WRAC Issues Workshop - Phase I Planning
July 1, 2009

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Planning Process

- Where We Have Been and Where We Are Headed
  - ✓ Development of Vision and Goal Statements
  - ✓ Development of Problems, Objectives, and Constraints
  - ✓ Development of Tools (including modeling and maps)
  - ✓ Development of Team Configurations
  - ✓ Evaluation of Stakeholder Team Configurations
  - Evaluation of Relationships and Developing Refined Concepts (we are here)
  - Discuss next steps for Phase II Planning

Planning Process- Evaluating Relationships and Developing Refined Concepts (continued)

- Discuss and Identify
  - **Initial Findings/Areas of Agreement-** What has this analysis of configurations shown us? What have we learned?
  - **Areas Requiring Further Evaluation/Additional Information-** What features show promise but require more detailed information or a greater understanding? For what issues is more data, detailed modeling, or additional discussion required?
  - **Common Elements/Foundation Projects-** What features are fundamental/common to all plans? What features should we pursue in the near term while planning and other evaluation activities continue?
  - **Next Steps for Phase II**

Planning Process - RESOPS Peer Review Workshop

- Held June 30th
- Technical Review Panel
  - Provide information and address panel questions on RESOPS computer model
  - Solicit experts opinions on use of the model for River of Grass Project
- Follow-up teleconference calls will be held in July if needed
- http://webboard.sfwmd.gov/default.asp?boardid=PR_RESOPS_P1&action=0

Relationships, Trends, Tradeoffs, Other Considerations

Staff Presentations

Analyses of Phase 1 River of Grass Modeling Results

Walter Wilcox, Lead Engineer,
Hydrologic and Environmental Systems Modeling

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River of Grass Modeling Analyses Objectives

- In addition to the various evaluations (benefits, cost, etc…) completed and presented on the public configurations, additional analysis can be used to analyze trends in performance.
- These analyses can examine the configurations as a whole, or focus on individual components of the idea such as
  - Effective use of storage (North, South or total)
  - Performance of conveyance features
  - Robustness checks to examine the ability to meet differing sets of system objectives
- This work helps to derive conclusions from the Phase 1 effort and to identify areas for additional study in Phase 2.

Modeling Analyses Methodology

- Data was extracted from RESOPS results (performance measures) and benefits evaluation (ecological summaries)
- This data was summarized in various forms to illustrate observed trends
- In some cases, sensitivity analysis was performed to further explore relationships or to examine “what if” scenarios
- The effort focused on examining the overall information provided by ALL configurations and not on further optimizing individual scenarios.

Modeling Analyses Topics

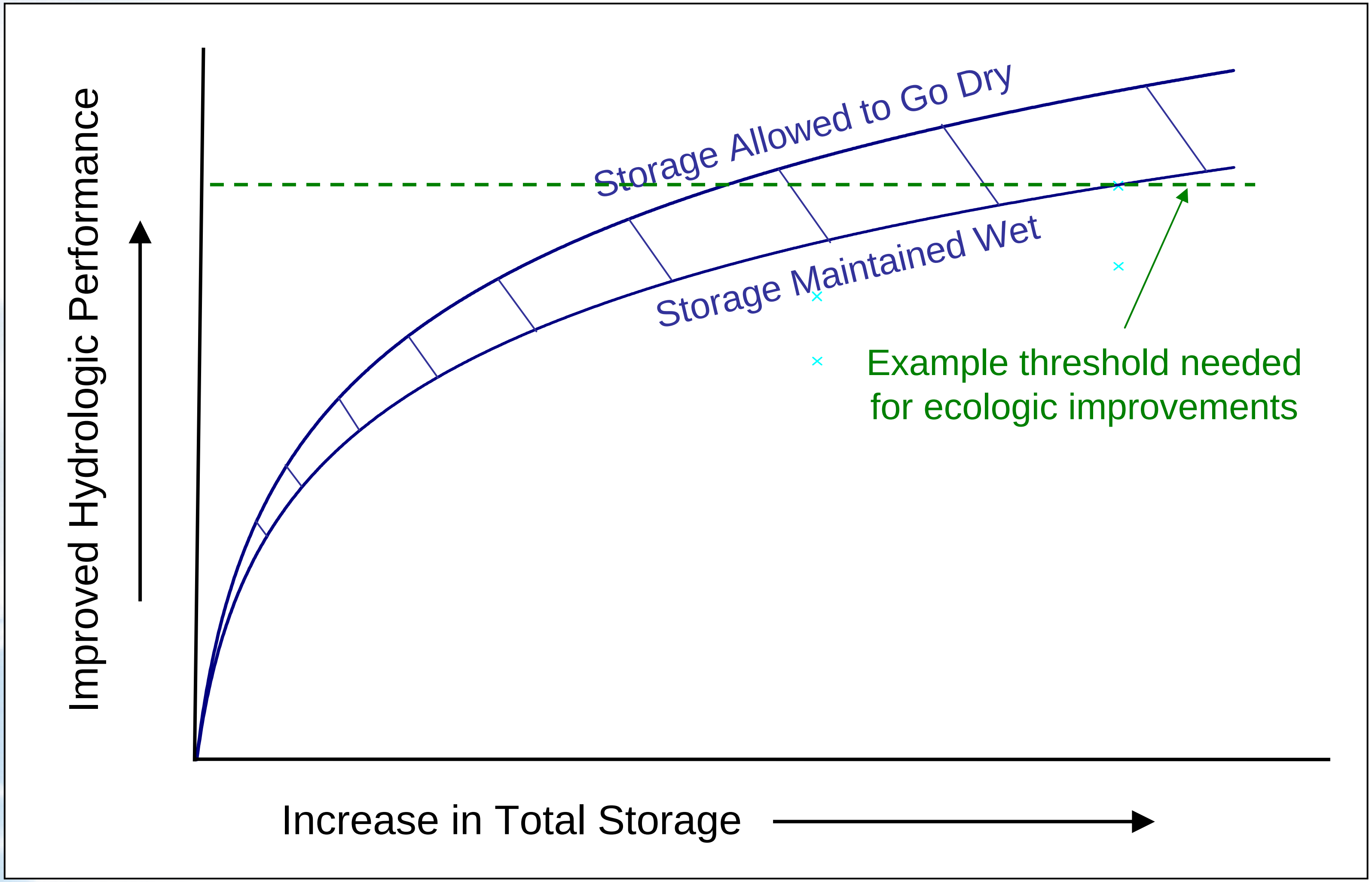
1. Observed hydrologic trends in configurations
2. Hydrologic sensitivity to water quality considerations
3. Hydrologic sensitivity to differing ecologic or system objectives
   - Examination of robustness
   - Role of storage in supplementing low Lake Okeechobee stages
4. Hydrologic efficiency of storage features
   - Deep / Shallow storage evaporation losses
5. Summary and Recap

Modeling Analyses Topics

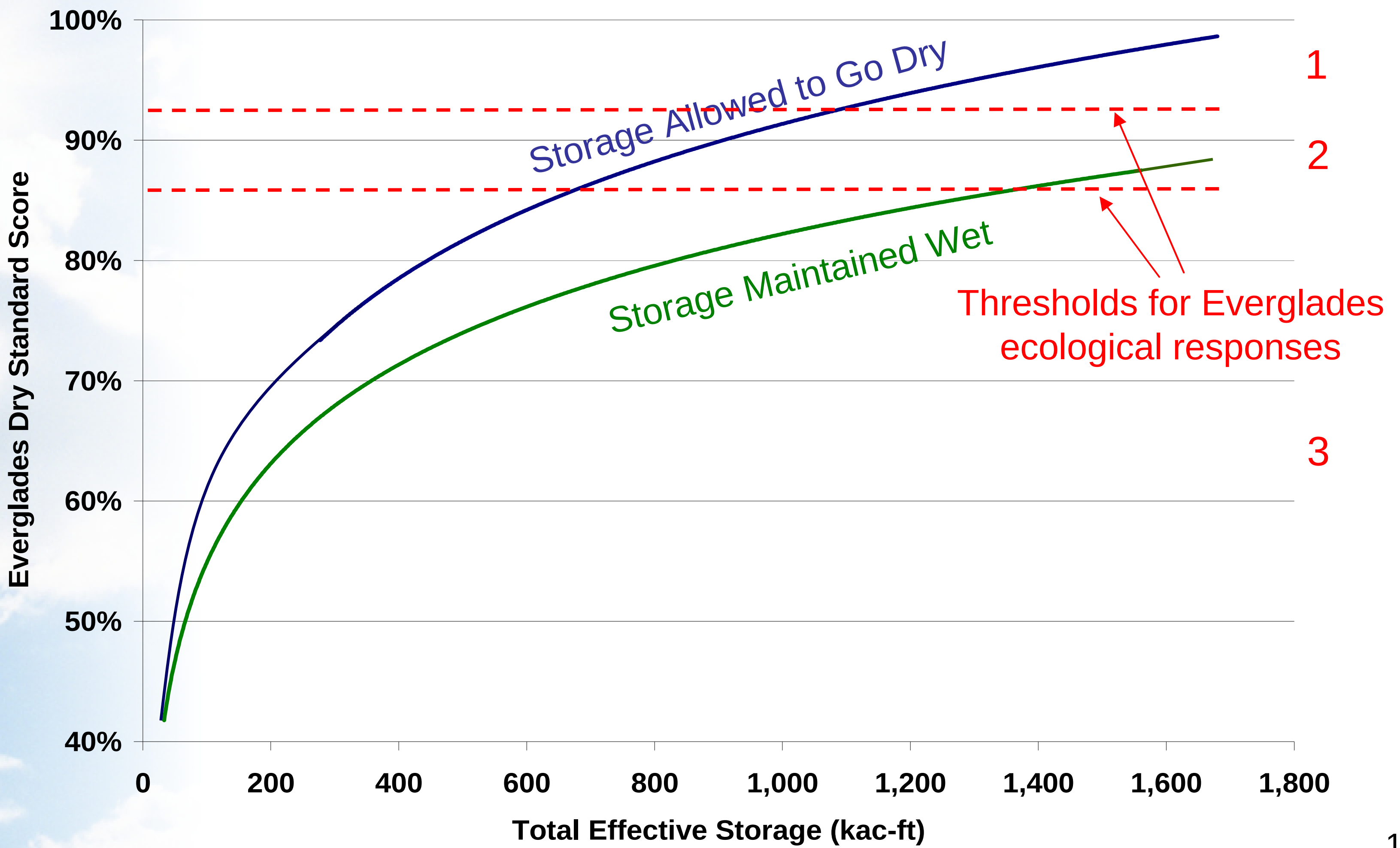
Topic 1

Observed Hydrologic Trends in Configurations

Example Trend Analysis Graphic (Presented at 6/2/2009 ROG Workshop)



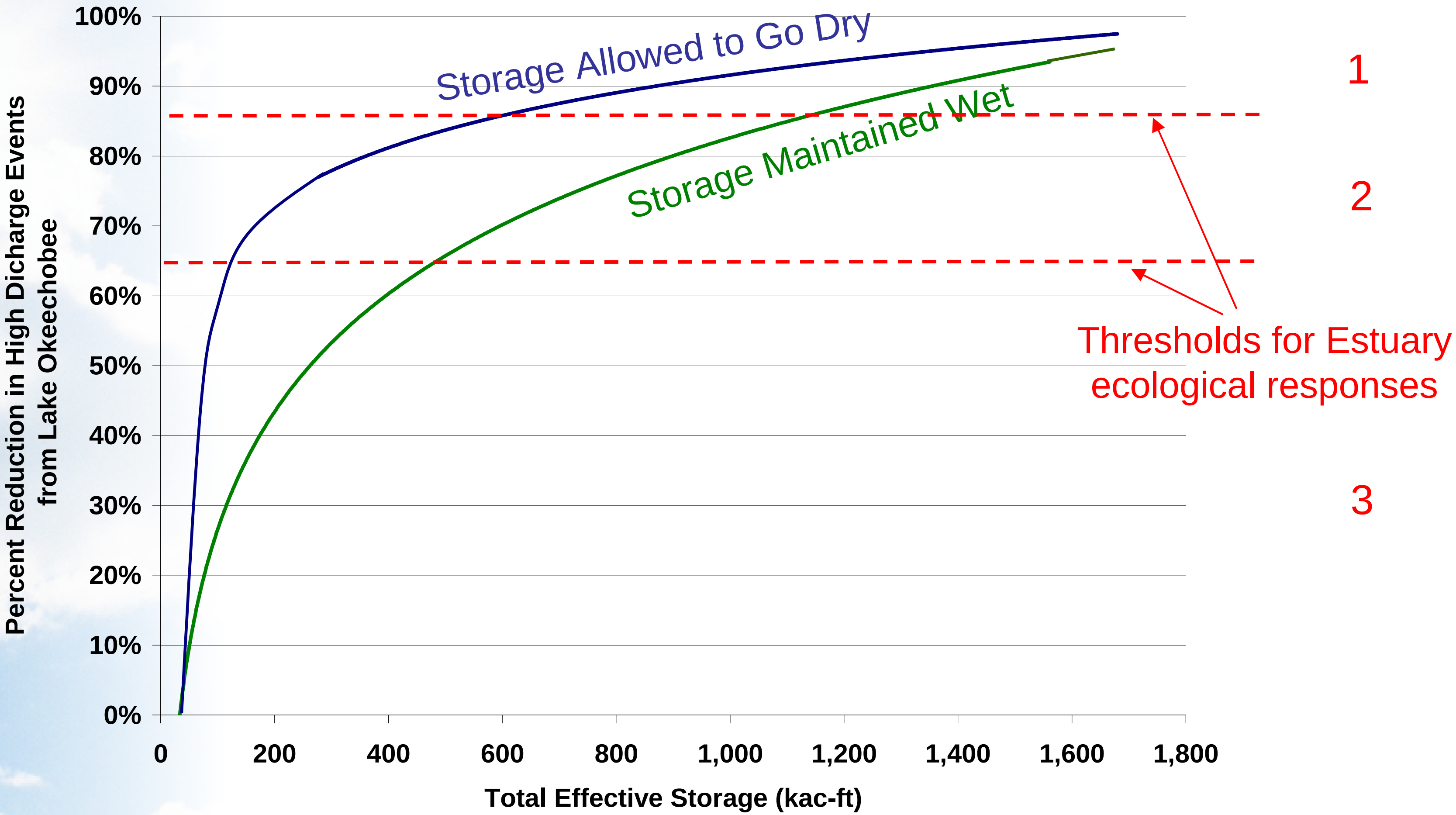
Trend Analysis Graphic for Everglades Dry Standard Score



Observations of Everglades Dry Standard Score Trend Analysis

- Allowing storage areas to go dry maximizes potential hydrologic benefit to the Everglades system.
- Maintaining storage areas wet improves treatment potential and, in the case of shallow storage, improves hydrologic performance within the project footprint.
- There is generally a range of diminishing returns where additional increase in storage capacity does not result in large hydrologic performance improvements
- Large gains in hydrologic performance (beyond the point of diminishing returns) may be necessary to reach threshold ecological responses

Trend Analysis Graphic for Lake Triggered Damaging Estuary Discharges



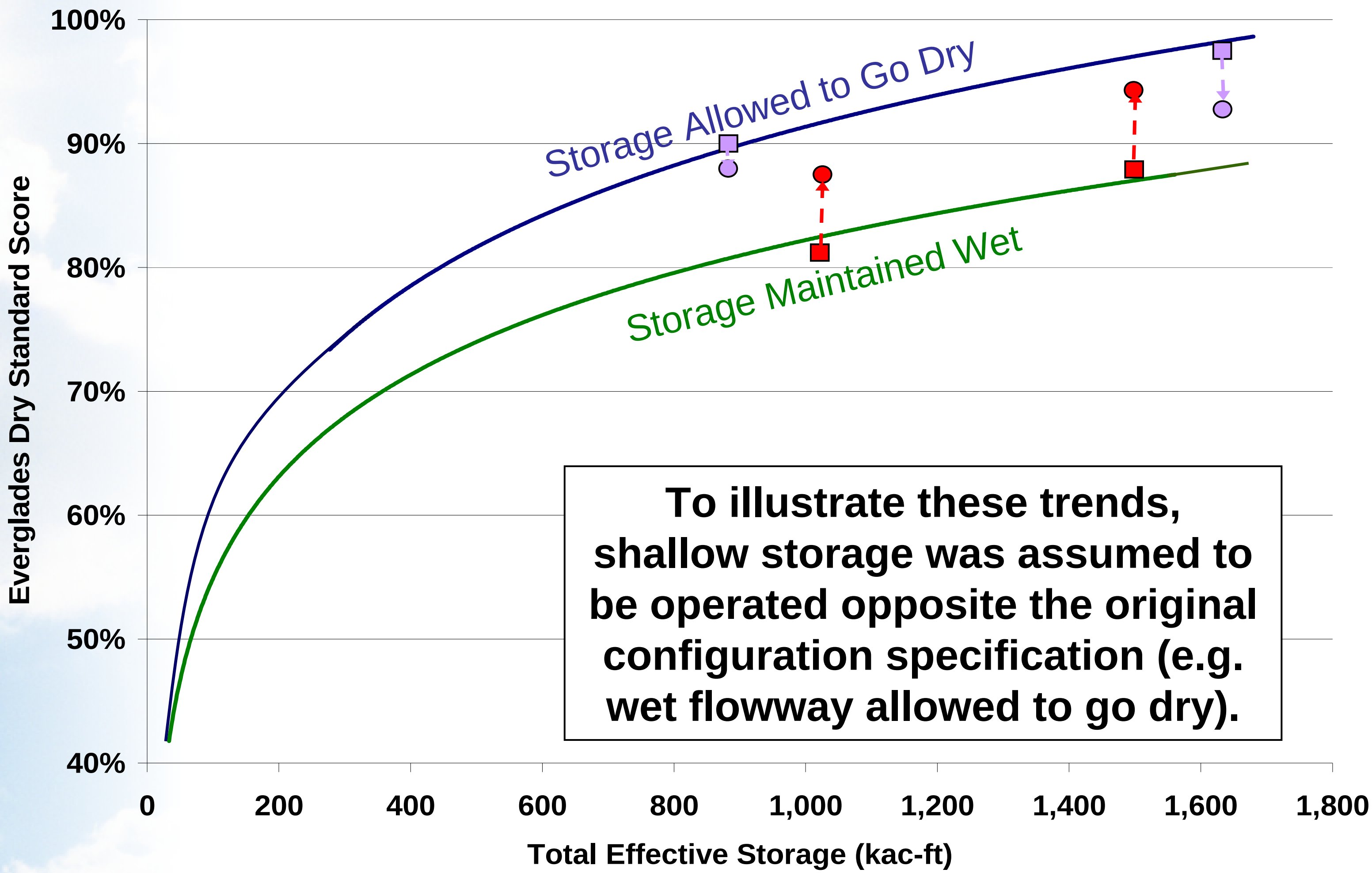
Observations of Lake Triggered Damaging Estuary Discharges Trend Analysis

- Overall, trend is similar to that for the Everglades Dry Standard Score trend graphic
- For smaller storage volumes, there is a large benefit to the estuaries when allowing storage to go dry
  - Provides capacity for discharges to storage instead of to the estuaries
- At large storage volumes, there is little difference between maintaining storage wet and allowing it to go dry (converging trend)

Trend Analysis General Observations

- It is possible for any particular configuration to achieve different hydrologic performance (i.e. migrate within the defined range) by modifying operational assumptions and/or changing assumed storage
- The defined ranges are based on analysis of the currently available configurations and may actually be larger than displayed
- Phase 2 modeling will need to further examine these trends with more detailed tools and/or structured sensitivity analyses.

Illustration of Changes in Performance due to Operational Changes



Modeling Analyses Topics

Topic 2

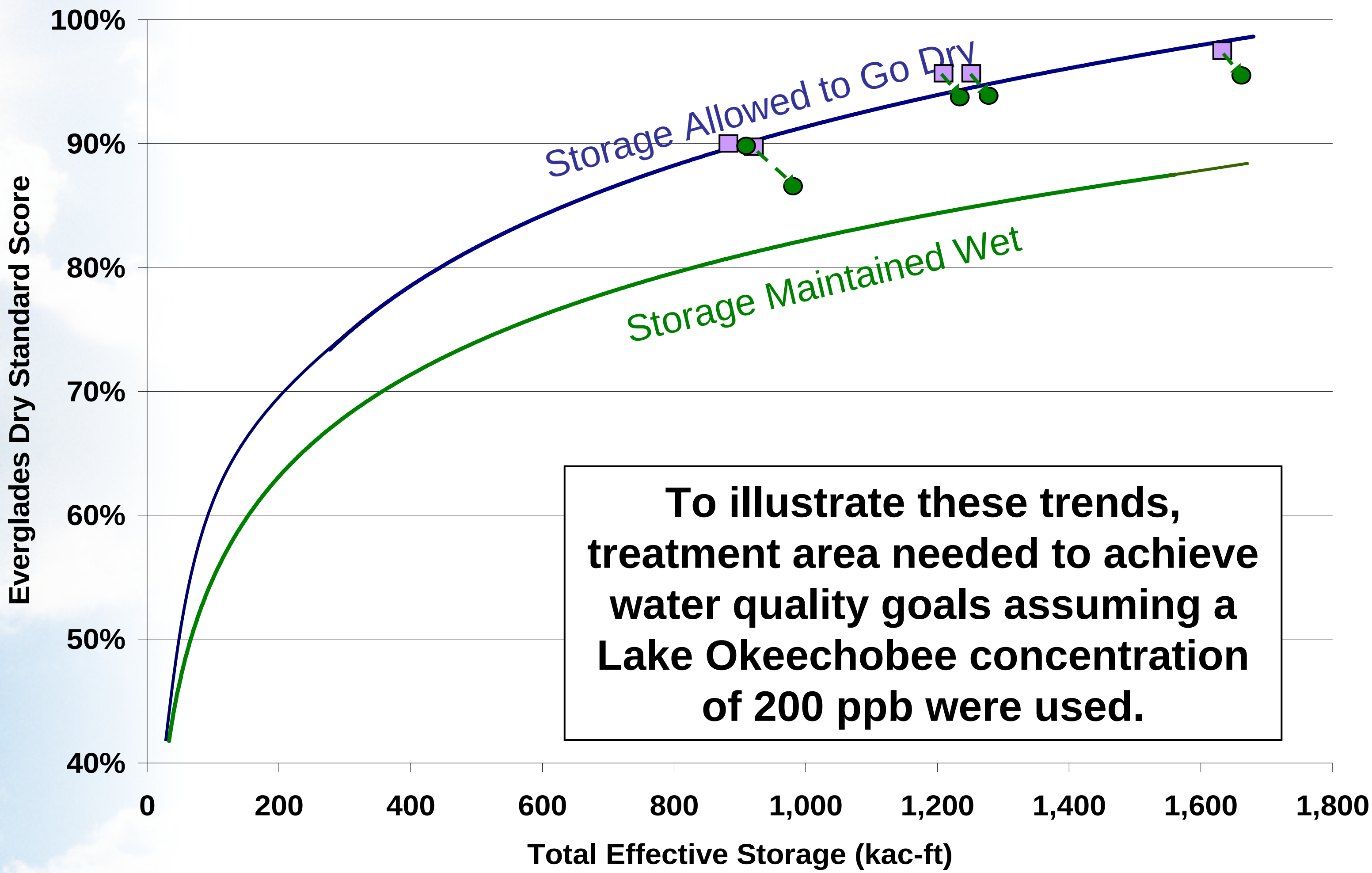
Hydrologic Sensitivity to

Water Quality Considerations

Hydrologic Sensitivity to Added Treatment Area

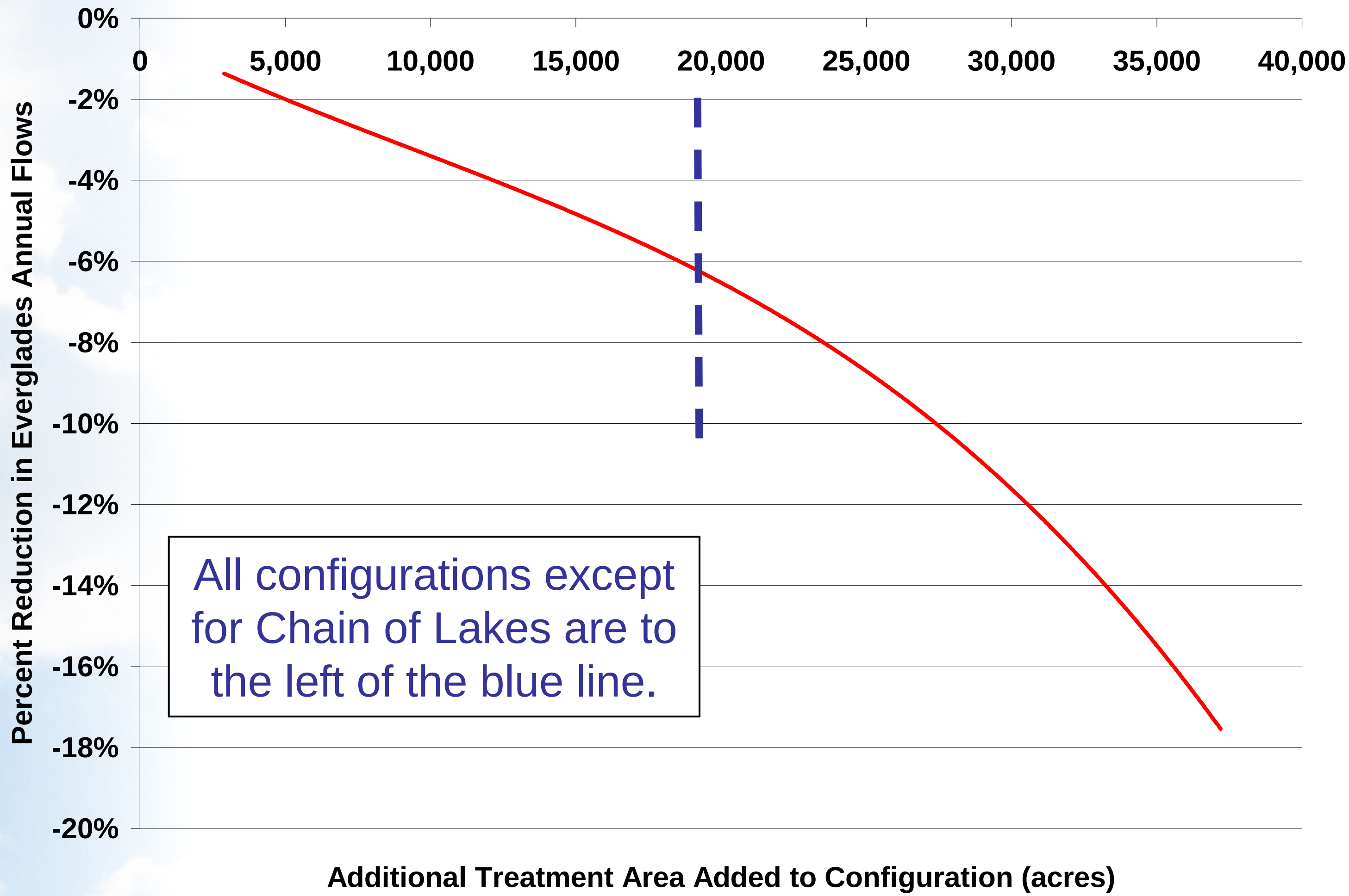
- At the June 2, 2009 ROG workshop, results of water quality assessments indicated that the configurations would need additional treatment area footprint.
- Based on the trend graphics, adding wetted area (e.g. treatment area) to "dry" configurations should result in a negative hydrologic trend.
- Sensitivity runs were made with RESOPS to determine the relative magnitude of this impact.
  - The acreage required assuming a 200 ppb Lake Okeechobee concentration was used.
  - This acreage was added to the configuration (i.e. no reduction in footprint of other features)

Illustration of Changes in Performance due to Operational Changes



To illustrate these trends, treatment area needed to achieve water quality goals assuming a Lake Okeechobee concentration of 200 ppb were used.

Additional Treatment Area Footprint Impacts to Everglades Additional Average Annual Flows



Hydrologic Sensitivity to Added Treatment Area - Observations

- For most configurations (except for Chain of Lakes), the hydrologic impact of adding needed treatment area was small.
  - Lake Okeechobee and estuary performance showed no change.
  - Everglades flows were reduced by an annual average of 27 kac-ft (or approximately 5% of the additional flow provided by the features) with a corresponding 1% to 2% impact to the Everglades Standard Score and Everglades Dry Standard Score.
- This result indicates that larger impacts to hydrologic performance of the Lake, estuaries and Everglades are associated with the goal of achieving hydrologic performance within the project footprint (e.g. maintained flowways) rather than achieving treatment goals.

Modeling Analyses Topics

Topic 3

Hydrologic Sensitivity to

Differing Ecologic or System Objectives

Hydrologic Sensitivity to Differing Ecologic or System Objectives

- When planning projects, it is desirable to consider the “robustness” of the design to handle potential changes in ecological or system objectives.
- The modeling results and associated benefits and water quality analyses for the ROG phase 1 planning effort to date have focused on a singular comprehensive operational objective for the South Florida system due to aggressive schedule constraints and screening level scope.
- This operational objective can be (over-simply) characterized as attempting to achieve significant improvements to the Everglades and estuary environments while keeping Lake Okeechobee near its current level of performance.

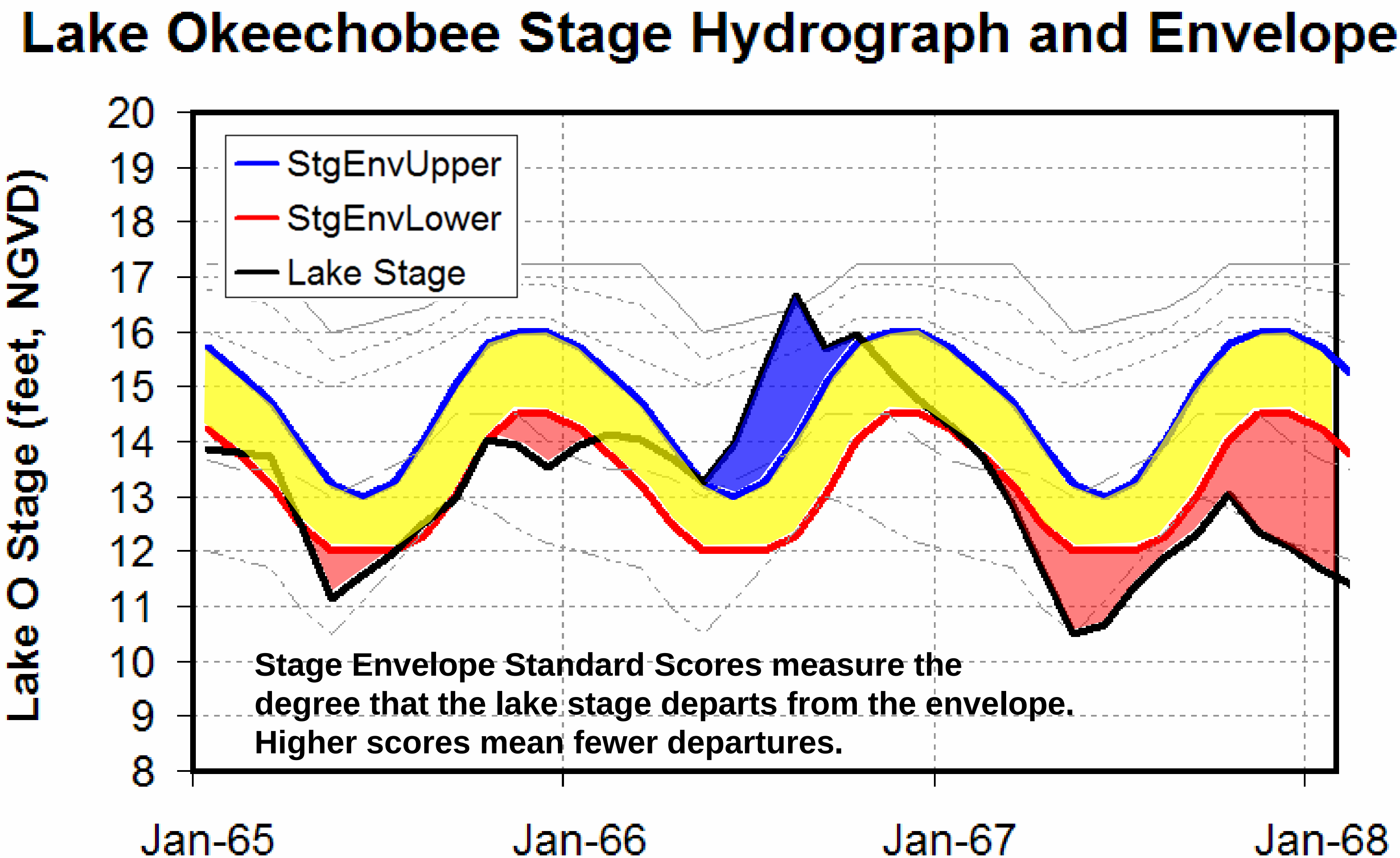
Hydrologic Sensitivity to Differing Ecologic or System Objectives

- Other combinations of system objectives are possible (and likely desirable). Some examples include:
  - Attempt to achieve higher levels of Lake Okeechobee performance (beyond current level).
  - Consider magnitude of flow needed in the Everglades during incremental construction of ROG features (e.g. what to send south today versus in a decompartmentalized Everglades)
  - How should the Lake be operated once the dike repair is complete?
- These and other considerations will affect the relative hydrologic performance of elements of the South Florida system.

Methodology of Hydrologic Sensitivity to Differing Ecologic or System Objectives

- As scored by the Lake Okeechobee stage envelope performance measure, configurations as modeled with RESOPS have aimed to maintain at least an 80 standard score above (SSA) and a 30 standard score below (SSB)
- For the robustness tests, Lake Okeechobee objectives were examined at two higher thresholds:
  - Outcomes consistent with the performance of the Northern Everglades Phase II Technical Plan for Lake Okeechobee (70 SSA & 70 SSB)
  - Outcomes consistent with the performance of the WSE regulation schedule (60 SSA & 55 SSB)

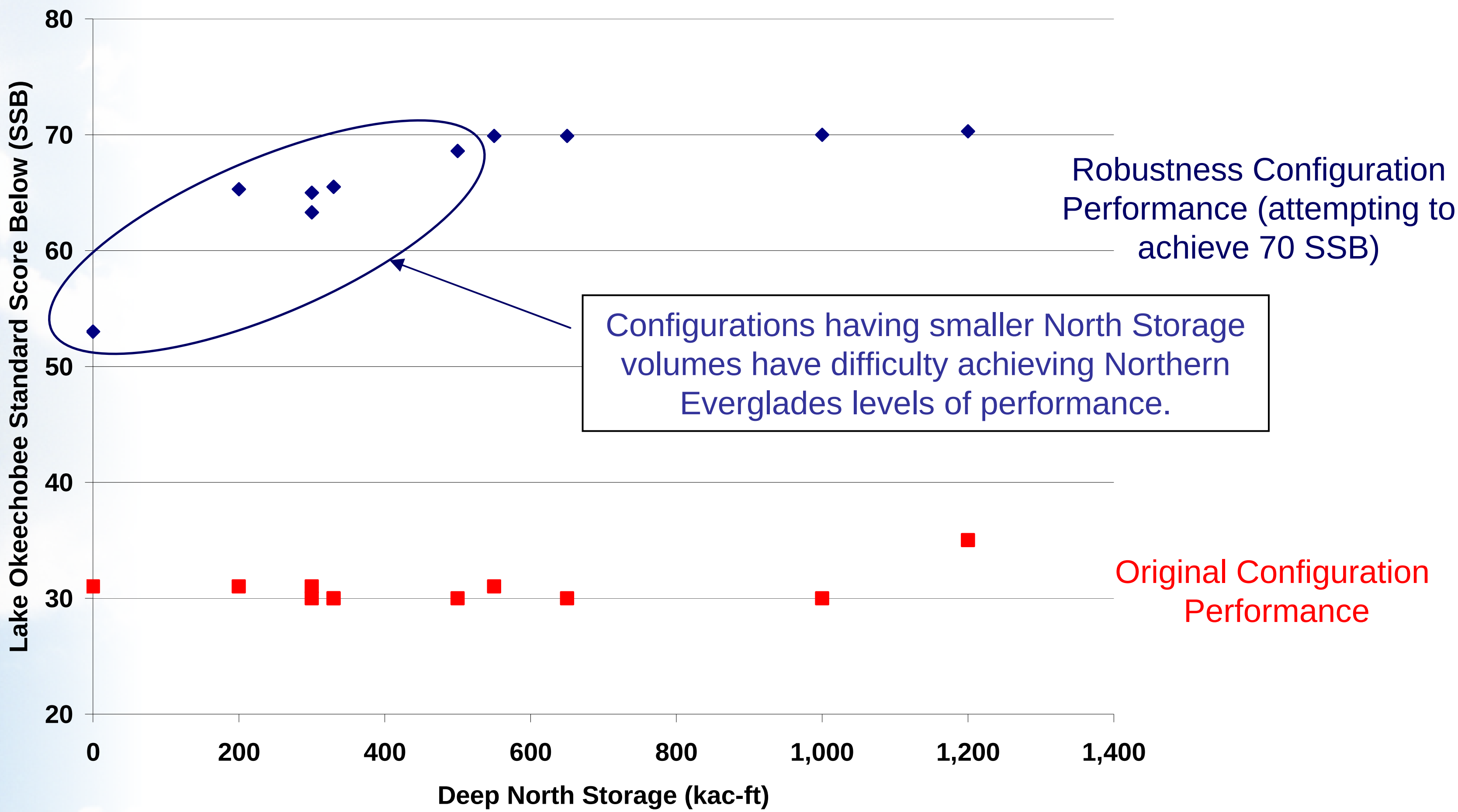
LOK Stage Envelope



Results of Hydrologic Sensitivity to Differing Ecologic or System Objectives

- Most configurations demonstrated high robustness.
- With the limited dataset available, it is difficult to establish statistically meaningful trends.
  - ROG Phase 2 could employ different approaches to examine relationships in more detail
- In general, when trying to improve low stage conditions in the Lake, there is a corresponding reduction in flow to the Everglades and an increase in high Lake stage impacts and estuary events.
- This trend identifies the potential need for a minimum level of "North Storage", which from a hydrologic perspective does not have to be sited north of the Lake, but must serve to help supplement low Lake stages.

North Storage Relationship to Meeting Lake Okeechobee Objectives



Note: "North" Storage need not be sited north of the Lake, but must serve to supply water during low Lake stage conditions

Results of Hydrologic Sensitivity to Differing Ecologic or System Objectives

- Configurations initially not achieving the 70 SSB target required the addition of “North” storage in order to achieve the goal.
- It appears that a range of between 450 kac-ft and 575 kac-ft of total North storage allows most configurations to achieve the 70 SSB target
- As an additional check, a RESOPS sensitivity run demonstrated that lowering the north storage (to below the desired range) of a configuration that previously achieved the target would result in inability to meet the goal.

Modeling Analyses Topics

Topic 4

Hydrologic Efficiency of

Storage Features

Evapotranspiration Relative to Storage Type

- Evapotranspiration (ET) magnitudes are a function of many factors including operational objectives
  - Increases in wetted footprint tend to increase ET
  - The longer that water is kept in storage, the more ET is possible
- RESOPS aggregates shallow and deep storage for many configurations, making analysis more complicated.
- For deep storage, a range of approximately 15% to 30% evaporation volume relative to total inflow volume (including rainfall) was observed.
- For shallow storage, a range of approximately 20% to 60% evaporation volume relative to total inflow volume (including rainfall) was observed.

Modeling Analyses Topics

Topic 5

Summary and Recap

Summary of Key Observations

- Total storage volumes beyond the range of diminishing hydrologic improvement will likely be needed to improve ecological conditions
- Per given storage capacity, features that are maintained wet maximize hydrologic performance within the project footprint, but generally have less overall potential to achieve hydrologic objectives in the Everglades and estuaries
- It is possible for any particular configuration to achieve different hydrologic performance by modifying operational assumptions and/or changing assumed storage characteristics (e.g. wet vs. dry, shallow vs deep, etc…)
- Hydrologic impacts associated with adding needed treatment area to configurations in order to achieve water quality goals are small in most cases

Summary of Key Observations (cont)

- Most configurations demonstrated high robustness (i.e. can be used to effectively meet multiple system objectives)
- In general, when trying to improve low stage conditions in the Lake, there is a corresponding reduction in flow to the Everglades and an increase in high Lake stage impacts and estuary events
- There is a potential need for a minimum amount of “North Storage”, which from a hydrologic perspective does not have to be sited north of the Lake, but must serve to help supplement low Lake stages
- Evapotranspiration volumes relative to total inflow volumes are markedly higher in shallow storage compared to deep storage (increased ET is water that does not reach the Everglades)

Acknowledgements

- Calvin Neidrauer
- Lehar Brion
- Danielle Morancy
- Harold Hennessey-Correa

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Questions?

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RESTORATION PLANNING

Everglades Ecology

Christopher McVoy, Sr. Environmental Scientist,
Everglades Division, Watershed Management

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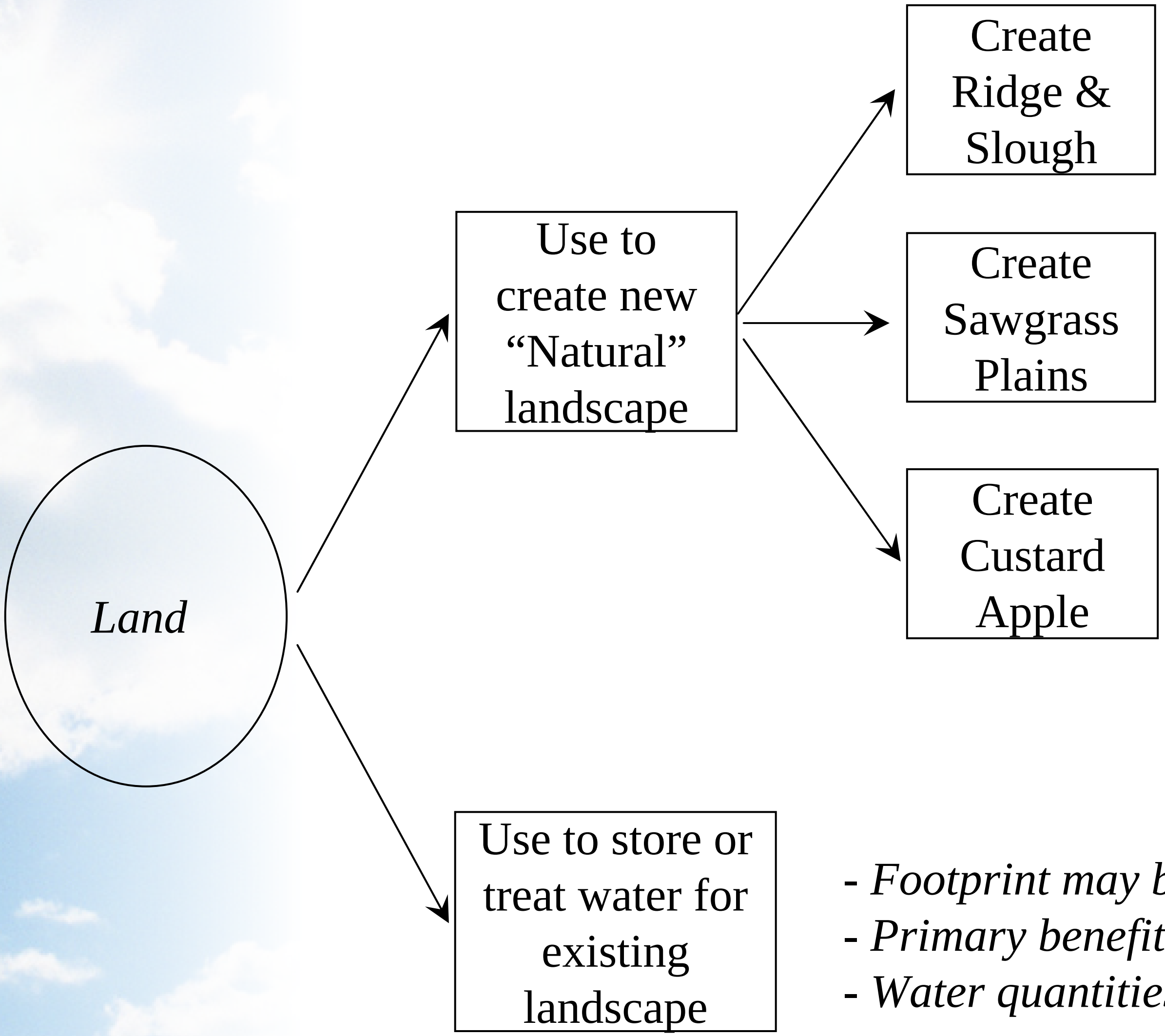
New Spatial Extent or Improved Remaining Extent?



-- *No historical basis*

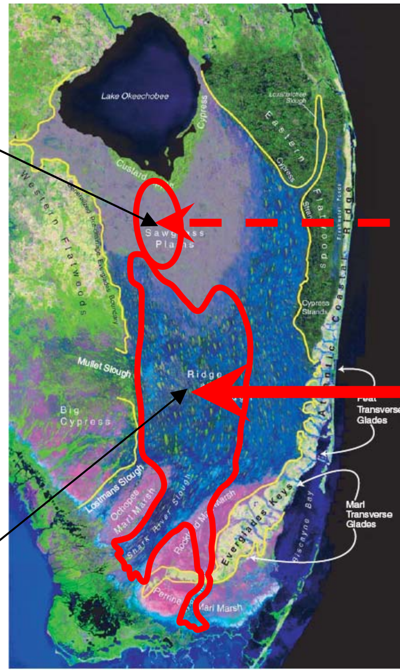
- *Missing slope*
- *Feasibility?*
- *Historical function?*

- *Historically small*
- *Treatment?*

- *Footprint may be much less "natural"*
- *Primary benefit is water / WQ to downstream*
- *Water quantities needed are very large*

New Spatial Extent or Improved Remaining Extent?

Sawgrass Plains



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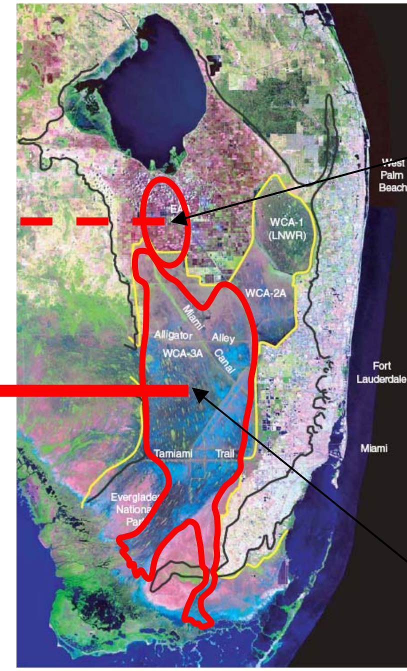


Subsided Ag Land

- *Elevation*
- *Slope*
- *Soil chem*
- *Plant comm.*

Healthy Ridge & Slough

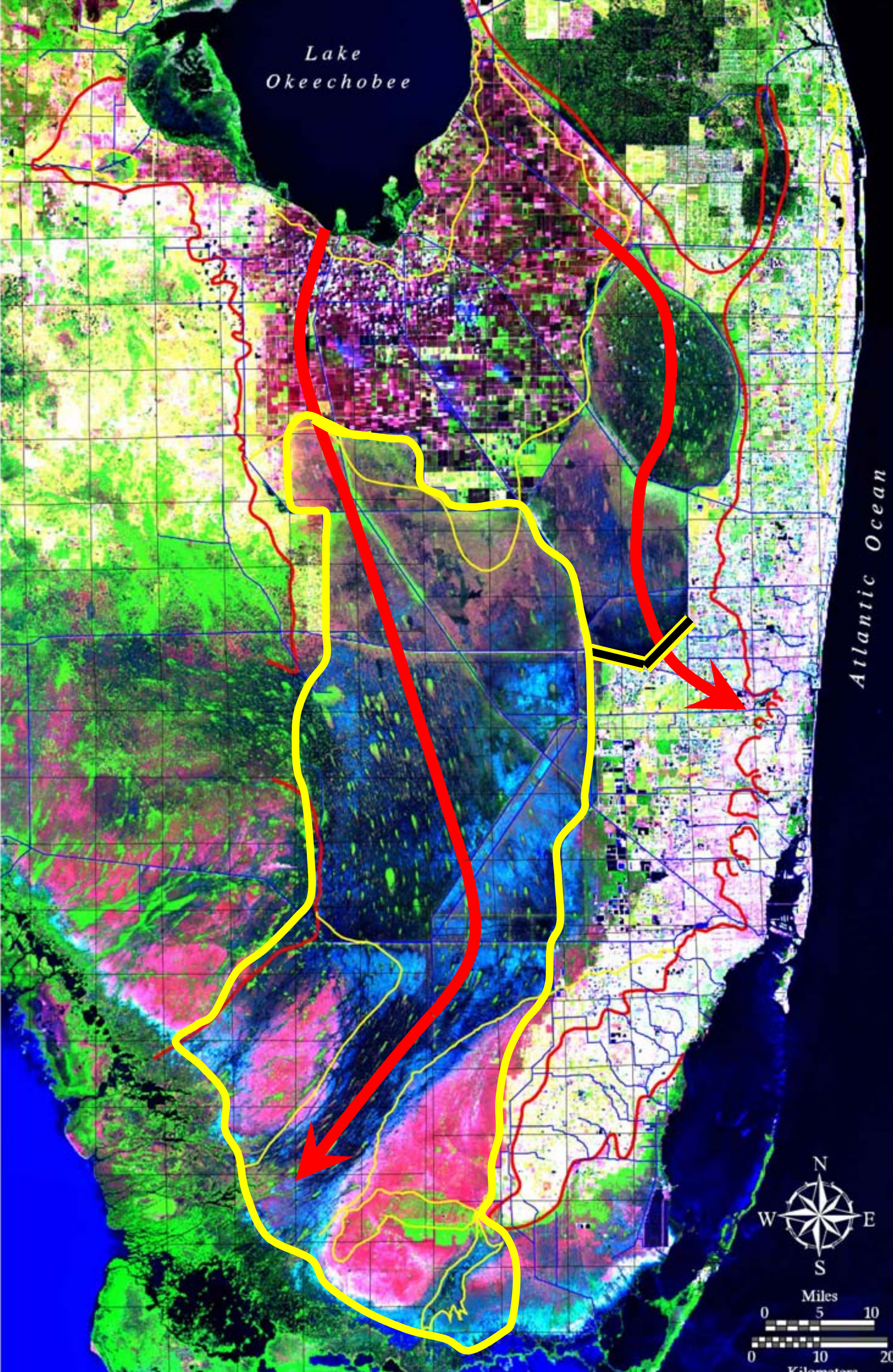
- *Depth*
- *Flow*
- *WQ*

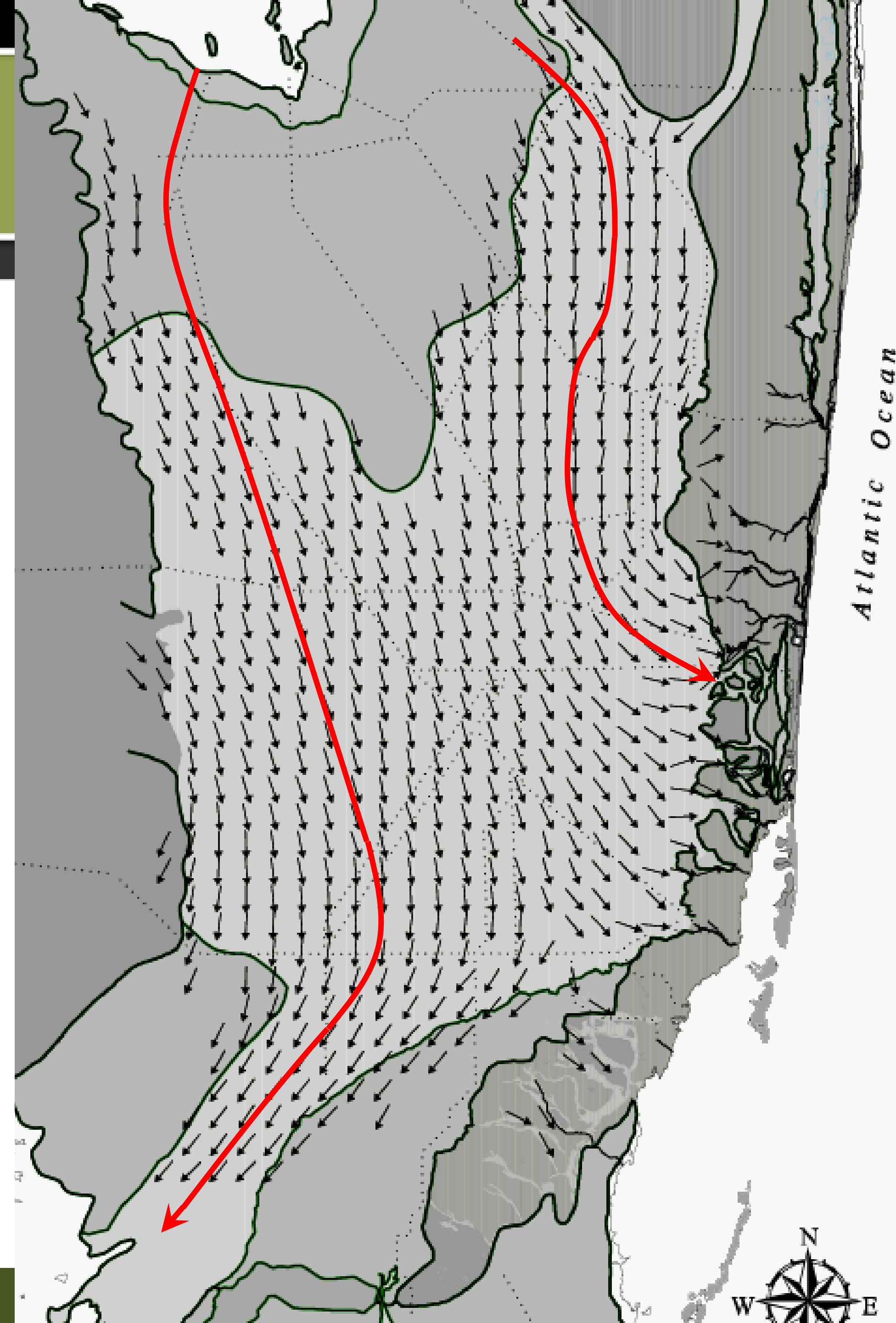
Degraded Ridge & Slough

Identifying Everglades Hydrologic Needs

Based On –

- Observed current conditions -- ecological
- Observed current conditions -- hydrological
- Observed post-drainage changes -- both ecology & hydrology
- Original Everglades conditions


Lake Okeechobee
Atlantic Ocean
N
W
E
S
Miles
0 5 10
0 10 20

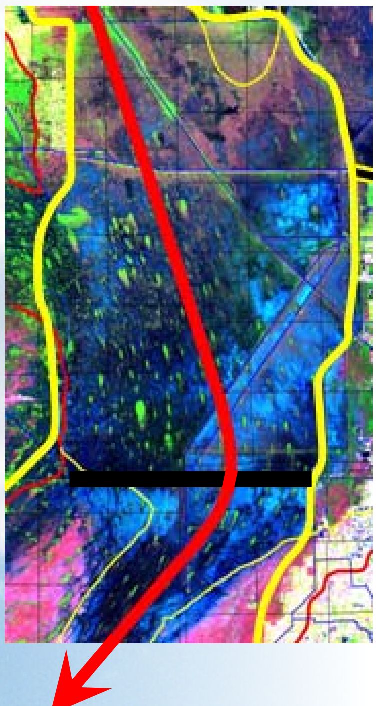

Atlantic Ocean
N
W
E

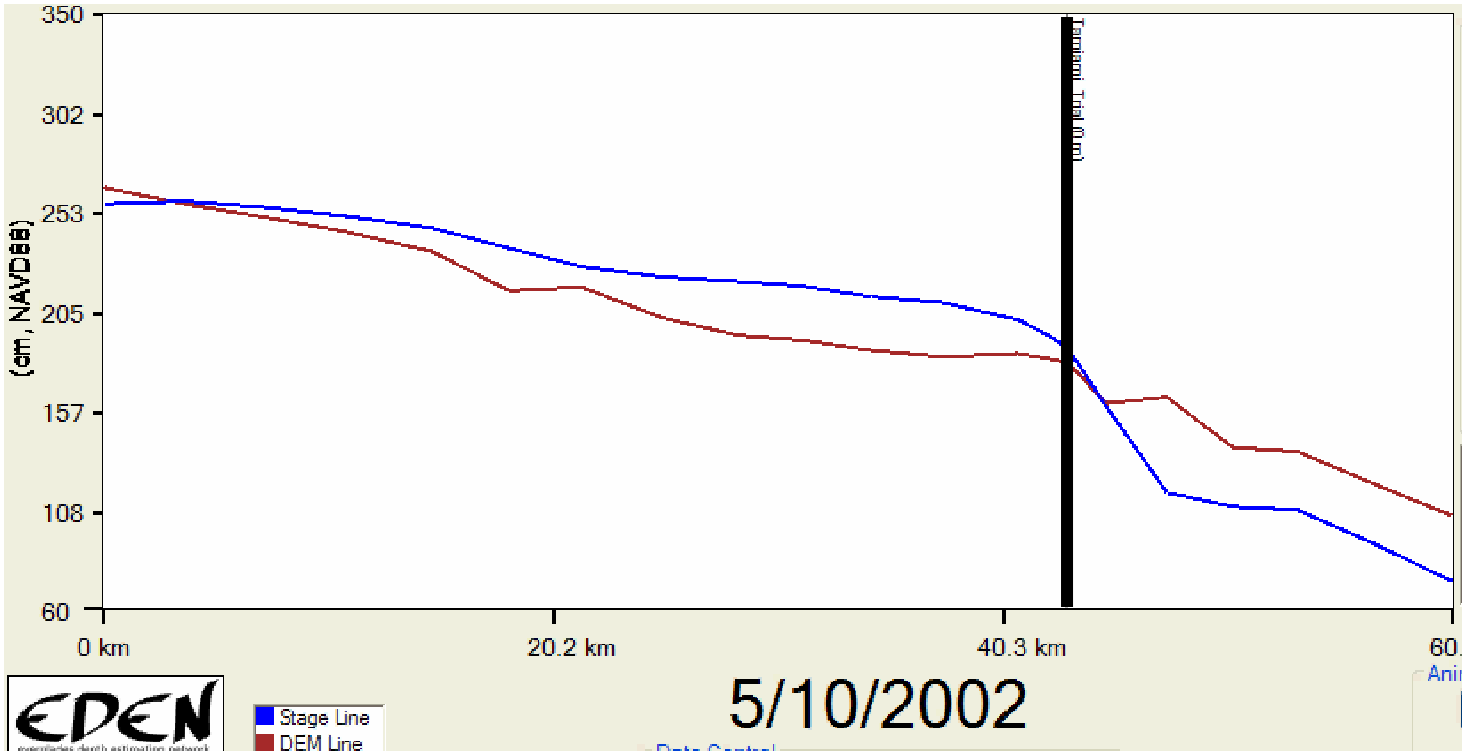
Current Condition: Water Surface in WCA 3 and ENP0

WCA 3A

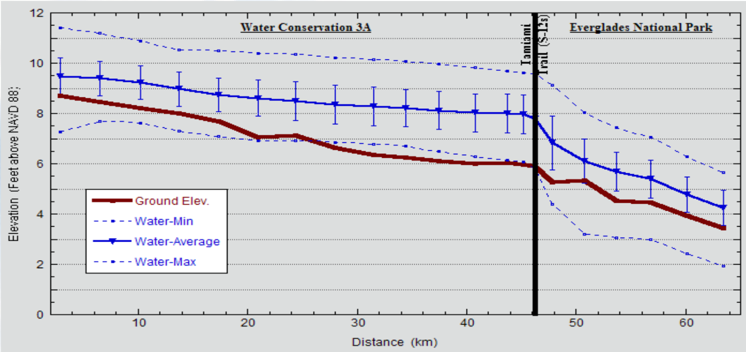
Tamiami Trail

ENP

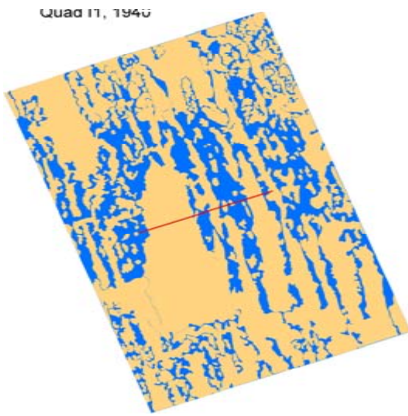




Test 0 Hydrology



1940



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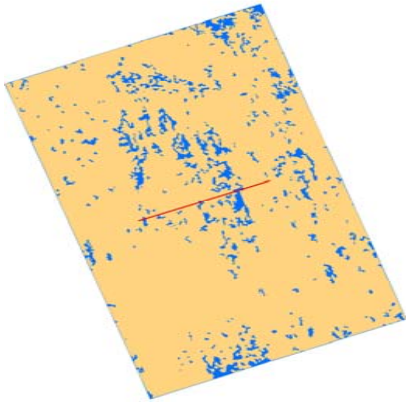


Loss of microtopography

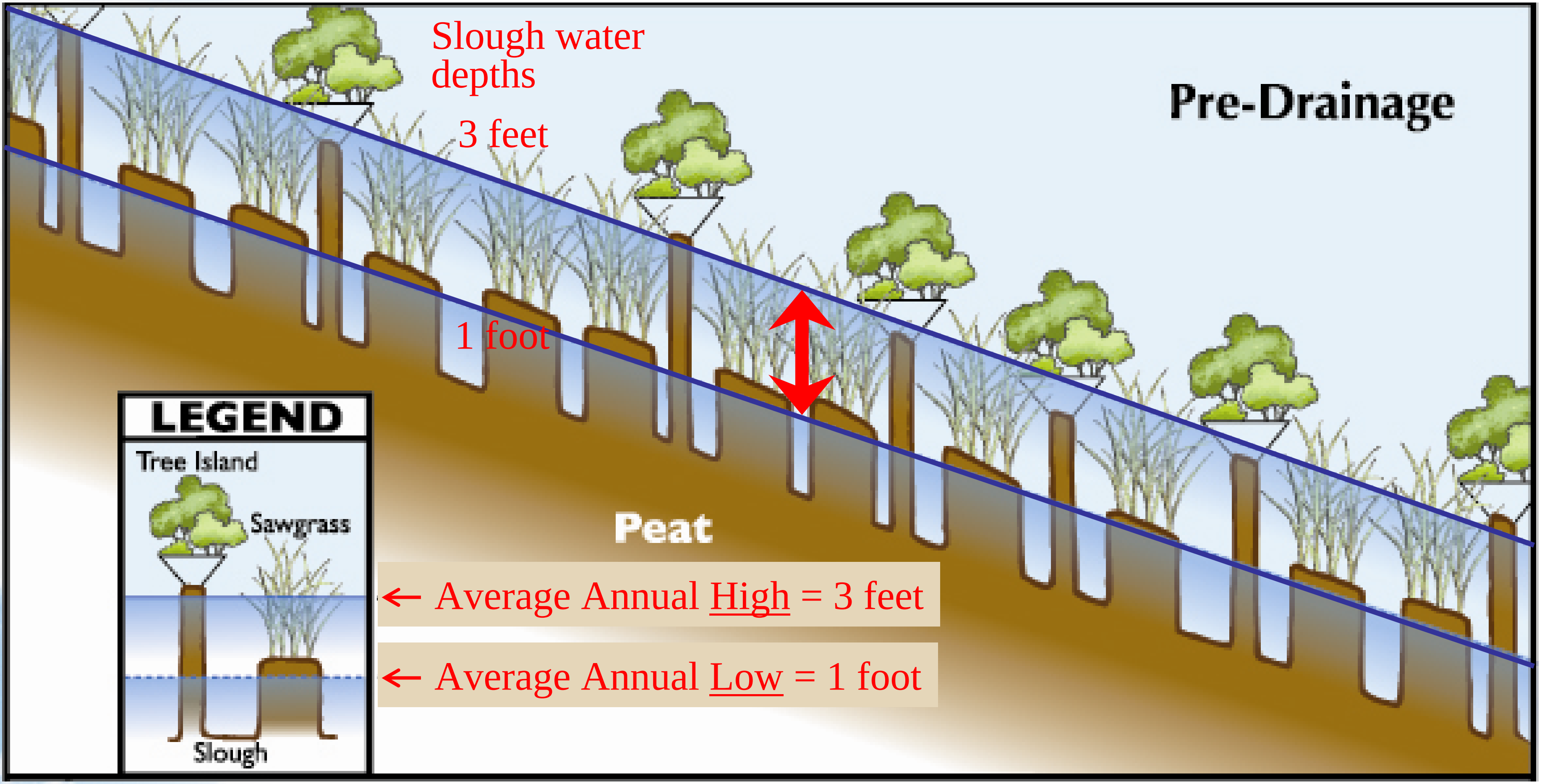
Loss of spatial pattern

Loss of habitat

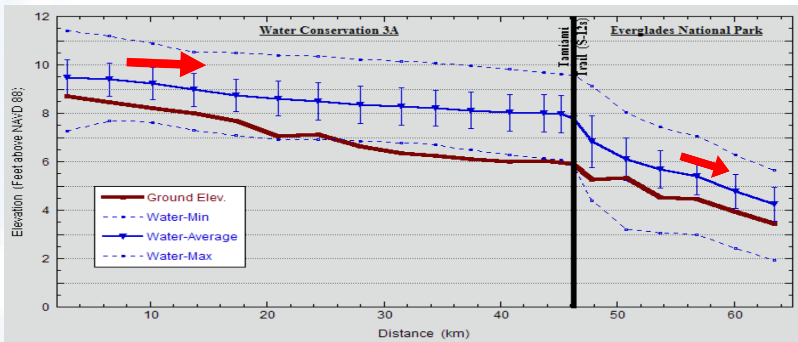
Loss of peat (oxidation)

Loss of tree islands

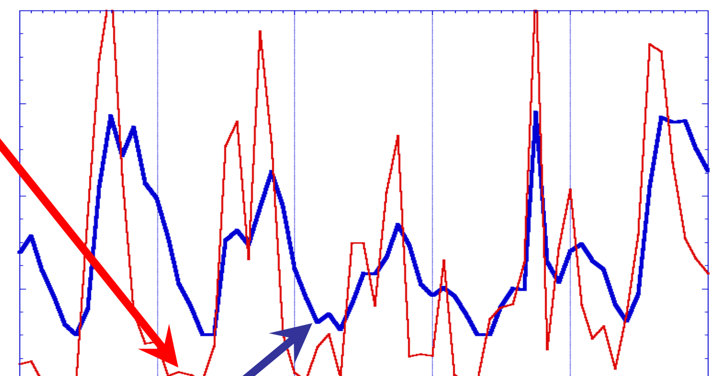
Original Condition: Water Surface in WCA 3 and ENP



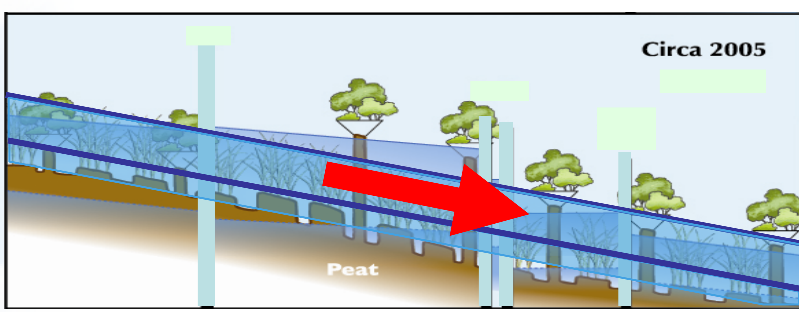
Current



Test 0

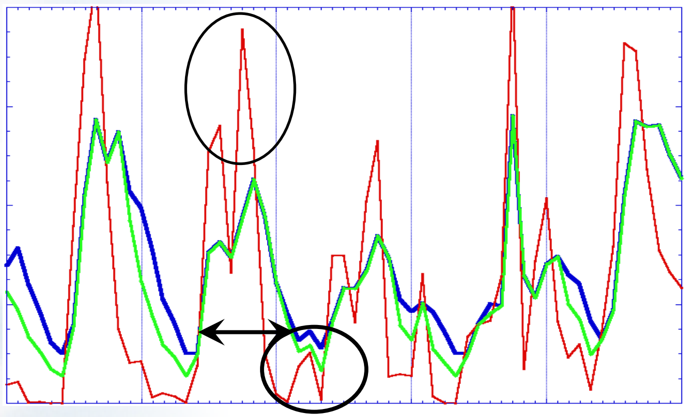


Restored



Synthetic

1



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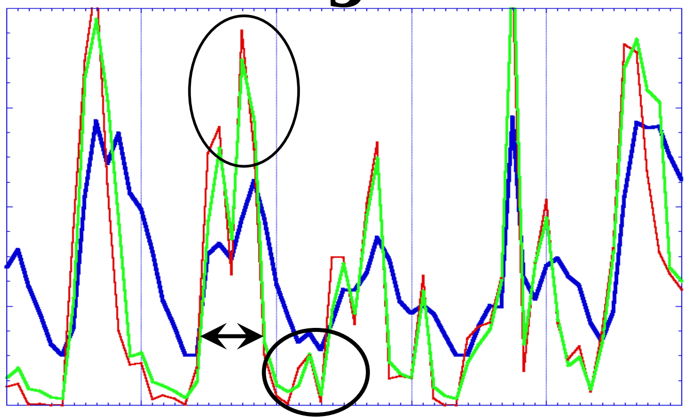

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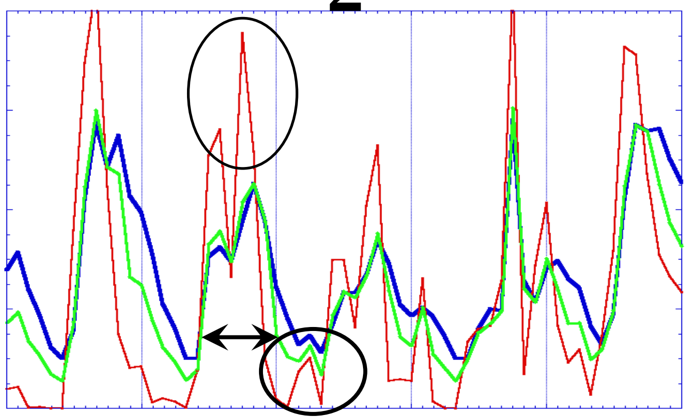

Questions??

Water Quality Performance - Relationships, Trends, Tradeoffs, Other Considerations

Gary Goforth, P.E., Ph.D., Consultant
South Florida Water Management District

Long-Term Plan

- District's existing STA program (Long-Term Plan) contains approximately 56,500 acres of constructed wetlands, designed to capture and treat approximately 1.7 million acre-feet per year as a long-term average
- The 1.7 million acre-feet is mainly basin runoff but includes approximately 100,000 acre-feet of Lake Okeechobee releases
  - If additional Lake Okeechobee releases are to be treated for delivery to the Everglades, additional STA treatment acreage will be required
- Existing Long Term Plan program includes Compartments B and C Build-outs and ECART
  - Construction has begun on build-outs; ECART is currently on hold
- River of Grass provides potential opportunity to address all of the District's restoration plans (i.e. Northern Everglades, CERP, Long-Term Plan) in a more holistic approach while providing additional water for the Everglades

Water Quality Performance – Overview

- As part of the Phase 1 Planning process, the goal was to provide feedback on potential TP removal performance
- Used a steady-state WQ modeling approach to work in concert with RESOPS
  - This Phase 1 Planning study will be followed by more detailed water quality analyses
- The water quality evaluation did not assess discharges into Lake Okeechobee or the estuaries, and did not extend into the Everglades
  - Water quality issues and recommended water quality projects for these watersheds are addressed in the Northern Everglades Lake Okeechobee Protection Plan (LOPP) and River Watershed Protection Plans.
    - An update to the LOPP will be prepared in 2010 and delivered to the legislature in early 2011.
  - During Phase 2 planning, Northern Everglades and ROG efforts will be coordinated and if necessary and/or appropriate, water quality evaluations related to discharges to the Lake or estuaries will be included in Phase 2 analysis

Water Quality Performance – Topics

- Relationships: TP removal is sensitive to
  - Hydrologic targets
  - TP concentrations in Lake Okeechobee deliveries
  - Type of water resource feature
  - Maintaining wet conditions
- Tradeoffs:
  - Degree of management vs. TP removal performance
  - Maintaining sufficient storage/treatment area to handle infrequent but high flows
- Other considerations:
  - Uncertainty
- Next Steps: Utilize more detailed analysis to identify optimal combination of features

Water Quality Performance – Relationships

- TP removal is sensitive to **Hydrologic Targets**
  - Magnitude
    - In general, treatment area increases as magnitude increase
  - Temporal variability (storm pulses, wet years/dry years)
    - In general, better removal with lower variability

- **As these targets are better defined, the water quality evaluations can be better defined.**

Water Quality Performance – Relationships

- TP removal is sensitive to **TP concentrations in Lake Okeechobee deliveries**
  - Evaluated a range of TP concentrations: 40 ppb to 200 ppb.
  - Additional STA acreage of ~10,000 acres across this range
- Location of Lake Okeechobee deliveries influence TP levels
  - Eastern releases (to West Palm Beach Canal) ~41% higher than southern releases (to North New River and Miami Canals)

- **Improving Lake Okeechobee TP Levels is Critical to Success**

Water Quality Performance – Relationships

- TP removal is sensitive to the **type of water resource feature**
  - **Reservoir -** Limited long-term TP removal performance data exist
    - Under ideal conditions, removal of 15-25% may be achieved.
    - Under less than ideal conditions, TP removal may drop significantly.
  - **STA** - The best performing STA (STA-3/4) has exhibited a range of 13-23 ppb.
    - Continuing to investigate ways to optimize STA performance
    - The current rule of thumb for optimal treatment vegetation is multiple parallel flow-paths, consisting of an emergent cell followed by a submerged aquatic vegetation cell comprising approximately 60% of the treatment area.
  - **Flow-way and other features -** not well-defined
    - The specific design features, operations, vegetation management requirements and performance of large constructed flow-ways are not well-defined.
    - Based on observations of TP removal in emergent wetland treatment cells, the current estimate of optimal performance of a flow-way that can be sustained in a wet condition for most of the year is a long-term average annual outflow TP concentration of 25 ppb.
    - Under less than ideal conditions, TP removal may drop significantly.

Water Quality Performance – Relationships

- TP removal is sensitive to **Maintaining Wet Conditions**
  - It is critical to maintain wet conditions over the majority of the treatment areas for most of the time in order to achieve optimal water quality treatment – both
    - to ensure viability of the highest performing treatment vegetation (submerged aquatic vegetation), and
    - to avoid dryout of the soil, which can release TP upon rewetting.
  - The evaluations conducted for Phase 1 included a best case scenario (maintaining wet conditions) and a worst case scenario (allowed to go dry such that no TP removal occurred), with a large range of results.
  - The hydrologic trade off is that maintaining wet conditions requires adding water during dry periods of the year, which reduces the water available for the Everglades.
  - Several of the configurations with large flow-ways may in fact have too much area devoted to flow-ways, and conversion to STA would improve water quality.
  - Phase 2: more detailed hydrologic/hydraulic and TP modeling will better refine the water quality evaluation.

Water Quality Performance – Tradeoffs

- Degree of management vs. TP removal performance
  - Hydraulic distribution (levees, canals, structures) – efficient use of land area
  - Operations management – maintain appropriate range of hydrology to sustain treatment vegetation and prevent dryout
  - Vegetation management – reduce undesirable species

Water Quality Performance – Tradeoffs

- Maintaining sufficient storage/treatment area to handle infrequent but high flows
  - Restoration flow targets call for pulsing (periods of dry/drought conditions, periods of high flows)
  - Features/system operations need to be able to handle idle periods followed by periods of high flows
  - Management would need to continue during dry years in order to sustain wet conditions and appropriate treatment vegetation so that sufficient treatment exists to address occurrences of infrequent high flow events

Water Quality Performance – Other Considerations

- **Scientific uncertainty** exists in estimating the long-term TP removal characteristics
  - We used a 30% uncertainty factor in these evaluations, a value commonly applied to estimates at a Phase 1 Planning level.
  - Uncertainty will decrease with refinement of characteristics of features, and more detailed hydrology and evaluation method
    - The Phase 1 water quality evaluation utilized a “lumped” hydrologic model (RESOPS) and a steady state TP removal model and hence, could not evaluate the influence of highly variable inflows (e.g., droughts and hurricanes).
    - Phase 2 water quality evaluations will consider inter-annual variability of inflows to the flow-ways and STAs, and the intent is to use a daily time step model for Phase 2 evaluations.

Water Quality Performance – Next Steps

- Depending on the hydrologic targets (magnitude, inter-annual and intra-annual variability) an optimal combination of water resource features can be implemented
  - For example, to capture extreme high pulses, reservoir(s) followed by appropriately-sized STAs
- Phase II and subsequent planning-
  - Conduct dynamic water quality evaluation using daily time step
  - Further refine information related to water quality benefits of various feature types (e.g., flow-ways)
  - Refined evaluation of issues related to wet versus dry footprints and associated effects on water quality and hydrologic performance

Water Quality Performance – Summary

- Relationships: TP removal is sensitive to
  - Hydrologic targets
  - TP concentrations in Lake Okeechobee deliveries
  - Type of water resource feature
  - Maintaining wet conditions
- Tradeoffs:
  - Degree of management vs. TP removal performance
  - Maintaining sufficient storage/treatment area to handle infrequent but high flows
- Other considerations:
  - Uncertainty
- Next Steps: Utilize more detailed analysis to identify optimal combination of features

Questions??

Aquifer Storage and Recovery (ASR) – Implementation Update

Bob Verrastro, Lead Hydrologist,
Northern Everglades

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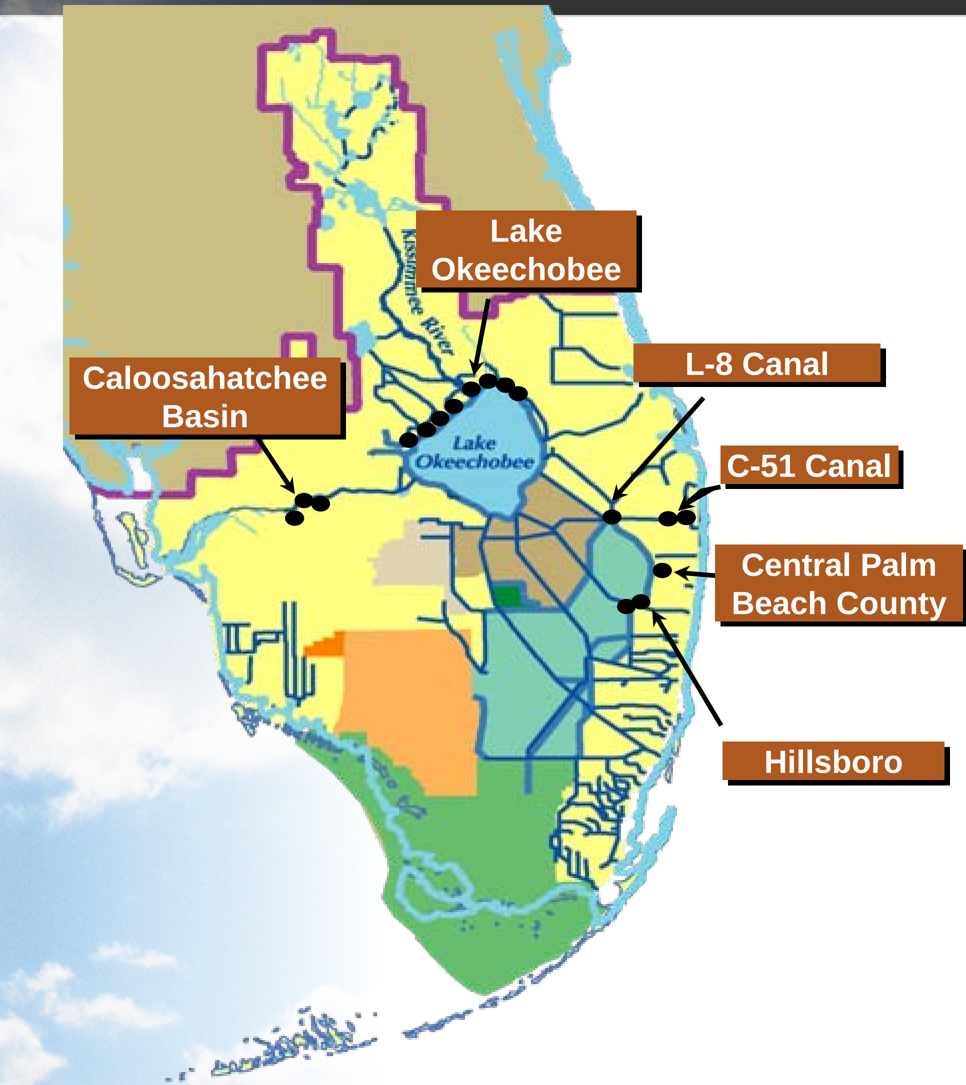
CERP Aquifer Storage and Recovery



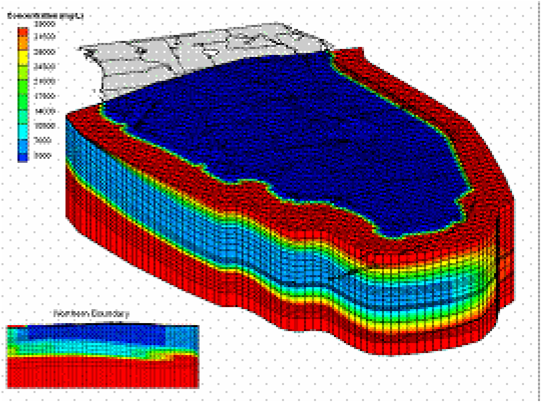
Site	ASR Wells
Lake Okeechobee	200
Caloosahatchee	44
L-8 Basin	10
C-51 Basin	34
Central PBC	15
Hillsboro	30
TOTAL	333

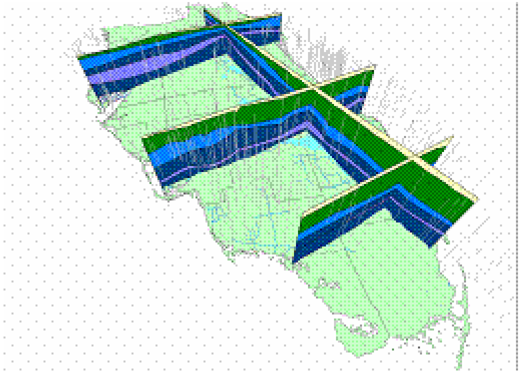
CERP ASR Pilot Projects

- Kissimmee River Pilot Project
  - Excellent recovery efficiency during Cycle 1
  - No toxicity or bioaccumulation
  - Some arsenic – FDEP is issuing Administrative Orders for testing
  - Apparent nutrient (P) reduction from >100 to <20 ppb
  - Already one month into Cycle 2
- Hillsboro ASR Pilot Project
  - Should begin cycle testing in early fall - delayed for nearly one year
  - High capacity (10 mgd) well – probably will need fewer at Site 1

CERP ASR Regional Study

- ASR Regional Study
  - To address regional issues beyond the scope of the pilot projects associated with full-scale ASR implementation
  - Groundwater model and ecological risk assessment underway
  - Results and simulations tied to pilot project cycle testing data
  - Final report due in 2012





Other ASR Projects

- L-63N Canal (Taylor Creek) ASR Project
  - Reactivating a 20-year old system
  - High capacity (10 - 15 mgd) well, completed in the “middle” FAS
  - Petition for a Limited Aquifer Exemption filed with FDEP
  - Begin operation in ~ 2010
- Seminole Bright Reservation ASR Project
  - Partnering with the Tribe, north of Lake Okeechobee
  - Attempting a “passive” treatment process using bank filtration – could serve as both filtration and disinfection

Aquifer Storage and Recovery – Cost Information

Jeff Kivett, Director,
Everglades Restoration Engineering

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CERP LO Aquifer Storage and Recover

- CERP Lake Okeechobee ASR Component
  - 200 ASR wells each 5 mgd
  - Total capacity ~ 1 billion gallons per day
  - Raise or lower the LO stages by about 2.5' in 1 year
  - ASR Systems typically include:
    - 24-inch exploratory well to 1,000 feet below ground surface
    - Dual zone monitor wells or two single zone wells
    - Surface facilities to convey water to and from the source
    - Integrated filtration and disinfection systems
  - ASR Systems typically require:
    - Facility maintenance and personnel time
    - Large amounts of electrical energy
    - Water quality treatment
    - Extensive water quality monitoring

CERP LO ASR - Construction Cost Estimates

- CERP Lake Okeechobee ASR Component
  - 1999 “Yellow Book” estimate - $1.1 billion
    - Hypothetical well with treatment and disinfection
  - 2007 CERP ASR cost estimate - $1.6 billion
    - Intermediate cost estimate with standard inflationary costs
  - 2009 ASR cost estimate - $1.0 billion
    - Based on unit cost for Hillsboro ASR Pilot Project
    - $5.2M per facility with 50 year life expectancy discounted and capitalized to present dollar cost

CERP LO ASR - O&M Cost Estimates

- Lake Okeechobee ASR Component
  - 1999 “Yellow Book” estimate - $TBD
    - Rely on ASR Pilot Projects to determine
  - 2007 CERP ASR cost estimate - $82M/year
    - $410,000 per year for each well
    - Standard inflationary costs
    - Electrical consumption costs
  - 2009 ASR cost estimate - $142M/year
    - $710,000 per year for each well
    - Largest operating costs are electrical power requirements and water quality monitoring
    - $7.1B at 50 years of operation

CERP LO ASR - Risks and Uncertainties

- Regional Study groundwater model may limit full implementation CERP LO ASR
- Ecological Risk Assessment may limit full implementation CERP LO ASR
- Long term operating costs associated with high energy requirements
- FDEP still unresolved as to how to deal with arsenic

Questions??

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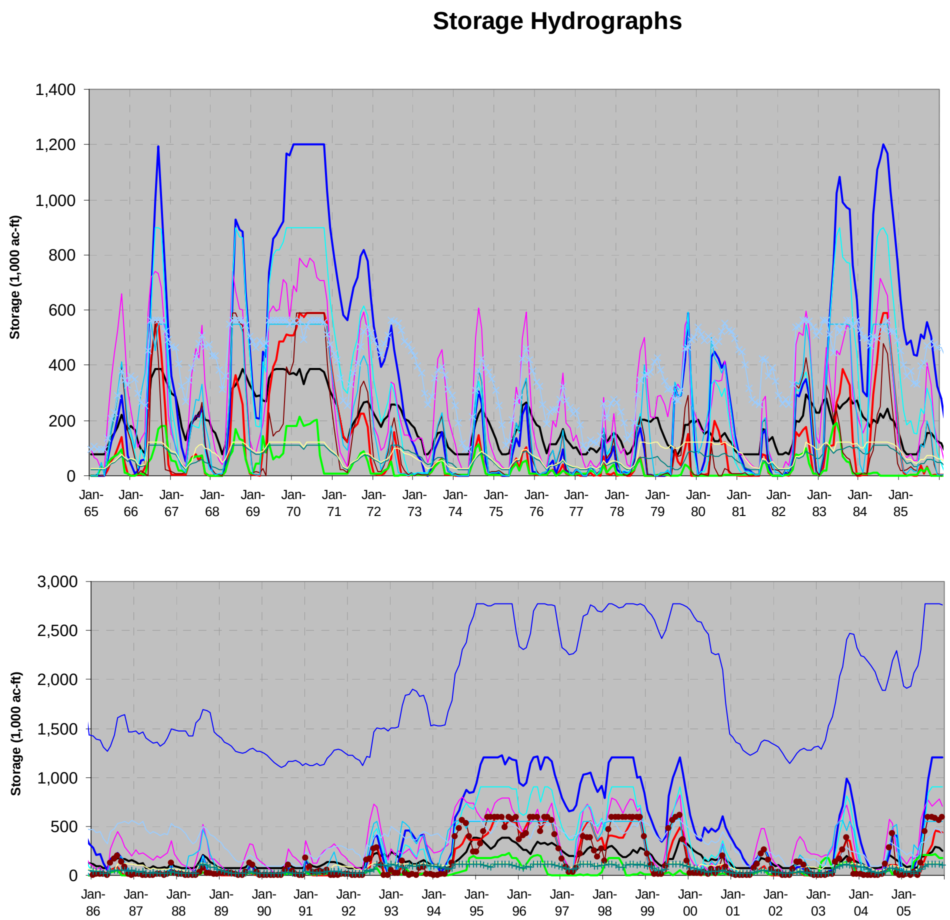
Storage Utilization Information

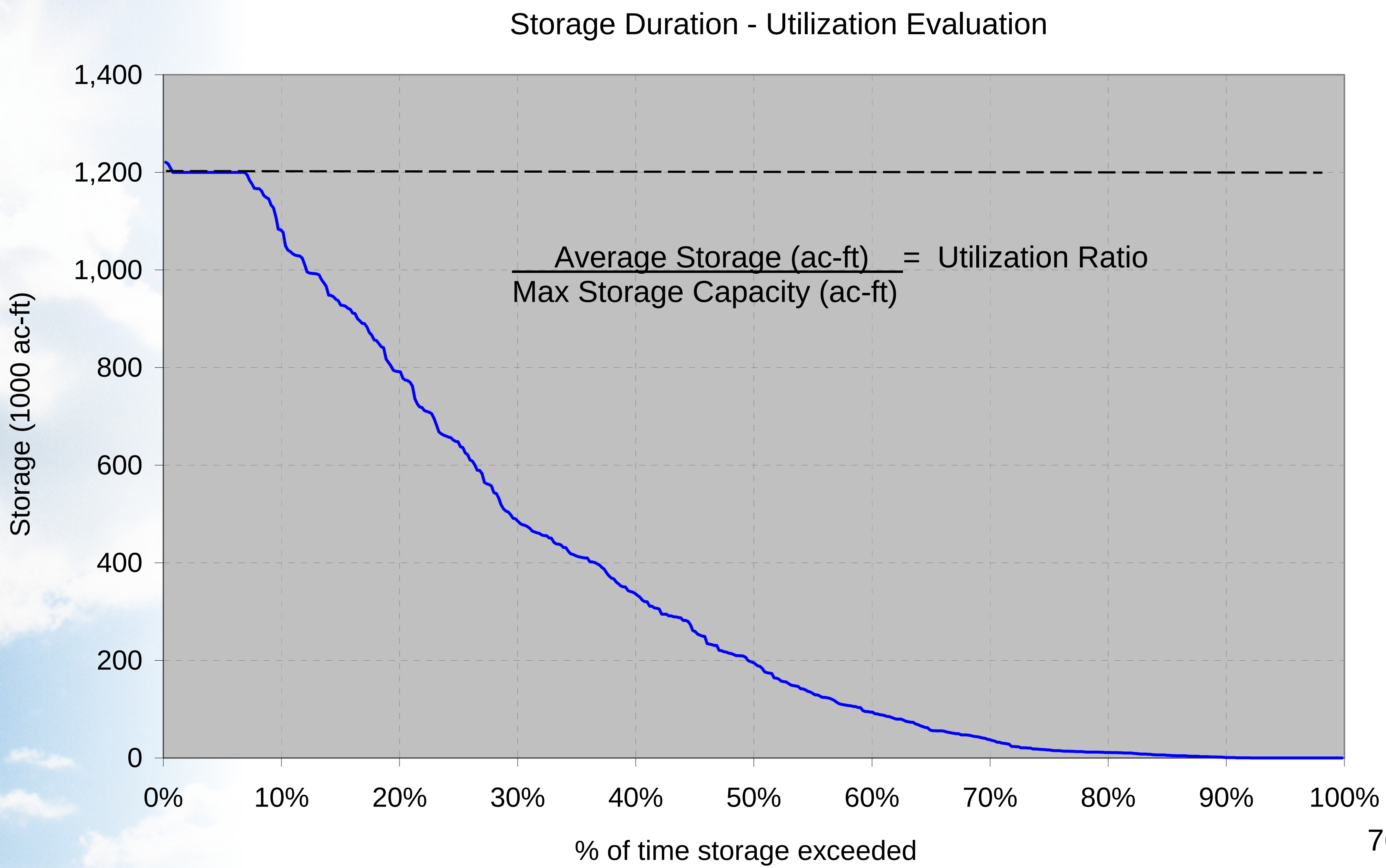
Matt Morrison, Lead Project Manager,
Everglades Restoration Project Planning

Storage Utilization

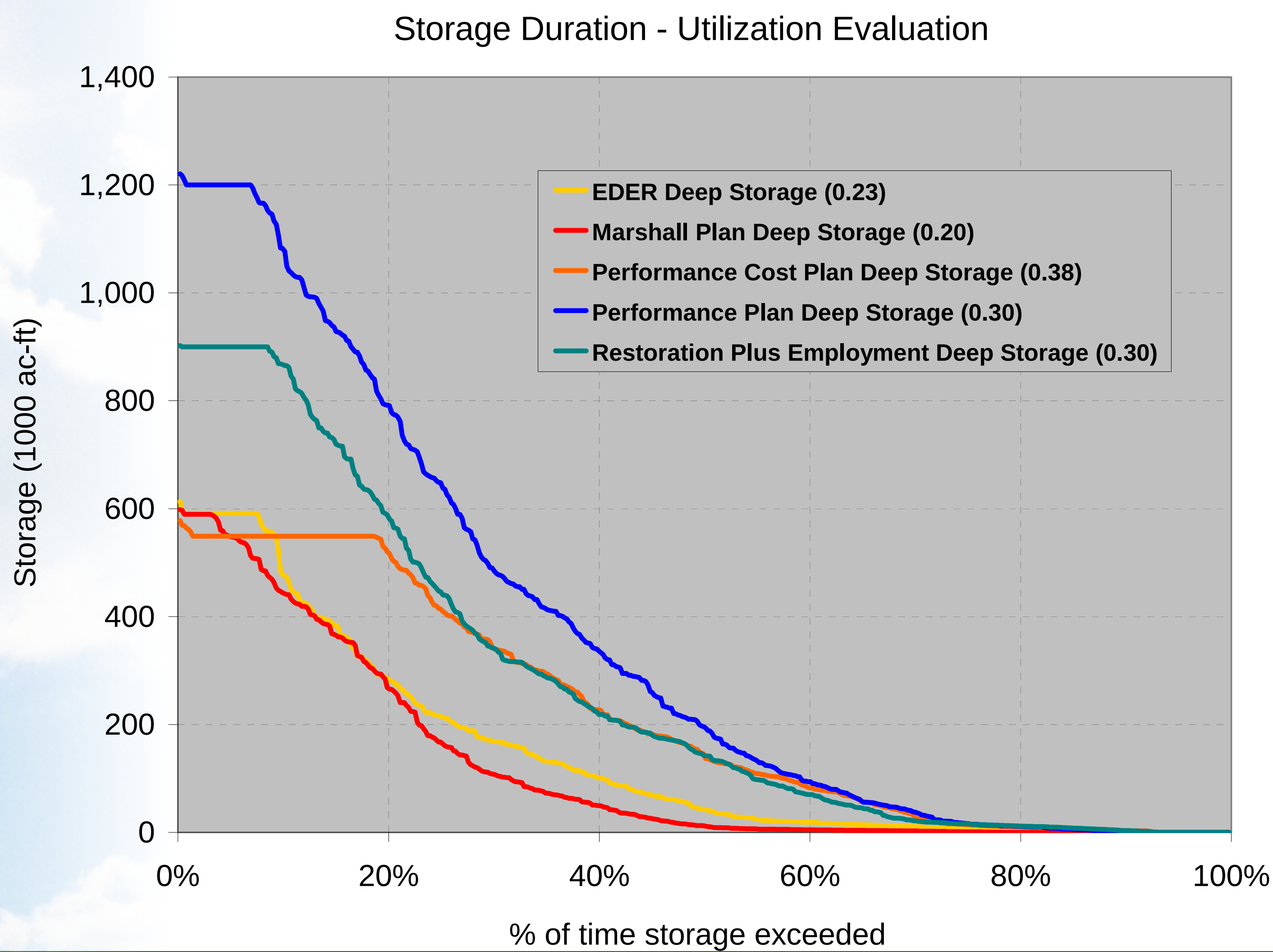
- RESOPS time series data
  - Evaluated storage volume and duration information for deep and shallow storage features for each configuration
  - Provided a utilization ratio by feature type based on the period of record for each configuration



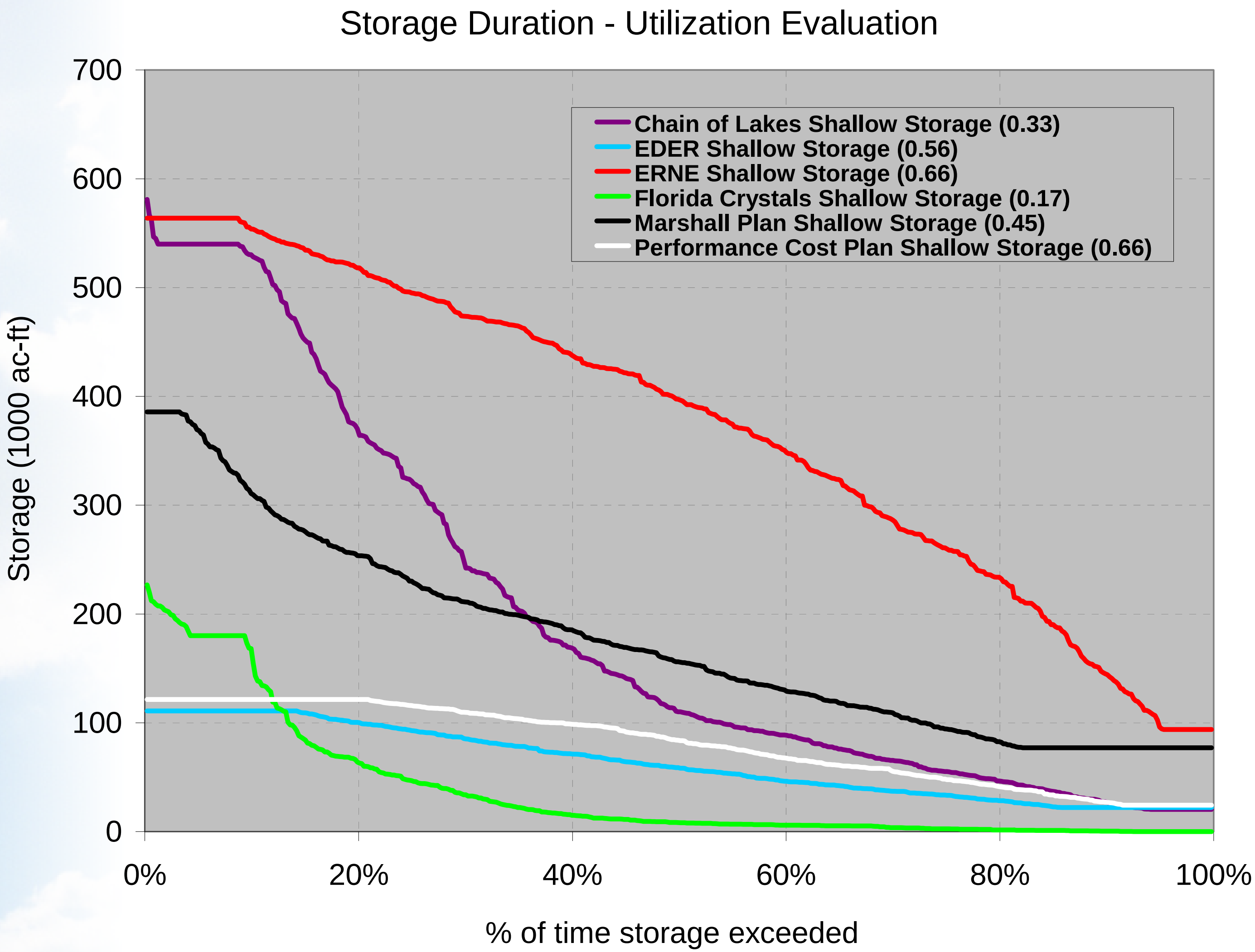
Storage Utilization



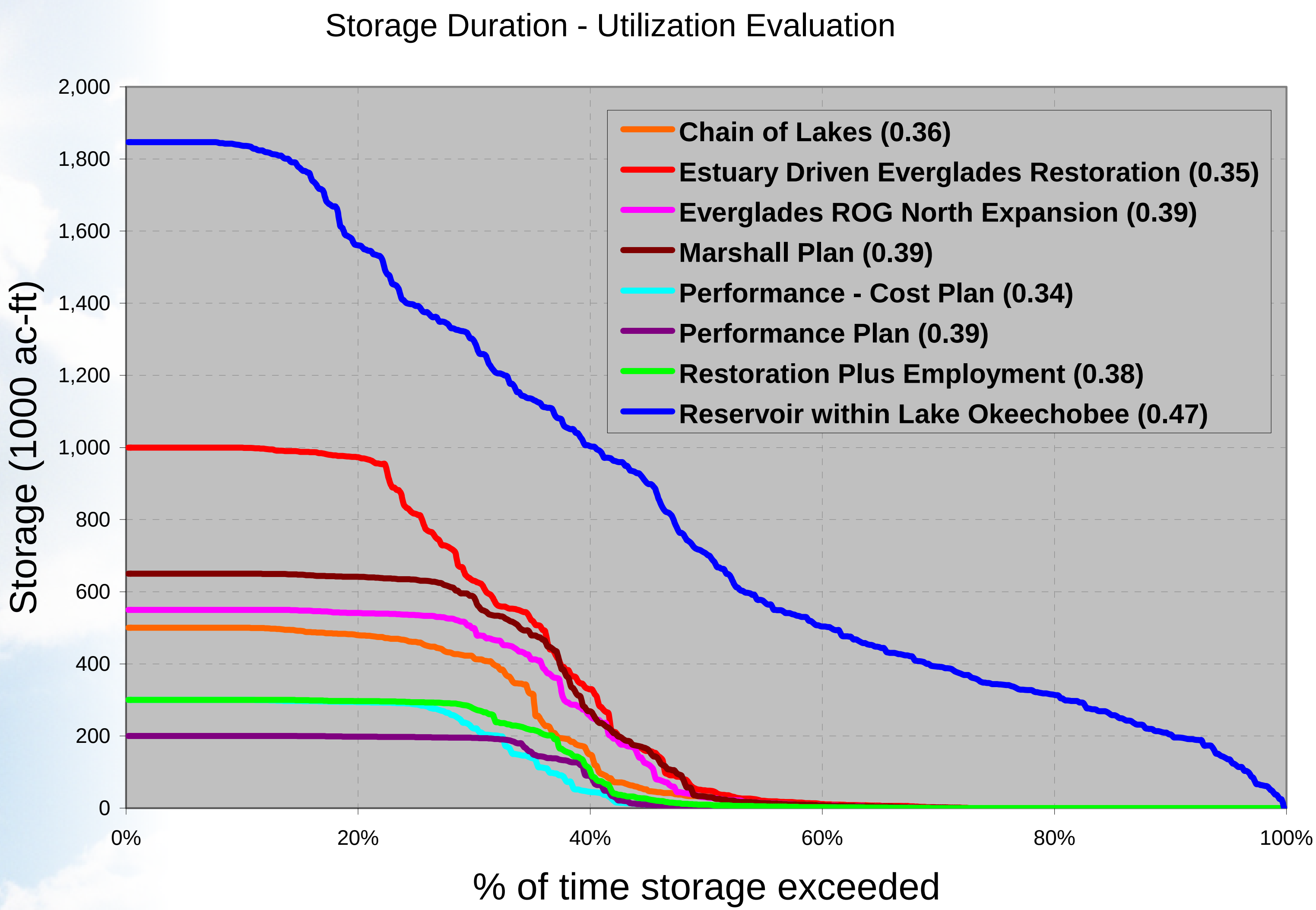
Utilization Ratio - Deep Storage South of LO



Utilization Ratio - Shallow Storage South of LO



Utilization Ratio – Storage North of Lake LO



Summary

- In general, utilization ratios are higher in shallow storage when compared with deep storage
- Utilization ratios are slightly higher in deep storage north of Lake Okeechobee when compared with deep storage south of Lake Okeechobee
- The average utilization ratio is merely an indicator of the hydraulic utilization when compared to total hydraulic capacity, and does not consider ecological benefits
- Further evaluation of utilization ratios, including relationships with benefits, will be further evaluated in Phase II

Questions??

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Generic Storage Cost Evaluation/ Construction Cost Estimate - North vs. South Storage

Sue Ray, Chief Engineer,
Technical Services, Everglades Restoration

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Generic Storage Cost Evaluation

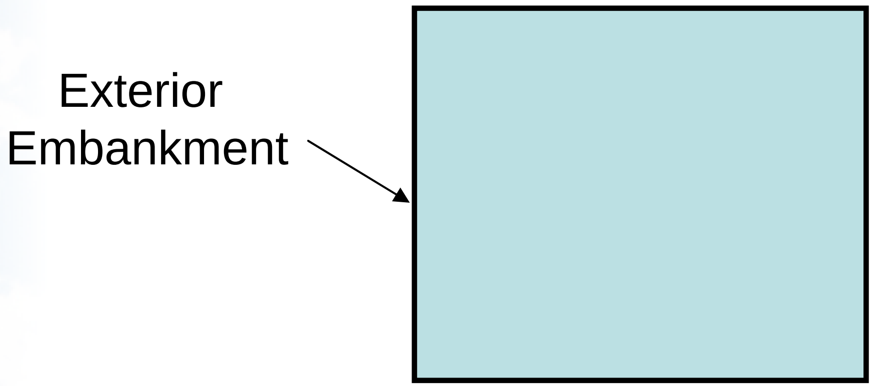
- Evaluation of 9 proposed configurations identified numerous variables that influence the cost evaluation of a storage feature
- Difficult to determine the single factor or combination of factors that drives the cost evaluation process
- Developing a Generic Cost Estimating Access Database that includes these variables with ability to estimate the cost of several storage configurations while holding certain variables constant

Initial Generic Storage Cost Estimating Database Development

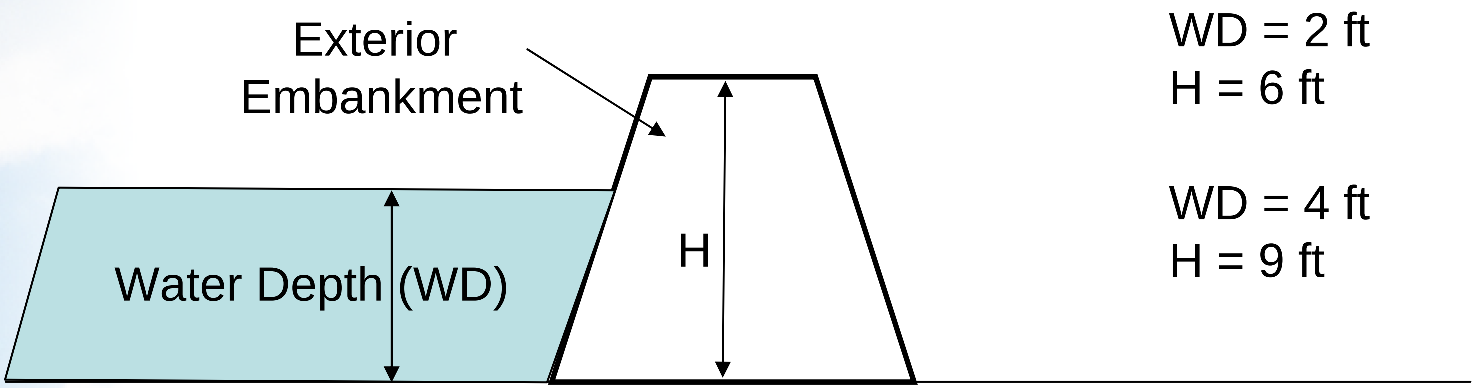
- Shallow Storage – water depth 4 feet or less, unmanaged with no interior compartments
- Deep Storage – interior compartments so that no open water greater than 5 miles long, water depth between 8 and 20 feet, exterior embankments 2 times water depth
- Deep Storage – open water between 5 and 10 miles long, no compartment greater than 200,000 ac-ft of storage, water depth between 8 and 20 feet, exterior embankments 2.5 times water depth
- Storage Capacity varied from 100,000 ac-ft to 1,500,000 ac-ft

Shallow Storage Schematic for Generic Storage Cost Estimating Database

Top View



Exterior Embankment Cross-Section

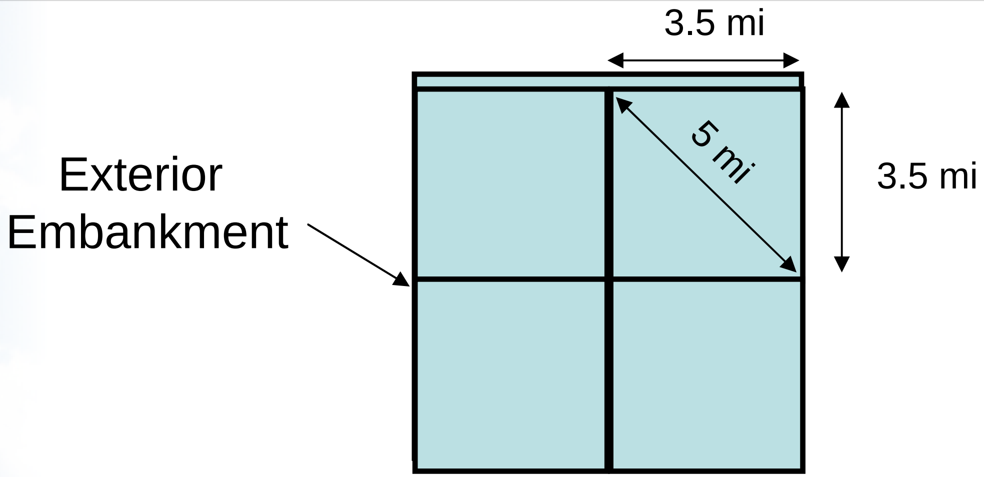


WD = 2 ft
H = 6 ft

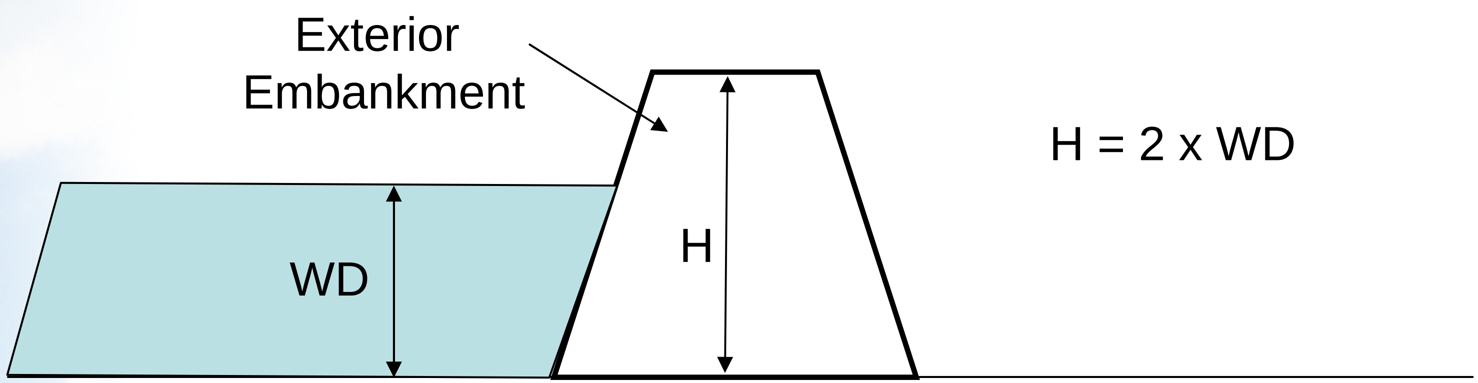
WD = 4 ft
H = 9 ft

Deep Storage Schematic for Generic Storage Cost Estimating Database – Open Water < 5 miles

Top View

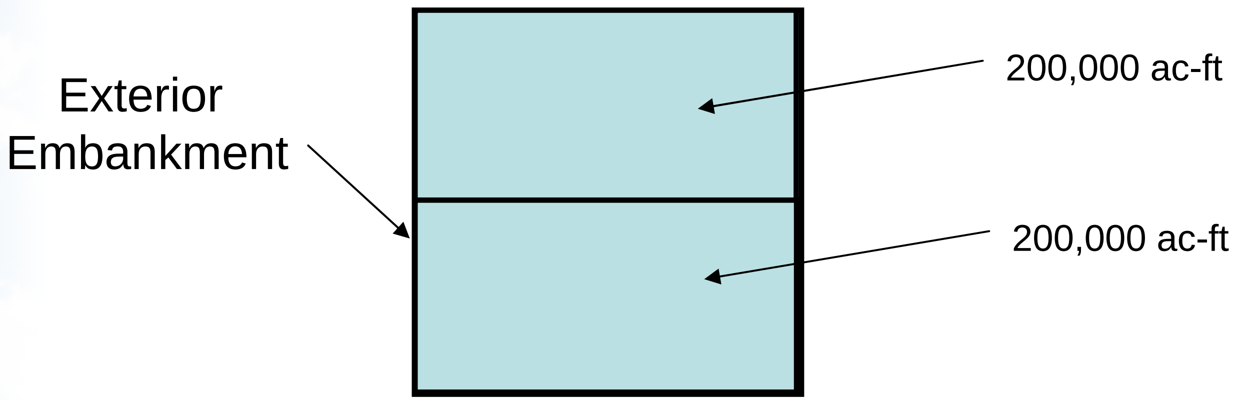


Exterior Embankment Cross-Section

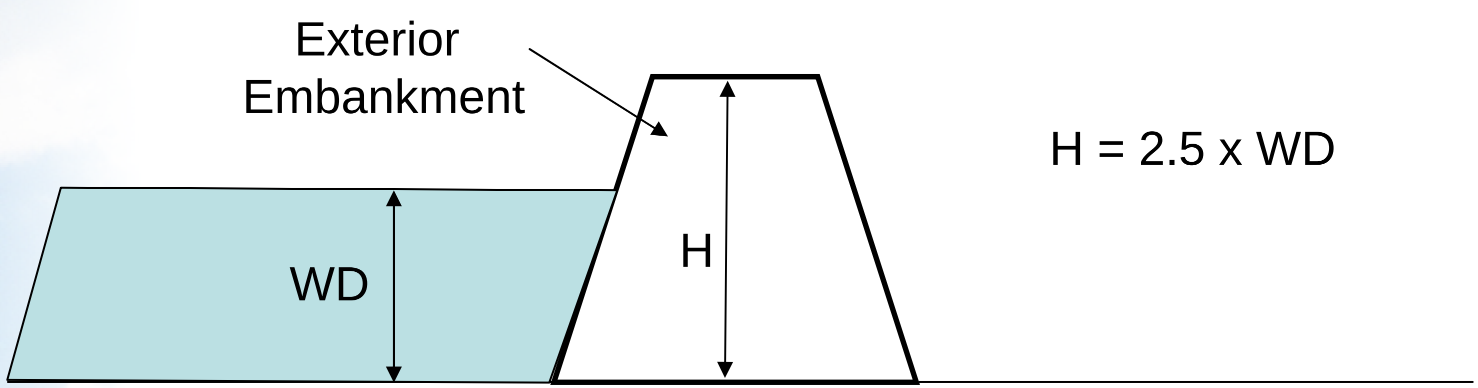


Deep Storage Schematic for Generic Storage Cost Estimating Database – Open Water > 5 miles

Top View



Exterior Embankment Cross-Section

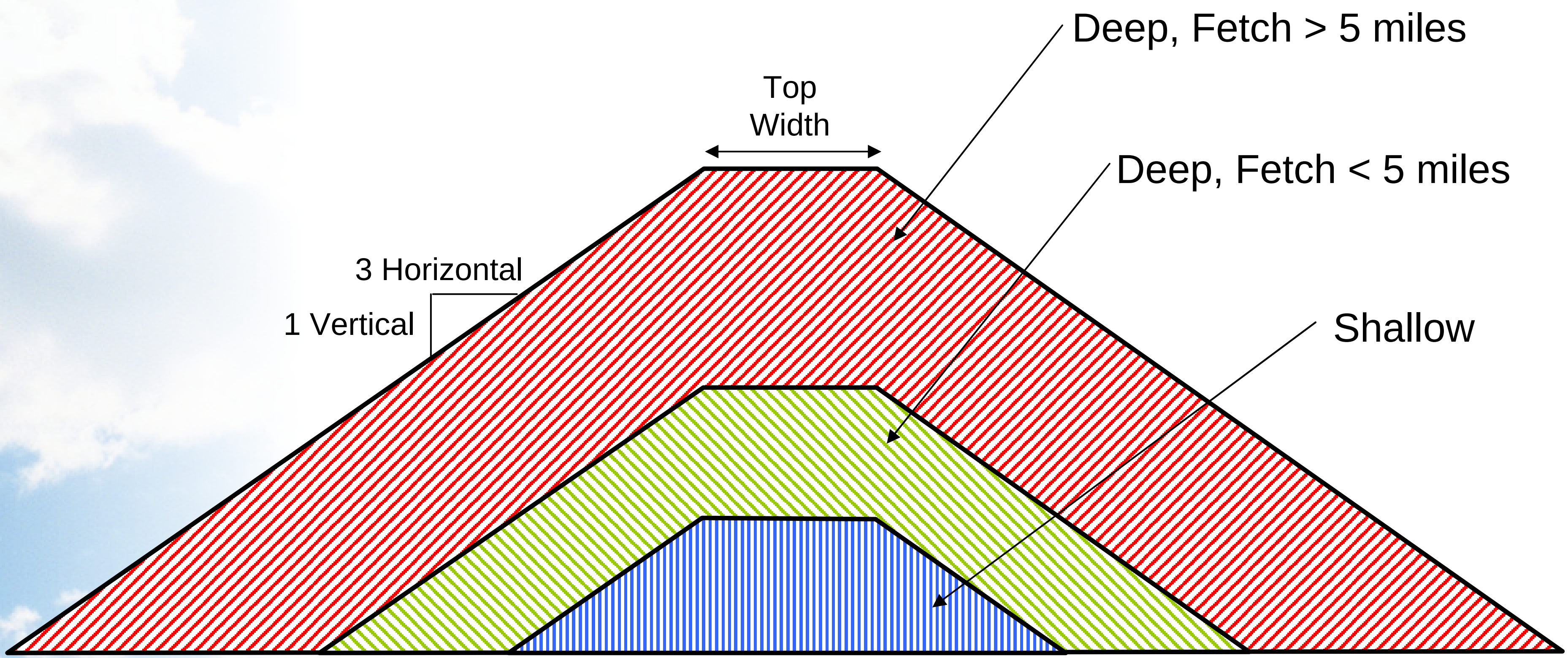


Initial Assumptions for Generic Storage Cost Estimating Database Evaluation

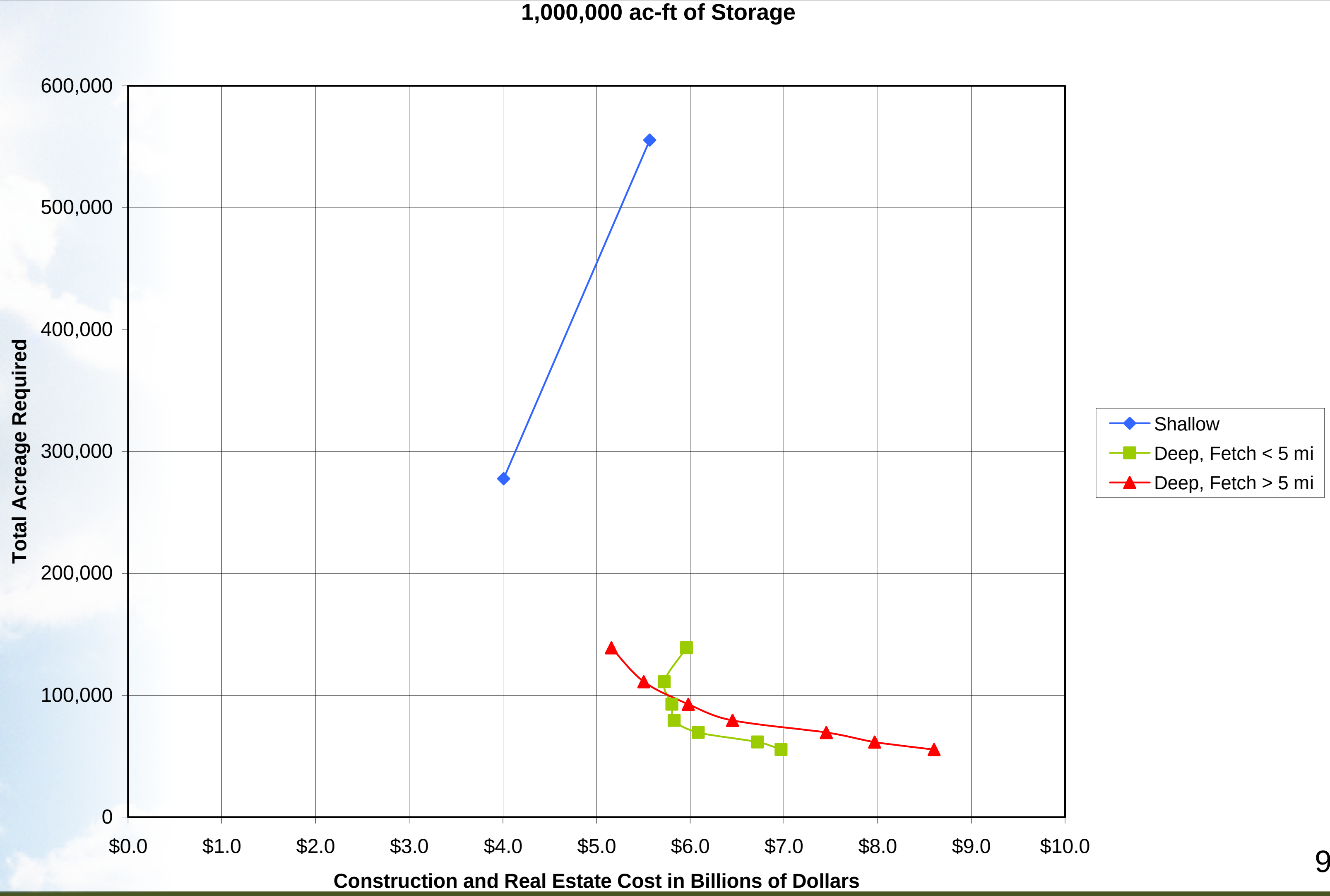
- Storage South of Lake Okeechobee
  - Constant 4 foot muck depth
  - Rock present and blasting required
  - Exterior embankment cutoff wall required for deep storage with depth equal to water depth plus muck depth
- Cost Evaluation includes construction and real estate costs
- Constant geotechnical, geology, and topography conditions
- Assumed square configuration
- All embankment and canal slopes are 3 Horizontal to 1 Vertical
- All interior embankment heights are 5 feet above the water depth
- Constant inflow and outflow capacities

Result of Assumptions for Generic Storage Cost Estimating Database Evaluation

Embankment Volume is the major cost driver



Generic Storage Cost Evaluation – 1,000,000 ac-ft



Generic Storage Cost Evaluation – Preliminary Findings

Most Cost-Effective Storage by Type for a Given Amount of Storage

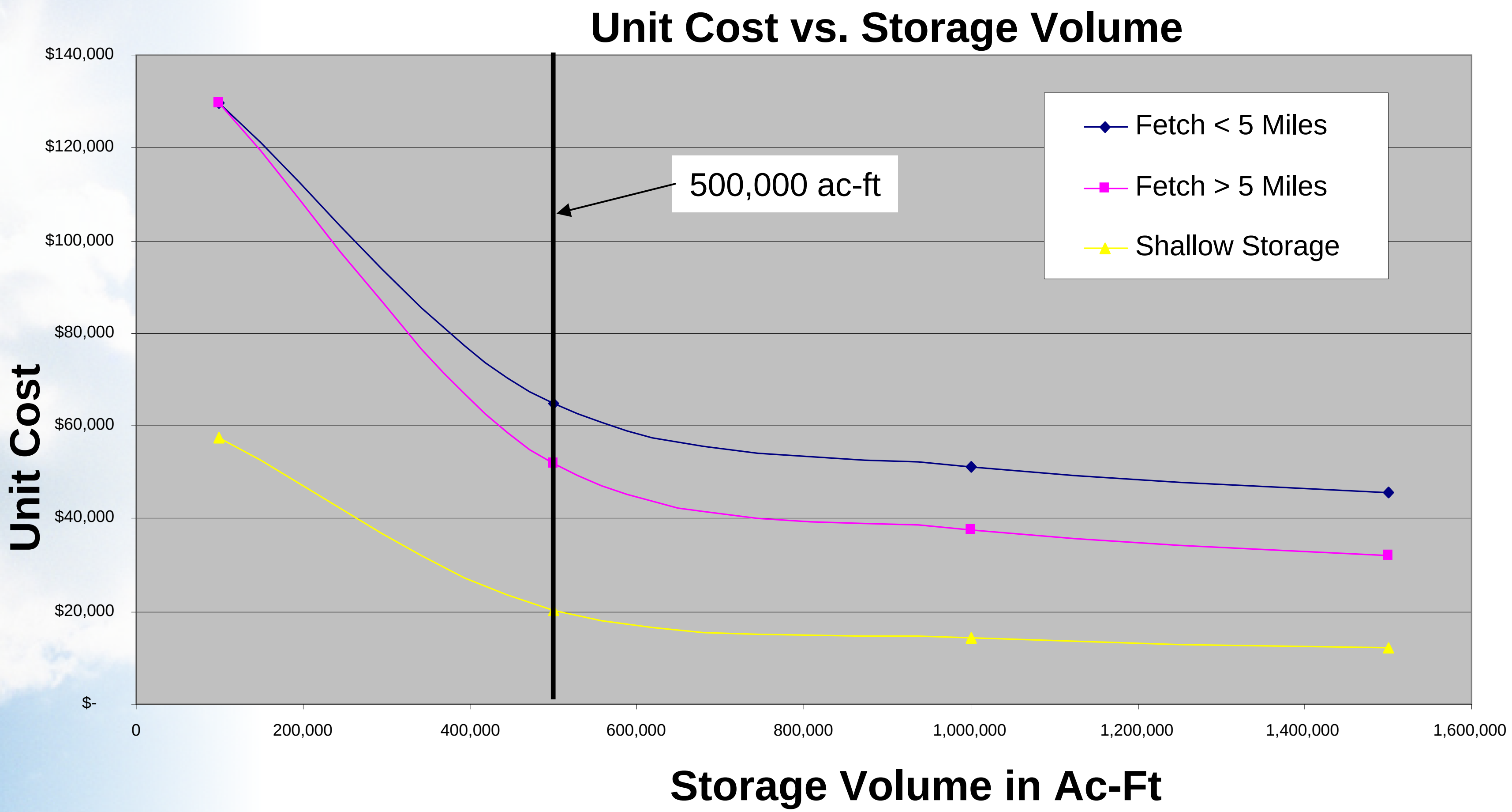
Storage	500,000 ac-ft			1,000,000 ac-ft			1,500,000 ac-ft		
Type	Water Depth (ft)	Total Acres	Total Cost	Water Depth (ft)	Total Acres	Total Cost	Water Depth (ft)	Total Acres	Total Cost
Shallow Storage	4	139,000	$2.8B	4	278,000	$4.0B	4	417,000	$5.0B
Deep Storage, Fetch < 5 miles	10	56,000	$3.6B	10	111,000	$5.7B	12	139,000	$7.6B
Deep Storage, Fetch > 5 miles	8	69,000	$3.6B	8	139,000	$5.2B	8	208,000	$6.7B

Generic Storage Cost Evaluation – Preliminary Findings

For a given storage volume

Type of Storage	Water Depth	Total Cost
Shallow	Increases	Lower
Deep	Decreases	Lower

Generic Cost Storage Evaluation – Preliminary Findings



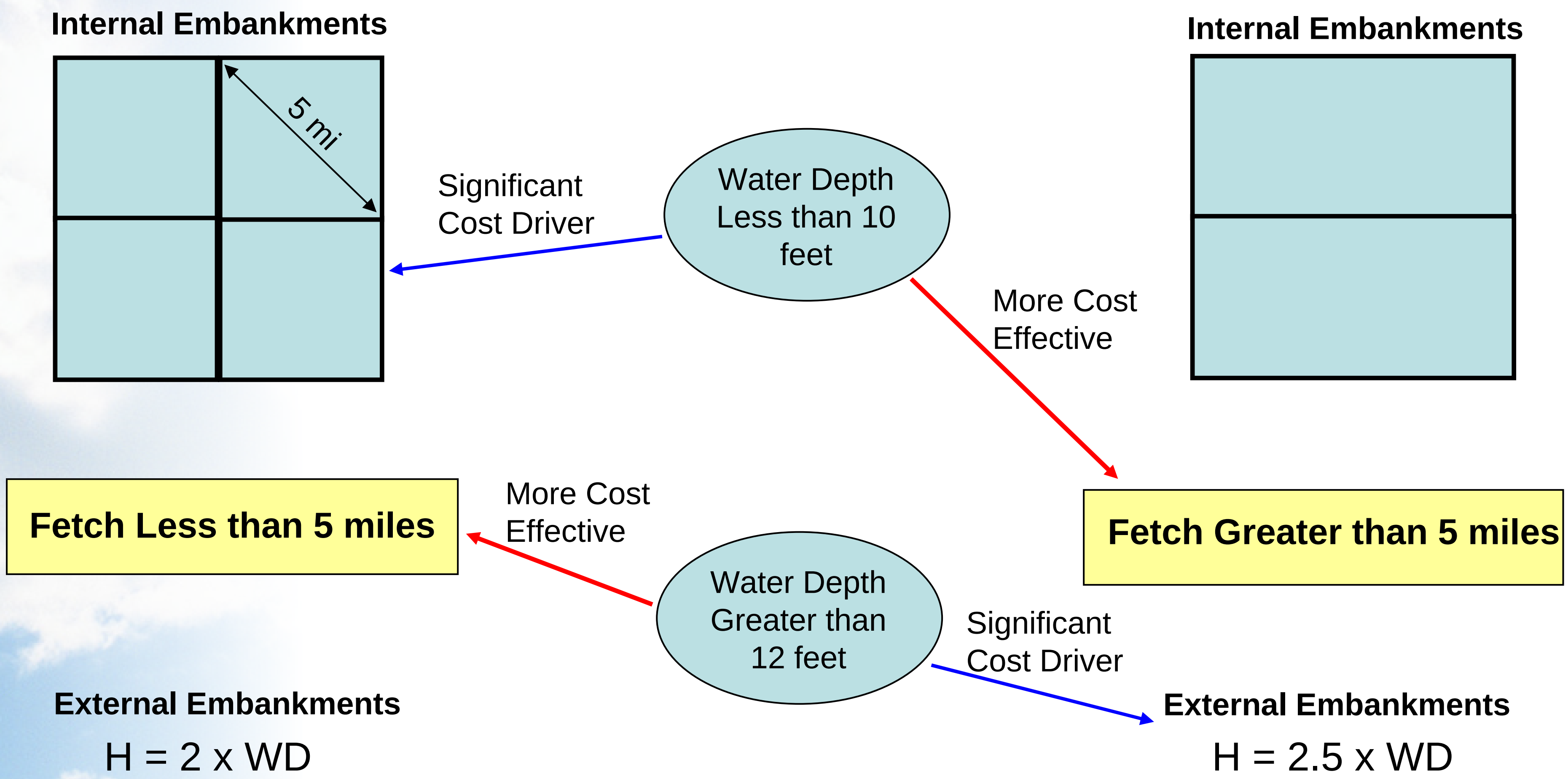
At 500,000 ac-ft of storage for all 3 storage types, there is essentially no additional decrease in unit cost for additional storage – no additional economy of scale

Generic Storage Cost Evaluation – Preliminary Findings

- For the same amount of storage, table provides cost comparison between features with fetch length < 5 miles and fetch length > 5 miles.

Depth	Fetch < 5 miles	Fetch > 5 miles
10 feet or less		Lower Construction Cost
10-12 feet	Equal Costs	Equal Costs
12 feet or more	Lower Construction Cost	

Generic Storage Cost Evaluation – Preliminary Findings



Storage Construction Cost - North vs. South

- North Storage Reservoirs
  - No Blasting
  - No Demucking
  - Material Import required
  - Varying Topography
  - Land Availability ~ Limited
- South Storage Reservoirs
  - Blasting
  - Demucking
  - Material available on site
  - Uniform Topography
  - Land Availability ~ Less Limited

SUMMARY

Assuming similar Reservoirs in both locations the North Storage without Blasting and Demucking should be more cost effective.

With the inclusion of land availability and siting issues and with site specific costs of importing material, the advantage of north storage could be minimized or totally negated.

Factors Not Considered in Generic Storage Cost Estimating Database

- Land Availability –
  - Ability to acquire contiguous blocks of land
  - Timing and sequencing of land acquisition and construction
- Operational advantages and optimization of entire configuration
  - Ability to gravity flow all water downstream utilizing passive fixed structures with higher head discharges from the deep reservoirs (pump water once and allow gravity flow-through features)

Generic Storage Cost Estimating Database – Phase II Planning

- Continue to develop and expand database
- Continue evaluation of findings and trends
- Perform sensitivity analysis by varying parameters previously held constant
- Adapt input values to evaluate generic storage components north of Lake Okeechobee
- As lands are acquired, utilize database to determine most cost effective storage component configuration as one of the evaluation criteria in determining the best utilization of land for restoration

Questions??

Phase II Planning Transition

Temperince Morgan, River of Grass Project Liaison/Northern Everglades Program Implementation Manager

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Transitioning from Phase I to Phase II

- Phase I Planning
  - Valuable screening level exercise
  - Document findings (what seems to work, what trends and relationships do we see, what needs further analysis)
  - Limitations of screening level model and unconstrained analysis
  - Need more detailed modeling and evaluation effort to further refine these findings
- Transition into Phase II for Further Evaluation and Discussion
  - Utilize these findings as starting point for more detailed planning and analysis in Phase II
  - More detailed model and evaluation methodology
  - Consider system constraints
  - Consider phasing and common elements

Phase I Planning

- Developed a better understanding of value systems and perspectives of stakeholders
- Discussed and refined environmental restoration targets
- Used a water budget model (monthly time step) to test ideas and develop better understanding of relationships and tradeoffs between:
  - Northern storage and southern storage
  - Shallow storage and deep storage
  - Performance within different regions of the system

Phase I Planning

- Utilized steady state model to evaluate water quality performance and determine additional treatment needs
- Developed preliminary cost estimates in order to improve understanding of cost drivers and relationships
- Document initial findings/common understandings
- Identify areas requiring further analysis or additional information
- Identify next steps which will allow us to transition from Phase I Planning into Phase II Planning

Initial Findings/Common Understandings

- As discussed at June 18th ROG Issues Workshop during Group Discussion
- As presented in July 1st ROG Issues Workshop staff presentations
- Further discussion during July and August Issues Workshops

Areas Requiring Further Evaluation or Additional Information- Examples

- Impact that constraints within WCAs will have on ability to achieve Everglades hydrological flow targets
- Water quality benefits of flow-ways, forested wetlands, and shallow storage, particularly when subjected to varying hydrologic regimes
- Hydraulics and O&M ramifications of more natural systems (gravity systems or gravity with pump assisted systems)
- Need better understanding of Dispersed Storage (e.g., FRESP) capabilities and costs
- Optimizing design and operation of storage and treatment features to address pulsing
- Utility of ASR to provide base flows to features (maintain wetted condition) and/or to complement storage and treatment feature operations
- Further discussion during July and August Issues Workshops

Phase II Planning

- Further refine Phase I Findings
  - Hydrologic and ecologic connections
  - Best balance of north storage and south storage
  - Determining the best mix of deep storage versus shallow storage
  - Wet footprints versus dry footprints- Use more detailed model to assess tradeoffs for water quality and hydrologic performance
  - Spatial extent of wetlands
- Evaluate Areas Requiring Further Evaluation or Additional Information from Phase I
  - Dispersed Storage/FRESP
  - ASR
  - Hydraulics

Initial Steps Phase II Planning

- Refine hydrologic and ecologic relationships and targets as appropriate
- Identify Phase II modeling toolbox and evaluation criteria
  - Complete model set-up
  - Finalize performance measure/evaluation methodology
- Identify Common Elements
  - Prioritize/decide which features can move first
- Develop Plans of Study for areas requiring further evaluation/additional information
  - Example: potential use of LILA or other site to study flow-way hydrologic and water quality performance

Initial Steps Phase II Planning continued

- Utilize results from Phase II modeling and Plans of Study to reassess or identify:
  - Ability to achieve restoration targets within constrained system
  - Likelihood of resolving/removing constraints; timeframes
  - Regional Robustness/System Wide Tradeoffs
  - Areas of Agreement/Disagreement
  - Phasing Approach
- Develop more detailed Phase II Planning Strategy

Next Meeting/Future Meeting Topics

Temperince Morgan, River of Grass Project Liaison/Northern Everglades Program Implementation Manager

Next Meeting- Date and Location

Next WRAC Issues Workshop

August 4, 2009

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL
10:00 a.m. – 4:00 p.m.

Next Meeting- Meeting Topics

- Discuss Initial Findings/Common Understandings
- Discuss Areas Requiring Further Evaluation or Additional Information

Phase I Planning
Future Meetings and Topics

<u>Future Meetings</u>

(10:00 a.m. – 4:00 p.m.)

- August 20, SFWMD, West Palm Beach
- September 2, SFWMD, West Palm Beach

<u>Future Meeting Topics</u>

- Next Steps for Phase II Planning

Phase I Planning
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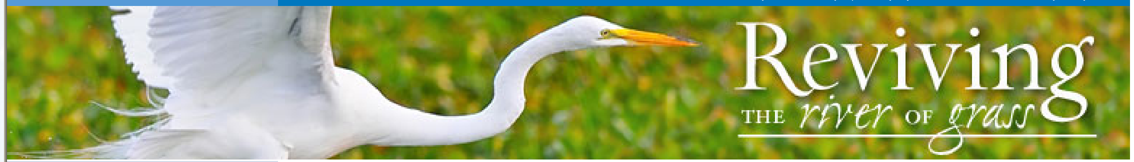

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Restoration Project Planning

On December 16, 2008, the South Florida Water Management District Governing Board voted to accept a contract with the United States Sugar Corporation to acquire more than 180,000 acres of agricultural land for Everglades restoration. This historic transaction provides water managers with the unprecedented opportunity to store and treat water on a scale never before envisioned for the benefit of America's Everglades, Lake Okeechobee and the St. Lucie and Caloosahatchee rivers and estuaries.

With full public involvement, the first phase of *River of Grass* restoration project planning is under way. Through a series of Water Resources Advisory Commission Issues Workshops, the Phase 1 planning process will determine viable configurations for constructing a managed system of water storage and treatment to support ecosystem restoration efforts.

Inform… decisio… plannin…

RELATED MATERIALS

- Public Workshops: Dates, Agendas, Presentations, Minutes
- News, Fact Sheets, Public Information
- Reservoir Sizing and Operations Screening (RESOPS) Model

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