FLOOD PROTECTION LEVEL OF SERVICE PROGRAM

MAKING EXPENSIVE INFRASTRUCTURE INVESTMENT DECISIONS

Addressing Uncertainty Using Dynamic Adaptive Policy Pathways (DAPP) Method

Water Utility Climate Alliance (WUCA)
Resilience Workshop
October 18, 2023

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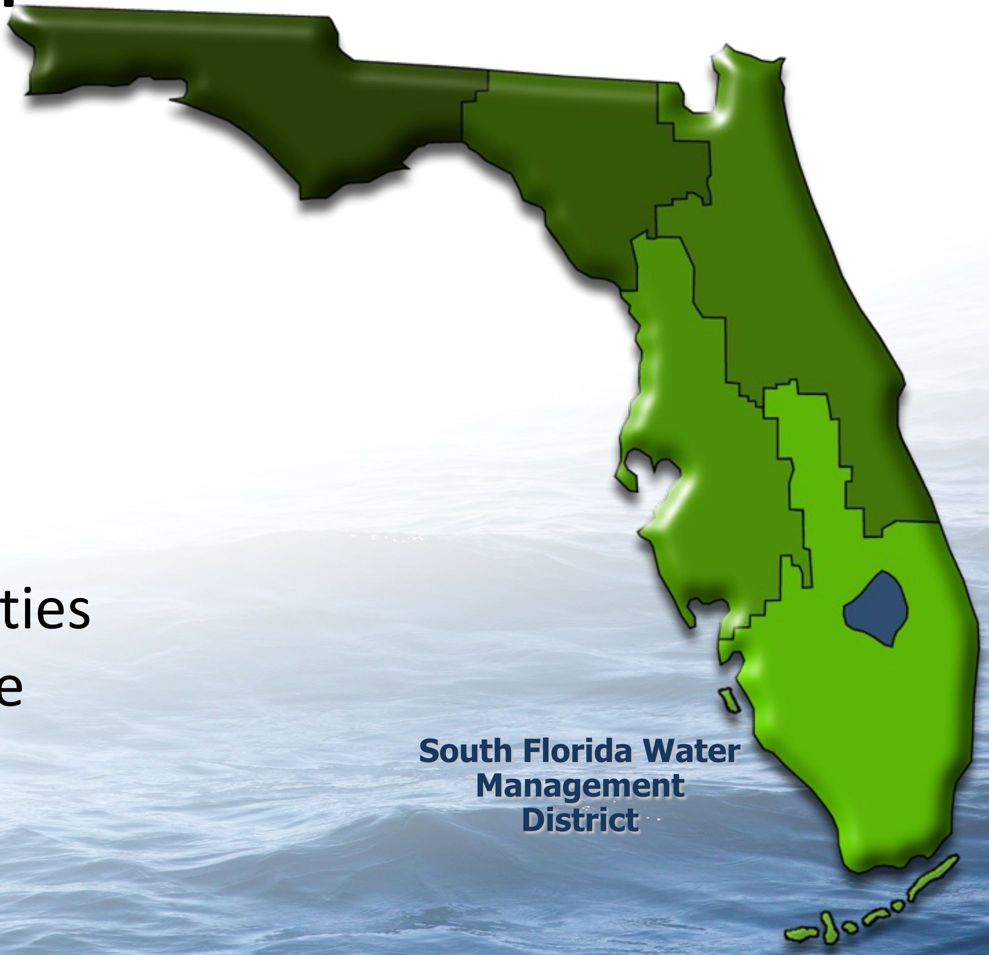
SFWMD - Who we are and what we do

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

- Oldest and largest of the state's five regional water management districts
- Protecting water resources in the southern half of the state since 1949
- Our mission: To safeguard and restore South Florida's water resources and ecosystems, protect our communities from **flooding**, and meet the region's water needs while connecting with the public and stakeholders



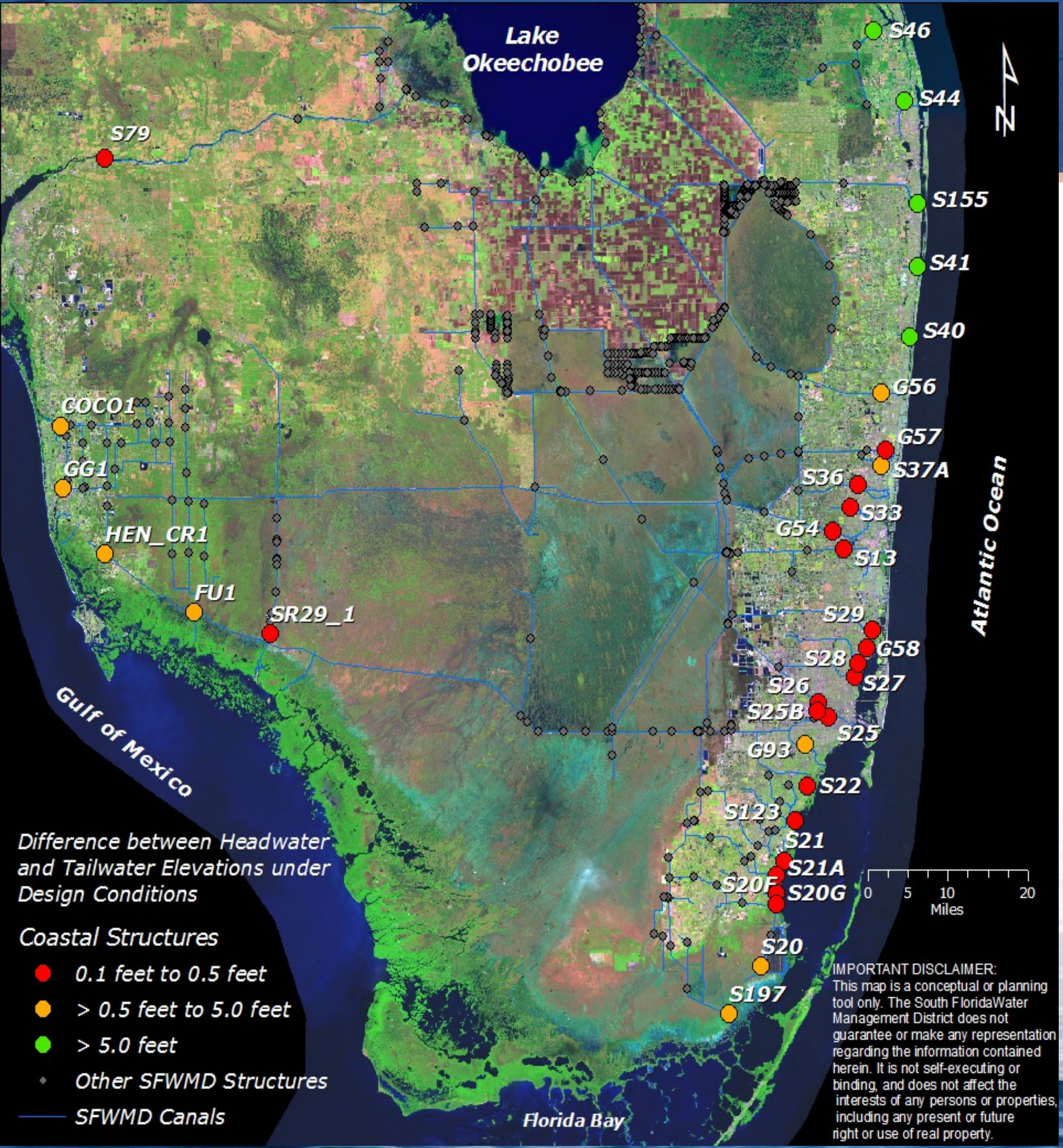
Water Management System

Central and Southern Florida (C&SF) System

(Built in the 50s to serve a projected future population of 2 million people, Today providing flood protection for a population of over 8 million people)

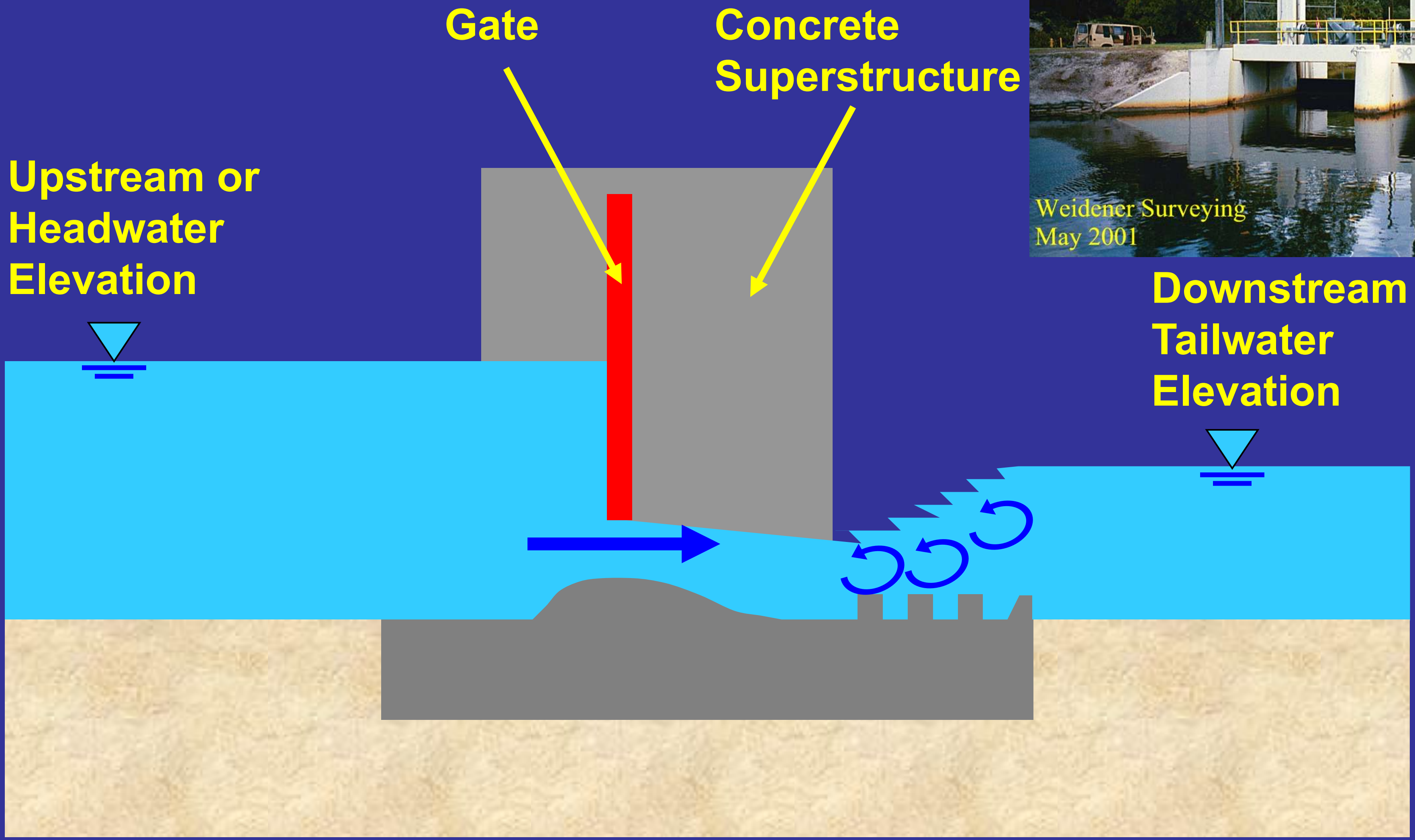
- Over 2,000 miles of canals and levees
- 160 major drainage basins
- 1,413 water control structures including hundreds of gated spillways, and 89 pump stations
- 60,000 acres of regional Stormwater Treatment Areas
- Lake Okeechobee - 450,000 acres surface area
- Water Conservation Areas - 959,000 acres water storage area

Gated Spillway Basics



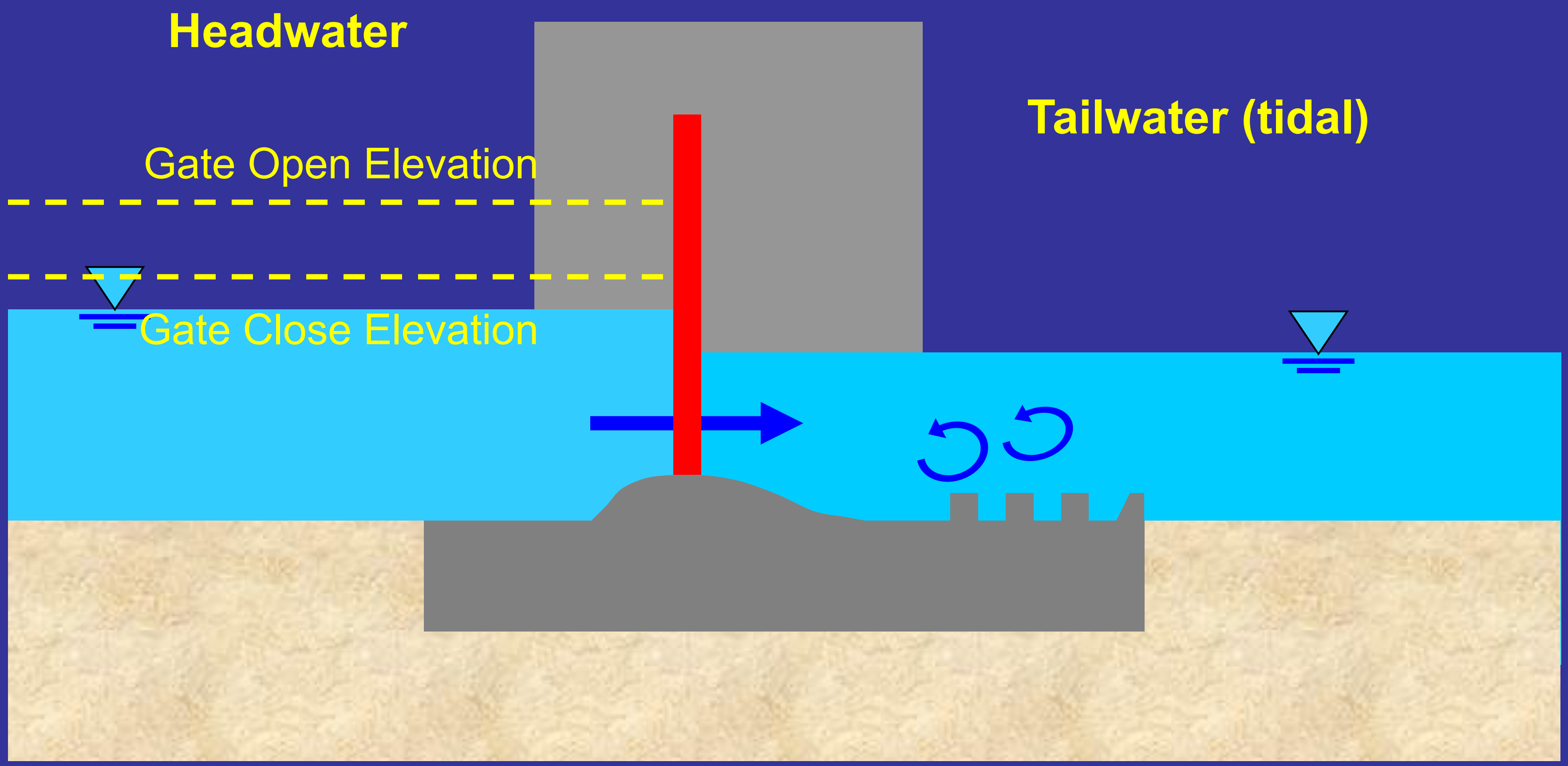
S-27 Structure – Gated Spillway

Gated Spillway Basics



Gated Spillway

(coastal structures)



Gated Spillway

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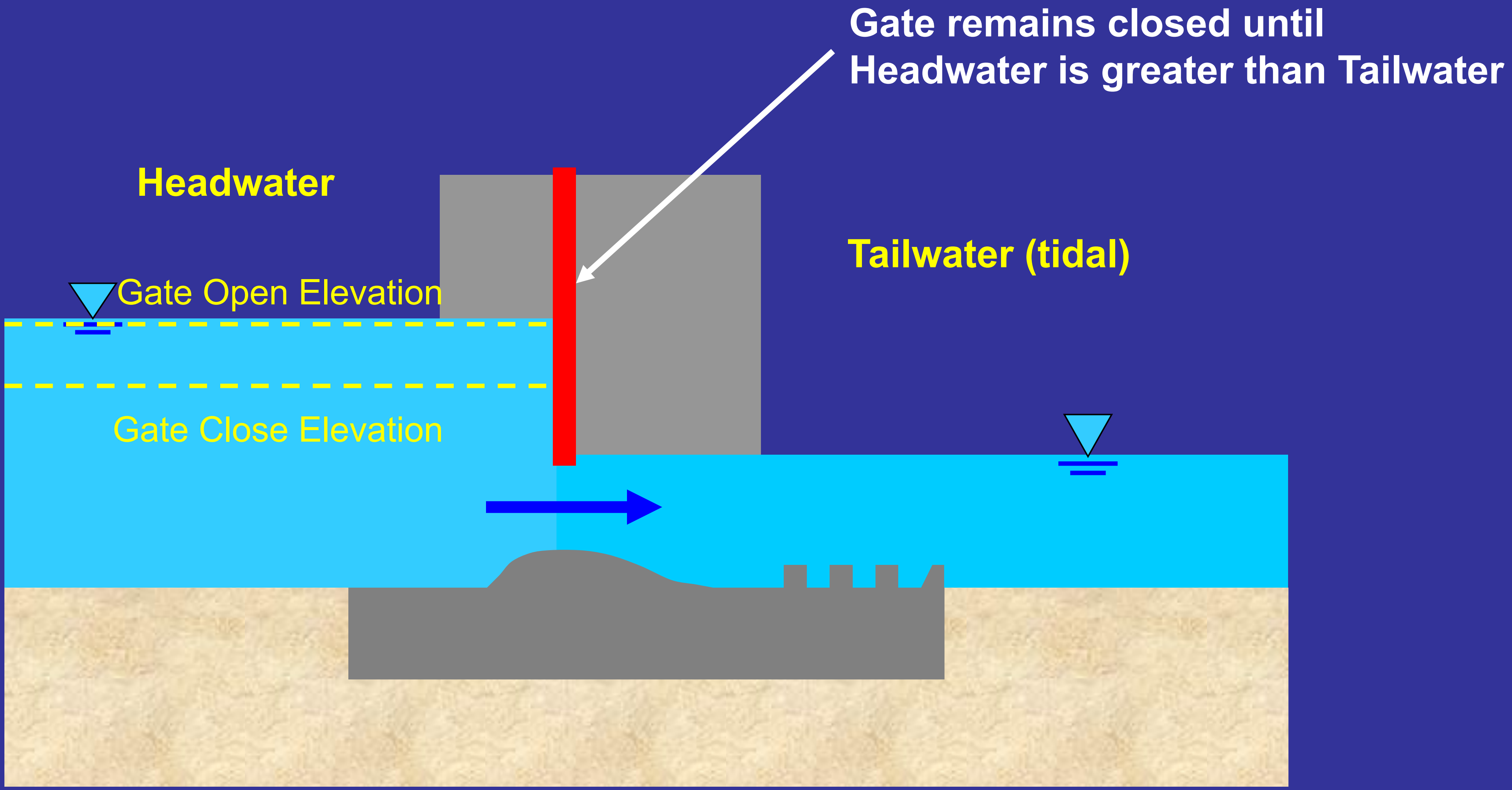


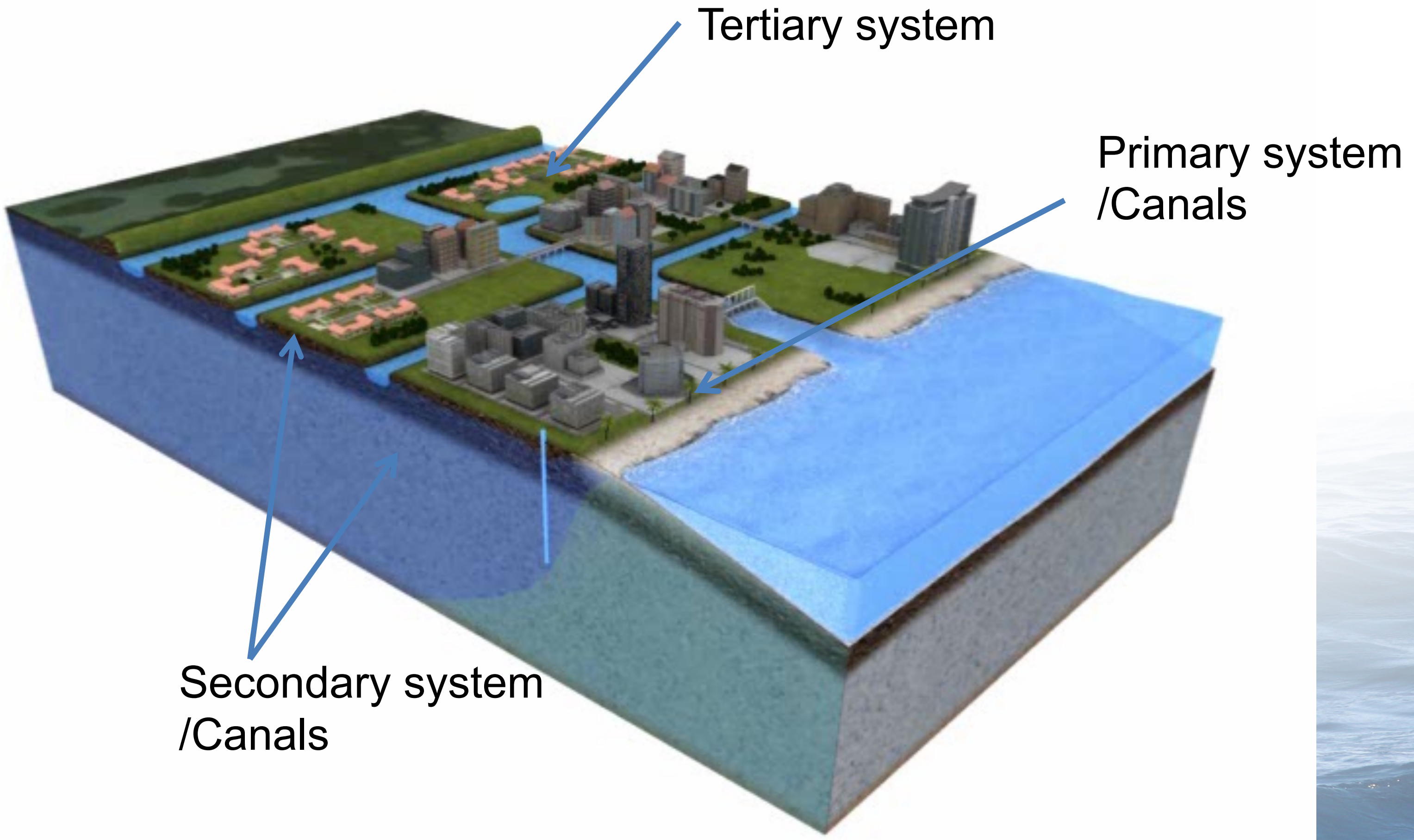
EFFECT OF HIGH TAILWATER CONDITION

Learn more about how sea level rise and other climate change impacts are affecting water resources management and flood protection in South Florida:

https://vimeo.com/416090381/a11cead328

Flood Protection Responsibility

- Primary System
  - **USACE**
  - **SFWMD**
- Secondary System
  - Local Governments
  - Special Districts
- Tertiary System
  - Home-owners Associations
  - Private Land Owners



Total System Approach

Some Sources of Uncertainty

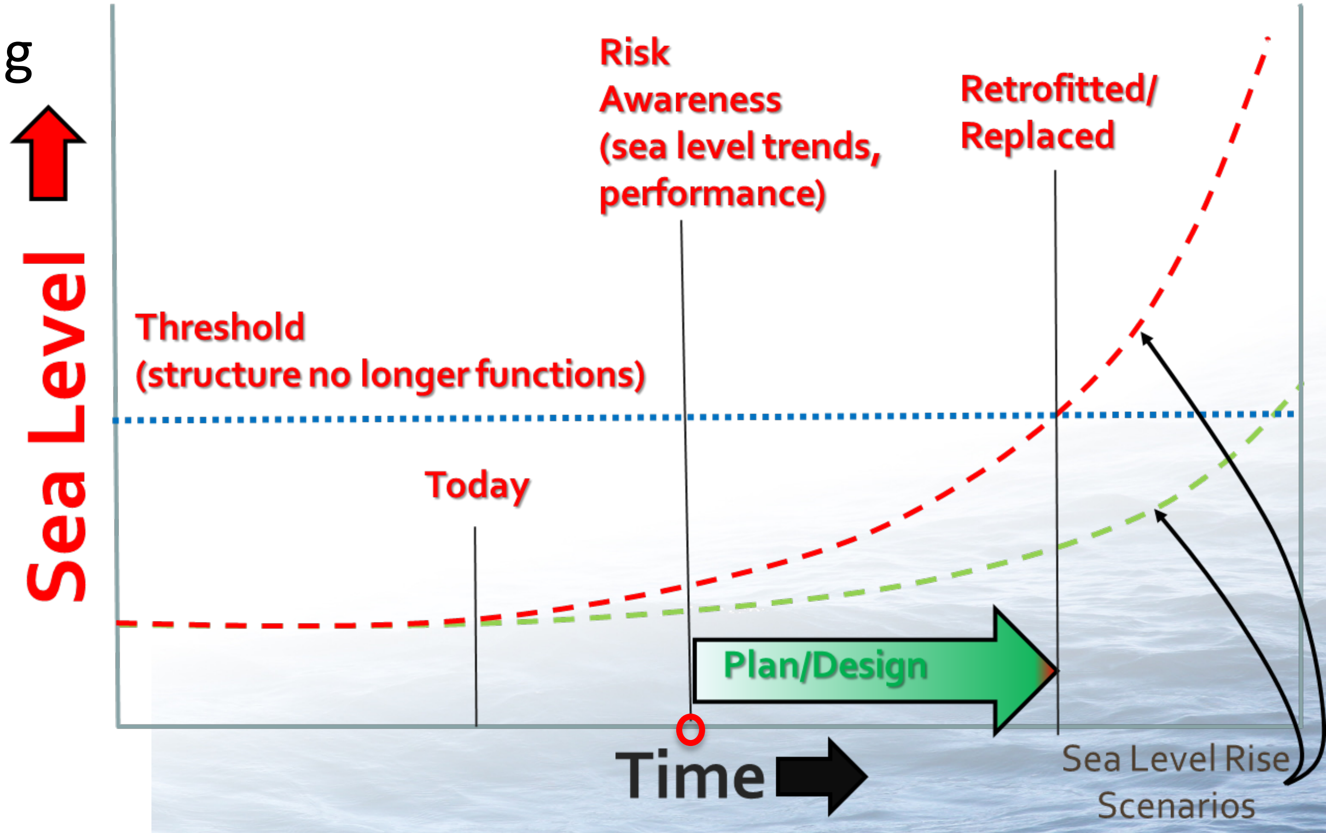
- Climate – several
  - SLR
  - Rainfall
  - Storminess and storm surge
- Land use and development changes
- Population growth
- Fluid and evolving stakeholder expectations and social norms
  - send water to tide
  - willing to take a little pain to ensure good quality water in the receiving systems
  - green spaces, parks, and public use areas occasionally wet?

Modified Planning Approach

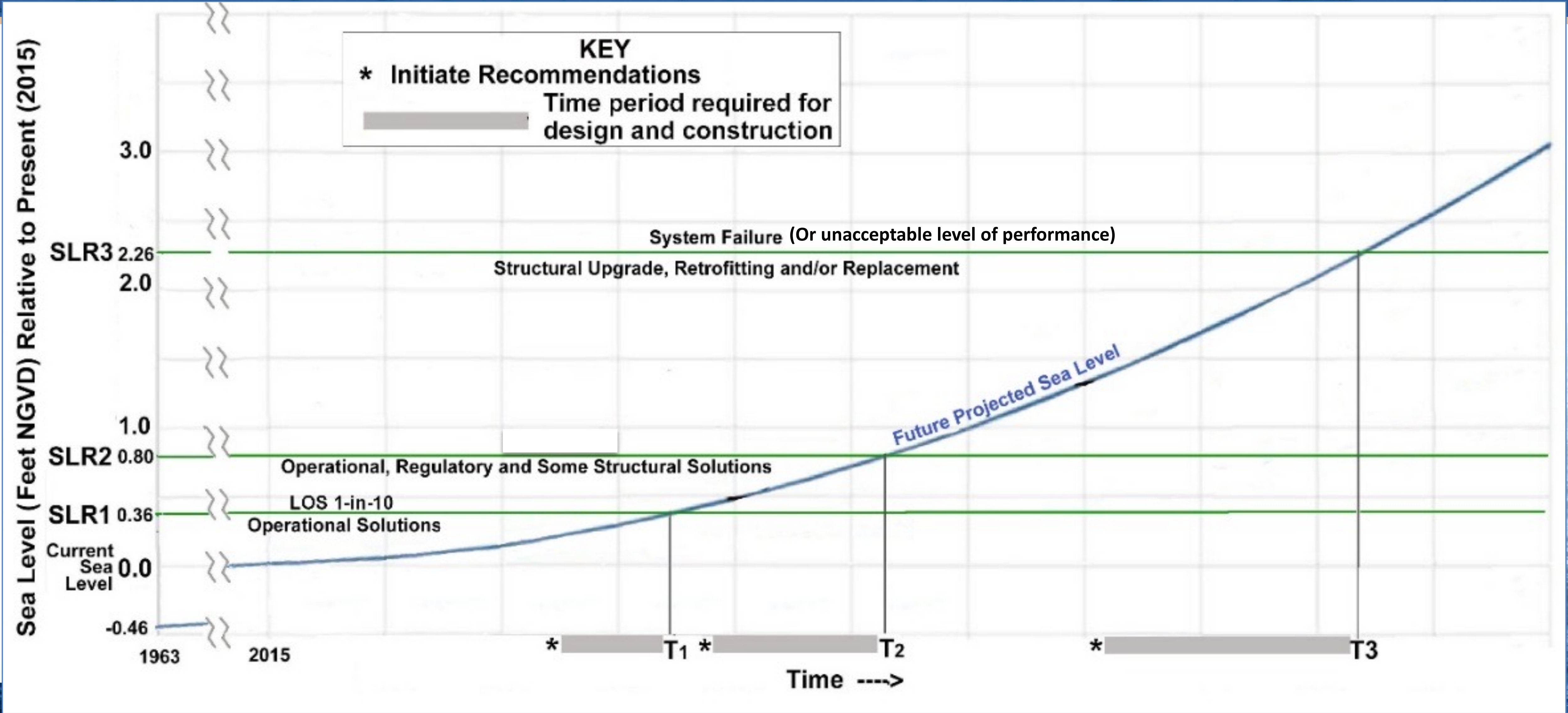
- Traditional Planning Process
  - Determine planning horizon or timeframe (and conditions such as future sea level)
  - Identify preferred course of action, suite of projects, regulations or operations strategies
  - Determine the cost to benefit comparison of the investment
  - Implement the projects, selected for a design event and monitor the performance
- Adaptive Resilience Planning Process
  - Similar to traditional planning in many aspects
  - Total systems approach for a remain functioning condition
  - Adaptive response based on smart phasing and sequencing of measure
  - Decision support under deep uncertainty
  - Actionable, no- or low-regret near term recommendations with a path for future measures

Conceptual Adaptive Resilience Planning Model

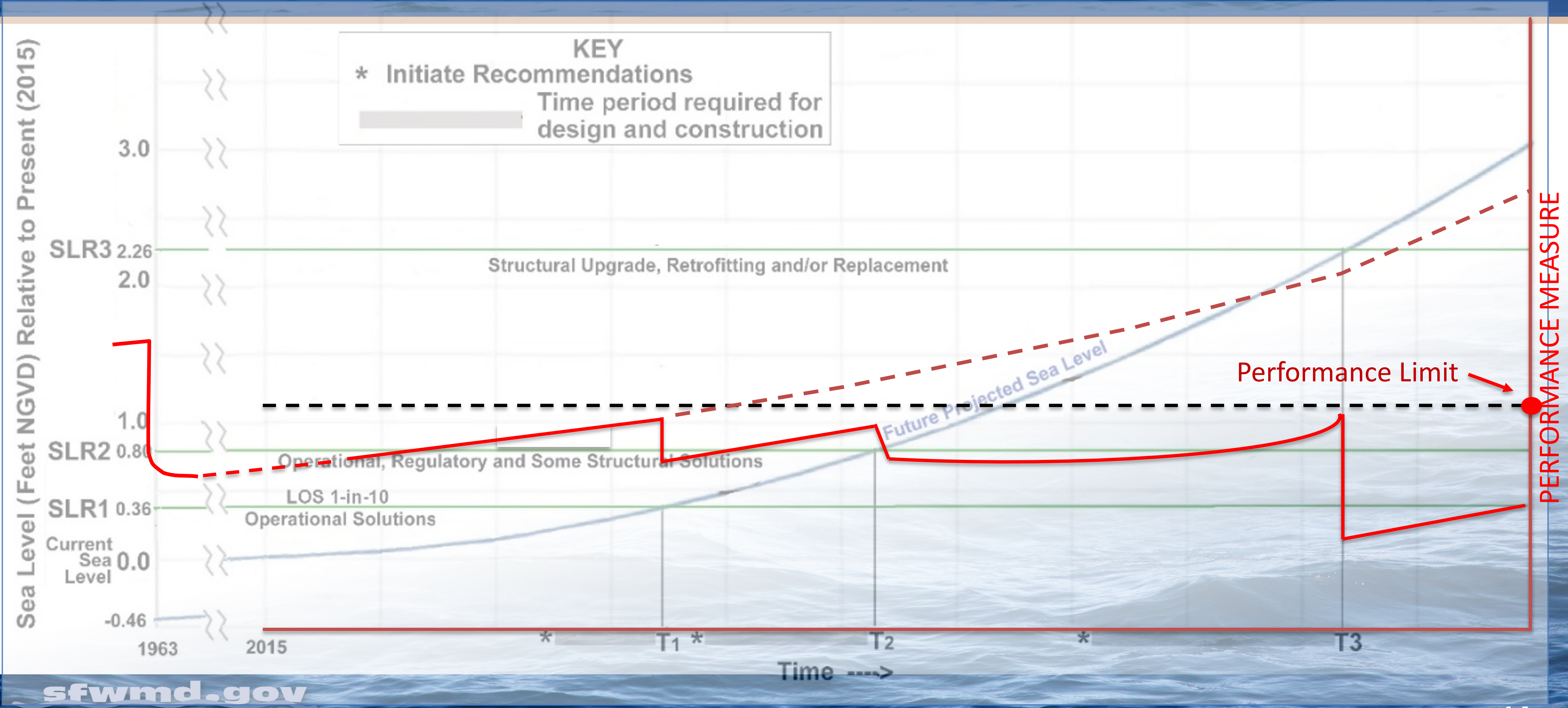
- Establish sea level threshold at which existing infrastructure can no longer provide acceptable flood protection
- Based on the time to build replacement, establish the conditions that trigger initiation of replacement infrastructure
- Monitor conditions and initiate adaptation strategy once trigger conditions are realized
- Flood Protection Level of Service program provides the framework to realize this concept for SFWMD assets.



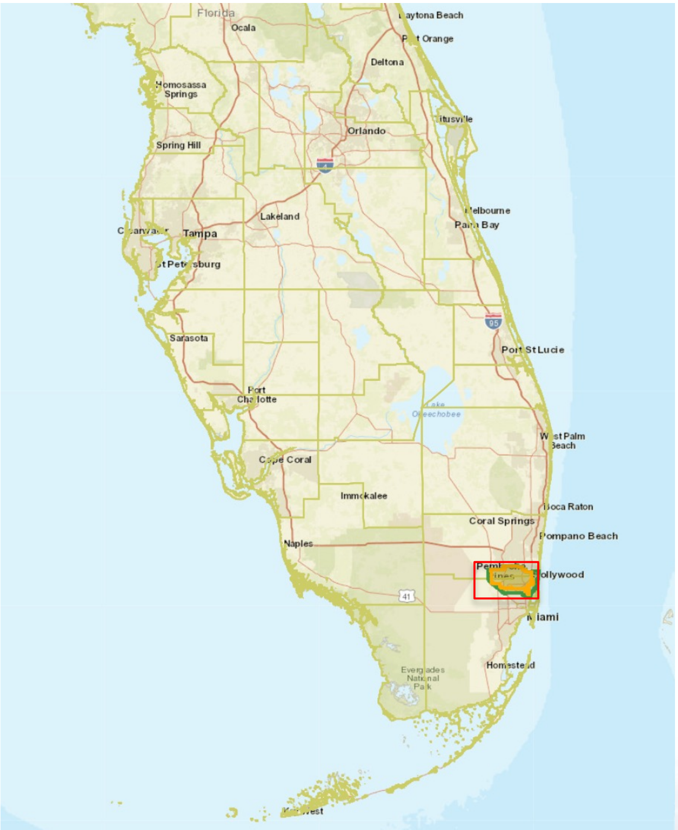
Sequenced Courses of Action

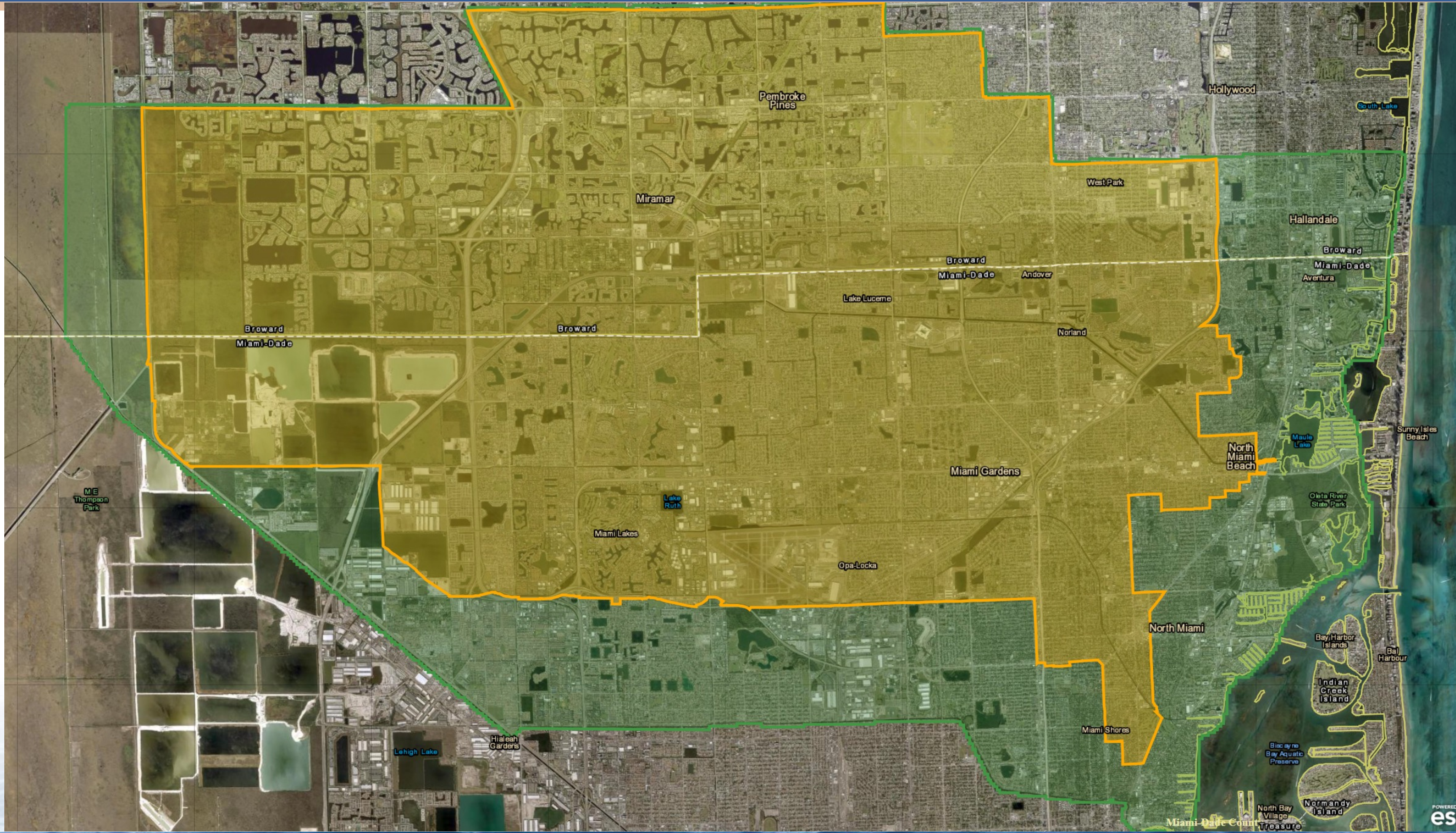


Sequenced Courses of Action



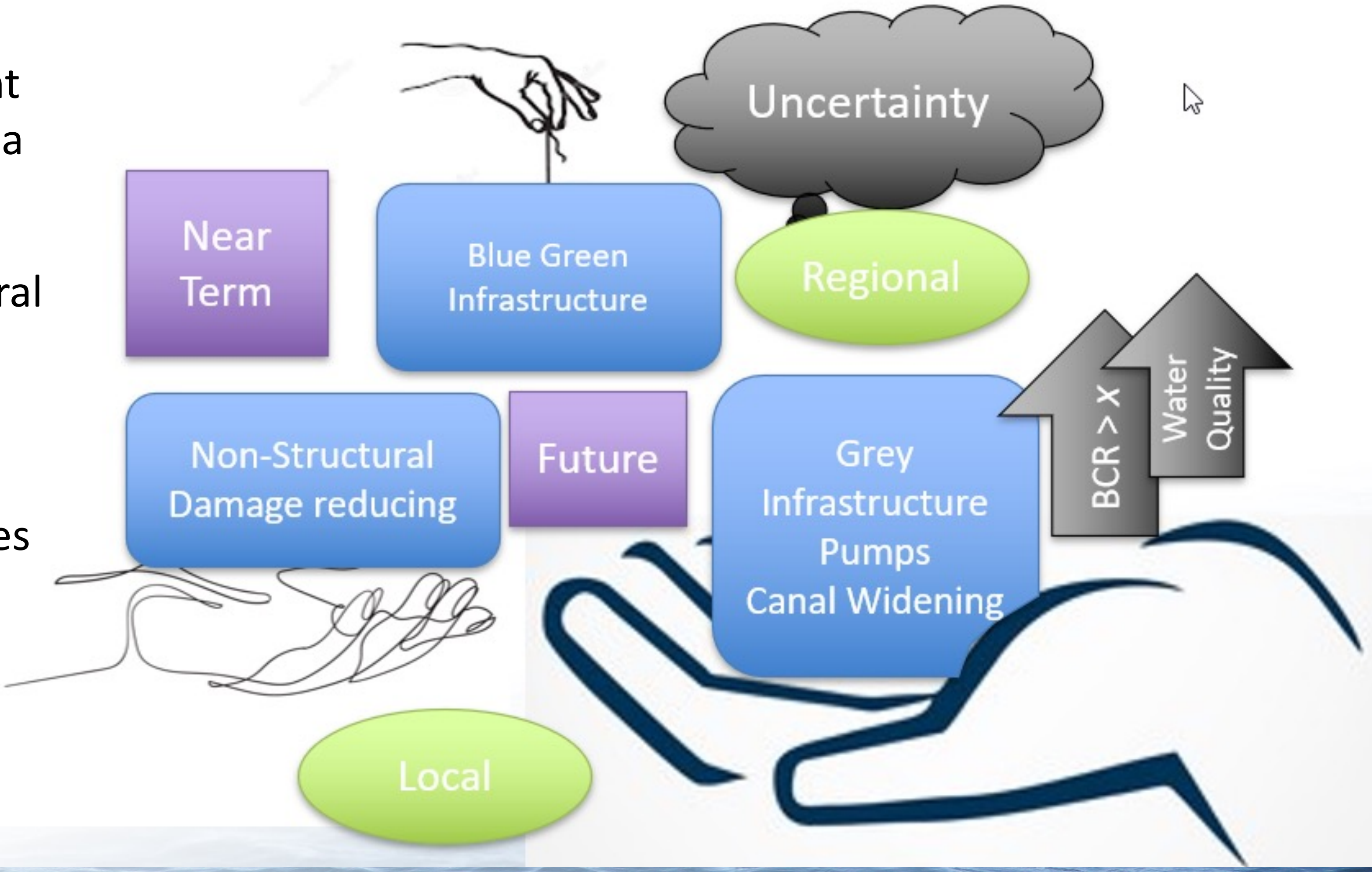
C-8/C-9 Adaptation and Mitigation Area





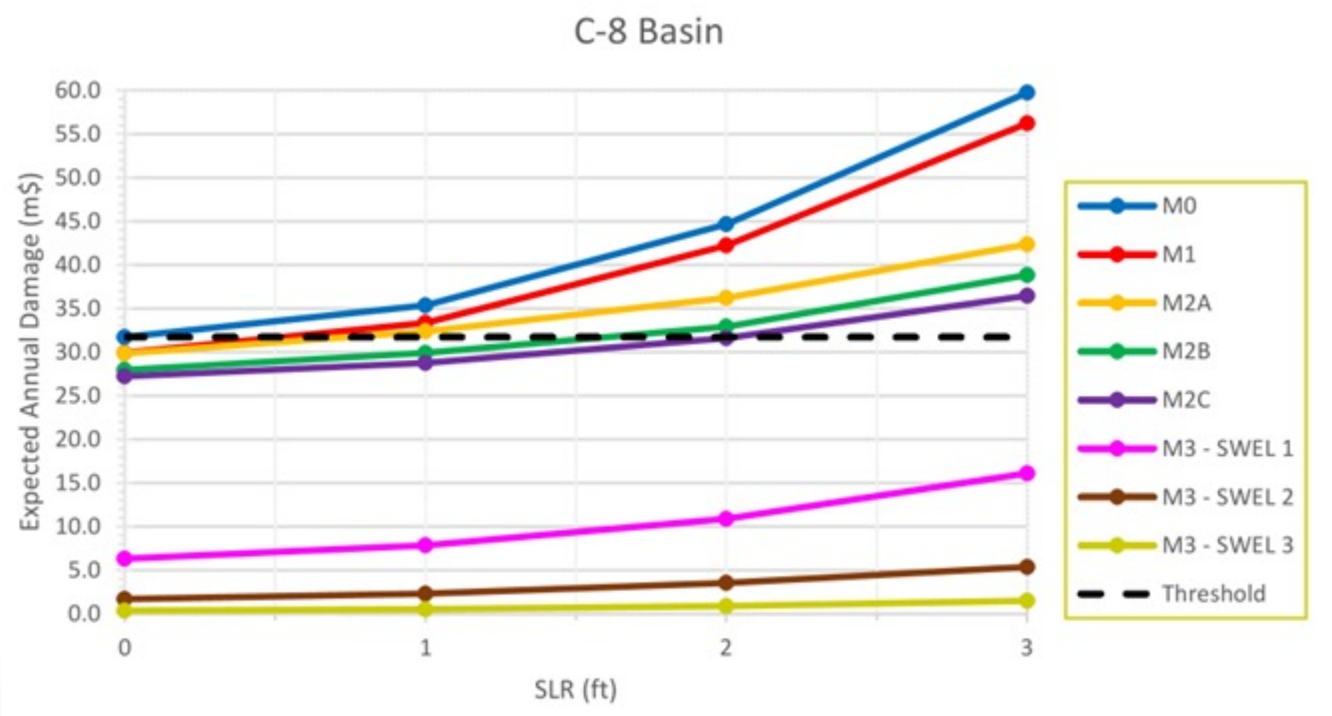
Comprehensive Mitigation and Adaptation Approach

- Assemble adaptation strategies
- Use modeling to test strategies, current and future conditions with different sea level rise and other assumptions
- Considered structural and non-structural measures
  - Grey infrastructure
  - Blue / green infrastructure
- Grouped potential adaptation measures as local regional
  - M0; No flood mitigation
  - M1: Local flood mitigation strategies
  - M2x: Regional flood mitigation strategies
  - M3: Non structural / land use strategies



Determining Tipping Point for Alternative Strategies

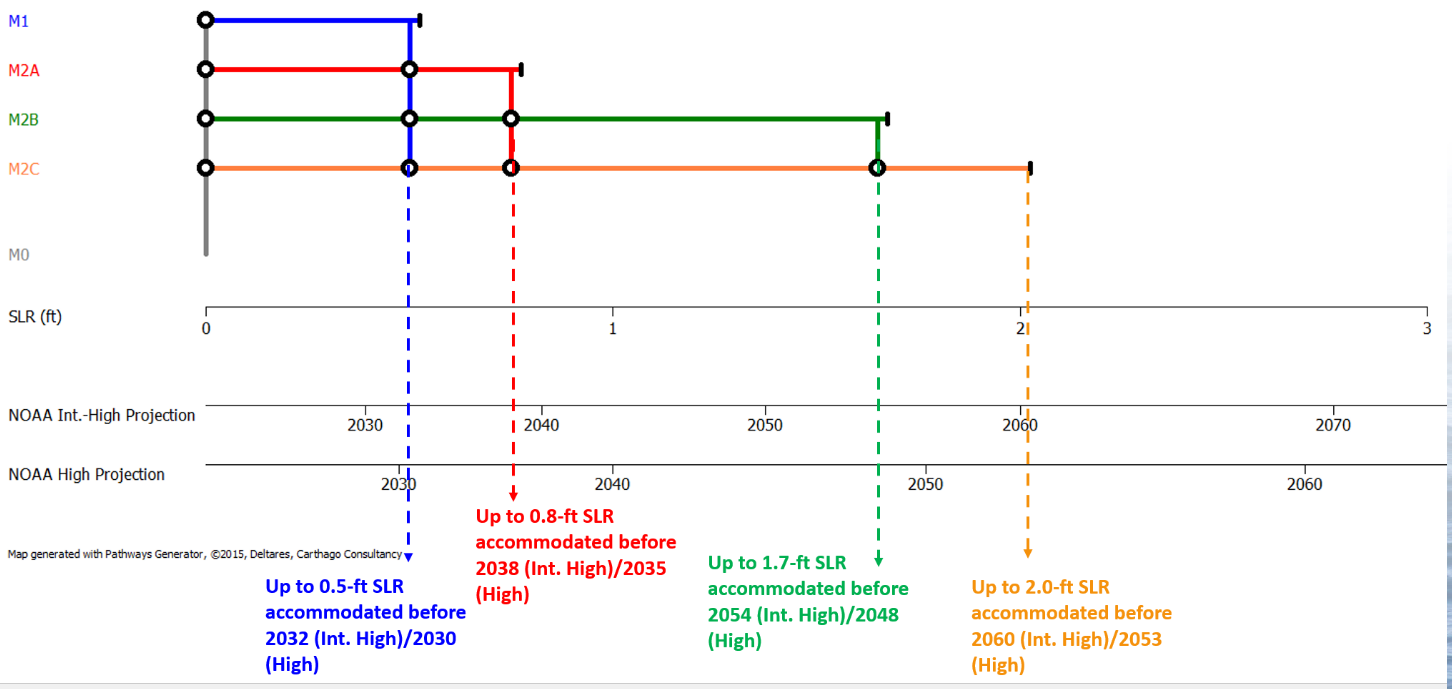
- Use Flood Impact Assessment Tools to do damage assessment
- Determine Expected Annual Damages (EAD) with and without measures
- Determine System Performance (EAD – Current Condition No Action)
- Flood risk increases with sea level rise
- Each strategy crosses the threshold at its tipping point (the SLR at which the strategy is unable to maintain annual damages below the threshold)



Mitigation Projects – Adaptation Pathway Planning – C-8 Watershed

- M1: It can accommodate up to 0.5 ft SLR
  - As early as 2030 based on NOAA High and as late as 2032 based on Intermediate High
- M2A: It can accommodate up to 0.8 ft SLR
  - As early as 2035 based on NOAA High and as late as 2038 based on Intermediate High
- M2B: It can accommodate up to 1.6 ft SLR
  - As early as 2048 based on NOAA High and as late as 2054 based on Intermediate High
- M2C: It can accommodate up to 2.0 ft SLR
  - As early as 2053 based on NOAA High and as late as 2060 based on Intermediate High

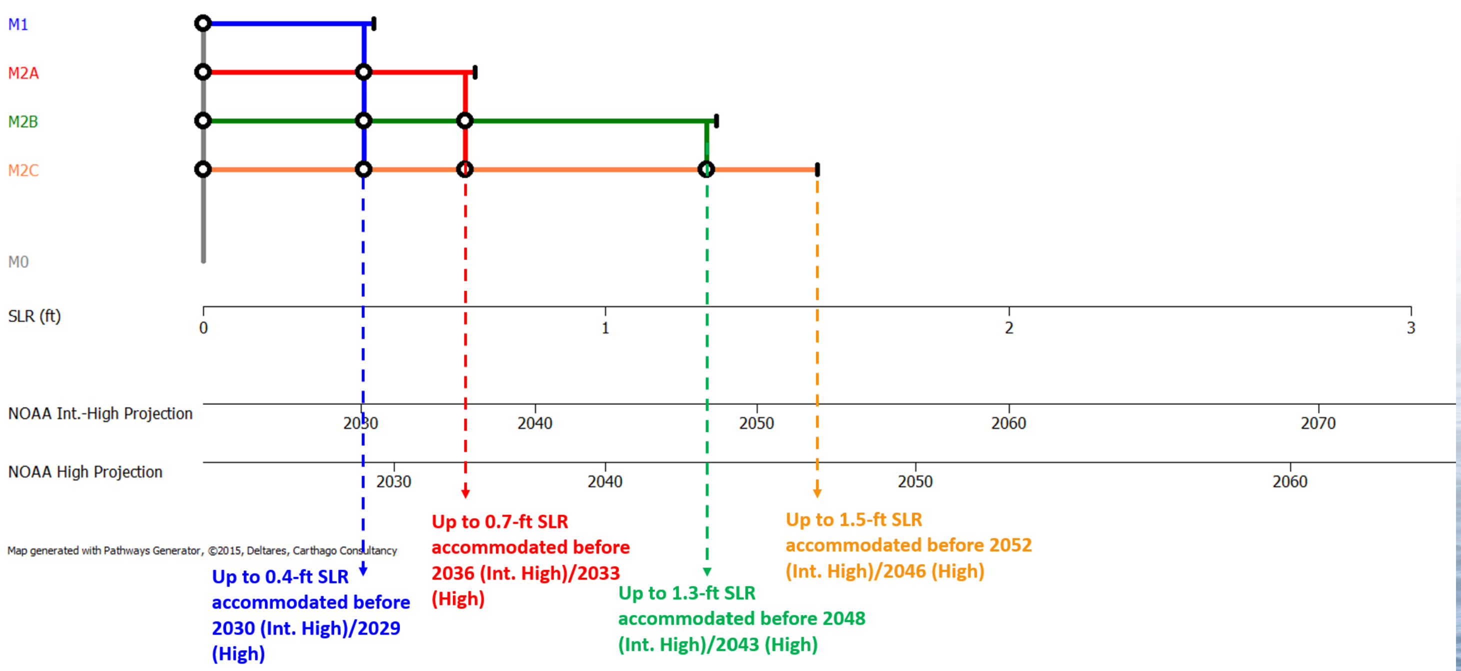
C-8 Basin



Mitigation Projects – Adaptation Pathway Planning – C-9 Watershed

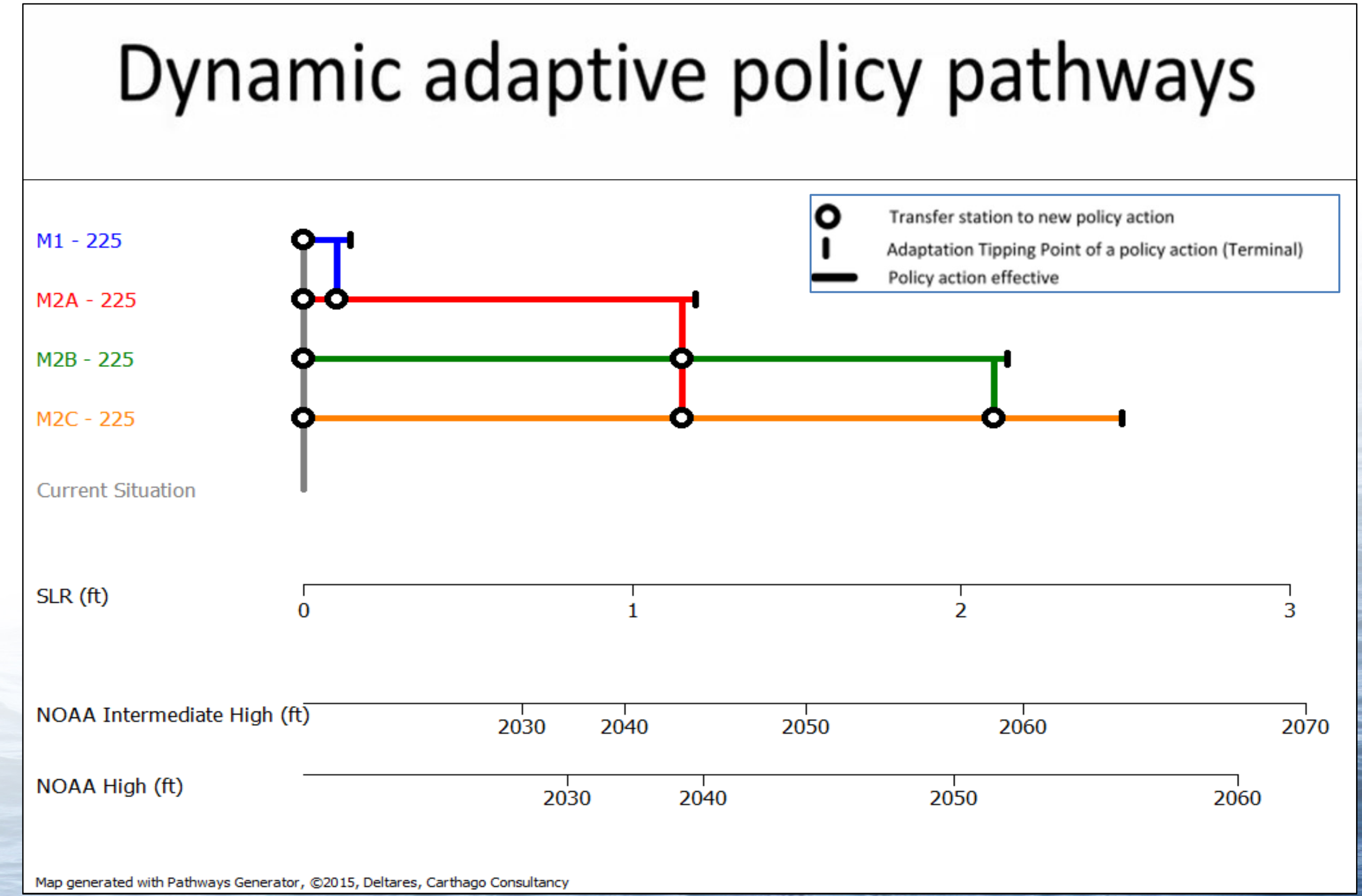
- M1: It can accommodate up to 0.4 ft SLR
  - As early as 2029 based on NOAA High and as late as 2030 based on Intermediate High
- M2A: It can accommodate up to 0.7 ft SLR
  - As early as 2033 based on NOAA High and as late as 2036 based on Intermediate High
- M2B: It can accommodate up to 1.3 ft SLR
  - As early as 2043 based on NOAA High and as late as 2048 based on Intermediate High
- M2C: It can accommodate up to 1.5 ft SLR
  - As early as 2046 based on NOAA High and as late as 2052 based on Intermediate High

C-9 Basin



Supporting Decision Making under Deep Uncertainty

- Infrastructure cost is high, so is the cost of doing nothing
- There is significant uncertainty
- How to make informed near-term decisions that do not preclude other courses of action
- The difference between a good plan and an *implemented* good plan



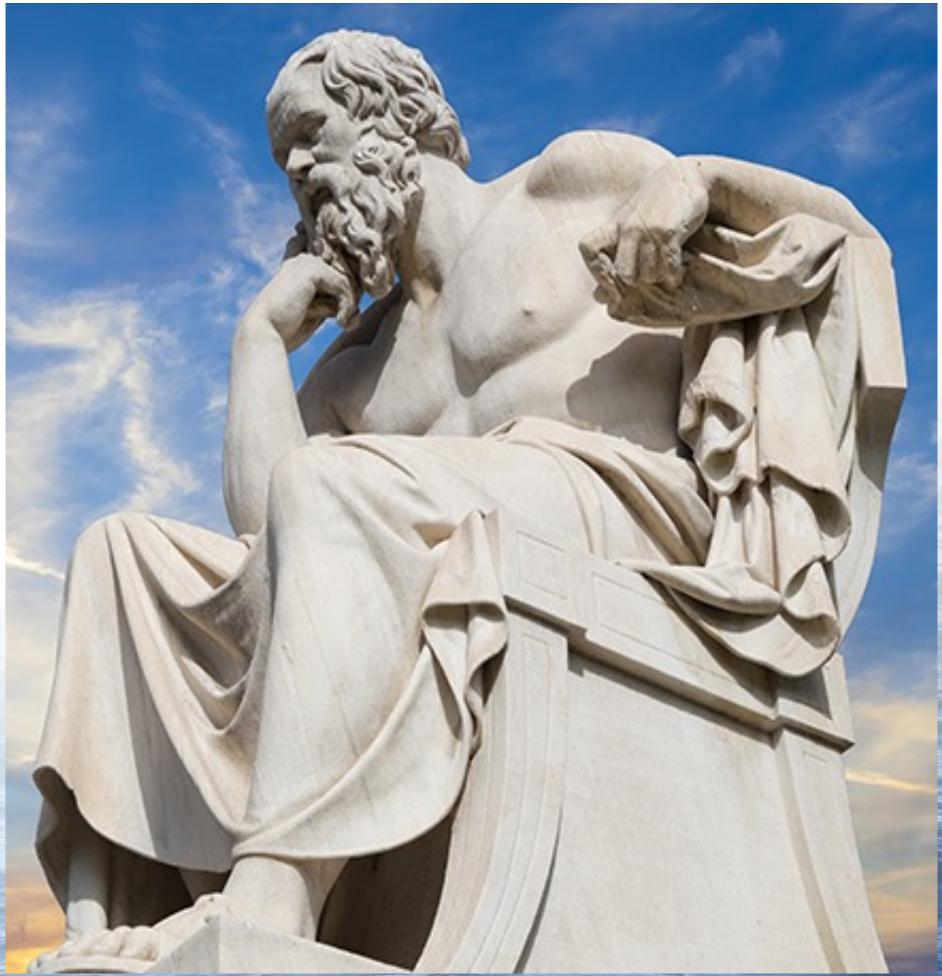
Free Book

https://link.springer.com/content/pdf/10.1007%2F978-3-030-05252-2.pdf

Decision Making under Deep Uncertainty; From Theory to Practice

Some Challenges and Opportunities

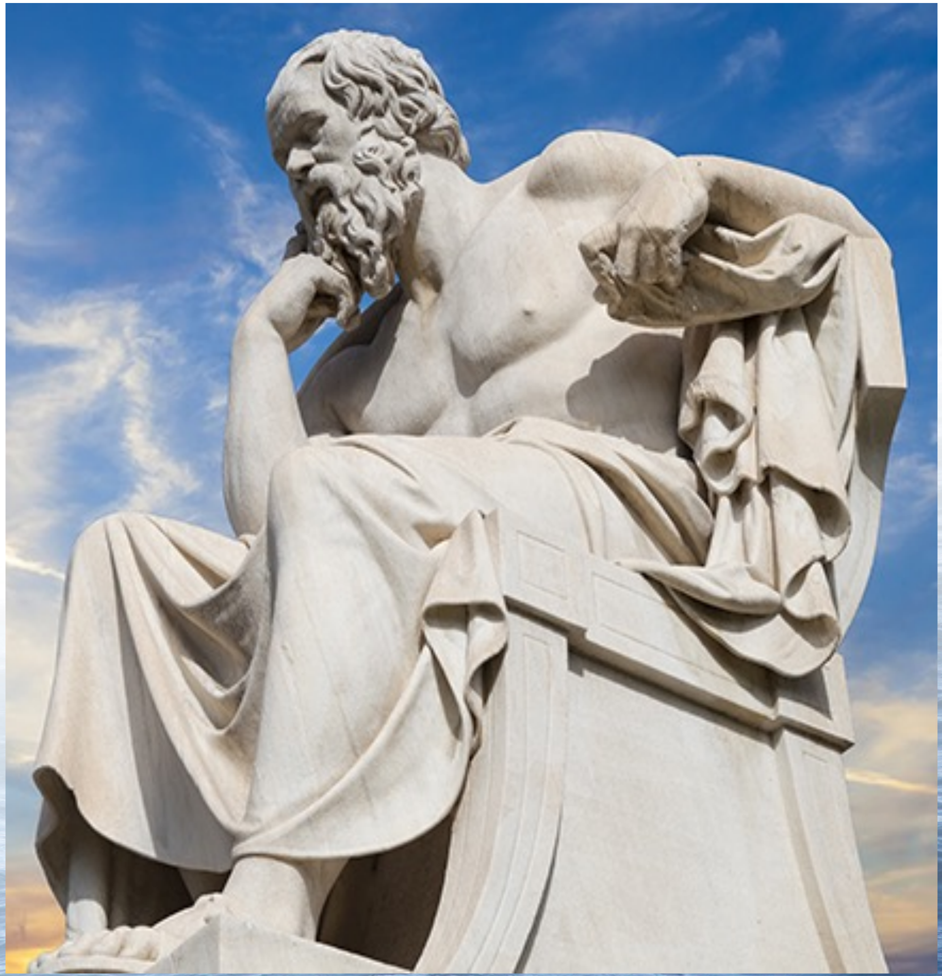
- The threshold selected is very important but not all project goals have easy to define thresholds, for example it is challenging to set threshold for social economic and water quality objectives
- Stakeholders' tolerance for risk may change after realizing the cost of adaptation necessitating revised thresholds
- From the threshold, a trigger needs to be selected that can be identified through monitoring. Often the underlying process has noise or natural variability
- For regional efforts, where do you measure the threshold
- For a total system, some of the thresholds may be outside of agency sphere of responsibility



Some Challenges and Opportunities

continued

- The choice of an economic based system threshold introduces an equity risk in our larger planning objectives. Damage avoidance for one building structures in an affluent community may generate more economic benefit than protecting many in a disadvantaged community, creating a risk if not carefully tracked, of planning outcomes with social imbalance
- Does the threshold – damage – represent the true pinch point, what if the composition of damaged features though having the same cost are not equally acceptable to the stakeholders?



Lessons Learned and Changes for Ongoing and Future Studies

- Exploring emulators or faster modeling tools to augment the physically based H&H models
- Better engage partners and stakeholders in the tradeoff and alternatives evaluation using these rapid evaluation tools
- Better capture co-benefits to justify investment – monetize ecological or water quality lift
- Broaden the check for transfer of risk
- Improve the mix of measures to better integrate regional and local solutions
- Rethink managed retreat and the land use /non structural solutions that don't reduce flooding or flood risk but avoids or reduces damages