South Florida Water Management District's South Dade Study

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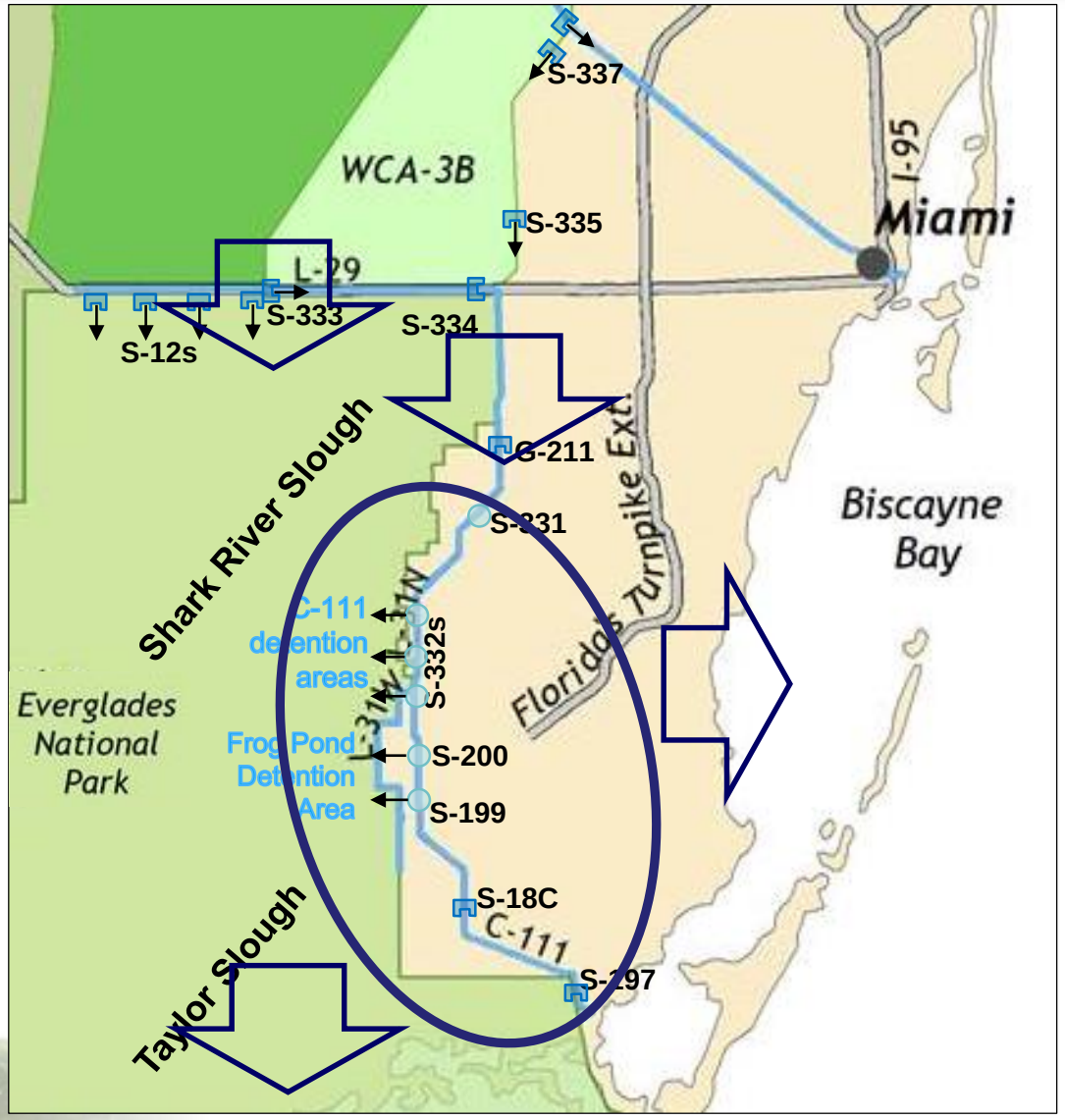
INTRODUCTION: THE SOUTH DADE SYSTEM

South Dade System Background

Multi-Objective System

- Urban Areas
  - Flood Control
  - Water Supply
- Everglades National Park
- Biscayne National Park
- Southern Glades / Model Lands
- Agriculture
  - Flood Control
  - Water Supply
- Evolving Infrastructure
  - MacVicar Presentation at Jan 2015 WRAC



South Dade Water Resource Management: A Unique Challenge

So Many Objectives…

So Small an Operating Range…

Add Some Technical Complexities…

Varying Rainfall

Regulations

Evolving Agricultural Practices

Changing Infrastructure

Everglades Restoration

Changing Objectives

Automation of Structures

Monitoring And Modeling

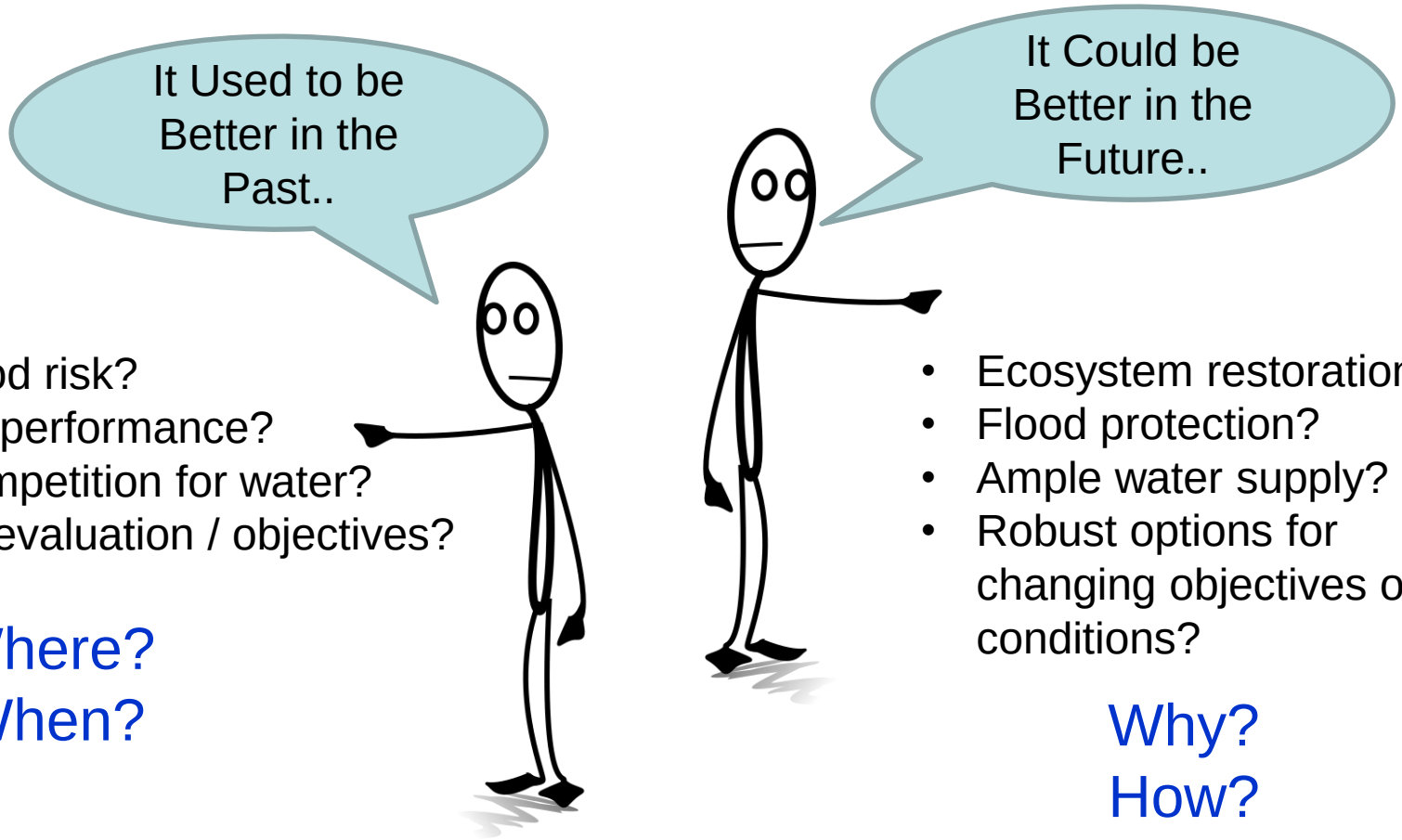
Project Construction

Sea Level Rise

?

What is Causing that Change?

Many Perspectives are Also Evident…



- Less flood risk?
- Species performance?
- Less competition for water?
- Simpler evaluation / objectives?

Where?
When?

- Ecosystem restoration?
- Flood protection?
- Ample water supply?
- Robust options for changing objectives or conditions?

Why?
How?

Operational Milestones in South Dade

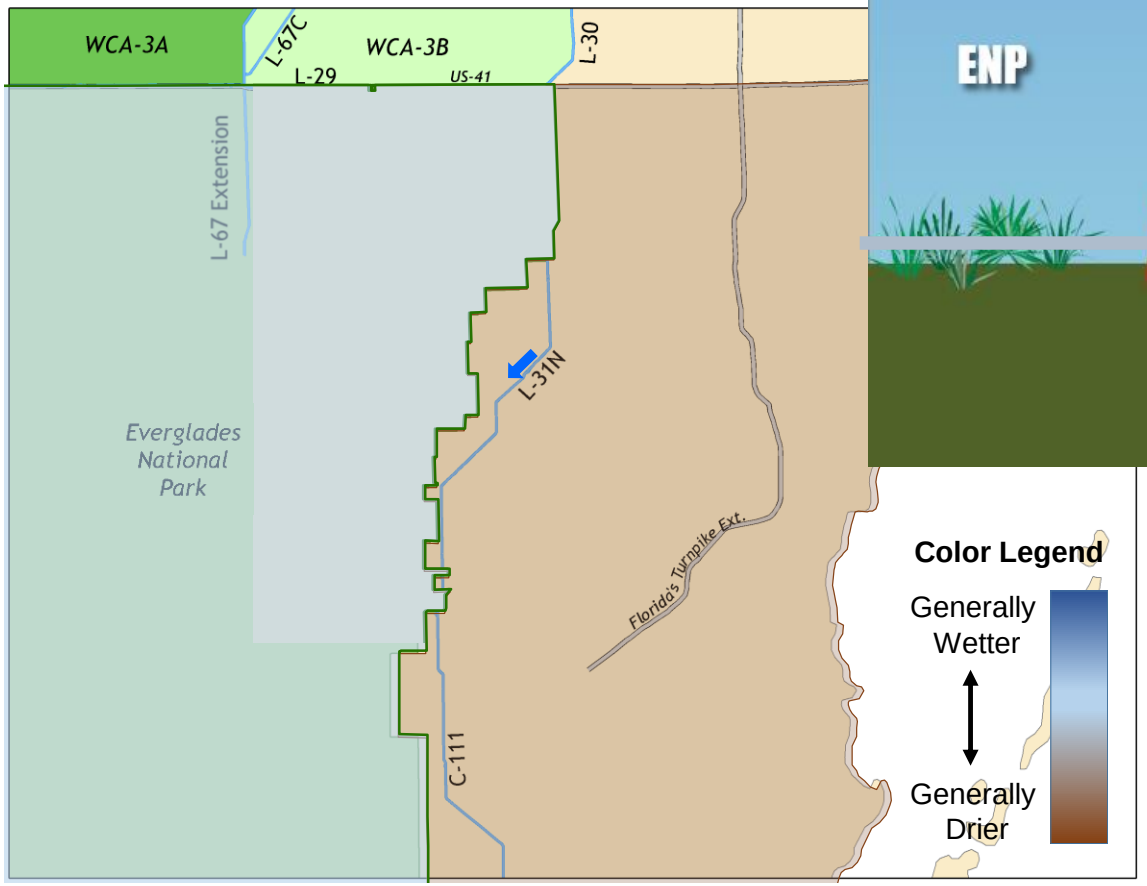
1970 – Minimum Delivery Schedule

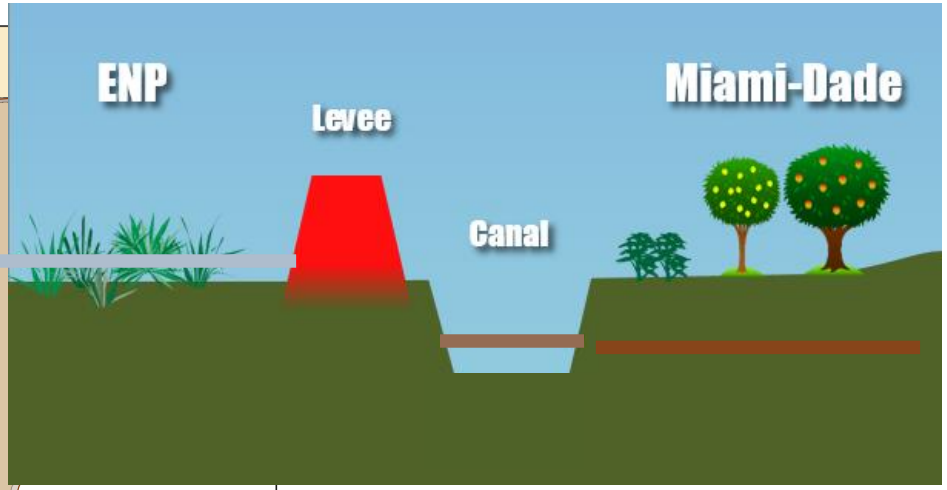
1983 – Experimental Water Deliveries

2000 – Interim Structural and Operational Plan/Interim Operational Plan

2012 – Everglades Restoration Transition Plan

1970-1982: Minimum Delivery Schedule



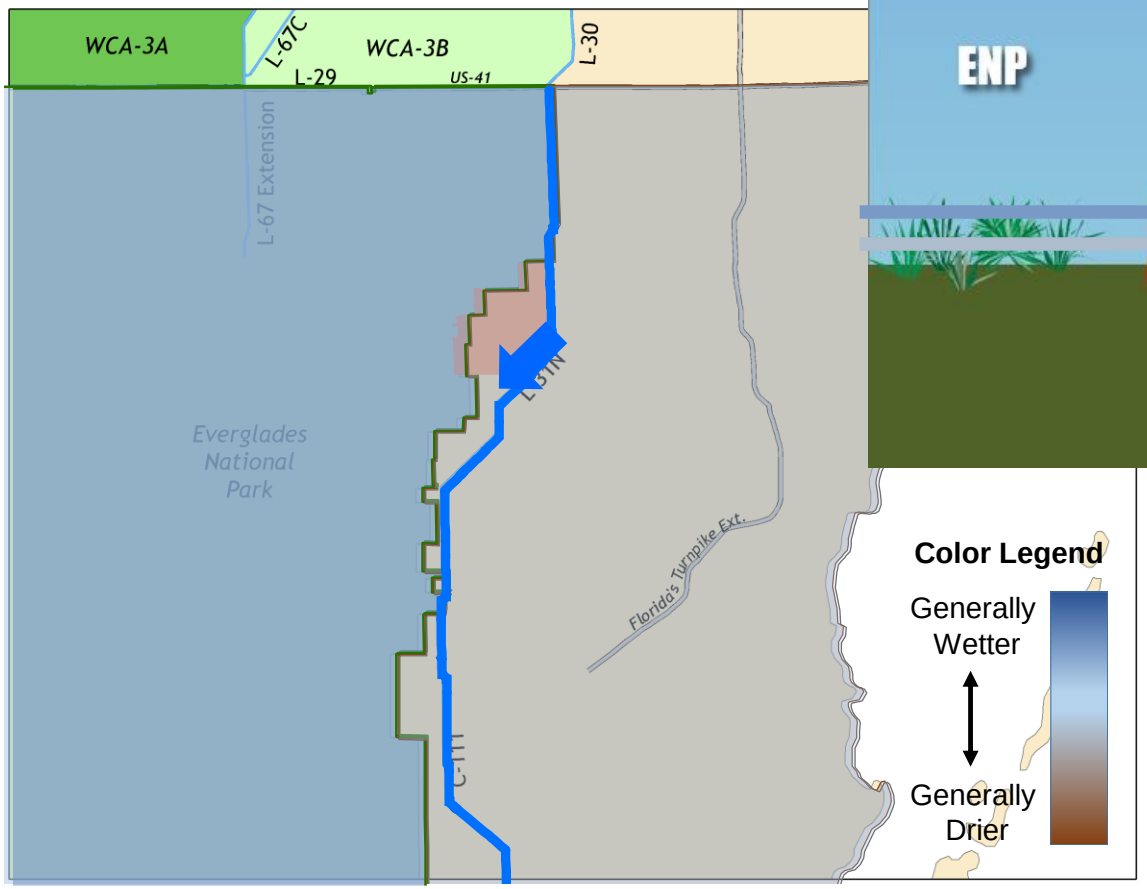


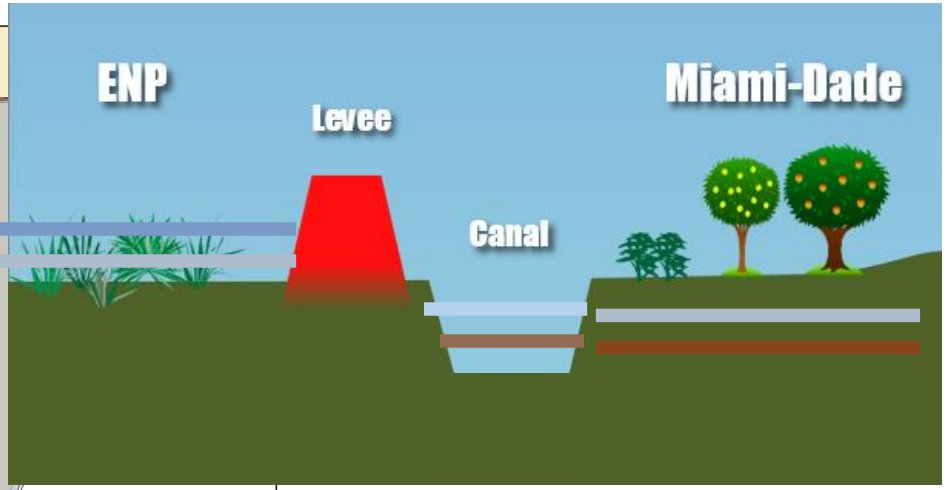
Key Observations:

- Generally low water levels both west and east of L31N & C111
- Little flow passes S331 location
- High connectivity between west and east

Note: Graphic are conceptual and intended to show general performance during the identified period, not all of the system details or changes during the timeframe or variations in spatial performance.

1983-2000: Experimental Water Deliveries



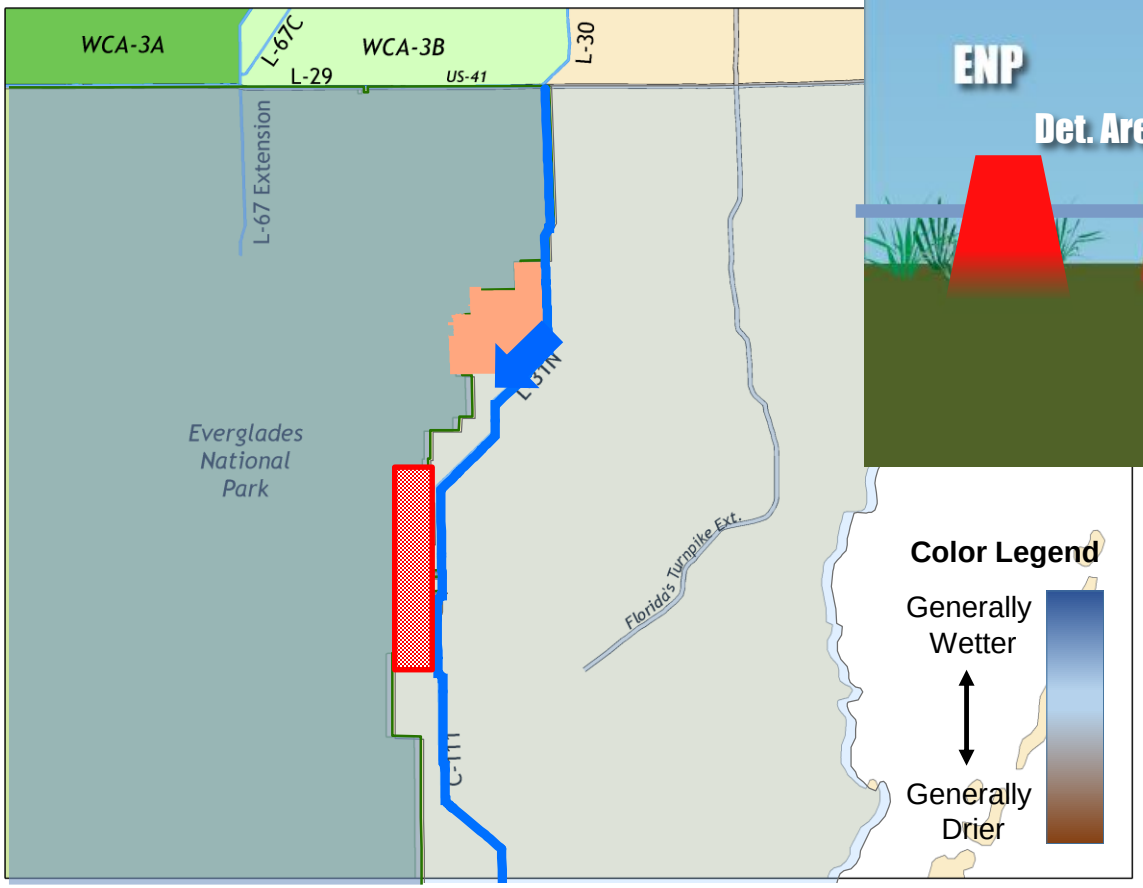


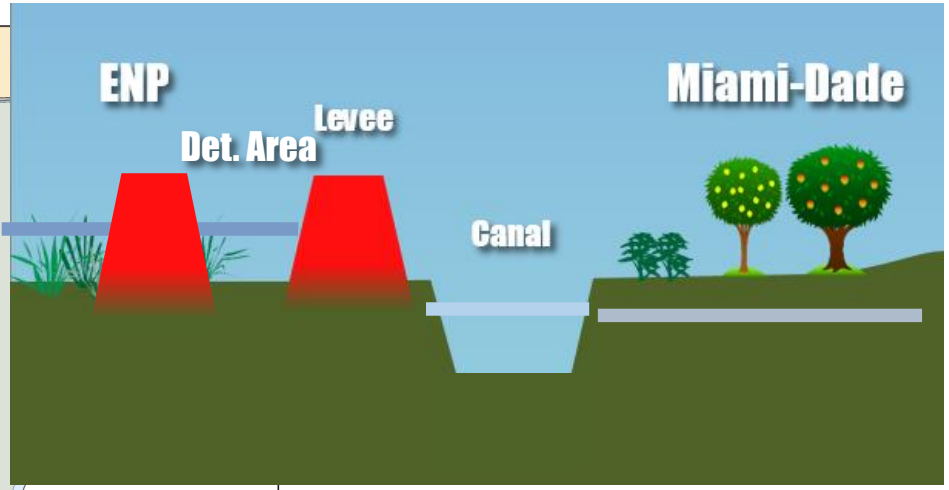
Key Observations:

- ENP expands to the east, SDCS improvements complete
- Water levels rise both west and east of L31N & C111
- Significant flow passes S331 location
- Canal buffers connectivity between west and east

Note: Graphic are conceptual and intended to show general performance during the identified period, not all of the system details or changes during the timeframe or variations in spatial performance.

2000-2012: ISOP/IOP + C111 Project



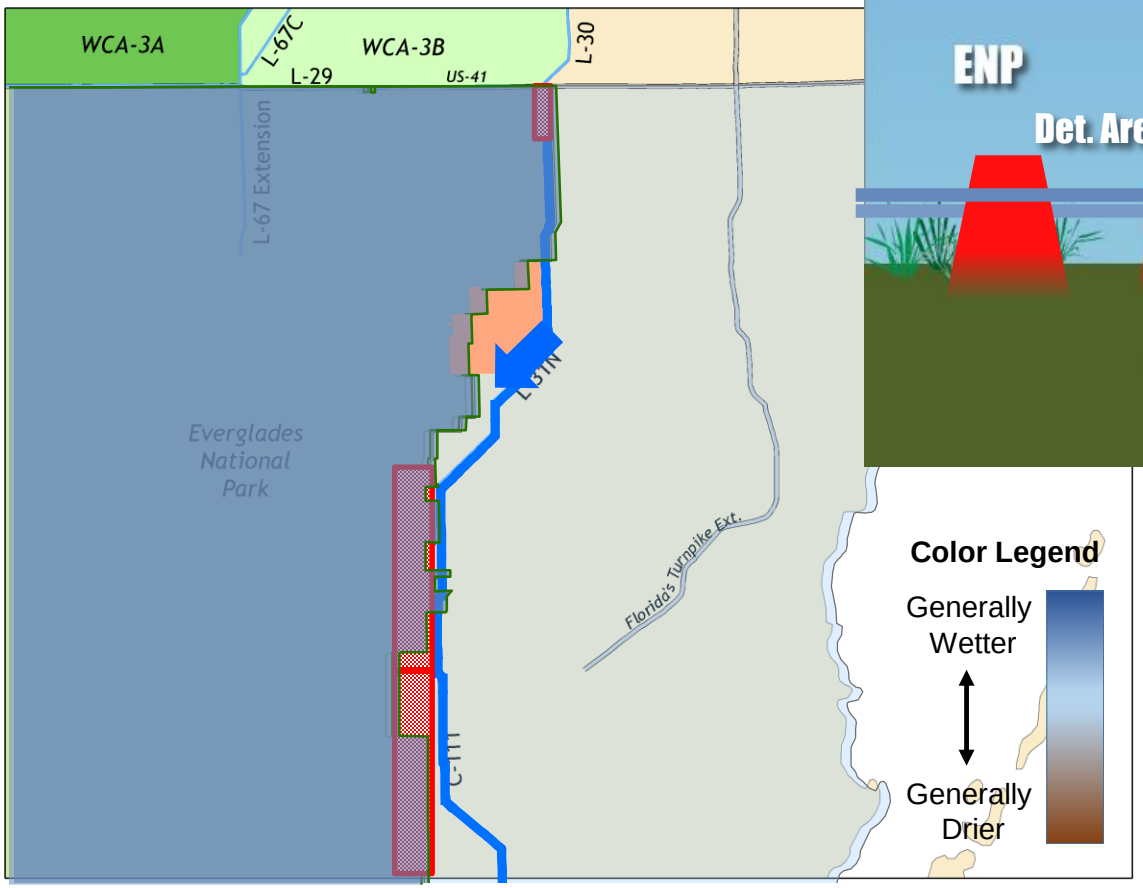


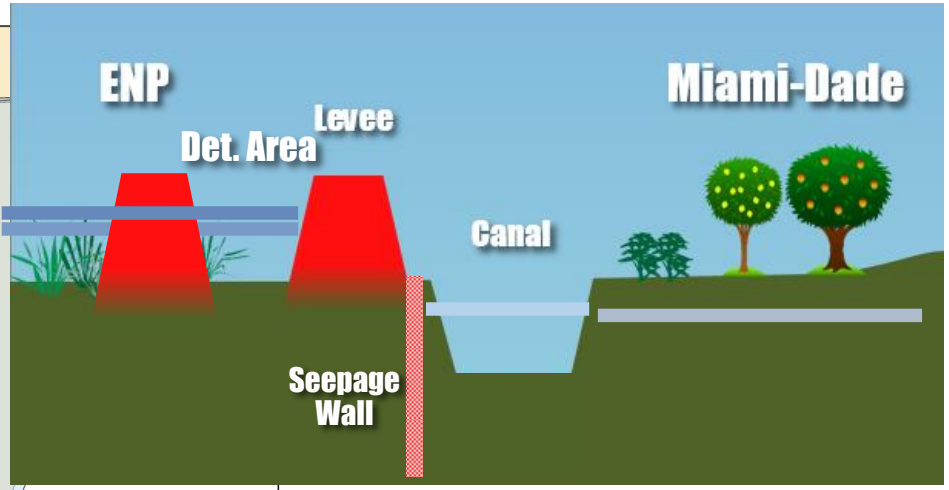
Key Observations:

- Water levels remain higher both west and east of L31N & C111
- Significant flow passes S331 location
- Canal and Detention Areas buffers connectivity between west and east

Note: Graphic are conceptual and intended to show general performance during the identified period, not all of the system details or changes during the timeframe or variations in spatial performance.

2012 – Current: ERTP + C111 Spreader





Key Observations:

- Water levels remain higher both west and east of L31N & C111
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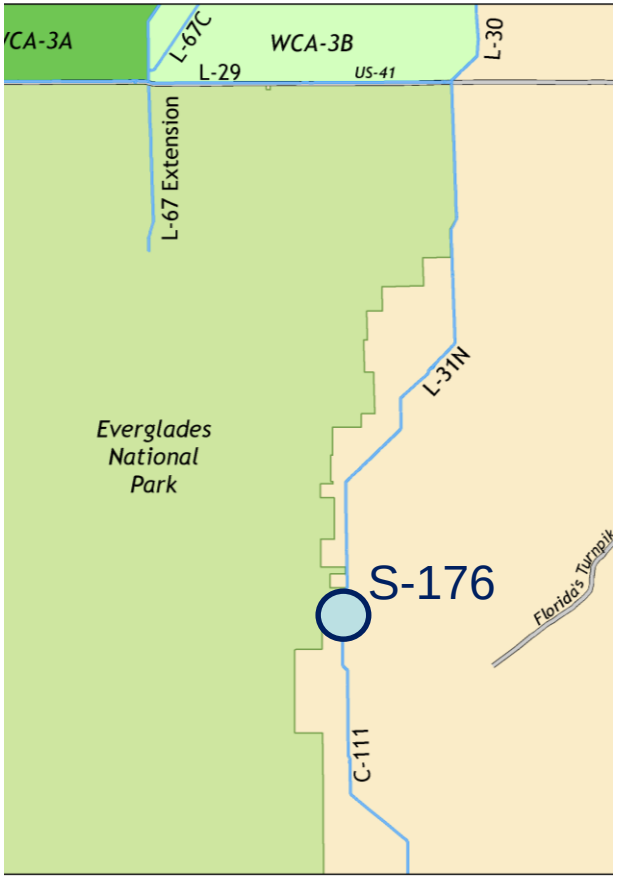
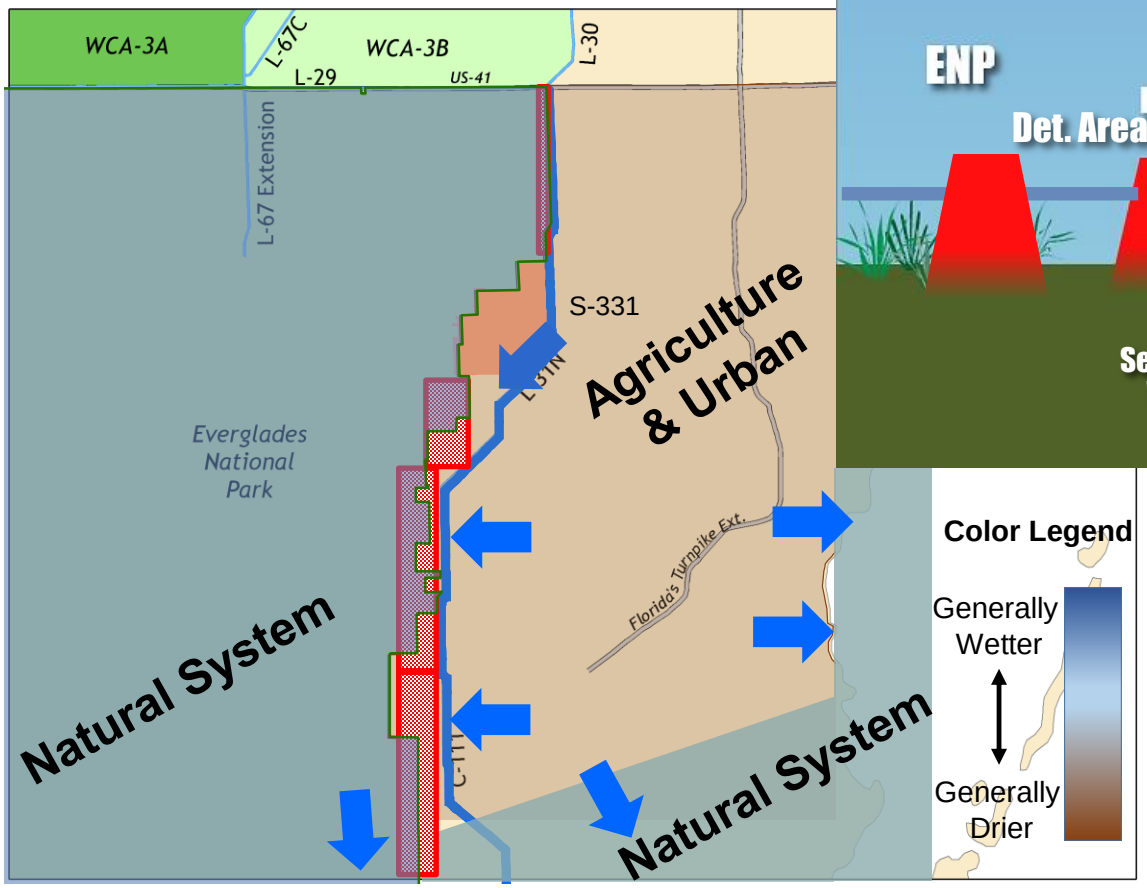
Causality is Not Straightforward: An Example at S-176

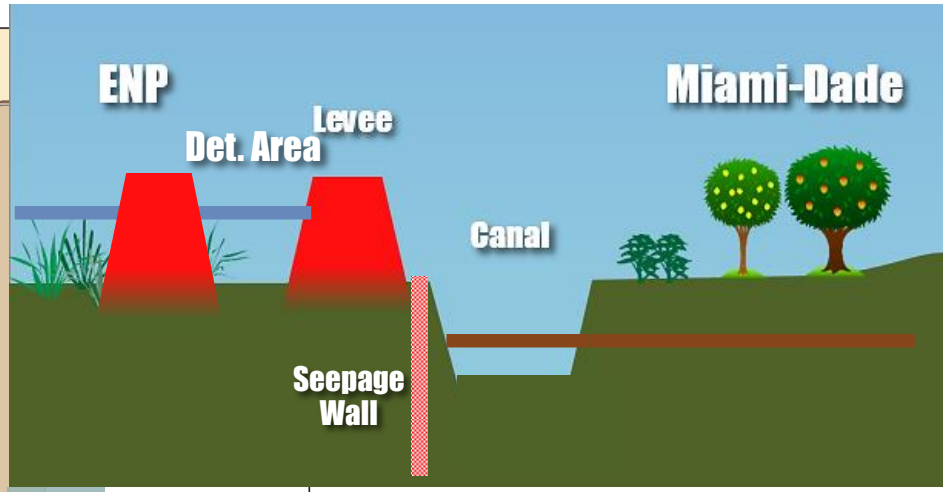
	Minimum Deliveries	Experimental Deliveries
Generalized Operations	5.5/5.0	4.5/4.1
Average Water Level (ft)	3.43	4.26
Wet 90th Percentile Water Level (ft)	5.13	4.83
	ISOP/IOP	**ERTP**
Generalized Operations	5.0/4.75 Col 1; 4.9/4.7 Col 2	5.0/4.75 Col 1; 4.9/4.7 Col 2
Average Water Level (ft)	4.33	4.48
Wet 90th Percentile Water Level (ft)	4.78	4.77



THE PURPOSE, GOALS AND METHODS OF THE SOUTH DADE STUDY EFFORT

Defining the Challenge





Objectives:

- Water levels managed independently west and east of L-31N and C-111
- Reduce flow at S-331 location, but provide flow to BNP, ENP and Florida Bay
- Canal and Detention Areas and Seepage Walls buffer connectivity between west and east

Note: Graphics are conceptual a
not all of the system details or variations in spatial

Why the South Dade Study?

- Provide a forum to integrate all perspectives
- Create common understanding
- Consider the big picture and how individual system elements interact and complement each other
- Identify options that can be considered in upcoming projects and plans
- Expedite implementation by providing conceptual analysis for future projects

Intentionally Broad Scope

- All objectives on the table
- Structural and operational options – no restrictions on ideas
- Range of options: small to big, traditional to non-traditional ideas
- Provide high-level evaluation of concepts
  - Effectiveness of proposed options
  - System view with the Regional Simulation Model (RSMGL)
  - Use of other tools as needed (e.g., detailed evaluation of local effects)

Many Opportunities for Dialogue

- ✓ Sept. 5, 2015 Workshop
  - ✓ Kickoff and brainstorm
  - ✓ Initial information sharing
- ✓ Oct. 15, 2015 and Dec. 14, 2015 Workshops
  - ✓ Goal Identification
  - ✓ Review initial model results and historical data
  - ✓ Identify trends in system performance and observations
- ✓ Feb. 2, 2016 Workshop
  - ✓ Refine options available to change system performance
- ✓ In-depth discussions with interested parties as requested

RSM-GL Model Details

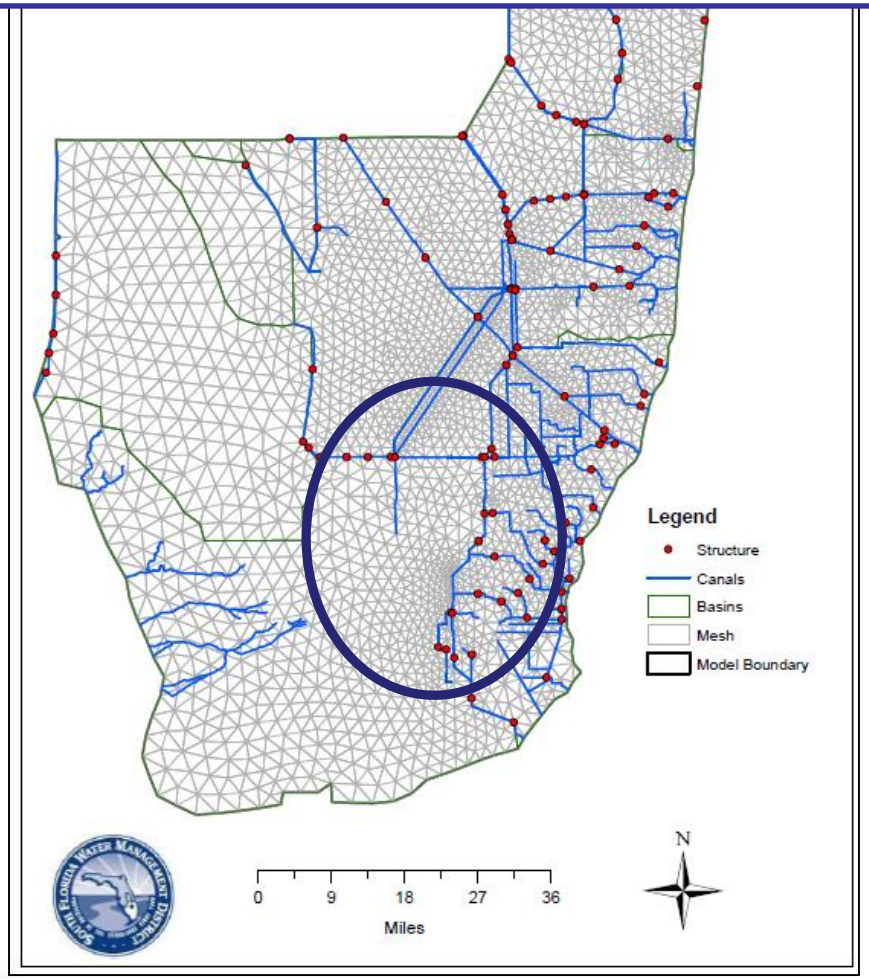
Model Domain:
Everglades and Lower East Coast service areas
Domain size: 5,825 sq. miles

Mesh Information:
Finite element mesh
Number of cells: 5,794
Average size: ~ 1 sq. mile

Canal Information:
Total length: ~ 1,000 miles
Number of segments: ~ 1,000
Average length: ~ 1 mile

Run Time:
~ 1 day

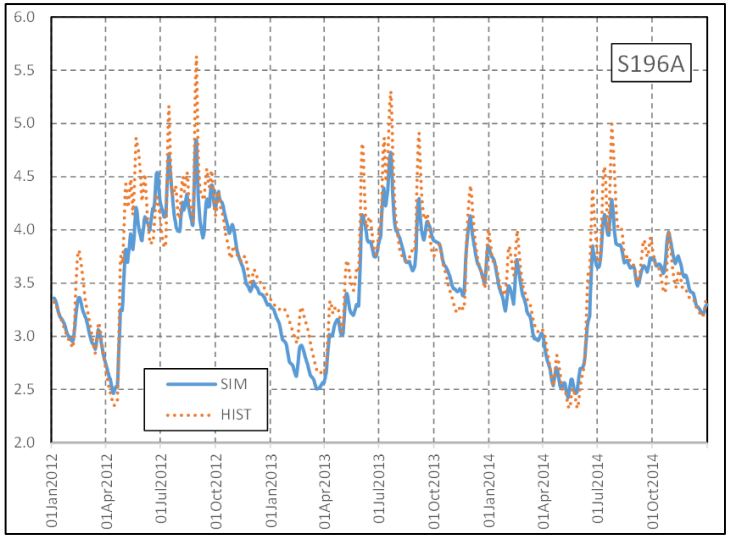
Climatic Simulation Period of record:
1965-2005

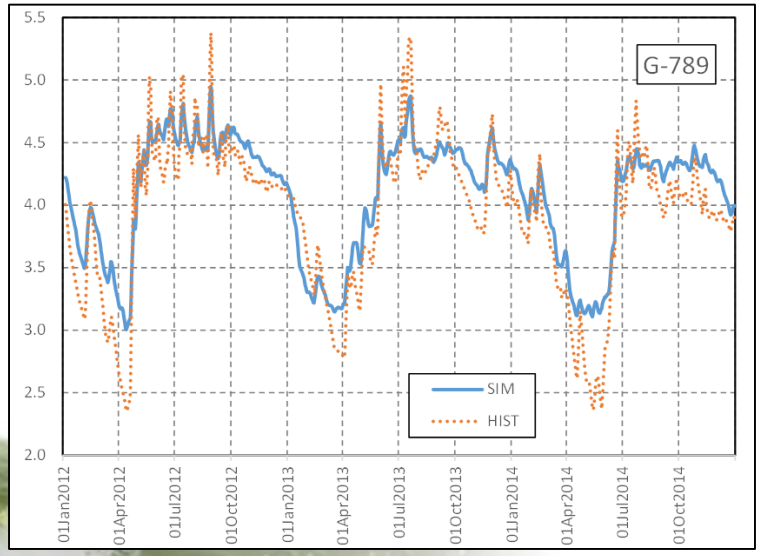


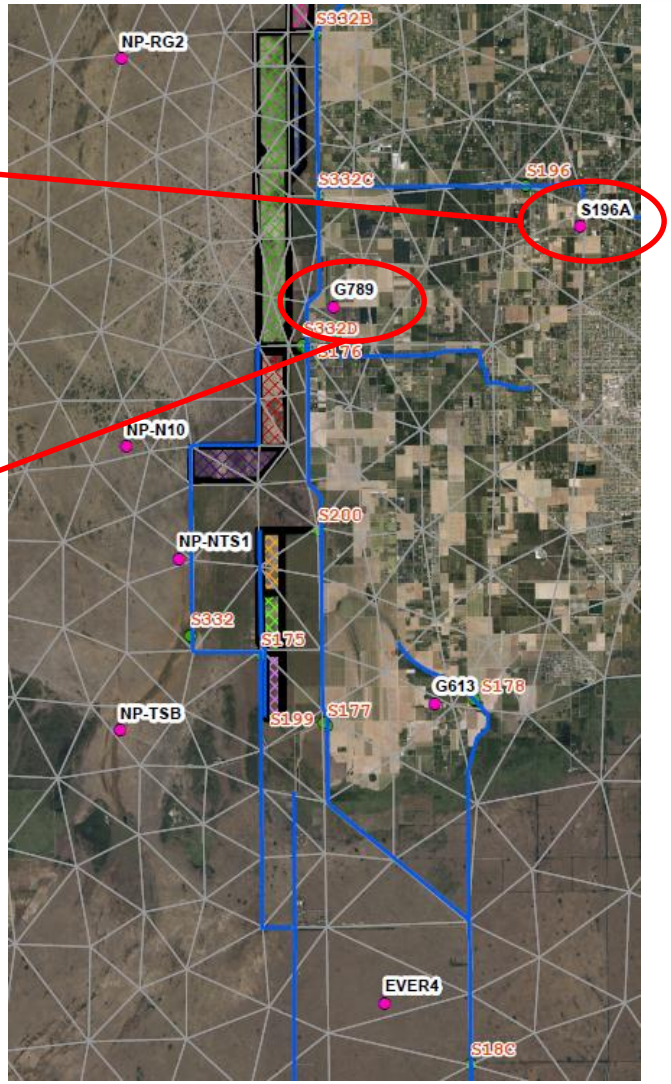
For Added Confidence…

- As an additional validation step, a quick check was made of the RSM-GL model performance using recent rainfall and S331 flows (2012-2014).
- This step helps to ensure that the model is robust in representing a variety of conditions (including recent experiences), even if they were not in the calibration effort.

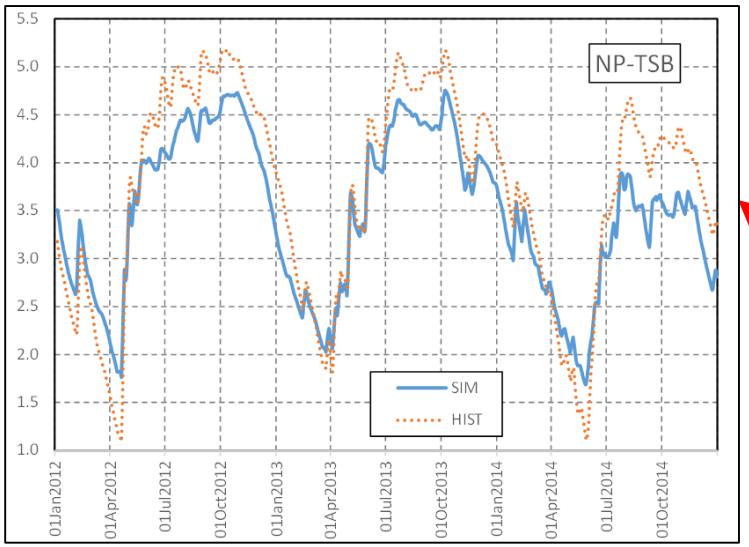
Example Performance

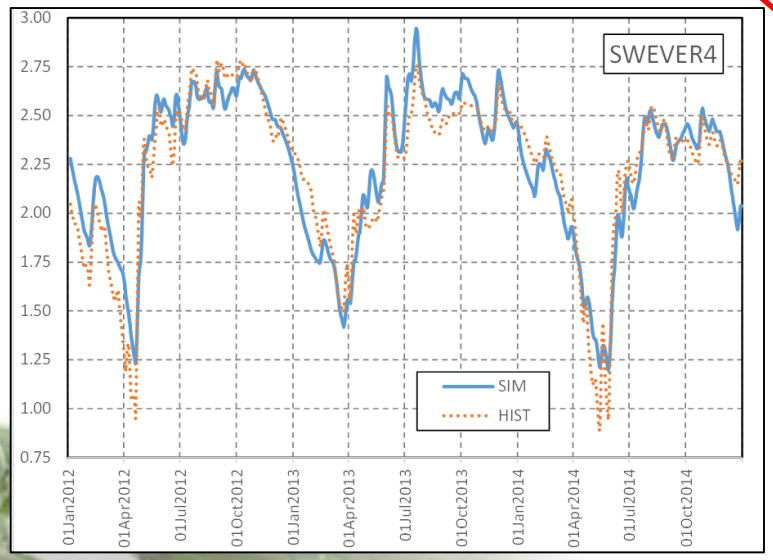


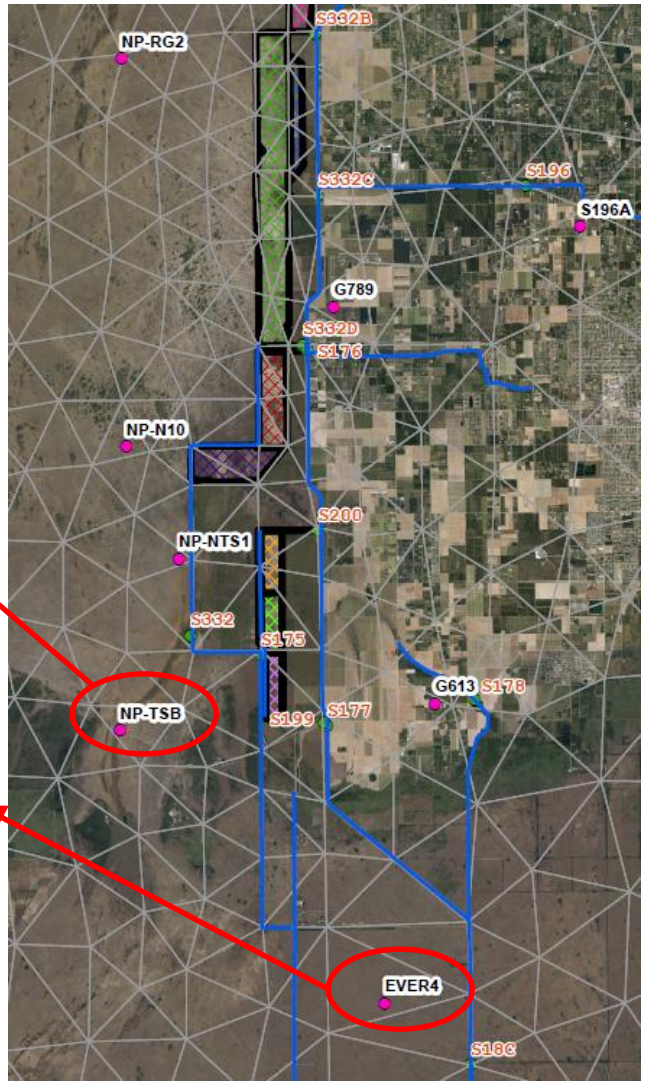




Example Performance (Continued)



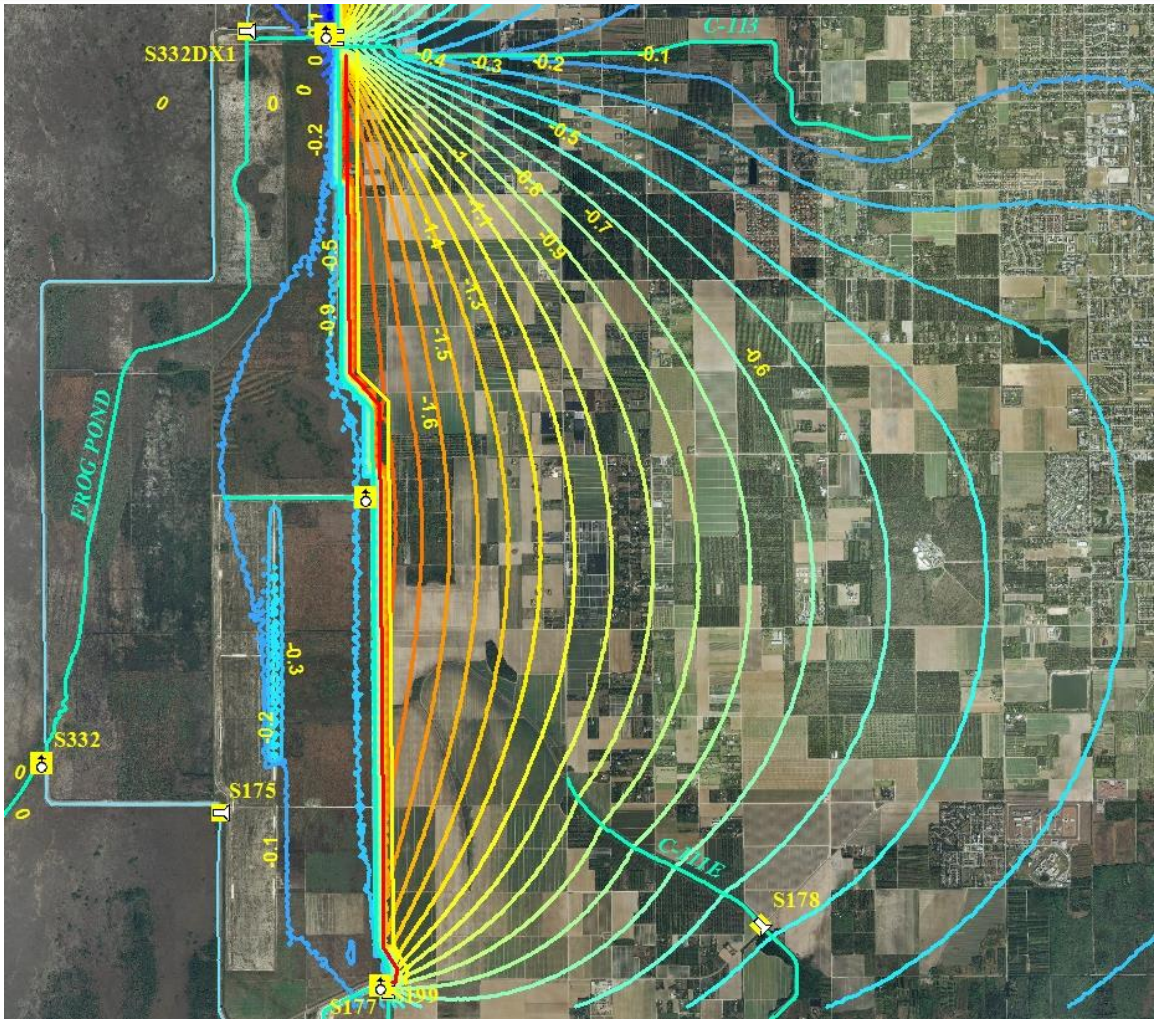




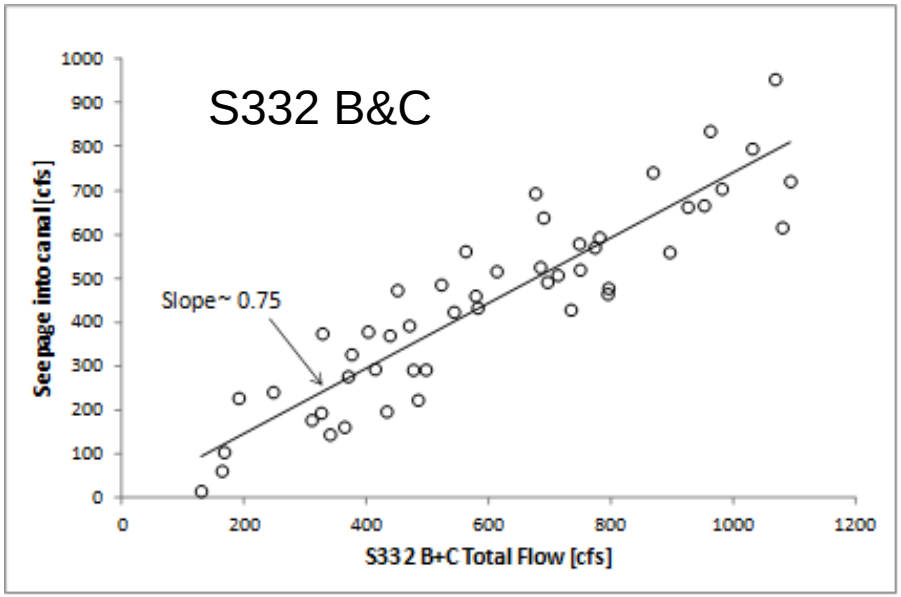
GFLOW: Seepage Analysis Tools

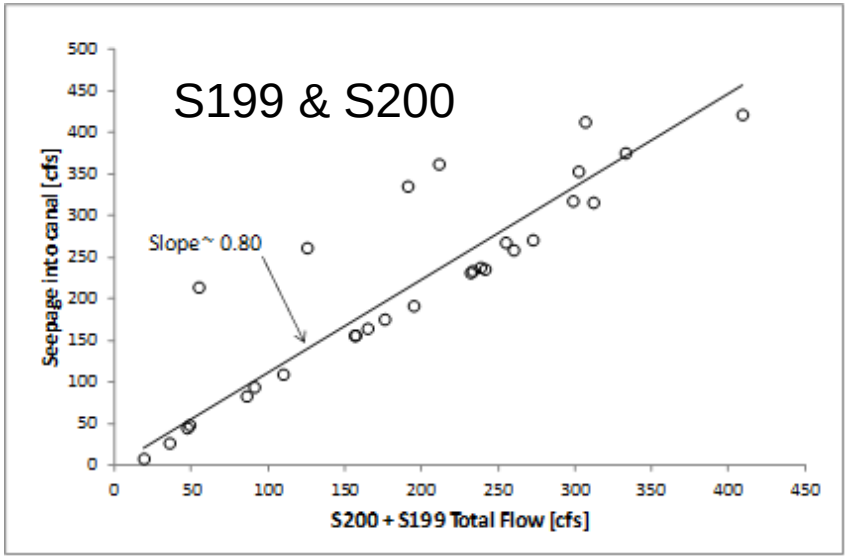
GFLOW : A stepwise groundwater flow modeling system based on the analytic element method (AEM).

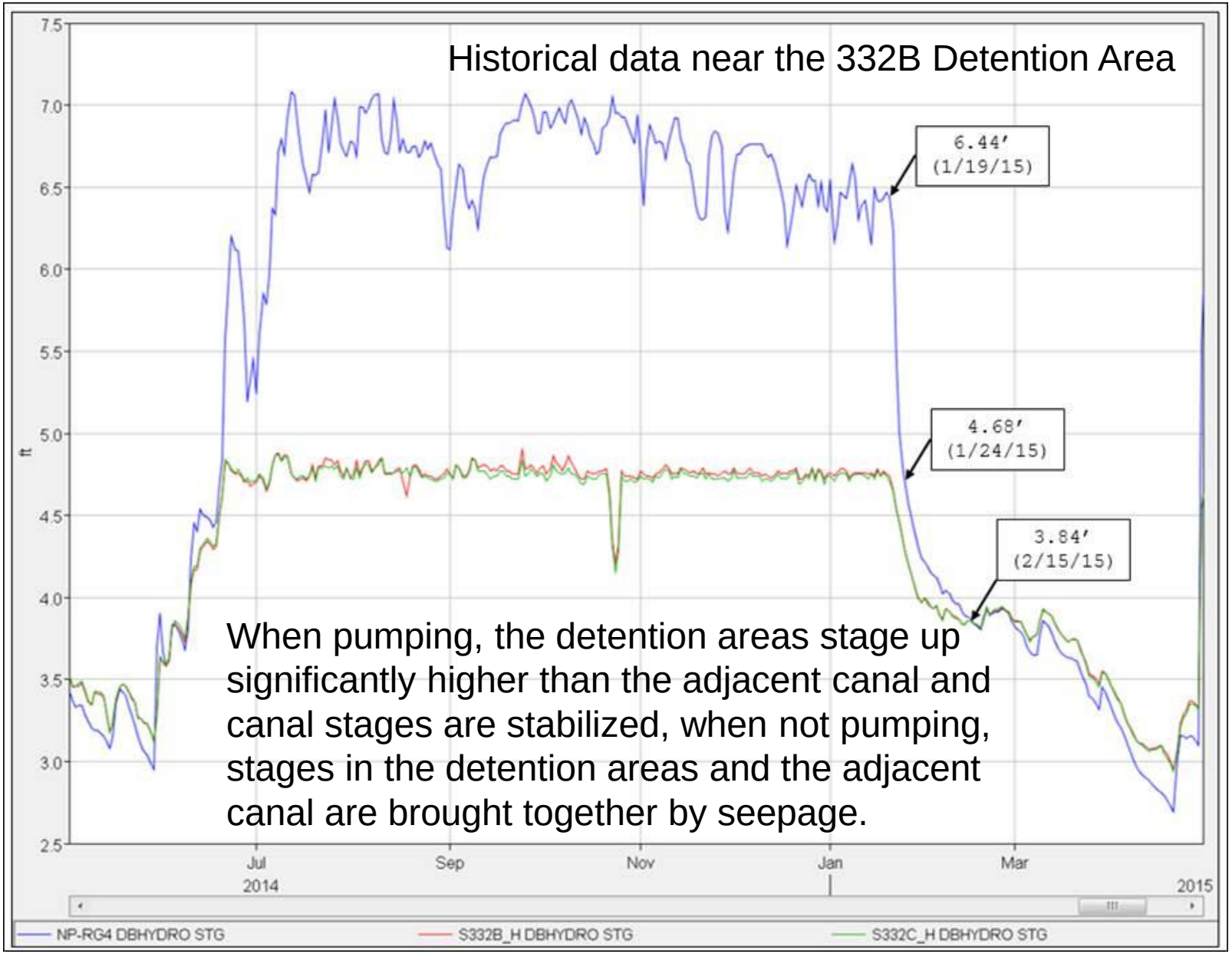
For Example: Groundwater changes with seepage barrier + lower canal level



Detention Area Pumping Largely Returns as Seepage

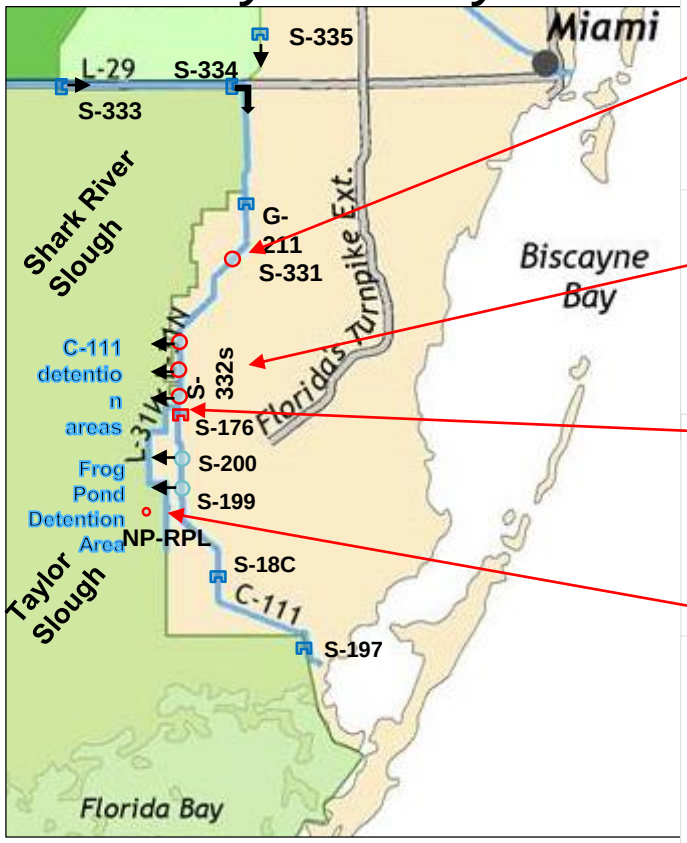


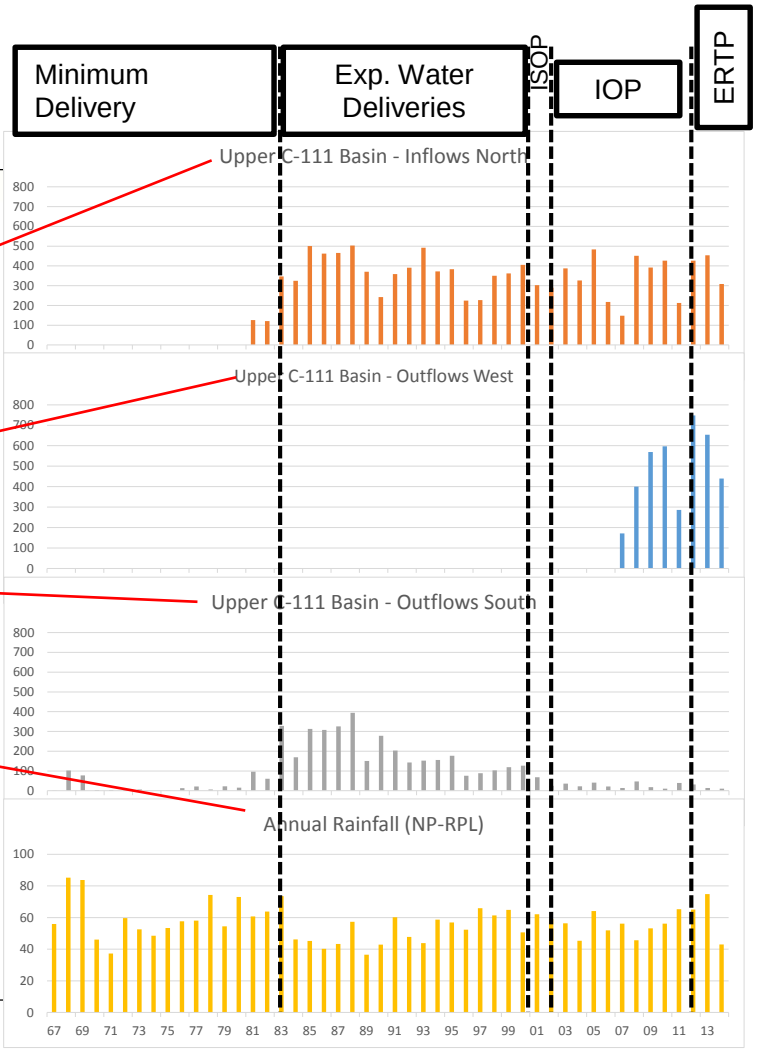



Historical data near the 332B Detention Area
6.44′
(1/19/15)
4.68′
(1/24/15)
3.84′
(2/15/15)
When pumping, the detention areas stage up significantly higher than the adjacent canal and canal stages are stabilized, when not pumping, stages in the detention areas and the adjacent canal are brought together by seepage.
ft
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
Jul
2014
Sep
Nov
Jan
Mar
2015
NP-RG4 DBHYDRO STG
S332B_H DBHYDRO STG
S332C_H DBHYDRO STG

Historical Changes in Flow along L31N/C111 Canals

South Dade Conveyance System





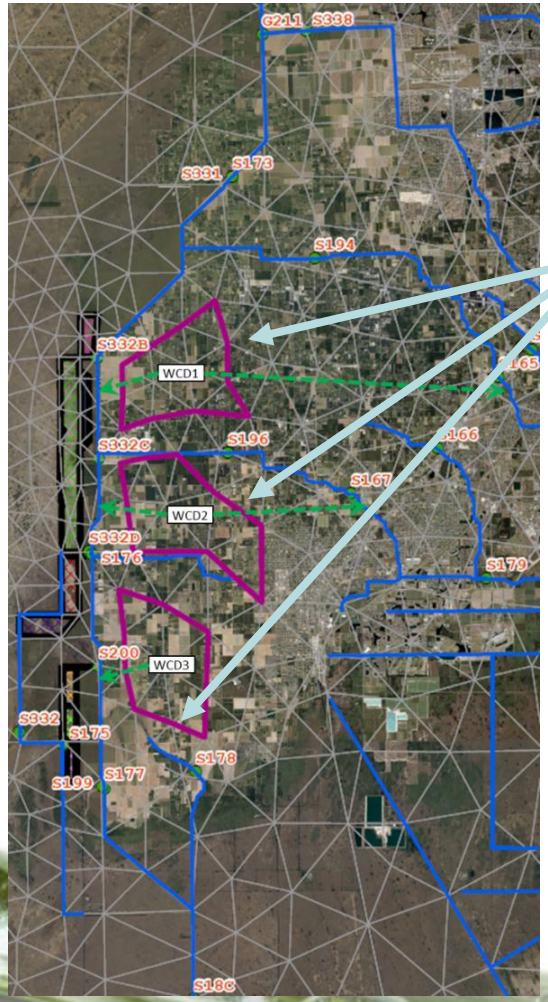
ANALYSIS – BROAD BRUSH TO MORE REFINED

Initial Modeling Outcomes

- Several “Proof of Concept” scenarios were run to examine the ability to move toward the goals identified in the South Dade Investigations discussion; for example:
  - Proof of Concept 1 (POC1) implemented local drainage districts with pumps toward Biscayne coastal structures and the L31N/C111 canals
  - Proof of Concept 2 (POC2) implemented lower canal operating levels in the L31N/C111 canals
  - Proof of Concept 3 (POC3) implemented lower canal operating levels in the L31N/C111 canals plus a seepage barrier
- Outcome: It is possible to improve toward identified objectives!
  - Improvements were frequently observed in the Everglades, Southern Estuaries and agricultural areas
  - Care must be taken to identify unintended adverse impacts

Initial Modeling Outcomes (continued)

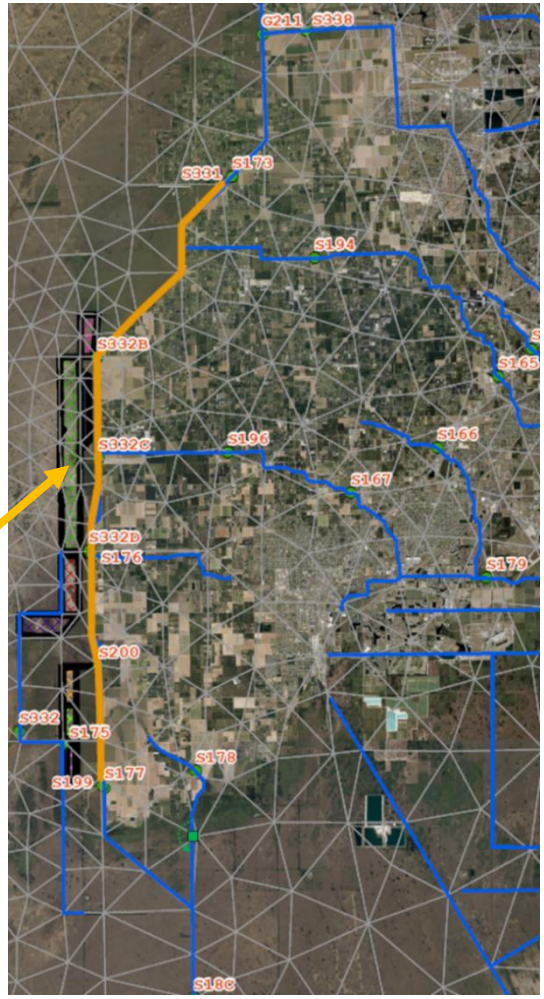
Proof of Concept 1 (POC1):



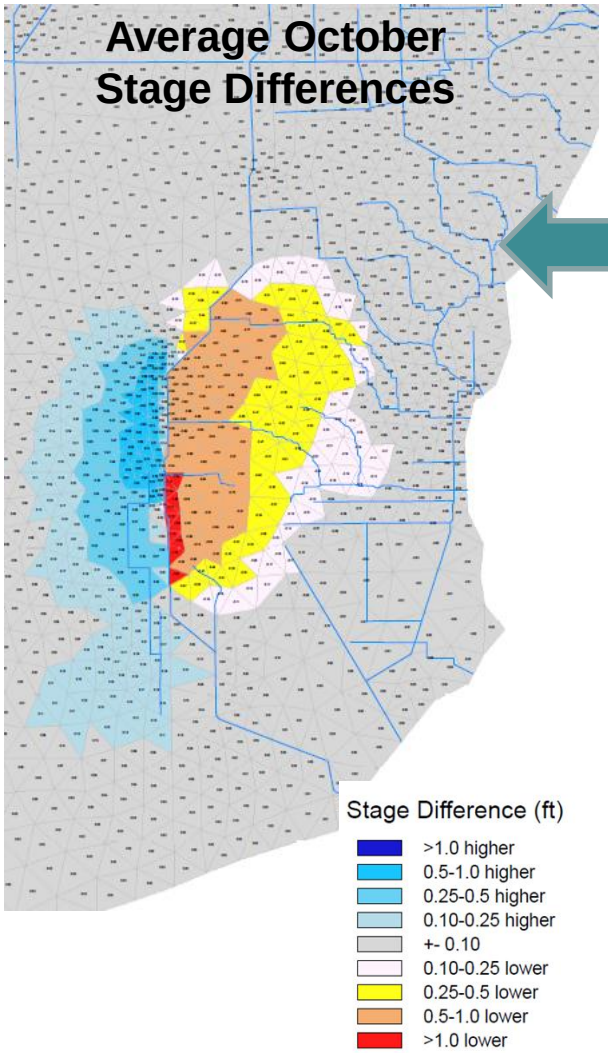
Simulated Local Drainage Districts

Simulated Seepage Barrier (approximately 40 ft deep)

Proof of Concept 3 (POC3):

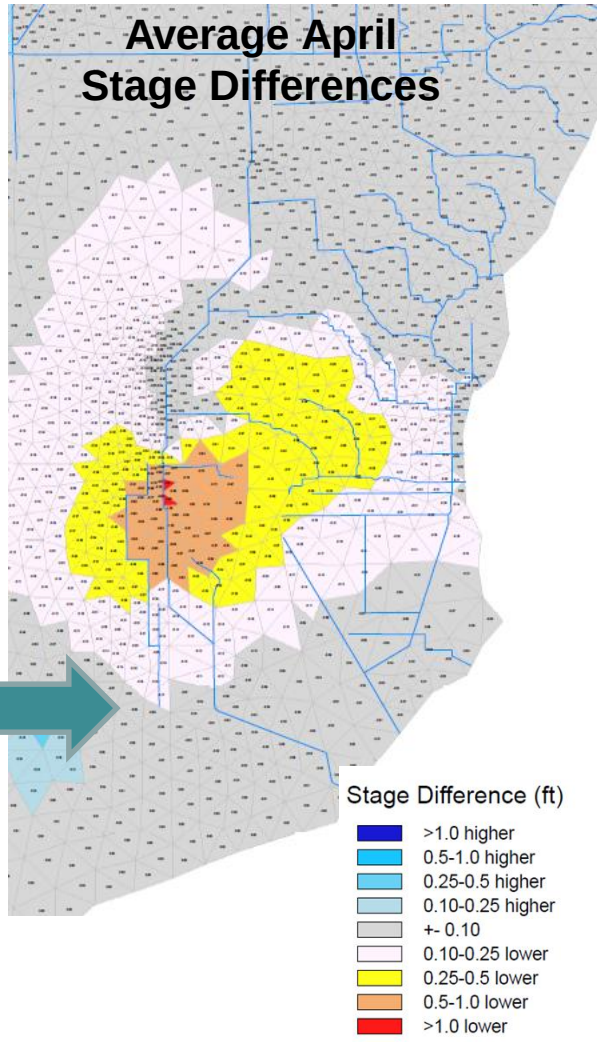


Examples of Initially Analyzed Options



Generally lower water levels east of L-31N/C-111 while promoting flow toward Taylor Slough and Florida Bay

Late dry season water levels are lower not just east of L-31N/C-111, but also in the Everglades, Biscayne Bay Coastal Wetlands and the Southern Glades



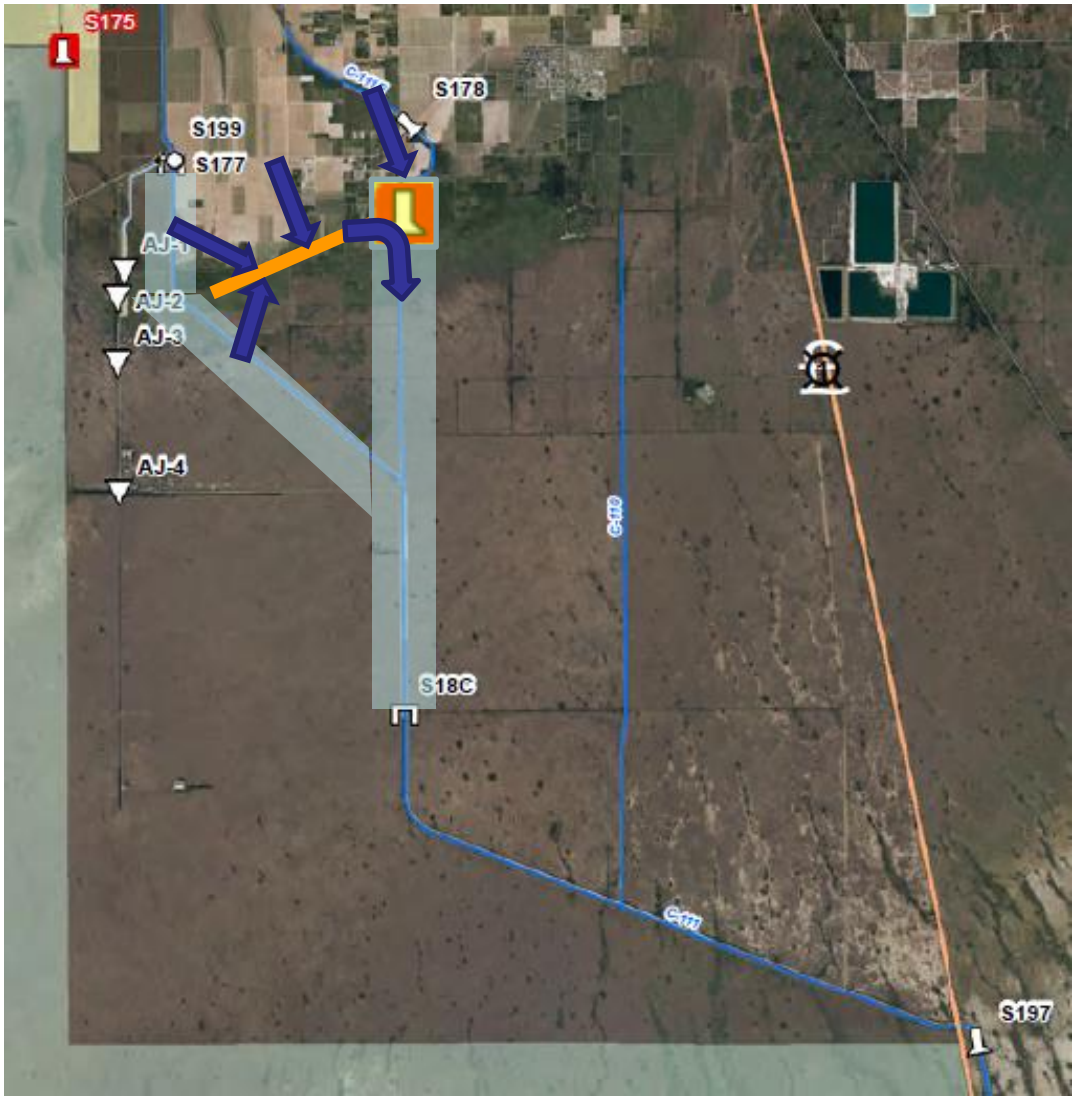
Hydrologic Challenges in the Vicinity of S18C

Operationally raising water levels at S18C as contemplated in the C111 Spreader Canal Project has the potential to raise water levels in upstream canals (C111 & C111E) and simultaneously trigger additional discharges through S197.

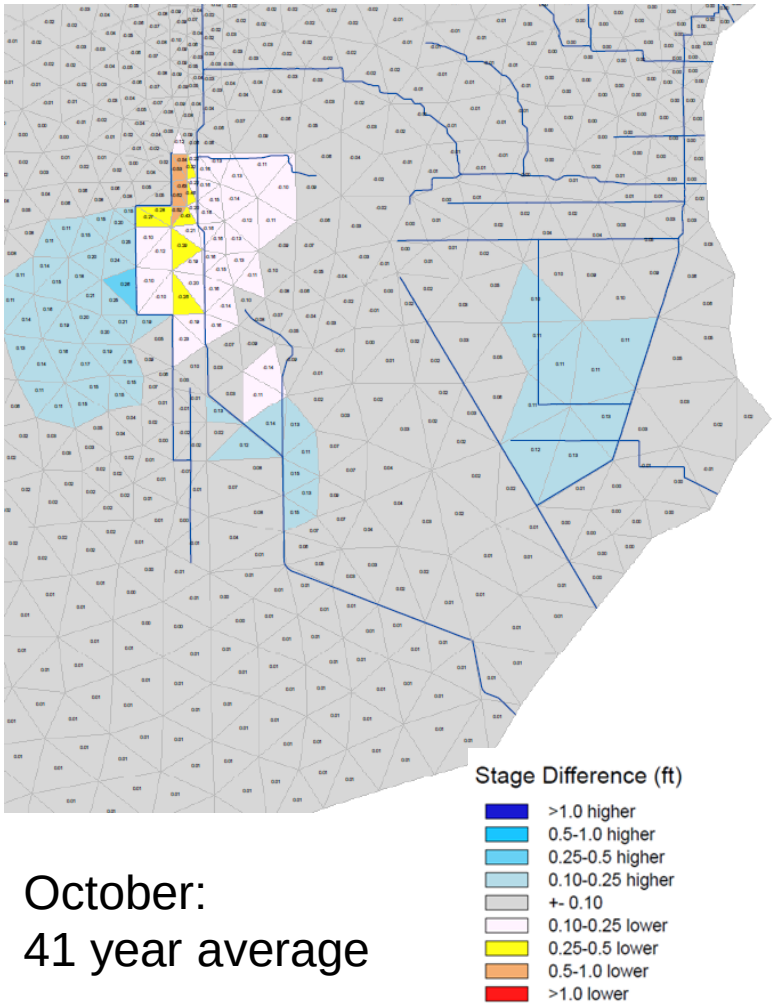
Hydrologic Challenges in the Vicinity of S18C
A Possible Engineering Solution

S197 concerns can be addressed through modifications to operational criteria, but effects in canals upstream of S18C may require infrastructure improvements.

For example: The addition of a pump station downstream of S178 and a seepage collection canal



Example Differences Compared to Increment 1 with S18C Raised 0.2 ft and S20 Raised 0.5 ft

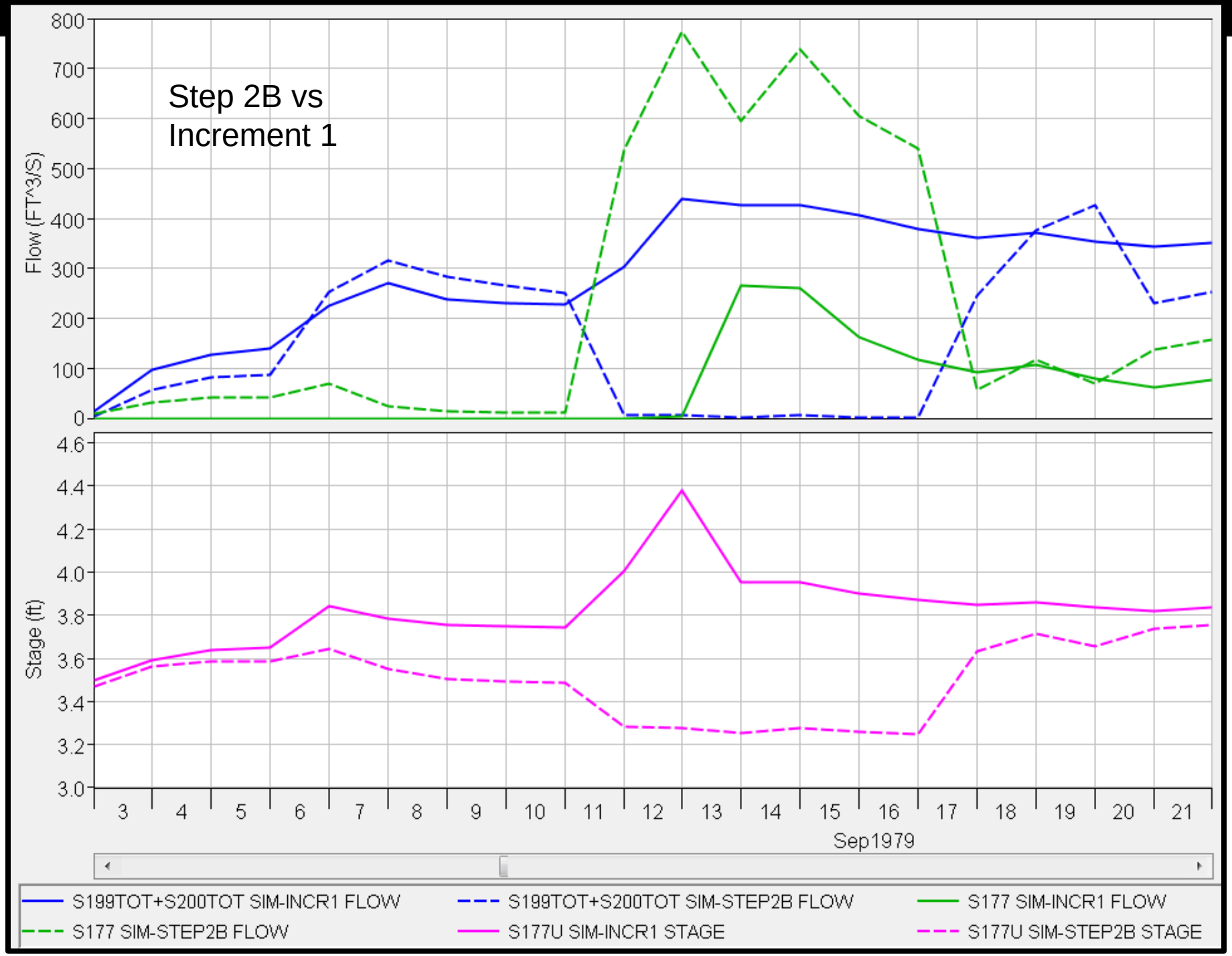


October:
41 year average

- In this example, raising S18C operating criteria is combined with infrastructure improvements as shown on the previous slide (pump downstream of S178 and seepage canal) along with corresponding operational changes to S197 and other operational changes upstream of S177.
- This outcome demonstrates improvement in wetland areas in the Southern Glades, while simultaneously maintaining or lowering water levels in agricultural areas.

Operational Refinement

- Typically when operational changes are discussed, persistent or seasonal changes in water level criteria are identified.
- While these type of operations can frequently balance multiple objectives, other operational changes can also be proposed that address a more targeted conditions (e.g. during rainfall events).

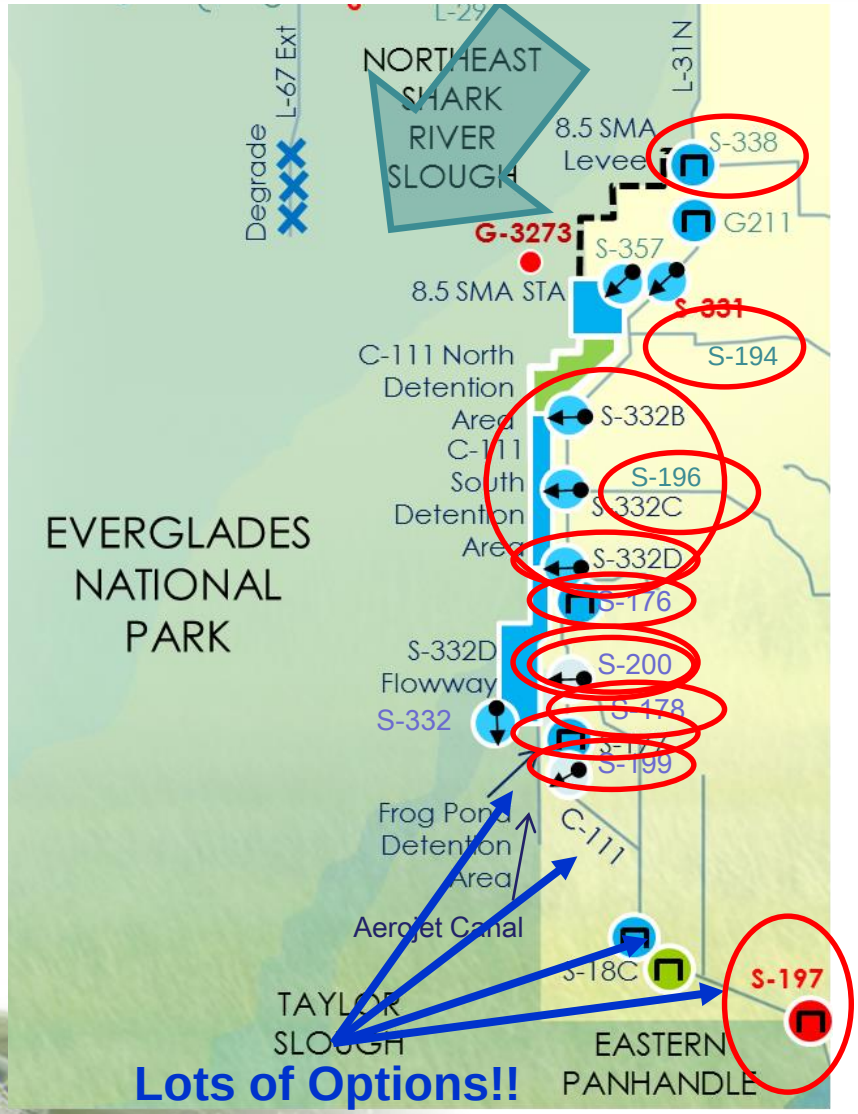

Step 2B vs
Increment 1
Flow (FT^3/S)
800
700
600
500
400
300
200
100
0
Stage (ft)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Sep1979
S199TOT+S200TOT SIM-INCR1 FLOW
S199TOT+S200TOT SIM-STEP2B FLOW
S177 SIM-INCR1 FLOW
S177 SIM-STEP2B FLOW
S177U SIM-INCR1 STAGE
S177U SIM-STEP2B STAGE

Current Infrastructure & Getting Water Where Needed

Some dry season capacity available for L-31N pump stations (S-332 B,C,D); limited efficiency gains with surface water discharge

Some potential for improved discharges via S-332D and/or S-200 toward Taylor Slough

Limited dry season capacity for C-111 pump stations (S-200, S-199)



Some capacity to move water east toward Biscayne Bay via S-338, S-194, S-196

Capacity exists to utilize S-176 and S-177 more frequently

Limited options to convey more water near S-178

Capacity available at S-197. Releases can be undesirable

SOUTH DADE STUDY OUTCOMES

South Dade Investigations: Turning The Corner

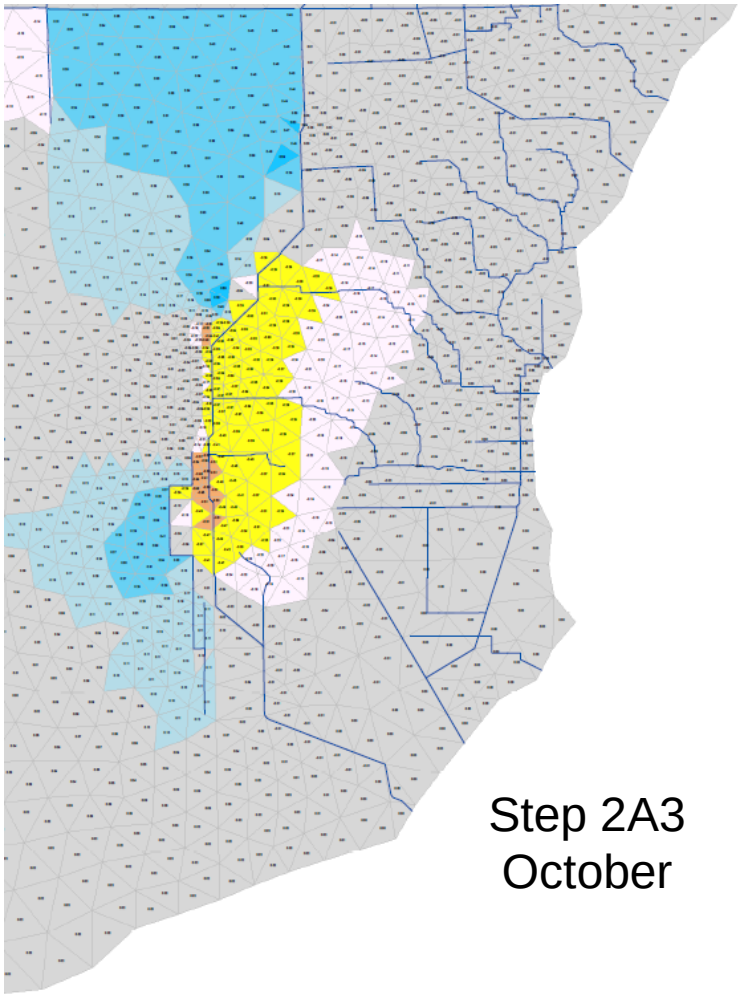
We can achieve the goal!

- Many robust combinations of options are feasible that lower water levels in agricultural areas of South Dade and increase water to natural systems (Everglades National Park, Florida Bay, Southern Glades, etc…)
- More comprehensive and balanced operational strategies will allow for performance improvements both independent of and as infrastructure improvements (such as more pump capacity or seepage walls) are realized.

An Example Scenario: Step 2A3

- Built upon “Increment 2”-like conditions: Contracts 8 & 8A, L-29 max stage at 8.5 ft
- Lower operations at S-332s, S-199s and S-200s for Aug-Dec and transition to current ops Jan 1-Feb 15
- Additional 75 cfs each for S-199 and S-200
- Revised operations to allow more frequent, lower capacity opening of S-176 and S-177
- Infrastructure improvement to promote flows toward Taylor Slough
- Add a 200 cfs pump downstream of S-178

Stage Difference Compared to Increment 1 (Current Operations)

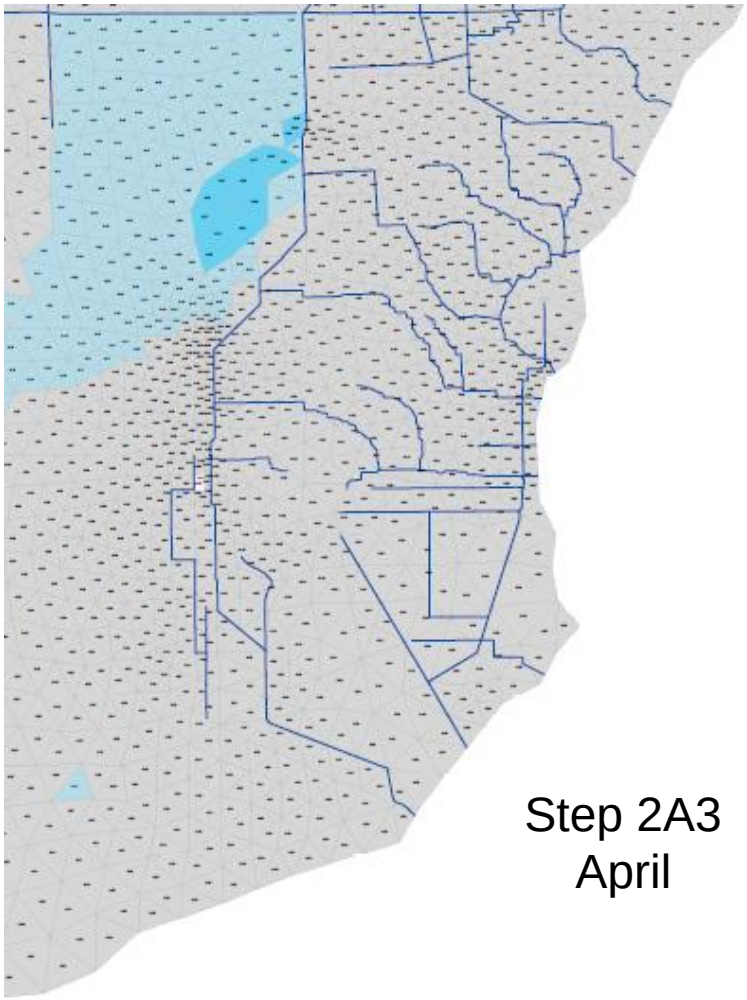


Step 2A3
October

41 Year Average Water Levels

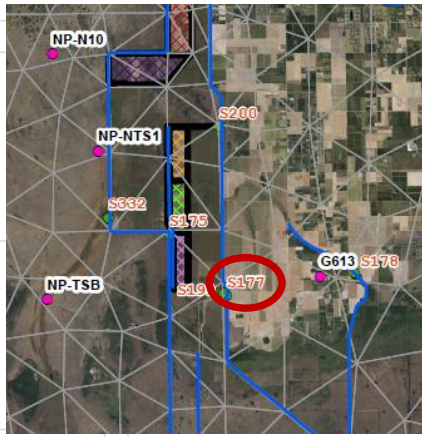
Stage Difference (ft)

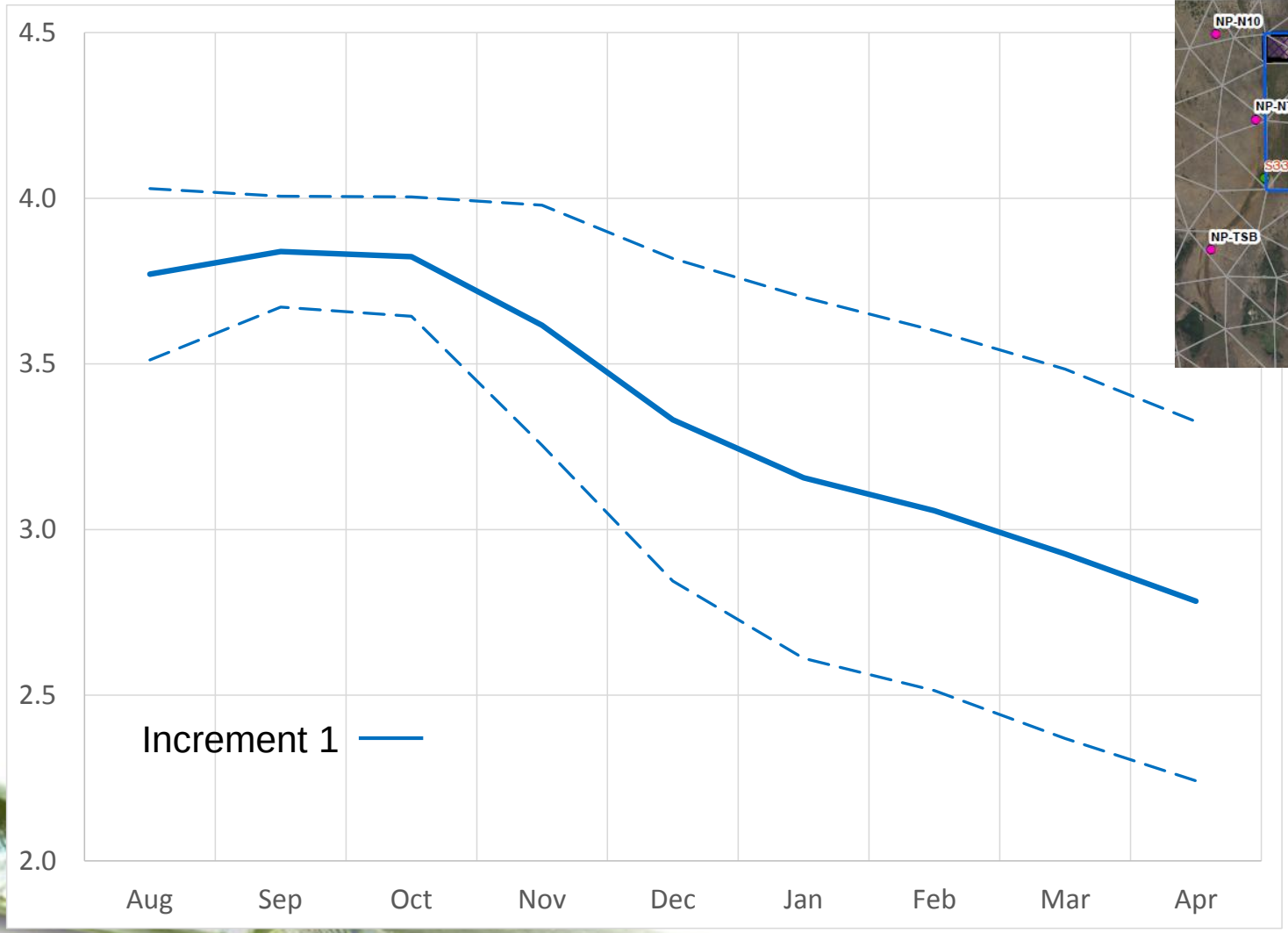
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- 0.10-0.25 higher
- +- 0.10
- 0.10-0.25 lower
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower



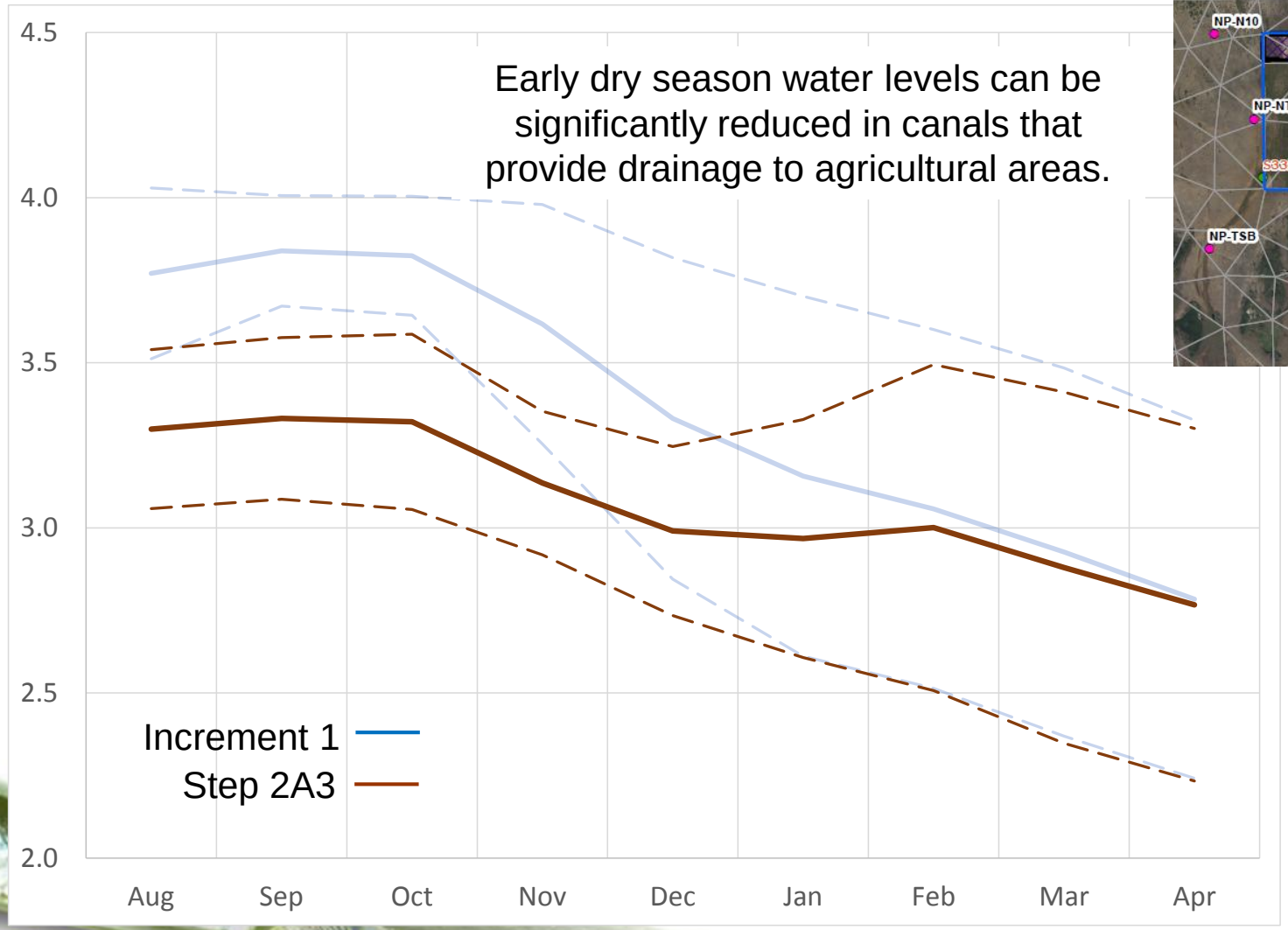
Step 2A3
April

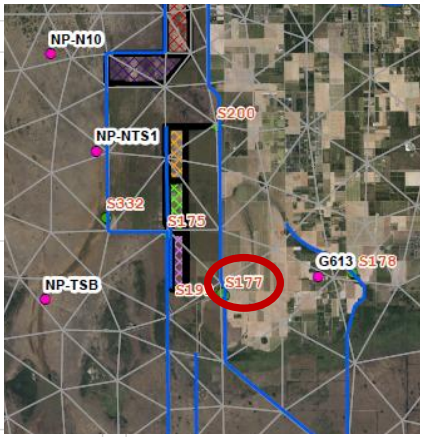
Seasonal Pattern in S177 Headwater



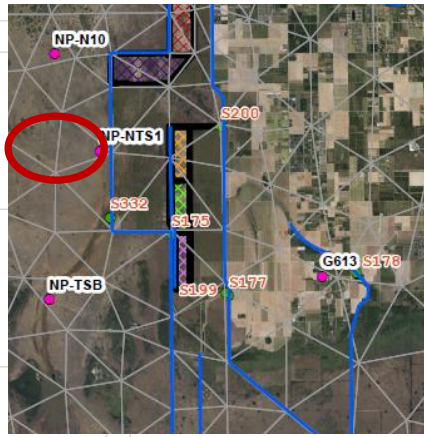


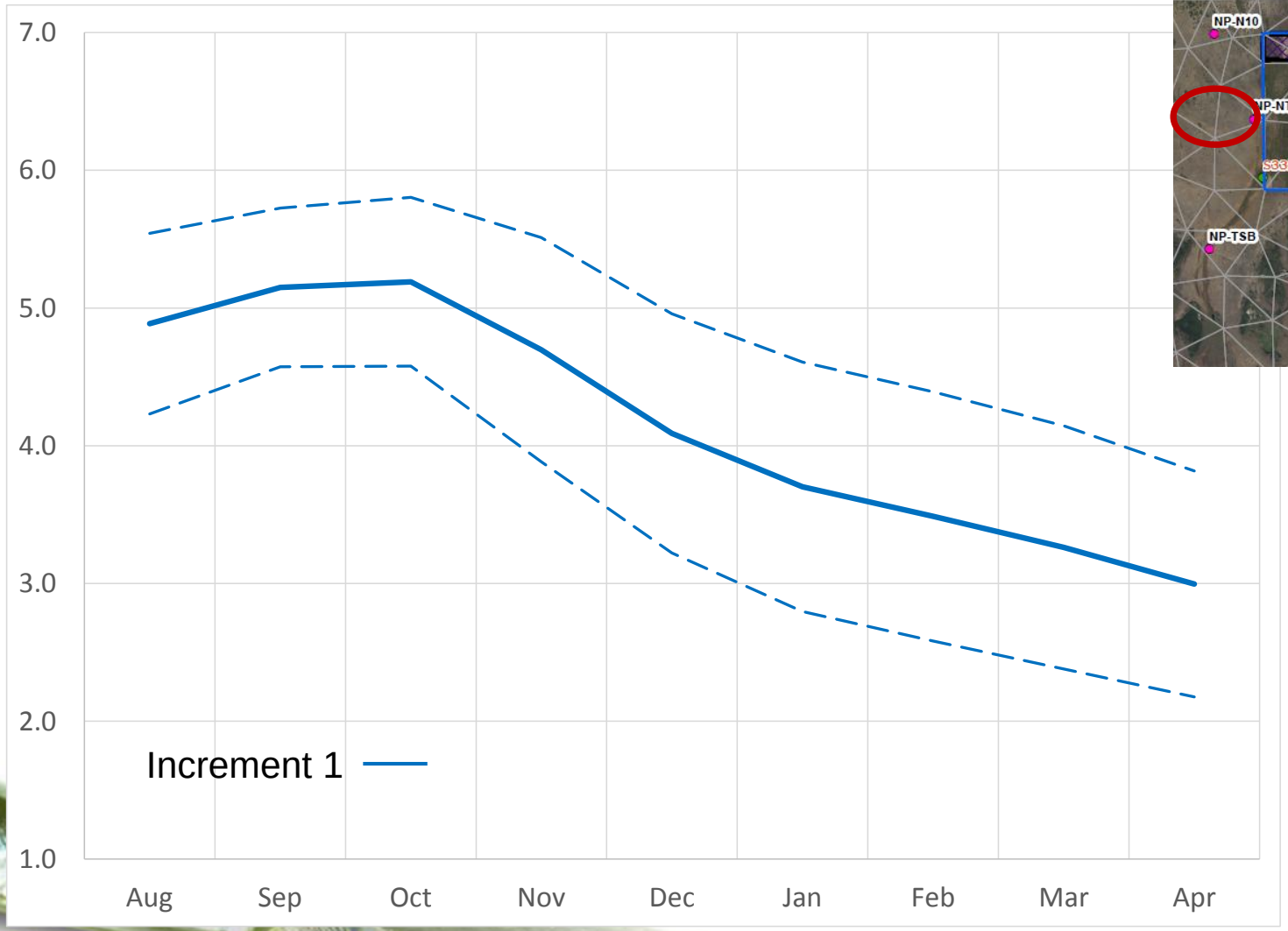
Seasonal Pattern in S177 Headwater





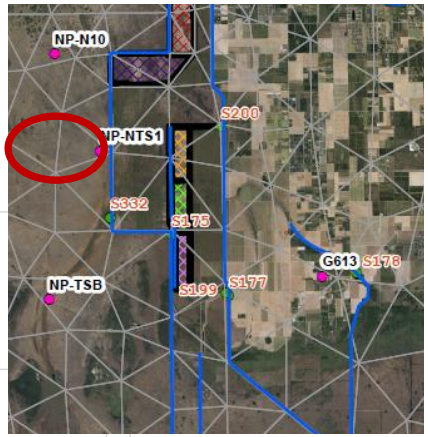
Seasonal Pattern at NTS1 (in Everglades National Park)

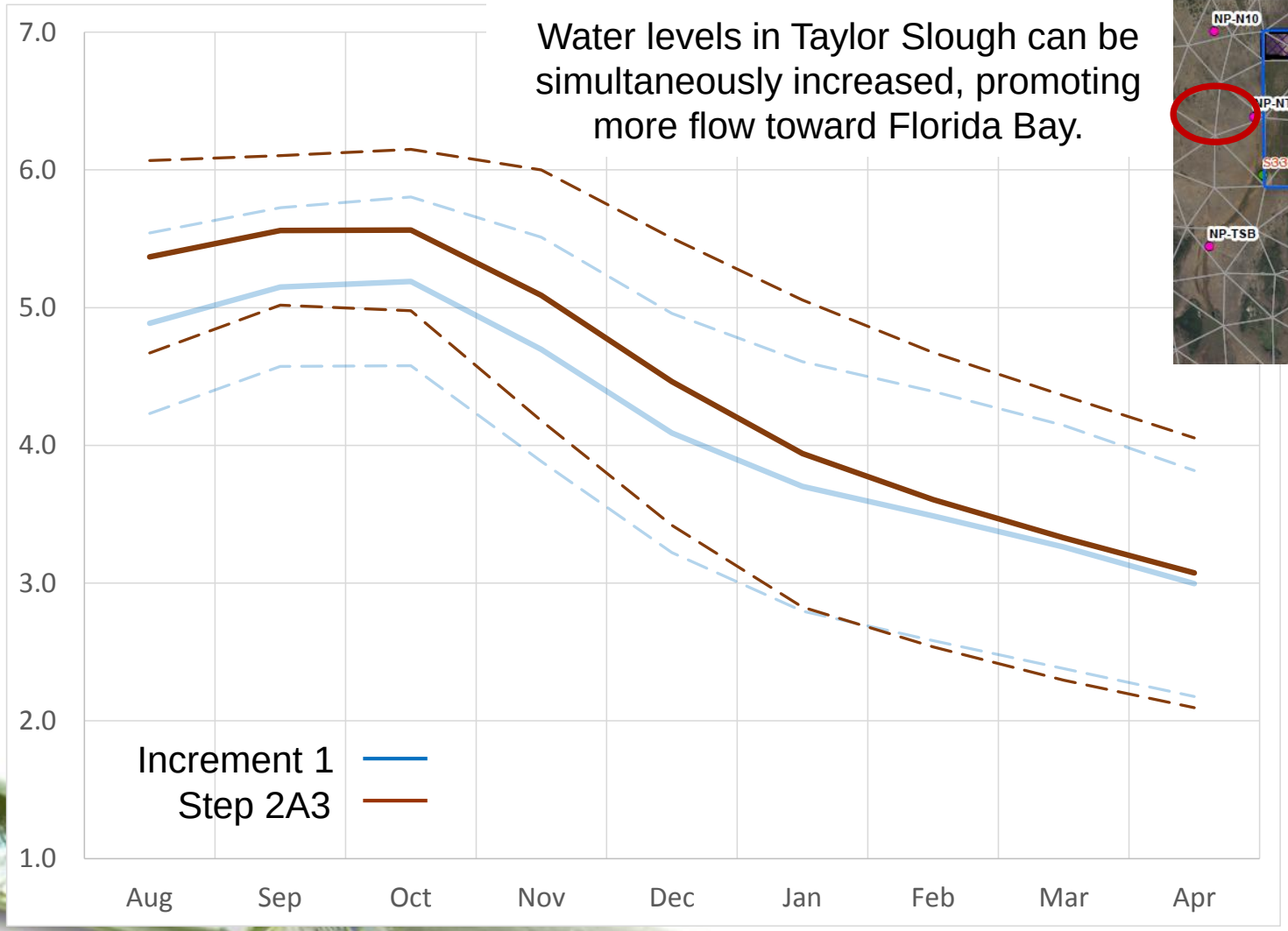




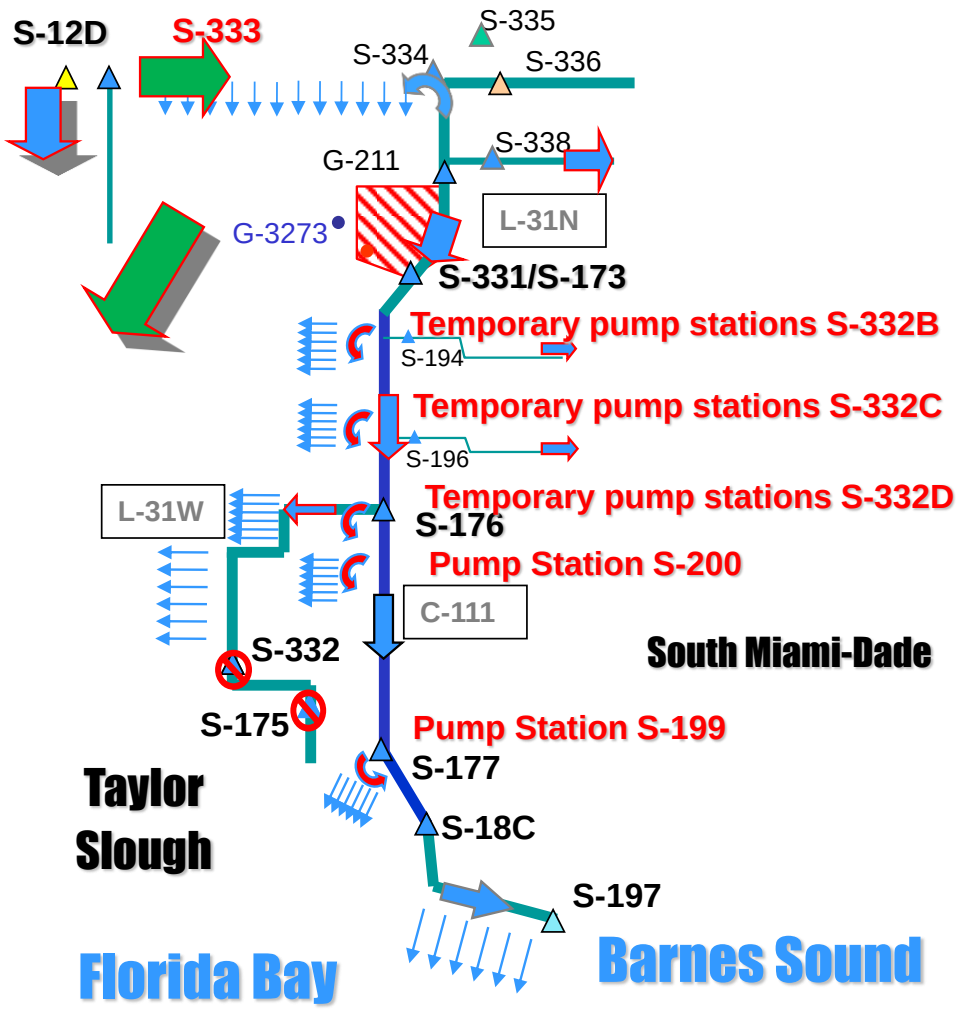
Seasonal Pattern at NTS1 (in Everglades National Park)

Water levels in Taylor Slough can be simultaneously increased, promoting more flow toward Florida Bay.



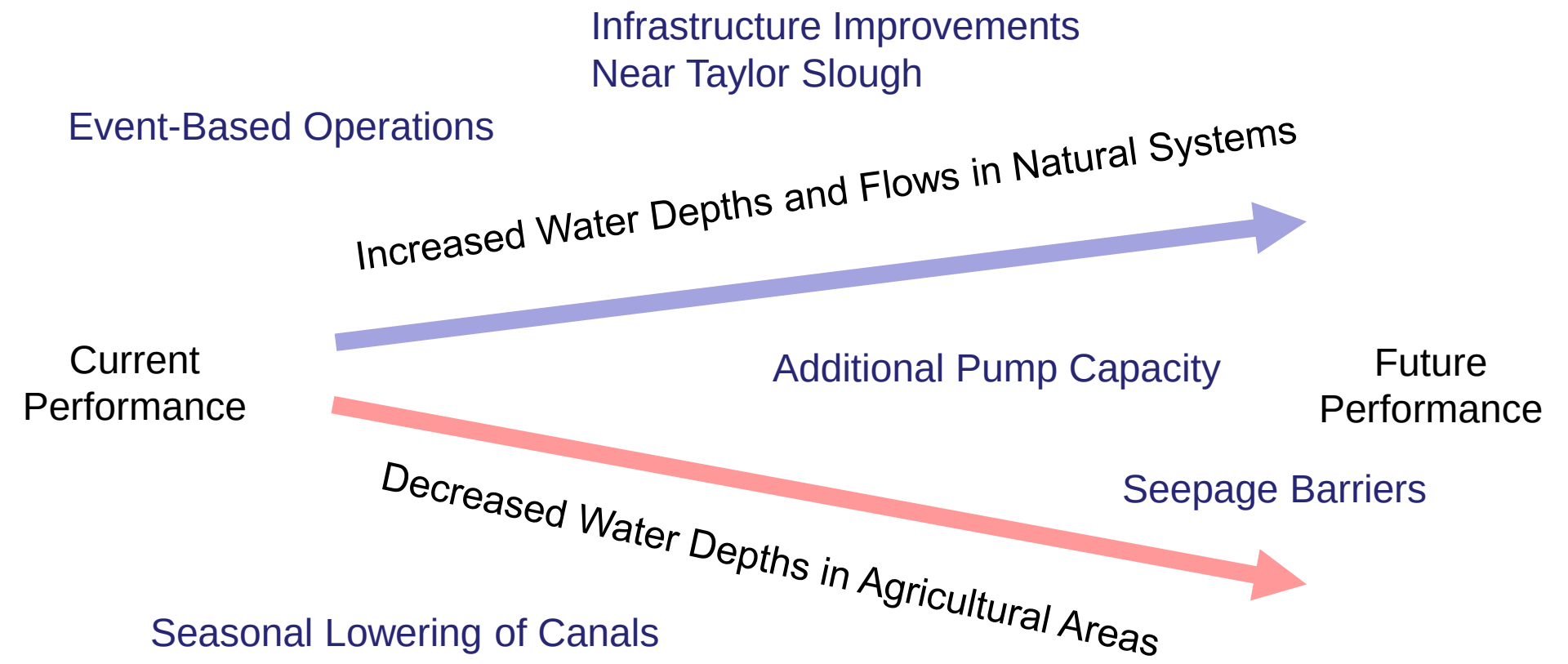


Why Does This Work?



- Rather than relying on flows primarily to the south (as in early operations of the SDCS) or primarily to the west (as in IOP or ERTP), the operations demonstrated today balance the use of both sets of infrastructure
- Improvements in seasonal and event-based operations make these operations robust across a broad range of conditions and infrastructure.

Feasible Options Discussed at the February 2 South Dade Workshop



Maintain Progress on Existing Efforts (MWD, C-111, C-111SC, CERP)

Path Forward

A number of feasible options are being pursued as of April 2016:

- Refine operations at key structures (0-6 months)
  - Rainfall event-based criteria at S177 and S176
  - Operate at lower end of range for S332s
  - Seasonal lowering of operations at S199 & S200
- Modify High Head Cell at S332D Flow-way to improve efficiency of water delivery to Taylor Slough and reduce seepage back toward developed areas (6-9 months)

These options are low cost or would only require staff time; they could be implemented by next dry season.

Path Forward (Continued)

With Governing Board direction, additional options are being pursued, either as part of ongoing planning efforts or expedited by the District:

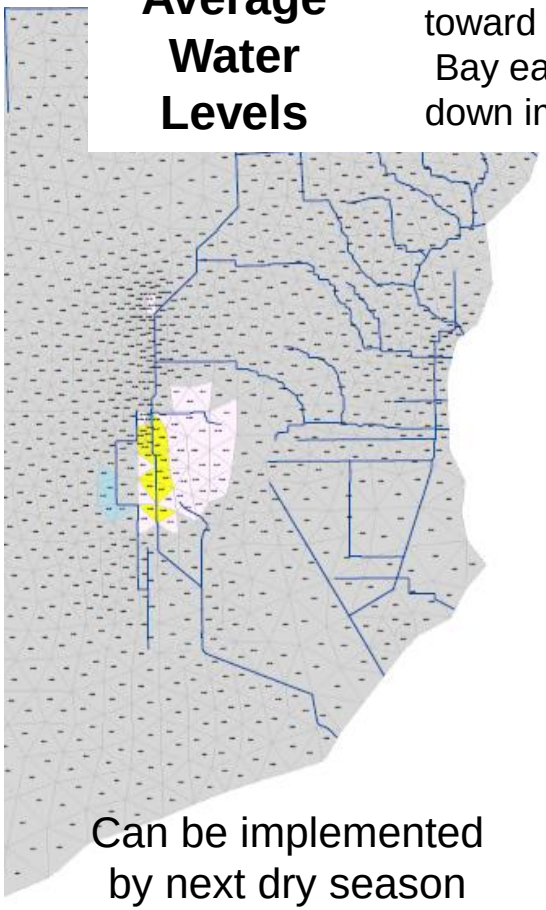
- Seasonal lowering of operating criteria at S332s (9-12 months)
- Modify infrastructure in vicinity of Taylor Slough headwaters: $1-5 million (1-3 years)
- Increase S199 and S200 pump capacity: $4 million (1.5-2 years)
- Seepage collection canal and pump station near S178: $11 million (2-3 years)
- Seepage barrier – up to 15 miles in length: $55-65 million (2-4 years)

Due to required planning, permitting, design, and construction efforts, these options will take time to implement.

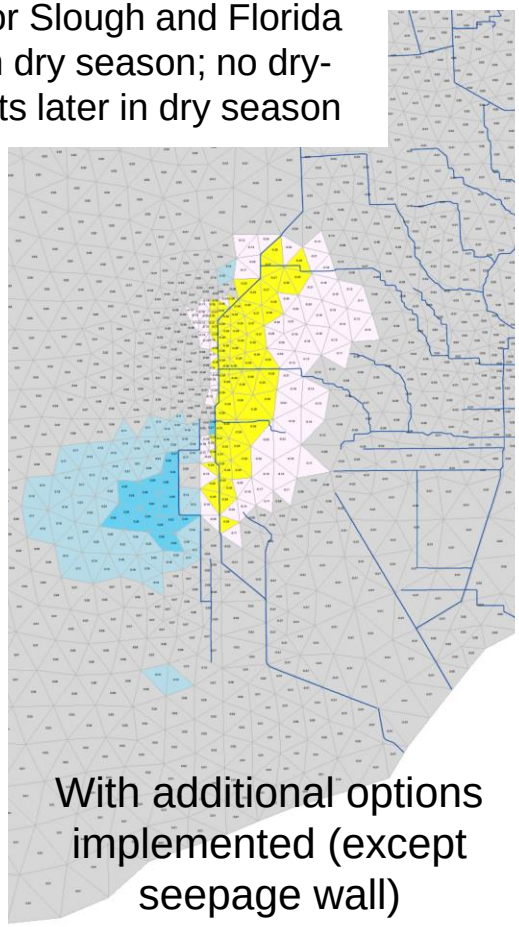
Examples Outcomes (Goals Achieved)

41 Year Average Water Levels

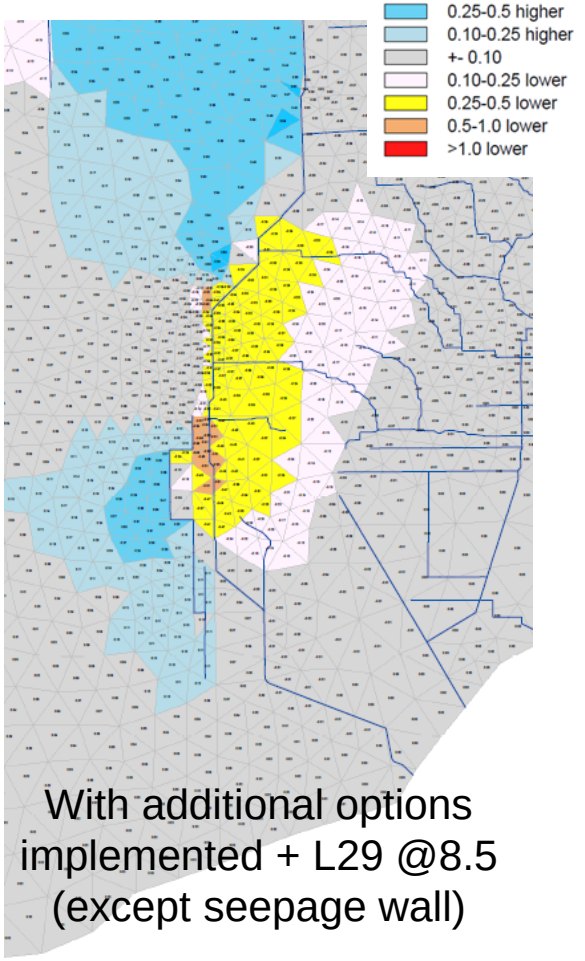
Generally lower water levels east of L-31N/C-111 while promoting flow toward Taylor Slough and Florida Bay early in dry season; no dry-down impacts later in dry season



Can be implemented by next dry season



With additional options implemented (except seepage wall)



With additional options implemented + L29 @8.5 (except seepage wall)

Achievements to Date

Thanks to the collective efforts of all participants, South Dade Investigations has accomplished many important outcomes:

- Technical assessment has demonstrated that it is possible to relieve flooding to agricultural lands while retaining water in or delivering water to Everglades National Park, Florida Bay and other natural systems.
- Water managers are already using knowledge gained during this effort to help manage the system response to unprecedented El Nino rainfall and the resulting emergency deviation.
- A list of infrastructure and operational options to pursue has been identified by the SFWMD Governing Board.
- Future implementation efforts will benefit from the analysis performed in this forum and will likely be able to move more quickly toward desired outcomes.

Acknowledgements

Many thanks to all who participated in the forum and/or helped with the brainstorming!

SFWMD Technical Team Members:

- Brenda Mills
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- Tibebe Dessalegne

Questions