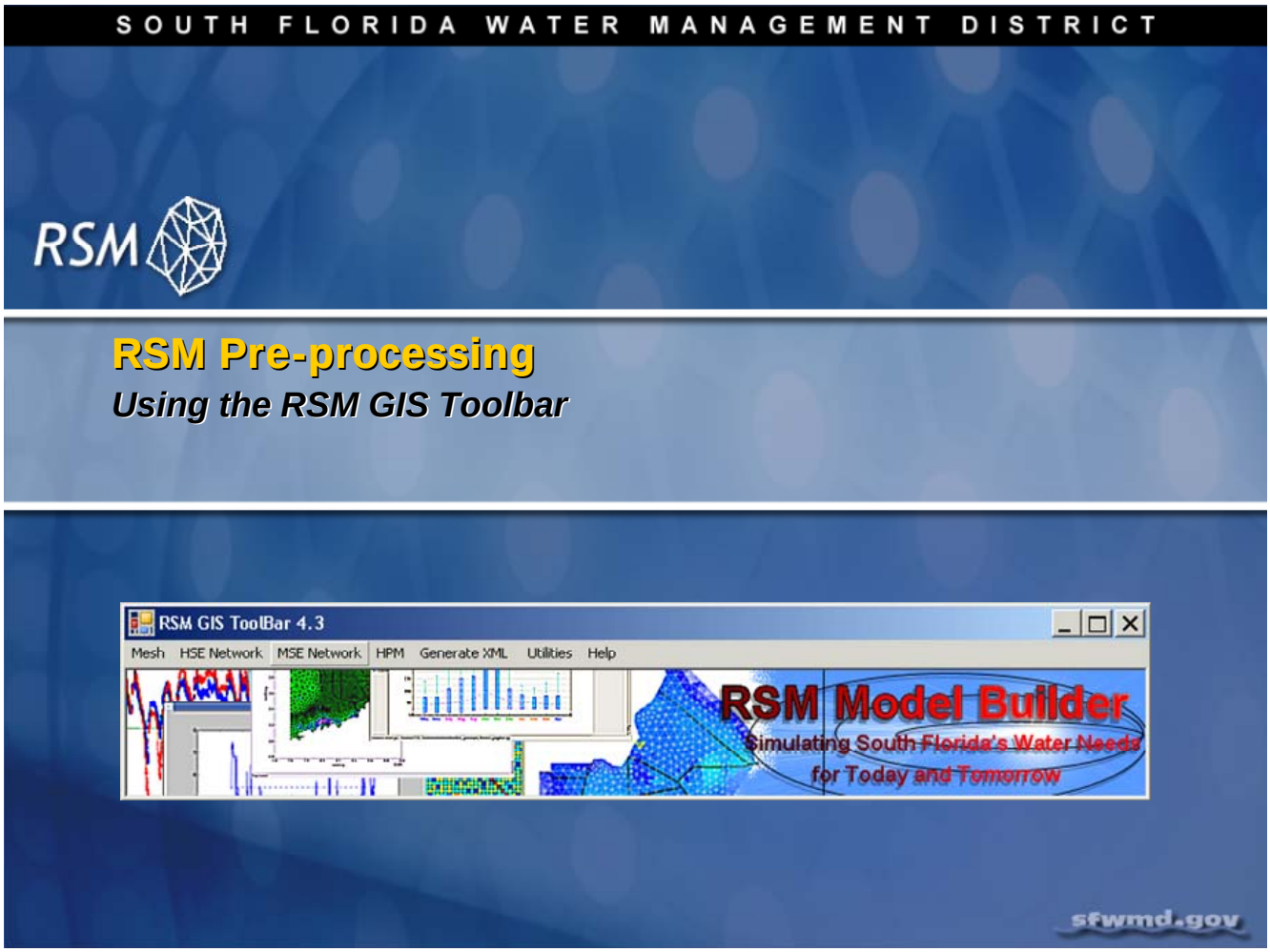


Lecture 7: RSM Pre-processing Using the RSM GIS Toolbar

This Regional Simulation Model (RSM) training session introduces the RSM Graphical User Interface (GUI). As part of this lesson, you will learn more about the custom tools available with the GIS ToolBar as well as the RSM Python Toolbar, which will make setting up an RSM scenario much easier.

NOTE:

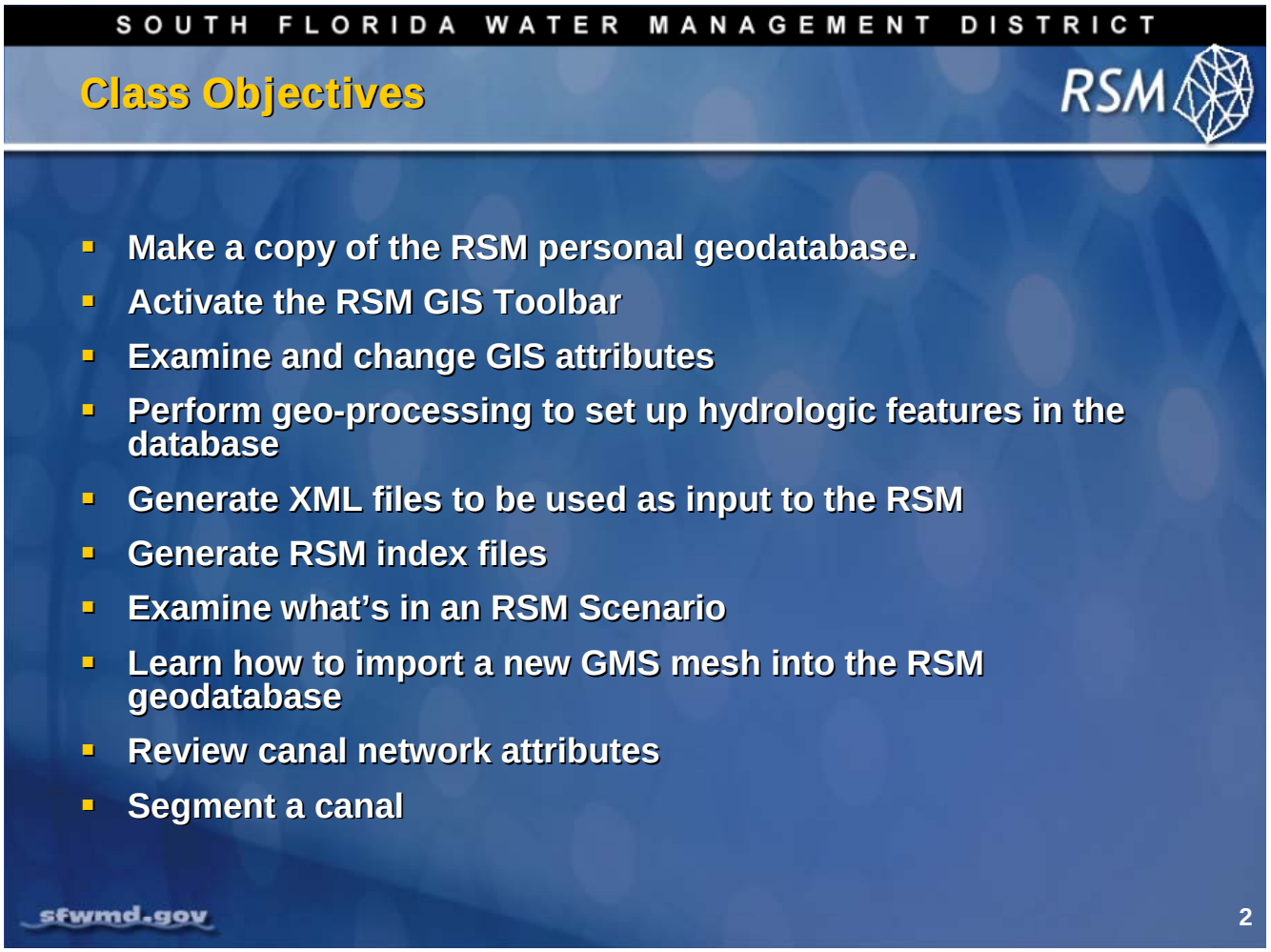
Prerequisite:

This training and the tools that will be used require some basic GIS experience. You will also need an active ArcInfo CITRIX account so you can access ArcGIS 9.1 via the CITRIX server.

The HESM team at the South Florida Water Management District uses the GIS to manage spatial data. We have custom utilities that generate XML files that are then used as input to the RSM.

Additional Resources

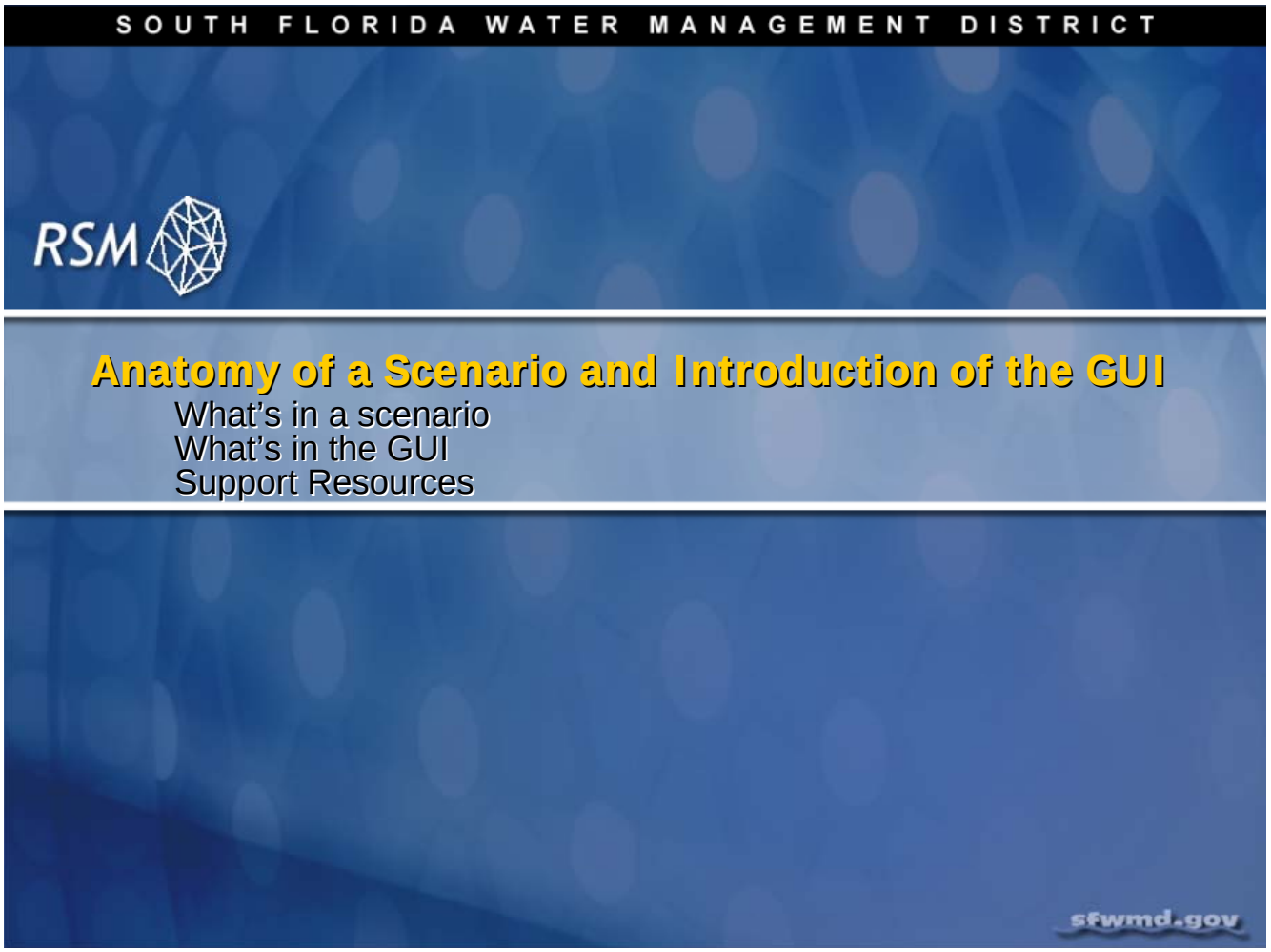
Three video files are proved for those modelers who do not have access to ArcInfo GIS Software.

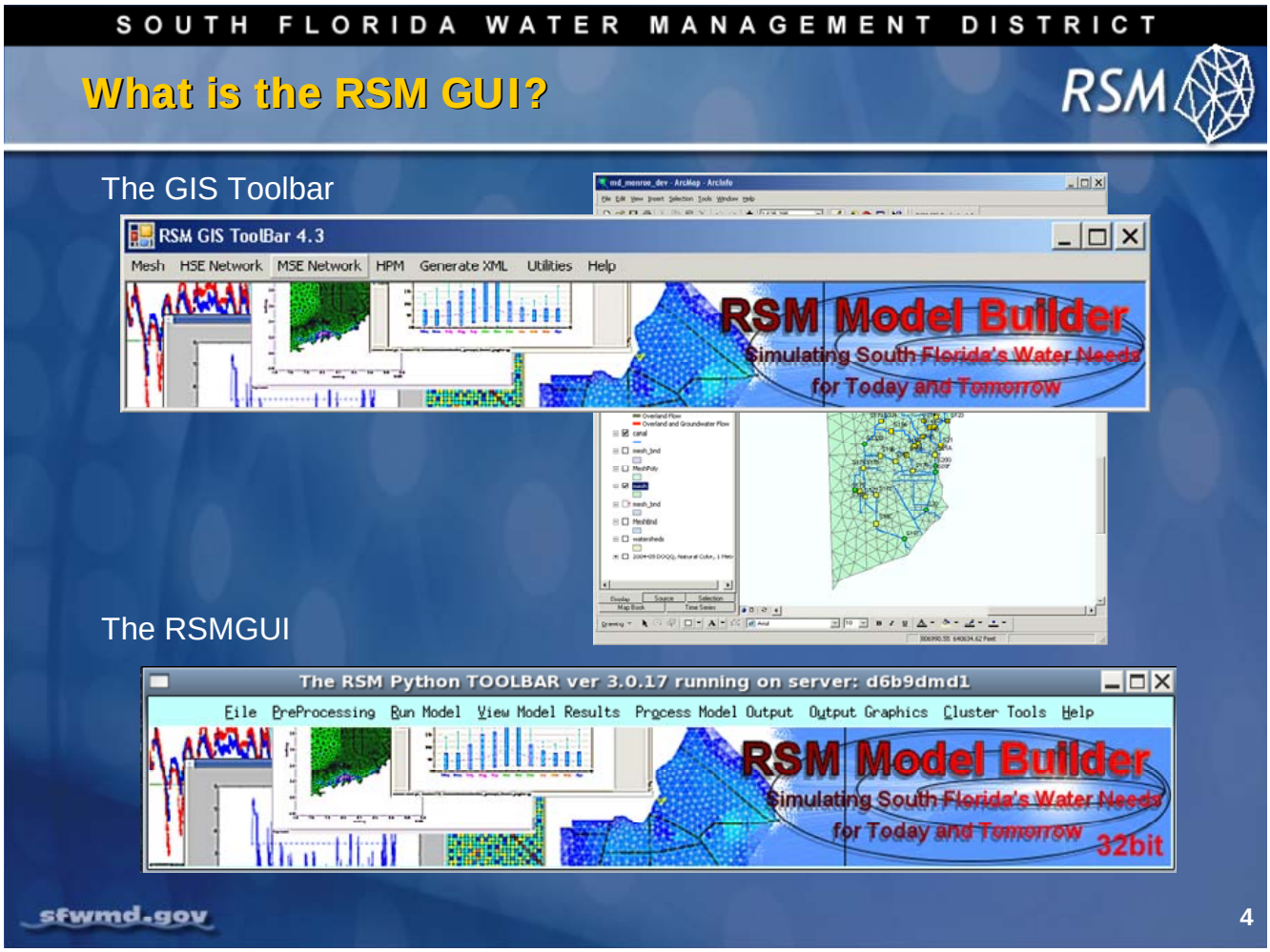


After completing this training module you will:

- Be able to create your own copy of the RSM personal geodatabase
- Set up features in the database for a modeling scenario
- Generate the input files needed to run the RSM
- Gain an understanding of how to use the RSM Toolbar

NOTE: If you do not have access to ArcGIS, the screen captures provided in this lecture are sufficient for reviewing basic features and lesson examples.


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM
Anatomy of a Scenario and Introduction of the GUI
What's in a scenario
What's in the GUI
Support Resources
sfwmd.gov



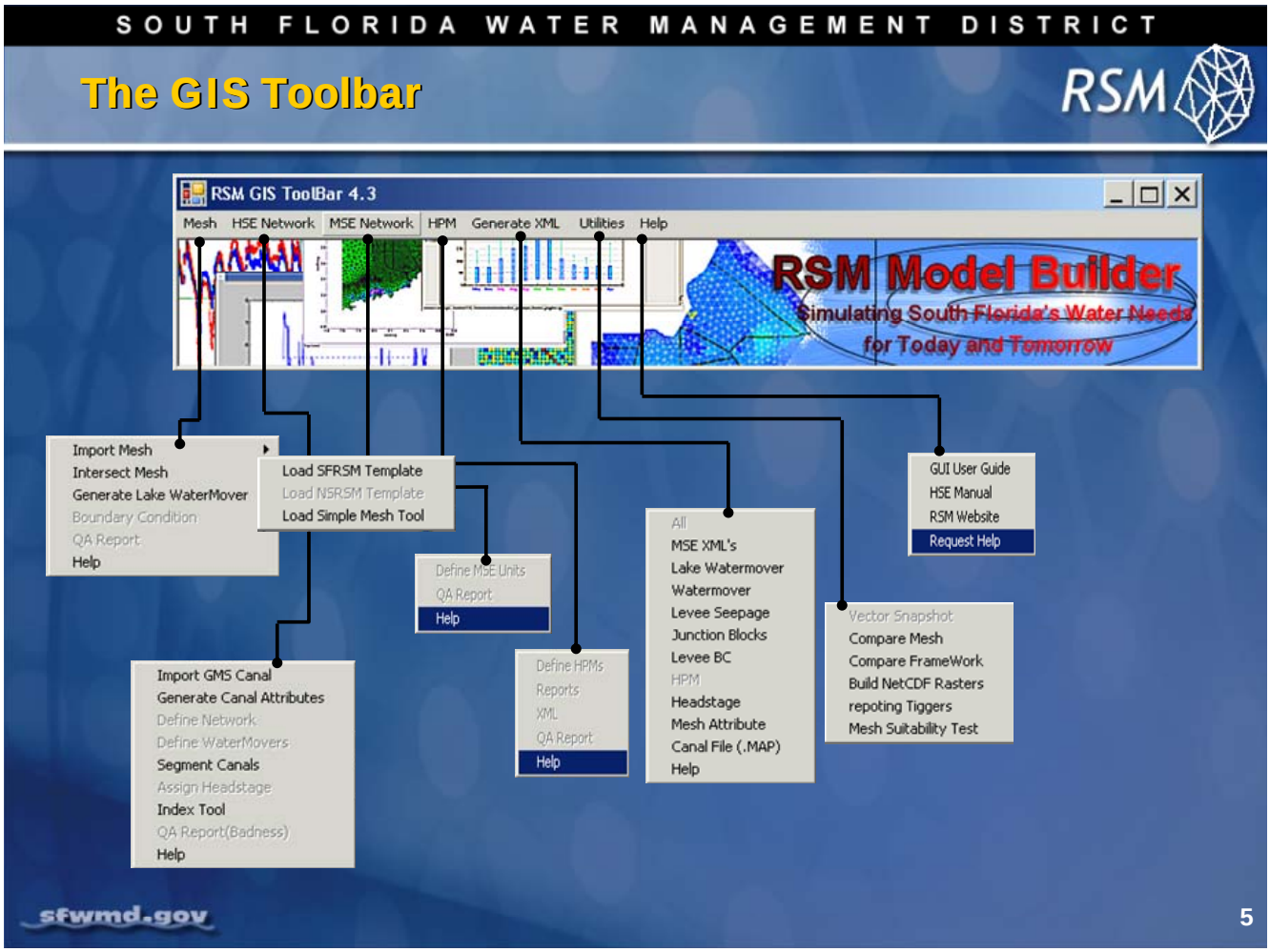
The RSM Graphical User Interface (GUI) currently consists of two toolbars:

1. The GIS ToolBar
2. The RSMGUI Python Toolbar

The Geographic Information System (GIS) ToolBar organizes a set of tools developed to run inside ArcGIS (9.2) to assist with generating input files for the Regional Simulation Model. The ArcGIS software is the South Florida Water Management District HESM's designated (spatial) database for storing RSM geographic features: structures, canals, boundaries, mesh.

The RSMGUI Toolbar organizes a set of tools developed to execute the RSM and post-process the output from the model. The RSMGUI uses Python, a platform independent programming language that can be deployed on any operating system.

Both toolbars are intended to help simplify some of the repetitive steps for setting up an RSM scenario in a self-documenting environment. The HESM team plans to complete a set of tools that will help build a scenario from beginning to end.

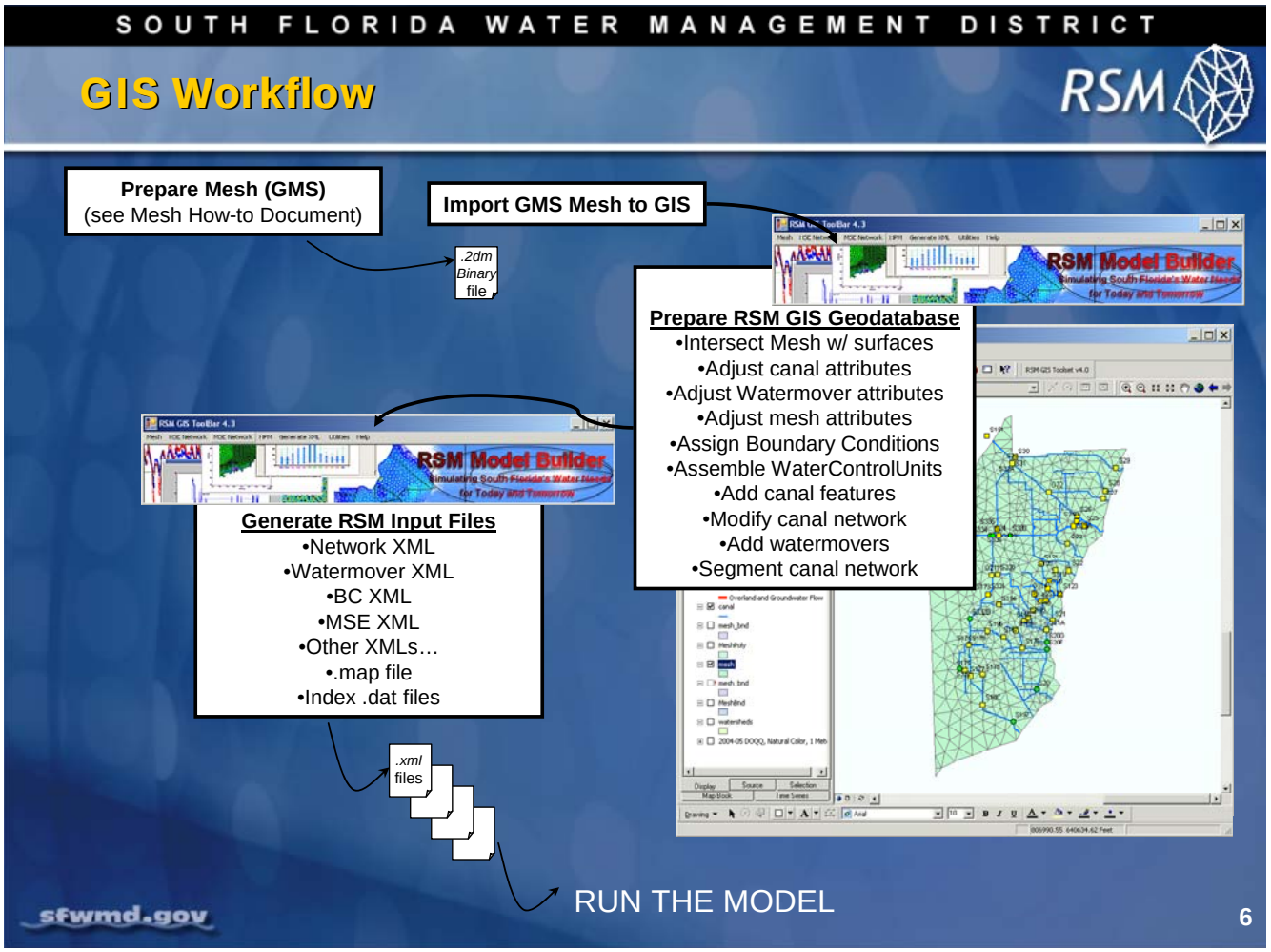


The RSM GIS ToolBar contains several tools to help configure the geodatabase and generate input files for the RSM.

The RSM geodatabase contains all of the data used to specify the physical features represented in the model. The geodatabase helps visualize the physical features in your model during setup and it serves as a documented source of data during post-processing. And, flexible RSM tools enable you to generate more than one type of file and output format.

Tools are organized by the main physical elements in the RSM: MESH, HSE Network, MSE, HPMs, GENERATING XMLs, Utilities and HELP.

NOTE: **Some features may not yet be active. New features will continue to be created and updated.**



The basic workflow to set up an RSM scenario using the GIS tools is outlined below:

- Generate a mesh using GMS
- Export the GMS to a .2DM file
- Import the .2Dm into GIS to generate a GIS mesh layer
- Combine the mesh layer with the base layers in the RSM geodatabase template*
- Intersect the mesh layer with other attribute information
- Configure the HSE canal network
- Configure the watermovers (structures)
- Add new canals
- Add new watermovers
- Configure boundary conditions
- Configure the MSE water control units
- Configure the HPMs
- Segment the canals
- Generate the RSM input files

* /data/geographic/geodatabase_templates/mesh_import_template.mdb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RSM
GIS via CITRIX and the RSM Geodatabase
Starting GIS via Citrix
Selecting Features
The RSM Geodatabase
Changing Attributes
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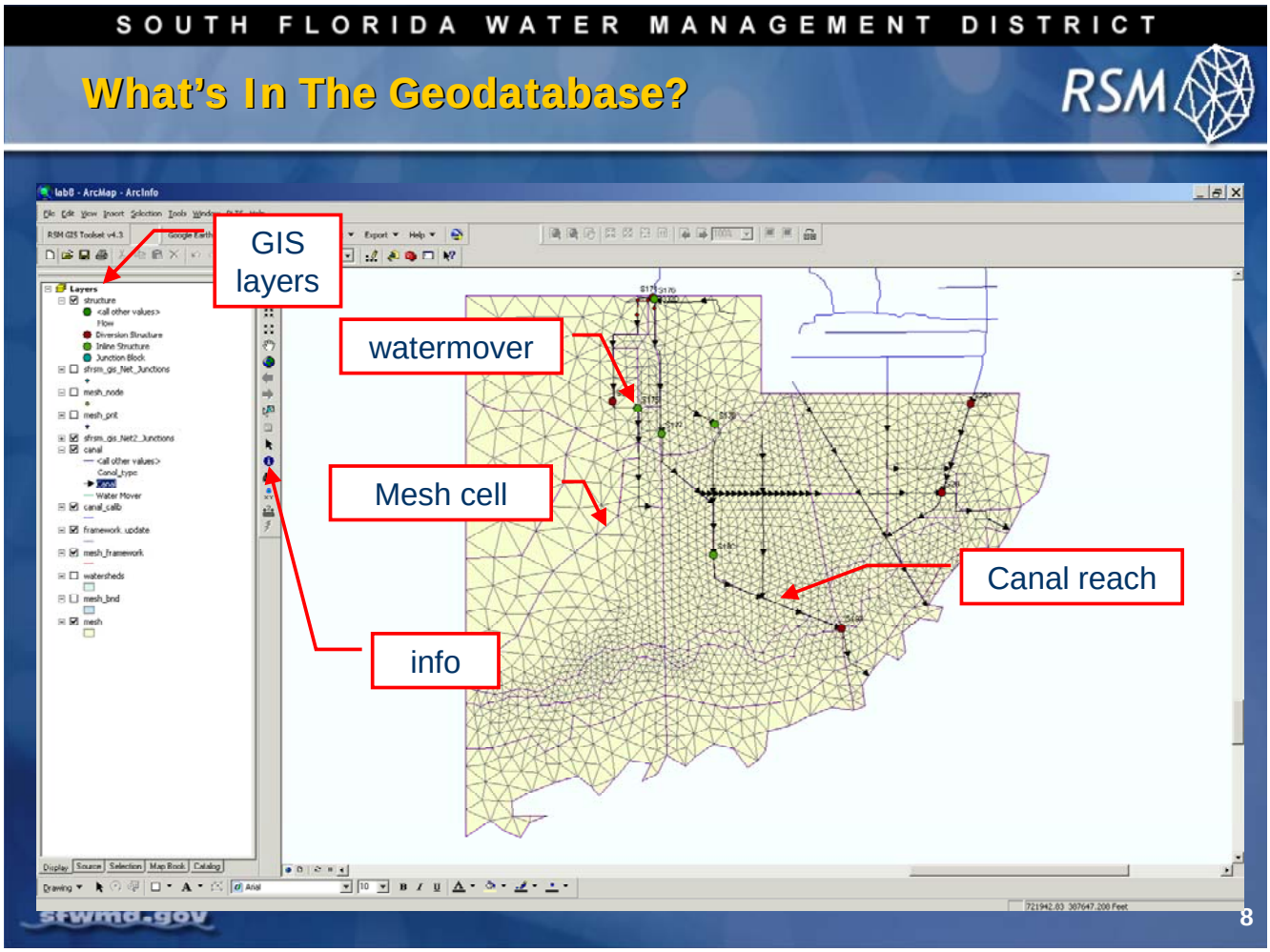
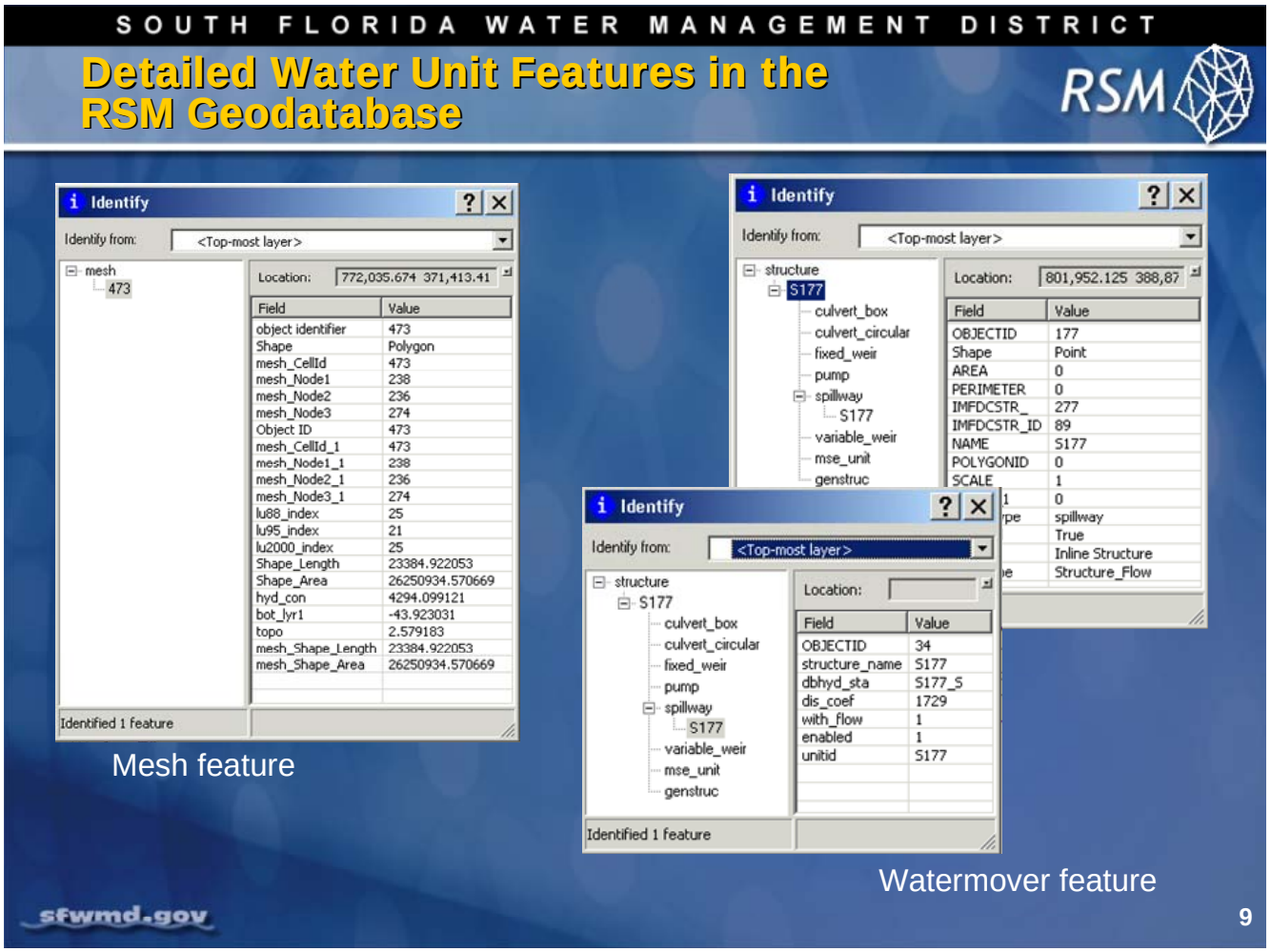


Open your own copy of the RSM personal geodatabase (a copy has been stored under **`$RSM/labs/lab8_RSMtoolbar/c111.mdb`**). And, become familiar with some of the basic GIS features, including the:

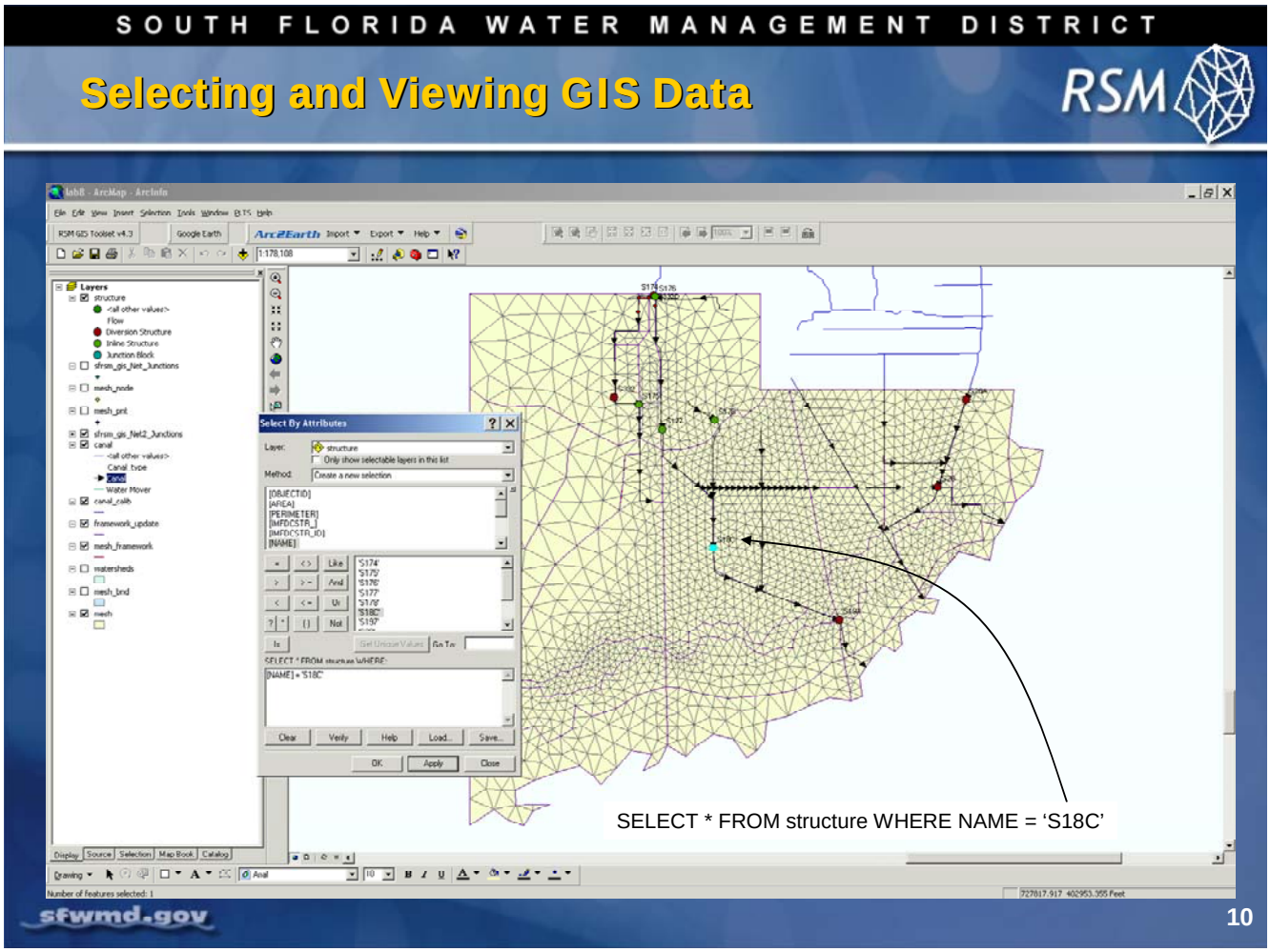
- Data layer index (right side)
- "Arrow at end" symbol which allows you to view canal default direction
- Mesh cells, which are polygons, have attributes which have been acquired from other data layers
- Watermovers (structures) which have associated tables describing the units at each structure in very specific detail
- Information tool which you can use to view some of the attributes in the geodatabase



The canal network consists of individual line segments. Each segment has been assigned attributes describing the physical characteristics as well as the participation of each segment in the overall network.

- Mesh cells contain attributes intersected from other GIS layers
- Canals are organized into reaches.
- Structures are fully attributed and contain associated unit tables

Select the Information tool and click on features in the geodatabase to view their attributes.



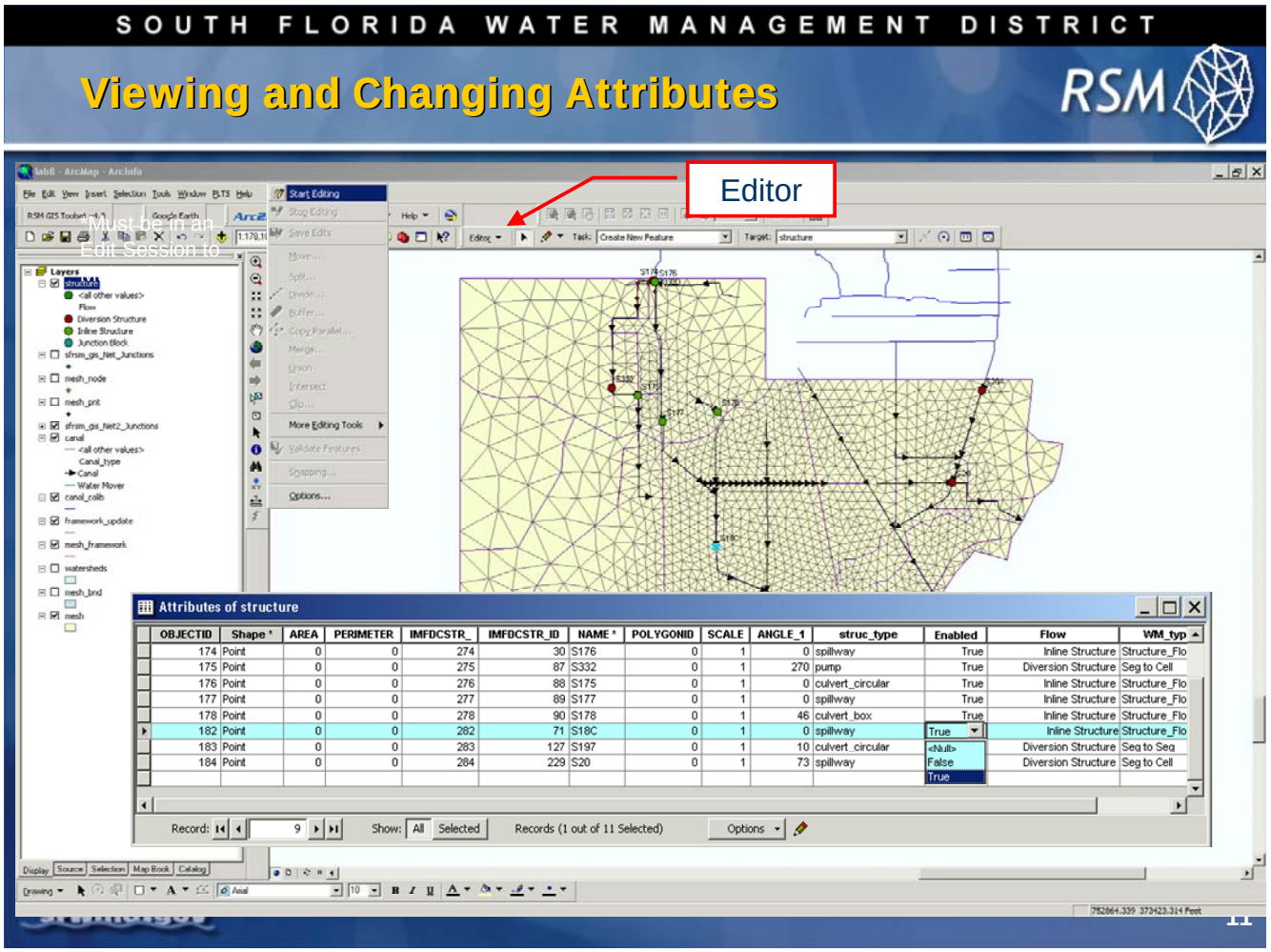
Query Data

From the GIS drop-down menu, choose Selection and click the option for Select by Attributes. Within the Select by Attributes query window:

- Specify the structure **Layer**
- Specify the [NAME] **Attribute** (the attribute you want to query) from the top list box
- Click the **=** button to select the qualifier to make the selection
- Click **Get Unique Values** to display a list of unique names
- Select **S18C** from the list of unique names in the second list box

Your query is displayed in the bottom portion of the Select by Attributes window. Your query should read: [NAME] = "S18C"

The complete query is: Select * from Structure WHERE Name = "S18C"

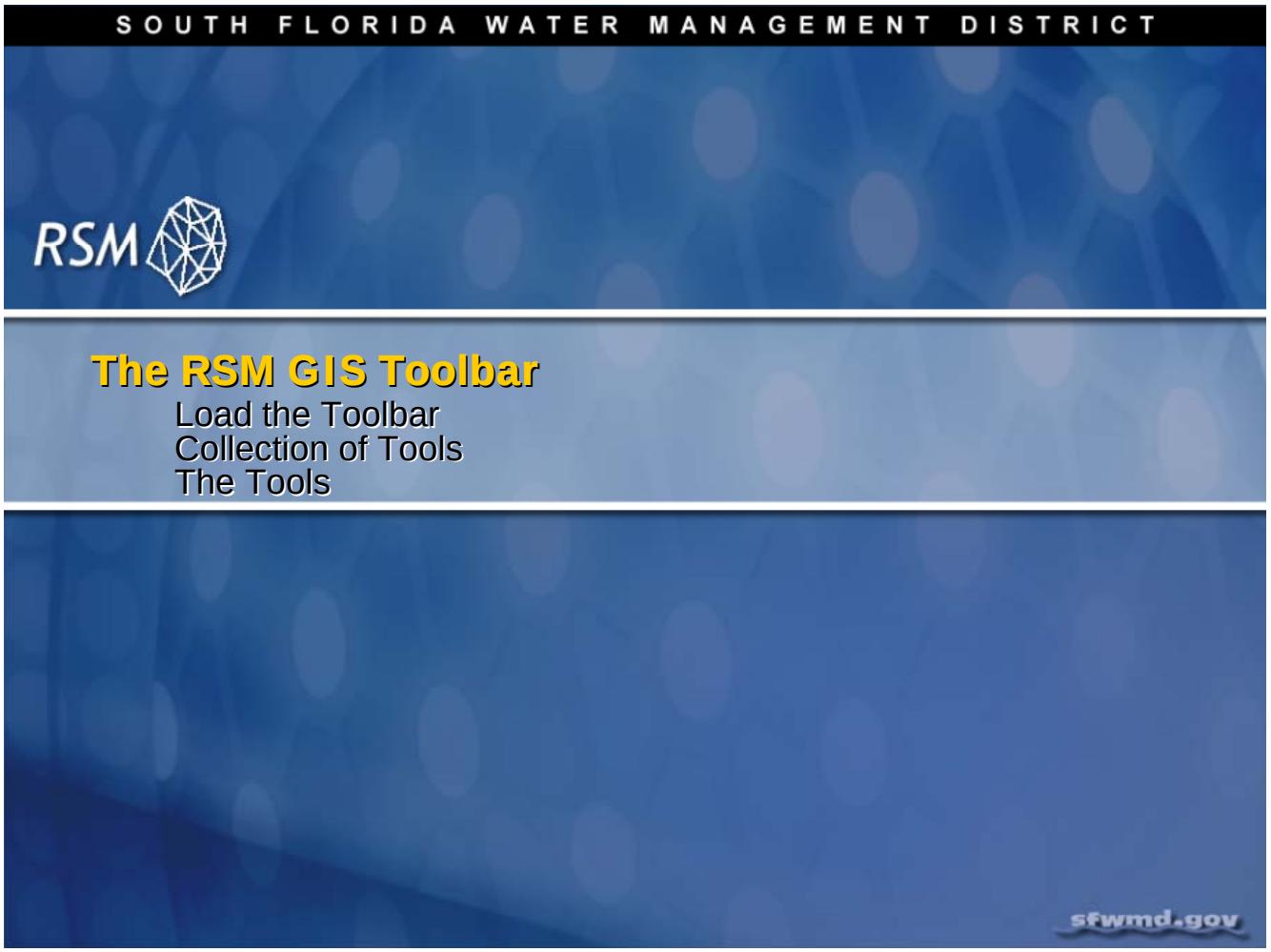


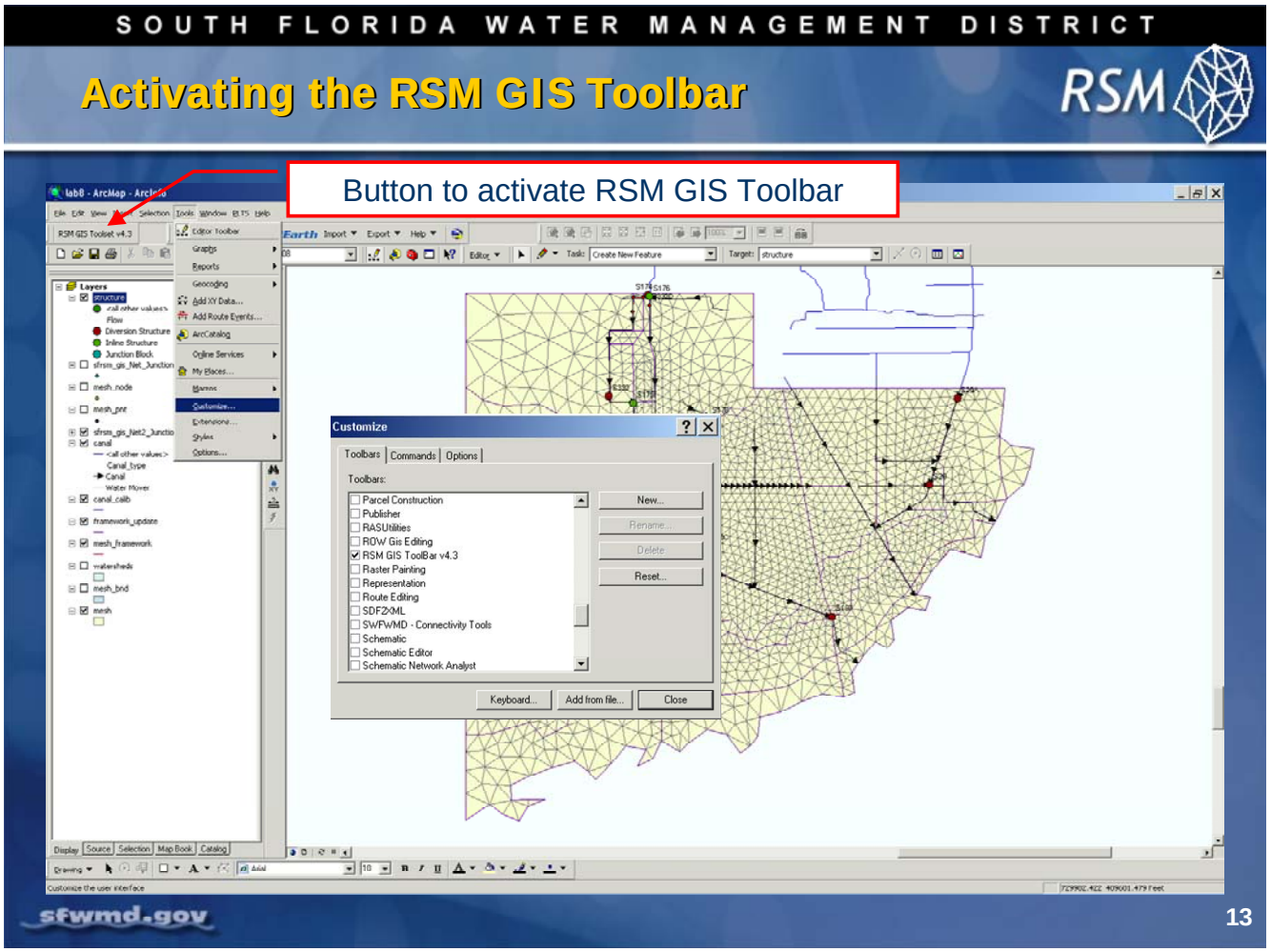
Editing

Before you can make changes to attributes in the geodatabase, you must be in an Edit Session:

1. From the **Tools** drop-down menu, select the **Editor** Toolbar and click **Start Editing**.
2. Right-click the **Structure** layer in the list of Layers (on the left side of your screen) and select **View Attribute Table**.
3. Structure S18C should be highlighted in the list of structures. Click the **Enabled** field and examine the choices.

Some fields are set up as domains, which helps to ensure that only valid data values are entered. The Enabled field has three optional values (True, False, and NULL).


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM
The RSM GIS Toolbar
Load the Toolbar
Collection of Tools
The Tools
sfwmd.gov

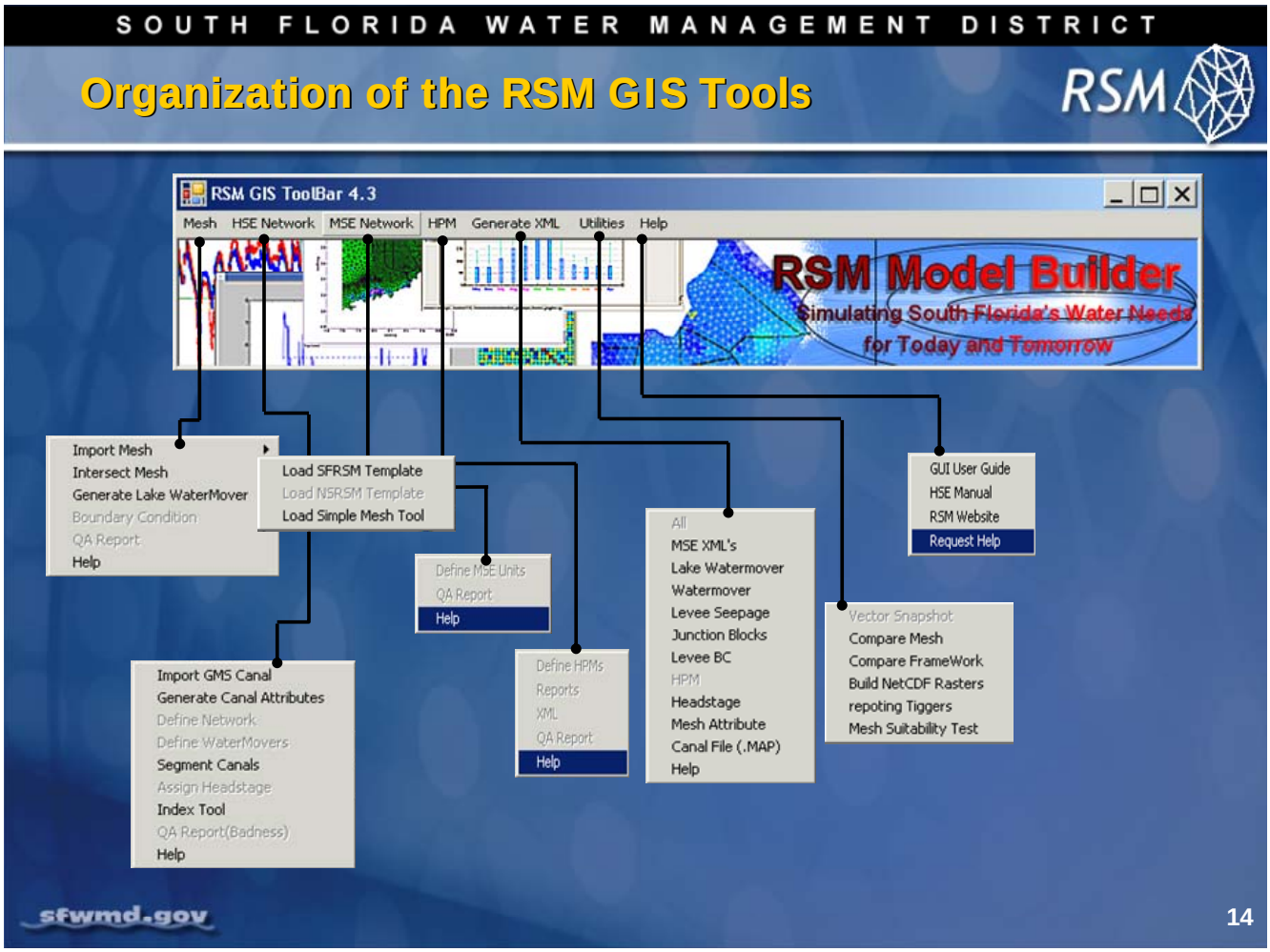


Installing the RSM GIS ToolBar

To install the RSM GIS ToolBar to your ArcMap GIS Desktop:

1. Select the **Customize** option from the **Tools** dropdown menu at the top of the screen
2. Select **RSM GIS ToolBar v4.3** from the list of choices available in the **Toolbars** tab
3. When the RSM GIS ToolBar button appears, you can drag and anchor it to your **Main** Menu bar in ArcMap

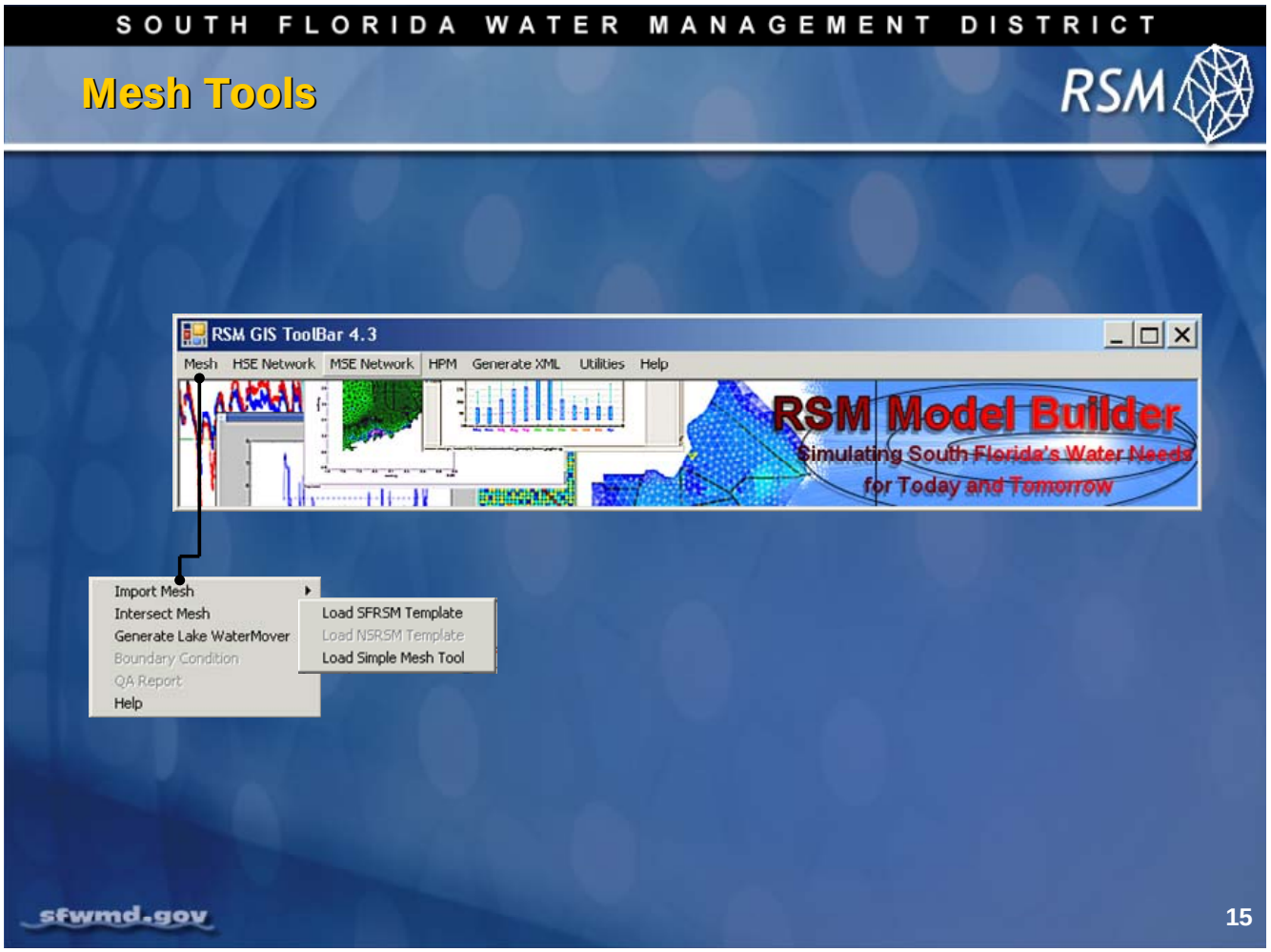
Click on the new RSM GIS ToolBar button and the toolbar will open. It will not be necessary to repeat this installation procedure. The next time you start ArcMap, the RSM GIS ToolBar will be ready to use.

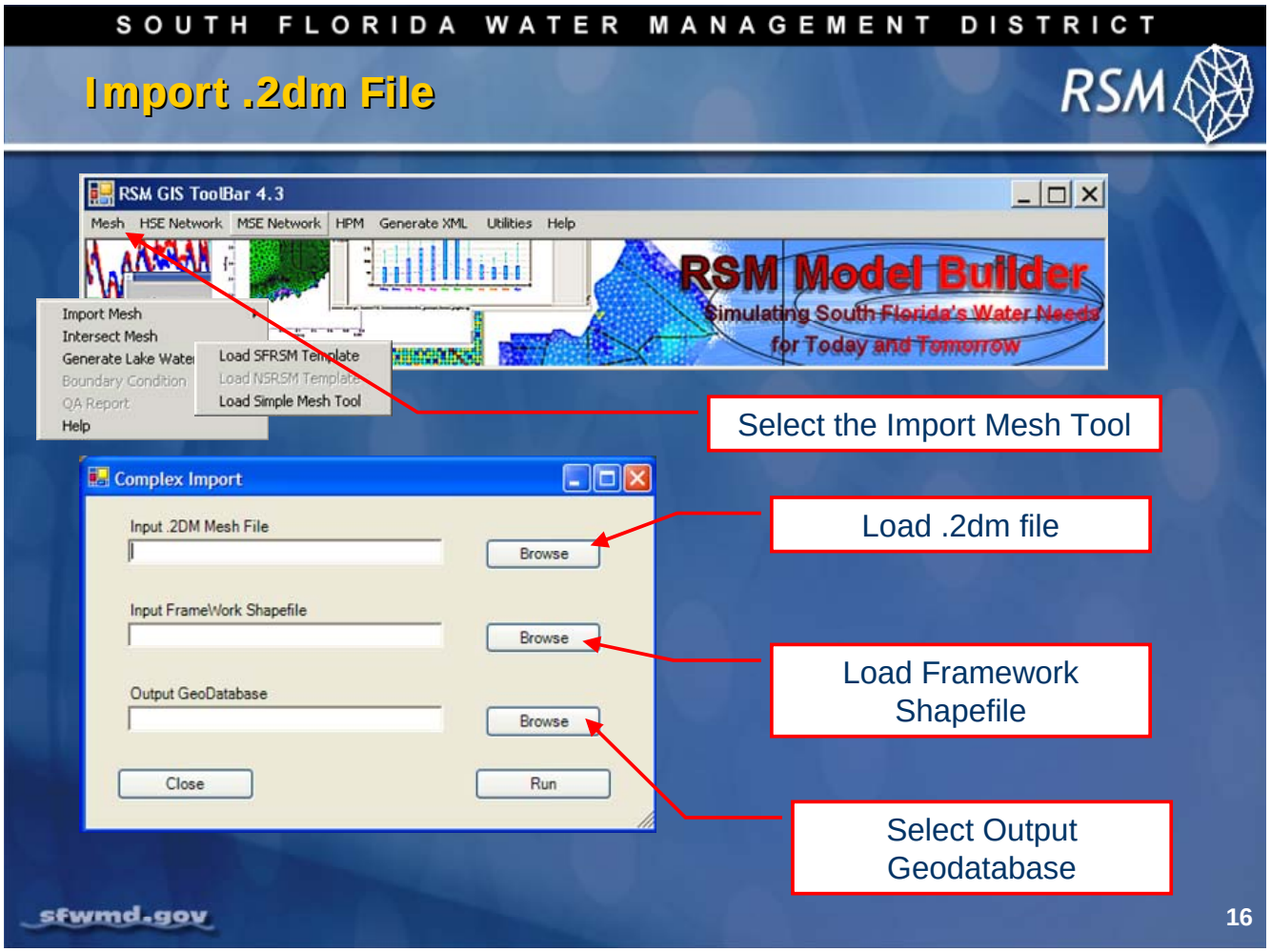


The RSM GIS Tools are organized by major RSM category and workflow functions to:

- Import a mesh and manage the elements in the mesh (cells)
- Set-up features in the canal network (segments)
- Set-up features for each watermover (structures)
- Generate your RSM XML files

There is also a menu for other utilities and for Help.


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Mesh Tools
RSM
RSM GIS ToolBar 4.3
Mesh
HSE Network
MSE Network
HPM
Generate XML
Utilities
Help
RSM Model Builder
Simulating South Florida's Water Needs
for Today and Tomorrow
Import Mesh
Intersect Mesh
Generate Lake WaterMover
Boundary Condition
QA Report
Help
Load SFRSM Template
Load NSRSM Template
Load Simple Mesh Tool
sfwmd.gov
15



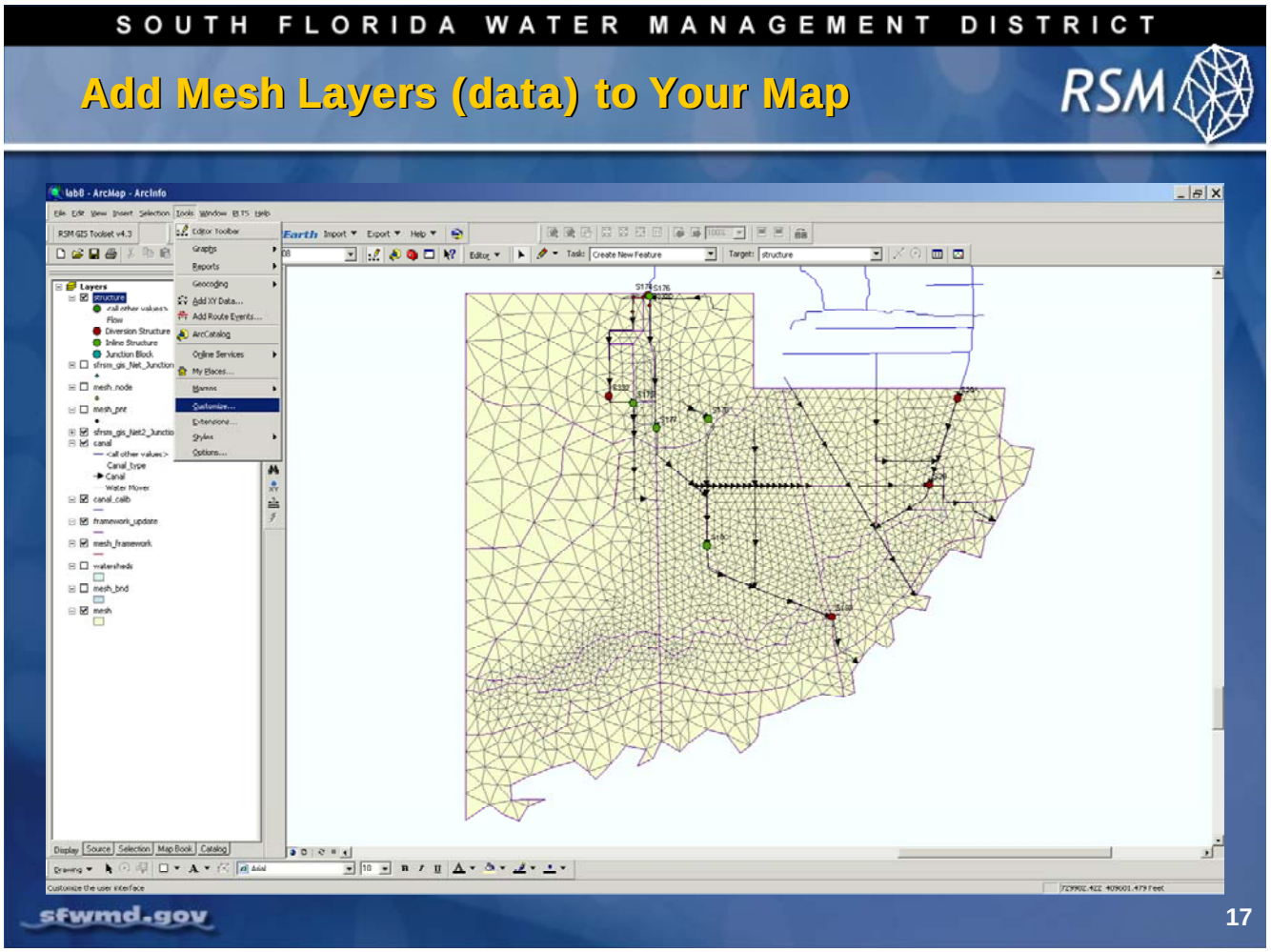
Import a Mesh

The Import .2dm File feature has been redesigned to import an existing GMS .2dm mesh and then incorporate it into the RSM geodatabase template. The new tool also immediately opens the new mesh and geodatabase in a GIS map session. The projection is defaulted to **NAD_1983_HARN_StatePlane_Florida_East.**

There are two methods to import a mesh: simple or using the RSM template. The following steps demonstrate using the RSM Template method:

1. Select **Import Mesh** from the **Mesh** drop-down menu and click **Load SFRSM Template**
2. Load **Input .2DM Mesh File** (file created in GMS)
3. Load **Input FrameWork Shapefile** (shapefile used to create mesh)
4. Select name and location of **Output Geodatabase**

The result will be a RSM geodatabase with the correct format for use with the RSM GIS GUI Tools for south Florida. Canals falling completely outside the framework are removed. Additional editing is required to clean canals that extend beyond the framework.

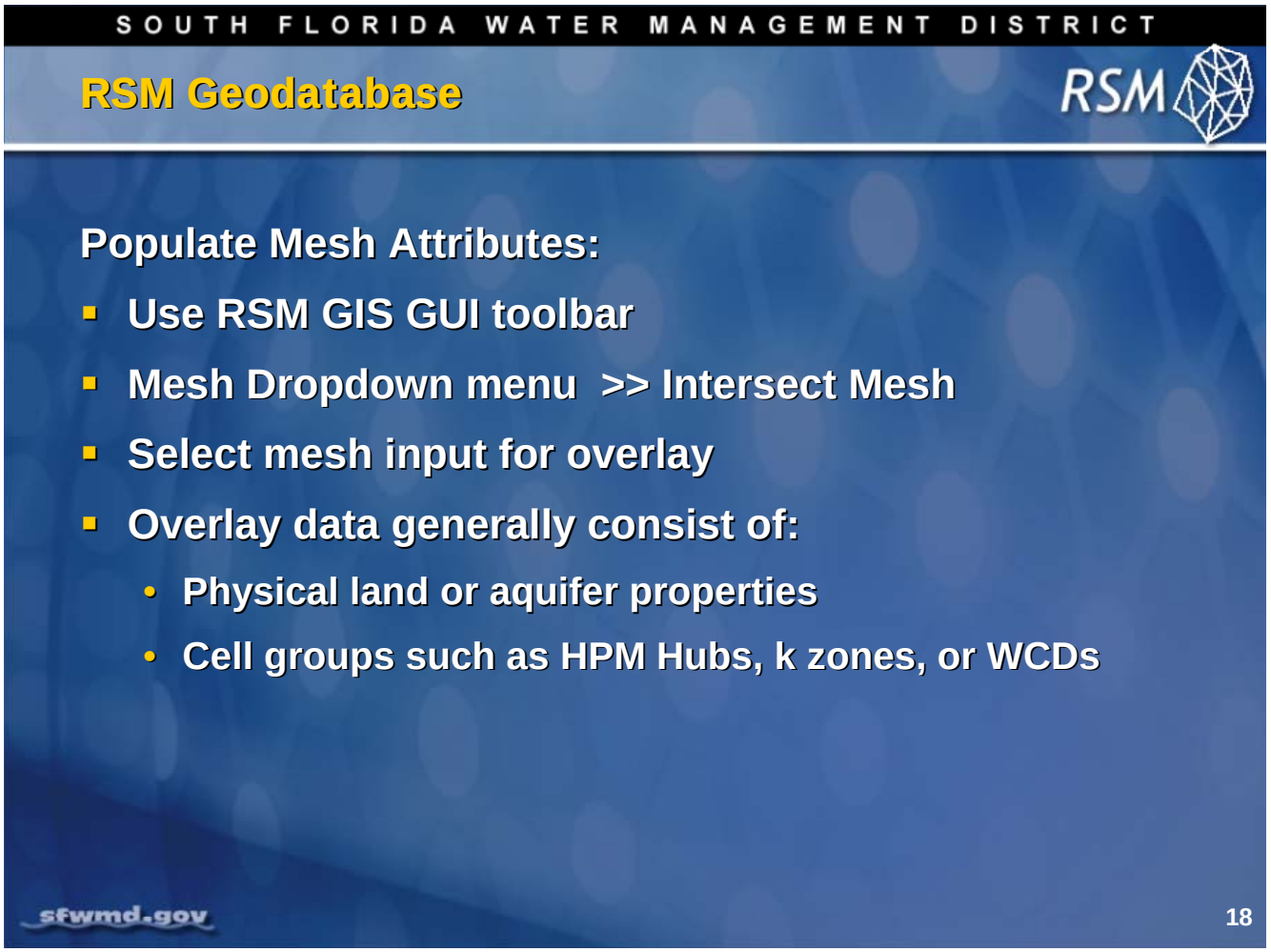


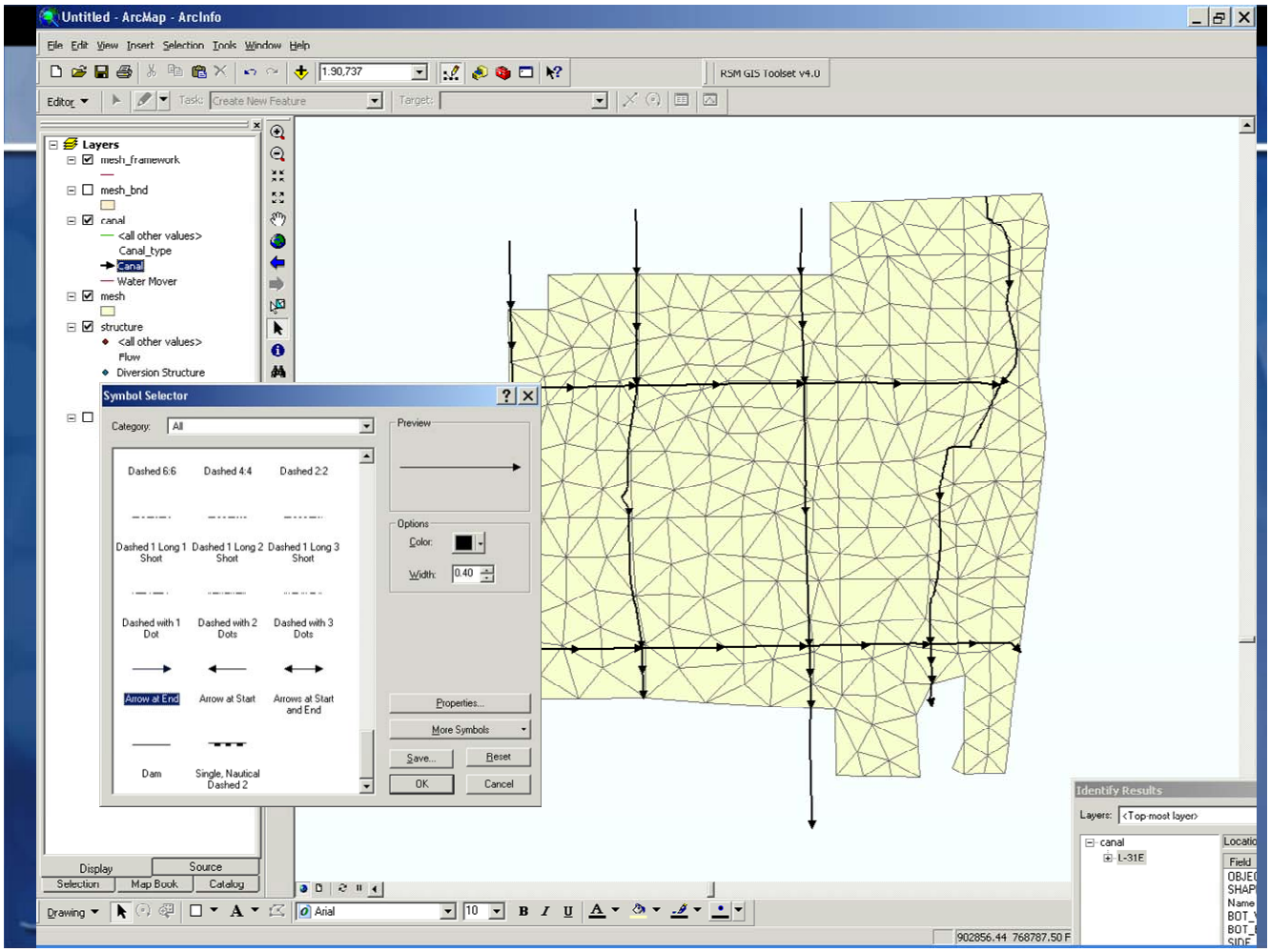
When working within a new map, it may be necessary to import your mesh for the first time.

1. Right-click the **Layer** menu to the left of the map display window and select **Add Data** from the menu.
2. Browse to the location where your mesh has been saved.
3. Select the **.mdb** file to be added to the map.

An RSM Mesh must contain:

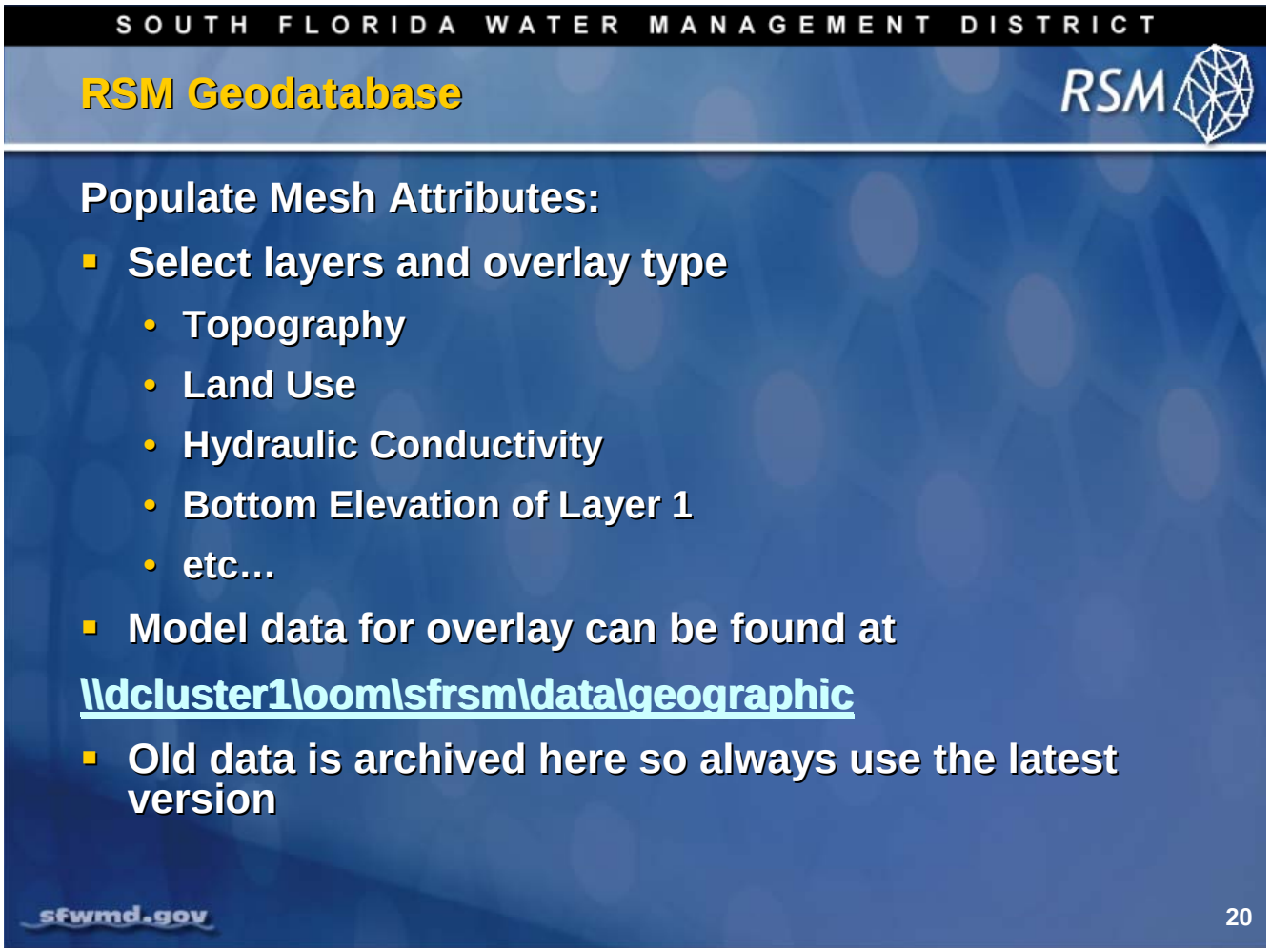
- A mesh_framework
- Mesh
- Mesh_pnt
- Mesh_bnd
- Mesh_node layers


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM Geodatabase
RSM
Populate Mesh Attributes:
Use RSM GIS GUI toolbar
Mesh Dropdown menu >> Intersect Mesh
Select mesh input for overlay
Overlay data generally consist of:
Physical land or aquifer properties
Cell groups such as HPM Hubs, k zones, or WCDs
sfwmd.gov
18



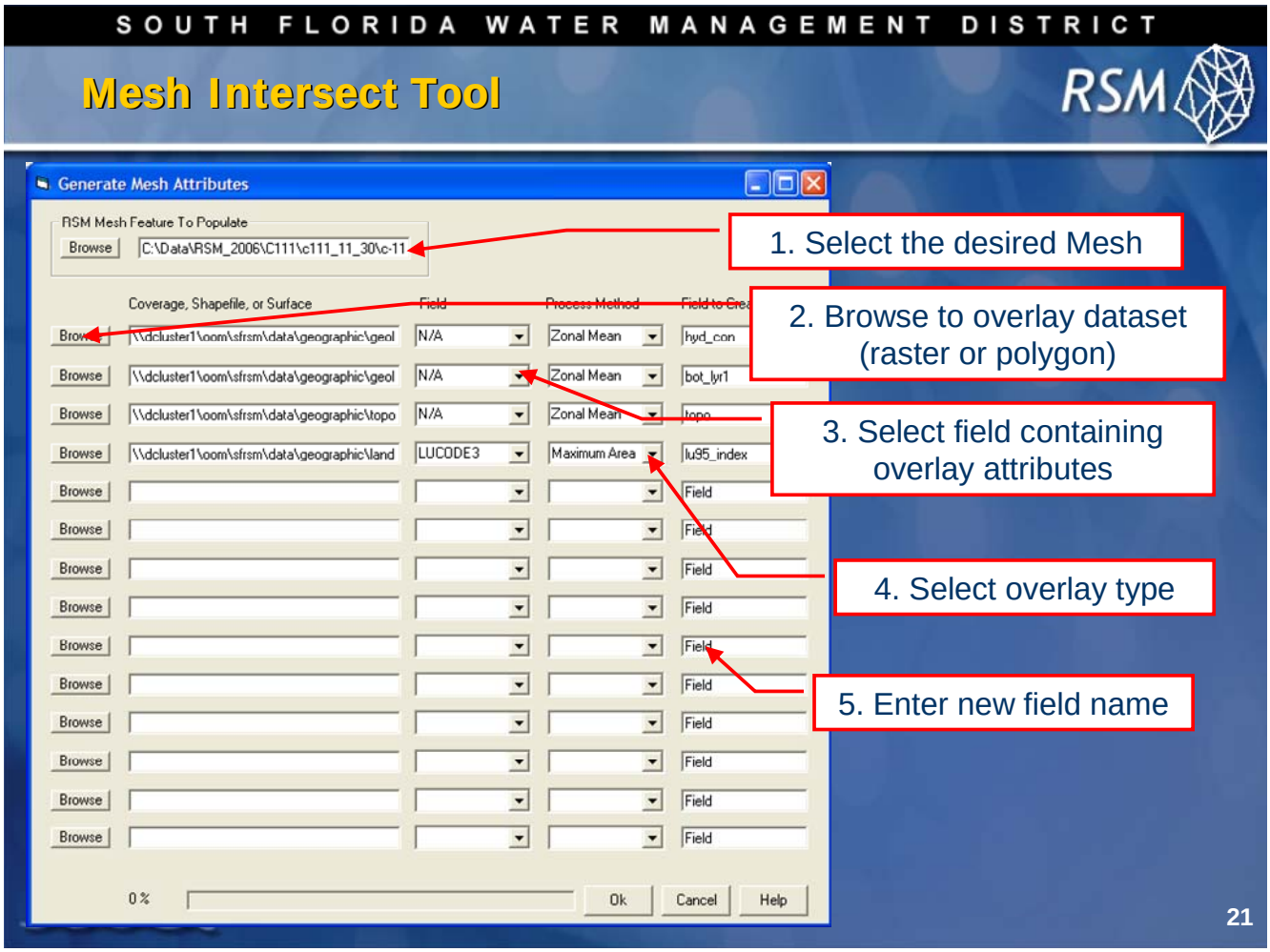
This slide shows an example of the results from importing a new mesh using the RSM Template.

- Note the canals extending beyond the framework.
- Note a new line symbol was chosen to display the canals to help view the default flow direction.



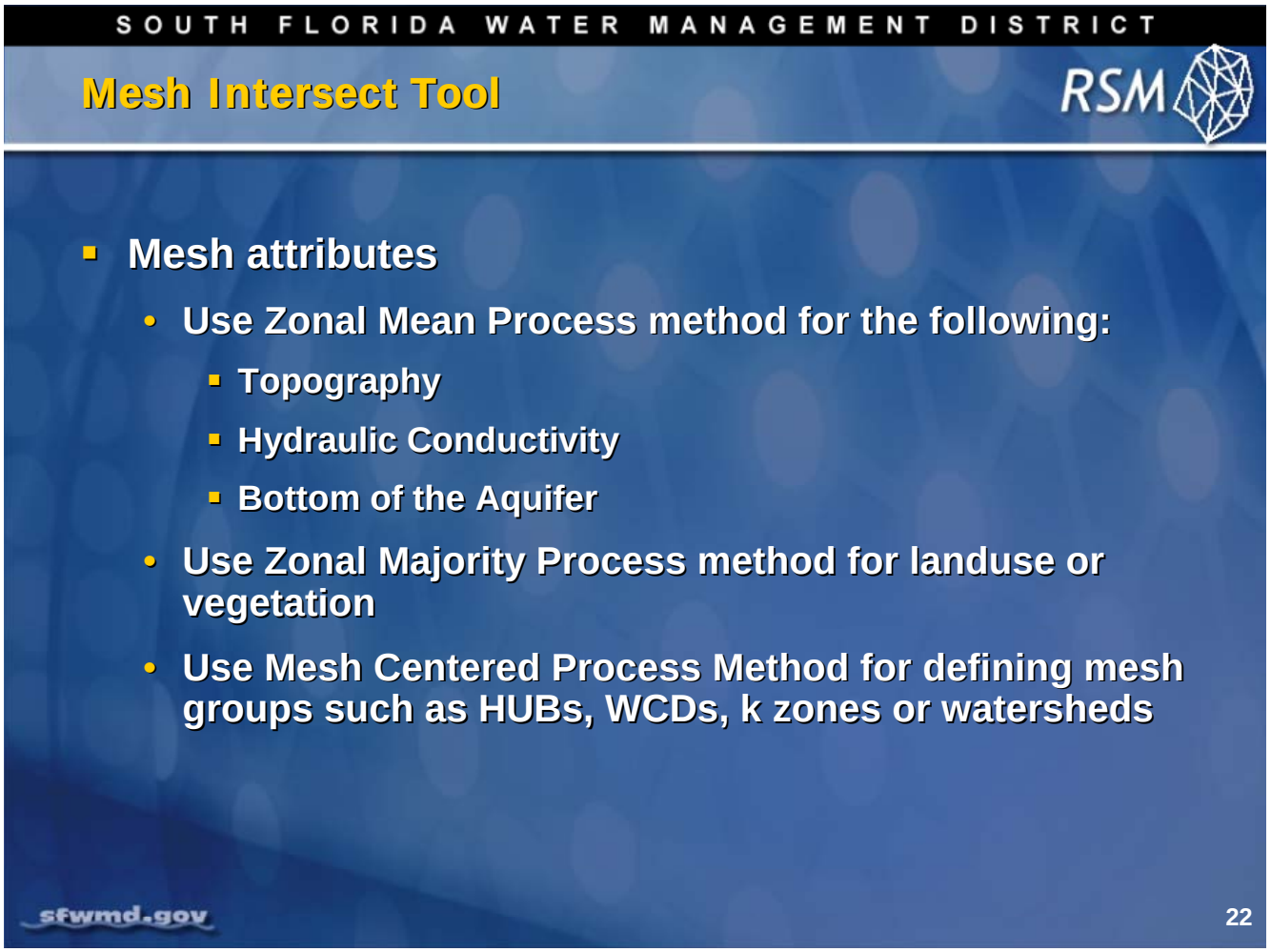
A **Mesh Intersect Tool**, available from the **Mesh** drop-down menu, helps you intersect your mesh with other data layers. It will populate the mesh with attributes needed by the RSM and utilized for generating index files.

NOTE: **The path `$RSM/data/geographic` will work if you are not on the SFWMD network.**



Intersect the mesh with other data layers to incorporate other data into the mesh as new attributes. Drop-down menus guide your selection of a method of intersection and the attribute layers to be added to your mesh.

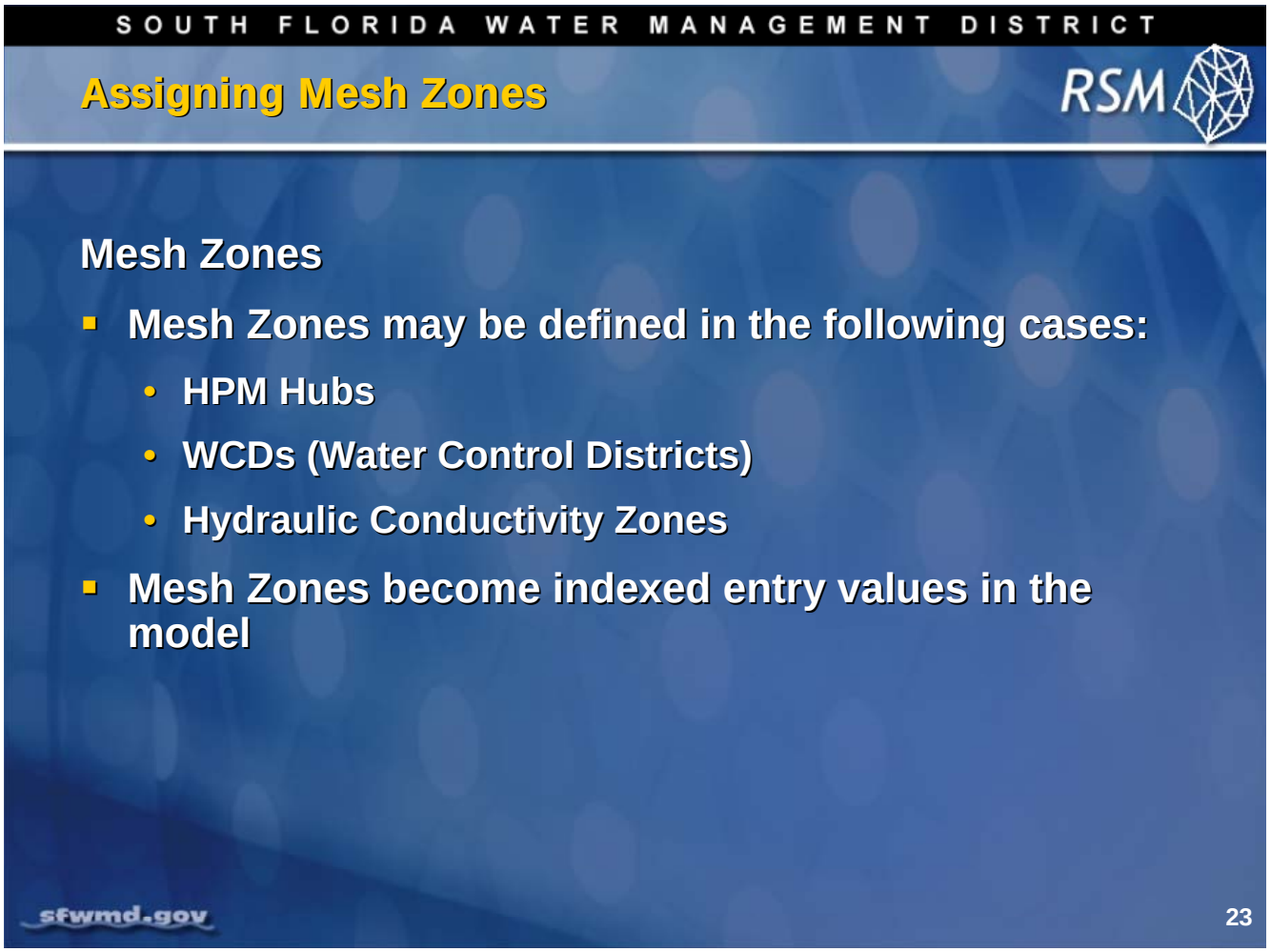
- Raster data such as topography are intersected using **Zonal Range**
- Point data such as wells are intersected using **Mesh Centered**
- Polygon data such as landuse are intersected using **Mesh Centered**



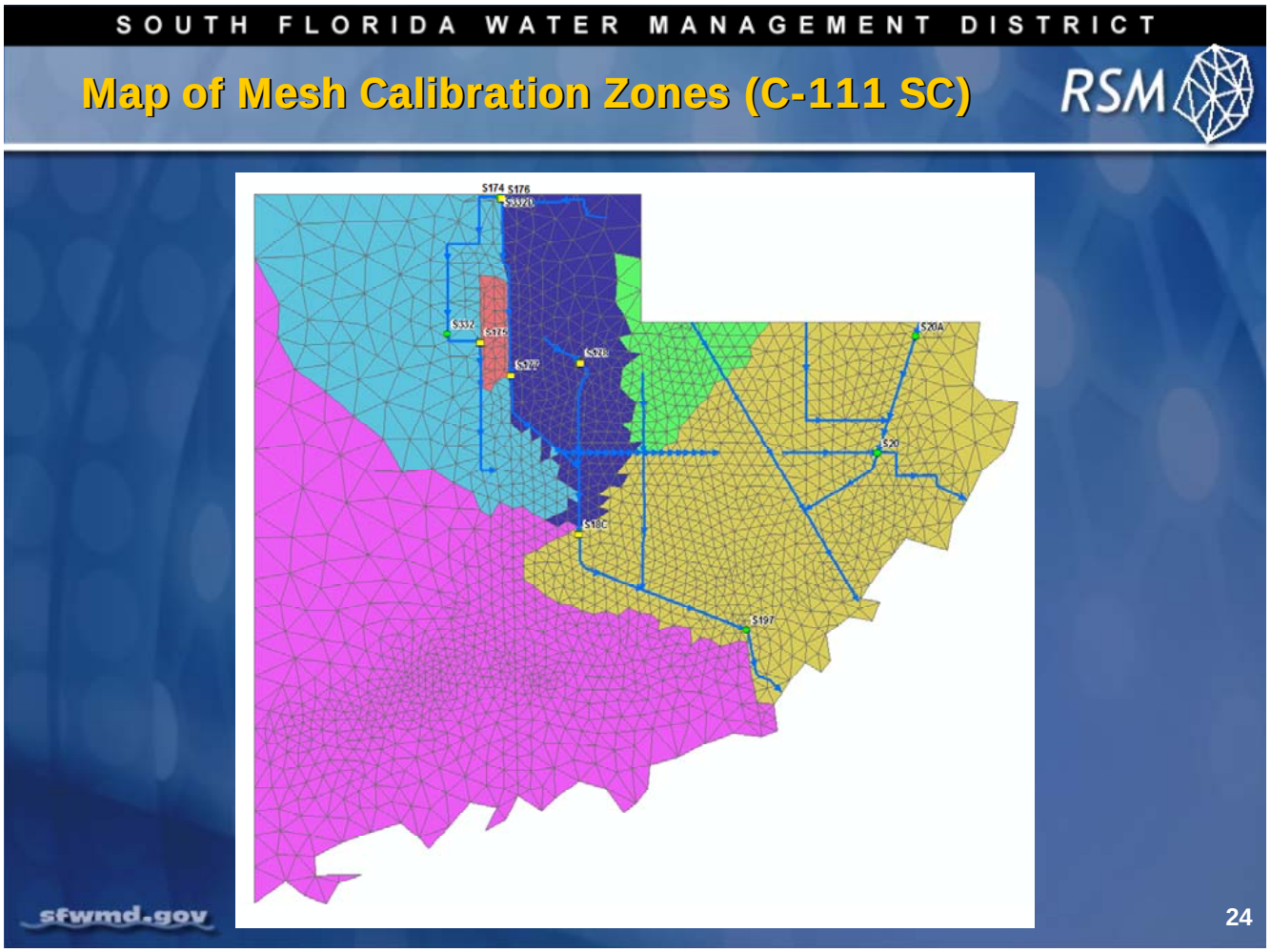
The **Zonal Mean** process works well for smooth continuous data. Zonal Mean does not work for categorical data like landuse. For topography data it is possible to have bad data such as buildings or missed data, but Zonal Mean is the method most often used.

The **Zonal Majority** process works well for landuse data and other categorical data. If there is a landuse that is more important, it may be best to manually adjust the landuse selections.

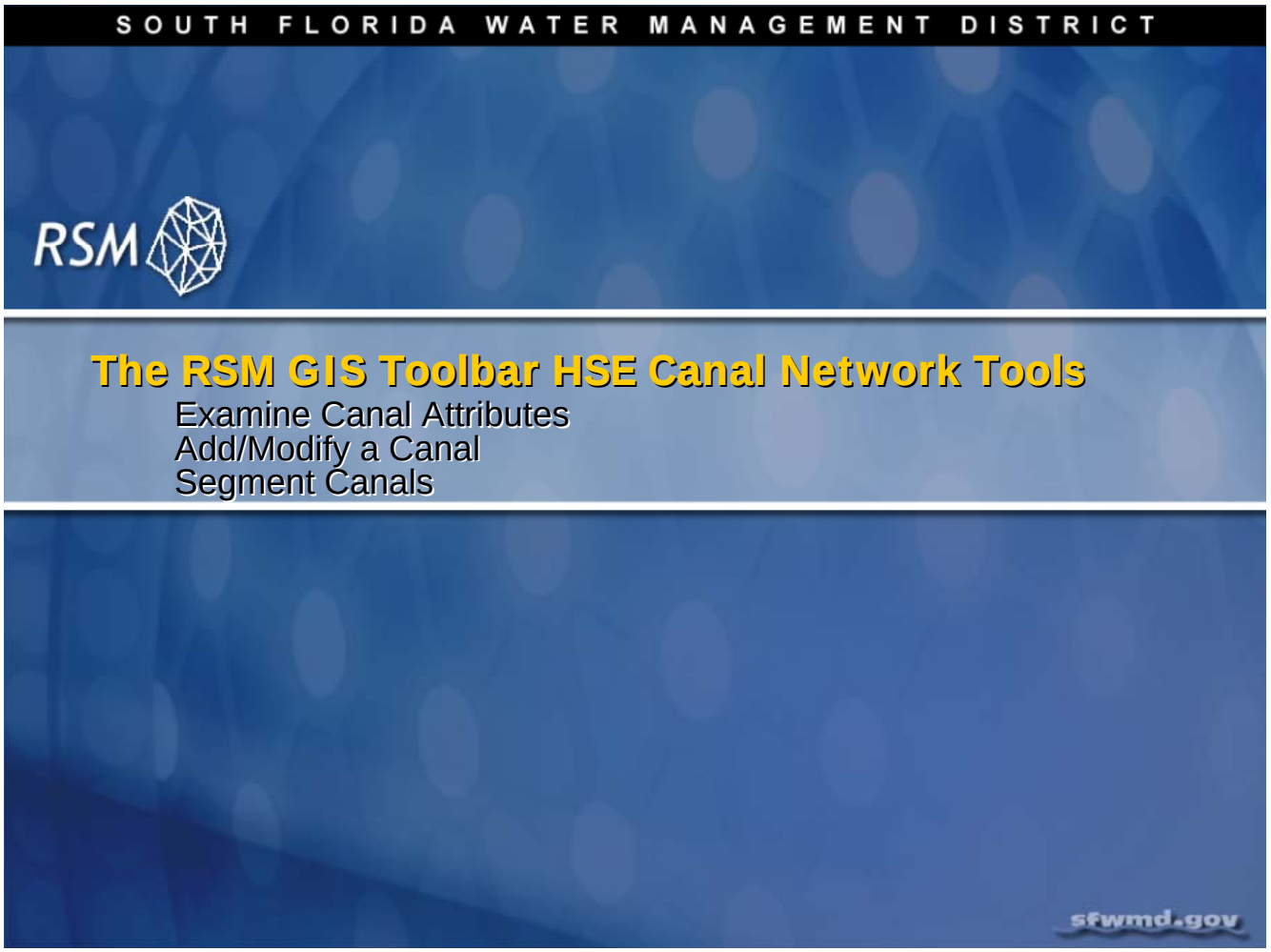
For groups such as hubs or watersheds, the **Mesh Centered** process works well.

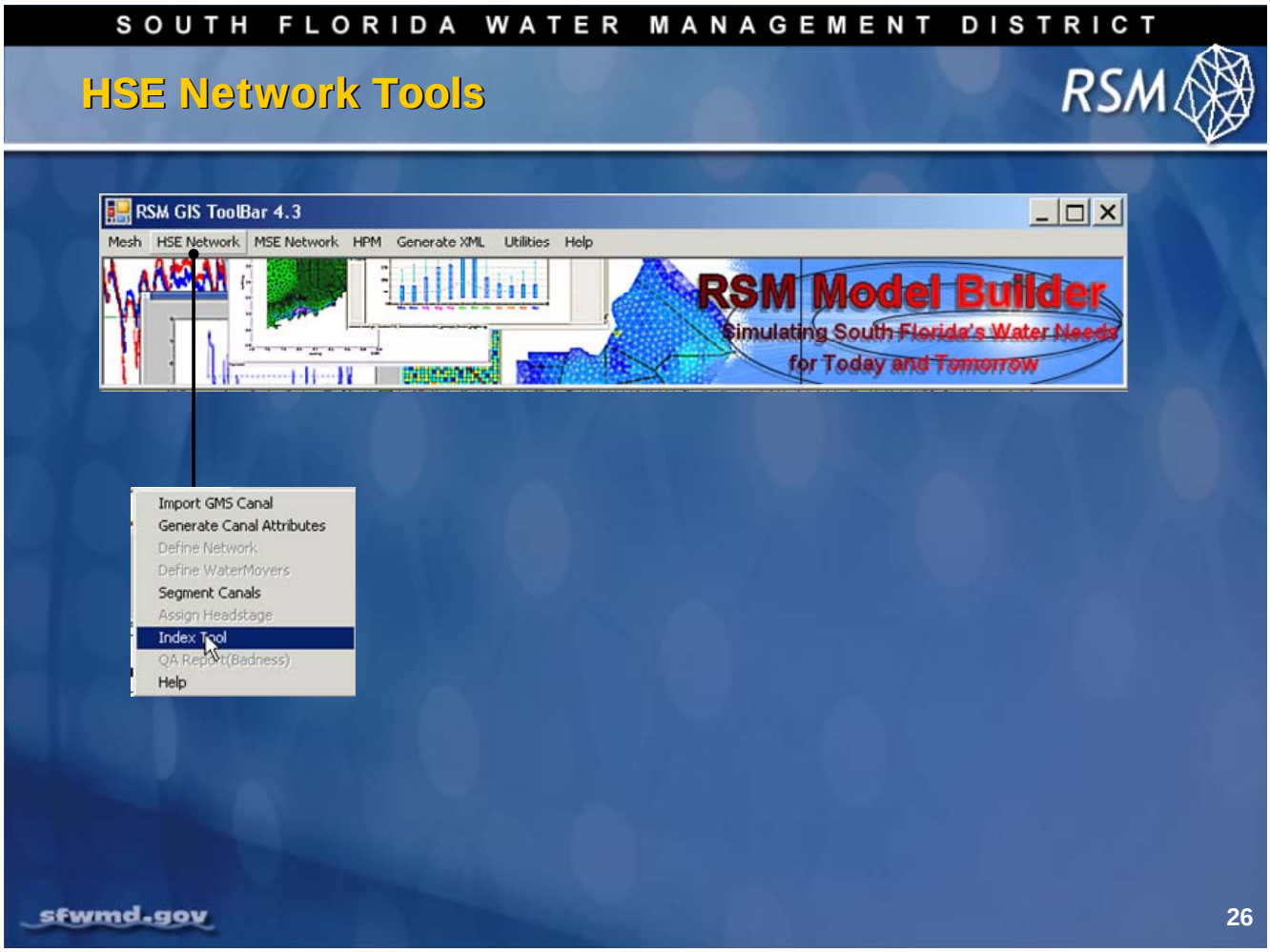


Mesh Zones are useful for large areas that have the same categorical value such as hubs or Water Control Districts (WCDs). Parameters such as hydraulic conductivity that have widely varying values may be grouped into ranges that can be assigned a single value in the model. This is useful in calibration.

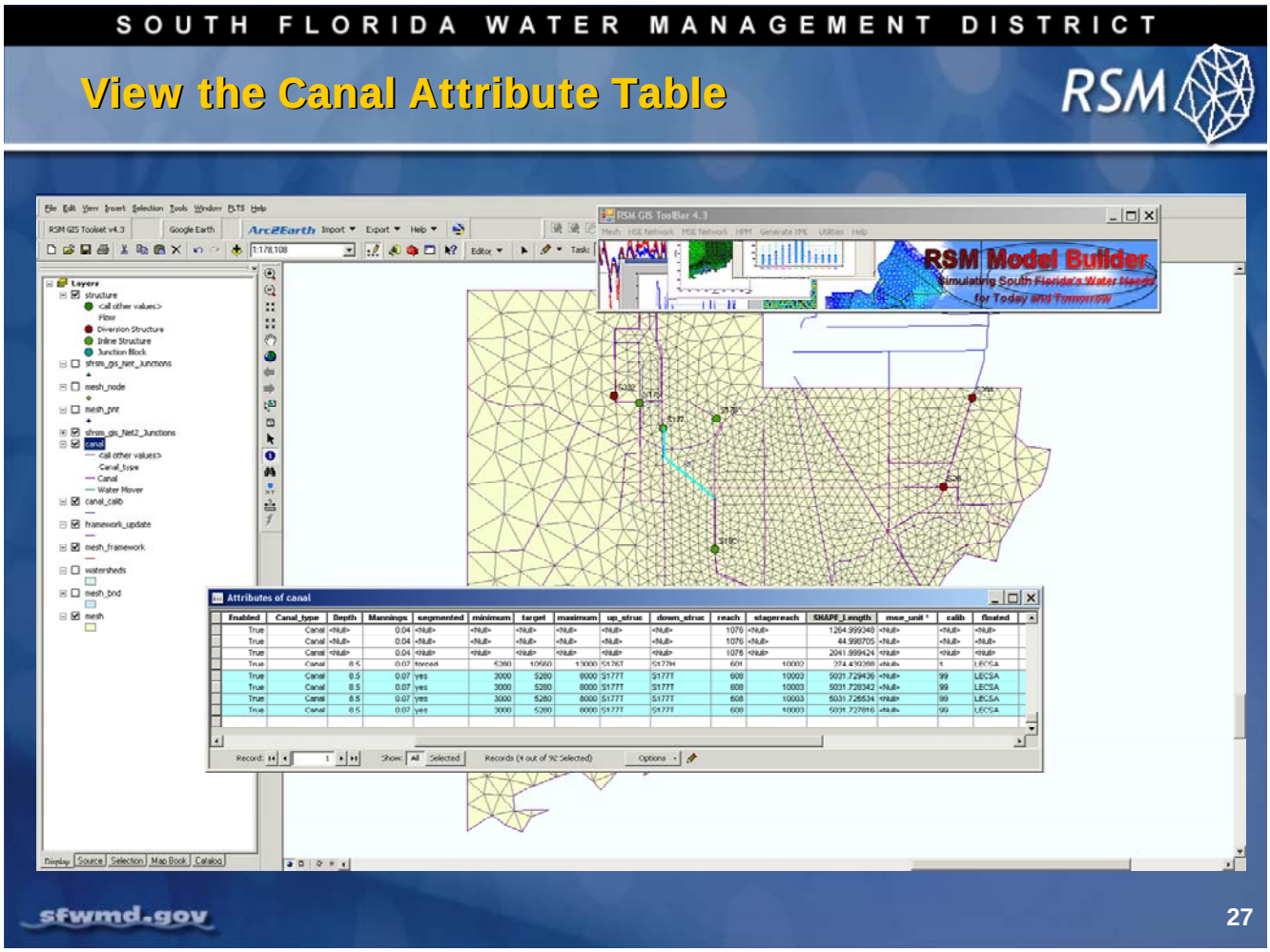


This slide presents an example of hydraulic conductivity zones used in the C-111 RSM implementation.


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM
The RSM GIS Toolbar HSE Canal Network Tools
Examine Canal Attributes
Add/Modify a Canal
Segment Canals
sfwmd.gov



The **HSE Network** tools drop-down menu includes the **Import GMS Canal** function and **Generate Canal Attributes** function, which are not active at this time and will not be covered in this training.



Viewing and Editing Attributes

In the Display window on the right side of the screen, right click the **Canal Layer**, then select **View Attribute Table** from the list of options.

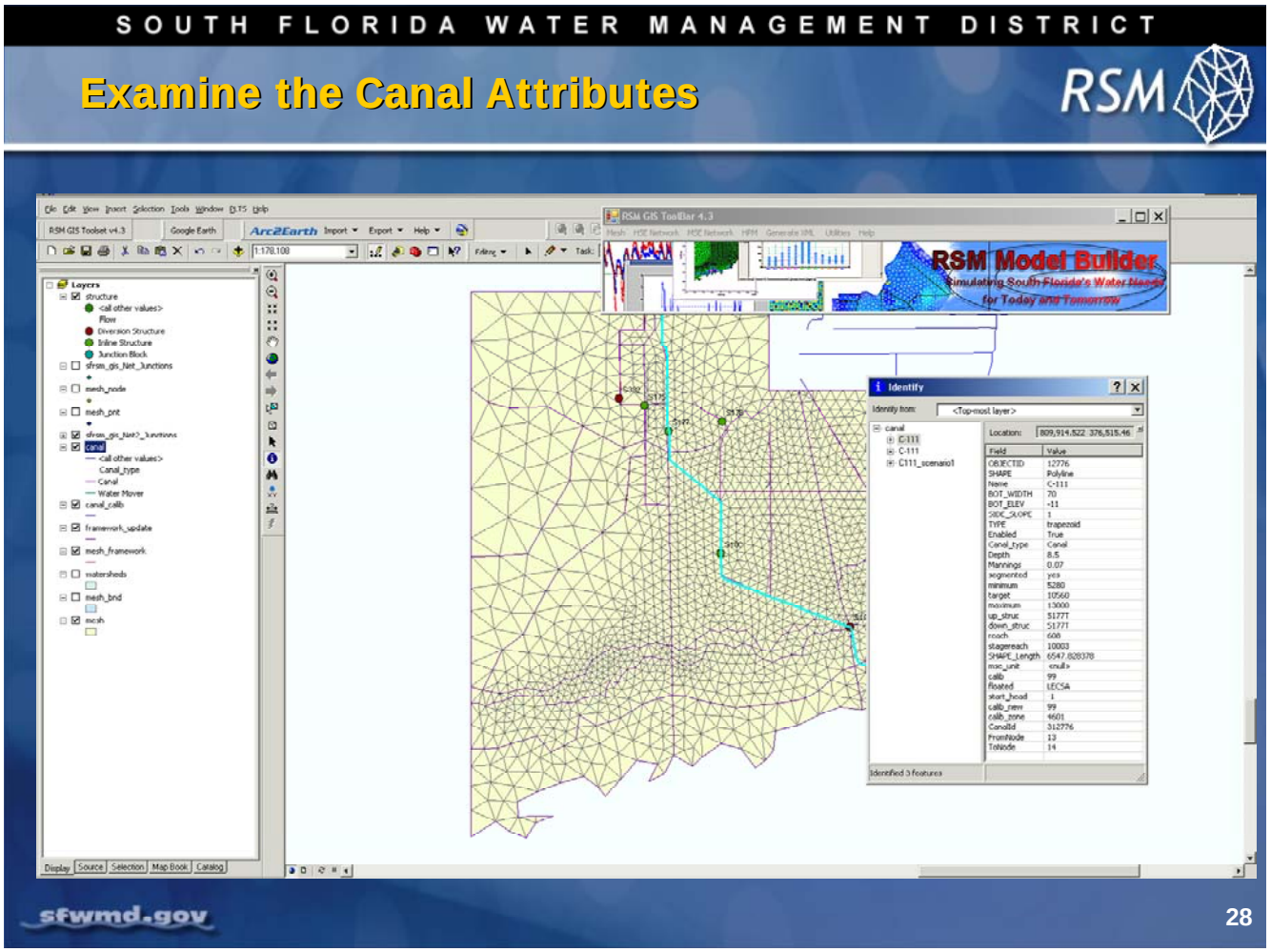
When the attribute table appears, click the button **Show: Selected** at the bottom of the window, to view the attributes for the canal reach you selected.

There are four canal segments in Reach 608. Look at some of the attributes to become familiar with the level of detail in the RSM geodatabase. Notice the attribute called **"segmented" = yes**. This means this canal has already been segmented. Notice that each segment in Reach 608 is the same length.

To change one of the attributes, open an Edit Session:

1. Click on the **Editor** button at the top of the GIS display window
2. Select **Start Editing** from the choices you are given

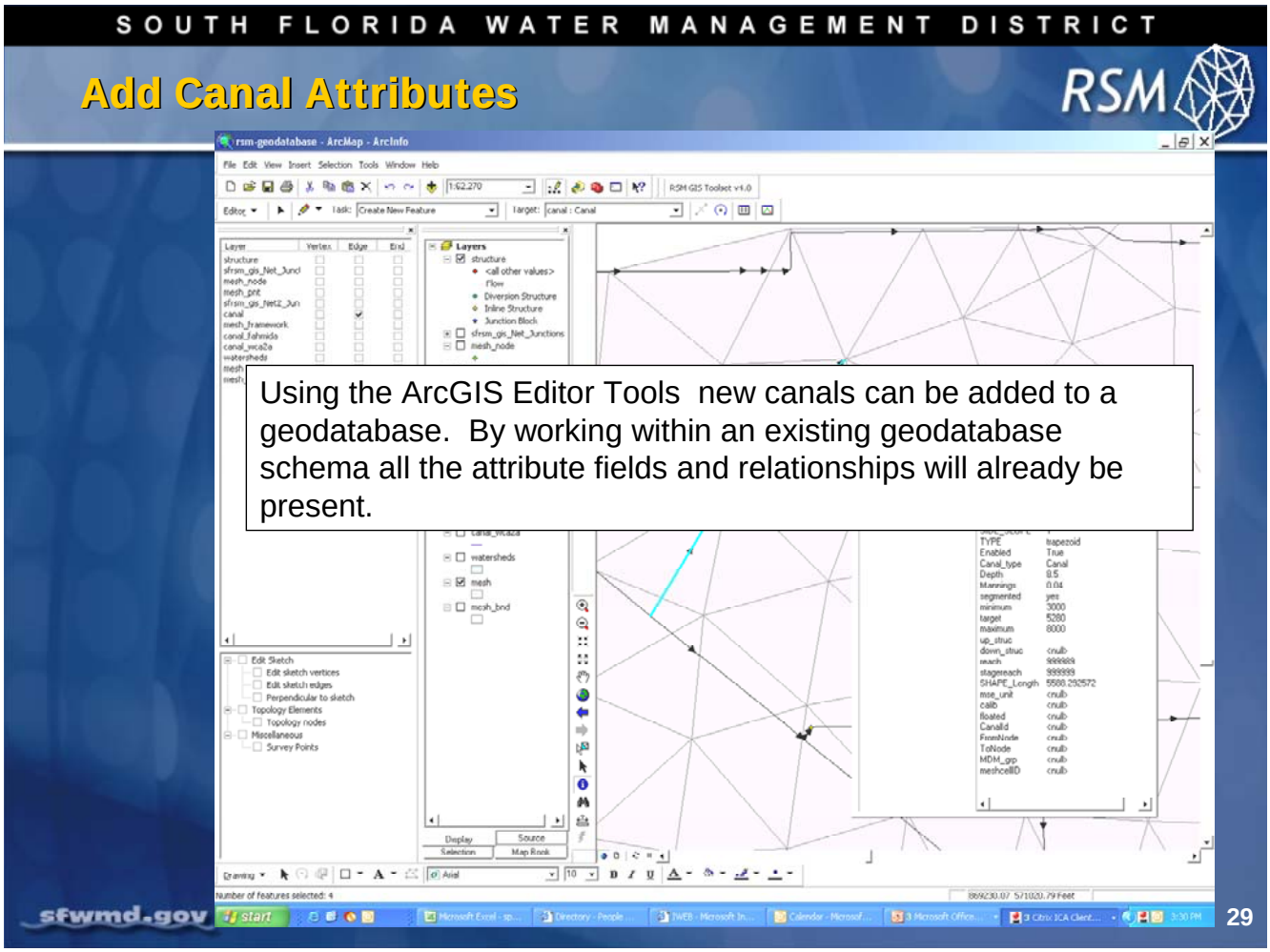
Some attributes are text fields that can be changed (name) and some have drop-down lists offering specific value choices (enabled). Others have restrictions on the range you can enter (e.g., Mannings).



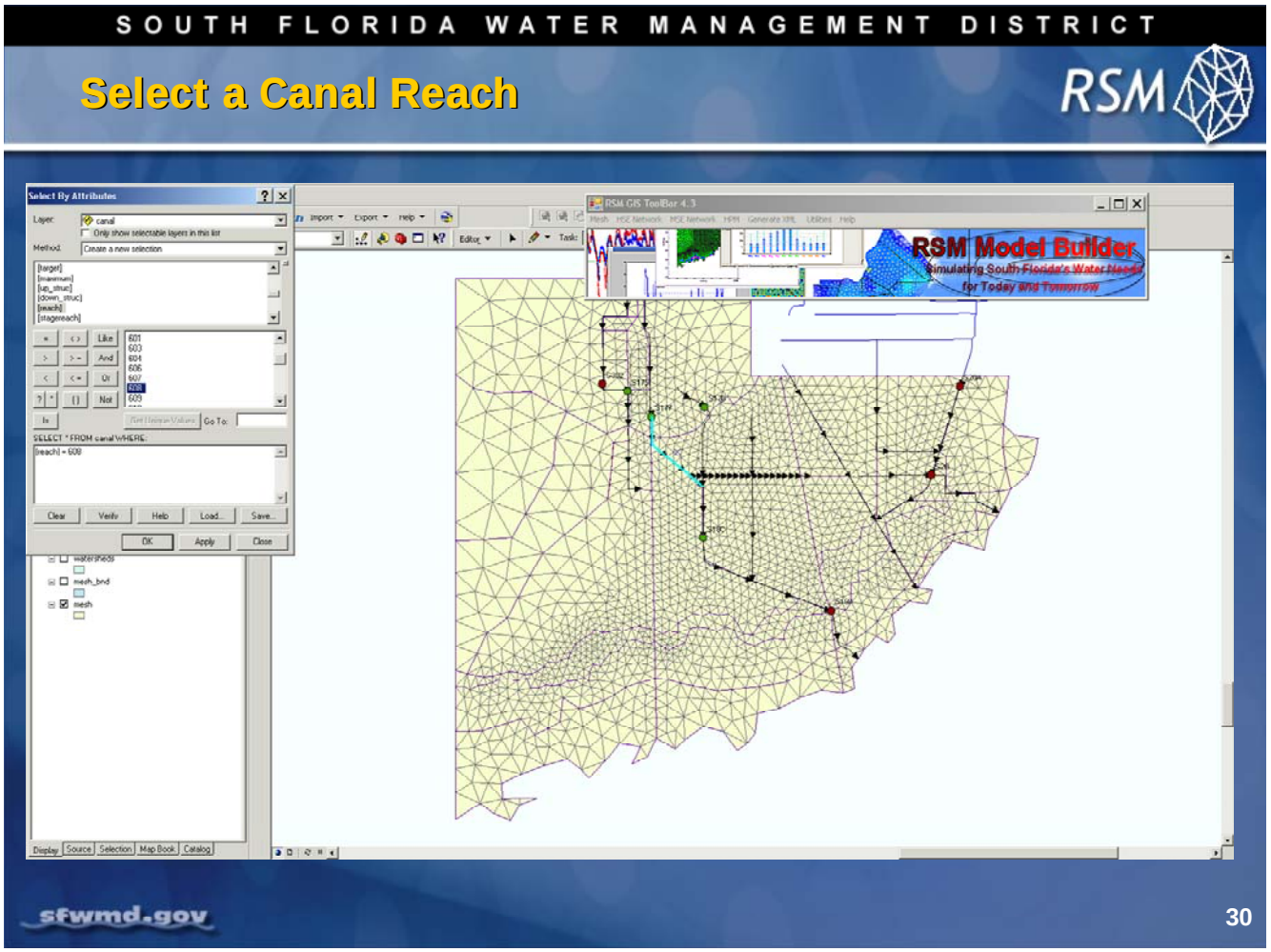
The standard GIS tools can be used to select features in the geodatabase and view attributes. The easiest way to view attributes is to use the **Information** Tool. Select the **GIS Information Tool** and click a feature in your map.

Helpful terms:

- A canal is a waterbody we know by name, like C-111
- Segments are pieces of a canal
- A reach is a group of similar segments bounded by a canal junction
- A stage reach is a group of reaches bounded by an upstream and downstream structure



To start with the database schema required in order for all of the RSM GIS tools to work properly, start with the RSM geodatabase template. Delete all of the data and then repopulate the geodatabase tables with new data.

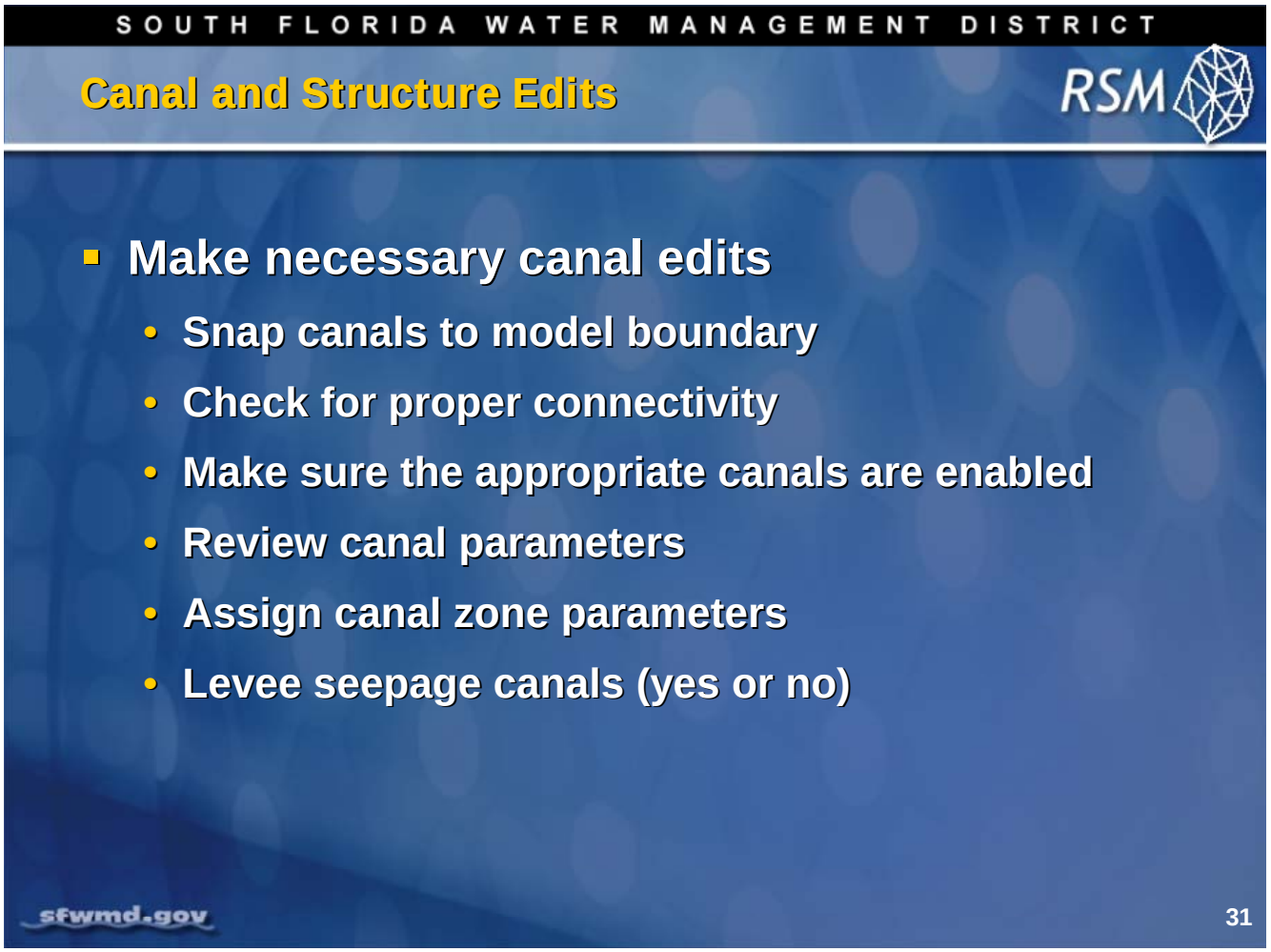


Select a Canal Reach

Select a canal reach using the standard GIS Selection Tool:

- Selection > **Select by Attribute**
- Select the canal layer
- Select the reach attribute
- Click the button for **Get Unique Values**
- Create a query by clicking the items to add to the window at the bottom of the tool
- Select * from canal WHERE reach = '608'

Reach 608 will be selected, and you can review its attributes.

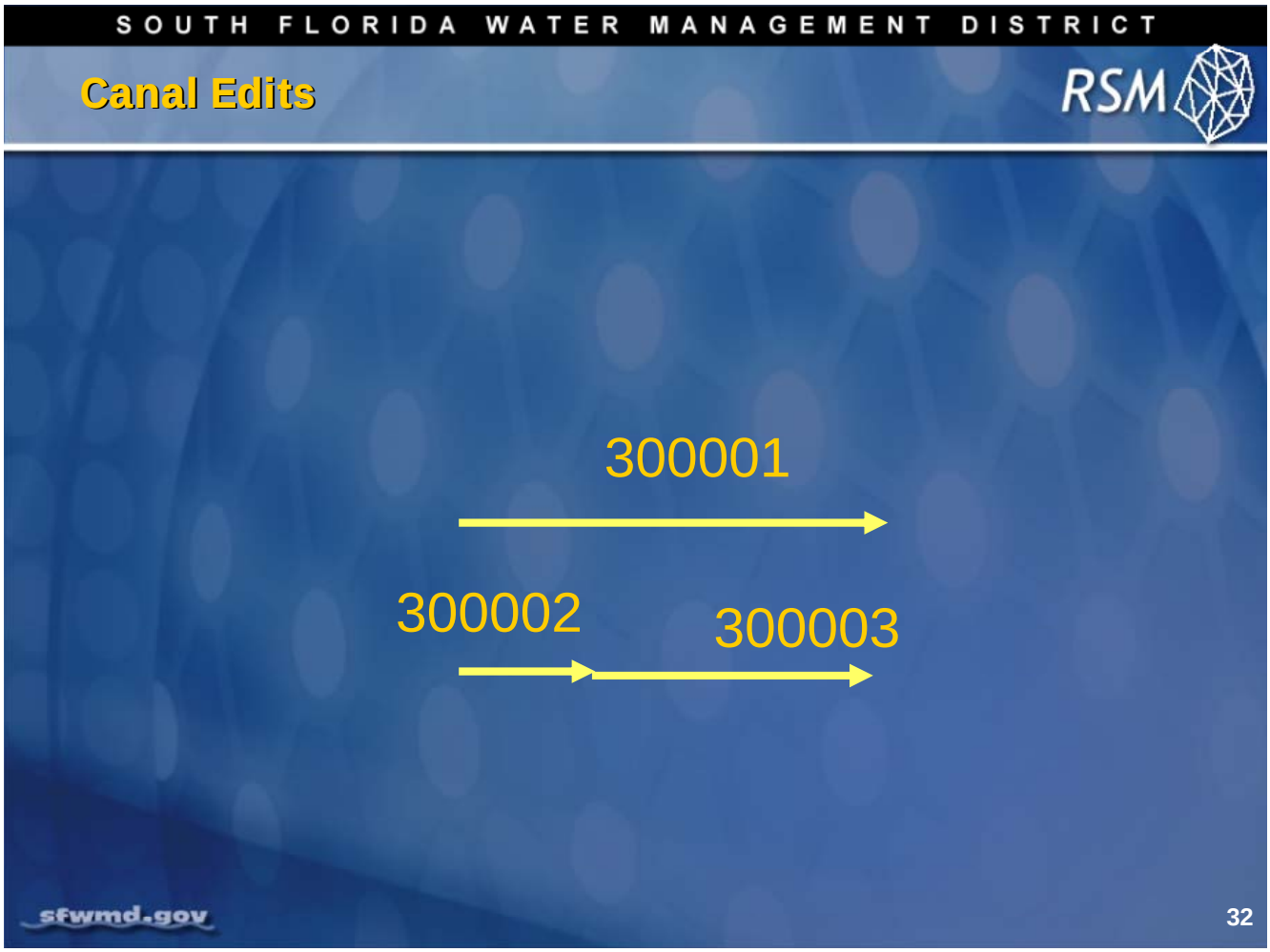


The Mesh Import Tool cuts features (with the exception of canals) to the edge of the model. To maintain canal ID values, canals extend the next full segment beyond the edge of the mesh. A structure (most likely a boundary condition for the canal) may be located at the end of a segment. Boundary condition files are used with the structure information with the new model. You want to keep structures at the ends of segments.

This practice also applies to canals that exit and re-enter the mesh. Rather than cutting the segment, the modeler preserves it and then moves the coordinates of the segment back into the mesh.

Segments should not end outside the model mesh. Check for canal connectivity to be sure that the canals are connected correctly. Make sure structures and canals are appropriately enabled. If canal segments are not needed, disable the canals or structures instead of deleting the segments. (Disabling the canals changes the segment IDs.)

When the canal network is changed, you need to create a new *.MAP file, arc.index file, and initial conditions files. Although the model will run with the incorrect files, the results will be wrong. So, review the canal parameters to verify values are correct.



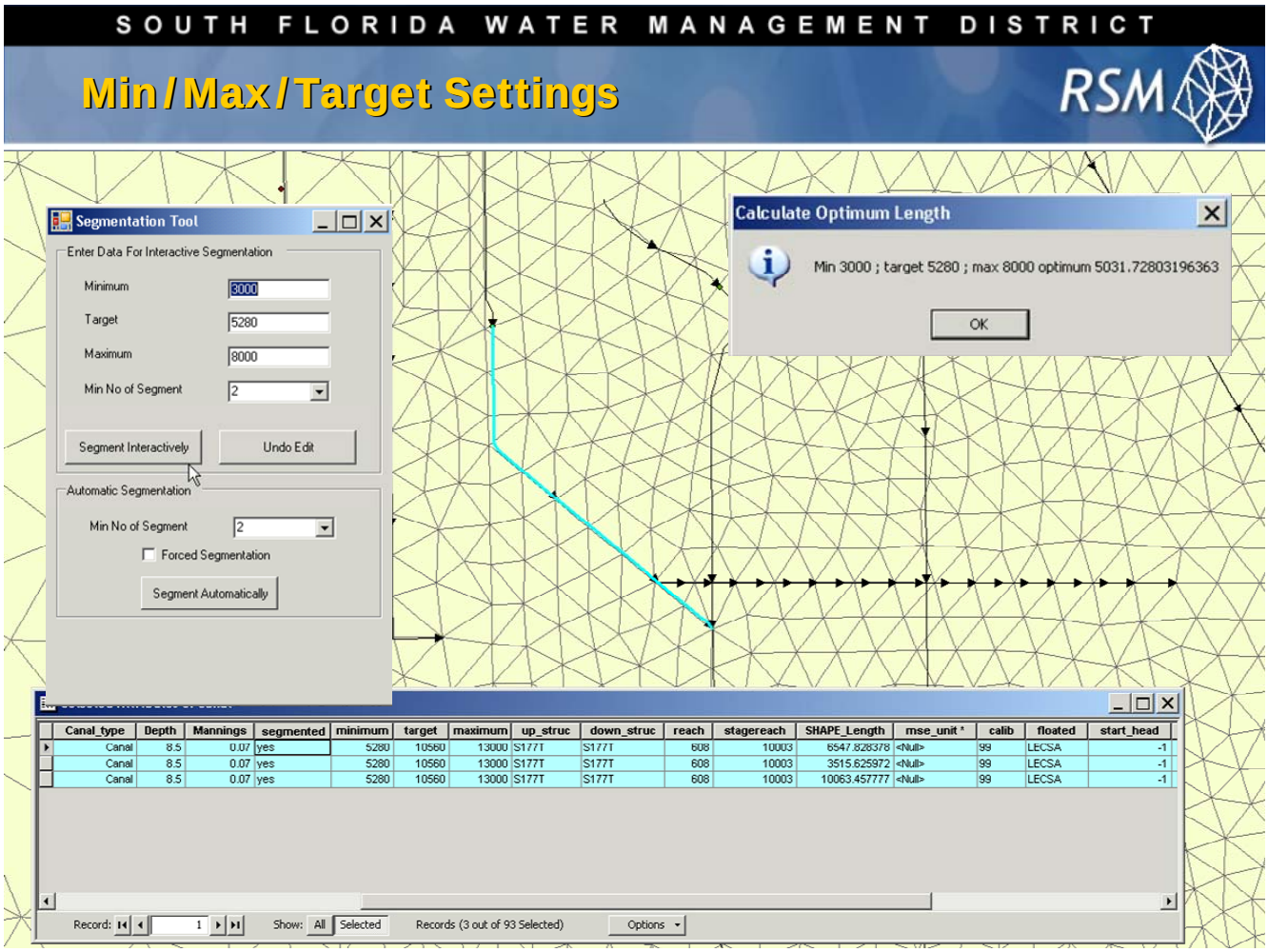
To build the canal IDs, use the ArcGIS objectIDs. ObjectIDs are intrinsic variables in ArcGIS that cannot be modified. Add 300,000 to obtain the segment IDs. This numbering convention assures that segment waterbodies are unique.

If you cut segment 300,001 and create a new segment, you cannot label the new segment 300,002 and keep the old segment as 300,001. This is because ArcGIS recognizes the two new segments and assigns new objectIDs (in this case new canalIDs) to the segments. The actual numbers are added to the bottom of the list of segment IDs.

In this case, the segment 300,001 no longer exists. Be careful not to use canalID 300,001 because that value refers to a longer segment that is no longer valid. However, canalID 300,001 may still be valid in a version of the model in use by another modeler.

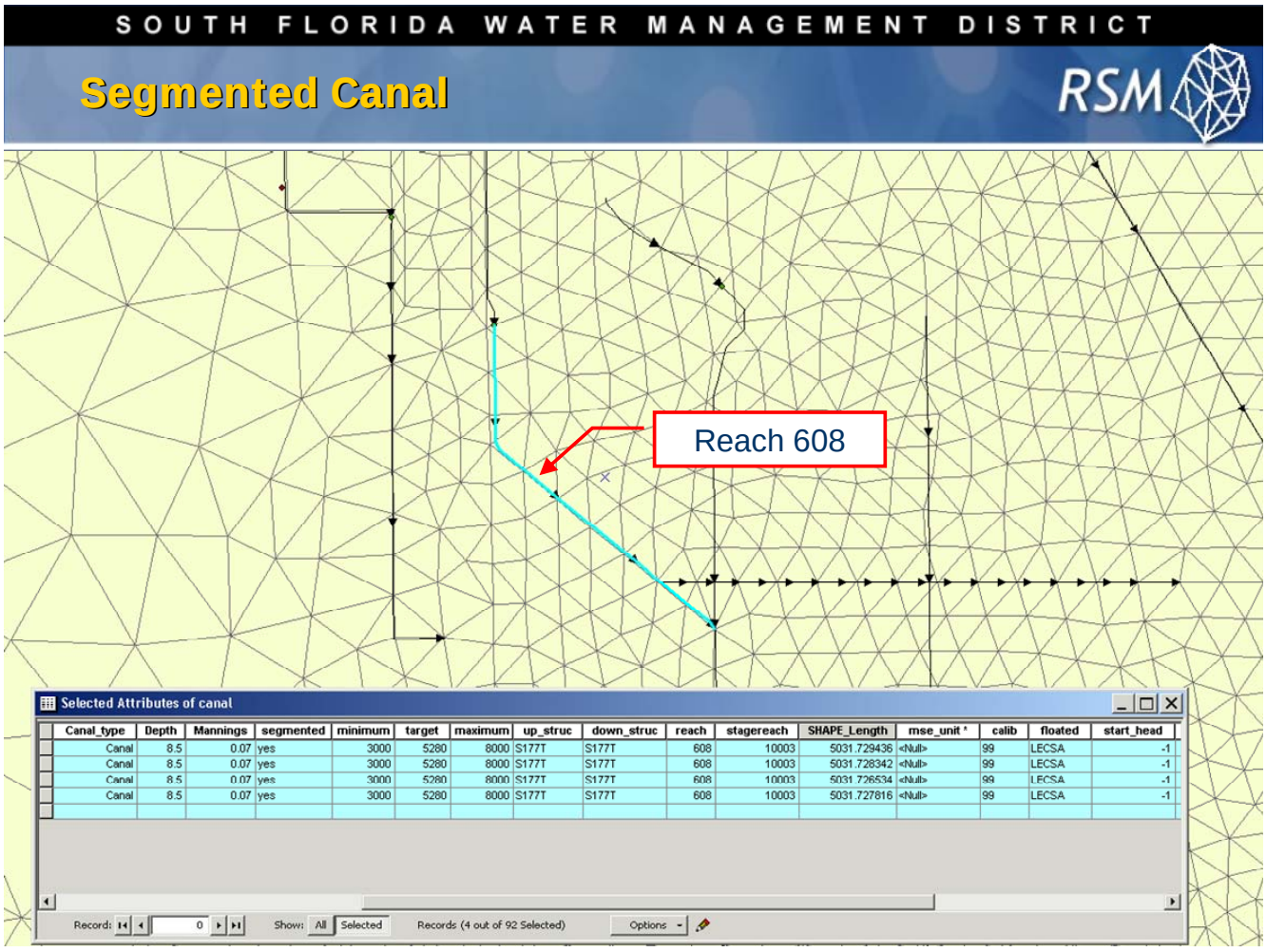
NOTE: When using boundary condition files, you will need to manually check for any instance where 300,001 was used and change that boundary condition ID.

Although, disabled segments maintain their objectID and canalIDs, they are not used in the map file.



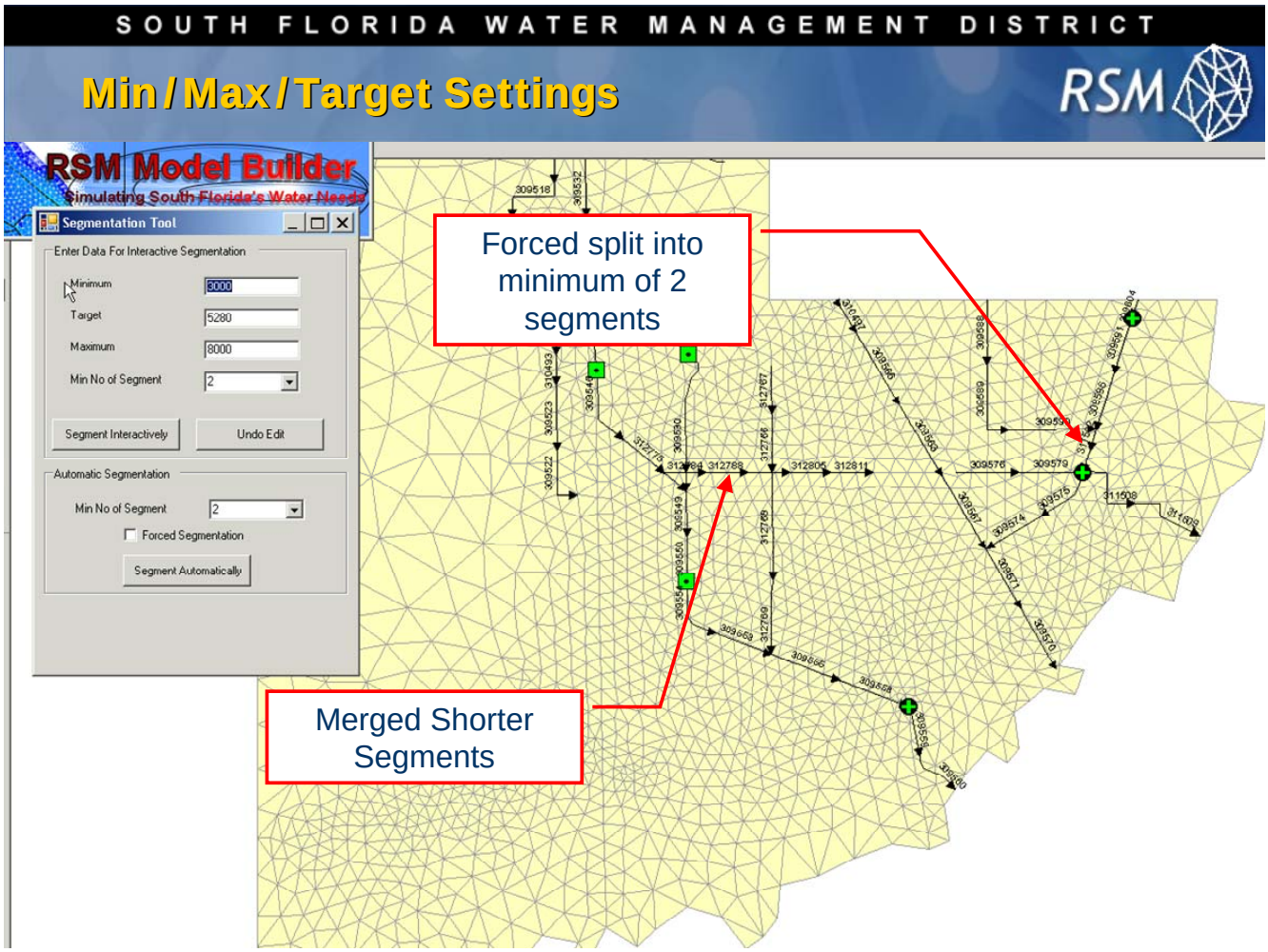
To Segment a Reach:

1. **Select by Attribute** feature:
2. Select **Reach='608'** from the canal layer.
3. Use the **Segmentation Tool** from the RSM GIS ToolBar to re-segment this reach into one mile segments.
4. From the RSM GIS ToolBar, choose the **Segment Canals** tool from the **HSE Network** Menu.
5. Zoom to the selected canal reach: click the **Selection** Menu at the top of the GIS window and choose the **Zoom to Selected Feature** option.
6. Segment a single reach (which currently consists of 3 segments), dividing it into 1-mile long segments.
7. Use a **Minimum** setting of 3,000 feet, **Maximum** setting of 8,000 feet and a **Target** setting of 5,280 feet (in order to get one-mile segments).
8. Accept 2 as the default for forcing a minimum of two segments to prevent inadvertently merging the reach into one segment.
9. An optimum length has been calculated using the selected range and target so no tiny segments will result due to a small remainder.
10. Reach 608 will now be segmented into 5031.72803196363 foot segments.
11. Click the **Segment Interactively** button.
12. When the optimum length is calculated, click the [OK] command.



Reach 608 has been segmented into four equal segments.

By right-clicking on the canal layer in the layers index on the left side of the screen, the line type can be changed to display "arrow at end." This will display an arrow showing flow direction at each segment.



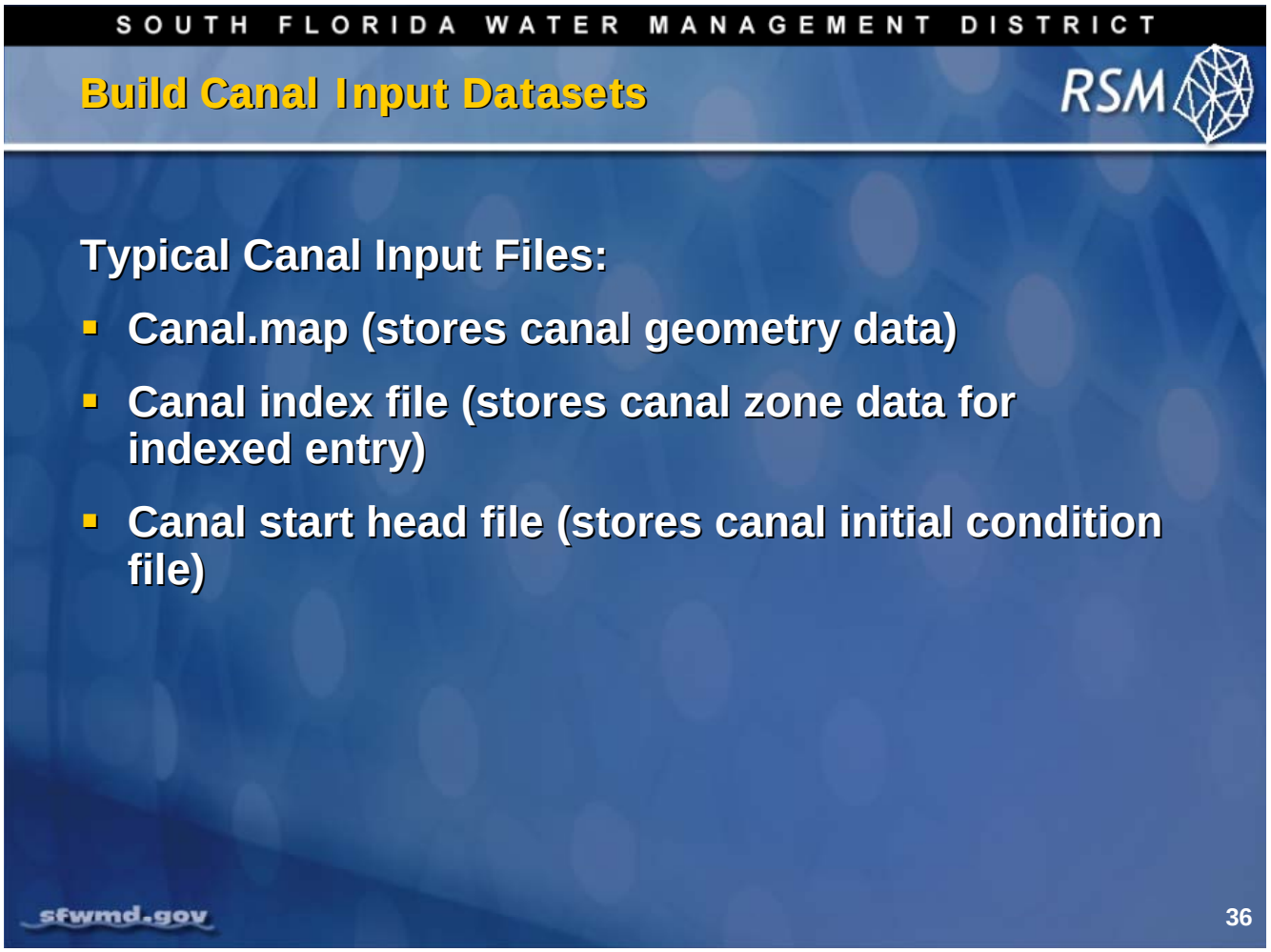
Segment an Entire Canal Network

A canal network with 14,000 segments can be segmented in approximately 5 minutes.

The **Segment Automatically** button enables you to segment an entire canal network in the geodatabase all at once. When the **Forced Segmentation** check box is selected in the **Segmentation Tool** dialog box, the **Segment Automatically** option forces segmentation to take place even if the minimum, maximum and target settings specified would not result in any action.

For example, if a canal is too small to be segmented according to the minimum, maximum and target settings specified, when the **Forced Segmentation** check box is selected (under Automatic Segmentation) and the **Min. Number of Segment** box value is "2", the canal will be split into two equal segments regardless of its size.

This tool applies a weighted calculation from Dr. Wasantha Lal, which ensures mass is preserved in the resulting segmented canal. (The Manning's, volume, depths, roughness and slopes are all properly distributed to the new segments.)



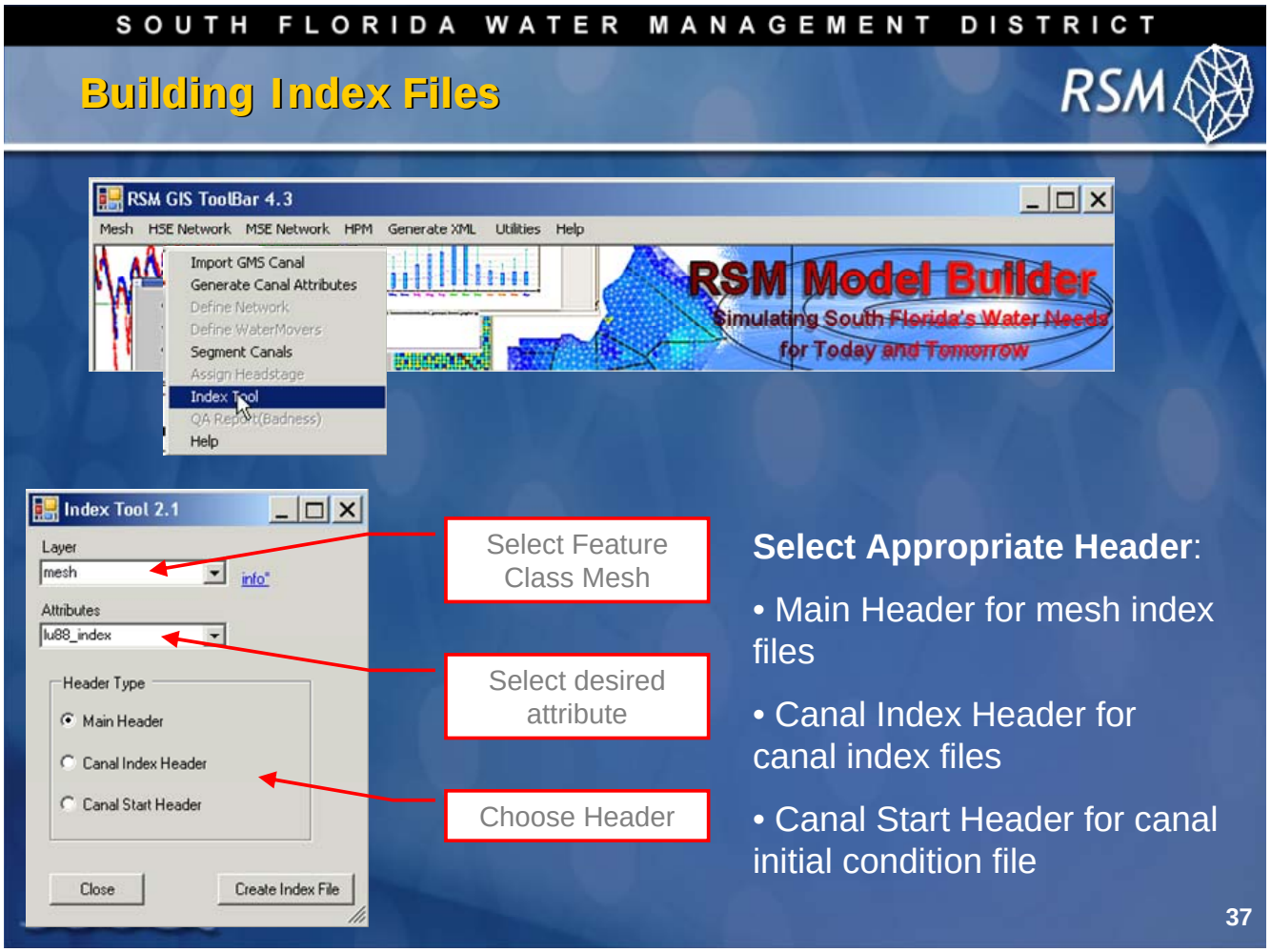
Canal files typically cause the majority of problems modelers encounter using the RSM setup.

- Canal geometry file: .MAP
- Initial conditions: initial.dat, sequential list of values by canalID
- Arc index files: arcs.dat, sequential list of values

The .MAP file contains the geometry of the nodes for the segments. When modifying the geometry of the canal network it is tempting to edit the map file manually. While manual editing is relatively easy to do, it is not a recommended practice because the resulting model canal geometry file will no longer match the information in the geodatabase.

The index files do not contain the canalIDs; values must be adjusted very carefully when creating new canal segments.

Currently no utility exists to import .MAP files into ArcGIS. The .MAP file can be viewed in GMS and then exported as a Shapefile. The RSMGUI post-processor reads the netCDF output file from the RSM. The post-processor can display exactly what the model sees, including the mesh cells and canals.

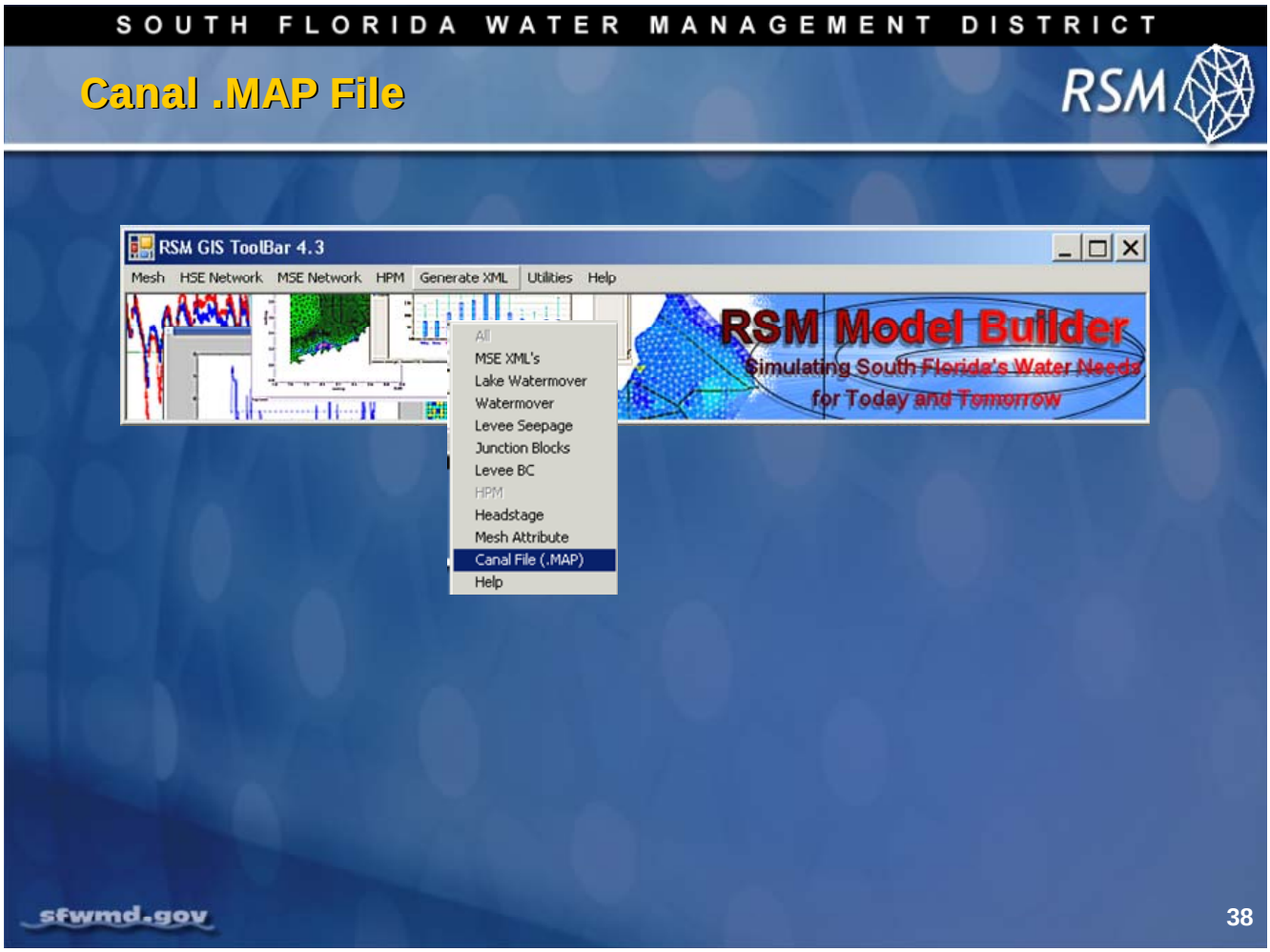


The **Index Tool** is a generic tool for writing index files. For this application, it is used to generate index files for the canal network and the mesh. The output from this tool is an ASCII (.dat) file containing a sorted list for any RSM attribute.

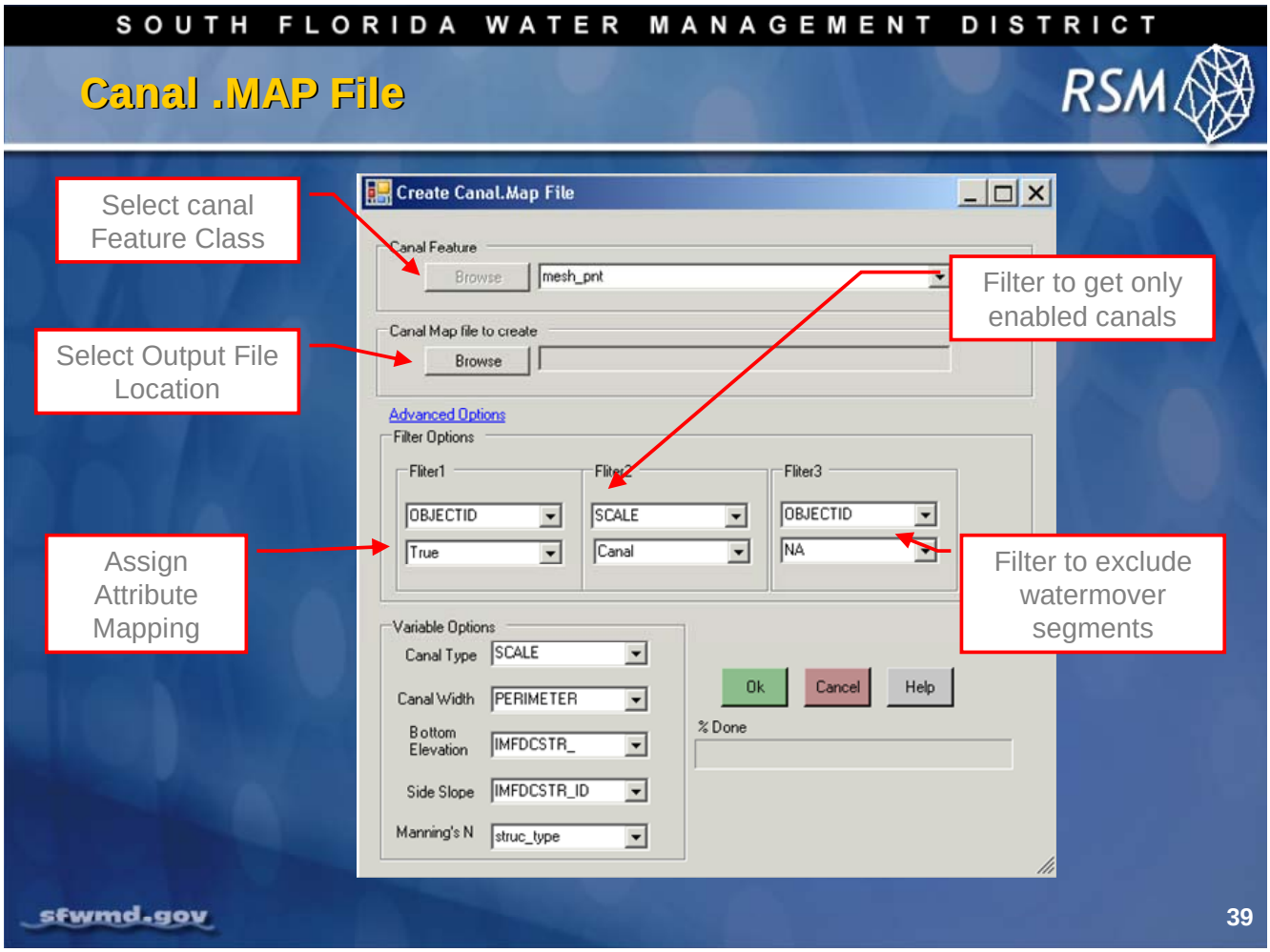
Select a database layer, then select an associated attribute and specify the desired header format. The index headers are specific for the type of index files you are creating. This tool automatically filters out and ignores any disabled features in the geodatabase. The tool will prompt you for an output file each time it is run.

To create the initial head index file, it is first necessary to create an attribute for the canal segments containing the initial head stage. Since this tool does not have the functionality for performing attribute field calculations, it is necessary to create a new field in order to make calculations (which can then be used to generate an initial head index file).

Using this tool, you can create several attribute index files, including: topo.dat, bot_lyr.dat, hyd_con.dat, mann_prop.dat, sv.index, landuse95.dat, and more.



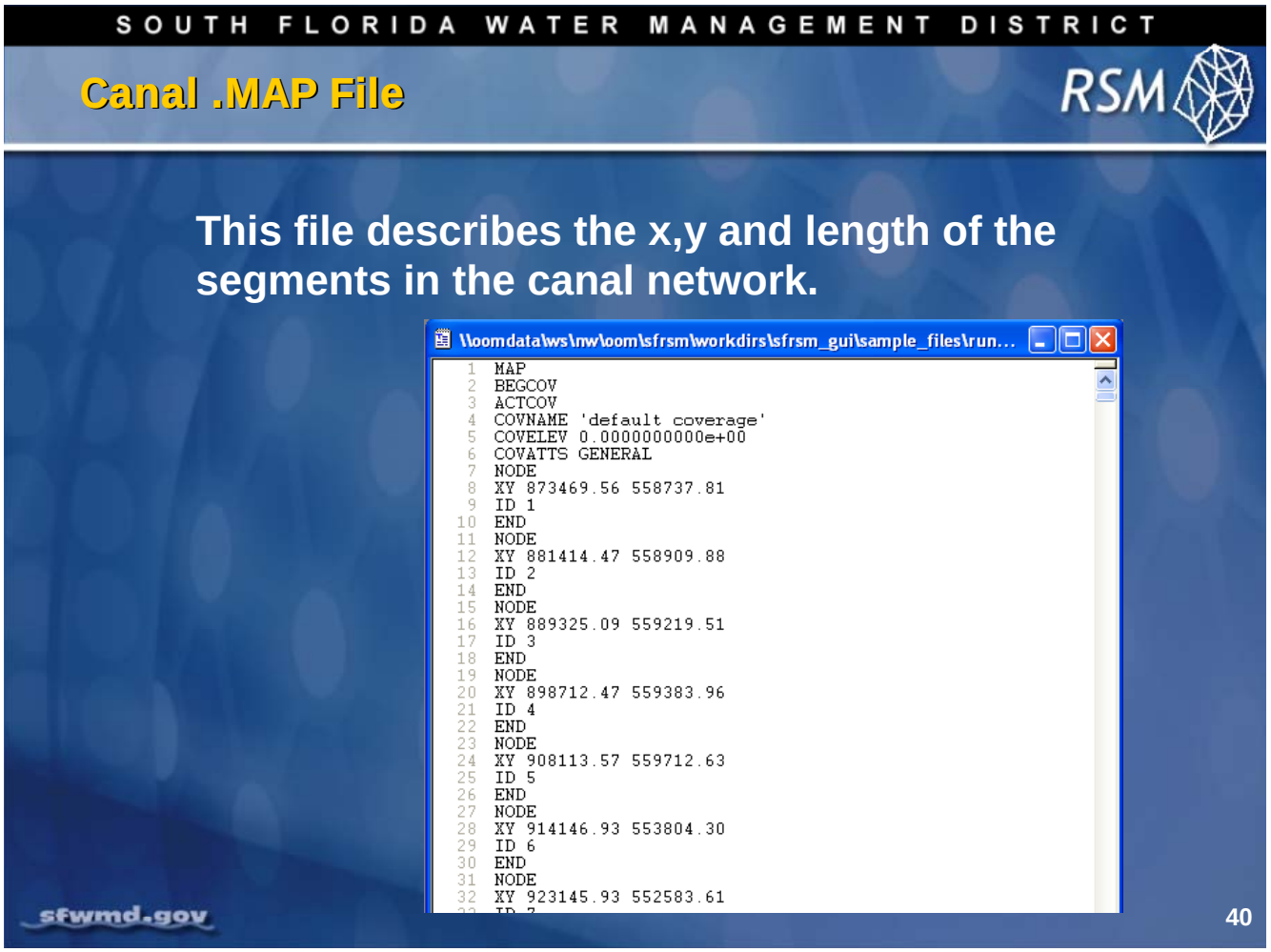
To create a canal.map file, select the **Canal File (.MAP)** option in the **Generate XML** Menu available in the RSM GISToolBar.



Select the geodatabase **Canal Feature** class that contains the canal line work and attributes.

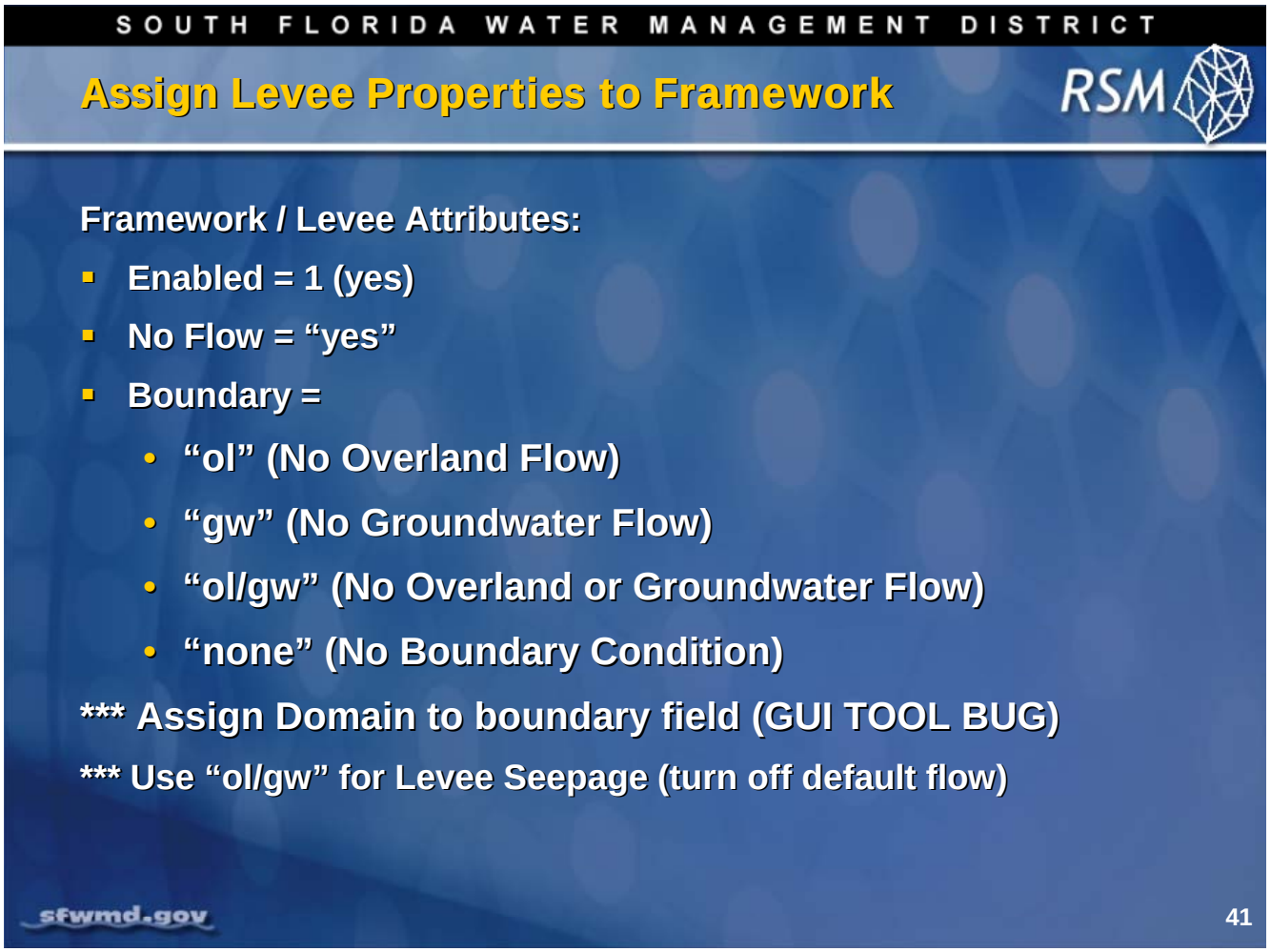
NOTE: Segments for canals and watermovers are enabled and disabled. Use filters to provide only the canal type=1 and enabled=1.

Next, select the attributes for the .MAP file. The **Variable Options** fields may be changed if you want to work with experimental values. The default is to use the variables which are part of the standard RSM geodatabase, which will produce the correct map files to be read by the RSM.



A single-click tool generates the canal.map file used by the model. The file contains all the information about each segment in your geodatabase.

- Beginning point (x,y)
- End point (x,y)
- ID



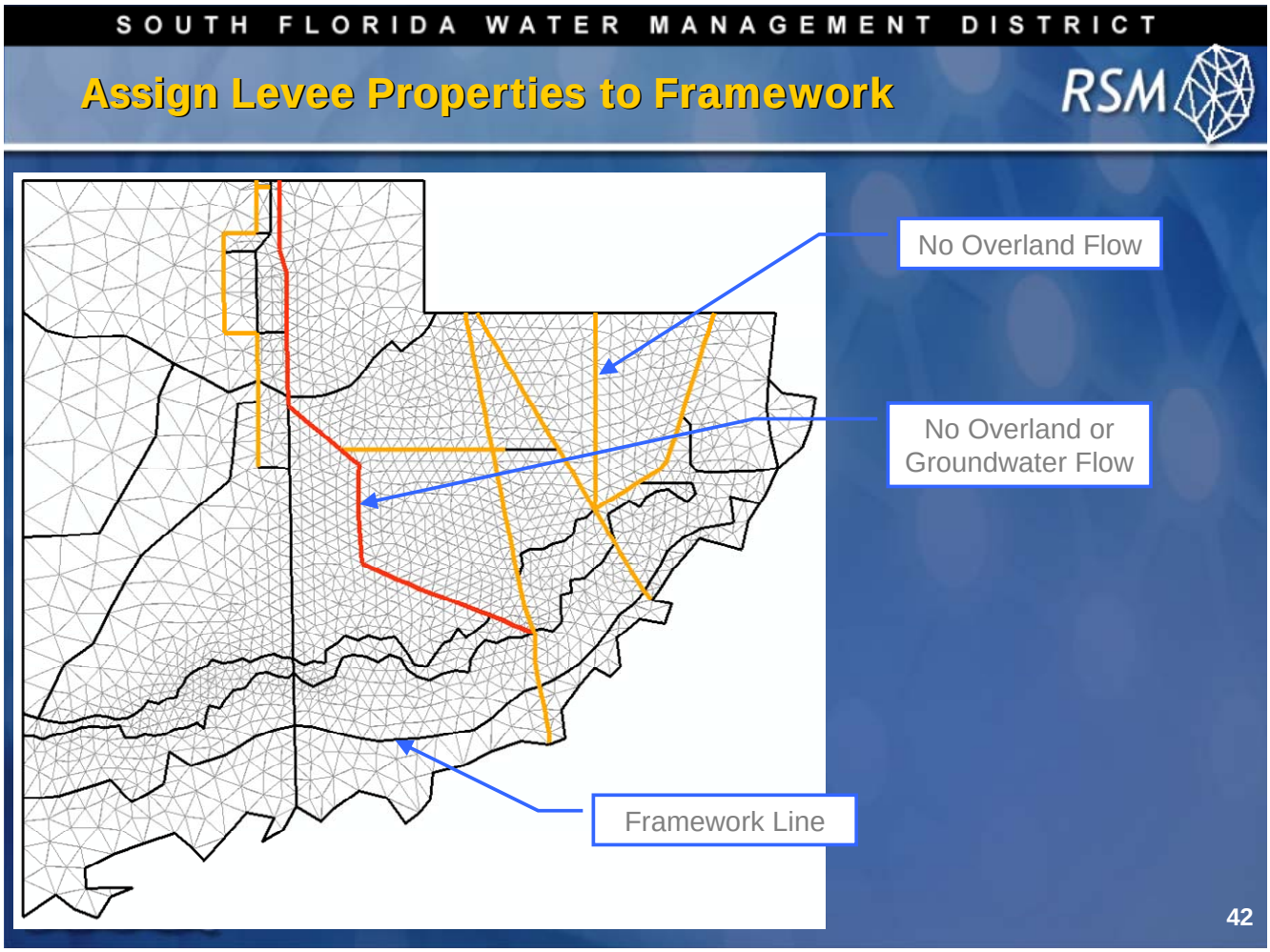
The framework was created to provide the flow boundaries for the mesh. There is a tool that selects the nodes and creates the necessary boundary files. Levees are collections of nodes along the model framework.

Within the XML there are three important attributes: Enabled, No Flow, and Boundary.

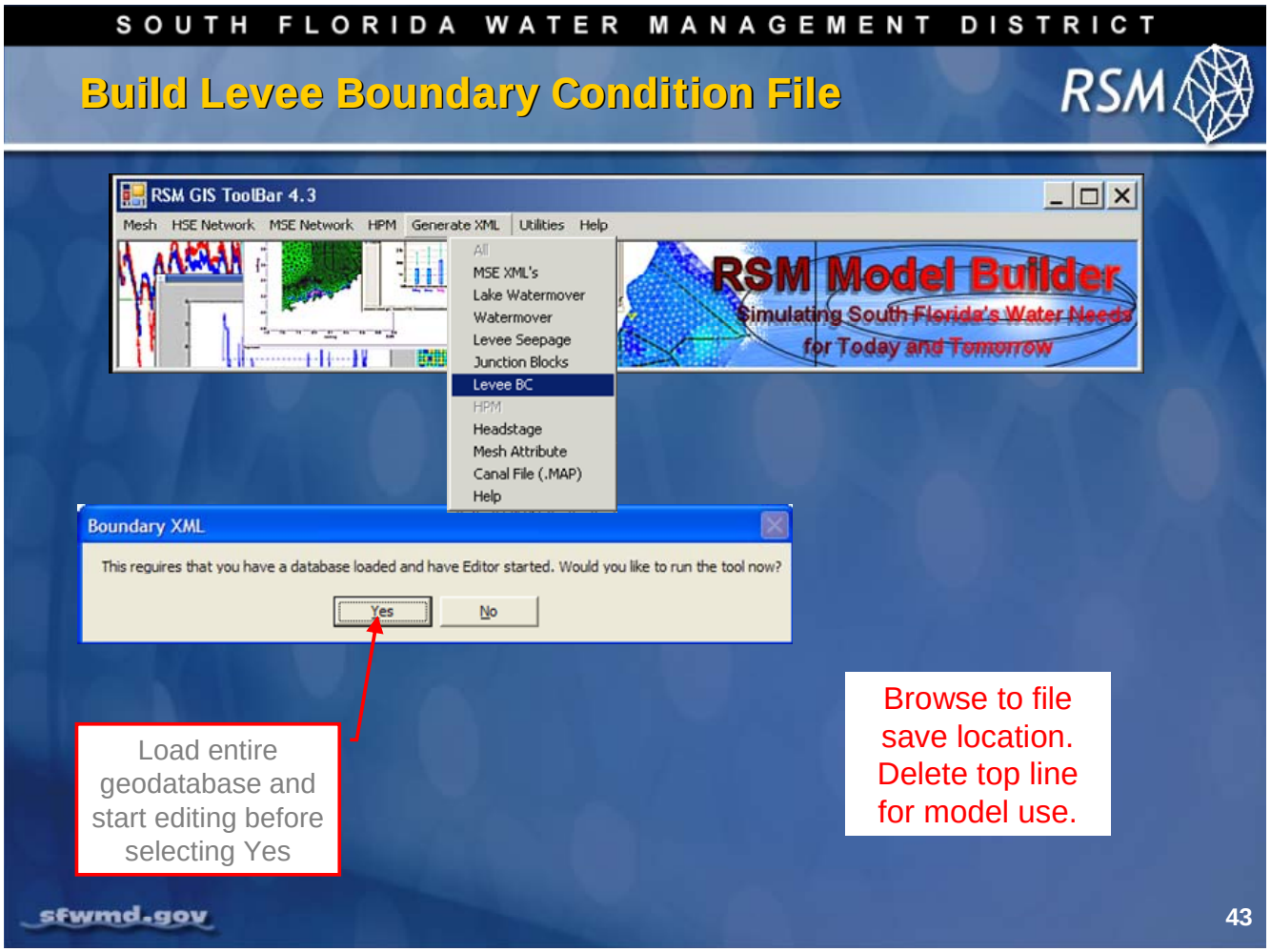
The Levee Seepage feature will create the necessary watermovers.

For the Levee Seepage watermover, select "ol/gw" and turn off the default overland flow and groundwater flow watermovers.

To visualize the boundaries, symbolize the framework feature class on the boundary field and the boundary conditions will show in a map.

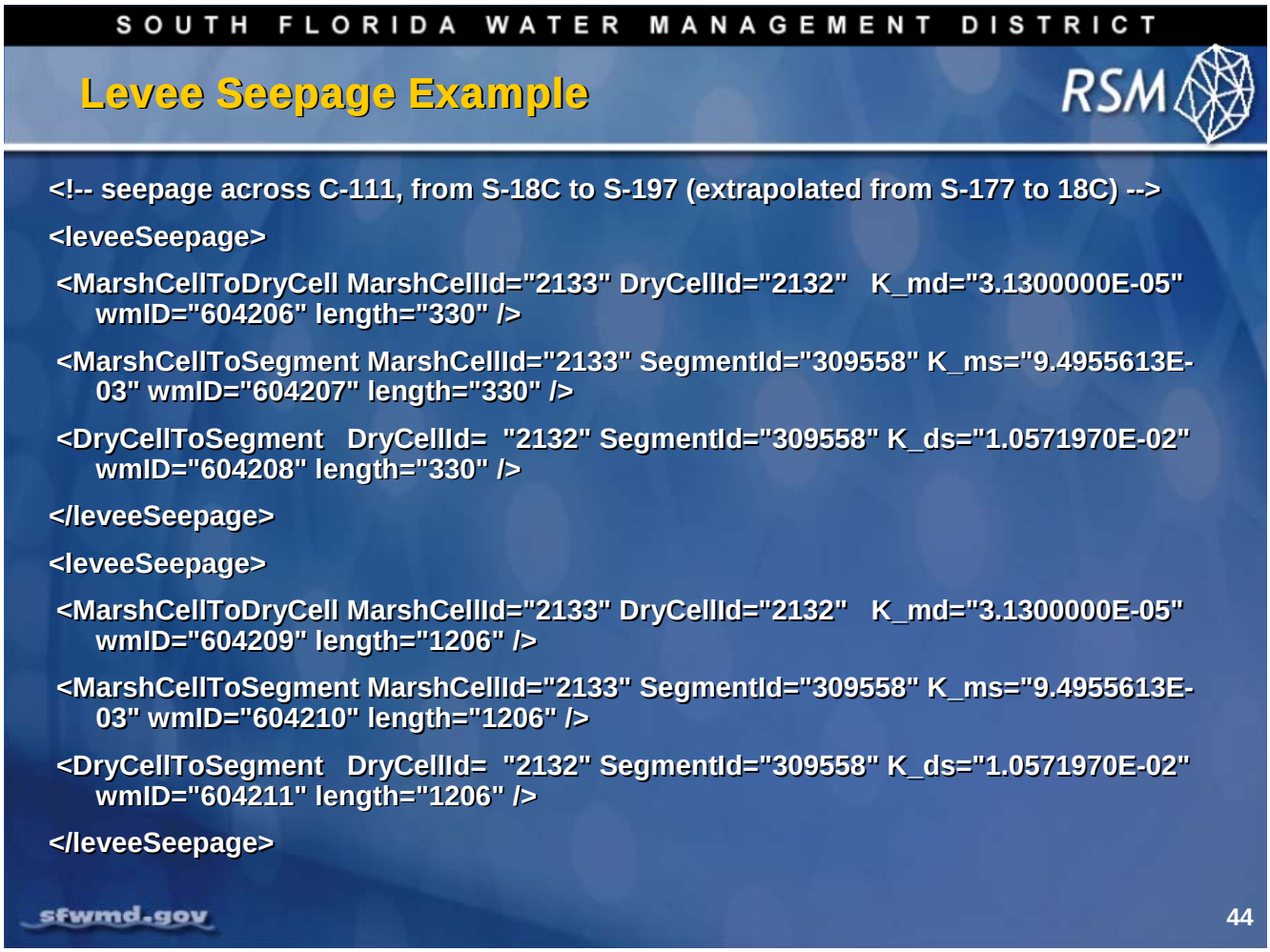


This is a map of the Levee feature class.

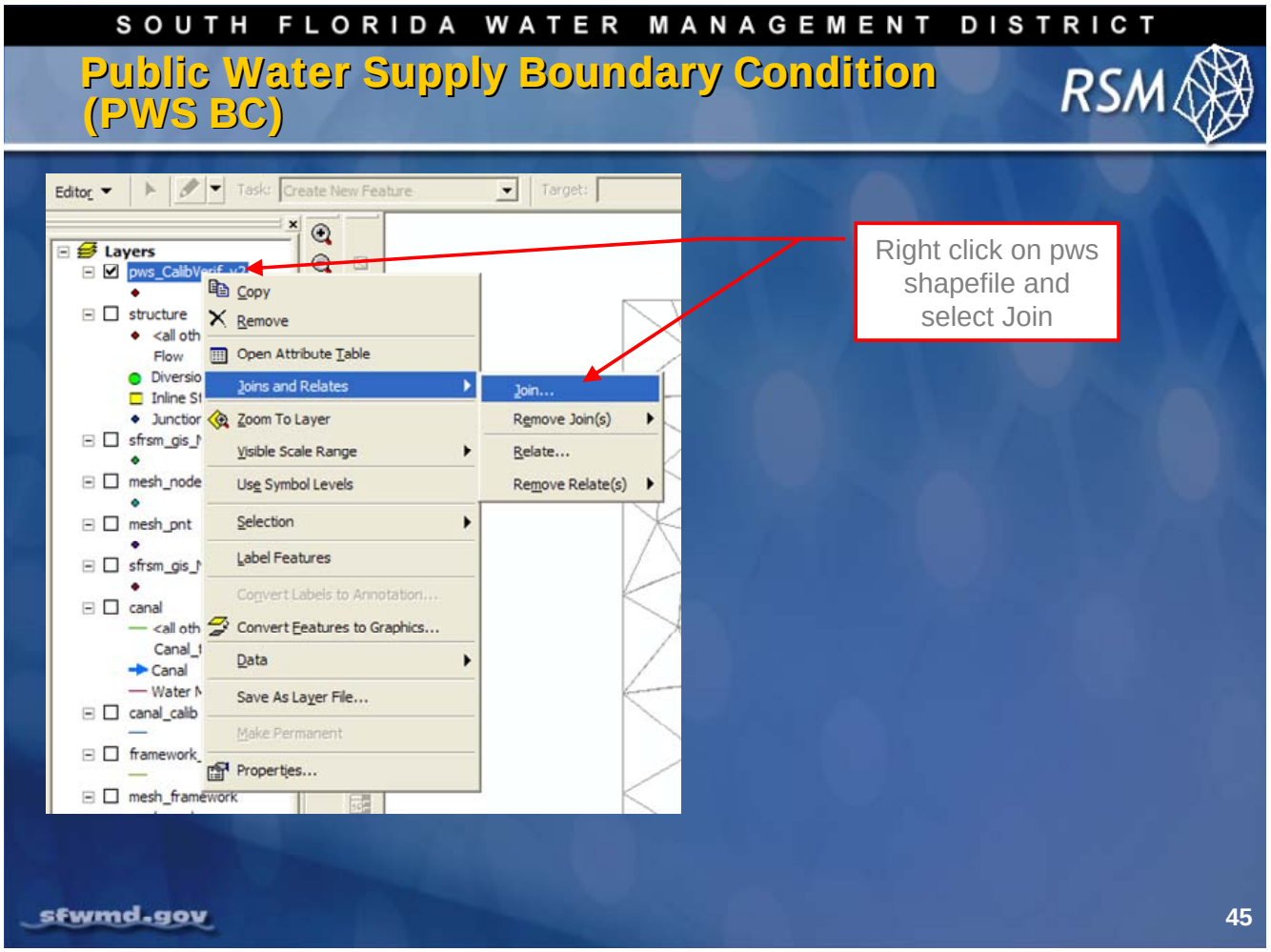


This is now the Levee Seepage Boundary Condition. Reminder: load the entire geodatabase when you load the data.

NOTE: This area is under development and may look different from what you see on the slide**

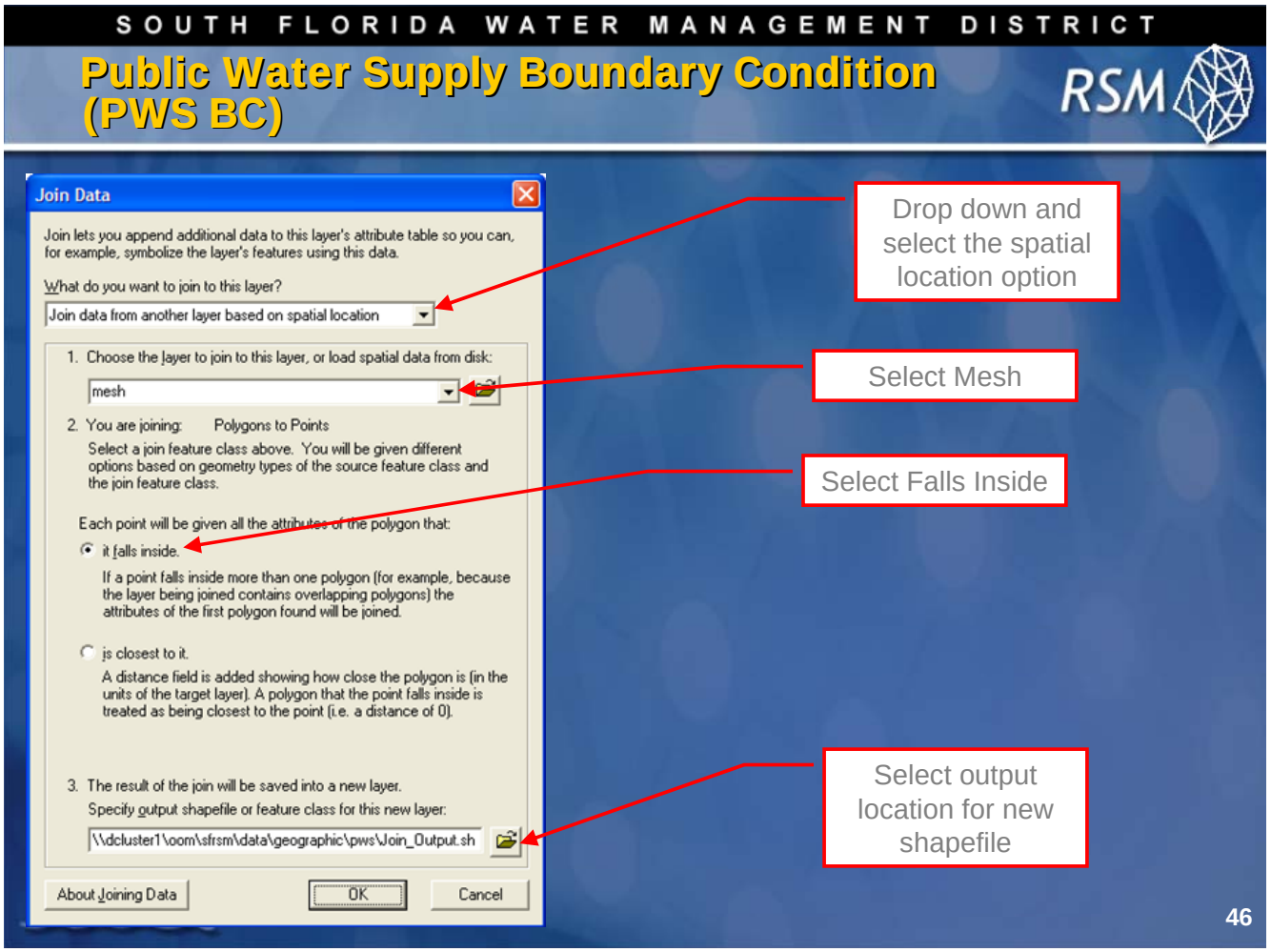


The GIS **Levee Seepage tool** on the Generate XML Menu extracts the data from the geodatabase attribute files and creates an ASCII table that contains the necessary data for the Levee Seepage .XML file.



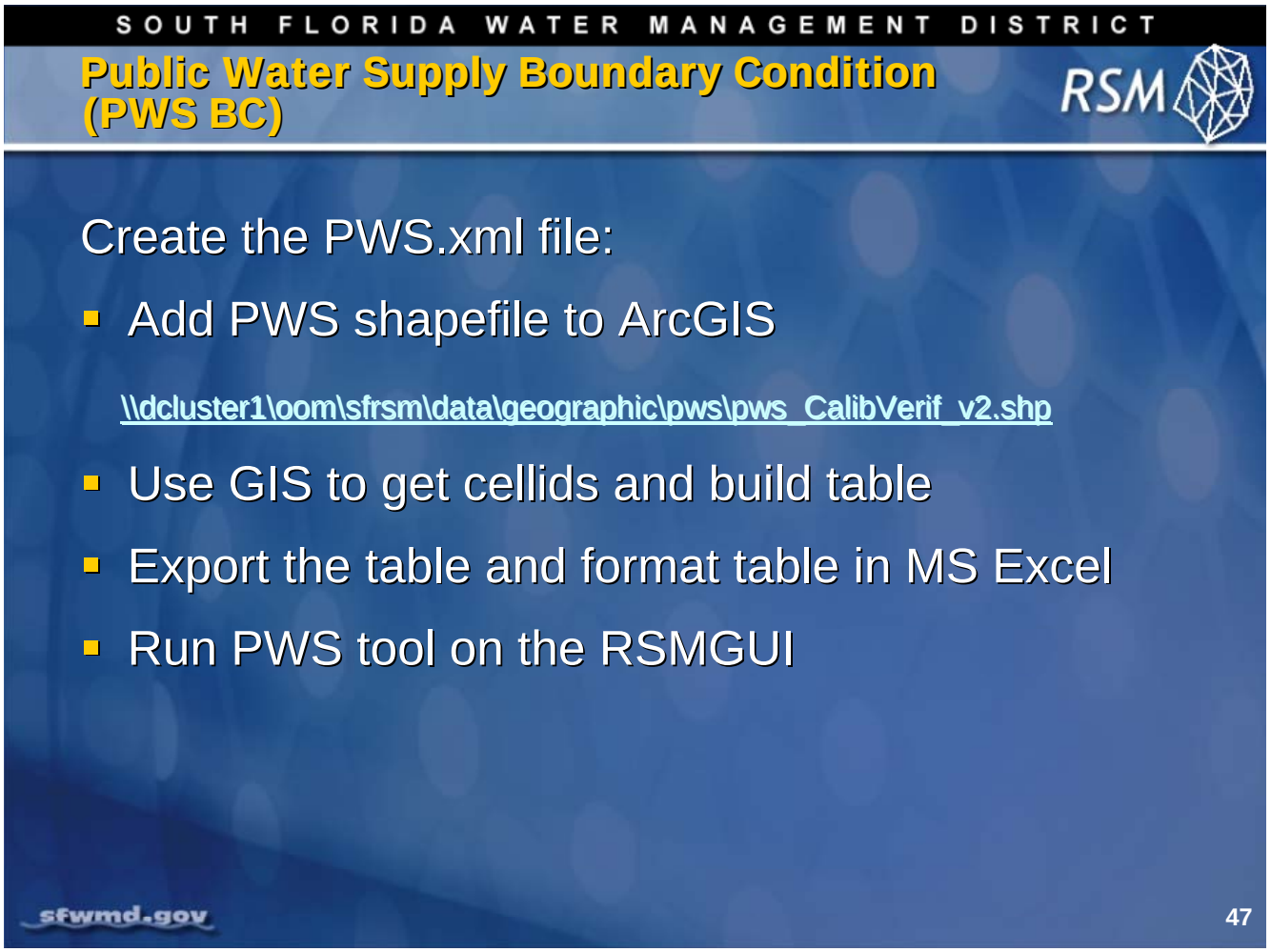
To complete a spatial "join" in GIS:

- Right-click the PWS shapefile name (the selected layer in the left-window shown in the slide above).
- Select **Joins and Relates** > **Join**

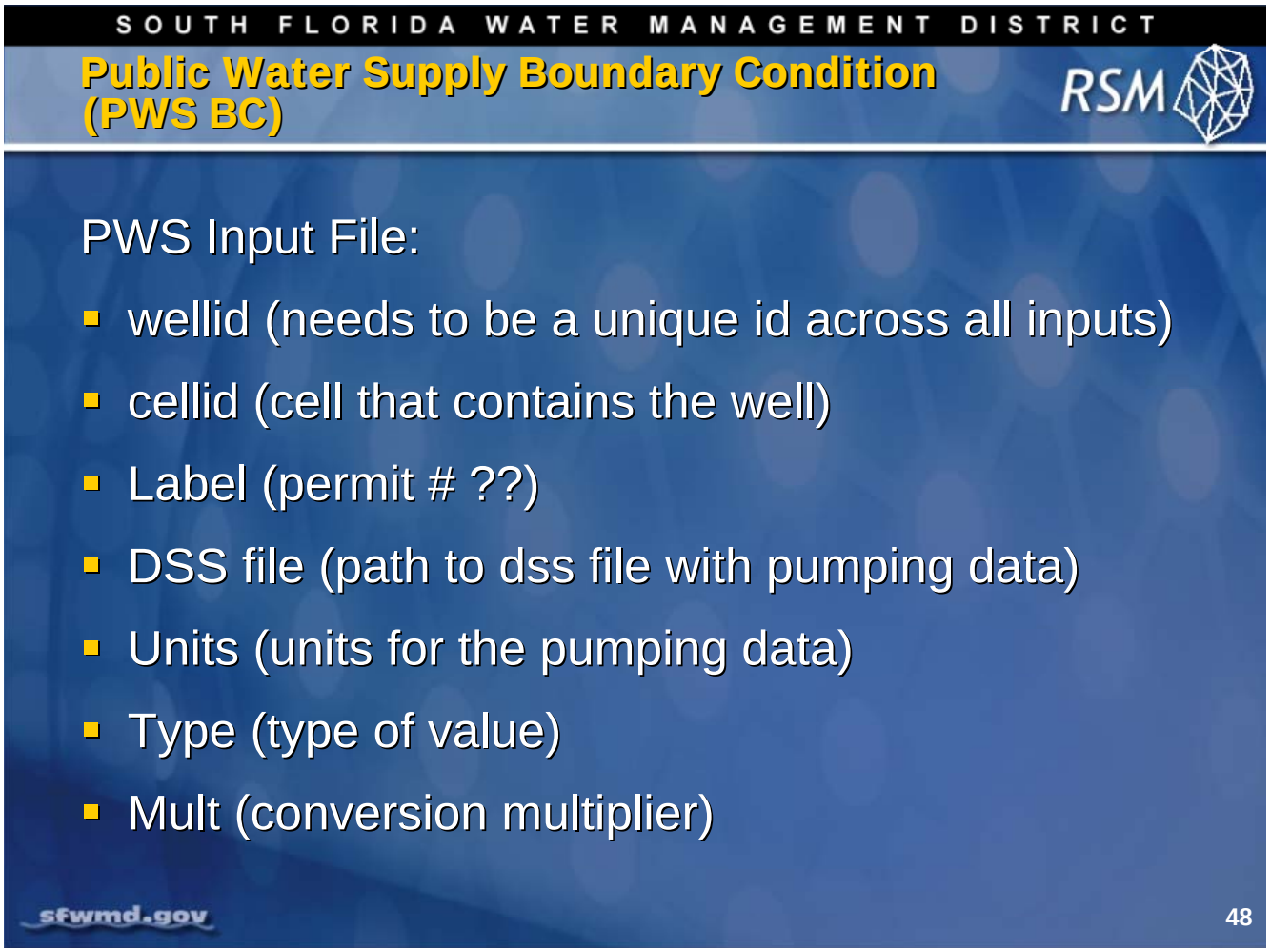


Adds cellIDs to the Shapefile using Join Data:

1. In the **Join** dropdown menu, select “Join data from another layer based on spatial location” (refer to slide above)
2. Select “Mesh” for Option 1
3. Click the “It falls inside” option button (located below Option 2)
4. Browse to the output directory and choose a file for Option 3
5. Click the [OK] command

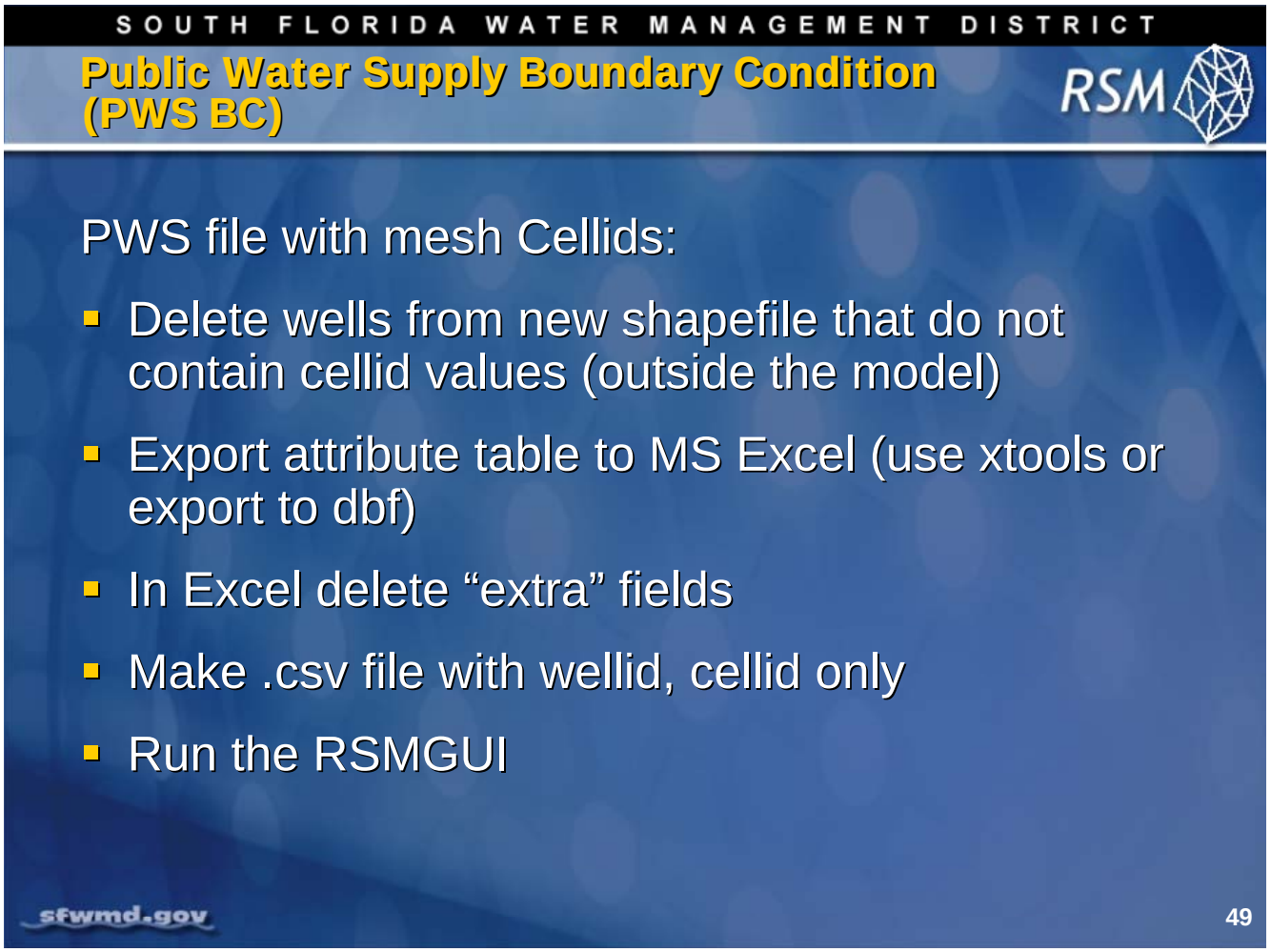


(Steps for constructing the PWS.xml file are described on the following slides.)

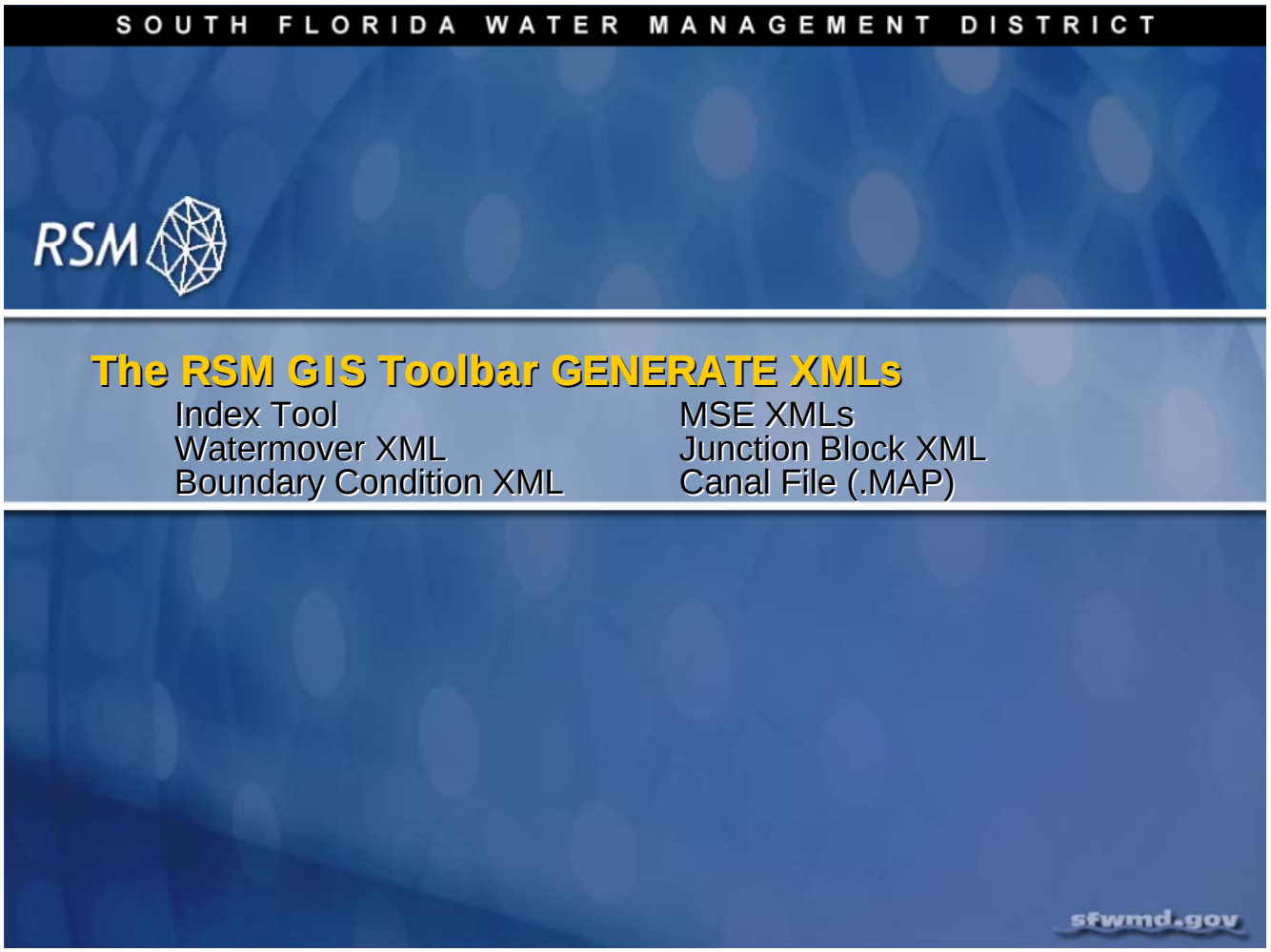


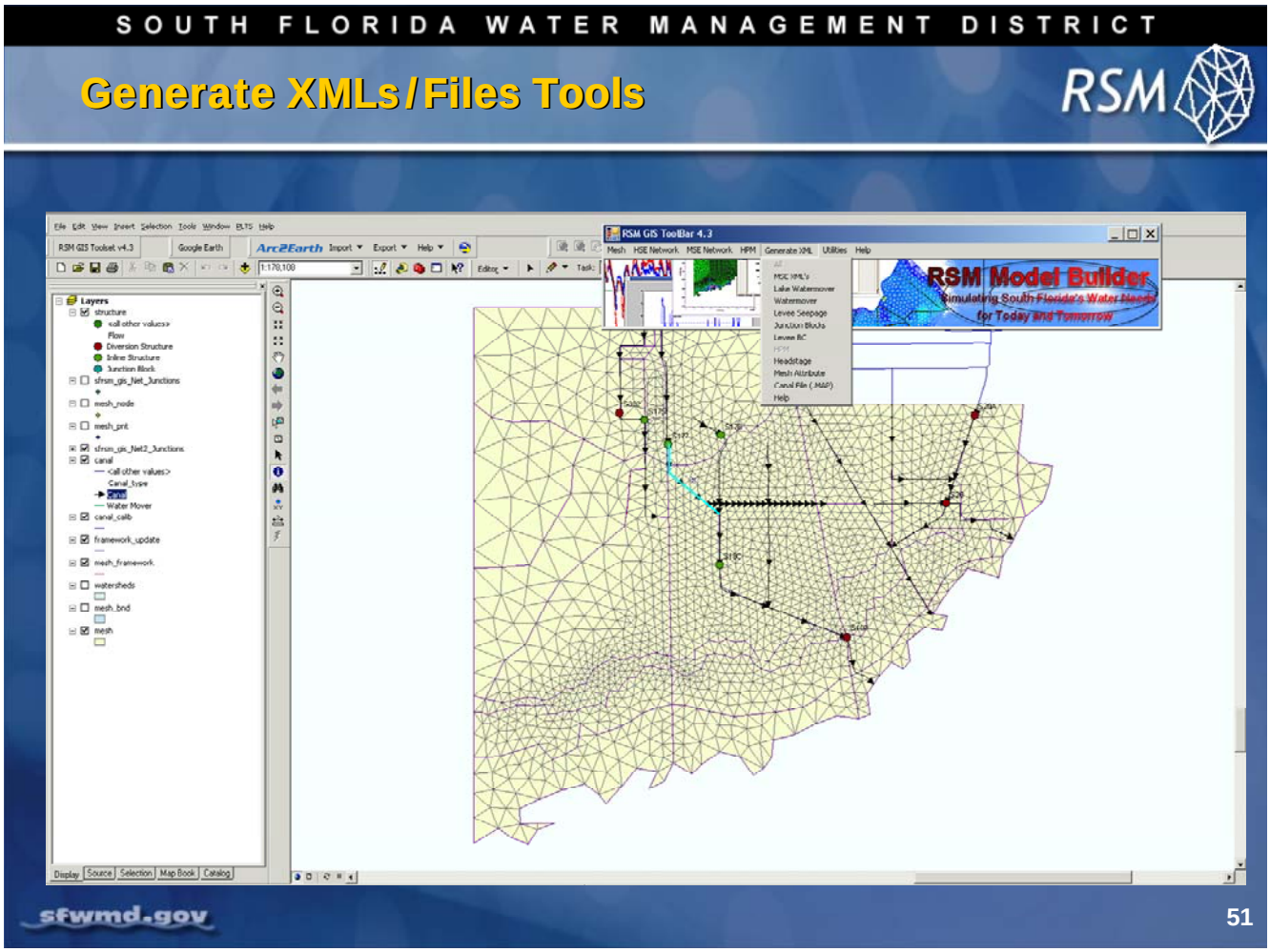
Pumping data has been compiled for the period 1980 to 2000 into standard RSM data sets. Data required for creating the pws.xml file, includes:

- Type: Instantaneous, period average, or cumulative flow. (For flow, period average is the preferred data so that DSSVue methods work correctly.)
- Multiplier: Converts the data from the native units into the model units. (If this step is overlooked, the model will still run, but the results will be incorrect.)



Edit the Shapefile attribute table to remove all of the PWS wells that have no value in the cellID field (wells outside of your mesh). Export the Shapefile .dbf file to Microsoft Excel to remove the unneeded wells and all of the fields except the cellID and the wellID fields.

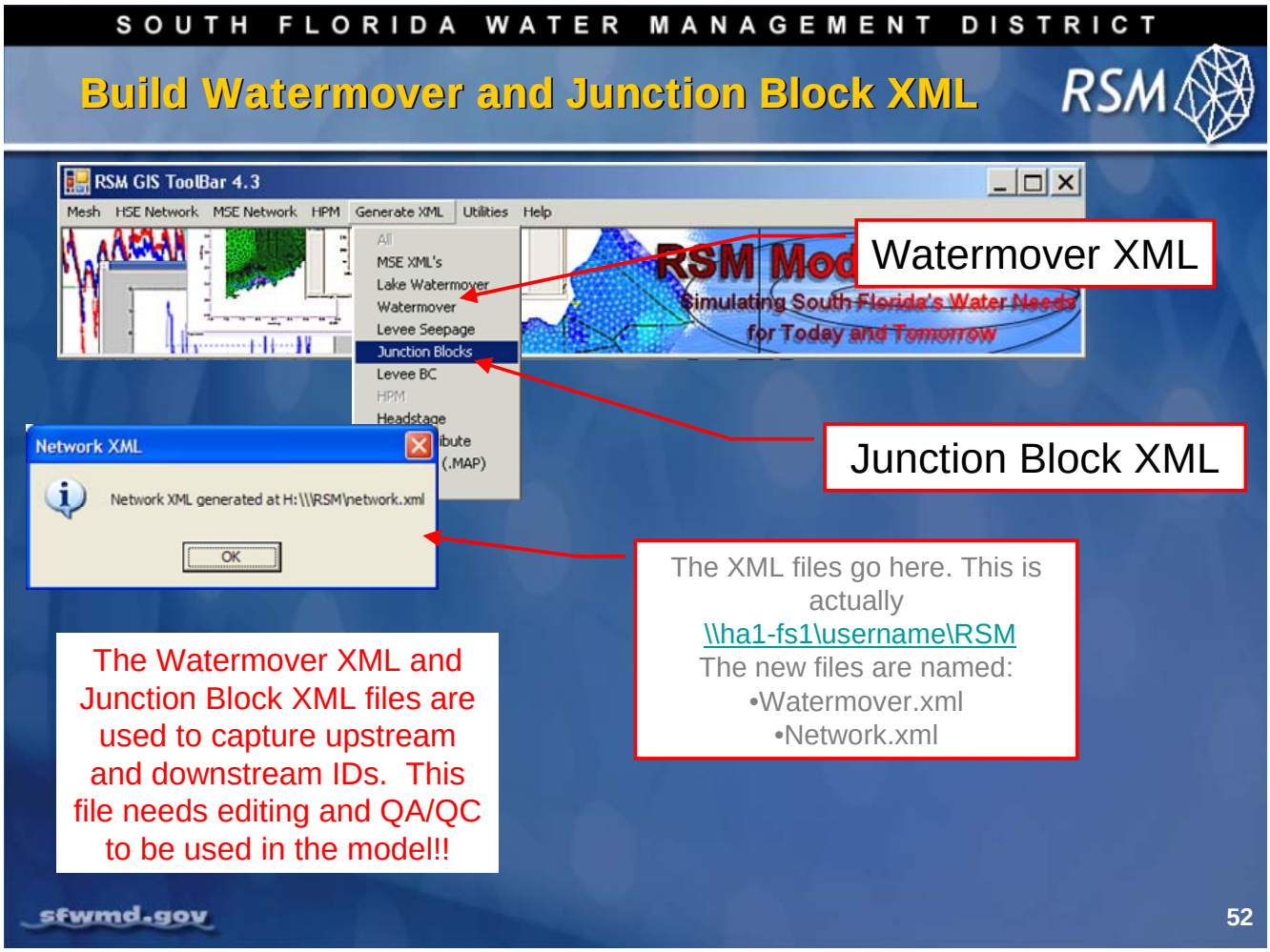

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM
The RSM GIS Toolbar GENERATE XMLs
Index Tool
Watermover XML
Boundary Condition XML
MSE XMLs
Junction Block XML
Canal File (.MAP)
sfwmd.gov



Your geodatabase is now the source (origin, repository, master data source, record of authority) for all the physical information that will be used by the RSM.

You can generate the input files for an RSM model implementation.

These are all SINGLE CLICK tools which automatically assemble the information into the format that is dictated to us via the DTD file.

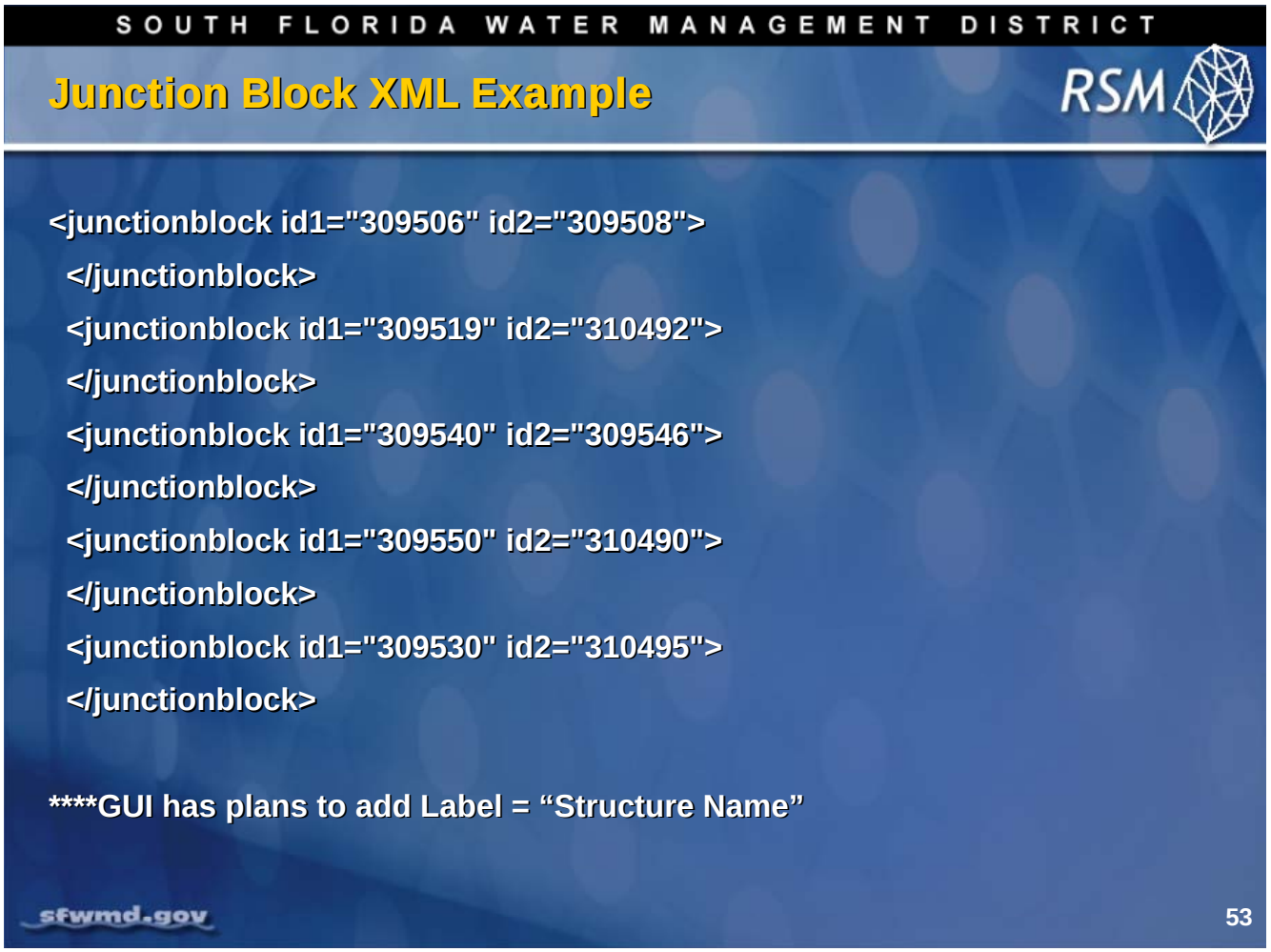


The **Build Watermover and Junction Block XML** routine traverses the canal network, finds the structures, identifies the upstream and downstream canalIDs and goes into the attribute table and identifies the structure type (e.g., culvert, weir, and pump). It assumes that your canal network is perfect.

This routine creates a junction block for each structure and creates the appropriate XML file. (The junction block XML file needs to be checked carefully, errors are typically a result of errors in the canal network.)

For output files, browse to the appropriate directory.

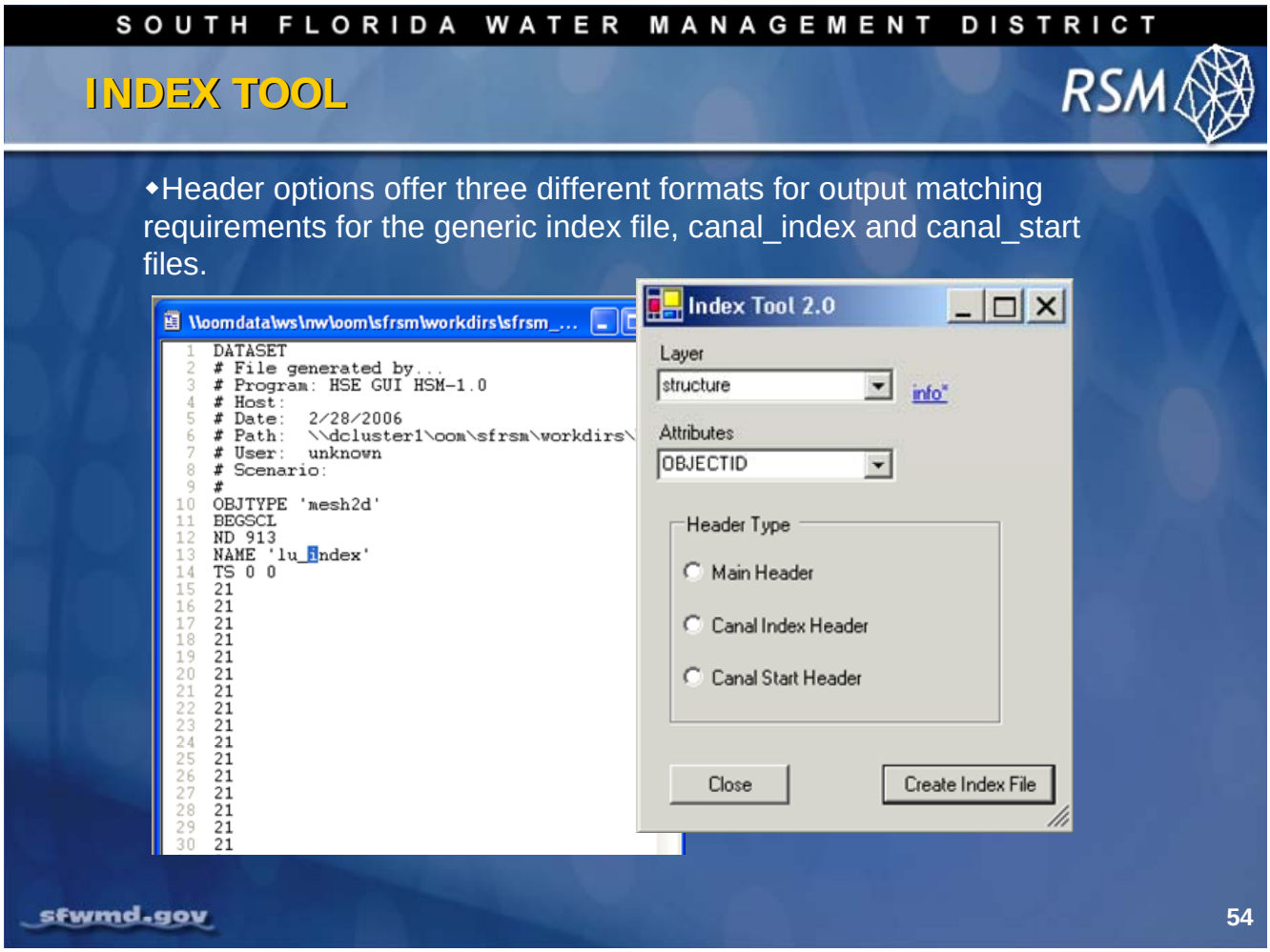
NOTE: If you are not on the SFWMD network, your XML files may go to another location based on how you installed RSM.



For structures, there are three structure types:

- Inline structures (between two segments)
- Diversion structures (between a segment and cell)
- Junction-block structures (no flow)

NOTE: Labeling of the junctionblocks is under development. Your file may look different from what is displayed here.

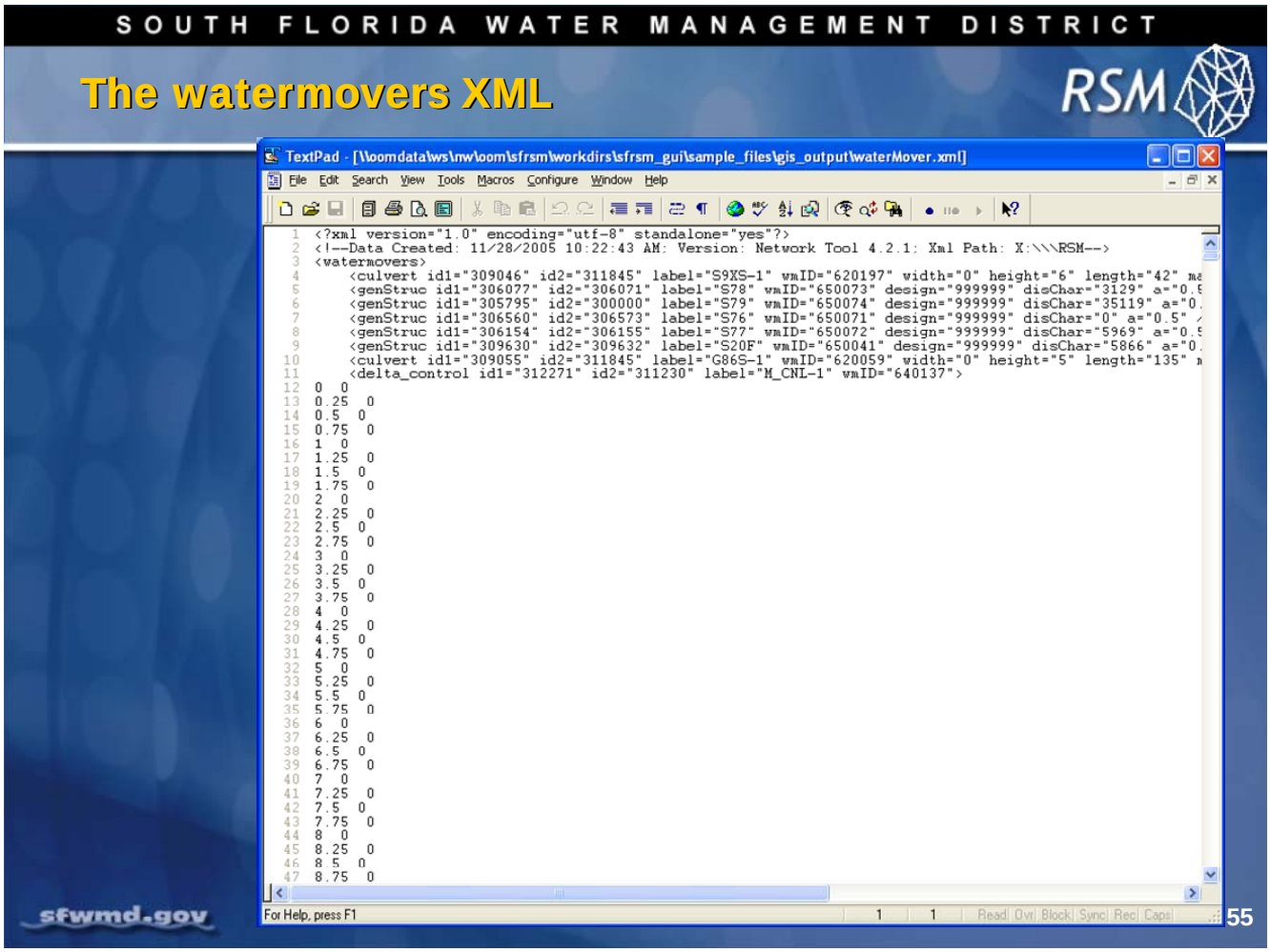


The Index Tool helps generate three different types of files:

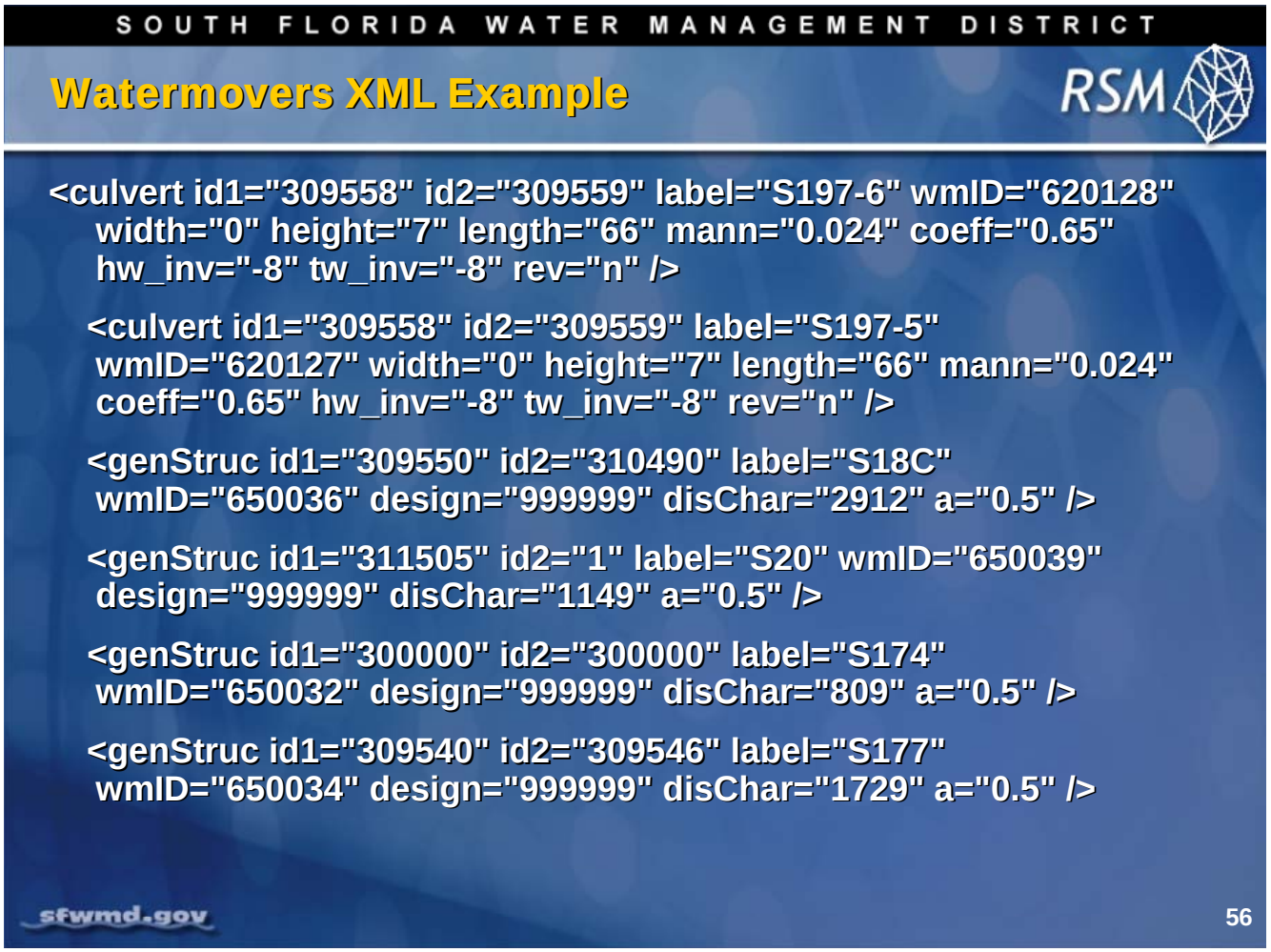
- Generic index file
- Canal_index
- Canal_start

The files are almost identical except for the headers and a comment line at the end of the file.

Any GIS layer attribute can be written out to an index file this way.

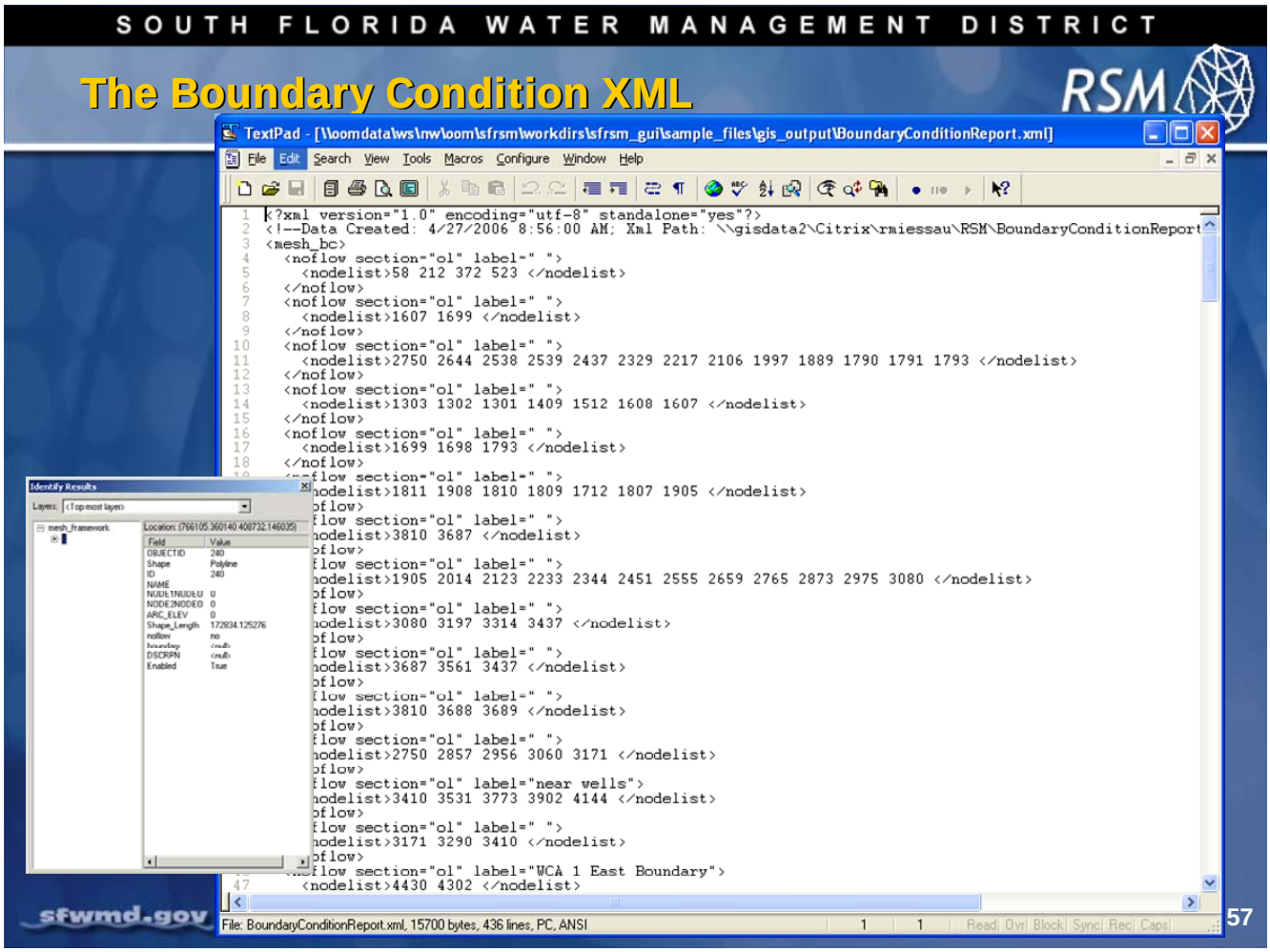


The Watermovers XML is a single-click tool that assembles an XML file containing information about all the watermovers in your scenario. This file was used in earlier versions of the RSM and now serves as a quality assurance and quality control tool for checking problems that arise in a scenario.



This slide shows a snippet of a Watermovers XML file for the different structures. The attributes are defined in the *HSE User Manual,* which can be found in the **`$RSM/labs/lab2_BM2`** directory. For a Junctionblock Watermover, there will be an entry in the junctionblock.xml, but not in the watermover.xml file.

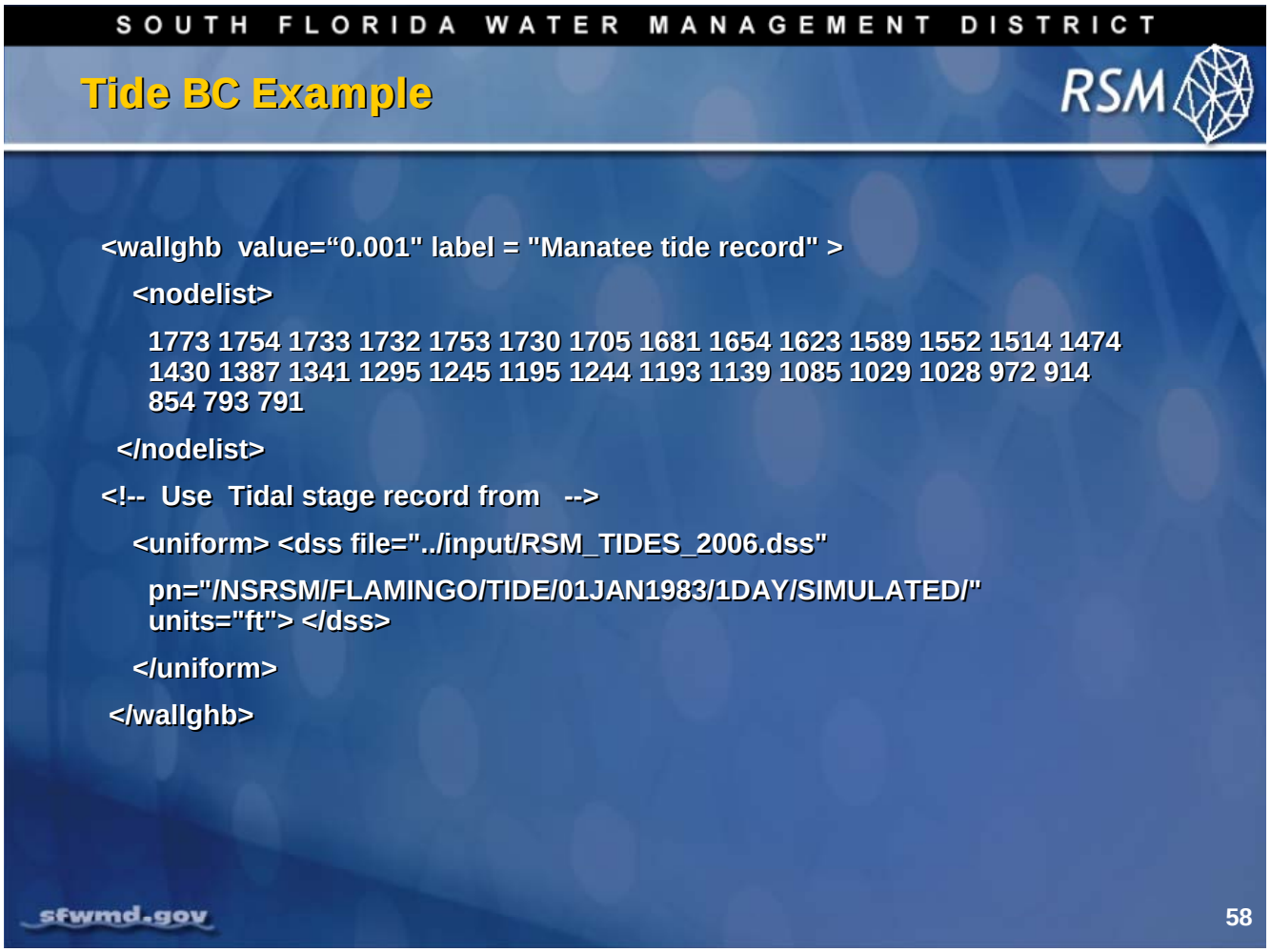
NOTE: There can be multiple watermovers at each junction. This is a designed component of RSM that allows the modeler the ability to separately manage each structure with multiple culverts, pumps and weirs.



The Boundary Condition Tool is a single-click tool that generates the bnd_condition XML. The Boundary Condition XML contains information pertaining to the boundary conditions in your scenario, such as:

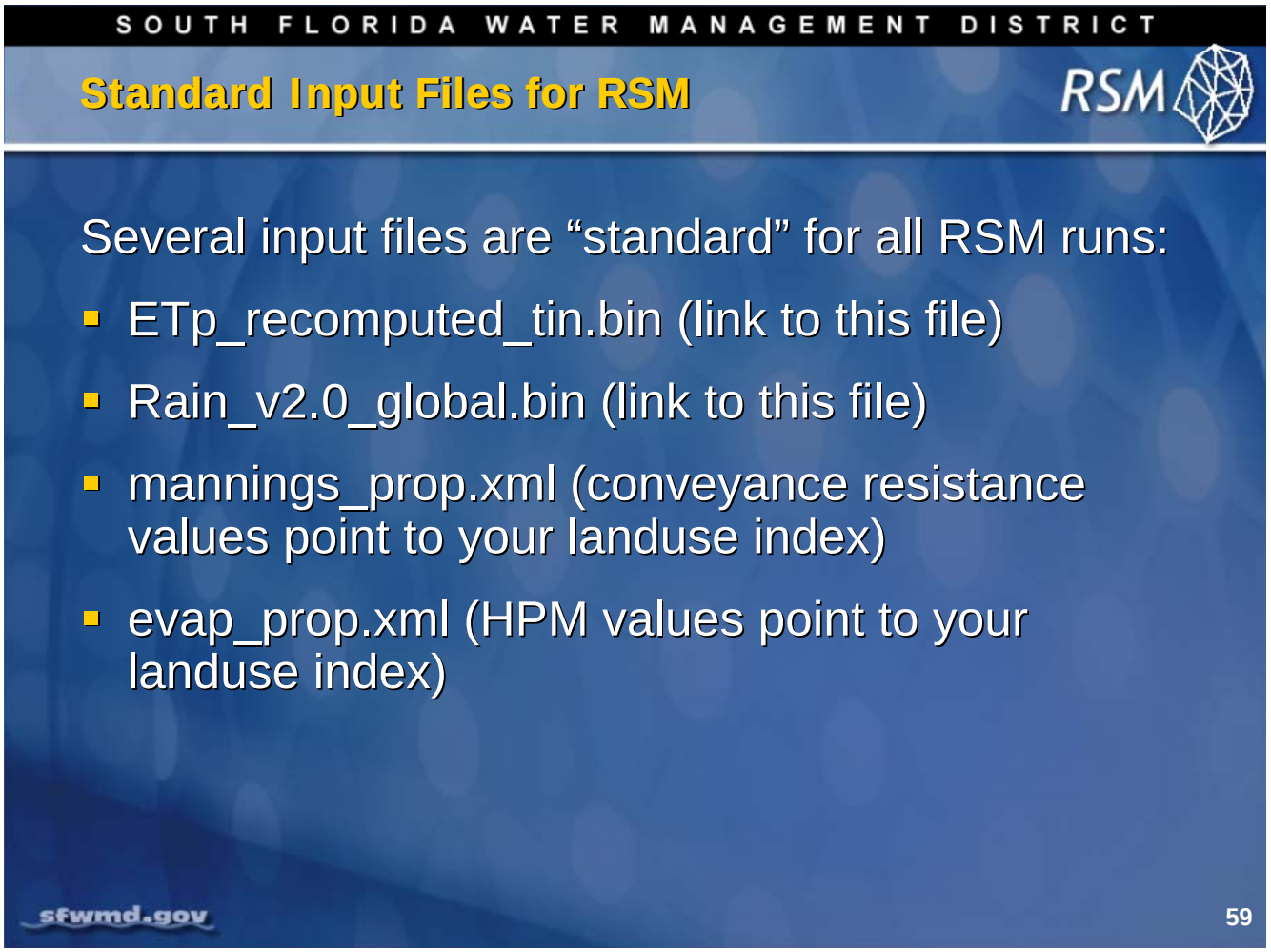
- Bnd_type (boundary type)
- A sequenced list of nodes that make up the mesh boundary
- A label containing the name of the boundary

This tool is applied against the mesh_framework by selecting the designated boundaries and outputting the nodes and attributes comprising each “no flow” levee boundary. Additional boundary types will be added sometime in the near future.

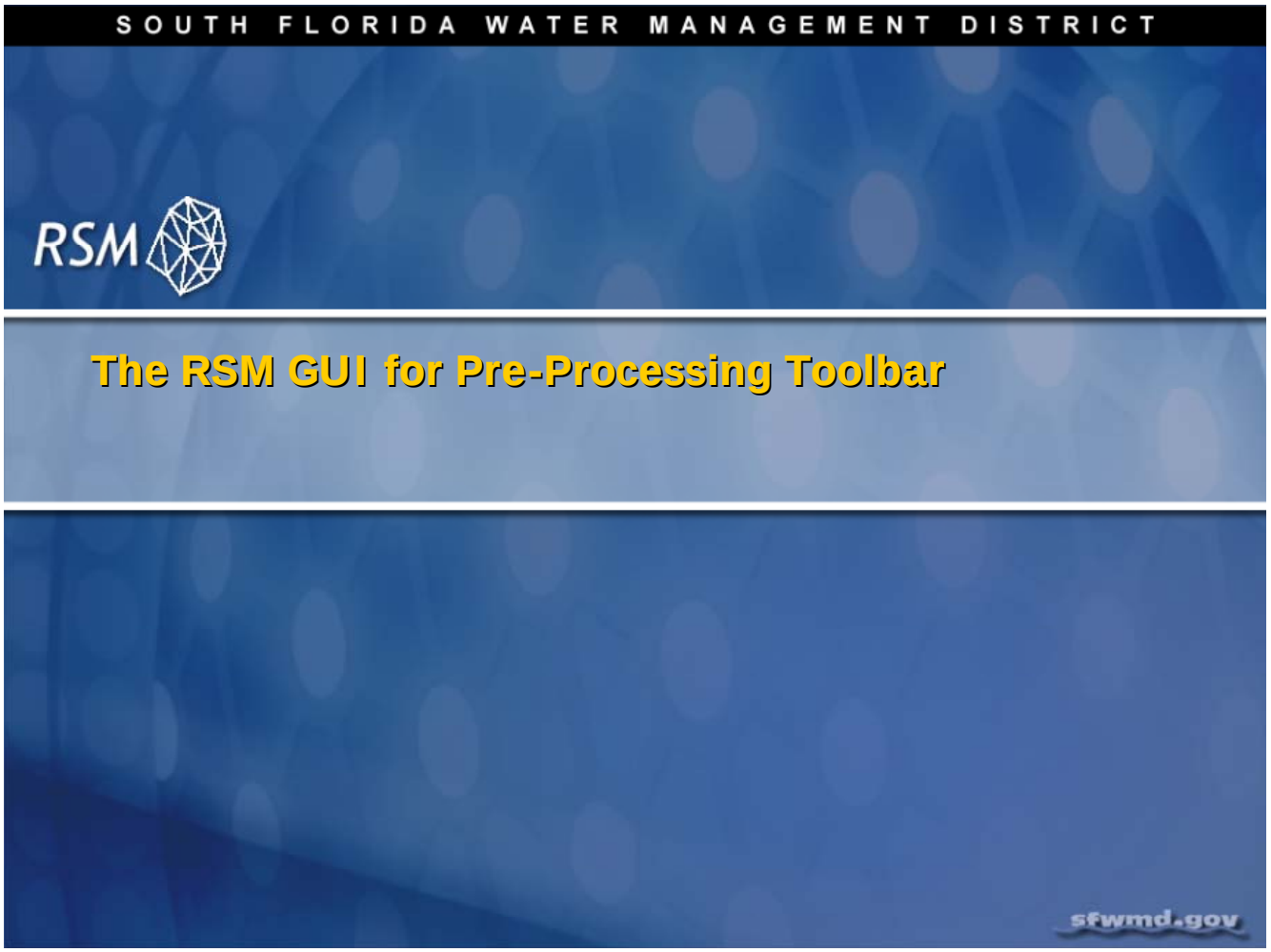


The Tidal BC xml file is built manually. All of the nodes are assigned to one tide gage.

NOTE: For the wallghb conductivity, values should be in the range of 0.001 to 1.0. The calibration results from the Broward Subregional RSM indicated that the conductivity of the walls should be set around 10^{-3}. In south Miami-Dade, values greater than 1.0 produced unreasonable cell heads near the coast, even though the cell conductivities were as high as 10,000.

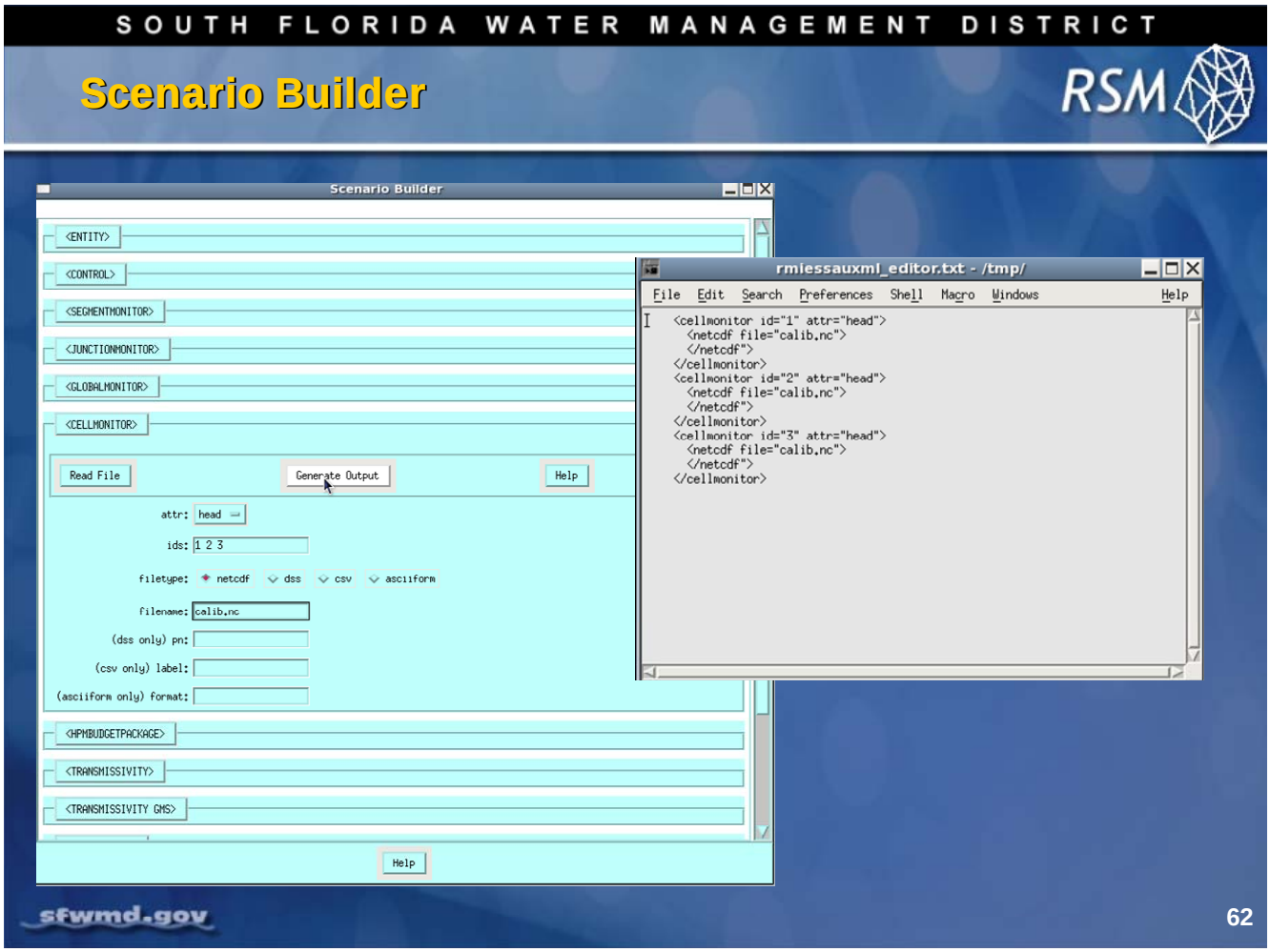


Subtypes are used for canals and structures. They are useful for Symbology, creating maps showing the unique components of the model. They maintain certain rules for network connectivity. The subtypes provide a basic framework for editing and data validation.



Pre-Processing tools have been developed using Python.

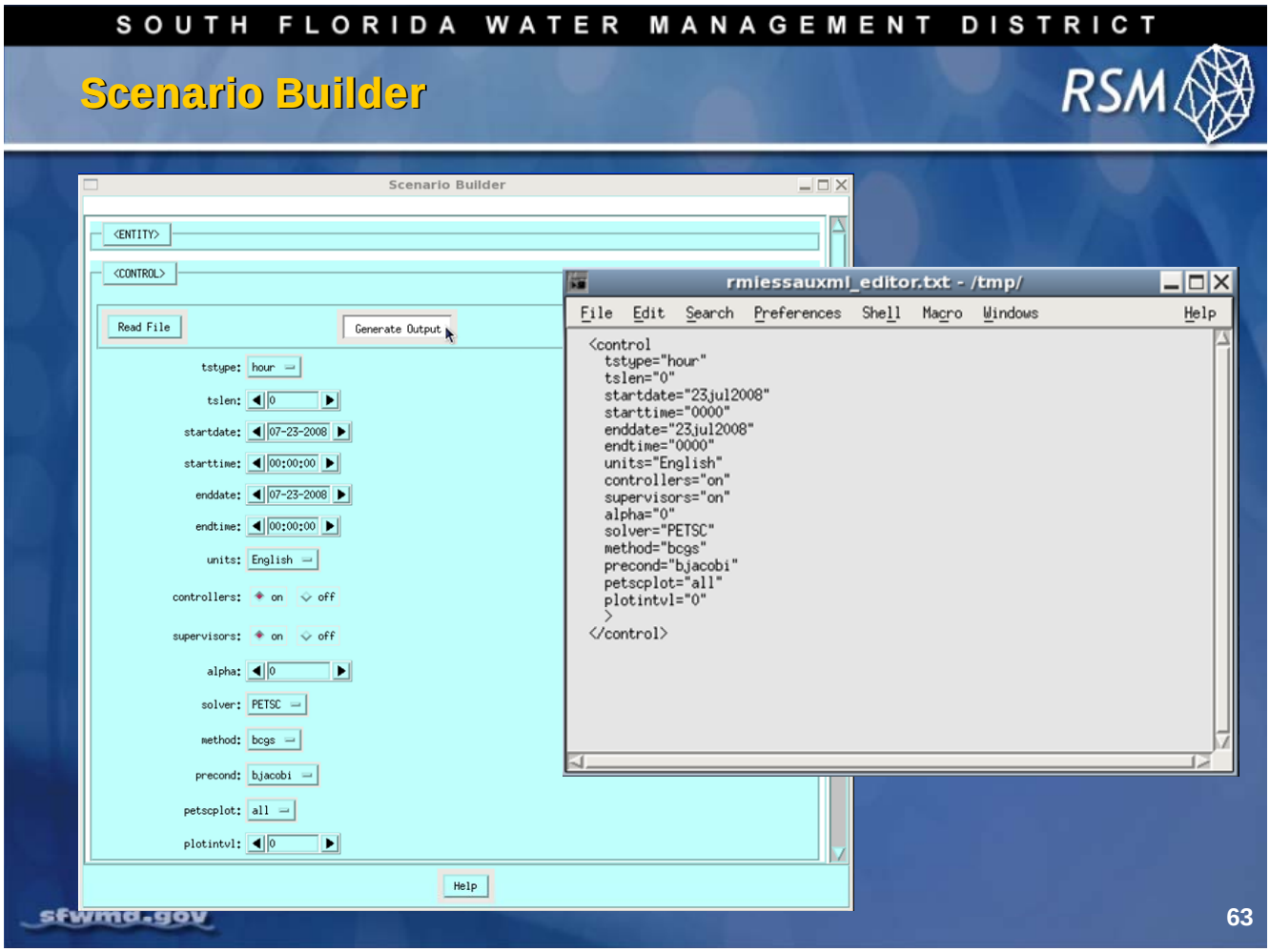
Create XML blocks using the RSM GUI Scenario Builder tool.



The Scenario Builder tool generates blocks of XML suitable to save as XML files, or to copy and paste into existing XML files.

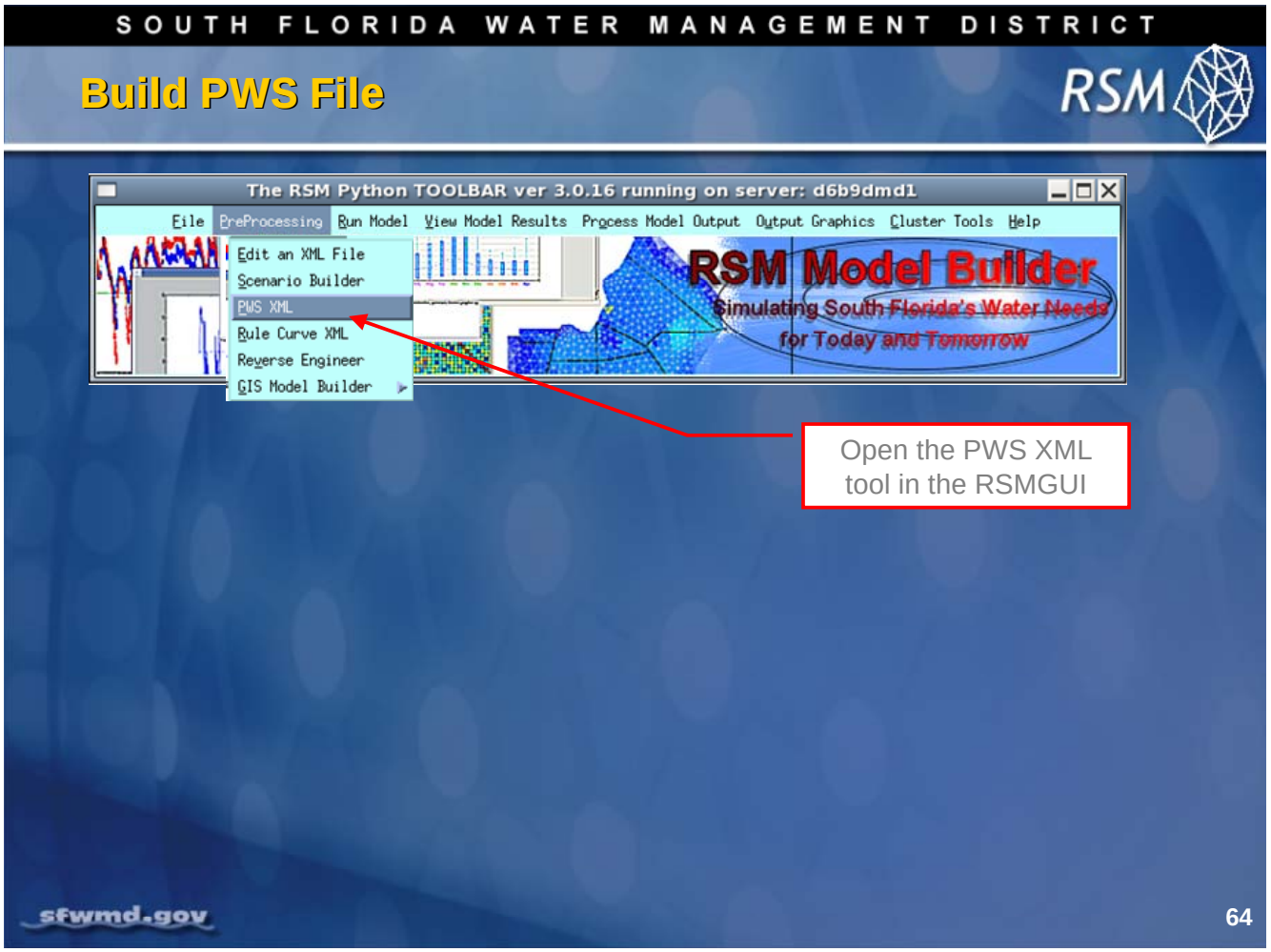
- Each tool area can be opened by clicking each named tab
- Each tool consists of drop-down lists, user input fields and a help button
- Output from each tool is generated in a text editor where the file can be saved, or copied and pasted to another text window

The resulting XML block will contain RSM-appropriate XML, saving time and avoiding costly data entry mistakes.

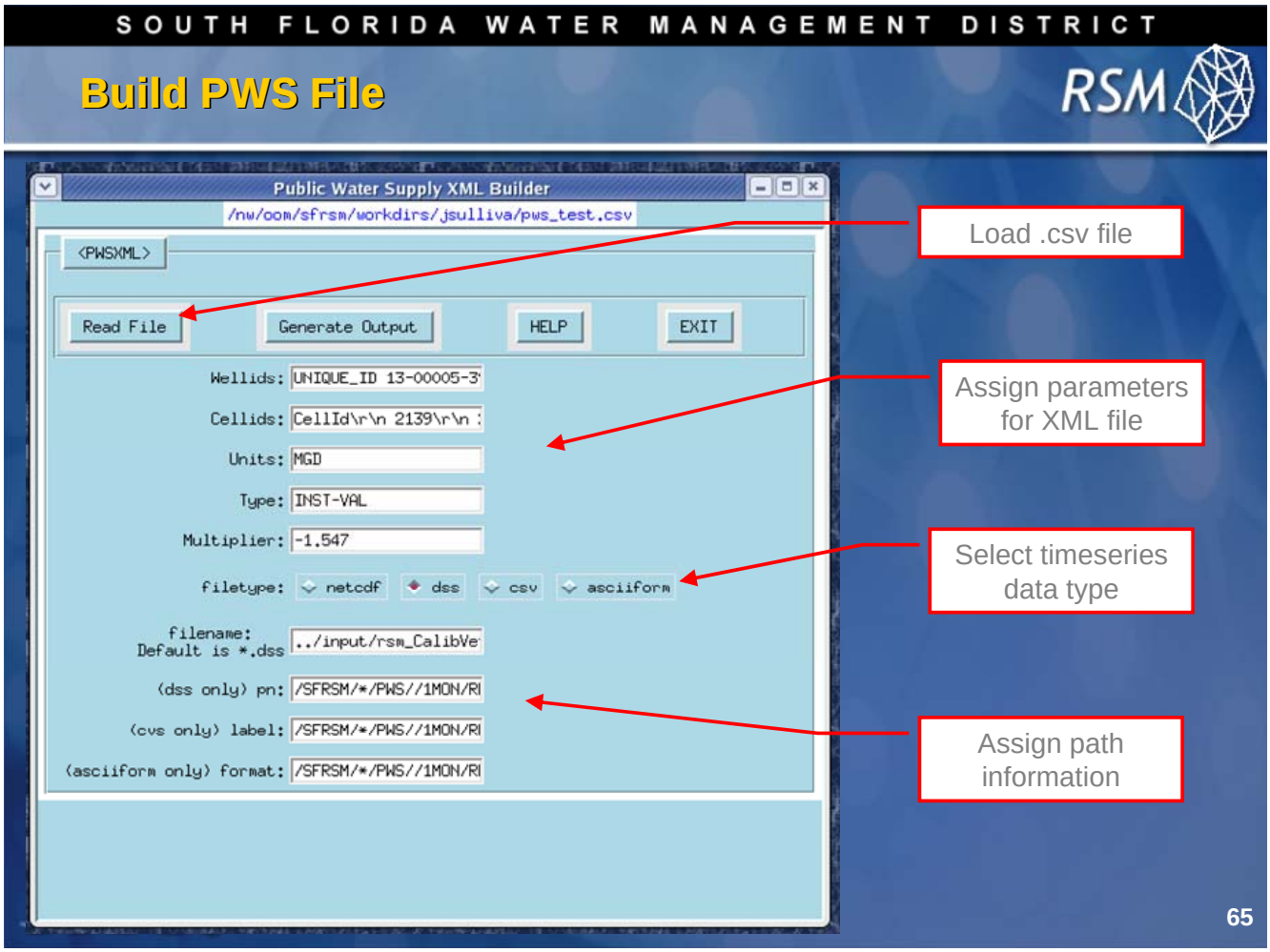


Subtypes are used for canals and structures. They are useful for Symbology, creating maps showing the unique components of the model.

Subtypes maintain certain rules for network connectivity. They provide a basic framework for editing and data validation.



Create the PWS .XML file using the PWS tool in the RSM GUI.



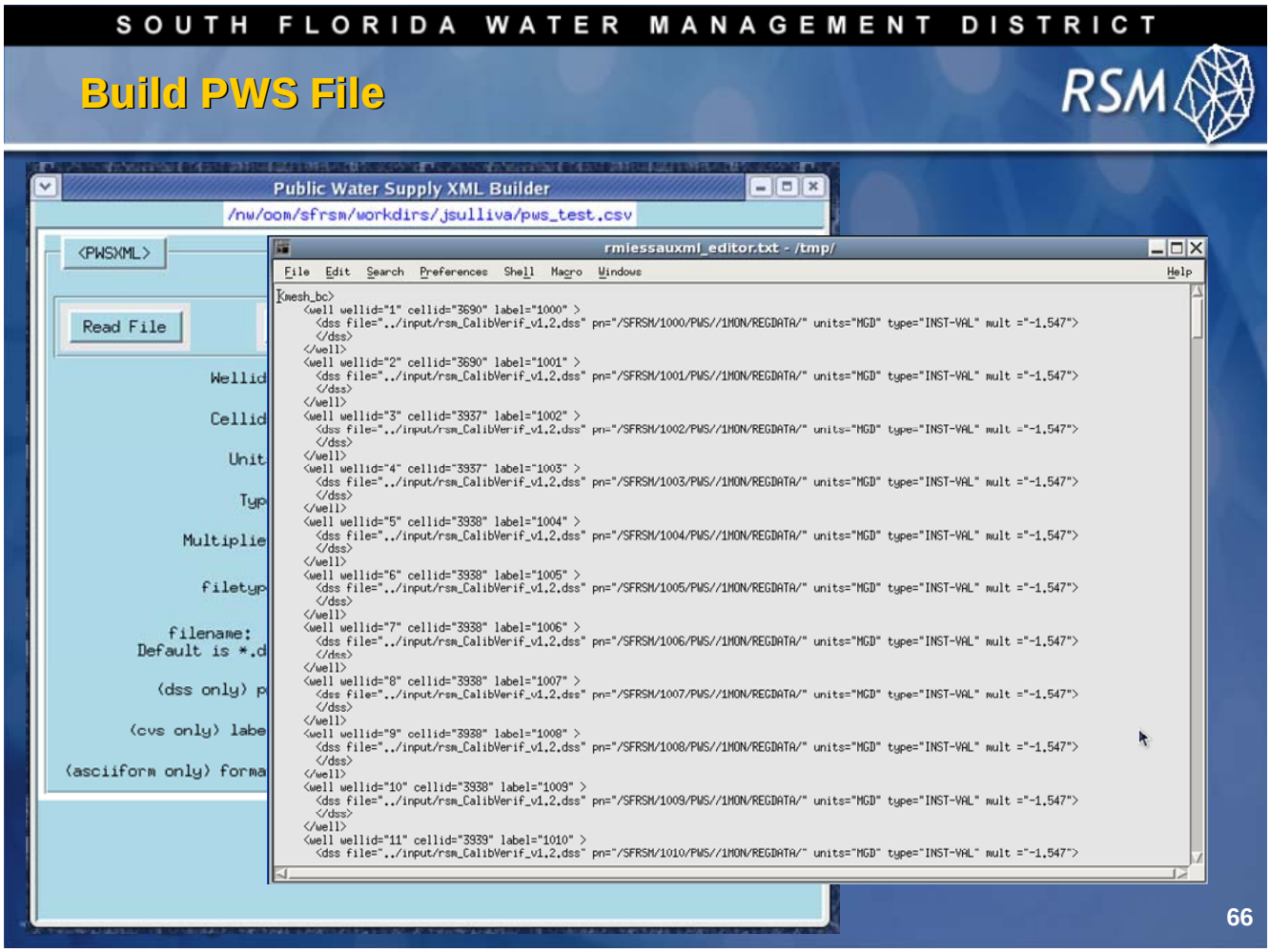
The PWS xml builder helps generate the PWS.XML This file contains information about each PWS well, the cellID it resides in, units, type and DSS path name.

This tool requires an ASCII file containing cellID and unique well ID, which is used to construct the PWS.XML.

User input options include:

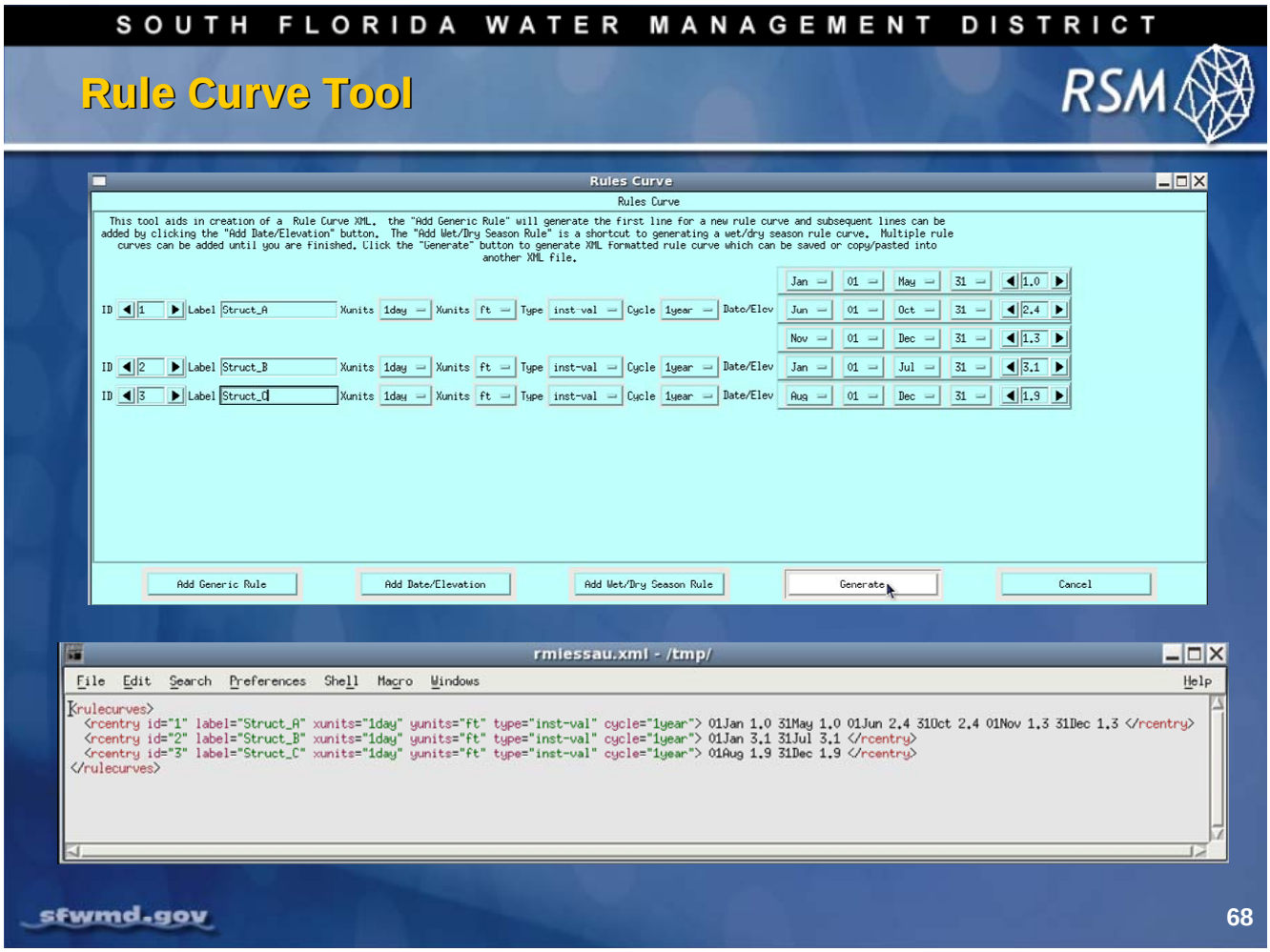
- Units
- Type and multiplier
- Output file type
- File name
- a DSS path (in the case of DSS output), used to generate the file

The resulting output file can be edited, or copied and pasted into another XML. This tool saves a lot of repetitive typing and helps avoid costly data entry mistakes.



Output from the PWS tool.

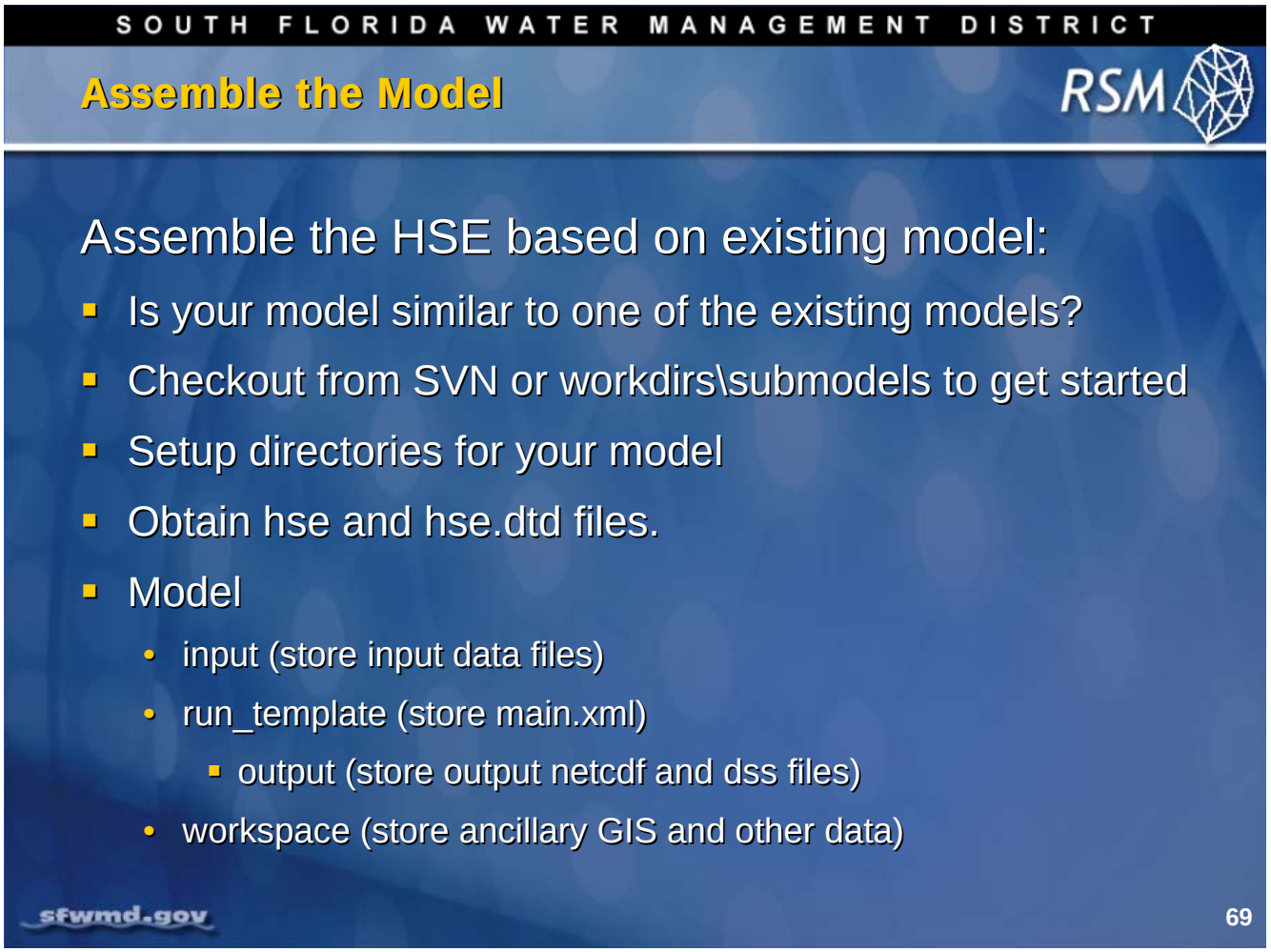
Create a Rule Curve XML using the RSM GUI Rule Curve tool



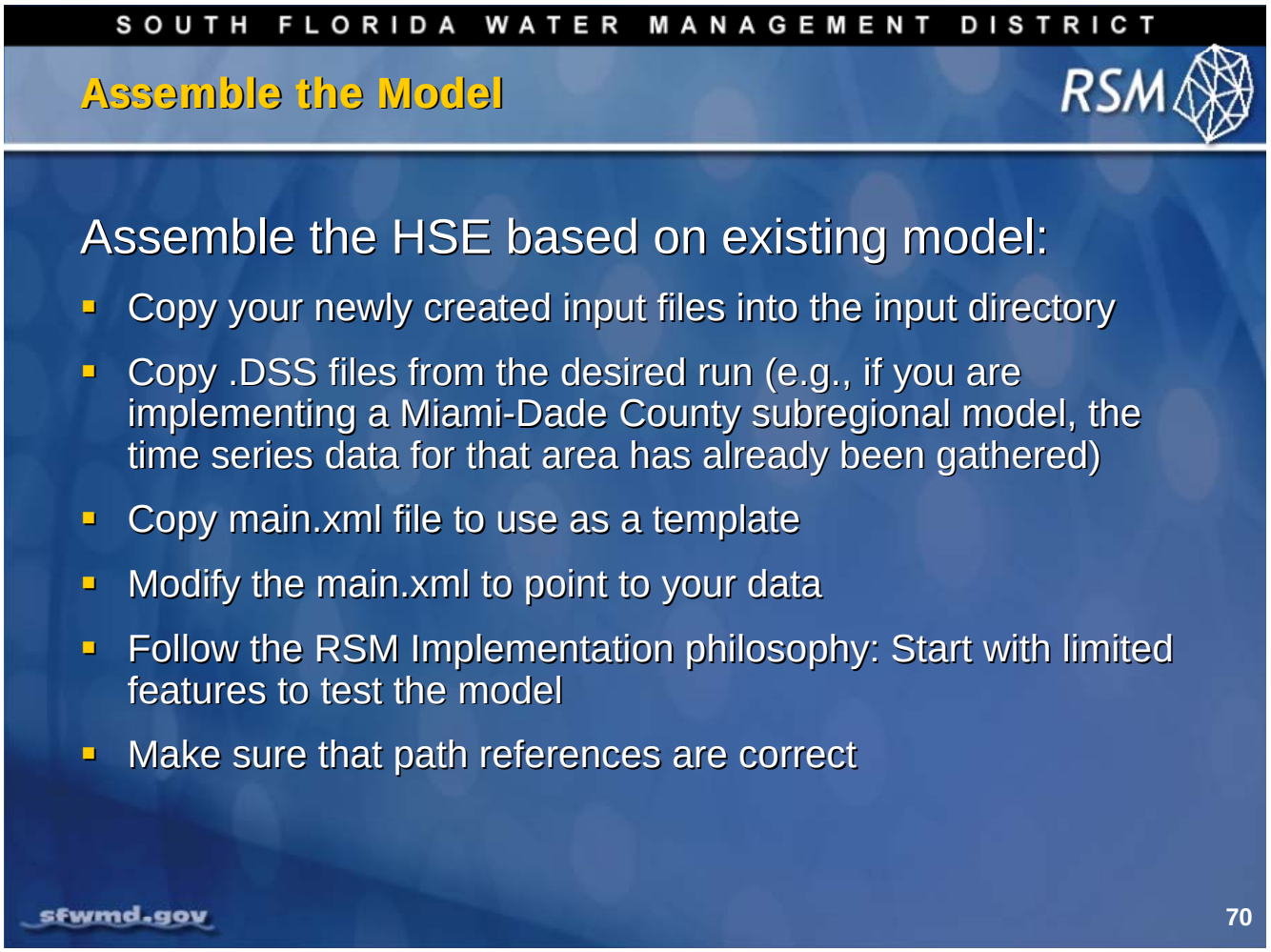
An RSM Rule Curve XML block consists of a:

- rcentryID
- label
- units
- type
- cycle
- rule curve
- date
- elevation

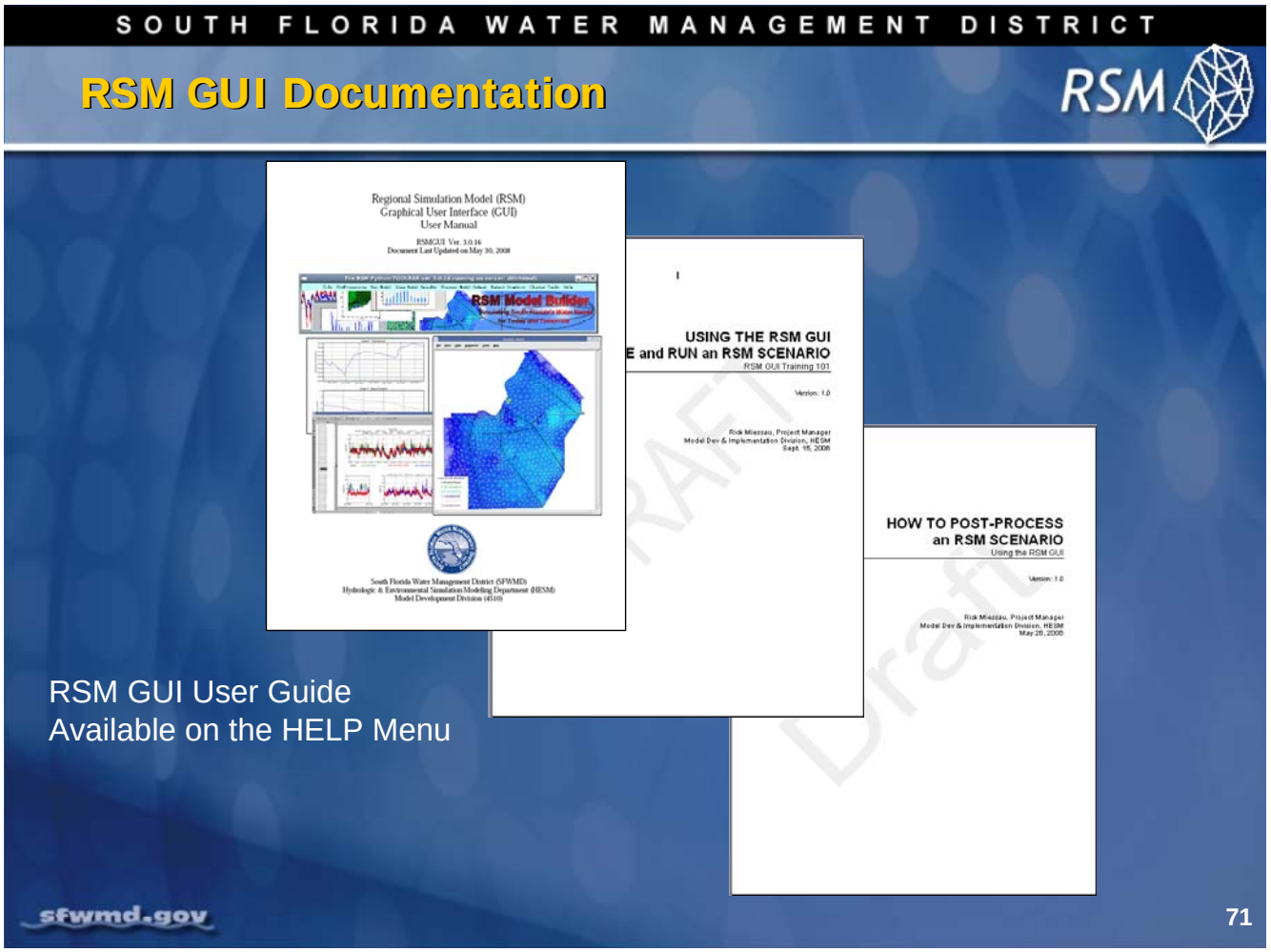
Users can choose to generate each line one-at-a-time or generate a generic seasonal (wet/dry) rule curve. Multiple rule curves can be added and then generated into one XML. The resulting XML block can be saved, or copied and pasted into another XML.



When creating a new model, you can use another subregional model or a benchmark model as your starting point. SFWMD modelers can find both production and testbed models in the SFWMD SVN Data Repository. External modelers can use benchmark models distributed with the RSM code.



In Lab 7 you will create a new model based on previously created files.



Documentation is available via the HELP button on the Toolbar

KNOWLEDGE ASSESSMENT

(pre- and post-lecture quiz to assess efficacy of training materials)

1. What are the two RSM GUI toolbars and how are they implemented?
2. What are the key functions of the GIStoolbar?
3. What are the key features in the RSM geodatabase?
4. What are the necessary components for importing a mesh?
5. How is a mesh populated with spatial attributes?
6. What canal attributes are contained in the RSM geodatabase?
7. What are canals composed of?
8. What information is necessary for adding canals to the RSM canal network?
9. What is the critical concern with canal network editing that is different from mesh editing?
10. Why is there a resegmenting tool in the GIStoolbar?
11. Which RSM features have specific XML generation utilities?

Answers

1. The two RSM GUI toolbars are the GIStoolbar, which is implemented within ArcGIS, and the RSMGUI which is implemented from the Linux operating system prompt.

2. The GIStoolbar is used to import the mesh, assign attributes to the mesh, and create XML files to run the model.

3. The RSM geodatabase contains the canal and structure information for south Florida and the model mesh.

4. The files necessary for importing a mesh are the following: mesh.2dm file, framework shape file and RSM template geodatabase.

5. Using the Intersect tool, spatial data can be assigned to each mesh cell and using the Index tool, the mesh attributes can be written to an index file for an RSM model.

6. The canal attributes include the cross-section properties, network connectivity, reach ID and segment ID.

7. The RSM canals are composed of junctions and individual segments that are grouped into reaches and the reaches are grouped into stage-reaches that are reaches with a water control structure at each end.

8. To add a canal (group of segments) it is necessary to have the appropriate accurate line-work, proper connectivity enabled, segment properties, and reach properties. It is necessary to assign a value of “enabled” or “disabled” to each segment.

9. In canal network editing, to add a new canal the segmented IDs will be renumbered, while it is possible in mesh editing to add a cell to the mesh and assign specific cellID values.

10. The resegmenting tool is necessary because of the complexity of adding and changing the topology of the segments in GIS.

11. Currently there are separate utilities to generate XMLs for public water supply wells and levee seepage watermovers, junction blocks, watermovers, rule curves and selected boundary conditions.

Lab 7: Creating and modifying canal networks

Time Estimate: 2.0 hours

Training Objective: Gain familiarity with the canal networks within the RSM geodatabase and RSM GIS Toolbar

The RSM GIS Toolbar is used (in ESRI ArcMap 9.2) for pre-processing Geographic Information System (GIS) data and producing the XML files used by the Regional Simulation Model (RSM). Users are expected to have a comfortable understanding of basic features in ArcMap 9.2.

Files for this lab are located in the **`$RSM/labs/lab7`** folder. Additionally, three demonstration videos are available, as a supplement to this lab, for students who do not have access to the proprietary ArcMap software.

NOTE:

For ease of navigation, you may wish to set an environment variable to the directory where you install the RSM code using the syntax

`setenv RSM <path>`

For SFWMD modelers, the path you should use for the NAS is:

`/nw/oomdata_ws/nw/oom/sfrsm/workdirs/<username>/trunk`

`setenv RSM /nw/oomdata_ws/nw/oom/sfrsm/workdirs/<username>/trunk`

Once you have set the RSM environment variable to your trunk path, you can use $RSM in any path statement, such as:

`cd $RSM/benchmarks`

Training files are currently located in the following directories:

```
INTERNAL_TRAINING
|
|____data
|        |__geographic
|        |__C111
|        |__rain+et
|        |__glades_lecsa
|        |__losa_eaa
|        |__BBCW
|
|____trunk
|        |___benchmarks
|        |___hpmbud
|
|____labs
```

Files for this lab are located in the **`labs/lab7`** directory. Additional materials in the directory include:

Video Files:

`Lab7_1_1.wmv`

`Lab7_1_2.wmv`

`Lab7_1_3.wmv`

Activity 7.1: Enabling and Manipulating Canal Segments

Overview

Activity 7.1 This activity includes two exercises:

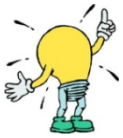
- **Exercise 7.1.1** Become familiar with canal segments
- **Exercise 7.1.2** Add a new canal feature to the C111 RSM

The objective of this activity is to familiarize the student with canal networks with the RSM geodatabase.

Exercise 7.1.1 Become familiar with canal segments

6. Open ArcGIS/ArcMap9.2 and activate the RSM GIS Toolbar.
7. Open a New Map.
8. Add all data from the **`$RSM/labs/lab7/c111.mdb`** catalog
9. Arrange the layers, or turn a few layers off, until you are satisfied with how it looks, and you can see your mesh and canal network
10. Save your map (.**`mxd`**) file in the **`lab7`** folder calling it **`lab7.mxd`**
11. Use the ESRI Identify Tool ⓘ and click on features in the map
12. Select a structure and view the attributes and associated tables
13. Select a canal segment and view the attributes

HINT



In ArcMap select Tools > Customize > RSM GIS ToolBar v4.3. The toolbar is now part of your ArcMap settings.

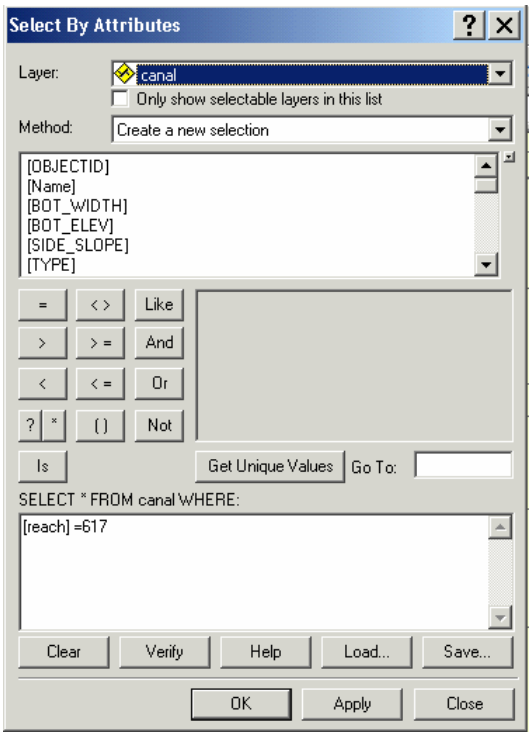


Figure 7.1 Select by Attributes dialog box

14. From the Selection Menu, open the Select by Attributes dialog box (**Fig. 7.1**)
15. Select **`[reach] = 617`**
16. Zoom to the selected features and right-click the Canal layer in the attribute window (on the left side of your screen) to view the attribute table for the canal layer (**Fig. 7.2**)
17. Use the option at the bottom of the attribute window to show selected records

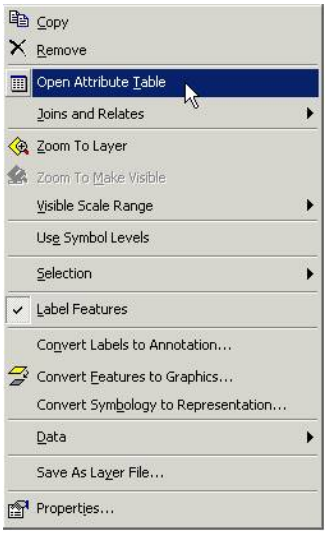
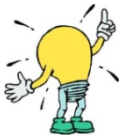


Figure 7.2 Open Attribute Table for Canal layer

HINT

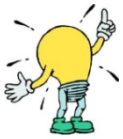


You must be in an edit session to change attributes.
There should be two records in your selection.

- How many segments are now in Reach 617?
- What is the bottom width?
- What is the Manning's coefficient?
- Select mesh **`cell_id=2783`**
- What is the topo elevation?

18. Select **`[reach] = 598`**. View the attribute table for the Canal layer. Use the option to only show selected records.

HINT



You must be in an edit session to change attributes.
There should be one record in your selection.

19. Click on the Editor toolbar to start editing. In the **`Attributes of Structure`** Table, 'disable' the segment in Reach 598 by changing the 'enabled' attribute to "***false***" (**Figure 7.3**). Save your edits.

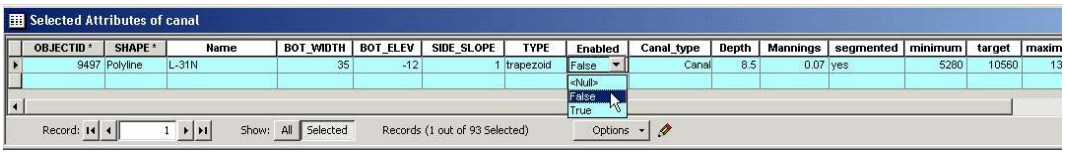


Figure 7.3 Disabling Reach 598 in the **`Attributes of Structure`** table.

20. Select the Index Tool from the HSE Network Menu in the RSM GIS ToolBar
21. Choose the Canal layer and click the **`CanalId`** attribute
22. Using the Index Tool, specify the **`Canal Index Header`** under the Header Type and click the Create Index File button to generate a canal index file
23. Provide a location and name to save the file
24. Open the file using Textpad (or any text editor).
    - What is the first **`CanalId`** listed in the report right after the header?

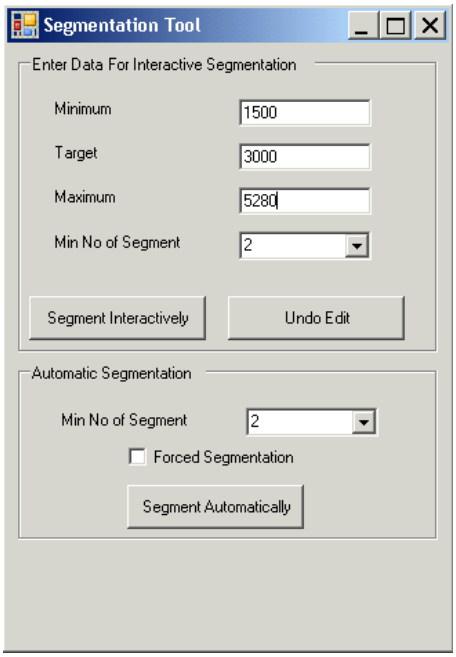
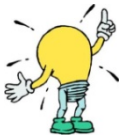


Figure 7.4 Segmentation Tool dialog box

25. While working in your **`lab7.mxd`** map, open an Edit Session

- Select **`[reach] = 617`**
- Zoom to the selected features
- Use the Segmentation Tool to Segment Interactively the reach specifying (as shown in **Figure 7.4**):
  - Minimum: **`1500`**
  - Target: **`3000`**
  - Maximum: **`5280`**.
- Refresh your screen and view the attribute table for the canal layer

HINT



1. Remember to save your edits.
2. You may need to activate the Editor toolbar.

- How many segments are now in Reach 617?
- What is the resulting length of the segments in Reach 617?

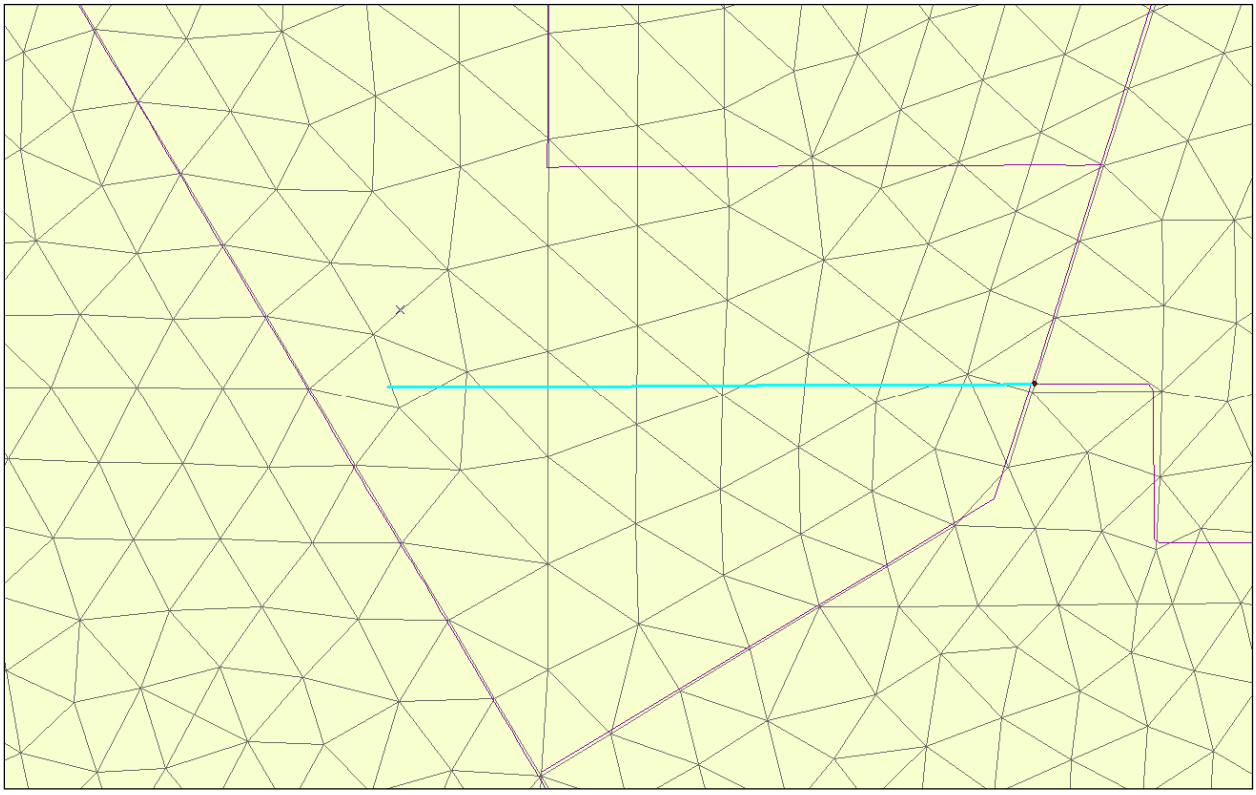


Figure 7.5 Canal reach 617 after editing (highlighted in turquoise).

Exercise 7.1.2 Add a new canal feature to the C111 RSM

26. Open **lab7.mx**d in ArcMap
27. Select canal segment with **canalId= 309549**
28. Add a new canal at that location (in Editing mode, as shown in **Fig. 7.6**)

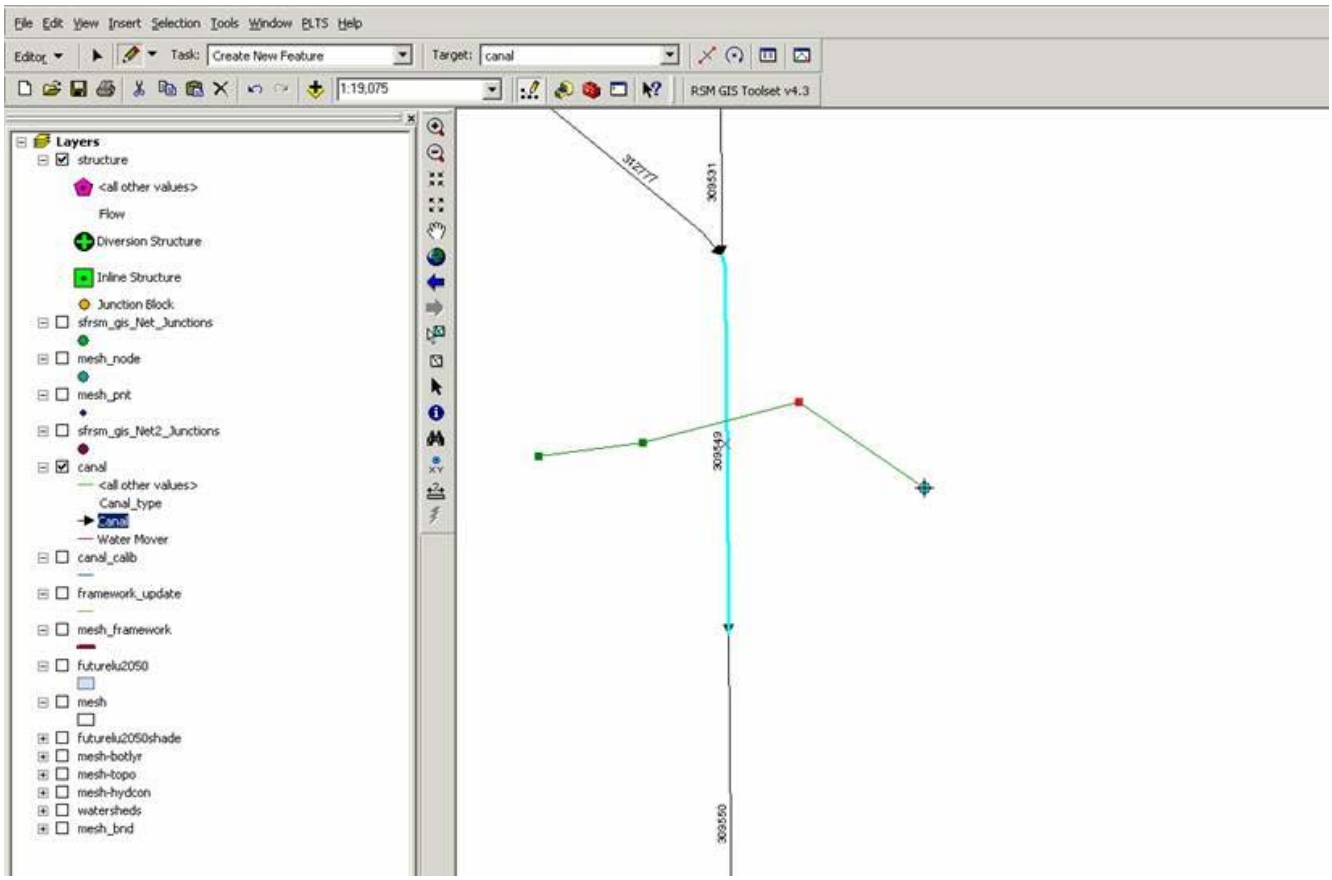


Figure 7.6 Adding a new canal segment to intersect with **canalId 309**549.

29. Click Start Editing in the Editor Toolbar
    - (Make sure the Target is the canal Layer and Task is Create new feature)
30. Select the Pencil tool and draw your four new segments
    - Click the F2 key at the end of each segment to end the segment and start a new one
    - After adding the segments remember that canal segments must break at intersections. Use the Line Split Tool to split necessary segments at intersections.

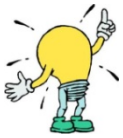
    Segment 1 should intersect the C-111 Canal at **canalId 309548**.
31. After your new segments are drawn, open the **Attributes of Structure** Table from the Table of Contents (on left side of screen)

32. Edit the segment field attribute values:

	Field Attributes Values			
	BOT_WIDTH	BOT_ELEV	SIDE_SLOPE	Mannings
Segment 1	56	-2.2	2	0.04
Segment 2	45	-2.4	2	0.04
Segment 3	40	-2.7	2	0.04
Segment 4	36	-2.9	2	0.04

33. Assign all of the new canals to a new reach. (The reach number should be the next highest number in the sequence of reach numbers.)
    - Assign a new reach number where necessary.
    - Symbolize canal segments by reach to display the new reach or reaches.
34. Once all changes and additions are final, end your editing session by clicking the Save Edits button in the Editor Toolbar.
35. Add a new structure, **`Name = Spillway1`**, between Segment 3 and Segment 4 in your new canal. The new structure should be **`Flow = Inline Structure`** with **`WM_type = Structure_Flow`** and **`struc_type = spillway`**.
    - How many Inline structures are now in the model?
    - Since the structure has been added, is your new reach still valid?
36. Since your new structure is a spillway it must be added to the related Spillway table. Add this entry into the related table and set the **`dis_coef = 2000`**. (There is more than one way to do this.)
37. Identify **`Spillway1`** to display the new spillway properties and include a screen capture.

HINT



Search for relationship class editing in ArcMap Help.

Activity 7.2: Construct a Canal Network from the SFRSM Template Network

Overview

Activity 7.2 This activity includes two exercises:

- **Exercise 7.2.1** Clip the canal network to the EAA RSM Mesh
- **Exercise 7.2.2** Add network boundary conditions

When it is necessary to create a new subregional RSM implementation within the SFRSM domain or create a new canal network, it is best to begin with the SFRSM template geodatabase. The template contains the complete primary canal system with canal properties and associated structures. The objective of this activity is to create a canal network from the SFRSM template canal system for a user-provided mesh using the RSM GIS ToolBar.

Exercise 7.2.1 Clip the canal network to the EAA RSM Mesh

38. Open New Map in ArcMap
39. Open RSM GIS ToolBar > Mesh Menu > Import Mesh > Load SFRSM Template (**Fig. 7.7)**

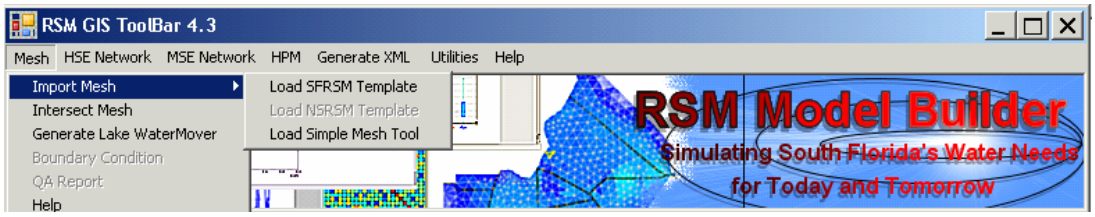


Figure 7.7 Load SFRSM Template for Mesh

40. Import the **`eaamc3.2dm`** file (as described in Lab 6, Exercise 6.1.2 Import a mesh into the RSM)
41. Create the output geodatabase: **`eaamc3.mdb`**
42. Close ArcMap

After importing the mesh, the geodatabase will contain a canal layer. The CanalId Index must be removed before proceeding so that the RSM can reset the segment IDs for the new canal network.

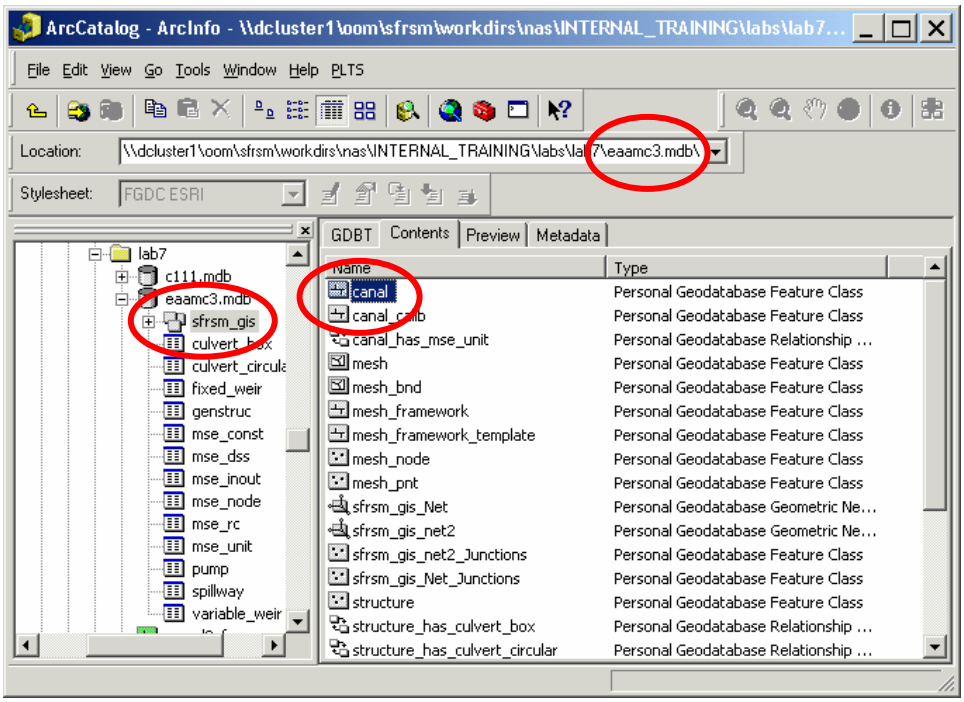


Figure 7.8 Opening eaamc3.mdb from ArcCatalog

43. Open new ArcMap > Open ArcCatalog > Open **`eaamc3.mdb`** **(Fig. 7.8)**
44. Open **`sfrsm_gis`** > Select canal feature class> Right-click to open properties (**Fig. 7.9**)

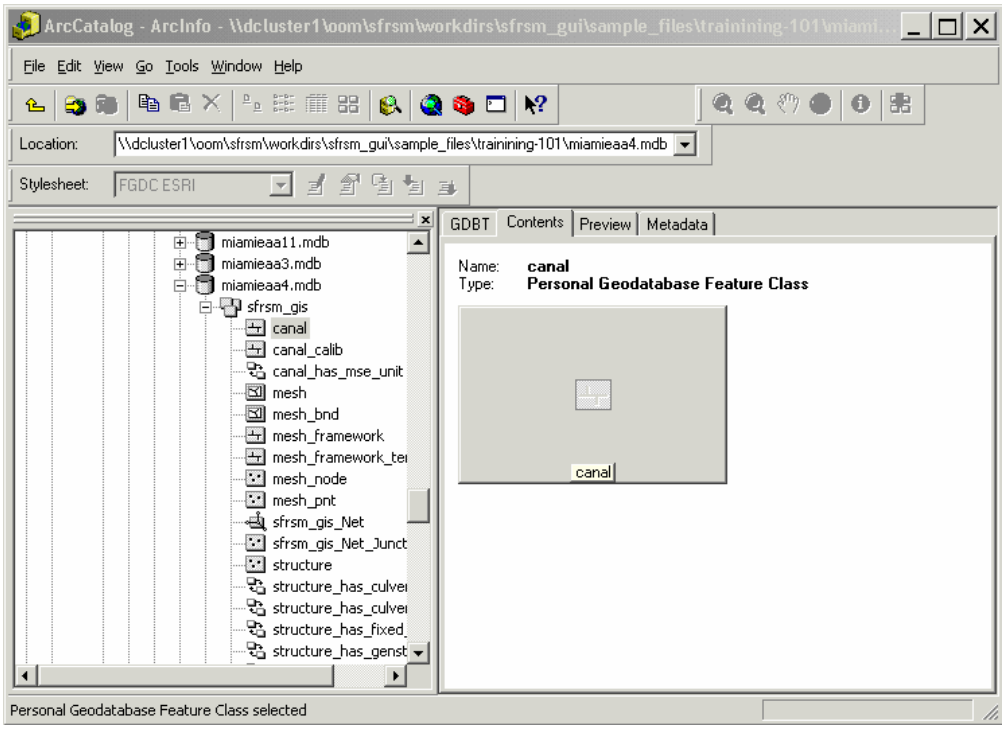


Figure 7.9 Opening the canal feature class properties in Arc Catalog.

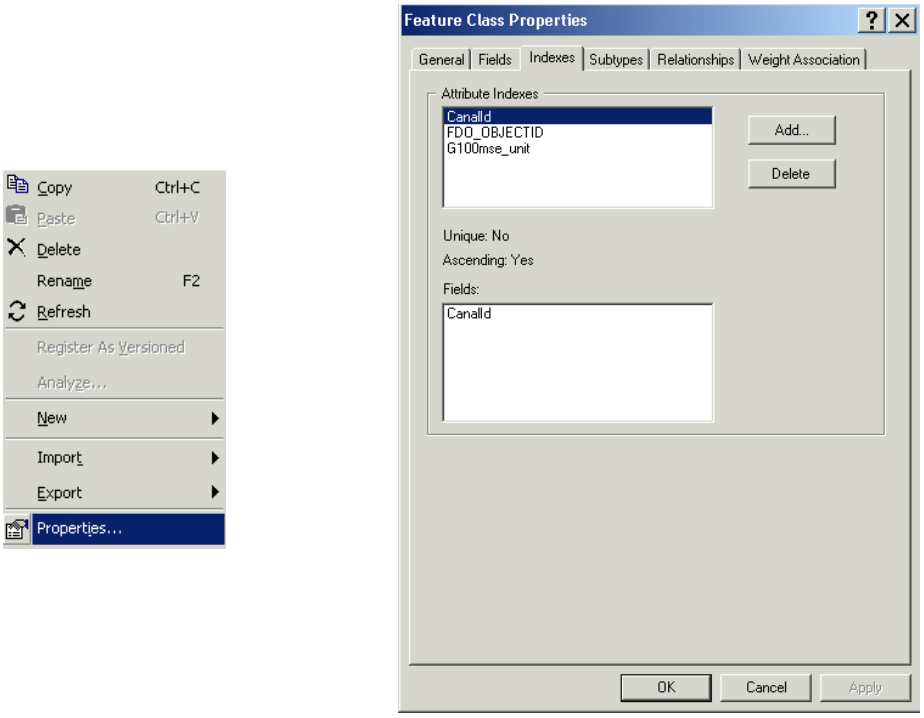


Figure 7.9 (cont.) Opening the canal feature class properties in Arc Catalog.

45. In the ArcCatalog Feature Class Properties interface, click the Indexes Tab
46. Select the CanalId attribute index (see **Fig. 7.9**) and click the Delete button. (If the Delete button is not highlighted, close out of ArcMap and repeat.)
47. Click the Apply button (located at the bottom of the window), and then click the OK button.
48. Return to ArcMap and your geodatabase.

After importing the mesh, your canal layer will include all of the canals from the **`SFRSM_Template`** geodatabase that intersect with your mesh including one or two segments outside of your mesh. There may be structures just outside of the mesh that are desirable to include in the model and this allows the modeler to select which segments to include.

You are now ready to generate your **`.MAP`** file. First, it is necessary to edit the Canal Feature Class:

49. Open a new ArcMap
50. Add mesh, structure and canal feature classes from **`eaamc3.mdb`**
51. Save as **`eaamc3.mxd`**
52. Start an Editing session for your Canal Feature Class (see **Fig 7.10**).

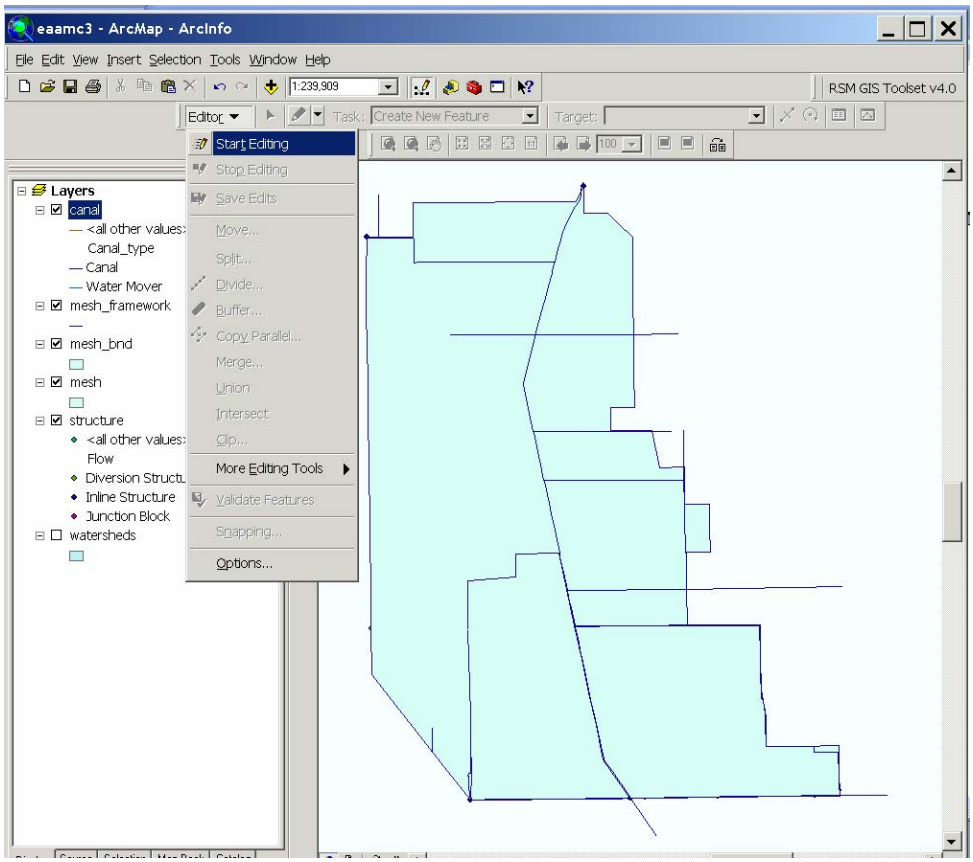


Figure 7.10 Starting to edit the **`eaamc3.mxd`** file.

53. Identify the features that extend outside your mesh boundary and determine which features should be clipped or simply moved back across the boundary.
    - If the canal goes over the boundary and comes back in, you should move it back within the boundary. You should only move the canal if it only slightly extends over the boundary.)
54. At the north end of the eaamc mesh the canal is outside of the mesh (see **Fig 7.11**). Use the Selection Tool to grab the canal segment and pull it back into the mesh (see **Fig 7.12**)

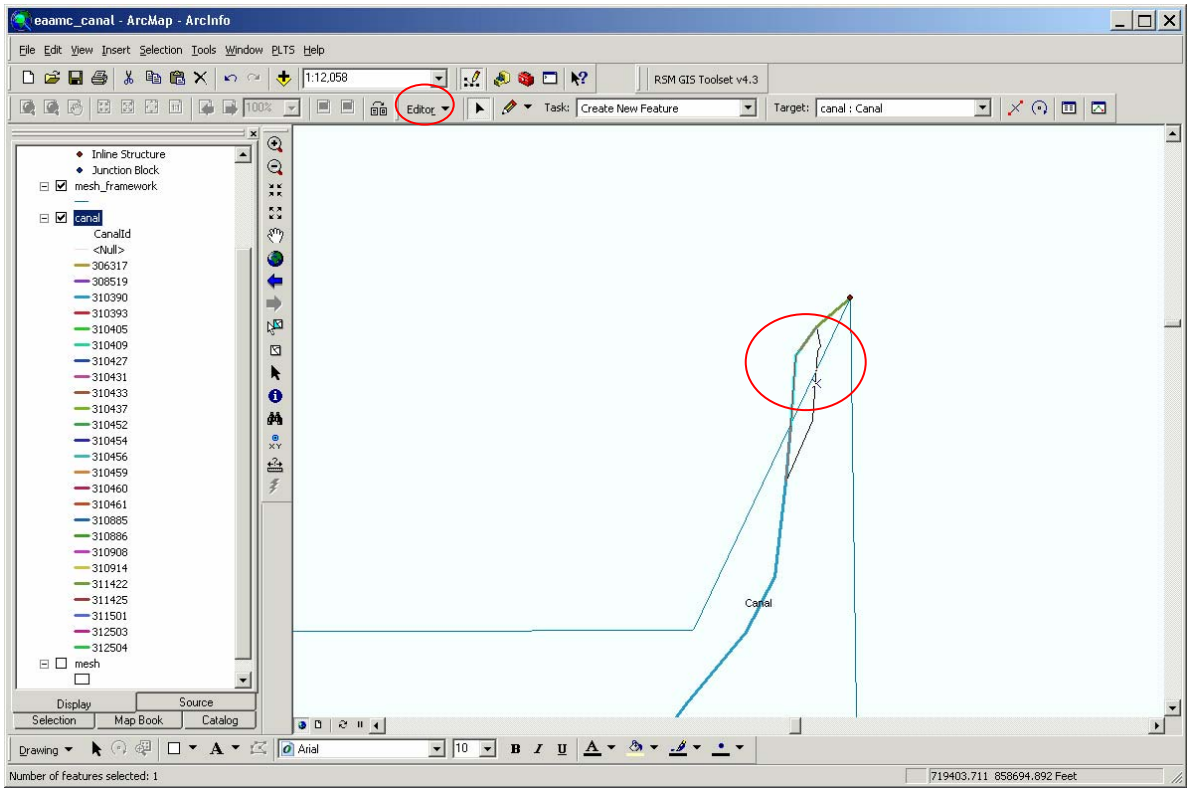


Figure 7.11 Canal is outside the mesh boundary.

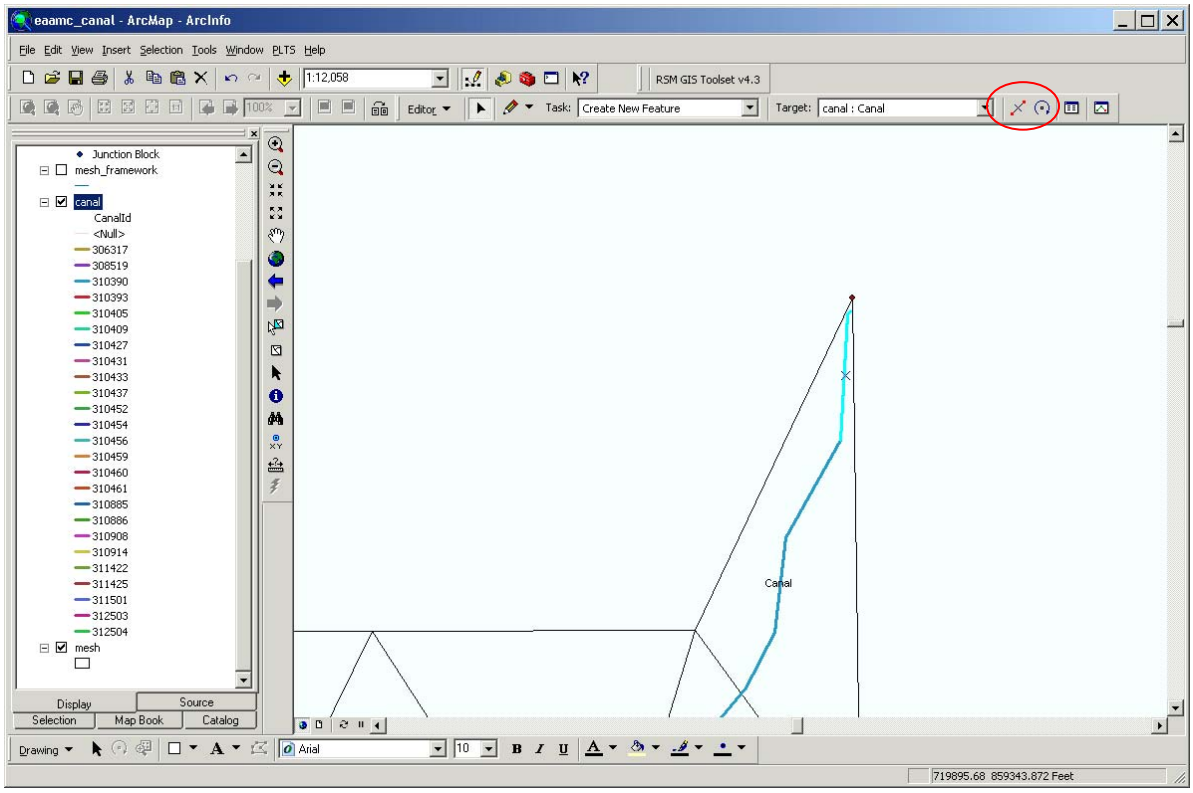


Figure 7.12 Canal segment pulled back in, plus Split Tool button on the Editor Toolbar.

55. Once the features that need to be clipped have been identified, use the Split Tool button on the Editor Toolbar (located to the right of the Target list box; see **Fig 7.12**).

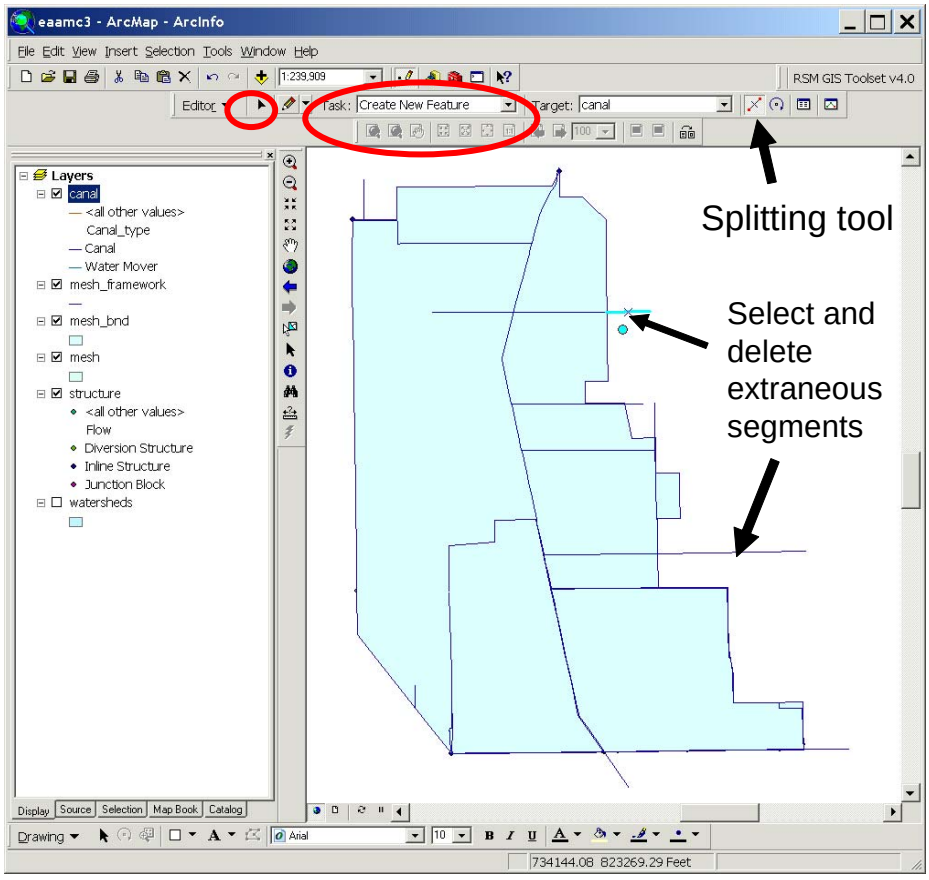


Figure 7.13 A mesh framework with segments extending outside the boundaries.

56. Delete the portion outside of the boundary.

HINT

Although it is tempting to delete any segments you may not want to include in the current model, it is better to keep the segments and simply disable them.

57. In the Editor drop-down menu, click Save Edits to save the modifications to the Canal Feature Class in **`eaamc3.mdb`**
58. If you chose to move the feature back inside the boundary, select Modify Feature from the Task list box in the Editor Toolbar, and use the Arrow tool to select and drag the vertices back inside the boundary (see **Fig. 7.13**).

59. Once all the nodes are inside the boundary, click the editor button and Save Edits.
60. Stop Editing. (This command is also located in the Editor drop-down menu.)
61. Export the map file: RSM GIS Toolbar > HSE Network Menu > Index Tool
62. Save your map and start a new map
63. Select the RSM GIS Toolset v4.3 Tab
64. Select Generate XML > Canal File **`(*.MAP)`**
65. Complete the Create Canal Map File data fields (refer to **Fig. 7.14**)
    - Enter the Canal Feature name and destination (**`eaamc_canal.map`**)
    - For Filter 1, select **`Enabled`** and **`value = True`**
    - For Filter 2, select **`Canal_type`** and **`value = canal`**
    - Click the Ok button

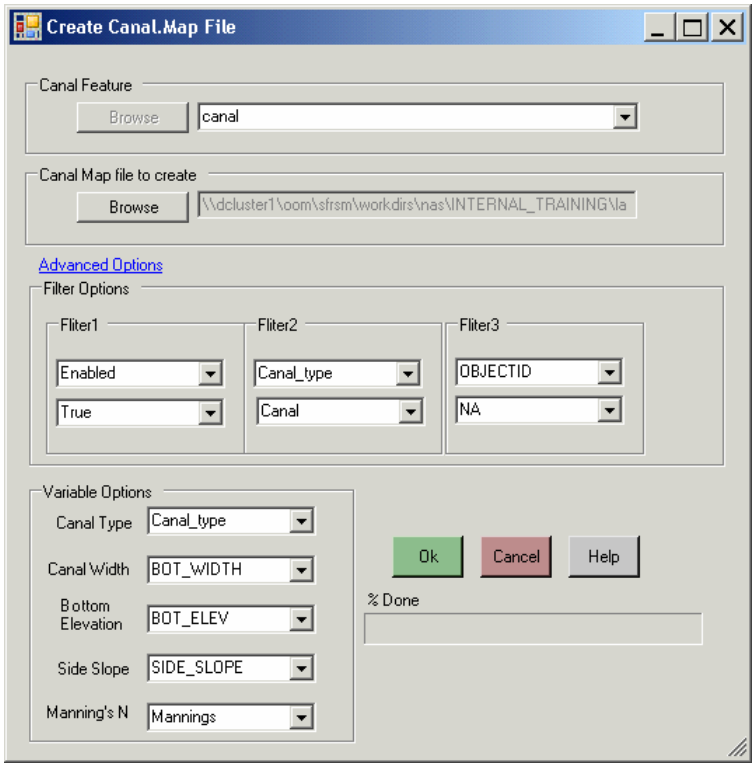


Figure 7.11 Create Canal Map File window

66. List the **`eaamc_canal.map`** file and examine the contents

    - Notice that there are several vertices in each of the segments

67. Examine the canal properties (see **Fig 7.15**). In ArcMap, select a canal segment.

    - The segment properties include the Mannings roughness, canal-aquifer leakage, and canal-overland flow coefficient. Values for these parameters have been tabulated for all canals as part of the subregional RSM implementations. The segment properties are typically listed in the main XML file.

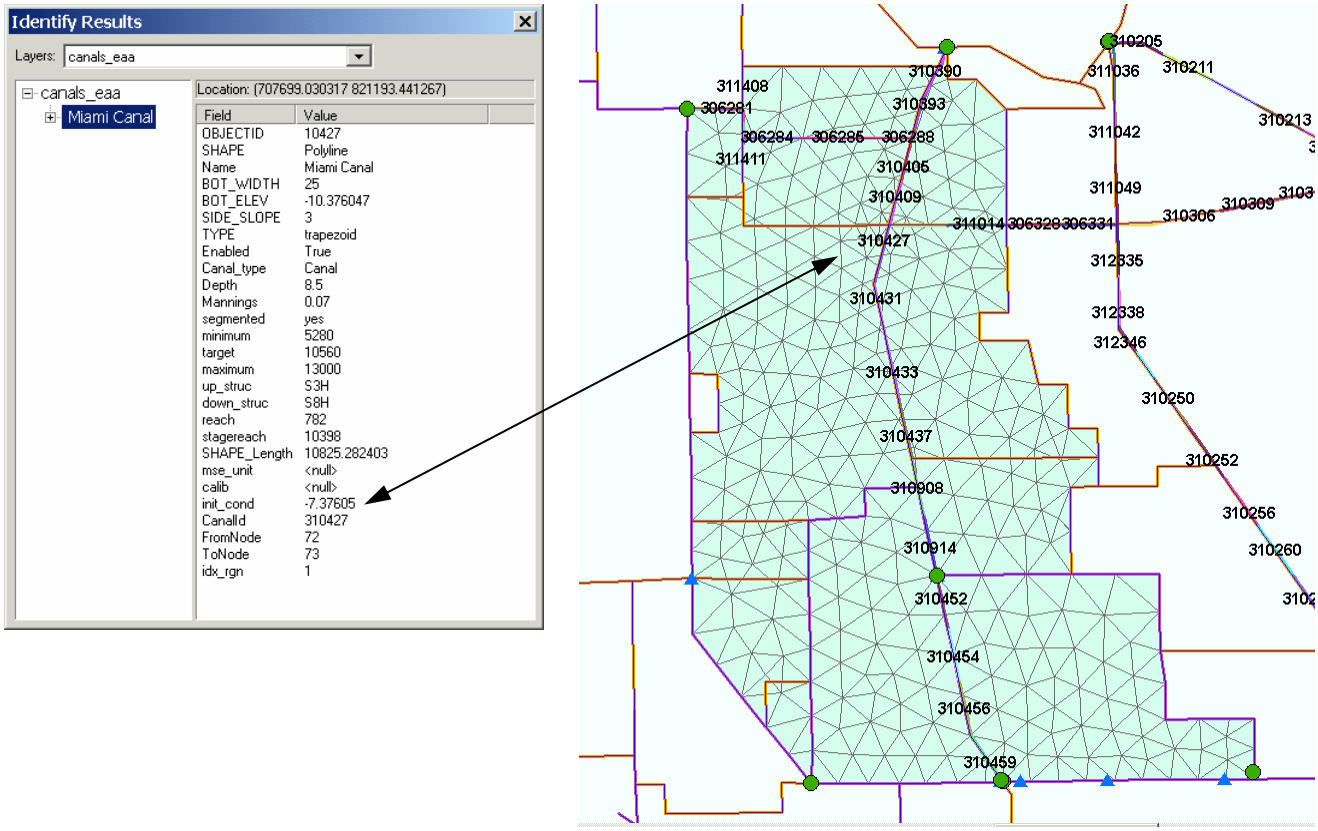
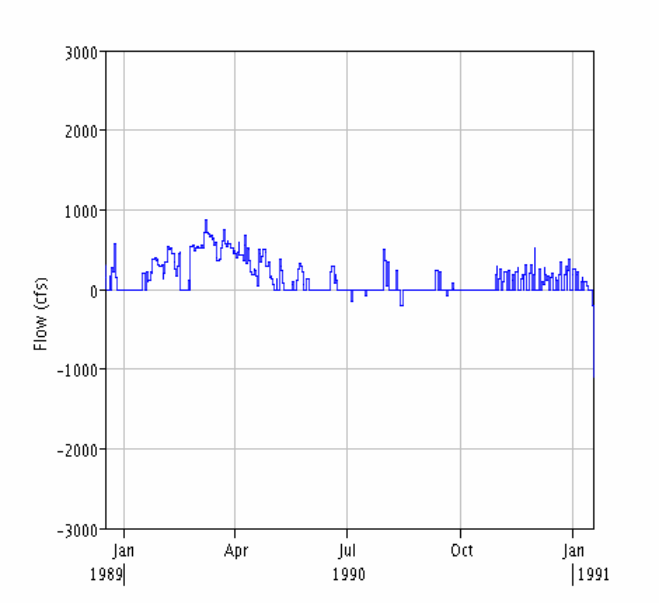


Figure 7.15 Canal properties for a selected canal segment (**`CanalId=310427`**)

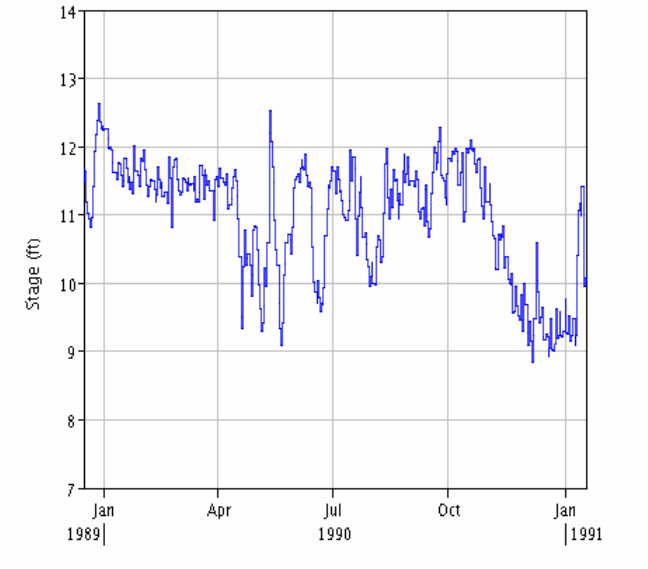
Exercise 7.2.2 Add network boundary conditions

Typically the upstream flow boundary condition (BC) and the downstream head boundary conditions are provided as time series of daily values at each location point (see **Fig 7.16**). Downstream BCs can be converted from constants to time series based on observed historical head and flow data (see example XML in **Fig 7.17**).

68. Open the Everglades Agricultural Area-Miami Canal (EAA-MC) Basin model file (**`eaamc_sp.xml`**) in the **`labs/lab6_GMS`** directory
69. Add a segment source boundary condition to the model for the upstream boundary conditions using the time series available for the S3 structure from the SFWMM dataset: **`$RSM/data/losa_eaa/input/flow_v5.0_09292003.dss`**.



Times series of daily flow at S3



Time series of daily head at S8

Figure 7.16 Examples of daily flow and head at structures S3 and S8, respectively.

70. Add a segment general head boundary condition to the model for the downstream boundary segment using observed data for the S8 structure: **`$RSM/data/losa_eaa/input/eaa_obs_canal_stage.dss`**
    - Set the conductivity to **`0.0001`**.

```
<segmentghb id="300007" bcID="1" kcoef="0.0001" label="S8(GHB)">
      <dss file="./input/eaa_obs_canal_stage.dss"
         pn="/SFRSM/S8H/STAGE//1DAY/OBS/"
         units="FT" type="PER-AVER" mult="1.0">
      </dss>
   </segmentghb>

<segmentsource id="300001" bcID="2" label="S3">
     <dss file="./input/flow_v5.0_09292003.dss"
          pn="/SFWMM/S3/FLOW//1DAY/HISTORICAL/"
          units="cfs" type="PER-AVER" mult="1.0">
     </dss>
</segmentsource>
```

Figure 7.17 Example XML for segment general head boundary and segment source boundary conditions at two structures.

71. Change the "runDescriptor" in the <**`control`**> block to "**`canal`**"
72. Save the model as: **`$RSM/labs/lab6_GMS/eaamc_spc.xml`**
73. Run the model using the RSM GUI and observe the changes in the head values in the cells and segments.

Answers for Lab 7

Exercise 7.1.1

12. # of segments in Reach 617 = *2*
bottom width = *24*
Manning's coefficient = *0.07*
mesh cell_id 2783 topo elevation = *2.8038*

19. First CanalId after header = *309,503*

20. # of segments in Reach 617 = *5*
length of segments in Reach 617 = *3130.64*

Exercise 7.1.2

10. # of inline structures = *5*
Is the new reach still valid? *Yes*

Exercise 7.2.1

Compare results with those in the lab7 directory

Exercise 7.2.2

Compare results with those in the lab7 directory

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