# Methodology for Evaluating Water Quality Performance of Team Configurations

Matt Morrison, Lead Project Manager, Everglades Restoration

# Water Quality Modeling Overview



- Water Quality Modeling Approach
  - Work in concert with RESOPS
  - Capable of quickly evaluating a large number of team configurations
  - Provides feedback on potential treatment performance of configurations
- Steady State Design Model (Kadlec and Knight 1996)
  - Simpler approach than dynamic model (e.g., DMSTA)
  - Strength - efficiently evaluates long-term average performance of a large number of alternatives identified in Phase I Planning
  - Weakness – forecasting short-term dynamic treatment performance and long-term performance of high hydraulic pulses
  - Phase 2 Planning study will include more detailed water quality analyses

# Water Quality Modeling Overview



- Steady State Design Model
  - Previously focused on treatment in reservoirs and STAs
  - Updated to evaluate treatment potential of other features
    - Flow-ways
    - Shallow storage areas
    - Wetlands – Managed Aquatic Plant Systems
    - Lake Technology Ecosloughs
    - Lake Technology Ecoreservoirs

# Water Quality Treatment Assumptions



- Northern Features
  - Did not evaluate features delivering water to LO, being addressed in the Northern Everglades Lake Okeechobee Technical Plan
- Western Features
  - Did not evaluate features delivering water to the Caloosahatchee River, being addressed in the River Watershed Protection Plan
- Water Quality
  - Lake Okeechobee- 40 ppb to 200 ppb
  - EAA current conditions – 87 ppb
  - S5A Basin – 180 ppb
  - S4 Basin – 227 ppb

# Potential Treatment of Other Features



- Reservoirs
  - Inherent uncertainty of water quality performance - established a range
  - With treatment - using data from Florida lakes
  - Without treatment – due to dry out and other factors
- STAs
  - Based on the best performing STA (STA-3/4)
  - 13-23 ppb, continuing efforts to improve performance

# Potential Treatment of Other Features



- Flow-ways
  - High uncertainty in predicting performance
  - Minimal vegetation or operational management
    - Less treatment compared to STA
  - May not be able to sustain a long-term positive phosphorus removal if allowed to go dry
  - If optimal treatment is preferred then flow-way will need to remain wet
    - RESOPS calculates the supplemental water needed to keep hydrated
    - May have an impact on meeting downstream hydrologic targets
- Shallow storage areas
  - For preliminary estimate of performance, evaluated as a flow-way

# Potential Treatment of Other Features



- Wetlands – Managed Aquatic Plant Systems
  - Forested wetlands
    - Anecdotal information that outflows were 40 ppb, however, inflows from Lake may also have been 40 ppb, so treatment is uncertain
    - Recent scientific literature (Ewel and Odum 1986, Kadlec and Wallace 2009)
      - Mixed results, including die-off, export of TP, minimal treatment
    - Although trees have aesthetic and wildlife habitat value, from the limited performance data available, a specific phosphorus removal cannot be assigned for forested wetlands
  - Non-forested wetlands – dominated by marsh vegetation
    - Evaluated as a flow-way

# Potential Treatment of Other Features



- Lake Technology Ecosloughs
  - High uncertainty in predicting performance
  - Evaluated as a flow-way
- Lake Technology Ecoreservoir
  - High uncertainty in predicting performance
  - Evaluated as a reservoir

# Water Quality Treatment Results



Configuration Example - Includes Reservoirs, Flow-ways, STAs, Wetlands Management Area

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | |
| 80 ppb | |
| 100 ppb | |
| *150 ppb | |
| 200 ppb | |

* Concentration specified by team during configuration development

# Questions?

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# Phase I Planning – Preliminary Results for Team Configurations

Tommy B. Strowd, P.E.
Asst. Deputy Executive Director, Everglades Restoration

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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 (You are here)
  - Evaluation of Relationships, Tradeoffs, Other Considerations
  - Discuss Viable Concepts/Features and Common Elements
  - Discuss Concepts for more Detailed Analysis
  - Utilize Analysis to Support Decision Making for Concepts in Phase II Planning

# Planning Process- Evaluation of Stakeholder Team Configurations



- June 2nd
  - Provide Preliminary Results and Planning Level Cost Estimates
  - Perspectives Regarding Review of Results and Evaluation of Relationships, Tradeoffs, etc.
- June 18th
  - Breakout Sessions with Evaluation Teams/Technical Staff for Q&A and Discussion re: Preliminary Results
  - Group Discussion - Initial Thoughts on Lessons Learned, Relationships, Tradeoffs, Other Considerations

# Planning Process- Evaluating Relationships and Developing Refined Concepts



- After June…
  - Evaluate Relationships
    - Tradeoffs between Benefits, Impacts, and Costs for -
      - Different Types of Features
      - Within Various Portions of the System
  - Discuss Viable Concepts/Features and Common Elements
    - What features are fundamental/common to all plans?
    - What features show promise but require more detailed information or a greater understanding?
    - What features show less promise?
    - Other considerations
  - Discuss Concepts for more Detailed Analysis

# Preliminary Results for Team Configurations

sfwmd.gov/riverofgrass

# Phase I Planning
## Symbols in Configurations



| | |
|---|---|
| SD | Storage – Deep – Above Ground (Reservoir, Major Impoundment) |
| SS | Storage – Shallow (Minor Impoundment) |
| FTS | Flow-ways – Managed for Conveyance, Treatment & Storage (dark green – wet year round; light green – allowed dry) |
| LT | Lake Technology Ecoreservoir Lake |
| $LT_E$ | Lake Technology Ecoslough |
| DS | Storage – Dispersed |
| STA | Stormwater Treatment Area |
| WM | Wetlands – Managed Aquatic Plant Systems |

# Estuary Driven Everglades Restoration

Mark Perry, Ted Guy, Rae Ann Wessel, Pete Quasias, George Jones, Paul Millar, Rob Loftin

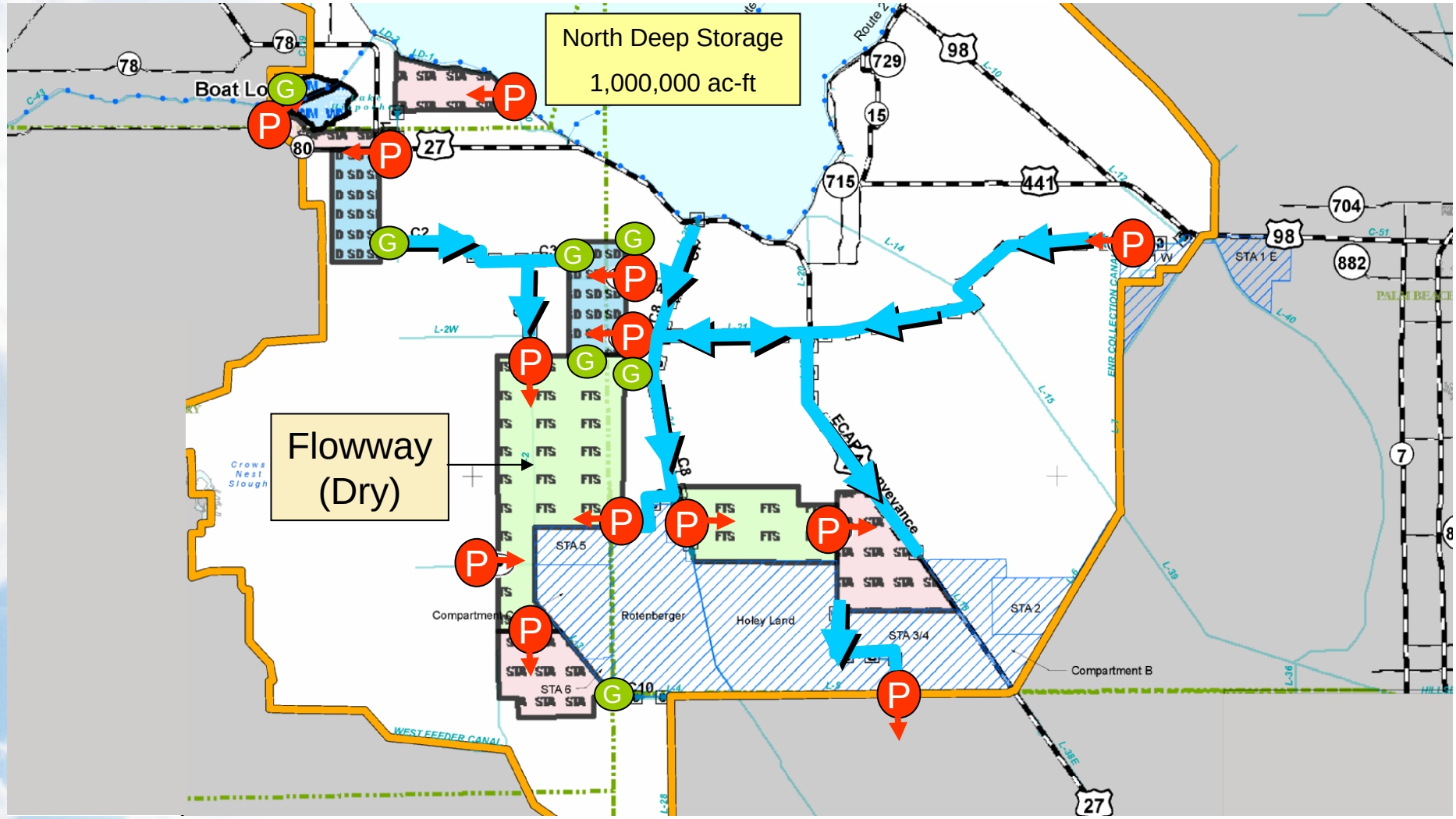


- Utilize the performance charts to achieve large reductions in Lake-triggered high discharges to the northern estuaries while maximizing storage north of Lake Okeechobee and maximizing storage and conveyance features south of Lake Okeechobee to meet the Caloosahatchee minimum flow level and dry season Everglades demand targets.

# Estuary Driven Everglades Restoration

## Conceptual Configuration- Map





# Estuary Driven Everglades Restoration
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 95% | 96% (3 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | 87 | 83 |
| Everglades- Demand Target (Std Score) | 29 | 93 | 98 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | 95 | 98 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | 380 | 548 |

# Estuary Driven Everglades Restoration

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Flow-ways, Reservoirs, Deep Storage, Shallow Storage, Wetlands Management Area

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 0 - 1,600 |
| 100 ppb | 0 - 3,000 |
| 150 ppb | 700 - 9,200 |
| *200 ppb | 2,900 - 14,300 |

* Reflects concentration utilized by team during configuration development

Includes additional treatment area for S-4 Basin

# Everglades River of Grass Northern Expansion

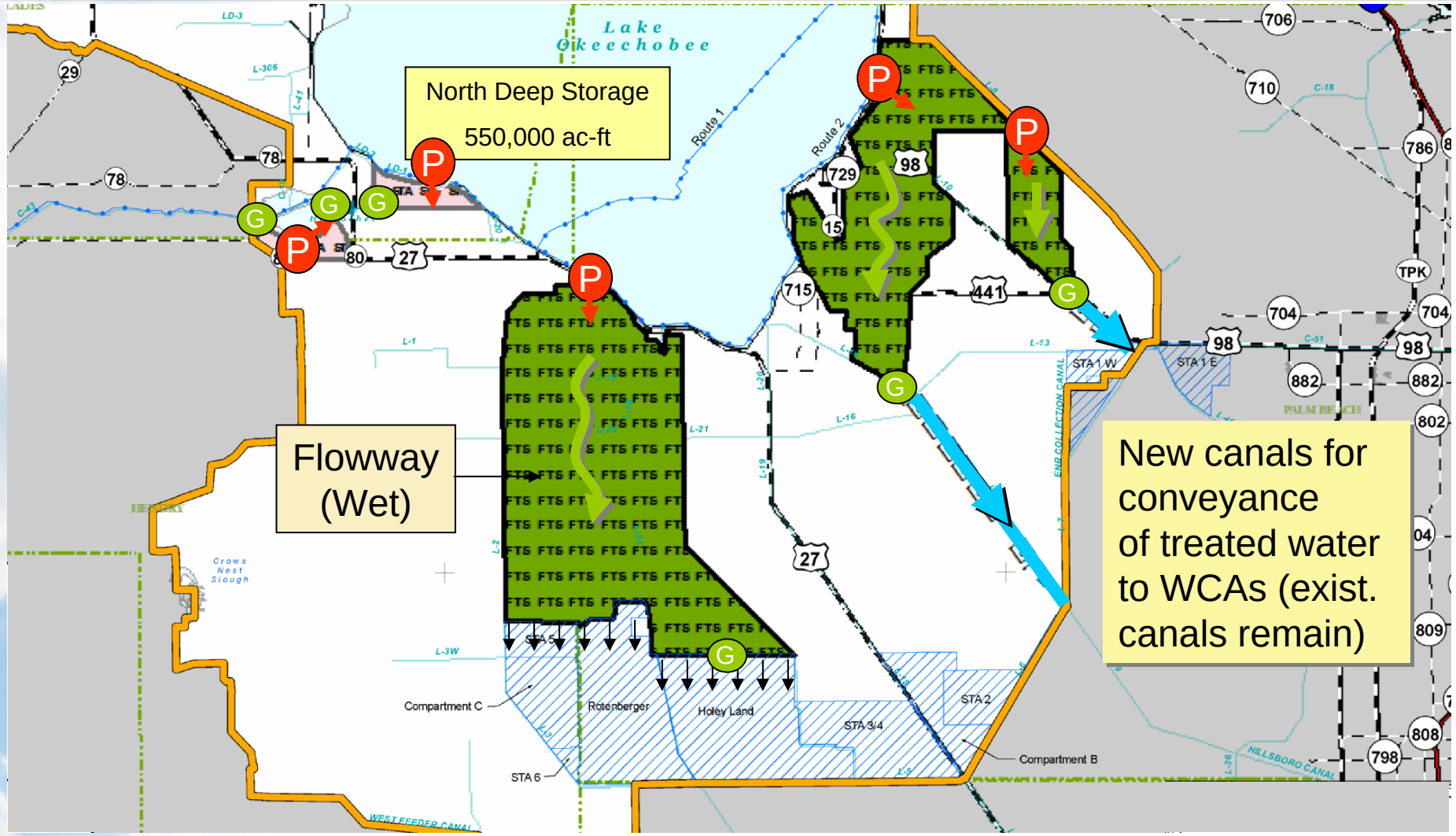
Drew Martin, Bret Harquitz



- Utilize natural, vegetated flow-ways to store and treat water prior to discharging into the Everglades. Mimic historic sheet flow as much as possible.
- Provide storage north of Lake Okeechobee to reduce harmful discharges to the estuaries and help maintain environmentally healthy lake levels.
- Provide STA's at Lake Hicpochee and Disston Island in order to improve water quality in the Caloosahatchee River.

# Everglades River of Grass Northern Expansion
## Conceptual Configuration





# Everglades River of Grass Northern Expansion

## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | NS | 77% (19 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | NS | 80 |
| Everglades- Demand Target (Std Score) | 29 | NS | 83 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | NS | 80 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 221 |

# Everglades River of Grass Northern Expansion

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Reservoirs, Flow-ways, New Canals, Deep Storage, Shallow Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 2,900 |
| 80 ppb | 2,900 |
| 100 ppb | 2,900 |
| 150 ppb | 2,900 |
| 200 ppb | 2,900 |
| No concentration specified by team during configuration development | |

# Chain of Lakes

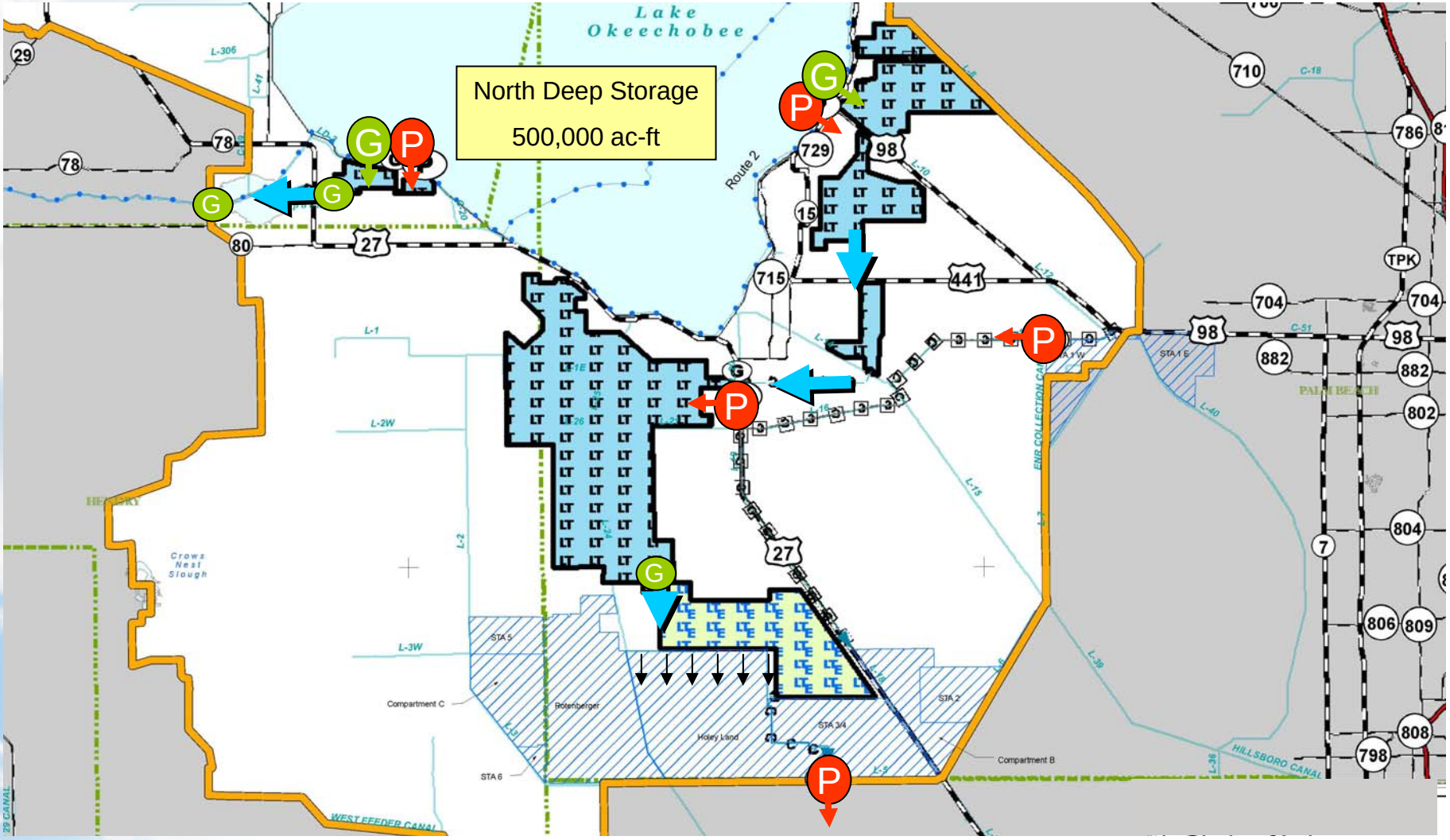
**Forest Michael**



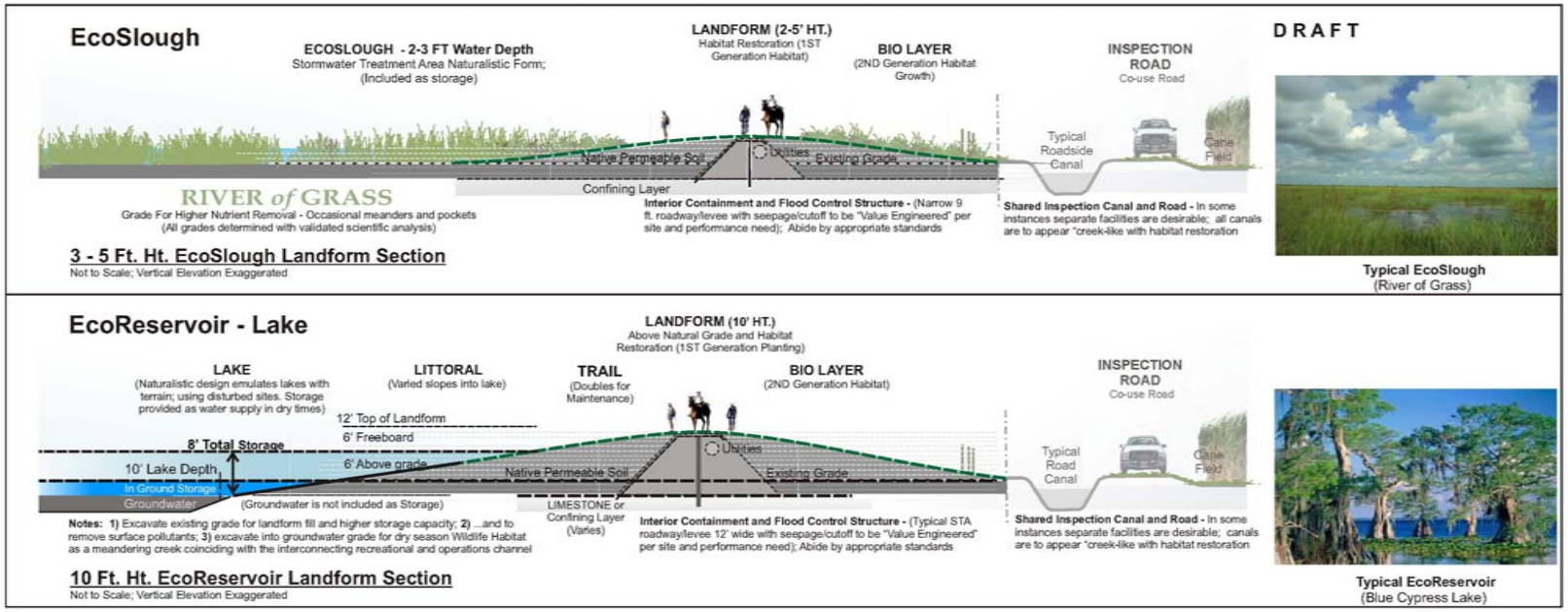
- Utilize above-ground water storage and treatment features intended to mimic a natural setting to a greater degree than CERP Standard Reservoirs and STA's. 12:1 vegetated variable side slopes are utilized to provide more natural aesthetics.
- Features are intended to be open for recreational uses such as hiking, angling, birding and hunting. An increase in storage of water for Everglades deliveries and decrease in harmful discharges to estuaries is expected, although no specific targets for these parameters are dictated by this configuration.
- Provide storage north of Lake Okeechobee to reduce harmful discharges to estuaries and help maintain environmentally healthy lake levels.
- Provide storage at Disston Island to further reduce harmful discharges to the Caloosahatchee River.

# Chain of Lakes
## Conceptual Configuration



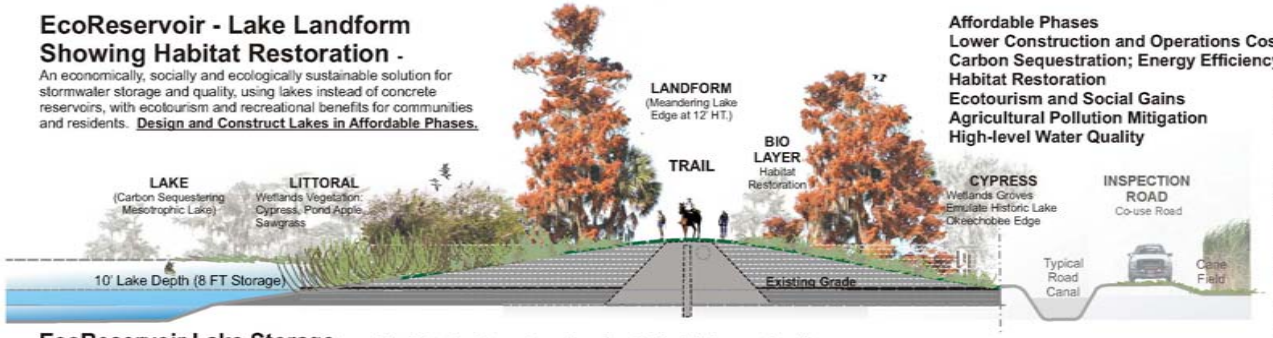


# Chain of Lakes
# Landform Sections




## EcoReservoir - Lake Landform Showing Habitat Restoration -

An economically, socially and ecologically sustainable solution for stormwater storage and quality, using lakes instead of concrete reservoirs, with ecotourism and recreational benefits for communities and residents. **Design and Construct Lakes in Affordable Phases.**




**Affordable Phases**
**Lower Construction and Operations Costs**
**Carbon Sequestration; Energy Efficiency**
**Habitat Restoration**
**Ecotourism and Social Gains**
**Agricultural Pollution Mitigation**
**High-level Water Quality**

**EcoReservoir Lake Storage -** provides 8' of water storage in configurations that include large and small areas where local infrastructure segments the landscape. Provides greater than 50% of the storage of larger 15' depth concrete reservoirs and substantially less cost and more tourism benefits including flood protection. The design allows the containment of the top 2 feet of polluted agricultural soil within the landform and associated areas.

**River *of* Grass Planning**
**Chain of Lakes Alternative**

Prepared April 2009 for the South Florida Water Management District, Public Participation Process

**Landform and Storage Sections Conceptual for Analysis**

Contact:
Forest Michael, Planning and Landscape Architecture
michaelplanning@gmail.com

Design uses the EcoReservoir (Lakes) Program
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# Chain of Lakes
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | NS | 94% (6 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | NS | 80 |
| Everglades- Demand Target (Std Score) | 29 | NS | 93 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | NS | 91 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 490 |

# Chain of Lakes

## Benefits- Water Quality



Configuration Proposal Includes: Deep Storage, Shallow Storage, Ecoslough

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 10,100 - 10,700 |
| 80 ppb | 10,100 - 18,000 |
| 100 ppb | 10,100 - 22,600 |
| 150 ppb | 10,100 - 32,000 |
| 200 ppb | 11,600 - 37,200 |
| No concentration specified by team during configuration development | |

# Florida Crystals

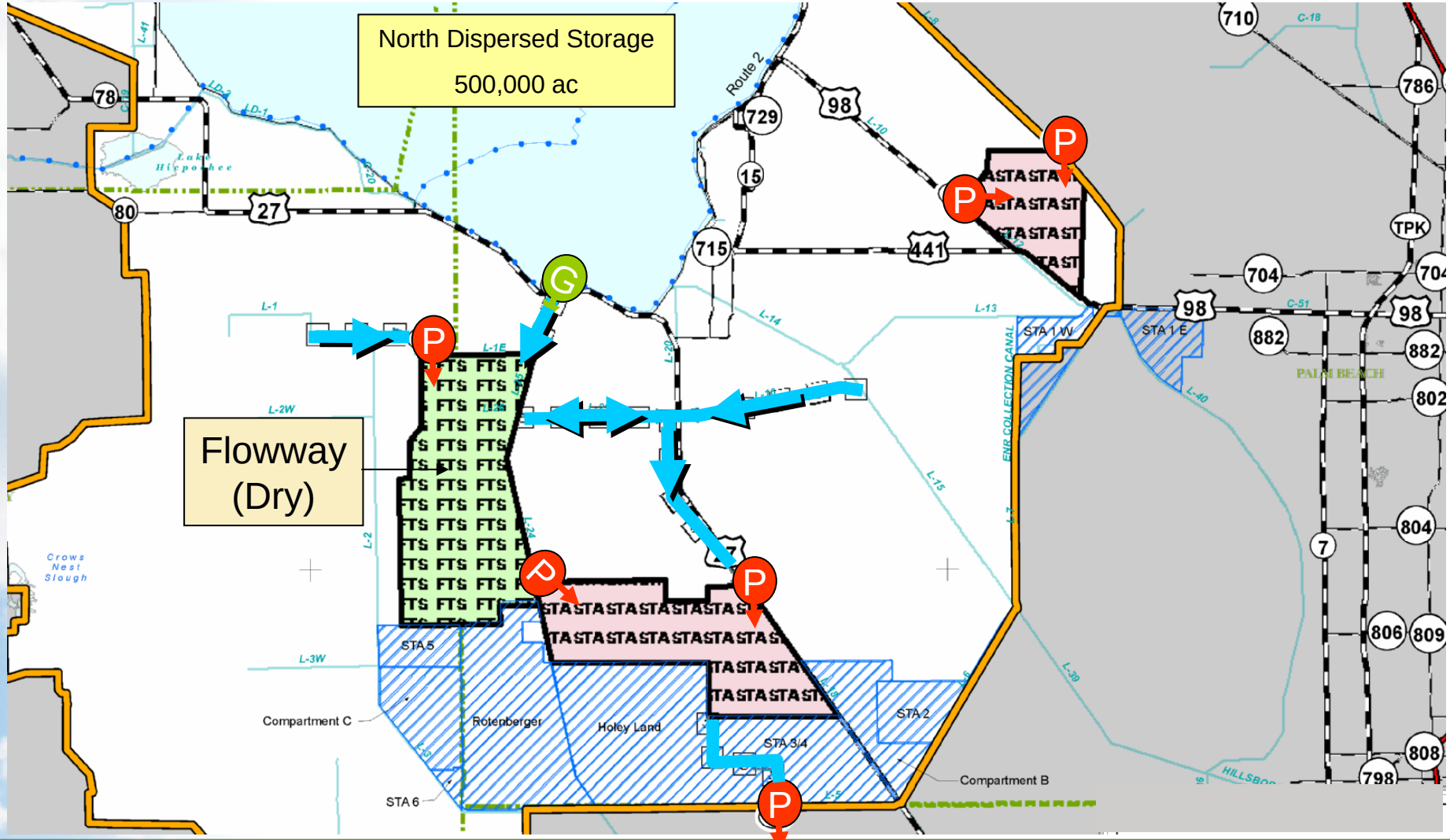
## Sam Poole, Galen Miller



- Provide system enhancements to benefit the Everglades while minimizing community impact.
- Enhancements will reduce harmful discharges to the estuaries and route additional water to the Everglades at a more affordable cost that will allow funding for completion of other CERP and Northern Everglades projects.

# Florida Crystals
## Conceptual Configuration





# Florida Crystals
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 90%* | 76% (20 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | 77* | 82 |
| Everglades- Demand Target (Std Score) | 29 | NS | 74 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | NS | 73 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 349 |

*implied performance from RESOPS simulation provided by stakeholder

# Florida Crystals

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Flow-way, Dispersed Storage, Shallow Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 0 - 0 |
| 100 ppb | 0 - 0 |
| *150 ppb | 0 - 0 |
| 200 ppb | 0 - 0 |

* Reflects concentration utilized by team during configuration development

Includes additional treatment area for S-5A Basin

# Restoration Plus Employment

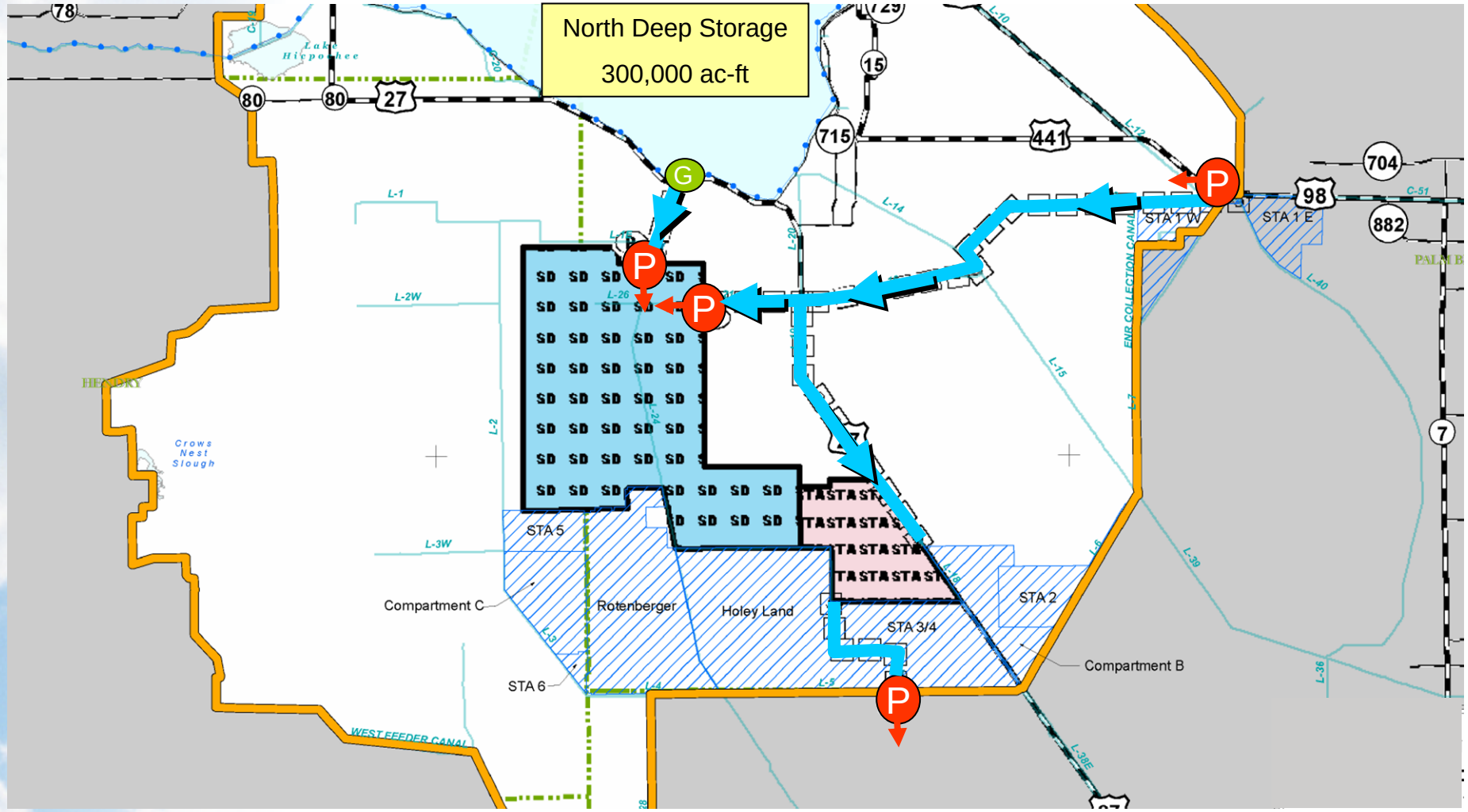
Joan Davis, Bevin Beaudet



- Provide storage and treatment components that will meet performance targets of 90%-95% for Lake Okeechobee discharges and Everglades water delivery while avoiding interference with the proposed inland port facilities.

# Restoration Plus Employment
## Conceptual Configuration





# Restoration Plus Employment
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 95% | 95% (4 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | 84 | 83 |
| Everglades- Demand Target (Std Score) | 29 | 93 | 96 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | 91 | 96 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | 370 | 550 |

# Restoration Plus Employment

## Benefits- Water Quality



Configuration Proposal Includes: STA, Reservoirs, Deep Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 2,000 - 6,000 |
| 100 ppb | 3,800 - 8,800 |
| *150 ppb | 7,800 - 14,500 |
| 200 ppb | 11,100 - 19,100 |

* Reflects concentration utilized by team during configuration development

# Marshall Plan Element 6

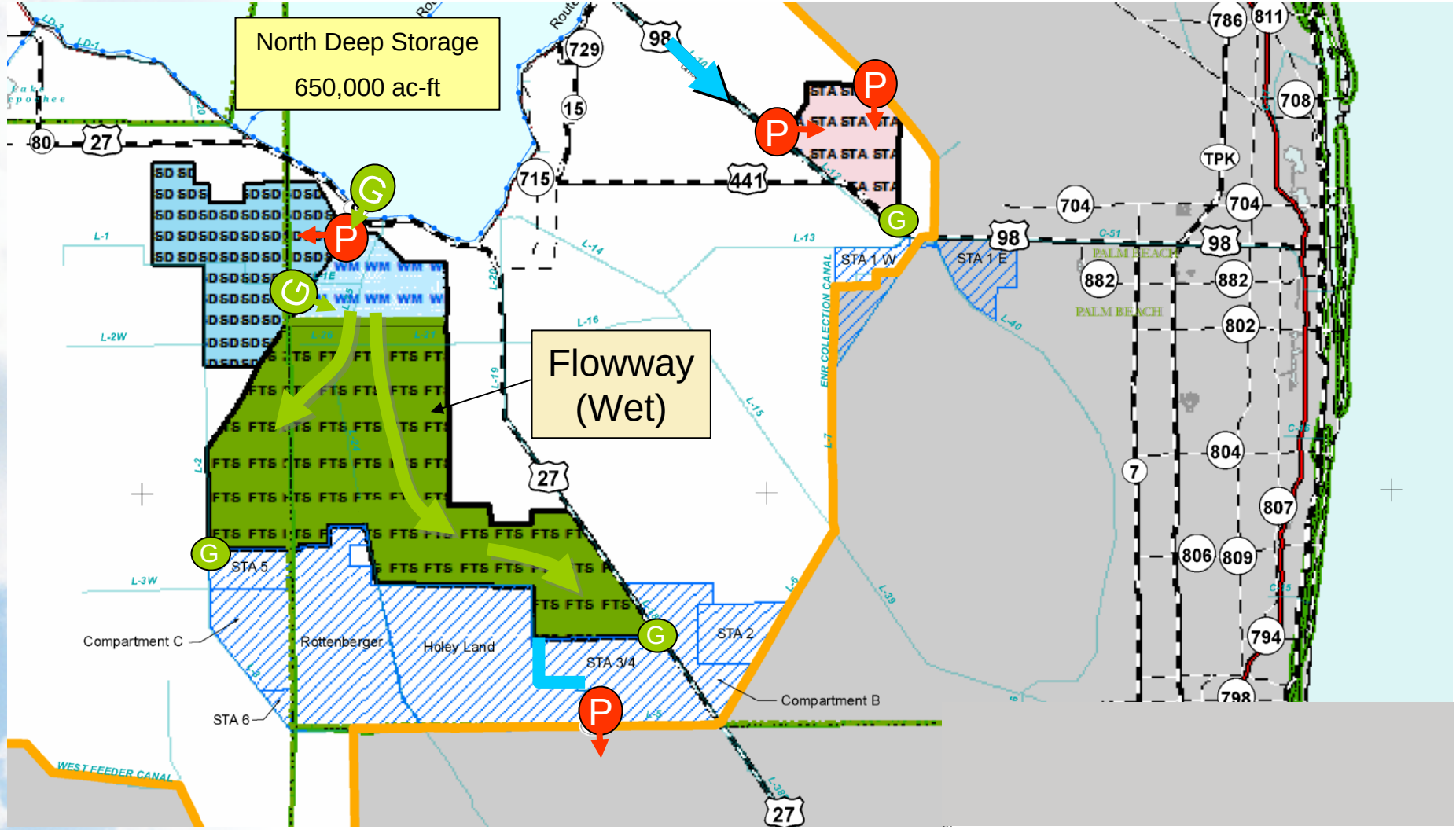
John Marshall, Martha Musgrove, Joel VanArman, Tom Poulsom, Deborah Nichols



- Establish a flow-way connecting Lake Okeechobee and Water Conservation Area 3A maximizing gravity flow and utilizing existing structures and newly acquired land.
- Includes significant storage north and south of the Lake to decrease estuary damaging discharges and to meet 90% dry season water demand for the Everglades.
- Includes a small flow-way and additional treatment capacity in the S5A Basin for treatment of water to be delivered to the Refuge.

# Marshall Plan Element 6
## Conceptual Configuration





# Marshall Plan Element 6

## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 95% | 95% (4 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | NS | 79 |
| Everglades- Demand Target (Std Score) | 29 | NS | 91 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | 90 | 89 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 395 |

# Marshall Plan Element 6

## Benefits- Water Quality



Configuration Proposal Includes: STA, Reservoirs, Flow-ways, Deep Storage, Shallow Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Byond Configuration |
|---|---|
| 40 ppb | 3,900 |
| 80 ppb | 3,900 |
| 100 ppb | 3,900 |
| *150 ppb | 3,900 |
| 200 ppb | 3,900 |
| * Reflects concentration utilized by team during configuration development | |

Includes additional treatment area for S-5A Basin

# Performance

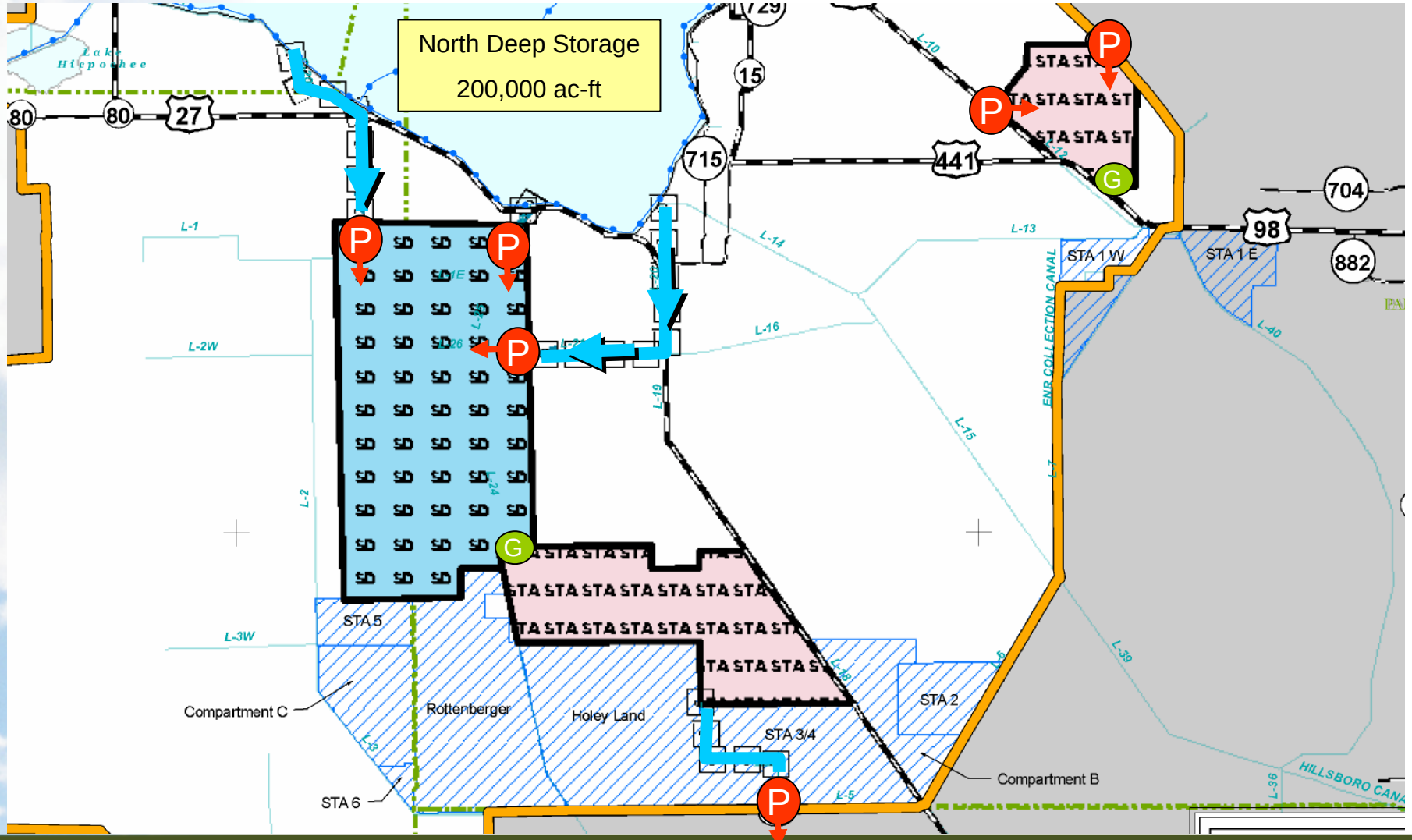
Karl Wickstrom, Jennifer Nelson, Lisa Interlandi, Joanne Davis, Maggy Hurchalla, Cynthia Plockelman, Mark Oncavage, Paul Gray, Tom VanLent



- Meet the performance targets including Lake Okeechobee high stage target, reductions of damaging flows to estuaries, and providing dry season deliveries to the Everglades.
- The implementation of dispersed storage north of Lake Okeechobee is included.

# Performance
## Conceptual Configuration





# Performance
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 95% | 95% (4 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | 85 | 84 |
| Everglades- Demand Target (Std Score) | 29 | NS | 95 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | >90 | 95 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 533 |

# Performance

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Reservoirs, Deep Storage, Shallow Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 0 - 0 |
| 100 ppb | 0 - 0 |
| 150 ppb | 0 - 0 |
| 200 ppb | 0 - 5,000 |
| No concentration specified by team during configuration development | |

Includes additional treatment area for S-4 and S-5A Basins

# Performance – Cost

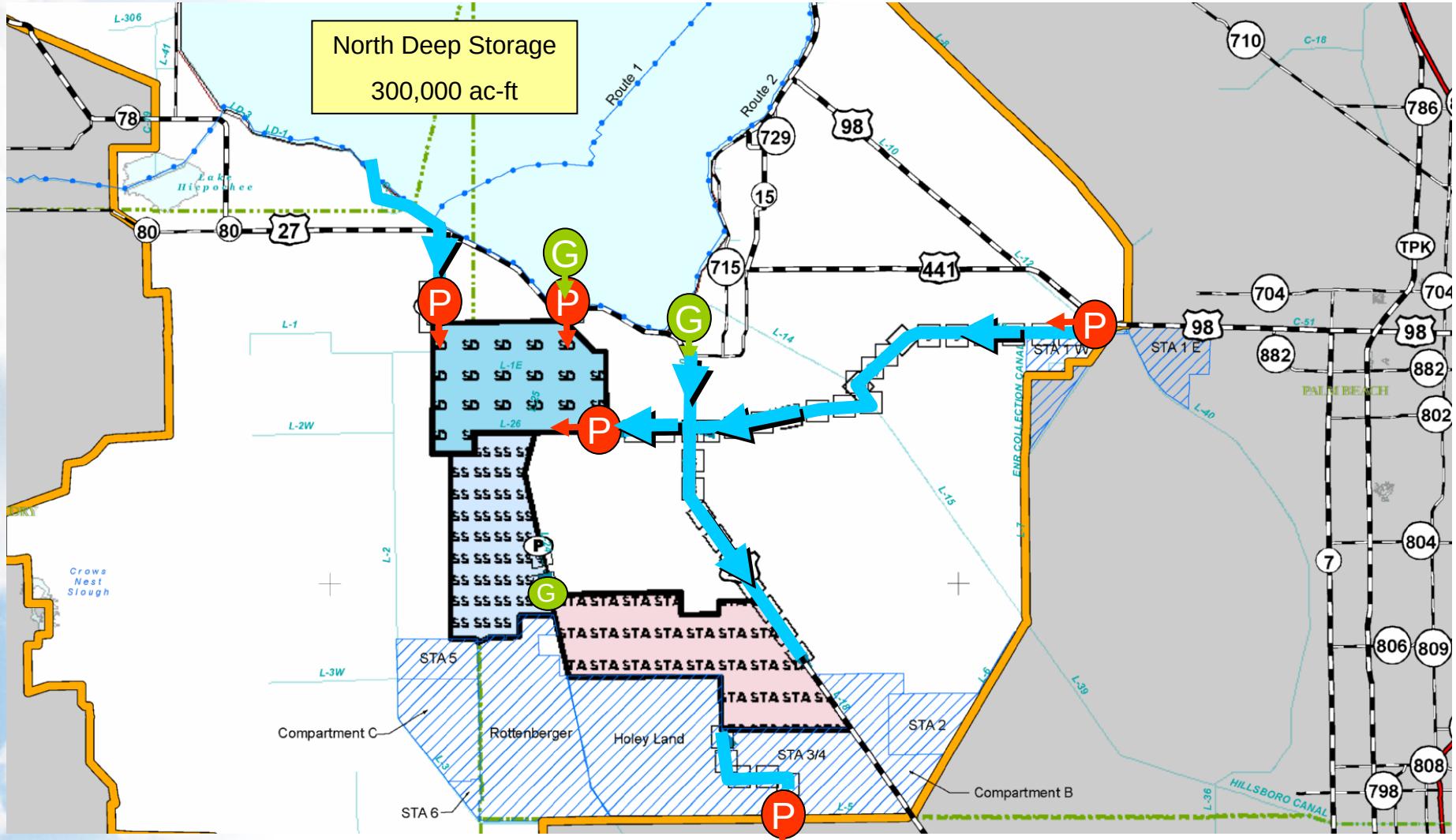
## Kevin Henderson



- Focused primarily on meeting set performance standards derived from the performance maps that were provided. Utilizing performance maps centered on roughly 300,000 ac-ft of storage north of Lake Okeechobee and roughly 550,000 ac-ft south of Lake Okeechobee.
- The storage south of the Lake is to be divided between both deep and shallow storage.
- The configuration also provides water quality treatment by locating a Stormwater Treatment Area on Compartment A of Talisman property.

# Performance – Cost
## Conceptual Configuration





# Performance – Cost

## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | 90% | 94% (5 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | NS | 81 |
| Everglades- Demand Target (Std Score) | 29 | 90 | 92 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | 85-90 | 91 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | NS | 537 |

# Performance - Cost

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Reservoirs, Deep Storage, Shallow Storage

| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 0 - 0 |
| 100 ppb | 0 - 0 |
| 150 ppb | 800 - 3,700 |
| 200 ppb | 4,400 - 8,700 |
| No concentration specified by team during configuration development | |

Includes additional treatment area for S-4 Basin

# Reservoir Within Lake Okeechobee

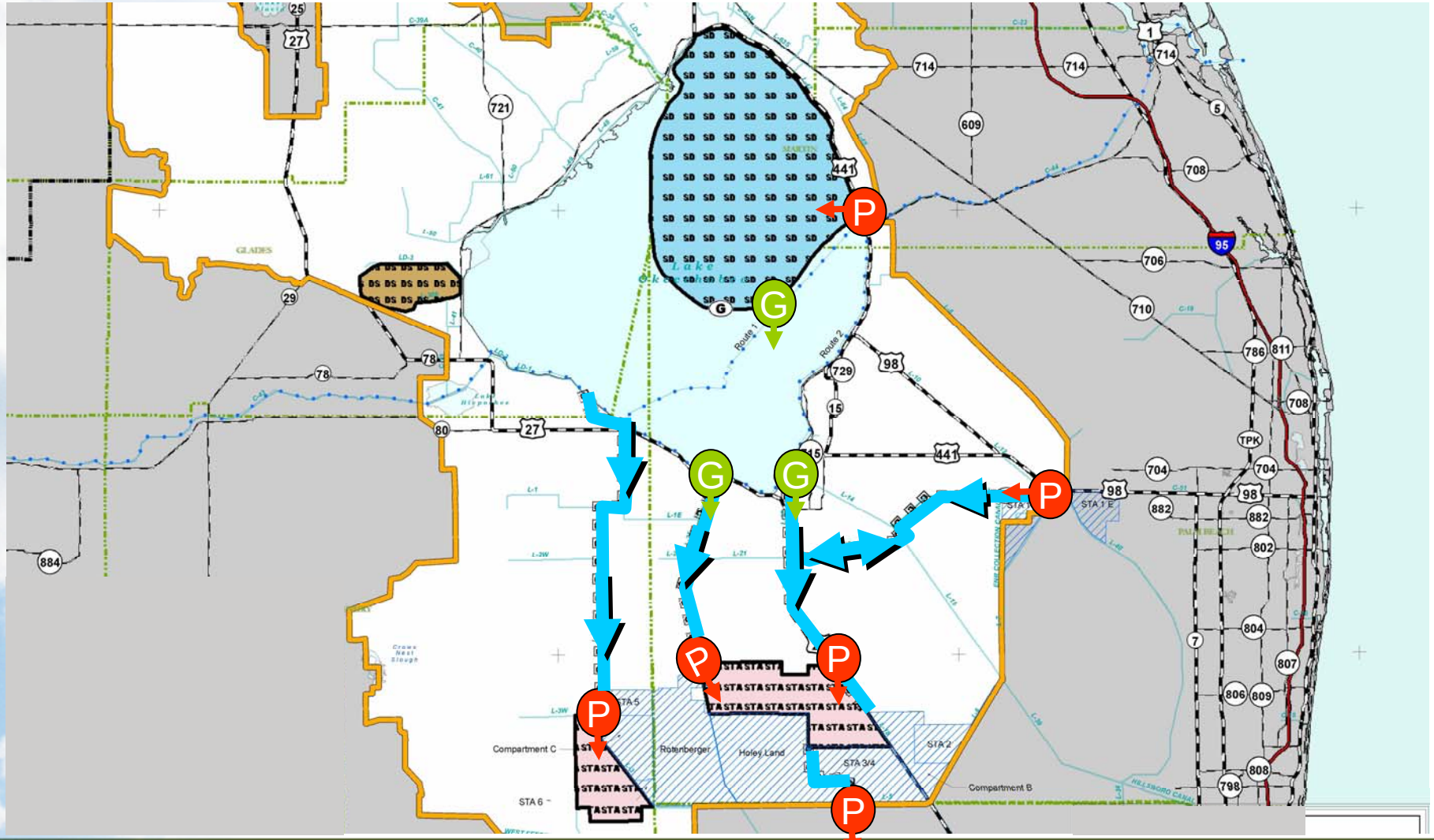
Kevin McCarthy, Tom MacVicar, Rebecca Elliott, Scott McCaleb



- Construct a reservoir in the northeastern portion of Lake Okeechobee which will provide 1.2 million ac-ft of storage. The flows from Kissimmee River will not go into the reservoir but rather into the main portion of the Lake.
- Improve conveyance south of Lake Okeechobee to allow the movement of water from the Lake to a stormwater treatment area that will be constructed on Talisman-Compartment A.
- Construct an STA on USSC lands immediately west of STA 5/6 which will receive water from the S-4 Basin. Construct conveyance from the S-4 Basin to the new STA.
- Implement the Nicodemus Slough management measure with potential to store 30,000 ac-ft on 18,000 acres.

# Reservoir Within Lake Okeechobee
## Conceptual Configuration





# Reservoir Within Lake Okeechobee
## Benefits- Hydrology



| | Base (Current Conditions) | Target | Results |
|---|---|---|---|
| Estuaries-High Discharges (% reduction) | NA (84 months) | >95% | 93% (6 months) |
| Lake O-Stage Envelope (Std Score Above) | 79 | 100 | 87 |
| Everglades- Demand Target (Std Score) | 29 | >90 | 84 |
| Everglades- Dry Season Demand Target (Std Score) | 42 | >90 | 86 |
| Increased Annual Average Flow to Everglades (kaf/yr) | NA (1,380 kaf) | 400 | 616 |

# Reservoir Within Lake Okeechobee

## Benefits- Water Quality



Configuration Proposal Includes: STAs, Reservoir, Shallow Storage

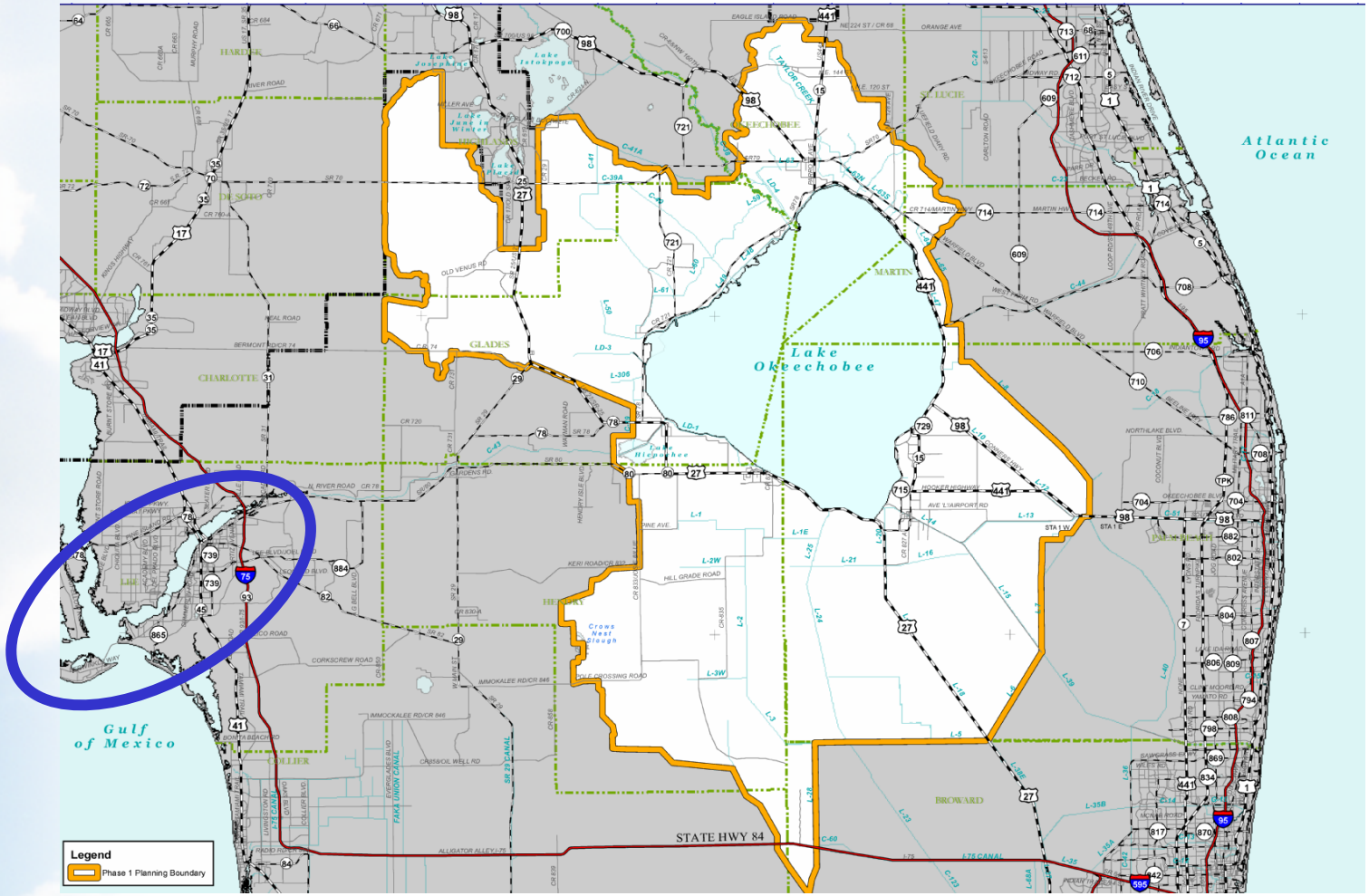
| Lake Okeechobee Discharge Concentration | Additional Stormwater Treatment Acreage Required Beyond Configuration |
|---|---|
| 40 ppb | 0 - 0 |
| 80 ppb | 0 - 0 |
| 100 ppb | 0 - 0 |
| 150 ppb | 1,600 - 1,600 |
| 200 ppb | 9,400 - 9,400 |
| No concentration specified by team during configuration development | |

Includes additional treatment area for S-4 Basin

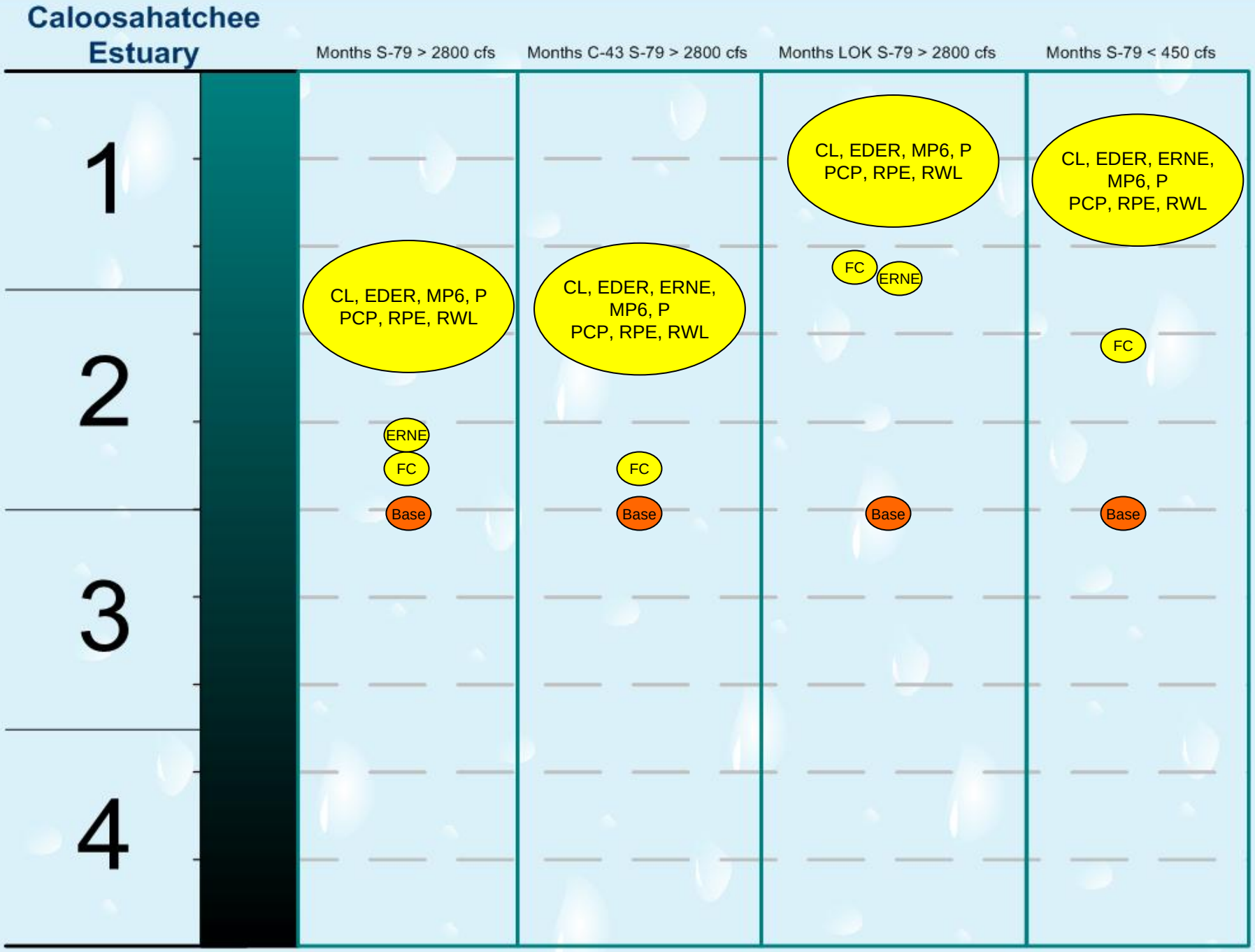
# Benefits Summary

# Caloosahatchee Estuary

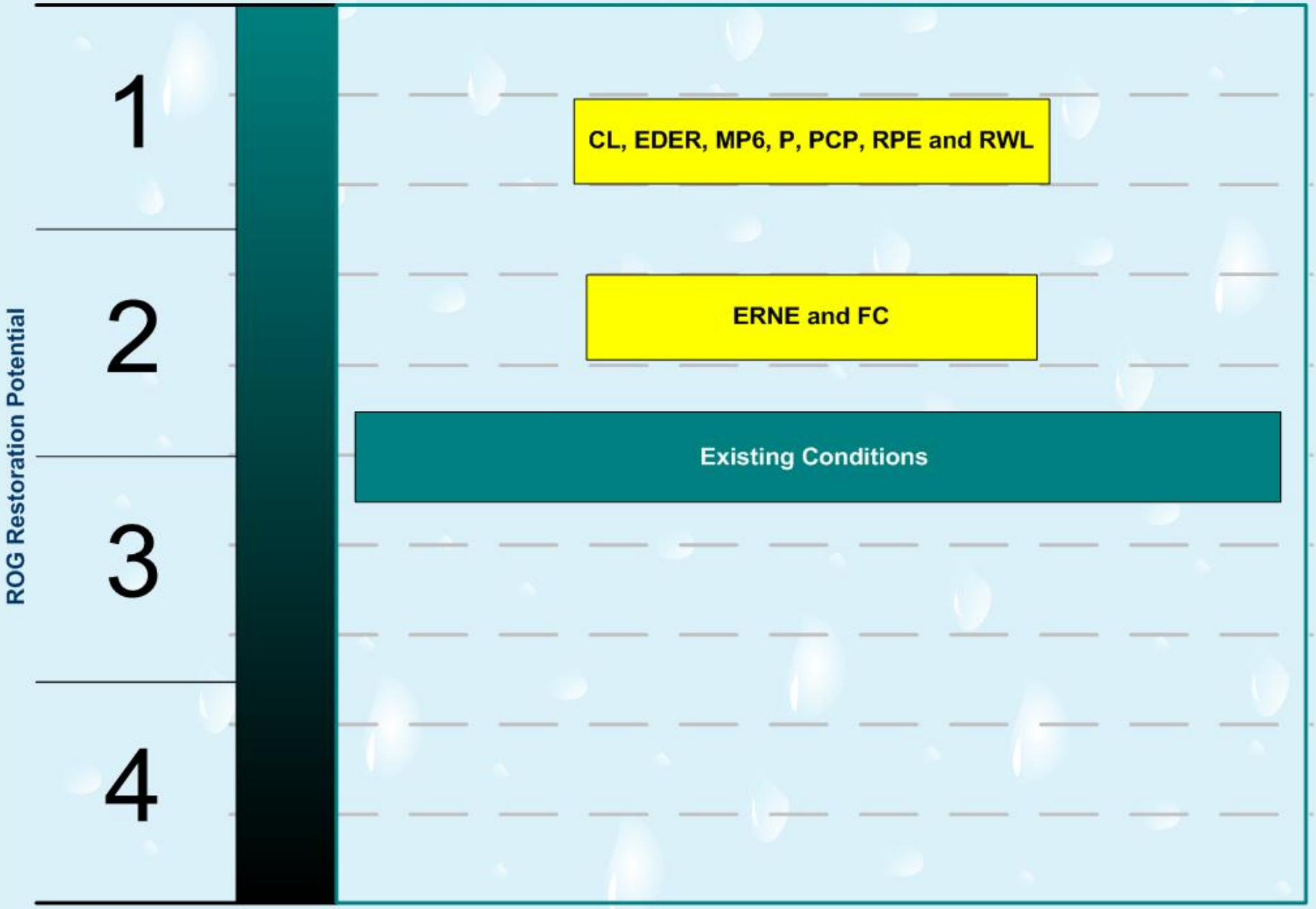




- **1** (If the model flows were achieved)
  - Permanent oyster reefs in the lower estuary
  - Permanent beds of Vallisneria in the upper estuary
  - Nursery function of the upper estuary would be maximized
  - With the sustained presence of habitat, fish and shellfish populations would reach high levels
- **2**
  - Mortality of Vallisneria and oysters once every 4 years
  - Vallisneria present in the upper estuary at least once in every 4 years
  - Oysters could maintain almost permanent populations with residents contributing to the supply of recruits
  - Upper estuary would serve as a viable nursery area for 3 of every 4 years
- **3**
  - Oyster and Vallisneria mortality events once every 2 years
  - Vallisneria would not be present in the upper estuary
  - Oysters would settle successfully every other year. The high frequency of mortality would prevent the establishment of a resident population.
  - Estuarine dependent fish populations would return to present day levels
- **4**
  - Frequency of Vallisneria and oyster mortality 3 of every 4 years
  - Unlikely that Vallisneria would be present in the upper estuary
  - Lack of structural habitat would impair its fish nursery function
  - Oysters would form oyster reefs once every 4 years, recruits from outside the estuary

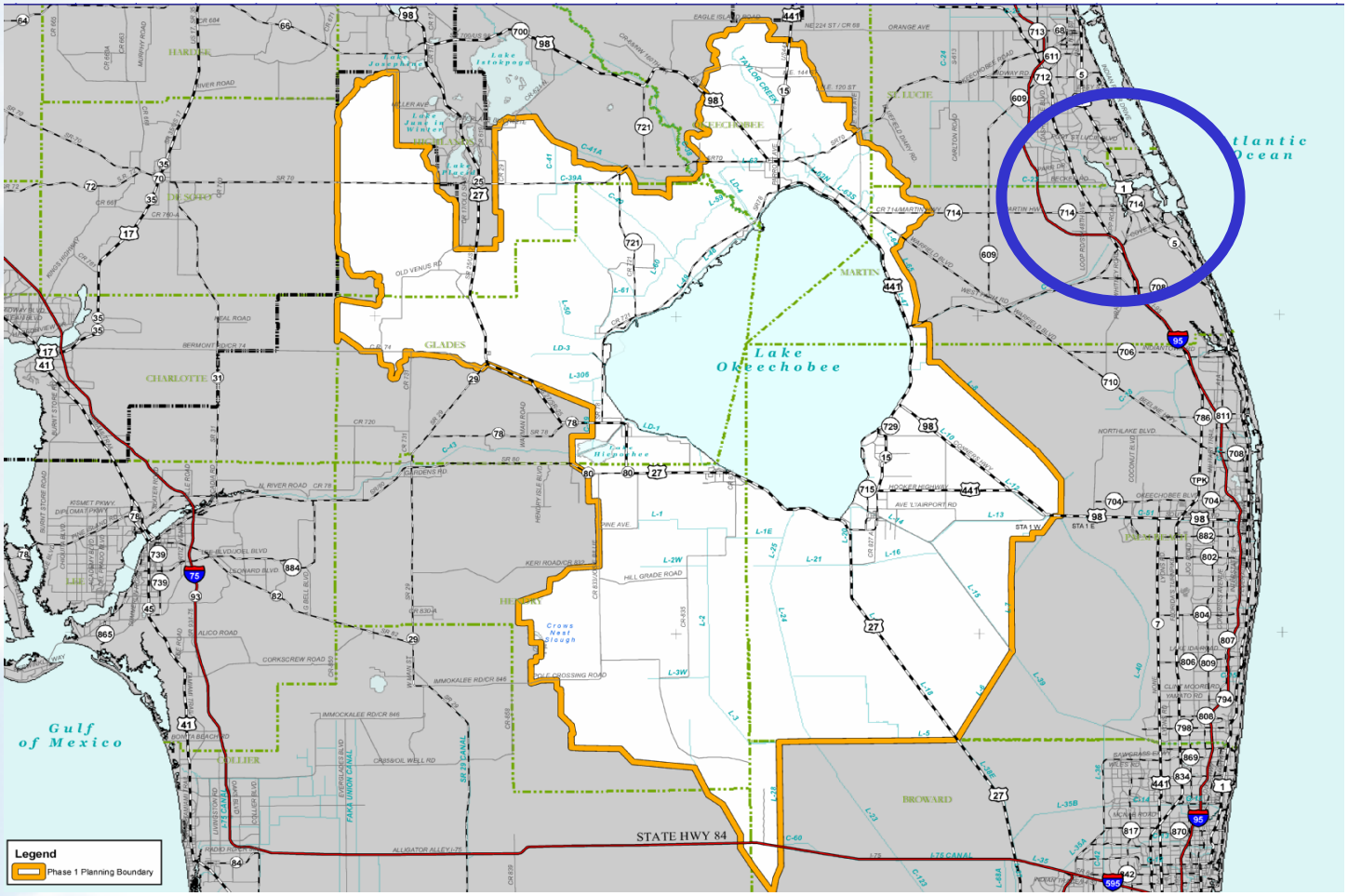

Caloosahatchee Estuary
Months S-79 > 2800 cfs
Months C-43 S-79 > 2800 cfs
Months LOK S-79 > 2800 cfs
Months S-79 < 450 cfs
1
2
3
4
CL, EDER, MP6, P
PCP, RPE, RWL
ERNE
FC
Base
CL, EDER, ERNE,
MP6, P
PCP, RPE, RWL
FC
Base
CL, EDER, MP6, P
PCP, RPE, RWL
FC
ERNE
Base
CL, EDER, ERNE,
MP6, P
PCP, RPE, RWL
FC
Base

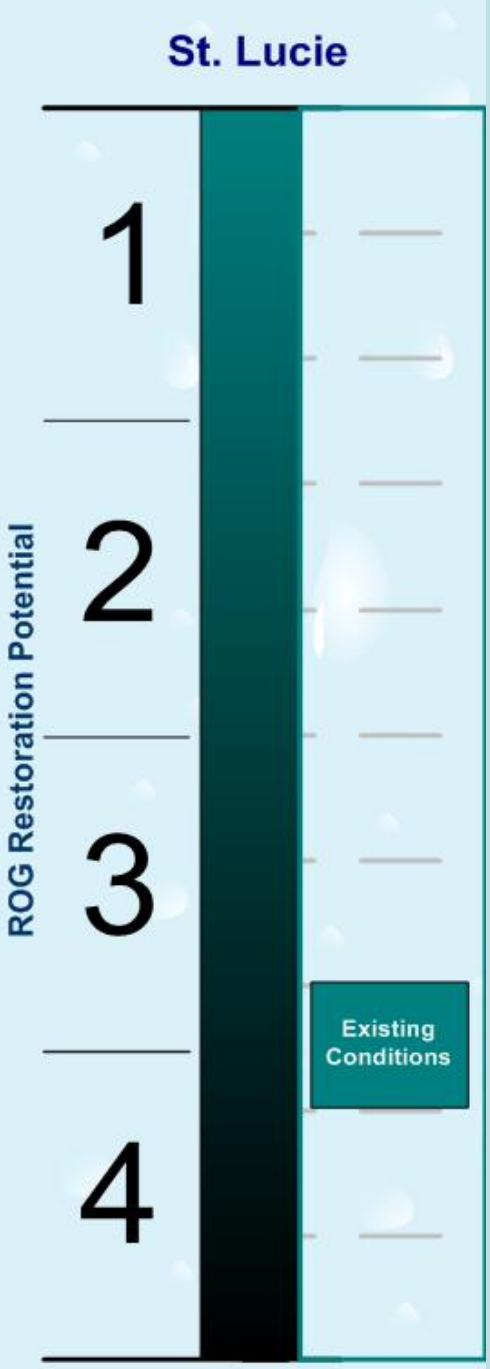
# Caloosahatchee Estuary



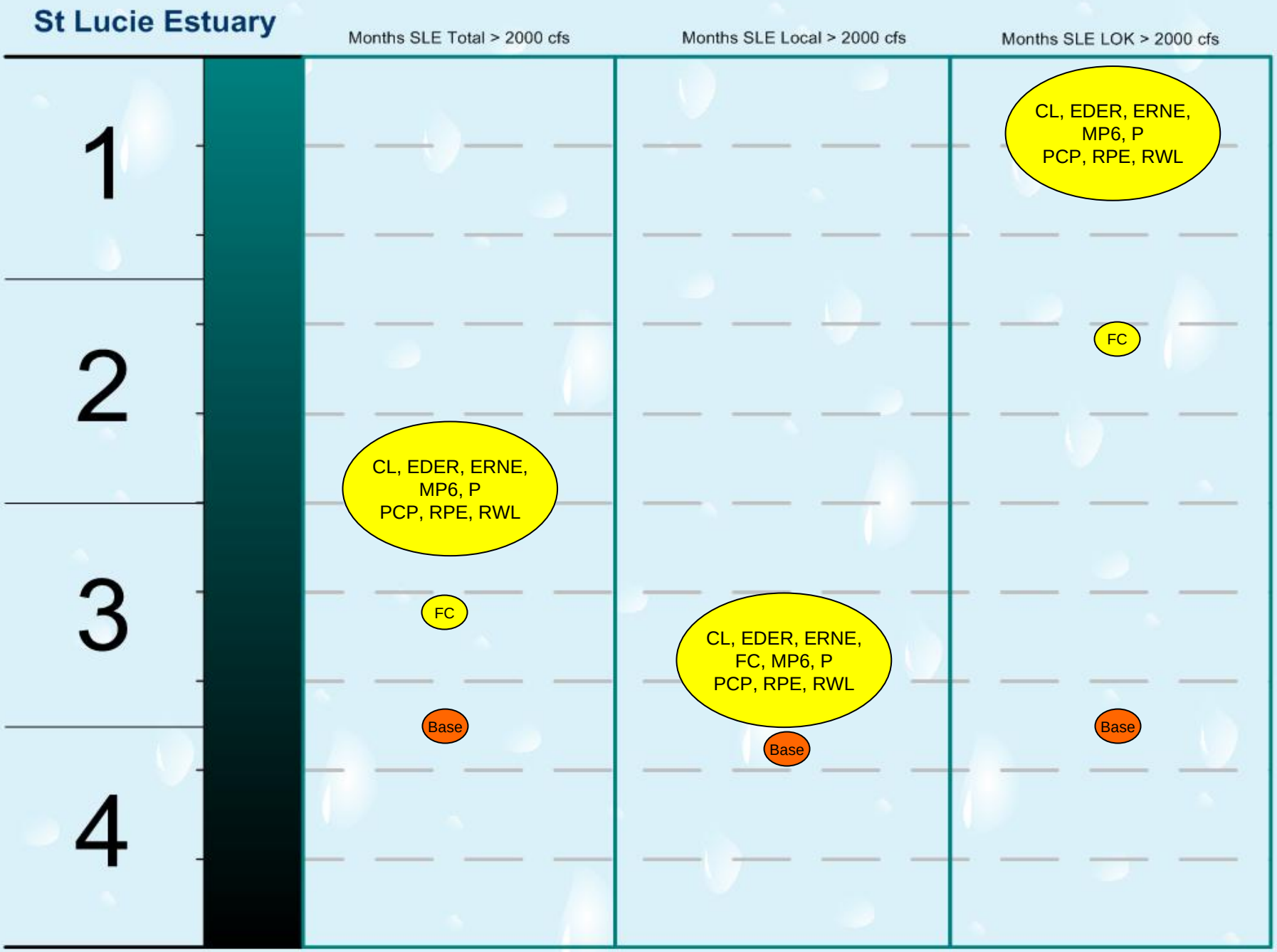
# St. Lucie Estuary



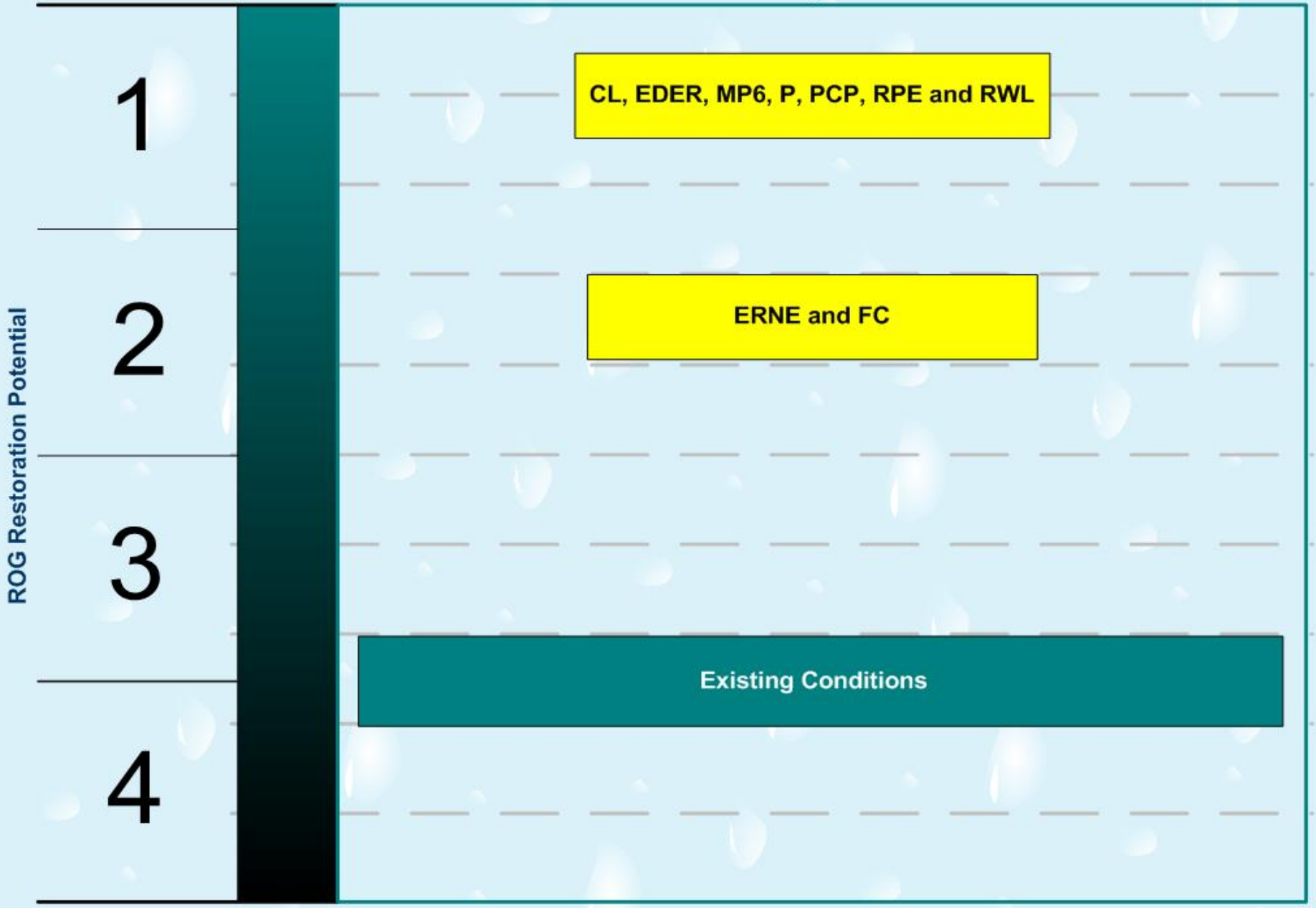





- **1**
  - Persistent Oyster reefs with extreme mortality once every 6 years
  - Oyster recruits from both inside and outside the estuary
  - Seagrasses in the adjacent IRL would improve
  - As habitat improves, the fish and shell fish will also become more abundant
- **2**
  - Oyster mortality once every 4 years with time to spawn once or twice before dying
  - Estuary larvae would contribute substantially to the population
  - Seagrasses would be present most of the time in the adjacent lagoon
- **3**
  - Oyster mortality occurs about once every 3 years and stress once every 8 months
  - Oysters present much of the time, but would not reach high densities or wide distribution
  - Seagrasses in the IRL would suffer mortality once every three years
  - Species sensitive to low salinity would show substantial recovery before the next episode of mortality
- 4
  - Oysters mortality once every 2.5 years (less than life span) and stress once every 6 months
  - High oyster mortality due to the high percentage of low flow months during the dry season caused by disease and predation
  - Permanent oyster populations would not be established in the estuary
  - Seagrasses in the adjacent IRL would suffer some mortality every three years.

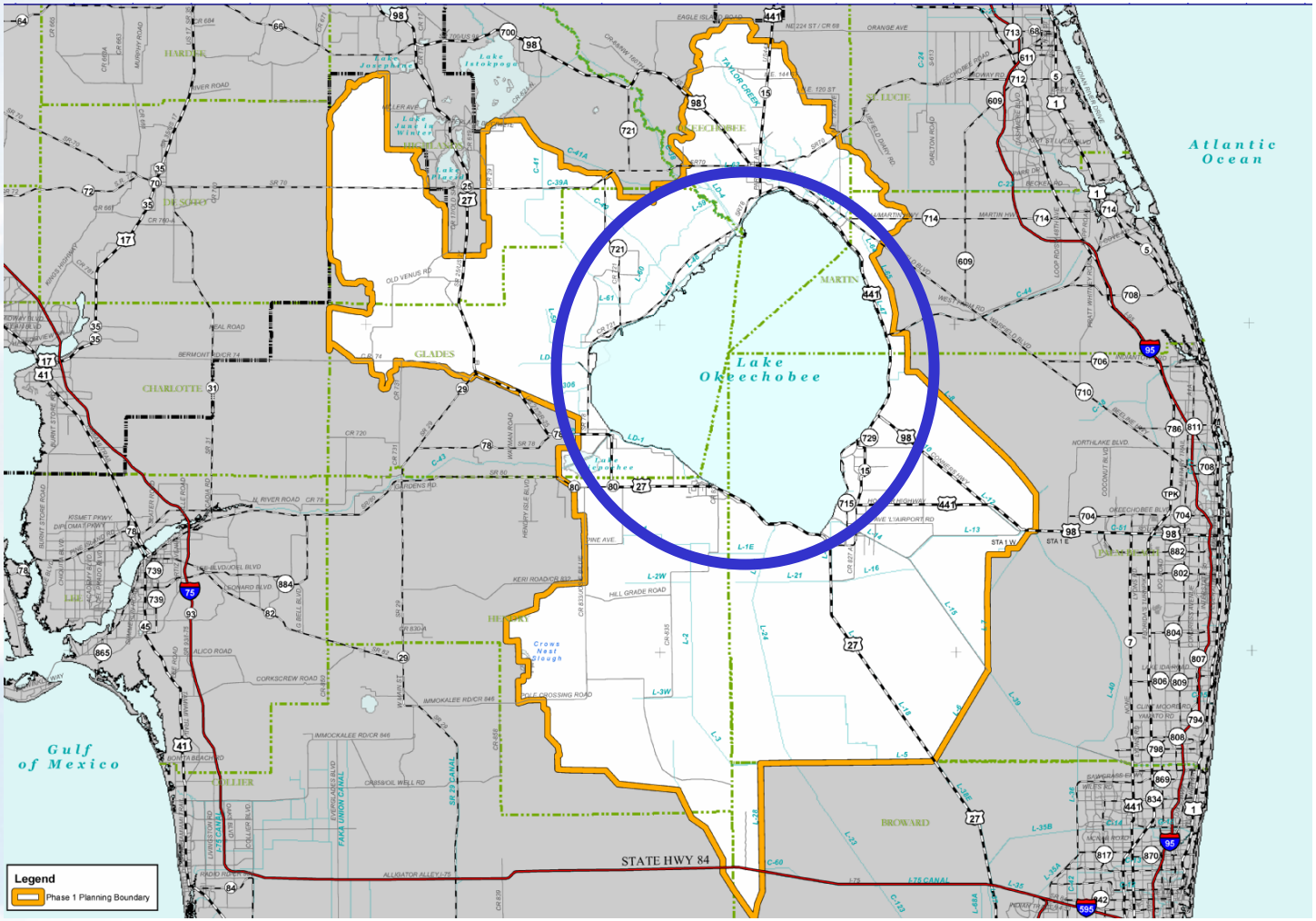

St Lucie Estuary
Months SLE Total > 2000 cfs
Months SLE Local > 2000 cfs
Months SLE LOK > 2000 cfs
1
2
3
4
CL, EDER, ERNE, MP6, P PCP, RPE, RWL
FC
Base
CL, EDER, ERNE, FC, MP6, P PCP, RPE, RWL
Base
CL, EDER, ERNE, MP6, P PCP, RPE, RWL
FC
Base

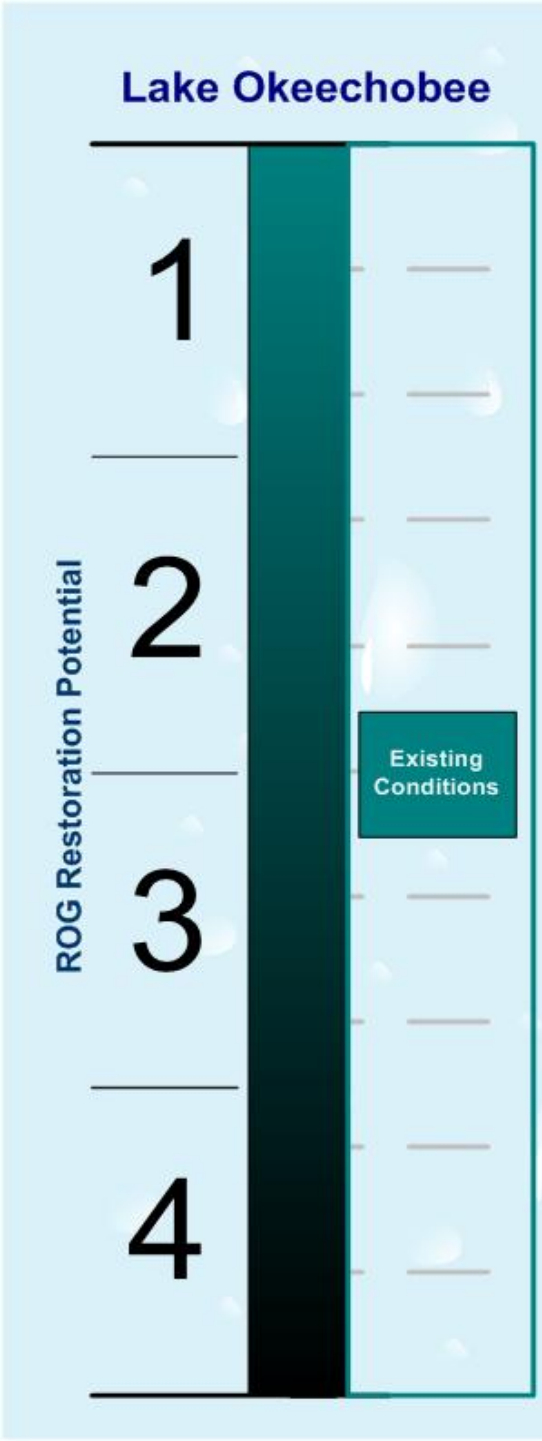
# St. Lucie Estuary



# Lake Okeechobee and LOSA








- 1
  - Lake Okeechobee would remain within the stage envelope virtually at all times
  - Maintain an extensive submerged aquatic vegetation community
  - A stable or expanding bulrush community
  - A health sport and commercial fish population
  - Good wading bird foraging and nesting
- 2
  - Characterized by 5 high or low deviation events over the 41 year simulation period. The lake is in a state of excessive high or low or in recovery for 10 years of the 41 year simulation.
- 3
  - Characterized by 10 to 15 high or low deviation events. The lake is in a state of excessive high or low or in recovery for 20 to 30 years of the 41 year simulation period.
- 4
  - Lake Okeechobee would be in a continual state of either excessive high, or excessive low years, or in recovery from one or the other condition
  - Always at extreme stage or in recovery from extreme events
  - Loss of native submerged and emergent plant communities
  - Phytoplankton dominated system with related negative impacts to aquatic fauna, including fish, apple snails, wading birds, amphibians, and reptiles
  - Depending on the particular mix of extreme high and low events, additional negative effects might include dominance of the littoral zone by cattail (extreme highs) or dominance of the littoral zone by exotic invasive or terrestrial vegetation (extreme lows) and the faunal effects of the resulting loss of habitat

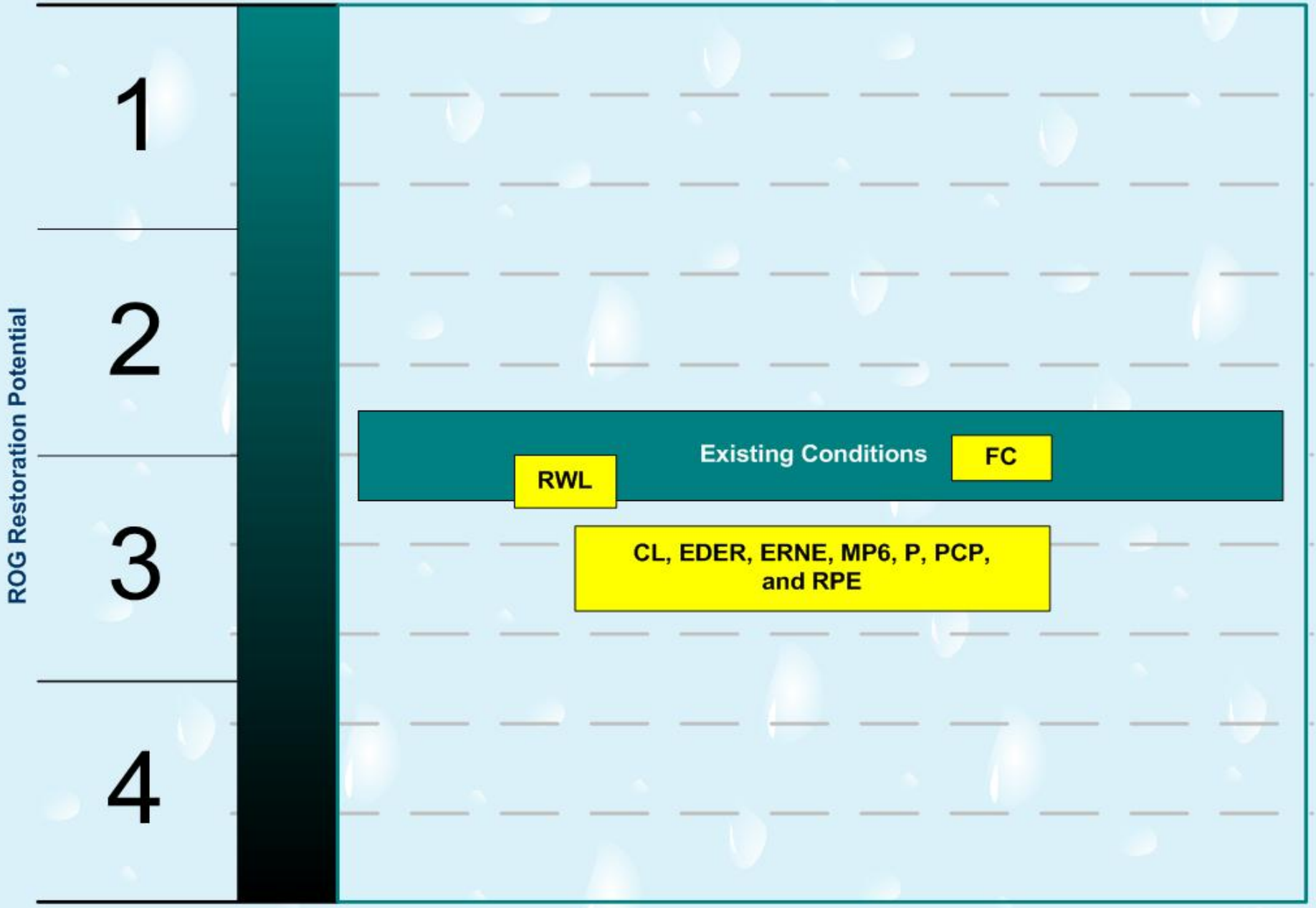
# Lake Okeechobee

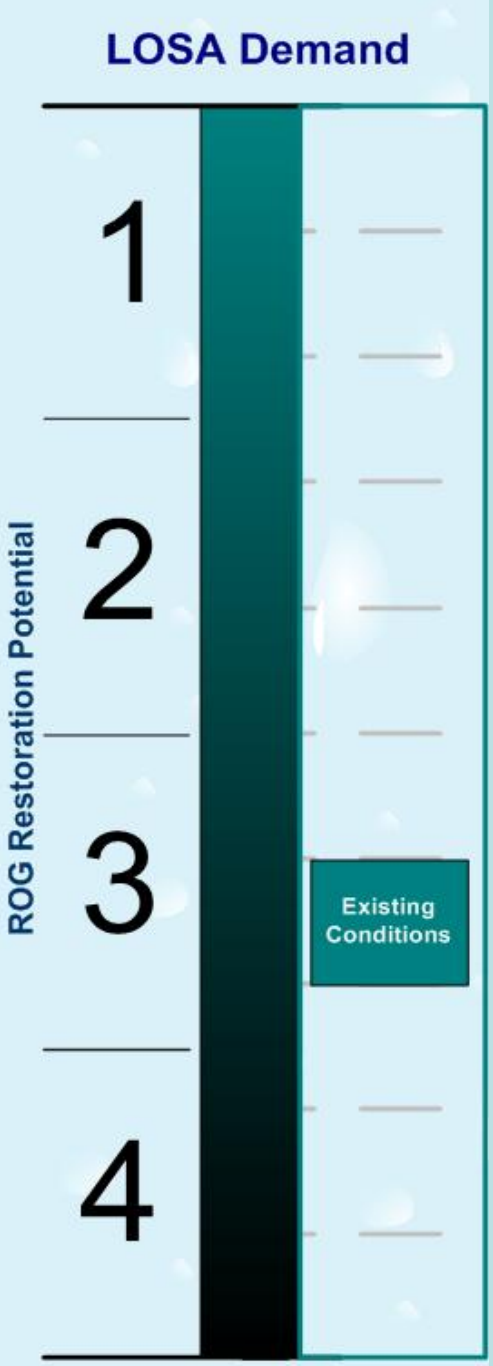
| | % Time in Stage Env. | Std. Score Above Env. | Std. Score Below Env. | Extreme Events (See Footnote) |
|---|---|---|---|---|
| 1 | | All Configurations + BASE | | |
| 2 | | | | FC, BASE |
| 3 | All Configurations + BASE | | All Configurations + BASE | RWL, ERNE, EDER, P, RPE, CL, PCP, MP6 |
| 4 | | | | |

Extreme Events are: > 17' for 2 consecutive months, >15' for 12 consecutive months, < 11' for 12 consecutive months & < 10' for 3 consecutive months.

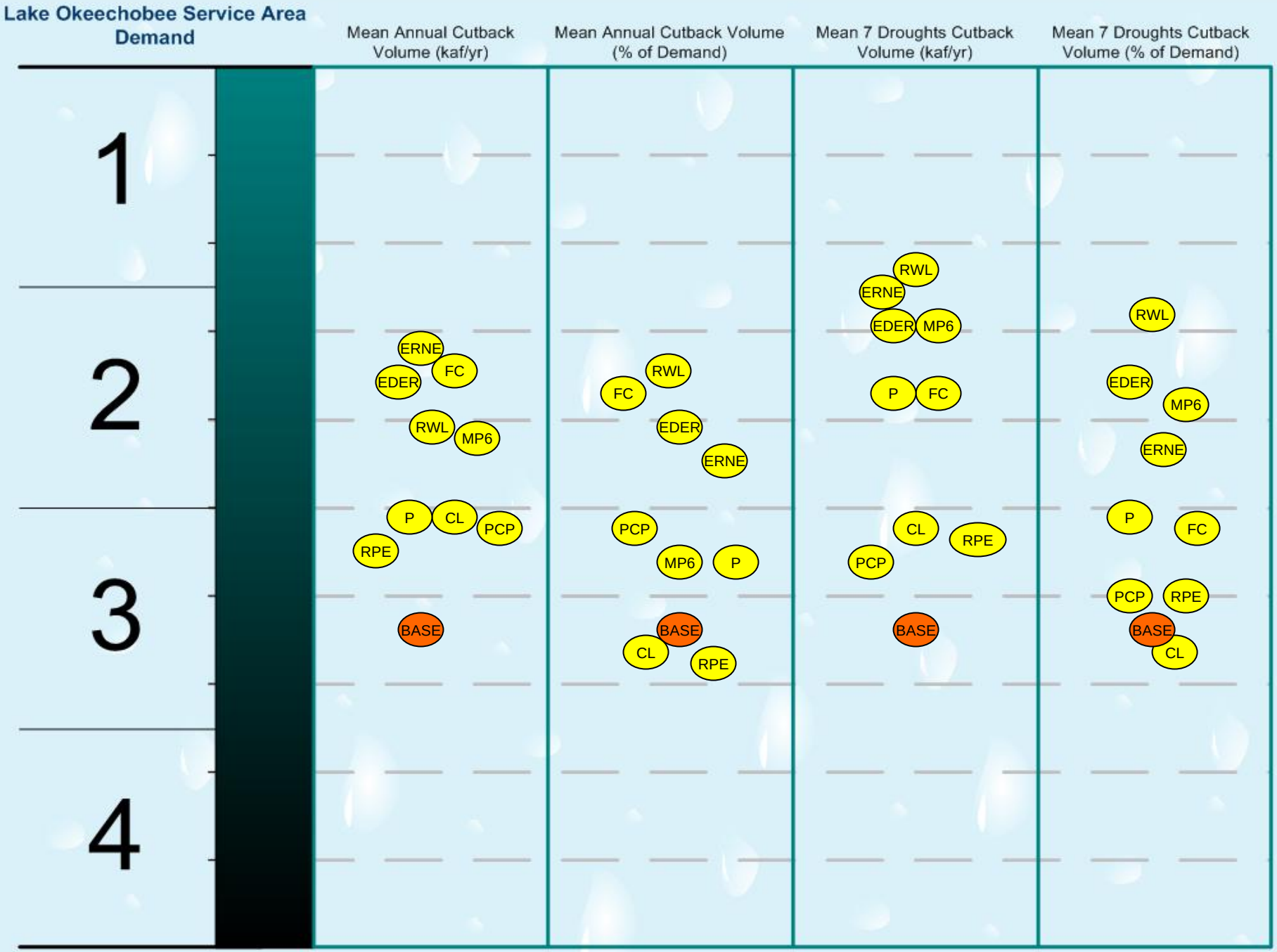
NO ADDITIONAL ALARM

# Lake Okeechobee

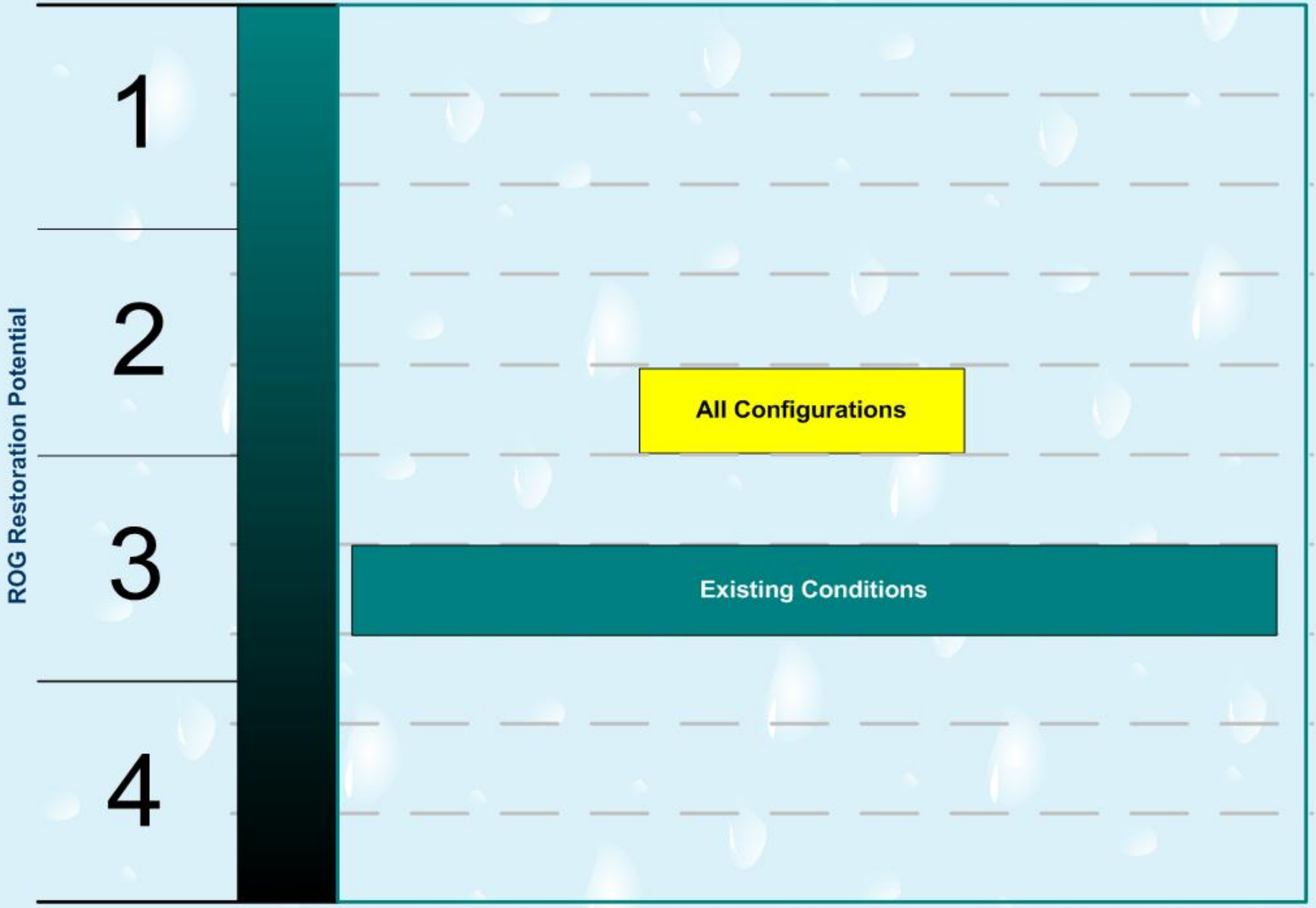





- **1**
  - Greater than 40% reduction in the volume and percentage of cutbacks required during the 41 year period of record as well as the Average of the 7 worst drought years. This results in greater ability of the agricultural community to maximize crop yields during dry as well as average years. Activities that would be improved and sustained would include sugarcane, rice and other crops.
- **2**
  - 20 to 40% reduction in the volume and percentage of cutbacks for both averages.
- **3**
  - 10 to 20% reduction in the volume and percentage of cutbacks for both averages.
- **4**
  - Less than 10% reduction in the volume and percentage of cutbacks for both averages.

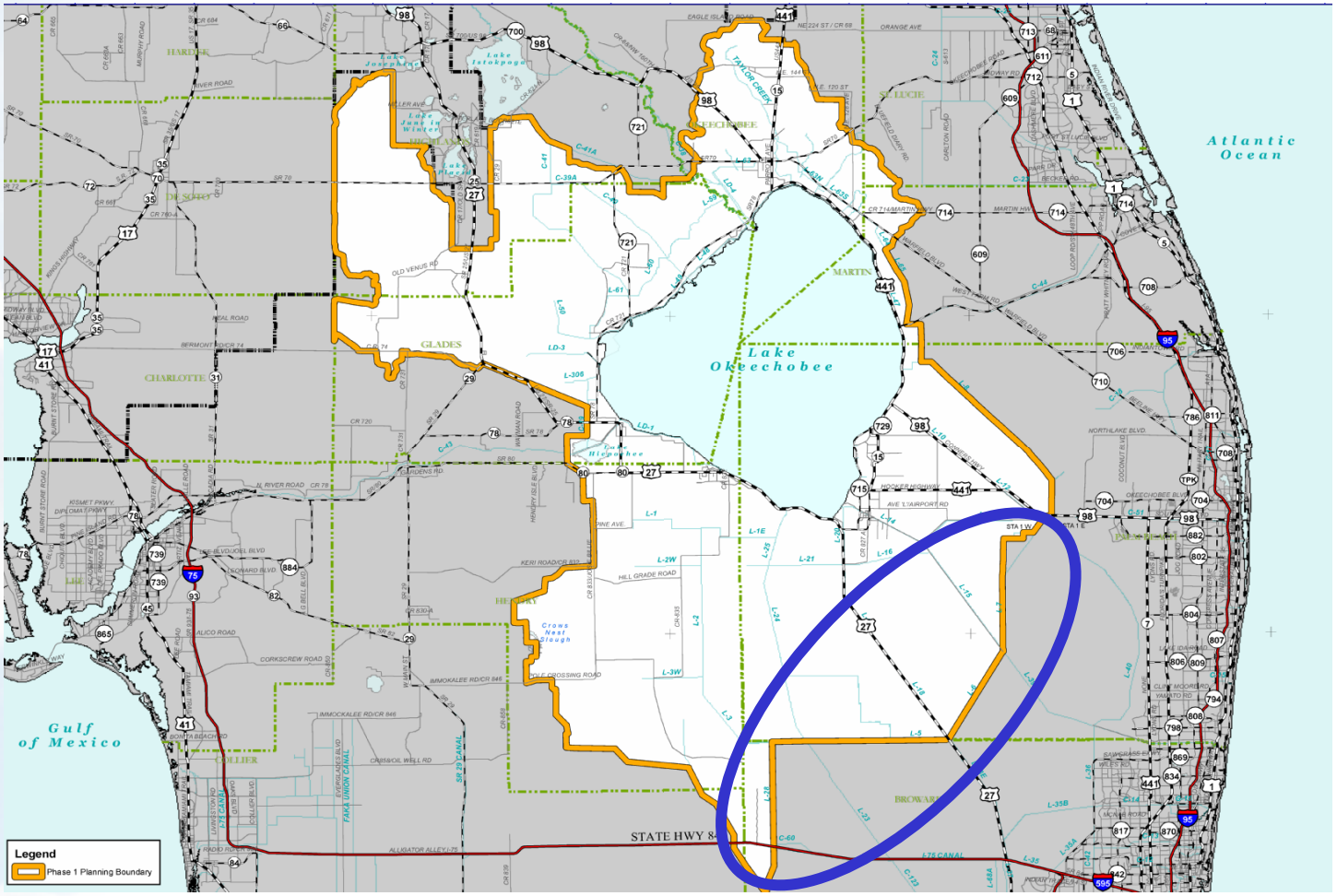

Lake Okeechobee Service Area Demand
Mean Annual Cutback Volume (kaf/yr)
Mean Annual Cutback Volume (% of Demand)
Mean 7 Droughts Cutback Volume (kaf/yr)
Mean 7 Droughts Cutback Volume (% of Demand)
1
2
3
4
ERNE
FC
EDER
RWL
MP6
P
CL
PCP
RPE
BASE
RWL
FC
EDER
ERNE
PCP
MP6
P
BASE
CL
RPE
RWL
ERNE
EDER
MP6
P
FC
CL
RPE
PCP
BASE
RWL
EDER
MP6
ERNE
P
FC
PCP
RPE
BASE
CL

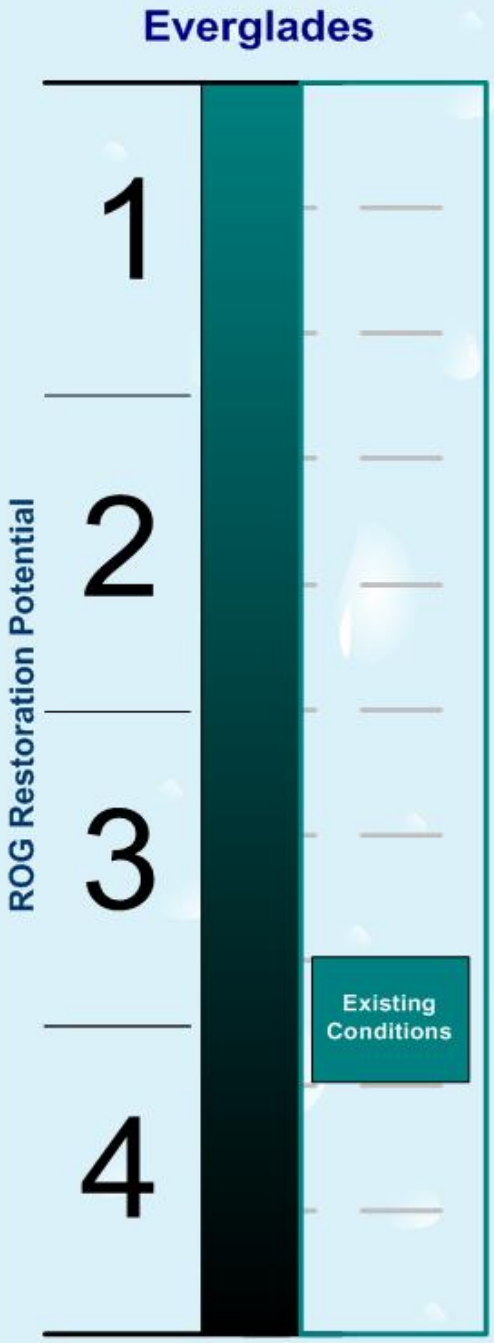
# LOSA Demand


ROG Restoration Potential
1
2
3
4
All Configurations
Existing Conditions

# Everglades




Atlantic Ocean
Gulf of Mexico
Lake Okeechobee
Lake Istokpoga
Lake Josephine
Lake Jane in Winter
Lake Placid
HARDEE
HIGHLANDS
DE SOTO
CHARLOTTE
GLADES
MARTIN
ST. LUCIE
OKEECHEECHEE
HENDRY
COLLIER
BROWARD
Cross Nest Slough
STATE HWY 84
Legend
Phase 1 Planning Boundary




•1

- Water moves as unobstructed sheetflow over full width of remaining landscape
- Long term average water depths match pre-drainage depths
- Depths and flows vary according to pre-drainage linkage to weather variation
- Depths and flows sustain peat processes and in turn sustain shapes, elevations, and vegetation of ridges and tree islands
- Populations of large multi-year fish persist; wading bird prey base present
- Flows into Florida Bay continue through most of the year, preventing hyper-salinity and sustaining diverse submerged aquatic vegetation, fish and shrimp

•2

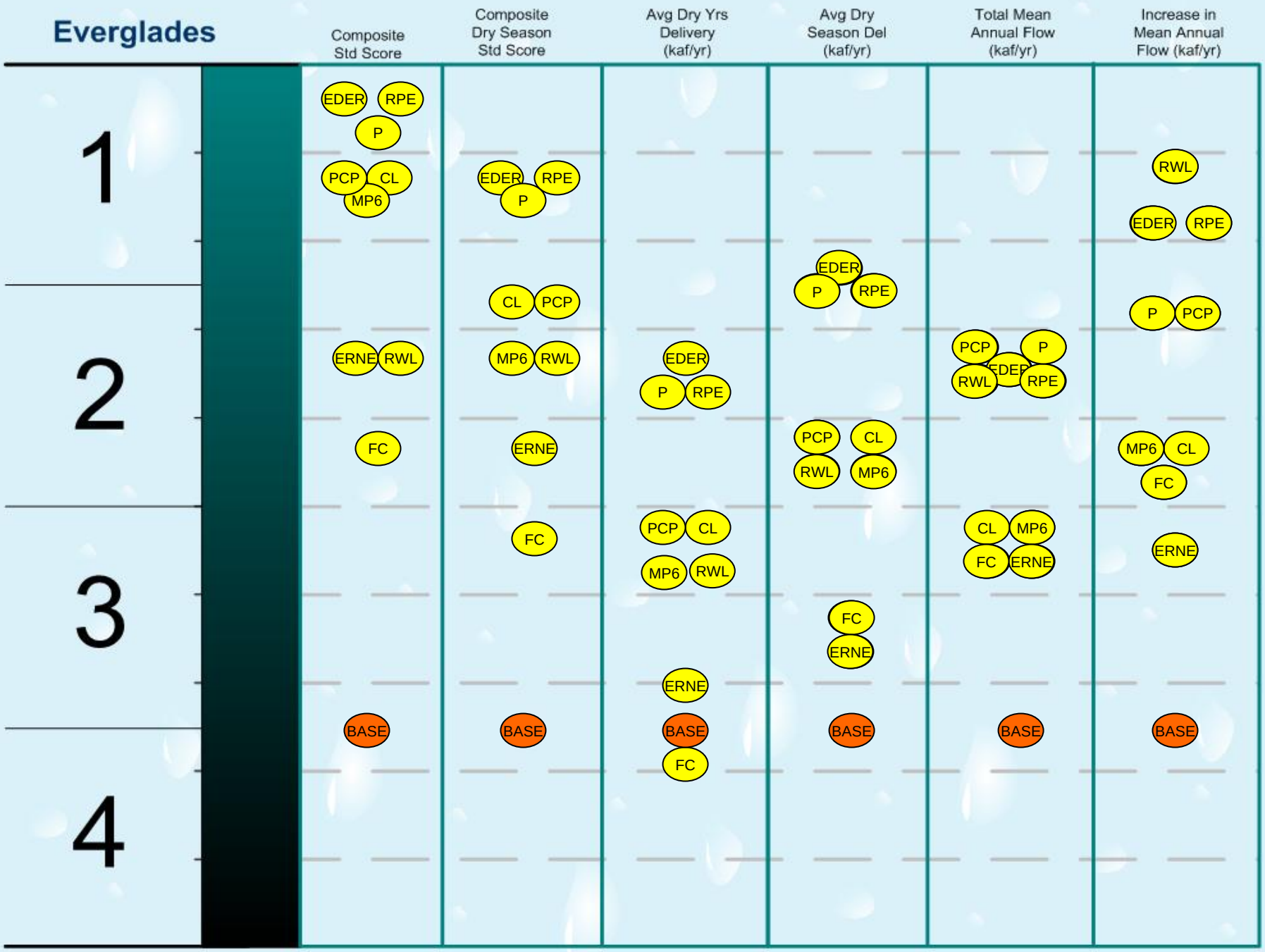
- Ecologically sub-optimal condition, but sustainable
- Hydrology cannot restore landscape to optimal condition, but can sustain in Condition 2
- Everglades ecology is very sensitive to hydrologic change - modest hydrologic improvements can tip ecological conditions from 2 to 1

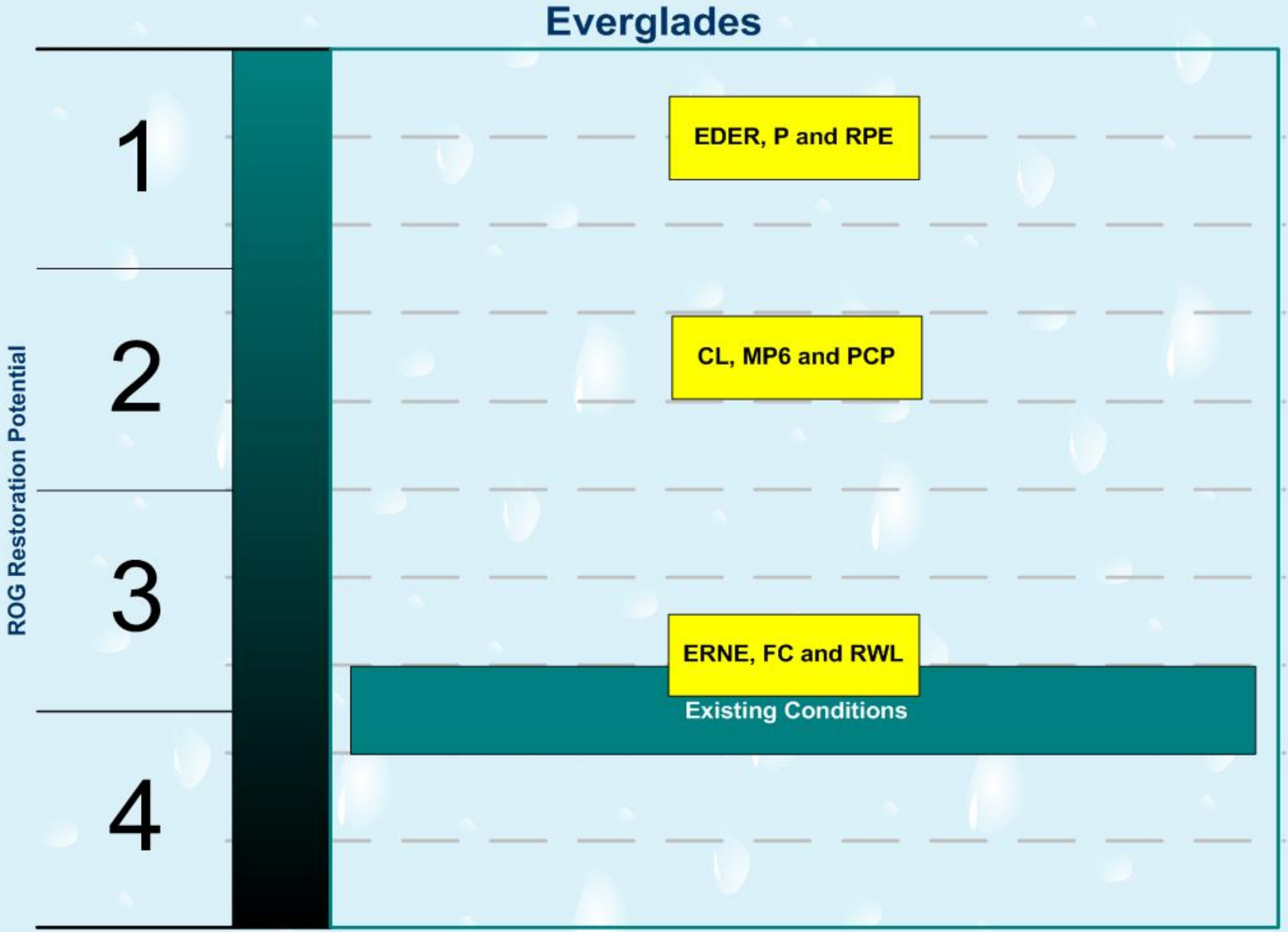
•3

- “Tipping point:” landscape on degrading ecological trajectory toward Condition 4
- Ecologically, very different from Condition 2 because of downward trajectory
- Everglades ecology is very sensitive to hydrologic change - modest hydrologic improvements can tip ecological conditions from 3 to 2

•4

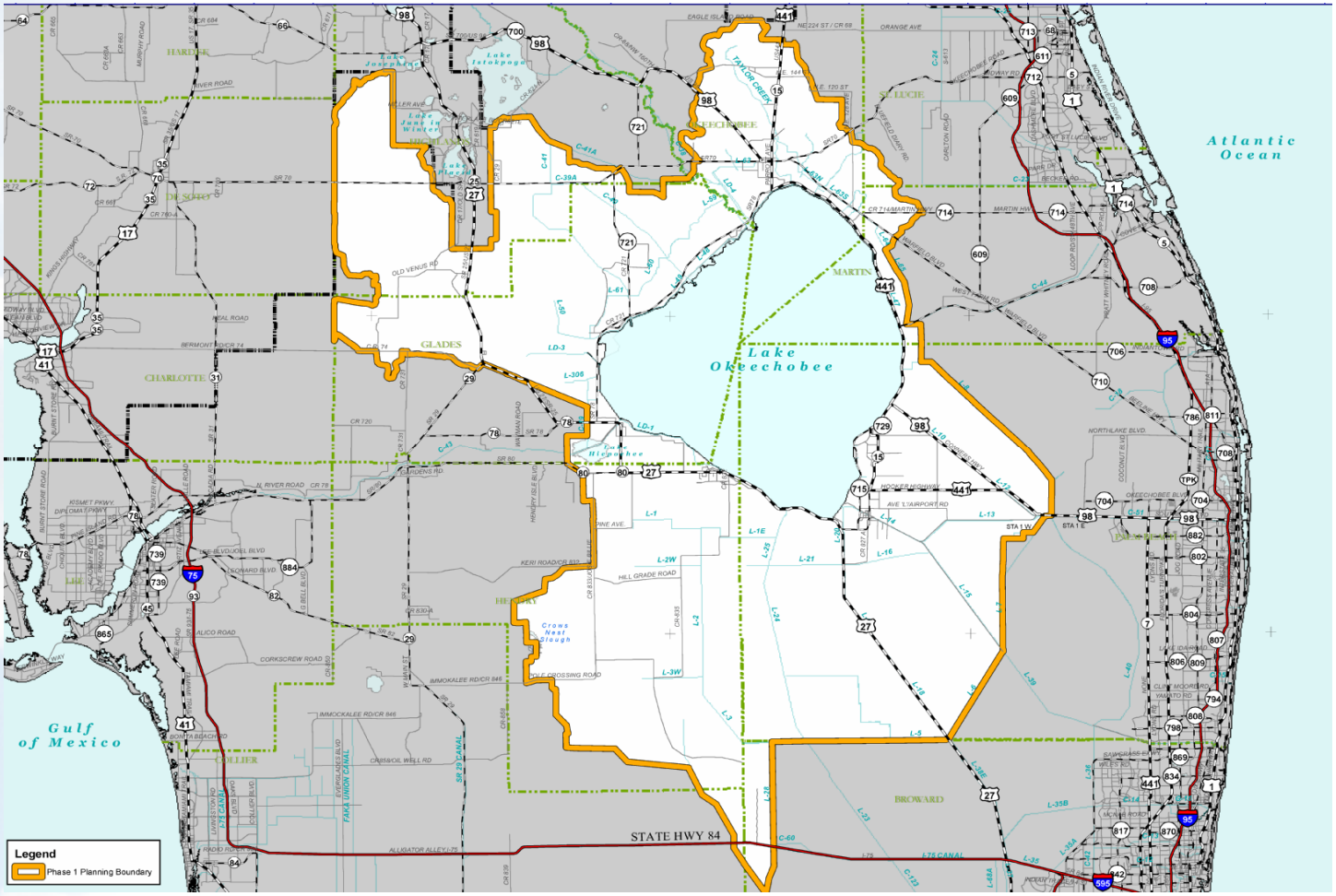
- Sloughs are dry (water depths zero) for more than four months of the year
- Flows zero for more than six months of the year; annual flows to FL Bay near zero
- Multi-year large fish populations eliminated; small fish populations greatly reduced
- Wading bird prey base essentially eliminated
- Widespread oxidation and/or burning of peat
- Elevations of ridges and tree islands reduced to level of sloughs (landscape flattened)
- Water lilies gone; sloughs invaded by sawgrass / dryland species; tree islands gone.


Everglades
Composite Std Score
Composite Dry Season Std Score
Avg Dry Yrs Delivery (kaf/yr)
Avg Dry Season Del (kaf/yr)
Total Mean Annual Flow (kaf/yr)
Increase in Mean Annual Flow (kaf/yr)
1
2
3
4
EDER RPE P PCP CL MP6
EDER RPE P
RWL EDER RPE
EDER P RPE
CL PCP
P PCP
ERNE RWL
MP6 RWL
EDER P RPE
PCP P RWL EDER RPE
FC
ERNE
PCP CL RWL MP6
MP6 CL FC
FC
PCP CL MP6 RWL
CL MP6 FC ERNE
ERNE
FC ERNE
ERNE
BASE
BASE
BASE FC
BASE
BASE
BASE


Everglades
ROG Restoration Potential
1
2
3
4
EDER, P and RPE
CL, MP6 and PCP
ERNE, FC and RWL
Existing Conditions

# System Wide




Atlantic Ocean
Gulf of Mexico
Lake Okeechobee
Lake Istokpoga
Lake Josephine
Lake June in Winter
Lake Placid
Lake Hicpochee
Crows Nest Slough
HARDEE
DE SOTO
CHARLOTTE
GLADES
HENDRY
COLLIER
LEE
MARTIN
ST. LUCIE
BROWARD
STATE HWY 84
Legend
Phase 1 Planning Boundary

| ROG Restoration Potential | Caloosahatchee Estuary | St. Lucie Estuary | LOSA Demand | Lake Okeechobee | Everglades |
|---|---|---|---|---|---|
| 1 | CL, EDER, MP6, P, PCP, RPE and RWL | CL, EDER, MP6, P, PCP, RPE and RWL | | | EDER, P and RPE |
| 2 | ERNE and FC<br>Existing Conditions | ERNE and FC | All Configurations | FC<br>Existing Conditions | CL, MP6 and PCP |
| 3 | | Existing Conditions | Existing Conditions | CL, EDER, ERNE, MP6, P, PCP and RPE, RWL | ERNE, FC and RWL<br>Existing Conditions |
| 4 | | | | | |

DRAFT

# Summary of Planning Level Cost Estimates & Sugar Cane Productivity for Team Configurations

sfwmd.gov/riverofgrass

# System-Wide Approach



**Program Overlap**

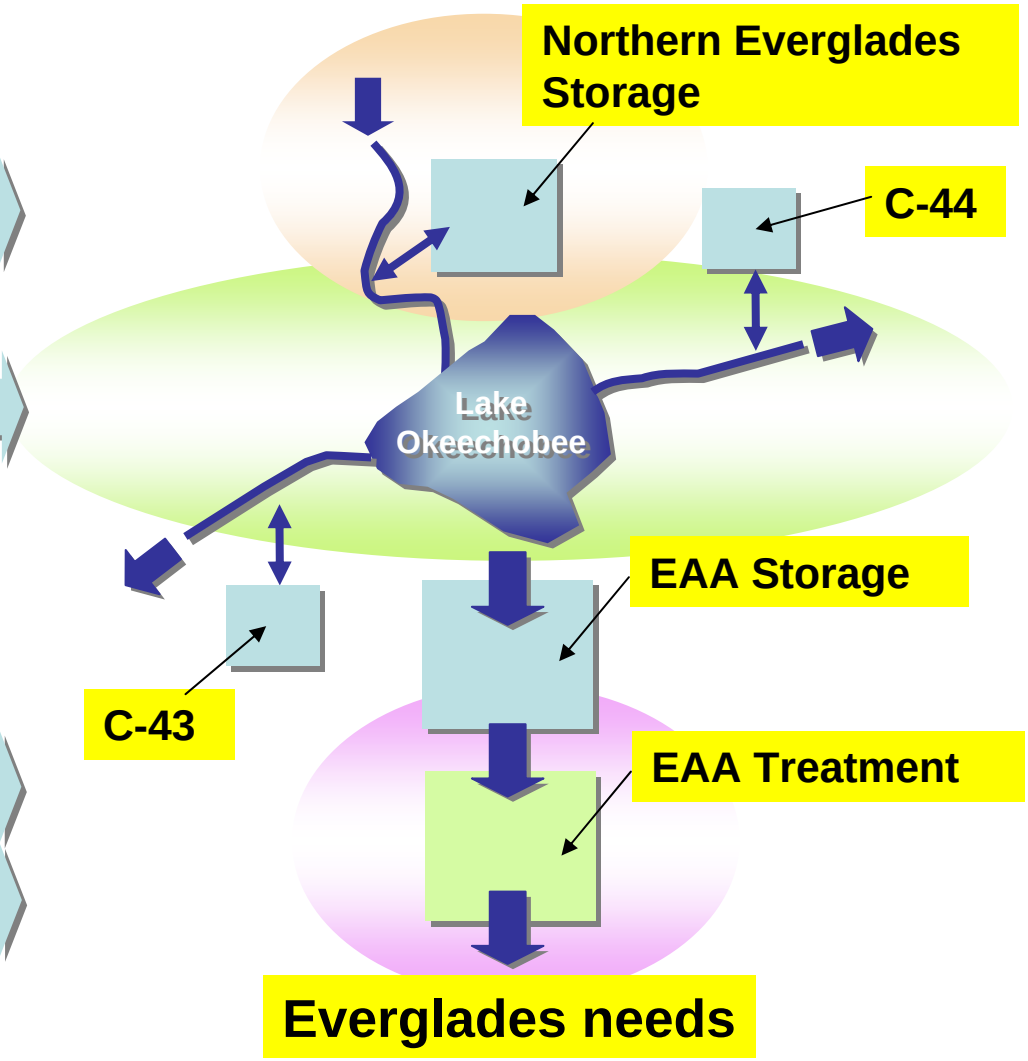
Lake Okeechobee Technical Plan

River Watershed Protection Plans

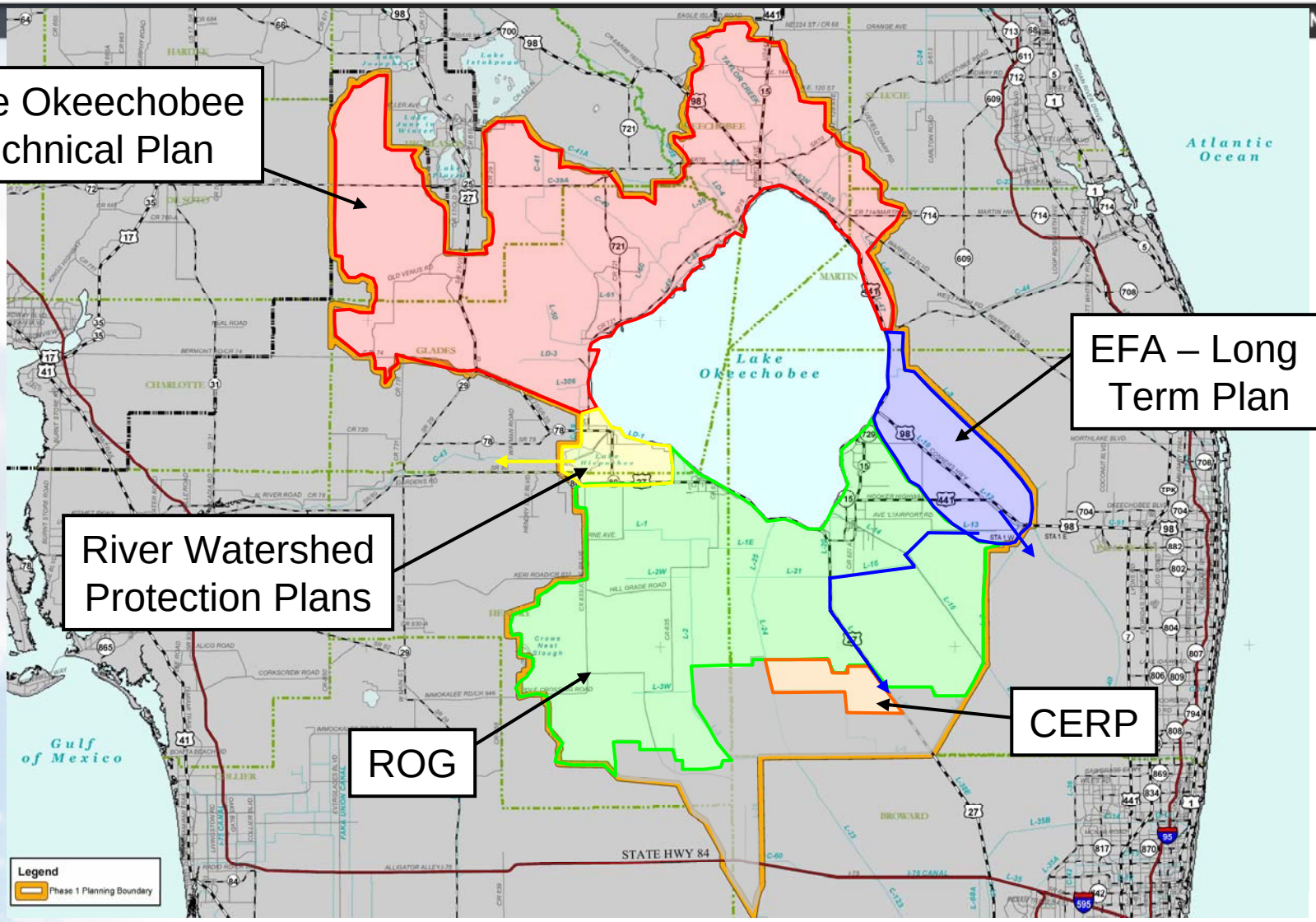
ROG

CERP

EFA -Long Term Plan

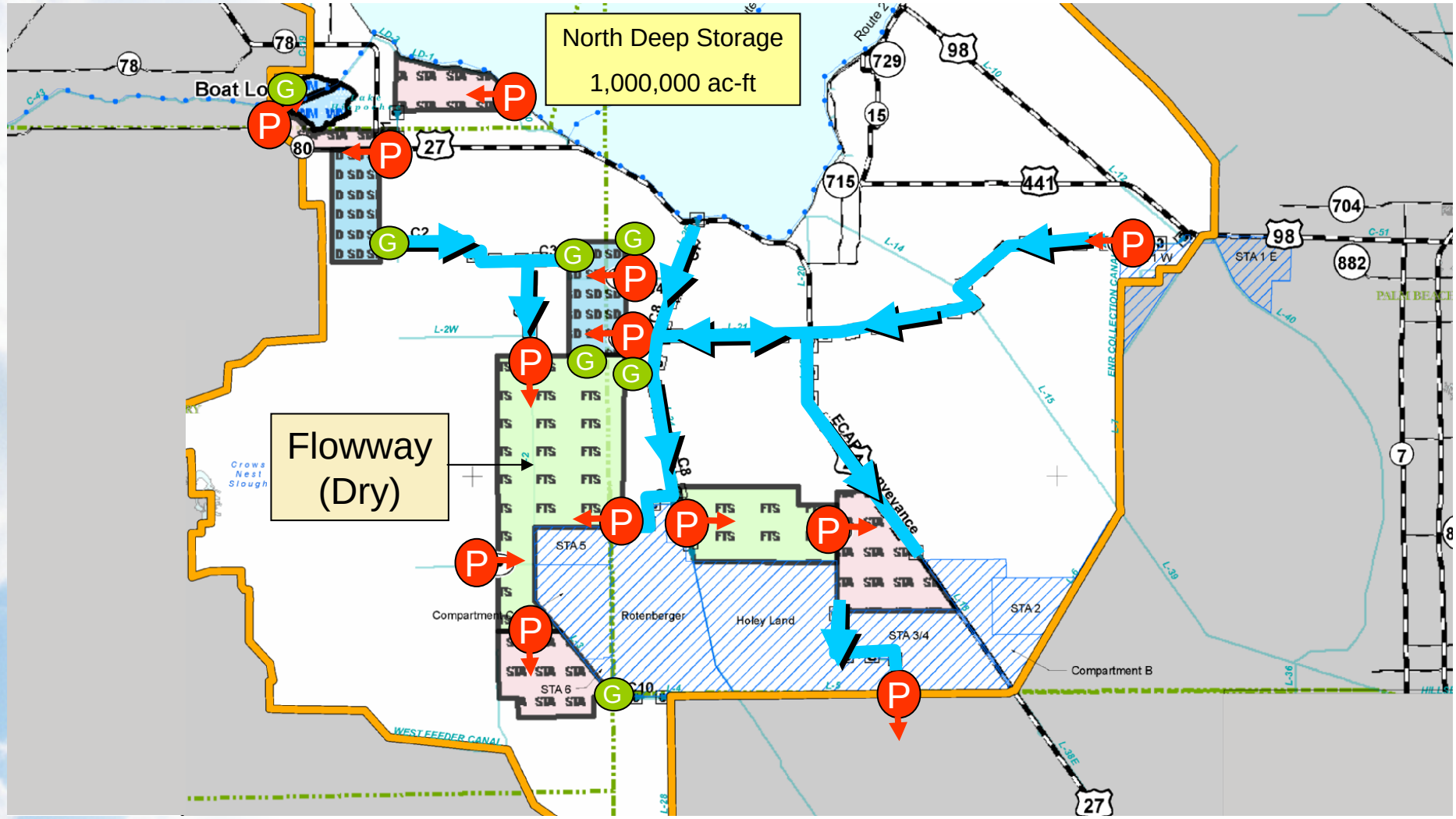


# Program Areas



# Estuary Driven Everglades Restoration
## Conceptual Configuration





# Estuary Driven Everglades Restoration
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $21.8M
  - River Watershed Protection Plan- $0.5M
  - Long Term Plan- $0
  - CERP- $0
  - River Of Grass- $65.2M

# Estuary Driven Everglades Restoration
## Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $708.7M
  - River Watershed Protection Plan- $1.4M
  - Long Term Plan- $0
  - CERP- $24.5M
  - River Of Grass- $637.1M

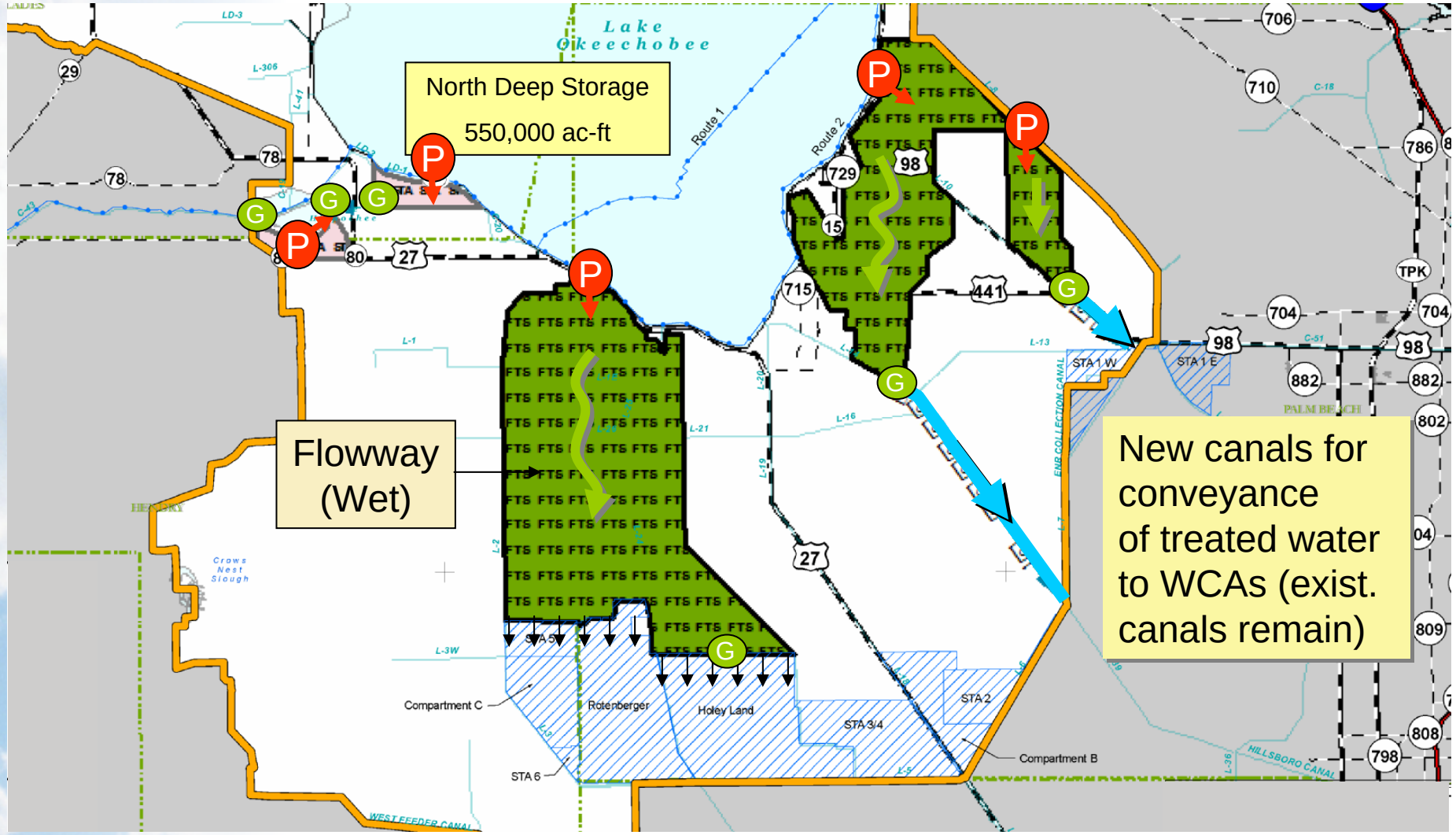
# Estuary Driven Everglades Restoration
## Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $6.8B
  - River Watershed Protection Plan- $118.6M
  - Long Term Plan- $260M
  - CERP- $1.5B
  - River Of Grass- $5.6B

# Everglades River of Grass Northern Expansion
## Conceptual Configuration





# Everglades River of Grass Northern Expansion
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $11.5M
  - River Watershed Protection Plan- $6.9M
  - Long Term Plan- $0
  - CERP- $30.9M
  - River Of Grass- $184.4M

# Everglades River of Grass Northern Expansion
## Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $374.1M
  - River Watershed Protection Plan- $54.4M
  - Long Term Plan- $0
  - CERP- $210.3M
  - River Of Grass- $1.3B

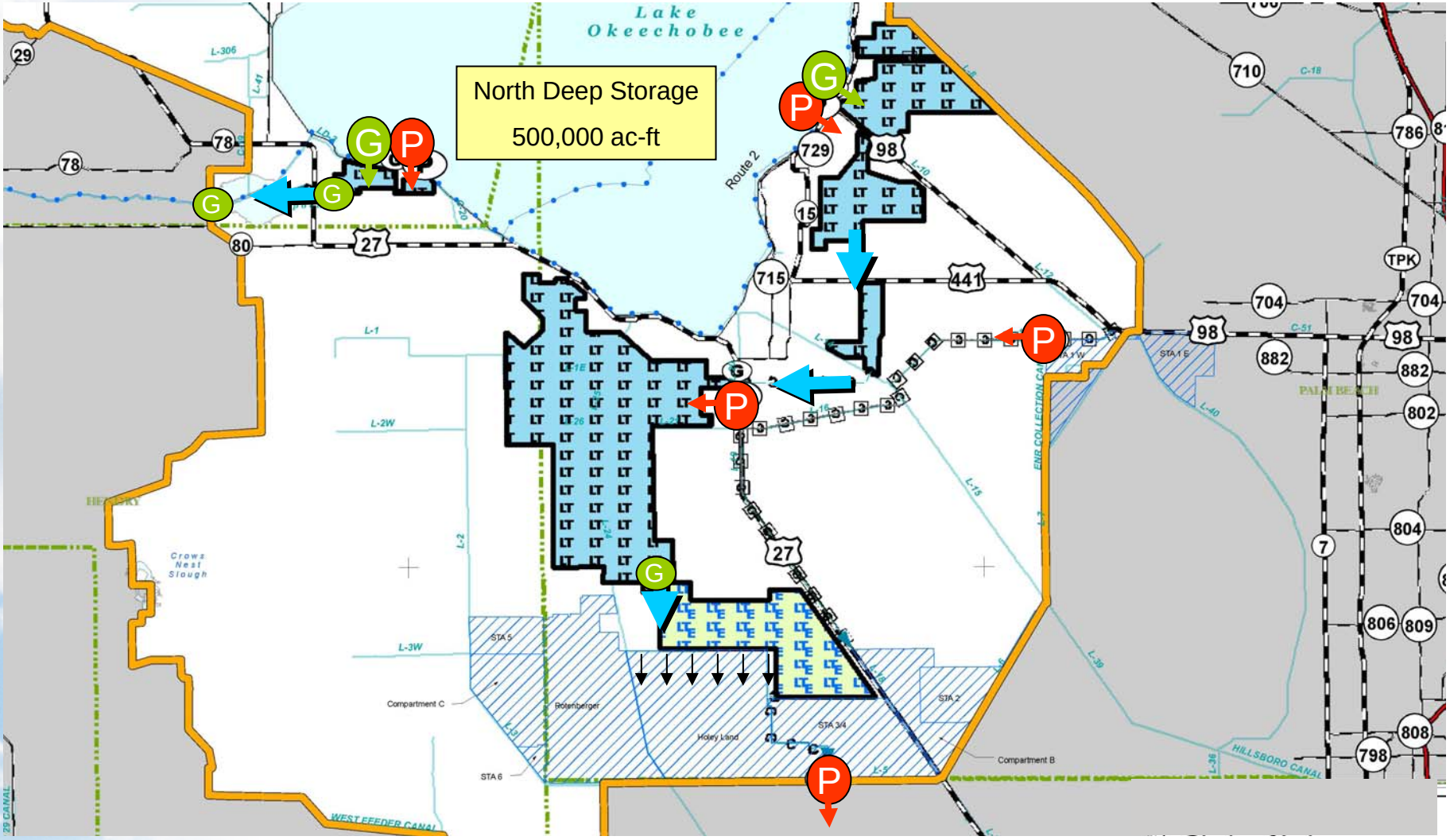
# Everglades River of Grass Northern Expansion
## Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $3.6B
  - River Watershed Protection Plan- $344.7M
  - Long Term Plan- $0
  - CERP- $421.8M
  - River Of Grass- $5.8B

# Chain of Lakes
## Conceptual Configuration





# Chain of Lakes
# Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $27.3M
  - River Watershed Protection Plan- $4.7M
  - Long Term Plan- $0
  - CERP- $0
  - River Of Grass- $127.7M

# Chain of Lakes
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $888M
  - River Watershed Protection Plan- $31.3M
  - Long Term Plan- $0
  - CERP- $0
  - River Of Grass- $749M

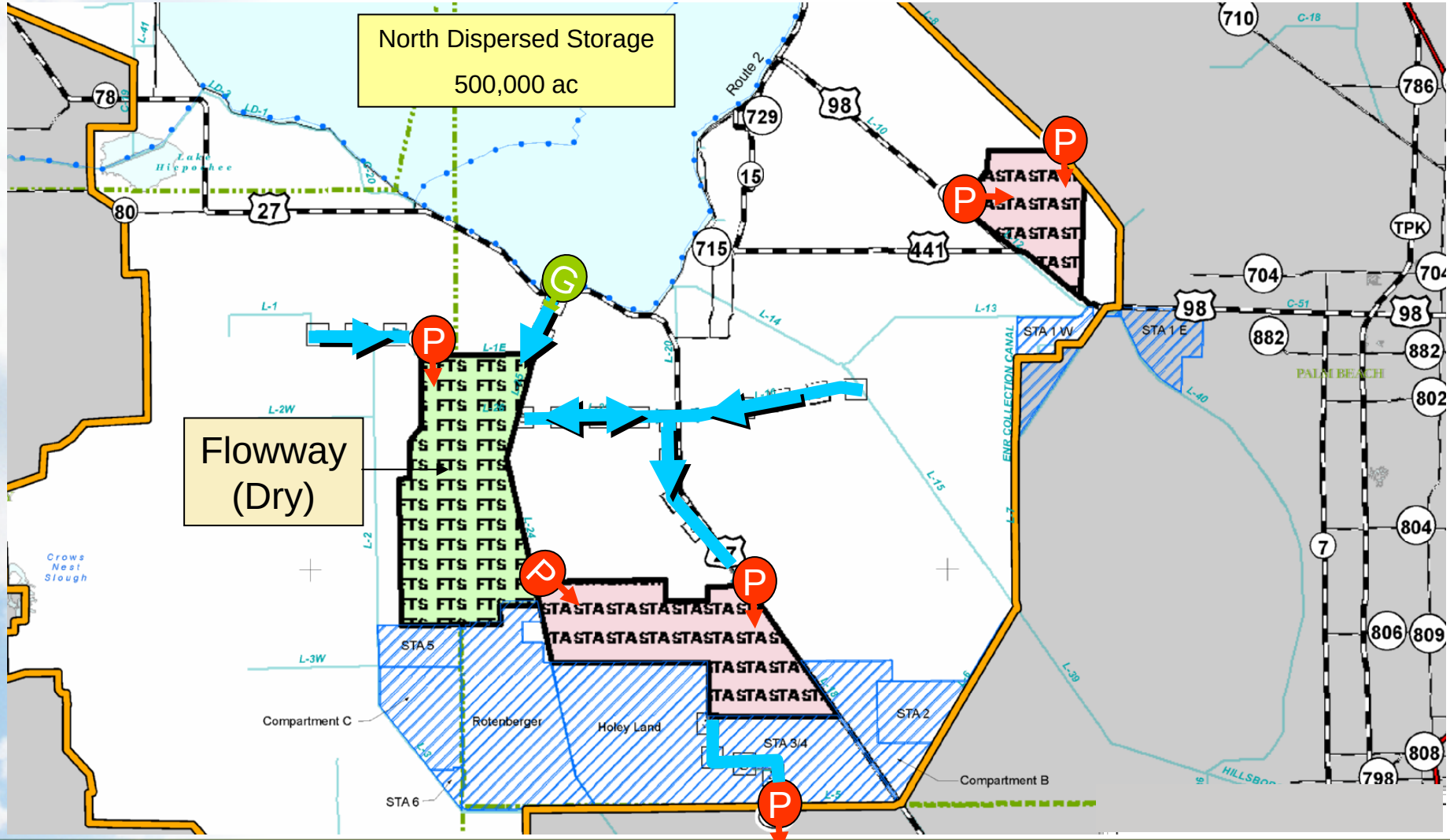
# Chain of Lakes
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $10.7B
  - River Watershed Protection Plan- $2.3B
  - Long Term Plan- $260M
  - CERP- $1.6B
  - River Of Grass- $10.9B

# Florida Crystals
## Conceptual Configuration





# Florida Crystals
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $0
  - River Watershed Protection Plan- $0
  - Long Term Plan- $18.6M
  - CERP- $0
  - River Of Grass- $48.2M

# Florida Crystals
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $0
  - River Watershed Protection Plan- $0
  - Long Term Plan- $155.4M
  - CERP- $11.8M
  - River Of Grass- $306.7M

# Florida Crystals
# Construction Cost Estimates

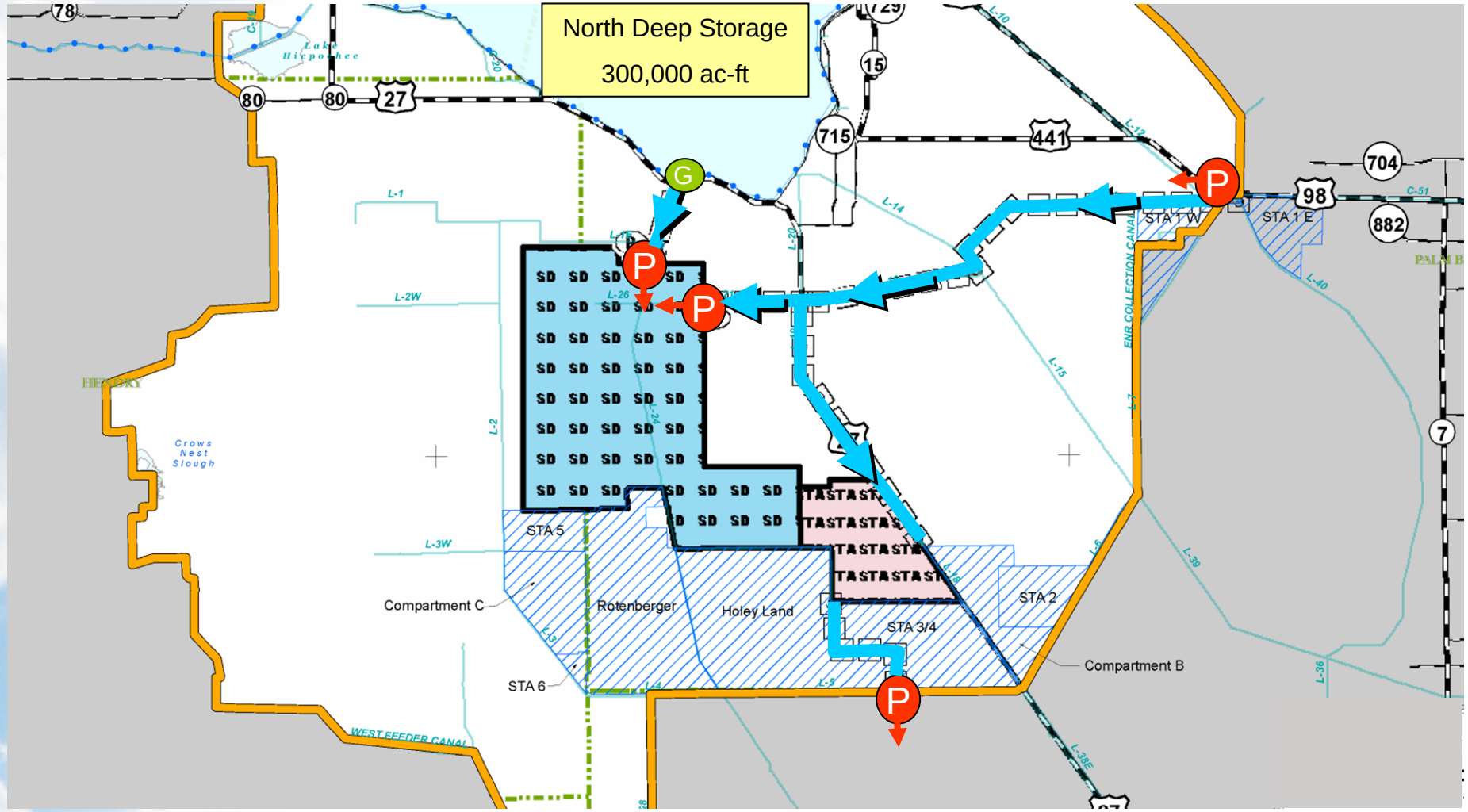


- Categories
  - Lake O Technical Plan- $35M*
  - River Watershed Protection Plan- $0
  - Long Term Plan- $784.9M
  - CERP- $1.6B
  - River Of Grass- $569.8M

* Does not include $1.3B estimate of 20 years of payment for disbursed storage

# Restoration Plus Employment
## Conceptual Configuration





# Restoration Plus Employment
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $6.1M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $13.9M
  - River Of Grass- $55.9M

# Restoration Plus Employment
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $199.5M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $89.7M
  - River Of Grass- $361.1M

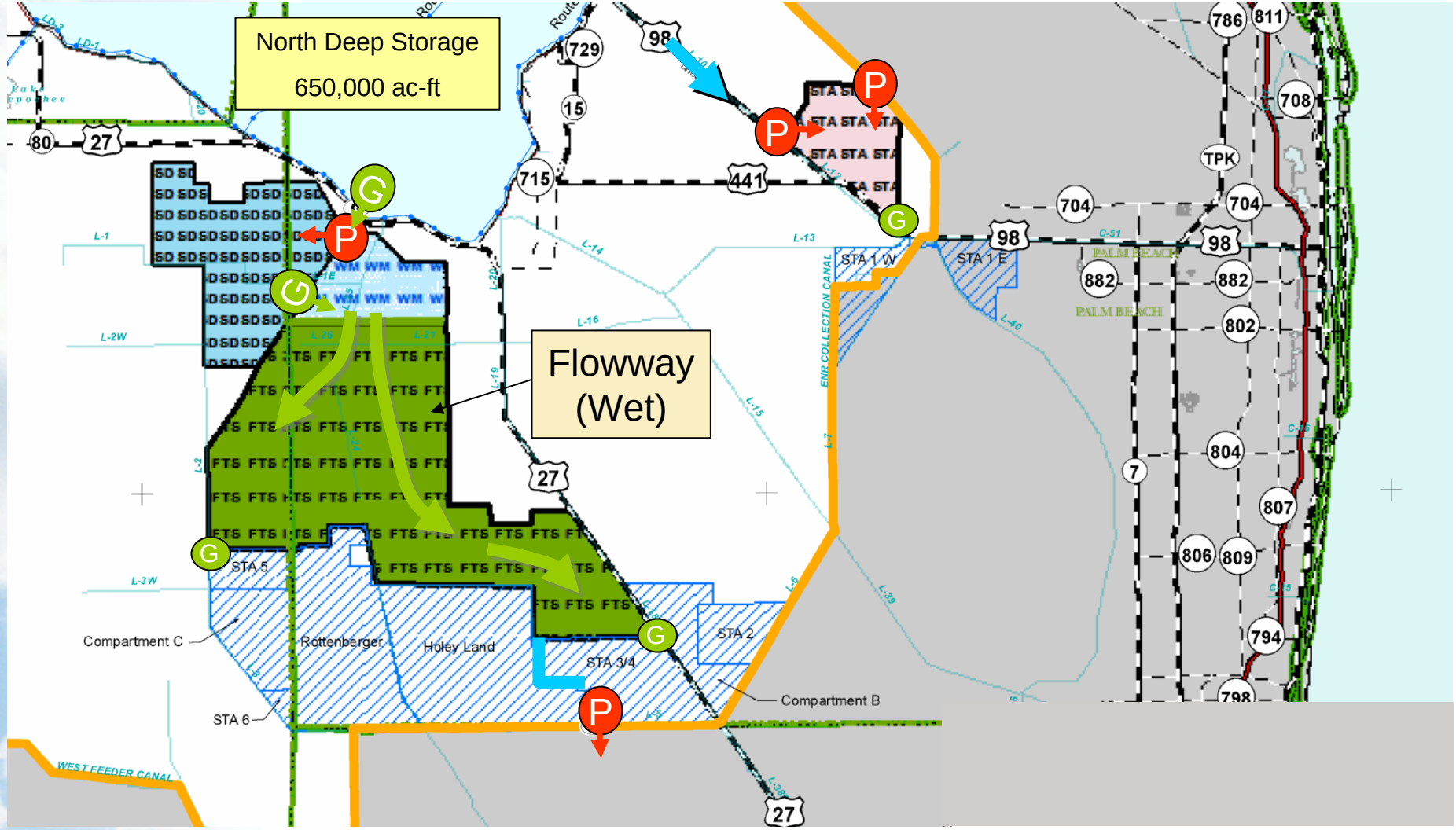
# Restoration Plus Employment
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $1.9B
  - River Watershed Protection Plan- $0
  - Long Term Plan- $260M
  - CERP- $2.2B
  - River Of Grass- $4.8B

# Marshall Plan Element 6
## Conceptual Configuration





# Marshall Plan Element 6
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $13.7M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $18.6M
  - CERP- $0
  - River Of Grass- $128.9M

# Marshall Plan Element 6
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $446.3M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $155.4M
  - CERP- $6.7M
  - River Of Grass- $831.2M

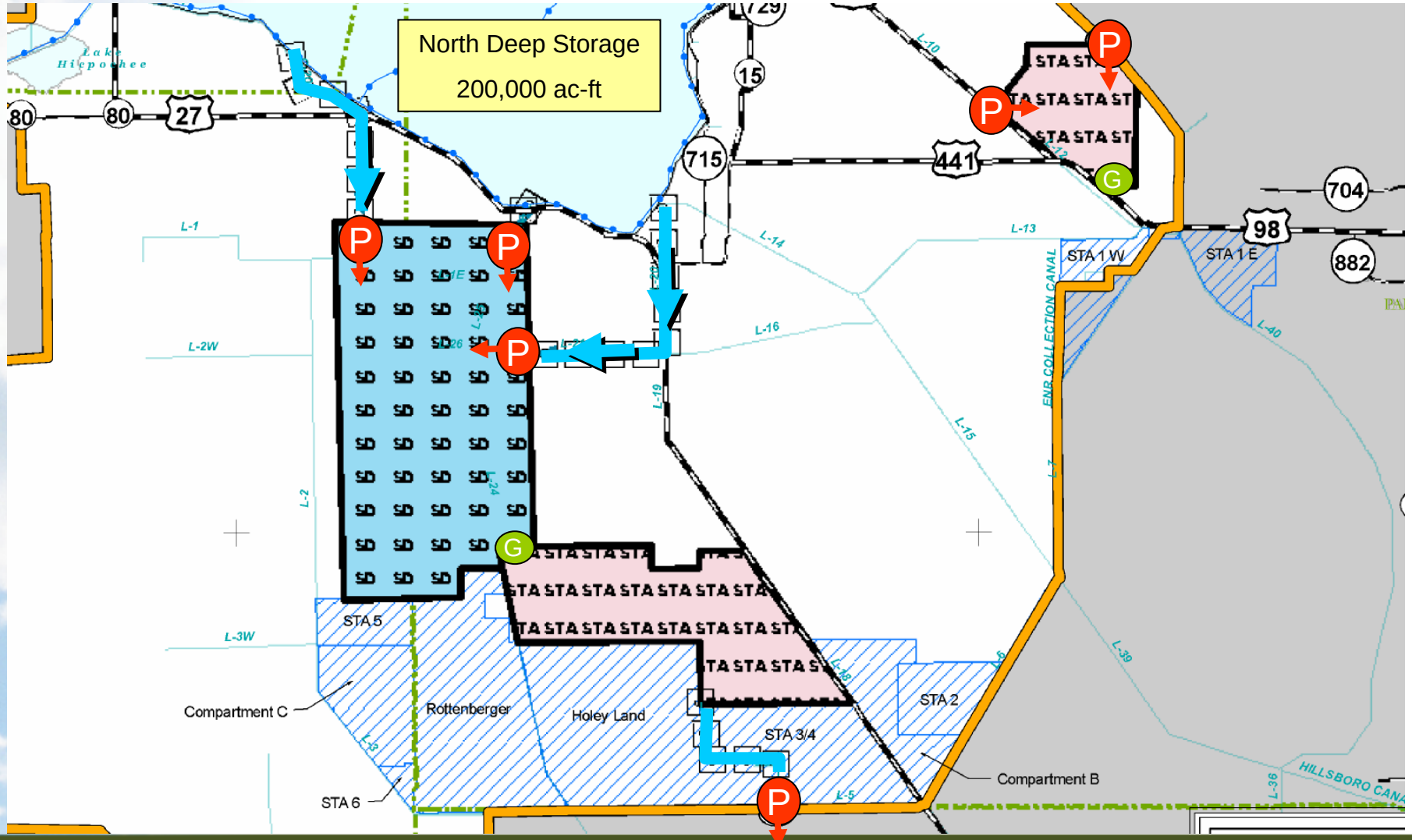
# Marshall Plan Element 6
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $4.3B
  - River Watershed Protection Plan- $0
  - Long Term Plan- $784.9M
  - CERP- $121.4M
  - River Of Grass- $5.5B

# Performance
## Conceptual Configuration





# Performance
# Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $5M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $18.6M
  - CERP- $0
  - River Of Grass- $78.2M

# Performance
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $131.3M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $155.4M
  - CERP- $11.8M
  - River Of Grass- $509.5M

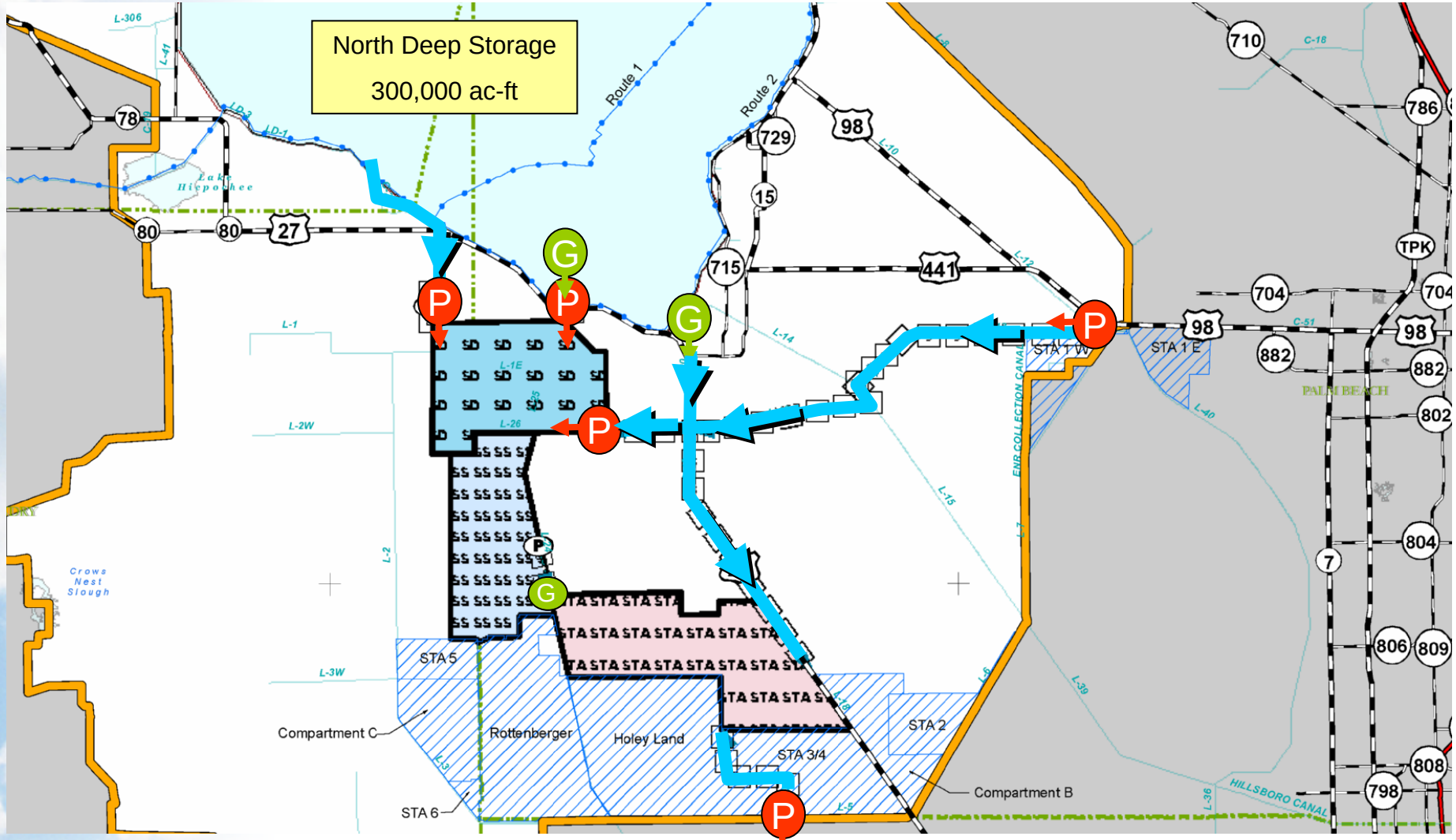
# Performance
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $1.3B
  - River Watershed Protection Plan- $0
  - Long Term Plan- $784.9M
  - CERP- $1.4B
  - River Of Grass- $8.3B

# Performance – Cost
## Conceptual Configuration





# Performance - Cost
## Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $6.1M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $0
  - River Of Grass- $62.9M

# Performance - Cost
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $199.5M
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $11.8M
  - River Of Grass- $446.7M

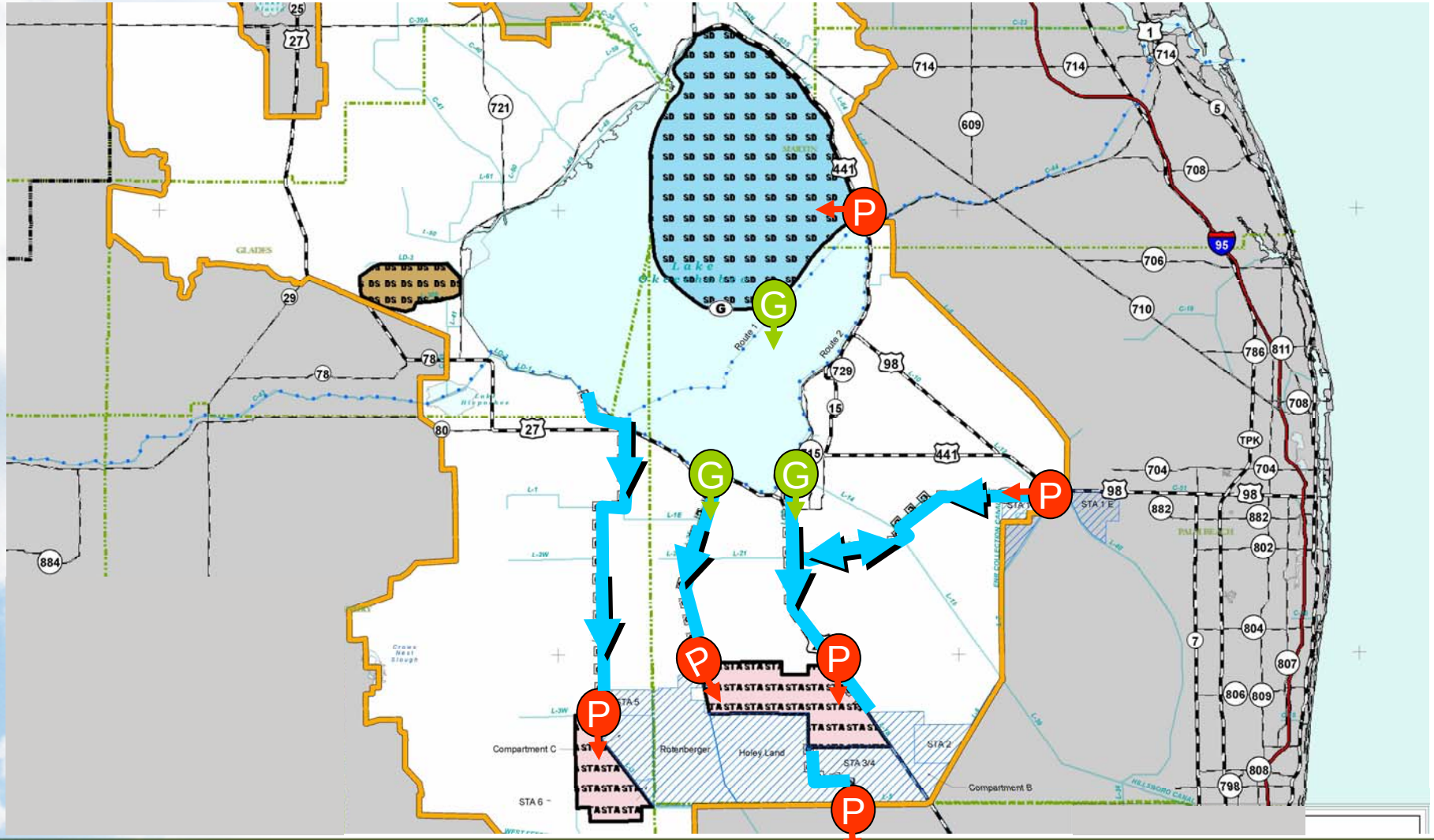
# Performance - Cost
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $1.9B
  - River Watershed Protection Plan- $0
  - Long Term Plan- $260M
  - CERP- $1.4B
  - River Of Grass- $5.3B

# Reservoir Within Lake Okeechobee
## Conceptual Configuration





# Reservoir Within Lake Okeechobee
# Remediation/Corrective Action Cost Estimates



- Categories
  - Lake O Technical Plan- $0
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $0
  - River Of Grass- $6.4M

# Reservoir Within Lake Okeechobee
# Real Estate Cost Estimates



- Categories
  - Lake O Technical Plan- $0
  - River Watershed Protection Plan- $0
  - Long Term Plan- $0
  - CERP- $11.8M
  - River Of Grass- $127.5M

# Reservoir Within Lake Okeechobee
# Construction Cost Estimates



- Categories
  - Lake O Technical Plan- $6.9B*
  - River Watershed Protection Plan- $0
  - Long Term Plan- $260M
  - CERP- $1.9B
  - River Of Grass- $612.9M

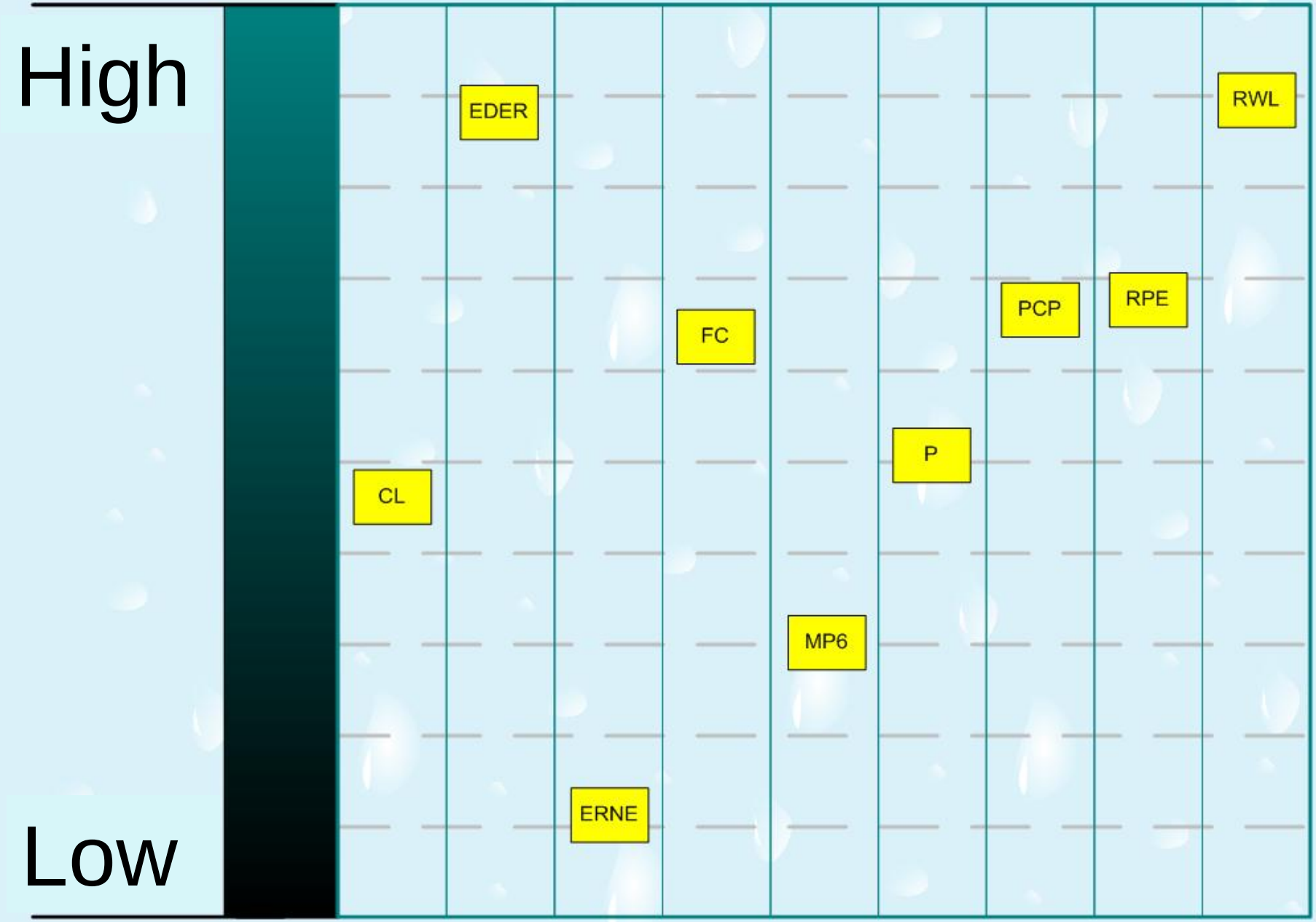
* Does not include $80.6M estimate of 20 years of payment for disbursed storage

# Sugar Cane Productivity



- Analysis focused to describe relative cane production comparison between alternative configurations
- Based on Sugar Cane productivity maps provided in earlier stakeholder meetings
  - Overlay of facility footprints to estimate sugar cane production in the EAA for each configuration.

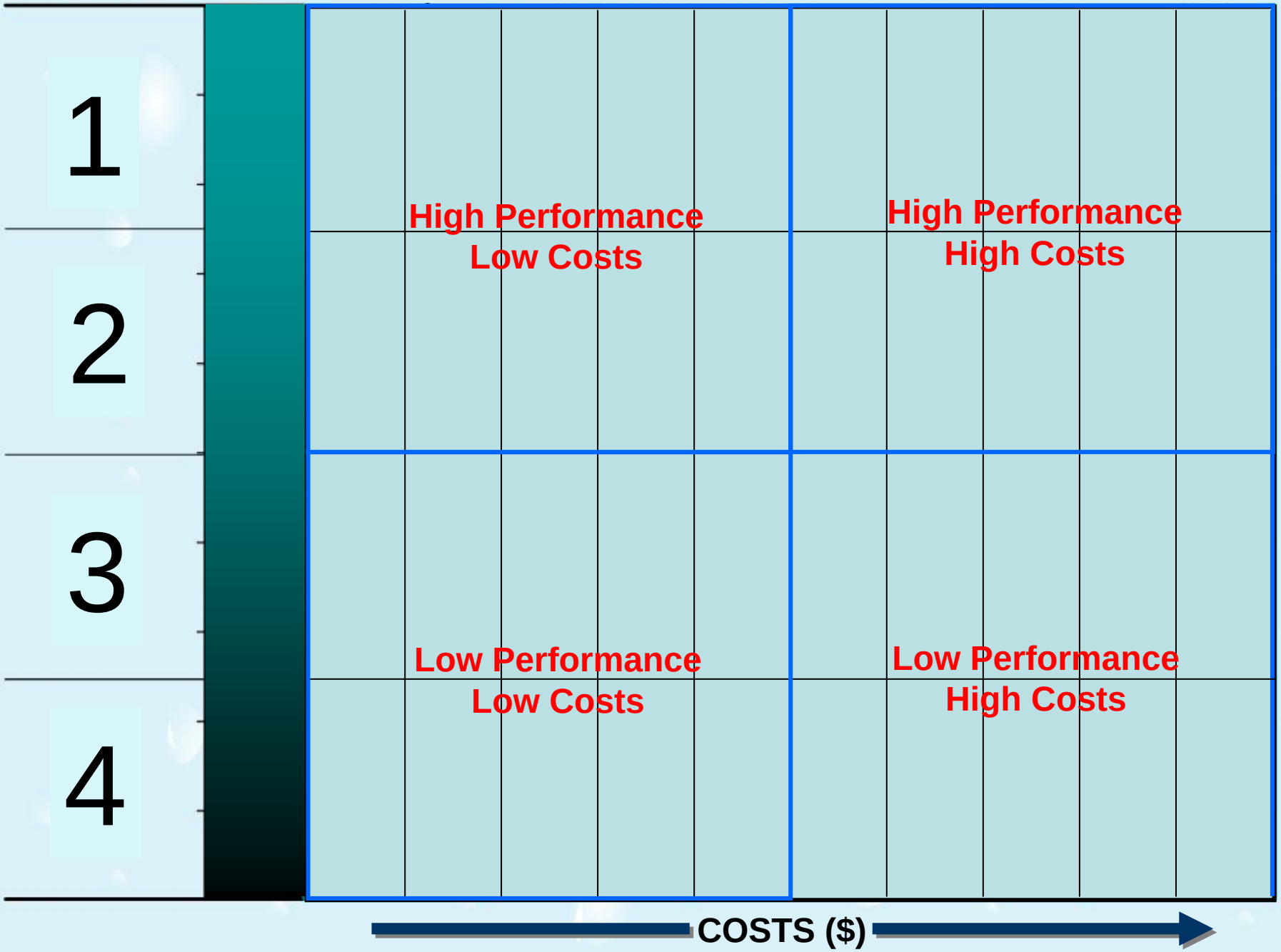
# Relative Comparison of Configurations



# Benefits Costs Summary

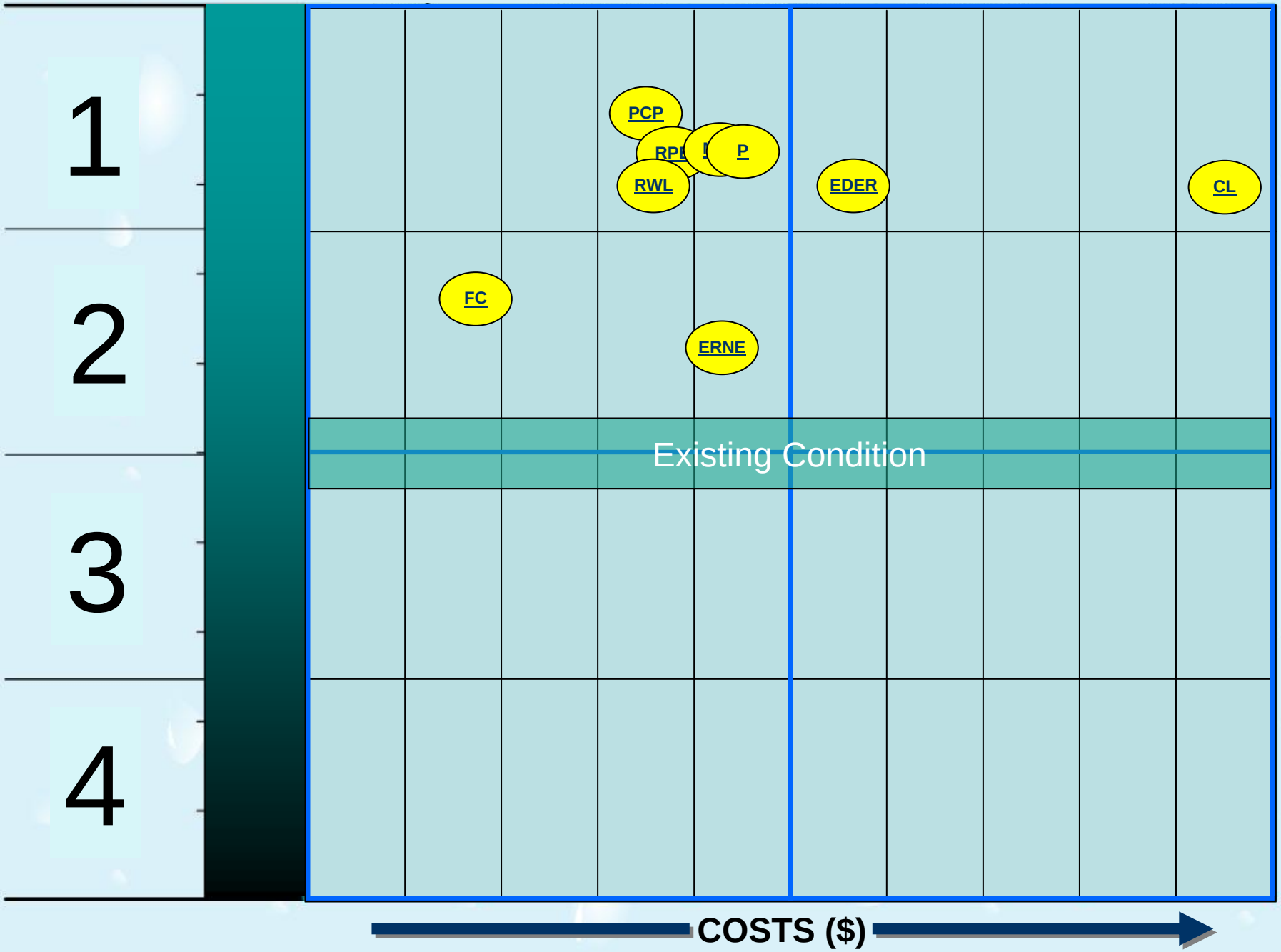
ROG Restoration Potential

# Graphic Relationships



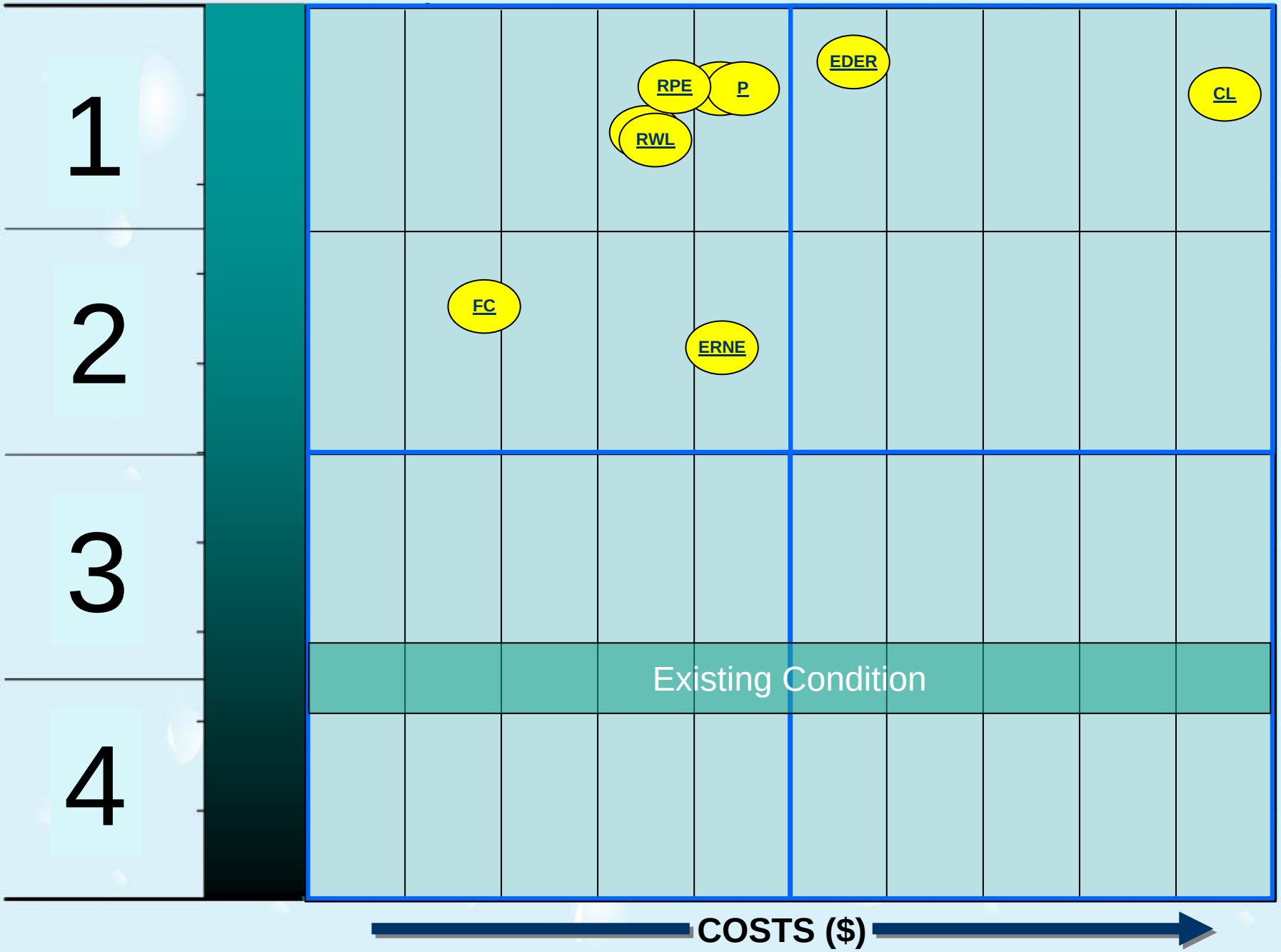
ROG Restoration Potential

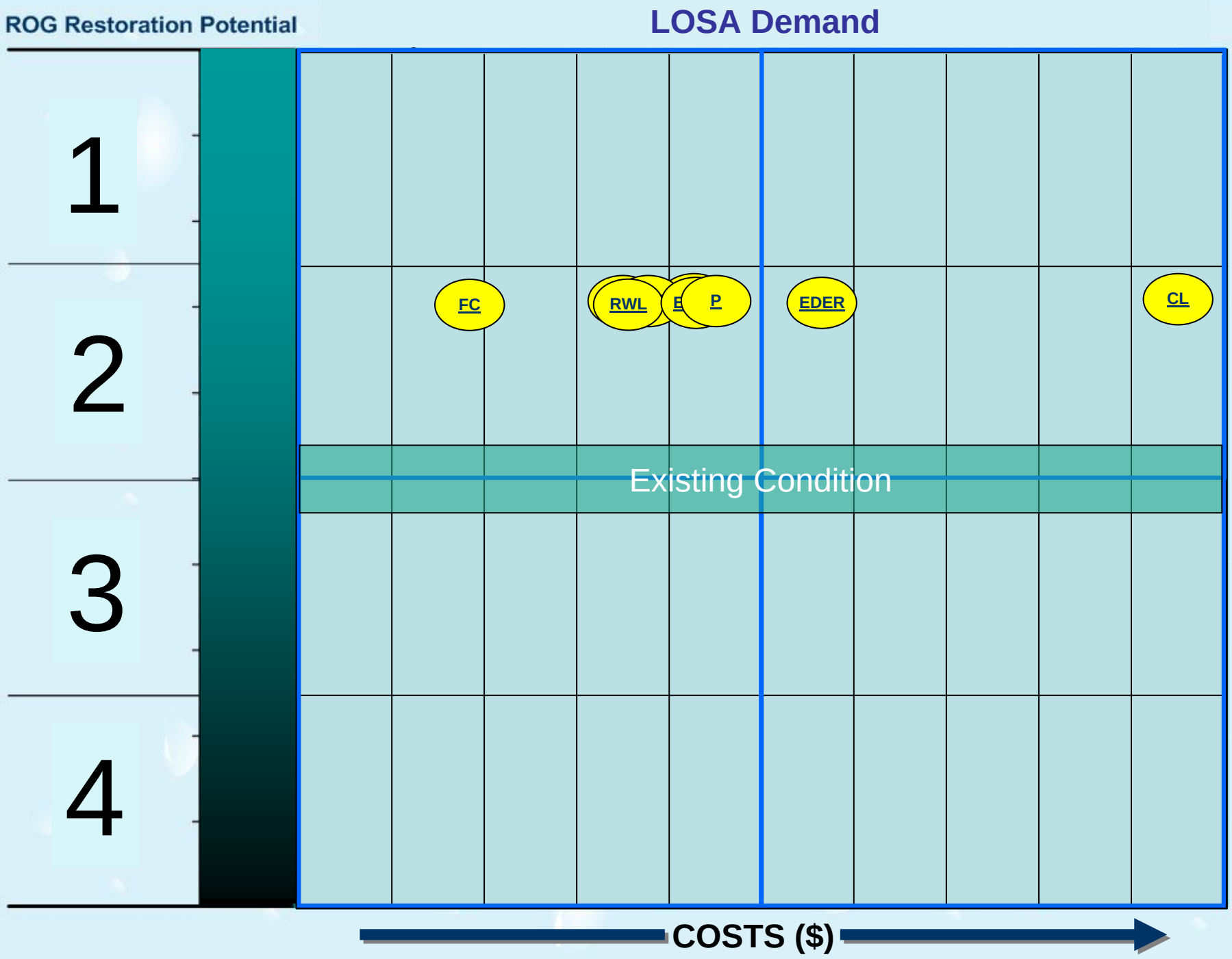
# Caloosahatchee Estuary



ROG Restoration Potential

# St Lucie Estuary




ROG Restoration Potential
LOSA Demand
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2
3
4
FC
RWL
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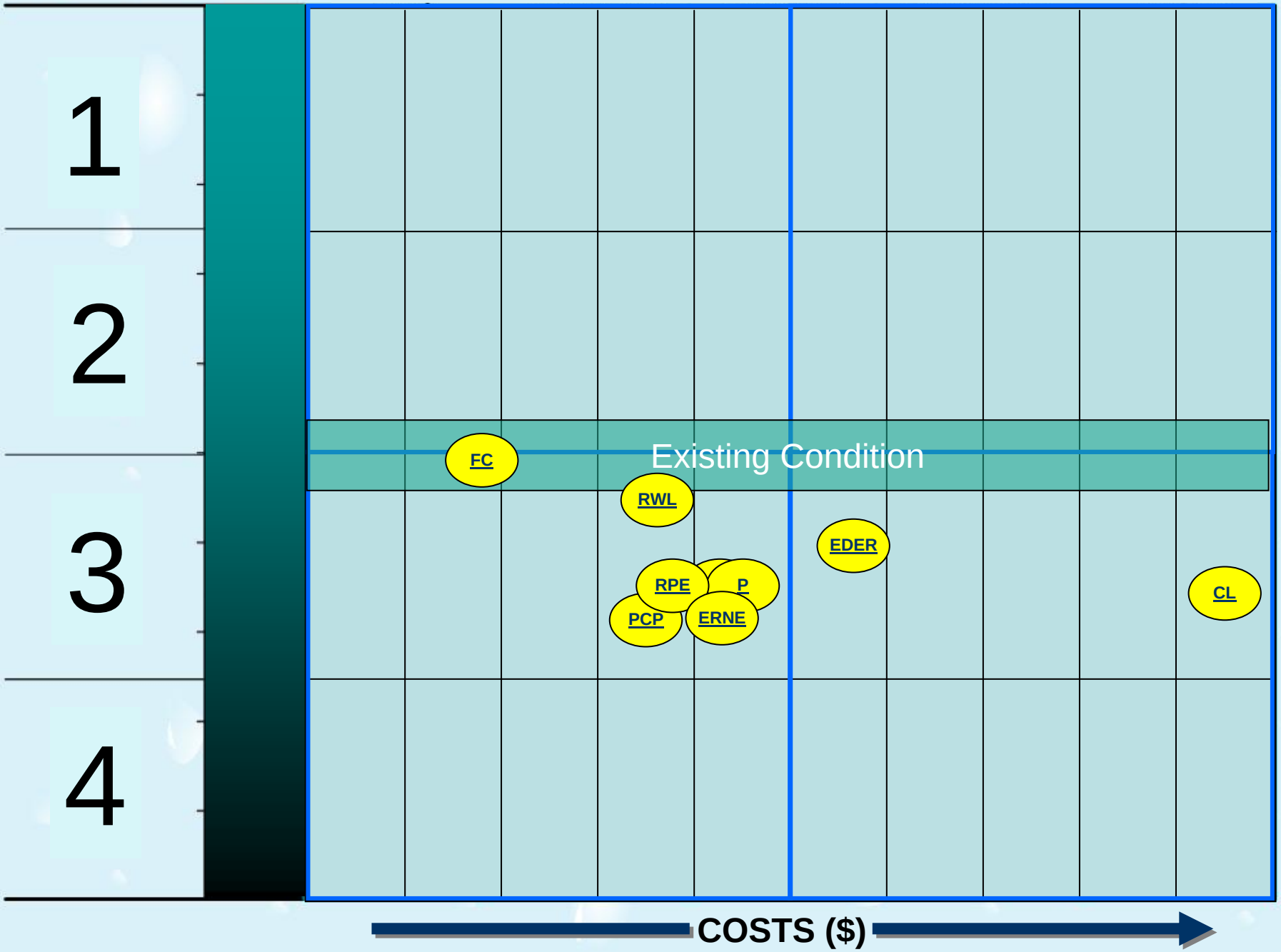
EDER
CL
Existing Condition
COSTS ($)

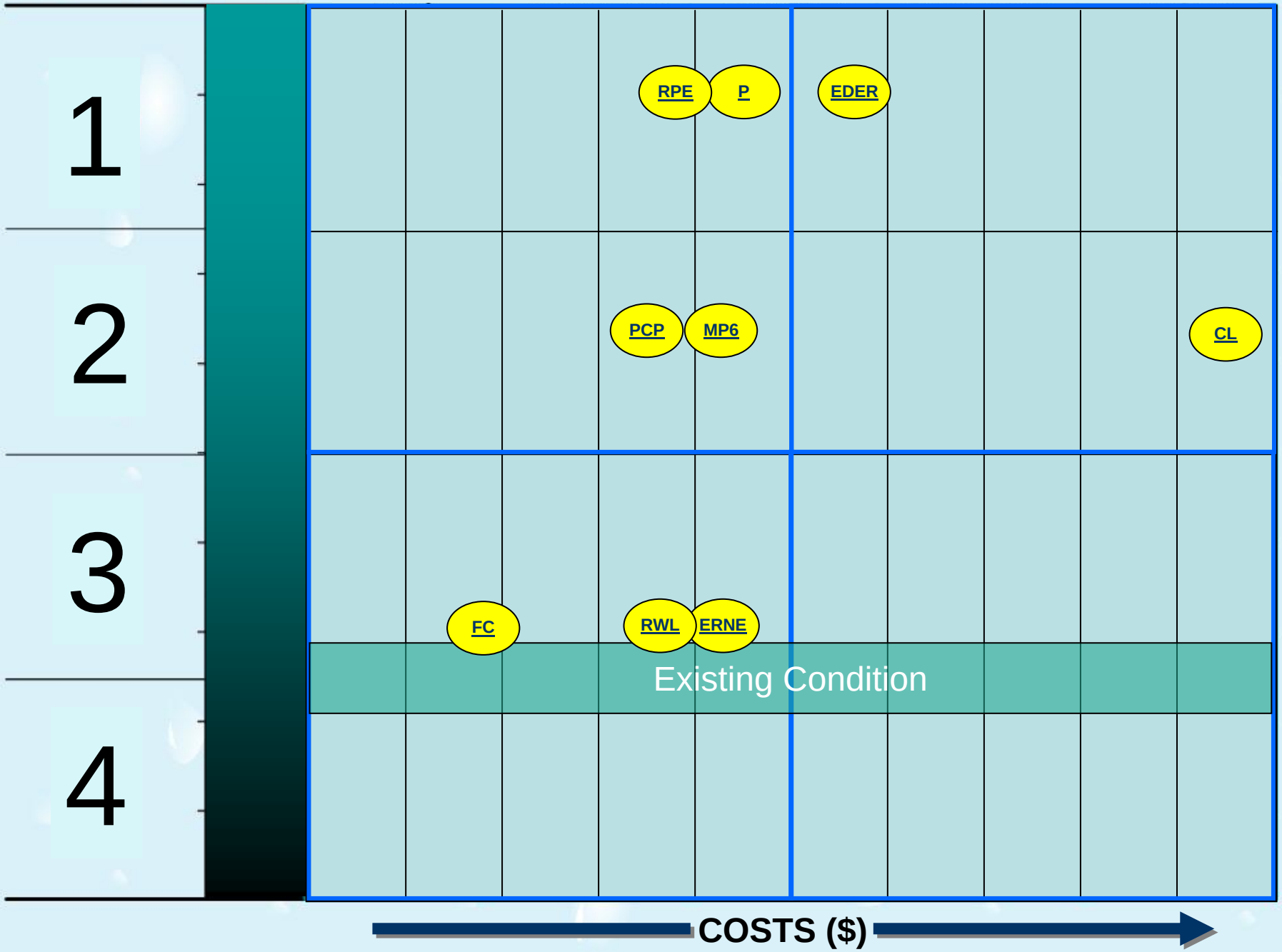
ROG Restoration Potential

# Lake Okeechobee



ROG Restoration Potential

# Everglades



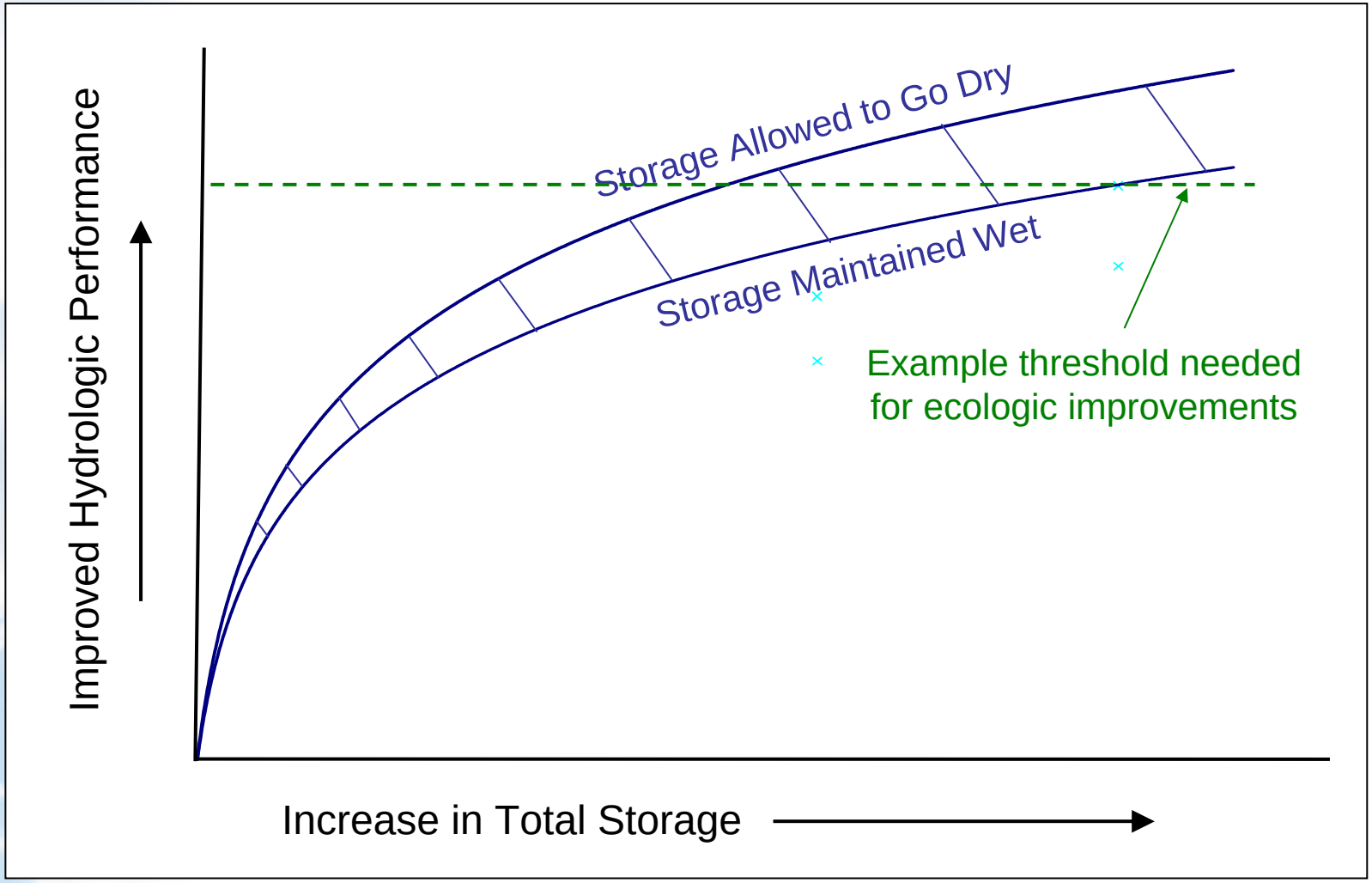
# Trend Analysis of Public Configurations



- In addition to the various evaluations (benefits, cost, etc…) completed on the public configurations, additional analysis can be used to analyze trends in performance.
- This analysis 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

# Example Trend Analysis Graphic





# Observations of Example Trend Analysis



- Allowing storage areas to go dry maximizes potential hydrologic benefit to the Lake, estuary and Everglades systems.
- 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
- Gains in hydrologic performance beyond the point of diminishing returns may be necessary to obtain desired ecological responses

# Next Meeting/Future Meeting Topics

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

sfwmd.gov/riverofgrass

# Next Meeting- Date and Location



## Next WRAC Issues Workshop

**June 18, 2009**

**SFWMD**
**3301 Gun Club Road**
**West Palm Beach, FL**
**10:00 a.m. – 4:00 p.m.**

# Next Meeting- Meeting Topics



## Review and Discussion of Preliminary Results

- Break-out Sessions
  - Teams can rotate through topic specific break-out sessions with the evaluation teams
    - Lake Okeechobee/LOSA
    - Northern Estuaries
    - Everglades
    - Water Quality
    - Remediation/Real Estate Costs and Sugar Productivity
    - Construction Costs
- Group Discussion- Initial Thoughts on Lessons Learned, Relationships, Tradeoffs, Other Considerations

# Phase I Planning
# Future Meetings and Topics



## Future Meetings

**(10:00 a.m. – 4:00 p.m.)**

- July 1, SFWMD, West Palm Beach
- July 14, TBD

## Future Meeting Topics

- Evaluation of Relationships, Tradeoffs, Etc.
- Discuss Viable Concepts/Features and Common Elements
- Development of Refined Configurations or Concepts for more Detailed Analysis

# Phase I Planning
# www.sfwmd.gov/riverofgrass

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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.

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### RELATED MATERIALS

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