



**US Army Corps  
of Engineers®**  
Engineer Research and  
Development Center

## **Sampling, Chemical Analysis, and Bioassessment in Accordance with CWA Section 404**

### **Houston Ship Channel Expansion Channel Improvement Project, North of Morgan's Point Houston Ship Channel, Texas (Part 1 of 6: Text, Figures, & Tables)**

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## List of Acronyms

|           |  |
|-----------|--|
| ABS       | Aquatic Biosystems   |
| ACR       | Acute – to Chronic Ratio   |
| AF        | Application Factor   |
| AOC       | Area of Concern  |
| ASTM      | American Society for Testing and Materials                           |
| AWS       | Air, Water, & Soil Laboratories, Inc.                                |
| BCC       | Barbours Cut Channel   |
| Benchmark | Benchmark Ecological Services  |
| BSC       | Bayport Ship Channel   |
| CCV       | Continuing Calibration Verification                                  |
| CDF       | Confined Disposal Facility   |
| CDFATE    | Continuous Discharge Fate (from Dredging Operations into Open Water) |
| cfs       | cubic feet per second  |
| cm        | centimeter   |
| CMC       | Criterion Maximum Concentration                                      |
| CME       | Central Mining Equipment   |
| COC       | Contaminants of Concern  |
| Cr        | Chromium   |
| CWA       | Clean Water Act  |
| DO        | Dissolved Oxygen   |
| DOC       | Dissolved Organic Carbon   |
| DOD       | Department of Defense  |
| DM        | Dredged Material   |
| DMMP      | Dredge Material Management Plan                                      |
| ECB       | Environmental Chemistry Branch                                       |
| ECIP      | Expansion Channel Improvement Project                                |
| EL        | Environmental Laboratory   |
| ERDC      | Engineer Research and Development Center                             |
| ER-L      | Effects Range - Low  |
| ER-M      | Effects Range - Median   |
| Fugro     | Fugro USA Land, Inc.   |
| fps       | feet per second  |
| ft.       | feet   |
| g         | grams  |
| g/L       | grams per liter  |
| GC/MS     | Gas Chromatograph/Mass Spectrometry                                  |
| GPS       | Global Positioning System  |
| GTS       | Geotechnical Testing Services, Inc. Laboratory                       |
| h         | hour   |

|       |   |
|-------|---|
| HDPE  | High-Density Polyethylene                       |
| hp    | horsepower                                      |
| HPAH  | High molecular weight Polyaromatic Hydrocarbons |
| HSC   | Houston Ship Channel                            |
| ICV   | Initial Calibration Verification                |
| ISE   | Ion Selective Electrode                         |
| J     | Estimated concentration                         |
| JV    | Joint Venture – AECOM and Gahagan & Bryant      |
| KCl   | Potassium Chloride                              |
| L     | liters  |
| L/B   | Lift Boat                                       |
| LC50  | Lethal Concentration (50% survival rate)        |
| LCS   | Laboratory Control Sample                       |
| LCSD  | Laboratory Control Sample Duplicate             |
| LPAH  | Low molecular weight Polyaromatic Hydrocarbons  |
| LOEC  | Lowest Observed Effect Concentration            |
| MB    | Mooring Basin                                   |
| MDL   | Method Detection Limit                          |
| m     | meter   |
| mg    | milligrams                                      |
| mg/kg | milligrams per kilogram                         |
| mg/L  | milligrams per liter                            |
| mi    | miles   |
| mL    | milliliters                                     |
| mm    | millimeters                                     |
| mS/cm | milli-Siemens per centimeter                    |
| mV    | millivolts                                      |
| MLLW  | Mean Lower Low Water                            |
| MPRSA | Marine Protection, Research and Sanctuaries Act |
| MRL   | Method Reporting Limit                          |
| MS    | Matrix Spike                                    |
| MSD   | Matrix Spike Duplicate                          |
| MZ    | Mixing Zone                                     |
| N     | Number  |
| NAS   | National Academy of Sciences                    |
| NMP   | North of Morgan's Point                         |
| NOAA  | National Oceanic and Atmospheric Administration |
| NOEC  | No Observed Effect Concentration                |
| NTU   | Nephelometric Turbidity Unit                    |
| ODMDS | Ocean Dredged Material Dumping Site             |
| ORP   | Oxygen Reduction Potential                      |
| PA    | Placement Area                                  |

|       |  |
|-------|--|
| PAH   | Polyaromatic Hydrocarbons                      |
| PCB   | Polychlorinated Biphenyls                      |
| PCP   | Pentachlorophenol                              |
| PI    | Plasticity Index                               |
| POHA  | Port of Houston Authority                      |
| ppt   | part per thousand                              |
| QA    | Quality Assurance                              |
| QC    | Quality Control                                |
| QSM   | Quality Systems Manual                         |
| RIA   | Regional Implementation Agreement              |
| RL    | Reporting Limit                                |
| RPD   | Relative Percent Difference                    |
| s     | second   |
| SAP   | Sample and Analysis Plan                       |
| S.D.  | Standard Deviation                             |
| SM    | Standard Method                                |
| SPT   | Sample Penetration Test                        |
| SRM   | Standard Reference Material                    |
| ss    | stainless steel                                |
| SVOC  | Semi Volatile Organic Compound                 |
| SWG   | Southwest Galveston                            |
| TAL   | Target Analyte List                            |
| TB    | Turning Basin                                  |
| TCE   | Tetrachloroethylene                            |
| TCEQ  | Texas Commission on Environmental Quality      |
| TDL   | Target Detection Limit                         |
| TEF   | Toxic Equivalency Factor                       |
| TEQ   | Toxic Equivalency                              |
| TMX   | 2,4,5,6-tetrachloro-m-xylene                   |
| TOC   | Total Organic Carbon                           |
| TPH   | Total Petroleum Hydrocarbon                    |
| TNRCC | Texas Natural Resource Conservation Commission |
| TRE   | Toxicity Reduction Evaluation                  |
| TSS   | Total Suspended Solids                         |
| TSWQS | Texas Surface Water Quality Standard           |
| U     | Not detected                                   |
| ug/kg | micrograms per kilogram                        |
| ug/L  | micrograms per liter                           |
| UIA   | Unionized ammonia                              |
| USACE | United States Army Corps of Engineers          |
| USCS  | Universal Soil Classification System           |
| USEPA | United States Environmental Protection Agency  |

|      |                                 |
|------|---------------------------------|
| USGS | United States Geological Survey |
| VOC  | Volatile Organic Compound       |
| WHO  | World Health Organization       |
| WQC  | Water Quality Criteria          |
| WQS  | Water Quality Standard          |
| YSI  | Yellow Springs Instruments      |
| ZID  | Zone of Initial Dilution        |

## 1.0 Introduction

### 1.1 Regulatory Background

Sediments proposed to be dredged as part of the Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) fall under Section 404 of the Clean Water Act (CWA). Section 404 requires the impacts of such activities to assess potential impacts to surface waters of the United States.

To assess these impacts, sediment and surface water samples were collected at representative sampling locations within the dredge prism in the ship channel from just north of Morgan's Point to the main turning basin in Houston. Media were chemically characterized, elutriate toxicity and elutriate chemistry data were generated, and the data were used in Fate of Continuous Discharge from Dredging Operations into Open Water (CDFATE) modeling to simulate dredged material discharges from four upland placement areas (PAs).

### 1.2 Objectives and Deliverables

The primary objectives and deliverables of this pre-dredging sampling and analysis effort for the U.S. Army Corps of Engineers (USACE) Southwest Galveston District (SWG) and the Port of Houston Authority (POHA), Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), are to provide a report that complies with the USACE project specific Sampling and Analysis Plan (SAP) (USACE, 2018). This report is focused on Segments 1, 4, 5, and 6 of the HSC that span from north of Morgan's Point (NMP) through to the main turning basin in Houston (Figure 1). These segments are described more fully in Section 1.4.

The primary objectives of this report are outlined below:

- a) Sample collection: Tabulate and plot sampling sites and locations (water and sediment) showing locations and the dredging prism and to summarize and cross-reference to study documents
- b) Field procedures: Summarize field procedures, observations and deviations and cross reference to project documents (i.e., compositing, physical observations (e.g., odor, stratification, etc.))
- c) Quality Control (QC) (field): Describe and cross-reference procedures followed and samples collected
- d) Analyses and Laboratory QC: Review and evaluate the media analyzed, analytical methods, procedures followed and results from the laboratory samples to ensure data that were usable and representative of the dredged material
- e) Results and Discussion: Present and discuss data by medium and then by analyte category and by each bioassay and then within each bioassay by test organism.

Each section has the following discussion components:

- i. Data Summary Tables: Including appropriate statistics (e.g., N=number, minimum, mean, maximum, etc.) for both analytical and miscellaneous parameters for all media and tests
- ii. Results: As per the SAP

- iii. Data Review and Validation: As per SAP Attachment C and Supplemental Attachment C-1
- iv. Field and Laboratory Qualifiers: As per the SAP and as well as an interpretation as to how qualifiers impact the evaluation
- v. Site-Specific Parameters: Factors that impact the data discussions (e.g., matrix effects, sample dilution etc.)
- vi. Deviations: Summarized and impact(s) on the study discussed
- vii. Cross-Referencing of text discussion with data summary tables.
- viii. Conclusions and Recommendations

### 1.3 Testing Approach

The evaluation of the new work sediments included chemical analyses of site surface water and sediment through direct sampling, and both chemical analysis and toxicity testing on the modified elutriate samples. Elutriate chemistry and elutriate bioassay data were evaluated and applied in CDFATE modeling to look at mixing zone requirements at the point of discharge from the upland PAs after placement.

The northern section of the HSC is industrialized and due to the industrialization in this area, no categories of contaminants of concern (COCs) listed in the Regional Implementation Agreement (RIA) between the Galveston District of the USACE and Region 6 of the USEPA (USEPA/USACE, 2003) were excluded from analysis. A full chemical analyses (i.e., volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), pentachlorophenols (PCPs) total petroleum hydrocarbons (TPH), pesticides, total polychlorinated biphenyls (PCBs), target analyte list (TAL) metals, dioxins/furans, and miscellaneous parameters) were performed for all media types. Dioxins/furans are not routinely analyzed for in dredging projects, however, due to the presence of the San Jacinto Waste Pits and the Area of Concern (AOC) associated with the historical releases of dioxins/dibenzofurans from this area north of Morgan's Point (Figure 2), this analysis has been added for this project.

Elutriate samples were analyzed for the same chemical suites as surface water and sediment, and had suspended particle bioassays run using two taxonomically and functionally dissimilar species (mysid shrimp *A. bahia* and the fish *M. beryllina*) to assess the potential for biological effects of dredged material (DM) released into the water column during DM discharge (elutriate toxicity tests).

Preliminary CDFATE modeling was run to examine the mixing zone dilution requirements. Simulations of dredged material discharges into four upland placement areas (PAs) were run using CDFATE to establish compliance with water column toxicity criteria for the HSC sediment samples HSCNew-NMP-02, HSCNew-NMP-03, HSCNew-NMP-04, HSCNew-NMP-05, HSCNew-NMP-06, HSCNew-NMP-07, HSCNew-NMP-08, HSCNew-NMP-09, HSCNew-NMP-10, and HSCNew-NMP-11.

## 1.4 Project Area Description

The Houston Ship Channel (HSC) system is located in southeast Texas and spans Harris, Chambers, and Galveston Counties in Texas and is approximately 52 miles (mi) in length from Bolivar Island to the Main Turning Basin (Figure 1). The HSC for the Expansion Channel Improvement Project (ECIP) has been divided into the following six study segments (USACE, 2017).

- Segment 1 - Bay Reach
  - Includes Bolivar Roads to Redfish (BR-RF), Redfish to Bayport Ship Channel (RF-BSC), and Bayport Ship Channel to Barbours Cut Channel (BSC-BCC)
- Segment 2 – Bayport Ship Channel (BSC)
- Segment 3 – Barbours Cut Channel (BCC)
- Segment 4 – Boggy Bayou to Sims Bayou
- Segment 5 – Sims Bayou to I-610 Bridge
- Segment 6 – I-610 Bridge to Main Turning Basin (TB)

This sampling and analysis effort focuses on the following segments only: Bay Reach (Segment 1) north of Morgan’s Point only (Stations 0+05 to 684+03), Boggy Bayou to Sims Bayou (Segment 4; Stations 684+03 to 833+05), Sims Bayou to I-610 Bridge (Segment 5; Stations 1110+77 to 1160+62), and I-610 Bridge to Main Turning Basin (Segment 6; Channel Stations 1160+60 to 1266+48, and Main TB Stations 0 to 30+95). The existing authorized depth of the Houston Ship Channel for this study area ranges from -41.5ft. to -46.5 feet (ft.) mean lower low water (MLLW) and the existing width is 300 ft. The entire channel is not proposed for widening and deepening, but instead, individual target segments were identified for improvements and are specified below:

Segment 1 (north of Morgan’s Point): The existing width and depth of the main channel in Segment 1 north of Morgan’s Point is 530 ft. to 600 ft. and -46.5 ft. respectively, and will remain at this existing width and depth. The Mooring Basin (MB) at Station 500+00 is approximately 57 acres and ranges in depth from approximately -18 ft. to -41 ft. and will be deepened to -41.5 ft.

Segment 4: Segment 4 has an existing width of 300 ft. with a new proposed width of 530 ft. from Boggy Bayou to Greens Bayou only; the remainder of Segment 4 (Greens Bayou to Sims Bayou) will remain at its existing width (300 ft.). The existing depth of Segment 4 ranges from -38.5 ft. to -41.5 ft. Boggy Bayou to Washburn Tunnel has an existing depth of -41.5 ft. and a proposed depth of -46.5 ft. The remainder of Segment 4 will remain at its existing depth.

Segment 5: Segment 5 has an existing width of 300 ft. and will remain at its existing width. The depth of Segment 5 is -37.5 ft. with a proposed depth of -46.5 ft.

Segment 6: Segment 6 from I-610 Bridge to Main TB has an existing width of 300 ft. and the Main TB has an existing width of 400 ft. to 932 ft. and will remain at its existing width. The depth of Segment 6 is -37.5 ft. with a proposed depth is -41.5 ft.

Evaluation of dredge material for Segments 1 (south of Morgan’s Point), 2, and 3 are discussed separately in the “Sampling, Chemical Analysis, and Bioassessment in Accordance with MPRSA Section 103, Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) South of Morgan’s Point Report, 2019” (USACE, 2019a) since the sediments from these segments will be placed in the Ocean Dredged Material Dumping Site (ODMDS).

## 2.0 Materials and Methods

### 2.1 Project Design and Rationale

As outlined in the SAP, the area to be dredged covered in this evaluation is composed of four primary segments:

- 1) Segment 1: Bay Reach North of Morgan’s Point (Mooring Basin, Station 500+00):** Dredged material from this segment was expected to consist primarily of new work material, consisting solely of undisturbed base layer geological formations free of impacts from industrial sources or transport mechanisms. There was a chance that influence from industrial sources may have occurred. As a result, these dredged materials were conservatively considered exposed new work surficially and unexposed new work at depth.
- 2) Segment 4: Boggy Bayou to Sims Bayou (Boggy Bayou to Washburn Tunnel ,Stations 684+03 to 974+07):** Dredged material from this segment was expected to consist of some maintenance material in the existing channel, but primarily be new work material, consisting solely of undisturbed base layer geological formations free of impacts from industrial sources or transport mechanisms. There was a chance that influence from industrial sources may have occurred. As a result, these dredged materials were conservatively considered exposed new work surficially and unexposed new work at depth.
- 3) Segment 5: Sims Bayou to I-610 Bridge (Stations 1110+77 to 1160+62):** Dredged material from this segment was expected to consist of some maintenance material in the existing channel, but primarily be new work material, consisting solely of undisturbed base layer geological formations free of impacts from industrial sources or transport mechanisms. There was a chance that influence from industrial sources may have occurred. As a result, these dredged materials were conservatively considered exposed new work surficially and unexposed new work at depth.
- 4) Segment 6: I-610 Bridge to Main TB (Stations 1160+60 to 1266+48; Main TB Stations 0 to 30+95):** Dredged material from this segment was expected to consist of some maintenance material in the existing channel, but primarily be new work material, consisting solely of undisturbed base layer geological formations free of impacts from industrial sources or transport mechanisms. There is a chance that influence from industrial sources may have occurred. As a result, these dredged materials were conservatively considered exposed new work surficially and unexposed new work at depth.

According to the SAP (USACE, 2018), the new work sample locations were based upon geotechnical borings from 1963 and 1964 and were selected to be representative of general subsurface geological



composition within the study area. Each channel sample is a composite of material representative of a geological component of the new work dredge prism in the ship channel, since the location of these sampling points was based upon geotechnical boring information. As noted in the SAP, geotechnical borings surveys were not available for Segments 5 and 6, these samples were distributed evenly across the length of the remaining channel to be spatially representative of the dredging prism materials. A total of 12 sediment, surface water, and bulk water samples were collected (11 channel locations and 1 duplicate location). Each sediment sample is a composite of subsamples from within the area proximate to the channel location. Justification for choosing these sample locations is discussed in detail in Attachment A of the SAP (USACE, 2018).

The SAP was written with the expectation that the optimal locations to maximize sediment boring volumes might require sampling locations to be shifted within each sampling area in the field. If a sediment sample could not be acquired at a designated location, the location was moved within the sampling area and the portion of the borings collected kept were consistent with the study's dredge prism. Final sediment sample locations are justified and summarized in Section 2.2.1 and are plotted in Figures 3 through 5. Surface water samples were collected mid-column at one sample location within each sampling area.

## 2.2 Sample Collection Techniques

### 2.2.1 Field Effort

In October 2018, the field contractor, FUGRO USA LAND, INC (Fugro), conducted sample collection according to the USACE SAP. USACE oversight was not provided for this sampling event as was the case for the south of Morgan's Point sampling effort; this is discussed further in "Sampling, Chemical Analysis, and Bioassessment in Accordance with MPRSA Section 103, Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) South of Morgan's Point, Houston Ship Channel, Texas" (USACE, 2019a). The full field report is included as Appendix 2 of this report.

The following samples were collected:

**HSCNew-NMP-01 (Segment 1, Station 503+00):** One representative sample (i.e., '-A') was collected from one side of the existing Mooring Basin as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-02 (Segment 4, Station 730+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-03(Segment 4, Station 794+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-03-Field Duplicate (Segment 4, Station 794+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-04 (Segment 4, Station 873+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-05 (Segment 4, Station 961+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-06 (Segment 5, Station 1127+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-07 (Segment 5, Station 1180+00):** One representative sample (i.e., '-A'), on one side of the HSC near the assigned station, was collected as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment is collected.

**HSCNew-NMP-08 (Segment 6, Station 1200+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-09 (Segment 6, Station 1230+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-10 (Segment 6, Station 1260+00):** Two representative samples (i.e., '-A', '-C'), one on each side of the HSC near the assigned station, were collected and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

**HSCNew-NMP-11 (Segment 6, Main TB, Station 24+00):** Two representative samples (i.e., '-A', '-C') were collected on each side of the current Main TB and composited to one sediment sample as proposed for this reach of new work material; surface water and bulk water samples were collected mid-column where the bulk of the sediment was collected.

### 2.2.2 Deviations from SAP

The following deviations occurred during the sample collected when compared with the procedures outlined in the north of Morgan's Point (NMP) SAP:

- **Sample Repositioning:** When possible in advance of field work, repositioning of sample locations was jointly agreed upon by Fugro, the JV (AECOM and Gahagan & Bryant), and ERDC study personnel. Additional changes were made in the field as a judgement call on the part of the field contractor at the time of sample collection (Appendix 2). Reasons for sample repositioning included:
  - Deviations existed to accommodate unfavorable field conditions and to avoid HSC traffic constraints. These deviations included the relocation of proposed sub-sampling locations, which changed ahead of and during the field effort due to one or more of the following reasons:
    - Sub-sample locations in the middle of the HSC ('B') were eliminated for all sampling locations; between the writing of the SAP and the initiation of field work, the decision was made to not deepen the ship channel only widen it, making the middle location unnecessary
    - Sub-sample locations were shifted to one side of the channel ('A' or 'C') for HSCNew-NMP-01 and -NMP-07 due to spatial constraints from berthed ships and moorings.
    - Sub-sample locations were moved the least distance possible from given locations to accommodate for pipeline obstructions, steep channel slopes or difficult sampling conditions, poor sediment recovery while remaining with the dredge prism, high occupancy ship docks . This deviation affected all sampling locations except HSCNew-NMP-02, -NMP-09, and -NMP-11 and is described more fully in Section 2.6 of the field report (Appendix 2).
- **Schedule and Deliverables:** Sediment samples were collected in October of 2018. Samples were collected in close coordination with ERDC laboratory personnel to work with the days that favored shipment strategy and openings in the laboratory testing schedule. Shipping deviations resulted in some sample arrival delays which are discussed later in this section. There were no other deviations from the NMP SAP and project schedule.
- **Sampling (approach and collection):** Sediment was sampled using a 4" Central Mining Equipment (CME) sampler in conjunction with a hollow stem auger system to collect large volumes of sample throughout the sediment column. There were deviations from the originally planned sampling method proposed due to soft sediment conditions. Although the soft and loose sediment located close to the mudline or within strata at deeper depths posed sample recover challenges, the use of hammer sampling to handle these conditions best handled the circumstances (Section 3.1 of the Field Report in Appendix 2). Deviations included corrective actions taken to replace the 4" CME sampler damaged by percussive driving. The use of a smaller percussion split spoon

sampler was attempted in an effort to maximize sample recovery and selective re-sampling of missing sample intervals at adjacent locations, however, the smaller sampler did not on average recover more sample and was impractical logistically due to the reduced volume of the 3" I.D. sampler.

- **Sample Storage:** Sediment sample collection completed on October 4, 5, and 6, 2018 remained on the lift boat (L/B) in the refrigerated trailer until they were delivered to the offloading dock in Galveston, TX on Monday, October 8, 2018. Benchmark Ecological Services, Inc. (Benchmark) employees arrived at the L/B first thing Monday morning to unload the sediment samples from the refrigerated trailer into a refrigerated box truck for delivery to the ERDC laboratory in Vicksburg, MS. At this point, it was discovered that the refrigerated trailer on the L/B was not running. Benchmark employees immediately began placing ice on the samples to keep the samples cool. Benchmark employees measured the temperature in one of the smallest sample jars and the temperature was 3.9 °C which is within the acceptable temperature range of 1 °C to 4 °C. Benchmark notified the appropriate AECOM, USACE, ERDC, and Fugro personnel of the issue on October 8, 2018. Sediment samples were removed from the L/B, placed into a refrigerated box truck and delivered to the ERDC Vicksburg laboratory on October 9, 2018.
- **Sample Delivery:** In order to meet sample hold times, sediment samples collected on October 2 and 3, 2018 were shipped via FedEx to the ERDC Vicksburg laboratory on October 4, 2018. The samples were scheduled to be delivered to the laboratory first thing October 5, 2018. Nine coolers were packed with ice and shipped from Houston, TX to Vicksburg, MS. Two of the nine coolers arrived at the laboratory within temperature on October 5, 2018. The remaining seven coolers were held-up at FedEx in Memphis, TN and were not delivered to the laboratory on October 5, 2018. Benchmark employees worked with FedEx employees and arranged to have the seven coolers held in Memphis, TN to be delivered to Jackson, MS on October 6, 2018. A Benchmark employee picked up the sample coolers at 0900hours on October 6, 2018 from a FedEx shipping center. The sample coolers were opened immediately, and ice was observed in all seven coolers. The temperature of the samples was measured below 4 °C. The coolers were repacked with fresh ice and driven to Vicksburg, MS. The sediment samples were delivered to ERDC personnel in Vicksburg, MS midday on October 6, 2018. The sediment samples arrived in time to conduct the analyses and within the acceptable temperatures defined in the SAP. No impact to the analyses resulted.
- **Chain of Custody and Shipping:** Appropriate chain of custody protocols were followed. Samples were shipped and samples were received in the facility with holding times met. No deviations reported on this field activity except by occurrence explained in the Sample Delivery above.

There were no deviations on the water collection operations, processing, sample storage, or shipping while conducting the sample event that adversely impacted the outcome of the study.

### 2.2.3 Decontamination Procedures

Prior to and between sample collection, all containers and sampling equipment were cleaned using a new scrub brush, tap water, Alconox Detergent Powder and rinsed with distilled water based on protocols described in Plumb (1981). Any equipment that came into contact with sediment samples was deconned between channel sample locations. Care was taken to avoid contamination to sampling devices from the barge deck or other surfaces. Powderless latex or nitrile gloves were worn during sample collection and sample handling. The equipment rinsate blank was collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated sampling equipment used for sample collection.

### 2.2.4 *In situ* Water Column Measurements

*In situ* water column samples were collected and water depth measurements were taken to determine the Mean Lower Low Water (MLLW). The following data was also recorded: dissolved oxygen (DO), pH, salinity, conductivity, water temperature, sample date, sample time, sample depth, sample location ID, and Sample ID (Appendix 2).

### 2.2.5 Site Water Sampling

In accordance with the SAP, eleven (11) site water samples and 1 duplicate sample, HSCNew-NMP-01, -NMP-02, -NMP-03, -NMP-04, -NMP-05, -NMP-06, -NMP-07, -NMP-08, -NMP-09, -NMP-10, -NMP-11, and -NMP-03-Field Dup were collected for analyses. The specific sample locations are presented in Tables 1A and 1B and Figures 3 through 5 and in the Field Report (Appendix 2). All water samples were collected on October 22, 2018 after completion of the sediment sampling to avoid any resuspended sediment that might have been produced. Water samples were collected for use in both chemical analyses and in bulk for toxicity/bioassay testing. Appropriate sampling methods and containers were used for each sample collection, as described below.

Water samples were collected using a 24-foot sample vessel subcontracted to Benchmark Ecological Services, Inc. (Benchmark) of Houston, Texas. Prior to conducting the sampling event, final sediment sample location coordinates were loaded onto a sub-meter Trimble Geo XH 6000 Global Position System (GPS) unit and used to navigate the sample vessel to each water sample location. A single site water sample was collected at each of the eleven (11) sample locations and 1 duplicate sample location (HSCNew-NMP-03-Field Dup).

Water samples were collected from mid-depth at each sample station. Mid-depth was determined using a weighted line and measuring tape. Water samples were collected using high-volume geopumps, tubing and filters. Field filtered water samples were submitted for all chemical analyses except total mercury, total selenium, and total suspended solids in accordance with the SAP (USACE, 2018). In addition, filters were not used when collecting bulk water samples into 5 gallon cubitainers a total of 5 five gallon cubitainers were collected at each sample location. New tubing and filters were used at each sample station and site water was flushed through the tubing with a volume of at least five times the volume of

the sample tubing. Flushing water was discarded back into the ship channel after each sample was collected.

Water samples were collected into laboratory-supplied pre-cleaned sample containers and new 5-gallon cubitainers. Care was taken to avoid contamination to sampling devices (tubing, sample containers, pumps) from the boat deck or other surfaces. Powderless nitrile gloves were worn during sample collection and handling.

Immediately after sample collection, water samples were placed into a refrigerated box truck set at 4 °C. Water samples were kept at 4 °C in the refrigerated truck and transported to the laboratory on October 23, 2018.

### 2.2.6 Sediment Sampling

Sediment core samples were collected from the channel from October 2, 2018 through October 6, 2018. A summary of the final sample locations are provided in Tables 1A and 1B. Full details of the sediment sampling are provided in the Field Report (Appendix 2).

Drilling operations were completed using Fugro's CME-75 Truck Mounted Drill Rig. The rig was positioned on the L/B Shallow Draft 17 such that drilling operations could be conducted on deck through the "moon pull" on the work platform. Sediment sampling was accomplished by lowering a CME 4" by 5 ft. long Bearing Head Continuous Sample Tube System (CME 4" sampler) through the Hollow Stem Augers into the seafloor. Once the sampler was secured inside the augers, the augers were rotated to the depth of the sampler length (about 5 ft.), and the first sample was obtained. The auger was then rotated through the next 5 ft. and sample obtained, with this process repeated to get through the target prism depth. Occasionally and due to very soft or very loose sediment conditions at and below seafloor, augers did not need to be rotated. Augers and samples were just lowered to the next sampling depth by hammering and/or using their own weight or by pushing them with the drill rig.

Augers were used as casing to stabilize the upper/near surface of the boreholes. At the completion of the borehole, all augers were recovered. Sampling was mainly performed with the CME 4" continuous sample tube sampler, however, driven sampling techniques were used as a last resort. Sampler for driven sampling techniques included the sample penetration test (SPT) split spoon and the Modified California Sampler (2 ft. long by 3" inside diameter). The hollow stem auger and CME 4" sampler configuration was modified at one point of the investigation, in efforts to maximize sample recovery on the loose sands and very soft clays. No rotary wash drilling techniques were used during the sediment sampling campaign.

Sampling was performed continuously from mudline to termination depth of the boring. Both the driller and the engineer on shift kept accurate logs of all activities performed and all recovered materials (Appendix 2).

### 2.2.7 Field Quality Control

A duplicate sediment sample was collected at sediment sample location HSCNew-NMP-03. A total of six (6) two (2) gallon buckets were filled with sediment at sample location HSCNew-NMP-03 and -NMP-03-Field Dup.

A duplicate water sample was collected at sample location HSCNew-NMP-03. Two sets of sample containers provided by the laboratory and ten (10) five (5) gallon cubitainers were processed at sample location HSCNew-NMP-03.

One (1) sediment equipment blank was processed associated with the sample collection of sediment samples using the drill rig. The equipment blank was prepared by pouring deionized water (provided by the laboratory) over sample and processing equipment that came into contact with the sediment while collecting and processing the samples (e.g., drill rig sampler device, stainless steel spoon, plastic bucket, and nitrile gloves).

One (1) sample equipment blank for water was prepared using deionized water provided by the laboratory for equipment that contacted water samples (e.g., tubing, filter, and nitrile gloves).

Field duplicate and equipment blank sample data were recorded on field data sheets and provided in the Field Report (Appendix 2).

### 2.2.8 Sample Transport, Processing, and Custody

To ensure the integrity of sediment and water samples during collection in the field, storage and during shipping, the procedures outlined below were followed.

#### 2.2.8.1 Sample Storage and Transport to the Laboratories

The procedures for sample collection, preservation, and storage as provided by the project laboratory are summarized in the SAP (Appendix 1) and the Field Report (Appendix 2).

Sediment samples were placed into pre-cleaned two (2) gallon buckets and sample jars provided by the analytical laboratory. Sediment samples were collected and processed for the following analyses:

- VOCs/ SVOCs
- Metals including chromium (Cr) III and VI
- Pesticides
- Dioxins/Furans
- PAH/PCPs
- PCBs
- TOC
- Grain Size
- Ammonia
- pH

- Cyanide
- Sulfide
- TPH
- Total and Volatile Solids

The buckets were labeled with sample location ID, sample date, sample time, initials of sampler, and bucket number. Immediately after sample collection, bucket lids were sealed on each sample container. Sealed sample buckets were placed into a refrigerated trailer located on the barge. The refrigerated trailer was kept at a temperature of 2 °C to 4 °C. At a minimum, the temperature of the refrigerated trailer was checked once a day and recorded on a temperature log data form. Sediment samples were stored in the refrigerated trailer from the time of sample collection until they were shipped to the analytical laboratory. Sediment samples from locations HSCNew-NMP-07, -NMP-08, -NMP-09, -NMP-10, and -NMP-11 were collected on October 2 and October 3, 2018 and shipped via FedEx on October 4, 2018 and delivered to the analytical laboratory on October 6, 2018. Sediment samples from locations HSCNew-NMP-01, -NMP-02, -NMP-03, -NMP-03 Field Dup, -NMP-04, -NMP-05, and -NMP-06 were collected on October 4 through October 6, 2018. These, sediment samples were offloaded from the sample barge on October 8, 2018 and immediately placed in a refrigerated box truck set at 2 °C to 4 °C; sediment samples were stored in the refrigerated box truck and delivered to the laboratory by Benchmark on October 9, 2018.

Water samples were collected into sample containers provided by the laboratory for the following chemical analyses:

- Dissolved Organic Carbon (DOC)
- Dissolved Ammonia
- Dissolved Metals including Cr III and VI
- Dissolved Sulfides
- TPH (preserved with HCl)
- VOC (preserved with HCl)
- TOC (preserved with sulfuric acid)
- Total mercury and selenium (preserved with nitric acid)
- Total Suspended Solids (TSS)
- SVOCs
- Pesticides
- Dioxins/Furans
- PAH/PCPs
- PCBs
- Cyanide

Bulk water samples for the additional analyses, elutriate samples, and bioassays listed were collected into new five (5) gallon cubitainers. A total of five (5) five (5) gallon cubitainers (in addition to the sample containers provided by the laboratory) were collected at each sample location. All sample containers



were labeled with sample date, sample time, sample location, and with the initials of the sampler. Immediately after sample collection, water samples were placed into a refrigerated box truck set at 4 °C. Water samples were kept at 4 °C in the refrigerated truck and transported by Benchmark to the USACE ERDC laboratory at Vicksburg, MS on October 23, 2018.

Samples were delivered within the recommended holding times, as listed in the SAP. Laboratory staff verified and confirmed all sample handling, storage and preservation requirements with the analytical facility performing the project analyses. Sample preservation and storage methods described in the SAP were followed without deviation.

Chain of custody protocols were followed while conducting the field sampling event. Chain of custody forms and sample labels were provided by the laboratory prior to sample collection. Chain of custody forms were filled out and signed by field personnel as the samples were collected and processed. Chain of custody forms were signed by laboratory personnel upon transfer of samples to the laboratory. Copies of the chain of custodies are included in Appendix 3.

#### *2.2.8.2 Homogenization and Compositing*

Discrete sediments from each representative sample composite were combined in equal volumes and homogenized in a 7 gallon high density polyethylene (HDPE) bucket (e.g., HSCNew-NMP-06A, -NMP-06-B, -NMP-06A&C combined in equal volume to create HSCNew-NMP-06) on 9 October 2018 (up to 3 days after collection depending on the sampling site). A total of 6 gallons of each composite was generated. Homogenization was performed with a 0.43 hp Lightnin™ homogenizer (Rochester, New York) with stainless steel (SS) dual impeller (7" diameter). Mixing was conducted for a minimum of 2 minutes or until uniform consistency was achieved. The 7 gallon HDPE buckets were pre-cleaned prior to homogenization with soap, water, isopropyl alcohol, and rinsed with reverse osmosis water. Props and shafts of the mixer and other tools utilized in the mixing were also cleaned following the same procedure between samples. The composited sediments were left in the 7 gallon bucket and placed in cold storage. Additional information on sample nomenclature and compositing can be found in the Tier III Biological Testing Report (Appendix 8).

#### *2.2.8.3 Modified Elutriate Preparation*

Modified elutriates were prepared by the ERDC-EL Environmental Chemistry Branch according to guidance (USACE, 2003). Briefly, 150 g/L sediment (dry weight, calculated from sediment wet-dry ratios in Appendix B of Appendix 8) was added to site-collected water at sufficient total volume to accommodate analytical chemistry and biological test requirements. The sediment-water slurry was agitated via aeration to maintain the suspension for 60 minutes, followed by 24 hours (h) settling. The resulting sample was the 100% (undiluted) elutriate used in chemical and biological analysis. Each sediment elutriate composite was prepared using a separate site-water associated with that sampling location. The supernatant was siphoned and used for testing. This supernatant was defined as the 100% elutriate.

Following elutriate preparation samples were analyzed for the following:

- VOCs/ SVOCs
- Metals including chromium (Cr) III and VI
- Pesticides
- Dioxins/Furans
- PAH/PCPs
- PCBs
- TOC
- DOC
- Dissolved Ammonia
- Dissolved Sulfides
- Cyanide
- TPH
- TSS

## 2.3 Physical and Chemical Analytical Procedures

All physical and chemical analytical procedures were performed and/or coordinated by ERDC. Additional details pertaining to physical and chemical analytical procedures are found in the following sections.

### 2.3.1 Physical Procedures

#### 2.3.1.1 Particle Size Distribution

Sub-samples were homogenized and composited into a composite sample by ERDC (Vicksburg, MS) for each sample location and sent to Air Water & Soil Laboratories, Inc. (AWS) (Richmond, VA) for particle size analysis. The samples were evaluated using sieve analysis (American Society for Testing and Materials (ASTM) D 422 (2007)) and hydrometer analysis (ASTM D 422 (2007)). The particle size distribution reports are provided in Appendix 4.

#### 2.3.1.2 Percent Solids

Percent solids was determined in general accordance with Standard Method (SM) 18 2540G by AWS (Richmond, VA). The sample weight was recorded and the sample was placed in an oven and dried to a constant mass at 105 °C. Once a constant dry mass was obtained, the percent moisture was determined by subtracting the dry mass from the wet mass, then by dividing the loss in mass due to drying by the wet mass.

#### 2.3.1.3 Physical Analyses Laboratory

All other physical procedures (specific gravity and Atterburg limits) for sediment samples were performed by the Geotechnical Testing Services, Inc. Laboratory (GTS) (Coraopolis, PA).

### 2.3.2 Chemical Analytical Procedures

The following sections describe the development of site-specific COC lists for all media types, analytical laboratories used, and analytical methods followed for this project. Analyses were tailored to be project-specific and site-specific to this portion of the HSC associated with new work in, or proximate to the Gulf of Mexico. A summary of the rationale is presented below and can be found in the SAP (Appendix 1).

#### 2.3.2.1 *Development of the Project Specific and Site Specific List of Chemicals of Concern (COCs)*

The list of COCs for evaluation for this project were determined from the master list of chemicals in the Target Detection Limits (TDL) table in Appendix C of the U.S. Environmental Protection Agency's (USEPA) *Regional Implementation Agreement (RIA)* (USEPA/USACE, 2003). This master list of chemical is comprehensive and includes:

- Metals (total), Cr+/Cr+6
- Organic compounds (low molecular weight PAH (LPAH) compounds, high molecular weight PAH (HPAH) compounds, organonitrogen compounds, phthalate esters, phenols/substituted phenols, dioxins, dibenzofurans, PCBs (congeners, Arochlors, total), pesticides, chlorinated hydrocarbons, VOCs, halogenated ethers, miscellaneous organics (isophorone, benzyl alcohol, benzoic acid, methyl ethyl ketone, resin acids and guaiacols)
- Conventional/ ancillary parameters (e.g., ammonia, cyanides, TOC, TPH, grain size, pH, percent moisture, etc.)

The northern section of the HSC is industrialized and due to the industrialization in this area, no COCs were considered for exclusion from the master list provided in the RIA.

Dioxins/furans are not routinely analyzed for in dredge material projects, however, due to the proximity of the San Jacinto Waste Pits and the Area of Concern (AOC) associated with the historical releases of dioxins/dibenzofurans from this area north of Morgan's Point (Figure 2), dioxins/furans have been retained in the analyte list for this project.

#### 2.3.2.2 *Analytical Laboratories*

All chemical analytical procedures for sediment, site water, and elutriate samples were performed by the Environmental Chemistry Branch (ECB) of the Environmental Laboratory (EL) at ERDC (Vicksburg, MS) or by their sublabs. ECB performed analysis for pesticides, sulfide, total suspended solids, (TSS), percent moisture, percent solids, total organic carbon (site water samples), and dissolved organic carbon. Alpha Analytical (Mansfield, MA) performed SVOC and PAH analysis. Kathadin (Scarborough, ME) performed TPH analysis. Air Water & Soil Laboratories (Richmond, VA) performed cyanide, VOC and TOC (sediment samples) analysis. Maxxim Laboratories (Mississauga, Ontario) performed dioxins analysis. Details of the chemical analytical procedures are summarized in the following sections.

#### 2.3.2.3 Site Water Chemistry

Site water samples were analyzed for COCs consistent with the analyte list as described in Section 2.3.2.1. The methods for each of these analyses are summarized below. The TDLs for site waters were extracted from the RIA and are included in Table 5 of this report and Table 3 of the SAP (Appendix 1).

- VOCs – USEPA 8260B
- SVOCs – USEPA 8270D
- PAHs – USEPA 8270D
- Pesticides – USEPA 8081A
- PCBs – USEPA 8082
- Dioxins and Furans – USEPA 1613Bm
- Metals – USEPA 6020
- Cr III/VI – USEPA 7199M
- Hg – USEPA 7474
- Cyanide – USEPA 9012B
- DOC – USEPA 9060
- TSS – USEPA 160.2
- TOC – USEPA 9060
- Ammonia as N – USEPA 350.2
- Sulfide – USEPA 376
- TPH – TNRCC 1005

#### 2.3.2.4 Sediment Chemistry

Sediment samples were analyzed for COCs consistent with the analyte list as described in Section 2.3.2.1. The methods for each of these analyses are summarized below. The TDLs for sediments were extracted from the RIA and are included in Table 6 of this report and Table 4 of the SAP (Appendix 1).

- VOCs – USEPA 8260B
- SVOCs – USEPA 8270D
- PAHs – USEPA 8270D
- Pesticides – USEPA 8081A
- PCBs – USEPA 8082
- Dioxins and Furans – USEPA 1613Bm
- Metals – USEPA 6020
- Cr III/VI – USEPA 7199M
- Hg – USEPA 7474
- Cyanide – USEPA 9012B
- Sulfide – USEPA 9030
- Volatile Solids – SM22 2540G-2011
- % Moisture – ASTM D2216-98
- TOC – USEPA 9060A

- Ammonia as N – USEPA 3501.1
- TPH – TNRCC 1005

#### 2.3.2.5 Modified Elutriate Chemistry

Modified elutriate samples were analyzed for COCs consistent with the analyte list as described in Section 2.3.2.1. The methods for each of these analyses are summarized below. The TDLs for sediments were extracted from the RIA and are included in Table 7 of this report and Table 3 of the SAP (Appendix 1).

- VOCs – USEPA 8260B
- SVOCs – USEPA 8270D
- PAHs – USEPA 8270D
- Pesticides – USEPA 8081A
- PCBs – USEPA 8082
- Dioxins and Furans – USEPA 1613Bm
- Metals – USEPA 6020
- Cr III/VI – USEPA 7199M
- Hg – USEPA 7474
- Cyanide – USEPA 9012B
- DOC – USEPA 9060
- TSS – USEPA 160.2
- TOC – USEPA 9060
- Ammonia as N – USEPA 350.2
- Sulfide – USEPA 376
- TPH – TNRCC 1005

## 2.4 Biological Testing

Bioassays were conducted by the ERDC Environmental Laboratory (ERDC-EL, Vicksburg, MS) in basic accordance with standard guidance (USEPA, 2002; USEPA/USACE, 1998; RIA USEPA/USACE, 2003; HSC NMP SAP). The aquatic toxicity testing facility at the ERDC-EL consists of three laboratories containing five (5) temperature and humidity controlled environmental rooms (Darwin, St. Louis, MO, USA) and four (4) temperature controlled water baths. Elutriate testing was conducted in the environmental rooms. Relevant equipment for processing samples and fulfilling all requirements of laboratory bioassays (e.g., pH meters, DO meters, temperature probes, ammonia probes, refractometers, centrifuges, etc.) were available. Bioassays were conducted to assess the potential for biological effects of dredged material (DM) released into the water column during DM discharge (elutriate toxicity tests), using two taxonomically and functionally dissimilar species. Elutriate toxicity tests employed the mysid shrimp *A. bahia* and the fish *M. beryllina*.

#### 2.4.1 Elutriate Bioassays

Elutriate bioassays were conducted for 96-hours using the 100% elutriate; where toxicity was expected due to elevated ammonia concentrations, additional 50% and 10% elutriate concentrations were added. All concentrations, including the control and reference waters, were replicated five times. The standard test organisms *A. bahia* (formerly *Mysidopsis bahia*) and *M. beryllina* and were used in survival tests in basic accordance with dredged material evaluation guidance (USEPA/USACE, 1991; 1998; 2003). All elutriate toxicity tests were conducted at  $20 \pm 1$  °C in temperature and humidity controlled environmental rooms (Darwin, St. Louis, MO, USA).

Other than the reference sediment, all of the site waters collected for elutriate preparation had low salinities ( $\approx 0$  to 22 parts per thousand (ppt)) that were outside the tolerance ranges of the standard test organisms (25 to 30 ppt; USEPA / USACE, 1998). The salinity of each site water was individually adjusted to approximately 30 ppt by incrementally adding  $\approx 151$  to 570 g/19L Crystal Sea® Marinemix prior to elutriate preparation. The salinity adjusted site waters were then used to prepare the elutriate test waters, as described above.

#### 2.4.2 *Americamysis bahia*

The mysid shrimp *A. bahia* was exposed to the sediment elutriate water at 4-days old (specified range: 1 to 5 days with no more than a 24-h range in age; USEPA/USACE, 1998). Shrimp were shipped overnight from Aquatic Biosystems (ABS, Fort Collins, CO, USA), immediately observed for potential shipment impacts and fed brine shrimp (*Artemia*) upon receipt. Mysid shrimp were held for 72-hours (received at the appropriate age to be 4-day old) prior to testing for acclimation and observation. The control water and dilution water was reconstituted seawater (30 ppt) prepared using Crystal Sea® Marinemix. Each test concentration included five (5) replicates, 1 L glass beakers containing 400 mL test media and ten (10) *A. bahia* each. The larger beaker size and two daily feeding rations were used to avoid aggressive interactions and potential for cannibalism during the exposure. Test acceptability criteria included water parameters (temperature, pH, salinity, dissolved oxygen) within the specified range (USEPA/USACE, 1991; 1998), at least ninety (90%) survival in the performance control and sensitivity to a reference toxicant (e.g., KCl) within acceptable control chart ranges ( $\pm$  two (2) S.D. from the mean). The ninety six (96) hour tests were conducted from October 29 to November 2, 2018, according to USEPA/USACE (1998). The measurement endpoint was survival.

#### 2.4.3 *Medindia beryllina*

The inland silverside *M. beryllina* was exposed to the sediment elutriate water at twelve (12) days old (specified range: 1 to 14 days with no more than a 24-h range in age; USEPA/USACE, 1998). Fish were shipped overnight from Aquatic Biosystems (ABS, Fort Collins, CO, USA) immediately observed for potential shipment impacts and fed brine shrimp (*Artemia*) upon receipt. The *M. beryllina* were held for 72-hours (received at 9 days old) prior to testing for acclimation and observation. The control water and dilution water was reconstituted seawater (30 ppt) prepared using Crystal Sea® Marinemix. Each test concentration included five (5) replicates, 600 mL glass beakers containing 400 mL test media and ten (10)

*M. beryllina* each. Fish were fed at 24-h and 72-h to maintain health. Test acceptability criteria included water parameters (temperature, pH, salinity, dissolved oxygen) within the specified range (USEPA/USACE 1991, 1998), at least ninety (90%) survival in the performance control and sensitivity to a reference toxicant (e.g., KCl) within acceptable control chart ranges ( $\pm$  two (2) S.D. from the mean). The ninety six (96) hour tests were conducted from October 29 to November 2, 2018 according to USEPA/USACE (1998). The measurement endpoint was survival.

#### 2.4.4 Reference Toxicity Tests for Elutriate Bioassays

Reference toxicant tests were conducted on each batch of test organisms to assess test organism sensitivity relative to historic information recorded ERDC-EL in-house laboratory control charts. The selected reference toxicant was potassium chloride (KCl). Reagent grade KCl was weighed and completely dissolved into the appropriate reconstituted waters for each test species (described above). Five concentrations (3 replicates each) were prepared (100%, 50%, 25%, 12.5%, and 6.25%) with the previously described number of organisms in each replicate. The 100% concentration used was 2.0 g/L for *M. beryllina* and 1.0 g/L for *A. bahia*. The endpoint measured was survival after a 48- hour or 96-hour exposure. The median effects endpoints generated in the reference toxicity tests were compared to historic information recorded in ERDC or vendor control charts ( $\pm$  two (2) S.D. from the mean).

#### 2.4.5 Water Quality Parameters

Water quality during bioassay testing was measured using either a Yellow Springs Instruments (YSI)<sup>™</sup> Model 556 multiprobe system (Yellow Springs, OH) or a Thermo Scientific Orion Star<sup>™</sup> A329 (Thermo Orion Electron Corp., Beverly, MA) for temperature, salinity, pH, and Dissolved Oxygen (DO). Total ammonia-N and pH was measured using a 720A ion-selective electrode (ISE) meter (Thermo Orion Electron Corp., Beverly, MA) equipped with a 95-12 ammonia-sensitive electrode and a 9107BN automatic temperature compensating pH triode (Thermo Orion Electron Corp., Beverly, MA). Total overlying water ammonia-N during bioassays was also measured using LeMotte titration kits (Chestertown, MD, USA). Note that both ammonia measurement methods determined ammonia as total ammonia-nitrogen (-N). Total ammonia and un-ionized ammonia were calculated based on molecular mass and measured pH, temperature and salinity in the test water (USEPA, 1999), specifically using the equation in Section 2.2.5 of the Tier III Biological Testing Report (Appendix 8).

#### 2.4.6 Statistical Analysis

The process by which elutriates were tested is summarized in Figure 1 of Appendix 8. Statistical analysis was performed when survival in the undiluted (100%) elutriate water was reduced by more than 10% relative to the dilution water control, as specified by guidance (USEPA/USACE, 1998; 2003). Statistical analyses are conducted using Toxcalc<sup>®</sup> statistical software (Version 5.0, Tidepool Scientific Software, McKinleyville, CA). Data normality was determined by the Shapiro-Wilk's Test and homogeneity of variance by Bartlett's Test. If survival was not reduced by at least 10% relative to the dilution water, no statistics were performed. If at least a 10% reduction was observed, initially a two sample t-test was performed to compare the undiluted (100%) elutriate to the dilution water control. If that was statistically

significant, then treatment differences (dilution water, 10%, 50% and 100% elutriates) were performed by one way ANOVA and Dunnett's Method (one-tailed analysis); the Bonferroni t-test was performed in the case of uneven replicates. If normality could not be achieved, Steel's Many-One Rank test (one-tailed analysis) was used. If applicable, the lethal median concentration producing 50% mortality (LC50) in elutriate or reference toxicity test dilutions is determined by the Spearman–Karber method using Toxcalc® (version 5.0, Tidepool Scientific Software, McKinleyville, CA).

## 2.5 Data Reporting and Statistical Requirements

Data reporting and statistics are summarized in the following sections.

### 2.5.1 Background

The chemical concentration, method detection limit (MDL), and reporting limit (RL) for water and elutriates were reported on a wet weight basis. The sediment chemical concentration, MDL, and RL were reported on a dry weight basis.

The MDL is the statistically-derived minimum level that can be measured and reported with 99% confidence that it is greater than zero but is present at levels that are too low to estimate analytically. The RL is the minimum level a lab will report with confidence in quantitative accuracy. Common laboratory procedures for defining a RL include assigning it to a fixed factor above the MDL or by using the lowest calibration standard. Reporting limits are often adjusted by the laboratory for sample-specific parameters such as sample weight, percent solids, or dilution.

### 2.5.2 Reporting for All Analyses Data for All Media Types

- 1) If the reported result was greater than the RL, the result was simply reported.
- 2) If analyte concentrations were equal to or greater than the MDL but below the RL, the result was qualified with a "J" flag as having lower precision and greater uncertainty; these values were reported in the summary tables as reported values with the "J" qualifier in the adjacent table cell.
- 3) "J" values represent potential concentrations of contaminants that were detected below the RL and were acceptable for use in sediment management decisions; they would be reported as real values.
- 4) If analyte concentrations were below the RL and qualified with a "U" flag, the analyte concentration was between zero and the MDL.
- 5) "U" values represent minimal concentration of contaminants and were reported in the summary tables as ###.## with the "U" qualifier in the adjacent table cell, where ###.## is the RL.

### 2.5.3 Calculations and Statistical Analyses for Site Water, Elutriate, and Sediment Data

- 1) If the reported result was greater than the RL, the result was used as reported.
- 2) If an analyte concentration was below the RL and "U" flagged, one-half of the RL was used in the calculation.



- 3) If an analyte concentration was between the MDL and the RL (i.e., “J” flagged values), the concentration was included in the summation at face value.
- 4) If the RL exceeded the TDL, regardless of whether the result was qualified or not, the RL was used (no half substitutions permitted).

#### 2.5.4 Calculating Total PAH

- 1) If the reported result was greater than the RL, the result was used as reported.
- 2) Undetected results (“U” flagged) were included in the summations at half the value of the RL.
- 3) The estimated values between the MDL and the RL (i.e., “J” flagged values) were included in the summation at face value.
- 4) If the RL exceeded the TDL, then the RL was used.
- 5) If all constituents in a chemical group were undetected, the group sum was reported as undetected, and the highest MDL and RL of all the constituents were reported as the MDL and RL for the group sum.

## 2.6 Data Reduction and Applicable Technical Quality Standards

### 2.6.1 Surface Water and Modified Elutriate Chemistry

Results of site water and elutriate sample analyses were screened against the following benchmark criteria, listed in order of prioritization: (1) 2014 Texas Surface Water Quality Standards (TSWQS) Marine - Acute and (2) USEPA Water Quality Criteria (WQC) Marine Criterion Maximum Concentration (CMC).

### 2.6.2 Sediment Chemistry

Results of laboratory analyses of sediment samples were screened against the following sediment guidance values, listed in order of prioritization: (1) National Oceanic and Atmospheric Administration (NOAA) Marine Effects Range – Low (ER-L) and (2) NOAA Marine Effects Range – Median (ER-M).

## 2.7 Mixing Zone Calculations- CDFATE

A full CDFATE report is provided in Appendix 7, and the approach is summarized below.

### 2.7.1 Objectives and Background

The CDFATE report details the mixing zone modeling performed by the ERDC to support a Clean Water Act (CWA) Section 404 sediment testing characterization study for HSC ECIP, NMP. Simulations of dredged material discharges into four upland placement areas (PAs) were run using the Fate of Continuous Discharge from Dredging Operations into Open Water (CDFATE) module, Windows version 1.0, (Havis, 1994; Doneker and Jirka, 1990; Akar and Jirka, 1991; Jones, 1990) of the ADDAMS model to establish compliance with water column toxicity criteria for the HSC sediment samples HSCNew-NMP-02, HSCNew-NMP-03, HSCNew-NMP-04, HSCNew-NMP-05, HSCNew-NMP-06, HSCNew-NMP-07, HSCNew-NMP-08,

HSCNew-NMP-09, HSCNew-NMP-10, and HSCNew-NMP-11. Modified elutriate chemistry and elutriate bioassay data were performed as described in Sections 2.3 and 2.4. Results were evaluated as described in Sections 4.5 and 4.6 and applied in the modeling.

### 2.7.2 Dredging and Placement Locations

The dredging and placement plan for NMP Segments 4, 5, and 6 is displayed in Figure 6. Four upland placement areas are identified to receive dredged material as represented by the sample locations summarized below.

- New BW-8 PA
  - HSCNew-NMP-02 (Segment 4)
  - HSCNew-NMP-03 (Segment 4)
- New E2-Clinton PA
  - HSCNew-NMP-04 (Segment 4)
  - HSCNew-NMP-05 (Segment 4)
- Glendale PA
  - HSCNew-NMP-06 (Segment 5)
  - HSCNew-NMP-07 (Segment 6)
  - HSCNew-NMP-08 (Segment 6)
  - HSCNew-NMP-09 (Segment 6)
  - HSCNew-NMP-10 (Segment 6)
- Filter Bed PA
  - HScNew-NMP-11 (Main Turning Basin)
- HSCNew-NMP-01 (Segment 1) is now not planned to be dredged and is therefore not included in the mixing zone analysis

Discharge locations and drainage paths to receiving waters for the four PAs are discussed in detail in Appendix 7 (Section 2.0, Figure 2). A mixing zone evaluation is needed to determine if the effluent discharged from these PAs would be sufficiently diluted within allowable mixing zones to comply with applicable water quality and toxicity criteria.

### 2.7.3 Mixing Zone Evaluation Approach

Dilution of effluent from the dredged material placement area occurs when the effluent discharge mixes with the waters of the receiving stream. The extent to which the two streams (PA effluent and receiving stream) mix depends on physical characteristics of the flows such as density and flow rate (or velocity) of both streams, geometry of the receiving stream, and size and orientation of the effluent pipe (or channel). The CDFATE model was used to evaluate the extent of mixing for effluent from each PA into their respective receiving streams.

The amount of dilution (D) that is required to meet water quality criteria is a function of the contaminant concentration in the effluent discharge (as represented by modified elutriate concentrations (C)), the

applicable water quality criteria ( $C_{wq}$ ), and the background concentration of the receiving water ( $C_B$ ). Required dilution is expressed in terms of how many parts of receiving water need to be mixed with one part of effluent to reach the applicable criteria.

Equations to calculate dilution requirements for both water quality ( $D_{a-wq}$ ) and toxicity ( $D_{a-tox}$ ) are provided below.

$$D_{a-wq} = \frac{C - C_{wq}}{C_{wq} - C_B} \quad (1)$$

where

- $D_{a-wq}$  = dilution required to achieve concentration equivalent to water quality criteria
- $C$  = contaminant concentration in modified elutriate sample
- $C_{wq}$  = water quality criteria
- $C_B$  = background (receiving water) contaminant concentration

$$D_{a-tox} = \frac{100 - LPC}{LPC} \quad (2)$$

where

- $D_{a-tox}$  = dilution required to achieve LPC for toxicity
- LPC = limiting permissible concentration based on elutriate toxicity evaluation

As shown in Equation 1, the quality of the receiving water affects dilution requirements. The higher the background concentration, the more water has to be mixed in to sufficiently dilute. The concentration of the mixture will necessarily fall between the concentration of the effluent and of the receiving water. If the background concentration is above the criteria, then it is impossible to demonstrate sufficient dilution to reach the criteria.

Texas Surface Water Quality Standards (TSWQS) allow for application of a mixing zone (MZ) and zone of initial dilution (ZID). Acute toxicity is not allowed in a mixing zone, and chronic toxicity is not allowed beyond a mixing zone (TCEQ, 2012). The ZID is a small area where initial dilution with receiving waters occurs and may not meet criteria applicable to the receiving water. Acute criteria may be exceeded within a ZID; thus acute criteria apply at the edge of the ZID. Chronic criteria apply at the edge of the MZ. Typically, the amount of mixing and dilution increases with distance from the discharge point. CDFATE modeling quantifies the location (distance from the discharge point) at which dilution is sufficient to reach acute and chronic criteria and thus determine the dimensions needed for the ZID and MZs for each discharge location.

#### 2.7.4 Modified Elutriate Chemistry and Toxicity

Modified elutriate chemistry and toxicity were evaluated for comparison to water quality criteria to determine the need for a MZ evaluation for each PA. Contaminants of concern for which the modified

elutriate concentration are shown to be below marine water screening criteria do not pose a problem for meeting criteria. In Section 4.5, 16 COCs are identified in which either the modified elutriate concentration exceeded the screening criteria (either acute or chronic), or the RLs are above the screening criteria and therefore cannot be verified as meeting the criteria.

The site water results for samples that represent receiving water are also provided in Table 1 of Appendix 7. Site water from the sample locations nearest the discharges to Buffalo Bayou/HSC (sample HSCNew-NMP-02-SW for New BW-8 PA, and sample HSCNew-NMP-11-SW for Filter Bed PA) represent background concentrations for the receiving water for those PAs. Site water data was not available for the receiving water location on Hunting Bayou from New E2-Clinton PA (receiving material from locations HSCNew-NMP-04 and -NMP-05) and Glendale PA (receiving material from sample locations HSCNew-NMP-06, -NMP-07, -NMP-08, -NMP-09 and -NMP-10). U.S. Geological Survey (USGS) gauge data from 2000 were reviewed but determined to be unusable for this work as the data set was not a COC match and had several unreported or elevated reporting limits. As Hunting Bayou discharges into Buffalo Bayou/HSC between sample locations HSCNew-NMP-04 and -NMP-05, and representative data was unavailable, the site water data (conservative worst-case) from these two locations were applied as the background concentrations for the discharges from Glendale and New E2-Clinton PAs into Hunting Bayou.

#### *2.7.4.1 COCs with Reporting Limits above Criteria*

In cases where contaminants are not detected in elutriate or receiving water, the RLs are (conservatively) assumed to be both the elutriate and the receiving water concentrations. Use of the RL in such circumstances makes it impossible to achieve dilution to meet either acute or chronic criteria concentrations, as it cannot be certain as to whether the criteria are exceeded. For COCs were non-detect in any of the elutriate, site water and sediment samples, there is no reason to believe these contaminants are present at concentrations of concern, and they were not evaluated further.

#### *2.7.4.2 COCs above Criteria and Background*

Several other COCs had limited evidence of their presence in the HSC sediment and waters with a few detections among all of the samples. The detection of these COCs suggests they are present, and they were retained for further evaluation.

#### *2.7.4.3 COCs with Background above Criteria*

If background receiving water concentrations are already above criteria, then it is impossible to dilute the effluent to below the criteria. In this case, a mixing zone evaluation is not necessary. Contaminants that have receiving water concentrations (either detected or RL applied) above chronic criteria, but below acute criteria were not further evaluated for mixing zone requirements. Contaminants where acute criteria were exceeded and dilution could be achieved were evaluated in the mixing zone analysis.

If contaminant concentrations of the background water exceeded acute screening criteria and dilution cannot be achieved resulted in the COCs not being evaluated in the mixing zone analysis.

#### 2.7.4.4 Bioassay Results

In CWA Section 404 evaluations, it is recommended (but not required) that a multi-species testing approach be used to assess potential effects on the receiving waters. As described in Section 2.4 and Appendix 8, standard acute (96 hour) toxicity tests were conducted to assess toxicity of the elutriate samples. Elutriate bioassay test results are reported in Section 4.6 and Appendix 8.

Reported endpoints from the bioassay tests depends on the resulting mortality. If test mortality was high enough (50% effect was bracketed by dilution series and a no observed effects concentration (NOEC) was obtained), the end result of the effluent elutriate toxicity evaluation is the 96-hr median lethal concentration (LC50), expressed as a percentage of the suspended dredged material concentration (or 100% elutriate). However, if acute toxicity was demonstrated but mortality was not high enough to calculate a LC50, then the NOEC and lowest observed effects concentration (LOEC) were reported. Only samples for which acute elutriate toxicity was observed were evaluated in the mixing zone analysis.

As discussed previously, chronic criteria apply at the edge of the mixing zone and acute criteria at the edge of the ZID. The NOEC was applied as the acute criteria. The chronic criteria was determined as either the LC50 multiplied by an application factor (AF) or (where a LC50 was not calculated) the LOEC multiplied by an AF. The AF generally represents the inverse of the acute-to-chronic ratio (ACR). An AF of 0.01 was used here as a conservative approach within this initial screening evaluation. The 0.01 AF was recommended by the National Academy of Science (NAS) and adopted in the MPRSA and USEPA/USACE dredged material testing guidance (Kennedy et al., 2015). There is precedent, however, for applying AFs other than 0.01 where ammonia is the driver of toxicity. Kennedy et al. (2105) suggests the use of a larger AF of 0.05 to 0.1 for dredging evaluations for non-persistent contaminants. Although the conservative AF of 0.01 was used in this evaluation, it is recommended that a less conservative AF be considered in light of the ammonia toxicity discussed in Section 4.6 and that the toxicity criteria be recalculated in subsequent evaluation.

#### 2.7.4.5 Dilution Requirements

*Water Quality* - Table 3 of Appendix 7 presents the chemical concentrations (elutriate and background), water quality criteria and calculated dilution requirements to be applied in the CDFATE modeling for the COCs that were not previously eliminated from evaluation based on lack of detection and inability to dilute due to background concentrations above criteria. The lowest of the acute criteria was applied to the dilution calculation using Equation 1 (Section 2.7.3).

*Toxicity* - Based on the acute and chronic criteria determined from the bioassay evaluation, dilution requirements were calculated for each elutriate and test species using Equation 2 (Section 2.7.3). The resulting dilution requirements are also presented in Table 3 of Appendix 7. The highest dilution required for any elutriate sample and species for a given PA was applied as the dilution requirement for that PA.

### 2.7.5 Dredged Material and Site Water Properties

The dredged slurry entering the PAs will consist of a mixture of the dredged material and entrained site water. Most of the solid particulates are expected to settle within the PA, so that the effluent will consist

primarily of site water with some fraction (primarily fines) of suspended solids that did not settle. Physical properties of both the effluent and receiving water, such as density as a function of salinity and temperature, affect the mixing behavior between the effluent and receiving water. Water samples were taken at mid-depth. Properties of the collected site water are shown in Appendix 7, Table 5.

Grain size distributions and other physical properties of the sediment samples were collected as part of the sampling event. Although they are not used directly in the CDFATE modelling, the physical properties of the dredged material are always useful in interpreting the results. These are provided in Section 4.2.1 and Appendix 4

## 2.7.6 CDFATE Input

Mixing zone calculations were made using the CDFATE model (Havis, 1994; Doneker and Jirka, 1990; Akar and Jirka, 1991; Jones, 1990). CDFATE uses four categories of input parameters for these calculations: 1) discharge parameters; 2) site receiving water conditions, 3) effluent density modeling and 4) mixing zone data. Each of these are discussed below.

### 2.7.6.1 Discharge Parameters

Table 6 of Appendix 7 describes the discharge parameters for each of the PAs. A 24-inch hydraulic cutterhead dredge is planned for use. Assuming a typical pipeline velocity of 15 feet per second (fps) and a conservative assumption of 20% downtime, yields a flow rate of 37.7 cubic feet per second (cfs) (1.07 m<sup>3</sup>/s) into the PAs. It was assumed the discharge rate from the PAs would be equal to the inflow rate. Each candidate PA is discussed further below.

#### 2.7.6.1.1 Placement Area – New BW-8 PA

New BW-8 PA discharges to Buffalo Bayou/HSC just east of the PA through an underground culvert. The culvert size was assumed to be 6 ft. (1.83 m). Using Manning's equation, and assuming a slope of 0.01 (vertical:horizontal) and roughness value of 0.014 for concrete pipe, yields a flow depth of 1.25 ft. (0.38 m). The pipe is assumed to extend perpendicular to the channel. Mixing is affected by the location the pipe discharges within the channel cross section, yet the actual pipe length is not known. Therefore, two separate model runs were performed assuming the pipe protrudes 150 ft. (45.72 m) and 196 ft. (60 m) into the channel. A cross section was developed based on the bathymetry, for which an average depth was calculated as 24.7 ft. (7.51 m). The channel width in that vicinity is approximately 1238 ft. (377.5m). The water depth at the end of the pipe was estimated as 5.02 m, although the actual bathymetry was not known outside the channel. It was estimated that the angle between the bank and the horizontal culvert was 3.00 degrees based on the bank slope.

#### 2.7.6.1.2 Placement Area – Filter Bed PA

The Filter Bed PA discharges to Buffalo Bayou/HSC through an underground culvert approximately 0.75 mi north of the turning basin. The culvert size was assumed to be 6 ft. (1.83 m), with a flow depth of 0.38 m. Bathymetry of the Buffalo Bayou/HSC channel at the Filter Bed PA discharge location was obtained from USACE hydrographic surveys (eHydro), and a cross section delineated with an average channel depth of 14.8 ft. (4.512 m). The channel width in that vicinity is approximately 305 ft. (93 m). Two model runs

were performed because the actual pipe distance was not known; one assumed the pipe protruded 2.2 m and one 15.24 m into the channel where the water depth is 3.5 m or 4.40 m, respectively. Side slope at the discharge location was estimated as 40 degrees.

#### 2.7.6.1.3 Placement Area – New E2-Clinton PA and Glendale PA

Although New E2-Clinton and Glendale PAs are not located proximate to each other, they are discussed together because both New E2-Clinton PA and Glendale PA discharge into Hunting Bayou from Turkey Run Gulley, and their discharge parameters are the same. Bathymetry data for Hunting Bayou and Turkey Run Gulley was not located. The depth of Hunting Bayou at the discharge location was provided as 7.5 – 8 ft. (USACE, 2019b). From Google Earth, it appears the channel width at this location is 50 ft. (15.24 m). A trapezoidal cross section was assumed with a depth of 7.75 ft. (2.36 m) and 2:1 (horizontal:vertical) side slopes (an angle of 26 degrees), which yielded an average depth of 5.35 ft. (1.63 m). Turkey Run Gulley was estimated from Google Earth to have a channel width of 17 ft. (5.18 m), an estimated water depth of 3.5 ft. (1.07 m) and to extend perpendicularly into Hunting Bayou 4.1 m at a water depth of 2.1 m.

#### 2.7.6.2 Site Receiving Water Conditions

Data input for the receiving water for each PA is provided in Appendix 7, Table 7. Receiving water widths and depths were provided based on bathymetry or assumptions discussed above. For each PA, the channel was assumed to be narrow (bounded), as a conservative assumption, even though the channel width at the New BW-8 PA discharge is rather wide. Receiving water density was calculated based on temperature and salinity. It is important to note that the salinities measured at mid-depth may not be representative of the salinity of the dredge slurry from a cutterhead dredge operating at the sediment surface. According to City of Houston and PBS&J (2003), there is significant density stratification within the artificially deepened Buffalo Bayou/HSC. Salinity/conductivity profiles with depth, taken during several years, shows a steep increase in salinity with depth in some years, and less stratification in drier years when overall salinity is higher. Plots of conductivity with depth from the City of Houston and PBS&J report (2003) were used to estimate bottom salinities at the Buffalo Bayou locations in the report as: 9 part per thousand (ppt) at Main Turning Basin (near Filter Bed PA discharge and location HSCNew-NMP-11), 12 ppt at Sims Bayou (downstream of HSCNew-NMP-06), and 15 ppt at Beltway 8 (near the New BW-8 PA discharge and HSCNew-NMP-02). As expected, salinity decreases with distance upstream.

For the purpose of the CDFATE model, the receiving waters near the Filter Bed PA and New BW-8 PA discharges were assumed to have linear stratification. As it is shallower, the Hunting Bayou receiving water is expected to be less stratified. Water temperatures and surface salinity were obtained from the collected water samples, location HSCNew-NMP-11 for the Filter Bed PA outfall, and -NMP-02 for the New BW-8 PA outfall. Salinity or density data was not located for Hunting Bayou at the discharge. It was assumed the receiving water at Hunting Bayou would be uniformly mixed, and might resemble the surface water of Buffalo Bayou/HSC at about the same distance from the mouth of Hunting Bayou, which would be between sample locations HSCNew-NMP-05 and HSCNew-NMP-06. Thus, the salinity and temperature of those samples (Appendix 7, Table 5) were averaged to estimate that of Hunting Bayou.

Stream gauges with discharge or velocity data were not in the vicinity of any discharge locations. The nearest stream location for Filter Bed PA discharge on Buffalo Bayou/HSC is USGS 008074000 Buffalo



Bayou at Houston, approximately 8 mi upstream. The closest gauge located for the New BW-8 PA outfall on Buffalo Bayou/HSC is the NOAA g08010 gauge approximately 10.4 mi downstream at Fred Hartman Bridge. The nearest gauge for Hunting Bayou is the USGS sta 08075770 for Hunting Bayou at IH 610, approximately 5.5 mi upstream of the Turkey Run Gulley discharge.

Summer stream flow data was located for Buffalo Bayou in a technical memorandum by Brown & Root, Inc. (1998), with a figure showing volume and velocity as a function of distance from river mouth. Based on the figure, it appeared the New BW-8 PA discharge location had a discharge of approximately 2,200 cfs or a velocity of 0.07 ft./s (0.022 m/s). The Filter Bed PA discharge location appeared to be approximately 2,000 cfs velocity 0.44 ft./s (0.136 m/s). For Hunting Bayou, discharge data was acquired for the upstream gauge at IH610. The median daily mean discharge between 1965 and 2019 was 7.66 cfs. It was assumed velocity would be similar between the gauge and discharge locations. Bathymetry was not available for either location. The channel width at the gauge was estimated as 20 ft. (Google Earth), and a cross sectional area estimated as 43 ft<sup>2</sup>. This yields a mean channel velocity of 0.18 ft./s (0.055 m/s).

Manning's roughness values were obtained for Buffalo Bayou/HSC as 0.0177 from Guthrie and Schoenbaechler (2012), and for Hunting Bayou as 0.055 from AECOM Technical Services, Inc. (2014). Hourly wind speeds at the NOAA 8770777 station at Manchester, TX averaged 2.5 m/s during the year 2018.

#### *2.7.6.3 Effluent Density Modeling*

Appendix 7, Table 8 provides CDFATE input data for the effluent discharged from the PAs and entering the receiving streams. The total suspended solids (TSS) content of the effluent was estimated as 0.1 kg/m<sup>3</sup> and was assumed to consist mostly of clay with some fine silt. A column settling test (USACE, 2015; Palermo et al., 1978; Palermo and Thackston, 1988; Thackston et al., 1988) would be needed to predict the site-specific settling behavior of the dredged material in the PA and resulting TSS, which is also a function of the PA design and weir operation. The assumed concentration of TSS is likely sufficient for modeling purposes; density is controlled more by the salinity than the solids content.

The effluent densities were calculated based on temperature and salinity at the corresponding sample locations on Buffalo Bayou/HSC. Due to the discussed salinity stratification, it was assumed the salinity of the dredge slurry and effluent would be best represented by the conservatively picking the bottom salinity in the channel where the salinity is greatest. The salinity of the effluent from the Filter Bed PA was assumed to be represented by the bottom salinity near HSCNew-NMP-11 (9 ppt); New BW-8 PA discharge was assumed to have a salinity of 15 ppt. The salinity of discharges into New E2-Clinton would range between that of the bottom salinities of Buffalo Bayou/HSC at Beltway 8 and Sims Bayou, estimated as 13.5 ppt, and that of the Glendale PA discharge would range between that of the bottom salinities of Buffalo Bayou/HSC at Turning Basin and Sims Bayou, estimated as 11.5 ppt. A maximum distance of 2000 m and 100 reporting periods, which are locations at which concentration is reported, were used to fully delineate mixing zone requirements and provide sufficient resolution.



#### 2.7.6.4 Mixing Zone Data

Mixing zone input is provided in Appendix 7, Table 9. CDFATE modeling was performed to delineate dilution with distance using a generic pollutant X with concentration of 100 and zero background concentration. These concentrations do not affect the physical degree of mixing and dilution and were used for easy calculation since this is a preliminary mixing evaluation. Though mixing zone distance and criterion were supplied as input, these values were also not used in determination of dilution with distance.

### 3.0 Quality Assurance/ Quality Control (QA/QC)

This section provides a QA/QC review of all field, laboratory, and toxicological data. The following are included in full detail as appendices: HSC ECIP NMP SAP (Appendix 1); field report (Appendix 2); chain of custody (Appendix 3); particle size distribution (Appendix 4); analytical summary tables (Appendix 5), analytical laboratory reports, MDL studies, case narratives, internal QC checks, calculations of data quality indicators (Appendix 6), CDFATE model output (Appendix 7), Tier III biological testing report (Appendix 8), and data validation worksheets (Appendix 9).

The following is applicable for all laboratory analyses (i.e., site water, sediment, and elutriate):

*Target Detection Limit (TDL)* is a performance goal set between the lowest, technically feasible, detection limit for routine analytical methods and available regulatory criteria or guidelines for evaluating dredged material.

*Method Detection Limit (MDL)* is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero (ERDC/TN EEDP-04-36) but is present at levels that are too low to estimate analytically. The MDL studies are conducted using ideal, laboratory-prepared samples of a spiked clean matrix.

*Reporting Limit (RL)* is established by the low standard of the initial calibration curve or low-level calibration check standard and represents a concentration at which quantitation is considered accurate. At a minimum, the RL should be three times the MDL.

The relationship between these three metrics should be:  $MDL < RL < TDL$ . When this is not the case, the implications for bias in the data usability and representativeness (negative/low, neutral, positive/high) will be discussed.

#### 3.1 Field Data

Deviations encountered during sample collection are summarized in Section 2.2.2. There were no additional deviations or QA/QC issues pertaining to field data. Field quality control is summarized in Section 2.2.8.

## 3.2 Laboratory Data

The following subsections include a summary of the analytical laboratory's case narratives. Full narratives and lab reports can be found in Appendix 6. These descriptions of specific analysis QC failures are reviews to ensure the usability and representativeness of data when QC deviations occurred.

### 3.2.1 Site Waters

#### 3.2.1.1 VOCs

The chain of custody did not request VOCs for the sediment equipment rinsate, HSCNew-NMP-EQPB. The laboratory control sample (LCS) had an elevated recovery of 157% (Laboratory Limits 45% to 150%) for tetrachloroethylene but the matrix spike/matrix spike duplicate (MS/MSD) had acceptable recoveries based on laboratory limits of 45% to 150%. No significant bias was suspected for the VOC results.

#### 3.2.1.2 SVOC/PAH/PCP

The RL of 20 ug/L exceeded the TDL of 1 ug/L for benzidine for all the samples, however benzidine was not detected in any of the site water samples. Azobenzene was reported instead of 1,2-phenylhydrazine due to the degradation of 1,2-phenylhydrazine in the injection port of the gas chromatograph/mass spectrometer (GC/MS). The WG1167814-3 laboratory control duplicate (LCD) recovery, associated with HSCNew-NMP-EQPB (L1841553-01), was below the acceptance criteria for benzidine (9 %); however, it has been identified as a "difficult" analyte and the results of the associated samples were reported. Per USEPA Method 8270D benzidine may be subject to oxidative losses during solvent concentration and its chromatographic behavior is poor (USEPA, 1998). The WG1167722-1 method blank had concentrations above the reporting limit for several compounds. The results of the original analysis were reported and are qualified with a "B" for any associated sample concentrations that are less than 10x the blank concentration for this analyte. For HSCNew-NMP-07-SW (L1843397-07) and HSCNew-NMP-11-SW (L1843397-11), the surrogate recoveries were outside the acceptance criteria for 2-fluorophenol (13 %) and phenol-d5 (12 %) (Project Limits 30 % to 150 %); however, re-extraction could not be performed due to lack of additional sample. The results of the original analysis were reported; however, all associated compounds are considered to have a potential low bias. The matrix spike/matrix spike duplicate (MS/MSD) was not performed on the SVOC/PAH/PCP due to insufficient sample volume. The sub-laboratory did not notify ECB of the required QC volume of 5 L and were supplied with 2 L as per standard practice. Without the MS/MSD the ability to assess bias associated with matrix interferences is not possible. There is an overall potential low bias of the data for SVOC/PAH/PCP due to low surrogate recoveries, however due to all detections being "J" qualified, and significantly below the screening criteria the data is deemed useable.

#### 3.2.1.3 Pesticides

The equipment rinsate, HSCNew-NMP-EQPB, was extracted five days outside of holding time due to a laboratory processing error. HSCNew-NMP-EQPB was sampled on October 6, 2018 and was received by ECB on October 9, 2018 with a shipment of sediment samples. The laboratory believed that the sample was a sediment sample and had a 14 day holding time versus the actual holding time of 7 days. One of

the continuing calibration verification (CCV) standards had low recoveries of 83.3 and 82.9 % for 4,4'-DDT and oxychlorodane, respectively (Project Limits 85 % to 115 %); however, the recoveries were within the DOD QSM 5.1 limits of 80 % to 120 %. The initial calibrating verification (ICV) standard had an elevated recovery of 127 % (Project Limits 80 % to 120 %) for delta-BHC. The results of toxaphene for the ICV was not reportable. The ICV is a second source standard that did not match the pattern of the standard used for the calibration. SW846 states that some toxaphene components, particularly the more heavily chlorinated components, are subject to dechlorination reactions. As a result, standards from different vendors may exhibit differences, which could lead to possible false negative results or large differences in quantitative results. No bias was observed for the pesticide results based on the quality control samples.

#### 3.2.1.4 PCBs

The laboratory control sample/laboratory control duplicate (LCS/LCD) and MS/MSD had elevated recoveries ranging from 156 % to 177 % (Project Limits 50 % to 150 %) for PCB 170. The MS/MSD had elevated recoveries ranging from 160 % and 167 %, respectively, (Project Limits 50 % to 150 %) for PCB 153. No bias was observed for the PCB congener results based on the quality control samples because all PCBs for all samples were non-detect.

#### 3.2.1.5 Metals

The duplicate had an elevated relative percent difference (RPD) of 72.3 % (Project Limits 30 %) for antimony; however, the RPD was calculated using estimated concentrations that were "J" qualified and below the RL of 0.005 mg/L. All other QC samples for antimony were within acceptable limits, and data is considered useable. One of the two matrix spike duplicates had a low recovery of 57.8% (Project Limits 70 % to 130 %) for zinc. The recoveries for the LCSs and MS and MS/MSD were within the acceptable project limits for zinc. The low recovery in MS/MSD does not impact data usability for zinc due to all samples being non-qualified detections. No bias was observed for the metal results based on the quality control samples.

#### 3.2.1.6 Cyanide

Residual chlorine or other oxidizing agents were detected in the container of all the site waters. Chlorine is an interference that can decompose cyanides; therefore, the results may have a low bias.

#### 3.2.1.7 Petroleum Hydrocarbons

The chain of custody filled out in the field did not request TPH for the sediment equipment rinsate, HSCNew-NMP-EQPB; resulting in the sample not being analyzed for TPH. The RLs for site water samples ranging from of 5,000 to 10,000 ug/L exceeded the TDL of 100 µg/L for TPH by TCEQ (TNRRC) 1005. The hydrocarbon ranges were not detected above the RL for all of the samples. Potential low bias was observed for the TPH samples since the RL was an order of magnitude greater than the TDL.

### 3.2.2 Sediment

#### 3.2.2.1 VOCs

The laboratory control sample had an elevated recovery of 166 % (Laboratory Limits 65 % to 140 %) for tetrachloroethylene (TCE). The matrix spike/matrix spike duplicate elevated recoveries of 156 % and

146 %, respectively (Laboratory Limits 45 % to 150 %). TCE was not detected in any of the sediments; therefore, a high bias was not suspected. The laboratory control sample had a slightly elevated recovery of 129 % (Laboratory Limits 75 % to 125 %) for 1,1-dichloroethane. The analyte, 1,1-dichloroethane, was not detected in any of the sediments; therefore, a high bias was not suspected.

#### 3.2.2.2 SVOC/PAH/PCP

The RLs ranging from 933 ug/kg to 2180 ug/kg exceeded the TDL of 5 ug/kg for benzidine for all samples, however, benzidine was not detected in any of the sediment samples. The RL ranging from 200 ug/kg to 468 ug/kg exceeded the TDL of 100ug/kg for pentachlorophenol (PCP). However, the MDLs ranging from 59.9 ug/kg to 98.7 ug/kg were below the TDL except for HSCNew-NMP-01-SD, which had a MDL of 140 ug/kg. PCP was not detected in any of the sediment samples. Azobenzene was reported instead of 1,2-phenylhydrazine due to the degradation of 1,2-phenylhydrazine in the injection port of the GC/MS. The MS/MSD for aniline had low recoveries of 3 % and 1 % (Projects Limits 50 % to 150 %), respectively, as well as an elevated RPD of 60 % (Project Limits 30 %). The LCS/LCD for aniline had acceptable recoveries of 71 % and 70 %, respectively, as well as an acceptable RPD of 1 %. Some of the SVOC analytes had slightly elevated RPDs in the MS/MSD ranging from 31 % to 41 % (Project Limits 30 %). Some of the SVOC analytes had low recoveries in the MS/MSD ranging from 0 % to 32 % (Project Limits 30 %). All of the SVOC analytes have acceptable recoveries and RPDs in the LCS/LCD. Low bias was suspected for aniline due to matrix interferences based on the quality control samples.

#### 3.2.2.3 Pesticides

There were some elevated recoveries in the CCV ranging from 116 % to 126 % (Project Limits 85 % to 115 %), however, several analytes were within DOD QSM 5.1 limits of 80 % to 120 %. The results of toxaphene for the ICV was not reportable. The ICV is a second source standard that did not match the pattern of the standard used for the calibration. SW846 states that some toxaphene components, particularly the more heavily chlorinated components, are subject to dechlorination reactions. As a result, standards from different vendors may exhibit differences, which could lead to possible false negative results or large differences in quantitative results. The LCS had low recoveries of 25.4 % and 42.3 % (Project Limits 50 % to 150 %) and an RPD of 50 % (Project Limits 30 %) for endrin aldehyde but that analyte had acceptable MS recoveries. The recovery of beta-BHC could not be determined in the matrix spikes due to an interfering peak but that analyte had acceptable recoveries in the LCS (Project Limits 50 % to 150 %). The matrix spikes had low recoveries of 22.6 % and 22.7 % (Project Limits 50 % to 150 %) for endosulfan I but that analyte had acceptable recoveries in the LCSs (Project Limits 50 % to 150 %). The standard reference material (SRM) recoveries were within manufacturer's acceptance limits. No bias was observed for the pesticide results based on the quality control samples.

#### 3.2.2.4 PCBs

The surrogate, 2,4,5,6 tetrachloro-m-xylene (TMX), had elevated recoveries of 119 %, 122 %, and 142 % in the CCVs and PCB 8 had an elevated recovery of 118 % in one of the CCVs. The recoveries of TMX were low in both the LCS and LSD at 14 % and 10 % (Project Limits 30 % to 150 %), respectively. The recoveries of PCBs 18, 44, and 52 could not be determined in the matrix spikes since the inherent analyte concentration in the samples were greater than the spiked concentrations; however, the LCSs for these

analytes were within acceptable ranges (Project Limits 50 % to 150 %). PCB 28 had a low recovery of 47.7 % in one of the matrix spikes but had acceptable recoveries in the other MS/MSD. The SRM recoveries were within manufacturer's acceptance limits. No bias was observed for the PCB congener results based on the quality control samples.

#### *3.2.2.5 Dioxins and Furans*

The peak detected for 1,2,3,7,8,9-hexa CDF does not meet ratio criteria and has resulted in an elevated detection limit of 0.640 pg/g for sample HSCNew-NMP-04-SD. The retention time for the detected peak was greater than 3 seconds when compared to the expected retention time from the internal standard for the analysis of 1,2,3,7,8-penta CDF in HSCNew-NMP-04-SD. The peak detected for 1,2,3,6,7,8-hexa CDF does not meet ratio criteria and has resulted in an elevated detection limit of 1.96 pg/g for HSCNew-NMP-10-SD. Potential low bias was observed for dioxins and furans based on the quality control parameters.

#### *3.2.2.6 Metals*

The MS/MSD had low recoveries for antimony of 55.3 % and 54.4 % (Project Limits 70 % to 130 %), respectively. Some low bias was possibly observed for the results of antimony due to matrix interferences. The method blank had a concentration of 2.4 mg/kg for barium that was above the RL of 0.1 mg/kg; however, the concentration was less than 10 % of the sample results, which was negligible according to the USEPA 6020 method criteria. One of the four CCVs had a slightly low recovery of 89.1 % (Project Limits 90 % to 110 %) for selenium. The duplicate had an elevated RPD of 46.1 % (Project Limits 30 %); however, the MS/MSD had an acceptable RPD of 27.2 %. The method blank had a concentration of 0.192 mg/kg for silver that was slightly above the RL of 0.1 mg/kg. Two of the four CCVs had slightly low recoveries of 88.5 % and 86.6 % (Project Limits 85 % to 115 %). The duplicate had a slightly elevated RPD of 33.7 % (Project Limits 30 %) for silver. There could be a potential for high bias for silver in the sediment samples. The standard reference material (SRM) had an elevated recovery of 173 % (Project Limit 70 % to 130 %) for mercury. The SRM has an acceptable concentration of 31.3 mg/kg based on the certificate of analyses from NSI labs for the SQCI-001 which states the acceptable limits for mercury is between 12.3 mg/kg to 35.5 mg/kg. Chromium(Cr) (VI) was not detected in any of the sediment samples, and both the matrix spike and matrix spike duplicate yielded a 0 % recovery (Project Limits 50 % to 150 %), despite acceptable recoveries of 96.5 % to 97 % for the two LCSs. USEPA Method 3060, alkaline extraction for chromium(VI), requires a post digestion spike, which was also performed, with low recovery of approximately 23 %. Section 8.5.1 of USEPA Method 3060 describes sediment samples that are incompatible with Cr(VI) and where no native Cr(VI) can be present. The Eh of the sediments in question was measured, with all values measured ranging from -22 mV to 58 mV. Section 8.5.1 and Figure 2 in USEPA Method 3060 indicates any sample with an Eh less than approximately 300 mV (lowest possible Eh at any relevant pH) will be incompatible with Cr(VI) (USEPA, 1996). Therefore, since all samples measured had Eh values substantially below this value, no Cr(VI) is present in any sample and the data cannot be qualified or rejected.

#### *3.2.2.7 Total Organic Carbon*

The method blank had TOC concentrations of 0.00559 mg/kg and 0.00725 mg/kg, which was slightly above the RL of 0.005 %. The MS/MSD had recoveries ranging from 125 % to 168 % (Project Limits 75 % to

125 %). The MSD had elevated RPDs ranging from 21.5 % to 26.5 % (Project Limits 20 %). These results suggest a high bias.

#### *3.2.2.8 Petroleum Hydrocarbons*

The RL of 50 mg/kg to 100 mg/kg exceeded the TDL of 5 mg/kg for TPH by TCEQ (TNRRC) 1005. Due to a laboratory error, another aliquot of the extraction surrogate, 1-chlorooctane, is used to test the effectiveness of the method for hydrocarbons C6 to C12. 1-chlorooctane was added to the LCS QG238699-2, instead of the spike mix. Consequently, the LCS had an elevated surrogate recoveries of 4.84 % to 3730 % (Laboratory Limits 70 % to 130 %) and very low recoveries of the hydrocarbons ranges. All of the associated samples were re-extracted within holding time, except for samples: HSCNew-NMP-10-SD, HSCNew-NMP-11-SD, and HSCNew-NMP-12-SD, which were extracted 1 day outside of holding time. The surrogate, 1-chlorooctane, had low recoveries ranging from 46.8 % to 67.8 % (Laboratory Limits 70 % to 130 %) in samples: HSCNew-NMP-01-SD, HSCNew-NMP-02-SD, HSCNew-NMP-03-SD, HSCNew-NMP-05-SD, HSCNew-NMP-07-SD, and HSCNew-NMP-08-SD. However, the second surrogate, o-terphenyl, had acceptable recoveries of 91.7 % to 128 % (Laboratory Limits 70 % to 130 %). No significant bias was observed for the TPH results even though there was a low surrogate recovery for 1-chlorooctane because all results were detected above the MDL for the C6 to C12 hydrocarbons.

### 3.2.3 Modified Elutriate

#### *3.2.3.1 SVOC/PAH/PCP*

The RL of 20 ug/L exceeded the TDL of 1 ug/L for benzidine for all the samples, however benzidine was not detected in any of the samples. Azobenzene was reported instead of 1,2-phenylhydrazine due to the degradation of 1,2-phenylhydrazine in the injection port of the GC/MS. The WG1175786-4 MS recoveries, performed on HSCNew-NMP-03-DUP-EL (L1844499-12), were outside the acceptance criteria of 40 % to 140 % for acenaphthene (36 %); however, the associated MSD and LCS/LCSD recoveries are within overall method allowances. No significant bias was observed for the results of acenaphthene.

#### *3.2.3.2 Pesticides*

One of the CCV standards had low recoveries of 83.3 % and 82.9 % for 4,4'-DDT and oxychlorane, respectively (Project Limits 85 % to 115 %). These analytes were within DOD QSM 5.1 limits of 80 % to 120 %. The ICV had a slightly elevated recovery of 127 % (Project limits 80 % to 120 %) for delta-BHC; however, delta-BHC was not detected in any of the samples. The results of toxaphene in the ICV was not reportable. The ICV is a second source standard that did not match the pattern of the standard used for the calibration. SW846 states that some toxaphene components, particularly the more heavily chlorinated components, are subject to dechlorination reactions. As a result, standards from different vendors may exhibit differences, which could lead to possible false negative results or large differences in quantitative results. No bias was observed for the pesticide results based on the quality control samples.

#### *3.2.3.3 PCBs*

The laboratory originally analyzed PCBs congeners on December 9, 2018 but due to failing CCVs the data was not reportable. Originally, the PCBs were not detected in any of the samples. After multiple re-

analyses of the extracts, acceptable CCVs recoveries were achieved based on the project limits of 85 % to 115 %; however, it was 7 days outside of the analytical holding time. PCBs were still not detected in the final analysis of the samples. The surrogate, PCB 198, had a low recovery in one of the LCS at 28.9 % (Project Limit 30 % to 150 %). However, the other surrogate, TMX, had an acceptable recovery of 87 %. No bias was observed for the PCB congeners even though the final analysis was outside of holding time the results confirmed those from the first analysis which was within holding times.

#### *3.2.3.4 Dioxins and Furans*

The peak detected for octa CDD does not meet ratio criteria and has resulted in an elevated detection limit of 29.6 pg/L for sample HSCNew-NMP-03-EL. The peak detected for 2,3,7,8-tetra CDF does not meet ratio criteria and has resulted in an elevated detection limit of 1.33 pg/L for sample HSCNew-NMP-03-EL. The peak detected for total tetra CDF does not meet ratio criteria and has resulted in an elevated detection limit of 1.33 pg/L for sample HSCNew-NMP-03-EL. The peak detected for total hepta CDD does not meet ratio criteria and has resulted in an elevated detection limit of 2.57 pg/L for sample HSCNew-NMP-10-EL. Potential low bias was observed for dioxins and furans based on the quality control parameters.

#### *3.2.3.5 Metals*

One of the two matrix spike duplicates had a low recovery of 57.8 % (Project Limits 70 % to 130 %) for zinc. The recoveries for the LCSs and MS and MS/MSD were within the acceptable project limits for zinc. No bias was observed for the metal results based on the quality control samples.

#### *3.2.3.6 Cyanide*

Residual chlorine or other oxidizing agents were detected in the container of all the elutriates. Chlorine is an interference that can decompose cyanides; therefore, the results may have a low bias.

#### *3.2.3.7 Petroleum Hydrocarbons*

The RL of 5,000 ug/L to 10,000 ug/L exceeded the TDL of 100 µg/L for TPH by TCEQ (TNRRC) 1005. The hydrocarbon ranges were not detected above the RL for all of the samples. Potential low bias was observed for the TPH samples since the RL was an order of magnitude greater than the TDL.

## 4.0 Results and Discussion

This section contains a description of field observation and analytical results. Tables 2 through 4 summarize the water quality parameters, particle size analysis, and physical properties, respectively. Summaries of detections in chemical analyses for site water, sediment, and elutriate are in Tables 5 through 7. Consistent analytical data sets were collected so that site waters, sediment, and elutriate samples had consistent analyte lists for comparative purposes. All-inclusive data tables for site water, sediment, and elutriate can be found in Appendix 5. Results of the bioassays are summarized in Sections 4.6 and in Appendix 8.

Tables 1A and 1B summarize sample IDs, proposed sample location coordinates, final sample location coordinates and media type collected. The summary of lithologic logs including sample date and time,



water depth, core length, recovery, number of pushes, and other sample descriptions is included in the field report (Appendix 2).

## 4.1 Field Data and In Situ Measurements

Water column parameters (i.e., temperature, pH salinity, ORP, DO, turbidity, specific conductance) were recorded at each sample location along with Global Positioning System (GPS) coordinates (Table 2). Water temperatures ranged from 19.3 °C to 23.1 °C with a mean of 21.2 °C. The mean pH was 7.69 and ranged from 7.47 to 8.06, and the mean salinity was 2.64 parts per thousand (ppt) with a range of 1.13 ppt to 4.59 ppt. The oxidation reduction potential (ORP) ranged from -41.6 mV to 26.3 mV with a mean of 11.0 mV. The dissolved oxygen ranged from 2.74 mg/L to 5.63 mg/L with a mean of 4.06 mg/L. The mean turbidity was 11.0 nephelometric turbidity units (NTU) with a range from 7.6 NTU to 26.3 NTU. The conductivity ranged from 2.29 milisiemens per centimeter (mS/cm) to 8.12 mS/cm with a mean of 4.88 mS/cm.

## 4.2 Physical Testing Data

### 4.2.1 Particle Size Distribution

The particle size distribution for the 12 samples in the NMP section of the HSC were dominated by clay type materials and are shown in Table 3. The unified soil classification (USCS) system was used to determine the particle size distribution and corrected for material that passed 100 % through a 3" sieve. Four of the 12 samples (HSCNew-NMP-03, -NMP-04, -NMP-05, and -NMP-06) contained fine gravel in a small fraction ranging from 0.3 % to 1.5 %. All of the samples contained a sand fraction divided between coarse, medium, and fine sand. The total sand fraction ranged from 8.6 % to 51 % with a mean of 26 % and median of 21 %. The silt fraction for all of the samples ranged from 18 % to 39 % with a mean of 27 % and median of 24.6 %. The clay fraction for all of the samples ranged from 26 % to 73 % with a mean of 48 % and a median of 41 %. Four of the 12 (HSCNew-NMP-04, -NMP-08, -NMP-09, -NMP-10) samples were classified as fat clays. HSCNew-NMP-01 was the only sample classified as a fat clay with sand. HSCNew-NMP-02 and -NMP-06 were classified as lean clay with sand. Four of the 12 samples (HSCNew-NMP-03, -NMP-05, -NMP-07, -NMP-11) were classified as sandy lean clay.

One field duplicate was taken for the NMP section of the HSC. The field duplicate was taken at sample location HSCNew-NMP-03 and identified as HSCNew-NMP-03-SD-Field Dup. The mean gravel fraction between the two samples was 0.65 %. The mean of the total sand fraction was 46 %. The mean of the silt fraction was 27 % with 27 % as the mean for the clay fraction. HSCNew-NMP-03-Field Dup was classified as a clayey sand.

### 4.2.2 Specific Gravity and Atterburg Limits

The specific gravity of the 12 samples ranged from 2.64 g/cm<sup>3</sup> to 2.69 g/cm<sup>3</sup> with a mean and median of 2.66 g/cm<sup>3</sup>. The specific gravity results are shown in Table 4 and were corrected to report values at 20 °C.



The Atterburg limits for the 12 samples in the NMP section of the HSC were identified as lean and fat clays and are shown in Table 4. Five of the 12 (HSCNew-NMP-01, -NMP-04, -NMP-08, -NMP-09, -NMP-10) samples were identified as fat clays and 7 of the 12 (HSCNew-NMP-02, -NMP-03, -NMP-03-Field Dup, -NMP-05, -NMP-06, -NMP-07, -NMP-11) samples were identified as lean clays. The USCS classification for the Atterburg limits was given to material that passes through a #40 sieve; any material retained by a #40 sieve was not included. The liquid limit of the 12 samples ranged from 23 % to 74 % with a mean of 48 % and median of 46 %. The plastic limit of the 12 samples ranged from 11 % to 23 % with a mean of 17 % and median of 17 %. The plasticity index (PI) for the 12 samples NMP ranged from 11 to 53 with a mean of 30 and median of 30.

#### 4.2.3 Percent Solids

Percent solids for HSCNew-NMP-01-SD through HSCNew-NMP-011-SD, including HSCNew-NMP-03-SD-Field Dup, ranged from 50 % to 81 % solids, with a mean of 67% solids. The percent solids results are summarized in Table 6.

### 4.3 Site Water Chemistry

A full chemical analysis for site water, as well as sediment and modified elutriate samples, were required in Section 2.5 of the USACE SAP (2018). A data summary of detections within the chemical analyses for site water samples are presented in Table 5 and are compared to published water quality criteria as defined in Section 5.2.1 of the SAP. An all-inclusive data summary table with comparisons to water quality criteria is presented in Appendix 5 (Table 5A). The prioritization of the screening criteria are as follows: (1) TSWQS (marine - acute); (2) USEPA WQC (marine – acute); (3) NOAA (marine – acute); (4) USEPA Region 6 (marine). One exception to this prioritization, copper was first screened against the USEPA Region 6 marine chronic criteria for copper (3.6 ug/L) which is protective of oyster waters then followed by TSWQS.

#### 4.3.1 VOCs

Of the 51 volatile organic compounds (VOCs) analyzed for in each sample, three compounds (chloroform, chloromethane, bromodichloromethane) were detected in one or more samples. Chloroform was detected in all of the samples except HSCNew-NMP-01-SW, which was “U” qualified (i.e., not detect) and reported at the RL. Chloromethane was detected in three samples, HSCNew-NMP-03-SW, -NMP-09-SW, and -NMP-03-SW-Field Dup, and was “U” qualified in all other samples and reported at the RL. Bromodichloromethane was detected in one sample, HSCNew-NMP-04-SW, and was “U” qualified in all other samples and reported at the RL. The remaining analytes in all samples were below the MDL, qualified “U”, and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor for all VOC analytes was 1. There are no exceedances of the surface water screening criteria for VOCs.

#### 4.3.2 SVOCs

Of the 43 semi-volatile organic compounds (SVOCs) analyzed for in each sample, two compounds (bis(2-ethylhexyl) phthalate and di-n-butyl phthalate) were detected in one or more samples. Bis(2-ethylhexyl) phthalate was detected and qualified “J” (i.e., detected below the reporting limit; estimated concentration) in 4 of the 12 samples, HSCNew-NMP-01-SW, -NMP-02-SW, -NMP-03-SW, and -NMP-04-SW. Bis(2-ethylhexyl) phthalate was not detected, qualified “U”, and reported at the RL in all other samples. Di-n-butyl phthalate was detected and qualified “J” in 2 of the 12 samples, HSCNew-NMP-06-SW and HSCNew-NMP-08-SW. Di-n-butyl phthalate was not detected, qualified “U”, and reported at the RL in all other samples. The remaining analytes in all samples were below the MDL, qualified “U”, and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor for all SVOC analytes was 1. There is an overall potential low bias of the data for SVOCs due to low surrogate recoveries, however due to all detections being “J” qualified, and significantly below the screening criteria the data is deemed useable. USEPA Region 6 surface water screening criteria was exceeded for hexachlorobutadiene and hexachlorocyclopentadiene, however, all results for all samples for hexachlorobutadiene and hexachlorocyclopentadiene were below the MDL, qualified “U”, and reported at the RL which was above the screening criteria for these 2 analytes. There were no other exceedances of any screening criteria for SVOCs.

#### 4.3.3 PAHs

Of the 17 PAHs analyzed for in each sample, 14 compounds (acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, pyrene) were detected in one or more samples. Acenaphthylene, anthracene, and fluorene were non-detects in all samples, qualified “U”, and reported at the RL. All PAH analytes had a dilution factor of 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. There is an overall potential low bias of the data for PAHs due to low surrogate recoveries, however due to all detections being “J” qualified, and significantly below the screening criteria the data is deemed useable.

Acenaphthene was detected in one sample, HSCNew-NMP-04-SW, and was “J” qualified. The remaining samples were non-detects, qualified “U”, and reported at the RL.

Benzo(a)anthracene was detected in 3 samples, HSCNew-NMP-09-SW, -NMP-10-SW, -NMP-11-SW, and was “J” qualified. The remaining samples were non-detects, qualified “U”, and reported at the RL.

Benzo(a)pyrene, benzo(b)fluoranthene, and benzo(e)pyrene were detected in 8 samples, HSCNew-NMP-03-SW, -NMP-05-SW, -NMP-06-SW, -NMP-07-SW, -NMP-09-SW, -NMP-10-SW, -NMP-11-SW, -NMP-03-SW-Field Dup, and was “J” qualified. The remaining samples were non-detects, qualified “U”, and reported at the RL.

Benzo(g,h,i)perylene was detected in all samples except HSCNew-NMP-02-SW, -NMP-04-SW, and -NMP-08-SW. The detected concentrations were all qualified "J". The remaining samples were non-detects, qualified "U", and reported at the RL.

Benzo(k)fluoranthene was detected in 7 samples, HSCNew-NMP-03-SW, -NMP-05-SW, --NMP-06-SW, -NMP-07-SW, -NMP-09-SW, -NMP-10-SW, -NMP-11-SW and was "J" qualified. The remaining samples were non-detects, qualified "U", and reported at the RL.

Chrysene was detected in all of the samples except, HSCNew-NMP-01-SW and HSCNew-NMP-02-SW, and was "J" qualified. The two remaining samples were non-detects, qualified "U", and reported at the RL.

Dibenz(a,h)anthracene was detected in one sample, HSCNew-NMP-04-SW, and was qualified "J". The remaining samples were non-detects, qualified "U", and reported at the RL.

Fluoranthene was detected in all of the samples except, HSCNew-NMP-04-SW and HSCNew-NMP-03-SW-Field Dup, and was "J" qualified. The remaining two samples were non-detects, "U" qualified, and reported at the RL.

Indeno(1,2,3-c,d)pyrene was detected in all 12 samples and "J" qualified, except for HSCNew-NMP-01-SW and HSCNew-NMP-11-SW which did not have a qualifier.

Naphthalene was detected in all of the samples except, HSCNew-NMP-09-SW and HSCNew-NMP-10-SW which were "U" qualified and reported at the RL. Samples HSCNew-NMP-01-SW and HSCNew-NMP-02-SW had detected concentrations of naphthalene that were unqualified. The remaining samples with detections were "J" qualified.

Phenanthrene was detected in 5 samples, HSCNew-NMP-07-SW, -NMP-09-SW, -NMP-10-SW, -NMP-11-SW, -NMP-03-SW-Field Dup and was "J" qualified. The remaining samples were non-detect, qualified "U", and reported at the RL.

Pyrene was detected in all of the samples except, HSCNew-NMP-03-SW, and was "J" qualified. The non-detect was qualified "U" and reported at the RL.

The calculated total PAHs was determined by summing the detections (i.e., non-"U" qualified results). Total PAHs (calculated) ranged from 0.020 ug/L to 0.059 ug/L with a mean of 0.037 ug/L.

None of the screening criteria were exceeded for individual PAHs in the 12 samples. However, PAHs were detected in the field equipment blank. Table 5B in Appendix 5 compares the PAH concentrations from the field equipment blank to the channel samples. The total PAH for the field equipment blank was 0.13 ug/L which was greater than the maximum of 0.059 ug/L for the channel samples. The laboratory blanks did not have any detectable levels of PAHs. Since there were no exceedances of screening criteria in the channel samples and there were no detections of PAHs in the laboratory blanks; PAHs are not a COC that will require further evaluation due to a detection in the field blank for the site water samples.

#### 4.3.4 Pesticides

Of the 22 pesticides analyzed for in each sample none of the analytes were detected and all results were below the MDL, qualified “U”, and reported at the RL. All dilution factors were 1 and no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. All screening criteria were exceeded for toxaphene in all samples. However, toxaphene was non-detect in all samples, qualified “U”, and reported at the RL which exceeded all screening criteria. USEPA Region 6 screening criteria was exceeded for 4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, and heptachlor epoxide in all samples; however each of these analytes were non-detect in all samples, qualified “U”, and reported at the RL which exceeded the screening criteria.

#### 4.3.5 PCBs

Of the 18 PCBs analyzed for in each sample, none were detected, and all results were qualified “U” and reported at the RL. All dilution factors were 1 and no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. Total PCBs were not calculated due to all results being qualified “U”.

#### 4.3.6 Dioxins and Furans

Of the 25 dioxins and furans analyzed for in each sample, 4 compounds were detected; 1,2,3,4,6,7,8 hepta CDD, OCDD, total hepta CDD, and total hexa CDF. 1,2,3,4,6,7,8 hepta CDD was only detected in 1 of the 12 samples, HSCNew-NMP-11-SW and was qualified “J”. OCDD was detected in 5 of the 12 samples, HSCNew-NMP-01-SW, -NMP-05-SW, -NMP-06-SW, -NMP-07-SW, -NMP-08-SW, and was qualified “J”. Total hepta CDD was detected in 4 of the 12 samples, HSCNew-NMP-05-SW, -NMP-09-SW, -NMP-10-SW, -NMP-11-SW, and was qualified “J”. Total hexa CDF was only detected in 1 of the 12 samples, HSCNew-NMP-011-SW, and was qualified “J”. The remaining analytes for the rest of the samples were below the MDL, qualified “U”, and reported at the RL. All dilution factors were 1 and no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

The total toxic equivalency (TEQ) value for dioxins and furans was calculated by using the 2005 World Health Organization (WHO) (Toxic Equivalency Factors (TEF) values (Van den Berg et al; 2006). Concentrations for detected analytes were multiplied by the TEF (where applicable) to calculate a TEQ (Table 5C of Appendix 5). The total TEQ was calculated as the sum of all individual TEQs for each sample. The samples that were detected for total hepta CDD and total hexa CDF were not included in the TEQ calculation due to the lack of a published TEF value. The total TEQ ranged from 0 pg/L to 0.094 pg/L with a mean of 0.011 pg/L. There are no screening criteria for dioxins and furans.

#### 4.3.7 Metals

Of the 16 metals analyzed for in each sample, 3 analytes (cadmium, selenium, and thallium) were non-detects (below the MDL), qualified “U” and reported at the RL in all samples. The remaining 13 analytes (antimony, arsenic, barium, beryllium, chromium (total), chromium (3+), chromium (6+), copper, lead, mercury, nickel, silver, and zinc) were detected above the MDL in one or more site water samples. Three of the 16 analytes (copper, silver and zinc) exceeded published screening criteria and are discussed

below. Samples were diluted 10X for analysis of antimony, arsenic, barium, beryllium, cadmium, chromium (total), copper, lead, nickel, selenium, silver, thallium, zinc, 1X for chromium (3+), and 2X for chromium (6+) and mercury.

Copper was detected in all 12 samples and was “J” qualified in all samples. The detected concentration for HSCNew-NMP-11-SW (4.6 ug/L) exceeded the USEPA Region 6 screening criteria of 3.6 ug/L. All remaining samples were below the USEPA Region 6 screening criteria. TSWQS, USEPA WQC, and NOAA screening criteria were not exceeded by any of the samples.

Silver was detected in 6 of the 12 samples; HSCNew-NMP-01-SW, -NMP-02-SW, -NMP-03-SW, -NMP-09-SW, -NMP-10-SW, -NMP-03-SW-Field Dup. Detections were above the MDL but below the RL and qualified “J”, except for sample HSCNew-NMP-01-SW which did not have a qualifier. Detected concentrations ranged from 0.9 ug/L to 9.2 ug/L with a mean of 2.8 ug/L. Detected silver concentrations in two samples, HSCNew-NMP-01-SW (9.2 ug/L) and HSCNew-NMP-09-SW (3.2 ug/L), exceeded the screening criteria for TSWQS (2 ug/L) and USEPA WQC (1.9 ug/L). Detected silver concentrations in 5 samples, HSCNew-NMP-01-SW (9.2 ug/L), -NMP-02-SW (1.3 ug/L), -NMP-09-SW (3.1 ug/L), -NMP-10-SW (1.2 ug/L), -NMP-03-SW-Field Dup (1.3 ug/L), exceeded the screening criteria for NOAA (0.95 ug/L). Reported concentrations of silver for non-detect samples were qualified “U”, and reported at the RL (5 ug/L) which exceeded the TSWQS, USEPA WQC, and NOAA screening criteria.

Zinc was detected in all 12 samples and was above the MDL and not qualified in any sample. None of the samples exceeded the TSWQS screening criteria of 92.7 ug/L. HSCNew-NMP-06-SW (91 ug/L) exceeded the screening criteria for both USEPA WQC (90 ug/L) and NOAA (90 ug/L). The detected concentration for 3 samples, HSCNew-NMP-06-SW (91 ug/L), -NMP-07-SW (88 ug/L), -NMP-11-SW (86 ug/L), exceed the screening criteria for USEPA Region 6 (84.2 ug/L).

#### 4.3.8 Miscellaneous

Cyanide was non-detect, qualified “U”, and reported at the RL (10 ug/L) for all 12 samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor was 1 for all samples. Chlorine was identified as an interference in the samples that can decompose cyanides; therefore, the results may have a low bias. The reported concentrations exceeded the screening criteria for USEPA WQC (1.0 ug/L), NOAA (1.0 ug/L), and USEPA Region 6 (5.6 ug/L). There is not a TSWQS for cyanide.

Dissolved organic carbon (DOC) was non-detect, qualified “U”, and reported at the RL of 0.01% for all 4 replicates for all samples except HSCNew-NMP-04-SW. The DOC of the 1<sup>st</sup> replicate for HSCNew-NMP-04-SW was 0.039 % and qualified “J”. There are no screening criteria for DOC. The dilution factor for DOC was 100 in all samples.

The total suspended solids (TSS) concentrations ranged from 6,400 ug/L to 18,700 ug/L with a mean of 10,827 ug/L. There are no screening criteria for TSS.

Total organic carbon (TOC) in each sample was analyzed in 4 replicates with the individual replicates and mean reported in the summary tables. The range of the mean was 0.0038 % to 0.010 % with an overall mean of 0.0090 %. Replicates that were non-detect were qualified "U" and reported at the RL (0.010%). All detections were qualified "J". There are no screening criteria for TOC. The dilution factor for TOC was 100 in all samples.

Ammonia (NH<sub>3</sub>-N) was detected in every sample with a range of 115 ug/L to 320 ug/L. The mean ammonia concentration was 254 ug/L. There are no screening criteria for ammonia. The dilution factor was 1 for all samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

Sulfide was detected in two of the 12 samples, HSCNew-NMP-03-SW (5.26 ug/L) and HSCNew-NMP-03-SW-Field Dup (2.62 ug/L) and qualified "J". The remaining samples were non-detect, qualified "U", and reported at the RL (10 ug/L). There are no screening criteria for sulfide. The dilution factor was 1 for all samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

#### 4.3.9 Petroleum Hydrocarbons

Petroleum hydrocarbons were analyzed using method TNRRRC 1005 which has a MDL of 5000 ug/L and did not meet the TDL of 100 ug/L. The analysis included 4 groups of hydrocarbons: C6-C35, C6-C12, >C12-C28, and >C28-C35. Each group is reported in the summary table (Table5A of Appendix 5). The only detected hydrocarbons were for C6-C12 hydrocarbons in samples HSCNew-NMP-01-SW, -NMP-10-SW, and -NMP-03-SW-Field Dup and were "J" qualified. All other samples and analytes were non-detect, qualified "U", and reported at the RL. The dilution factor was 1 for all samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. Potential low bias was observed for the TPH samples since the RL was an order of magnitude greater than the TDL.

#### 4.3.10 Summary

Below is a brief summary of the chemical analysis for the NMP site water samples.

- Screening criteria were not exceeded in any of the samples for VOCs, PAHs, and PCBs.
- USEPA Region 6 screening criteria was exceeded by all samples for 2 compounds, hexachlorobutadiene and hexachlorocyclopentadiene. Results for both compounds were below the MDL, qualified, "U", and reported at the RL, which exceeded screening criteria. There were no other exceedances of screening criteria for SVOCs.
- There were no pesticides detected in any of the samples. All analytical results for pesticides were below the MDL, qualified "U", and reported at the RL for all samples. USEPA Region 6 screening criteria was exceeded by 7 compounds, 4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide and toxaphene, in all samples which were qualified "U" and reported at the RL. Screening criteria for toxaphene for TSWQS, USEPA WQC, and NOAA was exceeded by all samples which were qualified "U" and reported at the RL.

- Dioxins and furans were detected in 8 samples. Total TEQ was calculated using results from non-“U” qualified data and ranged from 0.010 pg/L to 0.094 pg/L. There are no screening criteria for dioxins and furans.
- USEPA Region 6 screening criteria was exceeded by 1 sample for copper and 3 samples for zinc. NOAA screening criteria was exceeded by 11 samples for silver and 1 sample for zinc. USEPA WQC was exceeded by 8 samples for silver and 1 sample for zinc. TSWQS screening criteria was exceeded by 8 samples for silver. Screening criteria for antimony, arsenic, barium, beryllium, cadmium, chromium (total), chromium (3+), chromium (6+), lead, mercury, nickel, selenium, and thallium was not exceeded by any of the samples.
- Cyanide was not detected in any of the samples, qualified, “U”, and reported at the RL. The RL exceeded the screening criteria for USEPA WQC, NOAA, and USEPA Region 6. There are no TSWQS for cyanide.

#### 4.4 Sediment Chemistry

A full chemical analysis for sediment, as well as site water and modified elutriate samples, were required as discussed in Section 2.5 of the USACE SAP (2018). A data summary of detections within the chemical analyses for sediment samples are presented in Table 6 and are compared to published screening criteria as defined in Section 5.2.2 of the SAP. The prioritization of the screening criteria are as follows: (1) NOAA Marine ER-L, (2) NOAA Marine ER-M, and (3) USEPA Region 6 Marine. An all-inclusive data summary table with comparisons to screening criteria is presented in Table 5D of Appendix 5.

##### 4.4.1 VOCs

Of the 51 VOCs analyzed for in each sample, 8 compounds (1,3-dichlorobenzene, acetone, benzene, ethylbenzene, methylcyclohexane, o-xylene, m&p-xylene, toluene) were detected in one or more samples. There were no detections of VOCs for 4 samples, HSCNew-NMP-01-SD, -NMP-03-SD, -NMP-10-SD, and -NMP-03-SD-Field Dup. 1,3-Dichlorobenzene was detected in 2 of the 12 samples, HSCNew-NMP-02-SD and HSCNew-NMP-04-SD, and “U” qualified and reported at the RL in all other samples. Eight samples had detections for acetone, HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-11-SD, and the remaining samples were “U” qualified and reported at the RL. Benzene was detected in 3 of the 12 samples, HSCNew-NMP-02-SD, -NMP-04-SD, and -NMP-08-SD. Benzene was not detected, “U” qualified, and reported at the RL in all other samples. Ethylbenzene was detected in 4 of the 12 samples, HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-07-SD and -NMP-08-SD. Ethylbenzene was not detected, “U” qualified, and reported at the RL in all other samples. HSCNew-NMP-08-SD was the only sample with detections of methylcyclohexane and o-xylene. Two of the 12 samples, HSCNew-NMP-04-SD and HSCNew-NMP-08-SD, had detections for m&p xylene, and the remaining samples were “U” qualified and reported at the RL. Toluene was detected in 2 of the 12 samples, HSCNew-NMP-02-SD and HSCNew-NMP-08-SD. Toluene was not detected, “U” qualified, and reported at the RL in all other samples. For all other VOCs, the concentrations were non-detect, “U” qualified, and reported at the RL and below the TDL. The dilution factor for all samples was 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. None of the screening criteria were exceeded for VOCs.



#### 4.4.2 SVOCs

Of the 43 SVOCs analyzed for in each sample, 6 compounds (1,3-dichlorobenzene, bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, di-methyl phthalate, and hexachlorobutadiene) were detected in the samples. 1,3-Dichlorobenzene was only detected in one sample, HSCNew-NMP-02-SD, and was “J” qualified. In the remaining 11 samples, 1,3-Dichlorobenzene was not detected, “U” qualified, and reported at the RL. Bis(2-ethylhexyl) phthalate was detected in all 12 samples, and was “J” qualified in samples HSCNew-NMP-03-SD and HSCNew-NMP-03-SD-Field Dup. Bis(2-ethylhexyl) phthalate was above the USEPA Region 6 marine screening criteria (182 ug/kg) for 10 of the 12 samples with a concentration range of 229 ug/kg to 2,240 ug/kg. Butyl benzyl phthalate was detected in 2 of the 12 samples, HSCNew-NMP-09-SD and HSCNew-NMP-11-SD, and was “J” qualified. Butyl benzyl phthalate was not detected, “U” qualified, and reported at the RL in the remaining 10 samples. Diethyl phthalate was only detected in one sample, HSCNew-NMP-09-SD and was “J” qualified, and the remaining samples were non-detect, “U” qualified, and reported at the RL. Di-methyl phthalate was only detected in one sample, HSCNew-NMP-11-SD, and was “J” qualified, and the remaining samples were non-detect, “U” qualified, and reported at the RL. Hexachlorobutadiene was detected in 2 of the 12 samples, HSCNew-NMP-01-SD and HSCNew-NMP-02-SD. Hexachlorobutadiene was not detected, “U” qualified, and reported at the RL in the remaining 10 samples. All remaining SVOCs in all samples were below the MDL, “U” qualified, and reported at the RL. The dilution factor for all samples was 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. Low bias was suspected for aniline due to matrix interferences based on the quality control samples however, aniline was non-detect in all samples. The only screening criteria exceeded for SVOCs was the USEPA Region 6 criteria for bis(2-ethylhexyl) phthalate as discussed above.

#### 4.4.3 PAHs

All 17 PAHs were detected in one or more samples. The reported concentrations for 13 of the 17 analytes exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria for at least one of the samples. The reported concentrations for 3 of the analytes (acenaphthene, fluorene, phenanthrene) exceeded the screening criteria for NOAA ER-M marine screening levels, in addition to NOAA ER-L and USEPA Region 6 criteria. A discussion of each exceedance is provided below. The dilution factor for all samples was 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

Acenaphthene was detected in all samples except HSCNew-NMP-03-SD which was below the MDL, “U” qualified, and reported at the RL. Detected concentrations ranged from 5.7 ug/kg to 683 ug/kg with a mean of 216 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 16 ug/kg for 9 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD. HSCNew-NMP-08-SD exceeded the NOAA ER-M screening criteria of 500 ug/kg with a detected concentration of 683 ug/kg.

Acenaphthylene was detected in all 12 samples and was “J” qualified in HSCNew-NMP-03-SD and HSCNew-NMP-03-SD-Field Dup. Detected concentrations ranged from 2.2 ug/kg to 92 ug/kg with a mean



of 38 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 44 ug/kg in 4 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-08-SD, and -NMP-011-SD.

Anthracene was detected in all samples except HSCNew-NMP-03-SD which was below the MDL, "U" qualified, and reported at the RL. Detected concentrations ranged from 12 ug/kg to 733 ug/kg with a mean of 194 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 85.3 ug/kg for 6 samples: HSCNew-NMP-04-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD.

Benzo(a)anthracene was detected in all 12 samples. Detected concentrations ranged from 8.0 ug/kg to 902 ug/kg with a mean of 357 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 261 ug/kg for 7 samples: HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD.

Benzo(a)pyrene was detected in all 12 samples. Detected concentrations ranged from 8.9 ug/kg to 709 ug/kg with a mean of 269 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 430 ug/kg for 3 samples: HSCNew-NMP-04-SD, -NMP-07-SD, and -NMP-10-SD.

Benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-c,d)pyrene were detected in one or more samples. These analytes were detected with no qualifier in all samples and do not have NOAA or USEPA Region 6 marine screening criteria for comparison.

Chrysene was detected in all 12 samples. Detected concentrations of chrysene ranged from 7.0-ug/kg to 850-ug/kg with a mean of 337 ug/kg. Detected concentrations exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 384 ug/kg in 5 samples: HSCNew-NMP-04-SD, -NMP-07-SD, -NMP-08-SD, -NMP-10-SD, and -NMP-11-SD.

Dibenzo(a,h)anthracene was detected in all of the samples except HSCNew-NMP-03-SD which was below the MDL, "U" qualified, and reported at the RL. Reported concentrations for samples HSCNew-NMP-01-SD, -NMP-02-SD, and -NMP-03-SD-Field Dup were detected above the MDL and "J" qualified. Detected concentrations ranged from 4.1 ug/kg to 153 ug/kg with a mean of 58 ug/kg. Dibenzo(a,h,)anthracene was above the NOAA ER-L and USEPA Region 6 marine screening criteria of 63.4 ug/kg for 4 samples: HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD and -NMP-10-SD.

Fluoranthene was detected in all 12 samples. Detected concentrations of fluoranthene ranged from 14 ug/kg to 1830 ug/kg with a mean of 861 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 600 ug/kg was exceeded in 7 samples: HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD.

Fluorene was detected in all 12 samples except for HSCNew-NMP-03-SD which was below the MDL, "U" qualified, and reported at the RL. Detected concentrations of fluorene ranged from 5.3 ug/kg to 614 ug/kg with a mean of 220 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 19 ug/kg was

exceeded in 9 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD. The NOAA ER-M of 540 ug/kg was exceeded in 2 samples, HSCNew-NMP-08-SD and HSCNew-NMP-09-SD.

Naphthalene was detected in all 12 samples except for HSCNew-NMP-03-SD-Field Dup which was below the MDL, “U” qualified, and reported at the RL. Naphthalene was detected and “J” qualified in sample HSCNew-NMP-03-SD. The detected concentrations for naphthalene ranged from 2.1 ug/kg to 463 ug/kg with a mean of 81 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 160 ug/kg was exceeded in sample HSCNew-NMP-10-SD.

Phenanthrene was detected in all 12 samples and was “J” qualified in HSCNew-NMP-03-SD. Detected concentrations of phenanthrene ranged from 4.6 ug/kg to 1860 ug/kg with a mean of 665 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 240 ug/kg was exceeded in 7 samples: HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, -NMP-11-SD. Samples HSCNew-NMP-08-SD and -NMP-09-SD exceeded the NOAA ER-M marine screening criteria of 1500 ug/kg.

Pyrene was detected in all 12 samples. Detected concentrations ranged from 19 ug/kg to 1,480 ug/kg with a mean of 798 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 665 ug/kg was exceeded in 7 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD.

Total PAHs were calculated by the laboratory and concentrations ranged from 108 ug/kg to 11,200 ug/kg with a mean of 5,378 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 4,022 ug/kg was exceeded in 7 samples: HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD.

#### 4.4.4 Pesticides

Out of the 22 individual pesticides analyzed for in each sample, 11 analytes were detected in one or more samples. The eleven detected analytes were 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aldrin, alpha-BHC, dieldrin, gamma-BHC, alpha-chlordane, gamma-chlordane, oxychlordane, and trans-nonachlor. The remaining 12 analytes were below the MDL, “U” qualified, and reported at the RL for all samples. Detections and exceedances are discussed below. The dilution factor for all samples was 1.27.

4,4'-DDD was detected in all 12 samples. Detected concentrations ranged from 0.59 ug/kg to 10 ug/kg with a mean of 3.6 ug/kg. The NOAA ER-L (2 ug/kg) and USEPA Region 6 (1.22 ug/kg) marine screening criteria were exceeded in 9 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-10-SD, -NMP-11-SD, and -NMP-03-SD-Field Dup. Sample HSCNew-NMP-10-SD, 1.8 ug/kg, was the only sample to exceed the USEPA Region 6 marine screening criteria and not the NOAA ER-L screening criteria.

4,4'-DDE was detected in all 12 samples. Detected concentrations ranged from 0.30 ug/kg to 15 ug/kg with a mean of 5.0 ug/kg. The NOAA ER-L (2.2 ug/kg) and USEPA Region 6 (2.07 ug/kg) marine screening

criteria were both exceeded in 7 samples: HSCNew-NMP-02-SD, -NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-11-SD.

4,4'-DDT was detected in 4 samples. Samples, HSCNew-NMP-01-SD, -NMP-02-SD, -NMP-06-SD, -NMP-07-SD, -NMP-09-SD, -NMP-10-SD, -NMP-11-SD, and -NMP-03-SD-Field Dup were below the MDL, "U" qualified, and reported at the RL. Sample HSCNew-NMP-03-SD was the only sample with a "J" qualified detected concentration. Detected concentrations ranged from 0.082 ug/kg to 9.3 ug/kg with a mean of 4.2 ug/kg. Samples HSCNew-NMP-04-SD, -NMP-05-SD, and -NMP-08-SD exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 1 ug/kg and 1.19 ug/kg, respectively. Sample HSCNew-NMP-04 (9.27 ug/kg) was the only sample above the NOAA ER-M of 7 ug/kg.

Dieldrin was only detected in 1 sample, HSCNew-NMP-03-SD-Field Dup (0.79 ug/kg). All remaining samples were below the MDL, "U" qualified, and reported at the RL. The RL for dieldrin was above the NOAA ER-L of 0.02 ug/kg but below the USEPA Region 6 marine screening criteria of 0.715 ug/kg. Sample HSCNew-NMP-03-SD-Field Dup was above both the NOAA ER-L and USEPA Region 6 marine screening criteria.

Gamma-BHC was detected in 4 samples, HSCNew-NMP-02-SD, -NMP-05-SD, -NMP-06-SD, and -NMP-07-SD. All remaining samples were below the MDL, "U" qualified, and reported at the RL. The detected concentrations ranged from 0.42 ug/kg to 0.86 ug/kg with a mean of 0.71 ug/kg. All detections were all above the USEPA Region 6 marine screening criteria of 0.32 ug/kg.

Alpha-chlordane was detected in 7 samples and was "J" qualified for 1 sample HSCNew-NMP-01-SD. The remaining 5 samples were below the MDL, "U" qualified, and reported at the RL. The detected concentrations ranged from 0.045 ug/kg to 1.9 ug/kg with a mean of 1.1 ug/kg. Six of these detections, HSCNew-NMP-06-SD, -NMP-07-SD, -NMP-08-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD exceeded the NOAA ER-L screening criteria of 0.5 ug/kg.

Gamma-chlordane was detected in 3 samples, HSCNew-NMP-02-SD, -NMP-03-SD, and -NMP-09-SD, and was "J" qualified in HSCNew-NMP-03-SD. The remaining 9 samples were below the MDL, "U" qualified, and reported at the RL. The NOAA ER-L marine screening criteria of 0.5 ug/kg was exceeded by both HSCNew-NMP-02-SD and HSCNew-NMP-09-SD with concentrations of 2.2 ug/kg and 1.2 ug/kg, respectively.

Oxychlordane was only detected in 1 sample, HSCNew-NMP-02-SD, and was "U" qualified and reported at the RL for the remaining samples. The NOAA ER-L (0.5 ug/kg) and USEPA Region 6 (2.26 ug/kg) marine screening criteria were exceeded with a concentration of 3.61 ug/kg.

Trans-nonachlor was detected in 4 samples, HSCNew-NMP-06-SD, -NMP-09-SD, -NMP-10-SD, and -NMP-11-SD. The remaining samples were not detected, "U" qualified, and reported at the RL. The detected concentrations ranged from 0.61 ug/kg to 1.4 ug/kg with a mean of 1.0 ug/kg. The NOAA ER-L screening criteria of 0.5 ug/kg was exceed by all 4 samples..

#### 4.4.5 PCBs

Of the 18 PCB congeners analyzed for in each sample, there were detections of each in at least 1 sample, except for PCB 169 which was below the MDL, “U” qualified, and reported at the RL in all samples. The dilution factor for all samples was 1.27. Total calculated PCB congeners was determined and calculated by the laboratory. The total calculated PCB congeners concentration ranged from 2.7 ug/kg to 74 ug/kg with a mean concentration of 34 ug/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 22.7 ug/kg was exceeded in 7 of the samples: HSCNew-NMP-02-SD, NMP-04-SD, -NMP-05-SD, -NMP-06-SD, -NMP-07-SD, -NMP-08-SD, and -NMP-11-SD.

#### 4.4.6 Dioxins and Furans

All 25 dioxins and furans were detected in one or more samples. The dilution factor for all samples was 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. Potential low bias was observed for dioxins and furans based on the quality control parameters. The total TEQ for dioxins and furans was calculated by using the 2005 WHO TEF values (Van den Berg et al; 2006) (Appendix 5 Table 5E). The concentrations for detected analytes were multiplied by the TEF and converted TEF values were summed to calculate a total TEQ. The total TEQ ranged from 2.8 pg/g to 1,370 pg/g with a mean of 161 pg/g.

#### 4.4.7 Metals

Each of the 16 metals were detected in every sample. Chromium(+6) was the only analyte to be “J” qualified for all 12 samples. Six of the 16 analytes (cadmium, copper, lead, mercury, nickel, and zinc) exceeded published screening criteria for NOAA ER-L and USEPA Region 6 and are discussed below. No samples exceeded the NOAA ER-M marine screening criteria. Barium was qualified “MB-02” and “B” for all 12 samples and silver was qualified “B” for all 12 samples. MB-02 is defined as “the method blank contains the analyte at a concentration above the method reporting limit (MRL) due to memory interferences.” The “B” qualifier is defined as “analyte is detected in the associated laboratory blank as well as in the sample.” More detail on the laboratory qualifiers and the impacts on the data was addressed in Section 3.2.2.6. Some low bias was possibly observed for the results of antimony due to matrix interferences. There could be a potential for high bias for silver in the sediment samples due to an elevated RPD value. Dilution factors for chromium (3+) and chromium 6(+) were 1. All other dilution factors were greater than 1.

Cadmium was detected in all 12 samples. Detected concentrations ranged from 0.058 mg/kg to 2.1 mg/kg with a mean of 0.61 mg/kg. The highest concentration was in sample HSCNew-NMP-04-SD and exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 1.2 mg/kg. All other samples had detections below screening criteria.

Copper was detected in all 12 samples. Detected concentrations ranged from 4.6 mg/kg to 40 mg/kg with a mean of 19 mg/kg. The highest concentration was in sample HSCNew-NMP-04-SD and exceeded the NOAA ER-L and USEPA Region 6 marine screening criteria of 34 mg/kg. All other samples had detections below screening criteria.

Lead was detected in all 12 samples. Detected concentrations ranged from 8.4 mg/kg to 81 mg/kg with a mean of 39 mg/kg. The highest concentration was in sample HSCNew-NMP-04-SD. The NOAA ER-L and USEPA Region 6 marine screening criteria of 46.7 mg/kg was exceeded by 4 samples, HSCNew-NMP-04-SD, -NMP-06-SD, -NMP-07-SD, and -NMP-08-SD. All other samples had detections below screening criteria.

Mercury was detected in all 12 samples. Detected concentrations ranged from 0.012 mg/kg to 0.41 mg/kg with a mean of 0.15 mg/kg. The highest concentration was in sample HSCNew-NMP-04-SD. The NOAA ER-L and USEPA Region 6 marine screening criteria of 0.15 mg/kg was exceeded by 5 samples, HSCNew-NMP-01-SD, -NMP-02-SD, -NMP-04-SD, -NMP-07-SD, and -NMP-08-SD. All other samples had detections below screening criteria.

Nickel was detected in all 12 samples. Detected concentrations ranged from 7.0 mg/kg to 26 mg/kg with a mean of 15 mg/kg. The highest concentration was in sample HSCNew-NMP-04-SD. The NOAA ER-L and USEPA Region 6 marine screening criteria of 20.9 mg/kg was exceeded by 2 samples, HSCNew-NMP-04-SD and HSCNew-NMP-09-SD. All other samples had detections below screening criteria.

Zinc was detected in all 12 samples. Detected concentrations ranged from 20 mg/kg to 237 mg/kg with a mean of 107 mg/kg. The NOAA ER-L and USEPA Region 6 marine screening criteria of 150 mg/kg was exceeded in 2 samples, HSCNew-NMP-04-SD and HSCNew-NMP-07-SD. All other samples had detected concentrations below the screening criteria.

#### 4.4.8 Miscellaneous

Cyanide was non-detect, qualified "U", and reported at the RL for all 12 samples. The dilution factor for all samples was 1; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

Acid volatile sulfide was detected in all 12 samples with a concentration range of 27 mg/kg to 1,130 mg/kg. The mean sulfide concentration was 320 mg/kg and the maximum concentration was in sample HSCNew-NMP-04-SD. The dilution factor for all samples was 100.

Volatile solids were detected in all 12 samples with a concentration range from 10,600 mg/kg to 62,600 mg/kg with a mean of 39,050 mg/kg. The maximum concentration was in sample HSCNew-NMP-04-SD.

TOC in each sample was analyzed in four replicates with the minimum, maximum, and mean reported in the summary tables. The range of the mean was 0.15 % to 0.61 % with an overall mean of 0.38 %. The dilution factor for samples HSCNew-NMP-01-SD, -NMP-02-SD, and -NMP-04-SD was 10. The dilution factor for sample HSCNew-NMP-03-SD was 4 and the dilution factor for the remaining 8 samples was 5. There is a possible high bias for the TOC data due to the elevated MS/MSD recoveries.

Ammonia (NH<sub>3</sub>-N) was detected in every sample with a concentration range of 13 mg/kg to 235 mg/kg. The mean ammonia concentration was 124 mg/kg, and the maximum concentration was in sample HSCNew-NMP-07-SD. The dilution factor for all samples was 10.

#### 4.4.9 Petroleum Hydrocarbons

Petroleum hydrocarbons were analyzed using method TNRRRC 1005, which has a MDL of 9 mg/kg and did not meet the TDL of 5 mg/kg. The analysis included 4 groups of hydrocarbons (C6-C35, C6-C12, >C12-C28, and >C28-C35), and each group is reported in the summary table (Table 5D of Appendix 5). All four hydrocarbon groups were detected in all samples. The range of concentrations for C6-C35 was 24 mg/kg to 1,133 mg/kg with a mean of 237 mg/kg. The range of concentrations for C6-C12 was 7.3 mg/kg to 94 mg/kg with a mean of 23 mg/kg. The range of concentrations for >C28-C35 was 11 mg/kg to 140 mg/kg with a mean of 49 mg/kg. The range of concentrations for >C12-C28 was 7.3 mg/kg to 870 mg/kg with a mean of 168 mg/kg.

#### 4.4.10 Summary

Below is a brief summary of the chemical analysis for the NMP sediment samples.

- Screening criteria was not exceeded by any of the samples for VOCs.
- USEPA Region 6 screening criteria was exceeded by 8 samples for bis(2-ethylhexyl) phthalate. No other screening criteria were exceeded for SVOCs.
- NOAA ER-L and USEPA Region 6 screening criteria were exceeded by 1 or more samples for all analytes except, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-c,d)pyrene which do not have screening criteria. NOAA ER-M screening criteria was exceeded by 1 or more samples for acenaphthene, fluorene, and phenanthrene. All PAHs were detected in 1 or more samples.
- NOAA ER-L and USEPA Region 6 screening criteria were exceeded by 1 or more samples for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin. In addition, USEPA Region 6 screening criteria was exceeded for gamma-BHC (lindane) in 1 or more samples. NOAA ER-M screening criteria was exceeded for 4,4'-DDT for one or more samples.
- NOAA ER-L and USEPA Region 6 screening criteria for total PCB congeners was exceeded by 7 samples.
- NOAA ER-L and USEPA Region 6 screening criteria were exceeded by 1 or more samples for cadmium, copper, lead, mercury, nickel and zinc.

#### 4.5 Modified Elutriate Chemistry

A full chemical analysis for modified elutriate, as well as sediment and site water samples were analyzed as required in Section 2.5 of the USACE SAP (2018). A data summary of detections within the chemical analyses for modified elutriate samples are presented in Table 7 and are compared to published water quality criteria as defined in Section 5.2.1 of the SAP. An all-inclusive data summary table with comparisons to water quality criteria is presented in Appendix 5 Table 5F. The prioritization of the screening criteria are as follows: (1) TSWQS (marine - acute); (2) USEPA WQC (marine – acute); (3) NOAA

(marine – acute); (4) USEPA Region 6 (marine). One exception to this prioritization, copper was, first screened against the USEPA Region 6 marine chronic criteria for copper (3.6 ug/L) which is protective of oyster waters then followed by TSWQS. The TSWQS (2014) are the primary screening criteria used for the modified elutriate samples since the state of Texas is the regulatory authority granting the water quality certification for the placement area (PA) discharge.

#### 4.5.1 VOCs

Of the 51 VOCs analyzed for in each sample, 10 compounds (1,3-dichlorobenzene, 2-butanone, acetone, benzene, chloroform, chloromethane, methylcyclohexane, methylene chloride, o-xylene, and m&p-xylene) were detected in one or more samples. At least one of the previously listed VOCs was detected in each sample. All remaining analytes were non-detect, “U” qualified, and reported at the RL; no, matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor for all samples was 1. None of the screening criteria were exceeded in any of the modified elutriate samples. Detections are summarized below.

1,3-Dichlorobenzene was only detected in 1 sample, HSCNew-NMP-04-EL (0.47 ug/L), and was “J” qualified. All other samples were non-detect, qualified “U”, and reported at the RL.

2-Butanone was detected in 6 samples, HSCNew-NMP-04-EL, -NMP-05-EL, -NMP-06-EL, -NMP-07-EL, -NMP-08-EL, -NMP-11-EL. Detected concentrations were “J” qualified in all samples, ranged from 3.2 ug/L to 5.6 ug/L with a mean of 4.1 ug/L. All other samples were non-detect, qualified “U”, and reported at the RL.

Acetone was detected in all 12 samples except for HSCNew-NMP-03-EL, which was “U” qualified and reported at the RL. Detected concentrations of acetone ranged from 19 ug/L to 74 ug/L with a mean concentration of 45 ug/L.

Benzene was only detected in 1 sample, HSCNew-NMP-04-EL (0.47 ug/L), and was “J” qualified. All other samples were non-detect, qualified “U”, and reported at the RL.

Chloroform was detected in only 1 sample, HSCNew-NMP-11-EL (0.50 ug/L). All other samples were non-detect, qualified “U”, and reported at the RL.

Chloromethane was detected in 4 samples, HSCNew-NMP-06-EL, -NMP-07-EL, -NMP-09-EL, and -NMP-03-EL-Field Dup. Detected concentrations ranged from 2.1 ug/L to 3.4 ug/L with a mean of 2.8 ug/L. All other samples were non-detect, qualified “U”, and reported at the RL.

Methylcyclohexane was detected in only 1 sample, HSCNew-NMP-08-EL (1.2 ug/L). All other samples were non-detect, qualified “U”, and reported at the RL.

Methylene chloride was detected in all 12 samples, except HSCNew-NMP-11-EL, which was “U” qualified and reported at the RL. Detected concentrations ranged from 4.0 ug/L to 16 ug/L with a mean of 8.3 ug/L.

o-Xylene was detected in 3 samples, HSCNew-NMP-04-EL, -NMP-07-EL, and -NMP-08-EL. Detected concentrations ranged from 0.43 ug/L to 2.0 ug/L with a mean of 1.1 ug/L. o-Xylene was “J” qualified in samples HSCNew-NMP-04-EL and -NMP-07-EL. All other samples were non-detect, qualified “U”, and reported at the RL.

m&p-Xylene was detected in 2 samples, HSCNew-NMP-04-EL (0.98 ug/L) and HSCNew-NMP-08-EL (0.9 ug/L), and both “J” qualified. All other samples were non-detect, qualified “U”, and reported at the RL.

#### 4.5.2 SVOCs

Of the 43 SVOCs that were analyzed for in each sample, 3 compounds were detected (1,3-dichlorobenzene, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate). All other compounds were non-detect, “U” qualified, and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor for all samples was 1. USEPA Region 6 surface water screening criteria was exceeded for hexachlorobutadiene and hexachlorocyclopentadiene. All results for hexachlorobutadiene and hexachlorocyclopentadiene in all samples were below the MDL, qualified “U”, and reported at the RL which was above the screening criteria. There were no other exceedances of any screening criteria for SVOCs. Detections are summarized below.

1,3-Dichlorobenzene was detected and “J” qualified in 2 of the 12 samples, HSCNew-NMP-02-EL (0.10 ug/L) and HSCNew-NMP-04-EL (0.15 ug/L). All other samples were non-detect, qualified “U”, and reported at the RL.

Bis(2-ethylhexyl) phthalate was detected in all 12 samples and was “J” qualified in all except HSCNew-NMP-07-EL. Detected concentrations ranged from 0.1 ug/L to 1.7 ug/L with a mean of 0.27 ug/L.

Di-n-butyl phthalate was detected in all 12 samples and was “J” qualified in all except HSCNew-NMP-01-EL. Detected concentrations ranged from 0.15 ug/L to 0.68 ug/L with a mean of 0.28 ug/L.

#### 4.5.3 PAHs

All 17 PAHs were detected in one or more modified elutriate samples. Descriptions of the detections for each analyte are provided below. Any concentrations below the MDL were qualified “U” and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. All PAH analytes had a dilution factor of 1. USEPA Region 6 screening criteria was exceeded for 2 analytes, anthracene and pyrene, and exceedances are discussed below. There were no exceedances of TSWQS, USEPA WQC, or NOAA screening criteria.

Acenaphthene was detected in all 12 samples. Detected concentrations ranged from 0.0099 ug/L to 5.89 ug/L with a mean of 0.85 ug/L.



Acenaphthylene was detected in all samples except for HSCNew-NMP-03-EL, which was non-detect, qualified "U", and reported at the RL. Detected concentrations ranged from 0.0033 ug/L to 0.087 ug/L with a mean of 0.022 ug/L. Three samples, HSCNew-NMP-01-EL, -NMP-06-EL, and -NMP-03-EL-Field Dup, with detections had "J" qualified results.

Anthracene was detected in all 12 samples. Detected concentrations ranged from 0.0045 ug/L to 0.85 ug/L with a mean of 0.17 ug/L. One of the 12 detections, HSCNew-NMP-03-EL, was "J" qualified. USEPA Region 6 screening criteria of 0.18 ug/L was exceeded by two samples, HSCNew-NMP-08-EL (0.62 ug/L) and HSCNew-NMP-09-EL (0.85 ug/L).

Benzo(a)anthracene was detected in all samples except HSCNew-NMP-03-EL, which was non-detect, qualified "U", and reported at the RL. Detected concentrations ranged from 0.0022 ug/L to 0.029 ug/L with a mean of 0.015 ug/L. Four detections, HSCNew-NMP-01-EL, -NMP-02-EL, -NMP-05-EL, and -NMP-03-EL-Field Dup, were "J" qualified.

Benzo(a)pyrene was detected in all samples except HSCNew-NMP-03-EL and HSCNew-NMP-03-EL-Field Dup, which were non-detect, qualified "U", and reported at the RL. Detected concentrations range from 0.0012 ug/L to 0.0060 ug/L with a mean of 0.0032 ug/L. All detections were "J" qualified.

Benzo(b)fluoranthene was detected in 8 samples. The four samples that were non-detect, HSCNew-NMP-01-EL, -NMP-02-EL, -NMP-03-EL, and -NMP-03-EL-Field Dup, were qualified "U" and reported at the RL. Detected concentrations ranged from 0.0027 ug/L to 0.0072 ug/L with a mean of 0.0040 ug/L. All detected results were "J" qualified.

Benzo(e)pyrene was detected in all 12 samples except for HSCNew-NMP-03-EL and HSCNew-NMP-03-EL-Field Dup which were non-detect, "U" qualified, and reported at the RL. Detected concentrations ranged from 0.0018 ug/L to 0.070 ug/L with a mean of 0.0037 ug/L. All detected results were "J" qualified.

Benzo(g,h,i)perylene was detected in 7 samples. The 5 samples that were non-detect, HSCNew-NMP-03-EL, -NMP-08-EL, -NMP-09-EL, -NMP-10-EL, -NMP-03-EL-Field Dup, were "U" qualified and reported at the RL. Detected concentrations ranged from 0.0017 ug/L to 0.0031 ug/L with a mean of 0.0024 ug/L. All detected concentrations were qualified "J".

Benzo(k)fluoranthene was detected in 8 samples. The 4 samples that were non-detect, HSCNew-NMP-01-EL, -NMP-02-EL, -NMP-03-EL, and -NMP-03-EL-Field Dup, were "U" qualified and reported at the RL. Detected concentrations ranged from 0.0018 ug/L to 0.0040 ug/L with a mean of 0.0026 ug/L. All detected concentrations were "J" qualified.

Chrysene was detected in all samples. Detected concentrations ranged from 0.0014 ug/L to 0.026 ug/L with a mean of 0.014 ug/L. Samples HSCNew-NMP-01-EL, -NMP-02-EL, -NMP-03-EL, and -NMP-03-EL-Field Dup were "J" qualified.

Dibenz(a,h)anthracene was detected in one sample, HSCNew-NMP-07-EL (0.00076 ug/L) and was qualified "J". The remaining samples were non-detect, qualified "U", and reported at the RL.

Fluoranthene was detected in all 12 samples. Detected concentrations ranged from 0.017 ug/L to 0.61 ug/L with a mean of 0.21 ug/L.

Fluorene was detected in all 12 samples. Detected concentrations ranged from 0.0060 ug/L to 3.8 ug/L with a mean of 0.60 ug/L. Only 1 sample, HSCNew-NMP-03-EL, was qualified "J".

Indeno(1,2,3-c,d)pyrene was detected in all 12 samples and qualified "J". Detected concentrations ranged from 0.0052 ug/L to 0.0077 ug/L with a mean of 0.0063 ug/L.

Naphthalene was detected in all 12 samples. Six of the 12 detections, HSCNew-NMP-01-EL, -NMP-03-EL, -NMP-04-EL, -NMP-05-EL, -NMP-06-EL, -NMP-11-EL, were qualified "J". Detected concentrations ranged from 0.0029 ug/L to 0.52 ug/L with a mean of 0.072 ug/L.

Phenanthrene was detected in all 12 samples. Three of the 12 samples, HSCNew-NMP-03-EL, -NMP-06-EL, and -NMP-11-EL, were qualified "J". Detected concentrations ranged from 0.0050 ug/L to 3.8 ug/L with a mean of 0.67 ug/L.

Pyrene was detected in all 12 samples. Detected concentrations ranged from 0.017 ug/L to 0.33 ug/L with a mean of 0.14 ug/L. USEPA Region 6 screening criteria of 0.24 ug/L was exceeded by 3 samples, HSCNew-NMP-02-EL (0.33 ug/L), -NMP-08-EL (0.25 ug/L), -NMP-09-EL (0.28 ug/L).

The calculated total PAHs was determined by the laboratory. Total PAHs (calculated) ranged from 0.073 ug/L to 16 ug/L with a mean of 2.8 ug/L.

#### 4.5.4 Pesticides

Of the 22 pesticides analyzed for in each sample no analytes were detected except for heptachlor in sample HSCNew-NMP-05-EL at 0.0060 ug/L. All other results for all samples were below the MDL, qualified "U", and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analysis instrument range. The dilution factor for all samples was 1. All screening criteria were exceeded for toxaphene in all samples. However, toxaphene was non-detect in all samples, qualified "U", and reported at the RL which exceeded all screening criteria. USEPA Region 6 screening criteria was exceeded for 4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, and heptachlor epoxide in all samples; each of these analytes were non-detect in all samples, qualified "U", and reported at the RL which exceeded the screening criteria.

#### 4.5.5 PCBs

Sample HSCNew-NMP-11-EL was the only sample to have any detections of PCBs. PCB 153 and PCB 52 were both "J" qualified and detected at 0.0020 ug/L and 0.0040 ug/L respectively. None of the other samples had detected levels of PCBs and all other results were qualified "U", and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analysis instrument range. The dilution factor for all samples was 1. Total PCBs were not calculated due to all results being qualified "U" except for sample HSCNew-NMP-11-EL where the total is 0.0060 ug/L and did not exceed the NOAA screening criteria of 0.033 ug/L. All results were qualified "H" which is defined as

“this sample was extracted and/or analyzed outside of the USEPA recommended holding time” and was previously discussed in Section 3.2.3.3.

#### 4.5.6 Dioxins and Furans

Of the 25 dioxins and furans analyzed for in each sample, 9 compounds were detected: 1,2,3,4,6,7,8--hepta CDD, 2,3,7,8-tetra CDF, 2,3,7,8-tetra CDD, OCDD, OCDF, total hepta CDD, total hepta CDF, total tetra CDD, and total tetra CDF. 1,2,3,4,6,7,8- Hepta CDD was only detected in two samples, HSCNew-NMP-01-EL and HSCNew-NMP-07-EL, and was qualified “J”. 2,3,7,8-Tetra CDD was detected in 3 samples, HSCNew-NMP-04-EL, -NMP-07-EL, -NMP-03-EL-Field Dup, and was “J” qualified. 2,3,7,8-Tetra CDF was detected in 5 samples, HSCNew-NMP-02-EL, -NMP-04-EL, -NMP-05-EL, -NMP-07-EL, -NMP-03-EL-Field Dup, and was “J” qualified in all except HSCNew-NMP-04-EL which was not qualified. OCDD was detected in 3 samples, HSCNew-NMP-01-EL, -NMP-05-EL, -NMP-08-EL, and was “J” qualified. OCDF was detected in 1 sample, HSCNew-NMP-01-EL, and was “J” qualified. Total hepta CDD was detected in 3 samples, HSCNew-NMP-01-EL, -NMP-06-EL, -NMP-07-EL, and was qualified “J”. Total hepta CDF was detected in 1 sample, HSCNew-NMP-07-EL, and was “J” qualified. Total tetra CDD was detected in 3 samples, HSCNew-NMP-04-EL, -NMP-07-EL, and -NMP-03-EL-Field Dup, and was qualified “J”. Total tetra CDF was detected in 5 samples, HSCNew-NMP-02-EL, -NMP-04-EL, -NMP-05-EL, -NMP-07-EL, -NMP-03-EL-Field Dup, and was “J” qualified in all except HSCNew-NMP-04-EL which was not qualified. The remaining analytes for the rest of the samples were below the MDL, qualified “U”, and reported at the RL; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analysis instrument range. The dilution factor for all samples was 1. Potential low bias was observed for dioxins and furans based on the quality control parameters.

The total TEQ for dioxins and furans was calculated by using the 2005 WHO TEF values (Van den Berg et al; 2006). Concentrations for detected analytes were multiplied by the TEF to calculate a total TEQ (Appendix 5 Table 5G). The samples that were detected for total hepta CDD, total hepta CDF, total tetra CDD, and total tetra CDF were not included in the TEQ calculation due to the lack of a published TEF value. The total TEQ ranged from 0 pg/L to 10 pg/L with a mean of 1.5 pg/L. There are no screening criteria for dioxins and furans.

#### 4.5.7 Metals

Of the 16 metals analyzed for in each sample, 5 analytes (cadmium, chromium (total), chromium (+3), chromium (+6), and thallium) were non-detects (below the MDL), qualified “U” and reported at the RL in all samples. The remaining 11 analytes (antimony, arsenic, barium, beryllium, copper, lead, mercury, nickel, selenium, silver, and zinc) were detected above the MDL in one or more samples. Four of the 16 analytes, copper, lead, silver and zinc, exceeded published screening criteria in more than one sample and are discussed below. Samples were diluted 10X for analysis of antimony, arsenic, barium, beryllium, cadmium, chromium (total), copper, lead, nickel, selenium, silver, thallium, zinc, 1X for chromium (3+), and 2X for chromium (6+) and mercury.

Copper was detected in 3 samples, HSCNew-NMP-03-EL, -NMP-10-EL, -NMP-11-EL, and qualified “J”. The remaining samples were non-detect, qualified “U”, and reported at the RL of 5.0 ug/L. The non-detect,

“U” qualified, samples exceeded the USEPA Region 6 (3.6 ug/L), NOAA (4.8 ug/L), and USEPA WQC (4.8 ug/L) screening criteria. TSWQS screening criteria was not exceeded by any of the samples. All detected concentrations of copper were below screening criteria.

Lead was detected in 1 sample, HSCNew-NMP-10-EL (16 ug/L), and was above the USEPA Region 6 screening criteria of 5.3 ug/L. The remaining 11 samples were non-detect, qualified “U”, and reported at the RL. None of the samples exceeded the TSWQS, USEPA WQC, or NOAA screening criteria.

Silver was detected in 5 samples: HSCNew-NMP-01-EL, -NMP-02-EL, -NMP-09-EL, -NMP-10-EL, and -NMP-03-EL-Field Dup. The samples with detections were above the MDL but below the RL and qualified “J”, except for HSCNew-NMP-01-EL which was not qualified. Detections ranged from 1.1 ug/L to 8.8 ug/L with a mean of 3.1 ug/L. Detected concentrations in two samples, HSCNew-NMP-01-EL (8.8 ug/L) and HSCNew-NMP-09-EL (3.2 ug/L), exceeded the screening criteria for TSWQS (2 ug/L) and USEPA WQC (1.9 ug/L). All detected concentrations exceeded NOAA screening criteria of 0.95 ug/L. Reported concentrations for non-detect samples were below the MDL, qualified “U”, and reported at the RL (5 ug/L) which exceeded all screening criteria.

Zinc was detected in all 12 samples. Reported concentrations for zinc ranged from 43.7 ug/L to 184 ug/L with a mean of 83.7 ug/L. Three samples, HSCNew-NMP-08-EL (162 ug/L), -NMP-11-EL (149 ug/L), and -NMP-03-EL-Field Dup (184 ug/L), exceeded the TSWQS (92.7 ug/L), USEPA WQC (90 ug/L), NOAA (90 ug/L), and USEPA Region 6 (84.2 ug/L) screening criteria. All other sample detections were below screening criteria.

#### 4.5.8 Miscellaneous

Cyanide was non-detect, qualified “U”, and reported at the RL 10 ug/L for all 12 samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range. The dilution factor was 1 for all samples. The reported concentrations exceeded the screening criteria for USEPA WQC (1.0 ug/L), NOAA (1.0 ug/L), and USEPA Region 6 (5.6 ug/L). There is not a TSWQS for cyanide. All 12 samples were qualified “Cl” which is defined as “residual chlorine or other oxidizing agent was detected in the container used to analyze this sample” and resulted in a possible low bias for the samples (Section 3.2.3.6).

DOC was non-detect, qualified “U”, and reported at the RL of 0.01 % for all 4 replicates for 7 of the 12 samples; HSCNew-NMP-02-EL, -NMP-04-EL, -NMP-05-EL, -NMP-06-EL, -NMP-08-EL, -NMP-11-EL, and -NMP-03-EL-Field Dup. The other five samples had at least one detection in the 4 replicates for the DOC analysis. All detected results were “J” qualified. The overall mean DOC concentration for these 5 samples was below the calculated MDL, “U” qualified, and reported at the RL. The only sample with a calculated mean DOC was HSCNew-NMP-09-EL at 0.0035 % which was “J” qualified. There are no screening criteria for DOC. The dilution factor for DOC was 100 in all samples.

The total suspended solids (TSS) concentrations ranged from 5,710 ug/L to 43,000 ug/L with a mean of 16,784 ug/L. The maximum concentration was 43,000 ug/L in sample HSCNew-NMP-04-EL.

TOC in each sample was analyzed in 4 replicates with the individual replicates and mean reported in the summary table (Table 5G of Appendix 5). The range of the mean was 0.0035 % to 0.010 % with an overall mean of 0.0069 %. Replicates that were non-detect were qualified “U” and reported at the RL, 0.01 %. All samples with detections were qualified “J”. There are no screening criteria for TOC. The dilution factor for TOC was 100 in all samples.

Ammonia (NH<sub>3</sub>-N) was detected in every sample with a concentration range of 1,530 ug/L to 27,800 ug/L. The mean concentration was 13,599 ug/L, and the maximum concentration was in sample HSCNew-NMP-07-EL at 27,800 ug/L. There are no screening criteria for ammonia. The dilution factor was 20 for all samples.

Sulfide was detected in two of the 12 samples, HSCNew-NMP-04-EL (4.4 ug/L) and HSCNew-NMP-07-EL (3.0 ug/L). The remaining samples were non-detect, qualified “U”, and reported at the RL (10 ug/L). There are no screening criteria for sulfide. The dilution factor was 1 for all samples; no matrix effects or other analytical artifacts caused the samples to require dilution to be within the analytical instrument range.

#### 4.5.9 Petroleum Hydrocarbons

Petroleum hydrocarbons were analyzed using method TNRR 1005, which has a MDL of 5,000 ug/L and did not meet the TDL of 100 ug/L. The analysis included 4 groups of hydrocarbons; C6-C35, C6-C12, >C12-C28, and >C28-C35, each group is reported in the summary table (Table 5G of Appendix 5). All samples were non-detect, qualified “U”, and reported at the RL. Potential low bias was observed for the TPH samples since the RL was an order of magnitude greater than the TDL.

#### 4.5.10 Summary

Below is a brief summary of the chemical analysis for the NMP site water samples.

- Screening criteria was not exceeded by any of the samples for VOCs and PCBs.
- USEPA Region 6 screening criteria was exceeded by all samples for two compounds, hexachlorobutadiene and hexachlorocyclopentadiene. Results for both compounds were below the MDL, qualified, “U”, and reported at the RL which exceeded screening criteria. There were no other exceedances of screening criteria for SVOCs.
- USEPA Region 6 screening criteria was exceeded by two samples for anthracene and three samples for pyrene. The remaining samples were below screening criteria for USEPA Region 6. There were no exceedances of TSWQS, USEPA WQC, or NOAA screening criteria for any PAH samples.
- HSCNew-NMP-05-EL was the only sample to have a detection for pesticides with a detection for gamma-BHC. All remaining analytical results for pesticides were below the MDL, qualified “U”, and reported at the RL for all samples. USEPA Region 6 screening criteria was exceeded by seven compounds, 4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide and toxaphene, in all samples which were qualified “U” and reported at the RL. Screening criteria for toxaphene for TSWQS, USEPA WQC, and NOAA was exceeded by all samples which were qualified “U” and reported at the RL.

- Dioxins and furans were detected in 8 samples. Total TEQ was calculated using results from non-“U” qualified data and ranged from 0.00035 pg/L to 10 pg/L. There are no screening criteria for dioxins and furans.
- USEPA Region 6 screening criteria was exceeded by nine samples for copper, one sample for lead, and three samples for zinc. NOAA screening criteria was exceeded by nine samples for copper, all samples for silver, and three samples for zinc. USEPA WQC was exceeded by nine samples for copper, nine samples for silver and three samples for zinc. TSWQS screening criteria was exceeded by eight samples for silver and three samples for zinc. Screening criteria for antimony, arsenic, barium, beryllium, cadmium, chromium (total), chromium (3+), chromium (6+), mercury, nickel, selenium, and thallium was not exceeded by any of the samples.
- Cyanide was not detected in any of the samples, qualified, “U”, and reported at the RL. The RL exceeded the screening criteria for USEPA WQC, NOAA, and USEPA Region 6. There are no TSWQS for cyanide.

#### 4.6 Modified Elutriate Toxicity

Modified elutriate toxicity tests were conducted during the week of October 29, 2018 and are discussed in the following sections. The elutriates were prepared from project sediments within 3 weeks of compositing (October 9, 2018) at the initiation of the bioassays. All elutriate toxicity testing used a freshly prepared elutriate (aged <24-h). Additional details are included in the full Tier III Biological Report (Appendix 8).

##### 4.6.1 Elutriate Bioassay: *Americamysis bahia*

Water quality parameters were within the acceptability ranges specified by testing guidance (USEPA/USACE, 1991; 1998; 2003). Survival in the laboratory performance control (96 %) met the  $\geq 90$  % requirement. The LC50 value for the KCl reference toxicity test conducted on October 29, 2018 was 0.61 g/L (range: 0.55 g/L to 0.69g/L). This value was within two standard deviations around the mean LC50 values from ERDC control chart data (range: 0.40 g/L to 0.82 g/L). This indicates that the test organisms were within the historic sensitivity range.

Survival was at least 86 % (range: 86 % to 100 %) in all eleven site waters. Survival in the undiluted (100 %) elutriates ranged from 25 % to 94 %. Survival was both reduced by at least 10 % and statistically significantly different (by one-tailed t-test) for HSCNew-NMP-01, -NMP-04, -NMP-07, and -NMP-08. There was no acute toxicity observed in the other elutriates.

For elutriates in which significant mortality was observed, multiple treatment comparisons using Dunnett’s test were performed to determine NOEC and LOEC values. Mortality was only high enough in HSCNew-NMP-01 and HSCNew-NMP-07 to calculate LC50 values. For these types of bioassay determinations, the LC50 values are expressed in terms of fraction of 100% elutriate concentrations; for -NMP-01 and -NMP-07, LC50 values were 89 % and 79 %, respectively.

Total ammonia-N concentrations in the undiluted elutriates ranged from 1.4 mg/L to 20.7 mg/L and calculated un-ionized concentrations (range; 0.08 mg/L to 1.11 mg/L). The ammonia-N and un-ionized ammonia concentrations and comparison to known toxicity thresholds (Kennedy et al, 2015; Melby et al, 2018) are summarized in Appendix 8, Table 4. Since some of the ammonia levels were well above concentrations that are known to cause acute effects to this organism, there is a strong line of evidence that ammonia was high enough to cause mortality in all of the elutriates where acute toxicity was observed (HSCNew-NMP-01, -NMP-04, -NMP-07, and -NMP-08).

The *A. bahia* elutriate bioassay did not indicate acute toxicity for the 7 of the 11 tested sediment elutriates (HSCNew-NMP-02, -NMP-03, -NMP-05, -NMP-06, -NMP-09, -NMP-10, and -NMP-11). Statistically significant acute toxicity, greater than 10 % reduction in survival, was determined for HSCNew-NMP-01, -NMP-04, -NMP-07, and -NMP-08.

#### 4.6.2 Elutriate Bioassay: *Menidia beryllina*

Water quality parameters were within the acceptability ranges specified by testing guidance (USEPA/USACE, 1991; 1998; 2003). Survival in the laboratory performance control (98 %) met the  $\geq 90$  % requirement. The LC50 value for the KCl reference toxicity test conducted on October 29, 2018 was 1.46 g/L (range: 1.34 g/L to 1.59 g/L). This value was within two standard deviations around the mean LC50 values from ERDC control chart data (range: 1.07 g/L to 1.52 g/L). This indicates that the test organisms were within the historic sensitivity range.

Survival was at least 94 % (range: 94 % to 100%) in all eleven site waters. Survival in the undiluted (100 %) elutriates ranged from 0 % to 100 %. Survival was both reduced by at least 10 % and statistically significantly different (by one-tailed t-test) for HSCNew-NMP-01, -NMP-04, -NMP-06, -NMP-07, -NMP-08, -NMP-10, and -NMP-11. There was no acute toxicity observed in the other elutriates.

For elutriates in which significant mortality was observed, multiple treatment comparisons using Dunnett's test were performed to determine NOEC and LOEC values. Mortality was only high enough in HSCNew-NMP-01, -NMP-06, and -NMP-07 to calculate LC50 values. For these types of bioassay determinations, the LC50 values are expressed in terms of fraction of 100% elutriate concentrations; for -NMP-01, -NMP-06, and -NMP-07, LC50 values were 88 %, 95 % and 59 %, respectively.

Total ammonia-N concentrations in the undiluted elutriates ranged from 1.29 mg/L to 23.5 mg/L and calculated un-ionized concentrations (range: 0.08 mg/L to 1.11 mg/L). The ammonia concentrations and comparison to known toxicity thresholds (Kennedy et al, 2015; Melby et al, 2018) are summarized in Appendix 8, Table 4. Since some of the ammonia levels were well above concentrations that are known to cause acute effects to this organism, there is a strong line of evidence that ammonia was high enough to cause mortality in all of the elutriates where acute toxicity was observed (HSCNew-NMP-01, -NMP-04, -NMP-06, -NMP-07, -NMP-08, -NMP-11).

The *M. beryllina* elutriate bioassay did not indicate acute toxicity for the 5 of the 11 tested elutriates (HSCNew-NMP-02, -NMP-03, -NMP-05, -NMP-09). Statistically significant acute toxicity, greater than 10 %



reduction in survival, was determined for HSCNew-NMP-01, -NMP-04, -NMP-06, -NMP-07, -NMP-08, -NMP-10, and -NMP-11.

#### 4.6.3 Ammonia Toxicity Background

Ammonia is an important contaminant to consider in toxicity bioassays, especially when employing fish species (USEPA; 1999; 2009) or embryo development tests (Kennedy et al. 2015). The unionized fraction of ammonia, which is dependent on water temperature, pH and to a lesser extent salinity, is often most responsible for causing toxicity in elutriate testing (Kennedy et al., 2015).

Based on LC50 ranges for *A. bahia* (range: 0.23 mg/L UIA to 1.7 mg/L UIA) at similar temperatures and pH values taken from the literature (Miller et al, 1990; Boardman et al., 2004; Kennedy et al 2015) and a NOEC value reported in Melby et al, (2018) of 0.5 mg/L un-ionized ammonia (UIA). The un-ionized ammonia concentrations in the HSCNew-NMP-01, -NMP-04, and -NMP-07 elutriates were sufficiently high to cause toxicity to *A. bahia*. The HSCNew-NMP-05, -NMP-06, -NMP-08, -NMP-10, and -NMP-11 elutriates had elevated ammonia which may have caused some mortality.

Based on LC50 ranges for *M. beryllina* (range: 0.75 mg/L UIA to 1.94 mg/L UIA) taken from the literature (Boardman et al 2004, Miller et al 1990, Li 1997, Kennedy et al 2015) and NOEC values reported in Melby et al (2018) of 0.6 mg/L un-ionized ammonia. The un-ionized ammonia concentrations in the HSCNew-NMP-01, -NMP-04, and -NMP-07 elutriates were sufficiently high to cause toxicity to *M. beryllina*.

The HSCNew-NMP-05, -NMP-06, -NMP-08, -NMP-10 and -NMP-11 elutriates had elevated ammonia which may have caused some mortality.

In all of the elutriates in which acute toxicity was observed, there were high enough concentrations to cause mortality to the test organisms based on literature reported values for ammonia toxicity (Melby et al., 2018). Therefore, there is a line of evidence that ammonia was an important determinant of the toxicity observed in both test organisms.

#### 4.7 Mixing Zone Results - CDFATE

Six CDFATE model runs were performed using the input outlined in Section 2.7. Results are provided below for New BW-8 PA, Filter Bed PA, and New E2-Clinton PA, and Glendale PA. For each PA, the dilution/mixing achieved within a given distance downstream from the discharge was compared to the dilutions required to achieve acute and chronic concentrations of COCs to determine distance required for the ZID and MZ. The final mixing zone distances required for each PA are provided in Appendix 7, Table 10.

As outlined in Section 2.7, modeling focused on the subset of the contaminants remaining after two elimination steps:

- 1) contaminants were not evaluated further when they were not detected in elutriate or receiving water (Section 2.7.4.1)



- 2) contaminants were not evaluated further if contaminant concentrations of the background water exceeded acute screening criteria; dilution cannot be achieved under such circumstances (Section 2.7.4.3)

#### 4.7.1 Placement Area – New BW-8 PA

The model results for discharges from New BW-8 PA into Buffalo Bayou/HSC show dilution achieved with distance downstream from the discharge point. Two separate model runs were performed with different assumptions as to the length that the culvert extended into the channel, as the actual distance is unknown. The shorter length of the culvert provided greater dilution. The dilution values were sufficient to provide mixing to dilute the concentrations to within acute and chronic criteria. The greatest dilution requirements for the New BW-8 PA were for zinc which required a dilution factor of 6.9 for acute and 13.0 for chronic criteria. These dilution values can be met within 3.4 m (acute) and 11.0 m (chronic) for the longer culvert. Plume widths at these lengths are approximately 7 m and 13 m.

#### 4.7.2 Placement Area – Filter Bed PA

Dilution was achieved with distance for the two scenarios that were modeled. Modeling assumed two pipe extensions for the Filter Bed PA discharged into Buffalo Bayou/HSC, since the actual discharge pipe length is not known. One scenario used a culvert that protruded 2.2 m into the channel, and the other used a culvert that protruded 15.2 m. Extending the pipe farther into the channel achieved less dilution as it pushed the plume up against the opposite bank. A mixing zone was not possible for meeting chronic requirements because the receiving water concentration of zinc was above the chronic criteria. To meet acute requirements for determination of a ZID, the greatest dilution required was for zinc, with a dilution factor of 13.4, which could be met within approximately 45 m if the culvert protruded only 2.2 m. The plume width at 45 m would be approximately 23 m. Dilution could not be achieved with the longer pipe length that reached a maximum dilution of approximately 3.0.

#### 4.7.3 Placement Area – New E2-Clinton PA and Glendale

New E2-Clinton and Glendale PAs are considered together since both PAs discharge into Hunting Bayou from Turkey Run Gulley (Section 2.7.6.1.3). Dilution was achieved with distance downstream of the discharge into Hunting Bayou for effluent from New E2-Clinton PA and Glendale PA; note that the results are identical. The only difference for input parameters was a higher salinity assumption for New E2-Clinton PA, which did not impact the results. Very little dilution was achieved over approximately 18 m. Beyond 18.8 m, the plume interacted with the bottom and both banks. Additional dilution was not expected to occur under the modeled scenario. Therefore, the maximum dilution expected to occur within Hunting Bayou was 0.4.

The greatest dilution requirements for New E2-Clinton PA are 1 for acute conditions and 99 for chronic conditions, which were well above the predicted dilution in Hunting Bayou. For Glendale PA, the greatest dilution requirements were 6.7 for acute conditions and 168.5 for chronic criteria, which were also above that predicted. The predicted dilution of 0.4 was insufficient to achieve concentrations below acute

criteria for zinc or acute toxicity criteria based on bioassay results. Dilution of 0.4 was also insufficient to achieve concentrations below chronic criteria for anthracene, copper, lead, zinc, and chronic toxicity criteria from bioassay results.

The uncertainty within the input parameters should be evaluated and the model refined accordingly to determine if discharge to Hunting Bayou is a feasible alternative.

#### 4.7.4 Placement Area - Summary

The CDFATE modeling exercise showed that a ZID and mixing zone could be applied to meet acute and chronic criteria for the New BW-8 PA discharge. A rather large ZID (45 m) would be required to meet acute toxicity at the Filter Bed PA discharge location, assuming the discharge pipe was near the shore. Dilution requirements cannot be met for chronic conditions due to zinc background concentrations. Modeling showed dilution to be insufficient for the New E2-Clinton and Glendale PAs to meet either chronic or acute conditions.

#### 4.7.5 Uncertainty

Many of the input parameters for the preliminary CDFATE mixing zone calculation were not site-specific, which produced uncertainty in the results. The uncertainty associated with these parameters could be reduced through the refinement of the input parameters, making the mixing zone calculations more site-specific. Some suggested refinements are described below.

##### 4.7.5.1 Chemistry, Toxicity, and Elutriate Uncertainty

A mixing zone evaluation was performed to determine the ZID and mixing zone lengths needed to meet the greatest dilution requirements for each PA based on conservative assumptions regarding chemistry and toxicity results. In the absence of site-specific information, assumptions were made with respect to both the chemistry and toxicity evaluations. Sources of uncertainty include:

- 1) Elutriate and Site Water RLs Above Criteria: instances where reporting limits exceed criteria forced the use of overly conservative assumptions for background concentrations
- 2) Lack of Receiving Water Chemistry and Characterization for Hunting Bayou (New E2-Clinton PA and Glendale PA receiving water): Use of alternate data from Buffalo Bayou may not be appropriate
- 3) Conservative AF: A less conservative value could be used to calculate chronic criteria for bioassays
- 4) Ammonia: Consideration of impacts of ammonia on bioassay results. A toxicity reduction evaluation (TRE) could potentially be performed to evaluate the effect that ammonia had on the resulting toxicity, or the application of a higher AF might be justifiable in light of the ammonia effects and the highly conservative nature of the selected AF
- 5) Length of the Dredging Event: Determination of whether chronic criteria are applicable based on the length of time that discharge is expected to occur at each PA
- 6) Exclusion of COCs: A number of COCs were excluded from the evaluation because background concentrations were either above criteria or the RLs were above criteria (Section 2.7.4.2 and

Section 4.2 of Appendix 8). It is currently not possible to show that water quality criteria can be met for these COCs

The uncertainties from (1) through (6) above were addressed in this preliminary mixing zone evaluation by making conservative assumptions. Additional data collection or refinements would produce more site-specific results and reduce uncertainty for the factors listed above.

#### 4.7.5.2 Modeling Uncertainty

In the preliminary CDFATE modeling, several non-site specific conservative initial assumptions were made that would influence the model output and could be refined:

- 1) Non-Site Specific Input Parameters: Details pertaining to many of the CDFATE model input parameters were not available, requiring assumptions for which the introduced bias (positive or negative) is not fully understood
- 2) Discharge/Velocity Data: These data were not available in the near vicinity of any of the discharge locations and had to be extrapolated from distant gauges or report figures
- 3) Discharge Point Characteristics: The size and orientation of the culverts leading from New BW-8 PA and Filter Bed PA to Buffalo Bayou/HSC were not known, requiring assumptions to be made for water depth, culvert width, depth, slope and protruding distance into the channel
- 4) Bathymetry: Bathymetry data for Hunting Bayou and geometry of Turkey Run Gulley where it discharges to Hunting Bayou were estimated
- 5) Site Receiving Water Conditions: Site receiving waters were, in many instances, estimated
- 6) Salinity: Salinity/conductivity profiles with depth taken during several years showed a steep increase in salinity with depth in some years, and less stratification in drier years when overall salinity was higher. Salinity gradients within Buffalo Bayou were estimated based on a published figure of conductivity gradients for several years; salinity data for Hunting Bayou was not available and was estimated.

In order to provide greater confidence in results, additional site-specific data could be collected to refine the mixing zone modeling and evaluation.

## 5.0 Conclusions and Recommendations

### 5.1 Summary

Sampling, analysis, and evaluation of sediment, water, and elutriate for the HSC Expansion Channel Improvement Project north of Morgan's Point were conducted to evaluate the potential for adverse environmental effects associated with dredging and placement of new work sediments. A total of 12 sediment and site water samples were collected, 11 channel locations and 1 duplicate location.

Although a few deviations from the SAP occurred during field sampling, these deviations did not compromise the overall representativeness of the samples for purposes of decision making with regard

to sediment quality of proposed dredged materials. Similarly, minor analytical QC deviations occurred, but the overall usability and representativeness of the data was not compromised.

For site water samples, screening criteria were exceeded by all samples for two SVOC compounds, hexachlorobutadiene and hexachlorocyclopentadiene. Results for both compounds were below the MDL, qualified, "U", and reported at the RL which exceeded screening criteria. Seven pesticides (4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide and toxaphene) exceeded screening criteria in all samples, results were qualified "U" and reported at the RL. Screening criteria was exceeded by one sample for copper, three samples for zinc, and 11 samples for silver. Results for silver in 6 of the 12 samples were below the MDL, qualified, "U", and reported at the RL, but the RL exceeded both applicable screening criteria and the project TDL. Cyanide was not detected in any of the samples, qualified, "U", and reported at the RL which exceeded applicable screening criteria.

For sediment samples, screening criteria was exceeded by 8 samples for bis(2-ethylhexyl) phthalate. All PAHs were detected in one or more samples and screening criteria was exceeded for 12 analytes; acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Five pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and gamma-BHC (lindane)) exceeded screening criteria in one or more sediment samples. Screening criteria for total PCB congeners was exceeded by 7 samples. Screening criteria were exceeded by one sample for cadmium and copper, four samples for lead, five samples for mercury, and two samples for nickel.

For elutriate samples, screening criteria were exceeded by all samples for two compounds, hexachlorobutadiene and hexachlorocyclopentadiene. Results for both compounds were below the MDL, qualified, "U", and reported at the RL which exceeded screening criteria. Screening criteria were exceeded by two samples for anthracene and three samples for pyrene. Seven pesticides (4,4'-DDT, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide and toxaphene) exceeded screening criteria in all samples. Results for the analytes were qualified "U" and reported at the RL, which was above the screening criteria. Dioxins and furans were detected in 8 samples, the total TEQ was calculated using results from non-"U" qualified data and ranged from 0.00035 pg/L to 10 pg/L. Screening criteria were exceeded by one sample for lead and three samples for zinc. Nine samples exceeded screening criteria for copper, but all were non-detect, qualified "U", and reported at the RL, which exceeded applicable screening criteria. Silver exceeded screening criteria in all 12 samples, 7 of the samples were non-detect, qualified "U", and reported at the RL which exceeded applicable screening criteria. Cyanide was not detected in any of the samples, qualified, "U", and reported at the RL which exceeded applicable screening criteria.

Elutriate acute toxicity was not observed to the two species tested in four of the eleven sample locations; HSCNew-NMP-02, -NMP-03, -NMP-05, and -NMP-09. Sediment bioassays indicated acute toxicity for *A. bahia* in four samples and for *M. beryllina* in seven samples. In all of the elutriates toxicity tests for which acute toxicity was observed, ammonia concentrations were high enough to cause mortality to the

test organisms. Therefore, there is a line of evidence that ammonia was an important determinant of the toxicity observed in both test organisms.

Elutriate and site water chemistry was evaluated for ten sediment samples along Segments 4 – 6 of the HSC-NMP for the mixing zone modeling. Some of the site waters also represented receiving water for the four proposed PAs. COCs that were detected in at least one of the media were retained for evaluation. Several COCs were eliminated from the evaluation because their RLs were above criteria and they were not detected in any of the elutriate, site water or sediment samples. For instances when the background concentration exceeded criteria, dilution could not be evaluated. The contaminants that could not be fully evaluated for a mixing zone for this reason included hexachlorobutadiene, 4,4'-DDT, dieldrin, heptachlor, and silver, therefore, it could not be demonstrated that they would not violate water quality criteria. Required dilutions to meet chronic and acute water quality criteria were calculated for the contaminants remaining (i.e., anthracene, pyrene, copper, lead and zinc) after the preliminary COCs were evaluated/excluded.

The CDFATE model was used to complete a preliminary mixing zone evaluation of each PA effluent into the receiving waters. Due to the unknown length of the actual pipe, model runs were performed for two scenarios, each with different protruding pipe distances, for New BW-8 PA and Filter Bed PA. Although the discharge parameters were identical for PAs discharging into Hunting Bayou (New E2-Clinton and Glendale), two model runs were performed based on the different salinity assumptions for the bottom salinity ranges of Buffalo Bayou/HSC and Sims Bayou.

The chemistry data were compared to dilution requirements at each PA to estimate required ZID and mixing zone lengths for each PA. For New BW-8 PA, results showed that for the evaluated COCs and toxicity requirements, a ZID of 2.0 m – 3.4 m (depending on the actual pipe protruding distance, 46 m or 60 m) was required and a mixing zone length between 5.9 m and 11.0 m would be required. For Filter Bed PA, modeling showed that a ZID of 45 m would be required to achieve acute criteria if the pipe was near the shore; dilution would not be possible if the culvert extended 15 m into the channel. It would also not be possible to meet chronic criteria because zinc concentrations in the receiving water exceed chronic criteria. Modeling results for E2-Clinton PA and Glendale PA discharges into Hunting Bayou showed that a maximum dilution of 0.4 would be reached before the channel is completely mixed. This was insufficient to meet acute or chronic criteria for the COCs or toxicity requirements for either PA.

## 5.2 Conclusions

Although some environmental media screened above water quality and sediment screening values, the primary lines-of-evidence used in screening for the suitability of new work dredge materials for placement are the elutriate and the CDFATE modelling.

Using the chemistry data from the elutriate test and a combination of site-specific data when available and conservative worst-case assumptions when it was not, CDFATE modeling for evaluation of mixing zones at 4 placement areas selected in the Dredged Material Management Plan (DMMP) (USACE, 2019b) showed the following:

- Buffalo Bayou/HSC: sufficient mixing can be achieved in Buffalo Bayou/HSC to dilute the effluent from dredged material placement into the New BW-8 PA to within acute and chronic criteria, requiring a ZID of up 2.0 to 3.4 m and a mixing zone length of 5.9 m to 11.0 m
- Hunting Bayou: based on the modeling at Hunting Bayou, sufficient dilution is not available to achieve either acute or chronic criteria for effluent discharging from either the New E2-Clinton PA or the Glendale PA
- Filter Bed PA: mixing is insufficient and it is not possible to dilute effluent discharges from the Filter Bed PA to chronic criteria for zinc as receiving water (background) concentrations were shown to be above criteria. CDFATE modeling suggested that a ZID of 45 m would be required for sufficient mixing to achieve acute criteria for zinc
- Background: verification of the ability to meet water quality for several COCs (hexachlorobutadiene, 4,4'-DDT, dieldrin, heptachlor, and silver) that were dropped from the evaluation due to background concentrations above criteria was not possible with the available data

### 5.3 Recommendations

The preliminary CDFATE modeling results used several assumptions that were not site-specific. Refinements to the mixing zone calculations can be made with the addition of more site-specific data. Areas where data collection would be particularly helpful include:

- bathymetry and flow data at Hunting Bayou
- geometry of Turkey Run Gulley where it discharges to Hunting Bayou
- flow data at New BW-8 PA and Filter Bed PA discharge locations
- culvert geometries and orientation
- salinity distributions within each channel
- receiving water contaminant concentrations at Hunting Bayou
- alternate data for Buffalo Bayou receiving water COCs with RLs greater than criteria, and
- alternate AF for chronic criteria

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## FIGURES

Figure 1: Project Area - Bayou Reach North of Morgan's Point  
Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) - New Work, Houston Ship Channel, TX

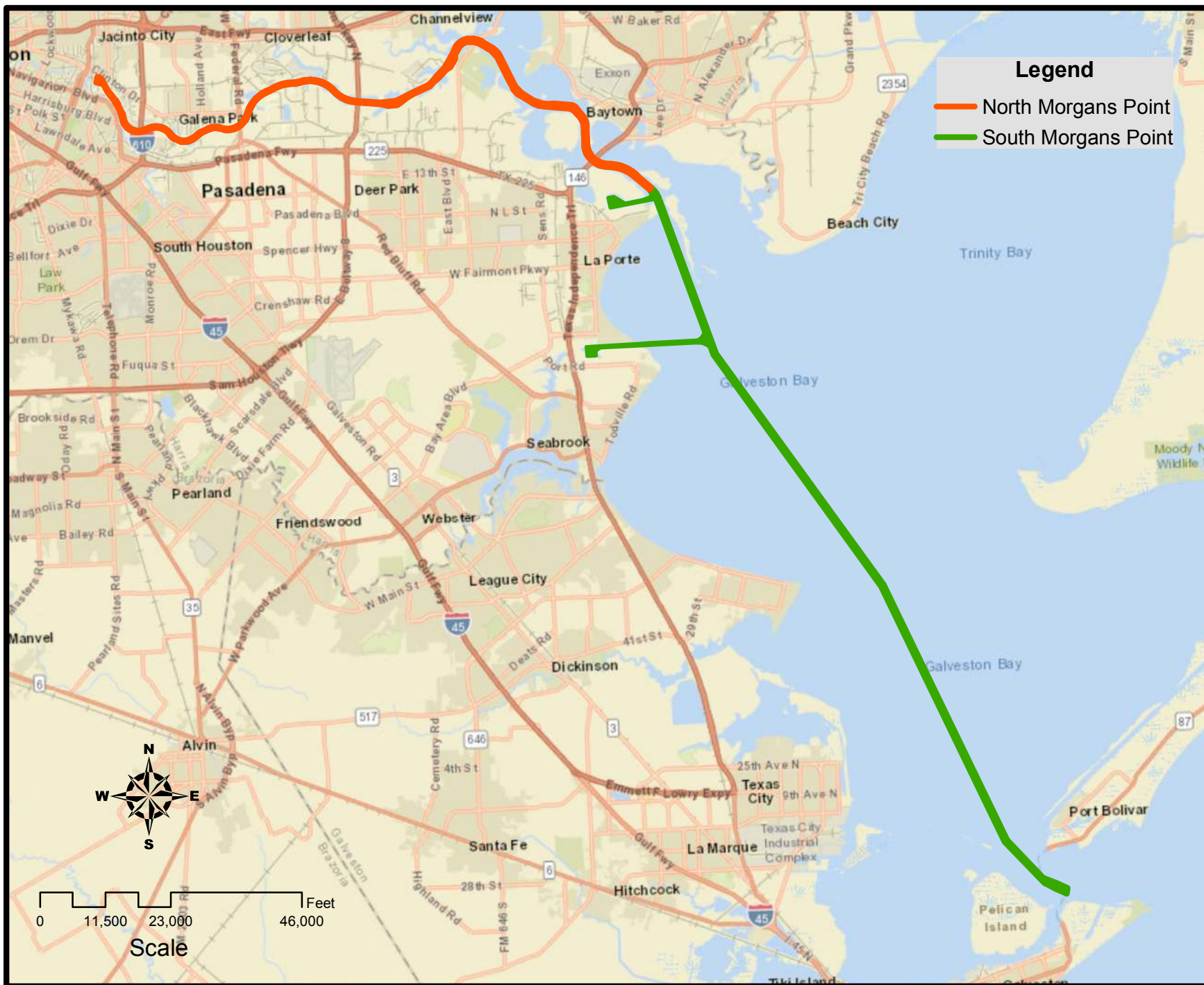




Figure 2: San Jacinto Waste Pit and Approximate Area of Concern  
 Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) - New Work, Houston Ship Channel, TX

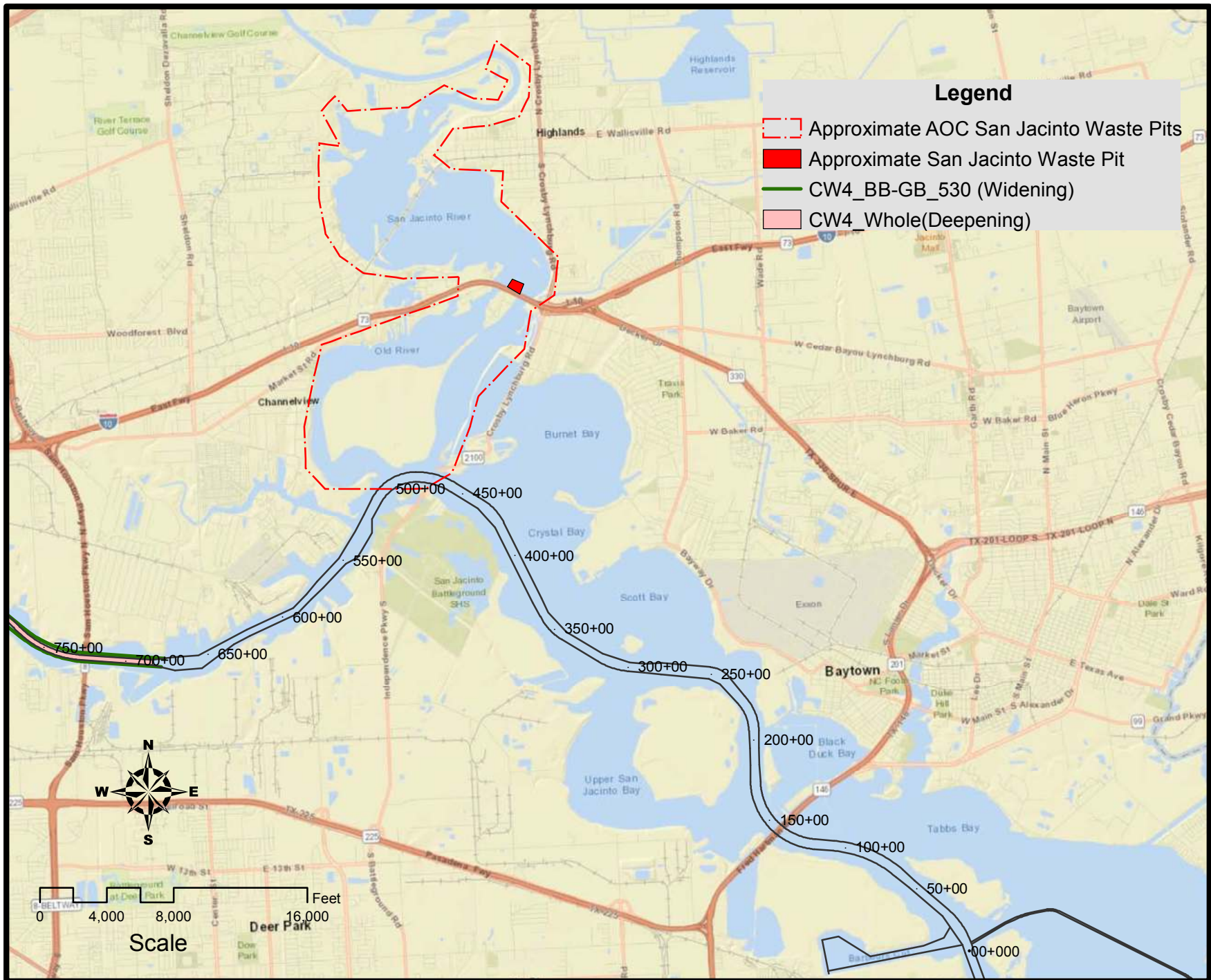


Figure 3: Pre-Dredging Sample Locations North of Morgans Point - Segment 1 Bayou  
 Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) - New Work, Houston Ship Channel, TX

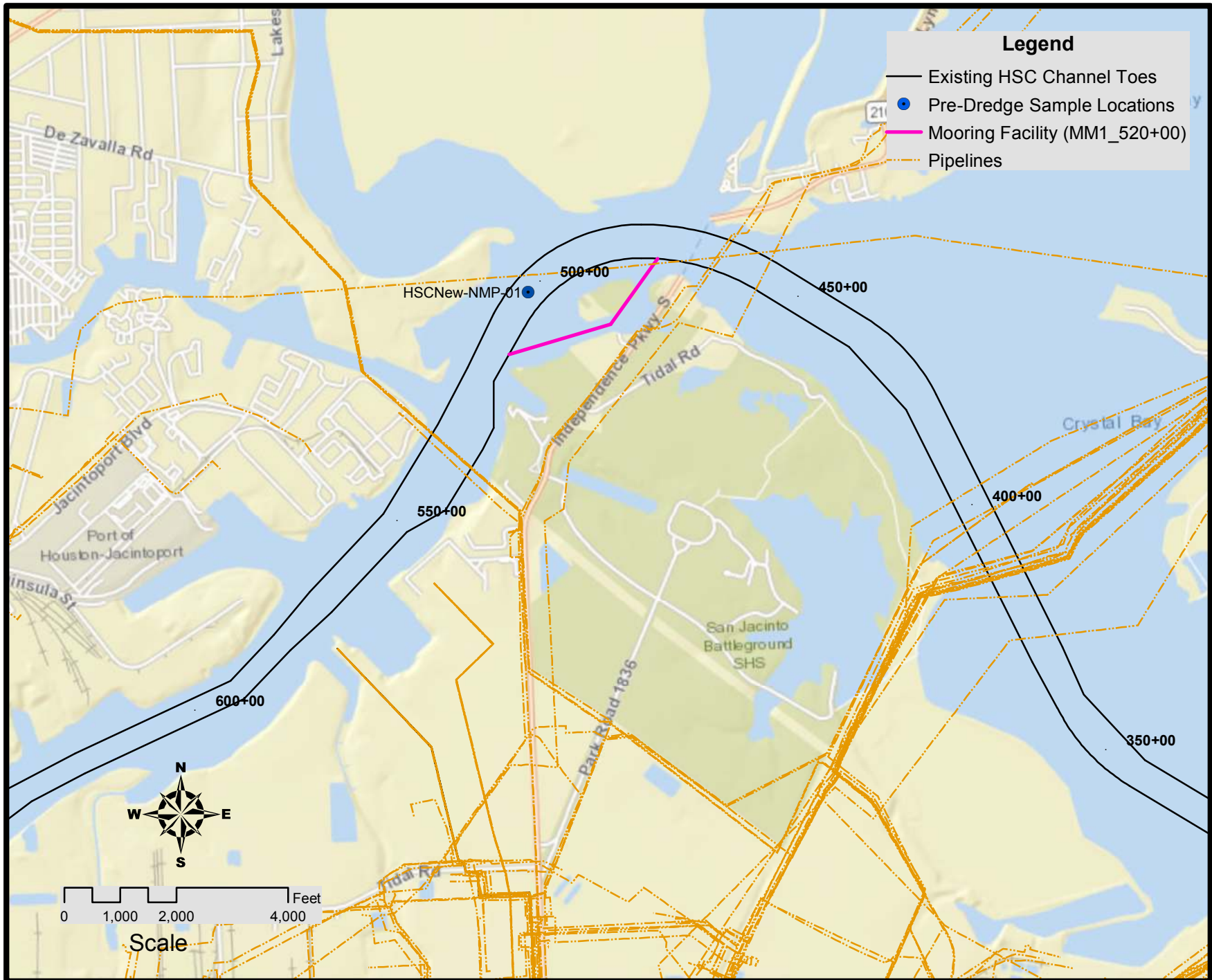
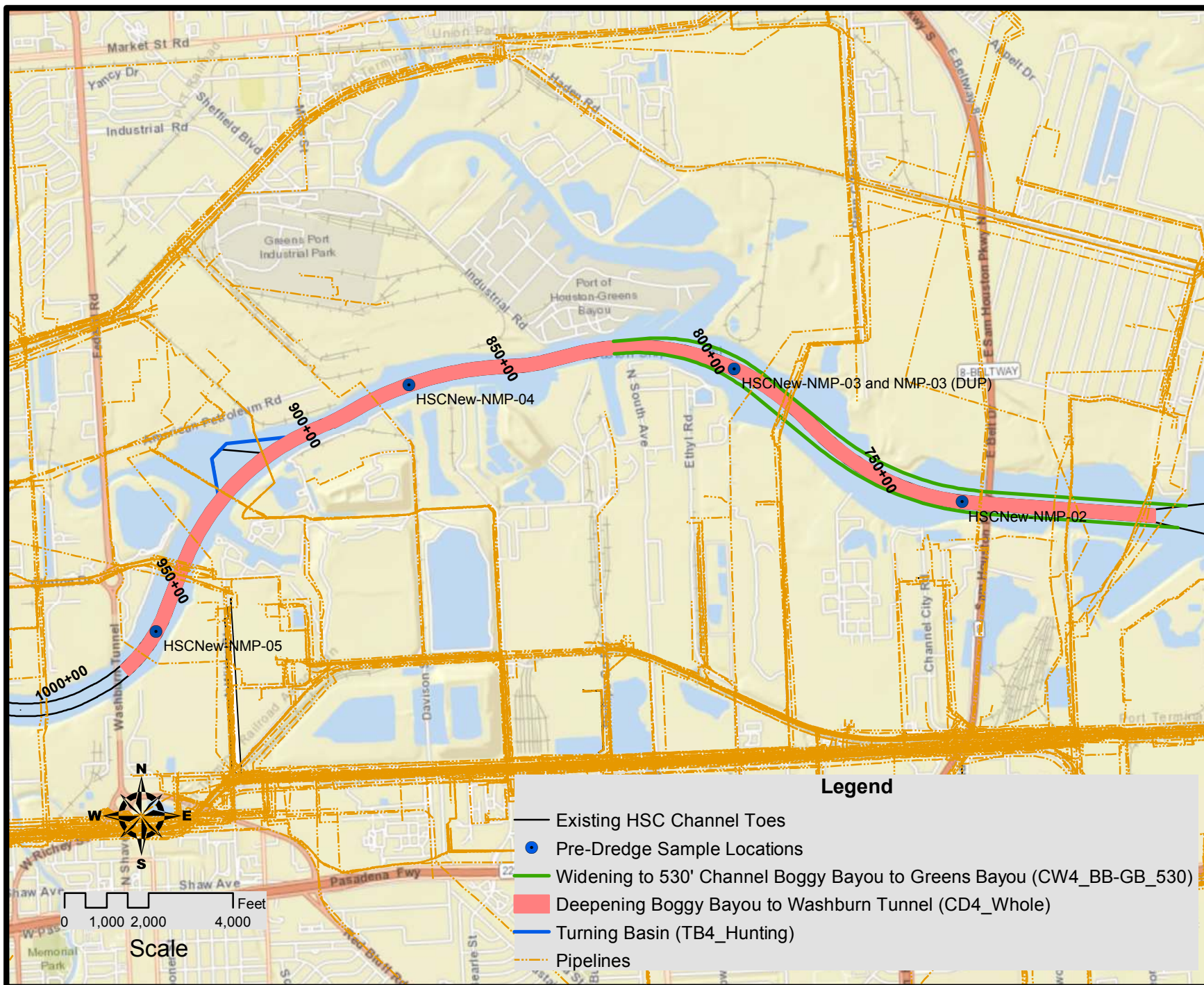




Figure 4: Pre-Dredging Sample Locations North of Morgans Point - Segment 4  
 Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) - New Work, Houston Ship Channel, TX

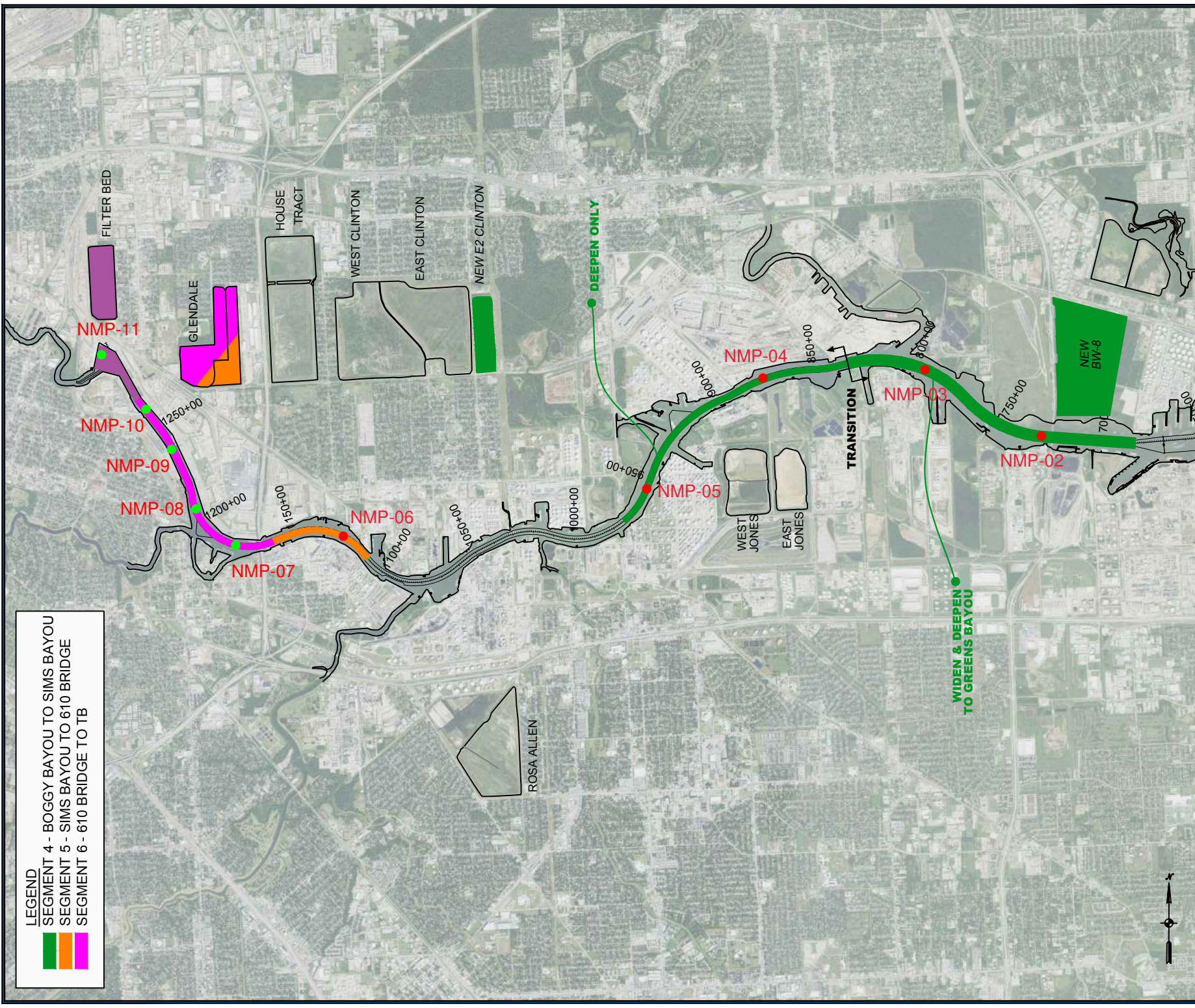


Imagery: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan (METI), Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community









**FIGURE 6 - DMMP NW DREDGING & PLACEMENT LOCATIONS**  
 SEGMENTS 4, 5, & 6

Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP) - New Work  
 Houston Ship Channel, Texas



## TABLES

**Table 1A: Summary of Site Water Sample Collection Sites  
Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) - North of Morgan's Point  
Houston Ship Channel, TX**

| Sample ID        | Coordinates <sup>(1)</sup> |                  | Coordinates |              | Channel Station <sup>(2)</sup> |
|------------------|----------------------------|------------------|-------------|--------------|--------------------------------|
|                  | X - Easting (ft)           | Y -Northing (ft) | LAT         | LONG         |                                |
| HSCNew-NMP-01-SW | 3,209,747                  | 13,844,644       | 29.75999587 | -95.08712336 | 503+00                         |
| HSCNew-NMP-02-SW | 3,190,661                  | 13,835,567       | 29.73678924 | -95.1481858  | 730+00                         |
| HSCNew-NMP-03-SW | 3,185,287                  | 13,837,835       | 29.74350819 | -95.1648778  | 794+00                         |
| HSCNew-NMP-04-SW | 3,177,594                  | 13,837,940       | 29.74448783 | -95.18909561 | 873+00                         |
| HSCNew-NMP-05-SW | 3,171,799                  | 13,832,335       | 29.72960272 | -95.20792127 | 961+00                         |
| HSCNew-NMP-06-SW | 3,157,170                  | 13,830,865       | 29.72685819 | -95.25413926 | 1127+00                        |
| HSCNew-NMP-07-SW | 3,151,909                  | 13,829,784       | 29.72434705 | -95.2708183  | 1180+00                        |
| HSCNew-NMP-08-SW | 3,150,587                  | 13,831,357       | 29.72878903 | -95.27482279 | 1200+00                        |
| HSCNew-NMP-09-SW | 3,149,158                  | 13,833,963       | 29.73607502 | -95.27906155 | 1230+00                        |
| HSCNew-NMP-10-SW | 3,148,043                  | 13,836,483       | 29.74310064 | -95.2823204  | 1260+00                        |
| HSCNew-NMP-11-SW | 3,145,766                  | 13,839,567       | 29.75177505 | -95.28918276 | 024+00                         |

**Footnote:**

(1) Coordinates reported in NAD83 State Plane, Texas South Central, US Feet □

(2) All stationing shown are Houston Ship Channel (HSC) stations.

**Table 1B: Summary of Sediment Sample Collection Sites**  
**Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) - North of Morgan's Point**  
**Houston Ship Channel, TX**

| Sample ID        | Sub-sample Locations    | Coordinates <sup>(1)</sup> |                   | Coordinates |              | Channel Station <sup>(2)</sup> |
|------------------|-------------------------|----------------------------|-------------------|-------------|--------------|--------------------------------|
|                  |                         | X - Easting (ft)           | Y - Northing (ft) | LAT         | LONG         |                                |
| HSCNew-NMP-01AH3 | HSCNew-NMP-01AH3-1      | 3,209,399                  | 13,844,992        | 29.76098545 | -95.08818212 | 503+00                         |
|                  | HSCNew-NMP-01AH3-2      | 3,209,391                  | 13,845,001        | 29.76101121 | -95.08820617 |                                |
|                  | HSCNew-NMP-01AH3-3      | 3,209,382                  | 13,844,988        | 29.76097396 | -95.08823598 |                                |
|                  | HSCNew-NMP-01AH3-4      | 3,209,370                  | 13,844,967        | 29.76091829 | -95.08827502 |                                |
| HSCNew-NMP-02    | HSCNew-NMP-02A-1        | 3,190,669                  | 13,835,075        | 29.73543624 | -95.14821161 | 730+00                         |
|                  | HSCNew-NMP-02A-2        | 3,190,674                  | 13,835,065        | 29.73540826 | -95.14819752 |                                |
|                  | HSCNew-NMP-02C-1        | 3,190,740                  | 13,835,560        | 29.73676370 | -95.14793893 |                                |
| HSCNew-NMP-03    | HSCNew-NMP-03A-1        | 3,185,272                  | 13,837,839        | 29.74352150 | -95.16492461 | 794+00                         |
|                  | HSCNew-NMP-03A-1(DUP)   | 3,185,291                  | 13,837,849        | 29.74354802 | -95.16486444 |                                |
|                  | HSCNew-NMP-03C-1        | 3,185,164                  | 13,838,758        | 29.74605715 | -95.16516982 |                                |
|                  | HSCNew-NMP-03C-1(DUP)   | 3,185,164                  | 13,838,762        | 29.74606814 | -95.16516941 |                                |
| HSCNew-NMP-04    | HSCNew-NMP-04A-1        | 3,177,578                  | 13,837,883        | 29.74433300 | -95.18915260 | 873+00                         |
|                  | HSCNew-NMP-04A-2        | 3,177,560                  | 13,837,887        | 29.74434626 | -95.18920932 |                                |
|                  | HSCNew-NMP-04C-1        | 3,177,446                  | 13,838,353        | 29.74563853 | -95.18952001 |                                |
|                  | HSCNew-NMP-04C-2        | 3,177,448                  | 13,838,374        | 29.74569561 | -95.18951197 |                                |
|                  | HSCNew-NMP-04C-3        | 3,177,473                  | 13,838,383        | 29.74571765 | -95.18943260 |                                |
|                  | HSCNew-NMP-04C-4        | 3,177,493                  | 13,838,377        | 29.74569936 | -95.18937022 |                                |
| HSCNew-NMP-05    | HSCNew-NMP-05A-1        | 3,171,789                  | 13,832,332        | 29.72959489 | -95.20795212 | 961+00                         |
|                  | HSCNew-NMP-05A-2        | 3,171,785                  | 13,832,337        | 29.72960811 | -95.20796574 |                                |
|                  | HSCNew-NMP-05A-3        | 3,171,778                  | 13,832,329        | 29.72958708 | -95.20798814 |                                |
|                  | HSCNew-NMP-05C-1        | 3,171,351                  | 13,832,522        | 29.73015513 | -95.20931390 |                                |
|                  | HSCNew-NMP-05C-2        | 3,171,367                  | 13,832,517        | 29.73014022 | -95.20926415 |                                |
|                  | HSCNew-NMP-05C-3        | 3,171,393                  | 13,832,512        | 29.73012307 | -95.20918258 |                                |
| HSCNew-NMP-06    | HSCNew-NMP-06A-1        | 3,157,010                  | 13,830,360        | 29.72548387 | -95.25469401 | 1127+00                        |
|                  | HSCNew-NMP-06A-2        | 3,156,997                  | 13,830,374        | 29.72552285 | -95.25473475 |                                |
|                  | HSCNew-NMP-06A-3        | 3,156,993                  | 13,830,383        | 29.72554794 | -95.25474644 |                                |
|                  | HSCNew-NMP-06C-1        | 3,157,267                  | 13,830,791        | 29.72664661 | -95.25384324 |                                |
|                  | HSCNew-NMP-06C-2        | 3,157,252                  | 13,830,786        | 29.72663213 | -95.25388940 |                                |
| HSCNew-NMP-07    | HSCNew-NMP-07A-1        | 3,151,931                  | 13,829,808        | 29.72441121 | -95.27074500 | 1180+00                        |
|                  | HSCNew-NMP-07 (ALT 1-1) | 3,151,936                  | 13,829,813        | 29.72442555 | -95.27072884 |                                |
|                  | HSCNew-NMP-07 (ALT 1-2) | 3,151,936                  | 13,829,809        | 29.72441456 | -95.27072925 |                                |
|                  | HSCNew-NMP-07 (ALT 1-3) | 3,151,924                  | 13,829,798        | 29.72438512 | -95.27076800 |                                |
|                  | HSCNew-NMP-07 (ALT 1-4) | 3,151,916                  | 13,829,792        | 29.72437015 | -95.27079239 |                                |
|                  | HSCNew-NMP-07 (ALT 1-5) | 3,151,921                  | 13,829,775        | 29.72432229 | -95.27077984 |                                |
| HSCNew-NMP-08    | HSCNew-NMP-08A-1        | 3,149,974                  | 13,831,274        | 29.72861350 | -95.27676215 | 1200+00                        |
|                  | HSCNew-NMP-08A-2        | 3,150,021                  | 13,831,253        | 29.72855041 | -95.27661364 |                                |
|                  | HSCNew-NMP-08C-1        | 3,150,638                  | 13,831,379        | 29.72884340 | -95.27465819 |                                |
|                  | HSCNew-NMP-08C-2        | 3,150,649                  | 13,831,382        | 29.72885070 | -95.27462545 |                                |
|                  | HSCNew-NMP-08C-3        | 3,150,637                  | 13,831,389        | 29.72887201 | -95.27466122 |                                |
|                  | HSCNew-NMP-08C-4        | 3,150,629                  | 13,831,393        | 29.72888159 | -95.27468662 |                                |
| HSCNew-NMP-09    | HSCNew-NMP-09A-1        | 3,149,149                  | 13,833,987        | 29.73614245 | -95.27908828 | 1230+00                        |
|                  | HSCNew-NMP-09A-2        | 3,149,153                  | 13,833,975        | 29.73610792 | -95.27907446 |                                |
|                  | HSCNew-NMP-09A-3        | 3,149,159                  | 13,833,976        | 29.73611062 | -95.27905544 |                                |
|                  | HSCNew-NMP-09C-1        | 3,149,514                  | 13,834,136        | 29.73652023 | -95.27792173 |                                |
|                  | HSCNew-NMP-09C-2        | 3,149,510                  | 13,834,140        | 29.73653052 | -95.27793365 |                                |
|                  | HSCNew-NMP-09C-3        | 3,149,513                  | 13,834,137        | 29.73652329 | -95.27792696 |                                |
| HSCNew-NMP-10    | HSCNew-NMP-10A-1        | 3,147,880                  | 13,836,082        | 29.74201267 | -95.28287514 | 1260+00                        |
|                  | HSCNew-NMP-10A-2        | 3,147,882                  | 13,836,063        | 29.74195908 | -95.28287006 |                                |
|                  | HSCNew-NMP-10A-3        | 3,147,894                  | 13,836,050        | 29.74192182 | -95.28283159 |                                |
|                  | HSCNew-NMP-10A-4        | 3,147,894                  | 13,836,063        | 29.74195833 | -95.28283174 |                                |
|                  | HSCNew-NMP-10C-1        | 3,147,863                  | 13,836,670        | 29.74362808 | -95.28286768 |                                |
|                  | HSCNew-NMP-10C-2        | 3,147,862                  | 13,836,675        | 29.74364408 | -95.28287223 |                                |
| HSCNew-NMP-11    | HSCNew-NMP-11A-1        | 3,145,331                  | 13,838,513        | 29.74891756 | -95.29065964 | 024+00                         |
|                  | HSCNew-NMP-11A-2        | 3,145,340                  | 13,838,513        | 29.74891419 | -95.29063264 |                                |
|                  | HSCNew-NMP-11C-1        | 3,145,773                  | 13,839,568        | 29.75177651 | -95.28916034 |                                |
|                  | HSCNew-NMP-11C-2        | 3,145,774                  | 13,839,559        | 29.75175263 | -95.28915869 |                                |
|                  | HSCNew-NMP-11C-3        | 3,145,774                  | 13,839,567        | 29.75177408 | -95.28915755 |                                |

**Footnotes:**

- (1) Coordinates reported in NAD83 State Plane, Texas South Central, US Feet
- (2) All stationing shown are Houston Ship Channel (HSC) stations.



**Table 2: Summary of In Situ Water Parameters <sup>1</sup>**  
**Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) - North of Morgan's Point**  
**Houston Ship Channel, TX**

| Sample ID                     | Station | Date     | Sample Time |        | Water Depth<br>ft | Sample Depth<br>ft | Water Temperature<br>°C | Salinity<br>ppt | pH<br>su | Conductivity<br>mS/cm | ORP<br>mV | Turbidity<br>NTU | Dissolved Oxygen<br>mg/L | Air Temperature<br>°F | Wind      | GPS Coordinates <sup>3</sup> |            | Time Sample Placed in Refrigerated Truck |
|-------------------------------|---------|----------|-------------|--------|-------------------|--------------------|-------------------------|-----------------|----------|-----------------------|-----------|------------------|--------------------------|-----------------------|-----------|------------------------------|------------|--|
|                               |         |          | Start       | Finish |                   |                    |                         |                 |          |                       |           |                  |                          |                       |           | Easting                      | Northing   |  |
| HSCNew-NMP-01-SW              | 503+00  | 10/22/18 | 1000        | 1025   | 8                 | 4                  | 19.3                    | 4.03            | 7.62     | 7.301                 | 45.3      | 9                | 4.57                     | 57.9                  | 6 mph NNE | 3209746.795                  | 13844644   | 1500                                     |
| HSCNew-NMP-02-SW              | 730+00  | 10/22/18 | 1002        | 1016   | 7.9               | 3.5                | 22.8                    | 4.59            | 7.56     | 8.123                 | -7.6      | 8                | 4.61                     | 56                    | 6 mph NE  | 3190661.487                  | 13835566.8 | 1500                                     |
| HSCNew-NMP-03-SW <sup>2</sup> | 794+00  | 10/22/18 | 1053        | 1128   | 30.2              | 15                 | 19.9                    | 3.93            | 7.72     | 7.05                  | 50.1      | 8.2              | 5.63                     | 59                    | 6 mph N   | 3185287.003                  | 13837834.7 | 1500                                     |
| HSCNew-NMP-04-SW              | 873+00  | 10/22/18 | 1030        | 1100   | 25.3              | 12.5               | 22.7                    | 3.61            | 7.62     | 6.587                 | -41.6     | 8.4              | 4.5                      | 58                    | 5 mph NNE | 3177594.445                  | 13837939.5 | 1500                                     |
| HSCNew-NMP-05-SW              | 961+00  | 10/22/18 | 1200        | 1221   | 31                | 15.5               | 19.7                    | 2.84            | 7.82     | 5.221                 | 48.5      | 8.6              | 3.68                     | 64                    | 5 mph NNE | 3171799.17                   | 13832335.5 | 1500                                     |
| HSCNew-NMP-06-SW              | 1127+00 | 10/22/18 | 1125        | 1150   | 10.3              | 5.1                | 22.9                    | 1.76            | 7.59     | 3.345                 | -23.4     | 9.8              | 4.02                     | 61                    | 2 mph NNE | 3157170.354                  | 13830865.4 | 1500                                     |
| HSCNew-NMP-07-SW              | 1180+00 | 10/22/18 | 1240        | 1304   | 20.2              | 10                 | 19.4                    | 1.18            | 8.06     | 2.289                 | 62.0      | 9.5              | 3.55                     | 66                    | 6 mph NNE | 3151908.532                  | 13829783.6 | 1500                                     |
| HSCNew-NMP-08-SW              | 1200+00 | 10/22/18 | 1200        | 1225   | 40.2              | 20.1               | 23.1                    | 1.81            | 7.47     | 3.476                 | -30.2     | 7.6              | 3.56                     | 62                    | 2 mph NNE | 3150586.751                  | 13831357.5 | 1500                                     |
| HSCNew-NMP-09-SW              | 1230+00 | 10/22/18 | 1310        | 1330   | 40.1              | 20                 | 20.2                    | 2.32            | 7.71     | 4.458                 | 55.0      | 12.1             | 2.74                     | 64                    | 5 mph NNE | 3149157.868                  | 13833962.8 | 1500                                     |
| HSCNew-NMP-10-SW              | 1260+00 | 10/22/18 | 1230        | 1255   | 32.6              | 16                 | 23.1                    | 1.8             | 7.5      | 3.44                  | -32.0     | 12.9             | 3.93                     | 64                    | 0 mph     | 3148042.984                  | 13836483.3 | 1500                                     |
| HSCNew-NMP-11-SW              | 024+00  | 10/22/18 | 1340        | 1400   | 40.3              | 20.1               | 19.5                    | 1.13            | 7.91     | 2.37                  | 445.4     | 26.3             | 3.89                     | 65                    | 6 mph NNE | 3145766.366                  | 13839566.9 | 1500                                     |

**Footnotes:**

- 1) Full In Situ Water Parameters are included in the Field Report as Appendix 2
- 2) Duplicate sample taken with NMP-003 at 1130
- 3) Coordinates reported in NAD83 State Plane, Texas South Central, US Feet

**Table 3: Summary of Particle Size Analysis**  
**Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) - North of Morgan's Point**  
**Houston Ship Channel, TX**

| Sample ID            | Station | Units | Gravel |      |       | Sand   |        |      |       | Fines |      |       |
|----------------------|---------|-------|--------|------|-------|--------|--------|------|-------|-------|------|-------|
|                      |         |       | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt  | Clay | Total |
| HSCNEW-NMP-01-SD     | 503+00  | %     | 0      | 0    | 0     | 0.4    | 0.5    | 19.3 | 20.2  | 20.7  | 59.1 | 79.8  |
| HSCNEW-NMP-02-SD     | 730+00  | %     | 0      | 0    | 0     | 0.4    | 1.4    | 19.7 | 21.5  | 38.7  | 39.8 | 78.5  |
| HSCNEW-NMP-03-SD     | 794+00  | %     | 0      | 1.3  | 1.3   | 0.7    | 0.8    | 39.6 | 41.1  | 29.6  | 28   | 57.6  |
| HSCNEW-NMP-03-SD-DUP | 794+00  | %     | 0      | 0    | 0     | 0.6    | 1.1    | 48.8 | 50.5  | 23.4  | 26.1 | 49.5  |
| HSCNEW-NMP-04-SD     | 873+00  | %     | 0      | 0.3  | 0.3   | 0.4    | 0.9    | 11.6 | 12.9  | 28.7  | 58.2 | 86.9  |
| HSCNEW-NMP-05-SD     | 961+00  | %     | 0      | 0.3  | 0.3   | 2.8    | 3.3    | 28.3 | 34.4  | 25.8  | 39.5 | 65.3  |
| HSCNEW-NMP-06-SD     | 1127+00 | %     | 0      | 1.5  | 1.5   | 0.1    | 1.3    | 16.7 | 18.1  | 38.1  | 42.3 | 80.4  |
| HSCNEW-NMP-07-SD     | 1180+00 | %     | 0      | 0    | 0     | 0.2    | 1.7    | 28.4 | 30.3  | 30.6  | 39.1 | 69.7  |
| HSCNEW-NMP-08-SD     | 1200+00 | %     | 0      | 0    | 0     | 0.1    | 0.6    | 13.5 | 14.2  | 17.7  | 68   | 85.7  |
| HSCNEW-NMP-09-SD     | 1230+00 | %     | 0      | 0    | 0     | 0.4    | 0.5    | 7.7  | 8.6   | 18.3  | 73.1 | 91.4  |
| HSCNEW-NMP-10-SD     | 1260+00 | %     | 0      | 0    | 0     | 0.2    | 0.4    | 12.4 | 13    | 23    | 63.9 | 86.9  |
| HSCNEW-NMP-11-SD     | 024+00  | %     | 0      | 0    | 0     | 0.4    | 0.6    | 41.4 | 42.4  | 23    | 34.7 | 57.7  |

**Footnotes:**

- 1) Full particle size analysis reports are included as Appendix 4
- 2) USCS Soil Classification; corrected for 100% passing a 3" sieve

**Table 4: Summary of Specific Gravity and Atterburg Limits Analysis <sup>1</sup>**  
**Houston Ship Channel (HSC) Expansion Channel Improvement Project (ECIP) - North of Morgan's Point**  
**Houston Ship Channel, TX**

| Sample ID            | Station | Specific Gravity <sup>2</sup><br>g/cm <sup>3</sup> | Atterburg Limits  |                    |                        | USCS Group Name <sup>3</sup> |
|----------------------|---------|--|-------------------|--------------------|------------------------|------------------------------|
|                      |         |  | Liquid Limit<br>% | Plastic Limit<br>% | Plasticity Index<br>PI |                              |
| HSCNEW-NMP-01-SD     | 503+00  | 2.68   | 74                | 21                 | 53                     | Fat Clay                     |
| HSCNEW-NMP-02-SD     | 730+00  | 2.67   | 44                | 17                 | 27                     | Lean Clay                    |
| HSCNEW-NMP-03-SD     | 794+00  | 2.64   | 23                | 12                 | 11                     | Lean Clay                    |
| HSCNEW-NMP-03-SD-DUP | 794+00  | 2.69   | 25                | 11                 | 14                     | Lean Clay                    |
| HSCNEW-NMP-04-SD     | 873+00  | 2.65   | 70                | 23                 | 47                     | Fat Clay                     |
| HSCNEW-NMP-05-SD     | 961+00  | 2.67   | 47                | 16                 | 31                     | Lean Clay                    |
| HSCNEW-NMP-06-SD     | 1127+00 | 2.65   | 42                | 17                 | 25                     | Lean Clay                    |
| HSCNEW-NMP-07-SD     | 1180+00 | 2.66   | 45                | 16                 | 29                     | Lean Clay                    |
| HSCNEW-NMP-08-SD     | 1200+00 | 2.64   | 57                | 19                 | 38                     | Fat Clay                     |
| HSCNEW-NMP-09-SD     | 1230+00 | 2.65   | 55                | 21                 | 34                     | Fat Clay                     |
| HSCNEW-NMP-10-SD     | 1260+00 | 2.69   | 56                | 20                 | 36                     | Fat Clay                     |
| HSCNEW-NMP-11-SD     | 024+00  | 2.66   | 32                | 14                 | 18                     | Lean Clay                    |

**Footnotes:**

- 1) Full specific gravity and Atterburg limits analysis reports are included as Appendix 4
- 2) Specific gravity results corrected for reporting at 20 °C
- 3) USCS Group Name given to material that passes through a #40 sieve; all material retained by #40 sieve not included

**Table 5: Site Water Analytical Results and Screening, Detections and Exceedances<sup>3</sup>**  
**Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point**  
**Houston Ship Channel, TX**

| Analyte                         | CAS No.          | Units | Target Detection Limit (TDL) | Marine Water Screening Criteria |                     |                         |                   | No. of Samples | Sample Min | Sample Max | Sample Mean | HSCNew-NMP-01-SW | HSCNew-NMP-02-SW | HSCNew-NMP-03-SW | HSCNew-NMP-04-SW | HSCNew-NMP-05-SW | HSCNew-NMP-06-SW | HSCNew-NMP-07-SW | HSCNew-NMP-08-SW | HSCNew-NMP-09-SW | HSCNew-NMP-10-SW | HSCNew-NMP-11-SW | HSCNew-NMP-03-SW-Field Dup |            |            |            |            |            |
|---------------------------------|------------------|-------|------------------------------|---------------------------------|---------------------|-------------------------|-------------------|----------------|------------|------------|-------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------------------|------------|------------|------------|------------|------------|
|                                 |                  |       |                              | TSWQS (Acute) (b)               | EPA WQC (Acute) (c) | NOAA (Marine Acute) (d) | Region 6 (Marine) |                |            |            |             | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018       | 10/22/2018                 | 10/22/2018 | 10/22/2018 | 10/22/2018 | 10/22/2018 | 10/22/2018 |
|                                 |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| <b>VOCs</b>                     |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Bromodichloromethane            | 75-27-4          | ug/L  | -                            | -                               | -                   | -                       | 12                | 0.50           | 0.58       | 0.51       | 0.50        | Ua               | 0.50             | Ua               | 0.58             | -                | 0.50             | Ua               | 0.50             | Ua               | 0.50             | Ua               | 0.50                       |            |            |            |            |            |
| Chloroform                      | 67-66-3          | ug/L  | 2                            | -                               | -                   | -                       | 4100              | 12             | 0.5        | 2.24       | 1.75        | 0.5              | Ua               | 1.6              | -                | 1.0              | -                | 1.9              | -                | 2.2              | -                | 2.2              | -                          |            |            |            |            |            |
| Chloromethane                   | 74-87-3          | ug/L  | -                            | -                               | -                   | -                       | 13500             | 12             | 1.0        | 2.26       | 1.22        | 1.0              | Ua               | 1.0              | Ua               | 2.3              | -                | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua                         |            |            |            |            |            |
| <b>SVOCs</b>                    |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Bis[2-ethylhexyl] Phthalate     | 117-81-7         | ug/L  | 2 (g)                        | -                               | -                   | 400                     | -                 | 12             | 0.17       | 0.51       | 0.40        | 0.20             | Jb               | 0.19             | Jb               | 0.17             | Jb               | 0.21             | Jb               | 0.50             | Ub               | 0.51             | Ub                         |            |            |            |            |            |
| Di-n-butyl Phthalate            | 84-74-2          | ug/L  | 1 (g)                        | -                               | -                   | 2944                    | NA                | 12             | 0.11       | 0.51       | 0.44        | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.50             | Ub               | 0.50             | Ub               | 0.12             | Jb                         |            |            |            |            |            |
| Hexachlorobutadiene             | 87-68-3          | ug/L  | 0.9 (g)                      | -                               | -                   | 32                      | 0.32              | 12             | 0.50       | 0.51       | 0.50        | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.50             | Ub               | 0.51             | Ub               | 0.51             | Ub                         |            |            |            |            |            |
| Hexachlorocyclopentadiene       | 77-47-4          | ug/L  | 3.0 (g)                      | -                               | -                   | 7                       | 0.07              | 12             | 0.50       | 0.51       | 0.50        | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.50             | Ub               | 0.51             | Ub               | 0.51             | Ub                         |            |            |            |            |            |
| <b>PAHs</b>                     |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Acenaphthene                    | 83-32-9          | ug/L  | 0.75 (g)                     | -                               | -                   | 970                     | 40.4              | 12             | 0.0020     | 0.010      | 0.0094      | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.0020           | Jb               | 0.010            | Ub               | 0.010            | Ub                         |            |            |            |            |            |
| Benzo(a)anthracene              | 56-55-3          | ug/L  | 0.4 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0018     | 0.010      | 0.0080      | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub                         |            |            |            |            |            |
| Benzo(a)pyrene                  | 50-32-8          | ug/L  | 0.3 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.00093    | 0.010      | 0.0047      | 0.010            | Ub               | 0.010            | Ub               | 0.0015           | Jb               | 0.010            | Ub               | 0.0020           | Jb               | 0.0012           | Jb                         |            |            |            |            |            |
| Benzo(b)fluoranthene            | 205-99-2         | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0015     | 0.010      | 0.0057      | 0.010            | Ub               | 0.010            | Ub               | 0.0026           | Jb               | 0.010            | Ub               | 0.0034           | Jb               | 0.0019           | Jb                         |            |            |            |            |            |
| Benzo(e)pyrene                  | 192-97-2         | ug/L  | -                            | -                               | -                   | -                       | -                 | 12             | 0.0015     | 0.010      | 0.0054      | 0.010            | Ub               | 0.010            | Ub               | 0.0025           | Jb               | 0.010            | Ub               | 0.0031           | Jb               | 0.0018           | Jb                         |            |            |            |            |            |
| Benzo(g,h,i)perylene            | 191-24-2         | ug/L  | 1.2 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0014     | 0.010      | 0.0046      | 0.0014           | Jb               | 0.010            | Ub               | 0.0026           | Jb               | 0.010            | Ub               | 0.0031           | Jb               | 0.0017           | Jb                         |            |            |            |            |            |
| Benzo(k)fluoranthene            | 207-08-9         | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0015     | 0.010      | 0.0058      | 0.010            | Ub               | 0.010            | Ub               | 0.0020           | Jb               | 0.010            | Ub               | 0.0025           | Jb               | 0.0015           | Jb                         |            |            |            |            |            |
| Chrysene                        | 218-01-9         | ug/L  | 0.3 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0011     | 0.010      | 0.0037      | 0.010            | Ub               | 0.010            | Ub               | 0.0021           | Jb               | 0.010            | Ub               | 0.0013           | Jb               | 0.0027           | Jb                         |            |            |            |            |            |
| Dibenzo[a,h]anthracene          | 53-70-3          | ug/L  | 1.3 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.010      | 0.010      | 0.010       | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub                         |            |            |            |            |            |
| Fluoranthene                    | 206-44-0         | ug/L  | 0.9 (g)                      | -                               | -                   | 40                      | 2.96              | 12             | 0.0020     | 0.0083     | 0.0039      | 0.0023           | Jb               | 0.0020           | Jb               | 0.0032           | Jb               | 0.0024           | Jb               | 0.0044           | Jb               | 0.0031           | Jb                         |            |            |            |            |            |
| Indeno[1,2,3-c,d]pyrene         | 193-39-5         | ug/L  | 1.2 (g)                      | -                               | -                   | 300                     | -                 | 12             | 0.0074     | 0.014      | 0.0092      | 0.014            | -                | 0.0074           | Jb               | 0.0088           | Jb               | 0.0077           | Jb               | 0.0089           | Jb               | 0.0081           | Jb                         |            |            |            |            |            |
| Naphthalene                     | 91-20-3          | ug/L  | 0.8 (g)                      | -                               | -                   | 250                     | -                 | 12             | 0.0019     | 0.024      | 0.0077      | 0.024            | -                | 0.012            | -                | 0.0036           | Jb               | 0.0076           | Jb               | 0.0019           | Jb               | 0.0051           | Jb                         |            |            |            |            |            |
| Phenanthrene                    | 85-01-8          | ug/L  | 0.5 (g)                      | 7.7                             | -                   | 7.7                     | 4.6               | 12             | 0.0019     | 0.010      | 0.0067      | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.010            | Ub               | 0.0023           | Jb                         |            |            |            |            |            |
| Pyrene                          | 129-00-0         | ug/L  | 1.5 (g)                      | -                               | -                   | 300                     | 0.24              | 12             | 0.0024     | 0.0079     | 0.0049      | 0.0037           | Jb               | 0.0024           | Jb               | 0.0048           | Jb               | 0.0028           | Jb               | 0.0066           | Jb               | 0.0032           | Jb                         |            |            |            |            |            |
| PAH (Total) calculated (h)      | 130498-29-2      | ug/L  | -                            | -                               | -                   | -                       | -                 | 12             | 0.020      | 0.059      | 0.037       | 0.046            | -                | 0.023            | -                | 0.034            | -                | 0.024            | -                | 0.039            | -                | 0.029            | -                          |            |            |            |            |            |
| <b>Pesticides</b>               |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| 4,4'-DDT                        | 50-29-3          | ug/L  | 0.1                          | 0.13                            | 0.13 (G, ii)        | 0.065                   | 0.001             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Dieldrin                        | 60-57-1          | ug/L  | 0.03                         | 0.71                            | 0.71 (G)            | 0.355                   | 0.002             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Endrin                          | 72-20-8          | ug/L  | 0.1                          | 0.037                           | 0.037 (G)           | 0.0185                  | 0.002             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Endrin Aldehyde                 | 7421-93-4        | ug/L  | 0.1                          | -                               | 0.037 (G)           | 0.0185                  | 0.002             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Heptachlor                      | 76-44-8          | ug/L  | 0.1                          | 0.053                           | 0.053 (G)           | 0.0265                  | 0.004             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Heptachlor Epoxide              | 1024-57-3        | ug/L  | 0.1                          | -                               | 0.053 (G)           | 0.0265                  | 0.004             | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Toxaphene                       | 8001-35-2        | ug/L  | 0.5                          | 0.21                            | 0.21                | 0.21                    | 0.0002            | 12             | 0.30       | 0.30       | 0.30        | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                          |            |            |            |            |            |
| <b>Dioxins and Furans</b>       |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Total TEQ (i)                   | -                | pg/L  | -                            | -                               | -                   | -                       | -                 | 12             | 0          | 0.094      | 0.011       | 0.0085           | -                | 0                | -                | 0                | -                | 0                | -                | 0.0094           | (o)              | 0.0038           | -                          |            |            |            |            |            |
| <b>Metals (z, l)</b>            |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Antimony                        | 7440-36-0        | ug/L  | 3 (0.03) (m)                 | -                               | -                   | 1500                    | 500               | 12             | 1.2        | 5.0        | 4.4         | 4.6              | J                | 1.6              | J                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Arsenic                         | 7440-38-2        | ug/L  | (m)                          | 149                             | 69 (A, D)           | 69                      | 78                | 12             | 1.9        | 3.2        | 2.5         | 1.9              | J                | 2.5              | J                | 2.1              | J                | 3.1              | J                | 2.8              | J                | 2.5              | J                          |            |            |            |            |            |
| Barium                          | 7440-39-3        | ug/L  | -                            | -                               | -                   | 1000                    | -                 | 12             | 64         | 82         | 74          | 74               | -                | 80               | -                | 73               | -                | 72               | -                | 74               | -                | 64               | -                          |            |            |            |            |            |
| Beryllium                       | 7440-41-7        | ug/L  | 0.2                          | -                               | -                   | 1500                    | -                 | 12             | 0.20       | 5.0        | 3.8         | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Chromium (total)                | 7440-47-3        | ug/L  | 1                            | -                               | -                   | -                       | 103               | 12             | 0.80       | 5.0        | 2.2         | 1.3              | J                | 0.80             | J                | 1.1              | J                | 5.0              | U                | 2.8              | J                | 5.0              | U                          |            |            |            |            |            |
| Chromium (3+)                   | 7440-47-3 (III)  | ug/L  | 1                            | -                               | -                   | 103000                  | -                 | 12             | 0.30       | 2.0        | 0.78        | 0.50             | J                | 0.30             | J                | 0.90             | J                | 1.0              | U                | 2.0              | -                | 0.40             | J                          |            |            |            |            |            |
| Chromium (6+)                   | 7440-47-3 (Cr6+) | ug/L  | 1                            | 1090                            | 1,100 (D)           | 1100                    | 49.6              | 12             | 0.80       | 2.0        | 1.9         | 0.80             | Z-03, J          | 2.0              | Z-03, U          | 2.0              | Z-03, U          | 2.0              | Z-03, U          | 2.0              | Z-03, U          | 2.0              | Z-03, U                    |            |            |            |            |            |
| Copper                          | 7440-50-8        | ug/L  | 1 (0.1) (m)                  | 13.5                            | 4.8 (D, cc)         | 4.8                     | 3.6               | 12             | 2.1        | 4.6        | 2.9         | 2.5              | J                | 2.4              | J                | 3.0              | J                | 2.2              | J                | 3.0              | J                | 2.3              | J                          |            |            |            |            |            |
| Lead                            | 7439-92-1        | ug/L  | 1 (0.03) (m)                 | 133                             | 210 (D)             | 210                     | 5.3               | 12             | 0.80       | 5.0        | 2.4         | 1.3              | J                | 5.0              | U                | 1.0              | J                | 5.0              | U                | 1.0              | J                | 5.0              | U                          |            |            |            |            |            |
| Mercury                         | 7439-97-6        | ug/L  | 0.2 (0.0003) (m)             | 2.1                             | -                   | 1.8                     | 1.1               | 12             | 0.0020     | 0.020      | 0.015       | 0.020            | U                | 0.020            | U                | 0.020            | U                | 0.020            | U                | 0.0020           | J                | 0.013            | J                          |            |            |            |            |            |
| Nickel                          | 7440-02-0        | ug/L  | 1 (0.1) (m)                  | 118                             | 74 (D)              | 74                      | 13.1              | 12             | 1.3        | 2.6        | 1.8         | 1.3              | J                | 1.8              | J                | 1.7              | J                | 1.3              | J                | 2.5              | J                | 1.4              | J                          |            |            |            |            |            |
| Silver                          | 7440-22-4        | ug/L  | 1 (0.1) (m)                  | 2                               | 1.9 (D)             | 0.95                    | -                 | 12             | 0.90       | 9.2        | 3.9         | 9.2              | -                | 1.3              | J                | 0.90             | J                | 5.0              | U                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Zinc                            | 7440-66-6        | ug/L  | 1 (0.5) (m)                  | 92.7                            | 90 (D)              | 90                      | 84.2              | 12             | 57         | 91         | 74          | 57               | -                | 77               | -                | 78               | -                | 79               | -                | 62               | -                | 91               | -                          |            |            |            |            |            |
| <b>Miscellaneous Parameters</b> |                  |       |                              |                                 |                     |                         |                   |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Cyanide                         | 57-12-5          | ug/L  | 100 (n)                      | -                               | 1 (Q)               | 1                       | 5.6               | 12             | 10         | 10         | 10          | 10               | Cl, U            | 10               | Cl, U            | 10               | Cl, U            | 10               | Cl, U            | 10               | Cl, U            | 10               | Cl, U                      |            |            |            |            |            |
| DOC rep1                        | NA               | %     | -                            | -                               | -                   | -                       | -                 | 12             | 0.0039     | 0.010      | 0.0095      | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.0039           | J                | 0.010            | U                | 0.010            | U                          |            |            |            |            |            |
| Total Suspended Solids          | NA               | ug/L  | NA                           | -                               | -                   | -                       | -                 | 12             | 6400       | 18700      | 10458       | 11200            | -                | 7600             | -                | 8000             | -                | 6400             | -                | 7200             | -                | 12700            | -                          |            |            |            |            |            |
| TOC rep1                        | NA               | %     | -                            | -                               | -                   | -                       | -                 | 12             | 0.0046     | 0.010      | 0.0096      | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                          |            |            |            |            |            |
| TOC rep2                        | NA               | %     | -                            | -                               | -                   | -                       | -                 | 12             | 0.0044     | 0.010      | 0.0087      | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                          |            |            |            |            |            |
| TOC rep3                        | NA               | %     | -                            | -                               | -                   | -                       | -                 | 12             | 0.0036     | 0.010      | 0.0095      | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                | 0.010            | U                          |            |            |            |            |            |
| TOC rep4                        | NA               | %     | -                            | -                               | -                   | -                       | -                 | 12             | 0.0038     | 0.010      | 0.0066      | 0.0038           | J                | 0.010            | U                | 0.0043           | J                | 0.010            | U                | 0.0038           | J                | 0.0043           | J                          |            |            |            |            |            |
| Total Organic Carbon            | NA               | %     | 0.1                          | -                               | -                   | -                       | -                 | 12             | 0.0038     | 0.010      | 0.0090      | 0.010            | U                |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |



**Table 5: Site Water Analytical Results and Screening, Detections and Exceedances<sup>3</sup>  
Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point  
Houston Ship Channel, TX**

**FOOTNOTES- lowercase footnotes were created by the table generator**

- a) The primary sources for this table were: TDLs - EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. USEPA/USACE, Regional Implementation Agreement, July 2003; US EPA SW-846 <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>;
- b) TSWQS Rule 307.6- (2014) <https://www.tceq.texas.gov/waterquality/standards> ; \*\*NOTE\*\*2018 TSWQSS were adopted by the commission on February 7, 2018, these Standards are effective for all state permits; however, until approved by USEPA, the 2014 Standards apply to federal permits.
- c) EPA WQC- <http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>; see EPA footnote section below for individual EPA value
- d) NOAA- <http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html>
- e) Region 6 screening benchmarks come from TCEQ's ecological benchmarks for water,
- f) Azobenzene is reported by the laboratory instead of 1,2-diphenylhydrazine. 1,2-diphenylhydrazine is rapidly oxidized into azobenzene during analysis.
- g) These values are based on recommendations from the EPA Region 6 laboratory in Houston; these values were based on data or other technical basis;
- h) PAHs did not have any elevated RL. PAH (total) calculated was determined by summing all non-U qualified data.
- i) Total PCBs were not calculated since all analytes were nondetect, U qualified, and there were no elevated RL.
- j) Total TEQ was calculated using 2005 WHO TEF values from Van den Berg et al; 2006 (doi:10.1093/toxsci/ktf055) and [https://clu-in.org/download/contaminantfocus/dioxins/Dioxin\\_TEFs\\_for\\_TEQs.pdf](https://clu-in.org/download/contaminantfocus/dioxins/Dioxin_TEFs_for_TEQs.pdf). Total TEQ was calculated by summing all TEF adjusted non-U qualified data.
- l) Samples for metals analysis were diluted 10X for antimony, arsenic, barium, beryllium, cadmium, chromium (total), copper, lead, nickel, selenium, silver, thallium and zinc, 1X for chromium (3+), 2X for chromium (6+) and mercury
- m) The values in parentheses are based on EPA "clean techniques", (EPA 1600 series methods) which are applicable in instances where other TDLs are inadequate to assess EPA water quality criteria;
- n) This value recommended by Houston lab using colorimetric method. This value is based upon FREE cyanide, not complexed as the method is designed to analyze for. If free cyanide is expected, consult the laboratory as to the best method for quantifying free cyanide;
- o) Total TEQ does not include J qualified result for Total Hepta CDD since there is no reported TEF for Total Hepta CDD.
- p) Total TEQ does not include J qualified result for Total Hexa CDF since there is no reported TEF for Total Hexa CDF.
- z) Metals are expressed as Dissolved values in water samples, except for mercury and selenium, which are reported as Total Recoverable Concentrations;

**EPA WQC footnotes- uppercase and double-lettered footnotes are directly from the NRWQC footnotes; only footnotes for constituents of concern are retained in this table**

- A) This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive. Please consult the criteria document for details.
- D) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.
- G) This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (PDF) (153 pp, 7.3MB) (EPA 440/5-80-019), Chlordane (PDF) (68 pp, 3.1MB) (EPA 440/5-80-027), DDT (PDF) (175 pp, 8.3MB) (EPA 440/5-80-038), Endosulfan (PDF) (155 pp, 7.3MB) (EPA 440/5-80-046), Endrin (PDF) (103 pp, 4.6MB) (EPA 440/5-80-047), Heptachlor (PDF) (114 pp, 5.4MB) (EPA 440/5-80-052), Hexachlorocyclohexane (PDF) (109 pp, 4.8MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines (PDF) (104 pp, 3.3MB). If evaluation is to be done using an averaging period, the acute criteria values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
- Q) This recommended water quality criterion is expressed as ug free cyanide (as CN)/l.
- Y) This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
- cc) When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.
- dd) Selenium criteria document (EPA 440/5-87-006, September 1987)states that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the conc.of selenium exceeds 5.0 µg/l in salt water because the saltwater CCC does not take into account uptake via the food chain.
- ii)This criterion applies to DDT and its metabolites (i.e., the total conc. DDT plus metabolites should not exceed this value).

**Laboratory Qualifier**

|      |  |
|------|--|
| Cl   | Residual Chlorine or other oxidizing agent was detected in the container used to analyze this sample.☒   |
| J    | Detected but below the Reporting Limit (Limit of Quantitation); therefore, result is an estimated concentration.   |
| Jb   | Estimated value less than RL   |
| Jd   | Used for Pesticides, PCBs, Herbicides, Formaldehyde, Explosives and Method 504.1 analytes when there is a greater than 40 % difference for detected concentrations between the two GC columns. |
| U    | Analyte included in the analysis, but not detected   |
| Ua   | Analyte included in the analysis, but not detected at or above the Reporting Limit   |
| Ub   | Compound was analyzed for but was not detected (non-detect)  |
| Uc   | Indicates the compound was analyzed for but not detected above the specified level.  |
| Z-03 | See case narrative.  |

**Samples with Detections are BOLD**

**One or more sample concentrations exceed screening criteria**

**Sample concentration exceeds screening criteria**

**Table 6: Sediment Analytical Results, Detections and Exceedances<sup>a</sup>**  
**Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point**  
**Houston Ship Channel, TX**

| Analyte                     | CAS No.     | Units | Target Detection Limit (TDL) | Sediment Screening Criteria |                       |                       | No. of Samples | Sample Min | Sample Max | Sample Mean | HSCNew-NMP-01-SD | HSCNew-NMP-02-SD | HSCNew-NMP-03-SD | HSCNew-NMP-04-SD | HSCNew-NMP-05-SD | HSCNew-NMP-06-SD | HSCNew-NMP-07-SD | HSCNew-NMP-08-SD | HSCNew-NMP-09-SD | HSCNew-NMP-10-SD | HSCNew-NMP-11-SD | HSCNew-NMP-03-SD-Field Dup |        |    |        |    |        |    |        |    |        |    |        |    |
|-----------------------------|-------------|-------|------------------------------|-----------------------------|-----------------------|-----------------------|----------------|------------|------------|-------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------------------|--------|----|--------|----|--------|----|--------|----|--------|----|--------|----|
|                             |             |       |                              | NOAA (Marine-ERL) (b)       | NOAA (Marine-ERM) (c) | Region 6 (Marine) (d) |                |            |            |             | 10/6/2018        | 10/6/2018        | 10/5/2018        | 10/5/2018        | 10/4/2018        | 10/4/2018        | 10/3/2019        | 10/3/2018        | 10/2/2018        | 10/2/2018        | 10/2/2018        | 10/5/2018                  |        |    |        |    |        |    |        |    |        |    |        |    |
|                             |             |       |                              |                             |                       |                       |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |
| <b>VOCS</b>                 |             |       |                              |                             |                       |                       |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |
| 1,3-Dichlorobenzene         | 541-73-1    | mg/kg | 0.02                         | -                           | -                     | 0.32                  | 12             | 0.0024     | 0.015      | 0.0042      | 0.0035           | Ua               | 0.0079           | -                | 0.0024           | Ua               | 0.015            | -                | 0.003            | Ua               | 0.0028           | Ua                         | 0.0029 | Ua | 0.0029 | Ua | 0.0028 | Ua | 0.0026 | Ua | 0.0027 | Ua | 0.0025 | Ua |
| Acetone                     | 67-64-1     | mg/kg | -                            | -                           | -                     | 167.23                | 12             | 0.059      | 0.26       | 0.13        | 0.086            | Ua               | 0.079            | -                | 0.059            | Ua               | 0.26             | -                | 0.13             | -                | 0.21             | -                          | 0.13   | -  | 0.15   | -  | 0.19   | -  | 0.078  | -  | 0.062  | Ua |        |    |
| Benzene                     | 71-43-2     | mg/kg | 0.01                         | -                           | -                     | -                     | 12             | 0.0024     | 0.047      | 0.0091      | 0.0035           | Ua               | 0.011            | -                | 0.0024           | Ua               | 0.047            | -                | 0.0025           | Ua               | 0.0028           | Ua                         | 0.0029 | Ua | 0.026  | -  | 0.0028 | Ua | 0.0026 | Ua | 0.0027 | Ua | 0.0025 | Ua |
| Ethylbenzene                | 100-41-4    | mg/kg | 0.01                         | -                           | -                     | 0.65                  | 12             | 0.0024     | 0.042      | 0.0072      | 0.0035           | Ua               | 0.015            | -                | 0.0024           | Ua               | 0.0043           | -                | 0.0025           | Ua               | 0.0028           | Ua                         | 0.0037 | -  | 0.042  | -  | 0.0028 | Ua | 0.0026 | Ua | 0.0027 | Ua | 0.0025 | Ua |
| Methylcyclohexane           | 108-87-2    | mg/kg | -                            | -                           | -                     | -                     | 12             | 0.030      | 0.14       | 0.044       | 0.043            | Ua               | 0.036            | Ua               | 0.030            | Ua               | 0.046            | Ua               | 0.032            | Ua               | 0.036            | Ua                         | 0.037  | Ua | 0.14   | -  | 0.035  | Ua | 0.033  | Ua | 0.033  | Ua | 0.031  | Ua |
| o-Xylene                    | 95-47-6     | mg/kg | -                            | -                           | -                     | -                     | 12             | 0.030      | 0.075      | 0.039       | 0.043            | Ua               | 0.036            | Ua               | 0.030            | Ua               | 0.046            | Ua               | 0.032            | Ua               | 0.036            | Ua                         | 0.037  | Ua | 0.075  | -  | 0.035  | Ua | 0.033  | Ua | 0.033  | Ua | 0.031  | Ua |
| m&p-Xylene                  | 179601-23-1 | mg/kg | -                            | -                           | -                     | -                     | 12             | 0.030      | 0.078      | 0.039       | 0.043            | Ua               | 0.036            | Ua               | 0.030            | Ua               | 0.047            | -                | 0.032            | Ua               | 0.036            | Ua                         | 0.037  | Ua | 0.078  | -  | 0.035  | Ua | 0.033  | Ua | 0.033  | Ua | 0.031  | Ua |
| Toluene                     | 108-88-3    | mg/kg | 0.01                         | -                           | -                     | 0.94                  | 12             | 0.0024     | 0.015      | 0.0041      | 0.0035           | Ua               | 0.0064           | -                | 0.0024           | Ua               | 0.0037           | Ua               | 0.0025           | Ua               | 0.0028           | Ua                         | 0.0029 | Ua | 0.015  | -  | 0.0028 | Ua | 0.0026 | Ua | 0.0027 | Ua | 0.0025 | Ua |
| <b>SVOCs</b>                |             |       |                              |                             |                       |                       |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |
| 1,3-Dichlorobenzene         | 541-73-1    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 36         | 78         | 50          | 78               | Ub               | 36               | Jc               | 42               | Ub               | 54               | Ub               | 55               | Ub               | 48               | Ub                         | 49     | Ub | 51     | Ub | 49     | Ub | 51     | Ub | 45     | Ub | 42     | Ub |
| Bis[2-ethylhexyl] Phthalate | 117-81-7    | ug/kg | 50                           | -                           | -                     | 182 (i)               | 12             | 22         | 2240       | 789         | 100              | -                | 22               | Jc               | 2240             | Ub               | 1020             | -                | 1800             | -                | 1250             | -                          | 598    | -  | 293    | -  | 1160   | -  | 560    | -  | 726    | -  | 26     | Jc |
| Butyl Benzyl Phthalate      | 85-68-7     | ug/kg | 50                           | -                           | -                     | -                     | 12             | 16         | 78         | 46          | 78               | Ub               | 48               | Ub               | 42               | Ub               | 54               | Ub               | 55               | Ub               | 48               | Ub                         | 49     | Ub | 51     | Ub | 17     | Jc | 51     | Ub | 16     | Jc | 42     | Ub |
| Diethyl Phthalate           | 84-66-2     | ug/kg | 50                           | -                           | -                     | -                     | 12             | 8.1        | 78         | 48          | 78               | Ub               | 48               | Ub               | 42               | Ub               | 54               | Ub               | 55               | Ub               | 48               | Ub                         | 49     | Ub | 51     | Ub | 8.1    | Jc | 51     | Ub | 45     | Ub | 42     | Ub |
| Dimethyl Phthalate          | 131-11-3    | ug/kg | 50                           | -                           | -                     | -                     | 12             | 24         | 78         | 49          | 78               | Ub               | 48               | Ub               | 42               | Ub               | 54               | Ub               | 55               | Ub               | 48               | Ub                         | 49     | Ub | 51     | Ub | 49     | Ub | 51     | Ub | 24     | Jc | 42     | Ub |
| Hexachlorobutadiene         | 87-68-3     | ug/kg | 20                           | -                           | -                     | -                     | 12             | 11         | 55         | 44          | 32               | Jc               | 11               | Jc               | 42               | Ub               | 54               | Ub               | 55               | Ub               | 48               | Ub                         | 49     | Ub | 51     | Ub | 49     | Ub | 51     | Ub | 45     | Ub | 42     | Ub |
| <b>PAHs (g)</b>             |             |       |                              |                             |                       |                       |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |
| Acenaphthene                | 83-32-9     | ug/kg | 20                           | 16                          | 500                   | 16                    | 12             | 4.7        | 683        | 198         | 9.2              | -                | 66               | -                | 4.7              | Ub               | 311              | -                | 35               | -                | 57               | -                          | 206    | -  | 476    | -  | 683    | -  | 410    | -  | 118    | -  | 5.7    | -  |
| Acenaphthylene              | 208-96-8    | ug/kg | 20                           | 44                          | 640                   | 44                    | 12             | 2.2        | 92         | 38          | 12               | -                | 89               | -                | 2.2              | Jc               | 92               | -                | 23               | -                | 21               | -                          | 39     | -  | 55     | -  | 21     | -  | 39     | -  | 57     | -  | 3.2    | Jc |
| Anthracene                  | 120-12-7    | ug/kg | 20                           | 85.3                        | 1100                  | 85.3                  | 12             | 4.7        | 733        | 178         | 20               | -                | 56               | -                | 4.7              | Ub               | 162              | -                | 35               | -                | 44               | -                          | 179    | -  | 733    | -  | 465    | -  | 288    | -  | 136    | -  | 12     | -  |
| Benzo(a)anthracene          | 56-55-3     | ug/kg | 20                           | 261                         | 1600                  | 261                   | 12             | 8.0        | 902        | 357         | 45               | -                | 82               | -                | 8.0              | -                | 745              | -                | 201              | -                | 390              | -                          | 902    | -  | 640    | -  | 351    | -  | 524    | -  | 381    | -  | 21     | -  |
| Benzo(a)pyrene              | 50-32-8     | ug/kg | 20                           | 430                         | 1600                  | 430                   | 12             | 8.9        | 709        | 269         | 63               | -                | 159              | -                | 8.9              | -                | 539              | -                | 166              | -                | 327              | -                          | 709    | -  | 292    | -  | 187    | -  | 434    | -  | 324    | -  | 22     | -  |
| Benzo(b)fluoranthene        | 205-99-2    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 6.7        | 1110       | 346         | 61               | -                | 76               | -                | 6.7              | -                | 471              | -                | 230              | -                | 502              | -                          | 1110   | -  | 406    | -  | 263    | -  | 604    | -  | 405    | -  | 23     | -  |
| Benzo(e)pyrene              | 192-97-2    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 6.8        | 810        | 306         | 64               | -                | 132              | -                | 6.8              | -                | 670              | -                | 227              | -                | 361              | -                          | 810    | -  | 360    | -  | 201    | -  | 488    | -  | 335    | -  | 20     | -  |
| Benzo(g,h,i)perylene        | 191-24-2    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 7.0        | 671        | 284         | 108              | -                | 526              | -                | 7.0              | -                | 510              | -                | 180              | -                | 307              | -                          | 671    | -  | 222    | -  | 149    | -  | 420    | -  | 290    | -  | 21     | -  |
| Benzo(k)fluoranthene        | 207-08-9    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 5.2        | 545        | 203         | 46               | -                | 45               | -                | 5.2              | -                | 238              | -                | 108              | -                | 270              | -                          | 545    | -  | 250    | -  | 164    | -  | 439    | -  | 311    | -  | 17     | -  |
| Chrysene                    | 218-01-9    | ug/kg | 20                           | 384                         | 2800                  | 384                   | 12             | 7.0        | 850        | 337         | 53               | -                | 76               | -                | 7.0              | -                | 651              | -                | 210              | -                | 370              | -                          | 850    | -  | 536    | -  | 291    | -  | 585    | -  | 389    | -  | 23     | -  |
| Dibenzo[a,h]anthracene      | 53-70-3     | ug/kg | 20                           | 63.4                        | 260                   | 63.4                  | 12             | 4.1        | 153        | 54          | 8.2              | Jc               | 4.6              | Jc               | 4.7              | Ub               | 153              | -                | 41               | -                | 66               | -                          | 147    | -  | 41     | -  | 32     | -  | 80     | -  | 62     | -  | 4.1    | Jc |
| Fluoranthene                | 206-44-0    | ug/kg | 20                           | 600                         | 5100                  | 600                   | 12             | 14         | 1830       | 861         | 126              | -                | 543              | -                | 14               | -                | 1240             | -                | 307              | -                | 739              | -                          | 1830   | -  | 1800   | -  | 1120   | -  | 1580   | -  | 990    | -  | 49     | -  |
| Fluorene                    | 86-73-7     | ug/kg | 20                           | 19                          | 540                   | 19                    | 12             | 4.7        | 614        | 202         | 10               | -                | 51               | -                | 4.7              | Ub               | 200              | -                | 49               | -                | 77               | -                          | 252    | -  | 614    | -  | 602    | -  | 436    | -  | 126    | -  | 5.3    | -  |
| Indeno[1,2,3-c,d]pyrene     | 193-39-5    | ug/kg | 20                           | -                           | -                     | -                     | 12             | 7.3        | 563        | 206         | 58               | -                | 171              | -                | 7.3              | -                | 246              | -                | 136              | -                | 283              | -                          | 563    | -  | 181    | -  | 142    | -  | 393    | -  | 268    | -  | 18     | -  |
| Naphthalene                 | 91-20-3     | ug/kg | 20                           | 160                         | 2100                  | 160                   | 12             | 2.1        | 463        | 74          | 8.9              | -                | 78               | -                | 2.1              | Jc               | 108              | -                | 94               | -                | 9.2              | -                          | 26     | -  | 61     | -  | 18     | -  | 463    | -  | 20     | -  | 5.0    | Ub |
| Phenanthrene                | 85-01-8     | ug/kg | 20                           | 240                         | 1500                  | 240                   | 12             | 4.6        | 1860       | 665         | 45               | -                | 239              | -                | 4.6              | Jc               | 888              | -                | 213              | -                | 317              | -                          | 952    | -  | 1860   | -  | 1620   | -  | 1300   | -  | 528    | -  | 20     | -  |
| Pyrene                      | 129-00-0    | ug/kg | 20                           | 665                         | 2600                  | 665                   | 12             | 19         | 1480       | 798         | 211              | -                | 1160             | -                | 19               | -                | 1480             | -                | 378              | -                | 644              | -                          | 1430   | -  | 1430   | -  | 865    | -  | 1160   | -  | 752    | -  | 53     | -  |
| PAH (Total) calculated      | 130498-29-2 | ug/kg | 20                           | 4022                        | 44792                 | 4022                  | 12             | 108        | 11220      | 5378        | 948              | -                | 3554             | -                | 108              | -                | 8704             | -                | 2632             | -                | 4783             | -                          | 11220  | -  | 9957   | -  | 7173   | -  | 9643   | -  | 5491   | -  | 317    | -  |
| <b>Pesticides</b>           |             |       |                              |                             |                       |                       |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |
| 4,4'-DDD                    | 72-54-8     | ug/kg | 5 (e)                        | 2                           | 20                    | 1.22                  | 12             | 0.59       | 10         | 3.6         | 0.59             | -                | 9.8              | -                | 0.81             | -                | 10               | -                | 2.4              | -                | 2.5              | -                          | 4.5    | -  | 4.3    | -  | 0.86   | -  | 1.8    | -  | 2.9    | -  | 2.5    | -  |
| 4,4'-DDE                    | 72-55-9     | ug/kg | 5 (e)                        | 2.2                         | 27                    | 2.07                  | 12             | 0.30       | 15         | 5.0         | 0.30             | -                | 3.4              | -                | 0.40             | -                | 9.2              | -                | 5.1              | -                | 8.9              | -                          | 15     | -  | 7.2    | -  | 1.6    | -  | 2.0    | -  | 5.7    | -  | 1.6    | -  |
| 4,4'-DDT                    | 50-29-3     | ug/kg | 5 (e)                        | 1                           | 7                     | 1.19                  | 12             | 0.082      | 9.3        | 1.5         | 0.29             | U                | 0.23             | U                | 0.082            | J                | 9.3              | -                | 2.6              | -                | 0.21             | U                          | 0.21   | U  | 4.7    | -  | 0.23   | U  | 0.18   | U  | 0.21   | U  | 0.18   | U  |
| Aldrin                      | 309-00-2    | ug/kg | 3 (e)                        | -                           | -                     | -                     | 12             | 0.17       | 0.47       | 0.24        | 0.29             | U                | 0.23             | U                | 0.19             | U                | 0.26             | U                | 0.22             | U                | 0.21             | U                          | 0.21   | U  | 0.17   | U  | 0.47   | -  | 0.18   | U  | 0.21   | U  | 0.18   | U  |
| Alpha-BHC                   | 319-84-6    | ug/kg | 3 (e)                        | -                           | -                     | -                     | 12             | 0.17       | 0.48       | 0.24        | 0.29             | U                | 0.23             | U                | 0.19             | U                | 0.26             | U                | 0.22             | U                | 0.21             | U                          | 0.21   | U  | 0.17   | U  | 0.48   | -  | 0.18   | U  | 0.21   | U  | 0.18   | U  |
| Dieldrin                    | 60-57-1     | ug/kg | 5 (e)                        | 0.02                        | 8                     | 0.715 (i)             | 12             | 0.17       | 0.79       | 0.27        | 0.29             | U                | 0.23             | U                | 0.19             | U                | 0.26             | U                | 0.22             | U                | 0.21             | U                          | 0.21   | U  | 0.17   | U  | 0.23   | U  | 0.18   | U  | 0.21   | U  | 0.79   | -  |
| Gamma-BHC (lindane)         | 58-89-9     | ug/kg | 3 (e)                        | -                           | -                     | 0.32 (i)              | 12             | 0.17       | 0.86       | 0.38        | 0.29             | U                | 0.86             | -                |                  |                  |                  |                  |                  |                  |                  |                            |        |    |        |    |        |    |        |    |        |    |        |    |

**Table 6: Sediment Analytical Results, Detections and Exceedances<sup>a</sup>**  
**Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point**  
**Houston Ship Channel, TX**

| Analyte                            | CAS No.          | Units | Target Detection Limit (TDL) | Sediment Screening Criteria |                       |                       | No. of Samples | Sample Min | Sample Max | Sample Mean | HSCNew-NMP-01-SD |           | HSCNew-NMP-02-SD |           | HSCNew-NMP-03-SD |           | HSCNew-NMP-04-SD |           | HSCNew-NMP-05-SD |           | HSCNew-NMP-06-SD |           | HSCNew-NMP-07-SD |           | HSCNew-NMP-08-SD |           | HSCNew-NMP-09-SD |          | HSCNew-NMP-10-SD |          | HSCNew-NMP-11-SD |          | HSCNew-NMP-12-SD |          |
|------------------------------------|------------------|-------|------------------------------|-----------------------------|-----------------------|-----------------------|----------------|------------|------------|-------------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|-----------|------------------|----------|------------------|----------|------------------|----------|------------------|----------|
|                                    |                  |       |                              | NOAA (Marine-ERL) (b)       | NOAA (Marine-ERM) (c) | Region 6 (Marine) (d) |                |            |            |             | 10/6/2018        | 10/6/2018 | 10/5/2018        | 10/5/2018 | 10/4/2018        | 10/4/2018 | 10/3/2019        | 10/3/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 |                  |          |                  |          |                  |          |                  |          |
|                                    |                  |       |                              | 10/6/2018                   | 10/6/2018             | 10/5/2018             |                |            |            |             | 10/5/2018        | 10/4/2018 | 10/4/2018        | 10/3/2019 | 10/3/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 | 10/2/2018        | 10/2/2018 |                  |          |                  |          |                  |          |                  |          |
| Total PCB Congeners calculated (h) | NA               | ug/kg | 1                            | 22.7                        | 180                   | 22.7                  | 12             | 2.7        | 74         | 34          | 7.9              | J         | 49               | -         | 2.7              | J         | 74               | -         | 24               | -         | 47               | -         | 64               | -         | 32               | -         | 14               | -        | 22               | -        | 52               | -        | 15               | -        |
| <b>Dioxins and Furans</b>          |                  |       |                              |                             |                       |                       |                |            |            |             |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |          |                  |          |                  |          |                  |          |
| Total TEQ (j)                      | NA               | pg/g  | -                            | -                           | -                     | -                     | 12             | 2.8        | 1370       | 161         | 28               | -         | 166              | -         | 2.8              | -         | 1370             | -         | 108              | -         | 34               | -         | 76               | -         | 65               | -         | 5.5              | -        | 15               | -        | 8.3              | -        | 54               | -        |
| <b>Metals (k)</b>                  |                  |       |                              |                             |                       |                       |                |            |            |             |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |          |                  |          |                  |          |                  |          |
| Antimony                           | 7440-36-0        | mg/kg | 2.5                          | 2                           | -                     | -                     | 12             | 0.10       | 0.52       | 0.33        | 0.27             | -         | 0.19             | -         | 0.10             | -         | 0.42             | -         | 0.28             | -         | 0.37             | -         | 0.50             | -         | 0.43             | -         | 0.41             | -        | 0.52             | -        | 0.32             | -        | 0.14             | -        |
| Arsenic                            | 7440-38-2        | mg/kg | 0.3 (e)                      | 8.2                         | 70                    | 8.2                   | 12             | 1.9        | 6.2        | 3.62        | 4.1              | -         | 2.6              | -         | 2.1              | -         | 6.2              | -         | 3.9              | -         | 3.6              | -         | 3.0              | -         | 4.5              | -         | 4.9              | -        | 4.1              | -        | 2.6              | -        | 1.9              | -        |
| Barium                             | 7440-39-3        | mg/kg | -                            | -                           | -                     | -                     | 12             | 66         | 263        | 151         | 129              | MB-02, B  | 108              | MB-02, B  | 66               | MB-02, B  | 263              | MB-02, B  | 137              | MB-02, B  | 130              | MB-02, B  | 140              | MB-02, B  | 216              | MB-02, B  | 211              | MB-02, B | 178              | MB-02, B | 124              | MB-02, B | 109              | MB-02, B |
| Beryllium                          | 7440-41-7        | mg/kg | 1 (e)                        | -                           | -                     | -                     | 12             | 0.41       | 1.8        | 0.83        | 0.99             | -         | 0.75             | -         | 0.41             | -         | 1.1              | -         | 0.78             | -         | 0.64             | -         | 0.68             | -         | 0.94             | -         | 1.8              | -        | 0.86             | -        | 0.49             | -        | 0.48             | -        |
| Cadmium                            | 7440-43-9        | mg/kg | 0.1                          | 1.2                         | 9.6                   | 1.2                   | 12             | 0.058      | 2.1        | 0.61        | 0.18             | -         | 0.30             | -         | 0.058            | J         | 2.1              | -         | 0.56             | -         | 0.95             | -         | 0.82             | -         | 0.77             | -         | 0.39             | -        | 0.64             | -        | 0.50             | -        | 0.13             | -        |
| Chromium (total)                   | 7440-47-3        | mg/kg | 1 (e)                        | 81                          | 370                   | 81                    | 12             | 10         | 66         | 28          | 26               | -         | 23               | -         | 10               | -         | 66               | -         | 28               | -         | 32               | -         | 29               | -         | 34               | -         | 31               | -        | 26               | -        | 17               | -        | 12               | -        |
| Chromium (3+)                      | 7440-47-3 (III)  | mg/kg | 1                            | -                           | -                     | -                     | 12             | 10         | 66         | 28          | 26               | -         | 23               | -         | 10               | -         | 66               | -         | 28               | -         | 32               | -         | 29               | -         | 34               | -         | 31               | -        | 26               | -        | 17               | -        | 12               | -        |
| Chromium (6+)                      | 7440-47-3 (Cr6+) | mg/kg | 1                            | -                           | -                     | -                     | 12             | 0.014      | 0.022      | 0.018       | 0.022            | J         | 0.020            | J         | 0.022            | J         | 0.020            | J         | 0.014            | J         | 0.020            | J         | 0.016            | J         | 0.015            | J         | 0.018            | J        | 0.015            | J        | 0.019            | J        | 0.020            | J        |
| Copper                             | 7440-50-8        | mg/kg | 1 (e)                        | 34                          | 270                   | 34                    | 12             | 4.6        | 40         | 19          | 14               | -         | 11               | -         | 4.6              | -         | 40               | -         | 19               | -         | 23               | -         | 27               | -         | 25               | -         | 19               | -        | 25               | -        | 14               | -        | 7.0              | -        |
| Lead                               | 7439-92-1        | mg/kg | 0.3 (e)                      | 46.7                        | 218                   | 46.7                  | 12             | 8.4        | 81         | 39          | 25               | -         | 32               | -         | 8.4              | -         | 81               | -         | 32               | -         | 48               | -         | 70               | -         | 60               | -         | 26               | -        | 38               | -        | 33               | -        | 16               | -        |
| Mercury                            | 7439-97-6        | mg/kg | 0.2                          | 0.15                        | 0.71                  | 0.15                  | 12             | 0.012      | 0.41       | 0.15        | 0.20             | -         | 0.40             | -         | 0.012            | -         | 0.41             | -         | 0.082            | -         | 0.12             | -         | 0.22             | -         | 0.16             | -         | 0.048            | -        | 0.11             | -        | 0.063            | -        | 0.026            | -        |
| Nickel                             | 7440-02-0        | mg/kg | 0.5 (e)                      | 20.9                        | 51.6                  | 20.9                  | 12             | 7.0        | 26         | 15          | 15               | -         | 14               | -         | 7.9              | -         | 26               | -         | 14               | -         | 15               | -         | 11               | -         | 19               | -         | 22               | -        | 15               | -        | 11               | -        | 7.0              | -        |
| Selenium                           | 7782-49-2        | mg/kg | 0.5 (e)                      | -                           | -                     | -                     | 12             | 2.2        | 11         | 3.9         | 3.9              | -         | 3.6              | -         | 2.8              | -         | 4.7              | -         | 3.3              | -         | 3.4              | -         | 2.4              | -         | 3.3              | -         | 11               | -        | 3.4              | -        | 2.2              | -        | 2.8              | -        |
| Silver                             | 7440-22-4        | mg/kg | 0.2                          | 1                           | 3.7                   | 1                     | 12             | 0.049      | 0.82       | 0.42        | 0.23             | B         | 0.14             | B         | 0.049            | J, B      | 0.70             | B         | 0.40             | B         | 0.77             | B         | 0.82             | B         | 0.62             | B         | 0.32             | B        | 0.53             | B        | 0.36             | B        | 0.11             | B        |
| Thallium                           | 7440-28-0        | mg/kg | 0.2                          | -                           | -                     | -                     | 12             | 0.100      | 0.34       | 0.18        | 0.23             | -         | 0.17             | -         | 0.10             | -         | 0.34             | -         | 0.17             | -         | 0.15             | -         | 0.15             | -         | 0.21             | -         | 0.24             | -        | 0.17             | -        | 0.11             | -        | 0.10             | -        |
| Zinc                               | 7440-66-6        | mg/kg | 2 (e)                        | 150                         | 410                   | 150                   | 12             | 20         | 237        | 107         | 90               | -         | 59               | -         | 20               | -         | 237              | -         | 99               | -         | 122              | -         | 168              | -         | 133              | -         | 96               | -        | 139              | -        | 91               | -        | 36               | -        |
| <b>Miscellaneous Parameters</b>    |                  |       |                              |                             |                       |                       |                |            |            |             |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |          |                  |          |                  |          |                  |          |
| Acid Volatile Sulfide              | NA               | mg/kg | 0.1                          | -                           | -                     | -                     | 12             | 27         | 1130       | 320         | 169              | -         | 567              | -         | 27               | -         | 1130             | -         | 486              | -         | 235              | -         | 485              | -         | 311              | -         | 48               | -        | 188              | -        | 161              | -        | 27               | -        |
| Volatile Solids                    | NA               | mg/kg | 10000                        | -                           | -                     | -                     | 12             | 10600      | 62600      | 39050       | 35800            | -         | 29600            | -         | 10600            | -         | 62600            | -         | 39300            | -         | 41800            | -         | 45200            | -         | 56800            | -         | 50500            | -        | 46300            | -        | 32500            | -        | 17600            | -        |
| % Moisture                         | NA               | %     | -                            | -                           | -                     | -                     | 12             | 19         | 50         | 33          | 50               | -         | 35               | -         | 19               | -         | 45               | -         | 35               | -         | 33               | -         | 32               | -         | 31               | -         | 31               | -        | 34               | -        | 28               | -        | 20               | -        |
| % Solids                           | NA               | %     | 0.10%                        | -                           | -                     | -                     | 12             | 50         | 81         | 67          | 50               | -         | 65               | -         | 81               | -         | 55               | -         | 66               | -         | 68               | -         | 68               | -         | 69               | -         | 69               | -        | 66               | -        | 72               | -        | 80               | -        |
| TOC Min                            | NA               | %     | -                            | -                           | -                     | -                     | 12             | 0.12       | 0.55       | 0.34        | 0.34             | Ua        | 0.27             | -         | 0.12             | -         | 0.50             | -         | 0.36             | -         | 0.26             | -         | 0.44             | -         | 0.33             | -         | 0.34             | -        | 0.55             | -        | 0.38             | -        | 0.20             | -        |
| TOC Max                            | NA               | %     | -                            | -                           | -                     | -                     | 12             | 0.23       | 0.70       | 0.43        | 0.58             | -         | 0.31             | -         | 0.24             | -         | 0.56             | -         | 0.41             | -         | 0.38             | -         | 0.56             | -         | 0.40             | -         | 0.42             | -        | 0.70             | -        | 0.41             | -        | 0.23             | -        |
| TOC Mean                           | NA               | %     | 0.10%                        | -                           | -                     | -                     | 12             | 0.15       | 0.61       | 0.38        | 0.47             | -         | 0.30             | -         | 0.15             | -         | 0.54             | -         | 0.39             | -         | 0.31             | -         | 0.49             | -         | 0.37             | -         | 0.38             | -        | 0.61             | -        | 0.41             | -        | 0.22             | -        |
| Ammonia as N, filtered             | 7664-41-7        | mg/kg | 0.1                          | -                           | -                     | -                     | 12             | 13         | 235        | 124         | 123              | B         | 114              | B         | 13               | B         | 139              | B         | 117              | B         | 149              | B         | 235              | B         | 165              | B         | 110              | B        | 170              | B        | 133              | B        | 22               | B        |
| <b>Petroleum Hydrocarbons</b>      |                  |       |                              |                             |                       |                       |                |            |            |             |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |           |                  |          |                  |          |                  |          |                  |          |
| >C12-C28                           | NA               | mg/kg | -                            | -                           | -                     | -                     | 12             | 7.3        | 870        | 168.2       | 30               | Ja        | 250              | -         | 8.3              | Ja        | 870              | -         | 7.3              | Ja        | 150              | -         | 77               | -         | 130              | -         | 310              | -        | 42               | Bb       | 44               | Bb       | 100              | -        |
| >C28-C35                           | NA               | mg/kg | -                            | -                           | -                     | -                     | 12             | 11         | 140        | 49.1        | 19               | Ja        | 46               | Ja        | 11               | Ja        | 140              | -         | 12               | Ja        | 81               | Bb        | 49               | Bb        | 44               | Bb        | 100              | -        | 33               | Ja       | 26               | Ja       | 28               | Ja       |
| C6-C12                             | NA               | mg/kg | -                            | -                           | -                     | -                     | 12             | 7.3        | 94         | 22.9        | 19               | Ja        | 41               | Ja        | 7.8              | Ja        | 94               | -         | 7.3              | Ja        | 15               | Ja        | 12               | Ja        | 17               | Ja        | 23               | Ja       | 12               | Ja       | 11               | Ja       | 16               | Ja       |
| C6-C35                             | NA               | mg/kg | -                            | -                           | -                     | -                     | 12             | 24         | 1100       | 237         | 62               | Ja        | 340              | -         | 24               | Ja        | 1100             | -         | 24               | Ja        | 240              | -         | 140              | Bb        | 190              | -         | 430              | -        | 84               | Bb       | 71               | Bb       | 140              | Bb       |

**FOOTNOTES- lowercase footnotes were created by the table generator**

- a) The primary sources for this table were: TDLs - EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. USEPA/USACE, Regional Implementation Agreement, July 2003; US EPA SW-846 <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>;
- b) NOAA - <http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html>
- c) These values are based on recommendations from the EPA Region 6 Laboratory in Houston; these values were based on data or other technical basis;
- d) Region 6 screening benchmarks come from TCEQ's ecological benchmarks for sediment, <http://www.tceq.state.tx.us/assets/public/remediation/eco/0106eragupdate.pdf>; unless otherwise noted, benchmarks are Effects Range Low (ERL) from: Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environ. Manage. 19(1):81-97; see footnote (i)
- e) These values are based on recommendations from the EPA Region 6 Laboratory in Houston; these values were based on data or other technical basis;
- g) PAHs methylanthalene and 2-methylnaphthalene were not analyzed for by the laboratory
- h) Total PCBs for Region 6 from "Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263 (revised) January 2006; Total PCBs for NOAA from Squirt Table for Organics in Sediment
- i) Threshold Effects Level (TEL) from: Smith, S.L., D.D. MacDonald, K.A. Keenleyside, and C.L. Gaudet. 1996b. The Development and Implementation of Canadian Sediment Quality Guidelines. In: Development and Progress in Sediment Quality Assessment: Rationale, Challenges, Techniques & Strategies. Ecovision World Monograph Series. Munawar & Dave (Eds.). Academic Publishing, Amsterdam, The Netherlands.
- j) Total TEQ was calculated using 2005 WHO TEF values from Van den Berg et al; 2006 (doi:10.1093/toxsci/kfi055) and [https://clu-in.org/download/contaminantfocus/dioxins/Dioxin\\_TEFs\\_for\\_TEQs.pdf](https://clu-in.org/download/contaminantfocus/dioxins/Dioxin_TEFs_for_TEQs.pdf). Total TEQ was calculated by summing all non-U qualified data.
- k) Samples for metals analysis were diluted 4X for antimony, arsenic, barium, beryllium, cadmium, chromium (total), copper, lead, nickel, selenium, silver, 1X for chromium (3+) and chromium (+6), 2X for zinc and mercury

**Laboratory Qualifier**

- B Analyte is found in the associated blank as well as in the sample.
- Bb Indicates the analyte was detected in the laboratory method blank analyzed concurrently with the sample.
- J Detected but below the Reporting Limit (Limit of Quantitation); therefore, result is an estimated concentration.
- Ja Estimated value. This analyte was detected in the sample at a concentration less than the laboratory Limit of Quantitation, but above the Method Detection Limit.
- Jc Estimated value less than RL
- MB-02 The method blank contains the analyte at a concentration above the MRL due to memory interferences.
- U Analyte included in the analysis, but not detected
- Ua Analyte included in the analysis, but not detected at or above the Reporting Limit
- Ub Compound was analyzed for but was not detected (non-detect)
- Uc Undetected at the limit of quantitation.

**Samples with Detections are BOLD**

One or more sample concentrations exceed criteria

Sample concentration exceeds criteria

**Table 7: Modified Elutriate Testing Analytical Results, Detections and Exceedances<sup>a</sup>**  
**Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point**  
**Houston Ship Channel, TX**

| Analyte                            | CAS No.     | Units | Target Detection Limit (TDL) | Marine Water Screening Criteria |                     |                         |                               | No. of Samples | Sample Min | Sample Max | Sample Mean | HSCNew-NMP-01-EL | HSCNew-NMP-02-EL | HSCNew-NMP-03-EL | HSCNew-NMP-04-EL | HSCNew-NMP-05-EL | HSCNew-NMP-06-EL | HSCNew-NMP-07-EL | HSCNew-NMP-08-EL | HSCNew-NMP-09-EL | HSCNew-NMP-10-EL | HSCNew-NMP-11-EL | HSCNew-NMP-03-EL-Field Dup |            |            |            |            |            |
|------------------------------------|-------------|-------|------------------------------|---------------------------------|---------------------|-------------------------|-------------------------------|----------------|------------|------------|-------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------------------|------------|------------|------------|------------|------------|
|                                    |             |       |                              | TSWQS (Acute) (b)               | EPA WQC (Acute) (c) | NOAA (Marine Acute) (p) | Region 6 (Marine Chronic) (q) |                |            |            |             | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018                 | 10/29/2018 | 10/29/2018 | 10/29/2018 | 10/29/2018 | 10/29/2018 |
|                                    |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| <b>VOCS</b>                        |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| 1,3-Dichlorobenzene                | 541-73-1    | ug/L  | 0.9                          | -                               | -                   | 1970                    | 142                           | 12             | 0.47       | 0.90       | 0.86        | 0.90             | Ua               | 0.90             | Ua               | 0.90             | Ua               | 0.90             | Ua               | 0.90             | Ua               | 0.90             | Ua                         |            |            |            |            |            |
| 2-Butanone                         | 78-93-3     | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 3.2        | 10         | 7.1         | 10               | Ua               | 10               | Ua               | 10               | Ua               | 5.1              | Jc               | 3.5              | Jc               | 3.3              | Jc                         |            |            |            |            |            |
| Acetone                            | 67-64-1     | ug/L  | -                            | -                               | -                   | 282000                  | -                             | 12             | 10         | 74         | 42          | 33               | -                | 19               | -                | 10               | Ua               | 49               | -                | 74               | -                | 42               | -                          |            |            |            |            |            |
| Benzene                            | 71-43-2     | ug/L  | 2                            | -                               | -                   | 5100                    | 109                           | 12             | 0.47       | 1.0        | 1.0         | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 0.47             | Jc               | 1.0              | Ua               | 1.0              | Ua                         |            |            |            |            |            |
| Chloroform                         | 67-66-3     | ug/L  | 2                            | -                               | -                   | 4100                    | 12                            | 0.50           | 0.50       | 0.50       | 0.50        | Ua               | 0.50             | Ua               | 0.50             | Ua               | 0.50             | Ua               | 0.50             | Ua               | 0.50             | Ua               | 0.50                       |            |            |            |            |            |
| Chloromethane                      | 74-87-3     | ug/L  | -                            | -                               | -                   | 13500                   | -                             | 12             | 1.0        | 3.4        | 1.6         | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 3.4              | -                          |            |            |            |            |            |
| Methylcyclohexane                  | 108-87-2    | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 1.0        | 1.2        | 1.0         | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 1.2              | -                          |            |            |            |            |            |
| Methylene chloride                 | 75-09-2     | ug/L  | -                            | -                               | -                   | 5420                    | -                             | 12             | 4.0        | 16         | 8.3         | 4.6              | -                | 4.0              | Jc               | 4.0              | Jc               | 4.0              | -                | 8.8              | -                | 14               | -                          |            |            |            |            |            |
| o-Xylene                           | 95-47-6     | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 0.43       | 2.0        | 1.0         | 1.0              | Ua               | 1.0              | Ua               | 1.0              | Ua               | 0.92             | Jc               | 1.0              | Ua               | 1.0              | Ua                         |            |            |            |            |            |
| m&p-Xylene                         | 179601-23-1 | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 0.90       | 2.0        | 1.8         | 2.0              | Ua               | 2.0              | Ua               | 2.0              | Ua               | 0.98             | Jc               | 2.0              | Ua               | 2.0              | Ua                         |            |            |            |            |            |
| <b>SVOCS</b>                       |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| 1,3-Dichlorobenzene                | 541-73-1    | ug/L  | 0.9 (g)                      | -                               | -                   | 1970                    | 142                           | 12             | 0.10       | 0.52       | 0.44        | 0.50             | Ub               | 0.10             | Jb               | 0.50             | Ub               | 0.15             | Jb               | 0.50             | Ub               | 0.52             | Ub                         |            |            |            |            |            |
| Bis[2-ethylhexyl] Phthalate        | 117-81-7    | ug/L  | 2 (g)                        | -                               | -                   | 400                     | -                             | 12             | 0.10       | 1.7        | 0.27        | 0.17             | Jb               | 0.10             | Jb               | 0.10             | Jb               | 0.15             | Jb               | 0.19             | Jb               | 1.7              | -                          |            |            |            |            |            |
| Di-n-butyl Phthalate               | 84-74-2     | ug/L  | 1 (g)                        | -                               | -                   | 2944                    | NA                            | 12             | 0.15       | 0.68       | 0.28        | 0.68             | -                | 0.22             | Jb               | 0.36             | Jb               | 0.15             | Jb               | 0.21             | Jb               | 0.22             | Jb                         |            |            |            |            |            |
| Hexachlorobutadiene                | 87-68-3     | ug/L  | 0.9 (g)                      | -                               | -                   | 32                      | 0.32                          | 12             | 0.47       | 0.52       | 0.50        | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.52             | Ub                         |            |            |            |            |            |
| Hexachlorocyclopentadiene          | 77-47-4     | ug/L  | 3.0 (g)                      | -                               | -                   | 7                       | 0.07                          | 12             | 0.47       | 0.52       | 0.50        | 0.50             | Ub               | 0.51             | Ub               | 0.50             | Ub               | 0.52             | Ub               | 0.50             | Ub               | 0.51             | Ub                         |            |            |            |            |            |
| <b>PAHs (d)</b>                    |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Acenaphthene                       | 83-32-9     | ug/L  | 0.75 (g)                     | -                               | -                   | 970                     | 40.4                          | 12             | 0.0099     | 5.9        | 0.85        | 0.061            | -                | 0.59             | -                | 0.0099           | -                | 0.68             | -                | 0.18             | -                | 0.060            | -                          |            |            |            |            |            |
| Acenaphthylene                     | 208-96-8    | ug/L  | 1.0 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0033     | 0.087      | 0.021       | 0.0033           | Jb               | 0.087            | -                | 0.0094           | Ub               | 0.024            | -                | 0.012            | -                | 0.0066           | Jb                         |            |            |            |            |            |
| Anthracene                         | 120-12-7    | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | 0.18                          | 12             | 0.0045     | 0.85       | 0.17        | 0.011            | -                | 0.079            | -                | 0.0045           | Jb               | 0.62             | -                | 0.037            | -                | 0.013            | -                          |            |            |            |            |            |
| Benzo(a)anthracene                 | 56-55-3     | ug/L  | 0.4 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0022     | 0.029      | 0.014       | 0.0022           | Jb               | 0.0062           | Jb               | 0.0094           | Ub               | 0.021            | -                | 0.0091           | Jb               | 0.013            | -                          |            |            |            |            |            |
| Benzo(a)pyrene                     | 50-32-8     | ug/L  | 0.3 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0012     | 0.010      | 0.0043      | 0.0012           | Jb               | 0.0019           | Jb               | 0.0094           | Ub               | 0.0044           | Jb               | 0.0028           | Jb               | 0.0036           | Jb                         |            |            |            |            |            |
| Benzo(b)fluoranthene               | 205-99-2    | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0027     | 0.010      | 0.0059      | 0.0027           | Ub               | 0.010            | Ub               | 0.0094           | Ub               | 0.0041           | Jb               | 0.0030           | Jb               | 0.0045           | Jb                         |            |            |            |            |            |
| Benzo(e)pyrene                     | 192-97-2    | ug/L  | -                            | -                               | -                   | 300                     | -                             | 12             | 0.0018     | 0.010      | 0.0047      | 0.0018           | Jb               | 0.0020           | Jb               | 0.0094           | Ub               | 0.0051           | Jb               | 0.0035           | Jb               | 0.0046           | Jb                         |            |            |            |            |            |
| Benzo(g,h,i)perylene               | 191-24-2    | ug/L  | 1.2 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0017     | 0.010      | 0.0055      | 0.0017           | Jb               | 0.0024           | Jb               | 0.0094           | Ub               | 0.0026           | Jb               | 0.0021           | Jb               | 0.0024           | Jb                         |            |            |            |            |            |
| Benzo(k)fluoranthene               | 207-08-9    | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0018     | 0.010      | 0.0050      | 0.0018           | Ub               | 0.010            | Ub               | 0.0094           | Ub               | 0.0021           | Jb               | 0.0022           | Jb               | 0.0024           | Jb                         |            |            |            |            |            |
| Chrysene                           | 218-01-9    | ug/L  | 0.3 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0014     | 0.026      | 0.014       | 0.0029           | Jb               | 0.0075           | Jb               | 0.0014           | Jb               | 0.022            | -                | 0.012            | -                | 0.026            | -                          |            |            |            |            |            |
| Dibenzo(a,h)anthracene             | 53-70-3     | ug/L  | 1.3 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.00076    | 0.010      | 0.0092      | 0.00076          | Ub               | 0.010            | Ub               | 0.0094           | Ub               | 0.010            | Ub               | 0.0099           | Ub               | 0.010            | Ub                         |            |            |            |            |            |
| Fluoranthene                       | 206-44-0    | ug/L  | 0.9 (g)                      | -                               | -                   | 40                      | 2.96                          | 12             | 0.017      | 0.61       | 0.21        | 0.021            | -                | 0.26             | -                | 0.017            | -                | 0.48             | -                | 0.085            | -                | 0.12             | -                          |            |            |            |            |            |
| Fluorene                           | 86-73-7     | ug/L  | 0.6 (g)                      | -                               | -                   | 300                     | 50                            | 12             | 0.0060     | 3.8        | 0.60        | 0.035            | -                | 0.30             | -                | 0.0060           | Jb               | 0.53             | -                | 0.15             | -                | 0.023            | -                          |            |            |            |            |            |
| Indeno[1,2,3-c,d]pyrene            | 193-39-5    | ug/L  | 1.2 (g)                      | -                               | -                   | 300                     | -                             | 12             | 0.0052     | 0.0077     | 0.0063      | 0.0052           | Jb               | 0.0060           | Jb               | 0.0052           | Jb               | 0.0064           | Jb               | 0.0068           | Jb               | 0.0070           | Jb                         |            |            |            |            |            |
| Naphthalene                        | 91-20-3     | ug/L  | 0.8 (g)                      | -                               | -                   | 250                     | 4.6                           | 12             | 0.0029     | 0.52       | 0.072       | 0.0065           | Jb               | 0.52             | -                | 0.0058           | Jb               | 0.010            | Jb               | 0.0094           | Jb               | 0.0059           | Jb                         |            |            |            |            |            |
| Phenanthrene                       | 85-01-8     | ug/L  | 0.5 (g)                      | 7.7                             | -                   | 7.7                     | 4.6                           | 12             | 0.0050     | 3.8        | 0.67        | 0.036            | -                | 0.46             | -                | 0.0067           | Jb               | 0.91             | -                | 0.20             | -                | 0.0050           | Jb                         |            |            |            |            |            |
| Pyrene                             | 129-00-0    | ug/L  | 1.5 (g)                      | -                               | -                   | 300                     | 0.24                          | 12             | 0.017      | 0.33       | 0.14        | 0.023            | -                | 0.33             | -                | 0.017            | -                | 0.20             | -                | 0.067            | -                | 0.092            | -                          |            |            |            |            |            |
| PAHs (Total) calculated (e)        | 130498-29-2 | ug/L  | -                            | -                               | -                   | -                       | 0.24                          | 12             | 0.073      | 16         | 2.8         | 0.21             | -                | 2.7              | -                | 0.073            | J                | 2.8              | -                | 0.77             | -                | 0.38             | -                          |            |            |            |            |            |
| <b>Pesticides</b>                  |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| 4,4'-DDT                           | 50-29-3     | ug/L  | 0.1                          | 0.13                            | 0.13 (G, ii)        | 0.065                   | 0.001                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Dieldrin                           | 60-57-1     | ug/L  | 0.03                         | 0.71                            | 0.71 (G)            | 0.355                   | 0.002                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Endrin                             | 72-20-8     | ug/L  | 0.1                          | 0.037                           | 0.037 (G)           | 0.0185                  | 0.002                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Endrin Aldehyde                    | 7421-93-4   | ug/L  | 0.1                          | 0.037 (G)                       | 0.037 (G)           | 0.0185                  | 0.002                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Heptachlor                         | 76-44-8     | ug/L  | 0.1                          | 0.053                           | 0.053 (G)           | 0.0265                  | 0.004                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Heptachlor Epoxide                 | 1024-57-3   | ug/L  | 0.1                          | 0.053 (G)                       | 0.053 (G)           | 0.0265                  | 0.004                         | 12             | 0.0060     | 0.0060     | 0.0060      | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                | 0.0060           | U                          |            |            |            |            |            |
| Toxaphene                          | 8001-35-2   | ug/L  | 0.5                          | 0.21                            | 0.21                | 0.0265                  | 0.0002                        | 12             | 0.30       | 0.30       | 0.30        | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                | 0.30             | U                          |            |            |            |            |            |
| <b>PCBs</b>                        |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| PCB 153                            | 35065-27-1  | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 0.0020     | 0.0060     | 0.0057      | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U                 |            |            |            |            |            |
| PCB 52                             | 35693-99-3  | ug/L  | -                            | -                               | -                   | -                       | -                             | 12             | 0.0040     | 0.0060     | 0.0058      | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U       | 0.0060           | H, Z-03, U                 |            |            |            |            |            |
| Total PCB Congeners calculated (f) | NA          | ug/L  | 0.01                         | -                               | -                   | 0.033                   | -                             | 12             | 0          | 0.006      | 0.0005      | 0                | H, Z-03, U       | 0                | H, Z-03, U       | 0                | H, Z-03, U       | 0                | H, Z-03, U       | 0                | H, Z-03, U       | 0                | H, Z-03, U                 |            |            |            |            |            |
| <b>Dioxins and Furans</b>          |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Total TEQ (j)                      | NA          | -     | -                            | -                               | -                   | -                       | -                             | 12             | 0          | 10         | 1.5         | 0.062            | j                | 0.52             | j                | 0                | -                | 10               | j                | 0.42             | j                | 0                | j                          |            |            |            |            |            |
| <b>Metals (l, m)</b>               |             |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |
| Antimony                           | 7440-36-0   | ug/L  | 3 (0.03) (h)                 | -                               | -                   | 1500                    | 500                           | 12             | 1.1        | 5.7        | 3.0         | 5.7              | -                | 3.4              | J                | 1.1              | J                | 3.7              | J                | 2.6              | J                | 2.7              | J                          |            |            |            |            |            |
| Arsenic                            | 7440-38-2   | ug/L  | 1 (0.011) (h)                | 149                             | 69 (A, D)           | 69                      | 78                            | 12             | 1.7        | 5.1        | 2.7         | 5.1              | -                | 1.7              | J                | 2.7              | J                | 4.1              | J                | 2.2              | J                | 2.8              | J                          |            |            |            |            |            |
| Barium                             | 7440-39-3   | ug/L  | -                            | -                               | -                   | 1000                    | -                             | 12             | 161        | 951        | 322         | 265              | -                | 167              | -                | 215              | -                | 189              | -                | 189              | -                | 186              | -                          |            |            |            |            |            |
| Beryllium                          | 7440-41-7   | ug/L  | 0.2                          | -                               | -                   | 1500                    | -                             | 12             | 0.20       | 5.0        | 3.8         | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Copper                             | 7440-50-8   | ug/L  | 1 (0.1) (h)                  | 13.5                            | 4.8 (D, cc)         | 4.8                     | 3.6                           | 12             | 0.60       | 5.0        | 4.0         | 5.0              | U                | 5.0              | U                | 5.0              | U                | 1.5              | J                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Lead                               | 7439-92-1   | ug/L  | 1 (0.03) (h)                 | 133                             | 210 (D)             | 210                     | 5.3                           | 12             | 5.0        | 16         | 5.9         | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                | 5.0              | U                          |            |            |            |            |            |
| Mercury                            | 7439-97-6   | ug/L  | 0.2 (0                       |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |            |            |            |            |            |

**Table 7: Modified Elutriate Testing Analytical Results, Detections and Exceedances<sup>a</sup>**  
**Houston Ship Channel Expansion Channel Improvement Project (HSC ECIP), North of Morgan's Point**  
**Houston Ship Channel, TX**

| Analyte                | CAS No.    | Units | Target Detection Limit (TDL) | Marine Water Screening Criteria |                     |                         |                               | No. of Samples | Sample Min | Sample Max | Sample Mean | HSCNew-NMP-01-EL | HSCNew-NMP-02-EL | HSCNew-NMP-03-EL | HSCNew-NMP-04-EL | HSCNew-NMP-05-EL | HSCNew-NMP-06-EL | HSCNew-NMP-07-EL | HSCNew-NMP-08-EL | HSCNew-NMP-09-EL | HSCNew-NMP-10-EL | HSCNew-NMP-11-EL | HSCNew-NMP-03-EL-Field Dup |               |            |               |            |               |            |               |   |               |   |               |   |
|------------------------|------------|-------|------------------------------|---------------------------------|---------------------|-------------------------|-------------------------------|----------------|------------|------------|-------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|----------------------------|---------------|------------|---------------|------------|---------------|------------|---------------|---|---------------|---|---------------|---|
|                        |            |       |                              | TSWQS (Acute) (b)               | EPA WQC (Acute) (o) | NOAA (Marine Acute) (p) | Region 6 (Marine Chronic) (q) |                |            |            |             | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018       | 10/29/2018                 | 10/29/2018    | 10/29/2018 | 10/29/2018    | 10/29/2018 | 10/29/2018    | 10/29/2018 |               |   |               |   |               |   |
|                        |            |       |                              |                                 |                     |                         |                               |                |            |            |             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                            |               |            |               |            |               |            |               |   |               |   |               |   |
| Total Suspended Solids | NA         | ug/L  | NA                           | -                               | -                   | -                       | -                             | 12             | 5710       | 43000      | 16784       | <b>22500</b>     | -                | <b>8000</b>      | -                | <b>10600</b>     | -                | <b>43000</b>     | -                | <b>23000</b>     | -                | <b>12800</b>     | -                          | <b>13300</b>  | -          | <b>10000</b>  | -          | <b>19500</b>  | -          | <b>19000</b>  | - | <b>5710</b>   | - | <b>14000</b>  | - |
| TOC rep1               | NA         | %     | -                            | -                               | -                   | -                       | -                             | 12             | 0.0038     | 0.010      | 0.0085      | 0.010            | U                | 0.010            | U                | 0.010            | U                | <b>0.0042</b>    | J                | 0.010            | U                | 0.010            | U                          | <b>0.0038</b> | J          | 0.010         | U          | 0.010         | U          | 0.010         | U | <b>0.0043</b> | J | 0.010         | U |
| TOC rep2               | NA         | %     | -                            | -                               | -                   | -                       | -                             | 12             | 0.0036     | 0.010      | 0.0079      | <b>0.0036</b>    | J                | 0.010            | U                | 0.010            | U                | <b>0.0038</b>    | J                | 0.010            | U                | 0.010            | U                          | <b>0.0036</b> | J          | 0.010         | U          | 0.010         | U          | 0.010         | U | <b>0.0037</b> | J | 0.010         | U |
| TOC rep3               | NA         | %     | -                            | -                               | -                   | -                       | -                             | 12             | 0.0036     | 0.010      | 0.0067      | <b>0.0058</b>    | J                | 0.010            | U                | <b>0.0036</b>    | J                | <b>0.0045</b>    | J                | 0.010            | U                | 0.010            | U                          | <b>0.0044</b> | J          | 0.010         | U          | <b>0.0037</b> | J          | <b>0.0037</b> | J | <b>0.0041</b> | J | 0.010         | U |
| TOC rep4               | NA         | %     | -                            | -                               | -                   | -                       | -                             | 12             | 0.0036     | 0.010      | 0.0045      | <b>0.0045</b>    | J                | <b>0.0036</b>    | J                | <b>0.0038</b>    | J                | <b>0.0047</b>    | J                | <b>0.0042</b>    | J                | 0.010            | U                          | <b>0.0038</b> | J          | <b>0.0038</b> | J          | <b>0.0040</b> | J          | <b>0.0041</b> | J | <b>0.0042</b> | J | <b>0.0036</b> | J |
| Total Organic Carbon   | NA         | %     | 0.1                          | -                               | -                   | -                       | -                             | 12             | 0.0035     | 0.010      | 0.0070      | <b>0.0043</b>    | J                | 0.010            | U                | 0.010            | U                | <b>0.0043</b>    | J                | 0.010            | U                | 0.010            | U                          | <b>0.0039</b> | J          | <b>0.0035</b> | J          | <b>0.0036</b> | J          | 0.010         | U | <b>0.0041</b> | J | 0.010         | U |
| Ammonia as N, filtered | 7664-41-7  | ug/L  | 30                           | -                               | -                   | -                       | -                             | 12             | 1530       | 27800      | 13599       | <b>21400</b>     | -                | <b>8590</b>      | -                | <b>1530</b>      | -                | <b>17200</b>     | -                | <b>13300</b>     | -                | <b>14100</b>     | -                          | <b>27800</b>  | -          | <b>14000</b>  | -          | <b>10600</b>  | -          | <b>15900</b>  | - | <b>15800</b>  | - | <b>2970</b>   | - |
| Sulfide                | 184-96-258 | ug/L  | 1                            | -                               | -                   | -                       | -                             | 12             | 3.0        | 10         | 9.0         | 10               | U                | 10               | U                | 10               | U                | <b>4.4</b>       | J                | 10               | U                | 10               | U                          | <b>3.0</b>    | J          | 10            | U          | 10            | U          | 10            | U | 10            | U | 10            | U |

**FOOTNOTES- lowercase footnotes were created by the table generator**

- a) The primary sources for this table were: TDLs - EPA 823-B-95-001, QA/QC Guidance for Sampling and Analysis of Sediments, Water and Tissues for Dredged Material Evaluations. USEPA/USACE, Regional Implementation Agreement, July 2003; US EPA SW-846 <http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm>;
- b) TSWQS Rule 307.6- (2014) <https://www.tceq.texas.gov/waterquality/standards>; \*\*NOTE\*\*2018 TSWQSs were adopted by the commission on February 7, 2018, these Standards are effective for all state permits; however, until approved by USEPA, the 2014 Standards apply to federal permits.
- c) Azobenzene is reported by the laboratory instead of 1,2-diphenylhydrazine. 1,2-diphenylhydrazine is rapidly oxidized into azobenzene during analysis.
- d) PAHs methyl-naphthalene and 2-methyl-naphthalene were not analyzed for by the laboratory
- e) PAHs did not have any elevated RL. PAH (total) calculated was determined by summing all non-U qualified data.
- f) Total PCBs were not calculated since all analytes were nondetect, U qualified, and there were no elevated RL. Except for Sample HSCNew-NMP-011-EL which had detected concentrations of PCBs and were
- g) These values are based on recommendations from the EPA Region 6 laboratory in Houston; these values were based on data or other technical basis;
- h) The values in parentheses are based on EPA "clean techniques", (EPA 1600 series methods) which are applicable in instances where other TDLs are inadequate to assess EPA water quality criteria;
- i) This value recommended by Houston lab using colorimetric method. This value is based upon FREE cyanide, not complexed as the method is designed to analyze for. If free cyanide is expected, consult the laboratory as to the best method for quantifying free cyanide;

j) Total TEQ was calculated using 2005 WHO TEF values from Van den Berg et al.; 2006 (doi:10.1093/toxsci/kfl055) and [https://clu-in.org/download/contaminantfocus/dioxins/Dioxin\\_TEFs\\_for\\_TEQs.pdf](https://clu-in.org/download/contaminantfocus/dioxins/Dioxin_TEFs_for_TEQs.pdf). Total TEQ was calculated by summing all non-U qualified data. Total TEQ does not include J qualified result for Total Hepta CDD, Total Hepta CDF, Total Tetra CDD, and Total Tetra CDF since there is no reported TEF for Total Hepta CDD, Total Hepta CDF, Total Tetra CDD, and Total Tetra CDF.

- l) Metals are expressed as Dissolved values in water samples, except for mercury and selenium, which shall be reported as Total Recoverable Concentrations;
- m) Samples for metals analysis were diluted 10X for antimony, arsenic, barium, beryllium, cadmium, chromium (total), copper, lead, nickel, selenium, silver, thallium and zinc, 1X for chromium (3+), 2X for chromium (6+) and mercury
- n) 6010/6020 are not suitable Methods for Cr+6. If Cr+6 is suspected from past dredging history or industrial landuse in the vicinity, US EPA SW-846 Method 7199 (modified);
- o) EPA WQC- <http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>; see EPA footnote section below for individual EPA value footnotes
- p) NOAA- <http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html>
- q) Region 6 screening benchmarks come from TCEQ's ecological benchmarks for water, <http://www.tceq.state.tx.us/assets/public/remediation/eco/0106eragupdate.pdf>; these values are equivalent

**EPA WQC footnotes- uppercase and double-lettered footnotes are directly from the NRWQC footnotes; only footnotes for constituents of concern are retained in this table**

- A) This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive. Please consult the criteria document for details.
- D) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.
- G) This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (PDF) (153 pp, 7.3MB) (EPA 440/5-80-019), Chlordane (PDF) (68 pp, 3.1MB) (EPA 440/5-80-027), DDT (PDF) (175 pp, 8.3MB) (EPA 440/5-80-038), Endosulfan (PDF) (155 pp, 7.3MB) (EPA 440/5-80-046), Endrin (PDF) (103 pp, 4.6MB) (EPA 440/5-80-047), Heptachlor (PDF) (114 pp, 5.4MB) (EPA 440/5-80-052), Hexachlorocyclohexane (PDF) (109 pp, 4.8MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines (PDF) (104 pp, 3.3MB). If evaluation is to be done using an averaging period, the acute criteria values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
- Q) This recommended water quality criterion is expressed as ug free cyanide (as CN)/l.
- Y) This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
- cc) When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.
- dd) Selenium criteria document (EPA 440/5-87-006, September 1987)states that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the conc.of selenium exceeds 5.0 µg/l in salt water because the saltwater CCC does not take into account uptake via the food chain.
- ii)This criterion applies to DDT and its metabolites (i.e., the total conc. DDT plus metabolites should not exceed this value).

**Laboratory Qualifiers**

|      |  |
|------|--|
| Cl   | Residual Chlorine or other oxidizing agent was detected in the container used to analyze this sample.▣           |
| H    | This sample was extracted and/or analyzed outside of the EPA recommended holding time.                           |
| J    | Detected but below the Reporting Limit (Limit of Quantitation); therefore, result is an estimated concentration. |
| Ja   | Estimated concentration between the EDL and RDL  |
| Jb   | Estimated value less than RL   |
| Jc   | The reported result is an estimated value.   |
| U    | Analyte included in the analysis, but not detected   |
| Ua   | Analyte included in the analysis, but not detected at or above the Reporting Limit                               |
| Ub   | Compound was analyzed for but was not detected (non-detect)  |
| Z-03 | See case narrative.  |

**Samples with Detections are BOLD**

One or more sample concentrations exceed screening criteria

Sample concentration exceeds criteria