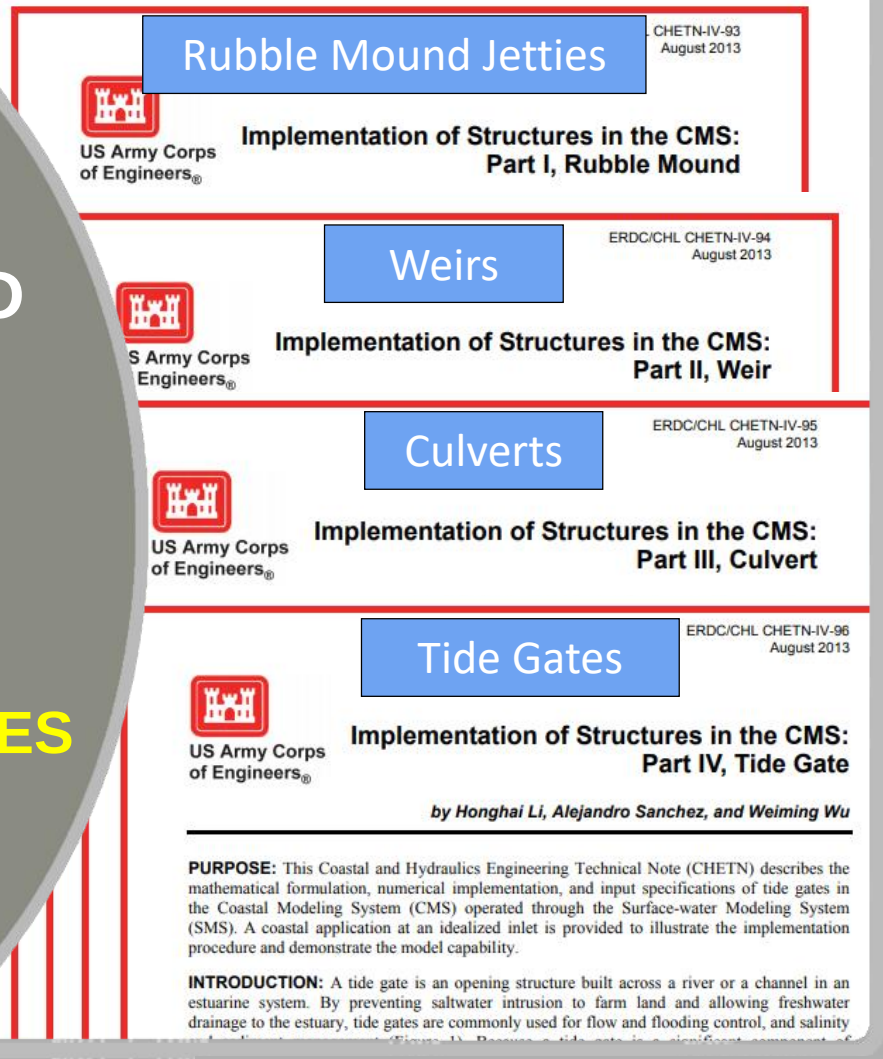
# Coastal Modeling System: Advanced Topics using CMS 5.1 and SMS 13.0

## Day 2: Using Structures with CMS

## Demo with Weirs and Rubble Mound Jetties

**Mitchell Brown, Honghai Li**




US Army Corps of Engineers

CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

# Documentation for Structures in CMS

## Rubble Mound Jetties – CHETN IV-93

https://erdc-library.erdc.dren.mil/xmlui/handle/11681/1989

## Weirs – CHETN IV-94

https://erdc-library.erdc.dren.mil/xmlui/handle/11681/1991

## Culverts – CHETN IV-95

https://erdc-library.erdc.dren.mil/xmlui/handle/11681/1983

## Tide Gates – CHETN IV-96

https://erdc-library.erdc.dren.mil/xmlui/handle/11681/2000

# Options for Weir Structures

| | | | CMS Cardname |
|---|---|---|---|
| Method for Calculating Flux | 1 - Approach 1 | 2 - Approach 2 | METH |
| Weir Coefficient | Pair of Values Required for each Weir<br>[bay to sea] [sea to bay] | | FLOW_COEFFICEINT |
| Crest Elevation (m) [positive Upward] | Values Required | | CREST_ELEVATION |
| Weir Type | 1 – Broad<br>2 – Sharp-crested | N/A | TYPE |
| Distribution Coefficient | Values Required | N/A | DISTRIBUTION_COEFFICIENT |
| Orientation [direction of sea side] | 1-North, 2-East, 3-South, 4-West | | ORIENTATION |

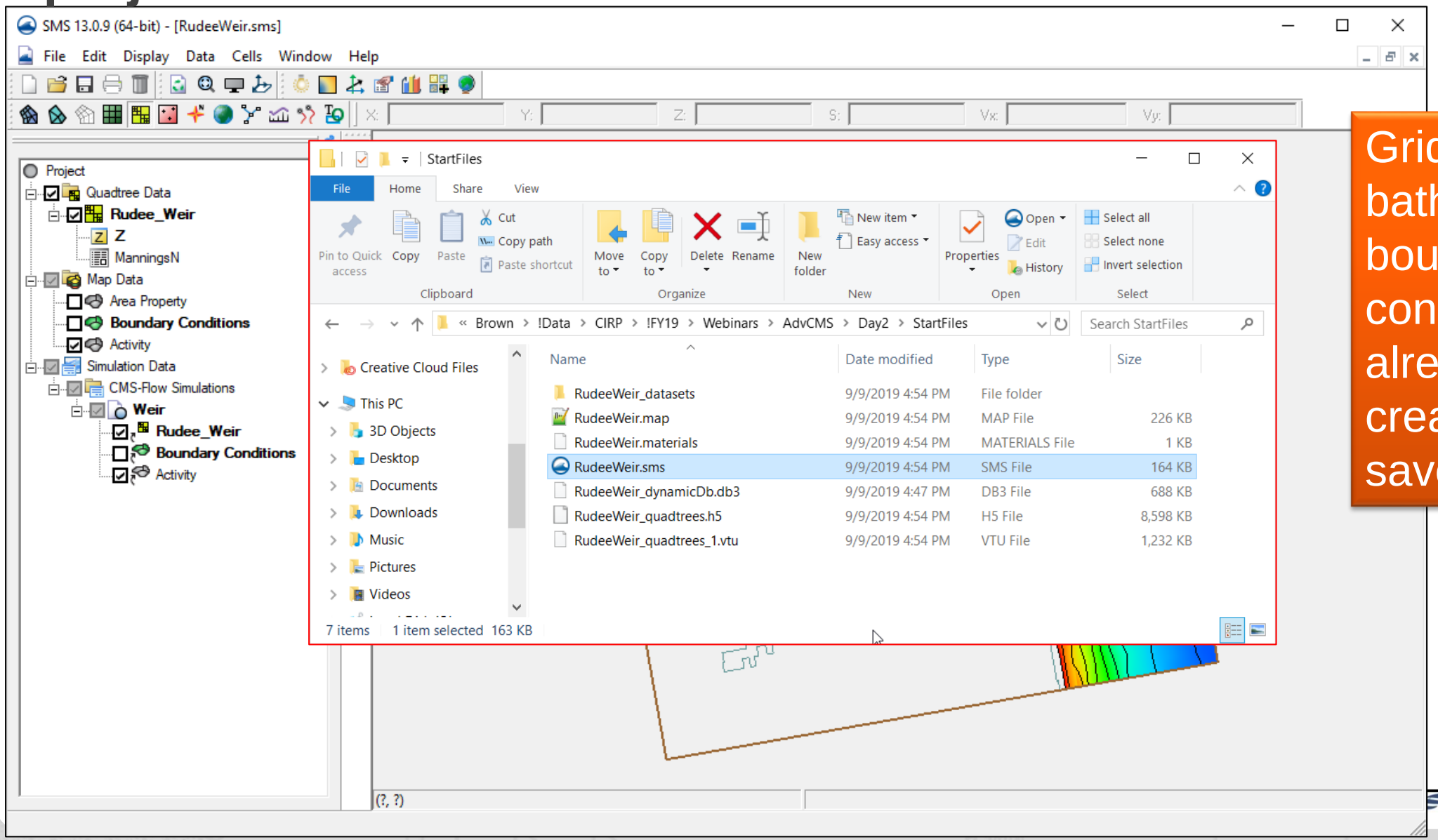
**Approach 1** follows the standard weir equation for a rectangular cross-section, where:

$Q$ is the flow rate over the weir crest,
$C_w$ is the weir coefficient,
$L_w$ is the weir crest length,
$h$ is the upstream water depth above the crest,
$C_{dw}$ is the submergence correction factor

$$Q = C_{df} C_w L_w h^{1.5}$$

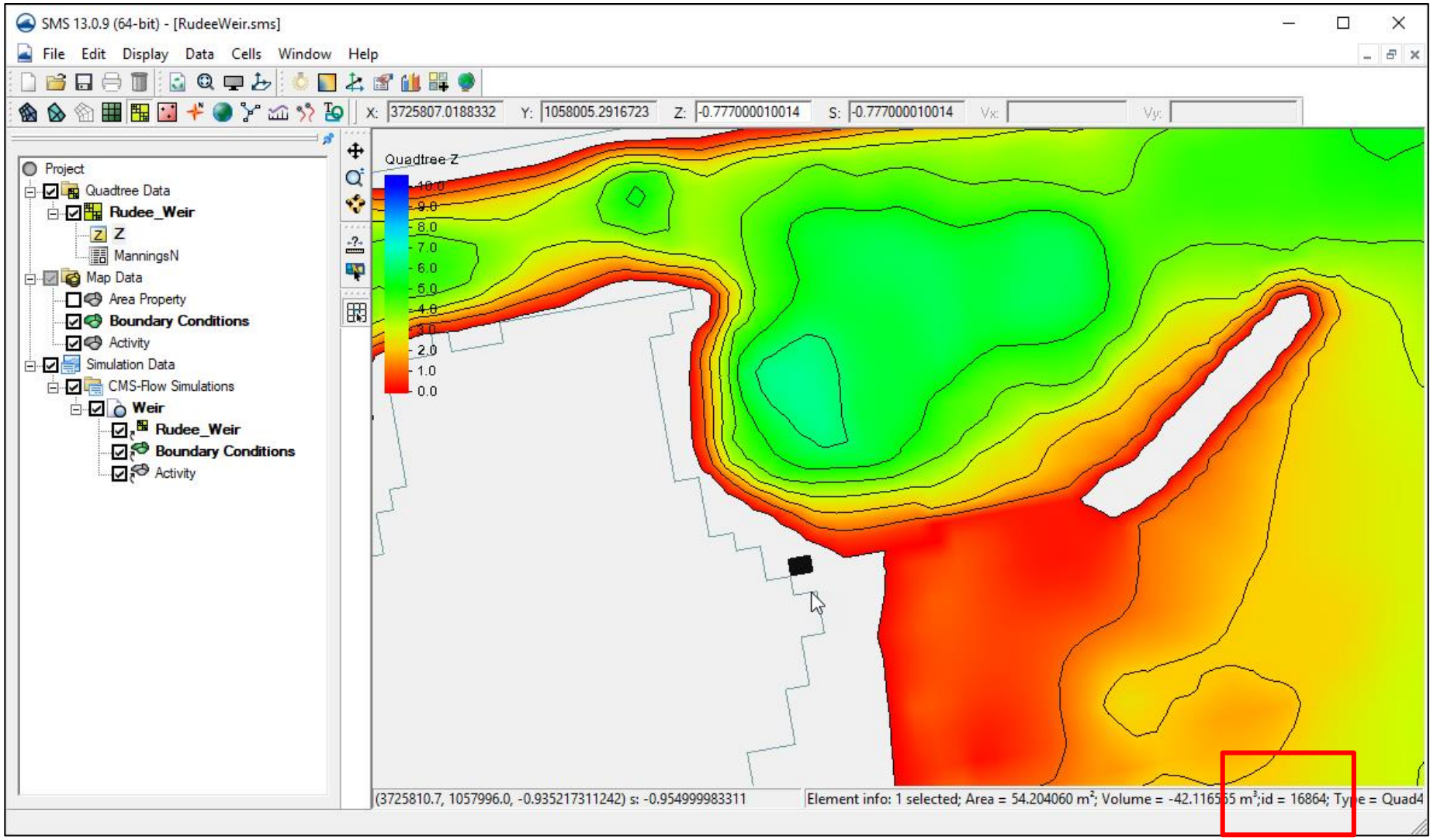
**Approach 2** treats structure cells as normal flow cells by adding resistance force terms induced by weir structures in the depth-averaged momentum equations.

# Weir Example - Open “Weir\StartFiles” folder and load project file




Grid with bathymetry and boundary conditions has already been created and saved.

# Gather Cell IDs for Weir location(s)



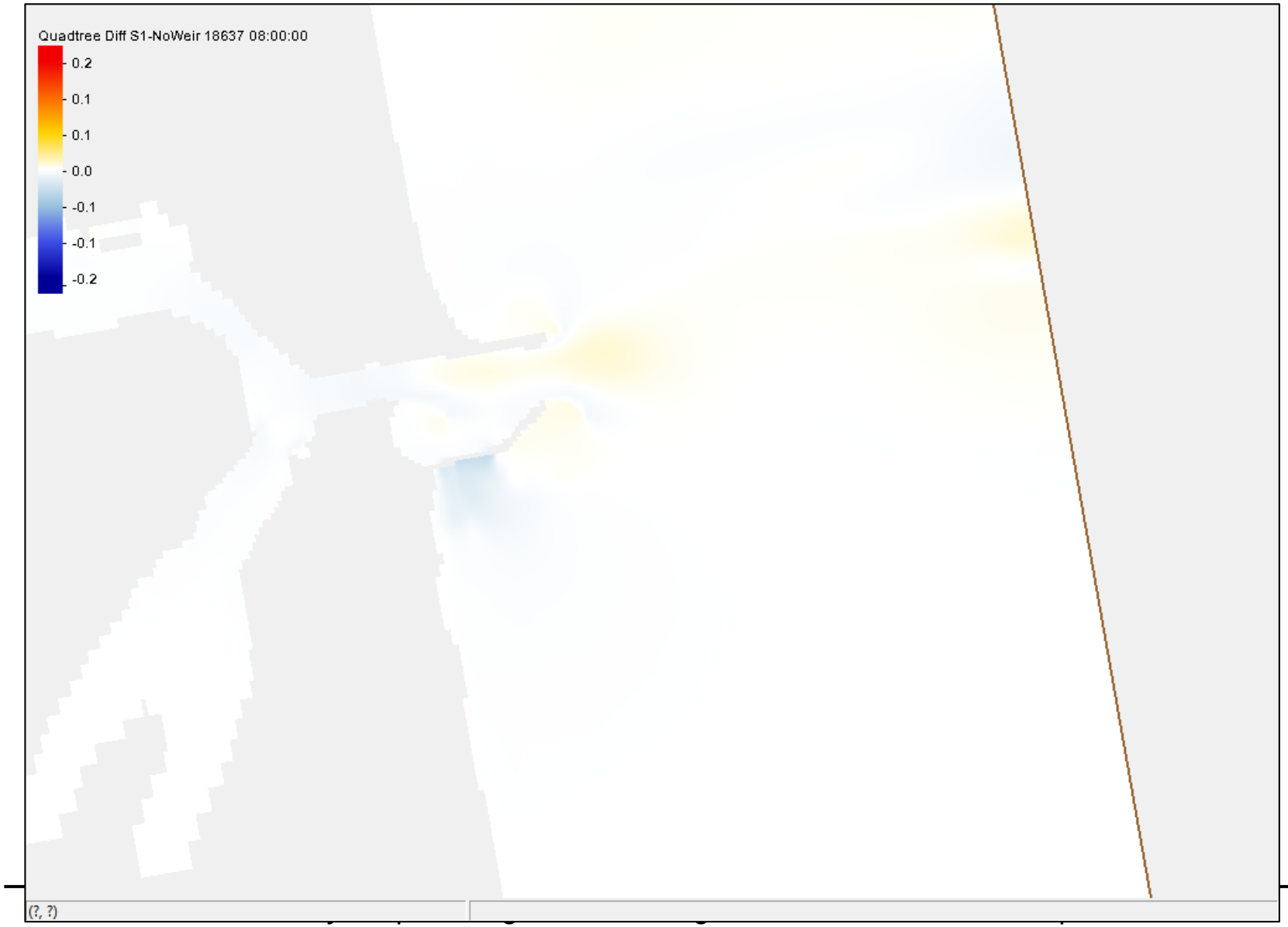

Click each cell which will be part of a weir and note the Cell ID at the bottom of the screen.

# Add Weir options/parameter values to “advanced.cmcards” file. **Note: This file must be in same directory as exported CMS files from project.**

```
WEIR_BEGIN
  NUMBER_WEIRS 2
  NUM_CELL_WEIRS 8 8
  CELLS 16864 16865 16866 16867 16868 16869 16870 16871 17247 17248 17249 17250 17251 17252 17253 17254
  DISTRIBUTION_COEFFICIENT 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95
  ORIENTATION 3 3
  TYPE 2 2
  FLOW_COEFFICIENT 0.46 0.46 0.46 0.46
  CREST_ELEVATION 0.0 -0.22
  METH 1 1
WEIR_END
```

- In this example, there are two weirs, consisting of 8 cells each.
- The Cell IDs are listed in sequence for each weir all on the same ‘CELLS’ line.
- The Distribution Coefficient for each cell is given in the same order of the Cell IDs.
- Direction of the sea side (Orientation) for each weir is given. [1- North, 2- East, 3- South, 4- West]
- Type of each weir [1- Sharp-crested, 2- Broad-crested]
- Pairs of Flow Coefficient for each weir is given [Bay-to-Sea, followed by Sea-to-Bay]
- Crest Elevation (m) is also given [Positive values are upward water surface]
- Approach 1 is being used for both weirs [METH 1 1]

# Save, export, and launch the simulation




After the simulation is complete, the solutions can be viewed and any comparisons made

# Options for Rubble Mound Structures

| | CMS Cardname for Dataset |
|---|---|
| Cell IDs for segment | RUBBLE_MOUND_DATASET |
| Rock Diameter [m] | ROCK_DIAMETER_DATASET |
| Porosity of Rubble Mound segment | STRUCTURE_POROSITY_DATASET |
| Depth of Base [m] | STRUCTURE_BASE_DEPTH_DATASET |
| Method Type [1, 2, or 3] | FORCHHEIMER_COEFF_METHOD_DATASET |

## Calculation of Forchheimer a and b coefficients

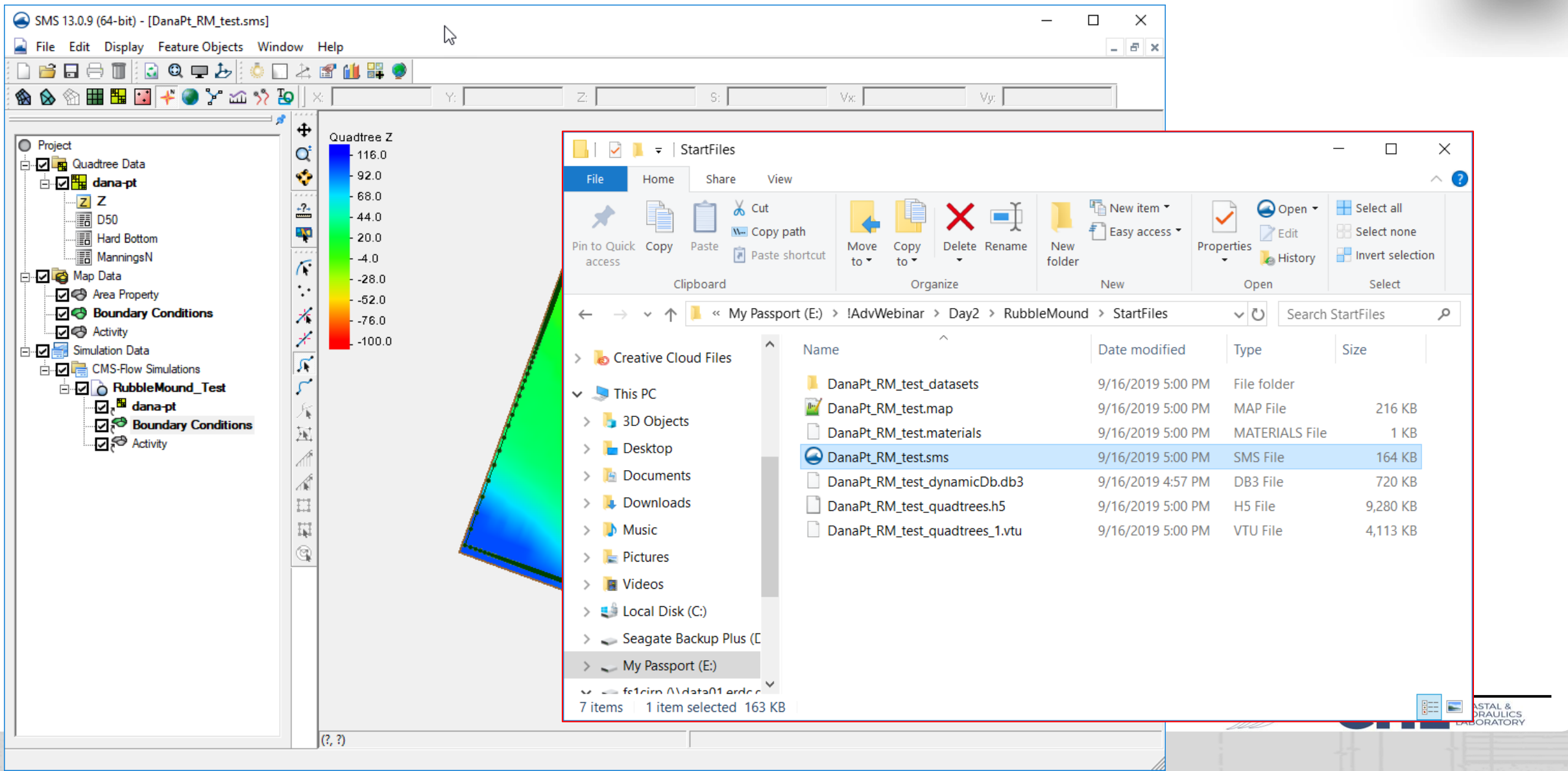
(D= rock diameter, n=porosity, v= water kinematic viscosity)

**Method 1** uses the Sidiropoulou method (2007): $a = 0.0033D^{-1.5}n^{0.06}$ and $b = 0.194D^{-1.265}n^{-1.14}$

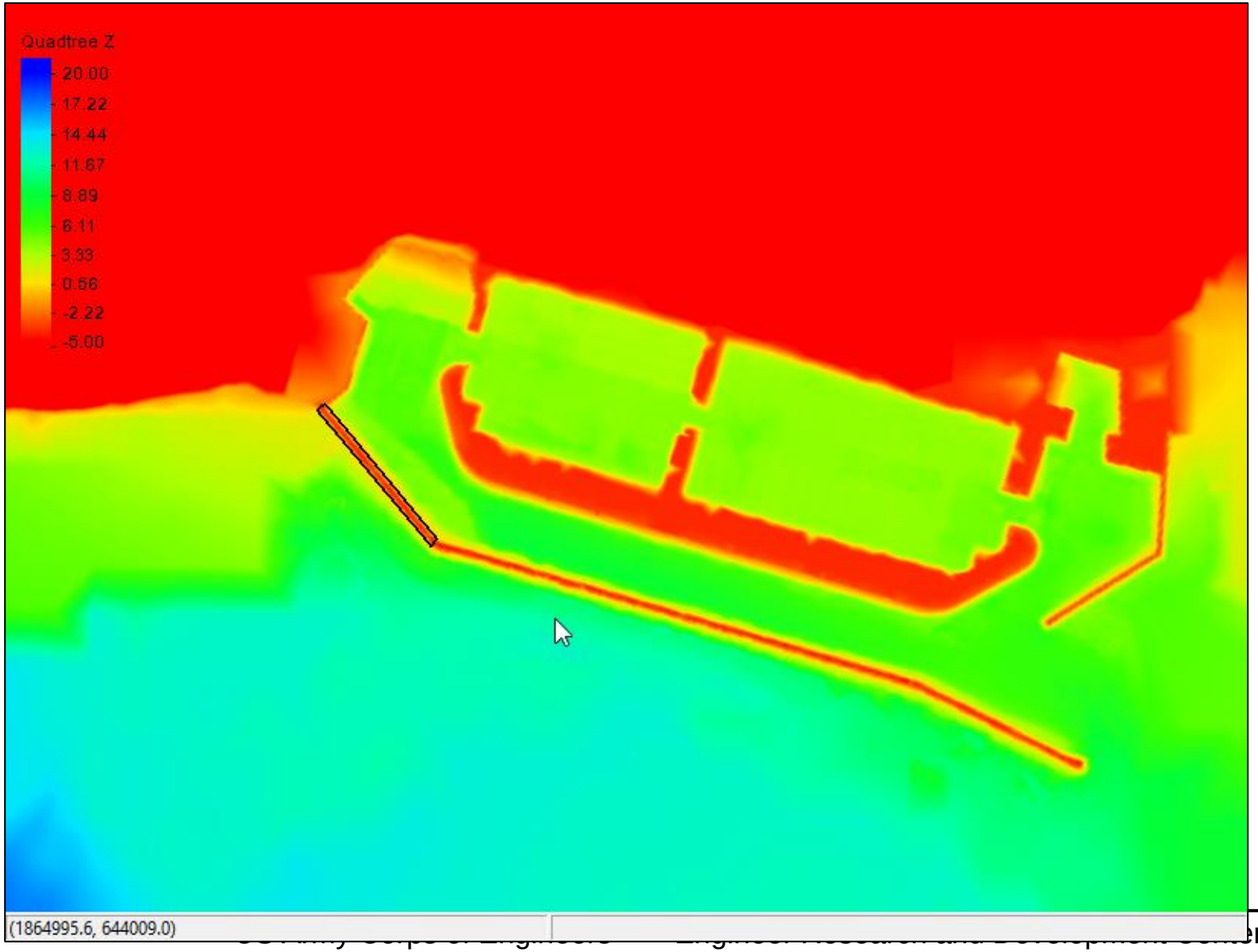
**Method 2** uses the Kadlec and Knight method (1996): $a = \frac{255v(1-n)}{gn^{3.7}D^2}$ and $b = \frac{2(1-n)}{gn^3D}$

**Method 3** uses the Ward method (1964): $a = \frac{360v}{gD^2}$ and $b = \frac{10.44}{gD}$

# Rubble Mound Example - Open "RubbleMound\StartFiles" folder and load project file



# Define areas for Rubble Mound Jetty location

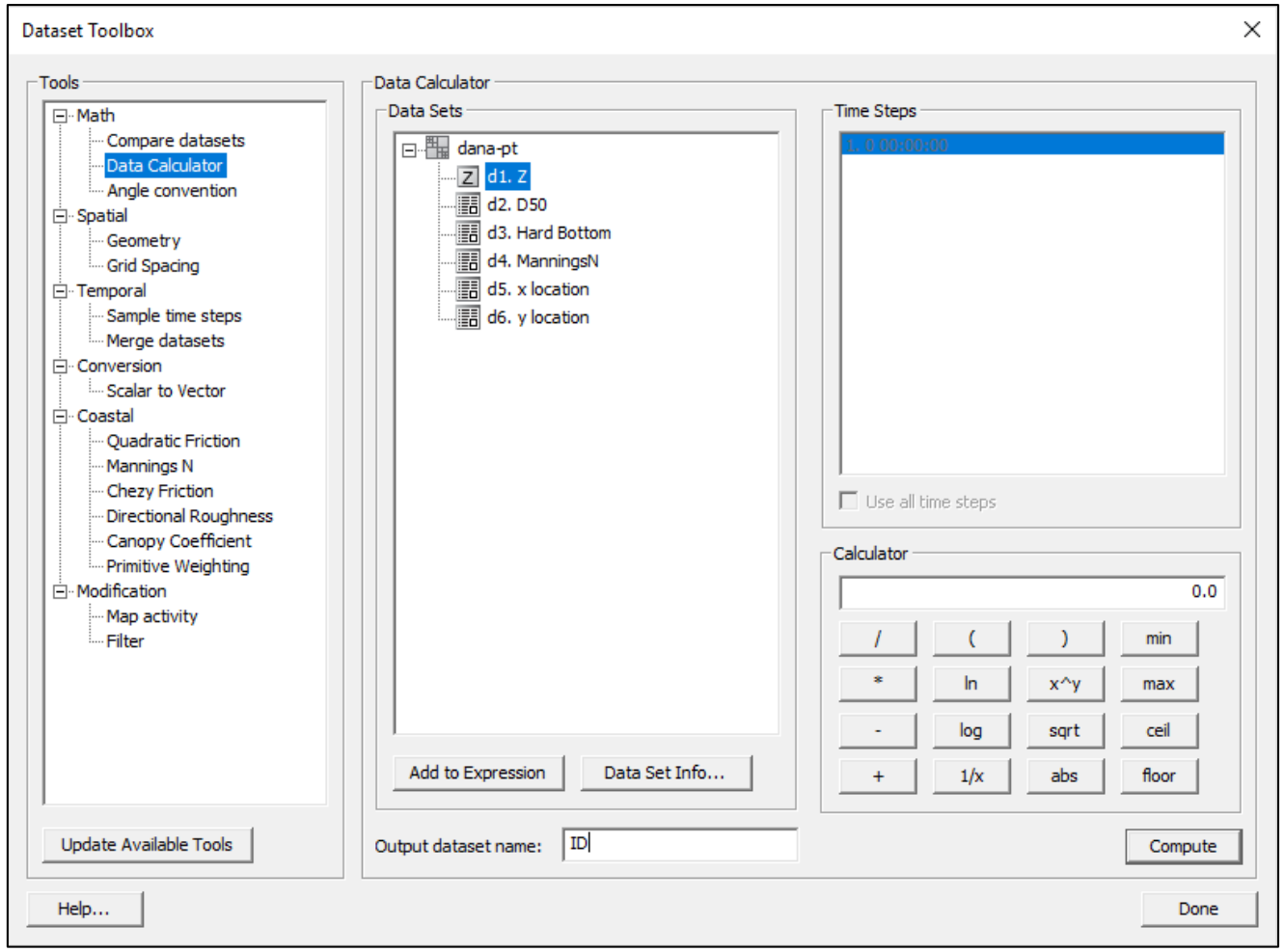



Create one coverage in Map Module of any type (default is “Area Property”).

Define arcs and build polygons for Rubble Mound location(s)

Feature polygons can also come in from ArcGIS shape files.

# Create datasets to specify values for structure parameters

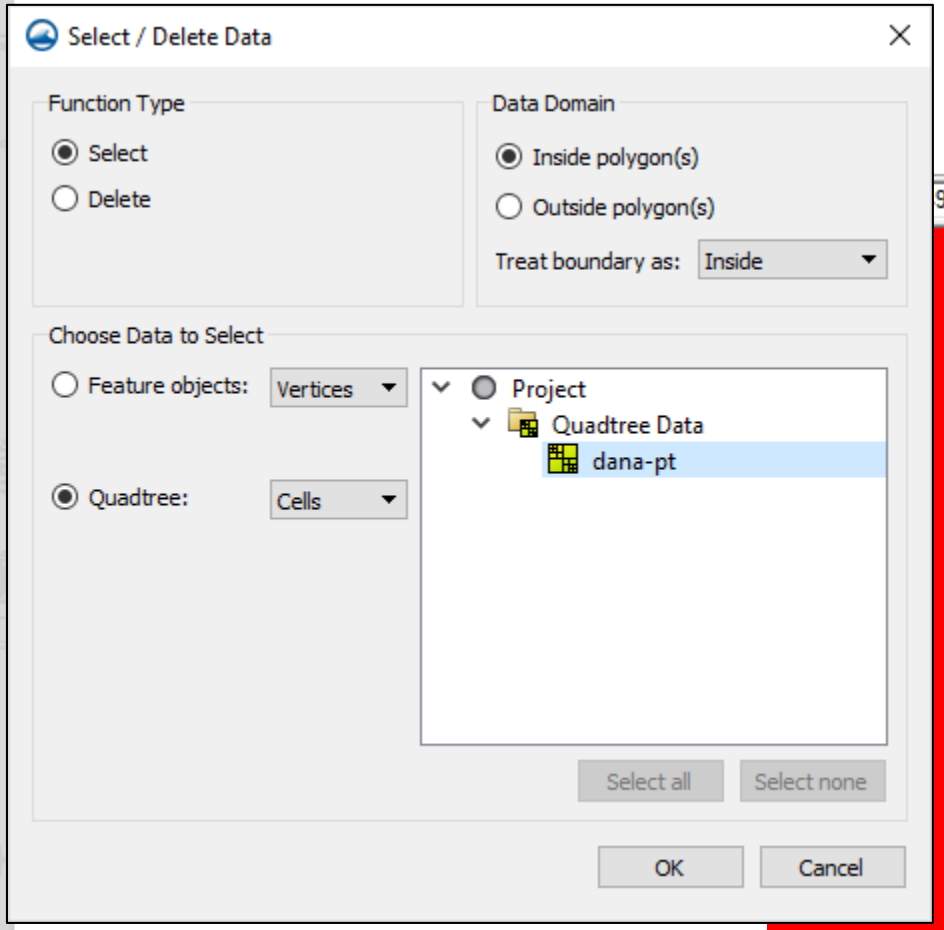


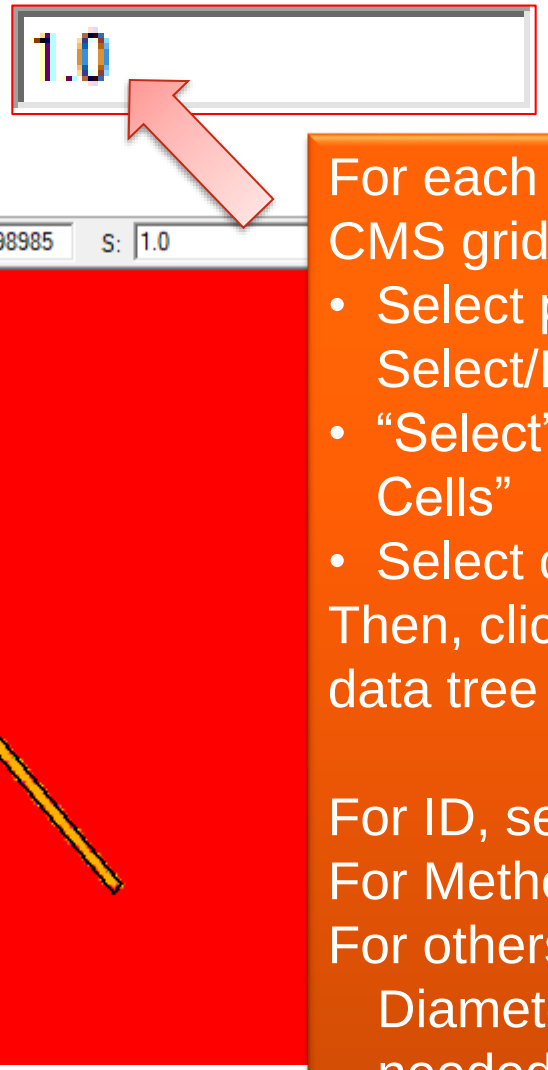

Using the Data Calculator, create datasets to specify the Cell IDs, Rock Diameter, Porosity, Base Depth, and Method.

Set the default value for each to 0.0.

Later steps will modify the values for each dataset depending on type.

# Select cells from polygons and modify values



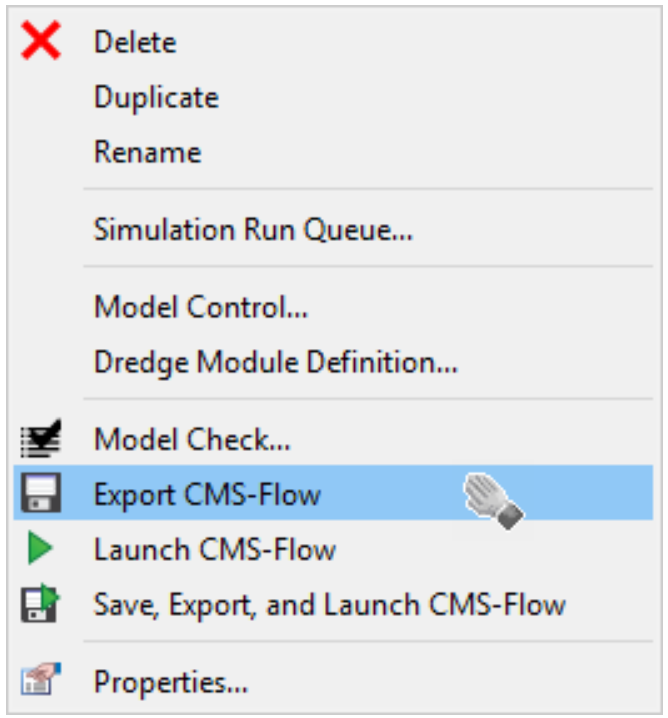

For each polygon, select the cells from the CMS grid and modify the values.

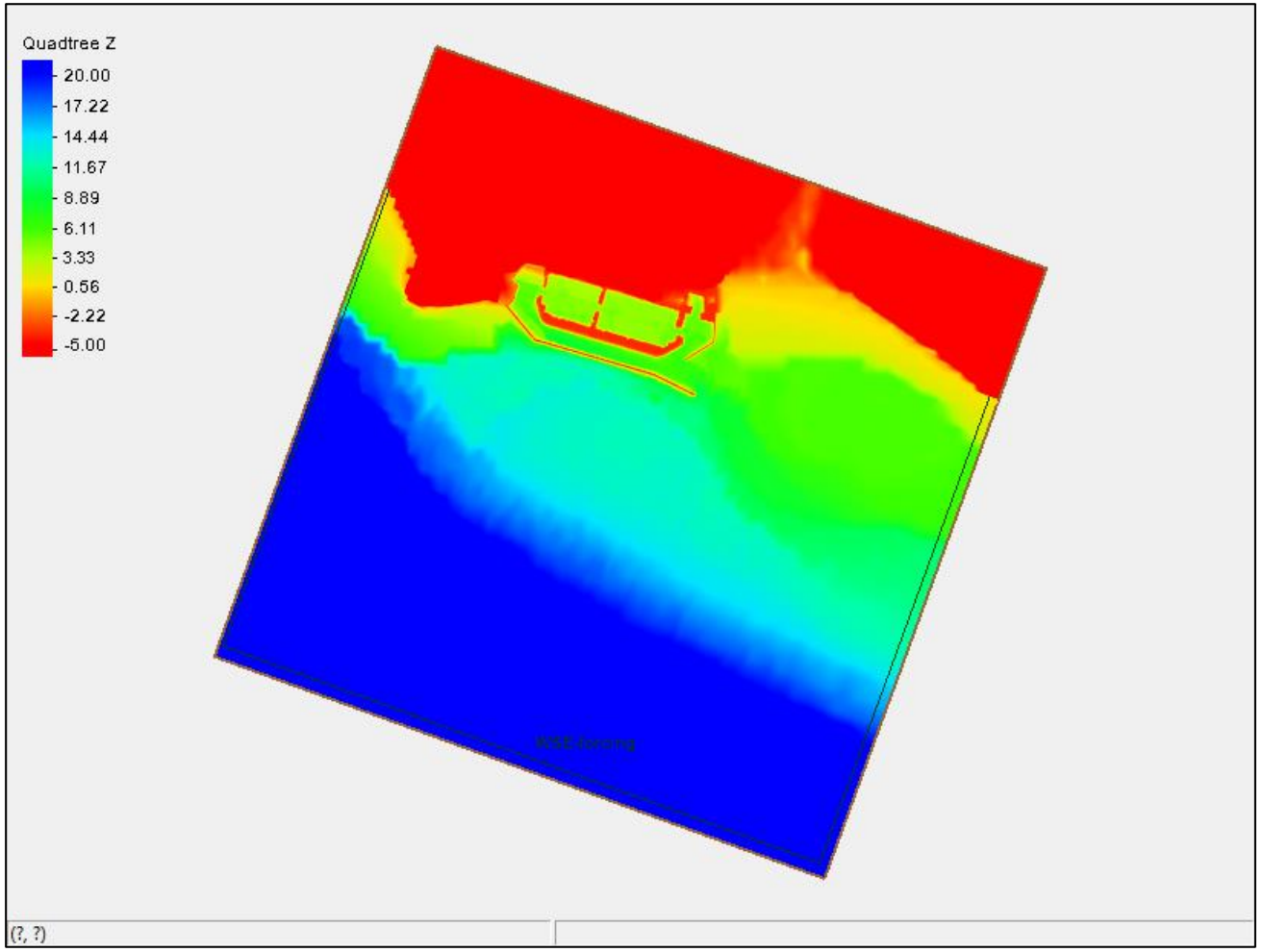
- Select polygon, then Feature objects | Select/Delete data
- "Select", "Inside Polygon", "Quadtree | Cells"
- Select correct Grid, then click OK.

Then, click the appropriate dataset in the data tree and modify the Scalar value.

For ID, set the value for each cell to 1.
For Method, set values to 1, 2 or 3. [1]
For others, use the Porosity [0.2], Rock Diameter [1.5], or Base Depth [2.0], as needed.

# Go through Model Control and set values, then Save project and Export files.



# Add RM options/parameter values to “advanced.cmcards” file.

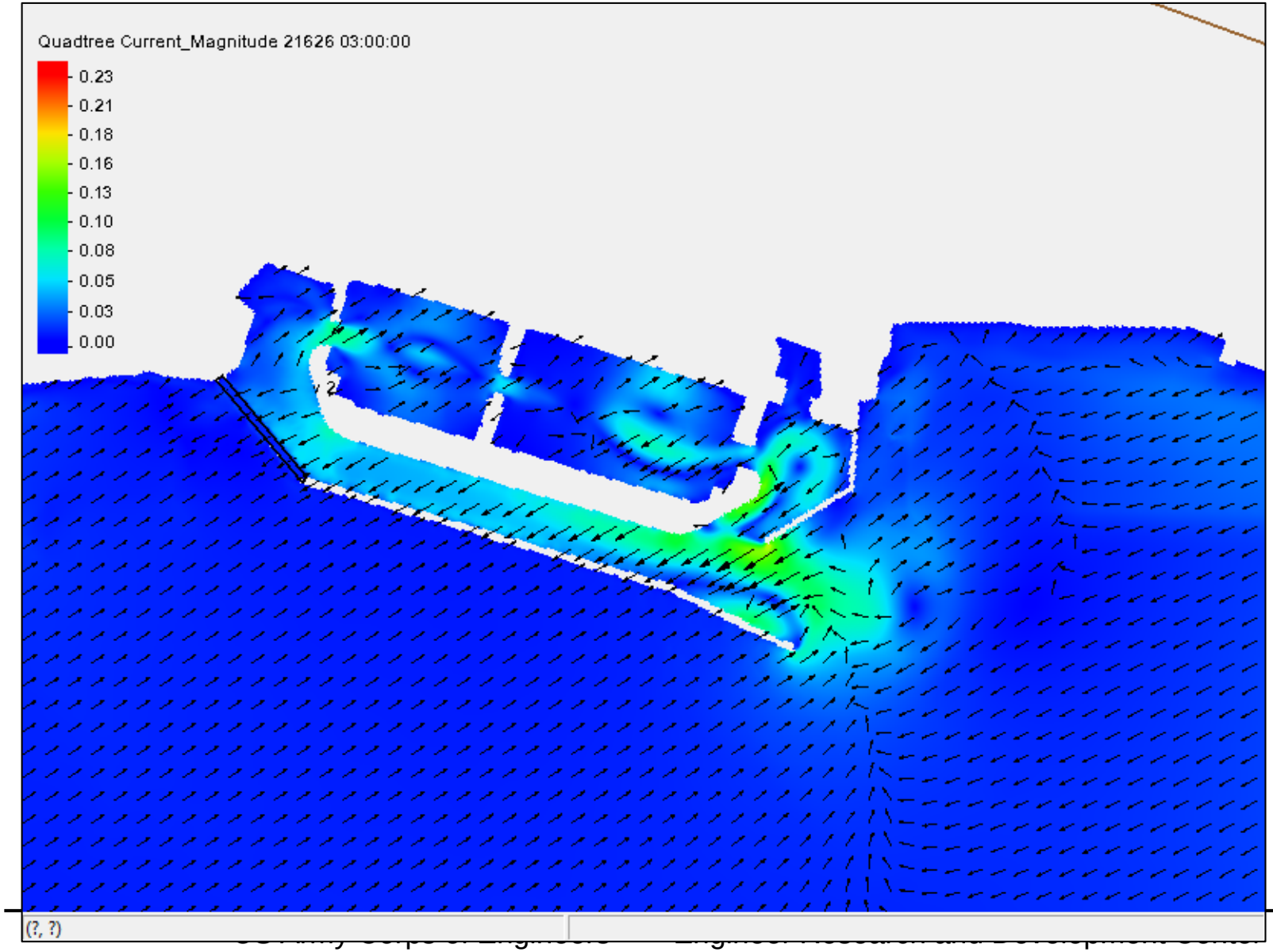
**Note: This file must be in same directory as exported CMS files from project.**

```
1  RUBBLE_MOUND_BEGIN
2    RUBBLE_MOUND_DATASET              "dana-pt_ID.h5"        "Datasets/ID"
3    ROCK_DIAMETER_DATASET             "dana-pt_Rock_D.h5"    "Datasets/Rock_D"
4    STRUCTURE_POROSITY_DATASET        "dana-pt_Porosity.h5" "Datasets/Porosity"
5    STRUCTURE_BASE_DEPTH_DATASET      "dana-pt_Base_D.h5"    "Datasets/Base_D"
6    FORCHHEIMER_COEFF_METHOD_DATASET "dana-pt_Method.h5"    "Datasets/Method"
7  RUBBLE_MOUND_END
```

Datasets that were created are saved under the “[project]_datasets” folder.
User must either:

1) Copy needed files from that folder to the CMS folder, or
2) Specify relative path (ie. “..\..\..\DataPt_RM_test_datasets\data-pt_ID.h5”

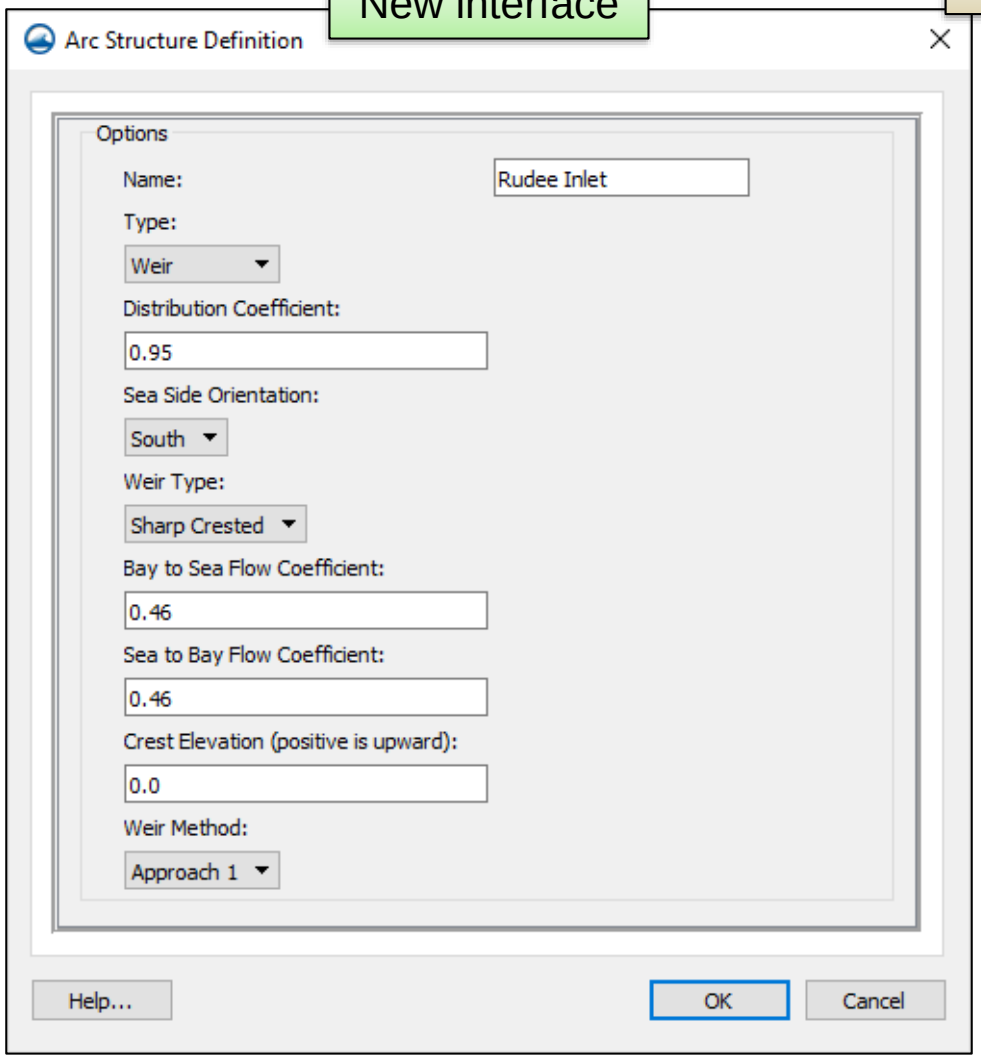
# Save, export, and launch the simulation



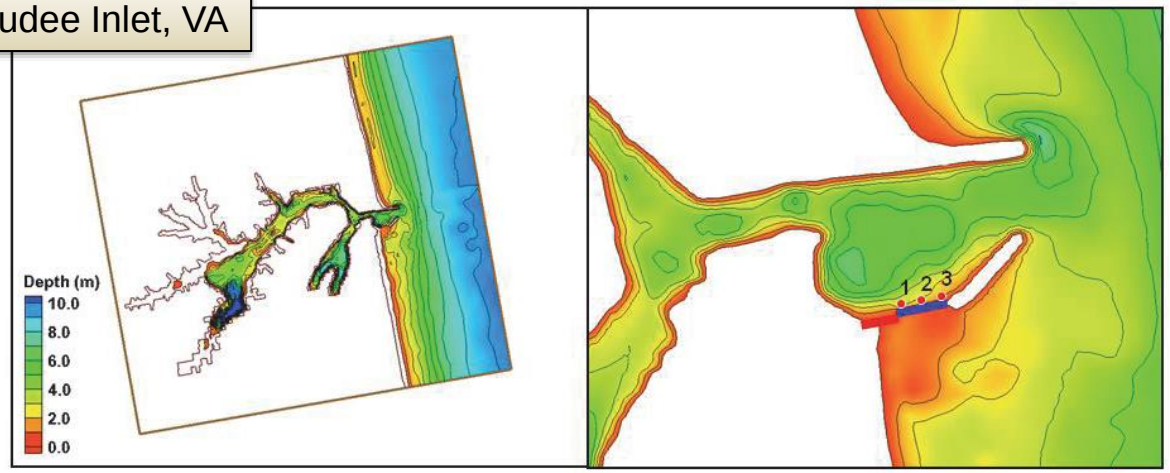

After the simulation is complete, the solutions can be viewed and any comparisons made

# Structures Interface planned for SMS 13.1

New interface




Rudee Inlet, VA




## Weir Example – Rudee Inlet, VA

Before – User had to search and keep track of every cell ID that makes up each weir. Parameter values were assigned using advanced cards. Had to know the exact values associated with different parameter options.

After – User will have a nice interface to describe the weir properties assigned to feature arcs. Drop-down selection boxes for options. The information automatically gets written to the parameter file after Save.