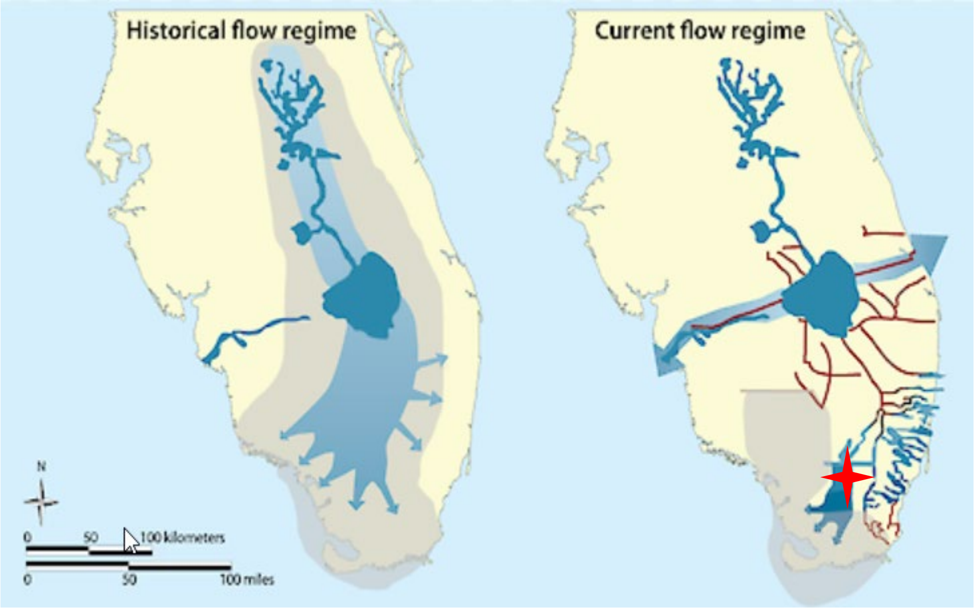
Hydrodynamic Modeling of the Blue Shanty Flowway

--Model Establishment and Reality Check

By *Jie Zeng, Towsif Bhuiyan, Colin J. Saunders and Matahel Ansar*

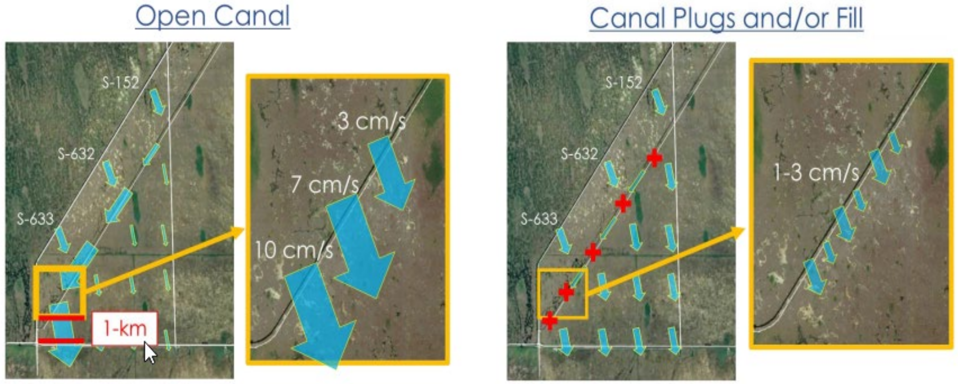
Project Background

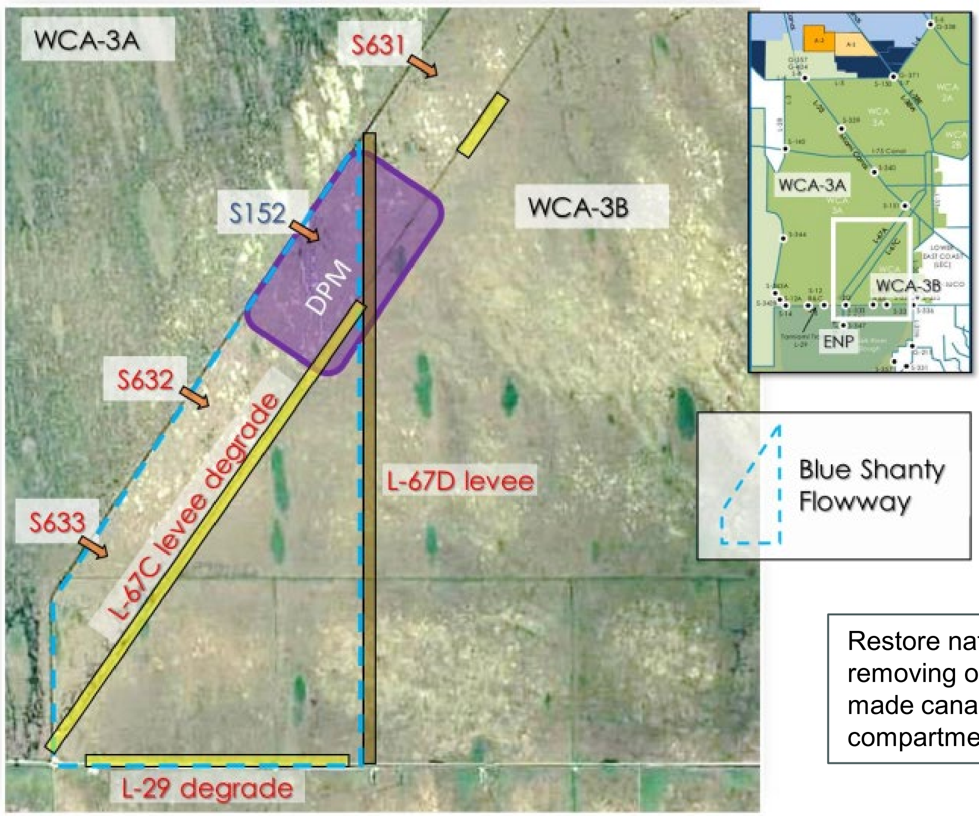


Historical and current Flows

➤ Part of the Central Everglades Restoration Planning: hydrologically to reconnect Water Conservation Area (WCA) 3A and WCA-3B with Everglades National Park and restore natural sheet flow

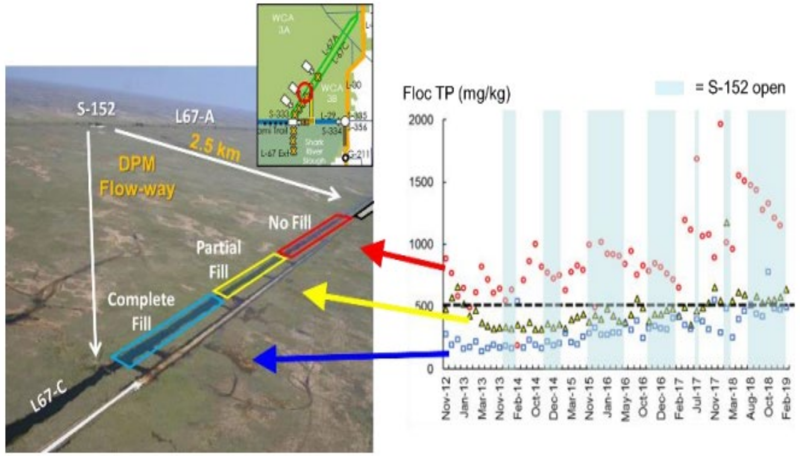
Expected Canal and Marsh Flow in BSF



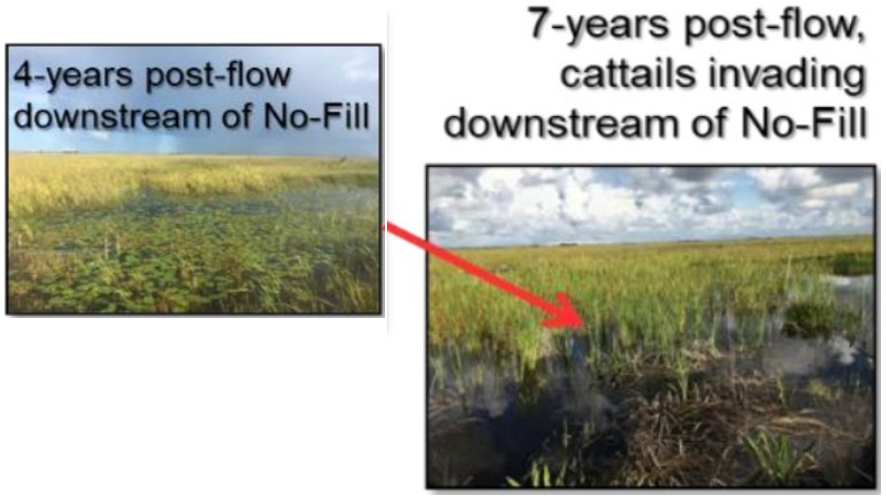


Restore natural sheet flow by removing or modifying man-made canals and levees that compartmentalize water flow

DECOMP Physical Model (DPM) Findings & Object of the Project



TP levels in flocculent sediments downstream of the No-Fill canal



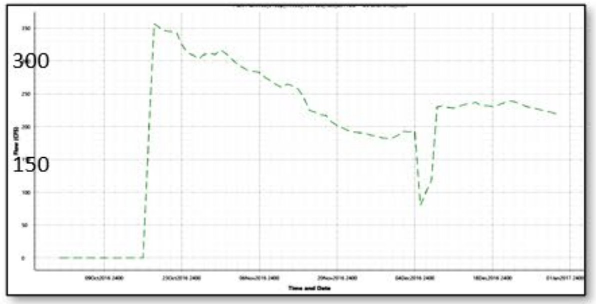
Invasion of cattails in marshes downstream of the No-Fill treatment

- Key findings from DECOMP Physical Model – DPM
  - Ecological Benefits of Restored Sheet flow
    - *Sediment redistribution helps rebuild natural topography.*
    - *Improved food quality for aquatic and terrestrial consumers.*
  - Unintended Consequences of High Flows:
    - *Fast flows carry phosphorus-rich sediments downstream.*
    - *extreme flows causes nutrient buildup and induce cattail spread in natural marshes*

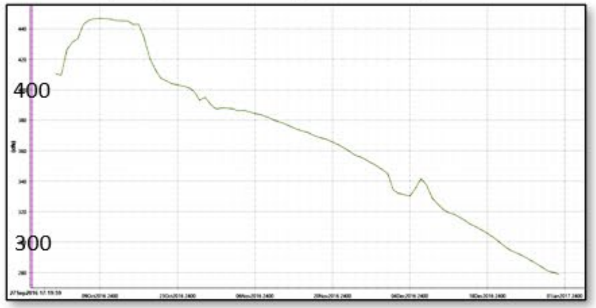
- Seeking a screening tool for canal plug configurations and swale design in the Central Everglades Planning Project

Model Description- Boundary Conditions

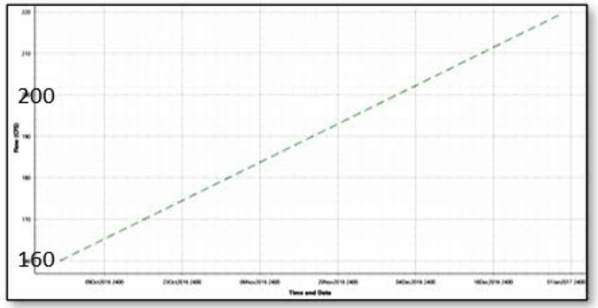
1. S152 Discharge (daily avg)

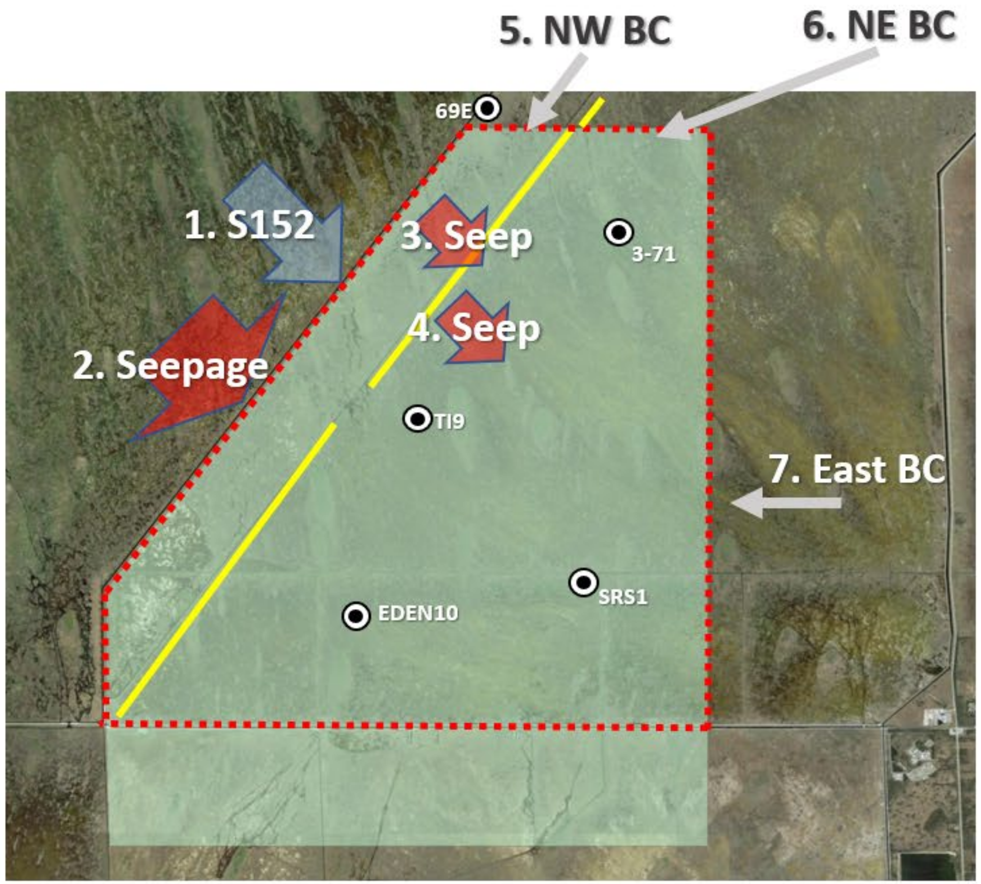


2. Seepage L-67A (RSMGL)

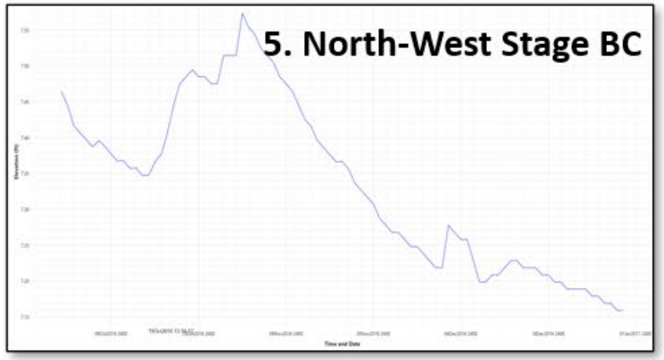


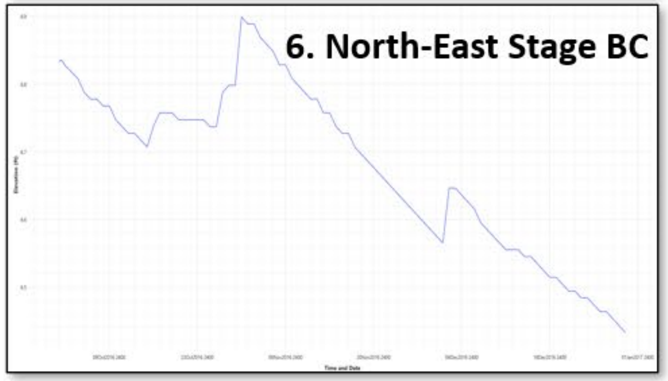
3 & 4. Internal Seepage Flow

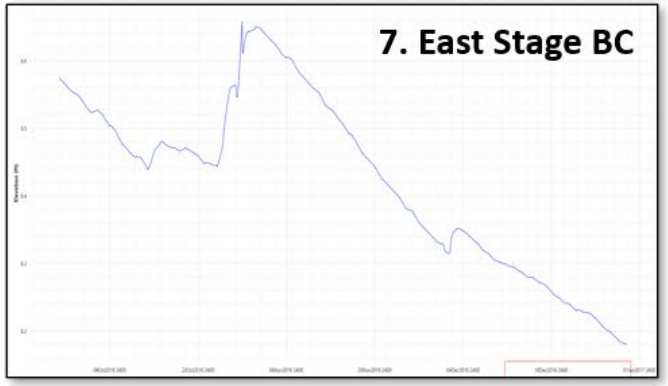




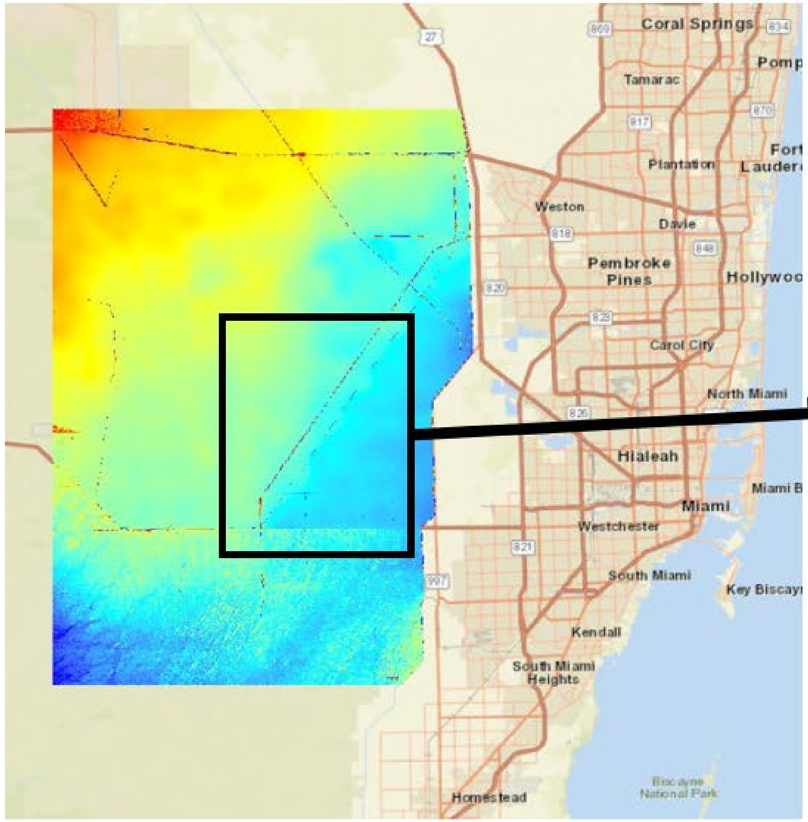
Simulation was conducted with initial conditions. Flow simulation scenario from 10/2/2016 - 12/30/2016 was chosen for the analysis and to compare the results with available data.





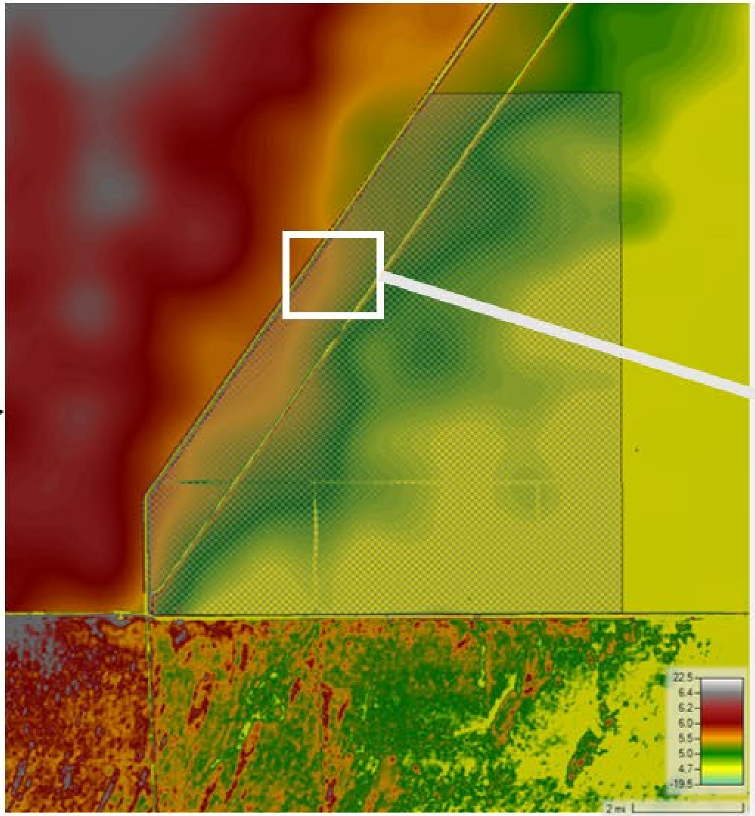


Model Description- Terrain & Mesh

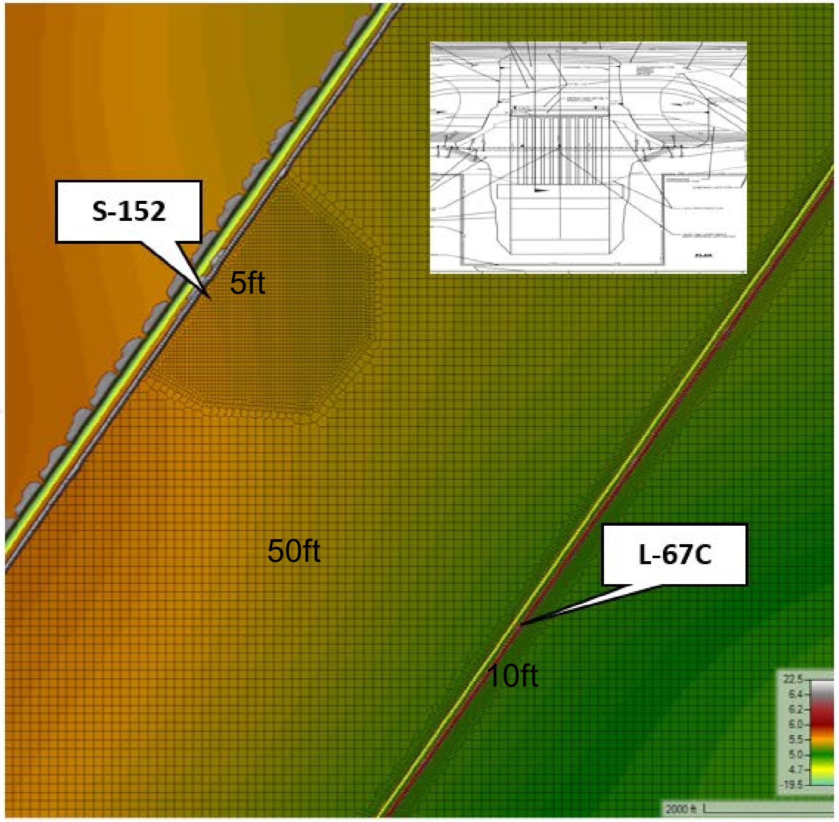


Base terrain for the model is the CEPP Watershed Digital Terrain Model (5'x5'; USACE 2019)

Surveyed bathymetry of canals/levee & gaps were burned into the base terrain

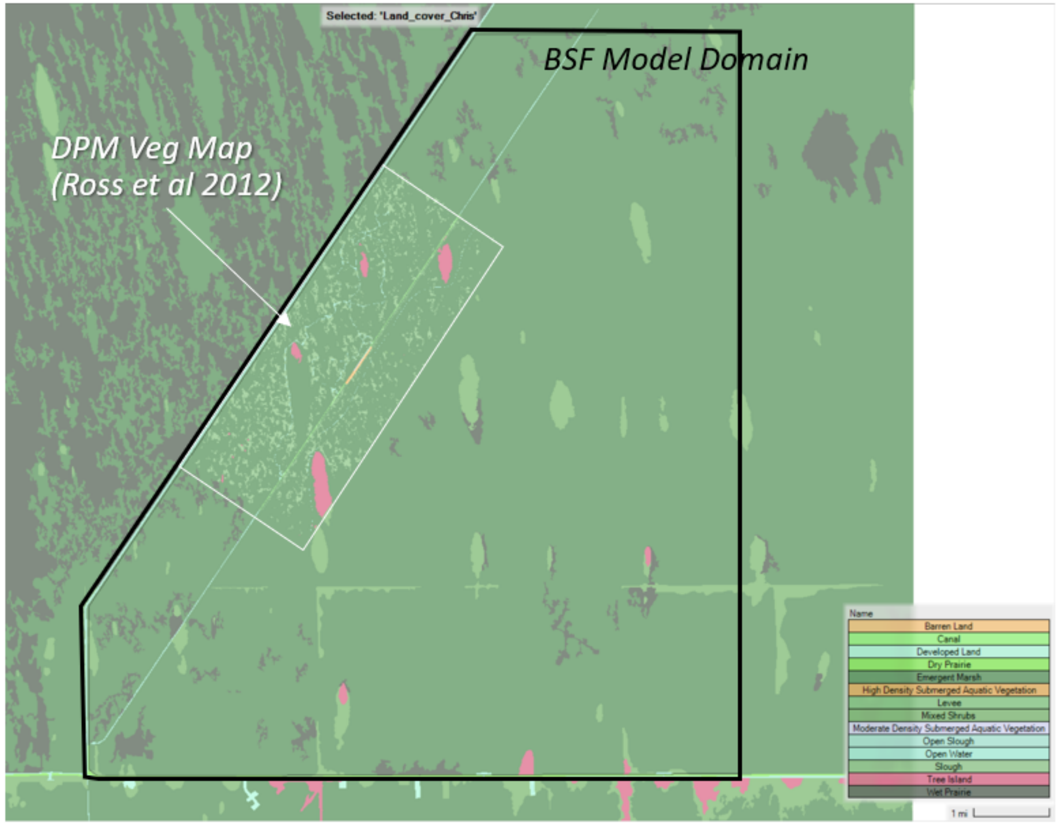


Model domain was incorporated into HEC-RAS 2D flow areas



Model cells closest to the S152 downstream and L-67C canal were refined to smaller grid size

Model Description- Land Use

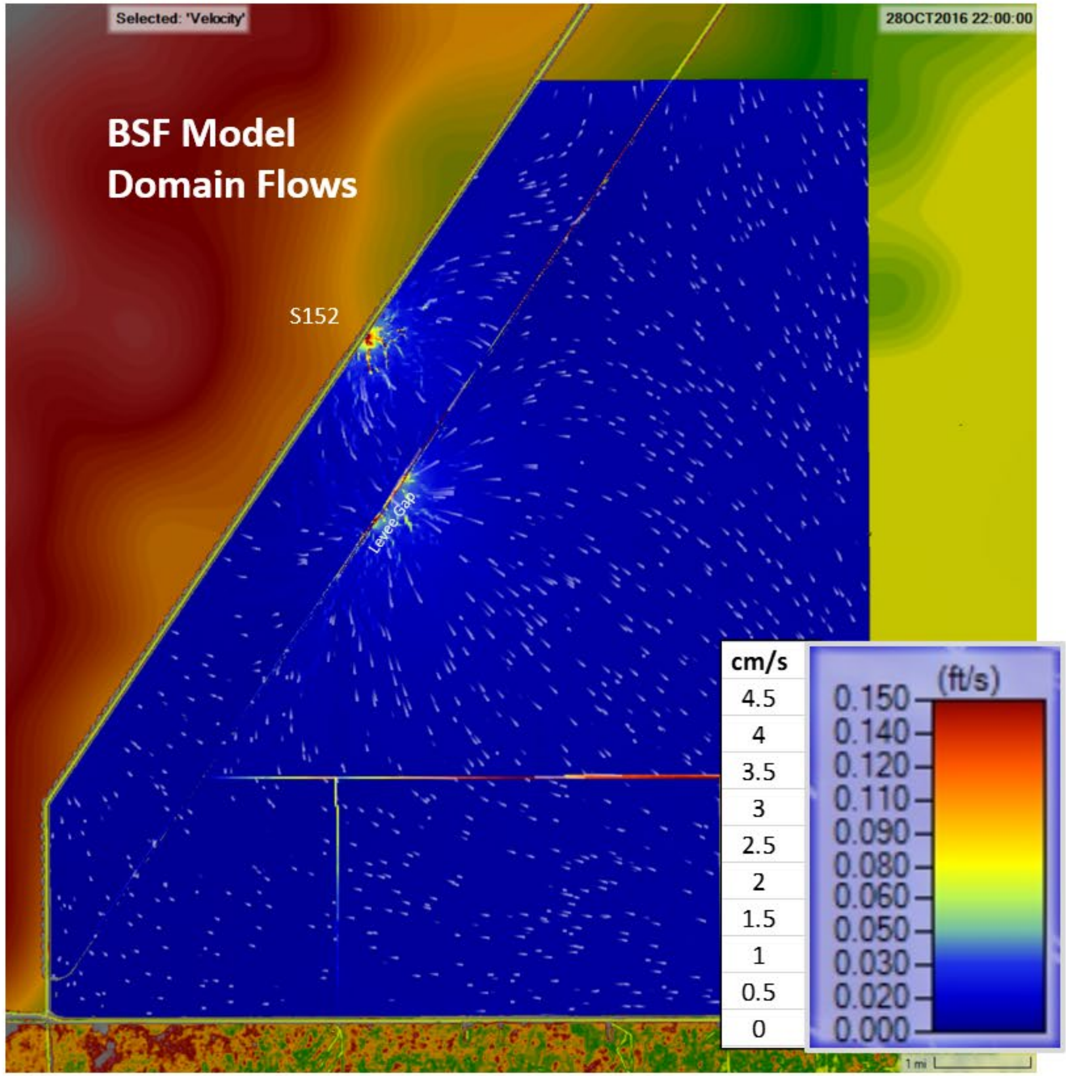


No.	Land use Classification	* Manning's *n*
1	Barren Land	0.06
2	Canal	0.04
3	Developed Land	0.07
4	Dry Prairie	0.85
5	Emergent Marsh	1.15
6	High Density SAV	1.2
7	Levee	0.07
8	Mixed Shrubs	1.5
9	Moderate Density SAV	1.0
10	Open Slough	0.13
11	Open Water	0.04
12	Slough	0.35
13	Tree Island	1.5
14	Wet Prairie	0.85

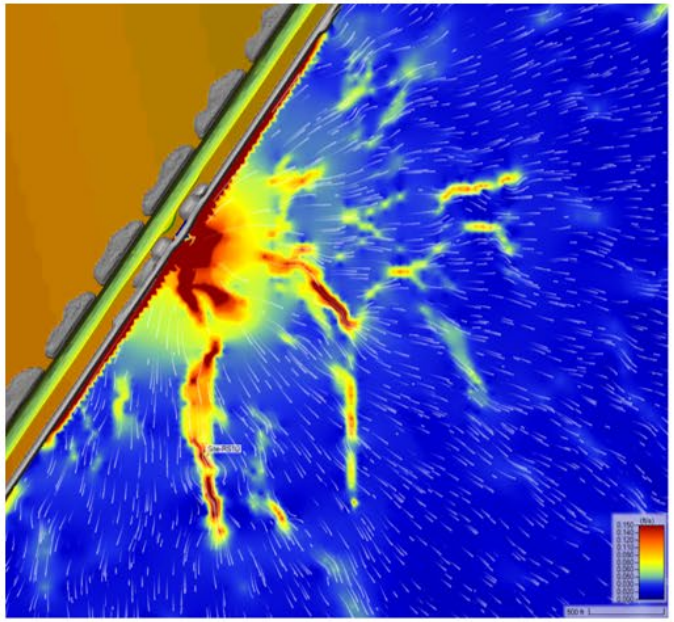
- ✓ The land use map: 2017-2019 SFWMD land cover map, combined with DPM vegetation map (Ross et al., 2012), generated by SFWMD Geospatial group (C. Carlson).
- ✓ Domain includes 14 land use types, with Manning's n values adapted from SFWMD (2005).

SFWMD, 2005. "Documentation of the South Florida Water Management Model, Version 5.5." Table 2.4.2.1. Overland Flow Coefficients for Effective Roughness as Used in the South Florida Water Management Model (cell-to-cell overland flow).

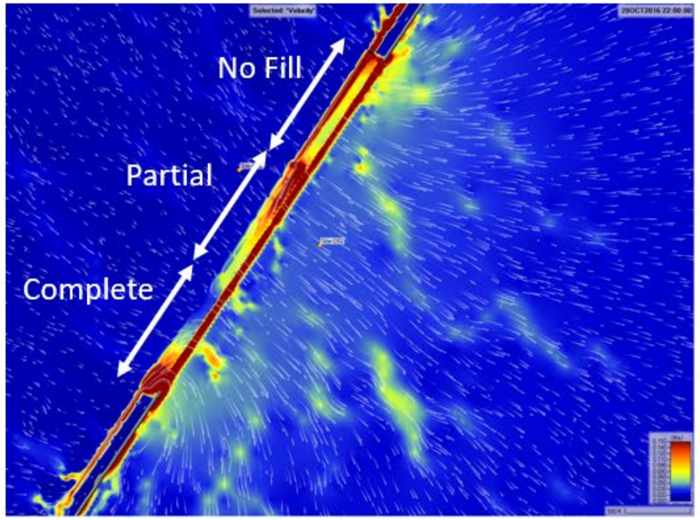
Simulated flows



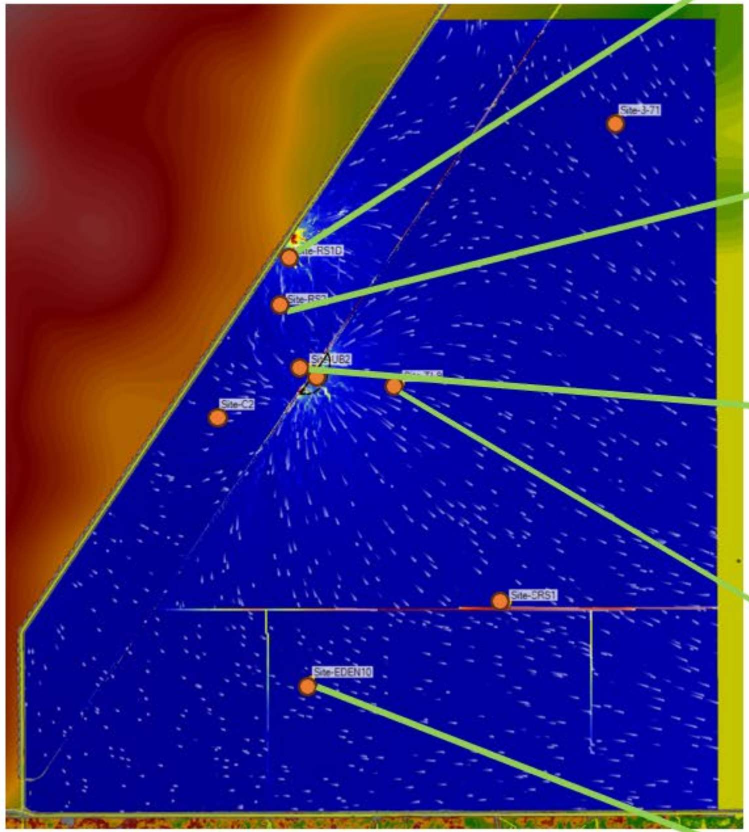
S152 Nearfield flows

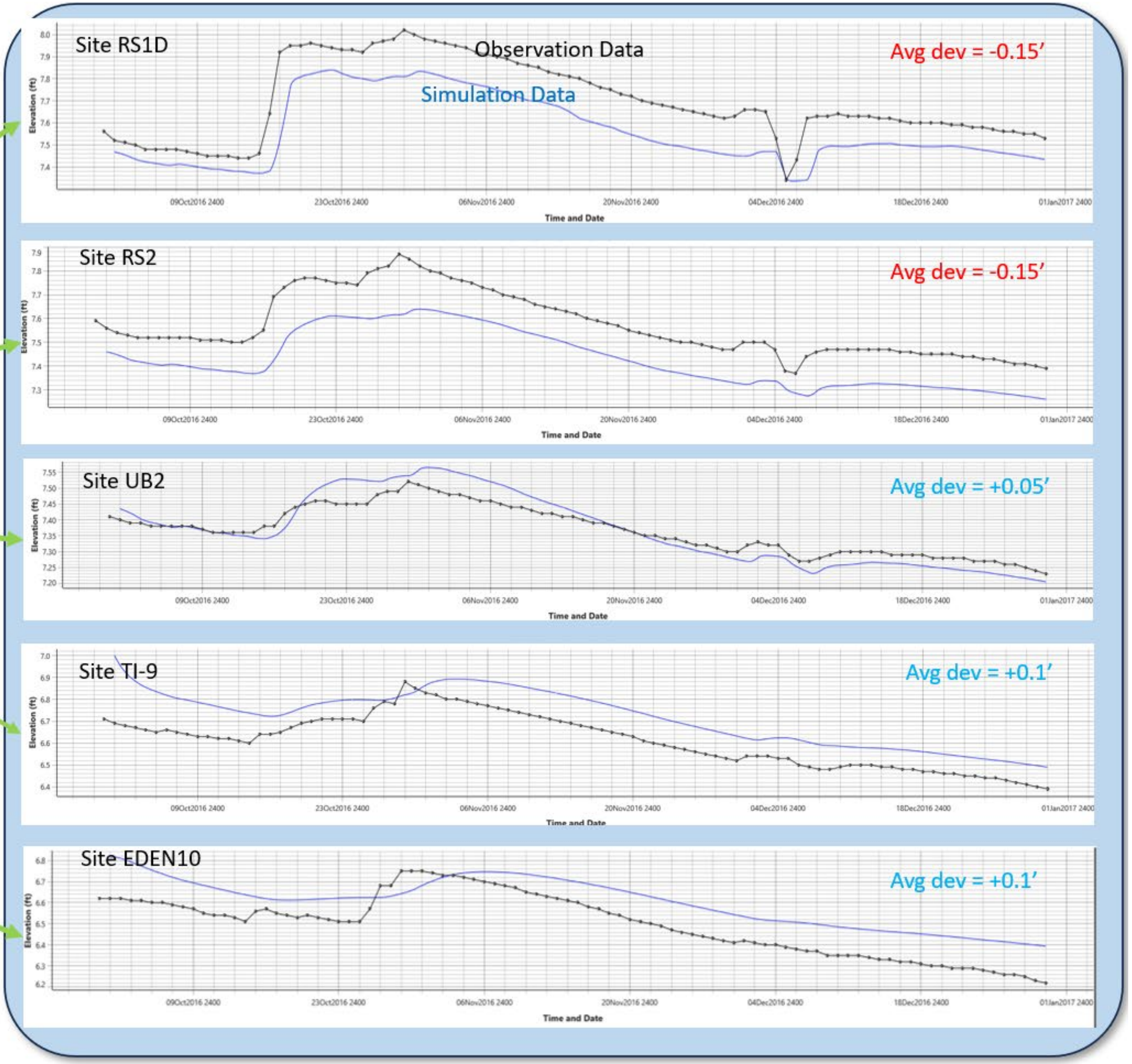


UB & Gap nearfield flows



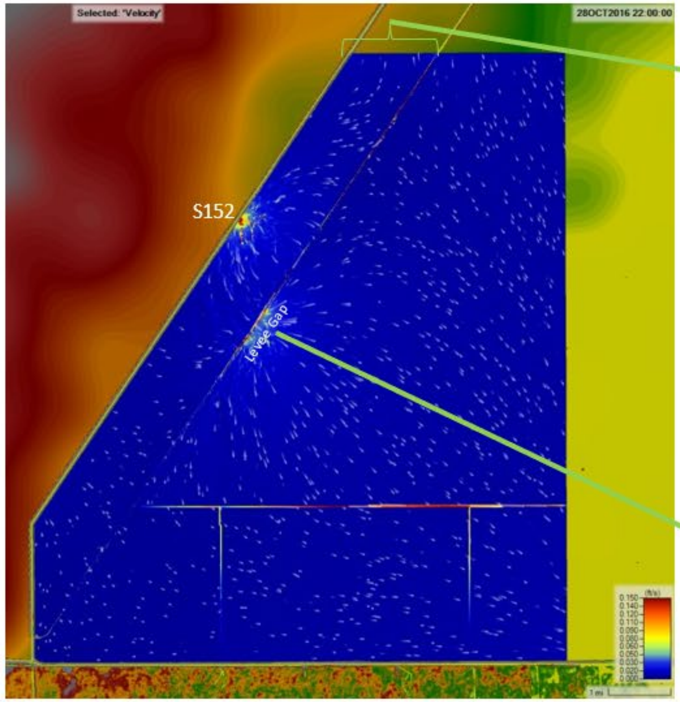
Simulated Stage – The Pocket & Interior 3B





** Blue line represents simulated stage and black line represents observed stage (Daily Mean)*

NW Boundary & DPM Gap Discharge

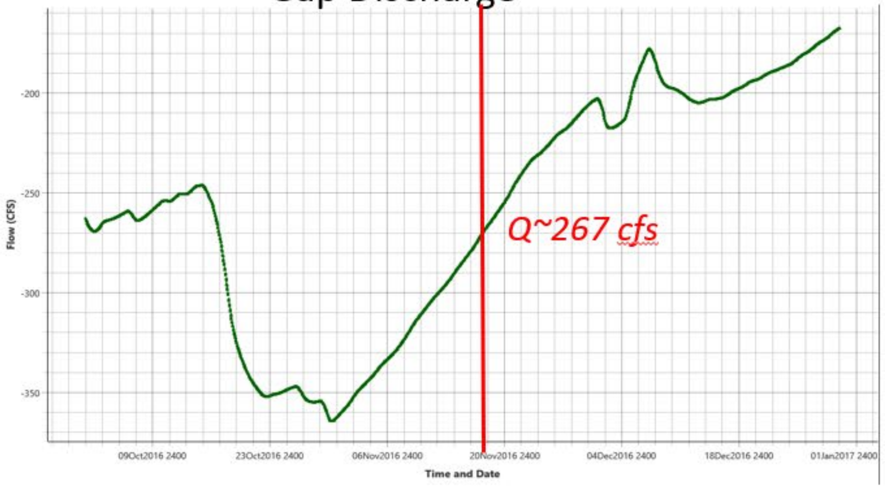


North Boundary (West) Discharge

Based on 3-69E Obs

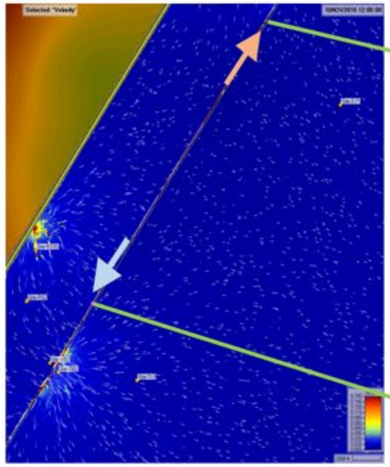
11/18/2016
Obs: Q~150 cfs
(estimated)

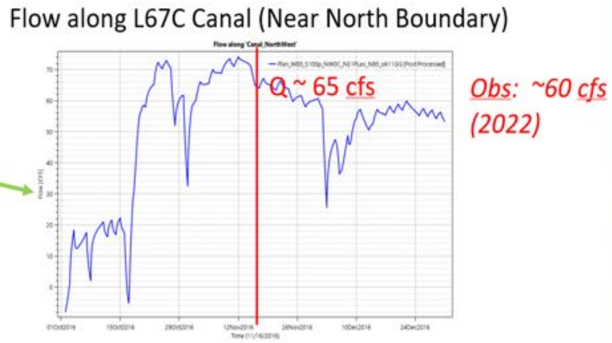
Gap Discharge

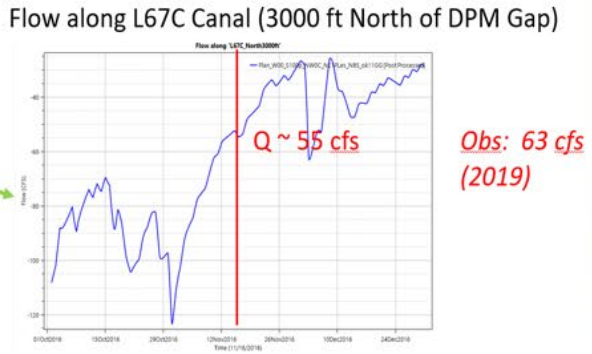


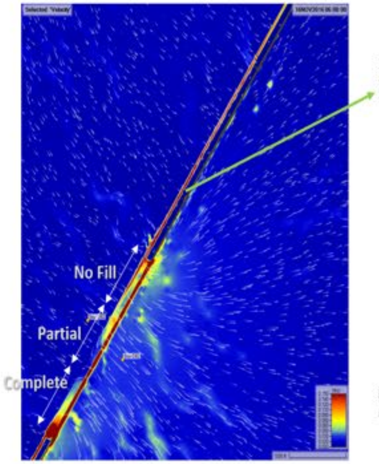
11/18/2016
Obs: Q~230-250 cfs

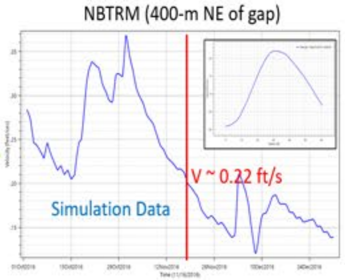
L67C Canal Discharge and Velocity

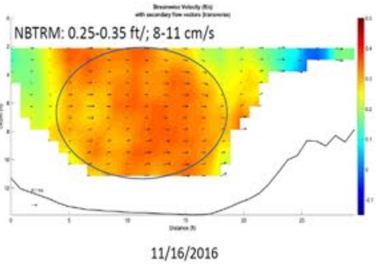


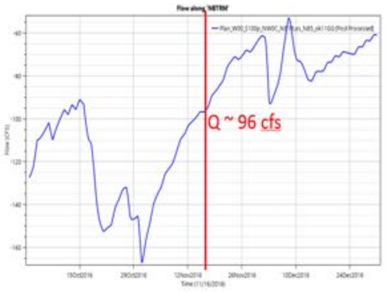








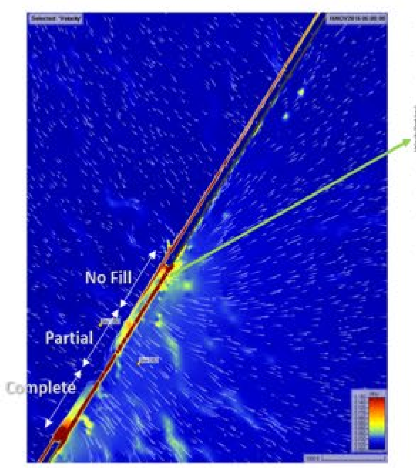


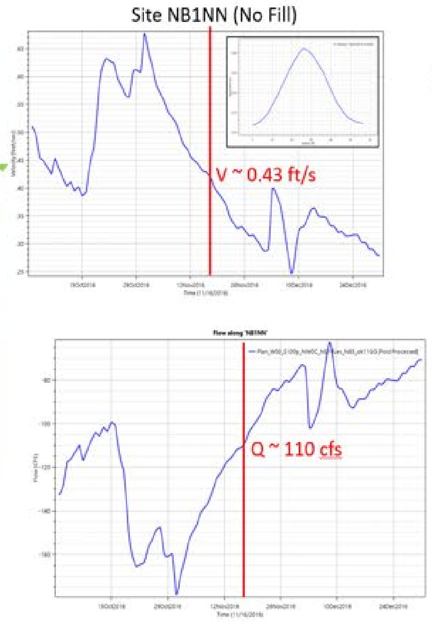


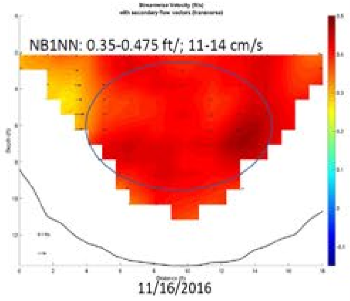
Location	Date	Discharge (CFS)	Discharge Heading (degrees)
NBTRM	11/16/2016	91.5	214
NBINN	11/16/2016	95.6	214
NBC1N	11/16/2016	91.8	214
NBC1S	11/16/2016	90	214
NBS	11/16/2016	20	214
PBTRN	11/17/2016	12.1	214
PBTRM	11/17/2016	8.1	214
PBTRS	11/17/2016	4	214
FBTRN	11/17/2016	2.7	214
FBTRM	11/17/2016	2.3	214
FBTRS	11/17/2016	2.4	34

- Near the northern boundary, the simulated discharge is 60 cfs, which aligns with the 2022 measurement of approximately 60 cfs. Along the L67C canal, at a section 3000 ft north of the DPM gap, the observation was about 63 cfs, whereas the simulation is 55 cfs.
- At a point 400 ft north of the levee gap. On 11/16/2016, the simulated velocity in the middle of the canal section is approximately 0.22 ft/s, whereas the ADCP measurement velocity ranges of 0.25-0.35 ft/s. The discharge from the model is approximately 96 cfs, which agrees closely with the observed discharge of 91.5 cfs.

L67C Canal Velocity & Discharge







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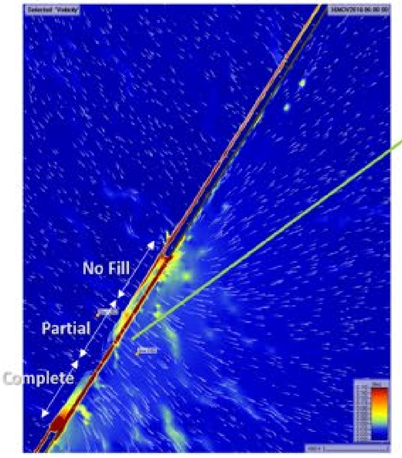

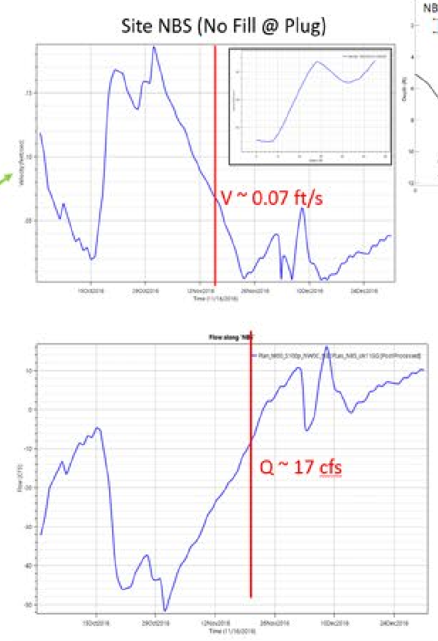

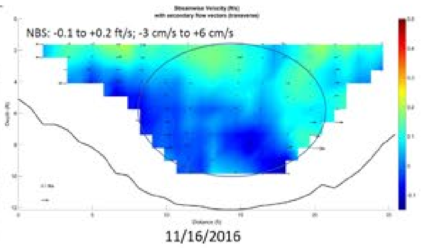

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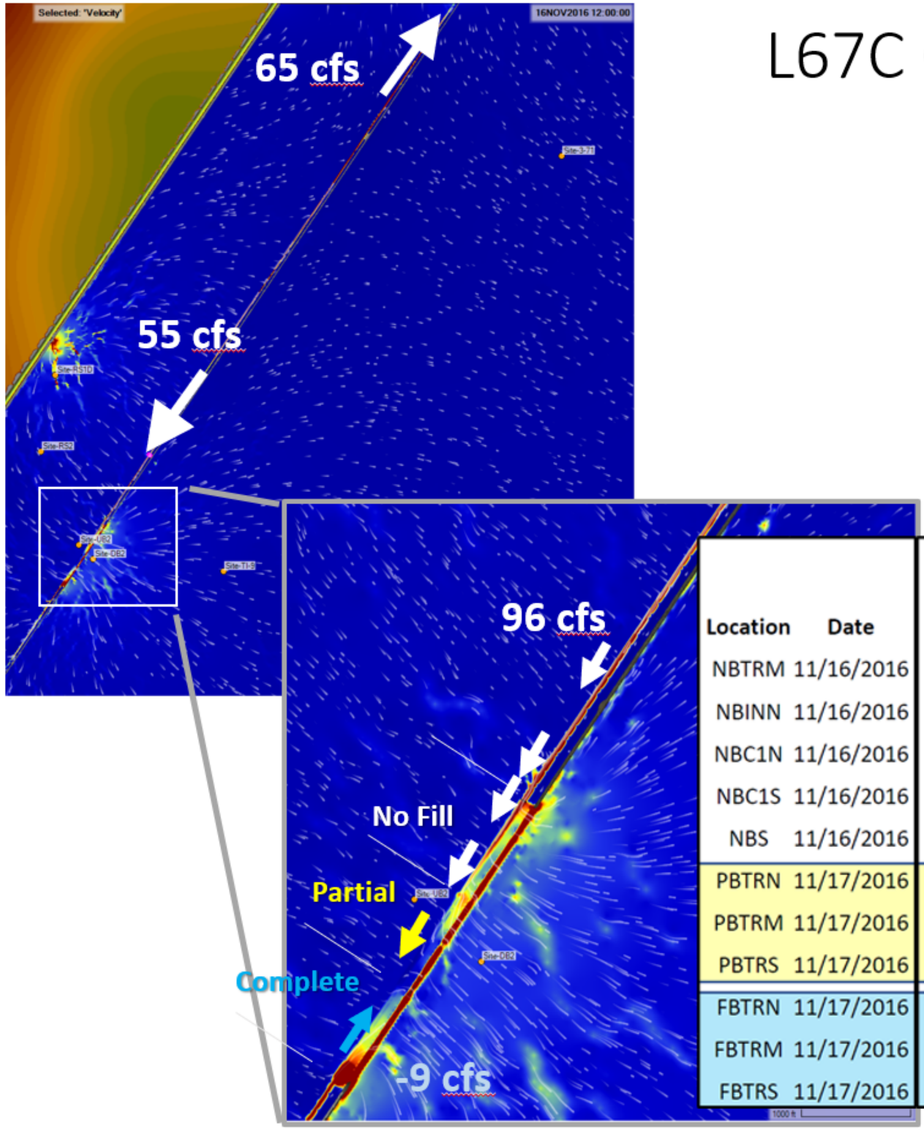
FBTRM	11/17/2016	2.3	214
FBTRS	11/17/2016	2.4	34

- Near the levee gap, at NB1NN, a none filled canal section, the simulated velocity is approximately 0.43 ft/s, while measurements range between 0.35 and 0.475 ft/s. The simulated discharge registers at 110 cfs, compared to the observed discharge of 95.6 cfs.

- Near the no-filled canal at the NBS station, the simulated velocity is recorded at 0.07 ft/s, whereas measurements range between 0.1 and 0.2 ft/s. These velocities are notably low. The simulation indicates a discharge of 17 cfs, slightly lower than the observed discharge of 20 cfs.

L67C Canal Discharge – OBS vs BSFM



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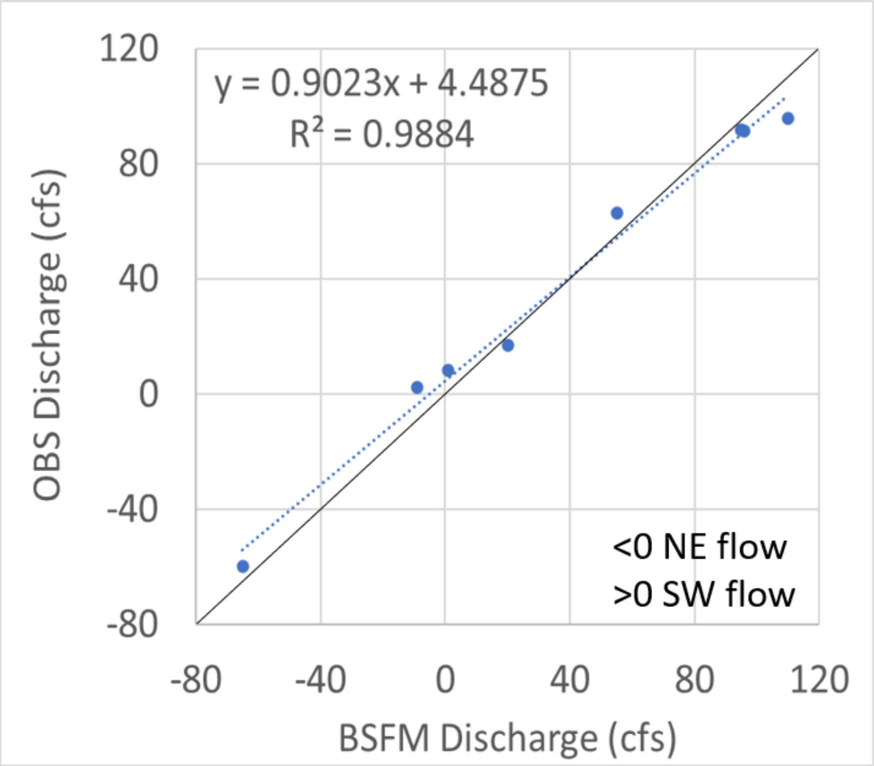
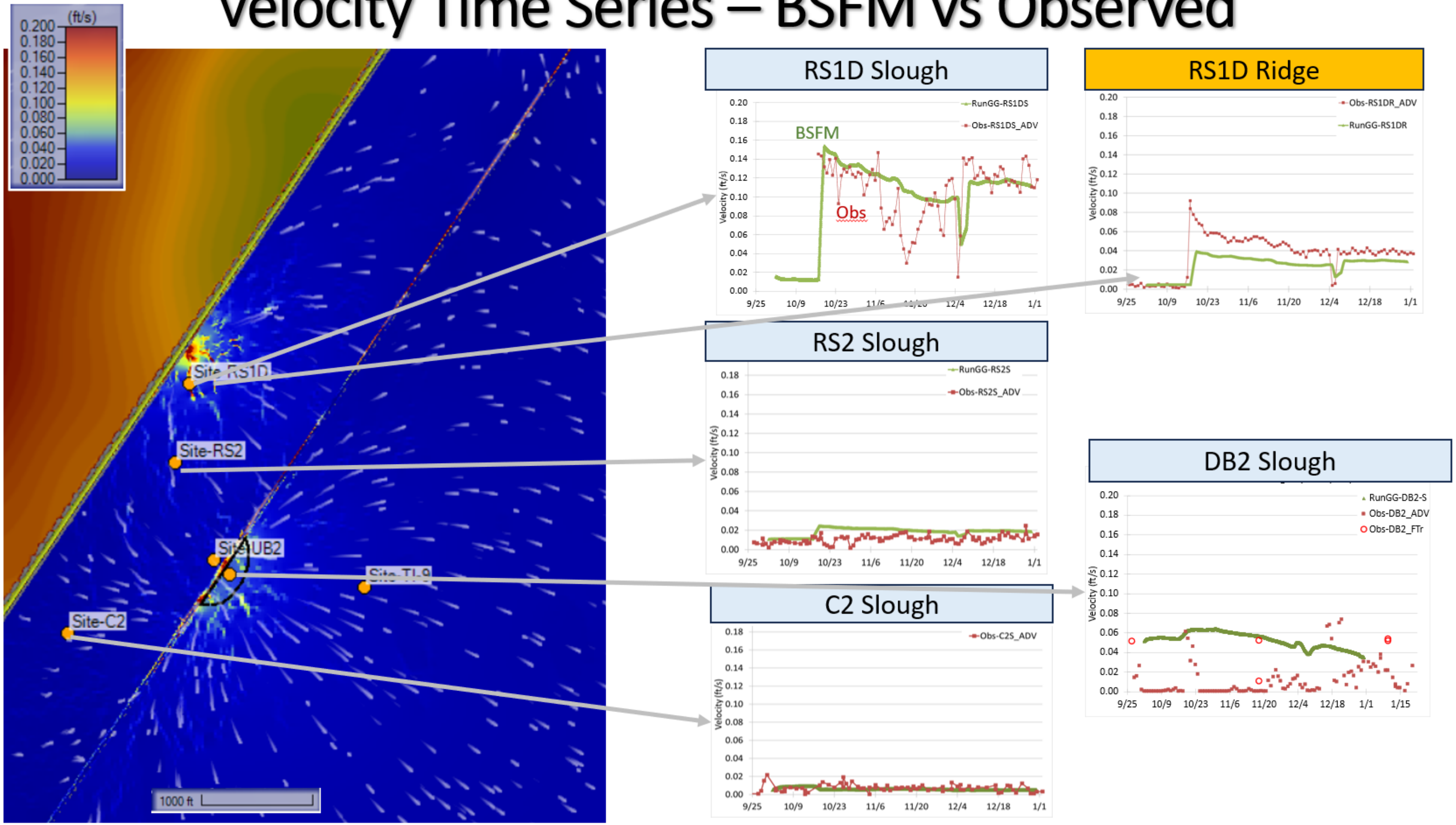
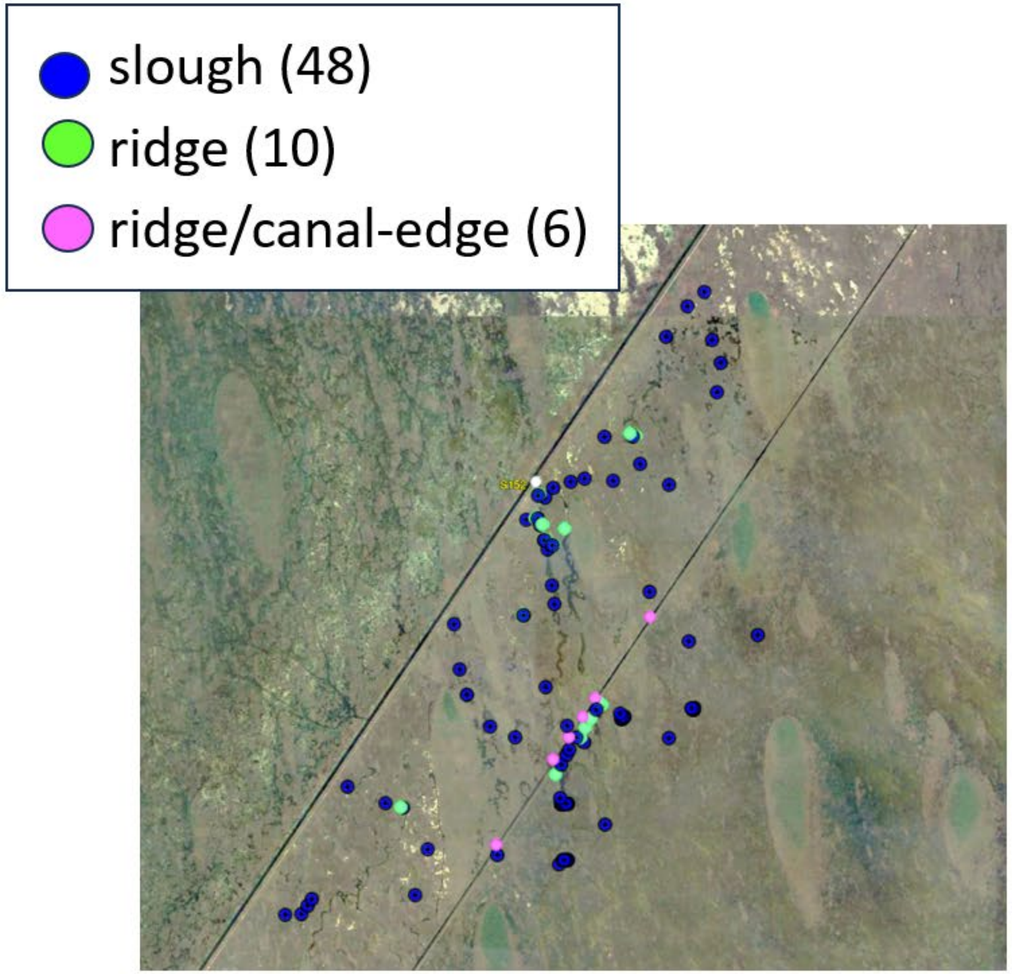


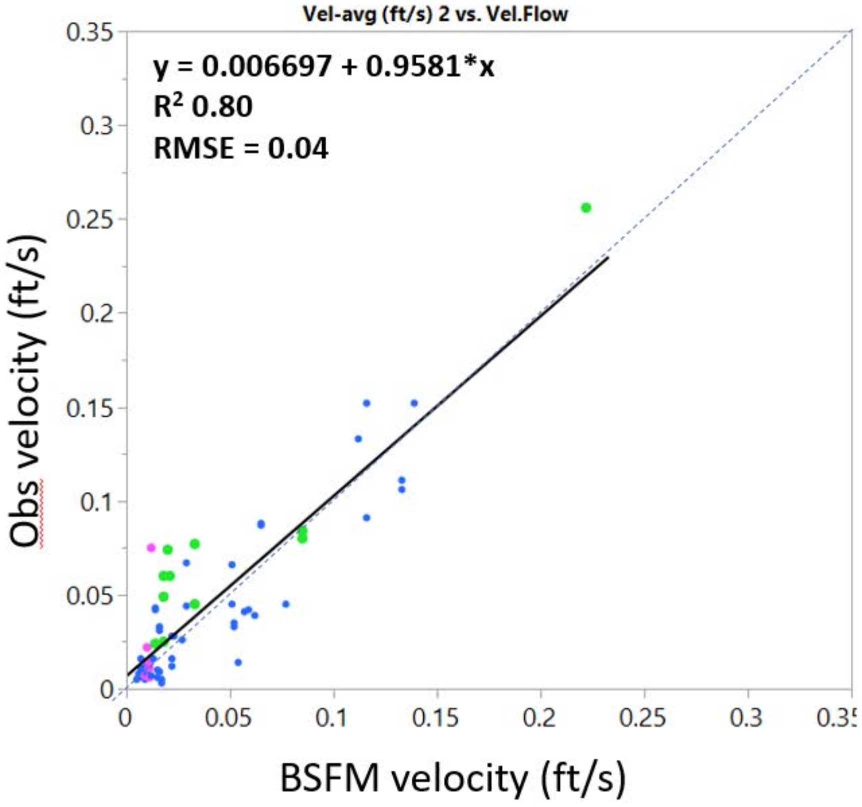
Velocity Time Series – BSFM vs Observed



Velocity – OBS vs BSFM (Spatial Data)



All: R2 0.80, y (ft/s) = 0.007 + 0.96*x
Slough: R2 0.82, y = 0.003 + 0.93*x
Ridge: R2 0.85, y = 0.019 + 1.02*x

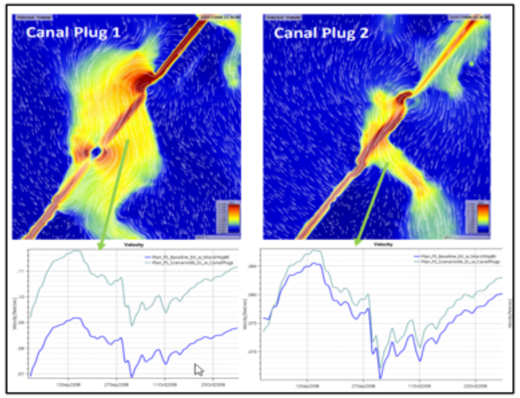


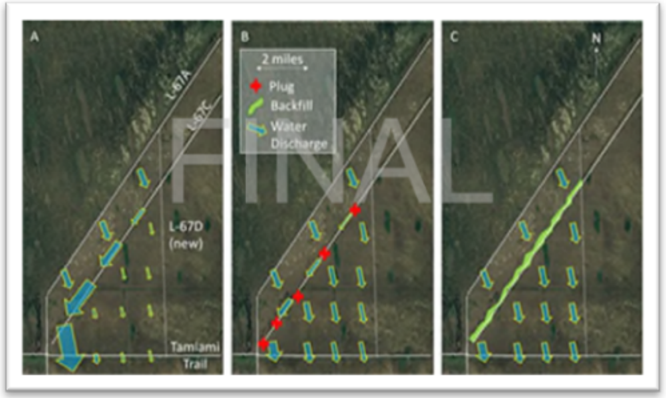
ft/s	cm/s
0.15	4.5
0.13	4
0.10	3
0.07	2
0.03	1
0.00	0

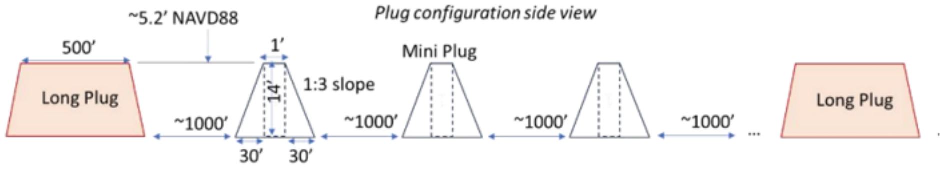
Model Application I - L-67C plug designs

Objectives

- Evaluate near-field hydraulic effects of L-67C plug designs to achieve sheet flow in BSF
- Provide CEPPS team cost-effective option(s)
  - Short-term (May): Approx. locations & CYD
  - June objective: Detailed locations, CYD

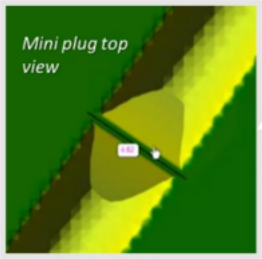






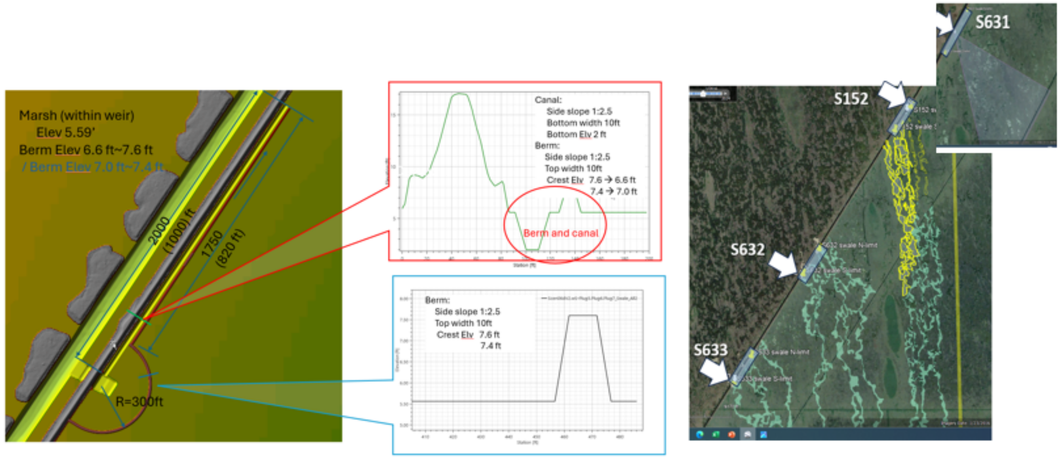
Long Plugs
- 500-ft length, spaced ~1-mile
- Middle fill section only (no N/S ends)
- Edges sloped (1:3) to canal bottom
- Parameterized as slough (marsh grade, low *n*)

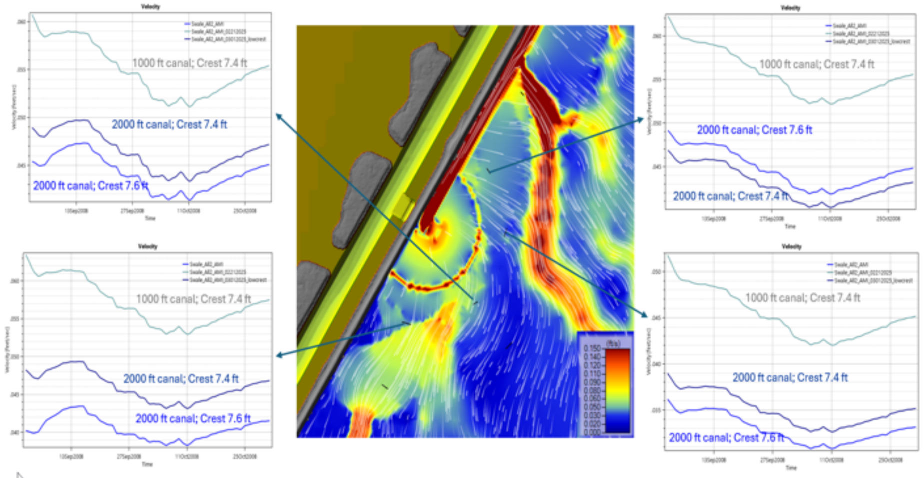
Mini-Plugs
- ~60-ft length, equally spaced throughout L-67C canal
- Middle fill : ~1-ft length
- Parameterized as slough (marsh grade, low *n*)
- Edges sloped (1:3) to canal bottom



Model Application II--Swale Design

- **Ecological targets based on DPM results (SFER):**
  - Ridge velocity < 0.03 ft/s
  - Slough velocity 0.03 – 0.1 ft/s
  - Flow direction 140-190°N
  - Q/w < 0.15 ft²/s
- S631
  - Orient swale ~centered around S631
  - minimizes canal re-routing of flow
  - maximizes flow towards gap (marsh-to-marsh)
  - bounded by tree islands NE and SW of flowpath
- S152
  - Orient swale/canal SW of S152
  - Connects to 2 new AMI sloughs (yellow) + existing AMI sloughs
- S632
  - Orient swale mostly NE of S632
  - Connects with existing (planned) AMI sloughs
- S633
  - Orient swale mostly NE of S633
  - Connects with existing (planned) AMI sloughs
  - Grade sill to reduce inflows to marsh, maximize to AMI, possibly to degraded tree island





Swale Design

Summary of Reality Check

- ✓BSFM simulated stage (domain-wide) within 0.15 ft of observed.
- ✓Landscape-scale flow patterns matched observed: radial flow around S152, preferential flow to the east, decreasing flow vs distance from S152
- ✓Discharges along the L67C canal & fill treatments were within range and highly correlated (R^2 = 0.99) with measured discharges
- ✓Model is consistent with observed slough >> ridge velocity
- ✓Good correlations between Observation ~ BSFM model velocities

HEC-RAS Model has been successfully established and well fits for the Central Everglades Restoration Planning study

Thank you !

Any Question?