ATTACHMENT 8

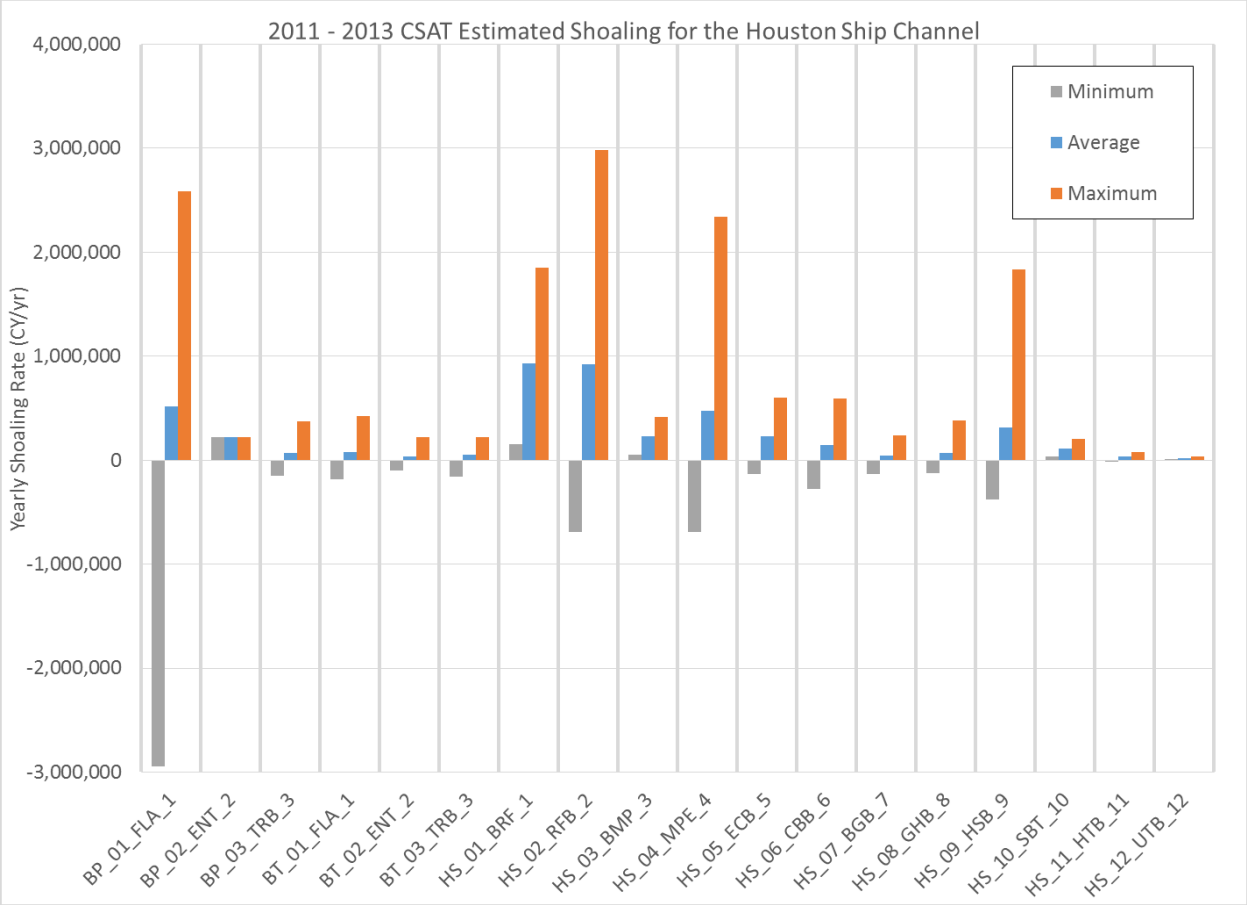
CORPS SHOALING ANALYSIS TOOL (CSTAT) REPORT

AdH Sediment Model Calibration to Corps Shoaling Analysis Tool (CSAT) Estimates

Approach:

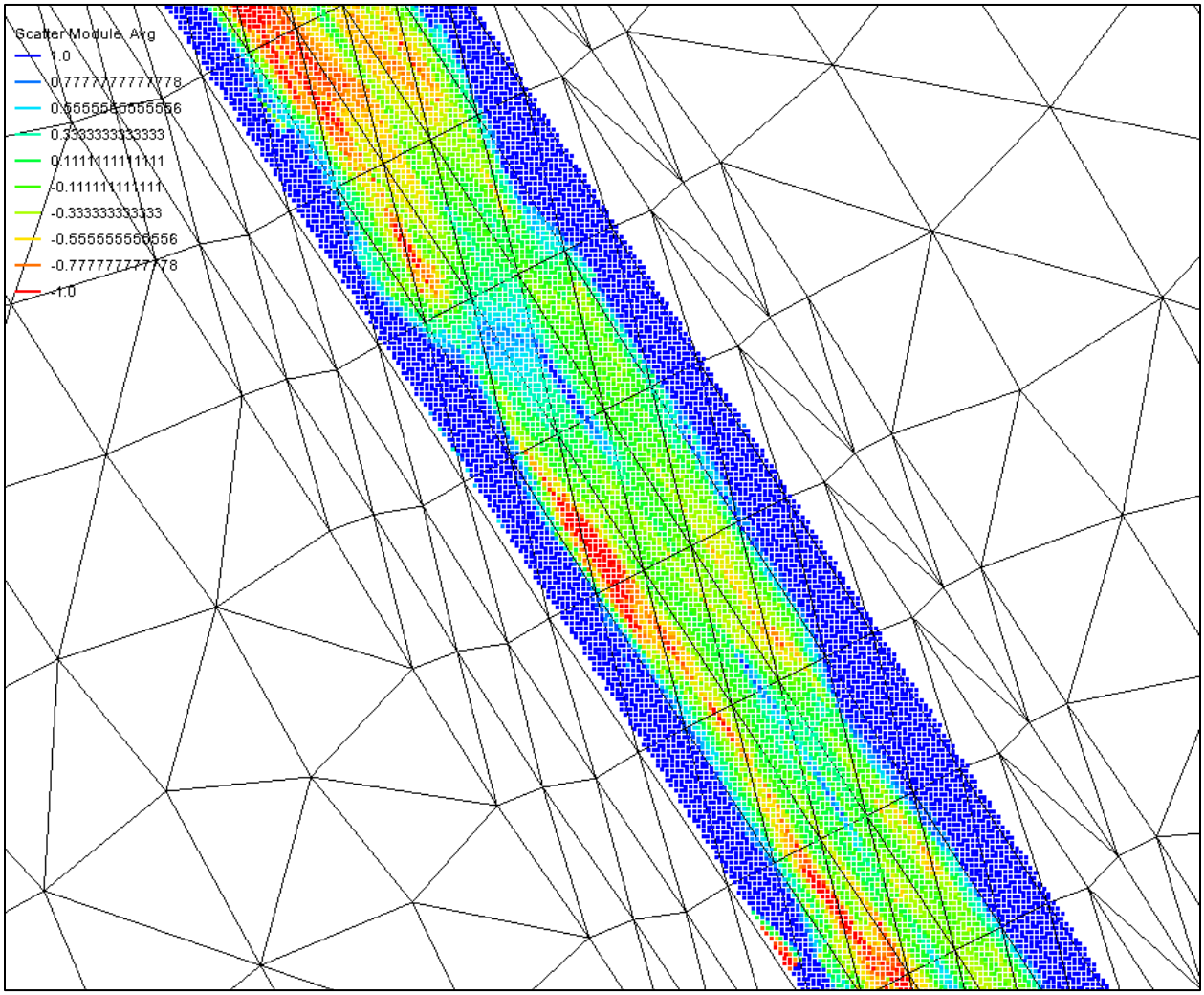
The CSAT compiles channel surveys over time to provide estimates of shoaling rates. These rates are based on the change in the bed elevation over time and in coordination with dredging events. For each reach of data provided to CSAT over the three analysis years (2011, 2012, 2013), a minimum, average, and maximum shoaling volume is determined for that reach (see figure 1). The range from maximum to minimum is extremely large (nearly 4 million CY) for many reaches and shows the large variability in the data provided to and/or being computed by CSAT. These maximum and minimum values, however, are based on a single cell maximum and applying it over the entire reach area – indicating an extreme possibility.

Figure 1. CSAT minimum, average, and maximum shoaling volumes by reach.



CSAT produces a scatter data set of yearly average shoal heights (see figure 2). These data are very fine, much finer than the AdH numerical model resolution. The AdH numerical model computes a yearly shoal height at each mesh node. However, within a single mesh element are hundreds of CSAT points that vary greatly with the element. Applying the CSAT data to the mesh nodes and determining a ratio or scale factor is impractical given this large disparity in resolution between the two tools.

Figure 2. CSAT shoal height points and AdH mesh elements/nodes.



A better approach is to average out the variations over several mesh elements/nodes. This option allows for the use of reach analysis which is more practical given the data available. This is also a better option given the AdH model simulation periods do not match the CSAT analysis periods, which also requires an averaging or "ball-park" analysis.

CSAT Comparison to Annual Reports:

All previous sediment modeling with this AdH model has applied a historical scale factor based on seven years of dredge volumes (post 40x530 ft construction) provided in the USACE Annual Reports. These reports are best viewed over several years since some reaches are not dredged every year. The CSAT analysis was performed on data from 2011-2013. The USACE Annual Reports are not available beyond 2012. However, the total shoaling estimates for the entire Houston Ship Channel for 2011 and 2012 are comparable to the CSAT shoaling estimate for 2011-2013: although there are large differences in some

of the reach shoaling volumes (see table 1). (CSAT reaches were combined to match the Annual Report reaches shown in figure 3). Presently there is no explanation as to why there are such large differences between the Annual Report reach volumes and the CSAT reach volumes.

Figure 3. Annual report dredge reaches.

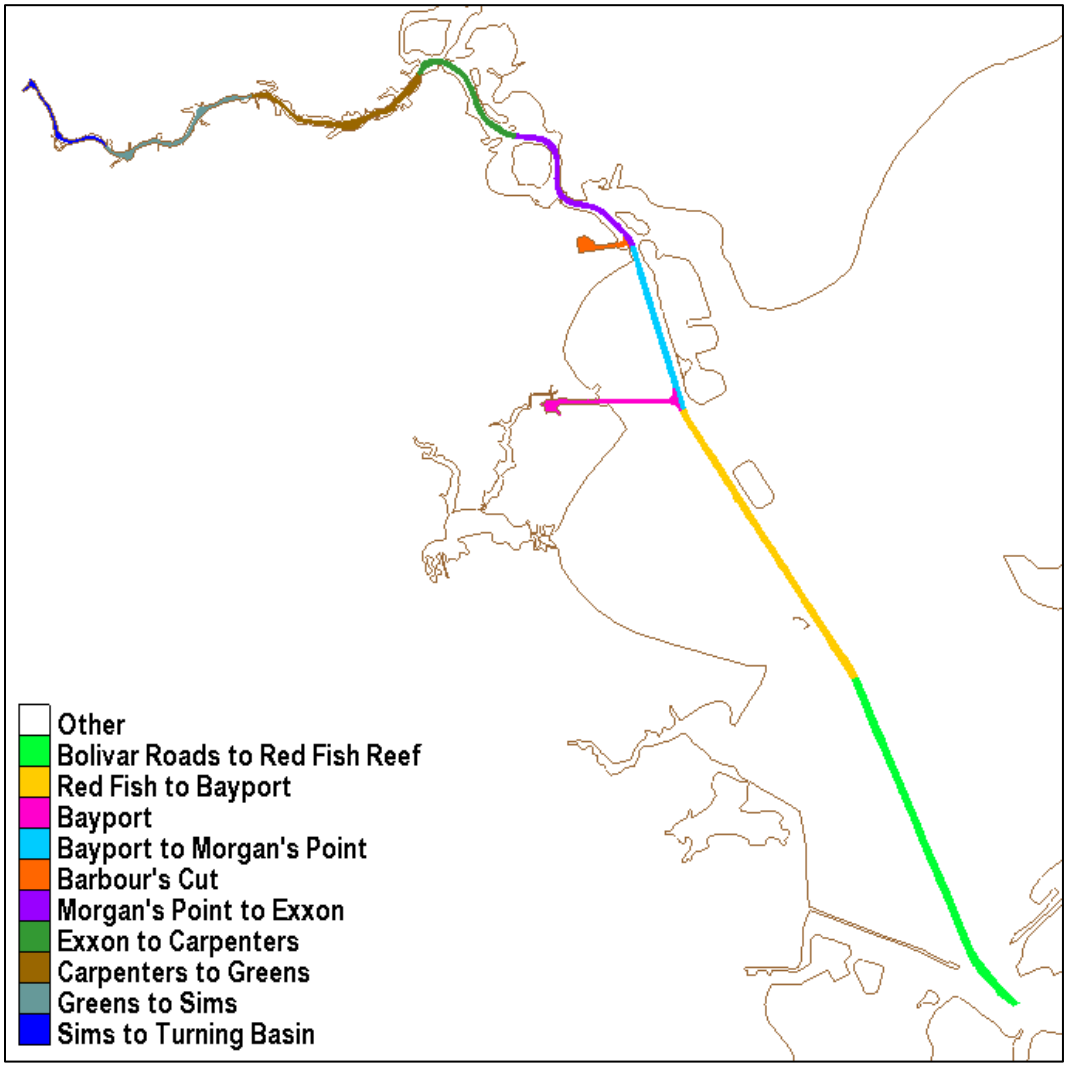


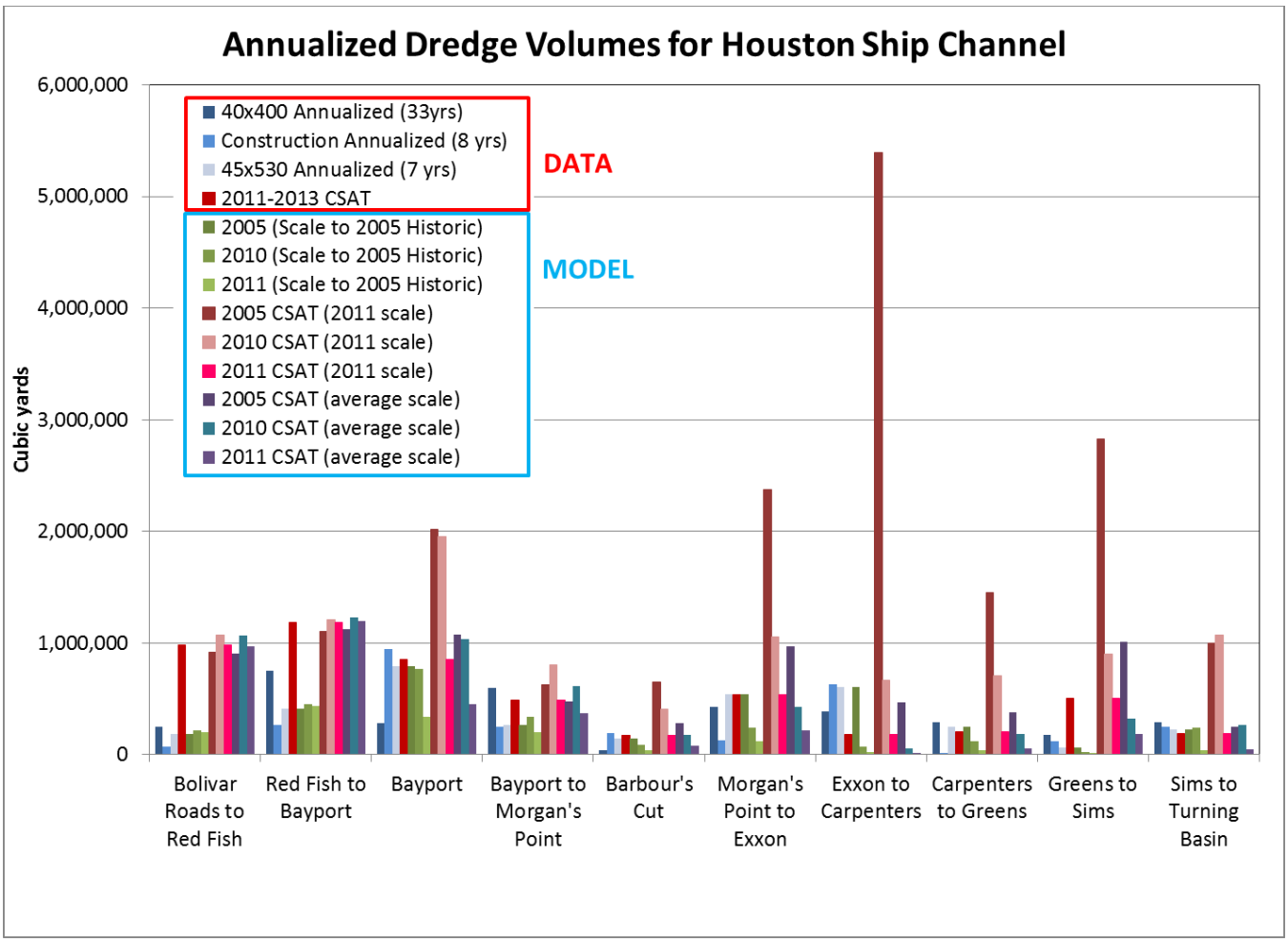
Table 1. Comparisons by reach for Annual Report data and CSAT estimates of shoaling volume for the HSC.

	Bolivar Roads to Red Fish	Red Fish to Bayport	Bayport	Bayport to Morgan's Point	Barbours Cut	Morgan's Point to Exxon	Exxon to Carpenters	Carpenters to Greens	Greens to Sims	Sims to Turning Basin	SUM
2011 (CY)			741,492	914,986	7,362	2,024,913	64,535			130,347	3,883,635
2012 (CY)		1,946,206	176,916				3,543,921		431,216		6,098,259
Avg/year	**0**	**973,103**	**459,204**	**457,493**	**3,681**	**1,012,457**	**1,804,228**	**0**	**215,608**	**65,174**	**4,990,947**
CSAT 2011-2013 Volume (CY)	**935,032**	**926,405**	**802,561**	**231,949**	**169,650**	**472,026**	**228,338**	**192,423**	**377,957**	**167,909**	**4,504,250**

CSAT scaling of AdH model results:

The CSAT results were analyzed over the Annual Report reaches and a scale factor determined such that the AdH model results could be adjusted to better match the CSAT values. Initially this scale factor was determined using the 2011 AdH model results. However, 2011 is a drought year and therefore a year of less shoaling. Using 2011 AdH results to compare back to CSAT 2011-2013 results artificially increases the scale factor since we know this is not an average condition. Instead, the average of the AdH shoaling results for 2005, 2010, and 2011 (the model validation years) for each reach were used to compare back to the CSAT results and a better scale factor determined. Figure 4 shows the results of the various scaling options. The Annual Report volumes and the CSAT volume analysis results are considered "data". The AdH model computed results scaled in various ways are listed as "model". The green data sets are model shoaling volumes scaled by the 2005 historic Annual Report data as documented in the AdH model validation report. The pink data sets are the model shoaling volumes scaled by the CSAT to 2011 AdH model shoaling results (the 2011 pink bar matches the red CSAT bar). The dark blue model data sets are model shoaling volumes scaled by the CSAT to 2005, 2010, and 2011 average AdH model shoaling results. The 2011 scaling option produces extremely large shoaling volumes at reaches in the upper Houston Ship Channel which are likely incorrect since they are so much larger than the Annual Report values and CSAT values. However, the CSAT maximum values do reach some extremely large shoaling volumes. Scaled results that fall in the general range of the reported data and the CSAT data are considered more reliable at this time.

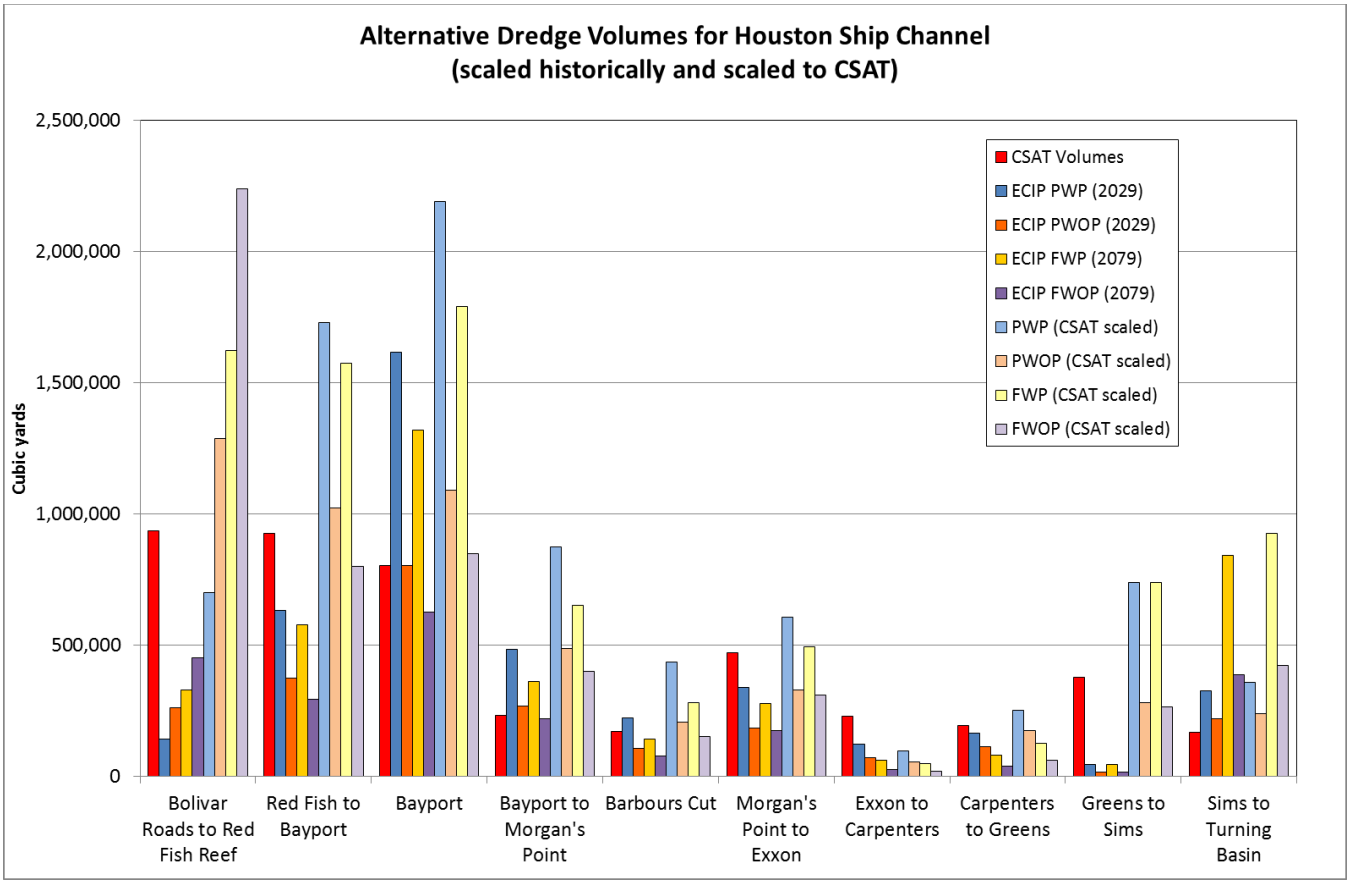
Figure 4. AdH model scaled shoaling results.



CSAT scaled ECIP alternative results:

The CSAT scaling of the AdH model results using the average shoaling of the three validation years is applied to the four ECIP alternatives – present with project (PWP), present without project (PWOP), future with project (FWP), and future without project (FWOP) – over the Annual Report reaches. The results for both the historic Annual Report scaling (as presented in the ECIP modeling report) and the CSAT scaling are shown in in Figure 5 along with the CSAT computed volume for each reach (red). The CSAT scaling generates higher shoaling volumes than the Annual Report scaling although most reaches do not show extreme differences (more than double) except Bolivar Roads to Red Fish Reef and Greens to Sims.

Figure 5. ECIP alternative scaled AdH model shoaling volume results for Annual Report reachs.



CSAT scaled ECIP alternative results over CSAT reaches:

The CSAT scaling of the AdH model results using the average shoaling of the three validation years is applied to the four ECIP alternatives – present with project (PWP), present without project (PWOP), future with project (FWP), and future without project (FWOP) – over the CSAT reaches (see Figure 6). Only reaches along the Houston Ship Channel, Bayport Channel, and Barbours Cut channel are included in this analysis. The Galveston Channel is also not included since the AdH model does not include sand transport which is dominant in this area. Figure 7 shows the CSAT scaled AdH estimated shoaling volumes for the alternatives. The CSAT estimated shoaling volumes for each reach are shown in red. The AdH model shoaling results scaled using the average shoaling of the three validation years are shown in the additional four data sets. Most reaches show alternative shoaling volume estimates on the order of the CSAT volumes except at the lower Houston Ship Channel reach of Bolivar Roads to Red Fish Reef (HS_01_BRF).

Figure 6. CSAT reaches.

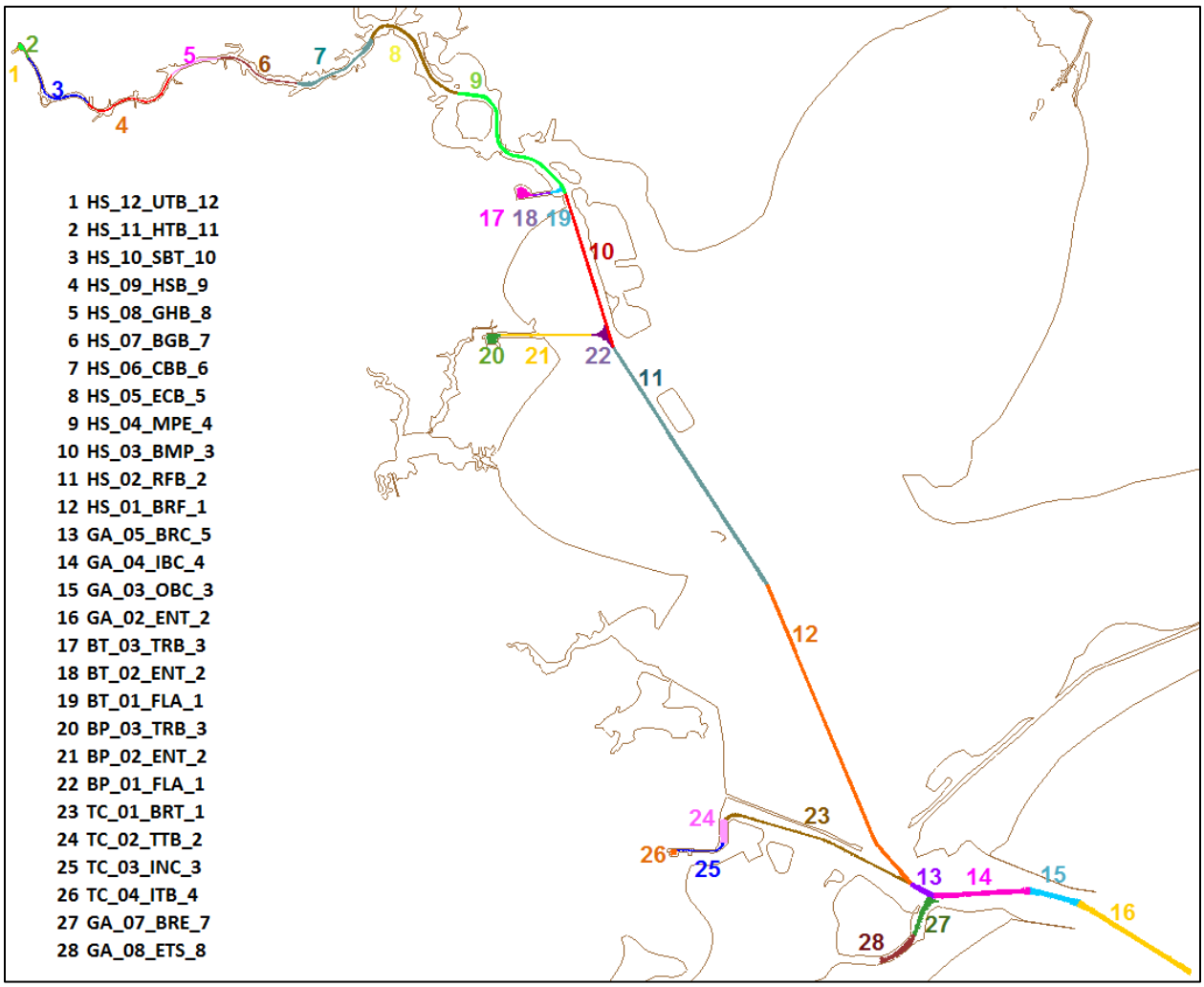
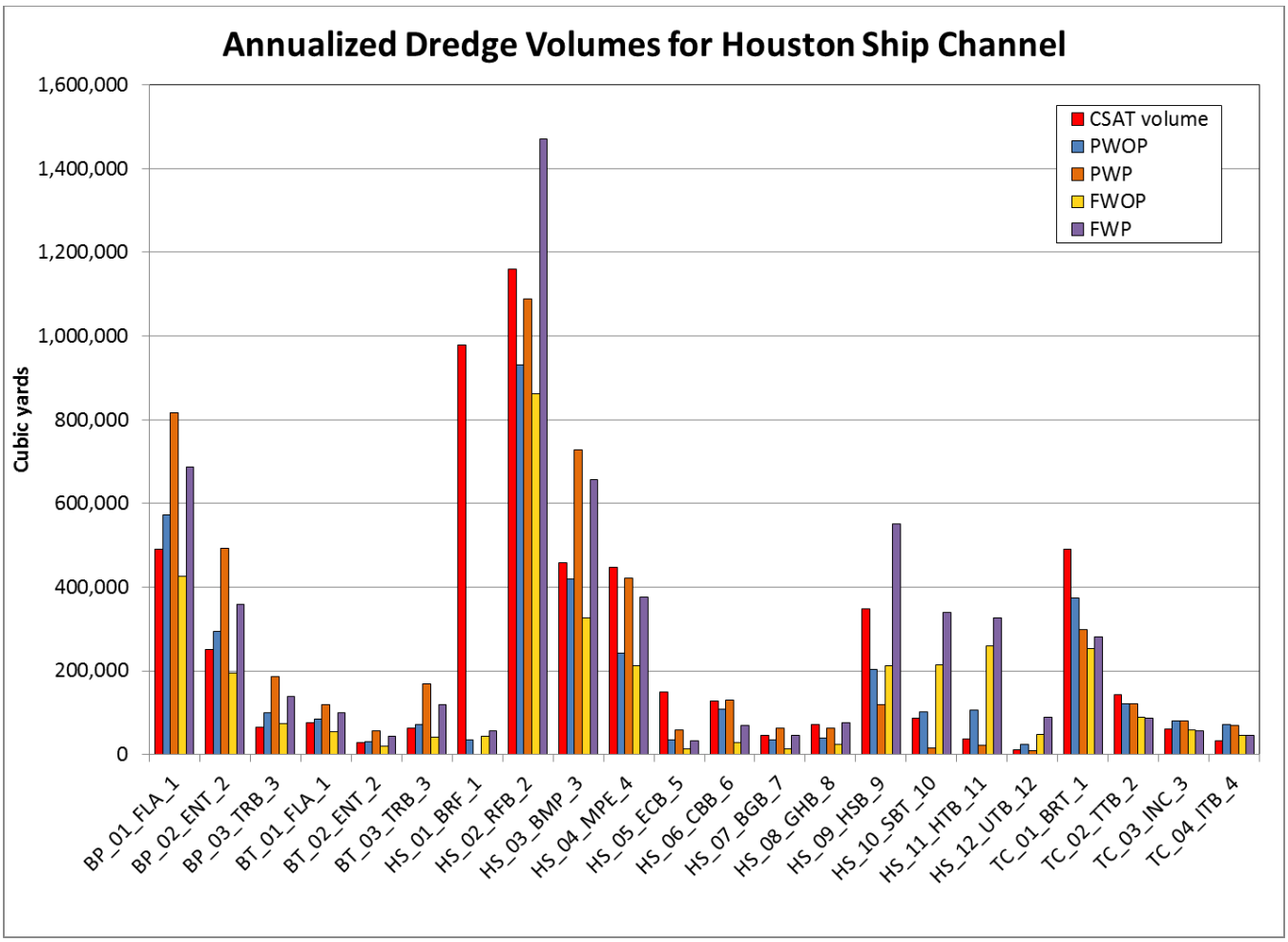


Figure 7. ECIP alternative scaled AdH model shoaling volume results for CSAT reaches.



CSAT shoal heights compared to AdH bed displacement:

The CSAT yearly average shoal heights (feet) are shown spatially for several segments of the Houston Ship Channel alongside the AdH computed bed displacement for year 2011. The scales are not the same, so patterns of change are most important. Looking at the CSAT data, it is obvious that reach shoaling values vary within the reach but also between reaches – as indicated by the definitive change in the contours. The CSAT data indicates shoaling along the channel sideslopes which is generated by the deep draft vessels preventing material to settle in the channel center. The AdH model does not enforce this pattern since vessel traffic is not included. However, the pattern of shoaling along the channel and in the flares is generally represented by the model and the historic dredge records (as noted in the model validation report).