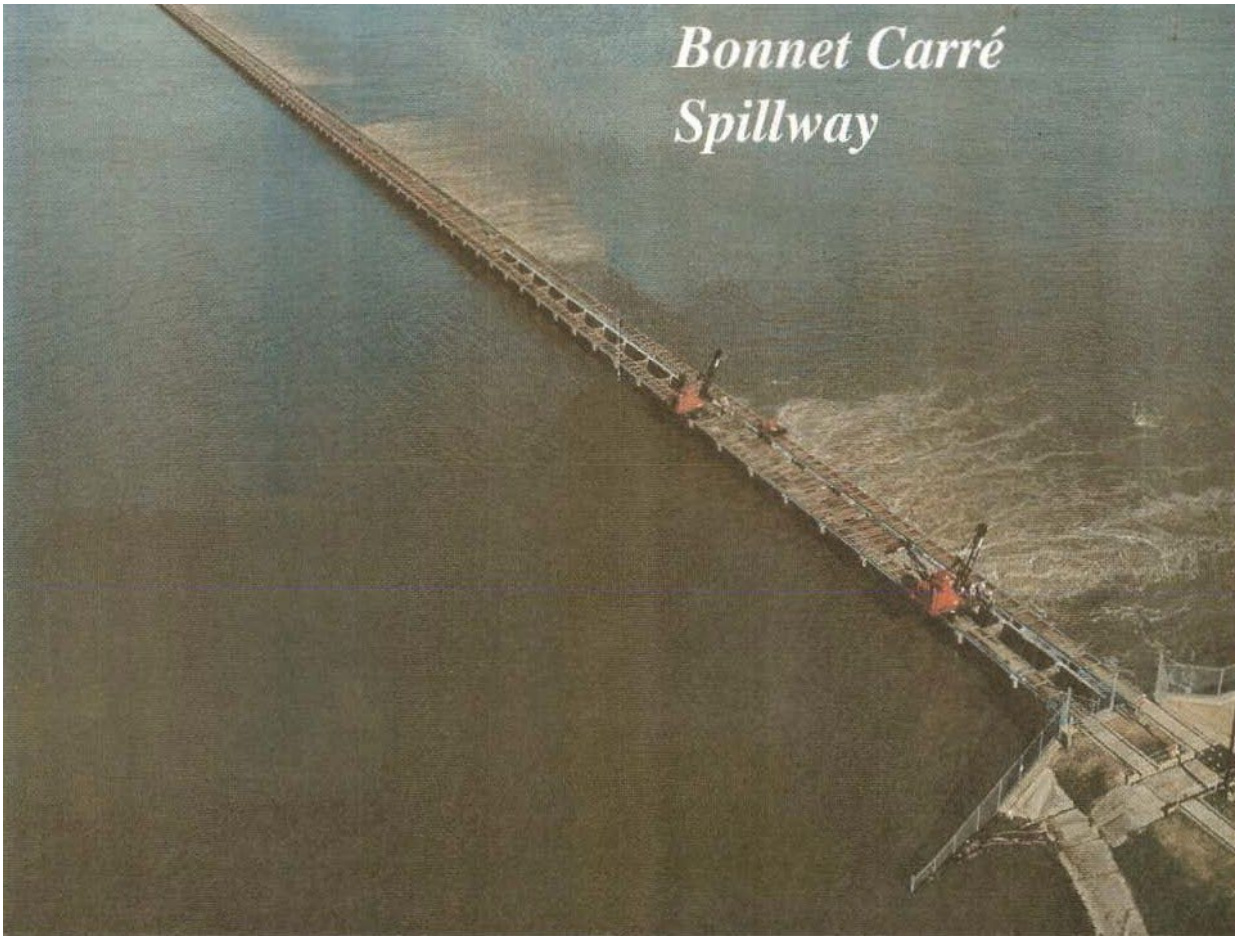
BONNET CARRÉ FOREBAY ELEVATION ANALYSIS

New Orleans District (MVN) Authors:
Hailey Laurent, MVN LMR&T
Deborah Centola P.E., MVN LMR&T



OBJECTIVE:

Modeling effort to determine the max elevation of sediment allowable in the forebay of the Bonnet Carré Spillway without restricting flow and operations.

MODEL USED:

HEC-RAS version 6.1.0 was used to model the Lower Mississippi River. An all-2D geometry was used. The latest "SLaMM" (Southeast Louisiana Master Model) model was provided as the base model, and modifications were added to better refine the geometry. The original 2D model spans across the Atchafalaya and Mississippi River Basins but was reduced to the Mississippi River between Laplace and Belle Chasse, Bonnet Carré Structure and Spillway, and the Lake Pontchartrain vicinity. Calibration and refinements were added to the Mississippi River between River Miles 76 and 138 and in front of the Bonnet Carré Structure for this effort. Figure 1 displays the coverage of the 2D model.

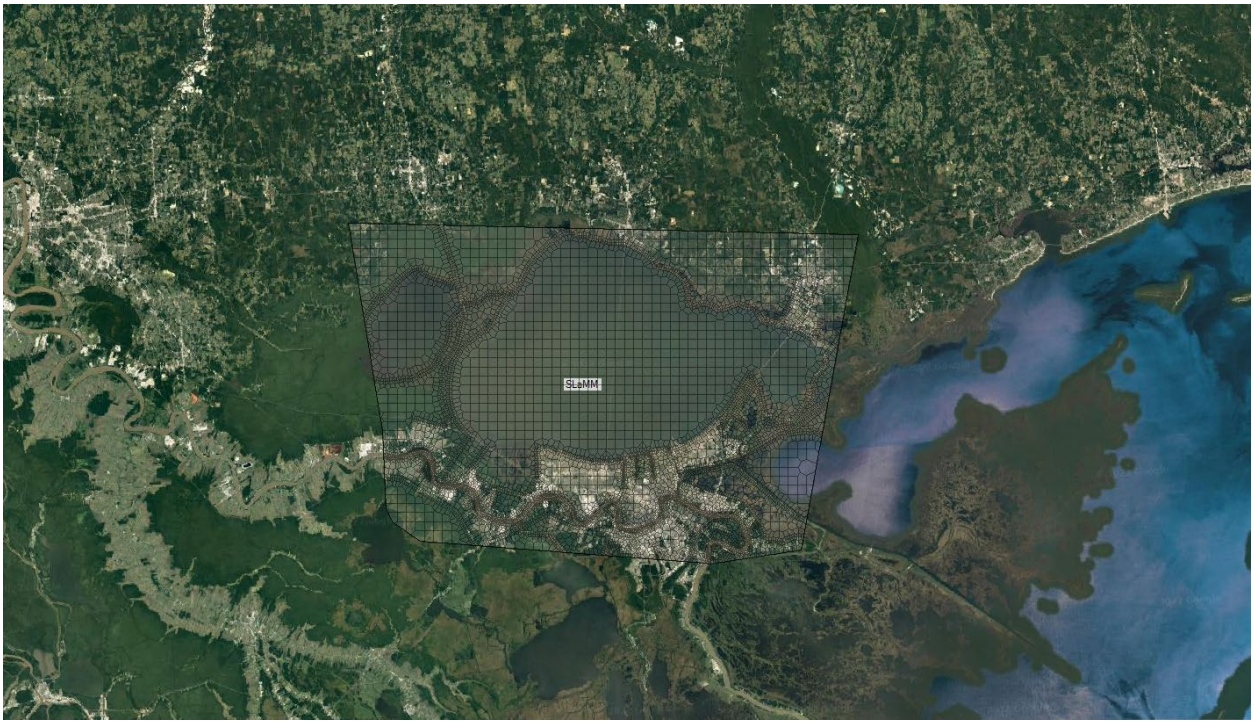


Figure 1: Mississippi River Basin 2D Model Domain

BATHYMETRY AND TOPOGRAPHY:

The bathymetry and topography represent existing conditions at the time of modeling. Details of the sources of hydrographic and topographic surveys can be found in the report(s) on the MR&T Flowline Assessment. Relative sea level change in the future is not accounted for because the objective is to determine risk at the present time. Future erosion and deposition trends are not accounted for because the objective is to determine risk at the present time.

The 2019 NLCD land cover dataset was used to allow for varying manning's n changes per area type. The terrain contains all available NLD alignments and elevations within the study area. Profile surveys for levee and floodwall segments were completed at different times and the most recent survey was used. Because of this, the 2D cells were aligned with the levee centerlines to not allow flow to bypass the levee via overlapping cells.

Lidar and hydrographic (bathymetry) surveys make up a vast majority of the terrain elevations used in the modeling.

MODEL BOUNDARY CONDITIONS:

The 2D model contains one upstream inflow location at Laplace and one downstream stage boundary condition. Observed flow was used for calibration events. Bonnet Carré Control Structure regulates flow to the Bonnet Carré Spillway and is intended to pass the excess beyond 1,250,000 cfs in the Mississippi River past the structure and New Orleans. The Bonnet Carré structure was modeled as a 2D connection with rules to divert the appropriate flow through sets of gates for each scenario. The downstream water level boundary condition of the model is the Mississippi River at Belle Chasse.

1. EXECUTIVE SUMMARY

This document presents a modeling effort to estimate the Bonnet Carré forebay elevation limits. . The HEC-RAS 1D/2D model includes the Mississippi River from Red River Landing to Bonnet Carré Spillway. The model predicts no impact to flow through the structure if the forebay is under 15’.

2. BACKGROUND

The Bonnet Carré structure is a diversion structure designed to divert water above 1,250,000 cfs in the Mississippi River. It spans from River Mile 129.2 to 126.9. The design conditions are based on the Project Design Flood event, shown in Figure 2.

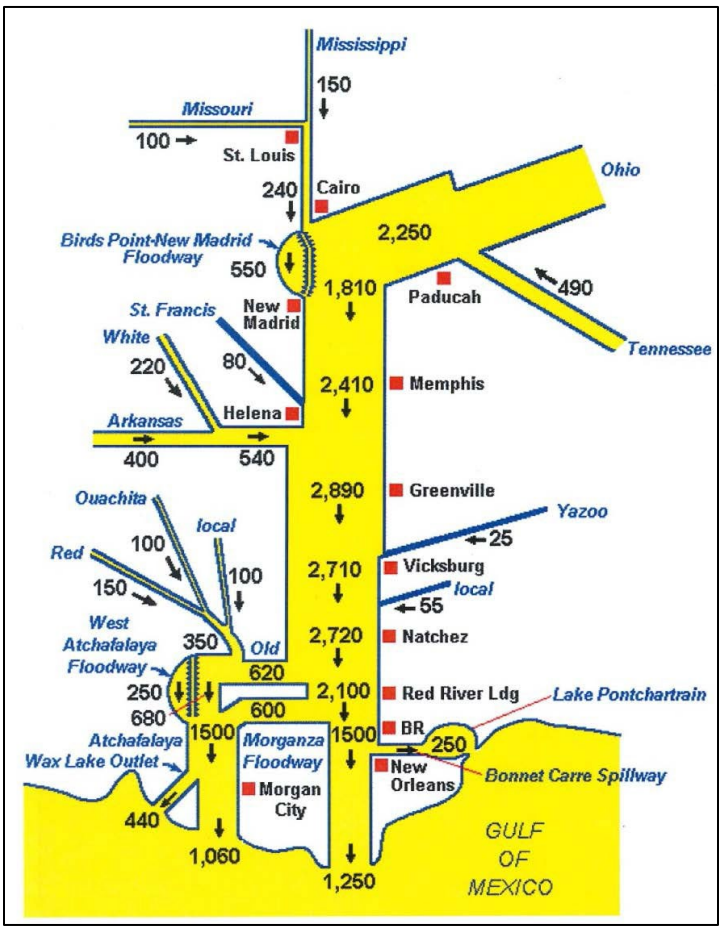


Figure 2: Flow Diagram representing Project Design Flood

When the structure is used, it draws water and sediment off the Mississippi River. As a result of this, sediment piles up in front of the structure, sometimes higher than the gate openings.

The Mississippi River in New Orleans had elevated high water stages for 6 months in 2020. Bonnet Carré Spillway was operated on April 3 and remained open for one month. The spillway saw a max flow of 81,070 cfs through the structure. While this was not one of the major openings of Bonnet Carré, the high water still deposited an incredible amount of sediment in front of the structure. In December 2020, a drone survey of the BCS Forebay elevations was performed and conditions were found in exceedance of 15 feet. Design elevation for the forebay is 12 ft. Operations expressed an interest in keeping a reasonable amount of material in the forebay to fend off wayward barge tows, by restricting available draft up to the structure. During an opening this has proven to cause barge tows that get sucked into the forebay by the flow through the structure to run aground before damaging the structure. There is concern keeping the forebay at design elevation. It is instead favorable to keep the elevation higher, therefore limiting the depth of water over the ground. Elevations of the gate bays in Figure 3 are from a survey that includes settle of the structure. Elevations in Figure 4 are design elevations from 1938.

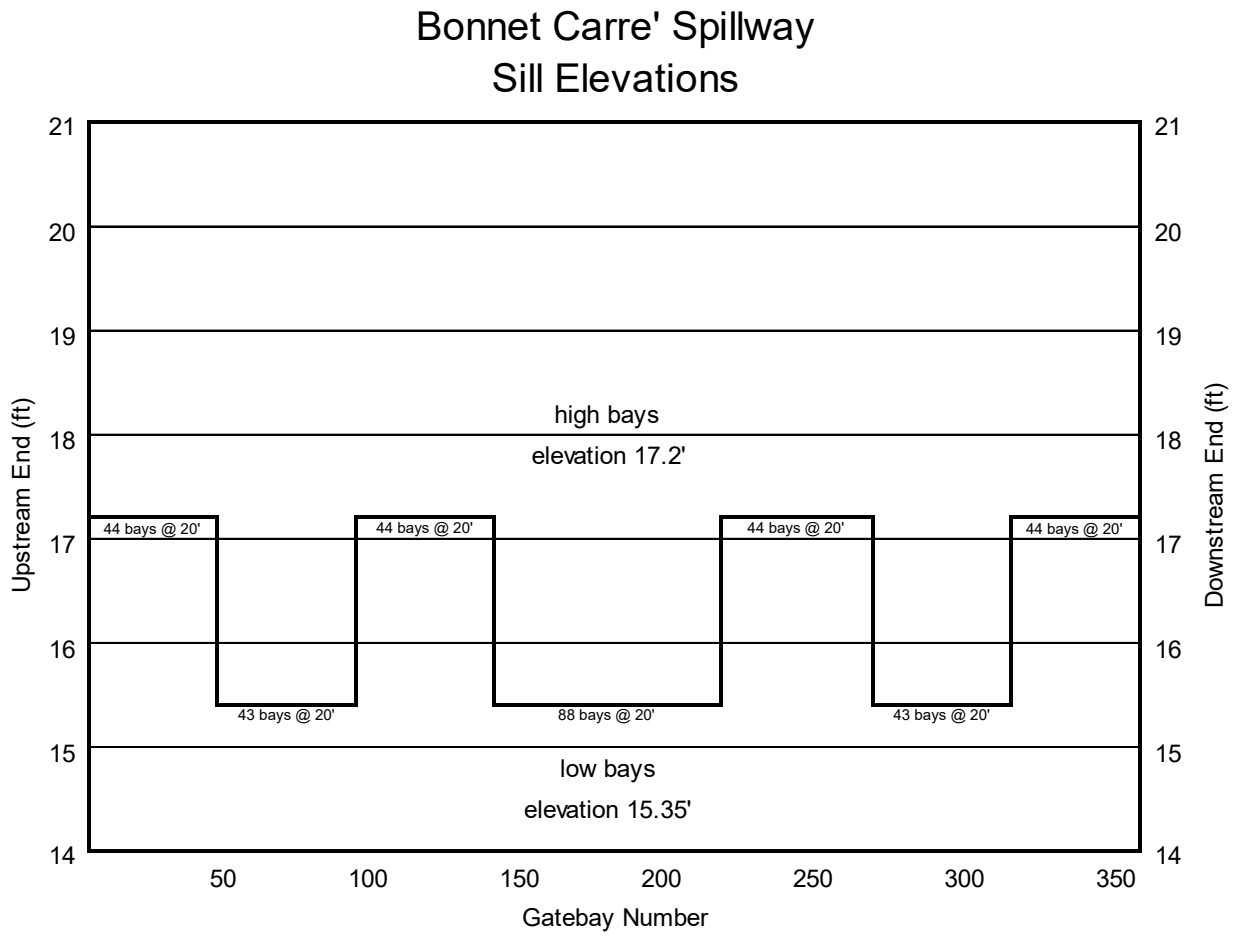


Figure 3: Design Elevations for Bonnet Carré Structure

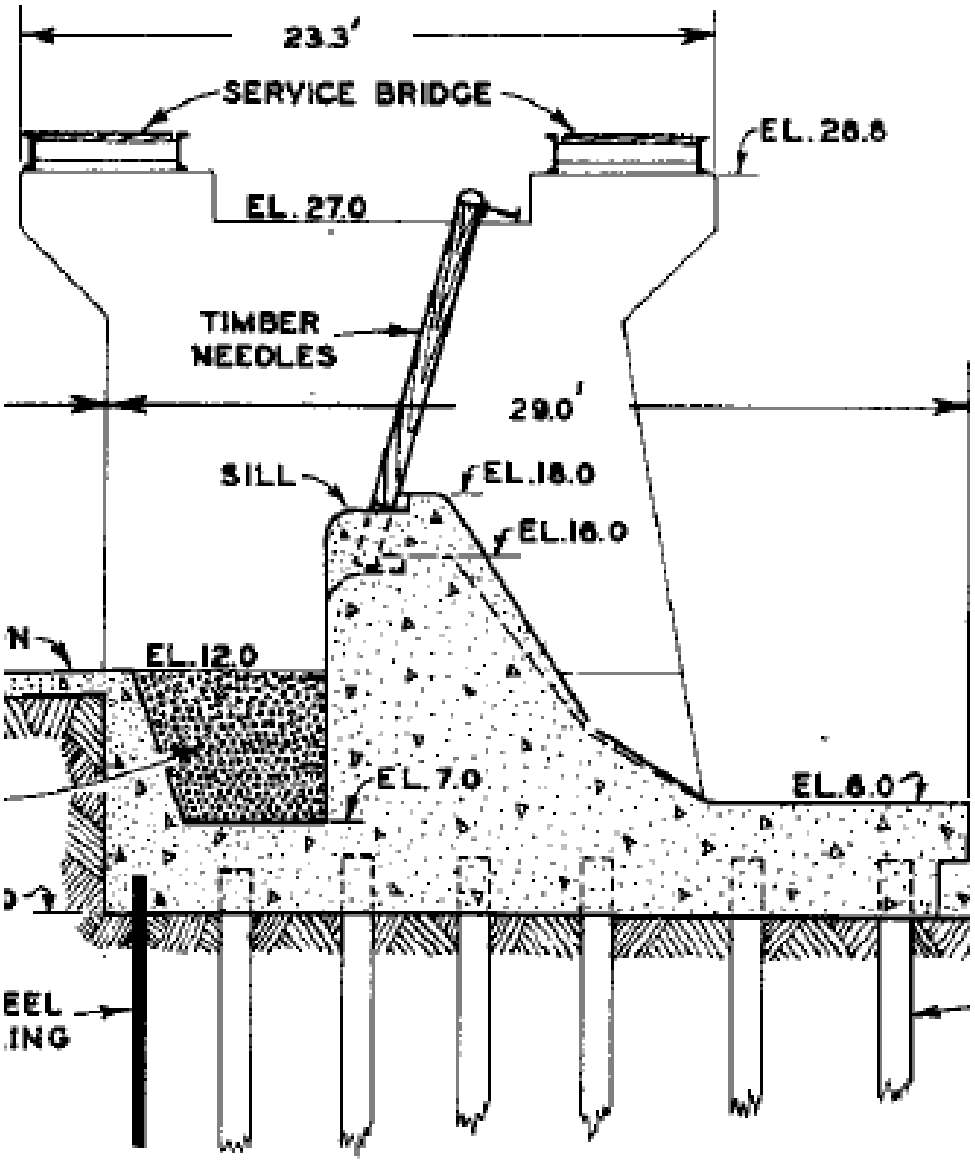


Figure 4: Bonnet Carré Section Profile

Figure 5: Bonnet Carré Location

3. METHODOLOGY

The information in this portion of the report describes the various steps taken to develop the HEC-RAS 2D model, including preprocessing of various topographic landcover, and other datasets.

HEC-RAS was used to do a hydraulic analysis with the objective of determining a forebay elevation and provide an opinion on potential flow restriction, or marginal areas that may restrict the flow as sediment builds up during the next opening.

Analysis was done using varying heights of sediment deposition in front of the structure that would ensure flow diversion through the structure up to the design of 250,000 cfs without concern of restriction. Starting with the design elevation of 12 ft, additional sediment was added in 2 ft increments up to 18 ft. For a conservative effort, a constant elevation was used across the forebay. Actual flows from 2019 were modeled for analysis. Project Design Flood flows were also modeled as a quality check effort and results were confirmed.

Actual observed flows from the April 2019 structure opening were used in modeling efforts. Gate bays were modeled in groups, and flows calculated accordingly.

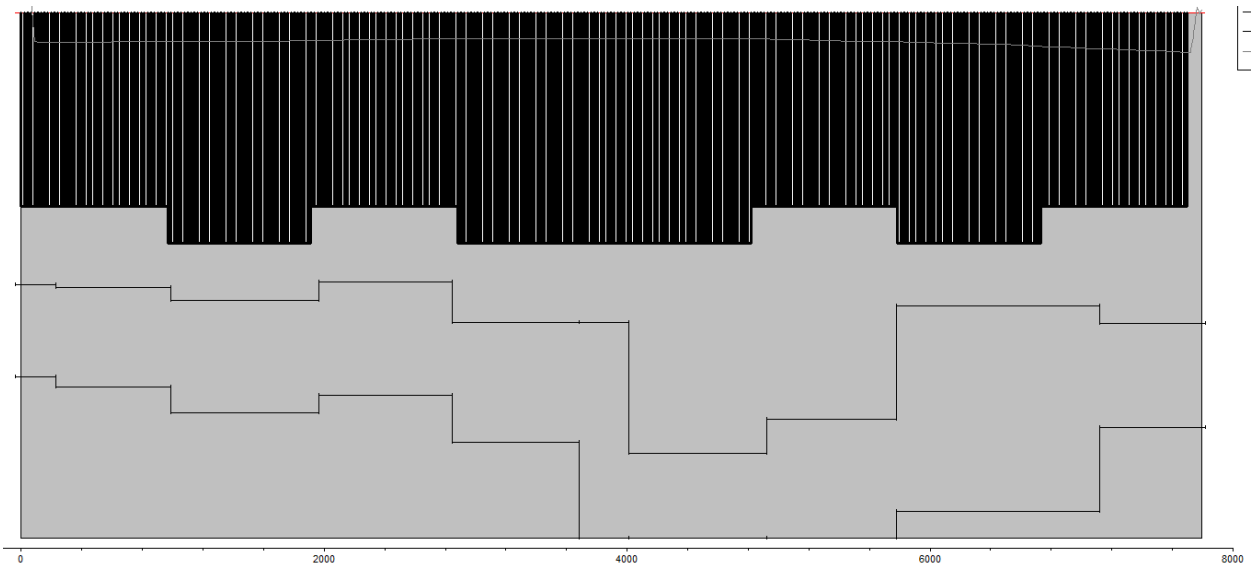


Figure 6: Grouped gates in the model

4. RAS 2D RESULTS

As seen in Figure 7, flows through the structure were not significantly impacted until 16 ft, and the addition of 2 feet on top of that created a drastic reduction. The difference between 14 and 16 raised the question of what 15 ft looked like. That run was added to the analysis. It was decided that 15 feet of constant sediment in front of the structure does not impede the purpose of the structure.

Max flows through the structure were recorded as see in Table 1.

Max Flow Through Bonnet Carre'					
Elevation of Forebay	12 ft	14 ft	15 ft	16 ft	18 ft
Flow through Structure (cfs)	196815	195680	194563	192743	183590
Difference from 12 ft flow		1135	2252	4072	13225

Table 1: Flow through the structure.

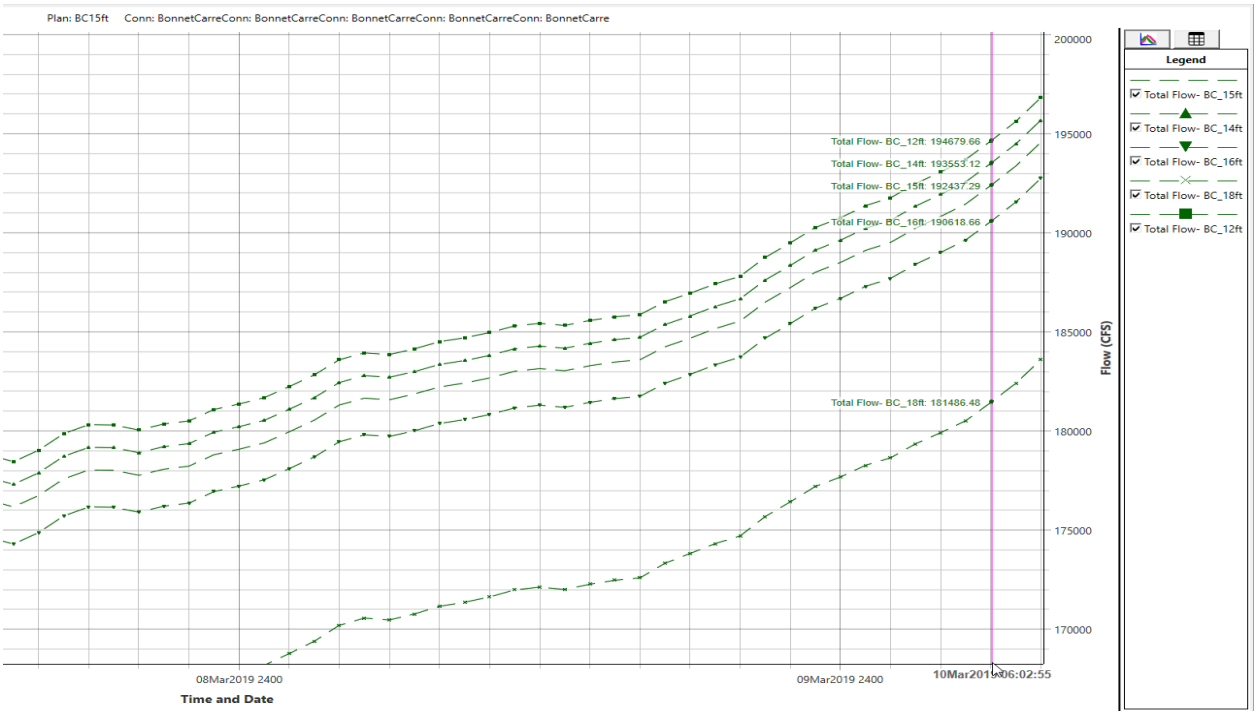


Figure 7: Flow through the structure with various elevations in the forebay.

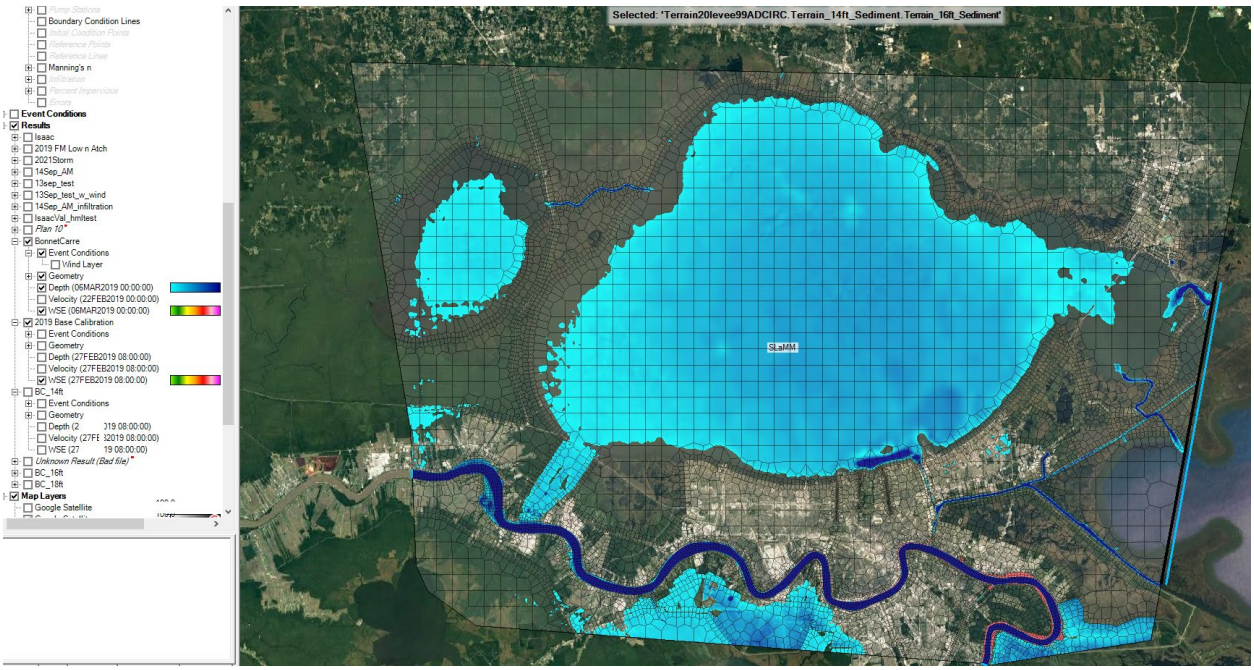


Figure 8: Inundation in RAS.

5. CONCLUSION

The lowest sill elevation of the gate bays of Bonnet Carré Structure are 15.35'. It was found that sediment across the forebay at elevation 15 ft could stay without a significant restriction in flow. This would ensure that we can, if needed, divert up to the design flow of 250,000 cfs without concern of restrictions in the forebay and provide a small buffer to fend off wayward barge tows, by restricting available draft up to the structure.

As a result, EDR recommends that the forebay can keep an average elevation of 15 ft.