Mississippi Valley Division
Regional Planning and Environmental Division South

Upper Barataria Basin, Louisiana Feasibility Report

Appendix A: Annex 10 – UPPER BARATARIA BAY STORM SURGE ASSESSMENT

December 2021

UPPER BARATARIA BAY STORM SURGE ASSESSMENT

. GENERAL DESCRIPTION OF WORK

The purpose of this effort is to determine stage frequency from hurricane storm surges impacting the Upper Barataria Bay (UBB) project vicinity. The hydraulic modeling provides stage-frequency including 10YR, 20YR, 50YR, 100YR, 200YR, 500YR and 1000YR return periods.

2. SOFTWARE

ADCIRC Version 53. ADCIRC is a system of computer programs for solving time dependent, free surface circulation and transport problem. These programs utilize the finite element method in space allowing the use of highly flexible, unstructured grids covering large domains as pictured in Figure 1. Typical ADCIRC applications include prediction of storm surge and flooding. See http://adcirc.org/ for more information.

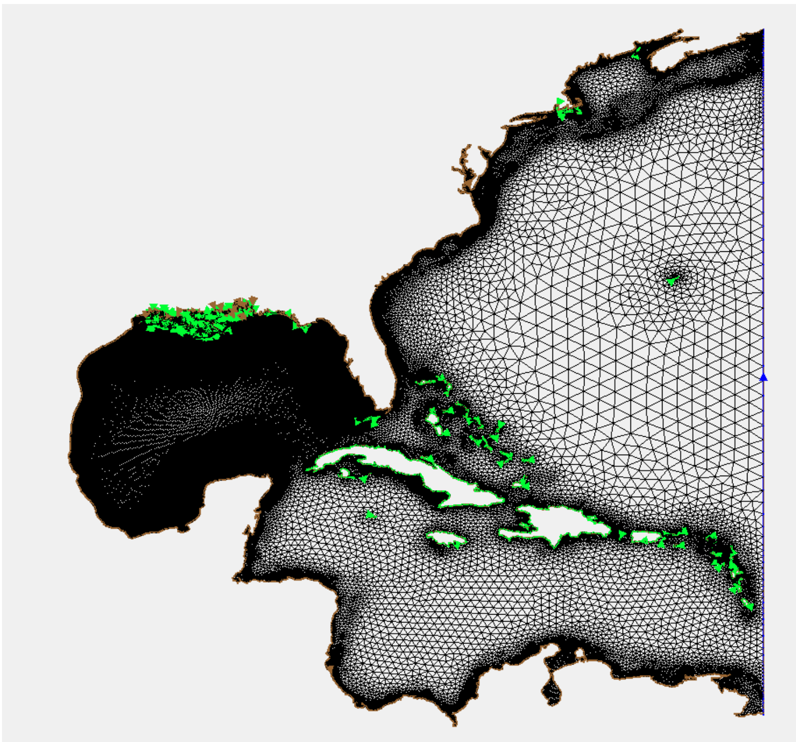


Figure 1 CPRA 2017 ADCIRC mesh

MATLAB R2017a. Matlab was used to post process the ADCIRC data and run a water level statistics code produced by the U.S. Army Engineer Research and Development Center (ERDC).

3. UBB STORM SURGE MODELING

a. WITH & WITHOUT PROJET CONDITIONS

The existing conditions hydraulic modeling was completed using the 2017 Coastal Protection and Restoration Authority's 2017 Master Plan ADCIRC mesh. The 2017 CPRA ADCIRC mesh was developed to represent base conditions for the 2017 State Master Plan. The 2017 Master Plan ADCIRC mesh is a heavily validated and verified ADCIRC mesh which performs well for hindcasts of Katrina, Rita, Gustav, Ike, Isaac. More information concerning the 2017 CPRA ADCIRC mesh can be found online here:

http://coastal.la.gov/wp-content/uploads/2017/04/Attachment-C3-25.1_FINAL_04.05.2017.pdf

http://coastal.la.gov/our-plan/2012-coastal-masterplan/cmp-appendices/

Figure 2 displays the levee and other raised feature (roads, spoil banks, etc) alignments in the UBB without project ADCIRC mesh. The elevations of the raised features are based on ~2017 era surveys or lidar data, which is generally representative of 2020 conditions. Figure 3 displays the modified "With Project" ADCIRC mesh. The levee elevation was set to 100YR elevations which are provided in Table 1.

Figure 2 Without project - levees and raised feature alignments

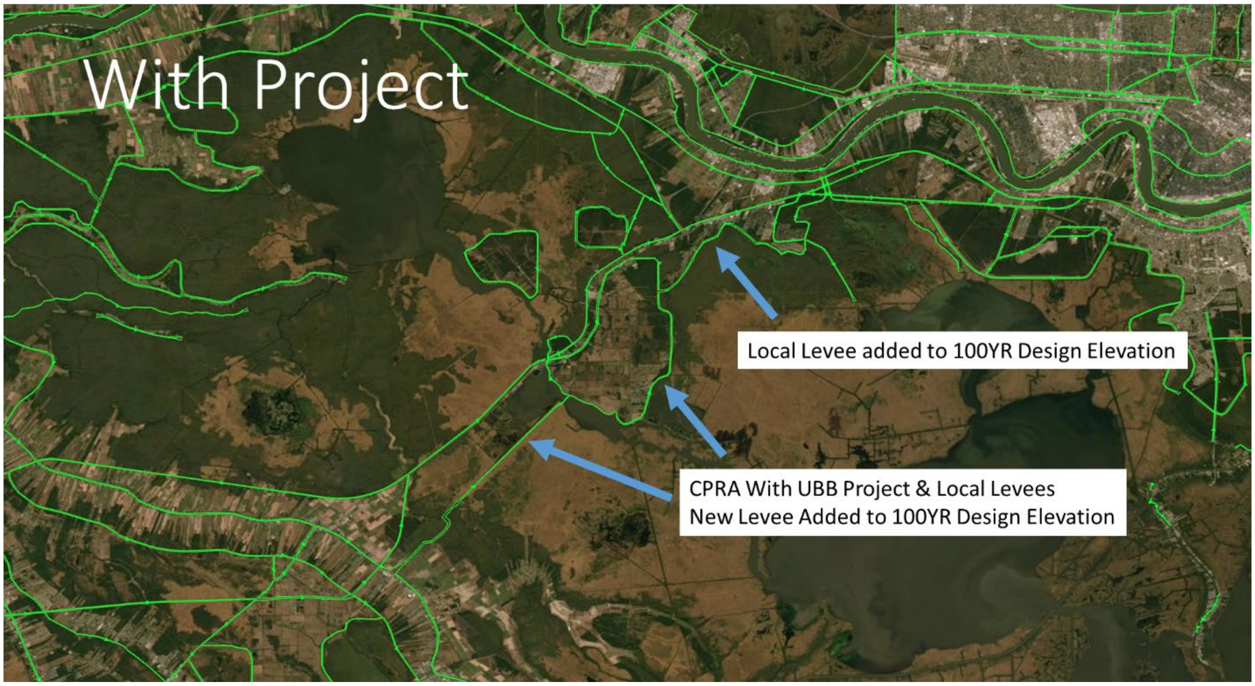


Figure 3 With project - levees and raised feature alignments

	Upper Barataria 1% Existing Conditions (2026)	Upper Barataria 1% Future Conditions (2076)
Hydraulic Reach	Required Levee Elevation (ft) NAVD88(2004.65)	Required Levee Elevation (ft) NAVD88(2004.65)
A	10.0	14.5
B	10.0	14.5
C	10.0	14.5
D	9.5	14.5
E	11.0	17.5
F	12.5	17.5
G	11.0	14.5
H	8.5	13.5

Table 1 2026 and 2076 1% required design elevations

b. SYNTHETIC STORMS

A suite of 22 synthetic storms including S008, S009, S012, S014, S015, S017, S018, S023, S026, S068, S069, S077, S083, S085, S094, S097, S116, S126, S132, S138, S145, and S146 were modeled for with and without project for existing and future conditions, which brings the total number of ADCIRC simulations to 88. The storms cover a range of hypothetical tracks and intensities as pictured in Figure 4 and Figure 5. The synthetic storms are basically an extension of the limited observed record of storms in this area. The synthetic storms range from category 1 to category 5 on the Saffir-Simpson scale and exhibit similar intensities to other storms which have impacted Louisiana.

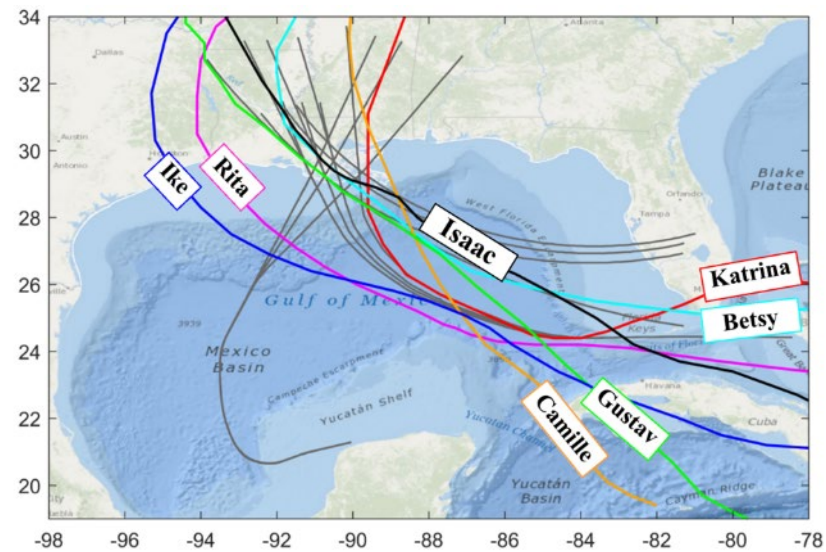


Figure 4 Synthetic and real storm tracks

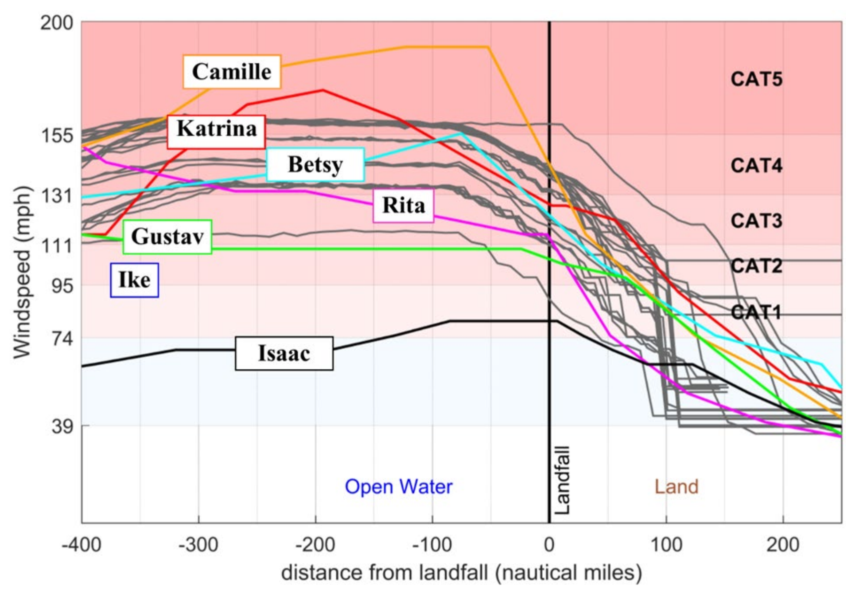


Figure 5 Synthetic and real storm intensities

c. With and Without Project Results

The 22 synthetic storms were simulated with ADCIRC for with and without project conditions. Figure 6 displays the maximum water surface elevation for without project conditions for synthetic storm 14. The simulation shows some flooding in the UBB area. Figure 7 displays the maximum water surface elevation for with project conditions for synthetic storm 14. The simulation including the 100YR levee shows a reduction in flooding in the interior and an increase in flooding on the exterior. Figure 8 displays the difference in maximum water surface elevation between with and without project. The difference plot shows the increase or stacking of water on the exterior is approximately 10 to 20" for this particular synthetic storm. The difference plot for all synthetic storms shows similar patterns of exterior stacking and interior reductions of peak water surface elevations.

A regression analysis was performed to determine stage frequency for with and without project. The maximum water surface results of all 22 synthetic storms for without project are compared to with project maximum water surface at all locations in the UBB area. The regression algorithm is completed at each ADCIRC node providing a continuous water level surface. The regression analysis allows prediction of the changes to the without-project stage-frequency due to the project based on results of all storms. Figure 9 displays the regression results at a location on the outside of the UBB levee. The regression analysis allows a generalized prediction of with-project stage frequency for both interior and exterior locations. Regression analysis adds extra error and uncertainty into the estimates. For this reason, all stage and wave frequency data should be reviewed and possibly recomputed during the PED phase of the project. Figure 9 shows an increase of the with-project stage-frequency on the exterior due to the stacking of water that occurs on the levee exterior. The regression analysis uses a linear regression approach, providing a general trend of expected changes to stage-frequency. Figure 10 through Figure 23 display the maximum storm surge for with and without project for the 10, 20, 50, 100, 200, 500 and 1000YR storm surge events. The bottom figure in each plot shows the maximum difference.

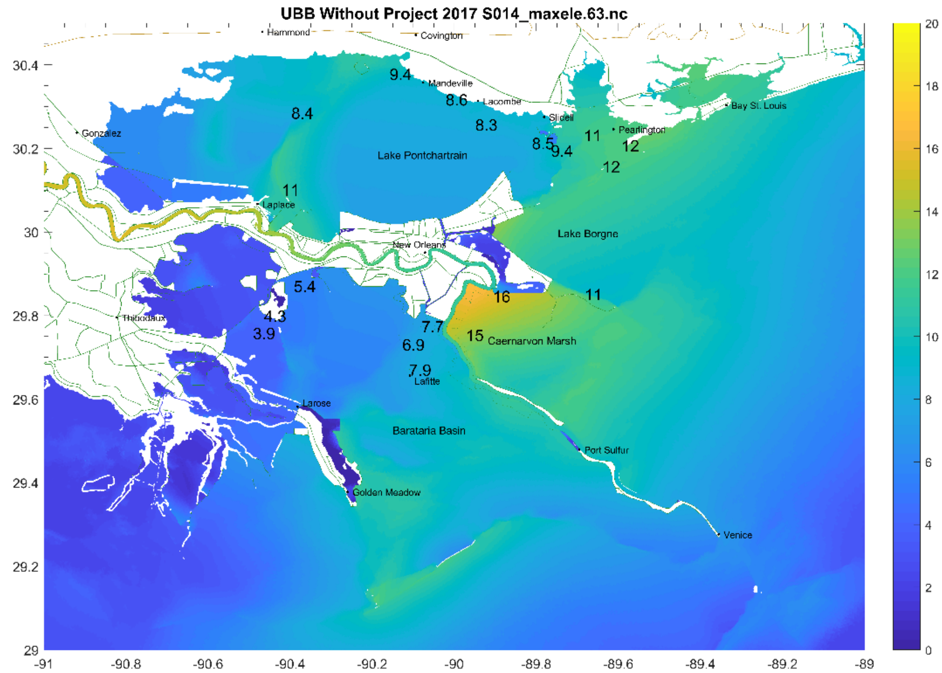


Figure 6 Without project maximum water surface elevation synthetic storm 14

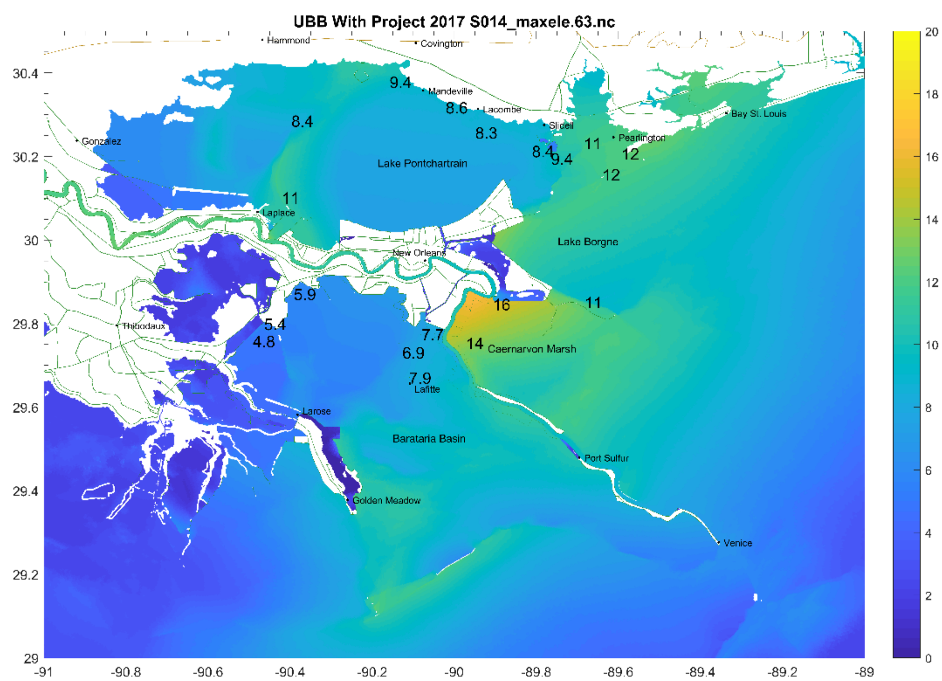


Figure 7 With project maximum water surface elevation synthetic storm 14

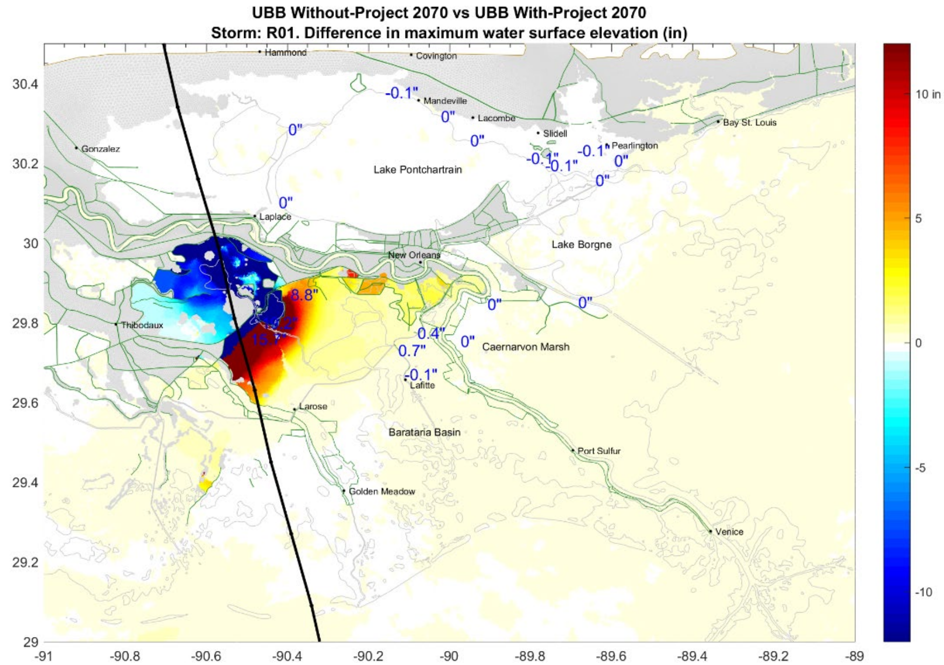


Figure 8 Difference in maximum water surface elevation for synthetic storm 014

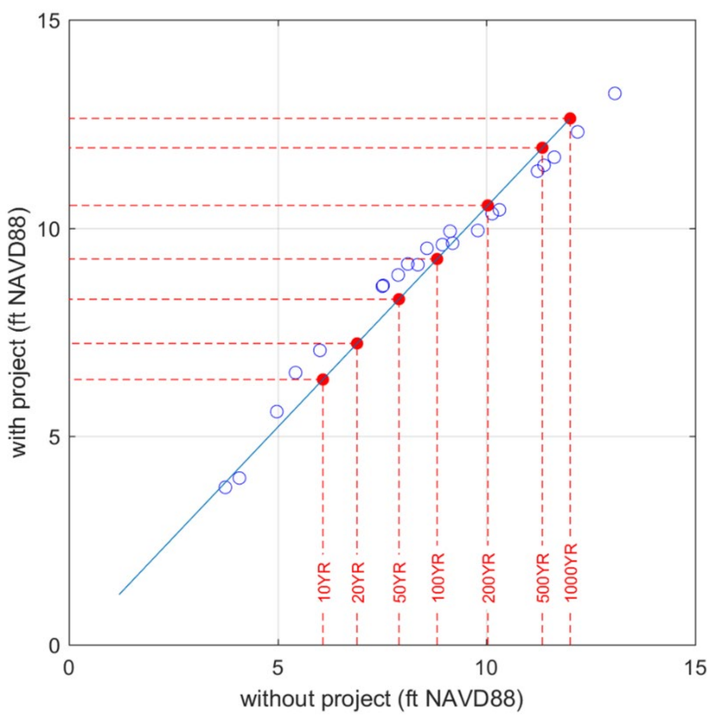


Figure 9 Regression plot at a location outside of the UBB levee

d. Relative Sea Level Rise Evaluation

Three relative sea level change (RSLC) values were evaluated in the hydraulic modeling for 2073 conditions, including 1.2, 1.6 and 3.2 ft. The Corps climate change website was used to determine the three RSLC amounts:

http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_nn_calc.html.

The Bayou Barataria gage was used given its close proximity to the project site. The average RSLC projections at 7 nearby gages show similar rates of RSLC. Table 4 contains the RSLC projections at the 7 gages. Figure 24 displays the location of the 7 gages.

Table 2. RSLC projections

Location	Rate of Ground Movement (mm/yr)	Subsidence over 50 Years (ft)	Projected RSLC from 2023 to 2073		
			Low (ft)	Int (ft)	High (Ft)
Lake Pontch West End (85625)	7.11	1.2	1.4	1.9	3.5
Rigolets (85700)	3	0.5	0.7	1.2	2.9
IHNC (76160)	8.77	1.4	1.7	2.2	3.8
Bayou Barataria (82750)	5.3	0.9	1.2	1.6	3.2
IHNC lock (01340)	5.1	0.8	1.1	1.6	3.2
MS River Carrolton (01300)	5.4	0.9	1.2	1.7	3.2
MRGO Shell Beach (85800)	8.5	1.4	1.7	2.2	3.7
average:	6.2	1.0	1.3	1.8	3.4

Table 3. USACE Relative Sea Level Change from 2023 to 2073 at Bayou Barataria (82750)

Relative Sea Level Rise Projections from 2023				
Target Year	Calendar Year	Relative Sea Level Rise from year 2023		
		Low (feet)	Int. (feet)	High (feet)
0	2023	0	0	0
10	2033	0.2	0.3	0.5
20	2043	0.5	0.6	1
30	2053	0.7	0.9	1.7
40	2063	0.9	1.3	2.4
50	2073	1.2	1.6	3.2

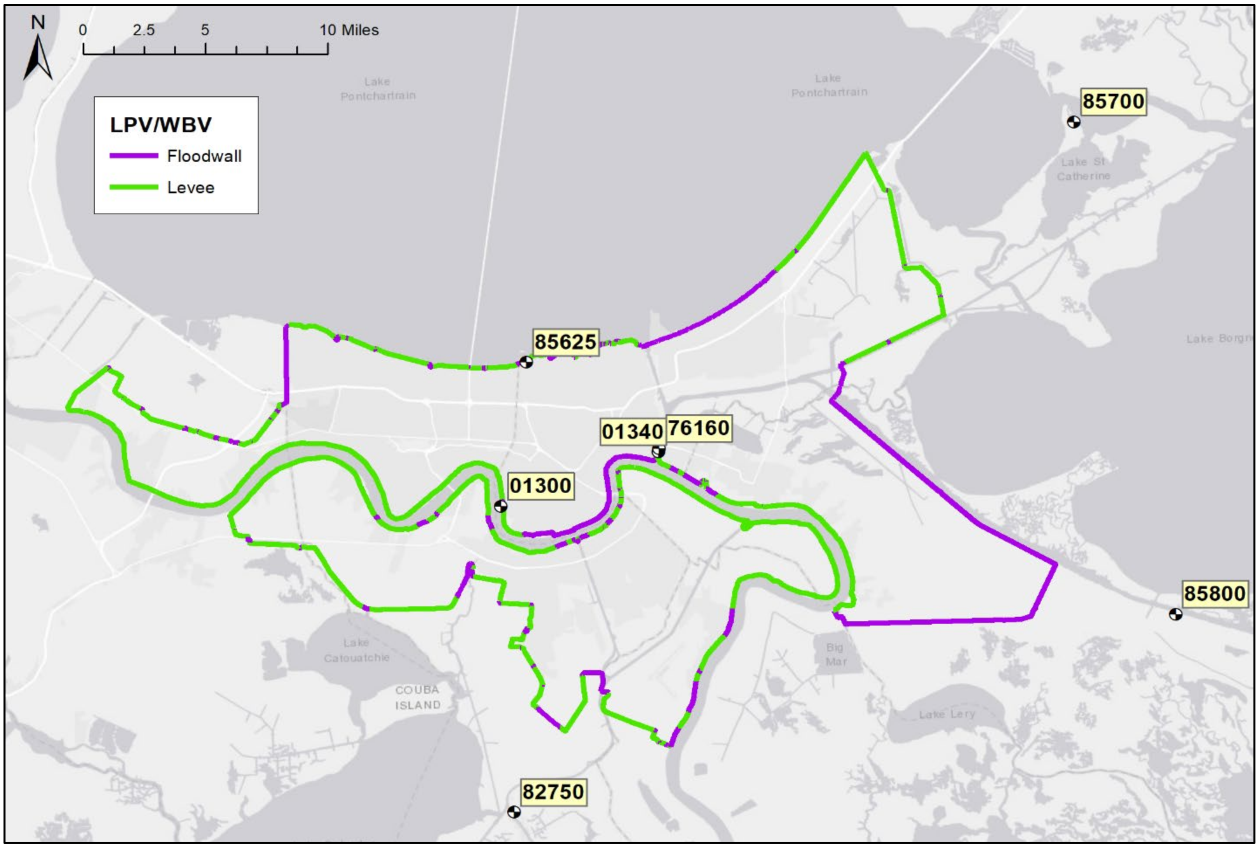


Figure 10. Location of water level gages used to determine RSLC projections

The ADCIRC based JPM-OS surge and wave statistics were estimated for the 2073 future with and without-project condition for low, intermediate and high RSLC. CPRA conducted a full suite of 152 storms for the future condition. The amount of eustatic sea level rise assigned in the CPRA future conditions ADCIRC simulations was 1.5ft. The grid bathymetry was changed to reflect future conditions. Some portions of the grid were subsided and some accreted, as depicted in Figure 27. In the UBB project vicinity there is a mix of projected subsidence and accretion.

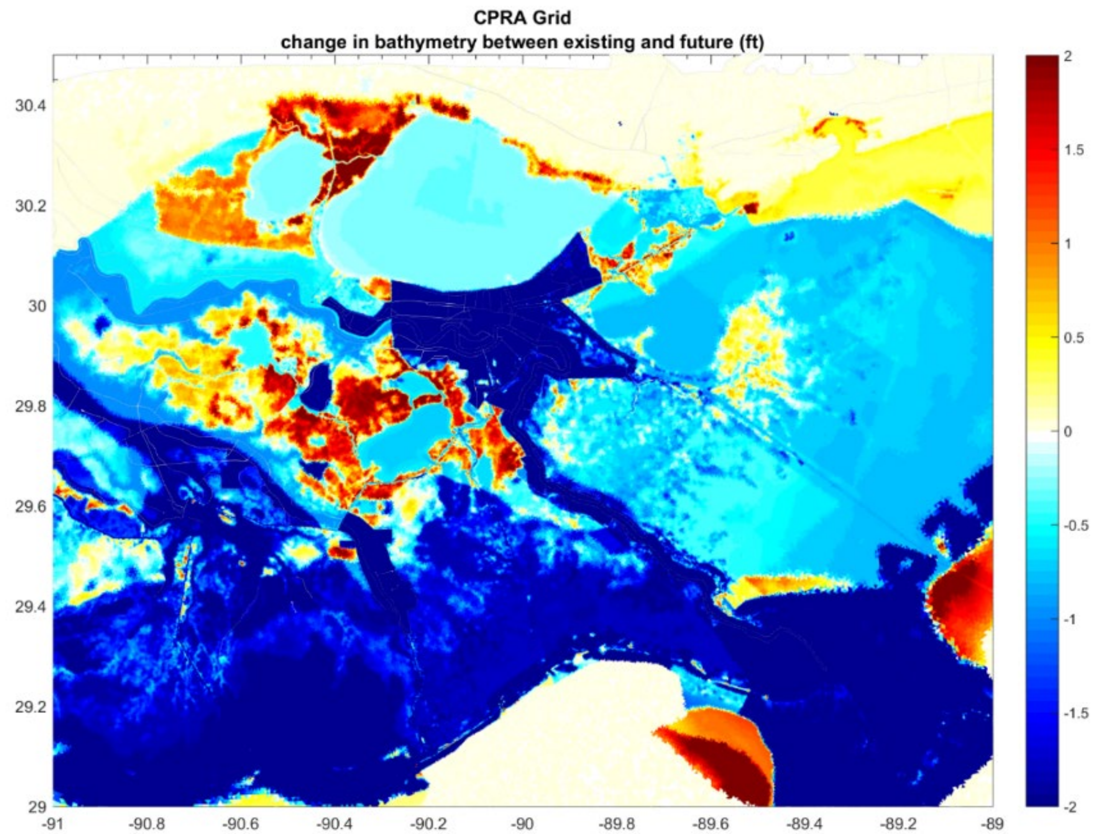


Figure 11. Change in bathymetry from existing to future conditions (CPRA mesh S13G60)

Surge and wave statistics for with and without project conditions for the various 2073 RSLC conditions (1.2, 1.6 and 3.2ft) were developed using linear interpolation and extrapolation of the CPRA simulation results. CPRA conducted the full suite of 152 ADCIRC simulations with 0.0ft and 1.5ft of eustatic sea level change (ESLC), and results were produced for 0.4, 0.8 and 2.4ft of projected eustatic sea level rise, which corresponds with 1.2, 1.6 and 3.2 feet of RSLC. The CPRA simulations provide the best representation of future conditions available due to the incorporation of spatially variable subsidence, land use changes, morphology and adjustments to bottom friction and canopy coefficients.

4 ASSUMPTIONS AND LIMITATIONS

- Interior water level statistics were computed with the latest JPM-OS code from ERDC. The code was applied as-is with no modification or verification.
- The interior stage frequency data does not include the effects of rainfall, wave overtopping, pumping, levee breaching. The interior inundation does include some free flow or weir overtopping of the proposed 100YR design for the lower frequency events.

- The ADCIRC modeling includes a smaller subset of 22 synthetic storms. During a PED phase, or if the project were to go to construction, design elevations should be reviewed and based on a more thorough analysis.
- The statistical results are based on regression analysis, which introduces some uncertainty into the modeling.

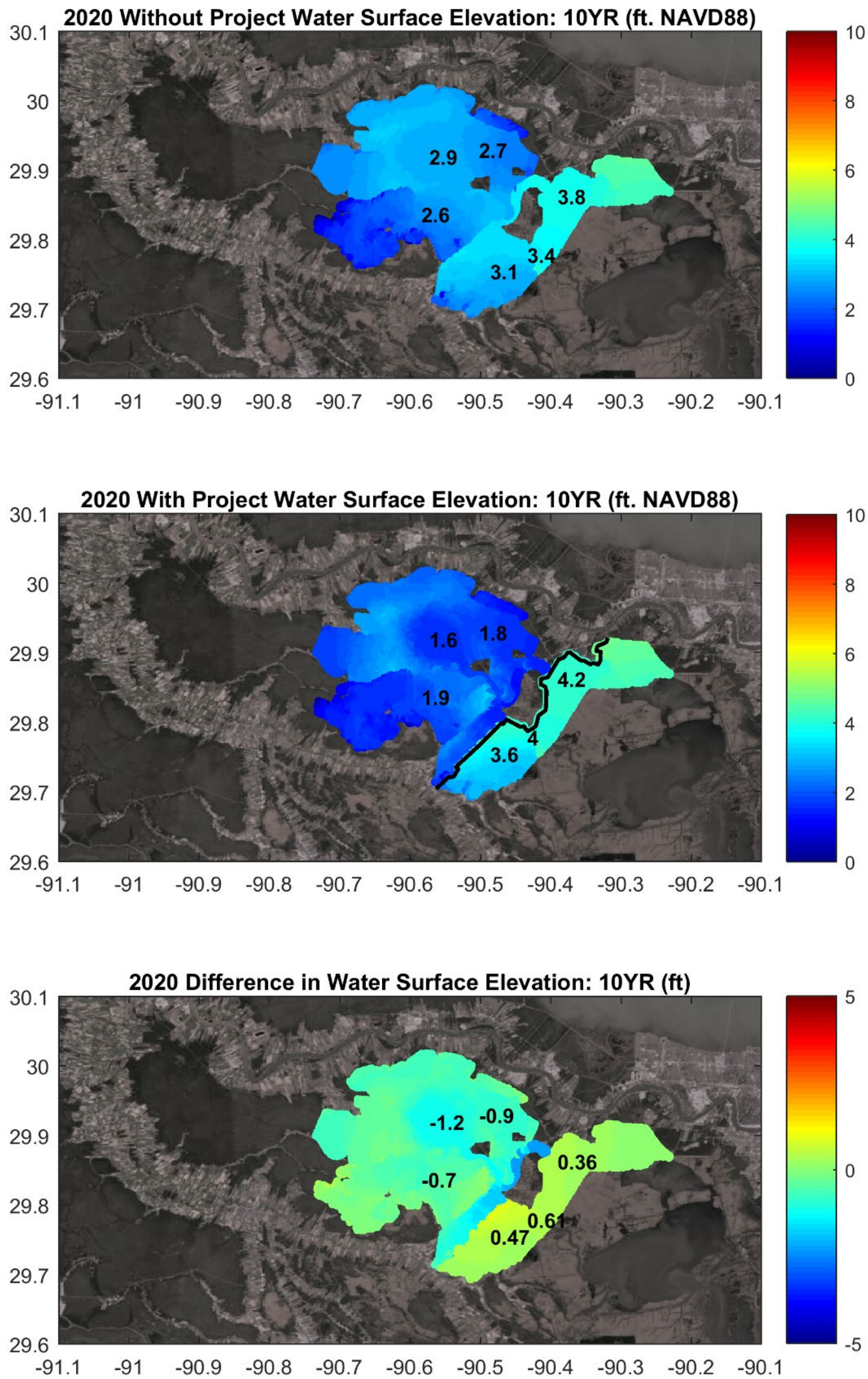

2020 Without Project Water Surface Elevation: 10YR (ft. NAVD88)
2.9
2.7
3.8
2.6
3.4
3.1
2020 With Project Water Surface Elevation: 10YR (ft. NAVD88)
1.6
1.8
4.2
1.9
4
3.6
2020 Difference in Water Surface Elevation: 10YR (ft)
-1.2
-0.9
0.36
-0.7
0.61
0.47
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 12

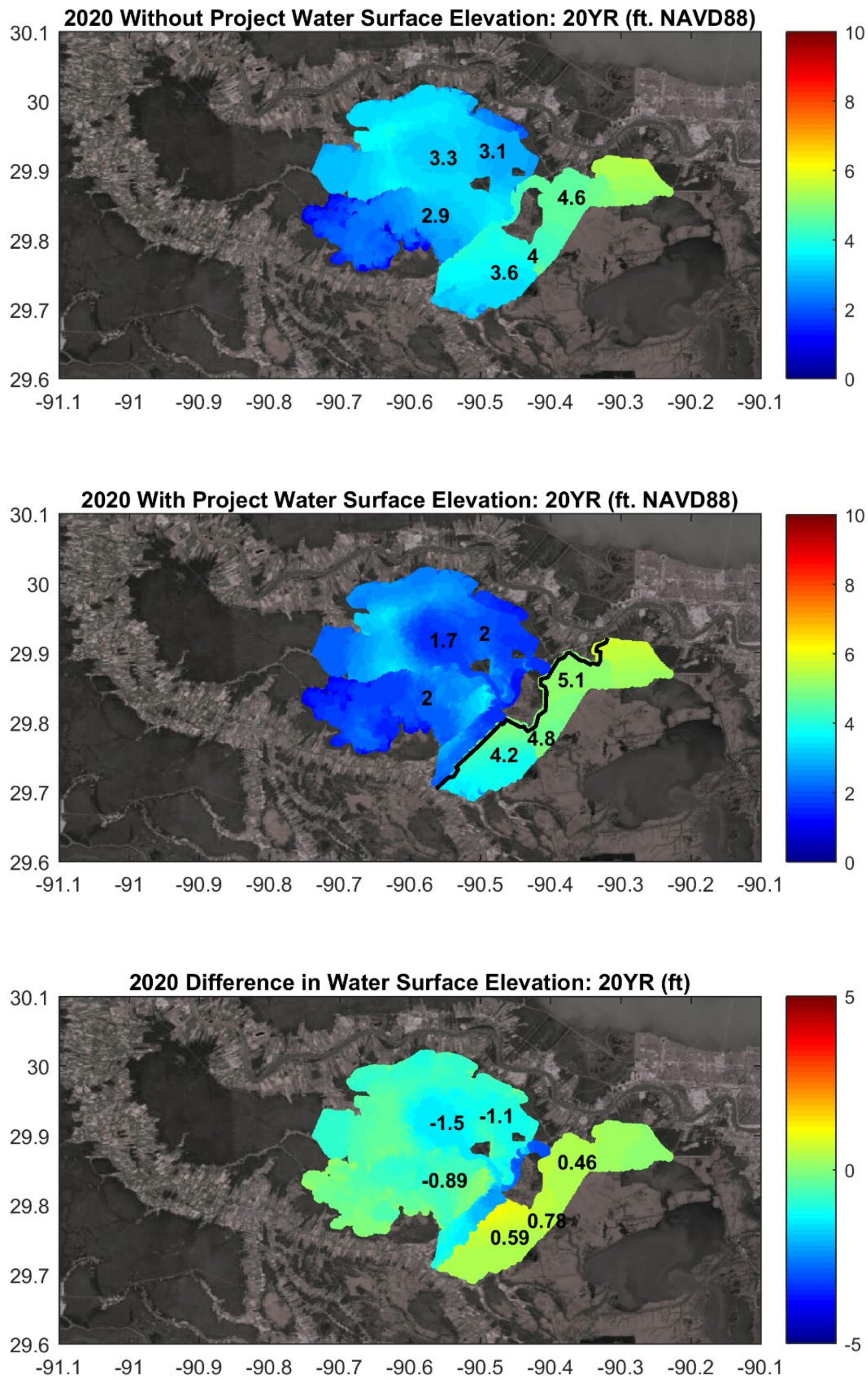

2020 Without Project Water Surface Elevation: 20YR (ft. NAVD88)
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
3.3
3.1
4.6
2.9
4
3.6
2020 With Project Water Surface Elevation: 20YR (ft. NAVD88)
1.7
2
5.1
2
4.8
4.2
2020 Difference in Water Surface Elevation: 20YR (ft)
5
0
-5
-1.5
-1.1
0.46
-0.89
0.78
0.59

Figure 13

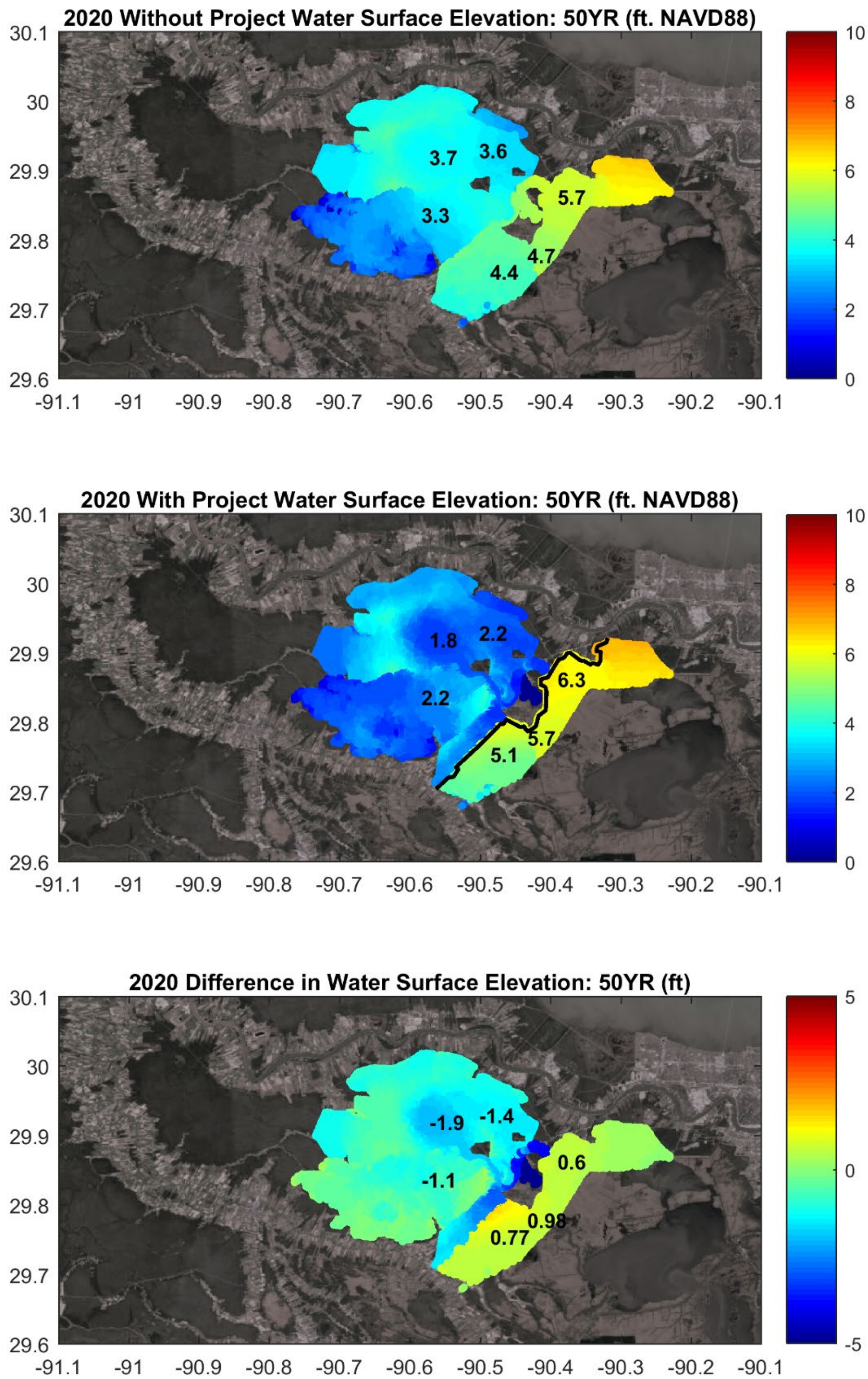

2020 Without Project Water Surface Elevation: 50YR (ft. NAVD88)
3.7
3.6
5.7
3.3
4.7
4.4
2020 With Project Water Surface Elevation: 50YR (ft. NAVD88)
1.8
2.2
6.3
2.2
5.7
5.1
2020 Difference in Water Surface Elevation: 50YR (ft)
-1.9
-1.4
0.6
-1.1
0.98
0.77
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 14

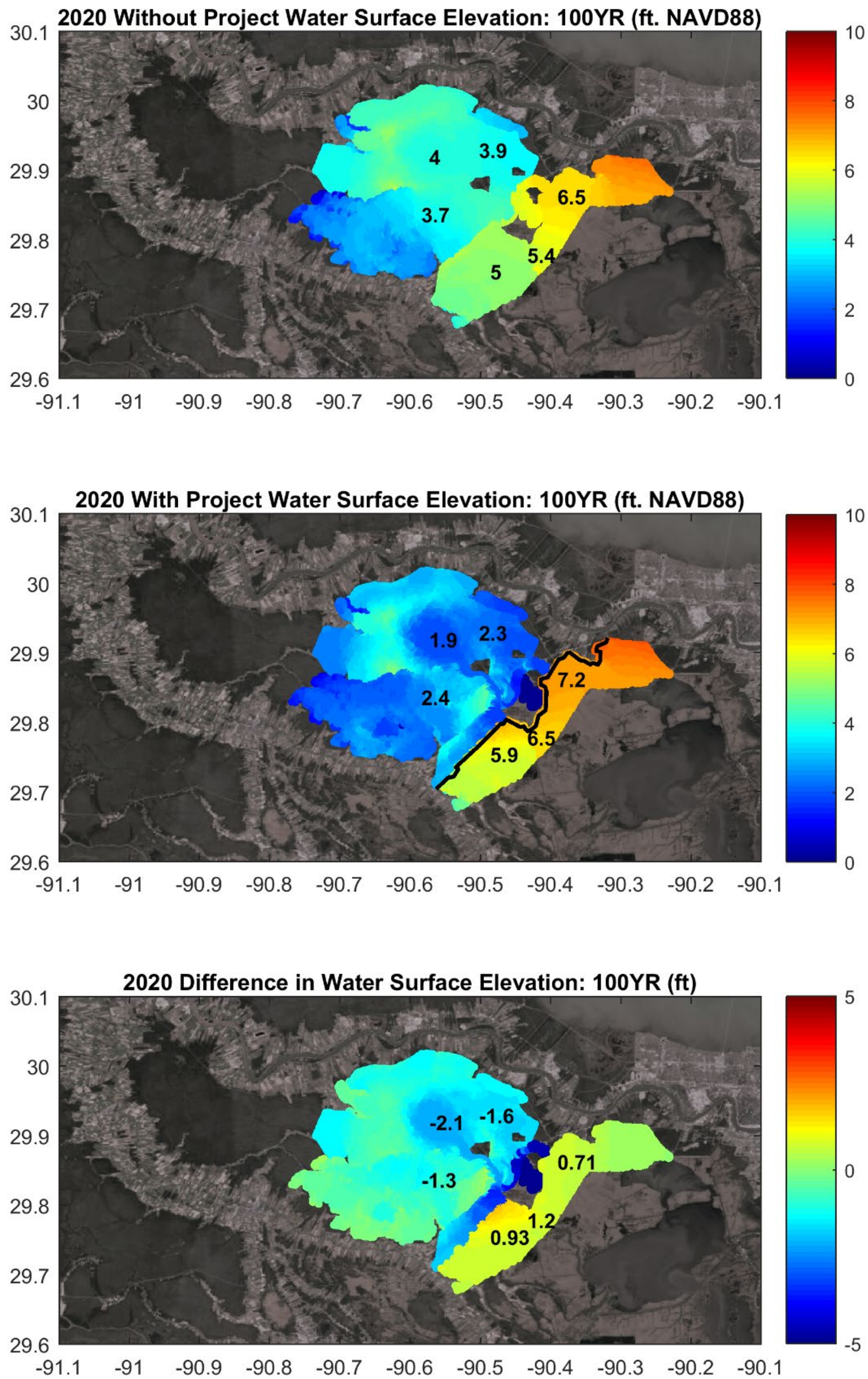

2020 Without Project Water Surface Elevation: 100YR (ft. NAVD88)
4
3.9
3.7
6.5
5.4
5
2020 With Project Water Surface Elevation: 100YR (ft. NAVD88)
1.9
2.3
2.4
7.2
6.5
5.9
2020 Difference in Water Surface Elevation: 100YR (ft)
-2.1
-1.6
-1.3
0.71
1.2
0.93

Figure 15

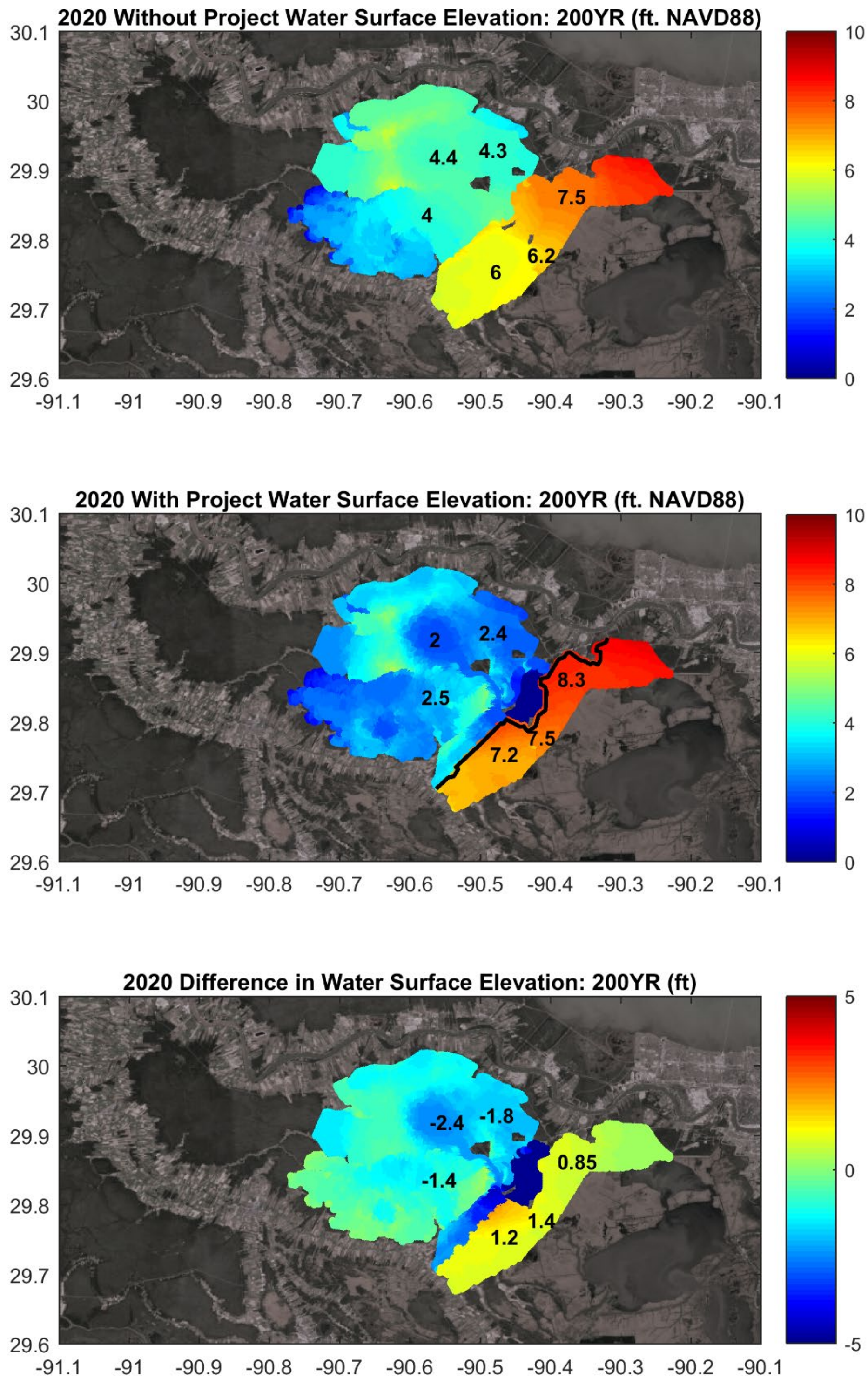

2020 Without Project Water Surface Elevation: 200YR (ft. NAVD88)
4.4
4.3
7.5
4
6.2
6
2020 With Project Water Surface Elevation: 200YR (ft. NAVD88)
2
2.4
8.3
2.5
7.5
7.2
2020 Difference in Water Surface Elevation: 200YR (ft)
-2.4
-1.8
0.85
-1.4
1.4
1.2
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 16

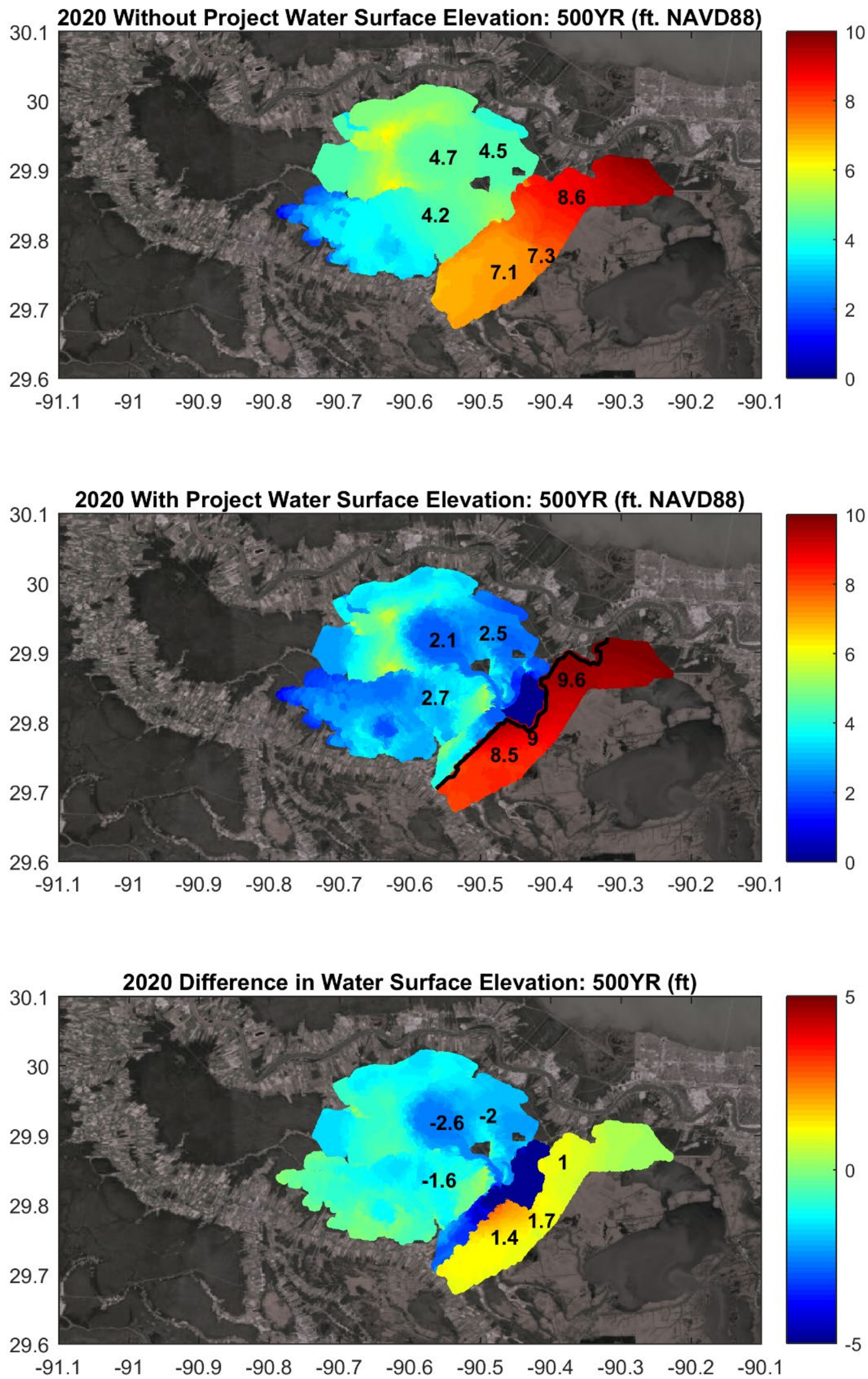

2020 Without Project Water Surface Elevation: 500YR (ft. NAVD88)
4.7
4.5
8.6
4.2
7.3
7.1
2020 With Project Water Surface Elevation: 500YR (ft. NAVD88)
2.1
2.5
9.6
2.7
9
8.5
2020 Difference in Water Surface Elevation: 500YR (ft)
-2.6
-2
1
-1.6
1.7
1.4
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 17

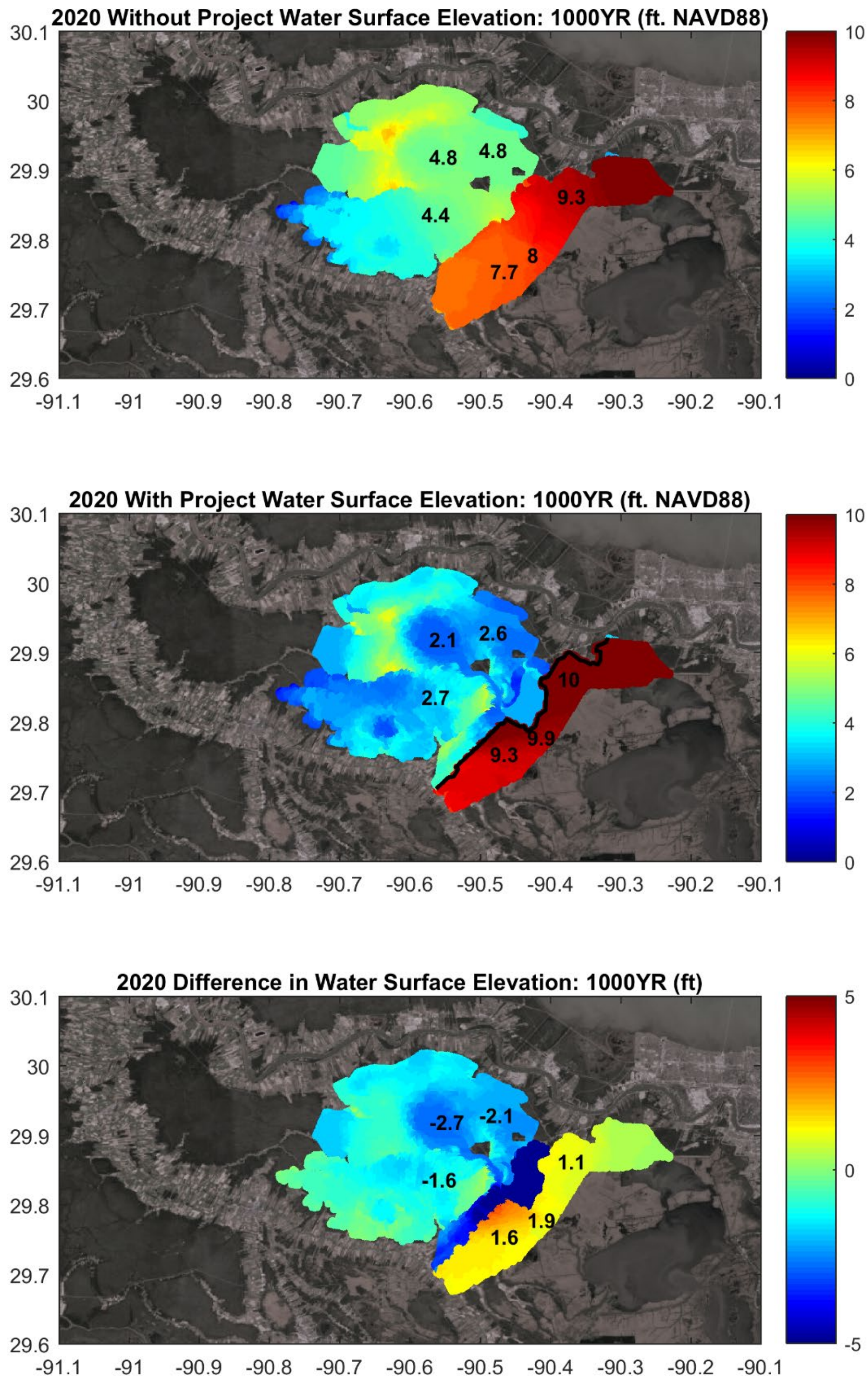

2020 Without Project Water Surface Elevation: 1000YR (ft. NAVD88)
4.8
4.8
9.3
4.4
8
7.7
2020 With Project Water Surface Elevation: 1000YR (ft. NAVD88)
2.1
2.6
10
2.7
9.9
9.3
2020 Difference in Water Surface Elevation: 1000YR (ft)
-2.7
-2.1
1.1
-1.6
1.9
1.6
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 18

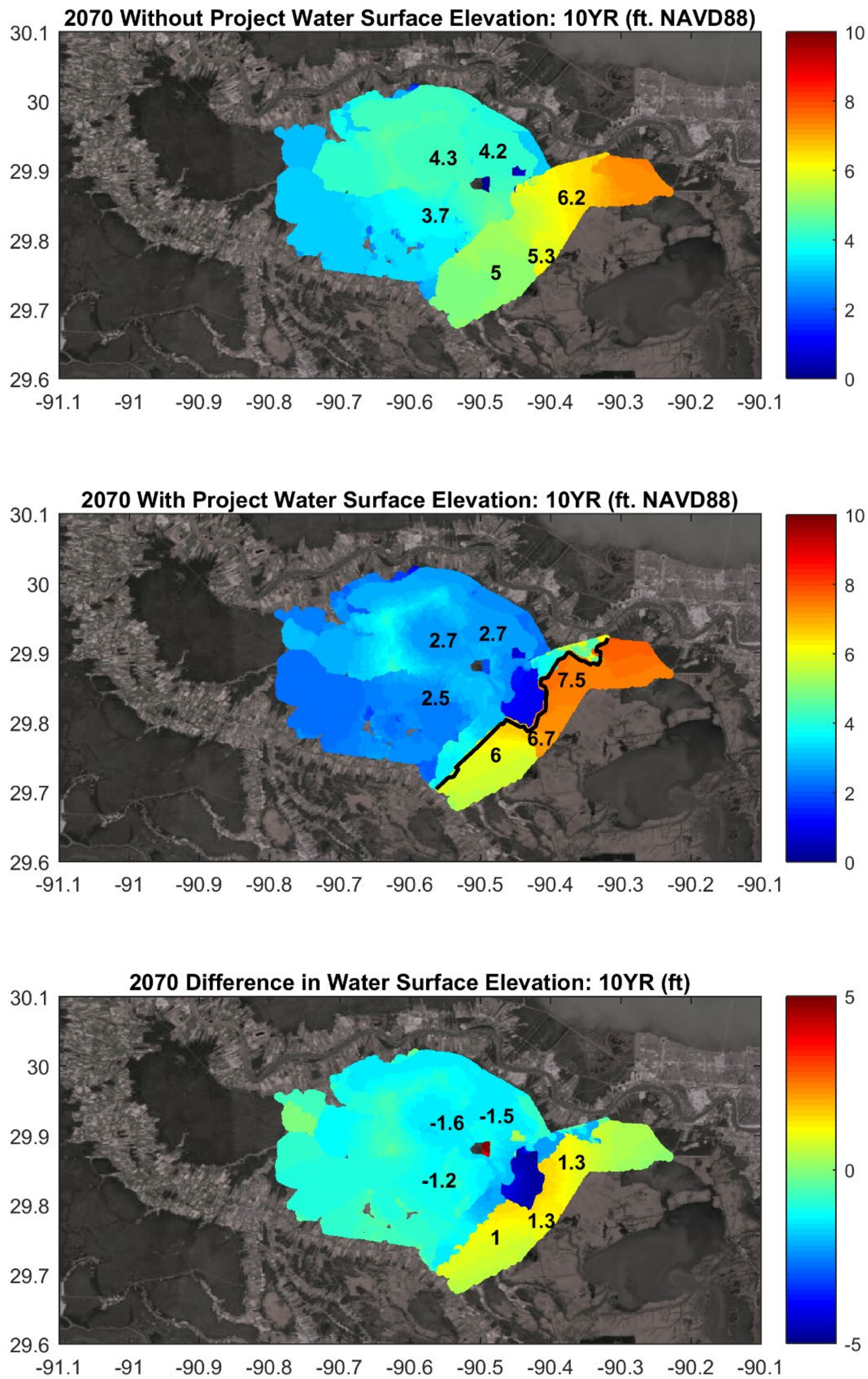

2070 Without Project Water Surface Elevation: 10YR (ft. NAVD88)
4.3
4.2
6.2
3.7
5.3
5
2070 With Project Water Surface Elevation: 10YR (ft. NAVD88)
2.7
2.7
7.5
2.5
6.7
6
2070 Difference in Water Surface Elevation: 10YR (ft)
-1.6
-1.5
1.3
-1.2
1.3
1
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 19

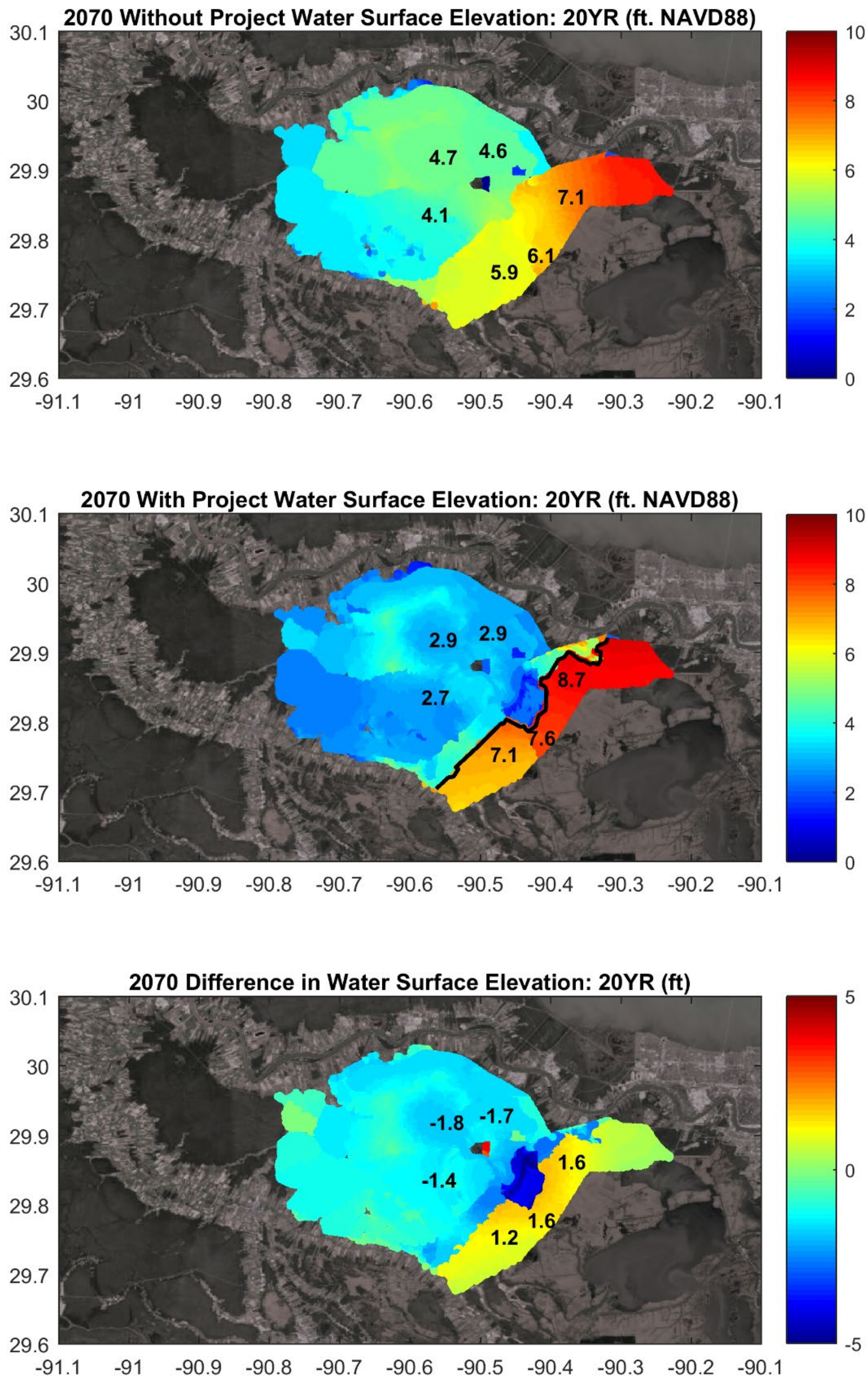

2070 Without Project Water Surface Elevation: 20YR (ft. NAVD88)
4.7
4.6
7.1
4.1
6.1
5.9
2070 With Project Water Surface Elevation: 20YR (ft. NAVD88)
2.9
2.9
8.7
2.7
7.6
7.1
2070 Difference in Water Surface Elevation: 20YR (ft)
-1.8
-1.7
1.6
-1.4
1.6
1.2
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 20

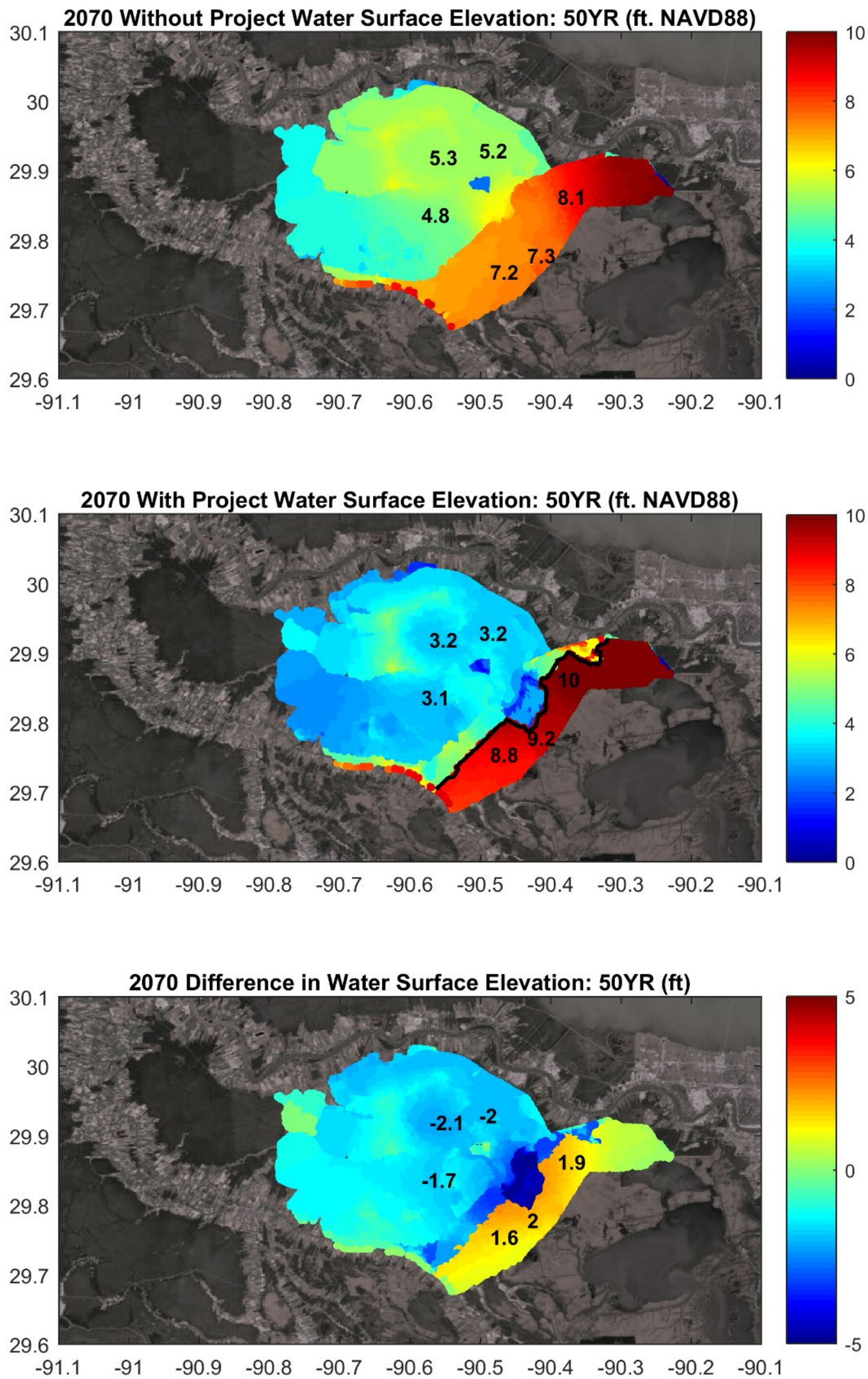

2070 Without Project Water Surface Elevation: 50YR (ft. NAVD88)
5.3
5.2
8.1
4.8
7.3
7.2
2070 With Project Water Surface Elevation: 50YR (ft. NAVD88)
3.2
3.2
10
3.1
9.2
8.8
2070 Difference in Water Surface Elevation: 50YR (ft)
-2.1
-2
1.9
-1.7
2
1.6
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
0
-5

Figure 21

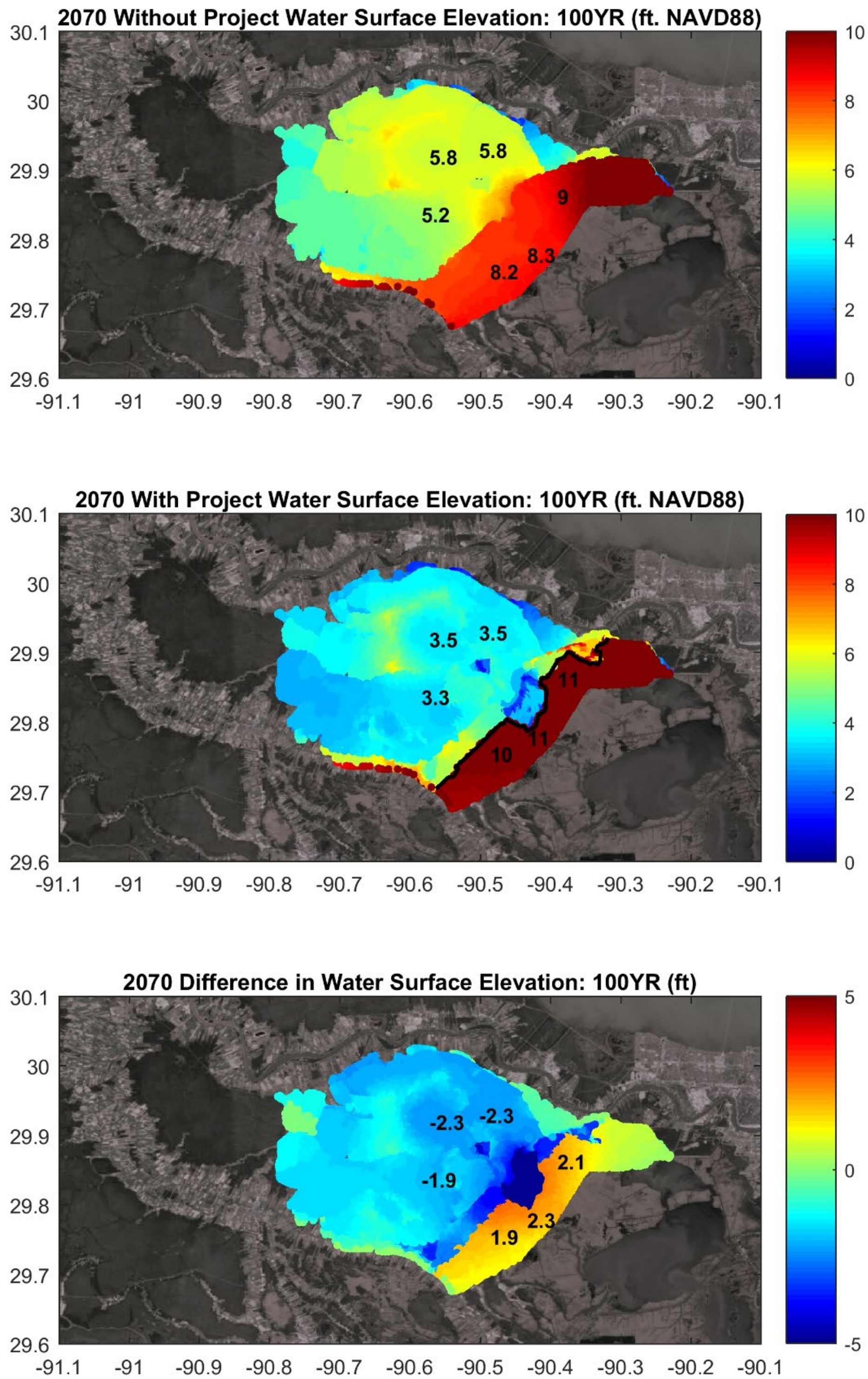
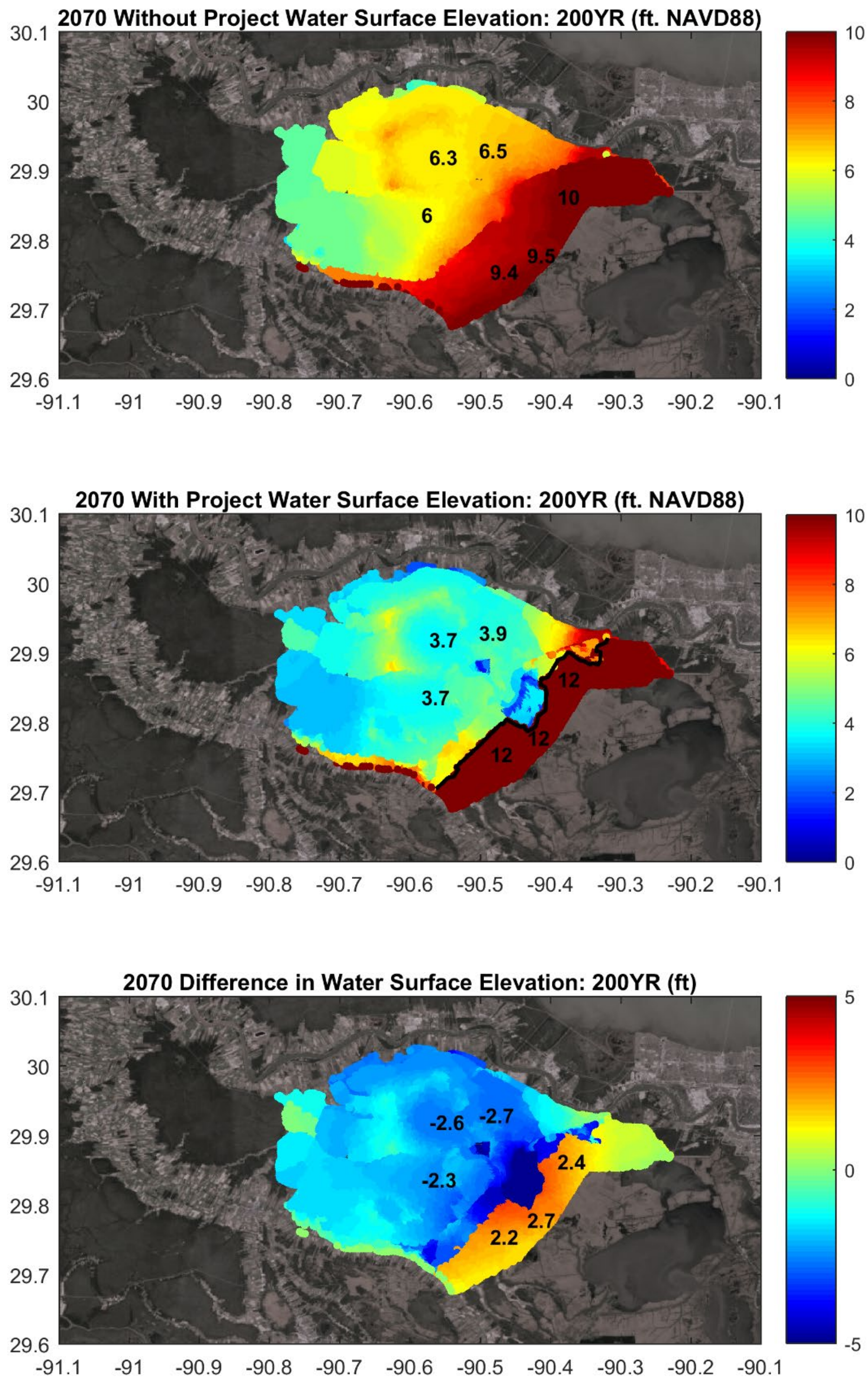

2070 Without Project Water Surface Elevation: 100YR (ft. NAVD88)
5.8
5.8
5.2
9
8.3
8.2
2070 With Project Water Surface Elevation: 100YR (ft. NAVD88)
3.5
3.5
3.3
11
11
10
2070 Difference in Water Surface Elevation: 100YR (ft)
-2.3
-2.3
-1.9
2.1
2.3
1.9
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1

Figure 22



2070 Without Project Water Surface Elevation: 200YR (ft. NAVD88)
6.3
6.5
6
10
9.5
9.4
2070 With Project Water Surface Elevation: 200YR (ft. NAVD88)
3.7
3.9
3.7
12
12
12
2070 Difference in Water Surface Elevation: 200YR (ft)
-2.6
-2.7
-2.3
2.4
2.7
2.2
30.1
30
29.9
29.8
29.7
29.6
-91.1 -91 -90.9 -90.8 -90.7 -90.6 -90.5 -90.4 -90.3 -90.2 -90.1
10 8 6 4 2 0
5 0 -5

Figure 23

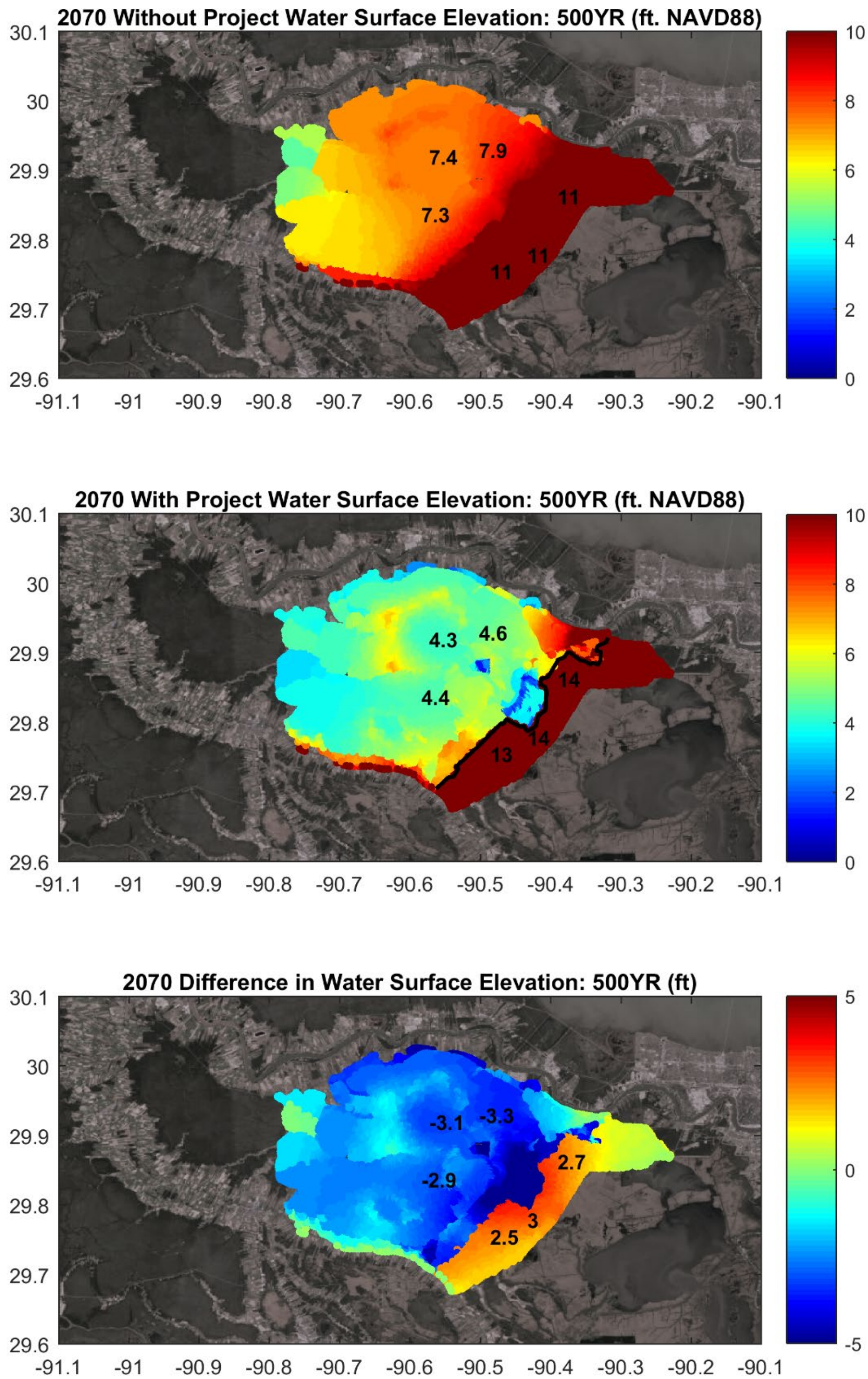

2070 Without Project Water Surface Elevation: 500YR (ft. NAVD88)
7.4
7.9
11
7.3
11
11
2070 With Project Water Surface Elevation: 500YR (ft. NAVD88)
4.3
4.6
14
4.4
14
13
2070 Difference in Water Surface Elevation: 500YR (ft)
-3.1
-3.3
2.7
-2.9
3
2.5
30.1
30
29.9
29.8
29.7
29.6
-91.1
-91
-90.9
-90.8
-90.7
-90.6
-90.5
-90.4
-90.3
-90.2
-90.1
10
8
6
4
2
0
5
-5

Figure 24

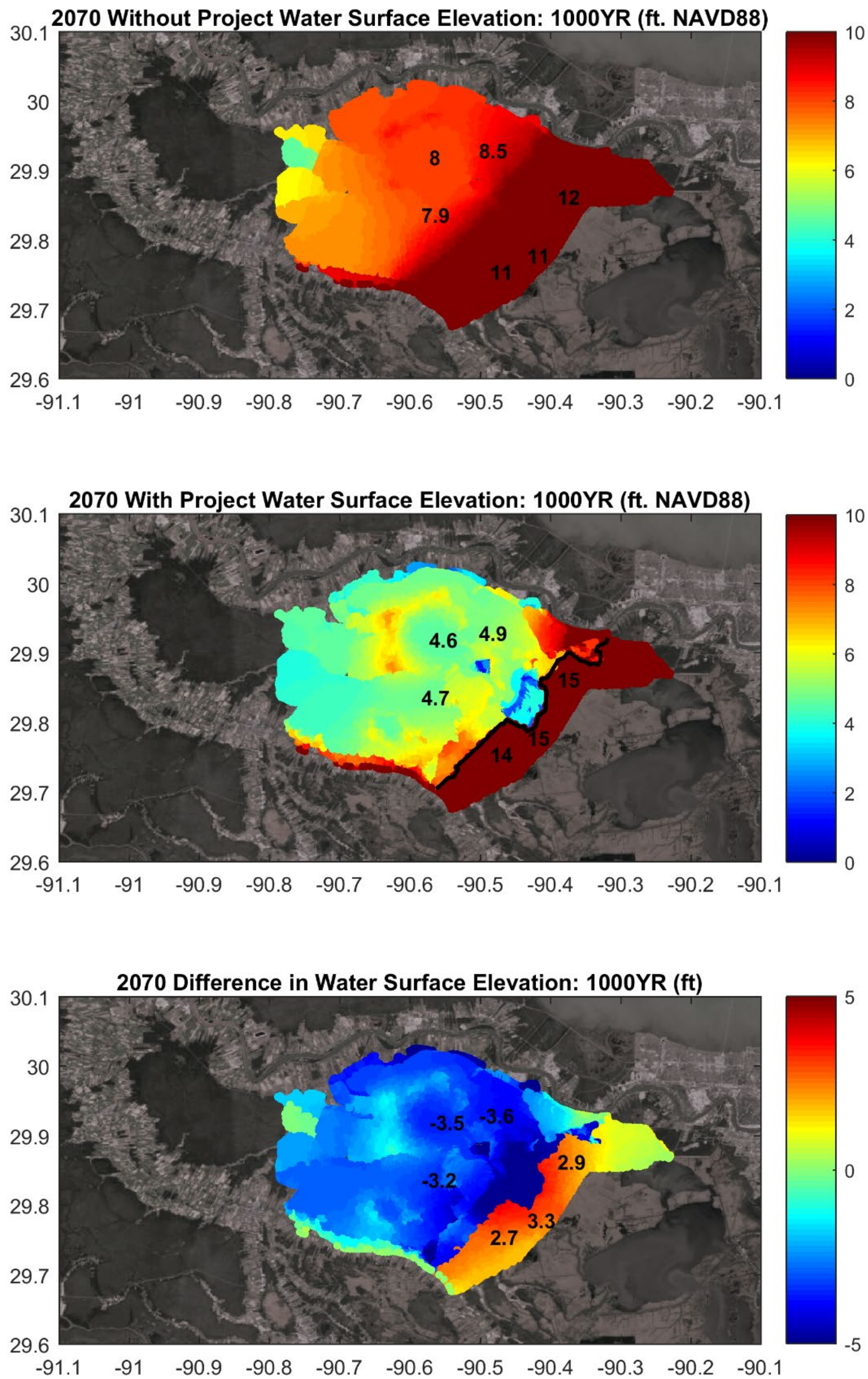

2070 Without Project Water Surface Elevation: 1000YR (ft. NAVD88)
8
8.5
7.9
12
11
11
2070 With Project Water Surface Elevation: 1000YR (ft. NAVD88)
4.6
4.9
4.7
15
15
14
2070 Difference in Water Surface Elevation: 1000YR (ft)
-3.5
-3.6
-3.2
2.9
3.3
2.7

Figure 25