

Coastal Texas Protection and
Restoration Feasibility Study
Final Feasibility Report

Appendix D – Annex 16:
Anchorage
Memorandum for Record (MFR)

August 2021

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SUBJECT: Coastal Texas Project: Anchorage Area

Prepared By: Himangshu Das, Mike Diaz, & Paul Hamilton

1. This memorandum documents the District's and Local Sponsor collaboration with stakeholders to acknowledge impacts to the existing anchorage areas as a result of the gate crossing across the Galveston Entrance Channel and a path forward to mitigate the loss of existing anchorage area by identifying potential areas to compensate for the lost area and address additional features required to assure the safe anchoring of vessels.
2. Figure 1 shows the existing anchorage location and approximate footage designated under each area.

Anchorage Area A : 0.93 Sq. Miles
Anchorage Area B : 0.90 Sq. Miles
Anchorage Area C : 0.55 Sq. Miles
Anchorage Area Alpha-East : 0.28 Sq. Miles

Total existing anchorage area approximately 2.7 Sq Mile

Water depths in these anchorage area vary between 30 to above 40 ft below MLLW where anchorage C is relatively shallower. Anchorage Alpha-East, which is authorized for USACE maintenance, has never been dredged.

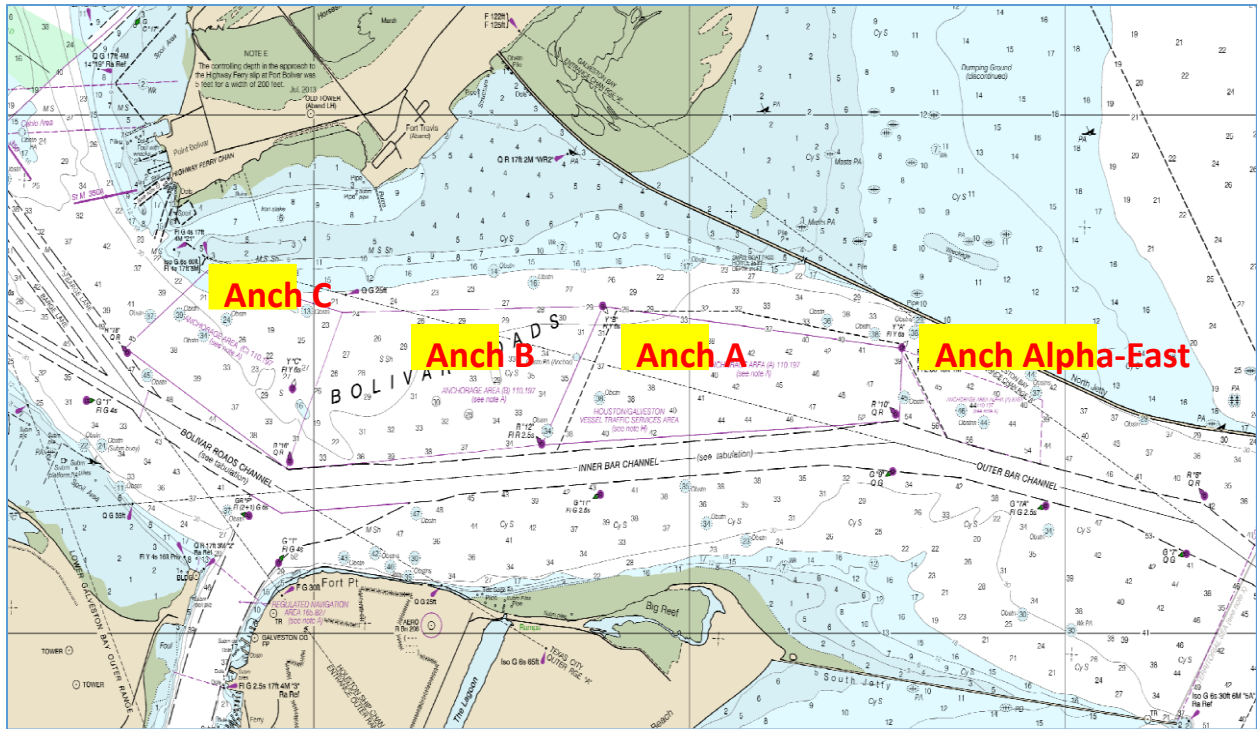


Figure 1: Existing Anchorage Area

3(a). AIS Data Analyses: Data on anchorage area usage was provided by the US Coast Guard for the period March 2018 – March 2020. Based on this data, anchorage area usage is herein reported two ways: (1) based on the number of uses irrespective of duration and (2) as a function of duration. Currently anchoring is accomplished by a vessel with minimal assistance from tugs. The areas are naturally deep and experience minimal impacts from currents and winds.

Table 1 shows various percentile values (daily usage) of the three individual anchorage areas and the combined dataset. *Area A is the most used of the three anchorage areas in terms of vessel use irrespective of time spent in the area.* For additional context, and combining the discrete uses and duration at each instance of use, the following is the total vessel-hours spent in each anchorage area: 9933 hours in area A, 4783 in area B, and 1753 in area C.

Table 1: Summary of daily usage statistics for the various anchorage areas and in combination

Area	Percentiles				
	10	25	50	75	90
A	2	3	5	7	10
B	0	1	3	4	6
C	0	0	1	2	3
Combined	4	6	9	12	15

Though used less than the other anchorage areas, vessels using area C tend to dwell in the area longer.

3(b). Current Usage of Existing Anchorage Area:

Based on inputs from the Anchorage Working Group (Email reference from JJ), depending on the ship's length, draft, holding power of the anchor & weather, the following is the approximate capacity for existing anchorages:

Anchorage A & A East (deeper, larger tankers): 4-6 ships

Anchorage B (ATB/ITB): 6-7 ATBs/ITBs

Anchorage C (light, smaller ships): 2-3 ships + 1 deeper ship near & just outside the northwest boundary

4. The proposed gate crossing across the Galveston Entrance Channel and modification of Houston Ship Channel (HSC) with scour protection will impact the existing Anchorage Areas A, B, and C as shown in Figure 2. The crossing results in Area B being unusable due to the gate crossing and construction of the sector gate island. Areas A, and C will also be impacted due to the extension of the existing HSC channel toe to the east to allow for the construction of an inbound channel for ship traffic and two sector gate system across the entrance channel. PDT estimates that total impacted anchorage area will be approximately 1.3 Sq. Miles or roughly 45% of the existing anchorage area are unusable.

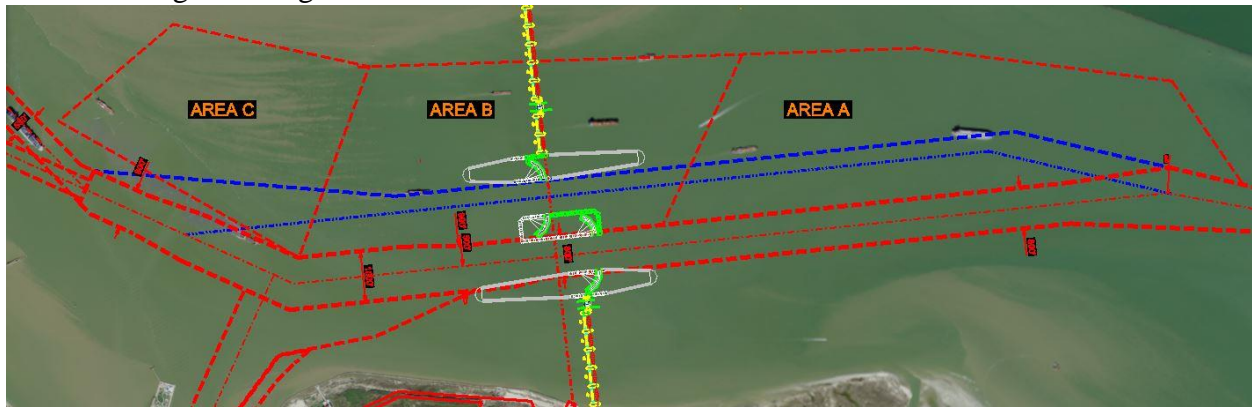


Figure 2 – Gate Crossing Location impacting Existing Anchorage Areas A, B, and C

5. An initial meeting with the Anchorage Working Group and Houston-Galveston Pilot Associations was conducted (2/11/2020) to discuss the impacts and present possible alternative anchorage areas to mitigate the impacts. The anchorage working group later discussed among themselves and proposed alternate anchorage area behind Pelican Island and on the protected side of the barrier as shown in Figure 3(a).

As shown in the figure, the proposed anchorage area is located inside the barrier system adjacent to the Texas City Ship Channel between Pelican Island and Shoal Point Placements Areas 3, 4, and 5. The existing bay bottom depth is approximately at elevation -5.0 ft MLLW as shown in Figure 3(b). Figure 3(b) also shows 12 swing circles identified by the Anchorage working group suggesting possibility of 12 ship anchorage at a given time. Each swing circle is 0.25 nautical miles in radius and is standard for ships using their own ground tackle. The proposed area covers approximately 2.4 sq. miles which would require the relocation of an existing 24" pipeline and 87 MCY of dredging. Due to naturally shallow depth, the proposed anchorage area would need significant initial impact to the bay bottom (e.g., transforming -5 to -30 ft) and regular

maintenance dredging to maintain the required anchorage depth which could be very costly and unacceptable from environmental regulations.

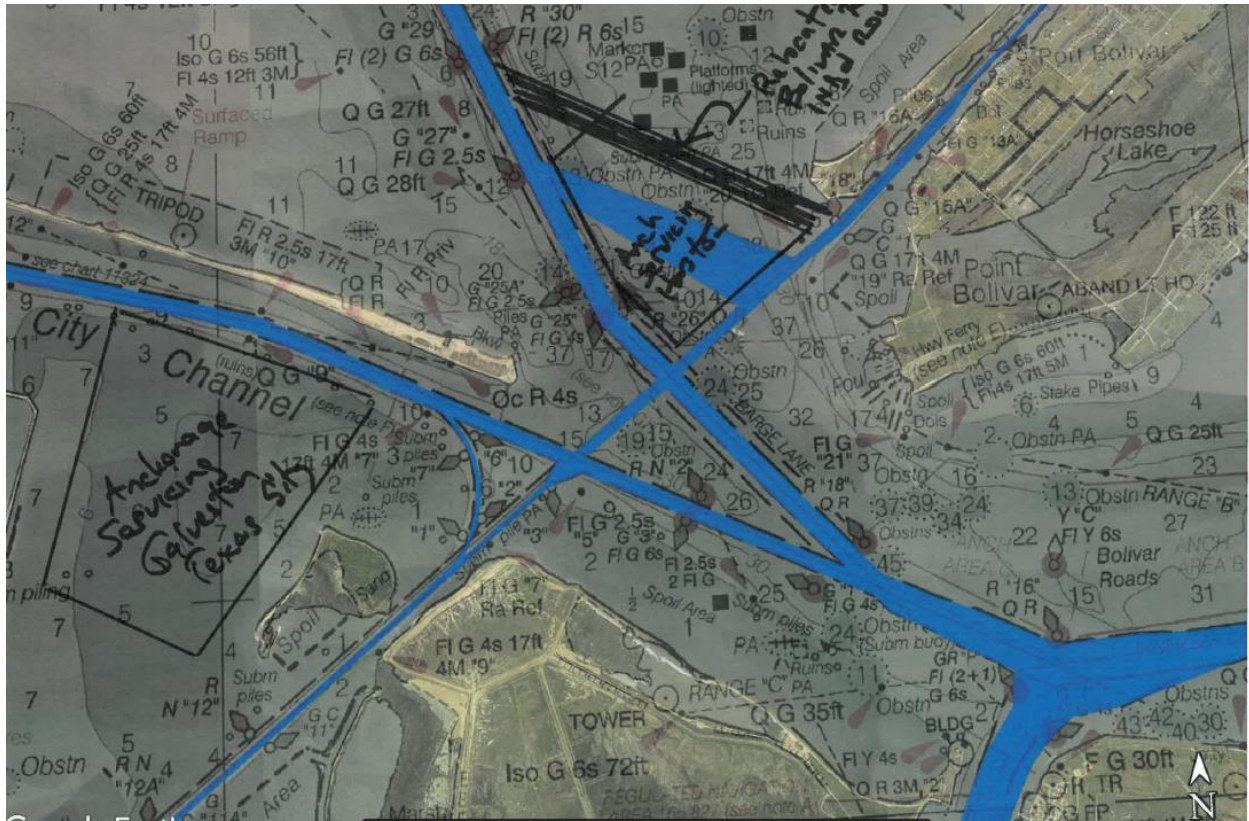


Figure 3(a) – Proposed New Anchorage Area Footage by the Anchorage Working Group

Anchorage Working group also recommended an area serving Houston located north of the GIWW & east of the ship channel. This location would require relocation of the current Bolivar Roads Inbound Route (BRIR) to just north of the proposed anchorage. BRIR is used by shallow draft tow traffic to safely merge with ship traffic. This proposed anchorage will impact ferry operation.

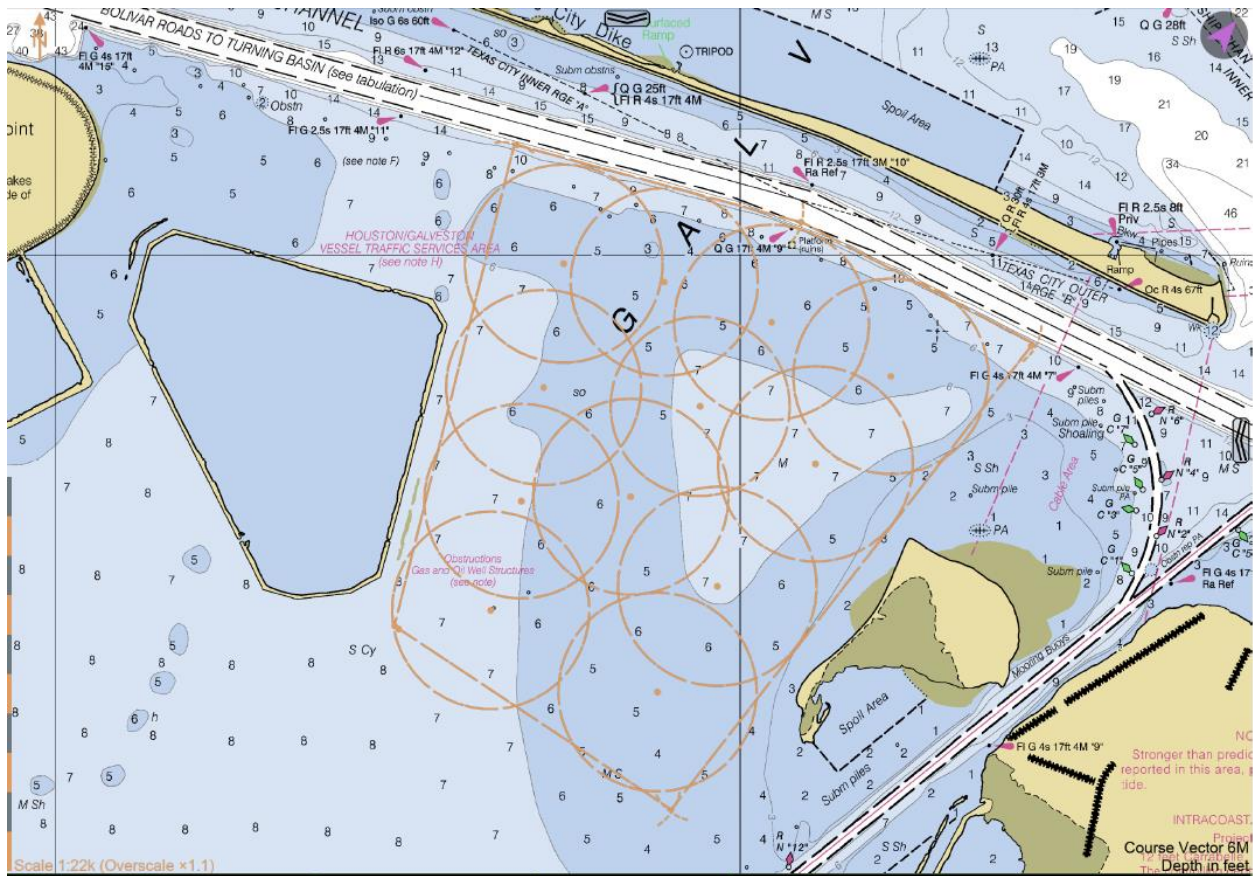


Figure 3(b) – Proposed New Anchorage Area Footage by the Anchorage Working Group with depth contour and 12 swing circles (0.25 nautical mile radius) demonstrating availability of 12 dwelling

6. PDT looked into naturally deep sections from historical bathymetry chart and existing bathymetry chart to evaluate potential alternatives. Figure shows depth contours identifying sections which are naturally deep and may be suitable for future anchorage areas. PDT also looked into shoaling rates along the outer Houston Ship Channel and noticed that outer HSC around end of jetties, shoaling is less prominent (Figure 4). However, it is likely that channel or anchorage area deepening will increase shoaling rate and sedimentation pattern. Also installation of the structure is going to change future conditions and extensive modeling (physical and numerical) will be needed to understand changed conditions.

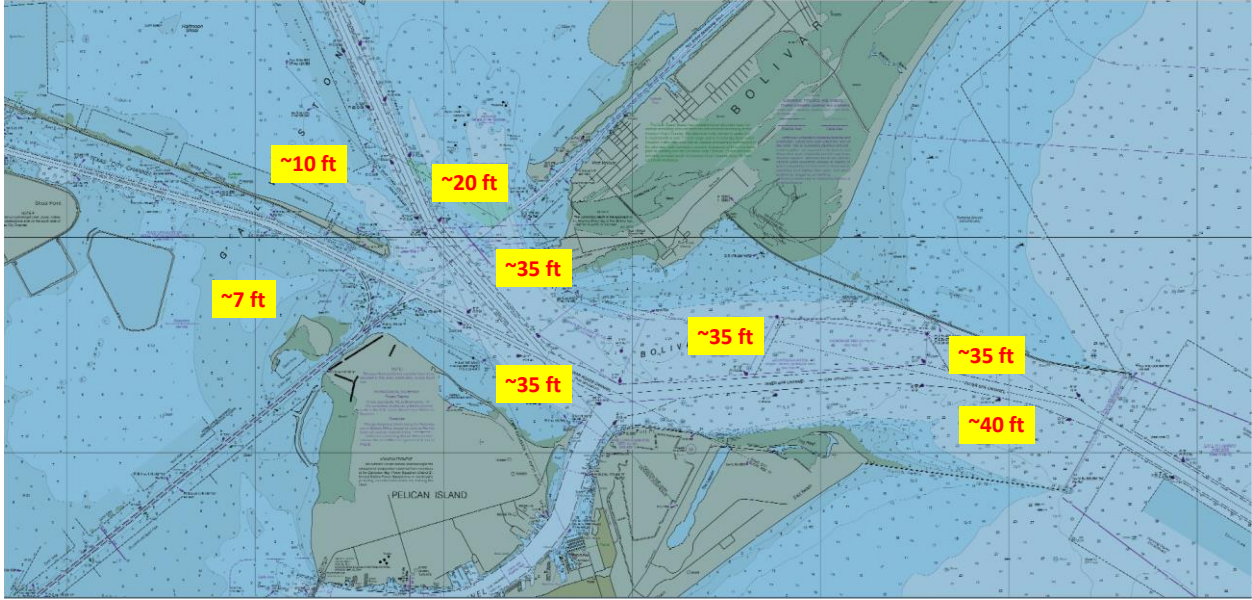


Figure 4: Nautical Chart showing depths across different sections around the proposed gate.

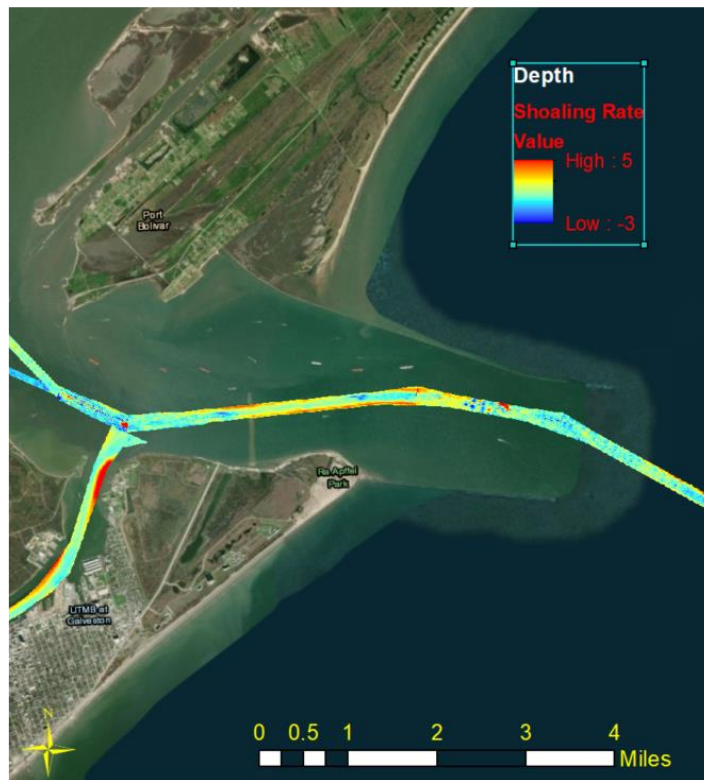


Figure 5: Shoaling rates along the upper HSC

7. PDT explored many alternatives as shown in Figure 6. Explored areas identified by points 1 & 2 are naturally very shallow (<10 ft) which will need serious initial dredging and maintenance dredging, will impact fish larvae transport. Explored area identified by point 3 is naturally deep (> 35 ft), however, it is adjacent to Big Reef Area and additional analyses will be needed to understand sediment accretion pattern. Explored area identified with point 5 is naturally deep (> 35 ft) but transitions to very shallow quickly. It is near the Galveston channel and close to surge barrier. However, this area is sheltered enough to be useful. Anchorage areas within the upper and mid bay along the HSC are very shallow (<10 ft). Extensive dredging will be needed along with oyster habitat mitigation. Although depths are favorable, expansion of existing Area C to the north will impact the current ferry operation and landing (See Point 4 in the picture).

Table 2 summarizes the pros and cons of the alternatives described above.



Figure 6: Initial Screening of Alternate Anchorage Areas

Table 2: Screening of Different Alternatives

Location Point.	Pros	Cons
Mid Bay	<ul style="list-style-type: none"> Mid-bay preferred by navigation community 	<ul style="list-style-type: none"> Currently shallow – highest initial dredging volume An isolated “hole” – likely very high shoaling rate and maintenance dredging volume Oyster mitigation
4	<ul style="list-style-type: none"> Relatively deep – expected low initial dredging and maintenance dredging volumes 	<ul style="list-style-type: none"> Located in a high-traffic area near the GIWW crossing and TxDOT ferry
1 & 2	<ul style="list-style-type: none"> Direct Eastward extension of existing A, B, and C 	<ul style="list-style-type: none"> Currently shallow – highest initial dredging volume Close to Shallow Gates
3	<ul style="list-style-type: none"> Partially deep – moderate initial and maintenance dredging volumes 	<ul style="list-style-type: none"> Adjacent to sensitivity Big Reef Area New anchorage area A and D likely extend too far out into the inlet and are not sheltered enough to be useful. They would in certain circumstances be worse than anchoring offshore.
5	<ul style="list-style-type: none"> Partially deep – moderate initial and maintenance dredging volumes Area is sheltered enough (Pelican Island and proposed surge barrier) to be useful. 	<ul style="list-style-type: none"> It is near the Galveston channel turning and close to surge barrier. Limited space and ship turning could be an issue Impact on Ferry operation

8. Figure 6 shows the USACE proposed modification of anchorage areas and surge barrier system across the entrance channel. The combined total of anchorage area with the expansion of A and new area D is approximately 2.9 sq. miles.

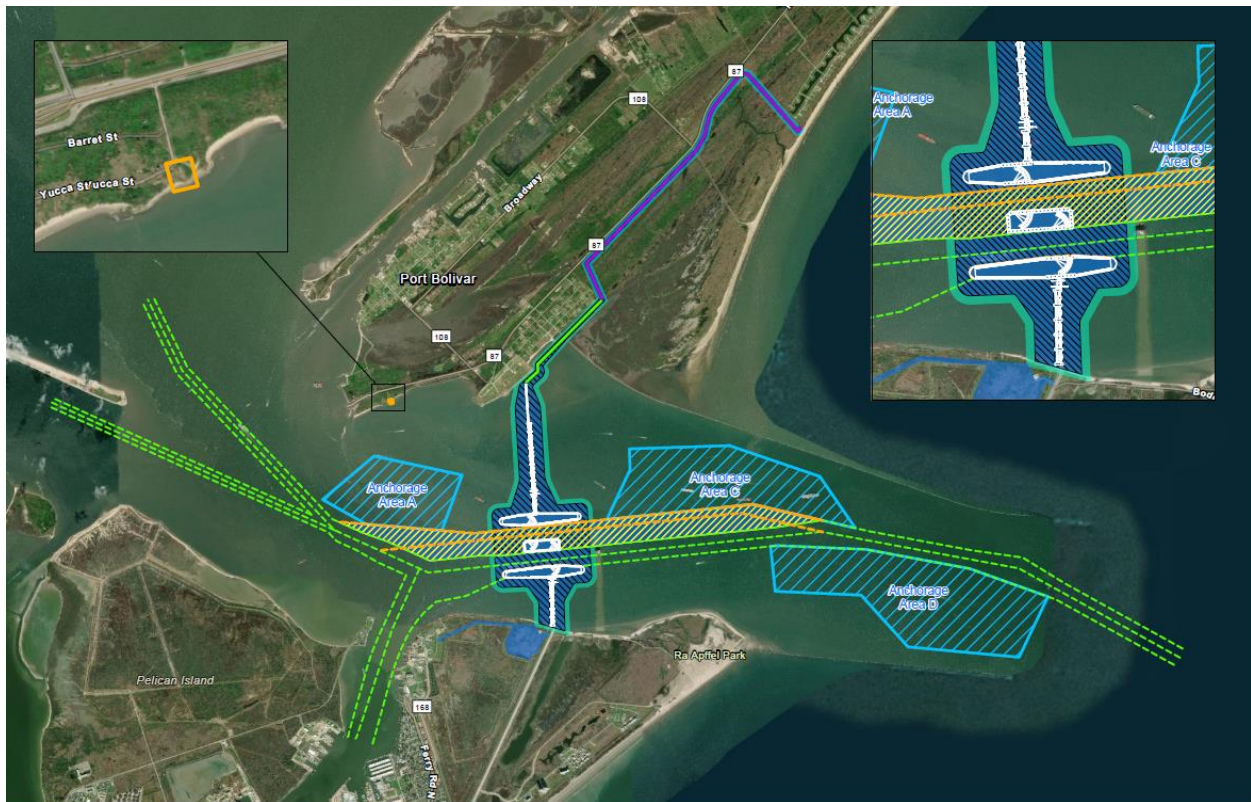


Figure 6: Modified anchorage areas and surge barrier system across the entrance channel.

9. Figure 7 below shows the existing anchorage areas (red line) and proposed anchorage areas (yellow line) and number of swing circles associated with each area. Swing circles are laid based on the guidance provided by the Anchorage Working Group

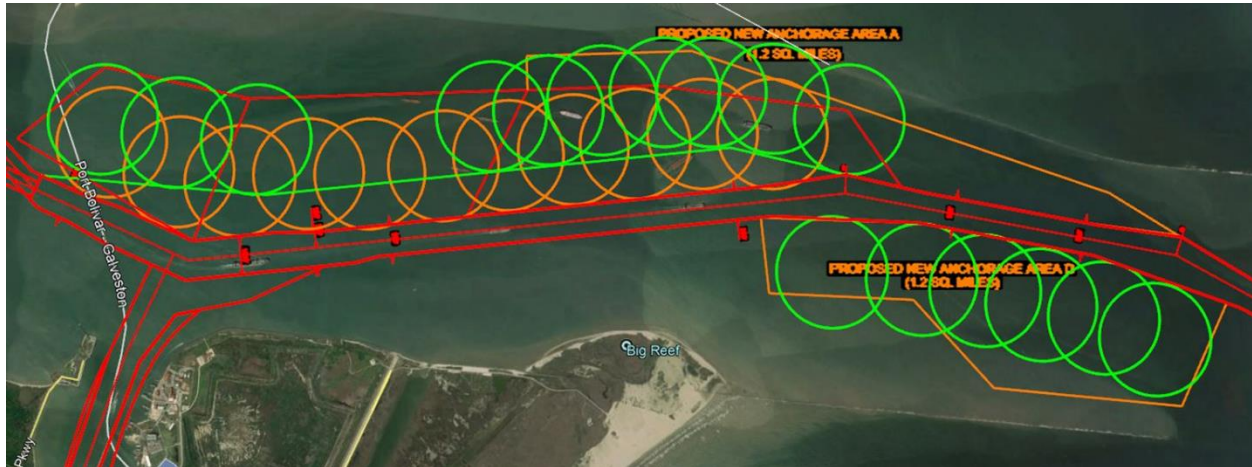


Figure 7 – Existing and Proposed Anchorage Areas with Swing Circles

We noticed that the existing anchorage areas accommodate approximately 11 swing circles (brown circles). With the elimination of Anchorage B, modifications of A and C and addition of new anchorage area D will provide 16 swing circles (green circles).

10. Proposed modifications of anchorage areas will require initial dredging to establish a depth of -40 ft MLLW. Estimated amount of dredging for the extension of Anchorage A is 2,655,300 CY with a bi-annual maintenance dredging of 26,000 CY. Approximately two-thirds of Anchorage Area D will have to be dredged to maintain a depth of -40 ft MLLW. The estimated amount of dredging for Anchorage Area D is 9,344,000 CY with a 2-year maintenance dredging cycle of 91,830 CY. A 2-year maintenance cycle was used to coincide with the maintenance cycle for the Galveston Entrance Channel Inner Bar Reach. PDT also conducted a baseline geotechnical analyses to identify dredged materials. We evaluated that at the proposed modified Area A, potential dredged material are predominantly sand and along proposed new Area D, potential dredged material are predominantly clay and silts.

The extension of Anchorage Area A will required the relocation of 1 aid to navigation and the establishment of 2 new navigation aids. The establishment of Anchorage Area D will allow for the anchoring of 6 additional vessels.

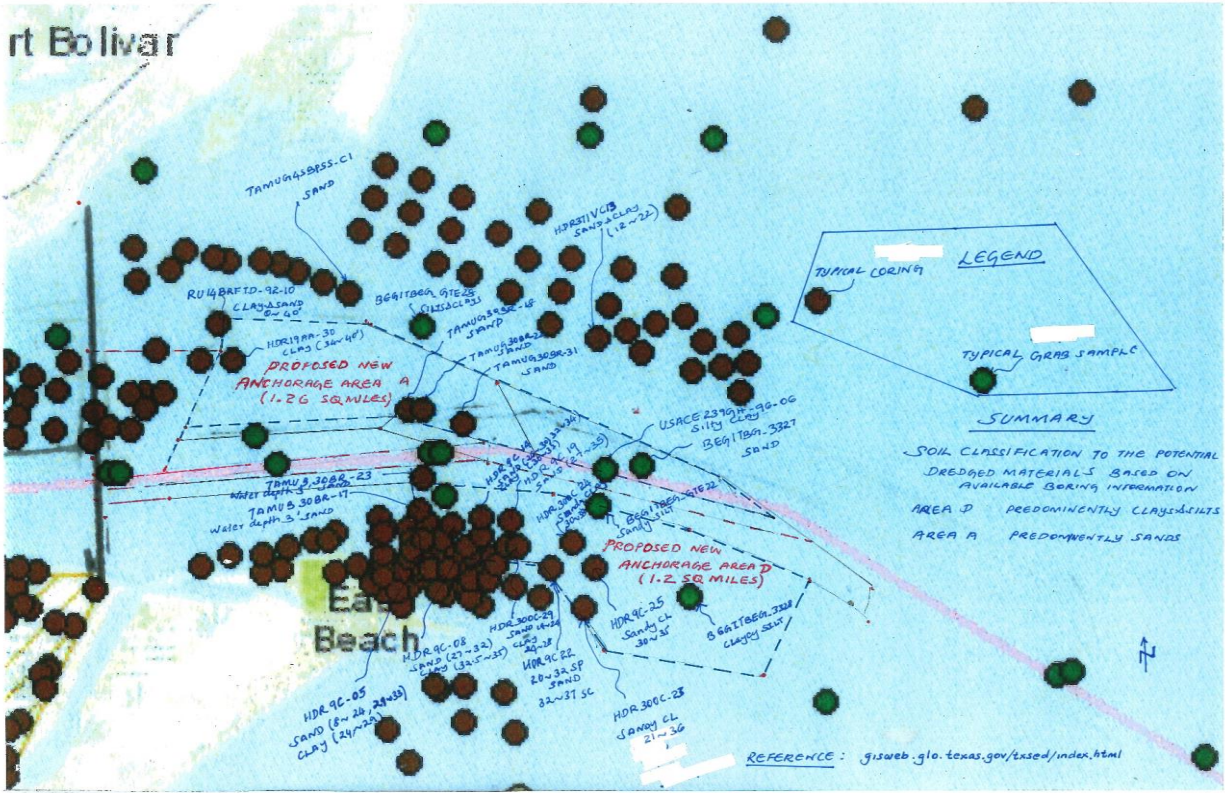


Figure 8: Dredged material properties along different anchorage areas.

11. Recommendation. Given the need for significant dredging, impacts to bay bottom, and relocation of an existing pipeline, new anchorage location (Figure 3) proposed by the Anchorage Working Group seem to be challenging, very costly and unacceptable from environmental regulations. PDT evaluated many other alternatives and screened the most suitable alternative based on limited data and analyses. Accordingly, the District and local sponsor are in agreement to move forward with the proposed anchorage areas (Figure 6) for cost analyses. Further investigation is needed to address the need for mooring points and tug boat assistance along the proposed Anchorage Area D adjacent to the South Jetty. Currently project costs assume double mooring anchors for each circle for a total of 12 mooring anchors to anchor the bow and stern of a vessel. Estimated cost for a double anchoring system is \$5.1M. It is expected that PDT will revisit this subject during the PED phase to model the currents and winds for further refinement in the anchoring system.

12. Risk and Uncertainties: PDT conducted initial screening to propose 3 anchorage areas with total footage area of approximately 2.9 Sq. mile which needs further evaluation (H&H, navigation, O&M and environmental) during the PED phase. Risks and uncertainties on the proposed are as follows:

- Existing anchorage areas do not require maintenance dredging; changes in the Bolivar Roads due to the surge barrier in place could change this due to long term morpho dynamic changes.
- Big Reef accumulates sands that come from a circulation eddy created in front of the East Beach (Gulf side) where sediments get over washed at the tip of the island and then get carried to the ship channel by aeolian processes or storm surges. The historical morphology also suggests that some sand returns to the ship channel and then gets trapped within the intertidal circulation processes of the inlet. Proposing an anchorage area will need detailed evaluation.
- Navigation suitability to proposed modified anchorage area needs to be further evaluated. Houston and Galveston pilots are concerned that the cross current at the proposed anchorage area D are not suitable for vessel mooring.

Near and long term analyses will be needed to better understand the suitability of proposed anchorage areas.

- Near-term: qualitative characterization of potential sedimentation based on simulated velocities in Bolivar Roads (predicated on having hydrodynamic models that include all project features, i.e., gate complex and expanded anchorage areas)
- PED: sediment transport modeling to quantify shoaling impacts of project features, ship simulations, PTM
- System wide sediment budget to understand sediment depositional pattern and bypassing.

Comments received..

-----Original Message-----

From: Maglio, Coraggio K CIV USARMY CESWG (USA)

Sent: Wednesday, March 25, 2020 8:17 AM

To: Das, Himangshu S CIV USARMY CESWG (USA) <Himangshu.S.Das@usace.army.mil>; Hamilton, Paul B CIV USARMY CESWG (USA) <Paul.B.Hamilton@usace.army.mil>

Subject: RE: CTX Anchorage Area (Summary Draft and map)

HD one last comment...

In the paper at the link below, by Paul, on Figure 8 , Alternative 2, could this sediment trap be multi-purposed as an anchorage area?

<https://erdc-library.erdc.dren.mil/jspui/handle/11681/32388>

Coraggio Maglio, P.E.

U.S. Army Corps of Engineers Galveston District Hydraulics and Hydrology Branch Chief

2000 Fort Point Road

Post Office Box 1229

Galveston, TX 77550

Office (409) 941-8517

Cell (409) 739-6031

Coraggio.Maglio@usace.army.mil

I think this area would work if we have the Bolivar Flare area included too.

Coraggio Maglio, P.E.

U.S. Army Corps of Engineers Galveston District Hydraulics and Hydrology Branch Chief

2000 Fort Point Road

Post Office Box 1229

Galveston, TX 77550

Office (409) 941-8517

Cell (409) 739-6031

Coraggio.Maglio@usace.army.mil

"Be like water, but not flood water"

Engineers - The Originals of "Social Distancing"

-----Original Message-----

From: Hamilton, Paul B CIV USARMY CESWG (USA)

Sent: Wednesday, March 25, 2020 8:27 AM

To: Das, Himangshu S CIV USARMY CESWG (USA) <Himangshu.S.Das@usace.army.mil>; Maglio, Coraggio K CIV USARMY CESWG (USA) <Coraggio.K.Maglio@usace.army.mil>

Subject: RE: CTX Anchorage Area (Summary Draft and map)

Coraggio,

I did think about that area, but wasn't sure if it was close enough to the HSC and concerned that ships going in and out could interfere with the ferry operations. Could be a good option for multiple benefits if it works from a navigation perspective.

Paul

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HD,

My comments are as follows:

Proposed anchorage behind Pelican Island - has the potential for hypoxia issues. It also eliminates the ability to create enough obstruction to force water out Bolivar Roads and not into West Bay during wrap around in-bay hurricane wind driven surge. This anchorage will likely slowly fill with fine grained sediment.

Proposed Anchorage servicing Houston (Bolivar Flare) - this location will increase conveyance through the Bolivar Roads inlet likely slightly offsetting losses in tidal prism from the Storm Surge Barrier's installation. It will have shoaling issues, however this is also a benefit as this material in this location is mostly sandy and will likely be suitable for beach placement, thus this area could also function as a sediment trap.

Anchorage Area 3 (D) - this location does not seem very sheltered at least on its outer extents, the sea state in this area will have to be modeled for its suitability for an anchorage.

Anchorage Area 5 - adding this anchorage area to the recommended plan seems valuable as the O&M will be likely minimal and its shelter location, adjacent to the Port of Galveston. It will likely require fixing moorings, however.

How were the anticipated shoaling rates determined for each of the anchorage areas? That is not discussed.

Coraggio Maglio, P.E.
U.S. Army Corps of Engineers Galveston District Hydraulics and Hydrology Branch Chief
2000 Fort Point Road
Post Office Box 1229
Galveston, TX 77550
Office (409) 941-8517
Cell (409) 739-6031
Coraggio.Maglio@usace.army.mil

Comments from Anchorage Working Group.

HD/Karla –

The LS HSC Anchorage working group met on 2/5. There was some discussion about the current carrying capacity of the existing anchorages. Depending on the ship's length, draft, holding power of the anchor & weather, the following is the approximate capacity for existing anchorages –

Anchorage A & A East (deeper, larger tankers): 4-6 ships

Anchorage B (ATB/ITB): 6-7 ATBs/ITBs

Anchorage C (light, smaller ships): 2-3 ships + 1 deeper ship near & just outside the northwest boundary

Alternate anchorage areas were discussed and two recommended areas were identified (neither without their own challenges). Recommended areas were:

- * An area serving Galveston located south of the Texas City dike on the green side of the channel
- * An area serving Houston located north of the ICW & east of the ship channel. This location would require relocation of the current Bolivar Roads Inbound Route (BRIR) to just north of the proposed anchorage. BRIR is used by shallow draft tow traffic to safely merge with ship traffic.

See the attached drawings. Areas and boundaries are approximate and could be adjusted depending on depth of the proposed anchorage & holding power of the bottom. Because both recommended areas are currently shallow, once deepened they would most likely require periodic maintenance dredging. Therefore, construction of any new anchorage would need to become part of the federal project (and not just be designated).

Another point of discussion at the 2/5 meeting, was the necessity of the sector gates crossing the anchorage. Were any locations considered by ACOE that put the gates & barrier downstream/closer to the jetties than the proposed location?

Any questions, please give me a call.

JJ

