Tools for Estimating the Hydrologic Performance of Proposed Conceptual Plans

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Provide an overview of the hydrologic modeling and evaluation tools that will be used to estimate the performance of the alternative conceptual plans for the River of Grass – Phase I Planning effort.
1. Physical System Relationships
2. RESOPS Model Overview
3. Performance Measures/Indicators
4. Tradeoffs and Linkages (examples)
5. Review of Conclusions from 2008 Due Diligence
6. Performance Summary Maps
Wet period flows
Current System (limited storage)
Wet period flows
Future System
(with more storage)
Topics

1. Physical System Relationships
2. RESOPS Model overview
3. Performance Measures/Indicators
4. Tradeoffs and Linkages (examples)
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2008 “Due Diligence” hydrologic assessment required a relatively simple tool for screening a large number of facilities and operations in a short period of time.

Available planning-level simulation tools provide a wealth of information, but can require extensive time to set-up, run, and evaluate.

- Regional Simulation Model (RSM) used for Northern Everglades
- South Florida Water Management Model (SFWMM, aka 2x2) used for 1999 C&SF Restudy and CERP

The REServoir Sizing and OPerations Screening (RESOPS) Model was used as a screening tool for the Northern Everglades Plan in 2007-08.

- Simple, flexible and fast water budget analysis tool developed as an EXCEL spreadsheet application
What is RESOPS?

• Provides rapid screening-level testing of the integrated effects of alternative reservoir sizes and proposed operating rules for...
  • Lake Okeechobee,
  • Northern Everglades Storage
  • EAA Storage
  • C-43 Storage
  • C-44 Storage
  • Flows to the Everglades Water Conservation Areas.

• Performs 41-year continuous simulations (monthly time-step) of the hydrology and operations of the water management system
The strength of the RESOPS Model is its ability to quickly test the performance of alternative configurations and scenarios to screen ideas for further in-depth analysis.

- Not a replacement for the detailed regional models
- Can reduce the burden on the SFWMM and SFRSM

It also includes an optimization routine that can automatically evaluate thousands of operating rules and select the best performer.

- For the 2008 Due Diligence effort approximately 250,000 individual scenarios were tested in 60 days.
What is RESOPS? (continued)

• Input requirements include:
  • Reservoir and treatment area capacities & operations, and Lake Okeechobee operations;
  • Monthly time-series (1965-2005) of rainfall, evaporation, tributary basin runoff, service area demands, estuary water needs.
    • Source of inputs is primarily the SFWMM
  • Everglades water needs
    • Monthly flow target time-series
    • Uncertainty in water needs of the Everglades
    • Multiple flow targets can be tested with RESOPS
• Simulates flows to the Everglades by attempting to meet a flow target time-series at the northern boundary of the Everglades Protection Area (EPA)
  • Users can experiment with alternative time-series, or use a multiplier to simulate what-if scenarios

• Specific benefits or impacts to the Everglades hydropatterns from additional flows cannot be estimated from RESOPS
  • Requires more detailed models such as the SFWMM or RSM to evaluate
Reservoir Sizing and Operations Screening (RESOPS) Model {Version 3.0}

This simple simulation model allows users to quickly test the system-wide effects of alternative reservoir sizes & operations. The intent is to use this tool to screen ideas so as to provide guidance for more-detailed modeling analysis.

SCENARIO MANAGER
- GET INPUT & MAKE ACTIVE:
- RUN ACTIVE TEST & SAVE AS:
- DISPLAY RESULTS:

Time-Series Graphics

Lake Okeechobee
- Duration Curves
- Average Flows
- Water Budgets
- Hydrograph
- StoDuration
- DivDuration

C-44 Reservoir

C-43 Reservoir

Northern Everglades Storage & Treatment

SLE Triggers E Reservoir

St. Lucie Estuary

EAA Storage & Treatment

Future System (with more storage)

C44 Basin Runoff

S308 Regulatory & WS to SLE

C43 Basin Runoff

Other LOSA Water Supply

Avg WS & Cutbacks

T-DryYr WS & Cutbacks

Avg Flow Summary

Flow Distribution

Frequency of High Lake O Discharge

Res to EAA Water Supply

Undiverted EAA Runoff

Diverted EAA Runoff

Res to TA

C-44 Reservoir

Res WS to Glades

Sizing & Operations

DivDuration

Sizing & Operations

North Reservoir

South Reservoir

Everglades Demand Target

Avg Flow Summary

Seasonality of Flows

Annual Variability

Avg Flows Dry Yr

Everglades

Res WS to TA

Res WS to Glades

Treatment Area

TA Sizing & Operations

Hydrograph

StoDuration

DivDuration

S308 Regulatory & WS to SLE

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Other LOSA Water Supply

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DivDuration

Sizing & Operations

North Reservoir

South Reservoir

Everglades Demand Target

Avg Flow Summary

Seasonality of Flows

Annual Variability

Avg Flows Dry Yr

Everglades

Res WS to TA

Res WS to Glades

Treatment Area

TA Sizing & Operations

Hydrograph

StoDuration

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S308 Regulatory & WS to SLE
1. Physical System Relationships
2. RESOPS Model overview
3. **Performance Measures/Indicators**
4. Tradeoffs and Linkages (examples)
5. Review of Conclusions from 2008 Due Diligence
6. Performance Summary Maps
Performance Measures & Indicators

Demonstration

RESOPS Performance Measures and Performance Indicator Review

Performance Measures include:
- Lake O stage envelope, estuary flow distribution, Everglades flow stats, water shortages & others

Performance Indicators include:
- water budgets, hydrographs, duration curves, stats, & others
Stage Envelope Standard Scores measure the degree that the lake stage departs from the envelope. Higher scores mean fewer departures.
RESOPS Strengths and Weaknesses

**Strengths:**
- Can quickly test the integrated effects of alternative reservoir sizes and system operating rules for the region surrounding and including Lake Okeechobee
- Operating rule optimization capability automates development of performance tradeoff curves & maps
- Appropriate for conceptual planning
- Can reduce the burden on the detailed planning models

**Weaknesses**
- Use of RESOPS requires significant understanding of south Florida system hydrology and operations as well as familiarity with Excel
- Impact of additional flows on Everglades hydropatterns cannot be estimated with RESOPS
Next Steps for RESOPS

- Peer Review
- Incorporate improved data sets and time-series for Everglades water needs (based on outcomes from January 2009 Everglades Flow Targets Workshop)
- Additional Model Documentation
- Provide screening-level hydrologic analysis for the 2009 River of Grass - Phase 1 Planning Effort
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The south Florida system is highly integrated, with observably complex infrastructure and operational protocols.

Changing structural and operational features in one geographic area can create benefits and/or impacts throughout the regional system.

RESOPS can help to evaluate the changes associated with different assumed configurations of storage in the Lake Okeechobee vicinity.
Demonstration #1

Lake Okeechobee and the Northern Estuaries

Lake Regulation Schedule Changes w/o Storage
Demonstration #2

Additional Storage Provides System Benefits
Demonstration #3

Everglades Flows Related to Lake Okeechobee Stages
Demonstration #4

Lake Okeechobee Stage Management

Use of Northern Storage
Demonstration #5

Lake Okeechobee and the Northern Estuaries
Regulation Schedule Changes with Storage
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Key Summary Findings

- Increasing the storage size in the EAA generally improves system performance for most of the key performance measures.
- There is generally a range of diminishing returns where additional increases in EAA storage capacity does not result in large performance improvements.
Everglades water needs are uncertain and can heavily influence storage capacity.

Flows to the Everglades can be substantially increased with the addition of EAA storage and treatment.

Timing of flows to the Everglades improves with additional storage.

Year-to-Year (Inter-annual) variability of flows to the Everglades is likely to increase with additional storage.

Meeting dry period needs of the Everglades increases the need for storage.
Percentage Increase in Dry Season Flows to the Everglades with the Addition of Storage South of Lake Okeechobee

Based on RESOPS Screening Analysis of November to May Deliveries During the 1965 to 2005 Period.
Increasing regional water flow to the south from Lake Okeechobee tends to increase the frequency and duration of low Lake stages.

Northern Everglades storage is effective in improving Lake Okeechobee lower stage envelope performance:
- Allows water to be released to Lake Okeechobee to offset low stages in dry periods.

Lake Okeechobee Regulation Schedule modifications need to take into consideration storage added to the system.
**Preliminary Findings - Estuaries**

- Significant reduction in Lake-triggered high discharge events are observed with additional storage/treatment

- Estuary performance is highly sensitive to Everglades needs
  - Larger Everglades needs = better estuary performance
  - Why?
    - Larger Everglades needs lead to more storage facility releases from the south reservoir to the Everglades
    - This frees up storage capacity in the south reservoir to receive Lake releases
    - Fewer Lake Okeechobee regulatory releases to estuaries are needed

- Both North and South storage can be used to effectively meet estuary objectives
Ability of South Storage to Reduce Impacts to Northern Estuaries

Analysis assumes 600 kac-ft of North storage and maintains minimum Lake Okeechobee performance equivalent to Northern Everglades Baseline of SSB = 37 and SSA = 85.

Based on RESOPS Screening Analysis of 1965 to 2005 Period.
Comparison of North Storage and South Storage Needed to Reduce Impacts to Northern Estuaries

The shaded region of the graph represents a range of feasible combinations of North storage and South storage that maintain Lake Okeechobee performance and reduce Lake-triggered high discharge events to the Northern Estuaries by 80% - 95% relative to the current condition.

Northern Everglades plan identified a need for at least 330 kac-ft of North storage.

Analysis maintains minimum Lake Okeechobee performance equivalent to Northern Everglades Baseline of SSB = 37 and SSA = 85.

Based on RESOPS Screening Analysis of 1965 to 2005 Period.
Additional treatment area beyond currently planned STA capacities is required when providing increased flows to the Everglades

- Based on a range of 100 to 200 ppb inflow concentrations and assuming a flow volume of approximately 1 million acre-feet per year, additional treatment area between 12,000 and 45,000 acres may be required.

Evapotranspiration losses in a wetted treatment area can significantly impact the ability to achieve system objectives

- New treatment area design and operational concepts may be needed to optimize water usage for facilities at this scale.
Losses and Water Supply Needs Associated with Assumed Additional Treatment Area

Analysis also indicates that increasing TA size can result in impacts to Lake Okeechobee low stage performance and reductions in flows to the Everglades.

Based on RESOPS Screening Analysis of 1965 to 2005 Period.
Based on the analysis to-date, the proposed acquisition can facilitate additional storage and treatment capacities to provide significant benefits to Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries and the Everglades.

Careful future consideration must be given to potential issues of treatment area management and water depths in the Water Conservation Areas.

The optimal size, capacity, configuration and costs of facilities and the associated operations will be developed through subsequent open, public planning processes.
Additional Information

- For more information on the modeling support of the Due Diligence effort:
  
  Go to www.sfwmd.gov and navigate through the following links:
  
  Everglades – Reviving the River of Grass –
  Governing Board Presentations and Discussions –
  October 2008 update

- Summary paper of Due Diligence effort available at:
  
  http://my.sfwmd.gov/pls/portal/docs/PAGE/COMMON/NEWSR/
  ROG_DUE_DILIGENCE_HYDROLOGY.PDF
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Performance Maps – Preliminary Examples

- Performance Maps summarize thousands of RESOPS simulations and provide a handy tool for:
  - selecting reservoir size needed to meet desired performance
  - illustrating performance trade-offs
- Example maps were developed from 140,000 RESOPS simulations
- Shape of performance surface changes with different assumptions for Everglades needs, reservoir maximum depths, etc.
- Maps have a high potential to guide conceptual design

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% Reduction in Lake-Triggered High Discharges to the Northern Estuaries

Note:
Each of the 400 points used to create this map represents an optimized operation of the corresponding storage configurations. Approx. 350 RESOPS model simulations were performed for each storage configuration.

Preliminary Example

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% Reduction in Lake-Triggered High Discharges to the Northern Estuaries

Preliminary Example

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Percent of Everglades Demand Target Delivered

North Storage Capacity (million af)

South Storage Capacity (million af)

% of Target Delivered
- 95-100
- 90-95
- 85-90
- 80-85
- 75-80
- 70-75
- 65-70
- 60-65
- 55-60
- 50-55

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Questions?