INWOOD FOREST STORMWATER DETENTION BASINS

WORK PLAN

SWG-2017-00335

Houston, Harris County, Texas

December 18, 2019

Prepared for:

Harris County Flood Control District
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1.0 GOALS AND OBJECTIVES

The Harris County Flood Control District (HCFCD) and City of Houston plan to repurpose the former Inwood Forest golf course as a regional stormwater detention facility to provide regional flood damage reduction benefits along White Oak Bayou and Vogel Creek and sub-regional/local flood mitigation benefits for communities and subdivisions adjacent to and near the basins. In addition to providing flood control benefits, the project will also provide stream channel enhancement within two streams within the project area. The proposed project consists of the construction of eleven proposed detention basins to be excavated on public land and construction of associated intake and outfall structures connecting the detention basins to White Oak Bayou and Vogel Creek (project area; **Appendix A**). The project area is approximately 226 acres of land in Harris County, Houston Texas. The proposed project would permanently impact a total of 4,456 linear feet (1.17 acres) of jurisdictional streams comprised of 3,206 linear feet (1.03 acres) of perennial streams and 1,250 linear feet (0.14 acre) of ephemeral stream.

Cypress Environmental Consulting LLC (CEC) prepared this work plan in accordance with the U.S. Army Corps of Engineers (USACE) Regulatory Program regulations 33 *Code of Federal Regulation*s (CFR) 320-331 and 40 CFR 230 for the compensation of unavoidable impacts to Waters of the United States (WOTUS) associated with proposed stormwater detention basins development within the project area. The project area is located approximately 0.53-mile southwest of the intersection of W Gulf Bank Road and Antoine Drive in Houston, Texas. This plan is intended as a supplement to the Clean Water Act (CWA) Section 404/Rivers and Harbors Appropriation Act Section 10 Individual Permit application to be submitted for the project to USACE Galveston District (District).

R.G. Miller Engineers, Inc. (RGME) conducted initial wetland assessment evaluations of the project site from February 15-17, 2017 and an approved jurisdictional determination of the project area was issued by the USACE Galveston District on October 25, 2017. Two preliminary application meetings were held with the USACE Galveston District on June 19, 2019 and November 6, 2019, to review the proposed project elements and alternatives, as well as the approach for permitting and mitigation for impacts to WOTUS. CEC conducted field surveys of the project areas on April 22, 2019, June 29, 2019, June 30, 2019, and August 8, 2019 and prepared a stream condition assessment report of the project area. The purpose of the project site field surveys was to assess and quantify the ecological functions of the WOTUS present at the site and to help the project planning and development to identify an alternative site design to avoid and minimize environmental impacts, while still meeting the project's purpose and need. The ecological functions of the resources at potential and final onsite mitigation locations were also assessed so that any loss of ecological functions from the unavoidable impacts from the proposed project could be compensated for.

The development of mitigation strategies includes specific objectives that serve to ensure that there is "no net loss" of ecological functions of aquatic resources. The proposed project will utilize in-stream design techniques including variable channel widths and depths, a bankfull bench along the floodplain, streambank plantings within adjacent wetlands, a lay back bank along the channel, and adding stream meanders where practicable to enhance the existing stream channel condition and

mitigate for impacts to WOTUS by improving the stream reach condition. The in-stream design will incorporate techniques to minimize erosion, improve natural stream function, and stabilize the banks that have eroded. Stabilization measures include improvements to the dimensions and profile of the impacted streams, allowing each stream to convey stormwater and sediment loads more efficiently without aggrading or degrading. HCFCD has developed a planting plan (**Appendix B**) to be implemented upon completion of construction activities that will be used to re-establish native vegetation and stabilize the banks.

2.0 BASELINE INFORMATION

2.1 Project Location

The project area is located in and along the former Inwood Forest golf course between W Gulf Bank Road and Victory Drive in Houston, Harris County, Texas. According to the FEMA Flood Insurance Rate Map Panels 48201C0654M (eff. 06/9/2014) and 48201C0655M (eff. 06/9/2014), most of the project area is located within the 100-year floodplain Zone AE of White Oak Bayou and Vogel Creek with significant portions lying within the regulatory floodways of White Oak Bayou and Vogel Creek.

The project area is comprised of maintained public lands with surrounding land use including a mixture of residential developments and commercial properties in a highly urban area within the City of Houston. The topography of the site is generally flat with a shallow (0-1%) slope from north to south. As described in the 2017 Wetland Delineation Report for the property (R.G. Miller Engineers 2017), there are six aquatic features.

2.2 Waters of the U.S. Impacts

Construction of the proposed project is anticipated to have unavoidable impacts to jurisdictional streams within the project area. Proposed construction plans include drainage improvements, including the excavation of stormwater detention basins and construction of associated intake and outfall structures for the purpose of flood reduction and increasing flood storage volume in the area. Impacts to aquatic resources are summarized in **Table 1** below.

Table 1: Stream Impacts in the Project Area

Stream Name	Permanent Impact (LF/Acre)	Activity
HCFCD Unit #E121-02-00	2,300/0.45	Excavation activities within Basin I and construction of associated outfall structures at the upstream and downstream ends of HCFCD Unit #E121-02-00 within Basin I
White Oak Bayou	448/0.46	Construction of proposed inflow structures along White Oak Bayou at Basin D
Vogel Creek	458/0.12	Construction of one inflow pipe and three outfall structures along Vogel Creek at Basins H, I, and L
Unnamed tributary to Vogel Creek (Ditch 1)	1,250/0.14	Excavation activities and construction of associated outfall structure within Ditch 1 within Basin L
Total	**4,456/1.17**	-

2.3 Avoidance and Minimization

The project alternatives analysis explored the feasibility of avoiding impacts to jurisdictional waters to the maximum extent practicable. The current design includes removal of several proposed outfall structures along White Oak Bayou as well as a reduction in the footprint of work within stream channels. These measures have minimized and avoided impacts to WOTUS to the greatest extent practicable.

2.4 Hydrological/Hydraulic Modeling

A hydrologic and hydraulic (H&H) analysis was conducted for the proposed project to assess existing (Pre-Project) and proposed (Post-Project) H&H conditions related to the construction of the proposed project. RGME developed typical basin sections for grading three types of basin excavations expected for the project including wet-bottom basins, dry-bottom basins, and dry-shelf expansion. The project activities include excavation of eleven stormwater detention basins (Basins A, B, C, D, E, F, G, H, I, J, and L). Basins A, C, D, E, H, I, and L are designed to be wet bottom basins and Basins B, F, G, and J are designed to be dry bottom basins. Construction activities would include excavation of all eleven basins, which includes deepening and widening of the existing HCFCD Unit #E121-02-00 stream channel within the footprint of Basin I, deepening and widening of an existing unnamed tributary to Vogel Creek (unnamed Ditch 1) within the footprint of Basin L, construction of two inflow structures along White Oak Bayou, and construction of two inflow structures and two outfall structures along Vogel Creek. The proposed project would create a total proposed flood volume storage of approximately 1250 ac-ft.

The basins located west of Antione Drive will connect to White Oak Bayou (Basins A, B, C, D, E, F, G) and are to be interconnected using culverts under existing roadways and the clubhouse parking lot. The interconnected basins on the north bank of White Oak Bayou (Basins A through E) will pull flow via two new inflow structures on Basin D. Within the project area, White Oak Bayou has a relatively low level of service, as the existing 10-year storm event is already out of banks at several cross sections and flow will spill into the basin from other locations during larger events. Basin F is an independent basin located south of White Oak Bayou. Basin G is a dry-shelf expansion on the south bank of White Oak Bayou meant to add floodplain volume directly to White Oak Bayou. While the primary purpose of the five interconnected cells (Basin A through E) will pull flow from White Oak Bayou, the basin will be partially be influenced by spillover from HCFCD Unit #E140-00-00.

The basins located east of Antoine Drive will connect to Vogel Creek and include three wet-bottom basins (Basins H, I, L) and one dry-shelf expansion (Basin J). Basins H and L are proposed to be interconnected, with flow entering the offline configured Basin H through a new inflow structure along Vogel Creek and flow exiting back to Vogel Creek through a new outfall structure on Basin L. Basin I will pull flow from Vogel Creek and HCFCD Unit #E121-02-00 through two new inflow structures and flow will exit to Vogel Creek through one new outfall structure.

2.5 Compensatory Mitigation

Compensatory stream mitigation will be achieved for the proposed project by utilizing in-stream design techniques including variable channel widths and depths, a bankfull bench along the floodplain, streambank plantings within adjacent wetlands, a lay back bank along the channel, and adding stream meanders where practicable to enhance the existing stream channel condition and mitigate for impacts to WOTUS by improving the stream reach condition. The proposed on-site mitigation project presents an opportunity to provide refuge for terrestrial and aquatic plant and animal life, especially fish, migratory birds and waterfowl, in an area that has reduced habitat complexity due to extensive residential development.

3.0 STREAM CONDITION ASSESSMENT

3.1 Existing Stream Condition

CEC conducted an assessment following the USACE June 2013 Level 1 Stream Condition Assessment and the USACE March 2014 Level 2 Stream Condition Assessment methodologies to evaluate the existing and anticipated post-project stream condition for the affected jurisdictional streams within the project area. The existing stream condition variable scores collected during the field investigations are summarized below.

Unnamed Ditch 1

The Ditch 1 stream channel has been previously altered through excavation, straightening, deepening, and widening of the channel and is connected to a storm sewer outfall structure from an adjacent neighborhood. The channel is leveed along most of its length and is normally dry. Ditch 1 does receive periodic inflow from residential stormwater drainage from two culverts at the northern end of the stream. There is currently an existing overflow drop structure from an adjacent detention basin, which would provide additional overflow volume from the detention basin into the stream during high flow periods. The banks of Ditch 1 are concrete lined at the location of this structure and are riprap lined at the downstream end of the stream near the confluence with Vogel Creek.

Flashy flows have resulted in eroded unstable stream banks and the surrounding land use has reduced the native riparian vegetation cover. Throughout the length of the stream, the channel banks were observed to be vertically cut and highly incised, with woody vegetation roots exposed along the stream banks. In addition, the southern half of the stream in the project area has a vertical drop of over 8 feet from the top of bank to the channel bottom, due to downcutting of the stream bed. The stream has been channelized and incised below the elevation of the floodplain and is not connected to the floodplain.

White Oak Bayou

The portion of White Oak Bayou within the project area is located within a maintained public right-of-way immediately adjacent to residential developments. The land surrounding the stream banks is regularly maintained with a vegetation community dominated by upland grasses. Flashy flows have resulted in areas of eroded stream banks and the surrounding land use has resulted in a lack of a

native woody riparian community. Throughout the length of the stream, the channel banks are incised, with areas of active erosion at portions of the channel that appear to be widening despite existing rip rap along both sides of the channel. The channel has been previously altered through excavation, straightening, deepening, and widening of the channel, and is connected to outfall structures from adjacent developments.

Vogel Creek

The portion of Vogel Creek located within the project area occurs within a maintained public right-of-way immediately adjacent to residential developments. The land surrounding the stream banks is regularly maintained with a vegetation community dominated by upland grasses and forbs. The channel has been previously altered through straightening, widening, and deepening of the channel and there are multiple existing stormwater outfalls upstream and downstream of the project area with portions of the banks armored with rip rap. Throughout the length of the stream, the channel banks were observed to be sharply incised and there are signs of active erosion along the channel and areas along the bank with reduced vegetation.

HCFCD Unit #E121-02-00

The HCFCD Unit #E121-02-00 stream channel is located within a maintained public right-of-way adjacent to residential developments. The entire segment in the project area has banks that are maintained and comprised of herbaceous vegetation species. The stream channel has been previously altered through straightening, deepening, and widening of the channel for drainage purposes. Multiple stormwater outfalls contribute flow to the channel within the reach. The banks of the stream are riprap lined at existing outfall structures within the project area and at the downstream end of the stream at its confluence with Vogel Creek. Flashy flows have resulted in eroded, unstable banks. Throughout the length of the channel, there are steep banks with evidence of downcutting and active erosion along bends in the channel with areas of reduced vegetation cover on the banks. The macroinvertebrate community score was poor, based on the number of individuals and their tolerance values. This reach was dominated by collector-gatherer species which indicates that there is a plentiful supply of decaying organic matter. The Regionalized Index of Biotic Integrity variable was intermediate, since there was moderate species richness and diversity with an imbalanced trophic structure and an expected species assemblage.

3.2 Reach Condition Index

The Reach Condition Index (RCI) was calculated for both existing and post- project conditions for Ditch 1, White Oak Bayou, Vogel Creek, and HCFCD Unit #E121-02-00. The proposed project plans (**Appendix A**) were used to estimate the post-project variable scores. The difference between the existing conditions and post- project conditions RCI is used to evaluate whether the project will cause a decline, no change, or improvement in the stream condition. **Table 2** summarizes the RCI scores for the jurisdictional streams assessed within the project area.

Impacts to Ditch 1, Vogel Creek, and White Oak Bayou stream channels were evaluated using the USACE June 2013 Level 1 Stream Condition Assessment methodology. Based on this assessment,

there is no net change in stream condition RCI scores for the White Oak Bayou or Vogel Creek streams at the location of the proposed inflow structures and outfall structures within the project area. Based on the proposed stream channel enhancement design which includes a bankfull bench, lay back bank, and stream bank plantings, the unnamed Ditch 1 stream condition will improve as a result of constructing the project with a net positive 1.25 improvement in the RCI score. Therefore, the proposed in-stream design for stream enhancement along Ditch 1 will provide the necessary compensatory mitigation for impacts to unnamed Ditch 1 as a result of the proposed project.

Impacts to the perennial HCFCD Unit #E121-02-00 stream channel were evaluated using the USACE March 2014 Level 2 Stream Condition Assessment Standard Operating Procedures. Based on the proposed stream channel enhancement design which includes a bankfull bench, lay back bank, and stream bank plantings, the HCFCD Unit #E121-02-00 stream condition will improve as a result of constructing the project with a net positive 1.1 improvement in the RCI score within the project area. Therefore, the proposed in-stream design for stream enhancement along HCFCD Unit #E121-02-00 will provide the necessary compensatory mitigation for impacts to this stream as a result of the proposed project.

Table 2: Summary of Stream RCI Scores

Feature Type	Feature Name	Existing Condition RCI	Post Project RCI	RCI Change
Ephemeral Stream	Unnamed Tributary to Vogel Creek (Ditch 1)	1.75	3.0	1.25
Perennial Stream	White Oak Bayou	1.75	1.75	0.00
Perennial Stream	Vogel Creek	2.0	2.0	0.00
Perennial Stream	HCFCD Unit #E121-02-00	2.1	3.2	1.1

4.0 MITIGATION WORK PLAN

4.1 In-Stream Design

Compensatory stream mitigation will be achieved for the proposed project by in-stream mitigation design within the HCFCD Unit #E121-02-00 and unnamed Ditch 1 stream channels. This project will incorporate three primary in-stream mitigation design techniques, namely: 1) bankfull bench creation, 2) lay back bank creation, and 3) streambank planting. Due to the low-to-marginal condition of the existing stream channels within the project area, incorporating these stream enhancements in the project design will significantly improve the post-project stream condition. The in-stream design techniques incorporate the enhancement of the stream functions within the project area as described below.

Bankfull Bench

A bankfull bench is a flat or shallowly sloped area above bankfull that slows high velocity flows during flows above bankfull. A stable bankfull bench will reduce the sediment loads to the system by eliminating channel bank and bed erosion. The installation of a bankfull bench throughout the project reach will restore connectivity to the geomorphic floodplain. The design will naturally create fringe wetlands within its bankfull benches, and it will improve the natural function of the entire stream.

Lay Back Bank

A lay back bank involves the manual manipulation of the bank slope to stabilize banks and reduce erosion. Eroding banks will be regraded to a stable dimension that will reduce erosion and sedimentation within the project area and allow for the long-term stabilization of the banks with vegetation.

Streambank Planting

Streambank planting includes the installation of plants other than seed, along the immediate streambank area for the purpose of streambank stabilization. The plantings will incorporate native species from the HCFCD planting list (**Appendix B**) and will further stabilize the banks. Hydric or wetland species may be planted at the water's edge providing bank stabilization, habitat diversity, and shade resulting in water quality improvements. Mesic or moderately wet-loving species may be planted along the mid slopes to stabilize the site and reduce mowing requirements. Xeric or upland species may be planted on the side slopes and top of bank areas outside of the maintenance berms, backslope drains, and other areas that require access or regular maintenance.

For comparison purposes, if the proposed stream enhancement activities were conducted for a stream mitigation project, implementation of the in-stream design techniques outlined above would generate a total of 9,150 credits. **Table 3** below summarizes the number of credits that would be generated by each design technique as well as the total number of credits generated upon construction of the proposed project, following the USACE SCA.

Table 3: Summary of Stream Credits Generated with In-Stream Mitigation Design Techniques

In-Stream Design Technique	Ephemeral Credits (Ditch 1)	Perennial Credits (HCFCD Unit #E121-02-00)	In-Stream Technique Total
Bankfull Bench Stream Credit (1.0 credit/ ln ft)	1,250	1,800	3,050
Lay Back Bank Stream Credit (1.0 credit/ ln ft)	1,250	1,800	3,050
Streambank Planting Stream Credit (1.0 credit/ ln ft)	1,250	1,800	3,050
Total Stream Credits Generated:	**3,750**	**5,400**	**9,150**

4.2 Construction Methods, Timing, and Sequencing

The project will include the construction of 11 proposed detention basins of varying size within the footprint of the former Inwood Forest golf course, with individual basin construction likely phased over several years. Construction activities will include clearing and grubbing, excavation and fill onsite, construction staging areas, concrete and rip-rap fill within discrete sections of basins, and construction of inflow and outfall structures.

During the grading activities, the appropriate dimension, pattern, and profile that is depicted in the project plans will be established (**Appendix A**). Before grading activities commence, Best Management Practices (BMPs) will be implemented for each segment to ensure that sediment and debris control is appropriately addressed per plans and standards. After grading activities and the completion of basin excavations, vegetation from the bankfull bench to the OHWM will be planted to naturally stabilize the banks as quickly as possible. Final vegetation planting will occur once construction equipment is removed after final grading and stabilization.

4.3 Water Sources and Connections

The project area lies within the USGS Hydrologic Unit Code (HUC) watershed basin number 12040104, the Buffalo-San Jacinto sub basin. More specifically, the site lies in the 12-digit HUC 120401040304, the Cole Creek-White Oak Bayou watershed. The White Oak Bayou watershed stretches from central to northwest Harris County and includes the City of Jersey Village and portions of the City of Houston. Rainfall within the 111 square miles of the White Oak Bayou watershed drains to the primary waterway, White Oak Bayou (HCFCD Unit E100-00-00). The bayou flows southeast from its headwaters northwest of FM 1960 to its confluence with Buffalo Bayou (HCFCD Unit W100-00-00) downtown Houston. All overland runoff from the site flows to White Oak Bayou either directly or to Vogel Creek and then to White Oak Bayou to the south of the site. Much of the site lies within the 100-year floodplain of White Oak Bayou and Vogel Creek with significant portions lying within the effective floodways of White Oak Bayou and Vogel Creek.

Proposed Basin I is designed to receive flows from HCFCD Unit #E121-02-00 during normal flow conditions. During high-flow conditions, there is an inflow structure proposed at the north end of Basin I to receive high stormwater flows from Vogel Creek. Proposed Basin L is designed to receive flows from stormwater drainage through an existing stormwater system within the Inwood Forest subdivision, and will connect at its downstream end to Vogel Creek.

4.4 Plant List and Planting Plan

As part of the proposed work plan, the planting of native wetland vegetation will occur specifically along HCFCD Unit #E121-02-00 in Basin I and unnamed Ditch 1 in Basin L after construction equipment has been removed and during the appropriate planting period. Broadcast seeding will be used for a majority of the upland portions of the project site, while native wetland plants will be planted along the bankfull bench. The broadcast seed mix and wetland planting list are included in **Appendix B.**

4.5 Invasive Species Control Plan

Vegetation plantings with native and other desirable species will be conducted along HCFCD Unit #E121-02-00 in Basin I and unnamed Ditch 1 in Basin L immediately following construction activities. This will limit the potential establishment of invasive species. Following construction and vegetation establishment, routine vegetation maintenance will be resumed on the channel ROW. Herbicide application for the control of nuisance and invasive species is strategically coordinated with mowing operations by HCFCD field crews, as needed, to achieve optimal control of undesirable species. Sensitive habitat maintenance contractors are also employed by HCFCD and will maintain the riparian buffer including the jurisdictional limits of the channel, with invasive species management on an as needed basis. Sensitive habitat maintenance techniques include non-mechanized removal of invasive and undesirable species and aquatic herbicide treatments applied, as needed, according to the Texas Department of Agriculture and Texas Commission on Environmental Quality regulations. As the native riparian buffer becomes established over time the need for mowing and invasive species control should diminish.

4.6 Grading Plan

The instream mitigation activities will occur in Basins I and L, which are proposed to be wet-bottom basins. The wet-bottom design will incorporate naturalistic side slopes and vary where possible, increasing the flow path of stormwater through the basins. This design has the advantage of minimal erosional impacts within the channel bottom itself as well as the creation of additional fringe wetlands and stream enhancement features. Side slopes along these two basins will be approximately 4:1 slopes depending on the geometry of the channel across the project area. Grading Cross Section Plans that show the proposed grading, slope, and elevation for the proposed channel are included in **Appendix A**.

4.7 Soil Management and Erosion Control Measures

Soil within the proposed channels will be stabilized by natural and artificial means. The slopes along proposed Basins I and L banks will be stabilized utilizing silt fencing, fiber mats and rock check dams along slopes during construction and will be fully re-vegetated with herbaceous vegetation after construction, thereby eliminating the potential for erosion. Rip-rap will be installed along the banks specifically at proposed outfall and intake structure locations. In addition, the basin bottom channel design will incorporate variations of pond depths, variations in side slopes, water quality enhancement features such as deep pools of varying depths between 6 ft to 8ft, shallow pools with varying depths of 1ft to 3ft, and vegetated shelves, and vegetative shelf plantings will be installed along the shallow water's edge on both sides of the proposed wet-bottom detention basins. The riprap/vegetative transition, along with the installation of several pools and shallow water pockets along the redesigned channel will slow the accelerated flow of water from the surrounding uplands and decrease momentum into the basins. The maintenance easements that run on both sides of the channel as well as the side slopes of the channel will be mowed and maintained. The easements will feature a backslope swale with drainpipes that tie down into the bottom bankfull bench, thereby preventing erosion due to sheet flows down the banks of the channel. Vegetation within the bottom bank-full

bench and low-flow channel will be maintained using the sensitive habitat measures described above. An occasional high deck mowing will be performed as necessary.

During construction, HCFCD will utilize the necessary BMPs to reduce erosion and siltation. Topsoil will be used to reestablish turf throughout the project site. Silt fencing and other BMPs will be used to ensure that fill material is not discharged into adjacent waters beyond the project site limits. Clay soils excavated from the project site will be used where appropriate. Temporary impacts to downstream waters will be minimized by utilizing standard BMPs for HCFCD projects such including rock filter dams, silt fencing, sod strips, inlet protection, and vegetated buffers (HCFCD 2005). These structures will be removed post construction, following site stabilization. Vegetative cover will be the long-term measure that stabilizes disturbed soils in the project area. Additionally, the channel has been designed to minimize long-term erosion concerns using natural channel design features that reduce water velocity.

4.8 Channel Geometry

Detailed cross sections of the proposed Basins I and L, where in-stream enhancement design techniques will be provided for the proposed project, are included in **Appendix A**.

5.0 METRIC/SUCCESS CRITERIA

The extent to which the proposed streams in Basins I and L effectively satisfy obligations for the restoration of natural stream functions will be determined based on adherence to the performance standards set in place to meet the following objectives for emergent wetland planting coverage and noxious invasive species management.

Emergent Wetland Plantings - Cover

Emergent wetland plantings should exhibit 70 percent cover by desirable wetland species by the end of the second full growing season following planting, as documented utilizing one transect across the length of the planted area. Planting will occur following the completion of all earthwork construction. Plantings that do not demonstrate the acceptable 70 percent cover at the end of the second full growing season following planting would require supplemental planting efforts.

Noxious Invasive Species

Noxious invasive species would be monitored utilizing 10 permanent transects established in the project area. Noxious invasive species monitoring will continue at least yearly for a minimum of five years to limit establishment and spread of these species. Presence of noxious invasive species (i.e., Chinese tallow, Chinaberry, wax-leaf ligustrum, and Chinese privet) will be managed according to the maintenance plan should areal coverage exceed 10 percent at the time of scheduled monitoring events. Localized areas observed with concentrations of noxious invasive species would be treated regardless of overall composition of the project area.

6.0 MAINTENENACE PLAN

HCFCD maintains earthen turf grass facilities through full-service contracts that provide for the normal removal of debris and mowing three times per year during the growing season. Additional requests for maintenance can be made on an as needed basis by the public or staff through HCFCD's Citizen Service Center. Sensitive habitat maintenance contractors will be managed by HCFCD to maintain the fringe wetlands and riparian zone within the channel. HCFCD's Outfield Program performs routine inspection of all flood control infrastructure and identifies any needed repairs. If any non-routine maintenance is required on the channel, such as erosion repair, it will be assessed and evaluated for repair by HCFCD.

7.0 3-YEAR MONITORING PLAN

HCFCD will monitor the proposed Inwood Forest Stormwater detention Basins project for geomorphic stability and vegetation establishment. HCFCD's turf grass establishment program will conduct regular vegetation inspections until the site has a minimum of 75% coverage. Additional overseeing will be applied as necessary until the site achieves the minimum coverage required for site stabilization. Specific vegetation maintenance techniques for controlling invasive species are described above in the invasive species control plan. HCFCD will establish monument cross-sections and a longitudinal profile that can be monitored annually for a minimum of three years. If monitoring cross-sections show a significant change in cross-sectional area or width-depth ration from as-built conditions, then HCFCD will evaluate the cause of the stability issues and determine a possible rectification, if necessary. Additionally, if the longitudinal profile monitoring indicates a significant change in slope, then the cause will be evaluated and corrected, as necessary. Also, the site will be managed to no more than 10% aerial coverage of noxious invasive species at the time of monitoring events.

8.0 ADAPTIVE MANAGEMENT PLAN

HCFCD will monitor establishment of tree and shrub plantings for a period of two years. Should the project area fail within the two-year period to achieve the prescribed 80 percent survival rate for container plants and 50 percent survival rate for live-stake plants, HCFCD will take measures to replace trees in the fall following the monitoring event that determined the deficiency. In the event the deficiency is caused by drought conditions, HCFCD may elect to defer supplemental plantings until more favorable conditions occur. For plantings in wetland areas that fail to achieve the prescribed 70 percent cover, HCFCD will replant those areas in the spring following the monitoring event in which the deficiency is identified. For areas in which plantings fail for reasons other than climatic conditions, HCFCD would evaluate those sites to determine the cause of the failure, which may include but would not be limited to, predation by animals or insects, soil deficiencies, vandalism, or storm damage for the specified location. Upon diagnosis of the cause for planting failure, HCFCD would take actions to correct the condition before replanting and would monitor that location for an additional two years.

The maintenance plan calls for no mowing and no pruning of woody vegetation in the project area; however, it is possible that as tree plantings mature on the demonstration site, overcrowding may

occur, resulting in closure of the tree canopy to an extent that would not allow light penetration sufficient for the survival of desirable understory, mid-story, and herbaceous vegetation. HCFCD may elect to selectively clear portions of the project area in which an over-crowded canopy is determined to be an issue. Downed trees from selective clearing would either be left in place to provide soil nutrients, cover, and browse for wildlife.

Eradication measures would be evaluated and implemented should noxious invasive species (i.e., Chinese tallow, Chinaberry, Chinese privet, and wax-leaf ligustrum) exceed 10 percent cover at any time during site monitoring. Removal of noxious invasive species will be accomplished through a combination of mechanical (e.g., uprooting, chainsaw) and herbicide (e.g., Garlon 4E and Rodeo w/basal oil and dye and/or other appropriate forms) methods. Monitoring for management of noxious invasive species would be conducted for a minimum of five years and would then continue through HCFCD's general long-term channel maintenance program.

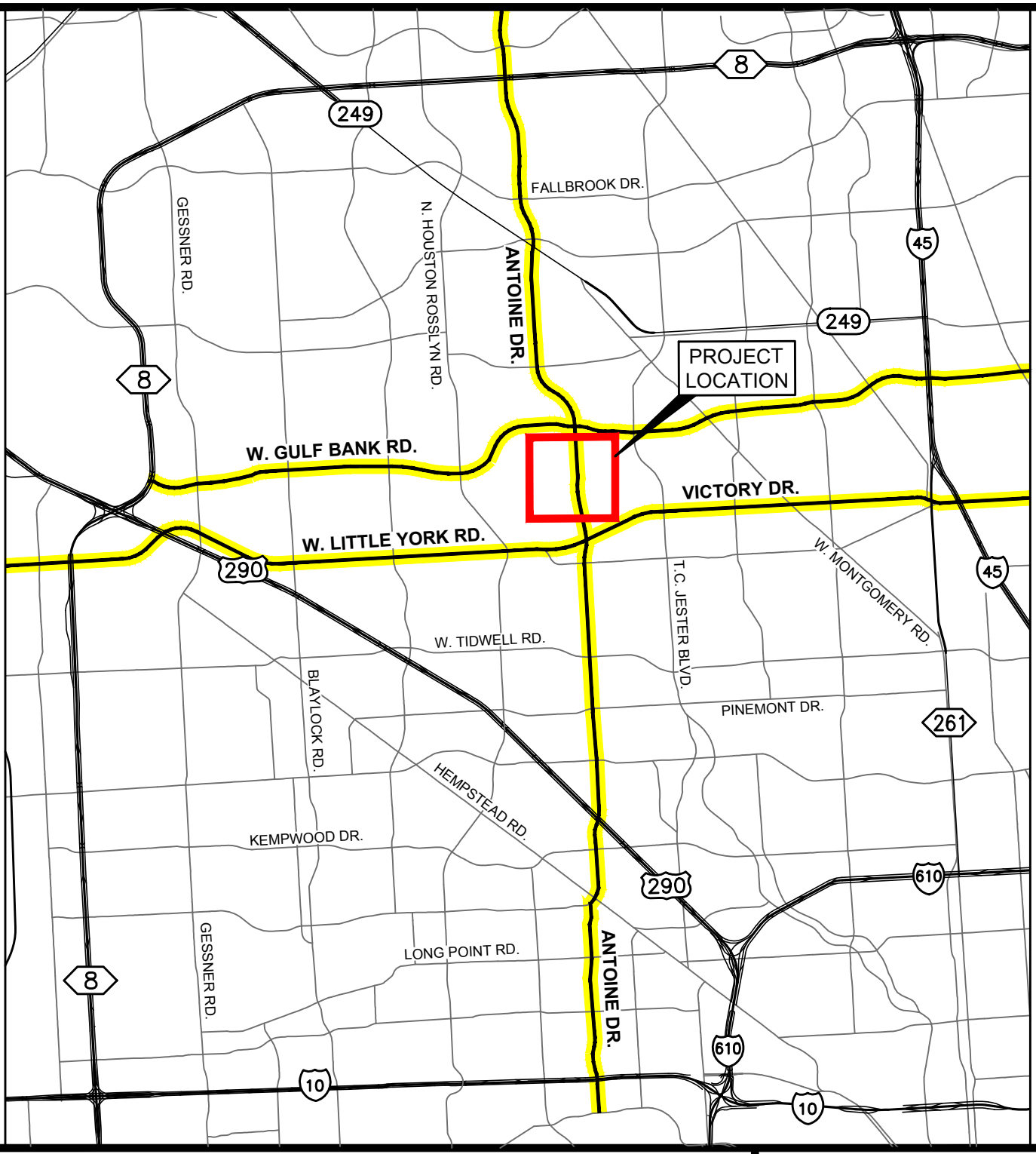
The proposed project plan calls for restoration of the channel and its surrounding riparian habitat resulting in anticipated improvements to aquatic habitats. As such, the project will result in no net loss of natural stream functions and no mitigation for impacts to wetlands and other potential waters of the U.S. subject to USACE jurisdiction under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act. HCFCD will evaluate the proposed project at the end of the five-year monitoring period to ensure a net increase in function. Should it be determined through the monitoring efforts as described herein that the proposed activities do not result in an increase in the function and value for the restored channel segments and their associated riparian habitats, additional adaptive management and monitoring activities will continue.

9.0 FINANCIAL ASSURANCES

A letter of addressing financial assurances is presented in **Appendix C**.

Appendix A

Project Plans and Typical Cross Sections



LOCATION MAP
INWOOD FOREST BASINS PROJECT
E500-21-00-E002
PROPOSED IMAPACTS TO W.O.T.U.S.
SWG-2017-00335

r.g.miller engineers

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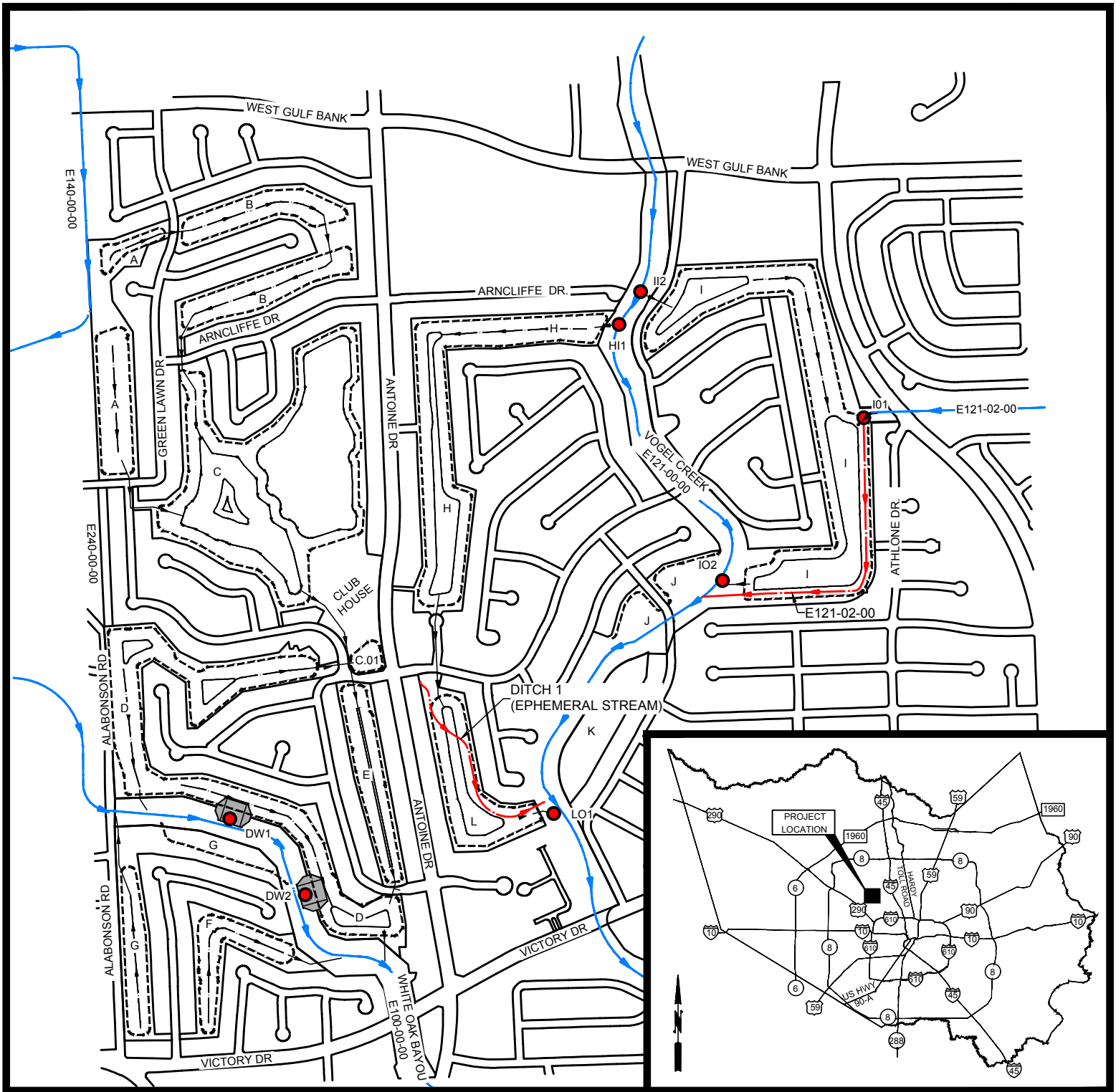
TEXAS FIRM REGISTRATION NO. F-487

DATE: 12/11/2019



IMPACTED STREAMS

EXISTING STREAMS

PROPOSED OUTFALL AND/OR INFLOW STRUCTURES

OVERVIEW MAP
INWOOD FOREST BASINS PROJECT
E500-21-00-E002
PROPOSED IMAPACTS TO W.O.T.U.S.
SWG-2017-00335

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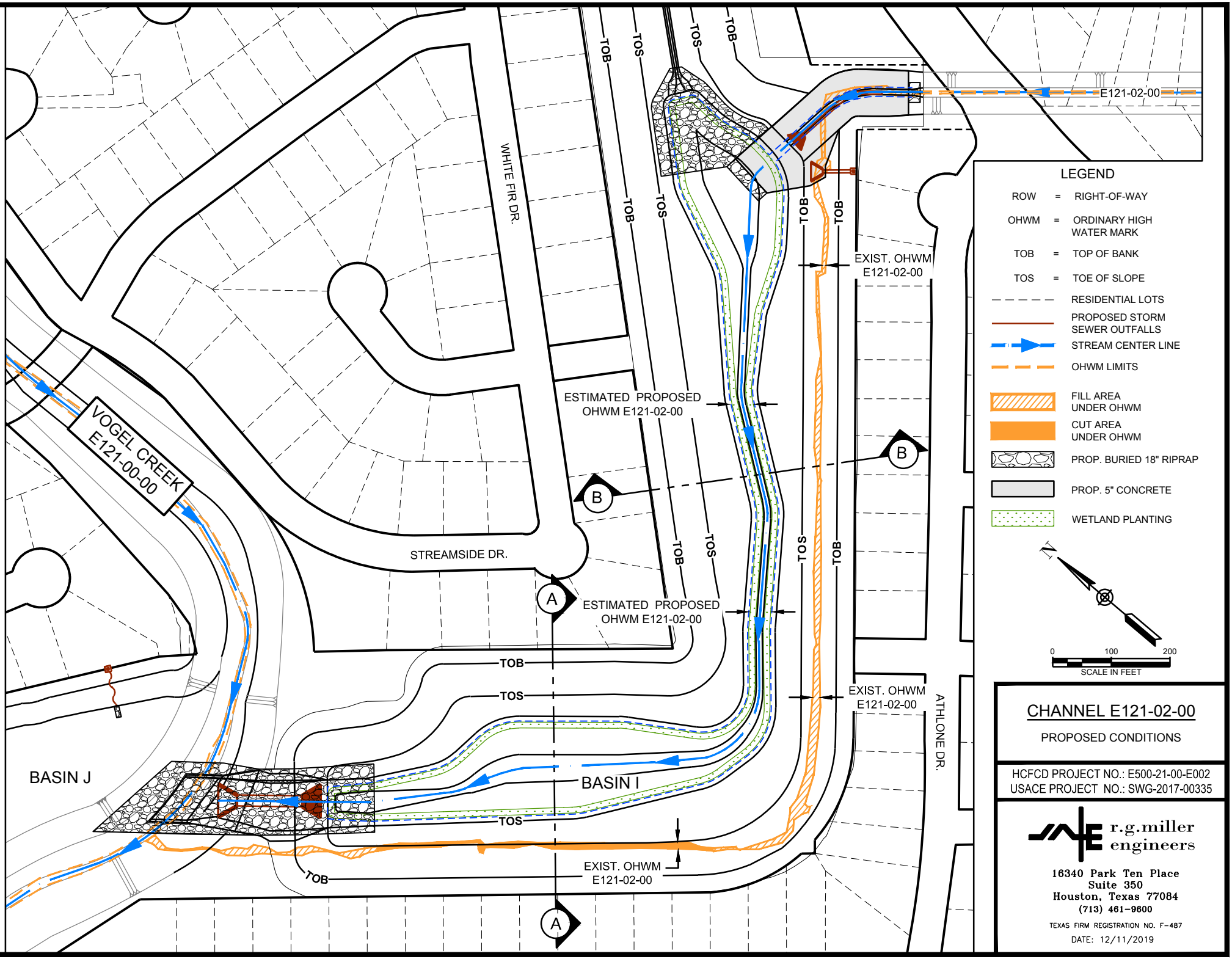
TEXAS FIRM REGISTRATION NO. F-487

DATE: 12/11/2019



CHANNEL E121-02-00

PROPOSED CONDITIONS

HCFCD PROJECT NO.: E500-21-00-E002
USACE PROJECT NO.: SWG-2017-00335

r.g.miller engineers
16340 Park Ten Place
Suite 350
Houston, Texas 77084
(713) 461-9600
TEXAS FIRM REGISTRATION NO. F-487

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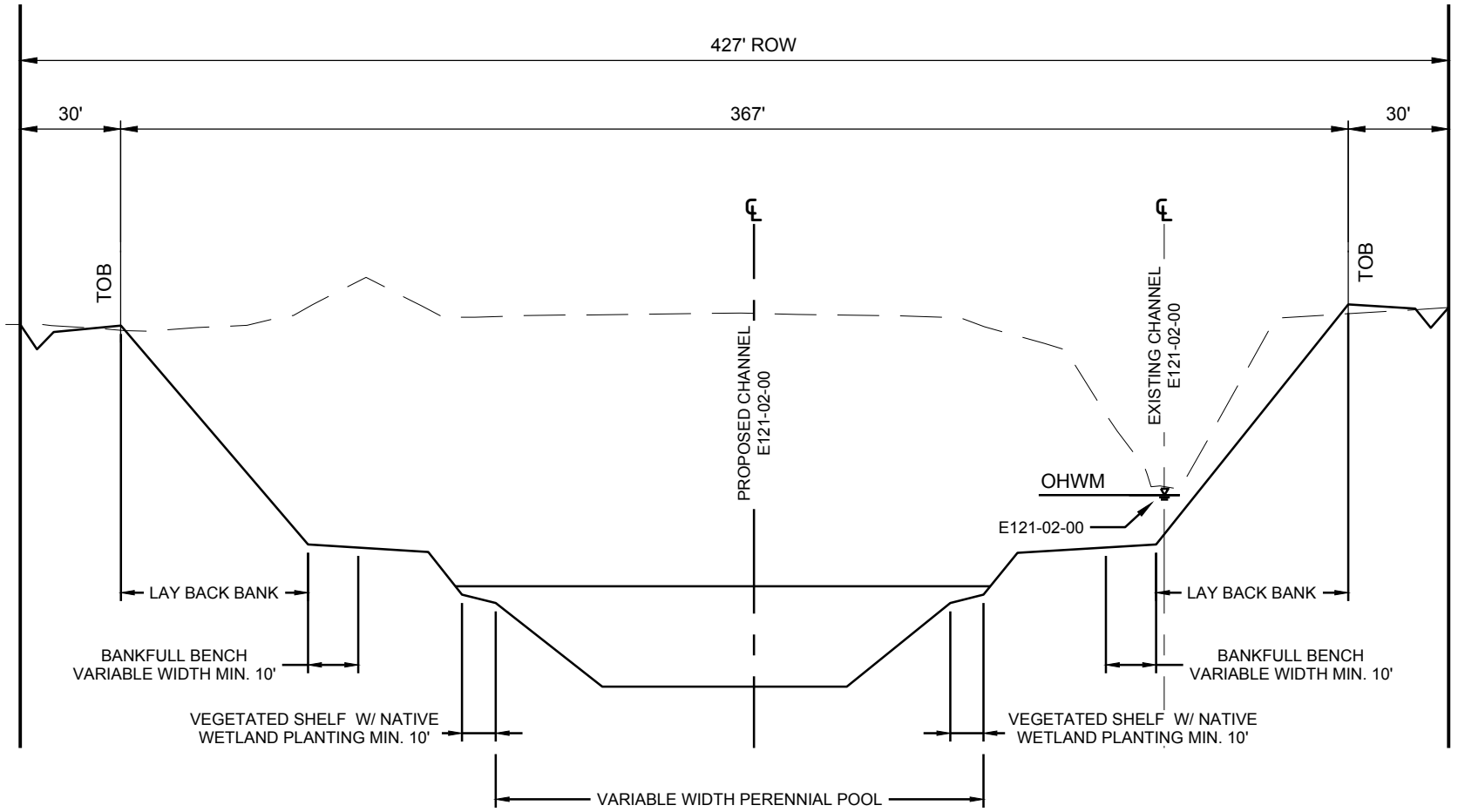

BASIN I TYPICAL SECTION A-A

N.T.S.

LEGEND

TOB	=	TOP OF BANK
OHWM	=	ORDINARY HIGH WATER MARK
— — —		EXISTING GROUND
———		PROPOSED GROUND

BASIN I

TYPICAL SECTIONS

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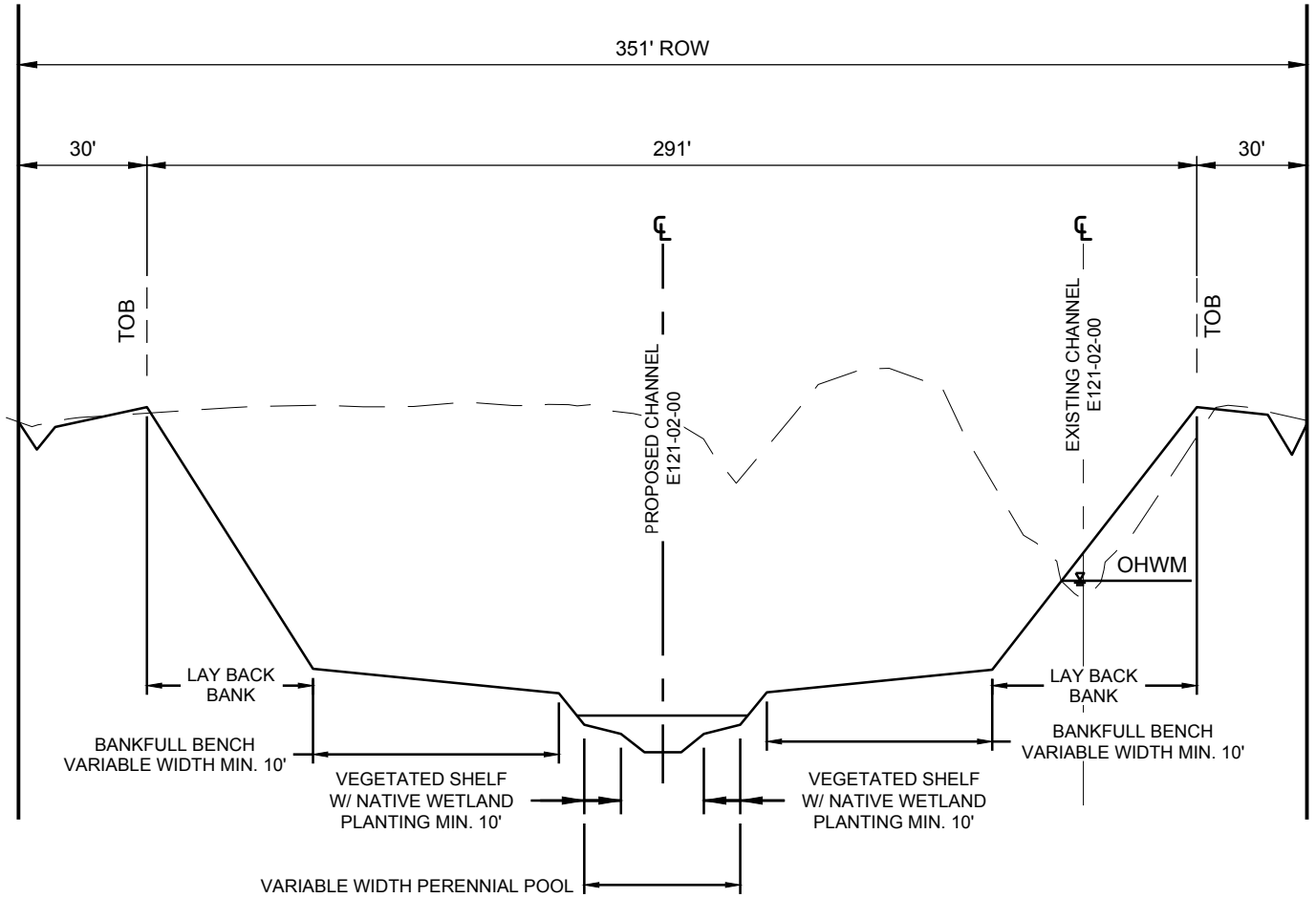

BASIN I TYPICAL SECTION B-B

N.T.S.

LEGEND

TOB = TOP OF BANK

OHWM = ORDINARY HIGH WATER MARK

EXISTING GROUND

PROPOSED GROUND

BASIN I

TYPICAL SECTIONS

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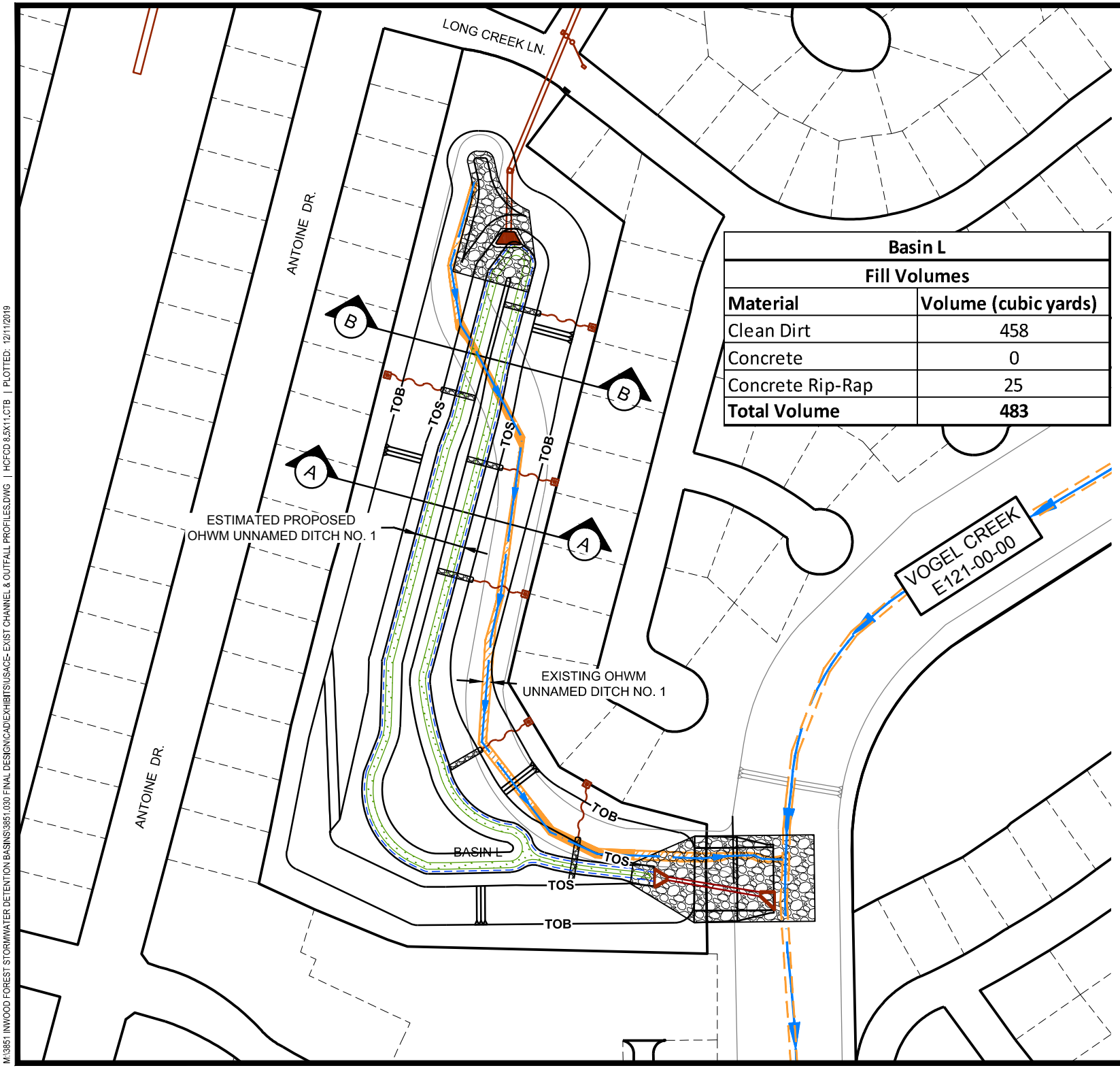

Basin L	
Fill Volumes	
Material	**Volume (cubic yards)**
Clean Dirt	458
Concrete	0
Concrete Rip-Rap	25
Total Volume	**483**

LEGEND

ROW = RIGHT-OF-WAY

OHWM = ORDINARY HIGH WATER MARK

TOB = TOP OF BANK

TOS = TOE OF SLOPE

RESIDENTIAL LOTS

PROPOSED STORM SEWER OUTFALLS

STREAM CENTER LINE

OHWM LIMITS

FILL AREA UNDER OHWM

CUT AREA UNDER OHWM

PROP. BURIED 18" RIPRAP

WETLAND PLANTING

EXISTING RIPRAP

N

0 100 200

SCALE IN FEET

UNNAMED DITCH NO. 1

PROPOSED CONDTIONS

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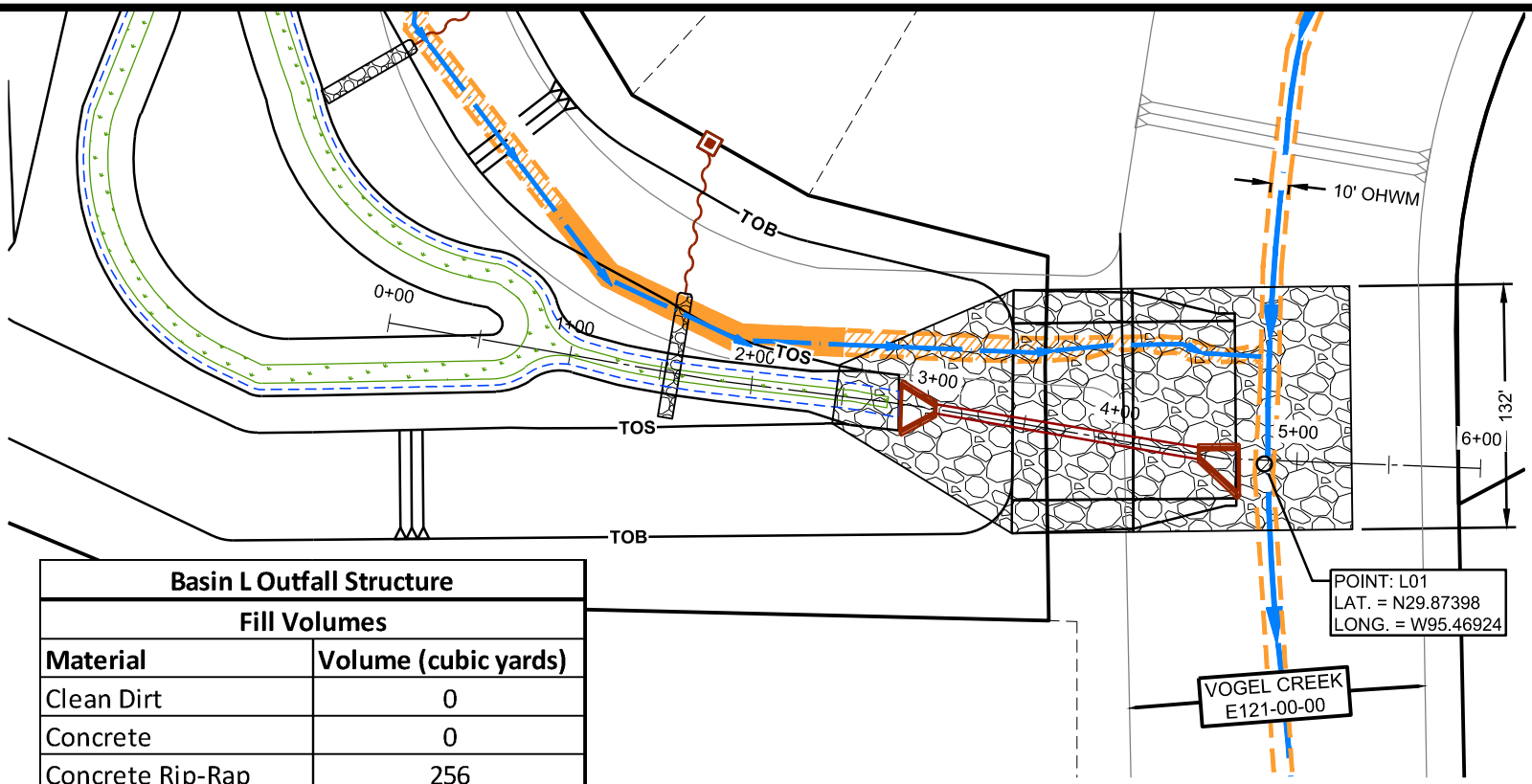
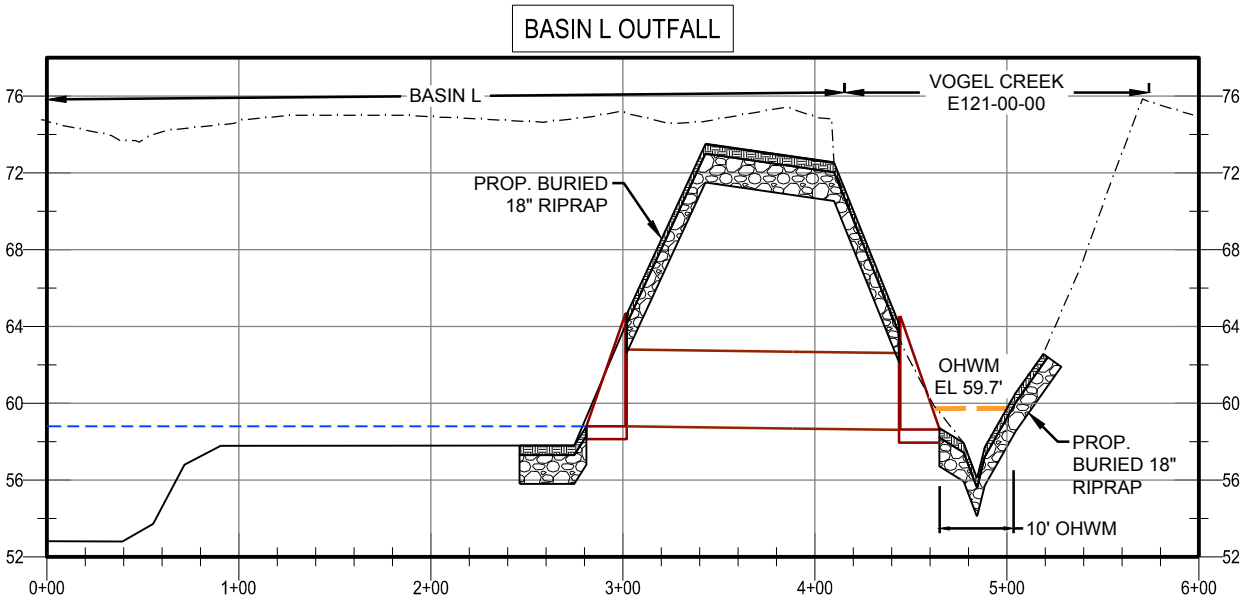


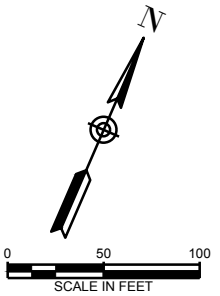
LEGEND

ROW	=	RIGHT-OF-WAY
OHWM	=	ORDINARY HIGH WATER MARK
TOB	=	TOP OF BANK
TOS	=	TOE OF SLOPE

RESIDENTIAL LOTS
PROPOSED STORM SEWER OUTFALLS
STREAM CENTER LINE
OHWM LIMITS
FILL AREA UNDER OHWM
CUT AREA UNDER OHWM
PROP. BURIED 18" RIPRAP
WETLAND PLANTING
EXISTING RIPRAP

Basin L Outfall Structure	
Fill Volumes	
Material	**Volume (cubic yards)**
Clean Dirt	0
Concrete	0
Concrete Rip-Rap	256
Total Volume	**256**





L01 - BASIN L

PROPOSED CONDITIONS

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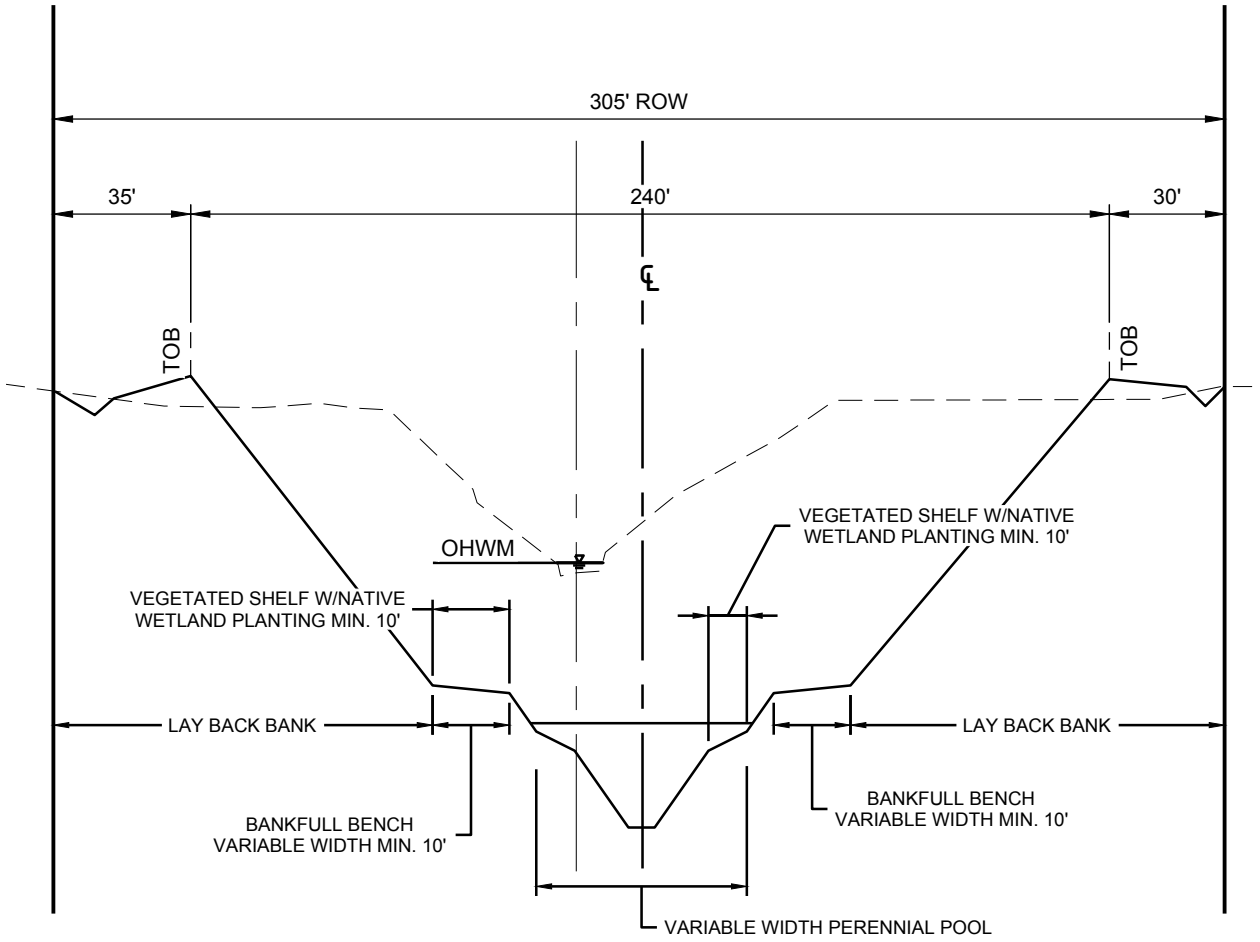

BASIN L TYPICAL SECTION A-A

N.T.S.

LEGEND

TOB	=	TOP OF BANK
OHWM	=	ORDINARY HIGH WATER MARK
— — —		EXISTING GROUND
———		PROPOSED GROUND

BASIN L

TYPICAL SECTIONS

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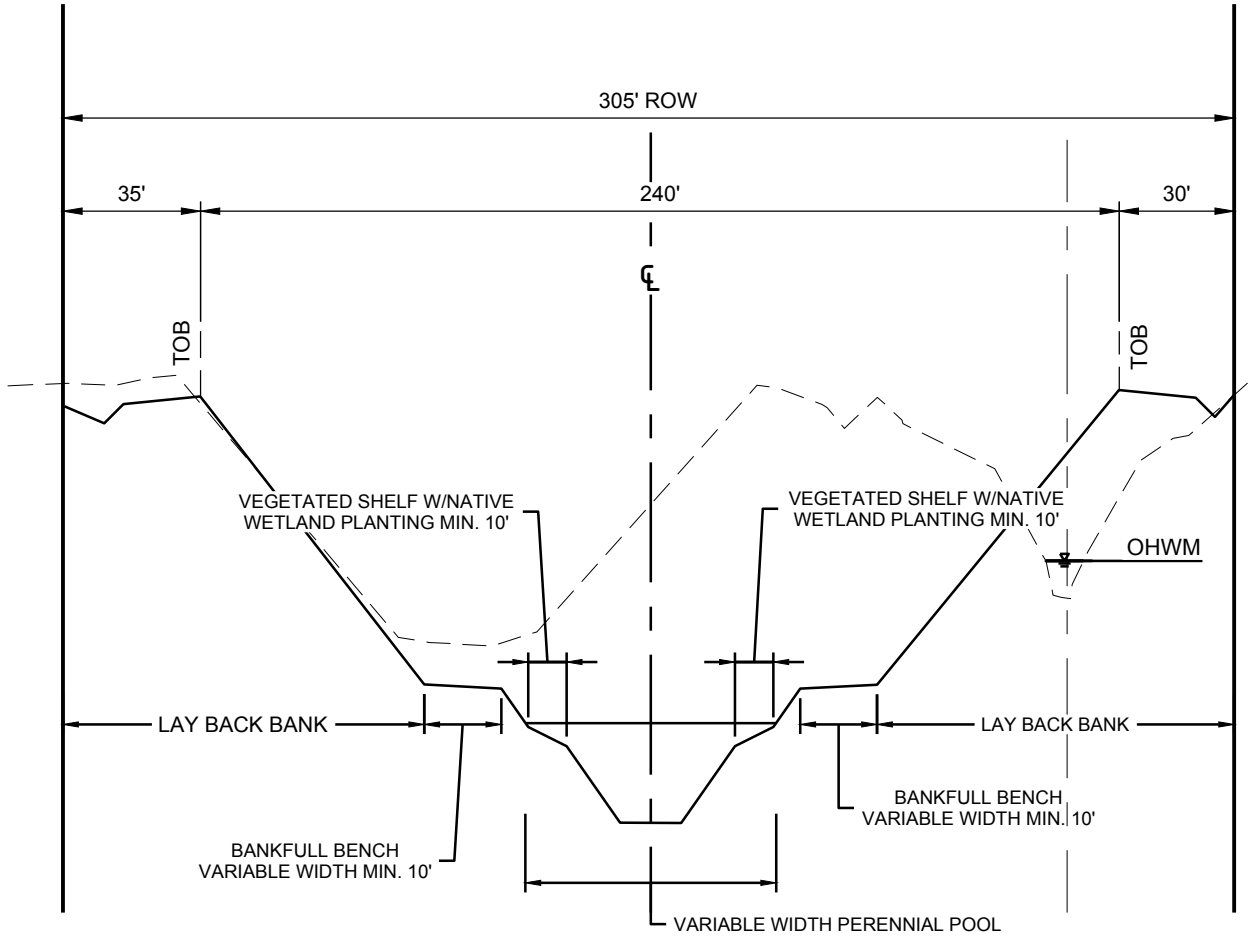

BASIN L TYPICAL SECTION B-B

N.T.S.

LEGEND

TOB	=	TOP OF BANK
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— — —		EXISTING GROUND
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BASIN L

TYPICAL SECTIONS

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DATE: 12/11/2019

Appendix B

Planting List

Table 1: Native Plant Species List	
Grass Seed Mix	
Common Name	Scientific Name
bermudagrass	*Cynodon dactylon*
tall fescue	*Schedonorus arundinaceus*
white clover	*Trifolium repens*
crimson clover	*Trifolium incarnatum*
bahia grass	*Paspalum notatum*
annual ryegrass	*Lolium perenne*
Wetland Plants	
Common Name	Scientific Name
swamp milkweed	*Asclepias incarnata*
red milkweed	*Asclepias rubra*
water hyssop	*Bacopa spp.*
golden canna	*Canna flacida*
sedges	*Carex spp.*
swamp lily	*Crinum americanum*
flat sedges	*Cyperus spp.*
smallseed spikerush	*Eleocharis microcarpa*
sand spikerush	*Eleocharis montevidensis*
sugarcane plumegrass	*Saccharum giganteum*
narrow plumegrass	*Saccharum baldwinii*
hedge hyssop	*Gratiola brevifolia*
sunflower	*Helianthus angustifolius*
mud plantain	*Heteranthera sp.*
scarlet rosemallow	*Hibiscus laevis*
swamp rosemallow	*Hibiscus moscheutos*
marsh-mallow	*Hibiscus spp.*
water-leaf	*Hydrolea ovata*
spider-lily	*Hymenocallis sp.*
zig-zagiris	*Iris brevicaulis*
blue flag (iris)	*Iris virginicana*
yellow flag (iris)	*Iris pseudacorus*
soft rush	*Juncus effusus*
cardinal-flower	*Lobelia cardinalis*
marsh primrose-willow	*Ludwigia palustris*
maidencane	*Panicum hemitomon*
false dragon-head	*Physostegia intermedia*
swamp smartweed	*Polygonum hydropiperoides*
Pennsylvania smartweed	*Polygonum pennsylvanicum*
Maryland meadow-beauty	*Rhexia mariana*
common meadow-beauty	*Rhexia virginiana*

beak-rush	*Rhynchospora glomerata*
white-topped sedge	*Rhynchospora colorata*
cone-flower	*Rudbeckia nitida*
pinewoods rose-gentian	*Sabatia gentianoides*
lizard's tail	*Saururus cernuus*
marsh-hay cordgrass	*Spartina patens*
prairie cordgrass	*Spartina pectinata*
eastern gramma grass	*Tripsacum dactyloides*
spikerush	*Eleocharis equisetoides*
mountain spikerush	*Eleocharis montana*
squarestem spikerush	*Eleocharis quadrangulata*
goldenclub	*Orontium aquaticum*
pickerelweed	*Pontederia cordata*
mermaid weed	*Proserpinacea palustris*
grassy arrowhead	*Sagittaria graminea*
duck potato	*Sagittaria lancifolia*
nipplebract arrowhead	*Sagittaria papillosa*
delta arrowhead	*Sagittaria platyphylla*
woolgrass	*Scirpus cyperinus*
olney bulrush	*Schoenoplectus americanus*
california bulrush	*Schoenoplectus californicus*
softstem bulrush	*Schoenoplectus tabernaemontani*
fire flag	*Thalia dealbata*
giant cutgrass	*Zizaniopsis milacea*
smooth water primrose	*Ludwigia peploides*
widgeon grass	*Ruppia maritima*
water-shield	*Brasenia schreberi*
fanwort	*Cabomba caroliniana*
coontail	*Ceratophyllum demersum*
naids	*Najas guadalupensis*
spatterdock	*Nuphar intera*
blue water-lily	*Nymphaea elegans*
yellow water-lily	*Nymphaea mexicana*
fragrant white water-lily	*Nymphaea odorata*
floating-hearts	*Nymphoides aquatica*
pondweed	*Potamogeton spp.*

Appendix C

Letter of Financial Assurances

HARRIS COUNTY FLOOD CONTROL DISTRICT
9900 Northwest Freeway
Houston, Texas 77092
713-684-4000

September 16, 2019

Ms. Kristy Farmer, Regulatory Project Manager
U.S. Army Corps of Engineers
Galveston District
P.O. Box 1229
Galveston, Texas 77553-1229

RE: Supporting Letter Addressing Financial Assurance for the
Inwood Forest Stormwater Detention Basin Project
HCFCD Project ID E521-04-00-E001

Dear Ms. Farmer:

I do hereby certify that I am aware of the financial obligations of the Inwood Forest Stormwater Detention Basin Project Compensatory Mitigation as outlined within the Mitigation Plan and that Harris County Flood Control District (District) has the financial capability to satisfy these obligations. Please accept this financial assurance letter as a formal documented commitment from the government agency for public authority as specified in 332.3 1 of the federal register, "in cases where an alternate mechanism is available to ensure a high level of confidence that the compensatory mitigation will be provided and maintained (e.g., formal, documented commitment from a government agency for public authority) the district engineer may determine that financial assurances are not necessary for that compensatory mitigation project."

The District is a special purpose district created by an act of the Texas Legislature and has been in operation for 75 years, demonstrating a long history in this community and a continued presence into the future.

If you have any questions or need additional information, please contact Ms. Denise Wade of my staff at 346-286-4050. **Please reference HCFCD Project ID E521-04-00-E001 on any correspondence regarding this project.**

Sincerely,

for

Russell A. Poppe, P.E.
Executive Director

RAP:rop

S:\Planningdiv\Environmental Services\1-Old Environmental\PROJECTS\E - White Oak Bayou\E521-04-00\19-L9-16coe E521-04-00-E001 Supporting Letter Addressing Financial Assurance Inwood Forest Stormwater Detention Basin.Docx

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