REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION

FOR

MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED

VOLUME 1
FINAL REPORT

(LITTLE CYPRESS CREEK, HCFC Unit I.D. #L100-00-00)
(LEMM GULLY, HCFC Unit I.D. #K120-00-00)
(SEALS GULLY, HCFC Unit I.D. #K124-00-00)
(SPRING GULLY, HCFC Unit I.D. #K131-00-00)
(DRY GULLY, HCFC Unit I.D. #K133-00-00)
(PILLOT GULLY, HCFC Unit I.D. #K140-00-00)
(FAULKEY GULLY, HCFC Unit I.D. #K142-00-00)
(DRY CREEK, HCFC Unit I.D. #K145-00-00)
(MOUND CREEK, HCFC Unit I.D. #K166-00-00)

Prepared for:
Harris County Flood Control District
&
Texas Water Development Board
TWDB Contract No. 2000-483-356

by

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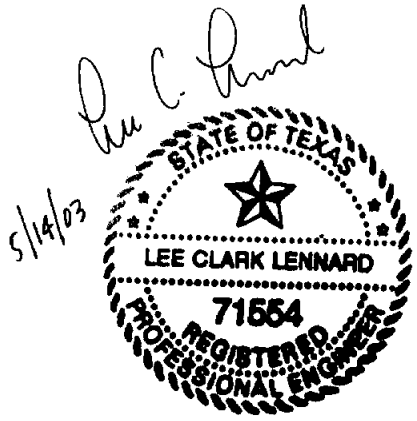

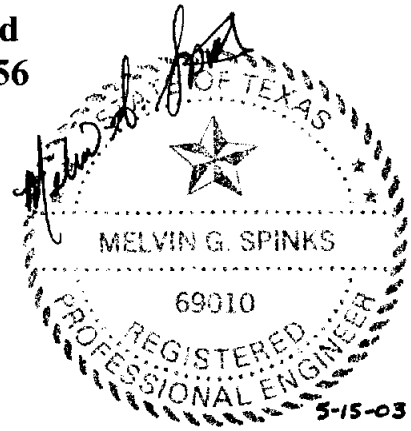

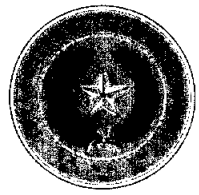

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1.0 INTRODUCTION

A planning effort to identify a stormwater management plan for the Cypress Creek watershed has been initiated with the first-phase study to prepare regional drainage plans for the watersheds of nine major Cypress Creek tributaries. This report presents the results of the study efforts identified for the regional drainage plan and environmental investigation for these watersheds. The information presented in this report provides recommendations for plans to be used to assist in providing flood reduction benefits as well as guidance for new development as they design their drainage features.

1.1 Regional Drainage Plan

A Regional Drainage Plan and Environmental Investigation has been commissioned for nine (9) major tributary watersheds in the Cypress Creek Watershed. The Cypress Creek Watershed drains an area of approximately 320 square miles in Harris and Waller Counties. This study encompasses approximately 146 square miles of the Cypress Creek Watershed, which includes the following nine (9) major tributaries:

- Little Cypress Creek (HCFC Unit L100-00-00)
- Lemm Gully (HCFC Unit K120-00-00)
- Seals Gully (HCFCD Unit K124-00-00)
- Spring Gully (HCFC Unit K131-00-00)
- Dry Gully (HCFC Unit K133-00-00)
- Pillot Gully (HCFC Unit K140-00-00)
- Faulkey Gully (HCFC Unit K142-00-00)
- Dry Creek (HCFC Unit K145-00-00)
- Mound Creek (HCFC Unit K166-00-00)

These tributaries and their watersheds are generally depicted in **Exhibit 1**. The regional flood control plans presented in this report identify flood control solutions that reduce or eliminate existing flooding problems along the major tributaries, while also recognizing the need to devise drainage plans to be used as guidance for future development in the tributary watersheds.

The regional drainage plan of proposed flood control improvements in the Cypress Creek Watershed was evaluated on a tributary basis to meet the following objectives:

1. To develop structural and non-structural flood control alternatives of sufficient detail to serve as preliminary conceptual designs of chosen alternatives for flood control protection needs for the Cypress Creek tributaries.

2. To select from the various flood reduction alternatives a cost effective, implementable plan that will reduce or eliminate flood damages and minimize the environmental consequences while allowing continued watershed development.

3. To assess the site-specific environmental consequences of alternative flood control improvements and to determine the potential for mitigation of environmental damages.

The scope of work for the Regional Drainage Plan and Environmental Investigation for Major Tributaries in the Cypress Creek Watershed has been divided into three phases of work, which is generally described as follows:

Phase I – Hydrologic and Hydraulic Baseline Report

This phase includes the data collection and update analysis of existing watershed hydrologic (HEC-1) and hydraulic (HEC-RAS) models. Land development changes in the watershed and channel improvements since 1984 were updated in the models. The future development condition in the watershed serves as the "baseline" condition. A hydraulic analysis was performed for each of the studied streams using HEC-RAS computer models. The "baseline" floodplain boundaries were delineated using digital elevation models based on Light Detection and Ranging (LIDAR)-obtained ground elevations. A main report and technical appendices have been prepared for the Phase I work, with a report date of February 2002.

Phase II – Environmental Baseline Report

A reconnaissance level effort was made in order to provide watershed or site specific information concerning general environmental conditions. The environmental setting describes the land use characterization, preliminary wetland areas, cultural resources, protected and endangered species, water quality, aquatic and terrestrial life, and the results of a limited Phase I ESA search of regulatory databases for contaminated sites. A complete report describing the environmental setting has been prepared, with a report date of August 2002.

Phase III – Regional Drainage Plan and Environmental Investigation Report

A regional drainage plan has been formulated for the nine (9) major tributaries to identify both structural and non-structural flood control measures that eliminate or reduce existing flooding problems and provide a plan of drainage improvements to be used as guidance for future development. Alternative flood control concepts were analyzed for ultimate development in the watershed. A description of the regional drainage plan alternatives and recommended plan has been prepared and is presented in this report, along with summaries of the information presented in the Phase I and Phase II reports.

1.2 Authorization

The Harris County Flood Control District (HCFCD) entered into a contract with the Texas Water Development Board (TWDB Contract No. 2000-483-356) to develop a "flood protection" plan

for nine major tributaries in the Cypress Creek Watershed. A formal Agreement was executed between the Texas Water Development Board (TWDB Contract No. 2000-483-356) and the Harris County Flood Control District on September 19, 2000. Amendments to the Agreement were executed on October 9, 2001, July 2, 2002, and February 16, 2003 to reflect changes in the task budgets, authorized maximum amount for reimbursement, and report and study completion dates.

The Harris County Flood Control District authorized Professional Services Agreements with four consulting engineering/environmental firms to provide professional services toward facilitating the work under this contract. The Consultants with their respective watersheds/responsibilities are listed as follows:

- CivilTech Engineering, Inc. — Hydrologic and hydraulic baseline and regional drainage plan identification for the following:
  - Lemm Gully
  - Seals Gully
  - Spring Gully
  - Dry Gully
- Dodson & Associates, Inc. — Hydrologic and hydraulic baseline and regional drainage plan identification for the following:
  - Little Cypress Creek
  - Faulkey Gully
  - Pillot Gully
- Brown & Gay Engineers, Inc. — Hydrologic and hydraulic baseline and regional drainage plan identification for the following:
  - Dry Creek
  - Mound Creek
- PBS&J — Environmental baseline identification for all watersheds.

1.3 Report Organization

This report presents a summary of the regional drainage plan and environmental investigation, and describes the approach and results for developing the recommended drainage plans for the nine Cypress Creek tributary watersheds. Specific information concerning each watershed's recommended plan and the information used in the plan development can be found in the appendices. The appendices are referenced as follows:

- APPENDIX A: Little Cypress Creek (HCFC Unit L100-00-00)
- APPENDIX B: Lemm Gully (HCFC Unit K120-00-00)
- APPENDIX C: Seals Gully (HCFCD Unit K124-00-00)

- APPENDIX D: Spring Gully (HCFC Unit K131-00-00)
- APPENDIX E: Dry Gully (HCFC Unit K133-00-00)
- APPENDIX F: Pillot Gully (HCFC Unit K140-00-00)
- APPENDIX G: Faulkey Gully (HCFC Unit K142-00-00)
- APPENDIX H: Dry Creek (HCFC Unit K145-00-00)
- APPENDIX I: Mound Creek (HCFC Unit K166-00-00)

A number of exhibits have been prepared to help clarify the presentation of the material discussed in this report. These exhibits are presented in each appendix and includes information related to each of the nine watersheds identified for this study

In the process of developing the regional drainage plans, several hydrologic and hydraulic models were prepared. These models are prepared in the U.S. Army Corps of Engineers' HEC-1 Flood Hydrograph program and HEC-RAS River Analysis System program formats. Electronic versions of the computer files generated for each watershed are contained on a compact disc which is included in this report.

2.0 IDENTIFICATION OF BASELINE CONDITIONS

The Cypress Creek Watershed was studied as a part of the "Flood Hazard Study of Harris County" started in 1982 and completed in September of 1984. This study applied to the Cypress Creek main channel and major tributaries. The final product was a main report with the hydrologic methodology and appendices describing the specific modeling assumptions used for the study of the Cypress Creek Watershed, and floodplain and floodway mapping for Federal Emergency Management Agency (FEMA) adoption. The mapping was officially adopted for Harris County, and cities in Harris County, in September of 1985 as published in the FEMA Flood Insurance Study for Harris County.

The hydrologic and hydraulic models developed for the Flood Hazard Study (1984) were used as the base condition models (i.e., a starting point) in the determination of "baseline" conditions. The nine (9) major tributaries were all originally studied in the Flood Hazard Study and have not been updated to account for changes in land use, channel improvements, and bridge alterations. The development of recommended regional plans for each tributary watershed involves an assessment of the watershed changes and channel modifications since 1984 for updating the existing watershed conditions and developing the future "baseline" conditions.

2.1 Hydrology

The HCFCD sets forth the methodology to be used in a watershed update project in their manual, *Hydrology for Harris County, Texas*, dated March 1988. It recommends that HEC-1 should be used to model hydrologic conditions for major watershed studies. The hydrologic methodology documented in the Hydrology Manual was established from the study entitled "Flood Hazard Study of Harris County," dated September 1984. The Flood Hazard Study compiled data from historical storm events at various stream gages throughout Harris County to develop a mathematical procedure for computing the unit hydrograph parameters Tc (time of concentration) and R (storage) following the Clark's unit hydrograph method.

2.1.1 HEC-1 Models

The HEC-1 base models used in this study were derived from the HEC-1 effective models developed for the FEMA Flood Insurance Study. These models incorporate rainfall information derived from the U.S. Weather Bureau's Technical Paper 40 (TP40) publication, with total rainfall amounts for the 24-hour duration and various frequencies based on values for Harris County. The time distribution of this rainfall is based on the U.S. Army Corps of Engineers' distribution generated for Harris County, with the peak rainfall intensity occurring at hour 16 in the 24-hour storm event. This rainfall is also reduced based on an areal distribution in consideration of increases in the overall watershed drainage area as the calculations occur from upstream to downstream.

The HEC-1 base model was updated to reflect existing conditions as of the date of this study or, in some cases, the date of the available aerial photography used in this study (1999). For planning purposes in this study, a HEC-1 baseline condition model was created to determine the flow increases that might occur in the watershed if the remaining portions of the watershed are developed using the current HCFCD criteria for on-site stormwater detention.

2.1.2 Methodology

The unit hydrographs generated using the HEC-1 model are based on the Clark Unit Hydrograph Method. The unit hydrographs parameters Tc & R were determined using the HCFCD methodology. The equations used to compute these values for tributary watersheds within the Cypress Creek Watershed are noted as follows:

For Subareas with Percent Development (DLU) $\leq$ 18%:

$$Tc = 2.46\ [L_{CA} / (S)^{1/2}]^{0.995}$$

$$Tc+R = 7.25\ [L / (S)^{1/2}]^{0.700}$$

For Subareas with Percent Development (DLU) > 18%:

$$Tc = 2.46\ [1 - (.0062)\ (.3\ DLU + .7\ DCI)][L_{CA} / (S)^{1/2}]^{(0.995)}$$

$$Tc+R = 4295\ (DLU)^{-0.678}\ (DCC)^{-0.967}\ [L / (S)^{1/2}]^{0.700}$$

In which:

Tc = Time of Concentration (hours)
R = Clark's Storage Coefficient (hours)
DLU = percent land urbanization (%)
L_{CA} = watershed length to centroid (miles)
L = watershed length, or longest watercourse along the flowpath (miles)
S = channel slope (ft/mile)
DCI = percent channel improvement (%)
DCC = percent channel conveyance (%)

2.1.3 Land Use Assumptions

Developed areas in the watershed were identified using aerial photography and a limited site reconnaissance in the watershed. HCFCD implemented a stormwater detention policy in 1984 that required new developments greater than 10 acres to construct on-site detention to mitigate increases in the peak runoff rate to pre-project conditions. A land use inventory was performed to identify developments built prior to 1984 in order to classify the developed areas as having on-site detention or without detention. Developed areas with on-site

detention were considered to produce peak runoff rates as an undeveloped area with adjustment to the HEC-1 model to account for the additional runoff volume due to the relative impervious cover of the developed area. The land use assumptions were subsequently used to determine the watershed parameters for the HEC-1 existing and baseline condition models.

2.1.4 Storage Routing

The HEC-1 models incorporate the Modified Puls Storage routing method for hydrograph routing and attenuation. The HEC-2 models were used to generate the storage-outflow relationship for each routing reach along the channel.

2.1.5 Summary of Baseline Hydrologic Results

Hydrologic analyses were performed to determine the peak flows along the tributaries based on full urbanization of the watershed. This "full urbanization" model is used as the baseline for future planning efforts to eliminate impacts. Baseline condition models assume full watershed urbanization with implementation of HCFCD On-Site Detention Policy to mitigate increased peak flows from new development in the watershed as is currently the criteria. However, the impervious cover (RTIMP) for each of the subareas was increased to 35%, a typical amount of impervious cover in fully developed areas, to account for the marginal increases in storm water volume that will occur even with storm water detention in place, as mentioned above. In some cases, if the existing impervious cover was calculated as higher than the 35%, it was left at the higher value when reflecting baseline conditions.

Peak flood flows for the 2, 5, 10, 25, 50, 100, 250, and 500-year storm events were computed at various locations along the tributaries throughout the watershed. The computed 100-year flows at hydrologic points of interest for each tributary are summarized in **Table 1**. Detailed baseline hydrologic results and discussion can be found in the appendix discussion of each tributary watershed.

2.2 Hydraulics

The hydraulic update was performed to incorporate channel modifications, bridge alterations, and to correct model inconsistencies to the effective FEMA HEC-2 models. A field reconnaissance was conducted to inventory the hydraulic structures and other data along the tributaries. All model corrections are documented in the technical appendices of the Phase I report dated February 2002. Floodplains have been created based on the computed 100-year "baseline" water surface elevations along the tributaries.

2.2.1 HEC-RAS Conversion

The effective HEC-2 models were converted to HEC-RAS Version 3.0 format in this study. All necessary model adjustments were made to achieve models that reflected the current hydraulic conditions along the tributaries. The resulting flood profile elevations and model cross-section geometry elevations are referenced to 1929 National Geodetic Vertical Datum (N.G.V.D.), 1973 releveling.

2.2.2 Summary of Baseline Hydraulic Results

Incorporating the peak flows determined in the hydrologic analysis, the hydraulic models were used to compute water surface elevations for the baseline condition flows determined for the watershed. Profiles for the 2, 5, 10, 25, 50, 100, 250, and 500-year storm event were prepared. The computed 100-year water surface elevations for each tributary are summarized in **Table 2**. The detailed hydraulic results are presented in the appendix respective for each tributary watershed.

2.3 Summary of Baseline Flood-Hazard Results

Topographic data for all watersheds (excluding the Mound Creek watershed) was obtained from TerraPoint, LLC, Woodlands, Texas. The data was collected from November 1997 through February 1998 using Light Detection and Ranging (LIDAR) technology and was originally delivered referenced to a 1995 datum adjustment. Therefore, before the topographic data could be used for this project a releveling process was performed to raise the surface to levels assumed to be present in 1973, the same datum adjustment that the hydraulic models is based. This was accomplished by examining surveyed benchmark data provided by Brown & Gay Engineers, Inc., as part of the scope of this project. The differential elevation adjustments were then input into the topographic dataset as a warped adjustment and the dataset raised to approximate ground elevations in 1973. The elevation adjustments ranged from approximately 1.5 feet in the southeastern portions of the entire Cypress Creek study area, to 0 feet at the northwestern ends of the study area, where little or no subsidence has taken place.

The LIDAR-obtained ground elevation information supplied by TerraPoint, LLC was available for only a portion of the Mound Creek watershed. As such, this information was supplemented with USGS Digital Elevation Model data for that area. The resulting topographic data was adjusted to the 1929 N.G.V.D., 1973 releveling datum consistent with the hydraulic models.

The "baseline" floodplain was created by projecting the computed water surface elevation at each cross-section of the hydraulic model onto the digital terrain model identified above. The floodplain maps are solely for the purpose of identifying the potential flood hazard areas in the watershed for the "baseline" conditions and are not intended to redefine flood hazard areas as

published in the FEMA Flood Insurance Rate Maps (FIRM). The "baseline" floodplains for each watershed are generally depicted in exhibits presented in the appendix for each watershed.

2.4 Environmental Baseline Investigation

The identification of a regional drainage plan would be shortsighted if no consideration were given to the existing environmental conditions of the watershed. Identifying projects that provide for flood protection while protecting environmentally important ecosystems has become one of the most challenging problems. Long-term, comprehensive planning is not only required to determine appropriate drainage considerations for the watershed, but also to minimize negative environmental impacts. The first step in minimizing such impacts is identifying the existing environmental baseline conditions of the watershed.

The existing environmental baseline conditions for the nine major Cypress Creek tributary watersheds are documented in the August 2002 report titled *Regional Drainage Plan and Environmental Investigation for Major Tributaries in the Cypress Creek Watershed – Phase II – Environmental Baseline Report.* This report is a summary of the information provided in the January 2002 document titled *Watershed Environmental Baseline (WEB) Mapping for the Cypres Creek Watershed Management Plan.* Further, this report presents information as it relates to the watersheds concerning cultural resources and conservation initiative status and trends.

2.4.1 Documentation Approach

Field visits and reviews of relevant literature were made in order to provide watershed or site specific information concerning general environmental conditions. The environmental setting describes the land use characterization, preliminary wetland areas, cultural resources, protected and endangered species, water quality, aquatic and terrestrial life, and the results of a limited Phase I ESA search of regulatory databases for contaminated sites.

A preliminary wetland determination was conducted using color infrared aerial photos, National Wetlands Inventory maps, county soils surveys, and other data sources to identify potentially jurisdictional wetland areas within the watersheds. A protected species literature review and cursory habitat evaluation was conducted by accessing the Texas Parks & Wildlife Department's Biological and Conservation Data System for elements of occurrence within the watersheds.

A cultural resources literature review was conducted by performing a records search for any State Archaeological Landmarks, Official State Historic Markers, properties listed on or eligible for the National Register of Historic Places, previously recorded sites at the Texas Archaeological Research Laboratory, and reports of previous surveys at the Texas Historical Commission. A literature review was conducted of available information relevant to the

water quality of the watersheds from the Texas Natural Resource Conservation Commission (now called Texas Commission on Environmental Quality) and the Texas Department of Water Resources. Reports from the Environmental Protection Agency were also used to identify sensitive water quality and aquatic life issues.

A limited Phase I Environmental Site Assessment was prepared by conducting a regulatory agency site listing and regulatory review. This review consisted of the acquisition, mapping, and summary of available public information pertaining to the watersheds. Further, using December 1995 and January 1996 aerial photography and 1990 census information, supplemented by interviews with developer organizations, areas of commercial, master plan, residential, agriculture and public land uses were designated within the watersheds. Finally, an analysis of conservation initiatives within the watersheds was conducted by interviewing various conservation organizations and other entities directly and indirectly involved in conservation efforts.

2.4.2 Summary of Environmental Baseline Investigation

The information generated from the investigation of the environmental baseline conditions for the watershed was used to help identify the appropriate recommendations for regional plans for the watersheds. One of the most important aspects of the investigation is the identification of the habitat quality along the streams within the watershed. This identification was purely qualitative and based solely on color infrared aerial photo interpretation and local knowledge. Stream segments were placed into one of three categories: high, medium, and low quality. This identification helped guide the planning process in the determination of the reaches of channel that have the highest value of stream habitat and should be protected. This information, along with wetlands and natural prairie locations are identified on exhibits provided in each appendix of this report for the respective watersheds. Additional information collected as part of this investigation is provided in a Geographic Information System (GIS) format contained on a compact disc located in the report.

Wetlands and Streams

Based on the combined NWI and CIR evaluations, the nine tributaries contain approximately 7,398 acres of wetlands. Approximately 4,215 acres are palustrine emergent (PEM) wetlands and 1,358 acres are palustrine forested (PFO) wetlands. The remaining 1,825 acres are made up of other wetland habitats, including palustrine scrub/shrub (PSS) and open water (POW).

Based on this qualitative wildlife habitat assessment, the nine tributaries contain approximately 23 percent high-, 34 percent medium-, and 43 percent low-quality wildlife habitat along its stream corridors. However, habitat quality varies greatly along the various

tributaries associated with the watershed. Little Cypress Creek, Mound Creek, and Pillot Gully are the top three subwatersheds with regard to relative remaining percentages of high- and medium-quality wildlife habitat along their respective tributaries.

Protected Species

Of the nine tributary watersheds studied for the Texas Water Development Board, only four (4) watersheds had identified protected threatened and endangered species sites; Little Cypress Creek with 8, Faulkey Gully with 3, Dry Creek with 4, and Mound Creek with 3.

Cultural Resources

The literature search and records review revealed a total of 152 previously recorded cultural resource sites within the Cypress Creek watershed. Of the identified sites, none were State Archaeological Landmarks and only one was considered eligible for the National Register of Historic Places. Over 500 potential historic sites and structures were identified during the historic maps research. A total of 24,240 acres of high probability and 8,153 acres of medium probability areas were identified within the watershed using aerial photography in conjunction with mapped topography. The general location of potential historic, cultural, and probable cultural sites within the nine tributary watersheds studied for the Texas Water Development Board are identified on exhibits for respective watersheds in the **Volume II** report.

Water Quality and Aquatic Life

A literature search of the water quality for the specific Cypress Creek tributaries only resulted in information for the main stem of Cypress Creek. The water quality of Cypress Creek is classified as limited by the Texas Natural Resource Conservation Commission (TNRCC) due to water quality parameter concentrations in excess of water quality standards and the need for advanced wastewater treatment. The water quality impairment is attributed to both point source and non-point source pollution. The 86 permitted wastewater discharge facilities are required to use an advanced secondary treatment with a nitrification process to meet the permitted effluent limits.

In a 1994 ranking of stream segments statewide, based on quality and need for corrective action, Cypress Creek (Segment 1009) ranked third out of 104 (1=worst, 104=best). These results were based on the water quality standards of 1994. If the new water quality standards (effective August 2000) were applied, Cypress Creek would not exceed the water quality parameter concentration criteria as frequently. However, dissolved oxygen, pH, chloride, and fecal coliform concentrations still exceed the revised standards.

Limited Phase I Environmental Site Assessment

A total of 626 facilities or properties within the Cypress Creek watershed were identified in the Phase I ESA database searches. Of these, a total of 111 occur within 1,000 feet of Cypress Creek or its tributaries.

Land Use

The watersheds have been significantly affected by the urban growth occurring throughout the Houston Metropolitan Region in recent decades. This growth has remained constant and shows no signs of slowing within the foreseeable future. Although much of the watersheds are "built out," residential subdivisions and ancillary urban development are in various stages of planning and completion throughout most of the watersheds. Rapid conversion of agricultural areas to residential developments within the watersheds represents the greatest current push or trend in land use.

There are factors that make certain areas more appealing for master-planned subdivision development. Infrastructure and a roadway network are primary draws, and as a result, the existence of such factors would increase the likelihood of growth in such areas.

Conservation Initiative Status and Trends

The following organizations were included in the interview in the determination of conservation initiatives and trends:

- U.S. Army Corps of Engineers - Galveston District (USACE)
- Texas Parks & Wildlife Department (TPWD)
- U.S. Fish and Wildlife Service (FWS)
- Natural Resource Conservation Service (NRCS)
- Katy Prairie Conservancy (KPC)
- Legacy Land Trust (LLT)
- Ducks Unlimited's Prairie Wetlands Program (DU-PWP)
- Wetland Habitat Alliance of Texas (WHAT)
- Houston Sierra Club
- Houston Audubon Society
- County Precincts
- Bayou Preservation Association (BPA)
- Nature Conservancy of Texas (TNC)
- Cypress Creek Flood Control Coalition (CCFCC)
- Houston Advanced Research Center (HARC)

The KPC is a local non-profit organization whose goal is to preserve as much fish and wildlife habitat on the Katy Prairie as possible. For conservation purposes, the upper Cypress Creek watershed south and west of US 290 has been identified by KPC as high priority for acquisition. The area where KPC land acquisition is the most active is best described as an 81-section rectangle (approximately 50,000 acres) bordered on the east by the north-south Katy-Hockley Road and Cutoff, on the west by the north-south FM 362, on the south by the east-west FM 529, and on the north by an east-west line on the same latitude as the north end of the Sky Lakes Subdivision Golf Course and Betka Road in Waller County. This area represents about 25 percent of the Cypress Creek watershed and is split nearly evenly between Harris and Waller Counties. KPC currently owns approximately 1,300 acres within the Cypress Creek watershed and controls (through deed restriction, conservation easement, etc.) between 3,000 and 5,000 acres. The ultimate goal of KPC is to manage between 50,000 and 100,000 acres within the Katy Prairie. At this point, it does not appear that the KPC offers any partnership opportunity for coordinating easement/buyout efforts on passive floodplain properties within the nine tributary watersheds since they are not located in close proximity to their immediate area of interest.

LLT may be interested in easements on passive floodplain properties. LLT's current activities in the Greens Bayou watershed would indicate that a series of interconnected properties along Cypress Creek and its tributaries that offered value to wildlife for movement within the corridor is desirable. Opportunities for passive recreation may also capitalize on efforts to acquire floodplain easements/buyouts.

3.0 REGIONAL DRAINAGE PLAN FORMULATION

The objectives of the study are to develop regional drainage plans to guide future development of the watershed and to address existing flooding issues. Various alternate drainage plans were formulated using several different plan elements, and each alternate compared against each other to determine which alternate best met the following 11 different screening criteria:

1. Minimizes the total cost for construction
2. Provides aesthetics
3. Can be easily implemented
4. Provides flood protection within the tributary watershed
5. Has the ability to accommodate multiple uses
6. Preserves/enhances water quality
7. Preserves/enhances the quality of the stream habitat
8. Can be maintained easily
9. Reduces the peak flows into Cypress Creek
10. Provides outfall capacity for future roadways/developments
11. Is acceptable to the public

The ability of the plan to meet each criteria is ranked from 0 to 10, with 0 indicating that the criteria is not met, and 10 indicating that the criteria is met to the best of its ability. Each criteria was assigned a weight to signify its relative importance concerning the determination of the plan. These weights are applied to the respective ranking, and the results totaled for each alternate. The results of this screening are presented in the appendices for the respective watersheds.

3.1 Alternative Plan Elements

The regional plans for each of the nine tributary watersheds utilize various plan elements. These elements consist of channel modifications, channel extensions, new channels/stream corridors in consideration of future drainage needs, detention, voluntary home buyouts, floodplain management and regulation, floodplain/stream corridor preservation, and bridge/culvert crossing modifications. Other elements such as flood-proofing structures, flood forecasting, bypass channels, and levees were not considered as they did not appear to be applicable for these tributary watersheds in meeting the goals and objectives of this study effort.

Channel modifications typically refer to increasing the flood-carrying capacity of the existing channel by means of excavating a larger channel cross-sectional area, straightening the channel, or lining the channel with concrete. Because of its impact to water quality and difficulty in permitting, concrete lining of channels was not considered an acceptable alternative channel modification. Further, channel straightening was not considered because this is typically performed along reaches of natural stream corridors, and the objective was to preserve these types

of corridors as much as possible. Where channel modifications are proposed, they are for reaches where the natural corridor has already been disturbed, i.e., where the channel has already been modified to accommodate outfall drainage from existing developments. These modifications consist of providing a larger grass-lined channel in place of a reach where the channel has already been altered, but has limited flood-conveyance capacity.

Alignments for channel extensions or new channels have been identified in an effort to help guide future development in planning for their drainage needs. For these channels, a "stream corridor" concept was used in the definition of the typical cross section and channel properties. This corridor consists of a relatively wide right-of-way necessary to contain a channel section with terraces and gently-sloping side slopes. Further, it is envisioned that this corridor section will accommodate the growth of native grasses, and trees along a meandering base-flow alignment at the bottom of the channel section. This type of corridor will have the potential to provide for multiple uses such as linear parks with hike-and-bike trails. A typical cross section of a stream-corridor channel with its potential features as identified above is presented in **Figure 1** of this report.

Detention facilities, as referenced in this study, incorporate considerations for multiple uses such as parks, soccer fields, water-quality features, etc. in addition to the storage of flood waters. A general vision of a multiple-use detention facility is presented in **Figure 2** of this report.

3.2 Plan Formulation

The formulation of the recommended regional drainage plan used an approach that considered the information prepared as part of the Phase I and Phase II study efforts. Further, information concerning the proposed major roadway thoroughfare alignments was also used to help in the identification of recommended alignments for lateral channels that could serve as outfall drainage for these roadways. A series of public meetings and coordination through advisory committee meetings helped in providing direction for identifying a recommended plan.

Hydrologic and hydraulic models prepared as part of the baseline study effort were modified appropriately to reflect alternate plans for the watershed and to determine the relative flood reduction benefits of each. Alternate plans were identified and the results measured against each other to determine which alternate represented the best plan for the watershed.

As previously mentioned, the study effort focused specifically on identifying plans for nine major tributary watersheds located in the Cypress Creek watershed. This study effort is one part of many other study parts that will be performed for the entire Cypress Creek watershed. As the other study parts are initiated, the impacts to the main stem resulting from the recommended tributary watershed plans will be addressed, and appropriate flood-reduction measures identified.

3.3 Summary of Recommended Plan Results

The recommended plans identified for each of the nine Cypress Creek tributary watersheds provide some reduction of the existing flows into Cypress Creek. This is a major objective identified early on in the formulation of the drainage plans. Because some watersheds are more developed than others, the number of plan elements identified for each plan will vary. **Table 1** and **Table 2** present the resulting recommended plan 100-year peak flows and studied tributaries' 100-year water surface elevations, respectively. Details of the results for each watershed are presented in the respective appendix. The 100-year floodplain for each watershed resulting from the recommended plan is identified in the appendices.

3.4 Plan Implementation and Management Strategies

The regional drainage plans identify plan elements and right-of-way requirements. Further, the plans present opportunities for multiple uses for many of the drainage facilities. Typically, the plan elements necessary for flood damage reduction are implemented by the Harris County Flood Control District (for areas within Harris County) or other appropriate governmental agency. Those elements associated with providing outfall for future development are typically provided by the developer or private entities. The cost associated with implementing each tributary plan is presented in **Table 3**. Detailed estimates of the cost associated with implementing the recommended plan for each tributary watershed is identified in the respective appendix.

4.0 CONCLUSIONS

The regional drainage plans identified for each of the nine major tributary watersheds to Cypress Creek represent feasible solutions to providing flood reduction benefits and guidance for drainage planning of new development projects while appropriately considering the existing environmental conditions of the watersheds. The plans not only provide benefits to the tributary watersheds, but also result in reduced peak flows into Cypress Creek.

Because of the varying levels of existing development within the watersheds, the drainage areas, and the existing flood carrying capacity of the channels, the recommended plans and related costs for each watershed differ greatly. The plans show that some watersheds require very little modifications to the drainage facilities, while others need more. As such, implementation of each plan will vary to account for these differences.

It is anticipated that the implementation of the plans will occur over several years and will require the cooperation of additional stakeholders to ensure the appropriate plan elements and multiple uses identified are funded accordingly.

Table 1
100-Year Flow Comparison

HEC-1 Analysis Point	Baseline Condition (cfs)	Recommended Plan Condition (cfs)	Difference (cfs)	% Change (%)
LITTLE CYPRESS CREEK WATERSHED				
Tributary 9.36 to Little Cypress Creek (L109-00-00)				
Mouth	1095	632	-463	-42.3
Tributary 10.99 to Little Cypress Creek (L112-00-00)				
Mouth	2922	1298	-1624	-55.6
Tributary 13.92 to Little Cypress Creek (L114-00-00)				
Mouth	2175	1382	-793	-36.4
Tributary 0.12 to Tributary 13.92 to Little Cypress Creek (L114-01-00)				
Mouth	1995	1268	-727	-36.4
Little Cypress Creek (L100-00-00)				
LT-1	2363	1222	-1141	-48.3
LT-2	4544	2552	-1991	-43.8
LT-3	7224	4667	-2557	-35.4
LT-4	7770	5401	-2369	-30.5
LT-5	8577	5466	-3111	-36.6
K100#12	9017	6331	-2686	-29.8
LEMM GULLY WATERSHED				
Wunsche Gully (K120-03-00)				
K12003#1	1144	1055	-89	-8.0
K12003#2	1555	1484	-71	-5.0
Senger Gully (K120-01-00)				
K12001#1	1559	1559	0	0
K12001#2	2428	2266	-162	-7.0
Lemm Gully (K120-00-00)				
K120A	1225	1225	0	0
K120#1	2577	2385	-192	-7.0
K120#2	4882	4385	-497	-10.0
K120#3	5959	5482	-477	-8.0
SEALS GULLY WATERSHED				
Kothman Gully (K124-02-00)				
K12402#1	2073	2073	0	0
K12402#2	2445	2073	0	0
Seals Gully (K124-00-00)				
K124#1	2278	1901	-377	-10.0
K124#2	2933	2456	-477	-16.0
K124#3	5989	5569	-420	-7.0
K124#4	6448	5433	-1015	-16.0

Table 1 (Continued)
100-Year Flow Comparison

HEC-1 Analysis Point	Baseline Condition (cfs)	Recommended Plan Condition (cfs)	Difference (cfs)	% Change (%)
SPRING GULLY WATERSHED				
Tributary 2.1 to Spring Gully (K131-03-00)				
SG#2	1108	1108	0	0
Theiss Gully (K131-02-00)				
TG#2				
TG#1	2440	2415	-25	-1.0
SG#1	3701	3622	-79	-2.0
Spring Gully (K131-00-00)				
SG#3	2361	2195	-166	-7.0
SG#2	3241	2939	-302	-9.0
SG#1	7973	7416	-557	-7.0
K100#16	8175	6715	-1460	-18.0
DRY GULLY WATERSHED				
Dry Gully (K133-00-00)				
K133#1	1402	1402	0	0
K133#2	3379	3379	0	0
K133#3	3923	3514	-409	-10.0
PILLOT GULLY WATERSHED				
Pillot Gully (K140-00-00)				
PG-1	1171	761	-410	-35.0
PG-2	1532	1105	-427	-27.9
PG-3	2435	1985	-450	-18.5
K100#14	3464	3043	-421	-12.2
FAULKEY GULLY WATERSHED				
Faulkey Gully (K142-00-00)				
FG-1	2298	2002	-296	-12.9
FG-2	3900	3666	-234	-6.0
FG-3	4213	4027	-186	-4.4
K100#13	6989	6867	-122	-1.7

Table 1 (Continued)
100-Year Flow Comparison

HEC-1 Analysis Point	Baseline Condition (cfs)	Recommended Plan Condition (cfs)	Difference (cfs)	% Change (%)
DRY CREEK WATERSHED				
Dry Creek (K145-00-00)				
STK-1	516	442	-74	-14.0
STK-2A	1182	1104	-78	-7.0
STK-2	1583	1484	-99	-6.0
STK-3	2851	2572	-279	-10.0
MOUND CREEK WATERSHED				
Mound Creek (K166-00-00)				
K166#1A	1199	1534	335	27.9
K166#1B	2332	2874	542	23.2
K166#1C	2959	3604	645	21.8
KA66#1	5237	5623	386	7.4
K166#2	7768	9800	2032	26.2
K166#3	9921	9299	-622	-6.3
K166#4	12541	11277	-1264	-10.1
K166#5	12320	11030	-1290	-10.5
K100#1	12003	12660	657	5.5
K100#2	13604	13514	-90	-0.7
Tributary 7.62 to Mound Creek (Kx166-01-00)				
K166#5A	338	360	22	6.5
K166#5B	1612	2869	1257	78.0
K166#5	2171	4027	1856	85.5
Little Mound Creek (K166-02-00)				
K100#1A	1038	1587	549	52.9
K100#1B	2140	2943	803	37.5
K100#1C	2989	3383	394	13.2
K100#1D	4290	4320	30	0.7
K100#1	5262	5835	573	10.9
Tributary 8.18 to Mound Creek (Kx166-03-00)				
K166#4A	863	389	-474	-54.9
K166#4B	1776	1926	150	8.4
K166#4	2456	3011	555	22.6
Middle Fork of Mound Creek (Kx166-04-00)				
K166#3A	1247	534	-713	-57.2
K166#3B	2607	2428	-179	-6.9
K166#3	3604	3907	303	8.4
West Fork of Mound Creek (Kx166-05-00)				
K166#2A	1152	1800	648	56.3
K166#2B	2130	2765	635	29.8
K166#2C	3906	4826	920	23.6
K166#2D	5165	5110	-55	-1.1
K166#2E	889	1691	802	90.2
K166#2	5915	5163	-752	-12.7
South Fork of Mound Creek (Kx166-06-00)				
K166#1	1096	2232	1136	103.6

Table 2
Comparison of Water Surface Elevations (100-Year)

LITTLE CYPRESS CREEK WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Little Cypress Creek (L100-00-00)							
2700	Mouth	9017	135.63	6331	134.75	-2686	-0.88
6910	Kluge Road	8924	137.09	6121	136.30	-2803	-0.79
10667	Longwood Drive	8703	139.93	5641	139.15	-3062	-0.78
10719	Trace Road	8703	140.12	5641	139.24	-3062	-0.88
18060	Spring-Cypress Road	7770	145.03	5401	143.68	-2369	-1.35
37818	Hill Road	7536	161.75	5187	160.92	-2349	-0.83
48218	L109-00-00 Confluence	7536	166.66	5187	165.86	-2349	-0.80
50068	Mueschke Road	7331	169.77	4839	168.54	-2492	-1.23
57053	L112-00-00 Confluence	7224	174.11	4667	173.07	-2557	-1.04
72638	L114-00-00 Confluence	4544	185.60	2552	184.46	-1992	-1.14
75504	Bauer Road	2363	187.64	1222	186.85	-1141	-0.79
85231	Becker Road	2363	196.18	1222	165.01	-1141	-1.17
93164	Roberts Road	2363	204.49	1222	202.27	-1141	-2.22
96936	Bauer-Hockley Road	1316	208.51	579	203.48	-737	-5.03
105495	U.S.-290	1316	217.77	579	215.10	-737	-2.67
106121	Grimes Road	1316	221.45	579	217.21	-737	-4.24
107063	Warren Ranch Road	1316	226.22	579	218.92	-737	-7.30
Tributary 9.36 to Little Cypress Creek (L109-00-00)							
2220	Mouth	1095	169.52	632	166.84	-463	-2.68
4640	Mueschke Road	718	173.67	414	170.26	-304	-3.41
5250	Bauer-Hockley Road	607	174.08	350	170.63	-257	-3.45
Tributary 10.99 to Little Cypress Creek (L112-00-00)							
290	Mouth	2922	172.97	1298	172.05	-1624	-0.92
3700	Bauer-Hockley Road	1288	179.87	527	177.11	-761	-2.76
Tributary 13.92 to Little Cypress Creek (L114-00-00)							
1650	Mouth	2175	186.78	1382	186.18	-793	-0.60
2505	Bauer-Hockley Road	2175	189.02	1382	188.36	-793	-0.66
2920	Bauer Road	2175	189.84	1382	188.81	-793	-1.03
11380	Botkins Road	1254	211.16	797	204.73	-457	-6.43
Tributary 0.12 to Tributary 13.92 to Little Cypress Creek (L114-01-00)							
190	Mouth	1995	187.20	1268	185.58	-727	-1.62
730	Bauer-Hockley Road	1995	188.23	1268	186.36	-727	-1.87
5930	Bauer Road	1840	200.78	1170	192.51	-670	-8.27

Table 2 (Continued)
Comparison of Water Surface Elevations (100-Year)

LEMM GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Lemm Gully (K120-00-00)							
2480	Mouth	5959	87.99	5482	73.8	-477	-0.31
3954	Lockridge Drive	5959	91.50	5482	79.5	-477	-0.35
Senger Gully (K120-01-00)							
300	Mouth	2428	80.63	2266	80.17	-162	-0.46
4063	North Hill Drive	2046	90.97	1961	90.73	-85	-0.24
9169	Cypresswood Drive	1575	102.55	1572	102.51	-3	-0.04
14074	Silverleaf Drive	1247	111.90	1247	111.90	0	0.00
15864	Louetta Road	1146	115.22	1146	115.23	0	0.01
Wunsche Gully (K120-03-00)							
30	Mouth	1555	104.82	1484	104.69	-71	-0.13
3447	Louetta Road	1447	114.88	1370	114.67	-77	-0.21
6599	Spring-Cypress Road	1233	125.19	1147	125.11	-86	-0.08
8349	North Freeway Frontage	1152	126.74	1063	126.65	-89	-0.09
8449	North Freeway Frontage	1152	126.77	1063	126.70	-89	-0.07

SEALS GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Seals Gully (K124-00-00)							
1850	Mouth	6448	93.34	5433	92.62	-1015	-0.72
3061	Cypresswood Drive	6203	95.60	6027	94.89	-176	-0.71
8419	Candle Creek Drive	5490	104.74	5088	104.57	-402	-0.17
8844	Mirror Lake Drive	5490	104.90	5088	104.75	-402	-0.15
11374	Louetta Road	2765	114.29	2313	113.91	-452	-0.38
16879	Spring-Cypress Road	2163	125.51	1803	124.65	-360	-0.86
21869	Rhodes Road	1778	134.07	1478	133.46	-300	-0.61
Kothman Gully (K124-02-00)							
105	Mourth	2445	108.91	2445	108.91	0	0
521	Louetta Road	2445	110.40	2445	110.40	0	0
5004	Spring-Cypress Road	2211	127.36	2211	127.36	0	0
7894	F.M. 2920	2120	130.01	2120	130.01	0	0
12900	Green Lake Drive	1014	134.33	1014	134.33	0	0
13349	Spring-Stuebner Road	797	134.97	797	134.96	0	-0.01

Table 2 (Continued)
Comparison of Water Surface Elevations (100-Year)

SPRING GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Spring Gully (K131-00-00)							
510	Mouth	8175	102.79	6770	101.98	-1405	-0.81
2710	Cypresswood Drive	8175	106.76	6770	105.96	-1405	-0.80
9042	Louetta Road	3582	113.17	3269	112.86	-313	-0.31
17711	Spring-Cypress Road	1238	125.08	1238	125.05	0	-0.03
21731	Pine Lake Boulevard	930	135.74	930	135.74	0	0.00
24479	T.C. Jester Boulevard	766	137.61	766	137.61	0	0.00
Theiss Gully (K131-02-00)							
1	Mouth	3701	106.33	3622	106.18	-79	-0.15
2929	Sir William Road	3375	111.82	3312	111.68	-63	-0.14
5346	Louetta Road	3067	114.08	3017	113.97	-50	-0.11
9159	Stuebner-Airline Drive	2440	119.81	2415	119.73	-25	-0.08
10058	Theisswood Drive	2172	120.87	2152	120.81	-20	-0.06
17170	Spring-Cypress Road	640	138.69	1164	135.70	524	-2.99
19538	Azalea Road	640	143.15	1164	138.75	524	-4.40
Tributary 2.1 to Spring Gully (K131-03-00)							
100	Mouth	1108	113.73	1108	113.73	0	0
1210	T.C. Jester Boulevard	996	115.15	996	115.15	0	0
4156	Spring-Cypress Road	714	122.51	714	122.51	0	0

DRY GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Dry Gully (K133-00-00)							
104	Mouth	3923	103.64	3514	103.06	-409	-0.58
1299	Cypresswood Drive	3923	107.77	3514	107.30	-409	-0.47
2547	Champions Forest Drive	3791	109.50	3338	108.87	-453	-0.63
4487	Herts Road	3580	117.01	3065	116.35	-515	-0.66
6505	Louetta Road	3379	126.77	3379	126.30	0	-0.47
15127	Spring-Cypress Road	1402	138.54	1402	138.55	0	0.01

Table 2 (Continued)
Comparison of Water Surface Elevations (100-Year)

PILLOT GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Pillot Gully (K140-00-00)							
1900	Mouth	3464	118.66	3043	118.51	-421	-0.15
2761	Compaq Center Drive	3215	120.16	2780	119.93	-435	-0.22
4655	Louetta Drive	2743	122.80	2293	122.46	-450	-0.34
10750	Cossey Road	1532	135.11	1105	134.39	-427	-0.72
12200	Spring-Cypress Road	1532	138.11	1105	137.12	-427	-0.99
15760	Huffsmith-Kohrville Road	1171	143.18	761	141.73	-410	-1.55

FAULKEY GULLY WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Faulkey Gully (K142-00-00)							
10	Mouth	6989	114.43	6867	113.69	-122	-0.12
2750	Jones Road	6989	119.73	6867	119.61	-122	-0.10
4554	Lakewood Forest Drive	6989	123.84	6867	123.77	-122	-0.08
8934	Louetta Road	6147	127.89	5997	127.79	-150	-0.10
12287	Eldridge Parkway	4928	134.74	4751	134.59	-177	-0.15
17508	Spring-Cypress Road	4323	140.66	4139	140.41	-164	-0.25
26186	Shaw Road	1463	154.41	1285	147.83	-178	-6.58

DRY CREEK WATERSHED

Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Dry Creek (K145-00-00)							
0	Mouth	2900	133.15	2570	132.55	-330	-0.60
1904	Jarvis Road	2900	141.11	2570	140.82	-330	-0.35
6224	Spring-Cypress Road	2450	146.11	2270	145.99	-180	-0.11
9835	Dry Creek Road	2270	147.03	2120	146.91	-150	-0.13
10798	Skinner Road	1900	148.37	1790	148.07	-110	-0.30
14599	Cypress-Rosehill Road	1650	149.94	1550	149.64	-100	-0.31
19195	Cypress-Chase Boulevard	1200	150.92	1130	150.55	-70	-0.38

Table 2 (Continued)
Comparison of Water Surface Elevations (100-Year)

MOUND CREEK WATERSHED

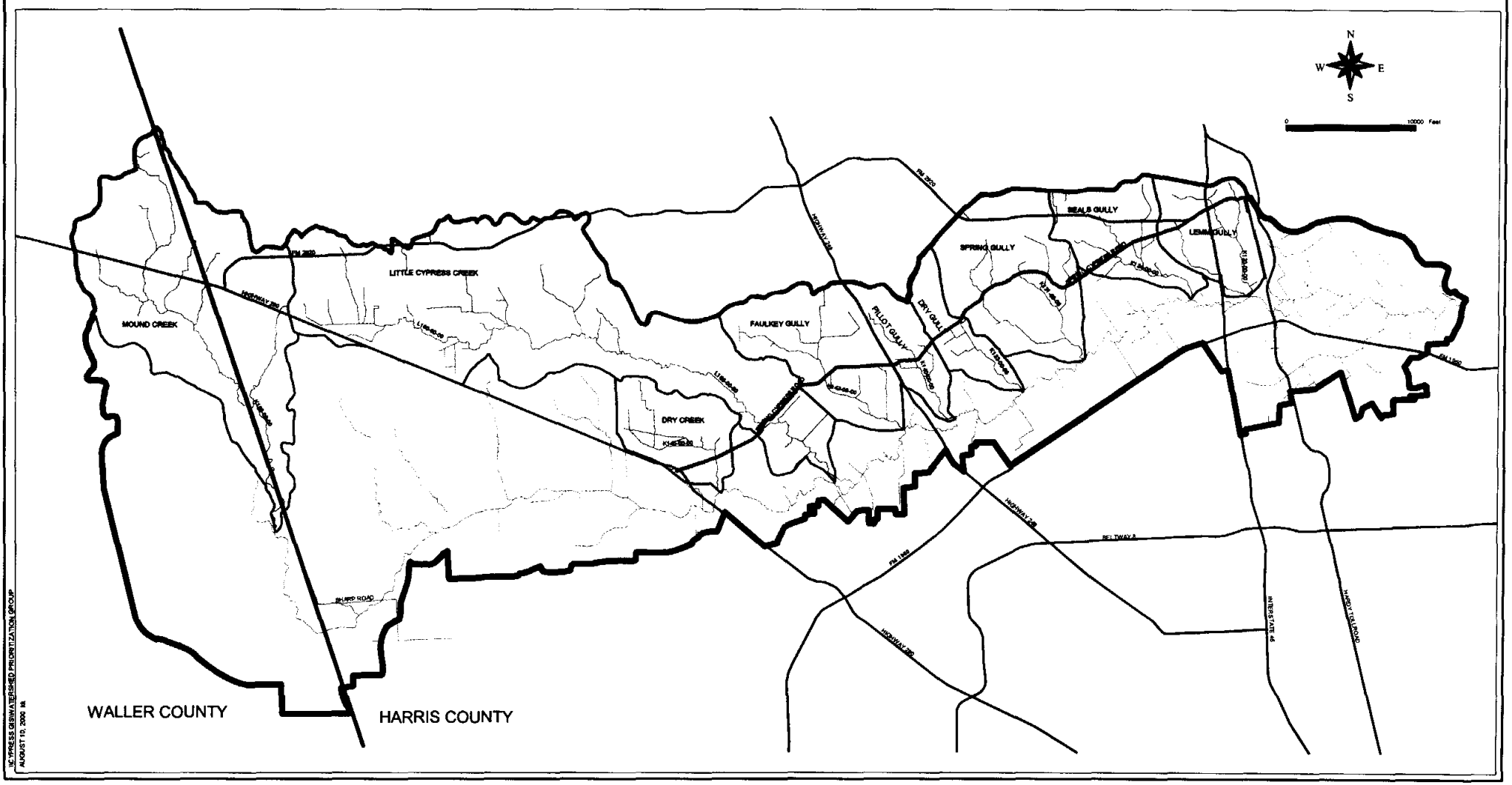
Station	Location	Baseline Conditions		Recommended Plan Conditions		Difference	
		Flow	WSEL	Flow	WSEL	Flow	WSEL
Mound Creek (K166-00-00)							
100	Mouth	13500	184.51	13500	184.51	0	0.00
29422	Mathis Road	13500	209.22	12600	209.07	-900	-0.15
8.2	Penick Road	10200	221.31	11000	221.29	800	-0.02
9.1	F.M. 362	9400	225.97	10000	226.26	600	0.29
11.786	Blinka Road	4600	241.38	5700	241.77	1100	0.39
12.707	Limit of Study	2600	249.31	2800	249.32	200	0.01
Tributary 7.62 to Mound Creek (Kx166-01-00)							
210	Mouth	1340	213.34	3044	209.96	1704	-3.38
5121	Limit of Study	710	225.6	2225	218.46	1515	-7.14
Little Mound Creek (K166-02-00)							
264	Mouth	2880	205.49	5835	204.02	2955	-1.47
8808	Betkard Road	2500	220.16	4320	217.90	1820	-2.29
13605	Limit of Study	1900	232.89	3383	229.03	1483	-3.86
Tributary 8.18 to Mound Creek (Kx166-03-00)							
0.086	Mouth	1330	220.94	3011	220.20	1681	-0.74
0.147	Charter Lane	1290	221.85	3011	222.24	1721	0.39
1.040	Ross Road	1210	232.11	1829	229.56	619	-2.55
1.671	Old Washington Road	1090	242.22	389	233.16	-701	-9.06
1.700	Business 290	1090	247.61	389	235.02	-701	-12.59
1.750	Mills Street	1090	247.66	389	235.17	-701	-12.49
1.811	Main Street	1090	247.68	389	235.99	-701	-11.69
1.921	Taylor Street	1090	247.77	389	237.83	-701	-9.94
2.0815	Field Store Road	1090	250.68	389	243.26	-701	-7.42
2.323	Ironwood Drive	740	255.97	389	256.20	-351	0.23
2.450	U.S. 290	740	262.96	389	263.70	-351	0.74
2.730	Limit of Study	740	271.18	389	270.73	-351	-0.45
Middle Fork of Mound Creek (Kx166-04-00)							
0	Mouth	1850	224.72	3907	225.66	2057	0.94
0.709	Old County Road	1850	234.9	2374	230.52	524	-4.38
1.197	Limit of Study	1550	237.62	534	232.68	-1016	-4.94
West Fork of Mound Creek (Kx166-05-00)							
0	Mouth	3900	229.26	5163	224.82	1263	-4.44
0.322	Old County Road	3900	230.35	5163	225.6	1263	-4.69
1.082	Old Washington Road	3700	241.93	4501	234.66	801	-7.27
1.123	Hempstead Highway	3700	242.30	4501	234.70	801	-7.60
1.230	Limit Study	3700	24417	4501	234.80	801	-9.37
South Fork of Mound Creek (Kx166-06-00)							
0	Mouth	1225	232.35	2232	228.88	1007	-3.47
1.04	Limit of Study	660	255.17	2232	242.73	1572	-12.44

Table 3
Cost Estimate for Recommended Regional Drainage Plans

Watershed	Recommended Plan Cost
Little Cypress Creek	$106,015,222
Lemm Gully	$13,018,938
Seals Gully	$19,436,009
Spring Gully	$13,149,330
Dry Gully	$1,030,246
Pillot Gully	$7,281,656
Faulkey Gully	$12,324,895
Dry Creek	$14,946,850
Mound Creek	$162,513,360
TOTAL	$349,716,506

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED

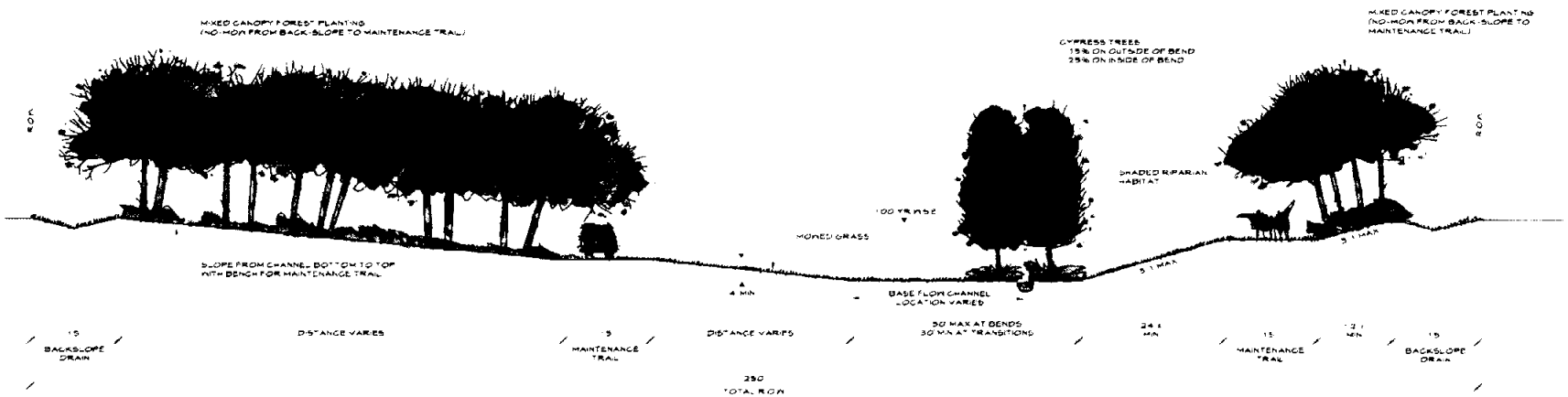
CYPRESS WATERSHED AND STUDY TRIBUTARIES
EXHIBIT 1



CYPRESS GEOWATERSHED PRIORITIZATION GROUP
AUGUST 10, 2000 ML

Harris County Flood Control District

Figure 1: Typical Cross Section for New Lateral Channel



1 SHADED RIPARIAN HABITAT STREAM SECTION
1"=1'-0"

Harris County
Flood Control District

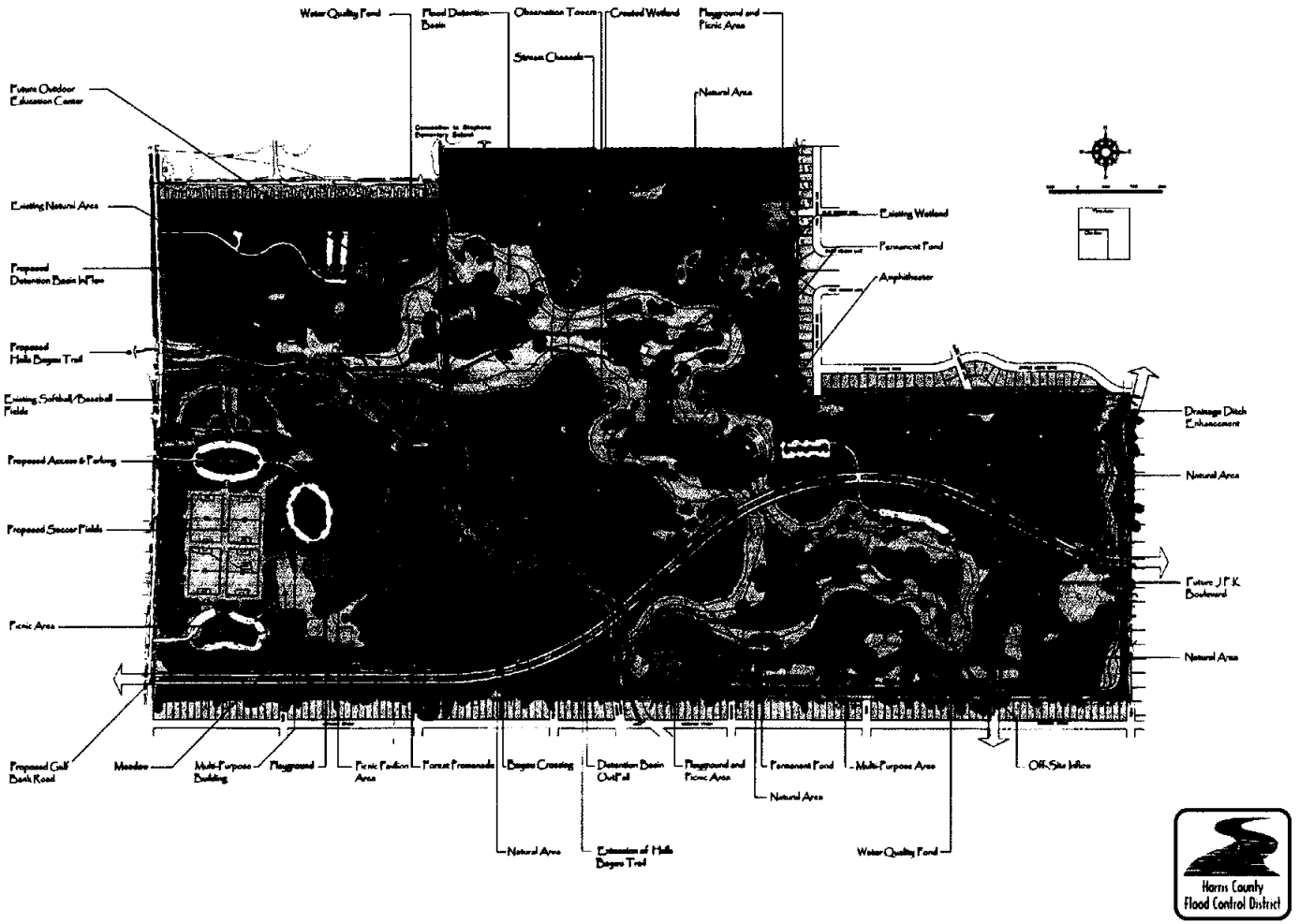


Figure 2: Example General Layout of Regional Detention Facility

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DEFINITIONS

Baseline Conditions or Baseline Model - Conditions identified for the watershed from which future planning efforts and the recommended plan will be compared to determine if the study goals and objectives will be met. This condition considers the watershed 100% developed, with new development after 1984 consistent with current HCFCD criteria for on-site storm water detention in the determination of the appropriate baseline hydrologic processes. Further, this condition considers the information identified in the environmental baseline report.

Plan Conditions or Plan Model - The baseline conditions model modified to reflect the land-use conditions and recommended plan elements identified for the recommended regional drainage plan for the watershed.

ELECTRONIC FILES

File Name:	Description
HEC-1 Models:	
L100B-2.ih1	Baseline Conditions 2-year Flows
L100B-5.ih1	Baseline Conditions 5-year Flows
L100B-10.ih1	Baseline Conditions 10-year Flows
L100B-25.ih1	Baseline Conditions 25-year Flows
L100B-50.ih1	Baseline Conditions 50-year Flows
L100B100.ih1	Baseline Conditions 100-year Flows
L100B250.ih1	Baseline Conditions 250-year Flows
L100B500.ih1	Baseline Conditions 500-year Flows
L100R-2.ih1	Recommended Plan 2-year Flows
L100R-5.ih1	Recommended Plan 5-year Flows

ELECTRONIC FILES *(continued)*

File Name:	Description
HEC-1 Models:	
L100R-10.ih1	Recommended Plan 10-year Flows
L100R-25.ih1	Recommended Plan 25-year Flows
L100R-50.ih1	Recommended Plan 50-year Flows
L100R100.ih1	Recommended Plan 100-year Flows
L100R250.ih1	Recommended Plan 250-year Flows
L100R500.ih1	Recommended Plan 500-year Flows
HEC-RAS Models:	
L100dod.prj	Project File – Little Cypress Creek
L100dod.p07	Baseline Multiprofile Plan – Little Cypress Creek
L100dod.p02	Recommended Multiprofile Plan – Little Cypress Creek
L109fem.prj	Project File – Tributary L109-00-00
L109fem.p04	Baseline Multiprofile Plan – Tributary L109-00-00
L109fem.p01	Recommended Multiprofile Plan – Tributary L109-00-00
L112fem.prj	Project File – Tributary L112-00-00
L112fem.p02	Baseline Multiprofile Plan – Tributary L112-00-00
L112fem.p04	Recommended Multiprofile Plan – Tributary L112-00-00
L114fem.prj	Project File – Tributary L114-00-00
L114fem.p03	Baseline Multiprofile Plan – Tributary L114-00-00
L114fem.p01	Recommended Multiprofile Plan – Tributary L114-00-00
L11401fem.prj	Project File – Tributary L114-01-00
L11401fem.p04	Baseline Multiprofile Plan – Tributary L114-01-00
L11401fem.p03	Recommended Multiprofile Plan – Tributary L114-01-00

1.0 INTRODUCTION

The information presented in this appendix report intends to document the process of developing the recommended regional drainage plan for the Little Cypress Creek watershed. The plan elements identified for the recommended plan are presented, along with the recommended funding and implementation strategies identified for the plan. All supporting regional-plan modeling information for the Little Cypress Creek watershed is included in this report.

1.1 Project Location

The Little Cypress Creek Watershed is located in northwest Harris County and is a subwatershed of the Cypress Creek Watershed. A vicinity map of the watershed is provided on **Exhibit 1** of the main text report.

The Little Cypress Creek Watershed includes one main stem (L100-00-00) and majore tributary ditches L109-00-00, L112-00-00, L114-00-00 and L114-01-00. These are the ditches that have been studied as part of the Flood Insurance Study (FIS). However, a number of additional ditches exist in the watershed, built primarily to serve developments in the watershed. None of the additional ditches are studied in the FIS or are presented in detail in this study. The 51.4-square mile watershed drains to Cypress Creek through the main stem. As seen in **Exhibit A1** and **Exhibit A2**, the upper reaches of the watershed lie just west of US 290 and the watershed drains in a southeasterly direction across US 290, approximately 20 miles through a number of crossings and to the mouth at Cypress Creek upstream of Eldridge Parkway (Addicks-Fairbanks Road).

1.2 Background Information

HCFCD intends to prepare a storm water management and flood reduction plan for nine tributary watersheds located within the Cypress Creek watershed. The Little Cypress Creek watershed is one of the nine watersheds. Several studies have been conducted within the Little Cypress Creek watershed at varying levels and are identified in Appendix A of the February 2002 *Regional Drainage Plan and Environmental Investigation for Major Tributaries in the Cypress Creek Watershed, Phase I – Hydrologic and Hydraulic Baseline Report.*

The baseline watershed boundary is shown on **Exhibit A1**, with the existing development conditions reflected on **Exhibit A2**. The information identified on these exhibits were generated as part of the Phase I study efforts, and was used to assist in identification of the appropriate regional drainage plan for the Little Cypress Creek watershed.

An assessment of the environmental baseline conditions of the Little Cypress Creek watershed was prepared as part of the Phase II – Environmental Baseline Report study efforts. The information presented in this report was used to help identify the recommended regional drainage plan and appropriate plan elements for the watershed. Much of the main stem of Little Cypress Creek and its tributaries are identified as having good stream corridor habitat beneficial for

wildlife and water quality. Further, several areas of wetlands have been identified throughout the watershed. Environmental considerations for the Little Cypress Creek watershed are shown on **Exhibit A3**.

1.3 Flood Hazard

Flood hazards along Little Cypress Creek and some of its tributaries (i.e., L109-00-00, L112-00-00, L114-00-00, and L114-01-00) for which existing model information was available were identified for the baseline conditions. These flood hazards were identified by modifying the current effective hydrologic models for the watershed to reflect appropriate baseline land-use conditions, with the resulting storm flows incorporated into the appropriate hydraulic model reflecting the current conditions of the channel system. The 1% storm flood profile information resulting from the hydraulic model was used in conjunction with existing digital terrain model produced from LIDAR-obtained ground elevation information to produce a flood-hazard boundary map. The result of this mapping is shown on **Exhibit A8**.

1.4 Summary of Baseline Conditions

The results of the study efforts for identifying the baseline conditions indicate that the 1% storm flood boundary is different from the current effective Federal Emergency Management Agency regulatory flood boundary. This is predictable since updated information about the watershed and its studied streams has been used in the identification of the baseline conditions. The information prepared in the identification of the baseline conditions flood hazards and environmental baseline conditions is suitable for use in identifying the appropriate regional drainage plans.

2.0 REGIONAL DRAINAGE PLAN FORMULATION

The objectives of this Phase III study are to develop Regional Drainage Plans to guide future development of the watershed and to address existing flooding issues. The sections below detail the methodology of the plan formulation steps, the watershed resources and alternate plans developed for the Little Cypress Creek watershed.

2.1 Methodology

The formulation of the recommended regional drainage plan used an approach that considered the information prepared as part of the Phase I and Phase II study efforts. Further, information concerning the proposed major roadway thoroughfare alignments was also used to help in the identification of recommended alignments for lateral channels that could serve as outfall drainage for these roadways. A series of public meetings and coordination through advisory committee meetings helped in providing direction for identifying a recommended plan.

Hydrologic and hydraulic models prepared as part of the baseline study effort were modified appropriately to reflect alternate plans for the watershed. Alternate plans were identified and the results measured against each other to determine which alternate represented the best plan for the watershed.

2.2 Watershed Description

The Little Cypress Creek watershed as delineated in this study contains 51.4 square miles and has southerly and easterly overland slopes that are mild in the lower portions of the watershed and somewhat steeper in the upper reaches. Development is primarily located in the lower portions of the watershed, with large open areas, agriculture, and large-lot homestead developments taking up the remainder of the watershed. There is one main stem (L100-00-00) and many tributary ditches and streams, but, as mentioned above, only the main stem and three tributaries have been studied in any detail.

This analysis uses the baseline conditions model subbasins and modifies the hydrologic parameters of each accordingly to reflect alternate plan scenarios. In some instances, the baseline subbasins were further subdivided in order to more accurately model particular plan elements. The subbasins can be described as follows:

- L100A – The uppermost subbasin from Roberts Road to US 290 to FM 2920 (6860 acres);
- L100B – The area to the south of Bauer-Hockley Road and west of Bauer Road. (1907 acres);
- L114A – The area north of Bauer-Hockley Road principally drained by Tributary L114 (4830 acres);
- L100C – The area between the confluence of Tributaries L112 and L114 (2586 acres);

- L112A – The area principally drained by Tributary L112 (4620 acres);
- L100D – The area downstream of the confluence of Tributary L112 and upstream of Cypress-Rose Hill Road (3504 acres);
- L100E – The area between Telge Road and Cypress-Rose Hill Road (4257 acres); and,
- L100F – The area from the mouth to Telge Road (4323 acres).

Little Cypress Creek discharges into Cypress Creek (HCFCD Unit K100-00-00) between Huffmeister Road and North Eldridge Parkway. **Exhibit A2** shows Little Cypress Creek Watershed subareas with location and station of each routing node along with sub-basin names. **Exhibit A5** shows the difference in watershed delineation between the baseline report and this report.

In the western (upper-most) portion of the watershed, the topography is relatively flat. However, along the mid to lower reaches, there is sufficient topography to create slight valley sections for both the main stem and its tributaries. Much of these channel reaches of valley sections have remained in its natural state and unimproved. It is in the areas with flat topography where channels have been rectified to improve drainage.

2.3 Basin Resource Inventory

Information was obtained for the watershed concerning existing and planned land use, structure values, environmental resources, etc. This information was used to help identify the value of the resources within the watershed and how best they should be considered in the overall planning efforts.

2.3.1 Stream Habitat Quality

The Environmental Baseline Report (EBR) qualitatively established stream habitat quality rankings based upon characteristics of the stream channel such as channelization, vegetation, and urban density. The ranking system is shown in the EBR and was based solely on color infrared aerial photos and local knowledge of the streams. The stream quality designations are shown on **Exhibit A3**. The goal of the regional drainage planning effort was to attempt to preserve areas of high stream quality in order to enhance the environmental benefits of the plan.

Areas of high quality stream habitat were identified within the Little Cypress Creek watershed, along nearly the entire reach of the main stem. Approximately 67 percent of the Little Cypress Creek and tributary main stems were identified as having high or medium level stream quality. Only the far upper reaches of the L100 main stem has been rectified in order to serve adjacent agriculture. The portion of the main stem below (downstream of) Zube Park is heavily wooded and in a natural condition.

2.3.2 Land Uses in the Watershed

Exhibit A2 illustrates land uses within the watershed. Approximately 15 percent of the total watershed is developed with most of the high-density development in the lower reaches of the watershed downstream of Spring-Cypress Road. Major high-density residential developments include Longwood and Lakewood Forest in the lower reaches of the watershed, and Lakes of Rosehill in the middle of the watershed. The remainder of the development consists of scattered large-acreage developments. The majority of the upper half of the watershed is used for agricultural purposes.

2.3.3 Structure Inventory

An inventory of structures that might be affected by flooding along the main stem was performed. The purpose of the inventory was to identify and estimate the economic value or benefit if the structures were either removed or protected from flooding by the regional plans. In the Little Cypress Creek watershed, a number of scattered areas were identified where existing structures might be affected by flooding from the main stem and tributaries. The general location of these structures is shown on **Exhibit A4**. In order to estimate the number and value of the structures included in these areas, a search of the Harris County Appraisal District (HCAD) records was performed using a GIS file supplied by HCFCD. In the areas noted, approximately 80 structures were identified as having a possible risk of flooding in baseline conditions. The total structure (improvements) value of these identified parcels was estimated by HCAD to be approximately $9,190,750. It should be noted that a large number of these structures have been recently constructed and therefore have first floor elevations above the currently effective base flood elevation. Therefore, it is likely that these structures would not experience damage in the baseline event.

In order to determine whether these structures were at risk, an examination of available Lambert Maps (2-foot contour maps with finish floor elevations identified for some structures near the floodplain) was performed. The maps were provided by HCFCD. Many of the structures noted above were not shown on the Lambert Maps, meaning that they had likely been constructed after the maps were created, as noted above. In areas where no Lambert Map information was available, visual surveys were conducted to attempt to discern the condition of the structures. Visual field surveys showed that the majority of the structures identified appeared to be constructed above natural ground level. A number of structures either were noted using the Lambert Maps or during the field visits as structures with first floor elevations either at natural ground elevations or below the base flood elevation. Of the approximately 80 structures noted above, approximately 30 were identified in this fashion. The total structure (improvements) value of these identified parcels was estimated by HCAD to be approximately $1.7 million.

2.3.4 Economic Factors for the Watershed

The Little Cypress Creek watershed is typical of many of the Cypress Creek tributary watershed in that it is in a gradual state of development. A portion of the middle third of the watershed has been planned for development. Much of the development that is planned will be built along the main stem of Little Cypress Creek or along existing tributary ditches. Land values in the watershed are rising due to this development pressure, especially in areas where outfall for drainage is present, along the main stem and the tributary ditches. As noted above, there are some structures currently located in flood-prone areas and current development regulations are written to ensure that new structures are not placed in areas without adequate flood protection. Therefore, significant structural damage prevention is not an overriding economic factor within the Little Cypress Creek watershed.

2.4 Problems and Opportunities Identification

The flood hazard information identified in the Phase I study efforts was used to determine the areas within the watershed most susceptible to out-of-bank flooding. Additionally, opportunities for enhancement of the watershed through the reduction of existing flooding and preservation of environmental features in the design of the regional plans were identified.

2.4.1 Economic Flood Damage Analysis

Since relatively few structures were identified in areas that may be subject to flooding, no formal economic analysis of flood damage was performed. The approximately 30 structures noted above total approximately $1.7 million. If approximately 50% of the value of the structure is added for the contents, the total economic benefit from any flood reduction planning in the area would be approximately $2.55 million, assuming the structures and their contents would be completely lost in flooding.

2.4.2 Identification of Flood-Prone Areas

As shown on the floodplain map, **Exhibit A8**, the baseline condition modeling identified areas along the main stem of Little Cypress Creek as subject to out-of-bank flooding. Nearly all the area adjacent to the main stem and tributary main stems experiences out-of-bank flooding during the 100-year baseline event. However, development has typically avoided areas immediately adjacent to the streams so although there is much out-of-bank flooding, there is limited structural damage from these events. The structures noted earlier as subject to flooding are scattered throughout the watershed and are typically built near the stream.

There are additional areas that are subject to flooding due to constrictions in the channel and a lack of maintenance on the main stem of Cypress Creek. Although this type of flooding is not

specifically addressed in the watershed study since it is part of a current program, it should be noted as an area for future improvement.

An additional area was noted in the lower reach of the watershed where local improvements have been made to a tributary channel. The improvements made to the channel, were made to protect new development from flooding. However, the improvement made has the potential to increase the risk of flooding for a neighboring development just downstream. A local improvement project needs to be addressed in this area in order to reduce the risk to the downstream development. A project of this nature is outside the scope of this project; however, the affected area is noted on the alternate plans exhibits.

2.4.3 Summary of Public Comments Received

Three public meetings have been held to discuss this project, and public comment on existing drainage problems, plan alternates, and the recommended plan have been solicited. A summary of public comments received regarding the Little Cypress Creek watershed is shown below.

First Public Meeting (August 2001)
Five comments received for the Little Cypress Creek watershed. The comments included concerns about development in the upstream portions of the watershed, poor maintenance on the main stem of Little Cypress Creek and other tributary ditches, and the desire for more and larger storm water detention/retention facilities in upstream developments. One commenter wanted more buyout programs to be instituted for homes in the watershed.

Second Public Meeting (October 2002)
Five comments received for Little Cypress Creek watershed. The comments again included requests that the creek be "cleaned out". Residents from the development noted in Part 2.4.2 above also provided comments and requests that a project be developed to assist their neighborhood.

Third Public Meeting (April 2003)
Three comments were received indicating a general acceptance of the plan as identified.

2.4.4 Summary of Repetitive Flood Loss Data

Data on structures that have experienced repetitive flood losses was collected for Harris County and the HCFCD. This data includes FEMA-related flood damage claims and does not include minor flooding that may have occurred throughout the watershed. Approximately 3000 properties are listed in the database of information obtained. Of the properties included in the database, 23 were identified in the Little Cypress Creek watershed. The locations of these properties are shown on **Exhibit A4**. A number of these properties have been purchased

by the county as part of a buyout program. Approximately half of the locations noted were in the lower reaches of the watershed where they were most likely affected by backwater from Cypress Creek, and not necessarily from flows on Little Cypress Creek.

2.4.5 Opportunities for Watershed Enhancement

There are many areas available within the watershed that may be beneficial to preserve and to enhance in order to benefit the community. As noted above, there are areas of high stream habitat quality along the main stem of Little Cypress Creek that are not under development pressure and can be preserved to enhance the environmental quality of the watershed. There are also large open areas near the main channel that may be available for dual-use facilities such as parks and sports fields that also serve as detention facilities. There are various and scattered wetlands that can be incorporated into a regional detention facility and expanded and enhanced as part of the project. The Harris County Parks Master Plan includes a bikeway along the entire main stem of Little Cypress Creek. The inclusion of recreational and/or environmental preservation features along this bikeway will also serve to enhance the recreational and educational opportunities in the watershed.

2.4.6 Identification of Major Thoroughfare Outfalls

Exhibit A1 and **Exhibit A3** show the major roads and proposed major roads through the watershed. There are a number of major roads that traverse the watershed and cross the main stem of Little Cypress Creek, or one of the tributary streams. The major roads, in order of distance from the mouth of Little Cypress Creek include Kluge Road, Longwood Trace, Spring-Cypress Road, Louetta Road *(future)*, Huffmeister Road *(future)*, Schiel Road *(future)*, Cypress-Rosehill Road, Mueschke Road, Mason Road *(future)*, Roberts Cemetery Road *(future)*, Grand Parkway *(future)*, Bauer Road, Becker Road, Roberts Road, and US 290. Of these crossings, Spring-Cypress Road and all the future roads are planned for improvements. The remaining roads do not have current plans for improvement, although many exist in a two-lane configuration that will likely eventually be upgraded as the watershed develops.

2.4.7 Storm Water Quality Issues

As part of new regulations enacted by Harris County in October 2001, all new development in the watershed will be required to provide storm water quality protection for the outfall drainage. This includes roadway projects, subdivisions and other development of 5 acres or more. The regional plans evaluated as part of this project are planned to provide general water quality benefits, as will be discussed later, but do not specifically address individual developments or roadway projects. Additional storm water quality features will have to be designed for these projects, in order to comply with the new effective regulations.

2.5 Alternate Drainage Plan Formulation

Several alternate drainage plans were identified for the watershed. Each plan was identified in consideration of the goals and objectives identified early on for the study effort. As mentioned above, the alternate plans were developed by considering channelization alternates, detention alternates, and non-structural and "no-action" alternates. In the case of Little Cypress Creek, the alternate plans were evaluated on a qualitative basis due to the large increase in flows detailed in the baseline report. This large increase dictated an approach to Little Cypress Creek that differed from the other watersheds in this report. This approach involved evaluating alternatives such as channelization and detention and then developing a recommended plan that included limited aspects of each of these elements and reduced the baseline flow levels sufficiently enough to offset the potential increase in flows in the baseline condition.

As mentioned in Section 2.2, the baseline subbasins were further subdivided in order to more accurately model particular plan elements. The additional subdivision created a model slightly different than the one included in the Phase I report. The addition of subareas to the model caused peak flows to increase slightly in the baseline models used in this study. **Table A1** of this report presents the updated watershed parameters resulting from this modification of subareas. The peak flows resulting from this subdivision are identified in the following sections describing the plan alternates.

The models used to simulate the plan alternatives are based on the revised modeling efforts that define an updated baseline condition. For the simulation of the Little Cypress Creek watershed, the watershed parameters did not change and are the same as that identified in **Table A1**. Additional storage volume resulting from alternative plan features were incorporated into the models, and the peak flow values along appropriate reaches were determined.

Each of the alternate plans presented below are combinations of these elements. Although the alternates differ somewhat in their features, there are common elements to all the plans presented in this study.

2.5.1 No-Action Alternate Plan Features and Benefits

The first alternate plan evaluated was the no-action plan. This plan involves making no changes to current HCFCD policy in the Little Cypress Creek watershed. The plan would allow development to continue, provided that adequate storm water detention and environmental issues were addressed by the developer. Outfall depth and capacity would also be provided by the developer. Opportunities for dual-use facilities and environmental enhancement projects would be contingent upon the developers as well. The no-action plan could also be viewed as a non-structural plan if the resulting flood-prone areas around the main stem and tributaries of Little Cypress Creek were purchased or encumbered by the local

governmental authority. The amount of ground to be reserved in this manner could be the entire floodplain area, the floodway, or an amount in between where the risk of flooding and the preservation of natural stream habitat areas balanced.

In either case, the baseline report for the Little Cypress Creek watershed outlined the effects of continued development on the watershed. Baseline 100-year flows would increase due to the effects of additional runoff volume produced from developments even with the inclusion of on-site detention storage requirements. Due to the large amount of undeveloped land within the watershed (approximately 45 square miles), complete development of the watershed under this alternate has the potential to increase flows in the main stem and into Cypress Creek. Although these alternates might address the Little Cypress Creek watershed, they do not address the potential for higher flows into the Cypress Creek watershed.

2.5.2 Channelization Alternate Plan Features and Benefits

Alternate 2 consists of channelization of the main stem and major tributaries of Little Cypress Creek. Channels would also be constructed in areas that are not presently served by outfalls in order to better guide development of the watershed. The channels would consist of the terraced section as shown in **Figure 1** and would provide outfall depth, channel capacity and additional storage to the watershed. Maintenance requirements for these channels would also be reduced, as noted earlier. Development would still be required to provide storm water detention, with some excess capacity provided by the channel sections.

The benefits provided by new main stem and tributary channels would be to bring the floodplain along Little Cypress Creek within the banks of the new channels, thereby protecting adjacent properties, reducing or eliminating existing flooding problems and providing outfall depth. It is also possible to design and construct the new channels with transition structures that reduce the peak discharges in the stream to acceptable levels. However, the construction of the channels would eliminate virtually all the high-quality stream habitat that is prevalent along nearly all of the main stem of Little Cypress Creek. This habitat could gradually be replaced as the channels are revegetated and grow, but it is likely that the environmental considerations would be difficult to overcome. The construction cost of this alternate plan would likely prove to be very high.

2.5.3 Detention Alternate Plan Features and Benefits

Alternate 3 modifies the elements of Alternate 2. Rather than channelizing the flows along Little Cypress Creek, detention basins along the main stem and at or near the mouths of the tributary streams are proposed to reduce the peak flows along the main stem and into Cypress Creek. Several detention basin locations were selected based on their location in the watershed and the density of adjacent development. One of the basins is currently in partial use by the HCFCD (L500-02-00). The basin locations could be designed to provide

approximately 5000 acre-feet (including L500-02) of storage in addition to the storage provided by the required storm water detention facilities for new development.

The effect of these detention facilities has a significant effect on peak flows in Little Cypress Creek and on peak flows entering Cypress Creek in the baseline condition. The basins also provide areas of dual-use potential and environmental enhancement. A possible general basin layout is shown in **Figure 2.** However, the peak flows in Little Cypress Creek still create a significant floodplain that must has the potential to continue existing flooding problems in the watershed. Therefore, additional provisions must be implemented in the watershed for this alternative to meet all the requirements of the study.

2.5.4 Combination Alternate Plan Features and Benefit

Alternate 4 combines the features of the previous alternates in order to address all the goals of the study. The current policy or requiring storm water detention is assumed to remain in place and a majority of the main stem and adjacent floodplain of Little Cypress Creek is preserved in its natural condition to restrict floodplain development and preserve stream habitat quality and to also provide a buffer between development and the stream channel. New channels are recommended in order to provide outfall depth for future development. The upper reach of the main stem of Little Cypress Creek, an area of low stream habitat quality, is channelized in order to provide outfall depth. Regional detention basins are provided to reduce peak flows in Little Cypress Creek as well as into Cypress Creek. Additionally, areas of significant structural flooding potential are noted for voluntary buyouts and a specific local drainage improvement has been recommended to alleviate potential structural flooding in another area. The plan features are shown on **Exhibit A7**.

The table below shows the hydrologic benefits of this plan by comparing peak flows at each hydrologic computational node in the baseline and combined plan condition.

Alternate 4 Benefits (100-Year Flows)				
Node	**Location**	**Baseline Flow (cfs)***	**Alt Flow (cfs)**	**Benefit (cfs)**
LT-1	At Katy-Hockley Road	2540	1313	-1227
LT-2	Confluence of L114-00-00	4685	2631	-2054
LT-3	Confluence of L112-00-00	7454	4816	-2638
LT-4	At Cypress-Rosehill Road	7989	5553	-2436
LT-5	At Spring-Cypress Road	8911	5679	-3232
K100#12	At Mouth	9334	6554	-2780

* The flow from the baseline model with subbasins revised as noted in Part 2.2 of this report.

The combination of detention along the main stem and tributaries and the additional volume provided by the new channel sections has the effect of lowering baseline peak flows at the

mouth by as much as nearly 50 percent, while lowering baseline flows throughout the watershed. This large reduction in flows was necessary in order to return the developed state of the watershed to its current condition. While likely requiring a significant investment and time to implement, the plan will benefit the Little Cypress Creek watershed, provide environmental preservation and enhancement, address existing flooding problems and also significantly reduce baseline flows entering Cypress Creek.

2.5.5 Public Input on Alternate Plans

On October 8, 2002, a public meeting was held to describe the progress of the project and to inform the public regarding the alternate plans being proposed for the watershed. As noted earlier, several comments were received regarding Little Cypress Creek. None of the comments however, were critical of the alternate plans presented. Those who commented were more concerned with adequate maintenance on Little Cypress Creek and local drainage problems noted earlier. As a result of the comments, the Combined Alternate Plan includes the recommendation of a local drainage improvement project to address the residents' concerns.

2.5.6 Screening of Alternates

The following criteria matrix was used when evaluating the alternate plans identified for each watershed. The ability of the plan alternative to meet each criteria was ranked from 0 to 10, with 0 indicating that the criteria is not met, and 10 indicating that the criteria is met to the best of its ability. Relative weights were then set for each of the criteria as shown below based on the stated goals of the study.

Table A1 – Screening Matrix for Little Cypress Creek

Criteria	Weight	Plan			
		ALT 1	ALT 2	ALT 3	ALT 4
Minimal Construction Cost	0.2	10	2	4	1
Provides Aesthetics	0.5	5	5	3	5
Ease of Implementation	0.8	10	4	6	6
Flood Protection within Tributary Watershed	1	0	10	7	10
Ability to Accommodate Multiple Uses	0.5	0	5	8	8
Preserves/Enhances Water Quality	0.8	5	7	8	8
Preserves/Enhances Stream Habitat Quality	0.5	5	2	3	10
Ease of Maintenance	0.8	5	8	3	5
Reduction of Peak Flows into Cypress Creek	1	0	5	10	10
Outfalls for Future Roadways/Development	0.8	5	10	5	10
Acceptable to the Public	0.8	2	2	5	8
TOTAL	-----	**47**	**60**	**62**	**81**
WEIGHTED TOTAL	**77 (max)**	**28.6**	**46.2**	**46.4**	**61.3**

Alternate 1 is the No-Action/Non-structural plan. Alternate 2 is the Channelization plan. Alternate 3 is the Detention Plan. Alternate 4 is the Combined Plan. As shown, only Alternate 4, the Combined Plan, meets all the goals of the study. The remaining alternates cannot meet all the critical goals of the study.

2.6 Recommended Plan and Identification of Elements

Based on the criteria noted above, a plan was recommended that met the needs of the watershed as noted in this report. The recommended plan is described in detail below.

2.6.1 Determination of Recommended Plan

The Combined Alternate plan was chosen as the recommended plan, due to the fact that it met all the criteria of the study. The plan preserves areas of environmental sensitivity, provides outfall depth for future development, addresses existing flooding problems, and reduces peak discharges into Cypress Creek. Ancillary goals of the study can also be promoted in the recommended plan such as the promotion of dual-use and recreational facilities, water quality and aesthetics.

2.6.2 Recommended Plan Features

The recommended plan consists of three primary features as shown on the Recommended Plan, **Exhibit A7**:

- Preservation of the areas of high-quality stream habitat and floodplain along and adjacent to the main stem of Little Cypress Creek;
- Channelization, using the stream section as shown in **Figure 1,** along the upper end of Little Cypress Creek and on the tributary streams including 26 proposed new lateral channels where stream habitat quality is of a lower quality; and,
- Detention along the entire main stem, with seven large detention basins proposed and one that is currently in operation expanded to provide approximately 4400 acre-feet of storage to the watershed in addition to that provided by onsite detention for new development and additional volume in the proposed lateral channels.

The extent of preservation of stream corridor and stream quality habitat was determined by the approximate boundary of the recommended plan floodplain. This area may be reduced somewhat, depending upon the final desire of the project stakeholders to encompass only those areas immediately adjacent to the creek. For the purpose of this study however, the area was assumed to be as shown in order to provide a broader area for consideration.

Where stream habitat was shown in the Environmental Baseline Report to be of lower quality, channelization of the area was recommended. These areas exist in the extreme upper watershed and along the tributary streams where the areas around these streams have been disturbed or developed.

Detention sites for the watershed were chosen on the basis of their proximity to the channel, property lines and extents of development within the area, and approximate size. Each of the detention sites were assumed to be excavated an average of 5 feet over the entire area. This assumption leaves room for other uses and deeper excavations on portions of the site to provide room for dual-use purposes, recreational areas and preservation of environmental features that may lie within the bounds of the proposed detention facility.

Beginning at the mouth upstream to Kluge Road, the recommended plan elements consist of an area of stream corridor preservation and a number of structures that should be considered for voluntary buyouts, since they are located well within the baseline floodplain. The stream habitat corridor narrows from Kluge Road to Future Louetta Road due to development on both sides of the stream and a much narrower strip of trees along the main stem of the creek. This area also includes the additional storage excavation in existing basin L500-02-00 of approximately 500 acre-feet and the local drainage improvement project described earlier.

Upstream of Future Louetta Road, the stream corridor widens again, and the first of the proposed lateral channels are shown. These channels (L100#C1 – L100#C4) consist of the typical section noted above, with a nominal depth of 9 feet. Upstream of these channels, the first proposed detention basin (L100#B1) is located in an area along the main stem of the creek. This basin provides approximately 620 acre-feet of storage as an in-line facility. Upstream of the basin are a number of proposed lateral channels (L100#C5 – L100#C9) which are assumed to be approximately 9 feet deep.

Tributary L109-00-00 is the first tributary and is proposed to include channel modifications to expand the channel to the typical section described above. This 9-foot deep channel modification will require a right-of-way width of approximately 240 feet and will terminate in a detention basin (L100#B2) that provides approximately 120 acre-feet of storage. Lateral channel L100#C10 is also proposed to drain into this tributary basin.

The next feature upstream is the drainage area of tributary L112-00-00. This tributary is also proposed to be modified with a similar project as tributary L109-00-00. Additional lateral channels L100#C12 – L100#C15 are proposed for this subwatershed and all will terminate in proposed detention basin L100#B3, which provides approximately 730 acre-feet of storage. These lateral channels are assumed to have an 8-foot nominal depth.

Tributary L114-00-00 and its tributary (L114-01-00) will also be modified with the similar channel modification project. Additional lateral channels L100#C18 – L100#C20 will serve this subwatershed and empty into two proposed detention basins. Basin L100#B4 will serve both tributary channels and provide approximately 500 acre-feet of storage in the watershed. Basin L100#B5 exists on land currently owned by the HCFCD and will serve the upper portion of the L114 subwatershed. This basin will provide approximately 425 acre-feet of storage in the subwatershed. The lateral channels will also have an 8-foot nominal depth.

The remainder of the Little Cypress Creek watershed will be served by the remaining proposed lateral channels, two detention basins, and an upstream channel modification of the main stem. Basin L100#B6 is proposed in Zube Park and, although not currently in operation, is also known as HCFCD basin L500-01-00. This basin is assumed to provide approximately 620 acre-feet of storage in an in-line configuration. Basin L100#B7 is the uppermost basin in the watershed and can provide approximately 860 acre-feet of storage in the subwatershed. Upstream of Zube Park, the main channel of Little Cypress Creek begins to be too shallow to provide adequate outfall depth for channels or adjacent development. This portion of the main stem, from Roberts Road to US 290, is proposed to be modified with a channel section as described above and a nominal depth of 9 feet.

All proposed elements of the plan terminate at US 290. A number of new bridges and bridge replacements will also be necessary as part of this plan. These areas are described in the following section on plan implementation and shown on **Exhibit A7**.

2.6.3 Recommended Plan Benefits

Hydrologic benefits due to the plan elements were summarized earlier in the alternate plan formulation section of this report. In order to maintain consistency with the Phase I report, the flows calculated as a result of this more detailed modeling were compared with the revised baseline flows, then the prorated decrease (or increase) resulting from the modeling of the recommended plan was applied to the original baseline flows to create an adjusted plan flow. The adjusted plan flows were used as the basis for the HEC-RAS modeling and floodplain mapping for the recommended plan. The resulting 100-year flows comparing the revised base conditions to the recommended plan conditions are presented in **Table A3** of this report. **Table A4** of this report presents the HEC-1 peak flows resulting from the recommended plan for various storm frequencies. These flows, which have been prorated, are used to generate the stream profiles presented on **Exhibits A11-1** through **A11-12**.

The plan significantly reduces baseline peak flows in the main channel of Little Cypress Creek and into Cypress Creek. Additionally, water surface elevations are lowered in conjunction with the lower flows. As shown in **Table A5,** water surface elevations decrease along Little Cypress Creek by as much about 1 foot throughout the watershed and by a greater margin

upstream of Roberts Road, where the channel modifications are proposed. As noted earlier, the goal of this plan was not to bring all areas of out-of-bank flooding to within the banks. The goal was to preserve some areas of out-of-bank flooding that occurs in areas that are beneficial to the watershed and to address out-of-bank flooding in areas where it causes existing or projected flooding problems outside of the stream corridor areas.

Finally, the plan provides environmental benefits by preserving identified areas of good quality stream habitat, preserving some naturally flood-prone areas, and reserving areas within the detention facilities for preservation and/or enhancement of environmental features.

Table A2: Watershed Physical Characteristics (Baseline & Recommended Plan Conditions)

Subarea Name	Drainage Area		Watershed Length	Length to Centroid	Channel Slope	Overland Slope	Urban Dev. *	Watershed Dev. *	Channel Imp.	Channel Conv.	Ponding
	acre	Sq mi	(mi)	(mi)	(ft/mi)	(ft/mi)	(%)	(%)	(%)	(%)	(%)
L100A1	4231	6.61	4.70	2.44	12.6	<20	0.4	0.12	0	100	50
L100A2	3633	5.68	4.26	2.39	12.6	<20	3.7	1.11	0	100	50
L100B	1907	2.98	3.62	1.94	5.5	<20	10.0	3.00	0	100	0
L114-1	2343	3.66	3.39	1.65	12.5	<20	4.3	1.29	0	100	0
L114-2	2487	3.89	3.66	1.88	12.5	<20	4.8	1.44	0	100	0
L100C	2586	4.04	3.90	2.71	8.6	<20	1.0	0.30	0	100	0
L112-1	2164	3.38	3.75	2.05	11.0	<20	13.8	4.14	0	100	0
L112-2	2456	3.84	4.28	2.29	11.0	<20	10.5	3.15	0	100	0
L100D1	1960	3.06	2.56	0.42	12.8	<20	7.0	2.10	0	100	0
L100D2	1544	2.41	2.18	0.85	12.8	<20	7.4	2.22	0	100	0
L100E1	1785	2.79	2.35	0.91	4.1	<20	15.1	4.53	0	100	0
L100E2	2541	3.97	3.71	1.52	4.1	<20	12.8	3.84	0	100	0
L100F	3647	5.70	4.96	2.64	6.2	<20	18.0	5.40	0	100	0

* % based on development in place prior to implementation of HCFCD on-site detention policy (1984)

Baseline & Recommended Plan Conditions*

Subarea Name	Tc	R	RTIMP
	(hrs)	(hrs)	(%)
L100A1	1.65	14.60	35
L100A2	1.61	13.48	35
L100B	1.97	7.88	35
L114-1	1.09	5.95	35
L114-2	1.25	6.18	35
L100C	2.26	6.61	35
L112-1	1.44	6.47	35
L112-2	1.63	7.05	35
L100D1	0.25	5.47	35
L100D2	0.53	4.58	35
L100E1	1.02	7.03	35
L100E2	1.77	9.35	35
L100F	2.53	9.26	35

* The baseline model with subbasins revised as noted in Part 2.2 of this report.

Ponding Storage Coefficients		
Storm Frequency	L100A1	L100A2
	R (hrs)	R (hrs)
2-Year	25.02	23.11
5-Year	21.79	20.12
10-Year	20.06	18.53
25-Year	17.54	16.20
50-Year	16.11	14.87
100-Year	14.60	13.48
250-Year	12.90	11.90
500-Year	11.79	10.89

Table A3: 100-Year Flow Comparison Table (Baseline vs. Recommended Plan)

HEC-1 Analysis Point	Baseline Condition (cfs)	Recommended Condition (cfs)*	Baseline vs. Recommended Plan	
			Difference (cfs)	% Change
Little Cypress Creek (L100-00-00)				
LT-1	2363	1222	1141	-48.3
LT-2	4544	2552	1991	-43.8
LT-3	7224	4667	2557	-35.4
LT-4	7770	5401	2369	-30.5
LT-5	8577	5466	3111	-36.6
K100#12	9017	6331	2686	-29.8
Tributary 9.36 to Little Cypress Creek (L109-00-00)				
Mouth	1095	632	463	-42.3
Tributary 10.99 to Little Cypress Creek (L112-00-00)				
Mouth	2922	1298	1624	-55.6
Tributary 13.92 to Little Cypress Creek (L114-00-00)				
Mouth	2175	1382	793	-36.4
Tributary 0.12 to Tributary 13.92 to Little Cypress Creek (L114-01-00)				
Mouth	1995	1268	727	-36.4

*The flow from the recommended plan model prorated as identified in Part 2.6.3 of this report.

Table A4: HEC-1 Peak Flow Rates for Recommended Plan Conditions*

HEC-1 Analysis Point	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	250-Year	500-Year
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Little Cypress Creek (L100-00-00)								
LT-1	388	599	703	864	1013	1222	1738	2452
LT-2	1046	1651	1940	2140	2295	2552	4236	5187
LT-3	1761	2650	3206	3677	4154	4667	5261	6586
LT-4	1938	2900	3546	4136	4712	5401	6272	7004
LT-5	2327	3446	4227	4898	5118	5466	6977	8324
K100#12	2573	3859	4592	5331	5761	6331	7460	8945
Tributary 9.36 to Little Cypress Creek (L109-00-00)								
L100D	241	382	457	524	575	632	902	1088
Tributary 10.99 to Little Cypress Creek (L112-00-00)								
L112	607	747	808	1023	1171	1298	1653	2186
Tributary 13.92 to Little Cypress Creek (L114-00-00)								
L114	487	769	939	1107	1235	1382	1567	1873
Tributary 0.12 to Little Cypress Creek (L114-01-00)								
L114	447	704	861	1017	1133	1268	1437	1718

*The flow from the recommended plan model prorated as identified in Part 2.6.3 of this report.

Table A5a: Comparison of L100-00-00 Water Surface Elevations (100-Year)

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
2700		9017	135.63	6331	134.75	-0.88
5500		8924	136.01	6121	135.11	-0.90
6830		8924	136.95	6121	136.15	-0.80
6910	Kluge Road	8924	137.09	6121	136.30	-0.79
6937		8924	137.32	6121	136.57	-0.75
7017		8924	137.40	6121	136.65	-0.75
7797		8703	137.89	5641	137.11	-0.78
8785		8703	138.26	5641	137.40	-0.86
9615		8703	138.76	5641	137.83	-0.93
10497		8703	139.90	5641	139.03	-0.87
10667	Longwood	8703	139.93	5641	139.15	-0.78
10719	Trace Road	8703	140.12	5641	139.24	-0.88
11764		8703	141.46	5641	140.08	-1.38
13677		8703	141.90	5641	140.70	-1.20
13912		8703	141.96	5641	140.77	-1.19
13924	Golf Course	8703	141.96	5641	140.77	-1.19
14877	Bridge	8685	142.25	5602	141.13	-1.12
16517		8685	143.67	5602	142.40	-1.27
18027		8577	145.03	5466	143.68	-1.35
18060	Spring-Cypress	7770	145.03	5401	143.68	-1.35
18120		7770	145.18	5401	143.80	-1.38
18154		7770	145.34	5401	143.94	-1.40
18989		7770	145.80	5401	144.55	-1.25
21949		7770	147.04	5401	146.08	-0.96
24899		7770	148.99	5401	147.99	-1.00
26349		7770	150.16	5401	149.22	-0.94
27749		7770	151.64	5401	150.65	-0.99
29699		7770	153.76	5401	152.81	-0.95
31949		7770	155.35	5401	154.41	-0.94
33430		7770	156.39	5401	155.57	-0.82
33490	Private Bridge	7770	156.57	5401	155.74	-0.83
33517		7770	156.81	5401	156.04	-0.77
33577		7770	156.91	5401	156.14	-0.77
35827		7770	159.05	5401	158.26	-0.79
37706		7770	161.22	5401	160.29	-0.93
37818		7536	161.75	5187	160.92	-0.83
37903		7536	161.84	5187	161.04	-0.80
40098		7536	162.72	5187	162.06	-0.66
42578		7536	163.52	5187	162.83	-0.69
44478		7536	164.69	5187	163.95	-0.74
46318		7536	165.62	5187	164.89	-0.73
48218	L109-00-00	7536	166.66	5187	165.86	-0.80
49935		7331	168.87	4839	167.84	-1.03
50019		7331	169.73	4839	168.49	-1.24

Table A5a: Comparison of L100-00-00 Water Surface Elevations (100-Year) - *continued*

		Baseline Condition		Recommended Plan		Delta
SECNO	Location	Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
50068	Mueschke Road	7331	169.77	4839	168.54	-1.23
50106		7331	169.90	4839	168.83	-1.07
50140		7224	169.90	4667	168.82	-1.08
50231		7224	169.91	4667	168.76	-1.15
50317		7224	170.09	4667	169.01	-1.08
51383		7224	171.71	4667	170.68	-1.03
53073		7224	172.18	4667	171.11	-1.07
55523		7224	172.93	4667	171.87	-1.06
57053	L112-00-00	7224	174.11	4667	173.07	-1.04
59003		5297	177.21	3487	176.05	-1.16
60643		4544	177.63	2552	176.41	-1.22
62493		4544	178.04	2552	176.78	-1.26
64293		4544	178.65	2552	177.29	-1.36
65933		4544	179.43	2552	177.95	-1.48
68363		4544	183.21	2552	181.93	-1.28
70263		4544	184.51	2552	183.18	-1.33
72638	L114-00-00	4544	185.60	2552	184.46	-1.14
73826		2907	186.59	1869	185.71	-0.88
74914		2363	187.15	1222	186.40	-0.75
75204		2363	187.29	1222	186.55	-0.74
75349		2363	187.55	1222	186.77	-0.78
75444		2363	187.58	1222	186.80	-0.78
75504	Bauer Road	2363	187.64	1222	186.85	-0.79
75531		2363	187.72	1222	186.89	-0.83
75591		2363	187.77	1222	186.93	-0.84
77191		2363	189.36	1222	188.37	-0.99
80095		2363	191.85	1222	190.84	-1.01
81415		2363	192.67	1222	191.72	-0.95
84535		2363	195.07	1222	194.38	-0.69
85181		2363	195.79	1222	194.95	-0.84
85231	Becker Road	2363	196.18	1222	195.01	-1.17
85258		2363	196.59	1222	195.28	-1.31
87196		2363	198.30	1222	197.24	-1.06
90417		2363	201.15	1222	200.60	-0.55
92157		2363	203.04	1222	201.83	-1.21
92934		2363	203.87	1222	202.08	-1.79
93034		2363	204.16	1222	202.12	-2.04
93134		2363	204.38	1222	202.16	-2.22
93164	Roberts Road	2363	204.49	1222	202.27	-2.22
93202		1316	204.73	579	202.28	-2.45
93240		1316	204.75	579	202.28	-2.47
93340		1316	204.83	579	202.29	-2.54
95457		1316	206.20	579	202.74	-3.46
96196		1316	206.84	579	203.06	-3.78

Table A5a: Comparison of L100-00-00 Water Surface Elevations (100-Year) - *continued*

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
96566		1316	208.17	579	203.26	-4.91
96751		1316	208.47	579	203.37	-5.10
96936	Bauer-Hockley	1316	208.51	579	203.48	-5.03
96977	Road	1316	208.61	579	203.52	-5.09
99406		1316	210.91	579	205.44	-5.47
101936		1316	212.87	579	207.96	-4.91
102996		1316	214.32	579	209.02	-5.30
105495	US-290	1316	217.77	579	215.10	-2.67
106005		1316	218.27	579	215.19	-3.08
106111		1316	219.75	579	217.06	-2.69
106121	Grimes Road	1316	221.45	579	217.21	-4.24
106145		1316	225.09	579	217.29	-7.80
106155		1316	225.13	579	217.30	-7.83
106605		1316	226.22	579	218.10	-8.12
107053		1316	226.22	579	218.91	-7.31
107063	Warren Ranch	1316	226.22	579	218.92	-7.30
107090	Road	1316	226.22	579	218.96	-7.26
107100		1316	226.22	579	218.97	-7.25
108473		1316	226.22	579	219.76	-6.46

Table A5b: Comparison of L109-00-00 Water Surface Elevations (100-Year)

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
2220		1095	169.52	632	166.84	-2.68
2720		1095	171.63	632	167.91	-3.72
3225		1095	172.71	632	168.66	-4.05
4640	Mueschke Road	718	173.67	414	170.26	-3.41
4680		718	173.70	414	170.29	-3.41
5250	Bauer-Hockley	607	174.08	350	170.63	-3.45
5290	Road	607	174.13	350	170.65	-3.48

Table A5c: Comparison of L112-00-00 Water Surface Elevations (100-Year)

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
290		2922	172.97	1298	172.05	-0.92
1090		2922	174.66	1298	173.74	-0.92
1890		2922	175.94	1298	175.16	-0.78
2345		2896	176.67	1286	175.97	-0.70
2800		2896	177.96	1286	176.66	-1.30
3255		2896	179.13	1286	176.91	-2.22
3700	Bauer-Hockley	1288	179.87	572	177.11	-2.76
3731	Road	1288	179.87	572	178.85	-1.02
3830		1288	180.02	572	178.85	-1.17
4255		1288	182.45	572	178.88	-3.57
4680		1288	183.84	572	178.91	-4.93
5105		1288	185.66	572	178.95	-6.71
5520		1288	185.95	572	179.01	-6.94
5845		1288	185.96	572	179.19	-6.77
6170		1240	186.06	551	179.75	-6.31
6495		1240	188.75	551	181.00	-7.75
6820		1240	190.06	551	182.62	-7.44
7145		1240	192.06	551	184.25	-7.81
7470		1240	194.22	551	185.88	-8.34
7795		1240	196.29	551	187.50	-8.79
8140		1211	198.43	538	189.21	-9.22
8415		1211	199.95	538	190.56	-9.39
8690		1211	201.44	538	191.94	-9.50
8965		1211	202.95	538	193.31	-9.64
9230		1211	204.94	538	194.64	-10.30
9830		1191	208.61	529	197.62	-10.99
11050		1128	212.75	501	203.64	-9.11

Table A5d: Comparison of L114-00-00 Water Surface Elevations (100-Year)

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
1650		2175	186.78	1382	186.18	-0.60
2495		2175	188.51	1382	187.84	-0.67
2505	Bauer-Hockley	2175	189.02	1382	188.36	-0.66
2525	Road	2175	189.03	1382	188.37	-0.66
2535		2175	189.09	1382	188.74	-0.35
2910		2175	189.83	1382	188.81	-1.02
2920	Bauer Road	2175	189.84	1382	188.81	-1.03
2940		2175	189.84	1382	188.82	-1.02
2950		2175	189.85	1382	188.82	-1.03
4110		2046	191.36	1301	189.09	-2.27
4660		2046	193.51	1301	189.32	-4.19
4670	Access Road	2046	193.61	1301	189.32	-4.29
4690		2046	193.91	1301	189.33	-4.58
4700		2046	193.93	1301	189.34	-4.59
5170		2046	194.73	1301	189.57	-5.16
5180	Access Road	2046	194.88	1301	189.57	-5.31
5200		2046	196.93	1301	189.59	-7.34
5210		2046	196.93	1301	189.59	-7.34
5730		2046	196.98	1301	189.88	-7.10
6420		1337	197.03	850	190.24	-6.79
6430	Private Road	1337	197.03	850	190.24	-6.79
6450		1337	197.04	850	190.25	-6.79
6460		1337	197.04	850	190.25	-6.79
7180		1337	198.67	850	190.53	-8.14
7900		1337	201.29	850	194.51	-6.78
8610		1337	202.62	850	196.50	-6.12
10160		1337	208.92	850	201.15	-7.77
11370		1254	211.16	797	204.70	-6.46
11380	Botkins Road	1254	211.16	797	204.73	-6.43
11400		1254	211.16	797	205.17	-5.99
11410		1254	211.17	797	205.19	-5.98
12085		1254	211.82	797	206.81	-5.01
12760		1254	214.64	797	208.81	-5.83
13430		1221	216.86	776	210.80	-6.06

Table A5e: Comparison of L114-01-00 Water Surface Elevations (100-Year)

SECNO	Location	Baseline Condition		Recommended Plan		Delta
		Flow (cfs)	WSEL	Flow (cfs)	WSEL	(ft)
190		1995	187.20	1268	185.58	-1.62
720		1995	188.19	1268	186.34	-1.85
730	Bauer-Hockley	1995	188.23	1268	186.36	-1.87
750	Road	1995	188.24	1268	186.75	-1.49
760		1995	188.29	1268	186.77	-1.52
2460		1995	191.99	1268	189.11	-2.88
4570		1878	197.23	1194	191.23	-6.00
5920		1840	200.74	1170	192.50	-8.24
5930	Bauer Road	1840	200.78	1170	192.51	-8.27
5950		1840	200.79	1170	193.14	-7.65

3.0 PLAN IMPLEMENTATION AND MANAGEMENT STRATEGIES

Since a majority of the Little Cypress Creek watershed is still undeveloped, the features identified as part of the recommended plan can be constructed as the watershed develops. As new development continues, mitigation for anticipated increases in storm water runoff can be implemented. The channel extensions and new channel elements through these undeveloped areas have been identified to be used as a guide for new development.

This information identifies ultimate drainage corridor right-of-way needed to implement the recommended plan features. Further, this identification of right-of-way will help local agencies in their coordination with new development to ensure that the appropriate considerations for drainage are being implemented. The following sections outline a suggested approach for implementing the recommended plan and identify recommended management strategies for the watershed.

3.1 Preservation of Stream Habitat Corridors

The recommended plan identifies areas of high quality stream habitat that are to be managed without any structural flood reduction project. These areas exist along the majority of the main stem of Little Cypress Creek from the mouth to Roberts Road (Zube Park). Throughout this area the channel of Little Cypress Creek has good natural stream habitat corridor that is beneficial to maintain in its existing condition. This area has historically been reserved from development as well, with major developments providing mitigation along the floodplain but not significantly reclaiming it with fill.

The area contained within these corridors consists of a varying right-of-way width. The right-of-way width was determined based on the extents of mature tree cover as well as the limits of areas of out-of-bank flooding as noted earlier. Because a majority of this right-of-way represents floodplain, it is anticipated that development consisting of homes and the placement of fill material will not occur as quickly within these areas. Any development in these corridors will require substantial mitigation and coordination with the HCFCD. In order to implement this plan element, it is necessary to reserve the right-of-way in some fashion in order to limit or restrict development within the extents of these corridors.

One alternative for implementing this plan element is to request the appropriate easements from the landowner as development occurs in the adjacent area. Another alternate would be to have the appropriate entity such as the Harris County Flood Control District acquire the appropriate right-of-way through the fee title or easement. However, this would severely tax the funding source of the district if implemented on a wide basis. Another alternative would be to allow adjacent developments to construct mitigation facilities such as detention basins and water quality basins (that are a requirement of the development process) within these corridors, and to have the

use of the corridors for recreational features such as hiking trails. No other portions of the development would be allowed within the corridors. Requirements would have to be placed on the construction of these facilities so that they did not overly disturb the stream habitat that is meant to be preserved in the corridors.

3.2 New Lateral Channels/Channel Extensions

There are 26 new lateral channels proposed in the recommended plan. The plan suggests a right-of-way width sufficient to incorporate a channel that has terraced sections and allows for multiple uses (see **Figure 1**). The recommended implementation of this channel corridor would consist of having the Harris County Flood Control District prioritize (as best as possible) the immediate need for these channels, and proceed with the acquisition of a portion of the right-of-way along the proposed lateral channel alignments. This portion of the right-of-way would be the minimum (approximately 100 feet) necessary to implement a typical trapezoidal channel with the appropriate depth for outfall. Additional right-of-way and construction of the channel would be provided by adjacent properties of new development as they occur. Alternative right-of-way acquisition strategies are similar to those already discussed in the previous section and consist of requiring dedication of larger easements, purchasing the land outright, or entering into an agreement with the proposed development to share the land.

3.3 Detention Facilities

There are several regional detention facilities identified for the Little Cypress Creek watershed drainage plan. There are three existing site in various stages of development. One (L500-02-00) is located near Kluge Road and is currently being excavated by contractors (authorized by HCFCD) on an as-needed basis for fill material. Final work to bring this facility on-line will be performed by HCFCD in the future. Another site (L500-01-00) is Zube Park. Excavation of this site is to occur such that the storage area will be compatible with park uses. A third site (L514-01-00) is located on a tributary to Little Cypress Creek. This site is currently leased by HCFCD to others for grazing cattle.

These existing sites are included in the recommended plan along with five additional sites. It should be noted that the recommended plan continues the requirement for on-site detention as a condition of development. These facilities proposed as part of the recommended plan are for further reduction of flows in the watershed. Therefore, it will likely not be feasible to allow developers to mitigate individual developments by excavating in a regional facility, as has been planned for the existing basins, unless the facility in the recommended plan is expanded and designed for that purpose. Implementation of the regional detention facility element of the recommended plan will consist of the actual purchase of the land and construction of the facility by public agencies such as the HCFCD.

3.4 Channel Crossings

Due to the length of Little Cypress Creek, the main stem of the creek is crossed by a number of major thoroughfares. As the watershed develops, many of these roads will be upgraded or extended. This plan provides guidance for future crossings of the main stem and tributaries. The majority of these crossings will be undertaken by Harris County at a later date and may or may not be in place prior to the implementation of the recommended plan features meant to be crossed. For the purposes of plan cost, only those current crossings that will be impacted by the plan are included in the plan cost. Future roadway crossings are assumed to be the responsibility of the entity improving the roadways. Crossings of the main stem in the stream corridor preservation area will be required to pass the 100-year recommended plan flows so that the volume and conveyance of the channel is preserved. This can be done by either spanning the entire floodplain of the channel, which is likely not feasible, or by designing the bridge to convey the required flows with as little head losses as possible. For the purposes of this plan, the head losses were assumed to be 0.5 foot, at full flow condition.

Future crossings of the proposed lateral channels and the channel modifications along the tributary channels can be constructed somewhat more constrictive, since the channels are designed to provide more volume and capacity than is currently present. Culvert crossings of these areas are most likely what will be required, with the head losses assumed to be limited to 0.5 foot in the full flow condition as well. The table below shows the proposed crossings of the main stem and tributary channels and the proposed lateral channels, whether the crossing is included in the recommended plan cost, and the proposed opening area necessary to meet the conditions noted above.

Recommended Plan Channel Crossings			
Location	**Recommended Plan 100-Year Flows (cfs)**	**Estimate of Opening Area Required (sq. ft.)**	**Cost Included in Recommended Plan? (Y/N)**
Main Stem (Crossing)			
Future Spring-Cypress Road	5401	1350	N
Future Louetta Road	5401	1350	N
Future Huffmeister Road	5401	1350	N
Future Schiel Road	5401	1350	N
Future Huffmeister Road	5187	1300	N
Cypress-Rosehill Road	4839	1200	N
Mueschke Road	2552	640	N
Future Mason Road	2552	640	N
Future Grand Parkway	2552	640	N
Roberts Road	1222	310	Y
Future Katy-Hockley Road	579	150	N

Recommended Plan Crossings (Continued)			
Tributary Channels and Proposed Lateral Channels (Channel – Crossing)			
C3 – Future Schiel Road	354	90	N
C5 – Future Schiel Road	382	100	N
C6 – Grant Road	290	80	Y
C7 – Future Schiel Road	390	100	N
C8 – Future Grant Road	349	90	N
L109 – Mueschke Road	414	110	Y
L112 – Future Grant Road	1286	320	N
L112 – Future Botkins/Mason	551	140	N
C12 – Future Botkins Road	1178	300	N
L112 – Future Grand Parkway	538	140	N
C12 – Future Grand Parkway	995	250	N
C12 – Future Unnamed Road	764	190	N
C12 – Mueschke Road	376	100	Y
C15 – Future Unnamed Road	352	90	N
C14 – Future Roberts Cemetery	257	70	N
C14 – Future Grand Parkway	229	60	N
C17 – Future Grand Parkway	243	60	N
C18 – Future Botkins Road	572	140	N
C18 – Future Unnamed Road	249	60	N
L114 – Becker Road	797	200	Y
C19 – FM 2920	433	110	Y
C20 – Future Botkins Road	714	180	N
C20 – FM 2920	204	50	Y
C25 – Future Botkins Road	204	50	N
C26 – Future Bauer-Hockley Rd	303	80	N
C26 – Future Botkins Road	199	50	N

There may be crossings that are constructed as part of developments or as revisions to the major thoroughfare plan. Channel crossings must be considered in light of the goals for the "frontier program" in each of these watersheds. Proposed crossings of the channel extension or new tributary channel included in the recommended plan could be designed in a more conventional manner however, care must be taken to ensure that the storage of the channel is not impacted by the construction of a too-narrow structure

3.5 Cost Analysis

Costs were identified for implementation of the recommended plan. These costs consider acquisition of right-of-way, engineering, and construction of the plan elements. The table below shows each plan element, the identified right-of-way, the unit costs and total costs for the project. The total cost when fully implemented is approximately $106 million, with the bulk of the cost in

excavation and land acquisition. These costs do not include the cost of any voluntary buyouts or local drainage improvements.

Table A6 – Estimate of Recommended Plan Construction Costs for Little Cypress Creek				
Description	**Unit**	**Quantity**	**Unit Cost**	**Cost**
1. Mobilization	Each	30	$10,000	$300,000
2. Clearing & Grubbing	Acre	445	$1,500	$667,500
3. Excavation & Haul	Ac-Ft	8028	$5,000	$40,140,000
4. Bridge Installation	S.F.	12800	$60	$768,000
5. Culvert Installation	S.F.	15360	$75	$1,152,000
6. Drop/Control Structures	L.S.	45	$100,000	$4,500,000
7. Backslope Drains	Each	562	$3,000	$1,686,000
8. Utilities Relocation	Each	2	$100,000	$200,000
9. Right-of-Way	Acre	3181	$9,000	$28,629,000
10. Seeding & Mulching	Acre	1174	$1,000	$1,174,000
11. Tree/Shrub Planting	Acre	459	$10,000	$4,590,000
SUB TOTAL				$83,806,500
Contingencies (15%)				$12,570,975
TOTAL CONSTRUCTION COST				$96,377,475
ENGINEERING AND ADMINISTRATION (10%)				$9,637,747
TOTAL				$106,015,222

3.6 Implementation Phasing

Implementation of the recommended plan features is likely to occur over a long period of time and is recommended to occur in phases so that the appropriate funding can be identified for each fiscal year. First priority should be given to implementing projects that result in flood reduction benefits to existing flood-prone structures. In the Little Cypress Creek watershed, plan elements that fit this category include additional excavation in L500-02-00 and the construction of basin L100#B1, review and construction of the area in need of local drainage improvements shown on the plans, and implementation of a voluntary buyout program for areas of repetitive flood losses. Second priority should be given to acquiring right-of-way ahead of new development, to ensure that future drainage projects can be implemented accordingly. This acquisition will also coincide with future major roadway thoroughfare projects. Construction of the proposed lateral channels from a generally downstream to upstream direction would fit this category as development progresses. Final priority should be placed on an ongoing land acquisition program to purchase right-of-way for stream corridor preservation projects and for remaining recommended plan elements. The stream corridor and detention elements of the Little Cypress Creek recommended plan and the upstream detention basins fit this category. Implementation of this plan should also be complemented by ongoing maintenance efforts along the main stem of Little Cypress Creek in order to improve the natural condition and reduce blockages in flows caused by debris, trash, etc.

Since the majority of structures that have a potential for flooding are located in the downstream third of the watershed, the first phase of implementation should be started as soon as practicable. The following phases and further elements of the plan could be delayed until there is

development pressure on areas slated for improvements. The recommended plan is estimated to take approximately 20 years to implement. The order of implementation would generally be to construct the downstream elements (expansion of L500-02-00 and construction of L100#B1) within the first years of implementation. The proposed lateral channels and upstream detention facilities would be constructed as the channel projects were completed. The stream corridors and right of way for lateral channels should be identified and right-of-way secured as development begins to occur in the adjacent areas or as the land becomes available.

3.7 Identification of Possible Funding Sources

Implementation of the plan is dependent upon the cooperation of other stakeholders in addition to the Harris County Flood Control District. The District's primary role is to implement flood reduction projects. The construction of parks and the creation of mitigation for new development cannot be implemented with District funds.

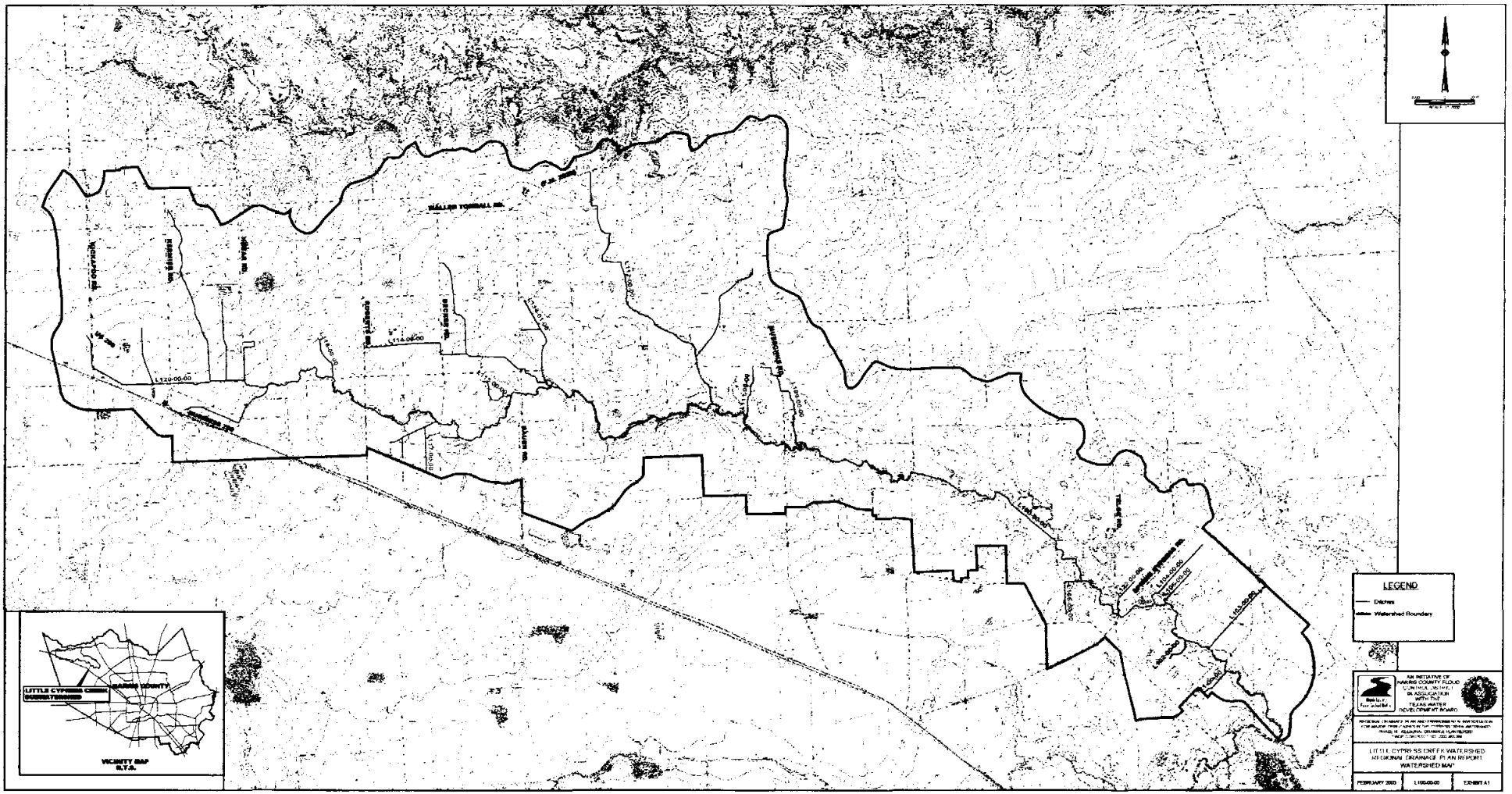
It is anticipated the implementation of parks or trails within the right-of-way could proceed through agreements between the District and stakeholders such as the Texas Parks and Wildlife, Legacy Land Trust, Harris County, and through civic associations. Management of these uses and respective maintenance of the facilities would also be performed by the stakeholders, who are particularly interested in the upper undeveloped portions of the Little Cypress Creek watershed. The District could enter into an agreement to construct the necessary detention, with consideration for multiple uses such that the park will take over maintenance of the facility. Harris County currently has a Parks & Recreation Master Plan that identifies corridors for proposed bikeway trails. As shown on **Exhibit A7**, a proposed bikeway is planned along the entire main stem of Little Cypress Creek. Implementation of this bikeway may open other avenues for funding additional recreational projects along the main stem and in the proposed detention facilities.

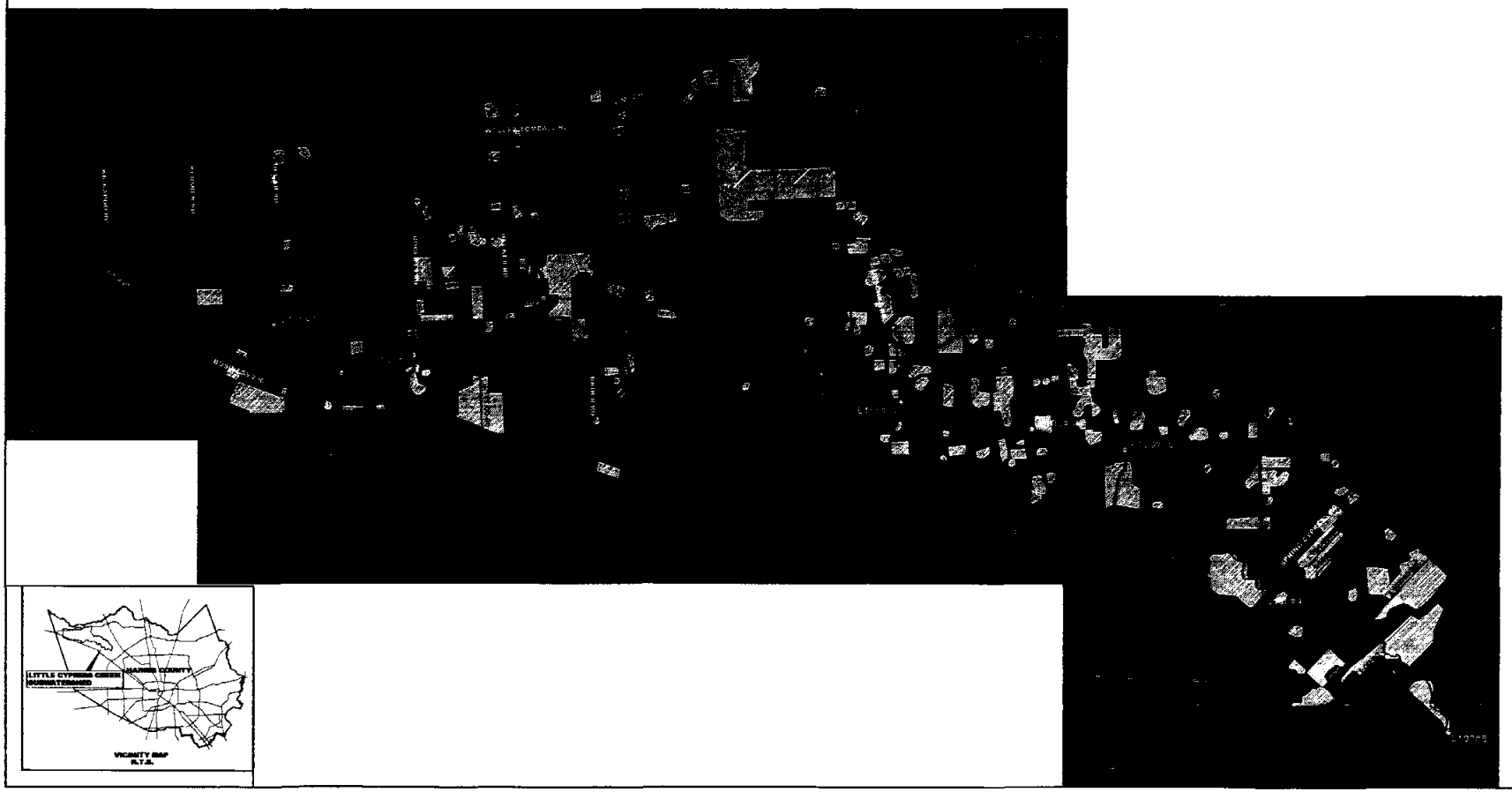
The construction of the necessary roadway crossing of the channels will be funded through the appropriate stakeholder responsible for the project, such as Harris County Engineering for county roads and developers for their respective developments that include roadway channel crossings.

4.0 CONCLUSIONS

The recommended plan identified in this report represents a feasible solution to providing flood reduction benefits and guidance for drainage planning of new development projects. Existing environmental conditions of the watershed are considered in the plan so they are preserved to the extent possible and, at a minimum, that they are not degraded. Further, the plan, when implemented, will result in reduced storm water peak flows into Cypress Creek, suggesting that the plan will also result in flood reduction benefits for existing developments along Cypress Creek.

Implementation of the plan will have to occur over many years as the watershed develops and will require the cooperation of additional stakeholders. Prioritization of the plan elements has been performed, suggesting that there is not an immediate need to implement most of the plan features along Little Cypress Creek. However, land acquisition or reservation should be planned for the watershed. It is estimated that, once begun, it would take approximately 20 years to implement the entire plan, with an average expenditure of $5.3 million per year.


MUELLER TOMBALL RD.
L120-00-00
L140-00-00
L130-00-00
L100-00-00
LEGEND
Ditches
Watershed Boundary
LITTLE CYPRESS CREEK WATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
WATERSHED MAP
FEBRUARY 2000
L100-00-00
T30-BWT A1



VICINITY MAP
N.T.S.

LEGEND

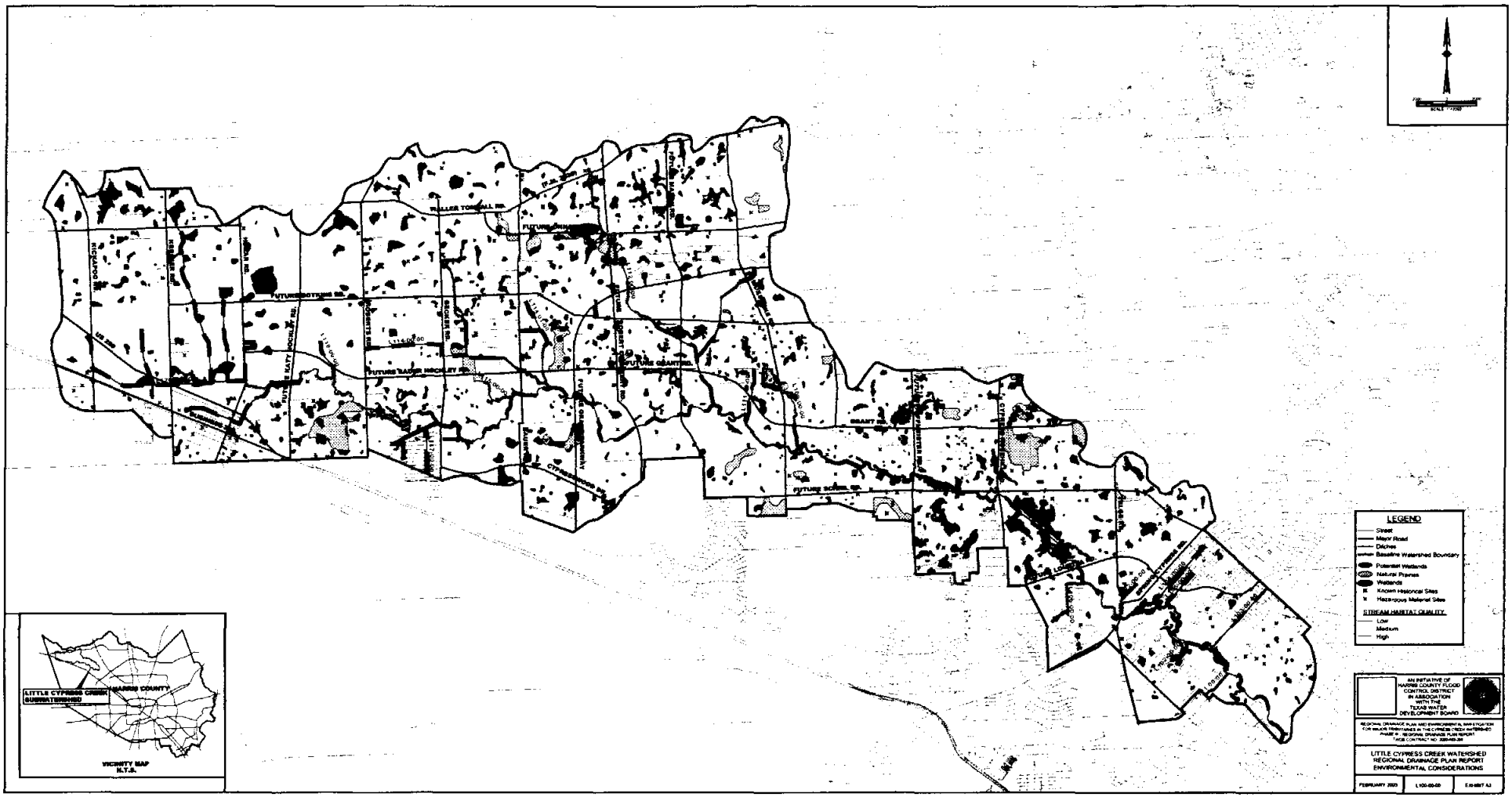
- Ditches
- Watershed Boundary
- Recommended Main Sub Watershed Boundary
- 1984 Developed Areas
- HCFCD Right-Of-Way
- Hydrologic Analysis Points

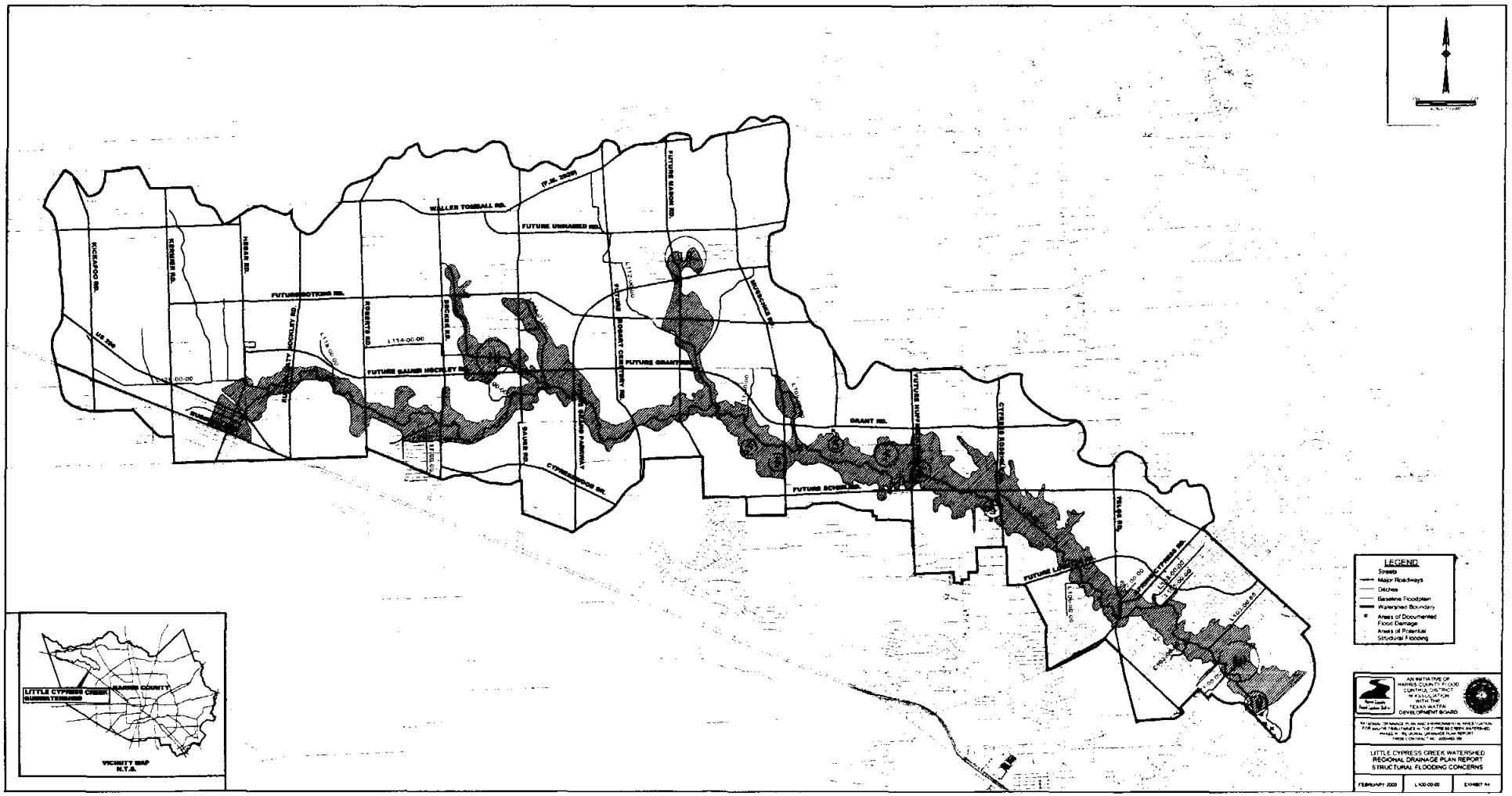
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

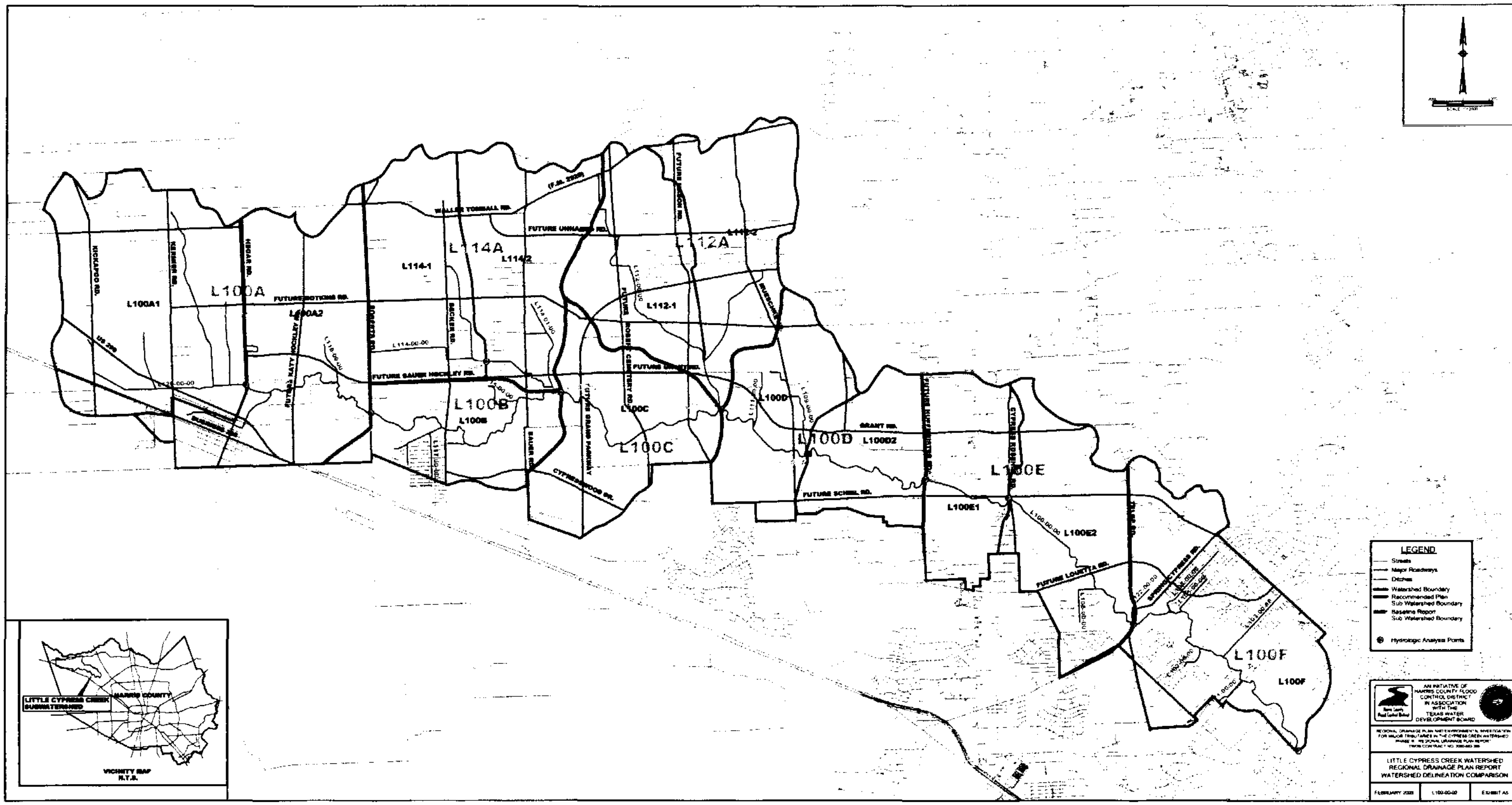
REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION

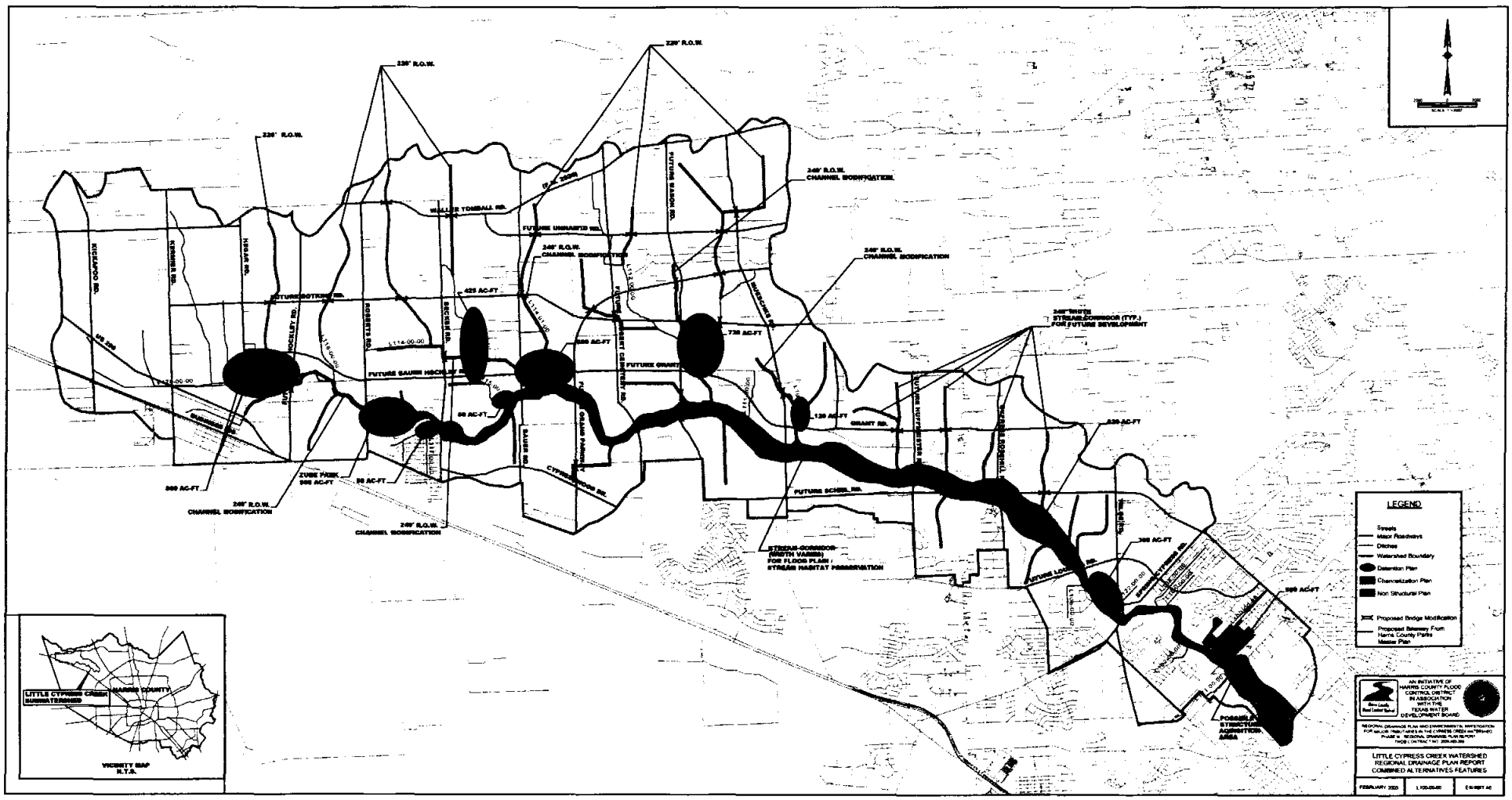
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
1999 AERIAL WATERSHED MAP

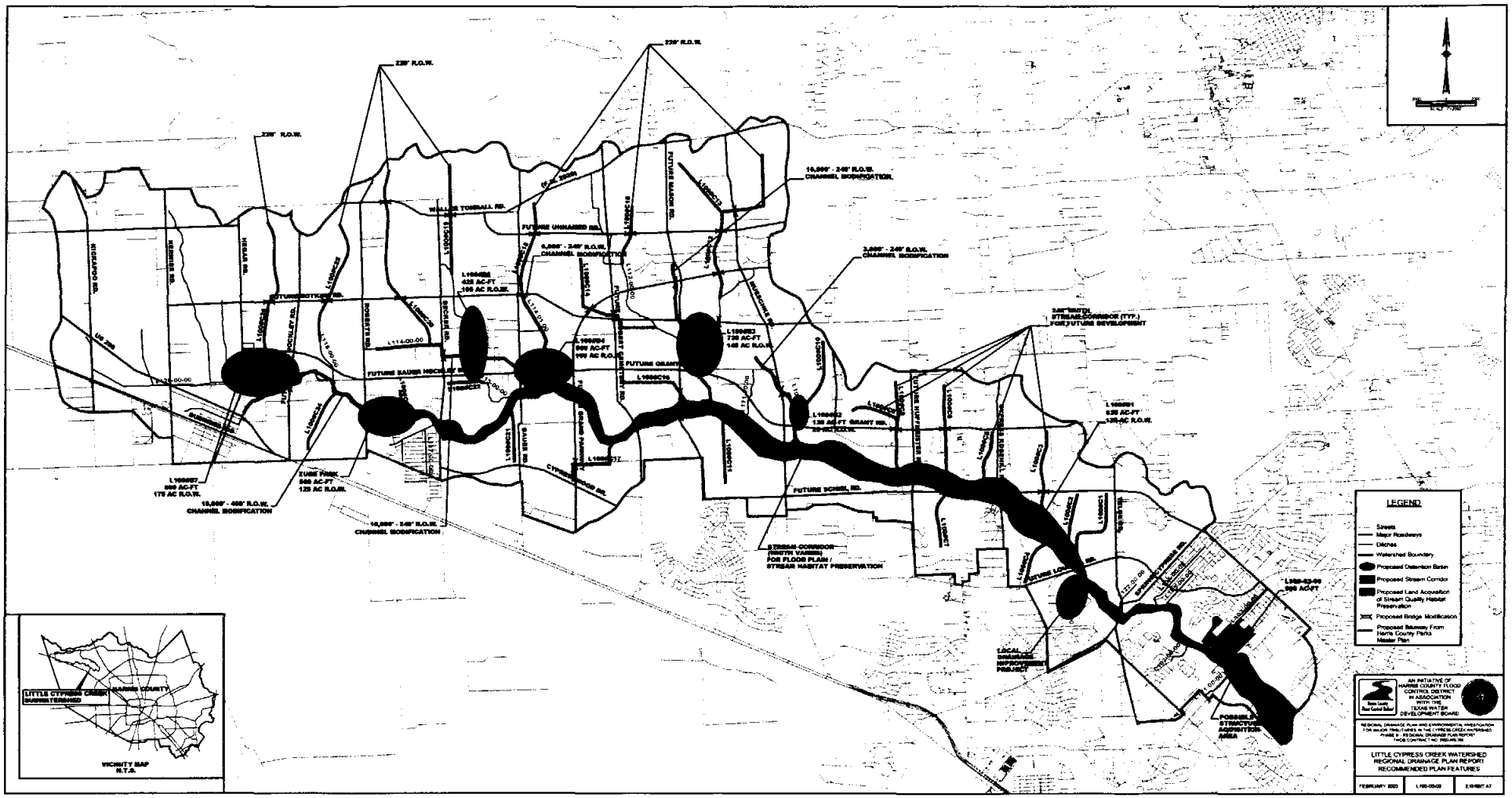
FEBRUARY 2003	1:30,000	EXHIBIT A2

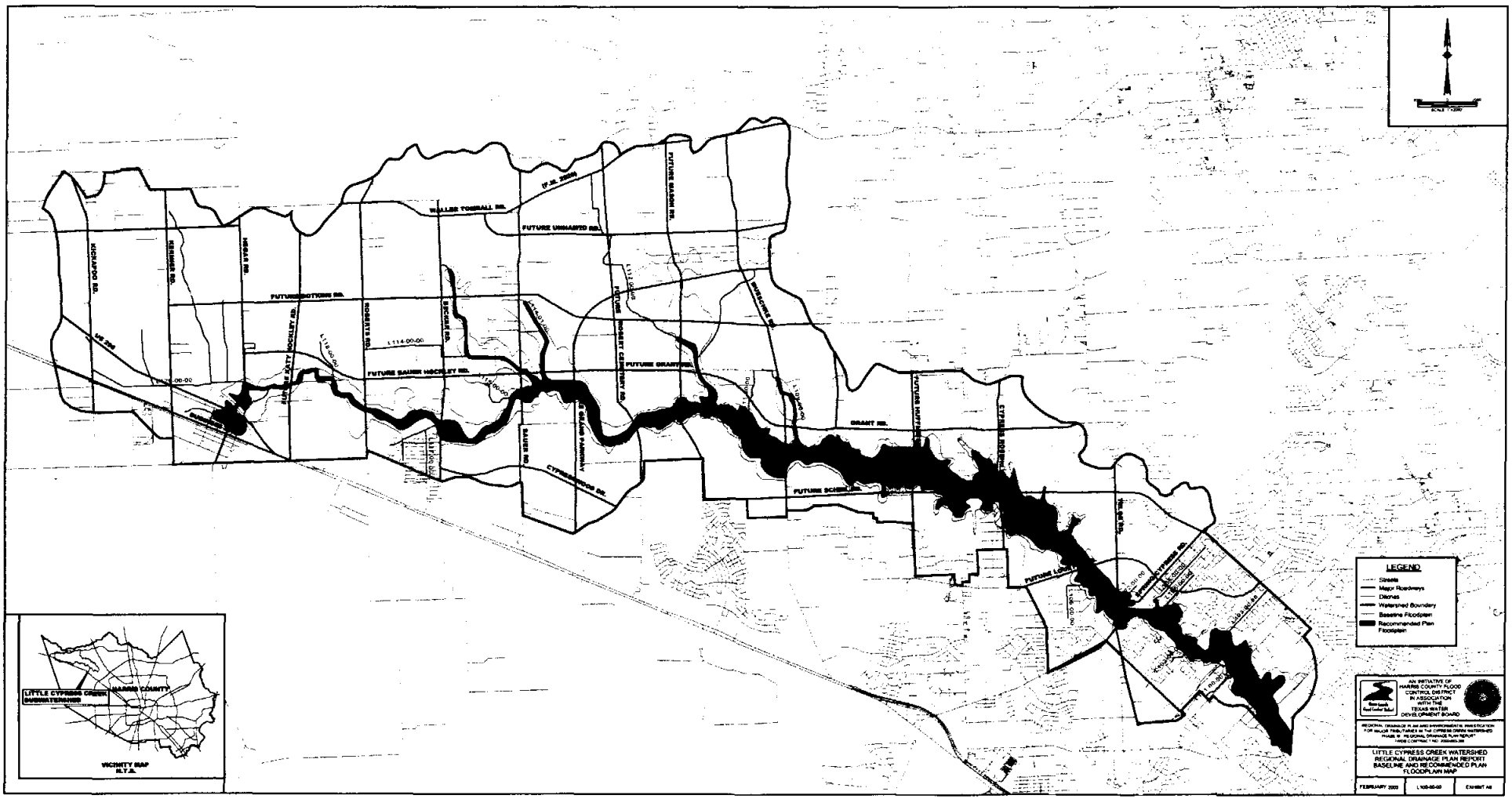

LEGEND
Street
Major Road
Ditches
Baseline Watershed Boundary
Potential Wetlands
Natural Prairies
Wetlands
Known Historical Sites
Hazardous Material Sites
STREAM HABITAT QUALITY
Low
Medium
High
LITTLE CYPRESS CREEK SUBWATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
ENVIRONMENTAL CONSIDERATIONS
FEBRUARY 2005
L100-00-00
EXHIBIT 4.3

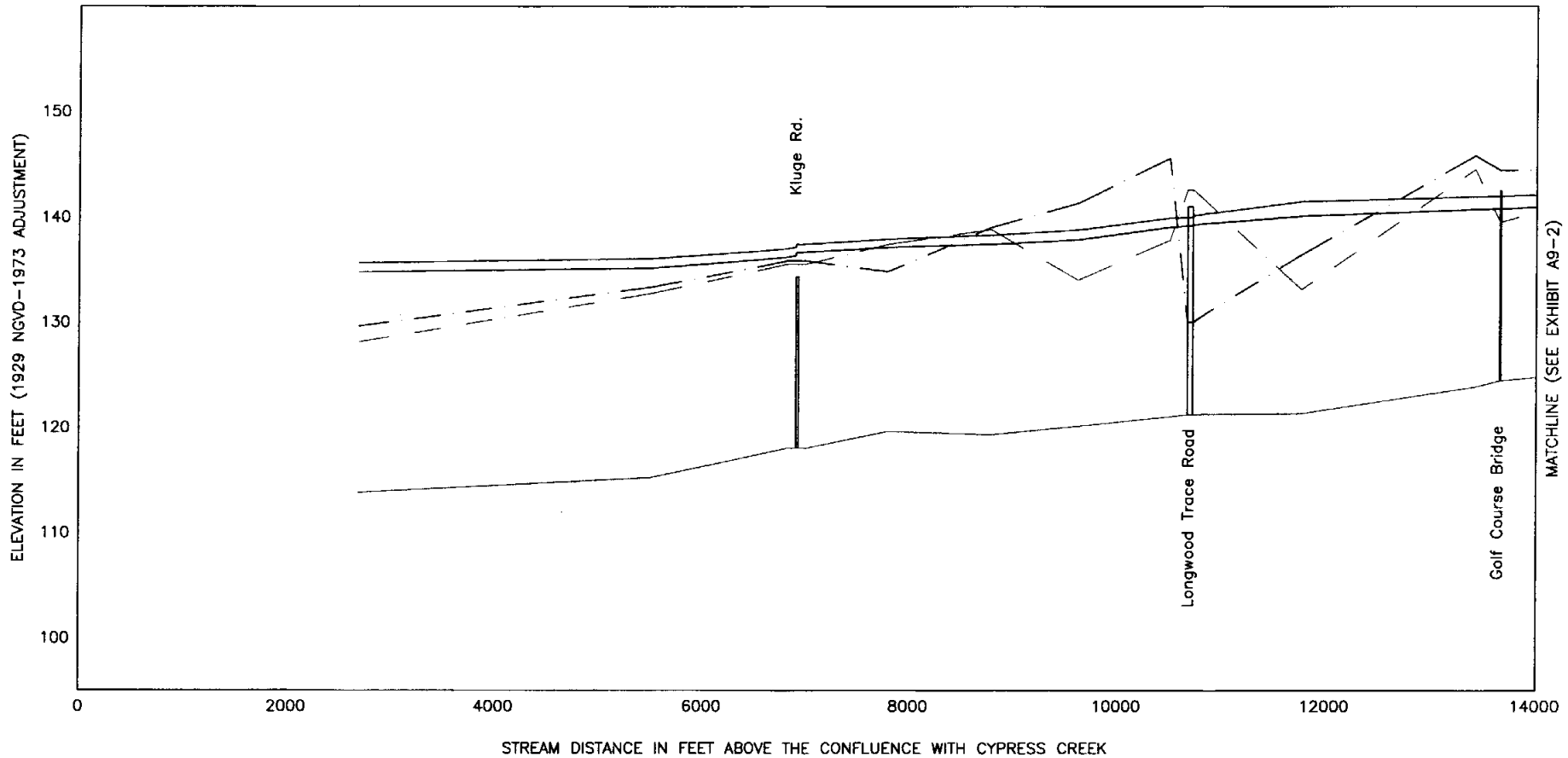

WALLER TOMBALL RD.
FUTURE UNNAMED RD.
FUTURE MARON RD.
FUTURE ROBERT CEMETERY RD.
FUTURE GRANT RD.
GRANT RD.
FUTURE SCHOOL RD.
CYPRESSWOOD DR.
BAUER RD.
KUYKENDAHL RD.
KEEBLER RD.
HEBAR RD.
FUTURE ROTTERS RD.
FUTURE BAUER HOCKLEY RD.
US 290
LEGEND
Streets
Major Roadways
Ditches
Baseline Floodplain
Watershed Boundary
Areas of Documented Flood Damage
Areas of Potential Structural Flooding
LITTLE CYPRESS CREEK WATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
STRUCTURAL FLOODING CONCERNS
FEBRUARY 2003
L100-00-00
EXHIBIT 44


L100A
L100A1
L100A2
L100B
L100C
L100D
L100D2
L100E
L100E1
L100E2
L100F
L114A
L114-1
L112A
L112-1
KICKAPOO RD.
KERMIER RD.
HEGAR RD.
US 290
ROBERTS RD.
BECKER RD.
FUTURE SAUER HOCKLEY RD.
WALLER TOMBALL RD.
FUTURE UNHASER RD.
FUTURE GRAND PARKWAY
CYPRESSWOOD RD.
SAUER RD.
GRANT RD.
FUTURE SCHIEL RD.
FUTURE LOUETTA RD.
SPRING CYPRESS RD.
LEGEND
Streets
Major Roadways
Ditches
Watershed Boundary
Recommended Plan
Sub Watershed Boundary
Baseline Report
Sub Watershed Boundary
Hydrologic Analysis Points
AN INITIATIVE OF
HARRIS COUNTY FLOOD
CONTROL DISTRICT
IN ASSOCIATION
WITH THE
TEXAS WATER
DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
WATERSHED DELINEATION COMPARISON
EXHIBIT A5
LITTLE CYPRESS CREEK SUBWATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.


LEGEND
Streets
Major Roadways
Ditches
Watershed Boundary
Detention Plan
Channelization Plan
Non Structural Plan
Proposed Bridge Modification
Proposed Bikeway From Harris County Parks Master Plan
LITTLE CYPRESS CREEK SUBWATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
COMBINED ALTERNATIVES FEATURES
FEBRUARY 2003
L100-00-00
E-9 SHEET A5


LEGEND
Streets
Major Roadways
Ditches
Watershed Boundary
Proposed Detention Basin
Proposed Stream Corridor
Proposed Land Acquisition of Stream Quality Habitat Preservation
Proposed Bridge Modification
Proposed Bikeway From Harris County Parks Master Plan
LITTLE CYPRESS CREEK WATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
RECOMMENDED PLAN FEATURES
FEBRUARY 2003
L105-00-00
EXHIBIT A7
STREAM CORRIDOR (WIDTH VARIES) FOR FLOOD PLAIN / STREAM HABITAT PRESERVATION
POSSIBLE STRUCTURE ACQUISITION AREA
LOCAL DRAINAGE IMPROVEMENT PROJECT


LEGEND
Streets
Major Roadways
Ditches
Watershed Boundary
Baseline Floodplain
Recommended Plan Floodplain
LITTLE CYPRESS CREEK WATERSHED
HARRIS COUNTY
VICINITY MAP
N.T.S.
AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD
LITTLE CYPRESS CREEK WATERSHED REGIONAL DRAINAGE PLAN REPORT BASELINE AND RECOMMENDED PLAN FLOODPLAIN MAP
FEBRUARY 2003
EXHIBIT A6



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
PHASE III - REGIONAL DRAINAGE PLAN REPORT
TWDB CONTRACT NO. 2001-443-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

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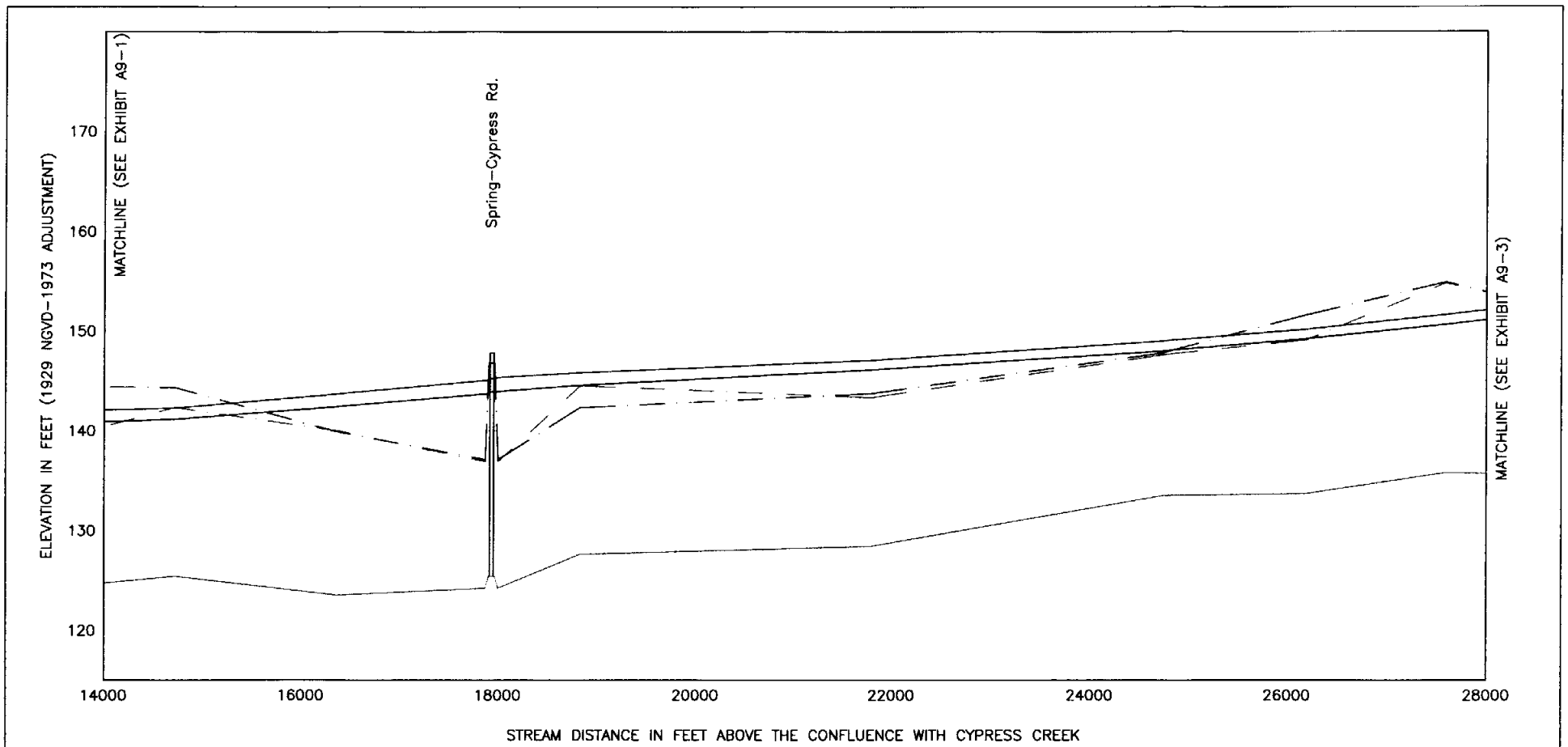

LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
PHASE III - REGIONAL DRAINAGE PLAN REPORT
TWDB CONTRACT NO. 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

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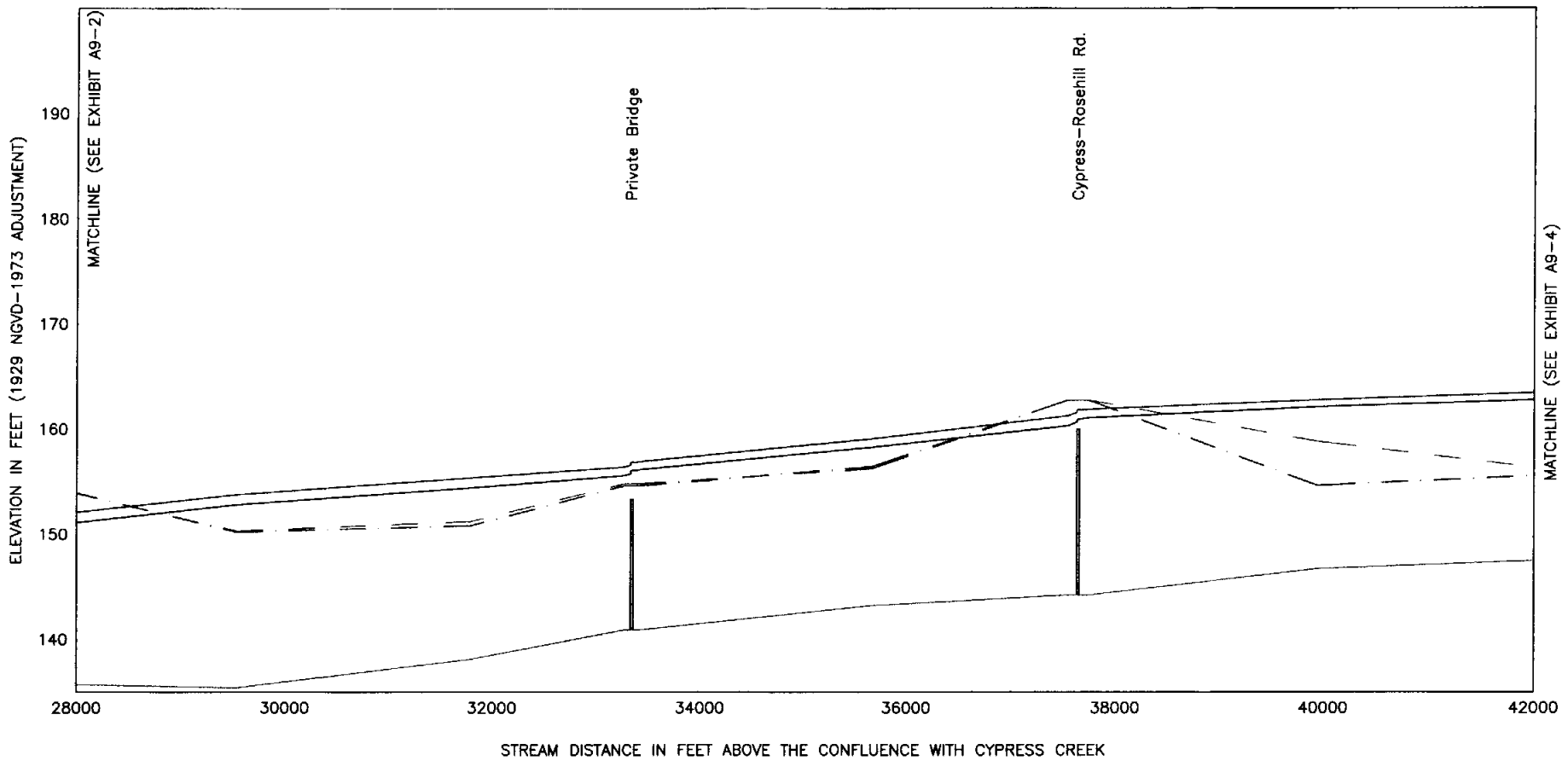

LEGEND

- FLOWLINE
- LEFT BANK
- RIGHT BANK
- BRIDGES

WATER SURFACE PROFILES

- 100-YEAR RECOMMENDED PLAN
- 100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
PHASE III - REGIONAL DRAINAGE PLAN REPORT
TWDB CONTRACT NO 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

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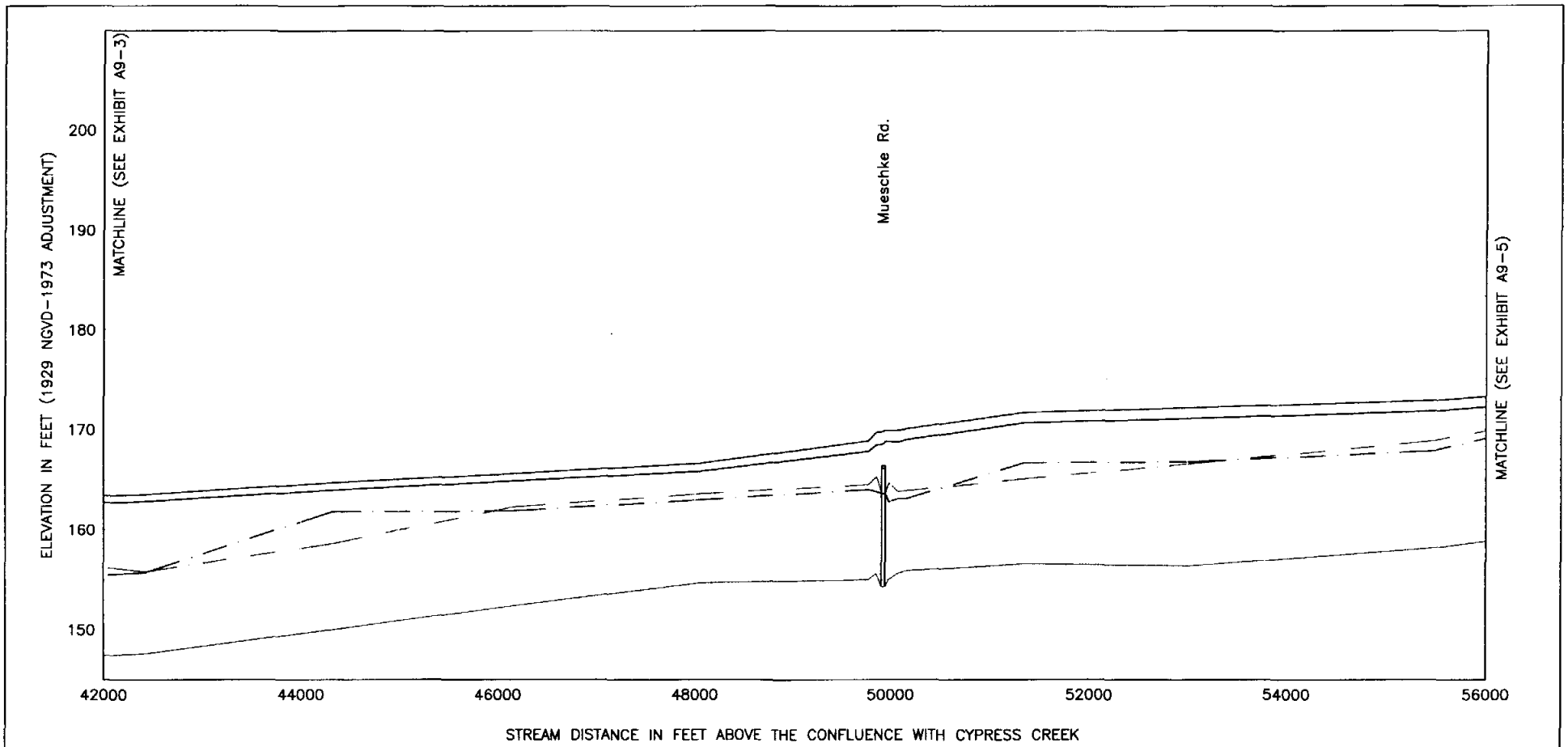


LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

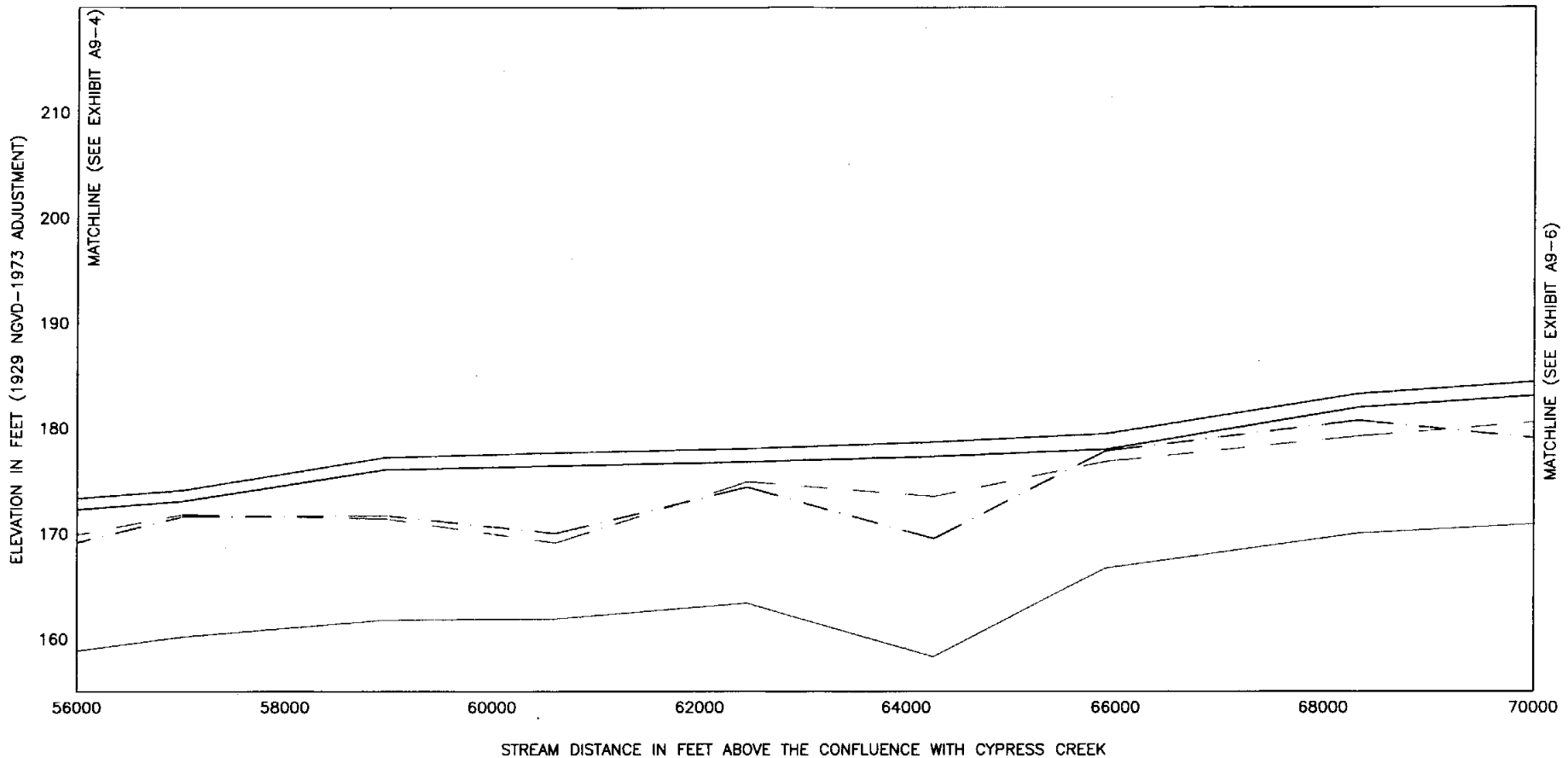
WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
PHASE III - REGIONAL DRAINAGE PLAN REPORT
TWDB CONTRACT NO. 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L100-00-00 | EXHIBIT: A9-4



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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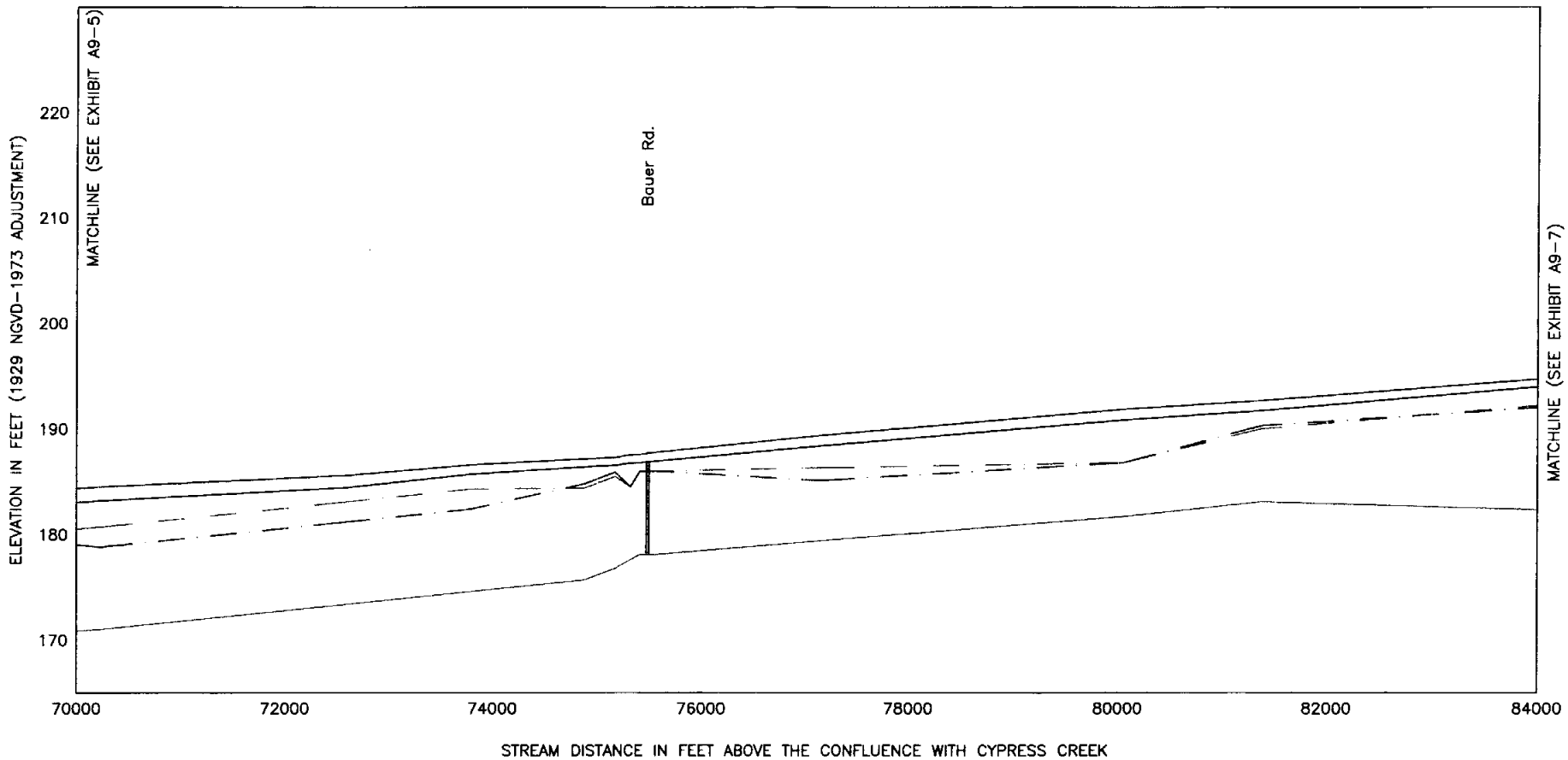
PHASE III - REGIONAL DRAINAGE PLAN REPORT
TWDB CONTRACT NO 2000-483-336

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L100-00-00 | EXHIBIT: A9-5



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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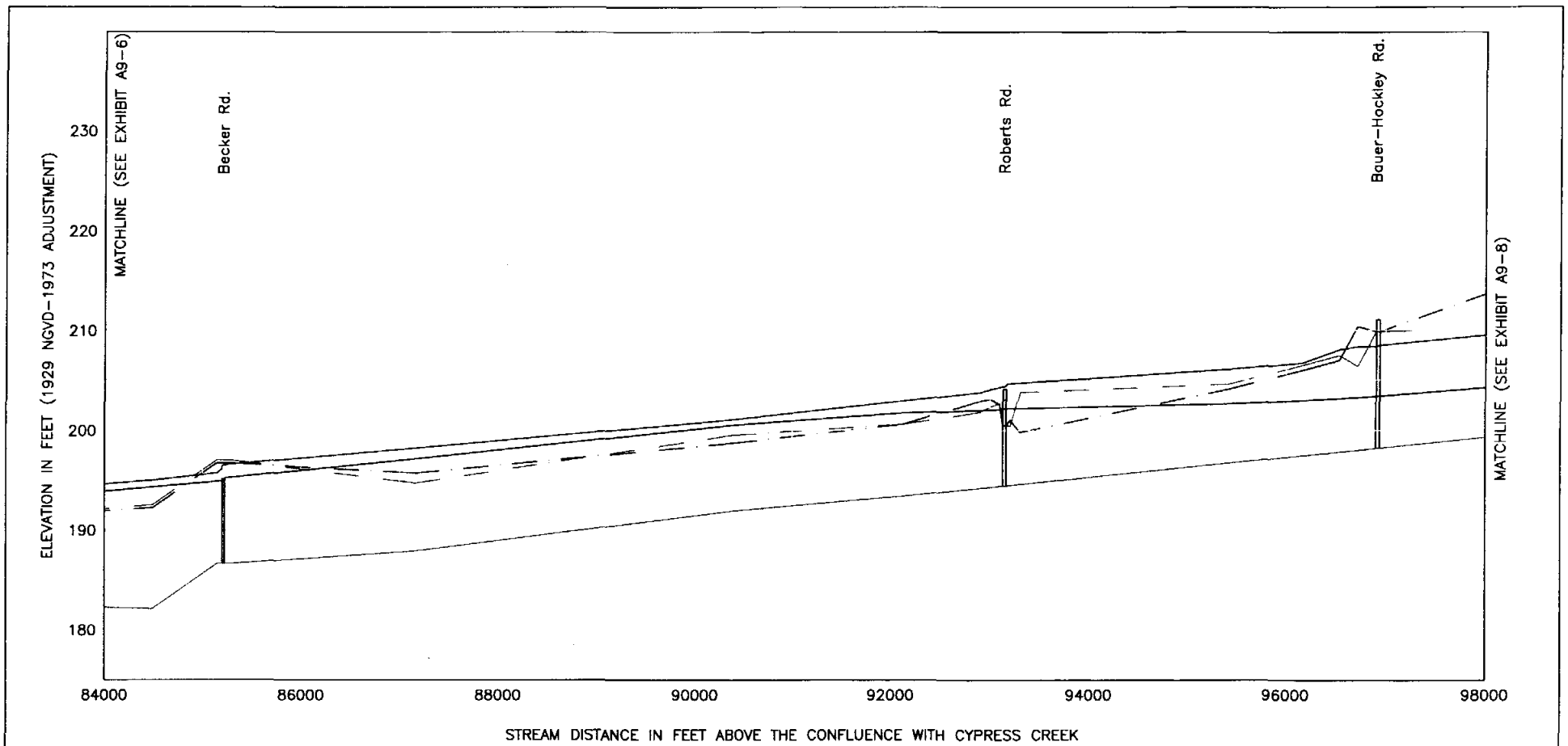
TWDB CONTRACT NO. 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L100-00-00 | EXHIBIT: A9-6



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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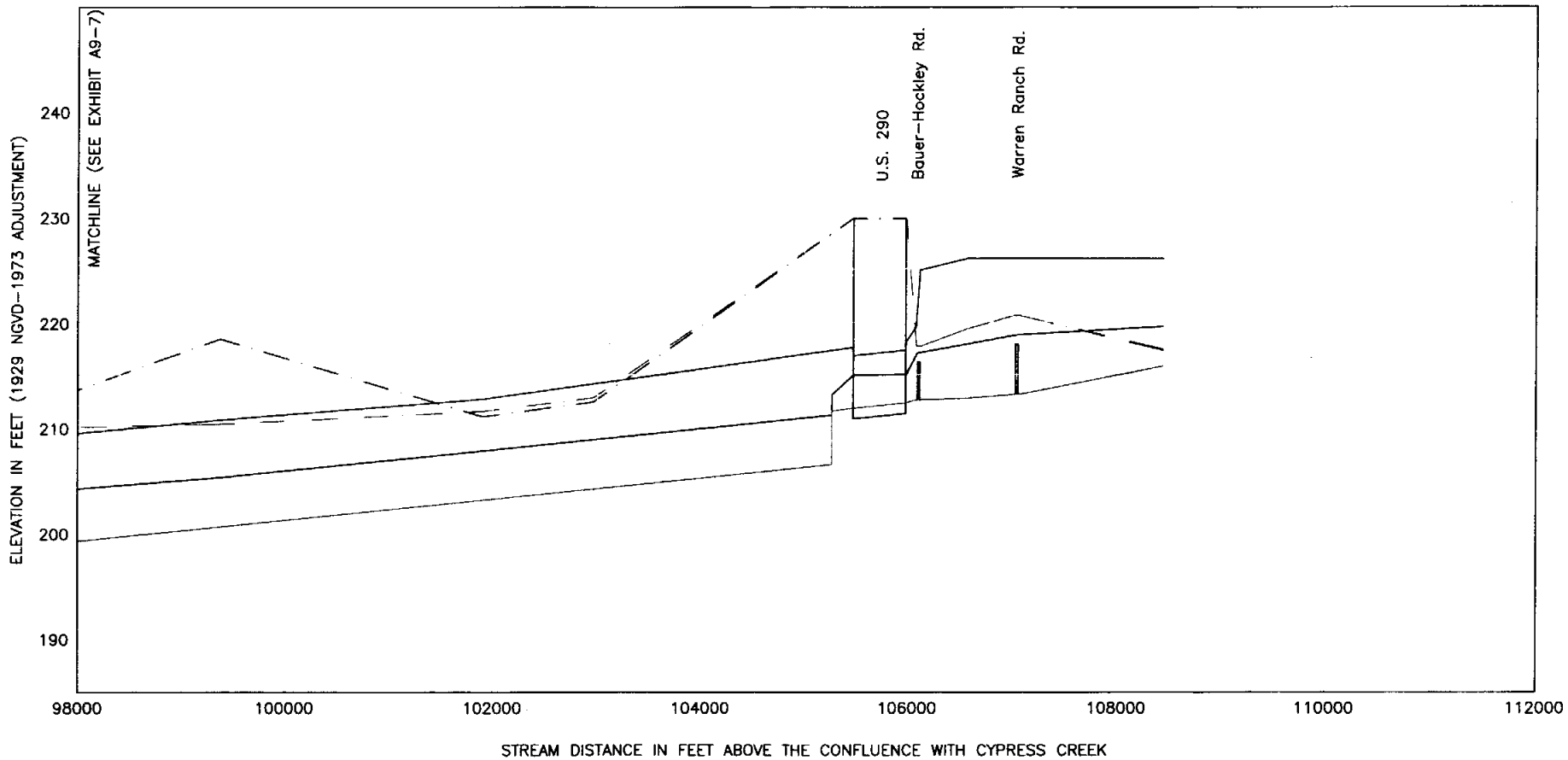
TWDB CONTRACT NO 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003	L100-00-00	EXHIBIT: A9-7



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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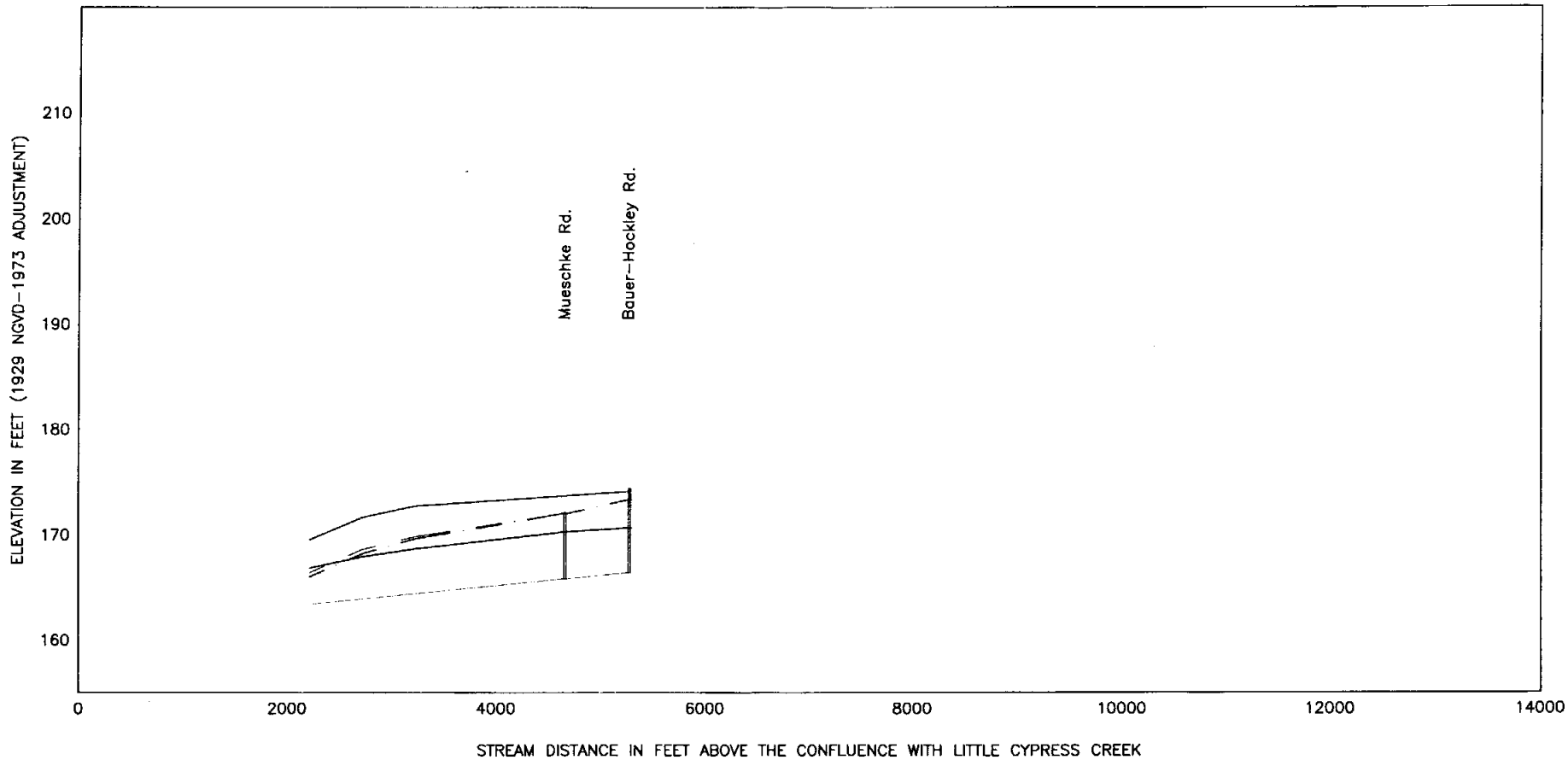
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L100-00-00 | EXHIBIT: A9-8



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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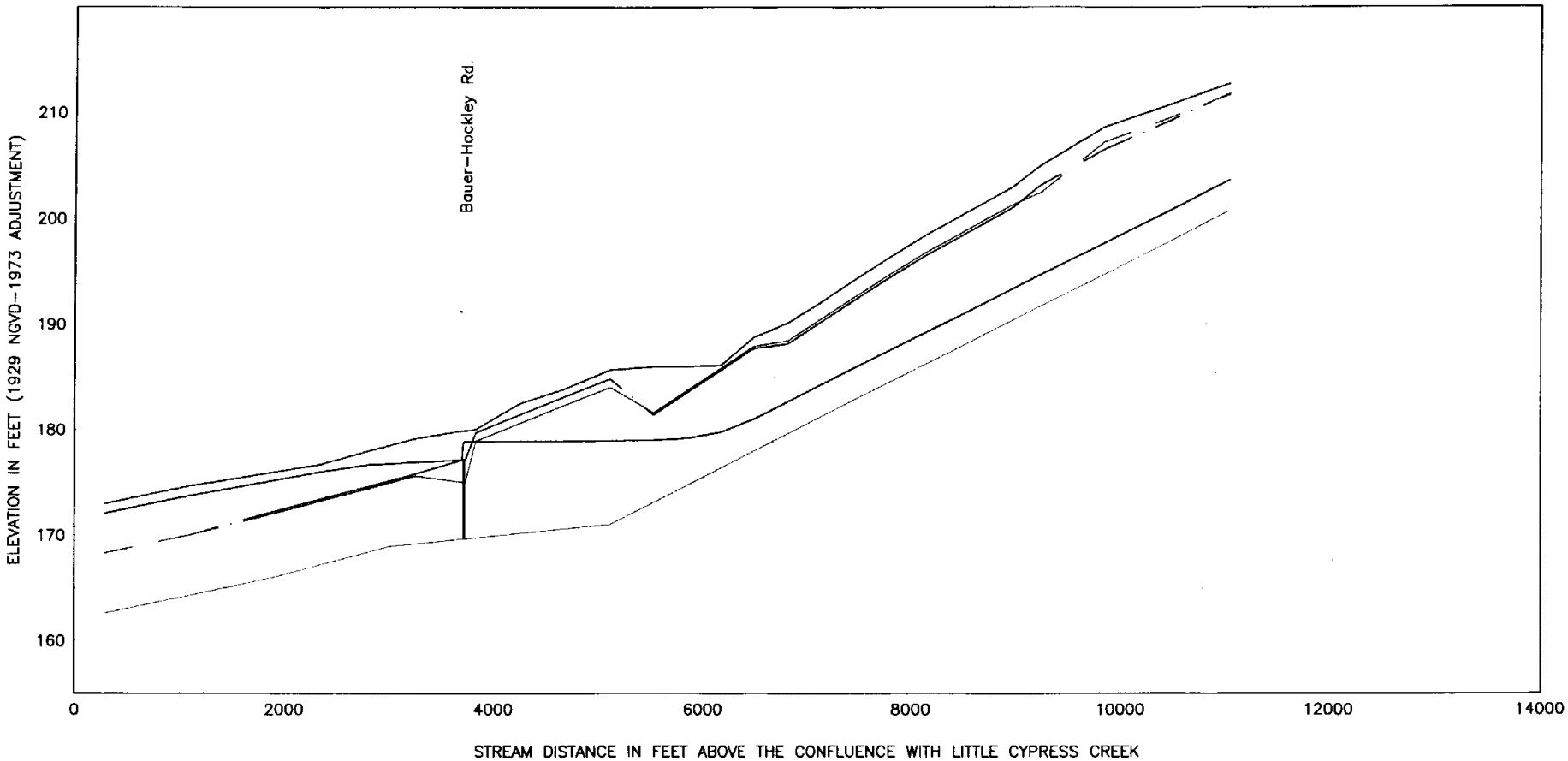
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L108-00-00 | EXHIBIT: A6-9



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

Harris County Flood Control District

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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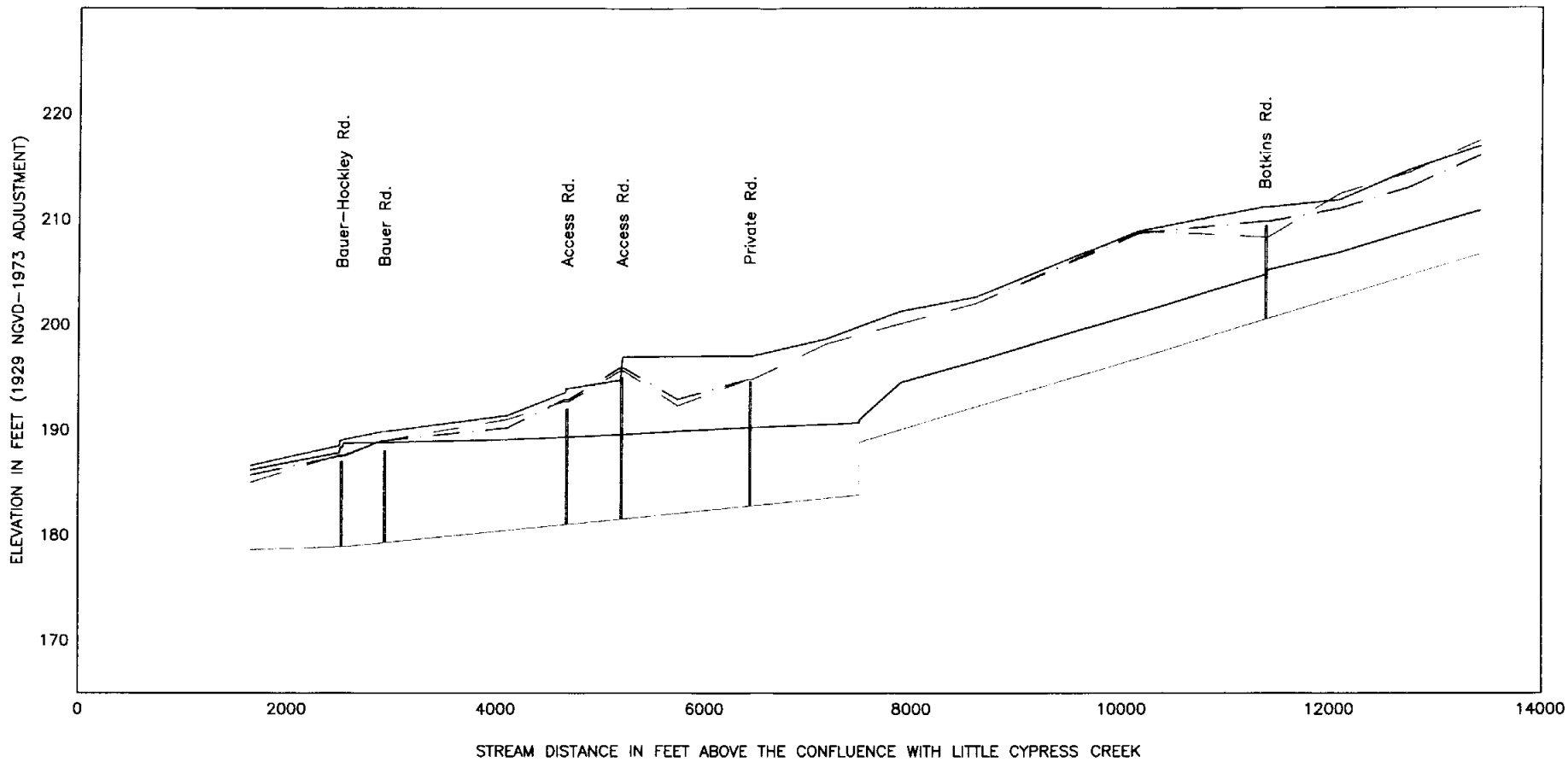
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003	L112-00-00	EXHIBIT A8-10



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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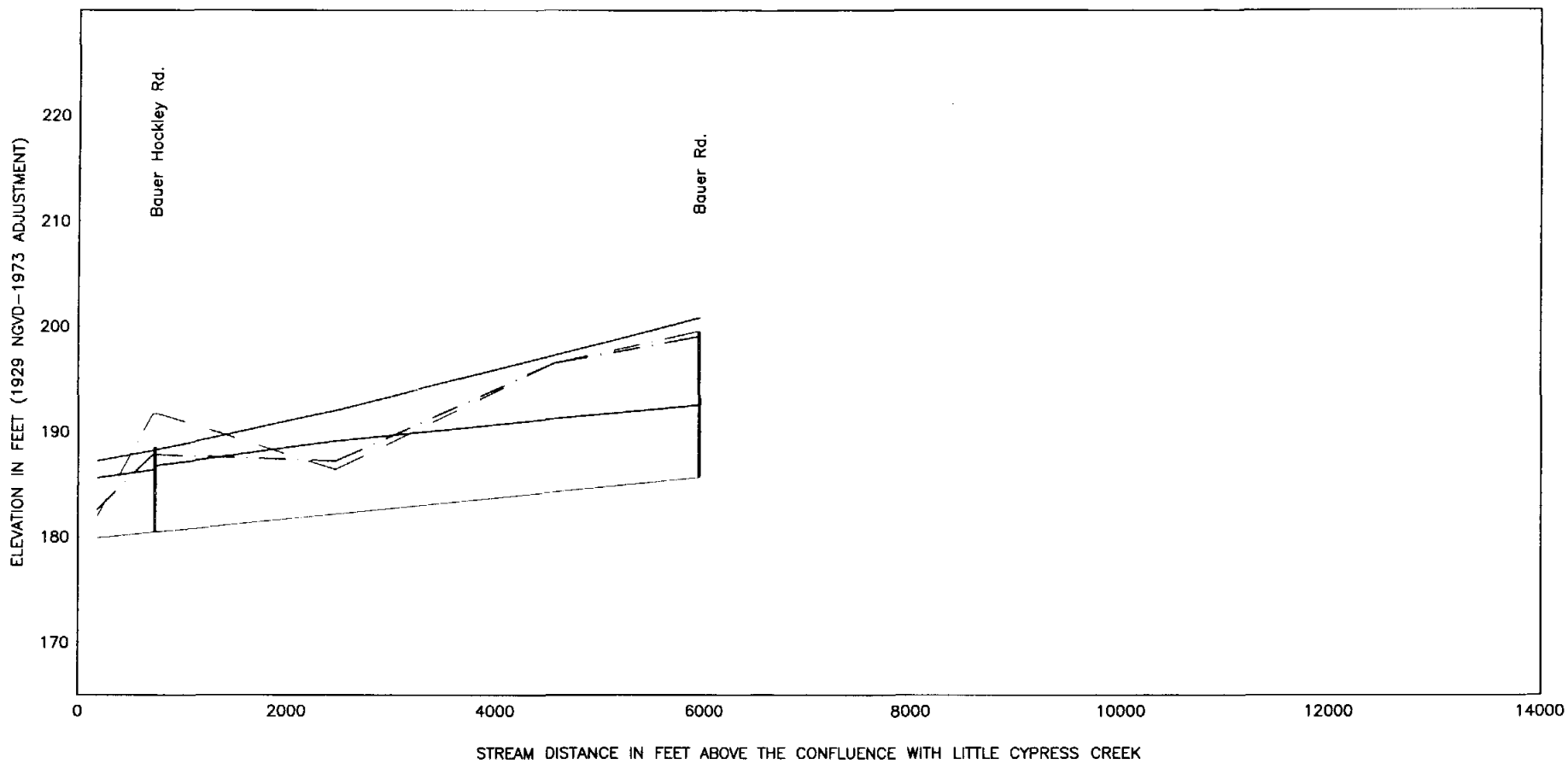
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L114-00-00 | EXHIBIT: A9-11



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
100-YEAR RECOMMENDED PLAN
100-YEAR BASELINE

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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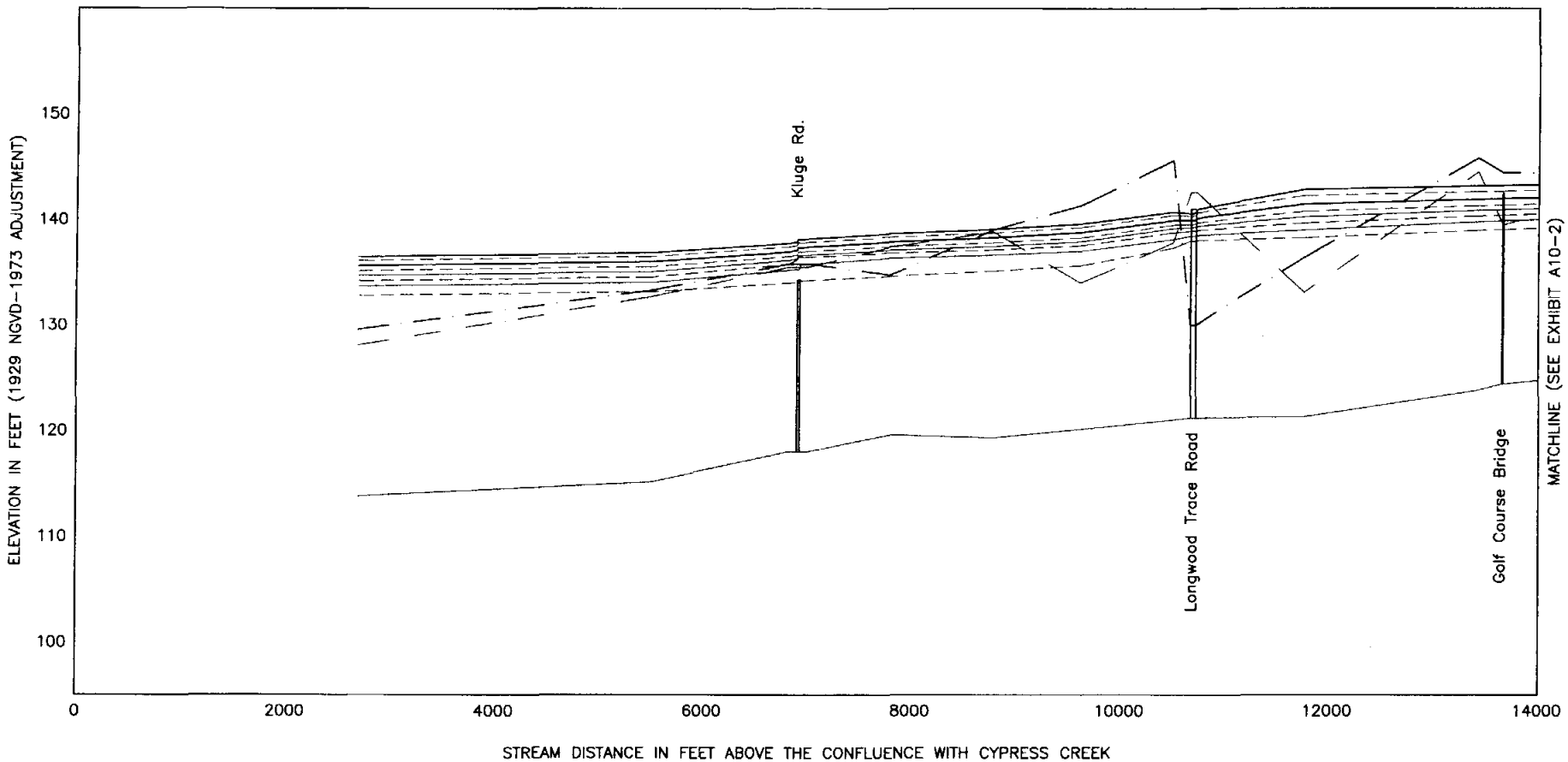
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
100-YR WATER SURFACE PROFILE COMPARISON

FEBRUARY 2003 | L114-01-00 | EXHIBIT A6-12



LEGEND

- FLOWLINE
- LEFT BANK
- RIGHT BANK
- BRIDGES

WATER SURFACE PROFILES

- 500-YEAR
- 250-YEAR
- 100-YEAR
- 50-YEAR
- 25-YEAR
- 10-YEAR
- 5-YEAR
- 2-YEAR

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
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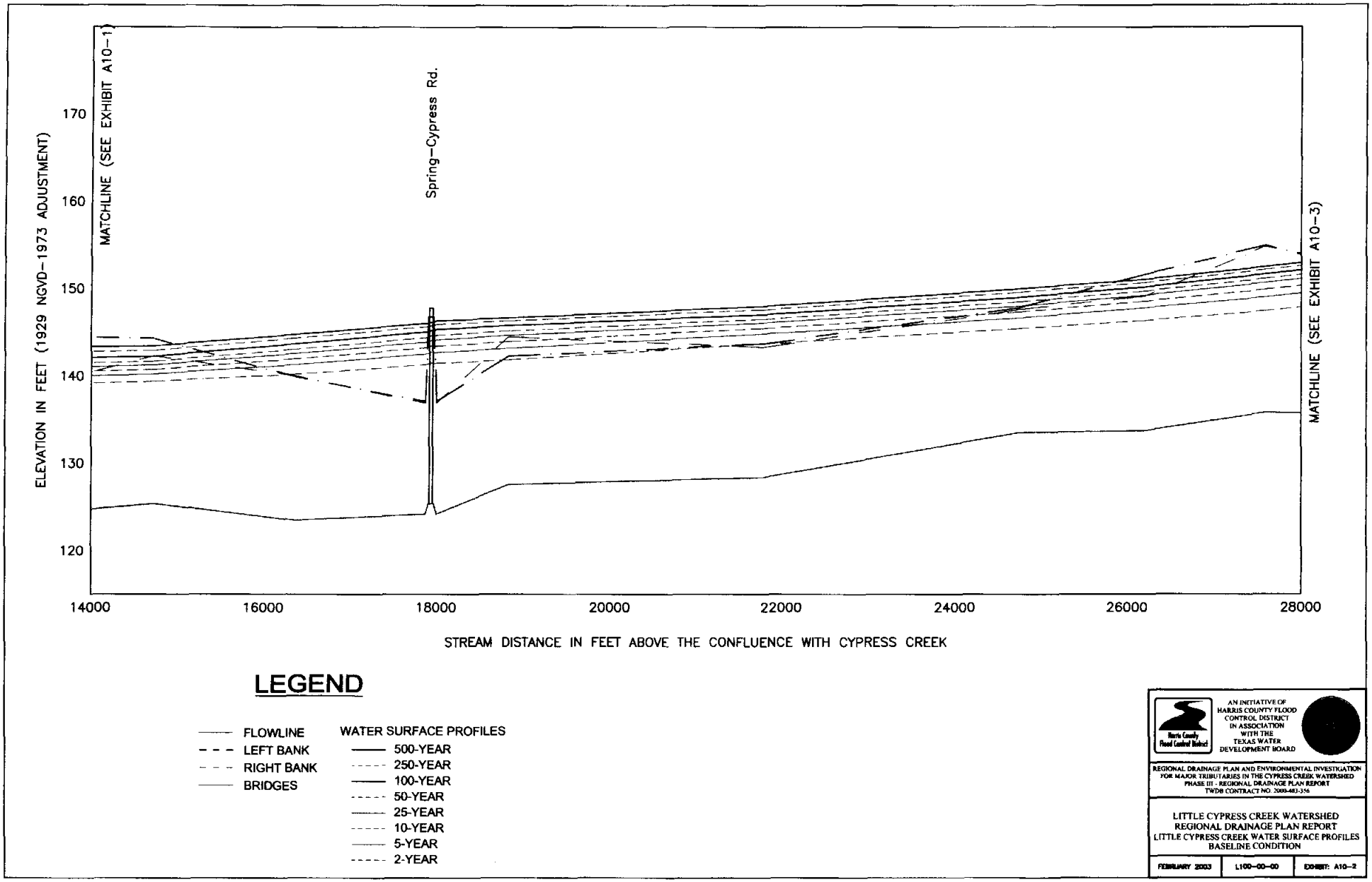
TWDB CONTRACT NO. 2000-483-356

LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
LITTLE CYPRESS CREEK WATER SURFACE PROFILES
BASELINE CONDITION

FEBRUARY 2003	L100-00-00	EXHIBIT: A10-1



AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
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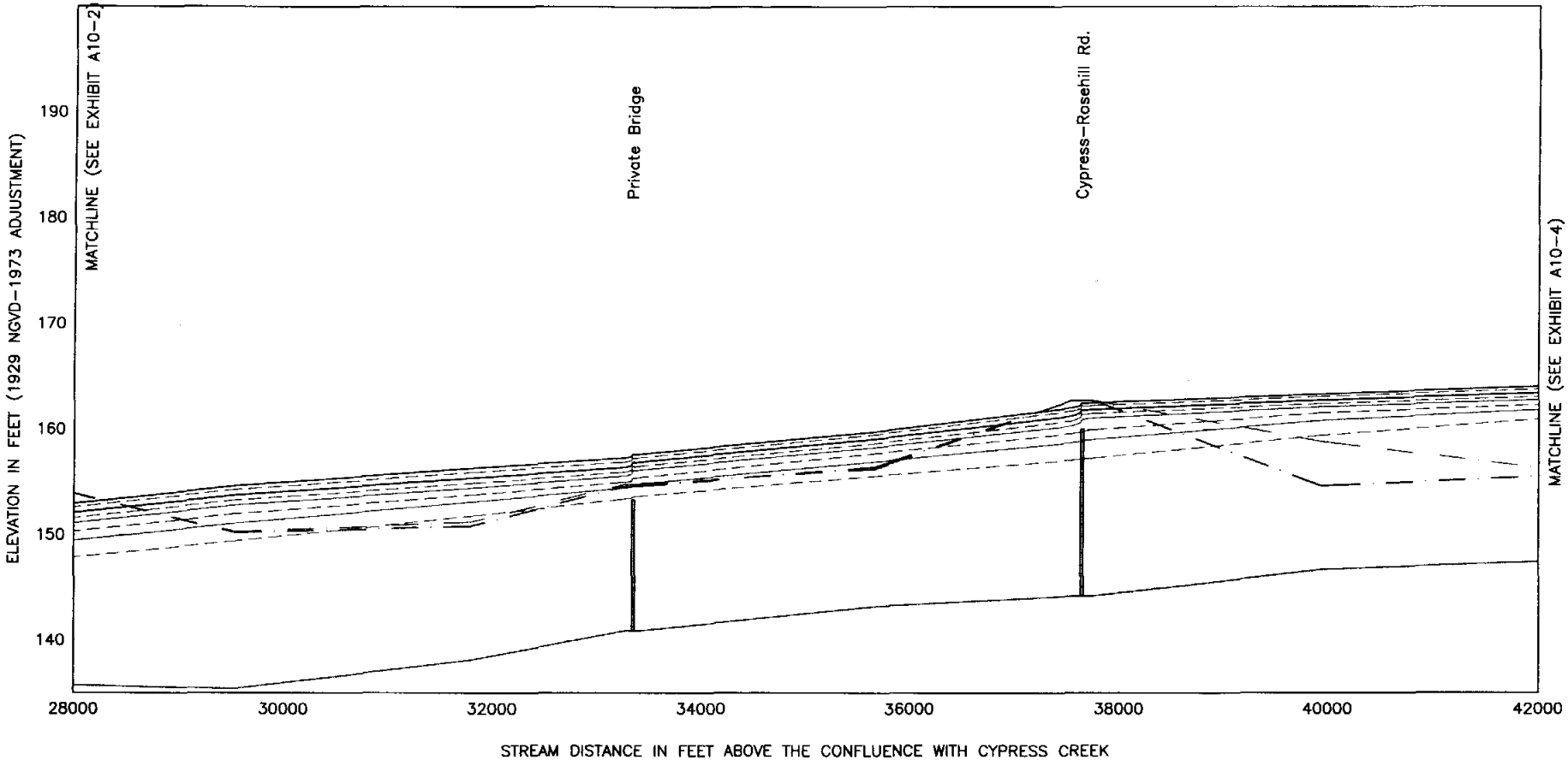
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
LITTLE CYPRESS CREEK WATER SURFACE PROFILES
BASELINE CONDITION

FEBRUARY 2003	L100-00-00	EXHIBIT: A10-2



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
500-YEAR
250-YEAR
100-YEAR
50-YEAR
25-YEAR
10-YEAR
5-YEAR
2-YEAR

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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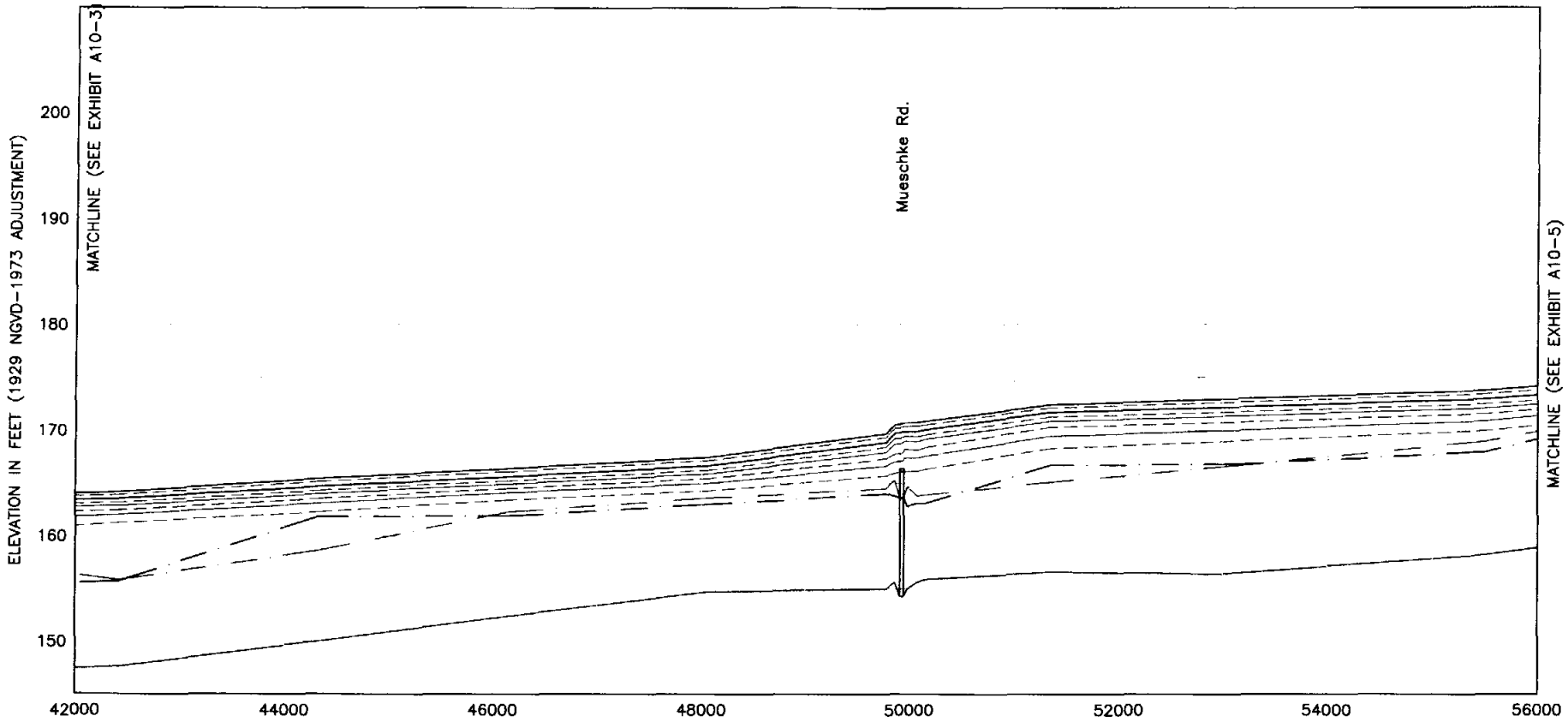
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
LITTLE CYPRESS CREEK WATER SURFACE PROFILES
BASELINE CONDITION

FEBRUARY 2003	L100-00-00	EXHIBIT: A10-3



LEGEND

FLOWLINE
LEFT BANK
RIGHT BANK
BRIDGES

WATER SURFACE PROFILES
500-YEAR
250-YEAR
100-YEAR
50-YEAR
25-YEAR
10-YEAR
5-YEAR
2-YEAR

AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

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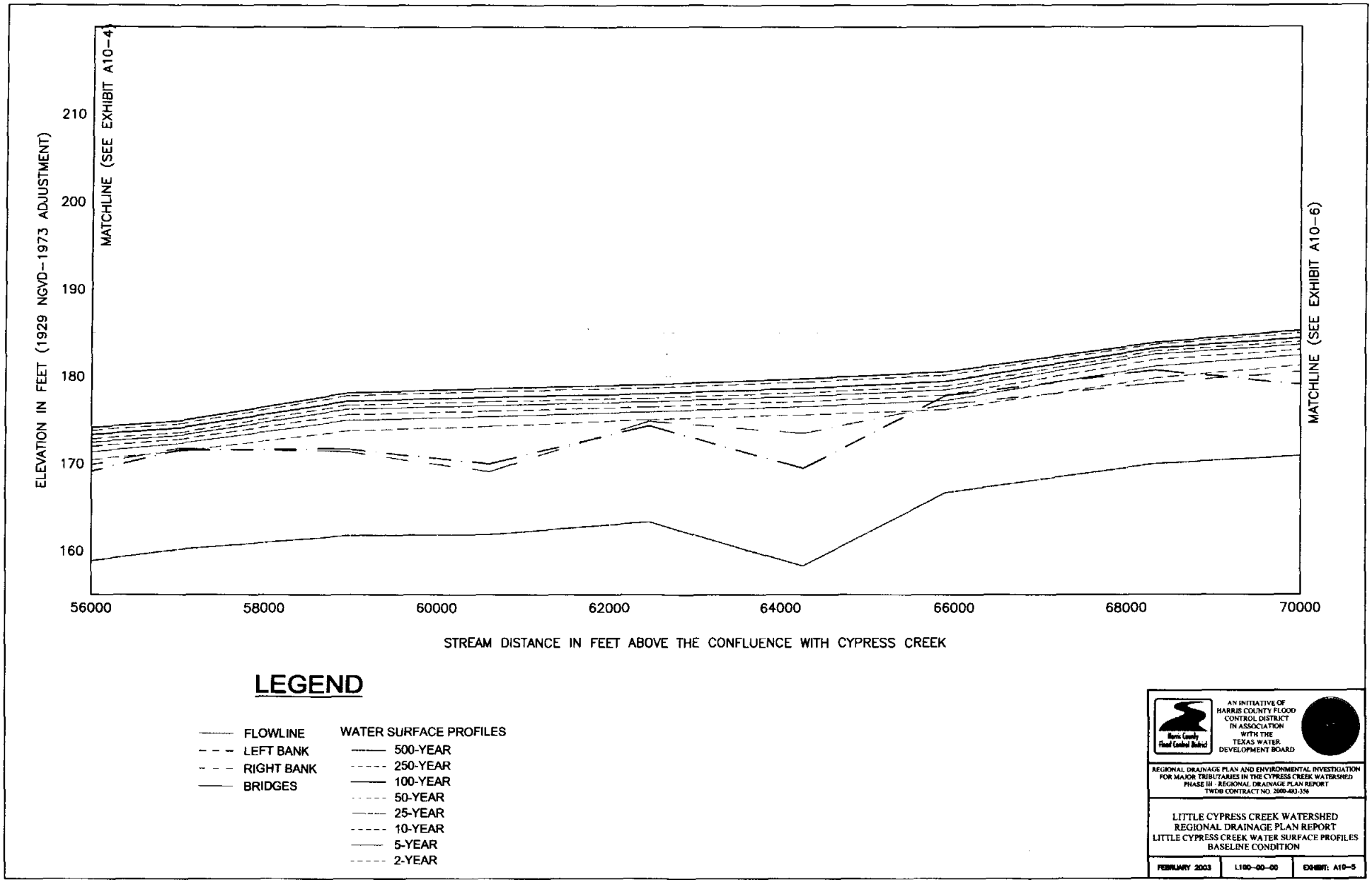
LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
LITTLE CYPRESS CREEK WATER SURFACE PROFILES
BASELINE CONDITION

FEBRUARY 2003 | L100-00-00 | EXHIBIT: A10-4



AN INITIATIVE OF HARRIS COUNTY FLOOD CONTROL DISTRICT IN ASSOCIATION WITH THE TEXAS WATER DEVELOPMENT BOARD

REGIONAL DRAINAGE PLAN AND ENVIRONMENTAL INVESTIGATION FOR MAJOR TRIBUTARIES IN THE CYPRESS CREEK WATERSHED
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LITTLE CYPRESS CREEK WATERSHED
REGIONAL DRAINAGE PLAN REPORT
LITTLE CYPRESS CREEK WATER SURFACE PROFILES
BASELINE CONDITION

FEBRUARY 2003	L100-00-00	EXHIBIT: A10-5