee has reason to believe may be eligible for listing, in the NHRP.

The general conditions of the Letter of Permission procedure provide that if a known historic property would be encountered, the permittee shall not conduct any work in the permit area that would affect the property until the requirements of 33CFR Part 325, Appendix C, have been satisfied. If a previously unknown historic property is encountered during work authorized by an LOP issued under this procedure, the permittee shall immediately notify USACE and avoid further impact to the site until USACE has verified that the requirements of 33 CFR Part 325, Appendix C, have been satisfied. Applicants must notify USACE if any historic properties listed, determined to be eligible, or which the prospective permittee has reason to believe may be eligible for listing in the NHRP might be affected by, or is in the vicinity of, the project and must not begin work until notified by the District Engineer that the requirements of the Section 106 have been satisfied and that the activity is authorized.

For authorization under nationwide, regional, or programmatic general permits, prospective permittees must submit a pre-construction notification to USACE (even if pre-construction notification is not otherwise required) if the project may affect any historic properties listed, determined to be eligible for listing, or which the prospective permittee has reason to believe may be eligible for listing in the NHRP. Information on the location and existence of historic resources can be obtained from the SHPO and the NRHP (see 33 CFR 330.4(g). For activities that may affect historic properties listed in, or eligible for listing in, the NRHP, then the notification must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property as well as any other information required by the general permit. Determinations for eligibility for listing in the NRHP are made USACE and the SHPO. In cases of disagreements between USACE and the SHPO, the National Park Service (NPS) has the final decision. All sites are potentially eligible and retain legal protection under Section 106 until it is determined otherwise. Permittees may not begin work

until notified by USACE that the requirements of the Section 106 of the NHPA and 33 CFR Part 325, Appendix C have been satisfied and that the activity is authorized.

In addition to federal laws, the Antiquities Code of Texas requires that the THC staff review any action that has the potential to disturb historic sites on public land. Actions that need review under the Antiquities Code of Texas include any construction program that takes place on land owned or controlled by a state agency or a state political subdivision, such as a city or a county. Because the proposed activities may involve construction on land owned by a public agency, the Antiquities Code applies. All cultural resources, historic and prehistoric, on public land are protected by the Code.

The THC online Texas Historical Sites Atlas was searched to identify known historic properties. No previously recorded historic properties in or immediately adjacent to the study area for any proposed alternative were identified. An examination of historic aerial maps was also made to determine the presence of historic-age properties within the study areas for the proposed alternatives, with "historic-age" being defined as fifty years of age or older. A windshield survey of the study areas for each alternative was conducted by a historian meeting the Secretary of the Interior's Qualification Standards for Historian and Architectural Historian (36 CFR Part 61) on August 26 and 27, 2008. Particular attention was paid during field investigation to a identification of historic-age irrigation systems, and to an evaluation of the historic significance and integrity of those systems. The results of the historic resources investigation are that no historic-age resources eligible for listing on the NRHP were identified in the study area for any proposed alternative.

3.4.2 Archeological Sites

Significant archeological sites are protected by the NHPA, in the case of federal permits, licenses, or funds, and by the Texas Antiquities Code for sites on lands belonging to or under the jurisdiction of the State of Texas or any subdivision thereof. Therefore the THC Texas Archeological Sites Atlas was reviewed for known archeological sites that could be impacted by the proposed project. This atlas contains listings of archeological sites that were usually recorded

for some federally-regulated or funded undertaking, or a project by the city, county or state government. The atlas contains records of archeological sites; however, since they may have been recorded for different projects over several decades using different methodologies, the level of effort and recording techniques may vary. Recently recorded sites, however, usually follow standardized recording methods according to the Council of Texas Archeologists' guidelines.

The project area is located within an area defined as the South Texas Plains. The South Texas plains area is one of the least known archeological regions of the state. There is considerable evidence that prehistoric people in the South Texas Plains lived along streams and rivers. Artifactual evidence along river and stream banks and adjacent terraces include flint flakes, snails, mussel shells, fire-cracked rocks and a variety of stone tools. The limited excavations in the region have identified a sequence of over 10,000 years of occupation. The earliest occupation is termed the "Paleo-Indian Period (9200B.C. to 6000 B.C.). Paleo-Indian sites in South Texas are identified by lance late projectile points such as Clovis, Folsom, Plainview, Golondrina, Scottsbluff, and Angostura. PaleoIndian occupants appear to have had a hunter/gatherer subsistence base augmented by the big game (mammoth and bison) of the late Pleistocene. This was followed by the Archaic Period, which is divided into early, middle and late periods. The Early Archaic (ca 6000 B.C. to 2500 B.C.). Early Archaic sites in South Texas are identified by Bell, Andice, Early Triangular, and Early Expanding Stem dart points, large thin triangular bifaces with concave bases and Guadalupe and unifacial Clear Fork Gouges--distally beveled tools. Early Archaic sites are rare, but when observed, they are commonly found on high terrace or in upland settings. Early Archaic components however, have been found in deeply buried alluvial settings at Choke Canyon (Black 1989). The Middle Archaic (ca 2500 B.C. to 400 B.C.). Evidence of Middle Archaic sites includes cemeteries, medium to small sized distally beveled tools, manos and grinding slabs, tubular stone pipes and burned rock accumulations. Projectile point types common to the Middle Archaic period are Pedernales, Langtry, Kinney, and Bulverde. Late Archaic (ca 400 B.C. to A.D. 800) sites show an intensified use of smaller animals and plants. Projectile point types common to the Late Archaic period include Ensor, Frio, Marcos, Fairland, and Ellis dart points, small distally beveled tools, corner-tang bifaces,

such as knives and perforators. Late Prehistoric sites are numerous in South Texas, and occupation sites are typically found within 5o meters of a dependable water source. The Toyah phase which extended through the late archaic into the proto-historic began A.D. 1300, and is characterized by Perdiz points, beveled knives, small end scrapers and ceramics, has been interpreted as representing a subsistence strategy based on bison hunting. The earliest Spanish presence in Texas was that of Cabeza de Vaca and his companions in 1528 when they were washed ashore near Galveston. Almost 200 years later, (1691), Texas was created as a frontier province in response to French presence in East Texas. Spain's continued expansionist policy to occupy new frontiers took place along the lower Rio Grande between El Paso and Eagle Pass, between the years of 1580 and 1680.

Although there are numerous sites in the project vicinity, a total of five could be affected by any of the project alternatives. These sites are described as follows:

41MV106 – This site is along the lower reaches of RGT 1 and would be impacted by both alternatives 1 and 2. It was recorded during an Archeological Reconnaissance of Proposed Sewerage System Improvement, State Revolving Fund and Economically Depressed Areas Program by Rick Hubbard and Dan Fox, 1990. The site was determined to potentially contain intact, buried cultural material; although, the uppermost lenses appeared to have been disturbed by clearing and agricultural activities. Gathering and processing activities are possibly represented by the artifact assemblage. Occasional burned rock, flakes, and possible ground stone fragments were observed in the southeast area of site. Artifacts, including burned rock and flakes, increase in density towards the intermittent drainage. This site was revisited in 2003 and six backhoe trenches were excavated by SWCA and had been visited by O'Neil (1991) who conducted limited testing.

41MV70 – This site would be impacted by all three RGT 3 alternatives. It was recorded in 2001 for the City of Eagle Pass Regional Water and Sewer Project. Partially exposed

prehistoric lithic scatter which may contain hearths and other features on the leading edge of a high terrace focusing on an intermittent to perennial creek (D. Fox 2001). It appears to have been, at least partially destroyed by construction, although deeply buried archeological deposits could remain.

41MV281 - This site would be impacted by all three RGT 3 alternatives. The site was originally recorded in 2001 by Dan Fox during a survey of proposed sewage system improvements. Several pieces of lithic debitage were identified on the surface and in backhoe trench profiles. No formal or otherwise diagnostic tools were identified. It was revisited by S. Carpenter in 2003. A review of the 2004 aerial photography indicates that this site appears to be intact.

41MV303- This site is along the Rosita Creek project, within the 10-year flood pool. Artifacts present at this site include primary, secondary, and tertiary flakes. Tested cobbles as well as angular debris were also observed. Artifacts were concentrated near south site boundary (extent of investigated area). Artifacts observed were primarily angular debris and tested cobbles with secondary flakes in association. Five projectile points were collected including Frio, Langtry and triangular points, as well as burned and fire-cracked rock in no distinct location.

41WM301 – This site is also along the Rosita Creek project, within the 10-year flood pool. It was recorded during a survey of the Rosita Valle Waste Water Treatment Plant Survey, City of Eagle Pass Water Works System. Artifacts observed include lithic debitage with all stages of reduction present and a predominance of primary and secondary flakes. Also noted were crude bifaces and utilized flakes and two projectile points. No further work was recommended for this site.

The presence of these sites indicates that additional archeological sites are most likely present in unsurveyed areas. Also, portions of these sites that could remain intact could be affected by the

proposed projects might contain important information for understanding local archeology. During the design phase of this project before construction an archeological survey should be conducted. This project is under the purview of THC, and will be routinely reviewed. Moreover, since it is a city project, future archeological survey activities would be conducted under a Texas Antiquities Permit. The permit should be acquired with adequate time for conducting the survey and any testing or other required work prior to construction.

3.5 Stormwater Issues

The Texas Surface Water Quality Standards are established by TCEQ. These standards protect surface water use and include measurements to assure water quality is maintained for that use. TCEQ periodically tests water quality to determine which water bodies meet set use standards established in Sections 303(d) and 305(b) of CWA. Stormwater runoff in the project area eventually flows into segments 2304-03 (from Las Moras Creek confluence to Highway 277) and 2304-04 (from Highway 277 to El Indio) of the Rio Grande River. These segments are listed in the TCEQ 2008 Water Quality Inventory and are rated "high" for aquatic life use.

To minimize impacts to water quality during construction, the proposed project would utilize temporary erosion and sedimentation control practices (i.e. silt fence, rock berm, and/or drainage swales). Where appropriate, these temporary erosion and sedimentation control structures would be in place prior to the initiation of construction and would be maintained throughout the duration of construction. Clearing of vegetation would be limited and/or phased to maintain a natural water quality buffer and minimize the amount of erodible earth exposed at any one time. Upon completion of earthwork operations, disturbed areas would be restored and reseeded.

The contractor would take appropriate measures to prevent, minimize, and control the spilling of fuels, lubricants, and hazardous materials in the construction staging area. All spills, including those of less than 25 gallons shall be cleaned immediately and any contaminated soil shall be immediately removed from the site and be disposed of properly. Designated areas shall be identified for spoil disposal and materials storage. These areas shall be protected from stormwater runoff. Materials resulting from the destruction of existing roads and structures shall

be stored in these designated areas. All materials being removed and/or disposed of by the contractor would be done so in accordance to state and federal laws and by the approval of the Project Engineer. Any changes to ambient water quality during construction of the proposed project shall be prohibited and may result in additional water quality control measures, shall be mitigated as soon as possible, and shall be reported to TCEQ within 24 hours of becoming aware of impacts. The contractor would practice "good housekeeping" measures, as well as "grade management" techniques, to help ensure that proper precautions are in place throughout construction of the proposed project. There are no public water supply intakes within the project limits or adjacent areas. No adverse effects are expected to aquatic resources as a result of the proposed project.

3.6 Texas Pollutant Discharge Elimination System

Because this project would disturb more than one acre, the contractor would be required to comply with the TCEQ Texas Pollutant Discharge Elimination System (TPDES) General Permit for Construction Activity. The project would disturb more than five acres; therefore, a Notice of Intent (NOI) would be filed to comply with TCEQ stating that the project would have a Storm Water Pollution Prevention Plan (SWPPP) in place during construction of the proposed project. This SWPPP would utilize temporary control measures. No permanent water quality impacts are expected as a result of the proposed project.

3.7 Hazardous Material Sites

A preliminary investigation was conducted to identify sites within the project study area that could be sources of environmental contamination by hazardous waste or petroleum products during construction of proposed structural alternatives. The scope of the investigation consisted of the following tasks:

- Review of maps, aerial photographs, and available historical maps to establish current and former land use in the vicinity of each proposed alternative;
- Review of regulatory agency listings of sites within the study area for each alternative using a consultant database service;

- Review of Texas Railroad Commission databases for the location of oil and gas wells in the study area for each alternative; and
- Field reconnaissance by a qualified environmental professional, as defined by ASTM International Standard E1527-05, on August 26 and 27, 2008, to confirm and/or supplement information pertaining to the types of land use in the study area of each alternative, and to visually observe the periphery of the project limits and sites located within the project limits for possible concerns.

Sites considered likely to be contaminated and within the proposed project areas are categorized as "high risk." An example of a "high risk" site is a landfill. Sites are categorized as "low risk" if available information indicates that some potential for contamination exists, but the site is not likely to pose a contamination problem during construction or operation. The results of the investigation are that there was one site, recorded as an approximately 1-acre landfill located on the west bank of Seco Creek, on the east side of Rodriquez Street, consisting of old oil drums and plastic, reported in 1992. This site, which could not be positively identified during site investigation, would require additional investigation to determine its effect on the project. There are no other sites of environmental concern for hazardous material or petroleum product contamination that may be encountered during construction.

3.8 Socio-Economic Impacts

An analysis of the socio-economic characteristics of the study areas of each proposed alternative solution, and of the potentially adverse impacts of proposed alternative solutions, was conducted to ensure that low income and minority populations within the area of potential effect for each alternative would not be subject to disproportionate adverse impacts. This analysis was crucial in determining the potential for adverse impacts in those cases where the proposed solution included buyouts of properties within the floodplain.

For each proposed alternative study area, the characteristics of the populations within census block groups that included the study area were examined, using data sets from the U.S. Census 2000 Summary File 3, and compared to the data for the Eagle Pass Census County Division (CCD) and for Maverick County as a whole. In each case, it was determined that the characteristics of the study area so closely matched those of the Eagle Pass CCD and of Maverick County, in terms of minority or income status, that no potential for disproportionate impacts exists.

4.0 ALTERNATIVE CONSIDERATIONS

4.1 Data Collection

The following is a summary of data collected regarding the Maverick County/City of Eagle Pass Flood Protection Study watersheds.

4.1.1 City of Eagle Pass

The City of Eagle Pass provided GIS shapefiles of the updated 911 roads file as well as a parcels shapefile of Maverick County. The 911 roads file was used to determine an accurate street reference within each basin. The parcels file was used to determine properties located within floodplains in order to be used in the economic analysis.

4.1.2 International Boundary and Water Commission (IBWC)

The International Boundary and Water Commission (IBWC) provided LIDAR topographic data for Seco Creek, Rio Grande Tributary One and the majority of Rio Grande Tributary Three. The IBWC also provided HEC-RAS models for portions of the Rio Grande River that fall within the areas of this study.

4.1.3 Tetra Tech

Two-foot contour data for Rosita Creek, Rio Grande Tributary Four, and the portion of Rio Grande Tributary Three that was not covered in the LIDAR data received from the IBWC was purchased from Tetra Tech. Plans were obtained from the City of Eagle Pass pertaining to the detention pond currently under construction located on the northwest quadrant of the Cherry Leaf/South Veterans Boulevard intersection.

4.1.4 Texas Department of Transportation, Laredo District

The TxDOT Laredo District provided construction drawings of some of the bridge and culvert structures within the study area. The hydraulic data and bridge class structure plans were utilized to calibrate the Existing and Fully Urbanized conditions for those areas within the vicinity of TxDOT highways and Farm Roads, mainly US Highway 277 and FM 1021 (El Indio Highway).

4.1.5 Site Visits

Several site visitations were conducted to Maverick County to take measurements of structure crossings, to take survey shots at key locations and ultimately to verify if all alternatives developed were viably constructible. Parameters documented include roadway deck dimensions, railing, pier dimensions, and culvert types and dimensions. Each location was also documented with a set of digital photographs taken of the channels and the structure faces both upstream and downstream.

4.2 Multi-Use Facilities

In the development of alternatives the use of the proposed flood control facilities to be used for other purposes were considered, such as parks and other recreational uses. For example a site may consist of the placement of trails along the banks of proposed channel modifications or recreational fields, such as soccer fields at the bottom of storm water detention ponds. The design of multi-use facilities will need to consider maintenance requirements, in particular after a flooding event occurs. Final design of these multi-use facilities will also need to be coordinated with the City of Eagle Pass and Maverick County. Multi use facilities could be feasible for Rio Grande Tributaries 1, 3 and 4. Those alternatives developed, which include detention ponds or channel modifications, where connectivity between major thoroughfares is available are good location examples for multi-use facilities.

4.3 Alternative Concepts

In general, there were 5 alternative concepts developed across the entire study. Depending on the extents of the study stream, some of these concepts did not apply because of available space, economic reasons and current conditions (existing flooding problems). The following are the list of concepts that were considered for alternative development:

- **Property Buyouts in Flood Prone Areas**
- **Do Nothing Alternative**
- **Detention Pond Facility**
- **Channel Modifications**
- **Culvert/Bridge Structure Upgrade**

Property Buyouts in Flood Prone areas would be necessary for those streams where any other alternative explored yielded a very low benefit/cost ratio. If the City of Eagle Pass/Maverick County would like to pursue as a solution the Property Buyout concept then once the land is purchased and the structure removed, this area could be utilized as green space.

Do Nothing Concept is a solution where economical, political or unfeasible factors play a role. Those areas where the benefit/cost ratio is so low, surrounding structures are minimal, flooded area covers empty, non developed land, are areas where the do nothing concept would be a suggested option.

Detention Pond Facilities were explored in strategic areas. These strategic areas are: areas where the natural terrain maximizes storm water flow catchment, empty vacant land to minimize construction costs and areas where minimizing downstream impacts are of great significance. The main hydraulic function of a detention basin is to slow down flow to impacting the timing of peak flows. Therefore flow timing was another factor taken into consideration as to where and to what streams to consider such facilities.

Channel Modifications were explored in areas where the existing terrain allowed for enough grade and horizontal space to modify the channel. The concept of channel modifications considers either widening or deepening of an existing channel to convey flow. The limits of channel modification were restricted to areas where additional open space is available. The typical cross section utilized was that of a trapezoidal channel with 4:1 side slopes, this will allow easy access for maintenance. Bottom widths vary from 10 to 70 feet depending on the stream. One to four feet drops were incorporated in certain areas where channel modifications are recommended.

Culvert/Bridge Structure Upgrade was taken into account in those areas where this was a viable, practical and economical solution. Especially for those structures owned by the City and County or within City or County right-of-way. Upgrading structures within TxDOT right-of-way were found to be unpractical since in most instances, upgrading a structure alone would not correct the problem. In addition, the difference in criteria from one agency to the other made

upgrading TxDOT structures unpractical and cost ineffective. This excludes Rosita Creek since the problem at Rosita Creek is localized to FM 1021.

5.0 ALTERNATIVE DEVELOPMENT

5.1 Alternatives

In general, three to four alternatives were explored for each individual stream (excluding Rosita Creek) and all concepts described in **Section 3.3** were taken into consideration. For all streams, the proposed changes (alternatives) were applied to the Fully Urbanized conditions model to create an Alternative model. All alternative models were created in accordance with the criteria, which is 10-year storm frequency.

5.1.1 Seco Creek

The limits of the Seco Creek study extend from approximately 4,400 feet to the east of Union Pacific Railroad on the upstream boundary to 750 feet west of FM 277 on the downstream boundary. The 8.49 square miles that encompassed this study generate 6,660 cfs of runoff for the 10-Year Fully Urbanized conditions. There were a total of three alternatives explored for this stream:

Alternative 1: This alternative consists of a 577 acre-foot detention pond located to the east of Union Pacific Railroad (UPRR). The proposed pond reduces the flows by more than 2,500 cfs throughout the extents of the study. Construction costs associated with alternative are estimated at $10.3 million.

Alternative 2: This alternative consists of a 447 acre-foot detention pond located to the east of Union Pacific Railroad (UPRR). Throughout the extents of the study, the proposed pond reduces the flows by more than 2,000 cfs. Channel modifications between UPRR and US Highway 277 have been incorporated into this alternative. The channel modifications consist of a grassed trapezoidal channel with 4:1 side slopes, a bottom width that ranges from 45 to 50 feet through most of the proposed channel modifications segment and depths varying from 7 to 14 feet. Channel modifications consist of more than 4,000 feet in length. Construction costs associated with alternative are estimated at $8.3 million.

Alternative 3: This alternative consists of the same channel modifications specified in the ***Alternative 2*** section above but with no detention pond. Construction costs associated with this alternative are estimated at $1.3 million.

Alternative 4: This alternative consists of buyouts of properties located in the floodplain. If the City of Eagle Pass and Maverick County decide to move forward with the buyouts Alternative, then those parcels to buy would have to be within strategic locations. ***Exhibit 6*** in ***Appendix G*** depicts those strategic locations for buyouts which in turn can be utilized for green space once the structures are removed. The 2007 property values were obtained from the Maverick County Appraisal District and a 5% inflation rate adjustment was made to those values for 2008. The total dollar amount associated with parcels of interest recommended for buyouts is $2.5 million. ***Appendix A***, ***Tables 4.1, 5.1, 7.1, 8.0, 9.0*** and ***10.0*** show the results for water surface elevations, flows and construction costs. ***Appendix G***, ***Exhibits 7*** thru ***10*** show the Fully Urbanized floodplains associated with each alternative for Seco Creek.

5.1.2 Rio Grande Tributary One

The limits of the Rio Grande Tributary 1 study extend from approximately 3,000 feet north of Eidson Road on the upstream boundary to 7,700 feet south of Eidson Road on the downstream boundary. The 1.44 square miles that encompassed this study generate 1,300 cfs of runoff for the 10-Year Fully Urbanized conditions.

Alternative 1: This alternative consists of a 44 acre-foot detention pond located to the northwest of Eidson Road. The proposed pond reduces the flows by more than 300 cfs throughout the extents of the study. This alternative also consists of channel modifications to the southeast of Eidson Road. The template utilized for channel modifications was made up of a trapezoidal grassed channel, with a 12 foot bottom width, 4:1 side slopes and a depth varying from 6 to 9 feet. In addition, a total of 3 drops have been incorporated into the model within the proposed channel. Construction costs associated with this alternative are estimated at $1.9 million.

Alternative 2: This alternative consists solely of channel modifications to the southeast of Eidson Road. The template utilized for channel modifications was made up of a trapezoidal

grassed channel, with a 12 foot bottom width, 4:1 side slopes and a depth varying from 6 to 8 feet. In addition, there are a total of 3 drops within the proposed channel. Construction costs associated with this alternative are estimated at $590,000.

Alternative 3: This alternative also consists solely of channel modifications. On this alternative, the channel modifications extend further to the north, up to Callejon Teran. The characteristics of the proposed channel are the same as in **Alternative 2** except the depth varies with **Alternative 3** from 3 to 9 feet. A total of 4 drops have been introduced in this alternative. Construction costs associated with this alternative are estimated at $1.1 million.

Alternative 4: This alternative consists of buyouts. According to the appraisal district, the total appraised value for all properties within the 10-year Fully Urbanized floodplain add up to $4.6 million. The 2007 property values were obtained from the Maverick County Appraisal District and a 5% inflation rate adjustment was made to those values for 2008. ***Appendix A***, ***Tables 4.2, 5.2, 7.2, 11.0, 12.0*** and ***13.0*** show the results for water surface elevations, flows and construction costs. ***Appendix G, Exhibits 16*** thru ***19*** show the Fully Urbanized floodplains associated with each alternative for Rio Grande Tributary 1.

5.1.3 Rio Grande Tributary Three

The limits of the Rio Grande Tributary 3 study extend from approximately 3,000 feet north of El Indio Highway (FM 1021) on the upstream boundary to 4,400 feet southeast of El Indio Highway (FM 1021) on the downstream boundary. The 11.53 square miles that encompassed this study generate 6,600 cfs of runoff for the 10-Year Fully Urbanized conditions.

Alternative 1: This alternative consists of a 79 acre-foot detention pond located North of FM 1021. This pond facility is located in the vacant lot area east of the existing channel and Memorial Junior High School between Rafael Street and Laura Street. The proposed pond reduces the flows by approximately 30%. This alternative also consists of channel modifications to the south (downstream) and north (upstream) of the pond facility. The extents of the channel modifications are from 3,000 feet north of El Indio Highway (FM 1021) to a few hundred feet

downstream of El Indio Highway. The template utilized for channel modifications was made up of a trapezoidal grassed channel, with a 40 foot bottom width, 4:1 side slopes and a depth varying from 5 to 7 feet. In addition, 1 drop has been incorporated into the model within the proposed channel. Construction costs associated with this alternative are estimated at $3.7 million.

Alternative 2: This alternative consists solely of channel modifications. The proposed channel modifications will tie down on to the recently reconstructed concrete channel by the City of Eagle Pass. The tie down point is approximately 700 feet south (downstream) of the existing pedestrian bridge in the Memorial Junior High School vicinity. From this point, the channel modifications will continue in a southerly direction (following the existing channel) for approximately 5,000 feet. The bottom width of the proposed channel will vary from 40 to 55 feet. The depth will vary from 6 to 9 feet.

There are seven driveway bridges that currently cross the existing channel between Jardines Road and FM 1021. These bridges are constricting the flow therefore the proposed driveway bridges have been kept to a minimum for this alternative and five of the existing bridges will have to be removed. A total of two proposed driveway bridges have been incorporated to the Alternative models. Since 5 of the driveway bridges will be removed there needs to be access to adjacent properties. A strip of land on both sides of the channel will have to be purchased to allow access to the properties on the south side of the channel. Two box culverts have been added to the Multiple Box Culert (MBC) structure at the Jardines Verdes crossing to help alleviate the flooding problems in this area. Construction costs associated with this alternative are estimated at $1.8 million. Two drops have been inserted in the proposed channel modifications

Alternative 3: This alternative builds up on Alternative 2. In addition to all the elements described in Alternative 2 with the exception of upgrading the existing (MBC) structure at the Jardines Verdes crossing, a diversion channel has been incorporated in the area just downstream of El Indio Road (FM 1021). This diversion channel is a grassed, trapezoidal channel with 4:1 side slopes for easy access and a bottom width of 20 feet. The depth varies for this diversion channel from 8 to 10 feet. To accommodate the diversion channel, two new crossing structures

are being proposed at Jardines Verdes and Canal Road. These new crossings consists of 3 – 8' by 7' MBC at Jardines Verdes and 3 – 5' by 5' MBC at Canal Road. The diverted flow helps in reducing the bottom width of the main proposed channel, the bottom width of the main channel varies for this alternative from 40 to 45 foot wide. Construction costs associated with this alternative are estimated at $2.9 million.

Alternative 4: This alternative consists of buyouts. According to the Maverick County Appraisal District, the total appraised value for all properties encroaching on the 10-year Fully Urbanized (FU) floodplain and within the extents of the study adds up to $19.50 million. The 2007 property values were obtained from the Maverick County Appraisal District and a 5% inflation rate adjustment was made to those values for 2008. ***Appendix A***, ***Tables 4.3, 5.3, 7.3, 14.0, 15.0*** and ***16.0*** show the results for water surface elevations, flows and construction costs. ***Appendix G, Exhibits 25*** thru ***28*** show the Fully Urbanized floodplains associated with each alternative for Rio Grande Tributary 3.

5.1.4 Rio Grande Tributary Four

The limits of the Rio Grande Tributary 4 study extend from approximately 200 feet north of FM 1021/Rosita Valley Road intersection on the upstream boundary to 600 feet east of the High Noon Drice/Latigo Circle on the downstream boundary. The 2.01 square miles that encompassed this study generate 1,500 cfs of runoff for the 10-Year Fully Urbanized conditions.

Alternative 1: This alternative consists of four separate elements. These four elements are as follow (starting on the downstream segment):

Element 1: The first element for this alternative consists of 3,400 feet of channel modifications in the downstream segment of the study. There is an existing WCID Irrigation Lateral (Lateral 50) that crosses the proposed channel reconstruction area. The Lateral is an elevated irrigation canal consisting of a 12 inch ductile iron pipe crossing the channel at approximately 8 feet above the channel bed and is currently operational. The elevated 12 inch pipe will be left to remain and the elevated irrigation canal needs to be cut back and flush with the proposed trapezoidal, grassed channel. The channel modifications consist of a 15 foot

bottom width, 4:1 side slopes and a grassed, trapezoidal channel. Depth will vary from 2 to 5 feet.

Element 2: There are more than 250 acres that generate runoff on the northwest side of Rosita Valley Road. This runoff overtops Rosita Valley Road during heavy rainfall events. Element 2 consists of a small grassed, trapezoidal (5' bottom widths) interceptor channel running along the northwest side of Rosita Valley Road. In addition to this small interceptor channel, an upgrade from the existing 2 - 30" RCPs to 2 - 6' by 4' Multiple Box Culvert (MBC) structure will keep all of the 10-year Fully Urbanized runoff under Rosita Valley Road. Element 2 captures all of the 10-Year Fully Urbanized runoff from the area northwest of Rosita Valley Road and dumps the runoff on the upstream portion of ***Element 1***.

Element 3: Rio Grande Tributary 4 consists of street and surface conveyance for a good portion of the tributary stretch along Chuck Wagon Road. Element 3 within this alternative redirects the existing "surface" conveyance underground via a proposed storm sewer system. The proposed storm sewer system was modeled utilizing the TxDOT drainage software Winstorm. The proposed storm main line extends for approximately 2,300 feet and ranges from a 48" reinforced concrete pipe to a 7' by 5' reinforced concrete box. This proposed storm sewer will capture runoff throughout all the blocks adjacent to Chuck Wagon Road and within the road. On the upstream portion of the proposed system a sloped grate inlet (6:1 TY S) has been recommended to capture all of the 10 Year Fully Urbanized runoff. Any other type of grate inlet will not capture the necessary flow needed to control the conveyance. If another grate inlet is utilized, runoff for the 10-year Fully Urbanized conditions will back up and flood the surrounding area. A water catchment area has been designed to work in tandem with the sloped grate inlet and allow the runoff to back up to a certain head without spilling over to the surrounding properties. Although preliminary, the proposed storm system will keep 100% of the 10-Year Fully Urbanized flow underground. During construction, this system needs to have a series of ditches running along the block perimeters to capture the runoff and convey it to the low point areas where water will be capture via grate inlets. The Winstorm model is strictly a nodal

analysis model to test the main sizes and hydraulic grade line. **Appendix C** within this report package contains the Winstorm report output.

Element 4: The element for this alternative consists of a 35 acre-foot Detention/Retention pond, an outfall structure, 2 proposed crossing culvert structures at Alamo Road and Fresno Street, and channel modifications from 500 feet southwest of the FM 1021 crossing up to the Detention/Retention pond outfall structure. A total of approximately 1,300 feet of channel modifications are being proposed.

The probable construction cost for all elements within this Alternative is $2.8 million.

Alternative 2: This alternative consists of ***Elements 1 and 2***, described in ***Alternative 1***. The probable construction cost estimate for this Alternative is approximately $340,000.

Alternative 3: This alternative consists of ***Elements 3 and 4***, described in ***Alternative 1***. The storm sewer system in ***Alternative 3*** differs from the one described in ***Alternative 1, Element 3*** in that the outfall for the system needs to be further downstream (south) to gain enough grade for the hydraulic gradeline to be kept underground. Therefore; the difference between ***Alternative 1, Element 3 and 4 Alternative 3*** is the length of the most downstream pipe segment. The extents of the entire storm sewer system are approximately 3,000 feet. The probable construction cost estimate for this Alternative is approximately $2.98 million. ***Appendix A***, ***Tables 4.4, 5.4, 7.4, 17.0, 18.0*** and ***19.0*** show the results for water surface elevations, flows and construction costs. ***Appendix G, Exhibits 34*** thru ***37*** show the Fully Urbanized floodplains associated with each alternative for Rio Grande Tributary 4.

5.1.5 Rosita Creek

The limits of the Rosita Creek study extend from approximately 5,000 feet north of El Indio Highway (FM 1021) on the upstream boundary to 12,000 feet south of El Indio Highway (FM 1021) on the downstream boundary. As stated in ***Section 3.5*** of this report, the criteria for this creek analysis, being the 25-year Fully Urbanized frequency storm, varies from the others in order to be in compliance with TxDOT criteria. The purpose for this particular study is to

minimize the amount of water currently flowing over FM 1021 for high storm events, which results in road closures. The length of roadway currently being overtopped by the 25-year Fully Urbanized is greater than 2,000 feet. The portion of FM 1021 being overtopped by the 25-year Fully Urbanized storm event exceeds a foot of depth.

Three existing crossings convey flow from upstream (north) to downstream (south) of FM 1021. These crossings are, from west to east: 60' span bridge, 2 - 6' by 4' Multiple Box Culvert (MBC) structure and a 3 – 6' by 6' MBC structure. The main conveyance occurs at the 60' span bridge, the most westerly relief structures is located at approximately 300 feet east of the main conveyance while the most easterly structure is located at 2,400 from the main conveyance.

Alternative 1: For Alternative 1, the main conveyance and relief structure closest to the main conveyance (2 – 6' by 4' MBC structure) will remain in place without any modifications. The 3 – 6' by 6' Multiple Box Culvert structure located 2,400 feet east of the main conveyance will be removed. This relief structure will be replaced with a 195' span bridge, 1 – 115' and 2 – 40' spans. The 115' span consists of Type IV I beams and the 2 - 40' spans will consist of Type C beams. This structure will also have 2 sloped, 2:1 abutments. Channel modifications have been incorporated with this alternative upstream and downstream of the proposed bridge structure. The extents of the channel modifications have been proposed to 430' upstream and 730' downstream of the proposed bridge structure. This is necessary for the expansion and contraction occurring upstream and downstream of such structure. The probable construction cost estimate for this Alternative is approximately $800,000.

Alternative 2: For Alternative 2, the existing 60' span bridge will be replaced with a 120' span bridge. The proposed bridge will consist of 3 – 40' spans, in which each span is a Type C I beam. The 2 – 6' by 4' MBC relief structure will remain in place without any modifications. In addition, this alternative will consist of 2:1 sloped abutments. The 3 – 6' by 6' Multiple Box Culvert structure located 2,400 feet east of the main conveyance will be upgraded to 16 – 6' by 6' boxes, therefore 13 – 6' by 6' boxes will be added to the existing structure. The probable construction cost estimate for this Alternative is approximately $790,000. ***Appendix A***, ***Tables***

4.5, 5.5, 7.5, 20.0 and ***21.0*** show the results for water surface elevations, flows and construction costs. ***Appendix H, Exhibits 36*** thru ***38*** show the Fully Urbanized floodplains associated with each alternative for Rosita Creek.

5.2 Probable Construction Costs

The probable construction costs were determined for each alternative including costs associated with the design and construction of the alternative. Unit cost rates were obtained from TxDOT and City of San Antonio unit cost rate tables. In addition, unit cost rates associated for excavation were verified with a private contractor. Alternative probable construction costs include the following:

- Construction cost
- Topographic surveys (2 percent of construction)
- Geotechnical (1 percent)
- Mobilization (8 percent)
- Stormwater Pollution Control (5 percent)
- Traffic control (2 percent)
- Right-of-way Acquisition
- Utilities (5 percent)
- Contingencies (20 percent)
- Engineering (8 percent)

Right-of-way acquisition costs were determined for each alternative based on the properties impacted by the alternative. ***Exhibits 5, 15, 24, 33*** and ***42*** in ***Appendix G*** presents the locations of the properties that could be impacted by the proposed projects. Property appraised values were originally obtained in early 2008, at a time when the updated 2008 appraised values were not published, therefore the 2007 property appraised values were adjusted with a 5% inflation rate. Costs associated with replacing street culvert crossings, included pavement replacement and backfill costs. Costs associated for other uses such as for recreation uses (green space) are not included. Due to the preliminary nature of the study, all excavation computations are based on mostly LIDAR and USGS topographic information, there was no survey topographic

information developed for this study. In ***Appendix A, Table 6.0*** summarizes alternative probable construction costs and ***Tables 8*** thru ***21*** contains itemized construction costs tables.

5.3 Benefit Cost Analysis

A benefit cost analysis was conducted to determine which alternative provides the best benefit considering probable construction cost and the value of properties removed from the floodplain. The benefit portion was based on the current (2008) appraised value for the properties removed from the floodplain as a result of the alternative being implemented. A benefit cost (B/C) ratio was determined by dividing the alternative probable construction cost by the appraised values of the properties removed from the 10-year floodplain. In ***Appendix A, Tables 7.1*** thru ***75*** summarize the alternative B/C ratio and the number of properties removed from the floodplain due to implementation of the alternatives for each individual stream. Results indicate that **Alternatives 3, 2, 2, and 2** have the highest B/C ratios for **Seco Creek, Rio Grande Tributary 1, Rio Grande Tributary 3 and Rio Grande Tributary 4** respectively. The benefit Cost analysis is strictly a tool utilized in determining the best, viable alternative. There could be instances where the highest benefit cost ratio is not necessarily the best solution. The benefit cost analysis did not consider the benefits associated with the potential of future higher property values, water quality, and damages to private and public property.

5.4 Public Involvement

A total of three public meetings were held to inform the public of the steps being taken to develop the Maverick County/City of Eagle Pass Flood Protection Study. Public Meeting publications were made within a minimum of 10 business days prior to the actual meeting.

The first public meeting, **Public Project Kick-off Meeting**, took place on August 23rd, 2008 in the Nick Carr Youth Recreation Center. Public attendance was at a minimum for this particular meeting, the attendees were composed mainly of city and county officials. Three major topics discussed in the **Public Project Kick-off Meeting:** Funding, Local Support, Study Area and Project Tasks.

The second public meeting took place on June 5th, 2008 in the Maverick County Courthouse. City Council members, the Mayor, County Commissioners, the Media and some public

constituents were present for this meeting. The items presented to the public were as follows: Existing Conditions findings, Concept Alternatives to explore and items on the third public meeting agenda.

The third public meeting took place on August 25th, 2008 in the Maverick County Courthouse. Attendance was similar to that of public meeting 2. The items presented in this meeting were composed of all alternatives explored on each individual study stream, probable construction estimates, benefit/cost ratio analysis for each stream and recommended alternatives. Although comment sheets were provided for public input, no one provided any type of community feedback for any of the public meetings held.

Public Meeting Agendas, Public Meeting advertisements and publications, meeting minutes and presentations are located in ***Appendix E*** within this package.

6.0 PERMITS, DESIGN AND CONSTRUCTION PHASING

The following is a summary of the permits that will be required for approval of the proposed Maverick County/City of Eagle Pass Flood Protection Study, design and bidding tasks, and a proposed construction phasing option.

6.1 Permits

Implementation of the proposed project will require the acquisition of permits and approvals from various agencies. The permits that are foreseen to be necessary for this project are as follow:

- TCEQ Water Quality Standards: TCEQ water quality standards will be addressed during construction utilizing temporary erosion and sedimentation control practices.
- TCEQ TPDES Permit: Prior to construction, a Notice of Intent (NOI) would need to be filed with the TCEQ to comply with the TPDES General Permit requirements.
- Section 401 Permit (Tier II): An individual Section 401 Certification Review will be required to be filed and reviewed by the TCEQ including a copy of a USACE individual Section 404 permit. This will also include a mitigation plan.
- Section 404 Permit: An individual Section 404 permit would be required to be filed and reviewed by the USACE, EPA, TCEQ, and United States Fish and Wildlife Service.
- Antiquities Permit: An Antiquities Permit from the Texas Historical Commission for any archeological site investigations in areas of disturbance that may contain archeological sites.
- Threatened and Endangered Species: A survey will be conducted to ensure that no known threatened or endangered species are located in or around the project area. Findings would be coordinated with the Texas Parks and Wildlife Department.
- TxDOT Approvals: Modified sections of the project located within TxDOT right-of-way will require coordination and approval from TxDOT.
- FEMA CLOMR and LOMR: Prior to the construction of the project, a request for a CLOMR would be submitted to FEMA. The CLOMR would describe the proposed project and present the revised 100-year floodplain, as compared to the current effective floodplain. After the project has been constructed, a request for a LOMR to change the 100-year floodplain would be submitted to FEMA.
- City of Eagle Pass Permits: Permits that may be required by the City of Eagle Pass including a floodplain development permit.

6.2 Design and Bidding Phase

Prior to the construction phase, there are several elements that involve the design and bidding phase and are summarized as follows:

- Preliminary Design Report: Prepare a design report describing the proposed project in more detail then presented in this report.
- Design Drawings: Prepare design drawings of the proposed projects that will be used for construction of the project.
- Construction Specifications: Prepare construction specifications in accordance with all ordinances and criteria set forth by the City of Eagle Pass and other agencies.
- Utility Coordination: Contact all utility companies that have facilities that could be impacted by the proposed projects. This effort will include determination how and who will make modifications to utilities, if required.
- Right-of-Way Acquisition: Contact property owners impacted by the proposed project regarding the purchase of right-of-way. This process will include determination of cost to acquire the right-of-way and the acquisition of the right-of-way.
- Cost Estimates: Prepare the probable construction cost estimate of the proposed modifications including right-of-way acquisition.
- Bid Documents: Prepare documents that will be required for contractors to bid the project.
- Project Advertising: Assist the City to advertise the project for construction.
- Bid Evaluation: Evaluate submitted bids, tabulate results, and make determination on awarding the project to a contractor.

7.0 RECOMMENDATIONS

Recommendations for the Maverick County/City of Eagle Pass drainage evaluation for all streams and tributaries are summarized as follows::

7.1.1 Seco Creek

- The **Buyouts Alternative** is recommended for Seco Creek. All other alternatives explored depicted a very low (B/C) ratio due to such high excavation quantities. The excavation rate utilized was $8/cubic yard. This value was taken from the Laredo TxDOT district and was applied to all excavation quantities across the entire study. ***Exhibit 6, Appendix G*** show the strategic areas of buyouts and the 2008 appraised value of each property. The total dollar amount reflecting those parcels is approximately @ 2.5 million. ***Table 7.1*** in ***Appendix A*** shows the Benefit/Cost analysis.

7.1.2 Rio Grande Tributary 1

- Alternative 2 is recommended for the RGT1 study which resulted in the highest (B/C) ratio. This is a very affordable alternative costing approximately $590,000.

7.1.3 Rio Grande Tributary 3

- Alternative 2 is recommended for the RGT3 study which resulted in the highest (B/C) ratio. The B/C ratio ended up being close to double that of **Alternative 3**. This one consists of a reduction in damages exceeding $5 million. Probable construction costs are approximately $1.9 million.

7.1.4 Rio Grande Tributary 4

- The 4 elements discussed in ***Section 4.2.3*** are recommended for this stream study. The four elements are necessary to reduce flows downstream; minimize surface flows, reduce flows overtopping FM1021 and Rosita Valley Road; and to mitigate all of the flow currently in people's backyards and homes. For Rio Grande Tributary 4, **Alternative 1** is the recommended alternative. The probable construction costs associated with this alternative is approximately $2.9 million.

7.1.5 Rosita Creek

- **Alternative 2** is the recommended alternative for this stream. The existing 60' span bridge is close to its full life span. Therefore, if improvements are to be made at this location is recommended that the City of Eagle Pass gives the Texas Department of Transportation the option to reduce the flooding occurring over FM 1021 as well as replace a structure that was built longer than 50 years ago. Probable construction costs associated with this alternative are approximately $819,000.