Water Quality Modeling Overview

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

sfwmd.gov/riverofgrass

Presentation Overview

- Planning Objectives and Constraints as related to water quality
- Synchronized hydrologic and water quality modeling with RSM and DMSTA
- DMSTA Modeling Overview

Planning Objectives and Constraints

Objectives:

- Improve Red Line flow volumes and timing to maximize benefits to the Everglades, Lake Okeechobee and the Northern Estuaries
- **Improve the quality of water delivered to the Everglades consistent with the phosphorus water quality standard**
- **Optimize flows and water quality for least cost**

Constraints:

- Minimize economic impacts to local communities
- Avoid adverse impacts to existing legal users
- **Avoid configurations that do not comply with federal or state law**

Potential Planning Groups Based on Feature Type Combinations

- Configuration Planning Groups to be modeled
  - Deep storage reservoirs with STAs
  - Shallow Dry Storage with STAs
  - Shallow Wet Storage With STAs
  - Deep Storage Reservoir and Shallow Storage with STAs
  - Deep Storage within Lake Okeechobee with STAs

Note: Does not preclude use of ASR

Configuration Planning

- Start with 180,000 acres unconstrained by location
- Develop configurations on July 21 and 22
- Teams provide as much detail as possible on water conveyance features, **STA loading**, reservoir sizes, etc.
- Staff will be communicating/clarifying with team leaders over following two weeks
- **SFWMD will model and develop cost estimates and performance evaluation**

Configuration Planning (Continued)

- Will report back to teams on September 23
  - Red Line flows and timing
  - Northern estuaries and Lake performance
  - **Water quality performance**
- **Discuss results and opportunities for optimizing performance**
- **Discuss viability of configurations based on objectives and constraints**
- **Will not remodel at this time**

Phase II Modeling Assumptions

- RSM model will simulate each of the Configurations with common elements
  - River Watershed Protection Plans (RWPPs) east & west
  - Storage north will be defined by ROG teams
    - **Will not model treatment features north of Lake**
  - **Storage, treatment and conveyance features south of Lake to be defined by ROG teams**

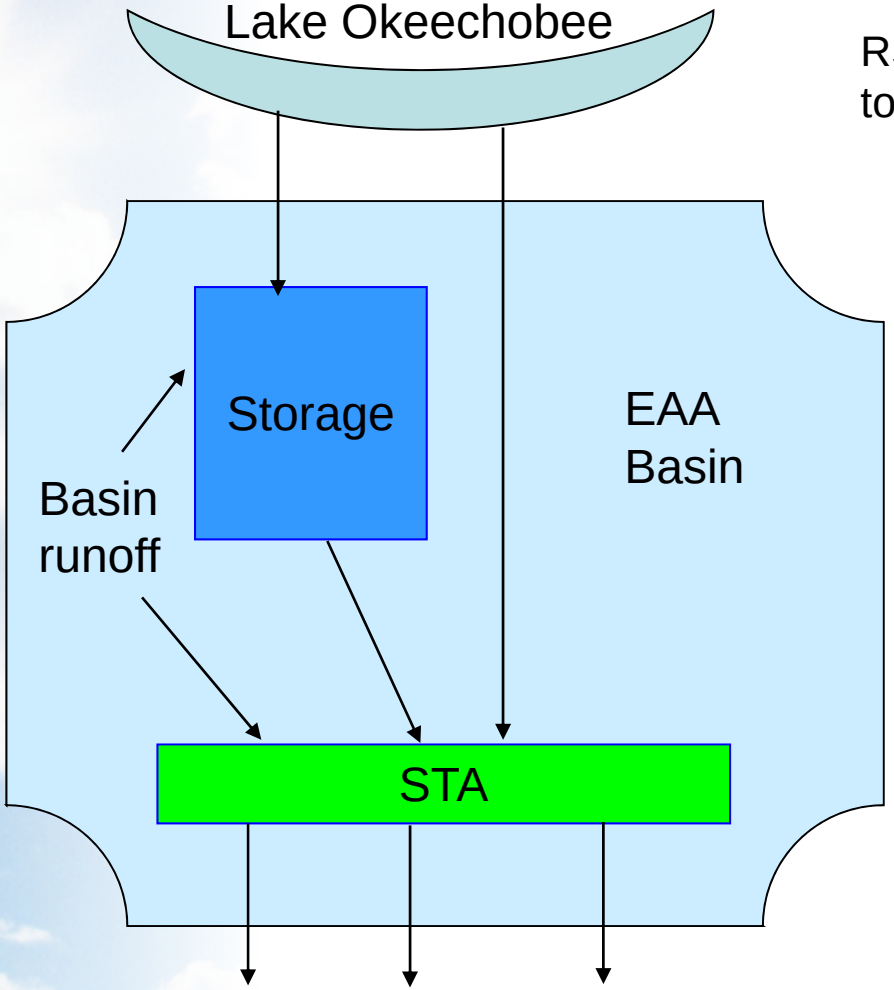
Configuration Planning Common Elements

- Lake Okeechobee operations: LORS 2008
- Caloosahatchee River Watershed Protection Plan in place with approx. 400,000 ac-ft of storage
- St. Lucie River Watershed Protection Plan in place with approx. 200,000 ac-ft of storage
- **Compartments B & C expansions in place. Cannot alter B&C purpose.**
- Up to 900,000 ac-ft of storage north of Lake (planning limit - can be less)

Water Quality Modeling – Overview

- Will evaluate TP performance of reservoirs, flow-ways and STAs
  - Will use daily flow values from regional hydrologic model
  - Will generate daily time series of TP concentrations from contributing sources
- Will use the Dynamic Model for Everglades Stormwater Treatment Area, Version 2 (DMSTA2)
  - Developed by Drs. Bill Walker and Bob Kadlec

Synchronized Hydrologic and Water Quality Modeling



RSM and DMSTA will use common hydraulics to ensure compatibility of results

1. RSM will simulate inflows to storage features

2. DMSTA will simulate TP removal of storage features

3. RSM will simulate distribution to STAs

4. DMSTA will simulate TP removal of STAs

5. RSM will simulate STA outflows

Modeling Considerations

- Will incorporate basin-specific TP concentrations within RSM
  - Distribution to STAs based on phosphorus loads
  - Will try to keep phosphorus loading rates to the STAs below 1 $g/m^2/yr$
- Land area converted from agriculture to storage/treatment will reduce the runoff and phosphorus load, e.g.,
  - Miami Canal Basin
    - ~2.4 AF/yr per acre
    - ~0.3 kg/yr per acre of TP
  - S-5A Basin
    - ~2.1 AF/yr per acre
    - ~0.4 kg/yr per acre of TP

Overview - TP Modeling Using DMSTA

(page 1 of 2)

Model characteristics - specific to each alternative

- Network of features to be modeled – e.g., storage followed by treatment
  - Identify upstream and downstream connections
  - Develop specific input time series of daily flows and TP concentrations for each feature
- Feature Configuration
  - Area – defined by each alternative
  - Input – combination of multiple contributing sources (Lake O., upstream storage, runoff)
    - Daily flow, rainfall and evapotranspiration – from RSM
    - Daily TP concentrations – will use source-specific long-term monthly concentrations

Overview - TP Modeling Using DMSTA

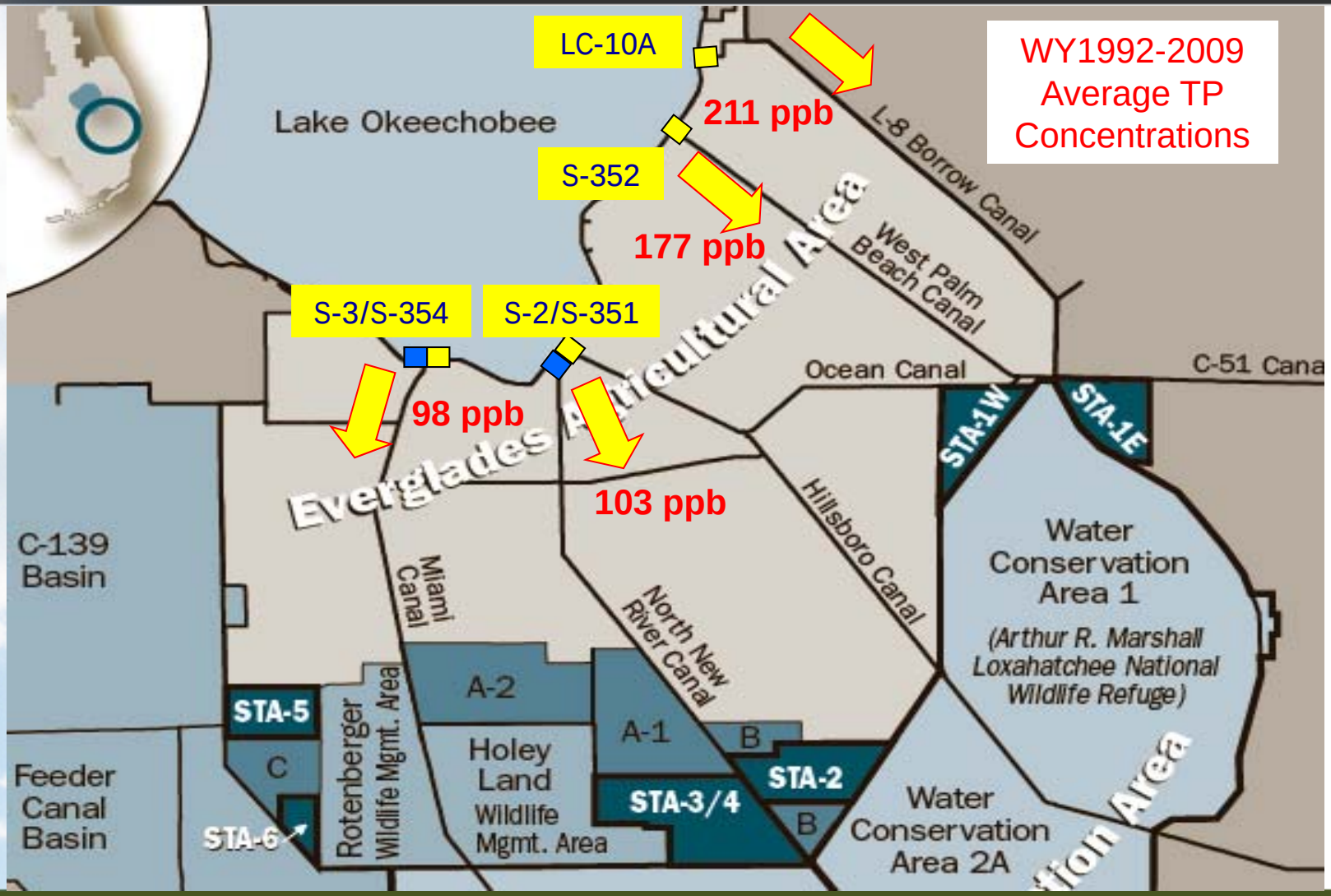
(page 2 of 2)

- Feature Configuration
  - TP removal characteristics available in DMSTA – based on feature type
    - Reservoir
    - Emergent Vegetation
    - Submerged Aquatic Vegetation (SAV)
    - Prior Existing Wetland
    - Periphyton-based STA (PSTA)
    - User-described
  - Physical characteristics – hydraulics, maximum depth, seepage, etc.
- Model Output
  - Extensive water balance summaries, including estimates of bypass (if any), depths, etc.
  - Extensive phosphorus mass balance summaries, including long-term outflow TP concentration, percent removal and uncertainty estimates
  - Comparison of results to DMSTA calibration data sets

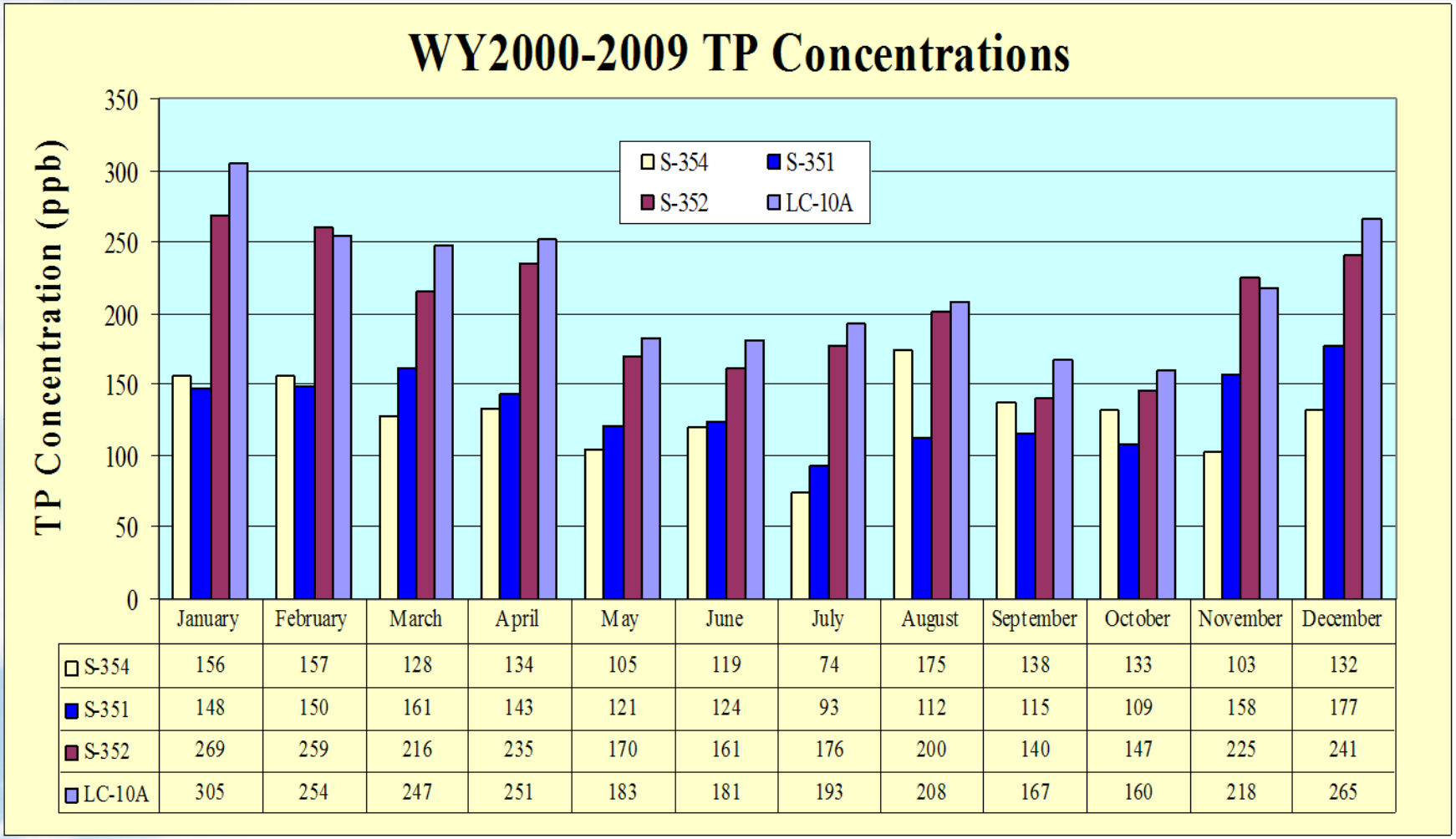
Water Quality Performance – Review

- Relationships: TP removal is sensitive to
  - Hydrologic targets – magnitude and pulsing
  - TP concentrations in Lake Okeechobee releases
  - 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 in flows and TP levels, model predictions

Lake Discharges to the South Exhibit Spatial Variability



Lake Discharges to South Exhibit
Spatial and Temporal Variability: Monthly Averages



	January	February	March	April	May	June	July	August	September	October	November	December
S-354	156	157	128	134	105	119	74	175	138	133	103	132
S-351	148	150	161	143	121	124	93	112	115	109	158	177
S-352	269	259	216	235	170	161	176	200	140	147	225	241
LC-10A	305	254	247	251	183	181	193	208	167	160	218	265

Cumulative flow-weighted mean = 170 ppb

Assumptions for Lake Okeechobee Releases to the South

- Base Assumption:
  - Preserve spatial and temporal variability of WY2000-2009 period
  - Long-term average of approximately 133 ppb (WY1992-2009 average)
- Sensitivity analysis:
  - Lower level: 40 ppb
  - Upper Level: 191 ppb (WY2005-2009 average)

Water Quality Performance

- TP removal is sensitive to the **type of water resource feature**
  - **Deep storage (reservoir) -** Limited long-term TP removal performance data
    - Under ideal conditions, removal of 15-25% may be achieved.
    - Under less than ideal conditions, TP removal may drop significantly.
  - **Shallow storage (flow-ways and other features) –** limited performance data
    - 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, and may export phosphorus following dry out

Water Quality Performance

- TP removal is sensitive to the **type of water resource feature**
  - **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.

Planning Guidelines

- **STAs: To be located in parallel, not series**
  - **Must consider loads to STAs**
  - **Retain function of existing STAs**
- **Large areas that are allowed to dry out will occasionally export phosphorus upon rewetting**
- **ASR has limited flow production capability, but may be a help with keeping features wet**
- **Compartment A is available for configuration planning**

Questions?