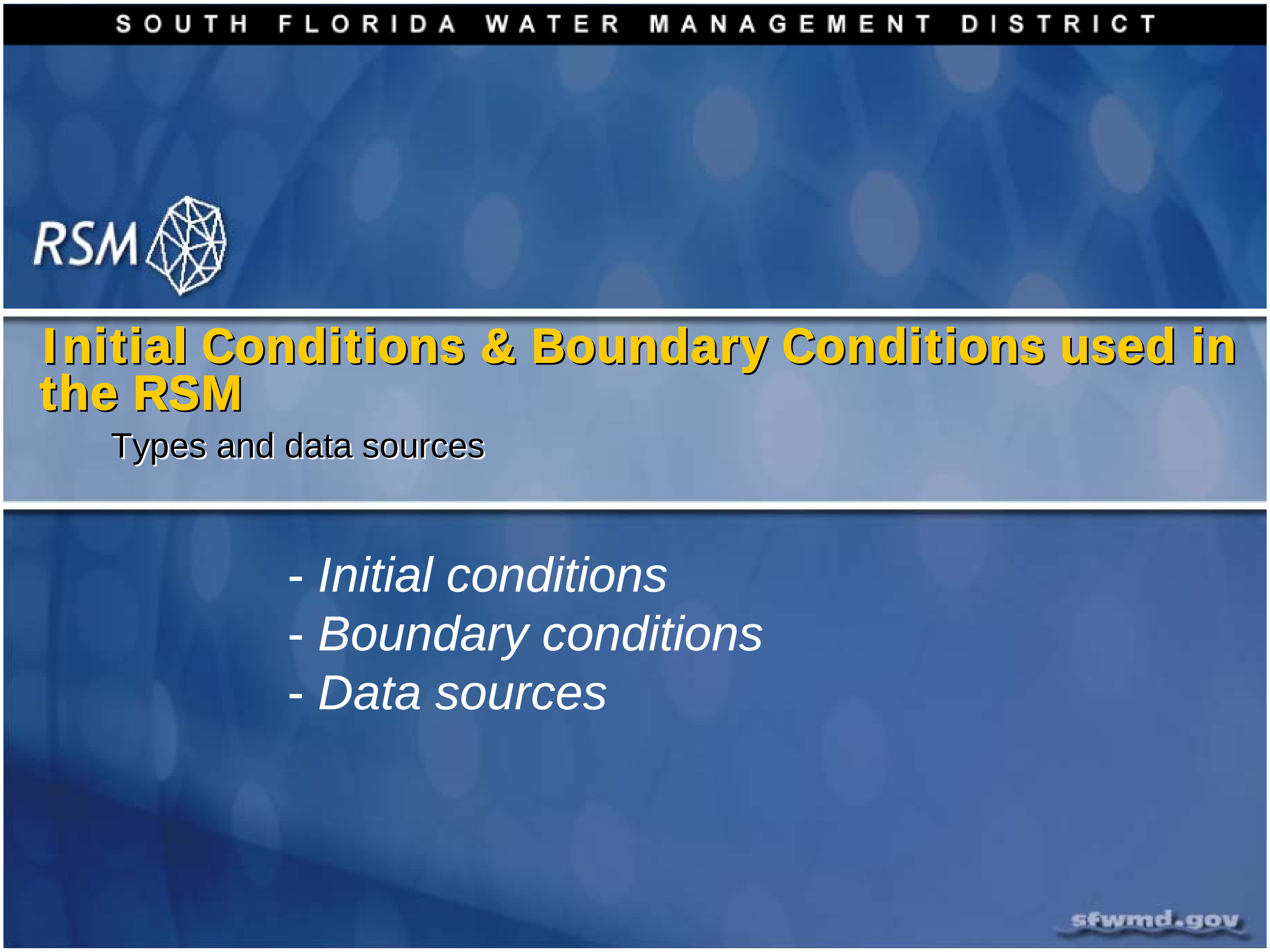
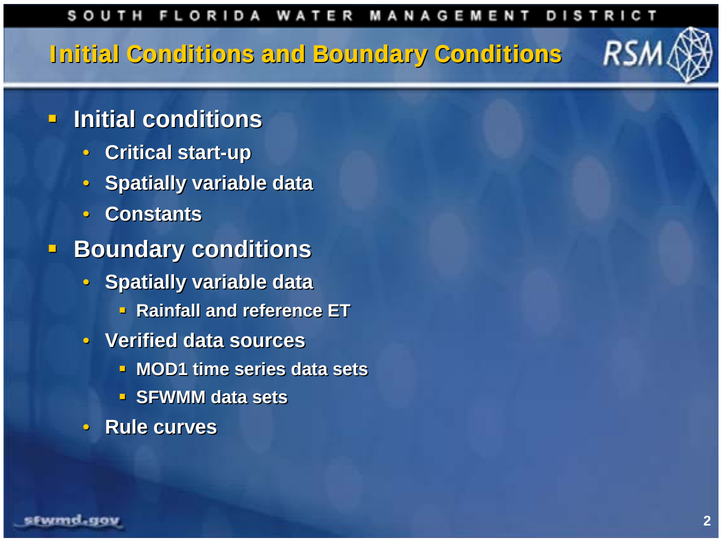


Lecture 9: Initial Conditions & Boundary Conditions used in the RSM—Types and data sources

Model performance is largely a function of the Initial Conditions (ICs) and Boundary Conditions (BCs) applied to the Regional Simulation Model (RSM). The quality and distribution of these data determine the effectiveness of the RSM subregional implementations. This lecture covers types of boundary conditions and available data.



The Initial Conditions for the mesh cells can be set as:

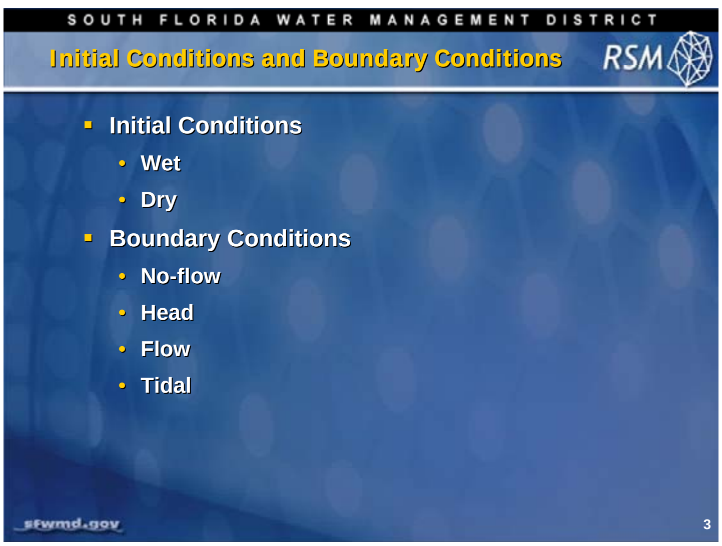
Constant,

- Indexed
- Through a GMS input file

The Initial Conditions for the network and wcdwaterbodies can be set as:

- Constant
- Through an indeed entry file

The indexed method allows for the input of zonal values. Input for other waterbodies is as a single-valued constant.



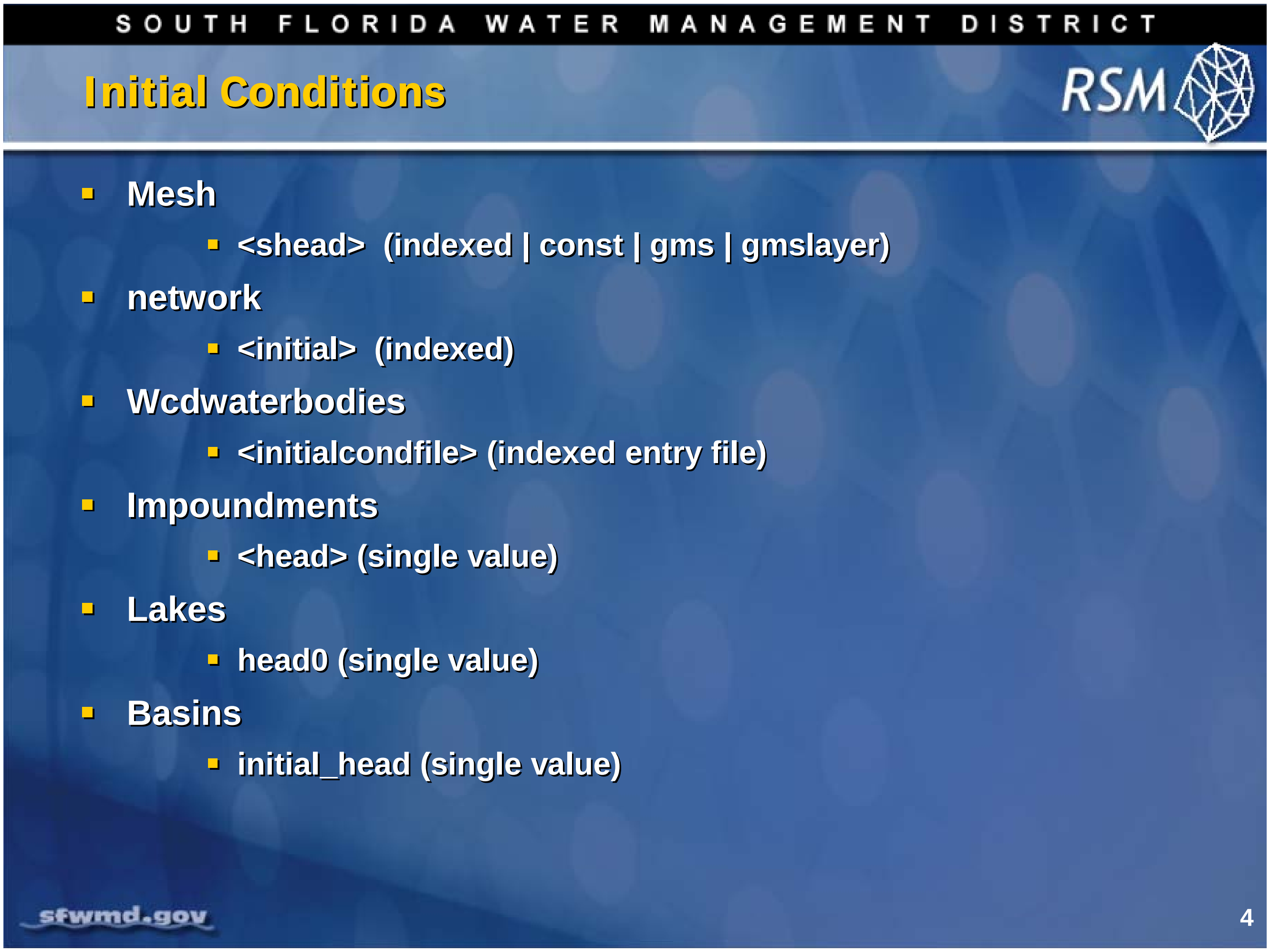
Initial Conditions

The choice of Initial Conditions determines how long it will take the model to come to the correct transient condition. For the regional system it is appropriate to start the system wetter than necessary, as the system drains more efficiently than it supplies water. For the surface hydrology (HPMs) it is necessary to avoid inundation, as the developed areas of the system cannot effectively transpire from a flooded condition.

Boundary Conditions

Typically, a model domain is defined by Boundary Conditions such as watershed boundaries that are no-flow conditions or the coastal tidal boundary that has a known head time series. The subregional RSM implementations rely on a time series of observed historical stage data and simulated stage and flow data from the South Florida Water Management Model (SFWMM). The boundary conditions for impoundments, lakes and WCDs include rule curves that set the seasonal head.

There are three general types of available boundary conditions for waterbodies and watermovers: specified head (Dirichelt), general head (mixed) and flow (Neumann) conditions. Specified head or general head boundary conditions are used for the downstream boundary conditions for mesh cells and segments. Upstream boundary conditions are typically flow conditions.

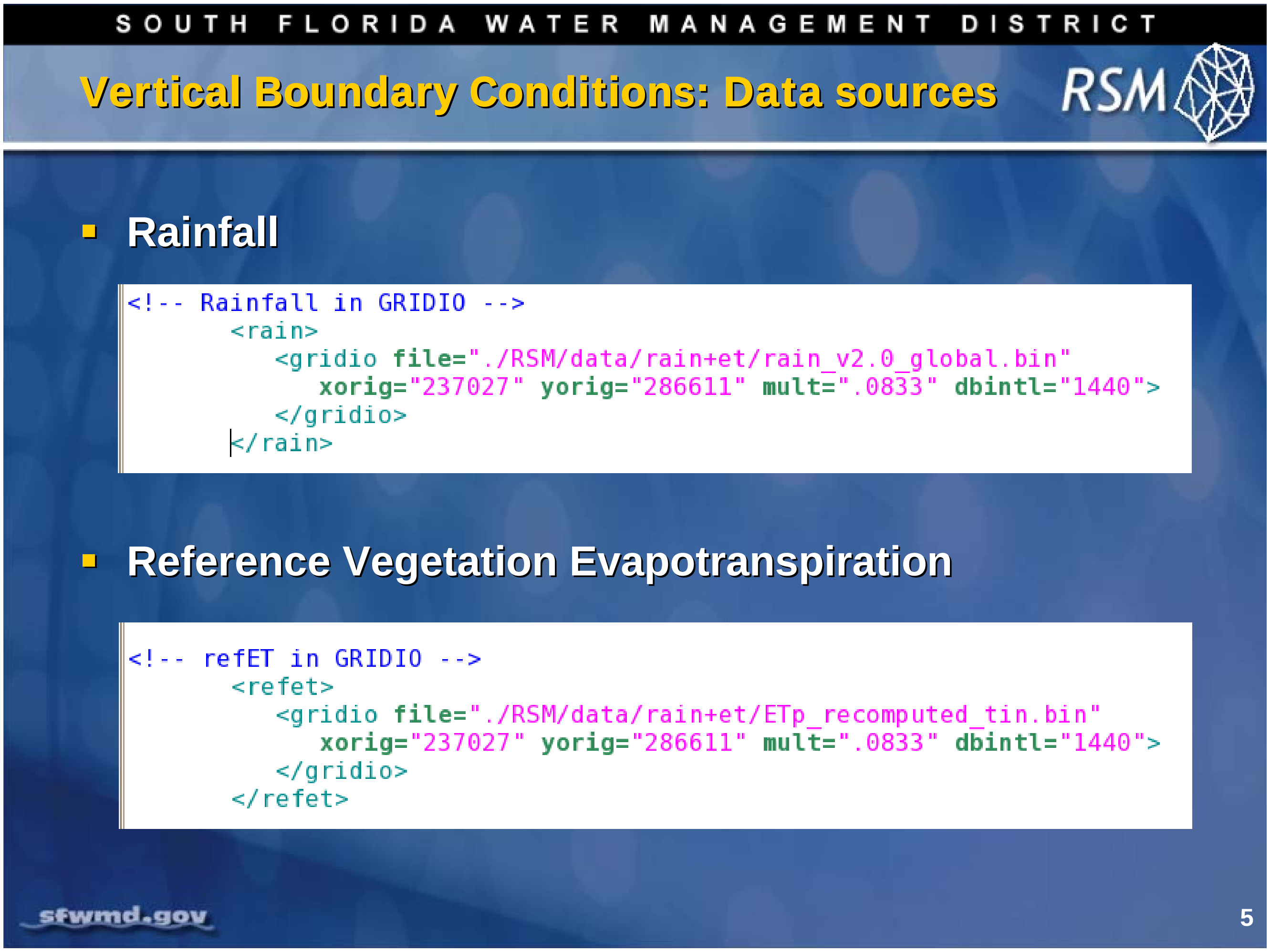


The allowable input for the Initial Conditions depends on the waterbody type.

For impoundments, lakes and basins, the initial head is entered as a single value for each instance.

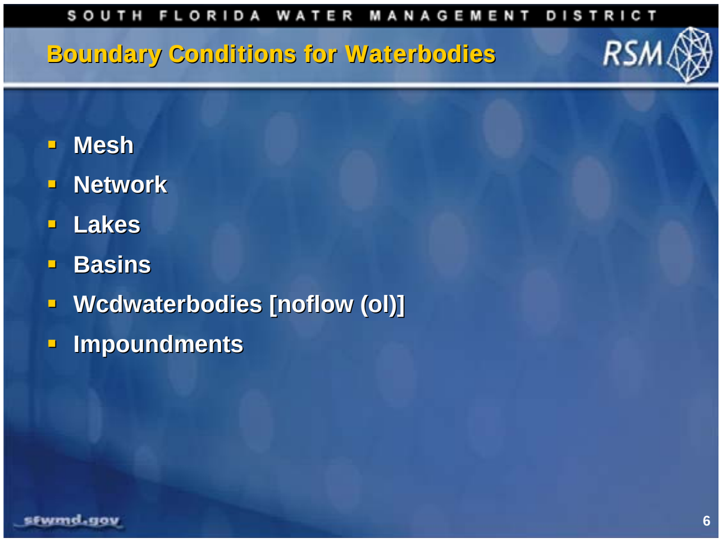
For wcdwaterbodies and the network segments, the initial head is entered for all instances as an indexed-entry file.

These values allow for spatial variability in the input. The initial heads for the mesh cells can be entered as indexed-entries or as a standard Groundwater Modeling System (GMS)-generated file.

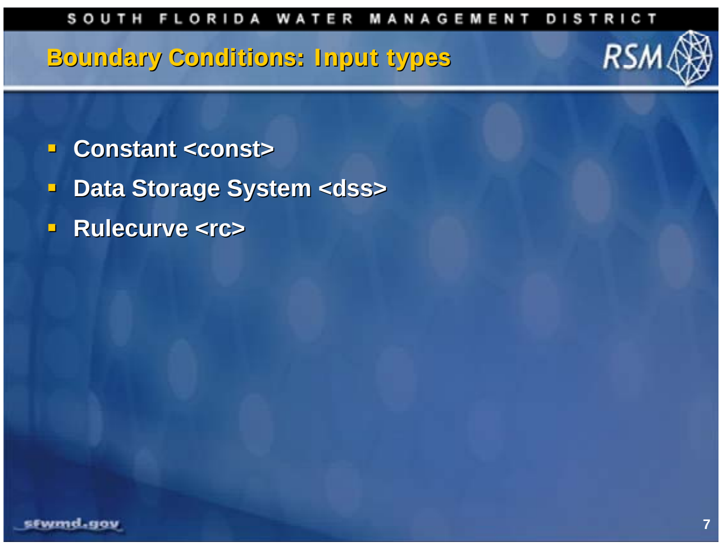


Vertical Boundary Conditions for the model are defined by a rainfall and a reference vegetation evapotranspiration record. Both of the data sets were developed from many field measurement stations.

The time series data at each station were used to create an interpolated record of values for each cell in the mesh. The Interpolation method requires a starting point for the grid which is defined using the state-plane coordinates in the southwest corner of the grid. This method requires a specification of the timestep (minutes) and the depth (feet).



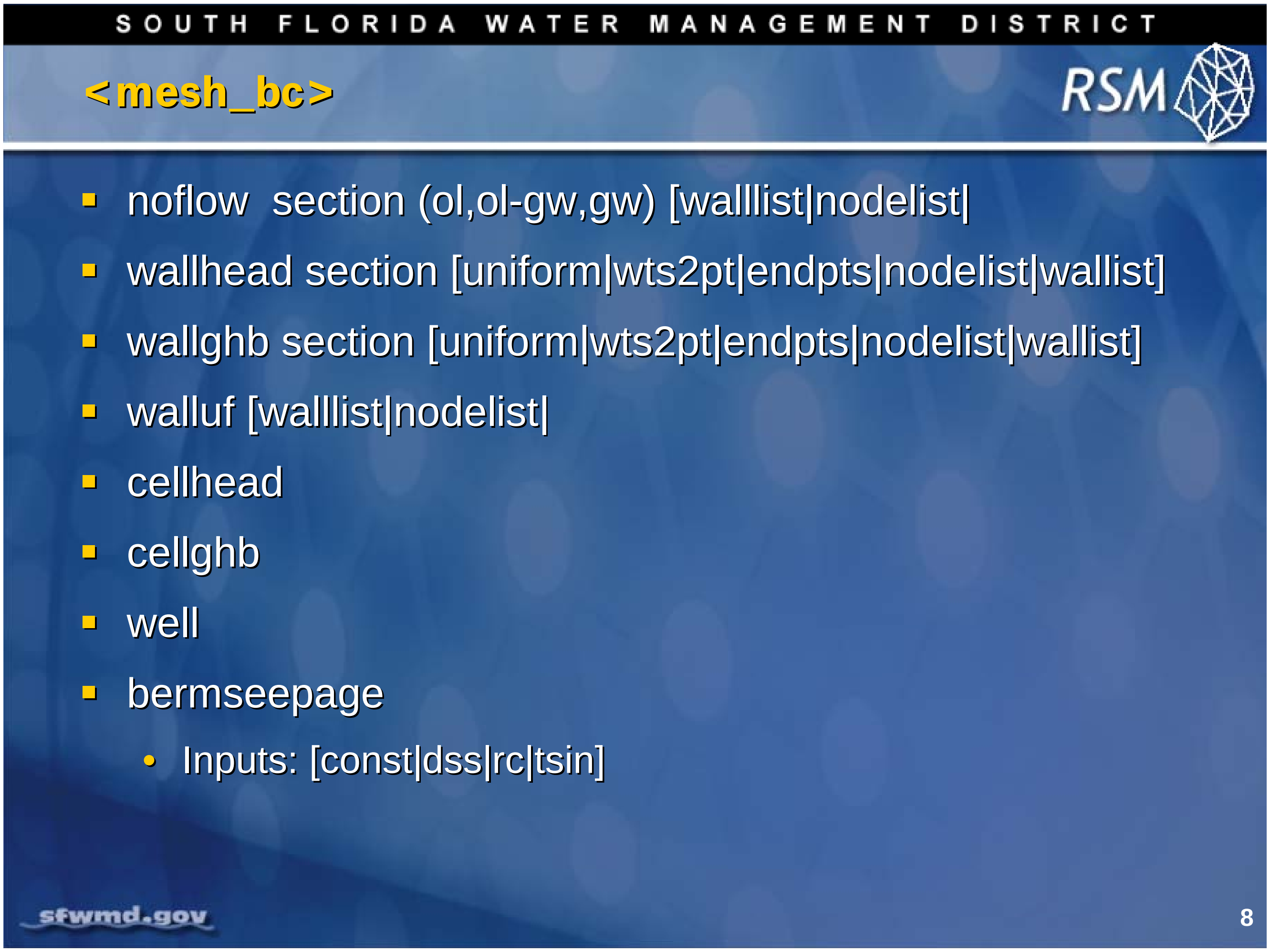
It is necessary to establish boundary conditions for each of the waterbodies instantiated in the RSM. The default boundary condition is noflow across the boundary of the model domain.



There is a common set of choices for data input options for each of the boundary condition types. These include constant values, rule curves and time series entered as the DSS files.

Rule curves are repeating annual cycles that are useful when the waterbody has a preferred annual stage pattern (e.g., a stage regulation schedule).

The DSS file is used for long-term daily time series.



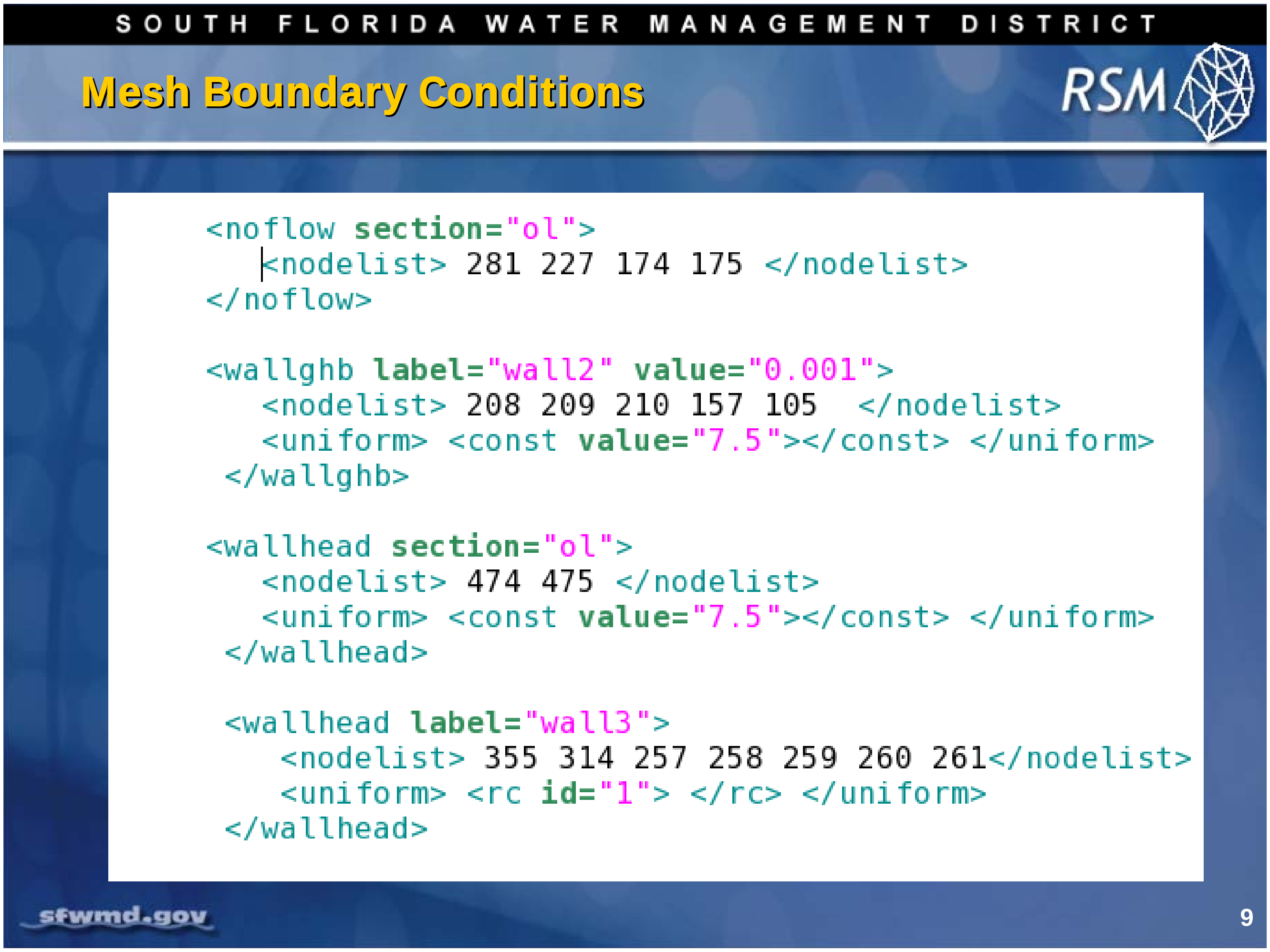
There are several possible boundary conditions for a mesh. The noflow boundary condition is used for catchment boundaries and along levees.

There are 3 boundaries available for walls:

- Fixed head
- General head
- Uniform flow

In each case, the wall is specified by a list of nodes or a list of walls. It is also possible to assign boundary conditions to the cell instead of a wall.

The well boundary condition is useful for applying a flow to the cell or extracting water from a cell. The <bermseepage> is an internal boundary condition that is used to move water across a berm.



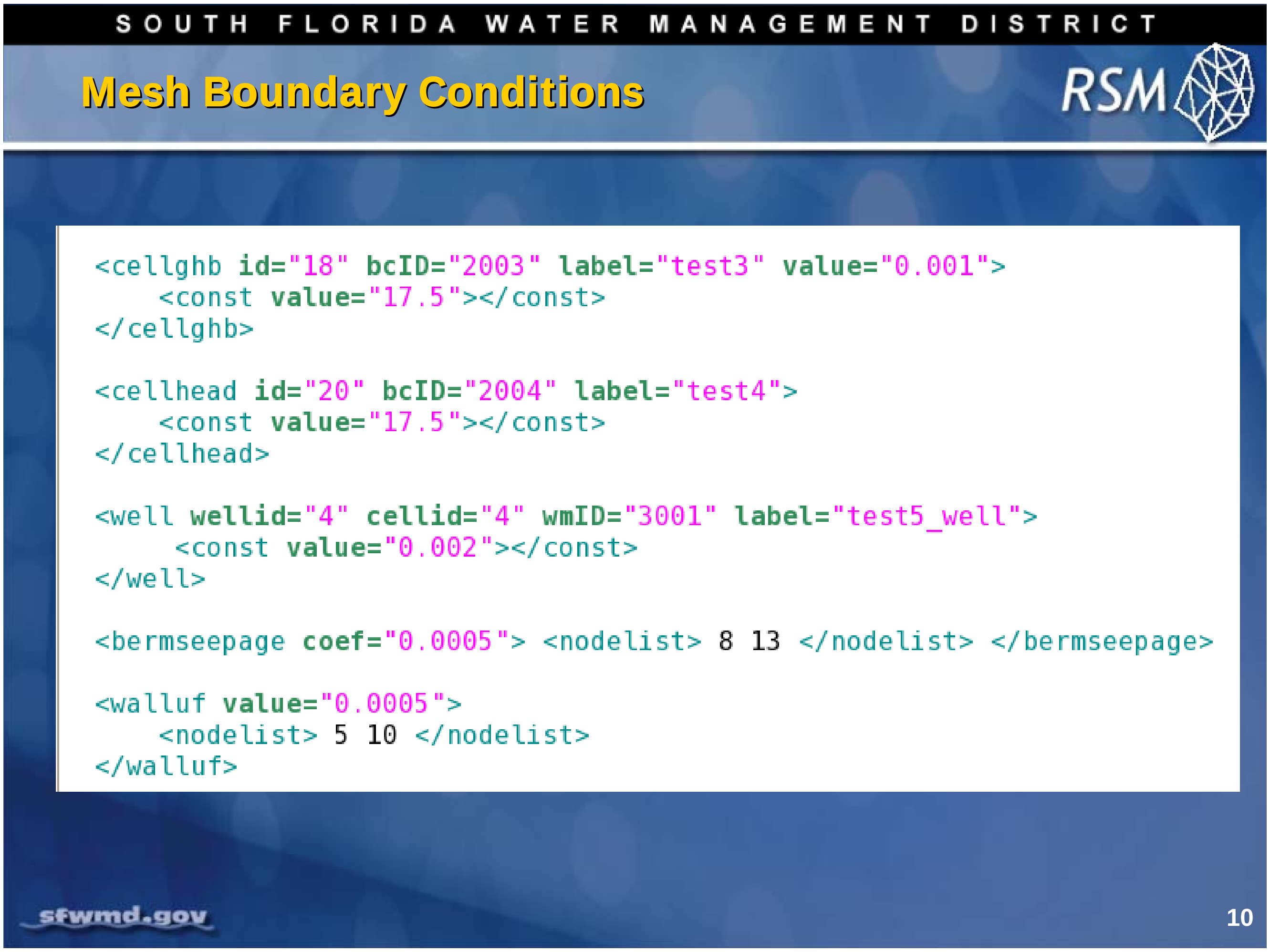
This slide shows the syntax for implementing the Mesh Boundary Conditions. The noflow can be applied to:

- Overland flow “ol”
- Groundwater flow “gw”
- Both “ol_gw”

Note: “ol-gw” is a syntax error and does nothing.

The wall general head boundary applies a fixed external head on a wall conductivity, which must be less than 1.0. The <wallhead> element is a preferred boundary condition which is more stable than the <wallghb> element.

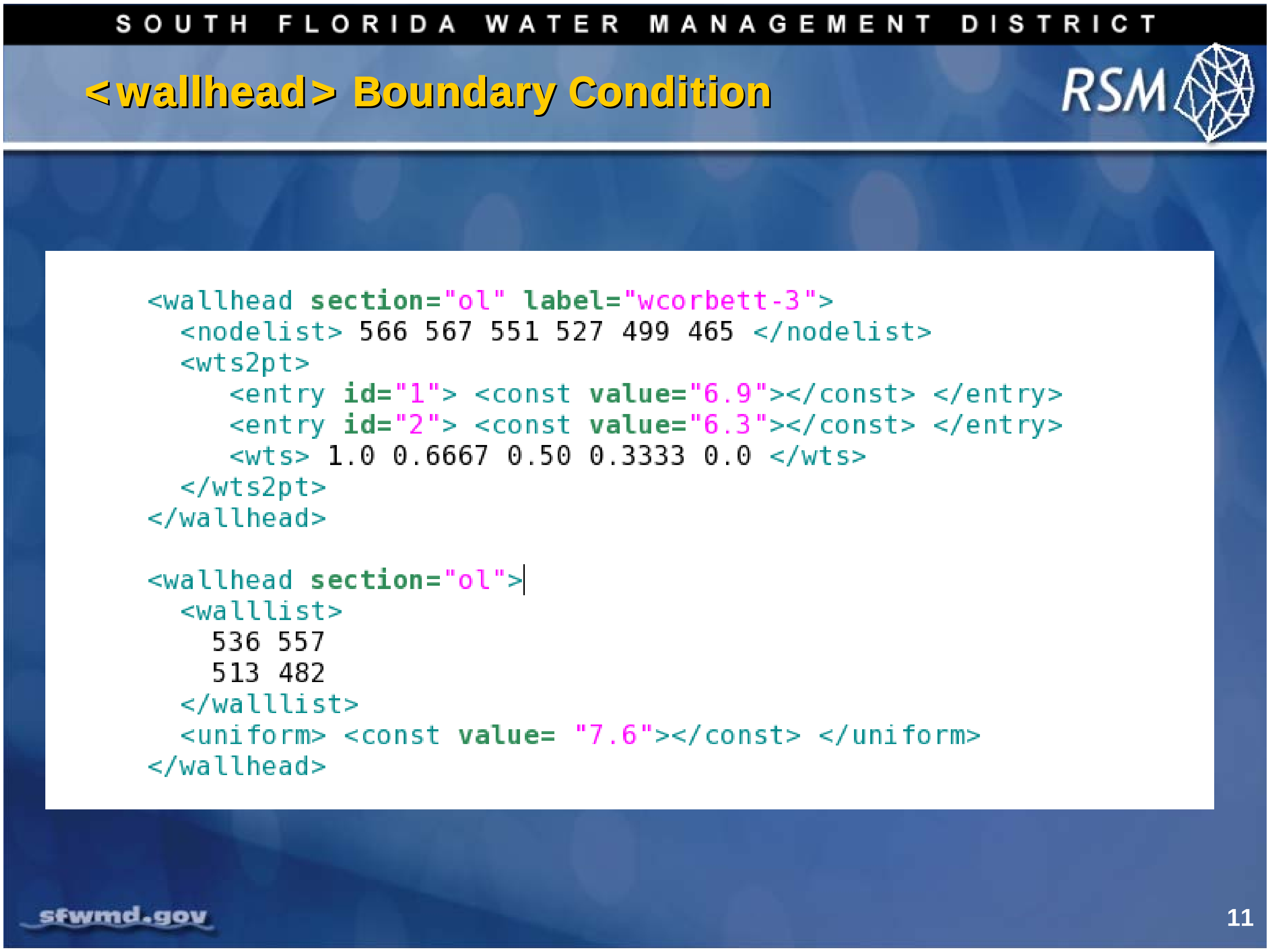
Each of these boundary conditions can be assigned a label which is used for tracking the flows in the output water budget. The application of a rulecurve as a head condition, which may represent a regulatory stage schedule or an annual cycle, is a typical example.



The syntax of the Cell Boundary Conditions is similar to the Wall Boundary Conditions, except they apply to the head of the cell. Although Cell Boundary Conditions are more stable than Wall Boundary Conditions, and produce faster run times, they fix the head in the cell which may be a problem with large cells. As such, it is desirable to create a row of cells outside the Catchment boundary on which to apply the Cell Boundary Conditions.

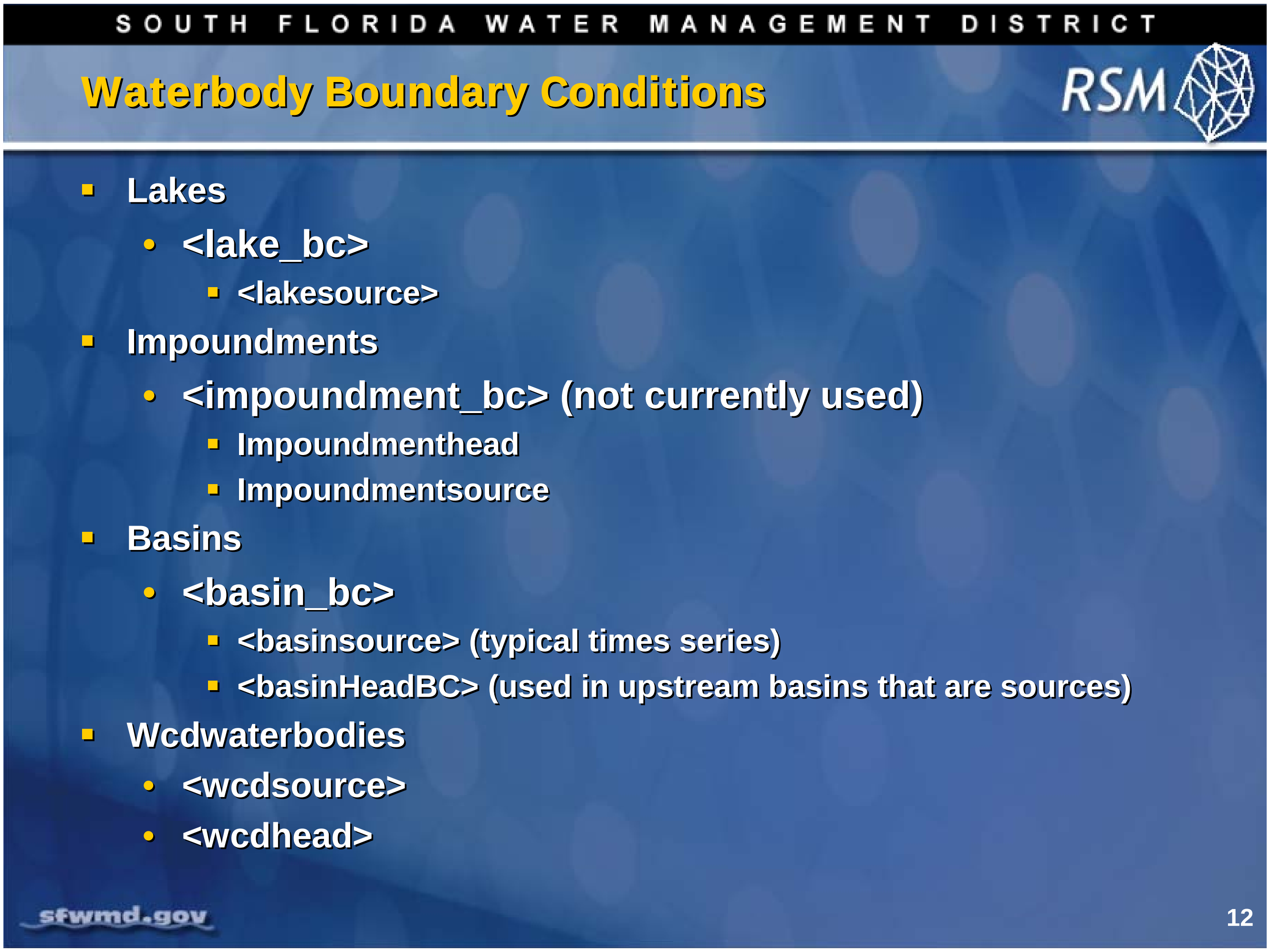
The Well Boundary Condition has a watermover ID label so that the flows can be readily tracked.

The Wall Uniform Flow Boundary Condition is used to apply a small flow across a basin boundary.



The wall head can be applied in a linear gradient (example 1) for groups of cells or where the weights for the heads are supplied for each wall section (example 2).

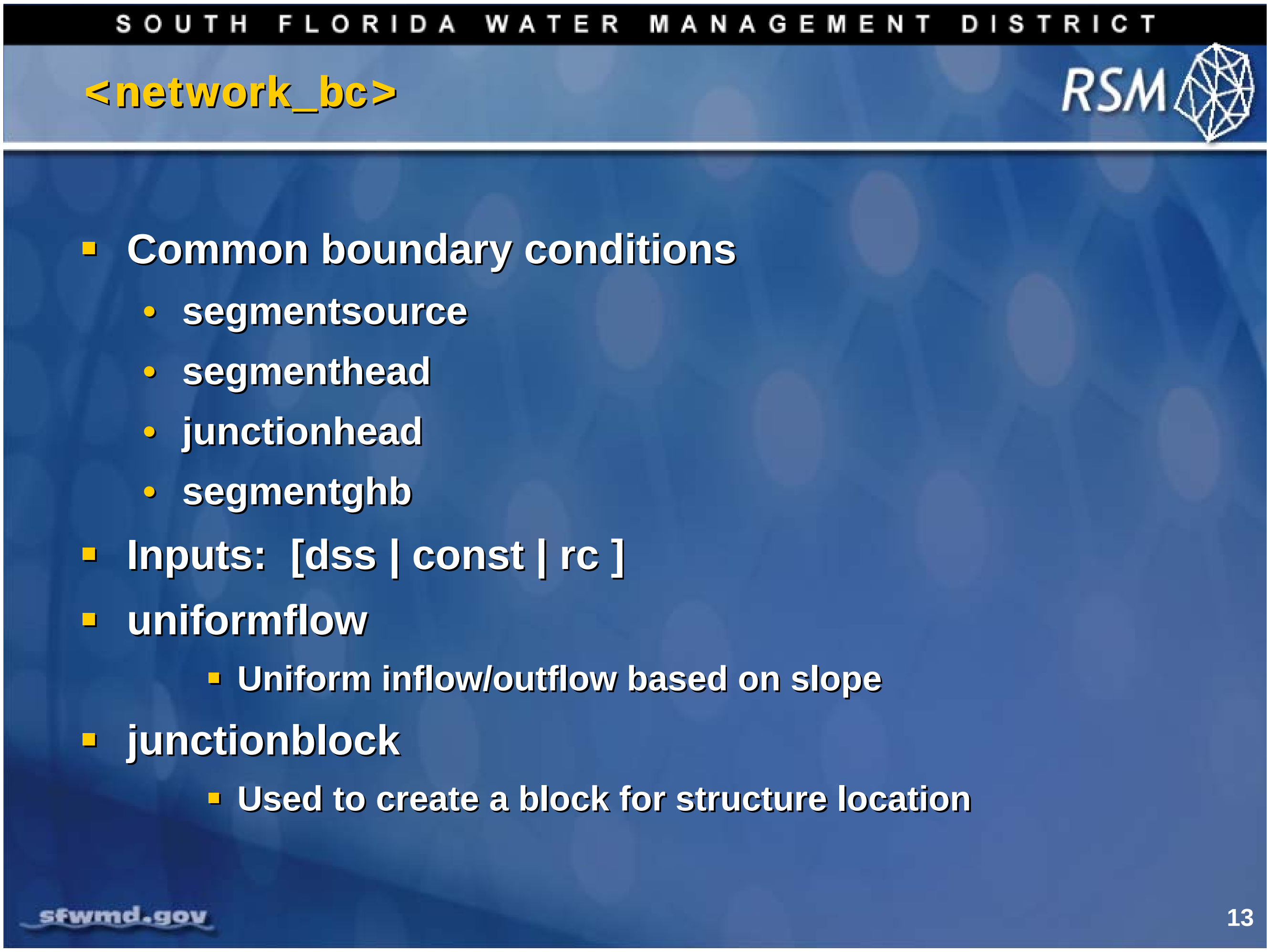
For the <wts2pt> option, the end values are provided as constants or time series, and the weights <wts> provide the gradient of the head from the first wall to the last wall. In this case, the first wall from nodes 566 to 567 is set at 6.9 while the second wall (nodes 567 551) is set to an interpolated value (.6667 * (6.9-6.3)+6.3) and the last wall has a value of 6.3. This can be used to provide a linear or exponential decrease in the head along a boundary.



The boundary conditions for the lakes, impoundments and basins waterbodies follow the same pattern as used for <mesh_bc> and <network_bc> elements using the standard time series, rulecurves or constant-value inputs.

Although Impoundment Boundary Conditions are available, they are currently not implemented.

Similarly, there are source and head boundary condition functions defined for the wcdwaterbodies, but these waterbodies seldom have inflows or outflows that are not implemented by the seepage and user-defined watermovers.



There are several boundary conditions for network segments that are similar to the mesh boundary conditions. These include the:

- <segmenthead> element which sets the head for the segment
- <junctionhead> element which sets the head at a junction between two segments
- <segmentghb> element which sets the head and conductivity of the segment boundary
- <segmentsource> element which is used to set the flow into a boundary

Each of these boundary conditions can have a constant input, time series or rule curve input.

The <uniformflow> element is used to apply flow between two segments based on slope.

The junction block breaks the continuity between two segments to allow flow to be determined by a user-specified watermover (structure).

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Network Boundary Conditions

RSM

```
<segmenthead id="30001" label="seg_head"> <const value="16.3"></const>
</segmenthead>

<junctionblock label="jncblk"    id1="30001" id2="30002"/>

<junctionhead id="30002" bcID="2001" label="jnc_head" > |
       <const value="16.5"></const>
</junctionhead>

<uniformflow id1="303" id2="304" bcID="2002" label="seg_uf" slope="0.001">
</uniformflow>

<segmentsource label="G123" id="308669">
        <dss file="./input/dss_files/sfwmm_cv_v54_flow.dss"
                   pn="/SFWMM/G123/FLOW//1DAY/CV_54/"/>
</segmentsource>

<segmentghb id="30005" bcID="2000" kcoef="0.0005" label="seg_gbh">
           <const value="16.3"></const>
</segmentghb>
```

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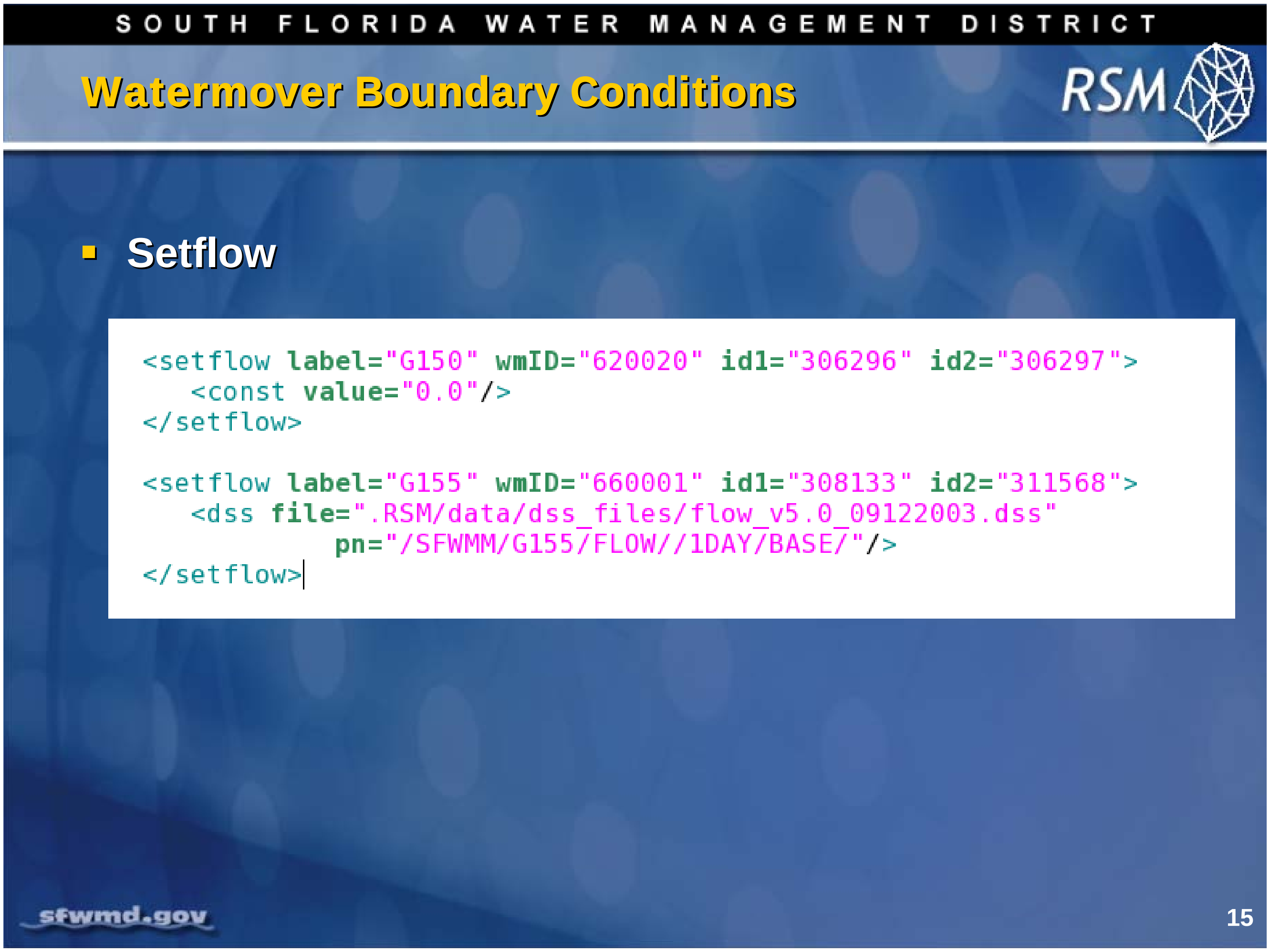
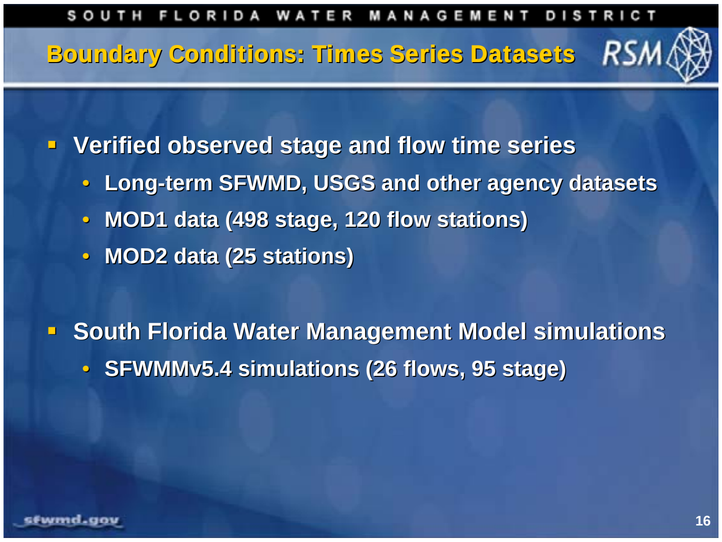
The syntax for the Segment boundary conditions is similar to the specification of the boundary conditions for the walls and the cells.

- The typical <segmenthead> will be a constant value or a time series such as a tidal head at the coast.
- The <segmentsource> will typically be a historical flow record or simulated flow from the SFWMM.
- The <segmentsource> can be used as an internal boundary condition during calibration.



The <setflow> watermover behaves like an internal boundary condition. It moves water from one waterbody to another waterbody based on constant flow or a time series. It is typically used when it is desirable to fix the flow at a structure for the values of the historically observed flow or calculated flow from the SFWMM. It can also be used to set the flow at a structure to zero.

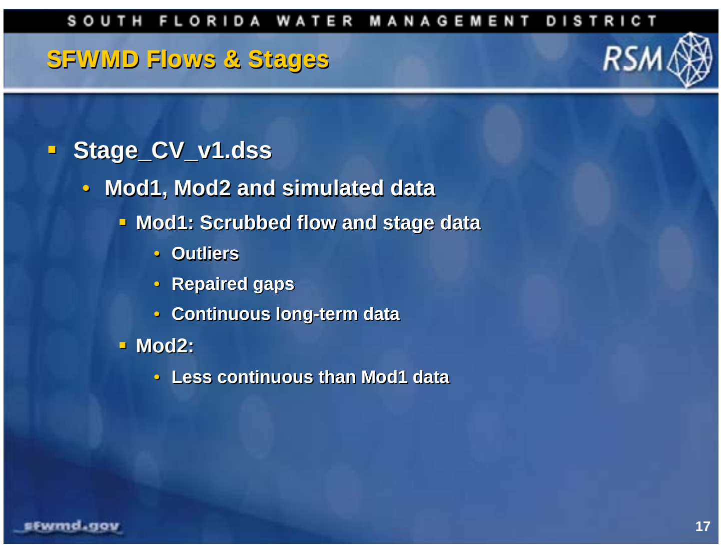


A primary use of RSM implementations is to simulate the hydrology of south Florida for evaluating the long-term regional impact of alternative formulations of water resource management strategies. These simulations are conducted using the historical (1965–2005) datasets for boundary conditions:

- Rainfall
- RefET,
- Stage
- Flows

This type of modeling also requires long-term historical observations against which to compare model simulations.

There are three different time series datasets available for creating boundary conditions. There are many sites in south Florida at which stage and flow data have been collected for many years. These data have been used to create two groups of hydrologic time series data; 'MOD1' and 'MOD2'. The final dataset includes the simulation results from the SFWMM that are frequently used for boundary conditions.

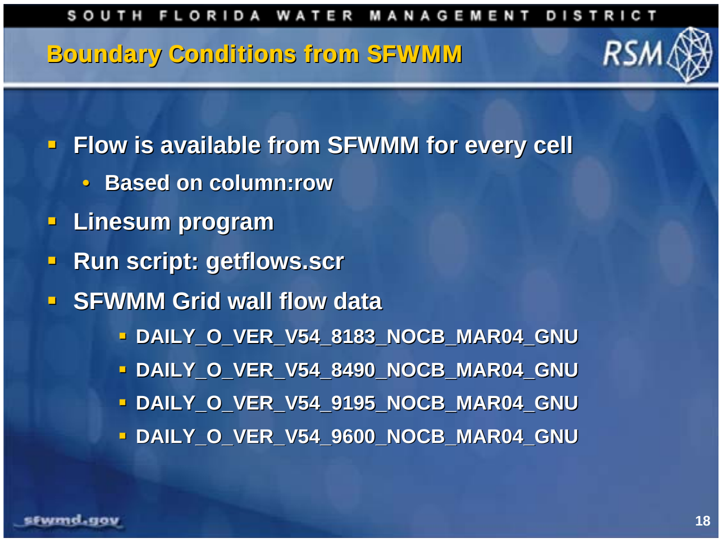


The field data were processed to produce two groups of time series.

The field data are often incomplete and have erroneous data (from faulty benchmarks or recorders).

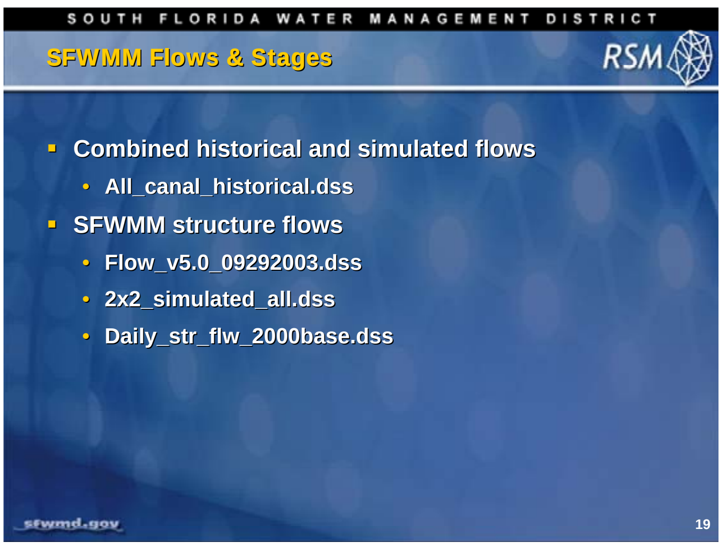
The South Florida Water Management District (SFWMD) conducted an intensive review of the raw data and modified the daily time series using rigorous methods and has stored these data as 'MOD1' data in the SFWMD DBHydro hydrologic database. These data have no gaps in the time series. And, outliers, as well as erroneous data, have been corrected.

A second, less accurate, group of time series data (MOD2) are available for locations where little data are available.



The results from the SFWMM v5.4 are available for providing daily flows for each wall of the 2x2 grid.

These data can be extracted using the “linesum” program developed at the SFWMD. (Access the data using the “getflows.scr” script from the archival data sets.) These are the flows across the 2-mile cell wall and typically need to be processed for the smaller RSM mesh cell walls.



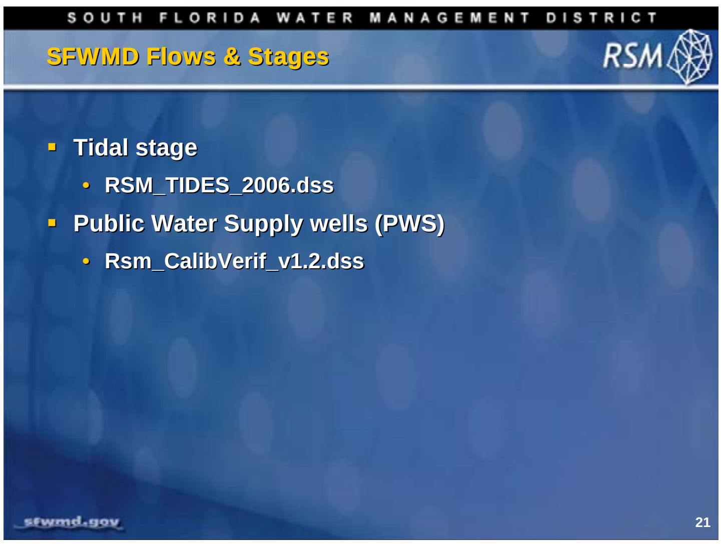
There are standard data sets, stored in DSS format, used for defining boundary conditions.

The data sets include:

- All of the historically measured flows
- Flows simulated for structures in the SFWMM
- Stage data for canals and cells used in standard RSM implementations

In addition to the SFWMD standard datasets, there are data available for water control districts, counties and project-specific data.

Time series data may be more limited in duration or accuracy, but are still the best available data for local conditions. These data have not been scrutinized to the level of the MOD1 datasets.



The SFWMD has collected and processed the tide data from several coastal stations and created a daily time series and a six-hour time series stage dataset for the coastal head boundary conditions.

The Public Water Supply wells, along with Industry and Institutional wells are a major stress on the aquifer in south Florida.

A time series of daily flow rates has been constructed from the available records for each permitted well for use in the RSM subregional models. Because these are individual wells, there may be several wells in any RSM mesh cell. The flow data for the wells may be daily or monthly average flows.

KNOWLEDGE ASSESSMENT

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

1. What are the four standard types of input for initial conditions for cells?
2. Is it best to start the RSM simulation with wet initial conditions or dry initial conditions?
3. What are the common types of input data for boundary conditions?
4. What are the preferred datasets for ET and Rainfall?
5. How are no-flow BCs utilized in the RSM?
6. What are the different types of mesh BCs?
7. What are the differences between the implementation of internal and external BCs?
8. What are the commonly used data for BCs for south Florida?
9. What are MOD1 datasets?
10. What are the two general types of boundary conditions for lakes, impoundments and basins?

Answers

1. The four standard types of input methods for mesh cell initial conditions are the following: Indexed, constant, gms, gmslayer

2. It is preferred to start with initially wet conditions because the modeled system drains more effectively than it satisfies water supply requirements.

3. Boundary condition values can be entered as one of the following forms: rule curves, gridio[*], constants and time series.

4. The preferred rainfall and refET datasets are *rain_v2.0_global.bin* and *ETp_recomputed_tin.bin* gridio binary data files.

5. No-flow boundary conditions are typically used for levees and WCD boundaries.

6. The boundary conditions for the mesh cells include the following: noflow, cellhead, cellghb, wallhead, wallghb and wells.

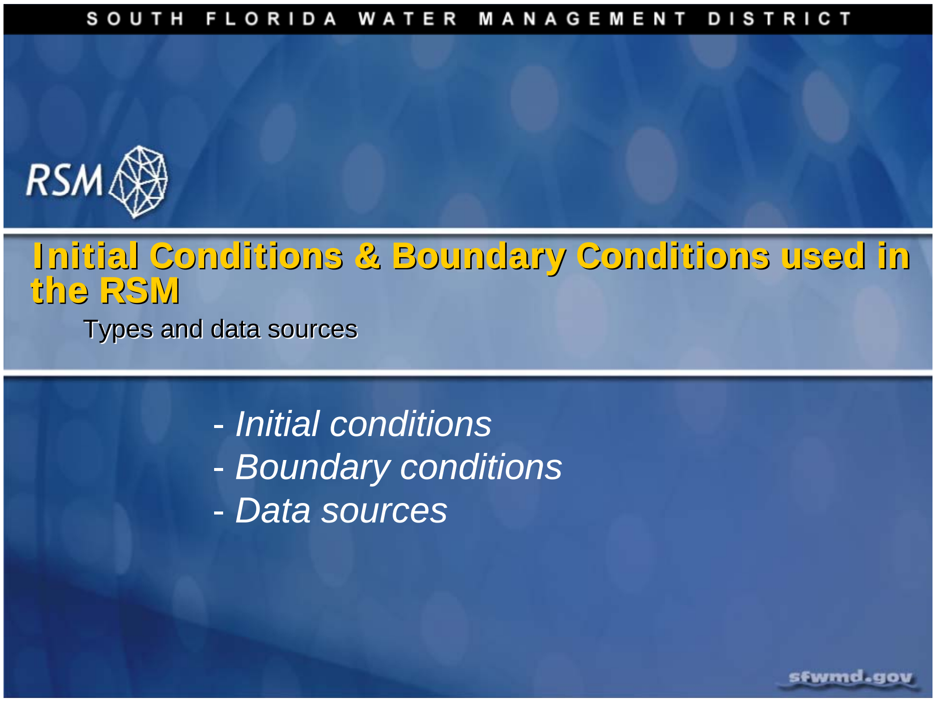
7. External boundary conditions are typically used for boundaries for subregional models, tidal boundaries and canal inflows. Internal BCs are typically used for wells and imposed flow at selected structures that are too difficult to simulate.

8. The common datasets used for boundary conditions are the output from the SFWMM, the MOD1 data from dbhydro and selected special local data.

9. The MOD1 data are time series data that have been scrubbed to remove bad data points and enhanced by filling missing data to provide the RSM modelers with preferred, high quality continuous datasets.

10. The two general types of boundary conditions are source BCs for upstream conditions and head BCs for downstream conditions

[*] gridio is a file format developed by SFWMD to handle large binary datasets. See grid_IO.pdf document in the training labs directory.



Lab 9: Initial Conditions & Boundary Conditions used in the RSM

Time Estimate: 2 hours

Training Objective: **Identify the Initial Conditions and Boundary Conditions used in the Regional Simulation Model (RSM)**

Lab 9 is designed to identify the Initial Conditions (ICs) and Boundary Conditions (BCs) used in the Regional Simulation Model (RSM). You will explore the basic functionality and the typical implementation of boundary conditions.

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/lab9_ICBC directory`**. Additional materials in the directory include:

`RAIN_V20_2-01-06_RSM.pdf`

Activity 9.1: Investigate Initial Conditions and Boundary Conditions

Overview

Activity 9.1 This activity includes four exercises:

- Exercise 9.1.1 Look at initial conditions in Glades-LECSA RSM and C111 RSM
- Exercise 9.1.2 Look at boundary conditions in C111 RSM
- Exercise 9.1.3 Extract flow data from the SFWMM output for use as boundary conditions
- Exercise 9.1.4 Look at boundary conditions in Glades-LECSA RSM

This activity investigates the initial conditions and types of boundary conditions used in the RSM and the data sources available for subregional implementations in south Florida.

Exercise 9.1.1 Look at initial conditions in Glades-LECSA RSM and C111 RSM

Find the distributed values for the different waterbodies used in the RSM.

Find the initial conditions for mesh cells using the Glades-LECSA Model.

1. Open the main file

   `$RSM/../data/glades_lecsa/run_calib_84-95.xml`

2. Find <shead> element and identify the mesh IC input dataset:

   - What is the apparent source of the initial conditions?

Find the segment initial conditions for the Glades-LECSA Model.

3. Open the main file:

   `$RSM/../data/glades_lecsa/run_calib_84-95.xml`

4. Find the <network> <initial> sub-element.

   - What is the data file for initial segment heads?

Find the lakes initial conditions for the C111 Model.

5. Open the main run file: **`$RSM/../data/C111/run_c111_mse_SR5_sss.xml`**

6. Find the <Lakes> element.

   - What is the initial head of the dummy lake?

Find the impoundment initial conditions for the C111 Model.

7. Open the main run file:

   `$RSM/../data/C111/run_c111_mse_SR5_sss.xml`

   - How many impoundments are there?
   - What are their initial heads?

Find the WCDwaterbody initial conditions for the Glades-LECSA Model.

8. Open the main run file:

   `$RSM/../data/glades_lecsa/run_calib_84-95.xml`

Find the <wcdwaterbodies> element and identify the file containing the initial conditions.

- What is the file?
- How many wcdwaterbodies are there?

The initial conditions can also be set as a function of another distributed dataset. Distributed values for mesh can be developed using topography data.

9. Open the main run file for the C111 Model:

   `$RSM/../data/C111/run_c111_mse_SR5_sss.xml`

10. Find <shead> element.

    - How are the initial heads set?

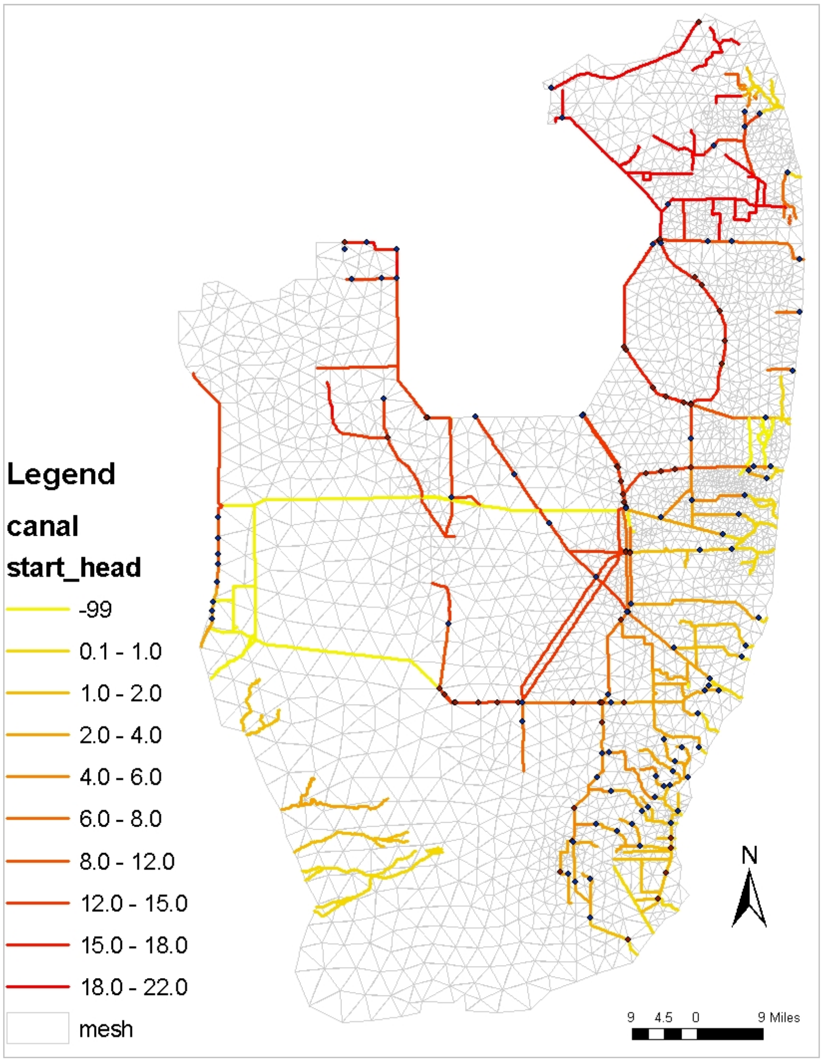


Figure 9.1 Head initial conditions for Glades-LECSA RSM subregional model network

Exercise 9.1.2 Look at boundary conditions in C111 RSM

There are several types of boundary conditions applied to the waterbodies in the RSM. For cells and segments there are head, general-head and source boundary conditions. For other waterbodies, lakes, impoundments, basins and wcdwaterbodies, the boundary conditions are flow conditions rather than head conditions.

In this exercise the implementation on typical RSM applications are explored. The answers are at the end on the Lab.

1. Find the boundary conditions for segments in the C111 Model.
   - Open the main run file for the C111 Model:

     `$RSM/../data/C111/run_c111_mse_SR5_sss.xml`

   - What is network boundary condition file?
   - What are the boundary conditions for the canal connection to the ocean?
   - What are the characteristics of the boundary conditions?
   - What are the boundary conditions for the structures at the upstream structures S-174 and S-176?

2. Find the imposed public water supply (PWS) well pumping from the aquifer.
   - Open the main run file for the C111 Model:

     `$RSM/../data/C111/run_c111_mse_SR5_sss.xml`

   - What is the file containing the PWS boundary conditions?
   - Where are the wells located?
   - What are the units of time and flow?
   - Is this a traditional outflow well or an inflow well?

3. Find the boundary conditions on the cells for the C111 Model.
   - Open the main run file for the C111 Model:

     `$RSM/../data/C111/run_c111_mse_SR5_sss.xml`

   - What files contain the mesh boundary conditions?
   - What is the boundary condition for the cells along the coast?
   - What are the boundary conditions applied to the north and western sides of the domain?
   - Where is the time series data for the flow boundary condition?

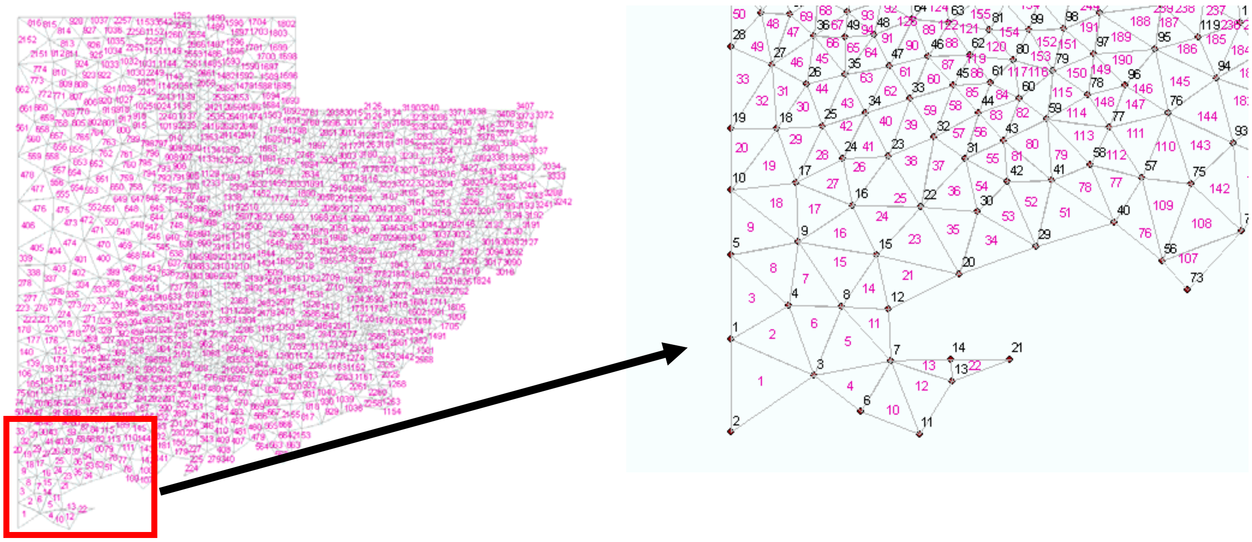


Figure 9.2 Location of cells and nodes in the C111 Model

4. Find the boundary conditions for the mesh in Benchmark 34 (BM34).
   - What are the different boundary condition types?

5. Find the boundary conditions for wcdwaterbodies in the Glades-LECSA Model?
   - Open the run file:

     `$RSM/../data/glades_lecsa/run_calib_84-95.xml`

   - Find the wcd boundary condition files in the <mesh_bc> element:
   - What are the boundary conditions?

6. Find the boundary conditions for an impoundment:
   - Open the main run file for the C111 Model:

     `$RSM/../data/C111/run_c111_mse_SR5.sss.xml`

   - Are there any defined impoundment BCs in the C111 Model?
   - Identify the waterbody ID for the impoundments. Is there a watermover that provides water to the impoundments?
   - Open the hse.dtd file which contains the schema for the XML input.

     `./RSM/trunk/benchmarks/hse.dtd`

   - What are the allowable values for impoundment_bc?

7. Find boundary conditions for Lake.
    - Find the files describing the lakes in Benchmark 73 (BM73), the Northern Everglades RSM. Where are they?
    - Open the lakes_lkb.xml file and find the lake boundary conditions.
    - What are the two types of lake boundary conditions and where are they applied?

8. Find boundary conditions for basins.
    - Find the files that describe the basins in Benchmark 70 (BM70), the Lake Okeechobee Service Area (LOSA) RSM. Where are the files?
    - Open the losa_basins.xml file and find the basin boundary conditions.
    - What are the two types of basin boundary conditions?
    - What are the two types of basinsource boundary conditions?
    - Where are basinHeadBC boundary conditions applied?

Exercise 9.1.3 Extract flow data from the SFWMM output for use as boundary conditions.

The objective of this exercise is to create groundwater flow boundary conditions from the South Florida Water Management Model (SFWMM) datasets. A script, **`getflows.scr`**, has been created to extract the daily groundwater and surface water flows across each face of the cell in the SFWMM 2x2 grid and produce the total flow across each face.

The user is still required to create a method for partitioning the flow from the 2-mile faces to the appropriate length of the RSM cell walls.

The output from the SFWMM exists in a binary file:

`$RSM/labs/Lab9_ICBC/daily_gw_flw.bin`
`$RSM/labs/Lab9_ICBC/daily_surface_flw.bin`

The script is set up by default to produce the total flows across selected grid cell faces for the calibration period 1984–2000. The script processes two text files that the user creates, that include the groundwater (gw) and surface water or overland (of) flows.

Set up the script to create the boundary flows for the RSM cells 1, 3, 9, 20, 33, 50 and 75 (see **Fig. 9.3**). It will be necessary to extract the flows for the SFWMM grid cells 420, 320 and 220.

9. Create a new directory [**`test`**] under **`Lab9_ICBC`**
10. Copy in **`getflows.scr`**.from **`Lab9_ICBC`**
11. Edit **`getflows.scr`**:
    - Set **`dssfilename`** (in line7) = desired filename.
    - Replace **`runpaths`** path list with **`(../ ../)`**
12. Create a text file that contains the required groundwater flows named: **`gwrocos2.txt`**
13. Create a text file that contains the required surface water flows named: **`ofrocos2.txt`**
    - **`gwrocos2.txt`** and **`ofrocos2.txt`** will contain the following lines of code.

```
420e;4;20;e
320e;3;20;e
220e;2;20;e
```

By convention, the direction of flow is positive north and east. Flows going south are "sr" and flows going west are "er".

14. Review the script **`getflows.scr`** before running

15. Run **`getflows.scr`** by entering the following command at the Linux prompt:

```
./getflows.scr gwrocos2.txt ofrocos2.txt
```

The getflow.src script produces a DSS file that contains the groundwater and surface water flows for a 2-mile transect. The cell sides of the RSM grid do not necessarily have 2-mile lengths and the flows from the SFWMM must be partitioned into the appropriate fractions for use as boundary conditions.

The preprocessing tools available for RSM do not currently include a utility for flow partitioning, so this must be done by hand using a spreadsheet to partition the flow.

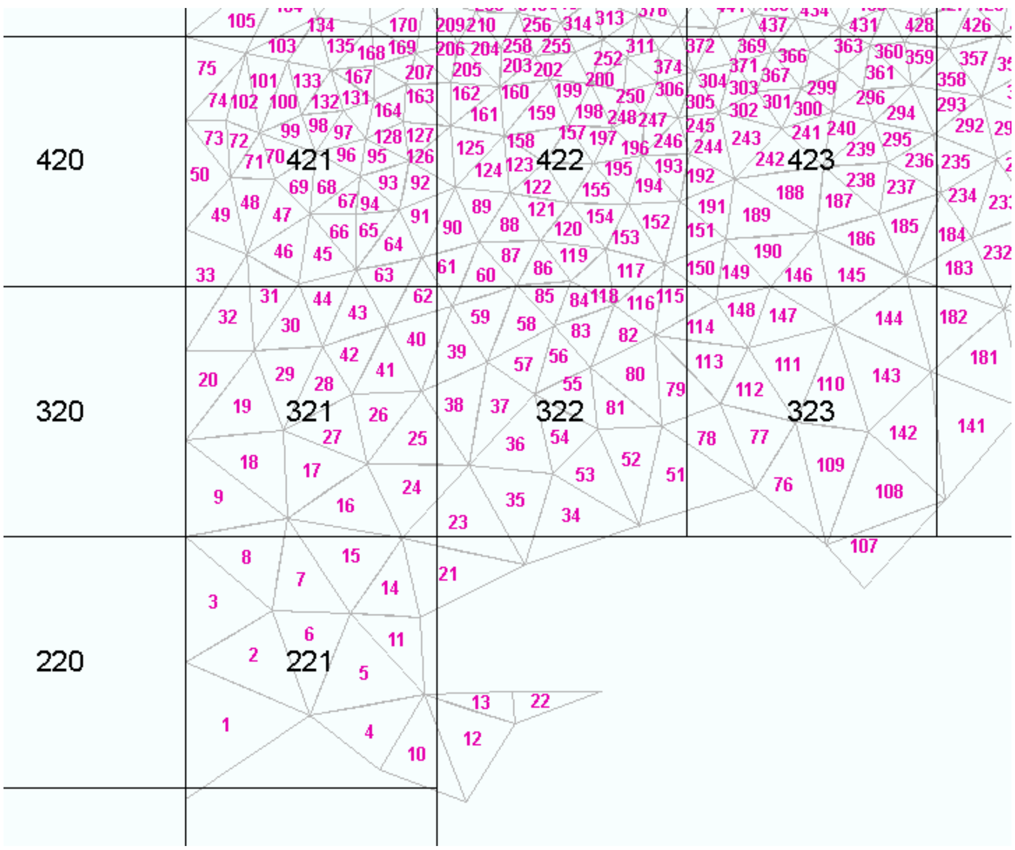


Figure 9.3 Mesh cells for the C111 Model and grid cells for the SFWMM for the southwest portion of the C111 domain

Exercise 9.1.4 Look at boundary conditions in Glades-LECSA RSM

The purpose of this exercise is to investigate the use of the boundary conditions in the RSM subregional implementations. Locate the following files in one of the subregional model input directories. Open the files using the HecDssVue utility from the RSM GUI and observe the contents.

16. Tidal head BCs:

    `$RSM/data/glades_lecsa/input/dss_files/RSM_TIDES_2006.dss`
    - How many stations are tabulated?
    - What is their period of record?
    - How many groups of boundary nodes are also used to define the tidal boundary conditions?

17. Public water supply (PWS) wells:

    `$RSM/data/glades_lecsa/input/dss_files/rsm_CalibVerif_v1.2.dss`
    - How many wells are tabulated?

18. Canal and mesh stage time series:

    `$RSM/data/glades_lecsa/input/dss_files/all_canal_historical.dss`
    - How many records are in this file?
    - How many sources for data?
    - How many years of record are available for Site **`NP-EV7`**?
    - How many years of record are available for Station **`S337_T`**?

19. Canal flow time series:

    `$RSM/data/glades_lecsa/input/dss_files/flow_v5.0_09122003.dss`
    - How many records?
    - What are these data?
    - How many years of record are available for **`S4`**?
    - How many years of record are available for **`S65E`**?

20. Canal flow time series:

    `$RSM/data/glades_lecsa/input/dss_files/all_canals_bc.dss`
    - How many records are in this file?
    - How many flow records?
    - What are the stage data?
    - What is the source of the stage data?

21. Canal flow time series:

    `$RSM/data/lecsaGlades/input/dss_files/daily_str_flw.dss`

    - What are these records?

NOTE:

In addition to the standard time series files found with the subregional models, there are several specialized DSS files that contain times series for local monitoring stations.

Answers for Lab 9

Exercise 9.1.1

2. Initial conditions (ICs)

Mesh Cells: ***./input/mesh/initial_cell_head_041307.dat***

Source: a 1983 HSE run and historical data

4. Segments***:*** ***./input/canal/initial_canal_head_041307.dat.*** See **Fig. 9.1** in the lab.

6. Lakes: *the initial head for the dummy lake is "5.5".*
9001=5.1, 9002=5.1, 9003=5.1, 9000=5.1, 9100=5.6, 9200=5.35, 9300=5.6

7. Impoundments: *There are 7 impoundments and their initial heads are:*
9001=5.1
9002=5.1
9003=5.1
9000=5.1
9100=5.6
9200=5.35
9300=5.6

8. WCDwaterbodies: *The file is* ***./input/wcd_waterbodies_init.dat*** *and there are 69 wcdwaterbodies.*

10. Mesh Cells: *The initial heads are set as 0.8 times the value of the topography. This works in the C111 model where the land elevation is very slightly above sea level.*

Exercise 9.1.2

1. C111 network boundary conditions:

   File: **`./input_SR5_sss/P1R1_Alt2Db_Canal_bc.xml`**

   Ocean connection: segment general head boundary condition

   Characteristics: a time series of historical tidal heads applied to the last segment and a conductivity of 10000 cfs/day.

   The BC applied to structure S-174 is a time series of measured historical flow.

   The BC applied to structure S-176 is a time series of simulated flow from the SFWMM model.

2. C111 PWS boundary conditions:

   `./input_SR5_sss/c111_pws_11_21.xml`

   The wells are part of a PWS well filed located in cell 2139 and cell 2240.

   The flows are monthly and the units are in million gallons per day.

   The flows are withdrawals as determined by the sign on the flows.

3. C111 mesh boundary conditions:

   `./input_SR5_sss/mesh_bc_11_01_I0P.xml`

   The coastal cells have a <wallghb> that applies the daily tide time series to a list of walls defined by a series of nodes with a conductivity of 10000.0.

   The inland perimeter cells have a flow boundary condition defined a well.

   The time series data is stored in **`./input_SR5_sss/2005bs_bc_c111.dss`**

4. The mesh boundary conditions in BM34 (see **Fig. 9.2**) include:

   wallhead with a uniform constant value

   wallhead that has a value that varies from 6.9 to 6.3 according to waypoints

   wallhead with a uniform head applied to two separate wall sections.

   noflow wall section.

```
<mesh_bc>
  <wallhead section="ol" label="wcorbett-1">
    <nodelist> 579 574 575 576 577 </nodelist>
    <uniform> <const value="7.6"> </const> </uniform>
  </wallhead>
  <wallhead section="ol" label="wcorbett-2">
     <nodelist> 566 577 </nodelist>
     <uniform> <const value="7.5"> </const> </uniform>
  </wallhead>
  <wallhead section="ol" label="wcorbett-3">
    <nodelist> 566 567 551 527 499 465 </nodelist>
    <wts2pt>
      <entry id="1">
        <const value="6.9"></const>
      </entry>
      <entry id="2">
        <const value="6.3"></const>
      </entry>
      <wts> 1.0 0.6666667 0.5 0.3333333 0.0 </wts>
    </wts2pt>
  </wallhead>
  <wallhead section="ol">
    <nodelist> 474 475 </nodelist>
    <uniform> <const value="7.5"></const> </uniform>
  </wallhead>
  <wallhead section="ol">
    <walllist>
      536 557
      513 482
    </walllist>
    <uniform> <const value= "7.6"></const> </uniform>
  </wallhead>
  <noflow section="ol">
    <nodelist> 355 314 257 258 259 260 261 262 208 209 210 157 105 57 19 </nodelist>
  </noflow>
  <noflow section="ol">
    <nodelist>
       465 464 463 462 461 419 380 379 337 284 228 227
       281 226 225 224 169 118 68 28
    </nodelist>
  </noflow>
</mesh_bc>
```

Figure 9.2 **Mesh boundary conditions for BM34, the L8 basin RSM application.**

5. WCD boundary conditions:

   File: **`$RSM/data/glades_lecsa/input/br_wcd_noflow.xml`**

   The boundary conditions are noflow around the perimeter.

6. Impoundment boundary conditions:

   There are no ***<impoundment_bc>*** *defined in the C111 model.*

   Impoundments: *9001, 9002, 9003, 9000, 9100, 9200, 9300*

   Watermovers: *setflow from dummy lake 40000 to 9300 and additional genxweirs that move water between impoundments:*

   genxweir from 9300 to 9100
   genxweir from 9100 to 9200
   genxweir from 9000 to 9001

genxweir from 9000 to 9002
genxweir from 9000 to 9003

A search for impoundment_bc reveals that there are two possible boundary conditions: impoundmentsource and impoundmenthead which can be implemented as time series, rule curve or a constant value.

7. Lake boundary conditions.

   The lake files are located in the **`$RSM/trunk/benchmarks/BM73/hse/lakes`** *directory.*

   The lakeHeadBC is applied to Lake Okeechobee to fix the head to match historical data.

   The lakesource is applied to the different pools of the Kissimmee River. It is applied as one of two "packages". What are those packages? 1) the default package that applies a time series to the lake, and 2) "areacorrected' package that has two area adjustments. There is a <A> sub-element that reduces the lake area by a fixed area which is typically the area of the associated basin, and <B> sub-element that reduces the lake areas by the area of the lakes within the <B> tags. For the lakes_lkb.xml The area of lakeID=360 is reduced by 10e+9 and the area of two other lakes; 9999 and 9998.

8. Basin boundary conditions:

   The basin file is located in the **`$RSM/trunk/benchmarks/BM70/hse/basins`** *directory. You want file* **`losa_basins.xml`**.

   There are two basin BCs: 1) basinsource, and 2) basinHeadBC.

   The basinsource has two types; the default and the area corrected which reduces the area of the basin by the area of the lakes listed in the <B> tags.

   The basinHeadBC is applied to Brighton and the Lake Okeechobee public water supply.

Exercise 9.1.3

Compare results with those in the lab9_ICBC directory

Exercise 9.1.4

1. Tidal head BCs:

   10 stations are tabulated

   The period of record is 20 years of monthly data

   16 reaches

2. Public water supply (PWS) wells:

   How many wells are tabulated? *1201*

3. Canal and mesh stage time series:

   703 records in this file

6 sources of data: observed, historical, Hist_DBHYDRO, Hist_MOD1, Hist_MOD2, WMM_SIM

8 years of record are available for site NP-EV

10 years of record are available for station S337_T

4. Canal flow time series:

   148 records

   These data are historical and estimated historical flows used by SFWMM

   22 years of record are available for S4

   36 years of record are available for S65E

5. Canal flow time series:

   4619 records are in this file

   361 flow records

   The stage data are 4258 simulated segment head time series identified by the 6-digit segment number and historical head time series for head-water and tail-water measurements at selected structures.

   The stage data source is the SFWMM simulation.

6. Canal flow time series:

   These records are daily simulated flows from the SFWMM.

   They are structure flows as well as combined flows between defined waterbodies.

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