U.S. Army Corps of Engineers

Galveston District
Southwestern Division

Houston Ship Channel Expansion Channel Improvement Project, Harris, Chambers, and Galveston Counties, Texas

Draft Integrated Feasibility Report–Environmental Impact Statement

APPENDIX H

CLEAN WATER ACT SECTION 404(B)(1) EVALUATION

AUGUST 2017

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HOUSTON SHIP CHANNEL EXPANSION CHANNEL IMPROVEMENT PROJECT
HARRIS, CHAMBERS, AND GALVESTON COUNTIES, TEXAS
SECTION 404(b)(1) EVALUATION

Background – This evaluation to comply with the Section 404(b)(1) Guidelines of the Clean Water Act (CWA) is provided for the Houston Ship Channel Expansion Channel Improvement Project (HSC-ECIP) feasibility study at the phase of study following the Tentatively Selected Plan (TSP) milestone to identify a TSP, and provide a draft feasibility and draft National Environmental Policy Act (NEPA) document for technical, agency, and public review. The HSC-ECIP study is being conducted under the U.S. Army Corps of Engineers (USACE) Specific, Measurable, Attainable, Risk Informed, Timely (SMART) planning process, and the TSP is at a stage of planning where the major components have been defined, but they have not been refined to final configuration and sizes.

As such, the dredged material placement, which is highly dependent on final sizes and details of the channel modifications of the TSP, has not been analyzed in detail. The TSP will propose to use existing placement areas (PA) including beneficial use (BU) sites, as much as possible, but it will likely be necessary to consider new placement sites, whether proposed as upland confined or BU placement. Therefore, this evaluation covers the TSP channel modifications in their current configuration and range of sizes identified, and the use of existing PAs. A specific dredged material management plan (DMMP) will be developed in the next planning phase following TSP refinement. Please see the beginning two paragraphs in **Chapter 7** of the Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS) for more detail on the process and planning status. This evaluation will be updated after the development of the DMMP and included in the Final DIFR-EIS.

I. PROJECT DESCRIPTION

a. Location

The project area for the HSC-ECIP is located on the upper Texas coast within Harris, Chambers, and Galveston Counties, Texas, in the Houston metropolitan region, and is defined as areas that would be directly affected by implementation of the proposed TSP. The TSP consist of the proposed dredging footprint for channel modifications (described in Item b. below), existing PAs including BU sites identified in **Section 2.5** of the DIFR-EIS, and mitigation areas.

The TSP includes the Houston Ship Channel (HSC), Barbours Cut Channel (BCC) and Bayport Ship Channel (BSC) which pass through various communities including Houston, Jacinto City, Pasadena, Deer Park, La Porte, Morgans Point, Shoreacres, and Galveston Bay, where several other communities line the shore. These channels provide deep draft navigation from the Gulf of Mexico (Gulf) to the Port of Houston. A more detailed description of the HSC system and study area can be found in Chapters 1 and 2 of the DIFR-EIS.

b. General Description

The project is a result of the study and planning process described in the DIFR-EIS. The study area was divided into 6 segments of the HSC and its side channels, described in **Section 1.4** and shown in **Figure 1-1** of the DIFR-EIS. The TSP was selected after the evaluation of 8 alternatives to improve deep draft navigation to address problems and opportunities described in **Chapter 4** of the DIFR EIS. The TSP is discussed and illustrated in detail in **Section 6.1** of the Main Report of the DIFR-EIS. The TSP for navigation improvements for the HSC consists of the following features proposed as necessary for safe and efficient navigation in the HSC.

- Four bend easings on the main HSC channel with associated relocation of barge lanes (**Segment 1**);
- Widening of the HSC main channel between Bolivar Roads and the BCC from the existing 530-foot width to a width between 650-feet to 820 feet (**Segment 1**);
- A new multipurpose mooring on the HSC near San Jacinto State Park **(Segment 1**)
- Minor widening of the channel in the bayou portion of the HSC in the Hog Island stretch (**Segment 1)** ,
- Alleviate a channel restriction by widening from the existing 400-feet to 530-feet for a distance of approximately 1.3 miles from just west of the San Jacinto Monument to Boggy Bayou (**Segment 1)**;
- Flare expansion on the BSC (**Segment 2**);
- Shoaling attenuation structure near the BSC Flare (**Segment 2**);
- A turning basin at the BSC at the mouth of the BSC land-cut (**Segment 2**);
- Widen BSC from the existing 300-400 feet to 455 feet (**Segment 2**);
- Widen the BCC from existing 300 feet to 455 feet (**Segment 3**);
- Combination flare and turning basin on the BCC (**Segment 3**);
- Deepen the HSC from Boggy Bayou to Sims Bayou from the existing 41.5-foot depth up to 46.5 feet (**Segment 4**);
- Widen the HSC from Boggy Bayou to Greens Bayou from the existing 400-foot wide channel up to 530 feet (**Segment 4**);
- A new turning basin at Station 775+00 (**Segment 4)**;
- Expand Hunting Turning Basin (**Segment 4)**;

- Deepen the HSC from Sims Bayou to the Main Turning Basin from the existing 37.5-foot depth up to 41.5 feet deep (**Segments 5 and 6**);

- Improvement of and consideration of federalizing an existing turning basin located near Brady's Landing in Segment 6 (**Segment 6)**;

<u>Recommended for Federalization</u>

Federalization of improvements already completed by the Non-Federal Sponsor (the Port of Houston Authority) to the BSC, BCC, Greens Bayou Channel, and the Jacintoport Channel will be recommended.

c. Authority and Purpose

The study is being performed under the standing authority of Section 216 of the Flood Control Act (FCA) of 1970 Public Law (P.L.) 91-611, as amended:

> "The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operations of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due [to] significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

The purpose of this feasibility study is to evaluate Federal interest in alternative plans (including the No-Action Plan) for reducing transportation costs while providing for safe, reliable navigation on the HSC system. The study will assess the effects of the alternatives on the natural system and human environment, including the economic development effects of existing inefficiencies. The study is being conducted to address the problems to deep draft navigation detailed in Chapter 4 of the DIFR-EIS. A summary of the main problems is as follows:

- Inefficient deep and shallow-draft vessel utilization of the HSC system resulting from existing channel depth, width, and configuration including
  - shallower drafts in the upper reach of the HSC
  - one-way transit restrictions throughout
  - substantial transit delays and waits due to channel and daylight restrictions
  - excessive transits to anchorage at or near the Gulf
- Safety navigation concerns for deep and shallow-draft vessel traffic
- Identifying environmentally acceptable dredged material placement (PA/BU) with capacity to serve the system.

The overall study goal is to provide an efficient and safe navigation channel while contributing to the National Economic Development (NED) consistent with protecting the nation's environment. Specific objectives used to formulate alternatives were:

- Reduce navigation transportation costs by increasing economies of scale for vessels to and from HSC over the period of analysis (starting in the base year for 50 years).
- Increase channel efficiency, and maneuverability in the HSC system for the existing fleet and future vessels through the 50-year period of analysis.
- Develop environmentally suitable placement for dredged material and maximize use of BU of dredged material for placement over the 50-year period of analysis.
- Increase channel safety for vessels utilizing the HSC, BSC, and BCC.
- Reduce high shoaling at BSC Flare to reduce dredging frequency.

d. General Description of Dredged or Fill Material

(1) General Characteristics of Material

Materials are expected to be predominantly new work and consist of soft silts and muds, soft, firm, hard, stiff, very stiff, silty, and sandy clays, fine to course sands, silty sands, calcareous nodules, shell and rock. Maintenance sediments encountered in the HSC consist of mixtures of clay, silt, and sand of varying percentages.

Actual grain size for individual dredging operations will vary based on climate conditions such as tropical storms, drought, and floods. Results of historic particle size analyses for maintenance sediment grab samples obtained from the HSC and tributary channels shown in **Table 7.1** of the **Appendix B** of the DIFR-EIS, indicate the percentage of fines (clay and silt particle sizes) ranges from about 43 percent to 91 percent. The balance of the maintenance sediment consists of sand-sized or larger particles.

(2) Quantity of Material

Construction of the TSP would generate an approximate range of 27.6- 52.5 million cubic yards (MCY) of new work dredged material. The 50-year incremental O&M quantity would generate an approximate range of 79.3-116.9 MCY of dredged material. The estimated quantities for each measure by segment is provided in the **Table 1** below. Widening volumes in the HSC Bay sections from Bolivar Roads to Morgans Point include the offset of the 235-foot barge lanes. The bold, italicized values show the measures that are identified for a size range that will be narrowed down to a selected width in the next planning phase.

Table 1 – TSP New Work Dredge Quantities

Measure	Description	New Work Quantity (CY)
SEGMENT 1		
Bolivar Roads to Red Fish Light 1 Station 138+369.011 - 78+844.001		
CW1_BR-Redfish_820	Widen HSC to 820-FT - 328-FT Bend Easing at Bay Reach P.I. Station 138+369 and 128+731	***9,476,058***
CW1_BR-Redfish_650	Widen HSC to 650-FT - 328-FT Bend Easing at Bay	***2,395,542***

Measure	Description	New Work Quantity (CY)
	Reach P.I. Station 138+369 and 128+731	
BE1_138+369_530	Existing 530-FT HSC - 328-FT Bend Easing at Bay Reach P.I. Station 138+369	20,554
BE1_128+731_530	Existing 530-FT HSC - 328-FT Bend Easing at Bay Reach P.I. Station 128+731	276,655
Redfish Light 1 To Beacon 76 Station 78+844.001 - 28+605.055		
CW1_Redfish-BSC_820	Widen HSC to 820-FT - 328-FT Bend Easing at Bay Reach P.I. Station 078+844	***16,762,613***
CW1_Redfish-BSC_650	Widen HSC to 650-FT - 328-FT Bend Easing at Bay Reach P.I. Station 078+844	***5,640,084***
BE1_078+844_530	Existing 530-FT HSC - 328-FT Bend Easing at Bay Reach P.I. Station 078+844	1,113,405
Beacon 76 To Lower End Morgans Point Cut Station 28+605.055 - 00+0.394		
CW1_BSC-BCC_820	Widen HSC to 820-FT - 328-FT Bend Easing at Bay Reach P.I. Station 028+605	***10,096,080***
CW1_BSC-BCC_650	Widen HSC to 650-FT - 328-FT Bend Easing at Bay Reach P.I. Station 028+605	***3,457,204***
BE1_028+605_530	Existing 530-FT HSC - 328-FT Bend Easing at Bay Reach P.I. Station 028+605	1,072,656
Morgans Point to Exxon Station 0+05 - 295+00		
CW1_HOG_600	Widen HSC to 600-FT between 10+00 to 83+00	242,181
BE1_153+06	Bend easing at Fred Hartman Bridge	468,465
BE1_246+54	Bend easing at Alexander Island	266,515
Carpenter's Bayou to Boggy Bayou Station 520+00 - 684+03.19		
CW1_SJM-BB_530	Widen HSC east of Boggy Bayou to maximum extents	576,626
MM1_520+00	Mooring Facility at Station 520+00	1,426,813
SEGMENT 2		
CW2_BSC_455	Widen BSC to 455-FT	2,066,032
BE2_BSCFlare	Widen south BSC Flare to 5,375-FT radius	1,017,392
TB2_BSCRORO_1800	Turning Basin at RORO dock of 1,800-FT diameter	2,549,535
MM2_BSC_1800	Mooring Facility at BSC RORO	3,435,615
SEGMENT 3		
CW3_BCC_455	Widen BCC to 455-FT	1,054,425
BETB3_BCCFlare_1800NS	(TB3_BCCMouth) Widen BCC N/S flare 1,800-FT diameter TB	1,252,290
SEGMENT 4		
CW4_BB-GB_530	Widen (530-FT)/Deepen (5-FT) Boggy Bayou to Greens Bayou	1,541,618
TB4_775+00	Turning Basin at Station 775+00 of 1,403-FT diameter	1,345,928
TB4_Hunting	Expand Turning Basin at Hunting Bayou of 1,196-FT diameter	40,897
CD4_Whole	Deepen (5-FT) Boggy Bayou to Sims Bayou	1,803,885
SEGMENT 5		
CD5_Whole	Deepen (4-FT) HSC Sims Bayou to I-610 Bridge	178,140
SEGMENT 6		
CD6_Whole	Deepen (4-FT) HSC I-610 Bridge thru Turning Basin	705,074
TB6_Brady_900	Turning Basin at Brady Island Station 1195+00	294,477

e. Description of the Proposed Discharge

(1) Location

Existing PAs proposed for use for new work and maintenance placement are listed in **Table 2** below. The new work material would be used beneficially as much as possible to raise containment dikes to increase incapacity and extend the life of the PAs, repair dikes, or continue construction of already planned PAs and marsh cells. Maintenance material would be placed in the interiors of the PAs, which are currently used to maintain the existing HSC system. In completed marsh cells, maintenance material would be used to nourish interior marsh if they subside or erode.

Table 2 – Potential Dredged Material PAs

Name	Type
ODMDS No. 1	Ocean Dredged Material Disposal Site
Bolivar 288-acre marsh	Beneficial Use Marsh Cell
Bolivar Marsh Cells 1 through 3	Beneficial Use Marsh Cell
Redfish Island	Beneficial Use Island
Midbay PA	Upland Placement
PA 14	Upland Placement
PA 14/15 Connection (partially built)	Upland Placement
PA 15	Upland Placement
M11 (future)	Beneficial Use Marsh Cell
M10	Beneficial Use Marsh Cell
M 7/8/9	Beneficial Use Marsh Cell
Cell M5/M6	Beneficial Use Marsh Cell
M1/M2	Beneficial Use Marsh Cell
NW	Beneficial Use Marsh Cell
M3	Beneficial Use Marsh Cell
M4	Beneficial Use Marsh Cell
Spilmans Island	Upland Placement
Alexander Island	Upland Placement
Peggy Lake	Upland Placement
Goat Island	Beneficial Use Island
Lost Lake	Upland Placement
East Clinton	Upland Placement
West Clinton	Upland Placement
Rosa Allen	Upland Placement
House-Stimson	Upland Placement
Glendale	Upland Placement
Filter Bed	Upland Placement

Beyond use of existing PAs, dredged material placement will be evaluated for new upland confined placement, or BU of dredge material where practicable in the next phase of the study during development of the specific DMMP to provide for 50 years of maintenance material placement capacity for the TSP features. New placement areas that may be developed are generally desired to be within 5 miles of the HSC, BSC, and BCC but may range up to 7.5 miles or greater depending on the need. General planning considerations for constraints and impact of new PAs are discussed in **Section 7.6** of the DIFR-EIS, and **Section 13** of the **Engineering Appendix** of the DIFR-EIS.

(2) Size

TBD during the next planning phase.

(3) Type of Site and Habitat

The majority of the TSP is dredged navigation channels, with permitted or authorized depths ranging from -13.5 to -46.5 MLLW (-12 to -45 feet MLT) that with advanced maintenance and allowable overdepths have maximum depths ranging from -14.5 to 50.5 feet MLLW (-13 to -49 feet MLT). The navigation channel bottoms are primarily characterized by fine grained silt and clay, with some sand/gravel content.

The existing 12 upland confined placement areas (PAs), 10 beneficial use (BU) marsh cells, and one existing ocean dredged material disposal site (ODMDS) will be used for construction and maintenance disposal. The existing PAs are periodically disturbed by deposition of dredged material during channel maintenance cycles or earthwork to de-water and manage these PAs, where pioneer herbaceous species continually re-vegetate areas of deposition in between these activities. Previous site investigations of several of the Bay segment PAs (Spilmans Island, PA 14, and PA 15) conducted during previous USACE and Non-Federal Sponsor projects indicate the typical nature of the vegetation as invasive with species such as salt cedar (Tamarix chinensis) and giant cane (Arundinaria gigantea) as well as typical marsh plants such as saltwater cordgrass (*Spartina alterniflora*) and salt-meadow cordgrass (*Spartina patens*) that readily colonize deposited material in between periods of disturbance. All of the upland disposal areas are periodically filled with additional material from current and future maintenance dredging activities. However, the PA areas that are designated BU areas are currently under construction and need additional fill material to complete the marsh creation. Once filled to the correct level for marsh creation they will no longer be used for dredged material placement. However, if the designated beneficial use areas are impacted by future subsidence or sea level rise, additional dredge material could be added to maintain quality marsh habitat. Similarly, currently filled marsh cells impacted by future subsidence or sea level rise may also receive additional maintenance dredged material to renourish marsh habitat.

The existing ODMDS is offshore ocean bottom composed if various levels of silts, clays and sands.

(4) Time and Duration of Discharge

Design and Construction Procedures will be formulated after the TSP milestone and prior to the Final Feasibility Report. Similarly, the schedule for design and construction will be formulated after the TSP milestone and prior to the Final Feasibility Report.

f. Description of Disposal Method

The type of dredging equipment considered depends on the type of material, the depth of the channel, the depth of access to the disposal or PA, the amount of material, the distance to the disposal or PA, the wave-energy environment, etc. A detailed description of types of dredging equipment, which includes mechanical-clamshell, hydraulic hopper, cutter-suction pipeline dredges and cutter suction dredges with barges for transportation of dredged material to designated disposal sites, can be found in EM 1110-2-5025, Dredging and Dredged Material Management (USACE, 2015b).

Mechanical – Clamshell Dredging

Mechanical dredges are classified by how the bucket is connected to the dredge. The three standard classifications are structurally connected (backhoe), wire rope connected (clamshell), and chain and structurally connected (bucket ladder). The advantage of mechanical dredging systems is that very little water is added to the dredged material by the dredging process and the dredging unit is not used to transport the dredged material. This is important when the disposal location is remote from the dredging site. The disadvantage is that mechanical dredges require sufficient dredge cut thickness to fill the bucket to be efficient and greater re-suspended sediment is possible when the bucket impacts the bottom and as fine-grained sediment washes from the bucket as it travels through the water column to the surface. These dredges can work in confined areas, can pick up large material, and are less sensitive to sea conditions than other dredges.

Mechanical dredging operations are not anticipated for large measures reviewed for this study. However, mechanical dredging may be employed in sensitive structural areas or areas where debris or old structures need to be removed.

Hydraulic – Hopper Dredging

Hopper dredges include self-propelled ocean-going vessels that hydraulically lift dredged material from the nourishment projects. Since hopper dredges are self-propelled, they are more maneuverable than dredges that rely upon tug boats to move. One or more suction tubes, equipped with a drag head or other suspension apparatus are dragged along the channel bottom. A pump system sucks up a mixture of materials such as sand, gravel, silt or clay, and water and discharges it in the "hopper" or hold of the vessel. Once the vessel is fully loaded, it sails to the unloading site. The material can be deposited on the seabed through bottom doors, reclaimed using a rainbow technique, or discharged through a floating pipeline to the shore.

It is anticipated that hopper dredges for new work and for long term maintenance of the channel may be conducted along with cutter head suction dredging in the Bay reaches of the HSC, BSC and BCC as part of the programmatic DMMP to be developed post TSP. Material would be transported to the ODMDS and disposed of according to the Site

Management and Monitoring Plan (SMMP) that is approved by the EPA.

Hydraulic – Cutter Suction Dredge

Large cutter suction dredges, or cutterhead dredges, are mounted on barges. The cutter suction dredge is equipped with a rotating cutterhead used for cutting and fragmenting the soils to be removed. It mobilizes the dredged material as it rotates. The mobilized material is hydraulically moved into the suction pipe for transport. The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface. The cutter suction dredge moves by means of a series of anchors, wires, and spuds. The cutter suction dredges as it moves across the dredge area in an arc as the dredge barge swings on the anchor wires. The discharge pipeline connects the cutter suction dredge to the PA. The dredged material is hydraulically pumped from the bottom, through the dredge, and out through the discharge pipeline to the placement location. Booster pumps can also be added along the discharge pipeline to move the material greater distances. Additionally, the cutter suction dredge can pump the dredged material into a series of barges that can be transported to a PA and pumped out or bottom dumped. Three types of barges are generally used to transport dredged material to the placement sites, which include a split hull barge/scow, bottom dump barge/scow, or a flat top barge/scow. All three barge types are typically pushed or pulled to the placement site by a tug. This is the least efficient option for cutterhead dredging. Cutterhead suction dredging is the predominant dredging currently employed in the study area and this is the continued anticipated practice for construction, operation and maintenance of the measures considered under this study.

II. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope

Section 1.d.2 above describes proposed modifications to the channels by segment.

(2) Sediment Type

Materials are expected to be predominantly new work and consist of soft silts and muds, soft, firm, hard, stiff, very stiff, silty, and sandy clays, fine to course sands, silty sands, calcareous nodules, shell and rock. Maintenance sediments encountered in the HSC consist of mixtures of clay, silt, and sand of varying percentages.

Actual grain size for individual dredging operations will vary based on climate conditions such as tropical storms, drought, and floods. Results of historic particle size analyses for maintenance sediment grab samples obtained from the HSC and tributary channels shown in Table 7.1 of the Appendix B of the DFIR-EIS, indicate the percentage of fines (clay and silt particle sizes) ranges from about 43 percent to 91 percent. The balance of the maintenance sediment consists of sand-sized or larger particles

(3) Dredged/Fill Material Movement

Surveys of the ODMDS prior to and following placement of dredged material indicate little to no accumulation within its boundaries; therefore, it is considered to be a dispersive site with unlimited future capacity. A Particle Tracking Model (PTM) was done for this site and showed that material placed in the ODMDS does move out of the area through the process of littoral drift and does not return to the channel. This site was coordinated for the Galveston Harbor and Channel project with the SMMP for the ODMDS being signed in 2008 by the EPA and USACE, Galveston. This site is currently used for placement of material from the Bolivar Roads to Redfish Reef dredging reach. Each use of the ODMDS requires sediment testing along with coordination and approval by the EPA.

Upland PAs will have containment levees to control fill movement after deposition; small amounts of suspended solids may be present in the discharge. BMPs will be implemented to control and reduce discharge turbidity..

(4) Physical Effects on Benthos

Dredging would impact and temporarily remove benthic infaunal communities present in the dredged material footprint, but these communities would be expected to recover sometime after dredging ceases. The resultant turbidity and settling from dredging has the potential for smothering sessile benthic organisms and/or inhibiting filtration functions required by some organisms for respiration and nutrition. The temporary lower DO concentrations that could result from temporary suspension of organic material during dredging could cause a temporary displacement of mobile organisms and may stress or cause mortality to sessile organisms. These effects would be temporary and minor given the nature of hydraulic dredging, as suspended sediments would return to background levels within a short time frame. For soft, featureless bay bottom, rapid recolonization by benthic species would occur and this type of habitat and benthic community is ubiquitous in Galveston Bay. Impacts to oyster reef will be mitigated, as detailed in **Section 7.5** and **Appendix P** of the DIFR-EIS. These effects are described in more detail in **Section 7.2.1.3** of the DIFR-EIS. The use of existing upland PAs would not impact benthos. The use of existing BU sites would not significantly impact benthos during placement to aid dike construction or repair, and placement. Filling the interior of the existing BU site would continue the already planned and approved tidal marsh construction that would result in beneficial changes to benthic communities that would have positive aquatic ecosystem impacts. The use of the existing offshore placement site ODMDS No. 1 would be temporarily detrimental to benthic organisms in the placement footprint, but these would also be expected to quickly rebound.

(5) Other Effects

The ODMDS No. 1 is located within the Sargassum Critical Habitat of loggerhead turtle. However, current use of ODMDS would not impact nesting or non-nesting sea turtles in the TSP project area, but may affect foraging loggerhead turtles in association with high densities of Sargassum within the existing loggerhead turtle Sargassum Critical Habitat area. The preliminary determination for this project is that hopeer dredging placement use of this ODMDS may affect but not adversely affect the critical habitat, consistent with National Marine Fisheries Service (NMFS) clarification to Regional Biological Opinions

(6) Actions Taken to Minimize Impacts

This project was fully coordinated with State and Federal resource agencies, and responses to their comments have been incorporated into the development of the dredged material PAs. Any unavoidable losses will be mitigated.

b. Water Circulation, Fluctuation, and Salinity Determinations

(1) Water

Dredging to construct the TSP and the use of the existing PAs, BU areas, and the ODMDS are expected to have only minor, short- term impacts on water quality in the area. Effects on the following parameters are summarized below. However, for additional detail, supporting literature, and discussion see **Section 7.1.5.1 Water Quality** of the Main Report and **Section 3.1.5.1 Water Quality** of **Appendix G** of the DIFR-EIS.

(a) Salinity

Modeling results discussed from previous studies with deepening of channels extending from oceanic to estuarine conditions, and the limited deepening for the TSP that does not extend into the Bay or Gulf, the TSP would not result in significant adverse impacts to salinity. The TSP would not result in significant adverse impacts to salinity. Impacts to salinity are discussed more fully in Section 4.2 and Appendix B of the DFIR-EIS.

(b) Water Chemistry

Dredging under the TSP, would result in minimal impacts, and would not be expected to degrade the long-term water quality within the project area. Physico-chemico parameters may be temporarily affected as a result of water column mixing during dredging and placement activities. These patterns would return to their previous condition following completion of dredging. Any impacts to the distribution patterns for these water quality parameters from dredging would be minimal, and discussed further in the DIFR-EIS.

Short-term changes in dissolved oxygen (DO), nutrients, turbidity, and contaminant levels could occur due to mixing and disturbance of sediments into the water column during dredging and dredged material placement. Temporary decreases in DO concentration may occur during and immediately after dredging due to the movement of anoxic water and sediments through the water column. Temporary DO decreases may occur due to the aerobic decomposition from short-term increases in organic matter suspended within the water column. These minimal impacts would be expected to be limited to the immediate vicinity of dredging and dredged material placement. Contaminants present in the surface sediments would be temporarily suspended during dredging and placement activity. However, once the dredging activities stop, disturbed material would settle, and the physico-chemico parameters temporarily affected would return to pre-disturbance levels. The vast majority of re-suspended sediments resettle close to the dredge within an hour. These impacts would be minimal and discussed further in the DIFR-EIS. For use of existing PAs, water chemistry would not be expected to be significantly adversely impacted, as these are contained areas designed to maintain water quality in return water decanted from placed materials.

(c) Clarity

There will be some temporary increase in local turbidity during dredging and placement operations. Water clarity is expected to return to normal background levels shortly after operations are completed, as discussed further in the DIFR-EIS.

(d) Color

Water immediately surrounding the construction area will become discolored temporarily due to disturbance of the sediment during dredging, but would be expected to return to normal after dredging operations cease, as discussed in the DIFR-EIS.

(e) Odor

The new work material is not expected to be anoxic, so there should be no odors associated with dredging and placement, nor are any expected from ODMDS placement.

Negligible amounts of hydrogen sulfide may be expected. There should be no change in the maintenance material.

(f) Taste

The water bodies receiving discharge from existing PAs are not drinking water sources. No detectable impacts in the marine environment.

(g) Dissolved Gas Levels

Negligible amounts of hydrogen sulfide (H_2S) may be expected. H_2S and other gases like methane are associated with high amounts of decaying organic matter which are not expected in the new work material that are expected to be predominantly clays. This type of material is very low in total organic carbon, an indicator of organic content, with recent new results from the BSC and BCC indicating values <1 percent, and with the vast majority of samples having no detected sulfides. Dissolved gases have not been identified as a problem with maintenance material of the current channels, and would not change in character with maintenance of the TSP improvements in these channels.

(h) Nutrients

Nutrient levels may be slightly and temporarily elevated during dredging and near the PAs since new work material is low in organics. Some maintenance material will be dredged along with the new work material. There should be no change in the maintenance material.

(i) Eutrophication

Nutrients are not expected to reach levels high enough for periods long enough to lead to eutrophication of the surrounding waters. Temporary increases in nutrients during dredging is short lived at less than a few hours and is discussed further in the DIFR-EIS.

(j) Others as Appropriate

None known.

(2) Current Patterns and Circulation

A hydrodynamic model is being developed by the U.S. Army Engineer Research and Development Center (ERDC) to evaluate those hydrodynamic effects as well as sediment transport in the next planning phase after the TSP is approved and will include modeling of the future without project condition. However, recent studies involving hydrodynamic modeling of these effects for similar channel modification projects found minimal increases to currents, surge levels, tidal variation, and small changes to salinity as a result of channel modifications. Therefore, no major changes in the circulation pattern and current magnitude are expected under.

(a) Current Patterns and Flow

No impacts are expected.

(b) Velocity

No impacts are expected.

(c) Stratification

No impacts are expected.

(d) Hydrologic Regime

No impacts are expected.

(3) Normal Water Level Fluctuations

Channel deepening has the potential to affect surge and tidal variations by lowering the bay bottom relative to existing conditions and reducing hydraulic resistance. Considering the minimal impacts shown in recent hydrodynamic modeling for channel modification projects involving deepening, the limited deepening proposed in the TSP constrained to the upper reaches, and the existing deep bathymetry in those reaches, significant adverse effects would not occur due to the TSP. These conditions would be minimally changed compared to the No Action Alternative. More information is available in Section 3.1.4.1 of Appendix G of the DFIR-EIS

(4) Salinity Gradients

The TSP would not result in significant adverse impacts to salinity. Impacts to salinity are discussed more fully in Section 4.2 and Appendix B of the DFIR-EIS and Section II.b.1.a above.

(5) Actions That Will Be Taken to Minimize Impacts

In addition to alternatives analyses, the selected dredged material placement areas avoid impacts to various resources such as threatened and endangered sea turtles, cultural resources, and essential fish habitat. BMPs will be implemented during construction and maintenance activities.

c. Suspended Particulate/Turbidity Determination

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

An increase in suspended particulates and the concomitant turbidity levels is expected during dredging and placement operations of new work and maintenance material (**Section 7.1.5.1 Water Quality** of the Main Report and **Section 3.1.5.1 Water Quality** of **Appendix G** of the DIFR-EIS). These are temporary and localized events. Existing PAs proposed for use are designed to control suspended solids in return water.

(2) Effects on Chemical and Physical Properties of the Water Column

(a) Light Penetration

Turbidity levels will be temporarily increased during dredging and placement operations of new work and maintenance material but will return to normal following completion of dredging and placement operations. No long term effects to light penetration would occur, and there is no submerged aquatic vegetation in the vicinity of dredging or existing placement areas.

(b) Dissolved Oxygen

No significant adverse impacts to dissolved oxygen are expected (**Section 7.1.5.1 Water Quality** of the Main Report and **Section 3.1.5.1 Water Quality** of **Appendix G** of the DIFR-EIS).

(c) Toxic metals and organics

Past periodic testing results have indicated that quality of maintenance sediments has been suitable for placement in the upland confined PAs, and BU marsh cells in the system. All previous sediment testing results for the HSC, BSC, and BCC are being reviewed to establish reasons to believe contaminants would not be present in construction material to have the potential to cause an unacceptable adverse impact in order to identify any additional testing requirements in the next phases of planning. Previous recent extensive testing for the BSC and BCC do not indicate construction material would be a concern, and testing will be identified as necessary to be conducted during or prior to the Preconstruction, Engineering, and Design (PED) phase of the project to verify no concerns would be present with HSC new work material

(d) Pathogens

None expected or found.

(e) Aesthetics

No expected effects from underwater chanel improvements or from use of existing PAs.

(f) Others as Appropriate

None known.

(3) Effects on Biota

No impacts are expected on photosynthesis, suspension/filter feeders, and sight feeders, except for temporary impacts from dredging (e.g., temporary increases in local turbidity levels) or placement operations (e.g., burial of benthos). Refer to **Section 7.2.1.3** of the Main Report and **Section 3.2.1.3** of **Appendix G** of the DIFR-EIS for more detail on effects to aquatic fauna.

(4) Actions Taken to Minimize Impacts

Construction and placement plans for the materials have been closely coordinated with the resource agencies to assure minimal impacts. BMPs will be applied to reduce and control turbidity and sediment discharge and impacts to threatened and endangered sea turtles.

d. Contaminant Determinations

Dredging at the site of channel improvements for the TSP will not introduce or increase contaminants. Chemical constituents in bottom sediments to be dredged are already subject to relocation and redistribution through tides, currents, and other natural climatic and weather-related forces in Galveston Bay. Hydraulic cutterhead dredging, the primary construction method anticipated, and trailing suction hopper dredging, the other method anticipated for use in the TSP, tend to limit the size of turbidity plumes due to the suction nature of the dredging. Only short term and localized increases in turbidity will be temporary and limited in size as explained in **Section 7.1.5** of the DIFR-EIS. The main effect at the dredge site will be removal of sediments with relocation to proposed dredged material placement sites. For use of existing placement areas (PA), material would be placed to raise or repair existing dikes, or otherwise placed within dikes. See response to c.(2)(c) above. As previously discussed, all previous sediment testing results for the HSC, BSC, and BCC are being reviewed to establish reasons to believe contaminants would not be present to have the potential to cause unacceptable adverse impacts. Previous recent extensive testing for the BSC and BCC do not indicate construction material would be a concern, and testing will be identified as necessary to be conducted during or prior to the PED phase to verify no concerns would be present with HSC new work material. Past periodic testing results have indicated that quality of maintenance sediments has been suitable for placement in the upland confined PAs, and BU marsh cells in the system..

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton

Construction and placement operations are expected to have only minor temporary, local impacts on plankton from increased turbidity levels. Refer to **Section 7.2.2.2** of the Main Report and **Section 3.2.2.2** of **Appendix G** of the DIFR-EIS for more detail on effects to aquatic fauna.

(2) Effects on Benthos

There would be permanent impacts to oyster reef that will be mitigated. These impacts are discussed in **Section 7.2.2.3** and mitigation detailed in **Section 7.5** and **Appendix P** of the DIFR-EIS. Impacts to other benthic organisms and bay bottom habitat would occur; however, benthic organisms are expected to quickly rebound from the short-term impacts of channel dredging, the use of existing BU areas, and use of the offshore ODMDS and no significant adverse impacts are expected (**Section 7.2.1.3** of the Main Report and **Section 3.2.1.3** of **Appendix G** of the DIFR-EIS). Use of existing upland PAs would have no appreciable effect on benthos.

(3) Effects on Nekton

Impacts to free-floating or limited-mobility nekton would be temporary during construction, and minor. These impacts, such as entrainment into cutterheads or vessel cooling water intakes and discharges would be temporary and minor, because the amount of water exchange involved is volumetrically insignificant compared to the Bay, and the ubiquity and high turnover in populations of these types of fauna would quickly replace any impacted organisms. Finfish would readily be able to avoid impacts given their mobility. No permanent or long term impacts on nekton would result from implementing the TSP and use of dredged material in the BU and marsh areas and from the placement of maintenance material. Refer to **Section 7.2.2.2** of the Main Report and **Section 3.2.2.2** of **Appendix G** of the DIFR-EIS for more detail.

(4) Effects on Aquatic Food Web

The effects on benthic biota (such as infauna) and nekton (e.g. plankton) that form the base of the aquatic food web would be localized, temporary, and not result in significant adverse impacts to populations as discussed in the responses above to c.(3) and e.(1), (2), and (3). No significant impacts to finfish populations are expected. (**Section 7.2.2.2** of the Main Report and **Section 3.2.2.2** of **Appendix G** of the DIFR-EIS)

(5) Effects on Special Aquatic Sites

Construction of the TSP would not impact any wetlands because the few wetlands that exist along the shoreline surrounding the proposed channel improvements will be avoided. No submerged aquatic vegetation, or tidal or mud flats are located within the TSP footprint. Use of the existing PAs, BU sites, and offshore placement site would not impact any special aquatic sites.

f. Proposed Disposal Site Determinations

(1) Mixing Zone Determination

Past maintenance sediment elutriate testing has not indicated a discharge quality problem that would require mixing zones at existing PAs or the ODMDS. This will be confirmed with detailed review of previous sediment testing results for the HSC, BSC, and BCC. Recent results for the BSC and BCC did not indicate discharge quality problems would be expected with new work material. Past testing results for the HSC is being reviewed to identify if any further testing is needing for HSC new work material. As discussed in response to c.(2)(c) above, testing would be performed during or prior to the PED phase. If identified for further testing, the dredged material would be tested for contaminants, to include elutriate testing, in accordance with the USACE or joint USACE/EPA Upland, Inland or Ocean Testing Manuals as appropriate for the specific disposal methods selected during development of the DMMP in the next planning phase. Elutriate results would be reviewed to ensure placement will not cause or contribute, after considering dilution and dispersion, to violation of any applicable surface water quality standards. After reviewing results, any necessary mixing zone calculations would be performed and the placement method evaluated in accordance with Engineer Manual (EM) 1105-2-5025, *Dredging and Dredged Material Management*.

(1) Factors in determining the acceptability of a proposed mixing zone.

Past maintenance sediment elutriate testing has not indicated a discharge quality problem that would require mixing zones at existing PAs or the ODMDS. This will be confirmed with detailed review of previous sediment testing results for the HSC, BSC, and BCC. Recent results for the BSC and BCC did not indicate discharge quality problems would be expected with new work material. Past testing results for the HSC is being reviewed to identify if any further testing is needing for HSC new work material. As discussed in response to c.(2)(c) above, testing would be performed during or prior to the PED phase. If identified for further testing, the dredged material would be tested for contaminants, to include elutriate testing, in accordance with the USACE or joint USACE/EPA Upland, Inland or Ocean Testing Manuals as appropriate for the specific disposal methods selected during development of the DMMP in the next planning phase. Elutriate results would be reviewed to ensure placement will not cause or contribute, after considering dilution and dispersion, to violation of any applicable surface water quality standards. After reviewing results, any necessary mixing zone calculations would be performed and the placement method evaluated in accordance with Engineer Manual (EM) 1105-2-5025, *Dredging and Dredged Material Management*.

(2) Potential Effects on Human Use Characteristics

(a) Municipal and Private Water Supply

No apparent private, public, or industrial water wells registered with the Texas Water Development Board (2017) would be destroyed and/or affected based on their proximal distances and completed depths below surface grade.

(b) Recreational and Commercial Fisheries

Oyster reef impacts will be mitigated as discussed above in e.(2). No significant adverse or long-term effects to other recreational or commercial fisheries are anticipated as a result of the TSP. See **Section 7.2.4** of the Main Report and **Section 3.2.4** of **Appendix G** of the DIFR-EIS for more detail.

(c) Water-related Recreation

The TSP will not have significant adverse effects on waterborne recreation, either through impeding use, or effects on water-quality dependent recreational uses such as fishing or aesthetics. See **Section 7.2.4**, and **7.4.1.4** of the Main Report and **Section 3.2.4** and **3.4.1.4** of **Appendix G** of the DIFR-EIS for more detail.

(d) Aesthetics

The TSP would not have any adverse impacts to the environment and aesthetic qualities in the area. The channel modifications are below water and out of sight, and use of existing PAs would not change the current aesthetics of the land use surrounding these existing facilities.

(e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

No parks, national or historic monuments, national seashores, wilderness areas, or research sites will be negatively impacted by the project.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

The TSP channel modifications is not expected to result in significant adverse cumulative impacts to the aquatic ecosystem, as discussed in **Section 7.7** of the DIFR-EIS. Use of existing PAs (including BU sites) would not result in significant adverse cumulative impacts to the aquatic ecosystem either, as these sites are already used for dredged material placement. These PAs have been used for the long term operations and maintenance (O&M) of the HSC system without impairment of the water quality of the receiving waters in Galveston Bay or Buffalo Bayou /San Jacinto River, and without interfering with the productivity of the existing aquatic ecosystems. Use of material for the BU sites would produce benefits to the productivity of aquatic ecosystems by helping in the continued restoration of tidal marsh.

h. Determination of Secondary Effects on the Aquatic Ecosystem

No significant adverse secondary effects on the aquatic ecosystem should occur as a result of implementing the TSP or use of existing PAs. The existing PAs would remain in use for long term O&M of the Federal channels, and are not planned for development into other land uses other than their current upland or BU placement.

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