HUNTING BAYOU FLOOD RISK MANAGEMENT, HARRIS COUNTY, TEXAS

DRAFT GENERAL REEVALUATION REPORT AND INTEGRATED ENVIRONMENTAL ASSESSMENT

APPENDIX 3
ENGINEERING ANALYSIS

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HARRIS COUNTY FLOOD CONTROL DISTRICT

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Acronyms

AREMA	American Railway and Maintenance-of-Way
AASHTO	American Association of State Highway and Transportation Officials
COH	City of Houston
EA	Environmental Assessment
ERRY	Englewood Railroad Yard
ESA	Environmental Site Assessment
FRM	Flood Risk Management
GRR	General Reevaluation Report
H&H	Hydrologic and Hydraulic
HB&T	Houston Belt & Terminal
HCFCD	Harris County Flood Control District
HVJ	HVJ Associates, Inc.
HTRW	Hazardous, Toxic and Radioactive Waste
IH	Interstate Highway
LERRD	Land, Easements, Rights-of-Way, Relocations and Disposal Areas
LPST	Leaking Petroleum Storage Tank
MBTA	Migratory Bird Treaty Act
NED	National Economic Development (Plan)
NGVD	National Geodetic Vertical Datum
NPDES	National Pollution Discharge Elimination
O&M	Operation and Maintenance
PED	Preconstruction Engineering and Design
REC	Recognized Environmental Condition
ROW	Right-of-Way
TCEQ	Texas Commission on Environmental Quality
TSP	Tentatively Selected Plan
TxDOT	Texas Department of Transportation
US	U.S. Highway
USACE	U.S. Army Corps of Engineers
WSELs	Water Surface Elevations

1.0 INTRODUCTION

This appendix presents the results from the engineering analysis performed for the flood risk management (FRM) components and alternatives considered to determine the National Economic Development (NED) Plan and the Tentatively Selected Plan (TSP), which is a scale of the NED Plan, to support the Draft General Reevaluation Report and Integrated Environmental Assessment (GRR/EA). The information presented herein addresses the requirements in the U.S. Army Corps of Engineers (USACE) ER 1110-2-1150, Engineering and Design for Civil Works Projects (USACE 1999).

1.1 Purpose

The engineering analysis was performed to define the major construction items, engineering considerations and effective construction techniques to support developing the associated costs for each alternative component and plan. The analysis considered the major elements for providing the appropriate flood protection level. Based on these elements construction cost, estimates were developed and compared to select the most cost-effective component combination and ultimately determine the NED Plan and the TSP, which is a scale of the NED Plan. The TSP, NED Plan Scale B60-A75, is the scale which best meets the planning objectives to minimize residential and business displacements and to not increase flooding in any area. The TSP also reasonably maximizes net excess benefits while best meeting the study objectives compared to the other scale, NED Plan scale B50-A25, which reasonably maximizes net excess benefits at the least cost. The components and construction items are the same between the two scales, except NED Plan scale B50-A25 has on average a 10-foot narrower channel cross section and 50 acres less offline detention. The engineering considerations for the TSP are presented in detail in this appendix.

1.2 Scope

The general scope of investigations performed in the engineering analysis for alternative plans is described as follows.

The following analysis was performed for each component.

1. The location, size and general layout for the component were determined. A Digital Terrain Model based on a combination of city of Houston (COH) 2-foot contour mapping and 1998 1-foot contour mapping was used as the topographic data source. All data were converted to a 1929 National Geodetic Vertical Datum (NGVD), 1973 adjustment, to develop a consistent Digital Terrain Model throughout the watershed. Digital aerial photography with 0.5-meter resolution taken between December 1998 and January 1999, developed for the Houston-Galveston Area Council was used to locate potential construction sites and existing facilities.

2. Environmental and geotechnical information were reviewed to identify major factors which would impact the feasibility and cost for a particular location or component feature.

3. Land acquisition costs were computed based on the plan layout, which included land required for additional right-of way (ROW) and excavated material disposal sites. Haul routes and distances to disposal sites were determined.

4. Existing utility and pipeline information was compiled, required relocations and adjustments were identified, and relocation quantities and costs were estimated.

5. For components requiring bridge replacements or modifications, the required bridge size and associated costs were calculated.

6. Construction quantities for the major construction items were calculated based on the plan layout and design. Cost estimates were then computed using unit costs developed for each construction item.

Please note, the detail level performed in the engineering investigations is intended to satisfy the requirements outlined in paragraph 13 of ER 1110-2-1150, *Engineering During Feasibility Phase* (USACE 1999).

1.3 Design Criteria

Design criteria used in the FRM components' conceptual design were based on USACE criteria (USACE 1999). Additional referenced criteria included the non-federal sponsor, Harris County Flood Control District (HCFCD) criteria (HCFCD 2004).

All elevations discussed below are referenced to the 1929 NGVD with the 1973 subsidence adjustment. The horizontal control datum used is the NAD83, Texas State Plane, South Central Zone.

2.0 PLAN FORMULATION ENGINEERING ANALYSIS

Engineering analysis was performed as necessary to support the various phases for formulating components (measures) and alternatives. The analysis was performed to support hydrologic and hydraulic (H&H) modeling and estimating the components construction cost. Details for the engineering investigation assumptions and criteria can be found in *Appendix 2 – Hydrology and Hydraulics* and *Appendix 4 – Cost Estimates*.

2.1 Component Formulation

In this study phase, hydrologic, hydraulic and economic information were used in conjunction with detailed modeling techniques to analyze individual components. A wide variety of components were analyzed including channel modifications, offline and inline detention, bypass channels, levees, nonstructural buyouts (floodplain evacuation), flood-proofing and selected bridge removal throughout the watershed's upper middle and lower reaches. Engineering investigations to support H&H analyses were generally performed on existing infrastructure to determine if certain proposed component configurations would be feasible. Examples include reviewing existing and proposed storm sewer outfalls to determine channel deepening flow lines and field investigations on older timber bridges to determine the feasibility of exposure to deeper proposed flows.

USACE and local criteria were used to size or configure connections to or replacements of drainage infrastructure, channel geometry and other features for components such as levee interiors, bypass channels and detention basins. Details for these assumptions and criteria are in *Appendix 2 – Hydrology and Hydraulics.*

For cost estimates, unit costs were established from recent historical data. These were the non-federal sponsor, HCFCD, and other local project bid tabulations for the same construction item types. These included data from many projects, with average prices calculated and adjusted if necessary for anticipated project conditions or effort. Quantities were mainly calculated using Computer Aided Design software or Geographic Information System in conjunction with aerial imagery and component layout data. Existing utility information was gathered through a variety of sources including COH Geographic Information Management System geospatial data for water and sewer, communication with private companies (pipeline, gas, telecommunication, etc.) and Harris County record drawings from past projects on Hunting Bayou. Local design criteria were used to define needed quantities or configurations for cost estimates. Examples include the non-federal sponsor, HCFCD, *Policy and Criteria Manual* to define the configuration and lengths for replacing storm sewer lines and outfalls. Details for these assumptions and criteria are in *Appendix 4 – Cost Estimates.*

2.2 Alternatives Analysis

The alternative analysis phase consisted of determining viable alternatives which addressed flooding damages throughout Hunting Bayou. Each alternative would, in theory, represent a viable and complete solution to reduce flooding problems in the watershed. The engineering investigations generally involved reuse or continuing the analysis, assumptions and criteria from the previous phase. The only difference was certain feature configurations were changed (i.e.,

weir structures connecting detention basins to modified channels), since components were now being analyzed together. Cost estimates involved the same assumptions and methods, except component costs were combined and interest during construction was calculated. Consultations with local contractors for earthwork helped define nominal construction schedules to aid in calculating interest during construction. More detail on engineering investigations during the alternatives analysis is available in *Appendix 2 – Hydrology and Hydraulics* and *Appendix 4 – Cost Estimates*.

3.0 TENTATIVELY SELECTED PLAN (TSP)

The TSP provides approximately a 4 percent annual exceedance probability protection level in the upper watershed and consists of the optimal offline detention basin in combination with 3.8 miles of earthen channel modifications. The following sections describe in detail the engineering considerations for the TSP.

3.1 Summary for Tentatively Selected Plan Features

The TSP consists of channel modifications which include a maintenance ROW on both sides of the channel, an offline detention basin and disposal sites. The channel modifications begin in Hunting Bayou's upper reaches just east of U.S. Highway (US) 59 and end just downstream from the Englewood Railroad Yard (ERRY) on Wayside Drive. Channel modifications necessitate acquiring 55 residential structures (single-family and multifamily) in Hunting Bayou's upper reaches from just east of US 59 to Lockwood Street. The offline detention basin is located between Homestead Road and Interstate Highway (IH) 610. Deepening and widening the existing channel requires 17 bridge modifications, 96 utility, storm sewer and pipeline relocations, and removing a few inactive utilities and street segments. The major TSP (and NED Plan) features are described as follows.

1. Channel modifications
    a. 3.8 miles of trapezoidal channel modifications
        1) 1.6 miles of trapezoidal channel modifications – from 0.3 mile downstream from ERRY (Station 549+50) to Homestead Road (Station 632+50). All of the modifications are earthen except for a 0.2-mile reach of concrete lining through ERRY (Station 560+00 to Station 572+50).
        2) 2.2 miles of earthen trapezoidal channel modifications – from Homestead Road (Station 632+50) to just downstream from US 59 (Station 748+50).
    b. Channel width

        The TSP channel configuration is referred to in the Draft GRR/EA as B60 and consists of 30- to 60-foot bottom width cross sections in the upstream portion, transitioning to 10-foot bottom width cross sections downstream from the offline detention.
    c. Erosion protection at transitions

        Erosion protection will be designed at all channel transition areas during Preconstruction Engineering and Design (PED).
2. Offline detention east of Homestead Road.
3. 17 bridge modifications consisting of either replacement or extension.
4. Environmental mitigation is being addressed by purchasing credits in the Greens Bayou Wetlands Mitigation Bank.

5. Disposal areas – the non-federal sponsor, HCFCD, has successfully disposed excavated soils in past projects through reuse in local road, development and other project types, and intends to do so for this project. However, sufficient disposal sites have been identified as a planning contingency, assuming at least 25 percent of the required placement volume can be reused in other projects.

6. Utility Relocations – 96 utilities adjustments will either be removed and abandoned or relocated.

7. Street Impacts – 13 local area streets will be abandoned or changed. Due to the channel widening, certain street segments are no longer needed to access occupied structures and will be removed as part of a dead end existing street.

A plan and profile layout for the TSP is shown on *Exhibits A3-1a* through *A3-1f*.

3.1.1 Channel Modifications

The channel component for the TSP provides FRM to the upper Hunting Bayou watershed, where the majority of the Without Project conditions damages are located. The channel was optimally sized to provide approximately a 4 percent annual exceedance probability protection level in the upper watershed and will be two basic types: 1) earthen trapezoidal channel modifications and 2) concrete-lined side-sloped trapezoidal channel sections. These modifications are discussed in detail in the following sections.

3.1.1.1 Trapezoidal Channel Modifications Downstream from Homestead Road

The proposed trapezoidal channel modifications extend along 1.6 miles of Hunting Bayou as described in Section 4.1, item 1. The design is an earthen section with 4:1 (horizontal:vertical) side slopes, except for a short reach through ERRY, which was designed to be concrete-lined with 2.5:1 side slopes. This existing channel section through ERRY is concrete-lined. The concrete lining was added to reduce erosion potential and to help stabilize the five bridges in this reach. Maintaining the concrete lining in this section reduces the potential for erosion problems and minimizes the railroad bridge replacement lengths.

The proposed flow line was based on analyzing existing and proposed storm sewers and lateral drains, with the channel bottom being set a minimum of 1 foot below all existing drains. This flow line achieved more capacity through deepening and allowed better function for lateral drainage infrastructure. This resulted in the channel being deepened by 2 to 4 feet on average. Two existing storm sewer outfalls near Homestead Road (Station 636+00) were identified as having an estimated 25-foot flow line elevation, which was below Hunting Bayou's existing flow line. The proposed flow line in Hunting Bayou was set 1 foot below the storm sewer outfalls at this location. The proposed channel's starting flow line elevation is 17.6 feet at Station 549+50. All elevations referenced in this paragraph are 1929 NGVD, 1973 adjustment].

The trapezoidal channel modifications use the 0.05 percent the non-federal sponsor, HCFCD, design criteria minimum channel slope (HCFCD 2004). The modifications were ended downstream as soon as the deepened channel bottom could be transitioned into the existing bottom. The trapezoidal channel modifications are presented in *Table A3-1*.

Table A3-1:
Tentatively Selected Plan (TSP)
Trapezoidal Channel Modifications Downstream of Homestead Road

Station		Description
Downstream	Upstream	
549+50	560+00	Earthen – 10-foot bottom width, 4:1 side slopes
560+00	561+00	Concrete – transition from 4:1 side slopes to 2.5:1 side slopes
561+00	571+50	Concrete – 10-foot bottom width, 2.5:1 side slopes
571+50	572+50	Concrete – transition from 2.5:1 side slopes to 4:1 side slopes
572+50	600+00	Earthen – 10-foot bottom width, 4:1 side slopes
600+00	602+80	Earthen – transition from 10-foot bottom width to 60-foot bottom width

Cross-sections at 500-foot intervals for the channel modifications are shown in *Exhibits A3-2a* through *A3-2i*. For the earthen channel reaches, a 30-foot maintenance berm was set on both sides of the channel to meet standard non-federal sponsor, HCFCD, criteria. For the concrete channel reach through ERRY (Station 560+00 to Station 572+50), a 20-foot maintenance berm was set on the east bank and a 10-foot berm on the west bank (HCFCD 2004).

3.1.1.2 Trapezoidal Channel Modifications Upstream from Homestead Road

The earthen slope section upstream from Homestead Road begins at Station 632+50, just upstream from the Homestead Road crossing and ends just downstream from US 59 (Station 748+50). All the sections have 4:1 side slopes. The channel's longitudinal slope was set at the non-federal sponsor's, HCFCD, 0.05 percent criteria minimum and includes an erosion protection channel bottom drop structure at the project's upstream limit to transition the existing flow line upstream from the project to the proposed deepened flow line.

Three design sections are within this channel modification reach. From Station 634+00 (just upstream from Homestead Road) to Station 705+50 (Wipprecht Road), the section has a 60-foot bottom width. From Station 706+00 to Station 720+00 (Los Angeles Road one block East of Hirsch), the bottom width is 40 feet, and in the final reach from Station 720+50 to Station 748+50 (US 59) the bottom width is reduced to 30 feet.

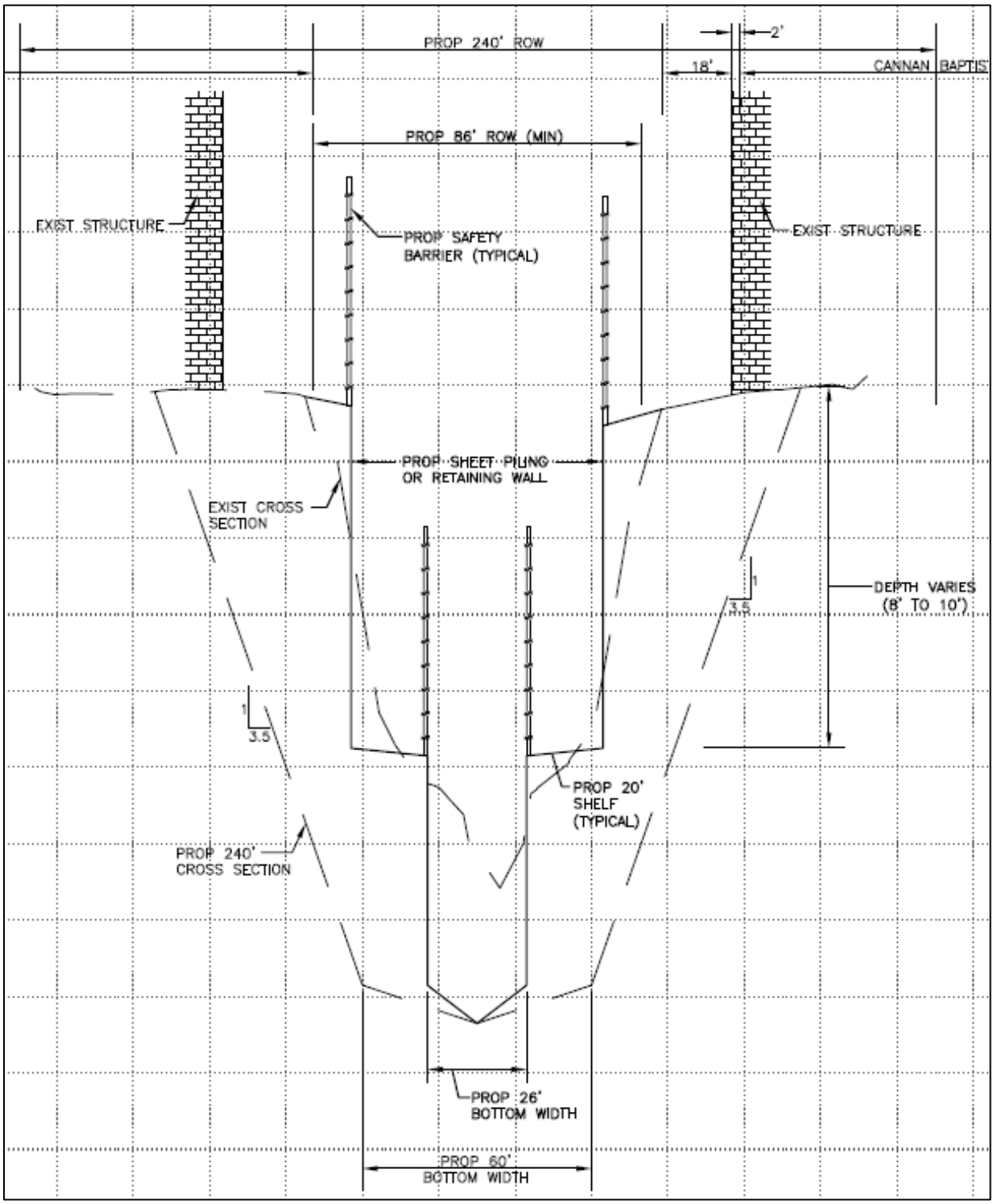
Table A3-2 summarizes these trapezoidal channel modifications. Cross sections at 500-foot intervals of the channel modifications are shown in *Exhibits A3-2a* through *A3-2i*. The basic cross section geometry through the Lockwood Drive bridge was deviated to avoid having to raise the Lockwood Drive bridge and potentially conflict with the Loop 610 overpass. The alternative channel section is designed to fit into a minimum 86-foot ROW. The alternative section begins approximately 150 feet upstream from Lockwood Drive and continues to Lockwood Drive's upstream face. Through the Lockwood Drive bridge, grading is proposed between the existing bridge supports to allow for a continuous flow line slope. The existing Lockwood bridge deck is left in place. The alternative section then resumes at Lockwood Drive bridge's downstream face and continues approximately 50 feet downstream. The alternative cross section is a rectangular channel section consisting of a 26-foot bottom width section with 6-foot vertical walls (see *Figure A3-1*). Above the 6-foot walls, a 20-foot shelf is proposed on each side. From the

20-foot shelf, 8- to 10-foot vertical walls extend to natural ground. The transition to and from the basic cross section geometry is done over approximately a 300-foot distance.

Table A3-2:
Tentatively Selected Plan (TSP)
Earthen Channel Modifications Upstream from Homestead Road

Station		Description
Downstream	**Upstream**	
602+80	705+50	60-foot bottom-width channel with 4:1 side slopes
705+50	706+00	Transition – 60-foot bottom-width to 40-foot bottom width
706+00	720+00	40-foot bottom-width channel, with 4:1 side slopes
720+00	720+50	Transition – 40-foot bottom-width to 30-foot bottom width
720+50	748+50	30-foot bottom-width channel with 4:1 side slopes

Figure A3-1:
Proposed Lockwood Alternate Cross Section (86-ft ROW)



3.1.2 Offline Detention Basin

The offline detention basin site is bounded by the Homestead subdivision on the north, the Houston Belt & Terminal (HB&T) railroad tracks on the south, Kirkpatrick Street and Settegast

Railroad Yard on the east, and Homestead Road on the west. The proposed layout is shown in *Exhibit A3-3*. The total basin area is approximately 75 acres. The basin has a 42-foot top-of-bank elevation and a 25.1-foot flow line elevation at the diversion structure; below 25.1 will be a permanent pool approximately 6 feet deep. *Table A3-3* shows the storage volume in the basin at 1-foot increments. All elevations referenced in this paragraph are 1929 NGVD, 1973 adjustment].

Table A3-3:
Offline Detention Basin Data

Elevation (feet)*	Storage Volume (acre-feet)
19.6	0
21.6	20
25.6	69
26.1	75
27.1	92
28.1	120
29.1	161
30.1	215
31.1	274
32.1	334
33.1	395
34.1	456
35.1	517
36.1	580
37.1	643
38.1	707
39.1	772
40.1	840
41.1	911
42.1	989

*All elevations referenced are 1929 NGVD, 1973 adjustment.

The diversion from the main channel to the offline basin is located at approximately Station 620+00 and would consist of the following features. The three existing 96-inch culverts plus a new 72-inch culvert would be used to convey flow under the HB&T railroad tracks to a control structure. The control structure is a 100-foot by 60-foot by 20-foot rectangular riser with a 100-foot sharp crested weir crest length at elevation 40.7 feet. The riser box includes two orifice openings. The lower orifice is a 6-foot by 6-foot opening located at the riser's base with a 24.2-foot flow line elevation. This orifice is equipped with a flap gate preventing flow from entering the basin from Hunting Bayou through the culverts in low flow events. When tailwater conditions recede, this opening allows the basin to empty into Hunting Bayou. The second orifice is designed to take flow into the basin during rainfall events in excess of a 2-year event. This orifice consists of a 1-foot-tall by 60-foot-wide opening with a 38.35-foot flow line elevation. To accommodate a deeper basin, the 72-inch reinforced concrete pipe culvert is required below the railroad embankment, with a flow line set approximately 4 feet below the

flow line of the three existing 96-inch culverts. The hydraulic basis and modeling approach for the control structure is discussed in *Appendix 2 – Hydrology and Hydraulics*. All elevations referenced in this paragraph are 1929 NGVD, 1973 adjustment.

3.1.3 Bridge Modifications and Replacements

Since the TSP proposes several major Hunting Bayou channel reaches be deepened and widened, it was determined a majority of the bridges had to be extended or replaced along these reaches. Seventeen bridge structures along the TSP alignment were identified as needing to be extended or replaced. COH owns 12 of the bridges, Texas Department of Transportation (TxDOT) owns two, and railroad companies own the remaining three. The Homestead Road bridge is counted as a single bridge crossing. *Table A3-4* identifies each bridge which would need to be extended or replaced along with the bridge widths and existing and proposed bridge lengths if the TSP was constructed.

Table A3-4:
Tentatively Selected Plan (TSP) – Bridge Replacements

Bridge Name	Station	Owner	Width (feet)	Length (feet)	
				Existing	Proposed
Wayside Drive	563+30	COH	150	200	161
SP ERRY bridge	566+26	Railroad	30	200	200
SP ERRY bridge	566+96	Railroad	20	180	180
SP ERRY bridge	568+48	Railroad	20	175	175
IH 610 second crossing	597+46	TxDOT	410	150	193
Homestead Road (both access roads)	635+10	COH	170	173	229
Kelley Road West	648+68	COH	39	105	242
IH 610 third crossing	657+60	TxDOT	260	159	247
Walkway @ Hutcheson Park	661+53	COH	5	97	204
Walkway @ Hutcheson Park	672+94	COH	5	97	204
Walkway @ Pickfair	692+83	COH	6	79	200
Wipprecht Street	704+35	COH	41	120	195
Wayne Street	716+45	COH	46	80	178
Hirsch Street	724+25	COH	80	120	170
Leffingwell Street	729+03	COH	41	82	155
Falls Street	732+43	COH	42	75	155
Walkway @ Russell	739+35	COH	5	60	161

Following COH criteria, the bridge low chord needs to be 18 inches above the 100-year water surface elevation (WSEL); 12 bridges within the reach need to be replaced to meet this condition. To accommodate the channel widening, two of the bridges needed to be extended. These two bridges currently meet COH criteria. Three bridges are being replaced due to channel deepening to address concerns related to the bridges' stability if their foundations were exposed resulting from the deepening. Previous deepening attempts in other areas resulted in moving the railroad bridge structures, which required a full replacement.

When the project proceeds to the PED phase, additional structural analysis will be required at each bridge. The structural analysis will require data from detailed field surveys, geotechnical investigations and environmental investigations at each bridge location, and record drawings for each existing bridge, as available.

The design for all new or replacement structures will be performed in accordance with TxDOT's latest Load and Resistance Factor Design Bridge Design Manual, Bridge Division Operation and Planning Manual, and Bridge Detailer's Manual; and the American Association of State Highway and Transportation Officials (AASHTO) manual *Load and Resistance Factor Design Bridge Design Specifications* 4th Edition. Evaluations for existing bridges to be widened will be in accordance with the AASHTO manual *Standard Specifications for Highway Bridges* and the *American Railway and Maintenance-of-Way* (AREMA) standards. The widening and/or lengthening for existing structures will be in accordance with the Standard Specifications.

3.1.3.1 Design Loads

The following sections describe the structural design load requirements which will be followed when designing bridge replacements and extensions.

3.1.3.1.1 Dead Loads

- Dead loads will be in accordance with AASHTO/AREMA requirements.
- Structural analysis will not include design for a future overlay.

3.1.3.1.1 Live Loads

- All new bridge structures carrying highway traffic will be designed for HL-93 loading.
- Structures carrying railroad traffic will be designed in accordance with AREMA requirements and any additional railroad requirements.
- In general, bridge widening will be designed for HS-20 loading according to the TxDOT *General Specifications for Highway Bridges*.

3.1.3.2 Design Criteria

- Vertical Clearances:
  - Roadway. A minimum 16-foot 6-inch clearance will be provided over all cross streets and the roadway and/or shoulders of area roads for widening. Existing clearances will be maintained if less than 16-foot 6-inches.
  - Railroad. A minimum 23-foot clearance will be provided over all existing and proposed railroad lines.
  - Transit Rail. A minimum 26-foot clearance will be provided over future transit rail lines.
- For all existing bridge widenings, the existing superstructure type will be matched.
- Other superstructure types may be used on smaller spans over waterway crossings or in widenings.
- For AASHTO girders, 0.5-inch diameter pre-stressing strands will be used whenever possible. Beam designs will be performed at various spans and beam spacings to achieve

maximum required concrete strengths of 8,000 psi at 28 days and 6,000 psi at release. The relative humidity for design is 75 percent.

- Grade 36, 36W, 50, 50W or HPS-70W steel will be used on steel plate girders.
- Concrete strength for all substructure elements will be f'_c = 3,600 pounds per square inch (psi) with reinforcing steel using f_y = 60,000 psi.
- Concrete strength for all bridge decks will be f'_c = 4,000 psi.
- Foundations will be single-drilled shafts, multiple-drilled shafts with cap or multiple pre-stressed concrete piles with pile cap.

3.2 Constructability Issues for Tentatively Selected Plan (TSP)

The following paragraphs discuss environmental and engineering aspects related to constructing the TSP.

3.2.1 Environmental Considerations

Several environmental issues related to the proposed TSP were evaluated to determine the affected environment's scope in the Hunting Bayou watershed. To meet the ER 1110-2-1150 requirements for considering environmentally beneficial design aspects for the recommended project, environmental engineering factors were also considered for the TSP. This section summarizes the environmental issues discussed in the GRR/EA separately from the TSP constructability issues and considers the environmental engineering factors listed in Appendix C of ER 1105-2-1150.

The following paragraphs summarize the key investigations to determine existing environmental conditions within the project limits which may be impacted by the project design elements or construction activities. Details for these investigations can be found in the GRR/EA.

3.2.1.1 Hazardous, Toxic and Radioactive Waste (HTRW) Investigations and Other Hazardous Material Concerns

During this study, HTRW investigations were performed consisting of reviewing initial environmental database. The initial review of hazardous material and waste regulatory records indicated 252 separate potential sites in the study area. In addition to a former landfill site, only six potential sites were determined to have environmental concerns within a 100-ft buffer of the project ROW. Construction activities along the channel ROW could potentially impact these sites.

One is the Kirkpatrick Road Landfill; two are Voluntary Cleanup Program sites at 5880 Kelley Road and 6701 North Loop East (this address is also assigned to other registered PST facilities); one is a PST/LPST at the former Humble Oil 99 Land Waste Disposal facility at 5118 Lockwood Drive; one is a PST owned by UPRR at 7000 Liberty Street; and one is a RCRA treatment, storage and disposal facility at 5202 Lockwood (identified as a new facility formerly identified as an Exxon Mobil PST/LPST site).

If Voluntary Cleanup Program sites have not been fully remediated within required standards prior to construction activity, it will be necessary to review specific site contaminant data (extent, location, direction, etc.) to determine if excavation in the area could impact the phase separated

hydrocarbon plume found on the site. Additional coordination would be conducted with the responsible party to determine the remedial action status and if alternate remediation actions such as soil excavation would be required to allow widening the channel through this site.

An unregistered closed COH municipal landfill, occupies most of the area north of the proposed channel modifications between Homestead Road and Station 600+00. This Type I landfill was operated as the Homestead Road Sanitary Landfill sometime during the 1960s and 70's to receive household wastes. The facility is included in the TCEQ required *Inventory of Closed Municipal Solid Waste Landfill*s but no additional information was available from the inventory. An April 2007 Phase I Environmental Site Assessment (ESA) for this property identified several recognized environmental conditions associated with unburied/partially buried miscellaneous debris, tires, and labeled and unlabeled paint buckets, drums and cans in several isolated areas of the property. The report recommended evaluation and proper disposal of the debris. Considering the isolation and extent of the debris, and results of later investigations, it is likely this debris is associated with illegal dumping occurring after the landfill ceased operation.

One site being considered for soil disposal, Disposal Site 4, was listed in the updated version of the *Inventory of Closed Municipal Solid Waste Landfills* as a site which received household waste and had signs of historically dumping miscellaneous debris. No other information was available. Soil disposal would not be anticipated to affect buried waste layers, but site liability transfer issues and appropriate due-diligence investigations would have to be considered prior to purchasing fee ownership of this tract if used for soil disposal. This site was also shown in historical USGS quadrangle maps as a previous borrow site that has since received fill.

3.2.1.2 Natural and Cultural Resources

Approximately 4.37 acres of forested, scrub-shrub and emergent wetlands have been identified within the proposed channel ROW, the offline detention basin and potential Disposal Site 4. It will be mitigated by purchasing mitigation credits from the Greens Bayou Wetland Mitigation Bank. More detail on that can be found in *Appendix 1*, Attachment D. Three other wetlands – in the channel segment south of the offline detention basin, along the southern boundary of Disposal Site 5a and on Disposal Site 6, not included in the acreage above – will be avoided by reconfiguring soil placement around them. Approximately 1.2 acres of fringe wetland vegetation are estimated to exist along the perennial channel within the current banks and are expected to return after reconstructing the perennial channel. All the wetlands and any planned mitigation for them are shown and discussed in *Appendix 1*, Attachment D.

Coordination with resource agencies and field investigations by qualified biologists for this study have indicated no federally-protected or state-listed threatened or endangered species or state-listed rare species are expected to occur in the study area, inclusive of the TSP ROW. Therefore, the TSP construction would not impact any threatened, endangered or state-listed rare species. The Southern Rein orchid, listed as rare in botanical literature, was found in clusters near some wetlands in the offline detention basin tract and was relocated to the Mercer Arboretum.

A Migratory Bird Treaty Act (MBTA) survey conducted in 2008 prior to constructing a smaller interim basin in the offline detention tract confirmed the presence of migratory birds' nests for species protected under the MBTA. The interim basin construction was scheduled to avoid activity during the nesting season. To comply with the MBTA, future construction activities would need to be planned to avoid disturbing nests and displacing birds during the nesting

season. In addition, construction contracts will include instructions to avoid impacts from construction-related activity to migratory birds and their nests. If any clearing activities are conducted from March 1 through September 15, a migratory bird survey may be required to comply with MBTA guidance.

Cultural resource investigations performed in coordination with the State Historic Preservation Officer have not identified archeological resources or historic properties included in or eligible for inclusion in the National Register of Historic Places within the TSP ROW or potential disposal sites. One site downstream from the TSP was identified as potentially vulnerable to erosion from increases in WSELs; however, the TSP will not increase WSELs in any downstream location. The State Historic Preservation Officer has indicated concurrence with these findings and recommendations as documented in the GRR/EA. Since the TSP will lower or not affect water surfaces through the downstream area of concern, no cultural resources will be affected by the TSP. More information on the natural and cultural resource investigations and coordination can be found in Chapters 2 and 5 of the GRR/EA.

3.2.1.3 Water Quality and National Pollution Discharge Elimination System (NPDES) Regulations

Because constructing the TSP will disturb more than one acre, a Storm Water Pollution Prevention Plan and storm water permit will be required to meet local and state NPDES regulations. Best Management Practices such as silt fences required during the construction phase are accounted for in the TSP cost estimate and are discussed in more detail in *Appendix 4 – Cost Estimates* under the Associated General Items account code. Other environmental issues considered for the TSP construction activities include NPDES regulations.

NPDES regulations enacted within COH city limits and unincorporated Harris County areas require constructing an NPDES Phase 1 water quality basin which will collect the first half-inch of runoff from the contributing area and store the water for an average of 24 hours. Because the TSP is not associated with new development and does not increase the impervious area within the Hunting Bayou watershed, it is anticipated a NPDES Phase 1 basin will not be required. While the NPDES regulations will be important relative to the TSP's final design issues, due to their relatively small cost they were not included in the overall plan formulation.

3.2.1.4 Environmental Engineering

The environmental engineering factors listed in Appendix C of ER 110-2-1150 were considered and are discussed as follows.

Using environmentally renewable materials – The TSP features will primarily have channel modifications and detention basins with a vegetated cover (normally grass). Project features requiring artificial materials are relatively minor in quantity. Bridge replacements, stormwater outfall and diversion structures, erosion protection lining through ERRY and slope protection for tributary laterals are some of the project features using concrete, steel and asphalt. These are materials for which recycled market sources can be used, but would be subject to the availability of finished materials meeting the required engineering performance specifications and standards.

Designing positive environmental attributes into the project – Except for the segment through ERRY which will remain concrete-lined, the TSP will be designed as a grass-lined channel which can provide pollutant removal as compared to artificial slope linings.

Including environmentally beneficial operations and management for the project – The TSP will not require operation to provide the intended FRM benefits. Operation and Maintenance (O&M) for the project was previously described and would be performed under the existing O&M program the non-federal sponsor, HCFCD, provides for typical flood conveyance channels.

Beneficial uses for spoil or other project refuse during construction and operation – Although sites have been identified for disposing excavated project soils, soil disposal will also be accomplished by reuse in other local projects. Excavated soils will preferentially be disposed through reuse by other local projects and contractors, with 25 percent of the total project excavated volume set as a minimum goal for this disposal method. Structures needing to be removed on lands, easements, ROW, relocations and disposal areas (LERRD) required for the project will need to be demolished. The deconstruction method for demolition, which allows contractors to remove and recover useable construction material, will be considered subject to project implementation needs. This method can often lower demolition costs and provides an avenue for reusing materials.

Energy savings features for the design – TSP's only electrical feature is a lift station required for a sanitary sewer relocation, which is needed to construct the offline detention basin. A lift station powered by alternative energy is not practical at this time due to commercial availability, operational redundancy and design requirements. The normal design process for sewage lift stations requires analysis and consideration for selecting the most efficient and cost-effective pumps, and will be used in this project. The design process may involve considering variable speed operation, using booster pumps and other design considerations which can reduce the lift station's energy consumption.

Maintaining the ecological continuity in the project with the surrounding area and within the region – The proposed TSP area is in a highly urbanized region in northeast central Houston. Natural habitat along the channel within the TSP area is severely limited and fragmented due to urban development directly adjacent to the channel. Due to these conditions, it is not anticipated the TSP will affect ecological continuity in the surrounding area.

Considering indirect environmental costs and benefit – Environmental costs beyond those documented in the GRR/EA are not foreseen. The TSP is not anticipated to induce permanent indirect effects such as increased traffic or increased human disturbance in natural areas. Indirect environmental benefits such as providing a buffer against development or disturbance for an adjacent natural preserve are not anticipated.

Integrating environmental sensitivity into all project aspects – The non-federal sponsor, HCFCD, has developed FRM projects which work with appropriate regard for community and natural values as a central tenet of its mission statement. Many non-federal sponsor, HCFCD, projects have integrated environmentally beneficial features with constructed FRM components where practicable. The non-federal sponsor, HCFCD, will continue to execute its mission consistent with these values when implementing the recommended project.

Incorporating environmental compliance measures into the project design – The previous section summarizes environmental compliance issue considerations. They are discussed in detail in the GRR/EA. NPDES compliance requirements were also taken into consideration. Silt fences would be used along the channel slopes to control sediment runoff. Measures such as seeding grass are planned where existing vegetation will not permit entrapping sediment. Constructing backslope drains, drop inlets and other hydraulic structures would include temporary drains, sediment traps and straw bale barriers to control bare soil runoff. These measures were accounted for in the TSP cost estimate discussed in *Appendix 4 – Cost Estimates*.

3.2.2 Geotechnical Considerations

Geotechnical considerations were based on available geotechnical reports containing the results from 88 soil borings for various construction projects along and adjacent to Hunting Bayou. These reports are listed in Section 7.0 as references 4 through 17. The available geotechnical information is considered adequate for proceeding with the channel modifications under consideration in the GRR/EA. Based on the geotechnical information, the plans under consideration can be constructed and maintained without encountering unusual problems or difficulties. It is recognized extensive geotechnical investigations will be required prior to preparing plans and specifications for any plan to be constructed.

The Hunting Bayou watershed is located on the Beaumont clay formation, a deltaic non-marine Pleistocene deposit. The Beaumont clay is a heterogeneous formation containing thick imbedded layers of clay, fine sand and silt. The clay fraction is primarily composed of montmorillonite, illite, kaolinite and finely ground quartz. The clay present in the formation has been pre-consolidated by a desiccation process. The sand and silts, which vary in compactness from loose to very dense, are composed of quartz, feldspar, large particles of kaolinite, calcite and occasionally hornblende. Reviewing available area geotechnical records indicates the subsurface stratigraphy is composed of strong clays and medium dense sands. In general, the soils along most of the Hunting Bayou channel consist of strong clays and clay fill at top-of-bank elevation and silty sand stratum near the slope bottom and under the lowered channel bottom.

A local geotechnical firm, HVJ Associates, Inc. (HVJ), evaluated existing geotechnical reports performed for various local government and private entities for past construction projects within the Hunting Bayou watershed. From 14 reports located, 80 borings within close proximity to the Hunting Bayou main channel were available for review; a large portion of these borings were taken within the proposed TSP ROW. The borings ranged in depths up to 70 feet below the surface. In addition to reviewing existing boring data, HVJ performed field reconnaissance on October 29, 1998, to assess existing channel conditions. The geotechnical feasibility study report, *Preliminary Findings and Recommendations – Hunting Bayou Channel Improvements* documents the review and field investigations (HVJ 1998).

One of the reports reviewed had three borings within the proposed offline detention basin, with their location shown in *Exhibit A3-4* and copies of the borings provided in *Exhibits A3-5* through *A3-7* (McBride-Ratcliff and Associates 1989). These borings indicated groundwater at an approximate 18-foot depth and rising in one boring to a 14-foot depth by the end of the drilling day. Another report reviewed had eight borings along the channel within the TSP limits, with copies of the borings provided in *Exhibits A3-8* through *A3-15* (Southwestern Laboratories, Inc. 1993). These borings indicated groundwater was encountered at depths greater than 16 feet in

the channel reach adjacent to the offline detention basin. Groundwater levels at the other borings upstream from the proposed detention site were generally between 10 and 14 feet below the surface. The report also contained results from slope stability analyses using the UTEXAS2 computer program. The analyses were performed initially for 2.5:1 side slopes and extended for 3:1 slopes. For 2.5:1slopes, the factor of safety with respect to deep-seated circular-type failures was computed as 1.3 to 1.5. To increase this factor of safety above 1.5, the slopes were reanalyzed for 3:1, in which the computed factor of safety exceeded 1.5.

A more recent geotechnical study was performed in 2004 for the federal study (HVJ 2004). The study involved slope stability analyses for several different channel slope alternatives including 2:1 slope with concrete liner, 3:1 earthen slope, 3.5:1 earthen slope and 2.5:1 slope with concrete liner, with each alternative tested at four locations (or stations). The analyses were conducted for End of Construction Case, Rapid Drawdown Case and Long-Term Case using the slope stability program WINSTABL. The End of Construction Case represents initial undrained conditions expected shortly after construction as soil has been loaded but not had time to drain. The Rapid Drawdown Case represents conditions where high floodwater saturates the slope, but then recedes rapidly at a rate faster than soil can drain. The Long-Term Case represents steady state conditions after soil pore pressures have adjusted to imposed load stresses and piezometric conditions.

The calculation for the factor of safety against instability was performed by the Modified Bishop Method and met the minimum factor of safety for the End of Construction case at all four locations for the 3:1 earthen slope, but failed to meet the minimum factors at three locations for the Rapid Drawdown case and at one of the four locations for the Long-Term case. Comparatively, the 3.5:1 earthen slope met the minimum factor of safety at all four locations for all cases, and hence was recommended. The 2:1 slope with concrete liner met the minimum factor of safety for the End of Construction case at all four locations, but failed to meet the minimum factor of safety for the Rapid Drawdown and Long-Term Cases at all locations. In comparison, the 2.5:1 slope with concrete liner met the minimum factor of safety at all locations for the End of Construction and Rapid Drawdown Cases, and only failed at one location for the Long-Term Case, where the slope height is 35 feet. HVJ recommended reducing the slope height by 12 feet if a 2.5:1 slope with concrete liner would be used at this location, or using a 3:1 slope. All elevations referenced in this paragraph are 1929 NGVD, 1973 adjustment.

The non-federal sponsor, HCFCD, has adopted a 4:1 slope for earthen channels as documented in the non-federal sponsor, HCFCD, *Policy Criteria & Procedure Manual for Approval and Acceptance of Infrastructure* published in October 2004 (HCFCD 2004). The 4:1 slope for earthen channels is recommended in the criteria manual due to various reasons including stability analysis results versus observations, weathered soil shear strength and back-calculated weathered soil shear strength for failed slopes. Therefore, the channel side slopes will adhere to this criterion. The available geotechnical reports in the Hunting Bayou watershed indicated the soils along the main channel are suitable for the proposed 4:1 side slopes. Groundwater was generally found to be between 8 and 14 feet below the surface, with groundwater depths near the offline detention facility ranging between 14 and 18 feet. The reports did not indicate any significant stability or groundwater control problems which would potentially require unusual construction techniques. Please note the channel reach which will be fully concrete-lined will only be

deepened by two feet. Therefore, it was deemed unlikely the concrete-lined channel section construction would be significantly impacted by the groundwater.

3.2.3 Excavation and Fill Requirements

The TSP would require excavating approximately 905,882 cubic yards of soil for the channel modifications and 1,506,789 cubic yards of soil for the offline detention basin. The total identified select fill requirements for the project were determined to be approximately 77,500 cubic yards of soil for the channel modifications and 2,400 cubic yards of soil for the offline detention basin.

3.2.4 Disposing Excavated Material

The non-federal sponsor's, HCFCD, intent is to dispose as much excavated material as possible through reuse in local projects. As a planning contingency, disposal sites have been identified. Preliminary placement site locations for excavated material were identified and are shown on *Exhibit A3-16*. Each potential disposal area was initially prescreened in 2001 to ensure the site's availability. The prescreening process included inspecting each site in the field, reviewing real estate issues, and including each site in the environmental assessments discussed in Chapters 2 and 5 in the GRR/EA. The sites were again screened in 2003, 2007 and 2012 resulting in the parcels shown in *Exhibit A3-16*.

Excavated sediment will be tested and disposed in the appropriate landfill according to the results of the testing. The excavated material will be hauled to these sites for placement after clearing and stripping the existing vegetation. It is planned for the upper topsoil stripped during construction to be collected and stored so it could be reused along the maintenance berms and the offline detention facility.

After reusing 201,828 cubic yards as fill for the Union Pacific Railroad intermodal yard, and assuming 25 percent of the remaining excavation is reused in other local projects, property needed for disposing excavated material – assuming a 12-foot height, 30-foot buffer and 3:1 side slopes – would total approximately 114 acres. More detail on prospective property parcels can be found in *Appendix 6 – Real Estate Plan*.

3.2.5 Utility, Pipeline and Road Relocations

Implementing the TSP would require relocating or altering all utilities and pipelines crossing Hunting Bayou within the project limits.

To identify required utility and pipeline relocations, obtained existing information concerning the utility or pipeline's location, type and size in the proposed construction area from the known providers in the area. The providers include COH, Centerpoint Energy, Southwestern Bell and other providers such as oil and gas pipeline companies. Other data collection means included obtaining record drawings in the area and field visits. A total of 43 utility relocations, 36 storm sewer adjustments and 19 pipeline relocations were identified within the TSP reach, as summarized in *Tables A3-5*, *A3-6* and *A3-7*, respectively.

Estimates for the required removal, rerouting and other potential adjustments were developed for the utilities listed in *Tables A3-5* and *A3-6* and the pipelines in *Table A3-7*. Construction quantities and costs were then developed for each adjustment.

Criteria used to determine if replacements or adjustments were required for utility bridges and pipeline crossings on Hunting Bayou included the following.

1. The top of the pipeline should be a minimum of five feet below the bottom of the new channel or a replacement or alteration was warranted.

2. A 12-inch or less utility line could be placed underground or alongside a bridge.

3. Greater than a 12-inch utility line would need a separate utility bridge.

Table A3-5:
Tentatively Selected Plan (TSP) – Identified Utility Relocations

Station	Utility Owner	Utility Description
Channel Modification		
562+00	COH	8" Water Line (On Bridge)
564+05	COH	36" Water Line (On Bridge)
564+35	COH	12" Water Line (On Bridge)
566+25	COH	36" Water Line (Aboveground)
566+60	COH	10" Sanitary FM (Aboveground)
570+30	COH	12" Water Line (Underground)
572+25	COH	4" Sanitary FM (On Bridge)
574+30	SWBT	5-3 1/2" SWBT Conduit
575+00	SWBT	5-3 1/2" SWBT Conduit
575+70	SWBT	5-3 1/2" SWBT Conduit
576+50	SWBT	9-3 1/2" SWBT Conduit
590+40	COH	8" Water Line (Underground)
596+00	COH	36" Water Line (Aboveground)
611+75	COH	10" & 8" Sanitary Siphon
634+20	SWBT	9-4" Southwestern Bell Conduit
634+50	COH	8" Sanitary Sewer Collector
634+65	COH	4" Sanitary Force main
635+99	COH	4" Sanitary Forcemain
635+99	COH	4" Sanitary (Sludge)
636+00	COH	16" Water Line (Underground)
645+90	SWBT	2-4" Southwestern Bell Conduit
650+60	COH	48" Water Line (Aboveground)
686+30	COH	84" Water Line (Underground)
687+20	COH	8" Water Line (On Bridge)
692+50	COH	60" Sanitary Sewer Collector
693+10	COH	2" Water Line (On Bridge)
698+50	COH	8" Water Line (Underground)
704+60	COH	8" Water Line (On Bridge)
710+55	COH	2" Water Line (Underground)
713+20	COH	84" Waterline (90" Casing)
716+45	COH	8" Water Line (On Bridge)
716+55	COH	2" Water Line (On Bridge)

Station	Utility Owner	Utility Description
717+00	COH	42" Sanitary Sewer Collector
720+96	COH	6" Water Line (Underground)
724+30	COH	36" Water Line (Aboveground)
728+90	COH	6" Water Line (On Bridge)
729+25	COH	8" Sanitary Sewer Collector
732+50	COH	8" Sanitary Sewer Collector
732+50	COH	8" Water Line (On Bridge)
735+75	COH	8" Water Line (Underground)
737+00	COH	8" Water Line (Underground)
Offline Detention Basin		
N/A	COH	12" San. Sew. - All Inclusive (Manholes, 290' 4" Forcemain, etc.)
N/A	COH	Public Sanitary Sewer Lift Stations, packaged sewage lift station, 2,000,000 GPD

Table A3-6:
Tentatively Selected Plan (TSP) – Identified Storm Sewer Adjustments

Station	Utility Owner	Utility Description
551+50	COH	24" Storm Sewer Outfall
559+50	COH	30" Storm Sewer Outfall
561+50	COH	24" Storm Sewer Outfall
563+05	COH	137" x 87" Storm Sewer Outfall
566+50	COH	36" Storm Sewer Outfall
580+00	COH	36" Storm Sewer Outfall
587+00	COH	24" Storm Sewer Outfall
600+50	COH	24" Storm Sewer Outfall
623+80	COH	96" Storm Sewer Outfall
635+10	COH	120" Storm Sewer Outfall
635+10	COH	96" Storm Sewer Outfall
638+50	COH	12" Storm Sewer Drain Pipe
647+00	COH	42" Storm Sewer Outfall
648+00	COH	30" Storm Sewer Outfall
649+00	COH	24" Storm Sewer Outfall (2nd)
649+80	COH	24" Storm Sewer Outfall (1st)
652+80	COH	24" Storm Sewer Outfall
652+81	COH	24" Storm Sewer Outfall
654+20	COH	30" Storm Sewer Outfall
661+00	COH	30" Storm Sewer Outfall
673+15	COH	60" Storm Sewer Outfall
685+85	COH	54" Storm Sewer Outfall
697+85	COH	90" Storm Sewer Outfall
703+60	COH	24" Storm Sewer Outfall
704+20	COH	42" Storm Sewer Outfall
710+60	COH	18" Storm Sewer Outfall

Station	Utility Owner	Utility Description
715+80	COH	96" Storm Sewer Outfall
716+00	COH	96" Storm Sewer Outfall
722+63	COH	66" Storm Sewer Outfall
722+63	COH	24" Storm Sewer Outfall
728+55	COH	24" Storm Sewer Outfall
728+73	COH	48" Storm Sewer Outfall
729+75	COH	24" Storm Sewer Outfall
732+20	COH	24" Storm Sewer Outfall (1st)
732+20	COH	24" Storm Sewer Outfall (2nd)
742+00	COH	42" Storm Sewer Outfall

Table A3-7:
Tentatively Selected Plan (TSP) – Identified Pipeline Relocations

Station	Pipeline Owner	Pipeline Description
Channel Modification		
553+40	Chevron	12" CS Pipeline Crude
554+50	Howard Energy Partners	6" Texas Pipeline Crude
555+45	Howard Energy Partners	16" Texas Pipeline Crude
558+60	Shell Pipeline Company LP	12" Pipeline Crude
566+20	Energy Transfer Company	36" Houston Pipeline
570+60	Union Pacific	Southern Pacific Pipe (Size Unknown)
572+25	Howard Energy Partners	6" Natural Gas Pipeline
572+40	Howard Energy Partners	36" Texas Pipeline
578+90	CenterPoint	4" Houston Pipeline Gas
635+40	Boardwalk Pipeline Partners	4" Gas Pipeline
687+20	Boardwalk Pipeline	4" Gas Pipeline
698+30	Boardwalk Pipeline	2" Gas Pipeline
716+00	Boardwalk Pipeline	2" United Gas Pipeline
717+00	CenterPoint	2" Natural Gas Pipeline
720+95	Centerpoint	2" Natural Gas Pipeline
728+70	Boardwalk Pipeline	2" Gas Pipeline
732+59	CenterPoint	2" Natural Gas Pipeline (On Bridge)
Offline Detention Basin		
N/A	Energy Transfer Company	12" Natural Gas Pipeline Relocation
N/A	Shell Pipeline Company LP	12" Crude Pipeline Relocation

Due to deepening and widening the existing channel, it was assumed all utility and pipeline crossings along the project reach would need to be replaced or adjusted. *Exhibits A3-1a* through *A3-1f* show the TSP plan and profile layouts and indicate the location for the identified utilities and pipelines within the TSP limits.

The required ROW will impact some existing road segments. Approximately 13 street segments would be affected. All but one involve either street segments no longer needed because residences or businesses served by them would also being relocated due to ROW acquisition, or dead end sections would be removed by ROW requirements. Only one road requires a relatively minor realignment – the connector between the Kelley Street and the Loop 610 west-bound feeder road. *Table A3-8* lists the affected roads.

Table A3-8:
Roads Impacted by the Tentatively Selected Plan (TSP)

Road Facility	Owner	Impact/Modification
N George Street	COH	Street segment no longer needed
Russell Street (W. Hunting Street)	COH	Street segment no longer needed
Sayers Street	COH	Remove non-crossing dead end
Los Angeles Street	COH	Remove non-crossing dead end
Los Angeles Street	COH	Remove non-crossing dead end
Kashmere Street	COH	Remove non-crossing dead end
Kashmere Street	COH	Remove non-crossing dead end
Lavender Street	COH	Remove non-crossing dead end
Pickfair Street	COH	Remove non-crossing dead end
Hoffman Street	COH	Street segment no longer needed
Hickman Street	COH	Street segment no longer needed
Dabney Street	COH	Street segment no longer needed
Loop 610 WB Feeder-Kelley Street EB Connector	TxDOT	Realign

3.2.6 Real Estate

The total ROW needed to be acquired along the Hunting Bayou channel was determined to be 59.5 acres. In obtaining this necessary ROW, 60 residential relocations were identified including two small apartment structures with four living units and 58 single-family residences. Other structure relocations required include two businesses, one religious use structure and a small former industrial use structure (garage). The total property acquisition cost for the TSP was estimated to be $25,927,300, excluding utility and bridge relocations. Details for determining the acquisition costs are in *Appendix 6 – Real Estate Plan*.

3.2.7 Construction Materials, Techniques and Access

Generally, concrete materials required for constructing channel and bridge modifications are readily available in Houston and the surrounding areas. At this time, material shortage is not anticipated to be an issue during construction.

Channel modification excavation is anticipated to be constructed with typical construction equipment including draglines and bulldozers. Excavated material will require hauling by dump truck to the disposal sites. Placing and compacting the excavated material at the disposal sites will require bulldozers and other typical compaction equipment. Constructing the bridge modifications and replacements will require typical equipment and procedures used to construct pre-cast concrete or steel plate girder bridges in the Houston area. Traffic control would be one

key element for the bridge construction and may require total closure of certain bridges or possible detours to other roads to avoid the bridge. Decisions regarding these issues will be made while preparing the construction plans. During the design phase, coordination will be necessary with TxDOT, COH and Harris County to ensure the bridge replacement schedule considers emergency accessible routes and school bus routes.

3.2.8 Operation and Maintenance (O&M)

The non-federal sponsor, HCFCD will perform all O&M activities. Typical activities anticipated include mowing the ROW and removing debris. Since the existing channel is already maintained by the non-federal sponsor, HCFCD, no significant increase in current O&M costs is anticipated due to the proposed modifications except for new ROW, detention acreage, the soil placement sites and the additional trees and shrubs. These annual additional O&M costs are presented in *Appendix 4 – Cost Estimates*. These costs were based on reviewing the non-federal sponsor's, HCFCD, maintenance program and historical maintenance costs for the watershed and typical turf establishment/maintenance and other channel maintenance costs contained in the Brays Bayou Federal Flood Damage Reduction Project and White Oak Bayou Federal Flood Damage Reduction Project. The non-federal sponsor's, HCFCD, maintenance program calls for the channel and detention basin ROW to be mowed on a regular basis during the season, and provides a help line telephone number which watershed residents can call to report any debris accumulation in the channel. The non-federal sponsor, HCFCD, has contracts with local construction firms who will provide debris removal or other channel cleanouts as needed.

The offline detention basin construction will result in relocating several utilities including a sanitary sewer line that crosses through the middle of the proposed basin site. The sanitary sewer will need to be rerouted along Homestead Road and then be pumped back into the trunk system via a lift station. The lift station will be designed in accordance with the Texas Administrative Code, Title 30, Chapter 217 – Design Criteria for Domestic Wastewater Systems, Subchapter C – Conventional Collection Systems and the City of Houston Department of Public Works and Engineering Design Manual for Submersible Lift Stations, dated October 2002.

It was determined a 2 million-gallon-per-day capacity lift station will be required at this location, which will result in additional O&M costs. The annual O&M costs for the lift station are estimated to be approximately $70,000.

The roadway bridges are owned, operated and maintained by either COH or TxDOT. TxDOT maintains the O&M for the IH 610 and US 59 bridges. No increase in the ongoing maintenance costs for these bridges is anticipated due to the proposed plan.

To minimize channel erosion and subsequent maintenance costs, slope protection measures, a concrete channel through ERRY, and backslope swales and drains have been included in the overall project costs. These design elements will help control erosion in the channel and prevent slope failures. Slope protection measures such as stone rip-rap will be placed at the confluence of major storm sewers and lateral channels. Backslope swales will run along the maintenance berms and drain into backslope interceptor structures.

3.2.9 Estimated Construction Costs

The construction costs are provided in the Micro-Computer Aided Cost Estimating System estimate provided in *Appendix 4 – Cost Estimates*.

3.3 Preconstruction Engineering and Design (PED)

Per Appendix C of ER 1110-2-1150, the Engineering Appendix should discuss the further engineering analysis and investigations which will be necessary in subsequent study phases for several required content elements. Some of this was discussed in previous sections, but is summarized in this section for convenience. The following items are anticipated to be required or performed during the PED project phase.

1. Aerial and topographic surveys and ground control for the Hunting Bayou channel.

2. Updated ROW mapping along the Hunting Bayou channel.

3. Utility relocation surveys and mapping along the Hunting Bayou channel and at the offline detention basin site.

4. Additional geotechnical surveys along Hunting Bayou along the reach of channel modifications and at the offline detention basin site. Surveys would focus on providing more data for confirming calculated slope stabilities and construction dewatering needs. Additional surveys should include a more detailed delineation for the waste layer's bank-side edges in the COH property with the unregistered landfill located between Homestead Road and Station 600+00, only if the slope along the left bank is determined to require any re-grading during PED. Currently this is not anticipated.

5. Additional structural analysis at each bridge modification including supporting detailed field surveys, geotechnical investigations and environmental investigations, and record drawings, as available.

6. Continue the HTRW Phase I ESA work being performed for required property acquisitions along the channel modification reach. Additional asbestos and lead-based paint surveys for pre-1980 structures required to be demolished as part of property acquisitions and channel modification as indicated by the Phase I ESA work, or as required.

4.0 REFERENCES

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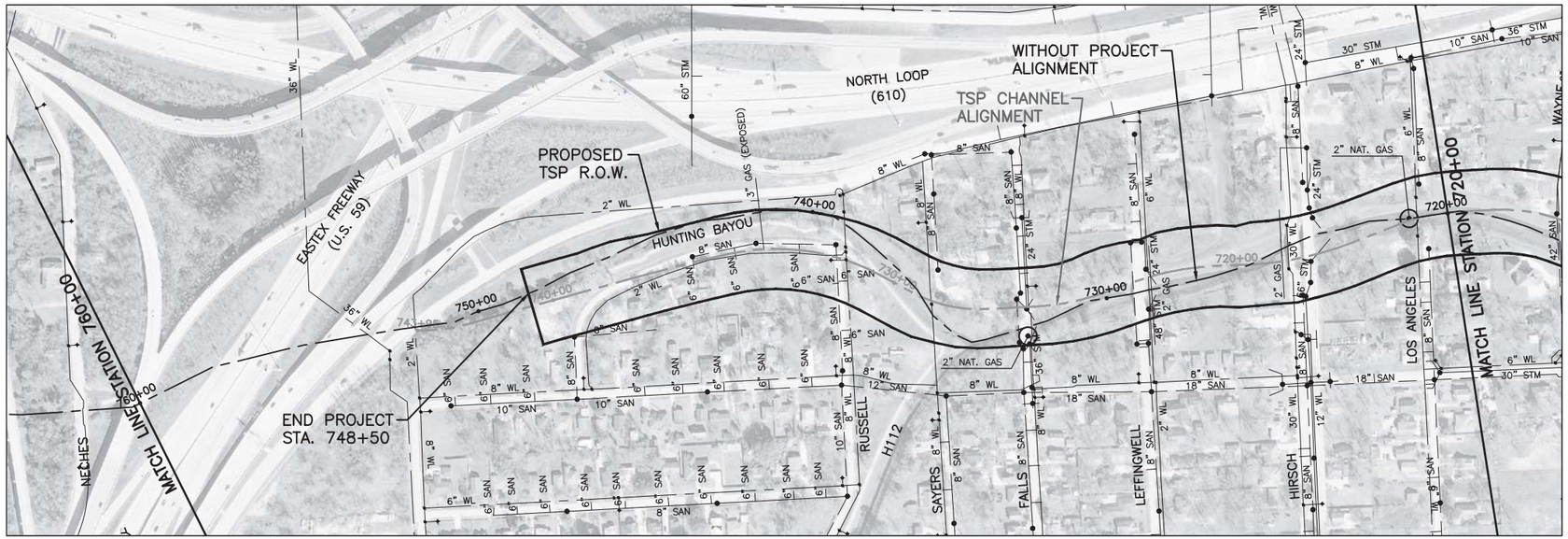


0 200 400
SCALE IN FEET

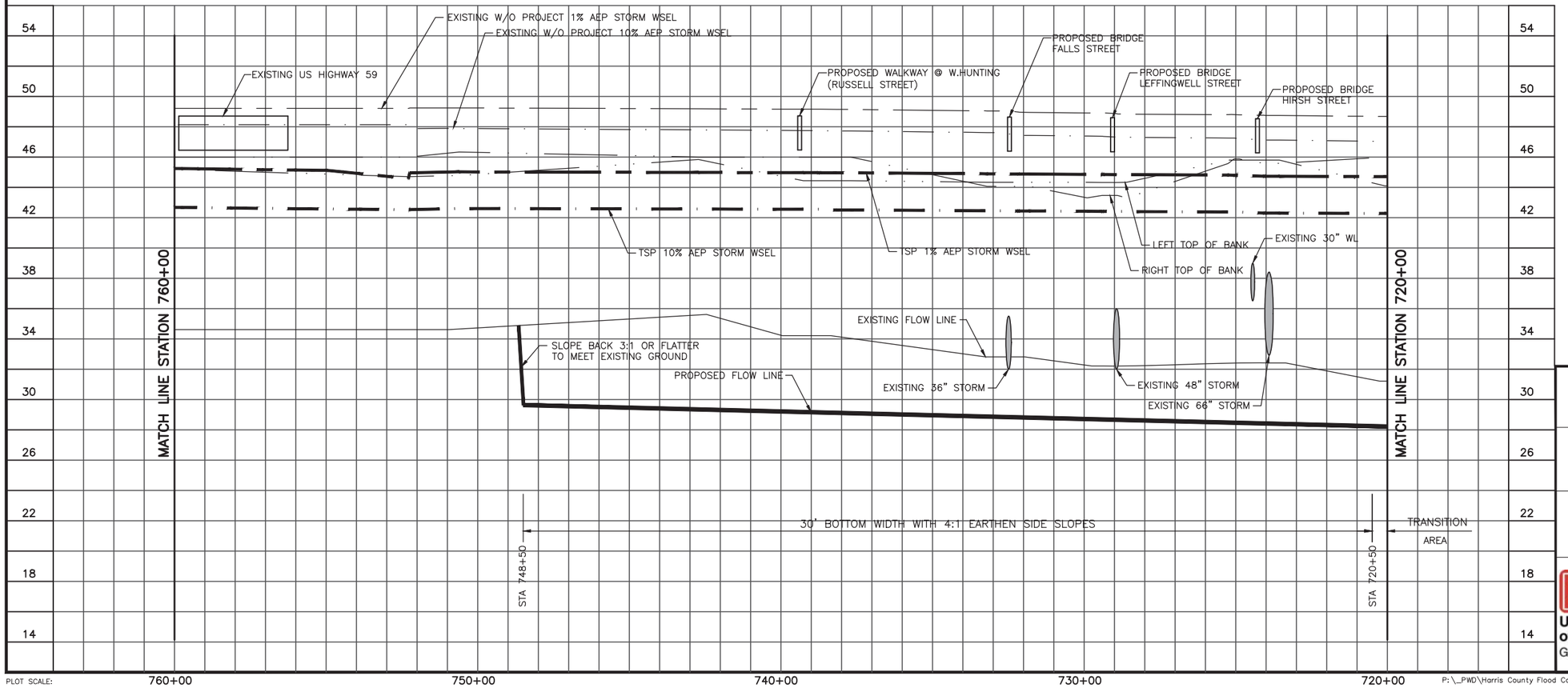
LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
- LEFT TOP OF BANK
- RIGHT TOP OF BANK



NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE–EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 760+00 TO STA 720+00

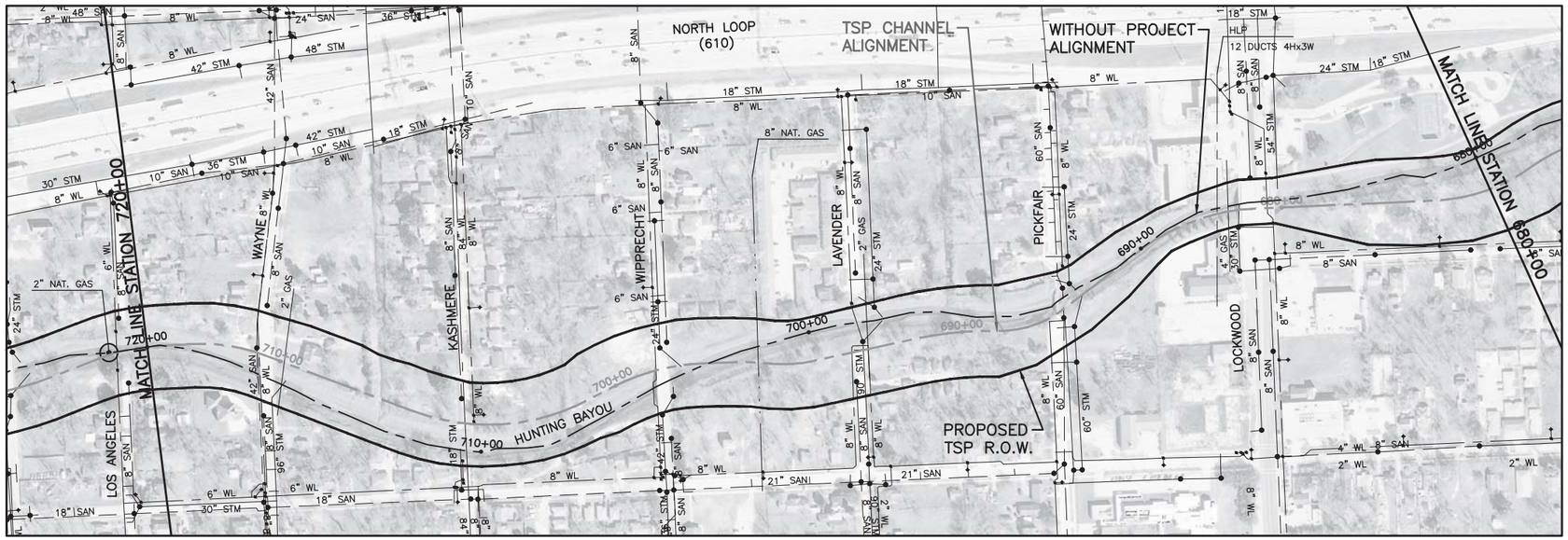
US Army Corps of Engineers®
Galveston District

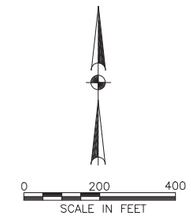
EXHIBIT: A3–1a

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 – Hunting Bayou\Cadd\Channel\SHEET02_RPb.dwg May 09, 2013





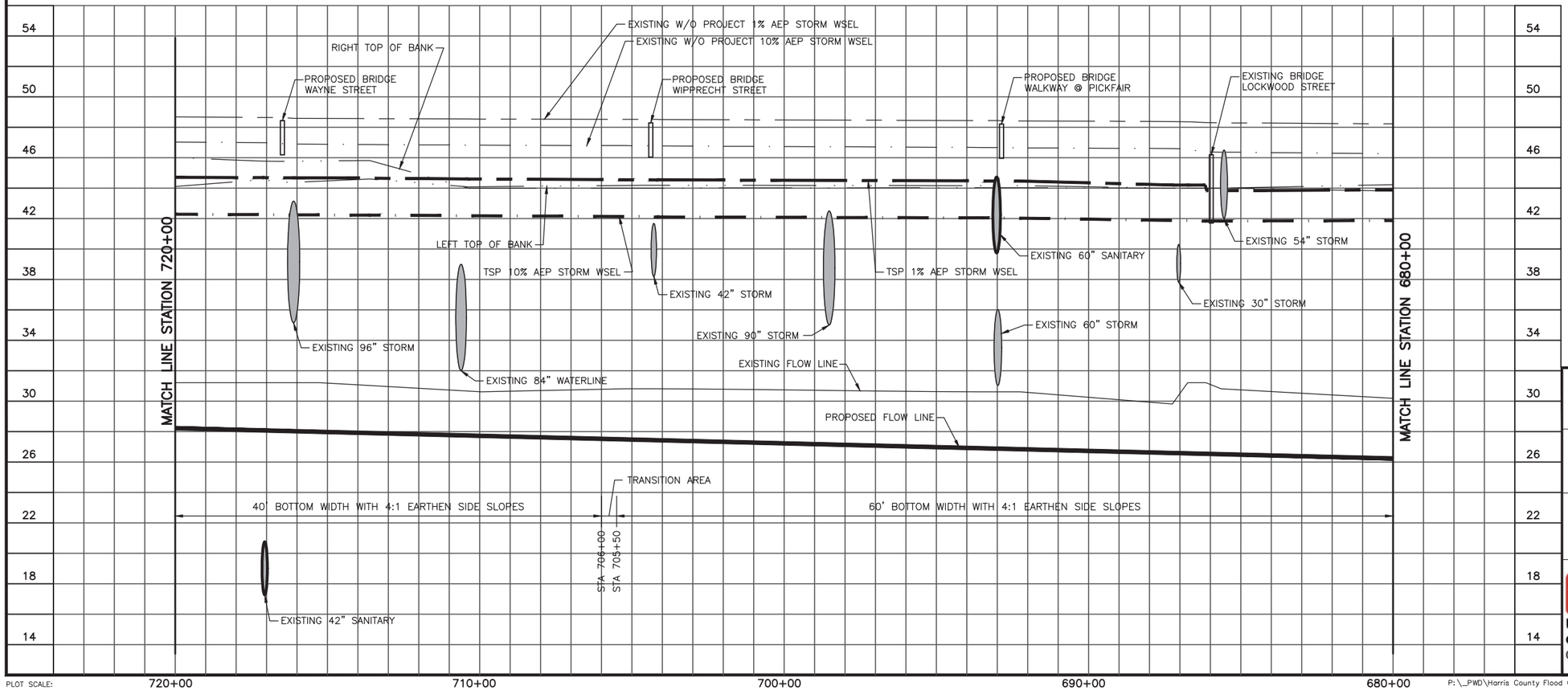
LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
- LEFT TOP OF BANK
- RIGHT TOP OF BANK



NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE-EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 720+00 TO STA 680+00

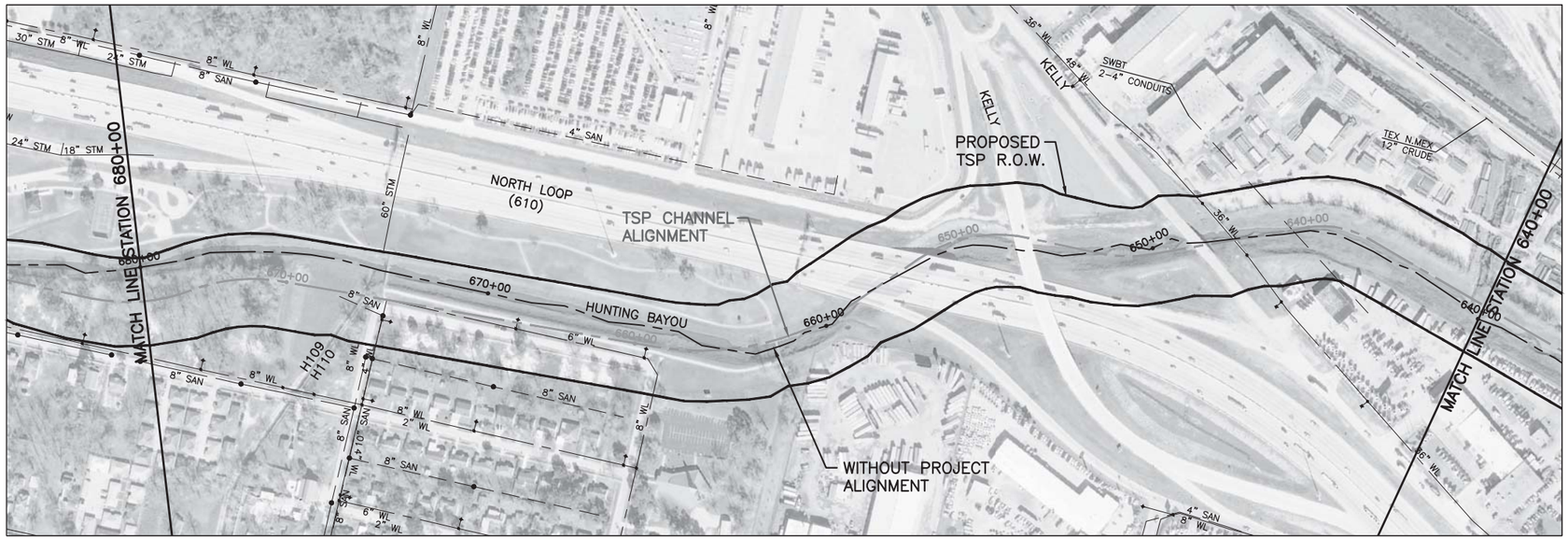
US Army Corps of Engineers®
Galveston District

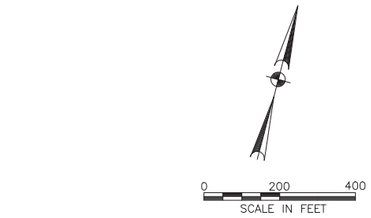
EXHIBIT: A3-1b

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\SHEET03_RPb.dwg May 09, 2013





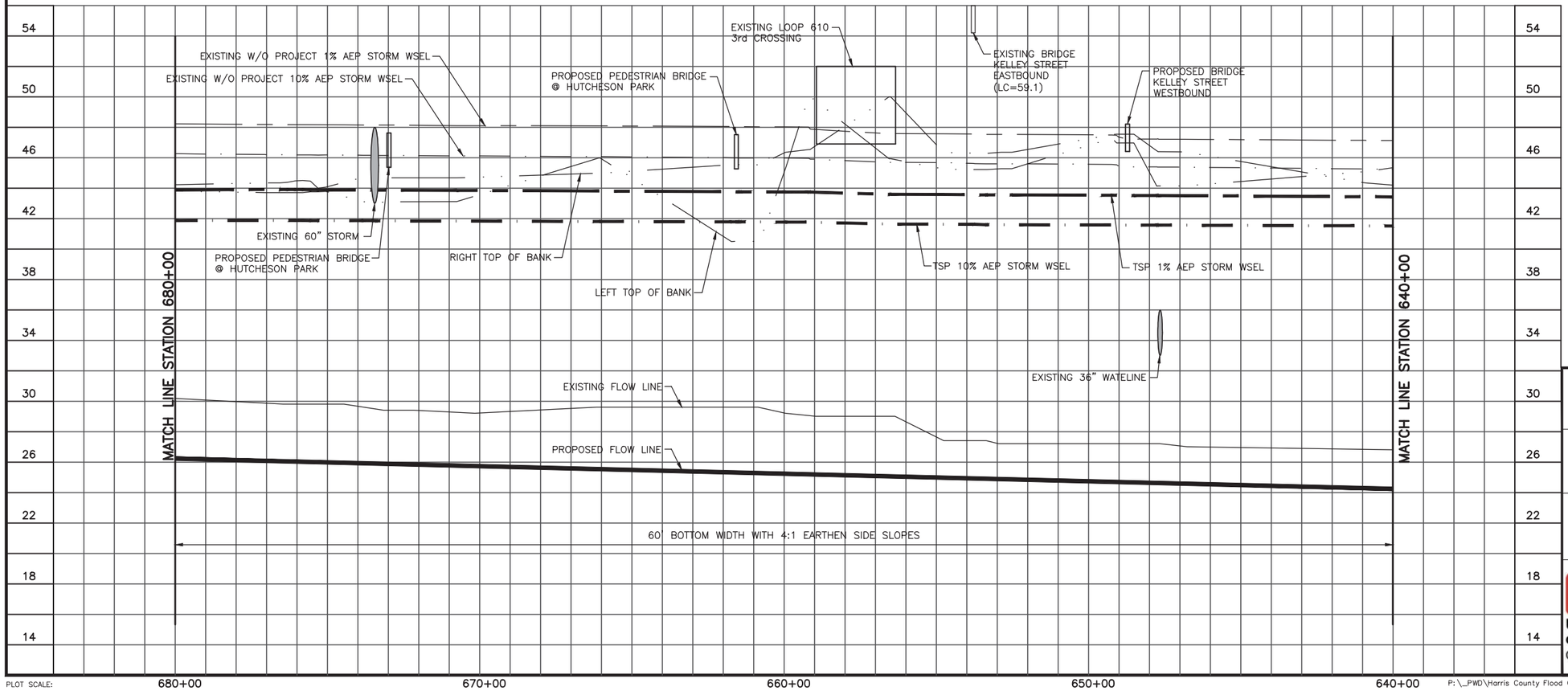
LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
- LEFT TOP OF BANK
- RIGHT TOP OF BANK



NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE-EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 680+00 TO STA 640+00

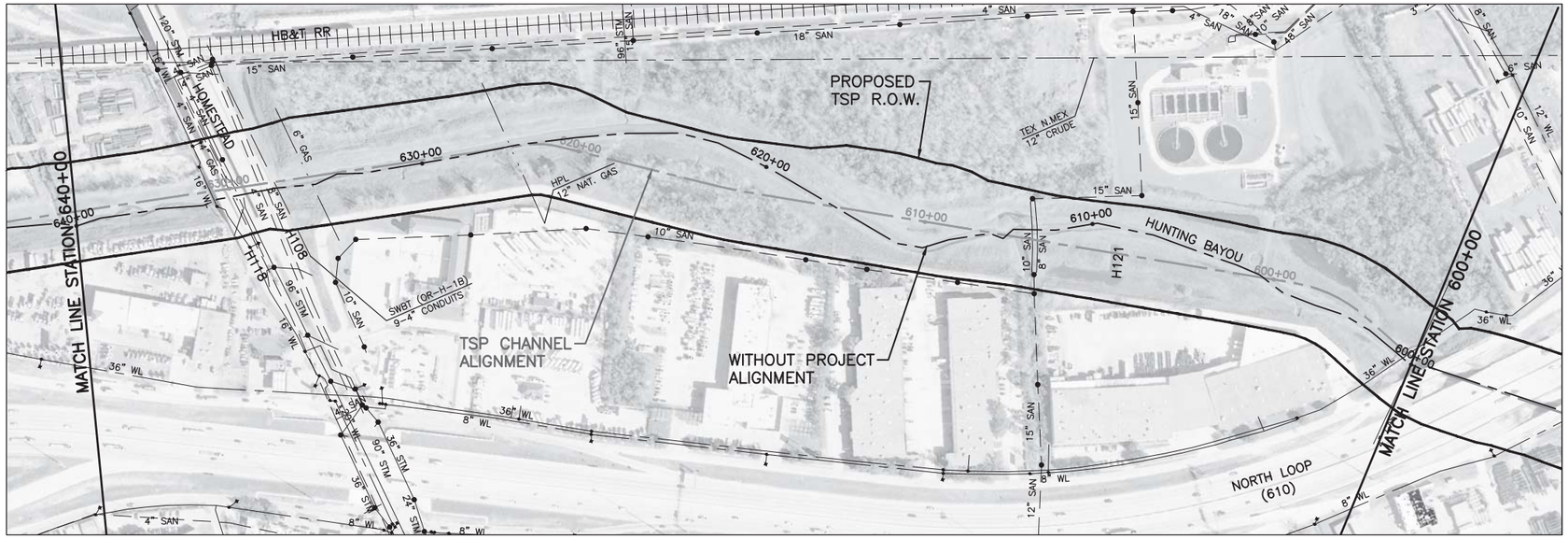
US Army Corps of Engineers®
Galveston District

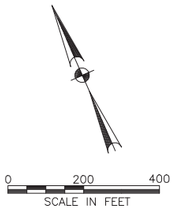
EXHIBIT: A3-1c

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\SHEET04_RPb.dwg May 09, 2013





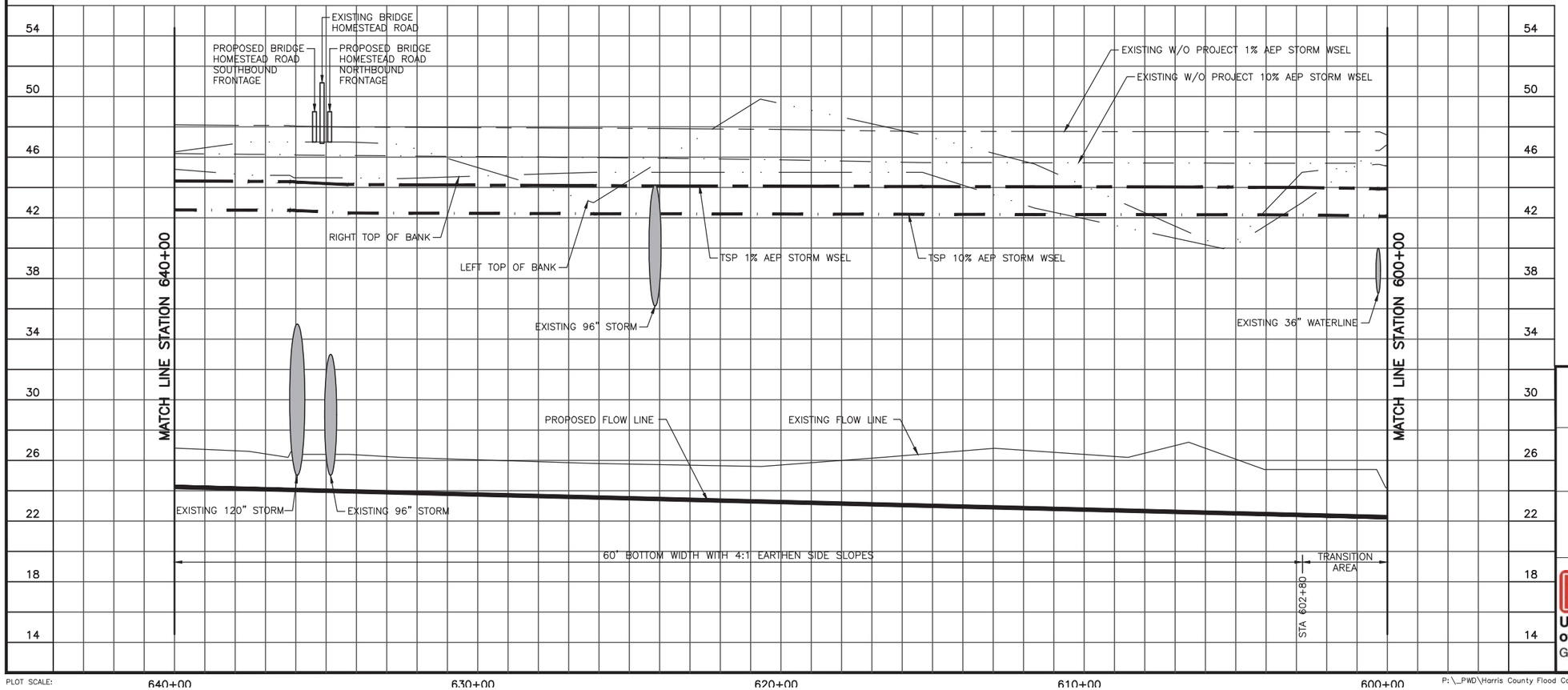
LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
- LEFT TOP OF BANK
- RIGHT TOP OF BANK



NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE-EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 640+00 TO STA 600+00

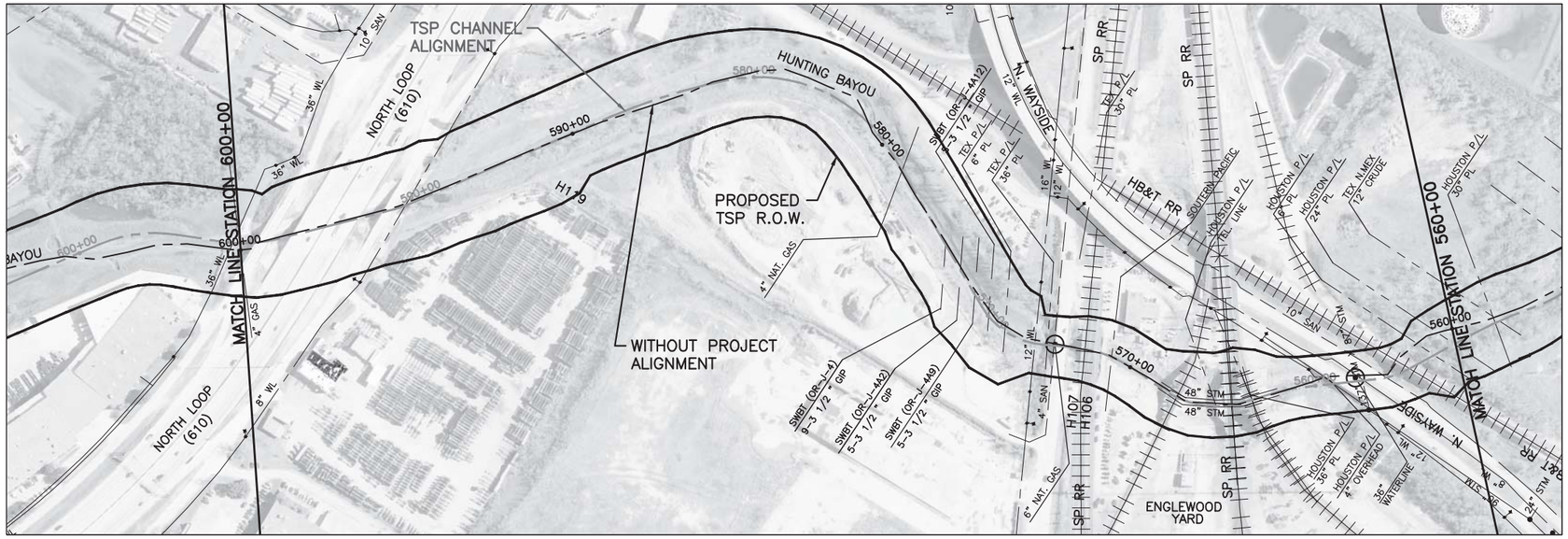
US Army Corps of Engineers®
Galveston District

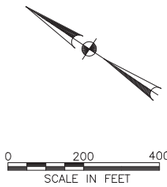
EXHIBIT: A3-1d

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\SHEET05_RPb.dwg May 09, 2013





LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
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- RIGHT TOP OF BANK

NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE–EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 600+00 TO STA 560+00

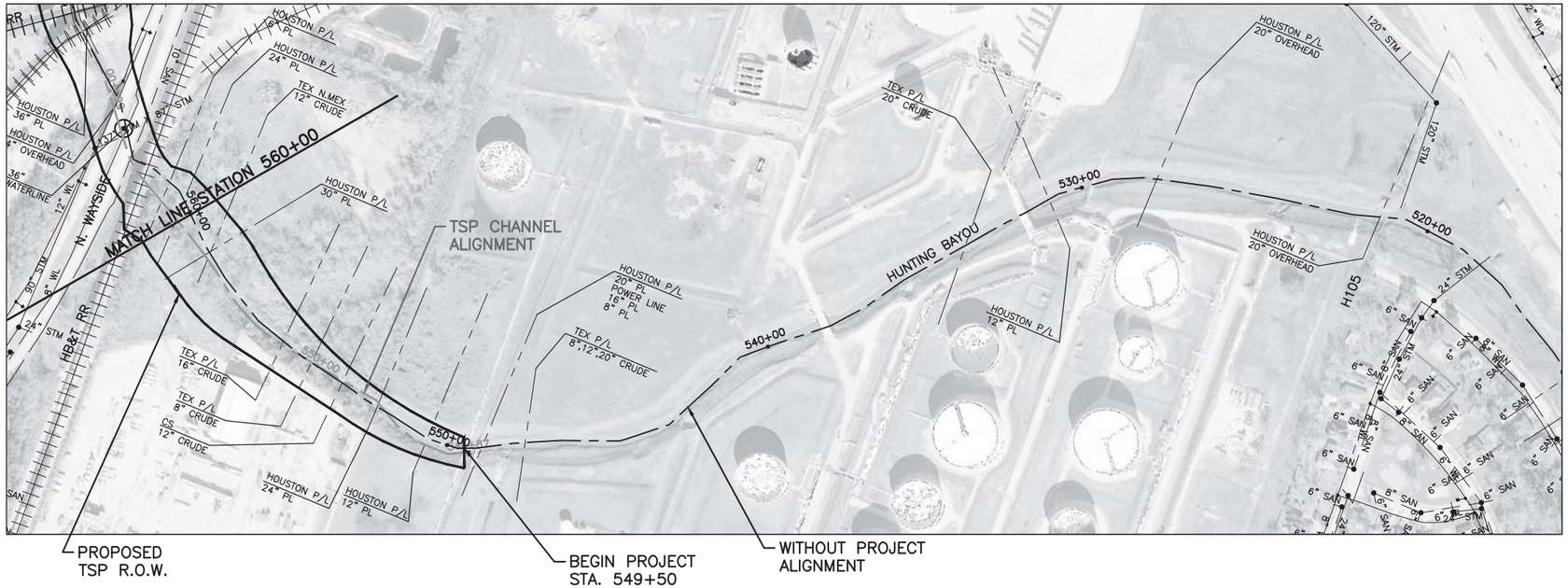
US Army Corps of Engineers®
Galveston District

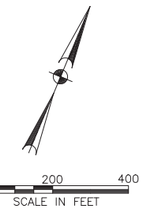
EXHIBIT: A3–1e

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 – Hunting Bayou\Cadd\Channel\SHEET06_RPb.dwg May 09, 2013





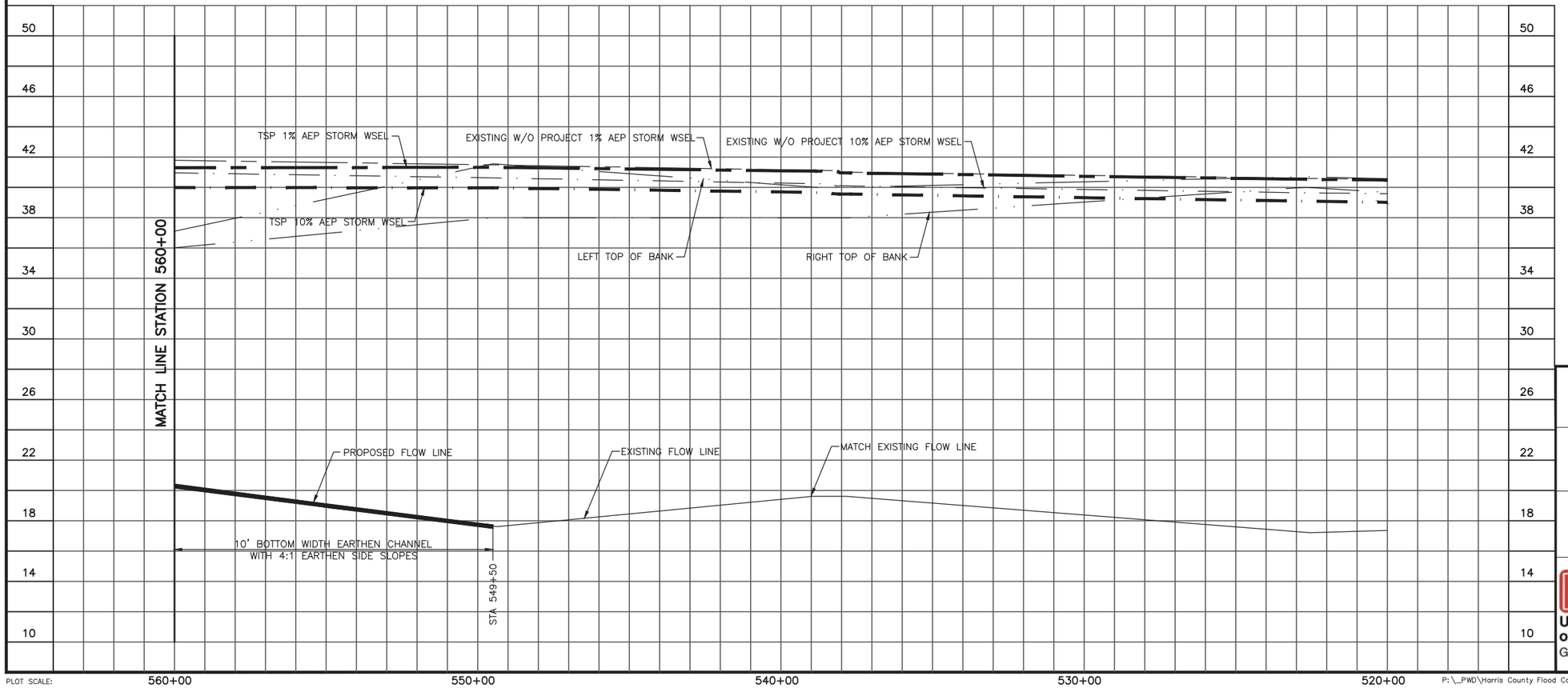
LEGEND

PLAN

- WITHOUT PROJECT ALIGNMENT BASELINE
- TSP CHANNEL ALIGNMENT BASELINE
- PROPOSED ROW
- STORM SEWER
- SANITARY SEWER
- WATER LINE
- PRIVATE UTILITY
- GAS LINE
- SWBT CONDUIT
- RAILROAD

PROFILE

- PROPOSED FLOW LINE
- EXISTING FLOW LINE
- EXIST W/O PROJECT 10% AEP STORM WSEL
- EXIST W/O PROJECT 1% AEP STORM WSEL
- TSP 10% AEP STORM WSEL
- TSP 1% AEP STORM WSEL
- LEFT TOP OF BANK
- RIGHT TOP OF BANK



NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE-EVALUATION REPORT ENGINEERING APPENDIX

TSP PLAN STA. 560+00 TO STA 520+00

US Army Corps of Engineers®
Galveston District

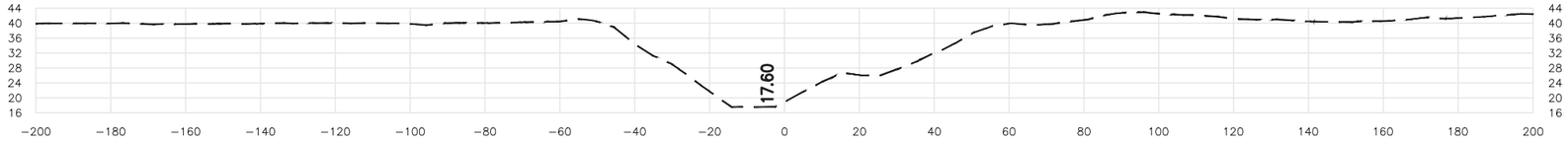
EXHIBIT: A3-1f

HARRIS COUNTY FLOOD CONTROL DISTRICT

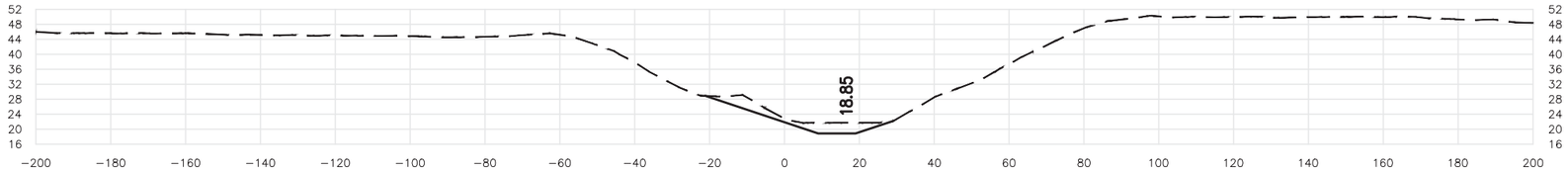
PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\SHEET07_RPb.dwg May 09, 2013

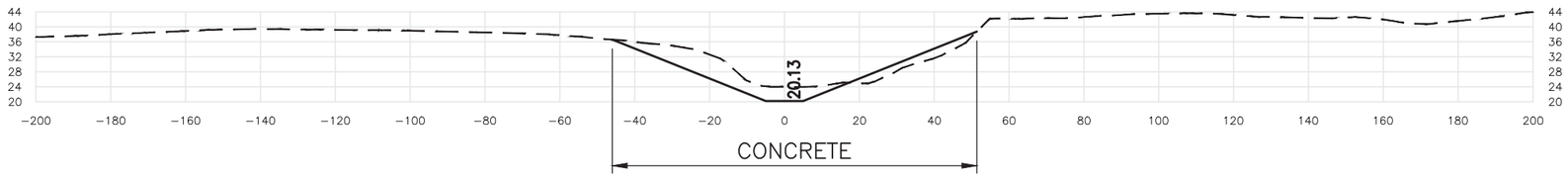
STA. 545+00
10 FT BW, 3:1 SS
R.O.W. = 150 FT



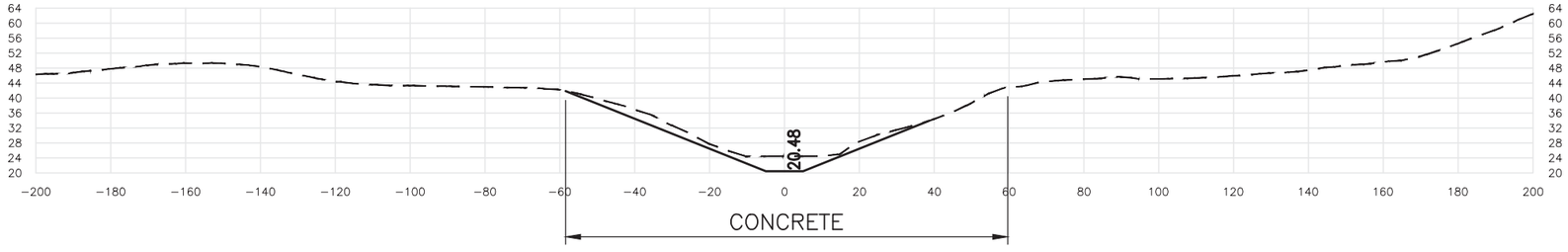
STA. 555+00
10 FT BW, 3:1 SS
R.O.W. = 160 FT

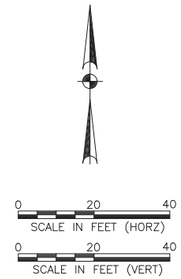


STA. 560+00
10 FT BW, 4:1 SS
R.O.W. = 170 FT



STA. 565+00
10 FT BW, 2.5:1 SS
R.O.W. = 195 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 550+00 TO STA. 565+00

US Army Corps of Engineers®
Galveston District

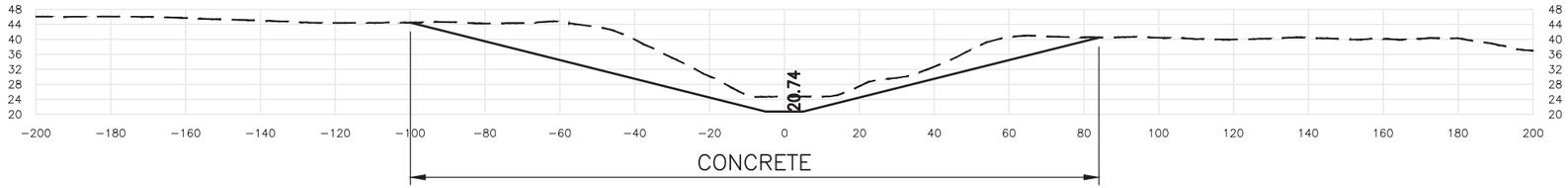
EXHIBIT: A3-2a

HARRIS COUNTY FLOOD CONTROL DISTRICT

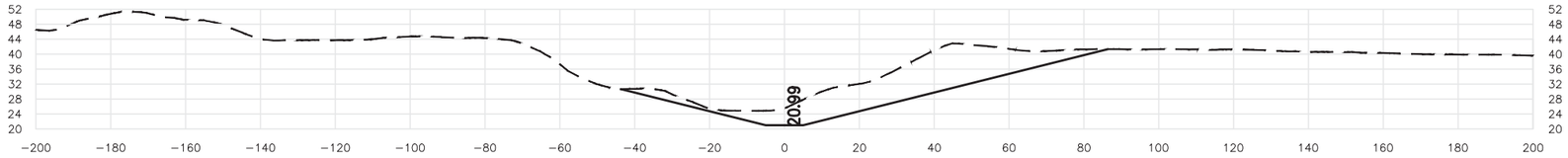
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

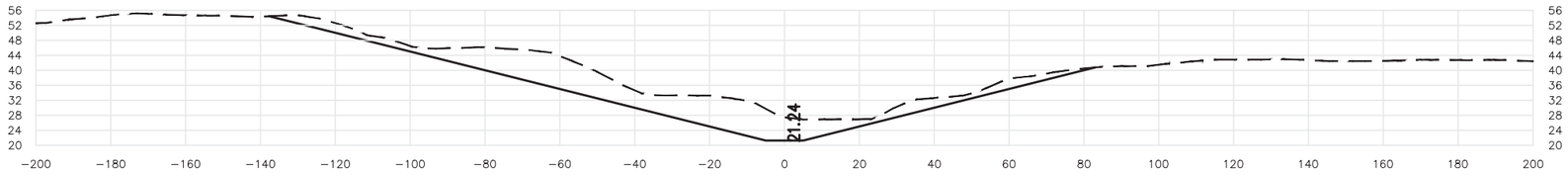
STA. 570+00
10 FT BW, 2.5:1 SS
R.O.W. = 270 FT



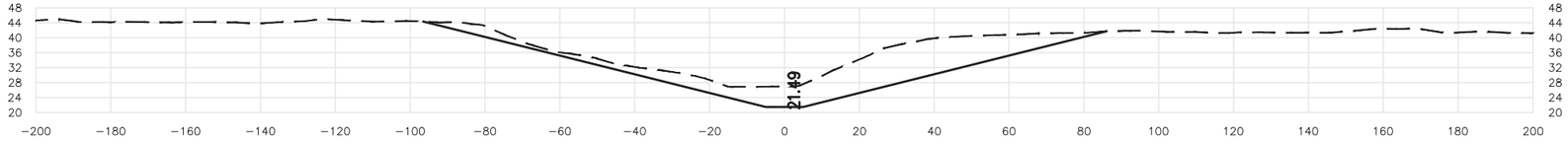
STA. 575+00
10 FT BW, 4:1 SS
R.O.W. = 270 FT

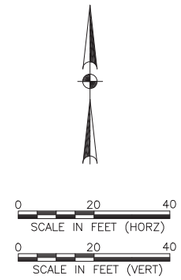


STA. 580+00
10 FT BW, 4:1 SS
R.O.W. = 250 FT



STA. 585+00
10 FT BW, 4:1 SS
R.O.W. = 275 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 570+00 TO STA. 585+00

US Army Corps of Engineers®
Galveston District

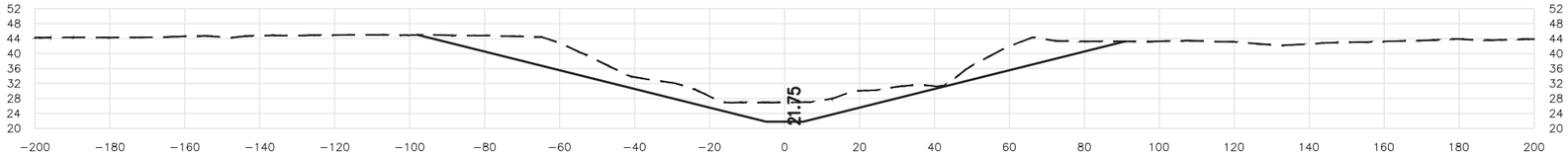
EXHIBIT: A3-2b

HARRIS COUNTY FLOOD CONTROL DISTRICT

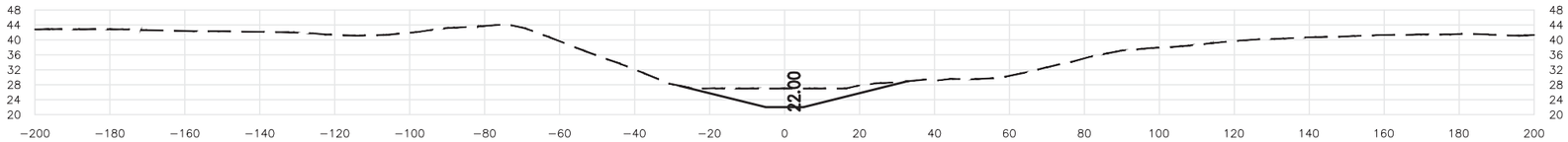
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

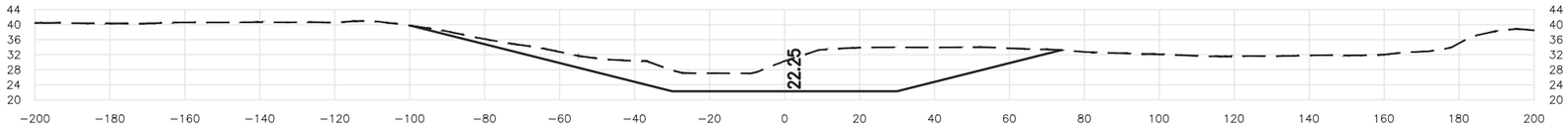
STA. 590+00
10 FT BW, 4:1 SS
R.O.W. = 310 FT



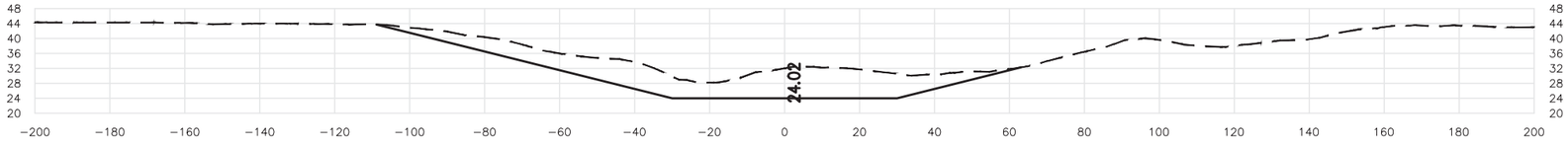
STA. 595+00
10 FT BW, 4:1 SS
R.O.W. = 305 FT

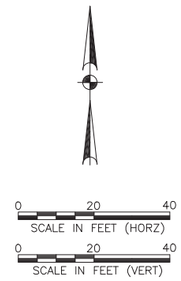


STA. 600+00
60 FT BW, 4:1 SS
R.O.W. = 280 FT



STA. 635+00
60 FT BW, 4:1 SS
R.O.W. = 290 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 590+00 TO STA. 635+00

US Army Corps of Engineers®
Galveston District

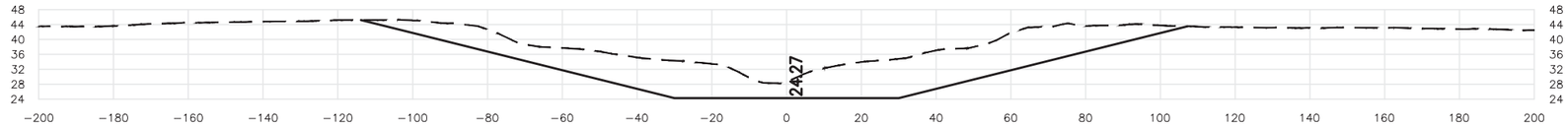
EXHIBIT: A3-2c

HARRIS COUNTY FLOOD CONTROL DISTRICT

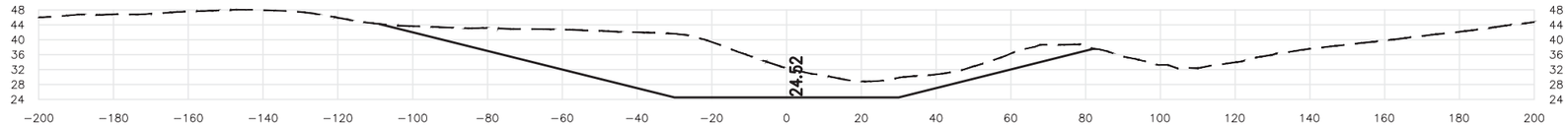
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

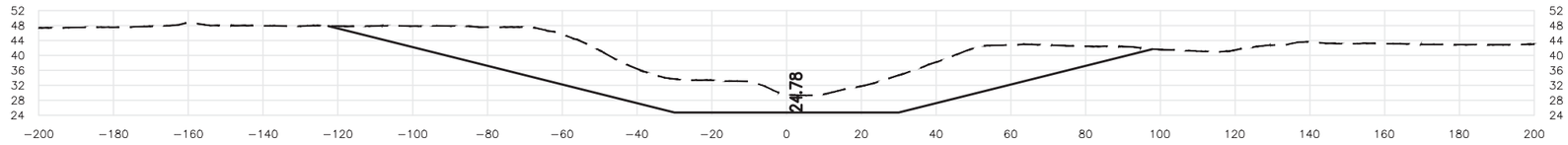
STA. 640+00
60 FT BW, 4:1 SS
MIN R.O.W. = 290 FT



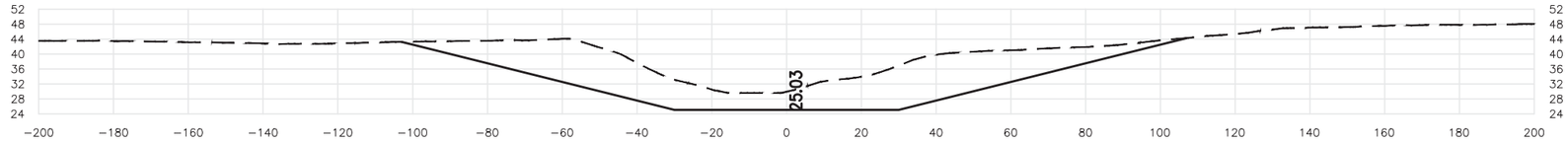
STA. 645+00
60 FT BW, 4:1 SS
MIN R.O.W. = 280 FT

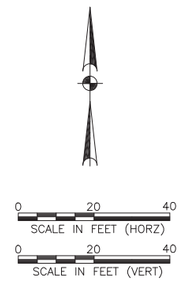


STA. 650+00
60 FT BW, 4:1 SS
R.O.W. = 300 FT



STA. 655+00
60 FT BW, 4:1 SS
R.O.W. = 300 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 640+00 TO STA. 655+00

US Army Corps of Engineers®
Galveston District

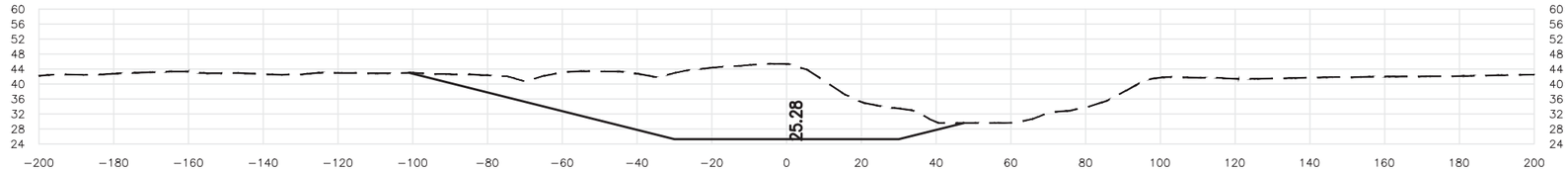
EXHIBIT: A3-2d

HARRIS COUNTY FLOOD CONTROL DISTRICT

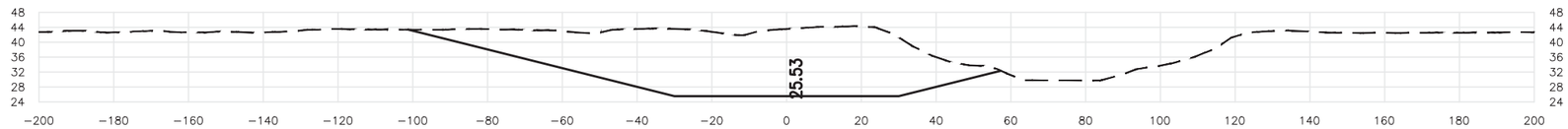
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

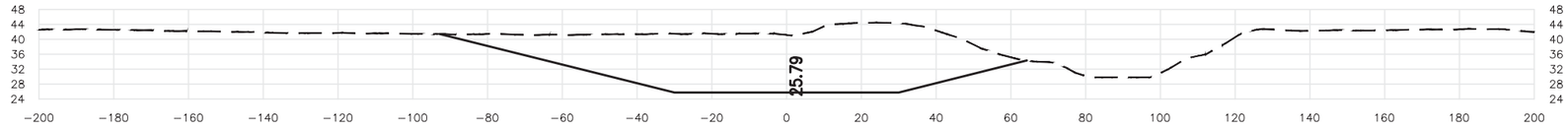
STA. 660+00
60 FT BW, 4:1 SS
R.O.W. = 270 FT



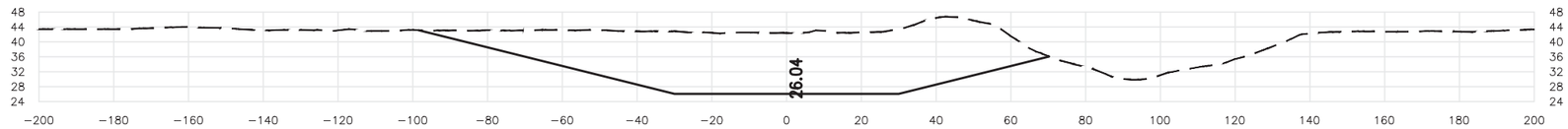
STA. 665+00
60 FT BW, 4:1 SS
R.O.W. = 270 FT

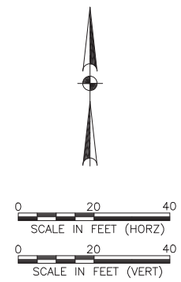


STA. 670+00
60 FT BW, 4:1 SS
R.O.W. = 265 FT



STA. 675+00
60 FT BW, 4:1 SS
R.O.W. = 250 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 660+00 TO STA. 675+00

US Army Corps of Engineers®
Galveston District

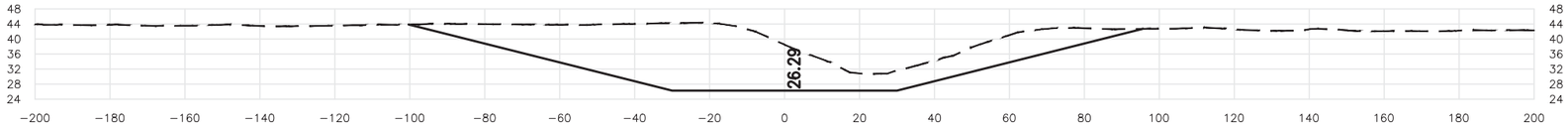
EXHIBIT: A3-2e

HARRIS COUNTY FLOOD CONTROL DISTRICT

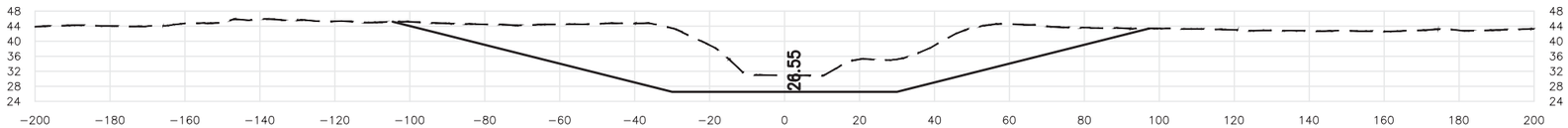
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

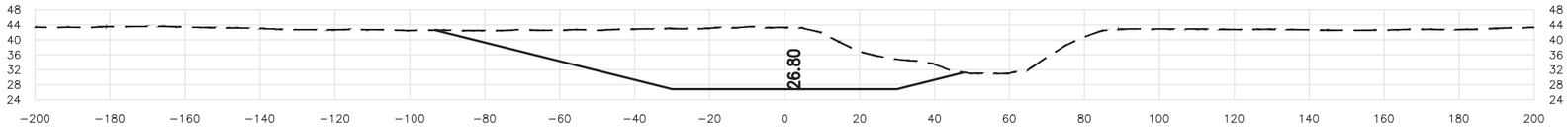
STA. 680+00
60 FT BW, 4:1 SS
R.O.W. = 140 FT



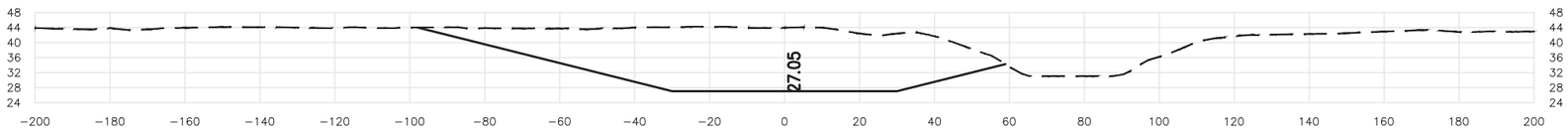
STA. 685+00
60 FT BW, 4:1 SS
R.O.W. = 165 FT

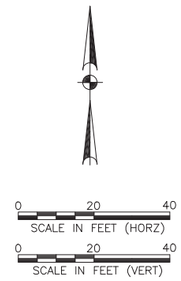


STA. 690+00
60 FT BW, 4:1 SS
R.O.W. = 260 FT



STA. 695+00
60 FT BW, 4:1 SS
R.O.W. = 250 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 680+00 TO STA. 695+00

US Army Corps of Engineers®
Galveston District

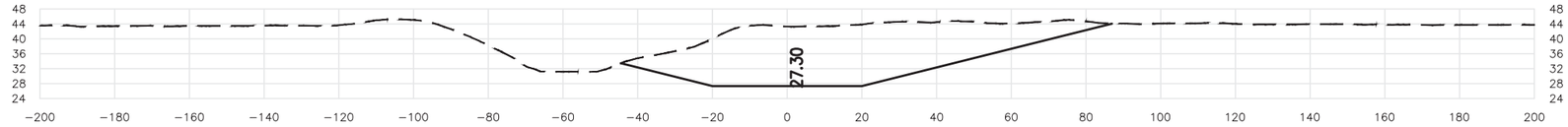
EXHIBIT: A3-2f

HARRIS COUNTY FLOOD CONTROL DISTRICT

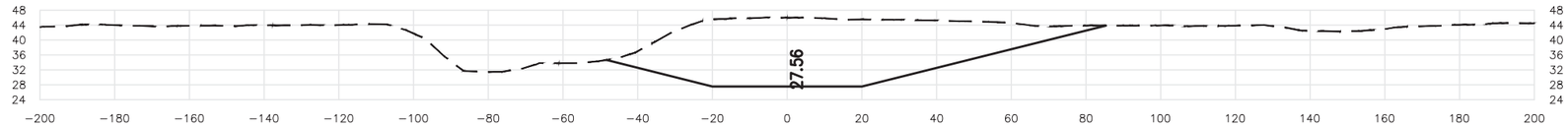
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

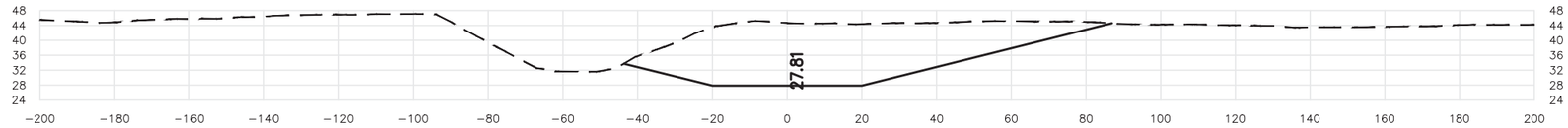
STA. 700+00
60 FT BW, 4:1 SS
R.O.W. = 250 FT



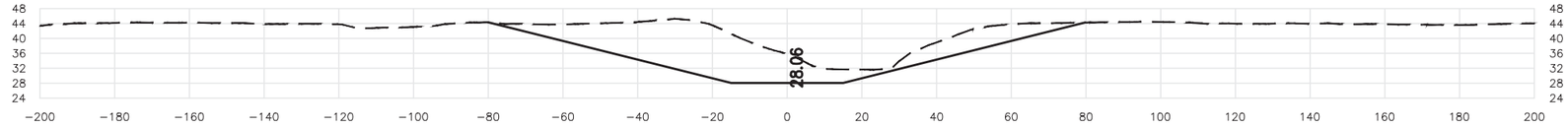
STA. 705+00
60 FT BW, 4:1 SS
R.O.W. = 245 FT

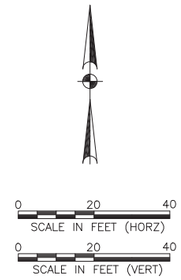


STA. 710+00
40 FT BW, 4:1 SS
R.O.W. = 245 FT



STA. 715+00
40 FT BW, 4:1 SS
R.O.W. = 235 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 700+00 TO STA. 715+00

US Army Corps of Engineers®
Galveston District

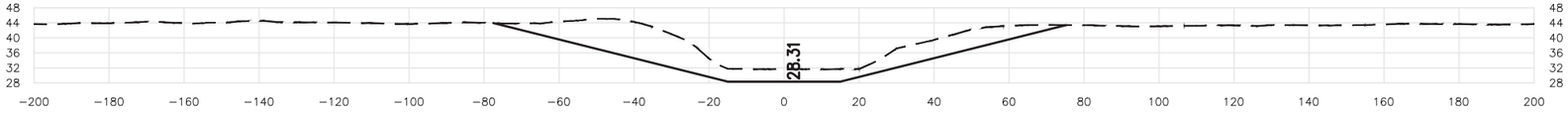
EXHIBIT: A3-2g

HARRIS COUNTY FLOOD CONTROL DISTRICT

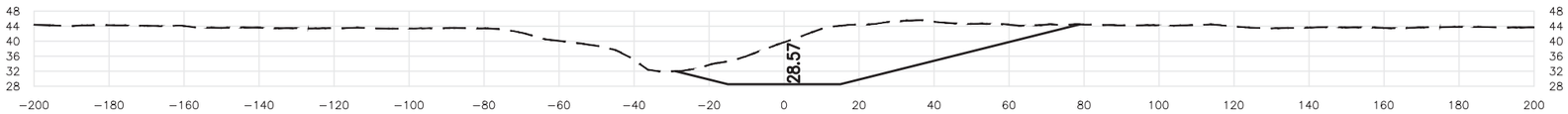
PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013

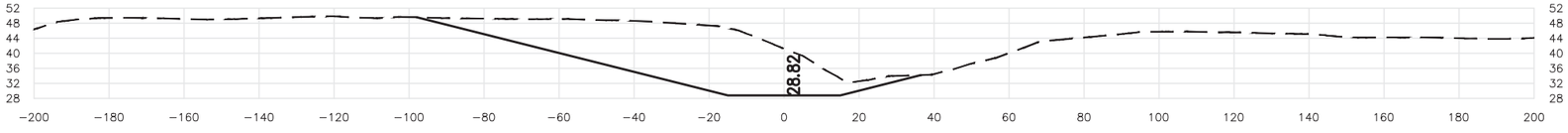
STA. 720+00
30 FT BW, 4:1 SS
R.O.W. = 230 FT



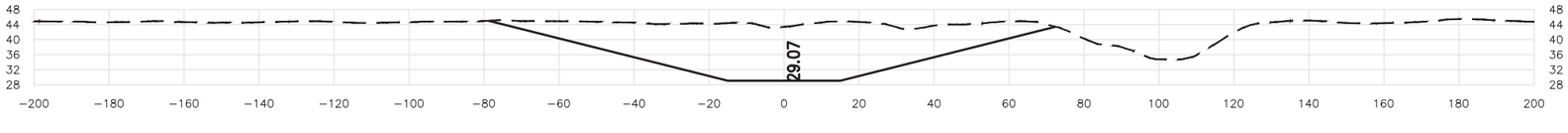
STA. 725+00
30 FT BW, 4:1 SS
R.O.W. = 225 FT

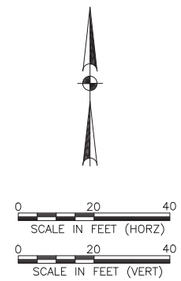


STA. 730+00
30 FT BW, 4:1 SS
R.O.W. = 230 FT



STA. 735+00
30 FT BW, 4:1 SS
R.O.W. = 225 FT





LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 720+00 TO STA. 735+00

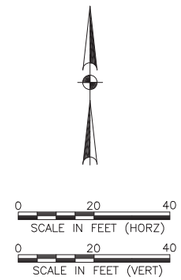
US Army Corps of Engineers ®
Galveston District

EXHIBIT: A3-2h

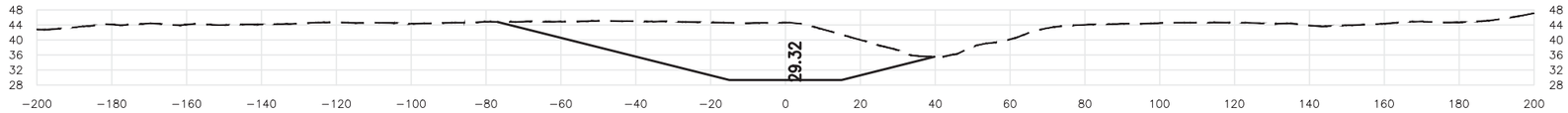
HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013



STA. 740+00
30 FT BW, 4:1 SS
R.O.W. = 225 FT



STA. 743+00
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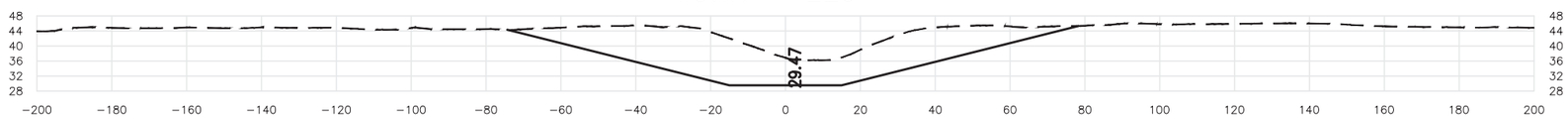
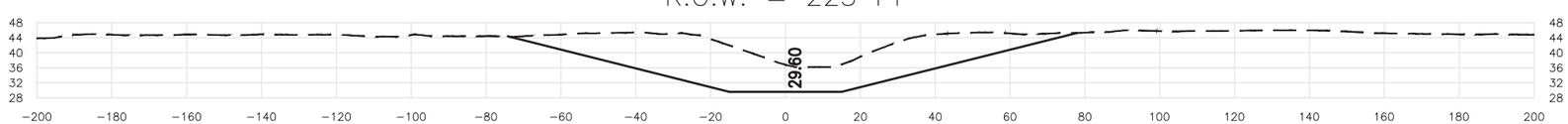
R.O.W. = 225 FT



748+50
30 FT BW, 4:1 SS
R.O.W. = 225 FT



LEGEND

PROPOSED

EXISTING

NOTES:

1. ALL CROSS SECTIONS SHOWN ARE EARTHEN LINED UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS REFERENCED TO NGVD29, 1973 ADJUSTMENT.
3. CROSS SECTIONS REFERENCED TO TSP CHANNEL ALIGNMENT.

HUNTING BAYOU
FLOOD RISK MANAGEMENT PROJECT

GENERAL RE-EVALUATION REPORT
ENGINEERING APPENDIX

TSP PLAN
CROSS SECTIONS
STA. 740+00 TO STA. 745+00

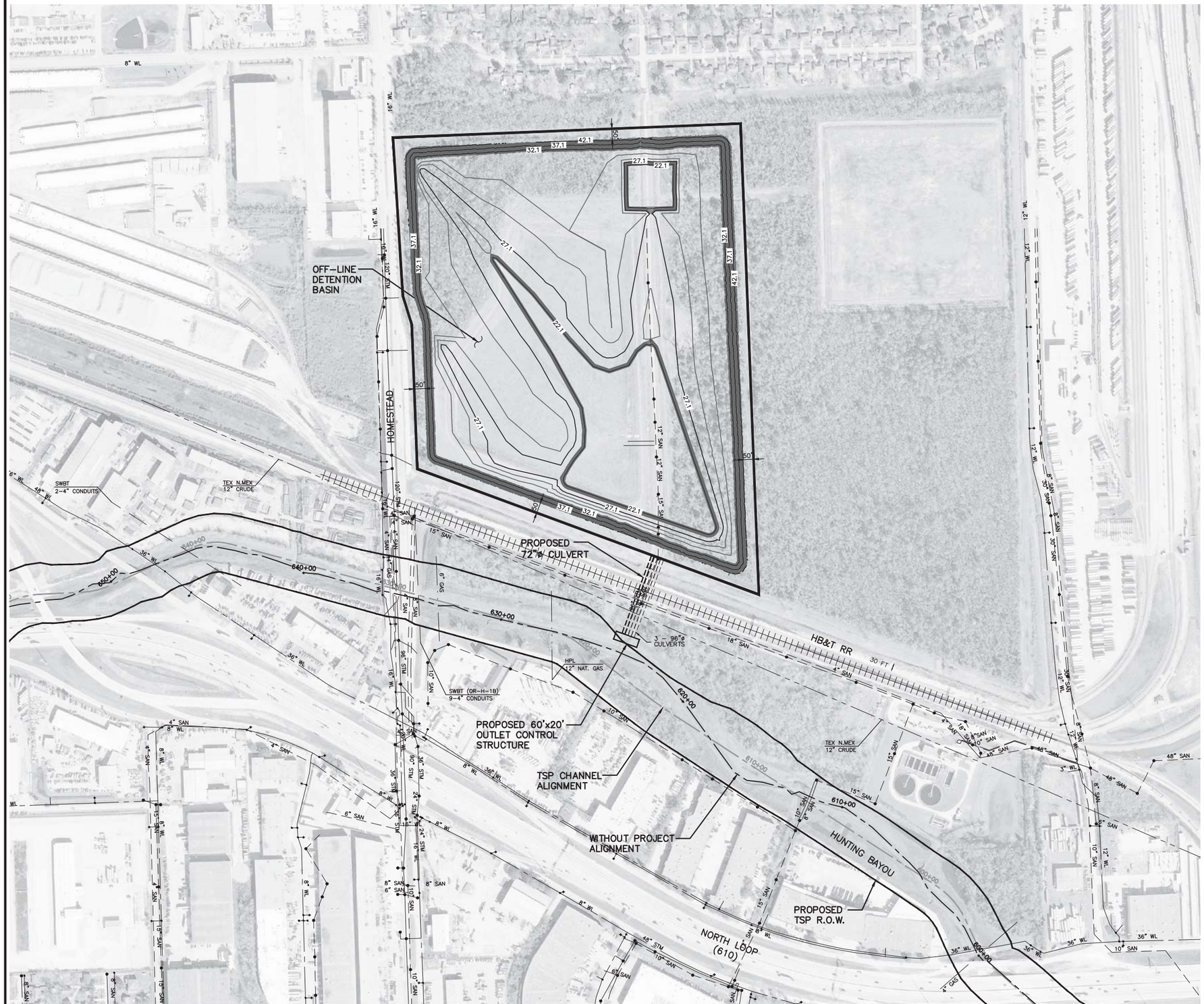
US Army Corps of Engineers ®
Galveston District

EXHIBIT: A3-2i

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE: 1:1

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\Channel\LPP cross-sections.dwg Feb 27, 2013



0 250 500
SCALE IN FEET

ELEVATION (FEET)	STORAGE VOLUME (ACRE-FEET)
19.6	0
21.6	20
25.6	69
26.1	75
27.1	92
28.1	120
29.1	161
30.1	215
31.1	274
32.1	334
33.1	395
34.1	456
35.1	517
36.1	580
37.1	643
38.1	707
39.1	772
40.1	840
41.1	911
42.1	989

NOTES:

1. ALL UTILITY CROSSINGS, BRIDGE CROSSINGS, CONSTRUCTION INFORMATION, AND HYDRAULIC MODELS REFERENCED TO WITHOUT PROJECT ALIGNMENT.
2. AERIAL SOURCE = HGAC 2010 AERIAL IMAGERY.
3. VERTICAL DATUM = NGVD 29, 1973 ADJUSTMENT.

HUNTING BAYOU FLOOD RISK MANAGMENT PROJECT

GENERAL RE-EVALUATION REPORT ENGINEERING APPENDIX

OFF-LINE DETENTION BASIN LAYOUT

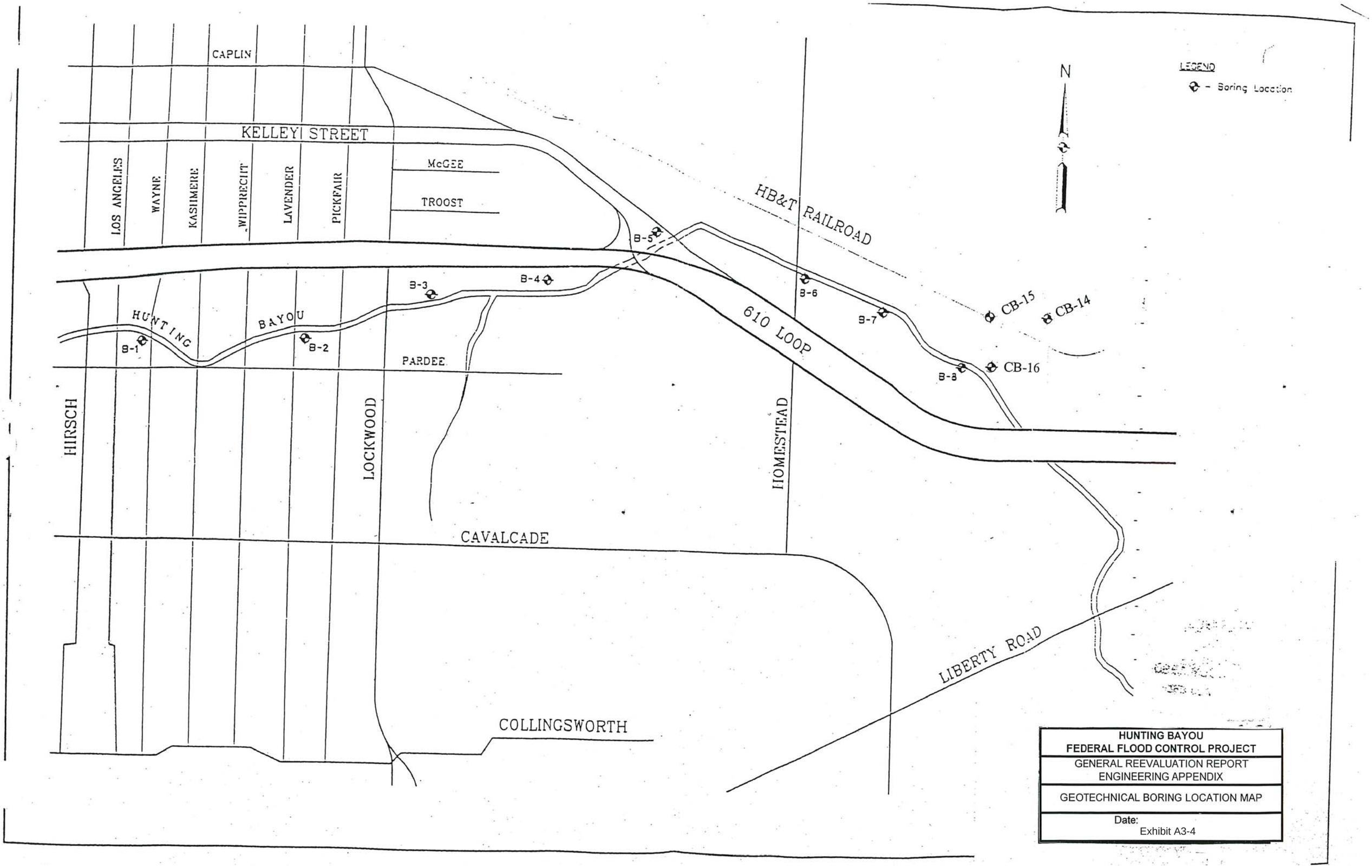
US Army Corps of Engineers®
Galveston District

EXHIBIT: A3-3

HARRIS COUNTY FLOOD CONTROL DISTRICT

PLOT SCALE:

P:_PWD\Harris County Flood Control District\60022913 - Hunting Bayou\Cadd\detention basin.dwg Feb 27, 2013



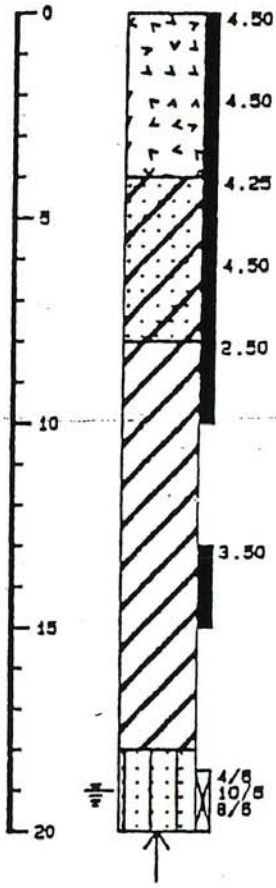
HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
GEOTECHNICAL BORING LOCATION MAP
Date: Exhibit A3-4

LOG OF BORING

Project : Darien Street Storm Sewer
Houston, Texas
Client : R.A. Peyton & Associates, Inc.
Houston, Texas

Boring No. : CB-14
File No. : 89-145
Date : 3-28-89
Elevation : - ft

Dry Augered 0 to 20 ft. Water at 19 ft.; Caving at 6.4 ft
Wash Bored to ft. Water at dry ft. after 3 days



ELEV / DEPTH	Description	Wc (%)	Dens. (pcf)	Qu or UU (tsf)	Str (%)	LL	PI	#200 (%)
	Hard gray SANDY CLAY "FILL" -top 0.5" gravel	13						
		13						
	-gray & tan w/ferrous nodules & sand pockets @ 3'	18	111					
	Very stiff gray & tan SANDY CLAY (CL) w/ferrous nodules & sand pockets	15						
	Stiff light gray & tan CLAY (CH) -w/sand pockets & soft zones @ 8'-10'	27	90					
	-very stiff, gray & tan w/sand streaks & ferrous nodules @ 13'	20	103	1.61	9			
	Firm light gray & tan VERY SILTY SAND (SM) w/clay layers	24						

Bottom @ 20'

McBride-Ratcliff and As

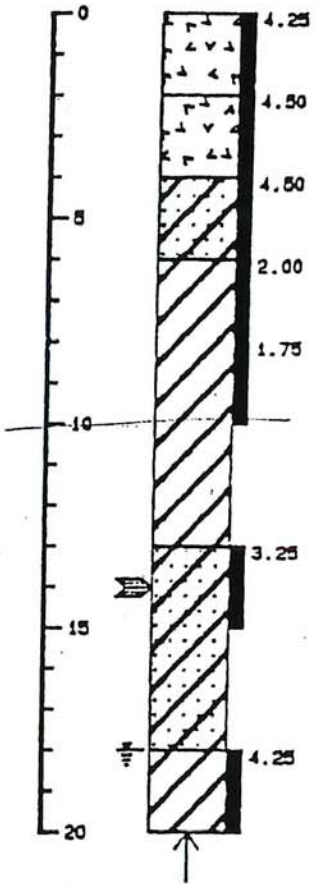
HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING CB-14
Date: Exhibit A3-5

LOG OF BORING

Project : Darien Street Storm Sewer
Houston, Texas
Client : R.A. Peyton & Associates, Inc.
Houston, Texas

Boring No. : CB-15
File No. : 89-145
Date : 4-5-89
Elevation : - ft.

Dry Augered 0 to 20 ft. Water at 18 ft.; Caving at ft.
Wash Bored to ft. Water at 14 ft. after end of day



ELEV / DEPTH	Description	Wc (%)	Dens. (pcf)	Qu or UU (tsf)	Str (%)	LL	PI	#200 (%)
	Hard gray & tan CLAY "FILL" w/sand layers & gravel	16						
	Hard gray & tan SANDY CLAY "FILL" w/sand pockets	14						
	Hard gray & tan SANDY CLAY (CL)	16	114					
	Stiff gray CLAY (CH) w/ferrous nodules	20						
	-gray & tan w/many calcareous nodules @ 8'	22	103					
	Stiff tan & gray VERY SANDY CLAY (CL) w/sand pockets	18	112	1.42	8	32	14	
	Very stiff red & light gray CLAY (CH) w/calcareous nodules	30						

Bottom @ 20'

McBride-Ratcliff and As

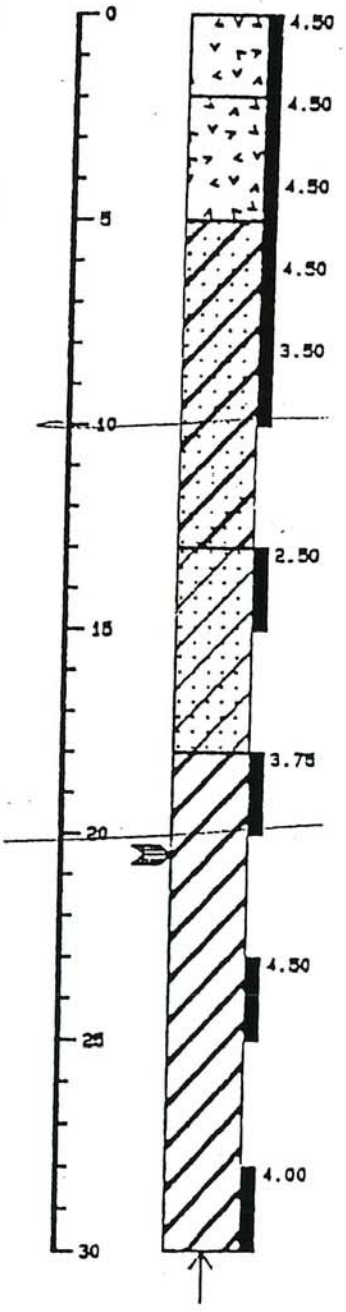
HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING CB-15
Date: Exhibit A3-6

LOG OF BORING

Project : Darien Street Storm Sewer
Houston, Texas
Client : R.A. Peyton & Associates, Inc.
Houston, Texas

Boring No. : CB-16
File No. : 89-145
Date : 4-5-89
Elevation : - ft

Dry Augered 0 to 30 ft. Water at ft.; Caving at ft
Wash Bored to ft. Water at 20.5 ft. after end of day



Description	Wc (%)	Dens. (pcf)	Qu or UU (tsf)	Str (%)	LL	PI	#200
Hard dark gray SILTY CLAY "FILL" -w/roots @ 0-1'	15						
Hard gray & tan SANDY CLAY "FILL" -w/sand pockets @ 2'-4'	14						
-gray @ 4'	12	117					
Hard gray & tan SANDY CLAY (CL) w/sand pockets -w/clay layers @ 5'-6'	12						
-very stiff, tan & light gray w/ clay pockets & ferrous nodules @ 8'	15	116	2.51	5	47	31	
Dense gray & tan CLAYEY SAND (SC) w/sand pockets	21	107					
Stiff tan & light gray CLAY (CH) w/slickensides -w/sand pockets & claystones @ 18'-20'	22	101	1.48	4*	63	40	
-hard, red & light gray @ 23'	31						
	29						

Bottom @ 30'

* Slickensided Failure

McBride-Ratcliff and As

HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING CB-16
Date: Exhibit A3-7

LOG OF BORING 1

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas

PROJECT NO.: 93-135

DATE: 02/24/93

DRILLING METHOD: Auger to 10 ft, wet rotary at 10 to 30 ft

BORING LOCATION: Station 721 +40

SURFACE ELEVATION: 42.0

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page Reference #)
0			Fill: Stiff gray SILTY CLAY		3.5										
					4.5										
5			Medium dense light gray SANDY SILT		1.5										
				14							67				
				18	2.2										
10			Stiff, light gray and tan SILTY CLAY with sand seams		2.2	18	114					1.87	10.0	0	
					1.2	20	110					2.06	9.7	0	
15			-interlayered with silty fine sand below 16 ft		1.8	22	108					0.62	15.0	0	
			-slickensided below 18 ft		1.8	20	111					2.85	6.1	18	
20					1.5	33	91					0.64	1.9	20	
			Very dense light gray and tan SILTY FINE SAND	50/4"											
25			Hard red-brown CLAY, slickensided, with sand seams		4.5+	31	94					2.14	2.3	0	
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS

24 HRS AFTER DRILLING: 10 FT. CAVED AT 21 FT

KE

GS = Grain Size
TX = Triaxial Shea
VN = Lab Vane Sh

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU
FEDERAL FLOOD CONTROL PROJECT

GENERAL REEVALUATION REPORT
ENGINEERING APPENDIX

LOG OF SOIL BORING B-1

Date:

Exhibit A3-8

LOG OF BORING 2

PROJECT: Hunting Bayou Improvements
Houston, Texas

Binkley - Barfield

PROJECT NO.: 93-135

DATE: 02/24/93

DRILLING METHOD:

BORING LOCATION: Station 702 + 20

SURFACE ELEVATION: 43.0 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Pavia Reference #)
0			Fill: Stiff gray and tan SANDY CLAY		2.0										
5			Medium dense light gray SILTY FINE SAND	12							66				
				11											
			Stiff, light gray and tan SILTY CLAY	13											
10					2.0	21	107					1.31	4.5	0	
				17											
			Medium dense light gray and tan SILTY FINE SAND ▼												
15				17							43				
				24							22				
20				23											
			Very stiff red-brown and light gray CLAY with sand seams		4.5+										
25															
					4.5+										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS

WATER AT SURFACE, CAVED AT 13.5 FT

KEY T

GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shear

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU
FEDERAL FLOOD CONTROL PROJECT

GENERAL REEVALUATION REPORT
ENGINEERING APPENDIX

LOG OF SOIL BORING B-2

Date:

Exhibit A3-9

LOG OF BORING 3

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas
PROJECT NO.: 93-135

DATE: 02/24/93

DRILLING METHOD:

BORING LOCATION: Station 685 +50

SURFACE ELEVATION: 40.5 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page footnote #)
0			Fill: Light gray and gray CLAY		1.5										
			Stiff dark gray and gray SILTY CLAY with calcareous and ferrous nodules												
			-with silt pockets, 2 to 6 ft		1.8	16	111					0.95	4.7	0	
5					2.2	18	113					1.16	11.1	0	
			-light gray and tan		1.8	18	111	44	13	31		1.04	15.0	0	
					1.2	22	107	38	15	23		1.22	11.1	0	
10			-becomes very silty below 10 ft		1.2										
			Medium dense tan and light gray SILTY FINE SAND	9											
			-with firm silty clay layer to 13 ft												
15				35							16				
				39							8				
20				32											
			Hard red-brown and light gray CLAY, slickensided, with ferrous nodules and sand seams		4.5+	23	101	68	26	42		0.89	1.2	0	
25															
					4.5										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS
24 HRS AFTER DRILLING: 9.3 FT. CAVED AT 13 FT

KEY T
GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shear

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING B-3
Date: Exhibit A3-10

LOG OF BORING 4

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas
PROJECT NO.: 93-135

DATE: 02/24/93

DRILLING METHOD:

BORING LOCATION: Station 671 +50

SURFACE ELEVATION: 43.5 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	ATTERBERG LIMITS (%) PLASTIC LIMIT	ATTERBERG LIMITS (%) PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page Reference #)
0			Firm light gray SILTY CLAY with roots		1.5										
			Stiff dark gray SILTY CLAY with ferrous nodules		2.0	17	105	37	14	23		0.53	2.4	0	
5			-with silt pockets, 4 to 6 ft -light gray and tan below 5 ft		2.2	15	115	36	12	24		1.20	3.8	0	
					2.0	16	118					2.14	13.8	0	
10			-with sand pockets below 10 ft		1.2	21	106	40	13	27		0.76	15.0	0	
			Medium dense light gray SILTY FINE SAND	22											
15				25											
				50							12				
20			Very stiff red-brown and light gray CLAY with sand seams	23											
					3.0										
25			-hard below 28 ft		4.2										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS
24 HRS AFTER DRILLING: WATER AT SURFACE, CAVED AT 13 FT

KEY
GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shea

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING B-4
Date: Exhibit A3-11

LOG OF BORING 5

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas
PROJECT NO.: 93-135

DATE: 02/26/93

DRILLING METHOD: Wet rotary
BORING LOCATION: Station 655 +83
SURFACE ELEVATION: 44.0 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page tolerance #)
0			Fill: Stiff light gray and tan CLAY		2.2										
					3.0	17	116					5.12	5.9	0	
5			Very stiff dark gray CLAY with ferrous nodules		4.0										
					1.5										
			Stiff light gray SILTY CLAY with calcareous nodules -with soft dark gray clay fill in crawfish hole at 7 ft -light gray and tan below 8 ft		0.5	26	100					0.41	15.0	8	
10			-becomes increasingly sandy below 10 ft		1.0	31	95	49	14	35		0.81	10.7	0	
					2.2										
					1.2										
15			Medium dense light gray and tan SILTY FINE SAND	33							37				
				18											
20			Red-brown and light gray CLAY with sand seams and slickensides		2.2	35	89					0.55	1.7	0	
25					3.8										
30					4.5	21	108				0.94	1.4	0		
			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS

KEY
GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shea

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU
FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT
ENGINEERING APPENDIX
LOG OF SOIL BORING B-5
Date:
Exhibit A3-12

LOG OF BORING 6

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas
PROJECT NO.: 93-135

DATE: 02/25/93

DRILLING METHOD: Wet rotary
BORING LOCATION: Station 638 +00
SURFACE ELEVATION: 42.0 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page Reference #)
0			Fill: Very stiff gray, tan, light gray and red-brown SILTY CLAY		3.0										
					2.5	16	117					2.27	6.6	0	
5			Stiff dark gray CLAY with ferrous nodules		2.0										
			-gray, 6 to 7 ft		1.8	21	107	56	16	40		1.70	15.0	0	
			-light gray and tan with calcareous nodules below 7 ft		1.5										
10					1.5	25	102					1.48	15.0	0	
				8											
15			-with infilled crawfish hole beginning at 15.5 ft and continuing to 18 ft		1.4										
				3											
20			Very stiff red-brown and light gray CLAY with sand seams	30											
					3.0	17	115	41	14	27		2.93	14.6	0	
25			-tan and light gray, 24.5 to 28 ft												
			-hard below 28 ft		4.5+										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS
21 HRS AFTER DRILLING: 5 FT. CAVED AT 15 FT

KEY T
GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shear

SWL SOUTHWESTERN LABORATORIES

HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING B-6
Date: Exhibit A3-13

LOG OF BORING 7

PROJECT: Hunting Bayou Improvements — Houston, Texas — Binkley - Barfield

PROJECT NO.: 93-135

DATE: 02/25/93

DRILLING METHOD: Wet rotary

BORING LOCATION: Station 628 +00

SURFACE ELEVATION: 41.5 (approx.)

DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	ATTERBERG LIMITS (%) PLASTIC LIMIT	ATTERBERG LIMITS (%) PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Fringe Reference #)
0			Fill: Stiff light gray and tan CLAY		1.5										
					1.0										
5			Stiff gray SILTY CLAY with ferrous nodules		1.0	16	112	24	13	11		0.57	8.0	0	
			-light gray and tan below 6 ft		1.5	16	116					1.90	8.7	0	
10			Stiff light gray and tan CLAY with sand seams and ferrous nodules		1.5	17	115					2.15	7.6	0	
					2.0	18	112					1.31	4.5	0	
			-with calcareous nodules below 12 ft		1.5	24	102	49	14	35		1.14	11.4	14	
15			-with silty clay and silty fine sand seams and pockets below 13.5 ft		2.0										
			Hard red-brown and light gray CLAY with sand seams and pockets		4.5	32	96					2.08	4.2	0	
			-with sand layer, 19 to 19.5 ft		4.5	27	100	69	28	41		0.84	1.0	0	
20															
					4.2										
25															
					4.2										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS

18 HRS AFTER DRILLING: 4 FT, CAVED AT 14.5 FT

KEY

GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane Shear

HUNTING BAYOU
FEDERAL FLOOD CONTROL PROJECT

GENERAL REEVALUATION REPORT
ENGINEERING APPENDIX

LOG OF SOIL BORING B-7

Date:

Exhibit A3-14

LOG OF BORING 8

PROJECT: Hunting Bayou Improvements — Binkley - Barfield
Houston, Texas
PROJECT NO.: 93-135

DATE: 02/25/93

DRILLING METHOD: Wet rotary
BORING LOCATION: Station 618 +00
SURFACE ELEVATION: 41.5 (approx.)

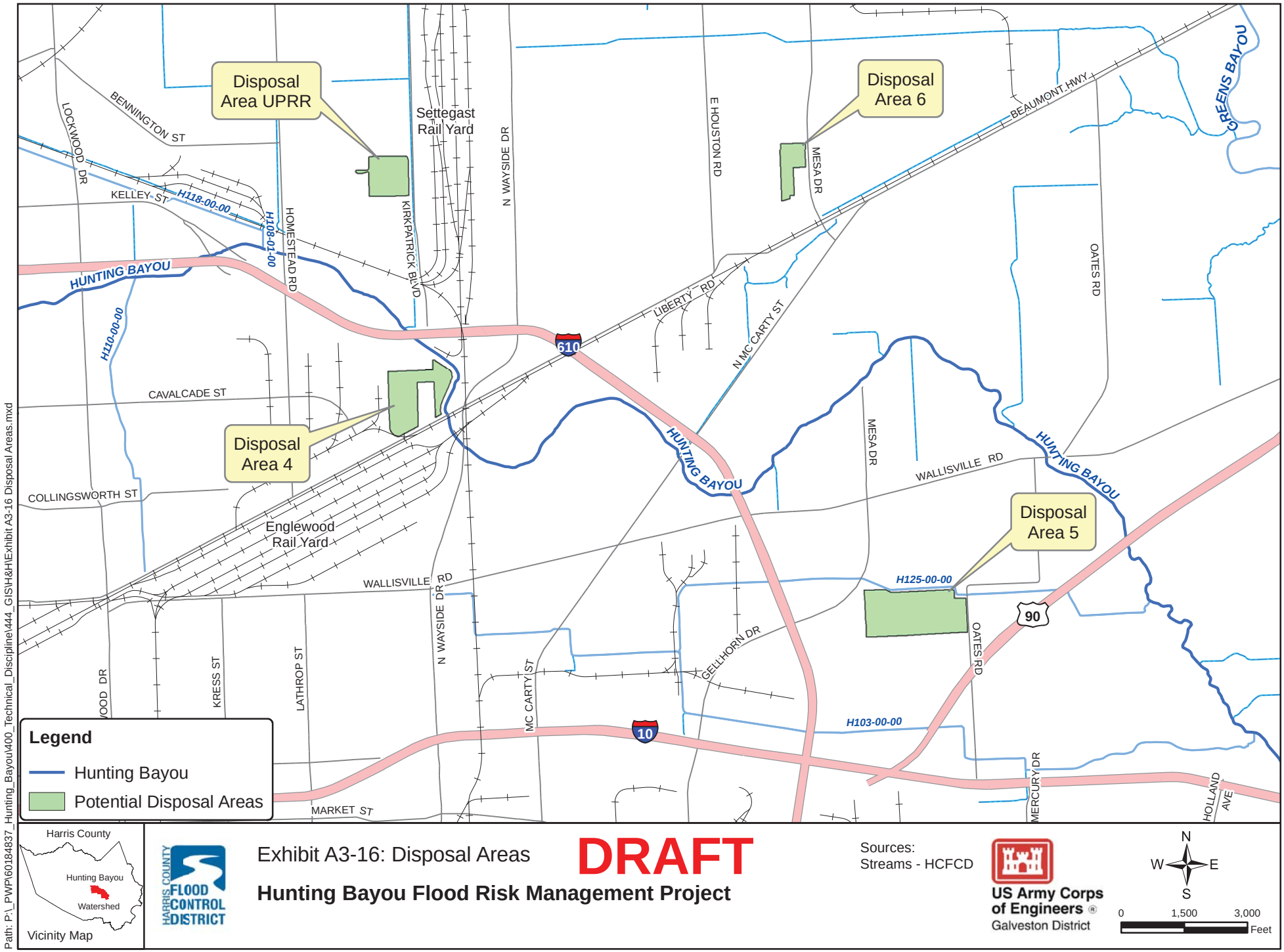
DEPTH (ft)	SAMPLE TYPE	SYMBOLS	MATERIAL DESCRIPTION	STD. PENETRATION TEST (blows/foot)	POCKET PEN (tsf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN(%)	CONFINING PRESSURE (psi)	OTHER TESTS PERFORMED (Page Reference #)
0			Fill: Stiff dark gray, gray, tan and light gray SANDY CLAY with gravel		2.2										
					2.2	17	110					0.95	9.0	0	
5					1.5	21	106					1.24	6.9	0	
			Stiff, light gray and tan SILTY CLAY with sand pockets, ferrous and calcareous nodules		1.5										
					1.2	17	114	32	14	18		0.82	2.9	0	
10					1.2										
					1.2	22	105					1.19	6.9	0	
15			Stiff light gray very SANDY CLAY		1.5	22	108	23	17	6		1.23	4.2	16	
					1.2	21	109					0.54	1.9	18	
			Light gray SILTY FINE SAND	50							12				
20															
				37											
25															
			Hard red-brown and light gray CLAY		4.5										
30			Boring terminated at 30 ft												

WATER LEVEL MEASUREMENTS
24 HRS AFTER DRILLING: 12 FT. CAVED AT 22.5 FT

KEY
GS = Grain Size
TX = Triaxial Shear
VN = Lab Vane She

HUNTING BAYOU FEDERAL FLOOD CONTROL PROJECT
GENERAL REEVALUATION REPORT ENGINEERING APPENDIX
LOG OF SOIL BORING B-8
Date:

Exhibit A3-15


Disposal Area UPRR
Disposal Area 6
Disposal Area 4
Disposal Area 5
Settegast Rail Yard
Englewood Rail Yard
BENNINGTON ST
LOCKWOOD DR
KELLEY ST
H118-00-00
H110-00-00
HOMESTEAD RD
KIRKPATRICK BLVD
N WAYSIDE DR
E HOUSTON RD
MESA DR
BEAUMONT HWY
GREENS BAYOU
HUNTING BAYOU
LIBERTY RD
N MC CARTY ST
OATES RD
610
CAVALCADE ST
COLLINGSWORTH ST
WALLISVILLE RD
H125-00-00
90
GELLHORN DR
MC CARTY ST
LATHROP ST
KRESS ST
H103-00-00
10
MERCURY DR
HOLLAND AVE
MARKET ST
Legend
Hunting Bayou
Potential Disposal Areas
Harris County
Hunting Bayou
Watershed
Vicinity Map
HARRIS COUNTY FLOOD CONTROL DISTRICT
Exhibit A3-16: Disposal Areas
DRAFT
Hunting Bayou Flood Risk Management Project
Sources:
Streams - HCFCD
US Army Corps of Engineers
Galveston District
N
W
E
S
0
1,500
3,000
Feet
Path: P:_PWP\60184837_Hunting_Bayou\400_Technical_Discipline\444_GIS\H&H\Exhibit A3-16 Disposal Areas.mxd