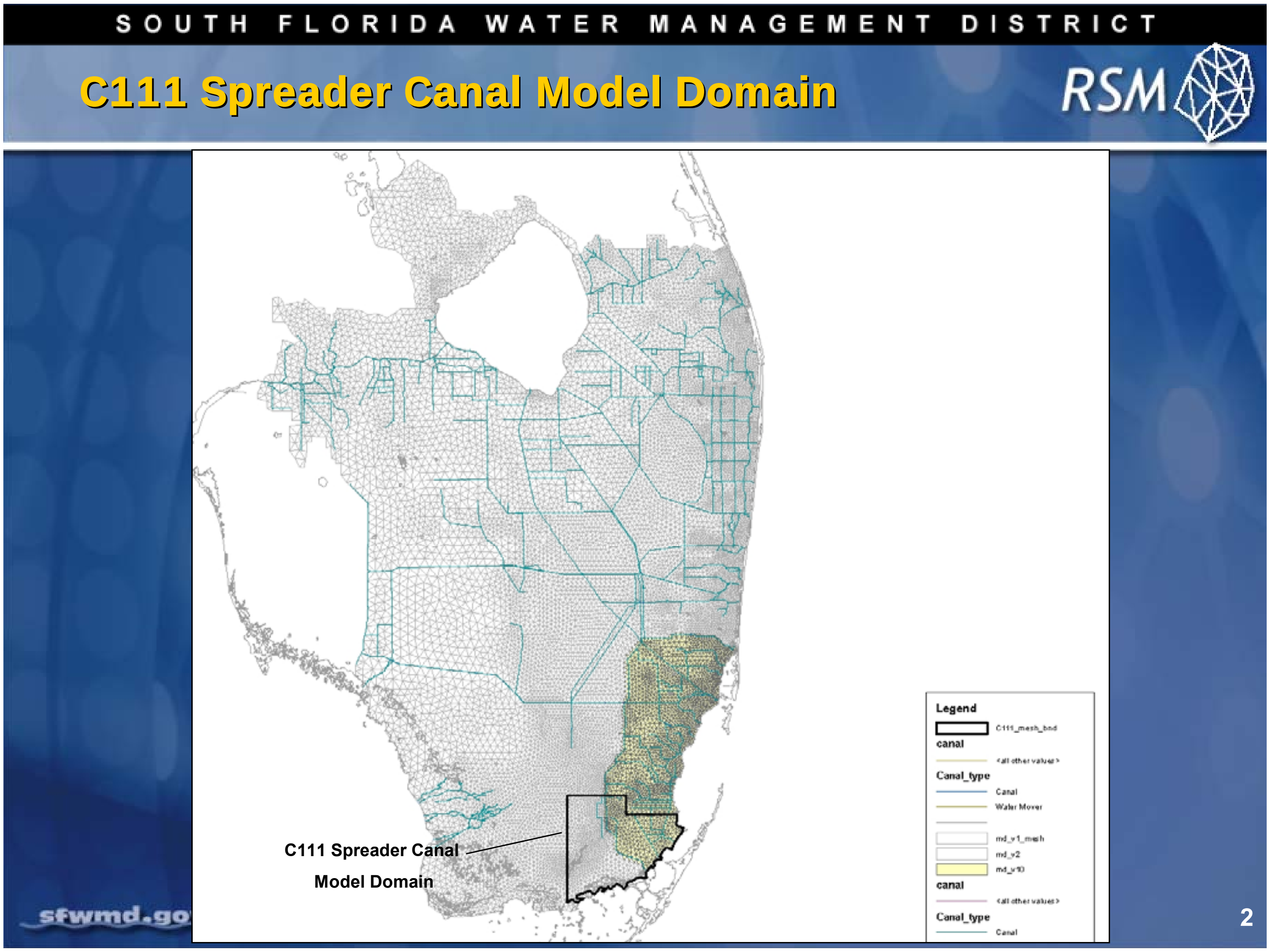
Lecture 12: C111 Spreader Canal / Frog Pond Reservoir RSM

The C111 subregional RSM was the first implementation to be used as an application for evaluating alternative project formulations. This lecture covers the calibration of the baseline model and initial testing of the implementation of the spreader canal features and the impoundment feature within the RSM for modeling the Frog Pond Reservoir.

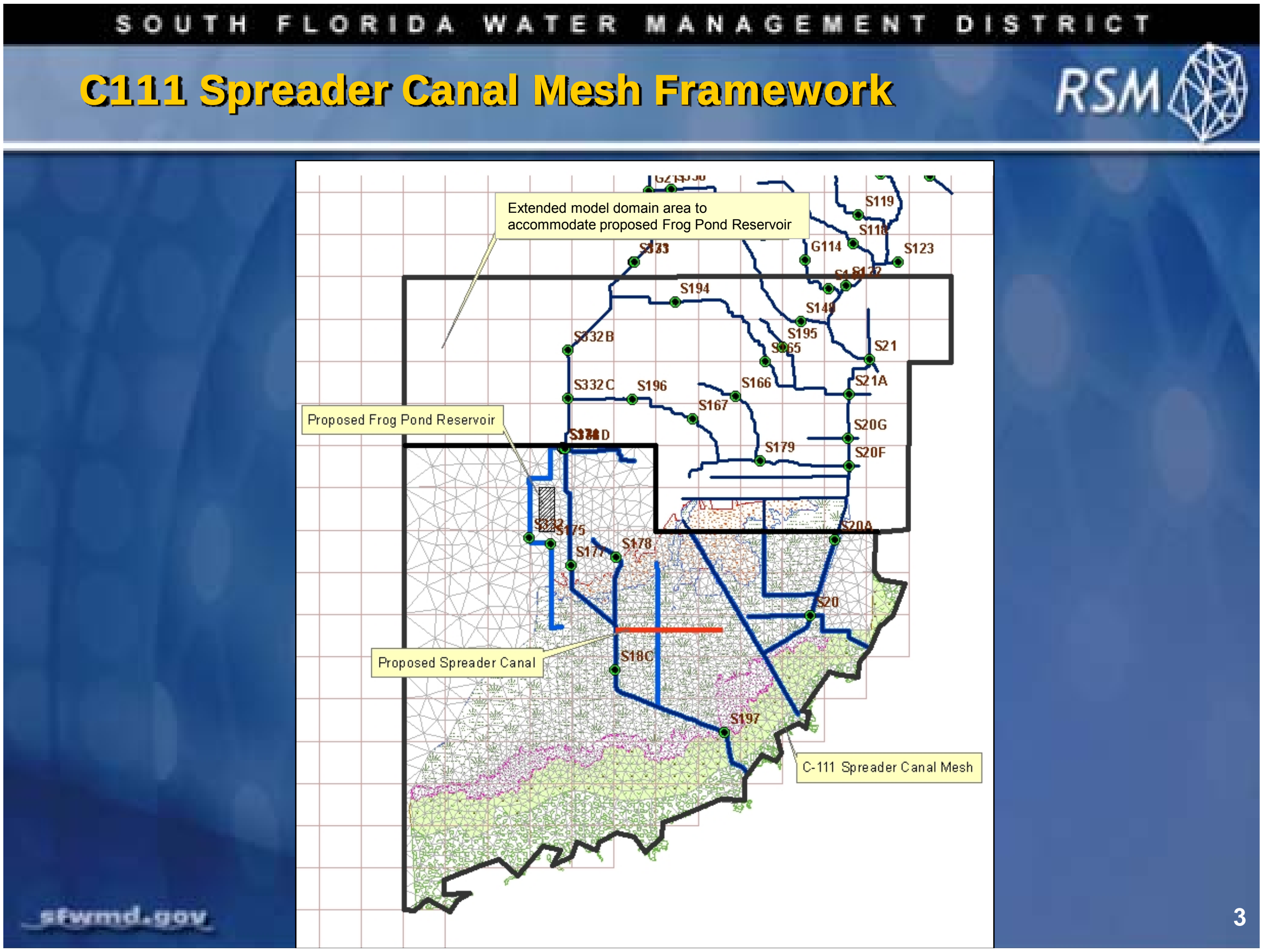
NOTE:

Additional Resources

A C-111 presentation file is available in the labs/lab12_subregion directory.

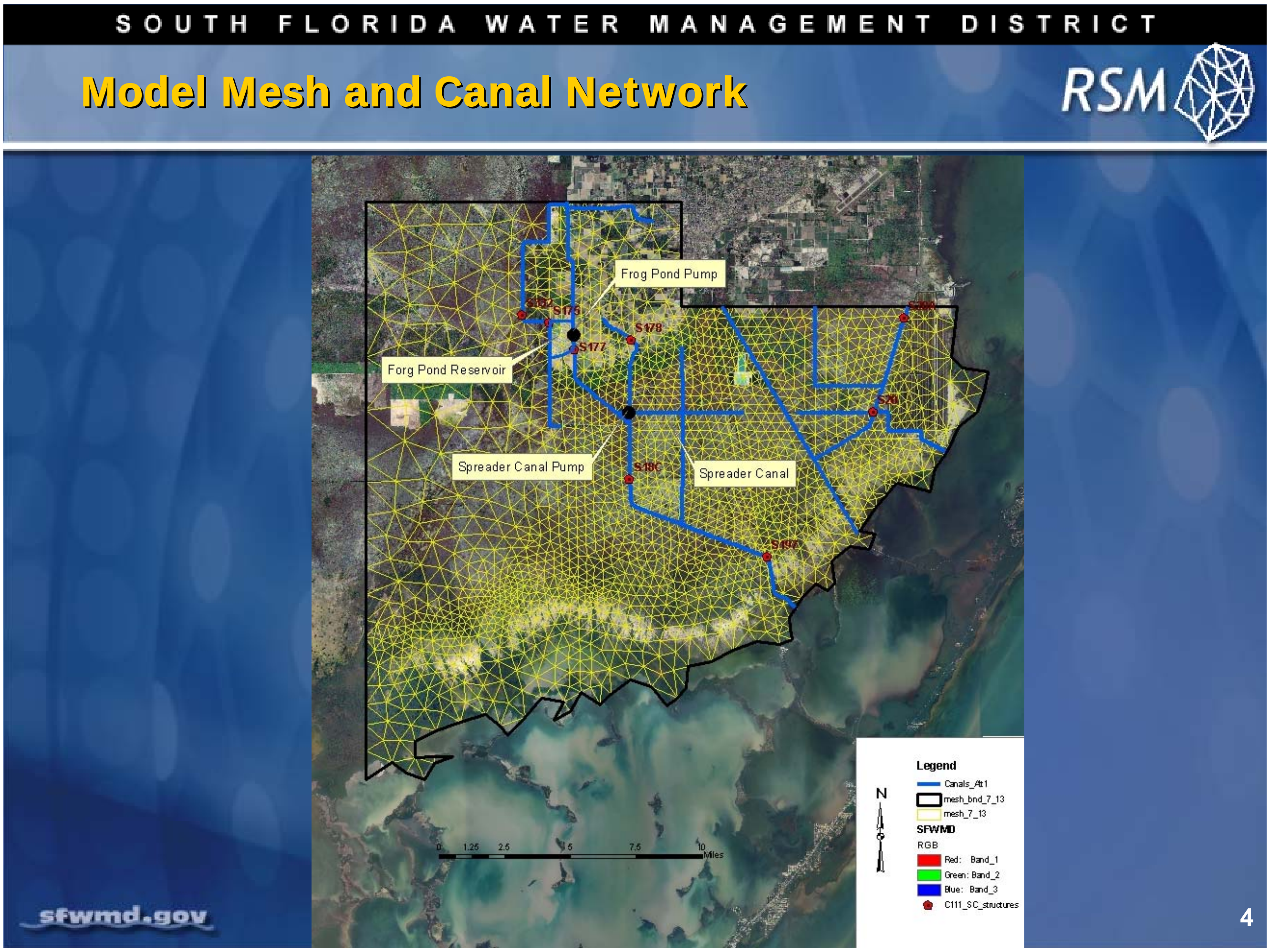


The boundary of the C111 Spreader Canal RSM domain is shown in the slide above. This map presents the model domain in relation to the Miami-Dade RSM and the mesh for the regional domain for south Florida.

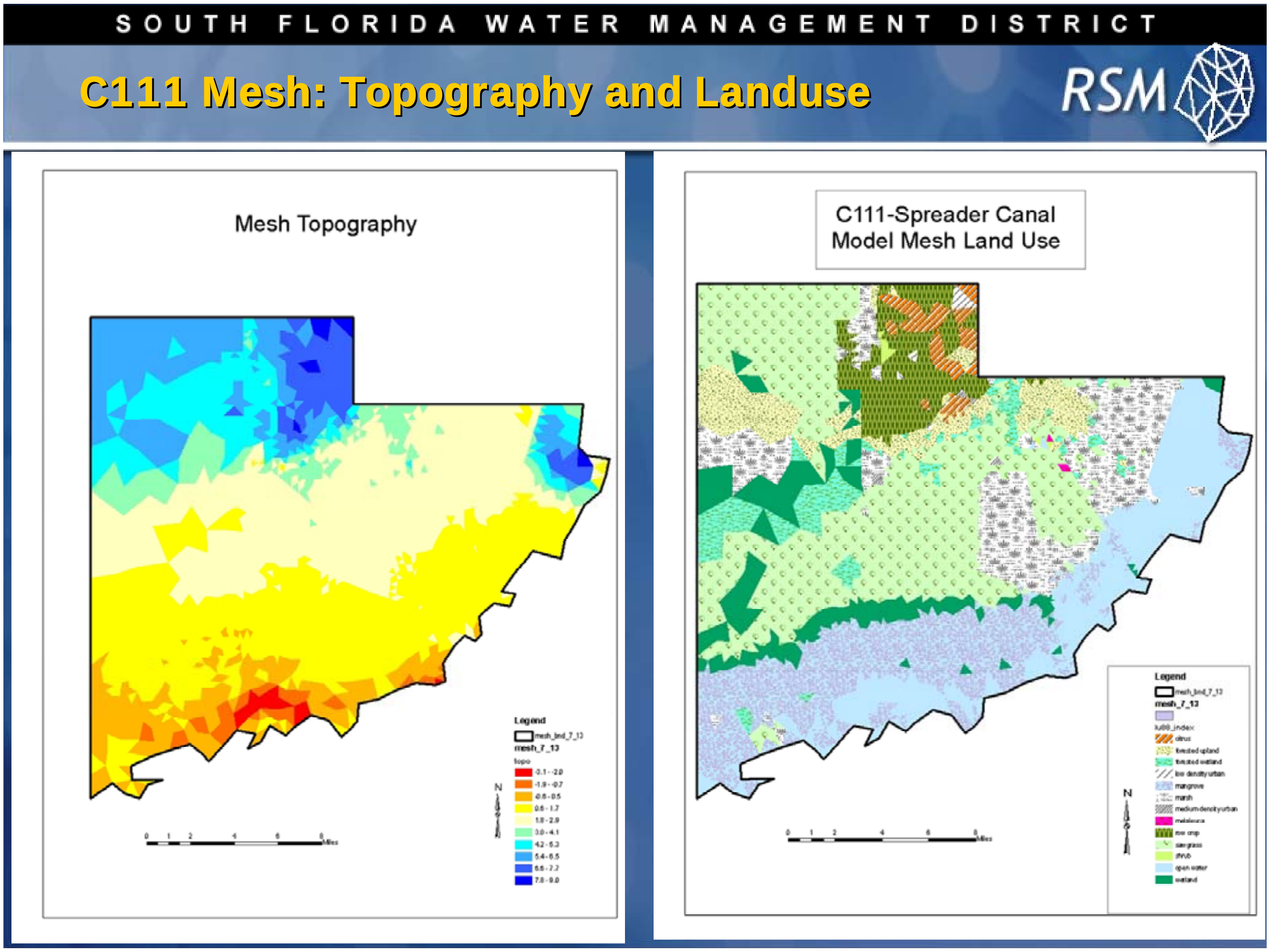


Subregional C111 RSM mesh framework detail:

- north boundary is an East – West line through S176
- western boundary is 8 miles west of the C111 Canal
- south and east boundaries are the coastline

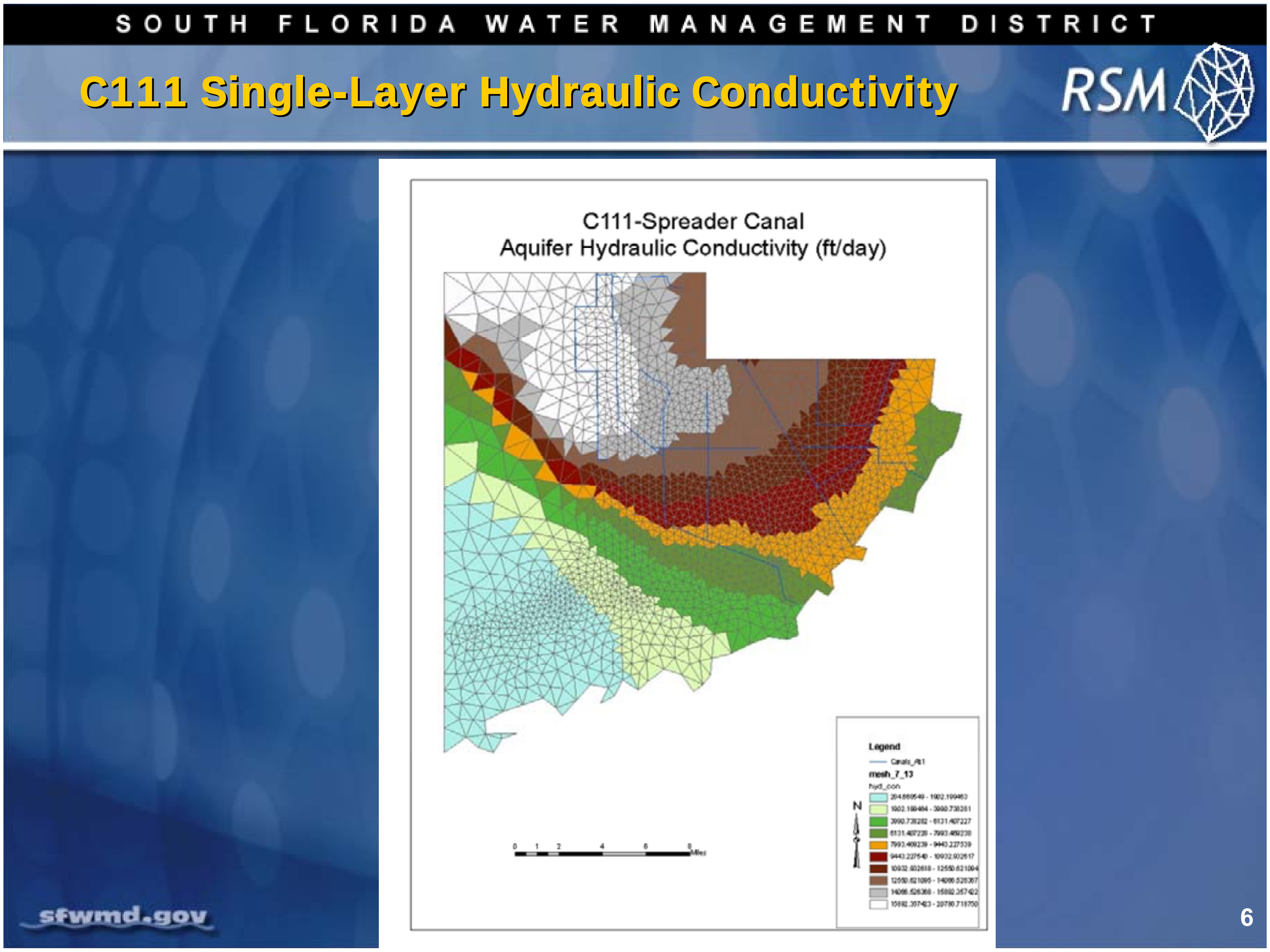


The C111 RSM model mesh consists of 3,505 cells with an average size of 64 acres. The average length of a triangle cell's side is about 2,000 feet.



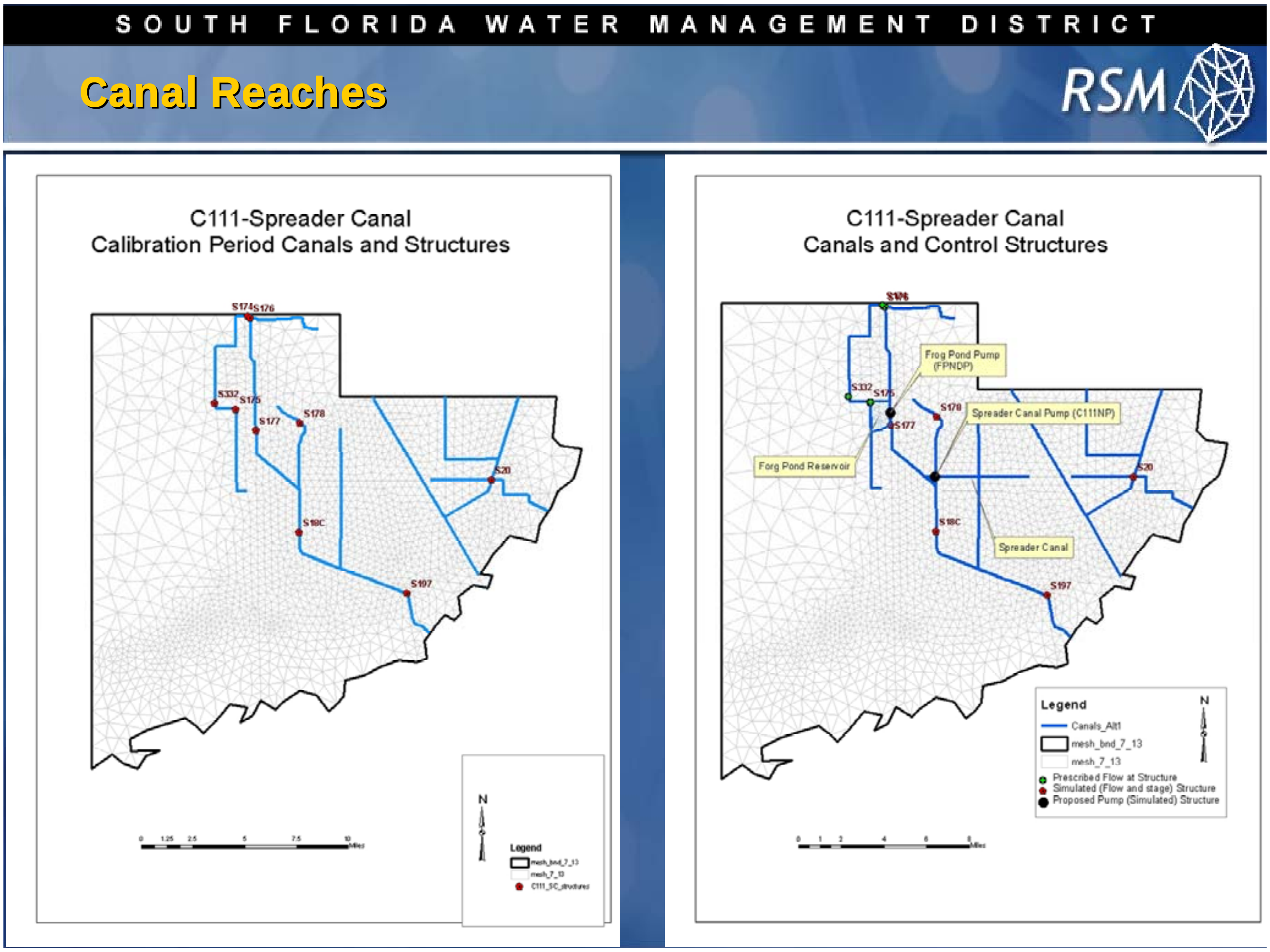
Topography and landuse are important data for this model. The mesh topography was derived from the LIDAR dataset. The topographic resolution on the east side of the L31-N Levee is a 100-foot grid derived from a Miami-Dade 25-foot resolution dataset. The resolution on the west side of the levee is 1,000-foot based on HAEDC USGS survey data.

Based on a combination of the South Florida Water Management District (SFWMD) 1988 landuse coverage and the SFWMD 1995 landuse coverage used for the calibration period (1984-1995), dominant landuses are mangrove (16%), sawgrass (30%) and marsh (13%).



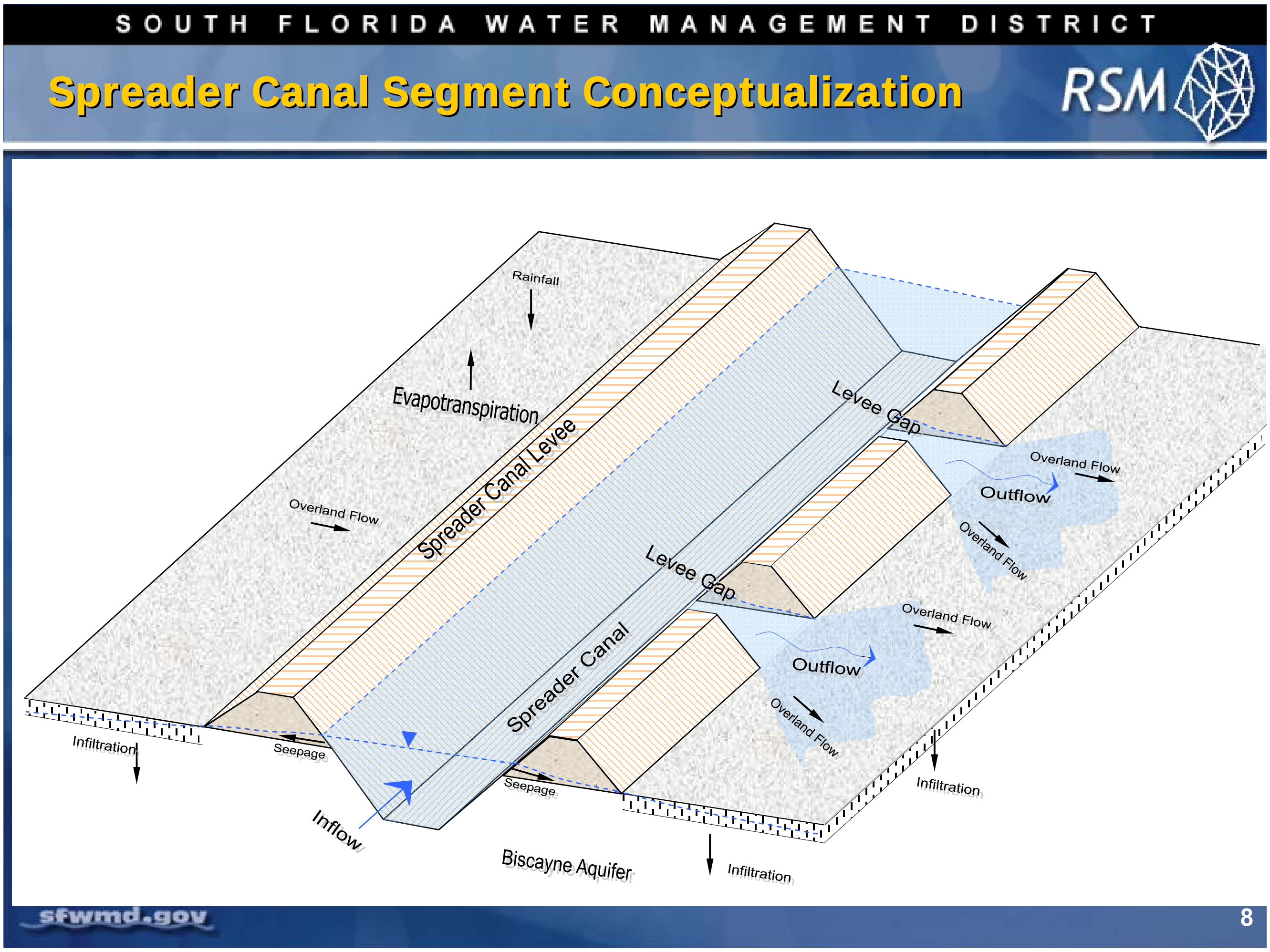
Hydraulic conductivity is another critical data set. There is an order of magnitude range in hydraulic conductivity across the domain.

This dataset was adopted from the Miami-Dade RSM v1.0 calibration datasets.

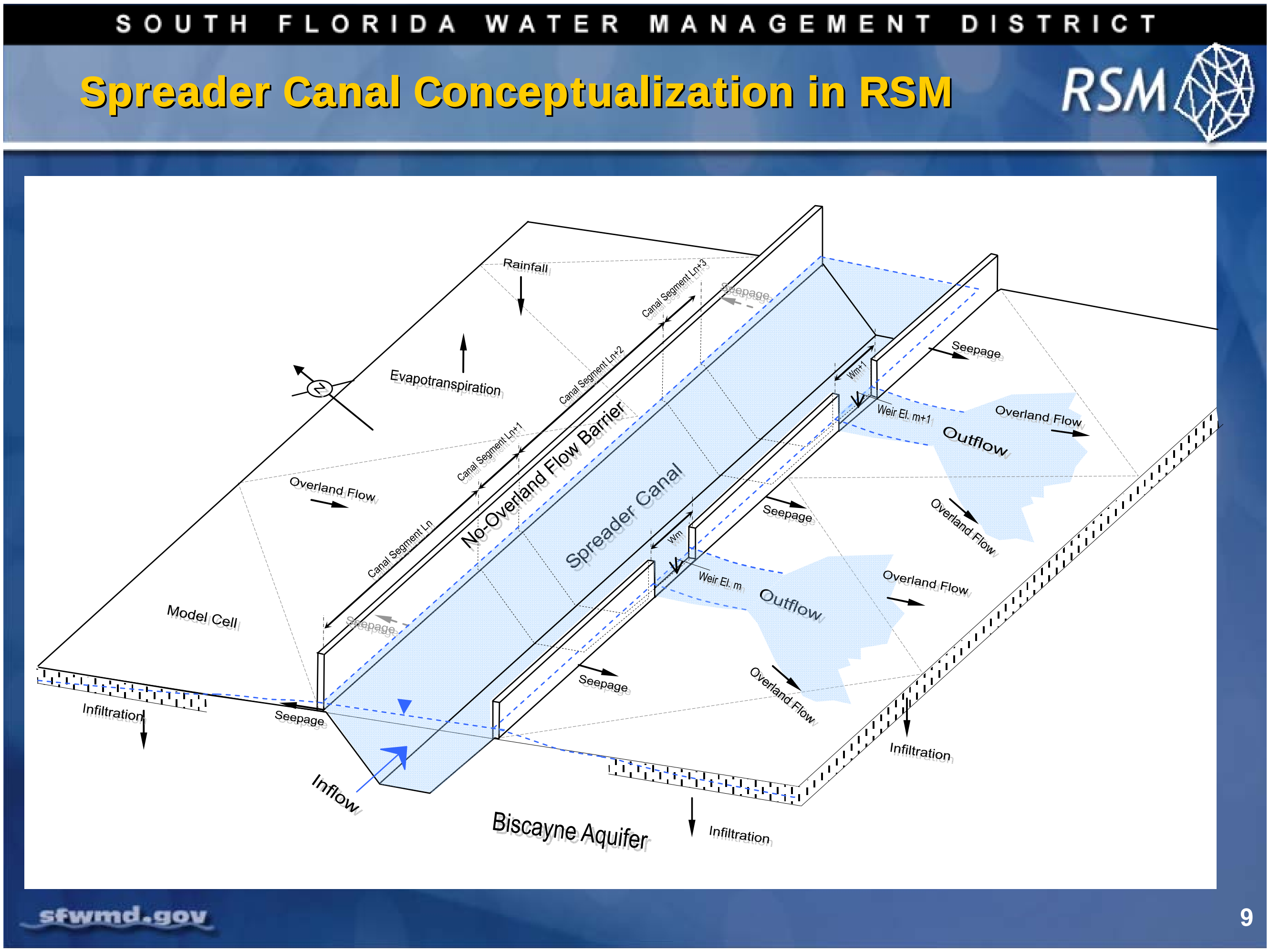


The base C111 Spreader Canal RSM was calibrated using the following canals: L31W, C111, C111E, L31E and Card Sound Rd canal.

The simulated structures included the following: S177, S178, S18C, and S197, while historical flows were imposed at S176, S174, S332 and S175 structures. For the C111-Spreader Canal/ Frog Pond Model, the same canals and structures were modeled as in the baseline model with two additional pumps (SC111NP and FPDNP).

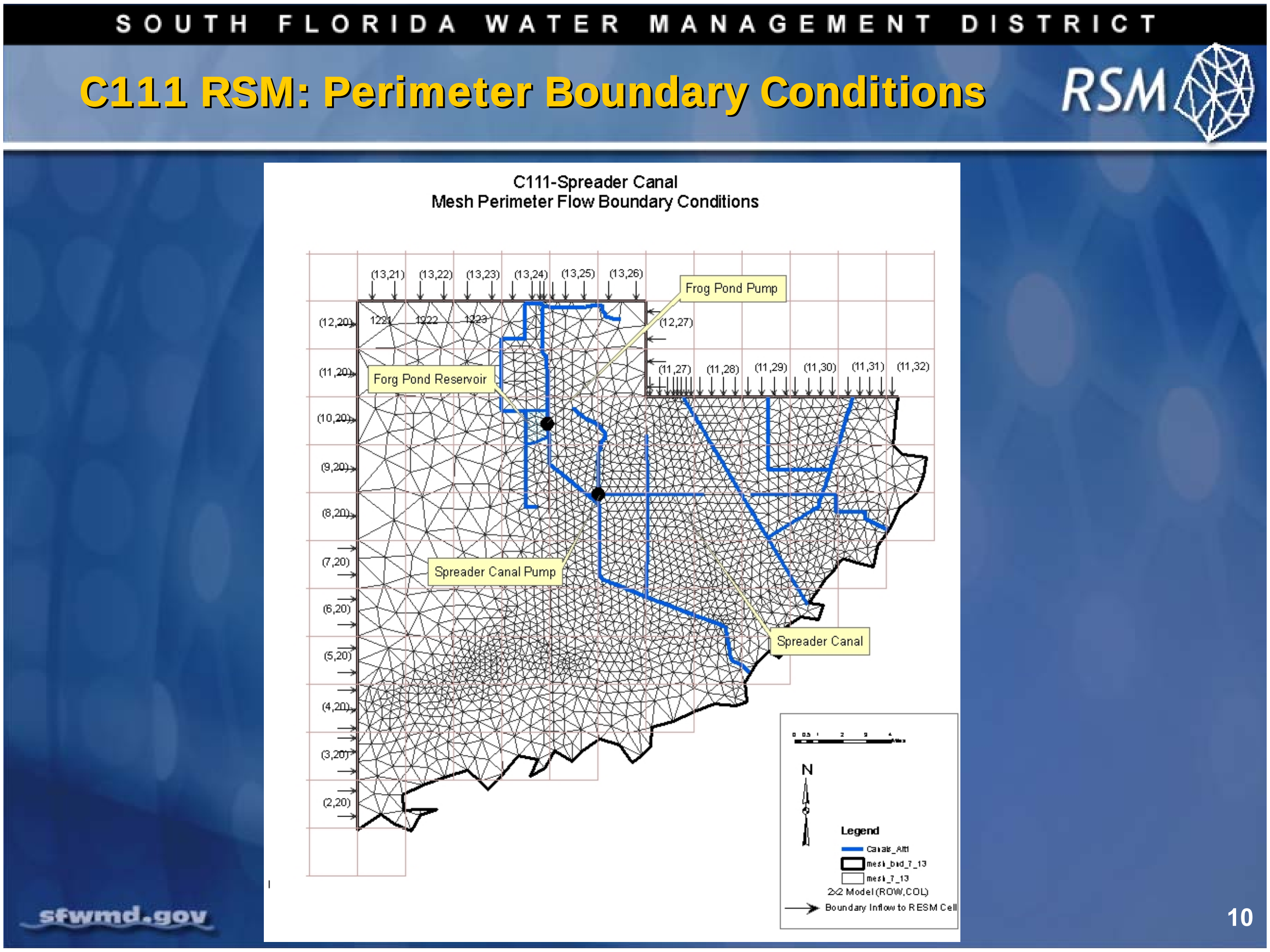


The Spreader Canal is designed to receive water from the C111 Canal and disperse the water across the marsh to create sheet flow. This is the schematic diagram of the Spreader Canal segment with the levee gaps on the south side, to promote sheet flow across the restored marsh.



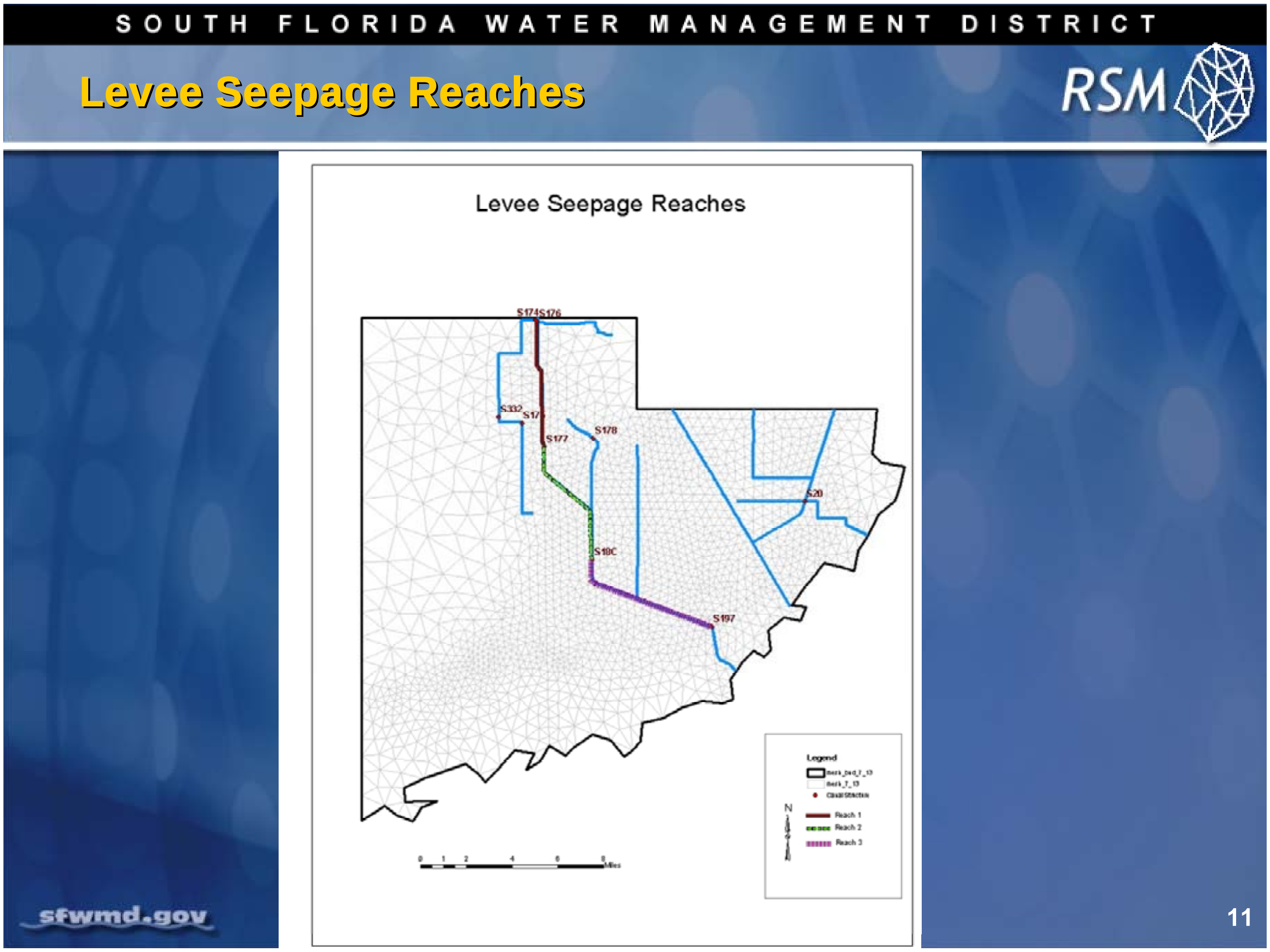
This is the Spreader Canal segment conceptualization within the RSM:

- No-flow boundary condition on the north bank
- Spreader Canal segments with and without free flow discharge
- Spreader Canal segments with gaps have overbank flow
- Seepage outflow from segments without gaps



The perimeter boundary conditions for the RSM were as follows:

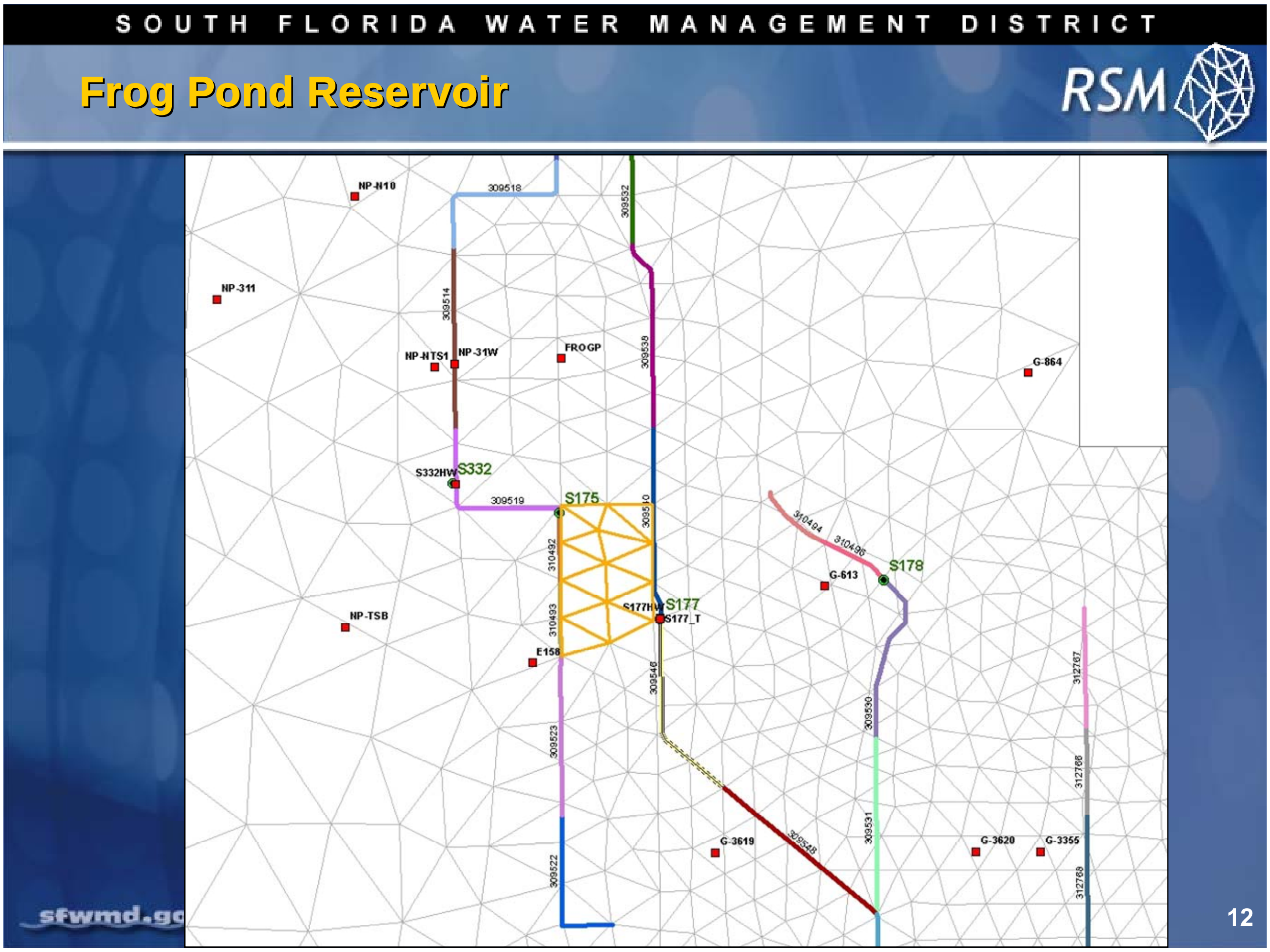
- Flows from the SFWMM simulation for the calibration period along the west and north boundaries
- Tidal stage (Manatee Bay gage) along the East-South boundary
- Historical S176 inflows for C111 Canal and S174 for L31W Canal



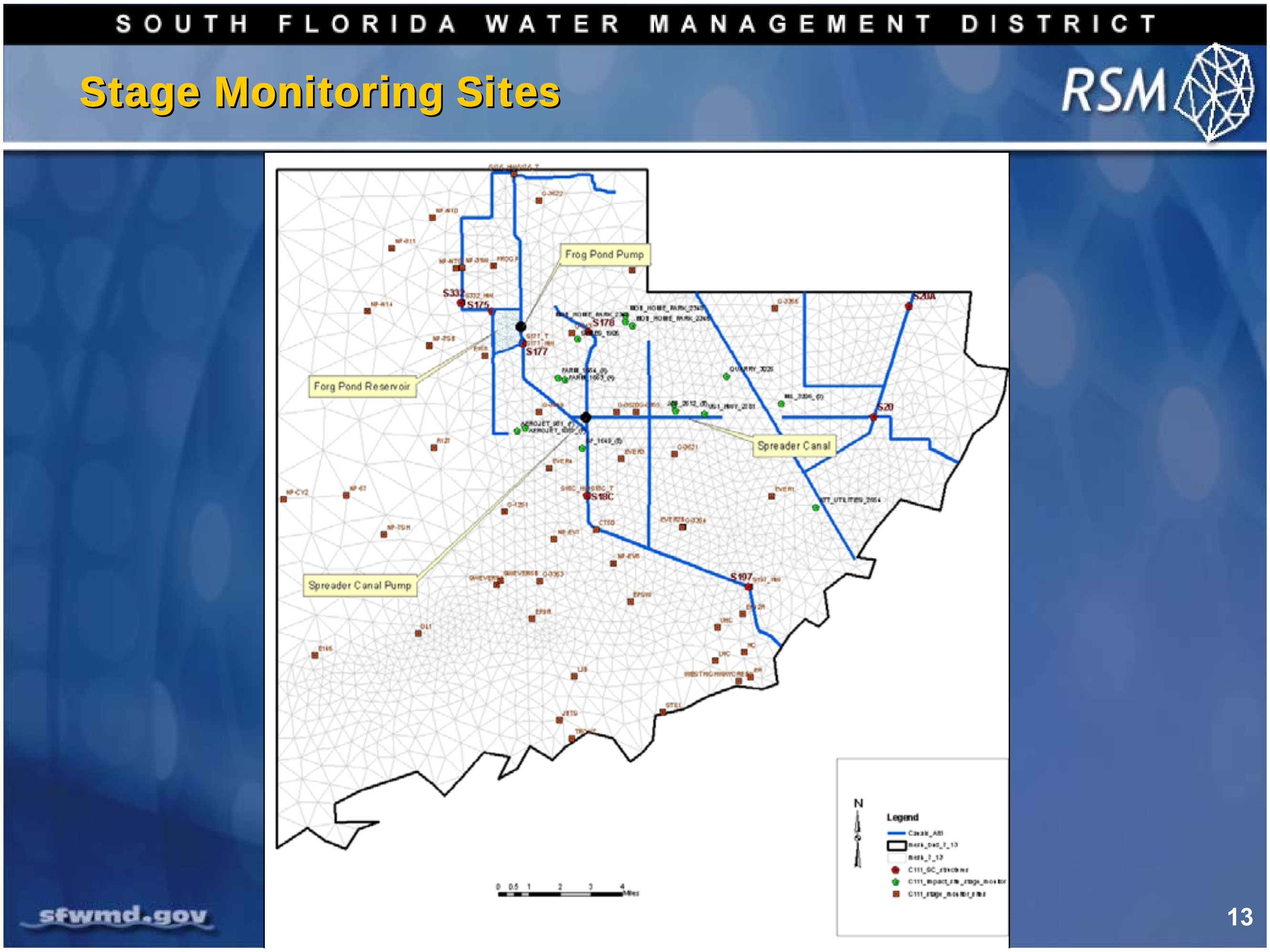
Levee seepage was included in the RSM in a similar way as modeled in the SFWMM via levee seepage watermovers.

Each levee reach has distinct sets of levee seepage properties and coefficients. Seepage flow across the levee is simulated as a linear function of the head differential on both sides of the levee. Values of the levee seepage coefficients were established through calibration.

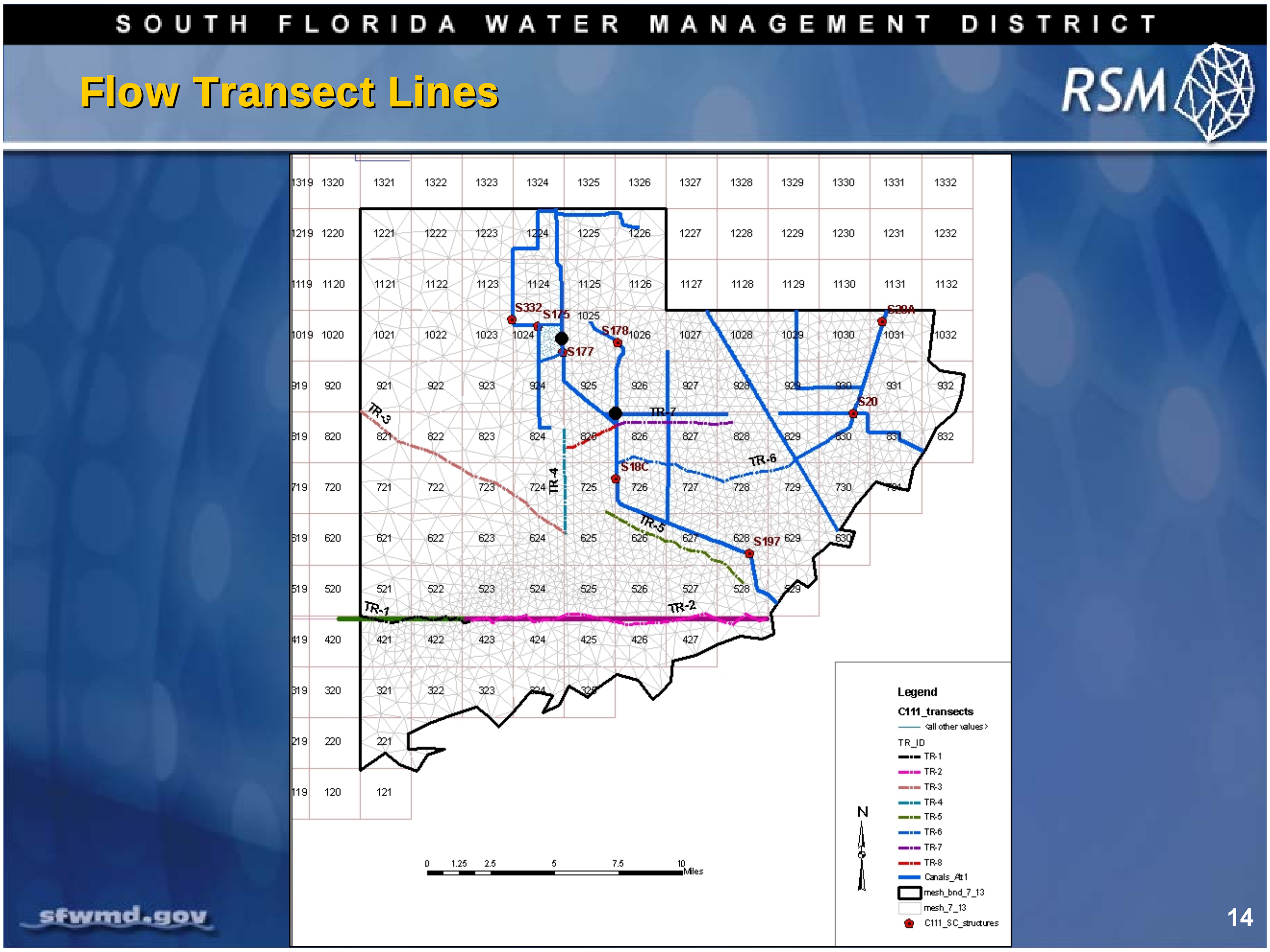
Seepage flow is calculated as a function of the linear levee seepage coefficients and the head difference across the levee.



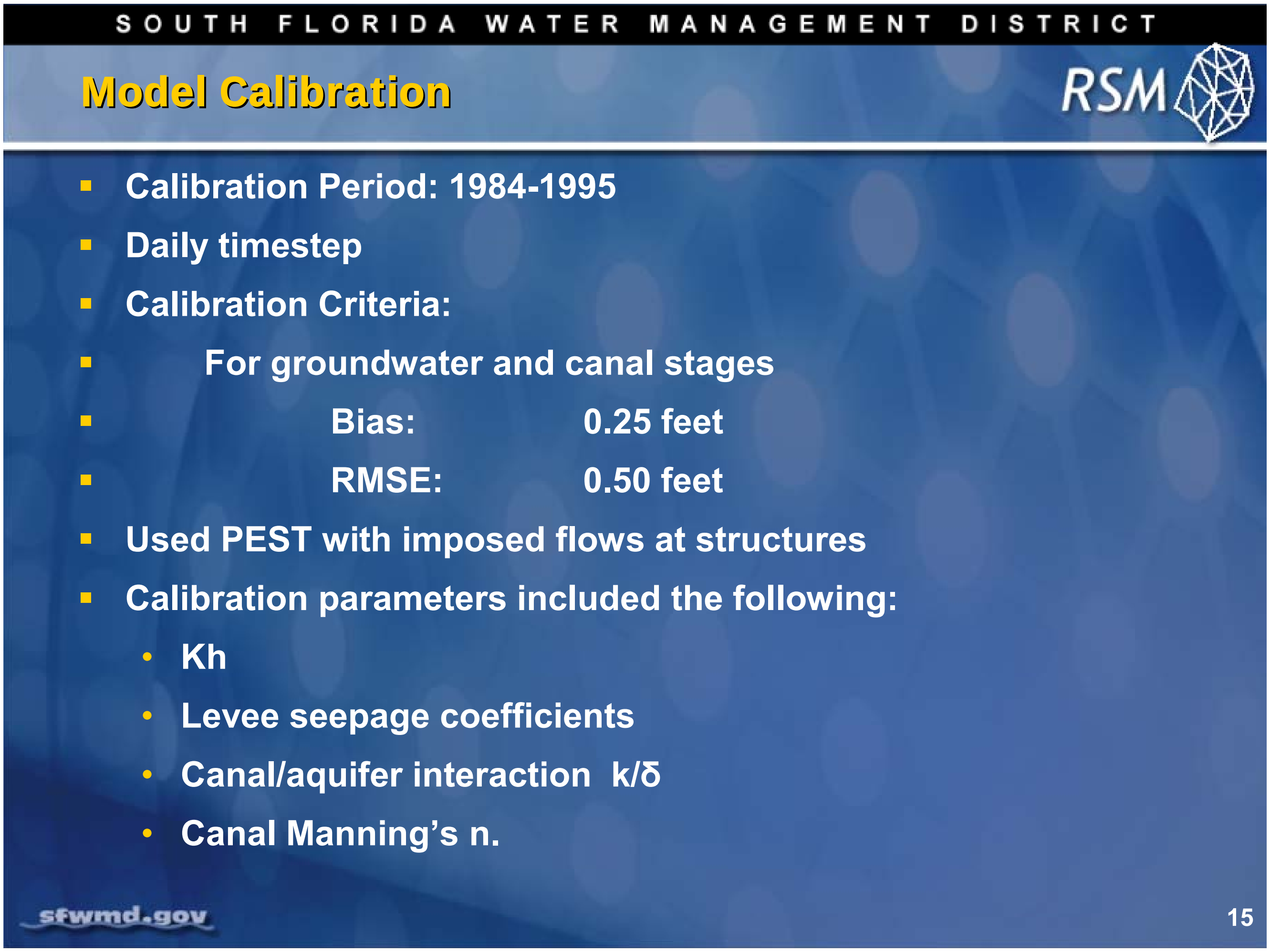
The Frog Pond impoundment is simulated as a single waterbody that interacts with the aquifer via vertical seepage.



There are 36 groundwater stage monitoring sites and seven canal structure flow monitoring sites used for calibration. Eighteen stage monitoring sites are in the Impact Assessment area.



Eight flow transect lines are used to determine if the overland sheet flow and groundwater flow are adequate in the evaluation of alternative project formulations.



The calibration criteria for the C111 RSMis presented in the slide above. The flows at the structures were fixed based on historically measured flow so that the canal and aquifer parameters could be calibrated.

The optimization function of the PEST software (http://www.sspa.com/pest/pestsoft.html) was used to minimize the bias and RMSE of the simulated daily values to historical daily records for the stage and flow monitoring stations.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Groundwater Stage Calibration Statistics (1984-1995)

	C111 Spreader Canal		Miami_Dade RSM v1		SFWMM v5.5	
Stage Gauge	Bias	RMSE	Bias	RMSE	Bias	RMSE
EP9R	0.22	0.28			0.07	0.22
EPSW	-0.04	0.29			-0.23	0.34
EVER1	-0.50	0.75	-0.46	0.60	-0.19	0.45
EVER2B	0.06	0.21	-0.14	0.22	-0.14	0.37
EVER4	0.34	0.40			0.10	0.25
FROGP	0.17	0.38			0.05	0.35
G613	0.46	0.56	0.22	0.33	0.17	0.37
G864	0.11	0.39	-0.24	0.42	0.00	0.39
G3354	0.02	0.20	-0.15	0.23	-0.14	0.24
G3355	-0.41	0.57	-0.37	0.51		
NP-31W	0.16	0.42				
NP-67	0.17	0.30			-0.24	0.41
NP-EV6	0.43	0.57				
NP-N10	0.03	0.30				
NP-TSB	-0.10	0.56			-0.37	0.69
SWEVER5A	0.31	0.36				

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Results from a subset of groundwater stage time series used in the C111 Spreader Canal RSM are shown in the slide above. Compared with the SFWMM, the RSM calibrated most of the sites as well or better. Additionally, performance of the C111 Spreader Canal RSM was also compared to the previous subregional RSM, Miami-Dade v.1.0. The red values in the table were outside the acceptable range.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

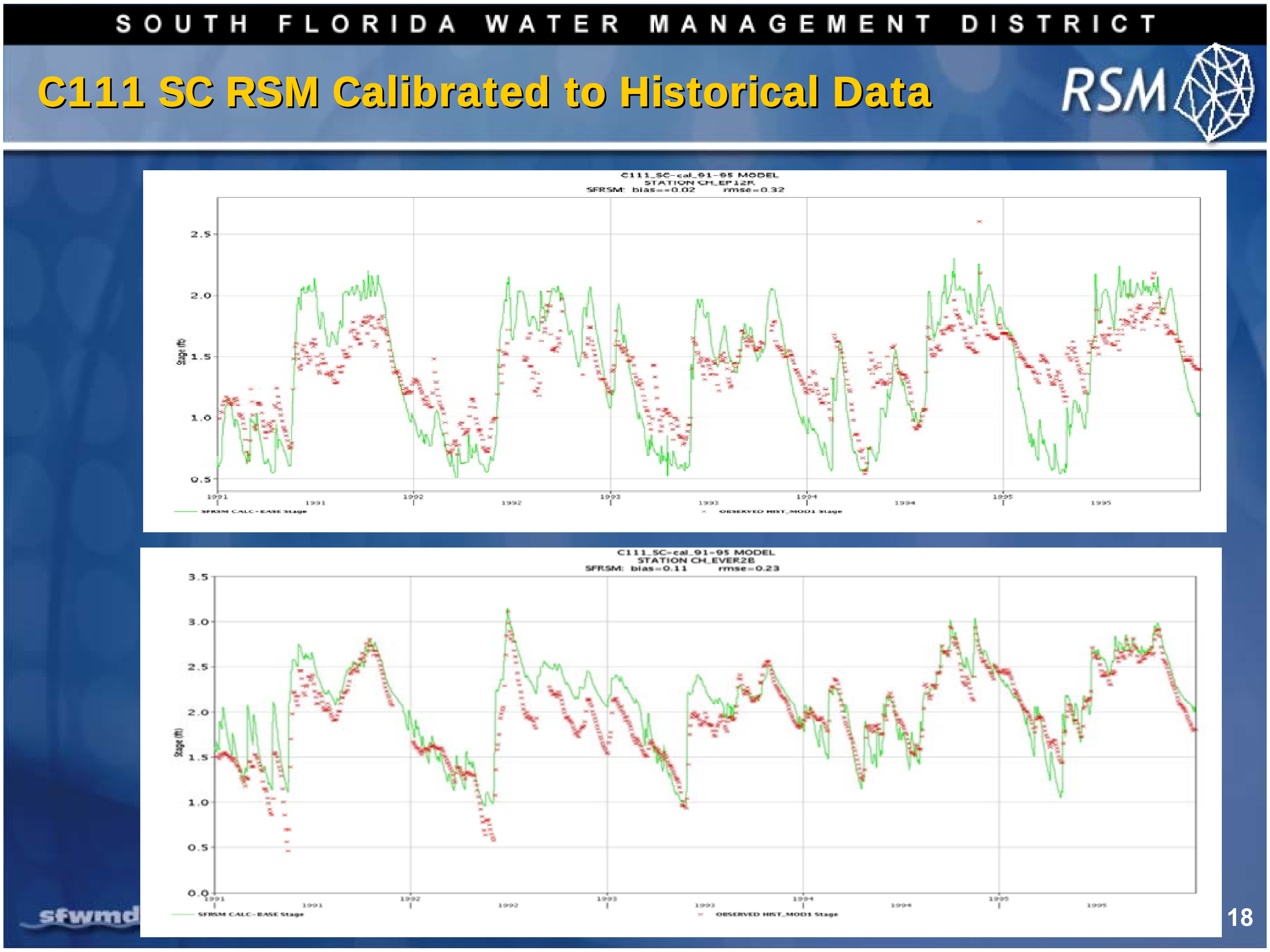
Canal Stage Calibration Statistics (1984-1995)

RSM

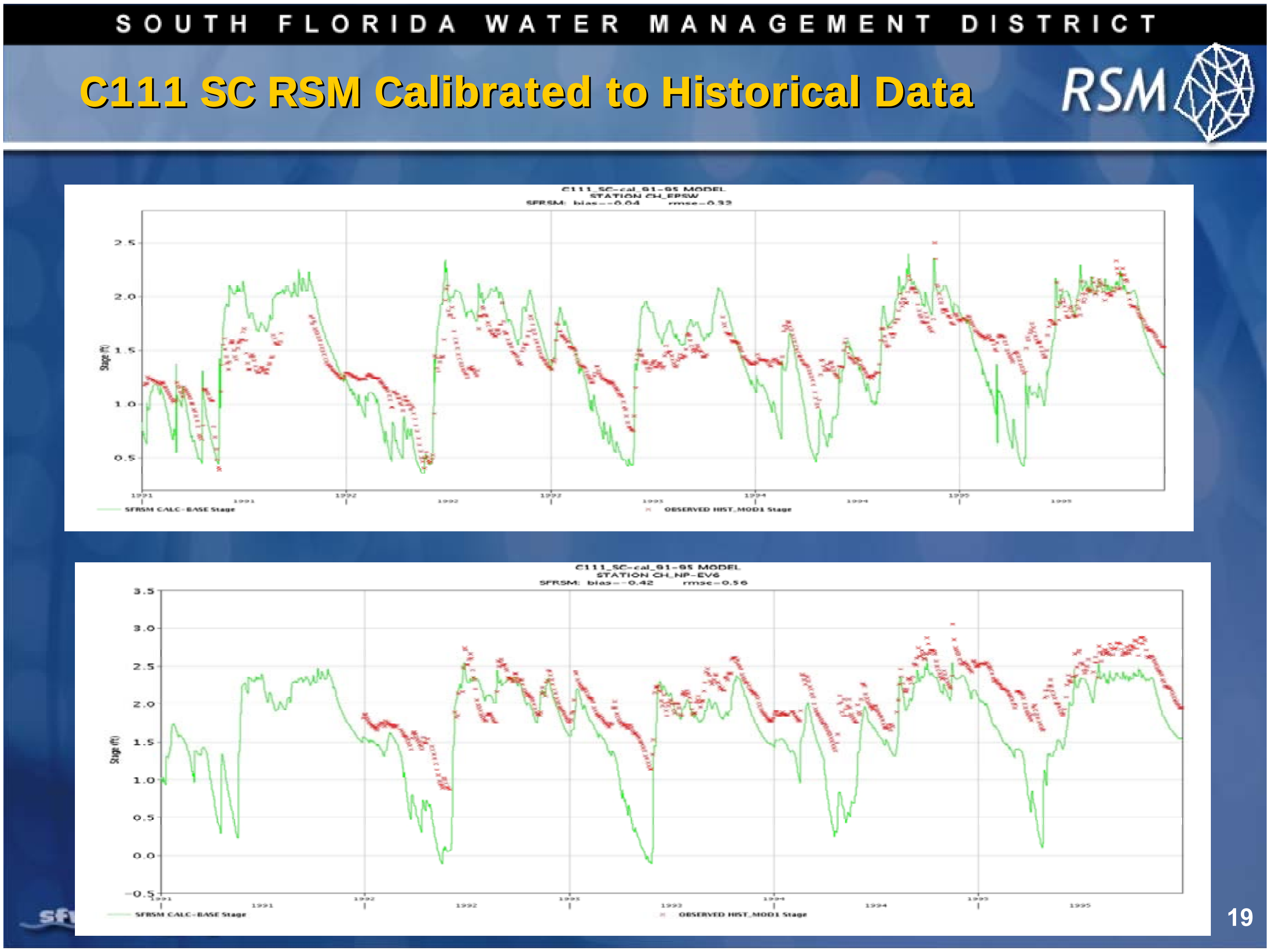
	C111 SC		MD v1		SFWMM v5.5	
Stage Gauge	Bias	RMSE	Bias	RMSE	Bias	RMSE
S197_HW	0.09	0.28			-0.24	0.33
S18C_HW	0.18	0.34			0.03	0.24
S18C_TW	0.14	0.29				
S177_HW	0.24	0.54			0.08	0.37
S177_TW	0.19	0.37				
S178_HW	0.28	0.44				
S178_TW	0.16	0.32				
S20_HW	-0.01	0.24				
S175_HW	0.00	0.36				

sfwmd.gov 17

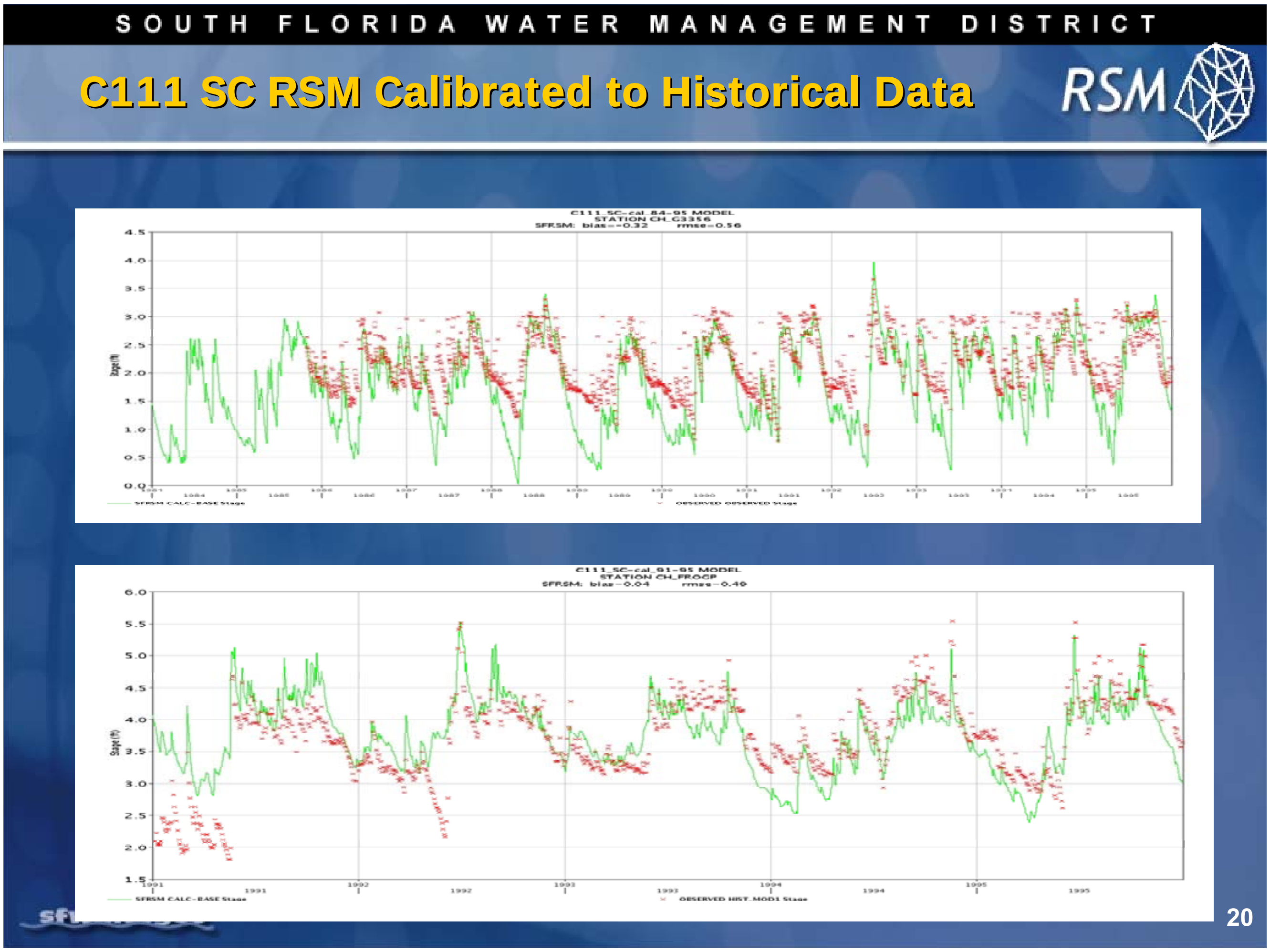
The C111 Spreader Canal RSM was calibrated to more sites than the SFWMM. Except at two stations, it performed within the calibration criteria.



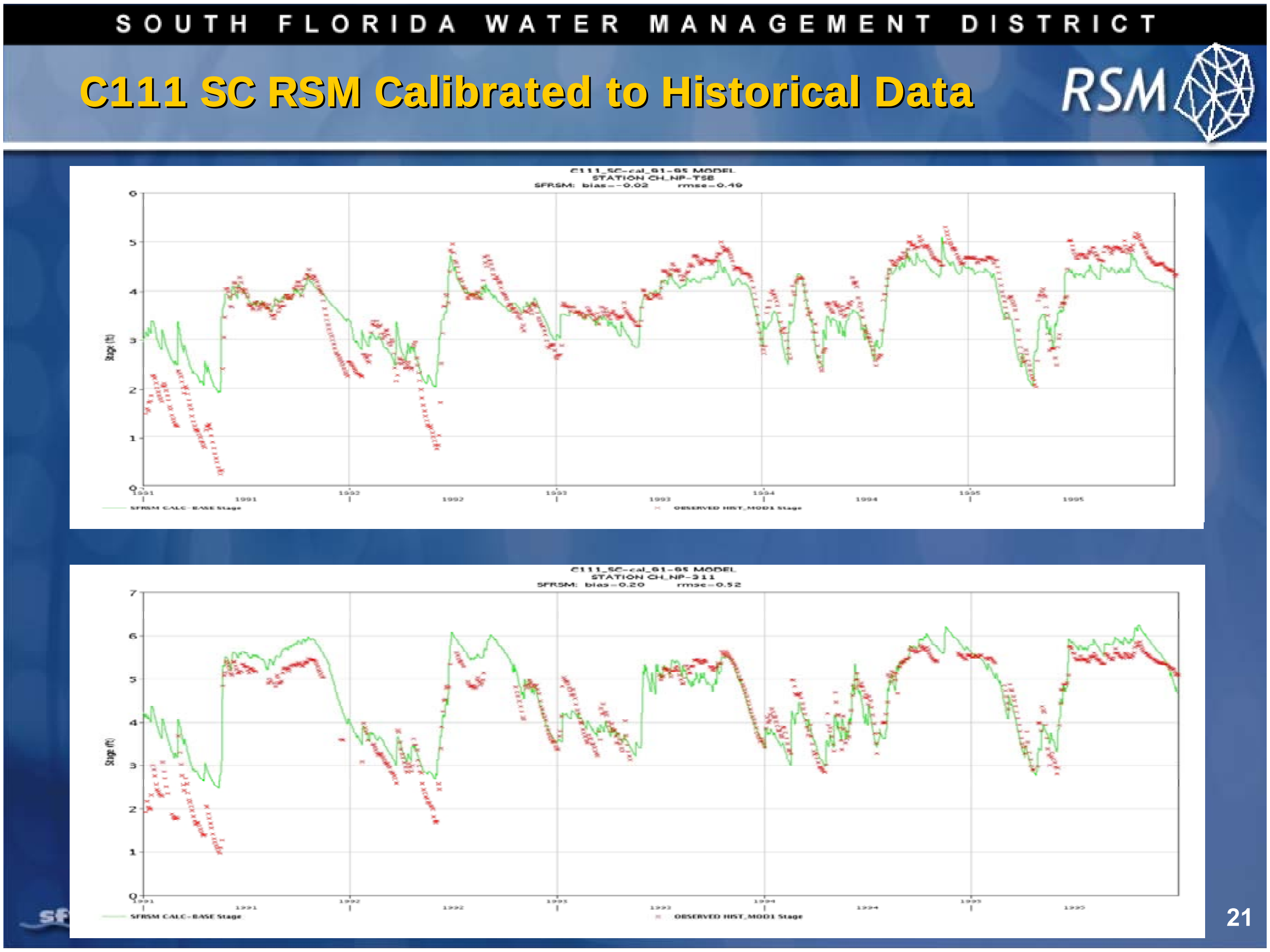
Groundwater stage values calibrated well with measured values for many sites. The hydrographs presented here, and on the following slides, show the comparison of the calibrated and observed stage data at different groundwater and surface water observation stations.



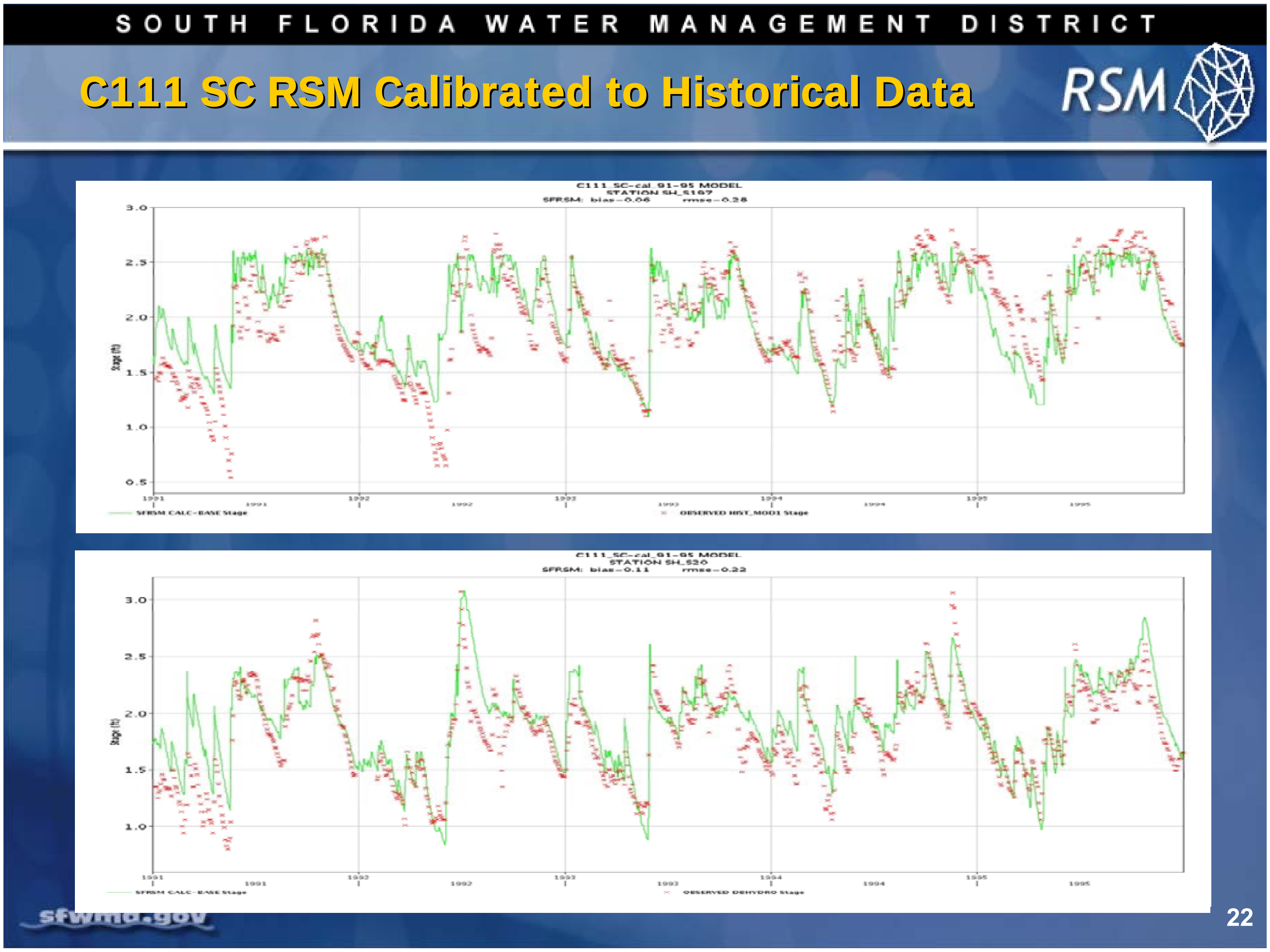
At some sites it was determined that the "extinction depth" parameter of the <layer1nsm> HPM was not correct and required calibration. There was insufficient evapotranspiration resulting in groundwater stage that was too high.



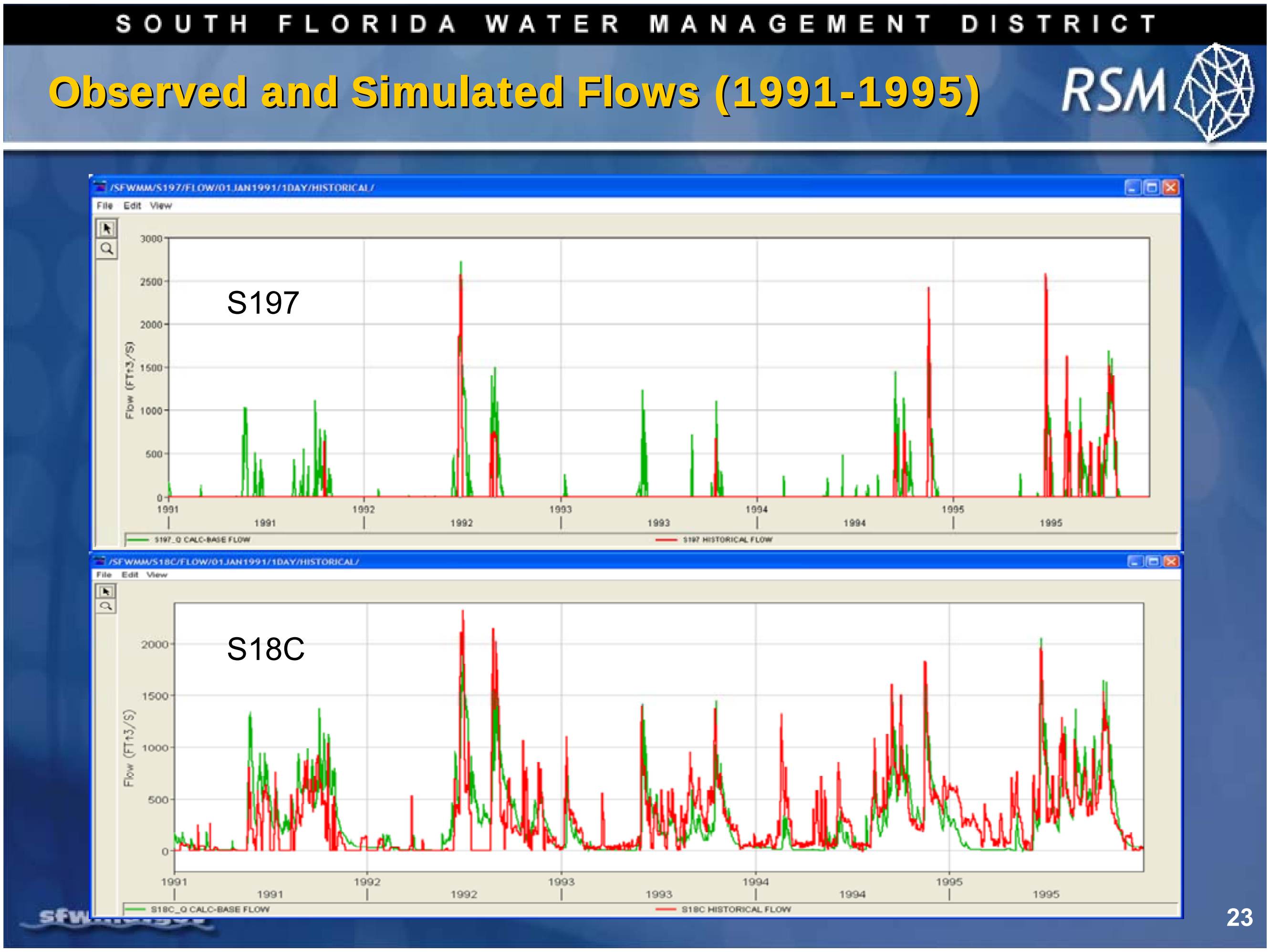
Simulated canal stages matched fairly well with historical stages. The RSM was not able to simulate the low stages because the model was not transpiring sufficient water.



In some marsh locations the pattern of stage time series was reproduced, but the seasonal peak flows were not well simulated.

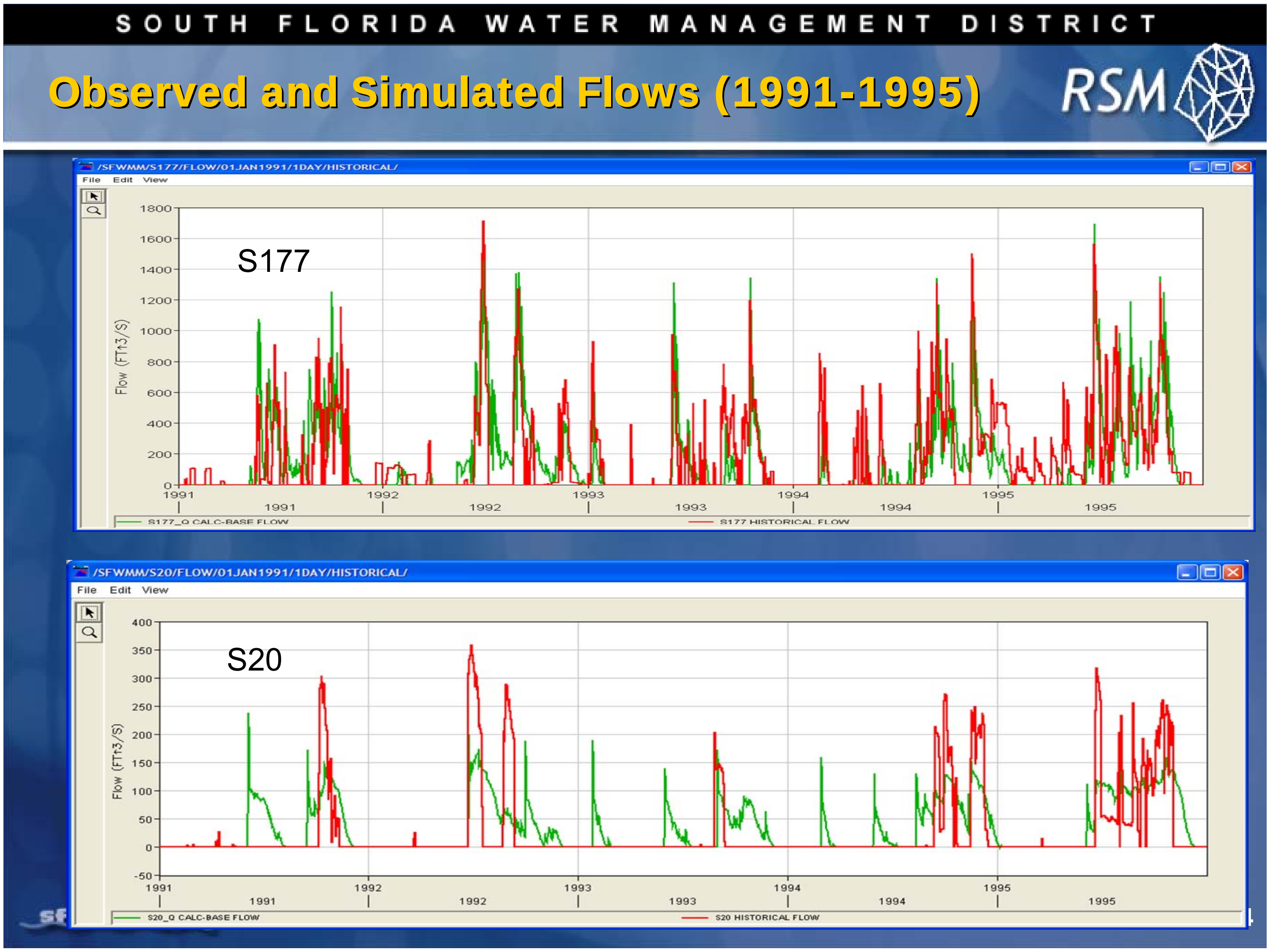


The simulated segment head matched well with the observed values in the canals.

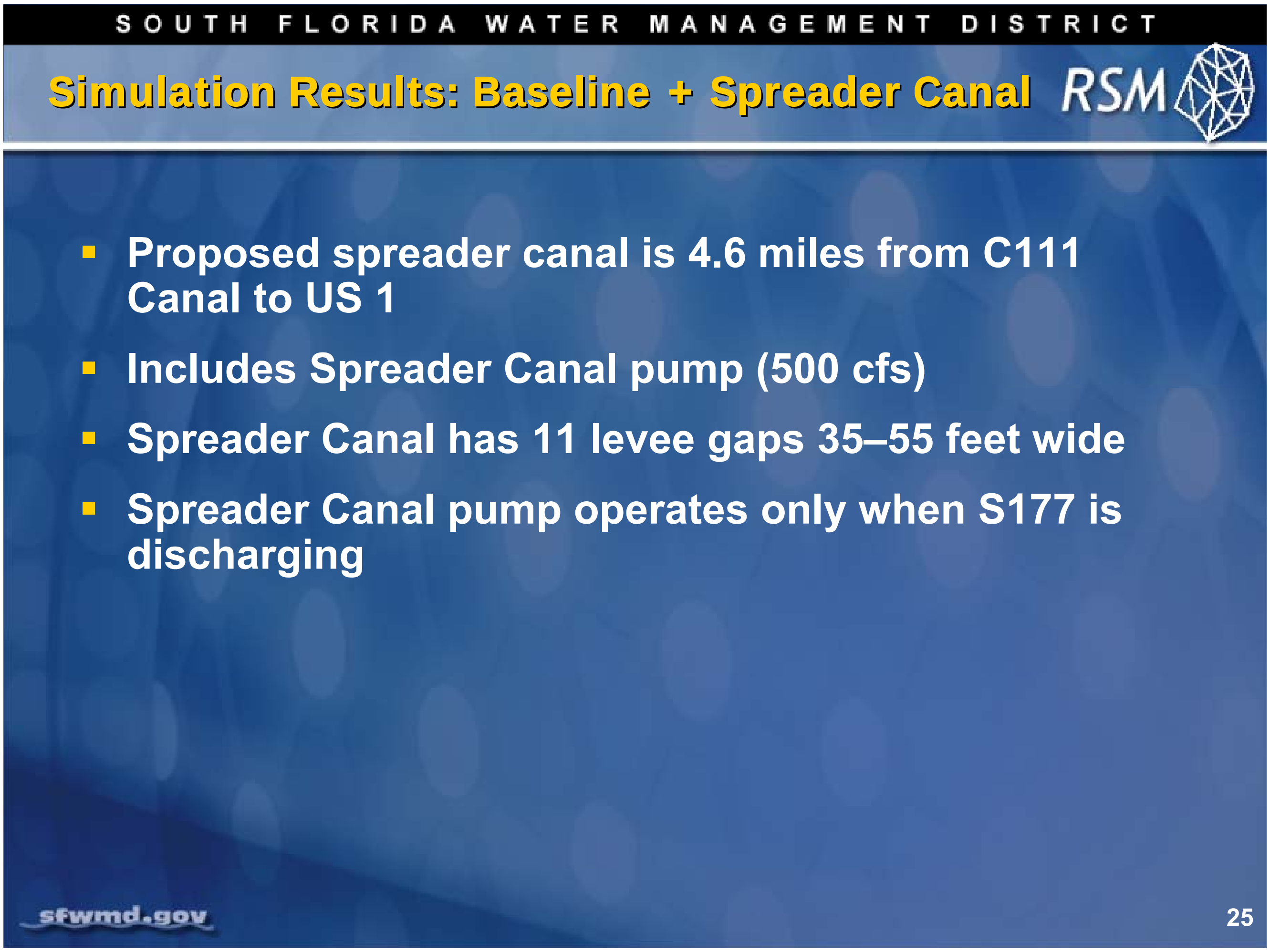


After the calibration was completed, the Management Simulation Engine (MSE) component of the model was implemented and the flow in the canals was simulated using management at the structures.

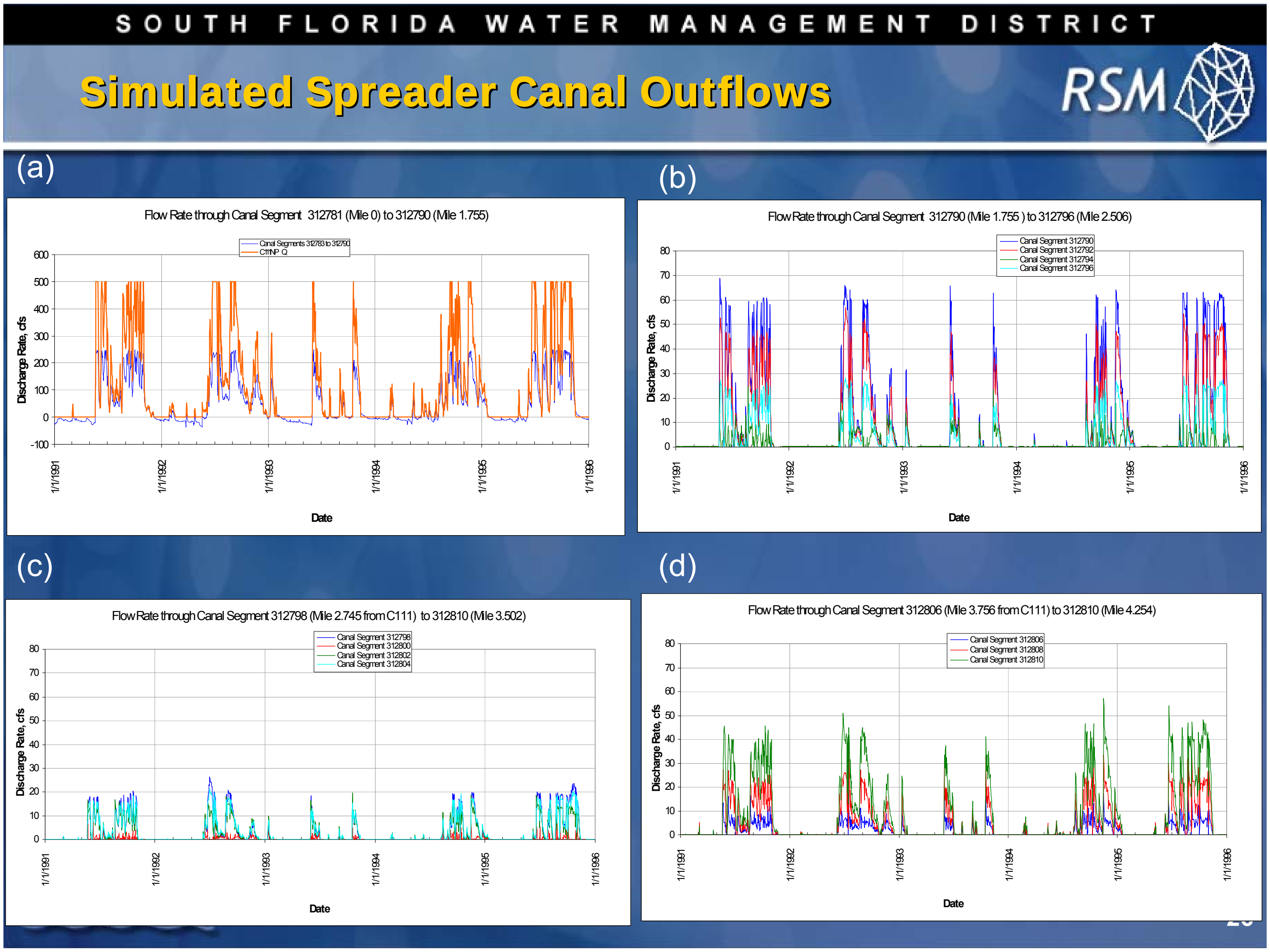
This slide shows a comparison of the simulated flows and the historical flows at the two downstream structures of the C111 Canal from the MSE simulation. The simulated flow at S18C compared well with historical flow.



The simulated flows matched the historical flows at S177, but did not match so well at S20.



The first alternative was to add a Spreader Canal to the C111 Basin. This slide lists the design parameters for the Spreader Canal alternative.



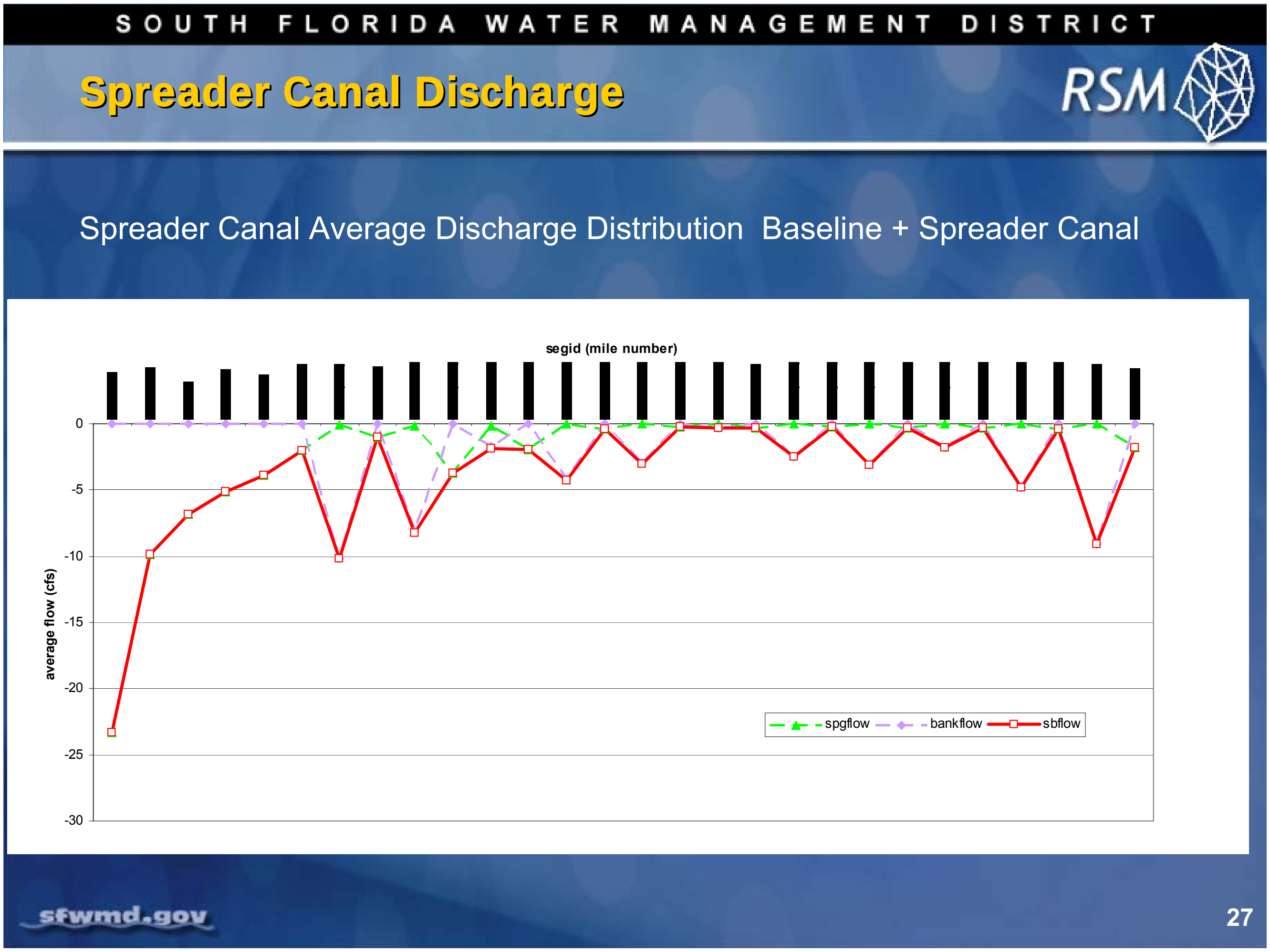
The graphs in this slide show the distribution of flow along the Spreader Canal decreasing

(a) from the pump to mile 1.755

(b) through the next four segments from mile 1.755 to 2.506

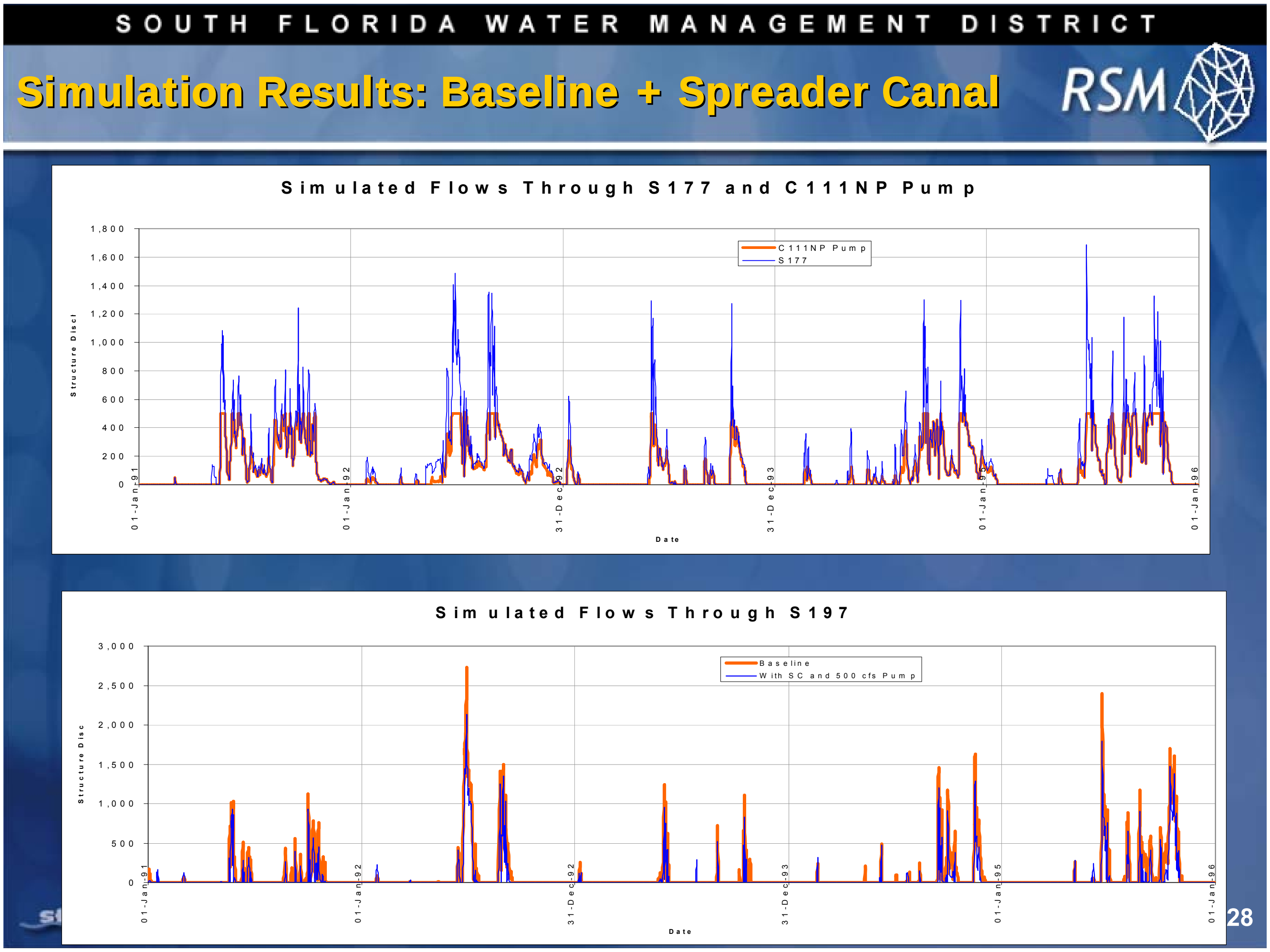
(c) from mile 2.745 to mile 3.502

(d) mile 3.756 to mile 4.254

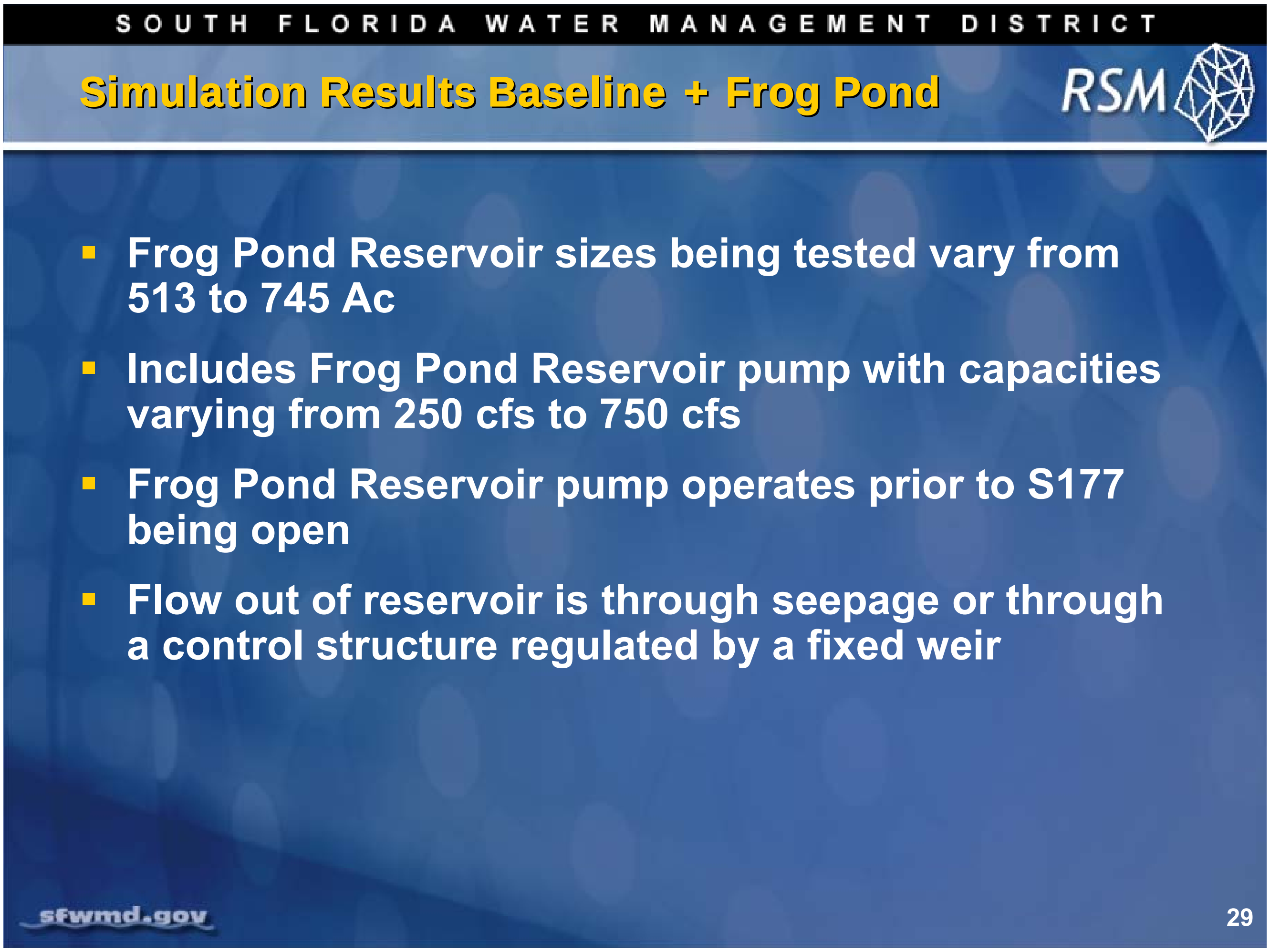


Discharge into the marsh along the Spreader Canal was simulated to show how well the Spreader Canal operated.

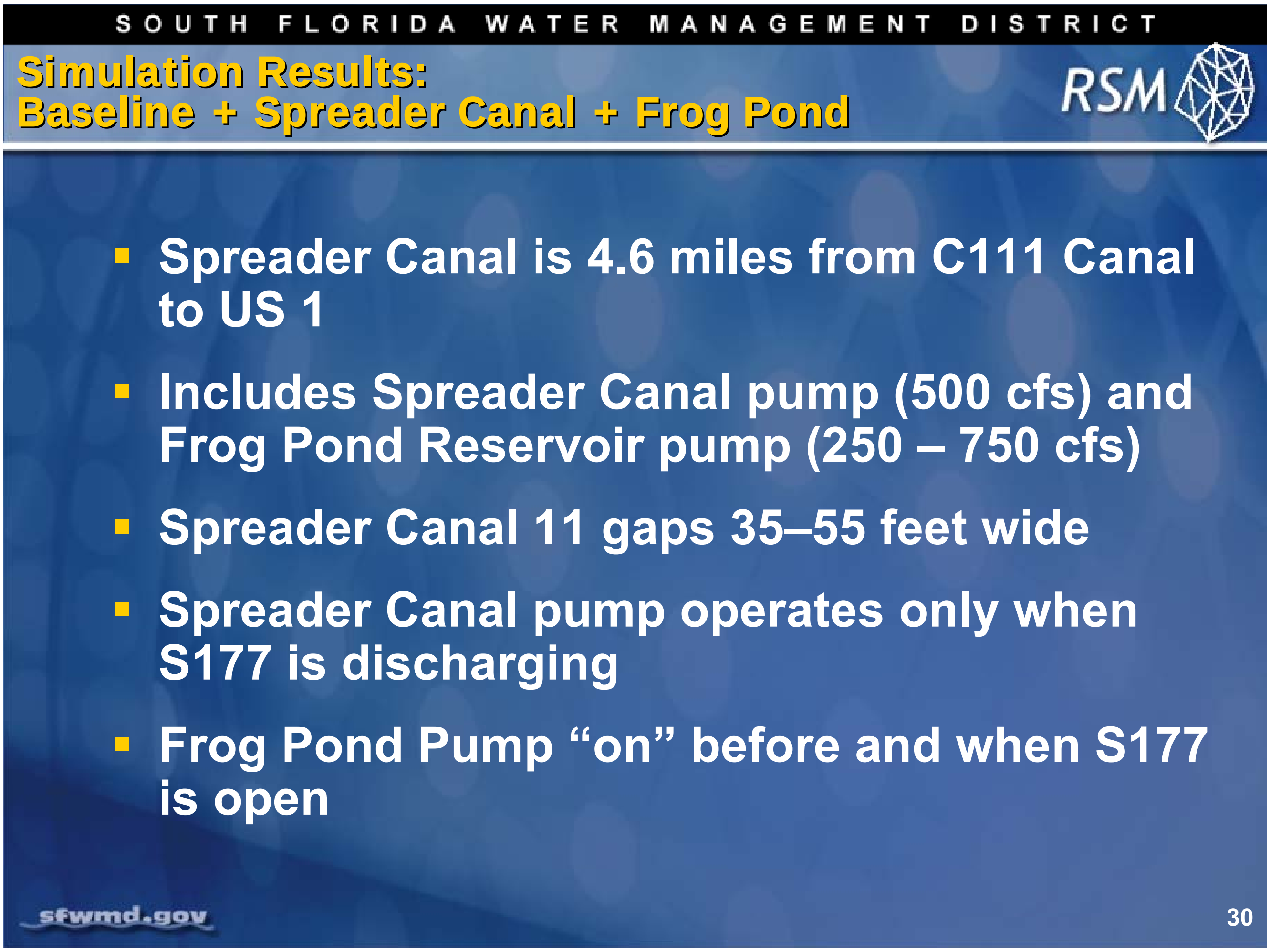
The flow includes seepage (spgflow) and overbank (bankflow) flows. The spikes in flows occur at the location of gaps in the berm.



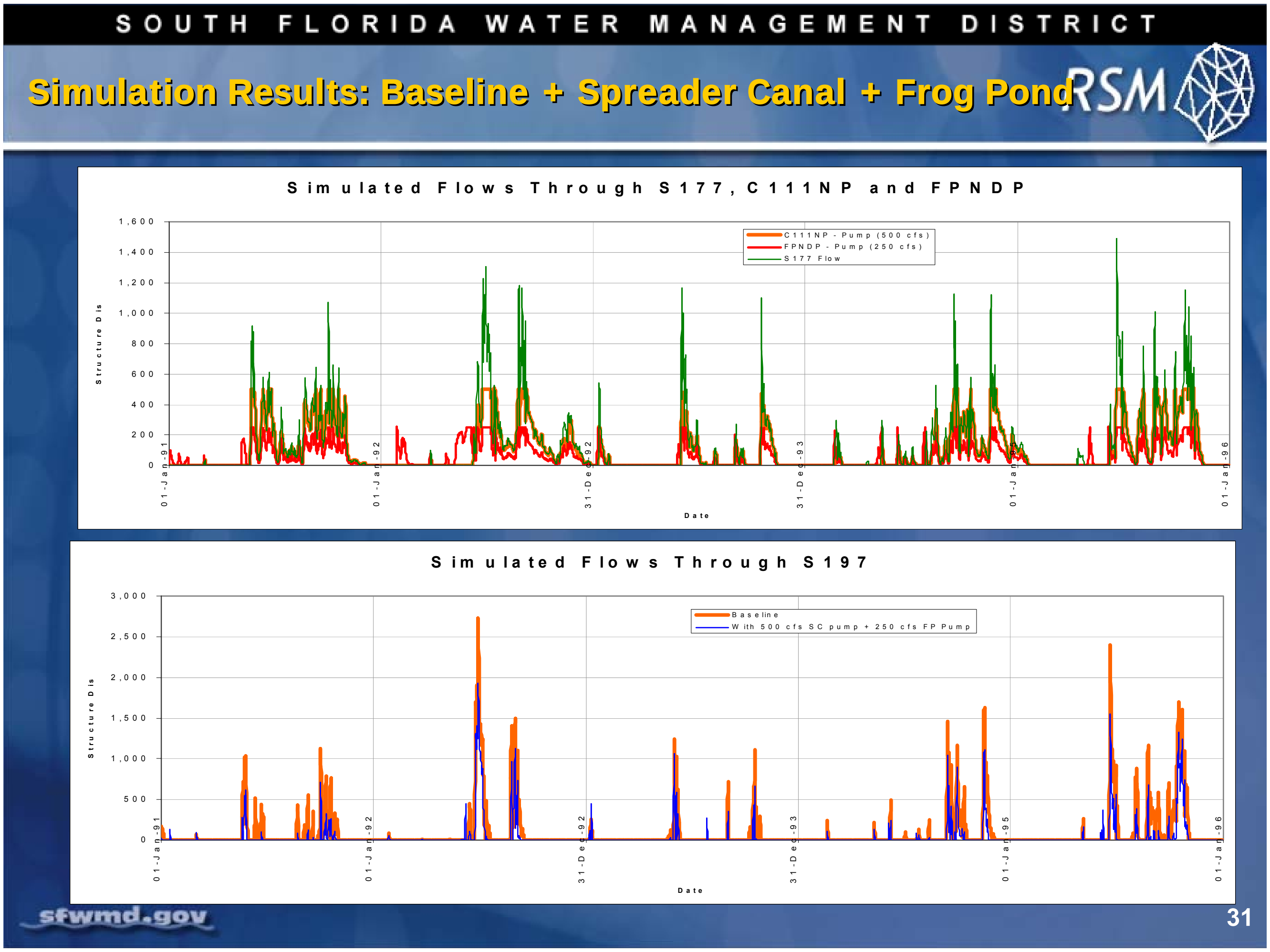
These graphs show the simulated flows through the Frog Pond Reservoir inflow pump (C111NP - 500 cfs maximum capacity) and the reduced flows at S197 as a consequence of flow diversion into Frog Pond Reservoir.



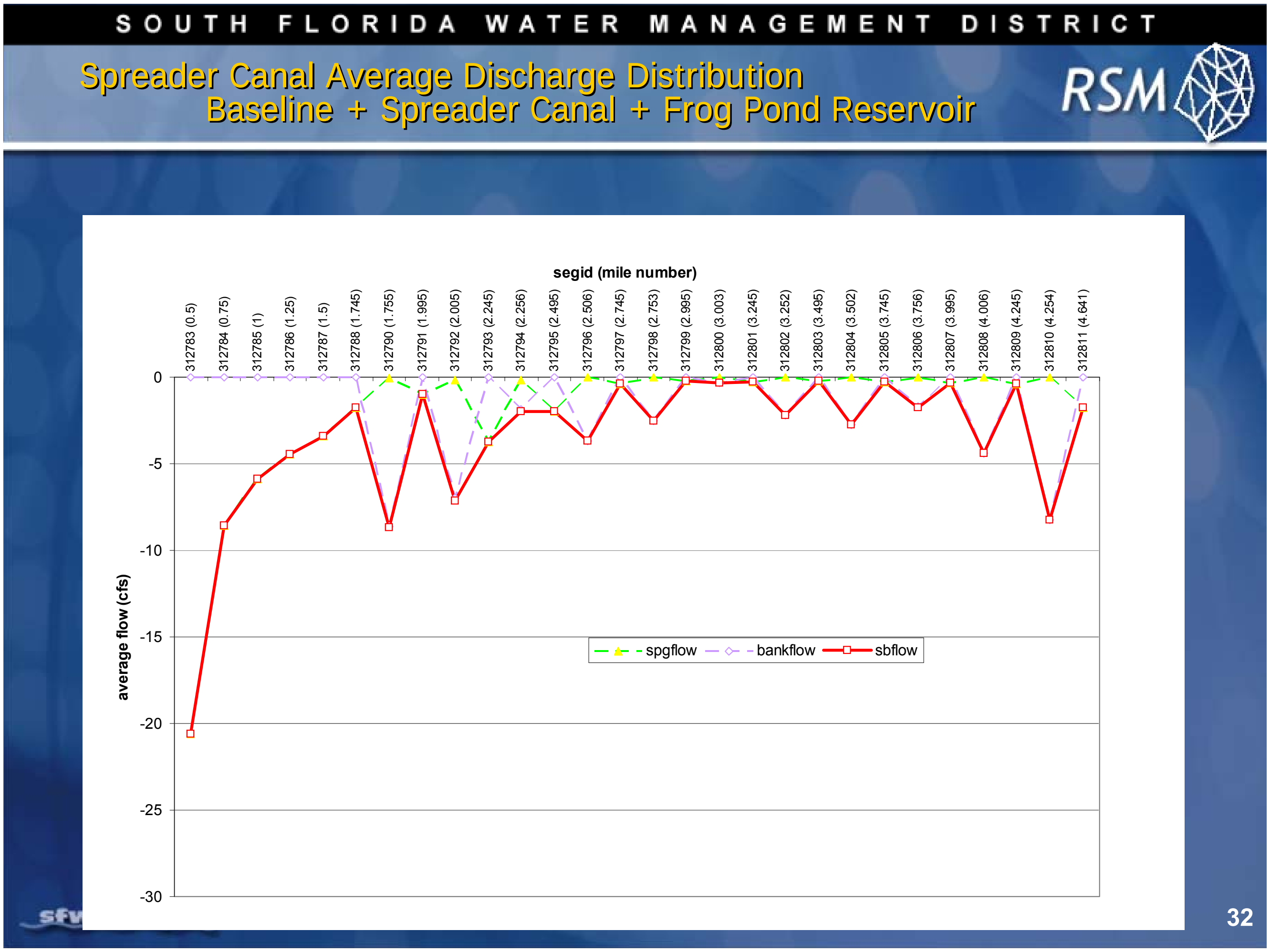
The design characteristics of the Frog Pond alternative are listed in the slide above.



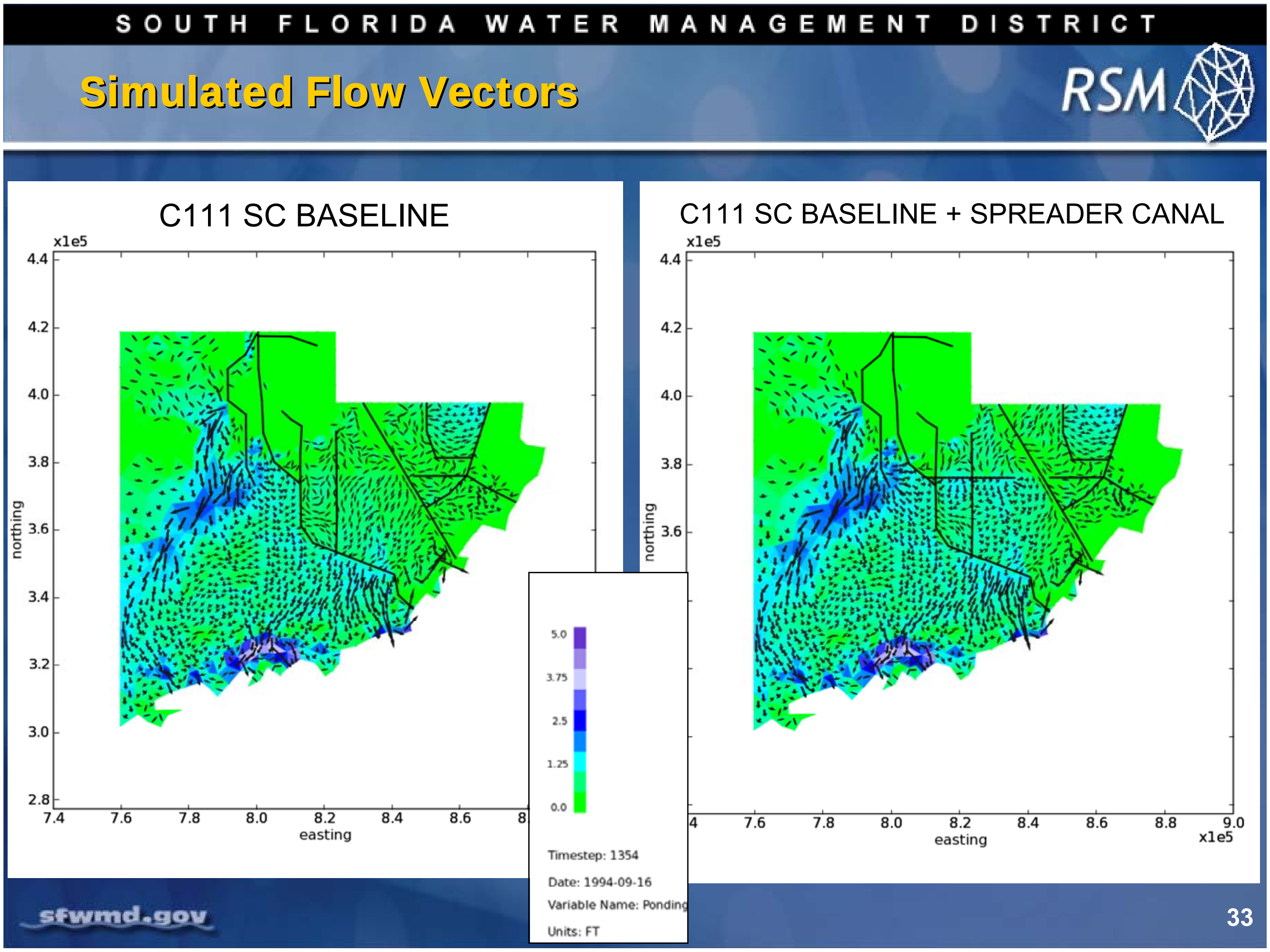
Design characteristics of the combination of the Frog Pond and Spreader Canal alternatives.



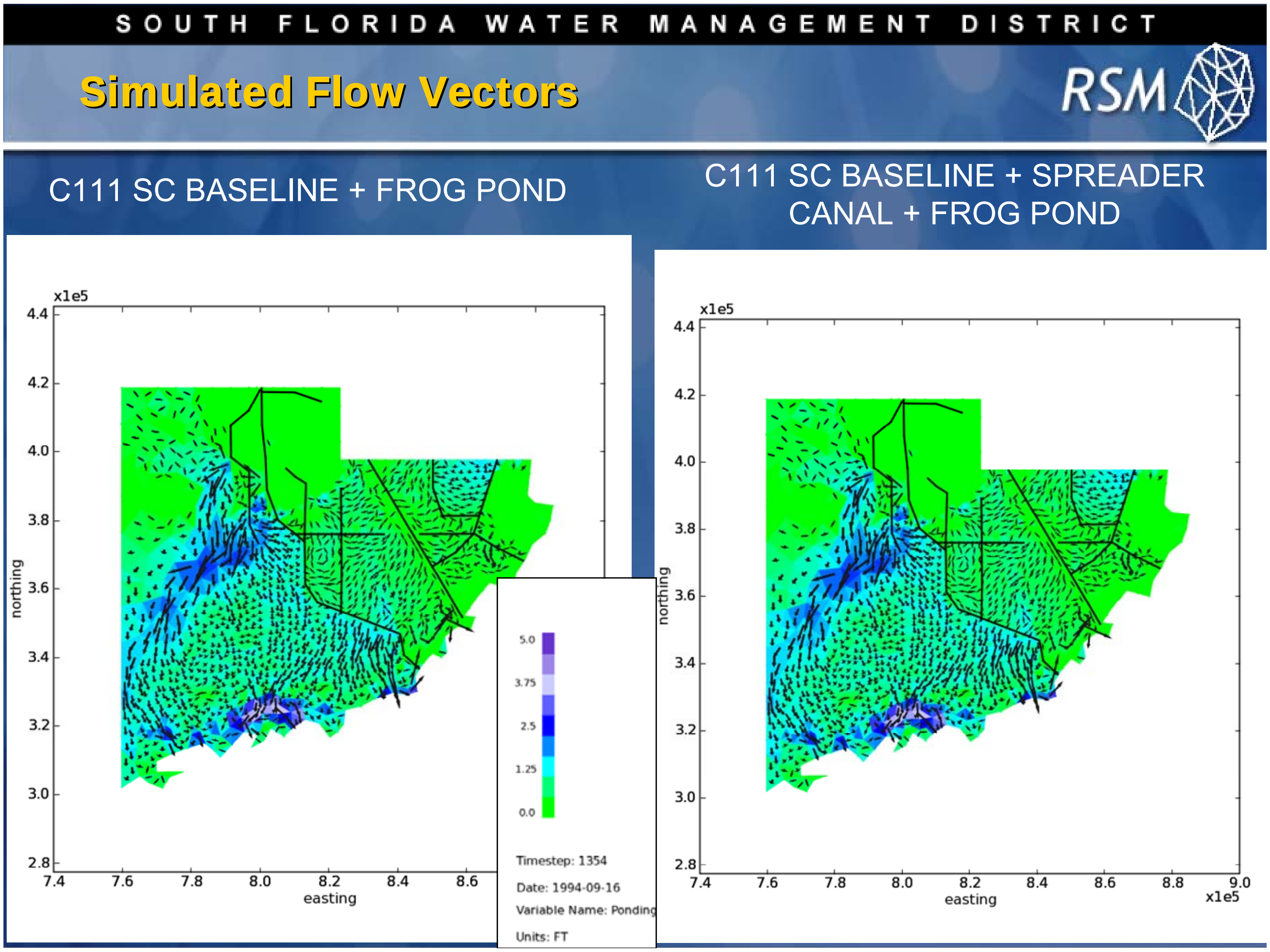
Simulated flows through S197 decrease more with the Spreader Canal and the Frog Pond Reservoir . And, there is greater flow into the Everglades National Park.



The discharge from the Spreader Canal into the marsh remains equivalent to the flows with the Spreader Canal alone.



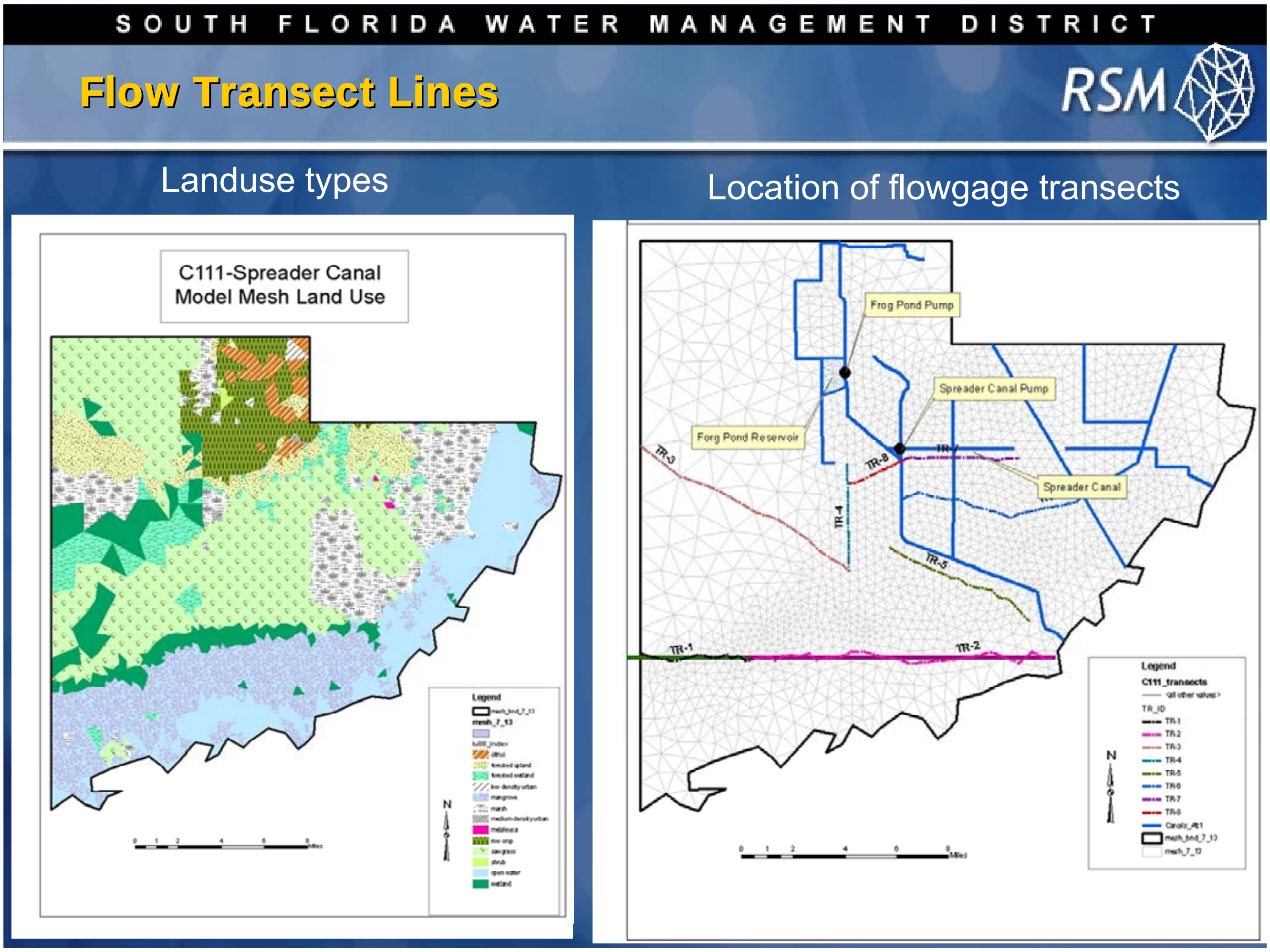
An assessment of the flow vectors created by the RSM shows greater ponding in the marsh downstream of the Spreader Canal.



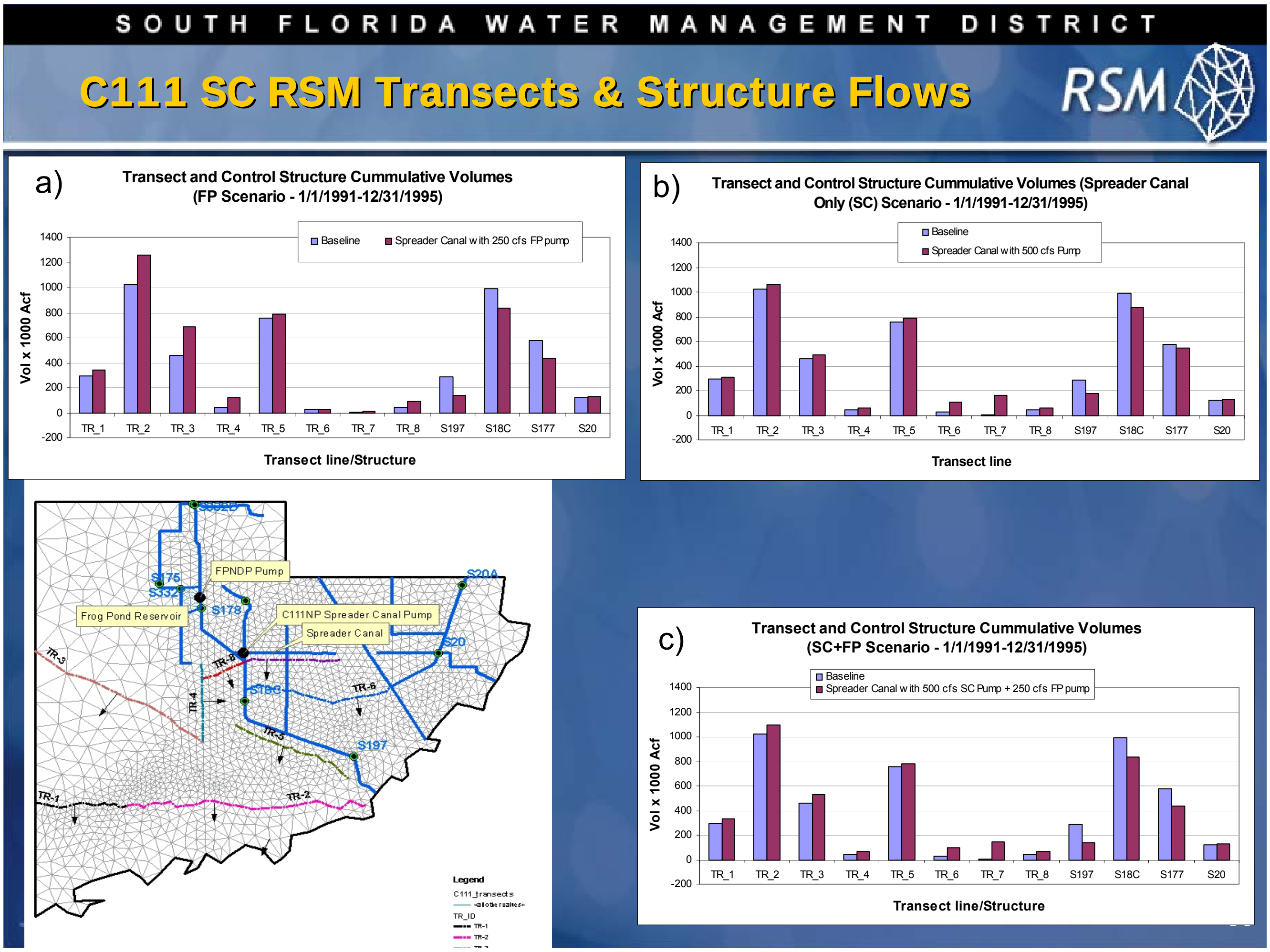
Comparison of scenarios:

1. Baseline with Frog Pond Reservoir and
2. Baseline with Frog Pond Reservoir and Spreader Canal.

The inclusion of the Spreader Canal diversion results in reduced flows at S197.

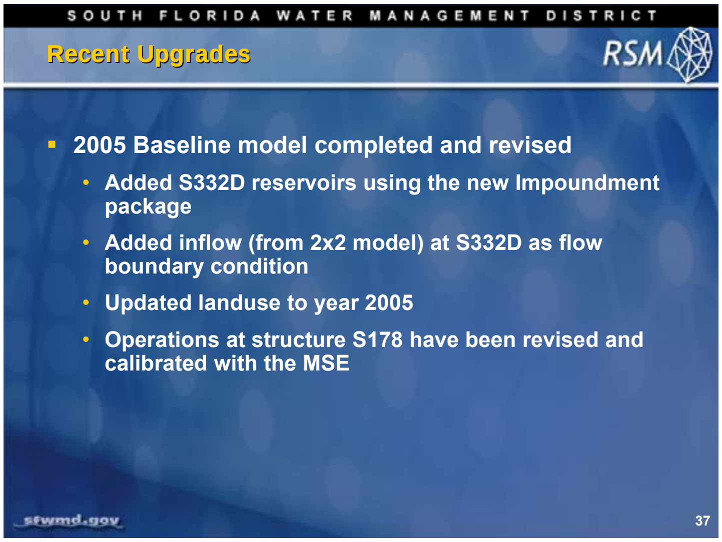


Several flow-volume transects were established to evaluate the impact of the alternative project formulations on the overland sheet flow and groundwater flow into specific vegetation types.



Implementation of the Frog Pond Reservoir greatly increased flow across Transect 1 and Transect 2, while reducing discharge through the C111 canal. Implementation of the Spreader Canal alone increased the flow across Transect 6 and Transect 7 (see graph 'b' on the top right of the slide above). The implementation of both structures maintained the flow across Transect 6 and Transect 7, but decreased the flow across Transect 1, Transect 2, and Transect 3.

The C111 Spreader Canal model has shown itself to be a useful tool for evaluating the effectiveness of spreader canals and impoundments for modifying the structure flows and flows into the marsh to be restored.



The 2005 Base RSM is being used to evaluate alternative project formulations for the Frog Pond and the Spreader Canal. Loveland Slough infiltration basins are also being evaluated through a series of alternative project formulations.

KNOWLEDGE ASSESSMENT

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

1. What was the purpose of the C111 Spreader Canal project?
2. How many cells and canals were in the C111 RSM?
3. What was the dominant landuse in the model domain?
4. How was the spreader canal modeled?
5. How many canal reaches have levees?
6. How big was the impoundment (i.e., number of cells)?
7. How many observations were used for calibration?
8. What parameters were calibrated?
9. What were the criteria for successful calibration?
10. Did C111 perform better than the SFWMM?
11. Did the model alternatives show a reduction in the number of high flow events at S20 and S18C?

Answers

1. The purpose of the C111 RSM is to test the effectiveness of the addition of a spreader canal and a storage impoundment for improving the hydroperiod of the C111 basin.

2. The C111 model includes 3505 cells and 14 canals.

3. The dominant landuse is wetlands (59%).

4. The spreader canal is modeled as a canal with a no-flow boundary along the north bank and leaky levee with long weirs along the south bank.

5. Three of the C111 canal reaches had levees.

6. The impoundment covered 15 cells. It was an above-ground impoundment so there was no interaction with adjacent cells.

7. Thirty six wells and 18 canal stage observations were used in the calibration.

8. Four groups of parameters were calibrated: aquifer conductivity, Kh; reach level seepage coefficients, canal/aquifer interaction, k/δ; and canal Manning's n.

9. The criteria for the objective function were to achieve bias less than 0.25ft and RMSE less than 0.50ft between the simulated and historical time series of daily values for each monitoring site for the period 1984-1995.

10. It appears that the C111 RSM met the performance criteria better than the SFWMM.

11. The peak flows at S20 and S18C structures were reduced and there were more low flow events with the implementation of the spreader canal and Frog Pond Impoundment simulations.

Lab 12: C111 RSM – Model Conceptualization, Calibration, and Application

Time Estimate: 3 hours

Training Objective: To learn subregional modeling components by studying the content of existing RSM files

There are several subregional RSMs currently being implemented by the South Florida Water Management District. These RSMs provide the most comprehensive application of the RSM features. One of the most effective methods for learning the Regional Simulation Model (RSM) is to explore the construction of other RSM applications.

In addition to modeling the flood control and water supply requirements for each subregion, each RSM has unique model features associated with the landscape and special subregional water resources issues.

There are currently four subregional models which include:

- C-111 subbasin (C111)
- Everglades- Lower East Coast Service Area (Glades-LECSA)
- Lake Okeechobee Service Area (LOSA-EAA)
- Biscayne Bay Coastal Wetlands (BBCW)

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/lab12_subregion`** directory. Additional materials in the directory include:

`C-111_WRAC_Presentation-12_06_06_Rev1.pdf`

Activity 12.1 Components of a Subregional Model

Overview

This activity includes five exercises:

- Exercise 12.1.1. Find input files for C111 RSM
- Exercise 12.1.2. Review content of C111 RSM input files
- Exercise 12.1.3. Review content of Biscayne Bay Coastal Wetlands RSM input files
- Exercise 12.1.4. Review content of Lake Okeechobee Service Area (LOSA-EAA) RSM input files
- Exercise 12.1.5. Run the LOSA-EAA RSM

In this activity, you explore the geodatabases, time series data, RSM input XML files and typical outputs from each subregional model. The information for each RSM implementation is placed in a common directory structure (**Fig. 12.1**).

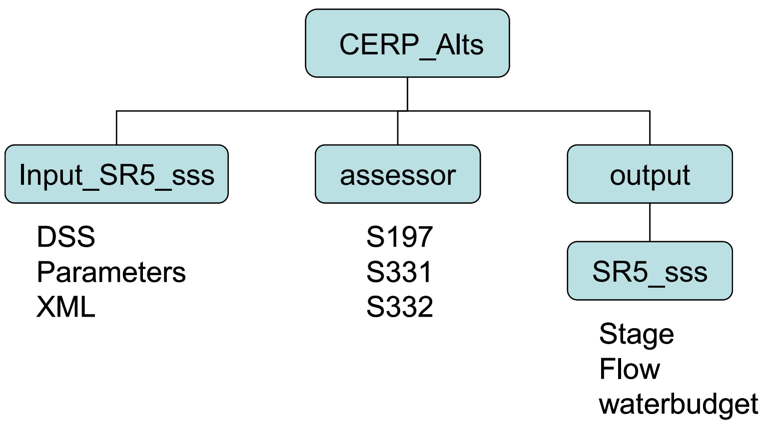


Figure 12.1 Diagram of directory structure for the RSM implementations

This directory structure is useful for finding the necessary files and data used in any RSM model. The overall subregional model contains input, workspace and one or more model directories that contain the **<main>.XML** program, together with any input files or data that are specific to that model run.

The input directory contains individual XML files for each of the element blocks in the input. The XML elements are grouped together to facilitate transporting elements to other subregional models.

Exercise 12.1.1 Find input files for C111 RSM

Four subregional RSM implementations have been created for south Florida. Each of the four models contains several input XML and data files that provide the components that are required for a complete RSM implementation.

1. In this exercise you will identify each of the input files for the C111 model:

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

   Similar files can be identified for each subregional model. This exercise provides a first look at the complexity of a subregional model.

File description	File name
Main program	
<mesh> block	
Mesh geometry	
Surface elevations	
Aquifer bottom elevations	
Initial heads	
Hydrologic Process Modules	
Conveyance parameters	
Rainfall depths	
Reference ET depths	
Aquifer hydraulic conductivities	
Public water supply wells	
Levee boundary conditions	
<network> block	
Network geometry	
Initial heads	
Arcs_index	
Canal boundary conditions	
Segmentsource flow data	
Segmentghb tidal data	
<Lakes> Block	
Lake inflow source data	
<watermovers> block	
Levee seepage parameters	
<assessors> block	

File description	File name
Special assessors	
<mse_network> block	
mse_network properties	
<controllers> block	
Controllers for mseStructures	
<Rulecurves> block	
Annual stage schedules	

Exercise 12.1.2: Review content of C111 RSM input files

It is not practical for you to run the model in this lab because the C111 Model requires 13 minutes for each year. This exercise is designed to acclimate you to the content of the standard files used in a subregional simulation.

1. Go to the **`$RSM/../data/C111/input_SR5_sss`** directory and look at the contents of each XML file
   - List the main XML file
   - What are the different types of boundary conditions implemented in the model?
   - How many mesh cells are in the model?
   - What is the deepest approximate bottom of the aquifer?
   - How many segments are in the model?
   - How many different HPMs are used in the model?
   - How many canal boundary conditions are implemented in the model?
   - Which type?
   - What kinds of waterbodies are used in the model?
   - What is the lake used for?
   - What kinds of user-defined watermovers are used in the model?
   - What types of output are generated from the model?
   - How many levee sections are there between S176 to S177?
   - How many cells does the S332DN impoundment cover?
   - How many special assessors are used in the model?
   - How many water control units <mse_units> are in the mse_network?

An RSM model has been developed for the C111 basin. This interim model was developed to model the 2005-base conditions of the area. One aspect of the model was to calculate flow across selected flow transects (**Fig. 12.2**).

2. Find the flow across Transect TR-3, Transect TR-23B and Transect TR-1.

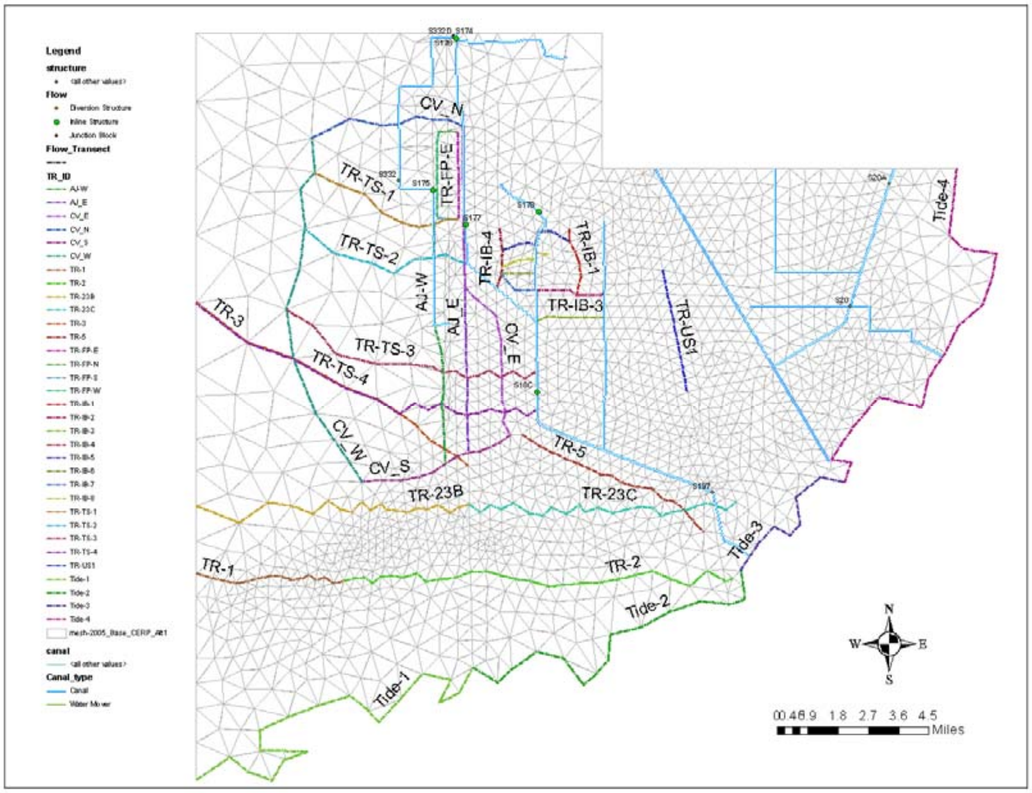
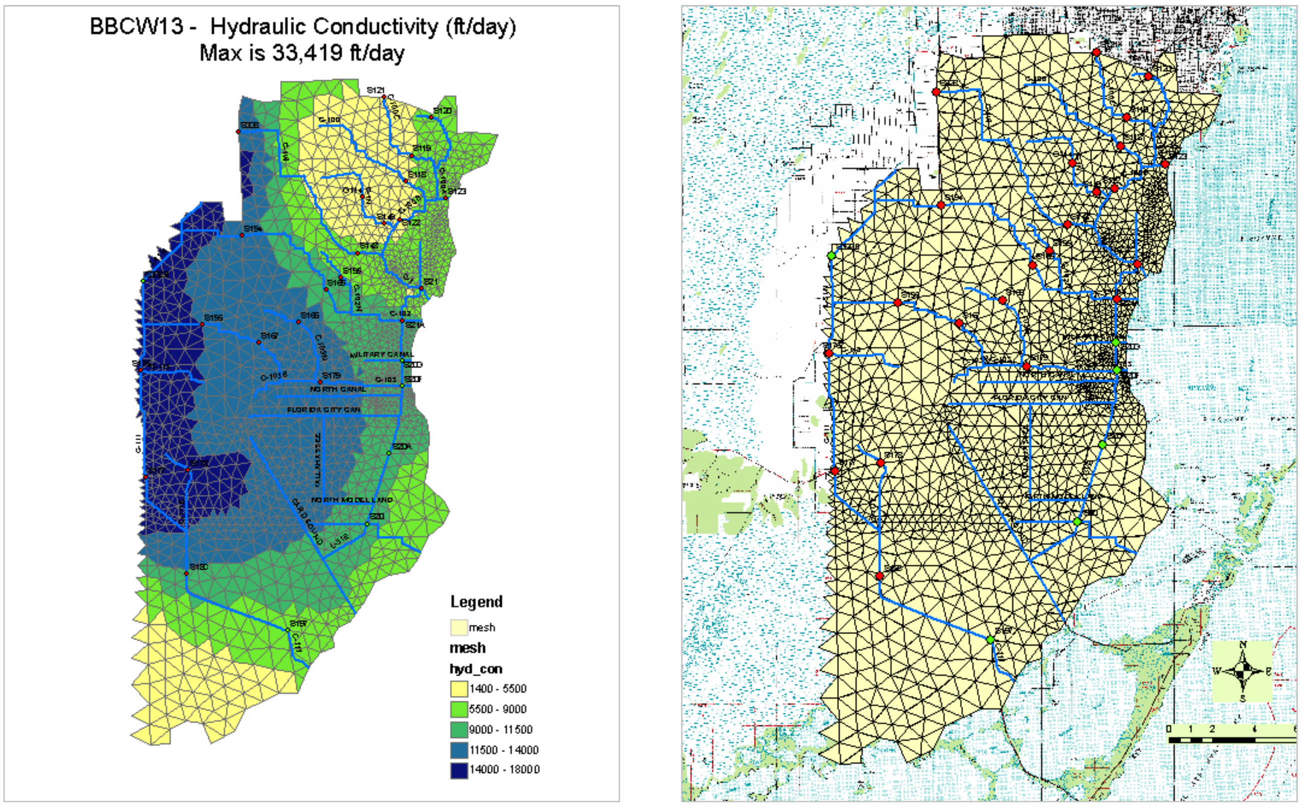


Figure 12.2 The mesh, canal network and flowgages used in the C111 Basin

Exercise 12.1.3 Review content of Biscayne Bay Coastal Wetlands RSM input files

An RSM model was developed for the coastal subregion of south Miami-Dade County. The Biscayne Aquifer underlying the domain has high and varied hydraulic conductivity (**Fig. 12.3**). There is a dense network of canals to provide adequate drainage to this low gradient area. The model XML code is organized in considerable detail (**Fig. 12.4**).



a) Distribution of aquifer hydraulic conductivity

b) Locations of canals and structures

Figure 12.3 Biscayne Bay Coastal Wetlands RSM domain and mesh

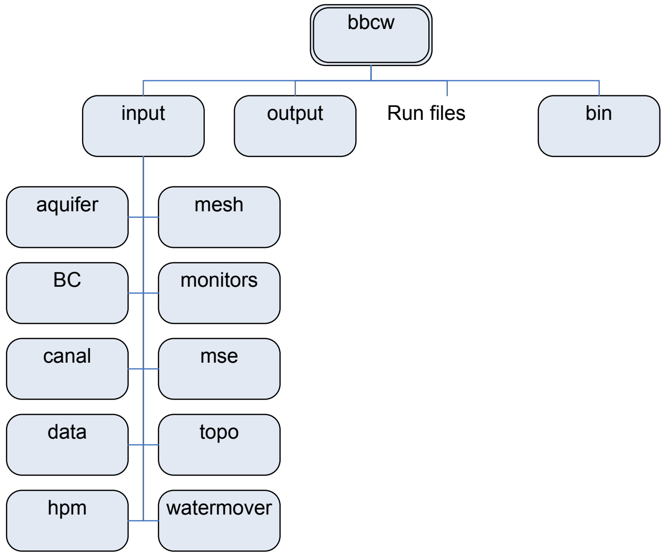


Figure 12.4 BBCW RSM XML code organization

3. Go to the Biscayne Bay Coastal Wetlands (BBCW) directory and identify the different components of the BBCW RSM. The input data are located in the **`$RSM/../data/BBCW`** directory. The main model, **`run_calib_bbcw.xml`**, is located in the directory: **`$RSM/../data/BBCW/bbcw`**
   - How are the boundary conditions (BCs) organized for the model?
   - What kinds of BCs are applied to the mesh?
   - What data is in the aquifer directory?
   - How many different HPM indexed-entry files are in the HPM directory?
   - What are the boundary conditions on the canal network and how many BCs are specified?
   - What kinds of watermovers are used in the BBCW model?
   - What outputs are generated from this model?
   - How many groundwater conductivity zones are used in the model?
   - Looking at the network, how many canal-arc parameter sets are there?
   - How many canal segments are in the BBCW RSM?
   - What is the range in leakage coefficient among the canal reaches?
   - What time series data are used in this model?
4. Run the BBCW model using the RSM Graphical User Interface (RSM GUI).
5. Run **`makePlots.py`** in the **`./pest/bbcw_test`** directory:

```
/opt/local/share2/bin/dssvue ./bin/makePlots.py ./bbcw_fetch_calibqh1.ctl
```

6. Observe the results in the **`./pest/bbcw_test/plots`** subdirectory.

Note that the model performs very well for some structures and poorly at other structures.

LOSA-EAA RSM

The LOSA-EAA model was developed to simulate the water supply requirements and flood control management issues for the agricultural land in the Everglades Agricultural Area (EAA).

The LOSA-EAA RSM is a development model used to test the implementation of water control districts (WCDs) for the EAA. It models the surface hydrology of agricultural land through the implementation of hub HPMs and water control districts. The hub HPMs describe the distribution of the HPMs, within each cell, for all of the cells in that area.

The WCDs are designed to manage the water levels in the secondary canal system within each WCD. The agricultural land is sub-irrigated and the water table is managed by managing the canal water levels.

LOSA-EAA RSM Geodatabase

The geodatabase **`$RSM/../data/losa_eaa/workspace/losa_mesh.mxd`** contains the spatial information about the LOSA-EAA RSM domain including the structures, mesh_framework, and mesh (Fig. 12.5).

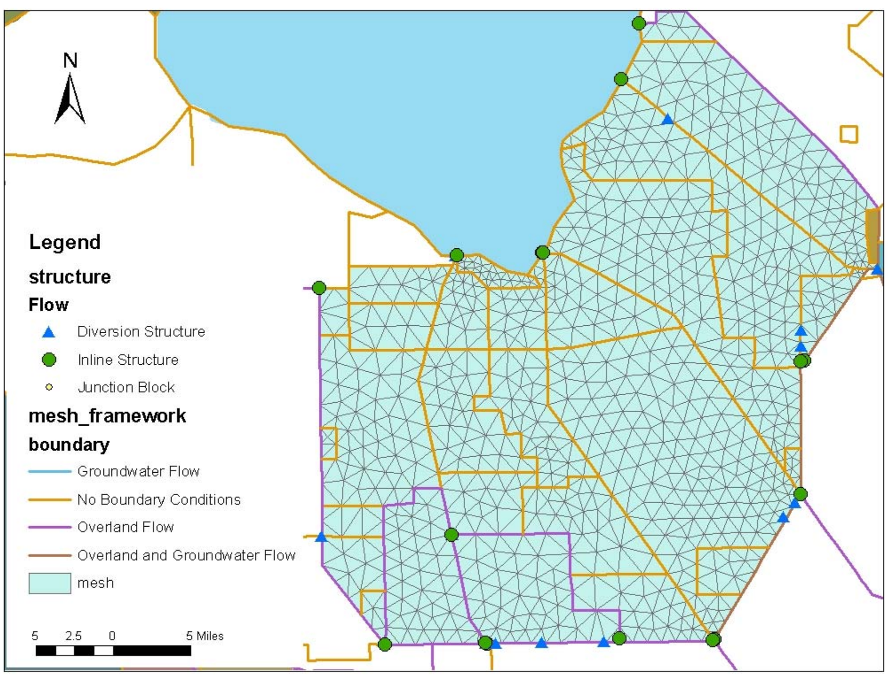


Figure 12.5 Lake Okeechobee Service Area (LOSA-EAA) RSM domain and mesh

The topography (Fig. 12.6), along with the levees (no-flow boundaries) and canals, define the locations of the water control districts (Fig. 12.7).

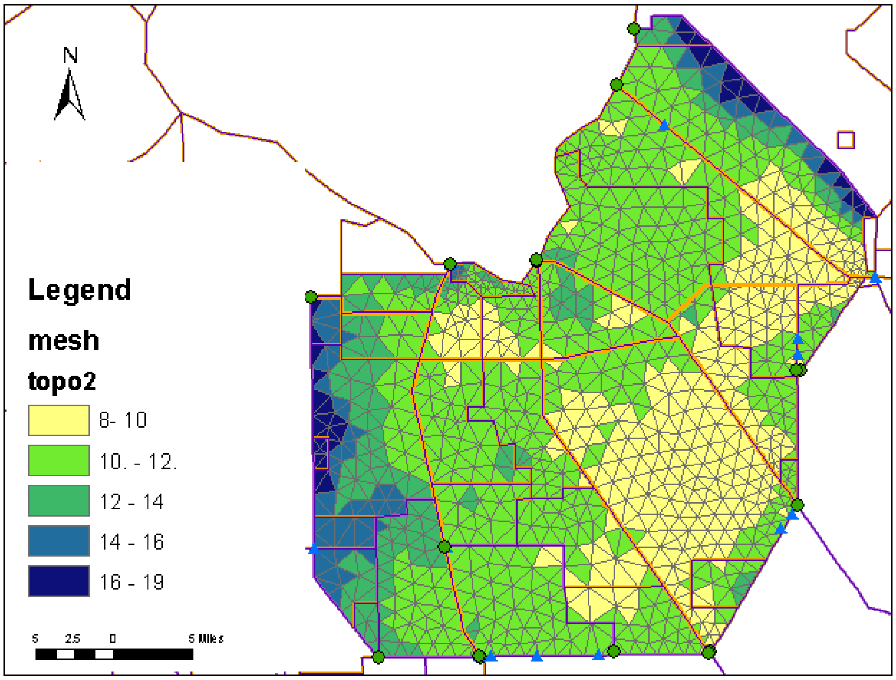


Figure 12.6 Topography for the LOSA-EAA RSM

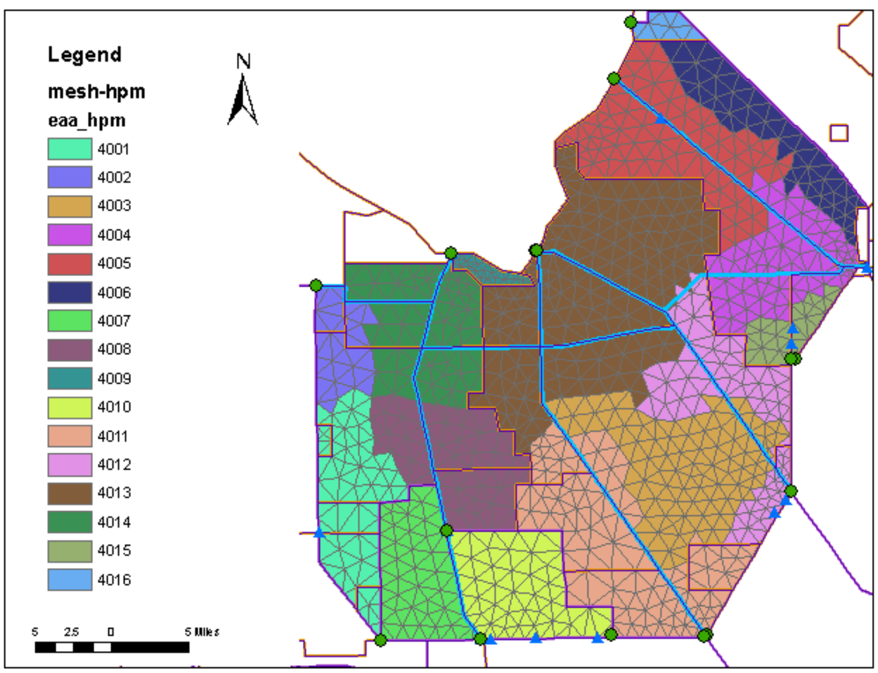


Figure 12.7 Distribution of HPMs for the LOSA-EAA RSM

Exercise 12.1.4 Review content of the Lake Okeechobee Service Area (LOSA-EAA) RSM input files

The LOSA-EAA RSM is located in the directory: **`$RSM/../data/losa_eaa`**

The main file is **`run_calib_HL_ROTT_newBC.xml`**

The XML input files and the time series data (DSS files) are found in the **`/input`** directory (**Fig. 12.8**).

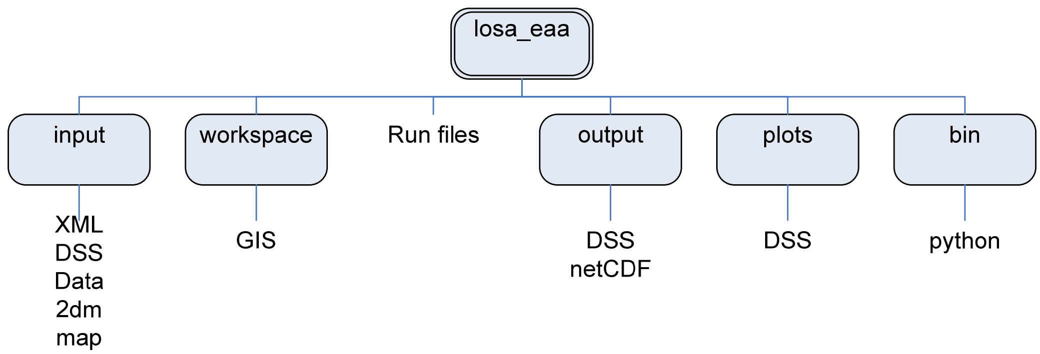


Figure 12.8 LOSA-EAA RSM XML code organization

The following questions will lead you through the important features of the LOSA-EAA RSM.

7. What are the network boundary conditions?
8. What are the hydraulic conductivity zones?
9. What types of HPMs are used within the hubs?
10. How many Water Control Districts (WCDS) are implemented in this RSM?
11. What are the characteristics of the WCDs?
12. How many canal reaches are there?
13. Find the location of wcdwaterbody '**295203**', and then find out how and where it connects to the network. Do this in ARCGIS.

Exercise 12.1.5 Run the LOSA-EAA RSM

14. Run the model (**`run_calib_HL_ROTT_newBC.xml`**) using the RSM GUI.
15. Compare simulated and historical stage time series for selected structures:
    - Go to **`$RSM/../data/losa_eaa`** directory
    - Run the Python script to create the DSS file:

```
./dssvue ./bin/post_process_verify.py ./bin/verify_stage_plot_daily.ctl
```

16. Run HecDSSVue from the RSM GUI and open **`./output/post_process.dss`**
17. Select "**`calc`**" and "**`HISTORICAL`**" parts for the same structure and plot.
    - How well does the model simulate historical flows?
    - What other comparisons can be made from **`post_process.dss`** file?

Answers for Lab 12

Exercise 12.1.1

File description	**File name**
Main program	run_c111_mse_SR5_sss.xml
<mesh> block	
Mesh geometry	./input_SR5_sss/PIR1_Alt2Db_mesh.2dm
Surface elevations	./input_SR5_sss/PIR1_Alt2Db_topo.dat
Aquifer bottom elevations	./input_SR5_sss/2005Base_BotL1_12_01.dat
Initial heads	./input_SR5_sss/PIR1_Alt2Db_topo.dat
Hydrologic Process Modules	./input_SR5_sss/CERP_Alt1_evap_prop.xml
Conveyance parameters	./input_SR5_sss/mann_prop_12_01_06.xml
Rainfall depths	../../data/rain+et/rain_v2.0_global.bin
Reference ET depths	../../data/rain+et/ETp_recomputed_tin.bin
Aquifer hydraulic conductivities	./input_SR5_sss/2005Base_Calib_Zones_12_01_06.dat
Public water supply wells	./input_SR5_sss/c111_pws_11_21.xml
Levee boundary conditions	./input_SR5_sss/PIR1_Alt2Db_levee_bc.xml
<network> block	
Network geometry	./input_SR5_sss/PIR1_Alt2Db_canal.map
Initial heads	./input_SR5_sss/PIR1_Alt2Db_canal_start_head.dat
Arcs_index	./input_SR5_sss/canal_index_PIR_Alt2Db.dat
Canal boundary conditions	
Segmentsource flow data	./input_SR5_sss/PIR1_Alt2Db_canal_bc.xml
Segmentghb tidal data	./input_SR5_sss/PIR1_Alt2Db_canal_bc.xml
<Lakes> Block	
Lake inflow source data	./input_SR5_sss/daily_str_flw_2005BS.dss
<watermovers> block	
Levee seepage parameters	./input_SR5_sss/PIR1_Alt2Db_levee-seepage.xml
<assessors> block	
Special assessors	./input_SR5_sss/SR5_sss_special_assessors.xml
<mse_network> block	
mse_network properties	./input_SR5_sss/SR5_sss_mse_network.xml
<controllers> block	
Controllers for mseStructures	./input_SR5_sss/CERP-Alt6_mseassessor_controllers.xml
<Rulecurves> block	
Annual stage requirements of the structures.	./input_SR5_sss/SR5_sss_rulecurves.xml

Exercise 12.1.2

1. Answers to individual bullets:

List the Main XML file: ***`run_c111_mse_SR5_sss.xml`***

What are the different types of boundary conditions implemented in the model?

> *(Boundary conditions are in the file:* **`mesh_bc_11_01_IOP.xml`***)*
>
> *pws wells*
> *levees*
> *inflow wells representing inflows to the perimeter cells*
> *wallghb representing the todal BC*

How many mesh cells are in the model?

> *3545 mesh cells (look at any of the mesh attribute files: topo, shead, bottom for the number)*

What is the deepest approximate bottom of the aquifer?

> *Bottom of aquifer: 77 ft (look in* ***`c111/input_SR5_sss/2005Base_Bot1_1_12_01.dat`****; values range from -40 to -80)*

How many segments are in the model?

> *57 segments (count the lines in the* **`PIR1_alt2Db_canal_start_head_7_12.dat`** *file)*

How many different HPMs are used in the model?

> *27 HPMs (look at the number of HPMs in the* **`evap_prop`** *file)*

How many canal boundary conditions are implemented in the model and which type?

> *7 canal BCs*
> *Three <segmentghb> for tides and four <segmentsource> for canals*

What kinds of waterbodies are used in the model?

> *cells, segments, impoundments and lakes*

What is the lake used for?

> *The dummy lake is used to provide a source of water for impoundment.*

What kinds of user-defined watermovers are used in the model?

> *<genxweir>, <mseStruc> and <setflow>*

What types of output are generated from the model?

> *Cell heads*
> *junction flows*
> *segment heads*
> *watermover flows*
> *wcu flows*
> *flowgages flows*

globalmonitor heads & overland flow vector
budgetpackage
psbudgetpackage
impoundment heads
flows
rain
ET

How many levee sections are there between S176 to S177?

14 (list the contents of **`PIR1_Alt2Db_levee-seepage.xml`**)

How many cells does the S332DN impoundment cover?

6

How many special assessors are used in the model?

2 (view the contents of **`special_assessors.xml`**)

How many water control units **`<mse_units>`** are in the mse_network?

9 (list the contents of the **`SR5_sss_mse_network.xml`** *file and count <mse_unit>)*

2. Find the flow across Transect TR-3, Transect TR-23B and Transect TR-1

(open **`transect_flows_2005Baseline.dss;`** *use HEC_DSS_Vue statistics function for CY 1984)*

Flow across Transect TR-3: GW= ____ ft³, OL=____ ft³

Flow across Transect TR-23B: GW=3.02e9 ft³, OL=2.66e9 ft³

Flow across Transect TR-1: GW=4.22e8ft³, OL=1.20e9 ft³

Exercise 12.1.3

1. Answers to individual bullets:

How are the boundary conditions (BCs) organized for the model?

canal, mesh, tidal, levee

What kinds of BCs are applied to the mesh?

tidal: <wallghb>

levee:<noflow>

mesh: <wallghb>, <cellhead>

well-inflow <well>

well-pws <well>

What data is in the aquifer directory?

Indexed-entry data for bottom elevation and hydraulic conductivity

How many different HPM indexed-entry files are in the HPM directory?

4 HPM indexed-entry files
LU1995, LU88 & LU2000 landuse datasets

What are the boundary conditions on the canal network and how many BCs are specified?

<segmentsource> (19) and <segmentghb> (38)

What kinds of watermovers are used in the BBCW model?

<mseStruc> and <leveeSeepage>

What outputs are generated from this model?

<globalmonitors> (commented out)
<flowgages>
<hpmbudgetpackage>
<wbbudgetpackage>
<cellmonitors>
<segmentmonitors>
<bcmonitors>

How many groundwater conductivity zones are used in the model?

6

Looking at the network, how many canal-arc parameter sets are there?

42 (look in **`canal_indexed_attr.xml`***)*

How many canal segments are in the BBCW RSM?

332

What is the range in leakage coefficient among the canal reaches?

0.0 to 1e-6

What time series data are used in this model?

rain_v2.0_global.bin
ETp_recomputed_tin.bin
north_bc_wallghb.dss
sfwmm_calib8395_bc_bbcw.dss
sfwmm_west_bc_bbcw_8395.dss
rsm_CalibVerif_v1.2.dss
RSM_TIDES_2006.dss
all_canal_bc.dss
all_bbw_historical.dss
all_bbw_historical_dbhydro.dss
all_canal_bc.dss
daily_str_flw.dss
sfwmm_cv_v54_gages_lecsaglades.dss

Exercise 12.1.4

1. What are the network boundary conditions?

   5 network boundary conditions:

   <segmentsource> elements using the **`flow_v5.0_09292003.dss`** *file*

   <segmentghb> for the five pumped discharge structures for the EAA, using observed stages from **`eaa_obs_canal_stage.dss`** *file for the downstream boundary*

2. What are the hydraulic conductivity zones?

   1) Rotenberger, 2) Holeyland, 3) remaining EAA. Little variability is being modeled.

3. What types of HPMs are used within the hubs?

   Find the reference to the HPMs within the <mesh> block **`(&eaa_hpms;)`** *which points at the* **`LOSA_eaa_hub.xml`**. *There are 14 HPM hubs that are 95% sugarcane and 5% pasture, and two hubs that are scrub and cattail.*

4. How many Water Control Districts (WCDs) are implemented in this RSM?

   30 WCDs (open the **`eaa_wcd.xml`** *file to find a description of the WCD wcdwaterbodies and wcdmovers. Note: the* **`eaa_wcd.init`** *file provides the initial head for each waterbody. Open that file and count the number of WCDs.)*

5. What are the characteristics of the WCDs?

   Use **`'grep'`** *to list the components of the wcdmovers at the command line:*

```
grep segwidth eaa_wcd.xml | more
```

   This provides a method to determine the characteristics of the WCDs if the design documents are not available. Repeat for other properties.
   wcdwaterbodies are 5.0 ft wide for all wcdwaterbodies
   Leakagecoeff = 7.76e-7 ft/sec for all wcdwaterbodies
   Lengths are variable for all cells
   BotElev are constant for all wcdwaterbodies
   Bankheight = 0.10 and bankcoeff = 0.00

6. How many canal reaches are there?

   8 canal reaches, 103 segments. There is one reach for each section of the primary canals.

7. Find the location of wcdwaterbody '**`295203`**', and then find out how and where it connects to the network.

   The WCD is connected to the network at segment '310459'; it is just upstream of pumpstation S8. (Open the **`losa_mesh_other.mxd`** *file and symbolize the* **`eaa_wcd_zn`** *feature class. Find* **`wcd_zn = '203'`**. *From the* **`wcd_pumps.xml`** *determine the connection. In ARCGIS, use identity to find segment* **`'310459'`**.*)*

Exercise 12.1.5

How well does the model simulate historical flows?

> *For structure S7, the calculated low-flows are lower than the historical ones and some peaks are too high. Overall, the simulation is good.*
>
> *For structure S6, the calculated flows follow the historical pattern well, but are generally too high.*
>
> *For structure S8, the calculated low-flows are lower than the historical flows. The model generally follows the flow pattern and does better after 1987.*
>
> *For structure S5A, the model does a very good job of simulating flows.*
>
> *The simulated runoff pattern is very close to the historical runoff in magnitude and pattern.*
>
> *The water demand pattern matches well for the model but the magnitude of demands is only okay.*

Comparisons can also be made for the irrigation demand and agricultural runoff.

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