Applicant: Harris County Improvement District No. 1
Memorial Park Central Connector Project
Mitigation Plan

The project area is located within Memorial Park, southeast of I-10 and I-610 in Harris County, Texas. The USGS Quad reference map is *Houston Heights* and the center of the project area is located approximately at NAD 83 UTM Zone 15 coordinates UTM 263,836 E; 3,294,962 N (WGS84/NAD83).

1.) Goals and Objectives

The Applicant is proposing to re-establish 1,485 linear feet of unnamed channels for the purpose of providing a sustainable, ecologically-beneficial connection between the northern and southern portions of the park, as well as improving storm water management. Substantial ecological uplift within the project area will be realized through the creation of floodplain wetlands and in-stream habitat structures, along with other design elements meant to prevent future erosion problems and serve as water quality features to remove suspended solids and other pollutants from storm water prior to release into Buffalo Bayou. Further, the planting of desirable native hydrophytic vegetation is proposed in the created wetlands, and other desirable native vegetation will be planted within the uplands surrounding the re-established active floodplain. The design criteria will meet all TCEQ, City of Houston, and Harris County water quality and flood control standards.

The applicant based the proposed plan on natural stream design by allowing water to flow in the wider floodplain area to create its own sinuous course rather than artificially engineering a path for the water to follow. This should allow for a stable stream bed and bank since the stream will be allowed to form its own equilibrium within the new wider flow area.

Since there will be a net increase in the Reach Condition Index score, based upon the Galveston District Stream Tool (SWG-Tool), and because the current channel is being restored to its approximate historical location based on historical aerial imagery and USGS topographic maps, the Applicant contends that the project is self-mitigating. The current channel has a Reach Condition Index (RCI) of 2.0 based on the SWG-Tool. The proposed project will have an RCI of approximately 3.0 once construction is complete.

The Applicant will achieve the proposed RCI of 3.0 by utilizing flood-plain wetlands, bank-full benches, in-stream structures, enhancement of the riparian buffer, and the implementation of specific erosion control devices. These include, but are not limited to, rock vanes, vegetative root wads, overhanging vegetation, and geotextile materials. These will help to create and maintain channel integrity. The primary function of the proposed channel in the area is drainage and suspended solids sequestration. However, the proposed construction will also create and maintain habitat, have a much more stable channel condition, promote increased sinuosity, and allow for better water quality within the immediate watershed.

Upstream of this mitigation project, an additional 3,800 linear feet of stream will be constructed with the same design and objectives.

2.) Baseline information

The current channel is within Memorial Park and beyond that is bordered by commercial and residential development and public infrastructure on all sides.

According to the Web Soil Survey of Harris County, the mapped units within the project boundary are Aldine-Urban land complex, Cyfair fine sandy loam, Bissonnet loam, Clodine fine sandy loam, and Verland silty clay loam.

The entirety of the project work area is located outside of the 100-year floodplain of Buffalo Bayou.

3.) Site selection

Historic aerial photography, USGS topographic maps, historical information from Camp Logan, the 1938 Thesis, and site reconnaissance were used to identify the ideal location for this system. The re-establishment of this tributary is not only a core element of this Central Connector Project but also representative of the broader goals and values of the Master Plan.

The draft design plan, submitted herein, limits the creation of potentially unnecessary structures and armoring of the banks. This is in an effort to allow the channel, once constructed, to shape itself, and only if needed will additional in-stream structures and erosion control methods be implemented. These may include additional rock vanes, bank protection, and log vanes.

4.) Mitigation Work Plan

The Applicant is proposing to re-establish the existing tributary and to create multiple habitat types therein, including riffle and pool complexes, floodplain wetland establishment, and vegetative plantings. Additionally, the Applicant is proposing to create a stable channel condition by considering the natural evolution of the channel within the wider floodplain area.

The proposed rock vanes, placed within the main channel at appropriate locations per the flow regime, will decrease near-bank shear stress, velocity, and stream power, while increasing the energy in the center of the channel to create pools. This will result in reduced bank erosion, creation of a stable width/depth ratio, and sustainable sediment transport. The rock vanes will improve stream habitat by providing an increase in bank cover due to a differential rise of the water surface in the bank region, the creation of refuge during both high and low flow periods in the pools, the development of feeding areas in the flow separation zones due to the various forces within the channel, and by the creation of spawning habitat in the tail-out portions of the pool.

To protect the integrity of the lower-volume west channel, woody debris (especially large trunks with roots attached) will be used as toe armoring. These will offer similar functional benefits to the rock vanes, but with materials more befitting the lesser flow regime.

The planting of native wetland and prairie species will create the thick vegetative root wads and overhanging vegetation desired by aquatic species.

5.) Site Protection and Maintenance

The Park is owned by the City of Houston, and maintained in partnership with the Applicant and the Memorial Park Conservancy. The site will be protected under a deed restriction to be recorded with Harris County. The Applicant will be responsible for financing the short and long term maintenance of the project, and for the installation any additional erosion control devices if deemed necessary based upon the monitoring results. Funding for the project is provided by a grant from the Kinder Foundation. Maintenance of the project falls in line with the overall mission of the Conservancy to maintain and enhance ecological resources within the park.

6.) Performance Standards

The proposed project design must achieve a minimum RCI of 3.0 within three (3) years from the completion of construction and maintain the proposed RCI of 3.0 for five (5) years following the

completion of construction. The RCI will be based on the SWG-Tool or subsequent stream models approved for use by the USACE Galveston District. The channel will be considered to have met minimum success criteria (MSC) if after three (3) years the RCI of 3.0 has been achieved and at least two (2) significant rainfall events have occurred.

Invasive species including Chinese tallow (*Triadica sebifera*) and Chinaberry (*Melia azedarach*) will be controlled within the new channel and will be make up no more than five-percent (5%) of the aerial coverage.

7.) Monitoring Plan

Monitoring will be conducted quarterly during first year after construction, ideally following rainfall events in the area to assess flow dynamics and stability. Monitoring will continue bi-annually for the next two (2) years and then annually for an additional two (2) years. Monitoring reports will be submitted to the USACE Galveston District and will be in compliance with Regulatory Guidance Letter No. 08-03.

8.) Long Term Management Plan

Long term maintenance will be carried out according to the City of Houston's standard operating procedure. Maintenance within the channel below the ordinary high water mark (OHWM) to remove accumulated sediment and debris impeding flow, and repair of rip-rap and other authorized structures covered by this action will be performed as needed and with coordination with the USACE Chief of Compliance. Due to the design of the system, this maintenance is expected to be minimal.

9.) Adaptive Management Plan

Should the project not meet MSC or not achieve the proposed RCI by year five (5), the Applicant will work with the USACE to develop an adaptive management plan so that the proposed RCI is ultimately achieved and maintained. Part of the adaptive management plan will be the implementation of erosion control in-stream habitat structures should the need arise. This project is proposed to be dynamic, utilizing minimal structures during construction but with the ability to install various structures as needed based upon the monitoring findings.

10.) Financial Assurances

Harris County Improvement District No. 1 will be financially responsible for the construction and monitoring, and for the long term maintenance of the proposed channel, as specified in Section 8. Funding via a $70 million grant from the Kinder Foundation is already secured, a portion of which will be utilized for the construction and long-term maintenance of this project. The Applicant is also a taxing entity and reserves the right to provide taxable resources long-term for the maintenance of the project.

11.) Long Term Financing

See Sections 6 and 10 above for a breakdown of maintenance and financial responsibilities.

LEVEL 1 STREAM CONDITION ASSESSMENT AND ASSESSMENT OF STREAM IMPACTS

USACE PERMIT SWG-2018-00549

1,485 ± LINEAR FEET
MEMORIAL PARK CENTRAL CONNECTOR PROJECT
HARRIS COUNTY, TEXAS

PREPARED FOR
HARRIS COUNTY IMPROVEMENT DISTRICT NO. 1

BERG◆OLIVER ASSOCIATES, INC.
ENVIRONMENTAL SCIENCE AND LAND USE CONSULTANTS
HOUSTON, TEXAS
REPORT NO: 10755N
DECEMBER 2018

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SUMMARY

A Level 1 Stream Condition Assessment and Assessment of Stream Impacts was performed for Harris County Improvement District No. 1, on a 1,485 ± LF portion tributaries within Memorial Park, located southeast of I-10 and I-610 in Harris County, Texas.

The Waters of the U.S. and wetlands on the subject property were delineated in September 2014 according to the Regulatory Guidance Letter 05-05 – Ordinary High Water Mark Identification and the 2010 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (v.2), respectively. Approximately 1,758 ± linear feet of Waters of the U.S. were identified on the subject property. All Waters of the U.S. identified on-site were determined to be intermittent.

A Level 1 Stream Conditional Assessment was conducted in December 2018 on the identified intermittent Waters of the U.S. according to the 2013 Galveston District Corps of Engineers Level 1- Stream Condition Assessment for All Ephemeral and Intermittent Streams and for Impacts Less Than 500 Linear Feet to Intermittent Streams with Perennial Pools, Perennial Streams and Wadeable Rivers.

Visual Channel Condition values (CVs) were severe (1) or poor (2). Riparian buffer values (BVs) was typically low sub-optimal (4). Aquatic Life Use Values (UVs) of all Stream Assessment Transects were severe (1). Visual Channel Alteration Values (AVs) were severe (1) or poor (2).

Based on the Level 1 Stream Condition Assessment and Assessment of Stream Impacts presented in this report, it is the professional opinion of Berg ♦ Oliver Associates, Inc. (BOA) that the Reach Condition Index (RCI) of the stream reach proposed to be directly impacted in this study is 2.0. Due to the proposed project plans showing a post-construction RCI of 3.0, this project is self-mitigating.

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LEVEL 1 STREAM CONDITION ASSESSMENT AND ASSESSMENT OF STREAM IMPACTS

USACE PERMIT SWG-2018-00549
1,485 ± LINEAR FEET
MEMORIAL PARK CENTRAL CONNECTOR PROJECT
HARRIS COUNTY, TEXAS

INTRODUCTION

The study reported herein is a Level 1 Stream Condition Assessment and Assessment of Stream Impacts for Harris County Improvement District No. 1, on a 107.8 ± acre portion of Memorial Park, located southeast of I-10 and I-610 in Harris County, Texas.

A Wetland Assessment Determination and Delineation Study was conducted on the subject property in September 2014 to evaluate the subject property for jurisdictional Waters of the U.S. and wetlands in accordance with Section 404 of the Clean Water Act and current regulations and policies of the U. S. Army Corps of Engineers (USACE). The Waters of the U.S. and wetlands on the subject property were delineated according to the Regulatory Guidance Letter 05-05 – Ordinary High Water Mark Identification and 2010 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (v.2), respectively. Approximately 1,758 ± linear feet of Waters of the U.S. were identified on the subject property, with no wetlands within the channel (***Appendix A***).

Harris County Improvement District No. 1 requested USACE AJD SWG-2018-00549 in November 2018 for these and other features within the larger Memorial Park tract. On this tract, all Waters of the U.S. identified on-site were determined to be intermittent. Proposed impacts occur only within 1,485 linear feet of intermittent streams according to the site development plans associated with USACE SWG-2018-00549.

AUTHORIZATION

This study was performed as authorized by Harris County Improvement District No. 1.

SCOPE OF WORK

The objective of this Level 1 Stream Condition Assessment and Assessment of Stream Impacts was to assess the condition of streams on the subject property to be impacted by development, and to use this condition as a baseline in determining the appropriate compensation for such impacts in accordance with Section 404 of the Clean Water Act and current regulations and policies of the U. S. Army Corps of Engineers (USACE). The following evaluations were performed for this project:

1. Visual Channel Condition Assessment: Assessment of the cross-section of the stream for signs of stability and/or instability indicators.

2. Riparian Buffer Assessment: Assessment of riparian buffer quality with respect to habitat type and nutrient retention capability.

3. Desktop Aquatic Use Assessment: Assessment of in-stream habitat with respect to its suitability for effective colonization or use by fish, amphibians, and/or macroinvertebrates based on previous TCEQ assessment, if applicable and available.

4. Visual Channel Alteration Assessment: Assessment of presence of channel alterations that disrupt natural stream conditions.

METHODOLOGY/INVESTIGATIVE WORK

The Level 1 Stream Condition Assessment and Assessment of Stream Impacts work consisted of reviewing published historical information and detailed site reconnaissance, to assess the condition of streams on the subject property. Stream channel condition was visually assessed using the following geomorphological indicators: channel incision, access to original or recently created floodplains, channel widening, channel depositional features, rooting depth compared to streambed elevation, streambank vegetative protection, and streambank erosion. The following activities were undertaken to perform the stream conditional assessment: 1) interpret current and historical aerial photography; 2) perform site reconnaissance to evaluate and document stream condition baseline data; and 3) evaluate permit plans with respect to impacts on stream condition.

1. Stream Assessment Transects

Based upon methodology described in the 2013 Galveston District Corps of Engineers Level 1- Stream Condition Assessment for All Ephemeral and Intermittent Streams and for Impacts Less Than 500 Linear Feet to Intermittent Streams with Perennial Pools, Perennial Streams and Wadeable Rivers, all streams assessed under Level 1 with proposed impacts occurring to less than 500 linear feet shall use one (1) fixed-distance Stream Assessment Transect (Transect) of 350 linear feet. Ephemeral and Intermittent streams with impacts greater than 500 linear feet will add one fixed-distance Transect for each additional 500 feet of impact. Transects must be placed between 125 and 200 feet apart. Waters of the U.S. were identified and delineated according to the Regulatory Guidance Letter 05-05 – Ordinary High Water Mark Identification in September of 2014. With the use of aerial photography, topographic maps, and delineation data, the Waters of the U.S. on the subject property were determined to be 1,485 linear feet long. Two (2) transects were established along the intermittent streams on the subject property (***Appendix B***).

2. Visual Channel Condition Assessment

The Visual Channel Condition is an assessment of the cross-section of the stream, along the Transect. Under typical circumstances, stream channels respond to disturbance or changes in flow regime in a sequential, predictable manner. The stream channel evolutionary process is defined by the manner in which a stream responds to degradation and begins re-stabilizing at a lower elevation. The majority of stream systems are degrading, aggrading, healing or stable. The stage of stream channel evolution can be correlated directly to the state of stream stability. The purpose of evaluating the stream channel condition is to determine the current condition of the stream channel and to evaluate the current state of stream stability. The following five (5) stream Condition Variables (CVs) were used to assess channel condition: 1) severe; 2) poor; 3) marginal; 4) sub-optimal; and 5) optimal. CVs were assigned based on visual assessment of the following channel condition parameters: channel geometry, channel stability, and ability to connect to the active floodplain. Additionally, channel alteration parameters are considered in evaluation of CVs, as they may affect channel condition parameters.

A. Channel Geometry: Channel incision and widening are common signs of excess flow energy or stream power relative to sediment load. Excess flow results in stream bed erosion and steep, eroding banks. A wide cross-section compared to the depth of the channel indicates low cohesiveness with loose, eroding sediment.

B. Channel Stability: Channel stability is assessed using visual indicators of stability or instability. Erosion and deposition are orderly and predictable in a stable stream. Point bars are one of the most common signs of stream stability. These gently sloping crescent-shaped depositional features of well-sorted sediment are located inside of stream meanders, very close to baseflow water level. Bankfull benches are also common signs of stream stability. These flat or gently sloping areas above bankfull help slow high velocity flows during extreme flow events. Other indicators of a stable stream include vegetated banks, natural rock surface along the banks, or even simply an absence of indicators of instability.

   Both depositional and erosional features can serve as indicators of stream channel instability. Depositional features indicating stream instability include: mid-channel bars, transverse bars, and transient sediments. Mid-channel bars and transverse bars are depositional areas that maintain a higher elevation that the surrounding areas. These result from low stream discharge, which causes water to flow in lower elevation areas that provide less resistance and sediments to build up along the higher elevation areas where flow is minimal. Erosional features indicating stream instability include: erosion scars, denuded banks, and threaded channels.

C. Active Floodplain Connection: Active floodplain includes the land between the active channel at bankfull elevation and the terraces that are flooded by the stream on a periodic basis. Natural channels that exist at or immediately below the surrounding floodplain elevations are connected to the active floodplain. Channels that are deeply incised or channelized will be below the floodplain elevation and typically will not have access to the active floodplain.

3. Riparian Buffer Assessment

Riparian buffers, the zones of vegetation adjacent to streams, are important for controlling nutrients entering the stream through plant sequestration and microbial denitrification. Buffer width is positively related to nutrient removal capacity, and is an important parameter for assessing stream condition and impacts. The Buffer Value (BV) is determined by evaluating land cover type percentages in a 100 foot wide band along each side of the ordinary high water mark of the stream channel within the Transects. Each land cover type is scored and weighted by the percent of the buffer it occupies. Land cover type percentages were estimated using aerial photography and site reconnaissance and delineation for field verification. The following six (6) BVs were used to assess channel condition: 1) severe; 2) poor; 3) marginal; 4) low sub-optimal; 4.5) high sub-optimal; and 5) optimal. A severe BV would indicate a predominance of intensive human activity such as impervious cover or mining, while an optimal BV would indicate a native woody community with wetlands present.

The right bank (RB) and left bank (LB) BVs were assessed separately, and then combined. RB and LB were determined facing downstream of the channel. Each bank was scored using the following formula:

Bank BV = [(BV 1) x (% of buffer)] + [(BV 2) x (% of buffer)] + [(BV 3) x (% of buffer)] + [(BV 4) x (% of buffer)] + [(BV 4.5) x (% of buffer)] + [(BV 5) x (% of buffer)]

The final BV was calculated by averaging the RB and LB BVs:

Final BV = [(RB BV) + (LB BV)] / 2

4. Desktop Aquatic Use Assessment

Aquatic Use is an assessment of the suitability of a stream for effective colonization or use by fish, amphibians, and/or macroinvertebrates. The Texas Commission on Environmental Quality (TCEQ) and its cooperators, in compliance with 305(b) and 303(d) of the Clean Water Act, evaluate and monitor the state's surface waters and assess the health of surface waters of the state using established water quality standards defined in the *Texas Surface Water Quality Standard (TSWQS)*. Standards are established based on designated uses and associated in-stream conditions necessary for such uses. These standards establish an aquatic life use based on physical, chemical, and biological characteristics of a stream segment. Specific criteria tested may include: water temperature, pH, chloride, sulfate, dissolved oxygen, total dissolved solids, and fish and macroinvertebrate presence. Data from biennial state water evaluations are published as the *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d).* Based on the TCEQ's assessment, each stream segment's Aquatic Life Use is designated into five (5) categories: 1) Minimal; 2) Limited; 3) Intermediate; 4) High; and 5) Exceptional.

The Aquatic Life Use Variable (UV) used in the present study is based on the TCEQ's assessment of state surface water quality. The following five (5) UVs were used to assess channel condition, and correlate directly with the TCEQ's categories: 1) severe; 2) poor; 3) marginal; 4) sub-optimal; and 5) optimal. For streams not classified in the TSWQS, the aquatic life use is designated based on the stream flow type. Intermittent and ephemeral streams that have not been assessed are assigned a Minimal aquatic life use score, and therefore a UV of severe (1). Intermittent streams with perennial pools that have not been assessed are assigned a Limited aquatic life use score, and therefore a UV of poor (2). Perennial streams that have not been assessed are assigned a High aquatic life use score, and therefore a UV of sub-optimal (4).

5. Visual Channel Alteration Assessment

The Visual Channel Alteration is an assessment of anthropogenic impacts to part or all of the Transects being evaluated. Channel alterations that may disrupt the natural conditions of the stream are considered in this assessment. These alterations include, but are not limited to: straightening of channel (channelization), stream crossings, riprap, articulated matting, concrete aprons, gabions, concrete blocks, manmade embankments, spoil piles, constrictions to stream channel or flood-prone areas (culverts, levees, weirs, impoundments), and livestock-impacted channels. Any impact to the Transect channel condition, riparian buffer, or in-stream habitat due to channel alteration will be captured in the assessments of such variables. Presence of a structure does not necessarily result in a reduced score if the structure does not affect the natural condition of the stream, such as a bridge that spans the entire floodplain. The following five (5) stream Visual Channel Alteration Variables (AVs) were used to assess visual channel alteration: 1) severe; 2) poor; 3) marginal; 4) sub-optimal; and 5) optimal. A severe AV would indicate greater than 300 feet of the reach is impacted by channel alterations, while an optimal AV would indicate an absence of channel alterations and/or the channel has normalized after previous impacts.

6. Determination of Reach Condition Index (RCI)

The Transect Condition Index (CI) represents the baseline score of existing stream condition in a single Transect and is calculated using the stream assessment values above. CI was calculated for each Transect individually as follows:

$$CI = (CV + BV + UV + AV) / 4$$

The Reach Conditional Index (RCI) represents the overall baseline score of existing stream condition for an entire reach proposed to be impacted and combines data from all assessments described above. This value will be used to assess degradation of the stream due to proposed impacts, and the compensation requirement associated with impacting these waters. RCI was calculated by averaging all CIs within the reach proposed to be impacted, using the following equation:

$$RCI = (\Sigma^{Y}_{n=1} CI_n) / Y$$

(Y = number of transects)

7. Assessment of Impacts on Stream Condition

Permitted impacts may result in impairments to a stream's transport of water and sediment, stream water quality, and the stream's ability to support and maintain a community of organisms. These impairments are often the result of alternations to stream parameters such as bankfull depth, slope, velocity, flow resistance, sediment size, sediment load, and bankfull discharge. Permitted impacts are assessed based on the severity of impairments expected to be imposed on the stream. Impacts are categorized into five (5) Impact Classifications, with corresponding Impact Factors (IFs): 1) Temporary; 2) Minor; 3) Moderate; 4) Major; and 5) Severe. Temporary impacts (IF=1) would impose no permanent loss of aquatic function, due to restoration of the stream channel to pre-construction contours and elevations. Minor impacts (IF=2) would result in loss of function equivalent to or less than a 1-point change in RCI. Moderate impacts (IF=3) would result in loss of function equivalent to a 2-point change in RCI. Major impacts (IF=4) would result in loss of function equivalent to a 3-point change in RCI. Severe impacts (IF=5) would result in loss of function equivalent to a 4-point change in RCI.

The proposed site development plans associated with USACE Permit SWG-2018-00549 indicate that the channel impacts are self-mitigated with the construction of a restored, higher quality channel with a projected score of 3.0, compared to the 2.0 score for the to-be-impacted channel.

8. Determination of Stream Compensation Requirement (CR)

Stream Compensation Requirement (CR) represents the total stream compensation required for the proposed impacts to Waters of the U.S. Determination of the CR ensures equality in crediting on-site and off-site compensation projects and evaluating and approving stream compensation banks and in-lieu fee fund projects for compensating for impacts. Various methods of stream compensation are designated different credits based on the value and impact those methods have to stream conservation and restoration. CR is typically calculated as follows:

CR = Length of impact x RCI x IF

FINDINGS

1. Visual Channel Condition Assessment

Transects associated with the proposed project evaluated for visual channel condition scored CVs between severe (1) and poor (2) (***Appendix B***). The stream reaches assessed were characterized by clear past evidence of human alterations, notably channelization, incision, and past attempts at erosion control. Instability was high for most of the evaluation area.

2. Riparian Buffer Assessment

All Transects associated with the proposed project evaluated for riparian buffer scored BVs between marginal (3) and sub-optimal (4.5) (***Appendix B***). The stream reaches assessed were largely surrounded by riparian buffers that are dominated by native woody vegetation with little maintenance. Percentage of native woody vegetation cover ranges from less than 30% to greater than 60%. Wetlands were not present within the riparian buffer.

3. Desktop Aquatic Life Use Assessment

The channels in the project area have not been classified in the TSWQS; therefore, the aquatic life use was designated based on the stream flow type. As all streams evaluated were determined to be intermittent, all Transects for aquatic life use scored UVs of severe (1) (***Appendix B***).

4. Visual Channel Alteration Assessment

All Transects associated with the proposed project evaluated for visual channel alteration scored AVs of severe (1)

(***Appendix B***). The stream reaches assessed are heavily impacted by channelization, alteration or hardening, dams, dikes, levees, culverts, riprap, bulkheads, and/or armor.

5. Determination of Reach Condition Index (RCI)

Stream reaches evaluated under the Level 1 Stream Condition Assessment were determined to have an existing RCI of 2.0, with both transects scoring very similarly.

6. Assessment of Impacts on Stream Condition

Based on the proposed site development plans associated with USACE Permit SWG-2015-00328, proposed impacts to Waters of the U.S. on the subject property include the permanent placement of fill material in, or complete excavation of, 1,485 linear feet of Waters of the U.S. The existing RCI of the stream reach to be impacted was 2.0, while the anticipated RCI of this reach after the proposed impacts was 3.0 (***Appendix C***). Therefore, there is no proposed loss of function associated with these impacts, but rather an improvement of 1.0 points.

7. Determination of Stream Compensation Requirement (CR) and Credits

Due to the post-construction RCI of 3.0 being higher than the observed RCI of 2.0 and since the segment lengths are equal, this project is self-mitigating and no additional calculations are necessary.

CONCLUSIONS

Based on the Level 1 Stream Condition Assessment and Assessment of Stream Impacts presented in this report, it is the professional opinion of Berg ♦ Oliver Associates, Inc. (BOA) that the Reach Condition Index (RCI) of the stream reach proposed to be directly impacted in this study is 2.0. Due to the proposed project plans showing a post-construction RCI of 3.0, this project is self-mitigating.

Respectfully,

Jeff Dunn
Project Coordinator
Berg♦Oliver Associates, Inc.

Susan Alford
President
Berg♦Oliver Associates, Inc.

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APPENDIX A
LEVEL 1 STREAM ASSESSMENT MAP


A
B
B
N
0 75 150 300 Feet
Location: Harris County, Texas
Image Source: Nearmap US (2018)
Projection: NAD 83, UTM Zone 15N
GIS Contact: Jeff Dunn (jdunn@bergoliver.com)
NOTE: Approximate location of the 100-year floodplain as depicted was derived from digitized 2014 Federal Insurance Rate Maps (FIRM). The proper authorities, prior to any land planning or engineering activities,should verify the exact location of the100-year floodplain.
Legend
Acres
Channels - Lvl 1 SAM
Potential Waters of the U.S.
Stream Assessment Transects
350 LF (Each)
FEMA 100-Year Floodplain
Project Boundary
107.8
LEVEL 1 STREAM ASSESSMENT - EXISTING CONDITIONS
SITE MAP
REVISIONS
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For: Uptown Development
Location: Memorial Park
Harris County, Texas
SWG-2018-00644
Mitigation Plan
Memorial Park Central Connector
15 of 30

APPENDIX B
USACE STREAM ASSESSMENT DATA FORMS – EXISTING CONDITIONS

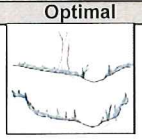
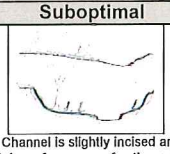
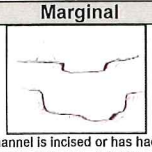
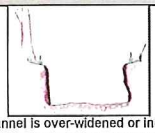
Stream Assessment Data Form for Level 1

U.S. Army Corps of Engineers Galveston District

File Number	Applicant	Stahler Stream Order	8 Digit HUC	Date	Transect #	Transect Description
SWG-2018-00549	Harris County Improvement District No. 1	1	12040104	12/4/18	A	Channelized tributary

Name(s) of Evaluator(s)	Stream Name and Type
Jeff Dunn	Unnamed Tributary - Buffalo Bayou (TCEQ#1014)

1. Channel Condition: Assess the cross-section of the stream and prevailing condition (erosion, aggradation)

	Optimal	Suboptimal	Marginal	Poor	Severe	
Visual Channel Condition Parameter	 Channel shows very little incision or widening and little or no evidence of erosion or unprotected banks. Indicators of stability include greater than 80% vegetative cover on the banks, stable point bars and bankfull benches may be present, mid-channel and transverse bars are rare or transient. The stream has access to active floodplain or fully developed bankfull benches. No bulkheading or riprap may be present	 Channel is slightly incised and contains a few areas of active erosion. Indicators of instability include vegetative cover or natural rock protection only present along 60-80% of the Transect, point bars and bankfull benches are likely present and transient sediment is present along 10-40% of the stream bottom. The stream has access to bankfull benches or developed floodplains along portions of the reach. Channel may show evidence of past channel alteration, but should be exhibiting notable recovery of a natural channel. Bulkhead and riprap are limited to 1-25% of the Transect.	 Channel is incised or has had its course widened. Indicators of instability include the presence of erosional scars on 40-60% of the Transect, vegetative cover or natural rock only found on 40-60% of the Transect, vertical or undercut banks, or nickpoints associated with headcuts may be present and portions of the channel may be widening while other portions of the channel are narrowing, and transient sediments are found in 40-60% of the natural stream bed or bottom. The stream does not have access to the active floodplain. Bulkheading or riprap is found along 25-50% of the Transect.	 Channel is over-widened or incised with vertically or laterally unstable banks. Visual indicators of over-widening and incision include near vertical banks with shallow root depths, erosional scars present along 60-80% of the Transect, vegetative cover or natural rock is limited to 20-40% of the Transect, substantial sediment deposition of uniformed-size material is present along 60-80% of the Transect and point bars and bankfull benches are absent. The stream does not have access to an active floodplain. Bulkheading and riprap are present along 50-80% of the Transect.	 Channel is deeply incised or excavated with vertical or lateral instability in the stream bank. Indicators of instability include the streambed elevation located below the rooting depth, both banks are vertical or undercut, vegetative surface protection or natural rock is only found along 20% or less of the Transect, the bank is sloughing and erosional scars or raw banks present on 80-100% of the Transect and 80% or more of the natural streambed is covered by substantial sediment resulting in threaded channels. The stream does not have access to an active floodplain.	CV
Score	5	4	3	2	1	2.0

Notes:

2. RIPARIAN BUFFERS: Assess both bank's 100 foot riparian areas along the entire Transect.

	Optimal	Suboptimal		Marginal	Poor	Severe
Riparian Buffers	Native woody species represent greater than 60% of the coverage and wetlands are present.	Native woody community species represent greater than 60% coverage with *NO* wetlands present within the buffer OR native woody community species represent 30-60% coverage with wetlands present. No maintenance or grazing activities.	Native woody community species represent between 30-60% coverage with *NO* wetlands present. No maintenance or grazing activities.	Native woody community represents less than 30% coverage with no maintenance or grazing activities.	The buffer is dominated by one or more of the following: lawns, mowed or maintained right-of-way, no-till cropland, actively grazed pasture, sparsely vegetated non-maintained area, recently seeded and stabilized or other comparable condition.	The area is dominated by impervious surfaces, mine spoil lands, denuded surfaces, conventional tillage row crops, active feed lots or comparable conditions.
Condition Scores	5	High = 4.5	Low = 4	3	2	1

Notes:

Right Bank	% Riparian Area>	35%	65%					100%			
	Score >	2	4.5								
									CI= (Sum % RA * Scores*0.01)/2		
Left Bank	% Riparian Area>	100%						100%	Rt Bank CI >	3.63	BV
	Score >	4							Lt Bank CI >	4.00	3.81

3. AQUATIC USE: The Transect is assessed based on the aquatic life use category score assigned to the stream segment by the TCEQ.

	Optimal	Suboptimal	Marginal	Poor	Severe	
AQUATIC USE	Aquatic Life Score of Exceptional.	Aquatic Life Score of High. Perennial streams that have not been assessed are also assumed to have an Aquatic Life Score of High	Aquatic Life Score of Intermediate.	Aquatic Life Score of Limited. Intermittent Streams with Perennial Pools that have not been assessed are also assumed to have an Aquatic Life Score of Limited.	Aquatic Life Score of Minimal. Intermittent and ephemeral streams that have not been assessed are also assumed to have an Aquatic Life Score of Minimal.	UV
Score	5	4	3	2	1	1.00

Notes

Stream Impact Assessment Form Page 2

Project #	Applicant	Locality	Cowardin Class.	HUC	Date	Transect #	Transect Description
2018-00549	Harris County Improvement District No. 1	Houston	Riverine	12040104	12/4/18	A	Channelized tributary

4. CHANNEL ALTERATION: Stream crossings, riprap, concrete, gabions, or concrete blocks, straightening of channel, channelization, embankments, spoil piles, constrictions, livestock

	Optimal	Suboptimal	Marginal	Poor	Severe	
Channel Alteration	Channelization, dredging, alteration or hardening absent. Stream has unaltered pattern or has normalize. No dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures within the Transect.	Less than 30% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability have recover. Withdrawals, if present, have no observable affect on flow	Between 30-60 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability are beginning to recovered. Withdrawals, if present, have may have an observable affect on flow, but no observable affect on habitat or biota.	Between 60-90 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration is present, and stream pattern and stability are not recovering. Withdrawals, if present, may have an observable affect on both flow and habitat or biota.	Between 90-100% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Withdrawals, if present, are large enough to have severe loss of flow and cause little to no habitat or biota.	AV
SCORE	5	4	3	2	1	1.00

Notes

REACH CONDITION INDEX and STREAM CONDITION UNITS FOR THIS REACH

THE CONDITION INDEX (CI) >> 1.95

INSERT PHOTOS:

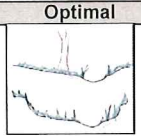
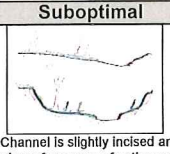
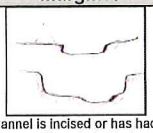
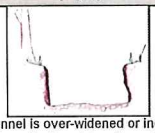
Stream Assessment Data Form for Level 1

U.S. Army Corps of Engineers Galveston District

File Number	Applicant	Stahler Stream Order	8 Digit HUC	Date	Transect #	Transect Description
SWG-2018-00549	Harris County Improvement District No. 1	1,2	12040104	12/4/18	B	Channelized tributary

Name(s) of Evaluator(s)	Stream Name and Type
Jeff Dunn	Unnamed Tributary - Buffalo Bayou (TCEQ#1014)

1. Channel Condition: Assess the cross-section of the stream and prevailing condition (erosion, aggradation)

	Optimal	Suboptimal	Marginal	Poor	Severe	
Visual Channel Condition Parameter	 Channel shows very little incision or widening and little or no evidence of erosion or unprotected banks. Indicators of stability include greater than 80% vegetative cover on the banks, stable point bars and bankfull benches may be present, mid-channel and transverse bars are rare or transient. The stream has access to active floodplain or fully developed bankfull benches. No bulkheading or riprap may be present	 Channel is slightly incised and contains a few areas of active erosion. Indicators of instability include vegetative cover or natural rock protection only present along 60-80% of the Transect, point bars and bankfull benches are likely present and transient sediment is present along 10-40% of the stream bottom. The stream has access to bankfull benches or developed floodplains along portions of the reach. Channel may show evidence of past channel alteration, but should be exhibiting notable recovery of a natural channel. Bulkhead and riprap are limited to 1-25% of the Transect.	 Channel is incised or has had its course widened. Indicators of instability include the presence of erosional scars on 40-60% of the Transect, vegetative cover or natural rock only found on 40-60% of the Transect, vertical or undercut banks, or nickpoints associated with headcuts may be present and portions of the channel may be widening while other portions of the channel are narrowing, and transient sediments are found in 40-60% of the natural stream bed or bottom. The stream does not have access to the active floodplain. Bulkheading or riprap is found along 25-50% of the Transect.	 Channel is over-widened or incised with vertically or laterally unstable banks. Visual indicators of over-widening and incision include near vertical banks with shallow root depths, erosional scars present along 60-80% of the Transect, vegetative cover or natural rock is limited to 20-40% of the Transect, substantial sediment deposition of uniformed-size material is present along 60-80% of the Transect and point bars and bankfull benches are absent. The stream does not have access to an active floodplain. Bulkheading and riprap are present along 50-80% of the Transect.	 Channel is deeply incised or excavated with vertical or lateral instability in the stream bank. Indicators of instability include the streambed elevation located below the rooting depth, both banks are vertical or undercut, vegetative surface protection or natural rock is only found along 20% or less of the Transect, the bank is sloughing and erosional scars or raw banks present on 80-100% of the Transect and 80% or more of the natural streambed is covered by substantial sediment resulting in threaded channels. The stream does not have access to an active floodplain.	CV
Score	5	4	3	2	1	1.0

Notes:

2. RIPARIAN BUFFERS: Assess both bank's 100 foot riparian areas along the entire Transect.

	Optimal	Suboptimal		Marginal	Poor	Severe
Riparian Buffers	Native woody species represent greater than 60% of the coverage and wetlands are present.	Native woody community species represent greater than 60% coverage with *NO* wetlands present within the buffer **OR** native woody community species represent 30-60% coverage with wetlands present. No maintenance or grazing activities.	Native woody community species represent between 30-60% coverage with *NO* wetlands present. No maintenance or grazing activities.	Native woody community represents less than 30% coverage with no maintenance or grazing activities.	The buffer is dominated by one or more of the following: lawns, mowed or maintained right-of-way, no-till cropland, actively grazed pasture, sparsely vegetated non-maintained area, recently seeded and stabilized or other comparable condition.	The area is dominated by impervious surfaces, mine spoil lands, denuded surfaces, conventional tillage row crops, active feed lots or comparable conditions.
Condition Scores	5	High = 4.5	Low = 4	3	2	1

Notes:

Right Bank	% Riparian Area>	100%						100%			
	Score >	4.5									
									CI= (Sum % RA * Scores*0.01)/2		
Left Bank	% Riparian Area>	100%						100%	Rt Bank CI >	4.50	BV
	Score >	4							Lt Bank CI >	4.00	4.25

3. AQUATIC USE: The Transect is assessed based on the aquatic life use category score assigned to the stream segment by the TCEQ.

	Optimal	Suboptimal	Marginal	Poor	Severe	
AQUATIC USE	Aquatic Life Score of Exceptional.	Aquatic Life Score of High. Perennial streams that have not been assessed are also assumed to have an Aquatic Life Score of High	Aquatic Life Score of Intermediate.	Aquatic Life Score of Limited. Intermittent Streams with Perennial Pools that have not been assessed are also assumed to have an Aquatic Life Score of Limited.	Aquatic Life Score of Minimal. Intermittent and ephemeral streams that have not been assessed are also assumed to have an Aquatic Life Score of Minimal.	UV
Score	5	4	3	2	1	1.00

Notes

Stream Impact Assessment Form Page 2

Project #	Applicant	Locality	Cowardin Class.	HUC	Date	Transect #	Transect Description
2018-00549	Harris County Improvement District No. 1	Houston	Riverine	12040104	12/4/18	B	Channelized tributary

4. CHANNEL ALTERATION: Stream crossings, riprap, concrete, gabions, or concrete blocks, straightening of channel, channelization, embankments, spoil piles, constrictions, livestock

	Optimal	Suboptimal	Marginal	Poor	Severe	
Channel Alteration	Channelization, dredging, alteration or hardening absent. Stream has unaltered pattern or has normalize. No dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures within the Transect.	Less than 30% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability have recover. Withdrawals, if present, have no observable affect on flow	Between 30-60 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability are beginning to recovered. Withdrawals, if present, have may have an observable affect on flow, but no observable affect on habitat or biota.	Between 60-90 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration is present, and stream pattern and stability are not recovering. Withdrawals, if present, may have an observable affect on both flow and habitat or biota.	Between 90-100% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Withdrawals, if present, are large enough to have severe loss of flow and cause little to no habitat or biota.	AV
SCORE	5	4	3	2	1	2.00

Notes

REACH CONDITION INDEX and STREAM CONDITION UNITS FOR THIS REACH

THE CONDITION INDEX (CI) >> 2.06

INSERT PHOTOS:

APPENDIX C
USACE STREAM ASSESSMENT DATA FORMS – PROPOSED CONDITIONS

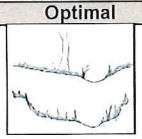
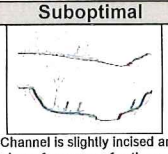
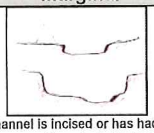
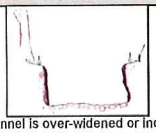
Stream Assessment Data Form for Level 1

U.S. Army Corps of Engineers Galveston District

File Number	Applicant	Stahler Stream Order	8 Digit HUC	Date	Transect #	Transect Description
SWG-2018-00549	Harris County Improvement District No. 1	1	12040104	1/18/19	P	Proposed/post-construction

Name(s) of Evaluator(s)	Stream Name and Type
Jeff Dunn	Unnamed Tributary - Buffalo Bayou (TCEQ#1014)

1. Channel Condition: Assess the cross-section of the stream and prevailing condition (erosion, aggradation)

	Optimal	Suboptimal	Marginal	Poor	Severe	
Visual Channel Condition Parameter	 Channel shows very little incision or widening and little or no evidence of erosion or unprotected banks. Indicators of stability include greater than 80% vegetative cover on the banks, stable point bars and bankfull benches may be present, mid-channel and transverse bars are rare or transient. The stream has access to active floodplain or fully developed bankfull benches. No bulkheading or riprap may be present	 Channel is slightly incised and contains a few areas of active erosion. Indicators of instability include vegetative cover or natural rock protection only present along 60-80% of the Transect, point bars and bankfull benches are likely present and transient sediment is present along 10-40% of the stream bottom. The stream has access to bankfull benches or developed floodplains along portions of the reach. Channel may show evidence of past channel alteration, but should be exhibiting notable recovery of a natural channel. Bulkhead and riprap are limited to 1-25% of the Transect.	 Channel is incised or has had its course widened. Indicators of instability include the presence of erosional scars on 40-60% of the Transect, vegetative cover or natural rock only found on 40-60% of the Transect, vertical or undercut banks, or nickpoints associated with headcuts may be present and portions of the channel may be widening while other portions of the channel are narrowing, and transient sediments are found in 40-60% of the natural stream bed or bottom. The stream does not have access to the active floodplain. Bulkheading or riprap is found along 25-50% of the Transect.	 Channel is over-widened or incised with vertically or laterally unstable banks. Visual indicators of over-widening and incision include near vertical banks with shallow root depths, erosional scars present along 60-80% of the Transect, vegetative cover or natural rock is limited to 20-40% of the Transect, substantial sediment deposition of uniformed-size material is present along 60-80% of the Transect and point bars and bankfull benches are absent. The stream does not have access to an active floodplain. Bulkheading and riprap are present along 50-80% of the Transect.	 Channel is deeply incised or excavated with vertical or lateral instability in the stream bank. Indicators of instability include the streambed elevation located below the rooting depth, both banks are vertical or undercut, vegetative surface protection or natural rock is only found along 20% or less of the Transect, the bank is sloughing and erosional scars or raw banks present on 80-100% of the Transect and 80% or more of the natural streambed is covered by substantial sediment resulting in threaded channels. The stream does not have access to an active floodplain.	CV
Score	5	4	3	2	1	4.0

Notes:

2. RIPARIAN BUFFERS: Assess both bank's 100 foot riparian areas along the entire Transect.

	Optimal	Suboptimal		Marginal	Poor	Severe
Riparian Buffers	Native woody species represent greater than 60% of the coverage and wetlands are present.	Native woody community species represent greater than 60% coverage with *NO* wetlands present within the buffer **OR** native woody community species represent 30-60% coverage with wetlands present. No maintenance or grazing activities.	Native woody community species represent between 30-60% coverage with *NO* wetlands present. No maintenance or grazing activities.	Native woody community represents less than 30% coverage with no maintenance or grazing activities.	The buffer is dominated by one or more of the following: lawns, mowed or maintained right-of-way, no-till cropland, actively grazed pasture, sparsely vegetated non-maintained area, recently seeded and stabilized or other comparable condition.	The area is dominated by impervious surfaces, mine spoil lands, denuded surfaces, conventional tillage row crops, active feed lots or comparable conditions.
Condition Scores	5	High = 4.5	Low = 4	3	2	1

Notes:

Right Bank	% Riparian Area>	100%						100%		
	Score >	4.5								
									CI= (Sum % RA * Scores*0.01)/2	
Left Bank	% Riparian Area>	100%						100%	Rt Bank CI >	4.50
	Score >	4.5							Lt Bank CI >	4.50

BV
4.50

3. AQUATIC USE: The Transect is assessed based on the aquatic life use category score assigned to the stream segment by the TCEQ.

	Optimal	Suboptimal	Marginal	Poor	Severe	
AQUATIC USE	Aquatic Life Score of Exceptional.	Aquatic Life Score of High. Perennial streams that have not been assessed are also assumed to have an Aquatic Life Score of High	Aquatic Life Score of Intermediate.	Aquatic Life Score of Limited. Intermittent Streams with Perennial Pools that have not been assessed are also assumed to have an Aquatic Life Score of Limited.	Aquatic Life Score of Minimal. Intermittent and ephemeral streams that have not been assessed are also assumed to have an Aquatic Life Score of Minimal.	UV
Score	5	4	3	2	1	1.00

Notes

Stream Impact Assessment Form Page 2

Project #	Applicant	Locality	Cowardin Class.	HUC	Date	Transect #	Transect Description
2018-00549	Harris County Improvement District No. 1	Houston	Riverine	12040104	1/18/19	P	Proposed/post-construction

4. CHANNEL ALTERATION: Stream crossings, riprap, concrete, gabions, or concrete blocks, straightening of channel, channelization, embankments, spoil piles, constrictions, livestock

	Optimal	Suboptimal	Marginal	Poor	Severe	
Channel Alteration	Channelization, dredging, alteration or hardening absent. Stream has unaltered pattern or has normalize. No dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures within the Transect.	Less than 30% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability have recover. Withdrawals, if present, have no observable affect on flow	Between 30-60 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration may be present, but stream pattern and stability are beginning to recovered. Withdrawals, if present, have may have an observable affect on flow, but no observable affect on habitat or biota.	Between 60-90 % of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Evidence of past alteration is present, and stream pattern and stability are not recovering. Withdrawals, if present, may have an observable affect on both flow and habitat or biota.	Between 90-100% of the Transect is impacted by dredging, dams, dikes, levees, culverts, riprap, bulkheads, armor, drop structures or withdrawal structures. Withdrawals, if present, are large enough to have severe loss of flow and cause little to no habitat or biota.	AV
SCORE	5	4	3	2	1	4.00

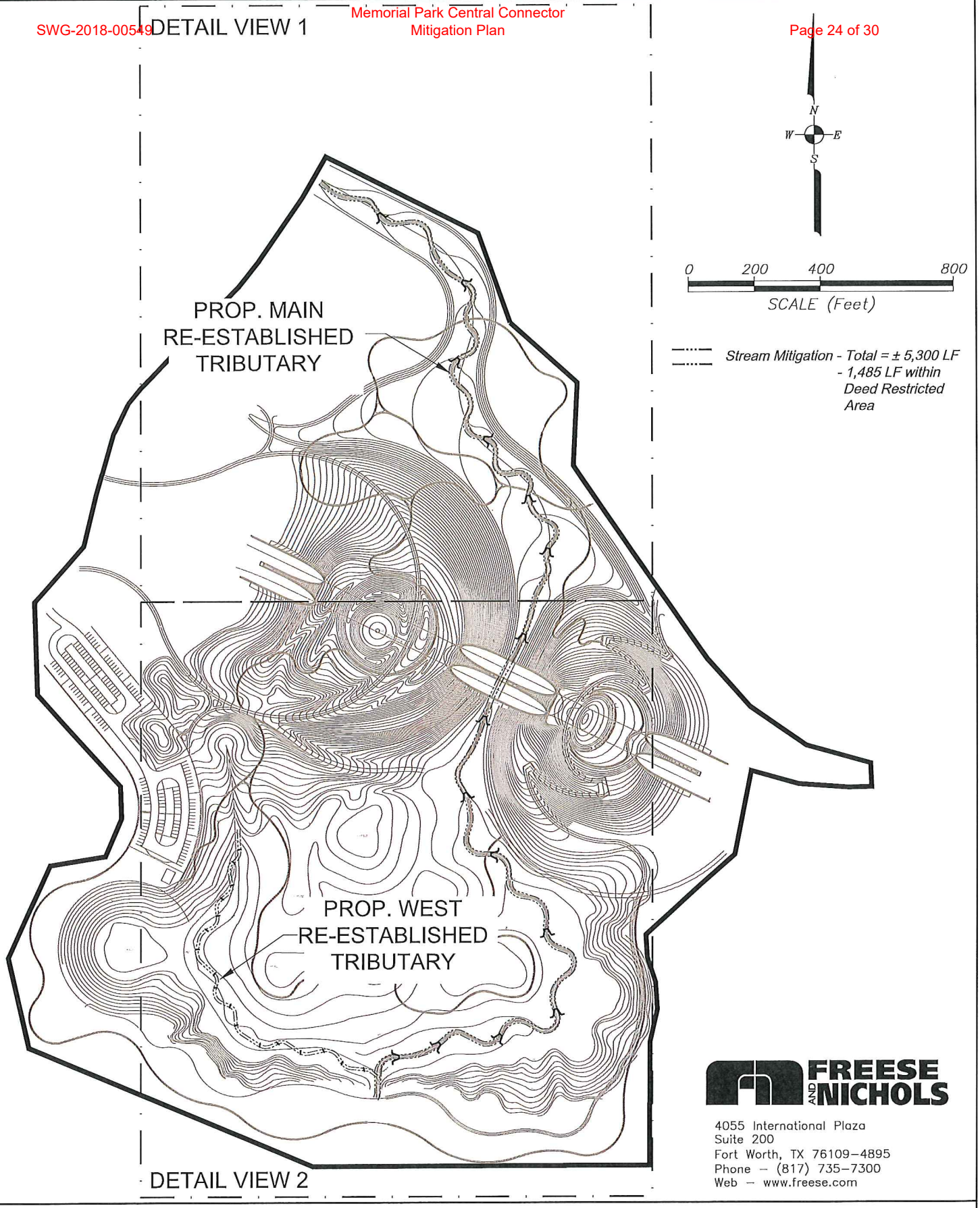
Notes

REACH CONDITION INDEX and STREAM CONDITION UNITS FOR THIS REACH

THE CONDITION INDEX (CI) >>	3.38

INSERT PHOTOS:

n / a



FREESE AND NICHOLS
4055 International Plaza
Suite 200
Fort Worth, TX 76109–4895
Phone – (817) 735–7300
Web – www.freese.com

MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
STREAM MITIGATION OVERVIEW

PROJECT #: 10755
FOR: Harris County Improvement District No. 1
LOCATION: Memorial Park Central Connector Project
Harris County, Texas

REVISIONS:
Jan. 18, 2019 by MDB

BERG◆OLIVER ASSOCIATES, INC.
ENVIRONMENTAL SCIENCE & LAND USE CONSULTANTS
14701 ST. MARY'S LANE, SUITE 400 HOUSTON, TX 77079
PHONE (281) 589-0898 http://www.bergoliver.com

Stream Mitigation - Total = ± 5,300 LF
- 1,485 LF within Deed Restricted Area

N
W E
S

0 100 200 400
SCALE (Feet)

FREESE AND NICHOLS
4055 International Plaza
Suite 200
Fort Worth, TX 76109–4895
Phone – (817) 735–7300
Web – www.freese.com

PROP. MAIN RE-ESTABLISHED TRIBUTARY WITH ROCK ARMORING AND RIFFLE/POOL STRUCTURES - SEE MAIN RE-ESTABLISHED TRIBUTARY DETAIL VIEWS 1 AND 2.

MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
SHEET 1

PROJECT #: 10755
FOR: Harris County Improvement District No. 1
LOCATION: Memorial Park Central Connector Project
Harris County, Texas

REVISIONS:
Jan. 18, 2019 by MDB

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14701 ST. MARY'S LANE, SUITE 400 HOUSTON, TX 77079
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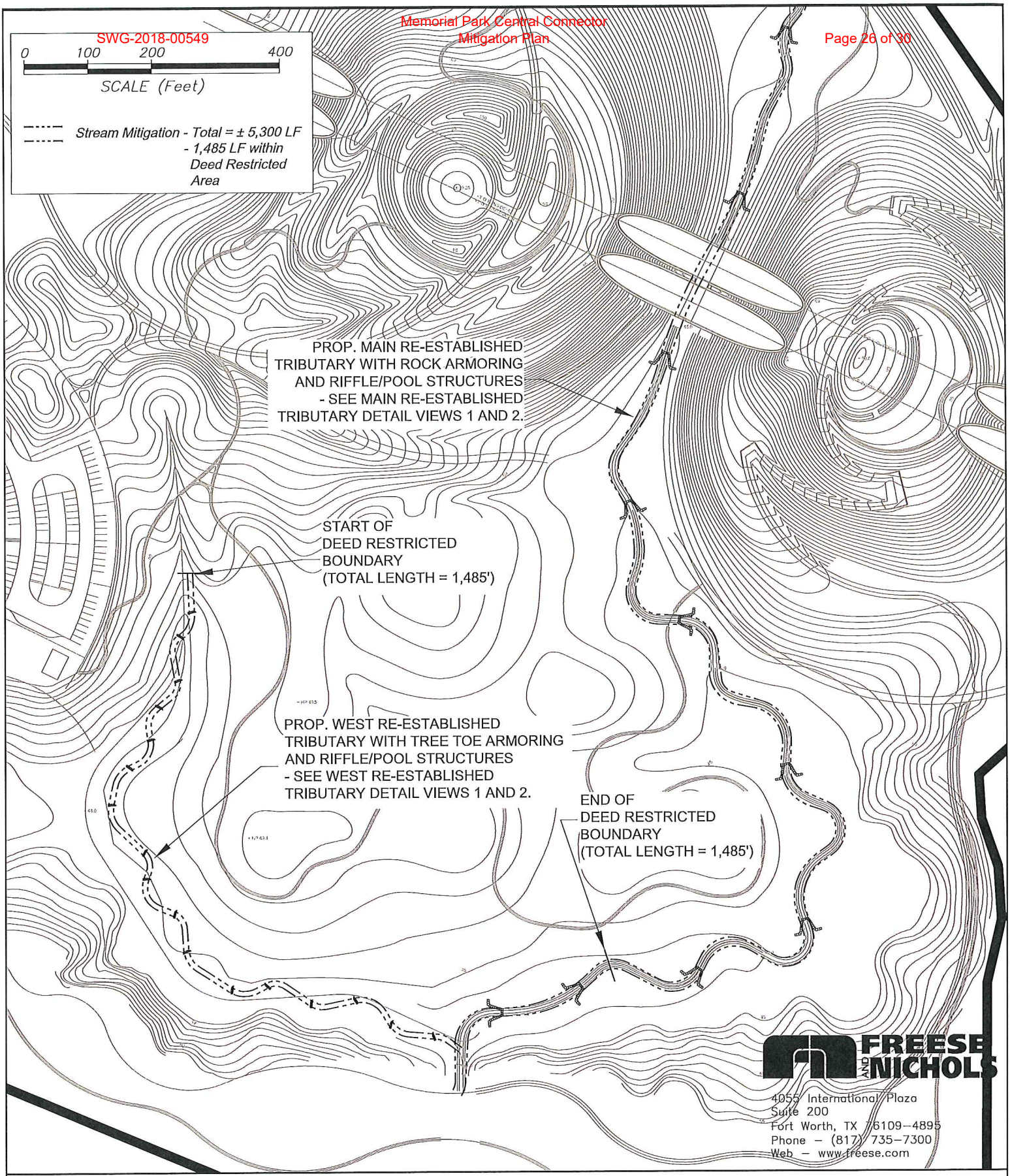

FREESE AND NICHOLS
4055 International Plaza
Suite 200
Fort Worth, TX 76109-4895
Phone – (817) 735-7300
Web – www.freese.com

MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
SHEET 2

PROJECT #: 10755
FOR: Harris County Improvement District No. 1
LOCATION: Memorial Park Central Connector Project
Harris County, Texas

REVISIONS:
Jan. 18, 2019 by MDB

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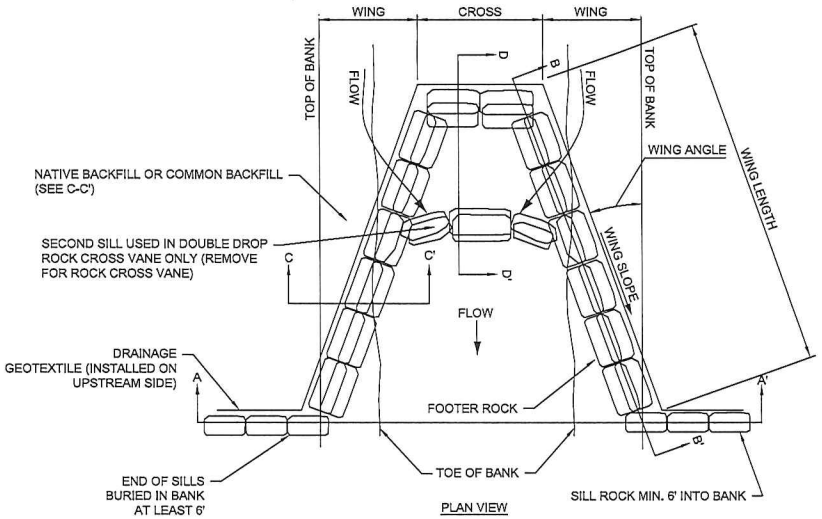
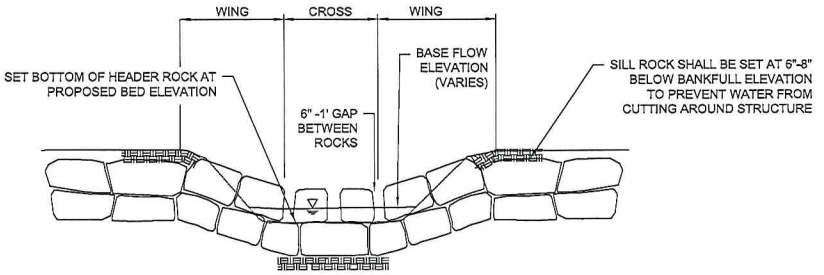
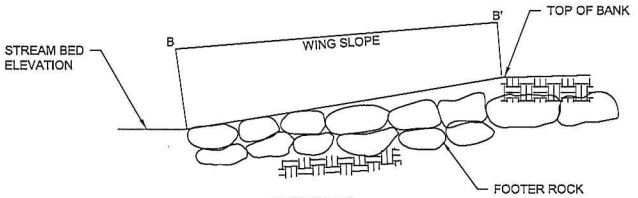


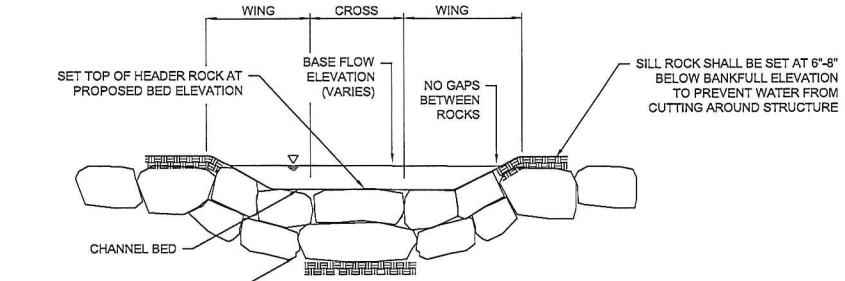
PLAN VIEW



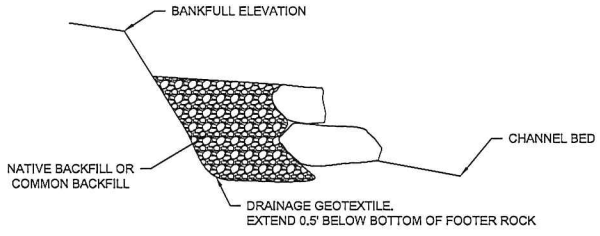
SECTION A-A' WITH GAPS IN HEADER ROCKS



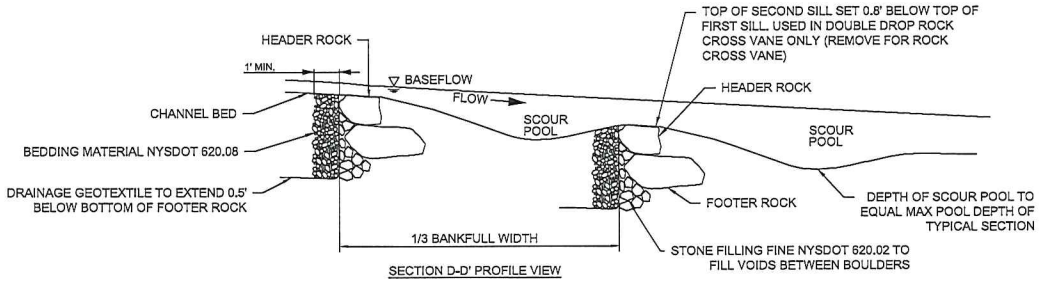
SECTION B-B'



SECTION A-A' (UPSTREAM VIEW)



SECTION C-C'



SECTION D-D' PROFILE VIEW

NOTE:
1. HEADER, FOOTER, AND SILL ROCKS TO BE STACKABLES
2. ALL VANE ARMS TO BE BACKFILLED WITH NATIVE FILL
3. 1/2 OF ROCK CROSS VANES TO BE CONSTRUCTED WITH GAPS IN SILL HEADER ROCKS AND 1/2 TO BE CONSTRUCTED WITH NO GAPS

MAIN RE-ESTABLISHED TRIBUTARY DETAIL VIEW 1

SCALE: NTS

NOT TO SCALE

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MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
MAIN RE-ESTABLISHED TRIBUTARY DETAIL VIEW 1

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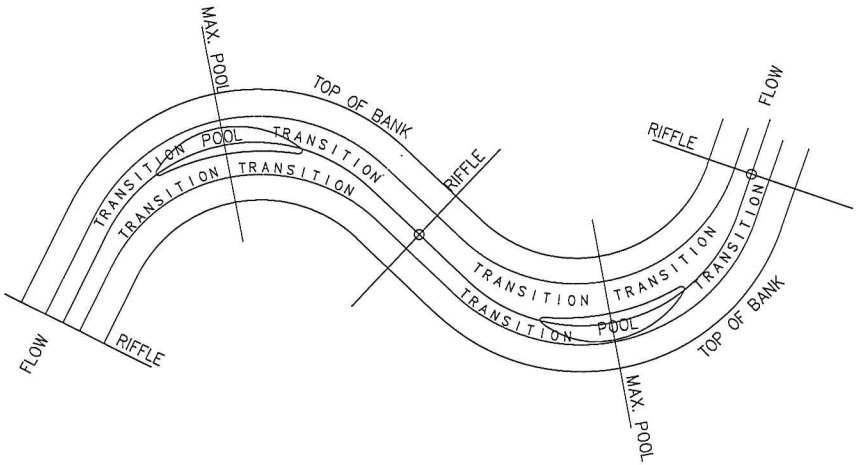
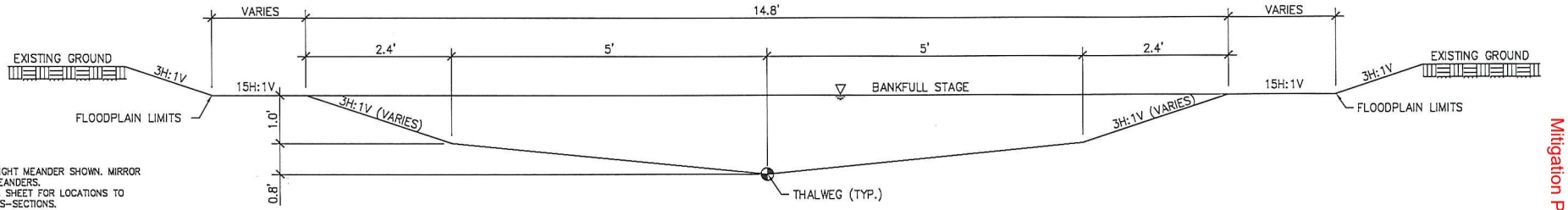


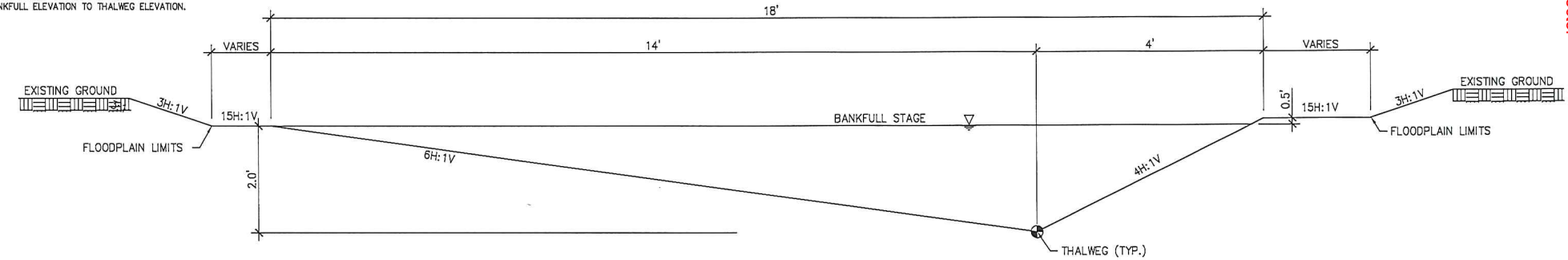
MAIN RE-ESTABLISHED TRIBUTARY RIFFLE/POOL PLAN VIEW
SCALE: NTS



NOTES:

1. POOL TYPICAL FOR RIGHT MEANDER SHOWN. MIRROR SECTION FOR LEFT MEANDERS.
2. SEE ALIGNMENT DATA SHEET FOR LOCATIONS TO APPLY TYPICAL CROSS-SECTIONS.
3. RIFFLE CROSS-SECTION TYPICALLY OCCURS AT MID-RIFFLE AND POOL CROSS-SECTION AT THE MID-POOL. CHANNEL DEPTH AND SIDE SLOPES WILL VARY ALONG TRANSITION FROM POOL CROSS-SECTION TO RIFFLE CROSS-SECTION. REFER TO PROPOSED PROFILE FOR DEPTHS FROM BANKFULL ELEVATION TO THALWEG ELEVATION.

MAIN RE-ESTABLISHED TRIBUTARY RIFFLE CROSS-SECTION
SCALE: NTS



NOT TO SCALE

MAIN RE-ESTABLISHED TRIBUTARY POOL CROSS-SECTION
SCALE: NTS

SWG-2018-00549

Memorial Park Central Connector
Mitigation Plan

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MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
MAIN RE-ESTABLISHED TRIBUTARY DETAIL VIEW 2

PROJECT #: *10755*
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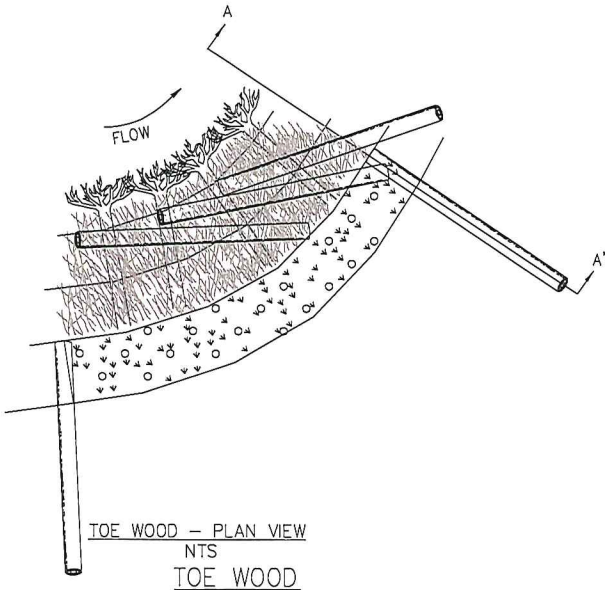
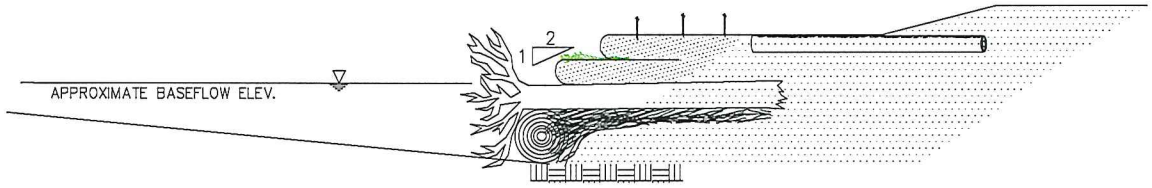
NOTES:

1. THE CONTRACTOR SHALL USE LOGS, TRUNKS WITH ROOTS, BRANCHES AND WOODY DEBRIS, TO FORM THE "TOE WOOD" STREAMBANK TOE PROTECTION.
2. THE STREAMBANKS ABOVE THE TOE WOOD SHALL BE FORMED FROM SOIL LIFTS WRAPPED IN COIR MATTING.
3. TOP OF LOG FOR ROOT WAD SET AT ELEVATION OF HEAD OF RIFFLE/GLIDE IMMEDIATELY DOWNSTREAM OF STRUCTURE



TOE WOOD – PLAN VIEW
NTS

TOE WOOD
SCALE: NTS



TOE WOOD – SECTION VIEW A–A'
NTS

WEST RE-ESTABLISHED TRIBUTARY DETAIL VIEW 1

SCALE: NTS

NOT TO SCALE

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MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
WEST RE–ESTABLISHED TRIBUTARY DETAIL VIEW 1

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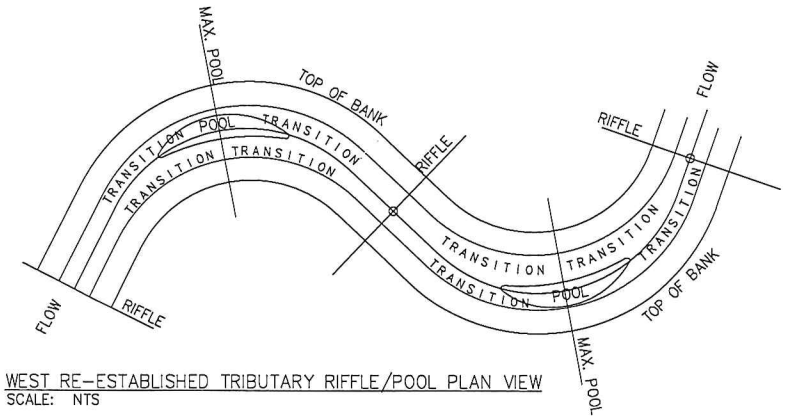
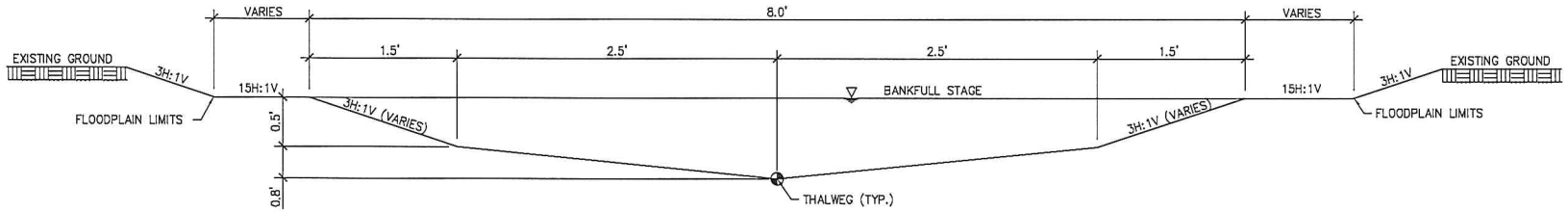
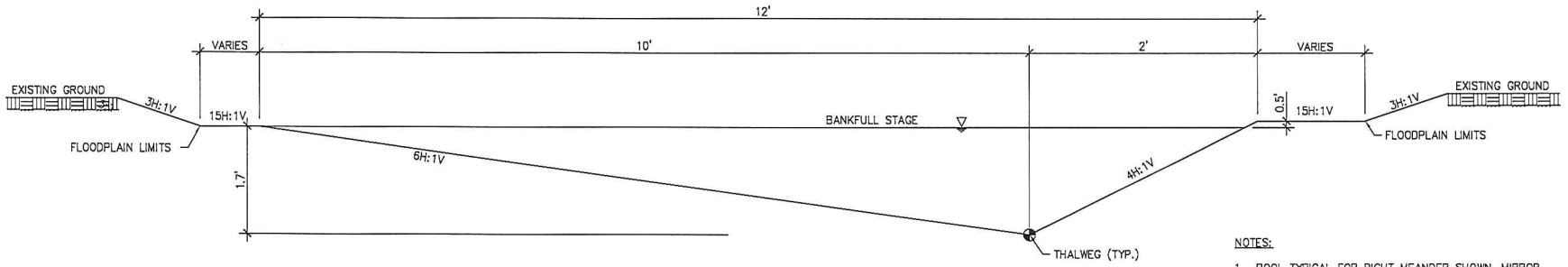


WEST RE-ESTABLISHED TRIBUTARY RIFFLE/POOL PLAN VIEW
SCALE: NTS



WEST RE-ESTABLISHED TRIBUTARY RIFFLE CROSS-SECTION
SCALE: NTS



WEST RE-ESTABLISHED TRIBUTARY POOL CROSS-SECTION
SCALE: NTS

NOTES:

1. POOL TYPICAL FOR RIGHT MEANDER SHOWN. MIRROR SECTION FOR LEFT MEANDERS.
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MEMORIAL PARK CENTRAL CONNCECTOR PROJECT
WEST RE-ESTABLISHED TRIBUTARY DETAIL VIEW 2

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