# APPENDIX B: H&H MODELING
## Part 1 of 2

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# Storm Surge, Currents and Wave Modeling for the Mid-Chesapeake Bay Islands Ecosystem Restoration Project: Barren Island

***DRAFT***

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**Abstract:** The U.S. Army Corps of Engineers Baltimore District (NAB) is currently undertaking the Mid-Chesapeake Bay Island Ecosystem Restoration project for James and Barren Islands. The project is focused on restoring and expanding island habitat to provide hundreds of acres of wetland and terrestrial habitat through the beneficial use of dredged materials. A feasibility study previously completed in 2009 recommended constructing environmental restoration projects at both James and Barren Islands. The present study is part of a pre-construction engineering and design phase and concentrates on Barren Island projects. Storm surge and nearshore wave modeling focused on the project area was conducted by the Coastal and Hydraulics Laboratory (CHL) using the Coastal Storm Modeling System (CSTORM-MS), which is composed of the coupled Advanced Circulation (ADCIRC) model and the Steady State Wave (STWAVE) model for this study. Model setups developed as part of the North Atlantic Coastal Comprehensive Study (NACCS) were leveraged and refined specifically in the Barren Island region. A set of 25 synthetic tropical storms from the NACCS study that made landfall near the project area were selected, and each storm was run for existing conditions as well as for six (6) with-project alternatives. Additional wave diffraction modeling was conducted using the Coastal Modeling System (CMS) Wave model (CMS-Wave) for one of the with-project scenarios.

**Introduction:**

Chesapeake Bay is the largest estuary located in the United States, and as such is an important ecological and economic natural resource. Islands and wetlands located in the Bay serve as vital habitats that help sustain the region's ecosystem. However, many of these habitats have been destroyed or significantly reduced in area during the past century due to natural and anthropogenic processes. To address this issue, the U.S. Army Corps of Engineers Baltimore District (NAB) conducted the Mid-Chesapeake Bay Island Ecosystem Restoration Study, which was designed to identify locations in the region that were deemed to have the most critical restoration and protection needs. A list of islands were examined and eight (8) site locations selected comprised of 21 separate islands. These sites were then ranked based on criteria critical to project execution such as acreage of potential restoration, dredged material disposal capacity, and the mean tidal range at each location (USACE FREA 2008). The study recommendations highlighted that Barren Island (Figure 1) was one of the locations that had the highest-priority restoration needs in Chesapeake Bay (USACE FIFR 2008).

Barren Island is located in the Chesapeake Bay west of the Honga River, approximately a mile to the west of Upper Hoopers Island. Historically, the island was comprised of a single landmass (Figure 1) whose wetlands served as a habitat for birds and other wildlife. However, due to erosion, the island has been split into two smaller islands and the resulting loss of wetlands has significantly diminished the habitat space available on the islands. A protective sill is currently in place on the northwest shore of the northern island, and the study recommendations published in 2008 by NAB proposed a further increase in built infrastructure on the islands (Figure 2). The goal of NAB's current efforts is to design and install protective measures to prevent further erosion on the islands and to maintain and restore critical wetland and aquatic habitats on and around Barren Island.

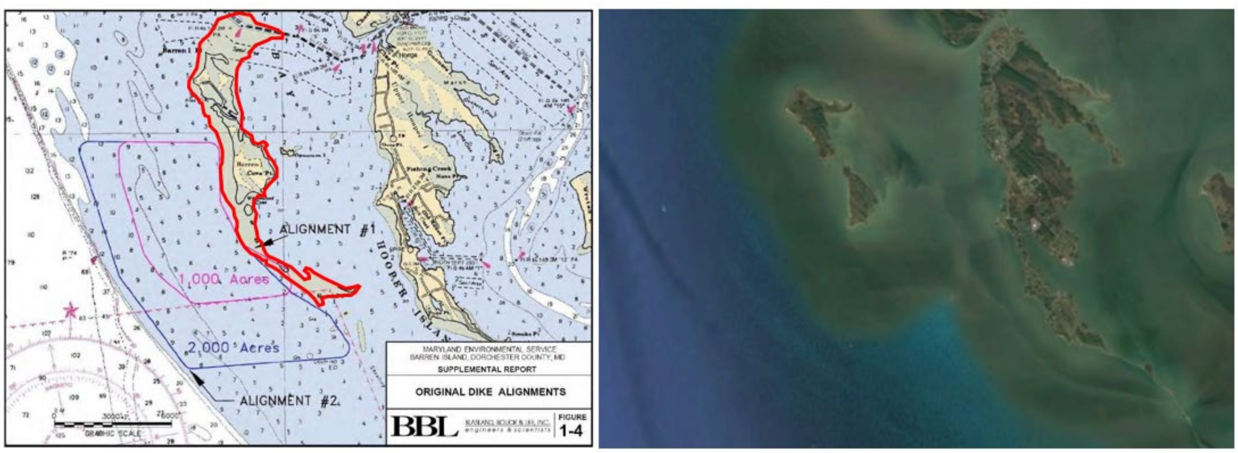


Figure 1 Historical extents of Barren Island (outlined in red) (left) (source: NAB); present-day satellite imagery of Barren Island (right)

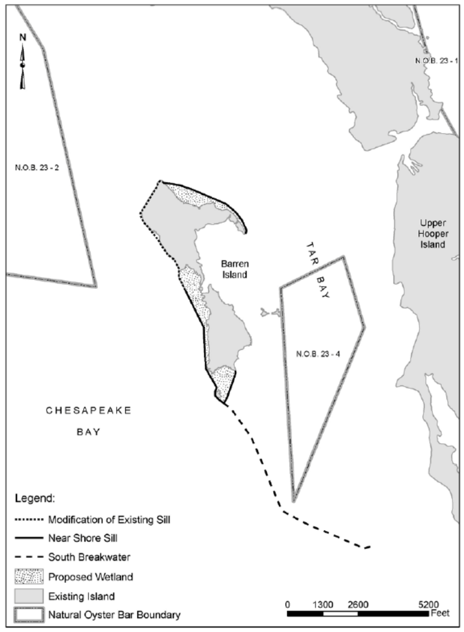


Figure 2 Recommended plan for Barren Island in the 2008 Feasibilty Report (source: USACE FIFR 2008)

The project design for the Barren Island protection effort must take a number of factors into account, including the presence of local aquatic vegetation. Surveys at the project site have observed a significant incidence of submerged aquatic vegetation (SAV) to the east of Barren Island in Tar Bay (Figure 3). To maintain the natural habitat in this area, it is important that construction of new protective features do not have significant adverse impacts to the SAV by any changes in hydrodynamics during major storm events. Although it is estimated that SAV can withstand water velocities of up to 180 cm/s, the upper velocity threshold that SAV in this region routinely survive without being damaged or otherwise adversely affected is approximately 100 cm/s. Thus, water velocities in Tar Bay during storm events should ideally remain below that threshold after the Barren Island restoration project is completed.

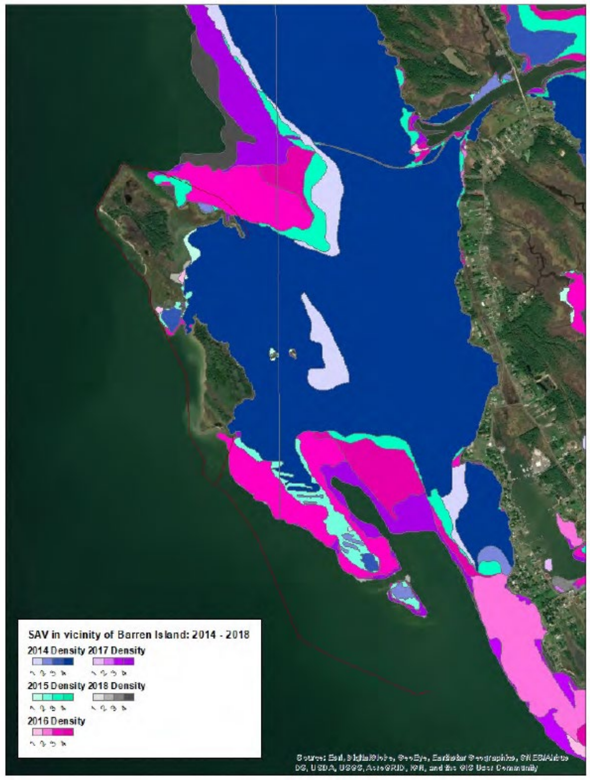


Figure 3 Submerged Aquatic Vegetation (SAV) located to the east of Barren Island as measured from 2014-2018 (source: NAB)

For this study, NAB sponsored hydrodynamic modeling of several proposed project scenarios as well as existing conditions to determine the impact of the project conditions on storm surge water levels, current velocities, and wave properties at Barren Island during storm events. These modeling results were also used as inputs to determining stone sizes for the project construction. The surge, currents, and nearshore wave modeling was performed using the Coastal Storm Modeling System (CSTORM-MS), (Massey et al. 2011, Massey et al. 2015), which is composed of the two-way coupled ADCIRC and STWAVE models. Model grids/meshes used in this study were adapted from those developed as part of the North Atlantic Coast Comprehensive Study (NACCS) (Cialone et al. 2015). Out of the 1050 synthetic tropical storms developed for the NACCS, 100 storms were selected for use for Mid-Bay. Those 100 storms were then winnowed down to a set of 25 storms that were used as screening storms on all of the with- and without project scenarios. These storms represent a variety of storm tracks, wind and pressure conditions, and water level annual recurrence intervals (ARIs) so that the impacts of a wide range of different storm conditions may be captured. Six (6) proposed with-project designs were modeled; these alternatives represent a variety of different sill, breakwater, and island configurations being considered for the final Barren Island protection project design. Wave diffraction modeling was also conducted using the Coastal Modeling System (CMS) wave model (CMS-Wave) to determine the impact of various gap design widths, between breakwaters/islands, on wave energy for one of the project scenarios. Further details about the model development and setup, storm selection process, simulation results, and the conclusions drawn from this study are discussed in the following sections.

## ADCIRC Model Development

The Advanced CIRCulation (ADCIRC) model is a finite-element-based hydrodynamic free surface circulation model (Westerink et al. 1994, Luettich et al. 1992). ADCIRC is a computational model that solves for the depth-integrated equations of mass and momentum conservation using a continuous Galerkin finite element method with highly flexible, unstructured meshes. The meshes are composed of nodes and elements. The nodes have specified locations of longitude and latitude along with a topographic/bathymetric depth value, and the elements are triangular-shaped and form a tessellation of the entire computation domain. ADCIRC applies wind velocity vectors, atmospheric surface pressure, tidal forcing conditions, river inflow fluxes, and other specified forcing values (such as wave radiation stress gradients, which in this case come from a coupled-wave model) as inputs to solve the above-mentioned depth-averaged shallow water equations. ADCIRC assumes that the water is incompressible, and that hydrostatic pressure conditions exist. The solution to these equations provides the depth averaged water currents and water height at each of the element nodes for every time step during the model simulation.

### *ADCIRC Nodal Attributes*

The ADCIRC model uses a nodal attribute file, e.g. fort.13 file, which specifies spatially varying model parameters at each node in the grid. For example, Manning's n are specified as nodal attributes and are used to represent friction, while the surface directional effective roughness lengths parameter is used to alter wind speeds due to land use types. The same nodal attributes settings that were used and validated in the North Atlantic Coast Comprehensive Study (NACCS) were used for this model (Cialone et al. 2015). Many of these nodal attributes are derived from land use/land cover data. Table 1 provides a list of the National Oceanographic and Atmospheric Association's (NOAA's) Coastal Change Analysis Program (C-CAP) Land Cover Atlas categories and associated Manning's n values used to represent them within the ADCIRC model (Riverside Technology and AECOM 2015).

Table 1: Manning's n Values Derived from NOAA's C-CAP Data

| CCAP Class | Land Cover Description | Manning's *n* |
|---|---|---|
| 2 | High-intensity developed, Impervious Surface | 0.120 |
| 3 | Medium-intensity developed | 0.120 |
| 4 | Low-intensity developed | 0.070 |
| 5 | Developed open space | 0.035 |
| 6 | Cultivated land | 0.100 |
| 7 | Pasture/hay | 0.055 |
| 8 | Grassland | 0.035 |

| | | |
|---|---|---|
| 9 | Deciduous forest | 0.160 |
| 10 | Evergreen forest | 0.180 |
| 11 | Mixed forest | 0.170 |
| 12 | Scrub/shrub | 0.080 |
| 13 | Palustrine forested wetland | 0.200 |
| 14 | Palustrine scrub/shrub wetland | 0.075 |
| 15 | Palustrine emergent wetland | 0.070 |
| 16 | Estuarine forested wetland | 0.150 |
| 17 | Estuarine scrub/shrub wetland | 0.070 |
| 18 | Estuarine emergent wetland | 0.050 |
| 19 | Unconsolidated shore | 0.030 |
| 20 | Bare land | 0.030 |
| 21 | Open water | 0.020 |
| 22 | Palustrine aquatic bed | 0.035 |
| 23 | Estuarine aquatic bed | 0.030 |

### *Vertical Datum*

The ADCIRC mesh used as the basis for this study was developed as part of the NACCS study and has a vertical datum set to mean sea level (Cialone et al. 2015). Since the vertical datum is assumed by the ADCIRC model to be local mean sea level (MSL) by default, no vertical adjustment was required to account for the model convention. However, vertical datum conversions were necessary when incorporating design features included in the different project scenarios into the meshes. The heights of the design features were generally provided by NAB with respect to the Mean Lower Low Water (MLLW) datum. NOAA's VDatum tool was used to find the conversion from MLLW to MSL at a point location, -76.248$^{o}$ longitude and 38.31$^{o}$ north latitude, close to the center of project site. A value of 0.872 feet was used for all structure and feature heights converted to MSL from MLLW. The units of these features also had to be converted from feet to meters (1 foot = 0.3048 meters) in order to conform to the unit standard employed by the ADCIRC model.

### *Steric Adjustment*

The ADCIRC model is barotropic and as such does not account for baroclinic effects in the oceans caused by seasonal changes in temperature and salinity throughout the model domain. To account for some of the sea surface variability caused by real-world baroclinicity, a single value referred to as the steric adjustment was added to the initial still water value throughout the entirety of the model domain. The steric adjustment value used for this study was 0.3576 feet (0.109 m) and is the same value used in the NACCS study. This value represents the average expected seasonal mean sea-level variability in the Atlantic as per the NACCS report (Cialone et al. 2015). According to the NACCS report, the value was calculated by obtaining the mean monthly spatial sea surface variability at two different NOAA water level stations located in the model domain. A weighted average temporal variability was then determined by applying weighting factors based on hurricane frequency to the average variability values for each month during hurricane season ranging from June to November (see Cialone et al. 2015 for more details).

### *ADCIRC Grid Modifications for Barren Island*

The ADCIRC unstructured mesh that was developed for the NACCS was used as a starting point for the mesh used for the Barren Island modeling. Figure 4 shows the base topography and bathymetry used in this study along with the mesh element edges drawn in to provide a visual measure to the range in element size and density used for this modeling effort.

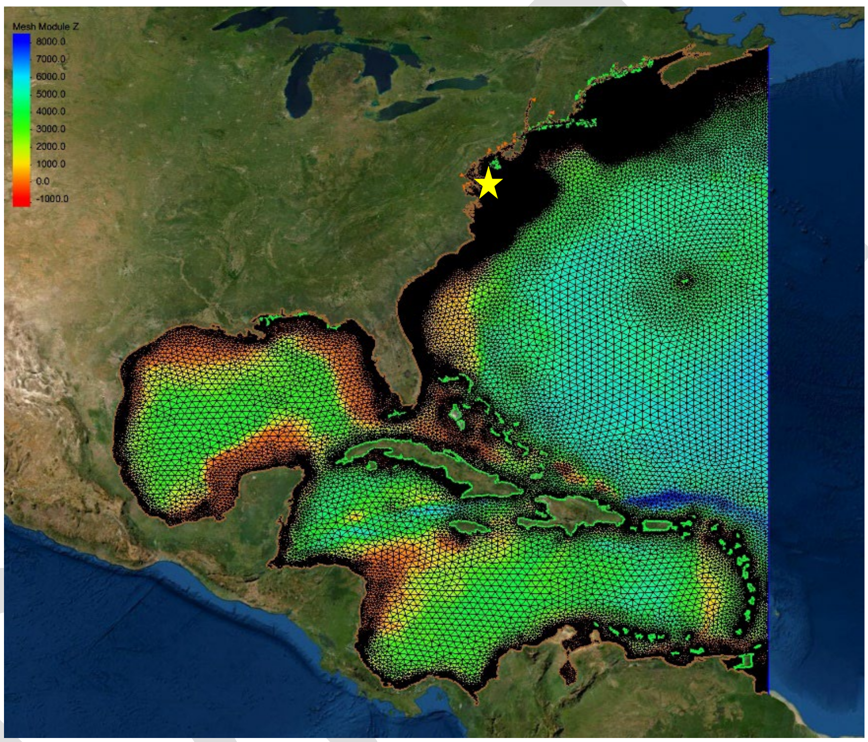


Figure 4 Map showing the extents of the NACCS ADCIRC mesh along with color contour plots of the mesh's topography and bathymetry (meters MSL) values. Note that the Barren Island project location is denoted by a yellow star.

### *Existing Conditions ADCIRC Mesh*

The NACCS ADCIRC mesh resolution in and around the Barren Island, area (see Figure 5) is approximately 200 to 600 m (about 660 to 1970 ft). For this study, the mesh needed to be refined in order to analyze the with-project design alternatives.

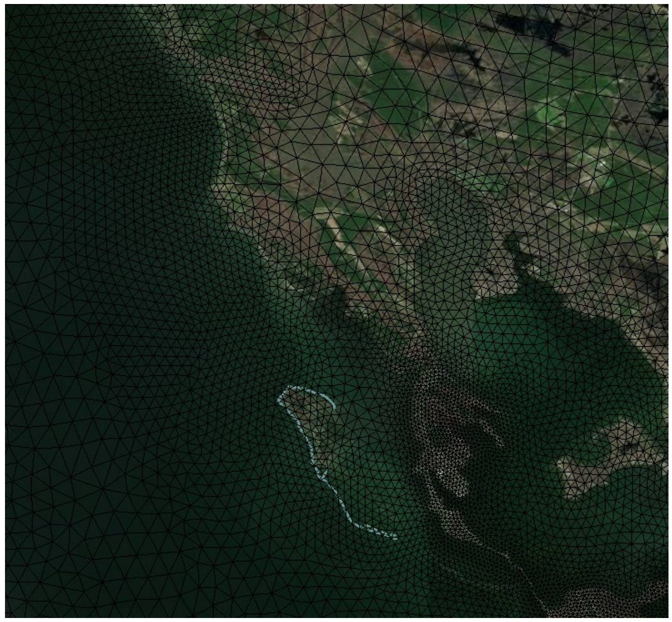

Figure 5 Map showing a close-up regional view of the existing NACCS ADCIRC mesh around Barren Island. The black lines represent mesh elements and the light blue line is the outline of one of the proposed with-project alternatives.

In order to represent the with-project alternatives, the existing ADCIRC mesh was refined for the Barren Island region to a minimum element spacing of approximately 20 m (about 66 ft) around the design features. Figure 6 shows a comparison of the nodal density between the Original NACCS grid and the updated existing conditions grid for Barren Island, and Figure 7 shows a zoomed-in view comparing the original NACCS mesh resolution with the modified existing conditions mesh resolution. Once mesh resolution modifications were made, the topography and bathymetry values from the NACCS ADCIRC mesh were linearly interpolated onto the updated Mid-Bay mesh. Then survey data provided by NAB for Barren Island was incorporated to update the topography and bathymetry values immediately around Barren. Figure 8 shows a comparison of the topography and bathymetry values between the original NACCS ADCIRC mesh and the updated existing conditions mesh for Barren Island, where the color scales have been restricted to an interval between +/- 1 foot. Figure 9 shows the same topography and bathymetry color contour comparisons except the color scales are restricted to +/- 5 feet in order to see larger-scale differences.

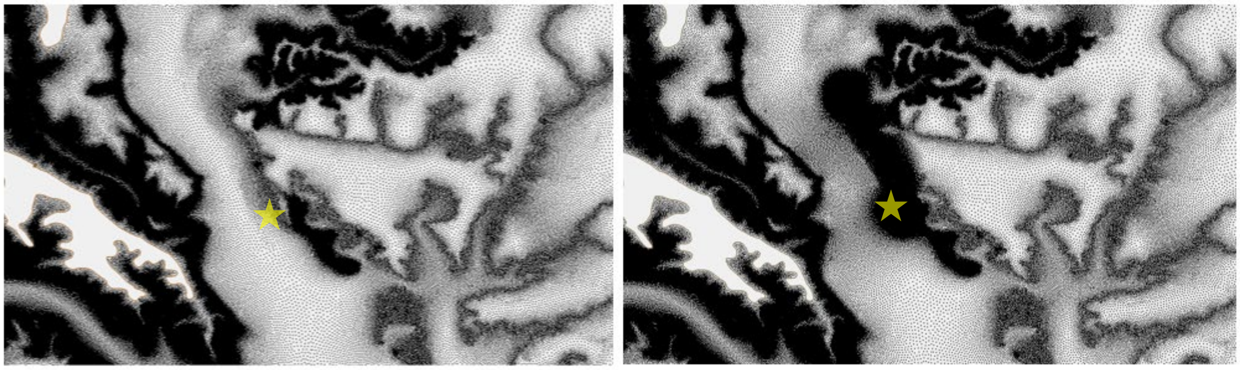

Figure 6 A view of the original NACCS ADCIRC mesh resolution (left) and the modified existing conditions Mid-bay mesh resolution (right) for the Barren Island region. The black lines represent mesh elements and the project location is denoted by a yellow star.

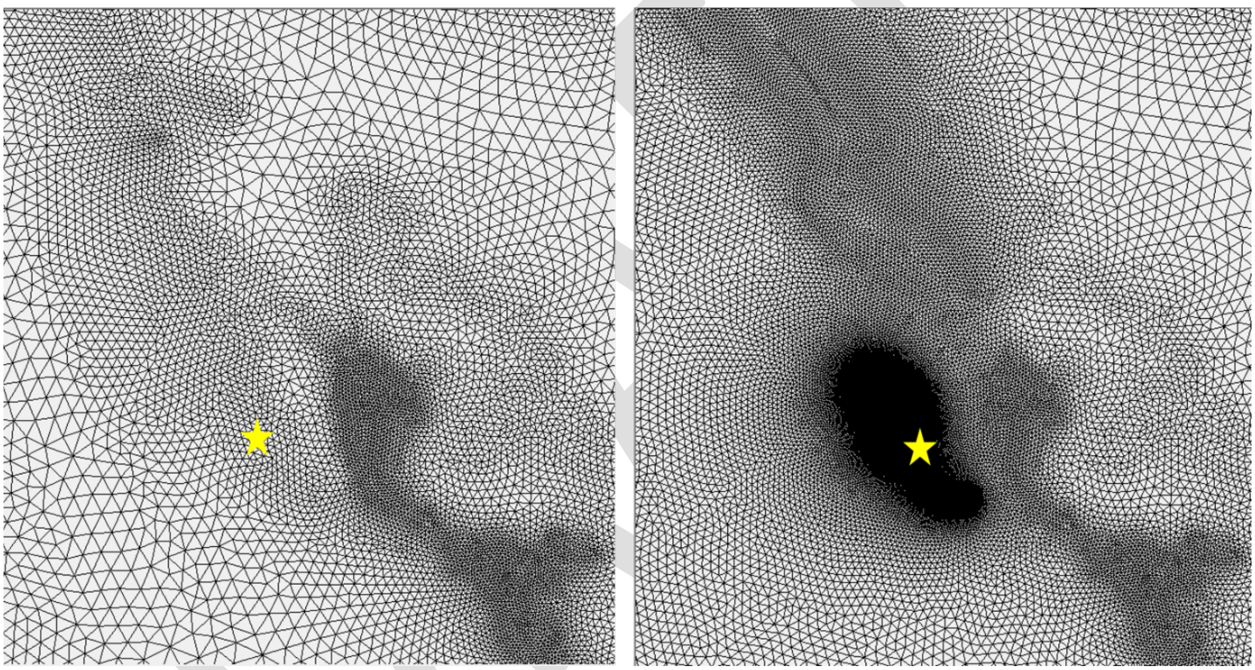

Figure 7 A zoomed-in view of the original NACCS mesh resolution (left) and the modified existing conditions Mid-bay mesh resolution (right) for the Barren Island region. The black lines represent mesh elements and the approximate project location is denoted by a yellow star.

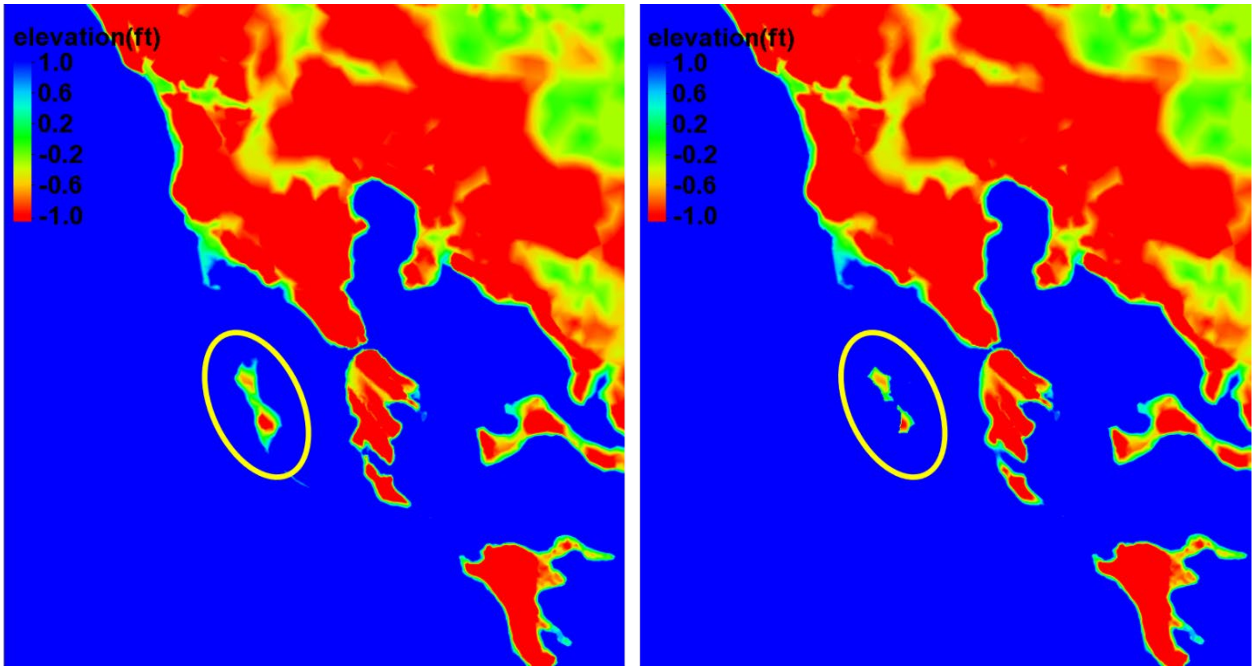


Figure 8 A zoomed-in view of the topographic(-) and bathymetric(+) color contours, given in units of feet and with the color scale restricted to bring out nearshore details, from the original NACCS ADCIRC mesh (left) and the modified existing conditions Mid-bay ADCIRC mesh (right).

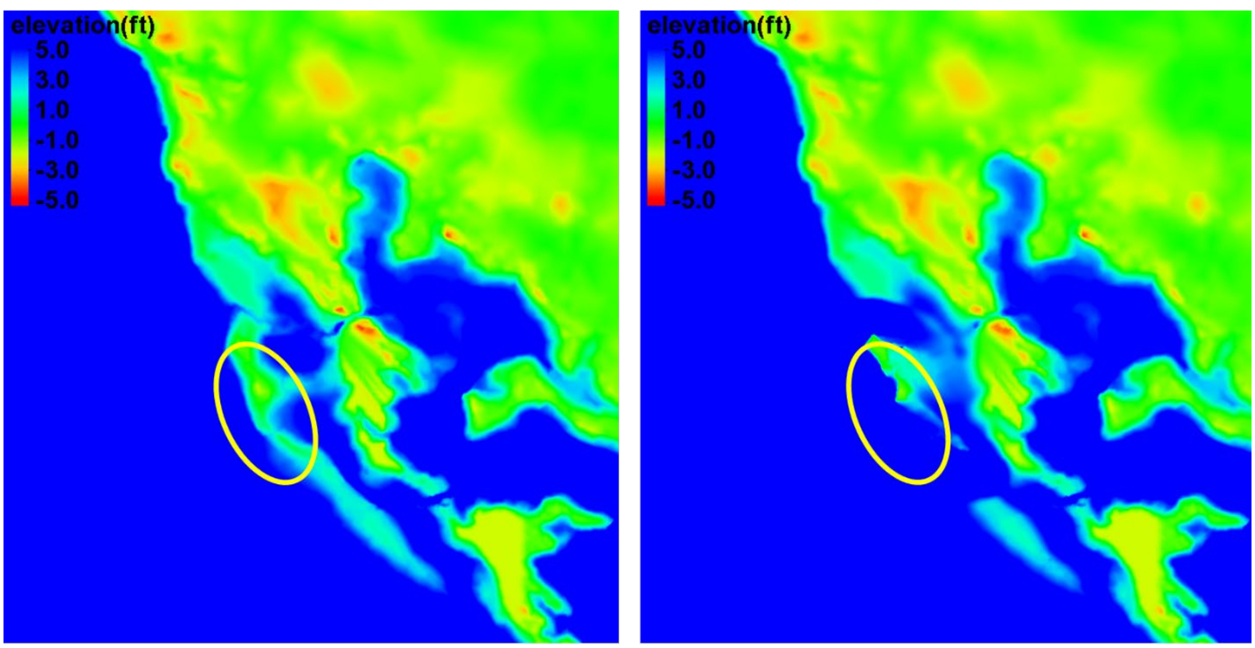


Figure 9 A zoomed-in view of the topographic (-) and bathymetric (+) color contour plots from the original NACCS ADCIRC mesh (left) and the modified existing conditions Mid-bay mesh (right). The contour units are feet (MSL) and the color scale is restricted to +/- 5 feet in order to bring out details.

### *Project Alternatives*

The existing conditions Barren Island mesh was edited to create ADCIRC meshes for six (6) different with-project alternative designed provided by NAB. Generally, an effort was made to keep element alignment as similar as possible between projects despite their different features. The minimum element size that was used in the area of interest in the project meshes was 15 m (49.2 feet). Smaller spatial resolution was avoided to prevent the model time-step size from being reduced to below 1.0 second and thus requiring substantially more computational resources. Topographic and bathymetric data from the existing mesh was interpolated onto each of these project grids, with some elevation adjustments made by hand to account for project features.

Alternative 1, abbreviated as Alt. 1, (Figure 10) is composed of the existing sill along the northwest shore of the northern island, along with the near shore sill extension proposed by NAB in the recommendations report produced in 2008. The northern part of this extension curves around the shoreline of the northern island and ends at the tip of the northeast portion of the island that juts out into Tar Bay. The second part of the sill extension stretches southward from the existing sill to curve down around the southernmost portion of the southern island. While the sill extensions generally follow the current shorelines of the islands, in several regions they are located slightly seaward of the shore. Restored wetland areas are proposed for placement in the regions between the sill and the shore; however, these wetland areas were not altered in the mesh for the project scenarios aside from the interpolation of the updated bathymetry and topography data. The height of the sill along its entire length was 4 ft (1.21 m) MLLW as requested by NAB. Using the VDatum tool, this value was converted to mean sea level and then from feet to meters; the resulting value that was used in the model to represent the sill height was 3.13 ft (0.953 m) with respect to MSL.

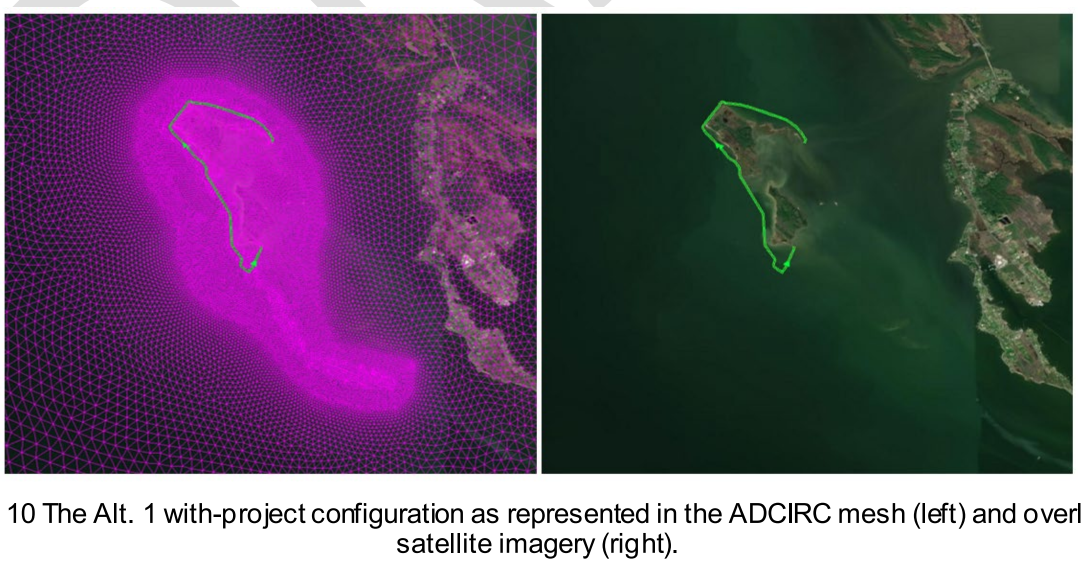

Figure 10 The Alt. 1 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery (right).

Alternative 2, abbreviated as Alt. 2, (Figure 11) consists of all of the sill structures around Barren Island included in Alternative 1, as well as an added breakwater stretching to the southeast of the islands approximately 8,153 ft (2485 m) in length along its outer edge. The specified height of this breakwater was 6 ft (1.83 m) MLLW, and this value was converted accordingly and set in the model as 5.13 ft (1.563 m) MSL.

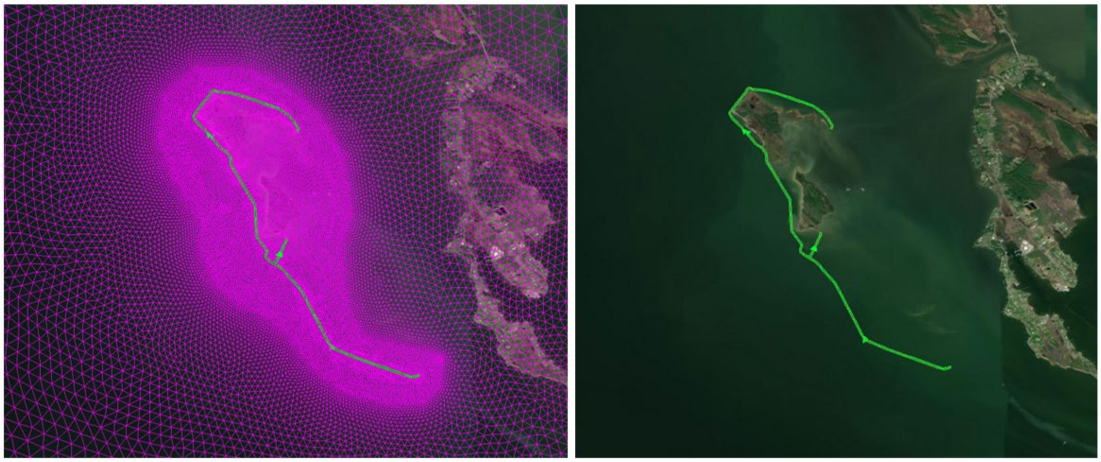

Figure 11 The Alt. 2 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery (right).

Alternative 3, abbreviated as Alt. 3, (Figure 12) is also comprised of the sill structures from Alt. 1, as well as a breakwater matching the location of the structure in Alt. 2, but truncated just past the major bend in the Alt. 2 breakwater. The total length of this shortened breakwater was approximately 5331 ft (1625 m) along the outer edge. As with the breakwater from Alt. 2, the height of the Alt. 3 breakwater was set to 5.13 ft (1.563 m) MSL.

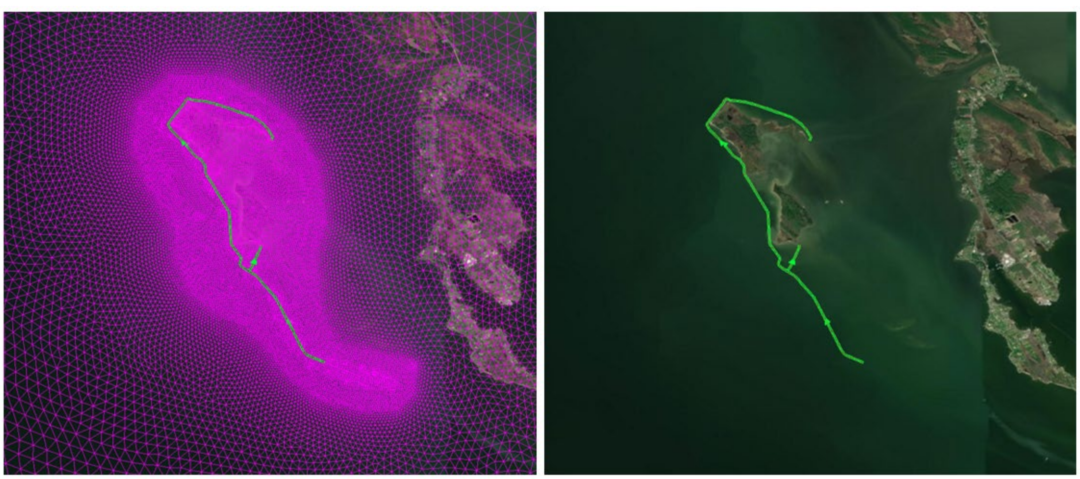

Figure 12 The Alt. 3 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery (right).

Alternative 4, abbreviated as Alt. 4, (Figure 13) is identical to Alt. 3 aside from the addition of two island features at the end of the breakwater structure to the southeast of Barren Island. These islands were represented in the mesh solely by altering the elevation of the nodes to represent dry land; the elevation of the two islands were set to 5.13 ft (1.563 m) MSL, which is the same value as the breakwater. Each island is approximately 591 ft (180 m) long and 344 ft (105 m) wide.

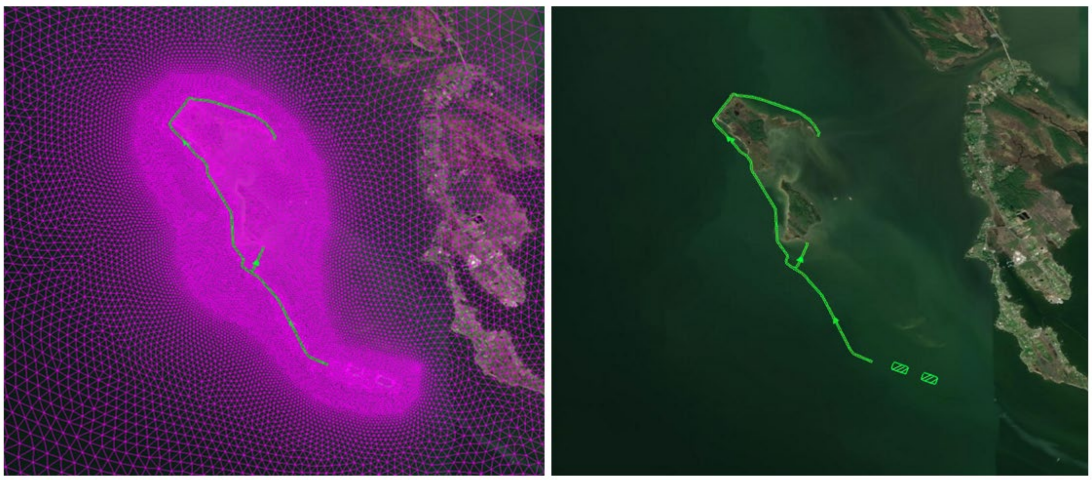

Figure 13 The Alt. 4 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery with island features depicted for illustration (right) .

Alternative 5, abbreviated as Alt. 5, (Figure 14) includes the same sill and breakwater structure as Alt. 3, but also incorporates a series of eight (8) staggered breakwaters located at the end of the main breakwater. The southernmost row of breakwaters in this scenario are set in the same footprint as the full breakwater modeled in Alt. 2. In the model each of these breakwaters are approximately 361 ft (110 m) in length and are set to a height of 5.13 ft (1.563 m) MSL just like the larger breakwater.

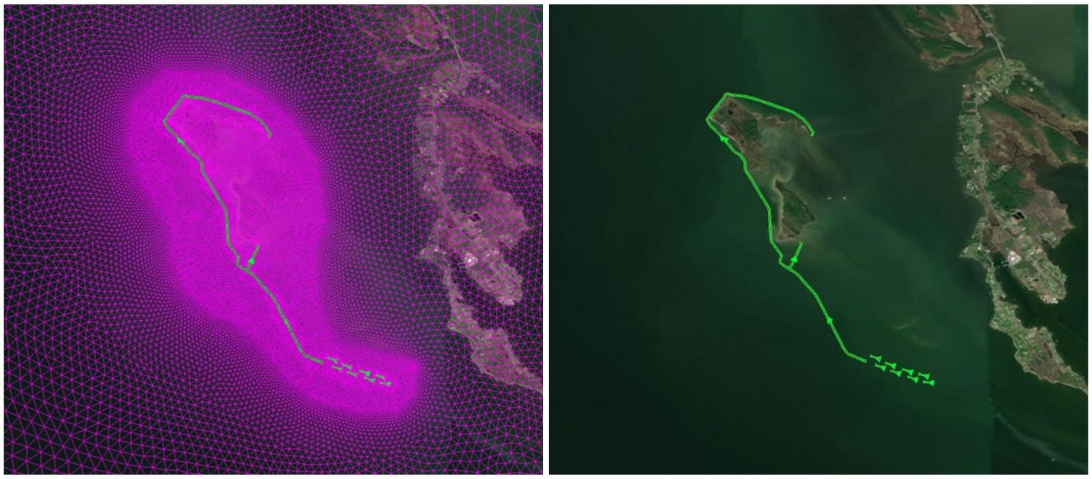

Figure 14 The Alt. 5 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery (right).

Alternative 6, abbreviated as Alt. 6, (Figure 15) is the sixth with-project scenario and is slightly different in design and approach from the other with-project configurations. This alternative design was motivated partially by soil and foundation surveys conducted near Barren Island that concluded that the region southeast of the island where the breakwaters and islands features proposed in Alternatives 2-5 were located might not have a foundation capable of sufficiently supporting the installation of those features. In response, the design of Alt. 6 was based on avoidance of that potentially problematic region and focused further north on the southern edge of the sill structure. The orientation of the southern portion of the sill was altered slightly to bring it into line with the rest of the sill, and the overall height of the sill was increased to 3.94 ft (1.202 m) MSL. A breakwater approximately 476 ft (145 m) in length and a height of 5.94 ft (1.812 m) MSL (6.8 ft MLLW) was added to the southern portion of the sill. Additionally, three island features were included to the south of the breakwater. The elevations of the islands as specified in the mesh were 4.94 ft (1.507 m) MSL. The gap between the breakwater and the northernmost island is approximately 344 ft (105 m), and the islands range from roughly 492 to 705 ft (150 to 215 m) in length along their shorelines facing the Bay and around 230 to 295 ft (70 to 90 m) in width.

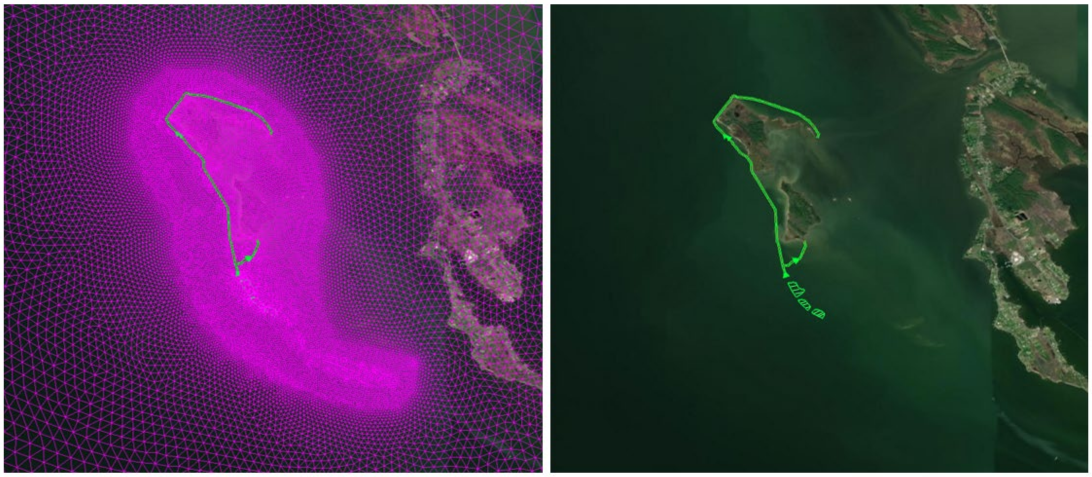

Figure 15 The Alt. 6 with-project configuration as represented in the ADCIRC mesh (left) and overlaid on satellite imagery with island features depicted for illustration (right).

## STWAVE Model Development

The Steady-State Spectral Wave (STWAVE) model is a phase-averaged spectral nearshore wave model that is capable of being tightly two-way coupled with ADCIRC as part of the CSTORM suite of numerical models. The model is based on the wave action balance equation and can be executed in either half-plane or full-plane mode. It is capable of calculating wave transportation phenomena including breaking, refraction, shoaling, and wind-wave generation (Massey et al. 2011).

Unlike the ADCIRC model, the setup of the STWAVE model for Barren Island was significantly different from that of the NACCS. As a large regional study, the NACCS used 10 different STWAVE domains to model nearshore waves along the entire coast from the southern Virginia state-line all the way to the northern most portions of Maine. Of those 10 STWAVE grids, the one covering the Chesapeake Bay was the largest domain size and had the smallest grid spacing, 125 m, which made it the most computationally demanding. That mesh was specifically designed to model both inside the bay and along the Atlantic coast outside the bay at the same time. As the focus of this study was the middle of the bay, the design focus of the wave grid could change to reduce the size of the grid domain and at the same time refine the grid spacing to capture more features. . Figure 16 shows the original NACCS Chesapeake STWAVE grid boundary demarked as yellow lines and the new STWAVE Chesapeake grid boundary as red lines. This smaller STWAVE grid covers the majority of the Chesapeake Bay. It ranges from the southern bay entrance to the region just south of Annapolis, Maryland and has a grid cell resolution of 70 m. Spectral forcing was not applied along the eastern boundary of this grid as was done with the NACCS grid, but rather to the southern boundary. This was done to capture the effects of wind driven wave fetch, which was judged to be the dominant factor contributing to wave growth in the Bay. In addition to this main “parent” grid, two nested, or “child,” STWAVE grids were also used for this project. These smaller grids are situated in the immediate region surrounding Barren Island (Figure 16) and have a resolution of 17.5 m in both the x- and y-direction. The two grids are identical except one is forced from the "northern" boundary and the other from the "southern" boundary. This was done to account for the fact that STWAVE only allows for spectral energy boundary forcing from a single grid boundary. As with the "parent" grid, the orientation and forcing directions of the smaller grids were based on the dominant wind fetch directions in the area. During the CSTORM simulations, these two grids execute independently of each other. The CSTORM coupler automatically selects the maximum wave gradient in locations where STWAVE grids overlap, therefore the wave radiation stresses that are passed to the ADCIRC model in this case are an appropriate representation of the wave conditions and the overall model results are not negatively affected.

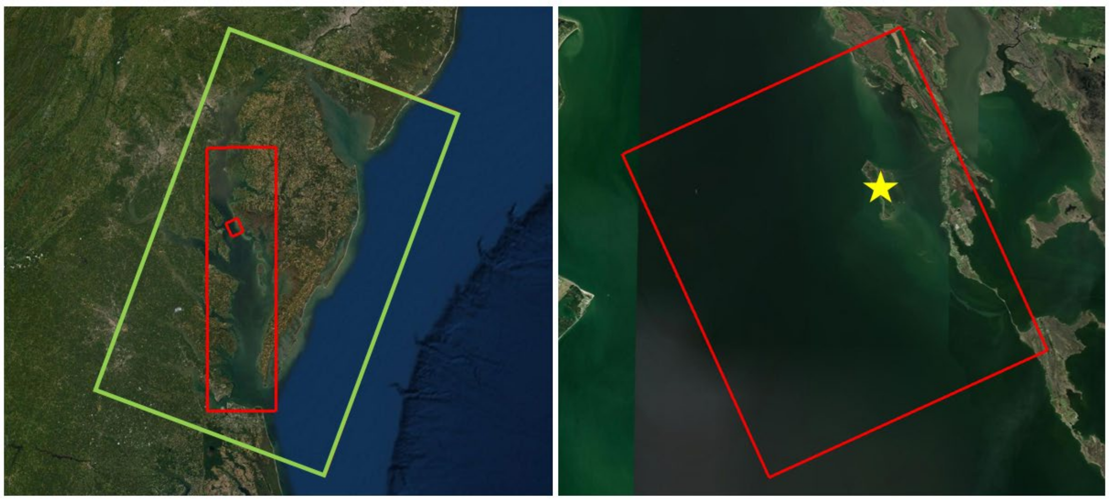

Figure 16 The boundary of the NACCS STWAVE mesh for the Chesapeake Bay (green) along with the boundaries of the grids used for Barren Island (red) (left); the boundary of the nested "child" grids, with the location of Barren Island indicated with a star (right)

The updated bathymetric and topographic data from the ADCIRC meshes were linearly interpolated for each scenario onto the STWAVE grids to create new depth input files for each grid for each modeled with-project scenario. The sills and breakwater structures that were included in the with-project alternatives were also interpolated onto the depth files so that they would be represented in the STWAVE model. The friction input file for each STWAVE grid was also updated to account for the changed bathymetry, but was the same for the existing and all with-project alternatives. All grids for this project were run in full-plane mode. In order to generate the spectral energy boundary conditions for the "child" domains, 100 CSTORM coupled ADCIRC + STWAVE simulations were conducted using the existing condition configuration and only the "parent" STWAVE grid. Spectral data generated from these simulations were then used as input boundary conditions for the "child" grids for all conditions. Both the "parent" and "child" grids were enabled for all simulations used for comparing with and without project conditions.

### CMS-Wave Model Development

Wave diffraction at narrow gaps and open side of proposed islands and structures was modeled by CMS-Wave (Lin et al. 2008, 2011a). CMS-Wave solves the steady-state wave-action balance diffraction on a rectangular grid for coastal wave transformation and interaction with inlets, islands, shorelines, and structures. The model can run in a full plane for wind wave generation and growth or in a half plane for wave propagation and transformation from offshore boundary toward shore. The diffraction formulation used in the model was theoretically developed for the spectral wave modeling and validated by laboratory experiments and field data (Lin et al. 2011b, 2012). In the present investigation, four different model grid domains were developed (Figure 17): (a) Large domain, (b) medium domain, (c) small domain, and (d) reduced domain. The grid cell size varies from 820 ft (250 m) in the large domain offshore area to 32.8 ft (10 m) at nearshore and around islands and structure area. The cell size in the reduced domain is approximately 32.8 ft (10 m).

The large domain covers a rectangular area of 6.8 mi x 7.8 mi (11 km x 12.5 km). The medium domain is approximately 4.1 mi x 5.2 mi (6.6 km x 8.4 km). Both large and medium domains are useful for wave transformation from offshore to the local island and surrounding area of interest. The small domain, covering a square area of 1.4 mi x 1.4 mi (2.3 km x 2.3 km), is a subset of the medium domain. The reduced small domain, approximately 0.99 mi x 1.4 mi (1.6 km x 2.3 km), is a subset of the small domain. The small and reduced small domains are useful for modeling local wave refraction and diffraction around the islands and structures. The water surrounding islands and structure

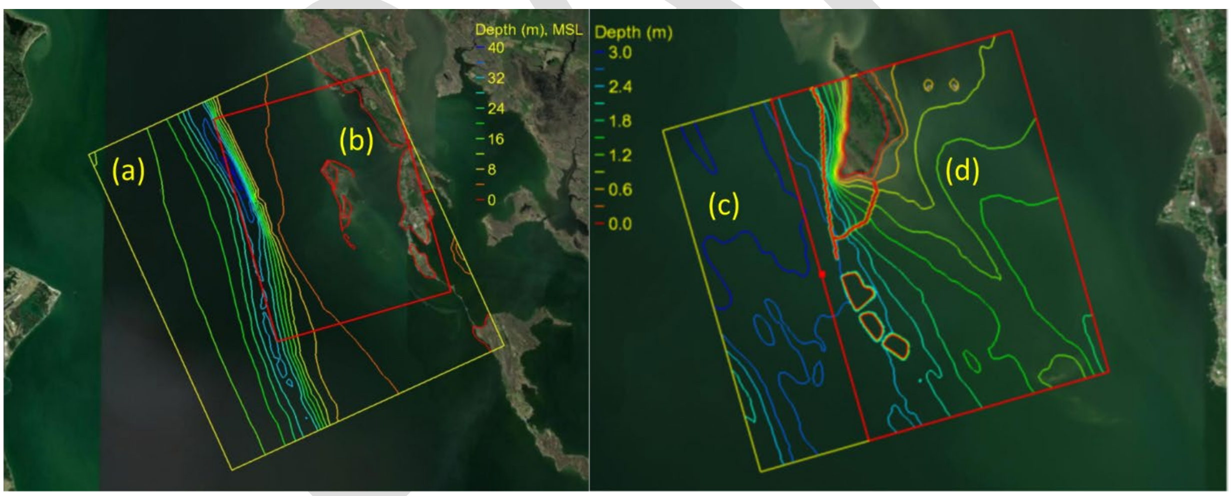


Figure 17 CMS-Wave model grid domains: (a) large domain, (b) medium domain, (c) small domain, and (d) reduced domain.

in small and reduced small domains is overall shallow with depth smaller than 9.8 ft (3 m) (MSL). Wave refraction is generally insignificant over the mild slope away from the shoreline. On the other hand, wave diffraction can become significant at gaps and open side of islands and structure because of short waves approaching is expected due to small fetch in the bay.

The grid domains contained Barren Island with three smaller bird islands extending to the south. The alignment of the islands are similar to the alignment for Alternative 6. The gap between Barren Island and the northern-most bird island is 800 ft (244 m), between the northern and middle bird islands is 174 ft (53 m), and between the middle and southern islands is 226 ft (69 m).

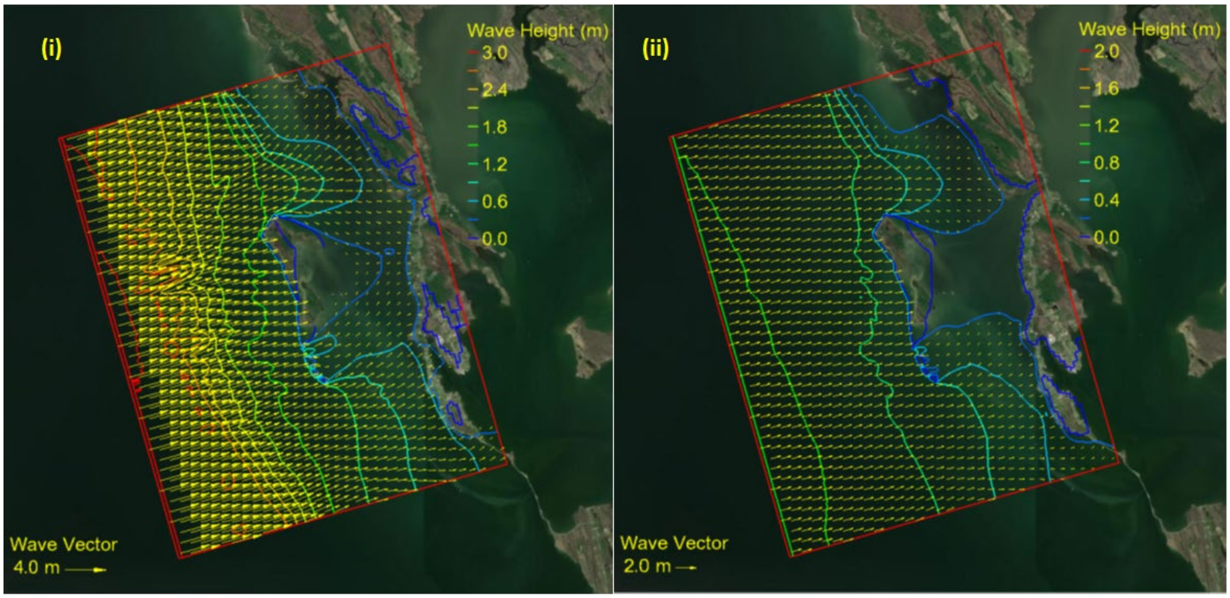


Figure 18 Maps showing two examples of CMS model wave heights in the medium domain: (i) incident wave of 3-m height, 9-sec period, normal to the offshore boundary, with a 0.5-m water level, and (ii) incident wave with 1-m, 4-second, normal to the offshore boundary, and a 0-m water level.

Figure 18 shows two examples of model wave heights in the medium domain: (i) incident wave of 3-m height, 9-sec period, normal to the offshore boundary, with a 0.5-m water level, and (ii) incident wave with 1-m, 4-second, normal to the offshore boundary, and a 0-m water level. With large incident wave height, waves can break over shallow depth. Because of mild slope change toward shore, model waves approaching the proposed island and structure area show similar wave height along shoreline. For this reason, the reduced model domain is selected for the diffraction investigation in the present study.

## Joint Probability Method and Storm Selection

The annual exceedance probability (AEP) of coastal storm hazards for Chesapeake Bay include both tropical cyclones and extratropical storms. Extratropical cyclone hazards were computed in NACCS (Nadal-Caraballo et al. 2015). Tropical cyclone hazards are a function of storm recurrence rate, joint probability of tropical cyclone parameters, and individual storm responses. The joint probability of tropical storm hazards can be computed using the joint probability method (JPM) integral (Resio et al. 2009):

$$\lambda_{r(\hat{x})>r} = \lambda \int P[r(\hat{x}) + \varepsilon > r|\hat{x}, \varepsilon]\, f_{\hat{x}}(\hat{x}) f_{\varepsilon}(\varepsilon) d\hat{x} d\varepsilon$$

$$\approx \sum_i^n \lambda_i\, P[r(\hat{x}) + \varepsilon > r|\hat{x}, \varepsilon] \qquad (1)$$

where $\lambda_{r(\hat{x})>r}$= AEP of storm response $r$ due to forcing vector $\hat{x}$; ε =unbiased error or epsilon term; $P[r(\hat{x})+\varepsilon>r|\hat{x},\varepsilon]$ = conditional probability that storm *i* with parameters $\hat{x}$ generates a response larger than *r*. The primary storm parameters commonly accounted for in the forcing vector $\hat{x}$ are: distance to reference location ($x_0$); central pressure deficit ($\Delta p$); radius of maximum winds ($R_{max}$), translation speed ($V_f$); and heading direction (θ). Secondary parameters may include Holland B parameter and astronomical tide.

The JPM model was built with the approach shown in Figure 19, where only tropical cyclones were considered for the analysis. The discrete version of Eq. 1 was used and a response surface was utilized to achieve a finer computational resolution. Epistemic uncertainty, representing lack of knowledge (Gonzalez et al. 2019), was incorporated into the joint probability model. The four uncertainty contributions considered were:

$\varepsilon_1$: deviation between a storm at a random tide phase and a zero tide level;

$\varepsilon_2$: deviation created by variation of the Holland B parameter;

$\varepsilon_3$: deviation created by variations in tracks approaching the coast; and

$\varepsilon_4$: deviation created primarily by errors in models and grids.

The uncertainties were generally considered independent except $\varepsilon_4$, which was considered to vary linearly with surge.

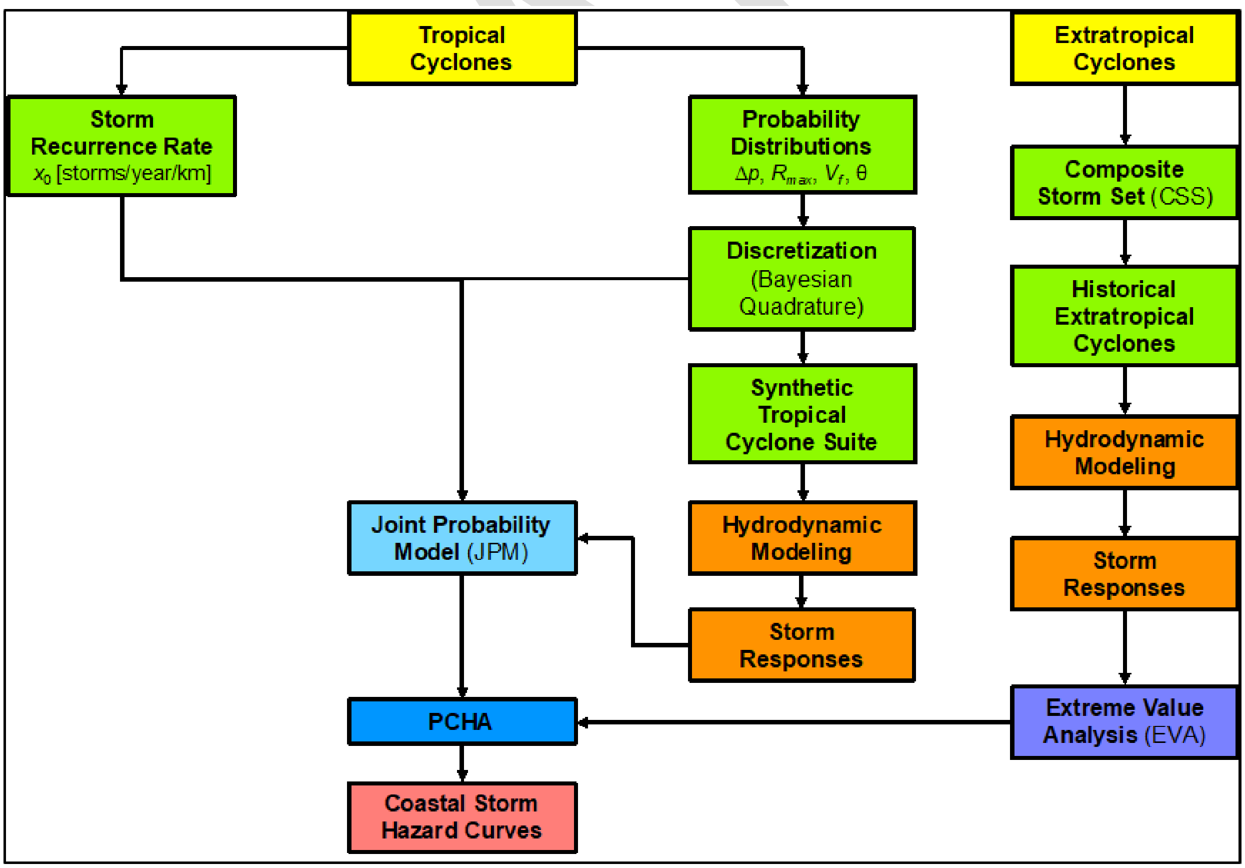


Figure 19. Typical joint probability approach employed by FEMA and USACE (Nadal-Caraballo et al. 2015)

Tropical cyclone parameters of historical storms that impacted the Virginia to Maine region were collected from the National Oceanographic and Atmospheric Administration (NOAA) National Hurricane Center HURDAT2 (Landsea et al. 2004) for the 1938-2013 period. A total of 1050 storms were developed for the NACCS study using the joint probability method with optimal sampling (JPM-OS) approach (Nadal-Caraballo et al. 2015). The storm tracks align with idealized master tracks shown in Figure 20.

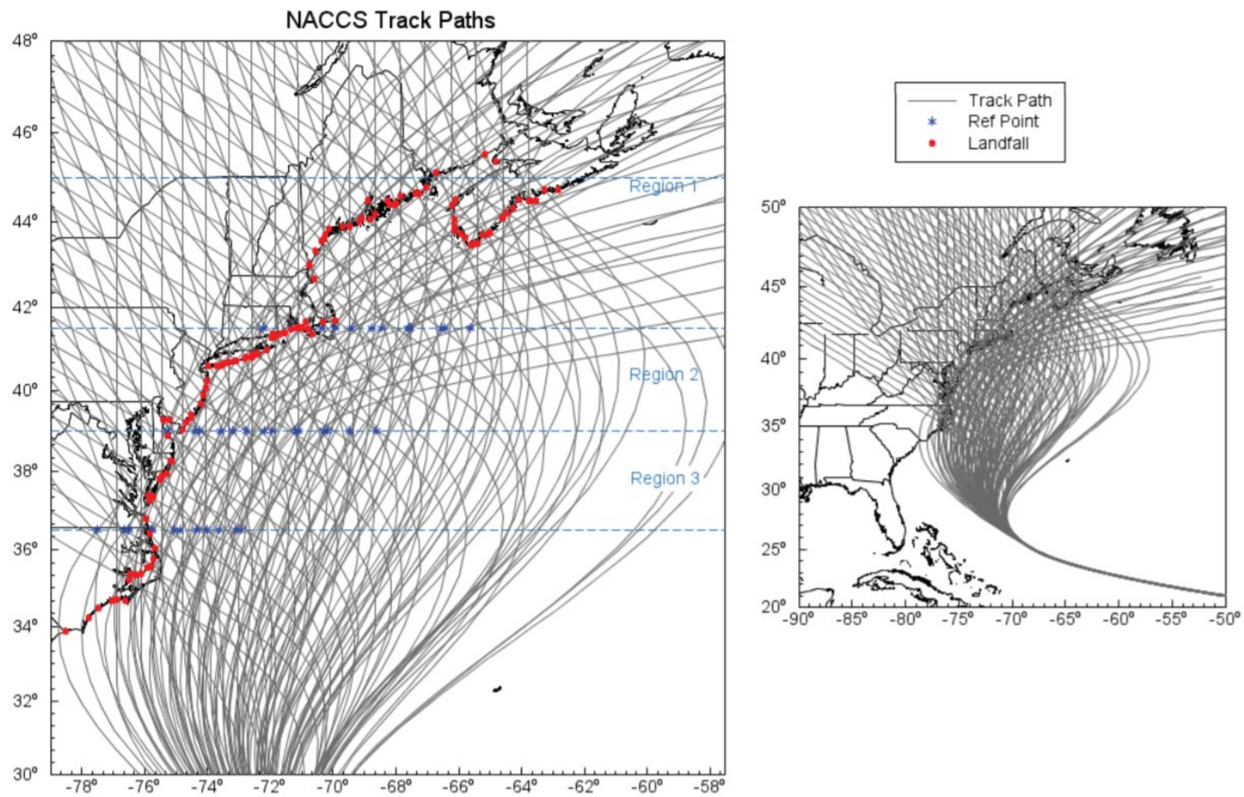


Figure 20. Map of master tracks of storms for NACCS, zoomed in (left) and over the Atlantic basin (right).

CSTORM mesh output is very comprehensive with output files for all the primary responses. The full model domain data are too large and cumbersome to manage for many applications. So in addition to the full domain file, CSTORM outputs are also generated at select locations known as save points. The NACCS modeling was output at approximately 19,000 locations spanning the Virginia to Maine region. The NACCS save point locations were sparse in the area of the Barren Island project, so an additional 2954 save points were created for the site-specific modeling of the 100-storm subset. Of those 2954 new and old save points, approximate 314 save points in the immediate Barren Island area were used for evaluation herein for the 25 storms and the 6 alternatives. Figure 21 shows the NACCS save points and for Barren Island alternative analysis.

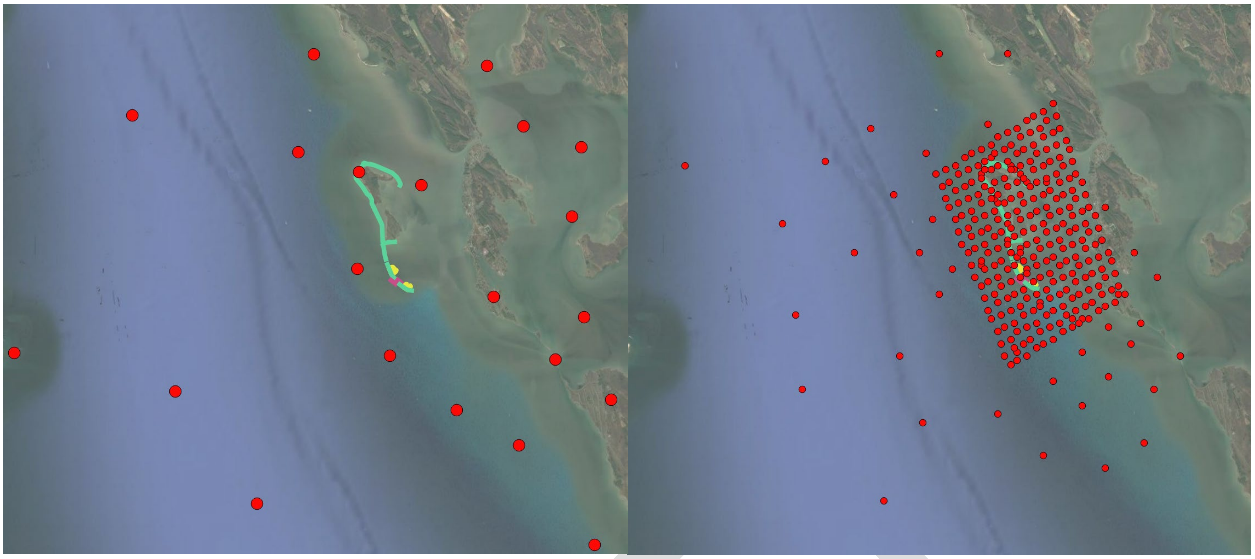

Figure 21. Save point locations (red dots) around Barren Island for NACCS (left) and Barren Island alternatives (right). A schematic of a proposed alignment is in green.

For this study, a metamodel or surrogate model with recursive iterative implementation selected an optimal subsample of the 1050 NACCS tropical cyclones using the method summarized in Melby et al. (2021). The full suite of 1050 storms had already been modeled using CSTORM so results across the region had been output at save points surrounding Barren Island. The peak SWLs from each of the 1050 events were stored for use as outputs.

In this metamodel approach, an initial sub-sample of storms is obtained and tested against the base condition with 1050 NACCS storms. The SWL hazard curves are computed for each save point location and the hazard curves from the reduced sample are compared against the hazard curves from the full sample. The best storm sample set is determined by minimizing the difference in the hazard curves using a genetic algorithm. The optimal set of events that minimizes the error is selected. For this study, 100 storms were selected. An additional optimal storm suite of 25 storms was constructed in order to screen the with-project alternatives. Figure 22 shows the SWL hazard curves for both the full storm set and the reduced optimized storm sets, where the 100-storm set is on the left and the 25-storm set is on the right. Note that the error between the sample and the original is relatively small for both storm sets. The reduced sets of 100 and 25 tropical cyclones are summarized in Appendix I. The storm tracks for the 100-storm set are shown in Figure 23 and the 25-storm subset are shown in Figure 24.

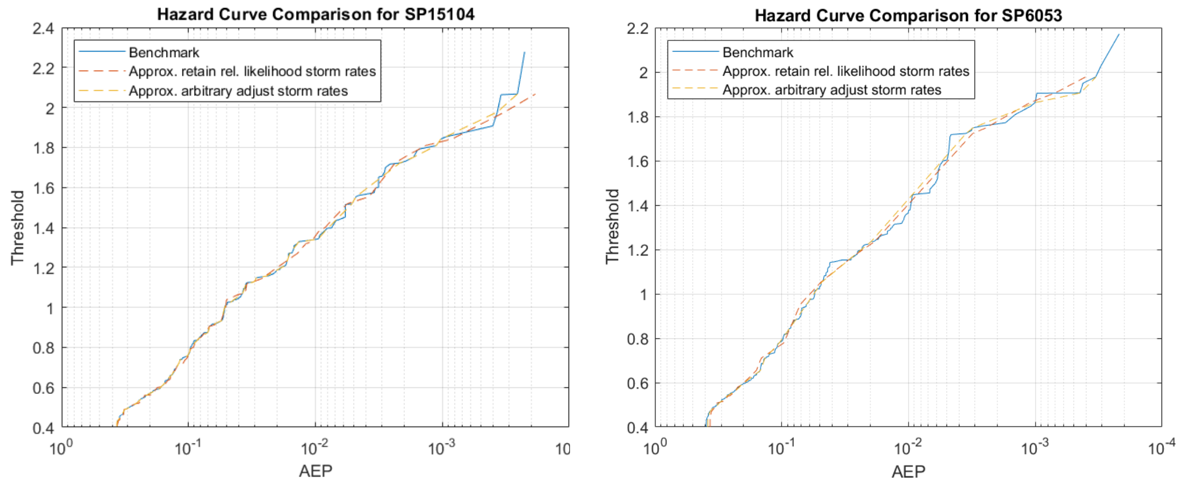


Figure 22. SWL hazard curves for the optimized 100-storm sample at NACCS save point 15104 (left) and the optimized 25-storm sample at NACCS save point 6053 (right).

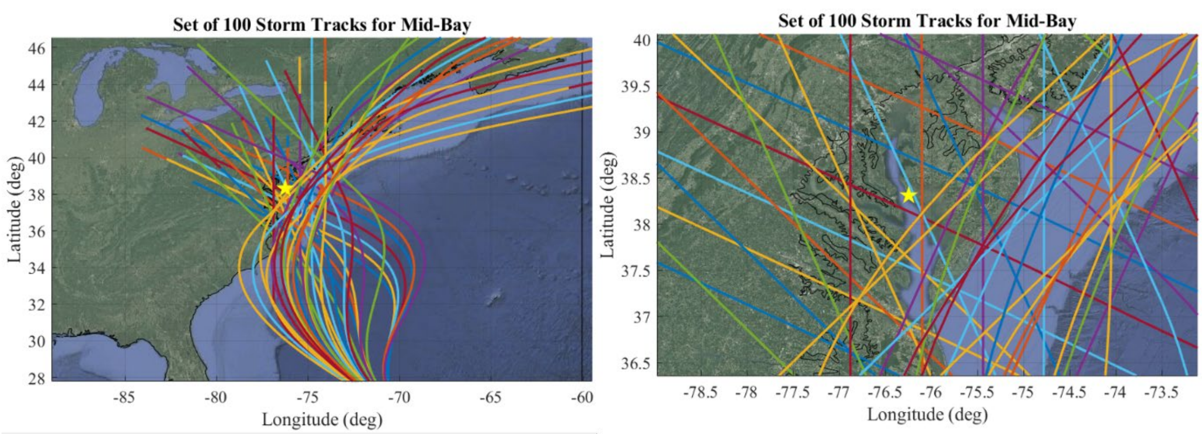


Figure 23 Images of the tracks of the 100 synthetic tropical storms used during initial screening runs; the star indicates the location of Barren Island

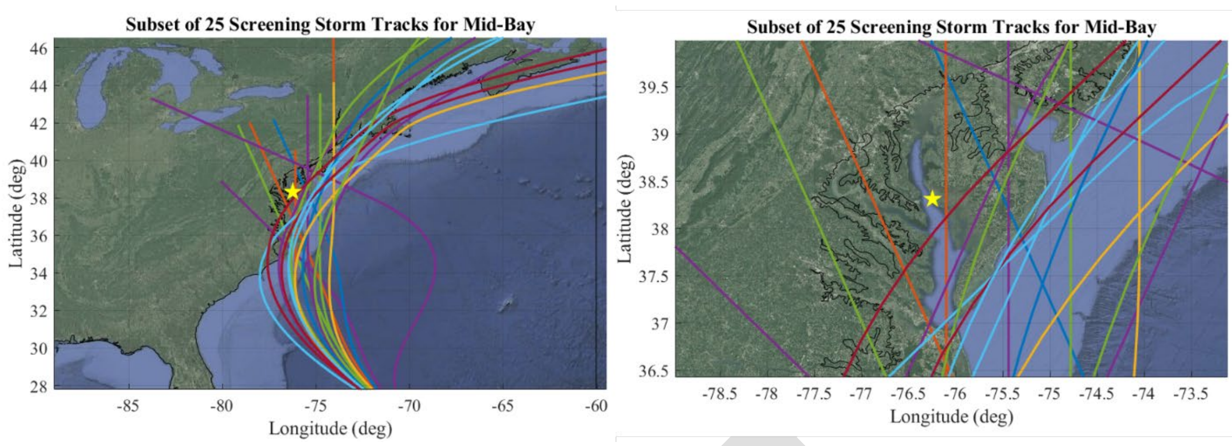


Figure 24 Images of the tracks of the selected 25 synthetic tropical storms run for all project scenarios; the star indicates the location of Barren Island

## CSTORM Model Results

### *Water Surface Elevation Comparisons between Without- and With-Project Conditions*

CSTORM coupled ADCIRC + STWAVE simulations were conducted using the 25 screening storms for existing conditions for Barren Island as well as for the six with-project scenarios. Spatial plots showing comparisons and differences between the maximum water surface elevations for the existing and project conditions for storm number 118, one of the 25 screening storms, are included in this section; similar plots for all 25 storms can be found in Appendix II. Storm 118 has approximately a 9.6 yr. annual return interval (ARI) for the Barren area. The storm passes about 41 miles (66 km) to the west of Barren Island, see Figure 25, and has a minimum central pressure of 965 mb with a radius of about 25 nautical miles and a translational speed of 22.1 knots. This storm track puts Barren Island on the northeastern side of the storm, which is the most intense quadrant for northern hemisphere cyclones. Under existing conditions, the average maximum water surface elevation in the Barren Island area was approximately 4 ft. (1.2 m) relative to MSL on the western side (Bay side) of Barren Island and between 4.5 and 5 ft. on the eastern side of the island in Tar Bay where the bathymetry is shallower than in the may bay. The surge levels away from the immediate proposed structures, in general undergo only small changes, on the order of a couple of inches, for the different with-project scenarios. With the northern portion of Barren Island enclosed by on three sides by the with-project structures, the elevated floodwaters are able to enter from the non-enclosed side, where the wind piles that water up against the “backside” of the features by about 0.5 feet higher or so.

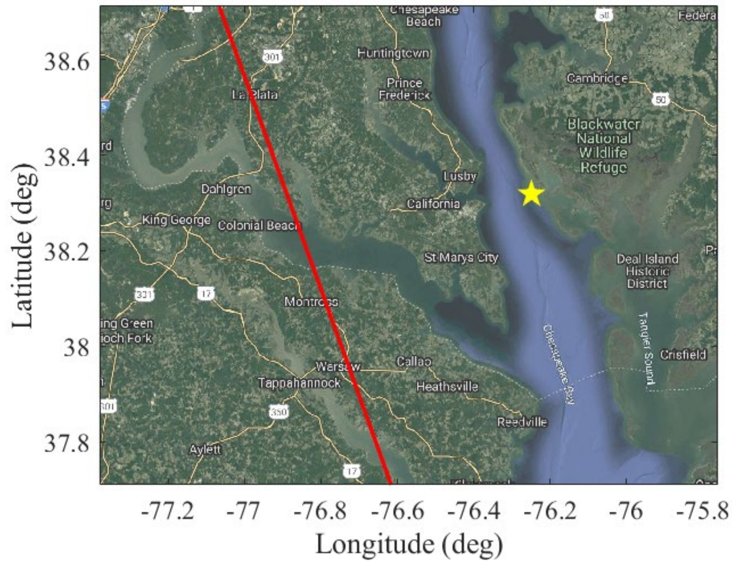


Figure 25 Map showing the location of Barren Island (yellow star) and the track of synthetic tropical storm 118.

Alternative 1 and Alternative 6 have shorter breakwater extents to the south of the island and their maximum WSE results are similar in nature with Alternative 6 having slightly higher water piled up against the northern most sills. They both results in a 0.5 ft. increase in the WSE just south of the Northern sill, and a 0.1 ft. decrease in WSE just north of the northern sill.  Alternatives 2 through 5 all have longer breakwaters to the south of the island and all have similar maximum WSE changes.

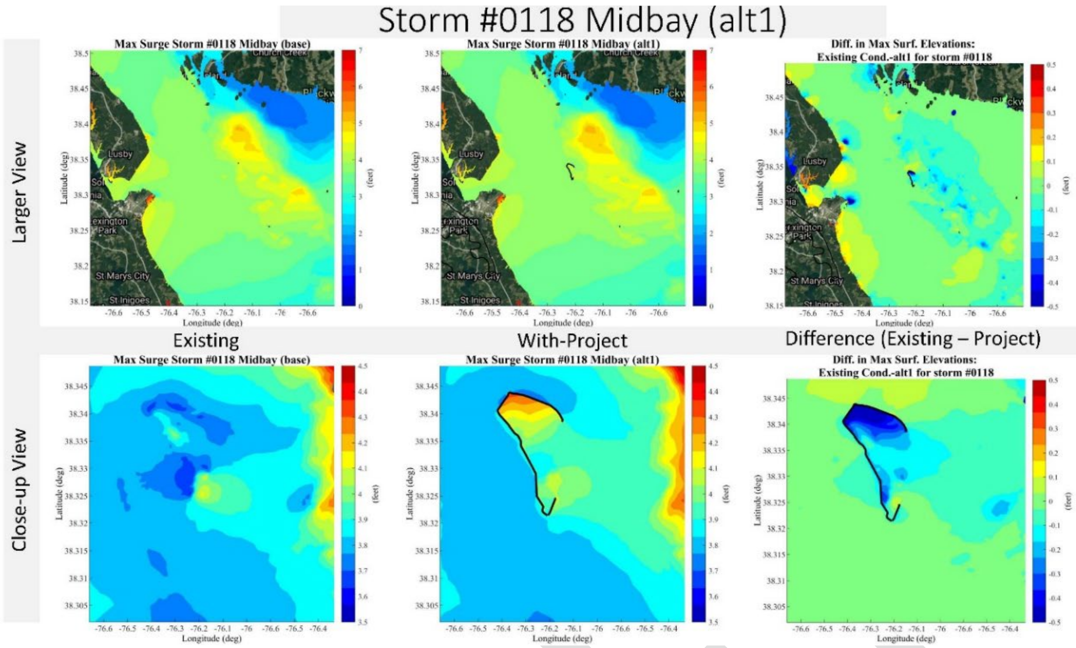


Figure 26 Results from storm number 118 run with Alternative 1 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

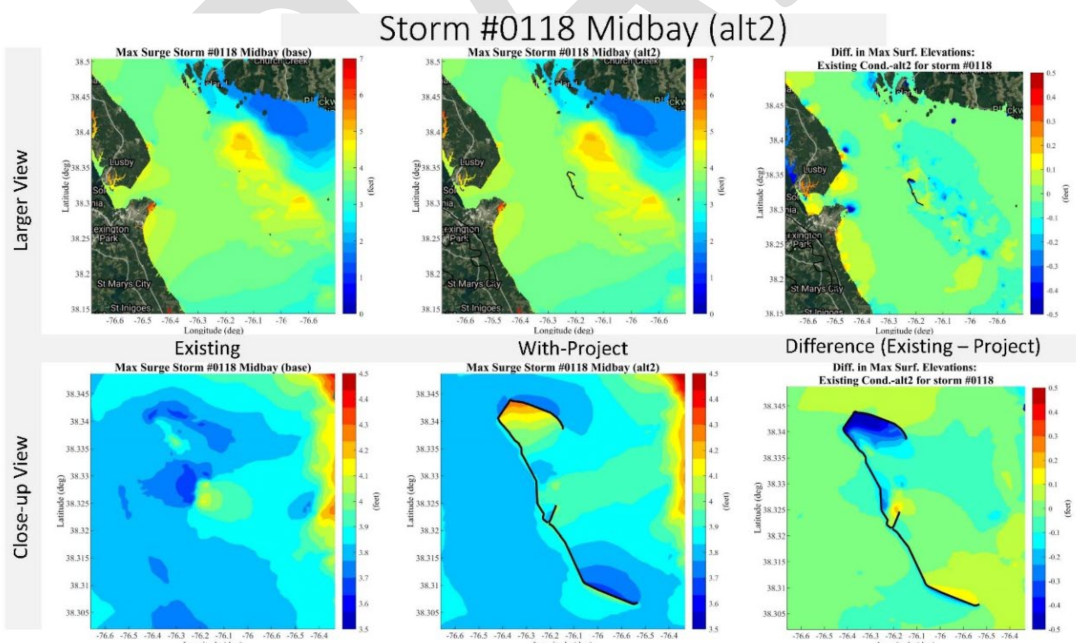


Figure 27 Results from storm number 118 run with Alternative 2 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

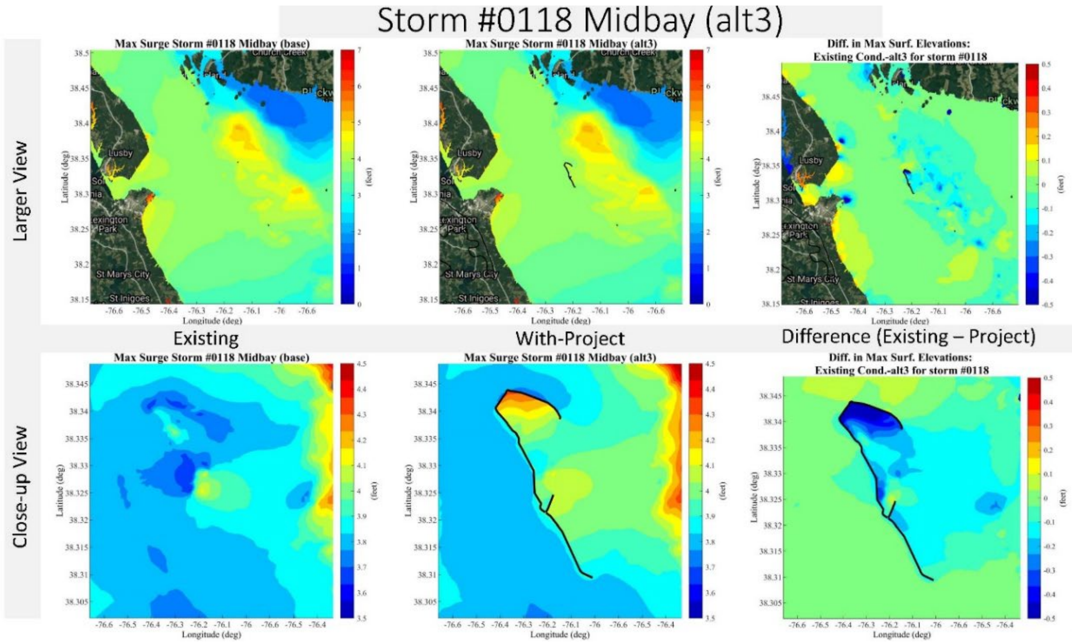


Figure 28 Results from storm number 118 run with Alternative 3 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

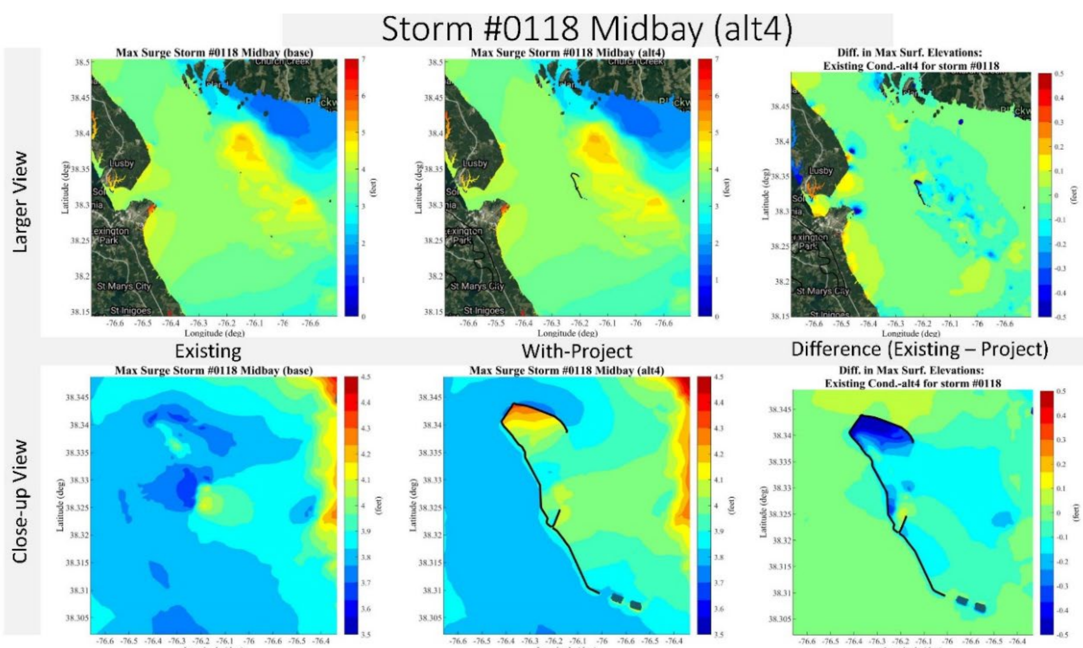


Figure 29 Results from storm number 118 run with Alternative 4 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

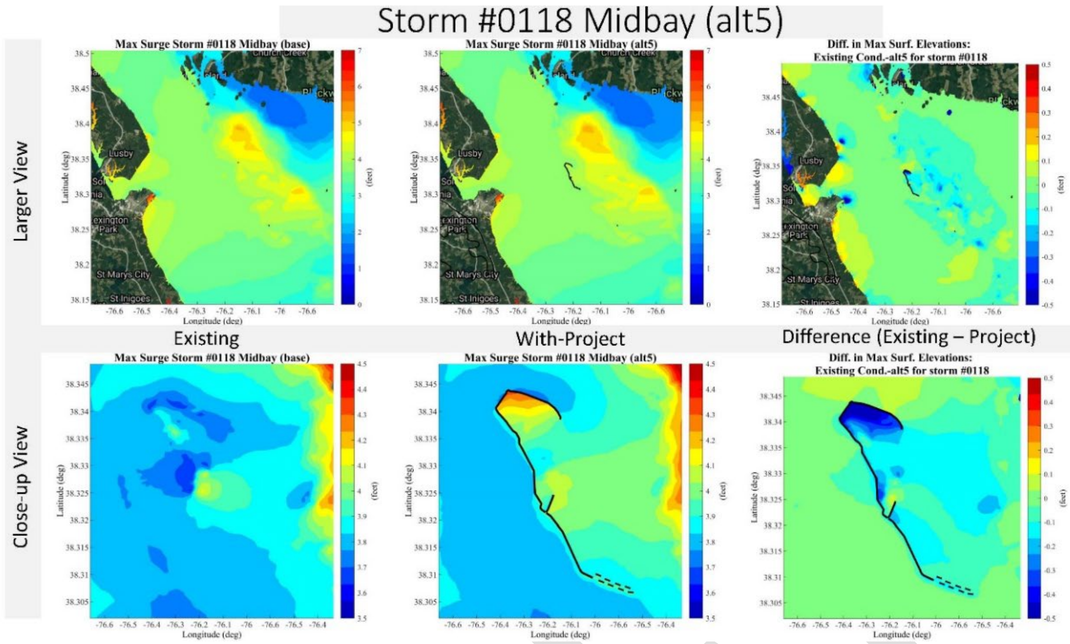


Figure 30 Results from storm number 118 run with Alternative 5 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

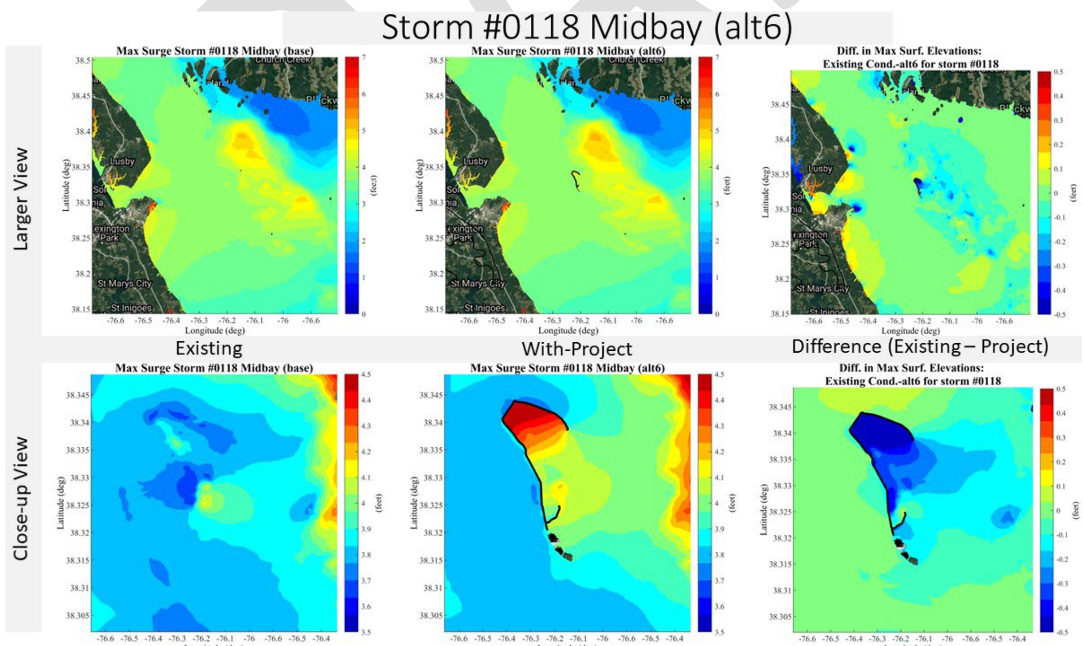


Figure 31 Results from storm number 118 run with Alternative 6 and existing conditions. Maximum Water Surface Elevations (WSE) observed during the runs are mapped as 2-D color contour plots over the existing conditions (left) and the project conditions (middle). The rightmost plots show the difference between these two WSE values (cooler colors represent where the project induced higher water surface elevation values, and warm colors represent where the project induced decreased water surface elevations).

For storm 118, the time series plots for WSE at save points 2068, 2096, 2713, and 2052 for all modeled scenarios generally seem to converge with the WSE for the base conditions. However, for save points 1991 and 2002, model results indicate that the inclusion of the with-project alternatives seem to result in WSE that are slightly higher, less than 0.25 feet, than those produced by the base conditions during the second half of the simulation.


Figure 32 The locations of the save points (with respect to the Alt. 2 with-project design shown as green lines) for which time series comparison plots of all modeled scenarios were generated for all storms.

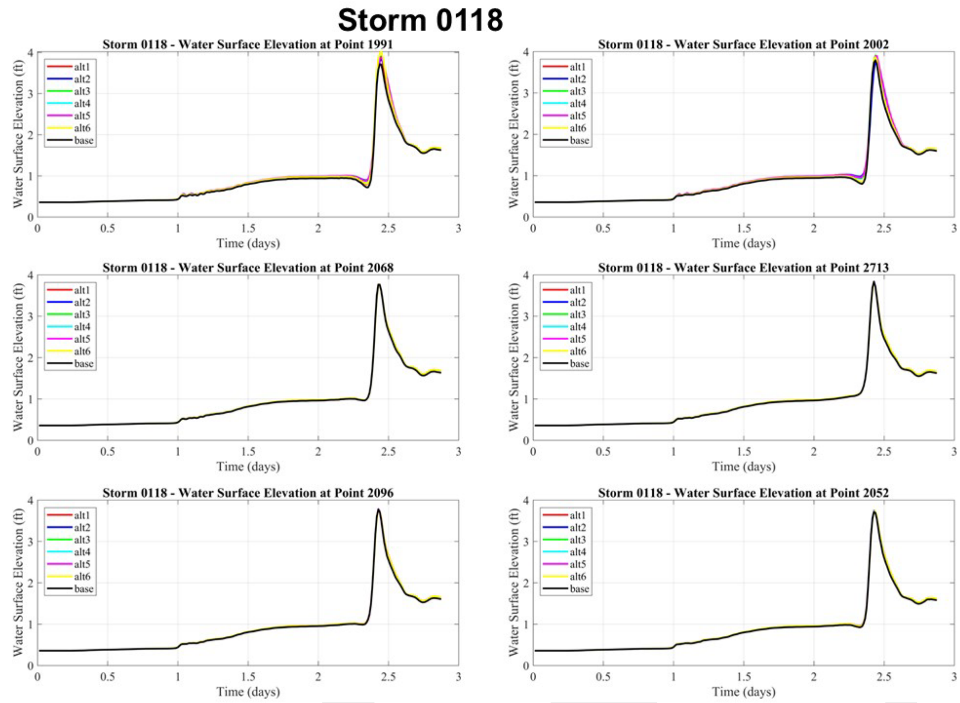


Figure 33 Time series plots for water surface elevation at selected save points for storm 118 for all modeled scenarios.

A set of 20 save points spread out around the project area, shown in Figure 34, are used to provide general characteristics over all 25 storms for each of the six with-project scenarios to provide further analysis in tabular form. Table 2 shows the mean differences in maximum WSE between with-project and existing conditions taken over all 25 storms at each of the 20 save points. Table 3 shows the maximum absolute difference in the maximum WSE values between with-project and existing conditions taken over all 25 storms at each of the 20 save points. These two tables show that away from the immediate structures, the maximum water surface elevations at these 20 save points do not change much. The images in Appendix II show color contour plots of the differences in maximum WSE on a storm-by-storm and project-by-project case for the entire area. Those images show that in general the water surface elevations change very little in Tar Bay and are in general slightly higher for with-project conditions. Storm 630 is the exception and shows lower maximum WSE on the order of 2 to 3 inches in Tar Bay. Appendix VII provides tables of maximum WSE at a collection of save point locations for existing and all six with project conditions.

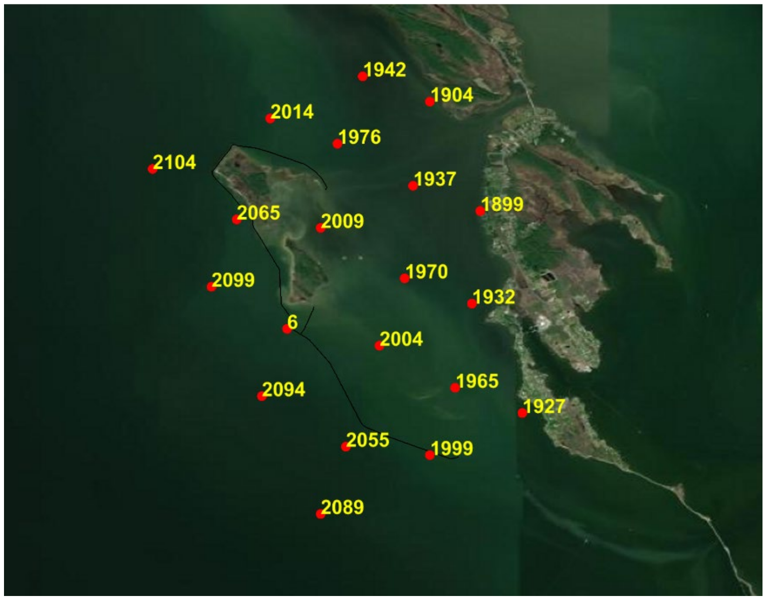


Figure 34 Map showing Barren Island and 20 save point locations as red dots along with their save point number. The black lines show the outline of the with-project Alternative 2.

Table 2 Mean difference in maximum WSE between with-project alternative and existing conditions taken over all 25 storms. Values are in inches rounded to the tenths place.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| 2099 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| 2094 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2089 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2065 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| 6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 1.3 |
| 2055 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2014 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2009 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 2004 | 0.2 | 0.6 | 0.5 | 0.6 | 0.6 | 0.4 |
| 1999 | 0.2 | 0.4 | 0.2 | 0.3 | 0.3 | 0.2 |
| 1976 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 1970 | 0.2 | 0.5 | 0.4 | 0.5 | 0.5 | 0.3 |
| 1965 | 0.2 | 0.4 | 0.3 | 0.4 | 0.4 | 0.2 |
| 1942 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 1937 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 1932 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| 1927 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 |
| 1904 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1899 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

Table 3 Maximum signed absolute difference in maximum WSE between with-project alternative and existing conditions taken over all 25 storms. Values are in inches rounded to the tenths place. Negative values indicate the existing conditions are higher, while positive values indicate the with-project conditons are higher.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | 0.5 | 1.2 | 1 | 1 | 1 | 0.5 |
| 2099 | 0.8 | 2 | 1.8 | 1.8 | 1.8 | 1.1 |
| 2094 | 0.4 | 1.9 | 1.4 | 1.5 | 1.5 | 0.5 |
| 2089 | 0.3 | 1.2 | 0.7 | 0.8 | 0.8 | 0.4 |
| 2065 | 1.4 | 1.7 | 1.4 | 1.4 | 1.4 | 0.9 |
| 6 | 3.7 | 4 | 3.8 | 3.7 | 3.6 | 6.5 |
| 2055 | 0.4 | 1.2 | 0.4 | 0.6 | 0.6 | 0.6 |
| 2014 | 0.7 | -1.6 | -1.5 | -1.5 | -1.4 | -0.7 |
| 2009 | 1.4 | 1.8 | 1.8 | 2 | 2 | 2.6 |
| 2004 | -0.8 | 2.1 | 2.3 | 2.5 | 2.6 | 1.6 |
| 1999 | 0.3 | 1.6 | -1.1 | 1.1 | 0.9 | 0.5 |
| 1976 | 0.9 | -2.2 | -1.9 | -1.9 | -1.9 | -0.8 |
| 1970 | -0.7 | -1.8 | -1.8 | 1.9 | 1.9 | 1.5 |
| 1965 | -0.6 | -1.8 | -1.8 | -1.9 | -1.9 | -0.9 |
| 1942 | -0.7 | -2.3 | -2 | -2.1 | -2 | -0.9 |
| 1937 | -0.9 | -2.6 | -2.2 | -2.3 | -2.3 | 1.5 |
| 1932 | -1 | -2.2 | -2.3 | -2.3 | -2.3 | -1.4 |
| 1927 | 0.4 | -1.8 | -1.5 | -1.6 | -1.6 | -0.6 |
| 1904 | -0.7 | -2.8 | -2.4 | -2.4 | -2.4 | -1 |
| 1899 | -0.9 | -2.5 | -2.2 | -2.3 | -2.3 | -1.4 |

***Water Velocity Comparisons between Without and With-Project Conditions***

Spatial two-dimensional color contour plots containing comparisons and differences between the maximum water velocity in the region around Barren Island for the existing and with-project scenarios are include in Appendix III for all 25 storms. Here, storm 118 is examined in detail, as it was for maximum water surface elevations. Figure 35 to Figure 40 are the color contour plots comparing the maximum water velocities for storm 118.

These figures represent the maximum water currents during each simulation for the 25 storms, for the six with-project configurations, compared to the existing conditions.

The values relate to the two main types of SAV in the Barren Island area. This particular species of SAV routinely survives in environments that experience between 5 cm/s and 100 cm/s water velocities and can withstand up to 180 cm/s. Thus, anywhere the max values are shown to be in the cooler color range of the color bar, the SAV mortality rates are likely lower.

For storm 118, all alternatives generally produce lower velocities as compared to the base conditions in Tar Bay along the southern extents of the structures and island. Along the immediate area of the exposed outer edges of the with-project alternatives, higher water velocities are observed compared to the existing conditions. This is to be expected, as the with-project conditions are reducing/eliminating flow over them and directing the majority of the water flow; all flow if not overtopped, tangentially along the structure. At the terminating ends of the structures that are located in water, the velocities are also higher, particularly for Alt. 2, Alt.4, and Alt. 5 for storm 118. For all project configurations there are higher velocities along the northeastern side of Barren Island along the structures and then extending out into Tar Bay in that northern area. These same general patterns for changes to maximum water velocities are seen for all storms. Table 4 and Table 5 show general summary information at the 20 save point locations, Figure 34, for maximum water velocities changes. Table 4 shows that the average changes to maximum water velocities taken over all 25 storms at each of the locations are below 10 cm/sec, except for locations right next to the structures. Table 5 shows the extreme changes in maximum velocities over all 25 storms for each points. Appendix III shows color contour plots of maximum velocities for all 25 storms and all existing conditions and with-project conditions. Appendix VIII provides tables of maximum velocity values at selected save point locations for all 25 storms for both existing conditions and all six with project conditions.

For the northern Tar Bay area where increases in maximum water velocities are seen, they do not result in maximum velocities that reach what would be considered threatening for SAV, which can withstand water velocities up to 180 cm/s. Behind the northern Barren Island areas of Tar Bay, there are some locations where the alternatives produce water velocities of 140 cm/s or higher under storm conditions. These higher velocities are explored in more detail in the section entitled "***Supplemental Submerged Aquatic Vegetation (SAV) Analysis Results.***"

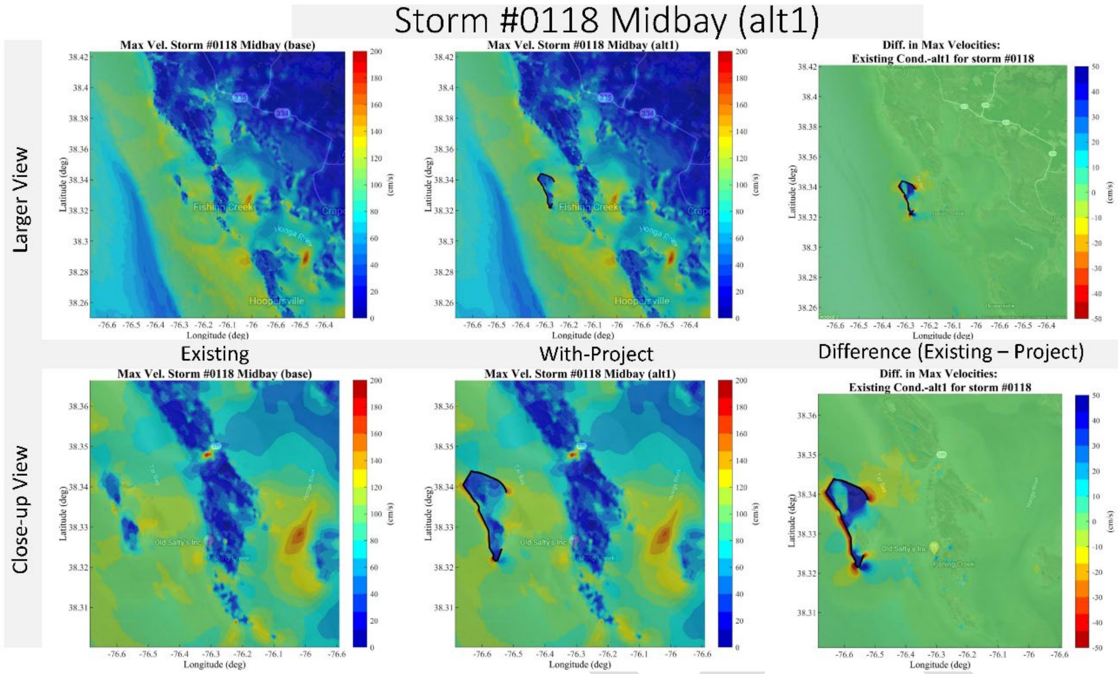


Figure 35 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 1, and the column on the right shows the difference between existing and Alt. 1 maximum velocities (Existing – Alt. 1) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values

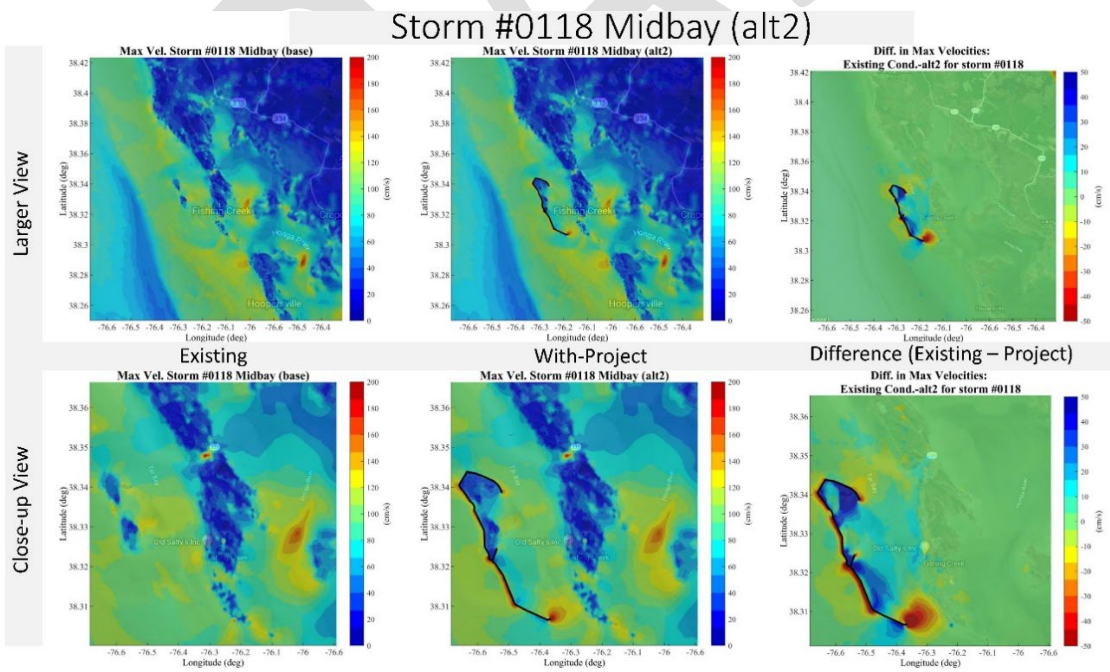


Figure 36 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 2, and the column on the right shows the difference between existing and Alt. 2 maximum velocities (Existing – Alt. 2) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values.

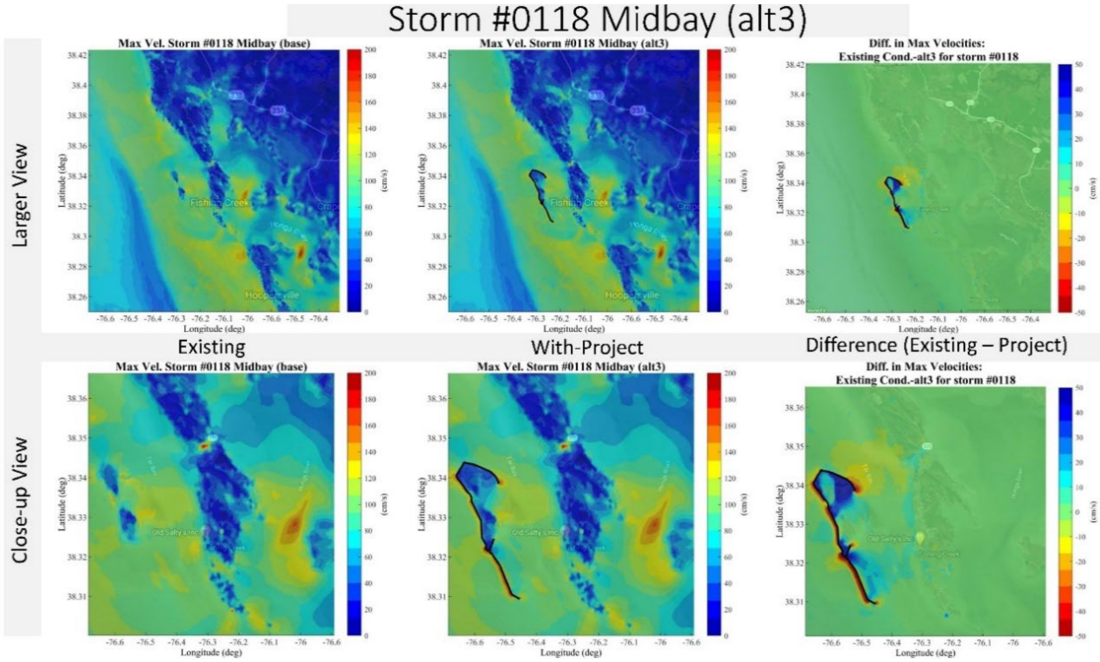


Figure 37 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 3, and the column on the right shows the difference between existing and Alt. 3 maximum velocities (Existing – Alt. 3) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values.

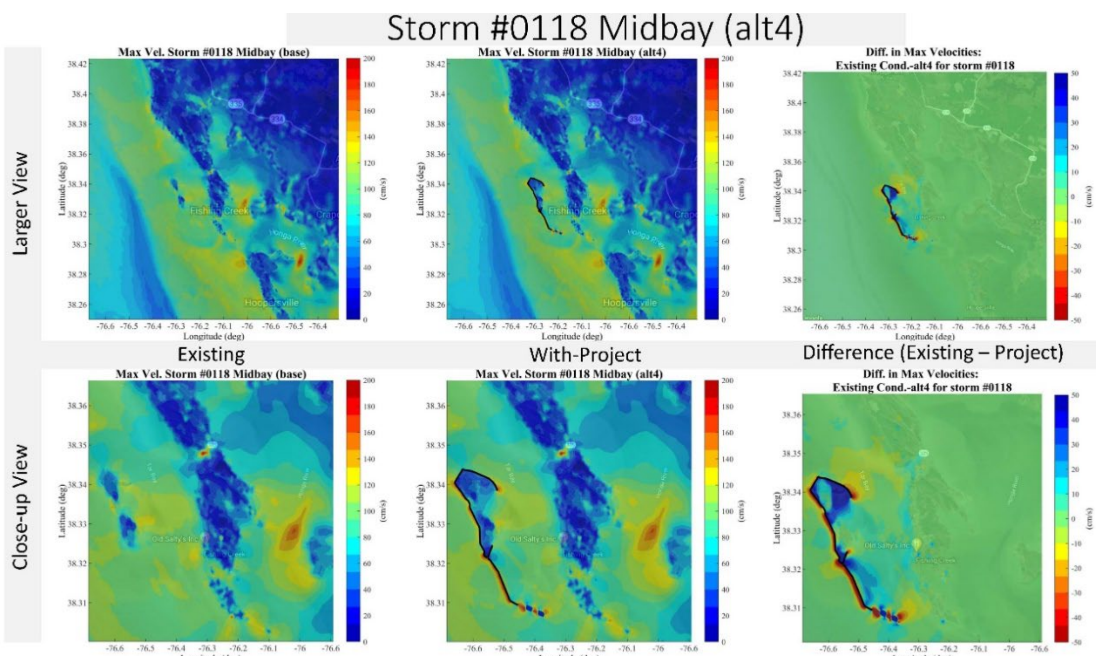


Figure 38 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 4,

and the column on the right shows the difference between existing and Alt. 4 maximum velocities (Existing – Alt. 4) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values.

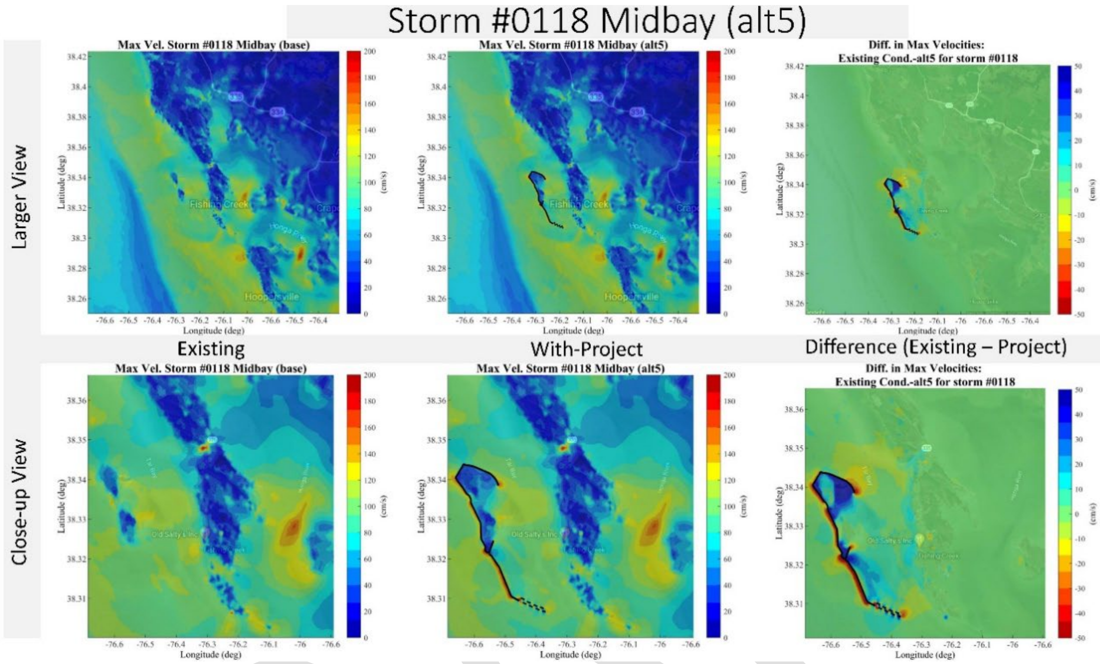


Figure 39 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 5, and the column on the right shows the difference between existing and Alt. 5 maximum velocities (Existing – Alt. 5) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values.

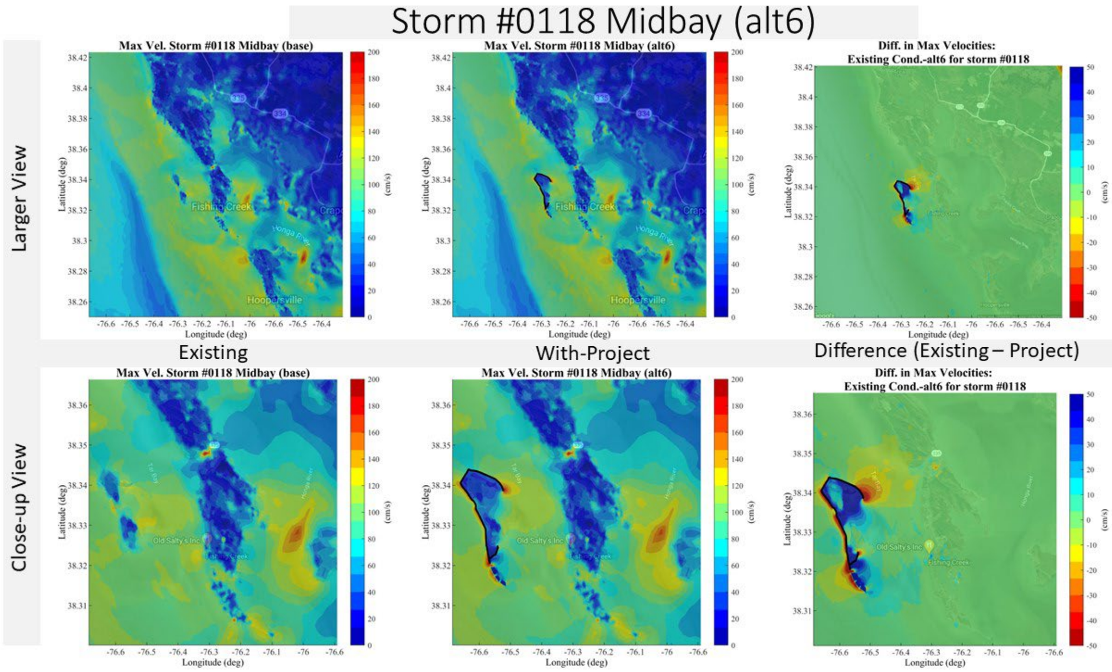


Figure 40 Spatial plots showing maximum velocity values (cm/s) for storm 118 in the Barren Island region. The images in the left column show the maximum velocity for existing conditions, the middle for Alt. 6, and the column on the right shows the difference between existing and Alt. 6 maximum velocities (Existing – Alt. 6) Cooler colors represent areas where the project induced lower velocities, and warmer colors represent where the project increased maximum velocity values.

Table 4 Mean difference in maximum water velocity between with-project alternative and existing conditions taken over all 25 storms. Values are in cm/sec rounded to the tenths place. Negative values indicate that the existing conditions are higher than with-project conditions, while postive values indicate that with-project conditions are higher.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | 0.3 | 0 | -0.2 | -0.1 | -0.1 | -0.1 |
| 2099 | -0.9 | -1.8 | -2 | -1.9 | -1.8 | -2.2 |
| 2094 | 1.2 | 1.7 | 1.4 | 1.2 | 1.4 | 4.5 |
| 2089 | -0.3 | 0.4 | 0.7 | 0.9 | 0.6 | -0.5 |
| 2065 | 3.6 | 3.4 | 3.2 | 3.3 | 3.3 | 3 |
| 6 | 19.3 | 19.2 | 18.4 | 18.5 | 18.5 | -37.6 |
| 2055 | -0.3 | 7.1 | 6.7 | 6 | 6.6 | -0.8 |
| 2014 | -1.1 | 0.8 | 1.1 | 1 | 1 | -0.4 |
| 2009 | -9.9 | -9.2 | -8.2 | -8.4 | -8.3 | -9.6 |
| 2004 | -2.3 | -8.7 | -7.6 | -7.8 | -7.6 | -5.1 |
| 1999 | -0.3 | 2.6 | -2.4 | 8.5 | 1.8 | -0.9 |
| 1976 | 5.7 | 8 | 8.3 | 8.1 | 8.2 | 6.7 |
| 1970 | -2.2 | -1.6 | -0.3 | -0.7 | -0.6 | -1.4 |
| 1965 | -1.2 | -8.5 | -8.1 | -7.8 | -9.2 | -3.6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1942 | 1.3 | 2.5 | 2.6 | 2.6 | 2.6 | 1.8 |
| 1937 | 1.9 | 3.2 | 4 | 3.7 | 3.7 | 2.7 |
| 1932 | -2 | -3.4 | -2.1 | -2.5 | -2.4 | -2 |
| 1927 | -0.7 | -1.7 | -4.8 | -3.6 | -4.2 | -2.6 |
| 1904 | 1.3 | 2.1 | 2.2 | 2.2 | 2.2 | 1.7 |
| 1899 | 0 | -4.2 | -3.8 | -4.2 | -4.2 | -0.6 |

Table 5 Maximum signed difference in maximum water velocity between with-project alternative and existing conditions taken over all 25 storms. Values are in cm/sec rounded to the tenths place. Negative values indicate that existing conditions have higher values, while positive values indicate the with-project conditions have higher values.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | 3.4 | 5.2 | 3.5 | 4 | 3.9 | 2.3 |
| 2099 | -3.4 | -5.2 | -5.3 | -5.3 | -5.1 | -6.4 |
| 2094 | 2.9 | 4.9 | 2.5 | 2.1 | 2.3 | 9.4 |
| 2089 | -1 | -6.2 | 3.2 | 3.2 | 3.2 | -2 |
| 2065 | 6.7 | 6.5 | 6.7 | 6.3 | 6.4 | 5.3 |
| 6 | 54 | 58.1 | 55.4 | 55.5 | 54.5 | -89.3 |
| 2055 | -1 | 12.8 | 16.8 | 15.2 | 15 | -3.2 |
| 2014 | -5.9 | 9 | 7 | 7.9 | 8.2 | 5.8 |
| 2009 | -20 | -17.8 | -17.4 | -17.8 | -17.7 | -24 |
| 2004 | -8.4 | -19.2 | -17.2 | -15.7 | -15.7 | -13.9 |
| 1999 | -0.8 | -44.6 | -4.8 | 29.2 | -24.4 | -3 |
| 1976 | 14.6 | 19.6 | 20.2 | 20.6 | 20.3 | 17 |
| 1970 | -6.5 | -14.1 | -7.6 | -9.4 | -9.4 | -5.5 |
| 1965 | -2.9 | -19.5 | -15 | -18.1 | -20.7 | -8 |
| 1942 | 6.2 | 9.1 | 9.1 | 9.5 | 9.3 | 7.3 |
| 1937 | 4.1 | 7.1 | 7.8 | 7.3 | 7.4 | 5.9 |
| 1932 | -4.8 | -11.6 | -4.7 | -6.6 | -6.3 | -4.9 |
| 1927 | -2.9 | 16.1 | -9.8 | -8.6 | -9.6 | -5.8 |
| 1904 | 5.4 | 7.1 | 7.4 | 7.1 | 7.2 | 7.1 |
| 1899 | 4.2 | -10.6 | -11.6 | -12.4 | -12.4 | -5.5 |

***Significant Wave Height Comparisons between Without- and With-Project Conditions***

Maximum significant wave height conditions for all 25 of the screening storms for both existing conditions and all six with-project conditions is examined in this section. For all cases, the two-dimensional color contour plots of maximum significant wave heights and the differences plots between existing conditions and with-project are provided in Appendix IV. As a representative case for discussion purposes, color contour plots of results for storm number 118 are presented here in Figure 41 through Figure 46. All with-project alternatives reduce waves to some extent on the eastern side of the island/structures. The alternatives that have longer breakwaters, like Alt. 2 through Alt. 5, all reduce significant wave heights in a larger area behind the structures than do the shorter structures for Alt. 1 and Alt. 6. Wave heights are reduced on the order of 0.5 to 1.5 ft. for this storm. Some wave propagation can been seen passing between the constructed islands in Alt. 4 for storm 118. In Appendix IV, storm 933 shows even more propagation between the breakwater and the constructed islands. These kinds of transmissions through the openings were examined in more detail using the CMS-Wave model for Alternative 6 and those results are discussed later in this document in the section entitled "**CMS-Wave Modeling Results**."

Figure 47 shows time series plots of significant wave height (Hs) for storm 118 at 6 save point locations located on both the east and west sides of the structures. Wave heights are reduced at both of save points 1991 and 2002 located behind the structures in all the alternatives. Point 1991 is located in shallow water near the island and has a maximum significant wave height around 3.0 feet for existing conditions while the different alternative reduce that peak value by 3.0 to 6.0 inches. Save point, 2002 has larger waves near 5 feet and the reduction of the wave heights is more dramatic for the with-project conditions, reducing them by approximately 1.5 feet.

Table 6 and Table 7 provide general details of changes to the maximum significant wave heights over all 25 storms at 20 save point locations, Figure 34, for all six with project conditions. Table 6 gives the mean change in maximum significant wave height taken over all 25 storms for each with-project condition for each save point. Negative values indicate that the existing conditions are higher than with project conditions. Overall, the mean changes over all storms for most of these locations shows a reduction in maximum significant wave heights for all with-project conditions on the order of 3.0 to 6.0 inches.

Table 7 gives the signed absolute maximum change in maximum significant have height, taken over all 25 storms for each with-project condition. Negative values indicate that the existing conditions are higher than with-project conditions. These values represent the extreme changes over all storms for each of the with project conditions. Generally, waves are reduced behind the with-project structures between 1.0 to 2.0 feet but going over 4.0 feet for one location, save point 6, for Alternative 6.

Appendix IV shows color contour plots of maximum significant wave heights for all 25 storms and all existing conditions and with-project conditions. Appendix IX provides tables of maximum significant wave height values at selected save point locations for all 25 storms for both existing conditions and all six with project conditions.

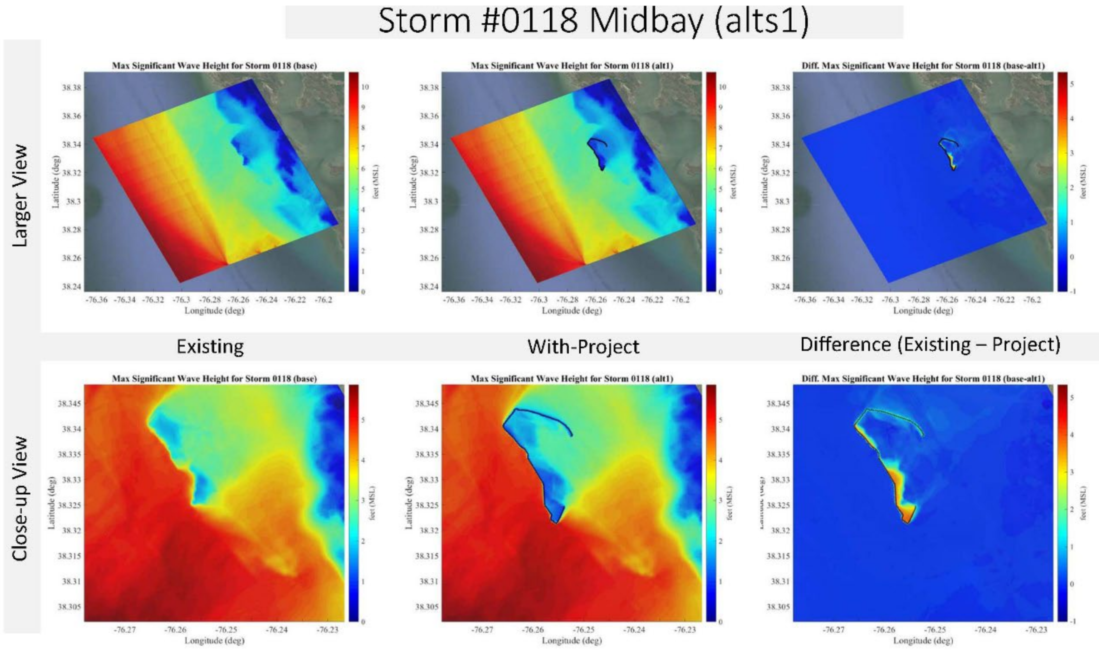


Figure 41 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 1, and the column on the right shows the difference between existing and Alt. 1 wave heights (Existing – Alt. 1) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

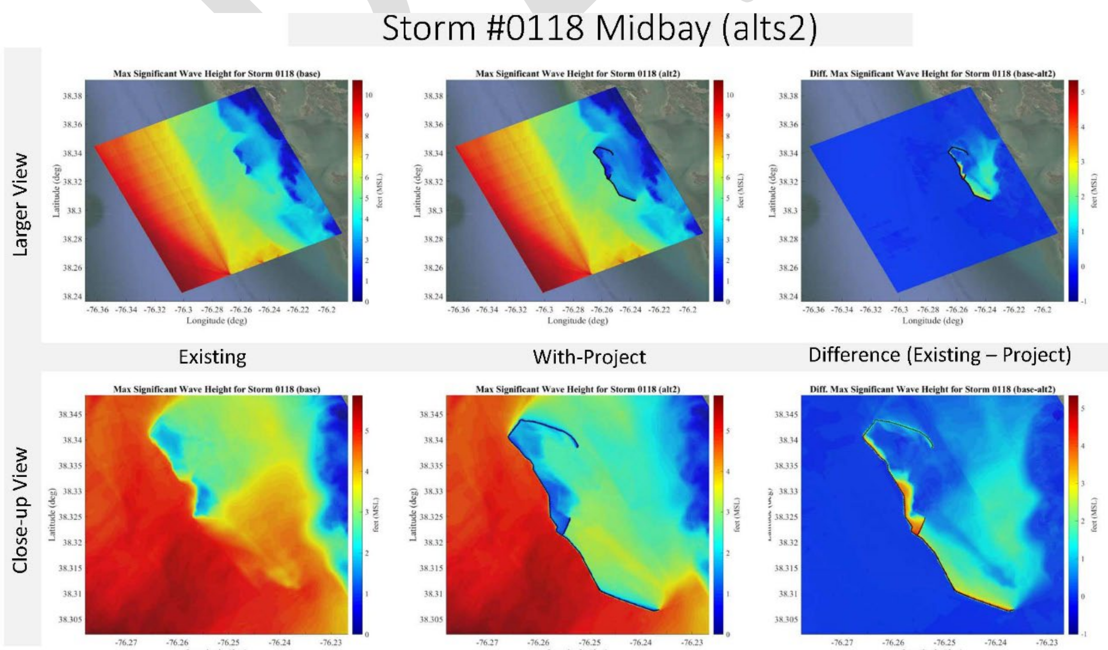


Figure 42 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 2, and the column on the right shows the

difference between existing and Alt. 2 wave heights (Existing – Alt. 2) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

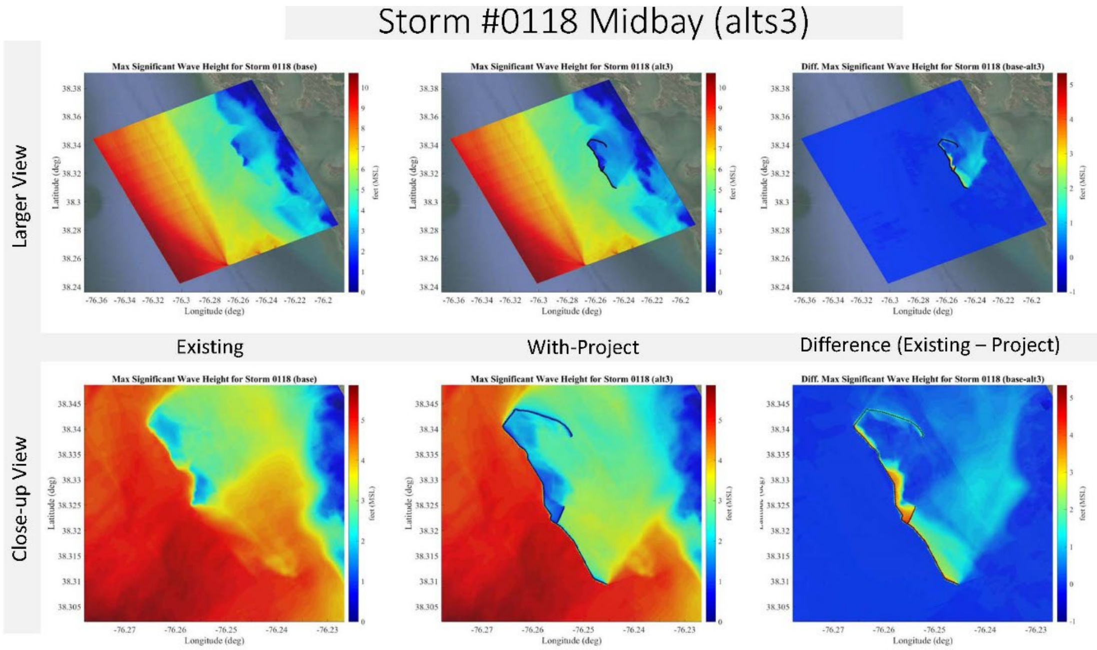


Figure 43 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 3, and the column on the right shows the difference between existing and Alt. 3 wave heights (Existing – Alt. 3) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

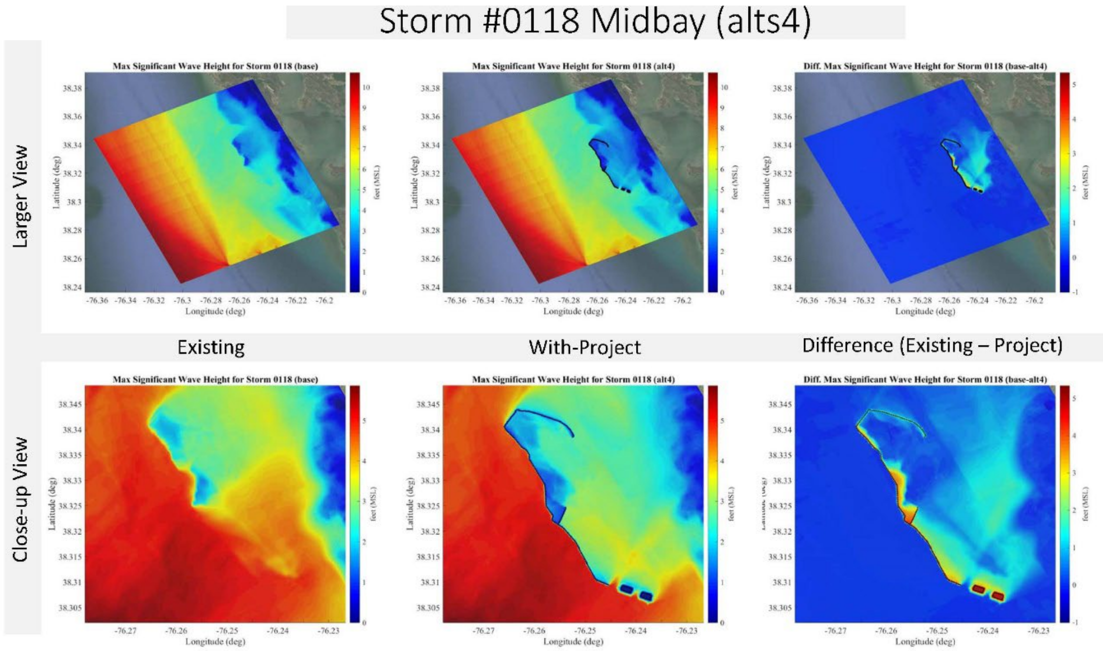


Figure 44 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 4, and the column on the right shows the difference between existing and Alt. 4 wave heights (Existing – Alt. 4) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

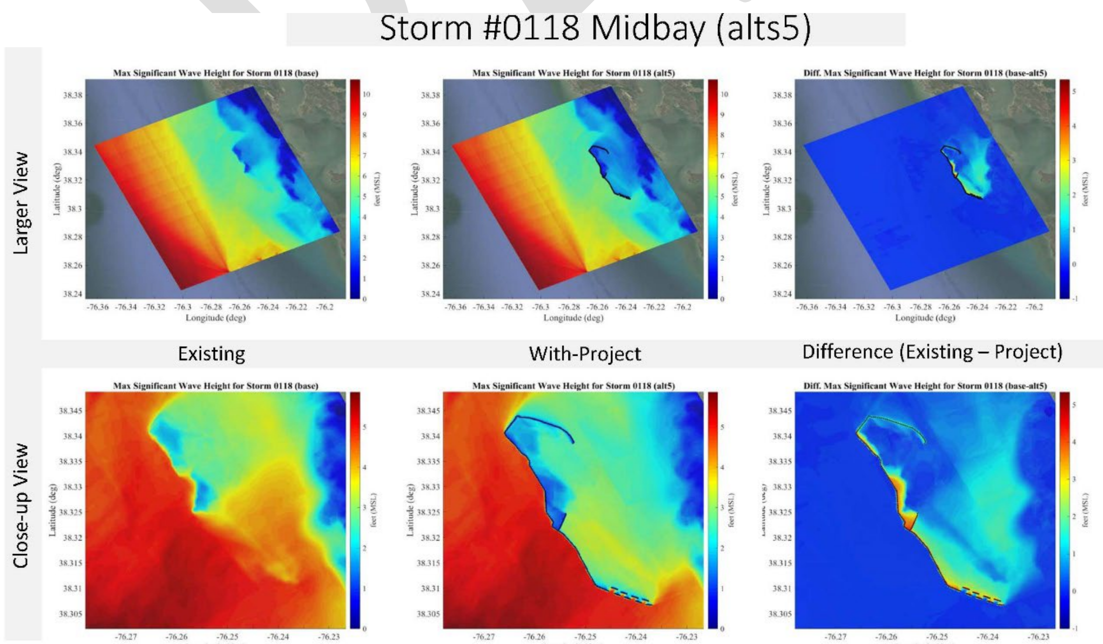


Figure 45 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 5, and the column on the right shows the

difference between existing and Alt. 5 wave heights (Existing – Alt. 5) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

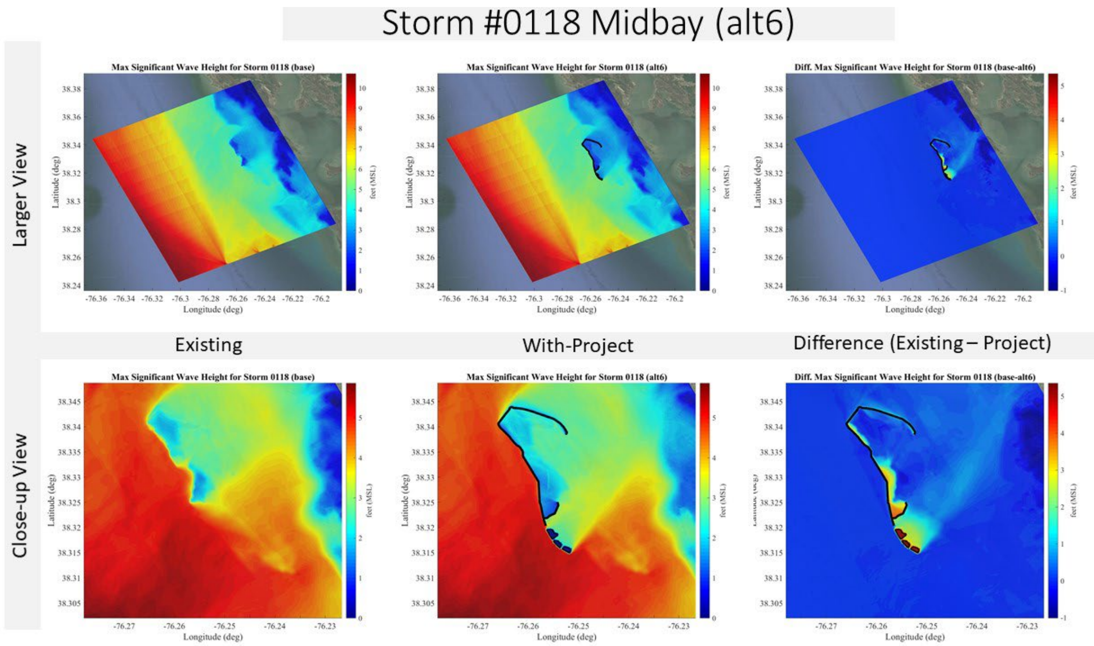


Figure 46 Comparison plots showing maximum significant wave height values (m) for storm 118 for the Barren Island STWAVE grid forced from the southern boundary. The left column shows the maximum significant wave height for existing conditions, the middle for Alt. 6, and the column on the right shows the difference between existing and Alt. 6 wave heights (Existing – Alt. 6) Cooler colors represent areas where the project caused higher wave heights, and warmer colors show where the project decreased maximum wave height values.

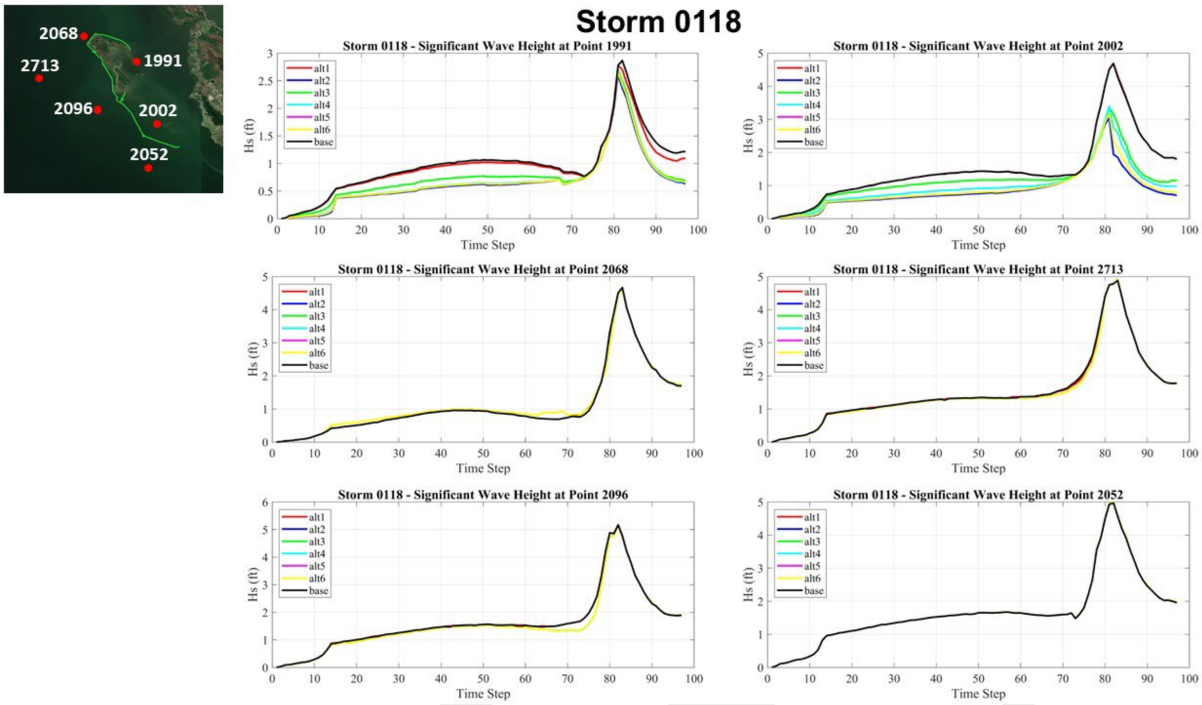


Figure 47 Time series plots for significant wave height at selected save points for storm 118 for all modeled cases; inset image of save point locations with respect to the Alt. 2 project configuration included for reference.



Table 6 Mean difference in maximum significant wave heights (Hs) between with-project alternative and existing conditions taken over all 25 storms. Values are in feet rounded to the tenths place. Negative values indicate that the existing conditions are higher than with-project conditions, while postive values indicate that with-project conditions are higher.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | -0.1 | 0.1 | -0.1 | 0 | 0 | -0.1 |
| 2099 | -0.1 | 0.1 | 0 | 0.1 | 0.1 | -0.1 |
| 2094 | 0 | 0 | -0.2 | -0.1 | -0.1 | 0 |
| 2089 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2065 | -0.1 | 0.1 | 0 | 0.1 | 0.1 | 0 |
| 6 | -1.8 | -1.6 | -1.6 | -1.6 | -1.6 | -24.8 |
| 2055 | 0 | 0.1 | 0.1 | 0 | 0.1 | 0 |
| 2014 | -0.7 | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 |
| 2009 | -2.6 | -3.2 | -3.2 | -3.2 | -3.2 | -2.9 |
| 2004 | -0.8 | -9.1 | -8 | -8.8 | -8.7 | -2.7 |
| 1999 | -0.2 | -4.2 | -3.2 | -6.2 | -3.8 | -1.8 |
| 1976 | -0.6 | -1.1 | -1 | -1.1 | -1.1 | -0.7 |
| 1970 | -0.2 | -8.1 | -6.2 | -7.7 | -7.8 | -3.5 |
| 1965 | -0.2 | -11.2 | -2.4 | -10.9 | -10.5 | -1.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1942 | -0.4 | -0.8 | -0.7 | -0.8 | -0.8 | -0.5 |
| 1937 | -0.5 | -2.3 | -1.5 | -2 | -2.1 | -0.8 |
| 1932 | -1.4 | -6.5 | -4.8 | -6.4 | -6.4 | -1.6 |
| 1927 | -0.5 | -4.7 | -3.5 | -4.8 | -4.4 | -2.1 |
| 1904 | -0.6 | -1.5 | -1.2 | -1.3 | -1.4 | -0.7 |
| 1899 | -0.1 | -2.2 | -1.5 | -2 | -2.1 | -0.3 |

Table 7 Signed maximum difference in maximum significant wave heights (Hs) between with-project alternative and existing conditions taken over all 25 storms. Values are in feet rounded to the tenths place. Negative values indicate that the existing conditions are higher than with-project conditions, while postive values indicate that with-project conditions are higher.

| Save Pt. # | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 |
|---|---|---|---|---|---|---|
| 2104 | -1.7 | -1.1 | -1.9 | -1.9 | -1.9 | -2 |
| 2099 | -0.8 | -3.1 | -3.1 | -3 | -3 | -3.6 |
| 2094 | 0.2 | -3.1 | -3 | -3.3 | -3.2 | -0.6 |
| 2089 | -0.6 | -0.6 | -0.6 | -0.6 | -0.6 | -0.6 |
| 2065 | -1.2 | -1.4 | -1.5 | -1.4 | -1.4 | -1.7 |
| 6 | -8.5 | -8.1 | -7.7 | -7.8 | -8 | -51.5 |
| 2055 | -0.1 | -1.1 | 0.8 | -1.3 | -0.8 | 0.5 |
| 2014 | -5.5 | -5.4 | -5.4 | -5.4 | -5.4 | -5.4 |
| 2009 | -10.3 | -9.7 | -9.9 | -9.8 | -9.7 | -10.2 |
| 2004 | -5.4 | -20.1 | -16.9 | -18.7 | -18.8 | -10.6 |
| 1999 | -0.5 | -9.5 | -7 | -13.8 | -9.2 | -4.2 |
| 1976 | -4 | -9.8 | -8.8 | -9.7 | -9.8 | -5.8 |
| 1970 | -1.4 | -21.4 | -16.4 | -19.3 | -19.9 | -9.2 |
| 1965 | -1.6 | -22.1 | -11.5 | -21.8 | -20.1 | -6.6 |
| 1942 | -3.4 | -8.4 | -7.2 | -8.3 | -8.3 | -4.5 |
| 1937 | -2.5 | -16.5 | -9.5 | -15.5 | -16 | -6.1 |
| 1932 | -3.9 | -22.1 | -13.2 | -20.5 | -21.3 | -4.1 |
| 1927 | -1.7 | -9.2 | -8.6 | -9.4 | -9 | -5.5 |
| 1904 | -3.6 | -11.8 | -10.3 | -11.3 | -11.6 | -5.9 |
| 1899 | -1.2 | -12.6 | -8.4 | -12.3 | -12.5 | -2.1 |

### *Supplemental Submerged Aquatic Vegetation (SAV) Analysis Results*

Based on the CSTORM results for the 25 storms for Alternative 6, additional analysis was requested by NAB due to concerns about the viability of the SAV located east of Barren Island. It was observed that some storms saw an increase in maximum water velocity for the Alternative 6 project scenario as compared with existing conditions in portions of Tar Bay. Additionally, several storms that had lower recurrence rates and were judged to be less severe events saw higher water velocities than more severe storms with higher recurrence rates. In response to these issues, further analysis focused specifically on the region of Tar Bay where SAV is present was conducted.

Maximum water level and velocity results for the Alt. 6 simulations were examined, and six (6) storms that showed higher than expected water velocities east of Barren Island were selected by NAB for further analysis. Time series comparing water elevations and velocities at three (3) point locations (Figure 48) in the area of concern were created for all six storms. Sample results for storm 118 are shown in Figure 49, and time series for the rest of the storms can be found in Appendix XII and Appendix XIII. While the water elevation values at the point locations did not significantly differ between the existing and Alt. 6 results, the peak water velocity values at two of the three point locations was higher for Alt. 6 than for the without project case. In many cases these peak velocities exceeded the 100 cm/s velocity threshold, which indicates that the SAV could potentially be damaged or destroyed during these storm events. One factor that was identified as a possible explanation for the high velocity values was the fact that the presence of the SAV was not being considered by the ADCIRC model as discussed in a previous section. Realistically, submerged vegetation causes drag that can significantly reduce velocity throughout the water column. This is usually accounted for in the ADCIRC model via the Manning's n nodal attribute, which has friction values derived from land cover classifications. However, in the model runs the Tar Bay region was considered strictly as open water and had a low Manning's n value of 0.02. To more accurately account for the vegetation, the Manning's n was increased to 0.03 in the region east of Barren Island where SAV has been observed (Figure 48). Two of the six storms of concern were rerun with this increased Manning's n for both existing conditions and Alternative 6.

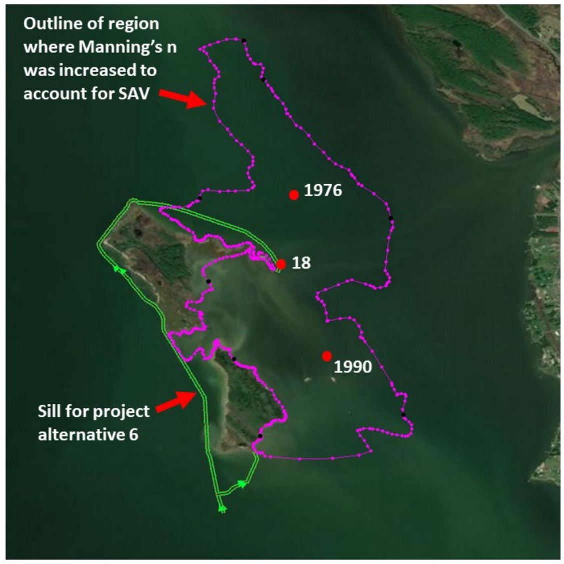


Figure 48 Map showing the save point locations where model results were examined due to increased velocities for Alternative 6. The purple outline represents the region where Manning's n was increased to account for the presence of SAV.

Figure 49 shows a comparison of the existing and Alt. 6 results with both the unchanged and increased Manning's n values at the three save points for storm 188. Although water elevation remained virtually the same, the cases for which Manning's n was increased saw noticeable decreases in peak velocity. On average the peak velocity was reduced by approximately 20-30 percent when the Manning's n was increased. For the majority of point locations, this reduction brought the peak velocity value below the 100 cm/s velocity limit required for the preservation of the SAV.

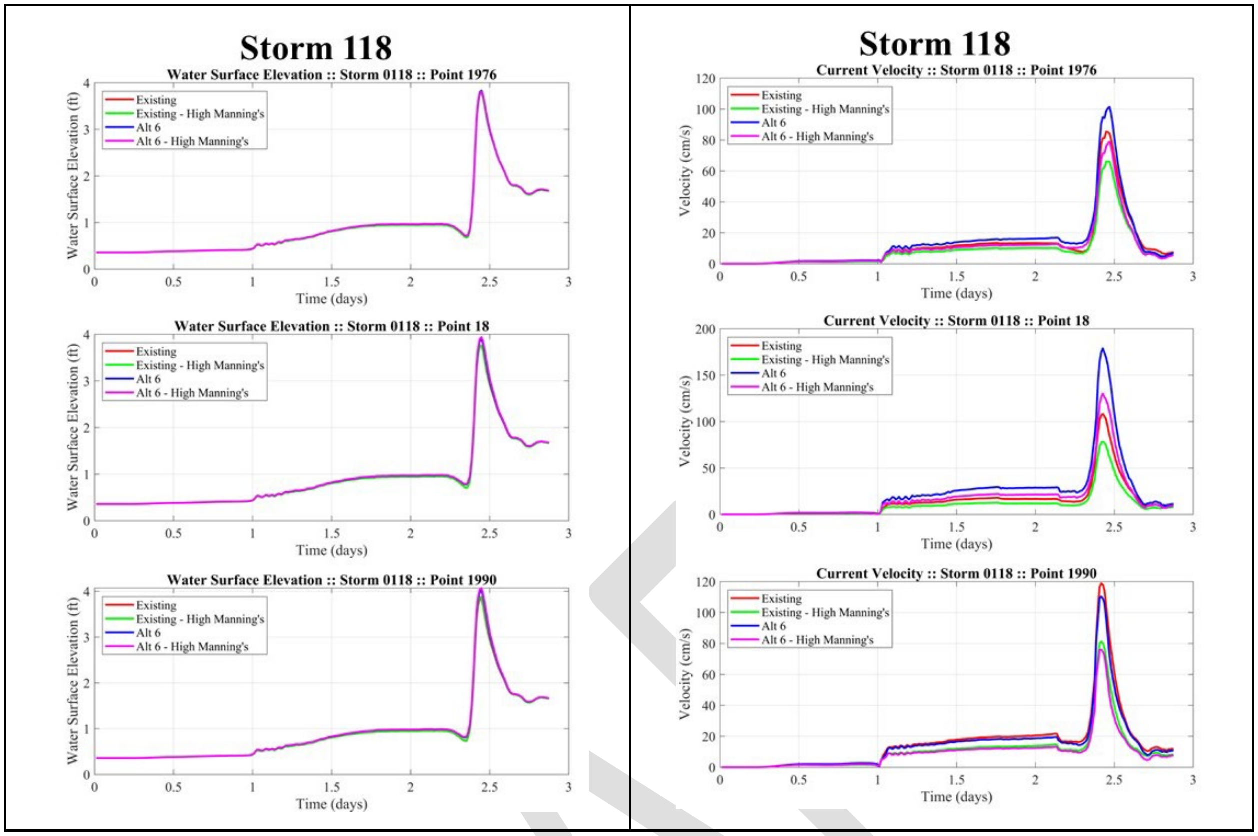


Figure 49 Time series for water surface elevation (left column) and velocity (right column) for storm 118 at save points 1976, 18, and 1990 for existing conditions and Alt. 6 with both unchanged and increased Manning’s n.

In order to determine why several storms with lower recurrence rates saw higher velocity values east of Barren Island than those with higher recurrence rates, time series of the wind speed and pressure at the save points as well as wind direction vector plots were created for the storms. An example of these wind and pressure plots for storm 118 at a single point is shown in Figure 49; similar plots for the three save point locations for all six storms can be found in Appendix XIII. When comparing these plots, it was observed that the storms had similar wind speeds and pressures at these point locations, but that the dominant wind direction differed between storms. This difference in wind direction accounts for the differences in computed water velocities that were observed for the different storms.

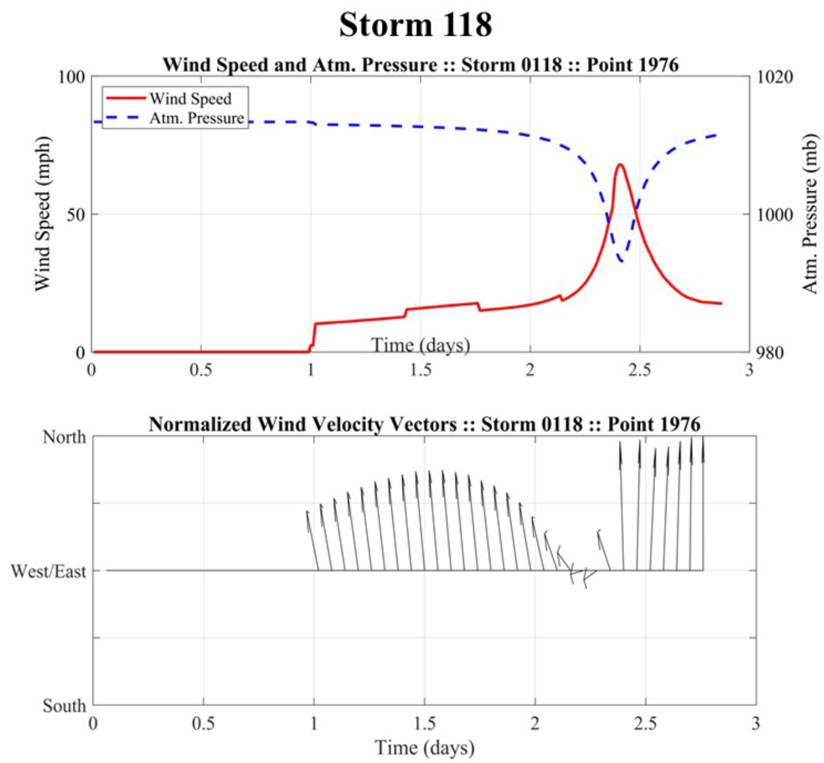


Figure 50 A wind speed and atmospheric pressure time series plot (top) and a normalized wind direction vector plot (bottom) for storm 118 at save point 1976.

### Coastal Hazard Results – 25 storms for Barren Island

The extremal statistics and confidence limits for waves and water levels were computed using StormSim (Nadal-Caraballo et al. 2015, Melby et al. 2015, Melby et al. 2017) and the joint probability method. The mean storm water level (SWL) and peak significant wave height ($H_{m0}$) annual exceedance probabilities (AEP) characterized a wide range of probabilities. Mean peak wave period ($T_p$) is from the joint probability of $H_{m0}$ and $T_p$. Mean and median are indistinguishable; therefore, only the mean is reported herein. The resulting probabilistic model of storm responses was conditionally joint with the JPM-OS storm parameters. Uncertainty included the standard deviation of epistemic uncertainty as well as the upper 90% confidence levels (CL).

The storm responses were computed using the CSTORM model and provided to the district for the 25-storm set. The hazards for Midbay save point 984 (corresponding to NACCS save point 15100, shown in Figure 51) are provided herein. The SLC0 condition was run in CSTORM. The SLC1 SWL hazards were calculated by linearly adding 1.5 ft to all the storm SWLs. The extratropical cyclone SWL hazard was computed from NACCS data at save point 15100 and combined with the tropical SWL hazard curves using methods from Nadal-Caraballo et al. (2015). The hazards for save point 984 are in Table 8 for SLC0 SWL, Table 9 for SLC0 $H_{m0}$, Table 10 for SLC0 $T_p$, and Table 11 for SLC1 SWL.


Figure 51. Location of NACCS save points near Barren Island.

Table 8. SWL in ft, MSL, for SLC0 from 25 storms for a range of ARIs for Midbay save point 984.

| | | Annual Recurrence Interval (ARI) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CL** | **1** | **2** | **5** | **10** | **20** | **50** | **100** | **200** | **500** | **1000** | **2000** | **5000** | **10000** |
| **Base Conditions** | **50%** | 1.6 | 2.2 | 2.9 | 3.3 | 3.6 | 4.0 | 4.3 | 4.7 | 5.5 | 6.0 | 6.5 | 6.9 | 7.2 |
| | **90%** | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 4.9 | 5.2 | 5.5 | 6.5 | 7.1 | 7.6 | 8.1 | 8.4 |
| **Alt 1** | **50%** | 1.6 | 2.2 | 2.9 | 3.3 | 3.6 | 4.0 | 4.3 | 4.7 | 5.5 | 6.1 | 6.5 | 6.9 | 7.2 |
| | **90%** | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 4.9 | 5.2 | 5.5 | 6.5 | 7.1 | 7.6 | 8.1 | 8.5 |
| **Alt 2** | **50%** | 1.6 | 2.2 | 2.9 | 3.3 | 3.7 | 4.0 | 4.3 | 4.8 | 5.5 | 6.1 | 6.5 | 6.9 | 7.2 |
| | **90%** | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 5.0 | 5.2 | 5.6 | 6.5 | 7.1 | 7.6 | 8.1 | 8.4 |
| **Alt 3** | **50%** | 1.6 | 2.2 | 2.9 | 3.3 | 3.6 | 4.0 | 4.3 | 4.7 | 5.5 | 6.1 | 6.5 | 6.9 | 7.2 |
| | **90%** | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 5.0 | 5.2 | 5.6 | 6.5 | 7.1 | 7.6 | 8.1 | 8.5 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alt 4 | 50% | 1.6 | 2.2 | 2.9 | 3.3 | 3.6 | 4.0 | 4.3 | 4.7 | 5.5 | 6.1 | 6.5 | 6.9 | 7.2 |
| | 90% | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 5.0 | 5.2 | 5.6 | 6.5 | 7.1 | 7.6 | 8.1 | 8.4 |
| Alt 5 | 50% | 1.6 | 2.2 | 2.9 | 3.3 | 3.6 | 4.0 | 4.3 | 4.7 | 5.5 | 6.1 | 6.5 | 6.9 | 7.2 |
| | 90% | 2.5 | 3.1 | 3.9 | 4.3 | 4.6 | 5.0 | 5.2 | 5.6 | 6.5 | 7.1 | 7.6 | 8.1 | 8.4 |

Table 9. $H_{m0}$ in ft, for SLC0 from 25 storms for a range of ARIs for Midbay save point 984.

| | | Annual Recurrence Interval (ARI) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL | 1 | 2 | 5 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | 5000 | 10000 |
| Base Conditions | 50% | NaN | 2.1 | 2.9 | 3.3 | 3.7 | 4.4 | 5.1 | 5.6 | 6.1 | 6.3 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.5 | 3.4 | 3.9 | 4.3 | 5.1 | 6.0 | 6.5 | 7.1 | 7.4 | 7.7 | 8.0 | 8.3 |
| Alt 1 | 50% | NaN | 1.9 | 2.9 | 3.3 | 3.7 | 4.4 | 5.1 | 5.6 | 6.1 | 6.4 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.2 | 3.4 | 3.9 | 4.3 | 5.1 | 6.0 | 6.6 | 7.1 | 7.4 | 7.7 | 8.1 | 8.3 |
| Alt 2 | 50% | NaN | 2.1 | 2.9 | 3.3 | 3.7 | 4.4 | 5.1 | 5.6 | 6.1 | 6.4 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.5 | 3.4 | 3.9 | 4.3 | 5.1 | 6.0 | 6.5 | 7.1 | 7.4 | 7.7 | 8.0 | 8.3 |
| Alt 3 | 50% | NaN | 2.1 | 2.9 | 3.3 | 3.7 | 4.3 | 5.1 | 5.6 | 6.1 | 6.3 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.5 | 3.4 | 3.9 | 4.3 | 5.1 | 5.9 | 6.5 | 7.1 | 7.4 | 7.7 | 8.0 | 8.3 |
| Alt 4 | 50% | NaN | 2.1 | 2.9 | 3.3 | 3.7 | 4.4 | 5.1 | 5.6 | 6.1 | 6.4 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.5 | 3.4 | 3.9 | 4.3 | 5.1 | 6.0 | 6.5 | 7.1 | 7.4 | 7.7 | 8.0 | 8.3 |
| Alt 5 | 50% | NaN | 2.1 | 2.9 | 3.3 | 3.7 | 4.4 | 5.1 | 5.6 | 6.1 | 6.4 | 6.6 | 6.9 | 7.1 |
| | 90% | NaN | 2.5 | 3.4 | 3.9 | 4.3 | 5.1 | 6.0 | 6.6 | 7.1 | 7.4 | 7.7 | 8.0 | 8.3 |

Table 10. *Tp* in s, for SLC0 from 25 storms for a range of ARIs for Midbay save point 984.

| | Annual Recurrence Interval (ARI) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | 5000 | 10000 |
| Base Conditions | 3.4 | 3.4 | 4.4 | 4.9 | 5.7 | 6.1 | 6.1 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| Alt 1 | 3.4 | 3.4 | 4.4 | 4.6 | 5.7 | 6.1 | 6.1 | 6.3 | NaN | NaN | NaN | NaN | NaN |
| Alt 2 | 4.0 | 4.0 | 4.5 | 5.5 | 5.9 | 6.1 | 6.1 | 6.3 | NaN | NaN | NaN | NaN | NaN |
| Alt 3 | 3.9 | 3.9 | 4.4 | 5.5 | 5.9 | 6.1 | 6.1 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| Alt 4 | 3.4 | 3.4 | 4.9 | 5.5 | 5.9 | 6.1 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| Alt 5 | 3.9 | 3.9 | 4.5 | 5.5 | 5.9 | 6.1 | 6.1 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |

Table 11. SWL in ft, MSL, for SLC1 from 25 storms for a range of ARIs for Midbay save point 984.

| | | Annual Recurrence Interval (ARI) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CL | 1 | 2 | 5 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | 5000 | 10000 |
| Base Conditions | 50% | 3.1 | 3.7 | 4.4 | 4.8 | 5.1 | 5.5 | 5.9 | 6.4 | 7.2 | 7.7 | 8.2 | 8.8 | 9.1 |
| | 90% | 4.0 | 4.7 | 5.4 | 5.8 | 6.1 | 6.5 | 6.9 | 7.5 | 8.4 | 9.1 | 9.6 | 10.3 | 10.6 |
| Alt 1 | 50% | 3.1 | 3.7 | 4.4 | 4.8 | 5.1 | 5.5 | 5.9 | 6.5 | 7.2 | 7.8 | 8.3 | 8.8 | 9.2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **90%** | 4.0 | 4.7 | 5.4 | 5.8 | 6.2 | 6.6 | 6.9 | 7.6 | 8.4 | 9.1 | 9.7 | 10.3 | 10.7 |
| | **50%** | 3.1 | 3.7 | 4.4 | 4.8 | 5.2 | 5.6 | 6.0 | 6.5 | 7.2 | 7.8 | 8.2 | 8.8 | 9.1 |
| **Alt 2** | **90%** | 4.0 | 4.7 | 5.4 | 5.8 | 6.2 | 6.6 | 7.0 | 7.6 | 8.4 | 9.1 | 9.6 | 10.3 | 10.7 |
| | **50%** | 3.1 | 3.7 | 4.4 | 4.8 | 5.1 | 5.6 | 6.0 | 6.5 | 7.2 | 7.8 | 8.3 | 8.8 | 9.2 |
| **Alt 3** | **90%** | 4.0 | 4.7 | 5.4 | 5.8 | 6.2 | 6.6 | 7.0 | 7.6 | 8.4 | 9.1 | 9.7 | 10.3 | 10.7 |
| | **50%** | 3.1 | 3.7 | 4.4 | 4.8 | 5.1 | 5.6 | 6.0 | 6.5 | 7.2 | 7.8 | 8.3 | 8.8 | 9.2 |
| **Alt 4** | **90%** | 4.0 | 4.7 | 5.4 | 5.8 | 6.2 | 6.6 | 7.0 | 7.6 | 8.4 | 9.1 | 9.6 | 10.3 | 10.7 |
| | **50%** | 3.1 | 3.7 | 4.4 | 4.8 | 5.1 | 5.6 | 6.0 | 6.5 | 7.2 | 7.8 | 8.2 | 8.8 | 9.2 |
| **Alt 5** | **90%** | 4.0 | 4.7 | 5.4 | 5.8 | 6.2 | 6.6 | 7.0 | 7.6 | 8.4 | 9.1 | 9.6 | 10.3 | 10.7 |

## CMS-Wave Modeling Results

CMS-Wave was used to simulate a total of 480 wave and water level forcing conditions for the reduced domain. These include: 6 wave height x 4 wave period x 4 wave directions x 5 water levels. Table 12 presents the incident wave and water level forcing conditions for model wave diffraction.

Figure 52 shows the example of model diffraction wave height contours for a small incident wave of 0.5 ft (0.15 m), 1.5 sec, with water level forcing of 0.5 ft (0.15 m), from (i) 230 degree and (ii) 290 deg. Figure 53 shows the example of wave height contours for a large incident wave of 9.5 ft (2.9 m), 9.0 sec, with water level forcing of 7.5 ft (2.3 m), from (i) 230 degree and (ii) 290 deg.

For small incident wave with small water level increase (Figure 52), wave diffraction pattern and magnitude are similar for incident wave from 230 degree (approximately SW or normal to shore) and 290 degree (approximately WNW). For large incident wave with longer wave period and high water level forcing (Figure 53), wave diffraction pattern and magnitude can become more complicated as wave overtopping and transmission may occur at the same time.

Table 12 Incident waves and water level forcing conditions for model wave diffraction.

| Wave height, ft (m) | Wave period, sec. | Wave direction, degrees | Water level, ft (m) |
|---|---|---|---|
| 0.5 (0.15) | 1.5 | 200 | 0.5 (0.15) |
| 1.5 (0.45) | 3.0 | 230 | 2.5 (0.75) |
| 3.5 (1.10) | 6.0 | 260 | 4.5 (1.35) |
| 5.5 (1.70) | 9.0 | 290 | 6.5 (2.00) |
| 7.5 (2.30) | | | 7.5 (2.30) |
| 9.5 (2.90) | | | |

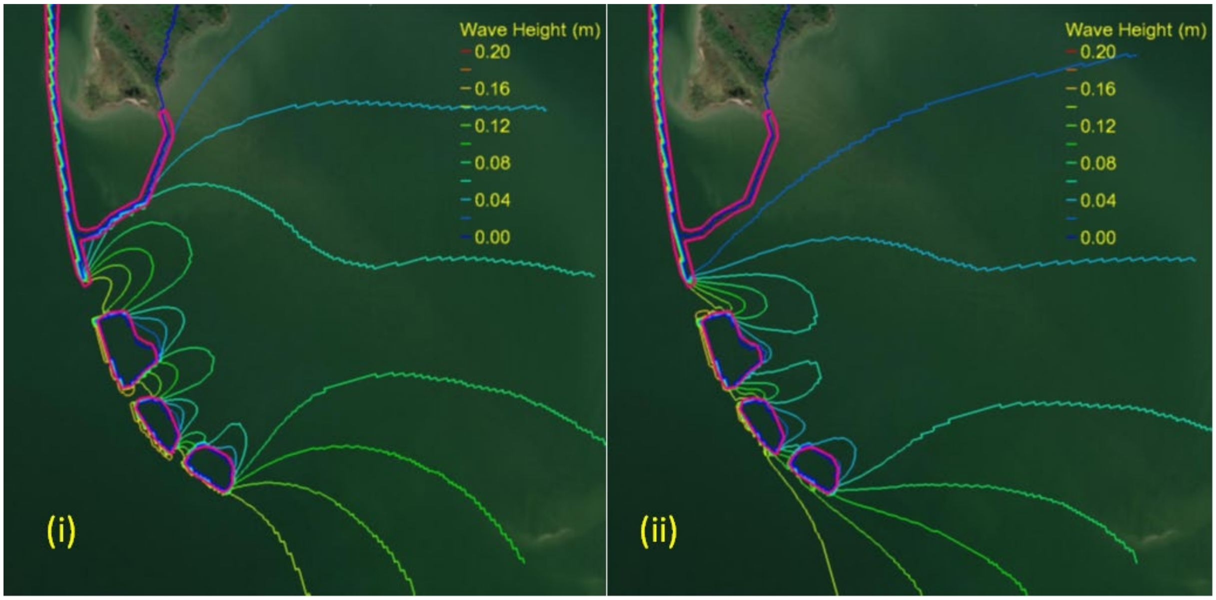


Figure 52 CMS-Wave examples in the reduced small domain for incident wave of 0.15 m, 1.5 sec, with 0.15-m water level forcing, from (i) 230 deg and (ii) 290 deg.

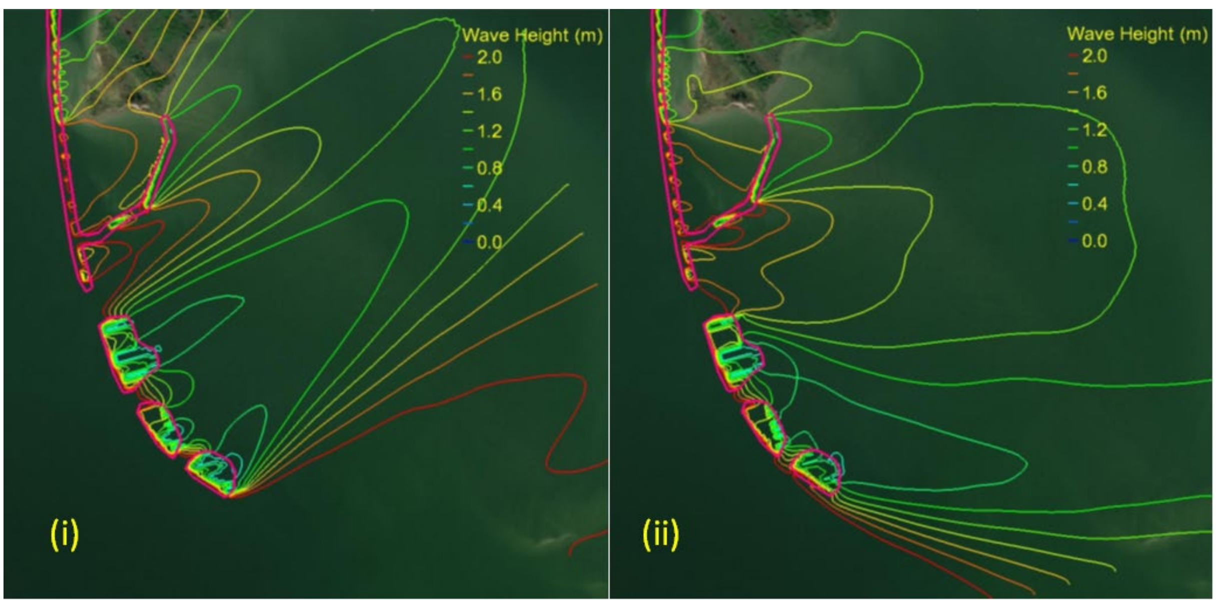


Figure 53 CMS-Wave examples in the reduced small domain for incident wave of 2.9 m, 9 sec, with 2.3-m water level forcing, from (i) 230 deg. and (ii) 290 deg.

Model diffraction results can be displayed by diffraction coefficient contours where diffraction coefficient is defined as the wave height in the diffraction zone divided (normalized) by the incident wave height. Figure 54 shows the example of model diffraction coefficient contours for (i) small incident wave of 1 m, 4 sec, from shore normal, and (ii) large incident wave of 2.9 m, 9 sec, from shore normal, with small water level forcing of 0.5 m. The diffraction coefficient contours from small and large incident waves from the same direction are similar with zero or small water level forcing regardless of different wave periods associated with incident waves. Figure 54 indicates some 40 percent of incident wave height can be diffracted and transmitted through gaps into the lee of proposed islands and structure. Waves were transmitted further into the leeside of the structure at the larger gap than the smaller gaps. Northern-propagating waves were not considered but may be substantial under certain storm conditions. Additionally, locally generated wind-waves may occur within the protected area and may be estimated using STWAVE results.

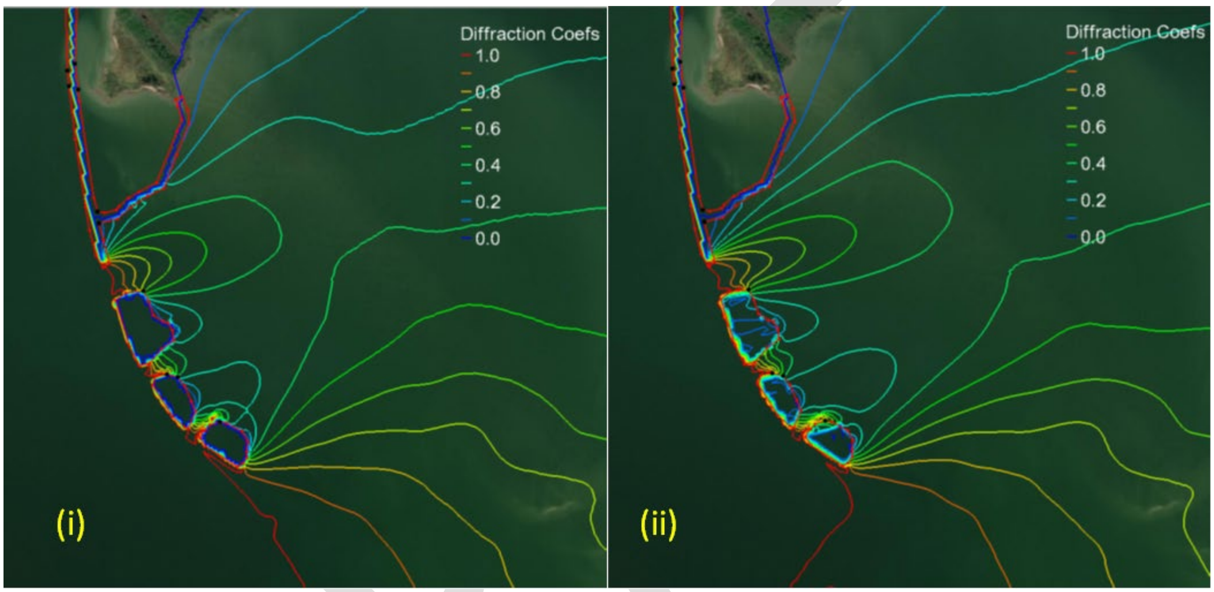


Figure 54 Wave diffraction coefficient contours for (i) incident wave of 1 m, 4 sec, from shore normal, with 0 water level forcing and (ii) incident wave of 2.9 m, 9 sec, from shore normal, with 0.5-m water level forcing.

Two breakwaters offset from Alternative 6 alignment were considered and shown in Figure 55. The image represents a possible location for breakwaters, but is not a final design. These breakwaters were considered to reduce wave propagation through the channel between main breakwater segments in order to reduce vulnerability to the bird islands and to SAV. Alternate locations of the offset breakwaters were considered to minimize vulnerability. The need for one or the other or both breakwaters was considered. Low crested structures are highly vulnerable because the wave loads at higher water levels can dislodge crest armor resulting in a breach. The breakwater seaward of Alternative 6 alignment is more vulnerable to wave attack than the leeward breakwater. Displaced stones from the seaward structure could end up in the gap in the main alignment, so the structure would need to be robust to reduce the possibility of stone movement. Additionally, the seaward breakwater would promote sedimentation on its protected side, which would accumulate in the channel and reduce flow. The leeward breakwater is less vulnerable to wave attacks and would likely require smaller armor stone sizes. Exposed sections of the bird-habitat island containment structure can be protected by constructing them as an extension of the breakwater alignments.

Figure 55. A schematic of the proposed southern portion of Barren Island breakwater, where Barren Island is at the top of the image and north is up. Alternative 6 breakwater alignment is green and the bird island containment structure is yellow. A proposed set of offset breakwaters are in pink. The blue arrow shows the angle of potential wave inundation for this particular configuration.

## Discussion and Conclusions

Overall, water surface elevation values did not significantly differ between the with-project and without project conditions for the 25-storm scenarios in the region around Barren Island. No induced flooding in nearby areas was observed. The water level modeling was able to provide the required information for stone sizing determinations and structure height calculations.

The CSTORM modeling was also used to examine possible changes to water velocity for the project locations. Of interest was the water velocities in Tar Bay and vicinities where SAV is located and is susceptible to damage when currents reach or exceed 180 cm/sec. Velocity typically increased along the Bay (or western) side of the sills and breakwaters as they diverted water along the structures rather than allowing it to flow over. Velocities on the island and designated wetland areas enclosed by the structures saw significant decreases for the with-project cases. This indicates that overall, these project features were working as expected to reduce flooding on Barren Island during the various storm events. However, there were locations where the water velocity results increased for the with-project alternatives. This typically occurred at the endpoints of sill and breakwater structures, as well as in the gaps between breakwaters and island features. This represents typical hydrodynamic behavior, and generally, the areas of velocity increase were limited in scope. Larger velocity increases were seen for many storms at the northeast endpoint of the sill surrounding Barren Island, and concerns were raised because these increases were found in areas where SAV occur. Additional analysis was performed to determine if better parameterization of the SAV in the CSTORM models would alter the results being computed. That additional analysis was performed for two storms under without-project conditions and for Alternative 6. Since the presence of submerged vegetation was not being accounted for in the initial model simulations, the Manning's n values were increased in Tar Bay region to represent more appropriately the increase in friction that would normally be induced by the presence of SAV. Analysis of velocity values at save points located in the region covered by SAV showed that increasing the Manning's n values in Tar Bay typically resulted in a 20-30% decrease in peak velocity results for both without-project and with-project conditions. In fact, the majority of the peak velocities were reduced to the extent that the new peaks were near or close to the 100 cm/s acceptable velocity threshold. These results indicate that actual water velocities in the region during storm events are likely to be less than the values produced by the initial modeling results due to the damping effects of the SAV.

It is noted that particular emphasis was placed on the Alt. 6 modeling and analysis later in the study. This is because surveys conducted by NAB after modeling had begun on the other project scenarios (Alts. 1-5) indicated that the foundation strength of the aquatic bed would likely not be capable of supporting the proposed structural features if they were installed in the area southeast of Barren Island. The Alt. 6 design was developed with this information in mind, and it is thus reasonable to assume that this configuration bears the closest resemblance to the final design that may be implemented for this project.

Results from the Alt. 6 simulations also raised concerns about the magnitude of the peak velocity values of certain storms with respect to those of other, seemingly less severe storms modeled in this region. Analysis of wind speed and surface level atmospheric pressure time series for six storms at three save points immediately east of Barren Island showed that the storms in question had reasonably comparable wind speeds and minimum pressures. However, the plots of normalized wind direction vectors showed that several of these storms had different wind directions at the storm's peak. Thus with different directions of winds, the water velocity results would also change due to that directionality and in combination with the local geometry of the area. It is also noted, that the 25-storm suite was selected based on still water levels and not representative of velocity AEPs. Thus, the peak velocity results that were generated by the model were judged to be reasonable when accounting for the disparate dominant wind directions seen for the different storms.

Spatial difference plots and time series figures showing comparisons of significant wave height values between the with-project and without-project cases reveal that significant wave heights around Barren Island tended to decrease for the with-project scenarios. Wave height decreases were particularly pronounced at locations east of the structures, the leeward side, and for many scenarios were over 1 ft. in magnitude. Decreases in significant wave height west of Barren Island, while perceptible, were generally smaller and without exception had magnitudes less than 0.5 ft. The results shows that the barrier and island features were typically quite effective at dispersing wave energy and damping wave height.

The color contour spatial plots of maximum significant wave height for a few storms show that, particularly for Alt. 4, the wave energy is able to propagate through the environmental gaps left between structural and island features. For this reason, wave diffraction analysis was conducted to determine appropriate gap sizing between the breakwater and northernmost island features proposed for Alt. 6. That diffraction analysis will be used to refine the gap distance between the structures and for possible inclusion of offset breakwaters in the final design of the with-project alternative.

Once the final project design is known, all 100 selected storms will be simulated using CSTORM and the resulting AEPs for water levels and wave heights will be recomputed.

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## Appendix I: Synthetic Tropical Cyclones

The JPM-OS methodology is described in the main report. In this approach, historical tropical storms from 1938 to 2013 were extracted from the HURDAT2 database. These storms are tropical cyclones and well parameterized by track track (heading θ, landfall location), intensity (minimum central pressure, $P$), size (radius to maximum winds, $R_{max}$) and forward speed ($V_r$). Central pressure is further defined according to the deficit from far-field atmospheric pressure, $\Delta P$ = 1013 mb - $P_{min}$. Historical tropical cyclones within the NACCS storm suite are found in Nadal-Caraballo et al. (2015). A joint probability model of the tropical storm parameters was constructed and discretized to develop a suite of synthetic tropical storms that defines the entire hazard from low-intensity frequent storms to high-intensity very infrequent storms. The upper limit of the storms extends beyond all historical events but only to reasonable extremes. The final storm list of 1050 storms with track landfalls extending over the Virginia to Maine Atlantic coast is provided in Nadal-Caraballo et al. (2015). Table A13 provides a reduced list of 100 Midbay storms that are a subset of the 1050 storms, and were determined to be optimal for SWL hazard for the region spanning James and Barren Islands. Similarly, Table AI-2 provides a reduced list of 25 storms for Barren Island.

Table A13. List of 100 storms for Midbay with associated tropical cyclone parameters.

| Storm # | NACCS Region | Track # | θ (deg) | ΔP (hPa) | Rmax (km) | Vf (km/h) |
|---|---|---|---|---|---|---|
| 15 | 3 | 3 | -60 | 88 | 104.8 | 24 |
| 26 | 3 | 4 | -60 | 48 | 28.2 | 34.5 |
| 28 | 3 | 4 | -60 | 28 | 75.1 | 37.9 |
| 30 | 3 | 5 | -60 | 78 | 35 | 26.1 |
| 31 | 3 | 5 | -60 | 68 | 62.4 | 12 |
| 32 | 3 | 5 | -60 | 58 | 109.3 | 25 |
| 42 | 3 | 6 | -60 | 28 | 61.3 | 46 |
| 43 | 3 | 7 | -60 | 88 | 49.7 | 37.4 |
| 55 | 3 | 8 | -60 | 38 | 25.2 | 18.6 |
| 57 | 3 | 25 | -40 | 88 | 52.6 | 20.2 |
| 58 | 3 | 25 | -40 | 78 | 104.7 | 21.4 |
| 61 | 3 | 25 | -40 | 48 | 50.9 | 40.3 |
| 68 | 3 | 26 | -40 | 48 | 79.7 | 13.5 |
| 69 | 3 | 26 | -40 | 38 | 62.6 | 47.5 |
| 70 | 3 | 26 | -40 | 28 | 50.4 | 22.8 |
| 74 | 3 | 27 | -40 | 58 | 51.6 | 16.9 |
| 83 | 3 | 28 | -40 | 38 | 62.1 | 37.8 |
| 102 | 3 | 31 | -40 | 58 | 44.3 | 17.1 |
| 109 | 3 | 50 | -20 | 68 | 112.8 | 32 |
| 114 | 3 | 51 | -20 | 88 | 117.1 | 28.8 |
| 115 | 3 | 51 | -20 | 78 | 68.4 | 42.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 117 | 3 | 51 | -20 | 58 | 72 | 12.4 |
| 118 | 3 | 51 | -20 | 48 | 32.6 | 41.4 |
| 119 | 3 | 51 | -20 | 38 | 30.5 | 12 |
| 121 | 3 | 52 | -20 | 88 | 38.2 | 22.2 |
| 123 | 3 | 52 | -20 | 68 | 69.8 | 38.5 |
| 125 | 3 | 52 | -20 | 48 | 43.7 | 42.7 |
| 127 | 3 | 53 | -20 | 98 | 59.3 | 19 |
| 132 | 3 | 53 | -20 | 48 | 75.1 | 21.1 |
| 143 | 3 | 72 | 0 | 78 | 77.2 | 34.8 |
| 145 | 3 | 72 | 0 | 68 | 40.2 | 16.3 |
| 148 | 3 | 72 | 0 | 53 | 55.4 | 21.1 |
| 150 | 3 | 72 | 0 | 43 | 71 | 15.1 |
| 151 | 3 | 72 | 0 | 38 | 59.1 | 38.5 |
| 152 | 3 | 72 | 0 | 33 | 98.5 | 34.8 |
| 154 | 3 | 73 | 0 | 88 | 52.9 | 27.3 |
| 165 | 3 | 73 | 0 | 33 | 49.7 | 12 |
| 173 | 3 | 74 | 0 | 58 | 68.5 | 46.6 |
| 177 | 3 | 74 | 0 | 38 | 67.1 | 25.9 |
| 191 | 3 | 75 | 0 | 33 | 70.7 | 21.4 |
| 192 | 3 | 75 | 0 | 28 | 39.1 | 35.9 |
| 196 | 3 | 107 | 20 | 73 | 71.1 | 49.4 |
| 197 | 3 | 107 | 20 | 68 | 59.6 | 12 |
| 198 | 3 | 107 | 20 | 63 | 55.8 | 12 |
| 199 | 3 | 107 | 20 | 58 | 72.9 | 28.5 |
| 205 | 3 | 107 | 20 | 28 | 58.5 | 34.6 |
| 216 | 3 | 108 | 20 | 38 | 73 | 34.5 |
| 218 | 3 | 108 | 20 | 28 | 55 | 33 |
| 223 | 3 | 109 | 20 | 68 | 135.5 | 21.3 |
| 228 | 3 | 109 | 20 | 43 | 33.7 | 32.6 |
| 231 | 3 | 109 | 20 | 28 | 39.6 | 28.9 |
| 235 | 3 | 110 | 20 | 73 | 55.8 | 44.3 |
| 243 | 3 | 110 | 20 | 33 | 74.5 | 12 |
| 271 | 3 | 125 | 40 | 98 | 76 | 28.1 |
| 272 | 3 | 125 | 40 | 93 | 50.8 | 23 |
| 273 | 3 | 125 | 40 | 88 | 67.8 | 46.2 |
| 276 | 3 | 125 | 40 | 73 | 25.6 | 20 |
| 277 | 3 | 125 | 40 | 68 | 55.2 | 12 |
| 283 | 3 | 125 | 40 | 38 | 47.4 | 26.7 |
| 290 | 3 | 126 | 40 | 68 | 73.8 | 15 |

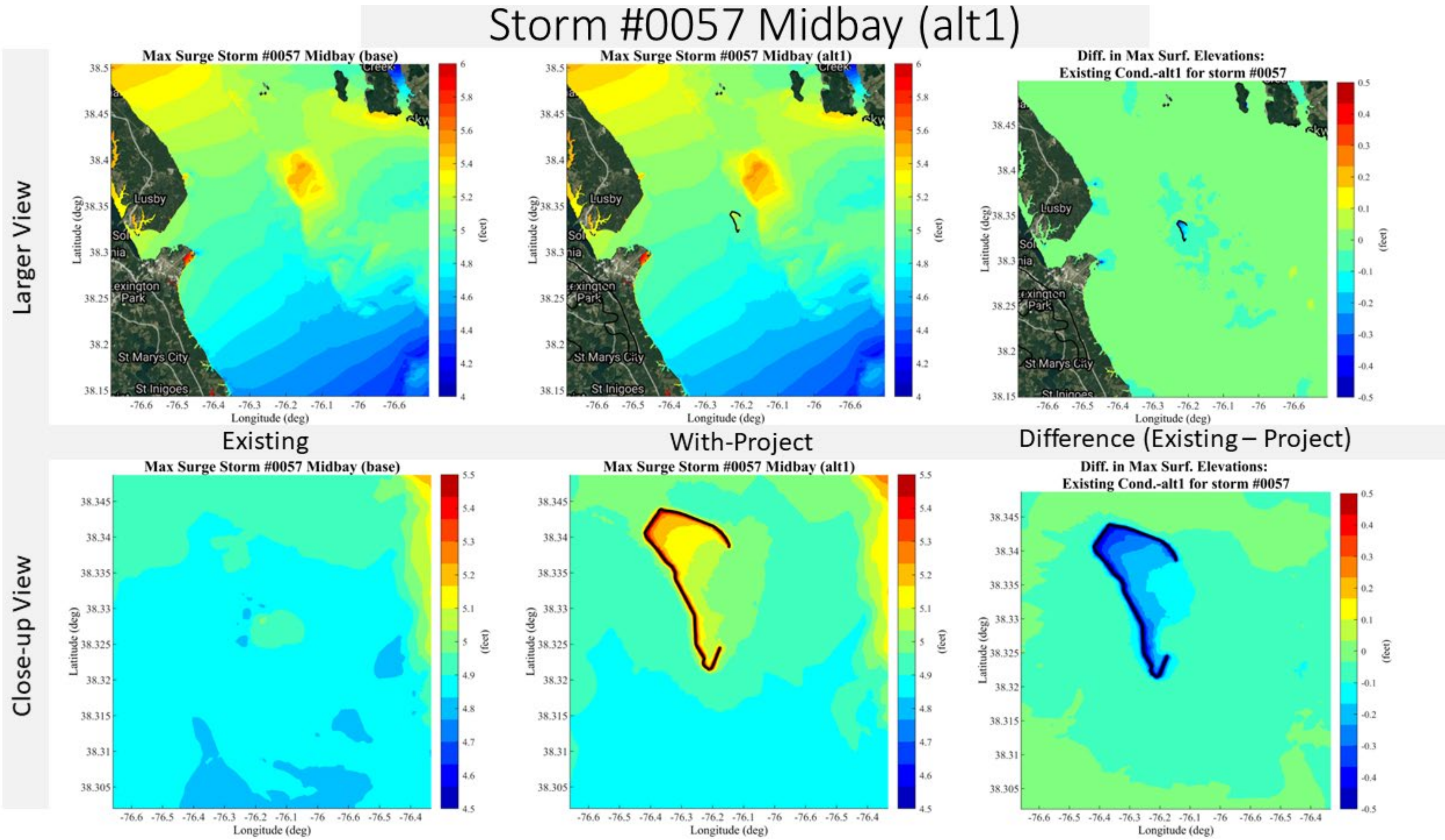
| | | | | | | |
|---|---|---|---|---|---|---|
| 294 | 3 | 126 | 40 | 48 | 41.7 | 59.2 |
| 296 | 3 | 126 | 40 | 38 | 63 | 47.4 |
| 299 | 3 | 127 | 40 | 88 | 55.2 | 37.3 |
| 300 | 3 | 127 | 40 | 83 | 49.6 | 12 |
| 302 | 3 | 127 | 40 | 73 | 29.9 | 27.4 |
| 309 | 3 | 127 | 40 | 38 | 25.8 | 40.1 |
| 354 | 2 | 9 | -60 | 28 | 93.4 | 36.7 |
| 402 | 2 | 33 | -40 | 28 | 77.7 | 50.5 |
| 437 | 2 | 55 | -20 | 48 | 48.2 | 29.3 |
| 442 | 2 | 56 | -20 | 58 | 72.7 | 23.5 |
| 473 | 2 | 76 | 0 | 58 | 61.8 | 50.2 |
| 475 | 2 | 76 | 0 | 48 | 58.4 | 47.2 |
| 478 | 2 | 76 | 0 | 33 | 52.2 | 19.3 |
| 533 | 2 | 98 | 20 | 33 | 59.2 | 57.9 |
| 534 | 2 | 98 | 20 | 28 | 44.8 | 34.7 |
| 538 | 2 | 99 | 20 | 63 | 144.8 | 49.7 |
| 540 | 2 | 99 | 20 | 53 | 69.8 | 16.6 |
| 543 | 2 | 99 | 20 | 38 | 50.2 | 47 |
| 552 | 2 | 100 | 20 | 48 | 59.7 | 59.8 |
| 553 | 2 | 100 | 20 | 43 | 25 | 41 |
| 625 | 2 | 119 | 40 | 78 | 75.8 | 60.5 |
| 628 | 2 | 119 | 40 | 63 | 128.7 | 56 |
| 629 | 2 | 119 | 40 | 58 | 97.7 | 29.4 |
| 630 | 2 | 119 | 40 | 53 | 29.1 | 50.4 |
| 631 | 2 | 119 | 40 | 48 | 45.7 | 14 |
| 632 | 2 | 119 | 40 | 43 | 65.8 | 52.8 |
| 633 | 2 | 119 | 40 | 38 | 51.6 | 33.6 |
| 634 | 2 | 120 | 40 | 88 | 69.4 | 38.9 |
| 638 | 2 | 120 | 40 | 68 | 59.7 | 44.9 |
| 642 | 2 | 120 | 40 | 48 | 53.9 | 40.7 |
| 644 | 2 | 120 | 40 | 38 | 63.9 | 66.9 |
| 647 | 2 | 121 | 40 | 78 | 45.7 | 35.7 |
| 653 | 2 | 121 | 40 | 48 | 84.7 | 49.4 |
| 655 | 2 | 121 | 40 | 38 | 54.1 | 54.1 |
| 927 | 1 | 90 | 20 | 58 | 65.6 | 77.6 |
| 933 | 1 | 90 | 20 | 28 | 59.3 | 59.6 |
| 1003 | 1 | 113 | 40 | 48 | 58.2 | 52.3 |
| 1005 | 1 | 113 | 40 | 38 | 68.9 | 44.7 |
| 1006 | 1 | 114 | 40 | 78 | 116.7 | 64.3 |

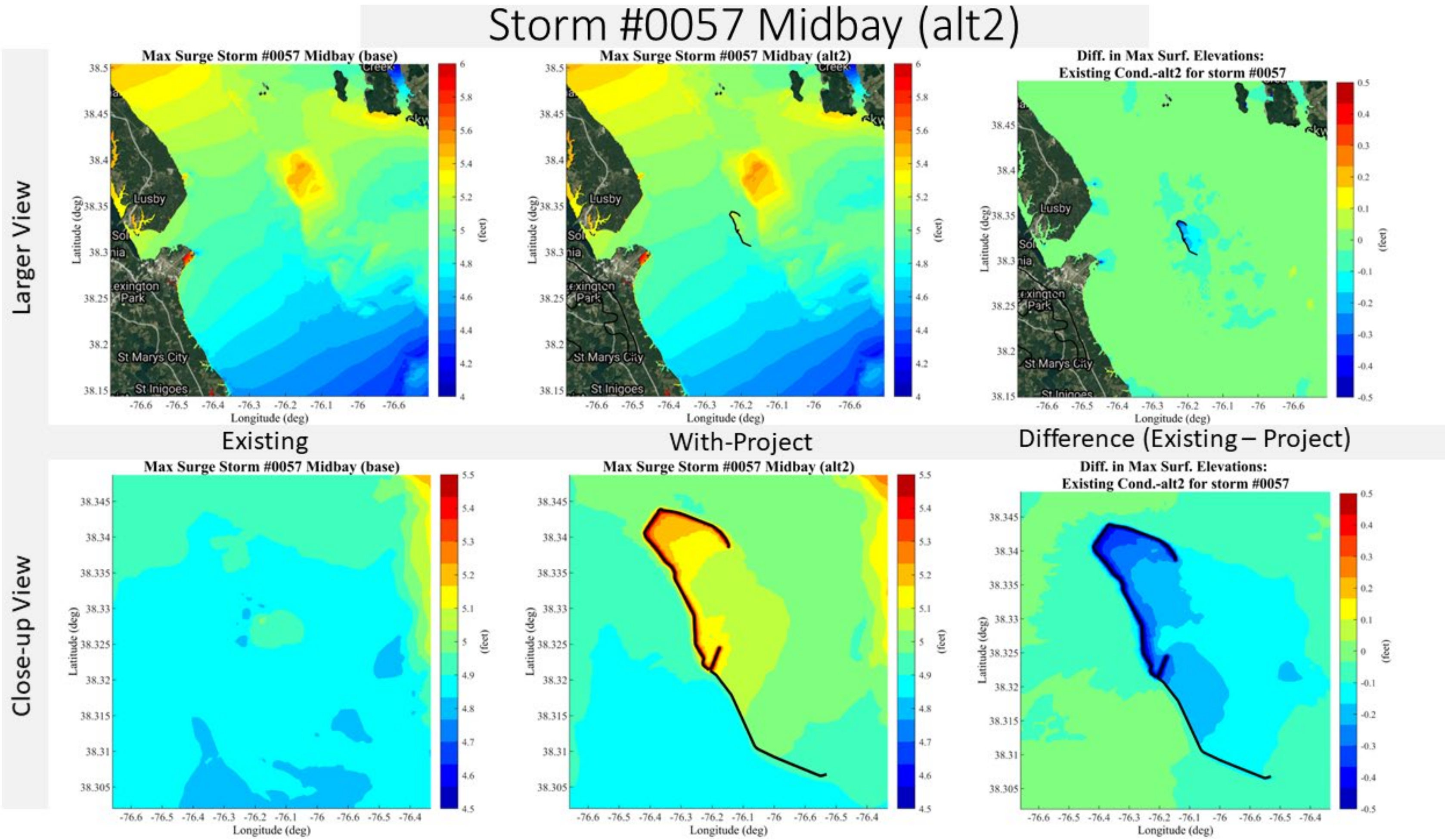
| | | | | | | |
|---|---|---|---|---|---|---|
| 1007 | 1 | 114 | 40 | 73 | 57.8 | 50.6 |
| 235 | 3 | 110 | 20 | 73 | 55.8 | 44.3 |
| 243 | 3 | 110 | 20 | 33 | 74.5 | 12 |

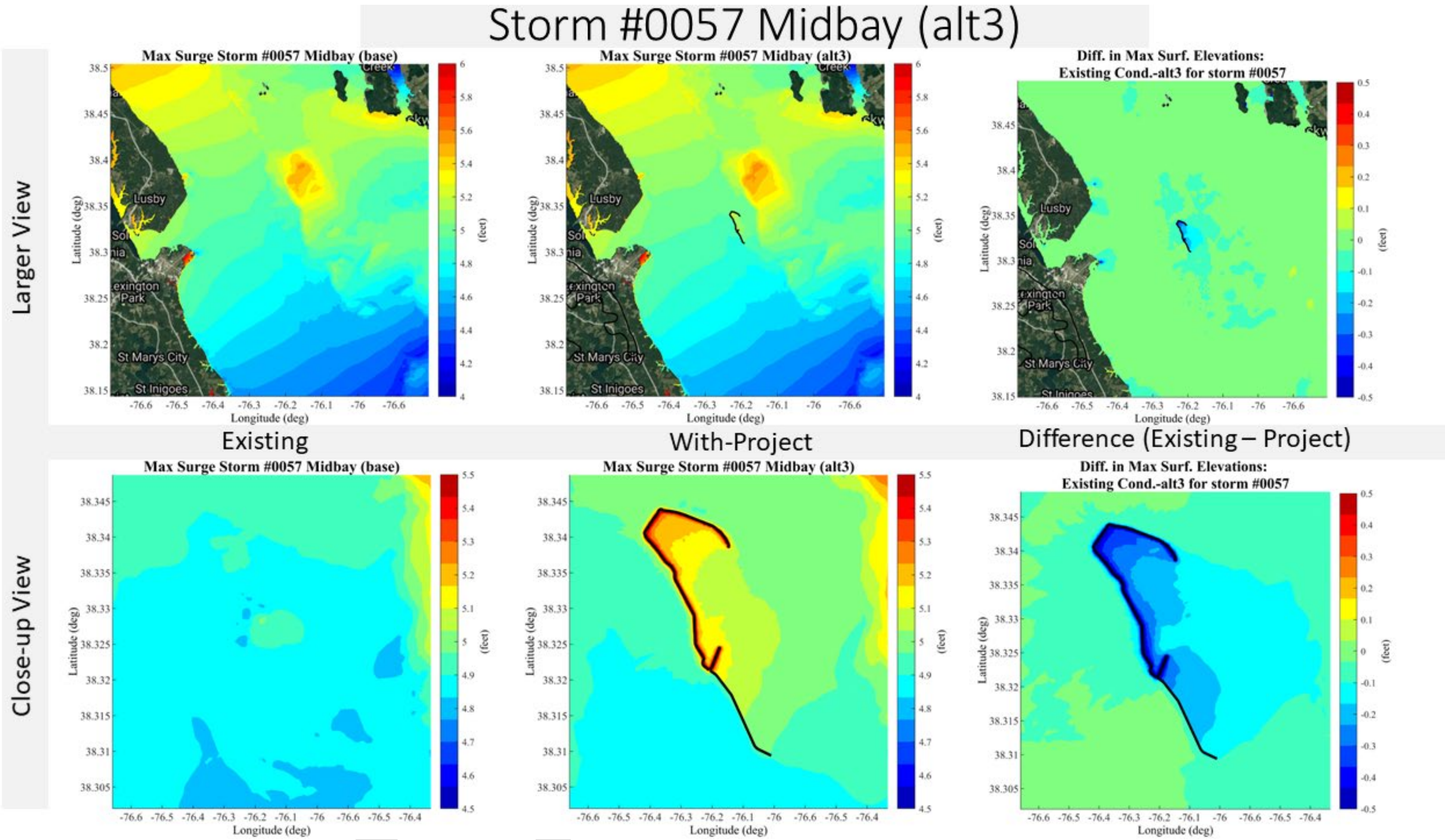
Table AI-2. List of 25 storms for Barren Island with associated tropical cyclone parameters.

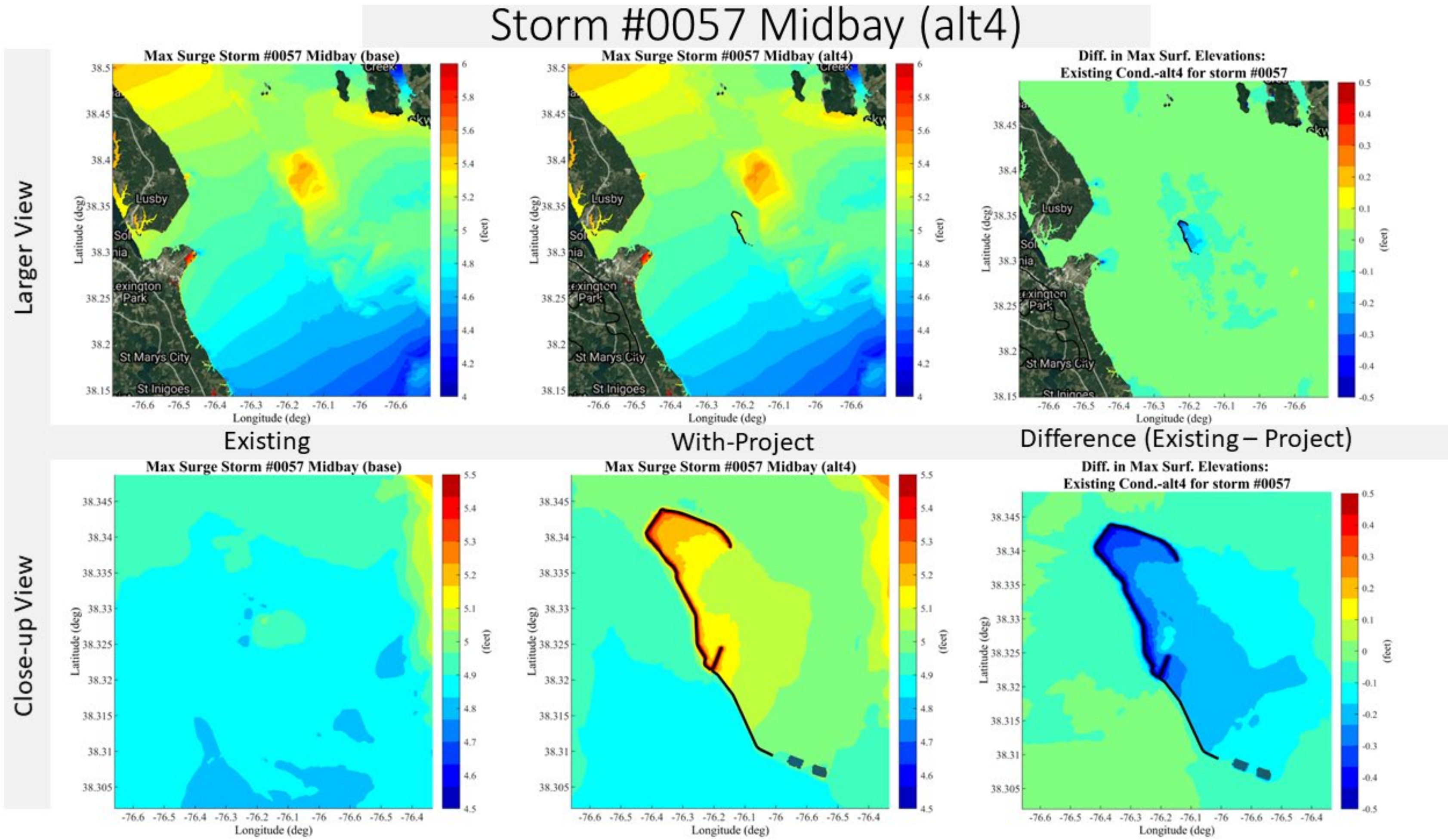
| Storm # | NACCS Region | Track # | θ (deg) | ΔP (hPa) | Rmax (km) | Vf (km/h) |
|---|---|---|---|---|---|---|
| 25 | 3 | 4 | -60 | 58 | 64.9 | 12 |
| 28 | 3 | 4 | -60 | 28 | 75.1 | 37.9 |
| 58 | 3 | 25 | -40 | 78 | 104.7 | 21.4 |
| 65 | 3 | 26 | -40 | 78 | 103.9 | 30.4 |
| 71 | 3 | 27 | -40 | 88 | 43.7 | 24.2 |
| 73 | 3 | 27 | -40 | 68 | 116.7 | 25.4 |
| 86 | 3 | 29 | -40 | 78 | 79 | 22.4 |
| 103 | 3 | 31 | -40 | 48 | 26.9 | 31.5 |
| 110 | 3 | 50 | -20 | 58 | 25 | 23.4 |
| 112 | 3 | 50 | -20 | 38 | 62.3 | 29.9 |
| 139 | 3 | 54 | -20 | 48 | 65.2 | 27.4 |
| 142 | 3 | 72 | 0 | 83 | 52.8 | 12 |
| 144 | 3 | 72 | 0 | 73 | 132.9 | 25.8 |
| 171 | 3 | 74 | 0 | 68 | 40.2 | 15.9 |
| 199 | 3 | 107 | 20 | 58 | 72.9 | 28.5 |
| 231 | 3 | 109 | 20 | 28 | 39.6 | 28.9 |
| 271 | 3 | 125 | 40 | 98 | 76 | 28.1 |
| 274 | 3 | 125 | 40 | 83 | 88.8 | 20.1 |
| 282 | 3 | 125 | 40 | 43 | 79 | 20.7 |
| 320 | 3 | 128 | 40 | 48 | 25 | 15.5 |
| 435 | 2 | 55 | -20 | 68 | 125.8 | 50.3 |
| 438 | 2 | 55 | -20 | 38 | 76.4 | 56.7 |
| 533 | 2 | 98 | 20 | 33 | 59.2 | 57.9 |
| 534 | 2 | 98 | 20 | 28 | 44.8 | 34.7 |
| 638 | 2 | 120 | 40 | 68 | 59.7 | 44.9 |

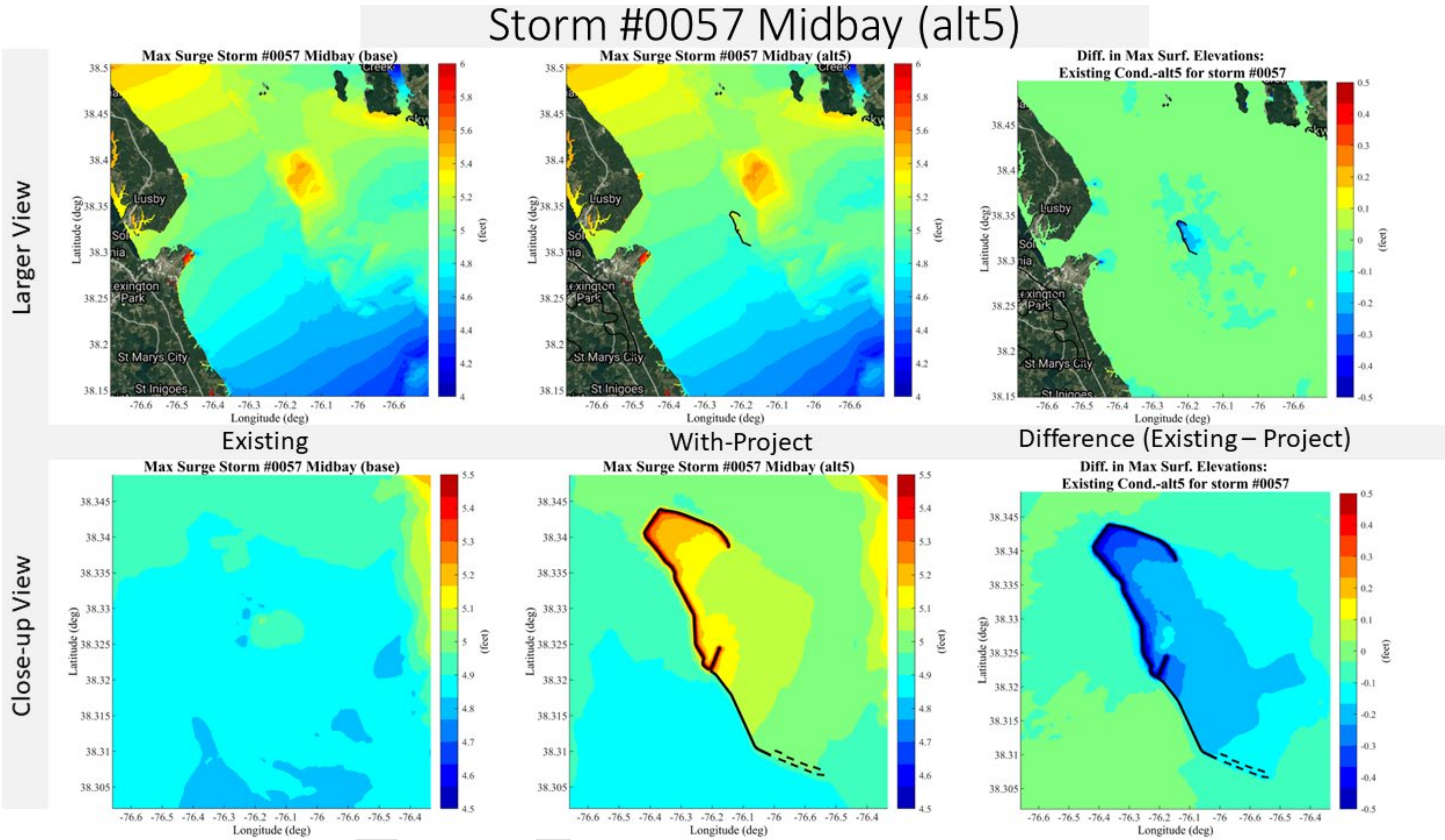
## Appendix II: Maximum Water Level Spatial Difference Contour Plots

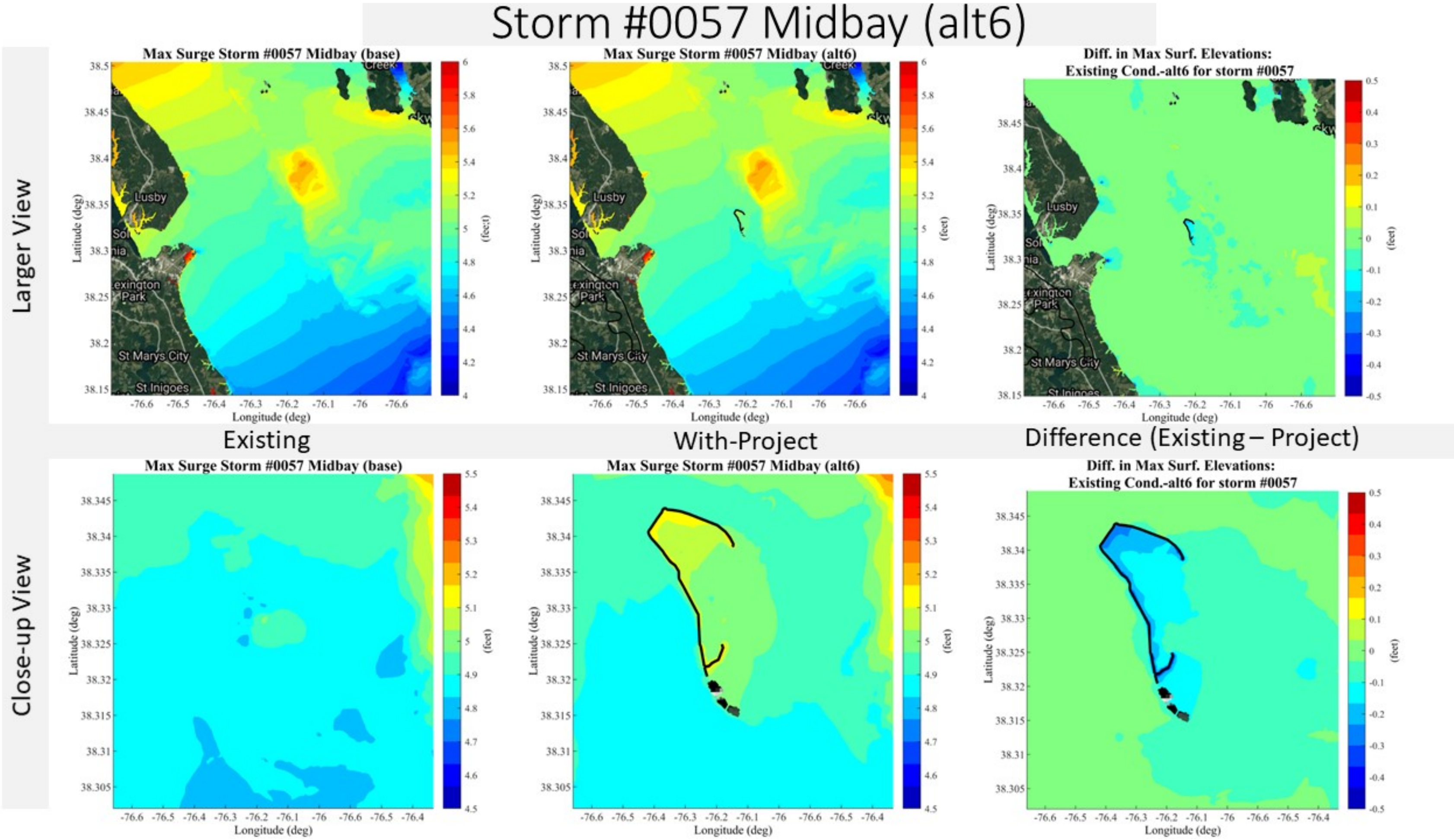


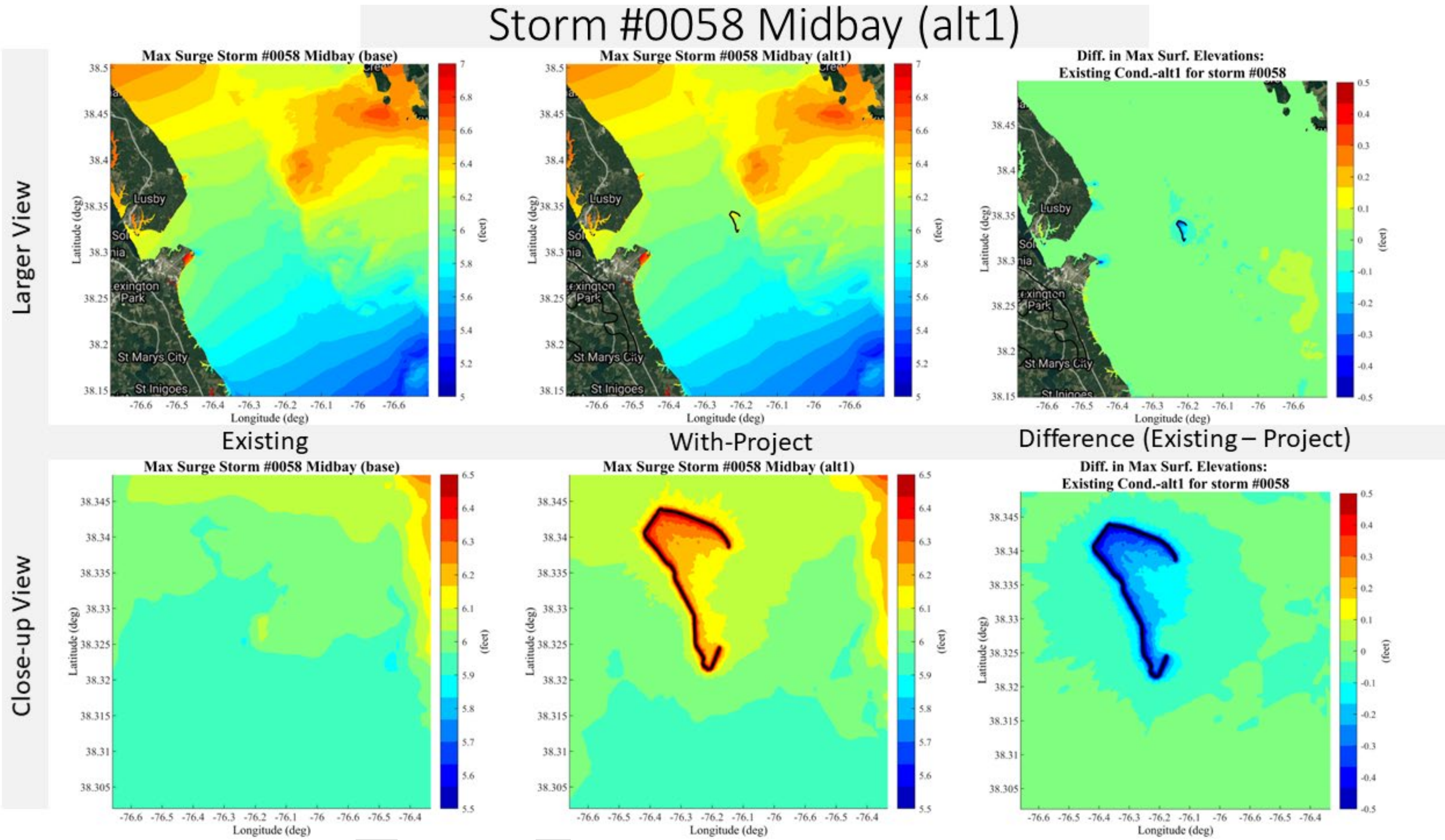

Storm #0057 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0057 Midbay (base)
Max Surge Storm #0057 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0057
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

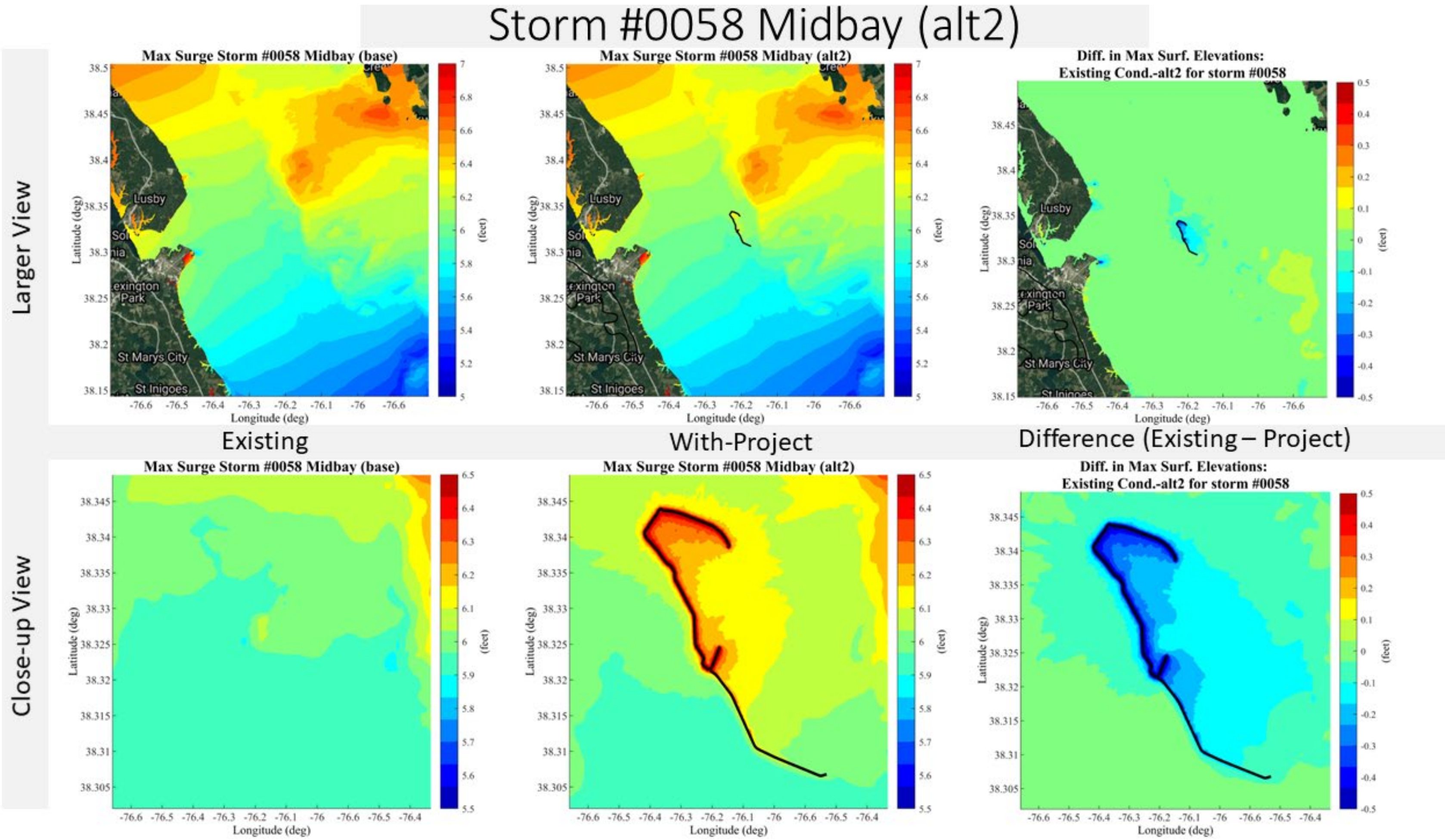

Storm #0057 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0057 Midbay (base)
Max Surge Storm #0057 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0057
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

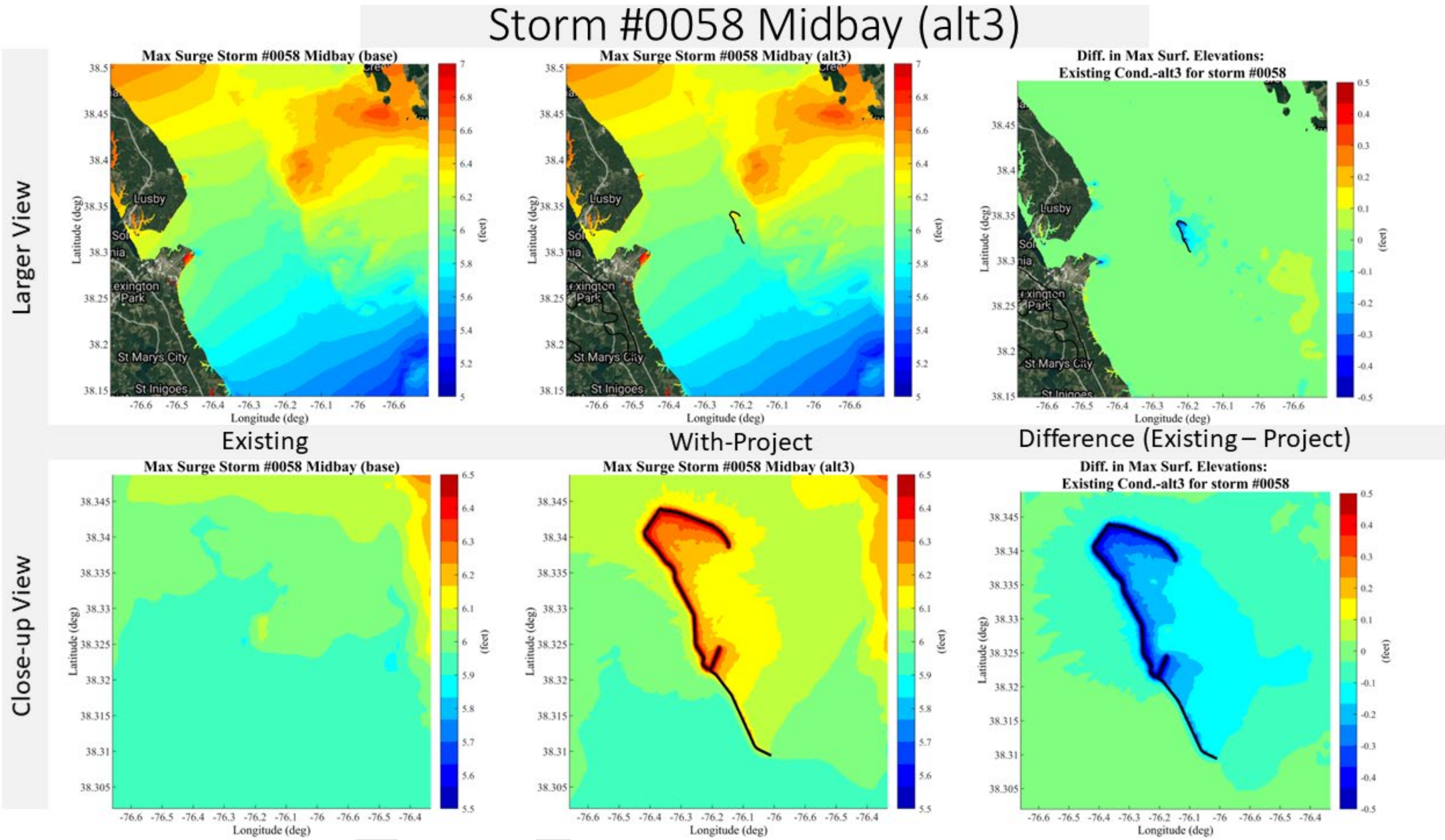

Storm #0057 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0057 Midbay (base)
Max Surge Storm #0057 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0057
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

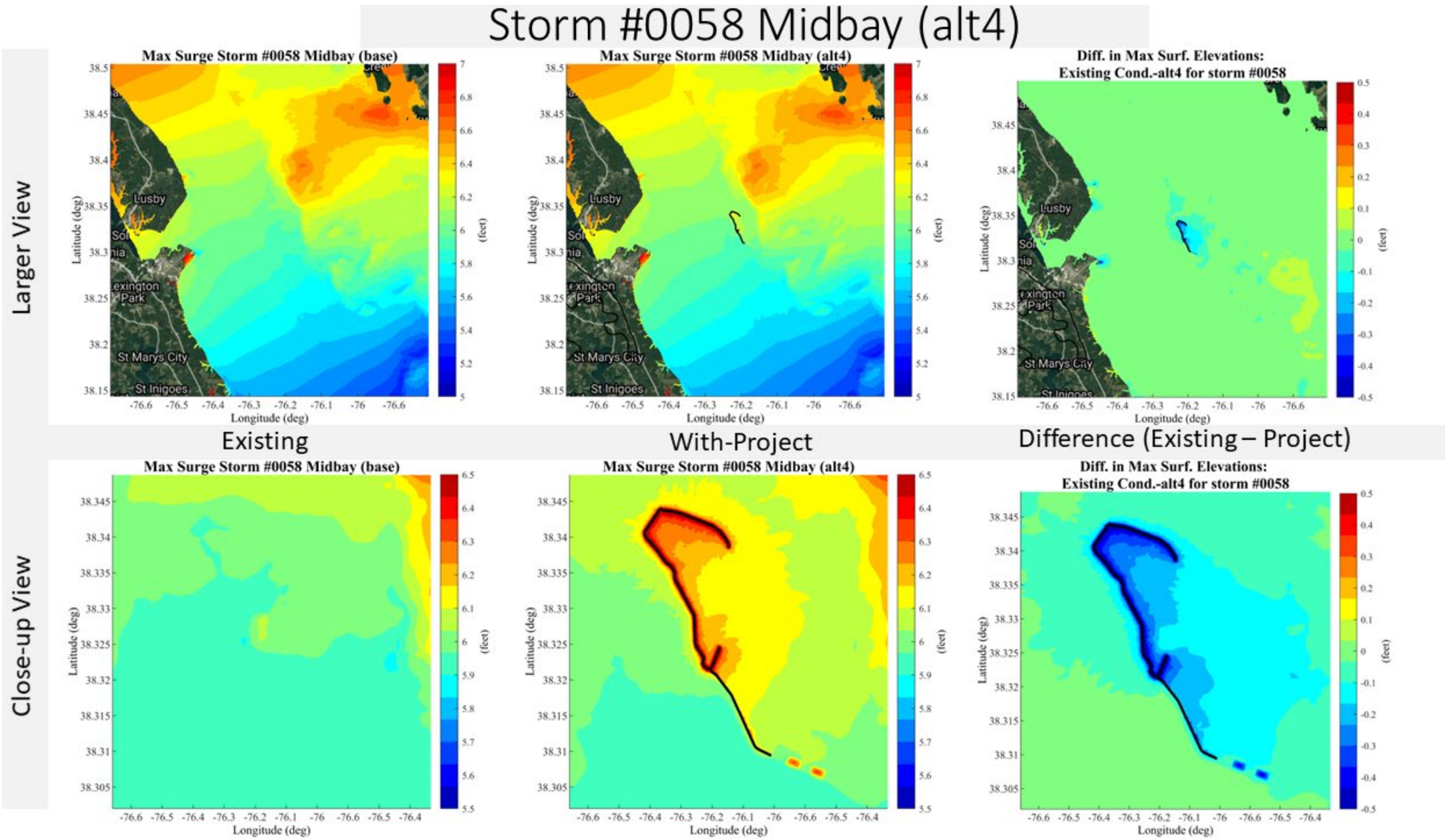

Storm #0057 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0057 Midbay (base)
Max Surge Storm #0057 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0057
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

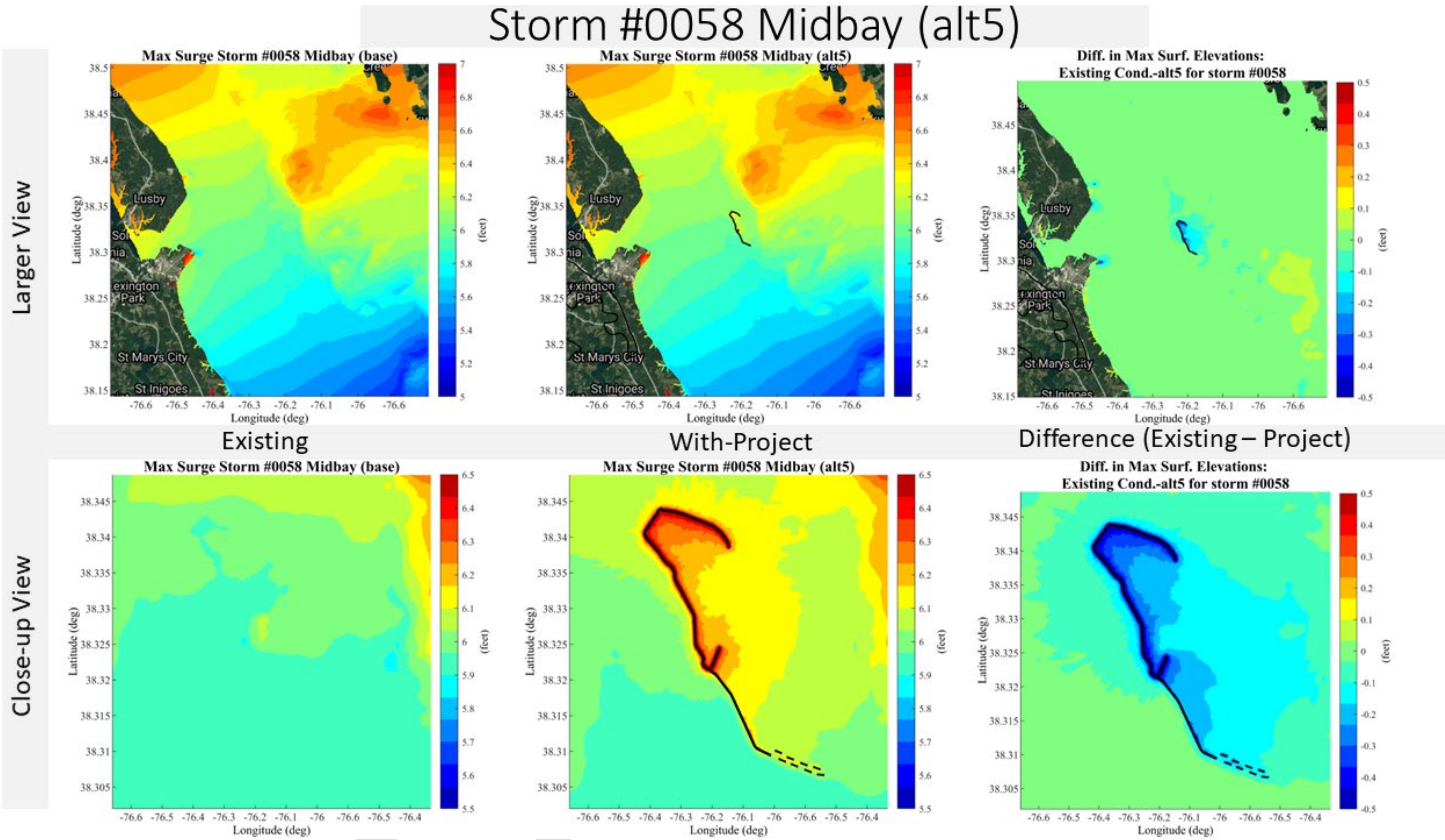

Storm #0057 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0057 Midbay (base)
Max Surge Storm #0057 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0057
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Creek

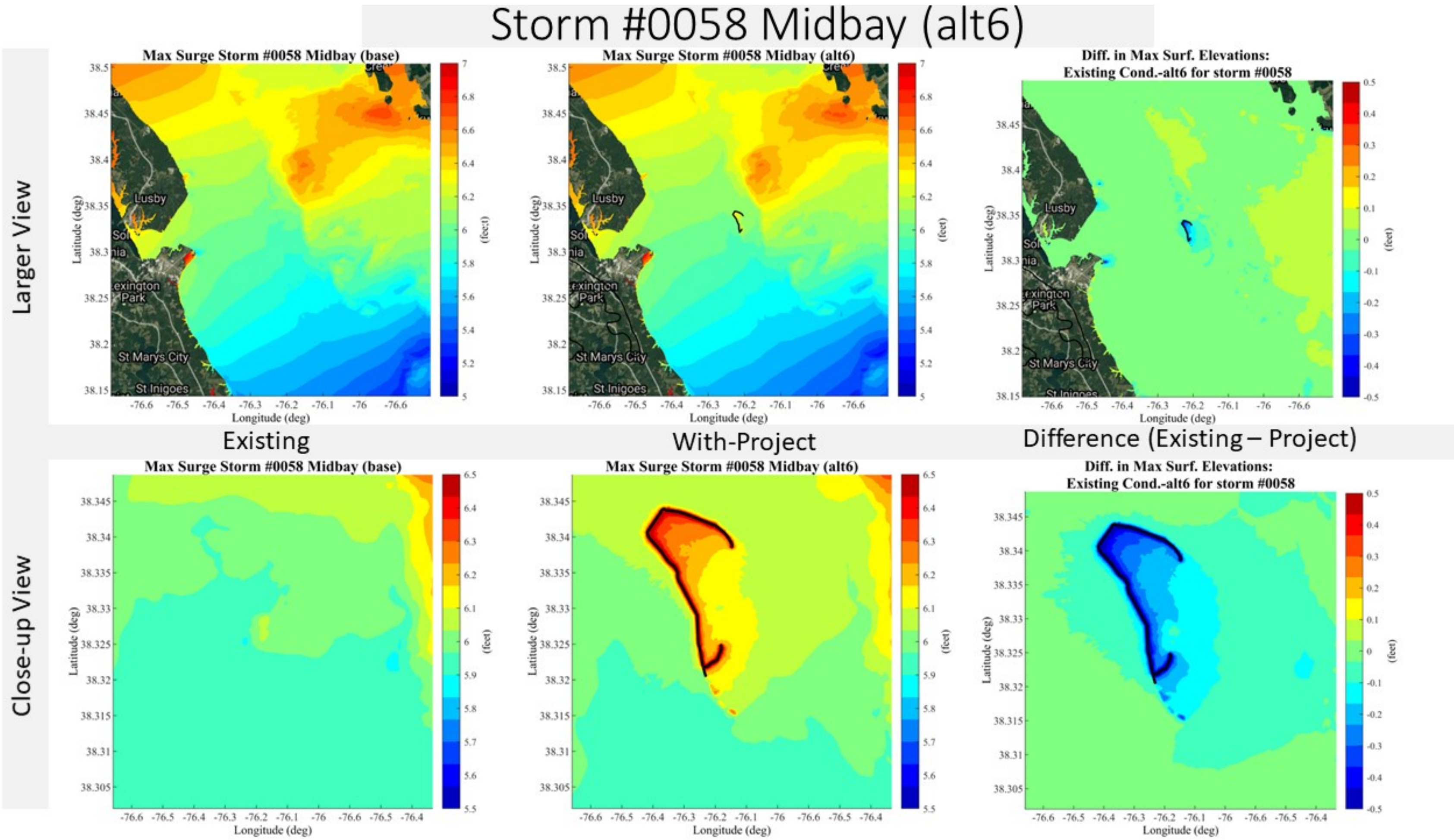

Storm #0058 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0058
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

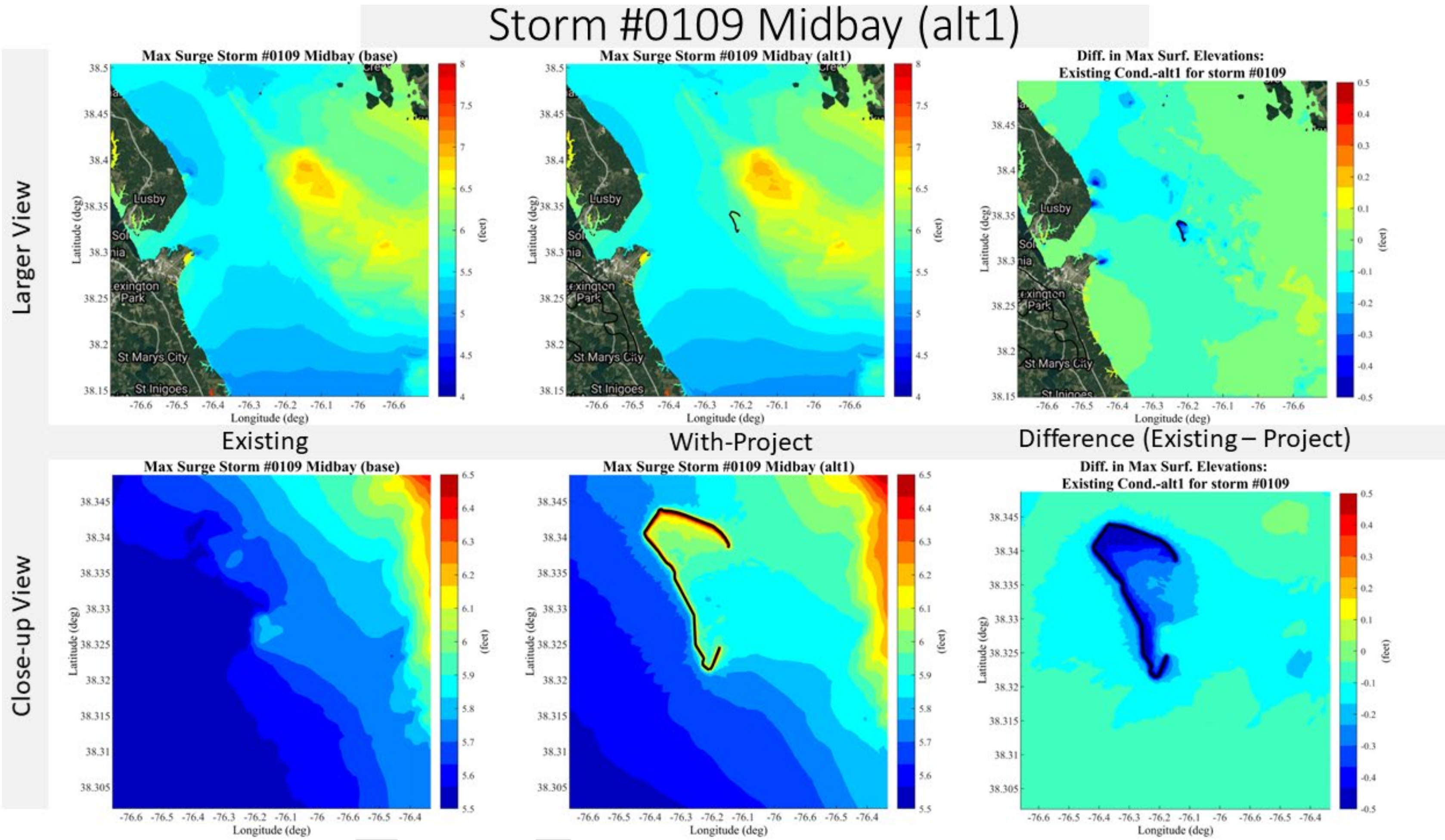

Storm #0058 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0058
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

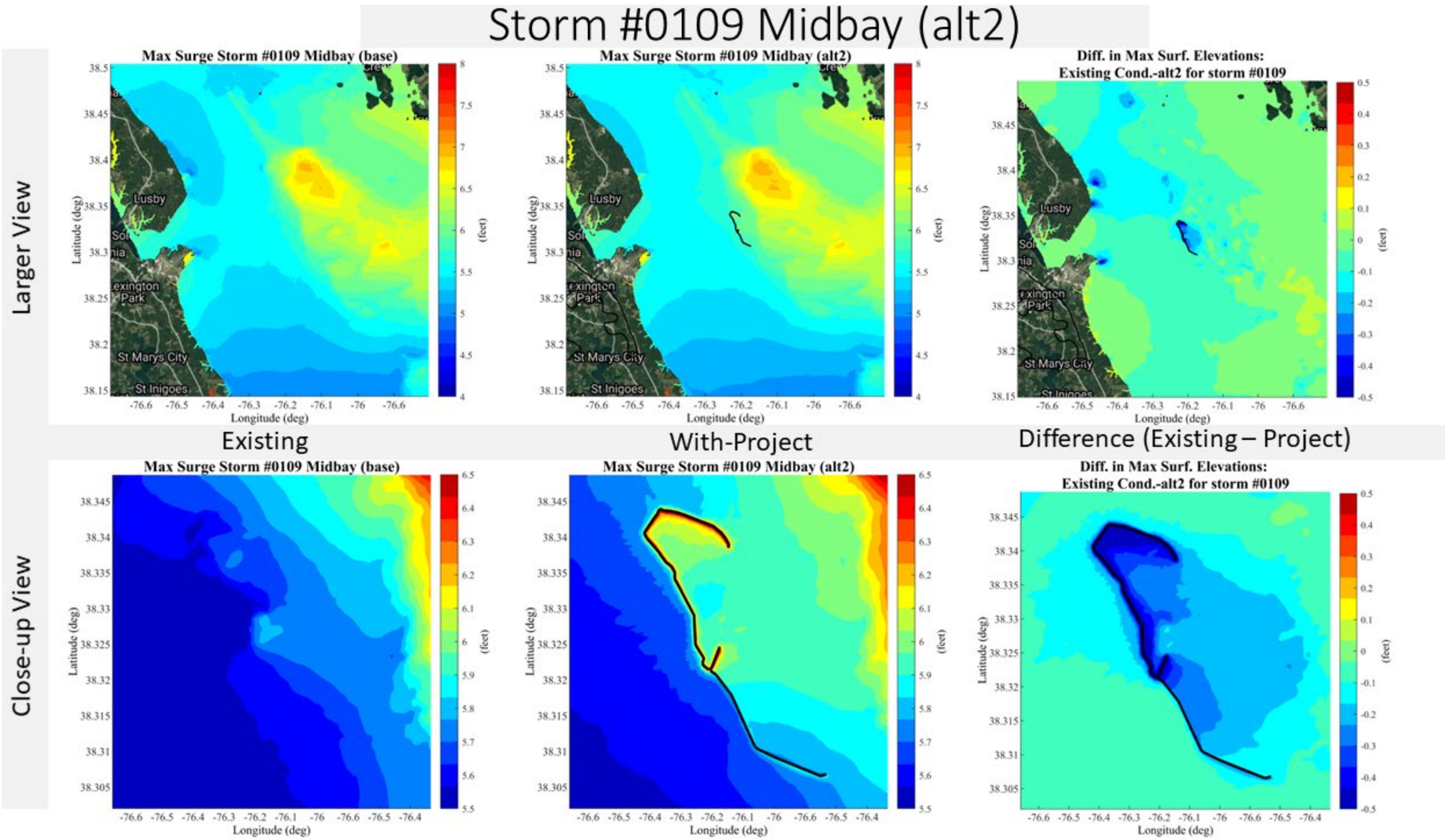

Storm #0058 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt3)
Diff. in Max Surf. Elevations: Existing Cond.-alt3 for storm #0058
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

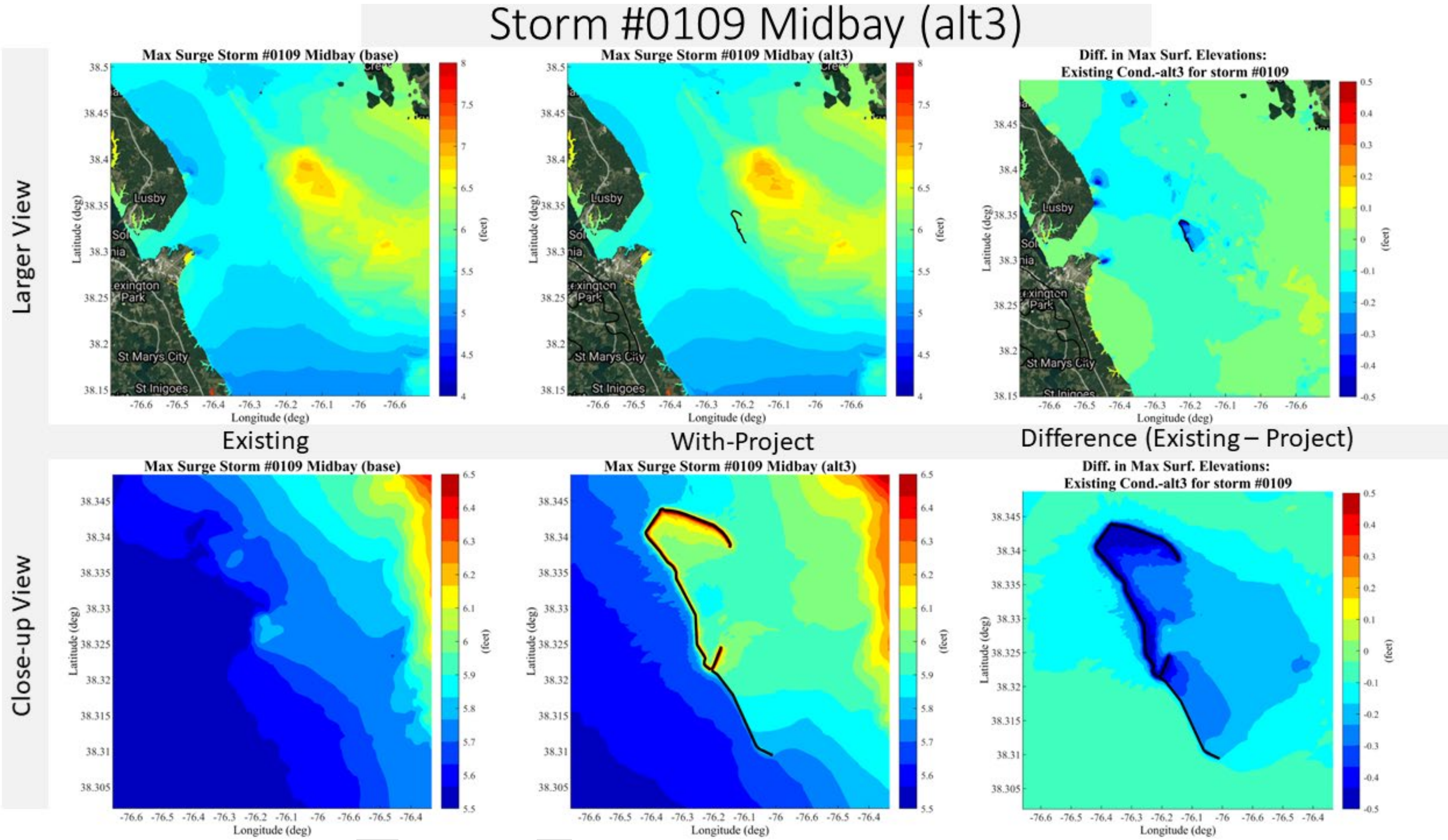

Storm #0058 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0058
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

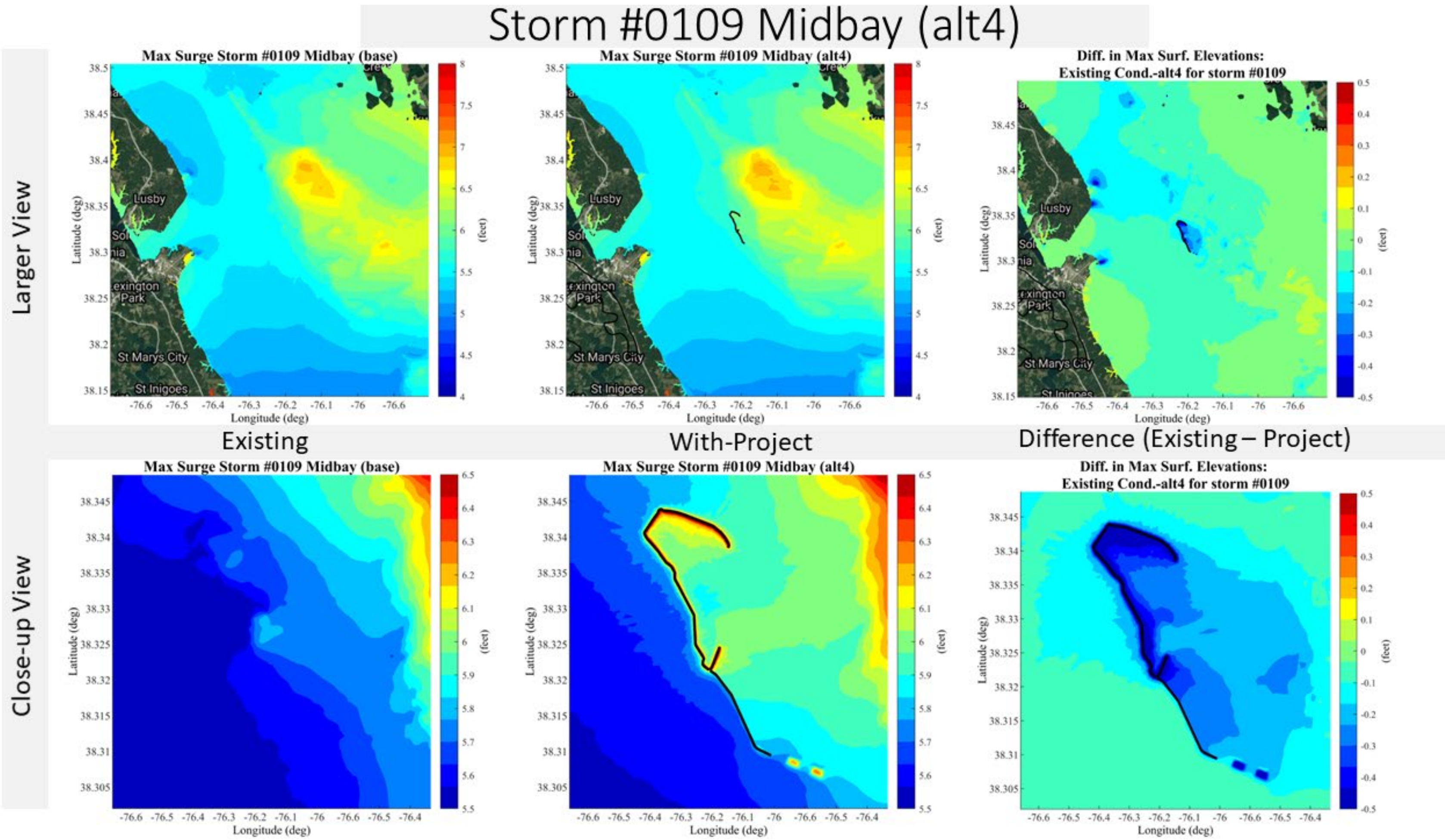

Storm #0058 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0058
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

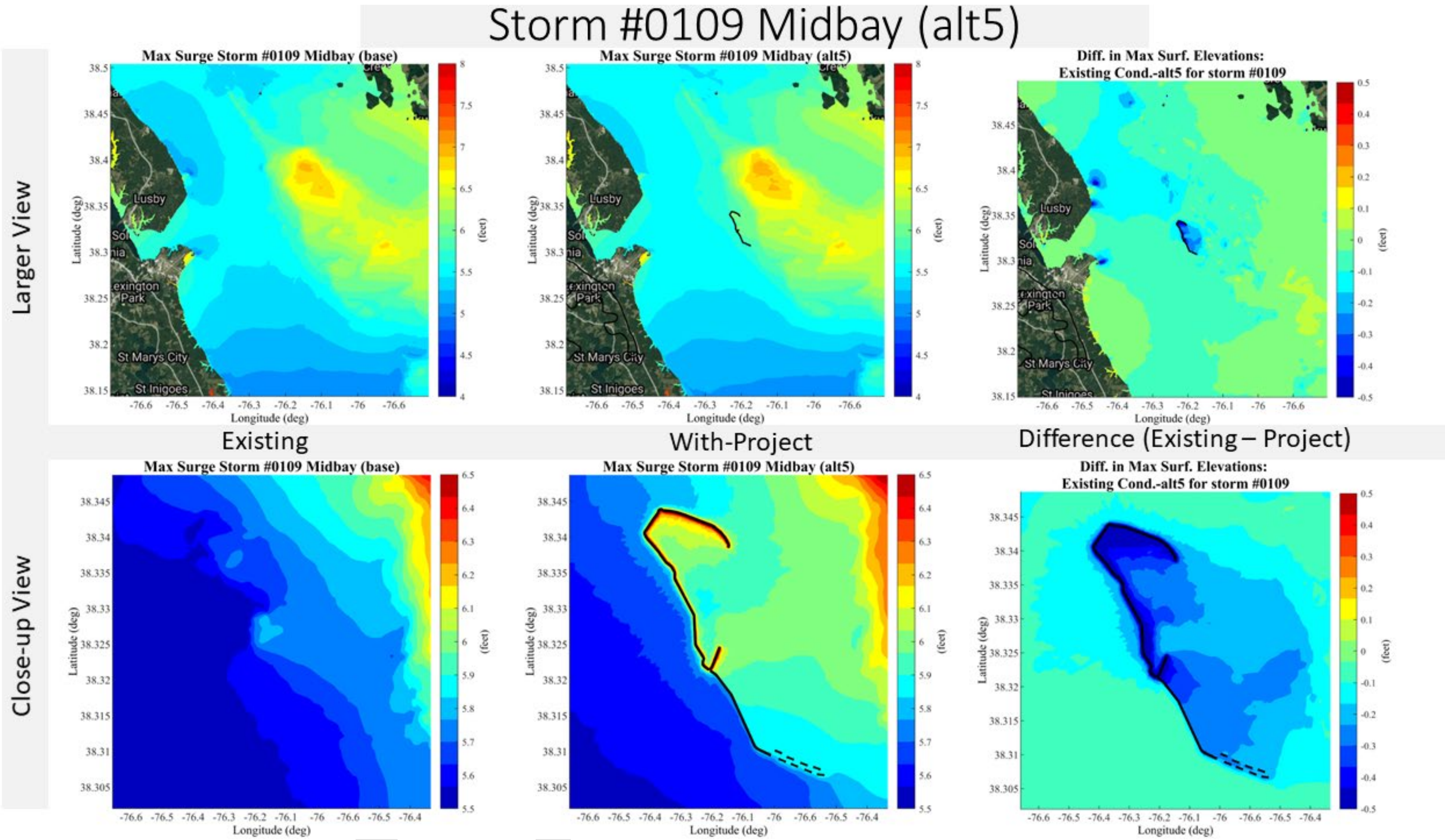

Storm #0058 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0058 Midbay (base)
Max Surge Storm #0058 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0058
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

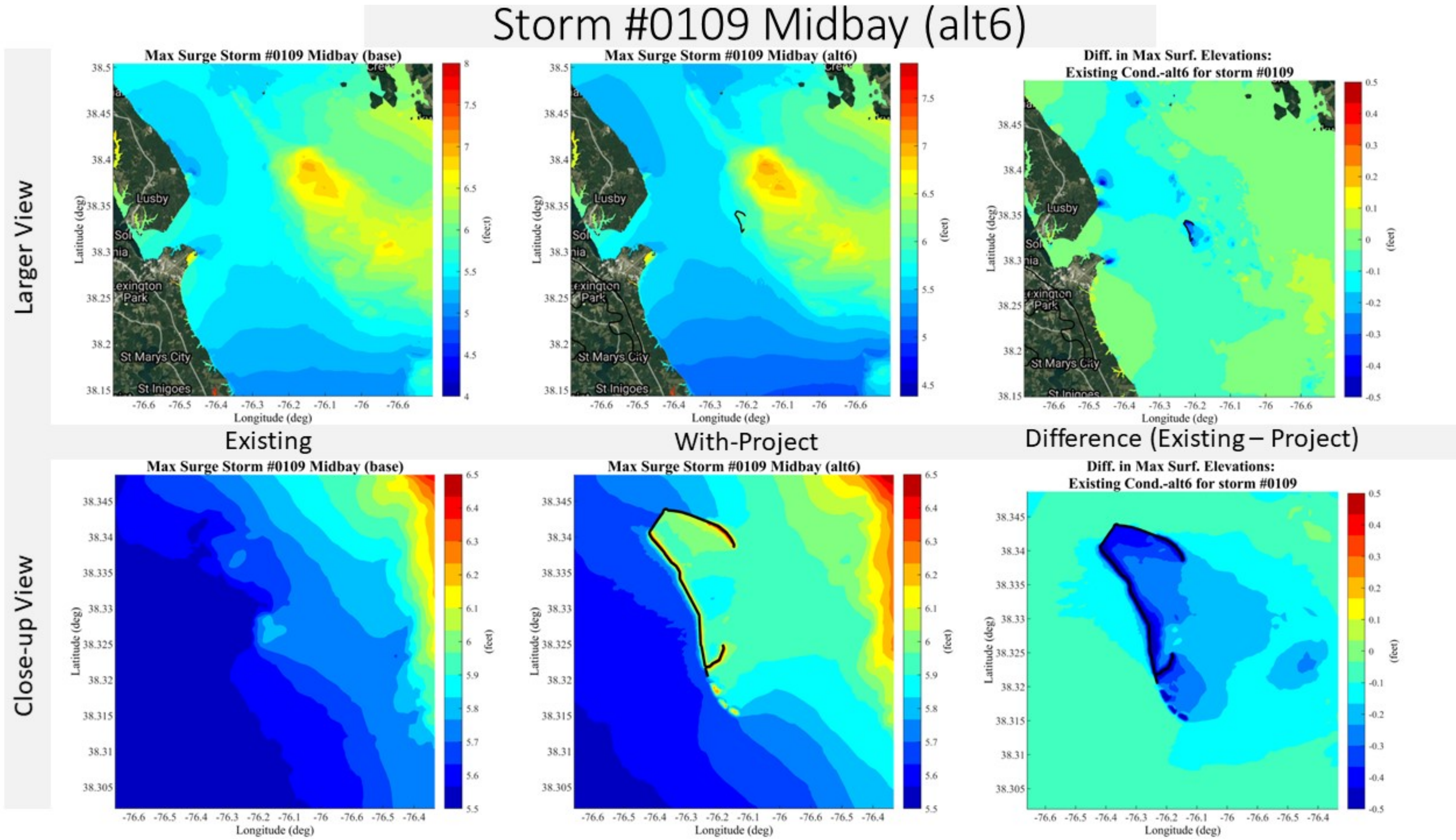

Storm #0109 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0109
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

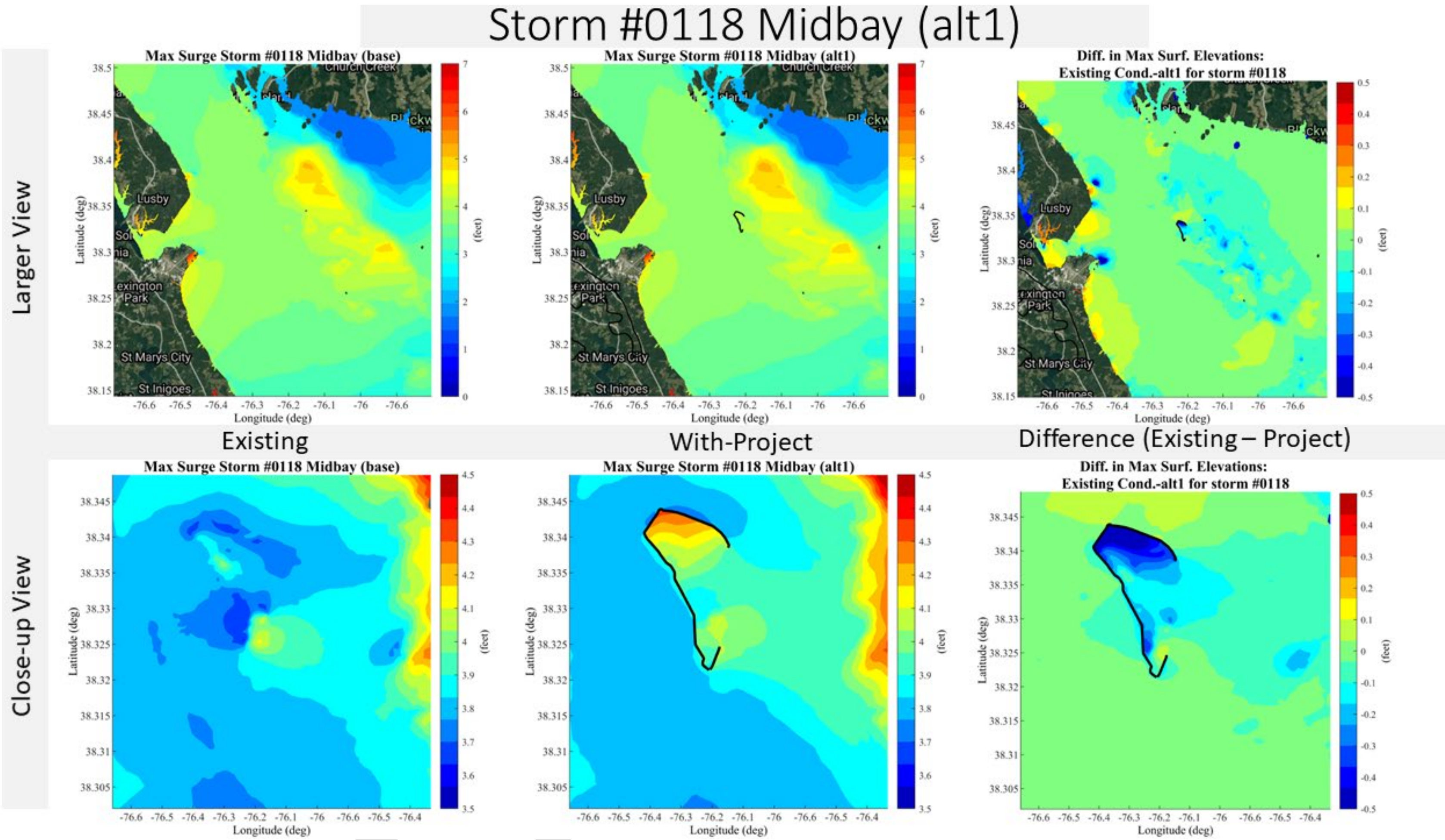

Storm #0109 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0109
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

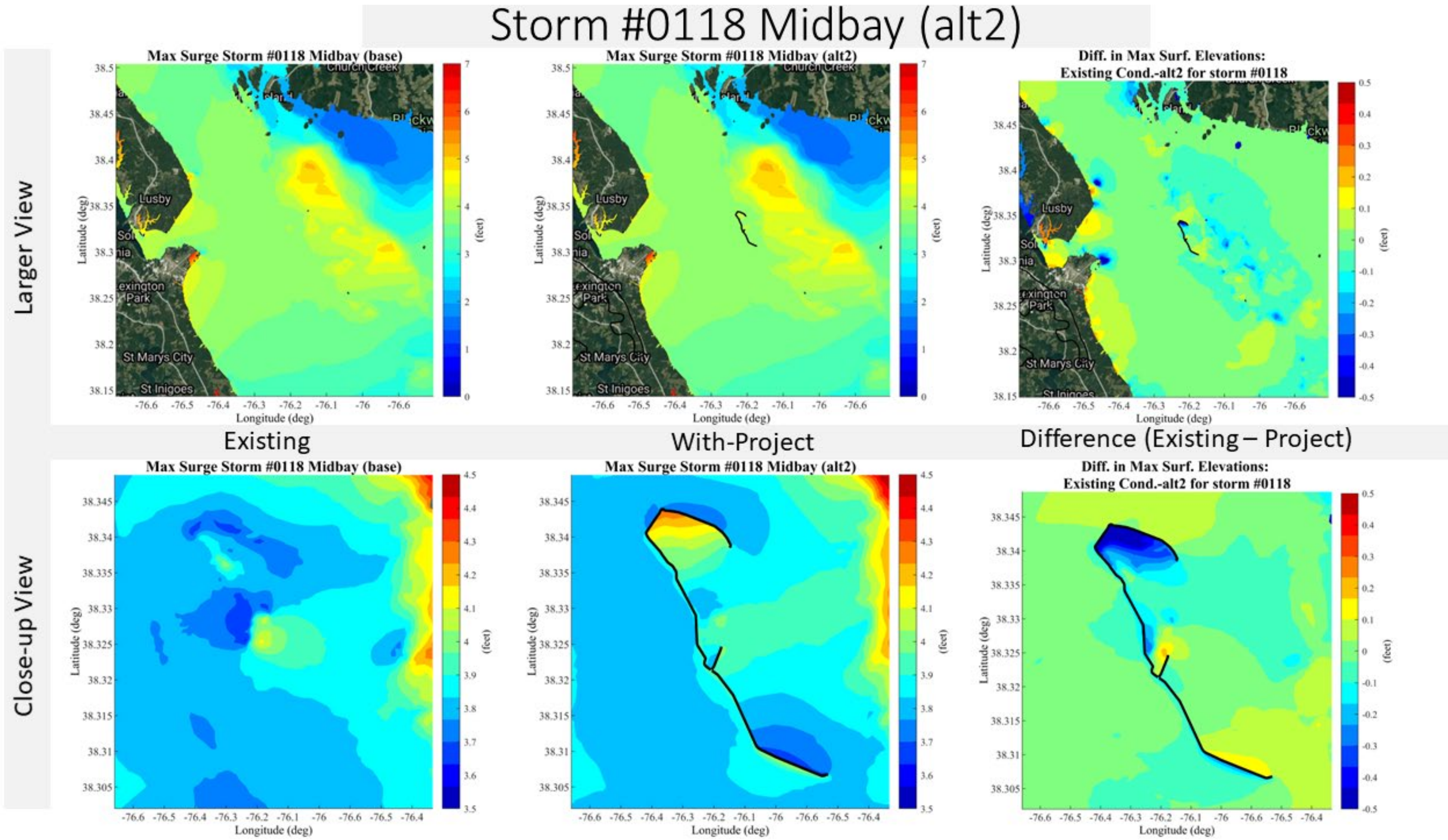

Storm #0109 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0109
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

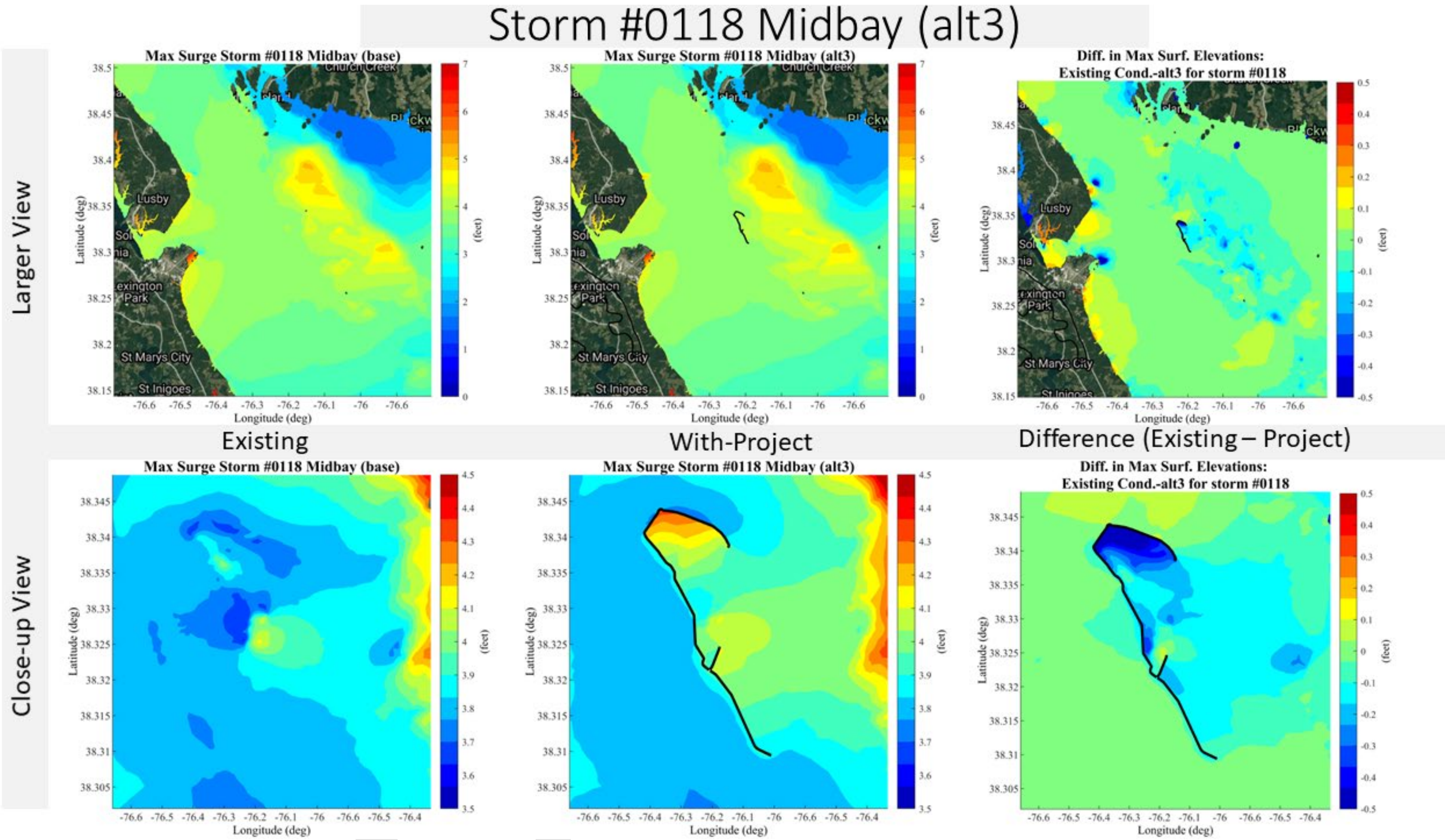

Storm #0109 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0109
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

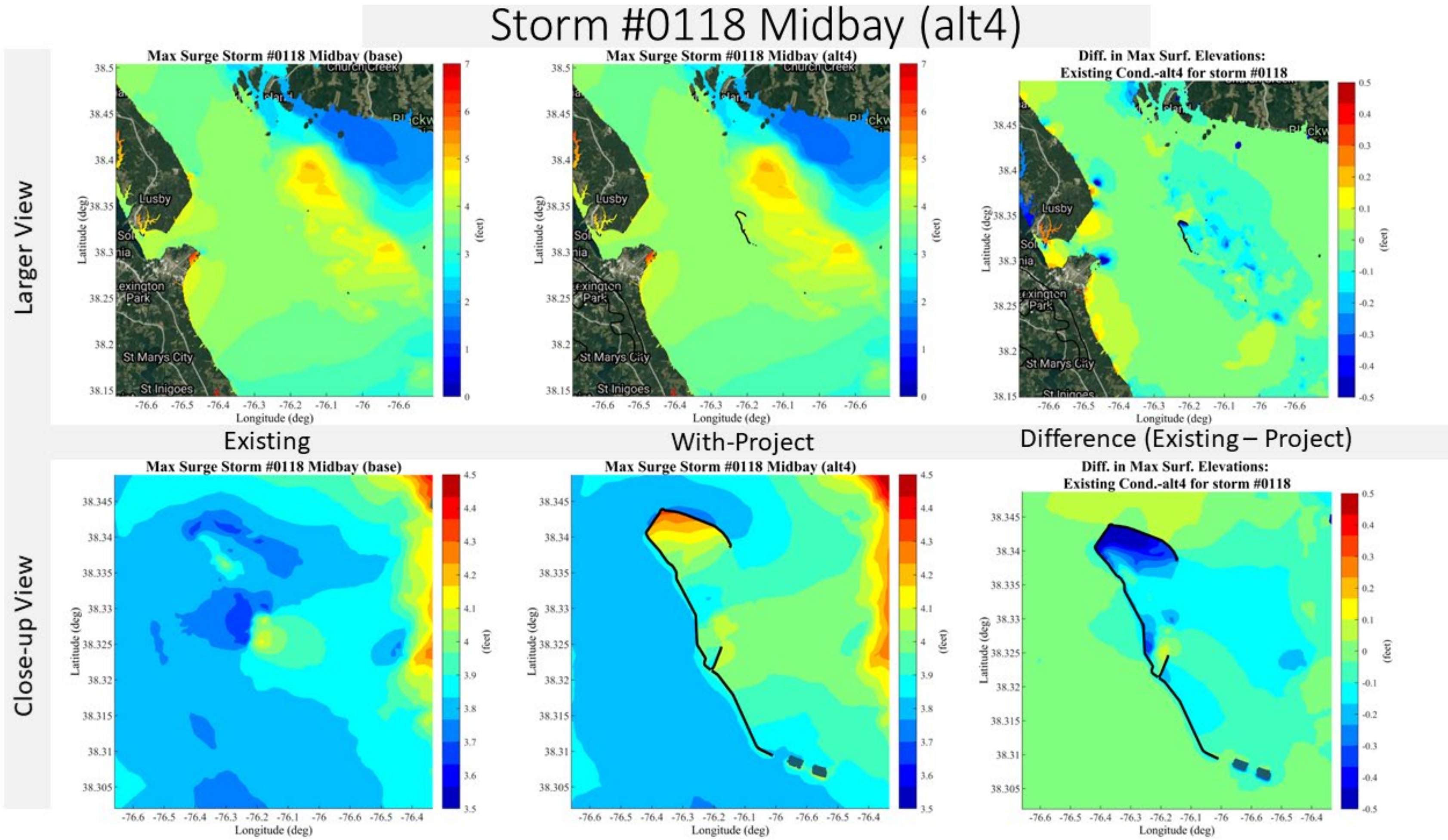

Storm #0109 Midbay (alt5)
Larger View
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0109
Lusby
Lexington Park
St Marys City
St Inigoes
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)
Close-up View
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0109

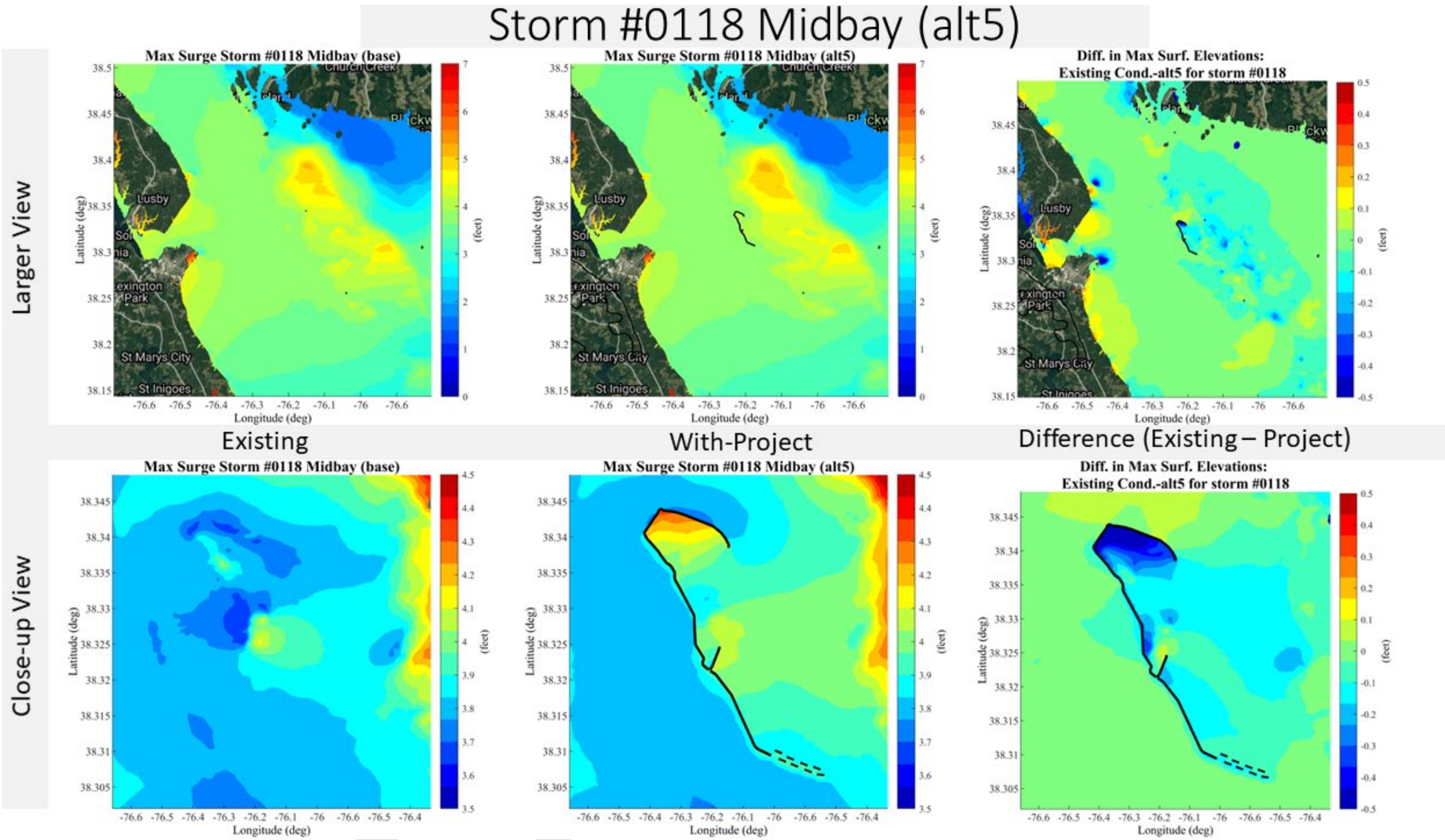

Storm #0109 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0109 Midbay (base)
Max Surge Storm #0109 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0109
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

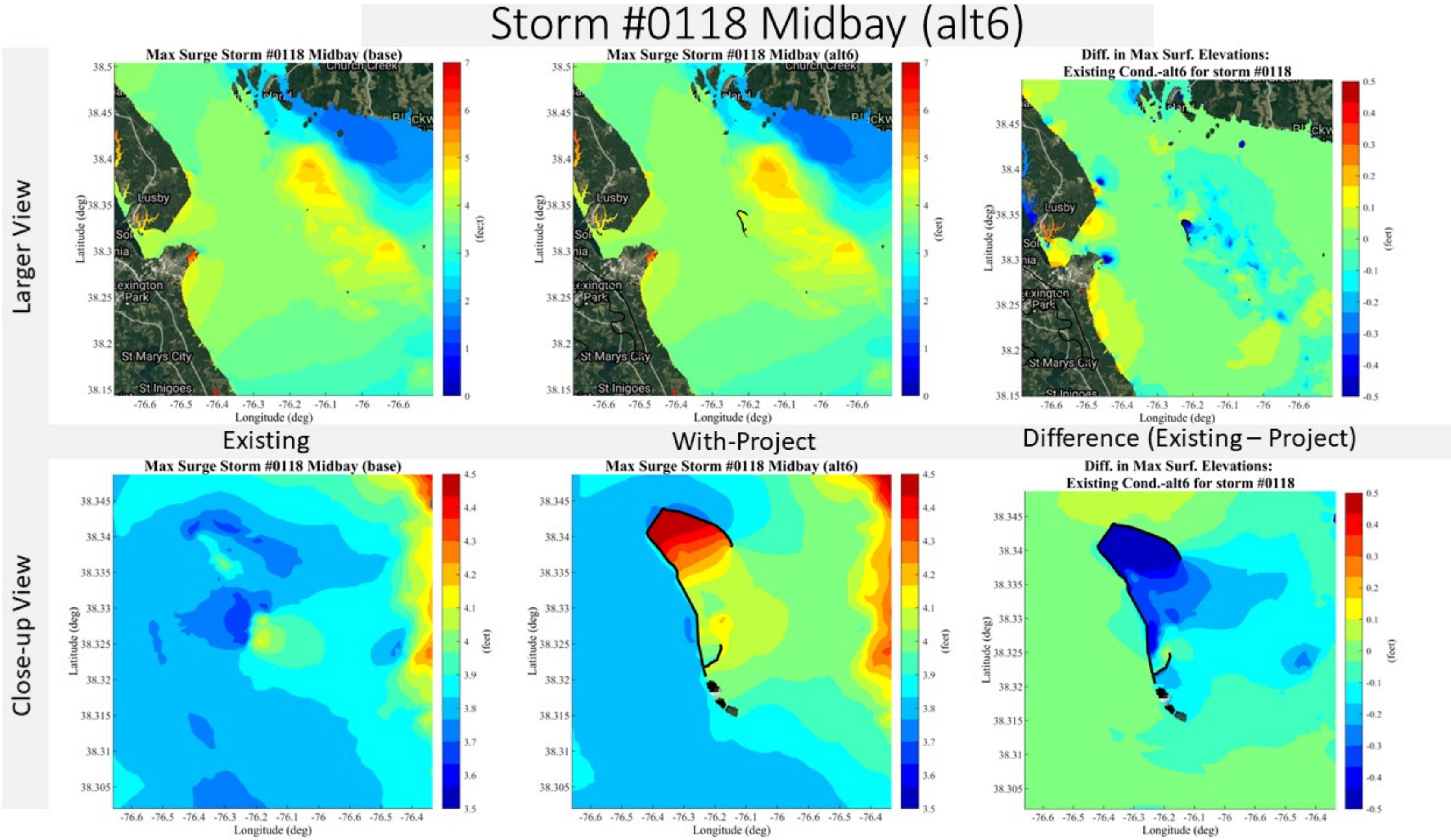

Storm #0118 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0118
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

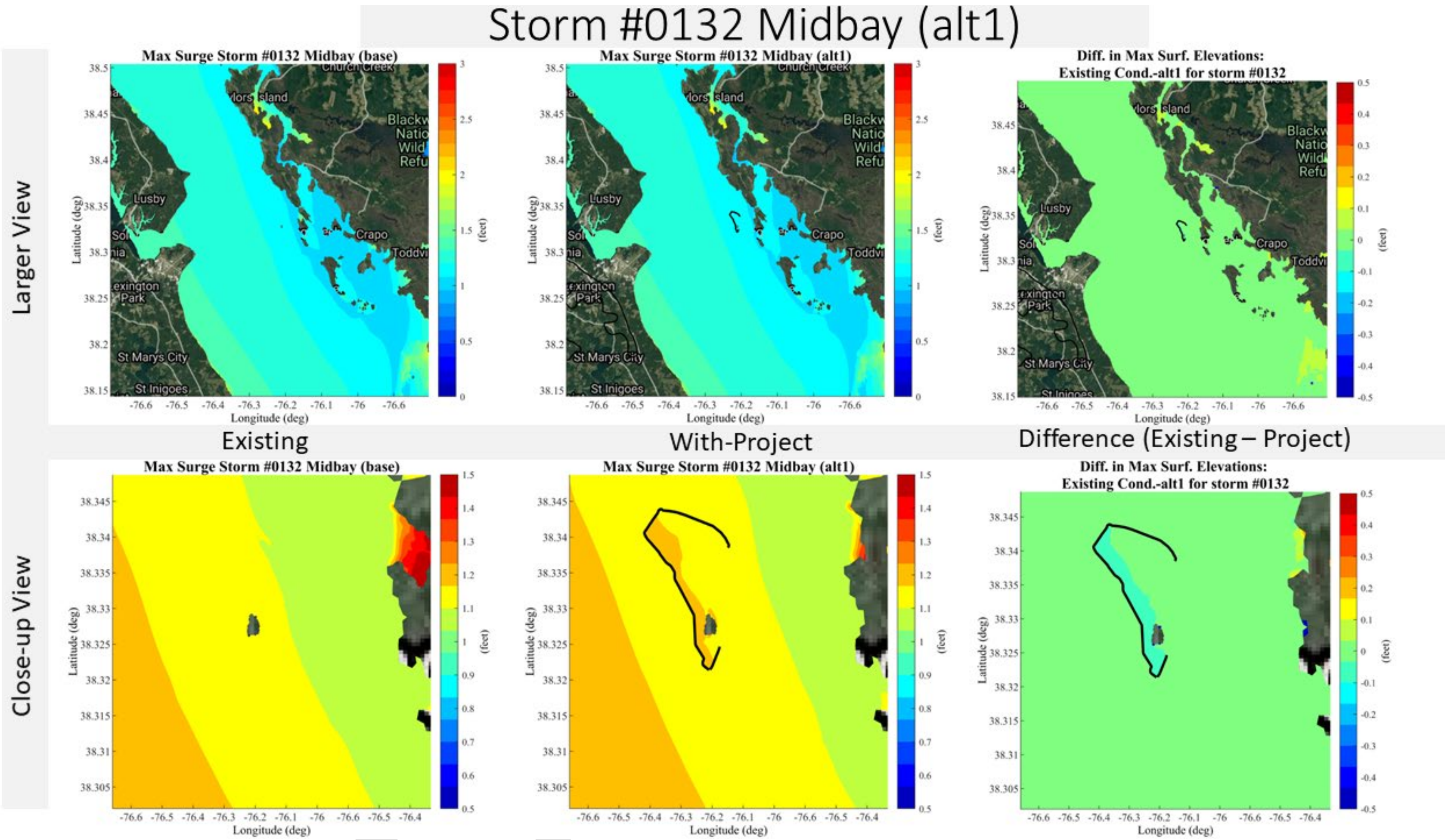

Storm #0118 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt2)
Diff. in Max Surf. Elevations: Existing Cond.-alt2 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

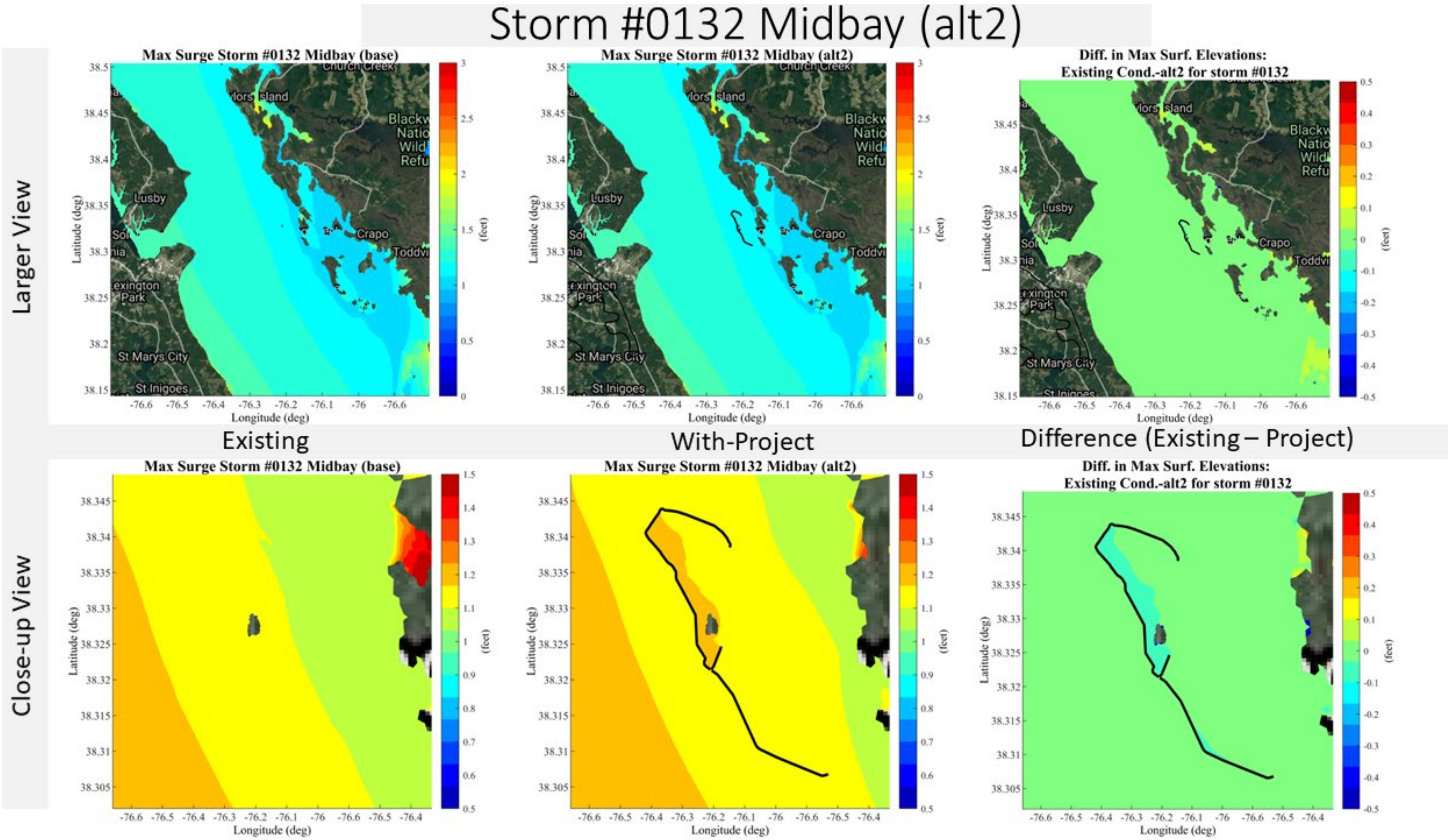

Storm #0118 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

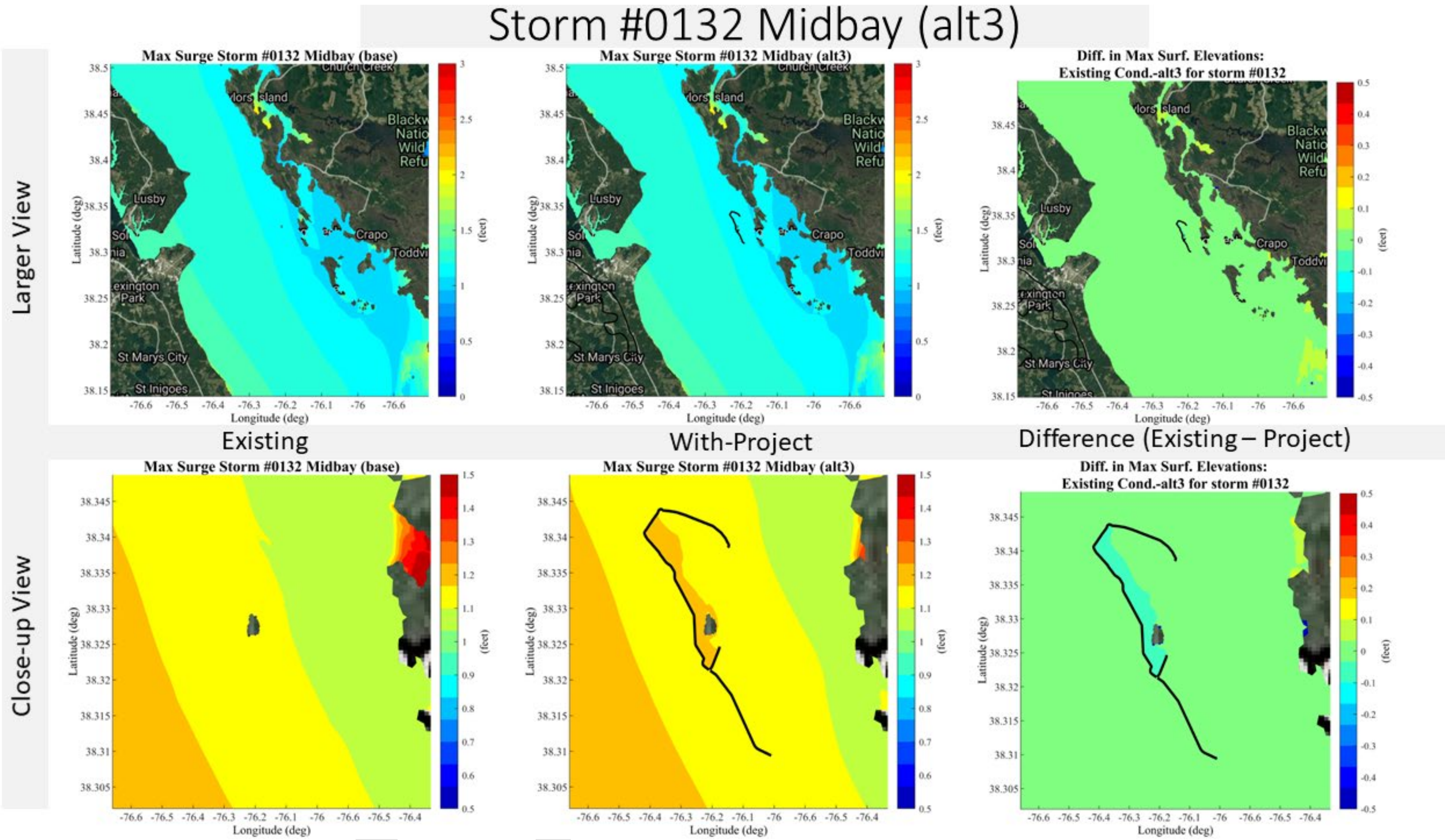

Storm #0118 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0118
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

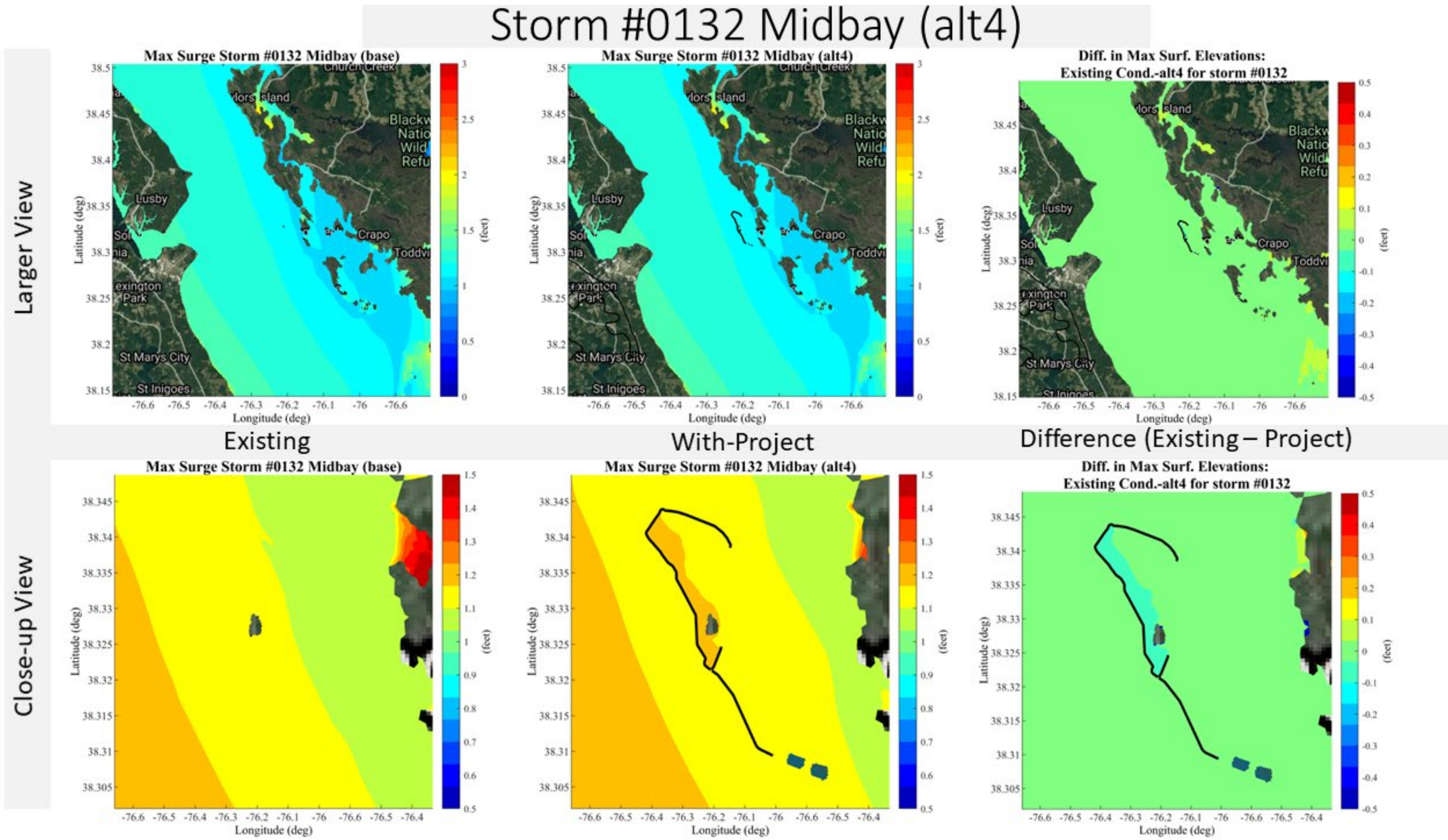

Storm #0118 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

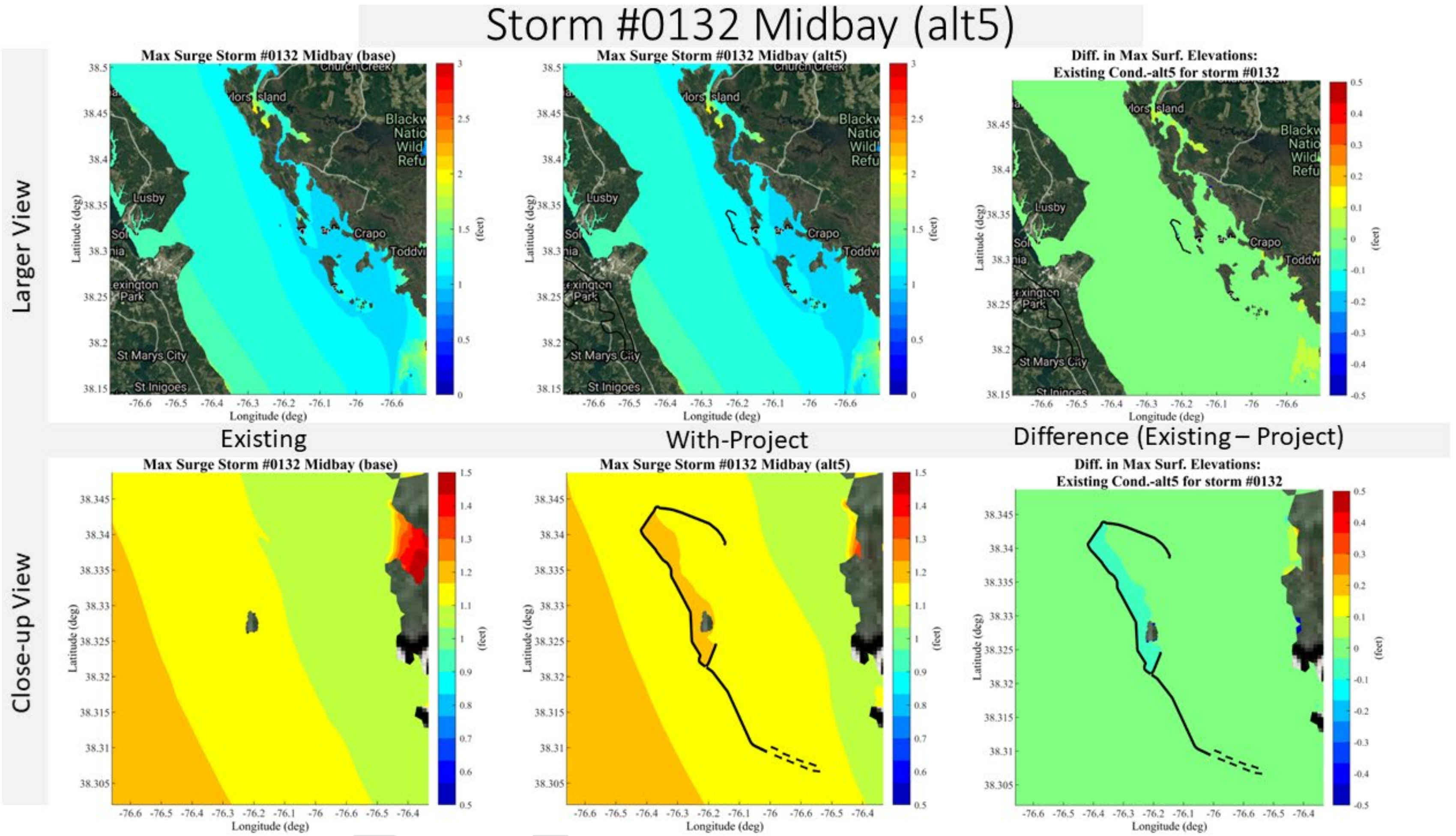

Storm #0118 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0118 Midbay (base)
Max Surge Storm #0118 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

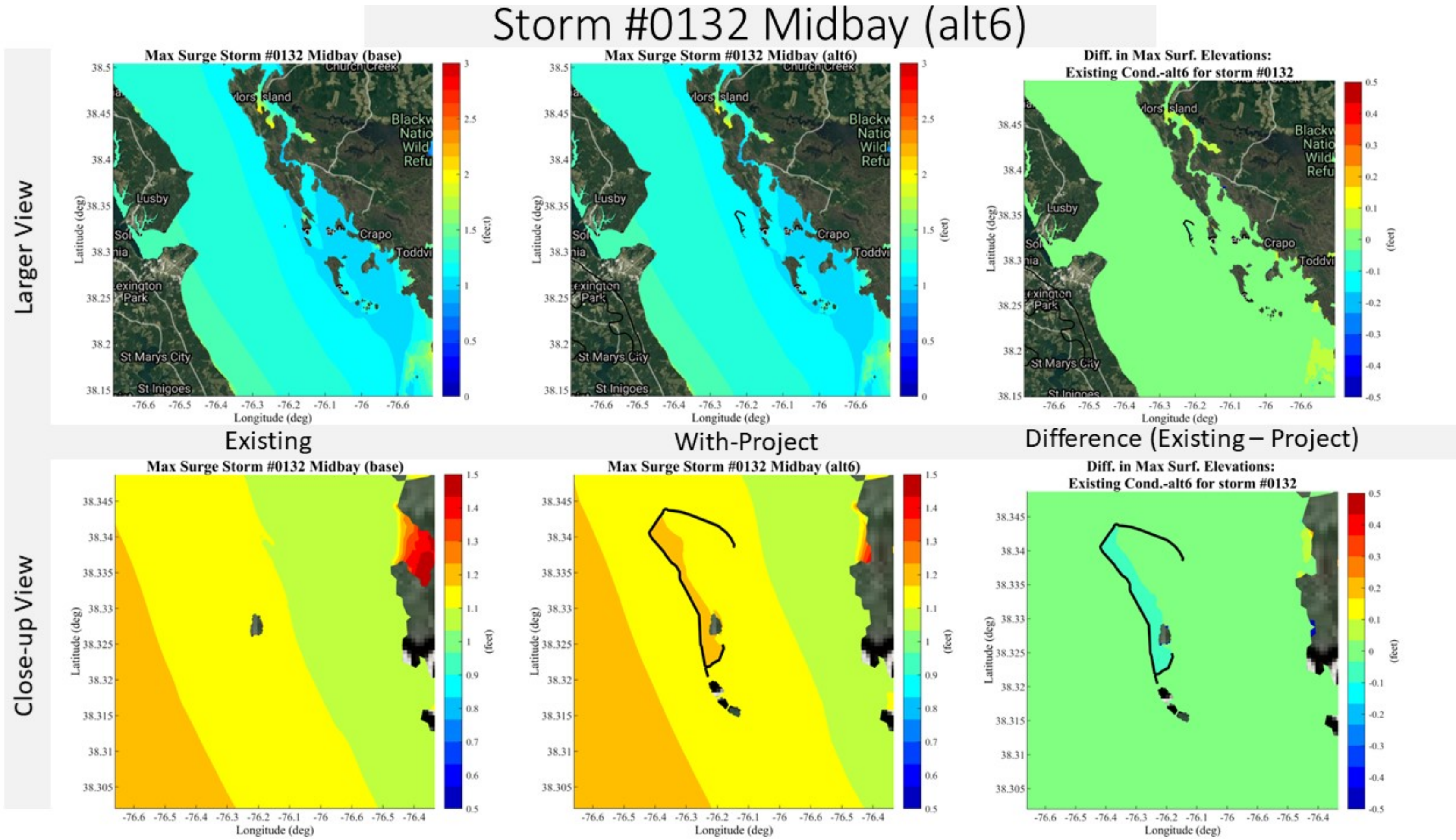

Storm #0132 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0132
Latitude (deg)
Longitude (deg)
(feet)

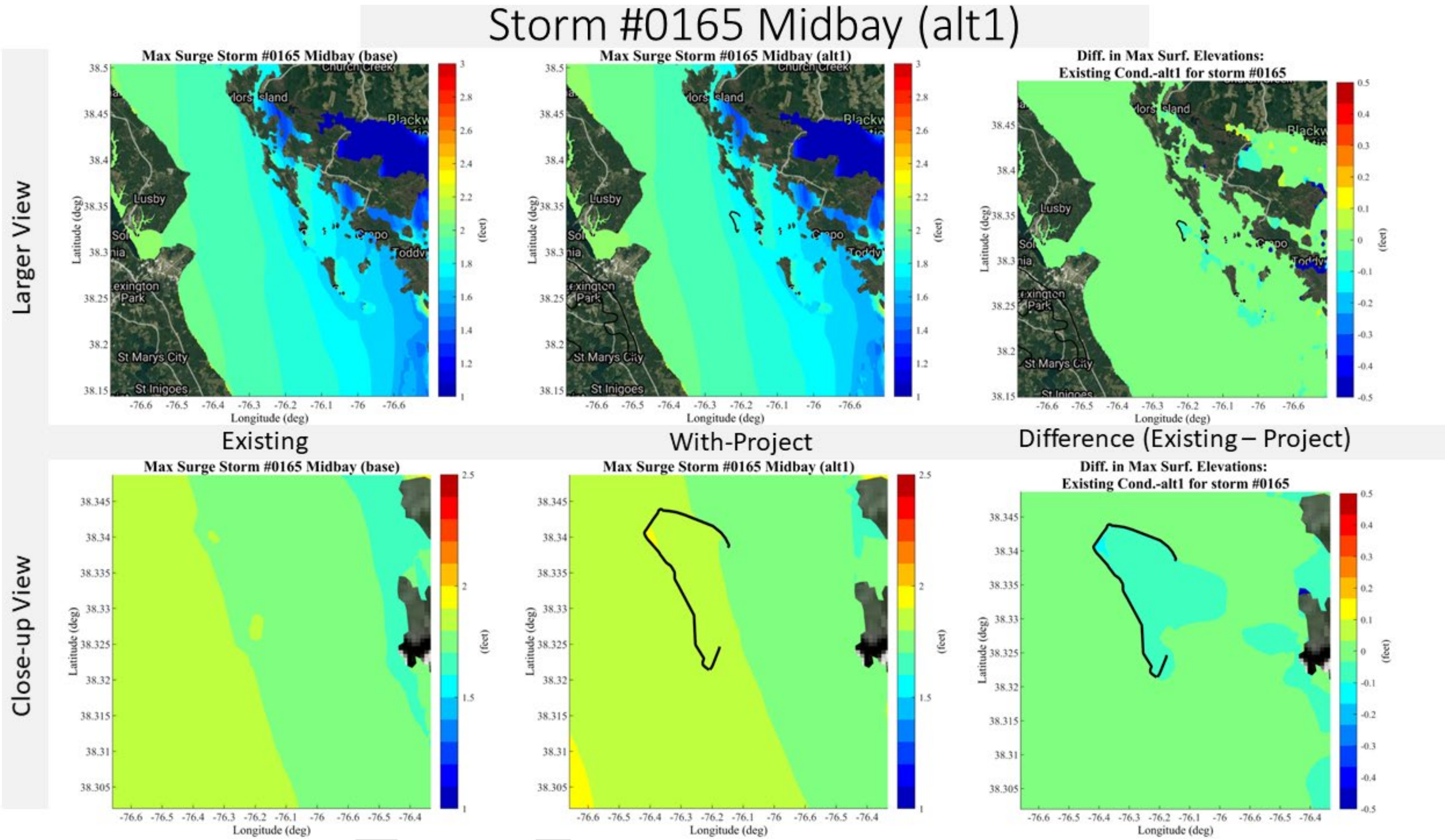

Storm #0132 Midbay (alt2)
Larger View
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0132
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo
Existing
With-Project
Difference (Existing – Project)
Close-up View
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0132

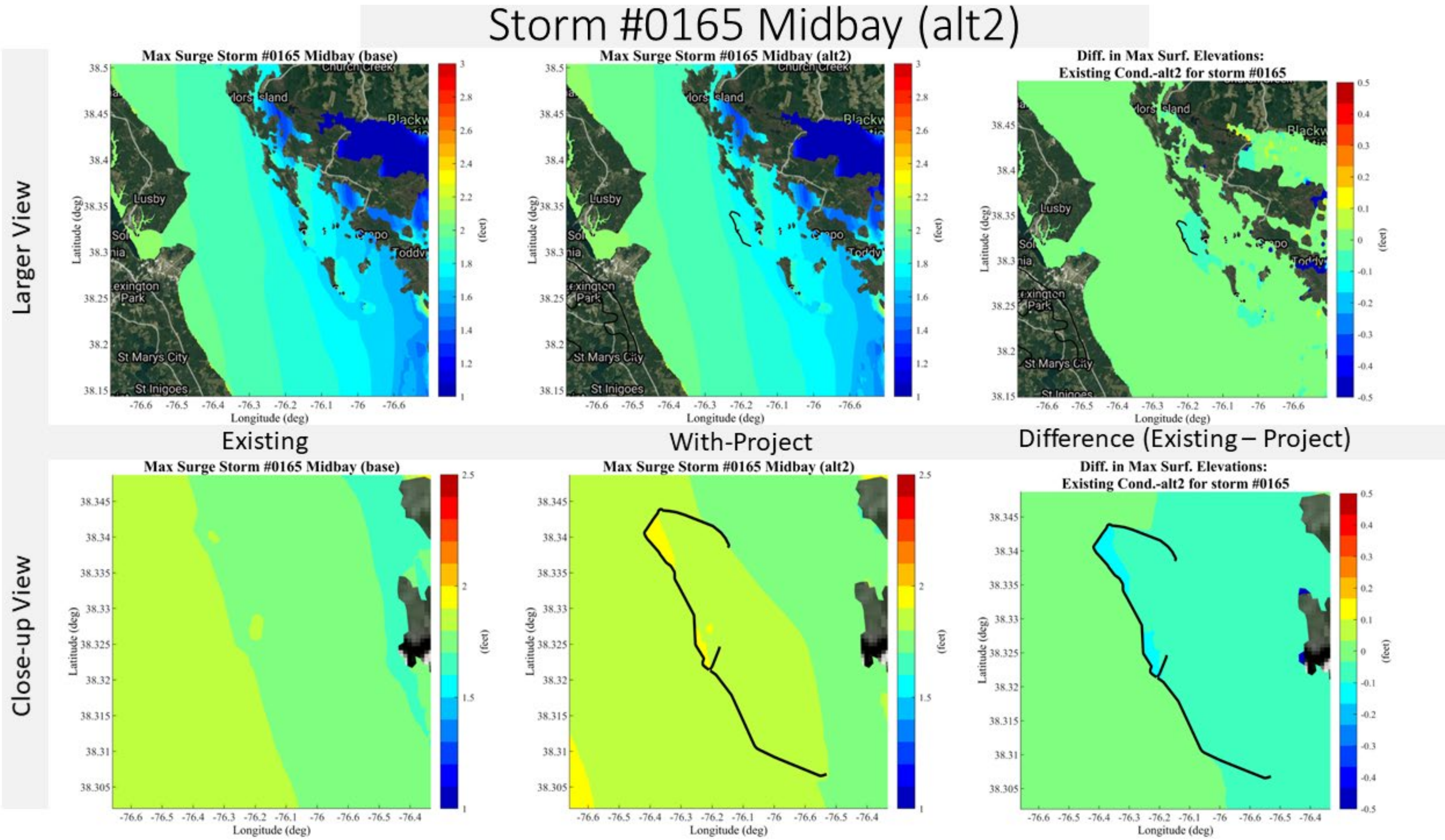

Storm #0132 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0132
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

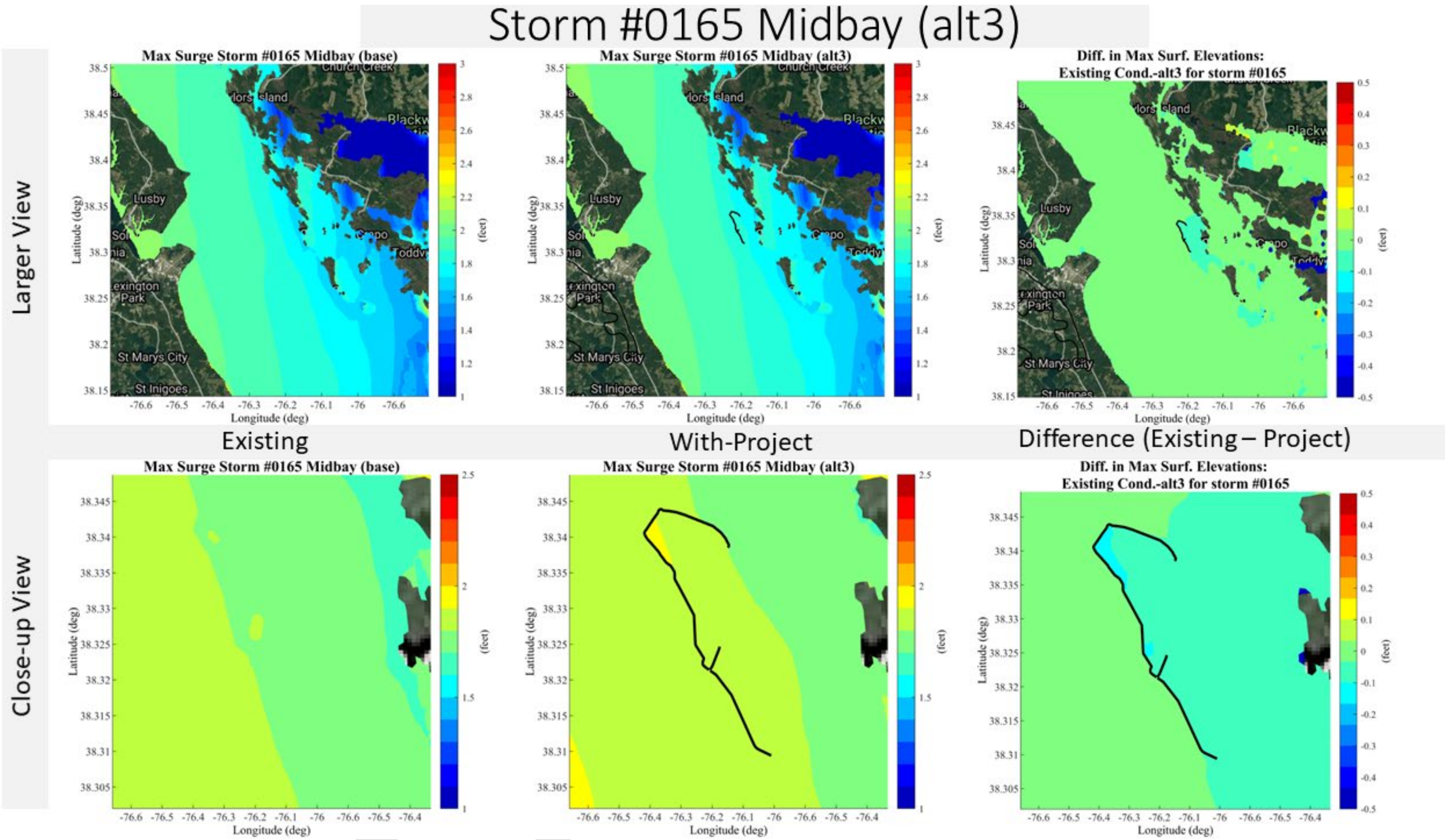

Storm #0132 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0132
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

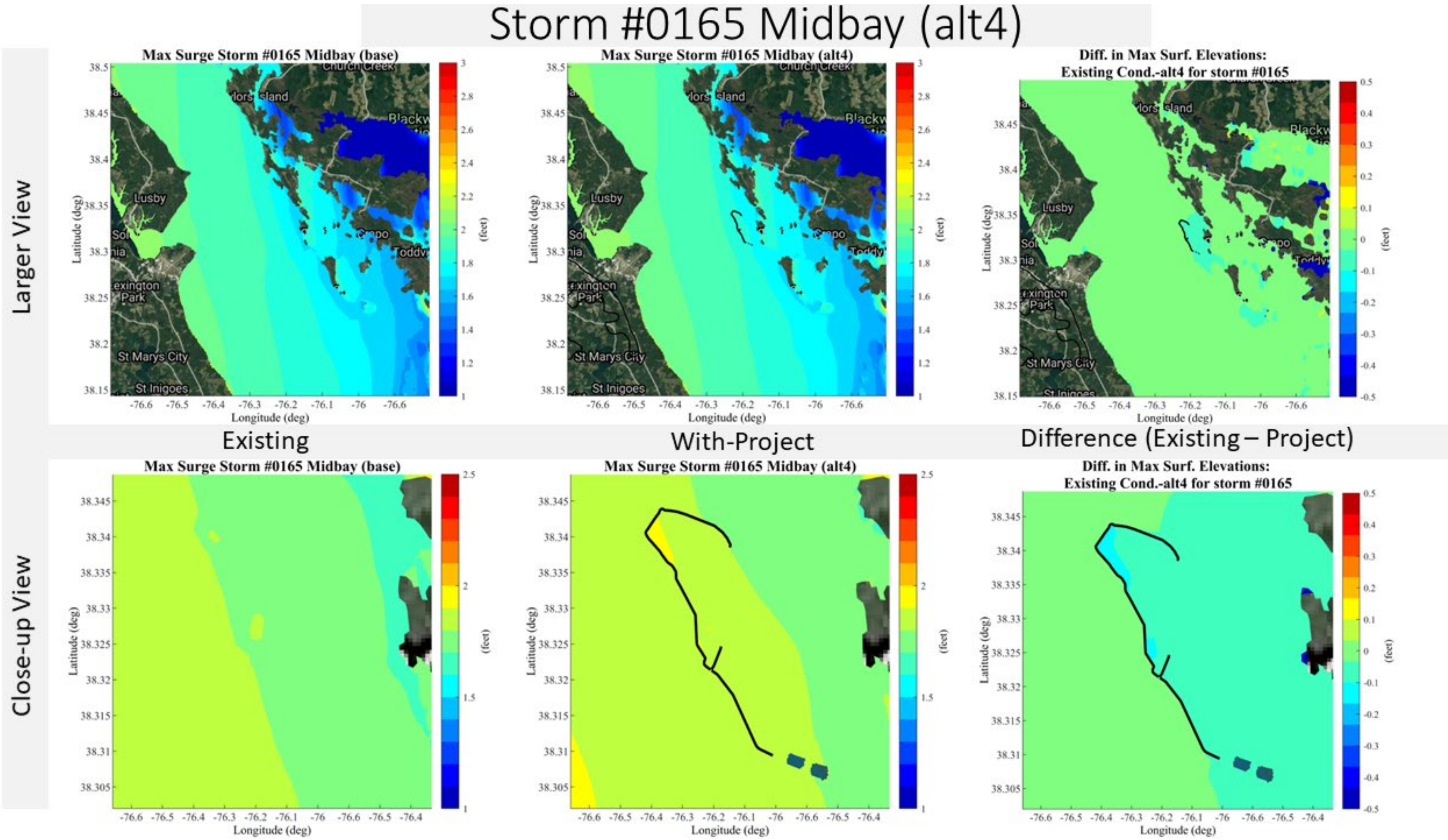

Storm #0132 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0132
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

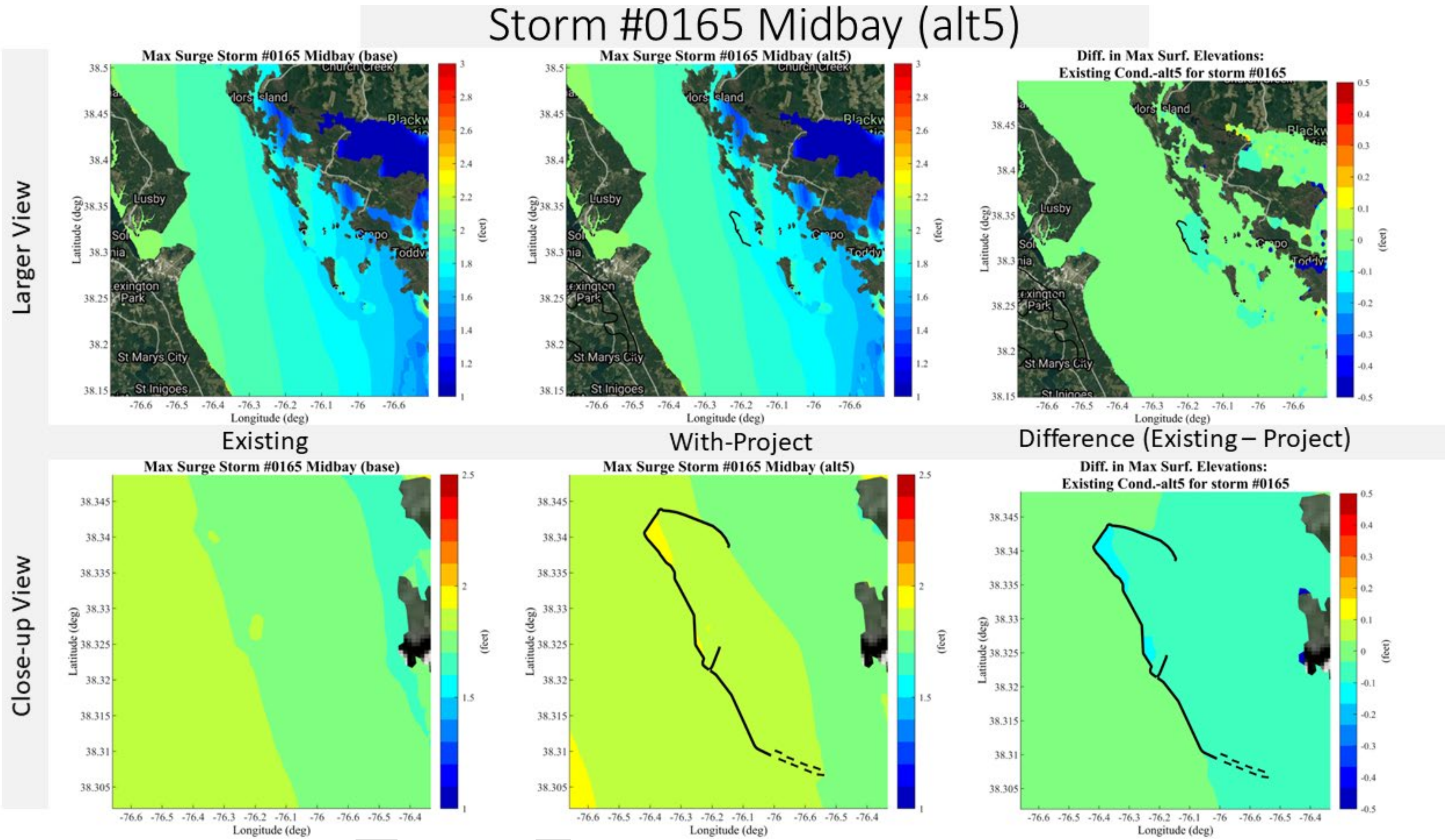

Storm #0132 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0132 Midbay (base)
Max Surge Storm #0132 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0132
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

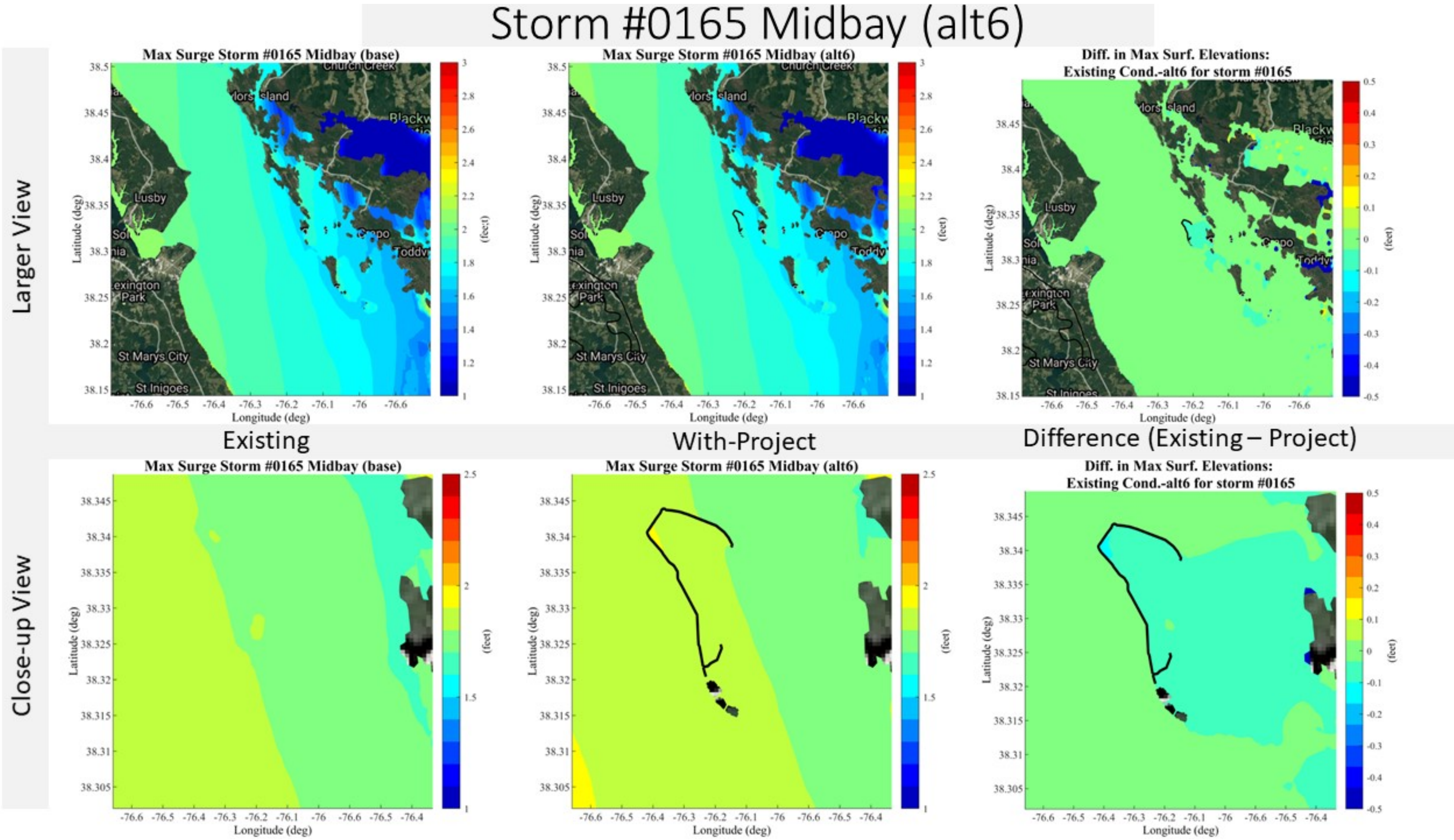

Storm #0165 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0165
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

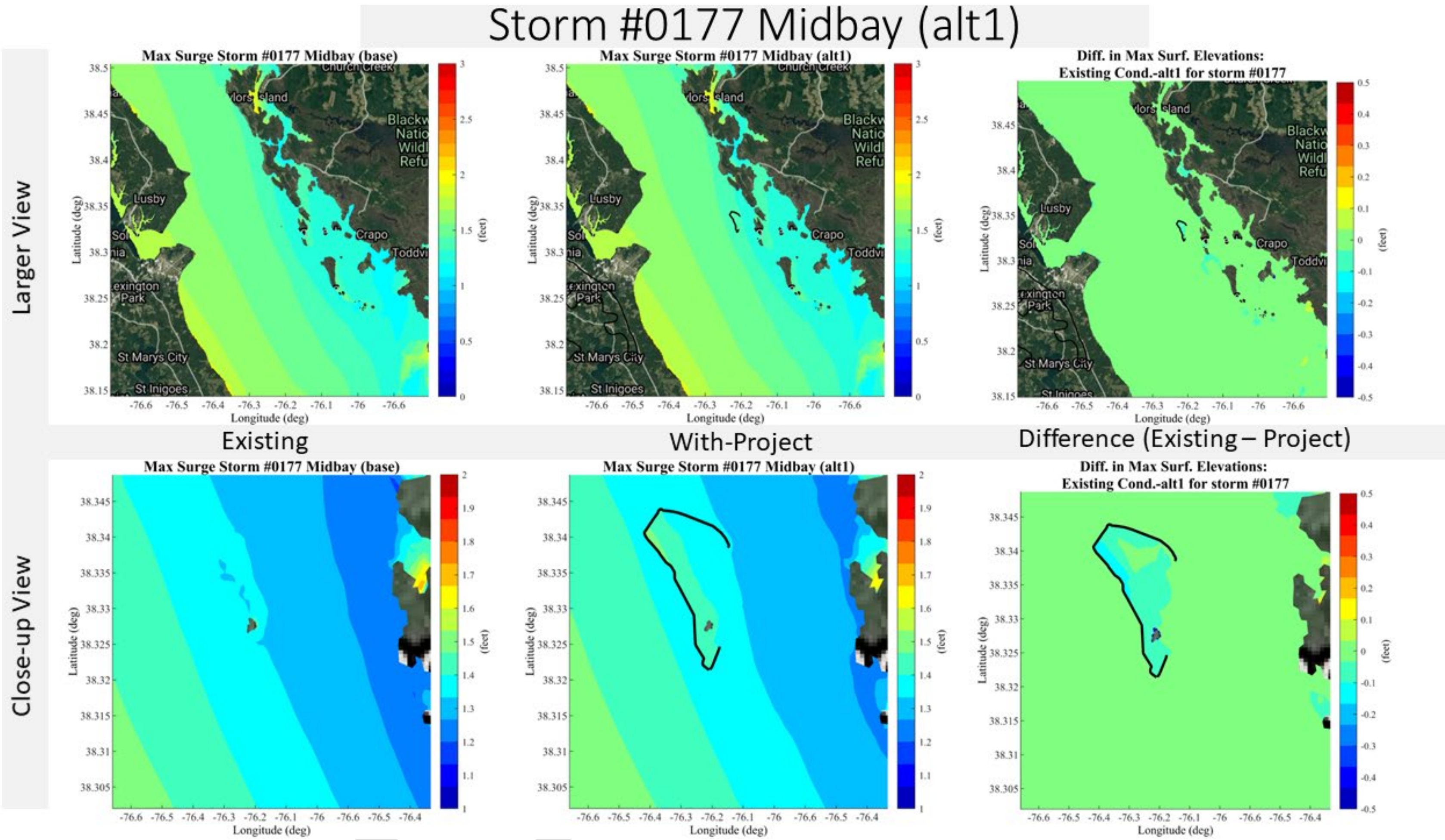

Storm #0165 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0165
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

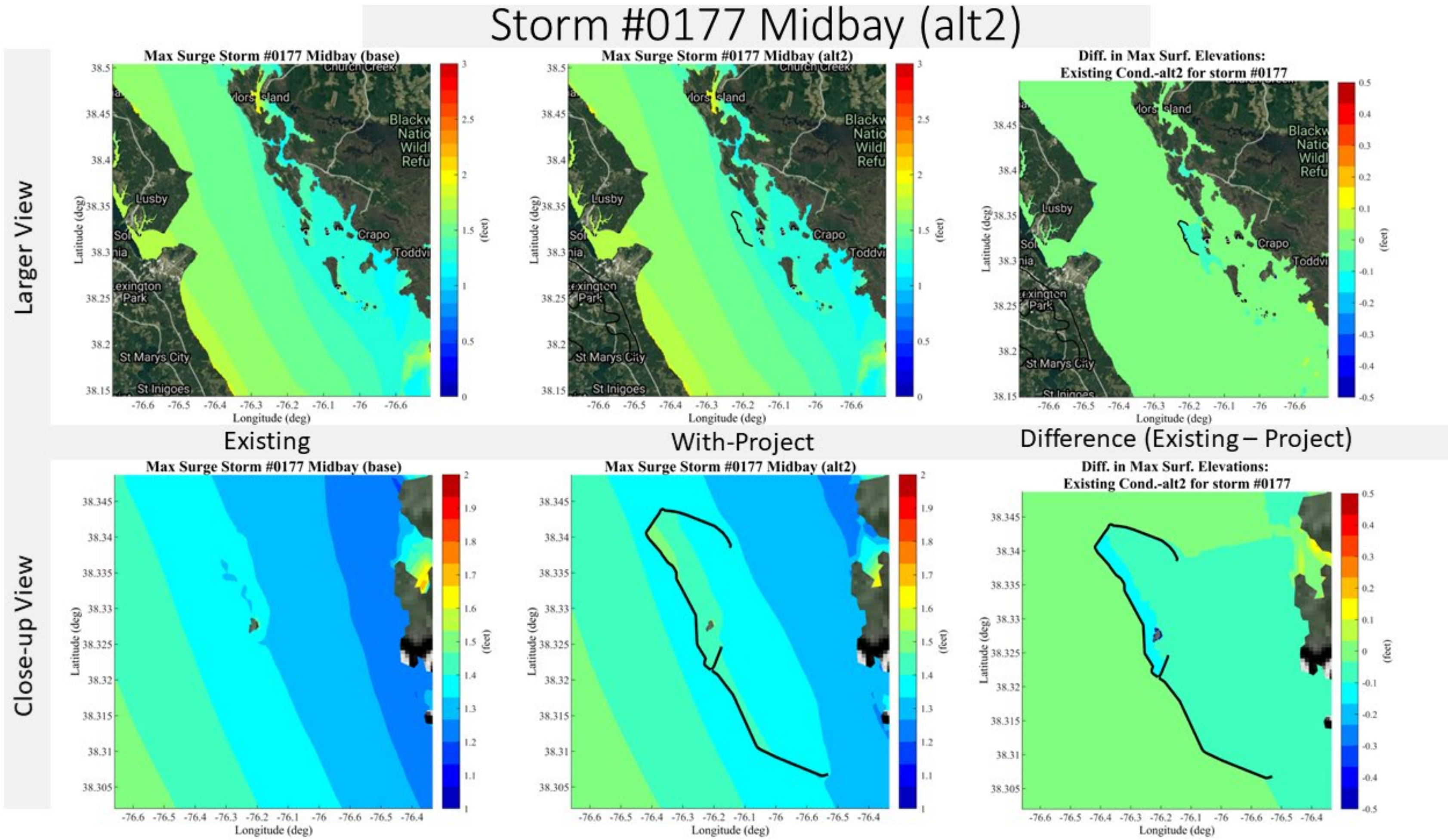

Storm #0165 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0165
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

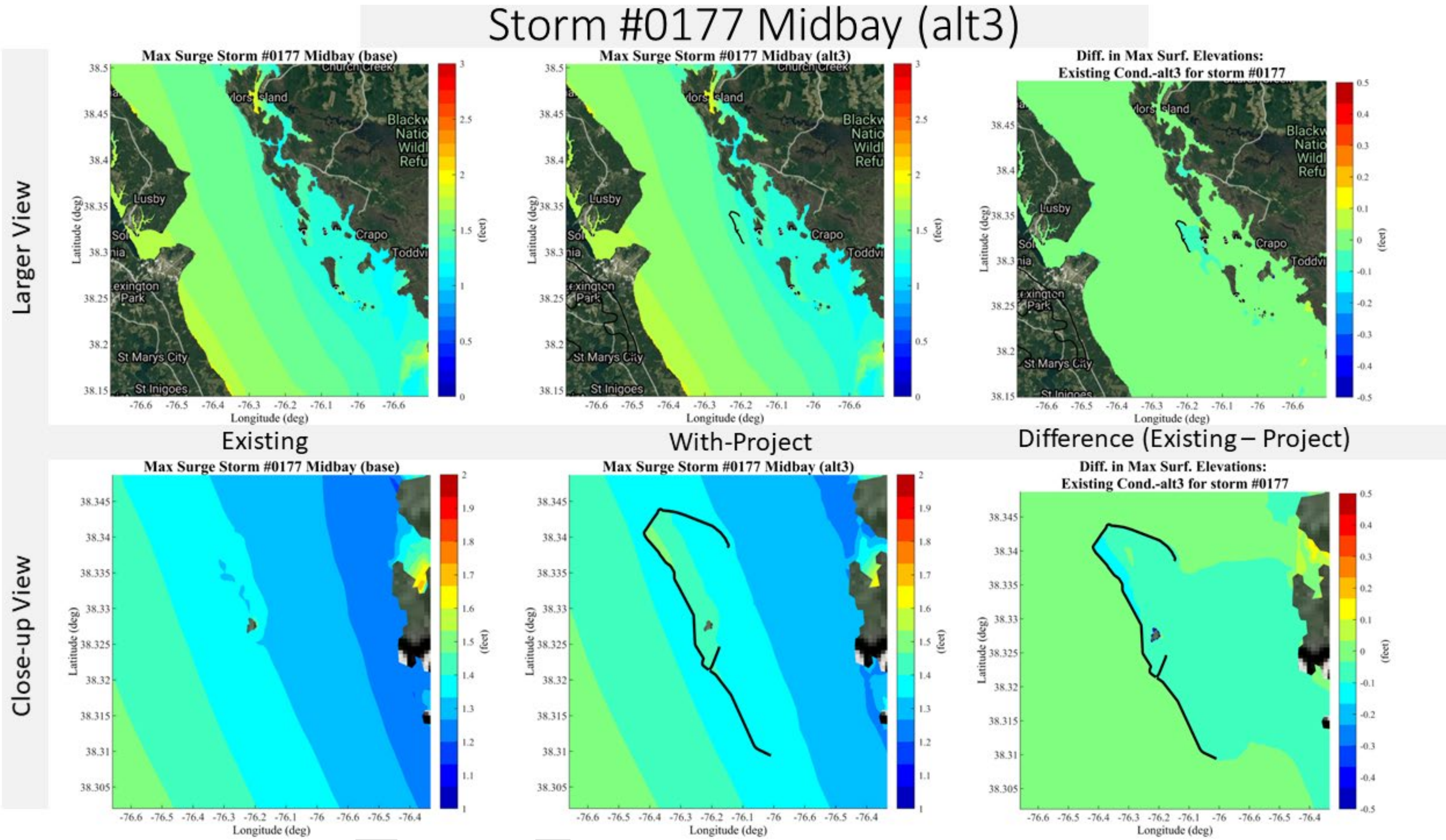

Storm #0165 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0165
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

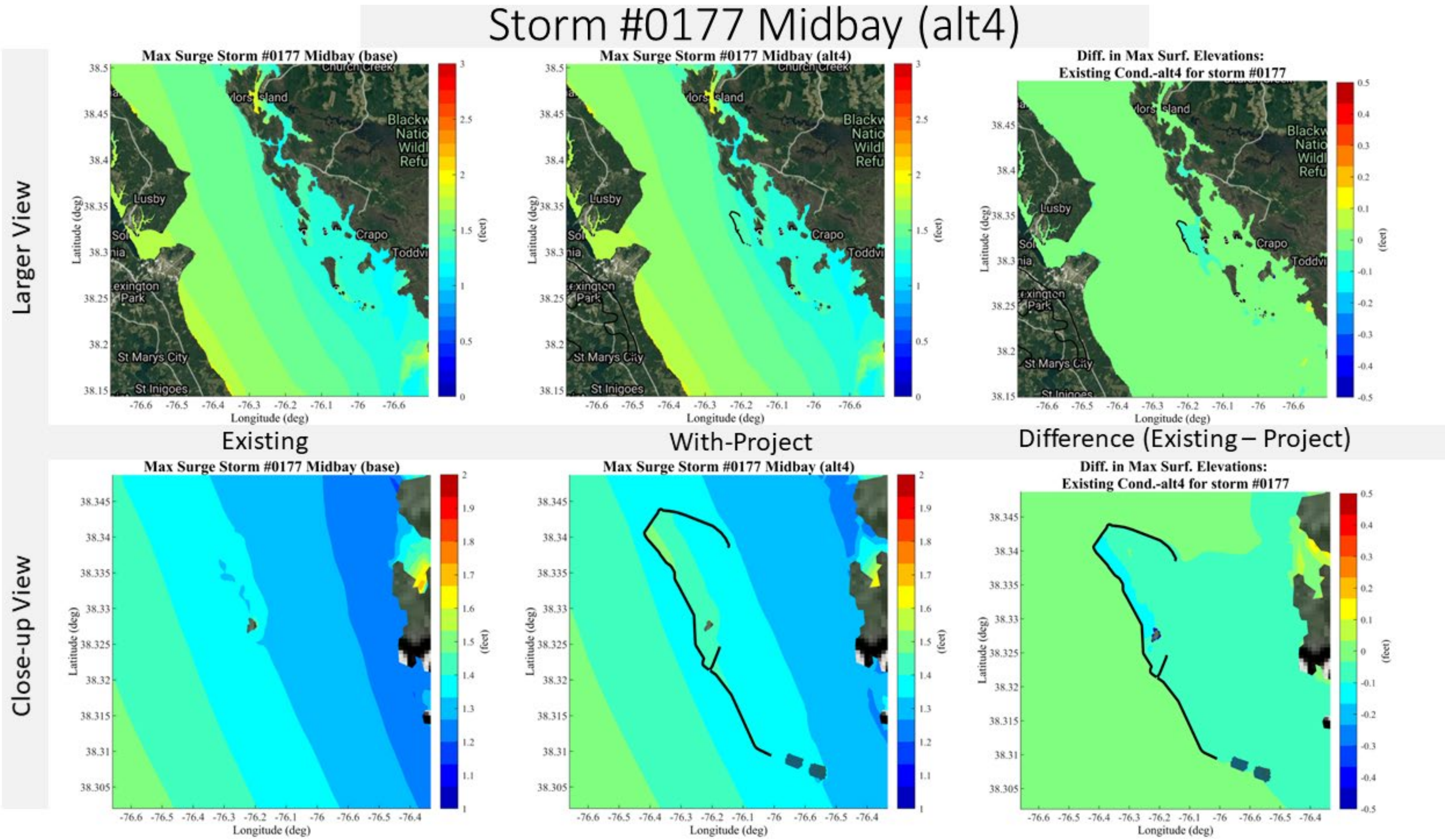

Storm #0165 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0165
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek
Taylors Island
Blackwater
Crapo
Toddville

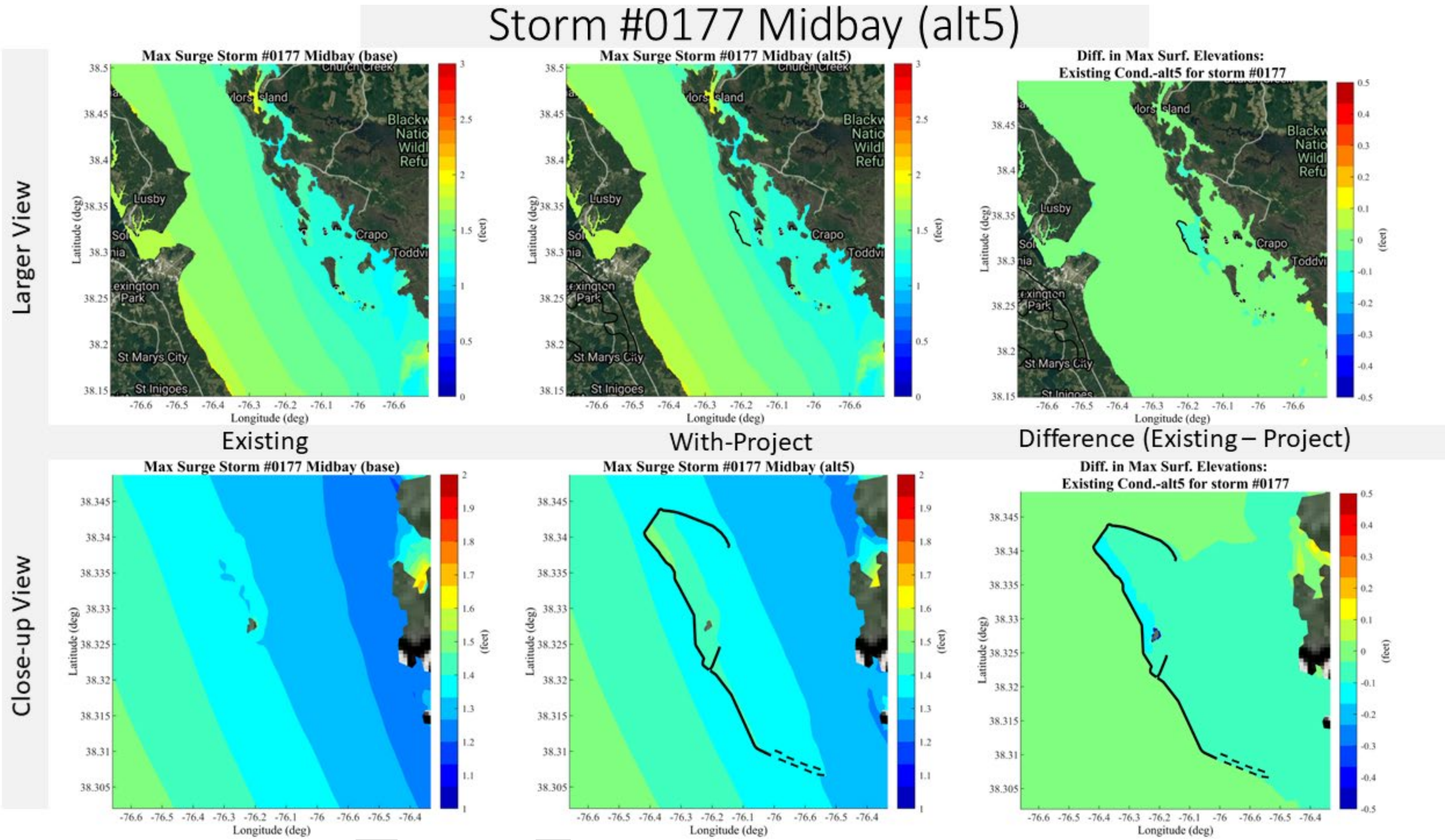

Storm #0165 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0165 Midbay (base)
Max Surge Storm #0165 Midbay (alt6)
Diff. in Max Surf. Elevations: Existing Cond.-alt6 for storm #0165
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

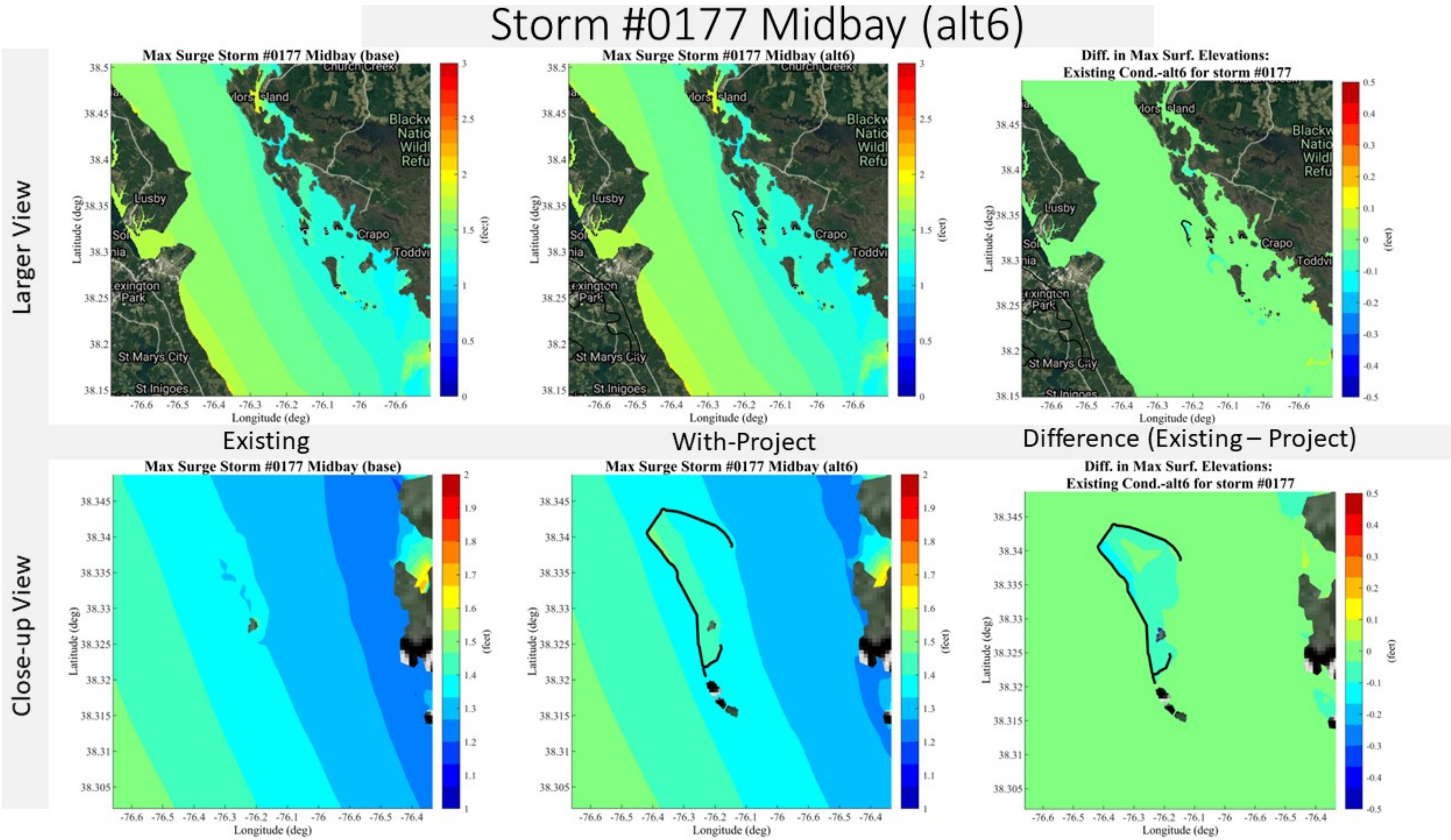

Storm #0177 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Church Creek

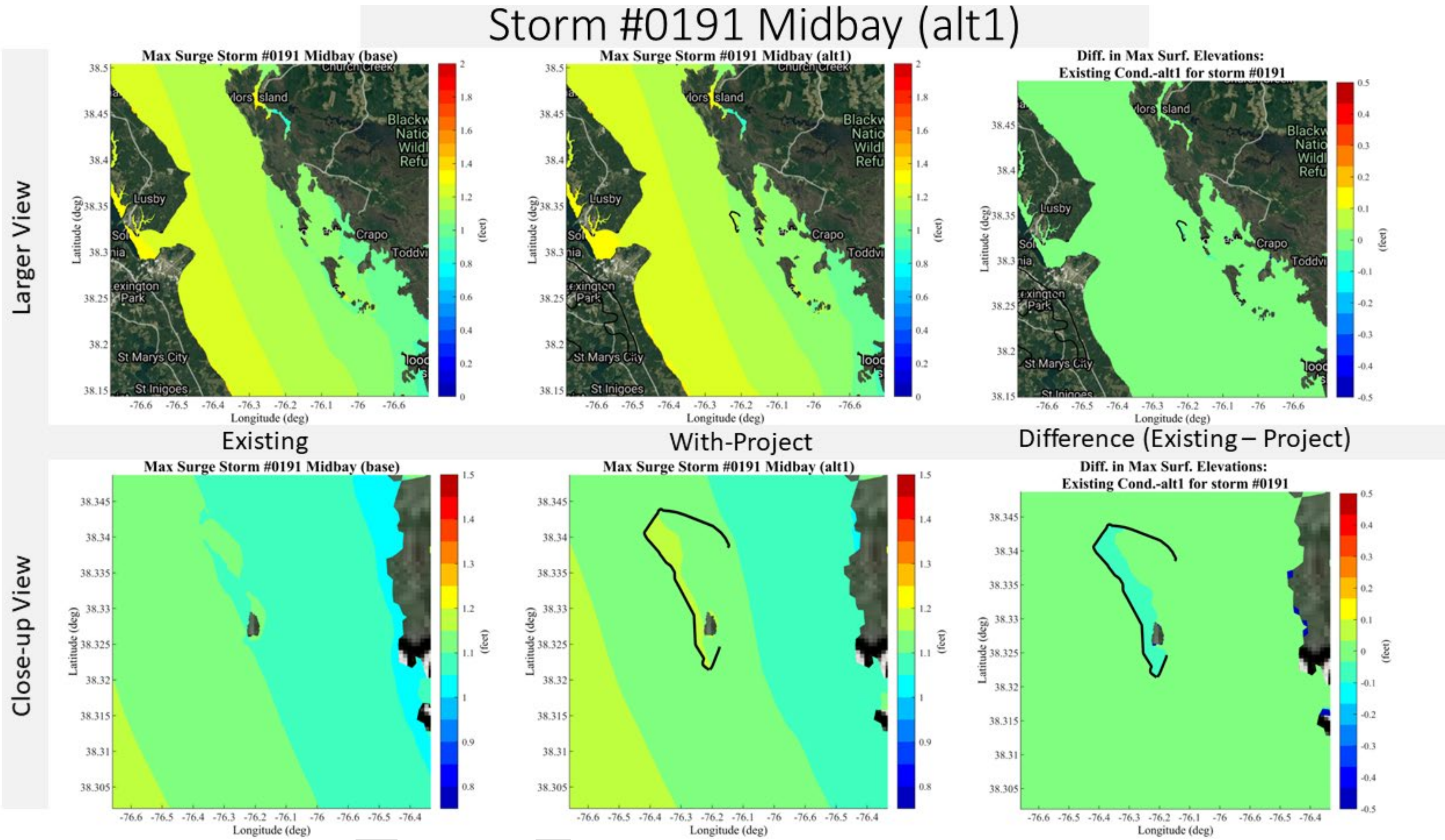

Storm #0177 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Lexington Park
St Marys City
St Inigoes
Church Creek

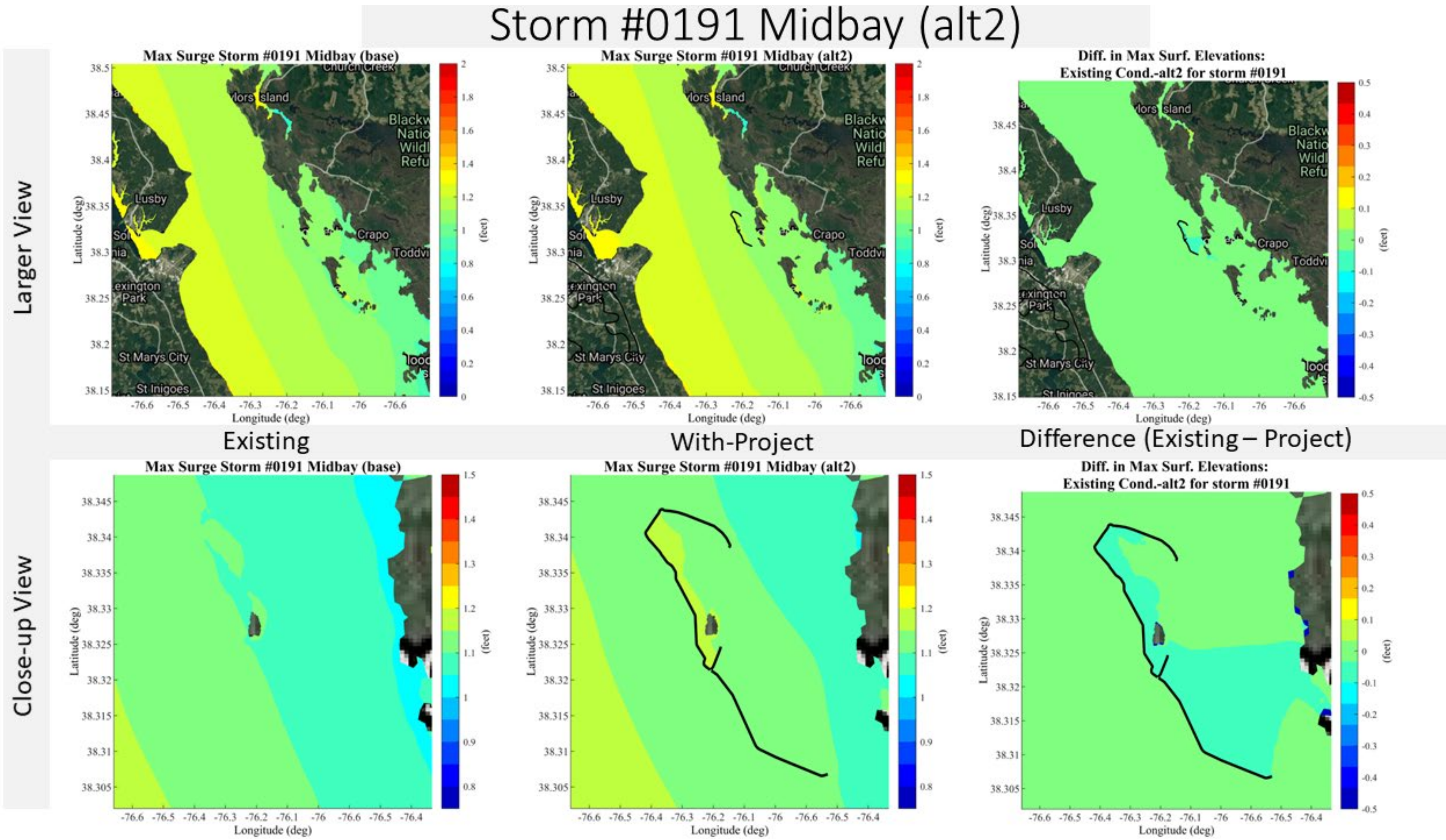

Storm #0177 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo
Lexington Park

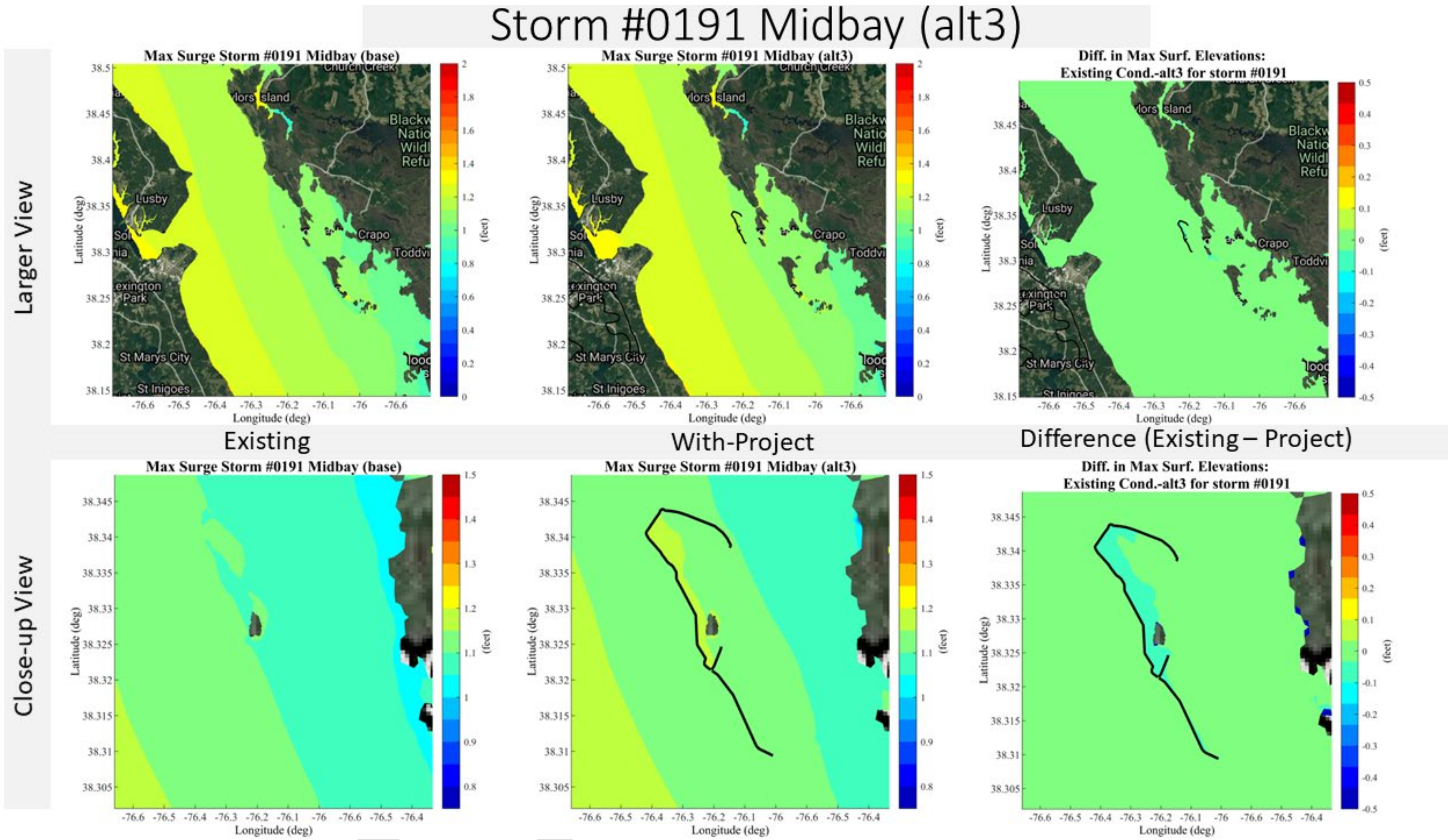

Storm #0177 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

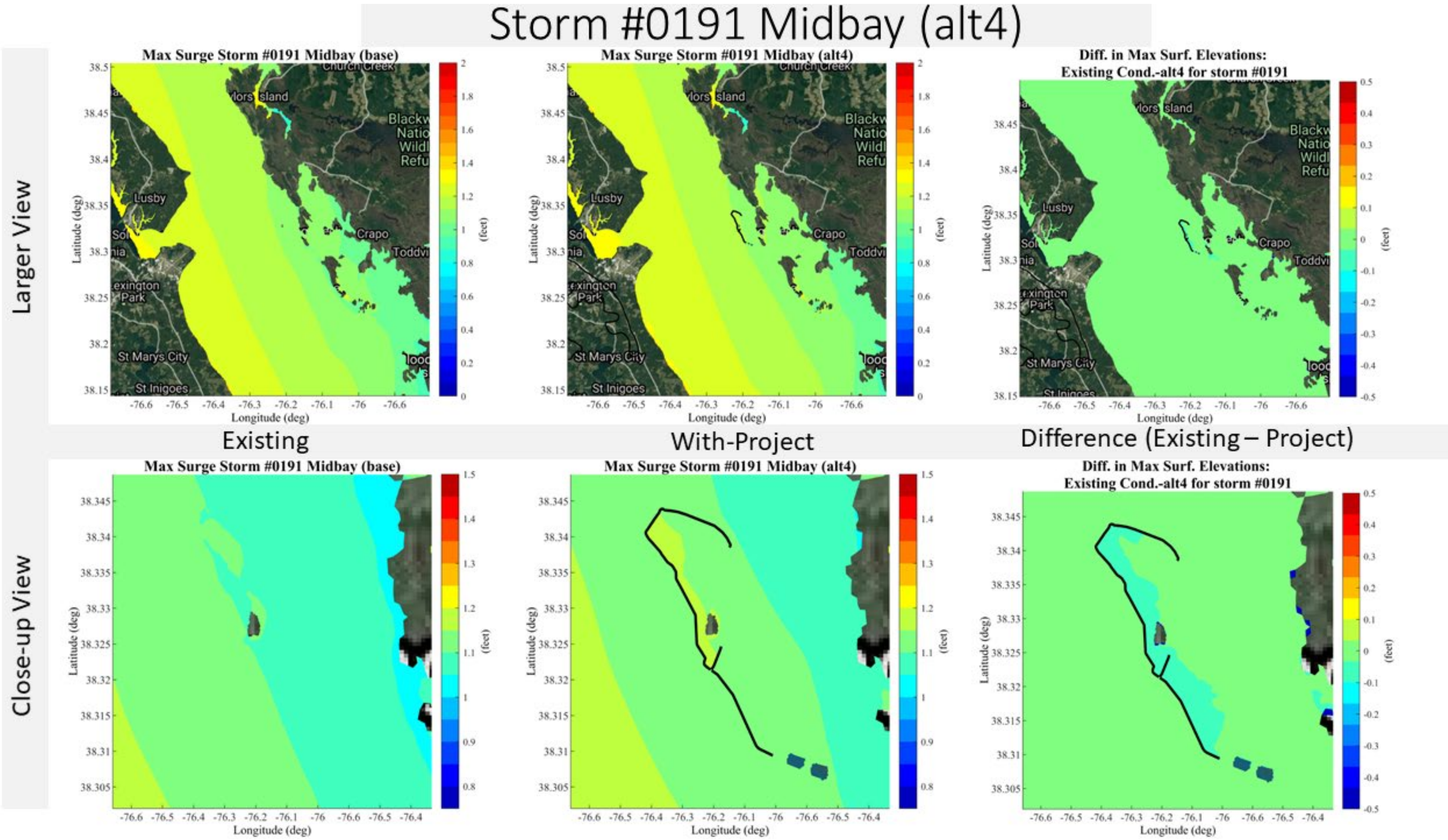

Storm #0177 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt5)
Diff. in Max Surf. Elevations: Existing Cond.-alt5 for storm #0177
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

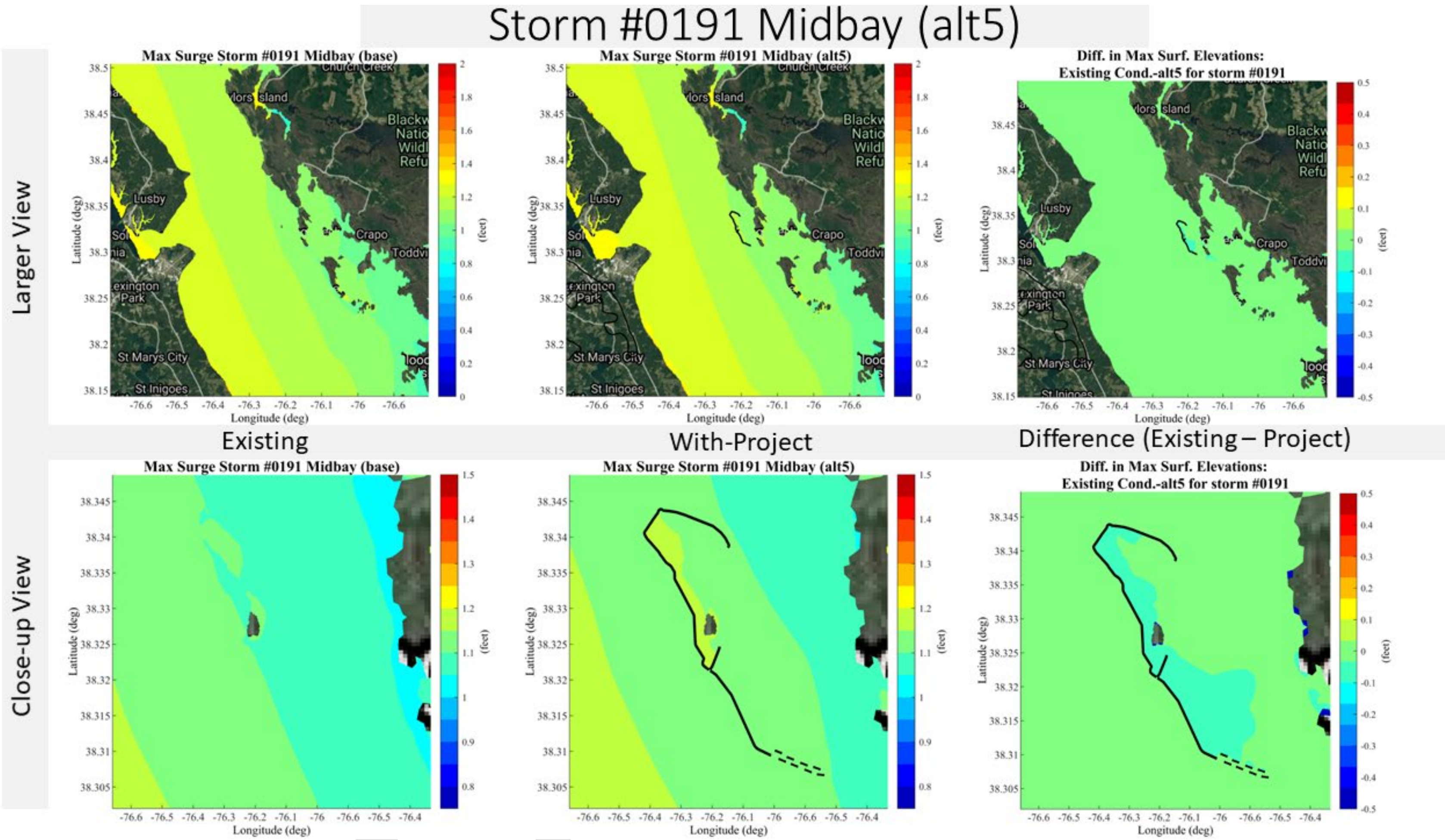

Storm #0177 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0177 Midbay (base)
Max Surge Storm #0177 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo

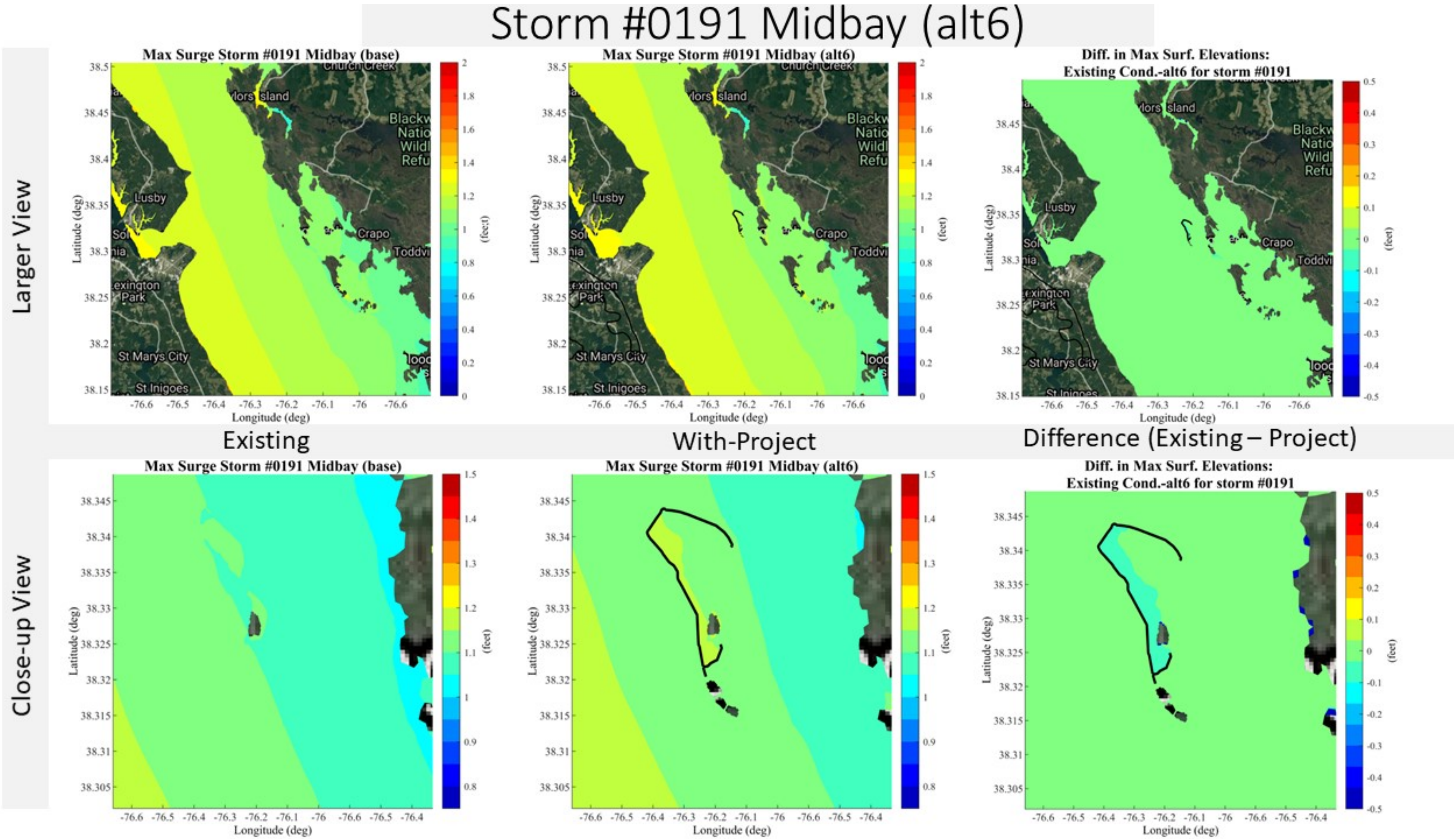

Storm #0191 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Toddvi
St Marys City
St Inigoes
Lexington Park

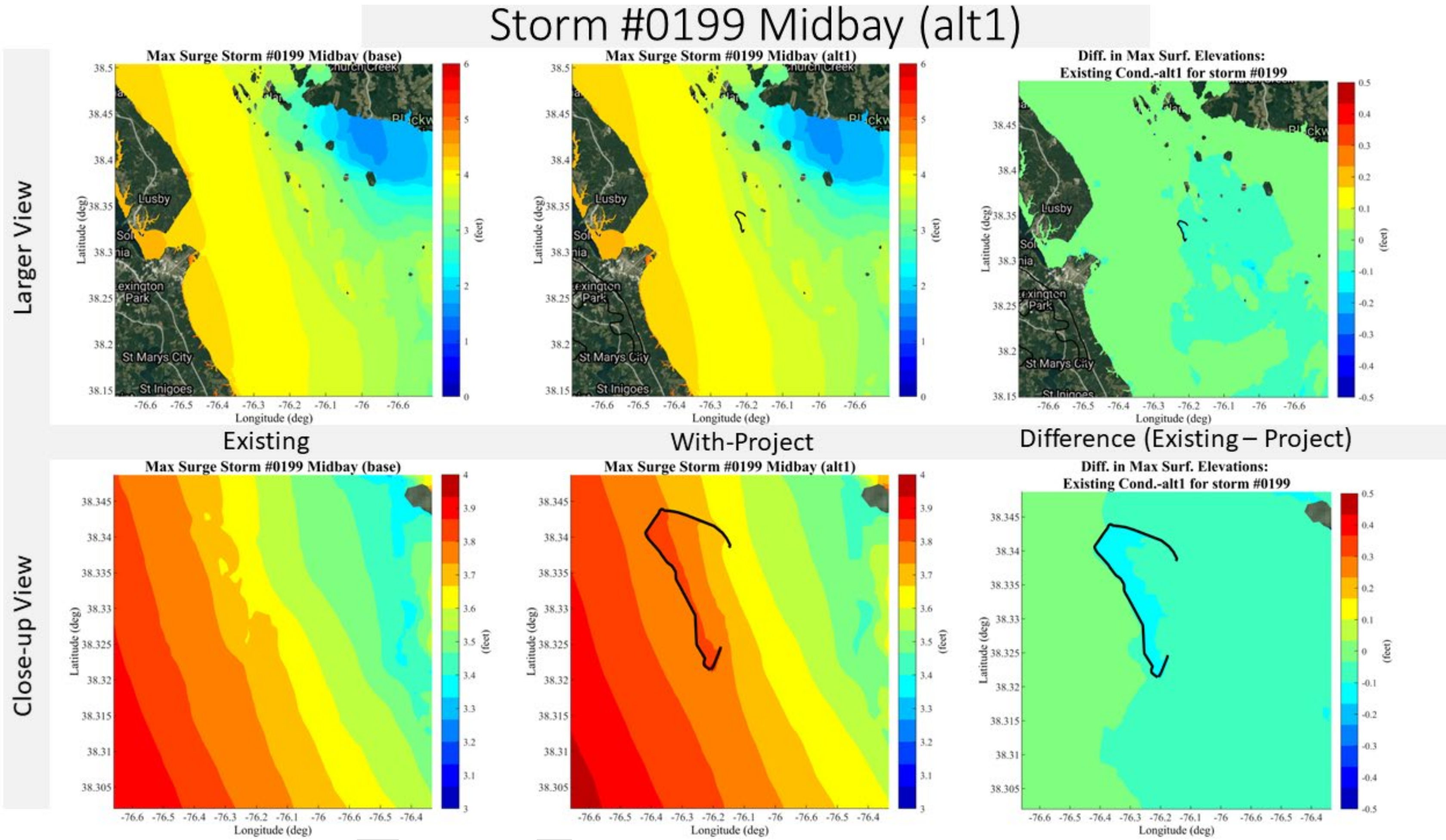

Storm #0191 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

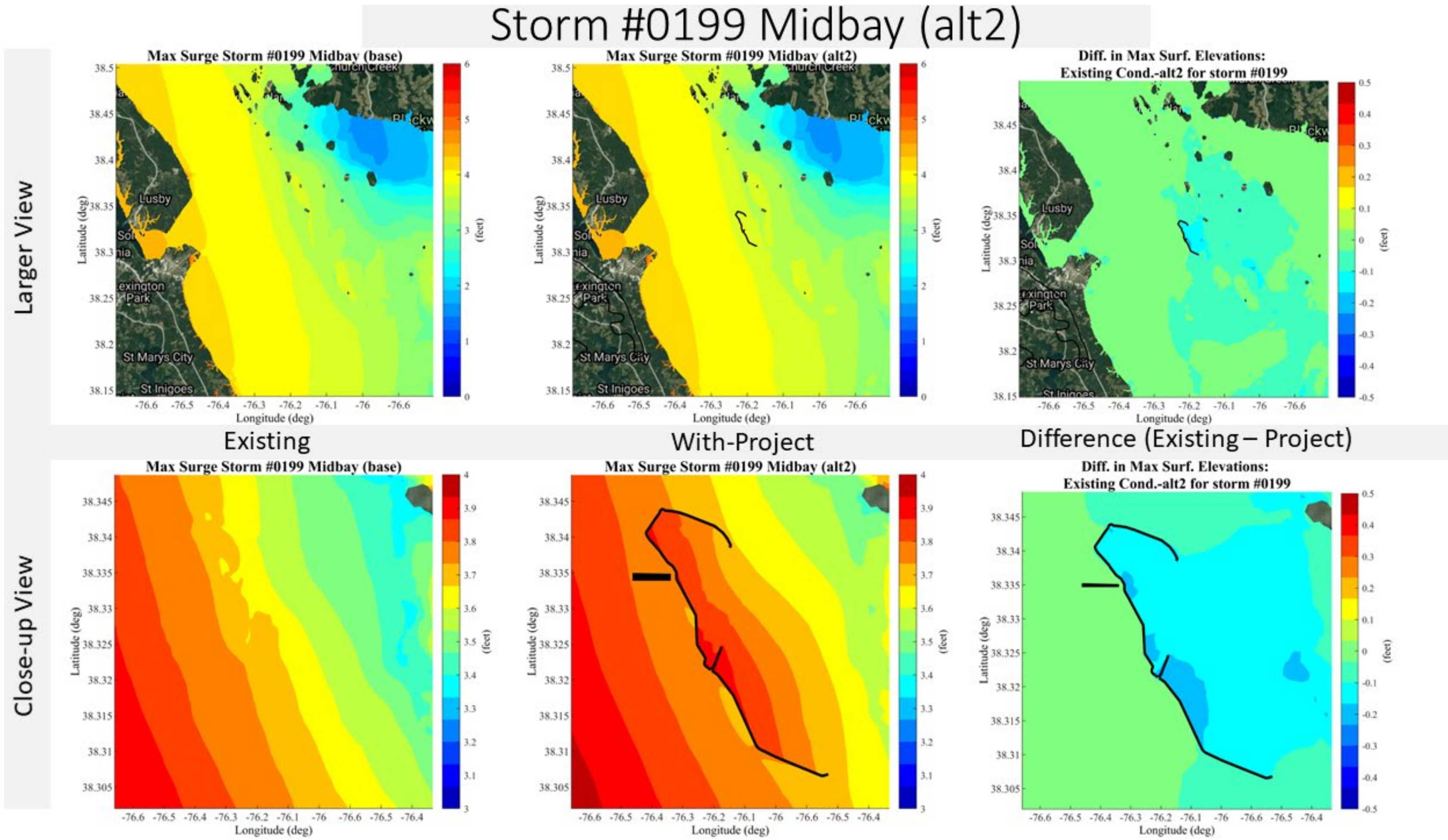

Storm #0191 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

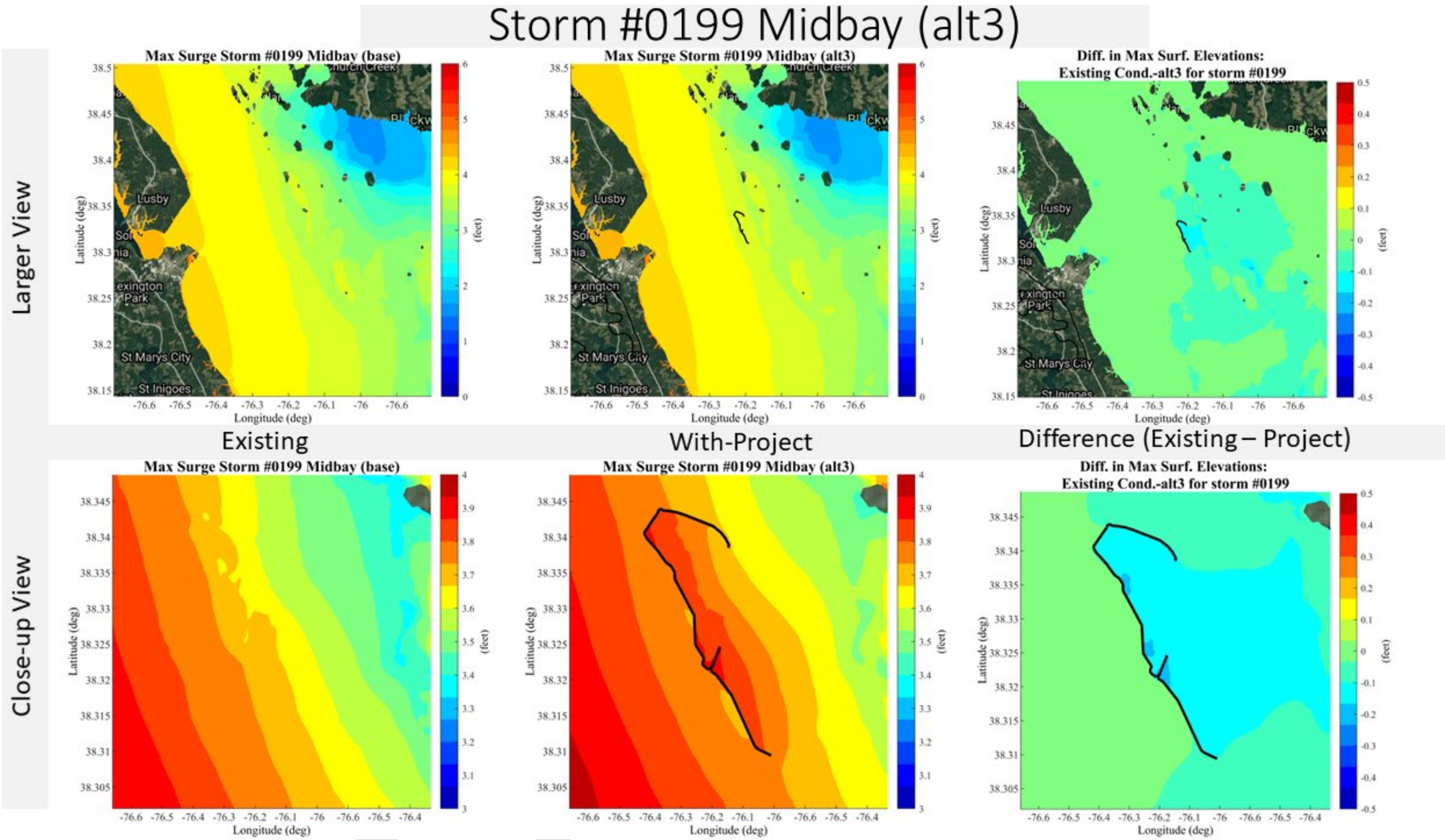

Storm #0191 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

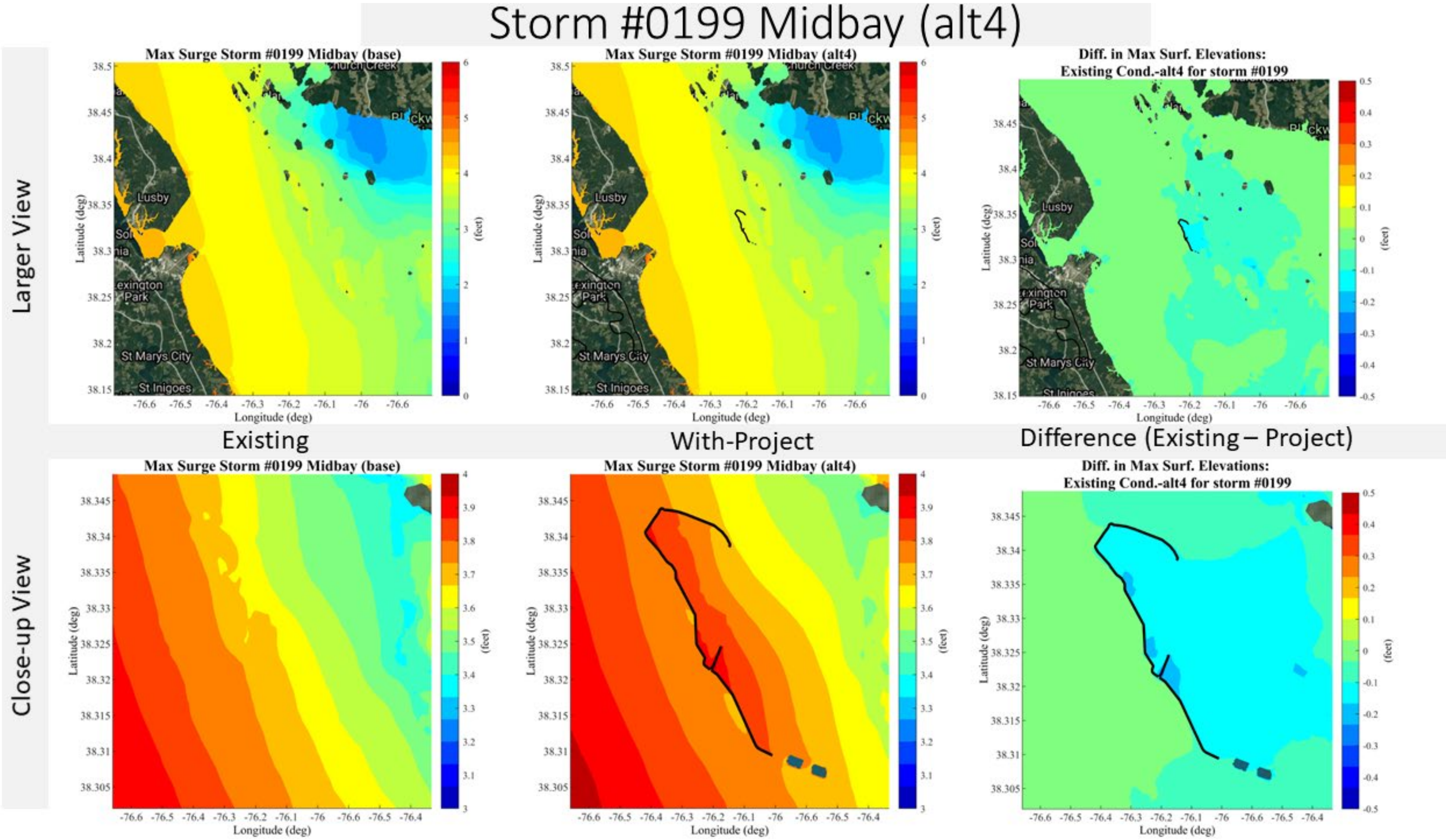

Storm #0191 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

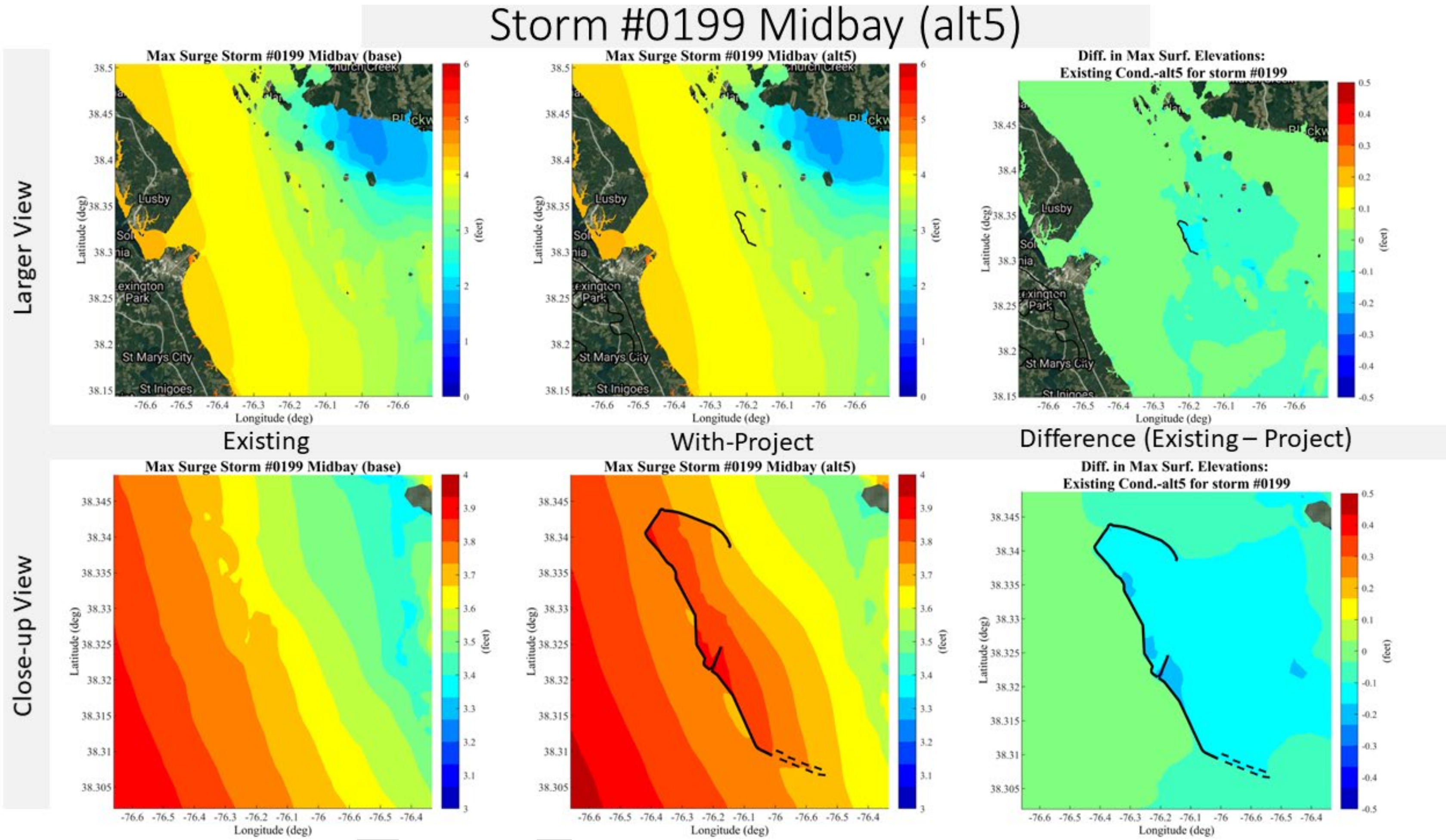

Storm #0191 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0191 Midbay (base)
Max Surge Storm #0191 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0191
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

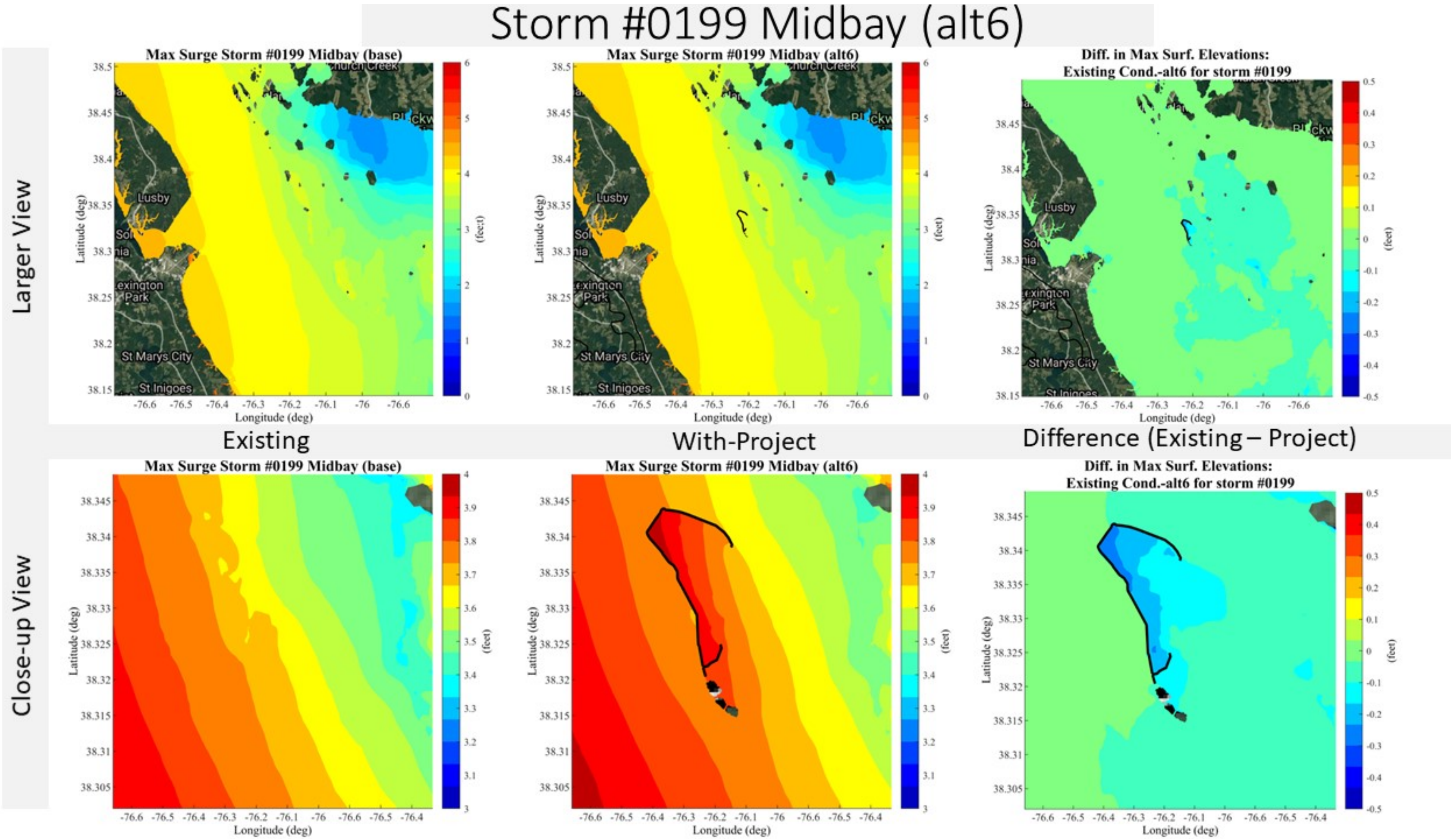

Storm #0199 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt1)
Diff. in Max Surf. Elevations: Existing Cond.-alt1 for storm #0199
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

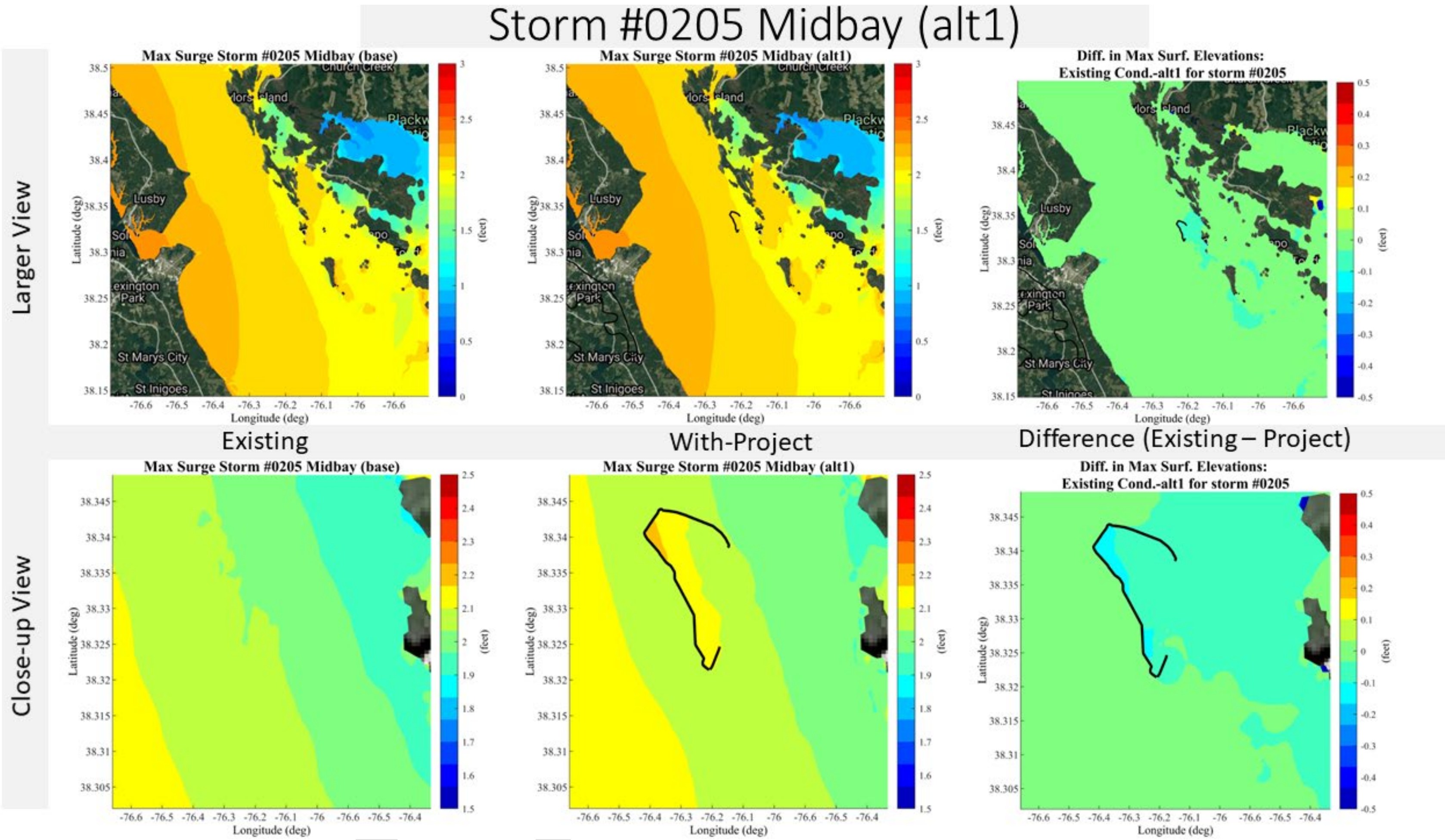

Storm #0199 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0199
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

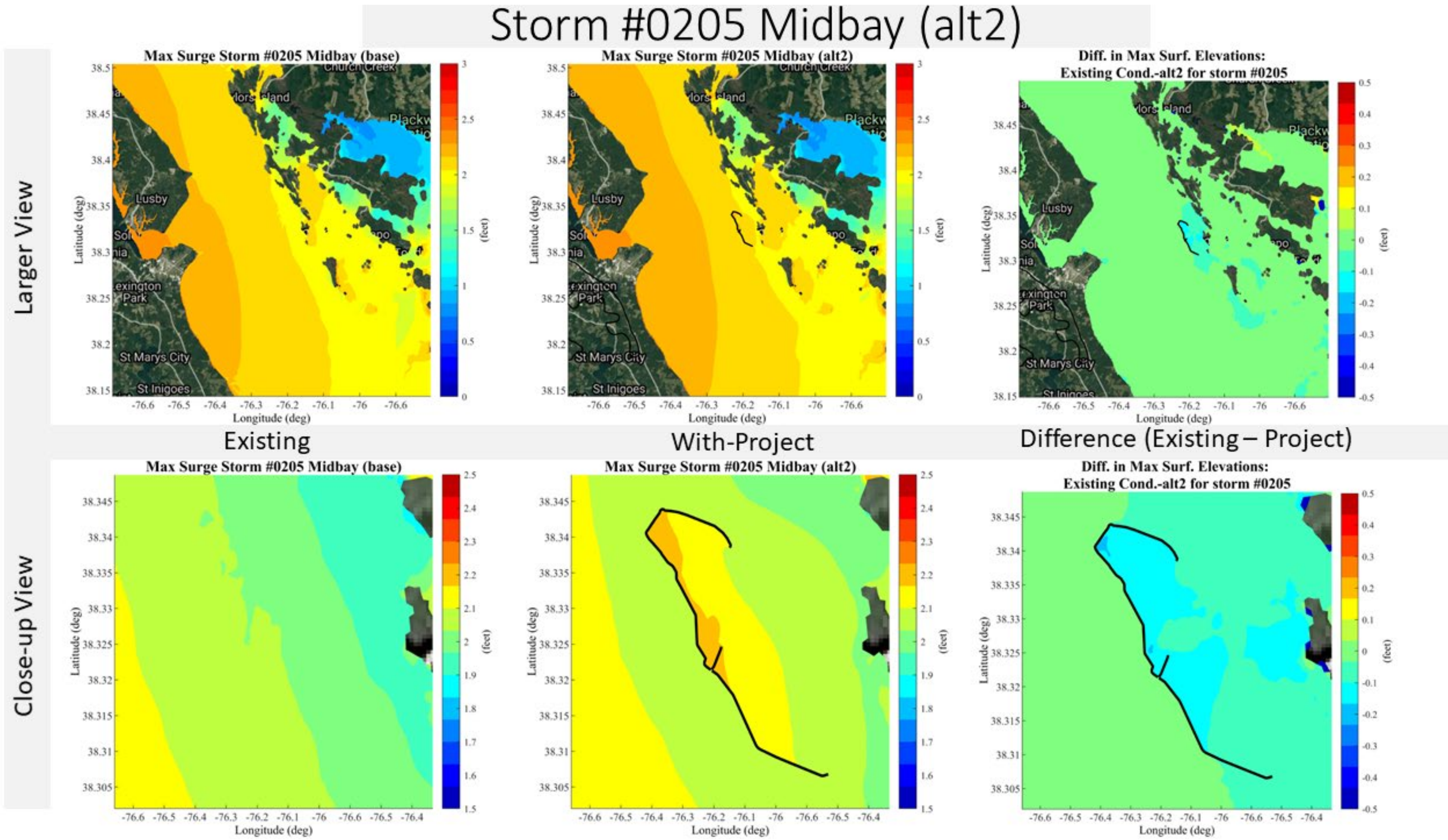

Storm #0199 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

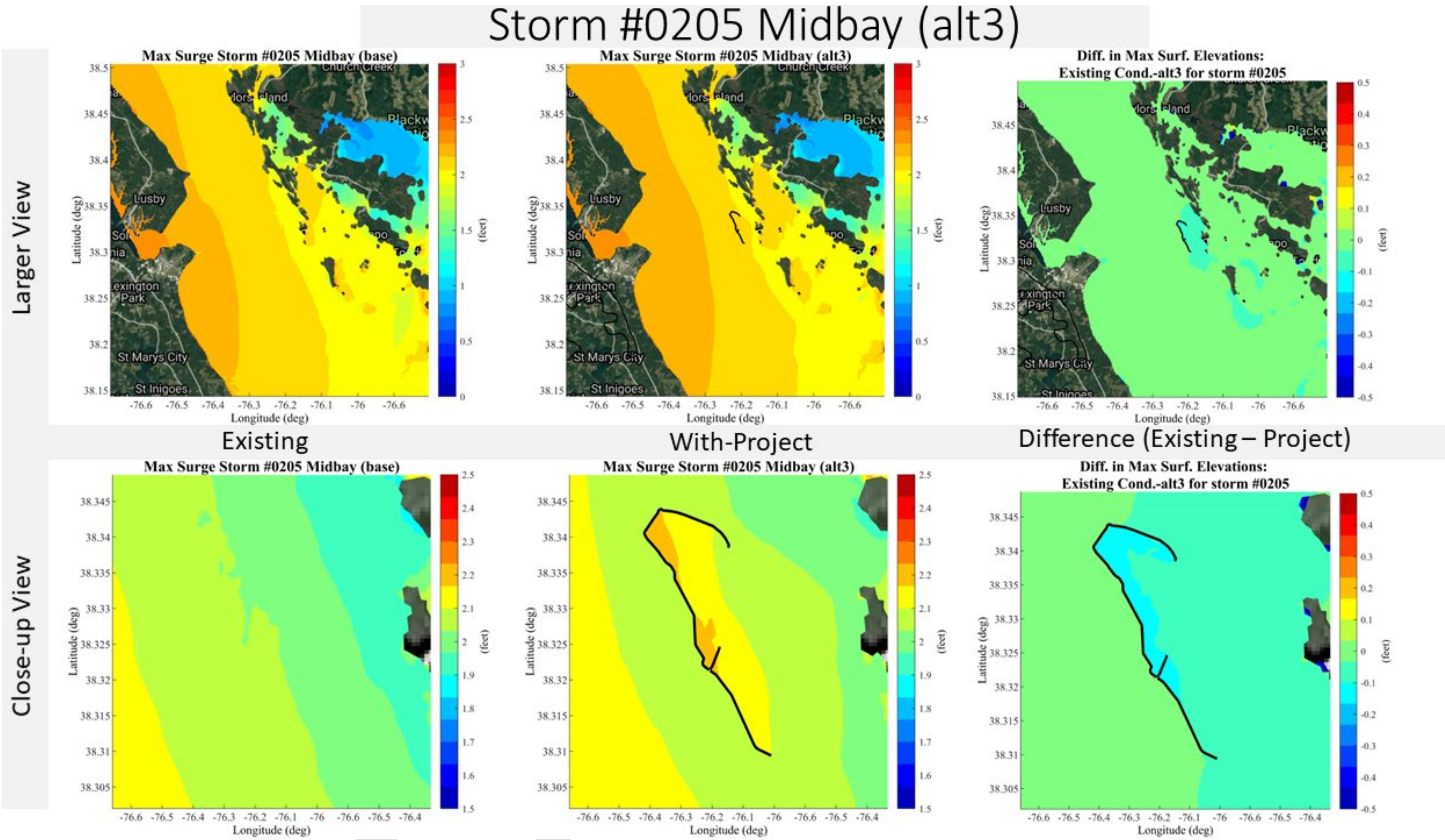

Storm #0199 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

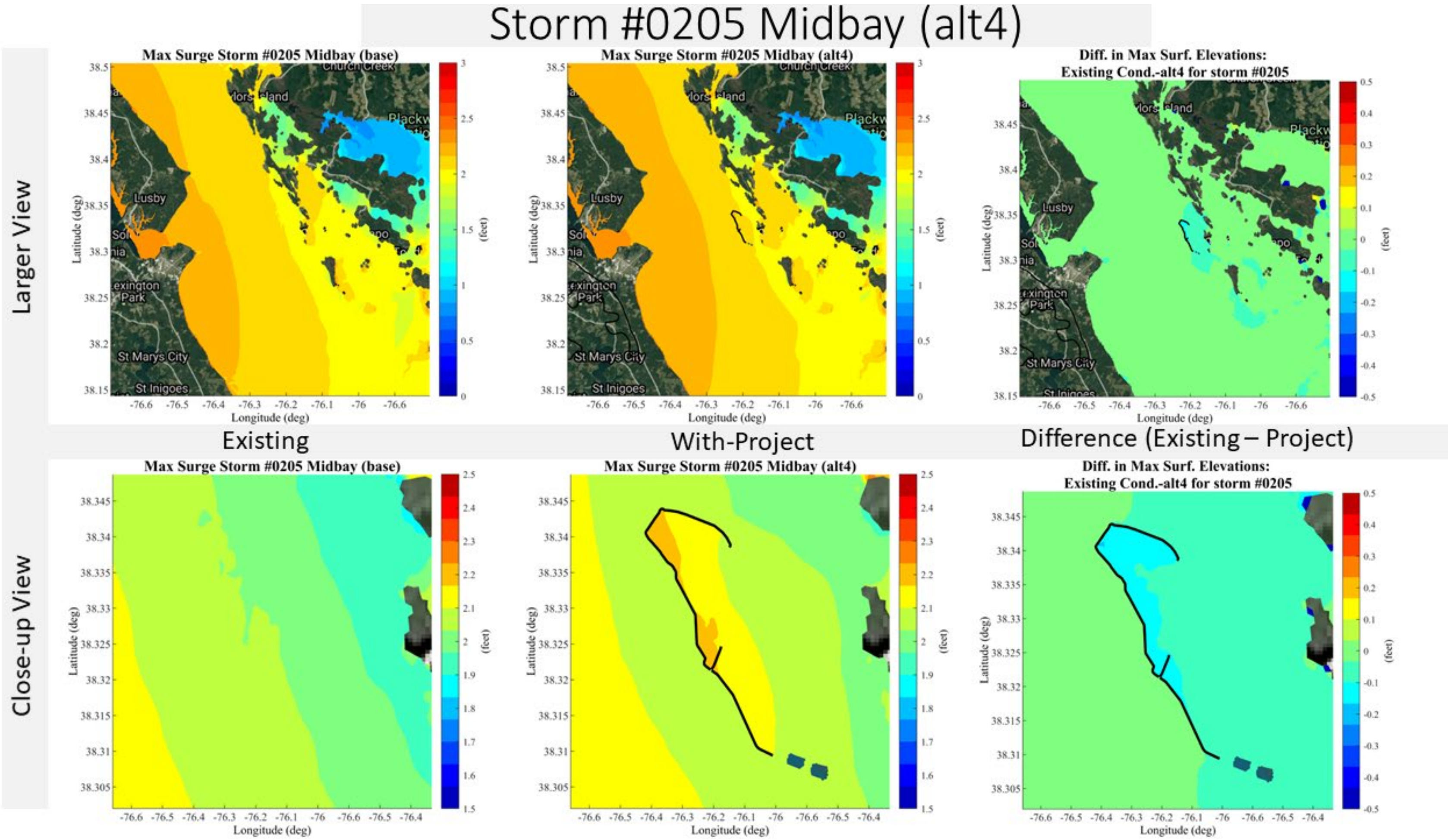

Storm #0199 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

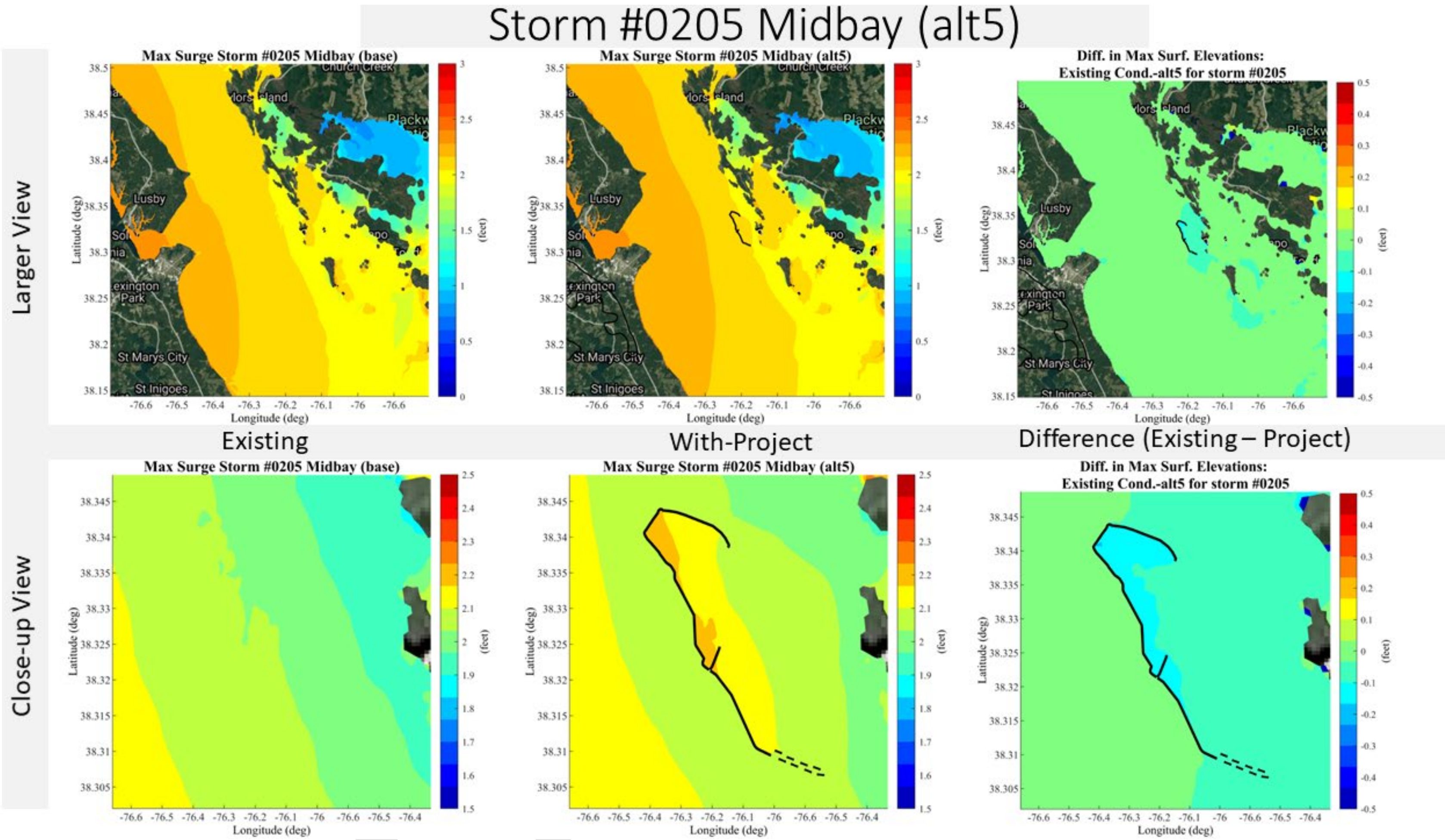

Storm #0199 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0199 Midbay (base)
Max Surge Storm #0199 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0199
Latitude (deg)
Longitude (deg)
(feet)

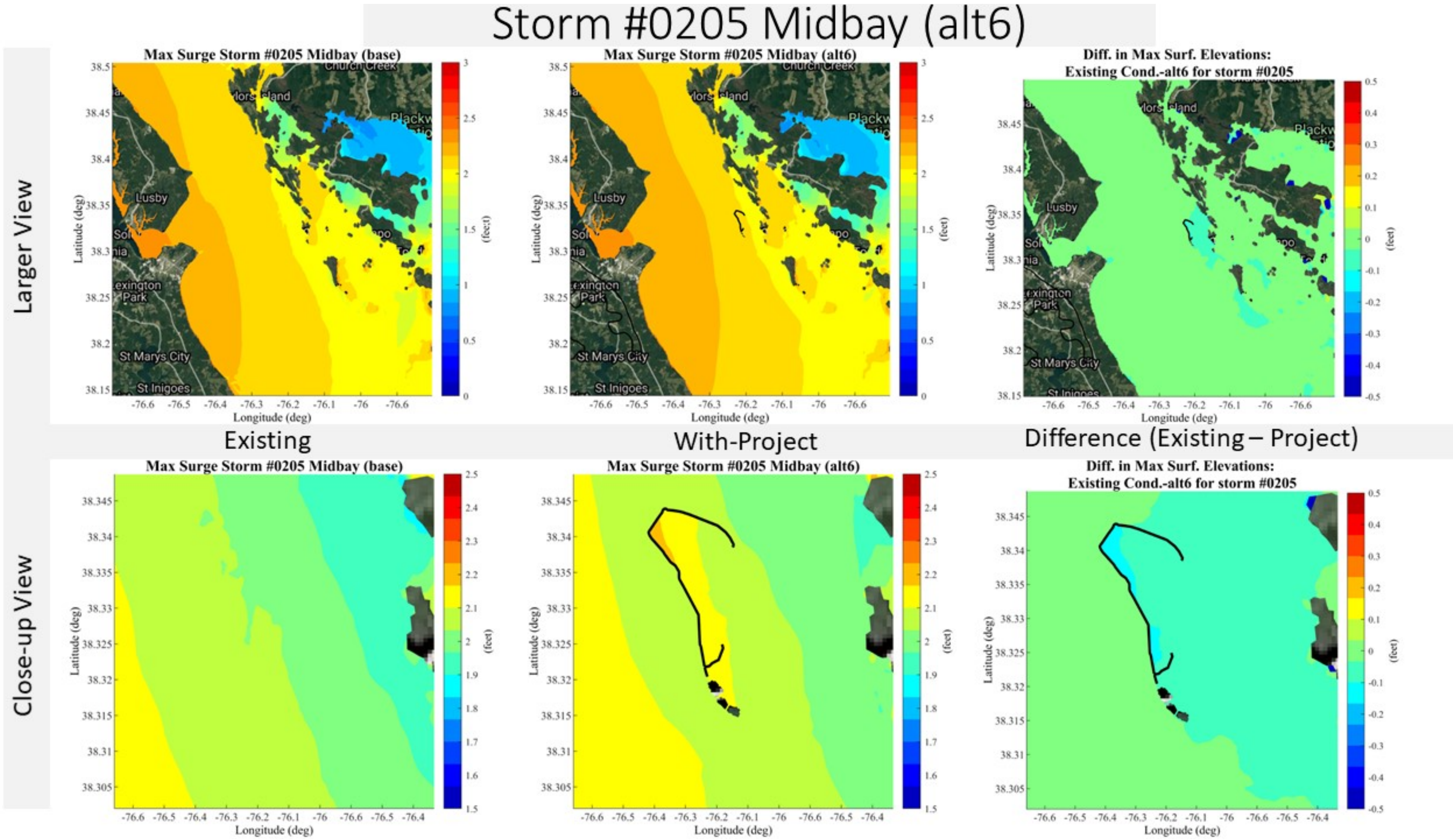

Storm #0205 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0205
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

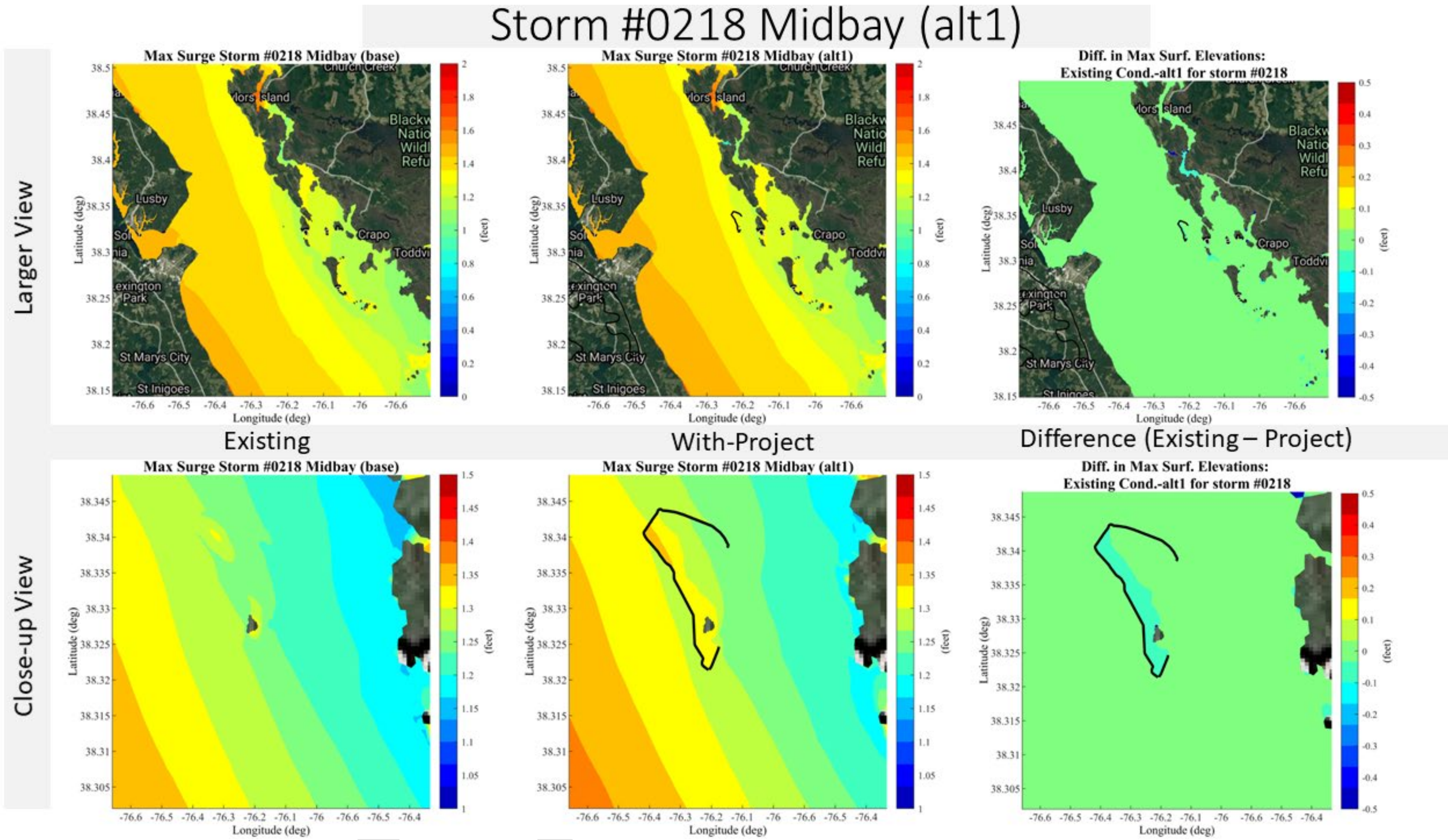

Storm #0205 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0205
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

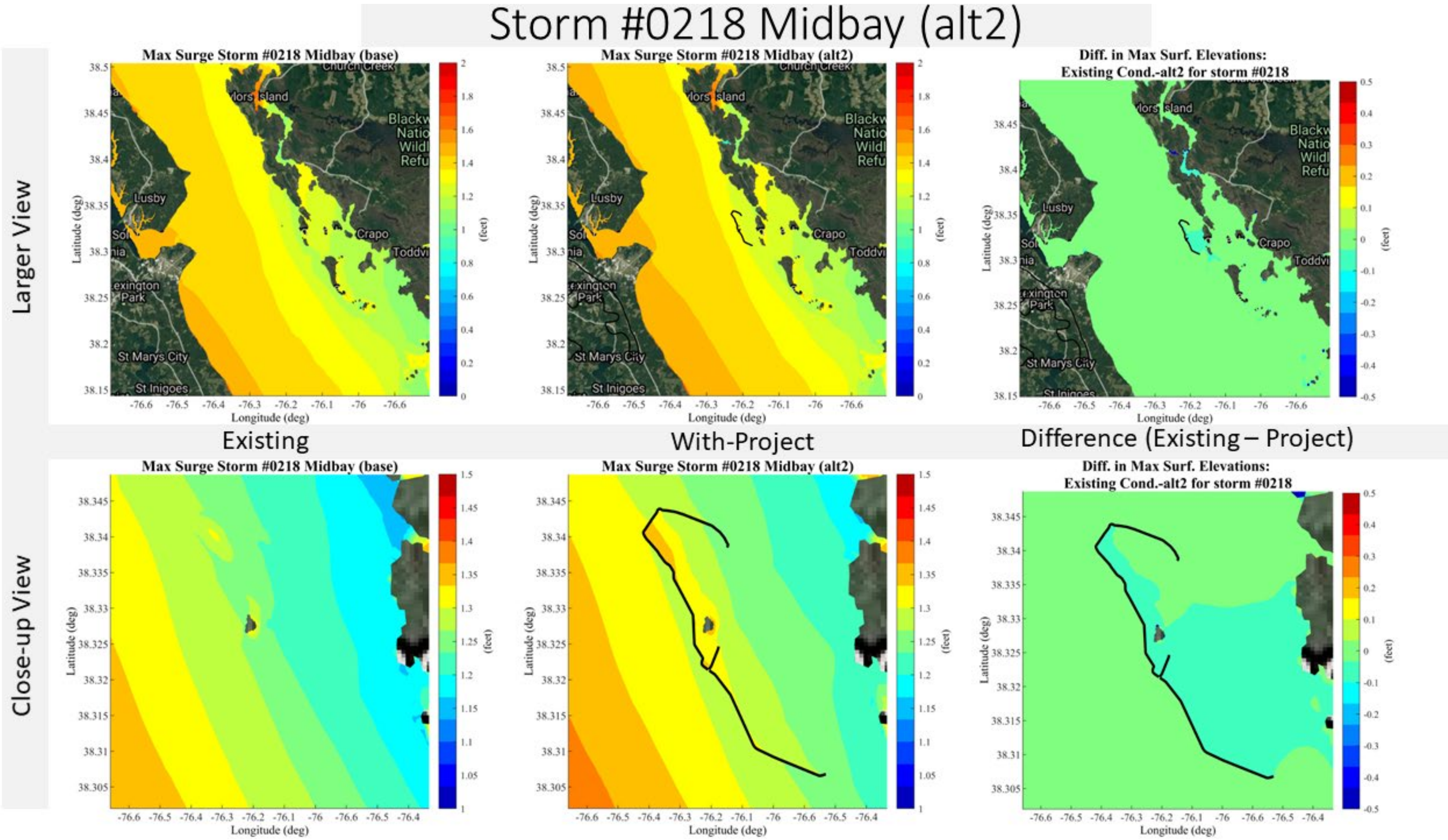

Storm #0205 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0205
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

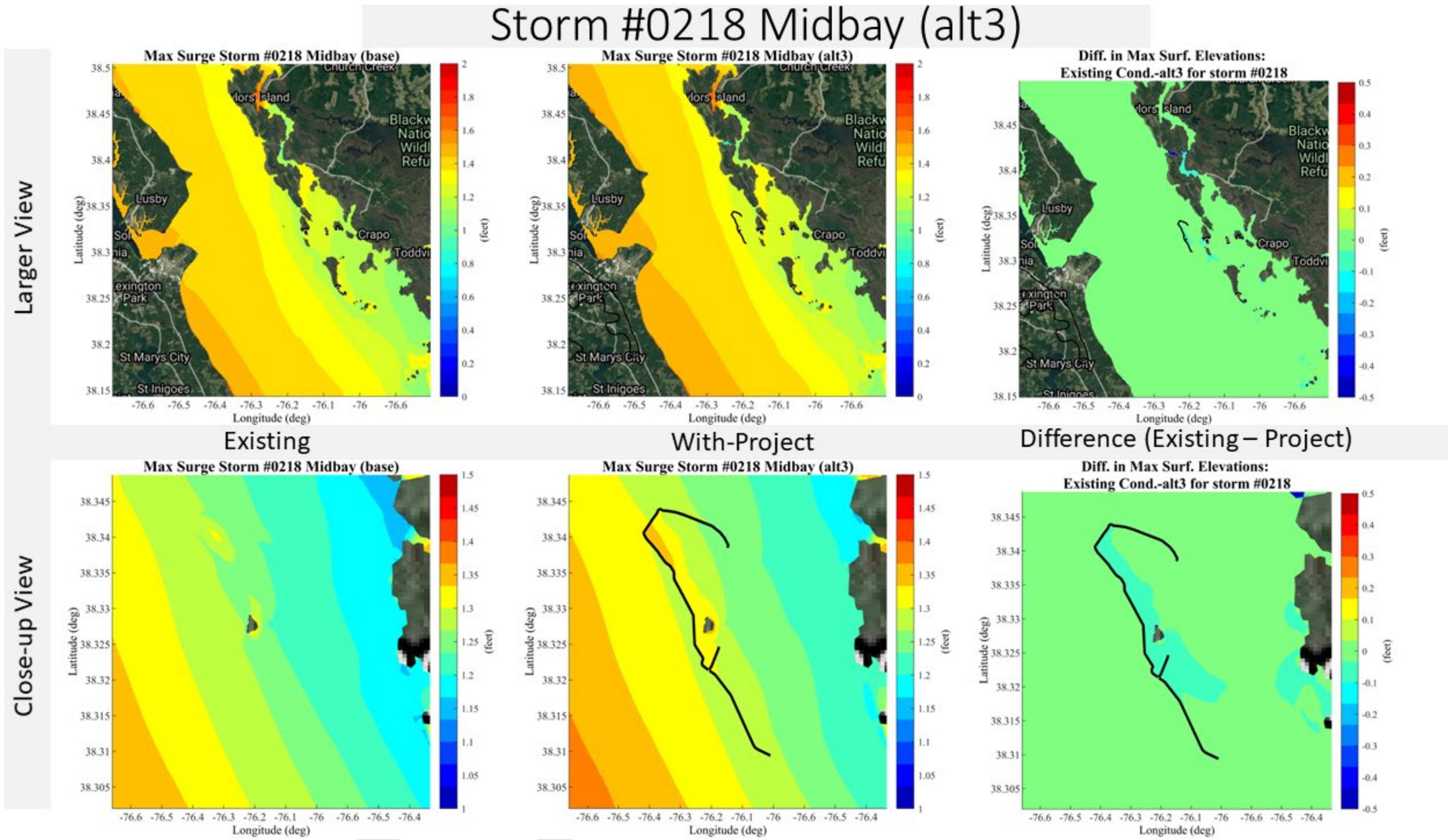

Storm #0205 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0205
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

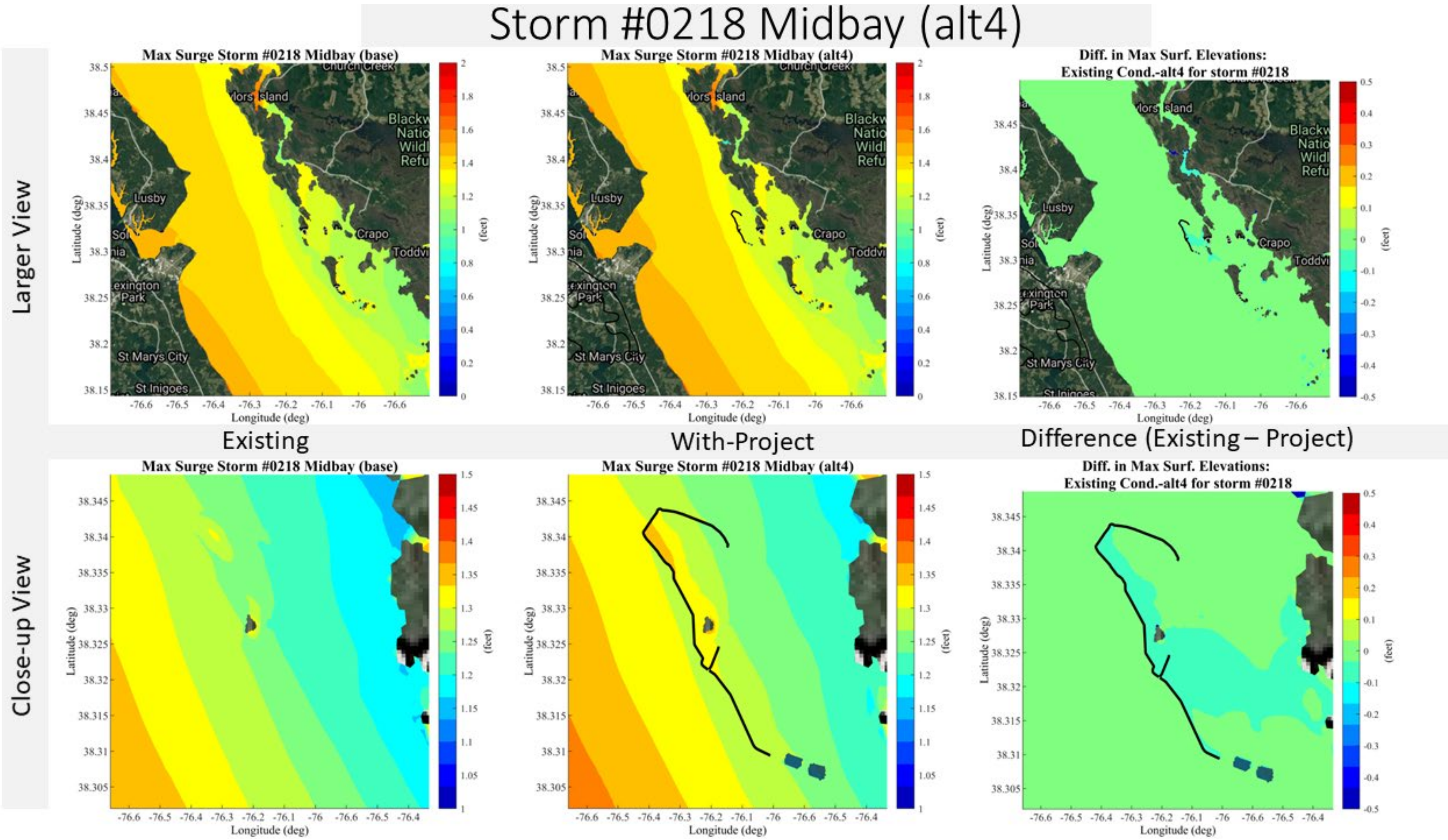

Storm #0205 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0205
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

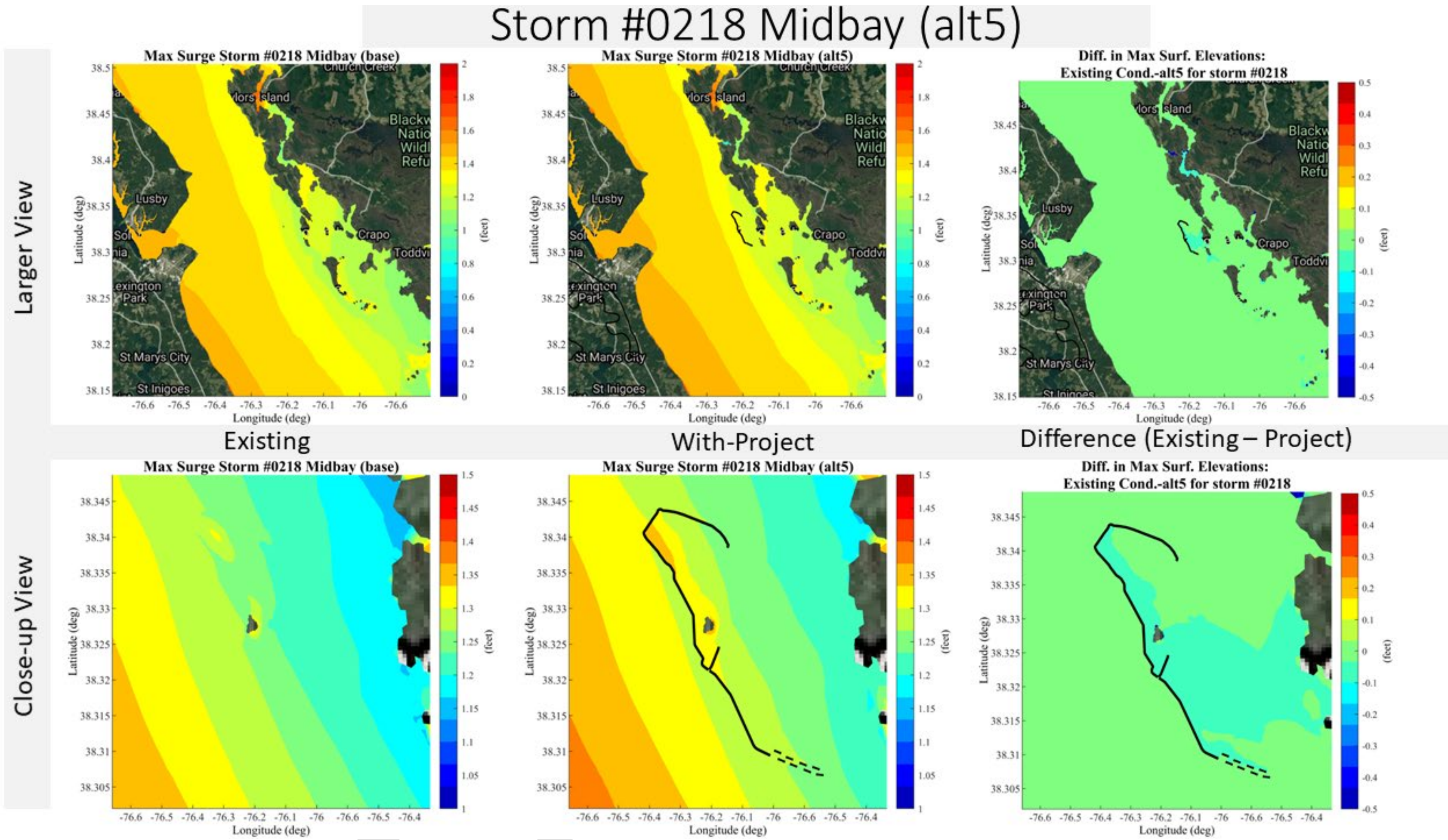

Storm #0205 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0205 Midbay (base)
Max Surge Storm #0205 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0205
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

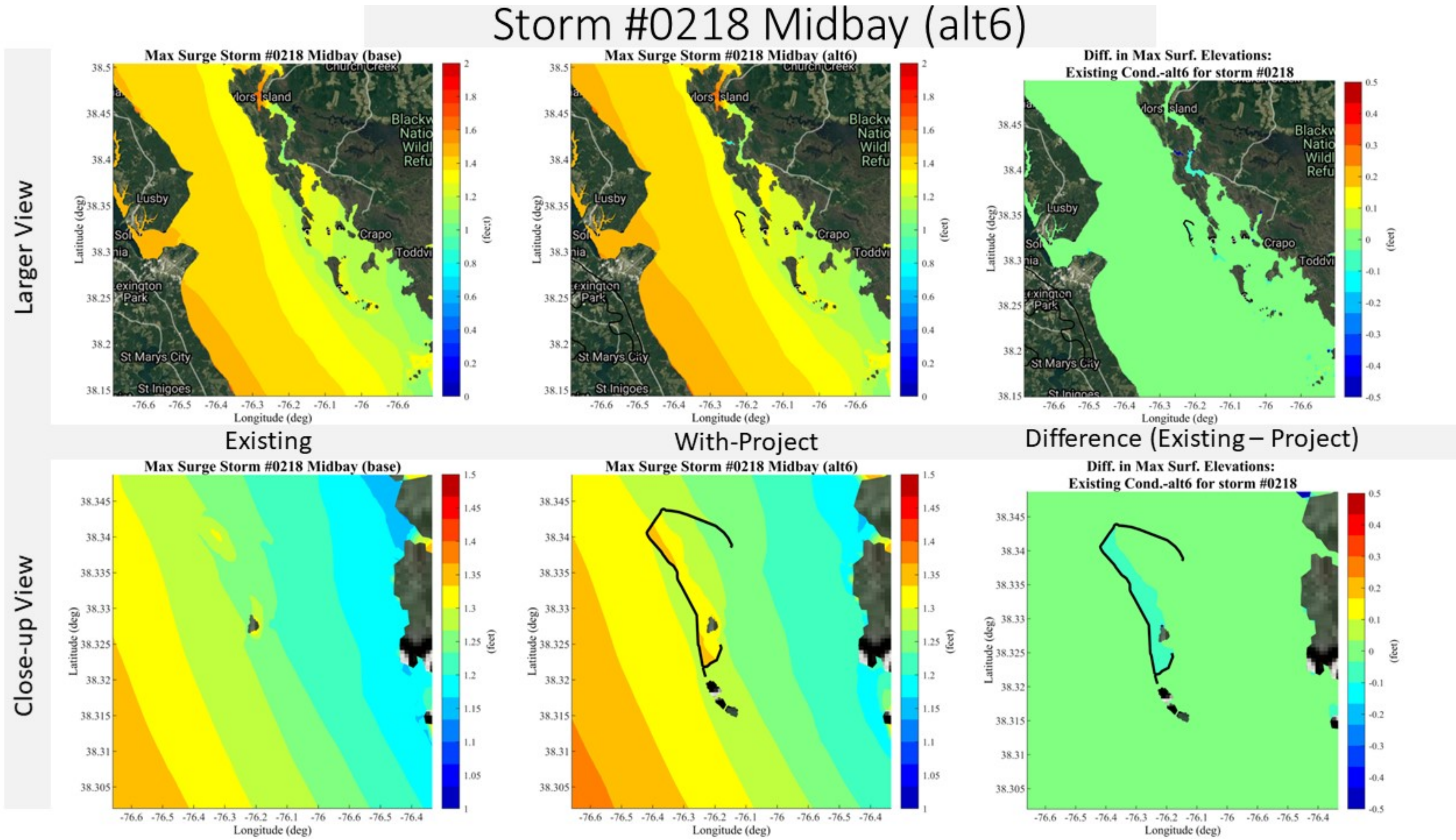

Storm #0218 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

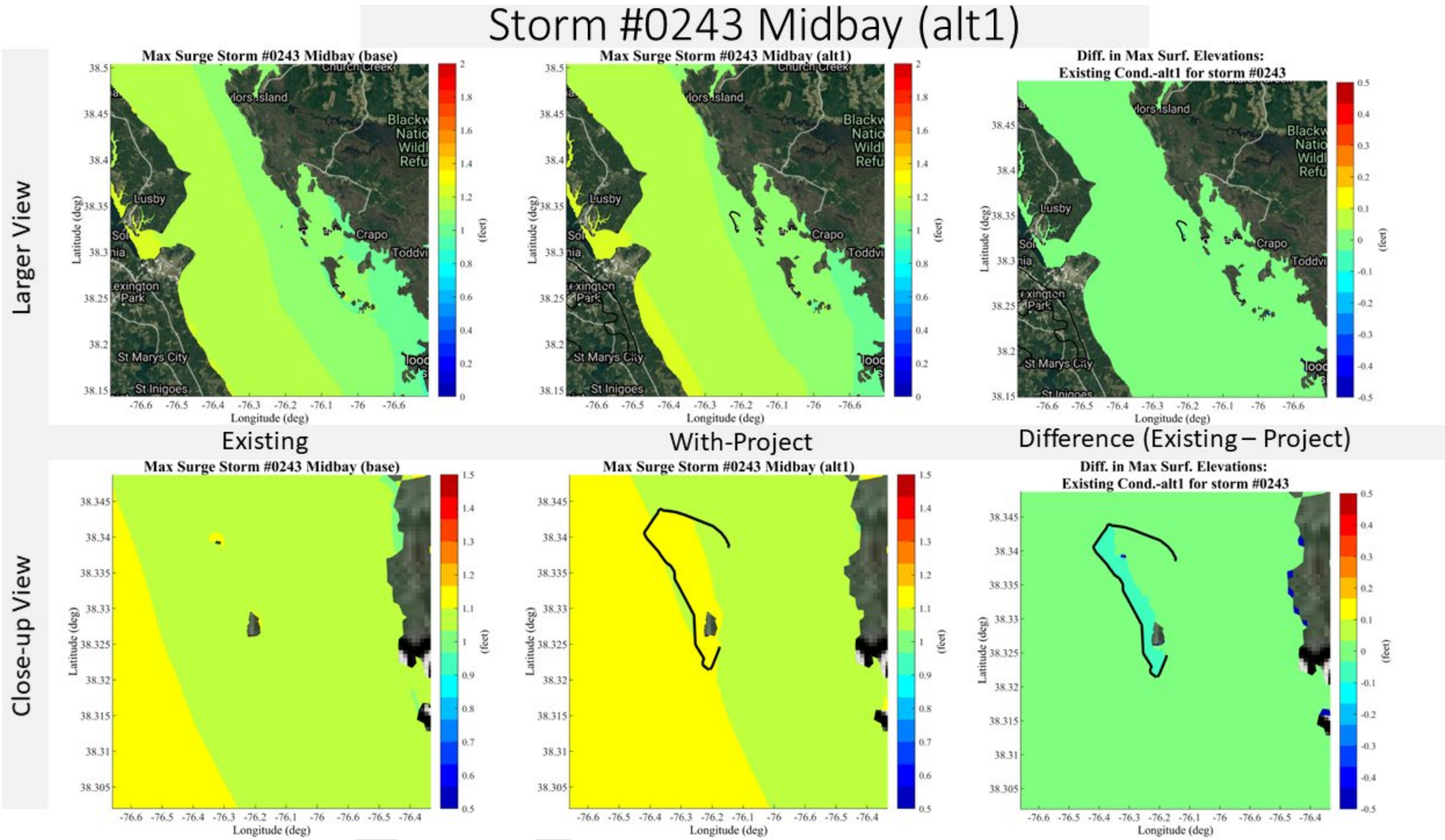

Storm #0218 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0218
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

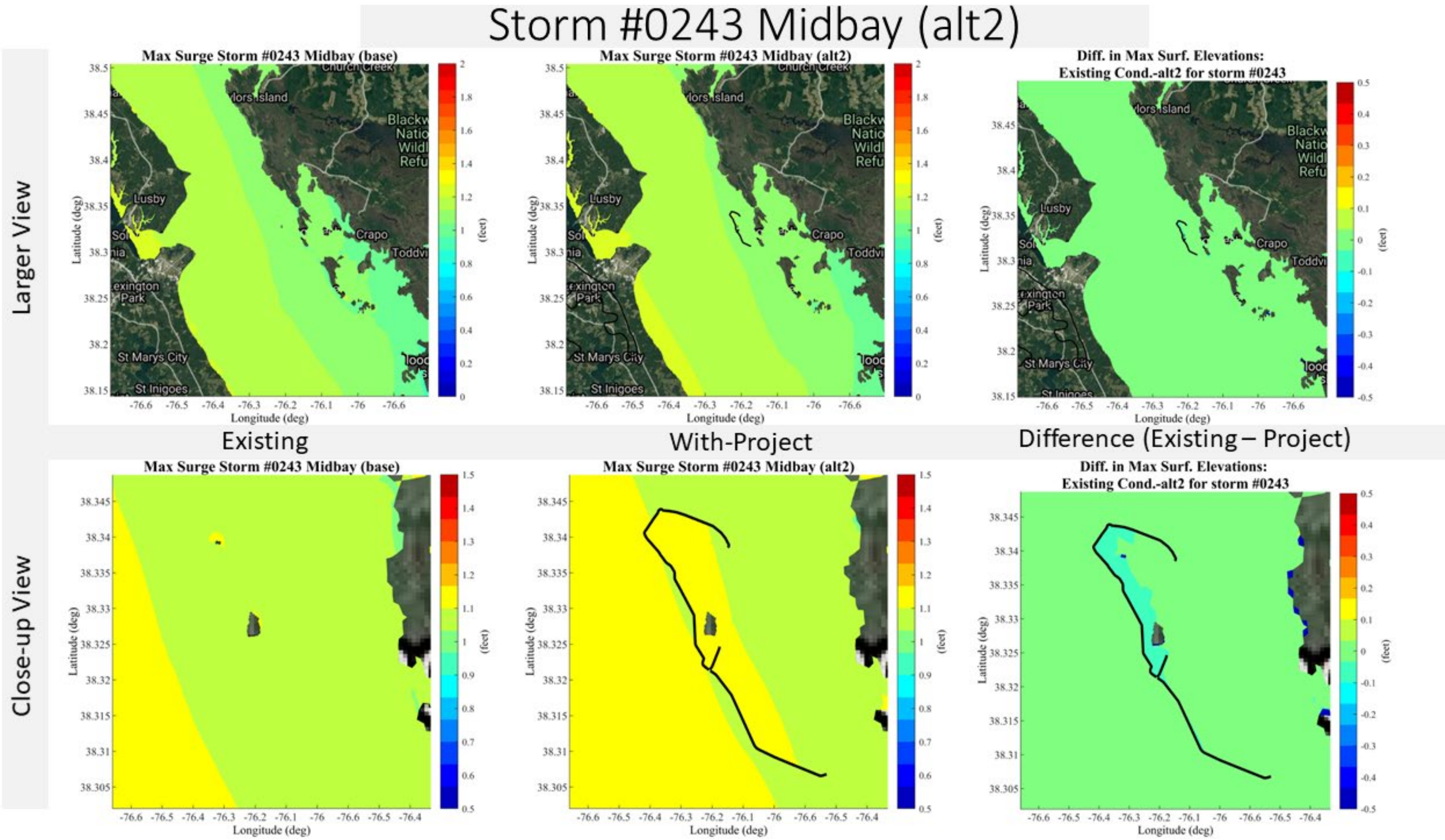

Storm #0218 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt3)
Diff. in Max Surf. Elevations: Existing Cond.-alt3 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

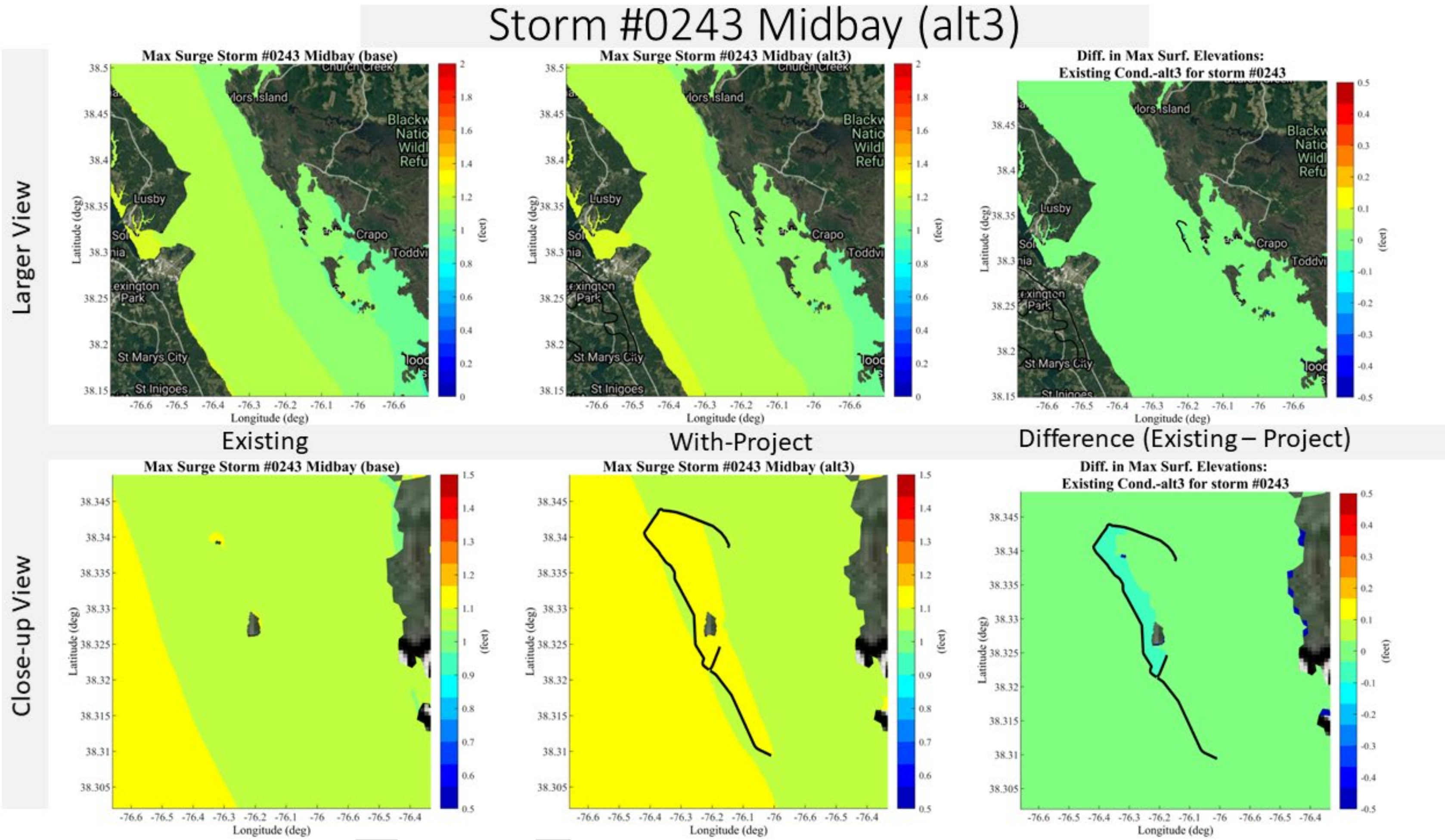

Storm #0218 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

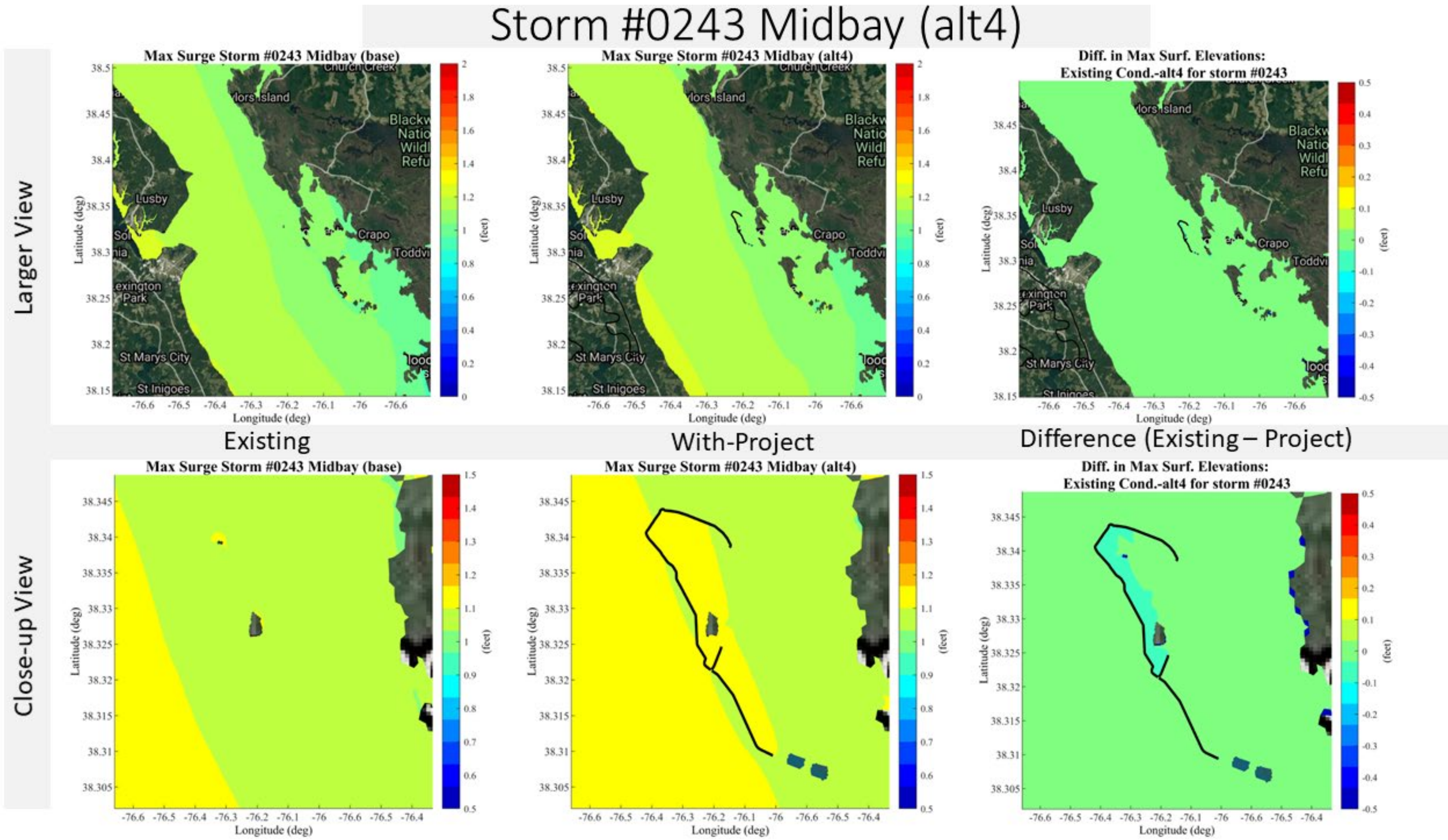

Storm #0218 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

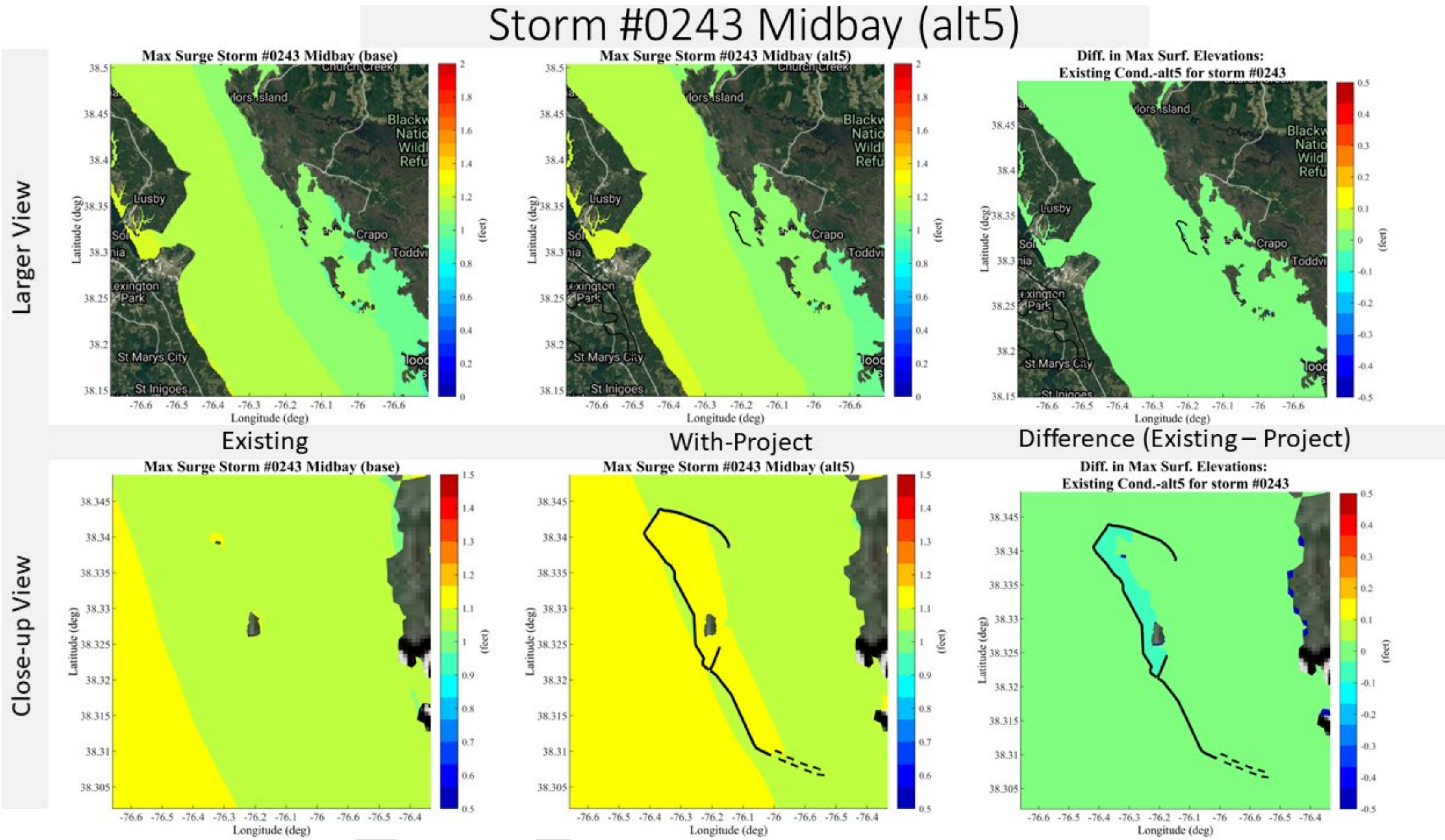

Storm #0218 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0218 Midbay (base)
Max Surge Storm #0218 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0218
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Lexington Park
St Marys City
St Inigoes

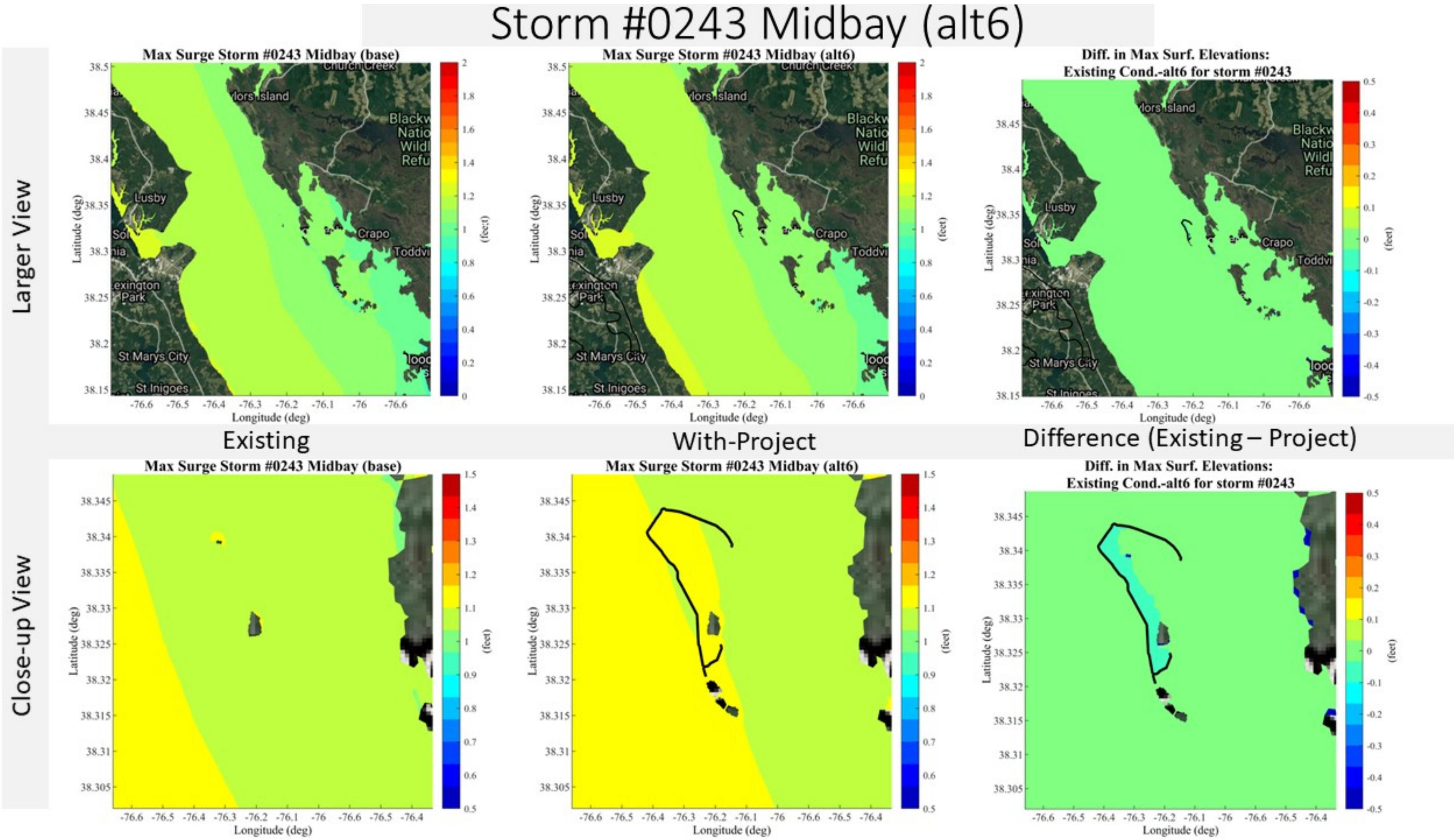

Storm #0243 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo
Church Creek

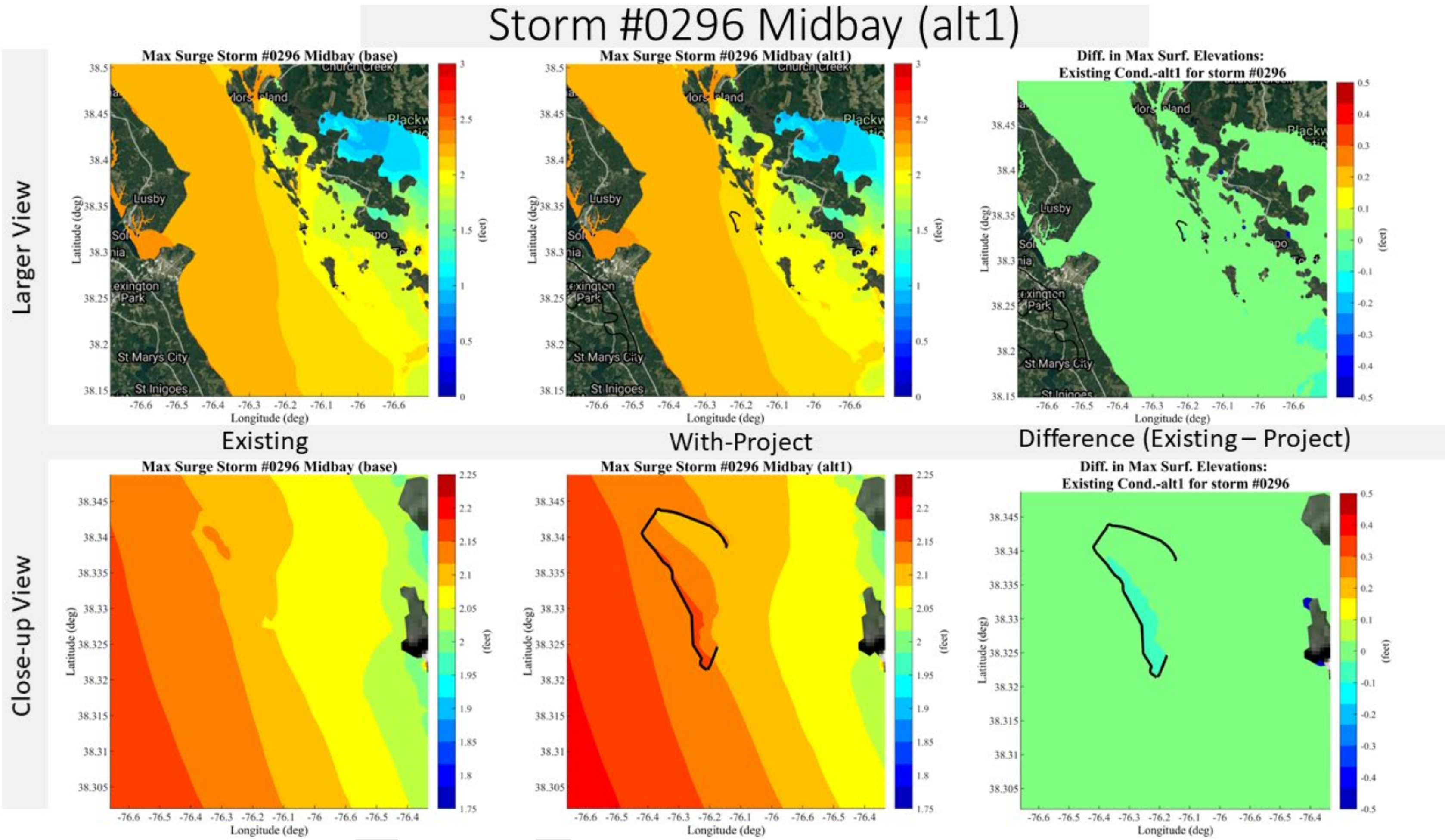

Storm #0243 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

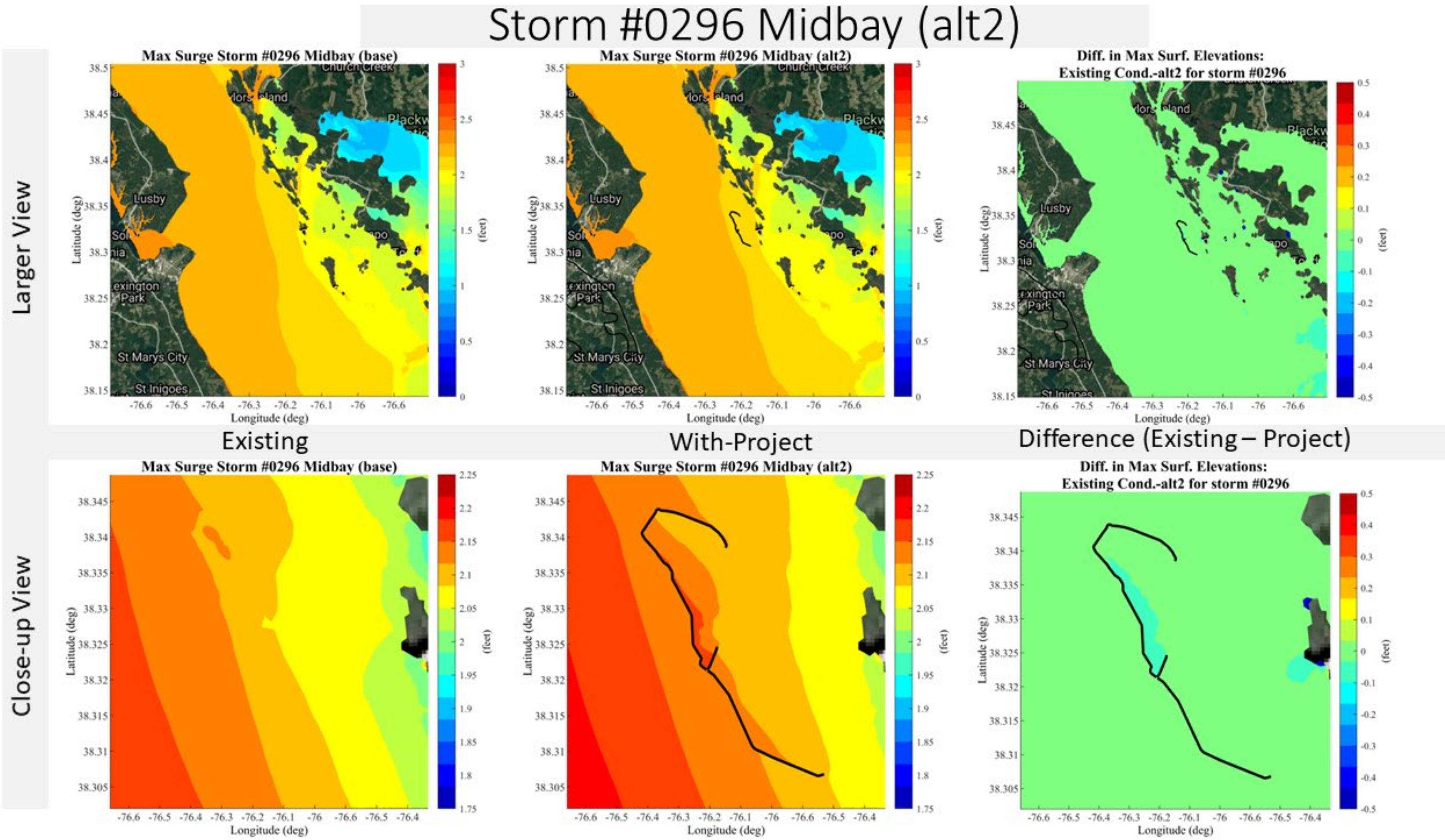

Storm #0243 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Toddvi
St Marys City
St Inigoes
Church Creek

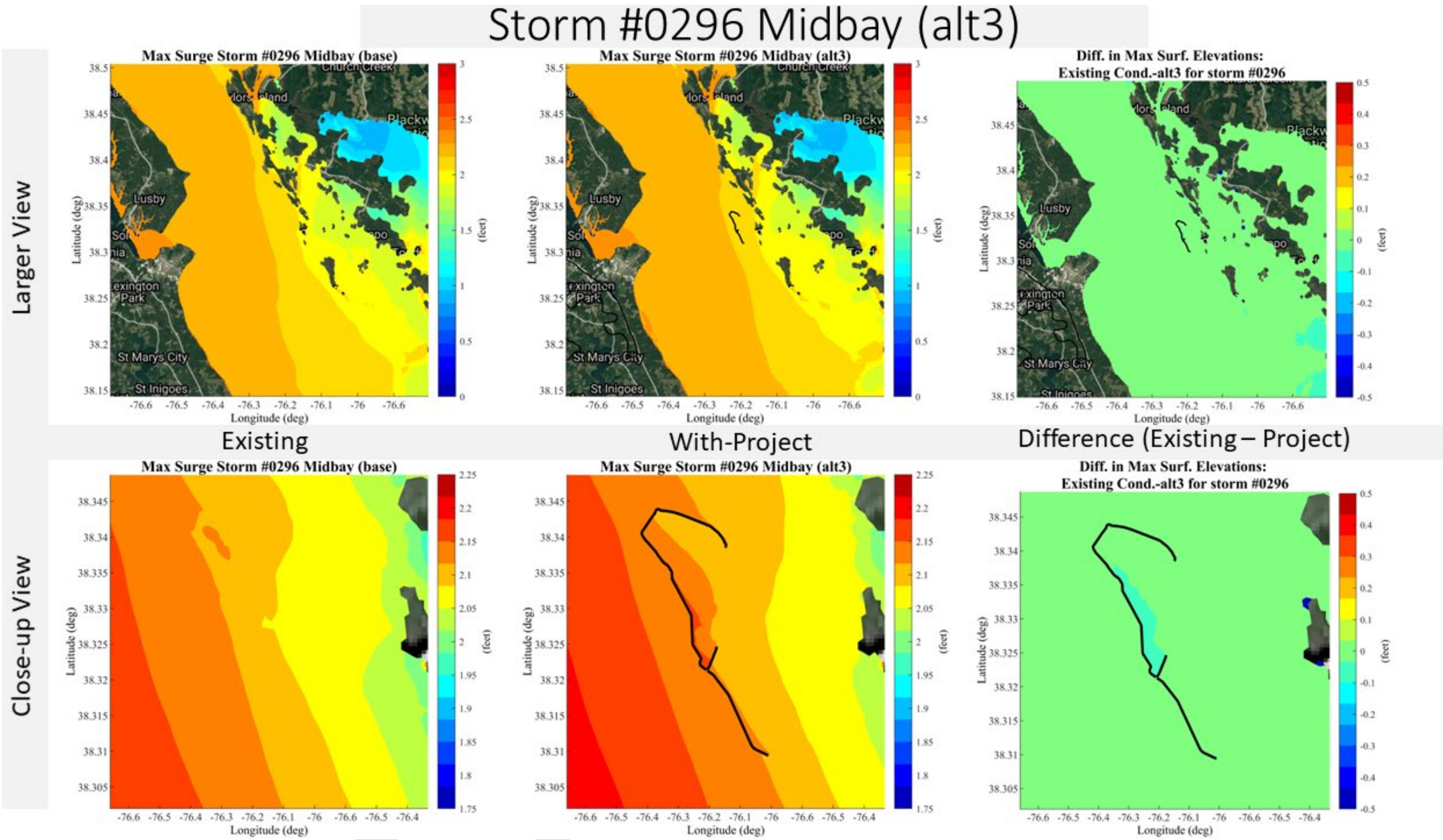

Storm #0243 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt4)
Diff. in Max Surf. Elevations: Existing Cond.-alt4 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

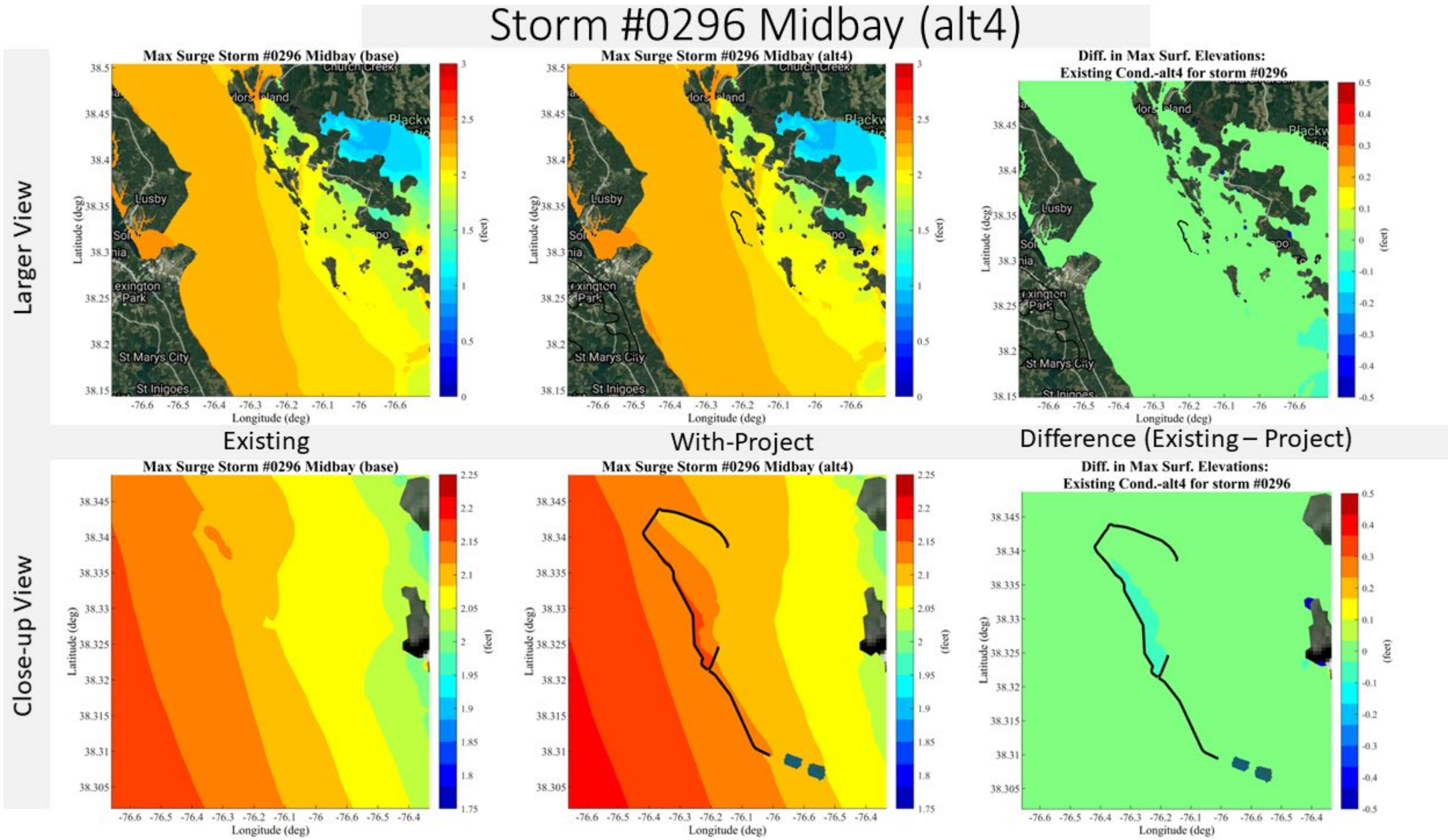

Storm #0243 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo
Church Creek

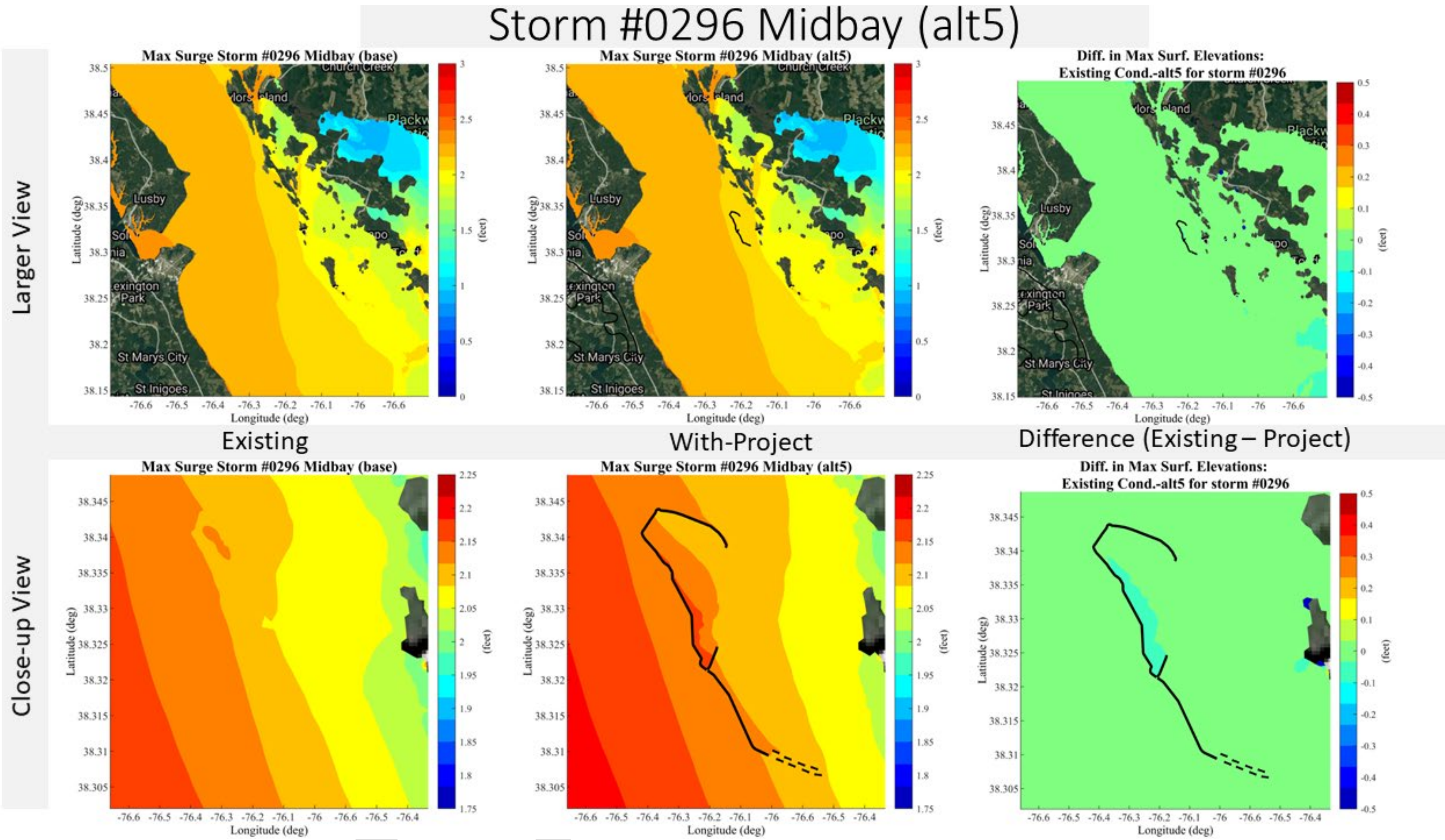

Storm #0243 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0243 Midbay (base)
Max Surge Storm #0243 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0243
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

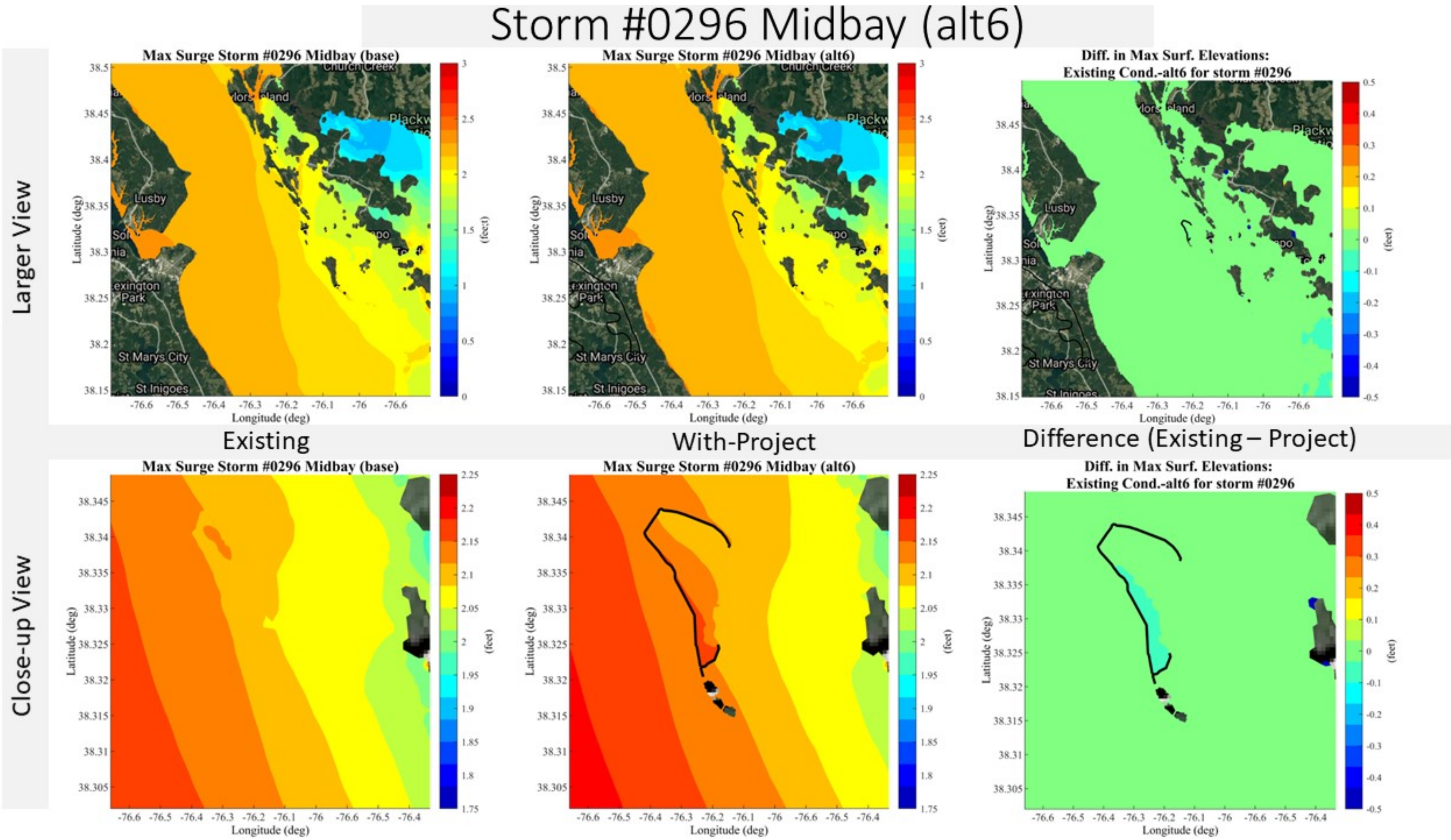

Storm #0296 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0296
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

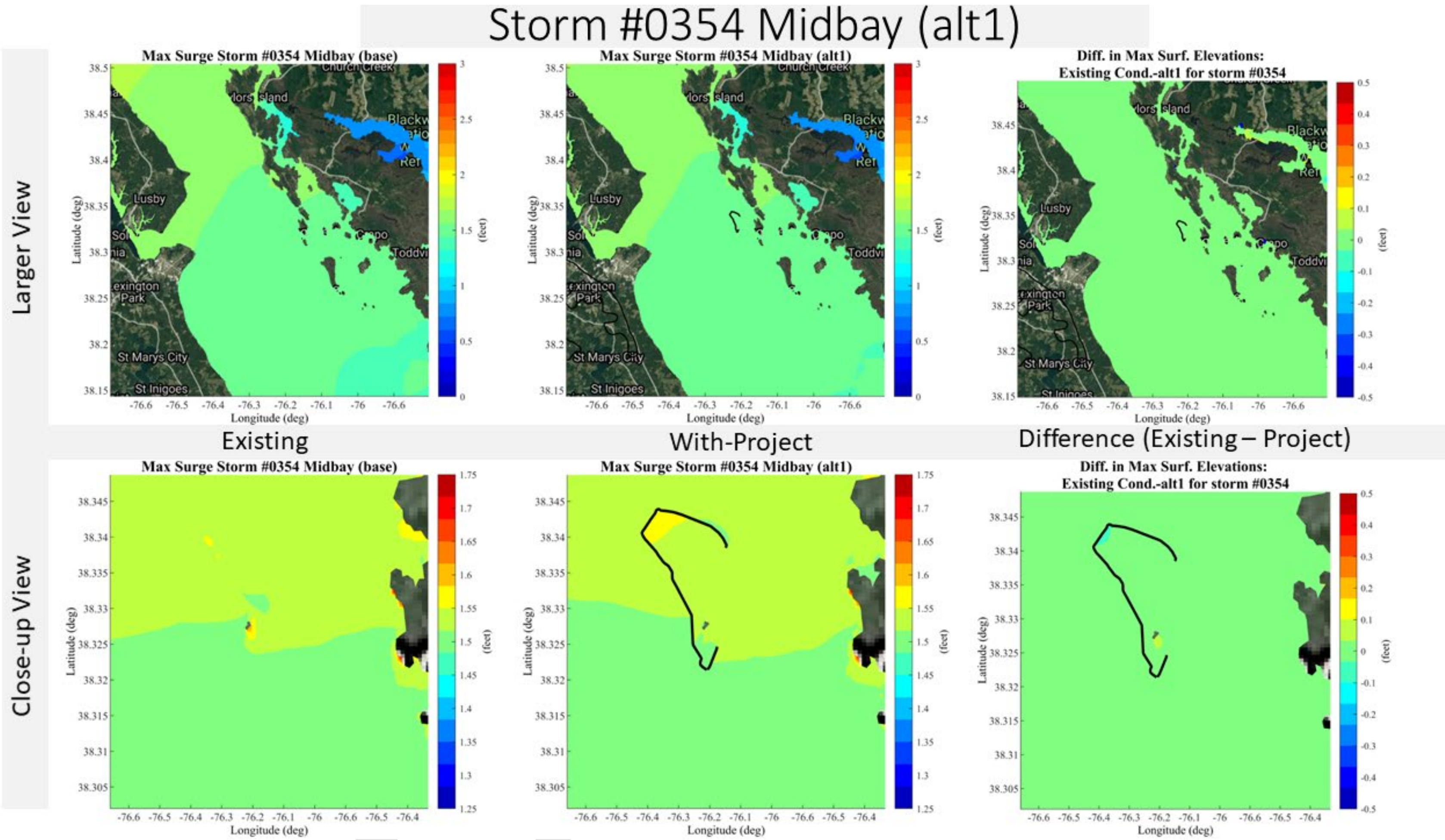

Storm #0296 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0296
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

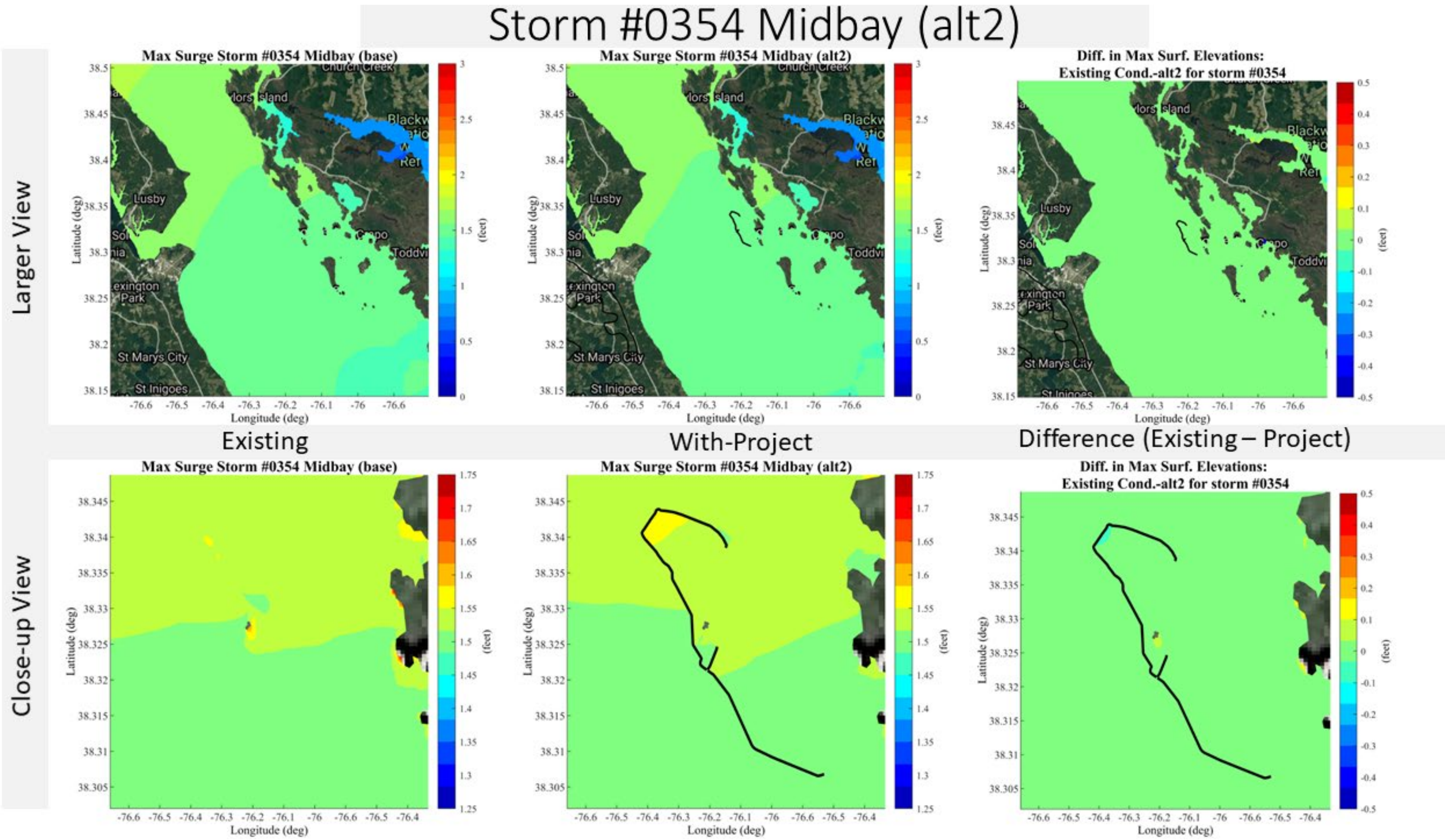

Storm #0296 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0296
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek

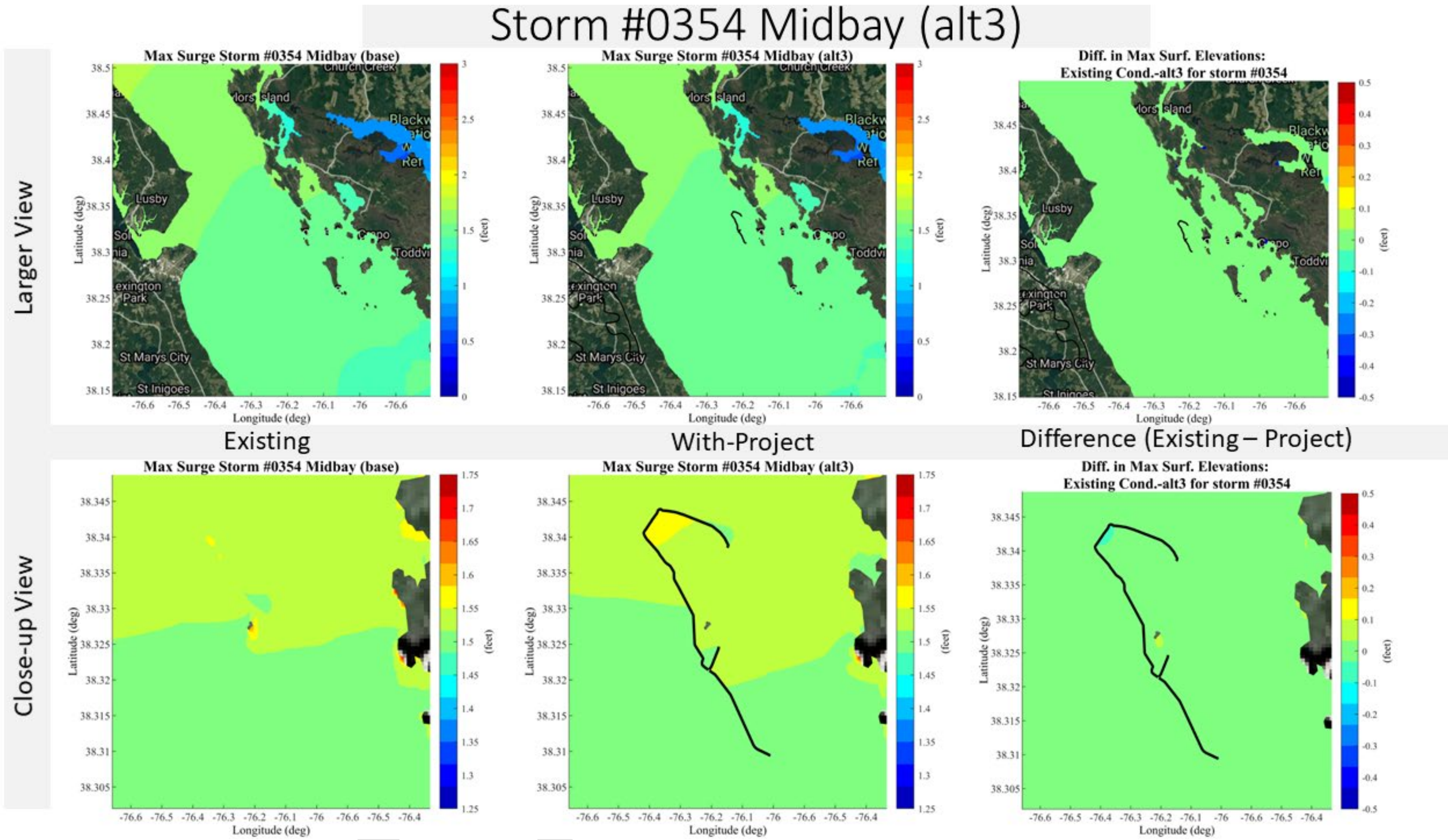

Storm #0296 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0296
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

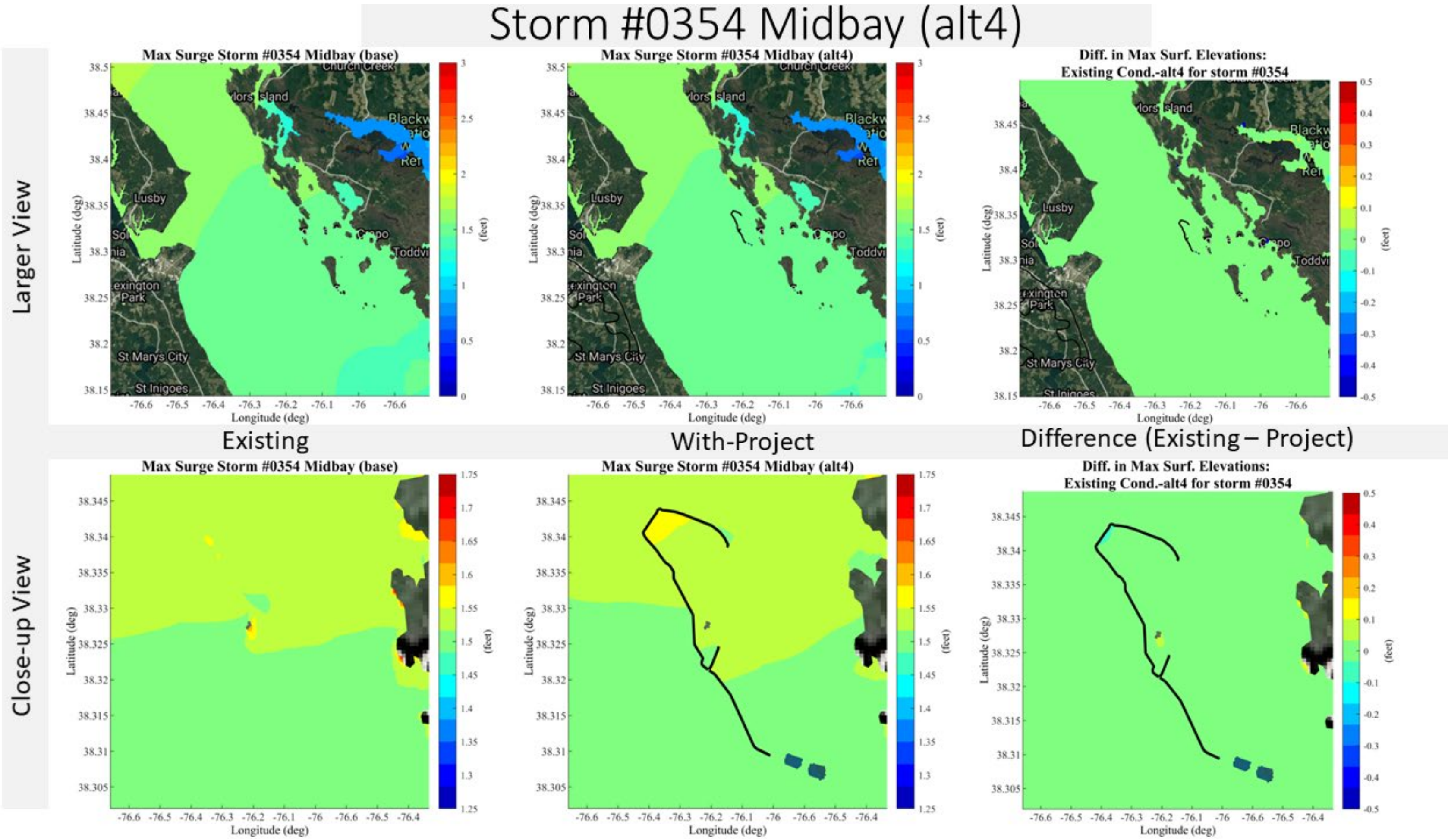

Storm #0296 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt5)
Diff. in Max Surf. Elevations: Existing Cond.-alt5 for storm #0296
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

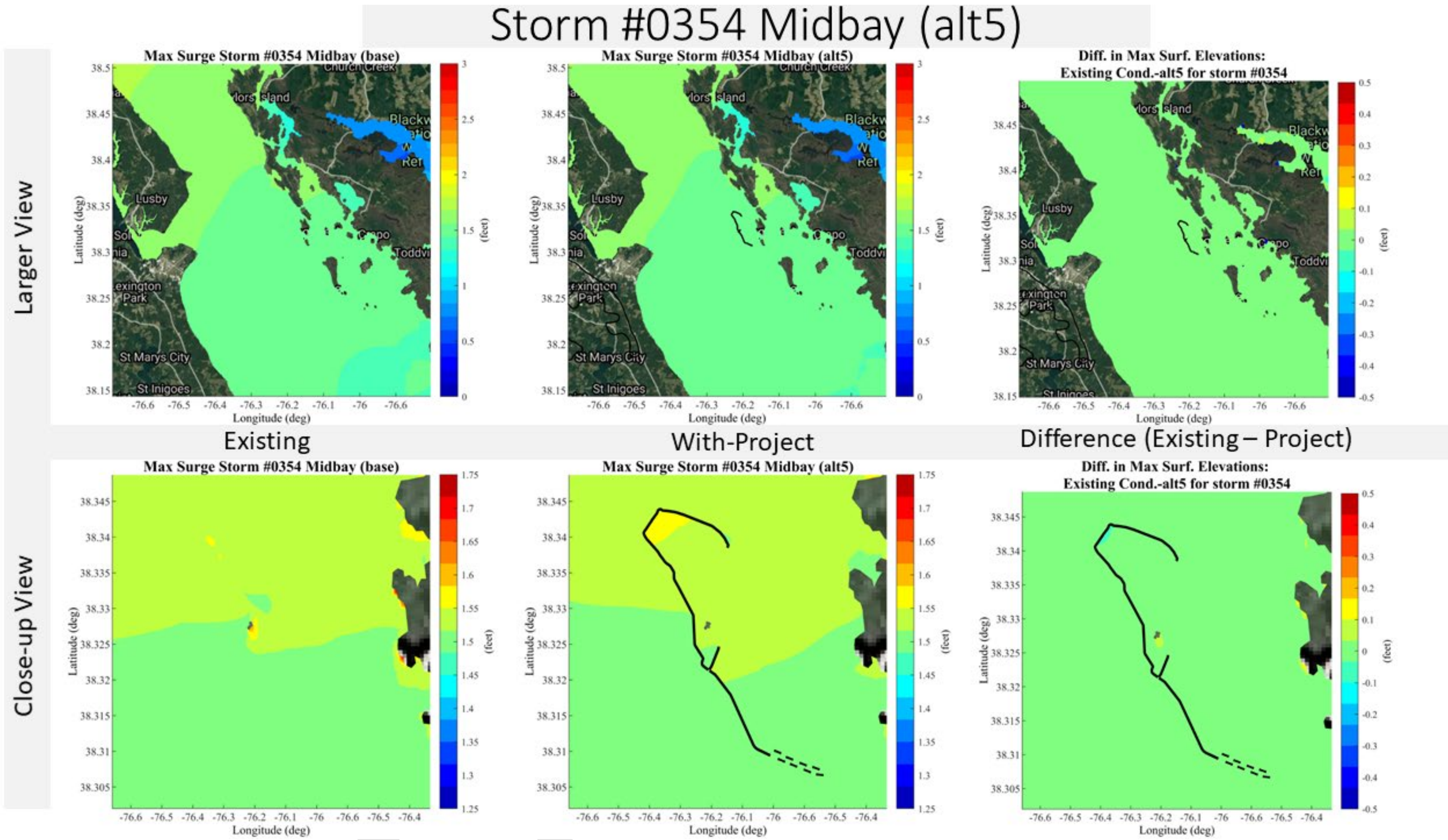

Storm #0296 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0296 Midbay (base)
Max Surge Storm #0296 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0296
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

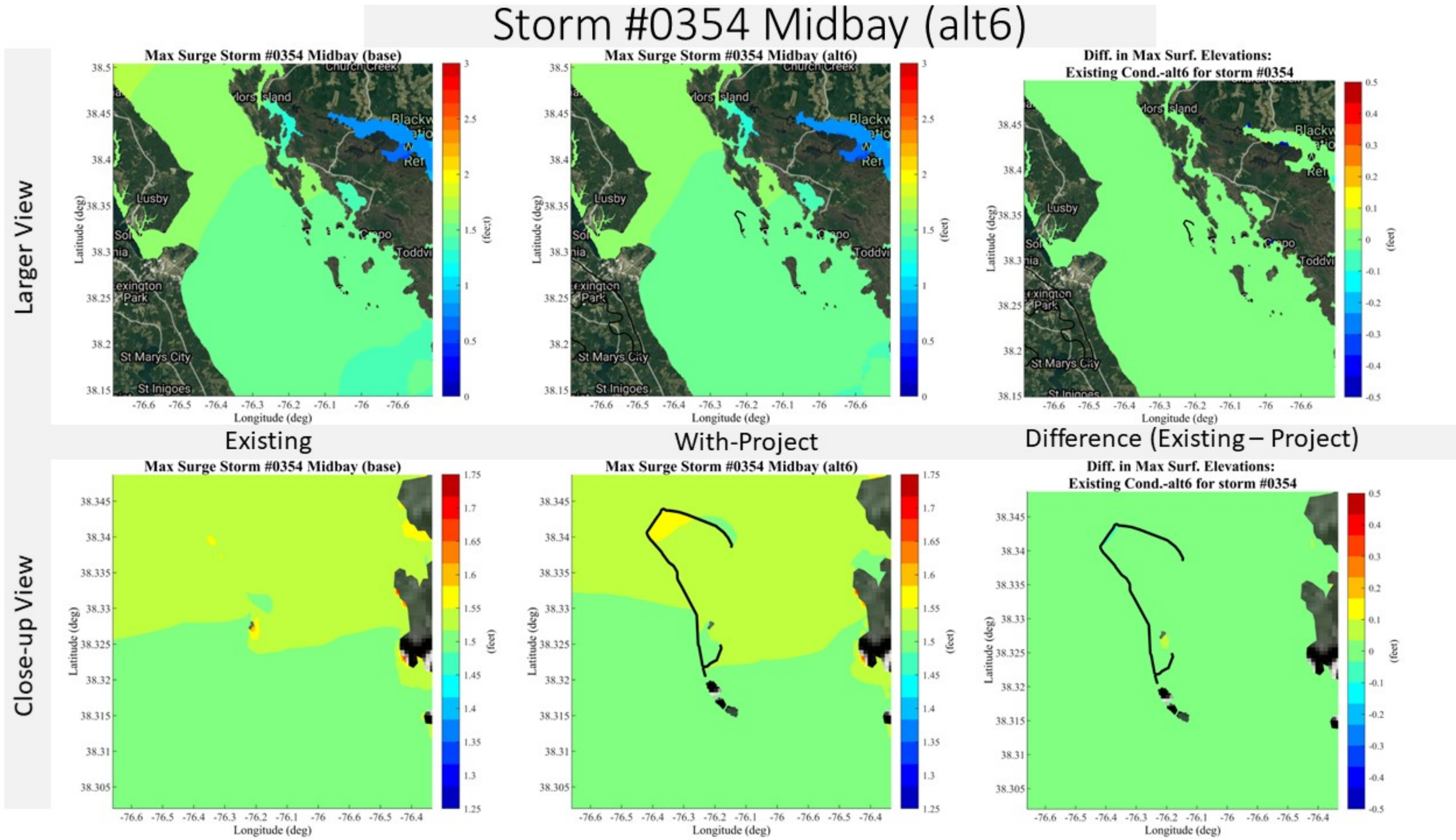

Storm #0354 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek
Taylors Island
Blackwater National Wildlife Refuge
Toddville

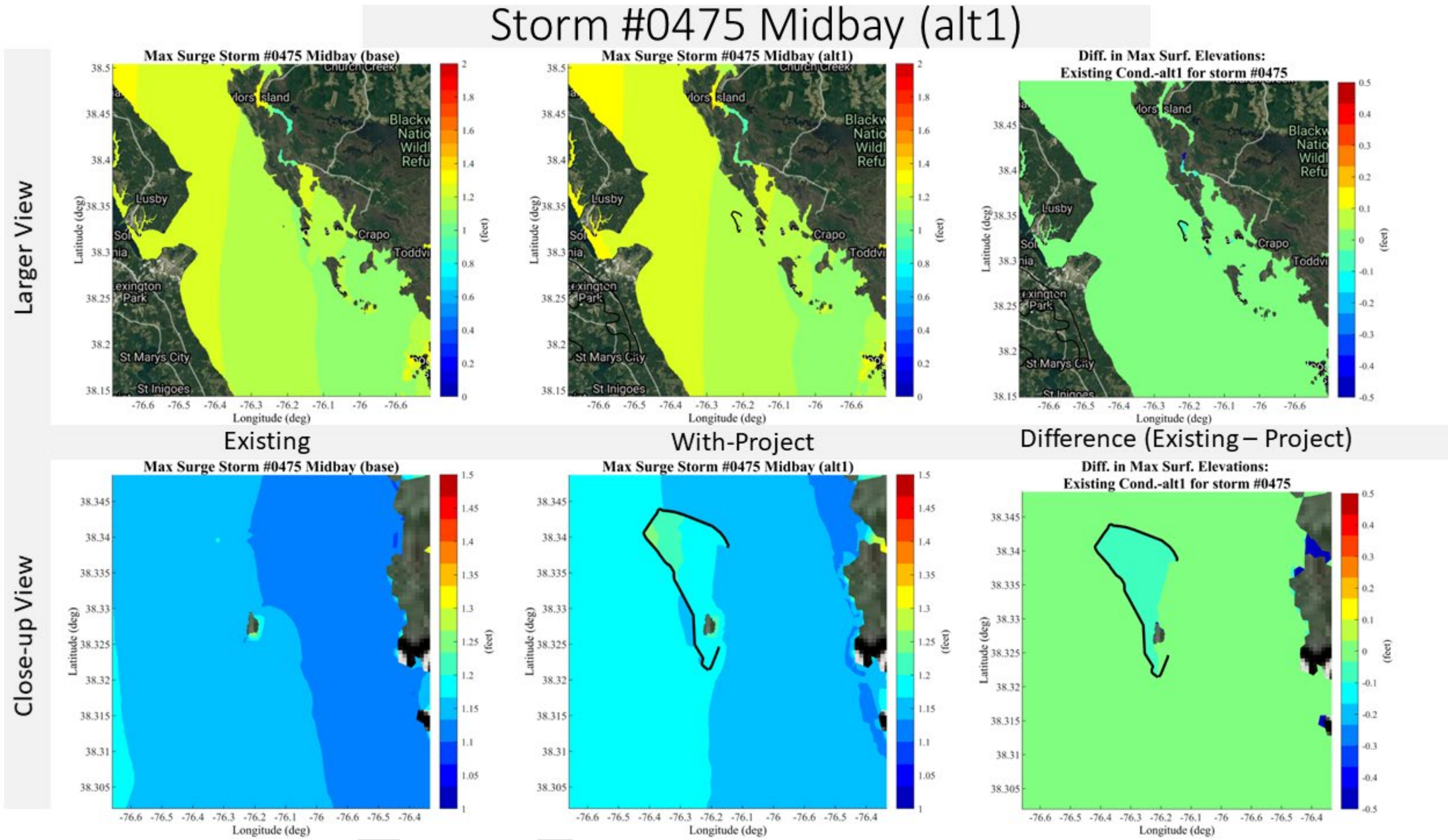

Storm #0354 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0354
Latitude (deg)
Longitude (deg)
(feet)

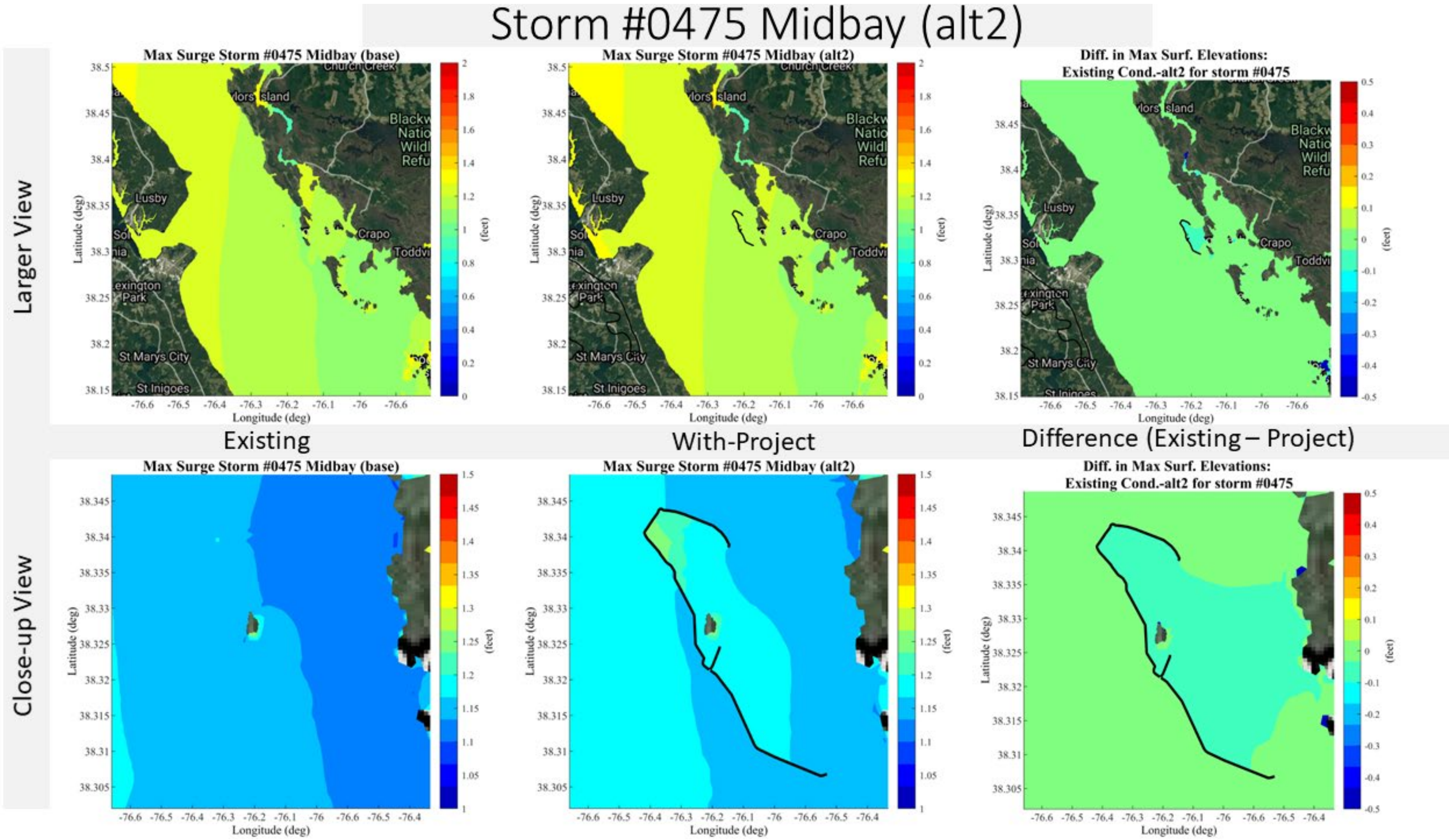

Storm #0354 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

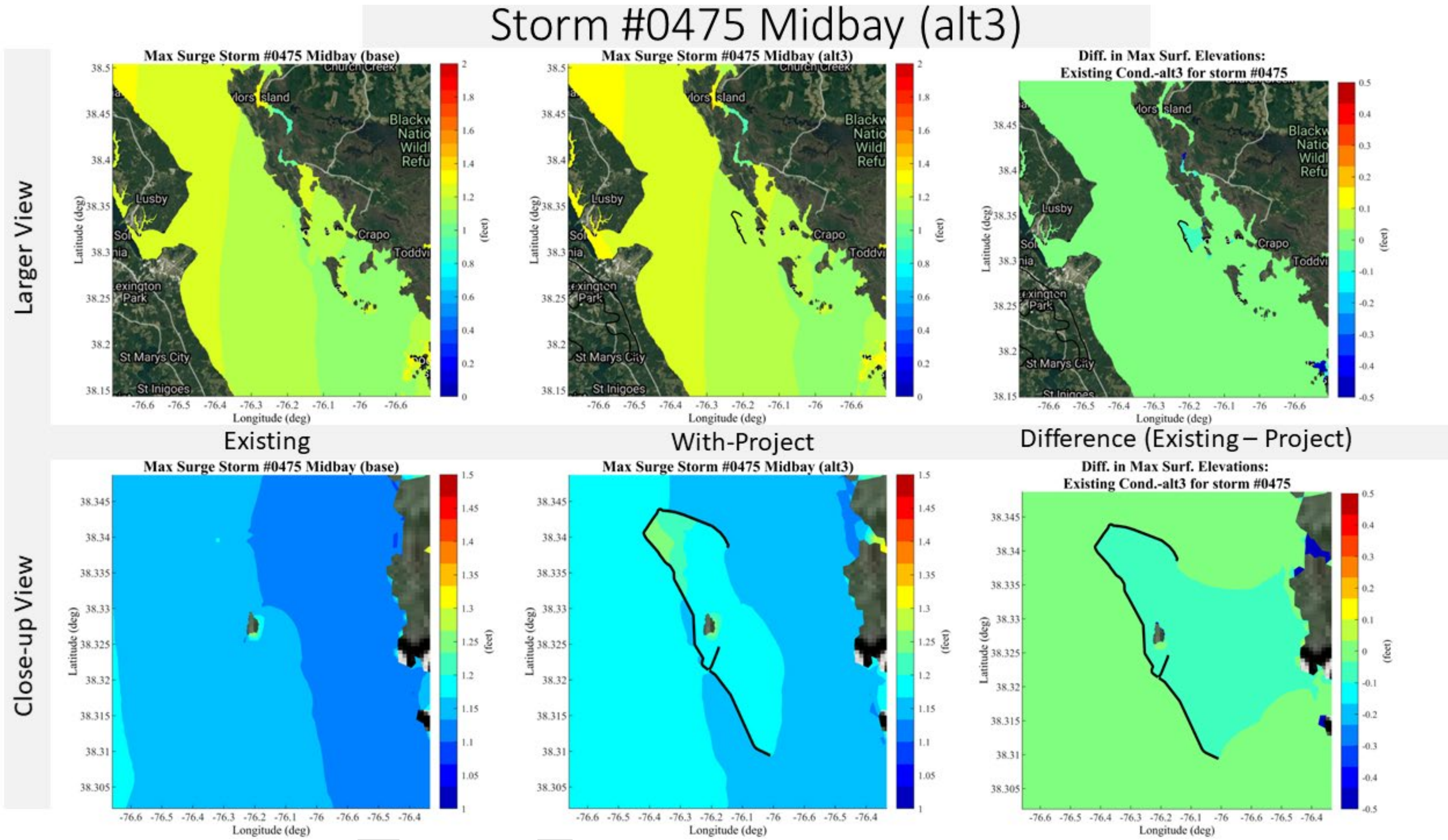

Storm #0354 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0354
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

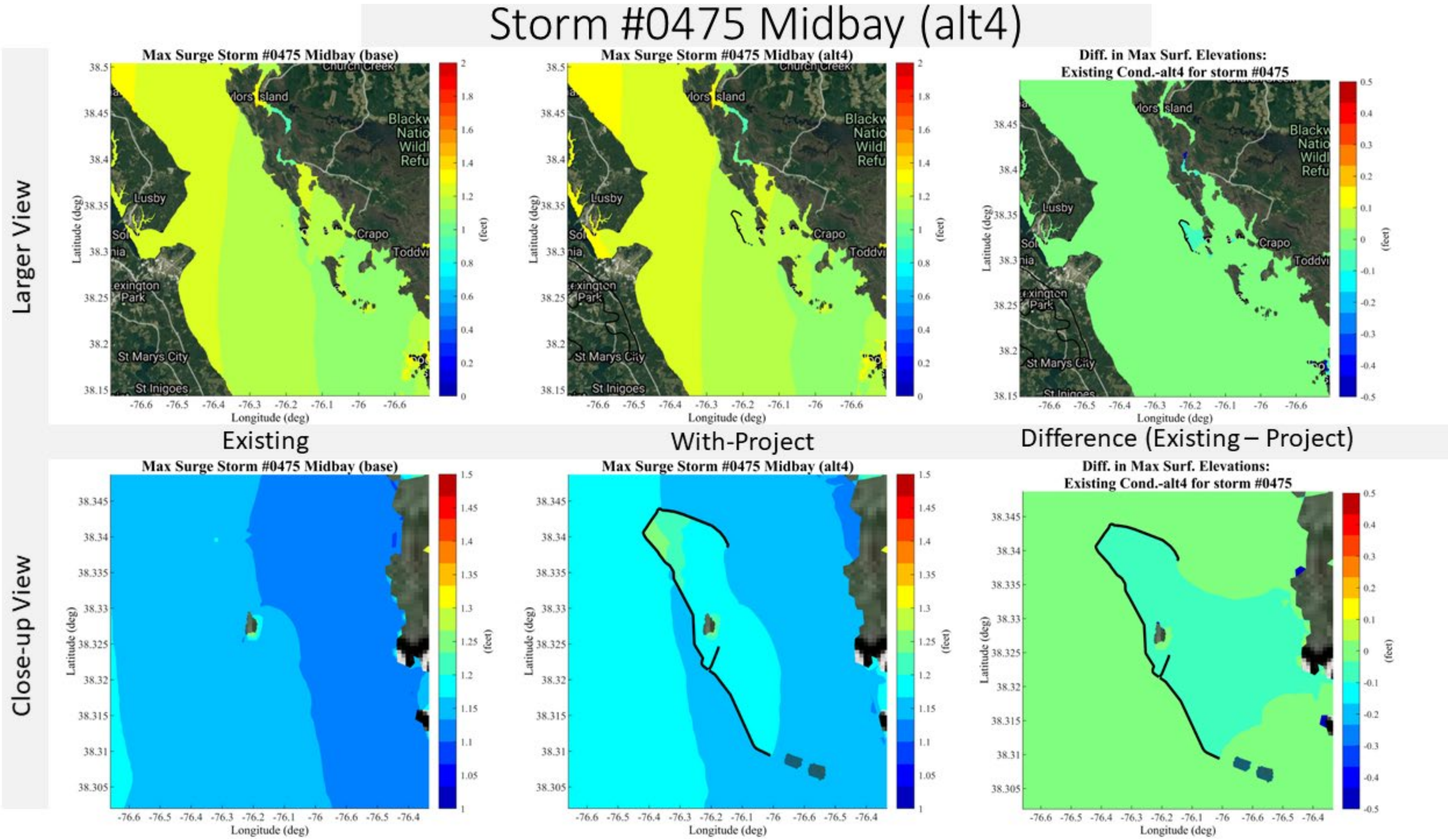

Storm #0354 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Toddvi
Blackw


Storm #0354 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0354 Midbay (base)
Max Surge Storm #0354 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

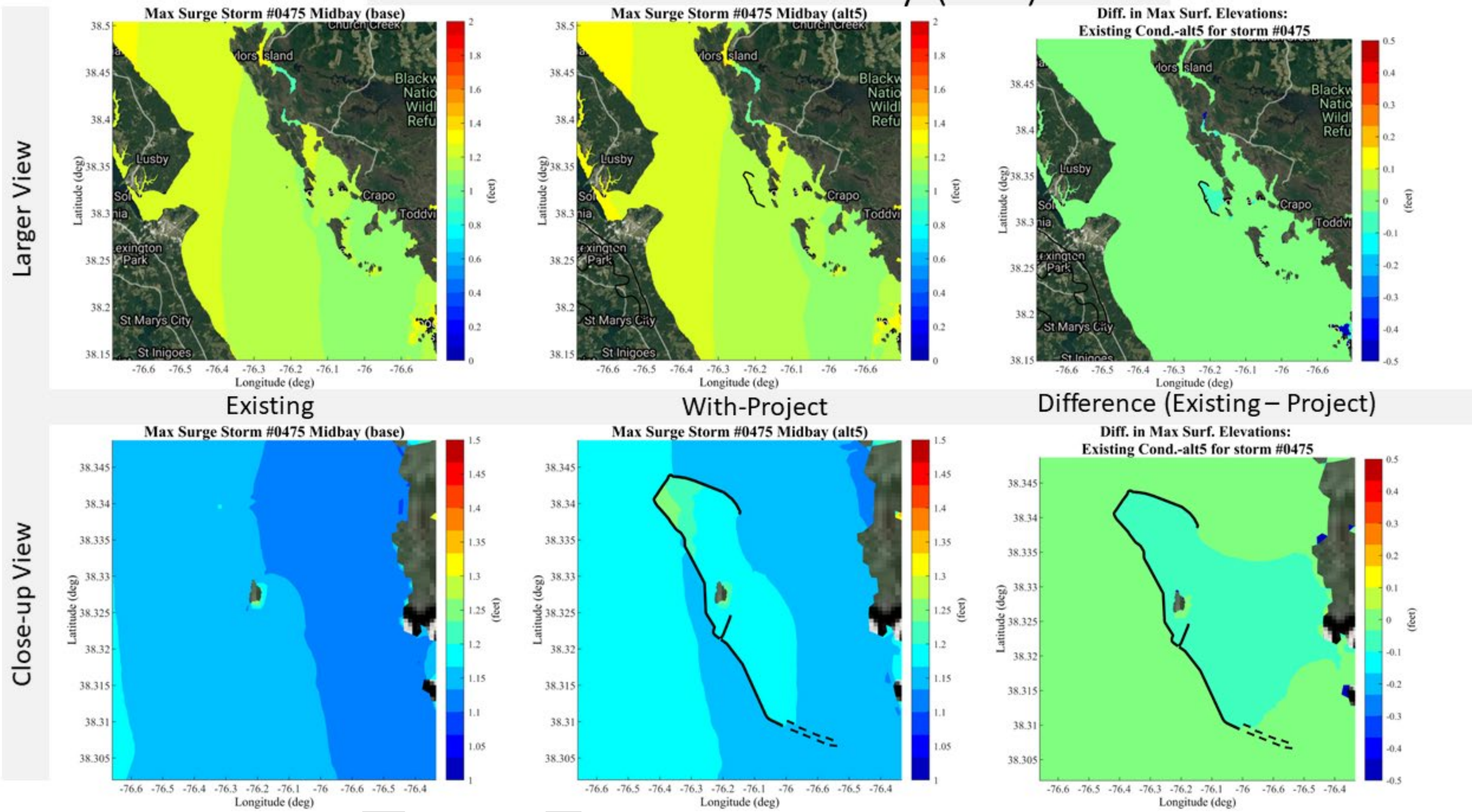

Storm #0475 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0475 Midbay (base)
Max Surge Storm #0475 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0475
Latitude (deg)
Longitude (deg)
(feet)

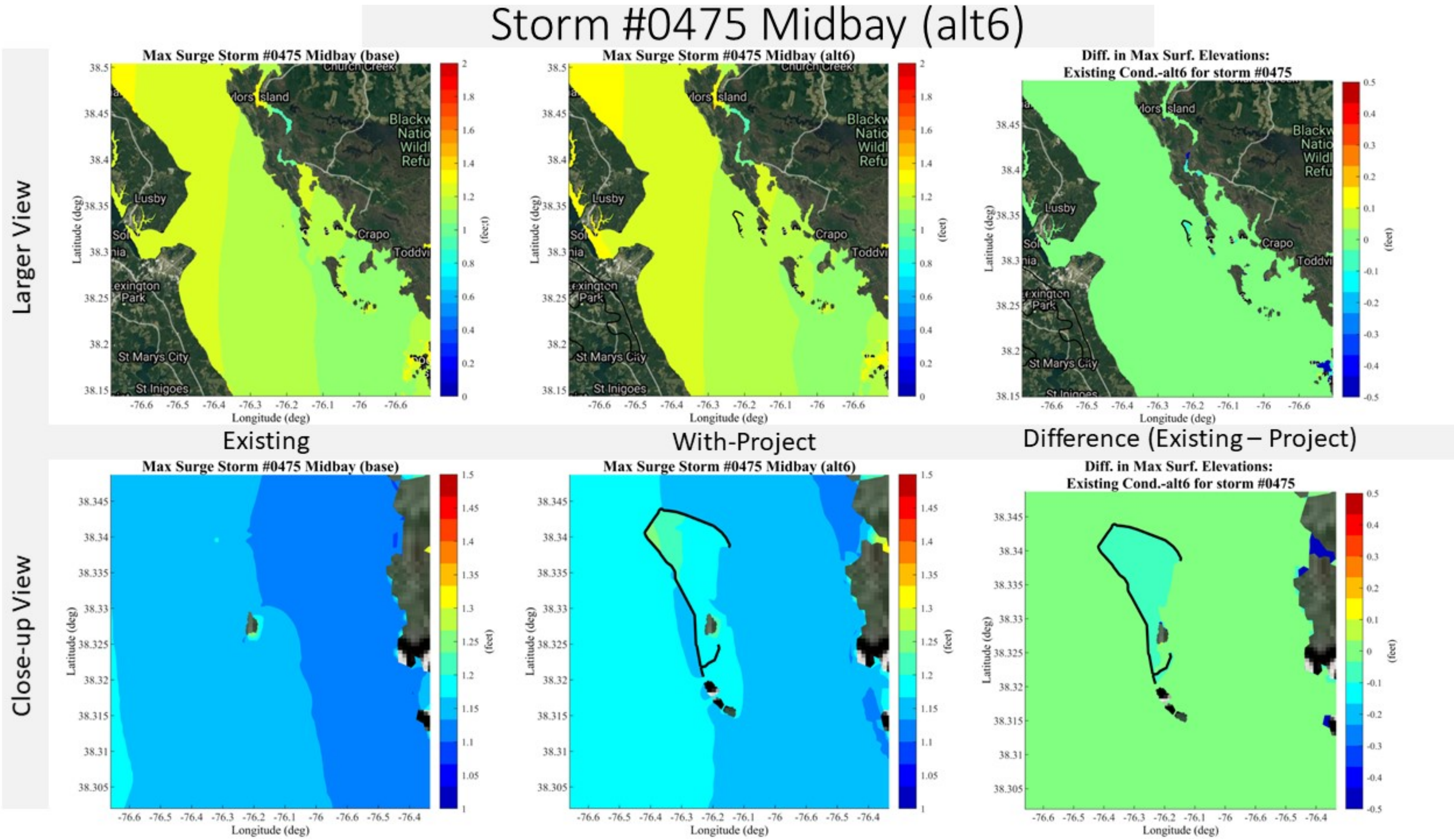

Storm #0475 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0475 Midbay (base)
Max Surge Storm #0475 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0475
Latitude (deg)
Longitude (deg)
(feet)


Storm #0475 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0475 Midbay (base)
Max Surge Storm #0475 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0475
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)


Storm #0475 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0475 Midbay (base)
Max Surge Storm #0475 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0475
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Toddvi
Lexington Park
Church Creek

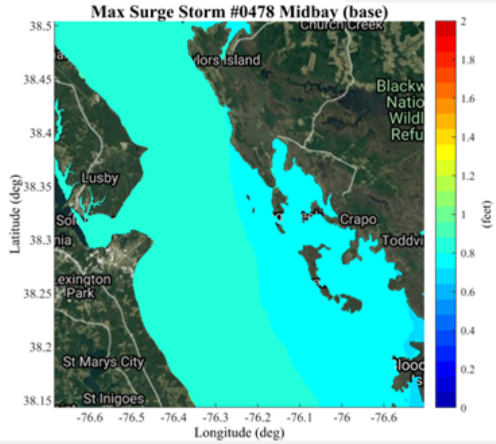
# Storm #0475 Midbay (alt5)




Storm #0475 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0475 Midbay (base)
Max Surge Storm #0475 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0475
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Crapo
Blackwater National Wildlife Refuge

# Storm #0478 Midbay (alt1)

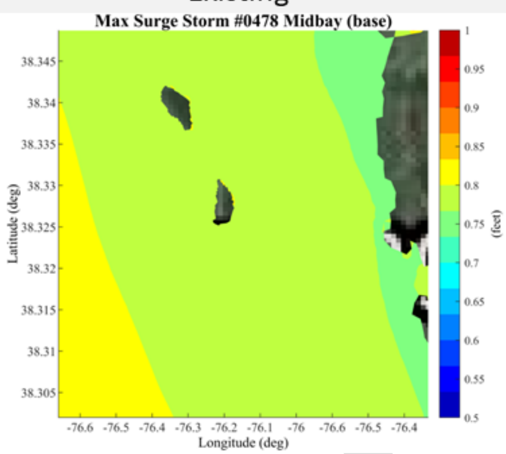
Larger View

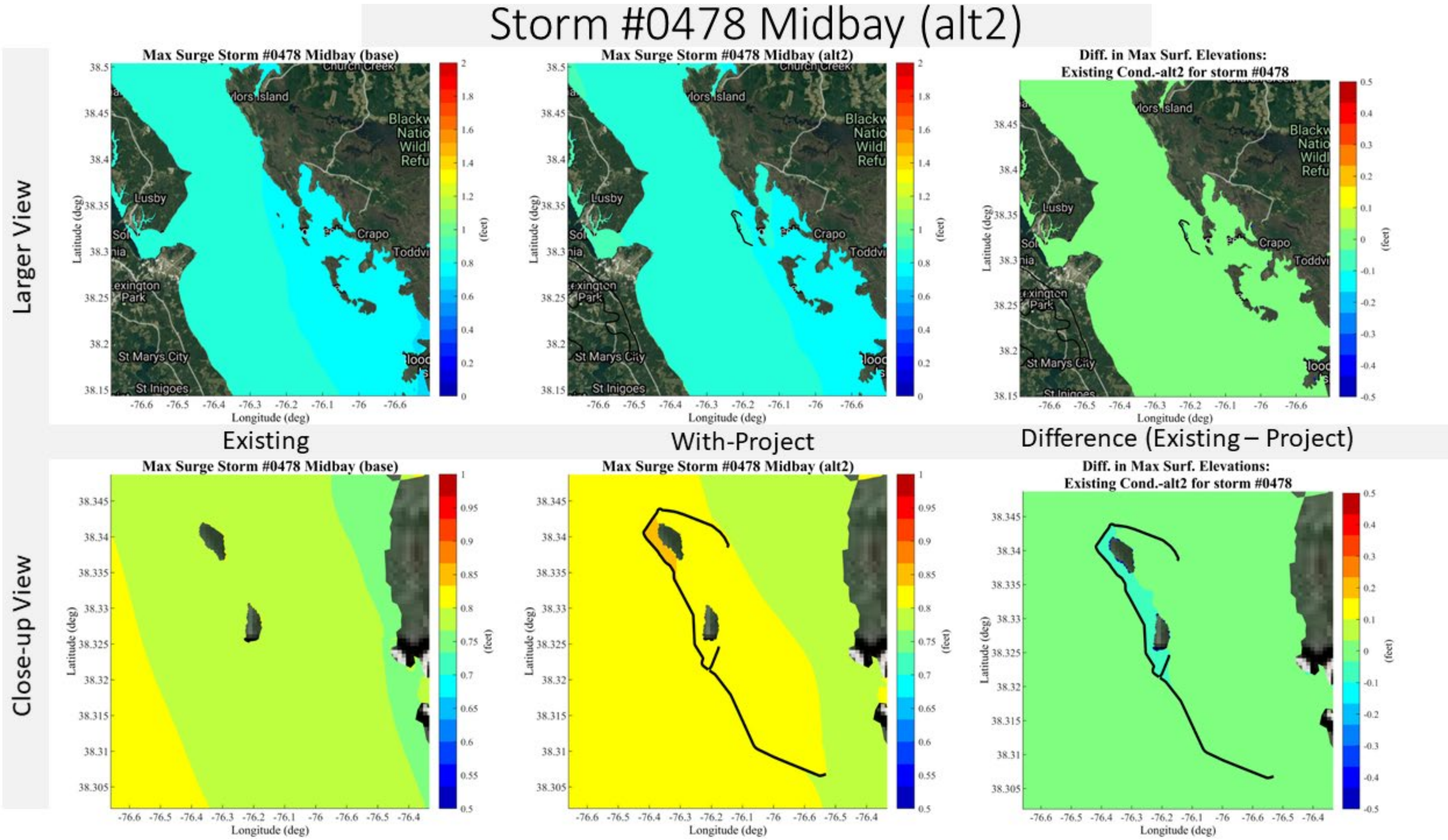


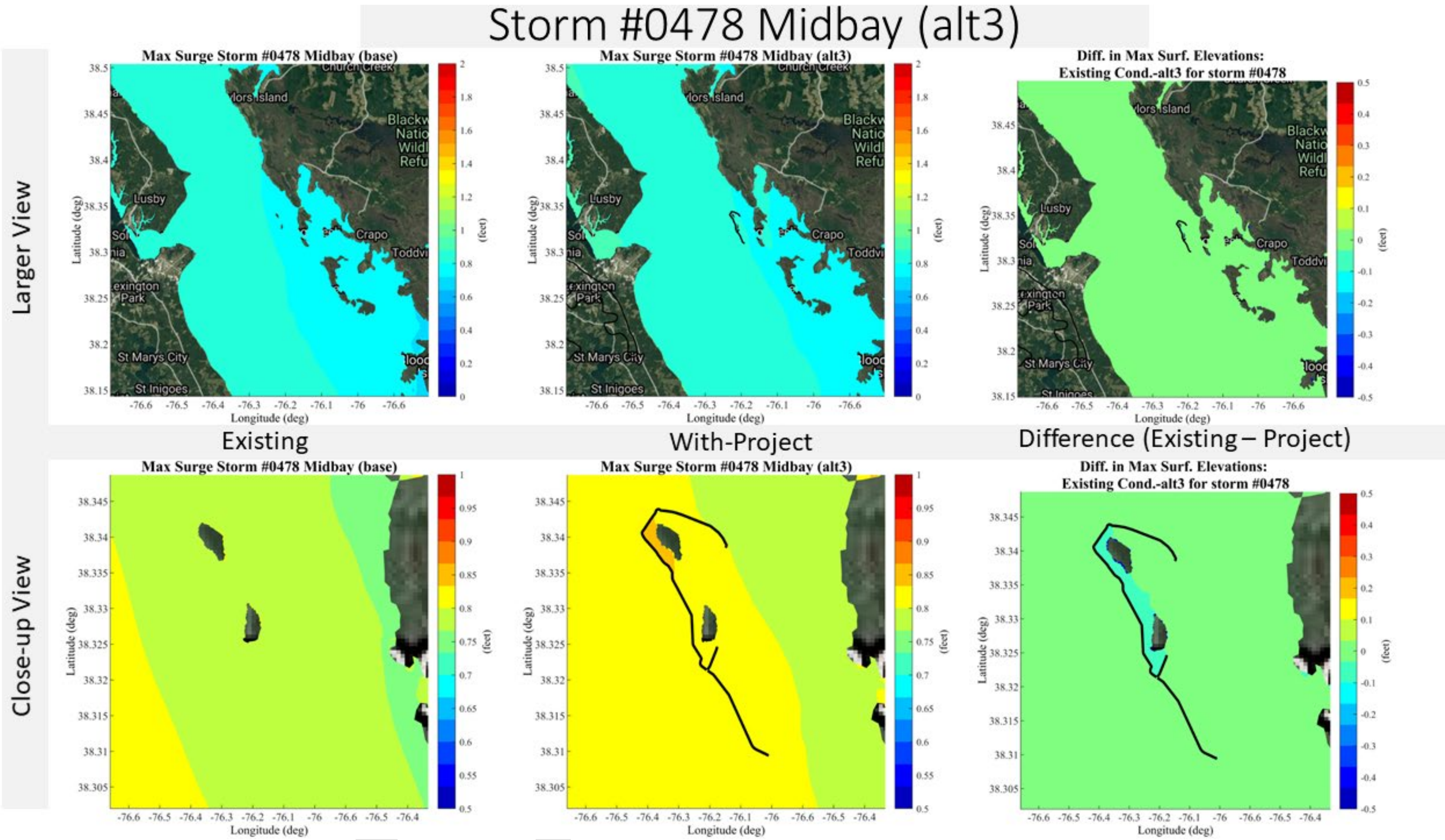

With-Project Data Not Available for this Storm

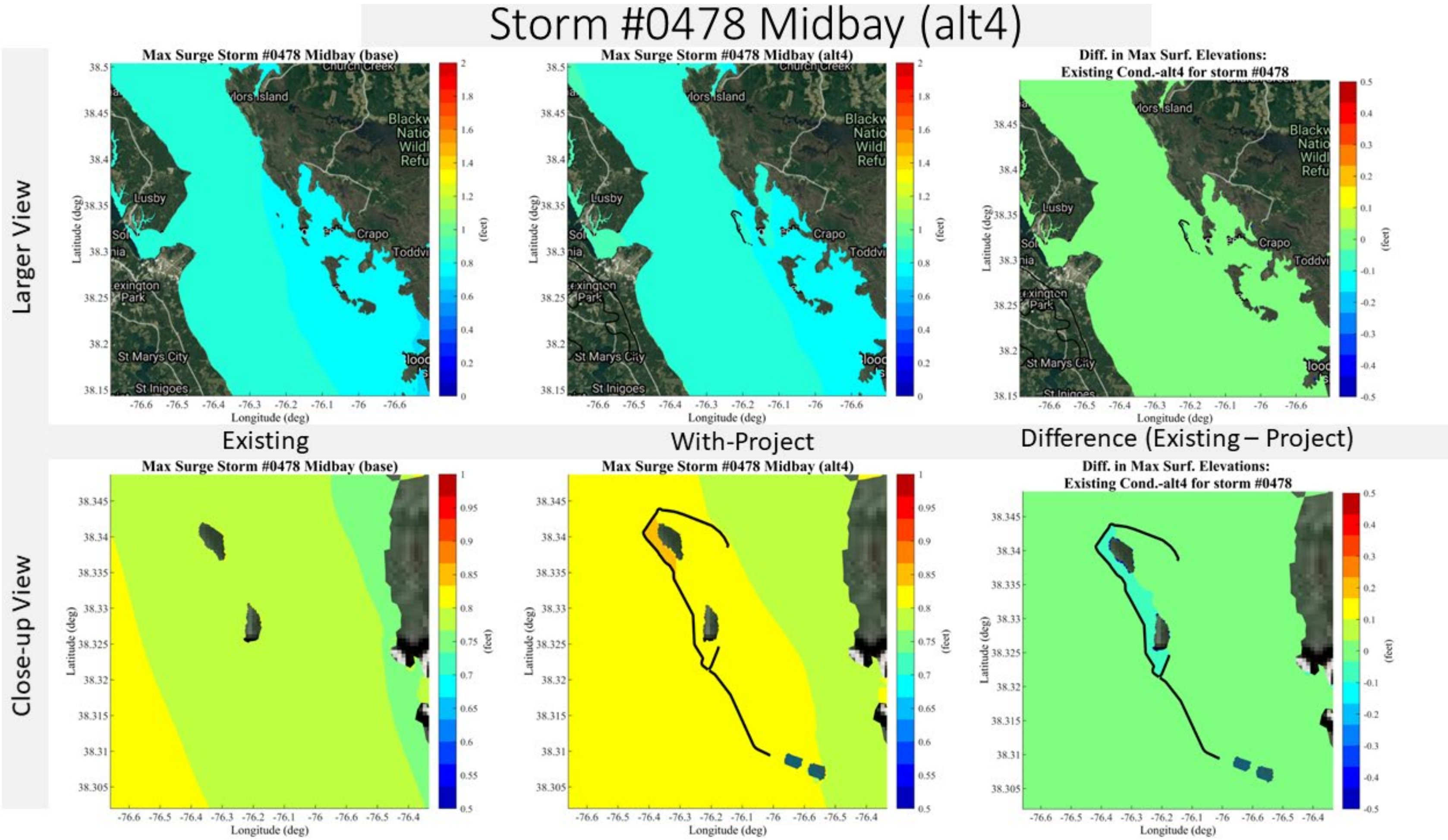
Existing | With-Project | Difference (Existing – Project)

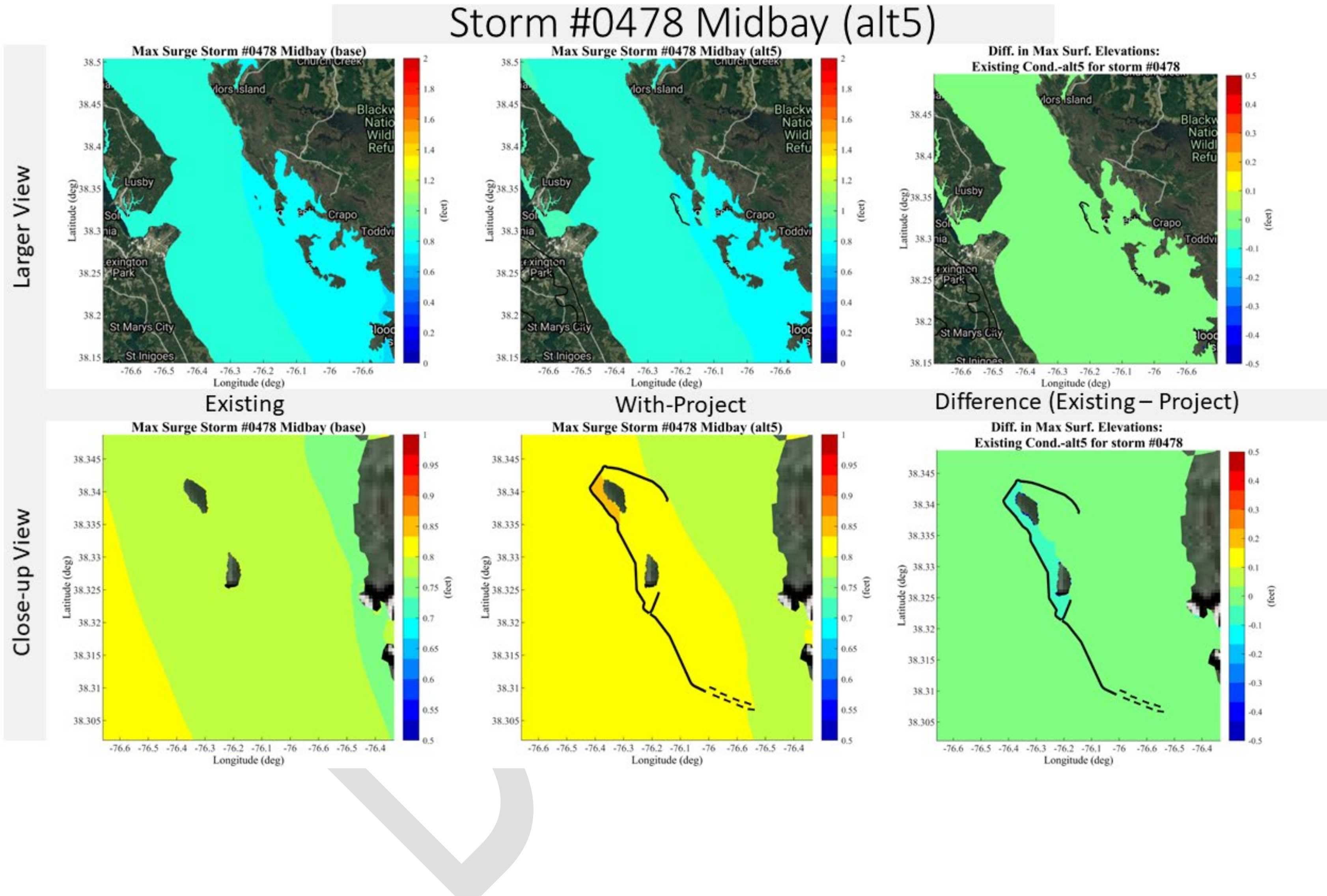
Close-up View

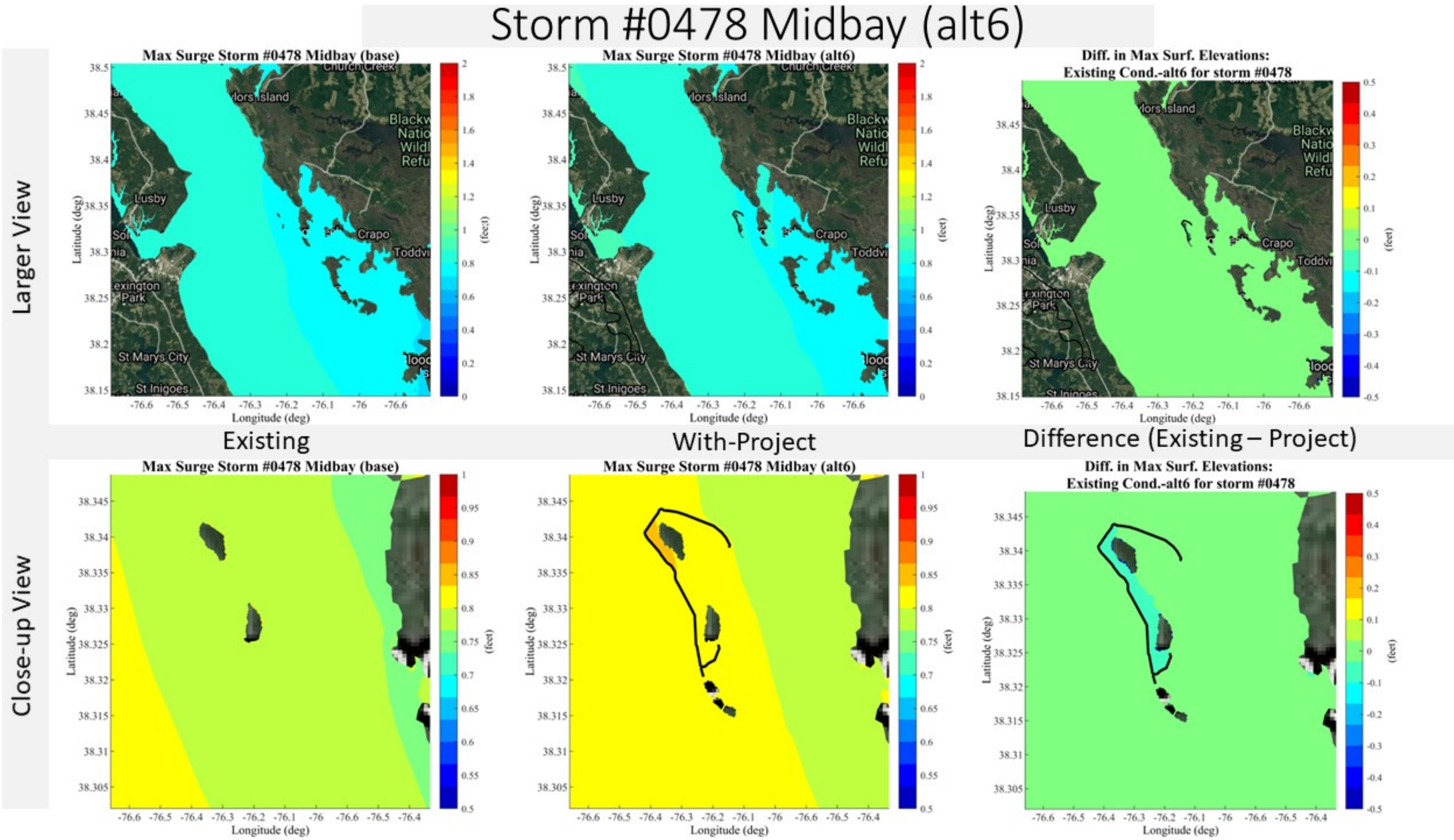


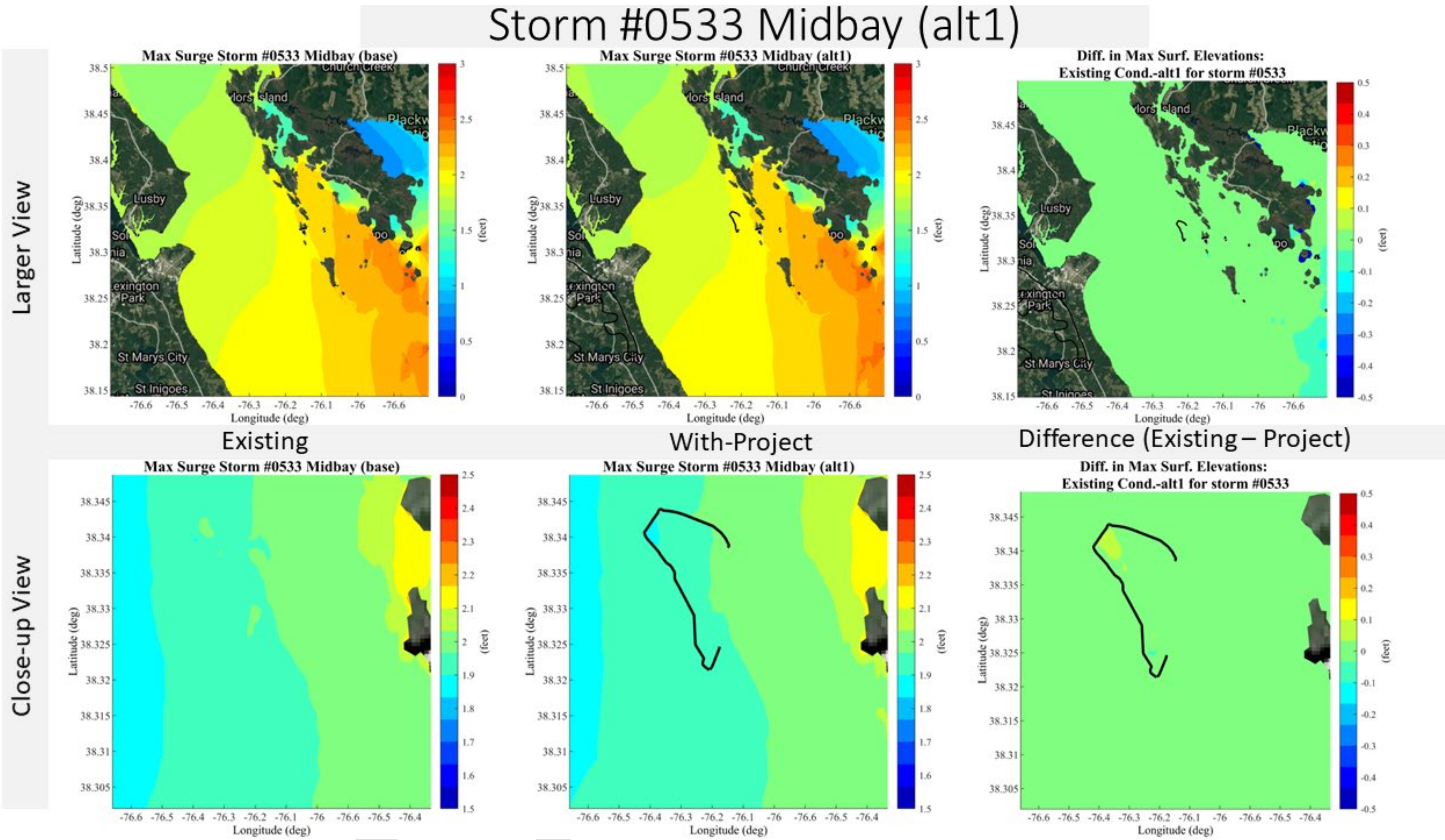

Storm #0478 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0478 Midbay (base)
Max Surge Storm #0478 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0478
Latitude (deg)
Longitude (deg)
(feet)

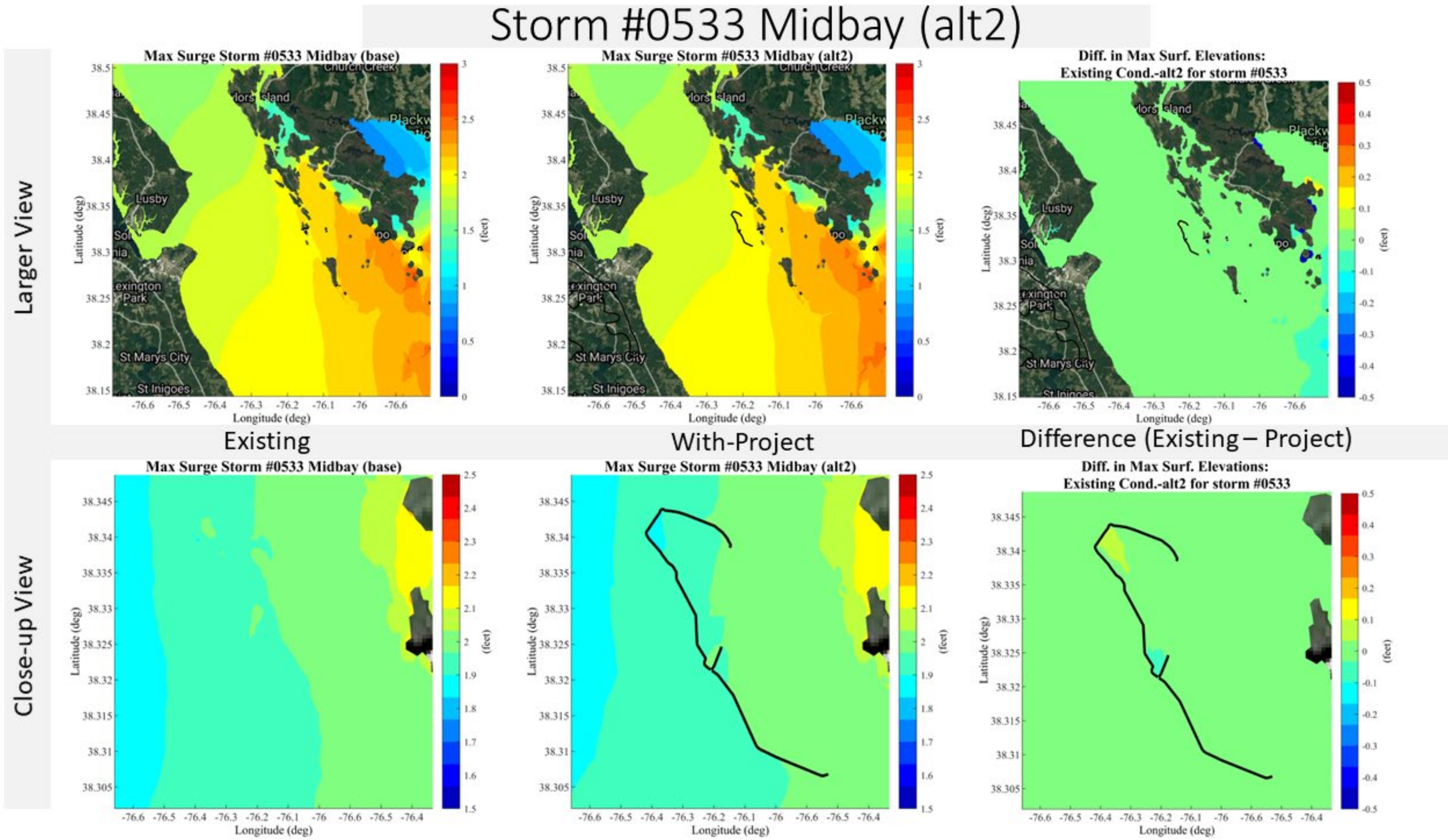

Storm #0478 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0478 Midbay (base)
Max Surge Storm #0478 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0478
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

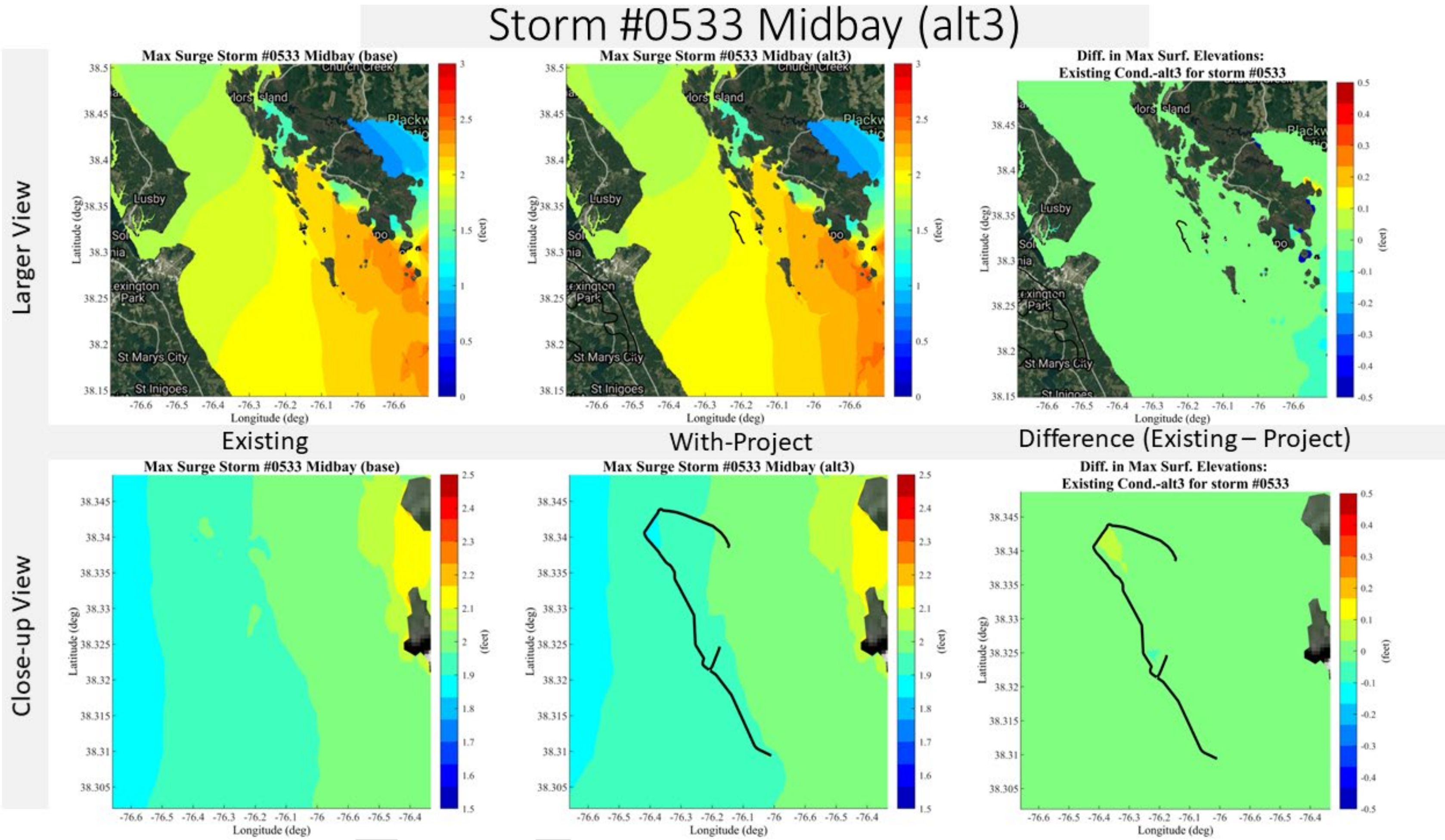

Storm #0478 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0478 Midbay (base)
Max Surge Storm #0478 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0478
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

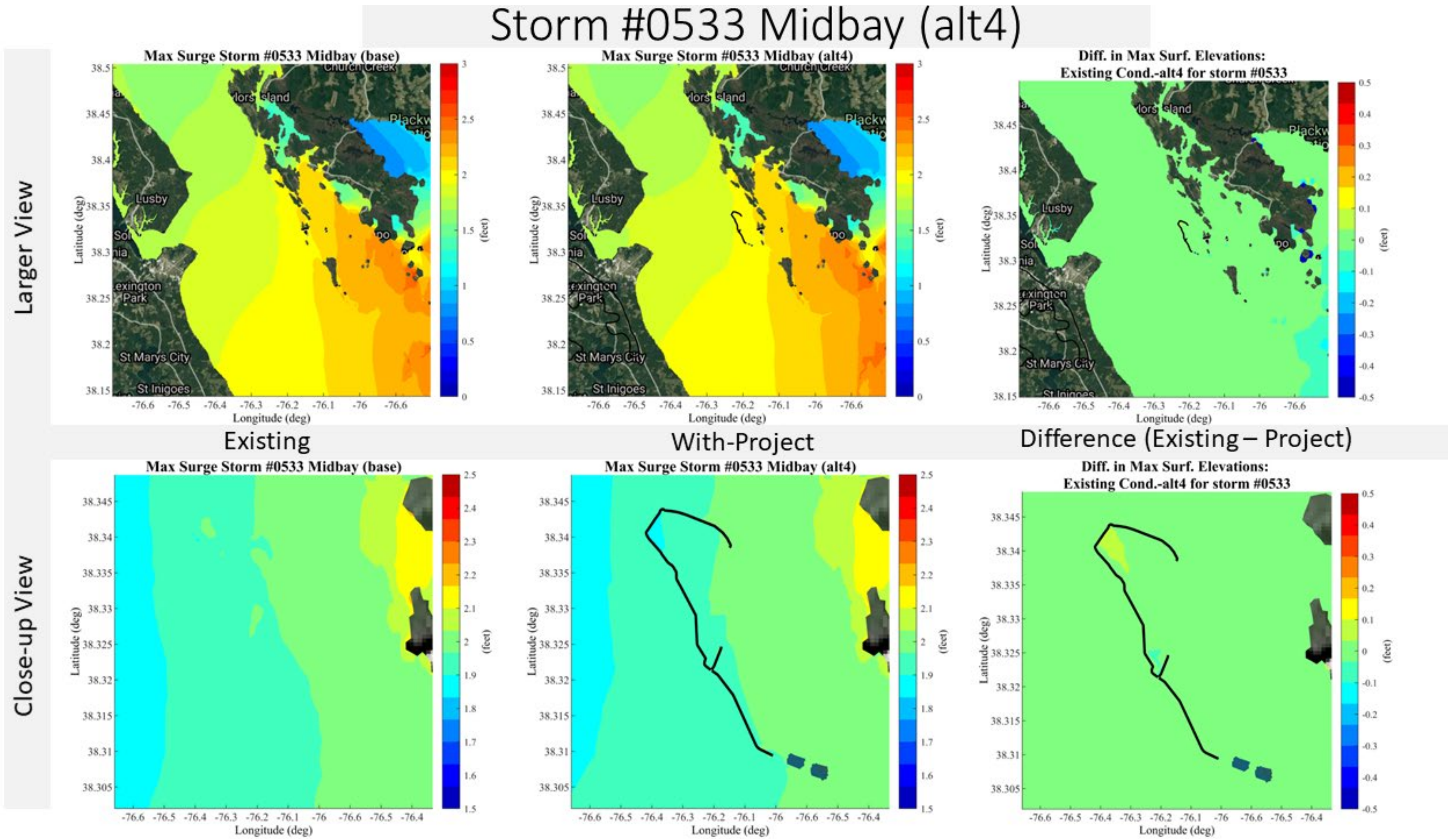

Storm #0478 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0478 Midbay (base)
Max Surge Storm #0478 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0478
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

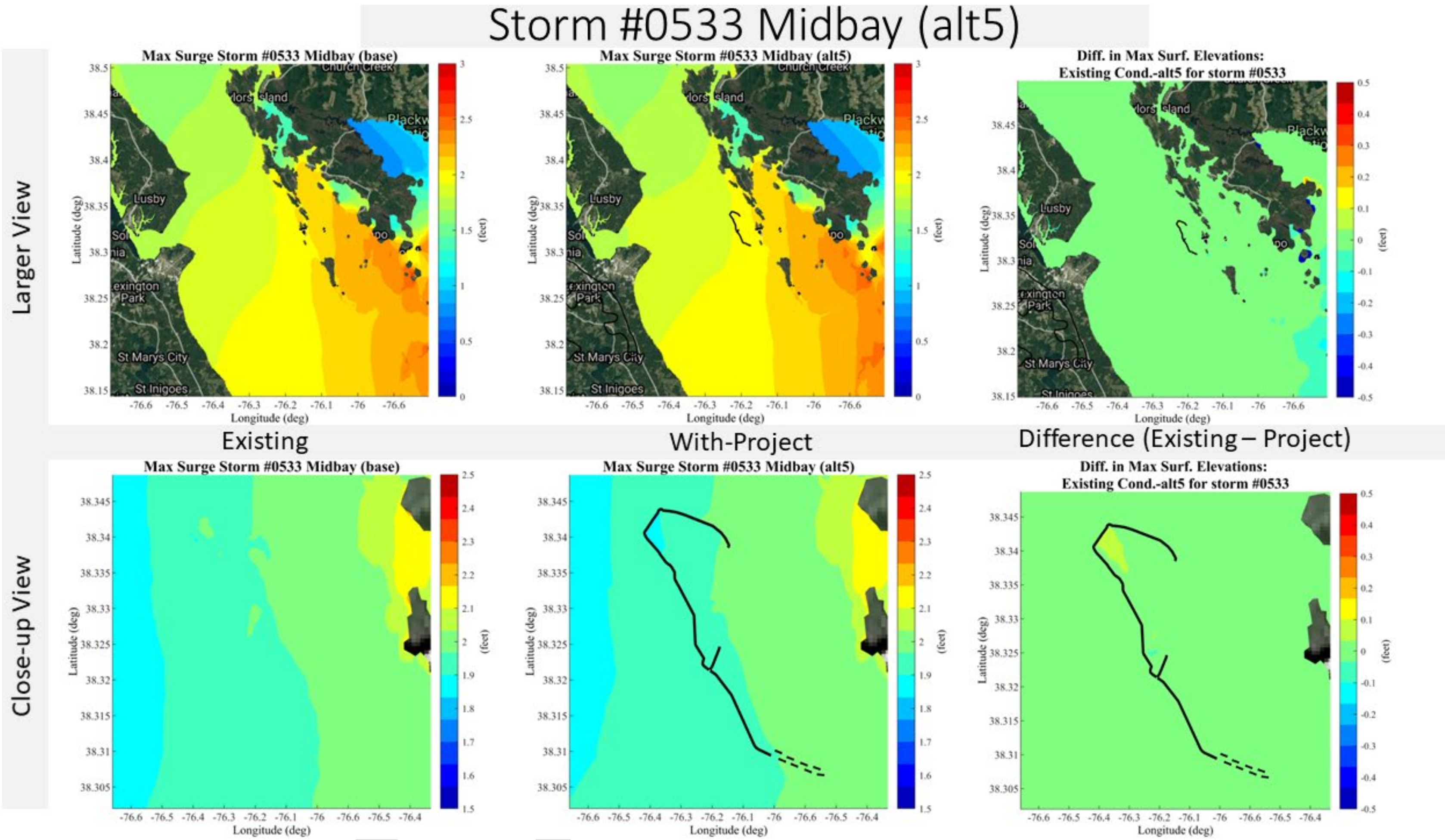

Storm #0478 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0478 Midbay (base)
Max Surge Storm #0478 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0478
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

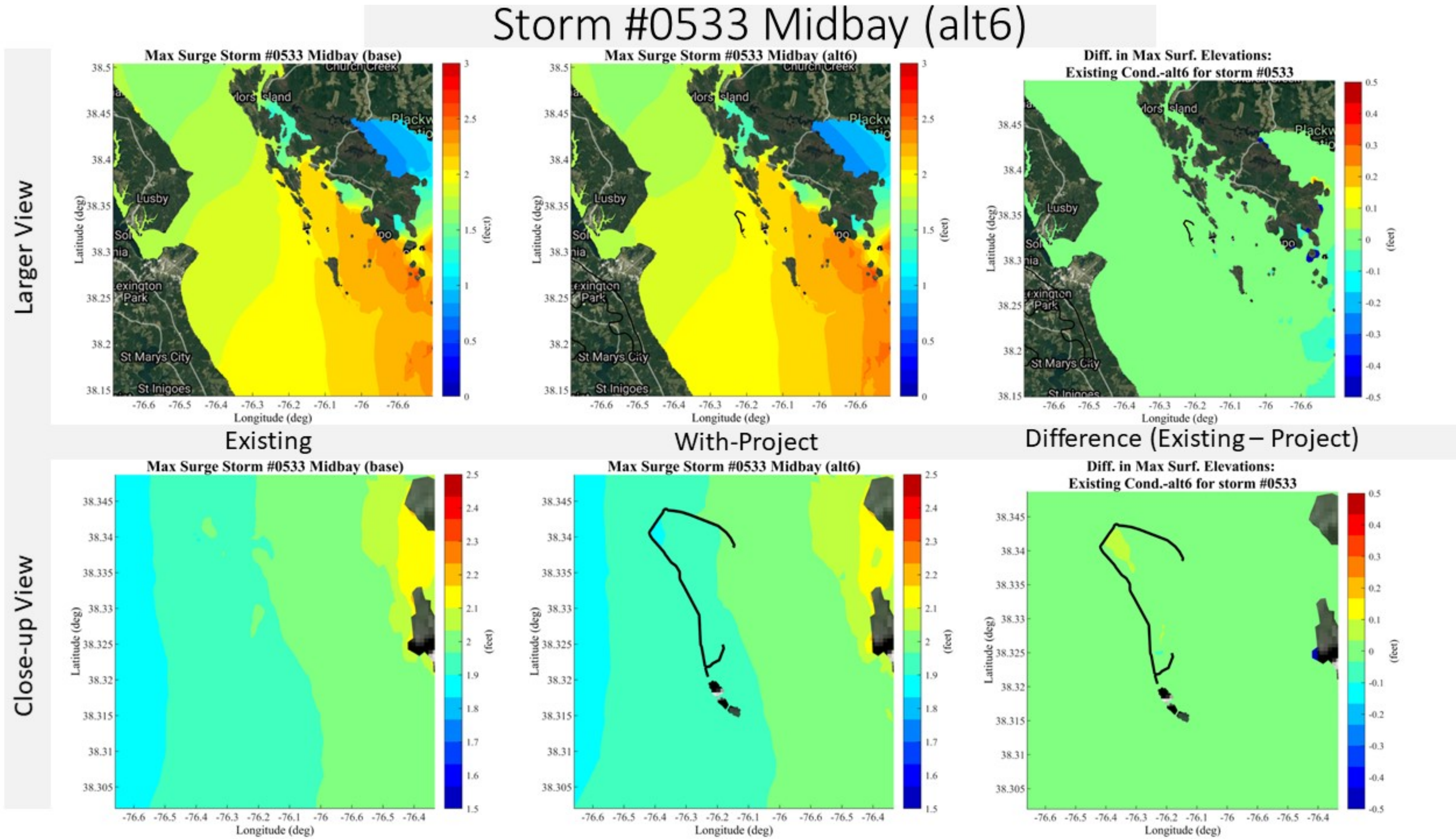

Storm #0533 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt1)
Diff. in Max Surf. Elevations: Existing Cond.-alt1 for storm #0533
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park

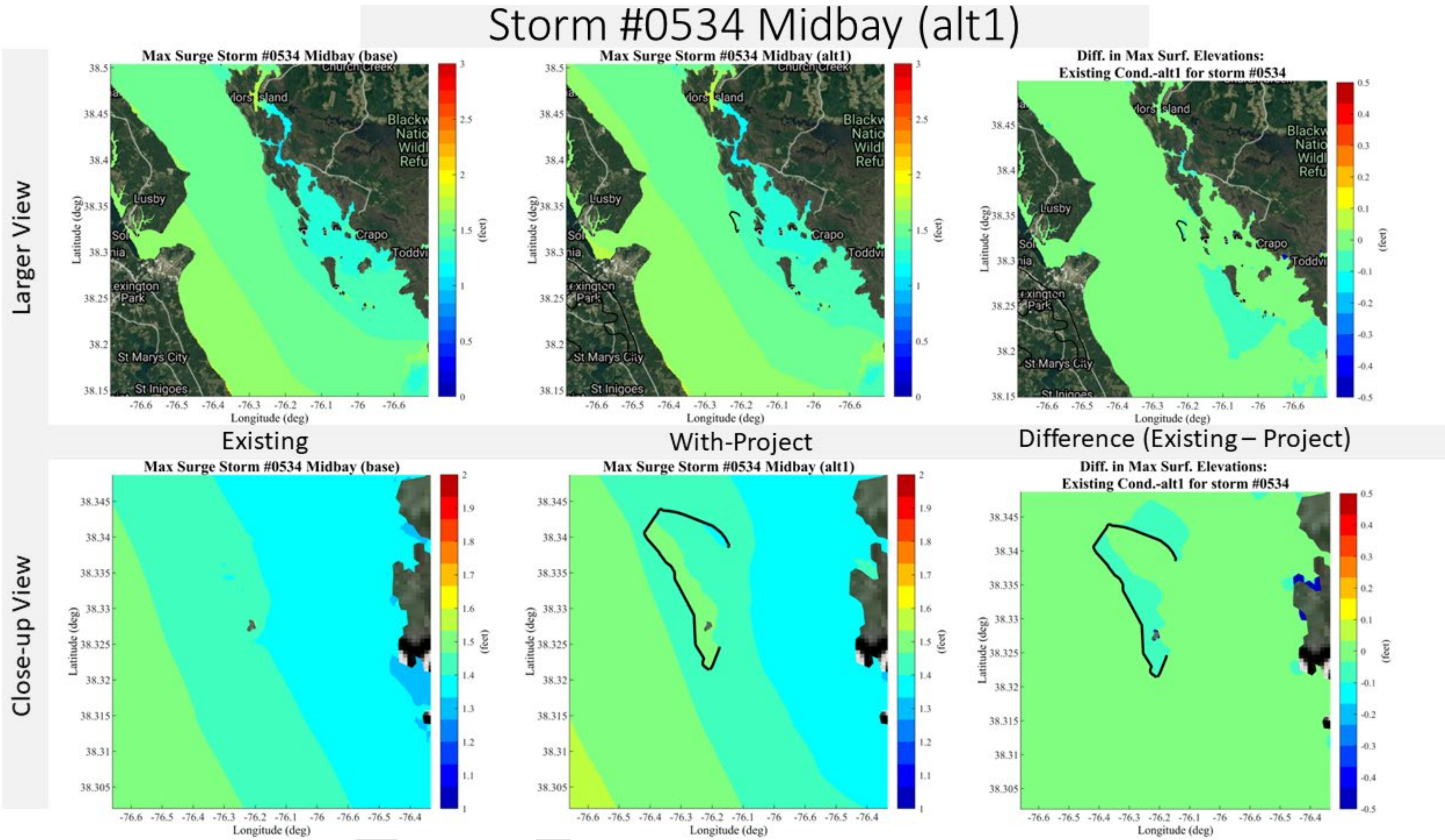

Storm #0533 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0533
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek
Blackw

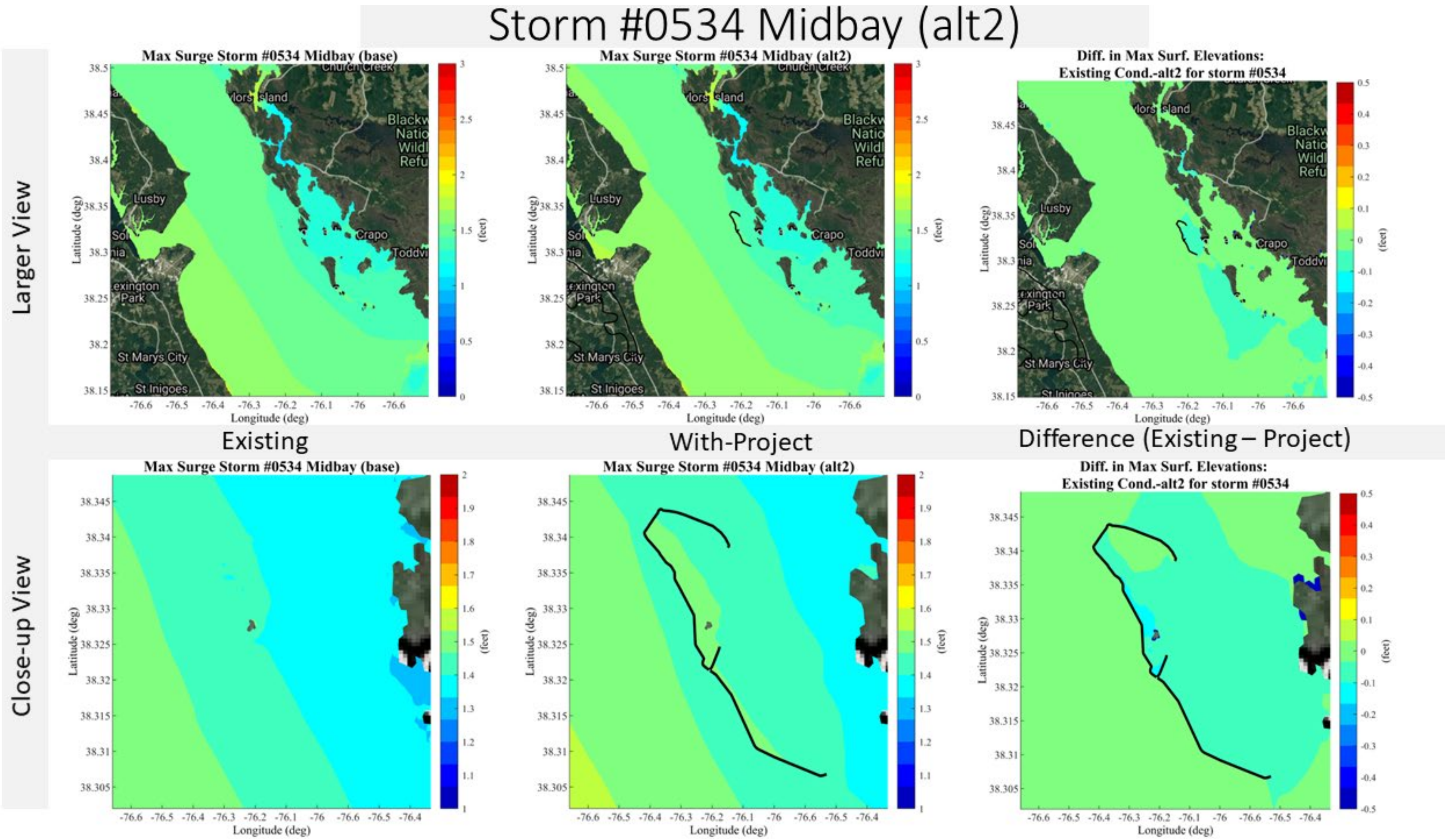

Storm #0533 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0533
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

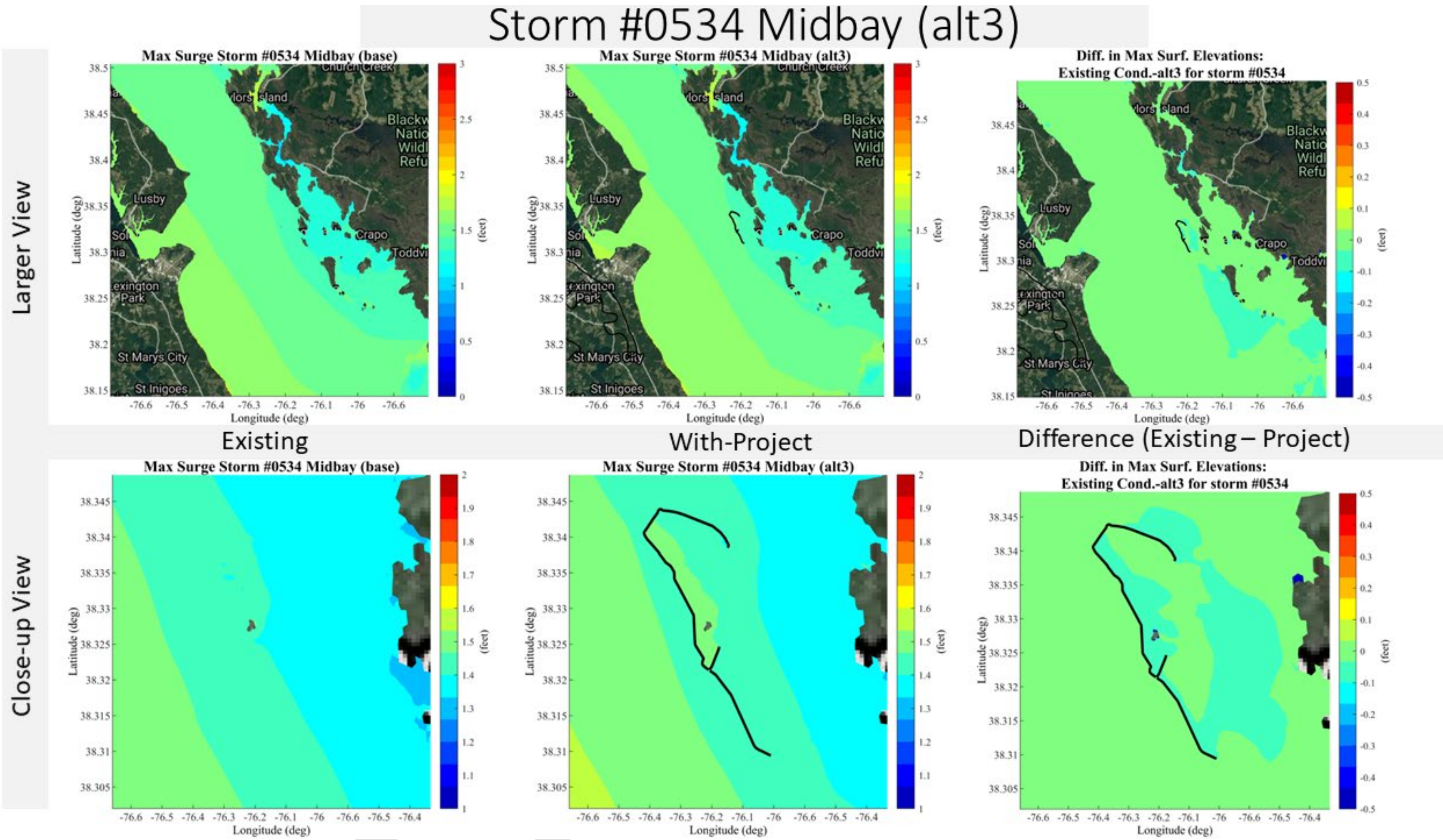

Storm #0533 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0533
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

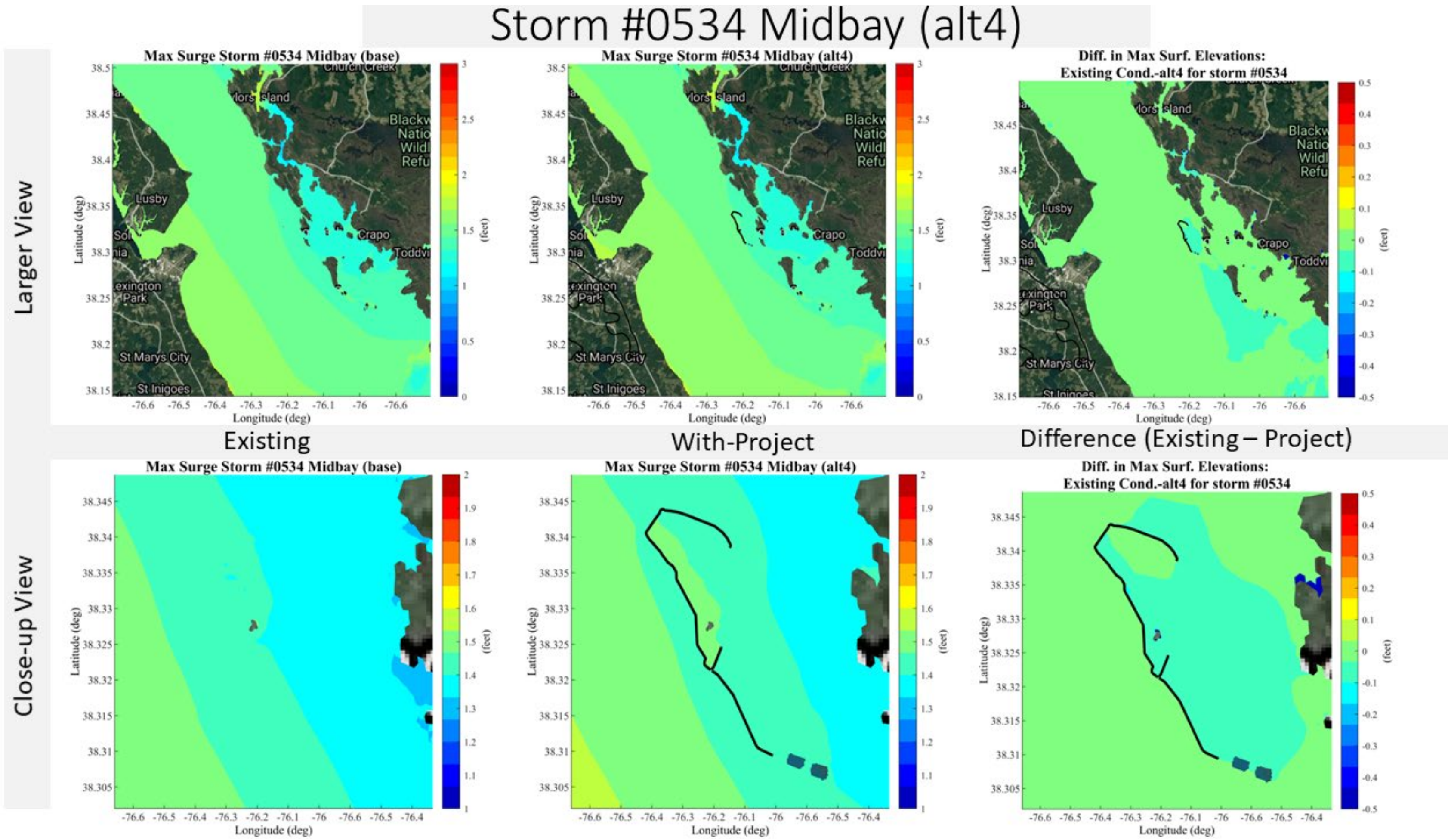

Storm #0533 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0533
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

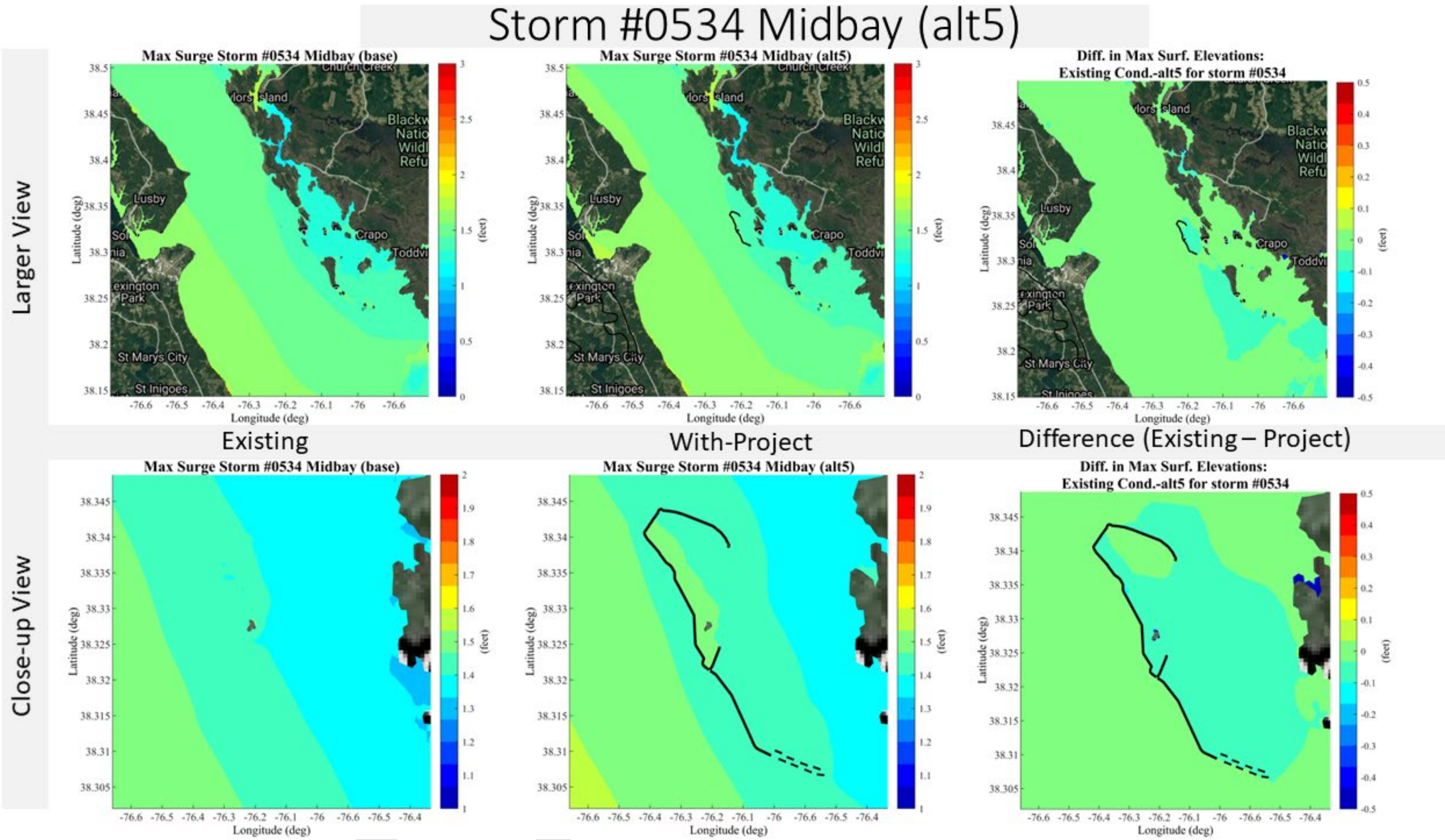

Storm #0533 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0533 Midbay (base)
Max Surge Storm #0533 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0533
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

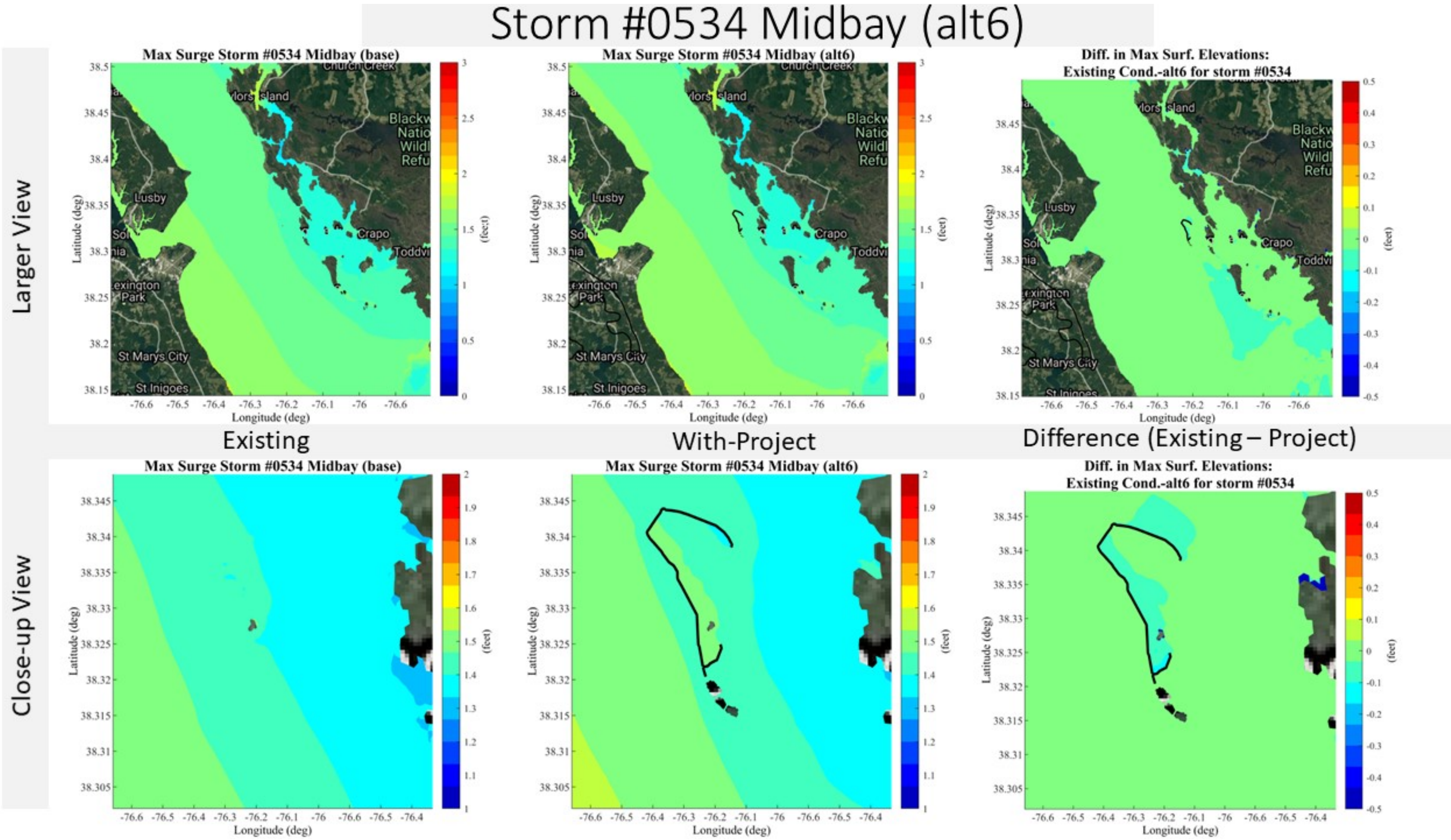

Storm #0534 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0534
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

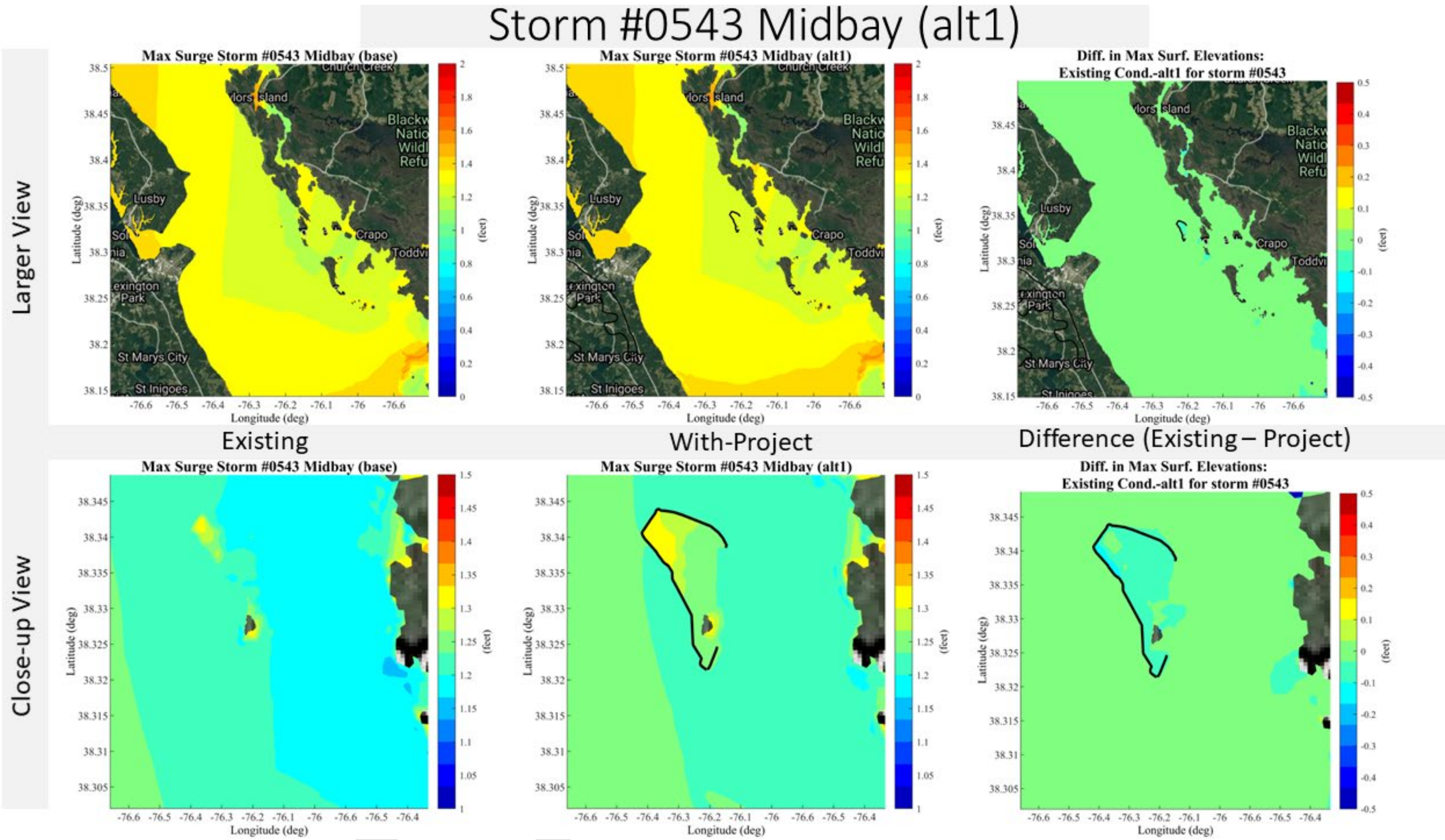

Storm #0534 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0534
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Lexington Park
St Marys City
St Inigoes
Church Creek
Blackw Natio Wildl Refu
Toddvi

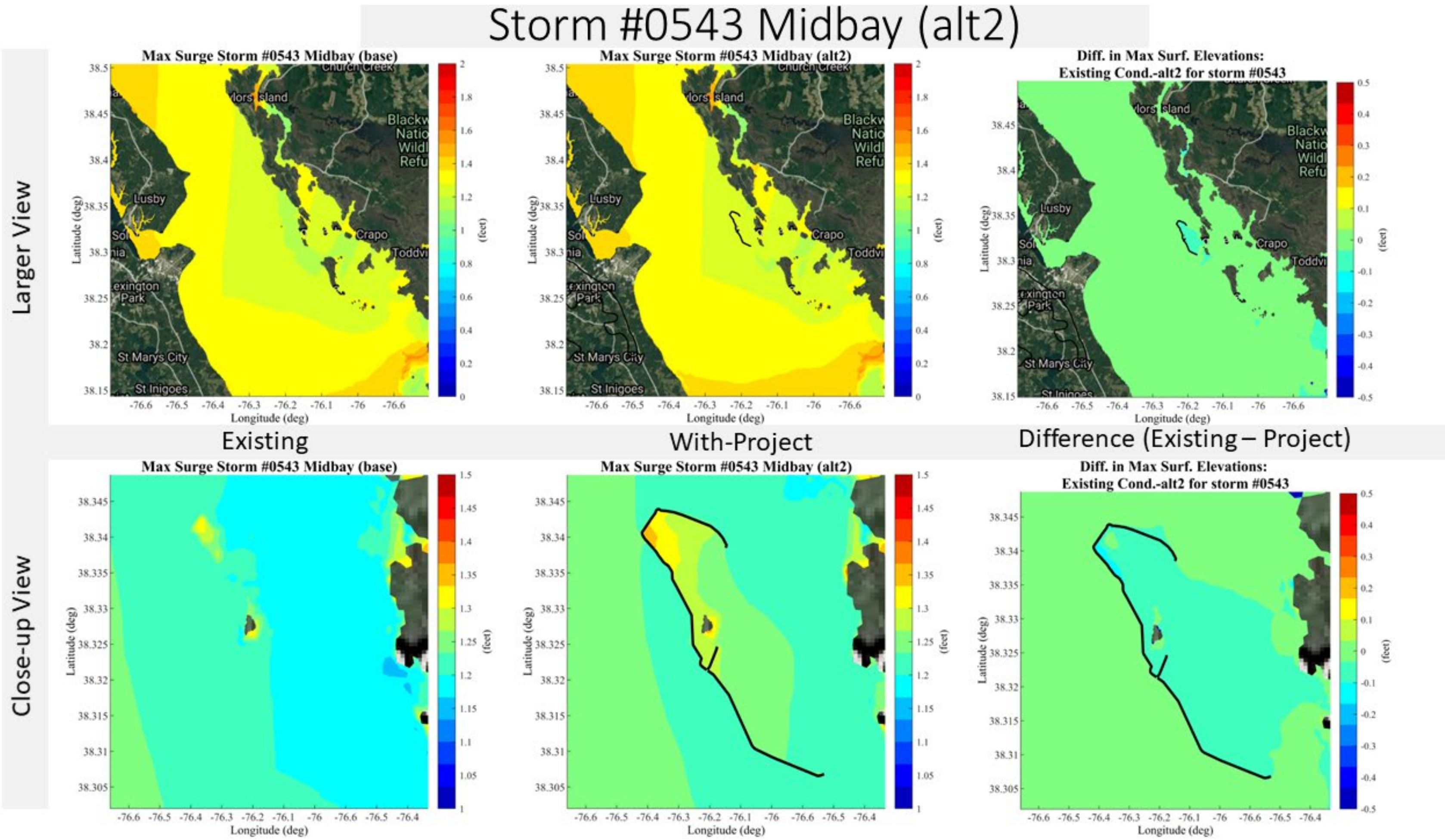

Storm #0534 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0534
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

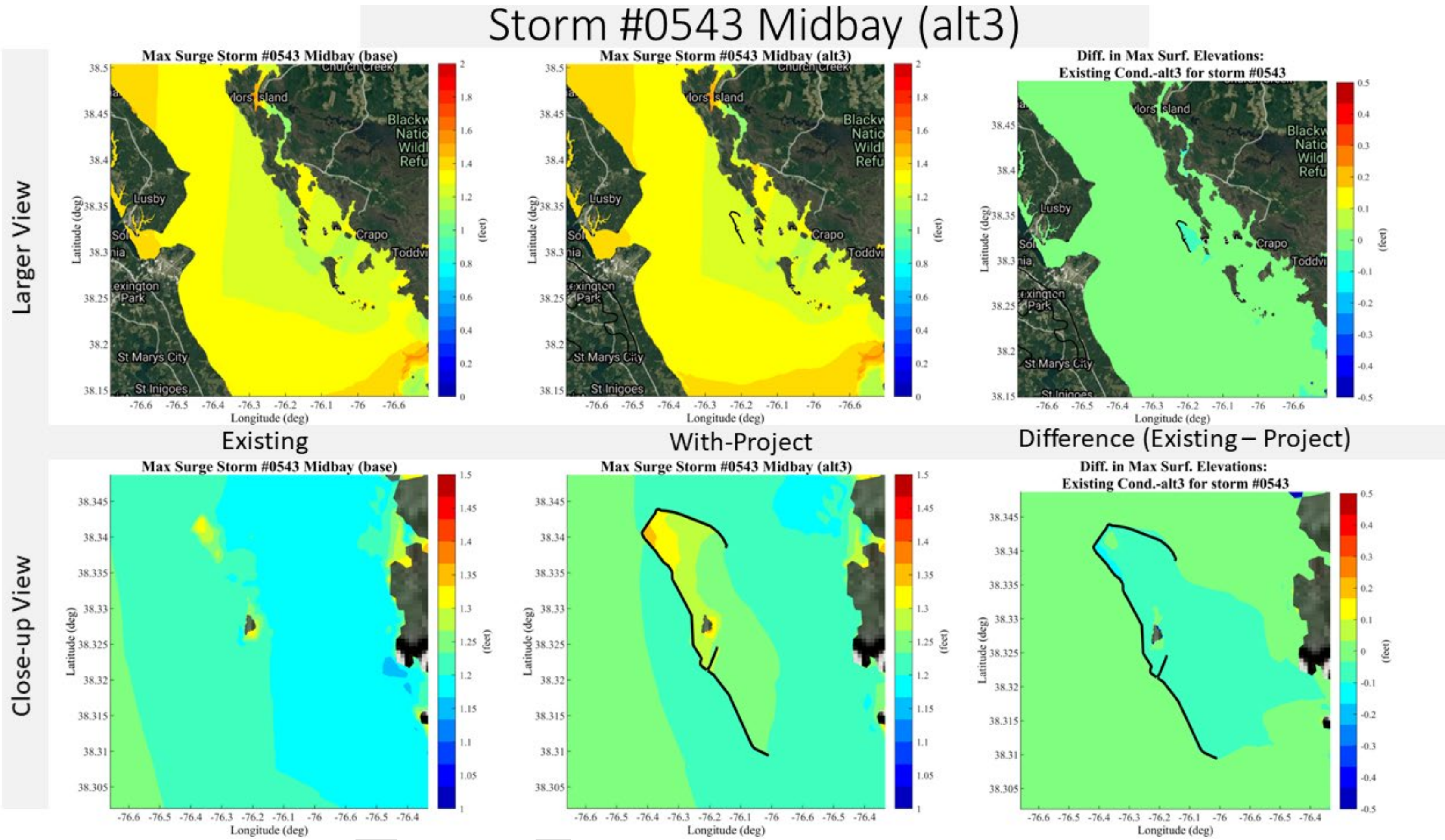

Storm #0534 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt4)
Diff. in Max Surf. Elevations: Existing Cond.-alt4 for storm #0534
Latitude (deg)
Longitude (deg)
(feet)

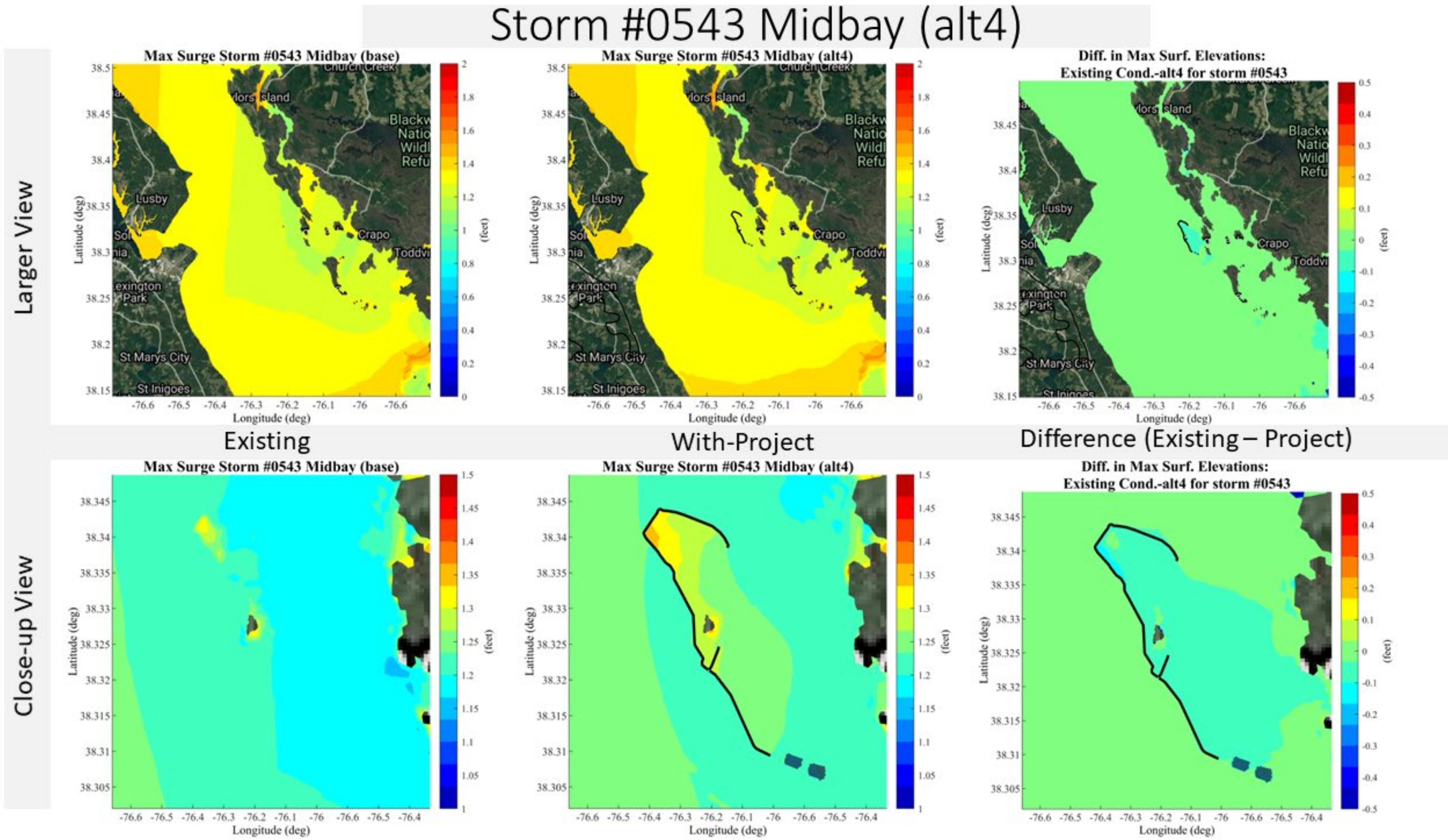

Storm #0534 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0534
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes

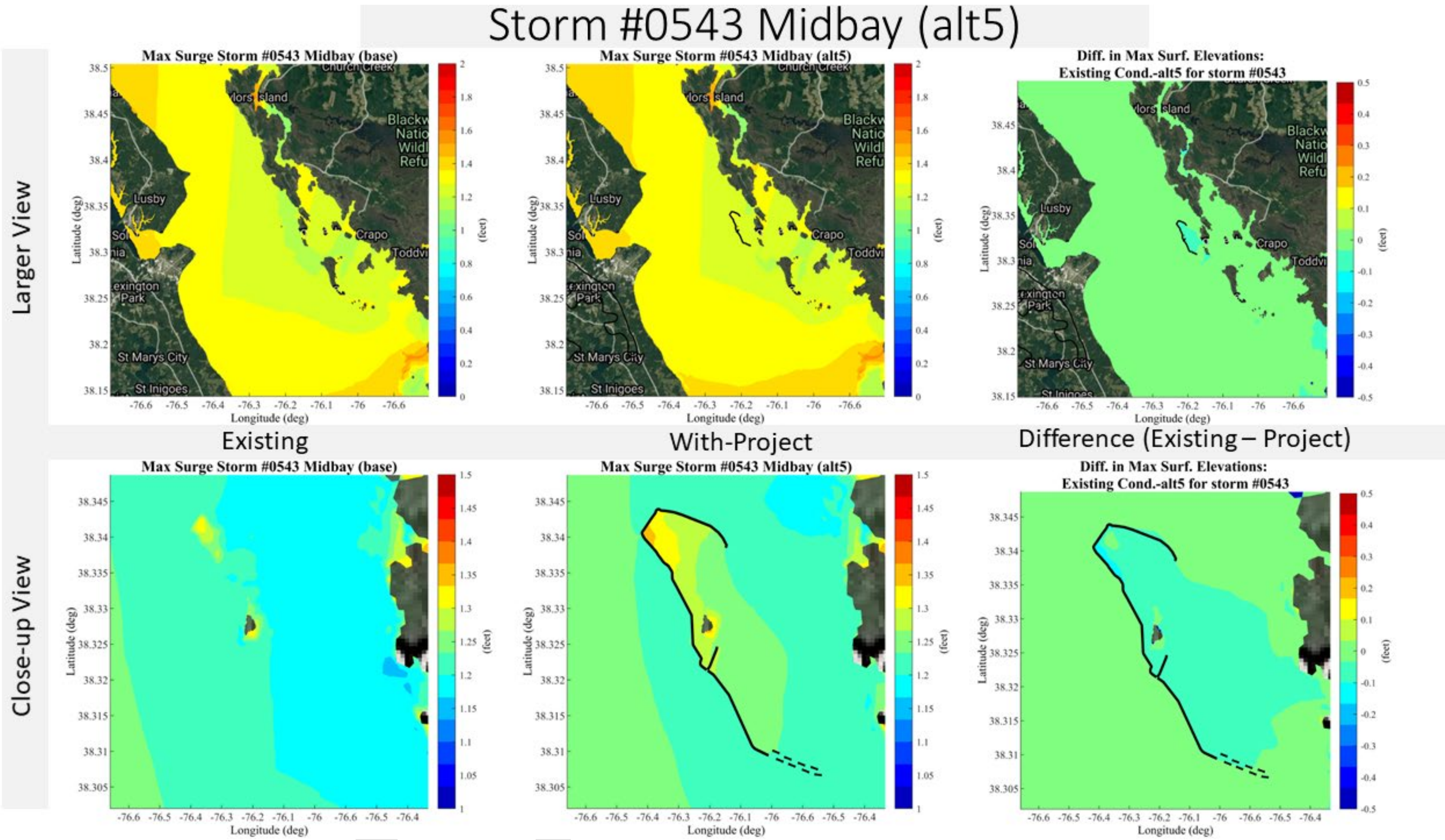

Storm #0534 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0534 Midbay (base)
Max Surge Storm #0534 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0534
Latitude (deg)
Longitude (deg)
(feet)

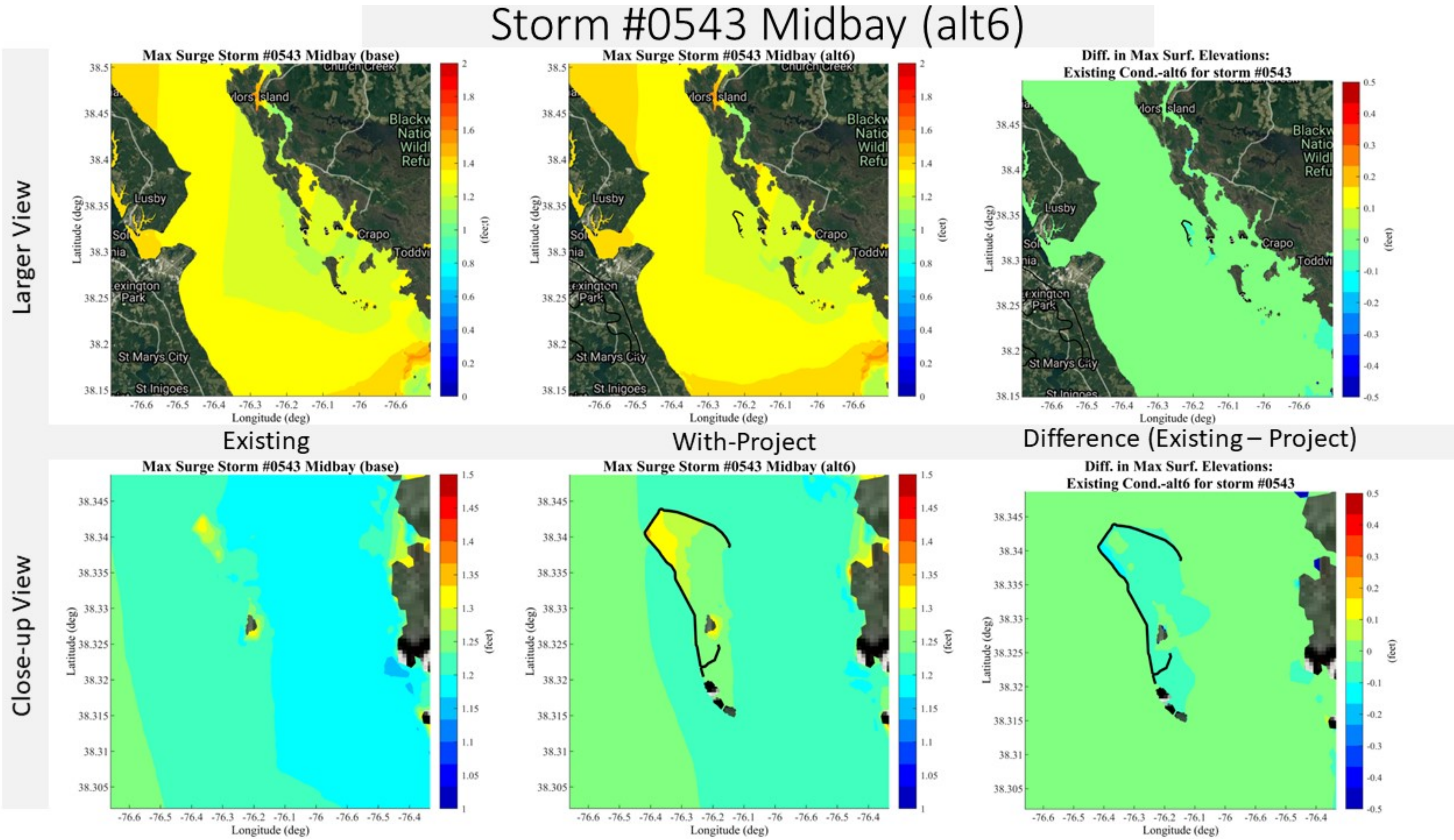

Storm #0543 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0543
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Lexington Park
St Marys City
St Inigoes

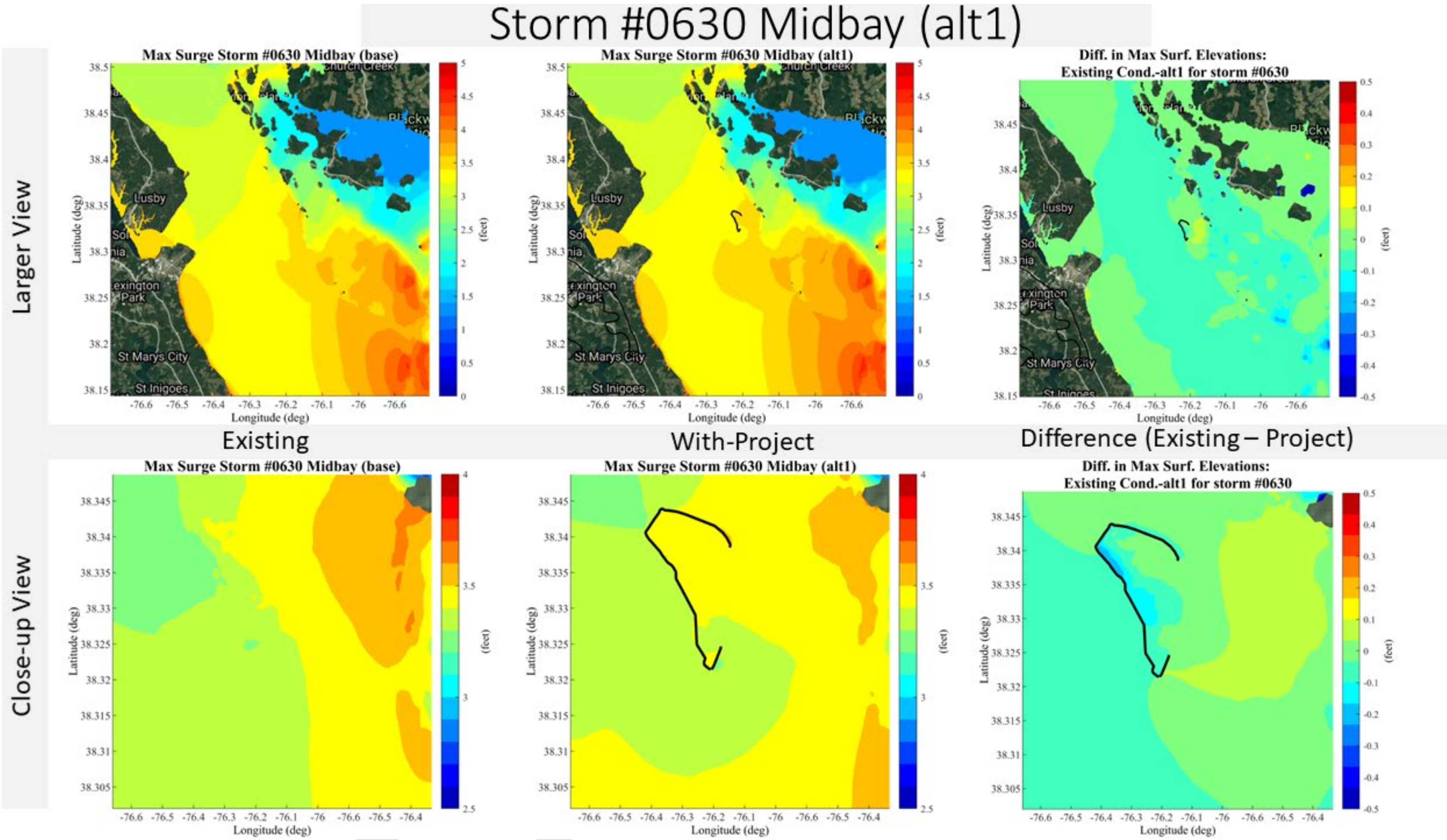

Storm #0543 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0543
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Crapo

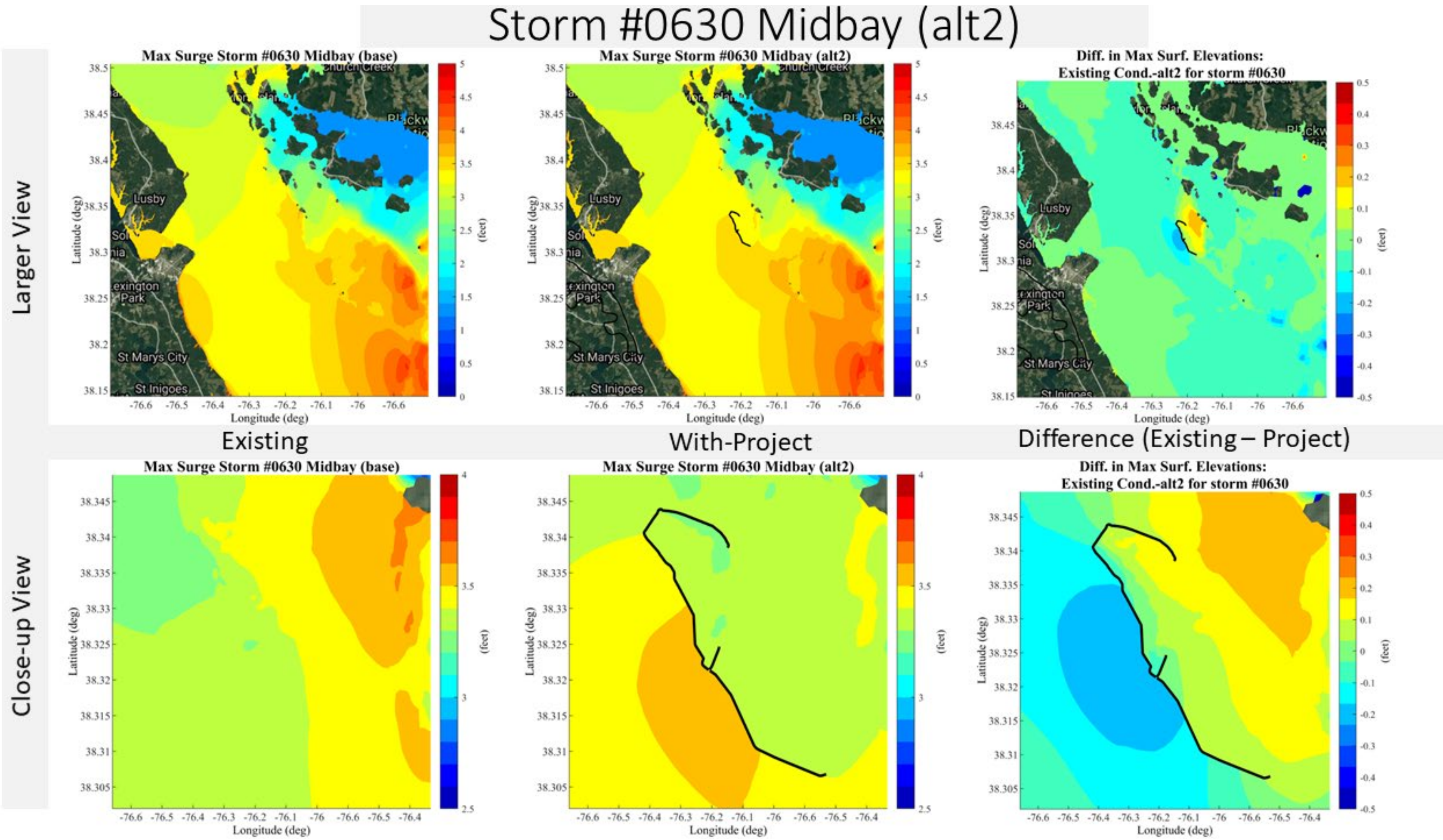

Storm #0543 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0543
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)


Storm #0543 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0543
Latitude (deg)
Longitude (deg)
(feet)

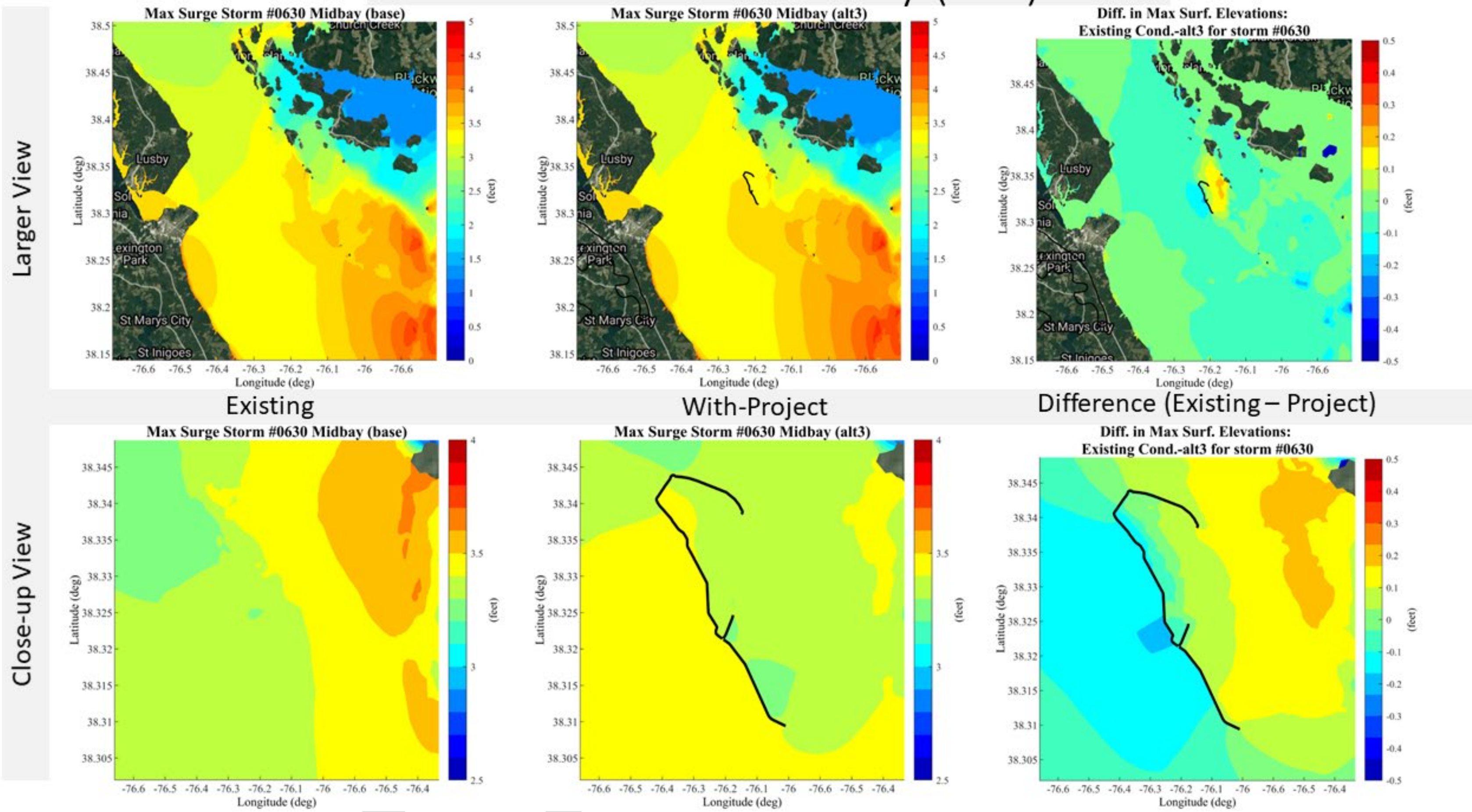

Storm #0543 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0543
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
Toddvi
Lexington Park
St Marys City
St Inigoes
Church Creek

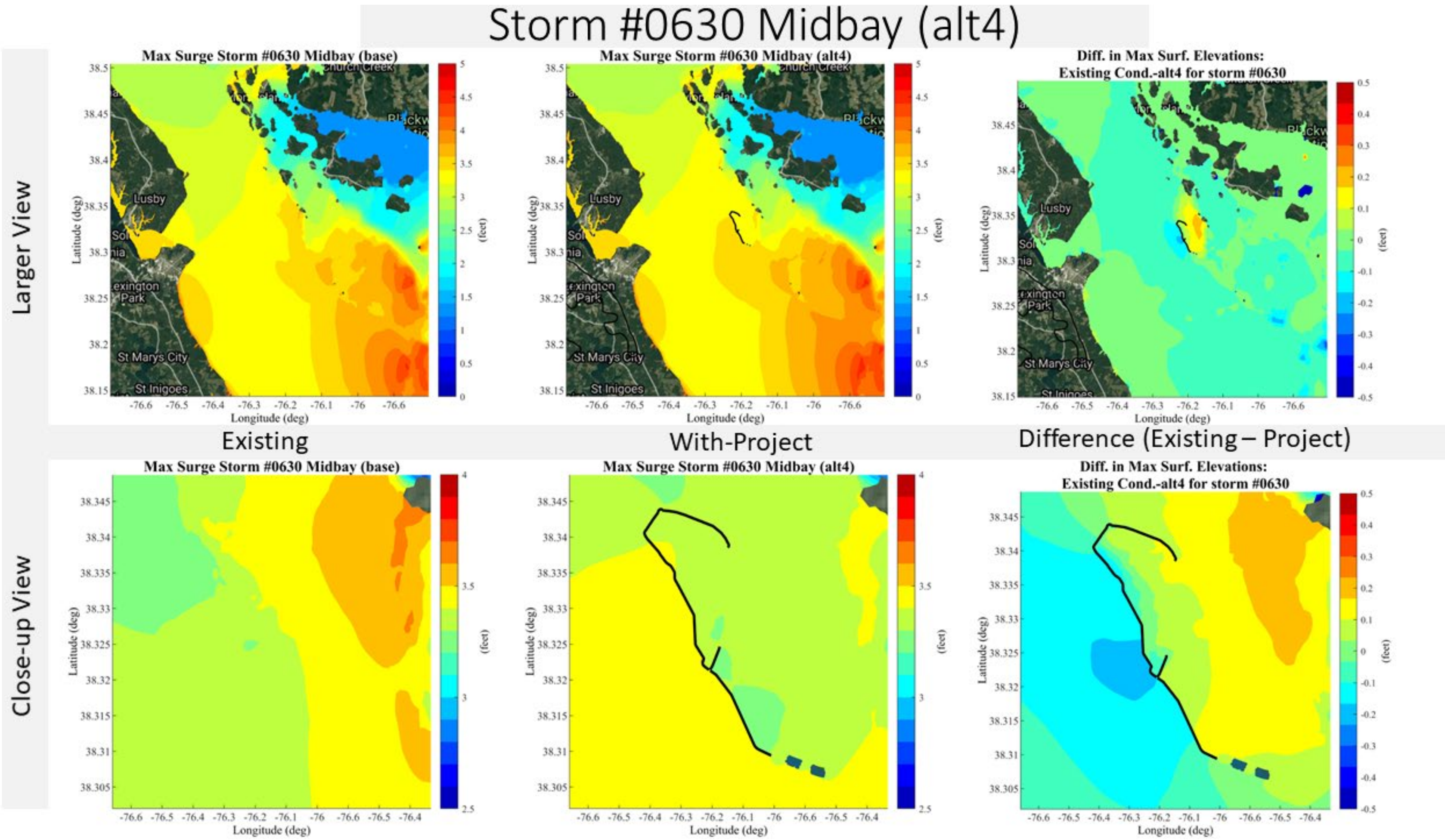

Storm #0543 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0543 Midbay (base)
Max Surge Storm #0543 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0543
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

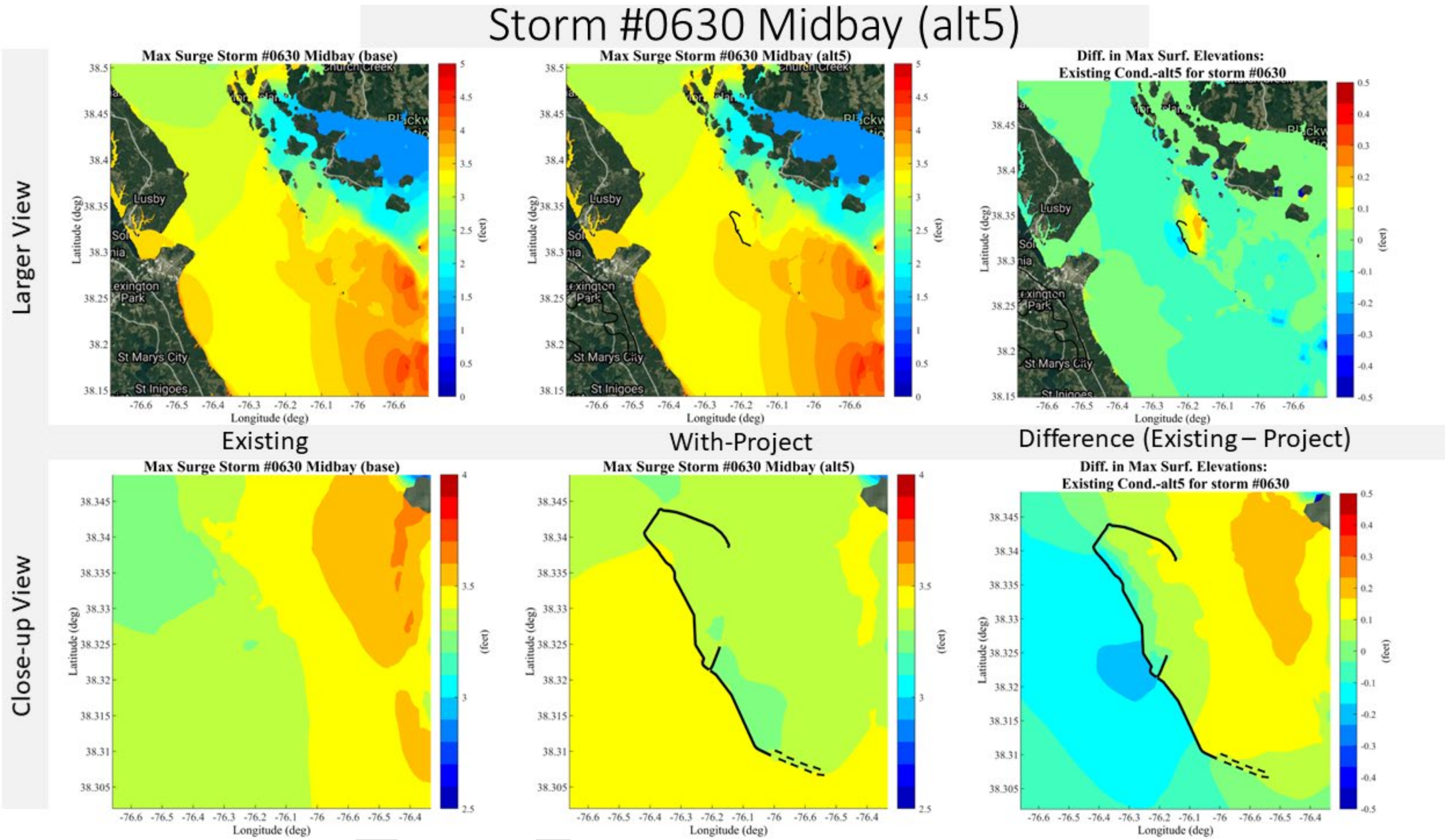

Storm #0630 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0630 Midbay (base)
Max Surge Storm #0630 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0630
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park
Church Creek
Blackw

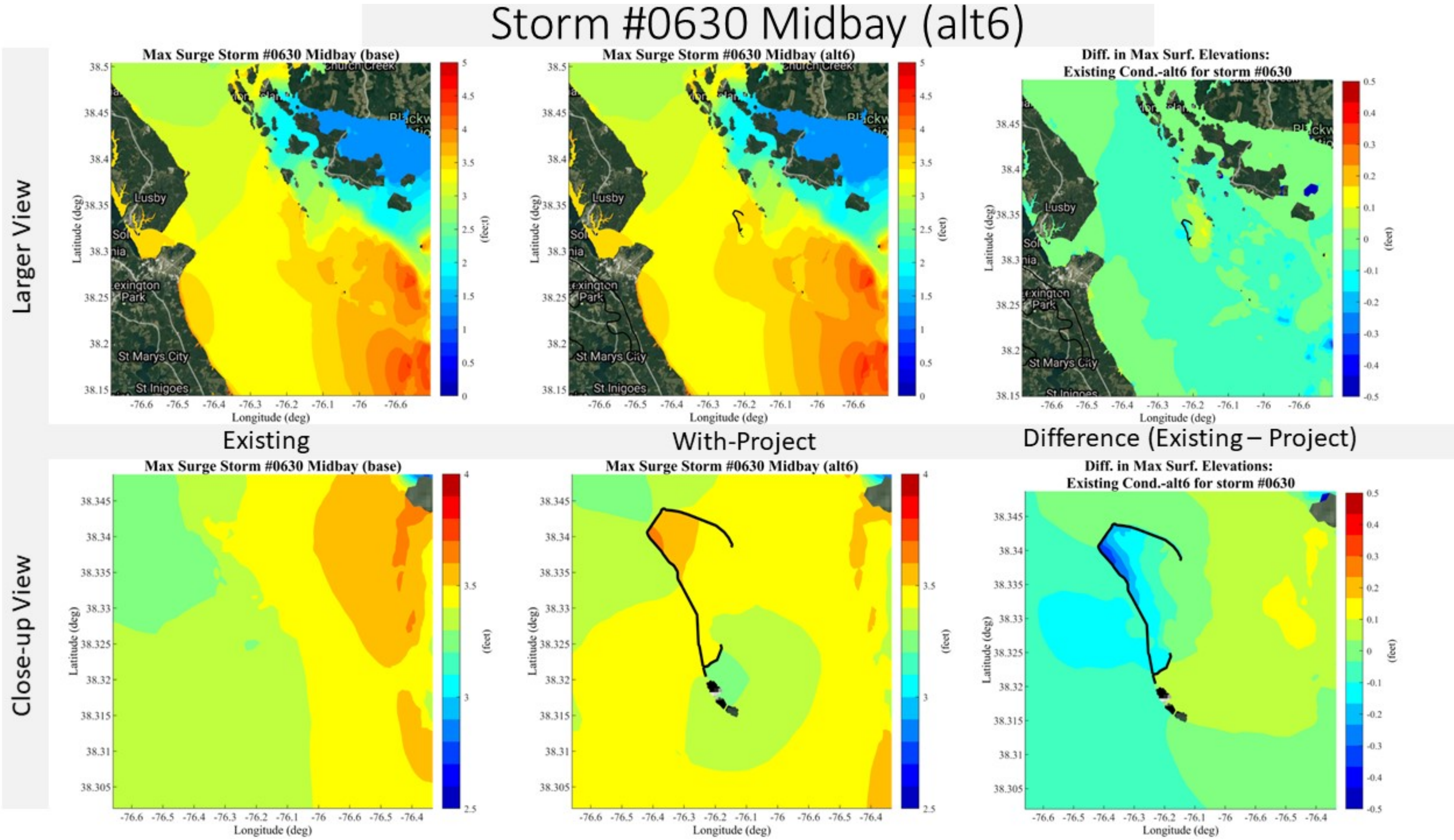

Storm #0630 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0630 Midbay (base)
Max Surge Storm #0630 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0630
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

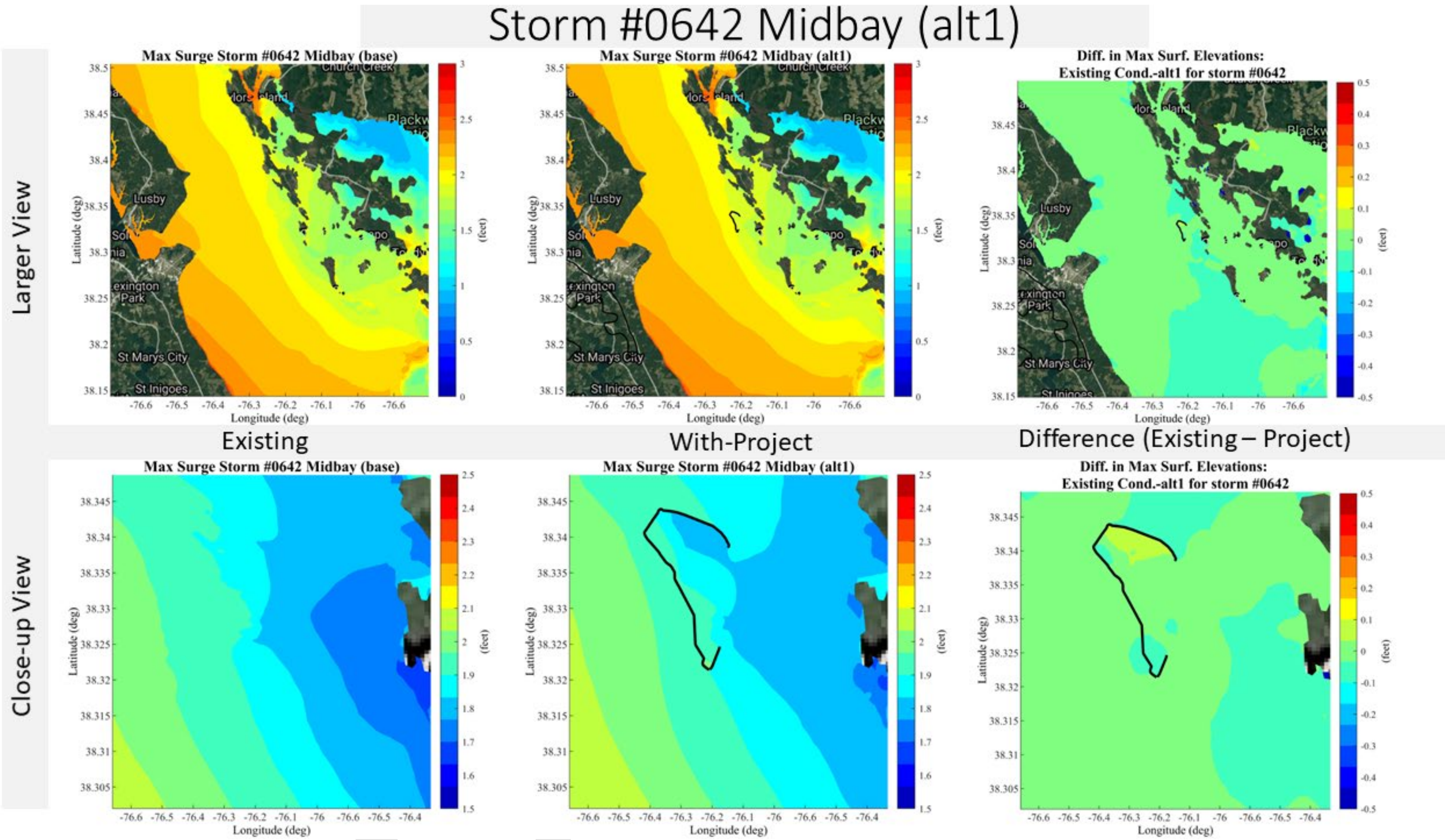
# Storm #0630 Midbay (alt3)

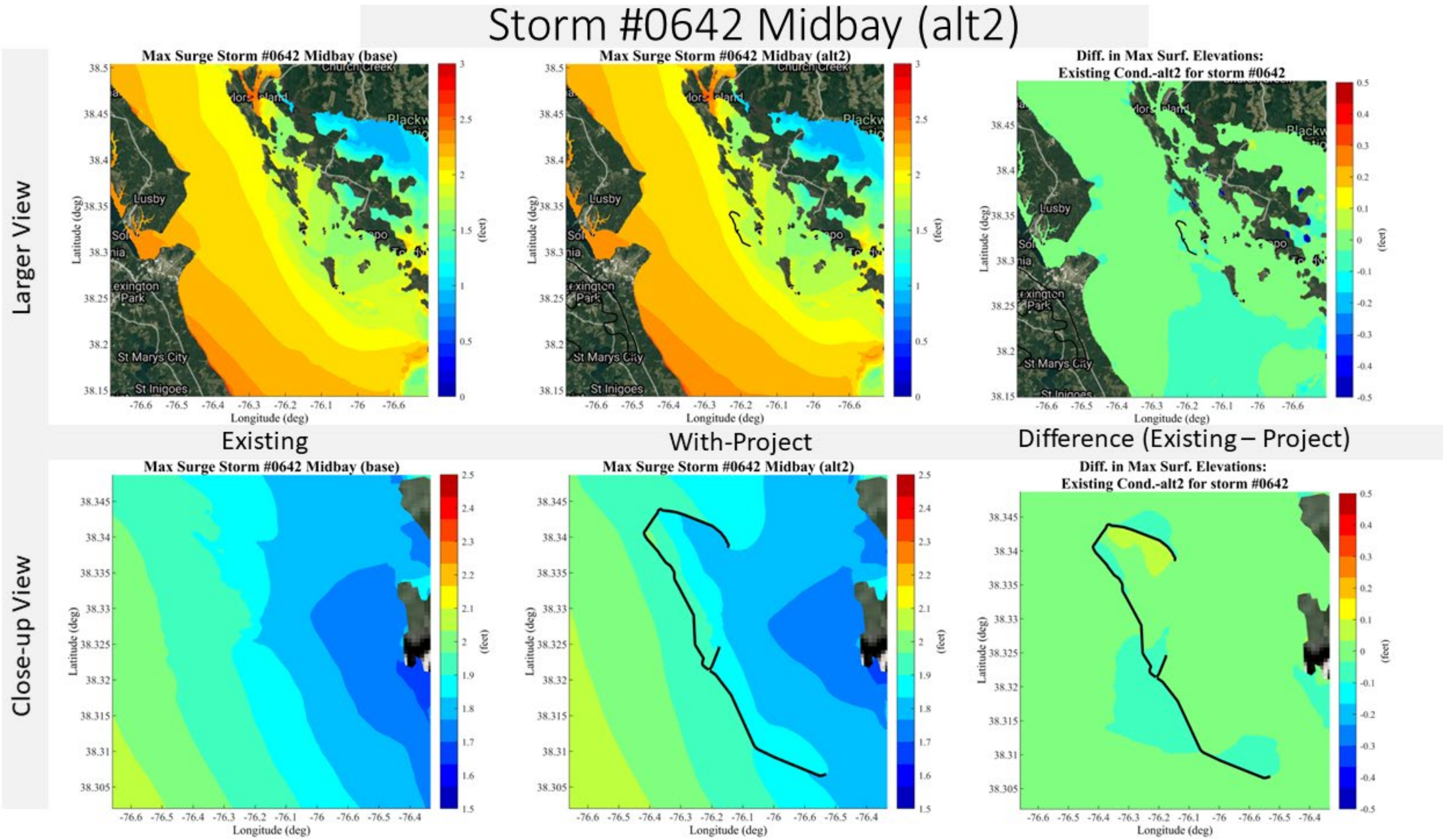


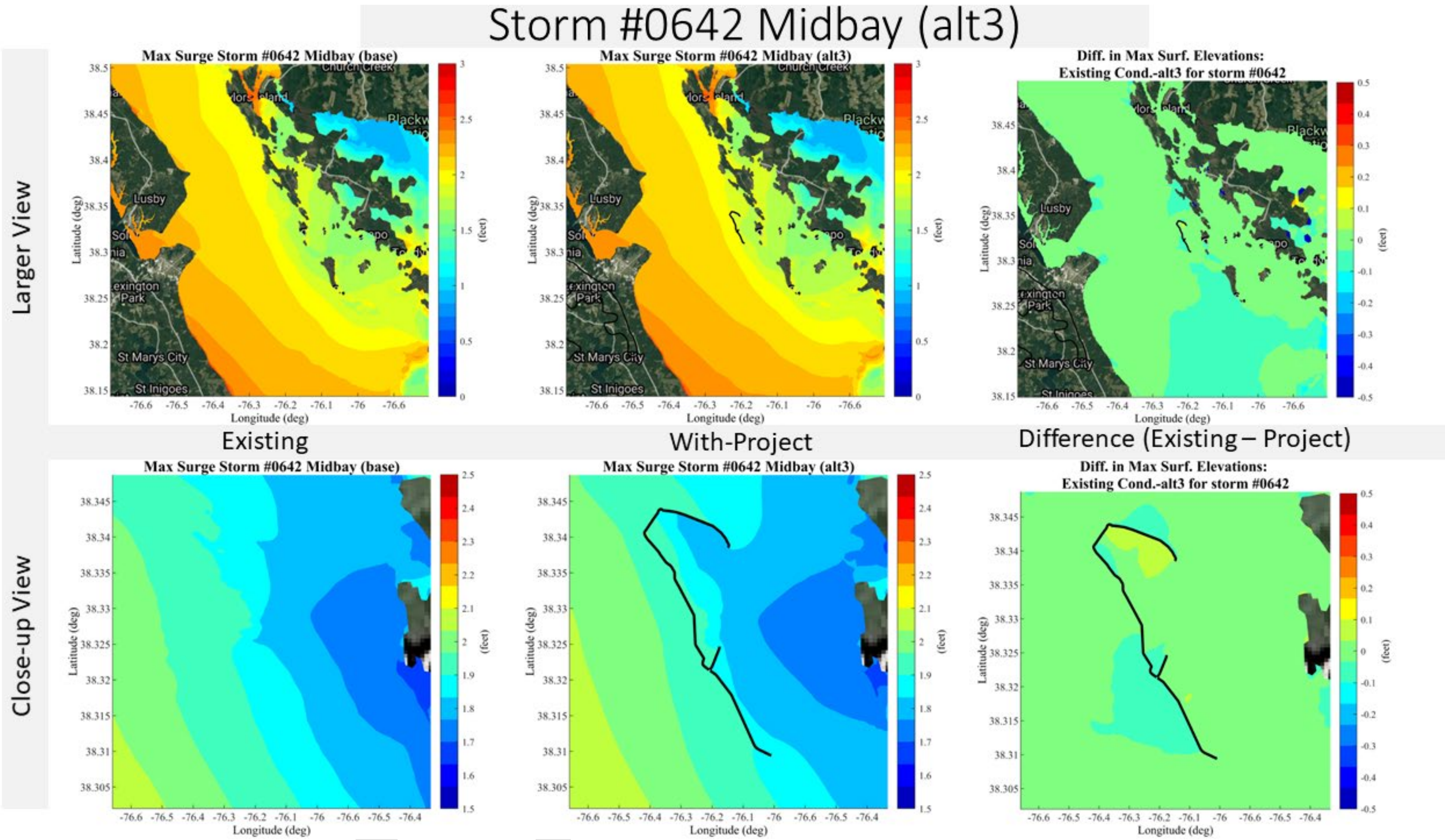

Storm #0630 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0630 Midbay (base)
Max Surge Storm #0630 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0630
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes

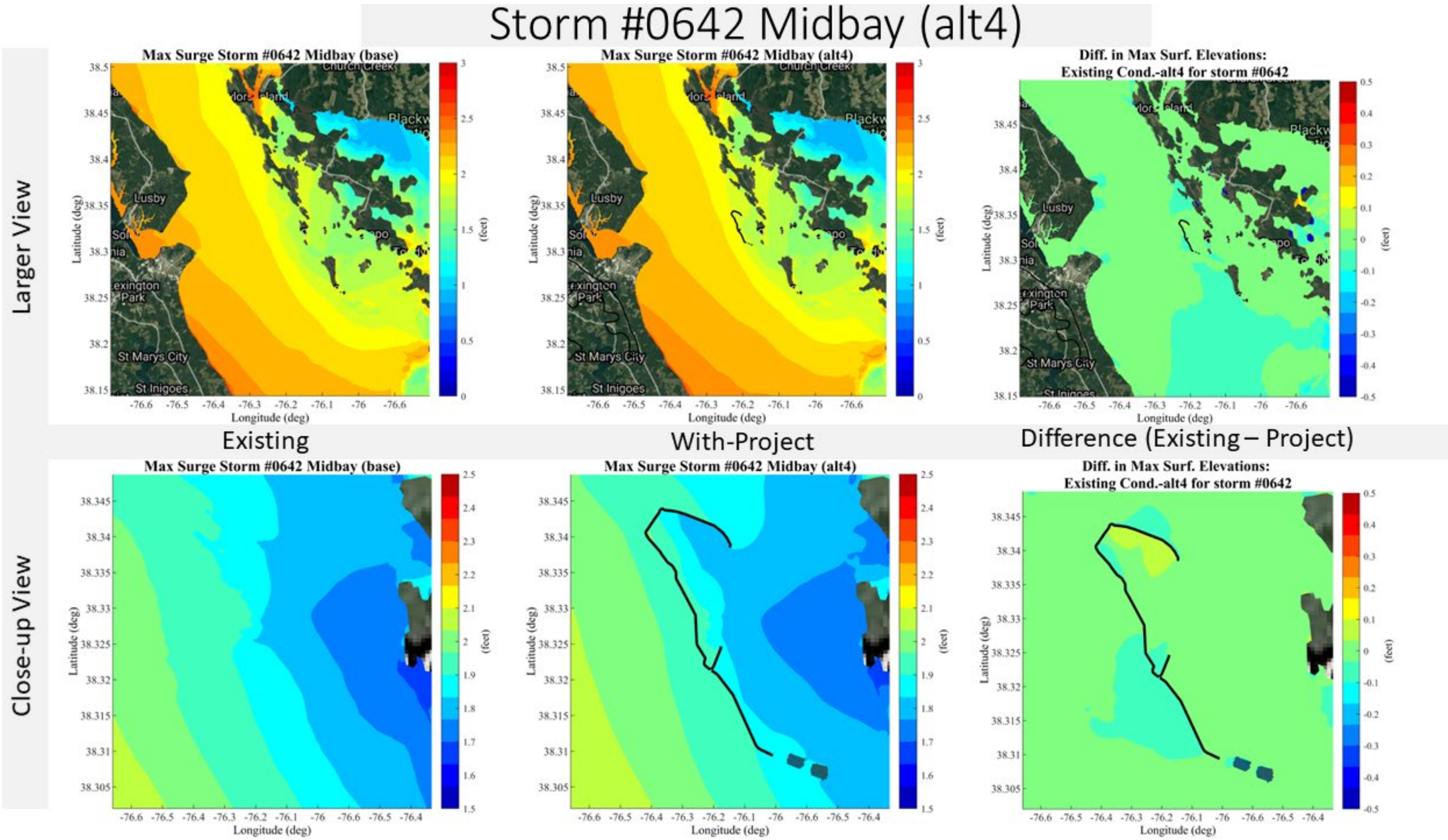

Storm #0630 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0630 Midbay (base)
Max Surge Storm #0630 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0630
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)

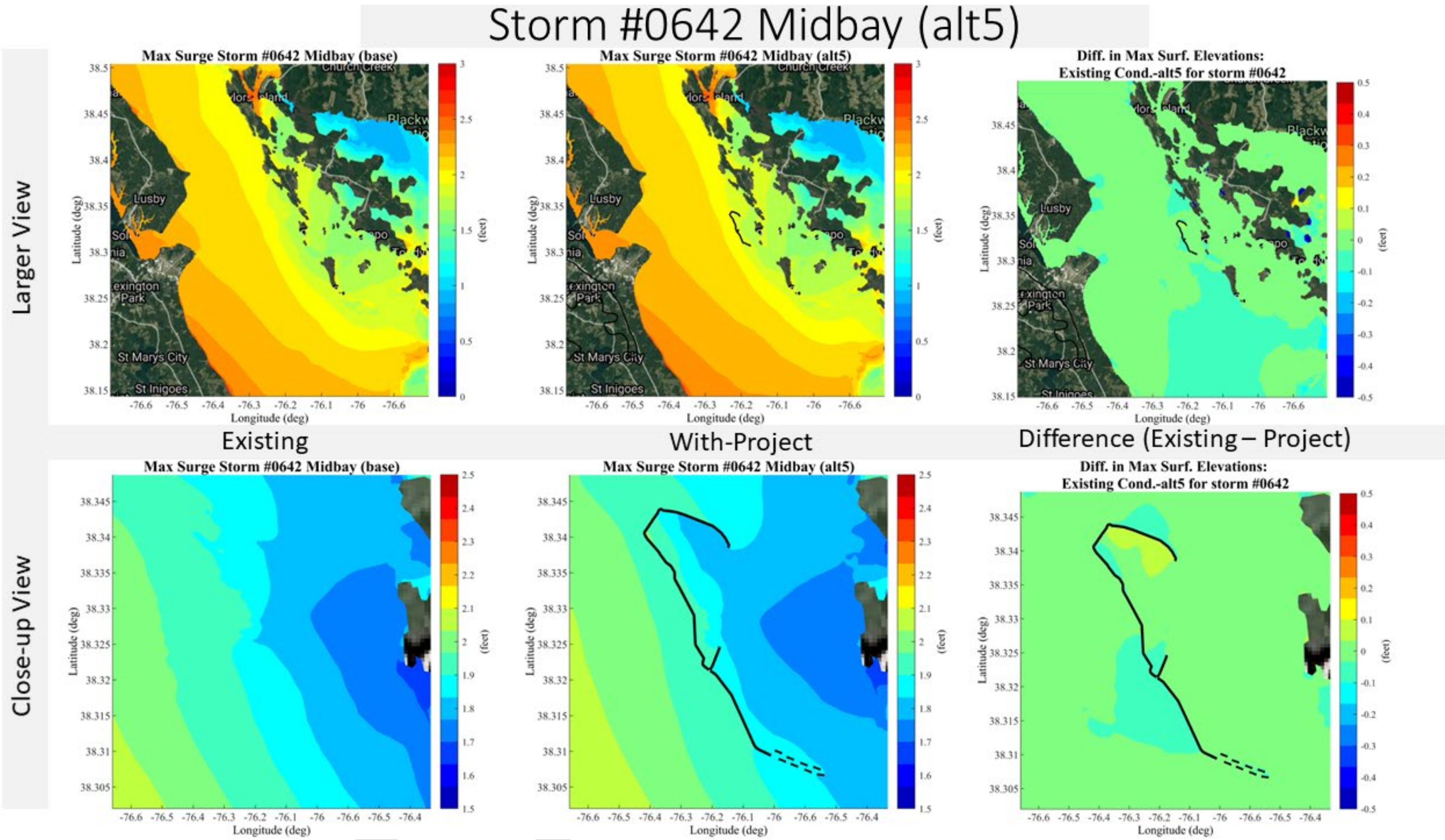

Storm #0630 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0630 Midbay (base)
Max Surge Storm #0630 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0630
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

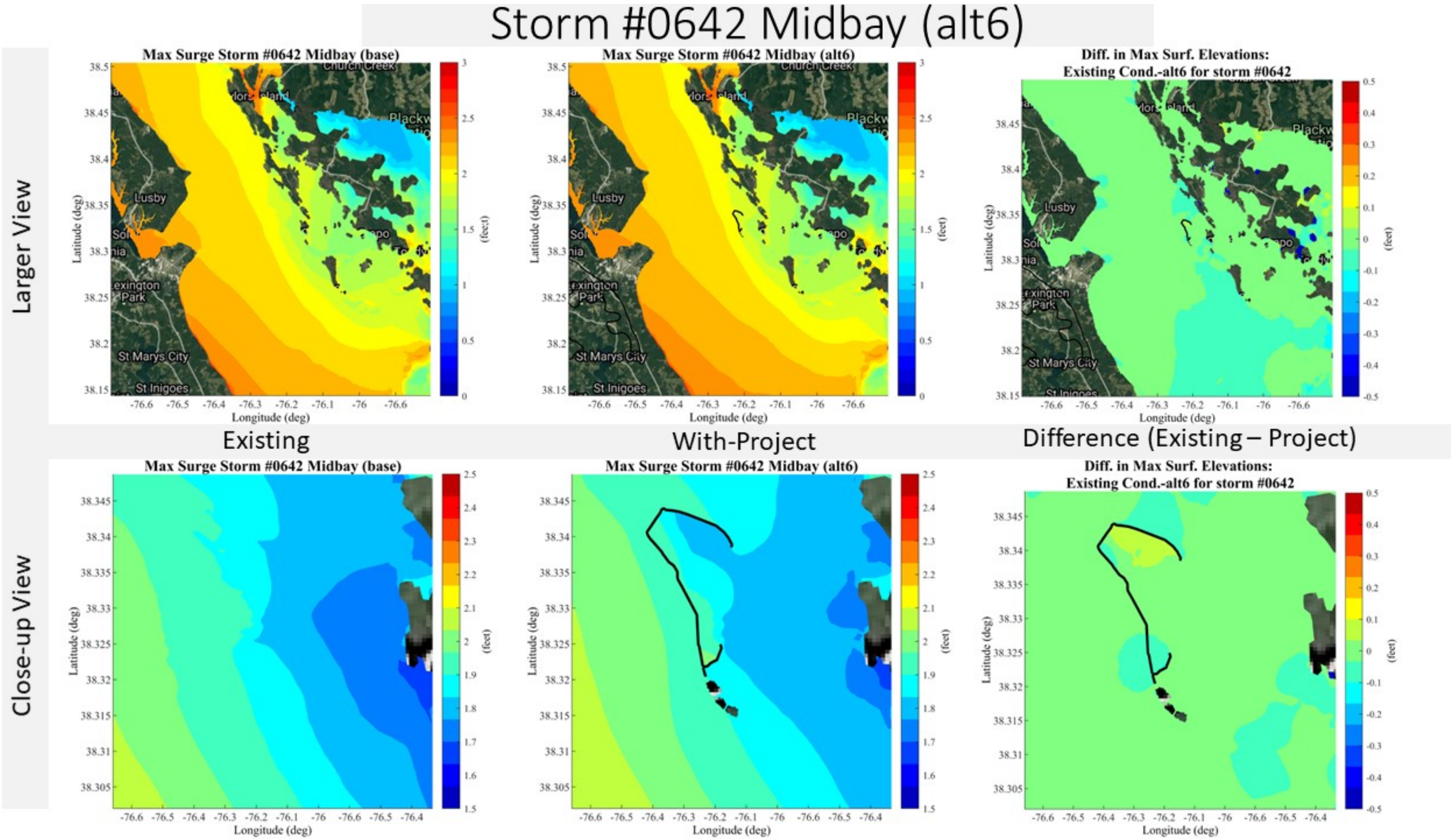

Storm #0642 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0642
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Church Creek

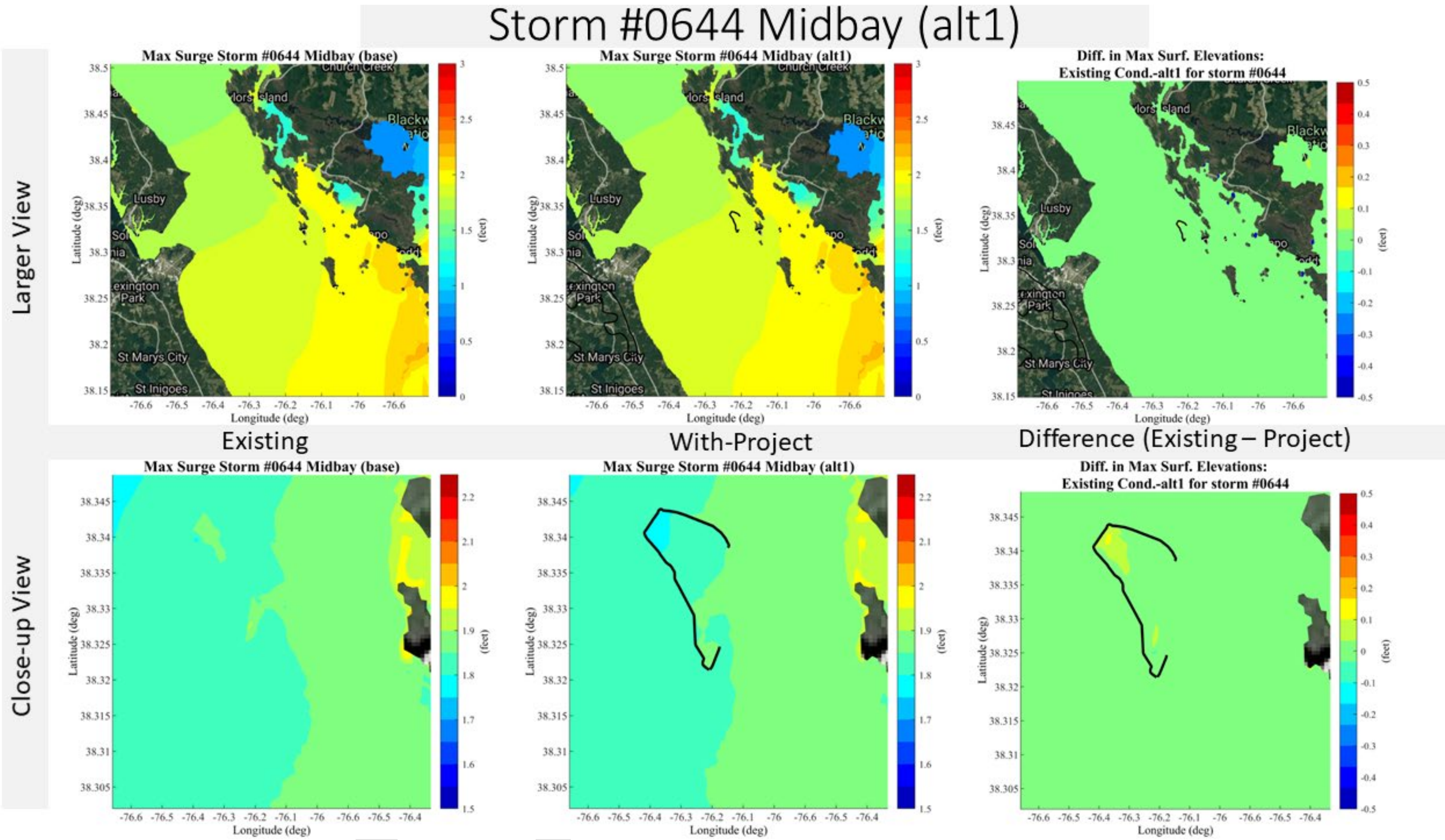

Storm #0642 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0642
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Church Creek

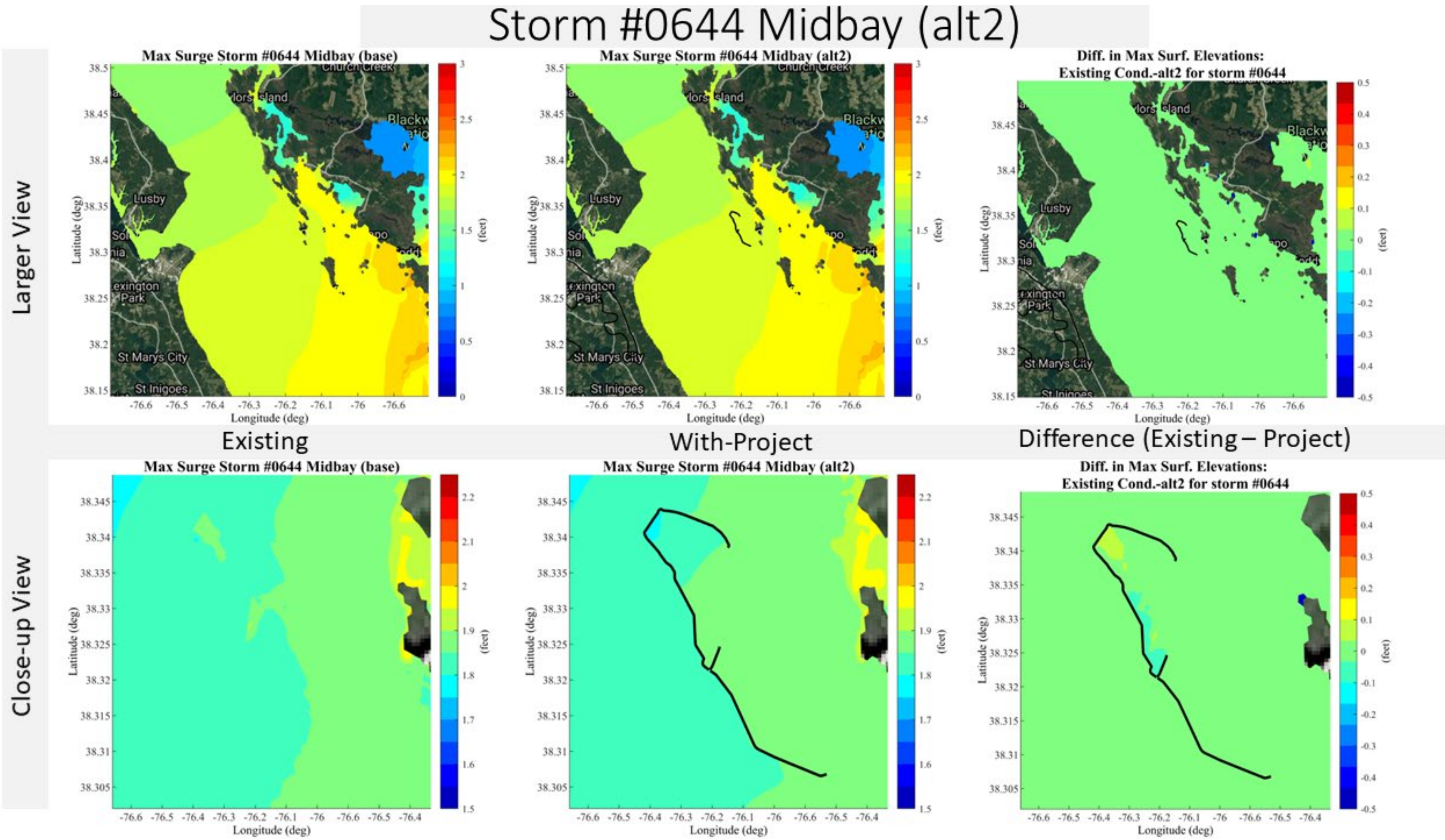

Storm #0642 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0642
Latitude (deg)
Longitude (deg)
(feet)

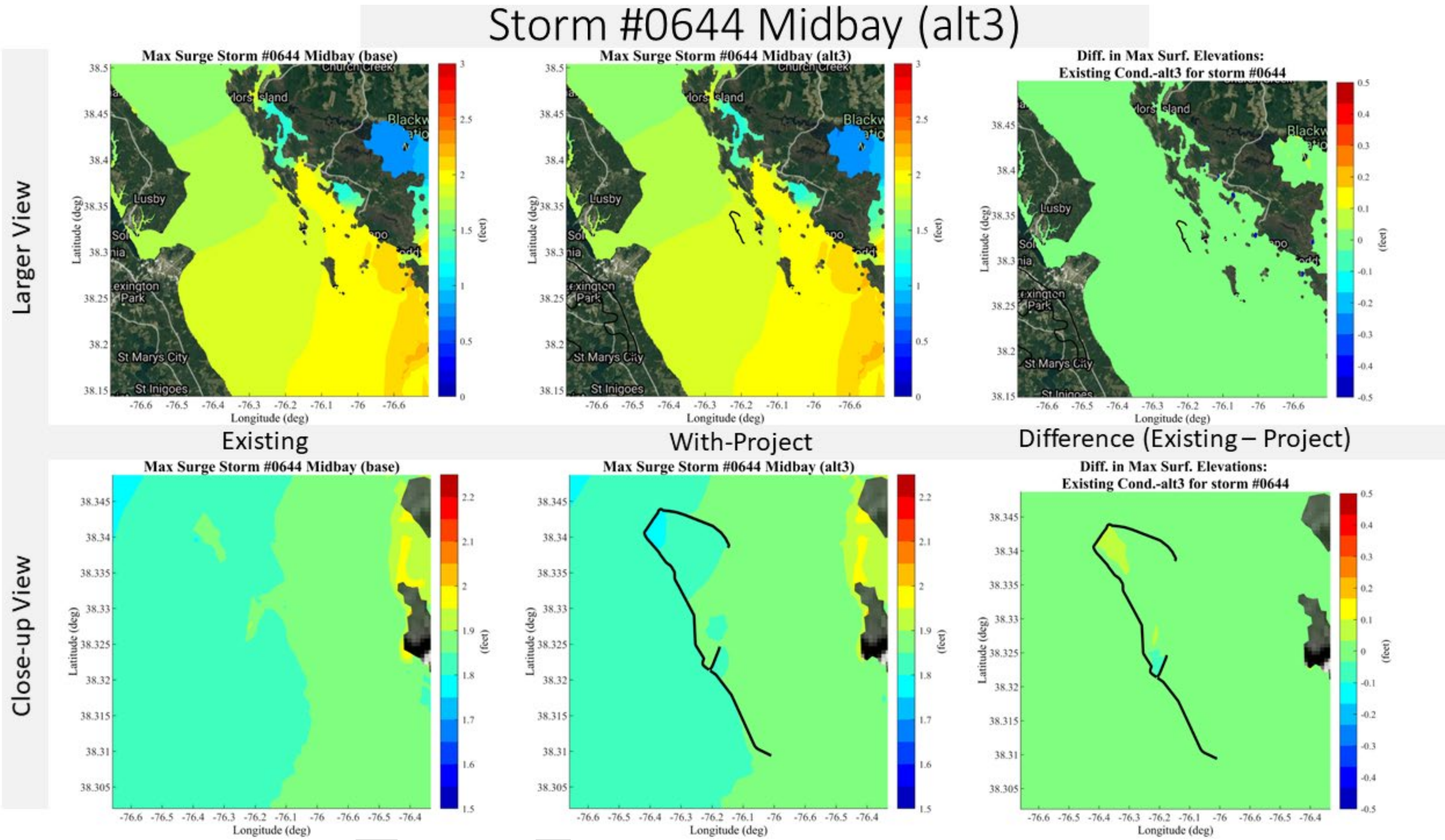

Storm #0642 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0642
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

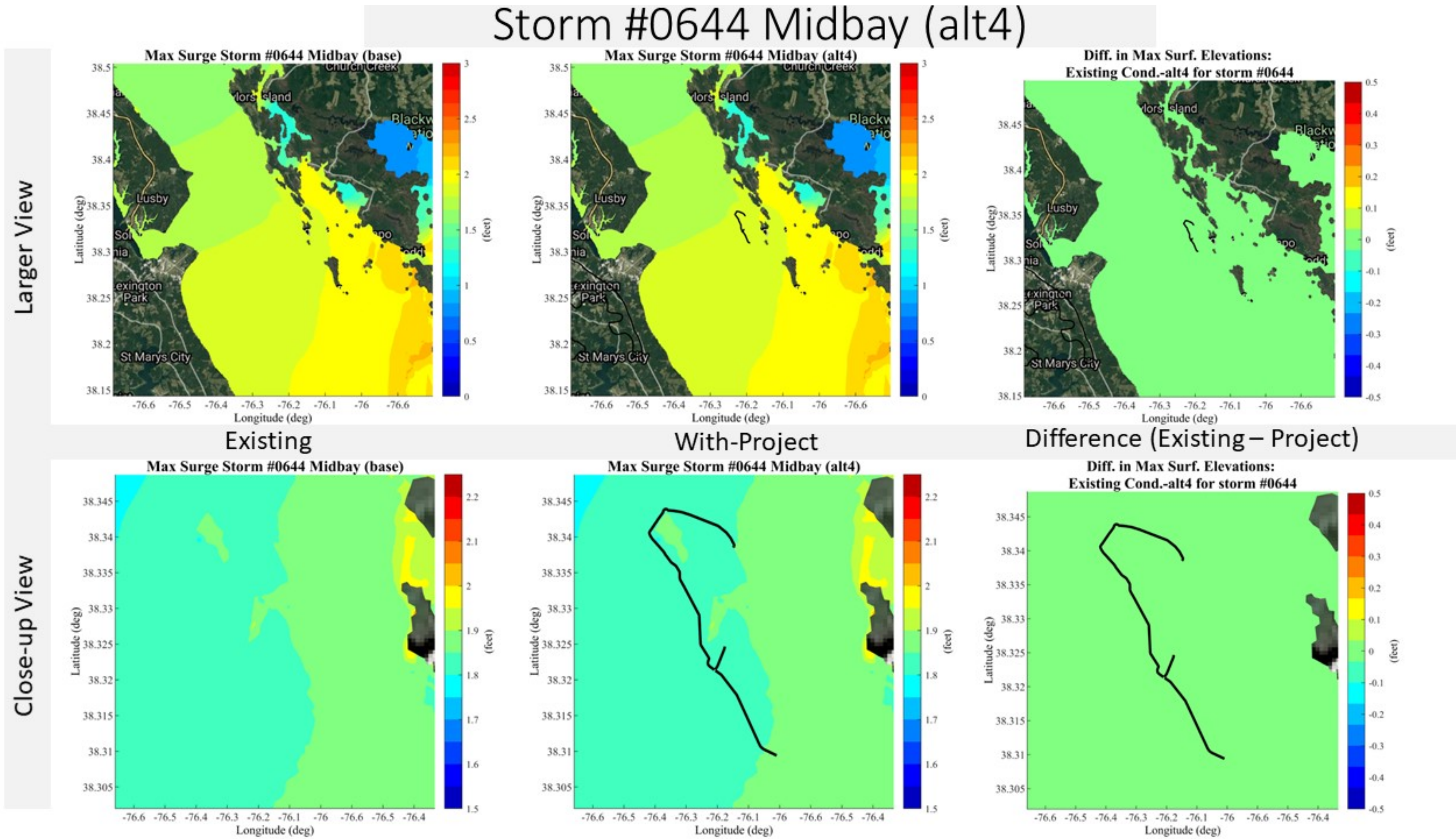

Storm #0642 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0642
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek


Storm #0642 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0642 Midbay (base)
Max Surge Storm #0642 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0642
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)

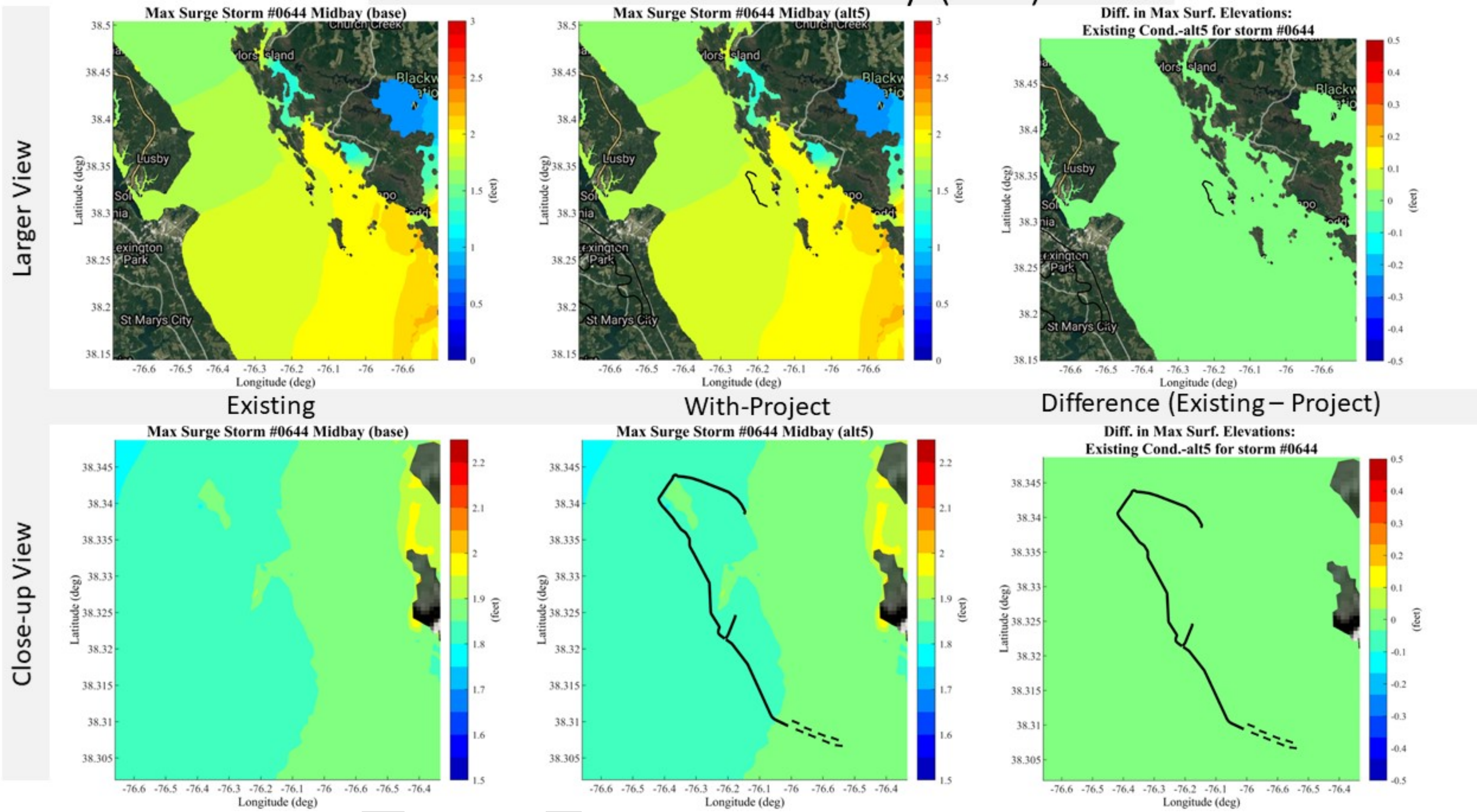

Storm #0644 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0644
Latitude (deg)
Longitude (deg)
(feet)

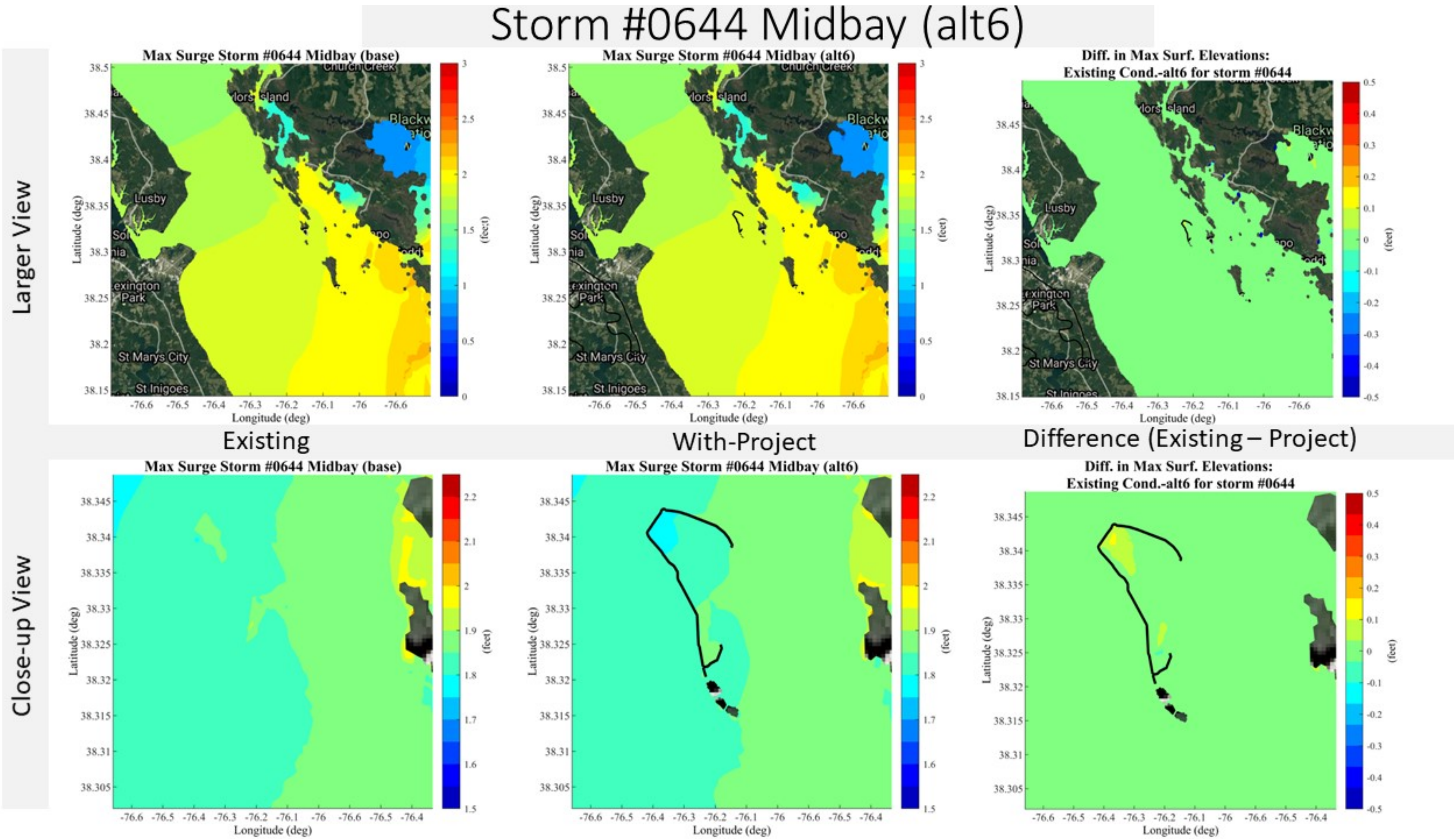

Storm #0644 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0644
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

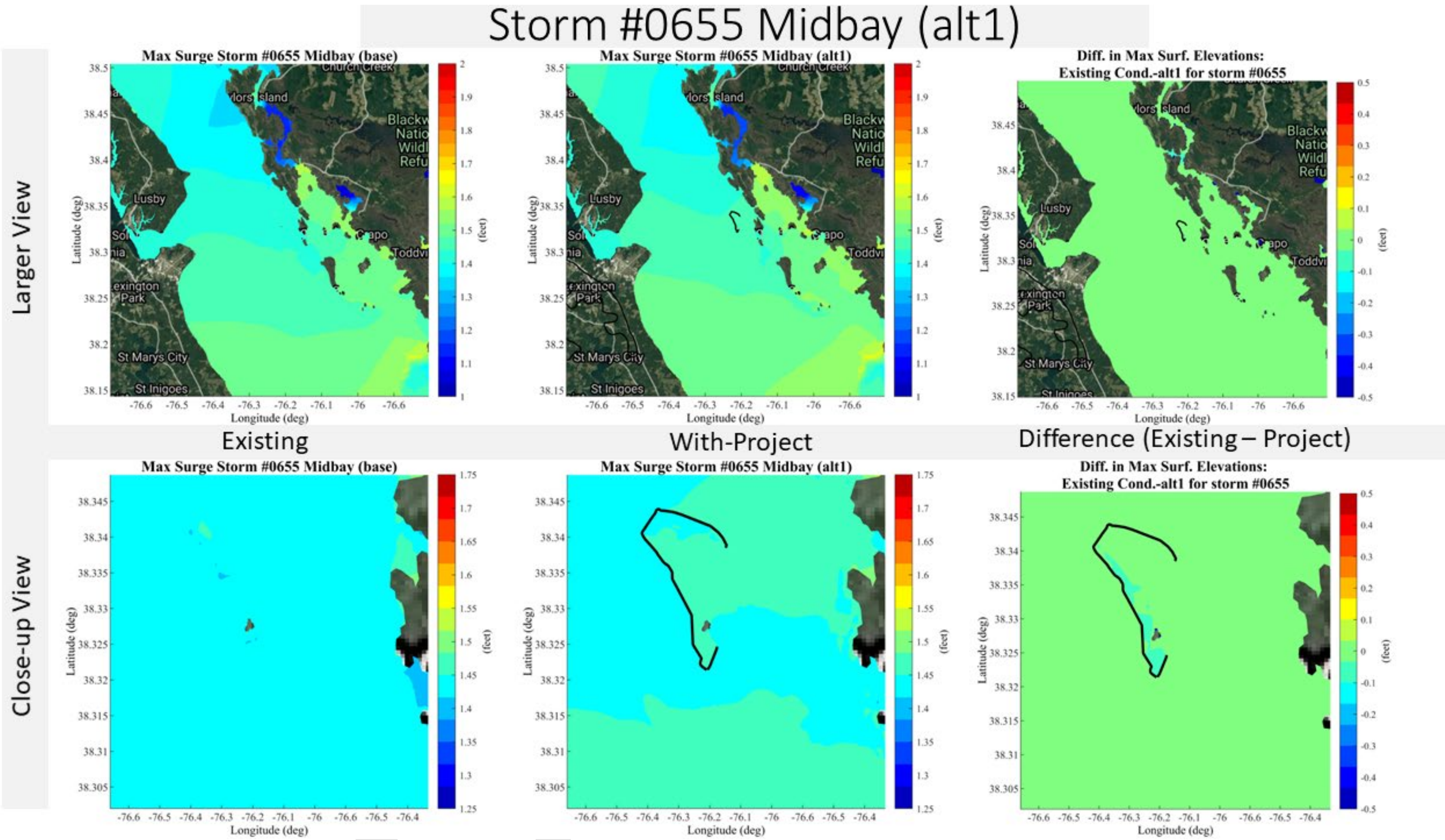

Storm #0644 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0644
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes


Storm #0644 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0644
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
Church Creek

# Storm #0644 Midbay (alt5)

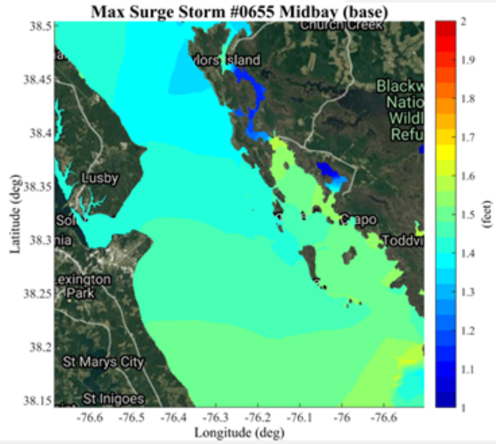



Storm #0644 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0644
Latitude (deg)
Longitude (deg)
(feet)
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0644 Midbay (base)
Max Surge Storm #0644 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0644


Storm #0655 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0655 Midbay (base)
Max Surge Storm #0655 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0655
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Church Creek
Blackw Natio Wildl Refu
Toddvi

# Storm #0655 Midbay (alt2)

Larger View



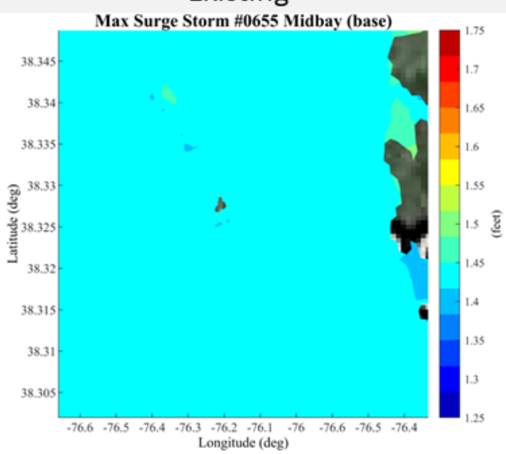

With-Project Data Not Available for this Storm

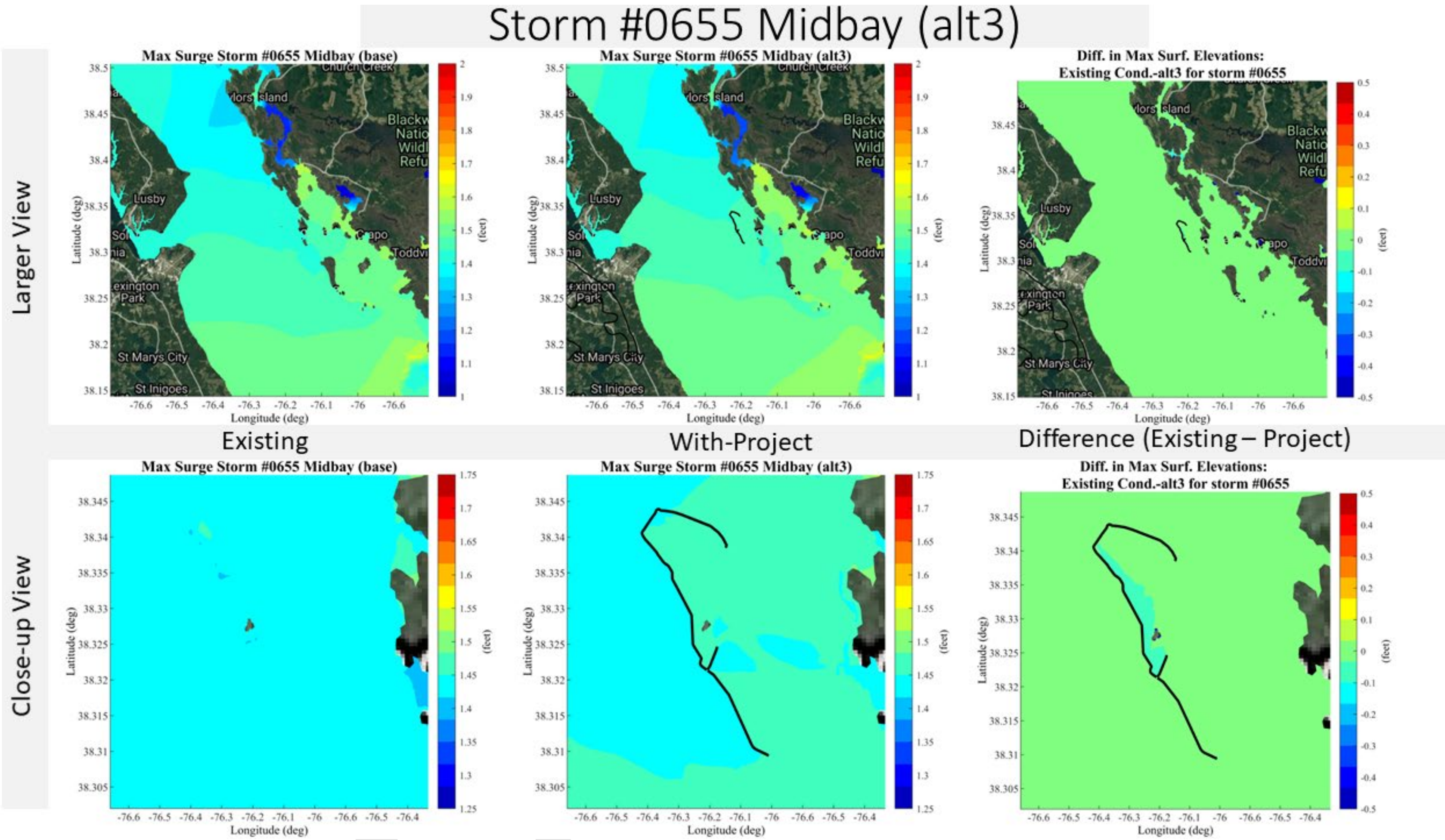
Existing

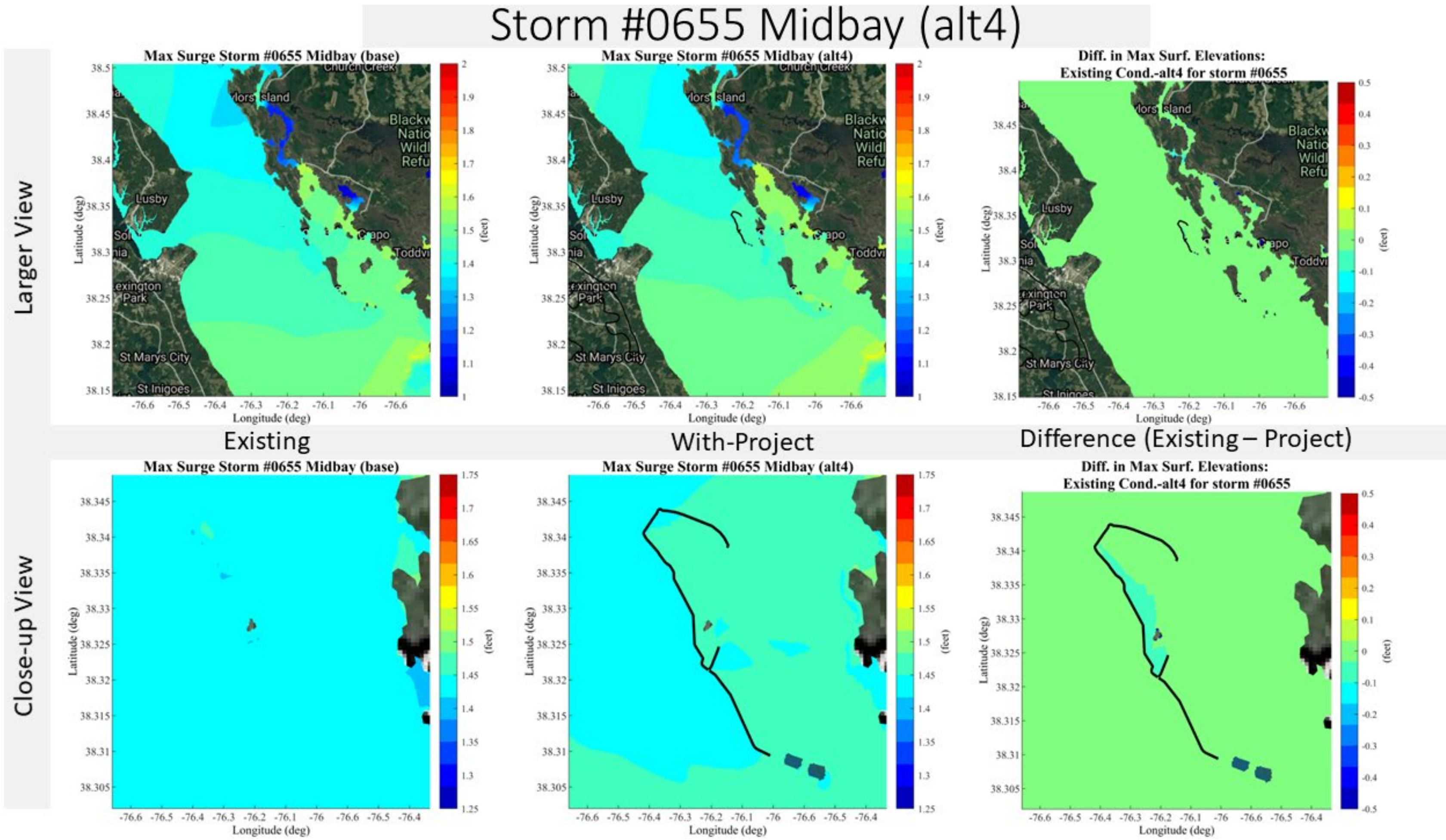
With-Project

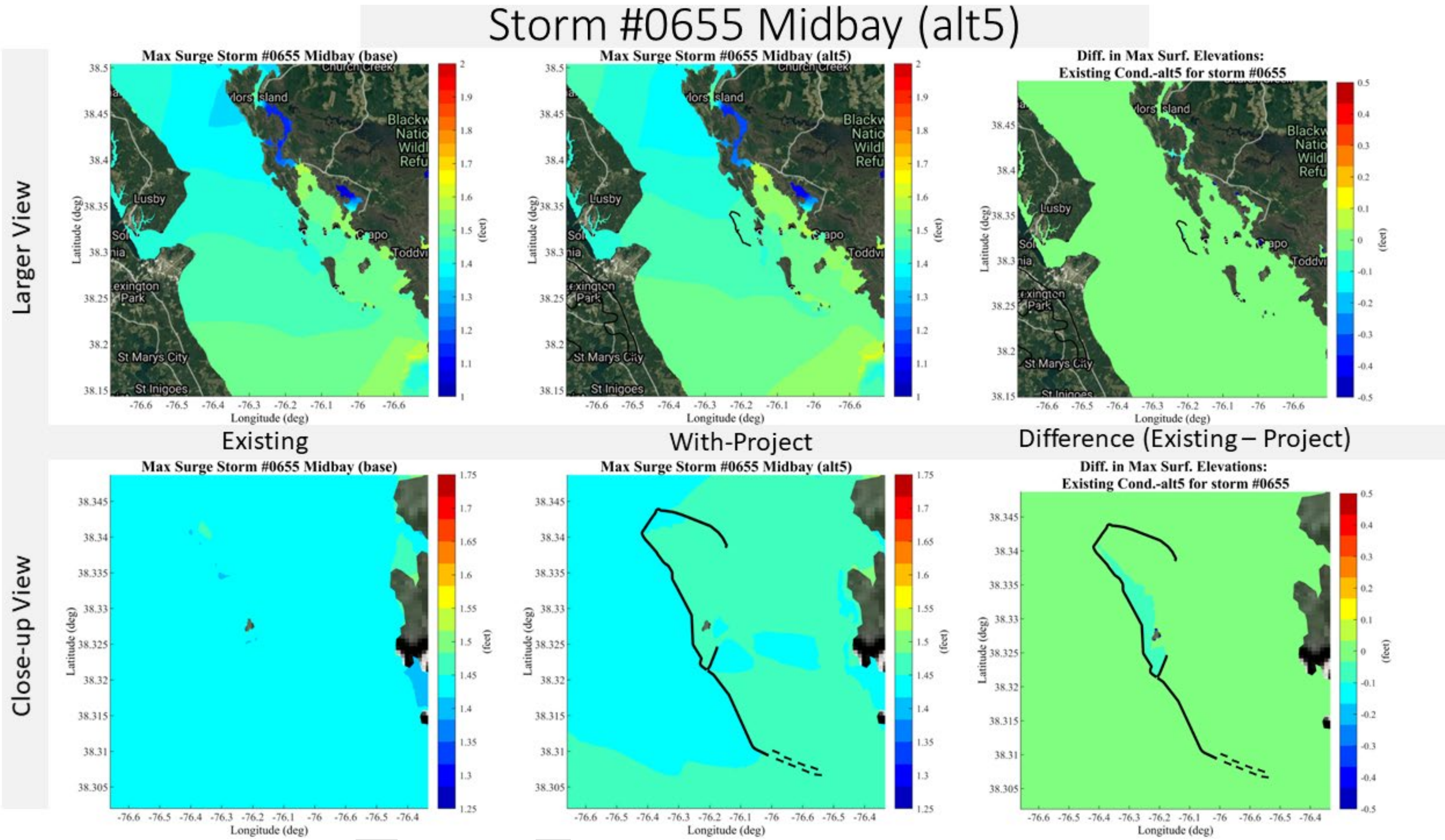
Difference (Existing – Project)

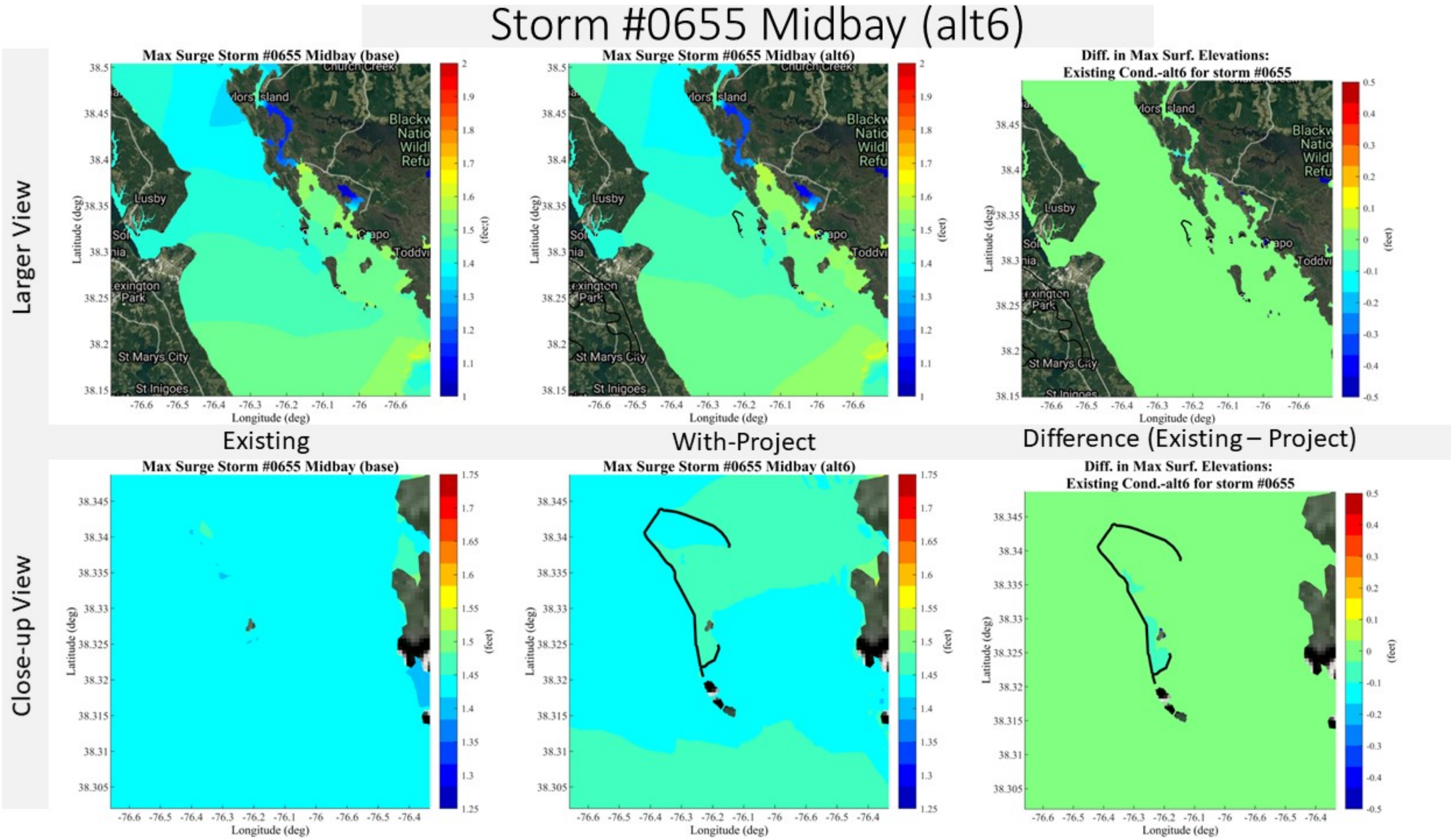
Close-up View

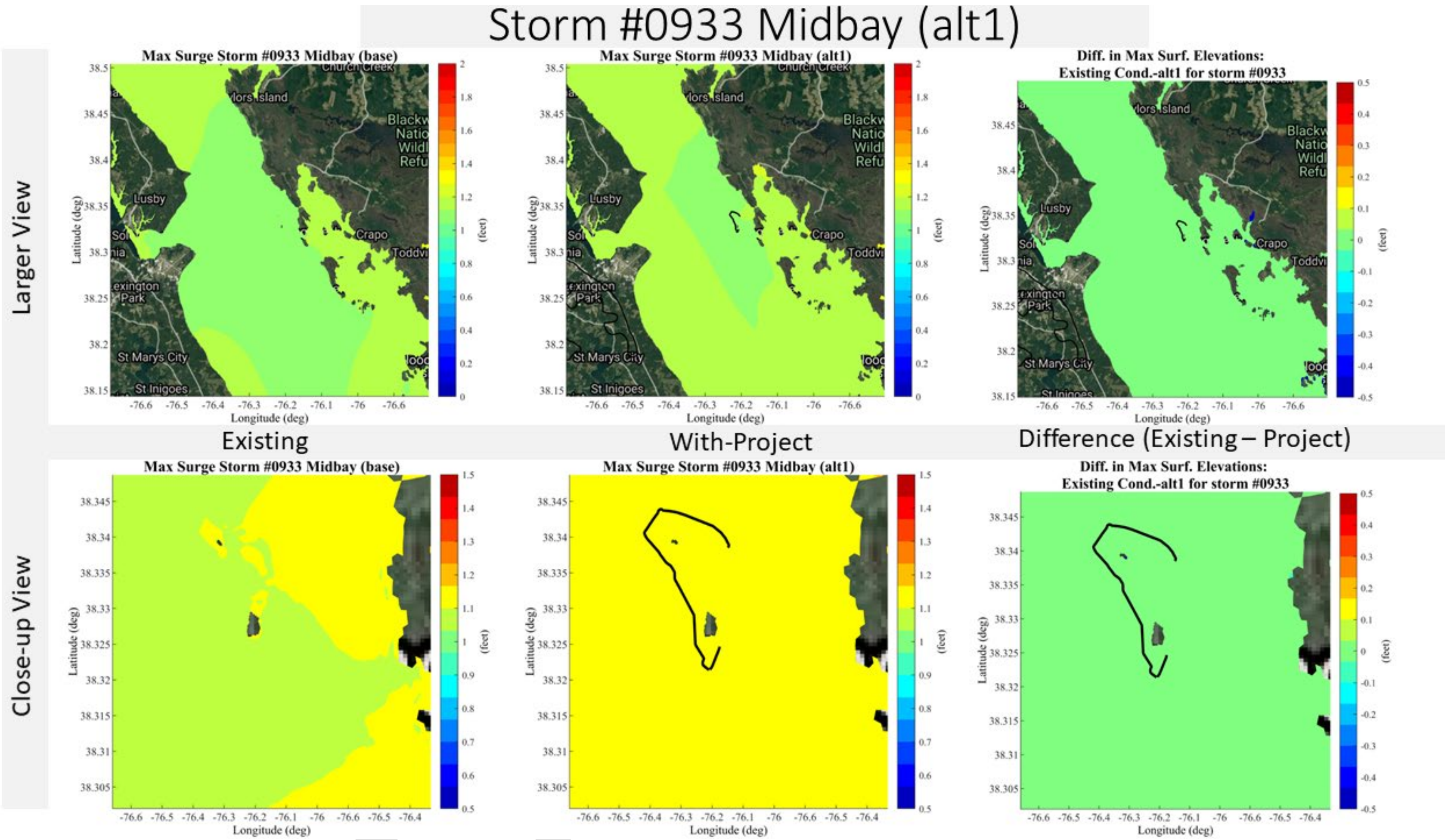


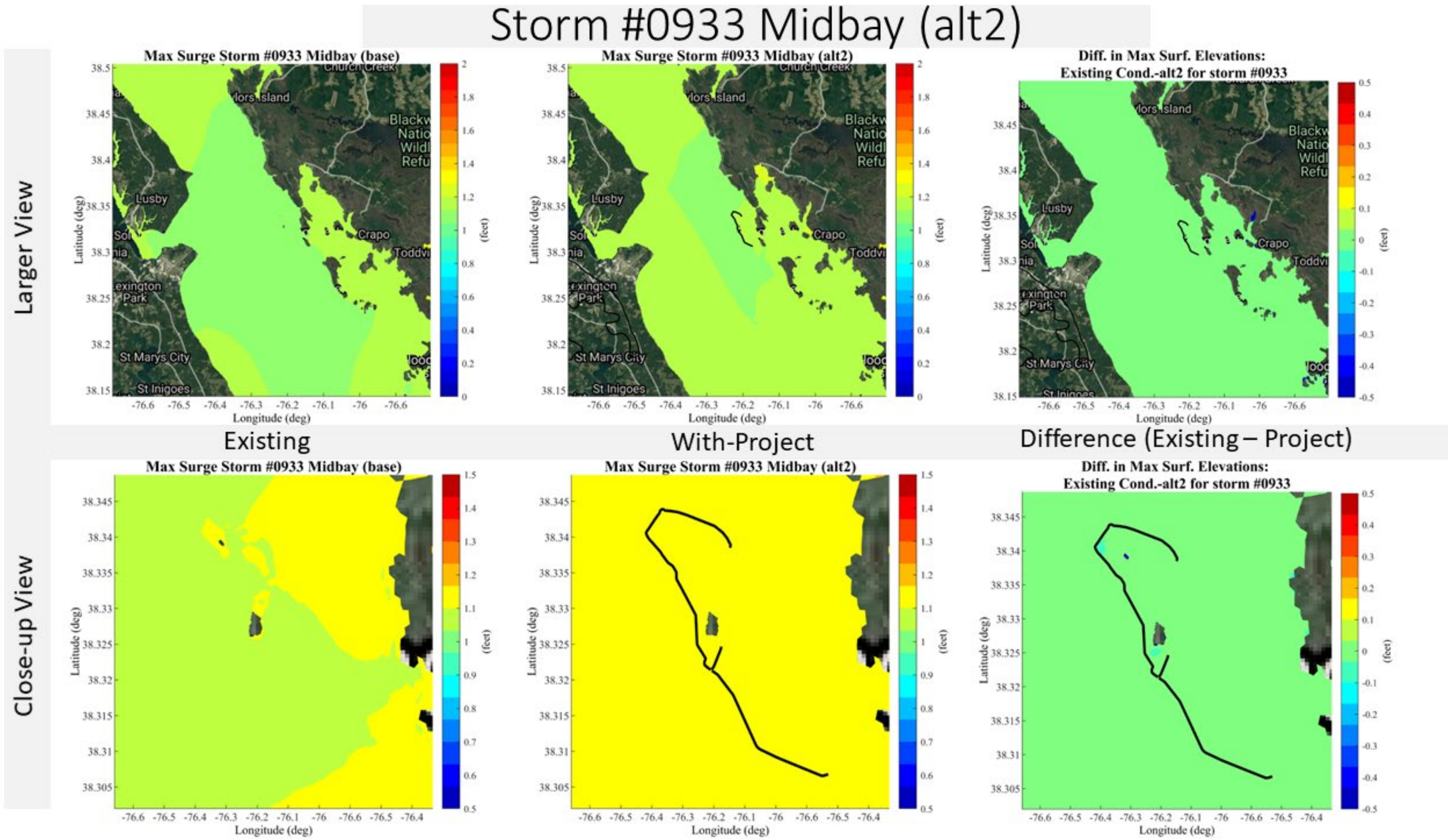

Storm #0655 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0655 Midbay (base)
Max Surge Storm #0655 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0655
Latitude (deg)
Longitude (deg)
(feet)

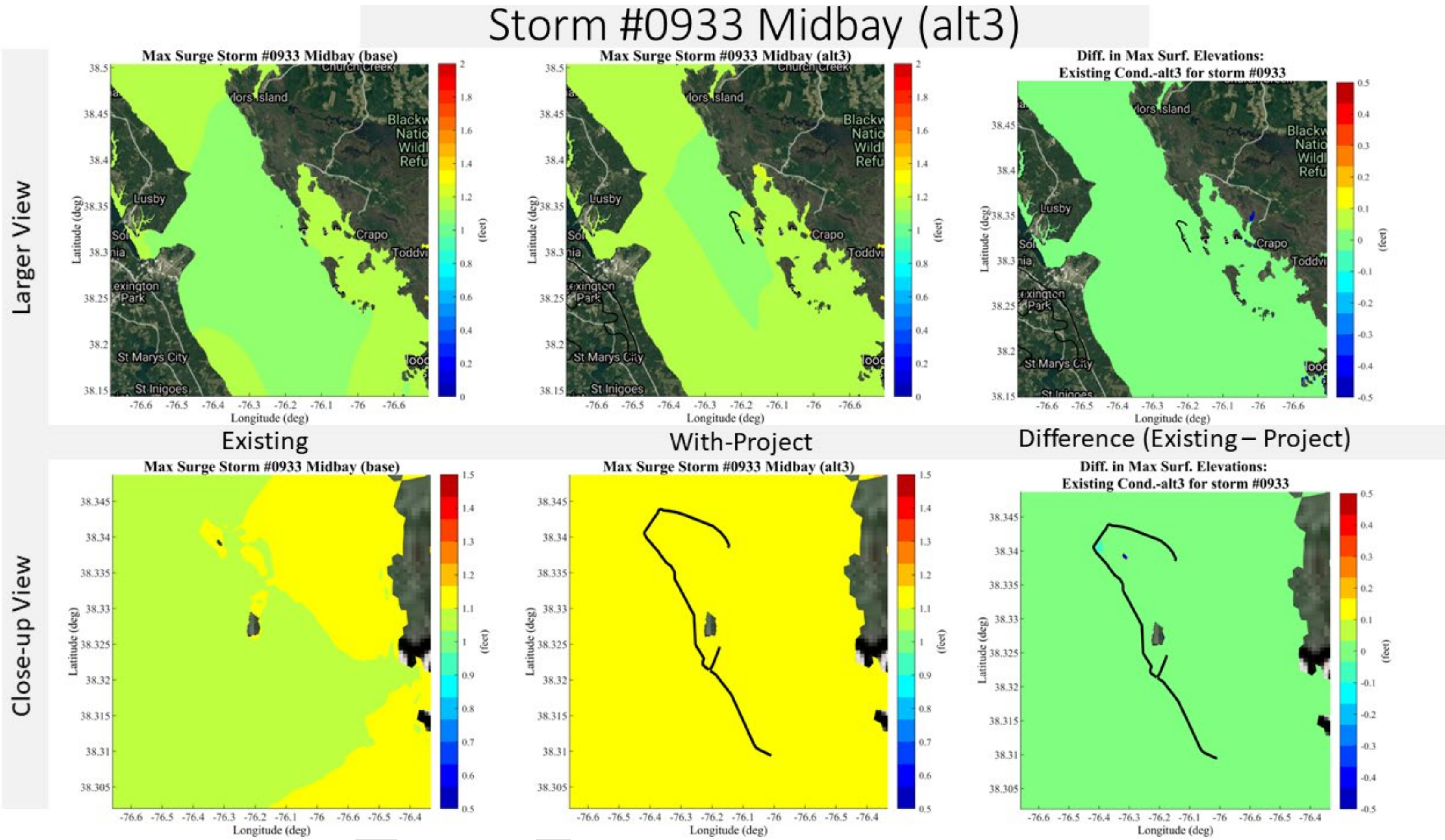

Storm #0655 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0655 Midbay (base)
Max Surge Storm #0655 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #0655
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Blackwater National Wildlife Refuge
Taylors Island
Church Creek

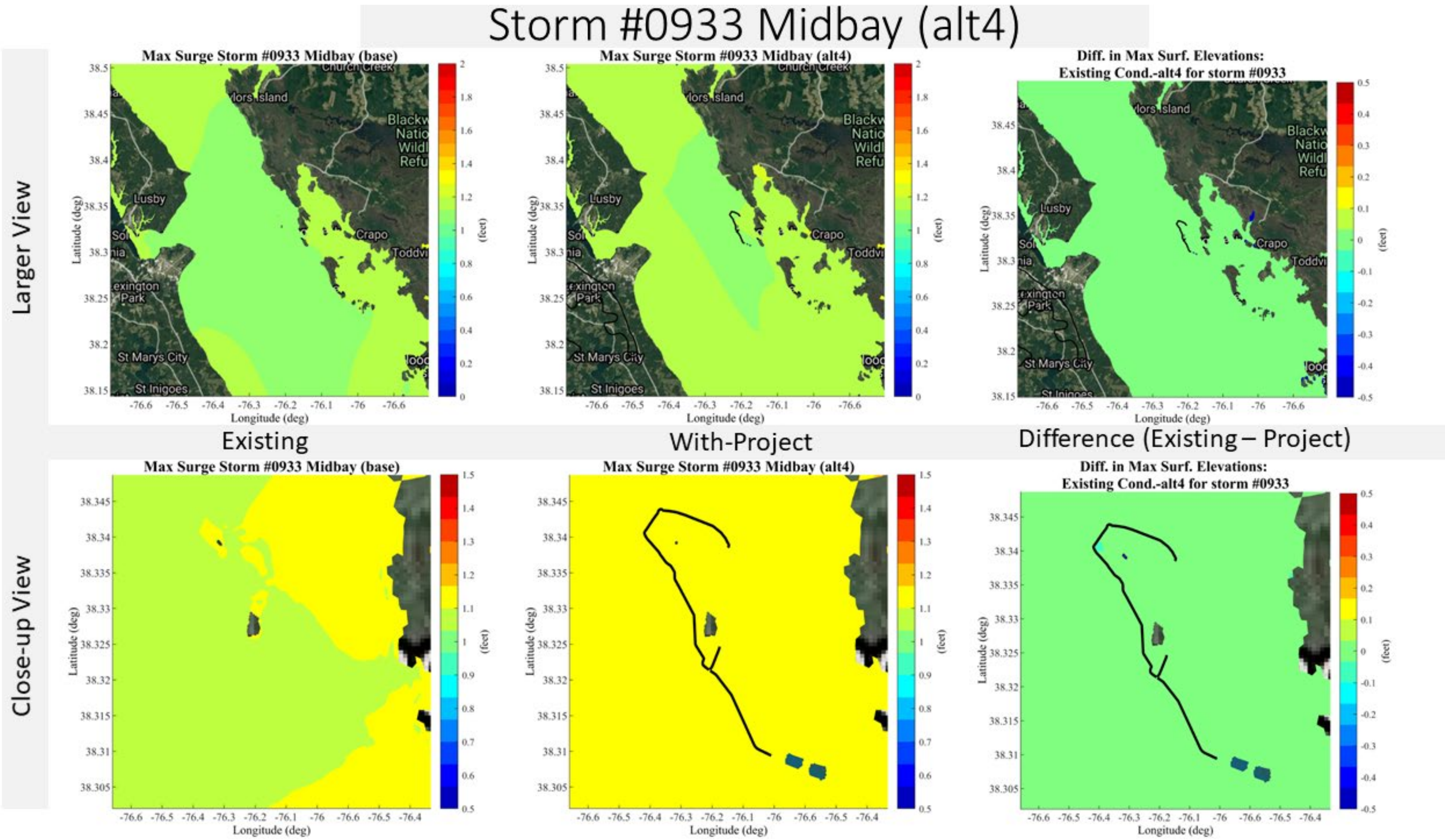

Storm #0655 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0655 Midbay (base)
Max Surge Storm #0655 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0655
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Blackwater National Wildlife Refuge

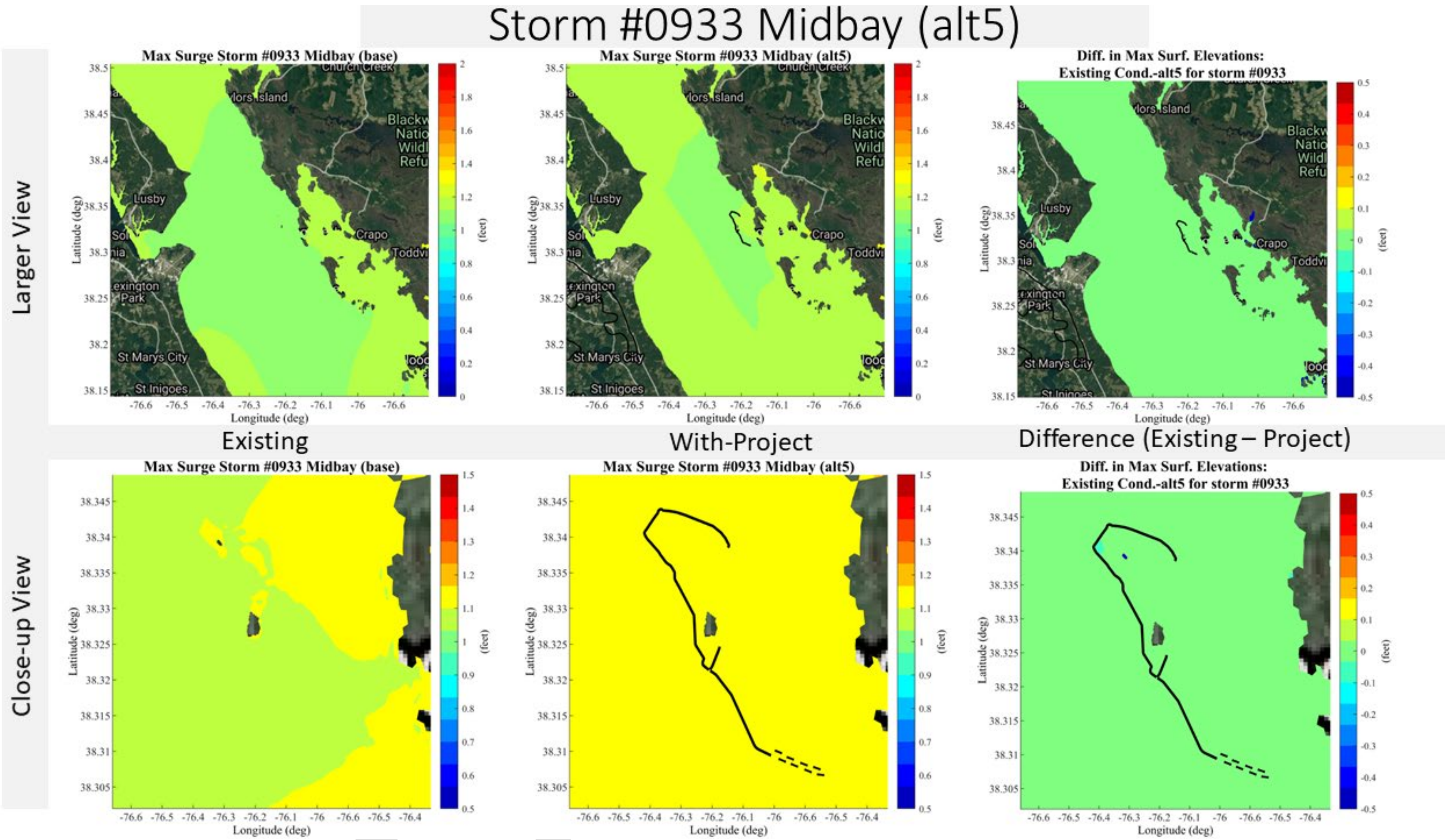

Storm #0655 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0655 Midbay (base)
Max Surge Storm #0655 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0655
Latitude (deg)
Longitude (deg)
(feet)

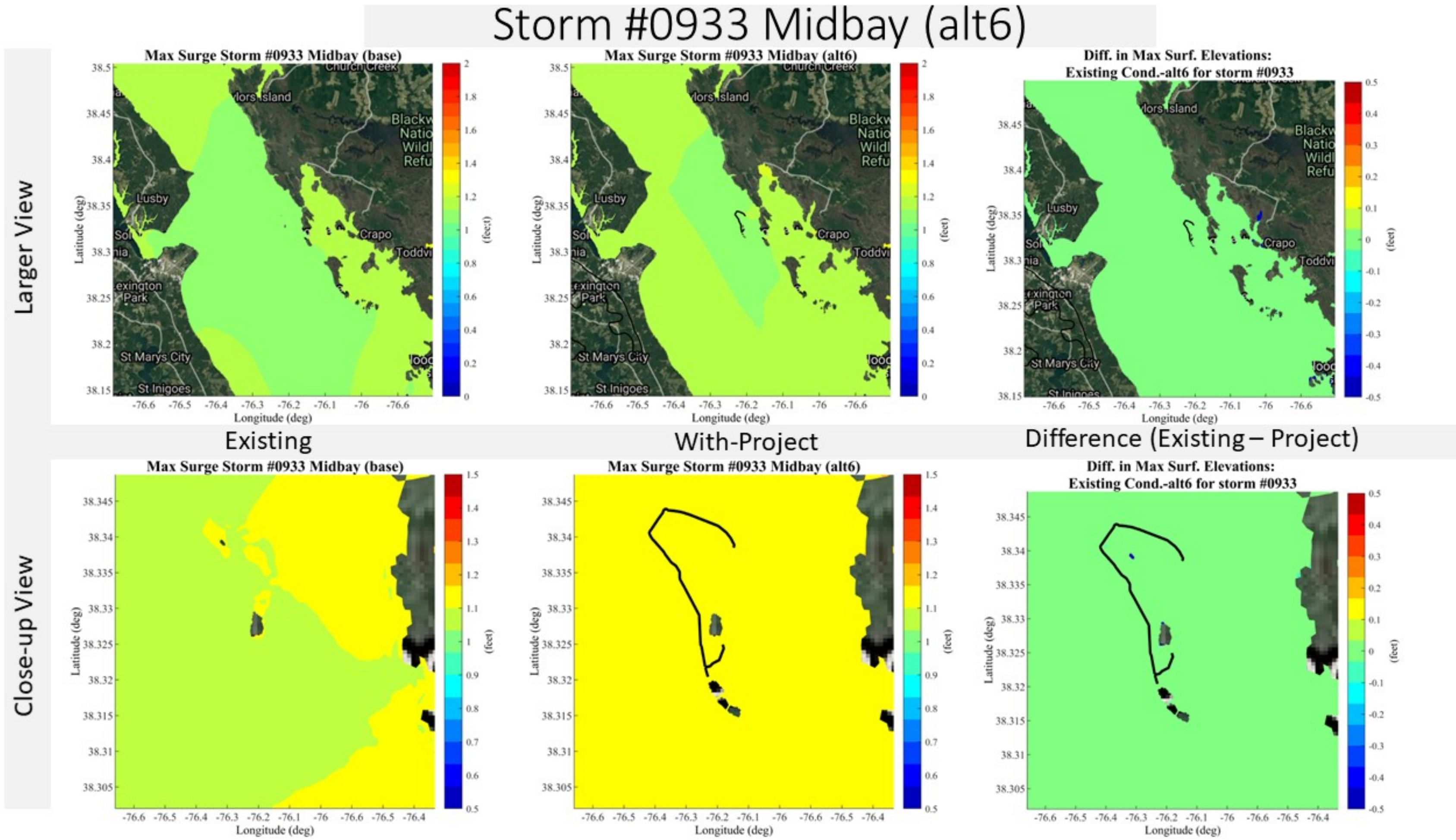

Storm #0933 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #0933
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

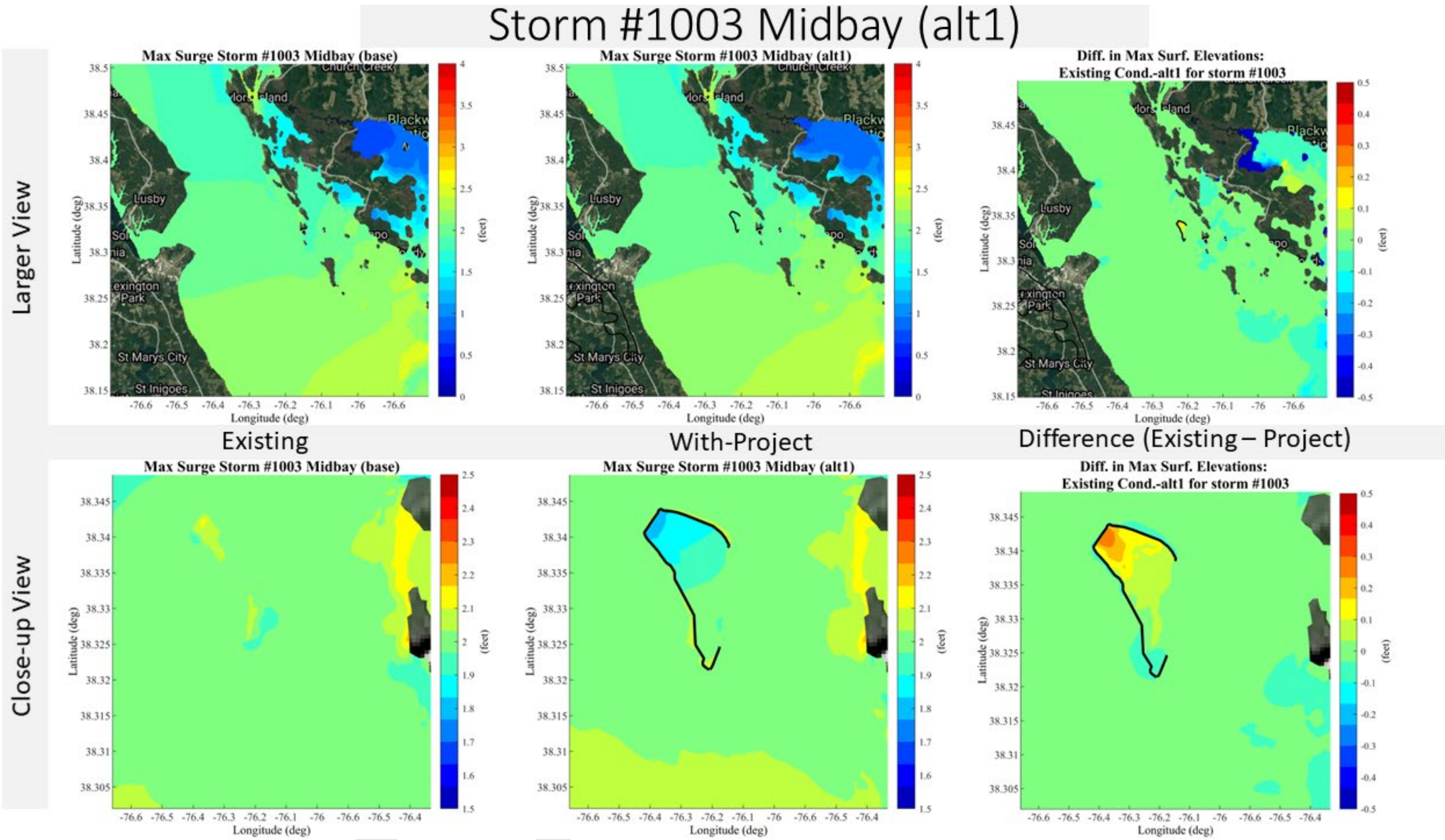

Storm #0933 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #0933
Latitude (deg)
Longitude (deg)
(feet)

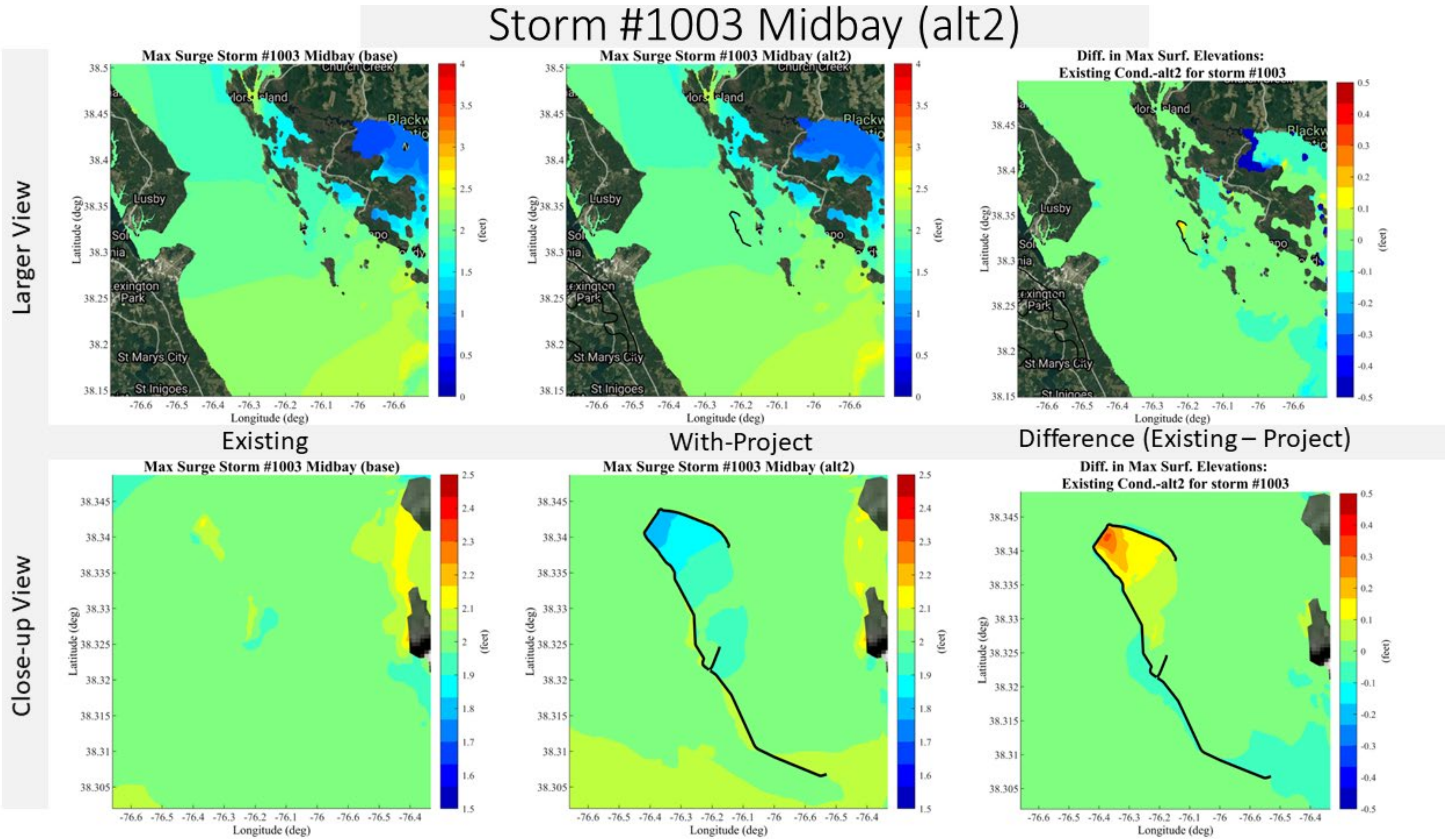

Storm #0933 Midbay (alt3)
Larger View
Close-up View
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #0933
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

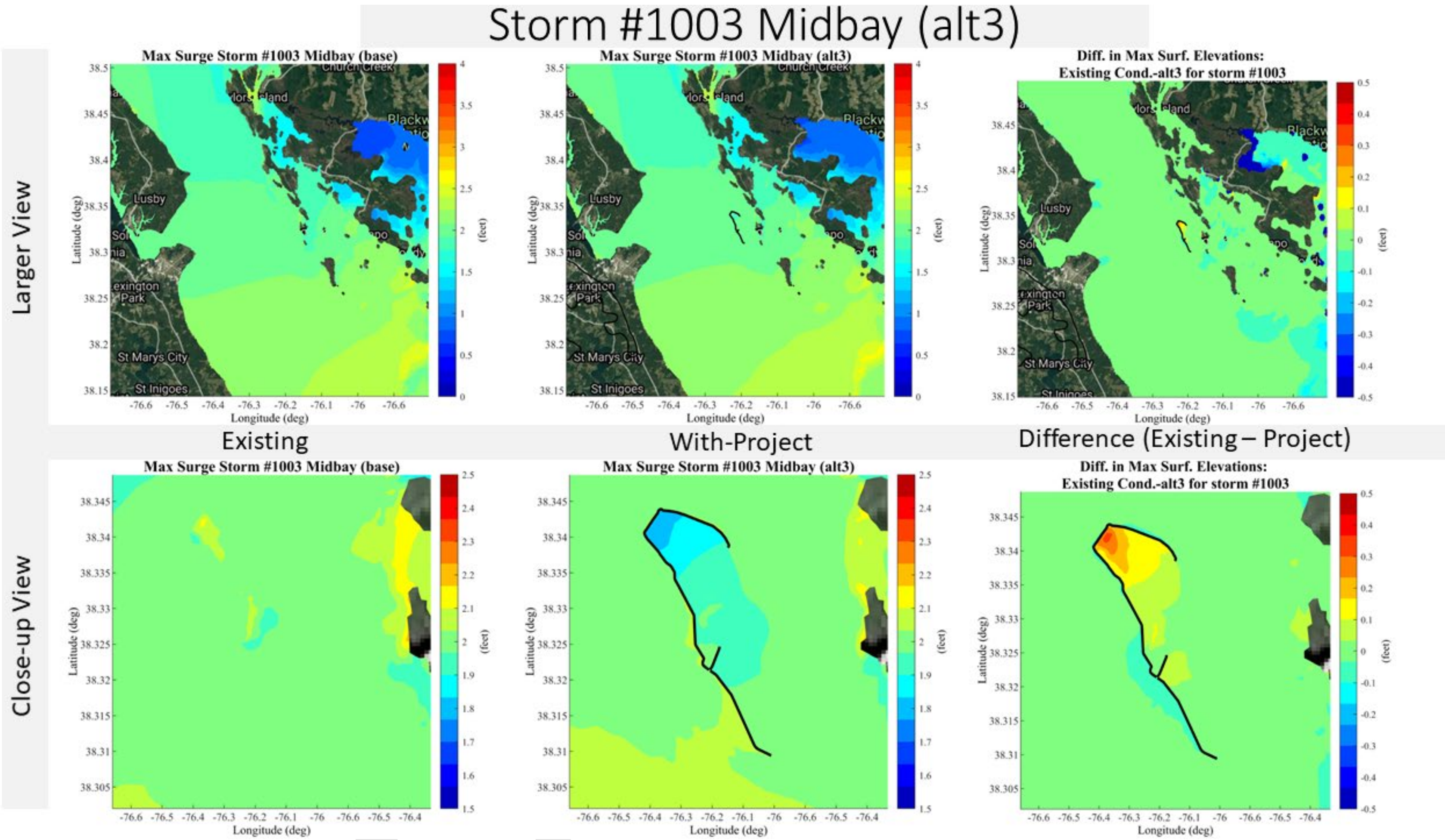

Storm #0933 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt4)
Diff. in Max Surf. Elevations: Existing Cond.-alt4 for storm #0933
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)

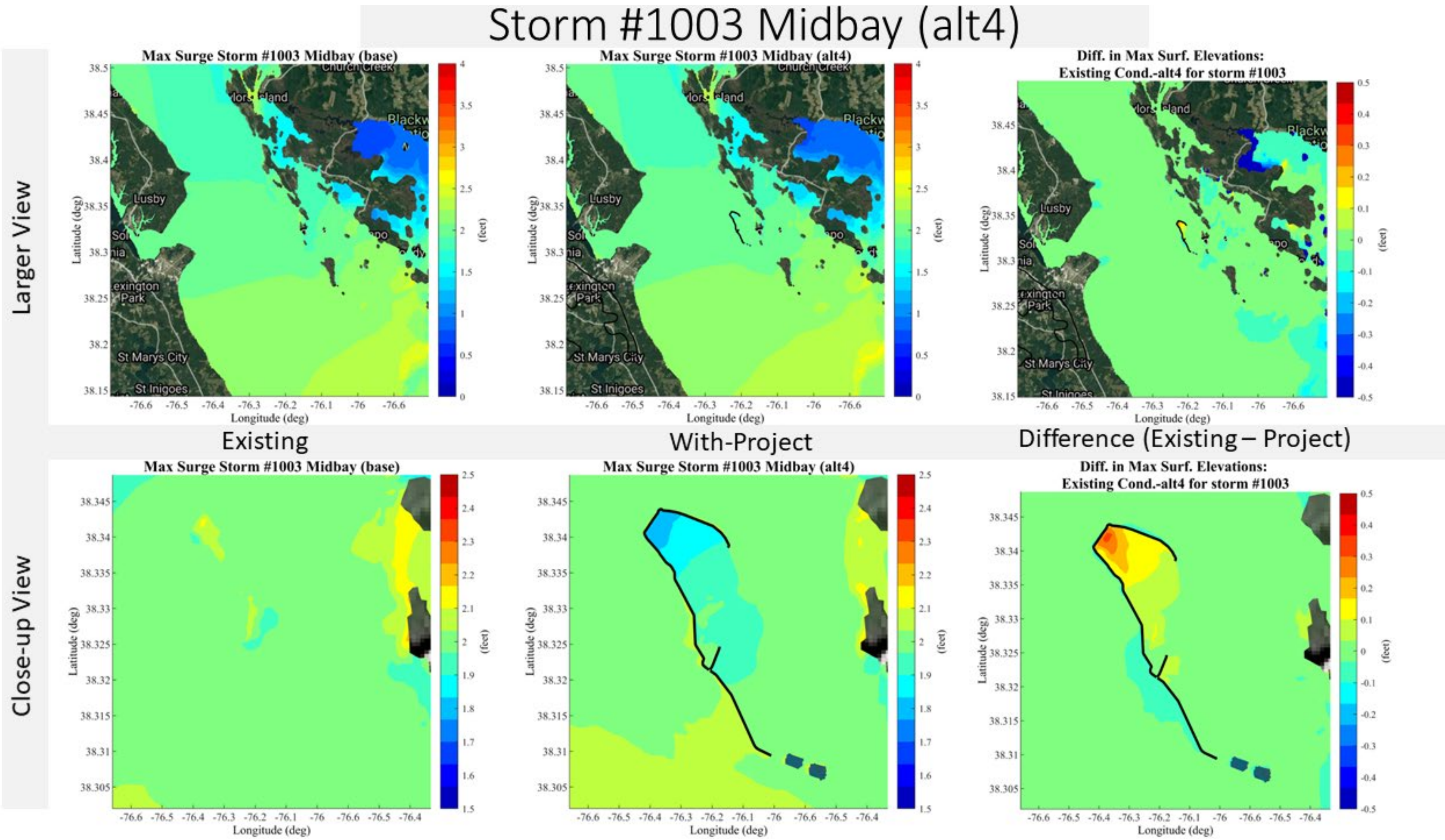

Storm #0933 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #0933
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

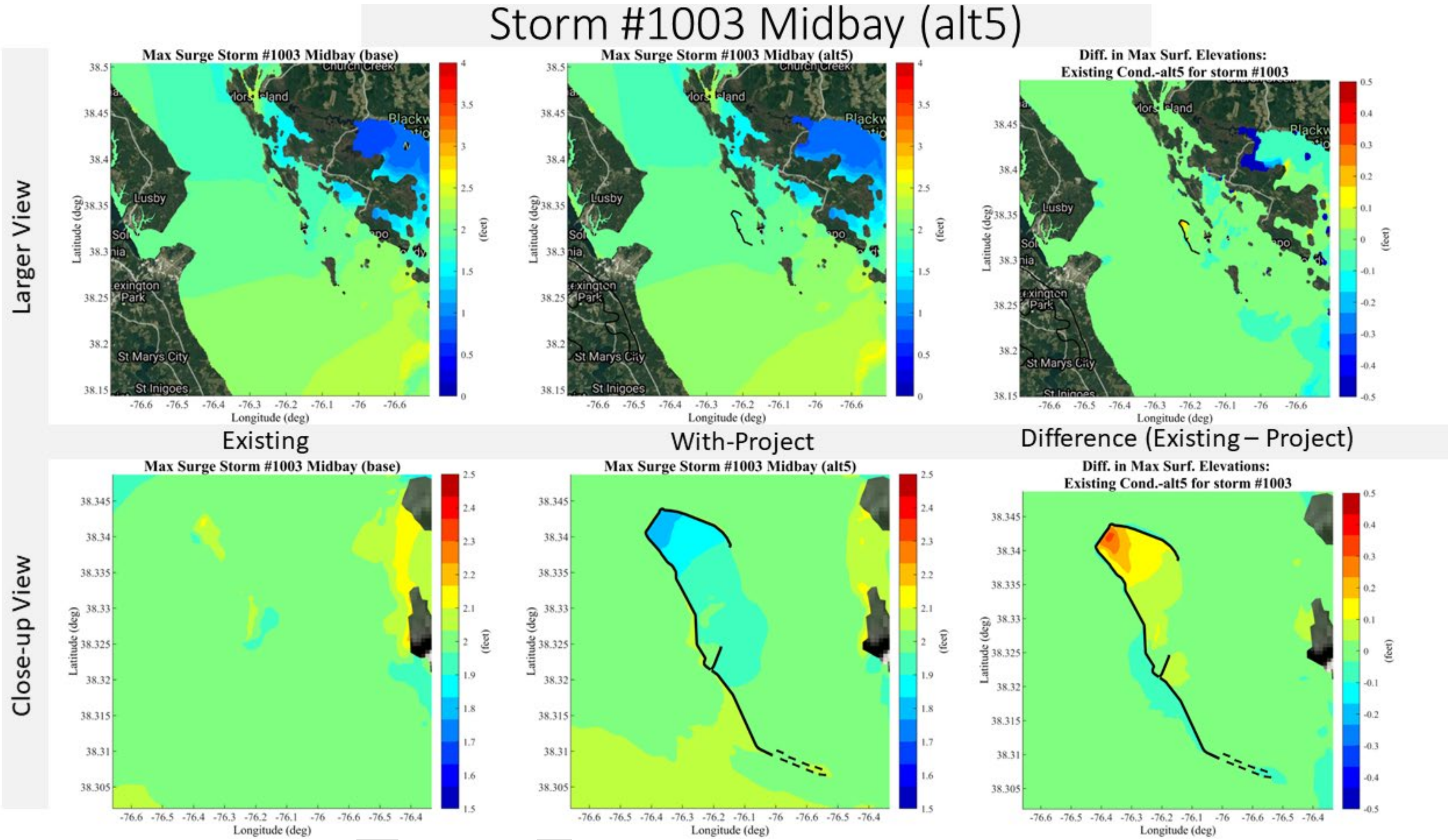

Storm #0933 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #0933 Midbay (base)
Max Surge Storm #0933 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #0933
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Crapo
St Marys City
St Inigoes
Lexington Park

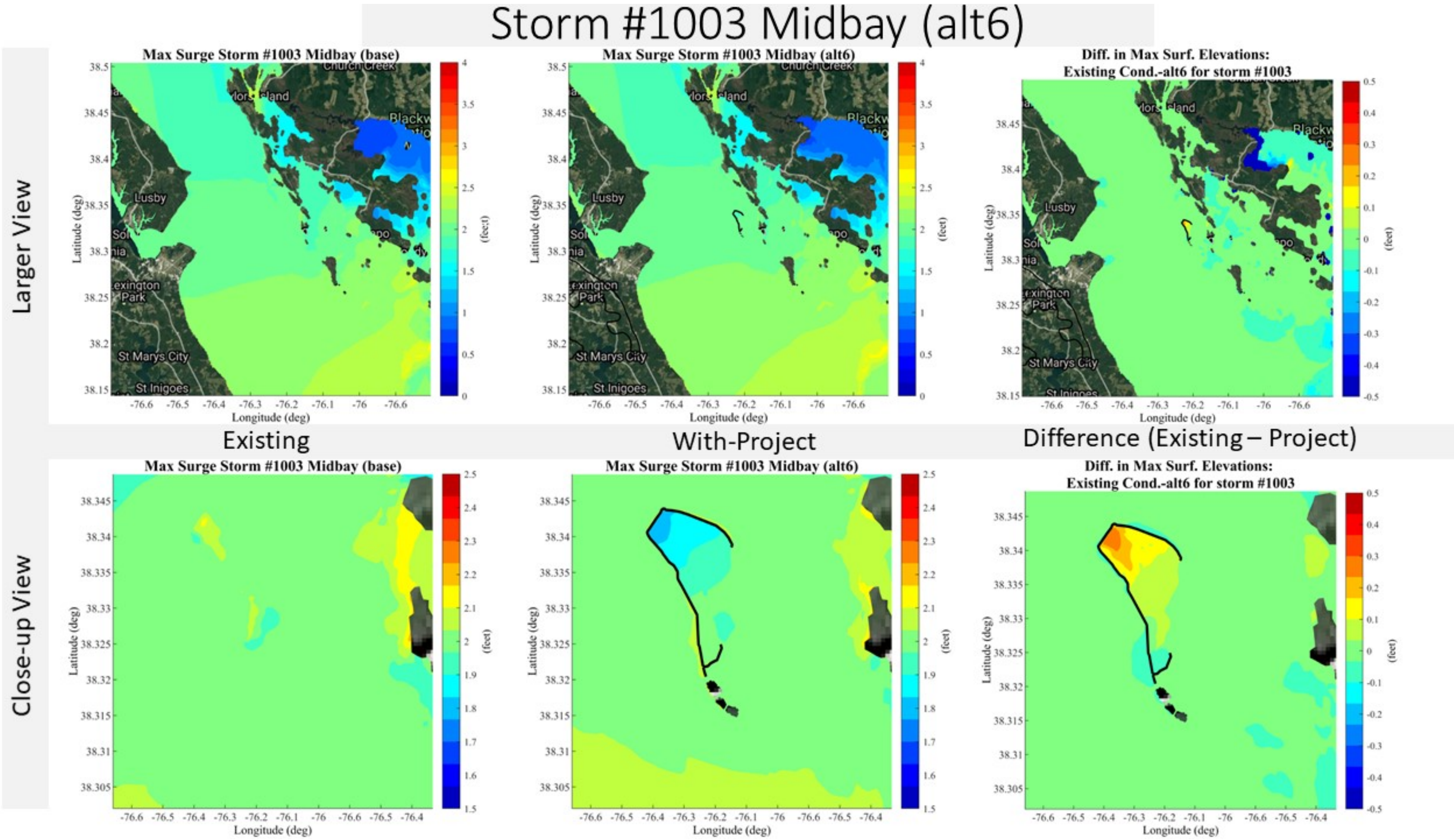

Storm #1003 Midbay (alt1)
Larger View
Close-up View
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt1)
Diff. in Max Surf. Elevations:
Existing Cond.-alt1 for storm #1003
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes
Existing
With-Project
Difference (Existing – Project)


Storm #1003 Midbay (alt2)
Larger View
Close-up View
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt2)
Diff. in Max Surf. Elevations:
Existing Cond.-alt2 for storm #1003
Latitude (deg)
Longitude (deg)
(feet)
Lusby
St Marys City
St Inigoes
Lexington Park
Existing
With-Project
Difference (Existing – Project)

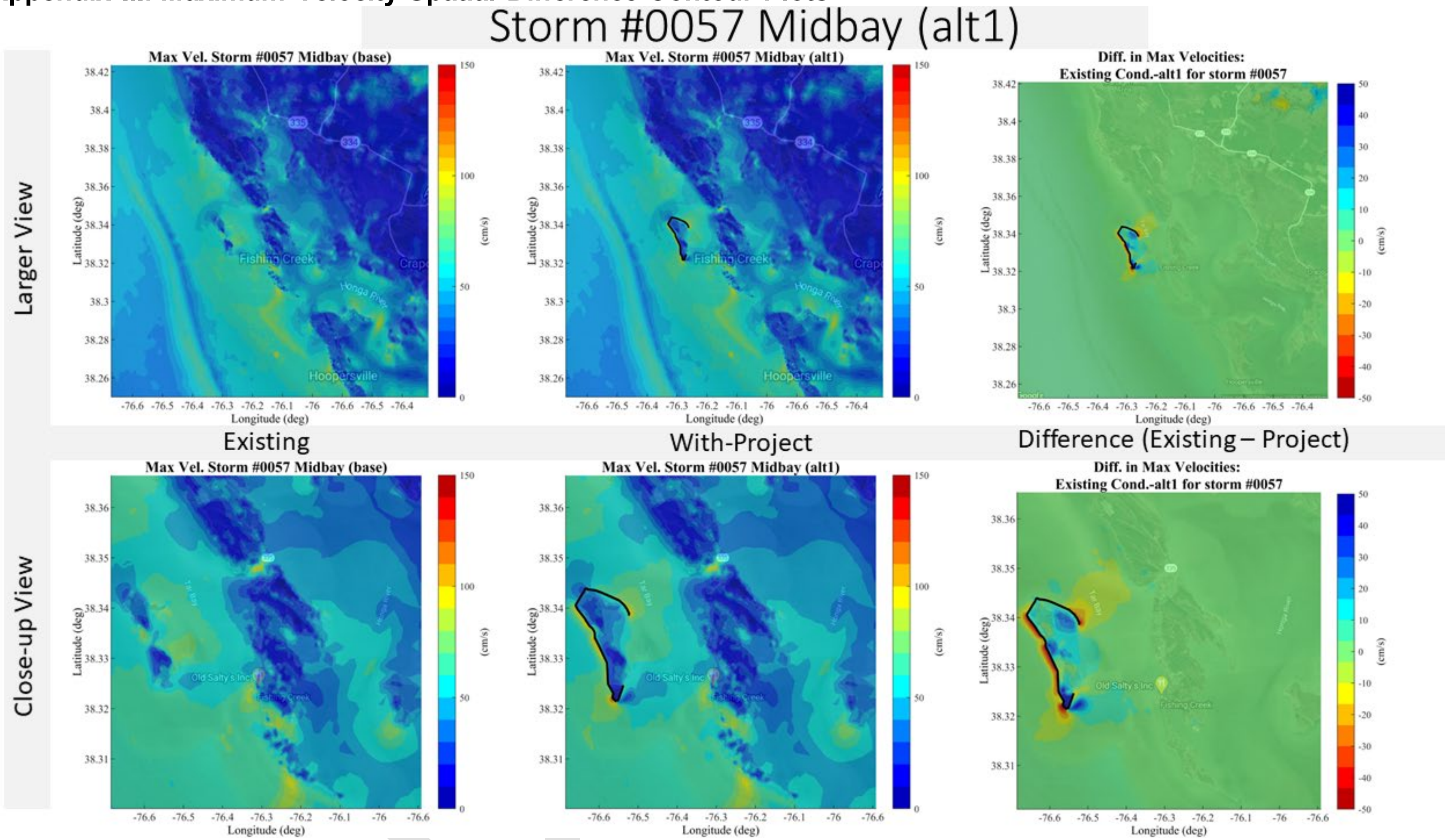

Storm #1003 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt3)
Diff. in Max Surf. Elevations:
Existing Cond.-alt3 for storm #1003
Latitude (deg)
Longitude (deg)
(feet)

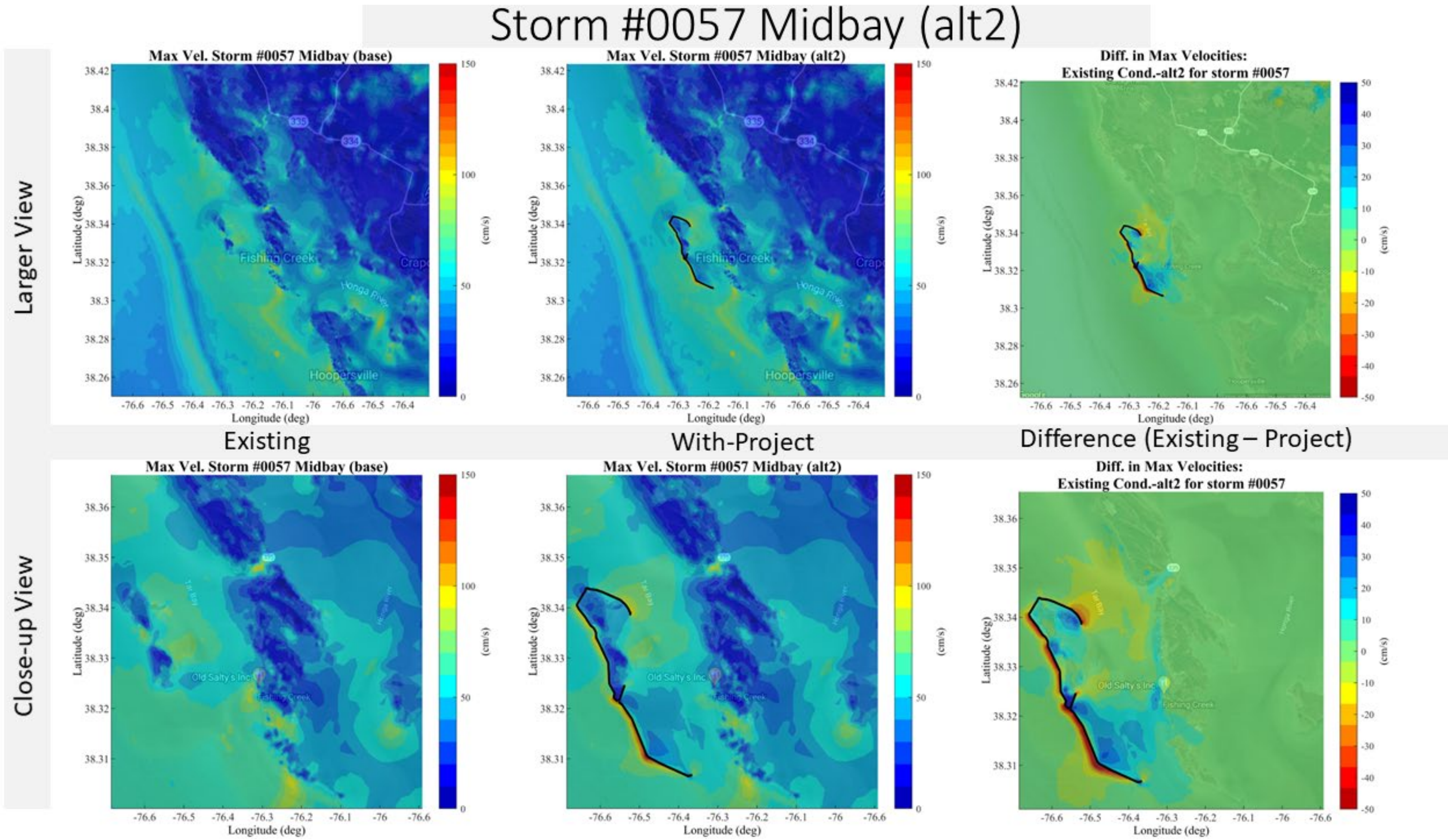

Storm #1003 Midbay (alt4)
Larger View
Close-up View
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt4)
Diff. in Max Surf. Elevations:
Existing Cond.-alt4 for storm #1003
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

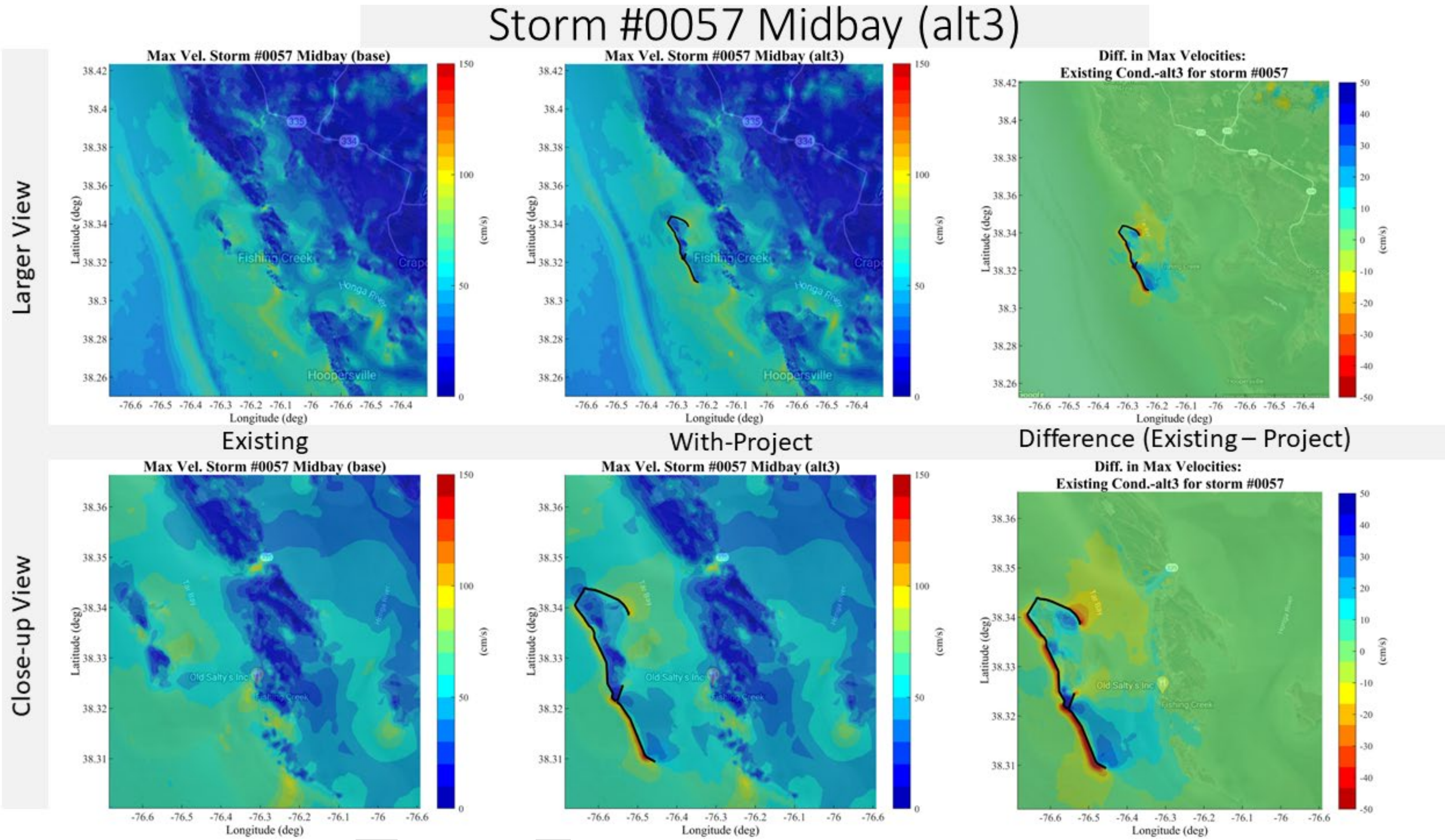

Storm #1003 Midbay (alt5)
Larger View
Close-up View
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt5)
Diff. in Max Surf. Elevations:
Existing Cond.-alt5 for storm #1003
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

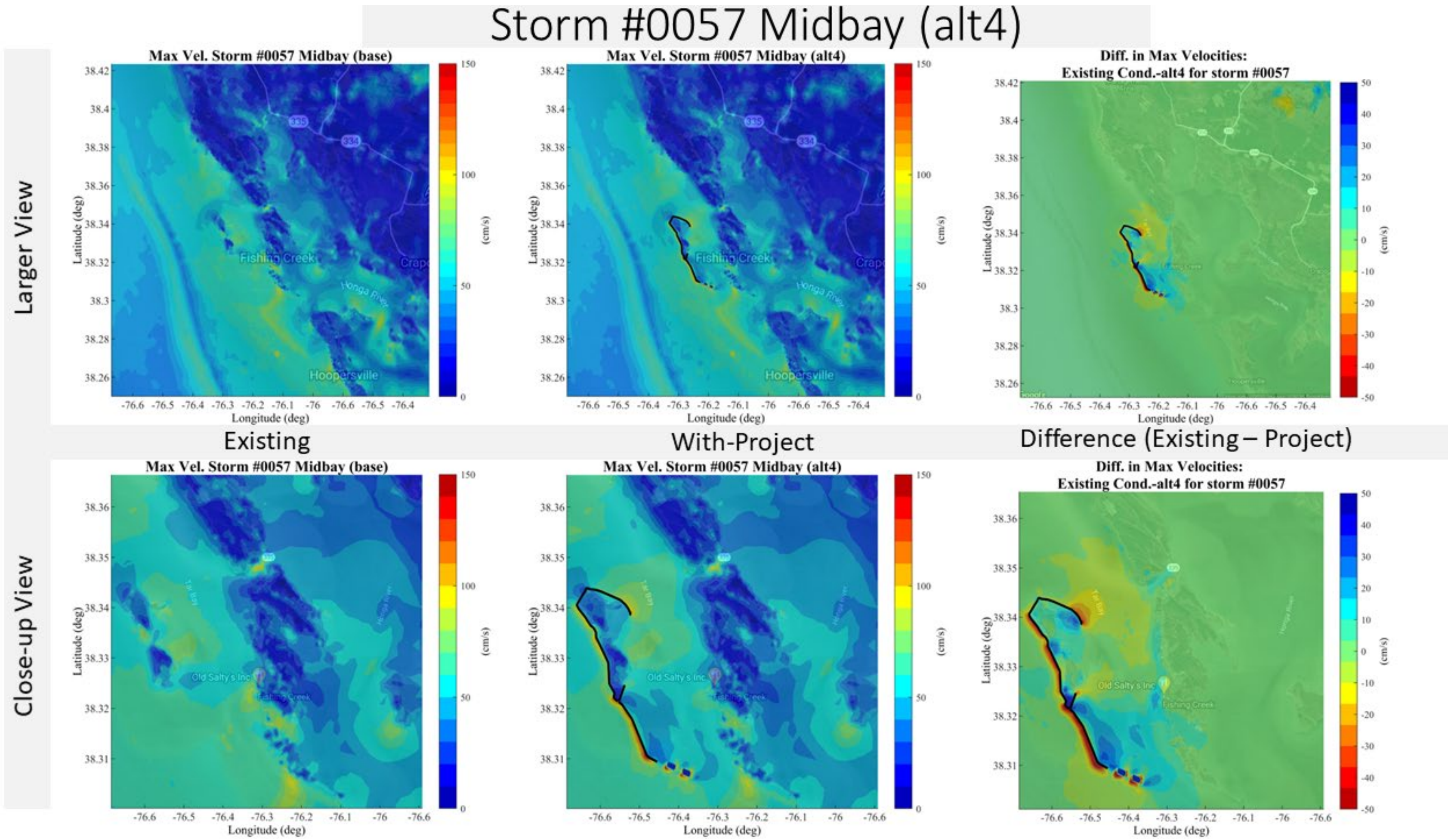

Storm #1003 Midbay (alt6)
Larger View
Close-up View
Max Surge Storm #1003 Midbay (base)
Max Surge Storm #1003 Midbay (alt6)
Diff. in Max Surf. Elevations:
Existing Cond.-alt6 for storm #1003
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(feet)
Lusby
Lexington Park
St Marys City
St Inigoes

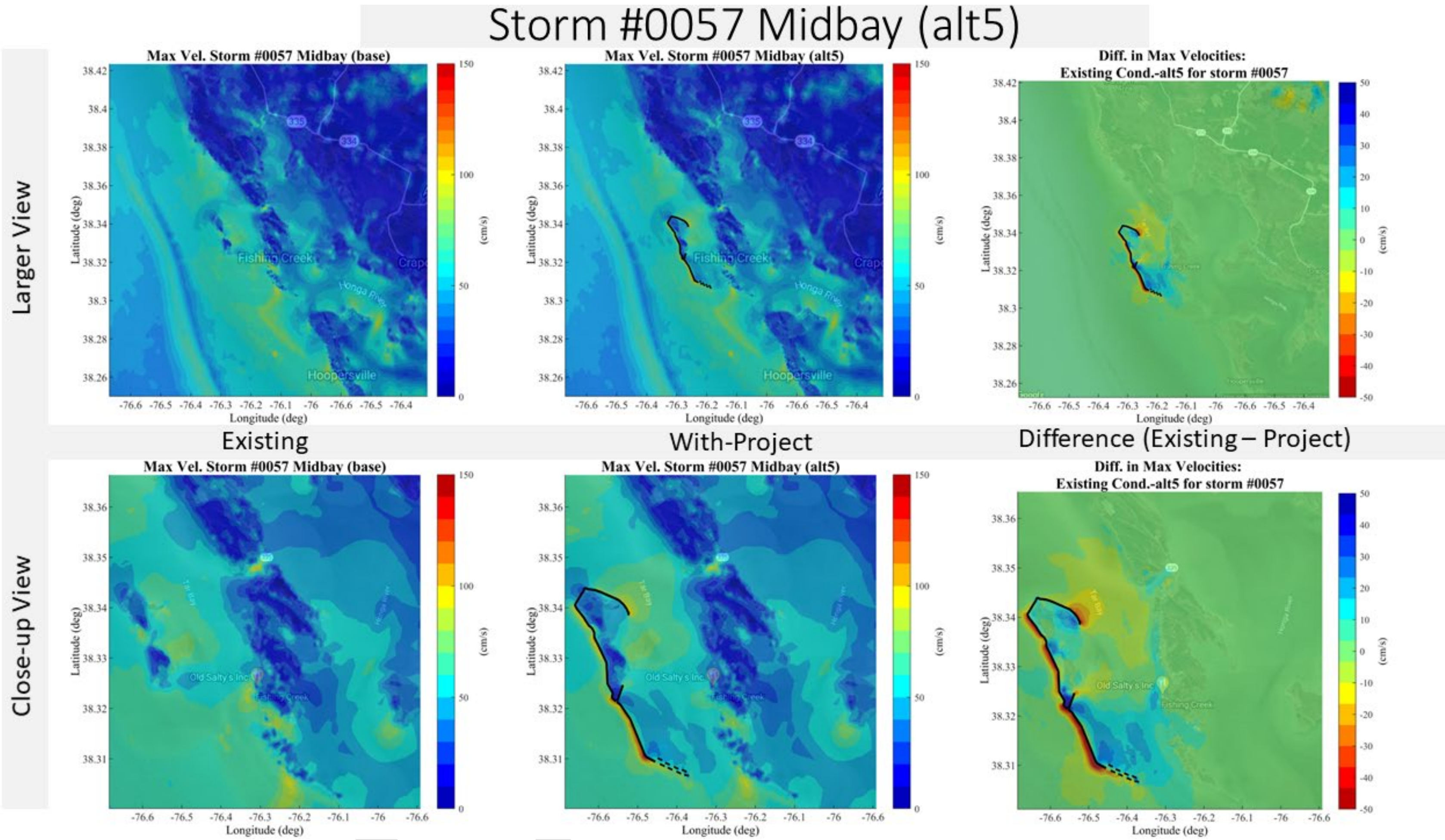
**Appendix III: Maximum Velocity Spatial Difference Contour Plots**

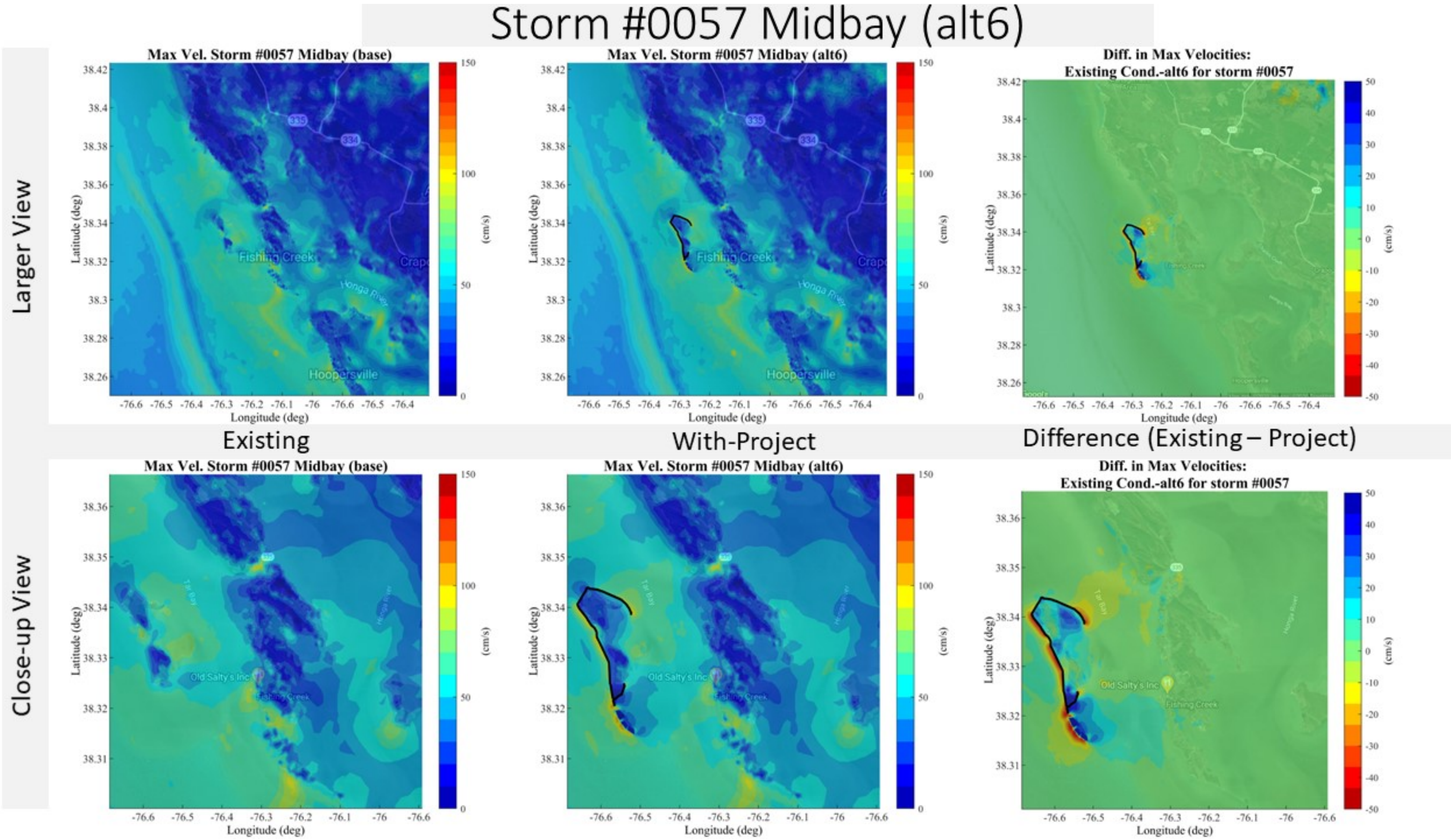


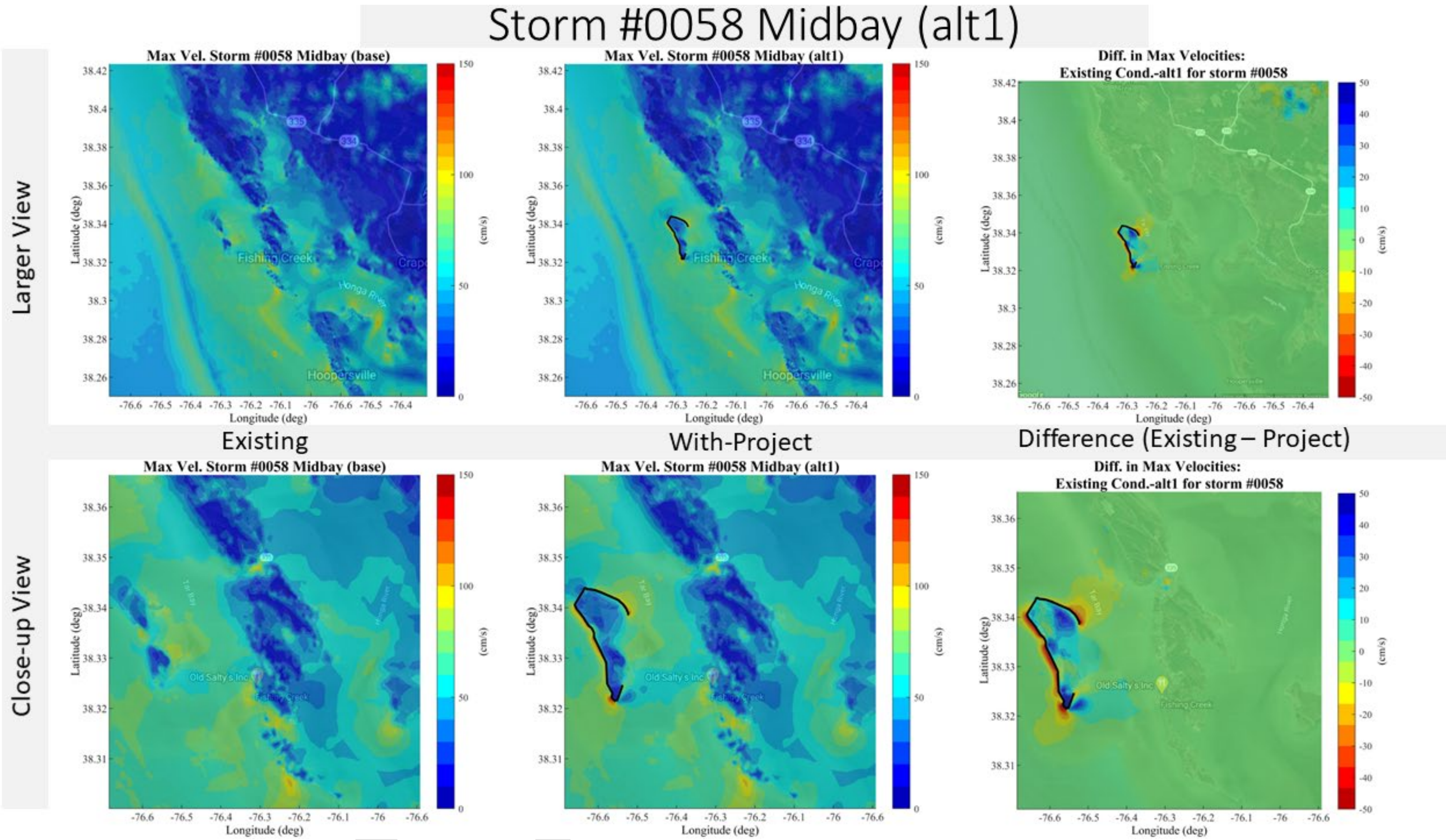

Storm #0057 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0057 Midbay (base)
Max Vel. Storm #0057 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0057
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

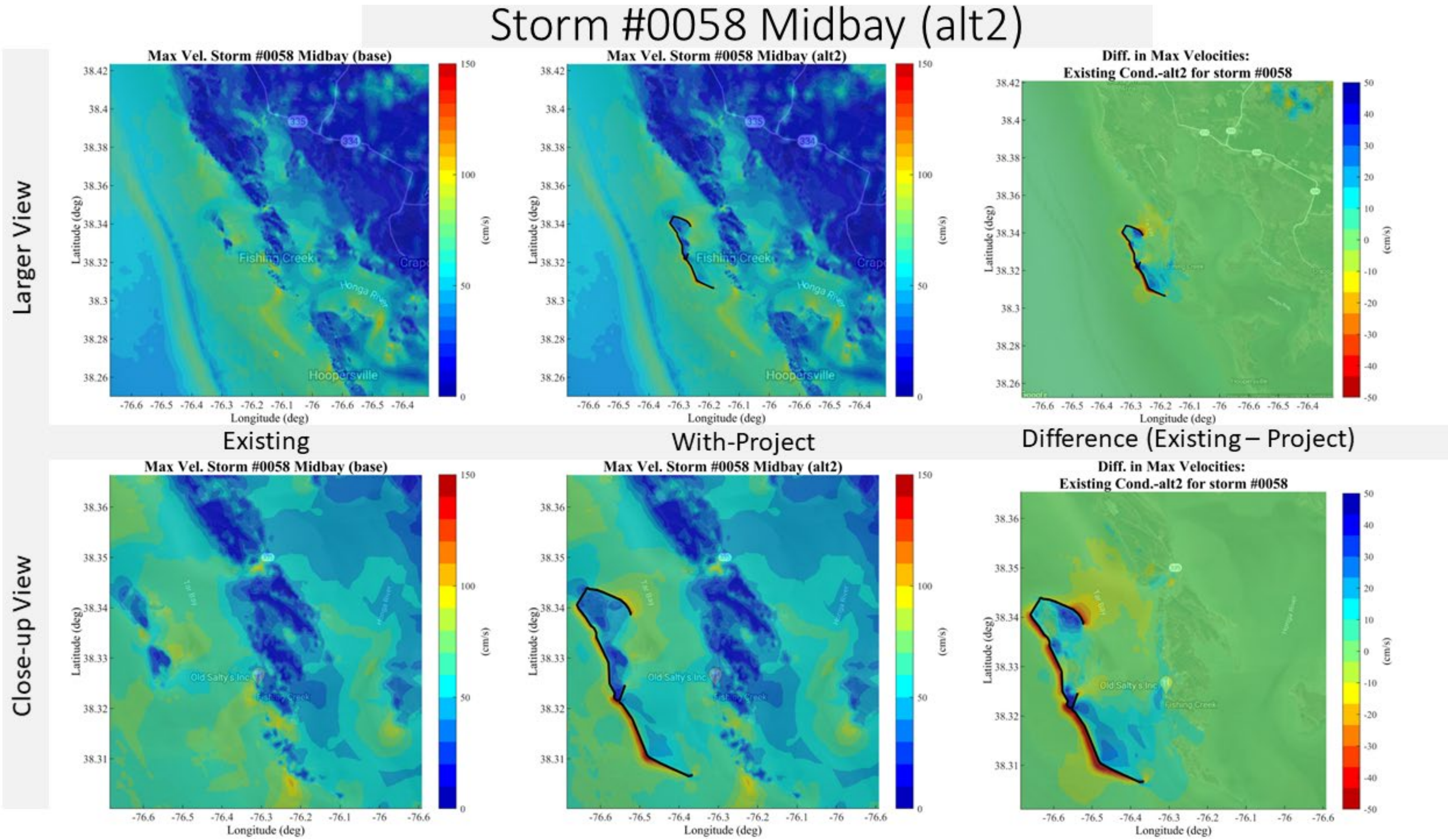

Storm #0057 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0057 Midbay (base)
Max Vel. Storm #0057 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0057
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

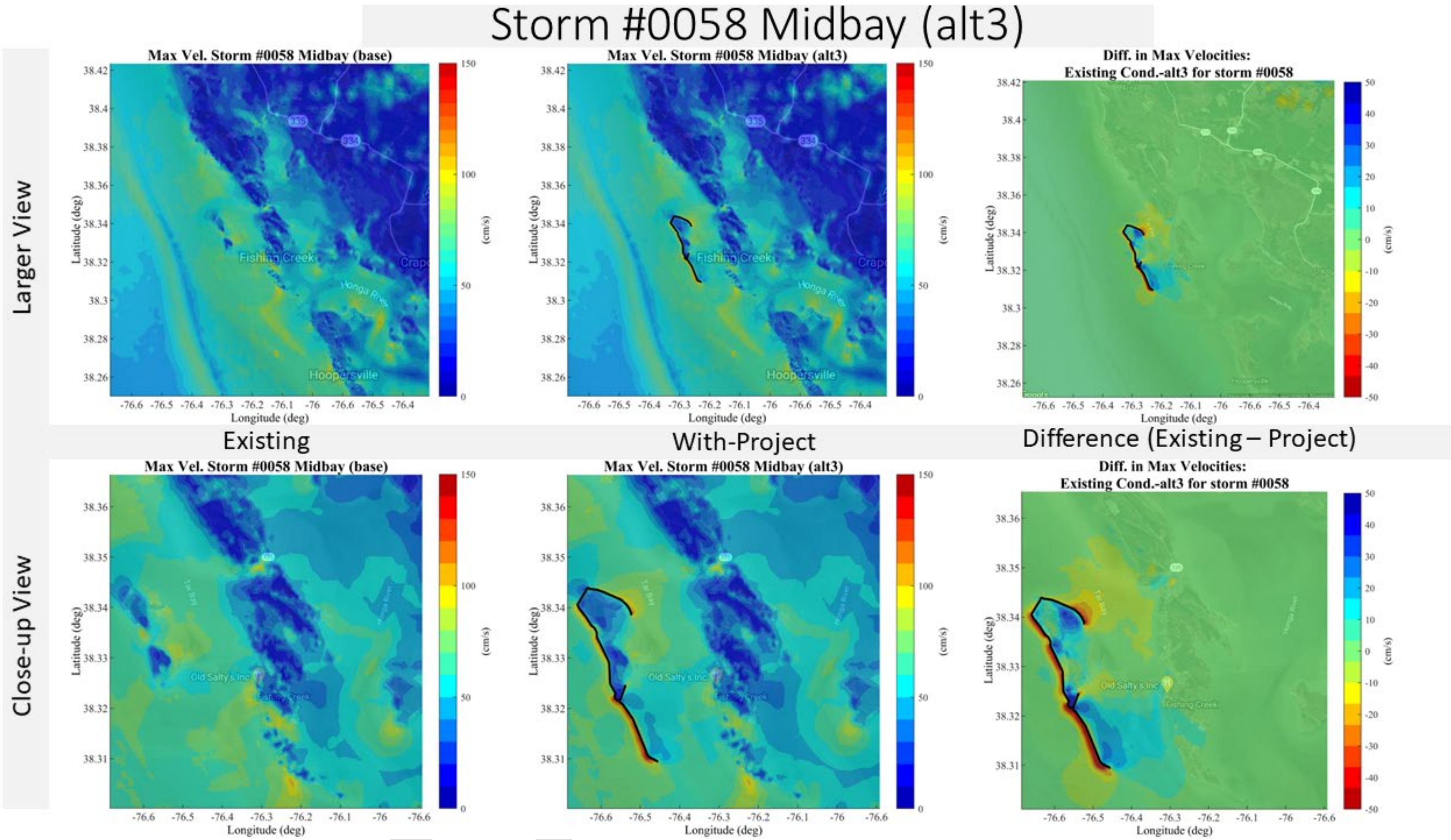

Storm #0057 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0057 Midbay (base)
Max Vel. Storm #0057 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0057
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

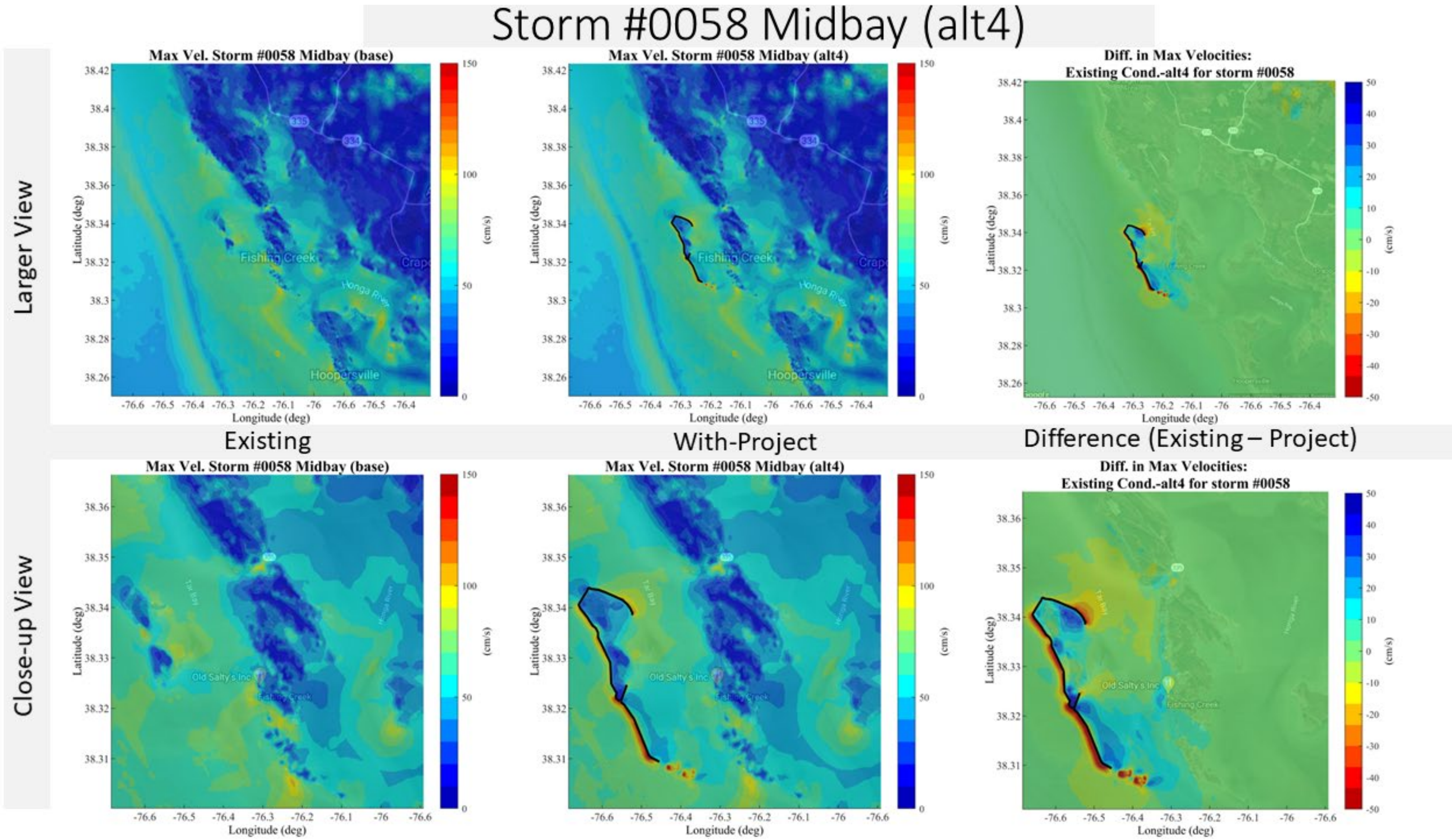

Storm #0057 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0057 Midbay (base)
Max Vel. Storm #0057 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0057
Latitude (deg)
Longitude (deg)
(cm/s)
Existing
With-Project
Difference (Existing – Project)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

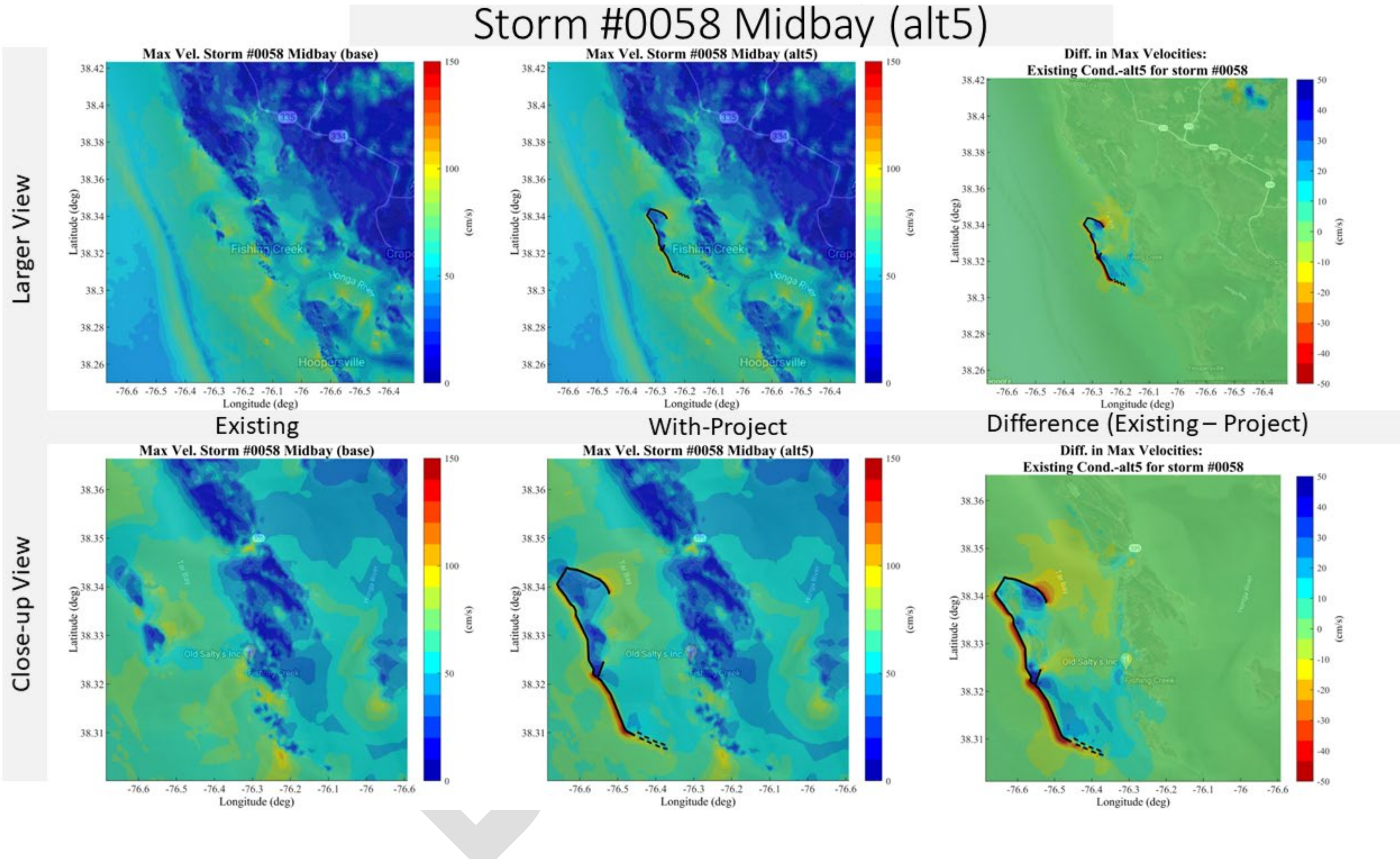

Storm #0057 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0057 Midbay (base)
Max Vel. Storm #0057 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0057
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

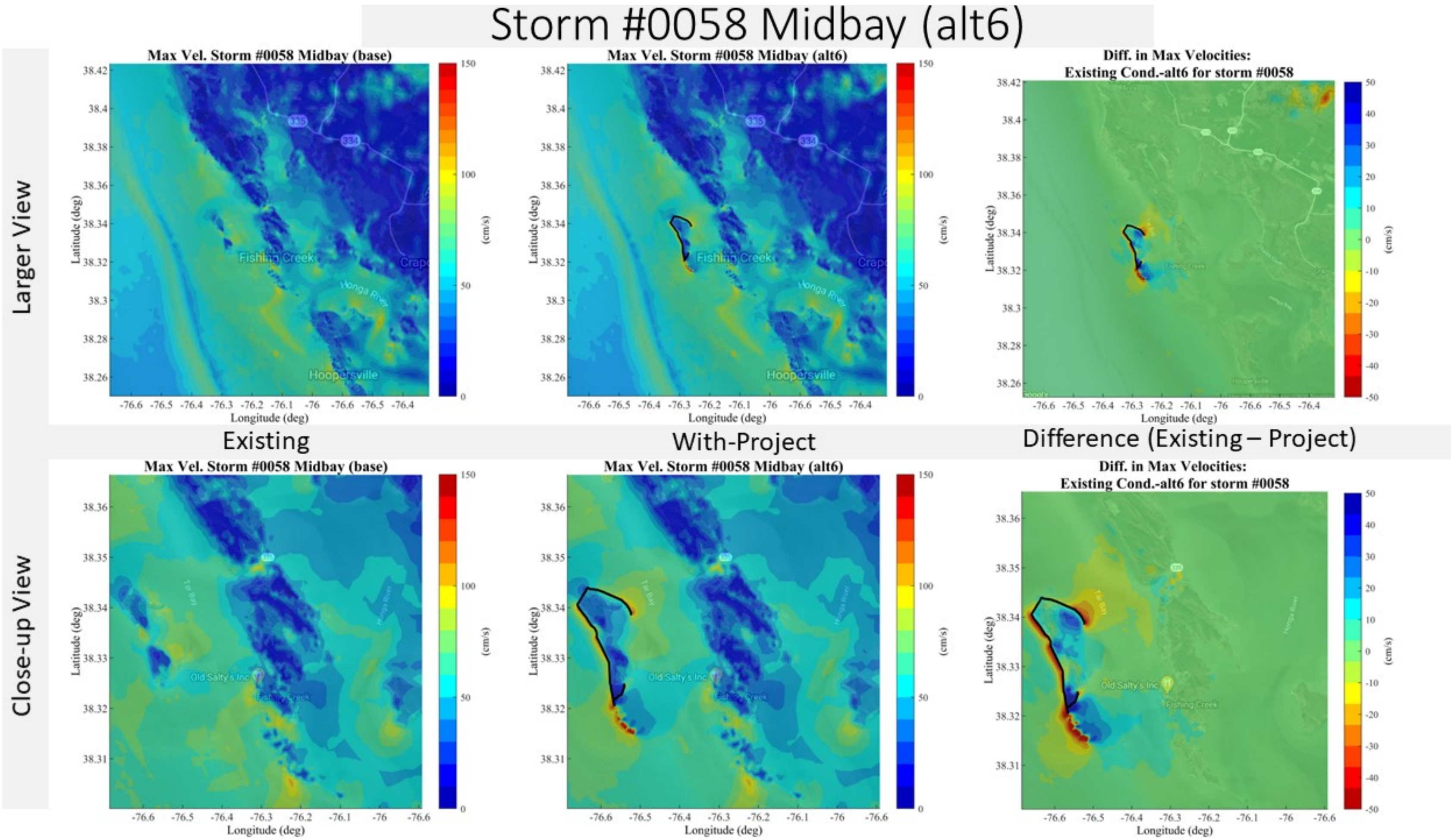

Storm #0058 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0058
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

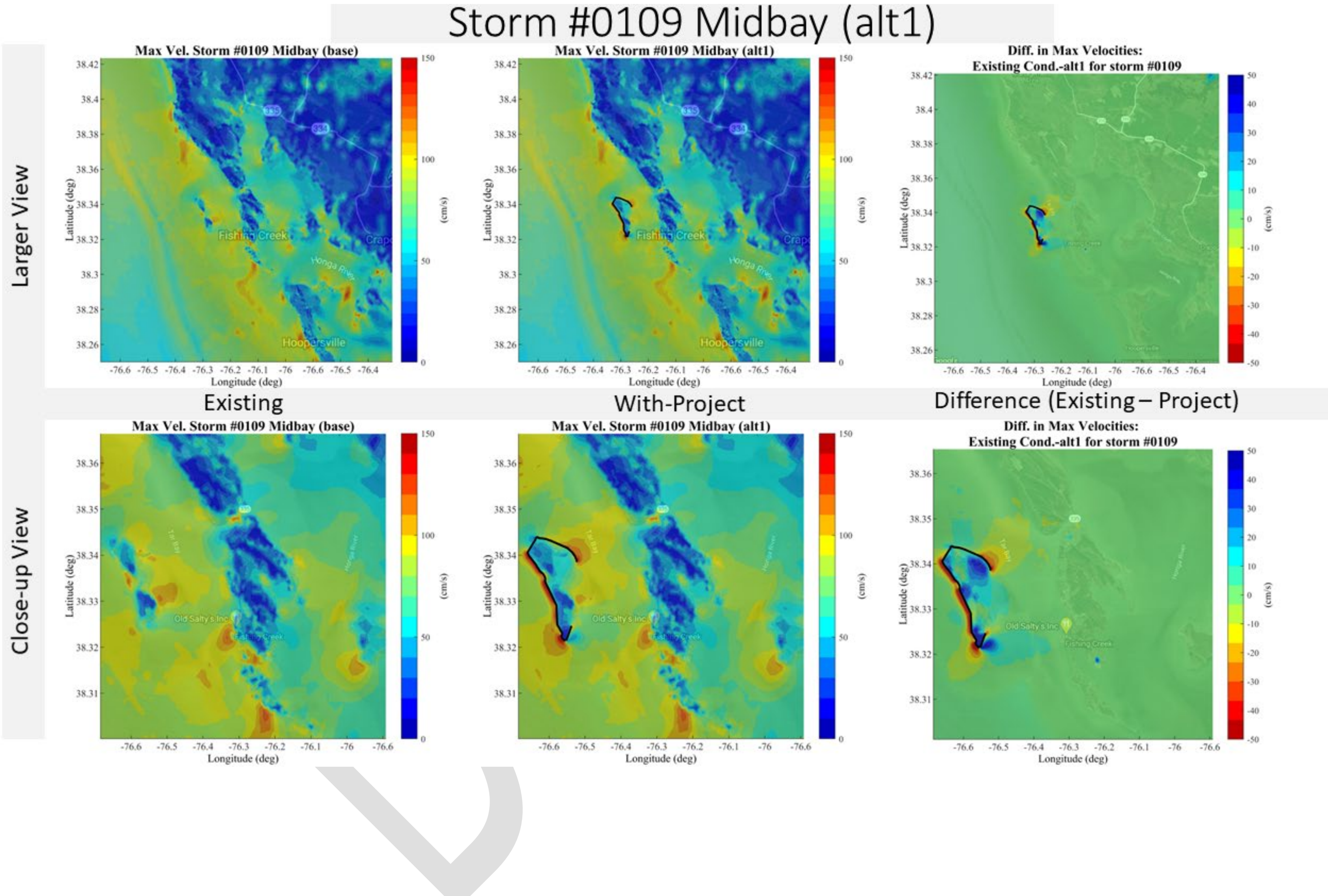

Storm #0058 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0058
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

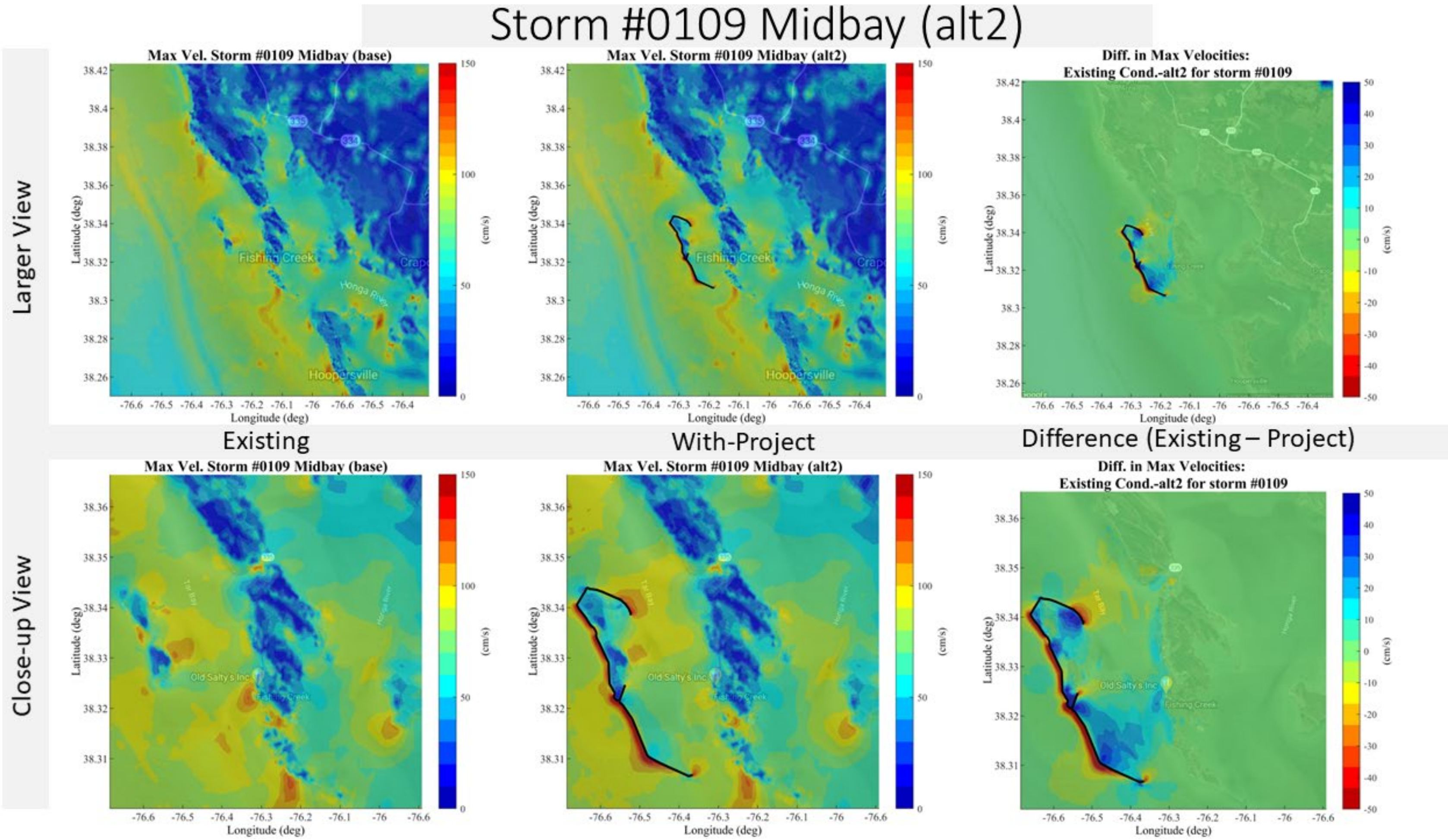

Storm #0058 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0058
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

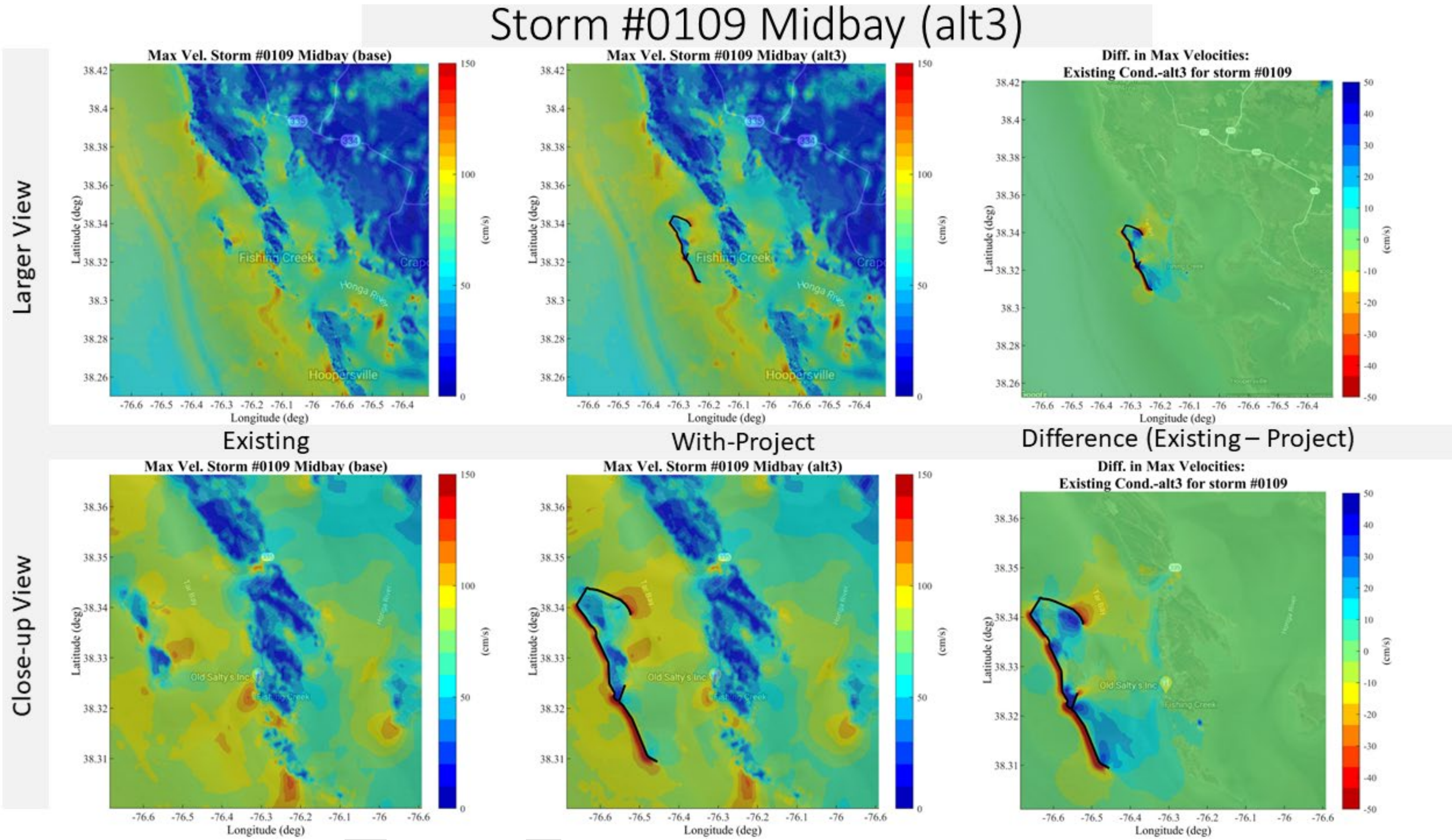

Storm #0058 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0058
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

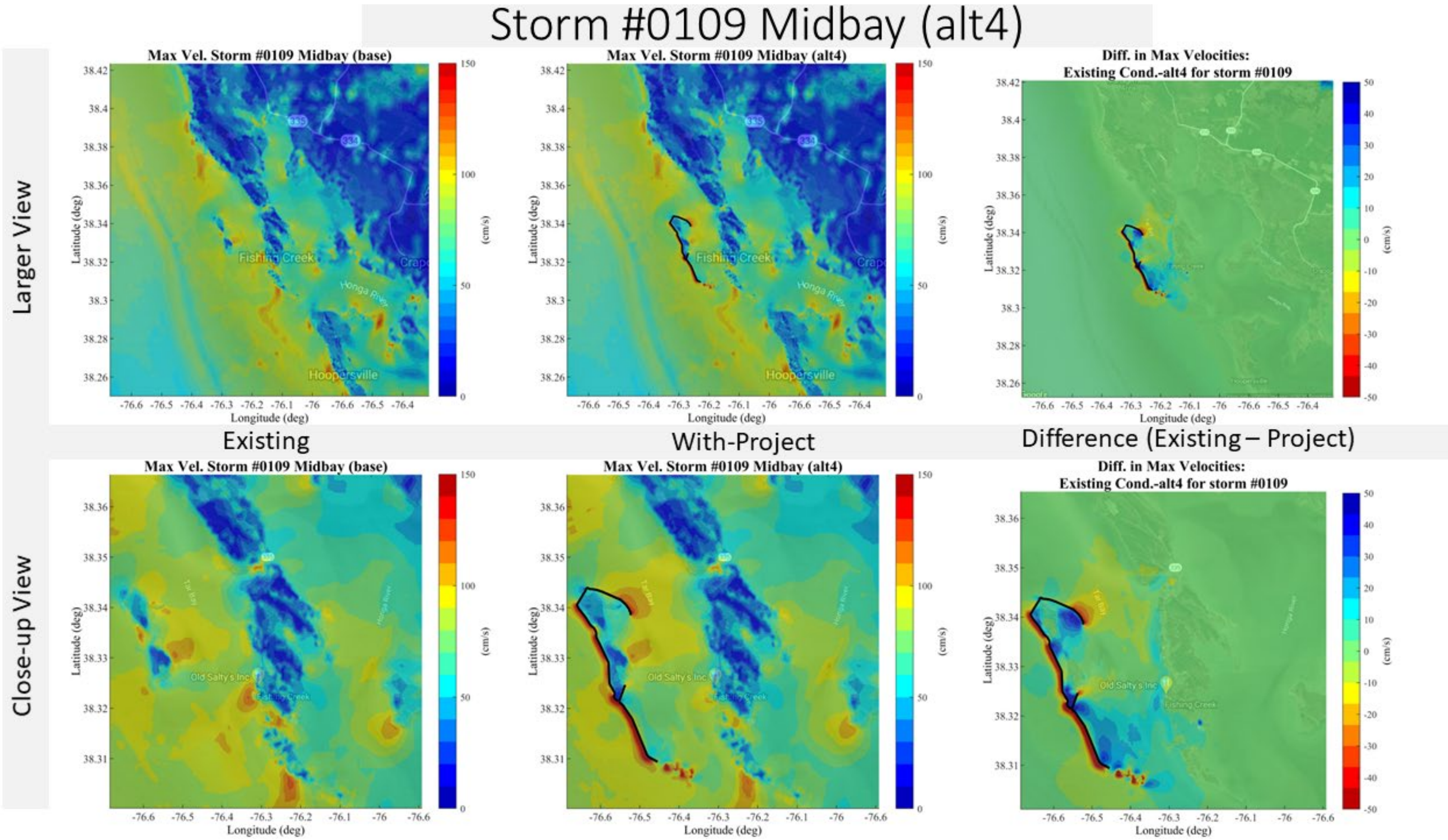

Storm #0058 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0058
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

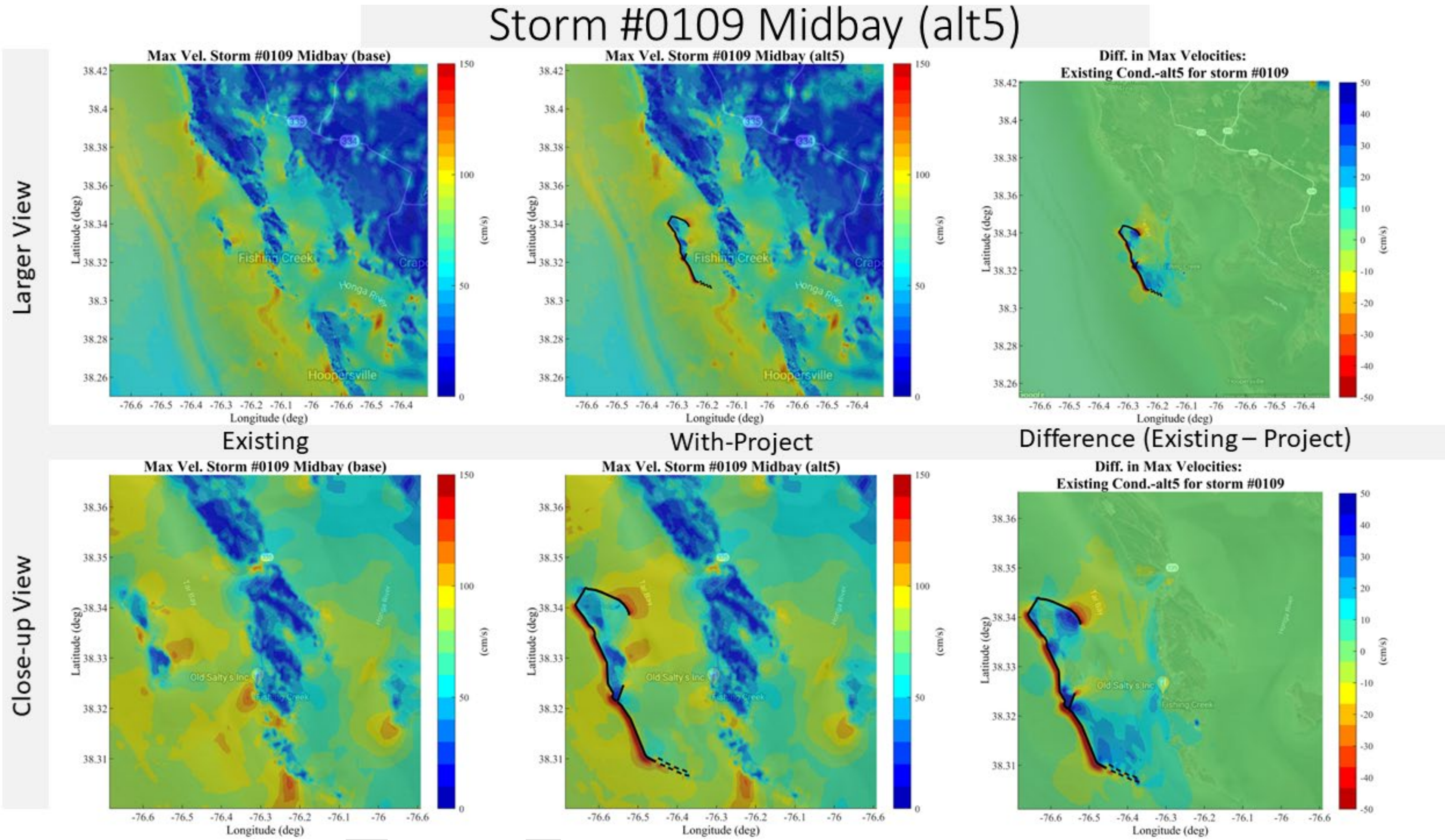

Storm #0058 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0058 Midbay (base)
Max Vel. Storm #0058 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0058
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

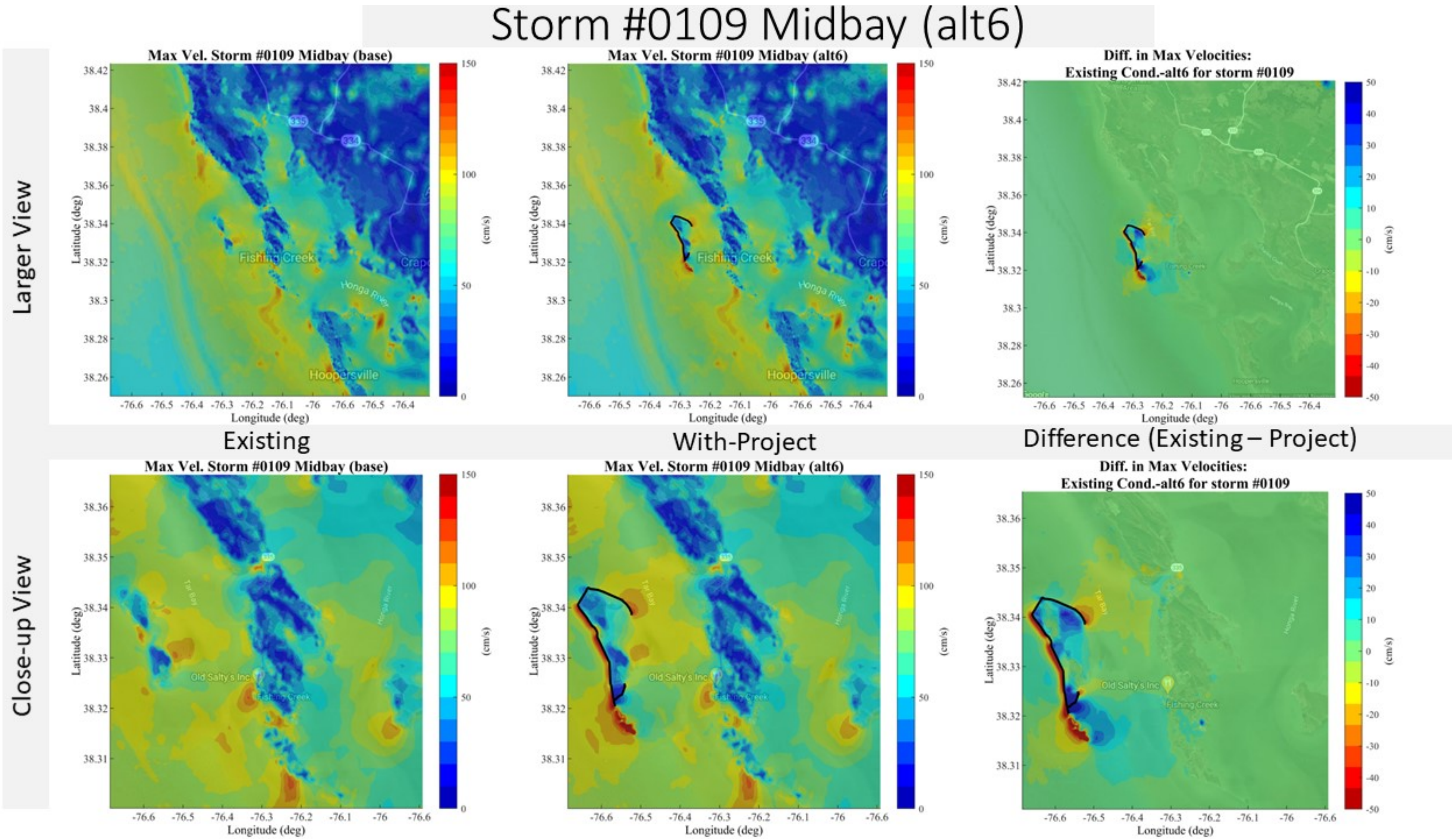

Storm #0109 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0109
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

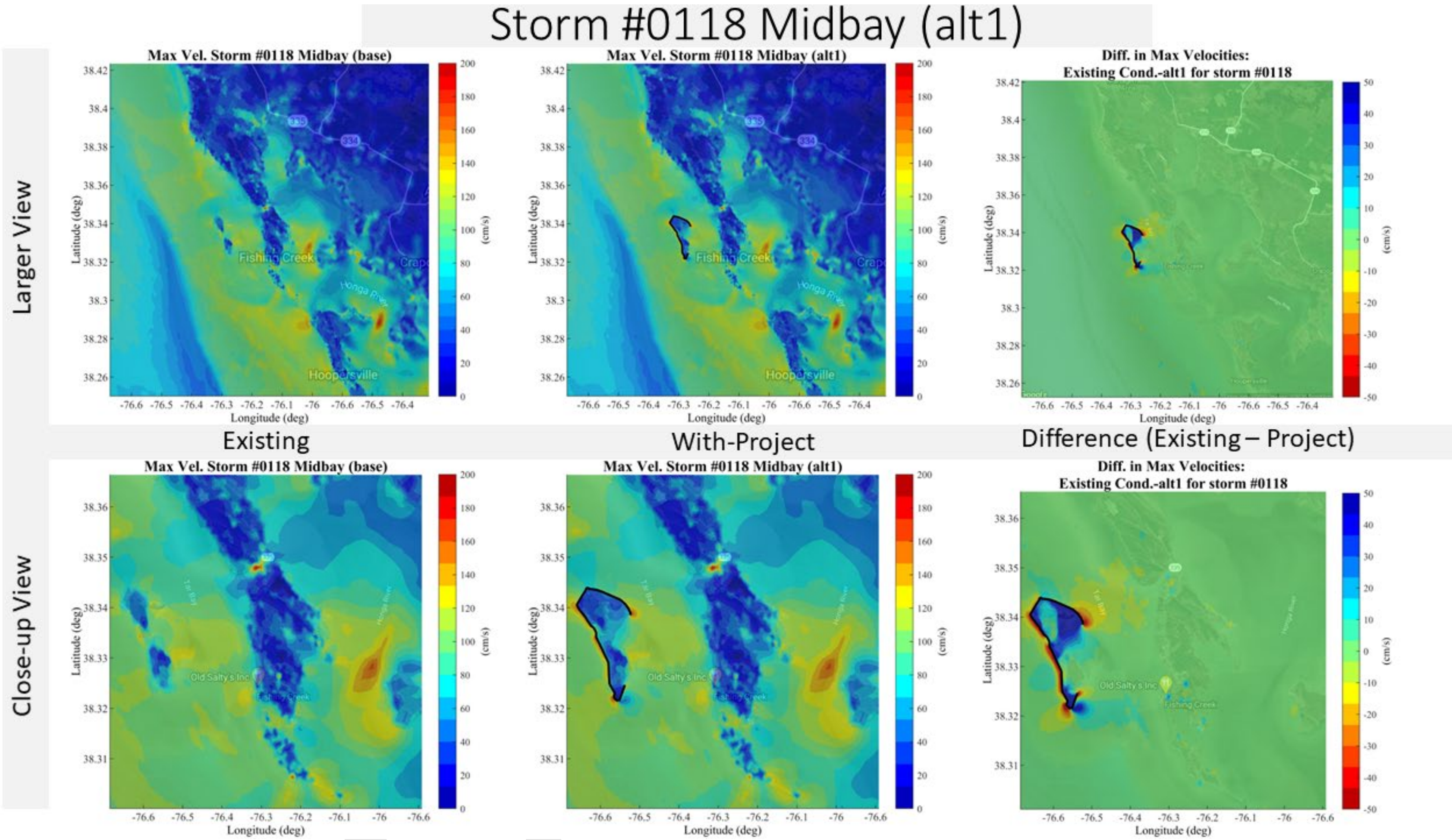

Storm #0109 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0109
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

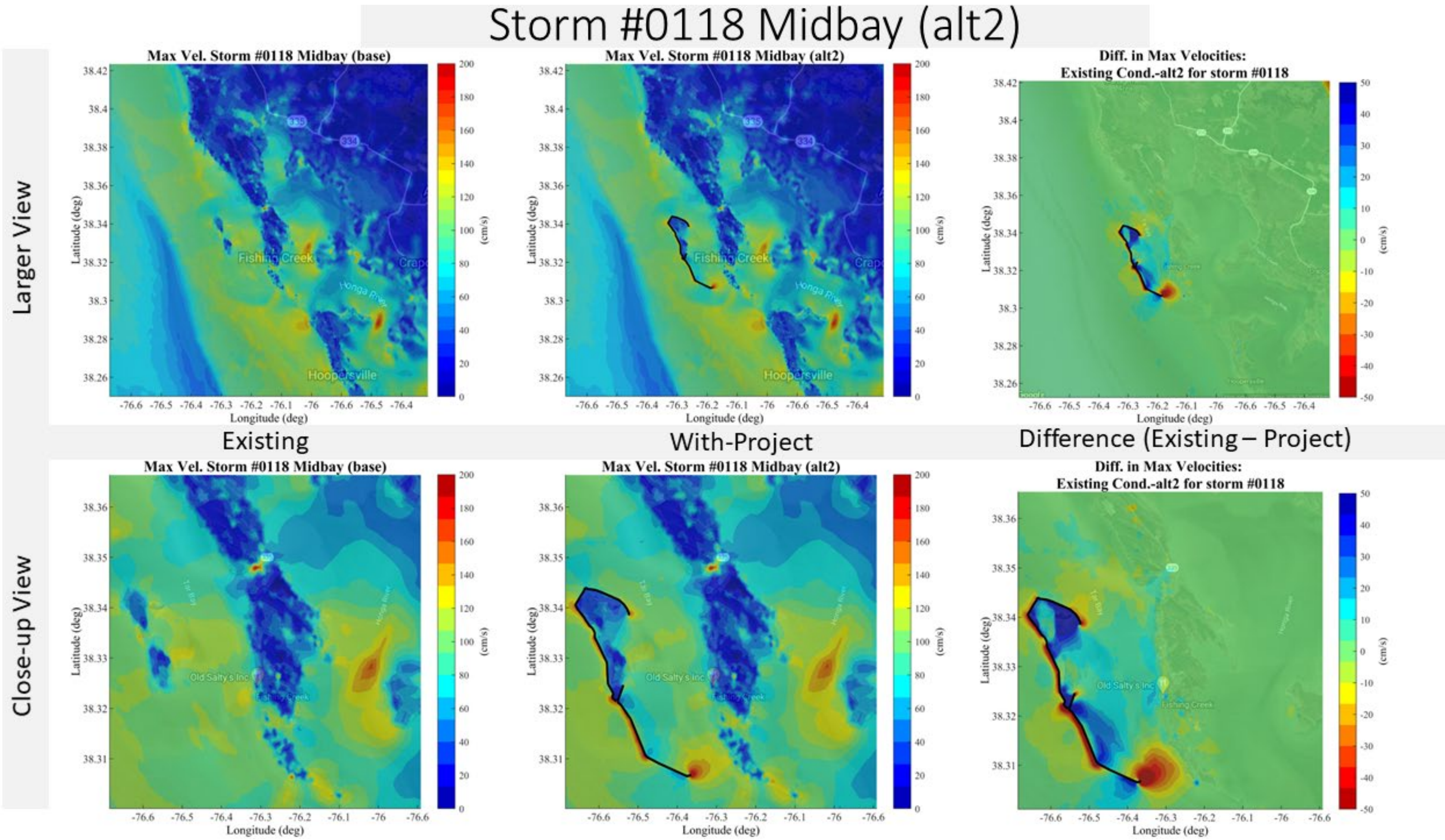

Storm #0109 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0109
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

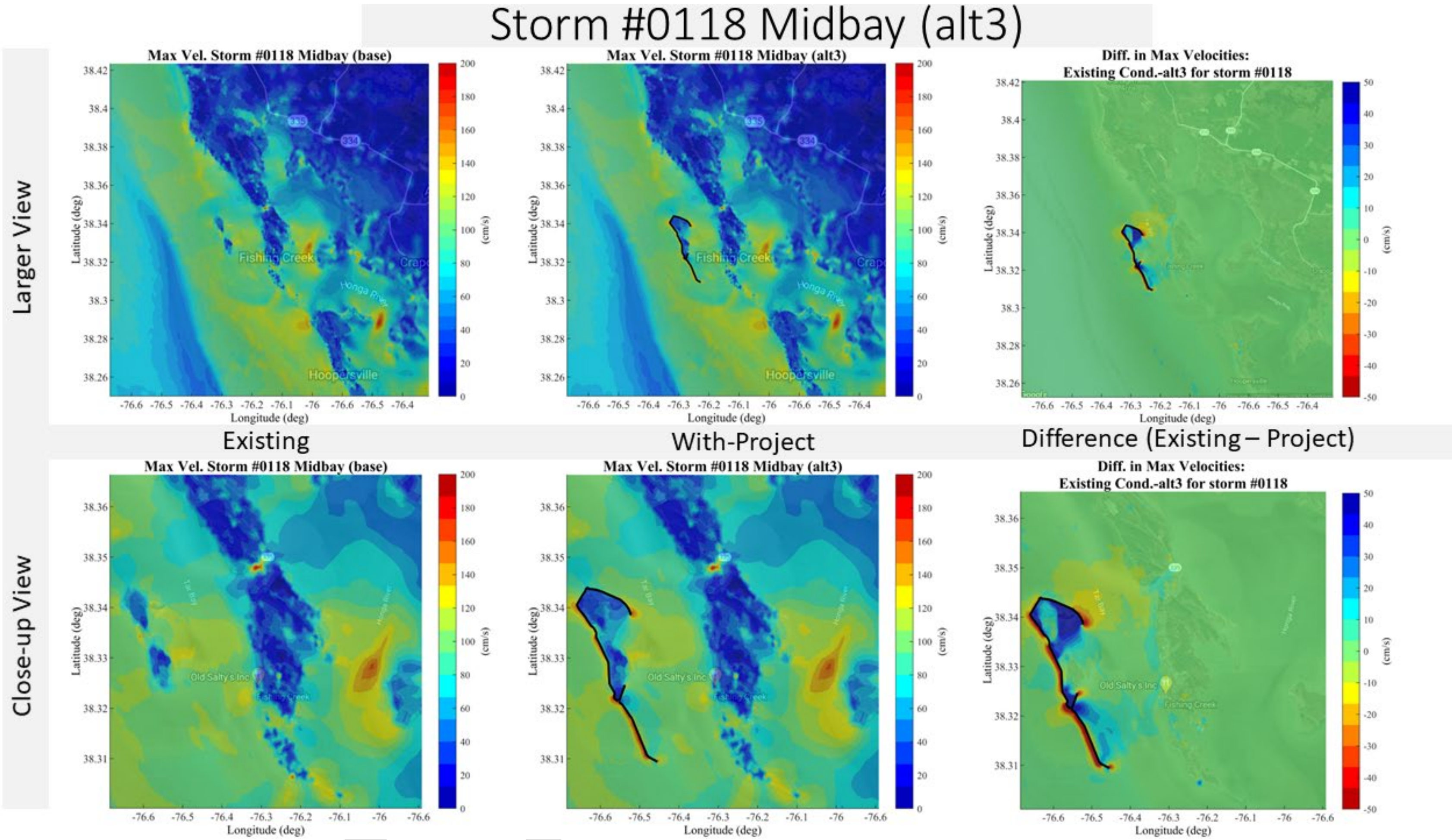

Storm #0109 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0109
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Existing
With-Project
Difference (Existing – Project)
Old Salty's Inc

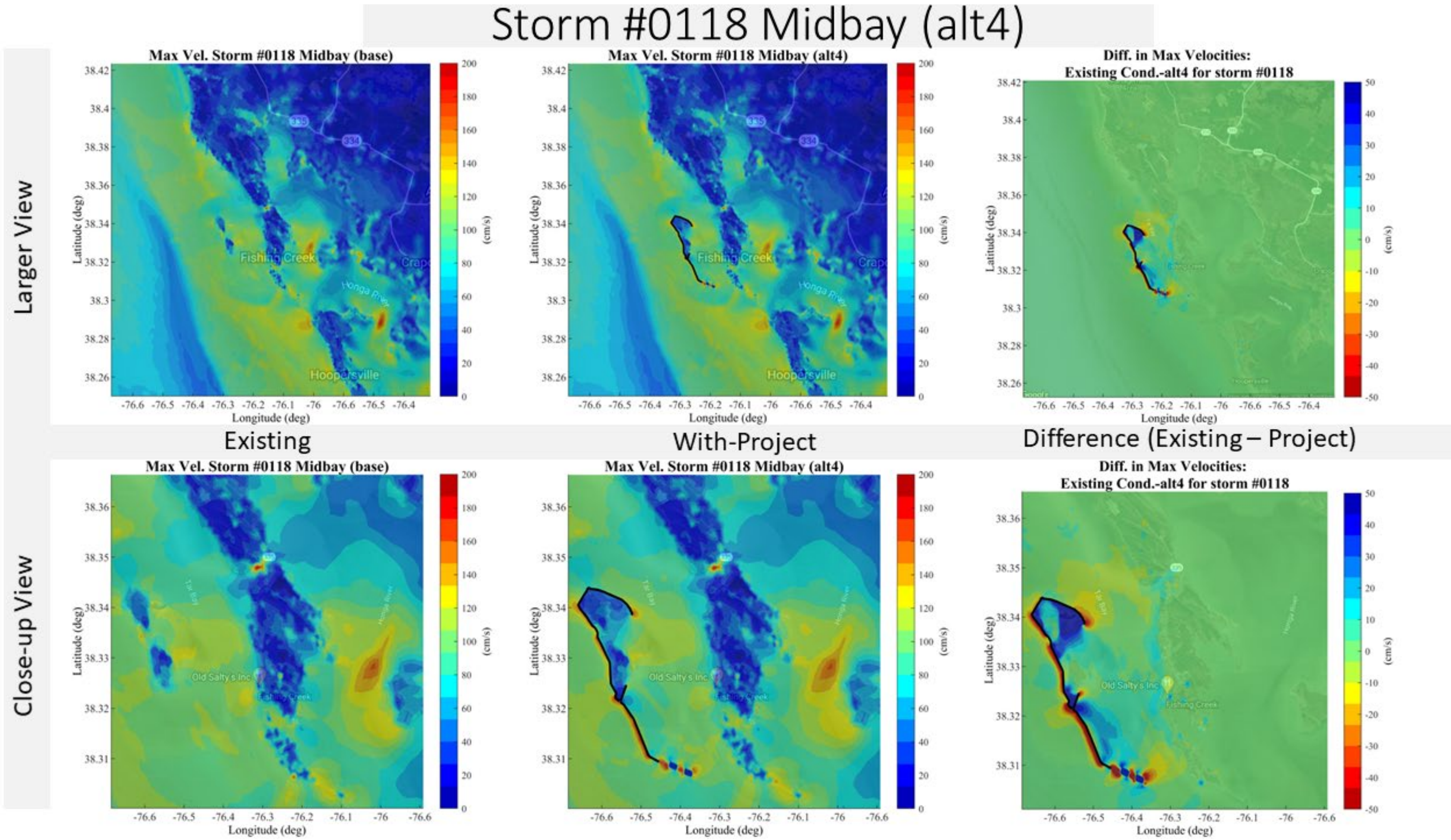

Storm #0109 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0109
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

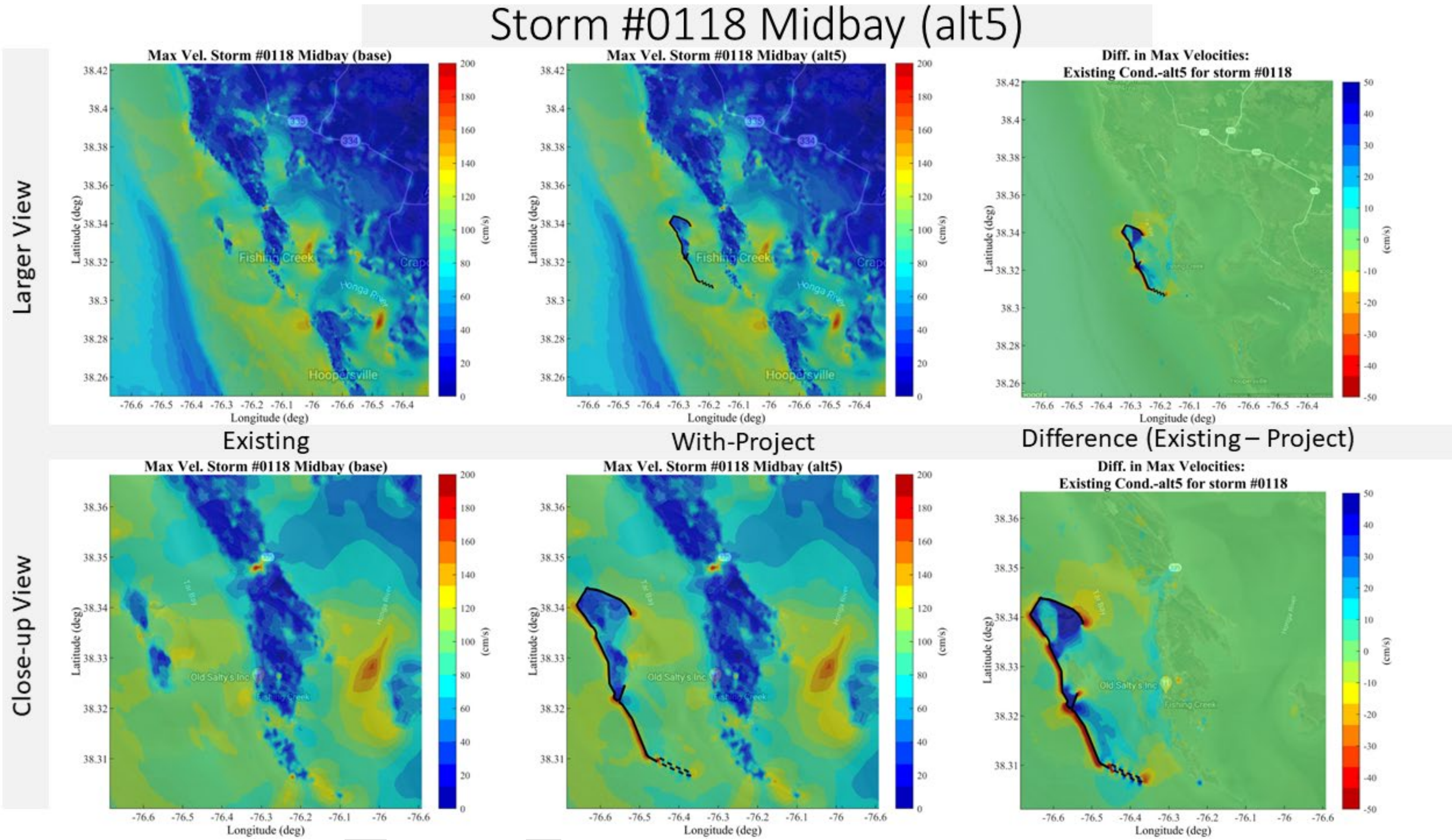

Storm #0109 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0109 Midbay (base)
Max Vel. Storm #0109 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0109
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

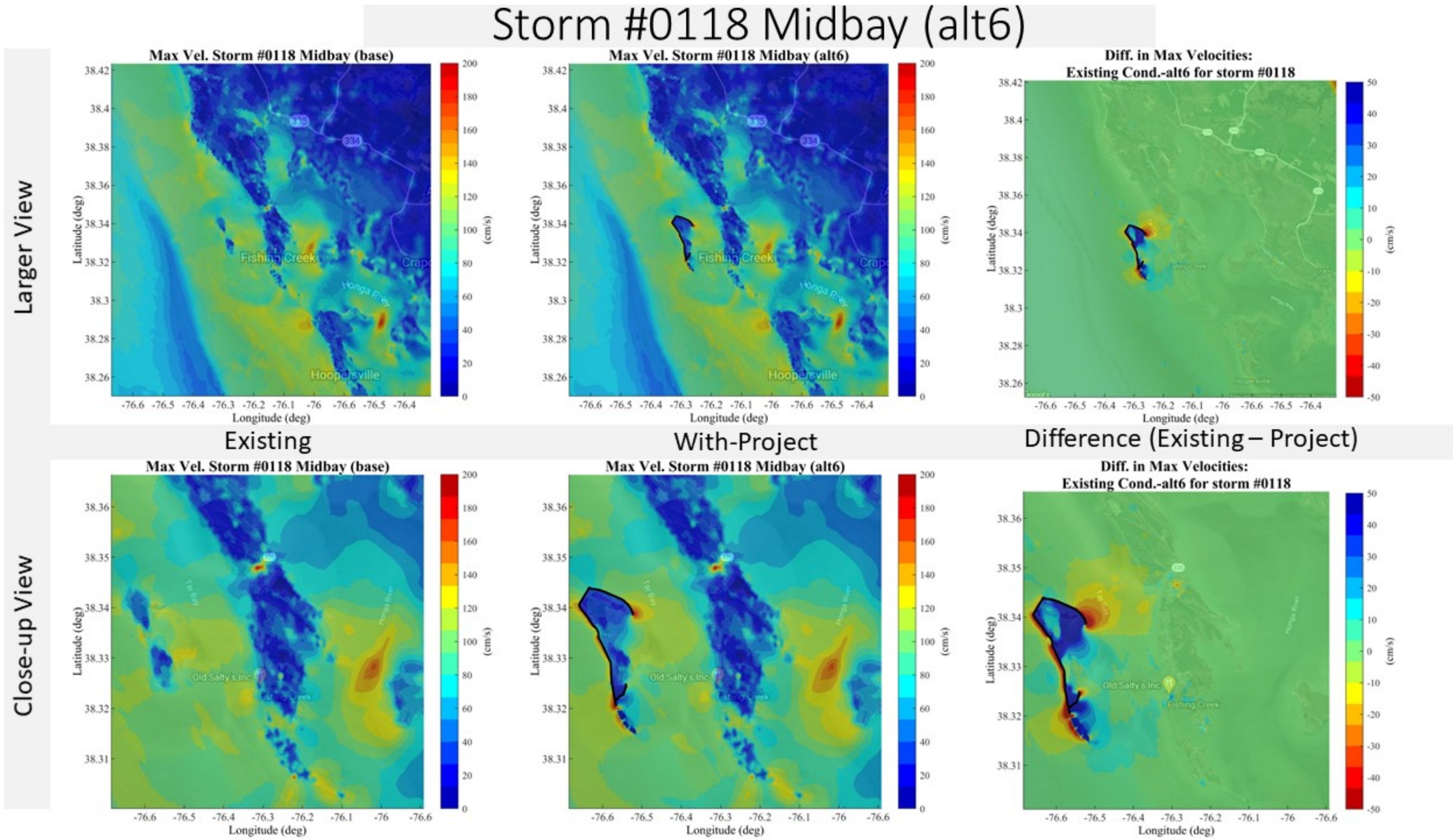

Storm #0118 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

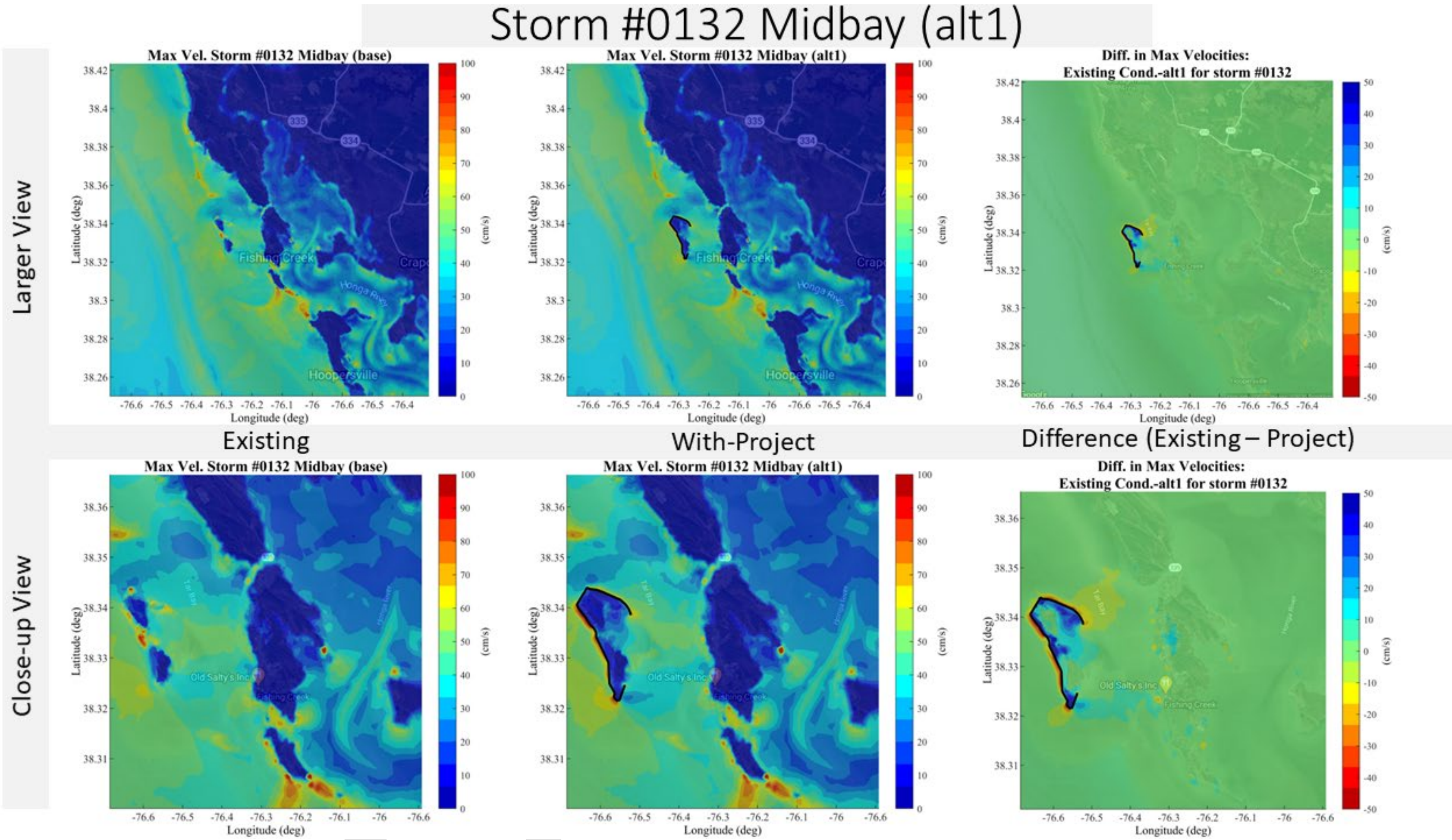

Storm #0118 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0118
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

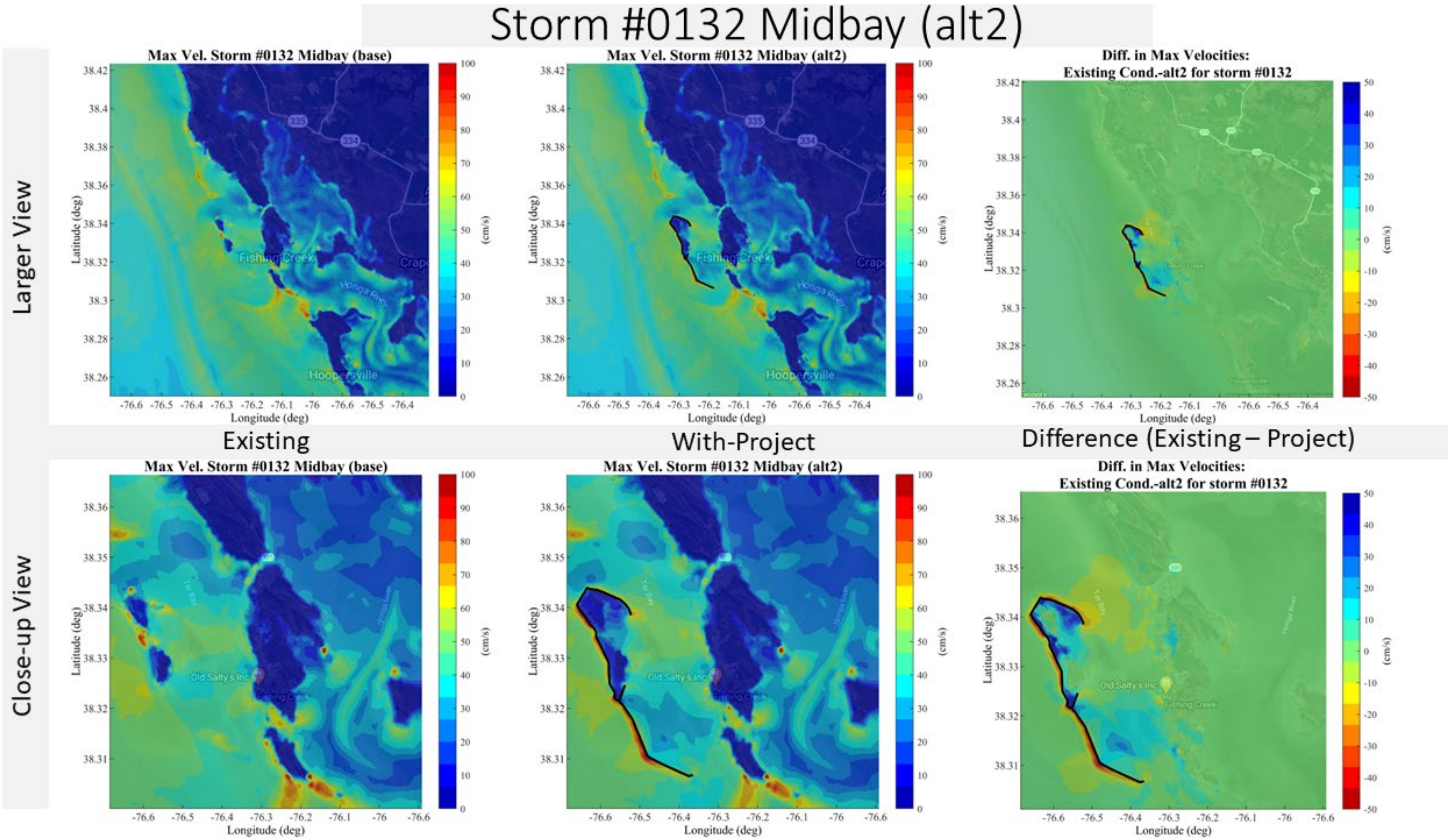

Storm #0118 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

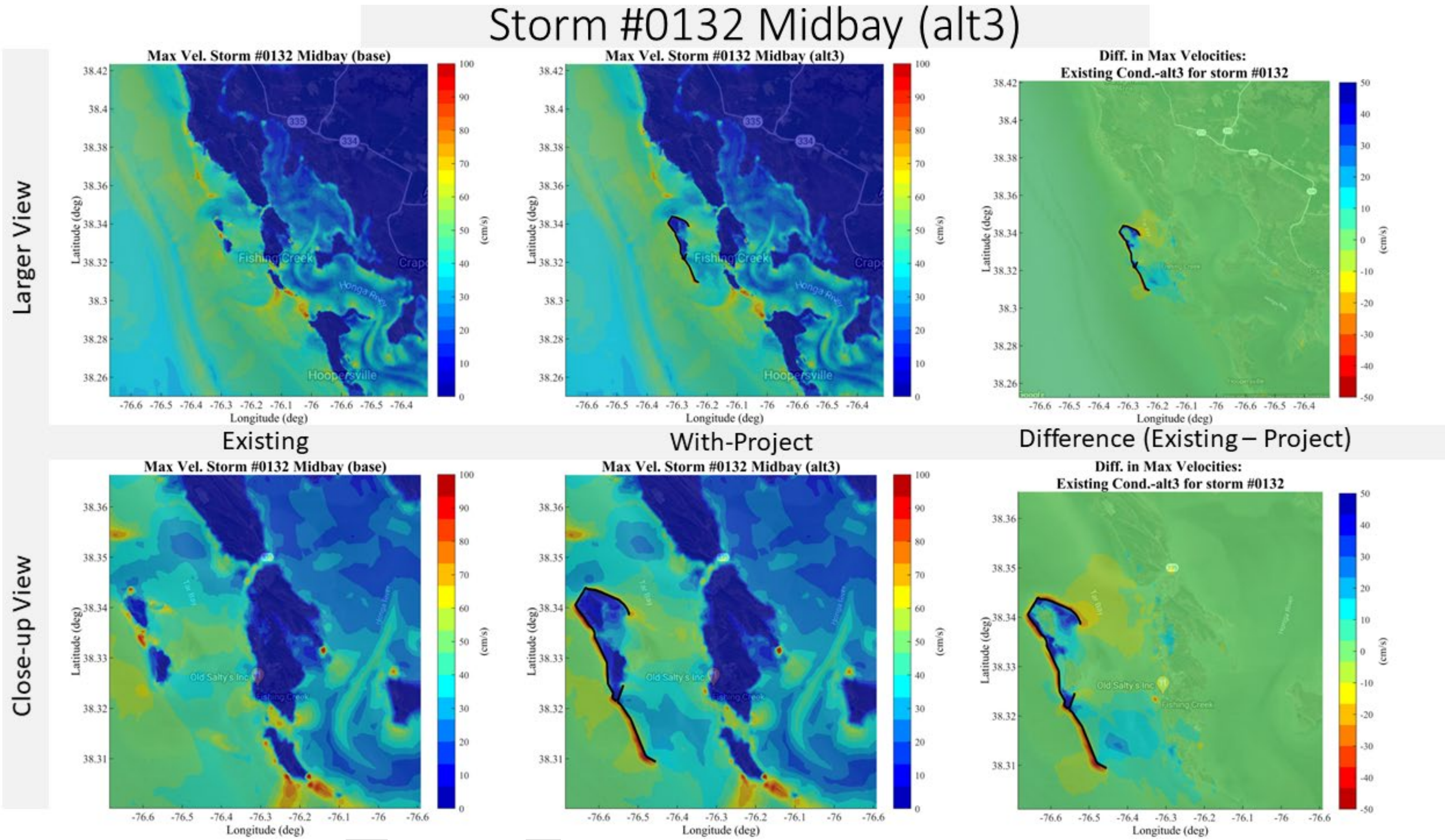

Storm #0118 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

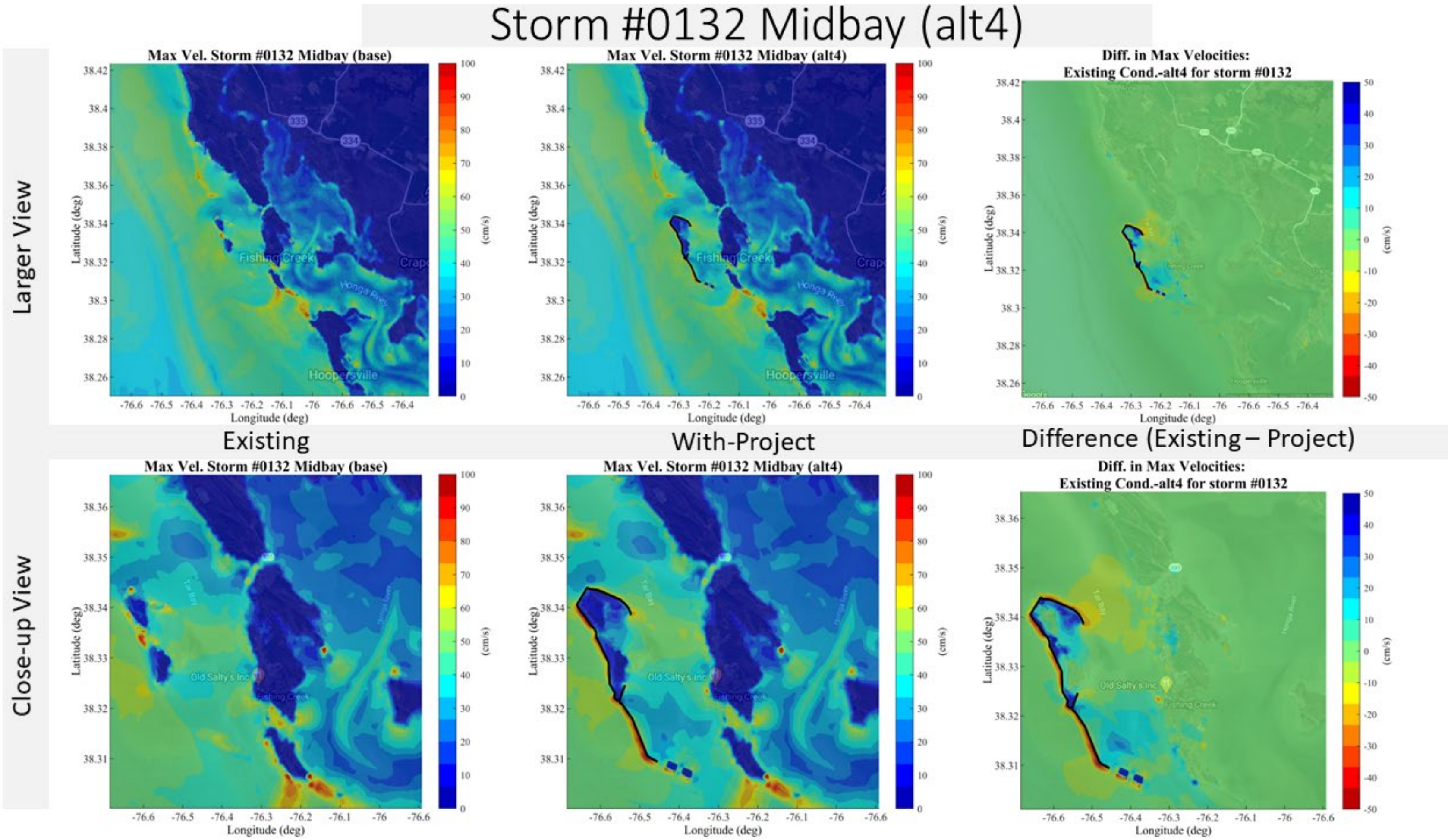

Storm #0118 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0118
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

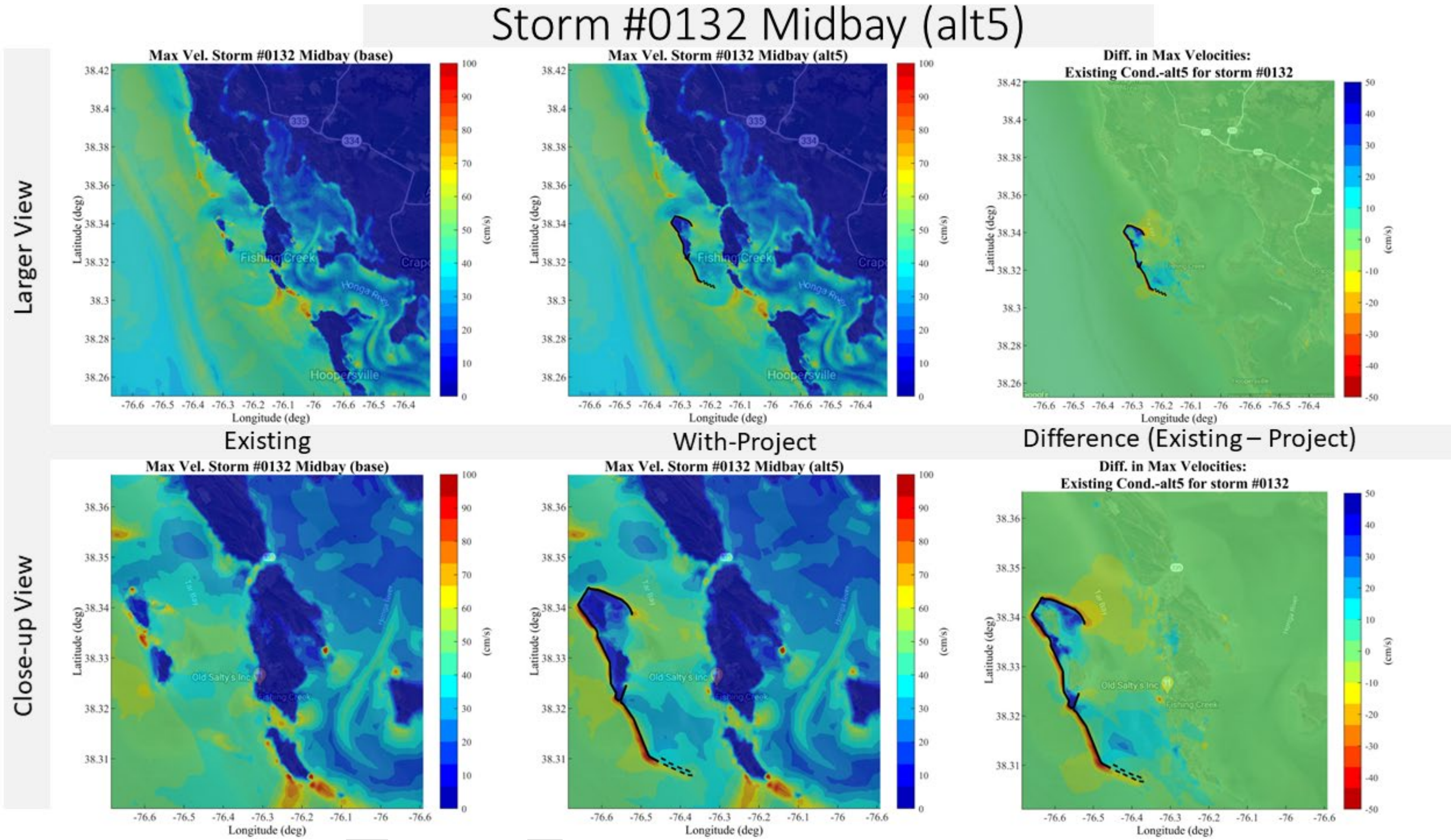

Storm #0118 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0118 Midbay (base)
Max Vel. Storm #0118 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0118
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

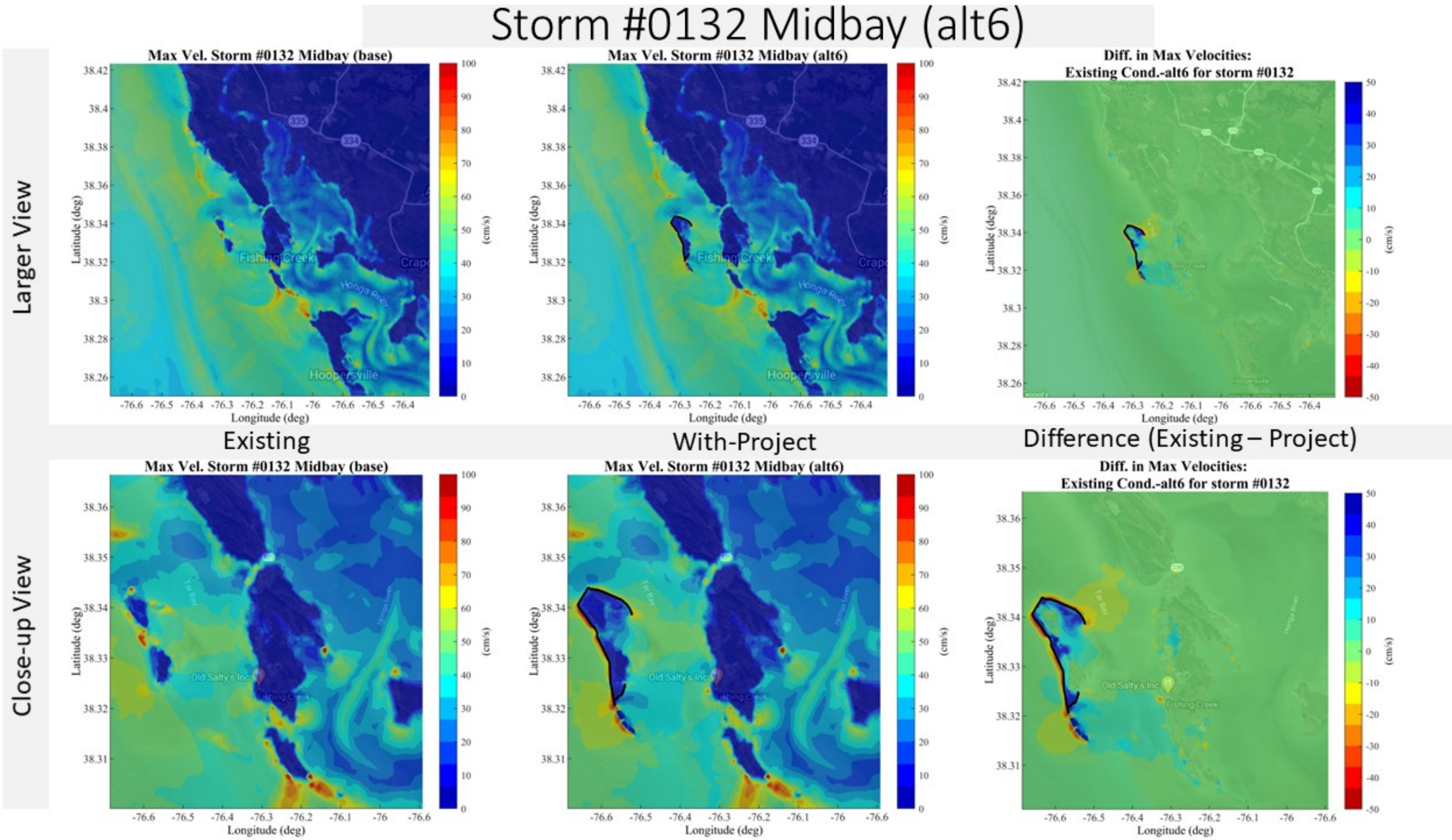

Storm #0132 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt1)
Diff. in Max Velocities: Existing Cond.-alt1 for storm #0132
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

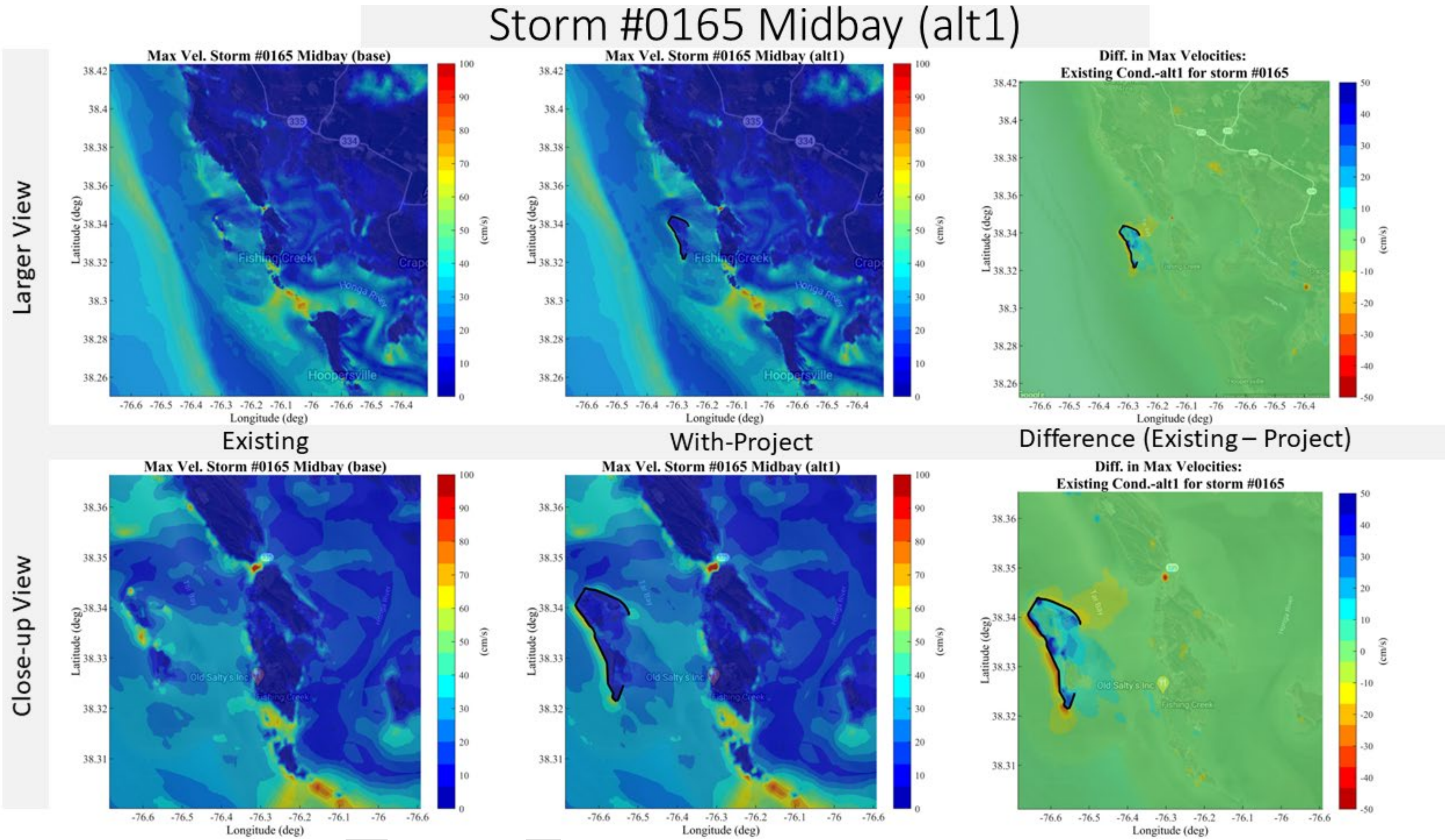

Storm #0132 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0132
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

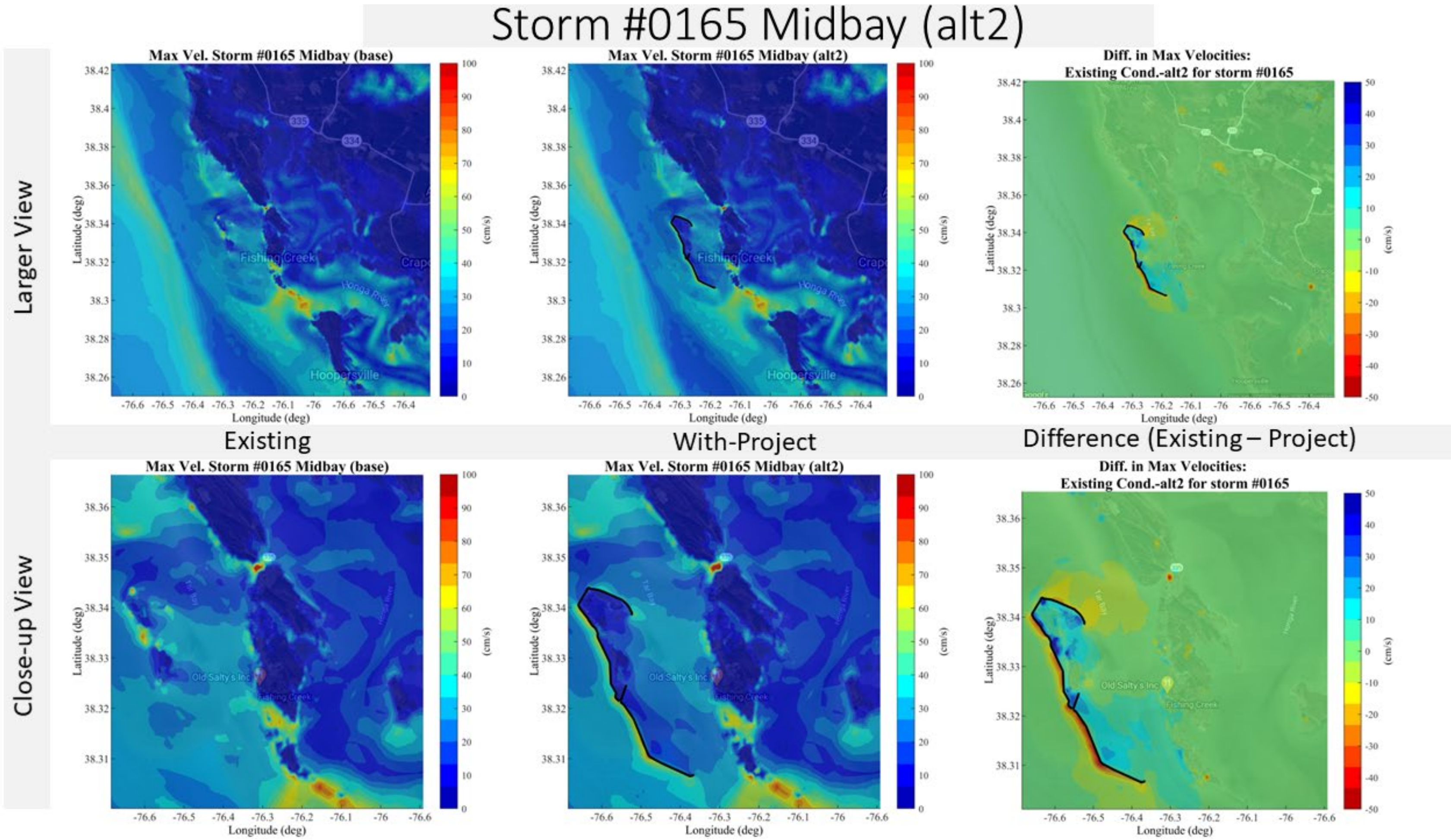

Storm #0132 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0132
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0132
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

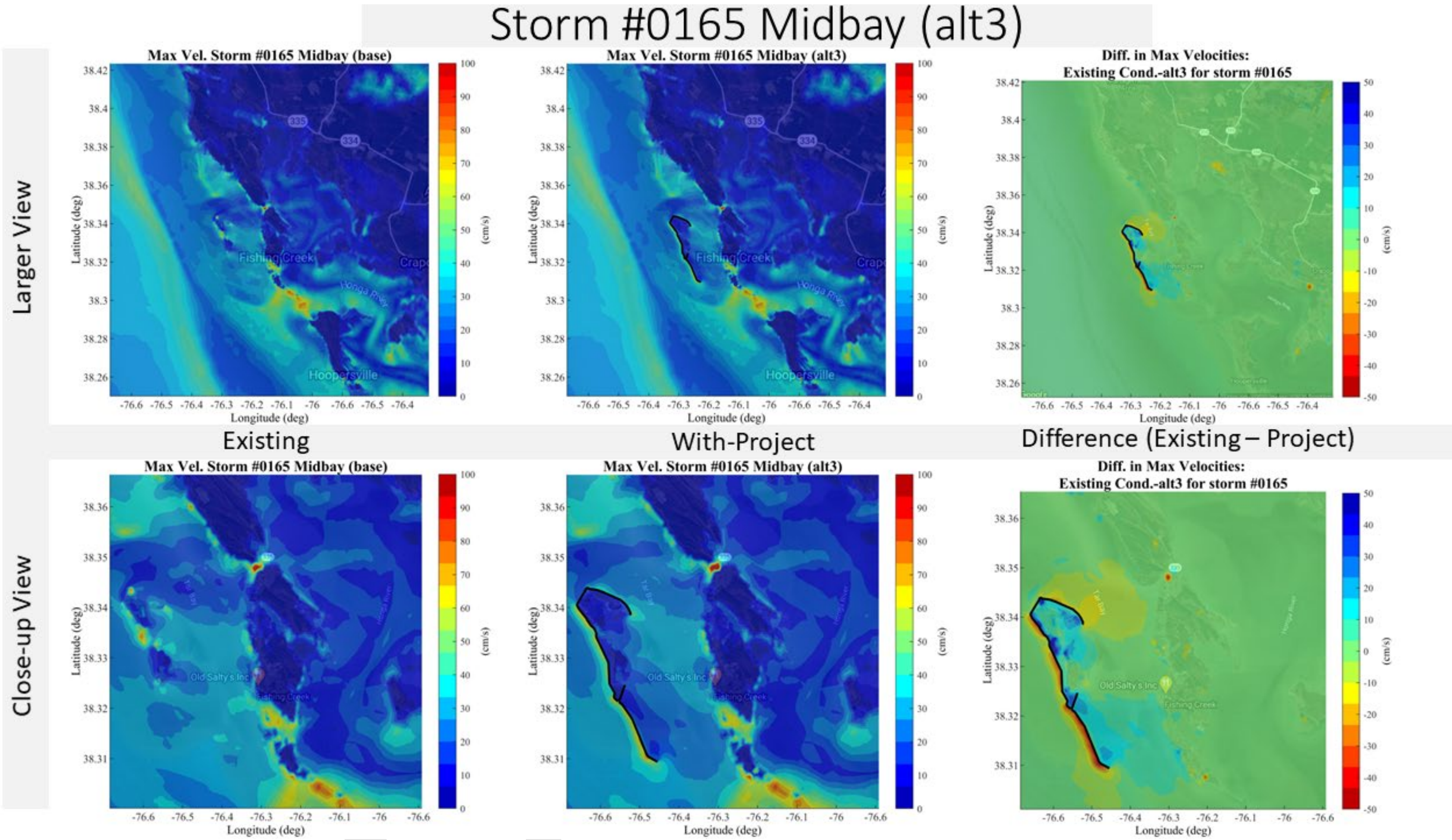

Storm #0132 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0132
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

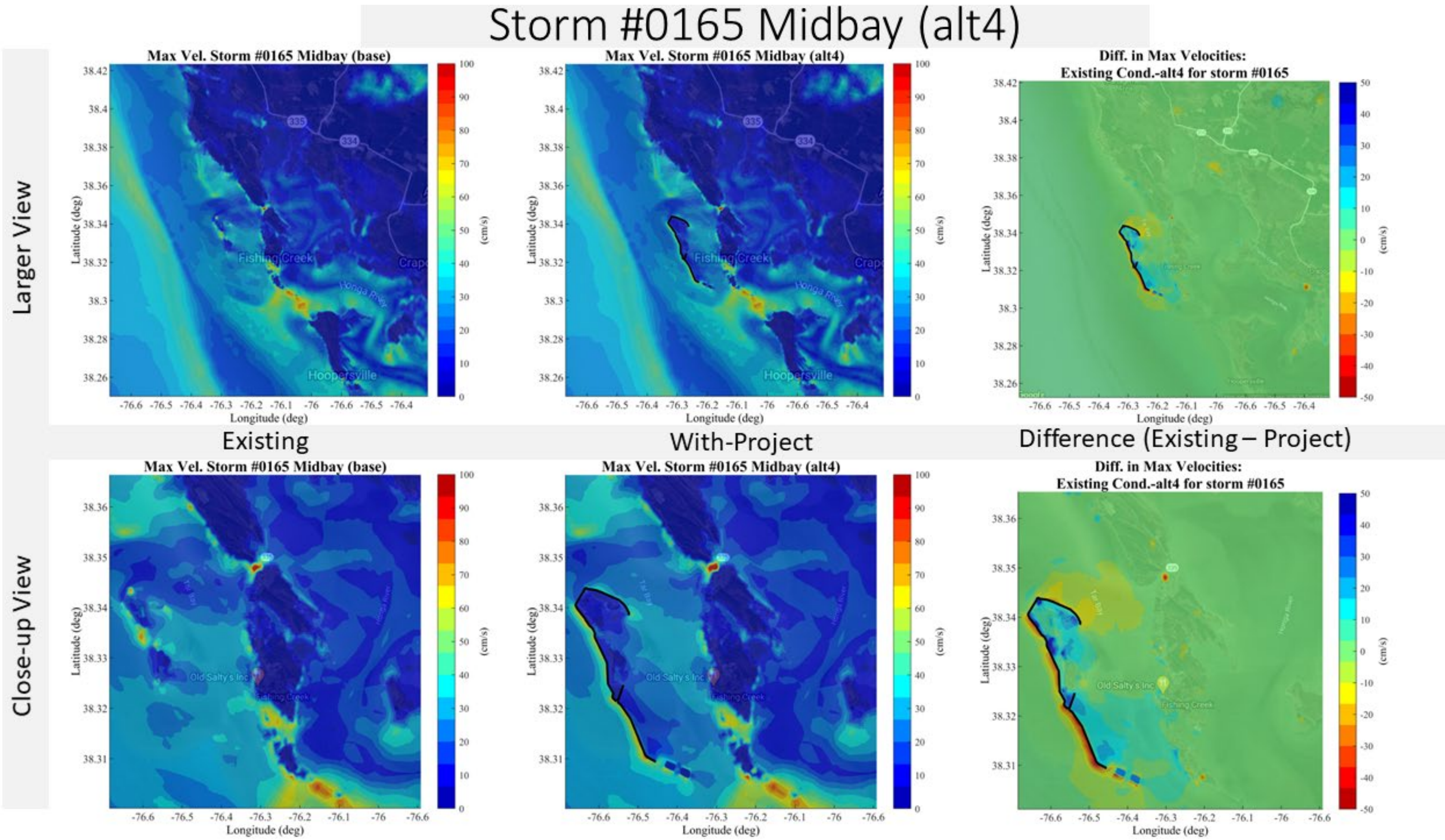

Storm #0132 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0132
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

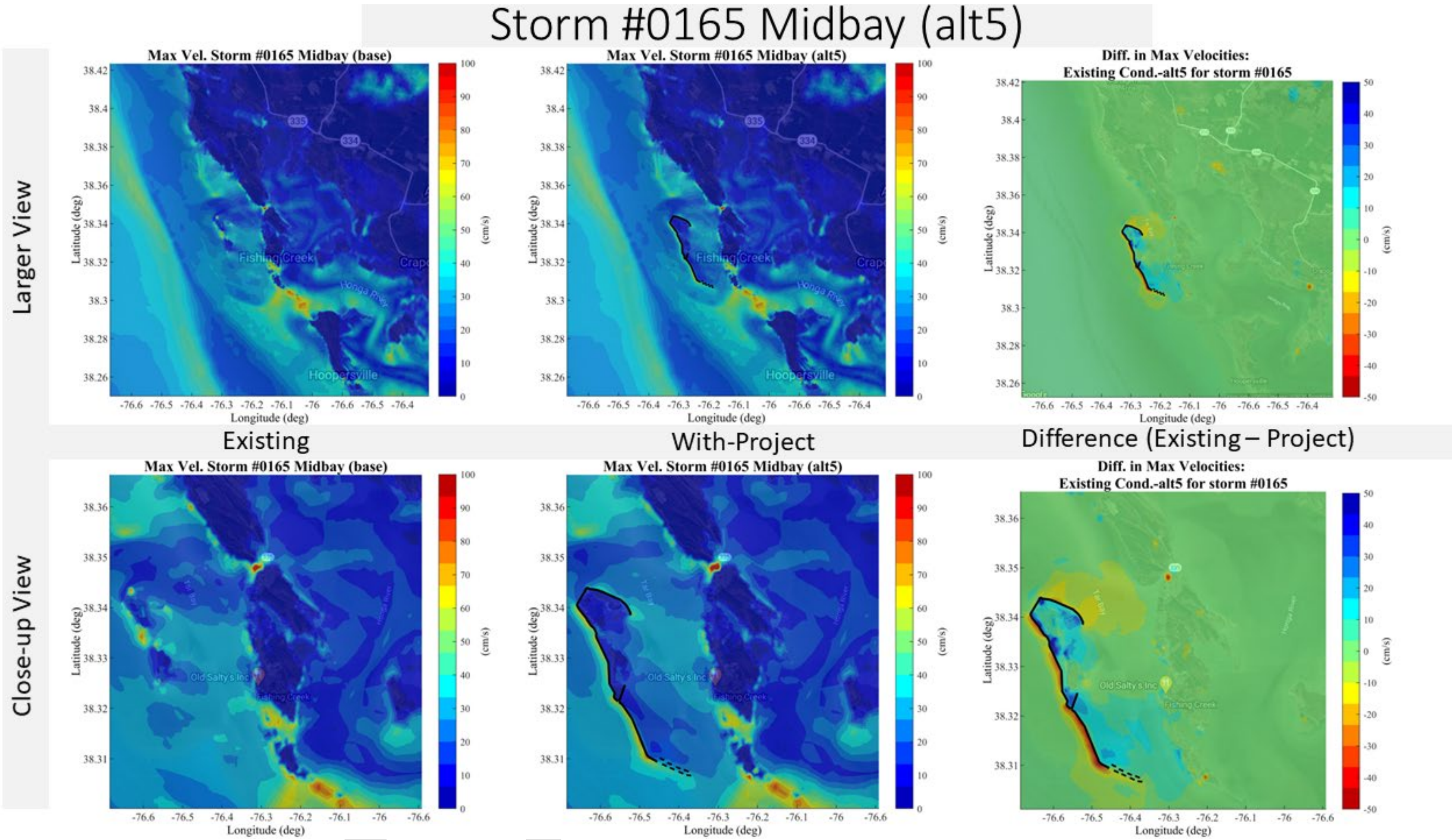

Storm #0132 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0132 Midbay (base)
Max Vel. Storm #0132 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0132
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

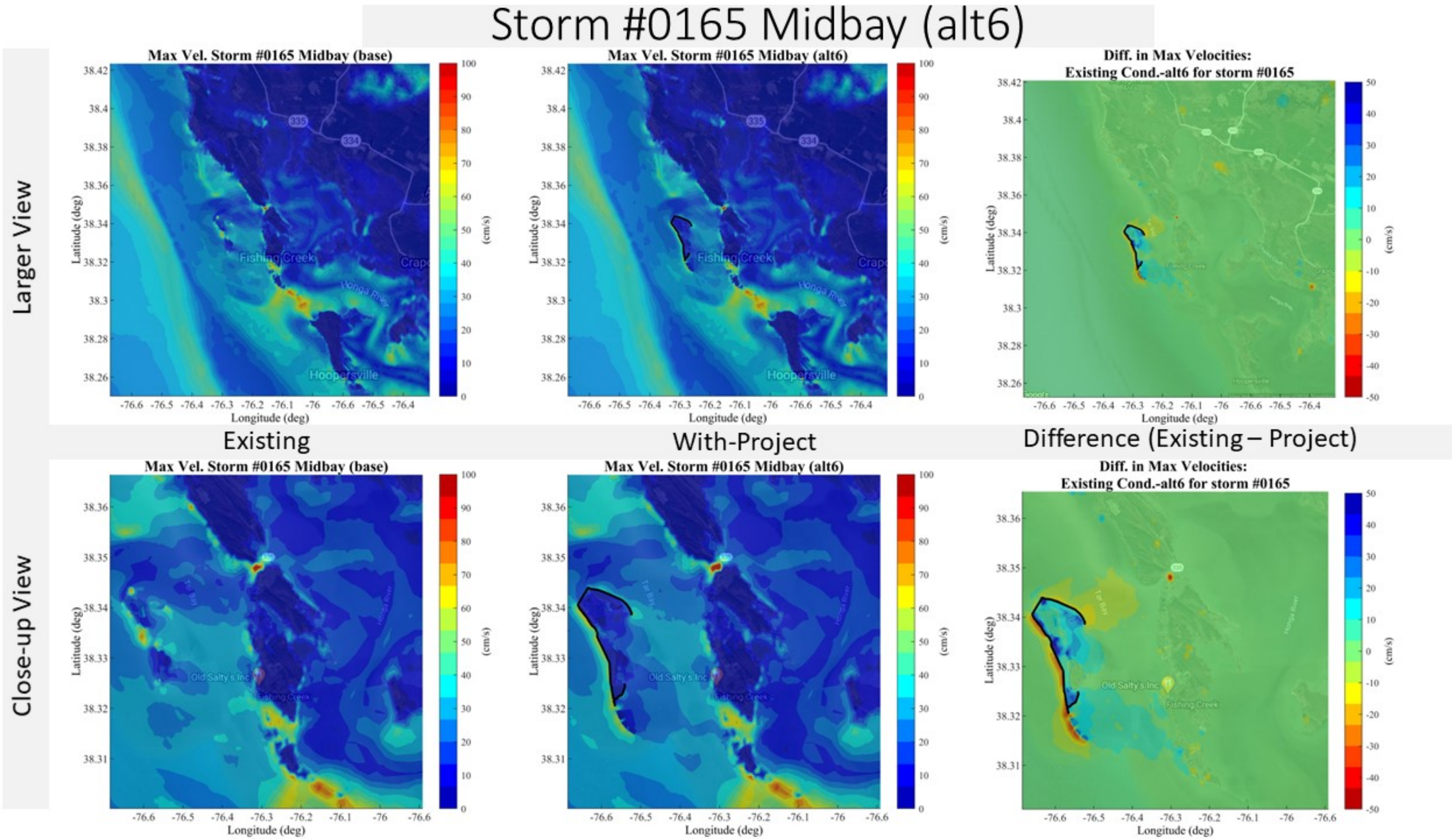

Storm #0165 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0165
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

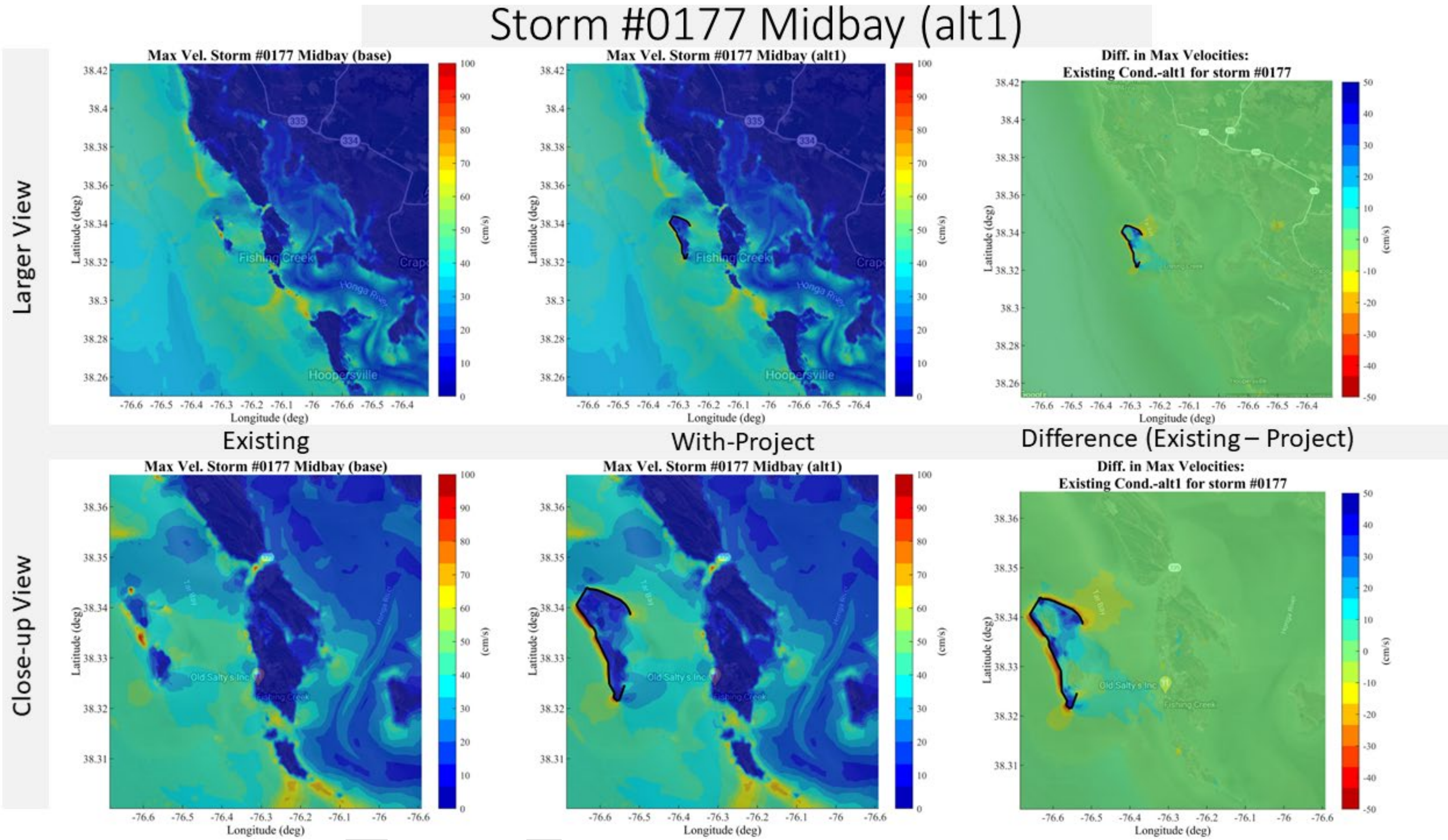

Storm #0165 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0165
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

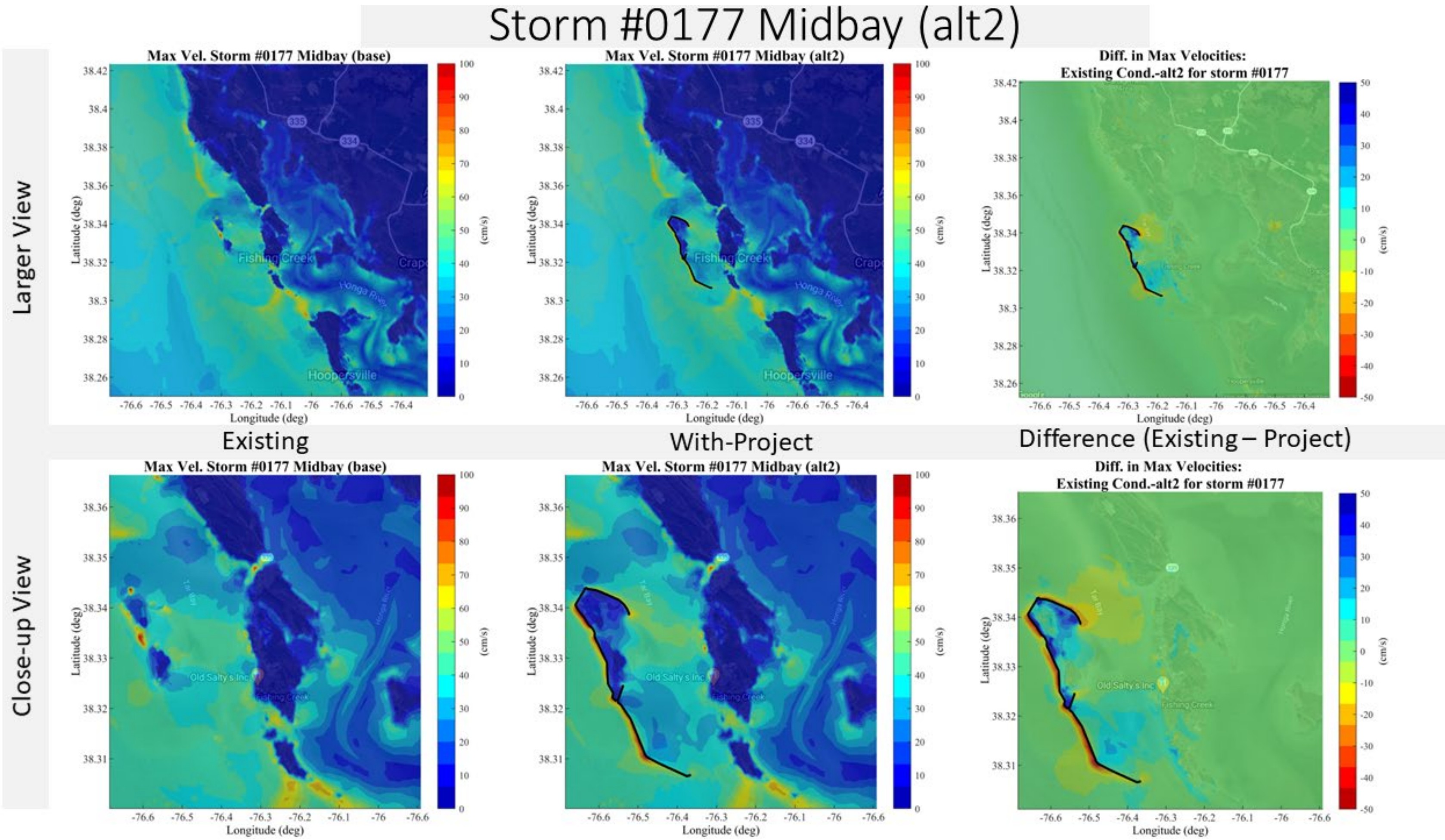

Storm #0165 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0165
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

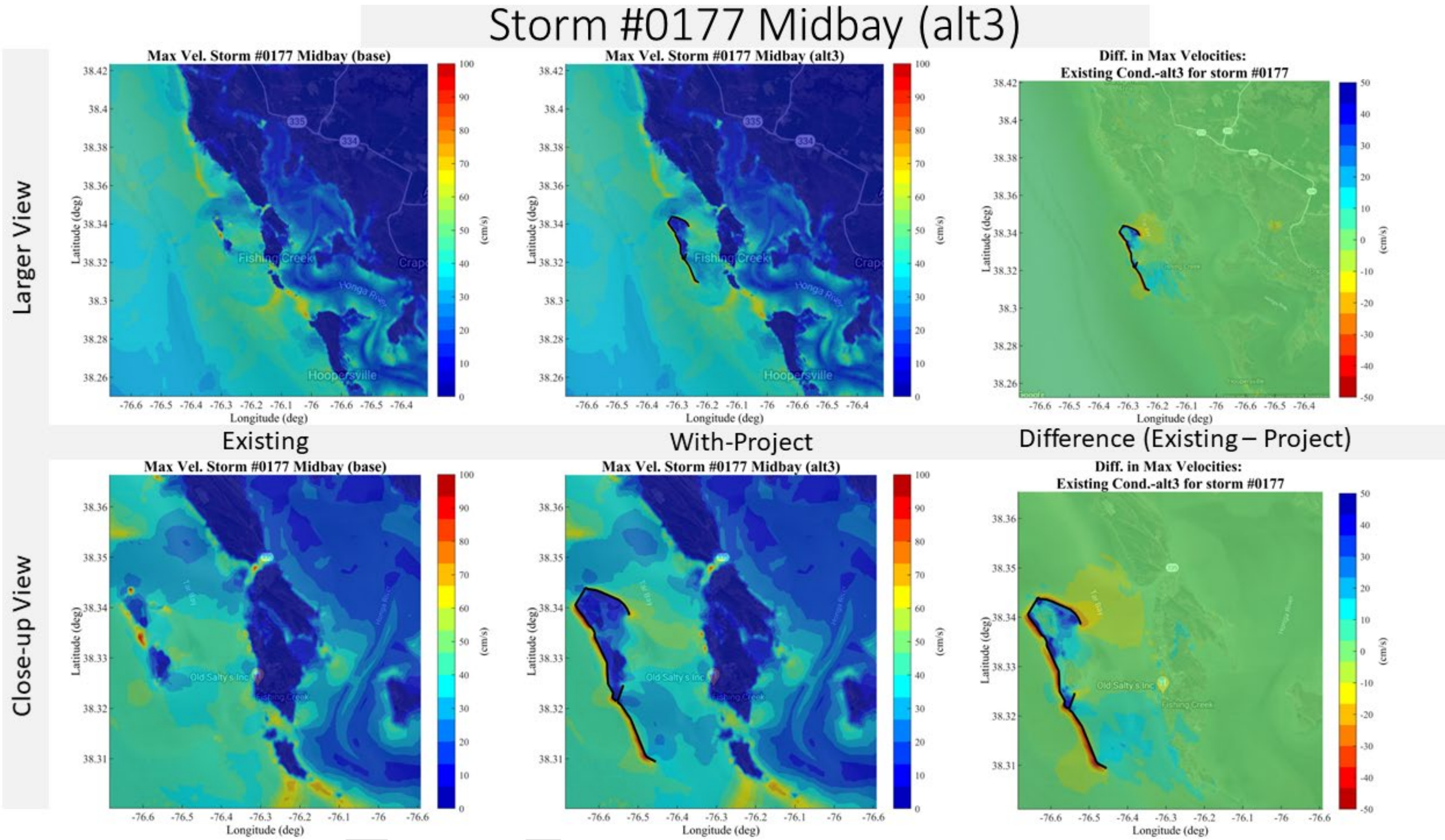

Storm #0165 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0165
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

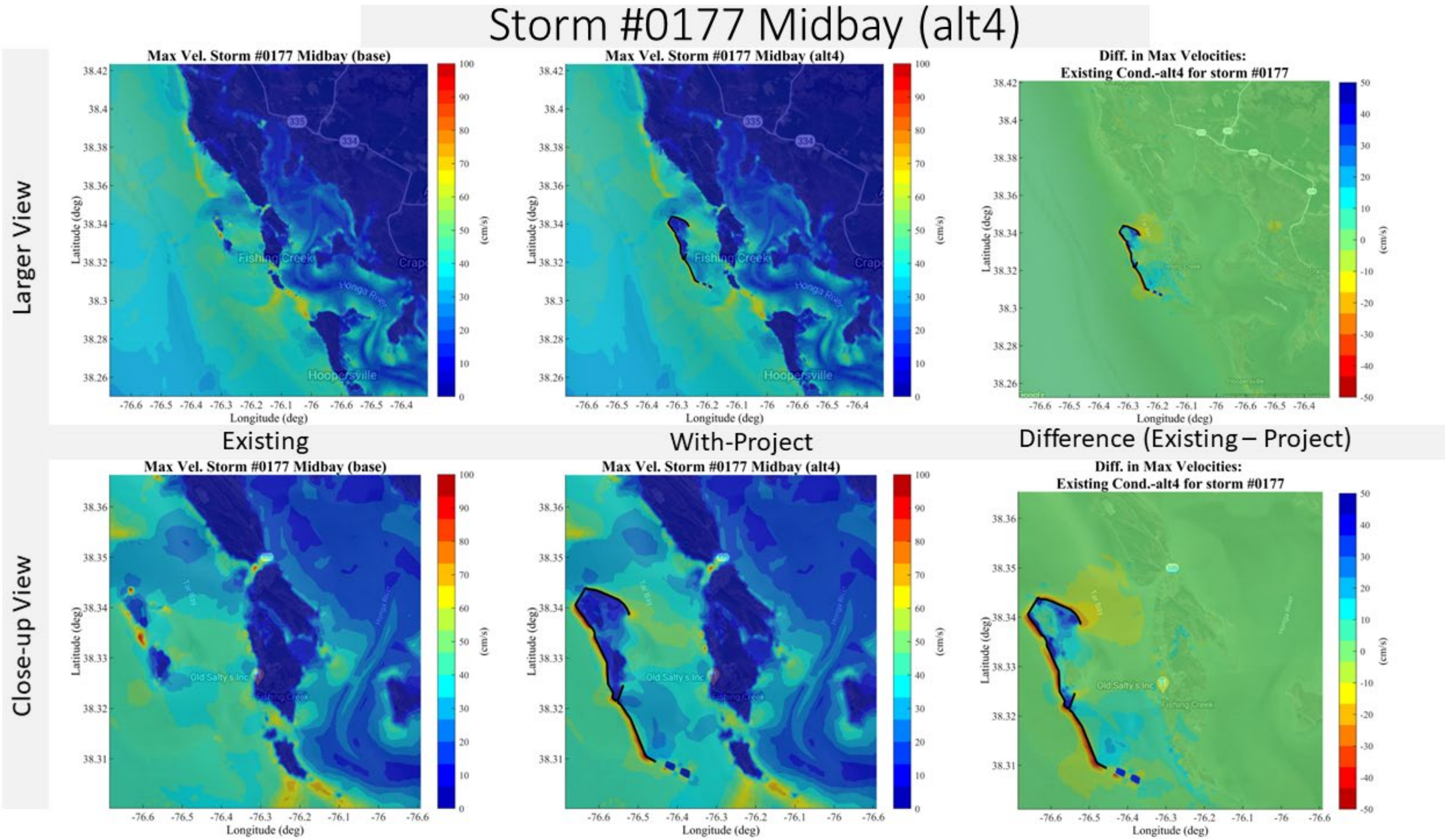

Storm #0165 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0165
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

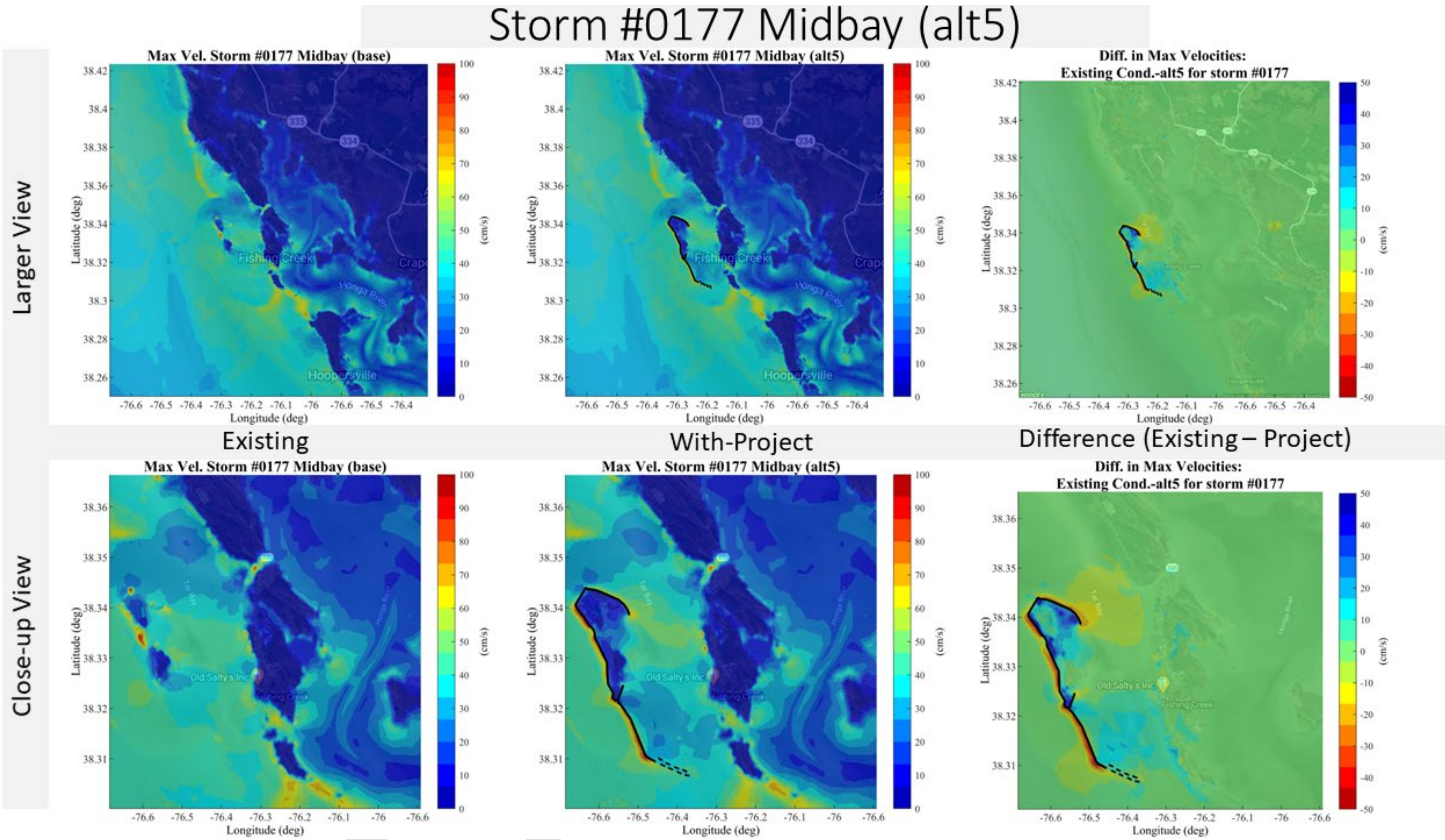

Storm #0165 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0165 Midbay (base)
Max Vel. Storm #0165 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0165
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

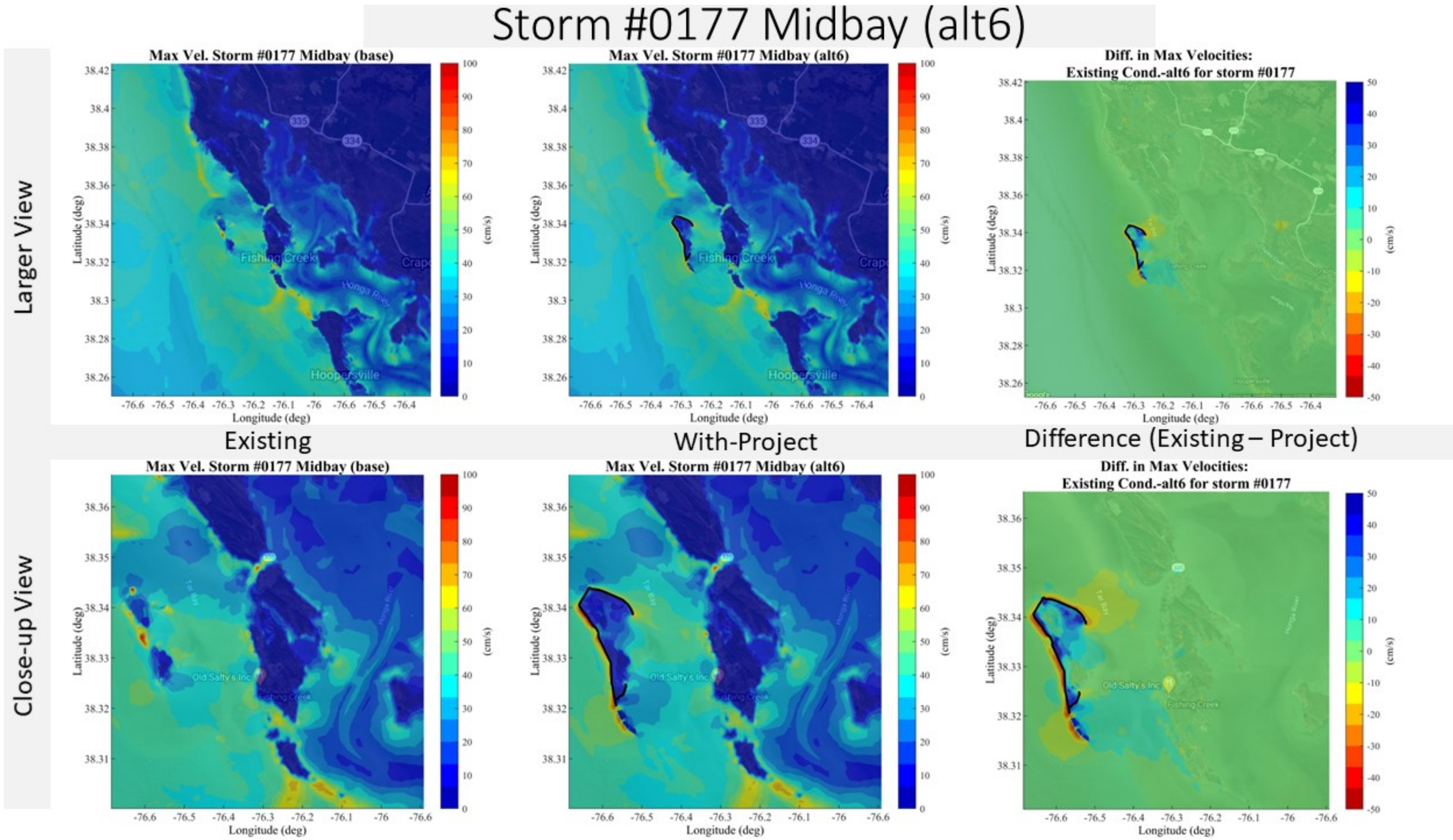

Storm #0177 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt1)
Diff. in Max Velocities: Existing Cond.-alt1 for storm #0177
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

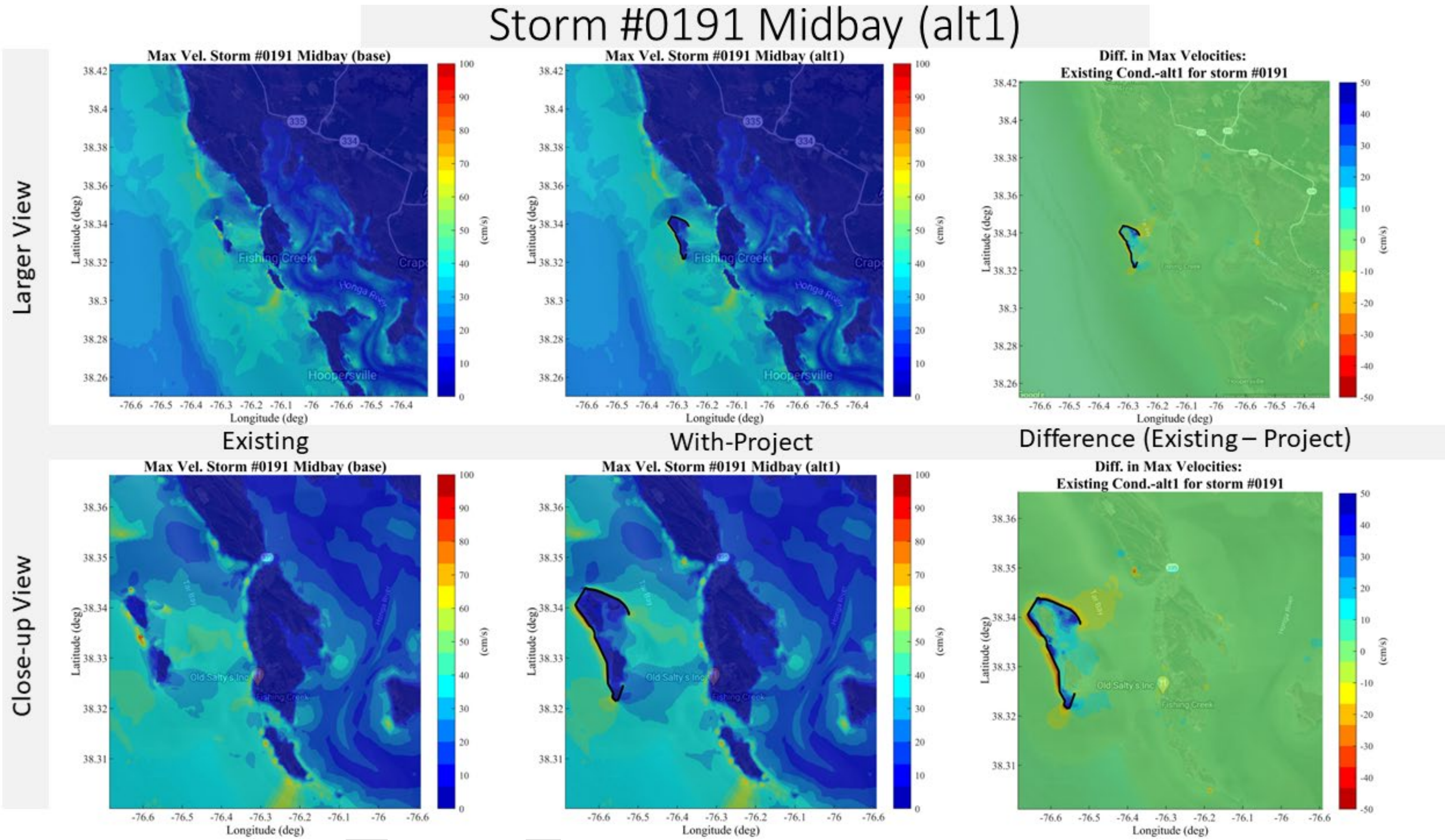

Storm #0177 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0177
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

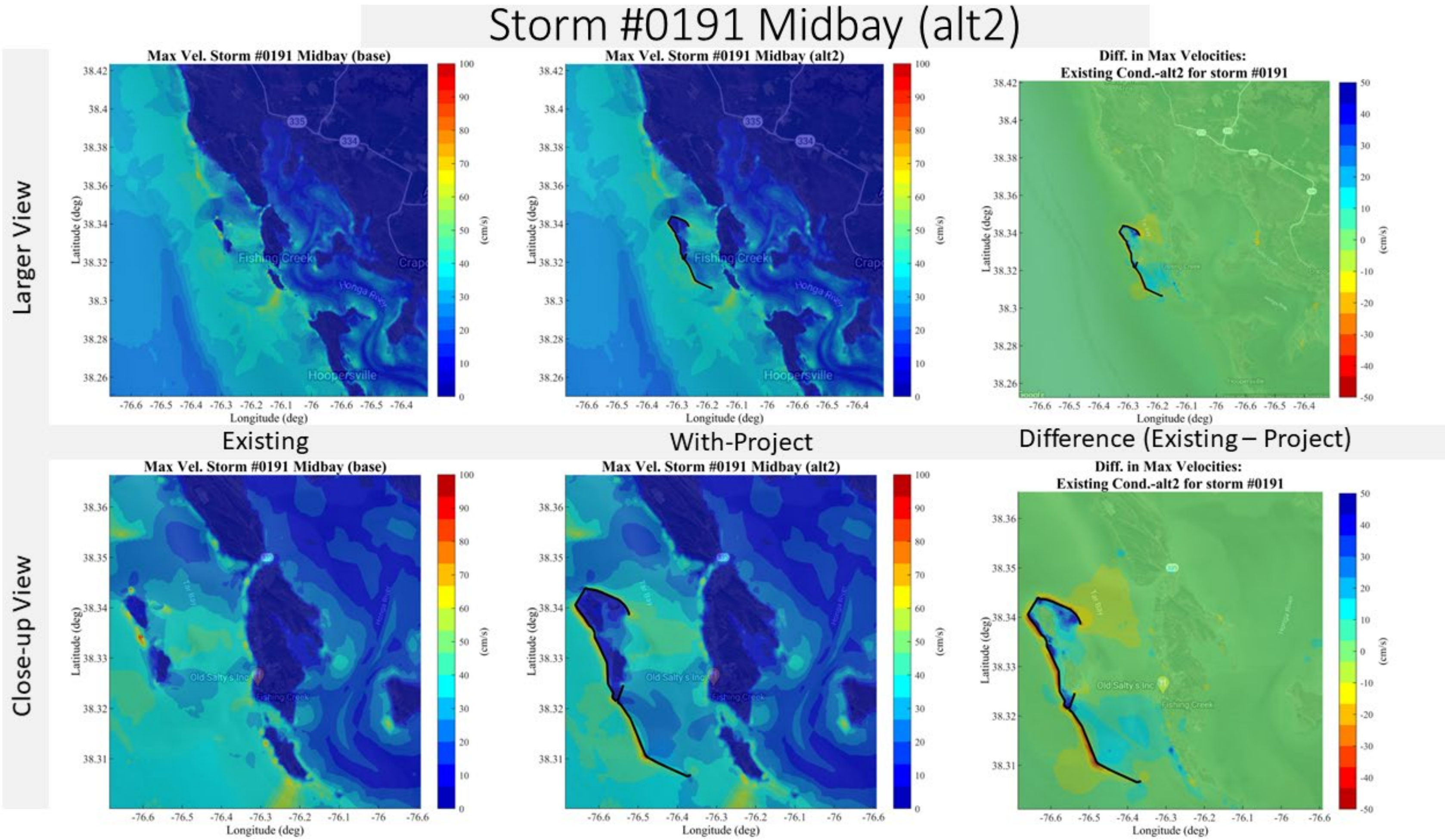

Storm #0177 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

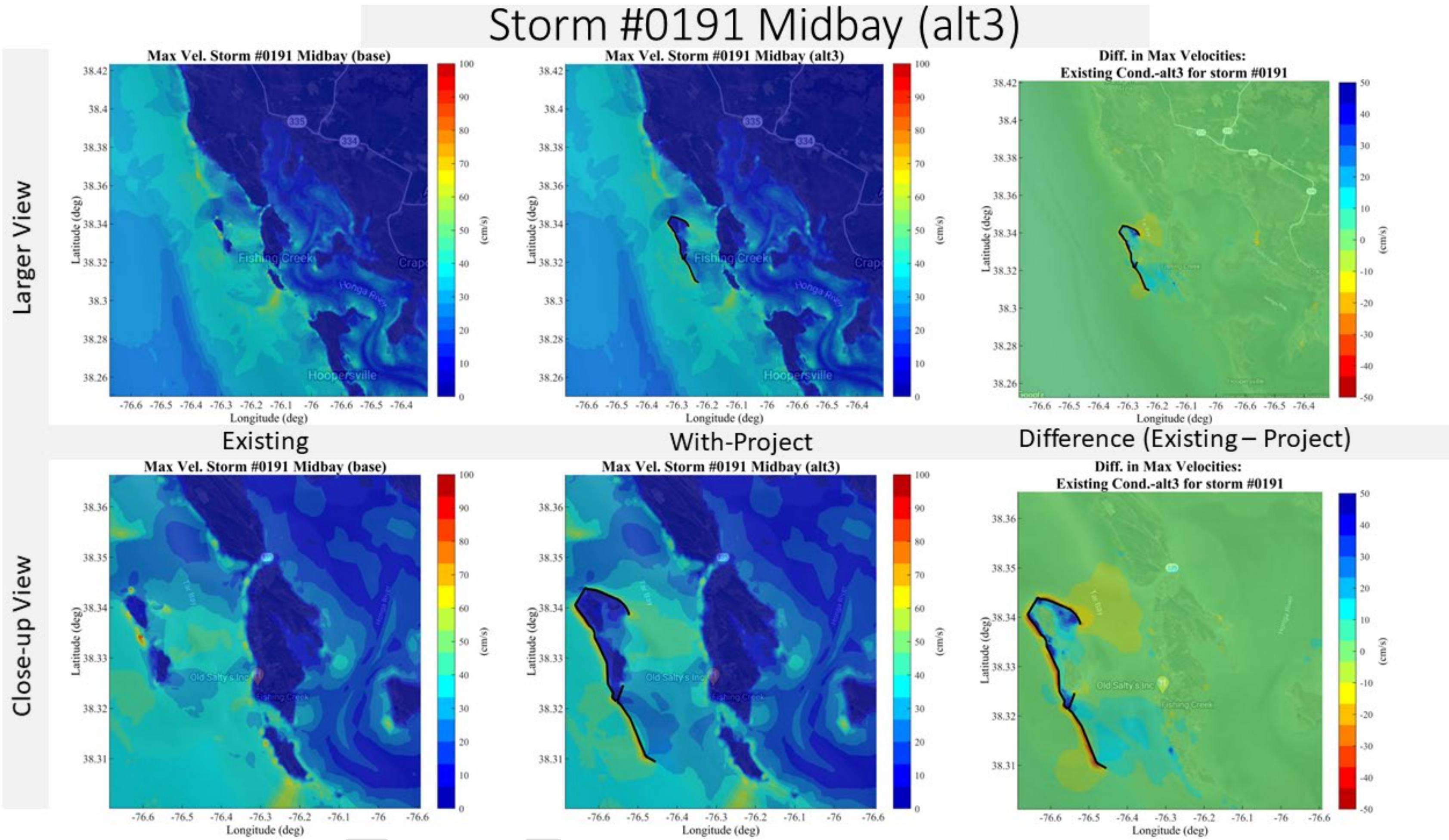

Storm #0177 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0177
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

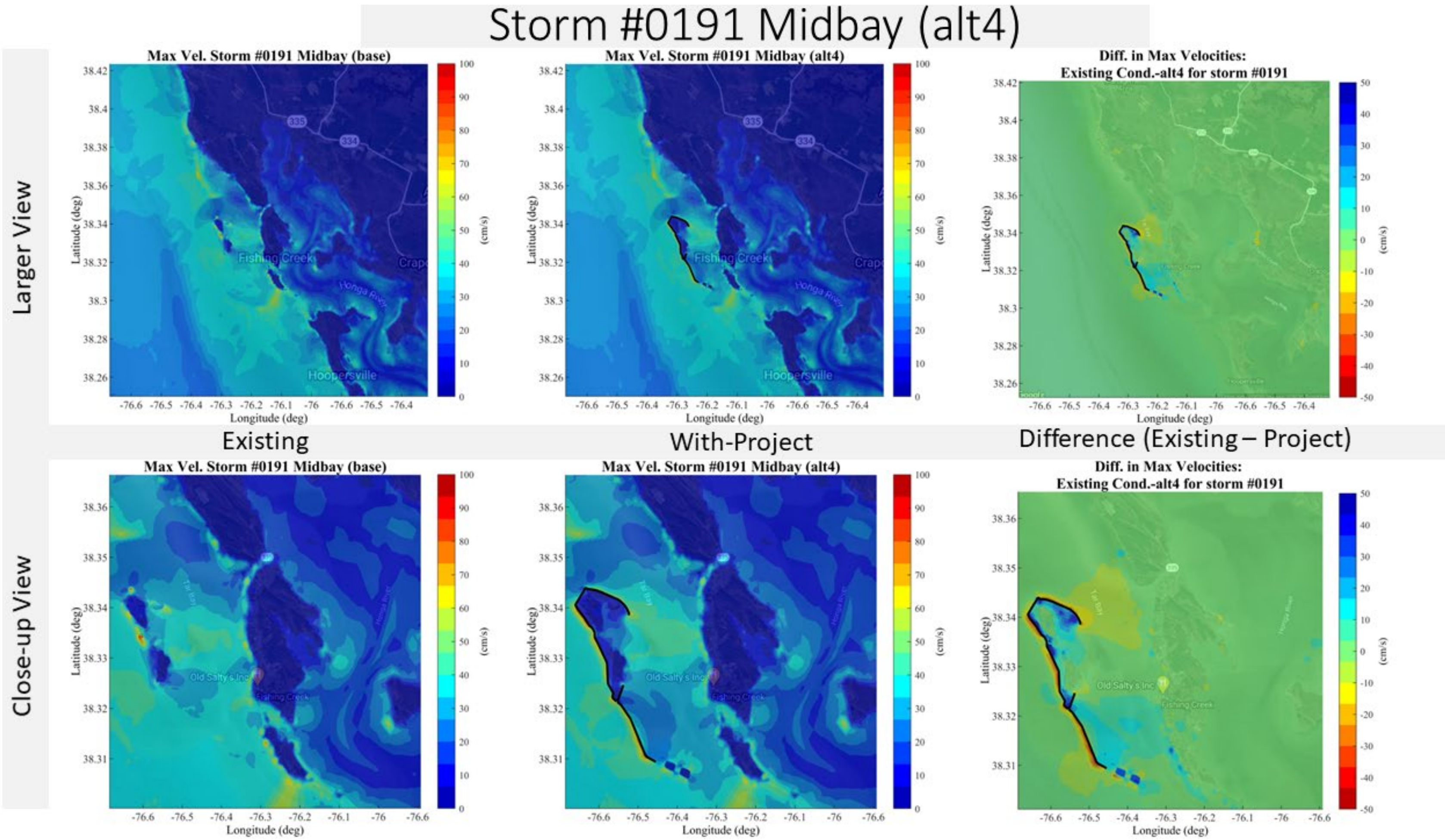

Storm #0177 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0177
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

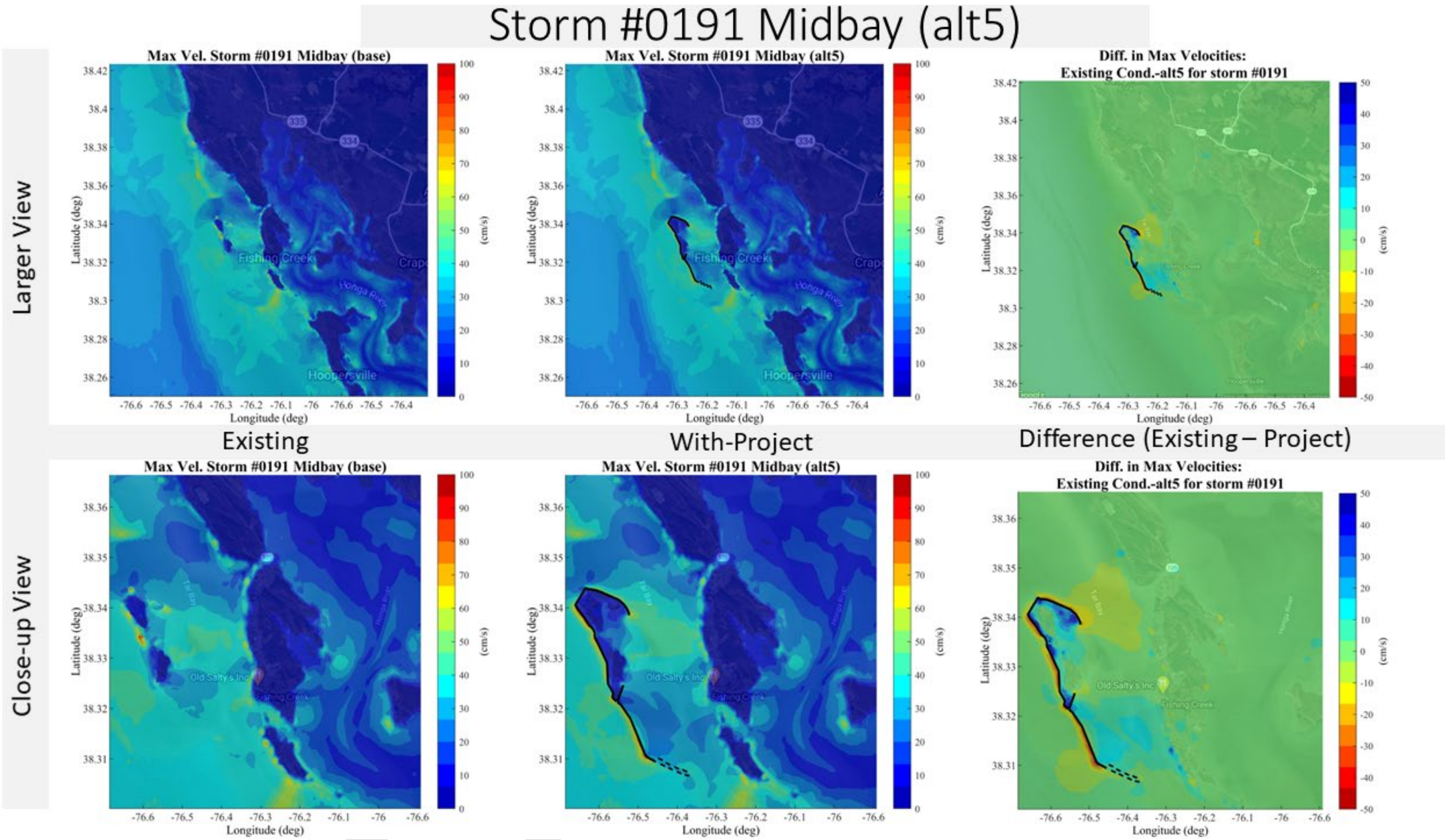

Storm #0177 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0177 Midbay (base)
Max Vel. Storm #0177 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0177
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

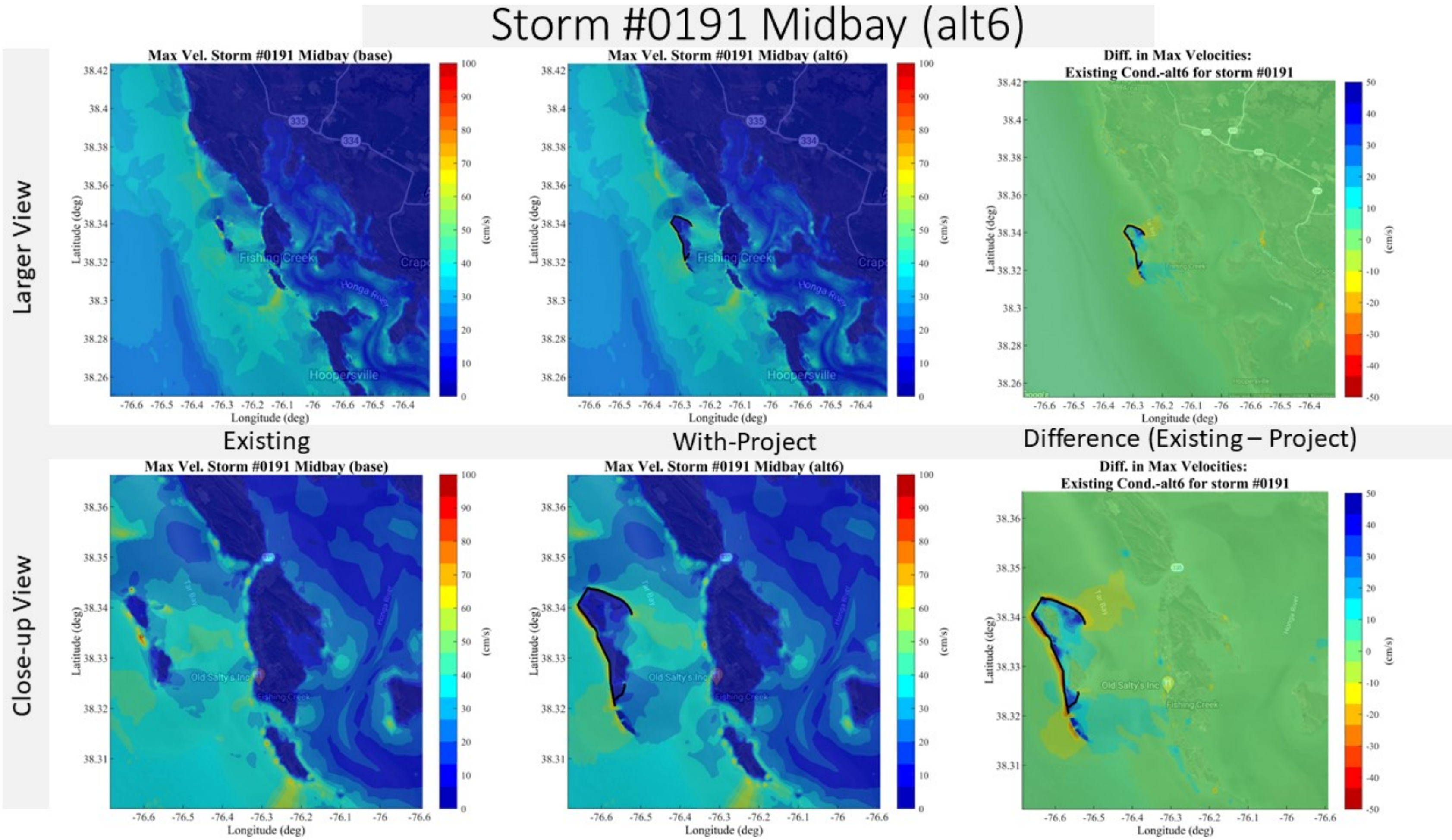

Storm #0191 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0191
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

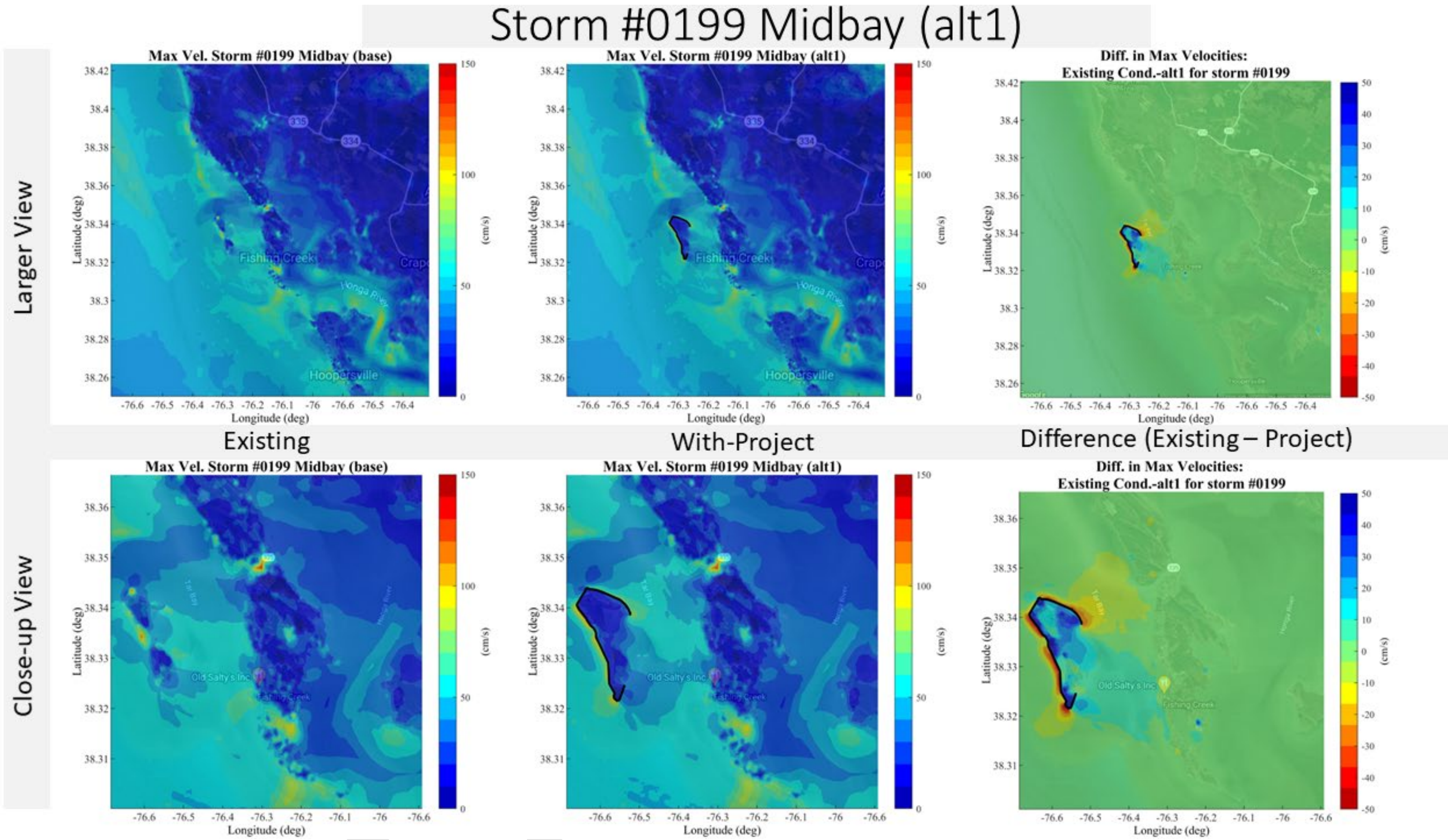

Storm #0191 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

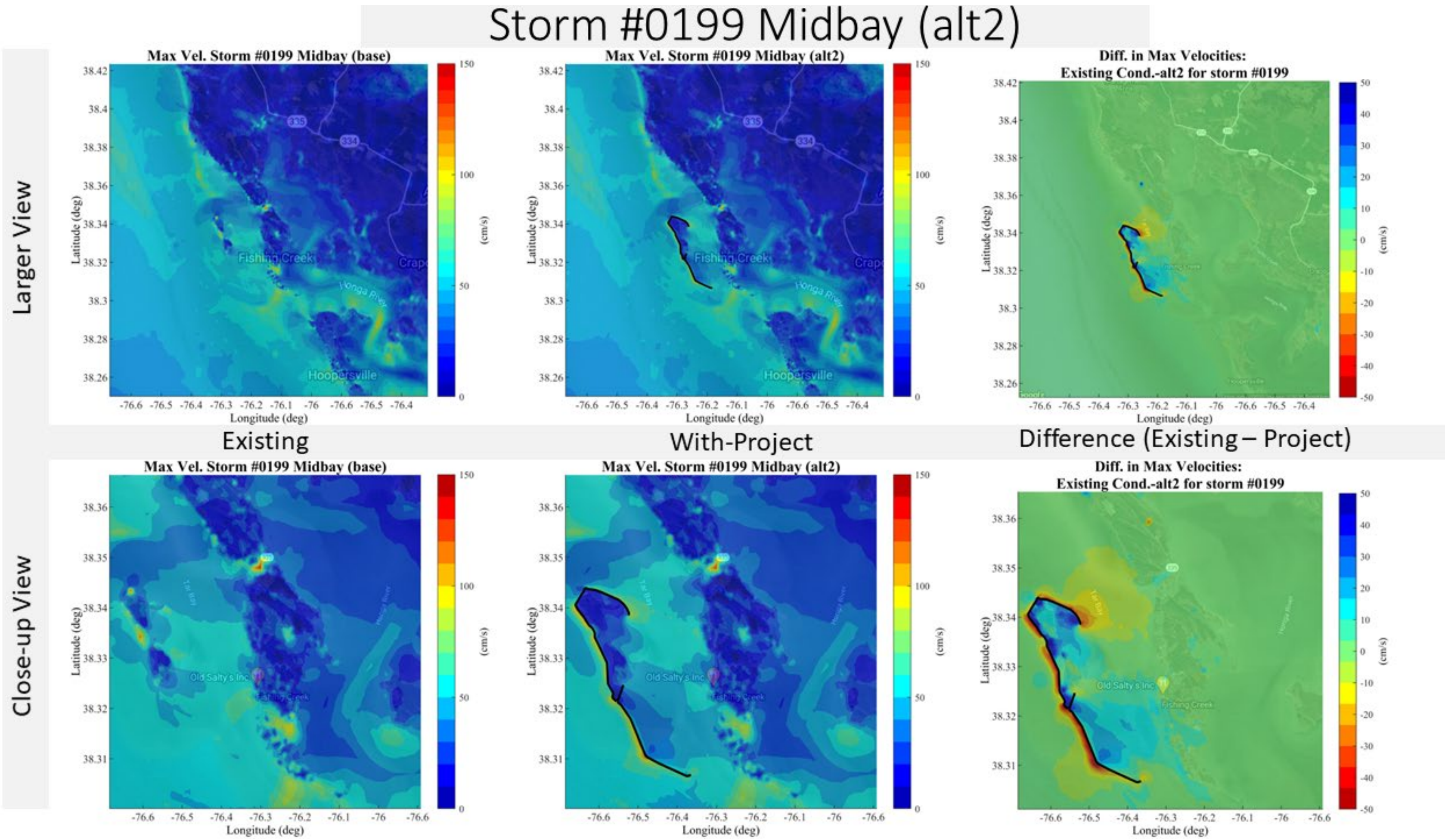

Storm #0191 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

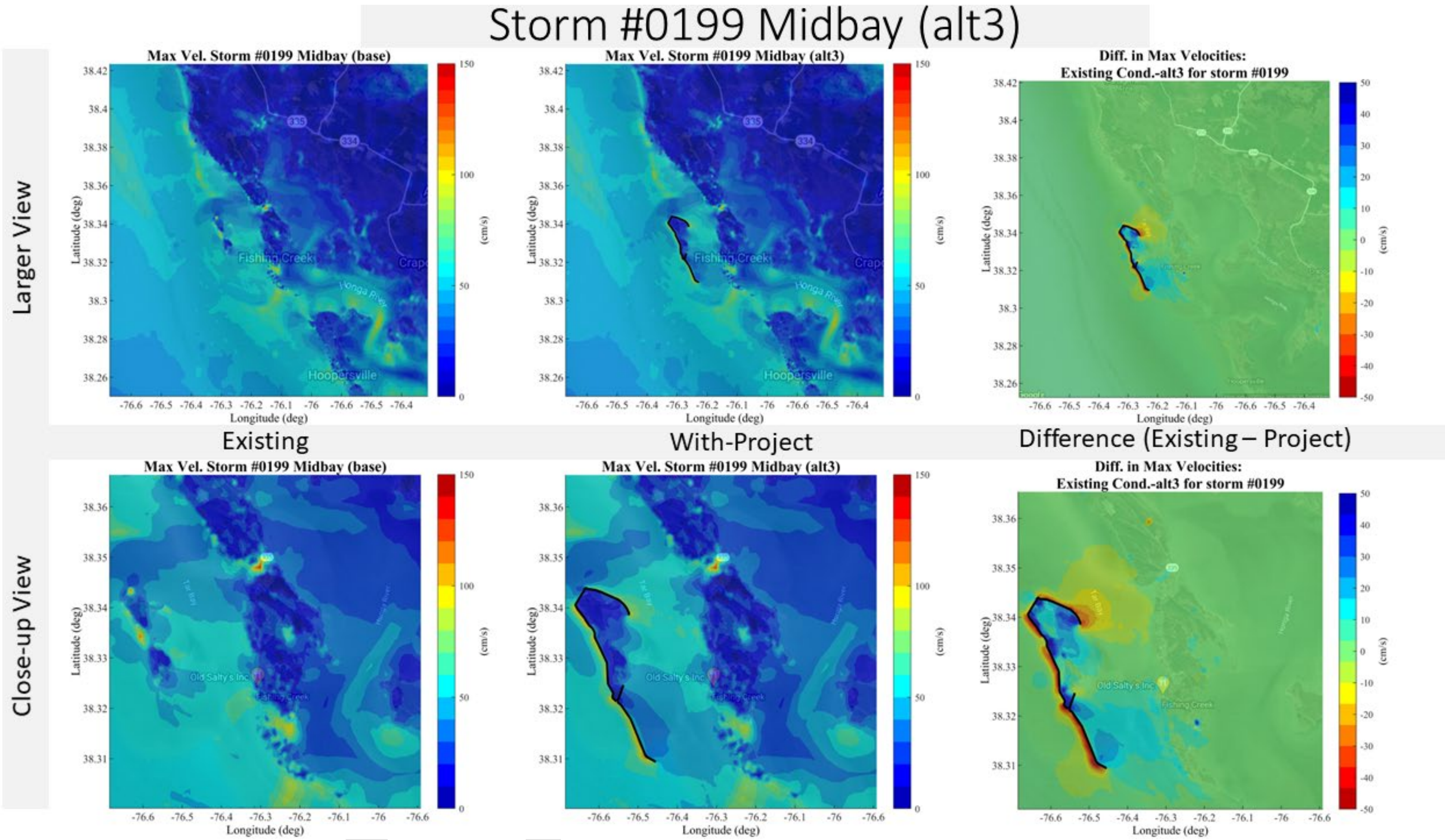

Storm #0191 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0191
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

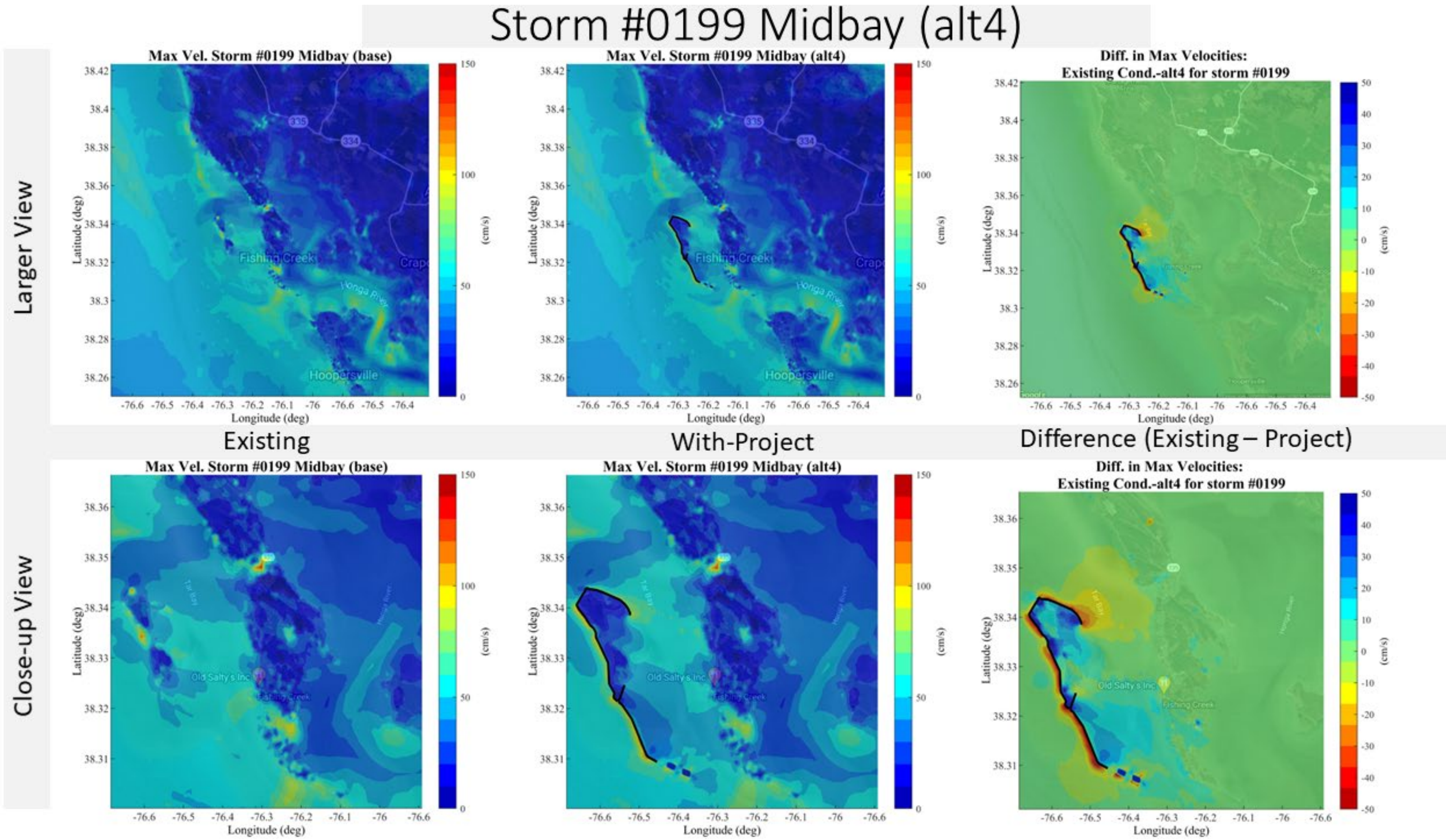

Storm #0191 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0191
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

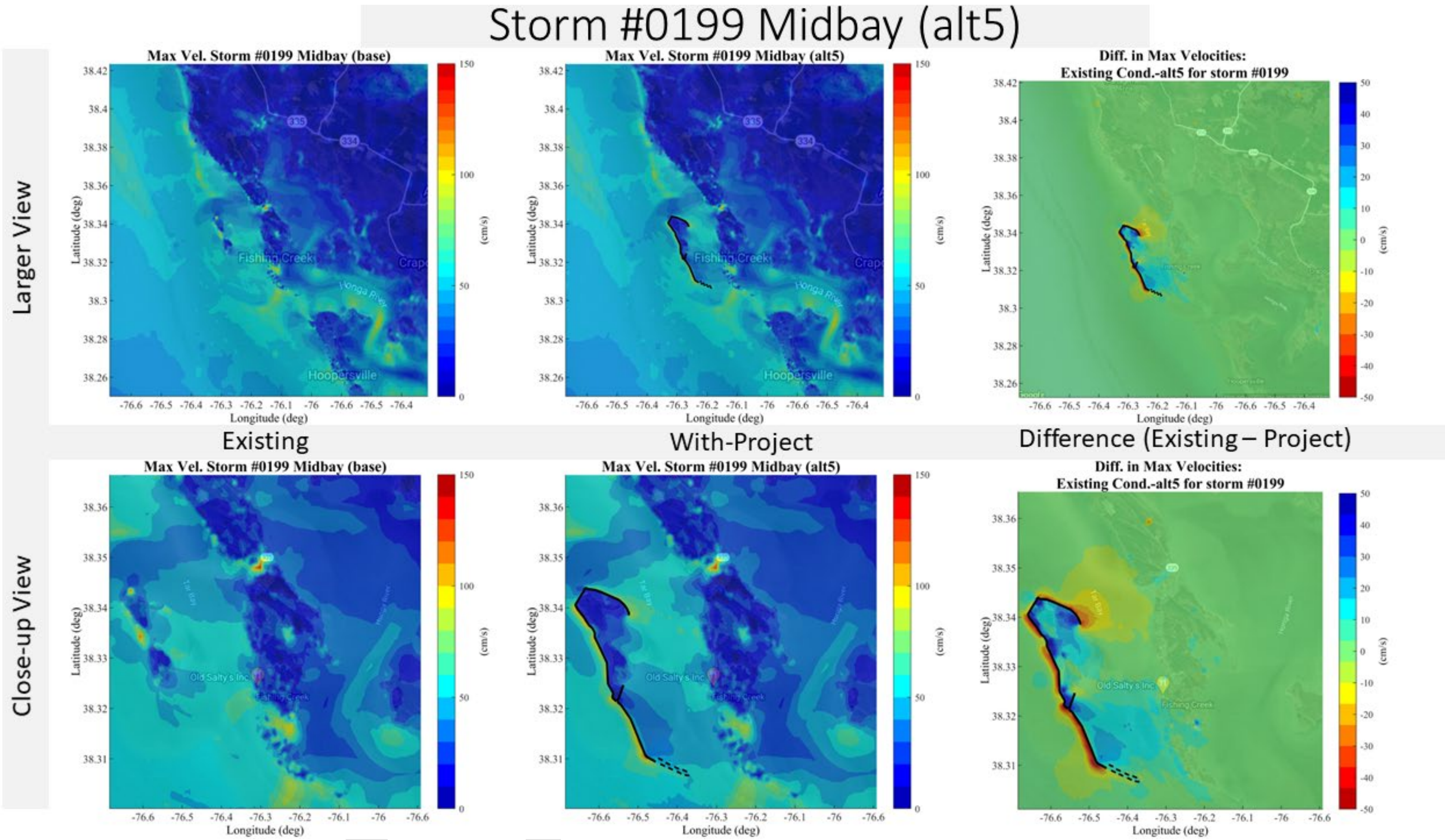

Storm #0191 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0191 Midbay (base)
Max Vel. Storm #0191 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0191
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

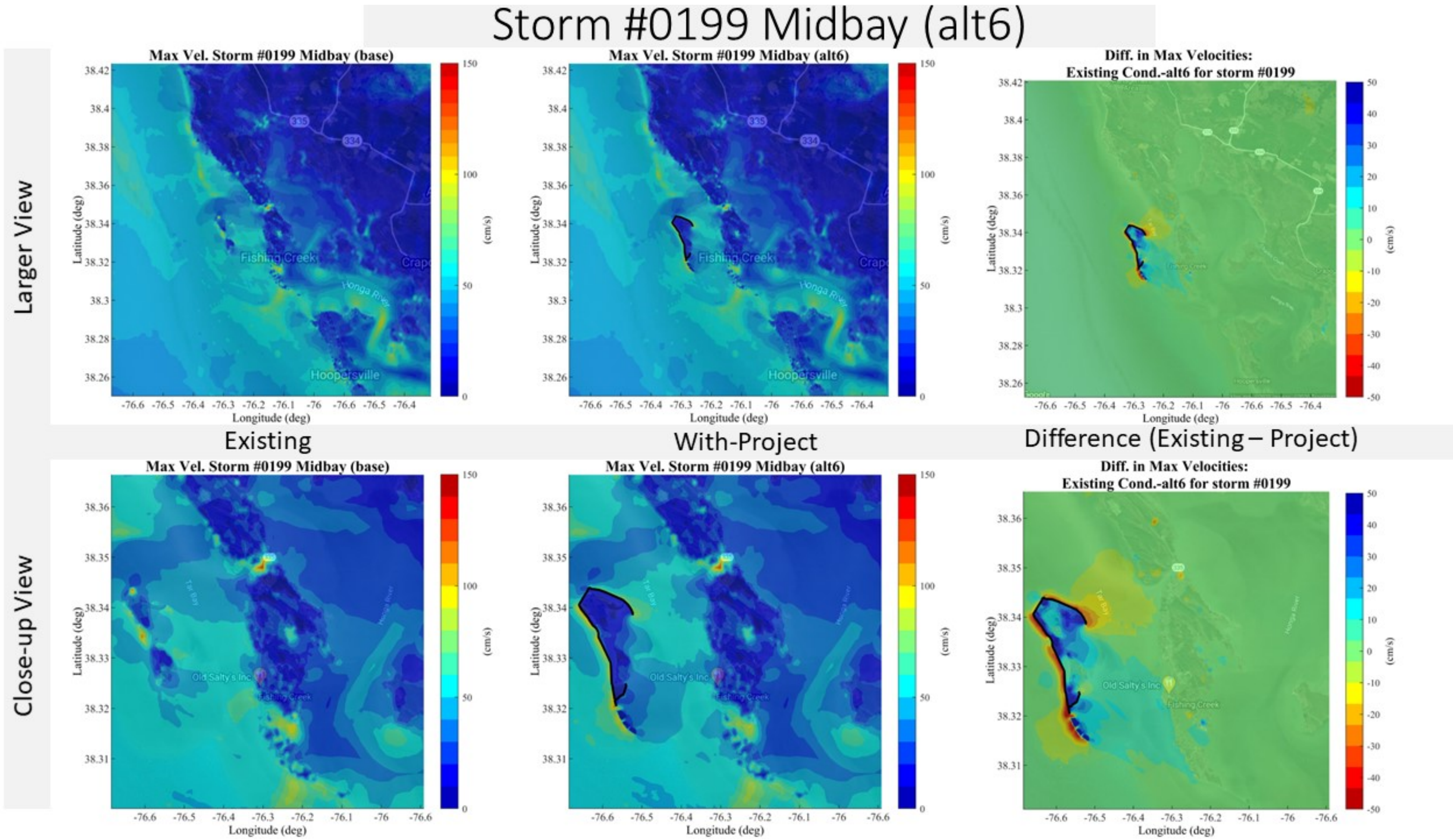

Storm #0199 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0199
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville

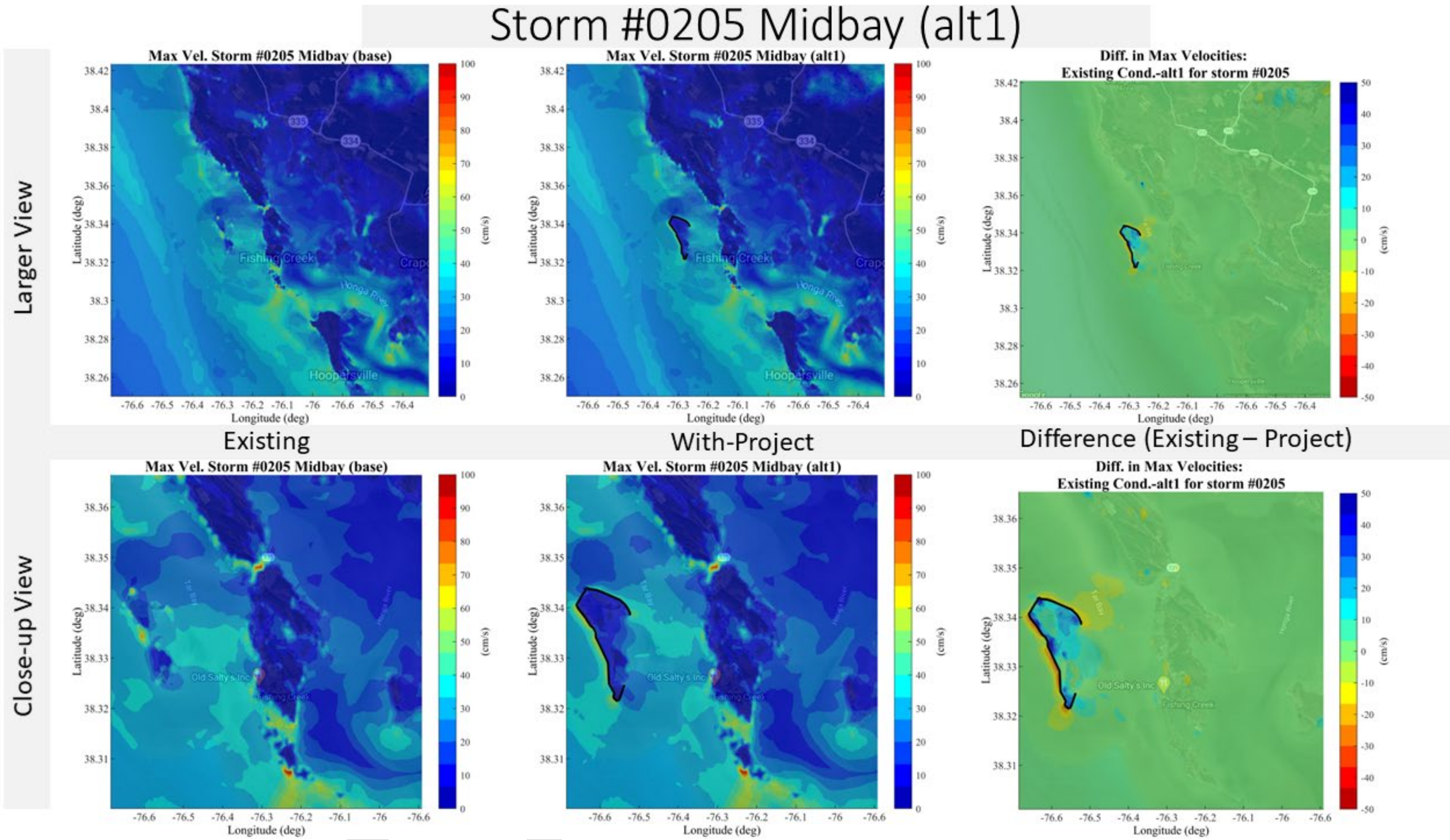

Storm #0199 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville

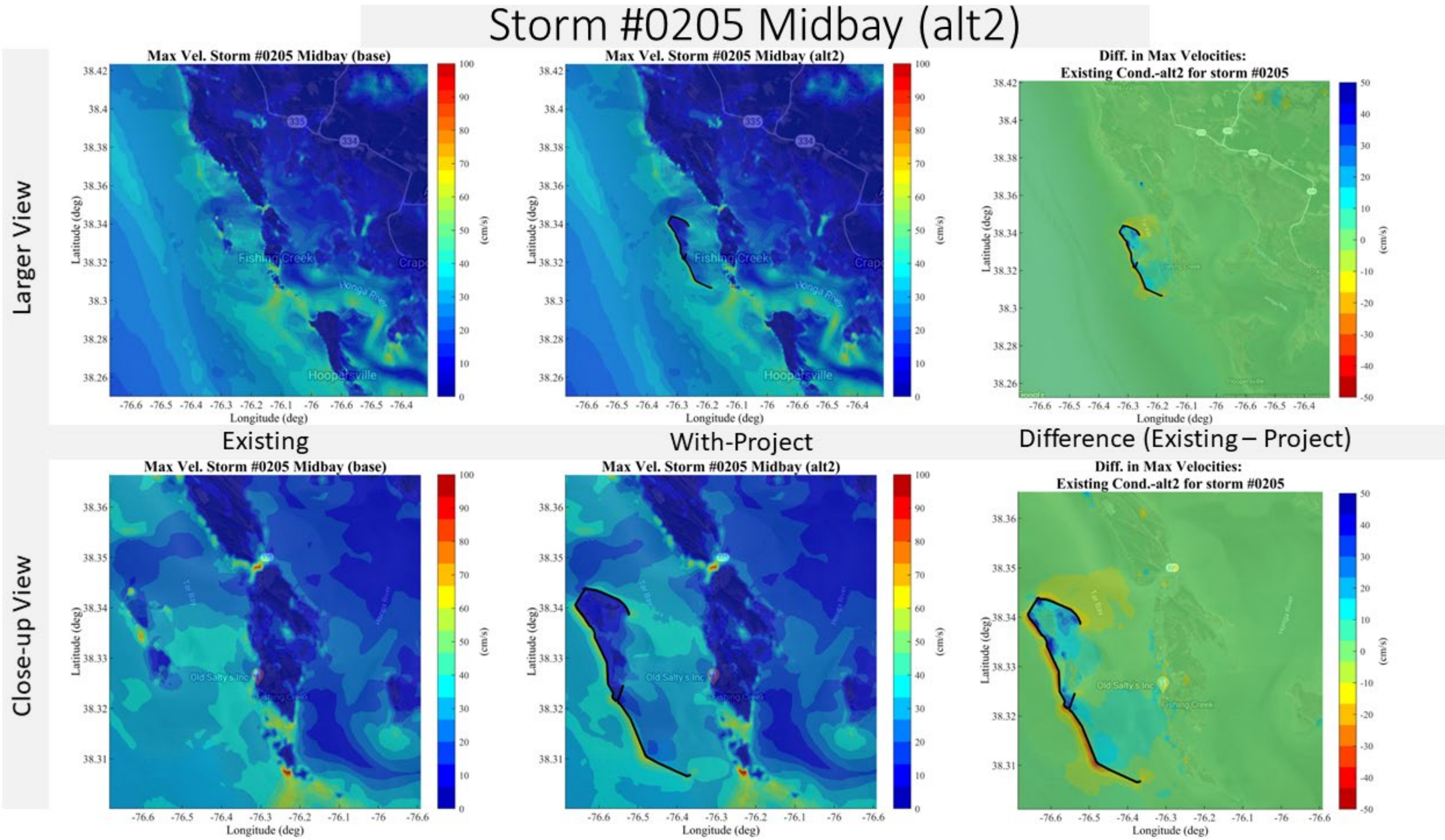

Storm #0199 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville

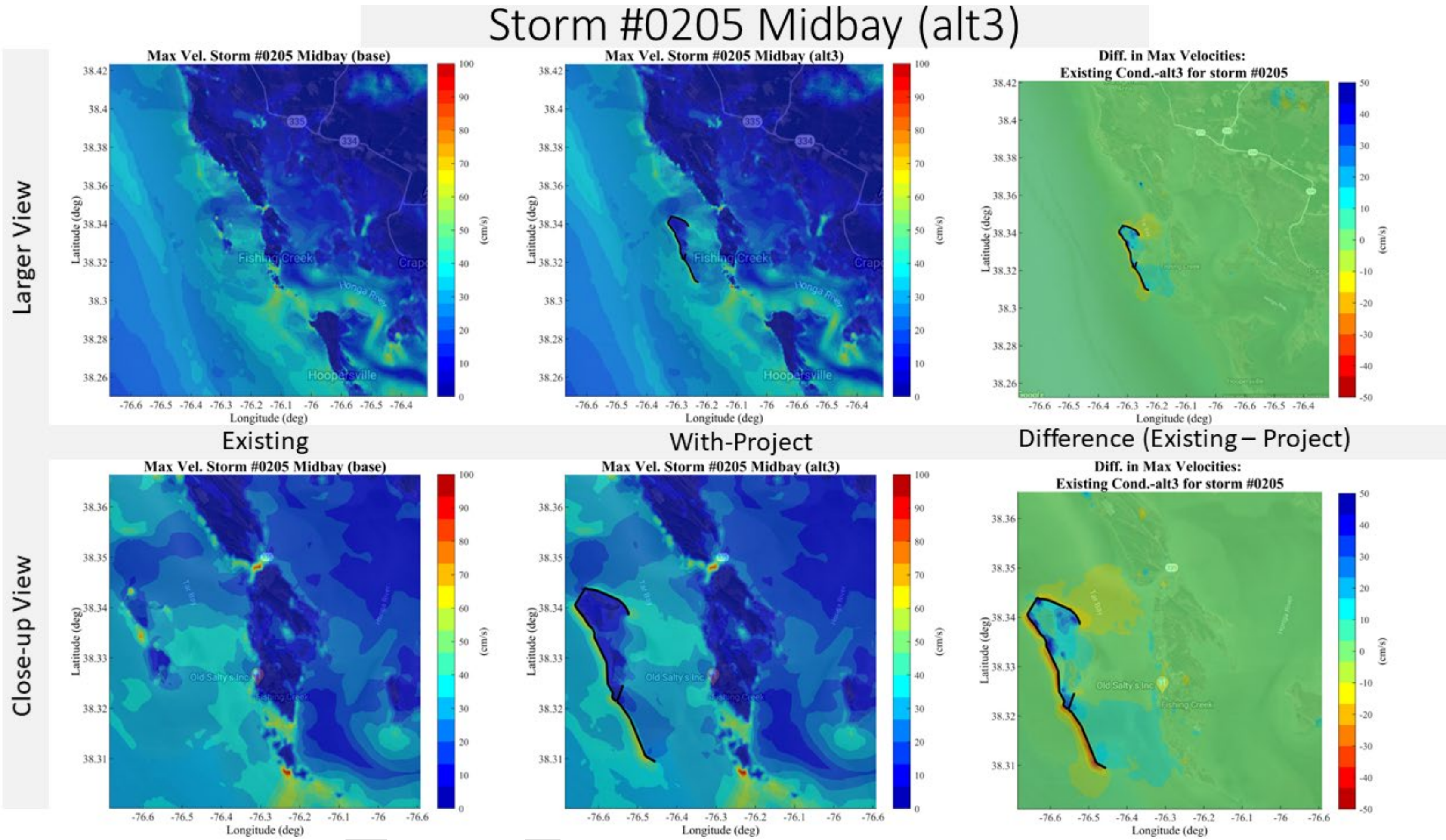

Storm #0199 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

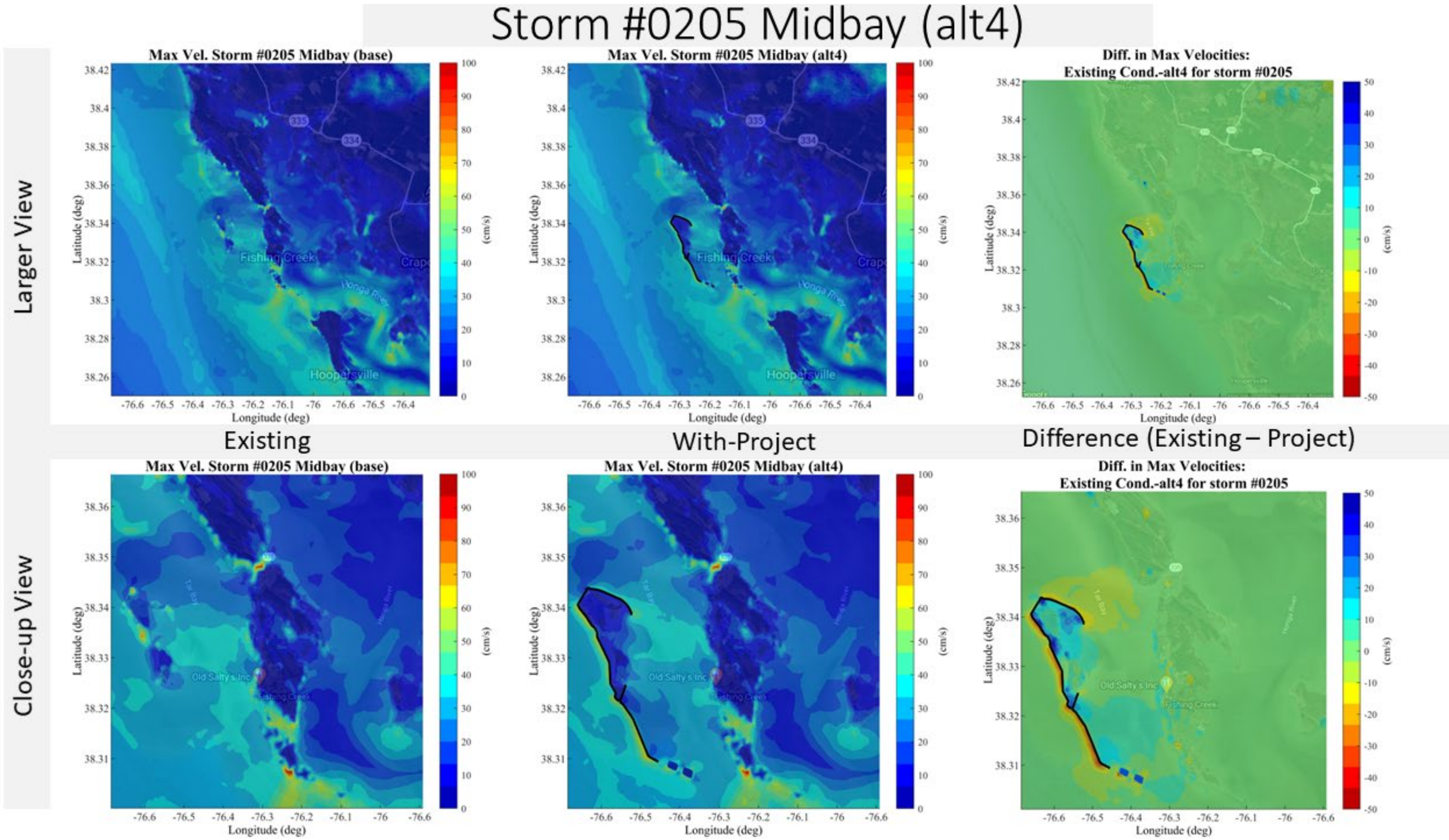

Storm #0199 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0199
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

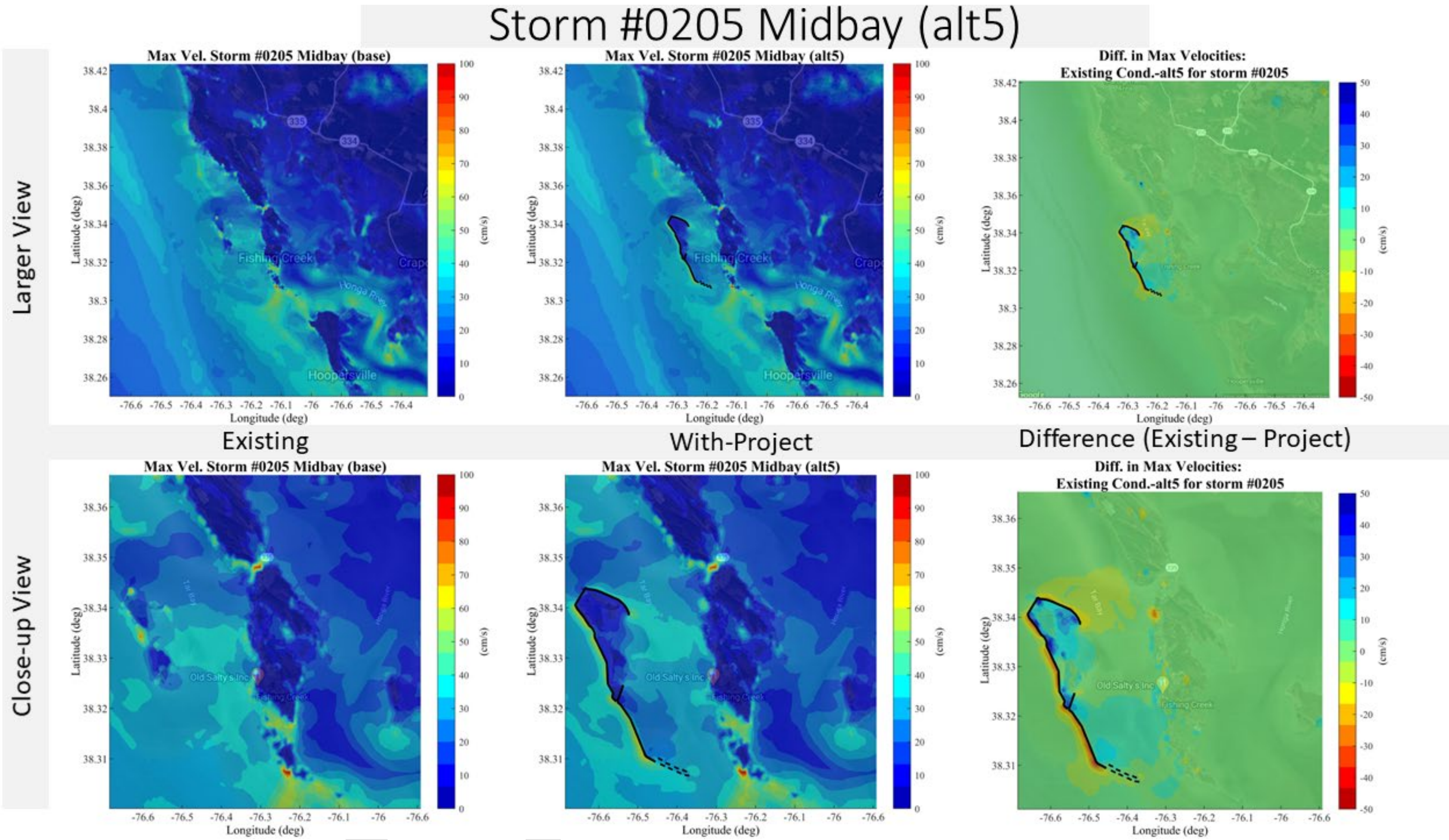

Storm #0199 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0199 Midbay (base)
Max Vel. Storm #0199 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0199
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

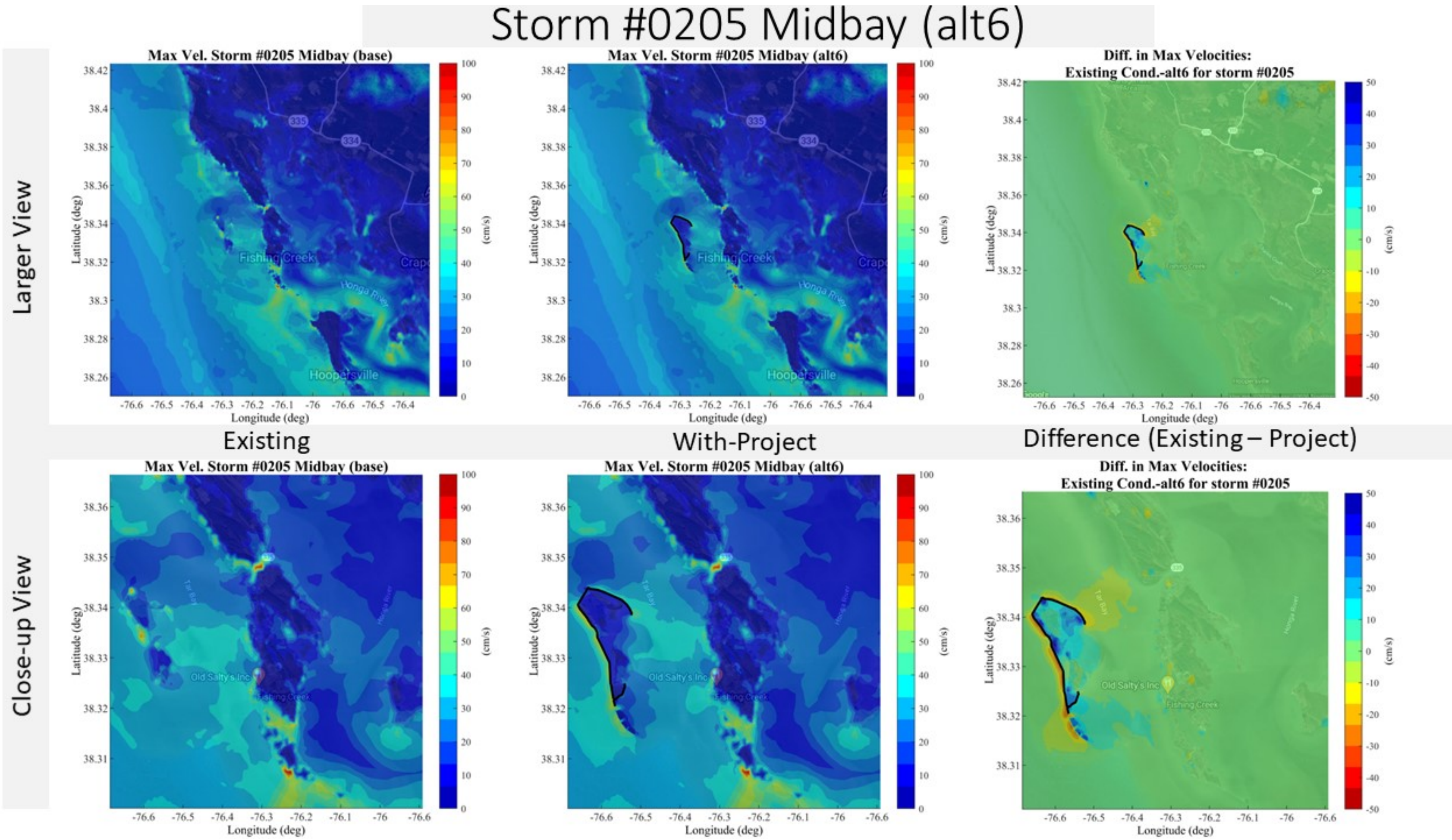

Storm #0205 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0205
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

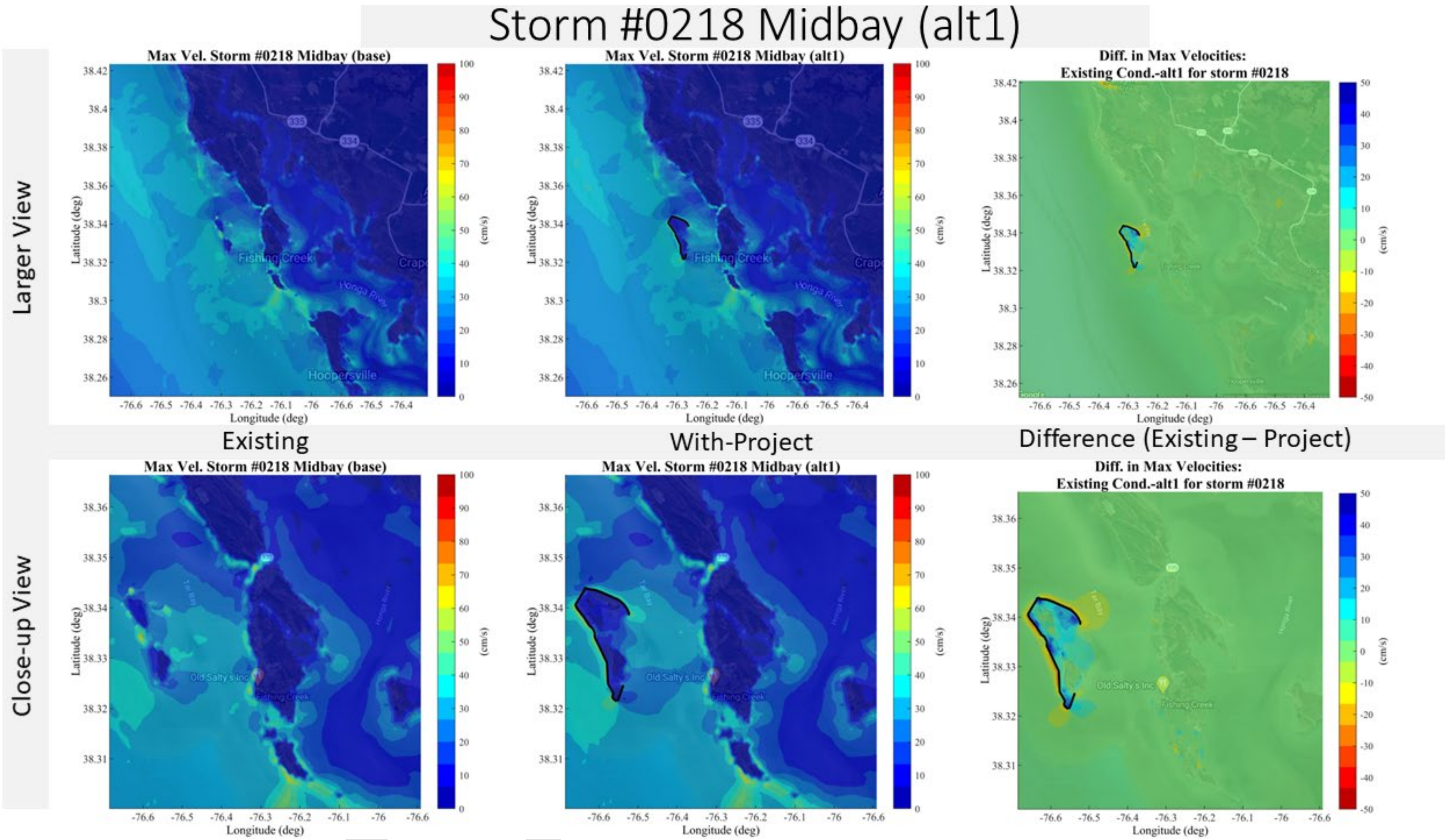

Storm #0205 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0205
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

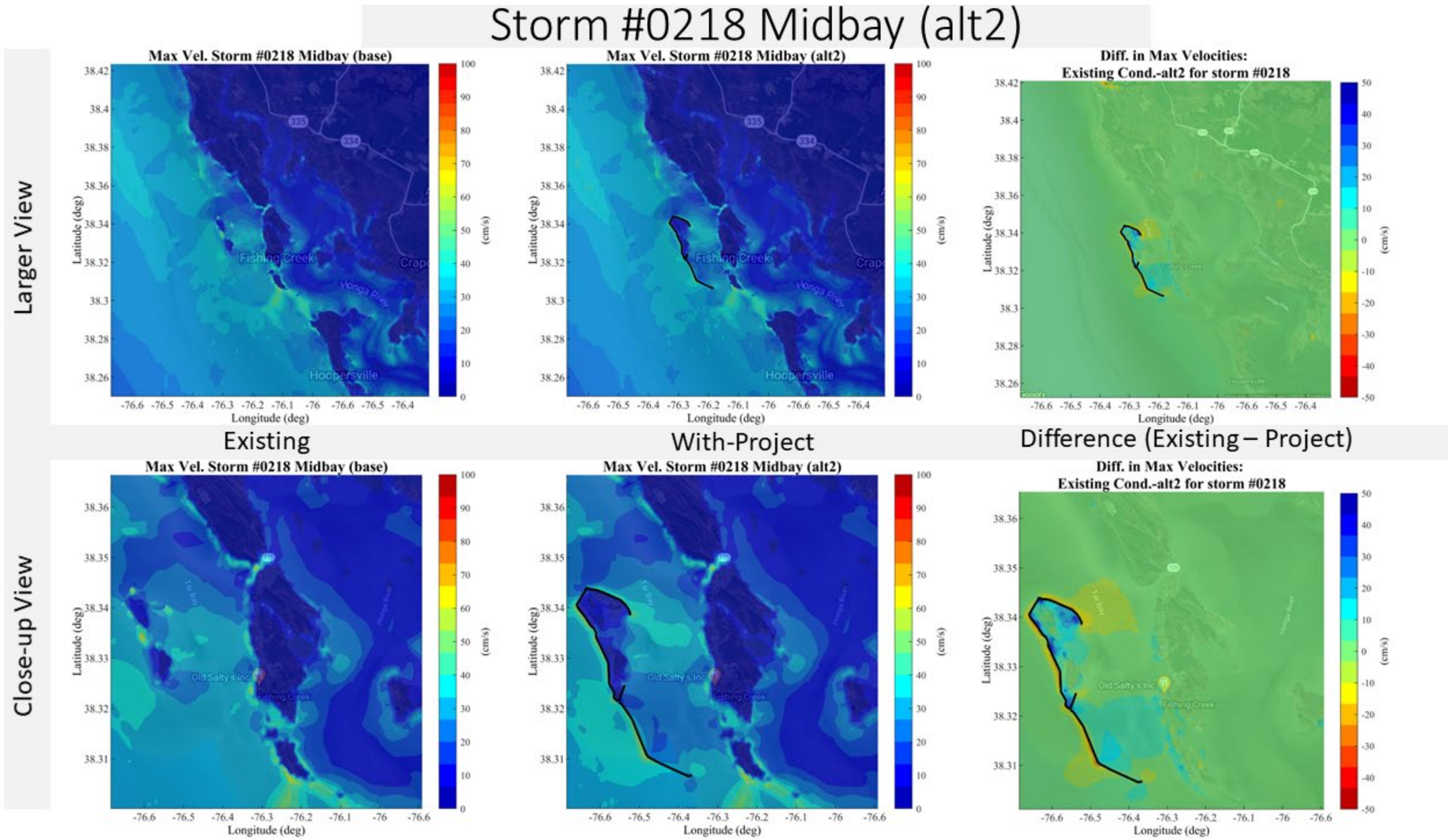

Storm #0205 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt3)
Diff. in Max Velocities: Existing Cond.-alt3 for storm #0205
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

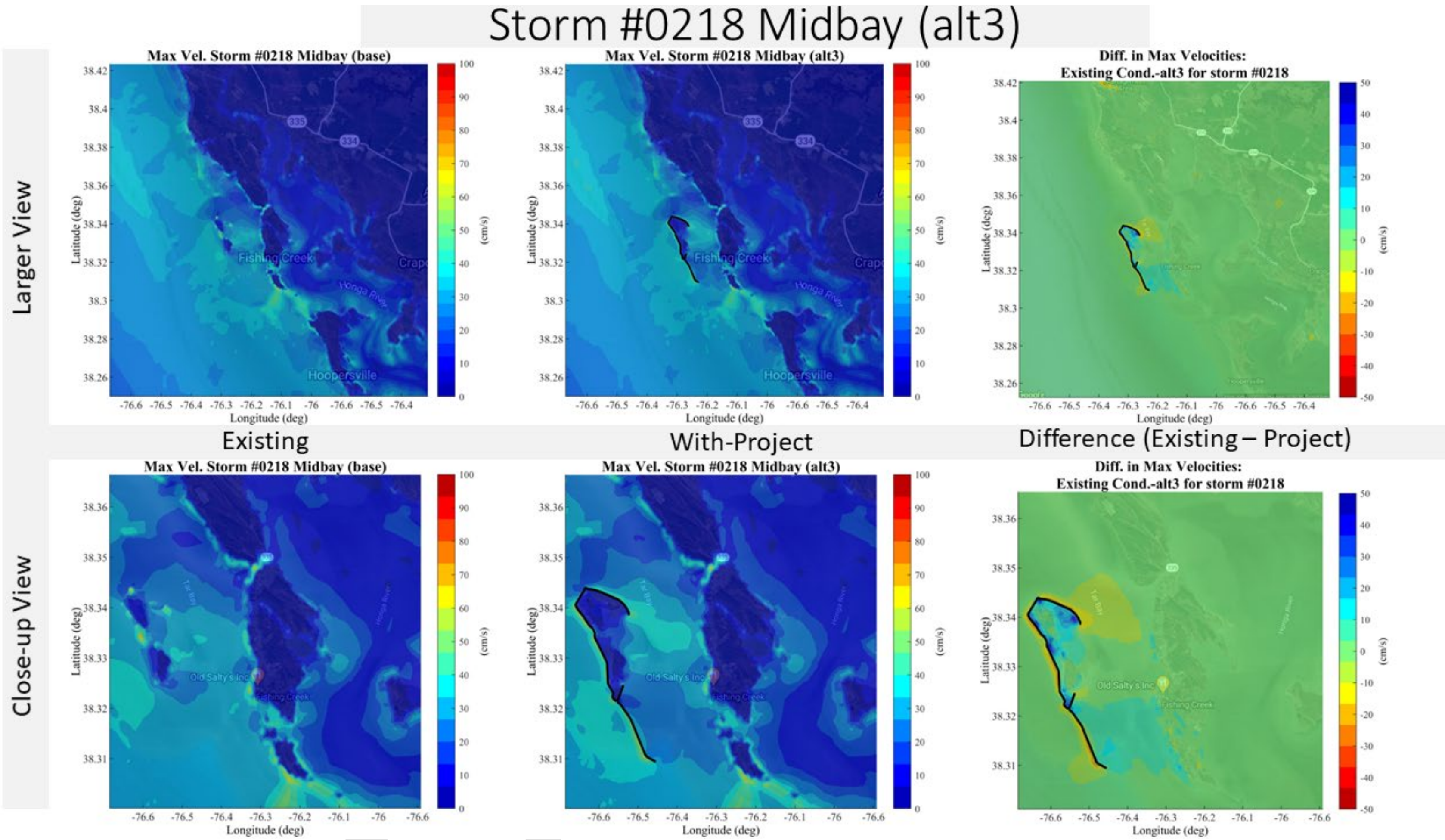

Storm #0205 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0205
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

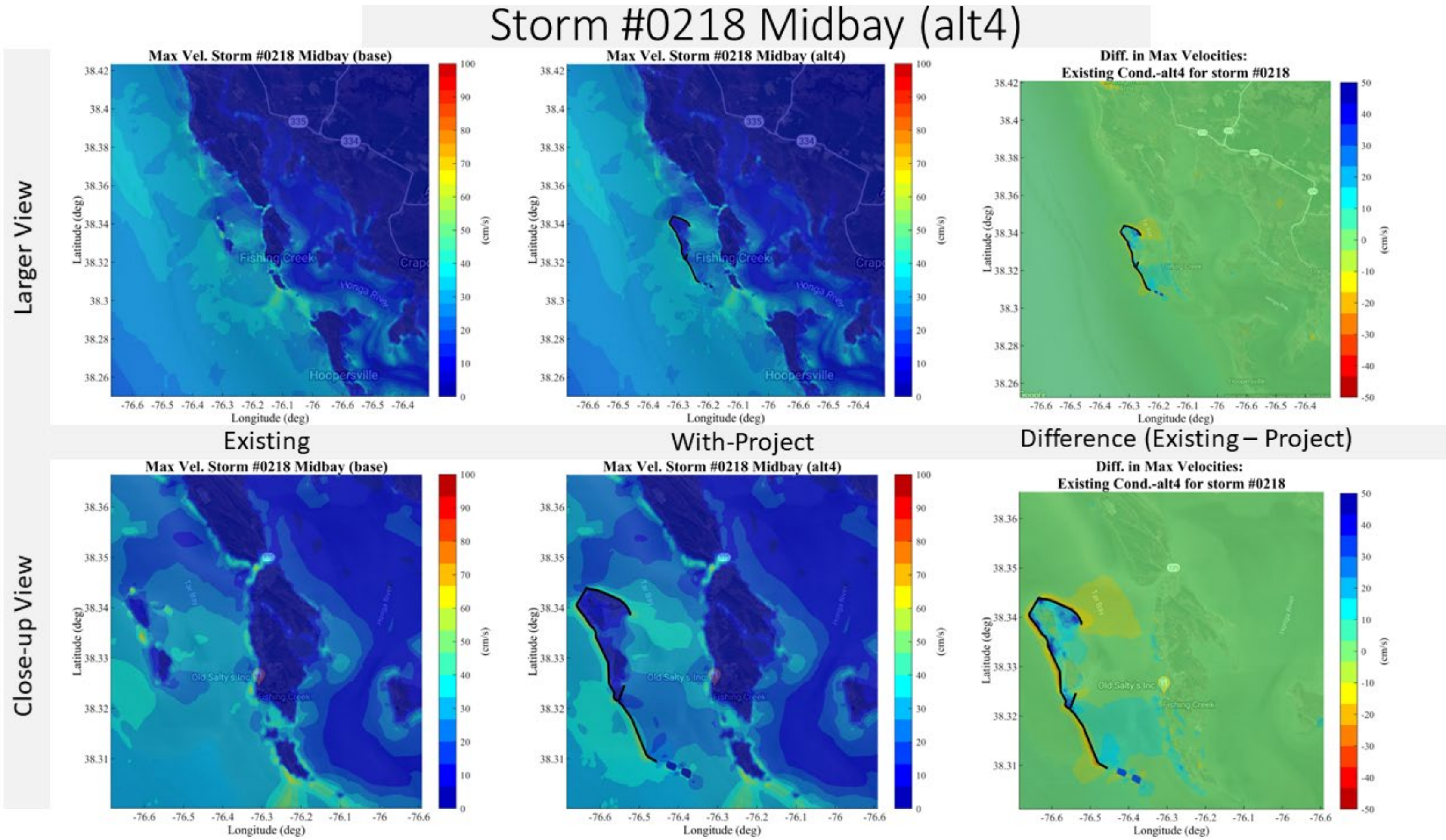

Storm #0205 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0205
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

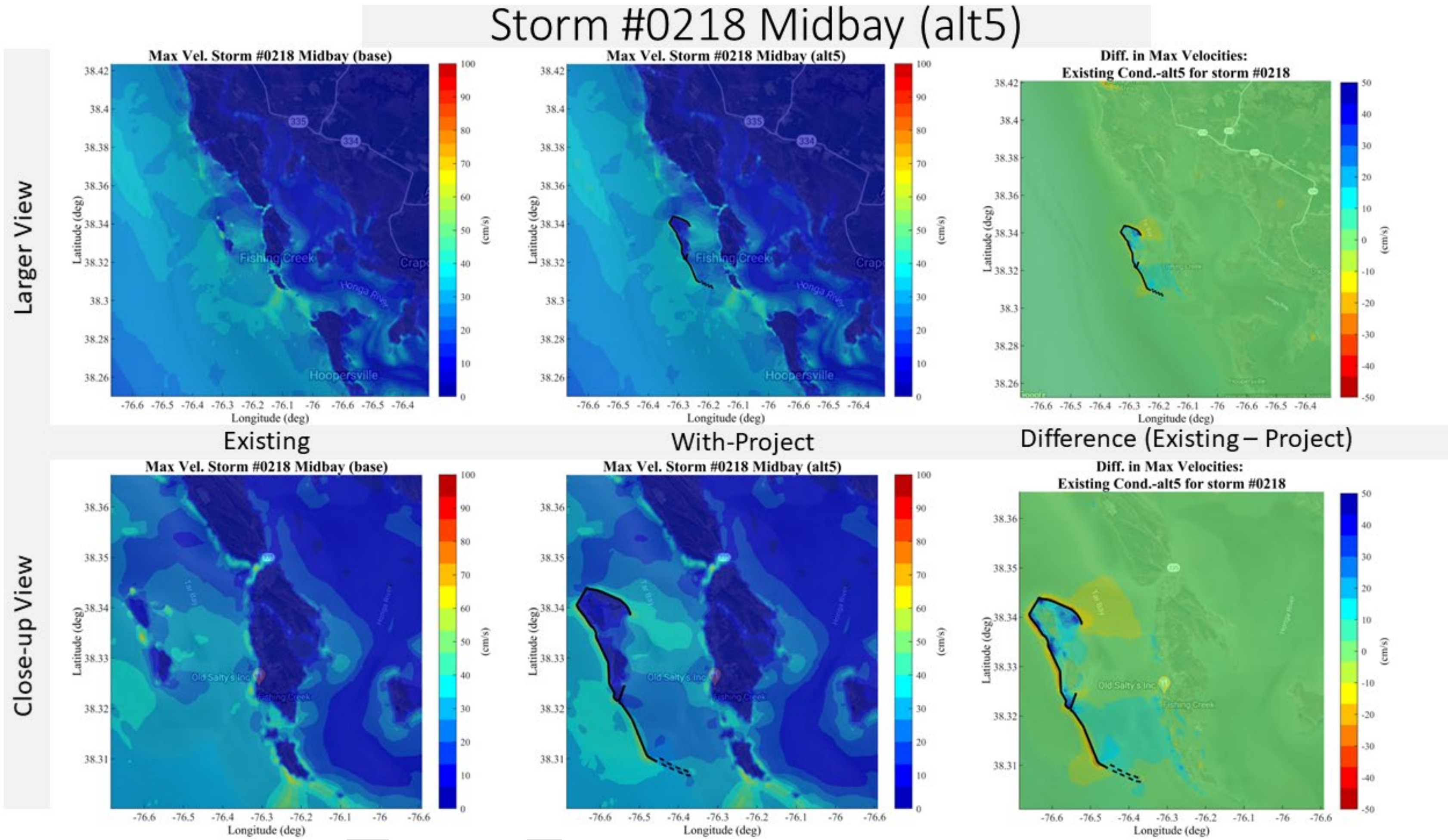

Storm #0205 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0205 Midbay (base)
Max Vel. Storm #0205 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0205
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

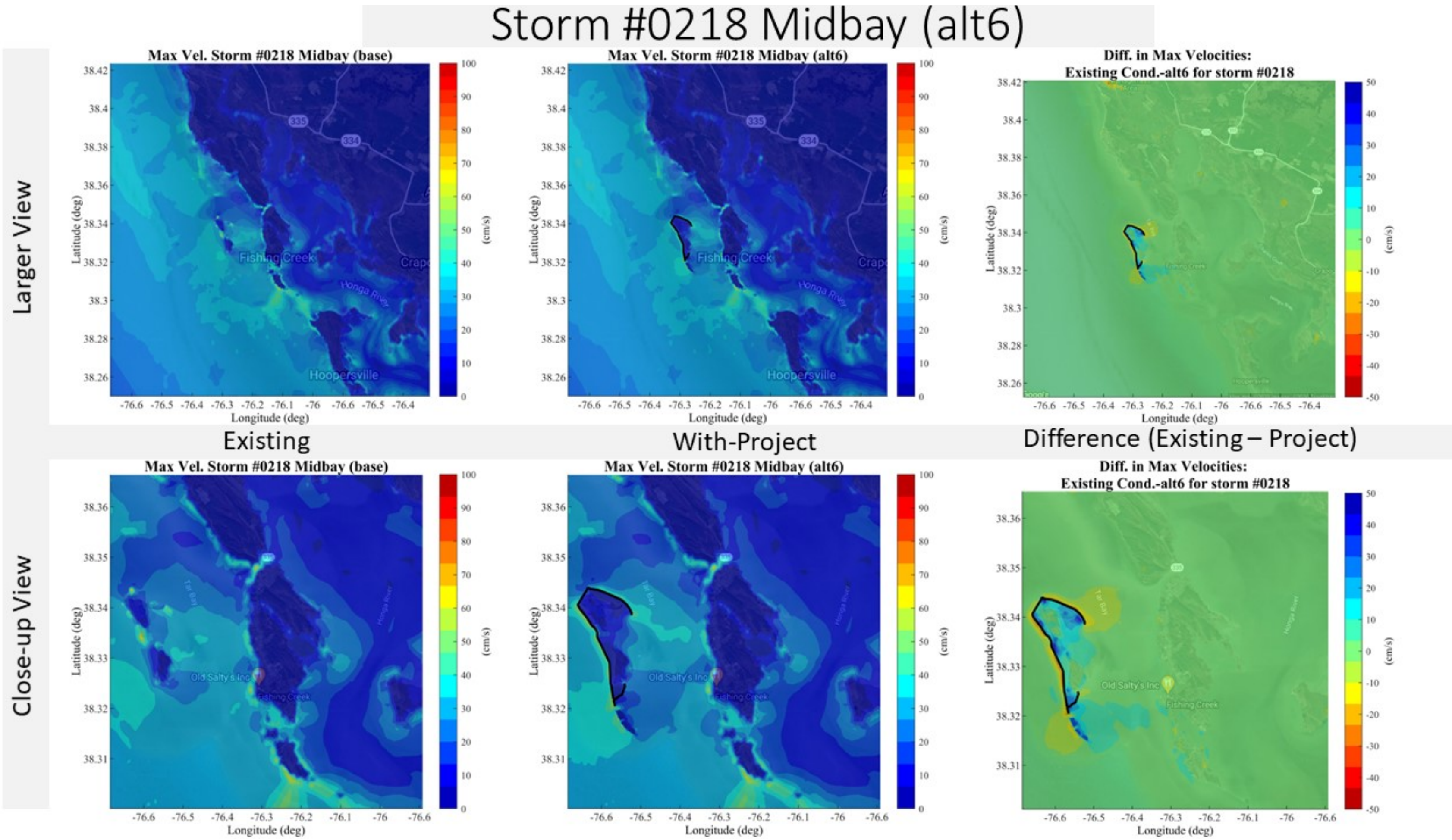

Storm #0218 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0218
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

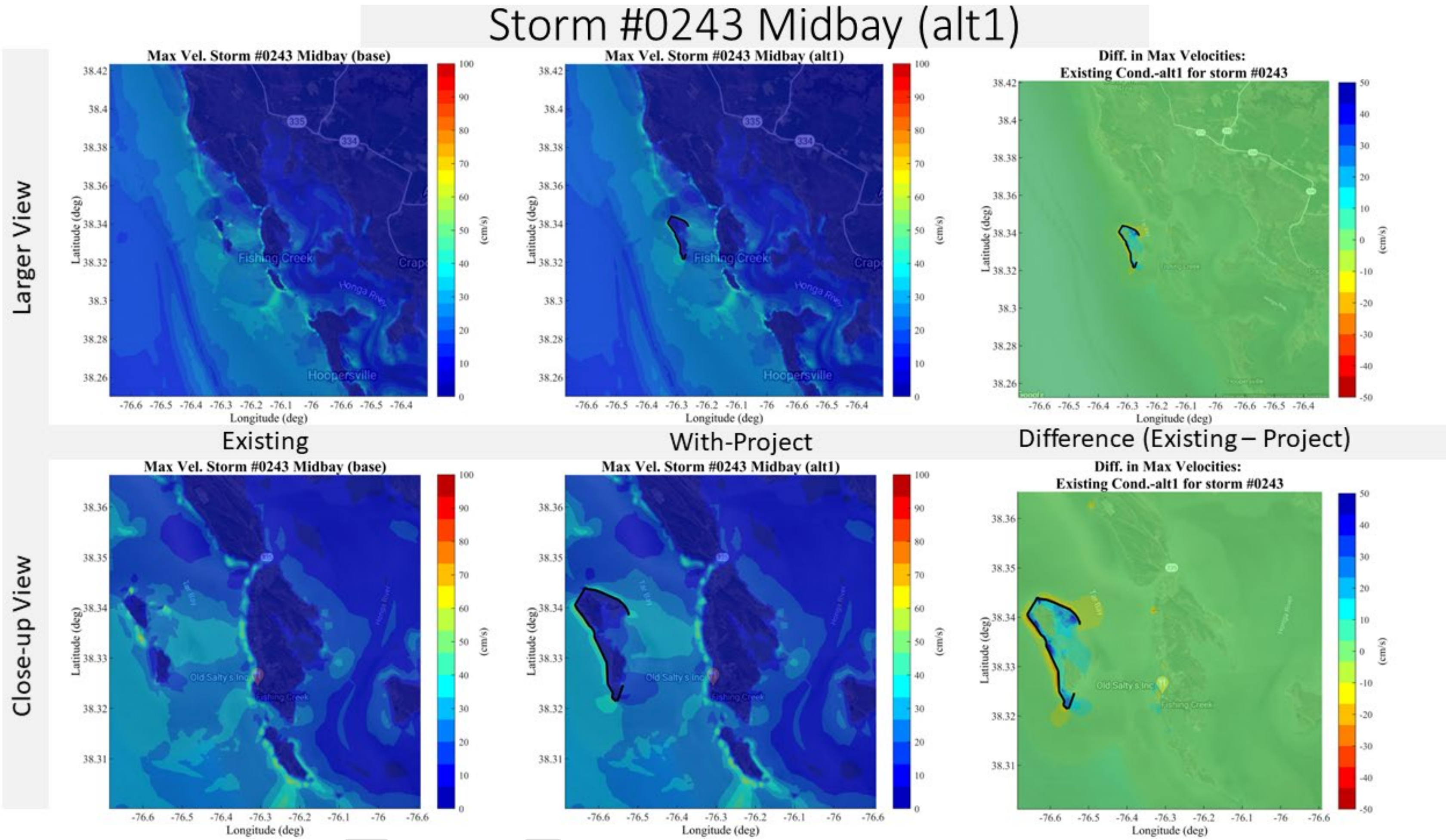

Storm #0218 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

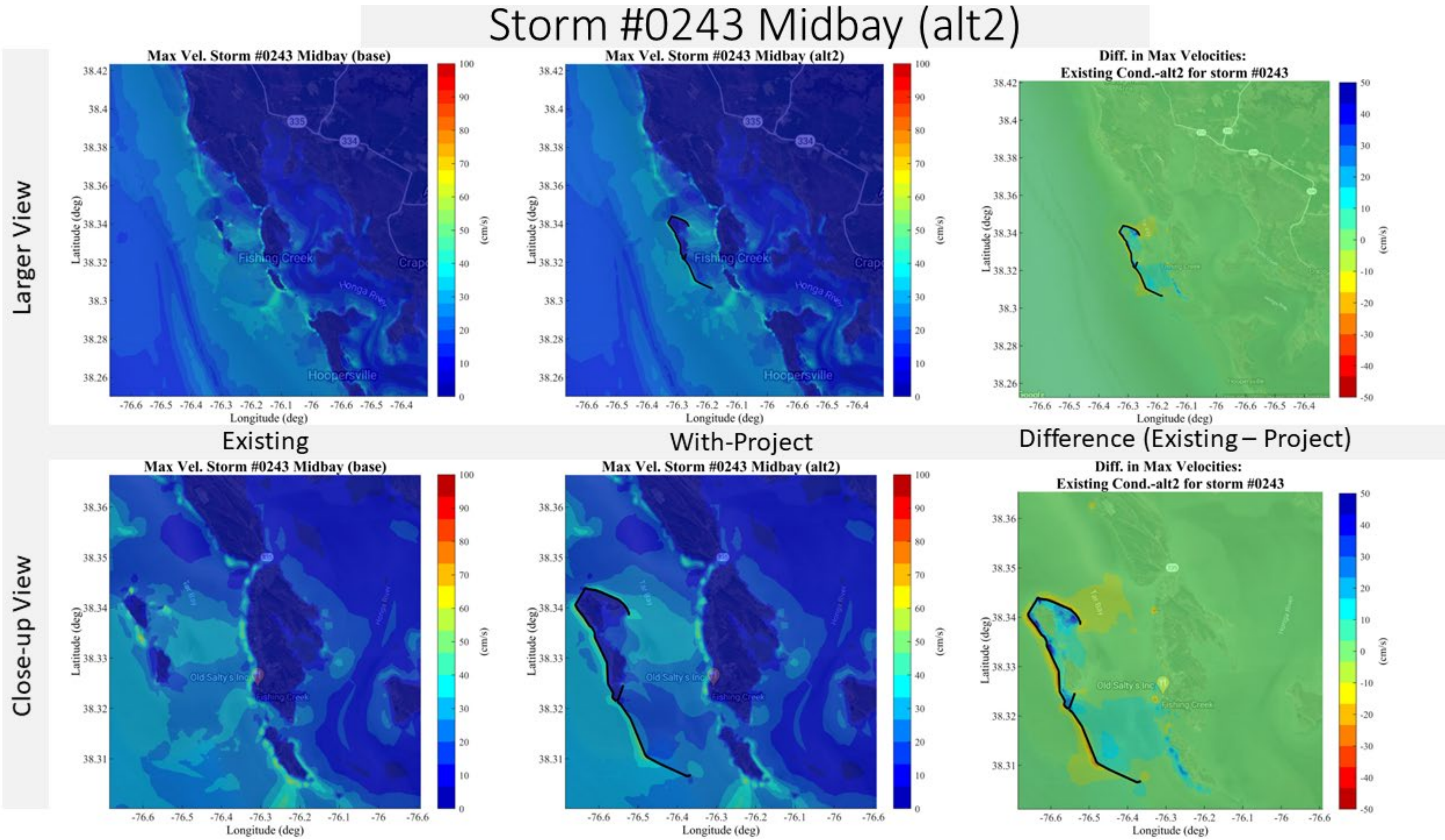

Storm #0218 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0218
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

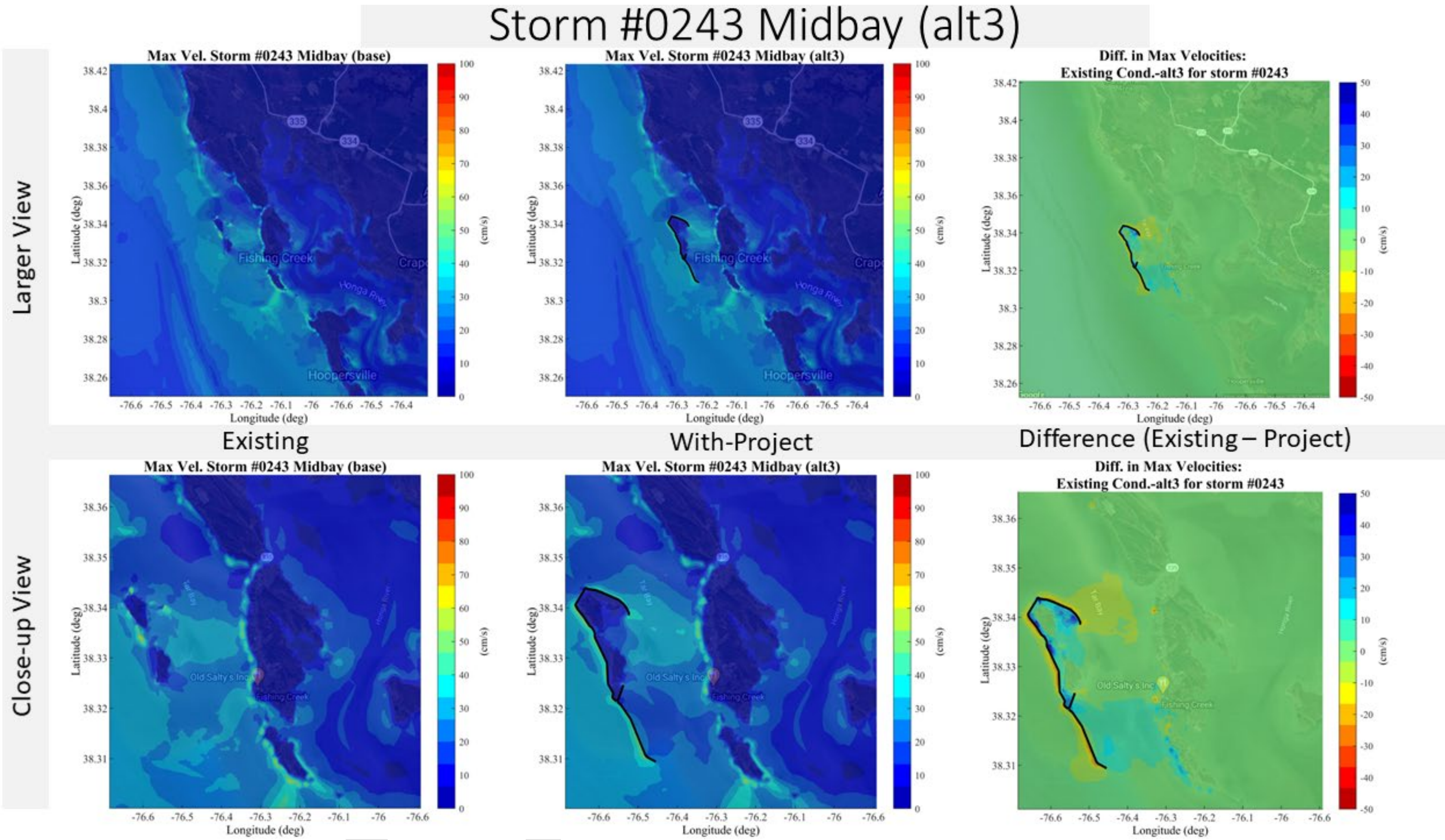

Storm #0218 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0218
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

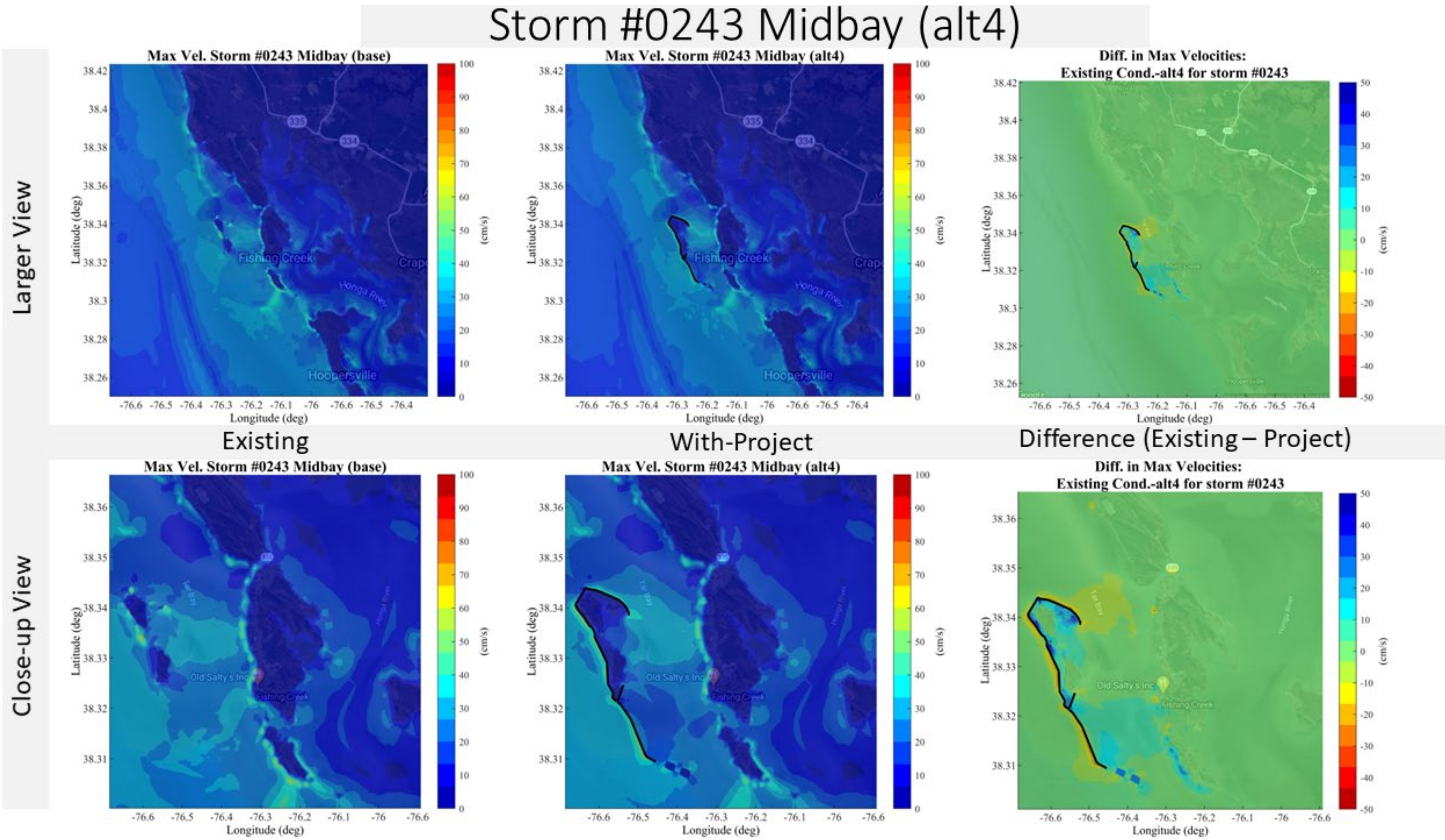

Storm #0218 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0218
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc
Tar Bay

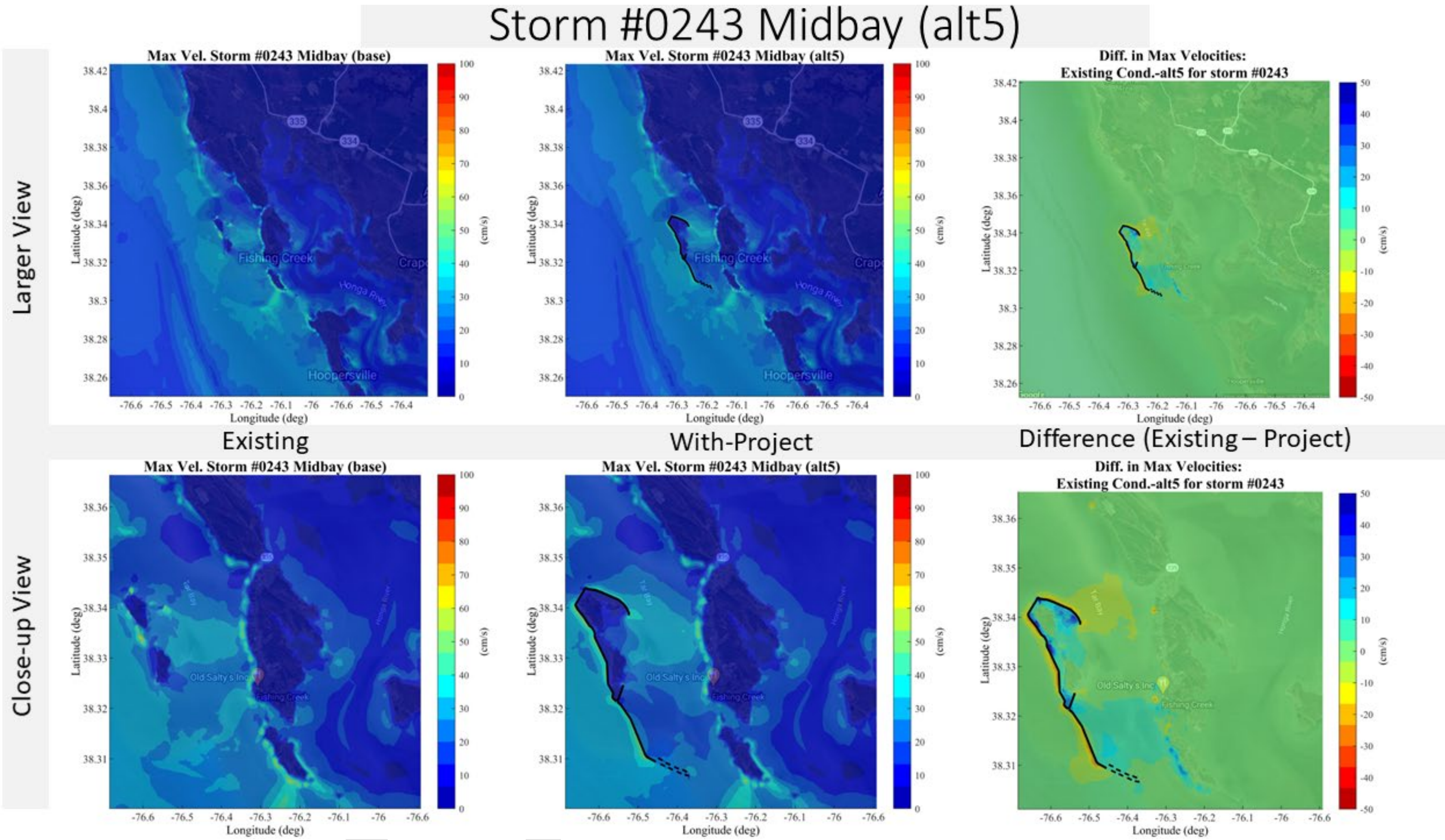

Storm #0218 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0218 Midbay (base)
Max Vel. Storm #0218 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0218
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Tar Bay

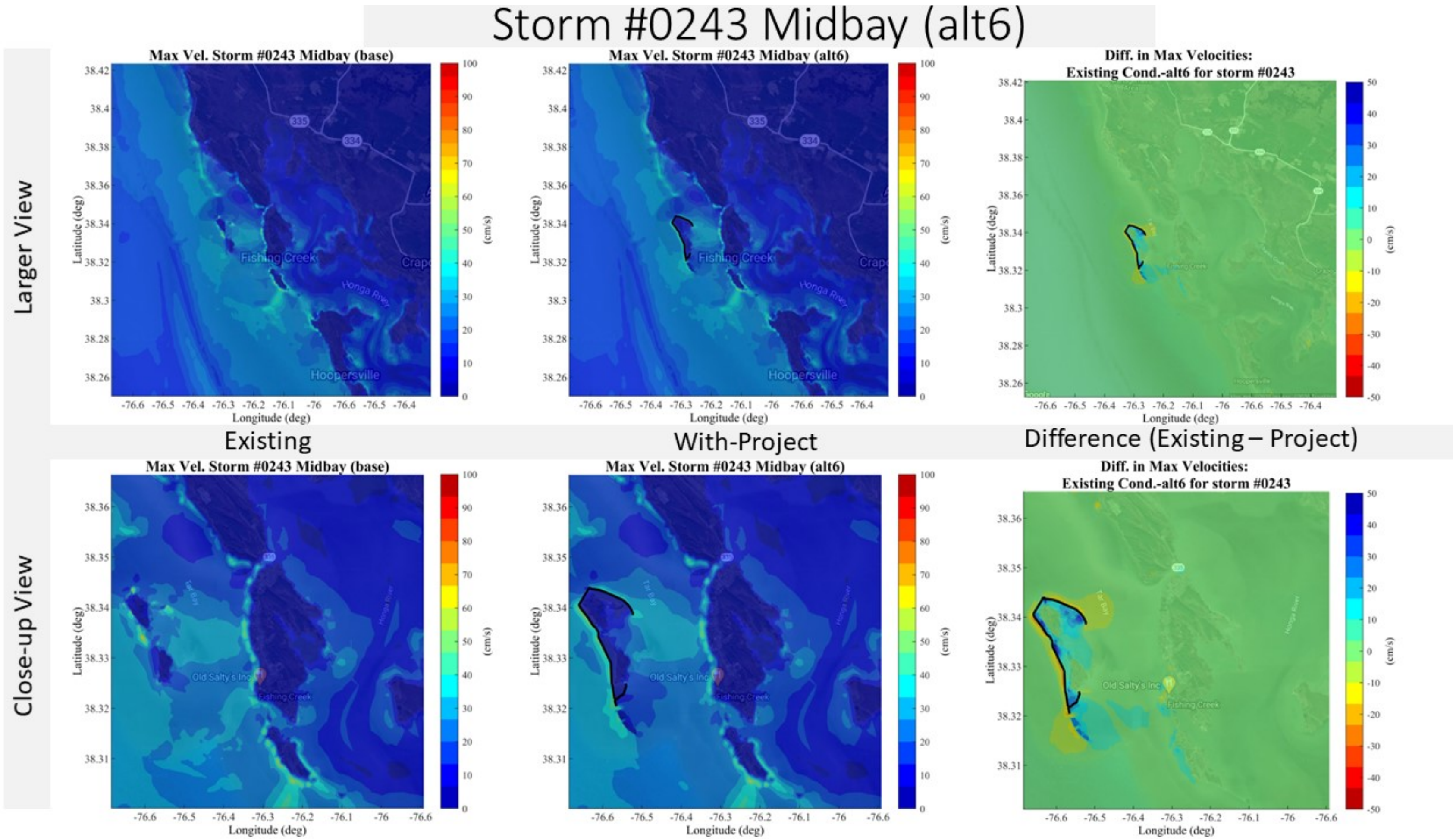

Storm #0243 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

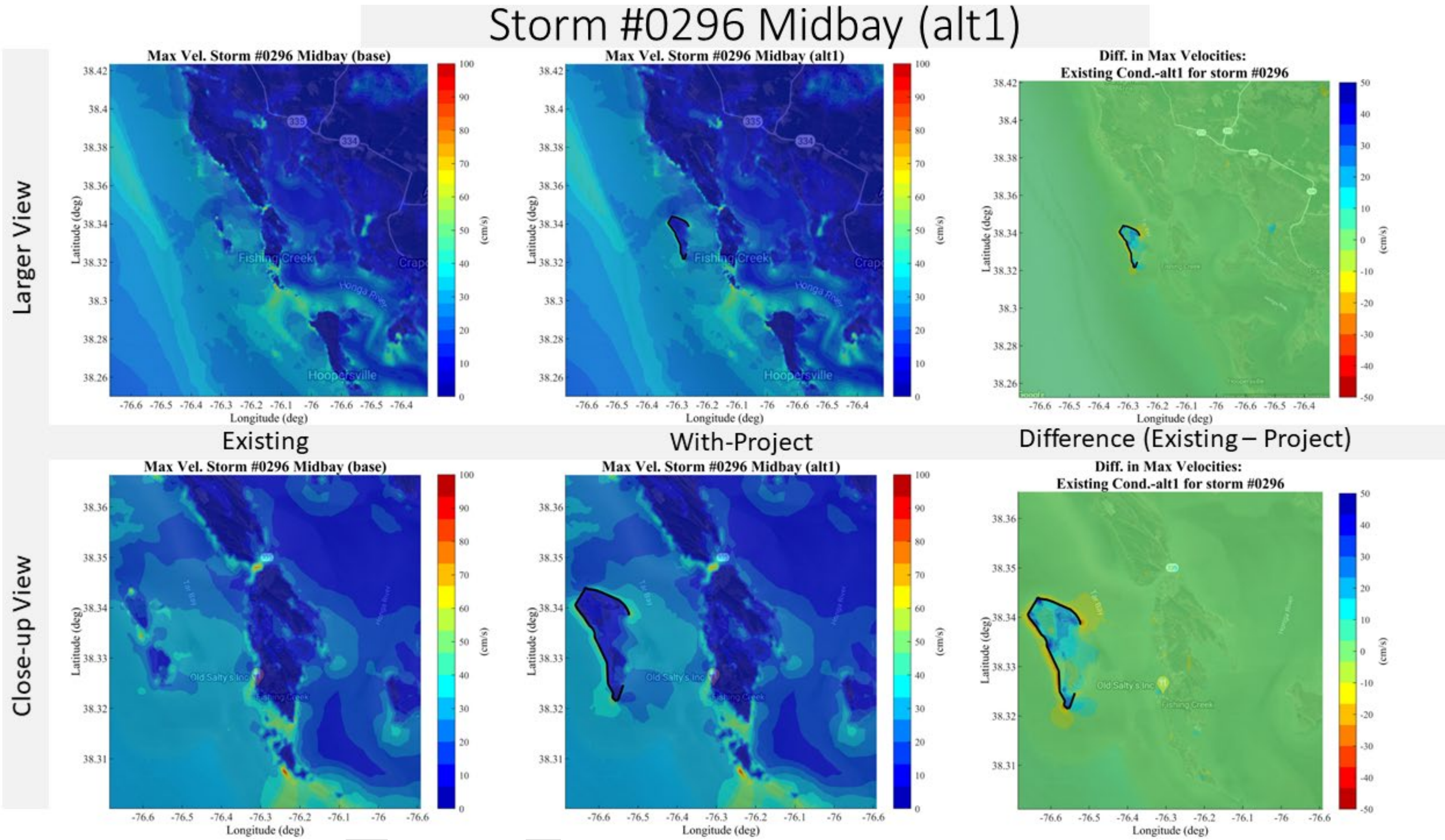

Storm #0243 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0243
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

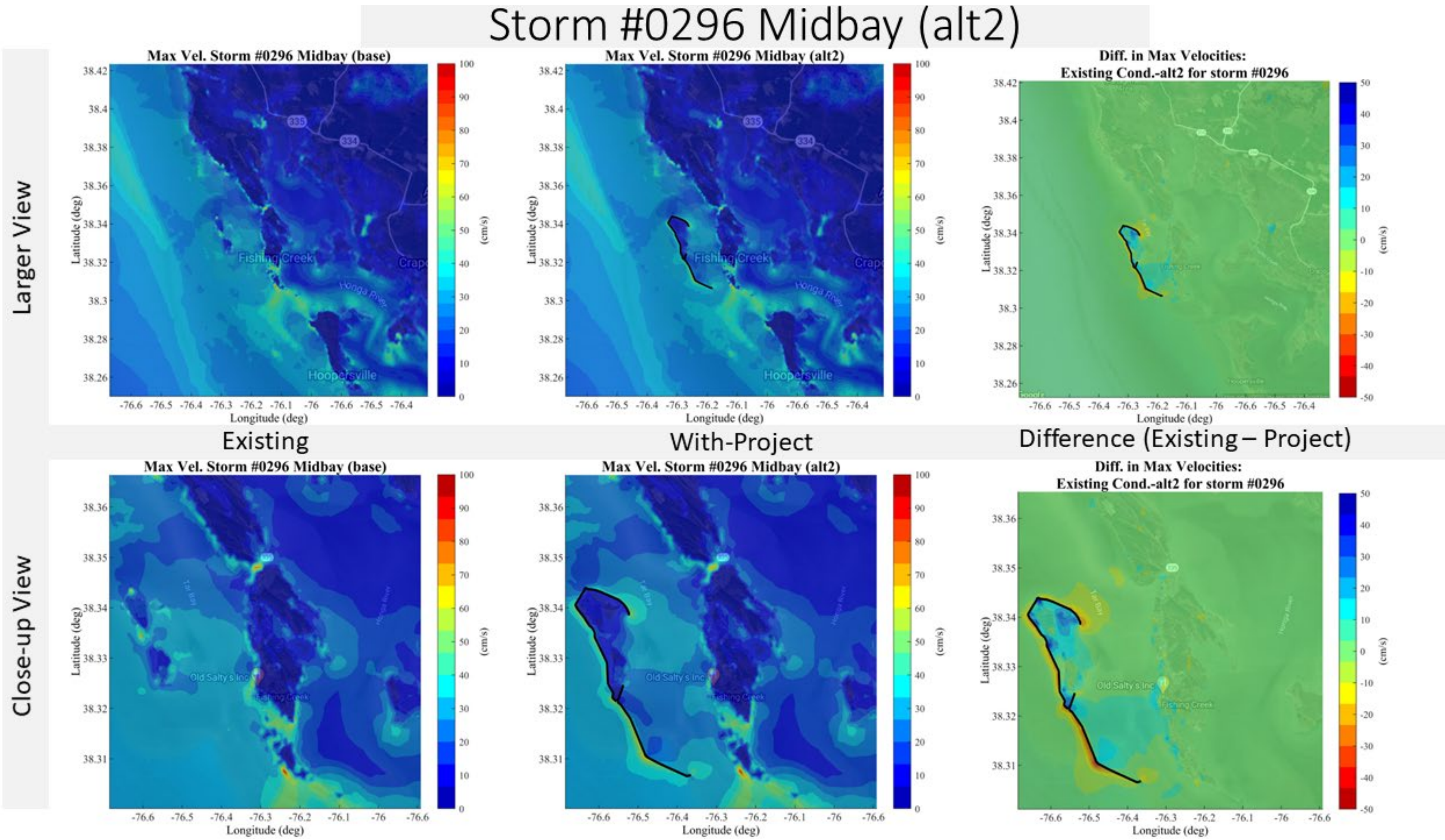

Storm #0243 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

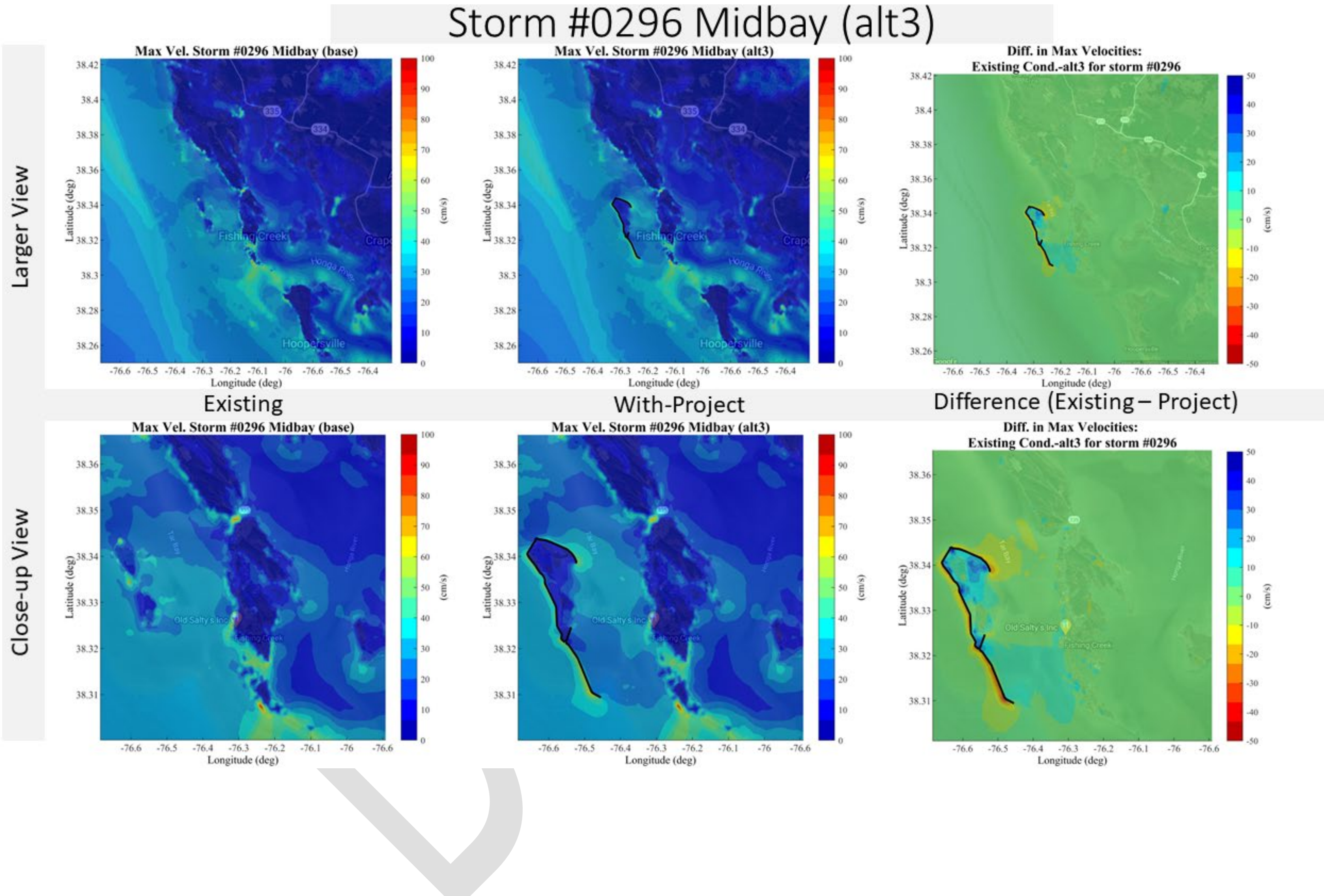

Storm #0243 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0243
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)

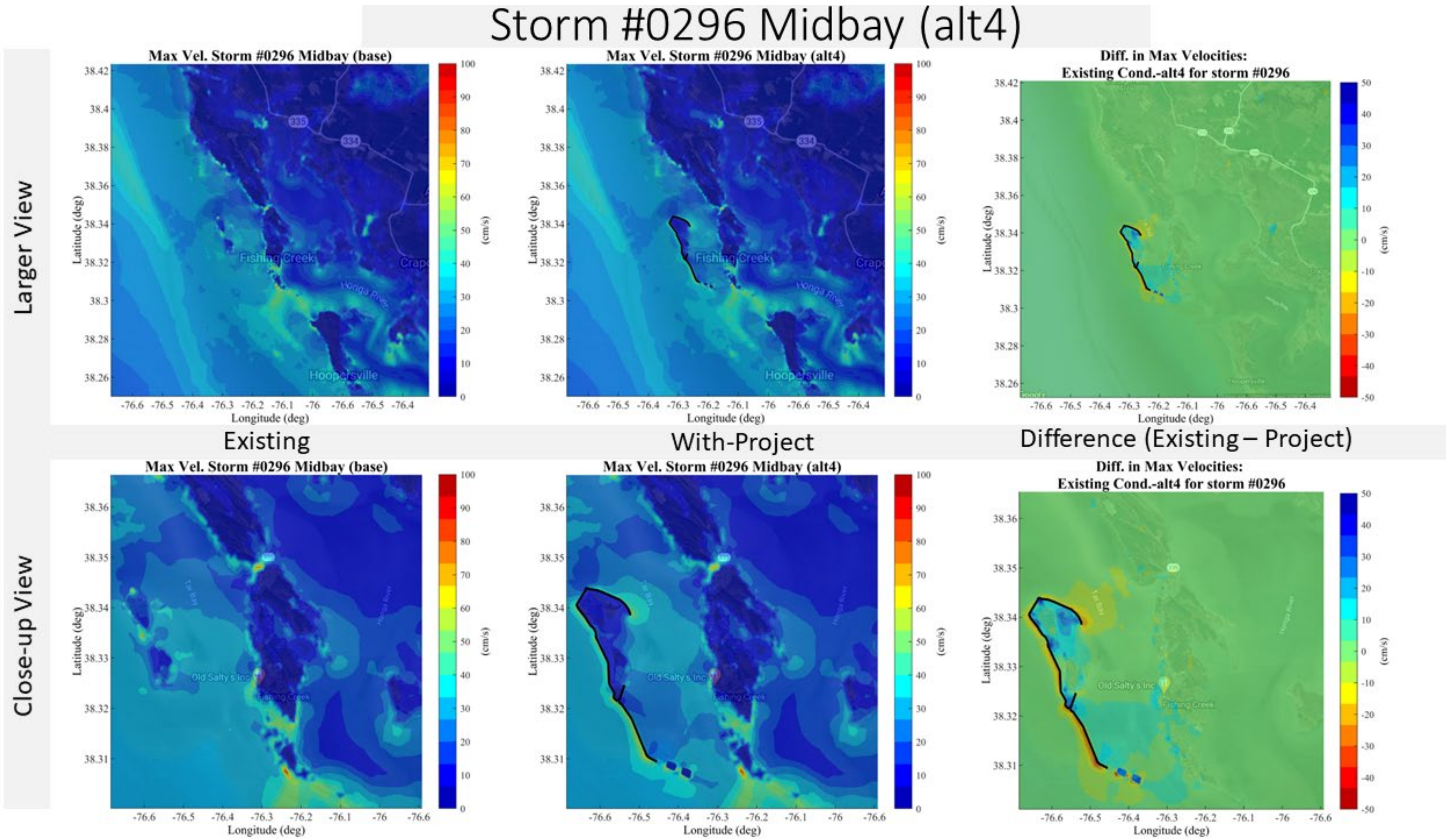

Storm #0243 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0243
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

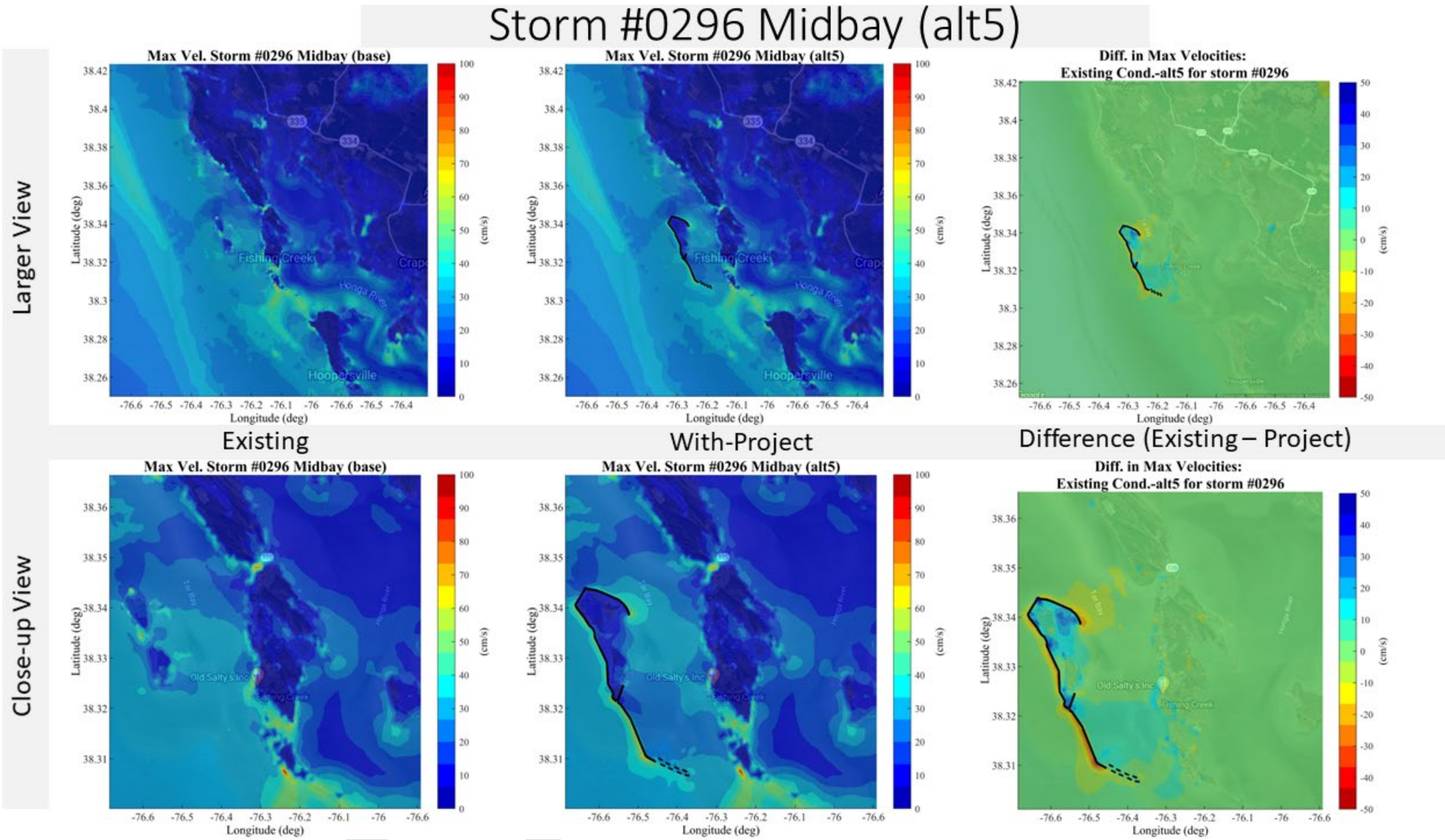

Storm #0243 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0243 Midbay (base)
Max Vel. Storm #0243 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0243
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

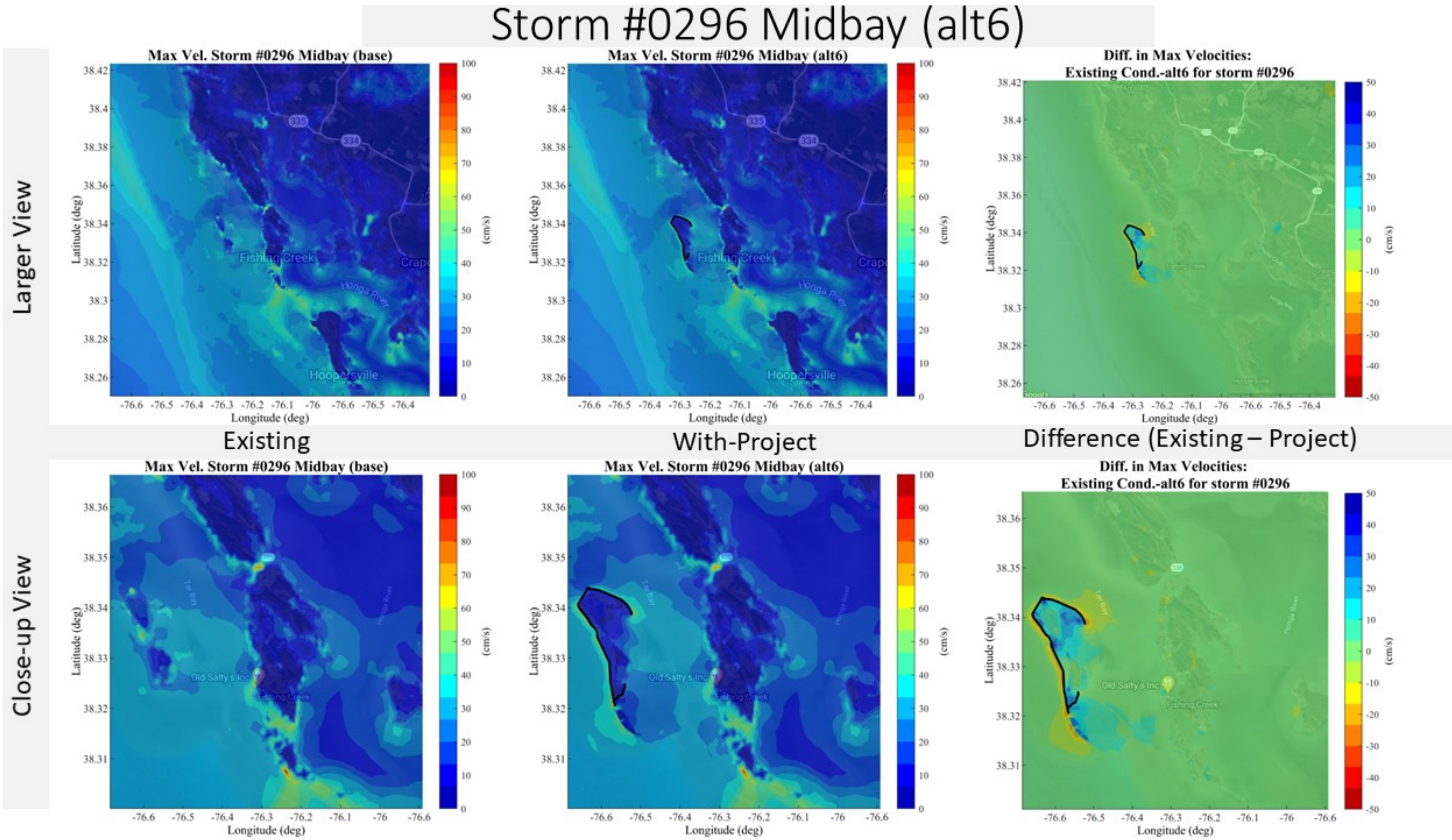

Storm #0296 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0296
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

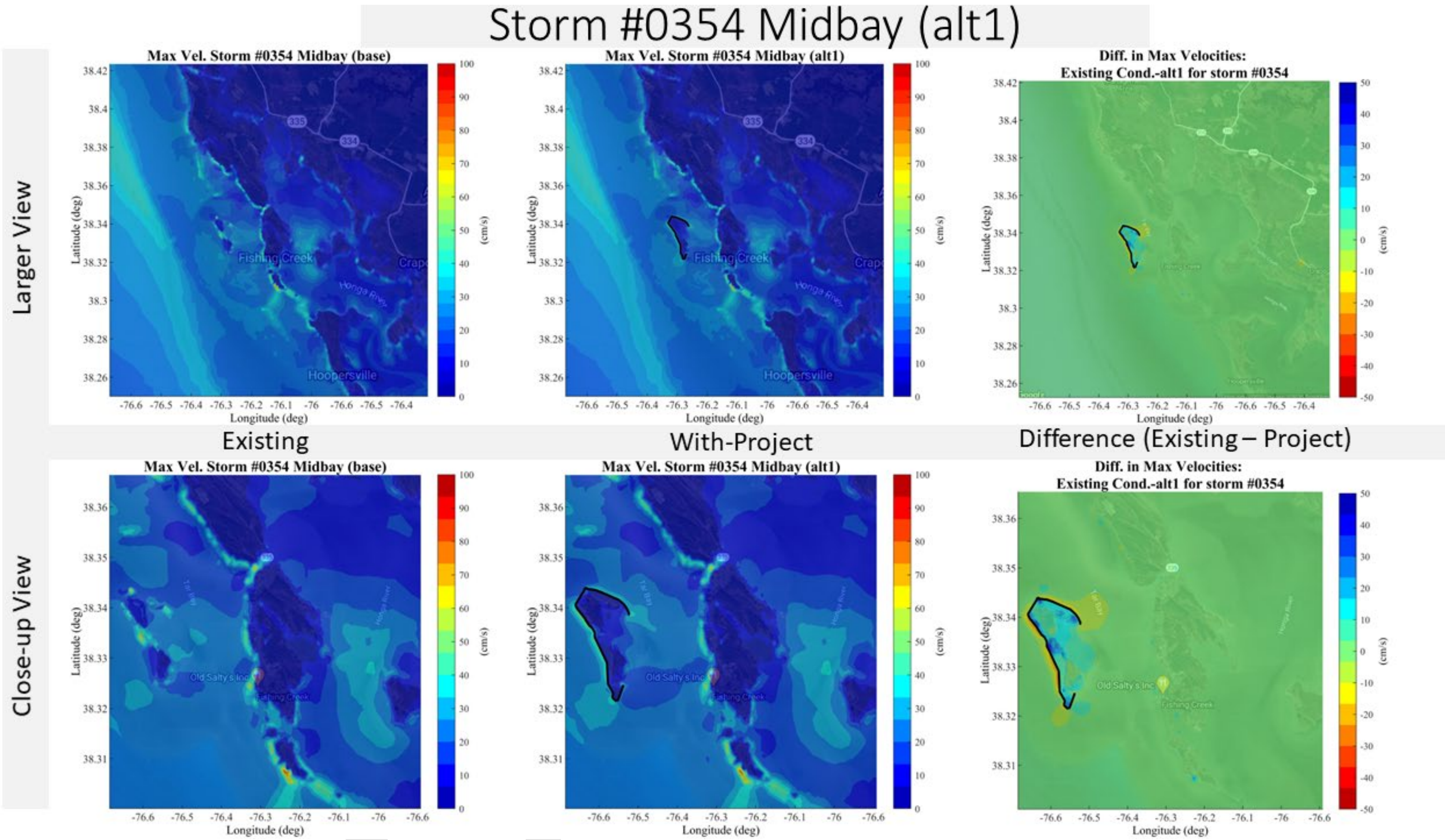

Storm #0296 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0296
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

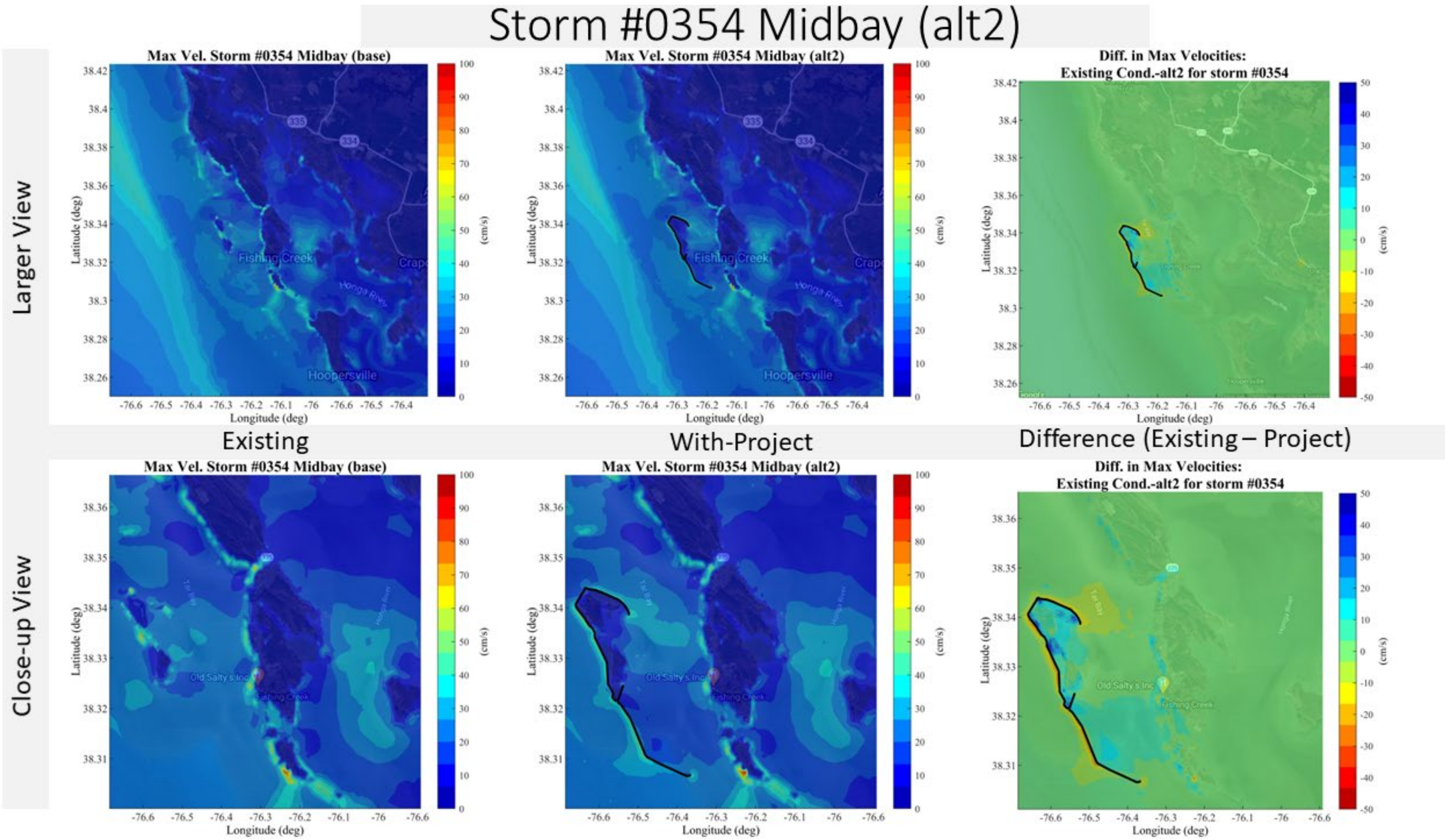

Storm #0296 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0296
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

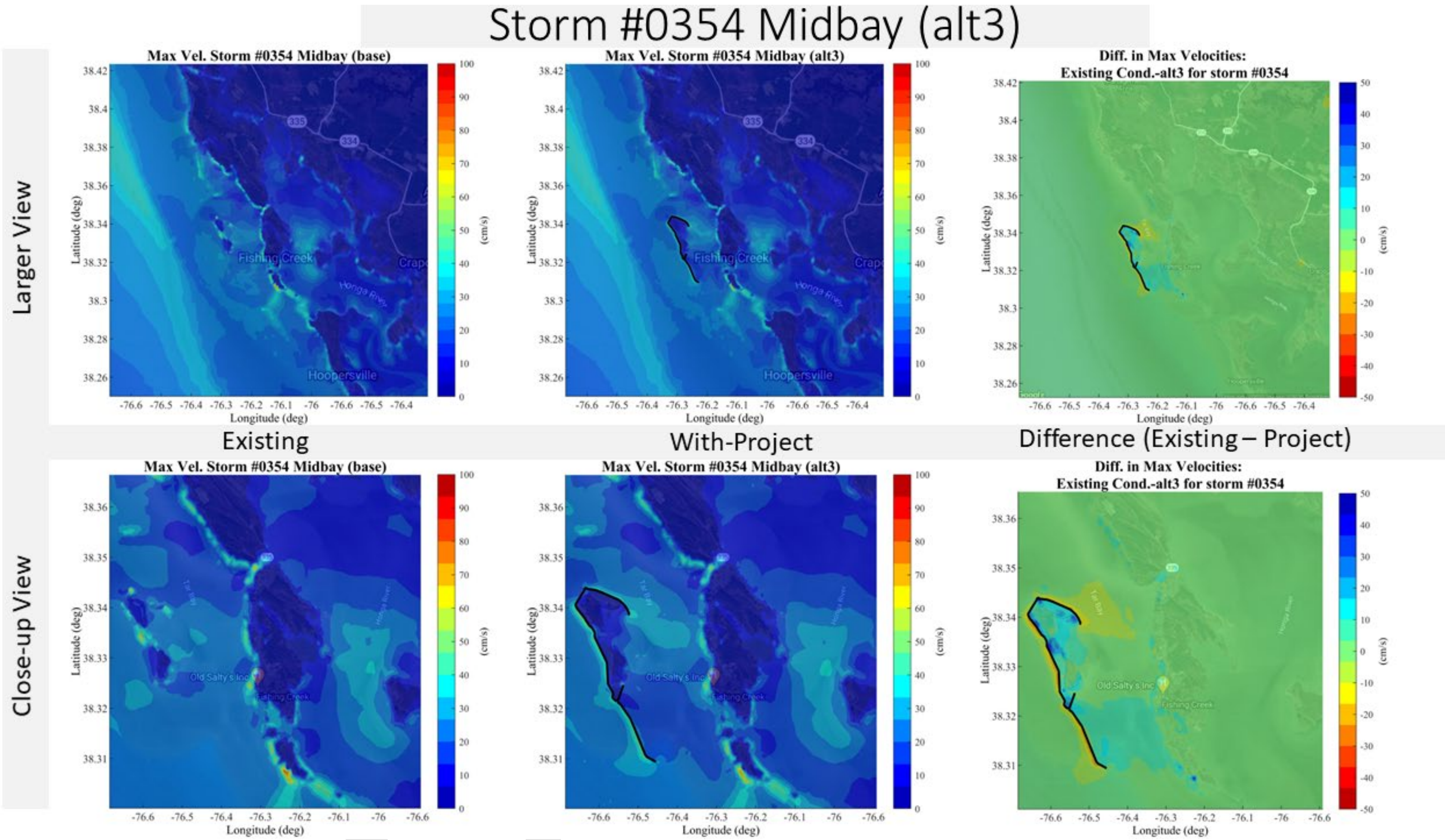

Storm #0296 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0296
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

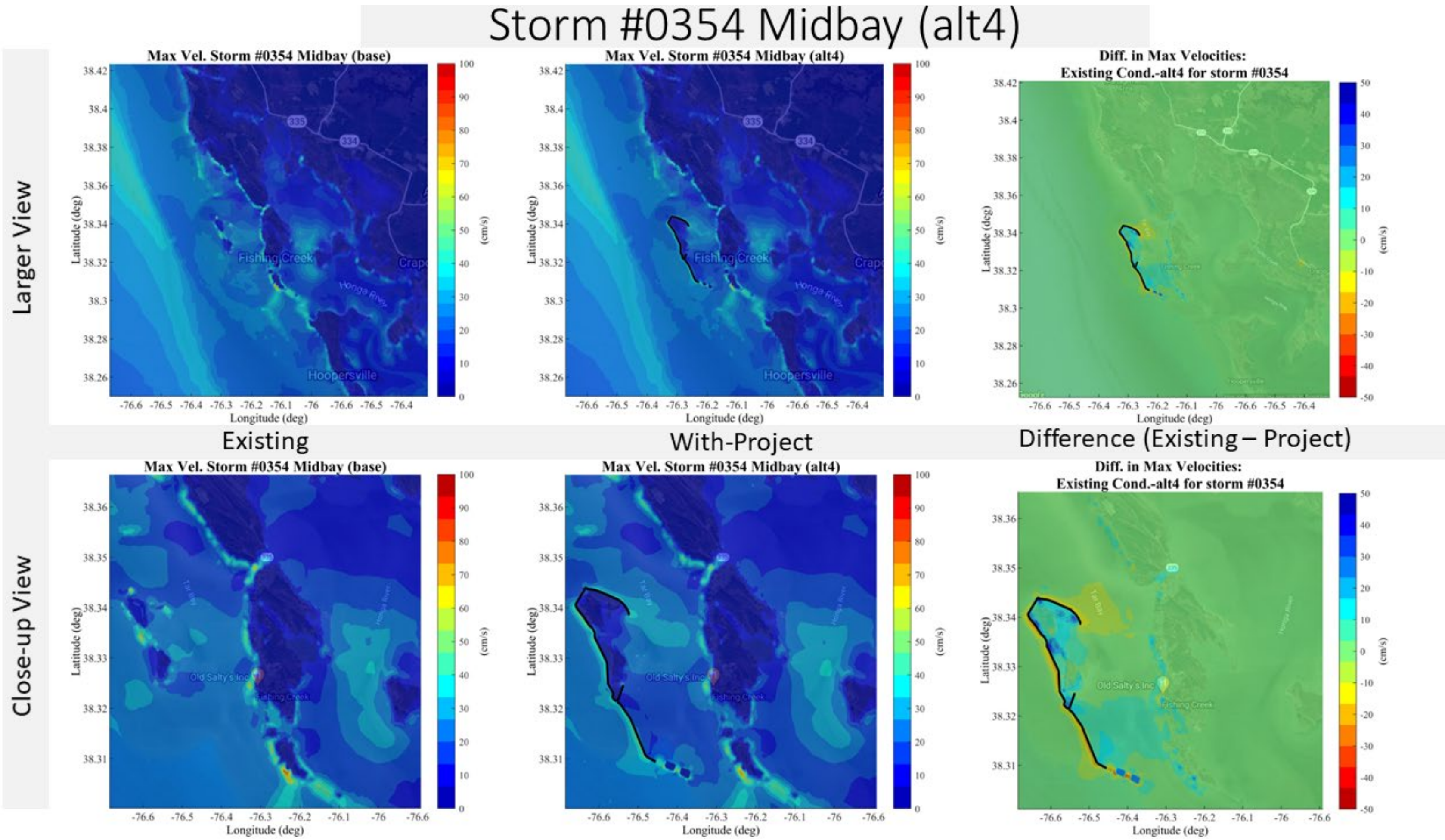

Storm #0296 Midbay (alt5)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0296
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

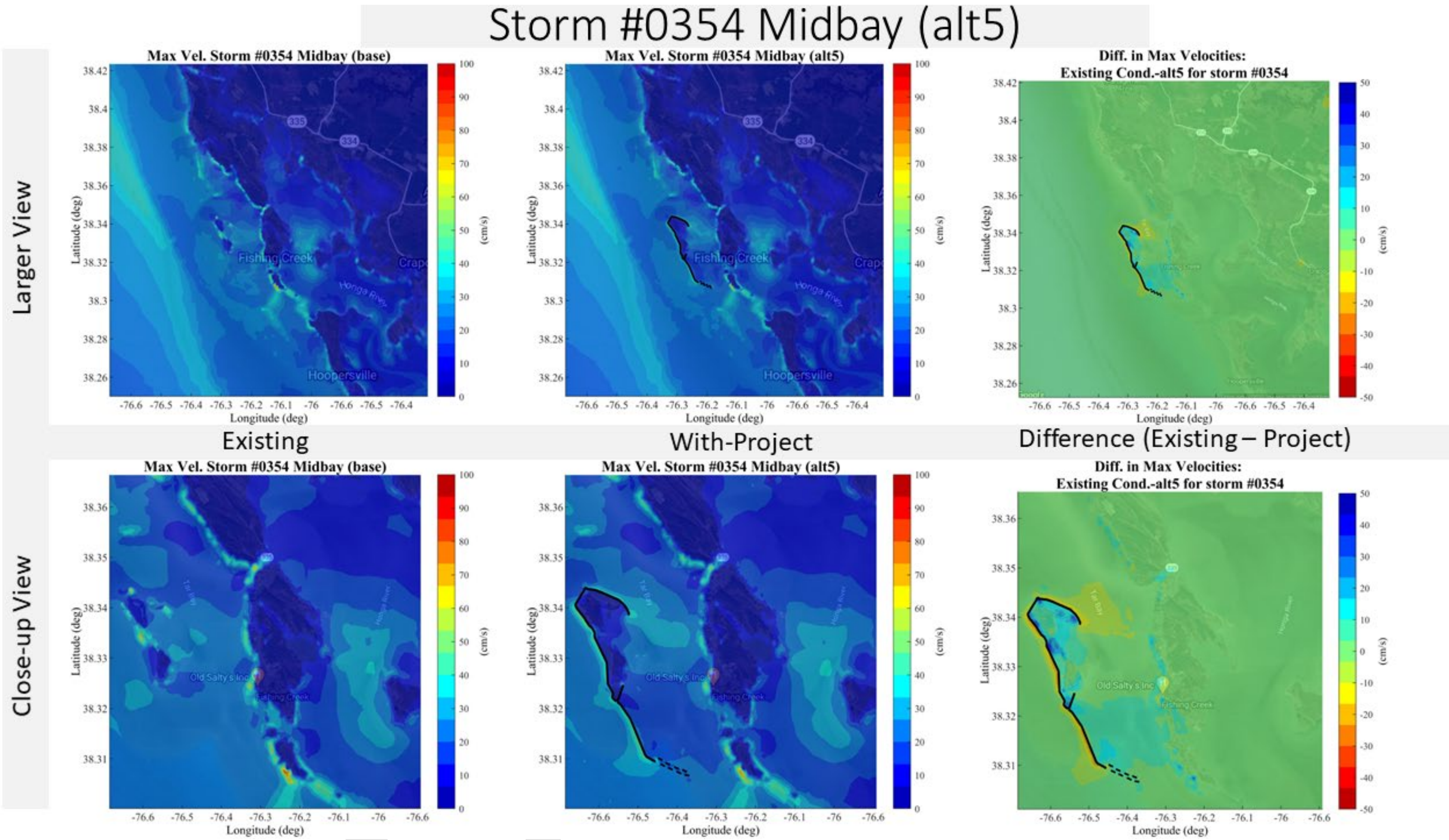

Storm #0296 Midbay (alt6)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0296 Midbay (base)
Max Vel. Storm #0296 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0296
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

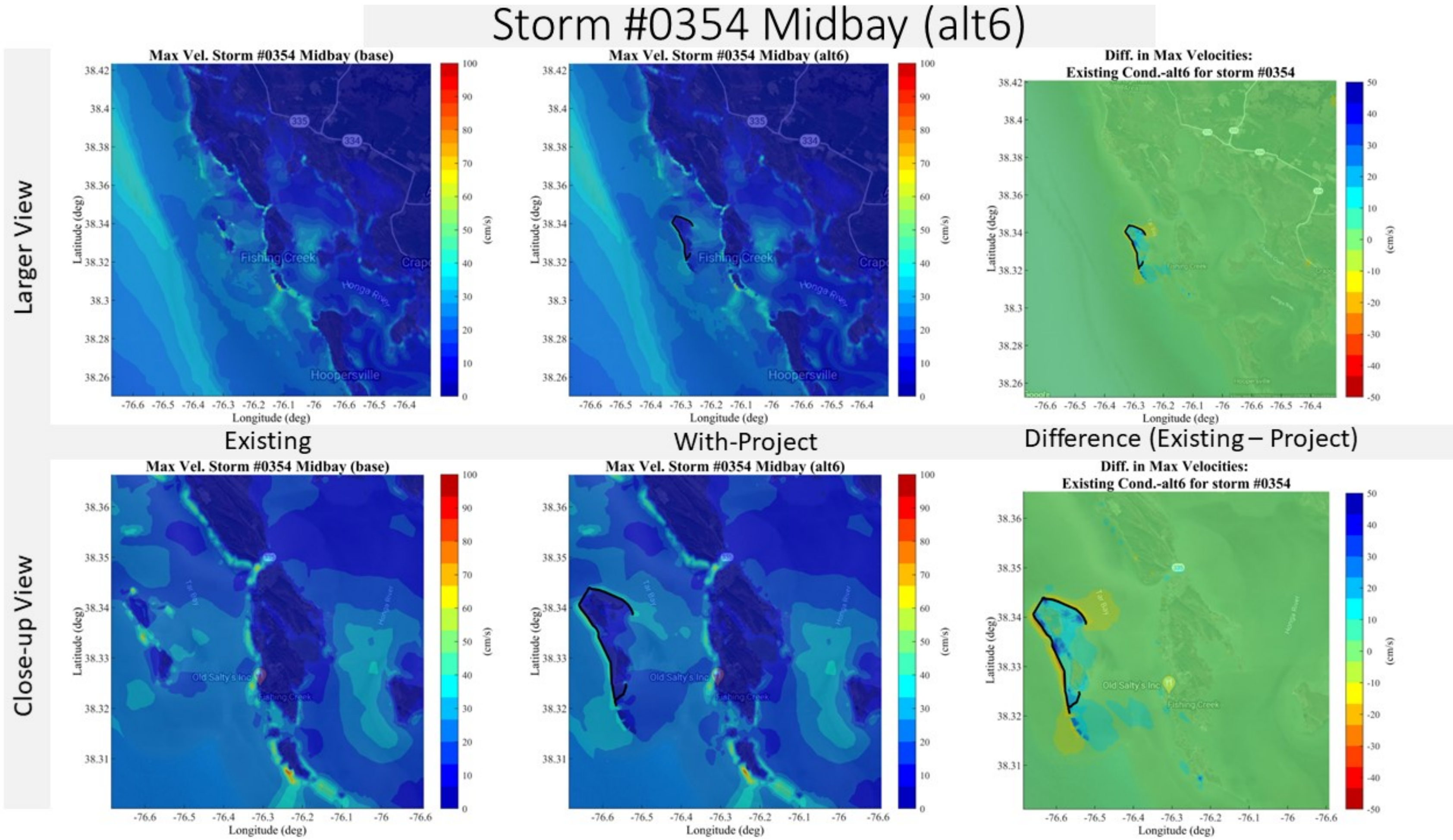

Storm #0354 Midbay (alt1)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0354
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

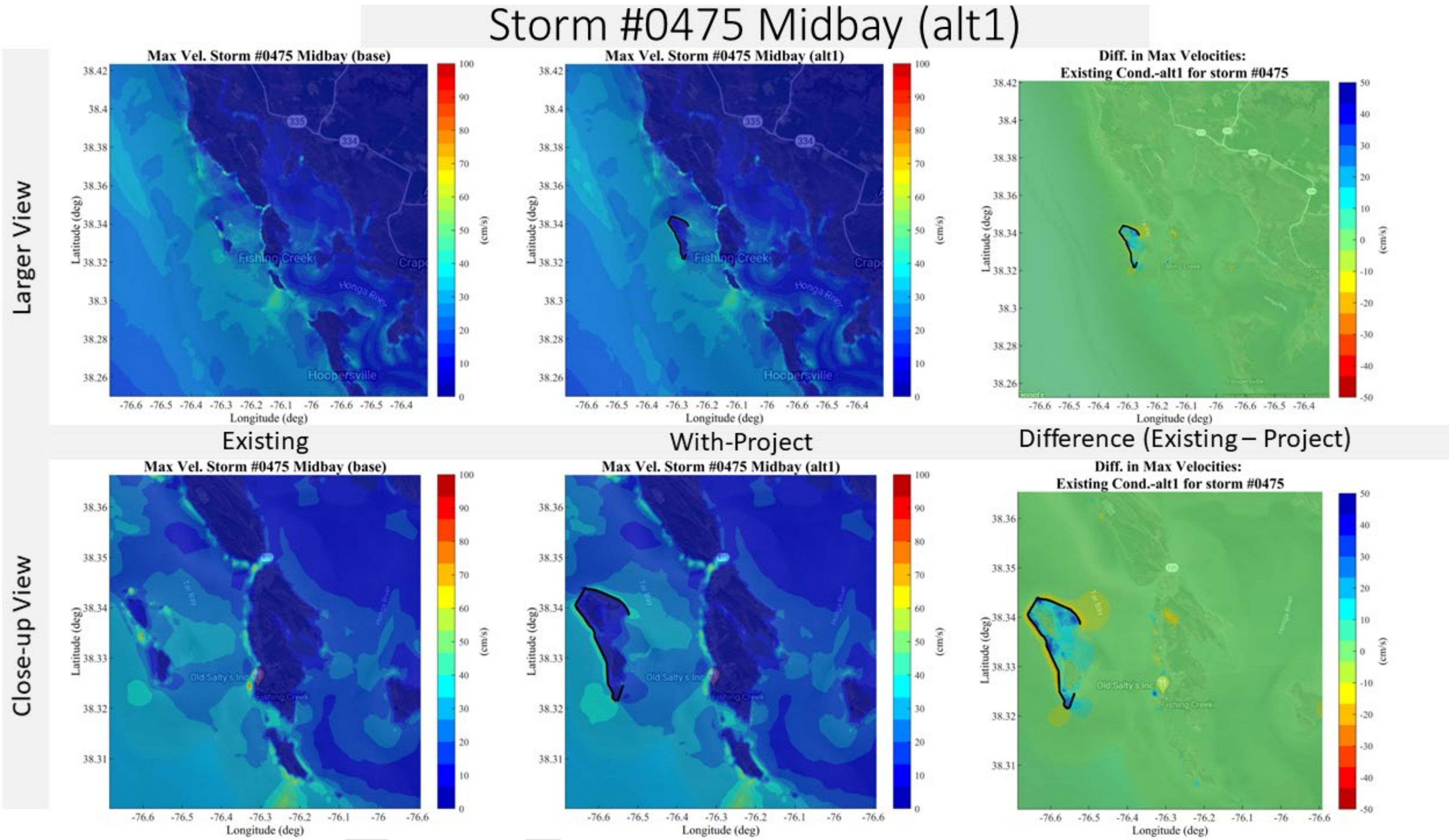

Storm #0354 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0354
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc

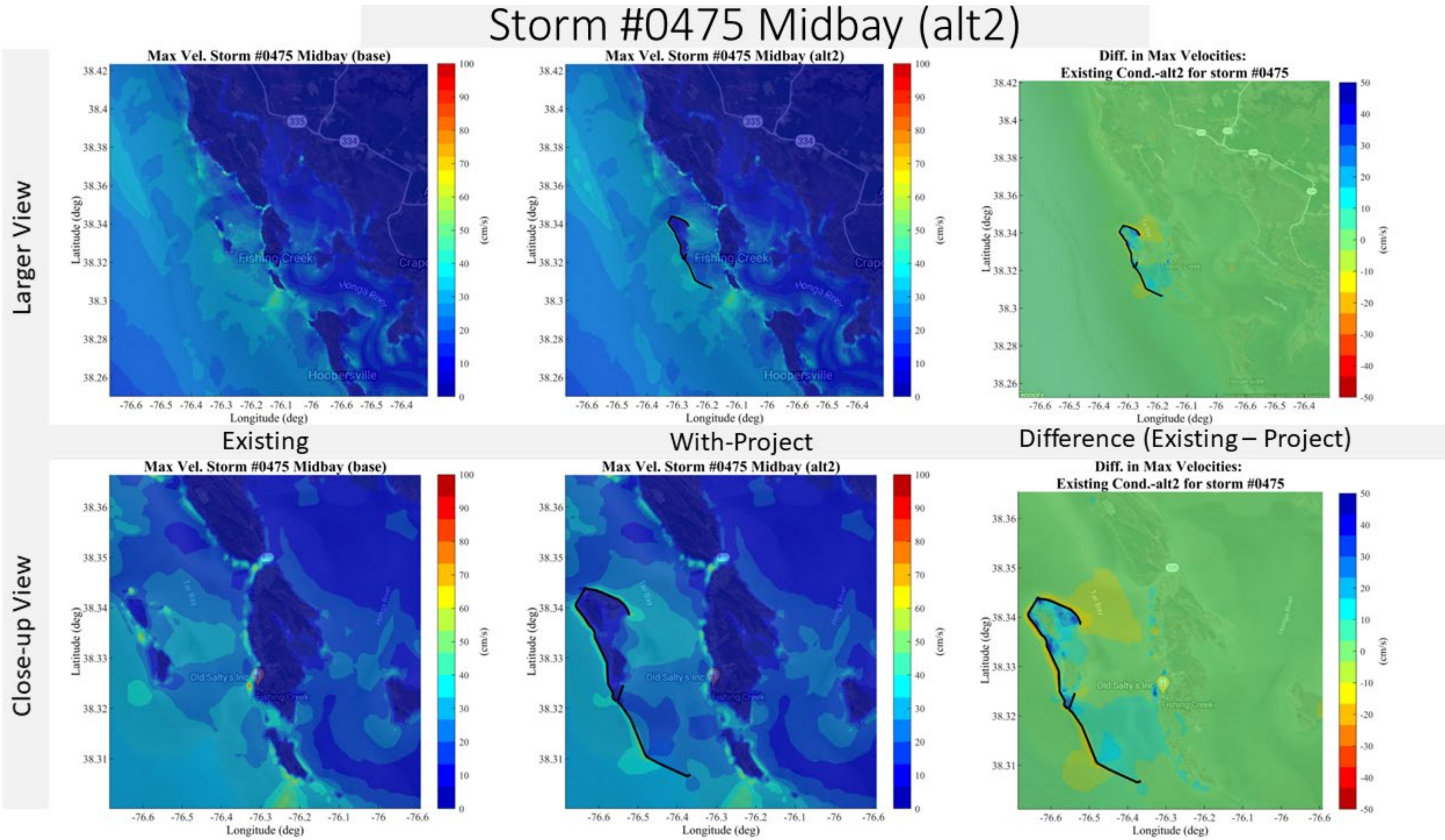

Storm #0354 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0354
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

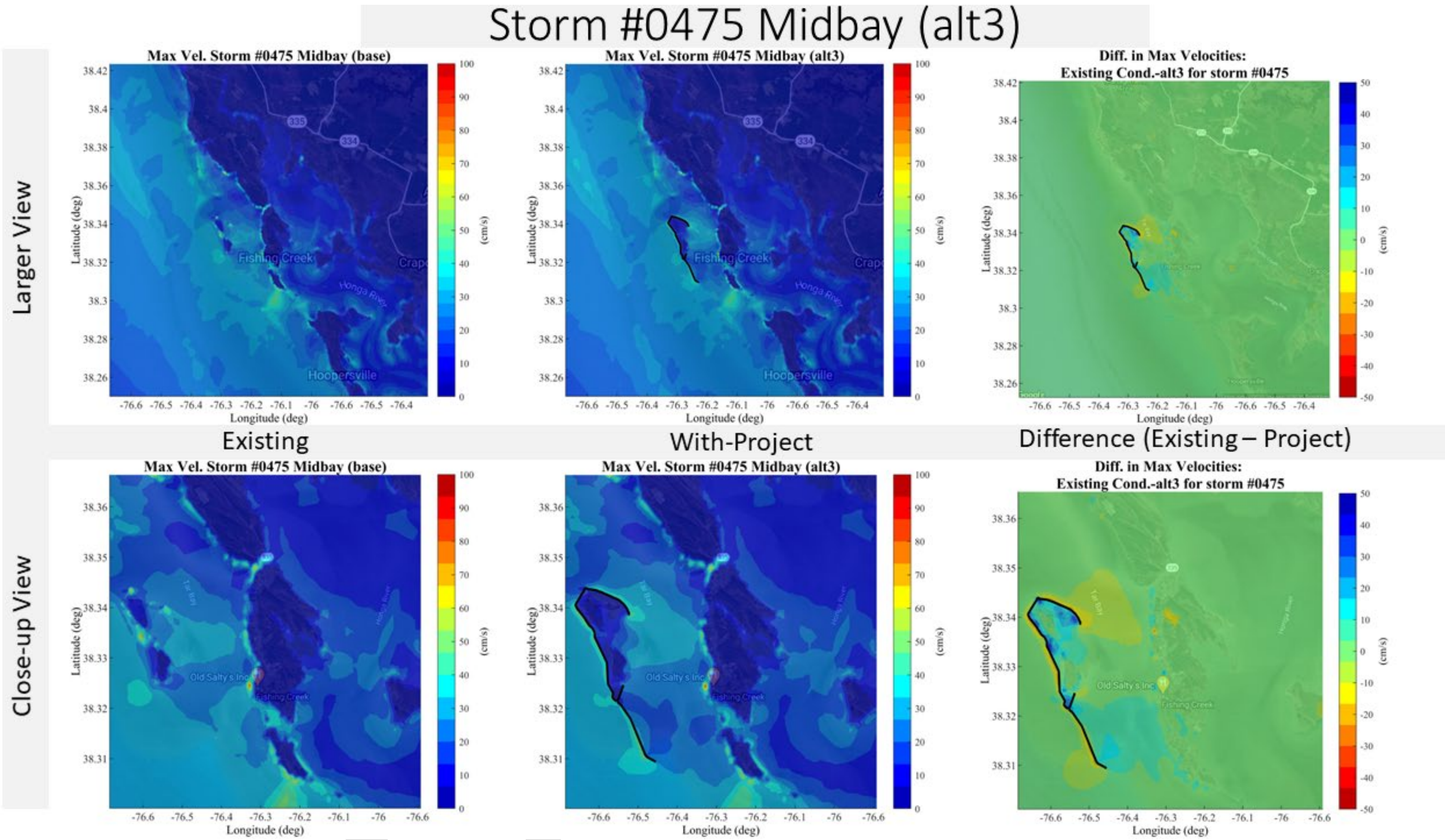

Storm #0354 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0354
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

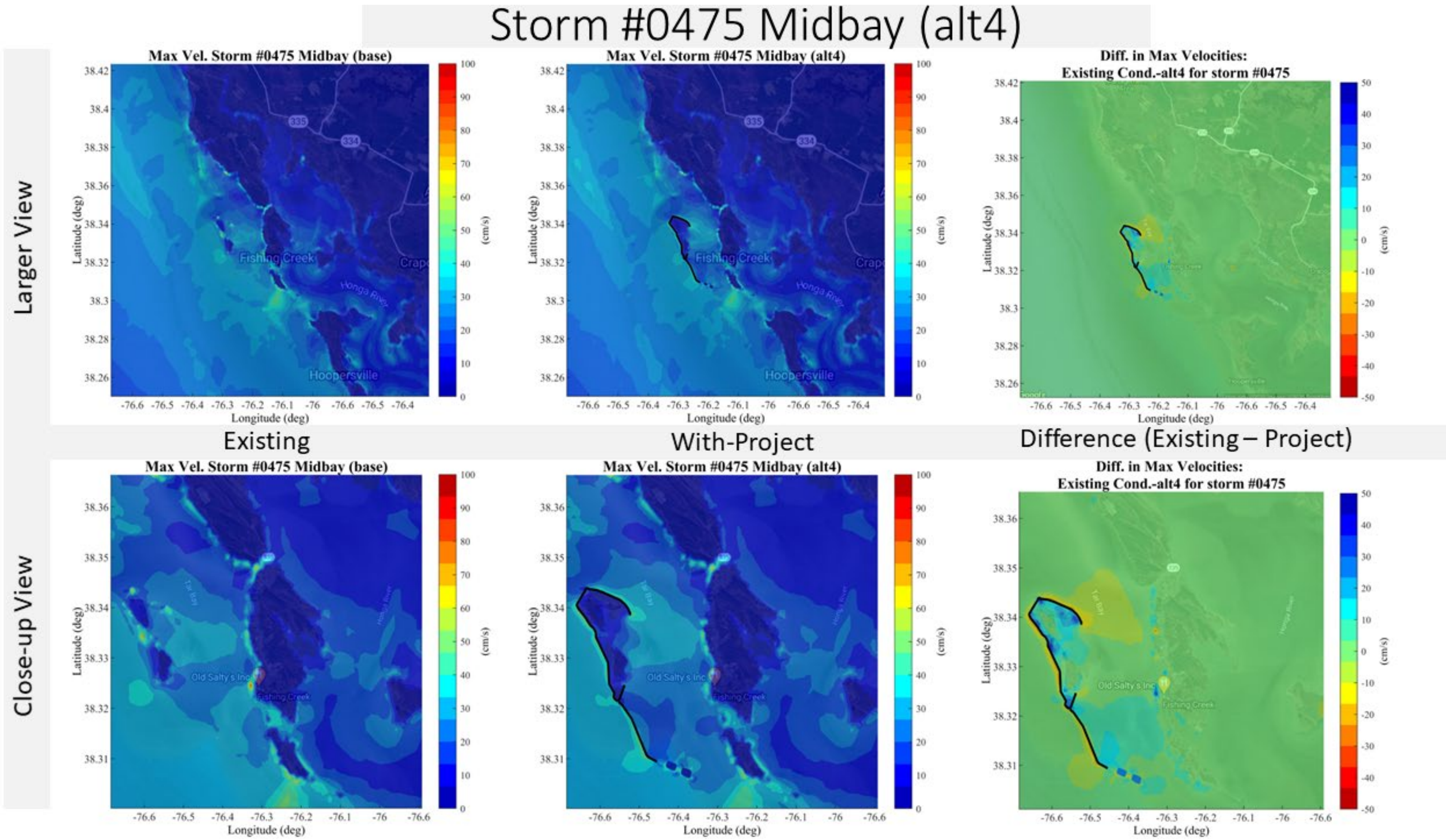

Storm #0354 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Tar Bay

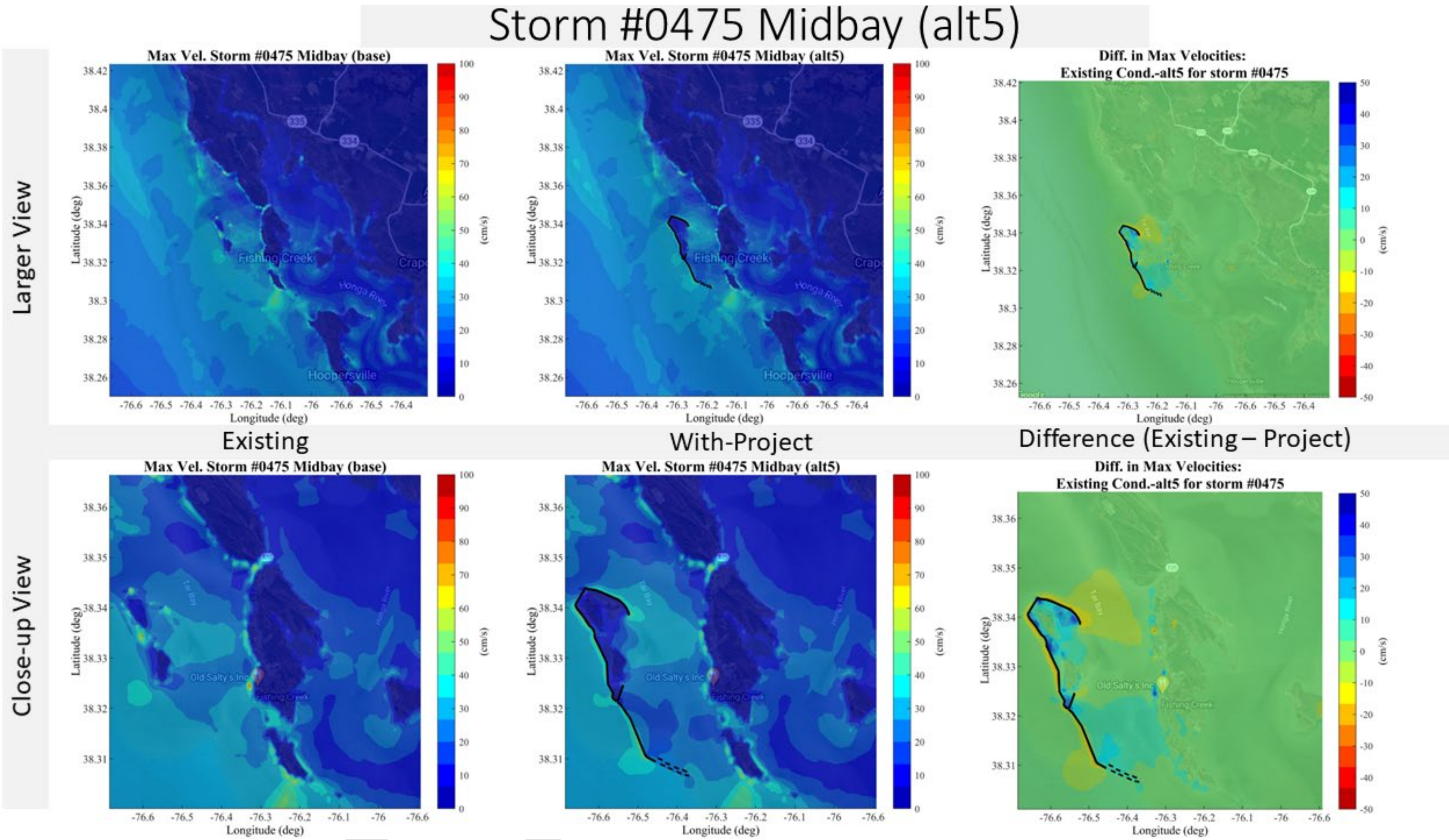

Storm #0354 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0354 Midbay (base)
Max Vel. Storm #0354 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0354
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc

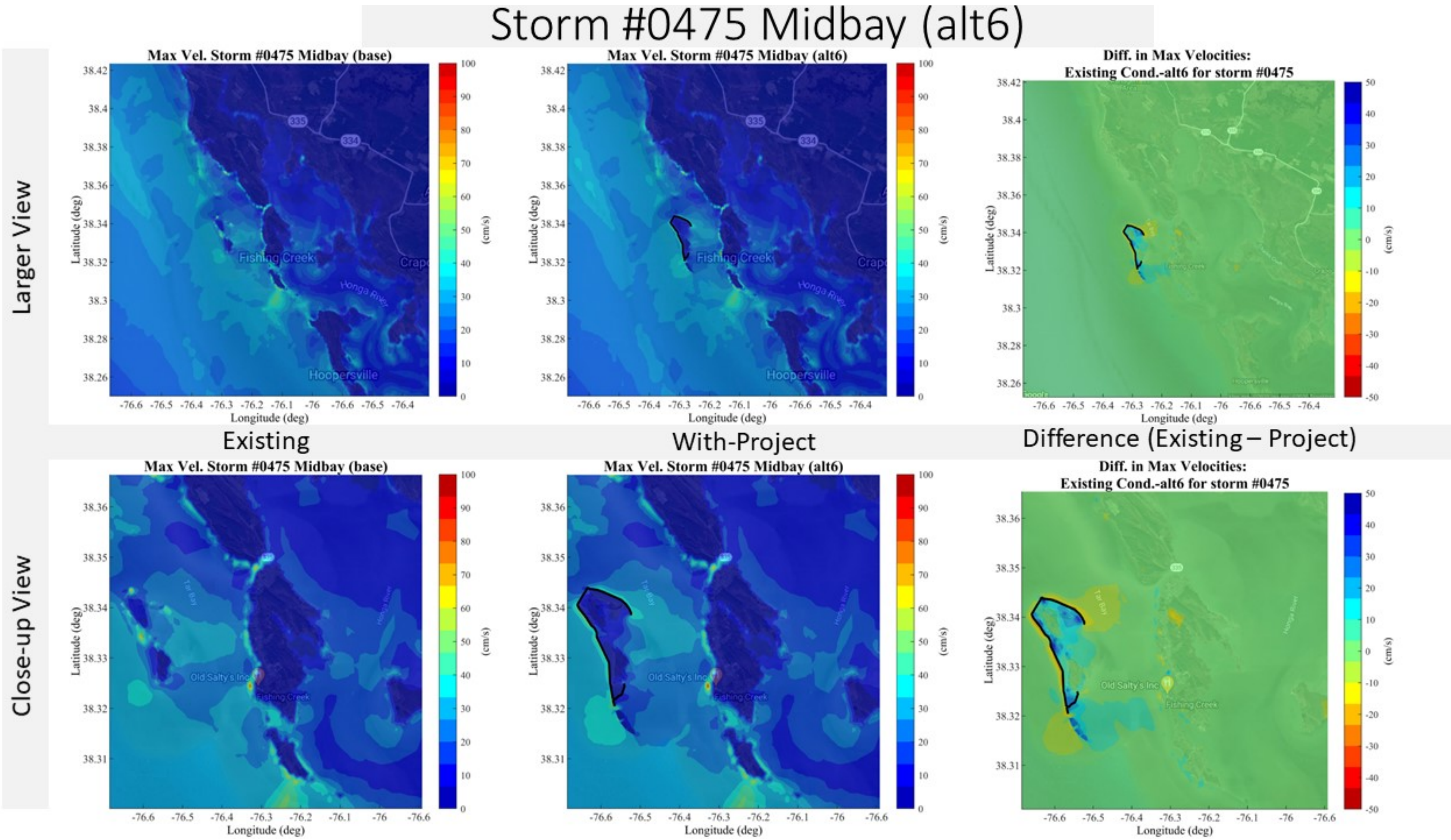

Storm #0475 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0475
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)


Storm #0475 Midbay (alt2)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0475
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc


Storm #0475 Midbay (alt3)
Larger View
Close-up View
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0475
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

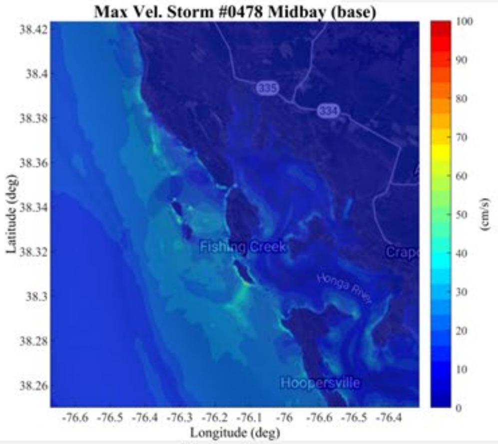

Storm #0475 Midbay (alt4)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0475
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Tar Bay


Storm #0475 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0475
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc


Storm #0475 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0475 Midbay (base)
Max Vel. Storm #0475 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0475
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc

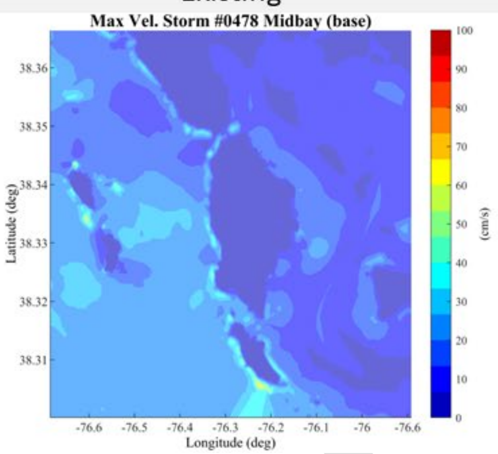
# Storm #0478 Midbay (alt1)

Larger View

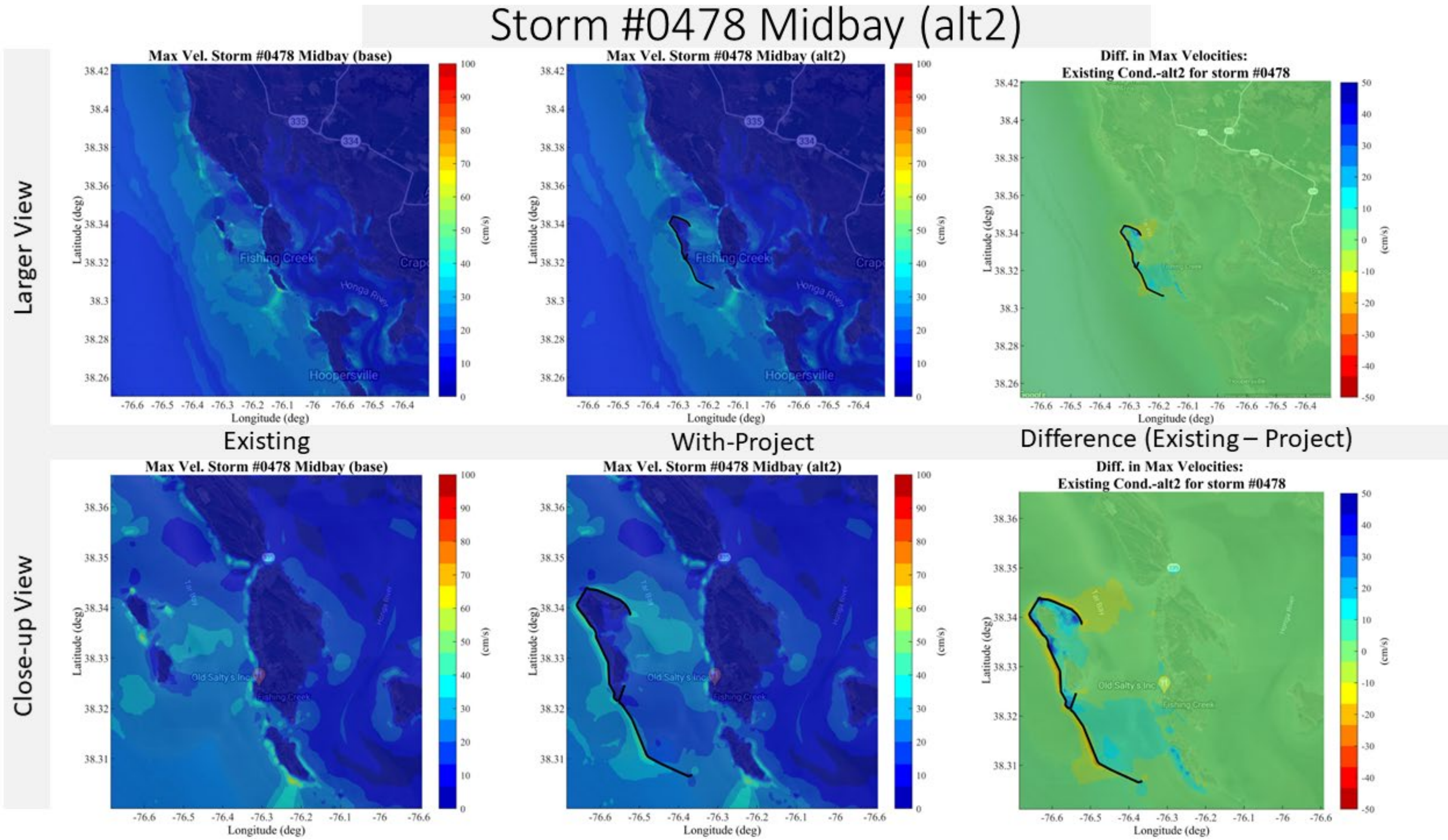


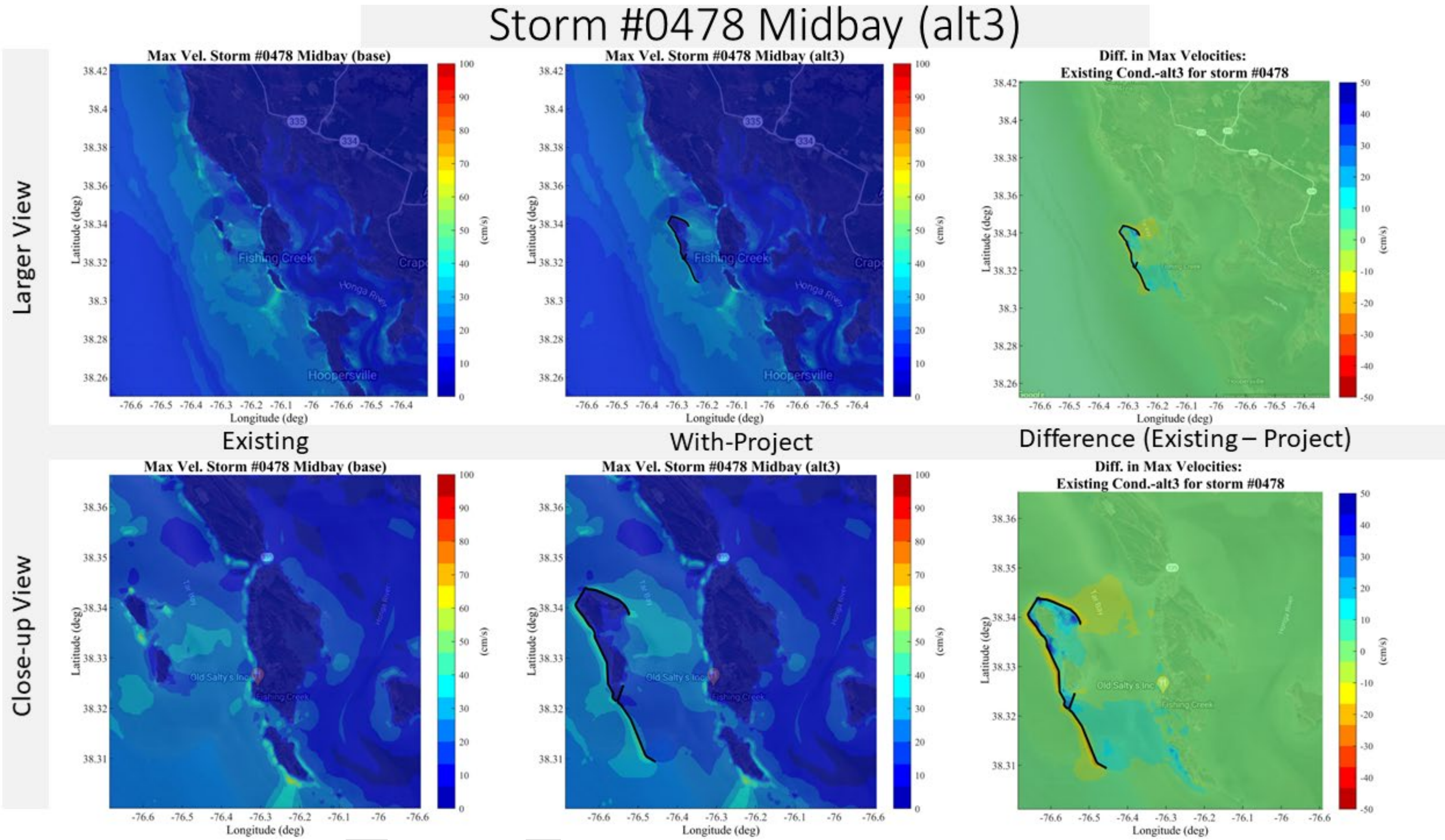

| Existing | With-Project | Difference (Existing – Project) |
| --- | --- | --- |

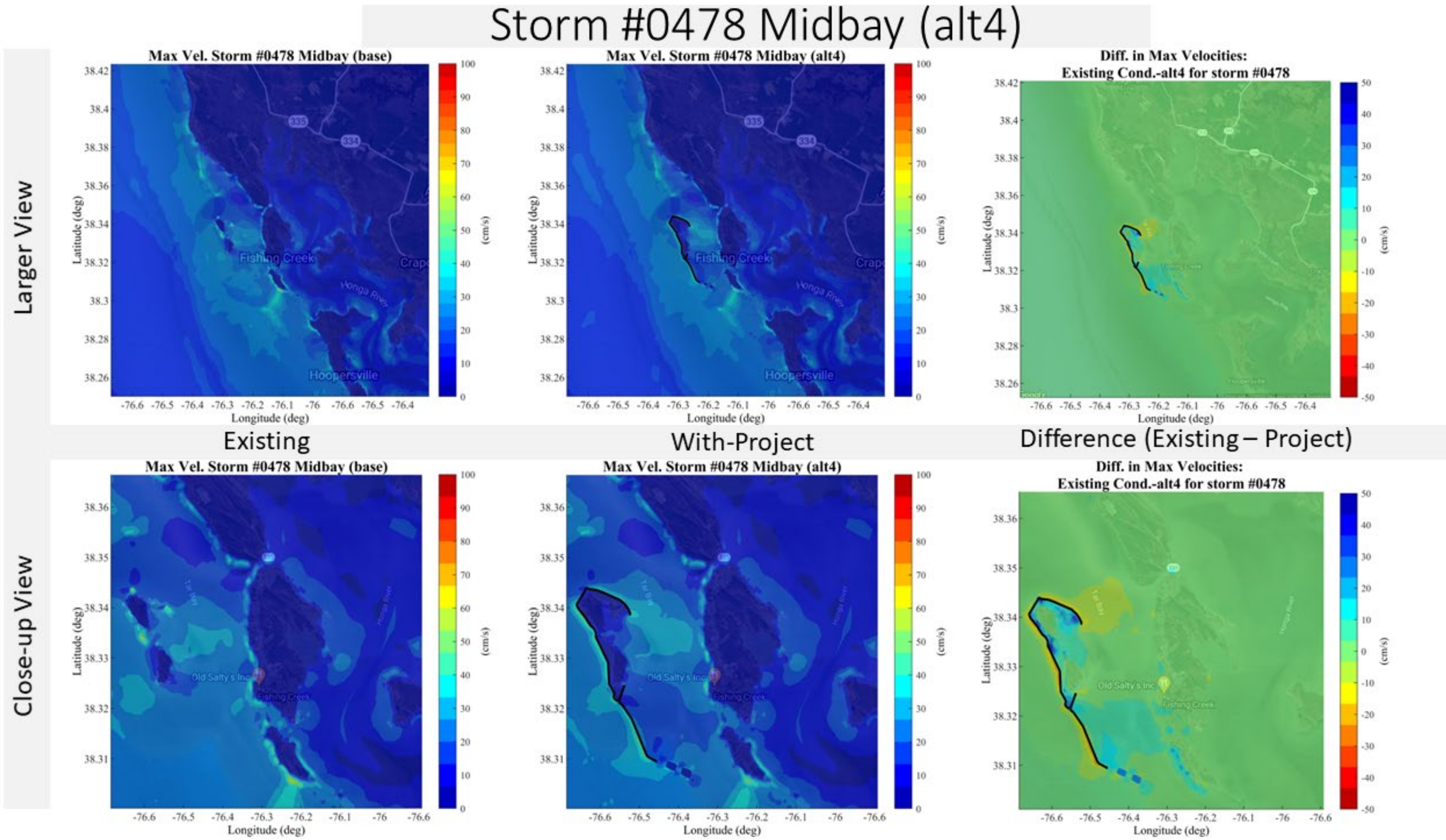
Close-up View

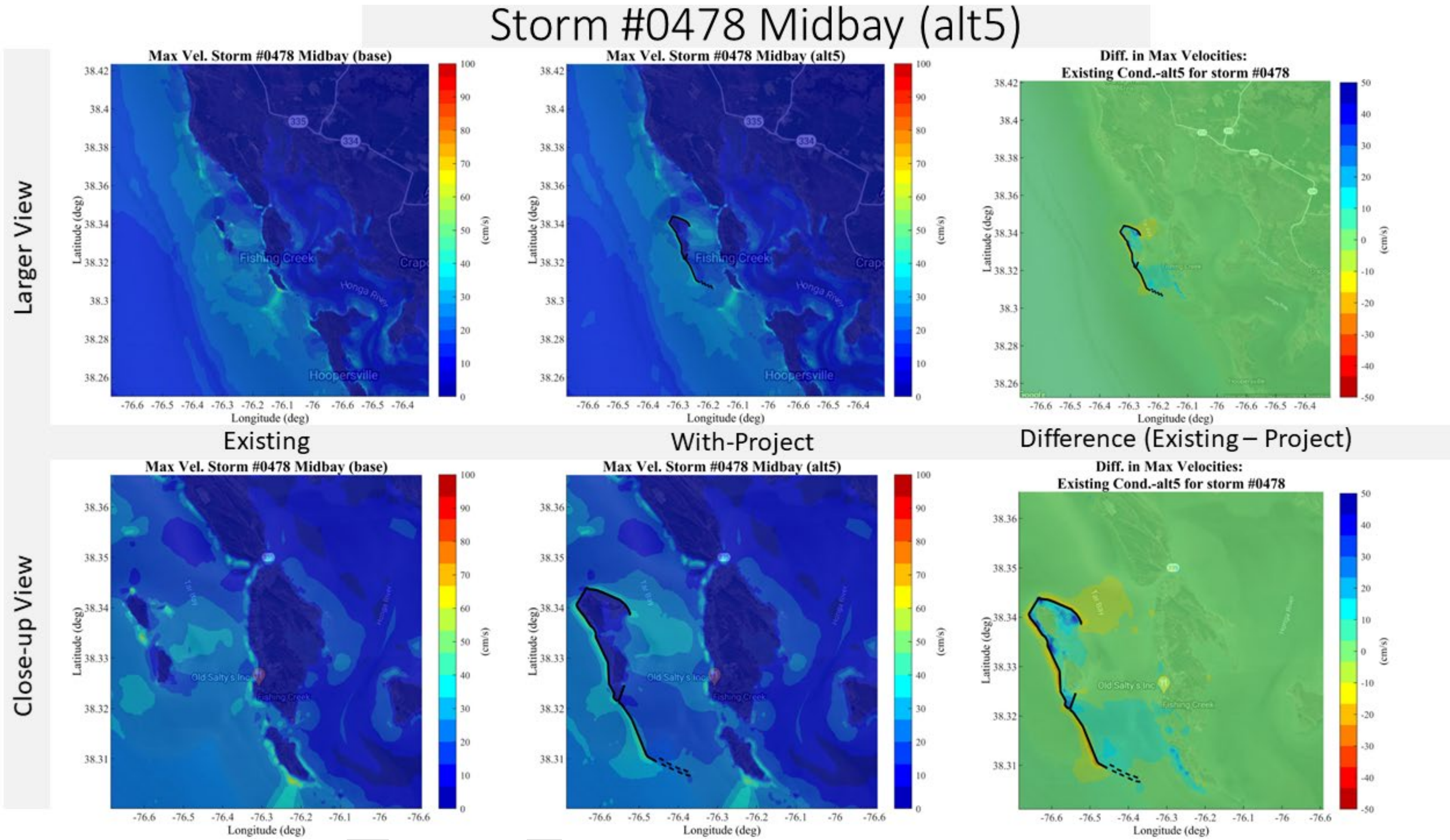


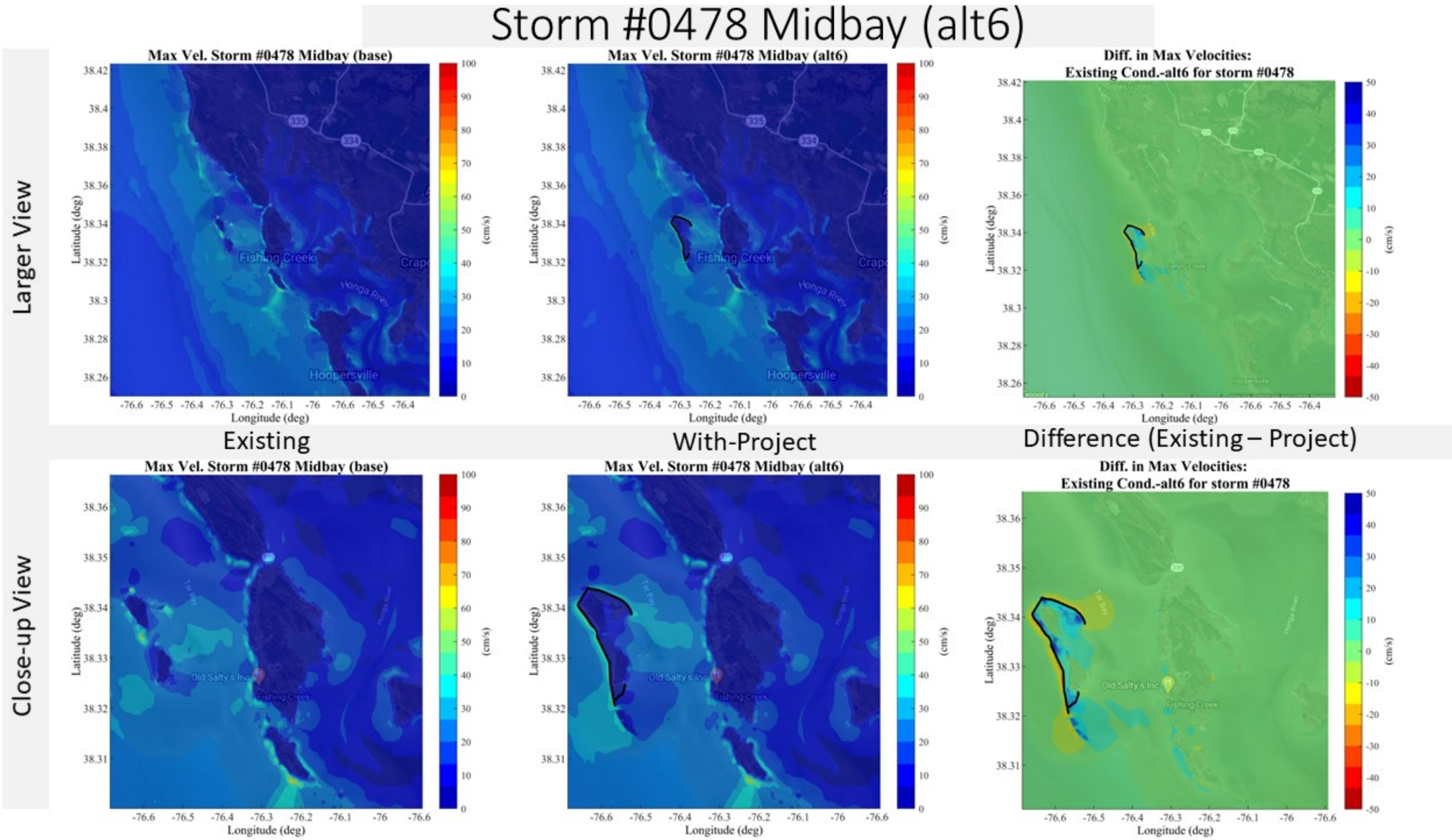

Note: There was an error with this model run and no results were produced.

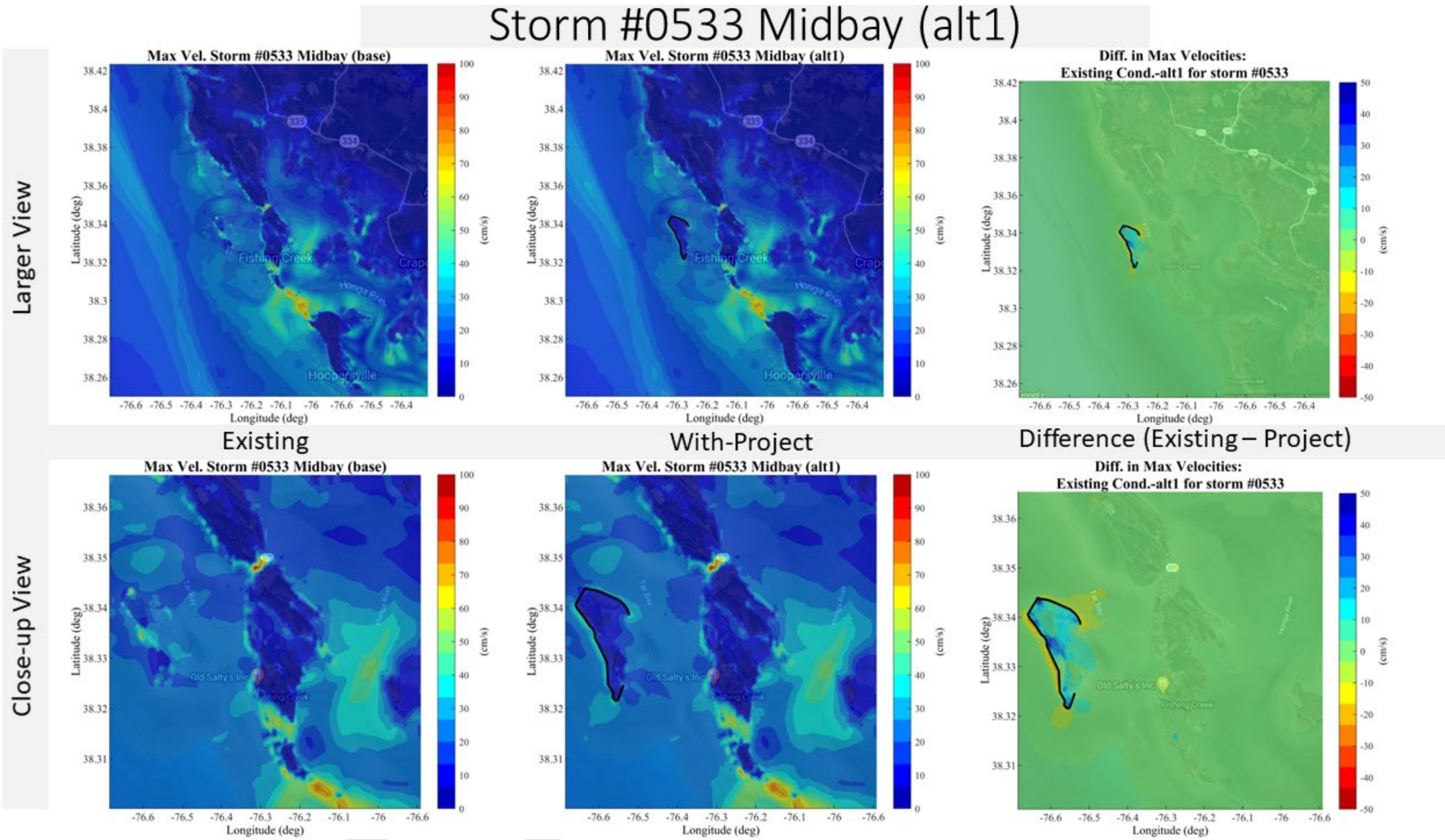

Storm #0478 Midbay (alt2)
Larger View
Close-up View
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt2)
Diff. in Max Velocities:
Existing Cond.-alt2 for storm #0478
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Honga River
Old Salty's Inc


Storm #0478 Midbay (alt3)
Larger View
Close-up View
Existing
With-Project
Difference (Existing – Project)
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0478
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt3)
Diff. in Max Velocities:
Existing Cond.-alt3 for storm #0478


Storm #0478 Midbay (alt4)
Larger View
Close-up View
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt4)
Diff. in Max Velocities:
Existing Cond.-alt4 for storm #0478
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)


Storm #0478 Midbay (alt5)
Larger View
Close-up View
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt5)
Diff. in Max Velocities:
Existing Cond.-alt5 for storm #0478
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)


Storm #0478 Midbay (alt6)
Larger View
Close-up View
Max Vel. Storm #0478 Midbay (base)
Max Vel. Storm #0478 Midbay (alt6)
Diff. in Max Velocities:
Existing Cond.-alt6 for storm #0478
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Honga River
Hoopersville
Old Salty's Inc
Existing
With-Project
Difference (Existing – Project)


Storm #0533 Midbay (alt1)
Larger View
Close-up View
Max Vel. Storm #0533 Midbay (base)
Max Vel. Storm #0533 Midbay (alt1)
Diff. in Max Velocities:
Existing Cond.-alt1 for storm #0533
Existing
With-Project
Difference (Existing – Project)
Latitude (deg)
Longitude (deg)
(cm/s)
Fishing Creek
Hoopersville
Old Salty's Inc