Section 203 C&SF Flood Resiliency Study for Broward Basins: Modeling Approach

GEER
Greater Everglades Ecosystem Restoration
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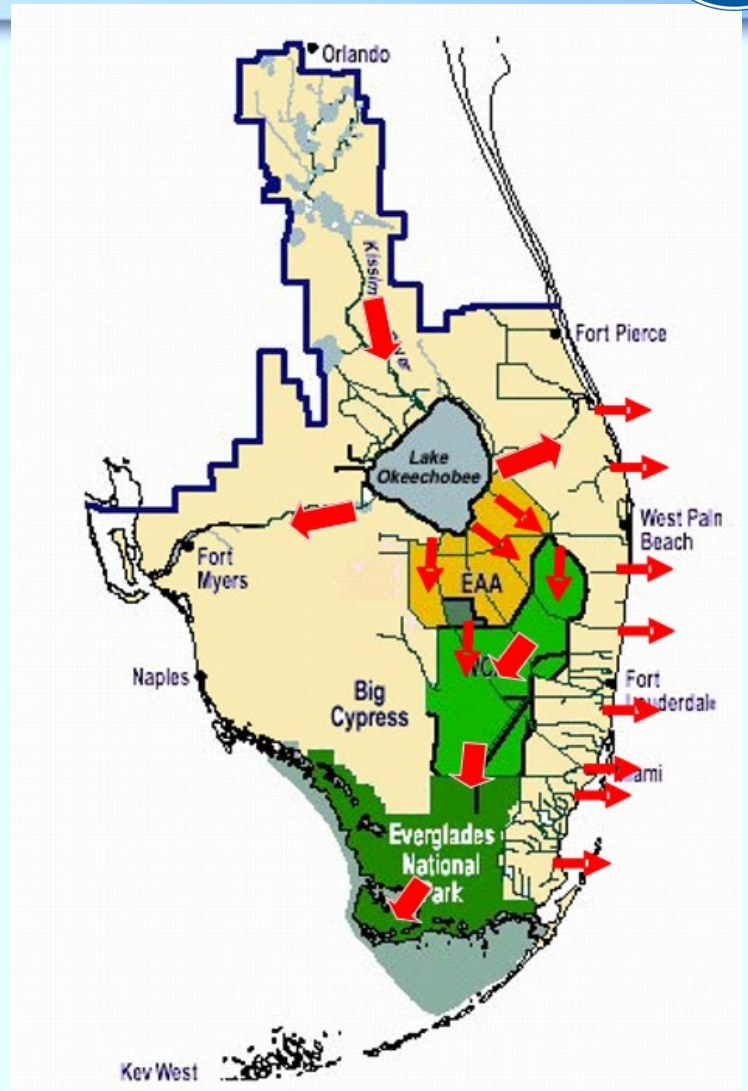
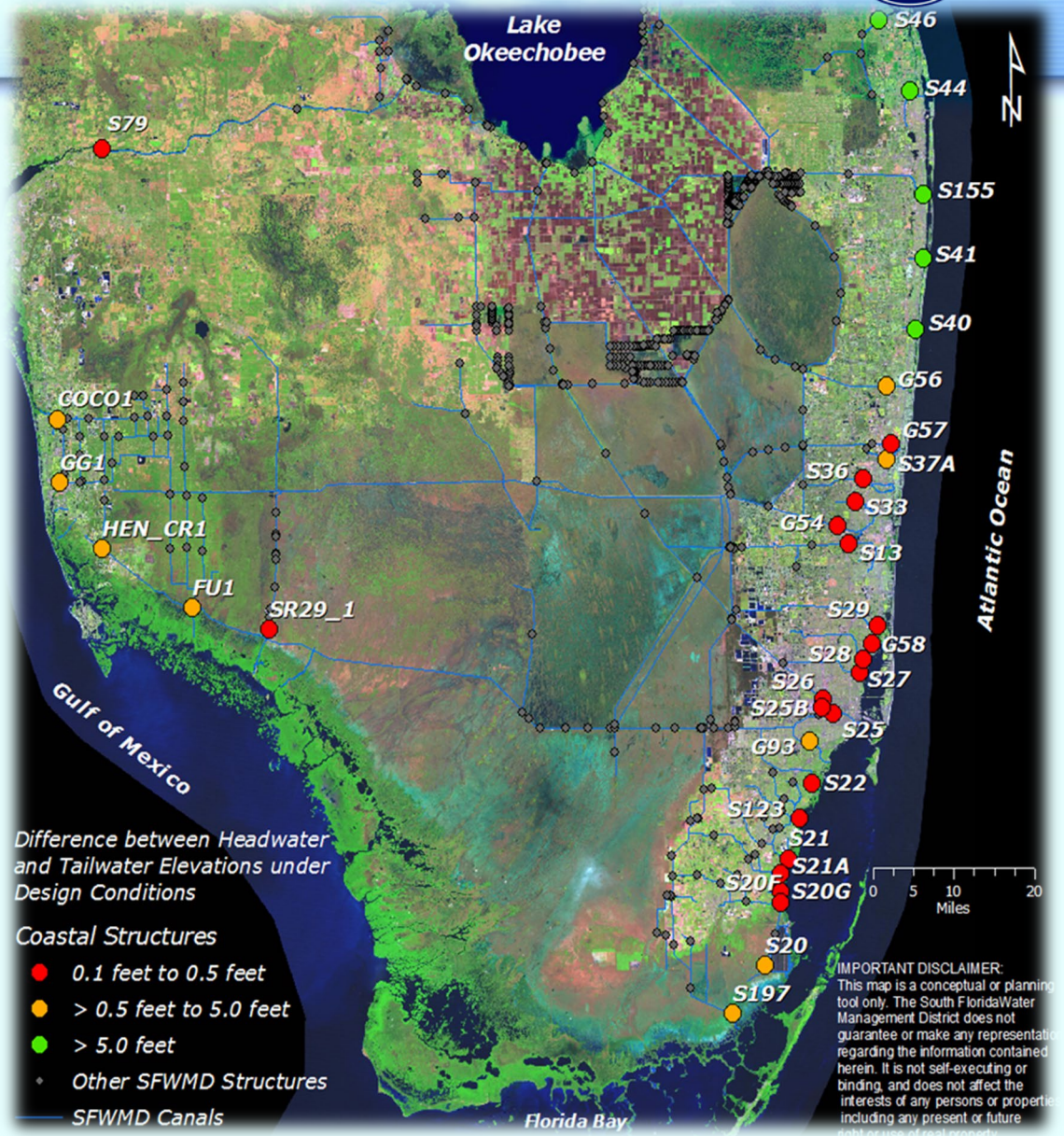
Central and Southern Florida (C&SF) Project for Flood Control and Other Purposes

- Designed for multiple purposes
  - Flood Control
  - Water Supply
  - Navigation
  - Prevention of Saltwater Intrusion
  - Protection of Fish & Wildlife
- Constructed by the U.S. Army Corps of Engineers between 1949 and 1970
- Operated and maintained by the South Florida Water Management District
  - 2,100+ miles of canals and levees
  - 915+ water control structures and 620+ culverts
  - 85+ pumping stations
  - 62,000+ acres of regional wetland Stormwater Treatment Areas
  - Lake Okeechobee (450,000 acre water storage)
  - Water Conservation Areas (959,000+ acre water storage)



Some Changes over the years to Design Considerations

- C&SF Project designed and built 60+ years ago
  - Approaching end of design life
- Original design for an expected population of 2 million people/ now 6 million +
- Original projections were for less urban development than has occurred over the years
- Original design did not take into account the occurrence of sea level rise (SLR)
- Many low-lying structures are vulnerable to SLR



Section 203

C&SF Flood Resiliency Study for Broward Basins

Authority

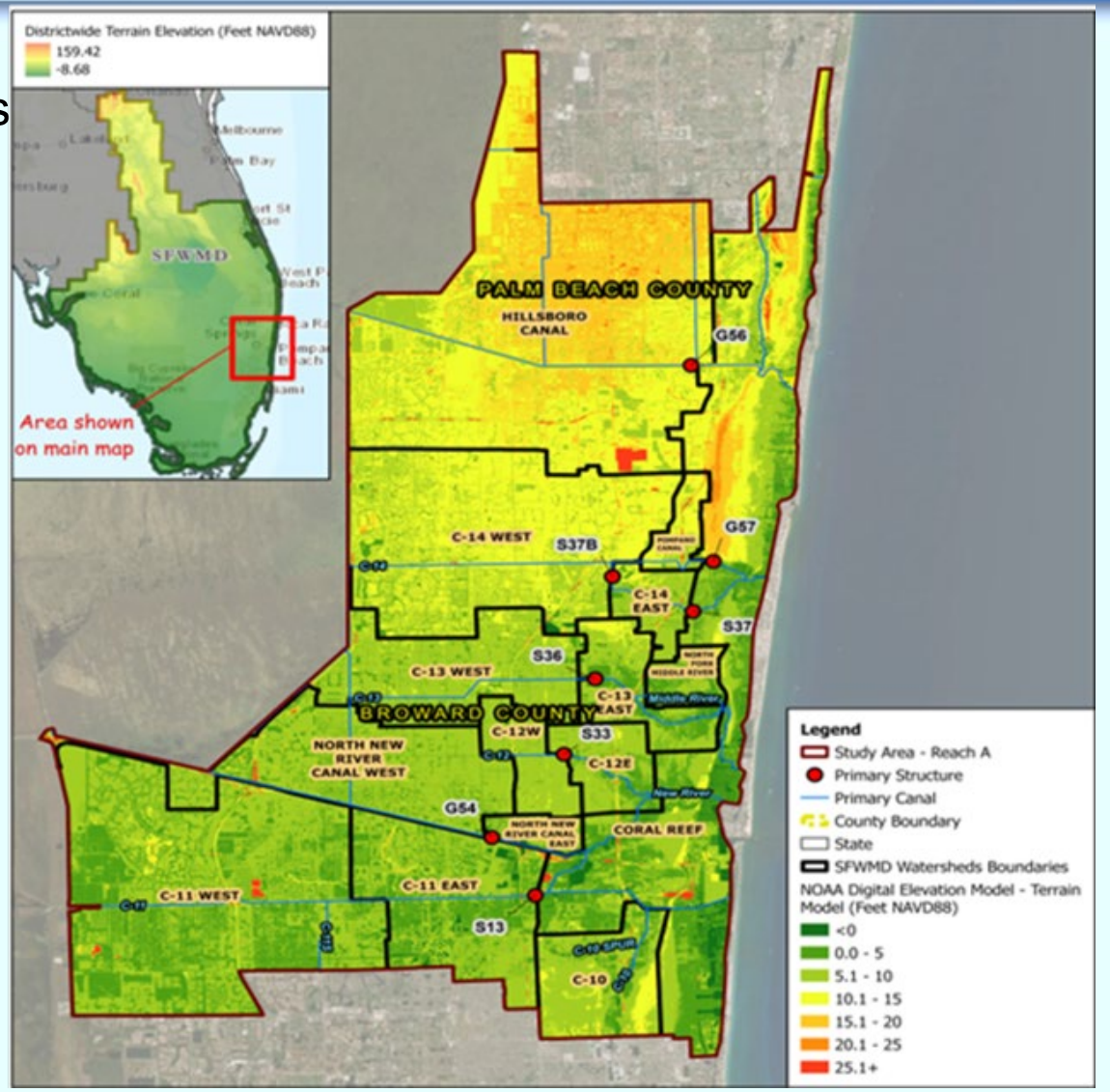
- Section 203 Flood Resiliency Study for Broward Basins is being conducted by the SFWMD as the non-federal sponsor of the Central and Southern Florida (C&SF) project under the Section 203 Water Resources Water Development Act (WRDA 1986)

Purpose

- The Study will identify flood risk management (FRM) recommendations to build flood resiliency, now and into the future, and reduce flood risks within the lower southeast coast of Florida in southern Palm Beach, and Broward Counties.

Focus

- Increasing the resilience and function of vulnerable coastal structures and the conveyance of the primary inflow canals



Section 203
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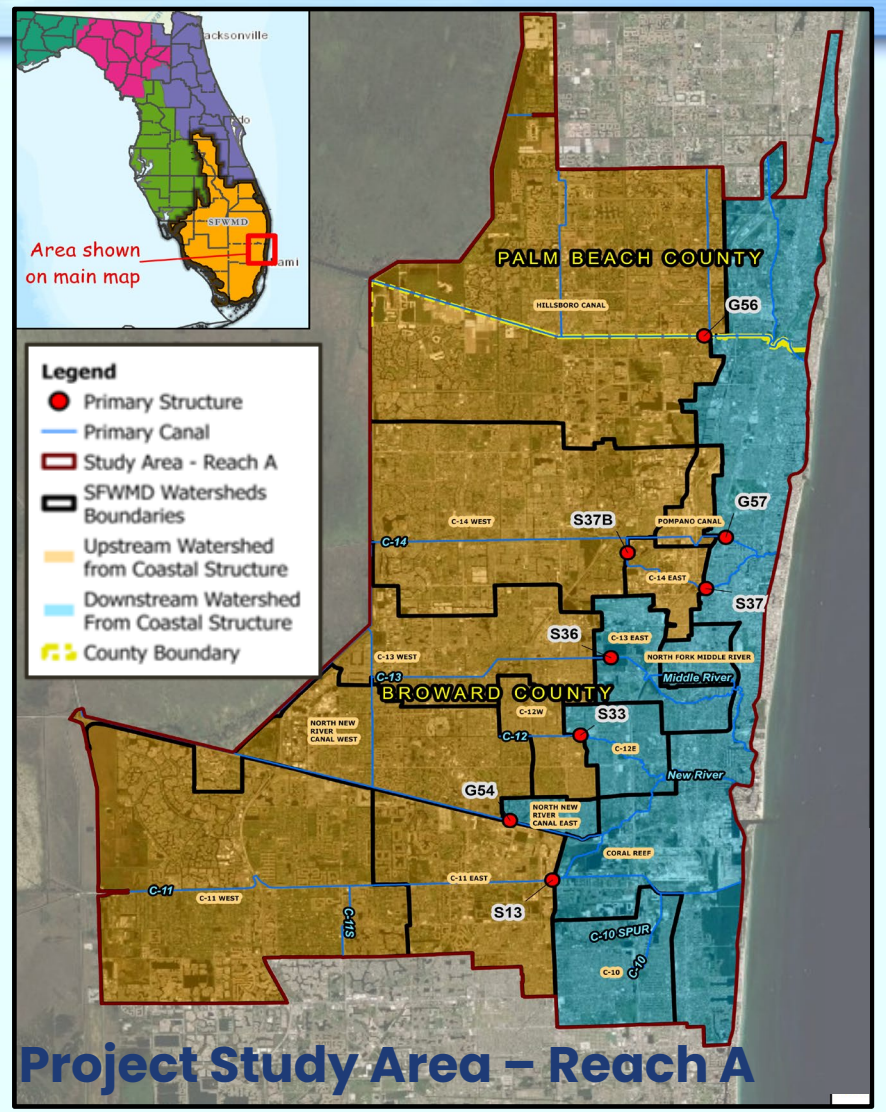
Project Study Area – Managed Watersheds

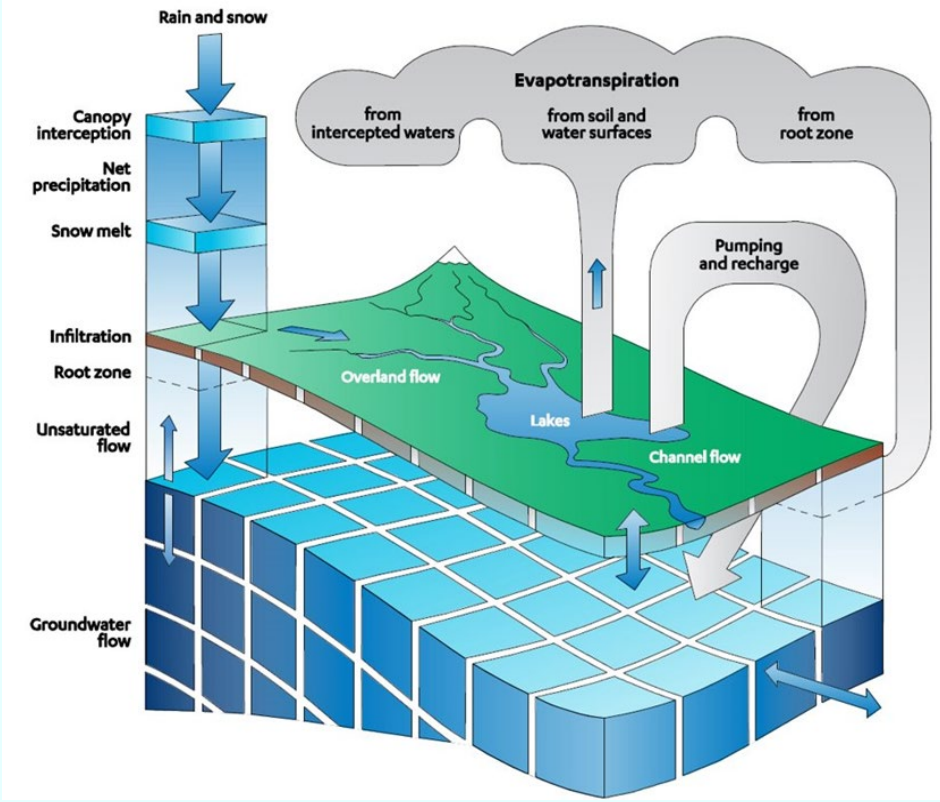
MANAGED WATERSHED	PRIMARY CANAL	COASTAL WATER CONTROL STRUCTURE
Hillsboro Canal	Hillsboro Canal (G-08)	G56 Gated Spillway
Pompano Canal	Pompano Canal (G-16)	G57 Gated Spillway
C-14 West	C-14 Canal	S37B Gated Spillway
C-14 East	C-14 Canal	S37A Gated Spillway
C-13 West	C-13 Canal	S36 Gated Spillway
C-12 West	C-12 Canal	S33 Gated Spillway
North New River Canal West	North New River Canal (G-15)	G54 Gated Spillway
C-11 West & East	C-11 Canal	S13 Pump Sta. & Gated Spillway



HYDROLOGIC AND HYDRAULIC MODELING TOOL

The integrated/coupled surface-groundwater model MIKE SHE/MIKE Hydro (2022) will be used to simulate the hydraulics and hydrology for the project area.

- Capability of conducting sub-regional scale simulations
- Simulate surface water and groundwater interactions
  - Allows for the accounting of rising water tables and reduced soil storage
- Able to simulate the effects of different boundary conditions such as tidal and storm surge-influenced tailwater conditions with current and future sea-level rise scenarios
- Comprehensive operational flexibility, can simulate structure gate operating rules and can use calibrated flow parameters for canal structures



PROBABILITY EVENTS: EVALUATION OF COMPOUND FLOODING

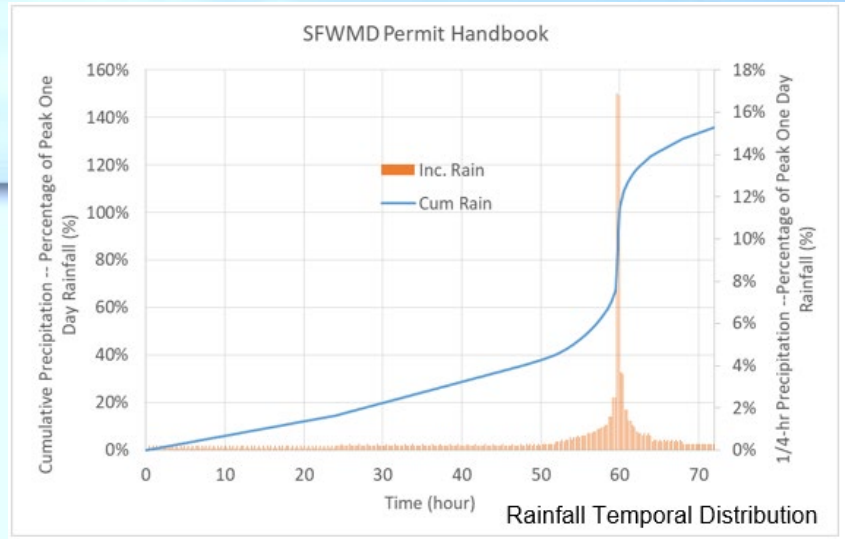
- The total water level (i.e., compound flooding) due to multiple flood sources, including rainfall runoff, groundwater and coastal forcings will be simulated.

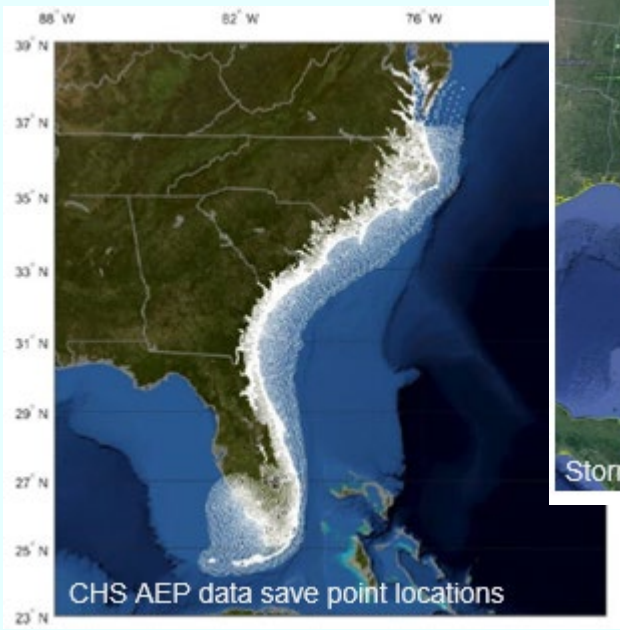
- Hydrologic & Hydraulic model simulations include an array of rainfall and coastal return frequency events. Sea level change is included in the coastal water level data & run in parallel for low, intermediate & high sea level scenarios.

Coastal water level Return Period (CHS data)	Rainfall return period (NOAA Atlas14)
2-year	5-year
2-year	10-year
10-year	10-year
2-year	25-year
20-year	25-year
2-year	100-year
100-year	100-year
2-year	500-year

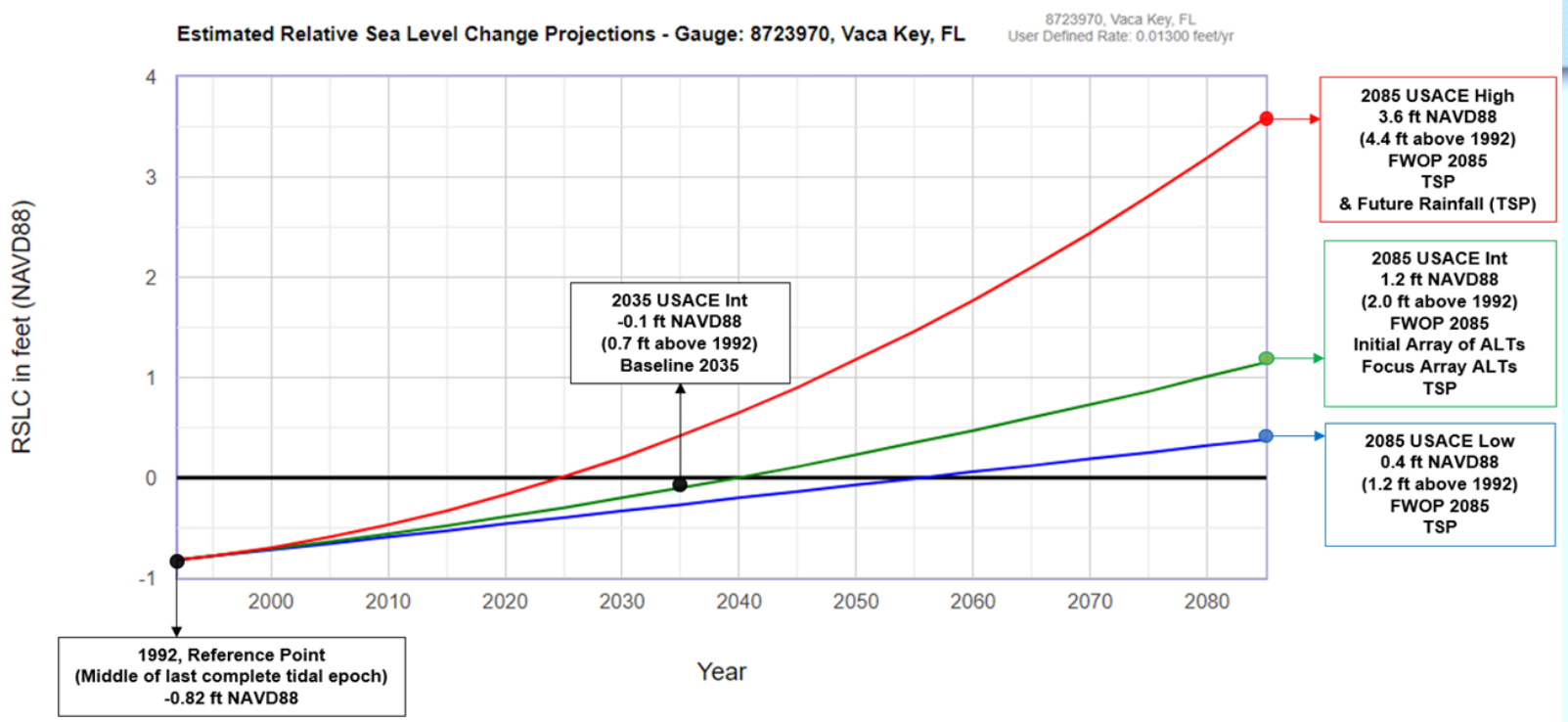
MODEL INPUT DATA

- **Rainfall**
  - spatially distributed gridded input derived from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall depths
  - Temporally distributed based on SFWMD 72- hour distribution
- **Coastal Boundary**
  - The South Atlantic Coastal Study (SACS) Coastal Hazard System (CHS) provides numerical and probabilistic modeling results for coastal forcings, including storm surge.
  - The CHS stage-hydrographs will be applied as a downstream boundary condition





CLIMATE CHANGE STRATEGY



Sea Level Change (SLC)

- Vaca Key gauge
- SLC will be incorporated into the modeling as a boundary condition.
- The Future conditions will assess project performance for the Low, Int., and High curves for 2085

Inland Hydrology

Future extreme rainfall change factors, as estimated by the 2022 USGS/SFWMD Study, will be incorporated as a sensitivity run for the tentatively selected plan

MODELING PROCESS

- Through iterative testing, the drainage basins have been shown to be sensitive to features such as
  - improved conveyance,
  - addition of pumping at tidal structures
  - Re-locating and/or adding tidal structures
  - use of additional storage and inter-basin flow (where available)
- Draft “initial array” of alternatives were determined based on initial testing
- Furthermore, refinements to features is iterative in nature when modeling ideas and experimenting to find what works to improve flood depths/damages
  - management operations,
  - pump sizes, and
  - effective canal and structure conveyance locations
- Combine the iterative process across 7 drainage basins each with its own tidal structure and the process is substantial to consider that drainage basins and primary systems have different responses to alternative features

DRAFT INITIAL ARRAY OF ALTERNATIVES

For consideration and discussion:

MODELED

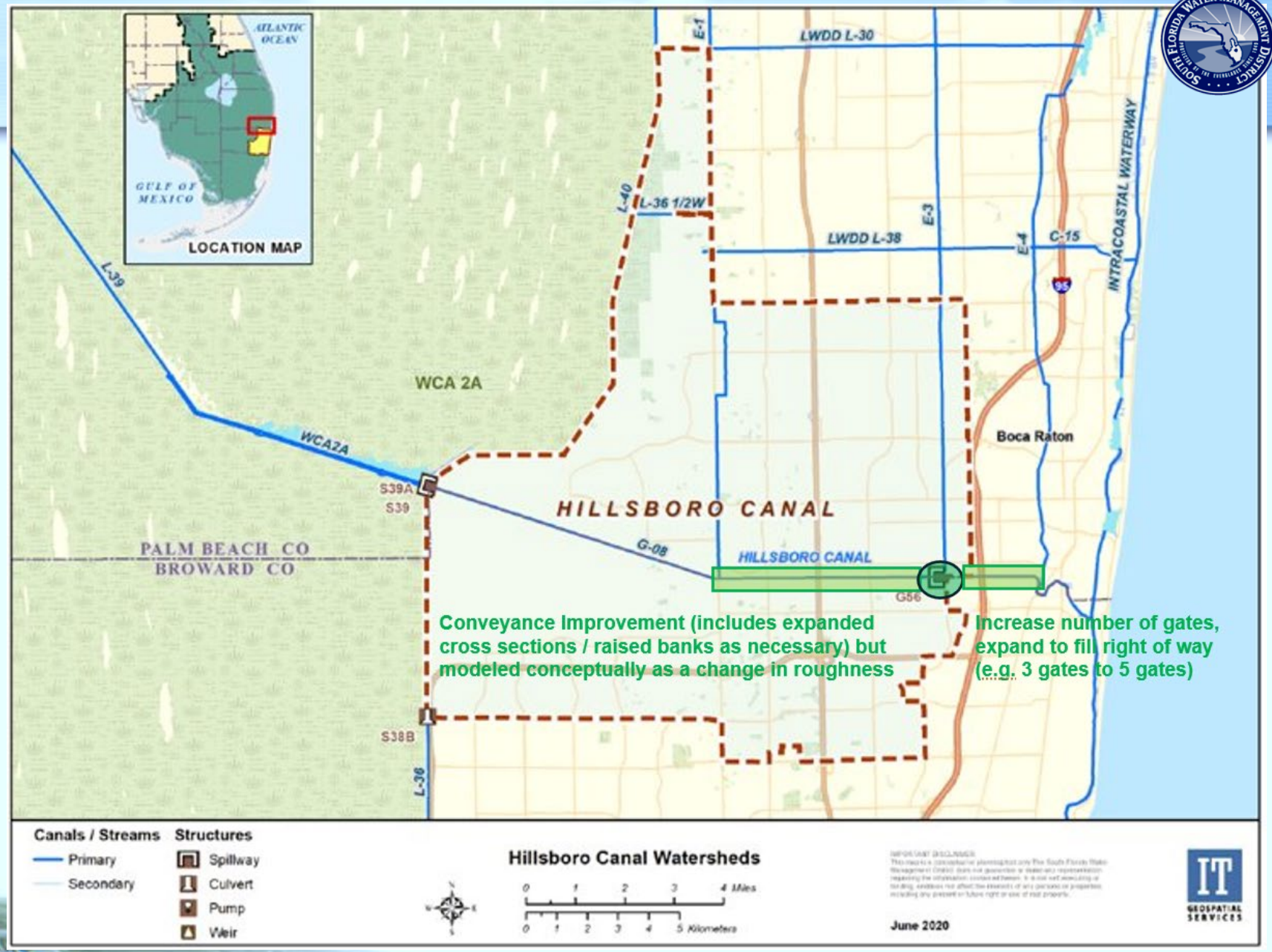
- Alt 1 Gravity Conveyance Improvements (Structures and Canals)
- Alt 2 Pumps at Structures & Hardening
- Alt 3 Removal of Coastal Structures
- Alt 4 Relocation of Coastal Structures to the East
- Alt 5 Alternatives to Discharging East on Peak (e.g., Route to Regional (C-11&Site 1 Impoundment) / Basin Storage or Inter-basin Transfer, if Possible
- Alt6 Natural & Nature Based Only
- Alt7 "Non-Structural" Only (e.g., Foundation Raising, Flood Warning Systems, etc.)

- *Alternatives Include raising gates/platforms/floodwalls as necessary to prevent backflow at the structure*
- *AS0: Adaptation Strategy 0 (baseline)*
- *FWOP: Future Without Project (AS0 and FWOP in the following slides are used interchangeably)*

EXAMPLE ALT1

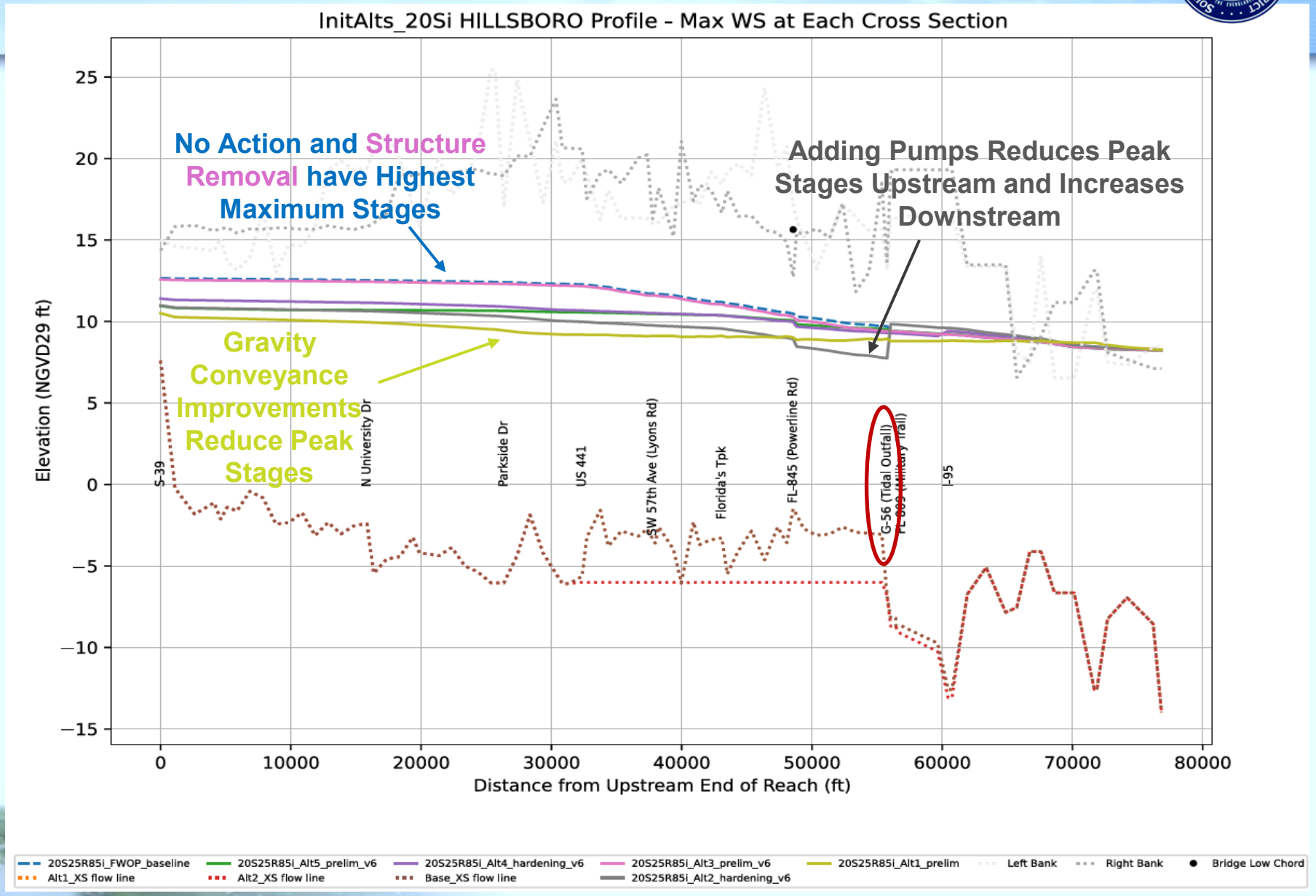
GRAVITY CONVEYANCE IMPROVEMENTS

HILLSBORO CANAL

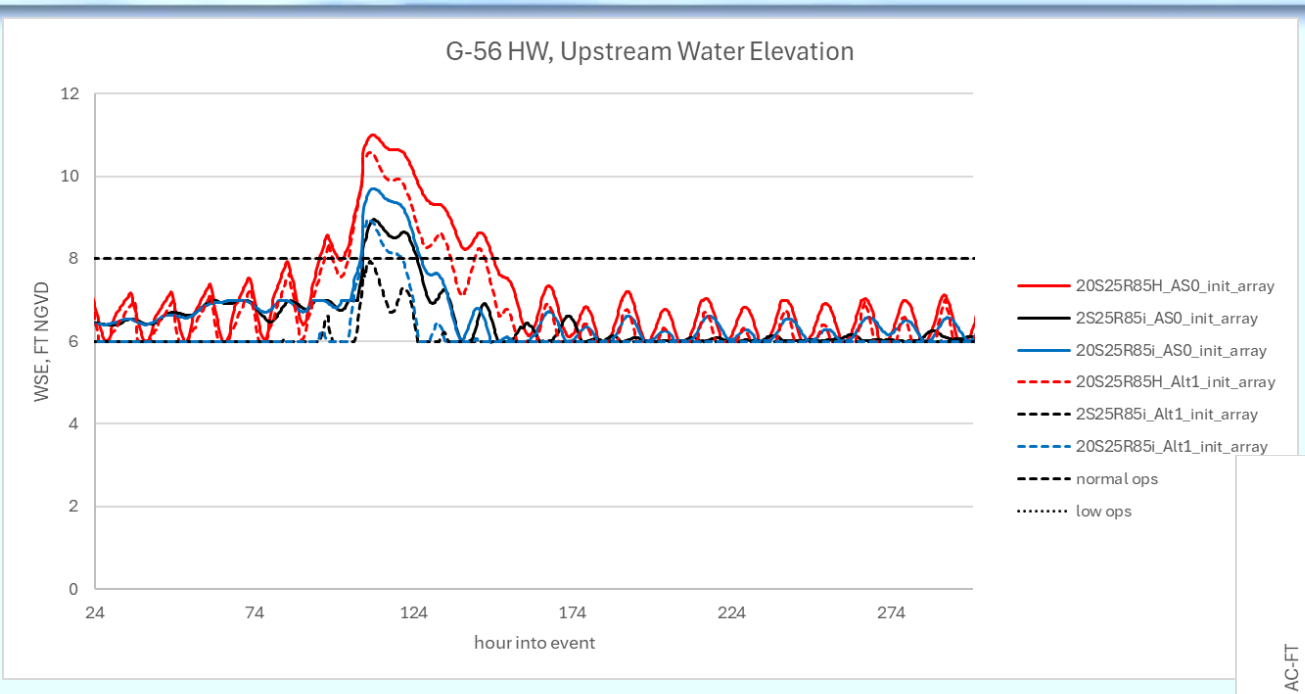


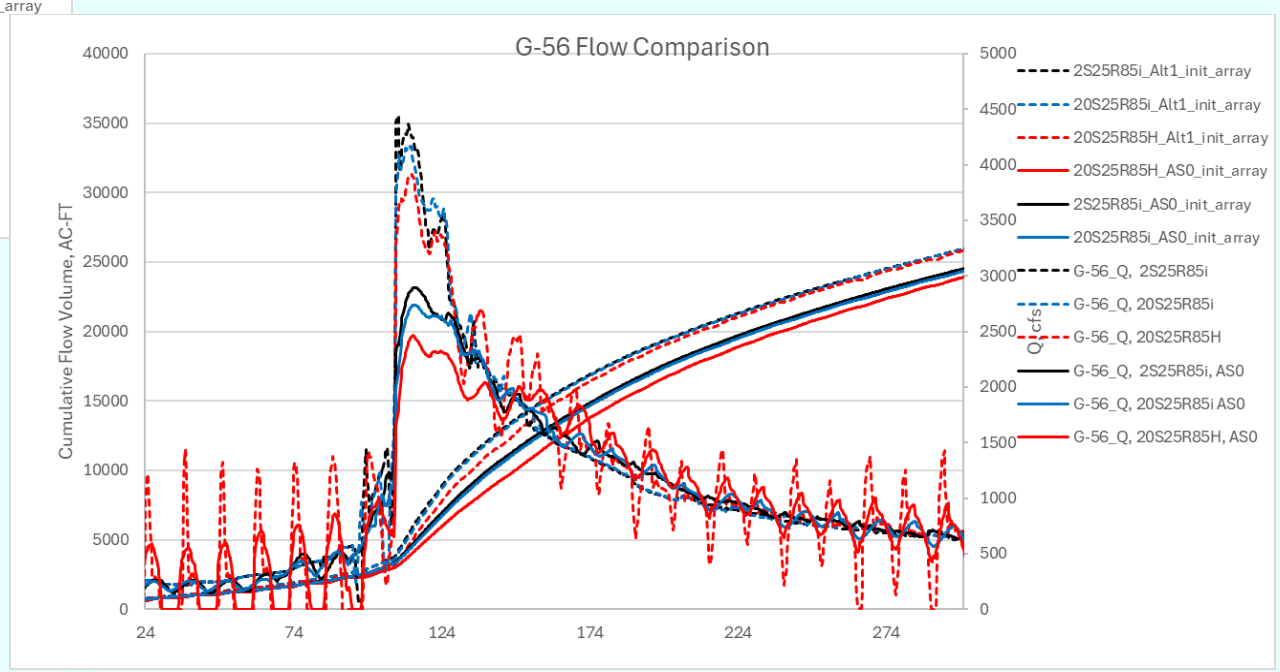
Example Model Output –Canal Peak Stages

- G56/ Hillsboro Canal Peak Stage Comparison for Initial Array of Alternatives
  - Gravity Improvements effective in lowering peak stages in primary canal
- 20S25R Intermediate sea level



Example Model Output –Structure Performance





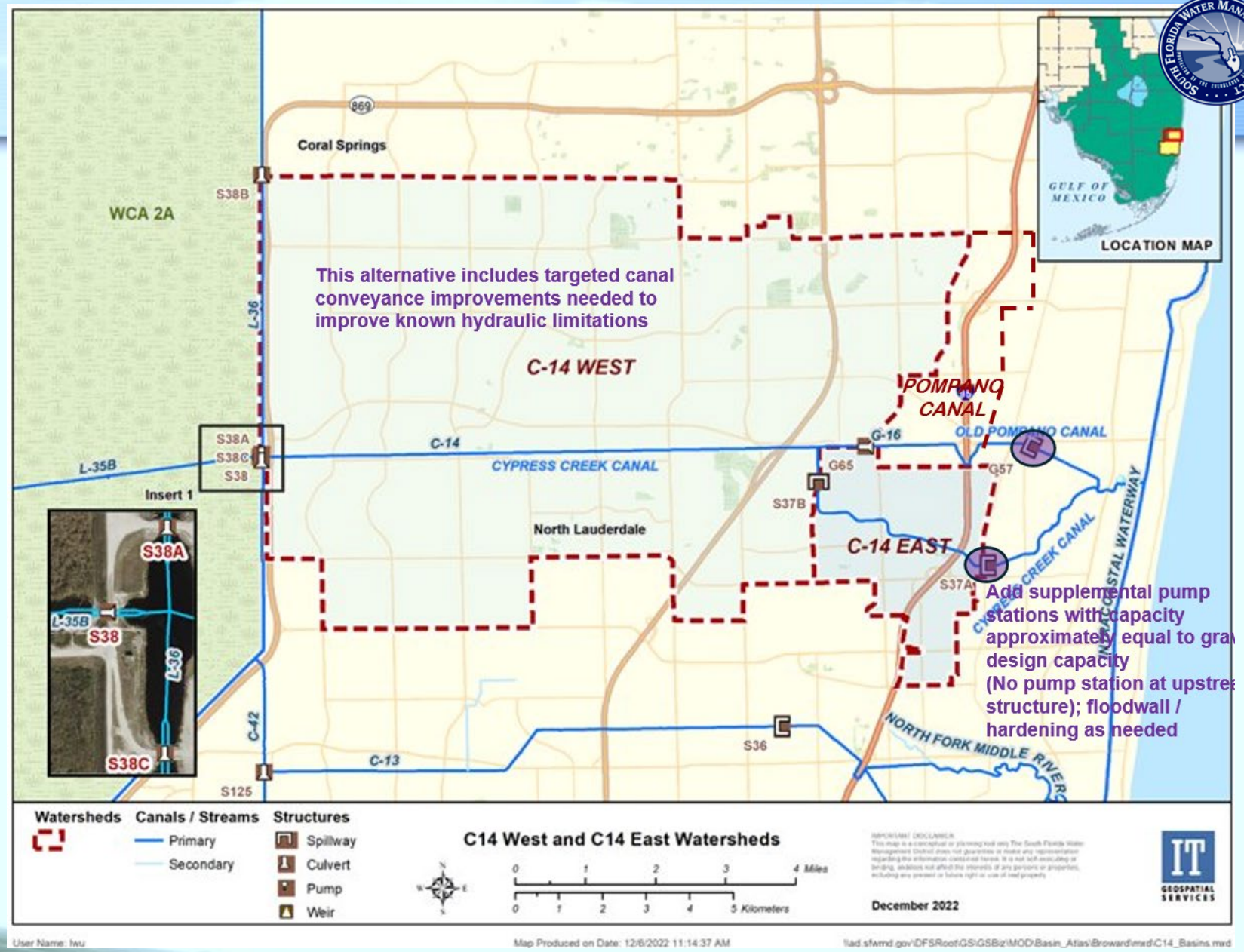
Hillsboro Canal - G56

- normal range: 7-8 ft NGVD
- Low range: not specified but can be maintained lower than normal during flood conditions

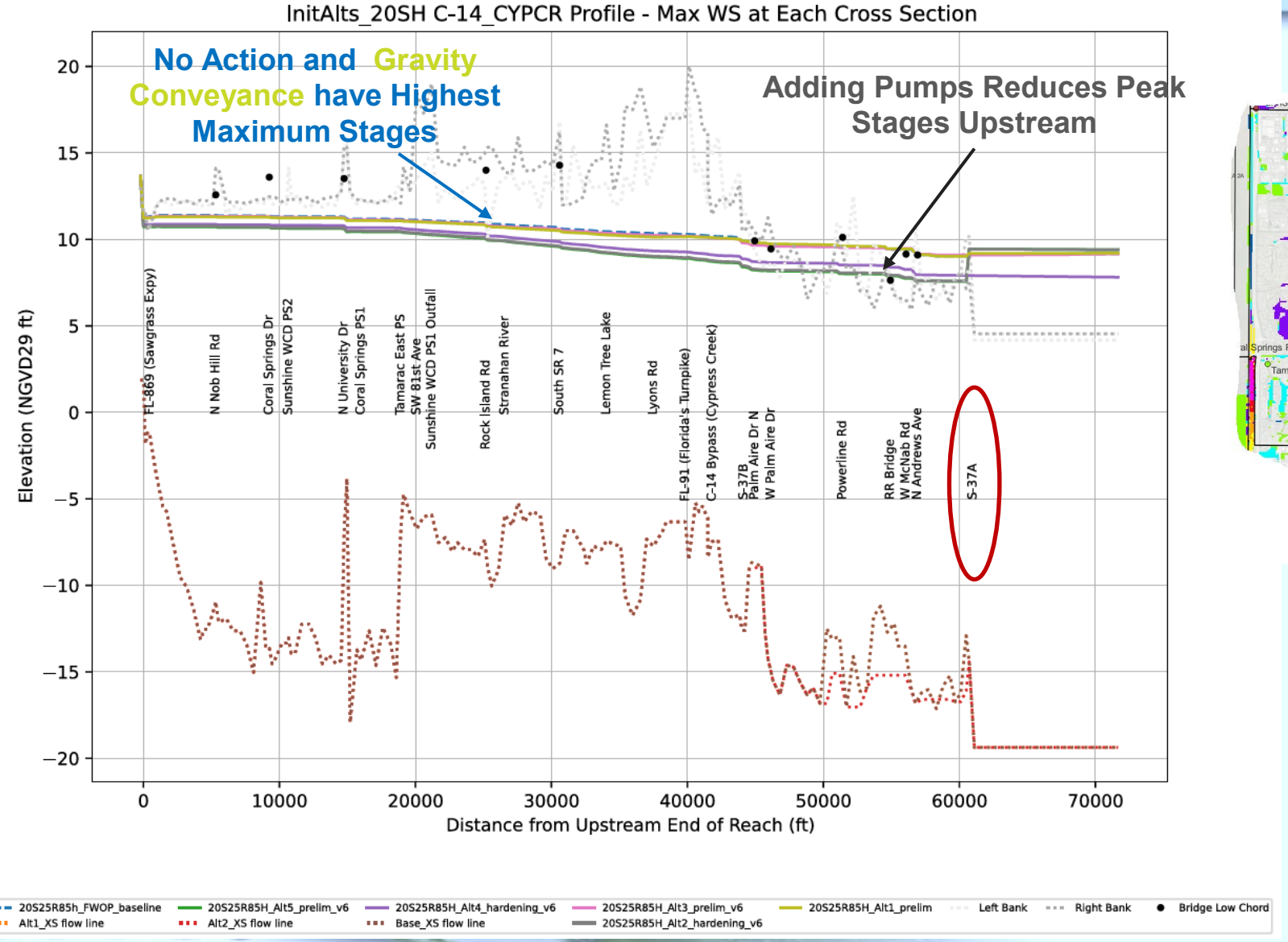
EXAMPLE ALT2

PUMPS AT STRUCTURES & HARDENING

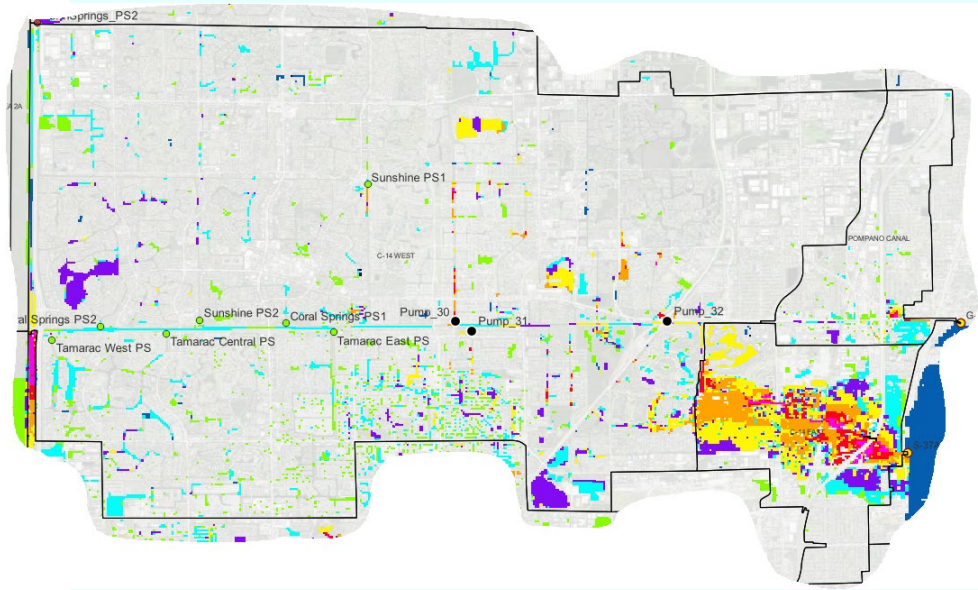
C-14/CYPRESS CREEK CANAL



Example Model Output – Alt2 Pumping Alternative



Max Depth [AS0] – Max Depth [Alt2 – v9]
20S25R85H

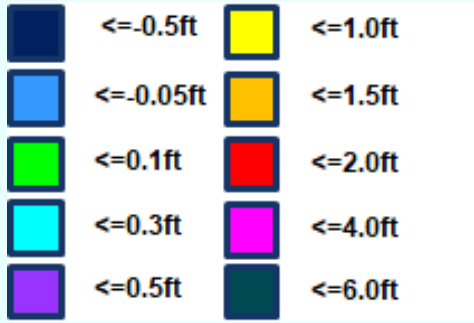


- <=-0.5ft
- <=-0.05ft
- <=0.1ft
- <=0.3ft
- <=0.5ft
- <=1.0ft
- <=1.5ft
- <=2.0ft
- <=4.0ft
- <=6.0ft

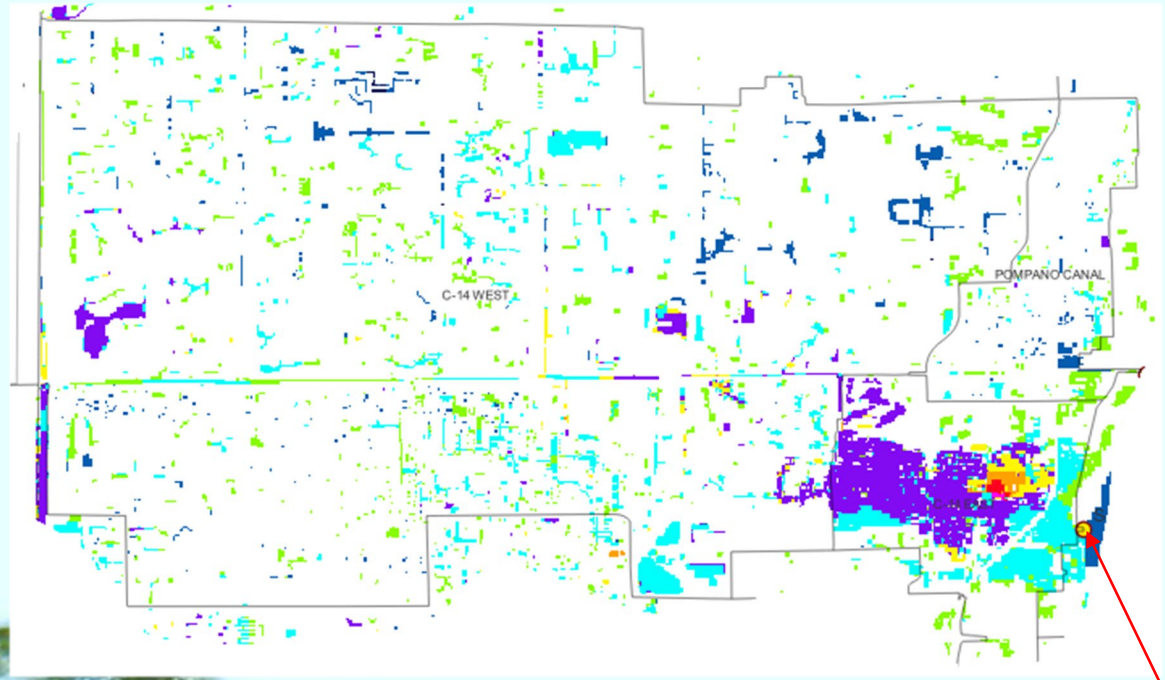
Example Model Output – Pump Capacity Sensitivity Testing

Structure	iteration_1	iteration_2	iteration_3	iteration_4	iteration_5	iteration_6	iteration_7
S37A	1000	1000	1500	2000	2500	3000	3500

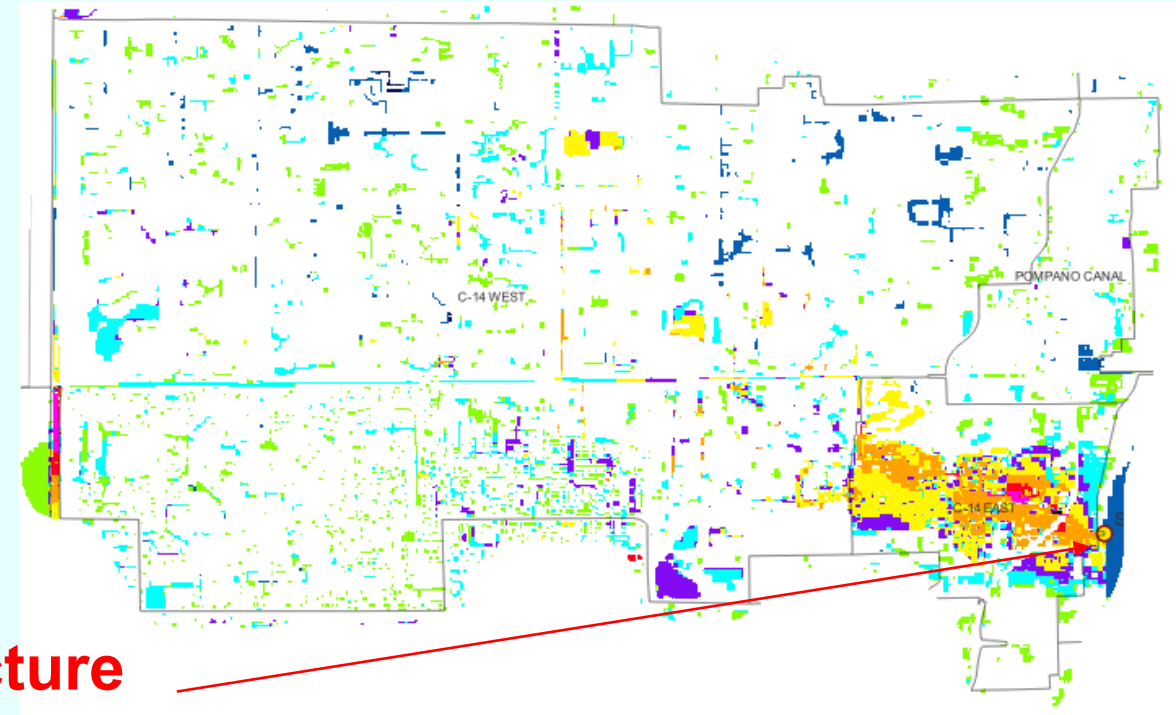
Legend:
Stage Difference
FWOP minus
Iteration



Iteration_1



Iteration_7



Structure Location

H&H Modeling Status

- Draft Initial array alternatives (5) have been simulated
- Further iterative refinements of select alternatives have been made
  - Control Elevation Modification – Pumps on Secondary System during Pre-Storm
  - Sensitivity Analysis of Different Pump Sizes – Primary System
  - Application of Pre-Storm Drawdown
- Testing has been evaluated using multiple forms of data visualization which includes canal peak profile plots, flood depth (depth difference) maps, structure performance hydrographs, and water budgets
- For select initial array alternative, initial benefits have been calculated using the HEC FDA tool
- Final array of alternatives (3) are being developed
  - Groundwork for selection of Tentatively Selected Plan (TSP)

Thank you! & Questions?