Annex 8 – Relative Sea Level and Climate Change

The Upper Barataria Basin (UBB) project is a coastal storm damage risk reduction (CSDR) project located in a coastal area subject rapid local sea level change. Therefore, changes in sea level are expected to affect project performance over time. By policy, USACE projects must perform as intended for their full project life, despite uncertainty about future conditions, including sea level and future climate. While the fact of sea level change is not uncertain, the rate of future change is unknown. USACE guidance, in the form of ER 1100-2-8162, requires sea level change to be considered in planning and design, and defines the range of reasonably plausible future sea level conditions using three scenarios, called Low, Intermediate, and High. For projects such as UBB, these scenarios can be used to address three main questions:

1) What is the reasonable extent of potential future climate change (particularly sea level change) in this area?
2) Is the selected plan the best alternative under all reasonable future climate scenarios?
3) How does the selected plan balance initial investment with adaptation cost to optimize performance in consideration of future climate change?

These three questions are addressed below.

1) The reasonable extent of future sea level change can be estimated by using the High sea level scenario in the year 2123, which is 100 years after the assumed construction date. Per ER 1110-2-8159, Life Cycle Performance and Design, major infrastructure such as levees are assumed to have a 100 year project life unless otherwise specified (note that this project life is distinct from the 50 year period of economic analysis that derives from discounting future costs and benefits to net present value). The closest tidegage to the UBB project is the USACE gage on Bayou Barataria at Barataria (MVN gage 82750). The three USACE sea level scenarios are plotted for this gage in Figure 2, below.

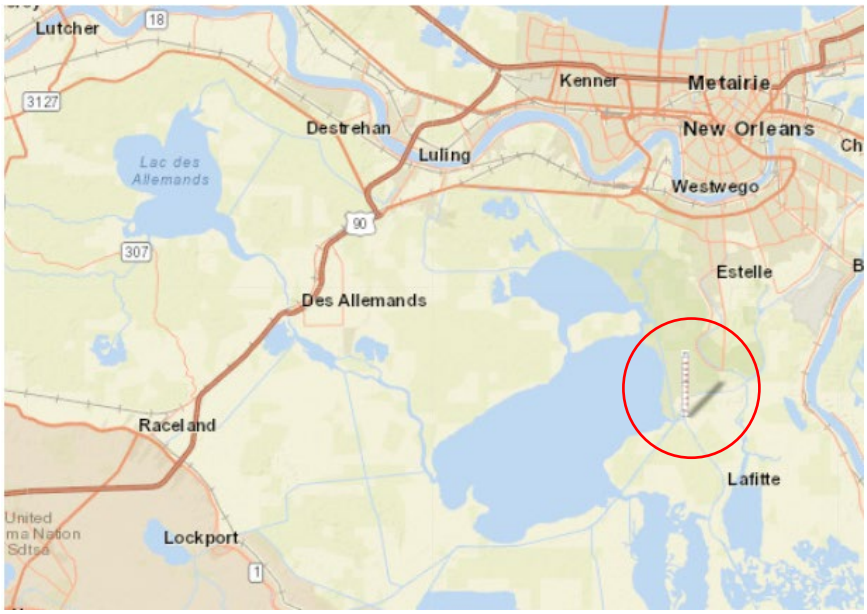

Figure 1. Location of Barataria gage relative to UBB project location

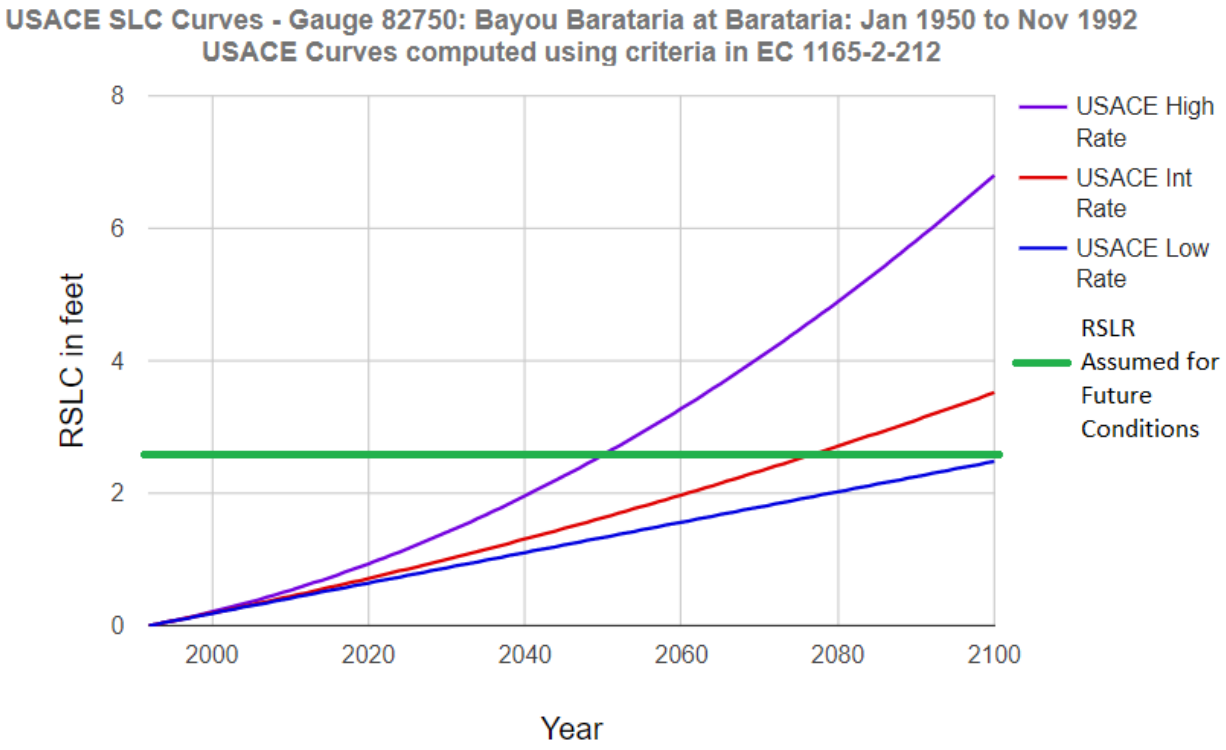

Figure 2. Sea level projections for Bayou Barataria at Barataria

The High scenario for relative sea level change at this gage is 9.37 ft relative to 1992, which is the midpoint of the most recent National Tidal Datum Epoch (NTDE) and thus represents presently published mean sea level. The extent of inundation at this sea level was visualized using the NOAA Sea Level Rise Viewer and is shown in Figure 3. It is no surprise that the UBB project area is largely covered by this degree of sea level change. This represents the maximum extent of potential impact for the project area and sets the strategic decision context for the project analysis of climate change.

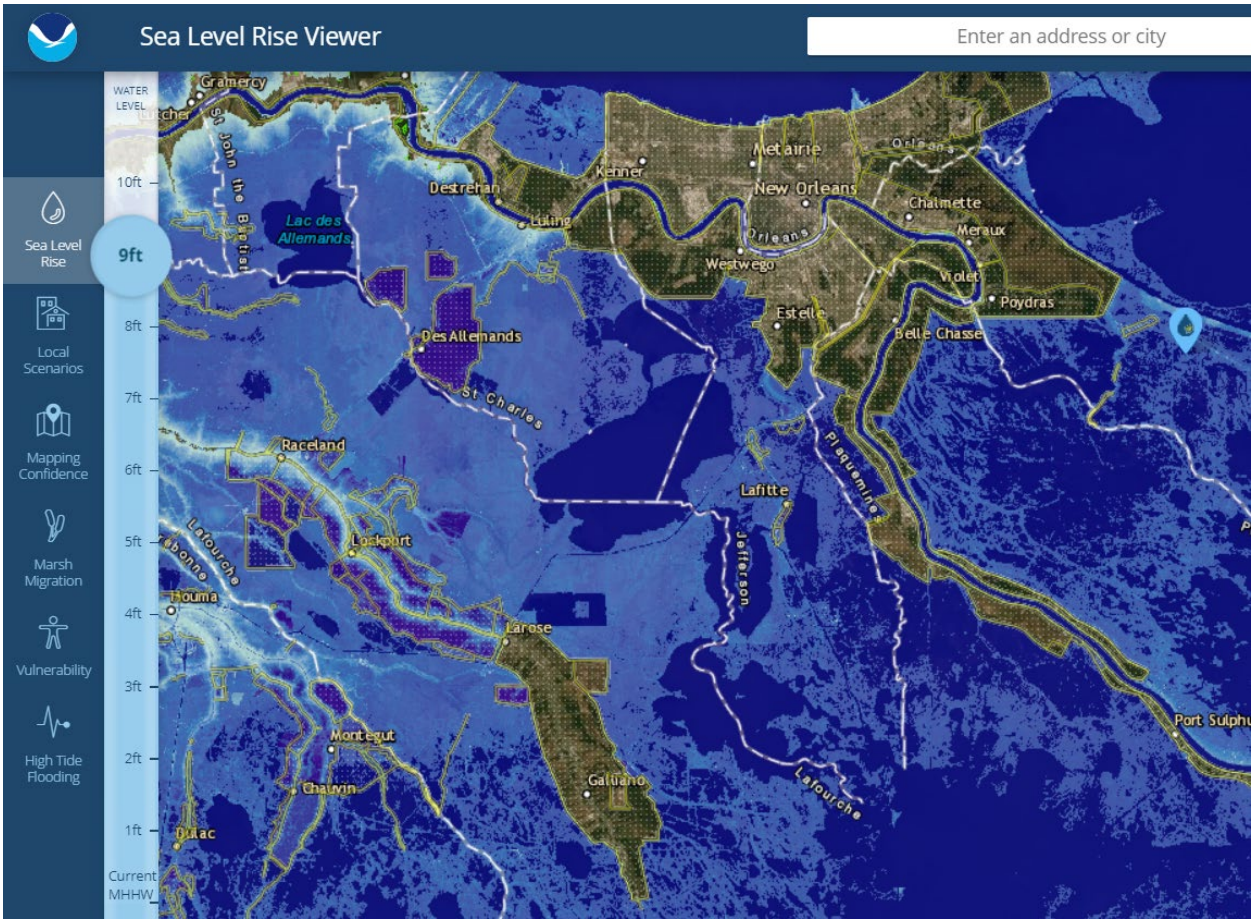

Figure 2. Inundation and mean sea level in the year 2123 under the USACE High sea level scenario. This represents the maximum plausible upper range of future conditions facing the UBB project.

2) USACE policy, outlined in ER 1100-2-8162, requires that sea level change be considered in project formulation. In particular, policy requires that alternatives be evaluated such that an alternative that performs best across the full range of plausible future conditions should generally be selected over an alternative that only performs well under one of the scenarios. At the TSP selection step, the team should demonstrate that uncertainty over future sea level conditions does not constitute uncertainty over which alternative will perform the best in the future. In the case of the UBB project, the TSP is the plan that ties into existing high ground and pre-existing levee systems without raising the elevation of those systems of the surrounding high ground. Alternative plans considered consisted of alternate levee alignments as well as nonstructural measures. Nonstructural measures such as house raisings were largely eliminated outside of limited hot spots due to low population density and resulting low net benefits, thus this elimination is not sensitive to uncertainty over sea level. Alternative levee alignments considered (see Hydraulic Levee Design Exterior Analysis for details) would be impacted by sea level similarly to the TSP alignment. Thus the choice of the TSP was not highly sensitive to sea level change uncertainty and the team is confident that the TSP is the best choice under all plausible future sea levels.

3) Performance of the selected plan over the project life can be assessed using future conditions model runs. The constraints of SMART planning, combined with the temporal urgency of projects funded under the Bipartisan Budget Act of 2018, did not allow for new model studies of future conditions for this project. Instead, the team leveraged analysis performed by the Coastal Protection and Restoration Authority of Louisiana for the 2017 Coastal Master Plan. This analysis modeled future conditions storm surge and waves for large areas of the Louisiana Coast using the ADCIRC storm surge model combined with the UnSWAN model for nearshore waves (model details are available at http://sonris-www.dnr.state.la.us/dnrservices/redirectUrl.jsp?dID=4734245). The CPRA analyzed several eustatic sea level scenarios; the one used for this study assumed approximately 1.5 feet of eustatic sea level rise beginning in the year 2017. Subsidence and accretion of topography and bathymetry in this analysis were spatially-varying based on the outputs of a geomorphic model; relative change in elevations is shown in Figure 4. The local land area around the UBB project shows net accretion of wetland over time (relative to NAVD88) but the bottoms of Lakes Salvador and Cataouatche are subsided approximately 0.5 feet. Thus this CPRA analysis is equivalent to approximately 2 feet of relative sea level rise.

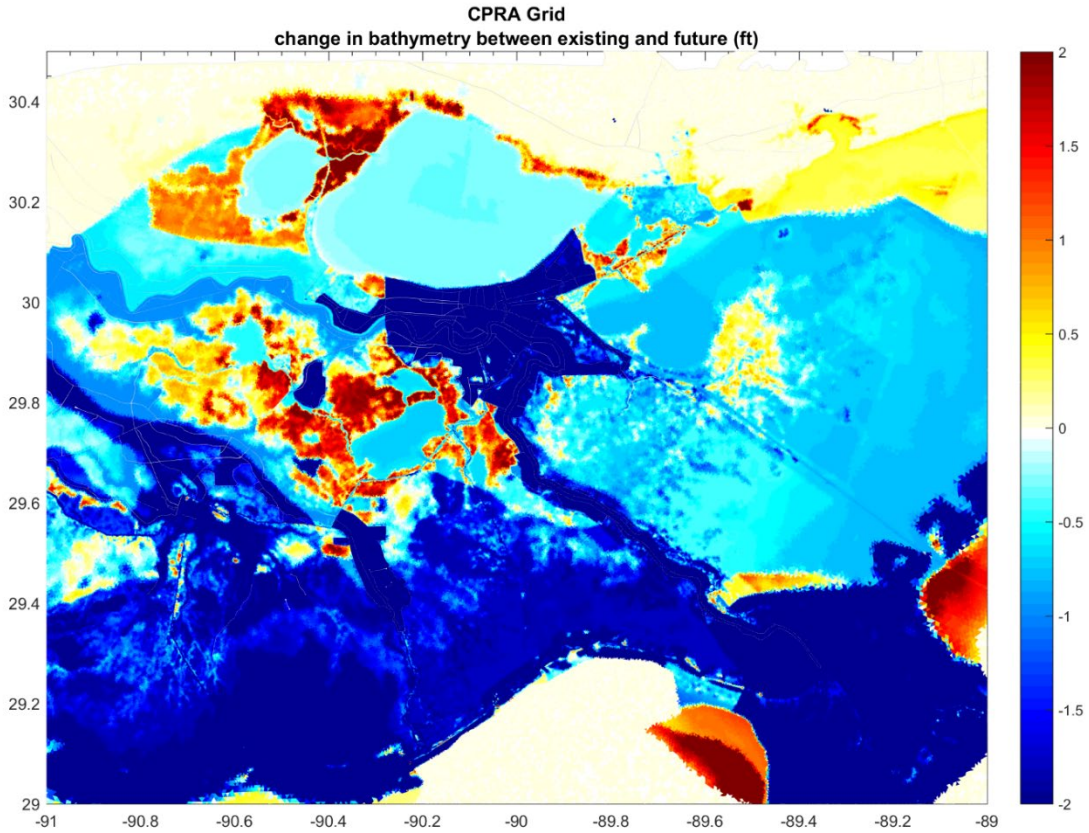

Figure 4. Relative change between CPRA 2017 and S13 future conditions ADCIRC model grids.

Mean sea level rise at the Barataria tidegage between 2017 and 2073 is approximately 1.8 feet under the Intermediate scenario, thus the CPRA analysis using scenario S13 for future conditions was considered reasonably similar, given the constraints of this study, to the Intermediate scenario at the end of the period of economic analysis. This was the sea level condition used to compute project economic benefits over the economic analysis period. While this assumption ignores the uncertainty in relative sea level in the year 2017, which may be 0.6-0.8 feet higher than 1992 at Barataria, the CPRA

ADCIRC model uses a starting water surface elevation of 1.2 feet NAVD88 to account for factors such as thermosteric effect, despite the fact that mean sea level at the NOAA gage located on Bayou Gauche (gage 8762482) is only about 0.8 feet above NAVD88 (note also that this MSL is based on the NOAA modified 5 year NTDE used in high-subsidence areas which spans from 2012-2016, rather than the standard NTDE that spans from 1983-2001). For the purposes of this study, the 1.2 foot initial water surface elevation was considered sufficient to address sea level rise between 1992 and 2017.

It is critical to understand that the UBB TSP design is optimized for NED benefits, rather than to deliver a set quantity of residual risk to the project area. Furthermore, the design is dictated by the elevation and performance of the surrounding high ground and pre-existing levee systems into which the proposed levee will tie. This means that the project will reduce risk to a known level (approximately 2% AEP) when construction is complete, at which point risk will gradually increase over time at an unknown rate due to sea level rise and subsidence. Because the plan does not address adaptation of the existing high ground or pre-existing levee system, there is no opportunity to adapt this project in the future to maintain performance because such adaptations would not be marginally economically justified. The project sponsor and public must be aware of the increasing risk to the project area communities and take actions to manage this risk.

Adaptation to sea level is most effectively considered in a “when, not if” context. The fact of sea level rise is certain; only the rate is uncertain. In the case of UBB, there is no performance threshold where the plan suddenly no longer performs due to excessive sea level. Instead, performance gradually decreases over time. The 50-year, Intermediate sea level change scenario used for economic analysis and represented by the CPRA 2017 analysis may be considered a benchmark for assessing the TSP against the other two USACE sea level scenarios. Under the Low scenario, this 2 foot increase would not be expected until approximately the year 2105, after the end of the assumed project life. Under the High scenario, it would be expected as soon as the year 2053. Thus at some point between the year 2053 and the year 2105, the risk to the project area can be expected to equal the conditions described in the CPRA 2017 analysis in the with-project condition (see Upper Barataria Basin Hydraulic Levee Design Exterior Analysis for details of the future conditions flood frequency).

While residual risk to the project area will increase faster under the High sea level scenario (and slower under the Low scenario) than assumed under the Intermediate scenario, this does not mean that the project benefits will necessarily be lower than computed if sea level rises faster than assumed. In fact, economic benefits may actually be higher under the High scenario due to worsened conditions in the without-project condition, though this cannot be confirmed without detailed economic analysis.

Year	USACE Low	USACE Int	USACE High
2017	0.57	0.63	0.81
2020	0.64	0.71	0.93
2025	0.76	0.86	1.16
2030	0.87	1.00	1.41
2035	0.99	1.15	1.67
2040	1.10	1.31	1.96
2045	1.22	1.47	2.26
2050	1.33	1.63	2.58
2055	1.45	1.80	2.92
2060	1.56	1.97	3.28
2065	1.68	2.15	3.65
2070	1.79	2.33	4.05
2075	1.91	2.52	4.46
2080	2.02	2.71	4.89
2085	2.14	2.91	5.34
2090	2.25	3.11	5.81
2095	2.37	3.31	6.30
2100	2.48	3.52	6.81
2105	2.60	3.73	7.33
2110	2.71	3.95	7.87
2115	2.83	4.17	8.43
2120	2.94	4.40	9.01
2123	3.01	4.54	9.37

Table 1. Duration of assumed future conditions project performance under the three USACE sea level scenarios