

Memorandum for: Bayou City Waterkeeper on behalf of the Healthy Ports Community Coalition and the Environmental Integrity Project (EIP) in support of ongoing public advocacy efforts regarding the Houston Ship Channel Expansion Channel Improvement Project located in Harris, Chambers, and Galveston Counties, Texas. Revised from September 2025 version.

**This document was prepared by Empson Consulting, LLC,
William B. Empson, PE, PMP Principal**

Limitations: The review of documents and considerations discussed in this document are related primarily to the upland confined dredged materials placement areas that are adjacent to communities, residences and businesses where direct and indirect human health and life safety concerns exist. This evaluation is based on the 11 August 2025 scope of work and does not consider, or propose, alternatives to the authorized modifications to the Houston Ship Channel. This evaluation also does not dispute the need for improvements to the efficient operation of the ship channel to accommodate future economic opportunities.

The discussions contained here are primarily focused on the physical, geotechnical and surface water aspects of the upland placement areas adjacent to communities, residences and businesses. Where chemical contamination is discussed in this document, this information is provided for general context and should not be considered definitive since soil or water chemical contamination evaluation is not within the scope of this effort.

Note also that the analyses here are based largely on feasibility level documents including the Environmental Impact Statement that is approximately five years old at the time of this writing and may require updating given the age of the analyses, the changes in USACE and other Federal Regulations and the exceptional cost inflation that has been experienced since these documents were completed.

This document is a final product and is the first in a series of independent project reviews that are expected to be performed over the design of the project. The statements and conclusions presented may require future adjustment if, and as, more information becomes available. This document recognizes that the design of the project is between 35% and 65% complete and, as a result, many of the issues discussed are likely to be conceptual at this time. The 65% design is not currently available for review and other documents requested through Freedom of Information Act requests have not been received. However, the reviews associated with this document are most effective early in

the design process when issues can be identified and resolved without significant impact to the overall project schedule. Communicating concerns and establishing mutual understanding is one of the intents of performing this review and providing this information at this time.

Executive Summary:

The Houston Ship Channel project is to deepen and/or widen the Houston Ship Channel to allow **more efficient access and reduce congestion** to private and public docks for larger and/or more heavily loaded ships. The channel is currently operational but requires extensive coordination and choreography of ship movements. There are no life safety risks related to the current or future operation of the port or ship channel defined in any project documents reviewed to date. Under the current plan which uses the upland placement areas for dredged material disposal, existing and future economic risks would be traded for life safety risks associated with most of the placement areas but Port Houston appears to be most interested in the highest risk placement areas of Glendale, Filterbed and Rosa Allen placement areas.

Significant gaps exist in the current project documents associated with social justice and socioeconomic considerations, risk assessment, risk informed design, risk informed decision making, Probable Maximum Precipitation analyses, storm water management design, sea level rise, ground subsidence, contaminated material placement, placement area capping, design rationale for selection of upland confined placement areas to be used, design review planning, dam safety design, Independent External Peer Review, Safety Assurance Reviews and most critically from a life safety standpoint, slope stability analyses.

Immediate Recommendations to Enhance Community Safety:

- Perform a life safety risk analysis for the current and future use of each placement area and utilize a risk informed design process and risk informed decision making on all aspects of the project as required by USACE policy.
- Develop a comprehensive upland placement area operation and maintenance (O&M) plan including a placement area surveillance plan that defines responsibilities and future funding for O&M and surveillance.
- Clear woody vegetation and mow tall grasses to allow for turf establishment or resilient slope surfacing installation on all exterior dike slopes on ALL upland placement areas to allow effective observation and monitoring.
- Implement routine inspection and monitoring program for all upland placement areas either directly on site and/or by remote means.

- Cap all placement areas that will not be used in the future or will not be used as part of this project using impervious clean fill from off site or a cap system with an impervious liner. Integrate runoff detention or storm drainage modifications to prevent runoff, flooding and other impacts to adjacent properties based on detailed stormwater modelling.
- Develop an Emergency Action Plan including water and dredged materials inundation mapping for each placement area.
- Install real time slope monitoring and water level monitoring equipment and an effective mechanism for warning the population at risk around each placement area in the event of an emergency.
- Perform community outreach and risk communication with communities adjacent to placement areas and potentially impacted by a breach of the containment dike or runoff from the areas.
- Investigate the existing data and future use of Interferometric Synthetic Aperture Radar or other conventional geotechnical instrumentation means to monitor the slopes of the placement areas by independent entities as well as to monitor ground subsidence of the Houston Ship Channel area.
- Base all decision on USACE regulations that state that “Life safety is paramount” and that public safety cannot be traded off for other project benefits. It also directs that the principle of “Do no harm” must guide all actions.
- To comply with USACE requirements, each placement area should undergo a detailed risk assessment and dam safety design review, especially where they border residential areas. The lifetime costs of doing this properly—design, construction, operation, maintenance, and risk communication—would likely exceed the cost of using safer, alternative placement sites to start with now.
- Protecting public safety and health must come first. This is the right time to adjust the project approach to meet USACE standards and ensure the Houston Ship Channel expansion proceeds on schedule without increasing risk to surrounding communities.

Document Review:

Environmental Impact Statement, Appendix C (Engineering): The Environmental Impact Statement was performed at the Feasibility Study level and as such did not and could not specifically consider the impacts of which placement areas are to be used for the project. The EIS very specifically stated that all available placement area alternatives would be considered including beneficial reuse.

The project is to deepen and/or widen the Houston Ship Channel to allow **more efficient access and reduce congestion** to private and public docks for larger and/or more heavily loaded ships. The channel is currently fully operational but requires extensive coordination and choreography of ship movements. The EIS and the Record of Decision also reference improvements to the safety of ship movements but the primary intent of the project is stated to be economic. Incidental benefits listed in the Record of Decision include reduced emissions, reduced hours of delay and reduction of the risk of vessel incidents. Life safety is not mentioned in any of the project documents.

EIS Study Description: “Dredged material placement is evaluated for upland confined placement, beneficial Use (BU) of dredged material, where practicable, and offshore placement at Ocean Dredged Material Disposal Sites (ODMDS).”

In addition to the upland placement areas other areas in Galveston Bay will also be created: Section 4.7.1.3 states that 4.5 Million Cubic Yards (MCY) of material will be placed in to create the Bird Island Marsh beneficial use area and “Should more material become available, the bird island sizes will be increased to improve the upland habitat being provided to avian populations, up to 6 acres, and the marsh dikes lengths or widths could be increased.” Section 4.7.1.5 discusses the creation of new Bay Aquatic Beneficial Use Sites to accommodate material dredged during the future 50 year O&M dredging of the ship channel. The volume required is stated to be 102 MCY total through construction of three 325-acre, 29 MCY cells and one 200-acre, 15 MCY cell. The material to be placed in the three upland placement areas could easily be accommodated in the Bird Island Marsh or the Bay Aquatic Beneficial Use sites.

Section 4.7.2 specifically discusses the design steps anticipated to be required during the design of the Upland Confined Placement Areas consistent with USACE Engineering Manual 1110-2-5025, Dredging and Dredged Material Management dated 2015. However, this design approach does not address the risk informed decision making, potential failure mode analyses on the placement area dikes or risk assessments required by the USACE Planning Guidance Notebook to determine if consequences of dike failure are high. The document specifically identifies project constraints as being protective of existing features

such as gas and oil wells, pipelines and other utilities without identifying human health and life safety as a project constraint which is inconsistent USACE planning guidance.

Authorization Documents:

Chief’s Report; April 2020 Houston Ship Channel Expansion Channel Improvement Project, Harris, Chambers, and Galveston Counties, Texas, Final Integrated Feasibility Report — Environmental Impact Statement: The Chiefs Report only mentions placement areas as follows: “Finally, the Galveston District Commander will manage placement cost uncertainty by working closely with the sponsor, the PHA, federal and state agencies, and other stakeholders on opportunities within the Galveston Bay Area to identify the least cost placement options and any potential beneficial use as authorized by law.” Section 8 of the Chief’s Report specifically states “In accordance with the Engineer Circular 1165-2-217 on review of decision documents, all technical, engineering, and scientific work underwent an open, dynamic, and rigorous review process to ensure technical quality. This included District Quality Control, Agency Technical Review, Policy and Legal Compliance Review, Cost Engineering Review and Certification, and Type I Independent External Peer Review (IEPR). The IEPR was completed by Battelle Memorial Institute.”

The June 30, 2020 Record of Decision for the project Section 2.m notes that “Proposed placement sites include upland disposal, marsh island creating, open water placement and placement in existing ocean dredged material disposal sites, as outlined in the Dredged Material Management Plan”. The Record of Decision notes specifically that the Locally Preferred Plan is the Recommended Plan. Table 6-5, below, presents the Locally Preferred Placement Plan from Appendix R of the Environmental Impact Statement, “Dredged Material Management Plan”. Based on all of the information currently available, the information presented in Table 6-5 is understood to define the purpose and use of the dredged material placement areas for the construction as well as O&M dredging materials disposal.

Table 6-5 – LPP Placement Plan

Segment and Features		PA/BU Site	Stations	NW Plan Description	NW Req. (KCY)	NW Avail. (KCY)	First Cost (\$000's)	O&M Plan Description	50-YR Total Incremental Cost (\$000's)
1	BE1_138+369_700 BE1_128+731_700 BE1_078+844_700 CW1_BR-Redfish_700	B18a B18b ODMDS	138+369 - 100+00	NW channel widening to Long Bird Island	1,172 ¹	1,994	\$94,400	BR-RF: ODMDS	\$19,400
				NW channel widening to 8-AC Bird Island	910 ¹				
			100+000 - 073+934	NW channel widening to ODMDS	3,038	3,038			
1, 2	CW1_Redfish-BSC_700 CW2_BSC_455	B18c B20 ODMDS	073+794 - 028+605	NW channel widening to ODMDS	2,474	2,474	\$172,800	RF-BSC: B18c, ODMDS, Mid Bay PA	\$291,100
				NW channel widening to Oyster Mitigation	2,030 ²	2,030			
				NW channel widening to Bird Island Marsh		3,181			
1	CW1_BSC-BCC_700	B6c B6a B10	-3.94 -28+605	NW channel widening to Bird Island Marsh	4,500 ¹	2,108	\$118,500	BSC & Flare: B6a, B6c, PA14, Connection, ODMDS	\$115,700
				NW channel widening to Atkinson Marsh Cell M11	2,800 ¹	2,800			
				NW channel widening to Atkinson Marsh Cell M7/8/9	600 ¹	1,000			
			NW channel widening to Sed. Attn. Feature	800 ¹	1,541				
3	CW3_BCC_455 BETB3_BCCFlare	B6b	08+78 - 67+11	NW channel/flare widening to Atkinson Marsh Cell M12	2,300 ¹	2,825	\$108,600	BCC & Flare: Spilman Island, BABUS, B6b, ODMDS	\$96,900
4	CW4_BB-GB CD4_Whole	BB1 BB2	684+03 - 850+00	NW widening/deepening to even lift on BW8	2,920	3,272	\$115,500	BB-GB: Lost Lake, BABUS	\$129,800
			850+00 - 930+00	NW deepening to even lift on E2 Clinton	352			GB-SB: Rosa Allen, Rosa Allen Exp., East Clinton	
5	CD5_Whole	BB9a	1110+78 - 1160+62	NW deepening to even lift on Glendale PA.	176	176	\$6,500	Sims to 610: West Clinton, BABUS	\$4,500
6	CD6_Whole TB6_Brady_900	BB9a BB9b	1160+62 - 1266+49	NW deepening to even lift on Glendale PA.	734	734	\$38,800	610 to Main TB: West Clinton, House Tract, BABUS	\$27,200
			00+00 - 30+95	NW deepening to even lift on Filterbed PA	267	267			
TOTALS					25,073	27,440	\$665,100		\$684,600
¹ All material is dredged and costs are accounted for in the estimate. Final PA sizes to be determined through additional geotechnical and engineering evaluations in PED ² Oyster mitigation varies by PA/BU type									
TABLE LEGEND NW=New Work BE=Bend Easing CW=Channel Widening CD=Channel Deepening B18b – 8 acre Bird Island B18c - 3-Bird Island Marsh B20 – Oyster Mitigation Sites B10 – Sedimentation Attenuation Structure B6a – Cell M7/8/9 B6b – Cell M12 BB1 – Develop BW8 site BB2- Develop E2 Clinton PA BB9a – Glendale PA BB9b – Filterbed PA B29 is used in DMMP Appendix for Existing ODMDS									
Table corresponds with Table 5-7 from Appendix R, DMMP.									

Figure 1: Recommended Plan (Locally Preferred Plan) Dredged Materials Placement Plan from EIS Appendix R.

Paragraph 9 of the Chief’s Report also states that “Washington level review indicates that the project recommended by the reporting officers is technically sound, environmentally and socially acceptable...”.

However, given that neither the Chief’s report, the Record of Decision nor the Environmental Impact Statement identified the placement areas to be used for the project, the life safety risks, health risks and societal impacts of using placement areas immediately adjacent to communities, residences and businesses could not have been properly considered. This is confirmed by the fact that a Type I Independent External Peer Review was documented to have been performed where a Type II Independent External Peer Review (Safety Assurance Review) is required and would have been performed had the life safety risks of the placement areas been recognized.

Neither the Record of Decision nor the EIS for the project mentions life safety or risk informed decision making and both documents state that the effects on Socio-Economics and Environmental Justice are insignificant despite only discussing construction of upland placement areas as it relates to compliance with local noise ordinances and minimizing

impacts during nesting seasons. There is no discussion of the use of upland confined placement areas adjacent to homes or the associated life safety risks or socio-economic impacts.

Upland Placement Area Site Locations: Site uses and locations are presented in Table 4-8: “Bayou Confined UCPA Quantities” in Appendix C of the EIS and the most relevant information is presented below.

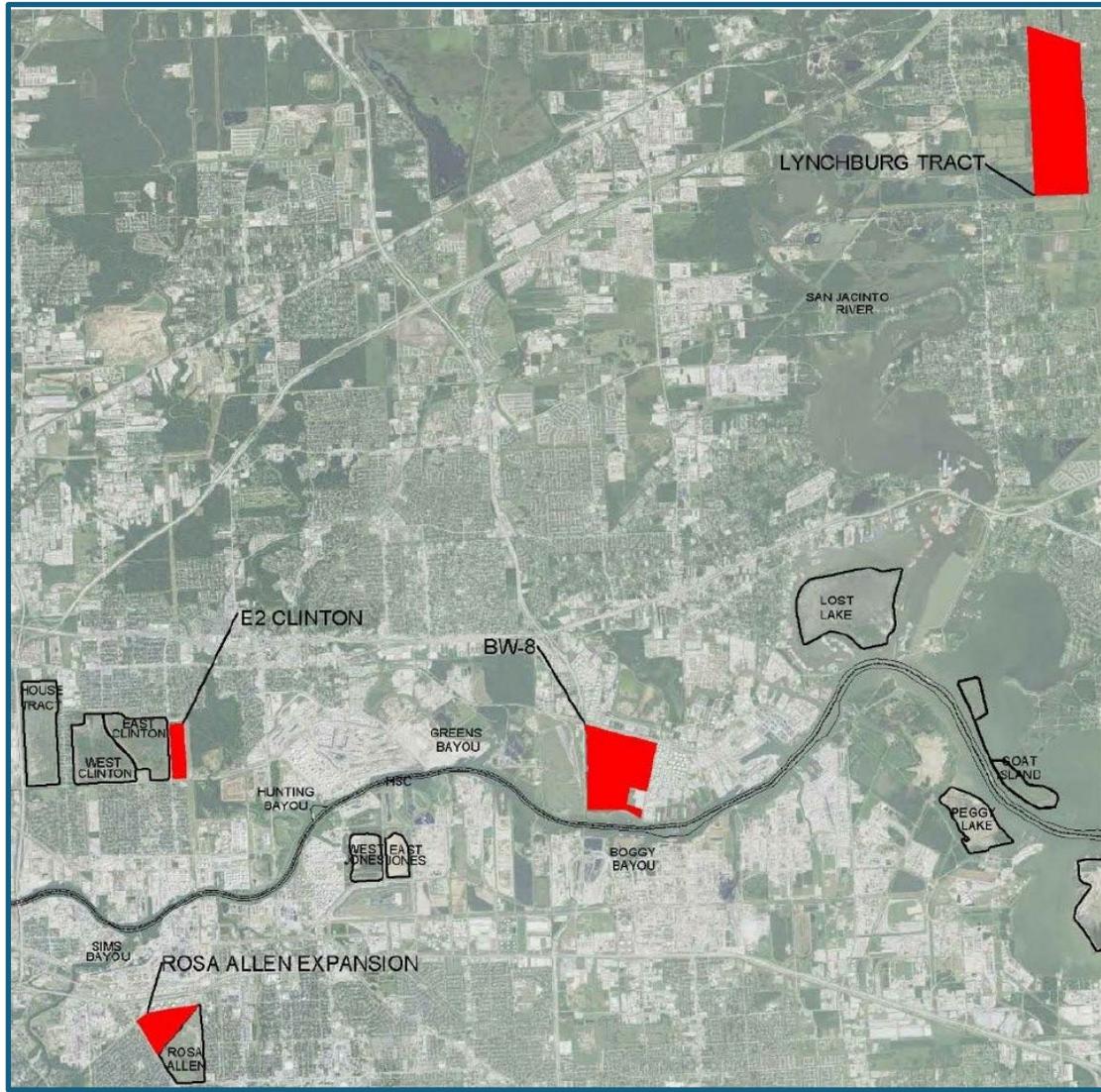


Figure 2: Upland Placement Areas Map (New areas shown in red)

As presented in the EIS, Appendix C, three **NEW** upland confined placement areas will be constructed and used for dredged material placement:

- 1) A new placement area at Beltway 8 (BW-8) with a 9' tall dike containing 2.92 MCY that does not have homes immediately adjacent to the site.



Figure 3: Beltway 8 (BW-8) New Placement Area

- 2) A new placement area at the E2 Clinton (E2C) location east of the existing Clinton placement areas with a 9' tall dike containing 562,000 cubic yards of dredged materials that has homes immediately north and south of the site.



Figure 4: Clinton East 2 New Placement Area

3) The current Rosa Allen placement area expanded to the northwest and the existing dikes raised from approximately 10' tall to 29' tall (55' top of dike elevation with an original ground elevation of 26') ultimately containing a total of 10.76 Million Cubic Yards of dredged material within the expanded placement area.



Figure 5: Rosa Allen Placement Area Raise and Expansion

The Rosa Allen site would be used for placement of dredged material from long term Operation and Maintenance and not from the current project. The other areas noted above would only be used for placement of materials dredged from the current ship channel improvement project.

It is unclear why the E2 Clinton and Rosa Allen sites that present significant public risk are required to be used at all given the proximity and size of the new BW-8 site and the potential to improve the dike foundation and raise the dikes on that site using modern risk informed design principals, as required by USACE guidance, all while limiting the induced risk on surrounding properties since there are no residential properties around the BW-8 site.

A typical dike section was developed to contain the anticipated fill. At BW-8 and E2C, the dike section was designed to contain the proposed new work materials. At RSE, the dike was designed to create an initial dike capable of containing maintenance materials and that future raising events would increase its height. In both cases, the dike initial construction consists of borrowing of interior materials to construct a dike to target elevation. The section would have a 20-foot crown and 3H:1V side slopes on both sides.

The dikes would be constructed mechanically and volumes account for 40% material losses during construction. Table 4-8 provides the measures and quantities relative to each location.

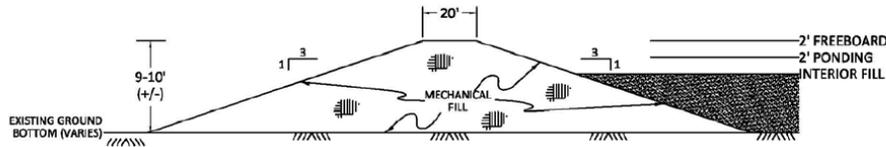


Figure 4-28: Typical Bayou UCPA Initial Dike Section

Figure 6: Typical Dike Section at BW-8 and East Clinton 2 Placement Areas

Measures Evaluated

Following placement of new work materials on BW-8 and E2C, no further work would be done at these sites. Following the initial dike raising at RSE, the area could begin receiving maintenance materials. Dikes would be raised through normal construction general means during future years operations and maintenance. An ultimate dike elevation of 55 feet was assumed feasible for RSE, matching the USACE stability analyses for the adjacent Rosa Allen PA as part of the HSC Preliminary Assessment. Adjacent ground elevation was approximated at +26 feet.

Table 4-8: Bayou Confined UCPA Quantities

Placement Area	Acreage (AC)	Perimeter (FT)	Dike Ht. (FT)	Dike Qty. (CY)	Site Cap. (CY)	Ult. Cap. (CY)
BW-8	355	16,800	9.1	446,000	2,920,000*	NA
E2C	70	8,900	9.3	244,000	562,000*	NA
RAE	138	11,300	10.0**	349,000**	1,113,200**	10,760,000

Notes:

*BW-8 and E2C represent quantities and capacities to contain new work fill only.

**RAE quantities representing initial dike raising quantity to make site ready to receive maintenance materials, and initial maintenance material capacity. Future dike raising events provide increased capacity to achieve estimated ultimate capacity.

Figure 7: Upland Placement Area Statistics for this Project

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				NW channel widening to Oyster Mitigation	2,030 ²	2,030			
	CW2_BSC_455		25+58 - 221+000	NW channel widening to Bird Island Marsh	4,500 ¹	2,108		BSC & Flare: B6a, B6c, PA14, Connection, ODMDS	
1	CW1_BSC-BCC_700	B6c	-3.94 - 28+605	NW channel widening to Atkinson Marsh Cell M11	2,800 ¹	2,800	\$118,500	BSC-BCC: B6a, B6c, PA15, ODMDS	\$115,700
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		BB9b	00+00 - 30+95	NW deepening to even lift on Filterbed PA	267	267			
TOTALS					25,073	27,440	\$665,100		\$684,600
¹ All material is dredged and costs are accounted for in the estimate. Final PA sizes to be determined through additional geotechnical and engineering evaluations in PED ² Oyster mitigation varies by PA/BU type									
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Table corresponds with Table 5-7 from Appendix R, DMMP.									

Figure 8: Recommended Plan (Locally Preferred Plan) Dredged Materials Placement Plan from EIS Appendix R.

The presentation of the use of dredged material placement areas is unnecessarily complicated in the project documents and to gain a clear understanding of the use of the new and existing upland placement areas, the information presented in the Record of Decision, the EIS Engineering Appendix C and the EIS Dredged Materials Management Plan Appendix R must be merged. For simplicity, a summary by site is listed below as best as it could be understood. It should be noted that there is no discussion of discontinuing the use and capping of any of these upland sites in any of the documents reviewed. USACE should develop a clear graphic showing the location and use of each placement area for reference by the community.

Existing House Placement Area: To be used for placement of dredged materials during long term Operation and Maintenance dredging but not for the deepening or widening project.

Existing Glendale Placement Area: To be used for placement of dredged materials from the Channel Deepening project in reaches 5 and 6. In recent community meetings, Port Houston has indicated that this site is a preferred placement area for future use and will be raised 10 feet but that information is not presented in the project formulation documents.

Existing Filterbed Placement Area: To be used for placement of dredged materials from the Channel Deepening project in reach 6. In recent community meetings, Port Houston has indicated that this site is a preferred placement area for future use and will be raised 10 feet but that information is not presented in the project formulation documents.

Existing West Clinton Placement Area: To be used for placement of dredged materials during long term Operation and Maintenance dredging but not for the deepening or widening project.

New E2 Clinton Placement Area: To be used for placement of dredged materials from the Channel Deepening and Channel Widening in reach 4 and the Back Bay.

New BW-8 Placement Area: To be used for placement of dredged materials from the Channel Deepening and Channel Widening in reach 4 and the Back Bay.

Existing and Expanded Rosa Allen Placement Area: To be used for placement of dredged materials during long term Operation and Maintenance dredging but not for the deepening or widening project.

USACE Guidance Documents:

Planning Guidance. The US Army Corps of Engineers (USACE) has requirements and procedures defined in existing national policy that requires Risk Informed Decision Making be applied to all civil works projects consistent with the 2017 USACE Institute for Water Resources authored, *Planning Manual Part II: Risk-Informed Planning* which is included as part of the Planning Community Toolbox at www.corpsplanning.us. Risk informed decision making has not been included as a part of the project development or implementation to date.

Review Policy Guidance. USACE also has a national review policy in place with specifically defined procedures that requires that projects undergo multiple detailed reviews for comparison with national Tolerable Risk Guidelines which are defined and accepted across multiple federal agencies. These required reviews are Agency Technical Reviews (ATR) within USACE (by independent staff outside of the Galveston District) as well as an Independent External Peer Review (IEPR) by experts from outside USACE as defined in Engineering Regulation 1165-2-217, *Civil Works Review Policy*. For projects with life safety risk, an Independent External Peer Review Type II, Safety Assurance Review is specifically required to evaluate ways to minimize the life safety risk of the project

The reviews discussed above were completed for the Houston Ship Channel Project at the Feasibility Study level but, since the placement areas to be used were not identified in any document prior to design, the placement areas could not have been considered in those reviews and the proper level of review and risk assessment was not performed. The proper reviews, specifically a risk assessment and Type II Independent External Peer Review, Safety Assurance Review, for the placement areas have not yet been performed and is required. Those reviews are typically performed as part of the 65% design and again upon completion of design that addressed the comments from the 65% process. A review plan that lays out the level and schedule for reviews is required by USACE policy to be developed and made available to the public and that plan has not been completed or publicly posted on the Galveston District web site that the author could locate. The author has high confidence that structure and staff exists within USACE and the Southwest Division to ensure that the health and safety of the public is protected if the project design is subjected to the proper reviews, as required by national USACE policy. However, it is the author's opinion that the use of some of the upland confined disposal areas, as currently proposed, is inconsistent with United States Government and international best practices for these types of facilities and, given the proximity of communities, homes and businesses to these facilities, the proposed future use of these facilities presents significant and unnecessary increased life and safety risks to the public. This opinion

should be confirmed or disputed through a risk assessment performed by personnel from outside of Southwest Division.

USACE has well-defined procedures in place and highly qualified staff at both the national level and within the Southwest Division (that includes Galveston District) to define, minimize and communicate these increased risks to the public. It is the author's opinion that when the Galveston District develops a review plan and follows the applicable USACE national guidance, that a decision will be reached that the future use of the upland confined disposal facilities that are adjacent to communities, homes and businesses presents significant and unnecessary increased life and safety risks to the public.

It is believed that the cost of modification and operation and maintenance of the existing placement areas for safe future use would be prohibitively expensive and would likely justify the use of placement areas, such as BW-8 that are not adjacent to populated areas for both the current project and long term O&M. There are numerous other confined placement areas and Ocean Dredged Material Disposal Sites (ODMDS) that could be made available for use that would not increase the risk to human life and safety. These opinions are particularly valid when it is considered that the increased imposed risk to life and safety of using placement areas adjacent to communities is in exchange for project benefits that are entirely economic benefits to be gained through future improved efficiency of the operation of the ship channel and port.

The ship channel and the port are operational now in their current configuration and there are no life safety risks in the current operation of the port or ship channel defined in any project documents reviewed to date. The tradeoff of economic benefits of construction of the project for dredged material disposal in placement areas that do not increase health risks, increase the risk for loss of life or increase the risk of economic damage to communities, homes and businesses would be a better long term solution for the communities, USACE and the Port of Houston Authority as the project sponsor.

Sea Level Rise and Changes to Future Conditions: Appendix C of the Environmental Impact Statement specifically acknowledges future sea level and other environmental changes and evaluates and discusses how those changes could potentially impact dredging and shipping operations, however it states that "Wind, tide, and current data and model outputs for the area should be collected and analyzed to evaluate design wave conditions for the design of the shore protection elements, and to consider future sea level change into the design process. Since future sea levels are unknown, dikes will be monitored and added to in a long-term "adaptive" approach." The documents do address the 2013 USACE issued guidance for incorporating the direct and indirect physical effects of projected future sea level change across the project life cycle but only as they

potentially apply to channel dredging and not as it potentially relates to the upland placement areas except to note that the placement areas would not be overtopped by projected sea level rise. *Engineering Regulation 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs* and *ETL 1100-2-1 Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptations*. ER 1100-2-8162 and ETL 1100-2-1 specifically provide guidance relevant to planning, engineering, designing, constructing, operating and maintaining USACE projects. Appendix C of the EIS also recognizes regional land subsidence and ER 1100-2-8162 also discusses the need to evaluate land subsidence and that requirement is particularly important for this project since the regulation states that “The areas of maximum vertical land motion can generally be regionally described. For instance, in the coastal Louisiana and Texas region and the southeast Alaska region, the vertical land motion component dominates the trend.” The adaptive management approach proposed in the project documents is also inconsistent with USACE program management and Federal project authorization and funding since, without specific authorization and funding, there will be no mechanism or funding by which to perform adaptive management of placement area slope stability, slope protection, erosion control, seepage or overtopping design, operation and maintenance.

The cost and schedule risk matrix did identify the implementation of estimating sea level rise could affect the project cost and discussed eliminating this cost risk during the design process by implementing the guidance discussed above. However, the cost and schedule risk matrix only discussed sea level rise as a potential cost reduction since it could reduce dredging depths. There is no discussion of the potential for sea level rise to increase the slope stability risks to all of the historical, current and future placement areas.

Capping of Placement Areas: Provisions for capping of the placement areas that will not be used in the future could not be located in the documents reviewed other than one mention in the dredged material management plan that public comment indicates that residential areas desire that upland sites that will not be used be closed and capped.

FEMA, USACE and Texas Dam Safety Regulations: The language associated with the placement area structures and the size of the dike raises appear to be intended to specifically avoid dam and levee safety regulations. However, where the dikes present life safety risk, regardless of their height or retained volume, the application of dam design and construction requirements and processes should be considered to be best practices and implemented in order to be protective of the safety of the adjacent neighborhoods.

Texas Commission on Environmental Quality Title 30, Part 1, Chapter 299, Subchapter A, Rule 299.1 dated 5/13/2024 states that Texas regulations apply to structures:

- 1) Over 25 feet tall with a storage capacity greater than or equal to 15 acre-feet.
- 2) Over 6 feet tall with a storage capacity greater than or equal to 50 acre-feet.
- 3) Are high- or significant-hazard dam over 6 feet high regardless of maximum storage capacity.

All of the placement area dikes are high hazard structures (three or more habitable structures in the breach inundation area downstream of the dam. (Chapter 299.14 33 TexReg 10465). None of the exemptions presented in the referenced regulation are applicable to the placement areas and all of the placement areas are subject to regulation, permitting and oversight under the Texas dam safety regulations once they are turned over to the sponsor.

Figure 1. Minimum Dam Heights

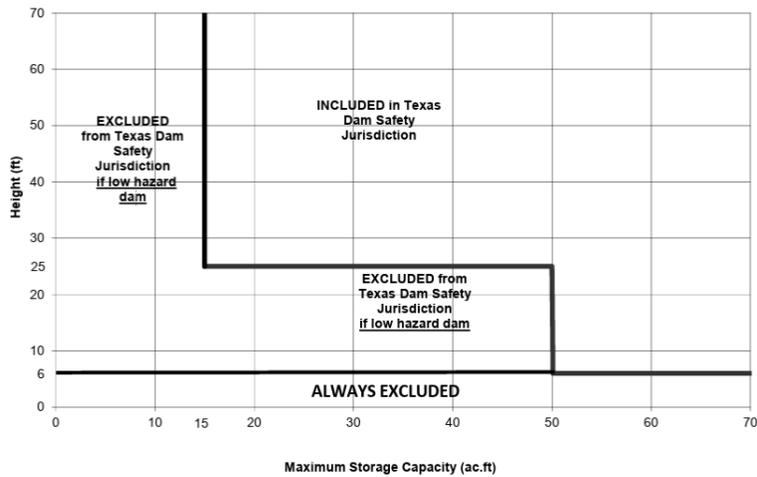


Figure 9: Figure: 30 TAC 299.1(a)(2) Texas regulatory applicability for dams.

Additionally, under its federal funding agreement with the Corps of Engineers as outlined in the Environmental Impact Statement (EIS), Port Houston must follow USACE regulations, policies, and guidance.

According to Engineering Regulation 1110-2-1156, “Safety of Dams – Policy and Procedures” (2014), any structure over 25 feet tall OR with 50 acre-feet of storage qualifies as a dam. All the proposed upland placement areas meet one of these criteria, meaning they fall under USACE dam safety regulations for design and construction using Federal funding.

That same regulation states that “Life safety is paramount” and that public safety cannot be traded off for other project benefits. It also directs that the principle of “Do no harm” must guide all actions.

Note that these structures should be designed and constructed using USACE dam safety standards and processes but those standards do not require that the structures be considered part of the USACE dam safety portfolio.

Hazardous, Toxic and Radioactive Waste: The EIS, Chief’s Report and Record of Decision state that the sponsor shall “Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, rights-of-way, relocations, and disposal areas that the Federal Government determines to be necessary for the construction or operation and maintenance of the general navigation features.”

EM 1110-2-5025 Dredging and Dredged Material Management extensively discusses that dredged materials are likely to be contaminated and lays out processes to sample, identify and address contaminated material including that “ Effluent monitoring (from placement areas) is required during filling and may be required for rainfall runoff while contaminated material is exposed (that is, prior to capping with clean material)”; “air monitoring may be considered where extremely high concentrations of organic contaminants are present in the dredged material and where there is a high likelihood of human receptors”

The cost and schedule risk assessment in Appendix C of the EIS specifically notes the potential for contaminated dredge material, specifically in segments 5 and 6, and the potential need for treatment of effluent from the placement areas. This effluent will flow through the neighborhood storm drainage systems in the neighborhoods around all of the placement areas and be a source of uncontrolled exposure to the community. Since the Rosa Allen Placement area is planned for use for the next 50 years the neighborhoods in

that area are at the greatest risk both in terms of potential exposure and the length of exposure. Without adequate sampling, of dredged material as well as sampling of drainage and precipitation runoff flow from the placement areas, the exposures will be entirely unknown and unmanaged. It should be clarified that the cost and schedule risk assessment ONLY provides consideration of project cost and schedule risk. It does not in any way consider chemical exposure health risk or physical life safety risk although it points to the fact that USACE did consider chemical contamination risk and how that risk could impact the cost of the project but not the health of the community.

Raising of the existing placement area dikes and future raising of the dikes at the Rosa Allen placement area was and is to be accomplished by excavating material from inside of the existing placement area for mechanical handling and compaction of this previously dredged material as fill to raise the dike. This construction technique is referred to as “Upstream Raise” construction in the tailings dam industry and has been legally prohibited in Brazil due to the frequent failures and loss of life associated with this construction technique. This construction approach is particularly challenging since it relies on the dredged material inside the placement area to serve as the foundation of the dike raise and the properties of this material are largely unknown and cannot be controlled. This construction approach also exposes the dredged material in the placement area that has been moved to the berm to uncontrolled runoff and offsite migration of the dredged material that may be contaminated or may have been comingled with contaminated material in the placement area.

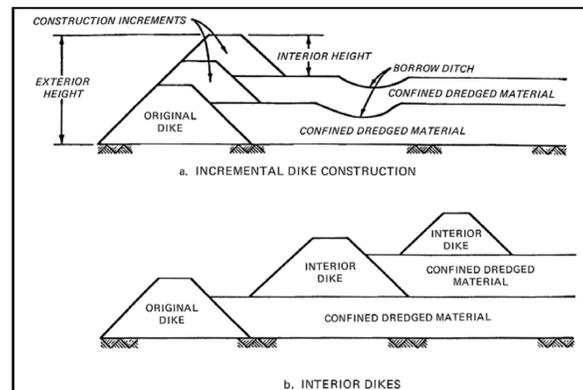


Figure 10: Upstream Dike Raising Method from EM 1110-2-5025.

Land Subsidence: As it relates to the potential impacts of sea level rise on the project, the potential impacts of regional land subsidence are recognized in the project documents and local monitoring can be performed by satellite through the use of Interferometric Synthetic Aperture Radar (InSAR). This technology has the capability to measure millimeters of settlement over wide areas and could also be used to monitor slope stability and settlement of the placement areas after

filling. Three regional resources exist that could be helpful to the District in addressing these questions:

- 1) Dr. Pietro Milillo, Assistant Professor of Geosensing Systems Engineering at the University of Houston.
- 2) Dr. Danielle Smilovsky with the Conrad Blucher Institute for Surveying and Science in Corpus Christi, Texas.
- 3) Harris Galveston Subsidence District (hgsubsidence.org). The Subsidence District uses InSAR and conventional surveying to monitor subsidence due to water, oil and gas extraction and has found that Houston is the fastest sinking major city in the United States.

Slope Stability: The stability of the slopes of the dikes around the placement areas appears to be recognized in project documents as a significant concern to the designers and slope stability analyses performed in 2016 are presented beginning on page 1653 of Attachment 7, Appendix C, the Engineering Appendix of the EIS. However, only typical or example slope stability cross sections for the “Short Term Condition” and the “Long Term Condition” for the Glendale, House, Filterbed, Clinton East and West placement areas as well as the Rosa Allen placement area are presented. Stability analyses for the “new” placement areas is not presented. The stability sections shown are dated 2016 and are not indicated to be approved or officially incorporated into the design. There also appear to be significant non-conservative inconsistencies in the water levels and failure surfaces used and the basis for the material properties is unknown. None of the stability analyses include a compacted clay cap which would make the analyses non-conservative. The cross sections also confirm that the proposed method of construction is the “upstream method” where dike raises are constructed on top of the previously placed dredged material. Legislation has been passed in Brazil banning this construction method for tailings dams that are very similar to placement area dikes (but much taller than the placement area dikes). The taller tailings dams in Brazil were designed based on the specific mine tailings characteristics which are much stronger than dredged materials. However, similar concerns exist for both types of structures. This legislation was passed due to the frequent fatal failures of upstream constructed tailings dams in Brazil.

None of the project slope stability evaluations consider the potential impacts of sea level rise or storm surge on the stability of any of the placement areas. There is no discussion in the document of the expected performance or results of the slope stability analyses or what criteria they are being evaluated against. The analyses are simply included in the appendix.

The issue of static liquefaction and flow failure (volumetric collapse of loose sediments) of the placement areas, the cause of the most recent fatal failure of a tailings dam in Brazil and at least one flood control dam in the US, is not discussed or addressed in any way. The most recent static liquefaction failures occurred in 2019 after the performance of the slope stability analyses presented in the EIS so the presented analyses are considered to be obsolete and of limited value. The 2025 Clinton Placement Area slope failure directly confirms that the presented slope stability

analyses should be revisited and adjusted for back analyses of the actual slope failures of the Houston Ship Channel placement areas.

It is interesting to note that the Lost Lake placement area slope stability analysis shows a significant area of deep soil mixing that may have been constructed to address a slope stability issue on the placement areas there but there is no discussion of these past challenges in any of the documents reviewed to date or the back analyses of the events that led to a major investment in ground modification on dredged material placement areas. The slope stability analyses for the project design should be presented and discussed in detail, with acceptable factors of safety for high risk slopes adjacent to neighborhoods defined. These results should be reviewed in detail as part of the Agency Technical Review and Type II, Independent External Peer Safety Assurance Review for the design documents. These analyses will be a significant effort given the stratigraphy of each area, the number of placement areas being used and the perimeter length of each of the placement areas.

The ability to properly perform design, operation and maintenance analyses on placement areas and the associated dikes are also a general concern because the US Army Corps of Engineers does not own, nor does it have any regulatory authority over, tailings dams. The placement area dikes are built and operate very much like mine tailings dams. Mine tailings dams have experienced much higher rates of failure than conventional dams that retain water reservoirs typically because of the construction methods and methods used to raise tailings dams which are similar to those used for placement areas except that tailings dams typically have features in the embankment to enhance drainage, improve stability and control progression of potential failure modes that placement area dikes do not. The high water content-low density semisolid materials behind the dams are also similar for both tailings dams and dredged materials placement areas.

Because of the unique challenges of tailings dams the Association of Dam Safety Organizations has specific guidance on the design and Construction of Tailings Dams; the Canadian Dam Association has defined specific guidelines for tailings dam breach analyses; the United States Society on Dams has endorsed the Geoprofessional Business Association's *Best Practices for the Engineer of Record for Tailings Dams* and developed the 2022 White paper on *US Regulations and State of Practice for the Closure of Tailings Dams*; the International Council on Mining and Metals (ICMM), United Nations Environment Programme (UNEP), and the Principles for Responsible Investment (PRI) convened GlobalTailingsReview.org to develop *Global Industry Standard on Tailings Management*; the International Council on Mining & Metals (ICMM) in 2019 developed the *Integrated Mine Closure, Good Practice Guide*, 2nd Edition, Published by Seacourt; the Society for Mining, Metallurgy & Exploration (SME) in 2022 developed the *Tailings Management Handbook, A Life Cycle Approach*, Englewood, Colorado, USA; and the International Commission on Large Dams has developed 13 separate documents regarding tailings dams, the most recent of which is ICOLD Bulletin No. 194 *Tailings Dam Safety*.

These documents provide valuable sources of information and guidance on the design, construction, operation, maintenance, monitoring and closure of tailings dams that would serve USACE well to consider for placement area design where life safety or high incremental economic losses are a concern.

ICOLD specifically states that for static conditions, a slope stability factor of safety of 1.5 is the minimum target factor of safety **IF** “leading international practice has been adopted with respect to site characterization, selection of parameters and design methodology. Stability analyses is most often based upon Factor of Safety (FOS) values calculated using limit-equilibrium (L-E) analyses. This is adequate where materials comprising the foundation and the structural zones of the tailings dam are expected to be dilative over the full range of operating conditions over the life of the facility.” ICOLD also states that Ignoring static liquefaction stability is unsafe and “Upstream tailings dams must be analyzed for liquefaction” and it must be assumed that static liquefaction can occur even after site closure. It should again be noted that the placement area use exactly the same upstream construction method as is being referenced for tailings dams. The failures in Brazil of upstream constructed dams in 2015 and 2019 followed all regulations but ignored liquefaction stability. The ICOLD document addresses this stability analysis in detail.

<https://www.youtube.com/watch?v=QEduIBY6Xw>

USACE Acceptable Factor of Safety: EM 1110-2-5025 *Dredging and Dredged Material Management* provides specific guidance for placement area dike investigations, characterizations and analyses including specific required factors of safety for dike slopes under various conditions. However, where the dikes are greater than 30’ in height or where the consequences of failure are very severe, the criteria in EM 1110-2-1902 Slope Stability for Earth and Rockfill Dams are to be used which are slightly higher than those required by EM 1110-2-5025. EM 1110-2-5025 also states in section “5.24.2.3 Design of a structure. EM 1110-2-1902 (Slope Stability) and EM 1110-2-2300 (Earth and Rockfill Dams – General Design and Construction Considerations) provide proven methods for design and construction of earth and rock filled structures. These procedures should be used to supplement engineering considerations of elevation requirements and earth and water pressure forces.” This statement effectively says that dam design standards should be used for dredged material placement dikes. The author believes that these statements establish a nexus between guidance for dredged material placement area dikes, conventional dams and potentially tailings dams where the consequences of failure are severe. The intent in the guidance is clearly that greater care should be taken with placement areas where the consequences of failure are severe and the dam safety community already has standards, policy and procedures in place for similar structures on projects where life safety is a consideration. Given the above discussion, it is possible that the design for different segments of a dike for a placement area would be different where it is adjacent to homes than where it is adjacent to a waterway or open field.

Previous Failures:

Glendale Spillbox: In 2017, during Hurricane Harvey, it was reported that a “metal pipe” associated with the Glendale placement area failed and caused a release of water into the neighborhood from the placement area. This failure was reported by the community adjacent to the placement area and was not included in any project documentation. The specific pipe that failed and the amount of water released and impacts is not known. However, this failure is assumed to be associated with the spillbox at the site and points out that the hydrologic and hydraulic design of the placement areas is also very important and is not specifically addressed in any project documents presented to date. Powerpoint slides from a “Technicalpalooza” meeting do show some stormwater design evaluation that indicates that the placement areas block the natural drainage and the stormwater systems around the placement areas are not adequate to handle neighborhood and drainage from the placement areas. These issues will require specific design effort and likely modification of the operation of the placement areas and/or the storm drainage systems to ensure that the residents are not exposed to water from the placement area. It appears that USACE and their designer is aware of this requirement but the design has not been completed which is reasonable at the current stage of the design. It will be essential to perform detailed three-dimensional hydrologic and hydraulic modeling to design the system and evaluate the risk.

Slope Stability: At least two slope failures of placement area dikes have occurred in the past on the Houston Ship Channel which have raised valid concerns from the residents adjacent to all of the placement areas. These failures also call into question the technical accuracy and/or conservatism of the placement area dike designs and potentially the operation of the placement areas.

1957: In 1957, a large slope failure in one of the placement area dikes occurred and the dredged material flowed into a neighborhood causing significant damage, potential long term health effects and a significant risk of loss of life. The cause of this failure is not known but given the large rapid failure of the dike and the large release of dredged materials, static liquefaction may be indicated.

2025: In late January 2025, a slope stability failure developed at the northwest corner of the East Clinton Placement Area. This slide is documented in a 07 February 2025 CESWG-ECE-S Memorandum for Record. The slide is documented as a surface slide on the exterior of the dike and the photos included in the Memorandum appear to confirm this conclusion. The cause of the slope failure was attributed to saturation of the slope due to snow the week before. While this slope failure was not an immediate threat to the overall integrity of the placement area berm it could have progressed to a breach in the placement area had it not been reported by the public and repaired quickly. It is not clear whether the placement

areas are inspected regularly by Government personnel or the sponsor or if there is a plan requiring inspections.

The 2016 slope stability analysis for the long term stability condition on the Clinton East PA from Appendix C of the EIS is presented below and raises several concerns. The factor of safety for the critical failure surface is shown as 1.78 and is a much different slope failure than the one that actually occurred. For a slope failure that actually occurred, the analyses should show a failure surface that looks almost exactly like the one observed in the field and the factor of safety should be at or below one. The slope geometry of the dike shown in the picture from the memo is also much different, and more critical, than that shown in the slope stability analyses. The memo also notes several other undulations along the slope without defining the reason for the mention of these undulations. It is believed that the geotechnical engineer was pointing out that there may be other areas of slope movement and/or failure that have not fully developed yet. The repair of the slope failure does not appear to have investigated or addressed these other areas of concern.



Figure 11: Location of the 2025 slope failure at the East Clinton Placement Area (2945'34.52N, 914'48.74"W)

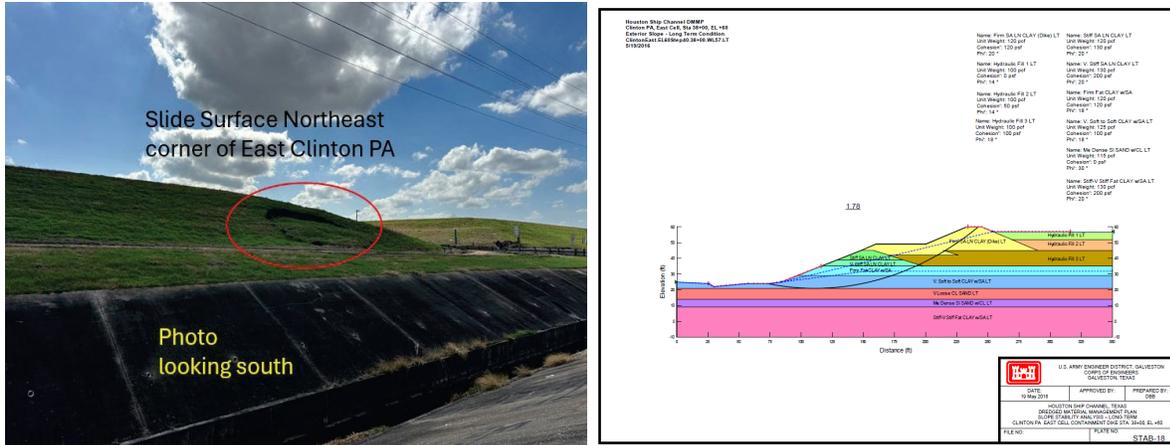


Figure 12: 2025 Slope Failure at East Clinton Placement Area and the 2016 Slope Stability Analysis of the same PA

Although this recent slope failure is an issue of concern it does provide an opportunity for USACE to perform a backward analysis of the failure that will allow them to calibrated the soil parameters of the dike to the actual observed performance potentially making all of their slope stability analyses more accurate. The discrepancy between the 2016 analyses and the 2025 actual behavior clearly identifies the need for updated slope stability analyses for all placement areas whether active or not.

Failures at these placement areas in 1957, 2017, and 2025 have already occurred which demonstrates the life safety risk. Yet the Final Integrated Feasibility Study and Environmental Impact Statement fails to include human health or life safety as project constraints, contrary to USACE risk informed Planning policy.

Placement Area Design Rainfall Intensity: Each placement area must be designed withstand and effectively contain or safely convey stormwater from a selected design level storm rainfall. Typically, general civil works projects are required to be designed to effectively manage stormwater runoff events that are approximately 10 to 25 year rainfall events (0.1 to 0.25 annual exceedance probability). USACE civil works projects such as levees are typically designed to effectively manage stormwater runoff events (interior drainage) at the 100 year rainfall level (0.01 annual exceedance probability). While the selection of events at these levels is typical, there are no restrictions on design teams that would prevent the selection of different events that are more, or less, protective given appropriate justification.

Rainfall events are selected from the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server (PFDS) that is based on the NOAA Atlas 14 precipitation database.

The Atlas 14 database is currently being revised and will be released as Atlas 15 which is scheduled for 2026 and should allow time for incorporation of the most current data into the design of the placement areas. For the purposes of this evaluation, the Atlas 14 data will be used since it is the most current available information.

Rainfall for the Hurricane Harvey level event is reported to be approximately 6" per hour, 14" over 3 hours and a storm total of 61" over four days.

The Atlas 14 table for the general area of the placement areas is shown below. The precipitation estimates vary slightly depending upon the exact point chosen on the map but are within the accuracy required to provide effective stormwater design.

As highlighted in the table below based on old data prior to Hurricane Harvey, the Hurricane Harvey one hour rainfall is between a 50 and 1000 year event, the three hour rainfall is between a 200 and 1000 year event and the storm total four day rainfall is at or above the 1000 year event given that it was the maximum recorded precipitation. The Hurricane Harvey precipitation will have to be included in the Atlas 15 database update and all of the precipitation data will increase from that currently and previously used which will also change the design of the placement areas even though all of these average return intervals are well above the frequencies typically used to design stormwater conveyance systems. It is important to note that a 200 year or 1000 year event DOES NOT mean that the rainfall will only happen once every 200 or 1000 years. This terminology is only a reference to a statistical method of modeling the sizes of storms, not necessarily how often that they happen. It has happened that two 100 year storms or a 100 year storm and a 500 year storm have happened in the same location over the course of a few months. It is also important to note that a rainfall event LARGER than Hurricane Harvey is possible and the upper end of the table should be expected to increase when the new rainfall statistics are recalculated. These exact "year"/return interval is not as important as the need for the new statistics to be used in the future design of the placement area runoff management systems and slope stability calculations to ensure that the risk to life posed by the placement areas is properly addressed in the design process. Both the State of Texas and USACE design guidance requires that a Probable Maximum

Precipitation study be conducted. This design is likely to require designed overtopping sections and/or emergency spillways be constructed over the placement area dikes.

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.509 (0.385-0.672)	0.607 (0.462-0.789)	0.763 (0.581-1.00)	0.897 (0.673-1.20)	1.08 (0.789-1.49)	1.23 (0.873-1.74)	1.39 (0.957-2.01)	1.56 (1.04-2.32)	1.79 (1.16-2.76)	1.98 (1.25-3.12)
10-min	0.804 (0.608-1.06)	0.961 (0.731-1.25)	1.21 (0.921-1.59)	1.42 (1.07-1.90)	1.73 (1.26-2.38)	1.97 (1.39-2.78)	2.21 (1.53-3.21)	2.47 (1.66-3.68)	2.82 (1.83-4.34)	3.09 (1.96-4.88)
15-min	1.03 (0.782-1.36)	1.23 (0.933-1.60)	1.54 (1.17-2.01)	1.80 (1.35-2.40)	2.17 (1.58-2.98)	2.46 (1.74-3.47)	2.76 (1.91-4.01)	3.10 (2.08-4.61)	3.56 (2.31-5.48)	3.93 (2.48-6.20)
30-min	1.49 (1.13-1.97)	1.76 (1.34-2.30)	2.19 (1.67-2.88)	2.56 (1.92-3.41)	3.07 (2.23-4.20)	3.47 (2.45-4.88)	3.89 (2.68-5.64)	4.37 (2.94-6.50)	5.06 (3.29-7.81)	5.63 (3.57-8.90)
60-min	1.96 (1.49-2.59)	2.34 (1.78-3.04)	2.94 (2.24-3.86)	3.46 (2.60-4.61)	4.18 (3.03-5.73)	4.74 (3.35-6.68)	5.35 (3.69-7.76)	6.06 (4.08-9.04)	7.12 (4.63-11.0)	8.02 (5.07-12.7)
2-hr	2.35 (1.94-3.34)	2.93 (2.46-4.12)	3.80 (2.90-4.95)	4.59 (3.46-6.09)	5.74 (4.19-7.85)	6.68 (4.75-9.40)	7.73 (5.36-11.2)	8.94 (6.03-13.3)	10.7 (7.00-16.5)	12.3 (7.79-19.3)
3-hr	2.54 (1.94-3.34)	3.28 (2.46-4.12)	4.35 (3.32-5.63)	5.34 (4.04-7.06)	6.83 (5.01-9.33)	8.08 (5.77-11.4)	9.50 (6.59-13.7)	11.1 (7.51-16.4)	13.5 (8.83-20.7)	15.6 (9.90-24.4)
6-hr	2.92 (2.24-3.81)	3.91 (2.92-4.83)	5.32 (4.08-6.84)	6.67 (5.06-8.78)	8.71 (6.43-11.9)	10.5 (7.52-14.7)	12.5 (8.71-17.9)	14.8 (10.0-21.8)	18.3 (12.0-27.9)	21.2 (13.6-33.2)
12-hr	3.39 (2.61-4.40)	4.60 (3.46-5.85)	6.34 (4.88-8.11)	8.00 (6.10-10.5)	10.5 (7.77-14.2)	12.7 (9.11-17.6)	15.2 (10.6-21.6)	18.1 (12.3-26.5)	22.7 (14.9-34.6)	26.7 (17.1-41.6)
24-hr	3.91 (3.02-5.06)	5.36 (4.04-6.54)	7.44 (5.75-9.46)	9.41 (7.21-12.3)	12.4 (9.21-16.7)	15.0 (10.8-20.8)	18.0 (12.6-25.5)	21.5 (14.7-31.4)	27.1 (17.9-41.0)	31.8 (20.5-49.4)
2-day	4.43 (3.44-5.71)	6.17 (4.64-7.43)	8.60 (6.67-10.9)	11.0 (8.43-14.2)	14.6 (10.9-19.7)	17.8 (13.0-24.7)	21.4 (15.1-30.3)	25.4 (17.4-36.9)	31.3 (20.7-47.1)	36.1 (23.3-55.8)
3-day	4.82 (3.76-6.19)	6.71 (5.05-8.05)	9.34 (7.26-11.8)	11.9 (9.19-15.4)	15.9 (12.0-21.4)	19.4 (14.2-26.9)	23.4 (16.5-33.0)	27.6 (18.9-39.8)	33.5 (22.2-50.2)	38.3 (24.8-59.0)
4-day	5.16 (4.02-6.61)	7.12 (5.38-8.54)	9.86 (7.69-12.4)	12.5 (9.70-16.2)	16.7 (12.6-22.5)	20.4 (15.0-28.3)	24.6 (17.4-34.6)	28.9 (19.8-41.6)	34.9 (23.1-52.2)	39.6 (25.7-60.9)
7-day	5.97 (4.67-7.62)	8.06 (6.11-9.64)	11.0 (8.57-13.7)	13.8 (10.7-17.8)	18.2 (13.9-24.6)	22.3 (16.4-30.8)	26.7 (19.0-37.4)	31.2 (21.5-44.7)	37.2 (24.8-55.4)	41.9 (27.3-64.2)
10-day	6.65 (5.22-8.47)	8.82 (6.73-10.6)	11.8 (9.29-14.8)	14.8 (11.5-19.0)	19.4 (14.8-26.0)	23.5 (17.4-32.4)	28.1 (20.0-39.3)	32.6 (22.5-46.7)	38.7 (25.8-57.4)	43.3 (28.2-66.2)
20-day	8.72 (6.88-11.0)	11.0 (8.56-13.4)	14.4 (11.3-18.0)	17.5 (13.6-22.3)	22.1 (16.9-29.5)	26.2 (19.4-35.8)	30.6 (21.9-42.6)	35.1 (24.4-50.1)	41.1 (27.6-60.9)	45.8 (30.0-69.7)
30-day	10.5 (8.31-13.3)	12.9 (10.1-15.8)	16.5 (13.1-20.6)	19.7 (15.5-25.1)	24.4 (18.6-32.3)	28.4 (21.0-38.5)	32.6 (23.3-45.3)	36.9 (25.7-52.6)	42.9 (28.8-63.4)	47.6 (31.2-72.2)
45-day	13.3 (10.6-16.8)	15.9 (12.6-19.7)	19.9 (15.9-24.9)	23.4 (18.4-29.7)	28.2 (21.5-37.0)	32.0 (23.7-43.2)	36.0 (25.8-49.9)	40.1 (28.0-57.1)	45.7 (30.9-67.5)	50.1 (32.9-75.9)
60-day	15.9 (12.6-20.0)	18.6 (15.0-23.2)	23.1 (18.5-28.9)	26.8 (21.1-34.0)	31.8 (24.1-41.5)	35.5 (26.2-47.7)	39.2 (28.2-54.2)	43.1 (30.2-61.2)	48.3 (32.7-71.2)	52.4 (34.5-79.2)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

Figure 13: NOAA Atlas 14 Rainfall for Project Area

To date, there has not been any stormwater management design presented for the Houston Ship Channel upland confined placement areas although the need for that design is identified in the “TechnicalPalooza” slides. The design team will need to perform a Probable Maximum Precipitation study and make a decision on the design precipitation to be used and will need to consider three design scenarios:

- 1) **Stormwater management during placement area operation:** Stormwater management during placement area operations may be the easiest situation to manage since the volume available within the placement area between the top of the dike and the water surface in the placement area is available for storage of precipitation prior to controlled discharge through the overflow weir. The overflow weir, however, must be designed to prevent overtopping of the dike and dike breach by overtopping erosion.
- 2) **Stormwater management after placement area closure:** After the placement area is closed, the stormwater management becomes entirely runoff management since the area will be capped and storage above the overflow weir may not be available.

- 3) **Offsite induced flooding due to placement area changes and stormwater runoff:** The majority, if not all of the placement areas discharge into local stormwater runoff systems and/or drainages and must be effectively carried to the ship channel without causing induced flooding of neighborhoods, homes and businesses. Given the low-lying nature of the area, and to comply with local and state stormwater regulations, it may be necessary to construct detention basins and/or modify offsite channels, culverts and other storm drainage features to carry the increased runoff from the placement areas back to the channel without adversely impacting neighbors especially during storm surge and high rainfall events. Any extra runoff into city or other locally owned drainage features that they were not designed for would likely be considered induced flooding caused by the placement areas. Detailed three-dimensional hydrologic modelling of the placement areas and surrounding properties both before and after placement area construction is strongly recommended.

Risk Assessment and Consequence Analyses: As a follow up to the previous discussion, it is necessary to perform a risk assessment and consequence analyses to determine if the consequences of failure are severe in order to determine which guidance to use for dike design. The appropriate consequence analyses would be a dike breach analysis for each side of a placement area adjacent to homes or businesses where a breach could cause a risk to life, health and/or economics. The Galveston District has utilized the Architect-Engineer firm, HDR for stormwater design on the placement areas and HDR has in-house personnel that are the best in the world at risk assessment for these types of structures so the resources to perform these analyses are readily available to the District.

Placement Area Management Risk Mitigation: Placement areas are historically managed as one large flow through cell as opposed to multiple cells that are each individually contained that allow flow from one cell to another across the placement area that functionally break up the area into multiple smaller areas and allow different grain sizes to settle out in each cell. Operating the placement areas in multiple cells could make borrow material for future modifications or capping more easy to locate and could reduce the potential release of materials and downstream inundation if a dike failure were to occur.

Placement Area Monitoring: Physical performance and safety monitoring of the placement areas and dikes is not discussed at all in *EM 1110-2-5025 Dredging and Dredged Material Management* at all and the recent slope failure in the Clinton East facility clearly identifies this as a gap in USACE guidance particularly where placement areas are adjacent to neighborhoods. This lack of monitoring is a direct factor to be considered in the risk analyses since “Intervention” would be a potential failure mechanism mode that would not be available to limit the project risk.

Summary:

The project is to deepen and/or widen the Houston Ship Channel to allow **more efficient access and reduce congestion** to private and public docks for larger and/or more heavily loaded ships. The channel is currently operational but requires extensive coordination and choreography of ship movements. There are no life safety risks in the current operation of the port or ship channel defined in any project documents reviewed to date.

The use of specific placement areas adjacent to neighborhoods, homes and businesses was not identified in any of the authorization documents including the Environmental Impact Statement. There was also no mention of life safety or risk informed decision making as required by USACE guidance and therefore the analyses presented in the documents could not consider societal and socioeconomic impacts properly.

The analyses reviewed are based largely on feasibility level documents including the Environmental Impact Statement that is approximately five years old and may require updating given the age of the analyses, the changes in USACE and other Federal Regulations and the exceptional inflation that has been experienced on most Federal projects over the last few years since these documents were completed.

The project authorization specifically notes that cost is the only factor to be considered in selecting the placement areas.

There is no discussion of the use of upland confined placement areas adjacent to homes and neither the Record of Decision nor the EIS for the project mentions life safety or risk informed decision making and both documents state that the effects on Socio-Economics and Environmental Justice are insignificant. Given that neither the Chief's report nor the Environmental Impact Statement identified the placement areas to be used for the project, the life safety, health risks and societal impacts of using placement areas immediately adjacent to communities, residences and businesses could not have been properly considered.

The proposed plan considers the future use of all upland confined placement areas for the current project and the construction of three new areas; BW-8 with adjacent businesses but no adjacent homes and East Clinton 2 with adjacent homes at the north and south ends. The berms on both of these areas will be no more than nine feet tall. A third expanded placement area at the Rosa Allen site will be increased in height to 29' and used for the next 50 years for O&M dredging material disposal. This site is surrounded by several hundred homes on three sides.

It is unclear why the E2 Clinton and Rosa Allen sites with significant public risk are required to be used at all given the proximity and size of the new BW-8 site and the potential to raise

the dikes on that site while limiting the induced risk on surrounding properties. The material to be placed in the three upland placement areas could easily be accommodated in the Bird Island Marsh or the Bay Aquatic Beneficial Use sites.

The design approach presented does not address the risk informed decision making, potential failure mode analyses on the placement area dikes or risk assessments required by USACE Planning guidance and to determine if consequences of dike failure are high. The document specifically identifies project constraints as being protective of existing features such as gas and oil wells, pipelines and other utilities without identifying human health and life safety as a project constraint which is inconsistent USACE planning guidance.

Design reviews, specifically a risk assessment, Agency Technical Review (outside of Galveston District) and a Type II Independent External Peer Review, Safety Assurance Review, for the placement areas have not yet been performed and are required. Those reviews are typically performed as part of the 65% design and again upon completion of design that addressed the comments from the 65% process. A review plan that lays out the level and schedule for reviews is required by USACE policy to be developed and made available to the public and that plan has not been completed or publicly posted on the Galveston District web site.

It is the author's opinion that the use of some of the upland confined disposal areas as currently proposed is inconsistent with United States Government and international best practices for these types of facilities and, given the proximity of communities, homes and businesses to these facilities, the proposed future use of these facilities presents significant and unnecessary increased life and safety risks to the public. This opinion should be confirmed or disputed through a risk assessment performed by personnel outside of Southwest Division.

Provisions for placing clean soil on top of the placement areas as a cap on those areas that will not be used in the future could not be located in the documents reviewed other than one mention in the dredged material management plan that public comment indicates that residential areas desire that upland sites that will not be used be closed and capped.

Where the dikes present life safety risk, the application of dam design and construction requirements and processes should be considered to be best practices and implemented to be protective of the safety of the adjacent neighborhoods.

The authorization documents, USACE guidance and sampling to date all indicate that the dredged material may be contaminated and that sampling, testing and monitoring will be

required. The use of dredged material to raise the placement area dikes may expose adjacent communities to contaminated material.

Sea level rise and changes to future conditions are acknowledged discussed as it relates to the potential for reduced dredging but sea level rise impacts as they relate to the stability of the placement areas or other considerations have not been addressed but are planned to be addressed in a long-term adaptive approach despite USACE guidance that specifically provides for incorporating sea level change in civil works and provides procedures to evaluate sea level change impacts, responses and adaptations. Land subsidence in the Houston area is significant and its impacts to the project were not considered.

Two previous slope failures and one hydraulic structure failure have occurred on Houston Ship Channel placement areas. Slope stability of ALL of the placement area dikes is a significant concern and appears to be recognized by the Galveston District as a significant concern and slope stability cross sections are provided. However, there is no written description of the design approach for the slope stability analyses and that analyses is almost ten years old so it has not benefited from any investigations or testing since 2016. The recent slope failure at the East Clinton Placement Area is also entirely inconsistent with the slope stability results on that dike that showed a robust factor of safety. The slope stability analyses also did not consider static liquefaction as a potential failure mode and have not considered tailings dams with construction very similar to the placement areas as design models or opportunities for lessons learned and it was not considered that the construction method being used for the placement area dikes has been legally prohibited in other countries due to multiple failures that resulted in loss of life (on much larger structures than the placement areas). Multiple national and international entities have published guidance that would support new detailed technical analyses and slope stability requirements. Entirely new slope stability analyses of all of the placement areas should be performed and subjected to detailed Agency Technical Review and Type II Independent External Peer Safety Assurance Review.

Stormwater management and prevention of induced flooding in neighborhoods adjacent to placement areas will be a significant challenge that has not yet been addressed. The National Oceanic and Atmospheric Agency's National Weather Service Atlas 14 database appears to accommodate the observed Hurricane Harvey rainfall as a 1,000 year event but the database is being updated for release in 2026 and the stormwater design will need to properly model and accommodate rainfall to avoid induced flooding.

Under its federal funding agreement with the Corps of Engineers, Port Houston must follow USACE regulations, policies, and guidance as outlined in the Environmental Impact Statement (EIS). Based on USACE Engineering Regulation 1110-2-1156, "Safety of Dams –

Policy and Procedures” (2014), any structure over 25 feet tall OR with 50 acre-feet of storage qualifies as a dam. All the proposed upland placement areas meet one of these criteria—meaning they fall under USACE dam safety regulations.

Immediate Recommendations to Enhance Community Safety:

- Perform a life safety risk analysis for each placement area and utilize a risk informed design process and risk informed decision making on all aspects of the project as required by USACE policy.
- Develop a comprehensive upland placement area operation and maintenance plan including a placement area surveillance plan that discusses responsibilities and funding.
- Clear woody vegetation and mow tall grasses to allow for turf establishment or resilient slope surfacing installation on all exterior dike slopes on ALL upland placement areas to allow effective observation and monitoring.
- Implement routine inspection and monitoring program for all upland placement areas either on site or by remote means.
- Cap all placement areas that will not be used in the future or will not be used as part of this project using impervious clean fill from off site or a cap system with an impervious liner. Integrate runoff detention or storm drainage modifications to prevent runoff, flooding and other impacts to adjacent properties.
- Development of an Emergency Action Plan including inundation mapping for each placement area.
- Install real time slope monitoring and water level monitoring equipment and an effective mechanism for warning the population at risk around each placement area in the event of an emergency.
- Perform community outreach and risk communication with communities adjacent to placement areas and potentially impacted by a breach of the containment dike or runoff from the area.
- Investigate the use of Interferometric Synthetic Aperture Radar or other means to monitor the slopes of the placement areas remotely as well as to monitor ground subsidence of the Houston Ship Channel area.
- USACE regulations states that “Life safety is paramount” and that public safety cannot be traded off for other project benefits. It also directs that the principle of “Do no harm” must guide all actions.

- To comply with USACE requirements, each placement area should undergo a detailed risk assessment and dam safety design review, especially where they border residential areas. The lifetime costs of doing this properly—design, construction, operation, maintenance, and risk communication—would likely exceed the cost of using safer, alternative placement sites to start with now.
- Protecting public safety and health must come first. This is the right time to adjust the project approach to meet USACE standards and ensure the Houston Ship Channel expansion proceeds on schedule without increasing risk to surrounding communities.

Document End