Innovative Hydraulic Modeling Approaches Used During the Design of an Everglades Treatment Wetland

Maria Loinaz[1], Brent Whitfield[2], John Visconti[3], Alexis San Miguel[4], Jeremy C. McBryan[4], and Ken Konya[4]

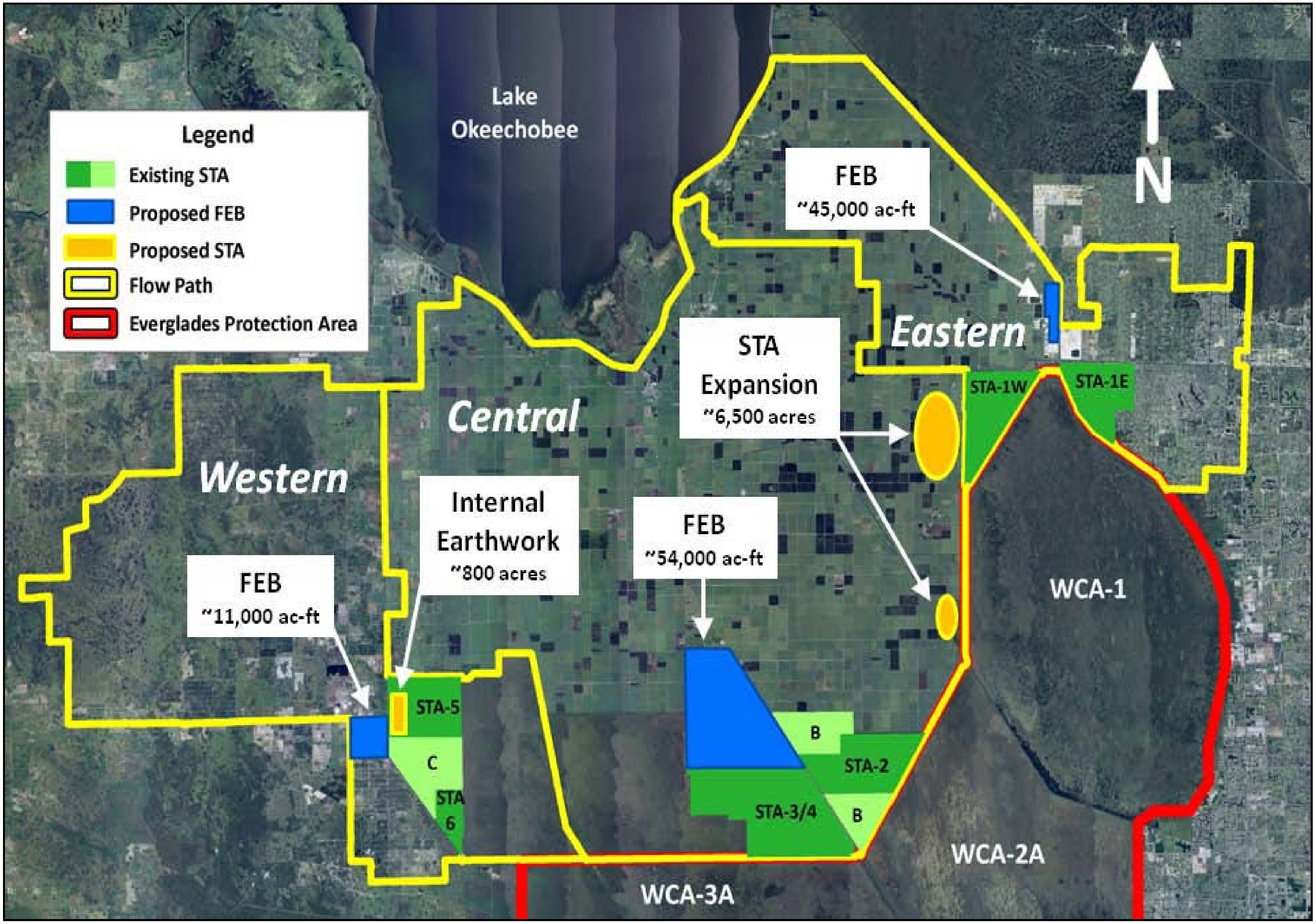
[1]ADA Engineering, Inc., Tampa, FL, USA

[2]ADA Engineering, Inc., West Palm Beach, FL, USA

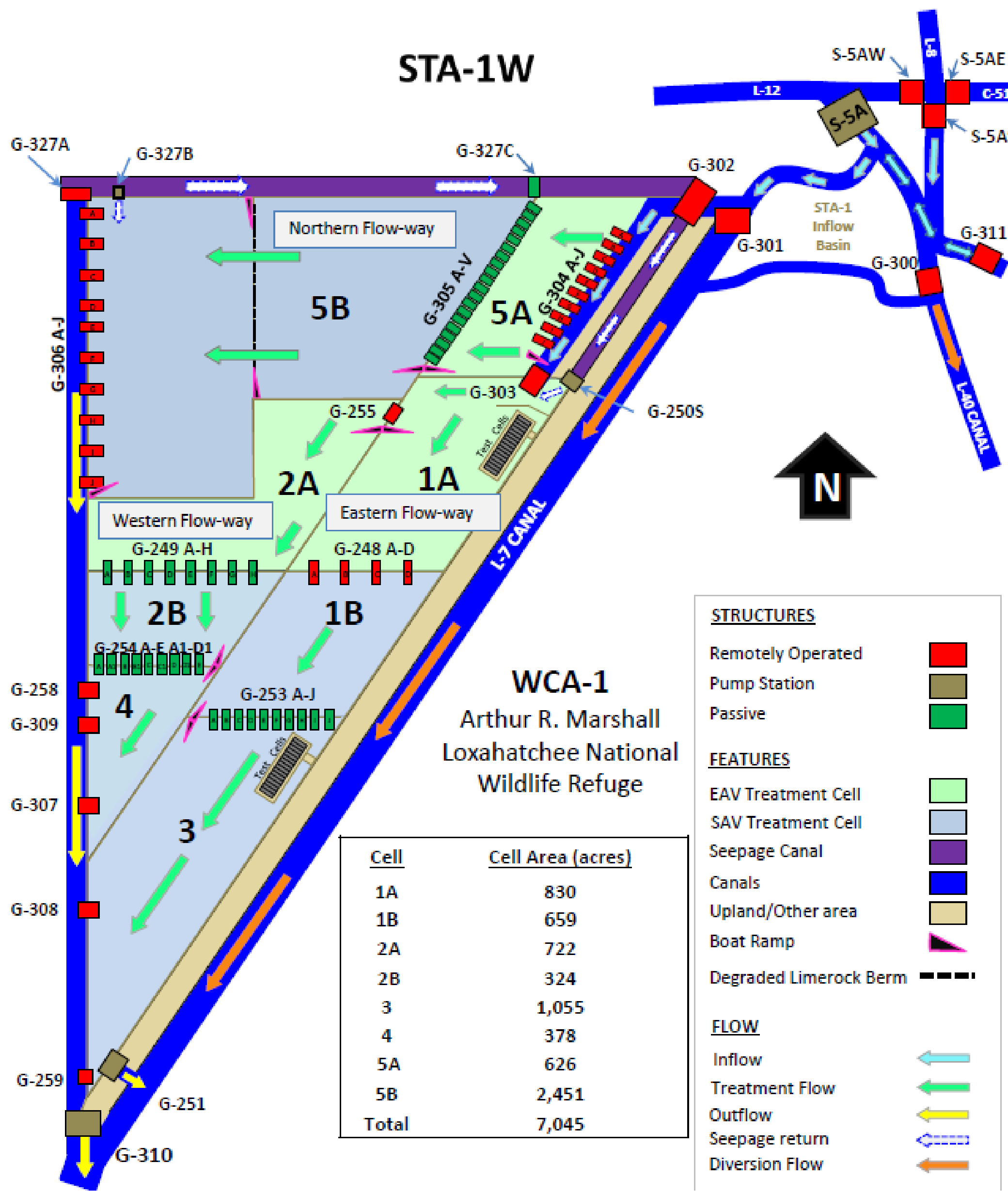
[3]MWH, West Palm Beach, FL, USA

[4]South Florida Water Management District, West Palm Beach, FL, USA

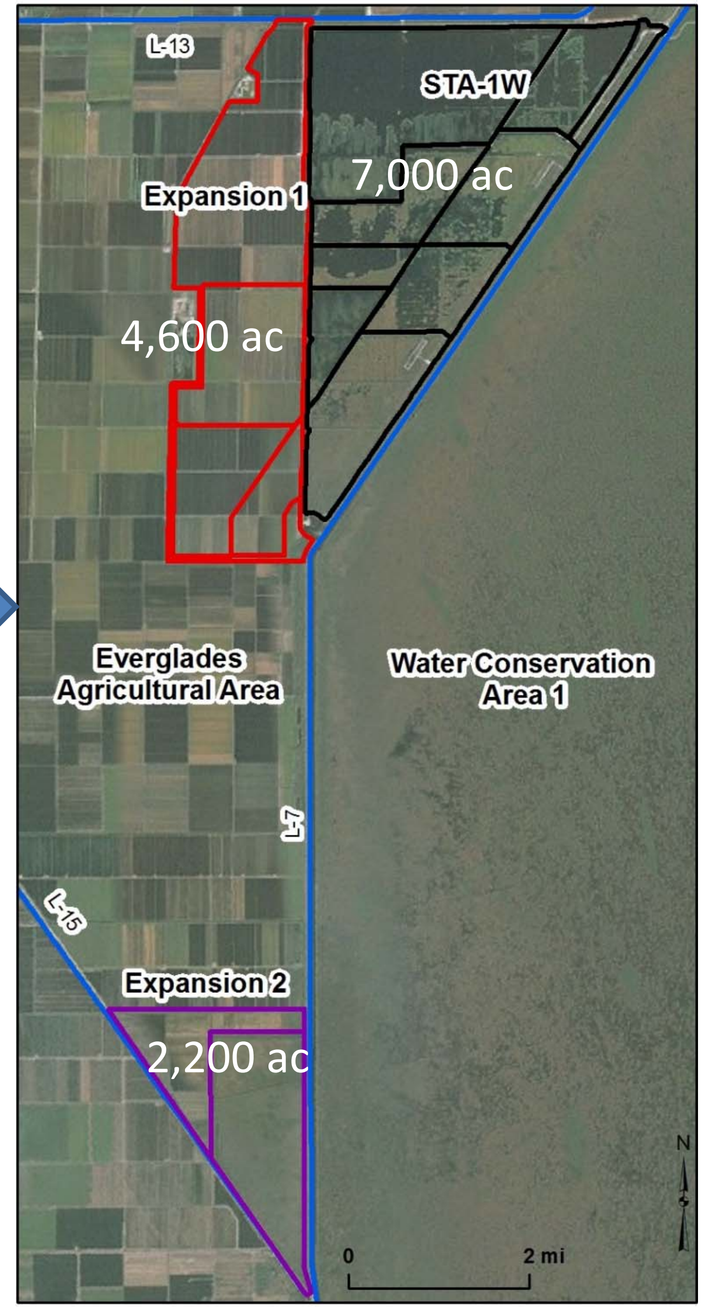
Everglades Restoration Strategies



STA-1W Expansion



Cell	Cell Area (acres)
1A	830
1B	659
2A	722
2B	324
3	1,055
4	378
5A	626
5B	2,451
Total	7,045



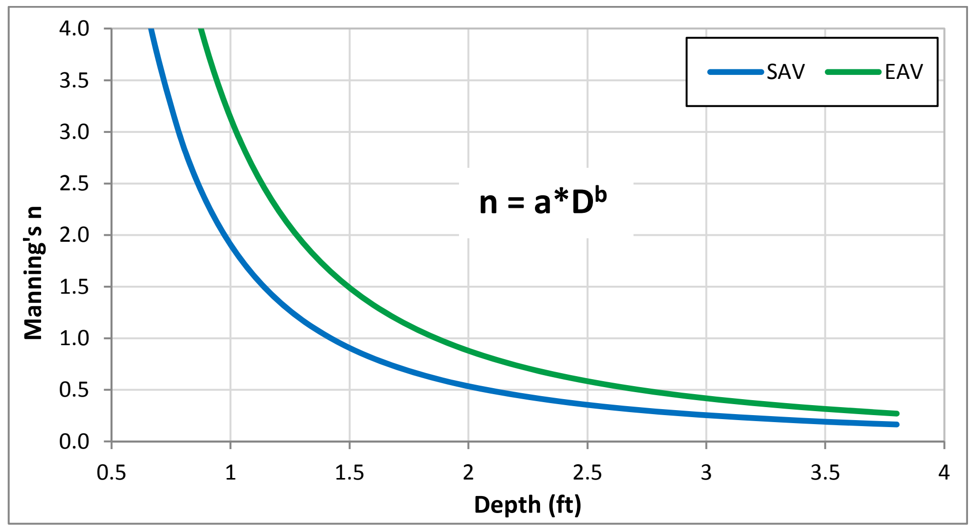
Overall Approach for Expansion Design

1. Initial modeling - calibrate 1D and 2D models of existing STA-1W (2-month wet period)

2. Screening tool to evaluated 12 alternatives.

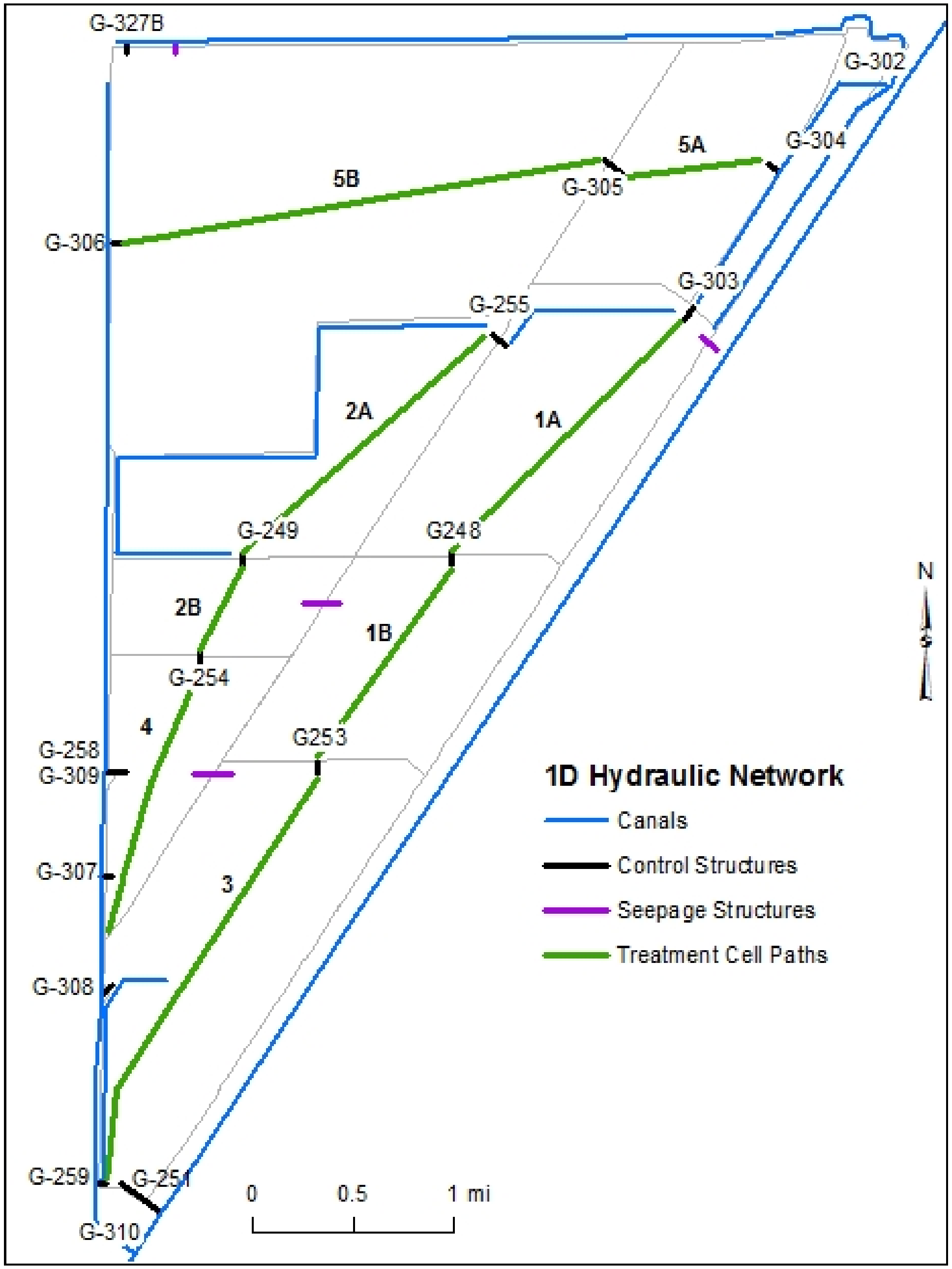
#	CONFIGURATION		DIRECTION		ALIGNMENT			CHANGES STA-1W	
	Series	Parallel	E-W	N-S	H	D	V	MINOR	MAJOR
1	X		X			X			
2	X		X		X				
3		X	X			X			
4		X	X		X				
5	X			X		X			
6	X			X			X		
7		X		X		X			
8		X		X			X		
9	X		X		X			X	
10	X			X			X	X	
11	X		X		X				X
12	X			X		X	X		X

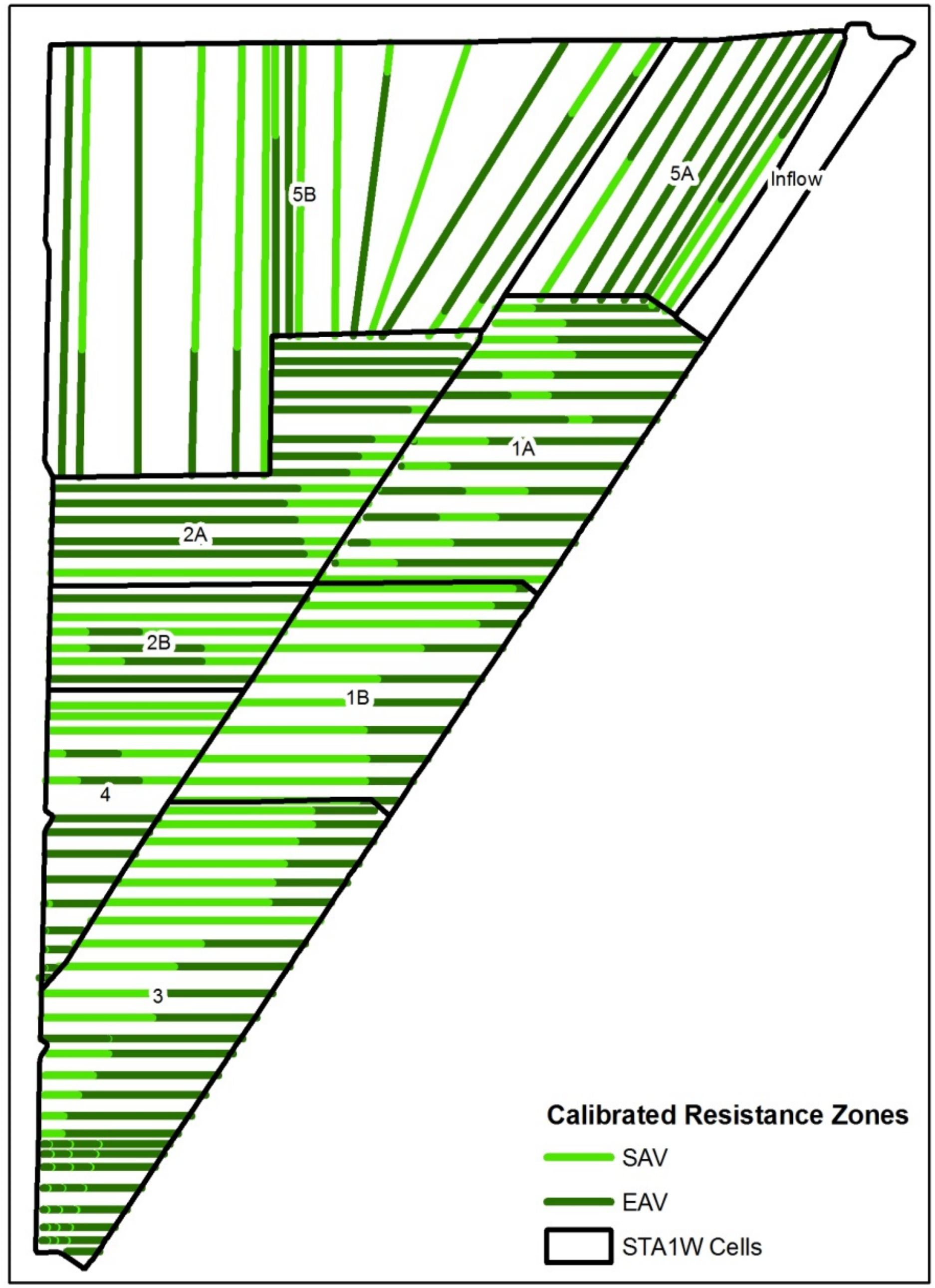
3. Recalibration of a 1D model
   - Two-year simulation period
   - Manual and automatic calibration techniques to generate Manning's n curves for SAV and EAV.



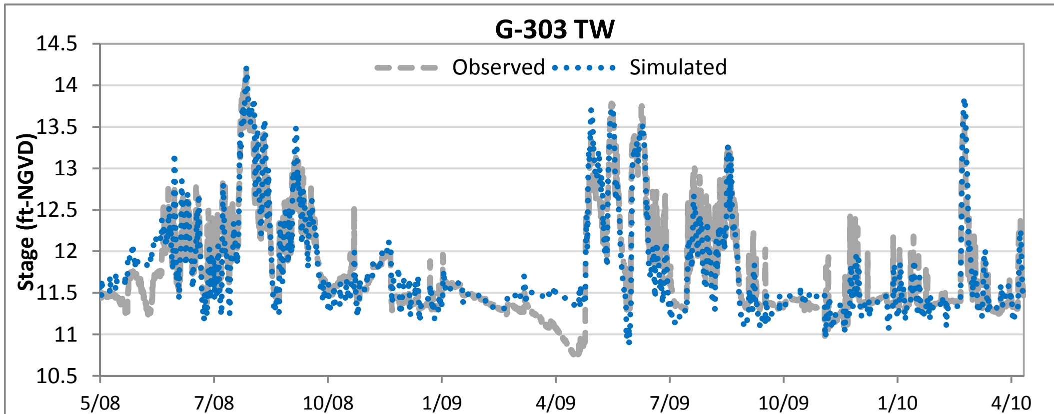
4. Evaluate the design of Expansion 1 (Interim Conditions Model) with 1D and 2D models

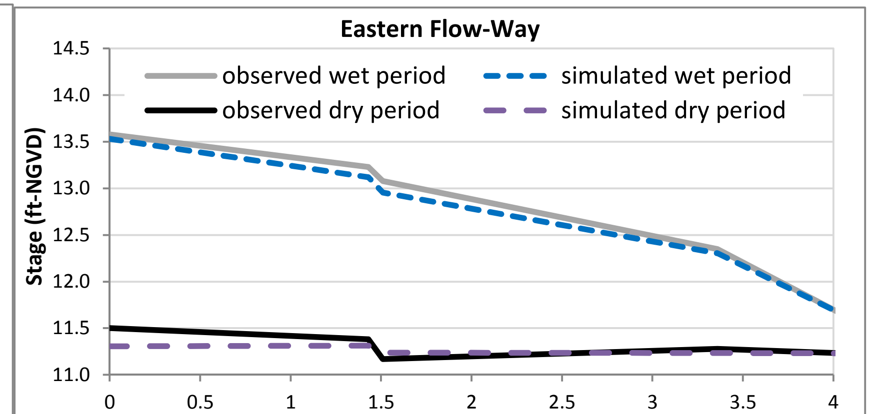
Existing STA1W Model

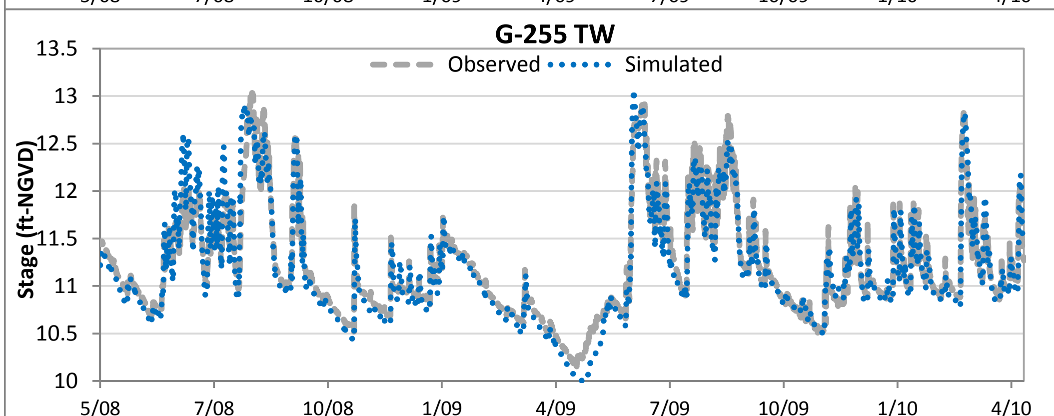


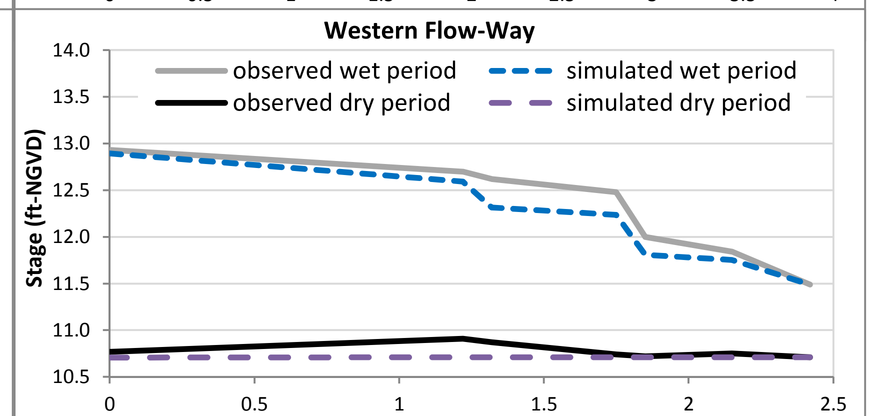


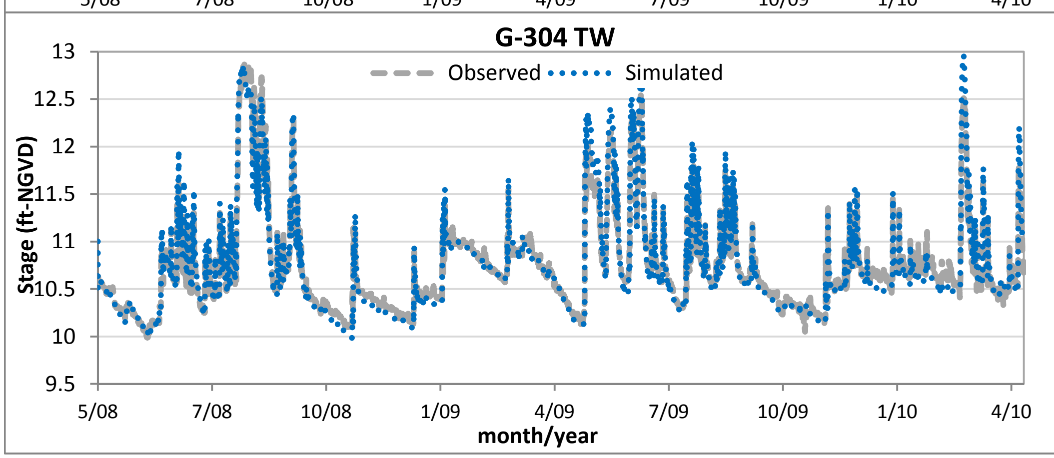
Existing STA1W Model Calibration

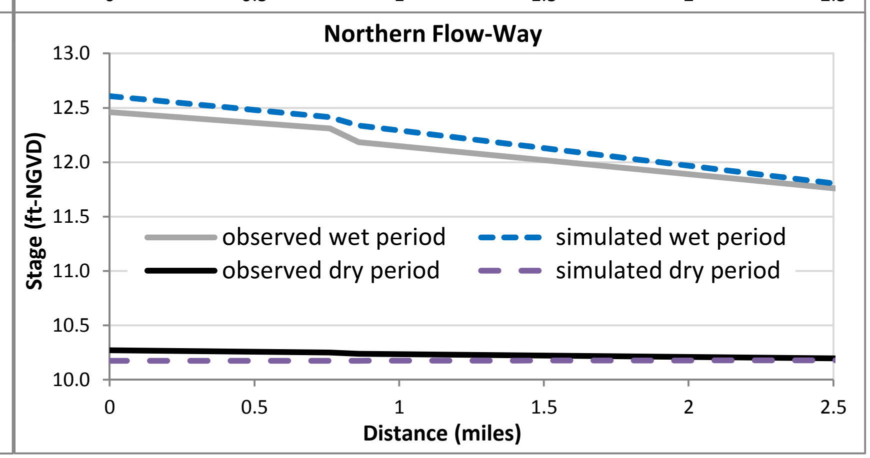












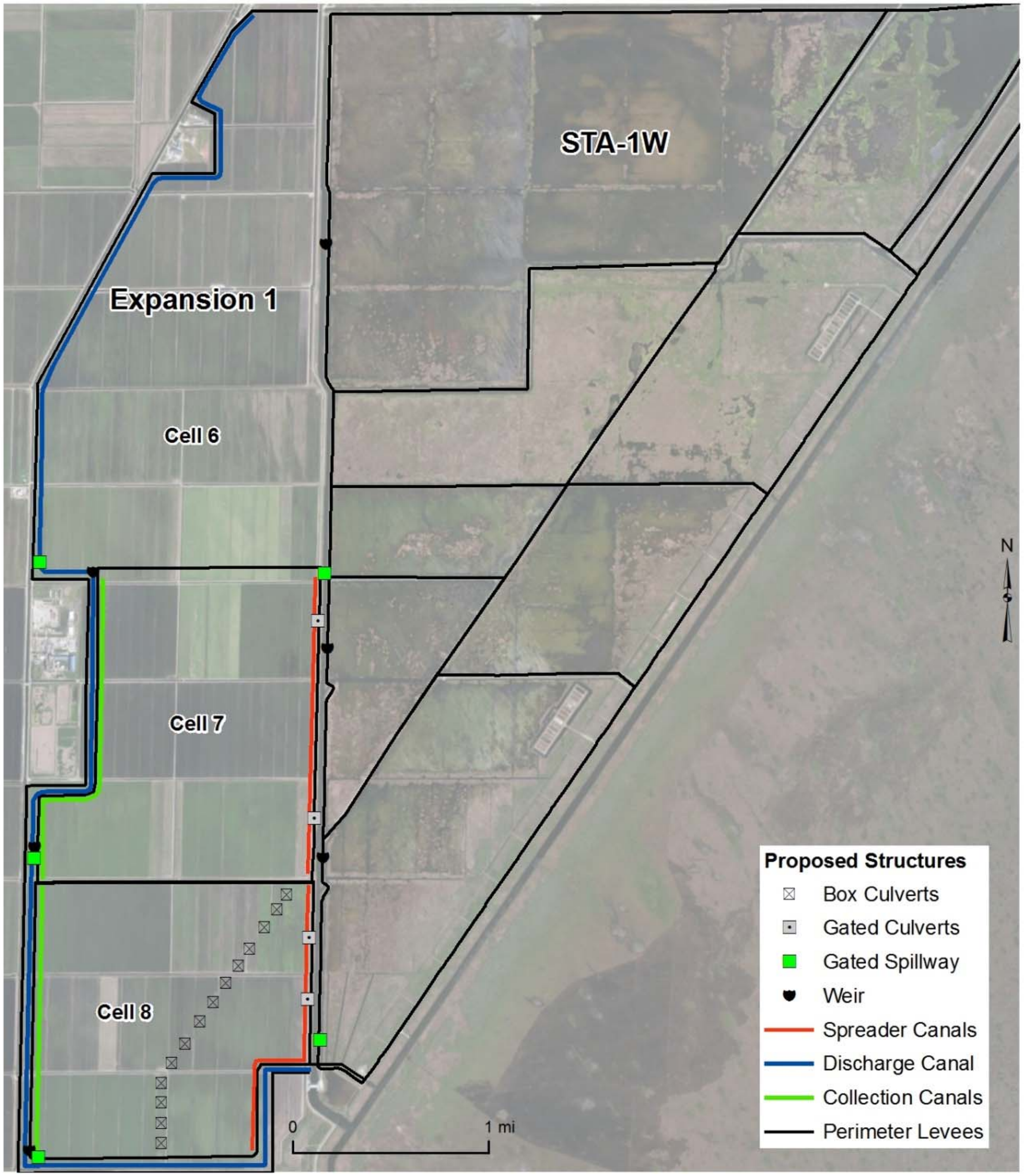
Interim Conditions Model Approach

- Set target operations
  - Wet/dry season stages
- 1D Model (MIKE 11)
  - 100-yr design storm
  - 41-yr simulation
- Hydraulic Design Criteria
  - Depth: maximum, average, minimum
  - Velocities: maximum in wetland and canals

Interim Conditions Design

- Modifications to the original design of preferred alternative based on preliminary results and further analysis
  - Topography (head losses)
  - Wind fetch
  - Operational flexibility

- Final design features
  - Divide structures
  - Cell re-configuration
  - Outflow structure types and sizes



1D Model Results

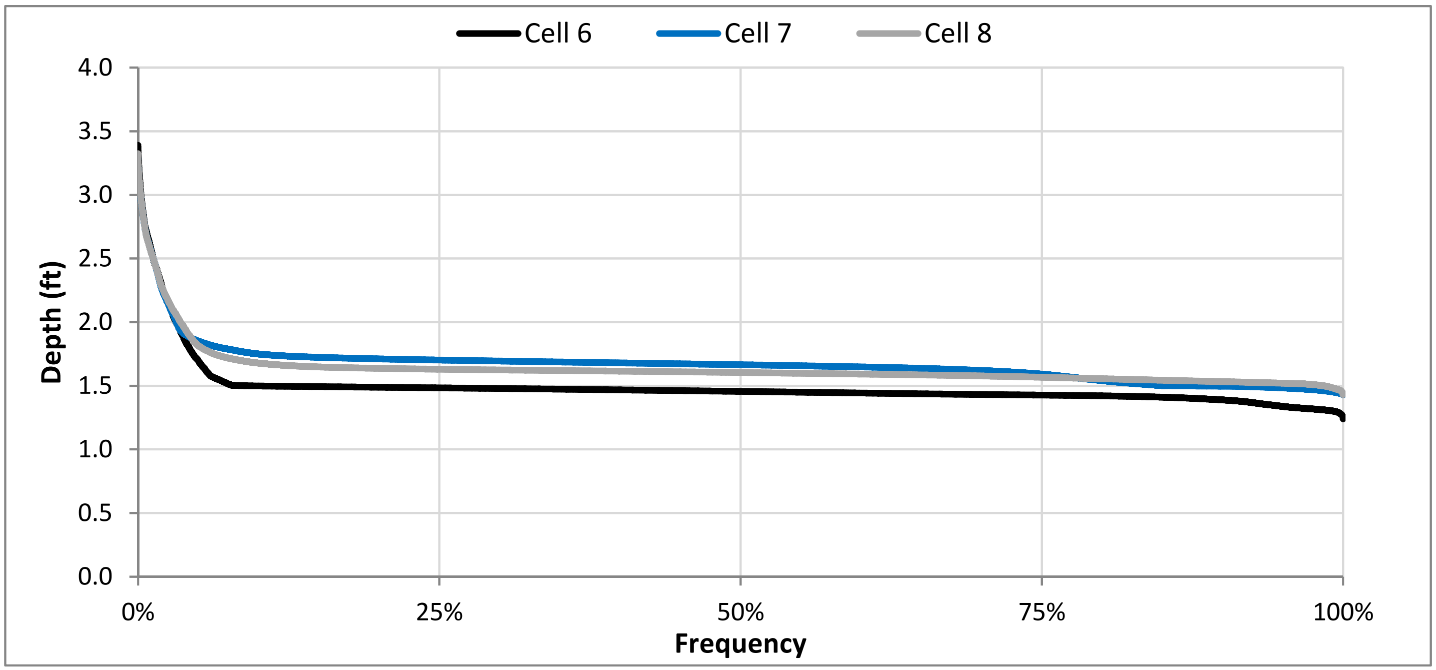
Peak Conditions during 100-yr Design Storm

TREATMENT CELL	DEPTH (ft)[1]	Velocity (ft/s)[2]
6	3.5	0.03
7	3.3	0.06
8	3.4	0.06

[1] Maximum allowable depth in an SAV treatment cell = 3.7 ft

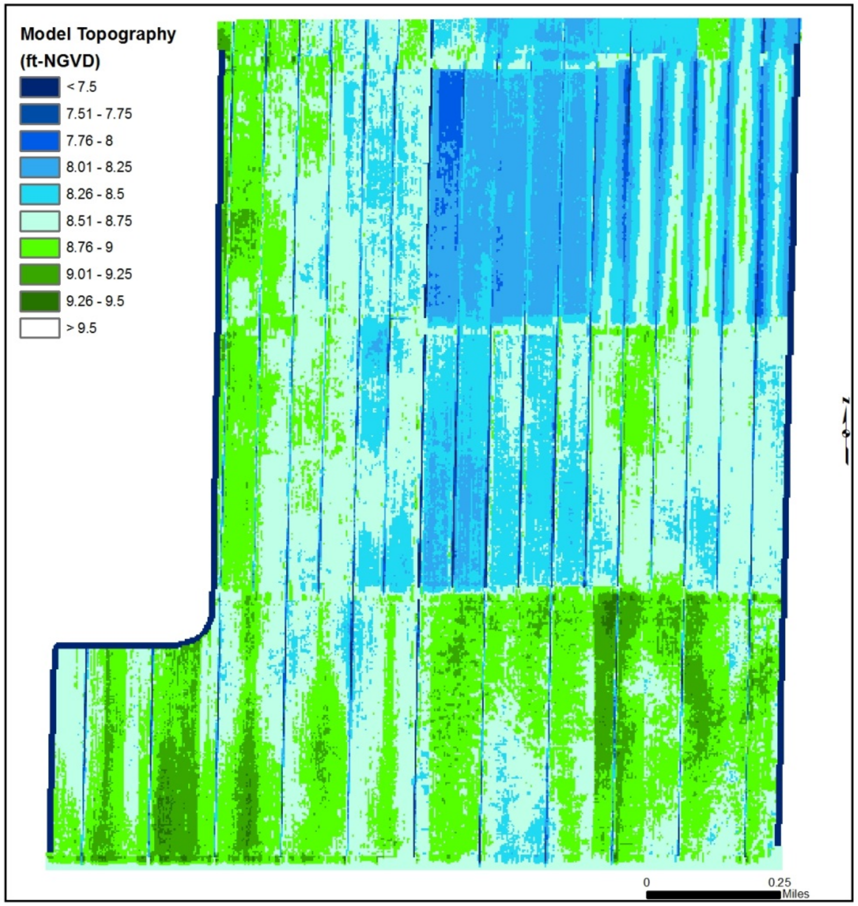
[2] Maximum allowable velocity in a treatment cell = 0.1 ft/s

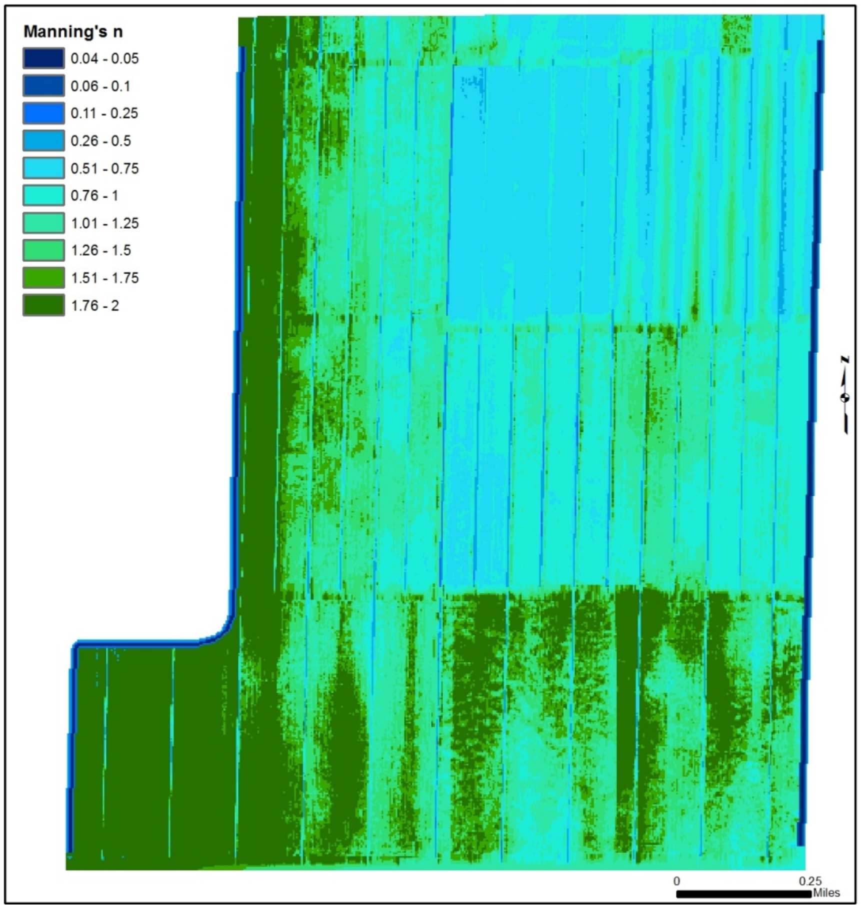
Long term (41-yr) simulation



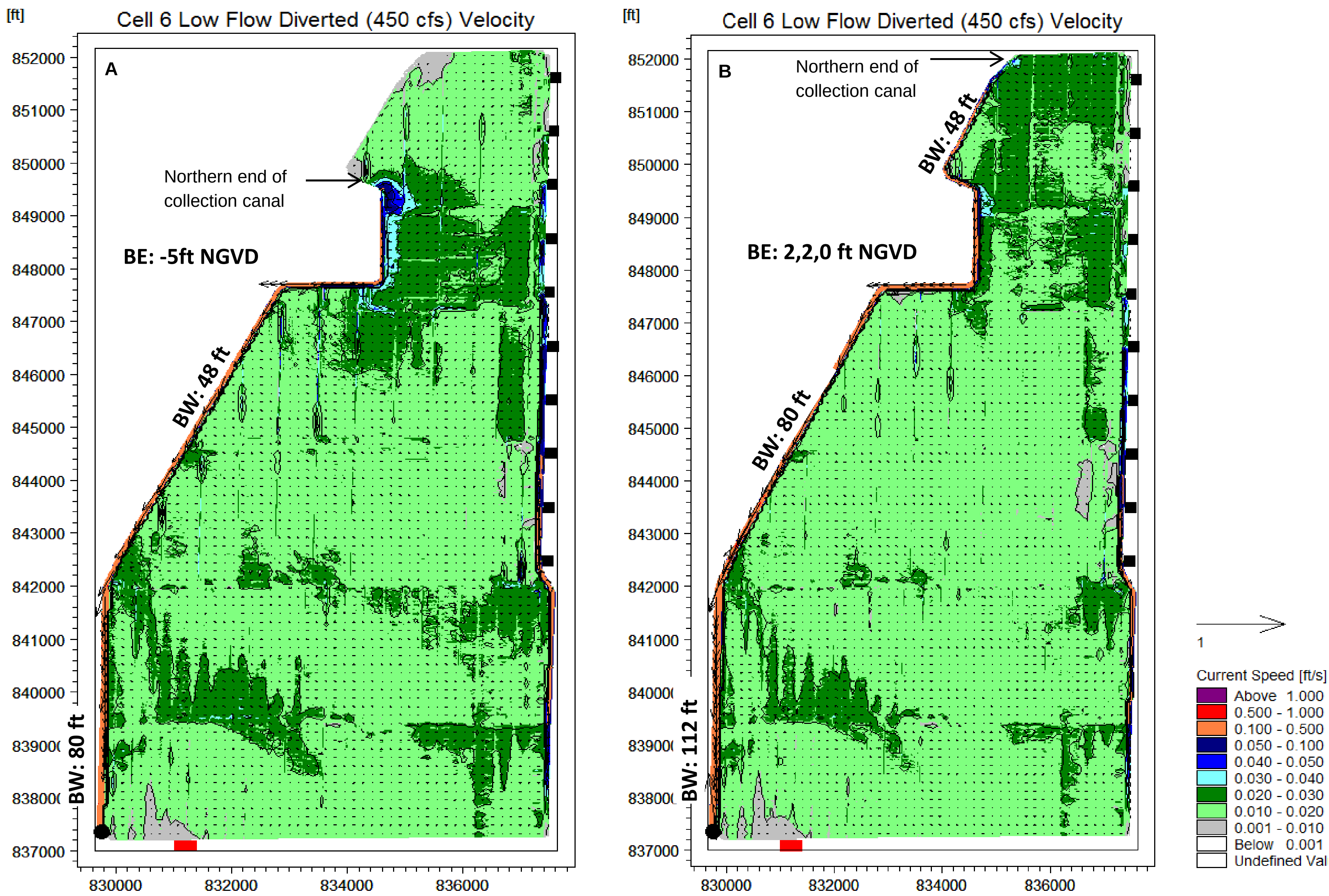
2-Dimensional Models

- Some hydraulic features are difficult to simulate in a 1D model
  - Wetland-canal connections
  - Spatial distribution of velocities
- Use models to evaluate
  - Size of canals
  - Location of Structures
- 16-ft grid resolution (simulate ditches)
- Three steady-state flow conditions
- Use calibrated n curves with a dynamic equilibrium approach

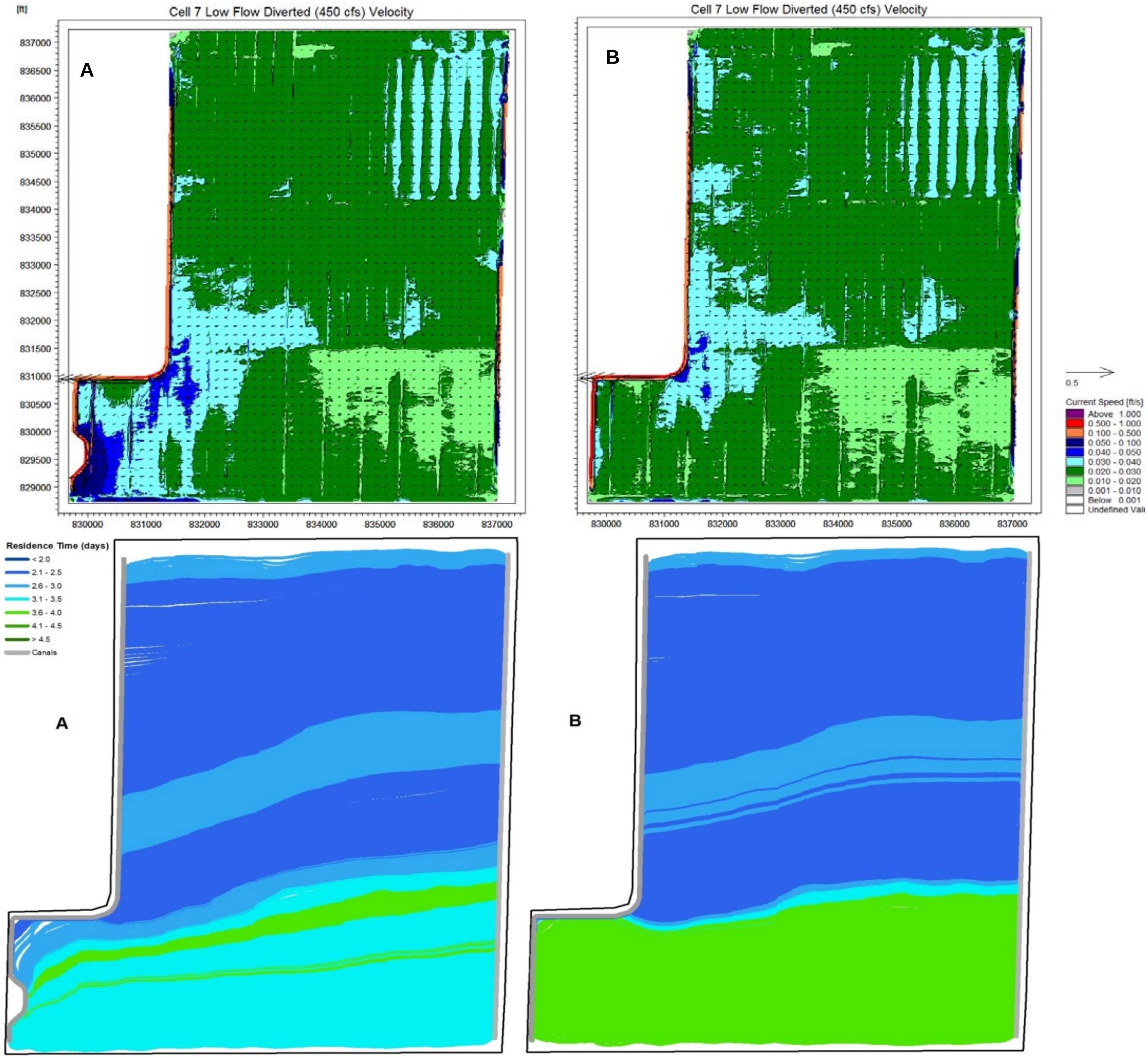




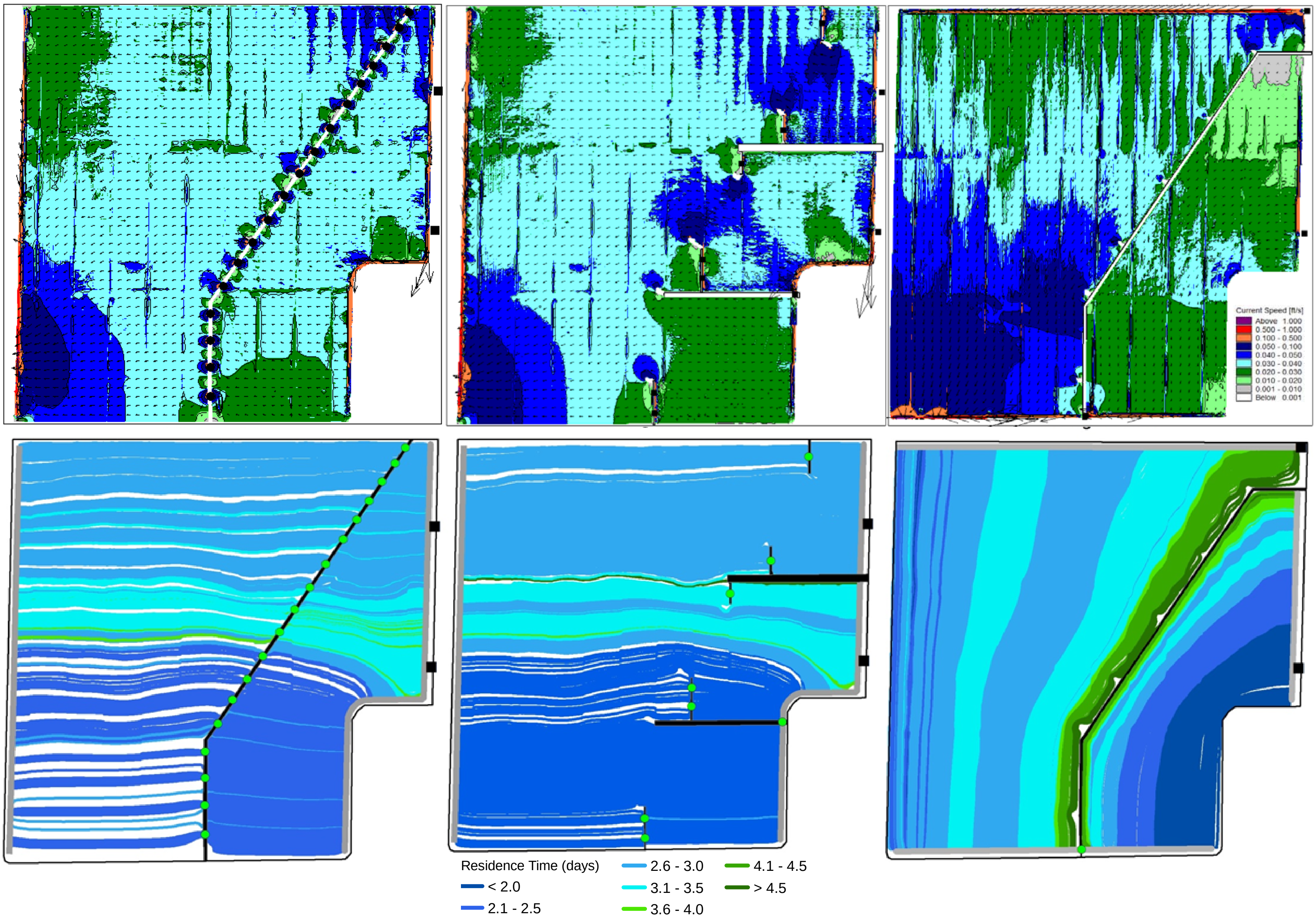
2D Results Cell 6 – canal sizing



2D Results Cell 7 – structure location



2D Results Cell 8 – three configurations



Conclusions

- Challenges in modeling the hydraulics of treatment wetlands
  - Relevant factors: seepage, unquantified flow, head losses, depth-dependent roughness, short-circuiting.
  - 1D vs 2D
- Stage calibration results are accurate, but better measured flow estimates are needed to close water budgets.
- 1D model iterations were used to design a system that meets the STA hydraulic criteria.
- 2D models were used to size canals and space structures by evaluating the velocity distributions and flow pathways in the treatment cells.
- Water quality benefits will be quantified using DMSTA models.

Thank you!