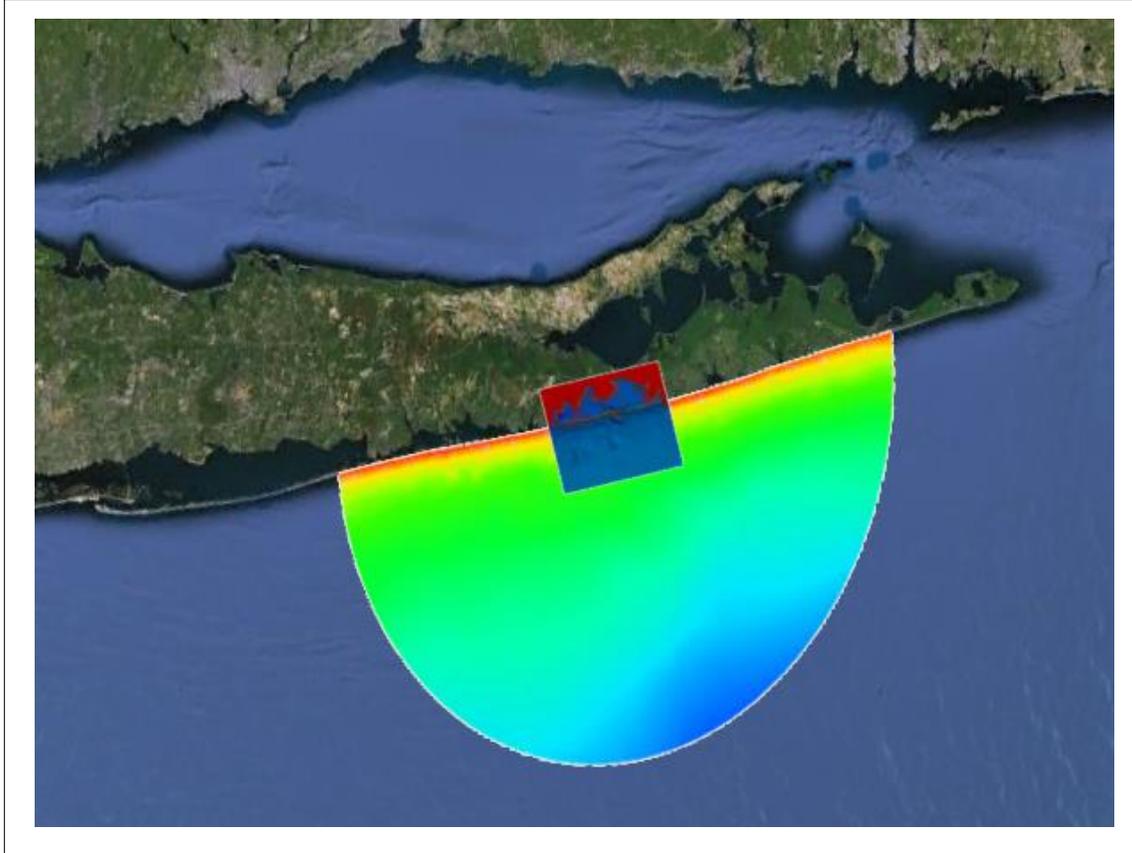*SMS 12.2 Tutorial*
STWAVE Analysis

Objectives

This tutorial gives a brief introduction to the STWAVE modules. Data from the Shinnecock Inlet, Long Island, New York, have been set up as an example. This example will use a scatter set generated in another tutorial. An STWAVE grid will be created over a small section of the scatter set data.

Prerequisites

- Overview Tutorial

Requirements

- Map Module
- STWAVE
- Cartesian Grid Module
- Scatter Module

Time

- 30-60 minutes

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1   Converting ADCIRC to Scatter

This tutorial starts by using files generated with the ADCIRC model.

1.1   Reading in the ADCIRC files

First, open the scatter set data of the area around Shinnecock Inlet on the south shore of Long Island, New York. For convenience, the scatter set data, and an XMDF version of the current file are supplied in the "data files" folder for this tutorial.

To open the files:

1. Select *File* / **Open...** to bring up the *Open* dialog.

2. Select the file "shinfinal.h5" located in the data file folder for this tutorial and click **Open** to read in the data file.

3. Repeat steps 1 and 2 to open the file "shincurrents.h5".

1.2   Coordinate Conversions

The coordinate of the project are currently set to geographic coordinate but this project requires viewing the data from a state plane coordinate for New York Long Island. To do this:

1. Click *Display* and select **Projection...** to bring up the *Display Projection* dialog.

2. Click **Set Projection** to bring up the *Select Pojection* dialog.

3. Set the *Projection* to "State Plane Coordinate System". The *Datum* should be "NAD83". The *Planar Units* should be set to "METERS" with the *Zone* set to "New York−Long Island (FIPS 3104)". Click **OK** to close the *Select Pojection* dialog.

4. Back in the *Display Projection* dialog, make sure the *Vertical Units* are set to "Meters". Click **OK**.

5. Next, right-click on the "Scatter_From_Mesh" scatter set in the Project Explorer and select **Projection**. to open the *Object Projection* dialog

6. Make sure that *Global projection* is turned on and click on **Set Projection** to open the *Select Projection* dialog.

7. Make sure that the *Projection* is set to "Geographic (Latitude/Longitude).*"* Make sure that the *Datum* is set to "NAD83" and the *Planar Units* are in "Arc Degrees". Click **OK** to close the *Select Projection* dialog.

8. Click **OK** to close the *Object Projection* dialog.

2   Creating the Cartesian Grid

Now it's time to create a Cartesian grid for running STWAVE. The grid frame is created in the Map ✛ module. The Map module contains tools for creating GIS objects such as points, arcs, and polygons. It is also used for creating a frame, which will be filled in by a Cartesian grid.

2.1   Creating the Cartesian Grid Frame

To create the grid frame:

1. Right-click on the "Area Property" default coverage in the Project Explorer. In the *Type* menu, select *Models* and in that menu select **STWAVE**.

2. Right-click on "Area Property" again and select **Rename**. Then enter the name "STWAVE Bounds" as the new coverage name.

3. Right-click on the "STWAVE Bounds" coverage and click on **Projection** to open the *Object Projection* dialog.

4. Select the *Global projection* radio button then click **Set Projection** to bring up the *Select Projection* dialog.

5. Set the *Projection* to "State Plane Coordinate System". The *Datum* should be "NAD83". The *Planar Units* should be set to "METERS" with the *Zone* set to "New York - Long Island (FIPS 3104)". Click **OK** to close the *Select Projection* dialog.

6. Back in the *Object Projection* dialog, the *Vertical Units* should also be set to "Meters". Click **OK** to set the projection.

7. **Zoom** 🔍 in to the harbor a little so it appears similar to Figure 1.

8. Select the **Create 2-D Grid Frame** ⊡ tool then click out three corners of the grid in the order shown in Figure 1 to create the grid frame. The first two points define the i-direction, which is the direction of the incoming waves, and the last two points are placed on the land.
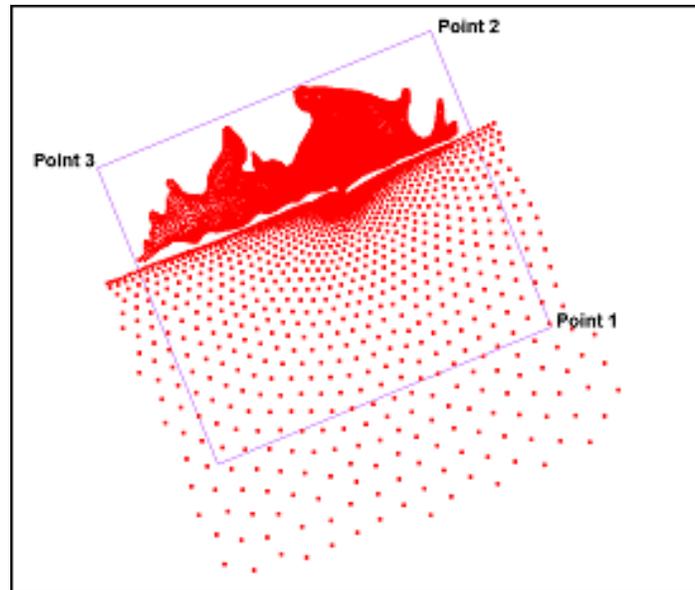

Figure 1   Creating the Cartesian Grid Frame

9. Switch to the **Select Grid Frame** ⊡ tool and select the box in the middle of the grid frame (it may be hard to see behind the scatter points). The origin should be in the bottom right corner of the grid, which will be shown by the two arrows appearing at that corner.

10. Resize the grid frame by dragging the corners or edges until the grid frame fits over the desired area. Dragging a corner or side resizes the frame. Dragging the middle point moves the entire frame. Rotate the frame around the origin by dragging the circle located just outside the grid.

11. Right-click on the grid frame and select **Properties**. This brings up attributes of the grid frame in a *Grid Frame Properties* dialog.

12. For consistency purposes, set the *Origin X* to "438,000", the *Origin Y* to "70,000", and the *Angle* to "112". Also make the grid size about "15,000" meters in the *I size* direction and about "17,000" meters in the *J size* direction. Click **OK** to exit the *Grid Frame Properties* dialog.

13. Click outside the grid frame to unselect the grid when finished.

2.2   Mapping to the Grid

Next, fill the interior of the grid. While the grid is filling, the depth and current values will be interpolated from the scatter set and mapped to each cell. To do this:

1. Go to *Feature Objects | **Map→2D Grid** to open the *Map →2D Grid* dialog.

2. Make sure the X, Y, and Angle values are set to "438,000", "70,000", and "112" respectively. Make sure the *I size* value is "15000" meters and the *J size* value is "17000" meters.

3. Make sure *Cell Size* is selected in the *Cell Options* section and change the cell size in both directions to "100" meters.

4. In the *Depth Options* section, make sure that the *Source* is set to "Scatter Set" and then click on the **Select** button to bring up the *Interpolation* dialog.

5. Select "elevation" in the *Scatter Set to Interpolate From* section then click **OK** to close the *Interpolation* dialog .

6. Turn the *Map Vector* option on. Make sure the *Interpolated* option is selected and click the **Select** button underneath it to open another *Interpolation* dialog.

7. Select the "Velocity (64)" scatterset. Make sure *All Time Steps* is selected. Select **OK** to exit the *Interpolation* dialog.

8. Click **OK** to close the *Map →2D Grid* dialog and create the Cartesian grid.

9. Right-click on the "STWAVE Bounds Grid" item in the Project Explorer and select **Rename**. Edit the name of the grid to "100m". This indicates the resolution of the grid.

   Note on interpolation: It is easiest to interpolate currents when creating the 2D Grid even if the project won't be using currents until a later simulation. Choose whether or not to use currents in the STWAVE model control. When interpolating, specify a single time step or multiple steps. Single times come from any time in the dataset. For multiple steps, specify to match all the steps from the dataset, or can specify a beginning and ending time step and a time step size.

A Cartesian grid has been created from the grid frame. To view the grid only:

1. Turn off the Scatter Data and Map Data in the Project Explorer by unchecking their respective toggle boxes in the tree.

2. **Frame** 🌐 the display.

3. Click on the "100m" item to work on the STWAVE simulation.

4. Select the **Select Grid Cell** ⊞ tool from the Cartesian Grid toolbox and select cells within the grid over the offshore edge of the grid to get an idea of the depth of the water. The average is approximately 32 meters.

3   Editing the Grid and Running STWAVE

With the grid generated, set up the STWAVE model parameters and run the model.

3.1   Generating Spectral Energy Distribution

To generate the spectral energy distribution:

1. Right-click on Map Data in the project explorer and select **New Coverage** to open the *New Coverage* dialog.

2. Select the *Coverage Type* as "Spectral" under the "Generic" section.

3. Enter a *Coverage Name* as "Spectral" then click **OK** to close the *New Coverage* dialog.

4. Using the **Create Feature Point** ∴ tool, create a point along the middle of the bottom grid boundary as shown in the Figure 2.
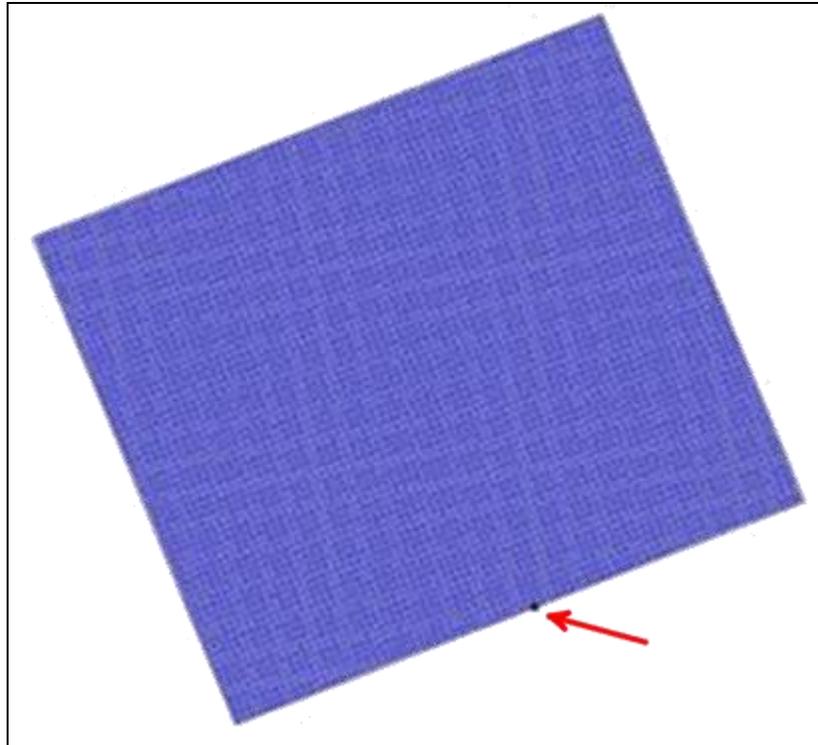

Figure 2   Spectral point location

5. Use the **Select Feature Point** tool and double-click on the point. The *Spectral Energy* dialog will appear.

6. Click the **Create Grid** button to bring up the *Spectral Grid Attributes* dialog.

7. Set the *Grid angle* to "112.0" degrees. This will match the angle of the STWAVE grid.

8. Make sure that the *Spectral energy grid plane type* is set to "Full - local" and select **OK** to close the *Spectral Grid Attributes* dialog. The *Create Spectral Energy Grid* dialog will appear.

9. In the *Frequency Distribution* section of the dialog, change the *Number* to "40" and click **OK** to create a new spectral energy grid.

10. The new spectral energy grid will appear in the *Spectral Manager* tree control. Select the "Spectral_Grid*"* to see an example displayed in the *Spectral Viewer*.

11. Click the **Generate Spectra** button to open the *Generate Spectra* dialog.

12. Enter the following parameters into the spreadsheet.

Time	Angle	Hs	Tp	Gamma	nm
1	25	1	20	8	30

13. This tutorial assumes that the wave gauge is approximately at the offshore edge of the grid. Therefore, set the *Seaward Boundary Depth* for the spectra to "32" meters. If the gauge was in deeper water, specify the actual depth of the gauge.

14. Push the **Generate** button to close the *Generate Spectra* dialog.

The new spectrum, labeled "1.00000" will appear below the grid in the *Spectral Manager* tree control. The "1.00000" represents the time offset from the reference time in hours. The reference time is displayed below the tree control.

15. Select the spectrum "1.00000". The contours show the energy distribution. Select cell corners to view/edit their energies.

16. Click **Done** to exit the *Spectral Energy* dialog.

3.2   Model Control

In the model control, STWAVE inputs can be set. To view the Wind parameters:

1. Select the grid "100m" in the Project Explorer to make the STWAVE grid active. Optionally, select the **Cartesian Grid** module macro.

2. Select *STWAVE | **Model Control*** to bring up the *STWAVE Model Control* dialog.

3. Select "Spectral coverage" from the *Boundary condition source* combo box.

4. Select the **Spectral Grid...** button to bring up the *Spectral Grid Properties* dialog.

5. In the *Frequency Distribution* section of the dialog, change the *Number* to "40".

6. Select **OK** to close the *Spectral Grid Properties* dialog.

7. Select *Half plane* for the *STWAVE Plane Mode*.

8. Click the **Boundary Control** button to bring up the *Spectral Events* dialog.

9. Click on the button that corresponds to Side 1 in the *Edge Boundary Type* section. At this time, the button will be labeled "(none selected)". The *Select spectral coverage* dialog will appear.

10. Select the "Spectral" coverage and click **OK** to close the *Select spectral coverage* dialog. This assigns the spectral data contained in the coverage to the boundary.

11. Back in the *Spectral Events* dialog, click on the **Populate From Coverage** button near the bottom on the dialog. This will create an event for every time

entry that is defined in the spectral coverage. In this case, there is one event created with a time of 1.00.

12. This case will not use wind or tide, so click **OK** to close the *Spectral Events* dialog.

13. Change the *Source Terms* to "Propagation Only". Since the wind was set to zero, this is a redundant setting, but it will speed up the model a little.

14. Click **OK** to exit the *STWAVE Model Control* dialog.

3.3   Selecting Monitoring Stations

The final step is to select cells to act as monitoring stations:

1.   Select the **Select Grid Cell** tool.

When selecting a cell, the i and j location can be seen at the bottom of the screen in the status portion of the *Edit Window*. SMS can also select cells by choosing their i and j coordinates.

2.   Make sure no cells are selected and choose *Data* / **Find Cell…** to bring up the *Find Cell* dialog.

3.   Enter "110" for *I* and "60" for *J* and click **OK** to close the *Find Cell* dialog.

A cell in the bay should now be selected. It is also possible to select cells by entering the nearest x and y values or entering the cell ID.

4.   Select *STWAVE* / **Assign Cell Attributes…** to bring up the *Cell Attributes* dialog.

5.   Change the *Cell Type* to *Monitoring Station* and click **OK** to close the *Cell Attributes* dialog.

6.   Using the **Select Grid Cell** tool, click outside to the grid to unselect the cell.

7.   Repeat steps 2 through 6 to assign a monitoring station in the inlet and the ocean. The i and j coordinates for the inlet cell are 92 and 66 respectively, and the i and j coordinates for the ocean cell are 50 and 70 respectively.

3.4   Saving the Simulation

To save the simulation:

1.   Select *File* / **Save As** to open the *Save As* dialog.

2.   Make sure the *Save as type* is set to "Project Files (sms)," and enter the *File name* "shin_half". Click the **Save** button.

3.5   Running STWAVE

To run STWAVE:

1.   Right-Click on the "100m" grid in the Project Explorer.

2.   Choose **Export STWAVE Files**

3.   Right-click on the "100m" grid again, and choose **Launch STWAVE**. The *STWAVE* model wrapper will appear.

- If a message such as "stwave.exe – not found" is given, click the file browser ☐ button to manually find the STWAVE executable.

4.   A *STWAVE* dialog will show the progress of the STWAVE run. Click **Exit** when STWAVE finishes. The solution will be loaded into SMS when **Exit** is clicked. The solution will be stored in the solution file (*shin_half__100m__sol.h5*. The model directory is composed of the project name (shin_half) and the grid name (100m) separated by a double underscore.

SMS has several visualization options to view the solution.

3.6   Visualizing the STWAVE Solution

To see the solution results:

1.   Select *Display* | **Display Options** 🔧 to bring up the *Display Options* dialog.

2.   Select *Cartesian Grid* from the list on the left the turn on the *Contours* and *Vectors* options. Turn off the *Cells* option.

3.   Select the *Contours* tab. For the *Contour Method* select "Color fill". Also set the *Transparency* to "20" percent.

4.   Select the *Vectors* tab. Make sure the *Shaft Length* is set to "Define min and max length" and set the *Min length* to "10" and the *Max length* to "35".

5.   Under *Vector Display Placement and Filter,* change the *Display* to "on a grid." Leave the spacing at "30" pixels in each direction and set the *Offset* to "10".

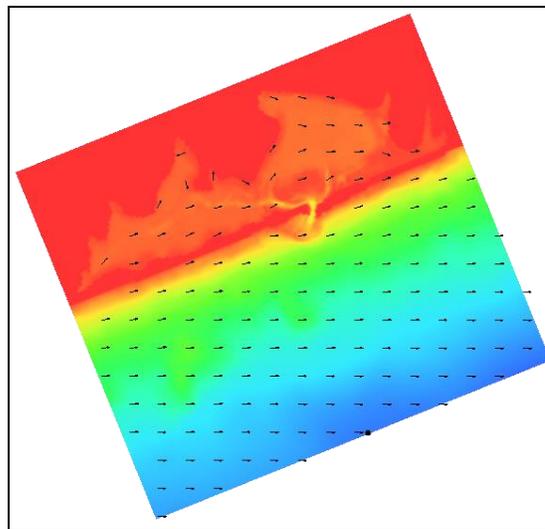6.   Push **OK** to exit the *Display Options* dialog.

Figure 3   Depth dataset with contours and vectors turned on

7. Select the different scalar and vector datasets of the "100m" grid model in the Project Explorer to view their contours and vectors.

8. **Zoom** <img> into the inlet and **Pan** <img> along the coast to view variations.

Notice that the waves do not cover the entire bay. STWAVE is limited on how fast the waves will spread out after going through the inlet.

3.7 Visualizing the Spectral Energy

The spectral energy is recorded at each monitoring station in the grid frame and written by STWAVE to an observation file (*.obse). The observation file is automatically read in at the end of an STWAVE run. The data in this file is put into a spectral coverage. In this case the coverage is named "100m.obse" or "100m.obse". To view the spectral energy:

1. Select the coverage "100m.obse" in the Project Explorer to make it the active coverage. Notice that there are nodes at each of the monitoring locations.

2. To view the data in each location, double-click on the desired node using the **Select Feature Point** <img> tool. This will bring up the *Spectral Energy* dialog.

3. Look at the spectral energy at each monitoring station using the *Spectral Viewer*. The ocean station is not much different than the input spectral energy (labeled as *1*). The energy increases in the inlet and changes direction. The energy in the bay is very low compared to the inlet.

4. Also look at the spectral energies of the monitoring stations with a current. Notice that the current dampens the energy in the inlet but slightly increases the energy in the bay.

5. When done, click **Done** to exit the *Spectral Energy* dialog.

3.8 Visualizing Current Effects

The next step is to see the effects when a current is added at the inlet from the receding tide. To do this:

1. Select *STWAVE* | **Model Control…** to bring up the *STWAVE Model Control* dialog.

2. Set the *Current interaction* to "Dataset" then click on the **Select** button to bring up a *Select Dataset* dialog.

3. Select "Velocity (64)_interp" as the vector dataset. Click **Select** to close the *Select Dataset* dialog.

4. In the *STWAVE Model Control* dialog, click on the **Boundary Control** button to bring up the *Spectral Events* dialog.

5. In the *Events* section, set the time to "1" hour in the first row, and "2" hours in the second row. These will be the snaps that SMS will put the transient current dataset to.

Note on current dataset: STWAVE simulates one or more boundary condition scenarios referred to as "snaps." In the original run, SMS used a single snap that represented a specified boundary condition. For this model run, SMS is going to run two snaps one at hour 1 and the other at hour 2. When using snaps based upon times, provide a current dataset that is transient. SMS will have STWAVE use the current dataset values for the time specified in the *Spectral Events* dialog. If the snap time step is between two time steps in the current dataset, SMS will interpolate values. If the snap time step is before all time steps in the current dataset, SMS will use the values from the first time step. Similarly if the snap time step is after all time steps, SMS will use the values in the last time step. If STWAVE is not using times and is instead representing independent boundary conditions, a steady state current dataset is chosen for each snap. The surge and wind datasets work similarly.

6. Click **OK** to close the *Spectral Events* dialog.

7. Click **OK** to close the *STWAVE Model Control* dialog.

8. Select *File* | **Save As** to open the *Save As* dialog.

9. Make sure the *Save as type* is set to "Project Files (sms)," and enter the *File name* "shin_curr". Click the **Save** button.

10. Right-click on the "100m" grid item and select the **Save project, Export, and Launch STWAVE** to bring up the *STWAVE* model wrapper.

11. When the model finishes running, click **Exit** to close the *STWAVE* model wrapper.

12. Select the different scalar and vector datasets of this simulation to view the contours and vectors. If viewing the current field, notice the current is a fairly strong ebb current. Notice the difference in wave height that the current makes to the results.

4 Re-running ST-WAVE in Full Plane Mode

Now to see the effects of running the STWAVE module in the full-plane mode.

4.1 Open the Previous Half Plane Simulation

By opening the previous solution, the tutorial avoids repeating the grid set up. To open the half plane simulation:

1. Select *File* | **Open** to bring up the *Open* dialog.

2. Select the "shin_half.sms" file that was saved previously and click **Open**.

3. Click **Yes** to delete the current simulation. The grid should appear on the screen.

4. Select *STWAVE* | **Model Control** to open the *STWAVE Model Control* dialog.

5. Set the *STWAVE Plane Mode* option to *Full Plane*. Check to ensure that the *Source terms* are still set to "Propagation Only."

6. Click **OK** to exit the *STWAVE Model Control* dialog.

4.2   Save and Run STWAVE in Full Plane Mode

To save the simulation:

1. Select *File* / **Save As**. The *Save As* dialog will open.

2. Make sure the *Save as type* is set to "Project Files (sms)," and enter the *File name* "shin_full" then click the **Save** button.

3. Right-click on the "100m" grid item and select the **Save project, Export, and Launch STWAVE** to bring up the *STWAVE* model wrapper.

4. When the model finishes running, click **Exit** to close the *STWAVE* model wrapper.

4.3   Visualizing the Full Plane Solution

Repeat step 3.6 to visualize the STWAVE solution for the full plane option. Notice that the direction of waves in the back bay is much more varied in the full plane option.

5   Conclusion

This concludes the STWAVE Analysis tutorial. The model contains many more features and capabilities that have not been explored in this document. Refer to the STWAVE Users manual and SMS help file found in *Help* / **SMS Help…** for more information.