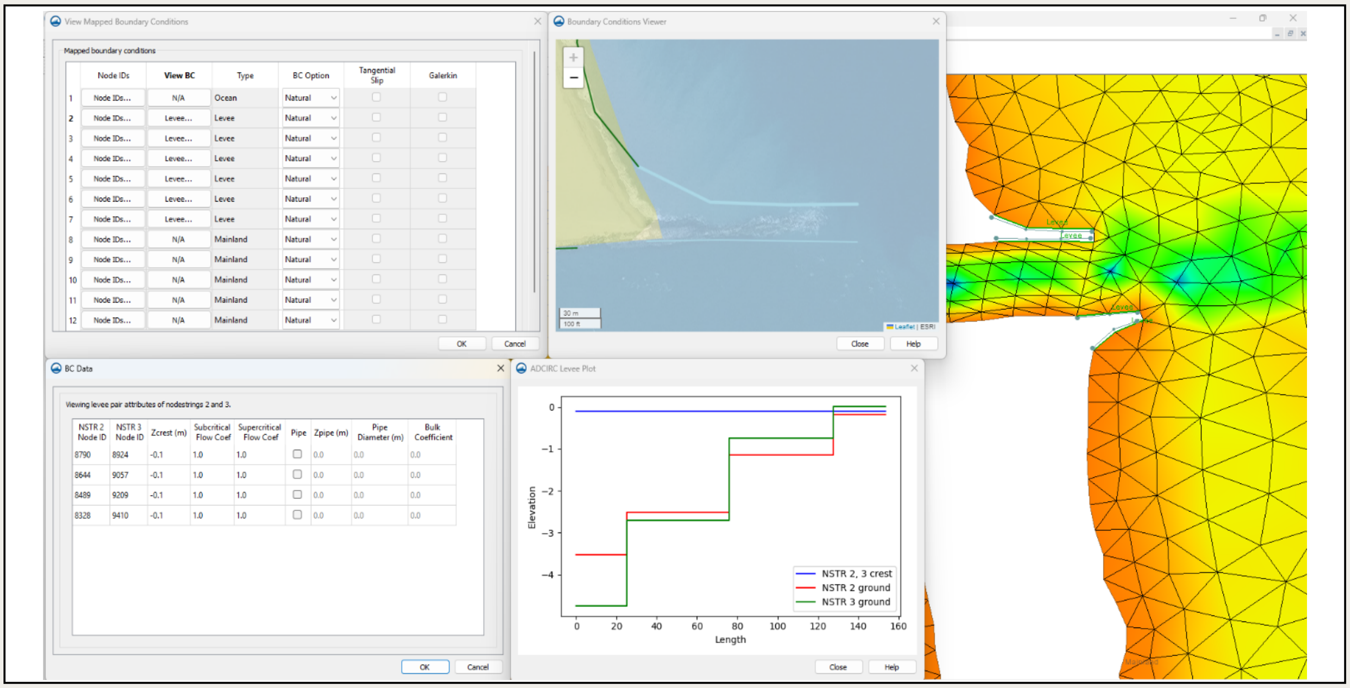
SMS 14.0 Training

ADCIRC Levee Simulation



Objectives

This tutorial demonstrates the procedure for incorporating levee boundary conditions into an ADCIRC simulation.

Prerequisite Tutorials

- Overview
- Map Module
- Raster
- Background Data
- Simulation Domain
- Mesh Generation
- Mesh Quality
- Levee Mesh Generation

Required Components

- SMS Core

Time

- 15–20 minutes

1 Introduction

This exercise illustrates how to set up and run an ADCIRC simulation with levees. It illustrates the default method for defining levee crest elevations and one approach for editing a levee crest.

This exercise utilizes data from the region around Indian River Inlet located on Delmarva Peninsula along the Maryland coast between Delaware Bay and Chesapeake Bay. It commences with the results of the *Levee Mesh Generation* exercise.

2 Getting Started

Start by importing a project file containing a mesh generated for use with levees:

1. Launch the SMS application.
2. From the *Menu* bar, select the *File* | **Open…** menu command to bring up the *Open* dialog.
3. Navigate to the *data_files* folder.
4. Select the “start.sms” file.
5. Click the **Open** button to import the project and exit the *Open* dialog.
6. From the *Menu* bar, select the *File* | **Save As…** menu command to bring up the *Save As* dialog.
7. For the *File Name*, enter “IR_levee_input.sms”.
8. Click the **Save** button to save the file.

This project includes the “patch inlet 50-1000m” mesh from the “Levee Mesh Generation” exercise, along with a stable simulation for the Indian River domain similar to those generated in the “ADCIRC Stability” exercise.

The project should appear similar to Figure 1.

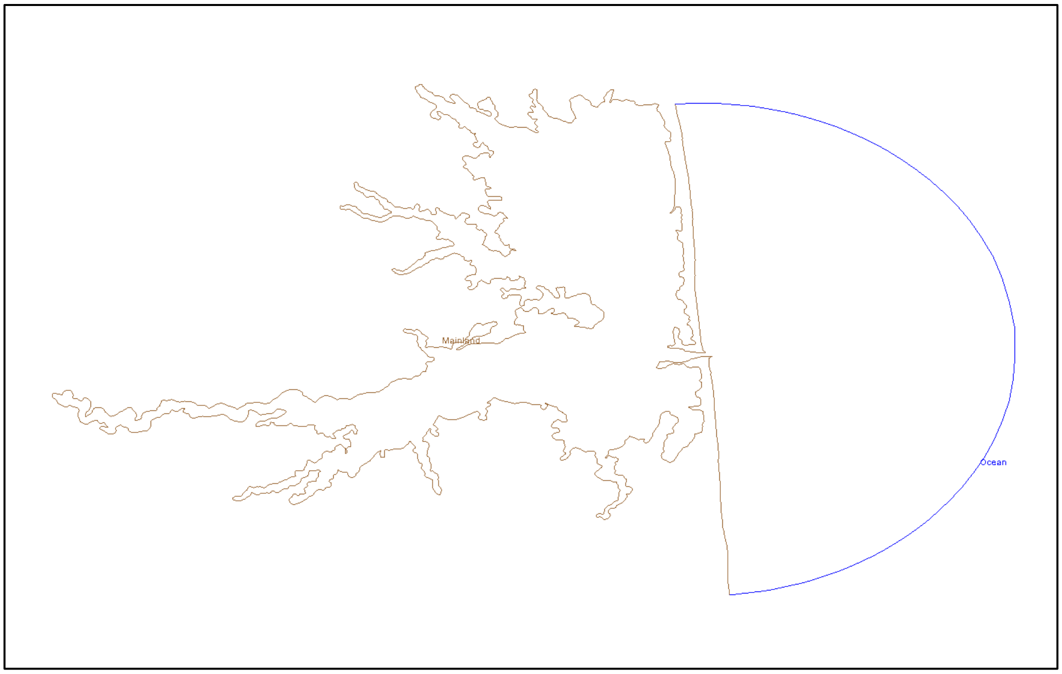


Figure 1 Levee Simulation Initial Map

3 Adding Levee Boundary Conditions

A levee can be added as a boundary condition to an ADCIRC simulation. In the ADCIRC computations they are treated as separate outflow/inflow boundaries in the ADCIRC domain. The flow rate is computed using a one-dimensional weir flow equation. ADCIRC also supports levee boundaries where flow just leaves the domain based on the same principles. When the flow leaves the domain, it is referred to as an outflow levee. This exercise illustrates internal levees only.

In this exercise we will add three levees to the simulation. Defining a levee involves:

- Specifying where the levee is in the domain.
- Defining the crest elevation
- Ensuring each levee is valid.
- The number of nodes on the two sides of the levee must match
- The crest elevation of the levee must be higher than the ground on both sides of the levee.

The levees always correspond to edges of the mesh. If they are completely enclosed in the interior of the mesh, there must be a hole in the mesh to represent the land occupied by the levee itself.

The levee and jetties are located at the inlet.

1. Using the **Zoom** static tool, zoom into the inlet, refer Figure 2Figure 3.

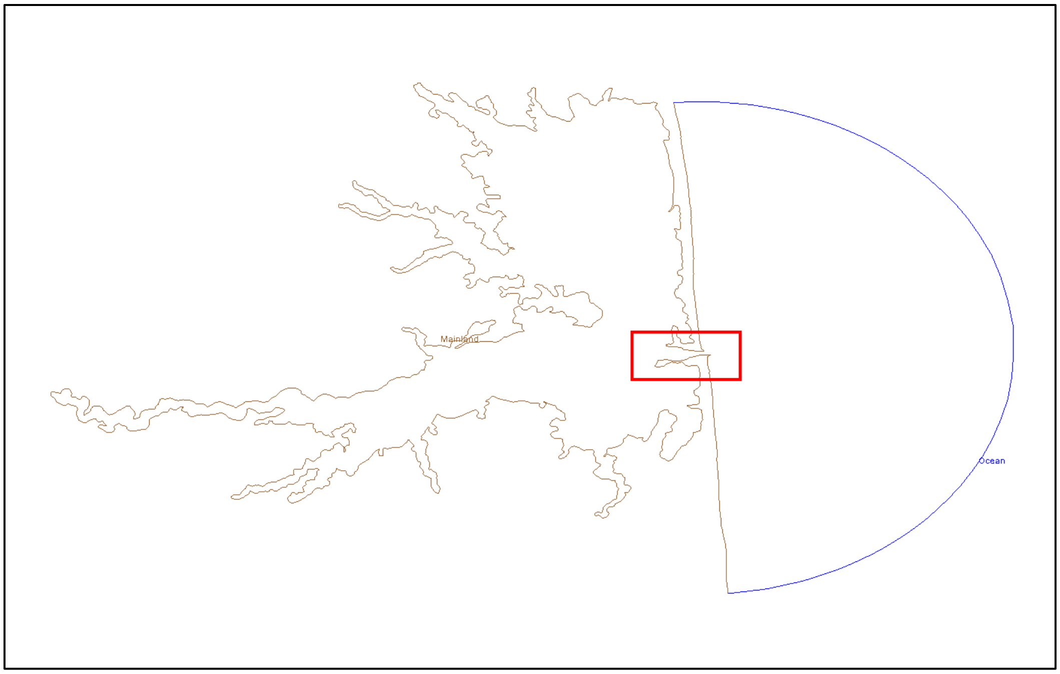


Figure 2 Levee and Jetties of the Inlet

3.1 Creating a New Boundary Conditions Coverage

A levee can be included in the same BC coverage that defines the ocean, mainland, island and river boundaries in an ADCIRC simulation, but they can also be separated out into one or more additional coverages. Since a complex simulation may include hundreds of these structures, multiple coverages can be included to decompose the complexity.

To create the new coverage:

1. In the Project Explorer, right-click on the " Map Data" folder and select the **New Coverage** context menu command to open the *New Coverage* dialog.
2. For the Coverage Type, select *Models* | *ADCIRC* | **Boundary Conditions**.
3. For the *Coverage Name,* enter "levee BC".
4. Click the **OK** button to close the *New Coverage* dialog.
5. Select the " levee BC*"* coverage to make it active.
6. Drag the " levee BC*"* coverage and drop into the " ADCIRC" map data folder, a black drop location line will appear.

3.2 Setting Boundary Conditions for the Levees on the Jetties

By default, the crest elevation for a levee is assigned using the elevation of the arcs that define the levee. This can be assigned at each node and vertex on the arc, or to the arc in general.

For this first pass, assign levee crest elevations of -0.1 meters for the north jetty, 0.5 meters for the south jetty and 0.3 meters for the levee on the south side of the inlet. Refer to the Levee Options tutorial to learn about other methods of setting and checking levee crest elevations.

A levee boundary condition consists of two arcs, one on either side of a gap in the mesh. If the water level exceeds the crest elevation specified for the levee, flow can pass from one side of the levee to the other. The first two levee structures will allow flow over the two jetties. To do this:

1. In the Project Explorer, turn off the " Simulation Data" folder checkbox.
2. Turn on the " patch inlet 50-1000m" mesh checkbox and click the mesh to make it active to display it for reference.
3. Click on the " levee BC" coverage to make it active.
4. Using the **Zoom** static tool, zoom into the inlet, refer Figure 3.

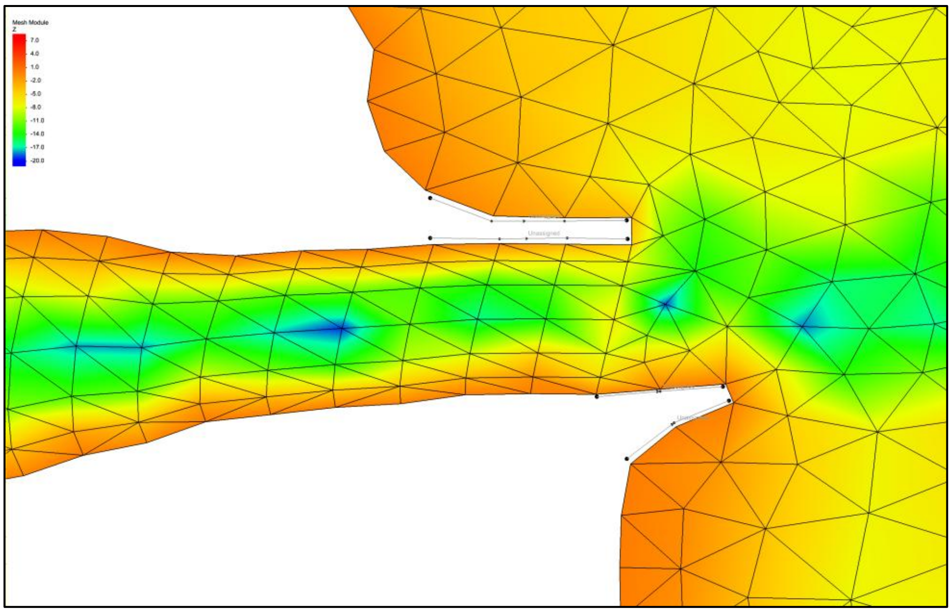


Figure 3 Arcs defined for levee structures at the jetties

3.3 Creating Levee Arcs

1. Using the **Create Feature Arc** dynamic tool, create two (2) pairs of arcs in the same direction, each pair having an equal number of vertices, near the edges of the jetties as shown in Figure 3. Note that they just need to be approximate, but it is good to keep them close to the mesh. They will be snapped to the mesh by the model.
2. Using the **Select Feature Arc** dynamic tool, hold down the *Shift* key and select the two arcs for the north jetty levee.
3. In the *Edit Window,* in the *Z* edit field, enter a value of "-0.1" and click the *Enter* key to set the value. This sets the elevation of the two arcs to be -0.1m.
4. In the *Graphic Window,* right-click on the selected arcs and select the **Assign BC…** context menu command. The *Assign Linear BC* dialog appears.
5. From the *Linear boundary condition options* drop-down menu, select "Levee". A *BC* Plot window appears with a plot showing the crest elevation as defined by the arcs. The value is -0.1 m (relative to sea level).
6. Click the **Close** button to close the *BC Plot* dialog.

7. Click the **OK** button to close the *Assign Linear BC* dialog.
8. Repeat steps 1 - 7 for the south jetty levee but set the arc elevation to “0.5” m.

3.4 Setting Boundary Conditions for the Levee in the Inlet

Now we will repeat these steps to define the levee on the southwest side of the inlet.

1. Using the **Pan** static tool to pan West (left) into the area on the south side of the inlet shown in Figure 4.

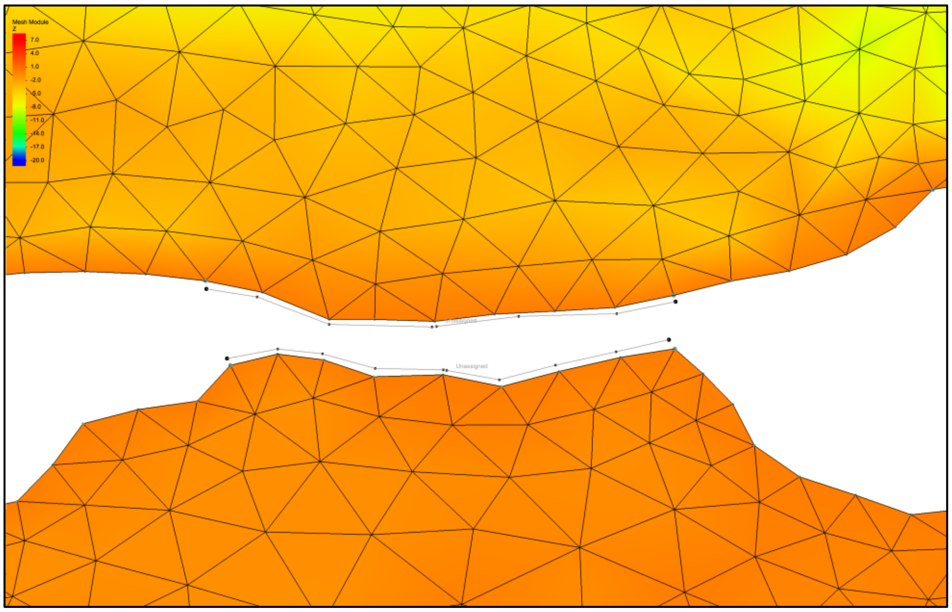


Figure 4 South side of the inlet

2. Using the **Create Feature Arc** dynamic tool, create two arcs in the same direction with an equal number of vertices, as shown in Figure 4.
3. Using the **Select Feature Arc** dynamic tool, hold down the *Shift* key and select the two arcs for the inlet levee.
4. In the *Edit Window,* in the *Z* edit field, enter a value of 0.3 and click the *Enter* key to set the value. This sets the elevation of the two arcs to be 0.3m.
5. In the *Graphic Window,* right-click on the selected arcs and select the **Assign BC…** context menu command*.* The *Assign Linear BC* dialog appears.
6. From the *Linear boundary condition options* drop-down menu, select “Levee”. A *BC* Plot window appears with a plot showing the crest elevation as defined by the arcs. The value is 0.3 m (relative to sea level).
7. Click the **Close** button to close the *BC Plot* dialog.
8. Click the **OK** button to close the *Assign Linear BC* dialog.

4 Duplicating a Simulation

Set up a new simulation. To do this:

1. In the Project Explorer, right-click on the existing “ Tide - constant” simulation and select the **Duplicate** context menu command.
2. Right-click on the “ Tide – constant (2)” simulation, select the **Rename** context menu command, enter “Levees constant Zc” and click the *Enter* key to set the new name.
3. In the “ Levees constant Zc” simulation, right-click on the “ constant pave 50-100m” link and select the **Remove** context menu command.
4. Right click on the “ patch inlet 50-100m” mesh and select the *Apply to* | **ADCIRC Simulation → Levee constant Zc** context menu command.
5. Right click on the “ levee BC” coverage and select the *Apply to* | **ADCIRC Simulation → Levee constant Zc** context menu command.
6. Right click on the “ Levees constant Zc” simulation and select the **Map Boundary Conditions...** context menu command. The *Applying Boundary Conditions* dialog appears while the command is running, it will close automatically when it completes successfully.
7. Right click on the “ Levees constant Zc” simulation and select the **Model Control** context menu command. The *ADCIRC Model Control* dialog appears.
8. In the *Geneal Parameters* tab, in the *Simulation description* section, change the *Project title* to “Indian River Zc const 10/24/2012”.
9. Click the **OK** button to close the *ADCIRC Model Control* dialog.

4.1 Reviewing the Levee Elevations

Now that the boundary conditions are mapped, they can be reviewed. This can be very useful for levee type boundary conditions. To review the levees:

1. In the “ Levees constant Zc” simulation, right click on the *Boundary Conditions (applied)* item and select the **Boundary Conditions…** context menu item. The *View Mapped Boundary Conditions* and *Boundary Conditions Viewer* dialog boxes appear. This allows you to review the conditions as they will be passed to ADCIRC.
2. In the *View Mapped Boundary Conditions* dialog, in the *Mapped boundary conditions* section, from *Row 2* of the *View BC* column, click on the **Levee…** entry. The *BC Data* table and *ADCIRC Levee Plot* dialog boxes appear, as seen in Figure 5, the dialog boxes are movable and resizable.

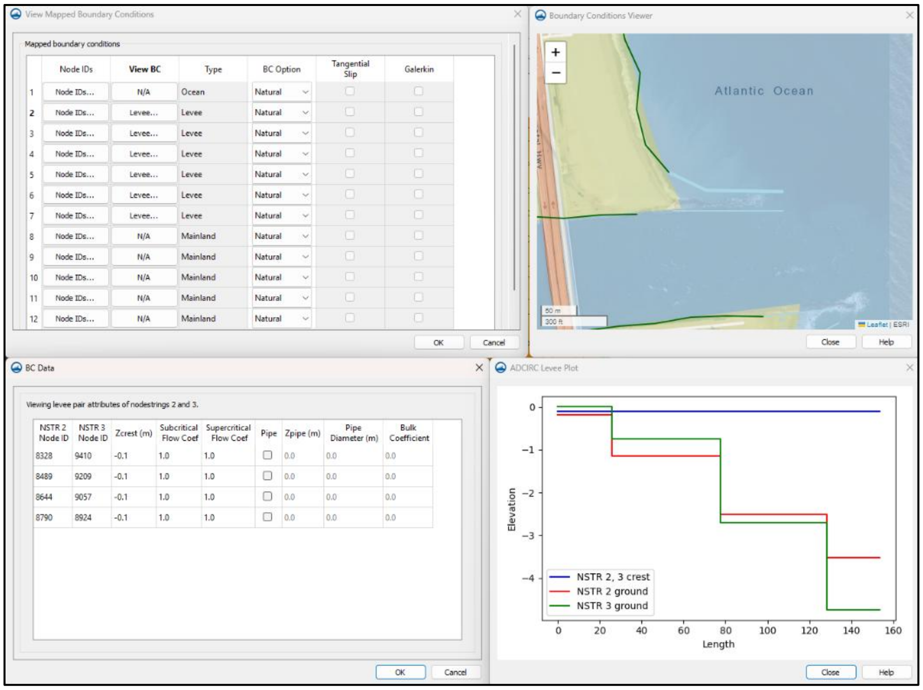


Figure 5 Boundary condition review tools

3. In the *BC Data* table, click on one of the cells in the second row. This will zoom the *Boundary Conditions Viewer* window on the levee.

Notes:

The viewer window zooms into the selected BC nodestring.

The selected nodestring is drawn as a bold line on the map. In the case of a levee, the other nodestring for this levee is drawn in the same color.

Other nodestrings are displayed in their own colors as set in the display options for the mapped boundary conditions.

The nodes associated with the row of the selected table are drawn as bold points in the viewer and a dashed vertical line appears in the *ADCIRC Levee Plot* at the location of the levee point pair.

The *ADCIRC Levee Plot* illustrates that there is a problem with this levee. Specifically, the ground elevation for NSTR 2 is higher than the levee crest elevation at node *9410*. This is invalid for the ADCIRC simulation.

There are two possible approaches to resolve this invalid levee. The first is to raise the crest elevation. The second is to lower the mesh node elevation. The appropriate method depends on what physical conditions exist.

For this exercise, we will assume that the assigned crest elevation is approximate and can be modified. This can be edited here in the *BC Data* table. Other methods are described in the Levee Options tutorial.

4. In the *BC Data* table, find the cell with *Node ID* of “9410”, go to the *Zcrest (m)* column of that row and change the value to “0.1” and press the *Enter* key. The plot updates to show that the crest is now higher than the ground elevation.

5. Click the **OK** button to close the *BC Data* table window, the *ADCIRC Levee Plot* dialog also closes.

6. If desired, review the other levee nodestrings in the *Mapped Boundary Conditions* table. They are valid definitions, and can be reviewed. When done, click the **OK** button on the *View Mapped Boundary Conditions* table.

Note: The Boundary Conditions Viewer dialog stays open until the View Mapped Boundary Conditions table is closed.

5 Running the Simulation

With a completed simulation, we will now save and run the simulation.

1. From the *Menu* bar, select the *File* | **Save as…** menu command.
2. For the *File Name,* enter “IR_levee_sim.sms”.
3. Click the **OK** button to save the file and close the *Save As* dialog.
4. In the Project Explorer, right-click on the “ Levees const Zc” simulation and select the **Save Project, Simulation and Run** context menu command.
5. If asked to renumber coverages, click the **Yes** button.
6. The *Simulation Run Queue* dialog opens showing the progress of the simulation.

6 Reviewing the Simulation Results

To review the simulation results:

1. When the simulation is complete in the *Simulation Run Queue* dialog, click the **Load Solution** button to load the solution into SMS.
2. Click on the **Display Options** macro to open the *Display Options* dialog.
3. From the list on the left select the *2D Mesh* item, in the *2D Mesh* tab on the right, turn on the *Vectors* checkbox.
4. Turn off the *Elements* checkbox.
5. Click the **OK** button to close the *Display Options* dialog.
6. Using the **Zoom** static tool, zoom into the south side of the inlet where the levee was defined.
7. In the *Time Step* window, step through the timesteps. Note the flow entering the bay south of the inlet indicating overtopping of the levee.
8. Zoom into the area of the jetties and step through the timesteps. Note the flow as the tide comes in where the flow is leaving the ocean by overtopping the levee. For example, during “Time step 22943 20:00:00” Refer Figure 6.

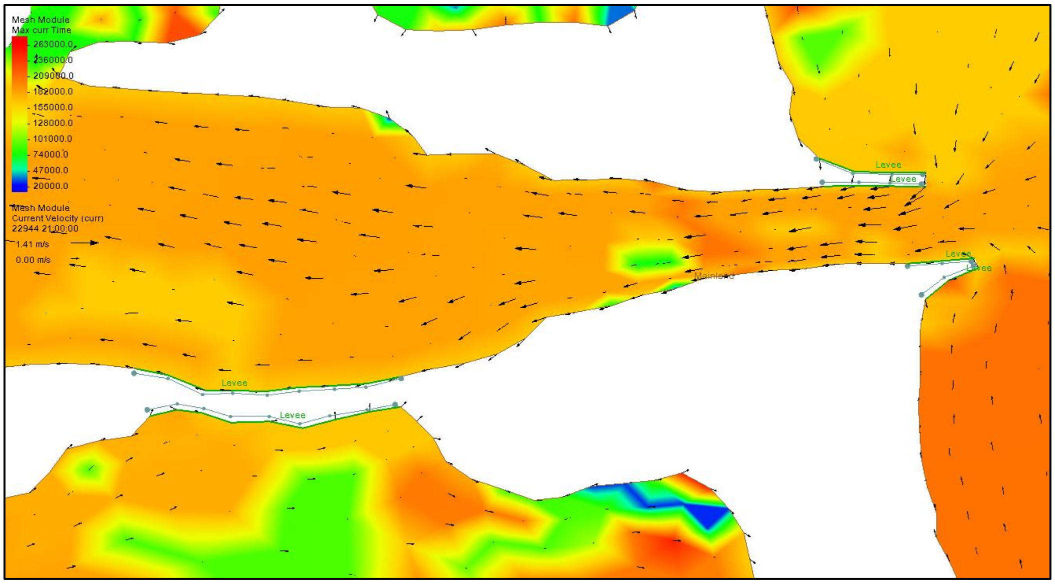


Figure 6 Overtopped levees

7 Saving the Project

To save the project:

1. From the *Menu* bar, select the *File* | **Save Project** menu command.

8 Conclusion

This concludes the "Levee Simulation" tutorial. Several features have been demonstrated including:

- Defining levee arcs
- Defining levee attributes
- Resolving levee crest issues
- Running the simulation
- Viewing simulation results

If time permits, you may wish to try experimenting with:

- Different values of levee elevations and crest heights.

