SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Evolving Strategies for Stormwater Treatment Area Operational Management

April 22, 2015

Greater Everglades Ecosystem Restoration Conference

Presented by:
Walter M. Wilcox
Section Administrator
Hydrology & Hydraulics Modeling Section, SFWMD
Co-Authors: Alaa Ali, Wasantha A. Lal, Mohammed Z. Moustafa and Raul Novoa

Science Plan Operations Study Background

Historically, the Everglades Stormwater Treatment Areas (STAs) have been operated with limited flexibility in response to upstream storm runoff.

The Restoration Strategies program will add new storage infrastructure in the form of Flow Equalization Basins (FEBs) that will significantly expand the flexibility and robustness of attempted operational strategies.

A New Paradigm: The Restoration Strategies Science Plan study "Development of Operational Guidance for FEB and STA and Regional Operation Plans" seeks to answer the following key questions:

- How can the FEBs be designed and operated to moderate phosphorus concentrations and optimize phosphorus loading rates and hydraulic loading rates entering the STAs, possibly in combination with water treatment technologies, or inflow canal management?
- What operational or design refinements could be implemented at existing STAs and future features (i.e., STA expansions, FEBs) to improve and sustain STA treatment performance.

Restoration Strategies Operational Considerations

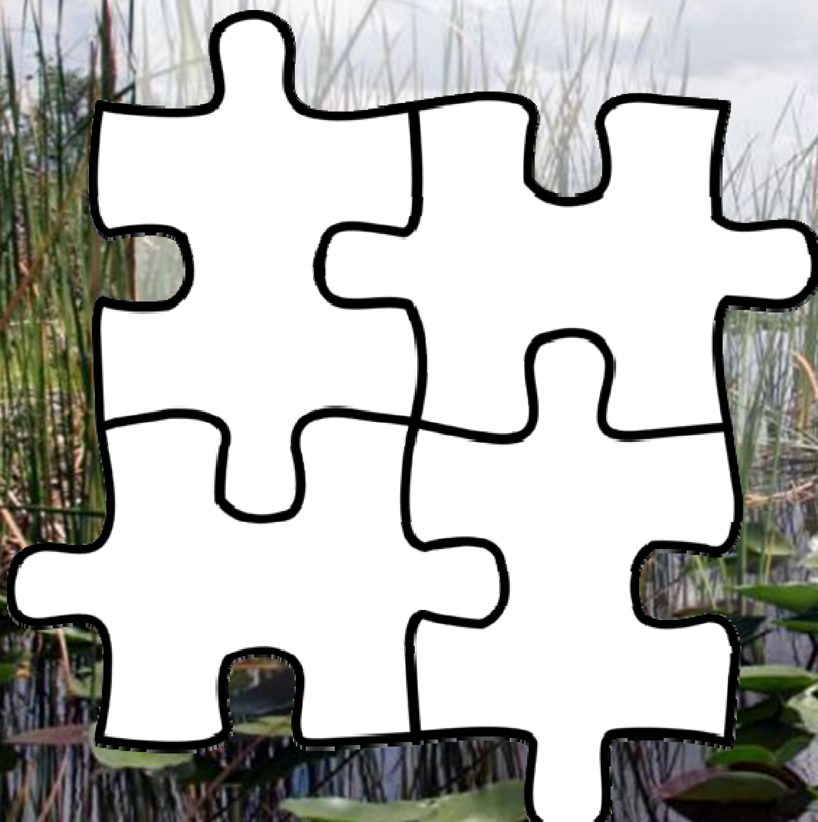
- State of the STAs & FEBs
  - Achieve P Treatment Objectives
  - Constraints
- State of the regional system
- Flexibility and/or limitations in infrastructure or operational control
- Regulatory framework
- Temporal and spatial considerations
- Others…

EACH CONSIDERATION IS ITS OWN PUZZLE PIECE…

EXAMPLE CONTROL ROOM CONSIDERATIONS

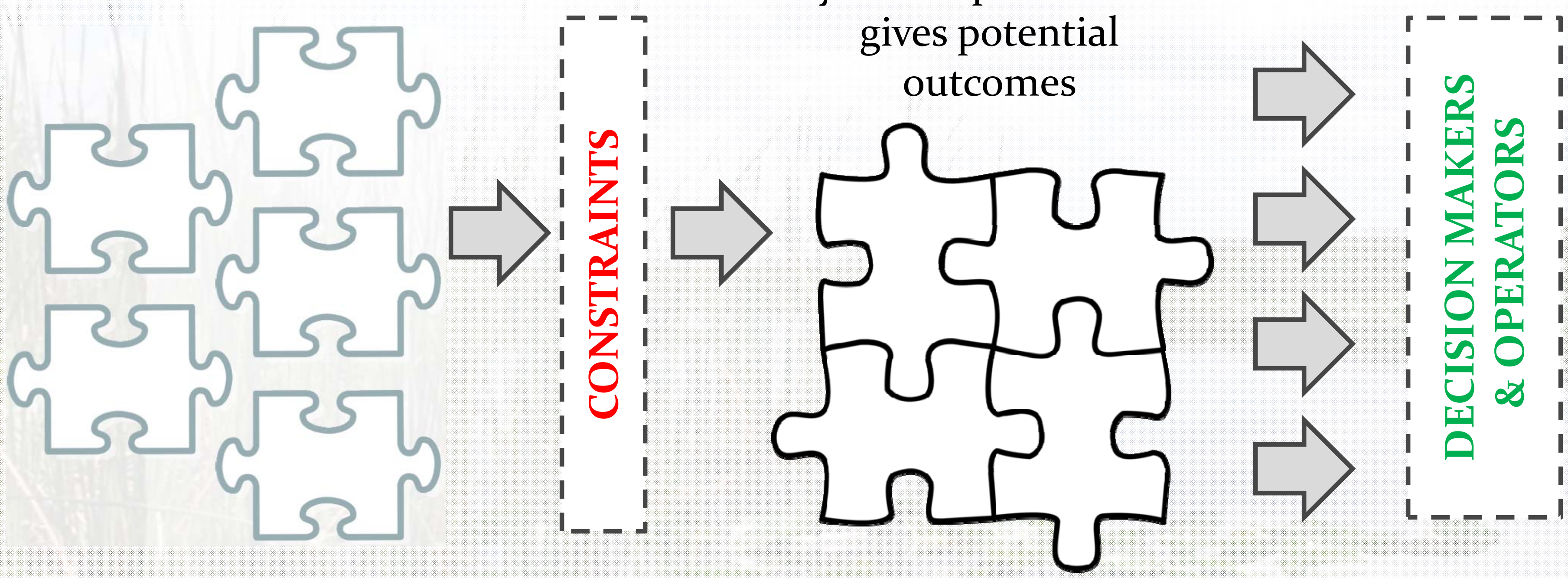
- Decision point: Water Managers / Technicians / ODSS / Others
- Pump operator shifts
- Temporal scale at which decisions need to be made
- Limitations in infrastructure / hydraulics
- Others

"SYSTEMS" THINKING AND OPTIMIZATION HELP US TO PUT THE PUZZLE PIECES TOGETHER TO PROVIDE INPUT TO DECISION MAKERS AND OPERATORS IN REAL TIME



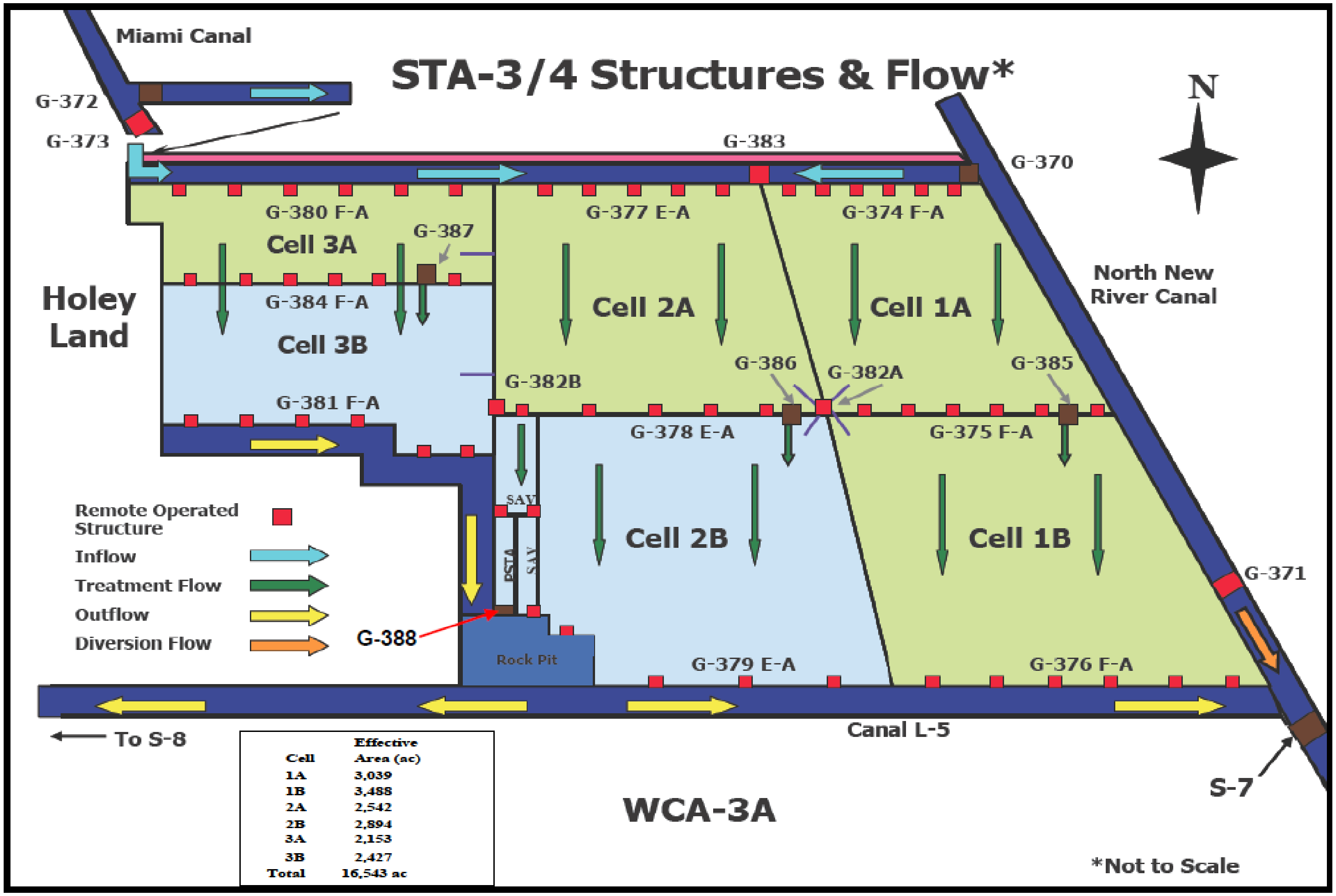
- The primary goal is to develop a decision support system
- Likely this will wind up being a two-tiered system with constraints considered up front and then flexibility within allowable operations displayed in a risk/tradeoff context
- A "communications system" is envisioned that will explain and archive the rationale for decisions.

Example: A possible form of the decision support system



Note: A suite of potential outcomes is expected from the decision support system, likely characterized in a risk/tradeoff context.

Field Experiment Site
STA3/4 (Cell 3A)



Cell	Effective Area (ac)
1A	3,039
1B	3,488
2A	2,542
2B	2,894
3A	2,153
3B	2,427
Total	16,543 ac

“Resistant” Emergent Vegetation

Example: WAVE experiment field tests

Clipboard | Font | Alignment | Number | Styles | Cells

R9 *fx*

WaveBot v1.0

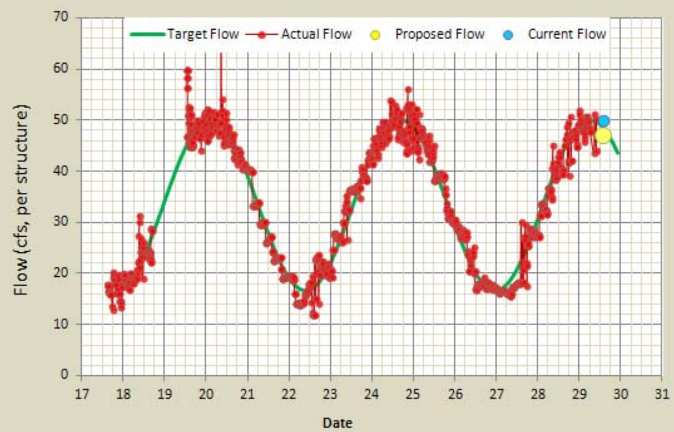
by Naiming wang and Jun Han HESM

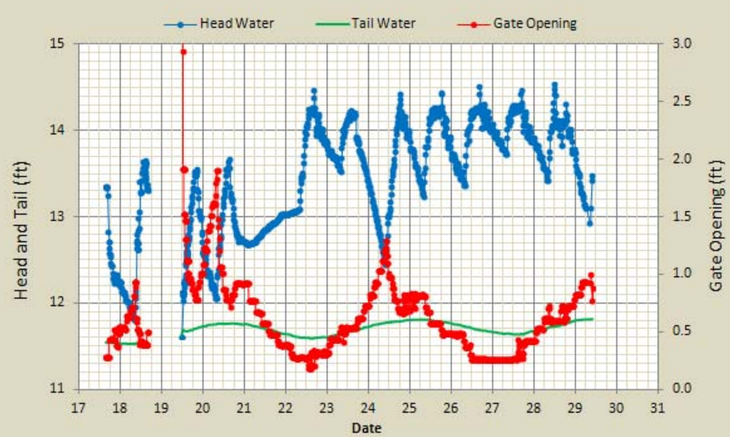
Timed

Instant

Starting	
Date	1/14/2013
Time	9:00 AM
Target Setting	
Average	200
Amplitude	100
Period	110
Email	
To	moustafa@sfwmd.gov
CC	nwang@sfwmd.gov

Pump G372	RPM
Current	721
Previous	721
Change	0





How can waves tell so much?

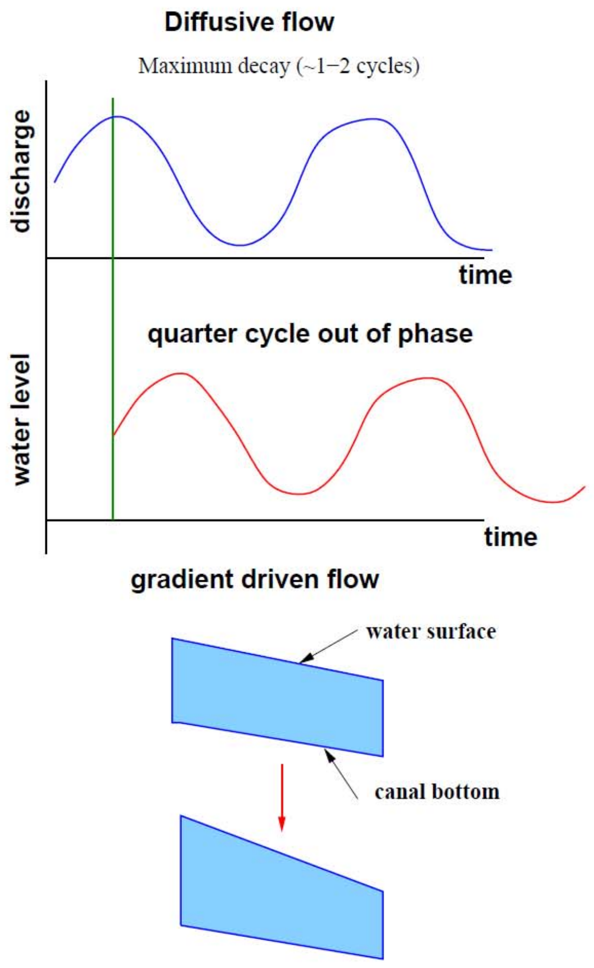


Figure 7.4: Two basic wave types within vegetated wetlands

STA-3/4 CELL 3A – Example findings

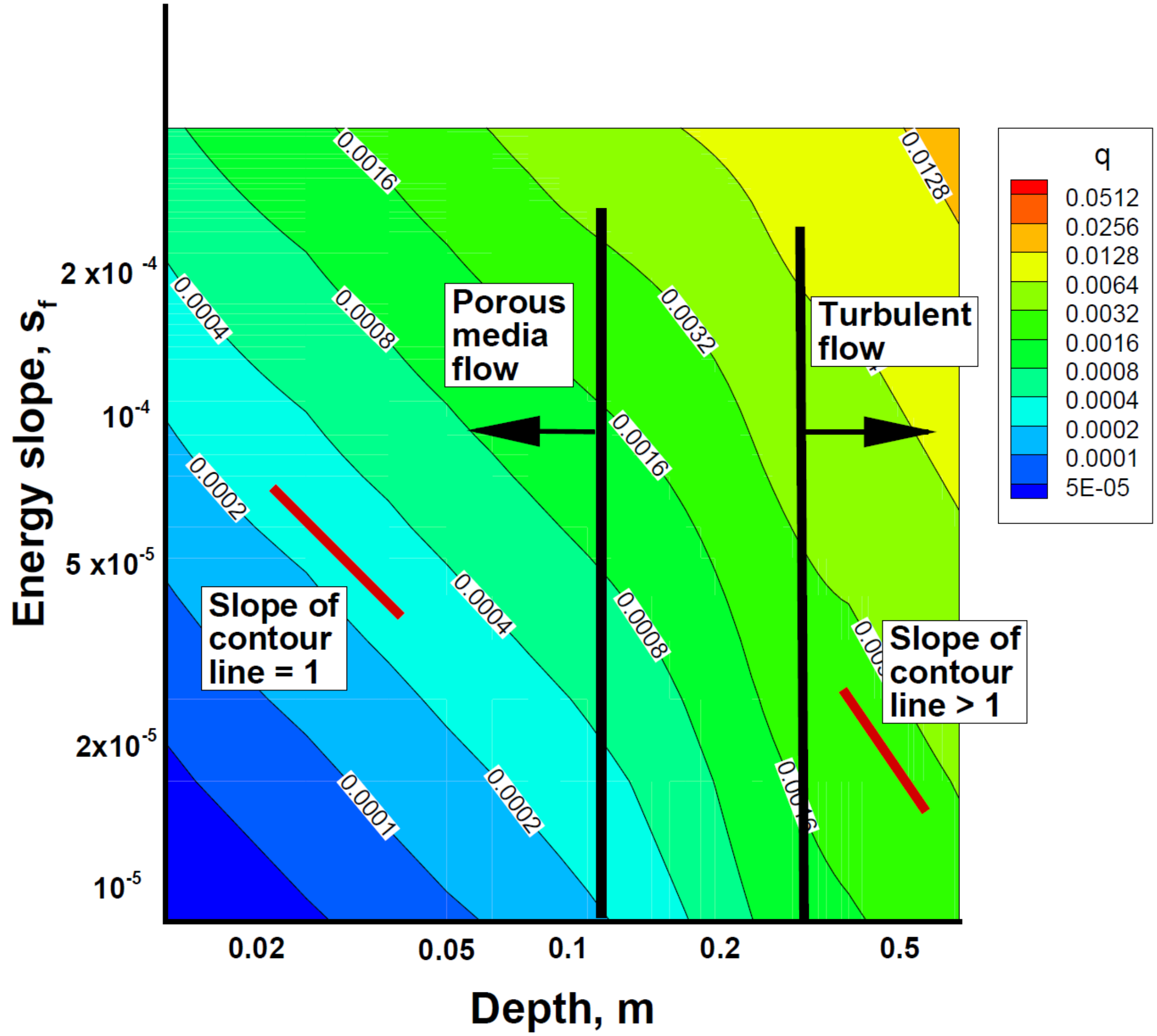


Figure 7. Contours of average discharge per unit width $q(m^2/s)$ obtained using power-law equations. The plots are made on log-log axes.

Understanding of the Flow Mechanics has Changed…

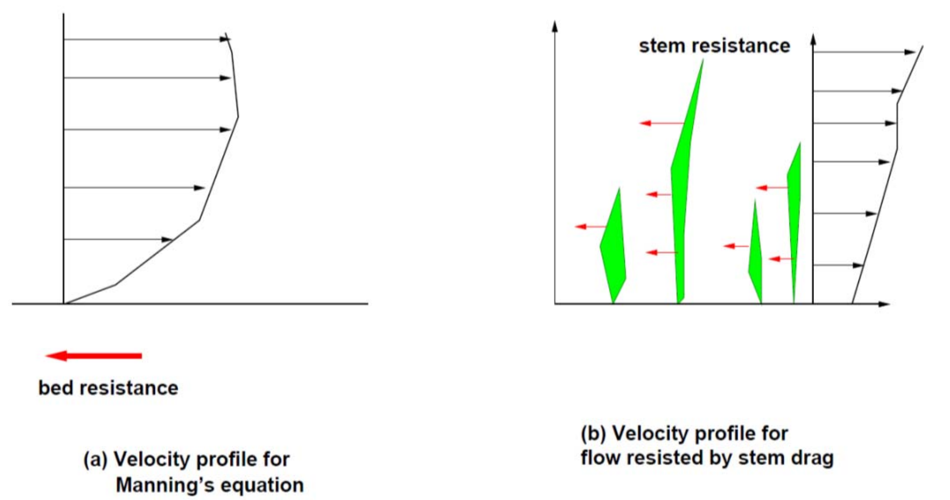


Figure 7.2: Vertical velocity profiles in open channels and vegetated wetlands

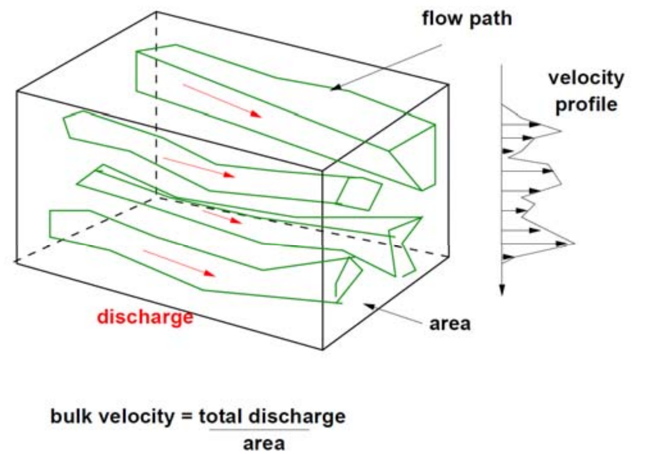


Figure 7.1: Definition of average or bulk velocity for a segment of the the wetland

Now we need to develop "generalized" forms of power functions, benchmarked by field test results

Example SIMULATION of Operational Filling Based on Analytical Results

- STA3/4, Cell 3A, verified with field data

STA3/4 simulated surge

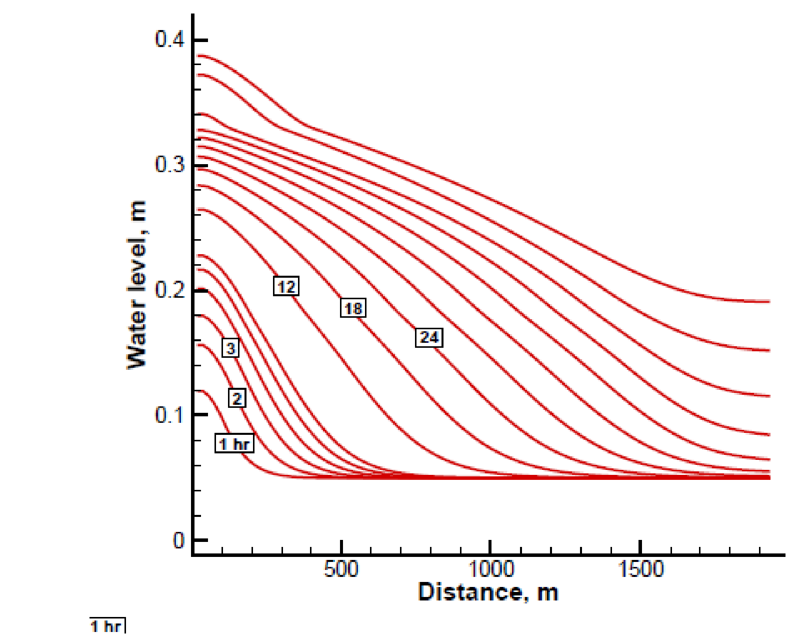


Figure C.11: Water level rise during the wave front movement with overland flow and groundwater-like flow

STA3/4 observed data logger data

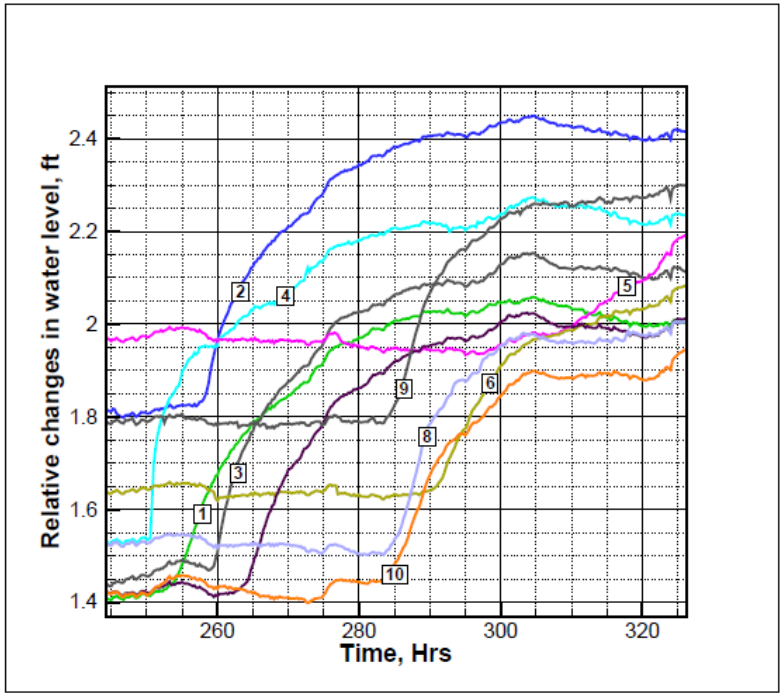
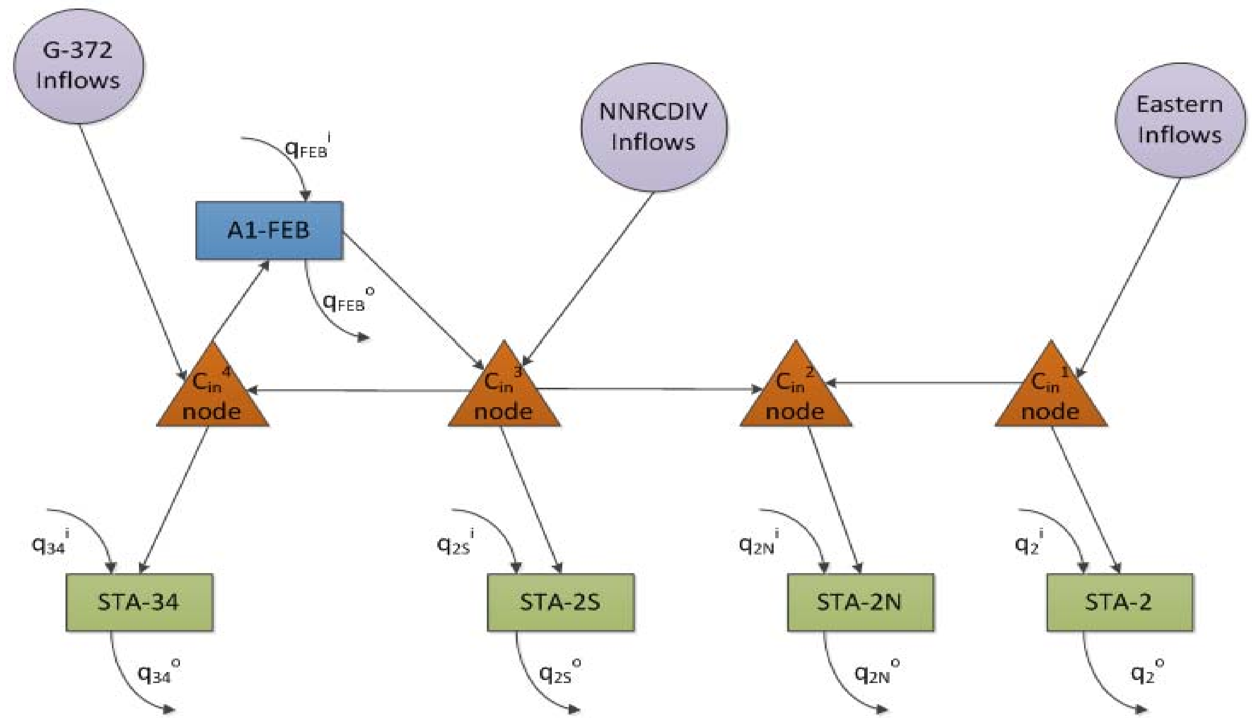


Figure B.3: Sketch showing the wave front for wave 3

Novel Approach to STA Management with Explicit Stage and Phosphorous Optimization



1) Keep QEast from passing into NNR: Q1 + Q2 + Q3 + Q7 + Q8 - Qeast >= 0
2) Keep G372 from passing into NNR: Q12 + Q13 + Q14 + Q19 - G372 >= 0
3) G337A capacity: T2 <= 1,020 cfs (needs to be converted to weekly in correct units)
4) G434 capacity: T4 <= 1,180 cfs (needs to be converted to weekly in correct units)
5) G370 capacity: T6 <= 2,775 cfs (needs to be converted to weekly in correct units)

System OPTIMIZATION

- DMSTA (Walker) is the basis for representative data
- HME (Hydrologic Model Emulator) to simulate stage and outflow phosphorous concentration for each STA and FEB by emulating the DMSTA dynamics
- Identify regional flow relationships
- Track loading mixings at key flow hubs before entering STAs
- Implement iModel simulation/optimization framework
- Estimate inflows and outflows, subject to all system's requirements, to achieve 13 ppb or less at the downstream end.

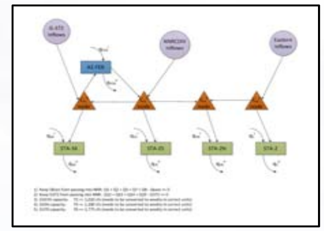
General Framework for Operations Decision Support (Evolving)

Water Year / Seasonal Awareness
- System state (e.g. schedules)
- WQBEL considerations
- Climate outlook
- Vegetation management activities

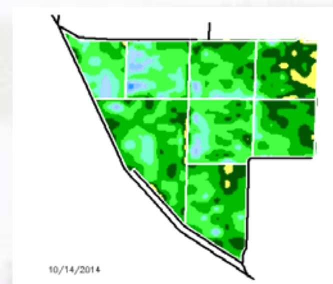
Weekly Management Strategies
- Optimal stage management and P-based flow routing (iModel)
- Areas off-line (e.g. avian protection, maintenance)
- Areas of vegetation risk

Sub-Weekly Management Assistance
- WaveOp / flow / gate management
- Hydraulics-based lookup tables for profiles, residence times
- Special considerations (e.g. rewetting, maintaining minimum levels in SAV)

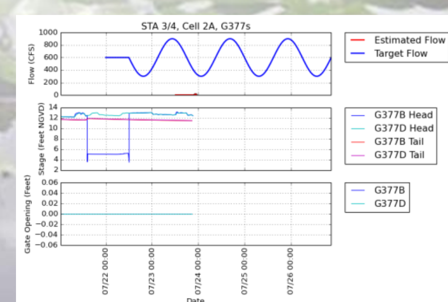
iModel



WDAT



WaveOp



Questions?