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San Bernard Watershed Flood Protection Planning Study Final Report

Prepared For:
Texas Water Development Board

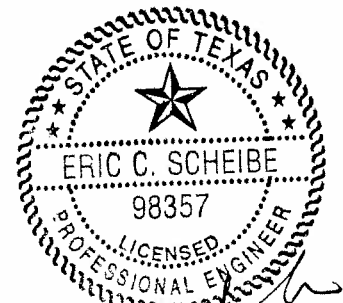


April 30, 2010

Prepared By:
Halff Associates Inc



For Wharton County and City of East Bernard



Eric C. Scheibe
4/26/2010
TBPE FIRM #317

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Eric C. Scheibe	98357	4/30/2010
Type or Print Name	PE#	Date

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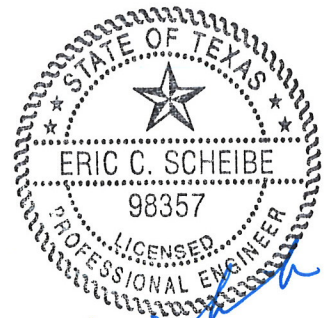


April 30, 2010

Prepared By:
Halff Associates Inc



For Wharton County and City of East Bernard



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4/26/2010
TBPE FIRM # 312

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Introduction and Background:

The San Bernard River watershed is located in southeast Texas on the Texas Gulf Coast Plain and drains approximately 1,000 square miles (see Figure 1). The river flows for approximately 114 miles through Austin, Colorado, Wharton, Fort Bend, and Brazoria Counties, and ultimately to the Gulf of Mexico about 8 miles south of Freeport, TX. The San Bernard River lies between the Colorado River and the Brazos River and has historically been inundated by the merging of these two larger basins during extreme flood events.

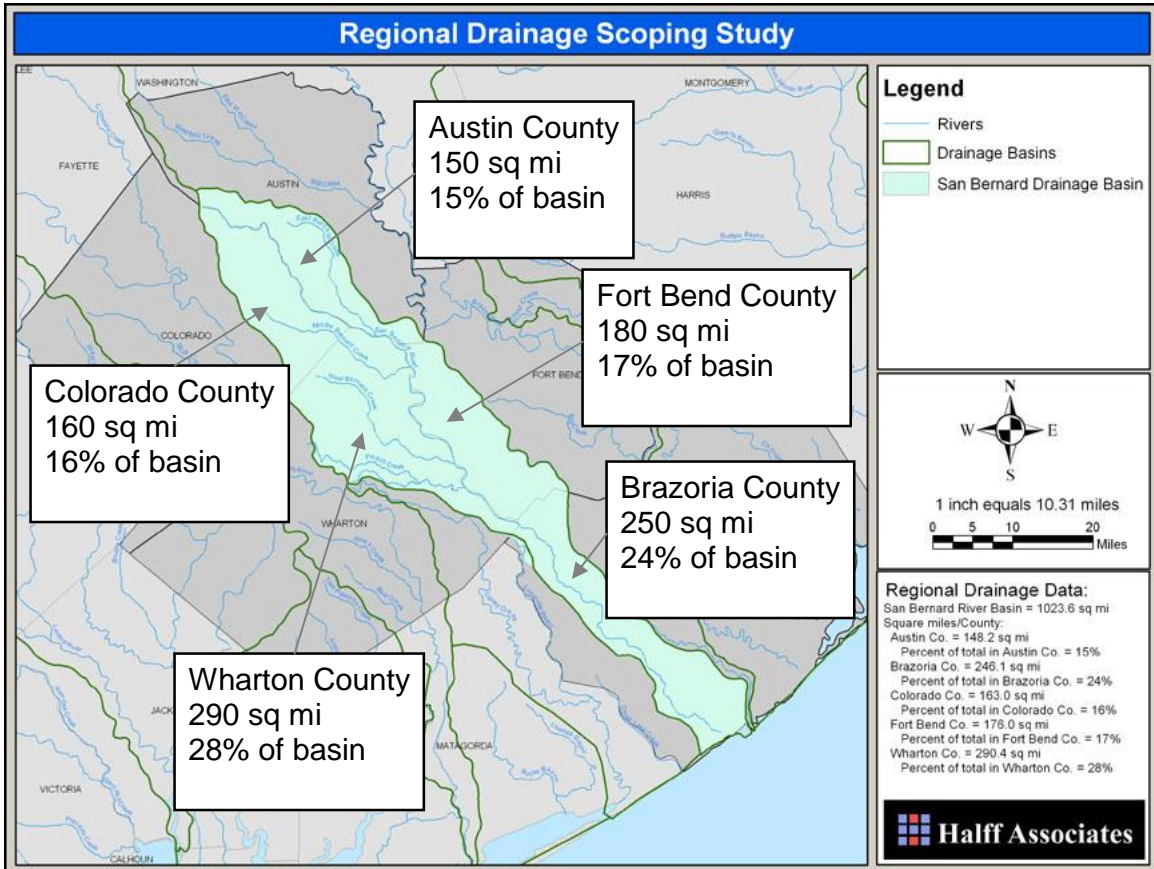


Figure 1: Project Area

The terrain through most of this study area is characterized by level to undulating plains rising to the north with a timber belt of hardwoods along the river. Closer to the Gulf, the terrain is referred to as Bay Prairie where prairie grasses, bunch grasses, mesquite, and oak predominate. The topography varies from elevation 0 to about 350 feet above sea level (NGVD 88). Annual rainfall in the basin ranges from 40 to 47 inches per year.

The San Bernard River bordering Wharton County on the eastern edge and its tributaries are subject to chronic flooding caused by inadequate drainage, sedimentation and overgrown vegetation. Historically, the river and its tributaries have experienced major flooding dating back to 1913 with the most recent flood occurring in November

2004. The major historical floods that have been recorded include the floods of 1913, 1922, 1926, 1935, 1938, 1957, 1985, 1991, 1998, 2001, and 2004. One particular flood of significance (flood of 1985) was the result of 21” of rainfall and caused the San Bernard River to overtop US 59 by 4 ft. This flood was so severe that the US Army Corps of Engineers authorized a Reconnaissance Study (completed in 1991), but unfortunately resulted in no flood relief for the local communities along the river. Examples of major flooding from the disastrous 1998 event are shown in Figures 2 through 4. As a result of frequent flooding and the potential for increased development in the area, Wharton County took a pro-active lead in applying for a Flood Protection Planning Grant from the Texas Water Development Board (TWDB), which was awarded in 2006. Wharton County teamed with Austin County, Colorado County, Fort Bend County, Brazoria County, City of East Bernard, and City of Wharton to not only evaluate the local drainage problems, but to also evaluate the overall problems from a regional perspective.

To facilitate regional input into the planning process, three public meetings preceded by appropriate public notice were held within the San Bernard region. The public meetings served to inform the public about the planning study and to gather information that could be used to enhance and confirm the study results and conclusions. The first two public meetings occurred in Wharton, TX on March 21, 2007 and July 1, 2008. The third public meeting was held in East Bernard on June 30, 2009. The resulting planning study has produced new planning and regulatory information for use in floodplain management as well as a recommended flood reduction project for the City of East Bernard.



Figure 2: Flooding of Residence in East Bernard, TX (1998)



Figure 3: Floodwaters overtopping US 90A, East Bernard, TX (1998)



Figure 4: Floodwaters in East Bernard, TX (1998)

The San Bernard Watershed Flood Protection Planning Project was conducted in two phases. The first phase was focused on a new existing conditions hydrologic and hydraulic analysis that produced updated flows and water surface elevations for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr, 250-yr, and 500-yr events for the entire study area (headwaters to FM 1301 in Brazoria County). This data was then used in phase 2, which consisted of a Flood Damage Assessment along the San Bernard River and its tributaries. Phase 2 was concluded with an alternatives analysis to determine a viable flood protection project.

The funding mechanism for this project was changed after the Flood Protection Planning Grant was approved. The funding mechanism at the time the application was submitted involved a 50% contribution from the Corps of Engineers, a 25% local contribution, as well as a 25% TWDB contribution for a total budget of \$2,767,130. The local contribution consisted of funds from Wharton County, Fort Bend County, Brazoria

County, and the City of East Bernard. Once the flood damage analysis in phase 2 was completed, it became clear that the most cost effective solution would be very small in overall cost. This compounded by the total upfront cost to the local community for the Corps to participate made it evident that it would be more cost effective for the local community to continue the project without the assistance of the US Army Corps of Engineers. Also, Fort Bend and Brazoria opted not to fund their portions of the original amounts as a result of budget limitations. The funding mechanism for the study was updated and is currently as follows. The total local contribution is 54% and consists of funds from Wharton County and East Bernard with TWDB funding the remaining 46% for a total budget of \$1,486,945. The study area under the final funding mechanism is limited to the main channel San Bernard River, Middle Bernard Creek, West Bernard Creek, Lower Peach Creek, Britt Branch and Boone Branch.

Existing Condition Studies:

Hydrologic models were created using the U.S. Army Corps of Engineers (USACE) HEC-HMS program. The goal of this hydrologic analysis was to determine flows at various key points along the San Bernard River and its tributaries. HEC-HMS requires the selection of a rainfall/runoff method, a unit hydrograph transformation method and a hydrograph routing method. The rainfall/runoff method used was the Green and Amp Loss Method, which determines the total volume of losses due to infiltration and ponding from each sub-watershed along a particular stream. The Clark unit hydrograph was then used to transform the runoff from each sub-basin into hydrographs which represent flow over time for a particular rainfall event. These hydrographs were then routed through the stream (using unsteady flow HEC-RAS for the San Bernard mainstem and steady flow HEC-RAS for all the tributaries) with the goal of accounting for any floodplain storage that may occur in the overbanks during a flood event.

Hydraulic models were created for the San Bernard River, West Bernard Creek, Middle Bernard Creek, Lower Peach Creek, Boone Branch, and Britt Branch using the USACE HEC-RAS program. The San Bernard River was modeled with detailed study methods, which include surveyed bridge data and some surveyed cross-section data (approximately 1 channel survey per stream mile). The other streams were modeled with limited detail study methods, which include structure data from TXDOT as-built drawings, BRINSAP data, or field measurements and cross-sections cut from LiDAR topographic data. The main sources of topographic information used in this analysis (outside the survey data) consisted of Wharton 1.4m LiDAR flown in 2006. All topographic and survey data was collected using the NAD 83 horizontal datum, and the NAVD 88 vertical datum. Flow data from the hydrologic models was input into the hydraulic models to develop peak stages for the 2-, 5-, 10-, 25-, 50-, 100-, 250-, and 500-yr flood events. The San Bernard River hydraulic analysis was conducted utilizing the unsteady flow method due to its size and complexity. The other hydraulic studies were conducted utilizing the steady flow method. All Manning's n-values were selected from a combination of aerial photos and site visits, and based upon tables found in *Open Channel Hydraulics, Chow, 1959*. For more details on the hydrologic and hydraulic

modeling methodology see the existing conditions reports included in Appendices A, B, C, D, E, and F.

The existing conditions analysis resulted in accurate information useful for planning and regulatory purposes. New 100-yr floodplains and Base Flood Elevations (BFEs) were delineated for regulatory and flood protection planning purposes. This information will eventually be submitted to FEMA in a LOMR which will be fully funded by Wharton County. The information produced was also included in an internet based GIS mapping tool funded by Wharton County. This mapping tool includes the regulatory floodplains and BFEs as well as several other base map layers that can be overlaid to create useful drainage and flooding related maps. The website can be accessed at <http://gis.halff.com/wharton>. Finally, the new information was used to identify bridges and culverts with inadequate flow conveyance. To determine adequate flow conveyance, a minimum 5-yr flow criterion was recently established by Wharton County for county maintained roads and a 25yr flow criterion was recommended for state-maintained roads. A list of inadequate bridges and culverts was submitted to the county as well as suggested improvements and cost estimates for meeting the criteria. The improvements will allow increased emergency access to endangered areas during flood events.

Flood Reduction Planning:

A baseline flood damage assessment was performed to determine the amount of damages occurring as a result of existing conditions flood elevations. The assessment was completed using the USACE HEC-FDA model. Data, such as structure value and first floor elevation, were gathered and organized, then used with the previously developed hydraulic data to compute risk of flooding for structures associated with damage centers within the San Bernard Watershed. Risk in this case is described by expected annual damage (EAD), a statistical average flood damage that considers both the probability of the flood hazard and the consequence of flooding. From the results it was concluded that most of the damages occurred along the lower reach of Middle Bernard Creek and along the San Bernard River in the East Bernard area. More details of the baseline existing conditions flood damage assessment can be seen in at the end of Appendix G. The purpose of the flood damage reduction analysis was to evaluate the baseline (current without-project) flood damages, to develop data and analysis tools with which proposed options can be evaluated, and to use the data and tools to estimate the maximum potential flood damage reduction. Using the without project EAD, a theoretical upper bound on flood damage reduction was computed. This represents, for planning, a limit on the cost of an efficient flood damage reduction project.

Following the creation of the existing condition or “without project” flood damage model, a flood damage reduction alternative analysis was performed. Alternative analysis procedures for flood damage reduction consisted of creating alternatives and evaluating them to determine the most cost effective option. These alternatives generally consisted of a combination of channel clearing, channel modifications and regional detention where applicable. It should be noted that for all recommended improvements,

the impact to adjacent property owners was considered and evaluated in HEC-RAS. It should also be noted that the potential impacts to both the overall hydraulics of the stream as well as the floodplain storage was evaluated for each alternative plan.

Once alternatives were developed for flood reduction on the lower portion of Middle Bernard Creek and the San Bernard River at East Bernard, they were evaluated using the previously created HEC-FDA flood damage model. Inputs for HEC-FDA included water surface profiles (for various flood risk probabilities) for each alternative as well as the existing condition economic data reflecting structure/building values in the project area, elevation of finish floor for each structure, and depth-damage curves for all structures. The results of the HEC-FDA analysis indicated the amount of damage reduction provided by each alternative over the existing flooding condition. The damage reduction values were compared to probable construction cost estimates to produce benefit to cost (B/C) ratios for each alternative. The recommended alternative was the one with the highest B/C ratio. Ideally the highest B/C ratio should be greater than 1 meaning that the project is cost effective from a purely financial perspective, but in some cases this did not occur. In these situations, recommendations were made based on other considerations such as likely future development impacts, safety concerns, and general public desire which are all almost impossible to quantify with a dollar value. It should be noted that most outside funding sources (FEMA, USACE, etc) request that the selected project have a Benefit/Cost (B/C) ratio greater than 1 to receive assistance. Further details on recommended alternatives can be found in the alternative analysis studies for each watershed in Appendices G and H.

Planning Results:

Alternatives with the best B/C ratio were recommended for the lower portion of Middle Bernard Creek and the San Bernard River at East Bernard. For the Middle Bernard reach, the highest B/C ratio (0.22) was produced by an overbank clearing project. The project consists of clearing underbrush for a 200-ft. width in the overbanks on either side of the main channel along a 1.5 mile length. The Middle Bernard Creek project location is shown in Figure 5.

The proposed San Bernard River flood reduction alternative includes a 7.7 mile stretch of the San Bernard River upstream and downstream of the City of East Bernard. The proposed project reach and vegetative cover can be seen in Figure 6. The original project, as recommended in the alternatives analysis report, consists of clearing underbrush and trees less than 12 inches in diameter for an approximate 150 ft. width along both overbanks of the San Bernard River and maintenance three times each year producing a B/C ratio less than 1 for this alternative. A recent addendum to this report recommended a smaller clearing area on the Wharton County side only. This modified recommendation resulted in a B/C ratio of 1.7 and is the final recommended flood reduction project for this area. This overall analysis was recently submitted to both the Texas Department of Emergency Management and FEMA for acceptance into their Hazard Mitigation Grant Program (HMGP) for a 25% local, 75% federal cost share on the overall construction of the clearing project. It should be noted that this HMGP application was funded separately by Wharton County.

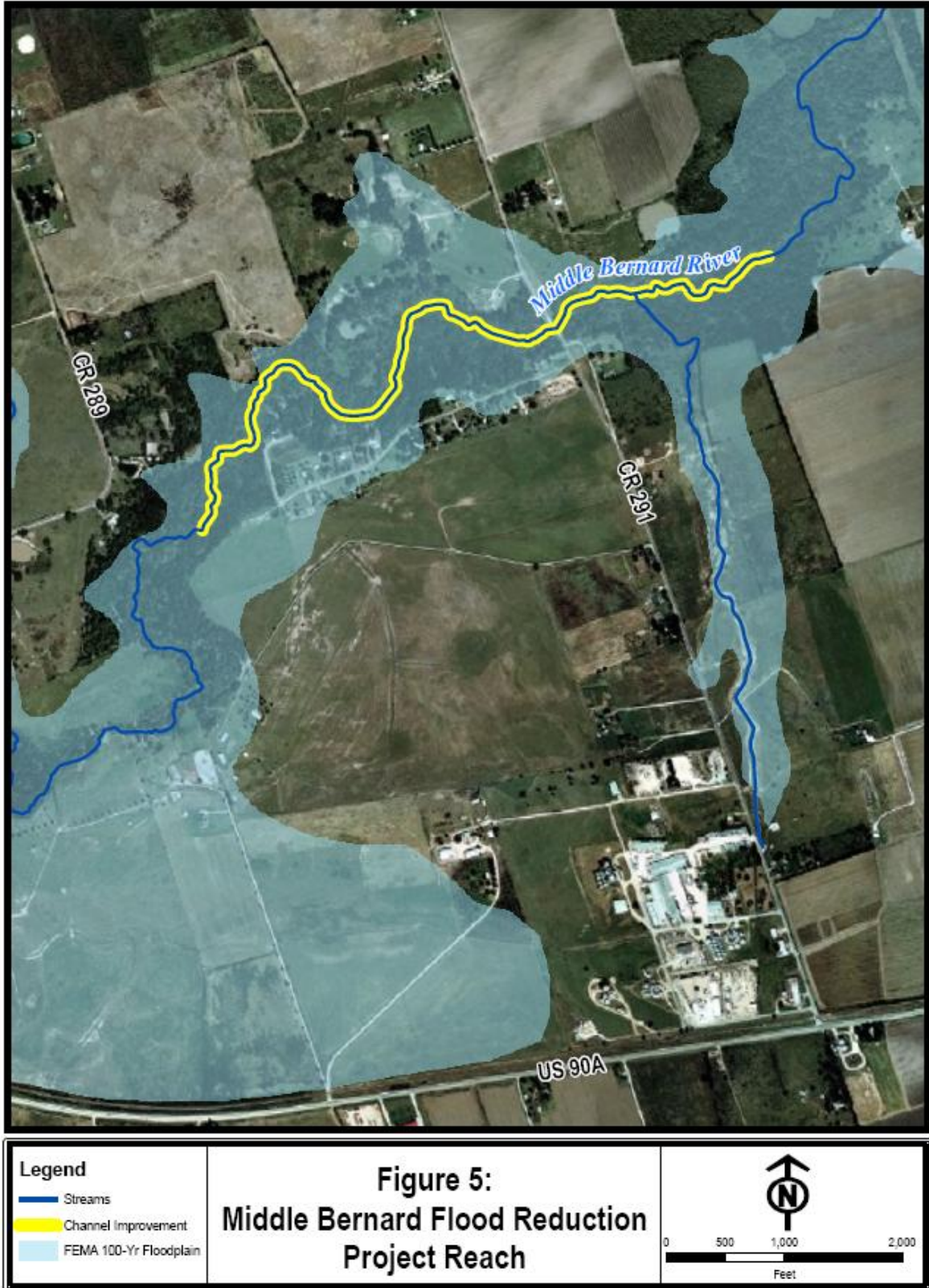


Figure 5: Middle Bernard flood reduction project reach

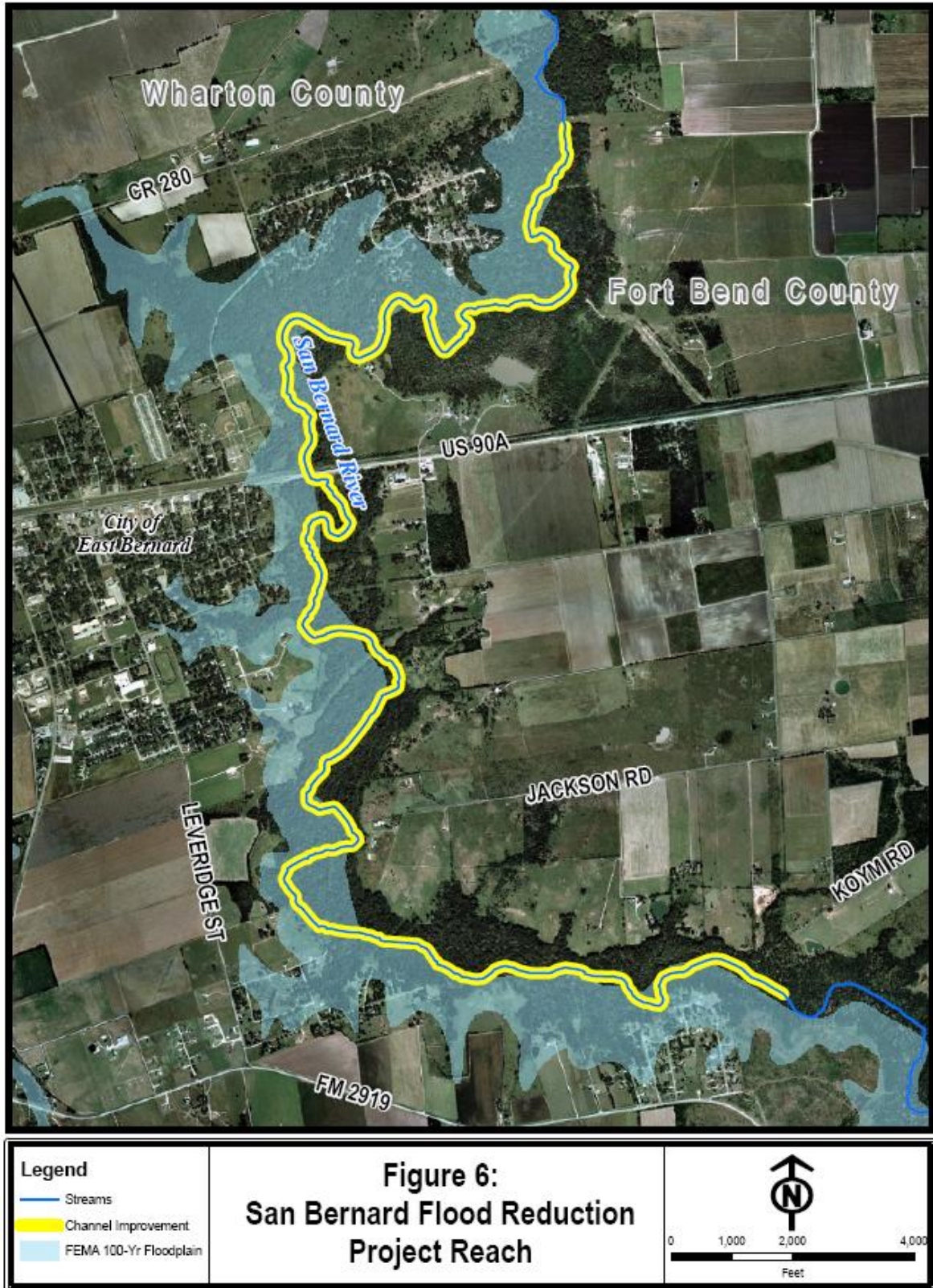


Figure 6: San Bernard River flood reduction alternative reach (Original Clearing Zone).

For the proposed project on the San Bernard River in East Bernard, 100-yr flood elevations will be reduced by approximately 0.4 ft in the City of East Bernard producing flood damage reductions for 56 affected structures. An analysis of the downstream affects of the proposed project showed a maximum rise of 0.07 ft south of US 59. However, no impacts to structures result from this rise in the downstream water surface elevation. The total present cost for the initial clearing is \$234,300 and will produce \$842,000 (present value) in benefits (flood damage reduction). As previously stated the B/C ratio for the proposed project is 1.70 and includes \$262,400 (present value) in maintenance costs.

The clearing involved in the San Bernard flood reduction alternative will occur in a complex environmental area containing jurisdictional waters of the US (wetlands) and some known endangered species. The wetland areas were delineated used standard procedures for this area. The 150-ft clearing path was adjusted accordingly so that all clearing activities would avoid these environmentally sensitive areas. In addition, a detailed evaluation of the existing endangered species, historic properties, and known archeological sites was performed, and it was concluded that the proposed clearing project would not have an adverse impact. A full environmental report and work plan for the clearing project was created and is included in Appendix I. An overview of the clearing zone for the project with adjustments for environmental consideration can be seen in Figure 7. The red hatched area is to be avoided and clearing is only to occur in green and yellow areas.

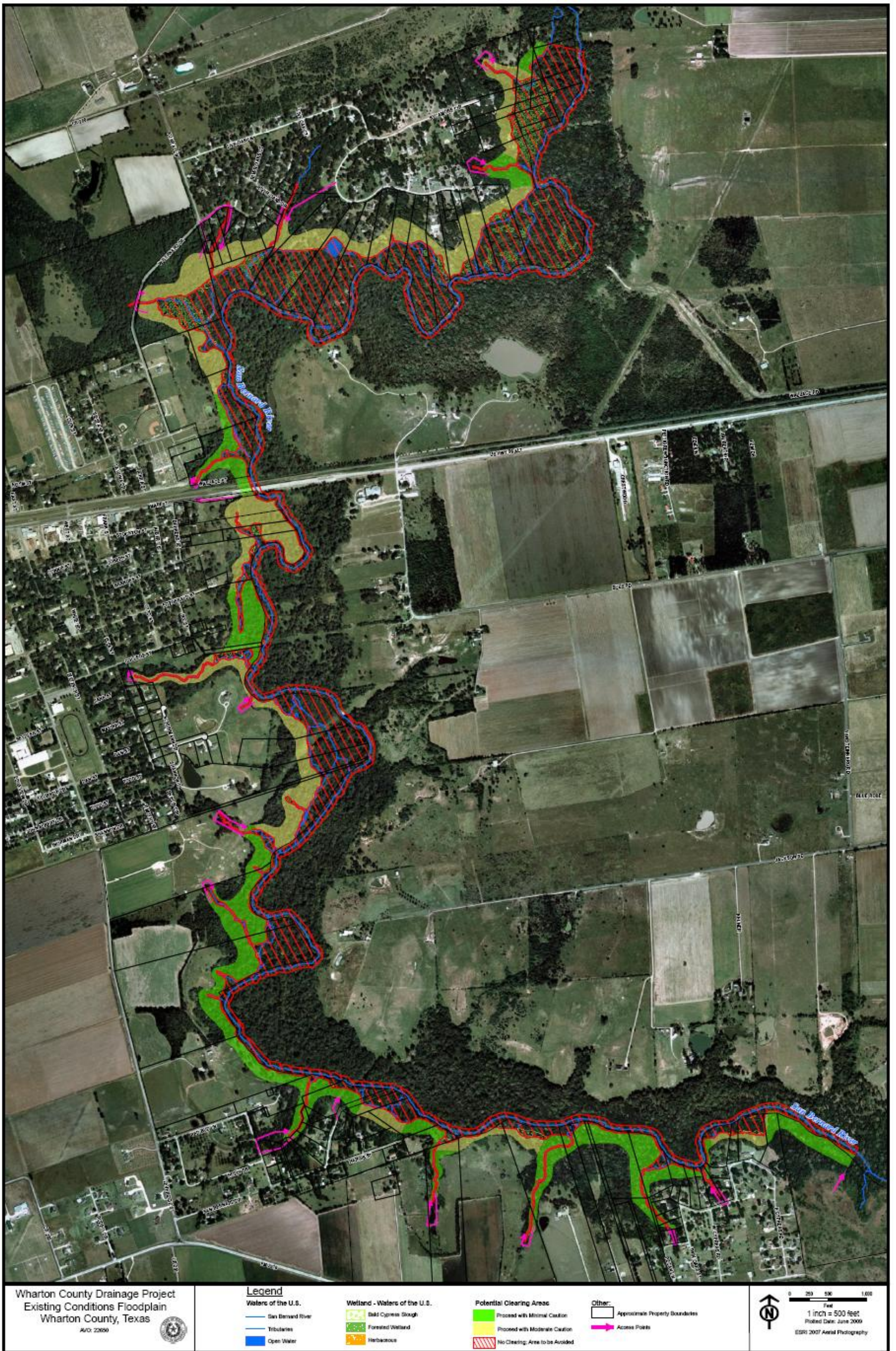


Figure 7: San Bernard (Final Clearing Zone)

Conclusion:

The San Bernard Flood Protection Planning Grant was requested to address flooding concerns in the San Bernard watershed in Wharton County. To fulfill these flood protection planning needs, baseline flooding information was created with existing conditions hydrology and hydraulic models for the San Bernard River and its tributaries. This existing information was used to create an initial flood damage assessment in the San Bernard watershed. Flood reduction alternatives for main damage areas including the City of East Bernard were analyzed to determine the most cost effective solution. The recommended projects provide decreases in flood damages while minimizing impacts on the environment and to adjacent property owners. The information produced as part of this flood protection planning grant study also provided valuable tools for floodplain planning and future regulation capabilities. By addressing current flooding issues, determining solutions for those issues and providing updated information for floodplain planning and regulation, the San Bernard Flood Protection Planning Grant has fulfilled its desired purpose.