TAYLOR ENGINEERING, INC.

Delivering Leading-Edge Solutions

SFWMD C-8 AND C-9 WATERSHEDS FLOOD PROTECTION LEVEL OF SERVICE ADAPTATION PLANNING AND MITIGATION PROJECTS STUDY

Date: June 6, 2022

Time: 2:30 PM – 3:30 PM

Subject: Bi-Weekly Meeting #25

Attendees Highlighted:

- Hongying Zhao, **SFWMD**
- Ana Carolina Maran, **SFWMD**
- Nicole Cortez, **SFWMD**
- Akin Owosina, **SFWMD**
- Ann Springston, **SFWMD**
- Lichun Zhang, **SFWMD**
- Matahel Ansar, **SFWMD**
- Larry Brion, **SFWMD**
- Carol Ballard, **SFWMD**
- Ruben Arteaga, **SFWMD**
- Sashi Nair, **SFWMD**
- Francisco Pena Guerra, **SFWMD**
- Shahana Mona, **SFWMD**
- Vijay Mishra, **SFWMD**
- Irela Bague, **Miami Dade**
- Marina Blanco-Pape, **Miami Dade**
- Alberto Pisani, **Miami Dade**
- Gregory Mount, **Broward**
- Kevin Hart, **SBDD**
- Susan Bodmann, **Broward**
- Jennifer Jurado, **Broward**
- Rajendra Sishodia, **Broward**
- Virginia Walsh, **WASD**
- Omar Abdelrahman, **RER**
- Pamala Sweeney, **RER**
- Katherine Hageman, **RER**
- Laura Eldridge, **(RER)**
- Valentina Caccia, **RER**
- Michael Zygnerski, **Broward Co**
- Karina Cordero, **RER**
- Michael DelCharco, **Taylor Engineering**
- Angela Schedel, **Taylor Engineering**
- Pat Lawson, **Taylor Engineering**
- Joseph Wilder, **Taylor Engineering**
- Stephanie Massey, **Taylor Engineering**
- Lynette Cardoch, **Moffatt & Nichol**
- Peter Sahwell, **Nova Consulting**
- John Loper, **Anclote Consulting**
- David Key, **ESP – Florida**
- Nathan Slaughter, **ESP – Florida**
- Carrie Sigrist -?
- Sarah Hamm, Moffatt & Nichol
- Elton Smith, Taylor Engineering

Notes:

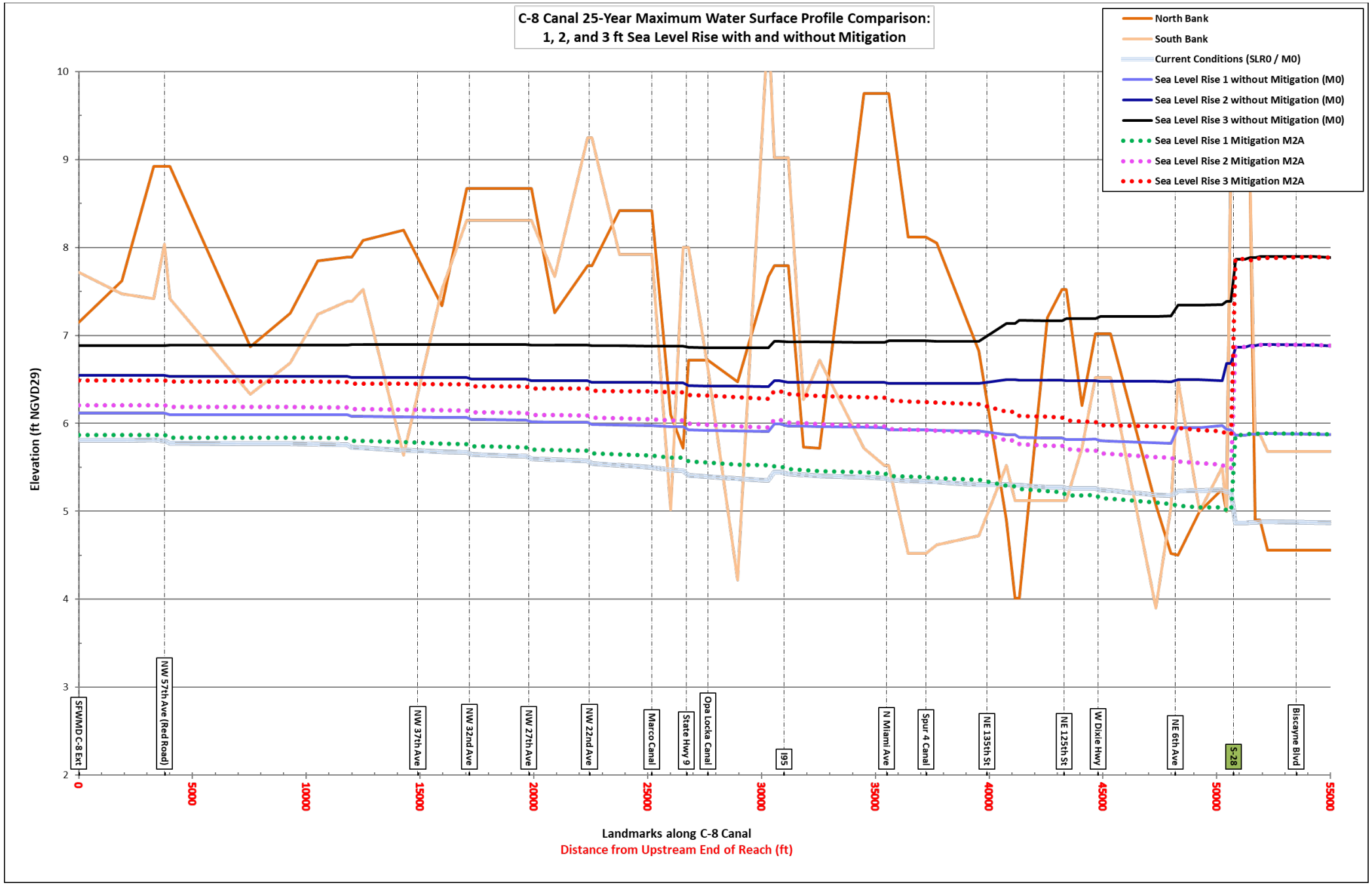
1. **Meeting Kickoff**
   - Roll Call
2. **Task 2 – Modeling Update**
   - M2A, M2B, and M2C complete
   - Brief presentation of M2B and M2C results
   - See attached slides.
   - Presented only 25 year results for with and without mitigation projects
   - C8 M2B increased pump to 2550 cfs
     i. The western side of the profile does not change much, but the eastern side does
   - C8 M2C increased pump to 3550 cfs
     i. The increased conveyance shows more impact to flood profile.
   - C9 M2B gets back closer to current conditions

- C9 M2C – gets very close to current conditions even with the SLR3.
- We noticed that a PM1 profile within bank does not mean there is no PM5 flooding. So, the mitigation projects are great – but fixing the profile does not always mean a reduction in 2D overland flooding.
    i. Joe presented PM5 results. Looked at with and without projects with SLR 1
    ii. PM5 results show the impacts of the mitigation projects and SLR
- Ruben – are the lakes masked? Joe – they will be in final products. These are just preliminary results.

3. **Task 3 – Flood Damage Assessment**
    - Preliminary results based on water surface elevations
    - The team had to mask some of the modeling results because the mitigation project had raised elevations of the canal. So, adding in elevations on embankments lead to having higher elevations in the results. The team was able to mask those out and take them out of the EAD calculations.
    - Carol – so you do see flooding on that topo for which you added elevation? Yes, it is small, but since you added the elevation it shows.
    - C9 is larger than C8 basin – so typically you see higher damages there. But in SLR3 you see higher damages in C8 basin than in C9.
    - ESP Audit Discussion
        i. They have started spot checks, looked at tool and output, comparing to other tools
        ii. Complete:
            - Completed review of client provided documents and data
            - Extracted WSEL and depth grid values for samples of points in areas C8 & C9 using client provided rasters, calculated inundation for each event
            - Calculated damage values for inundation levels using client provided USACE-IWR damage functions for samples of points in areas C8 & C9
            - Ran samples of buildings in areas C8 & C9 through NC RISK, calculating inundation and damage costs based on WSE rasters
        iii. To-Do:
            - Calculate damage values for inundation levels using HAZUS damage functions
            - Complete spatial review of building risk by recurrence interval
            - Continue cross comparison of inundation water level and damage costs between client provided data, manually calculated values from USACE-IWR and HAZUS functions, and NC RISK calculated values
    - Carol asked about M3 analysis – what is that? Pat – we just added 1, 2, and 3 feet to elevation.
4. **Task 4 – Adaptive Pathways Analysis**
    - Discussion of approach of Dynamic Adaptive Policy Pathways (DAPP)
    - See attached slides
    - The maps show “junctions” where a change can be made – like a transfer station. The tipping point is a terminal – a hard stop.
    - Sarah presented examples from the C7 Report
    - Akin would like us to change nomenclature to “small regional projects” and “mid-size projects” and “Large scale” projects. Let’s see if we can get away from the shorthand we are using to more generic language.
    - The team will have to help develop some language for each M1, M2A, M2B, M2C, etc….

- Hongying – we need to understand what the "5% Risk Increase" means? Sarah – they added 5% increase in EAD. Hongying did some quick math and that doesn't seem to be exactly right? Lynette – we'll check on that and get back to you.

5. **Additional action Items from Previous Meeting**
    - Schedule update
    - Mitigation Project Cost Development
    - M1 projects developed for C7 project – Ruben helped on that work. He would be available to discuss it.


C-8 Canal 25-Year Maximum Water Surface Profile Comparison:
1, 2, and 3 ft Sea Level Rise with and without Mitigation
North Bank
South Bank
Current Conditions (SLR0 / M0)
Sea Level Rise 1 without Mitigation (M0)
Sea Level Rise 2 without Mitigation (M0)
Sea Level Rise 3 without Mitigation (M0)
Sea Level Rise 1 Mitigation M2A
Sea Level Rise 2 Mitigation M2A
Sea Level Rise 3 Mitigation M2A
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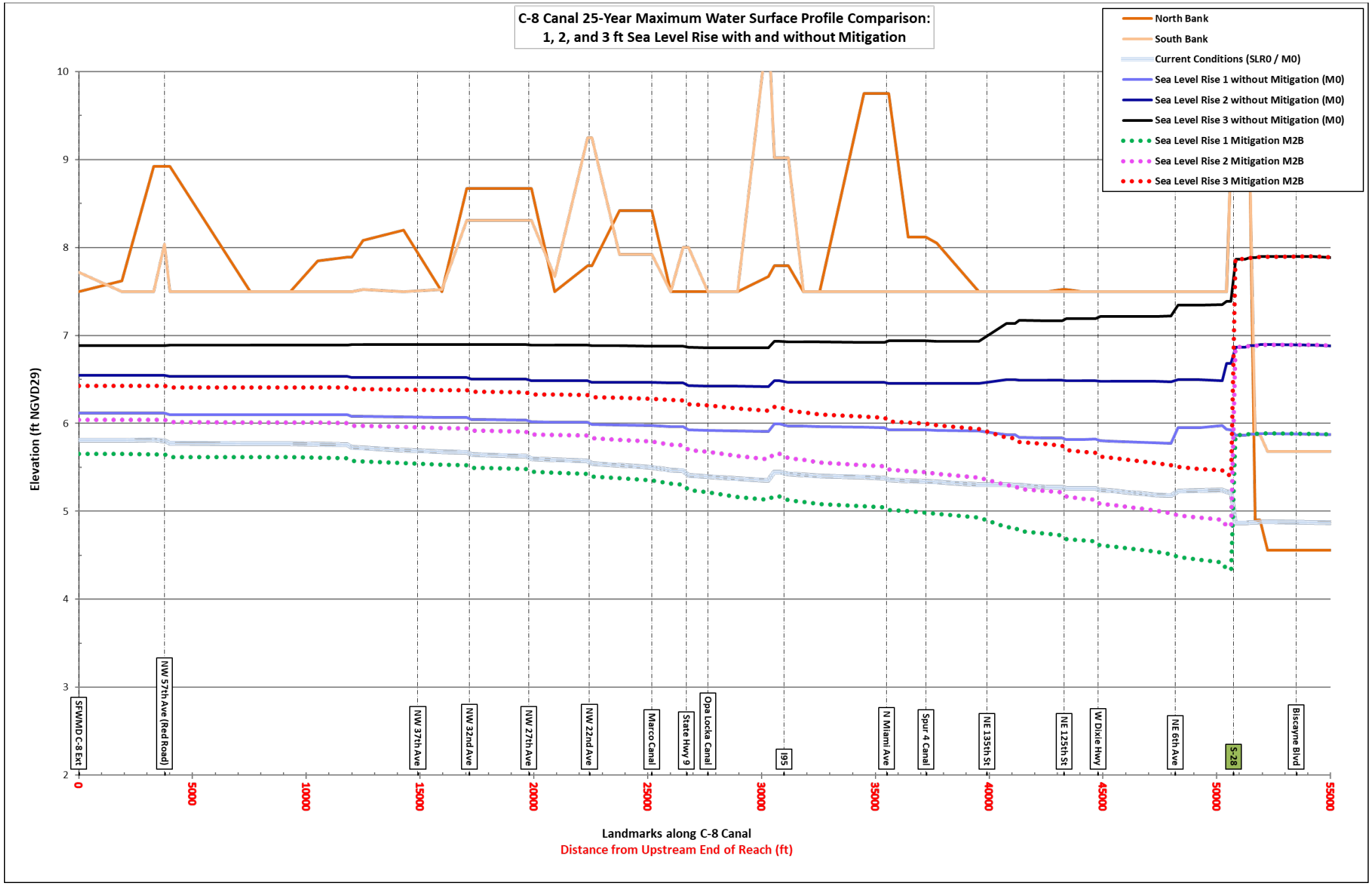
Landmarks along C-8 Canal
Distance from Upstream End of Reach (ft)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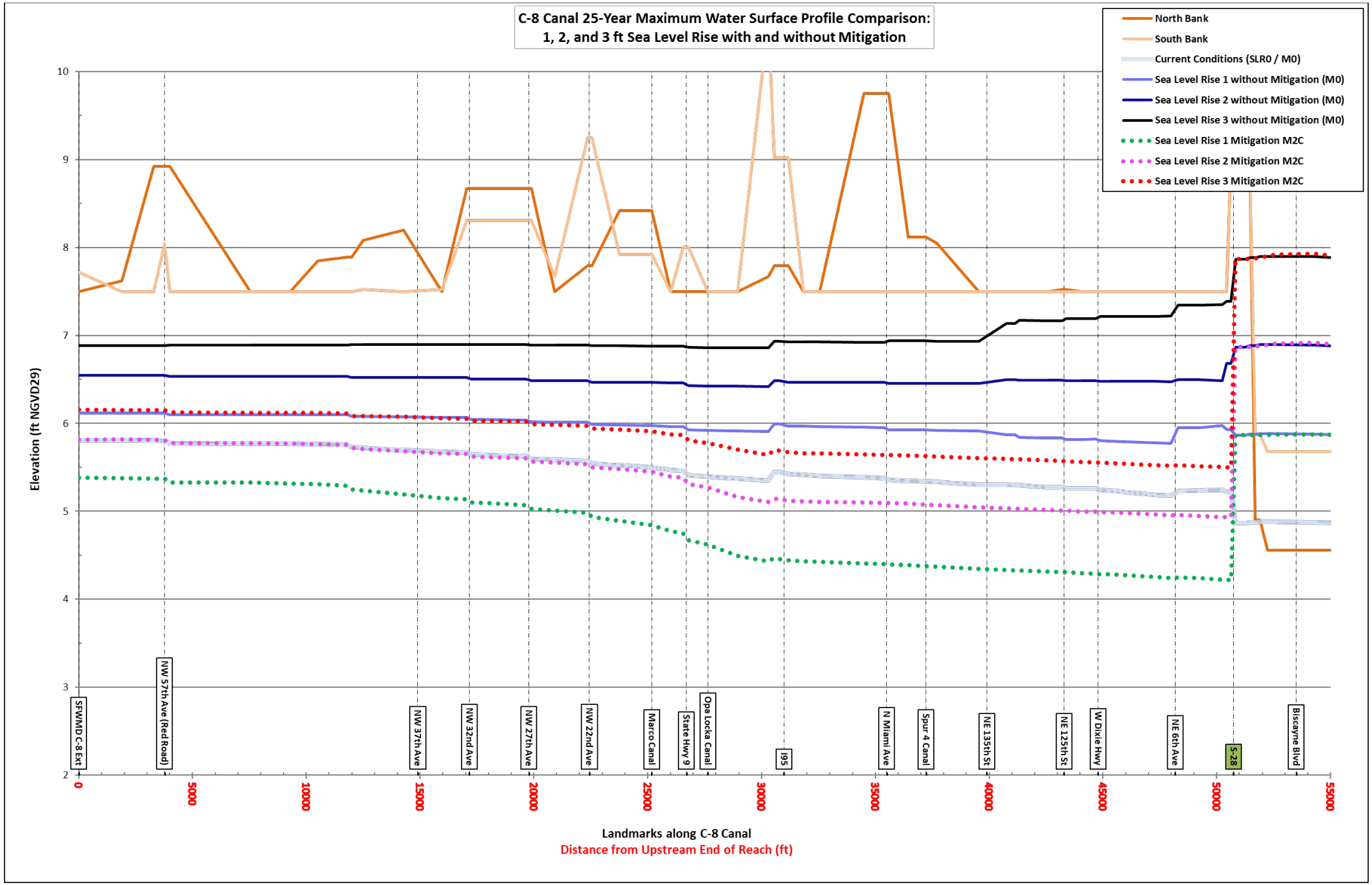
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Sea Level Rise 3 without Mitigation (M0)
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Sea Level Rise 2 Mitigation M2C
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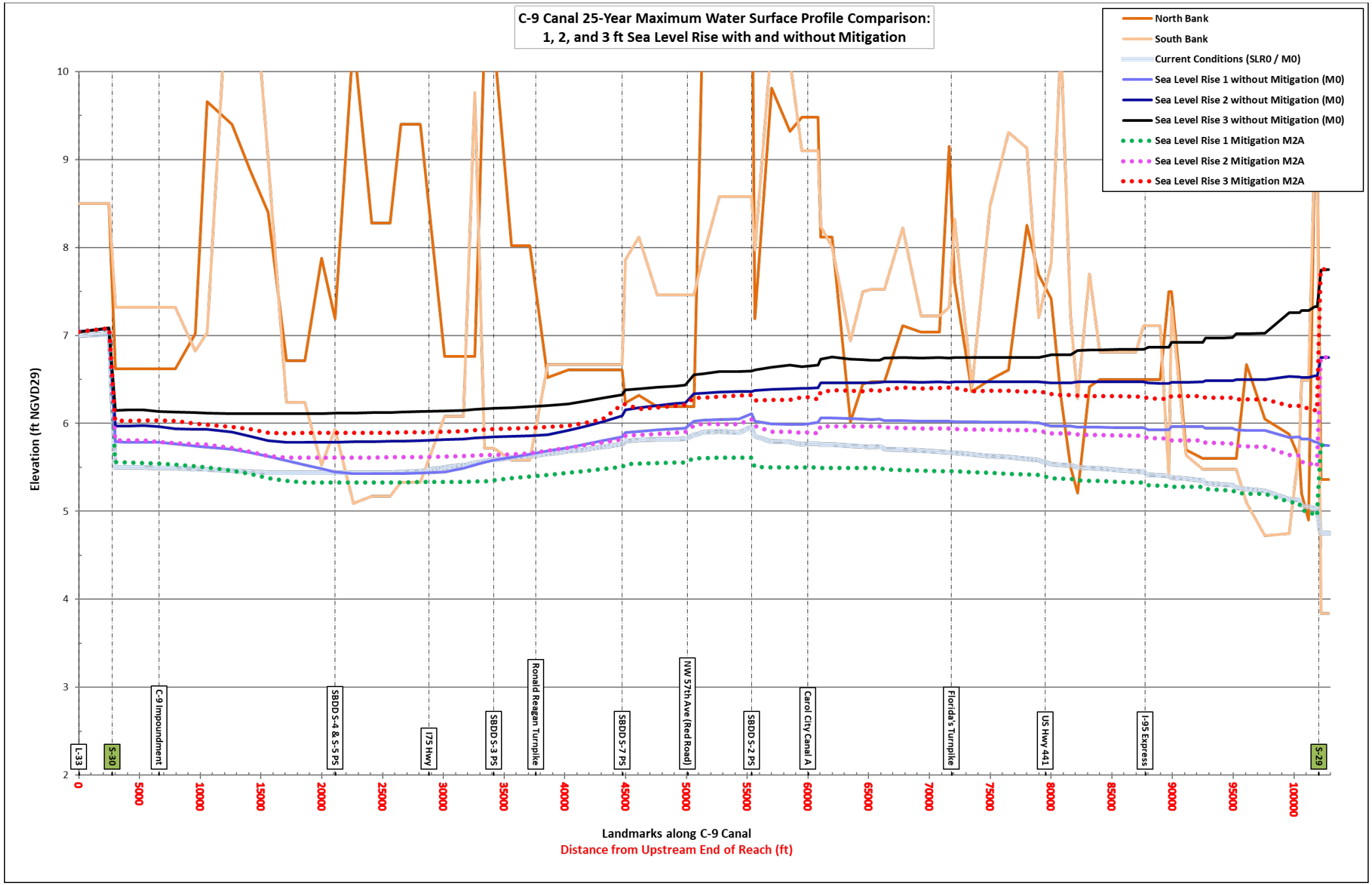
C-9 Canal 25-Year Maximum Water Surface Profile Comparison:
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South Bank
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Sea Level Rise 3 without Mitigation (M0)
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C-9 Impoundment
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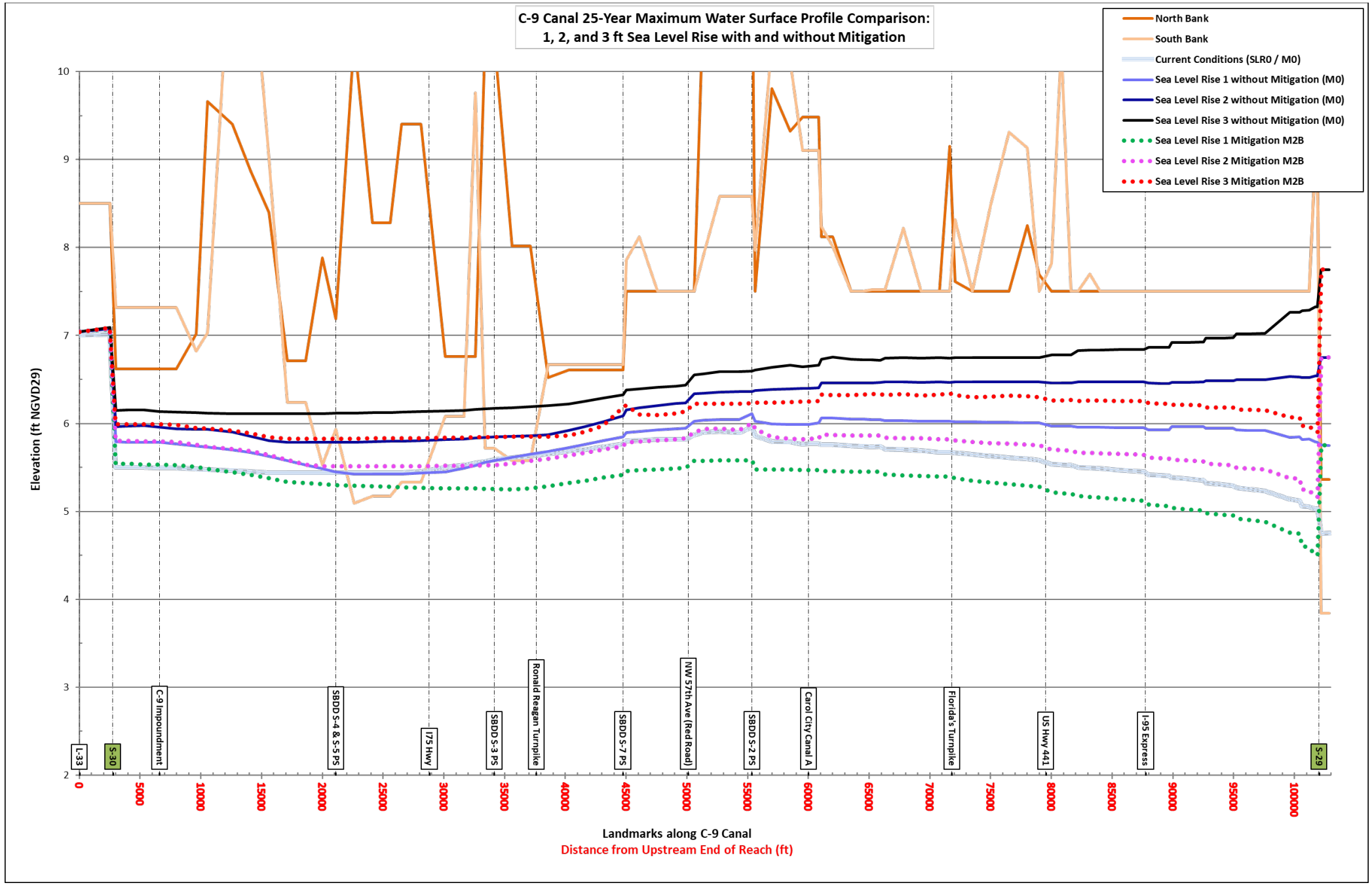
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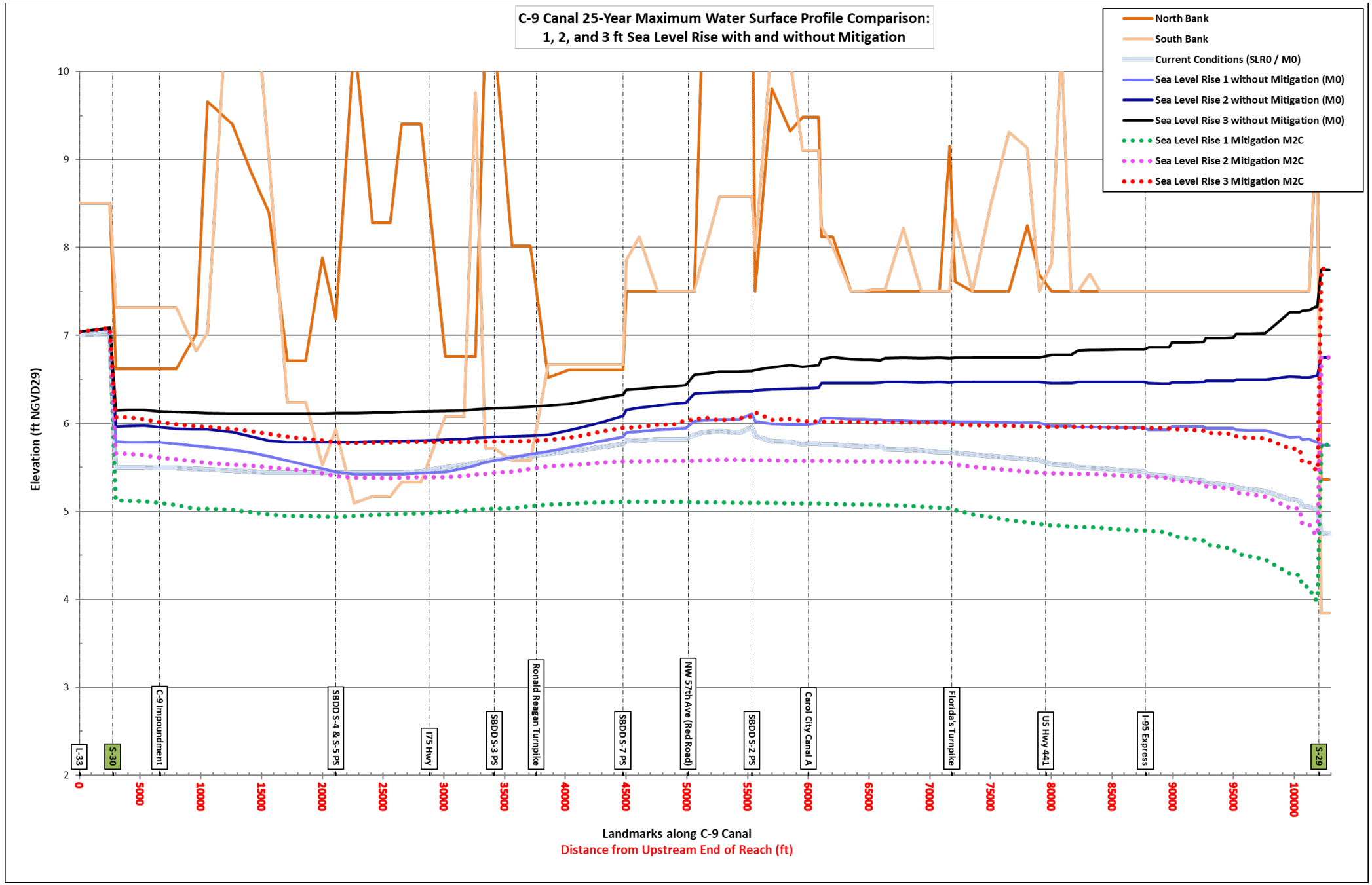
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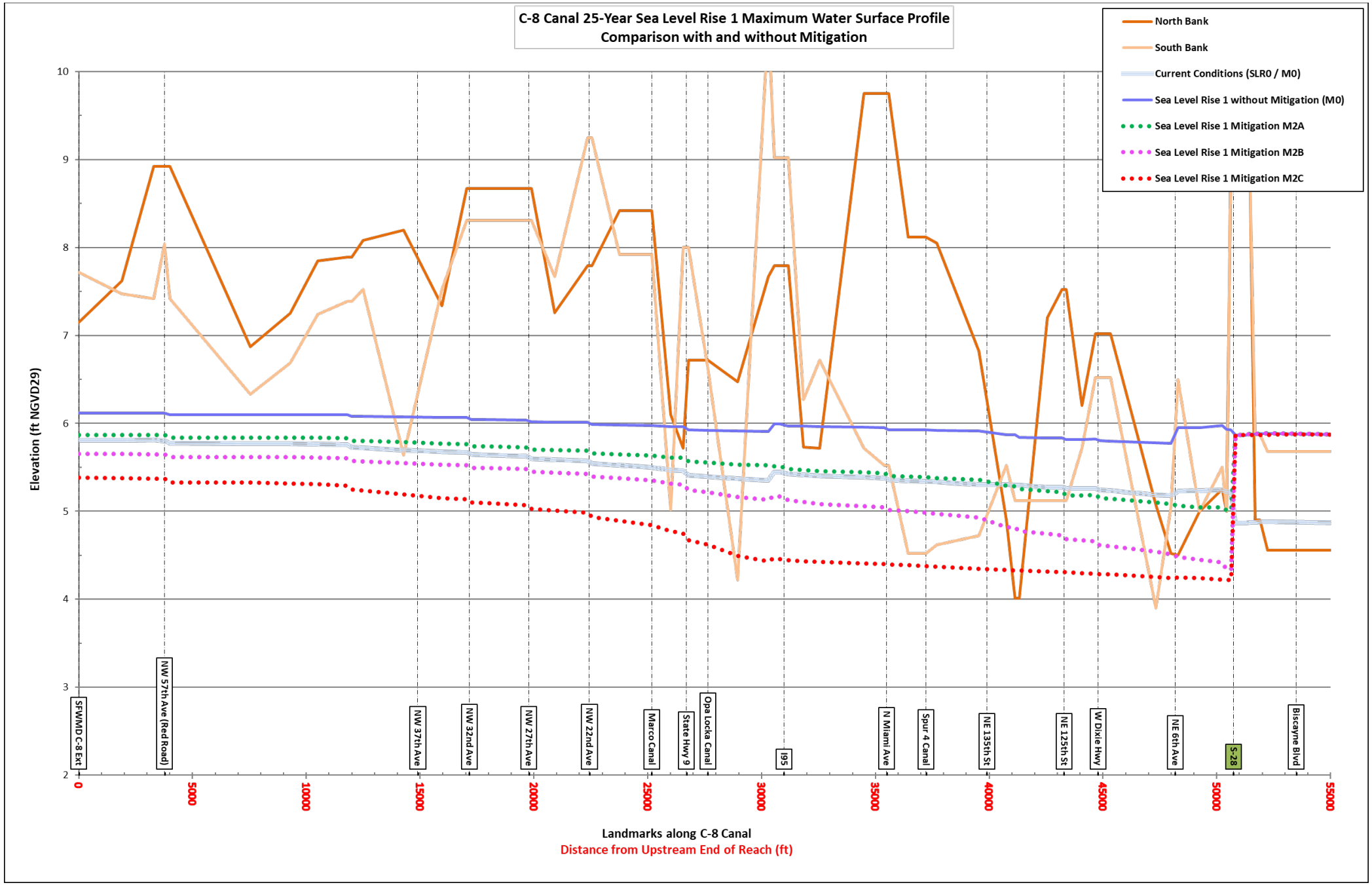
C-8 Canal 25-Year Sea Level Rise 1 Maximum Water Surface Profile
Comparison with and without Mitigation
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Current Conditions (SLR0 / M0)
Sea Level Rise 1 without Mitigation (M0)
Sea Level Rise 1 Mitigation M2A
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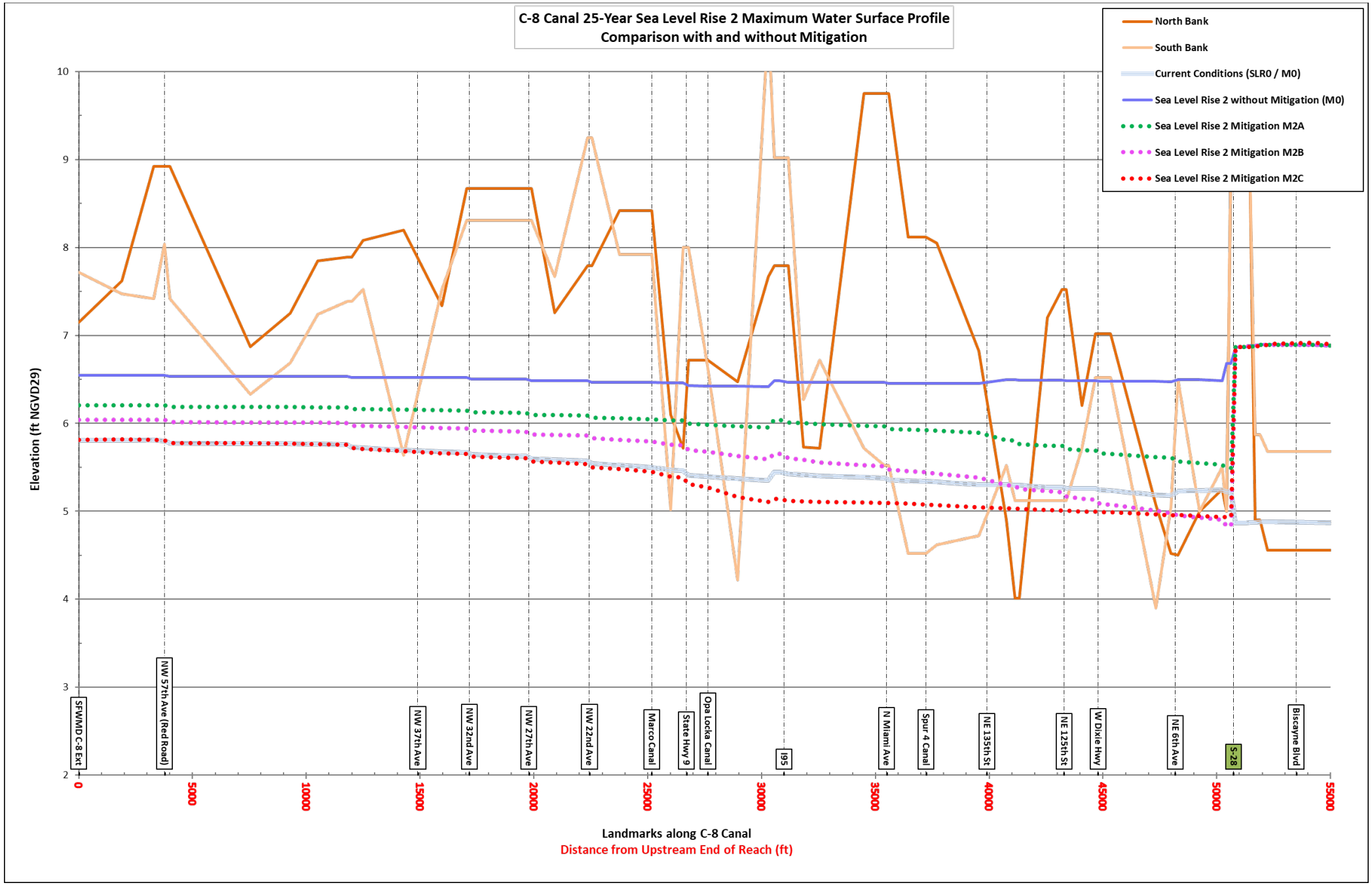
C-8 Canal 25-Year Sea Level Rise 2 Maximum Water Surface Profile
Comparison with and without Mitigation
North Bank
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Current Conditions (SLR0 / M0)
Sea Level Rise 2 without Mitigation (M0)
Sea Level Rise 2 Mitigation M2A
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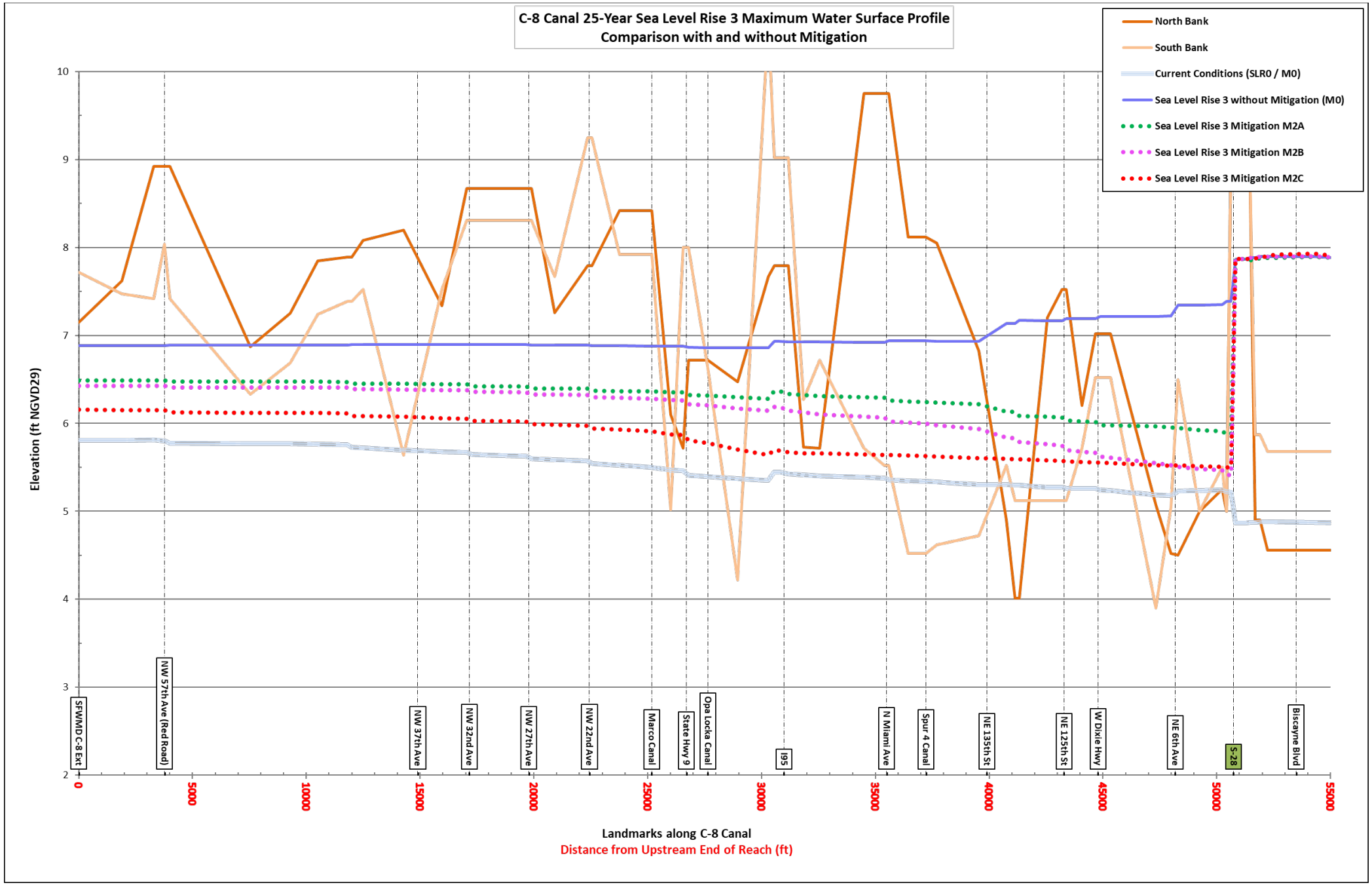
C-8 Canal 25-Year Sea Level Rise 3 Maximum Water Surface Profile
Comparison with and without Mitigation
North Bank
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Current Conditions (SLR0 / M0)
Sea Level Rise 3 without Mitigation (M0)
Sea Level Rise 3 Mitigation M2A
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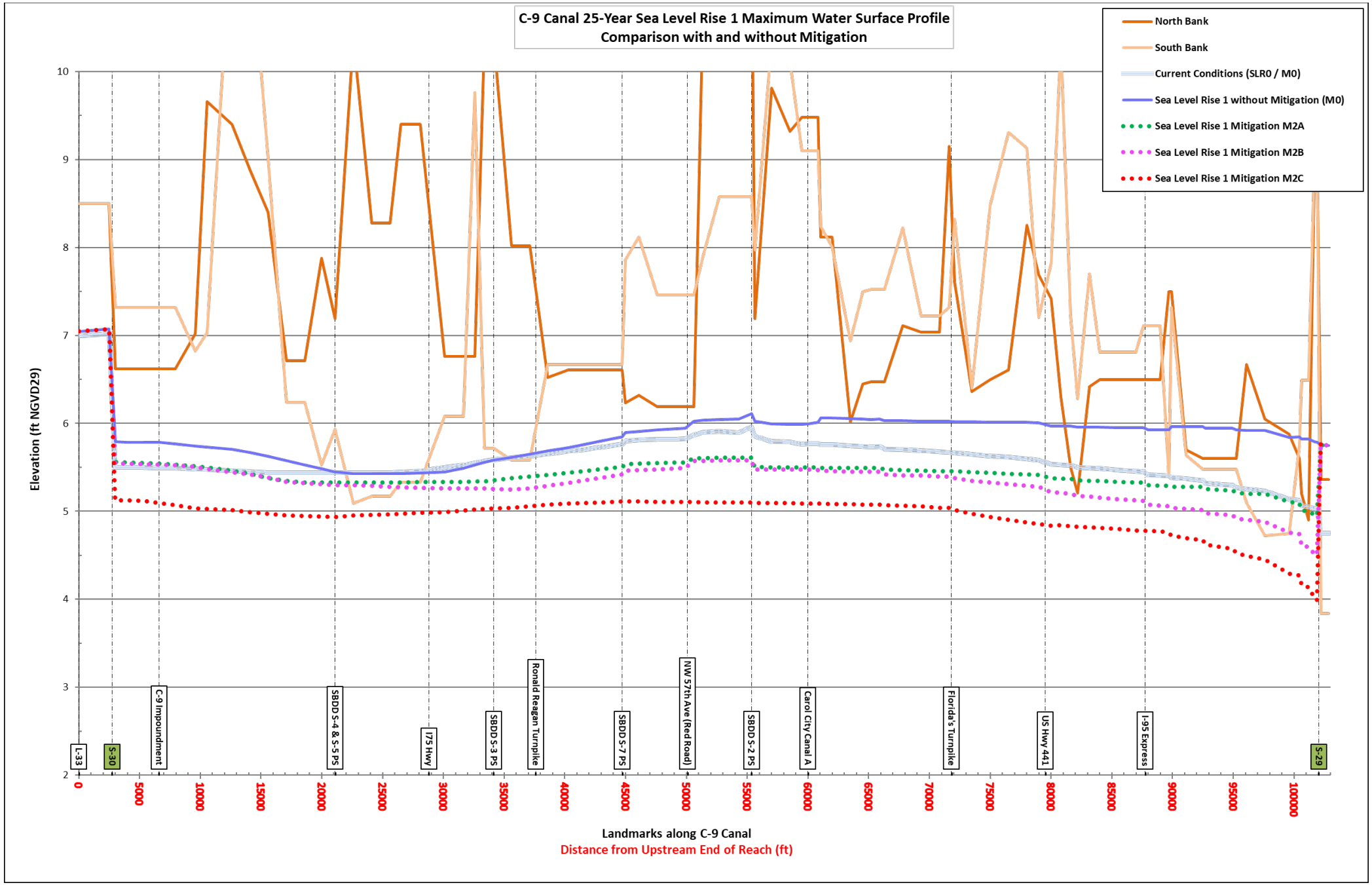
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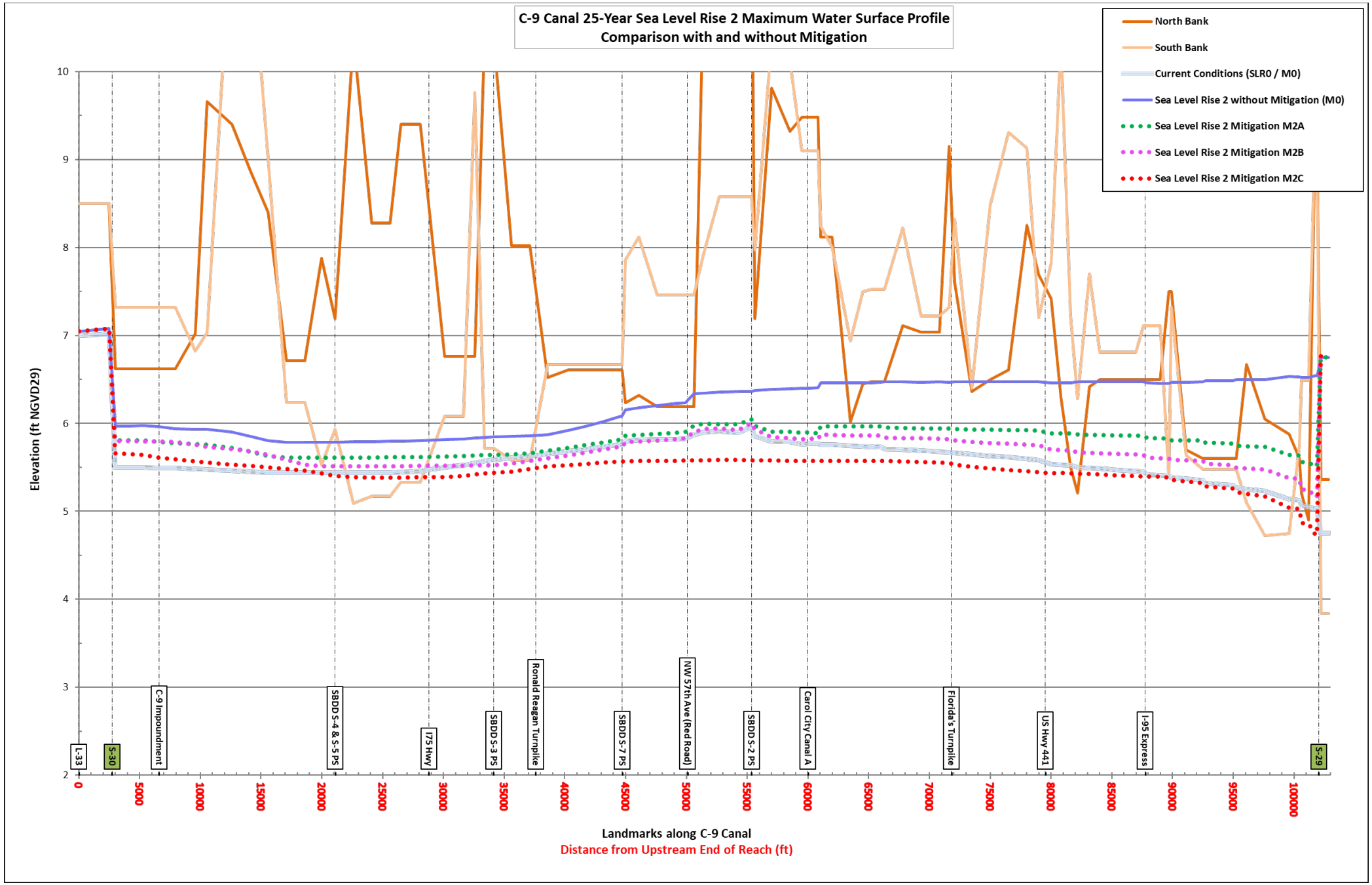
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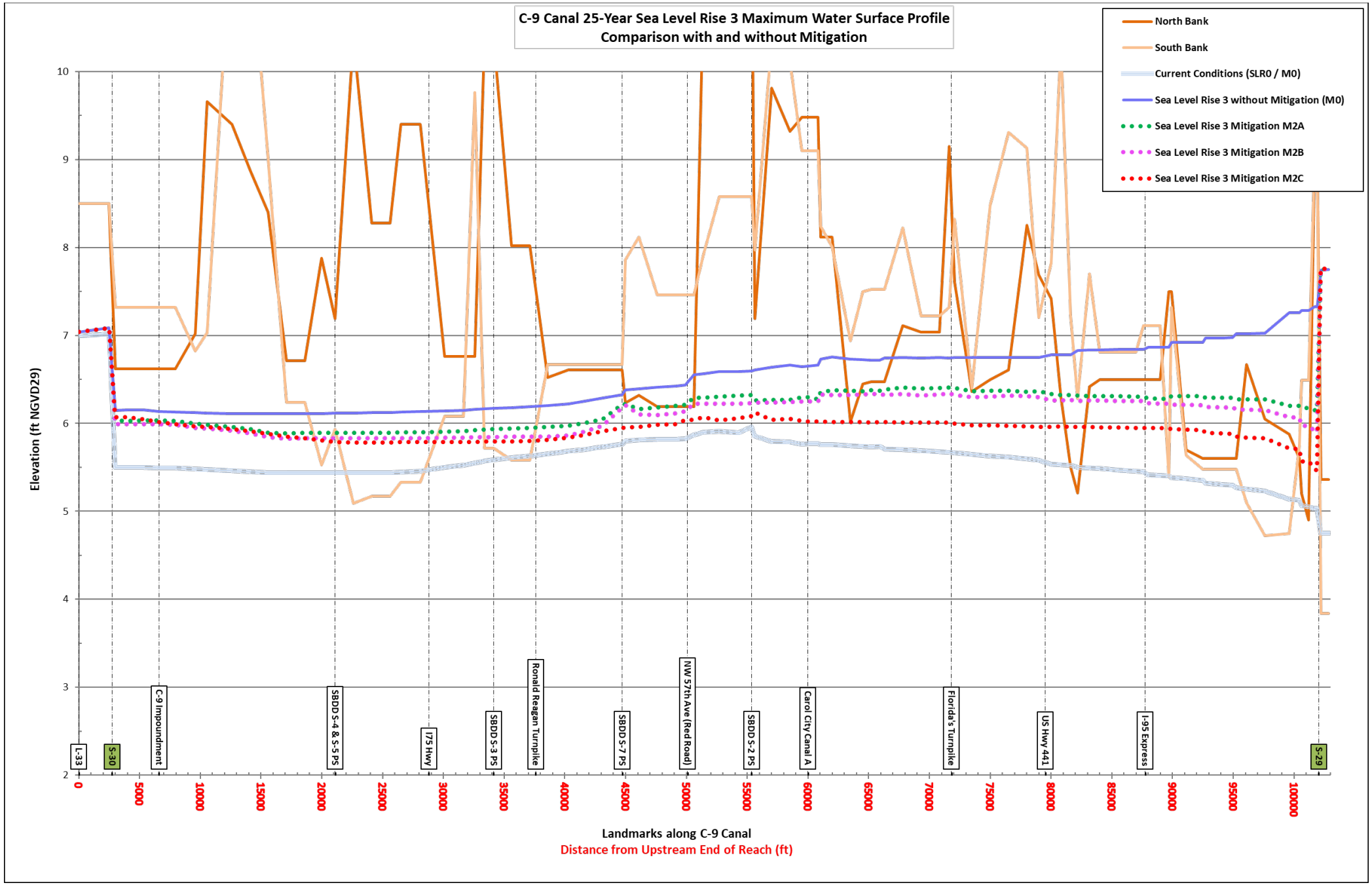
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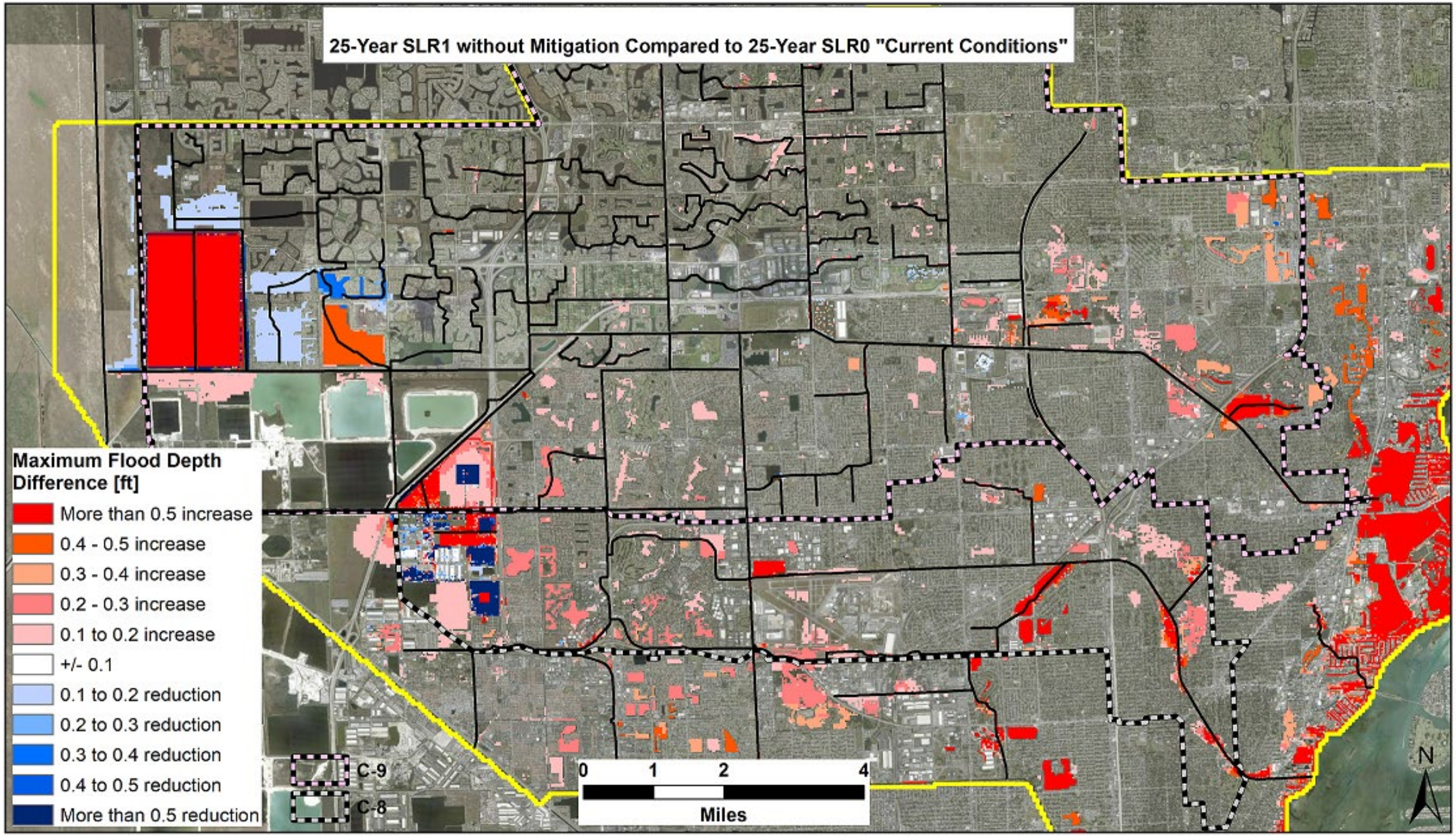
25-Year SLR1 without Mitigation Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
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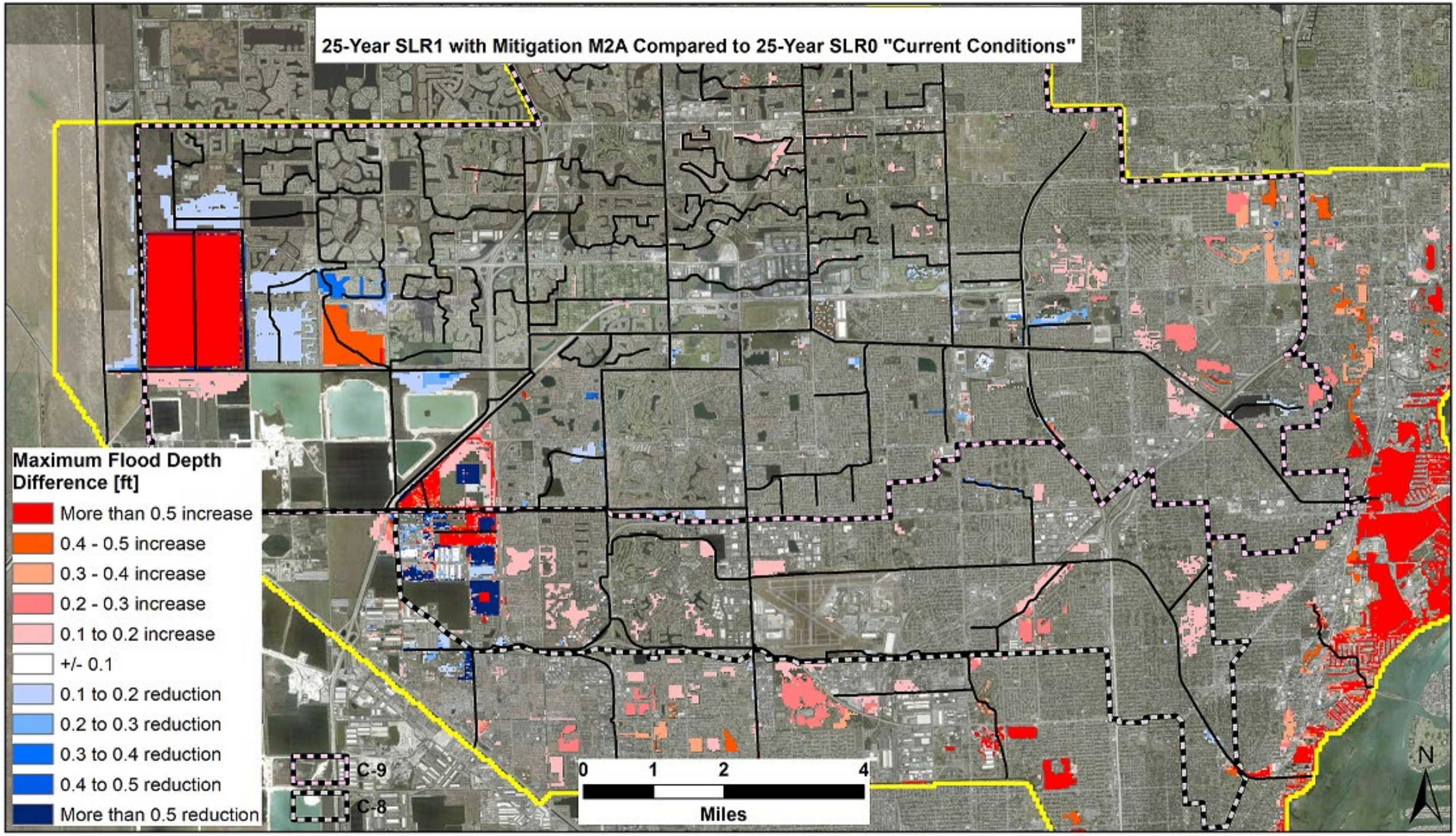
25-Year SLR1 with Mitigation M2A Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
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+/- 0.1
0.1 to 0.2 reduction
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More than 0.5 reduction
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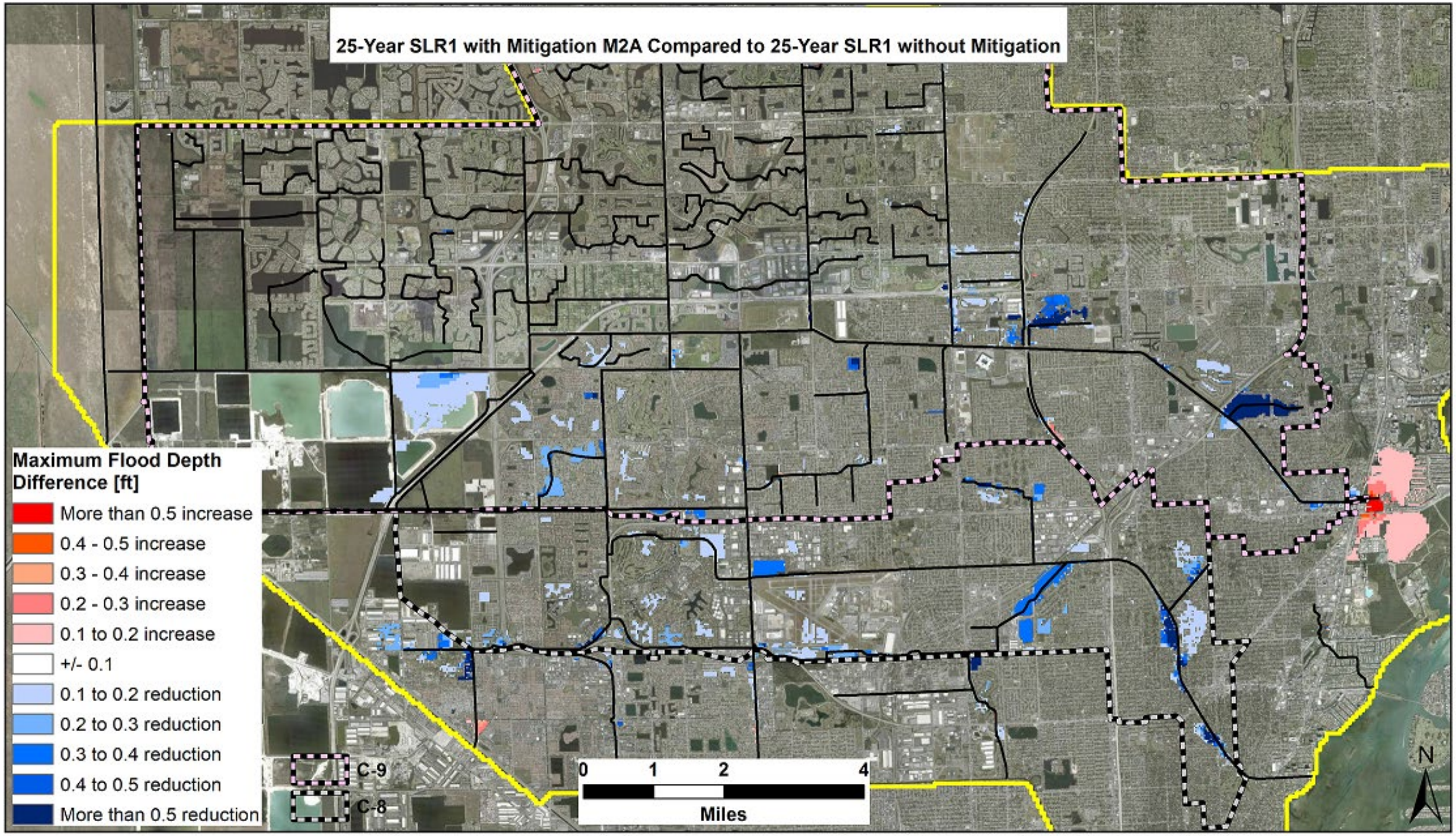
25-Year SLR1 with Mitigation M2A Compared to 25-Year SLR1 without Mitigation
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
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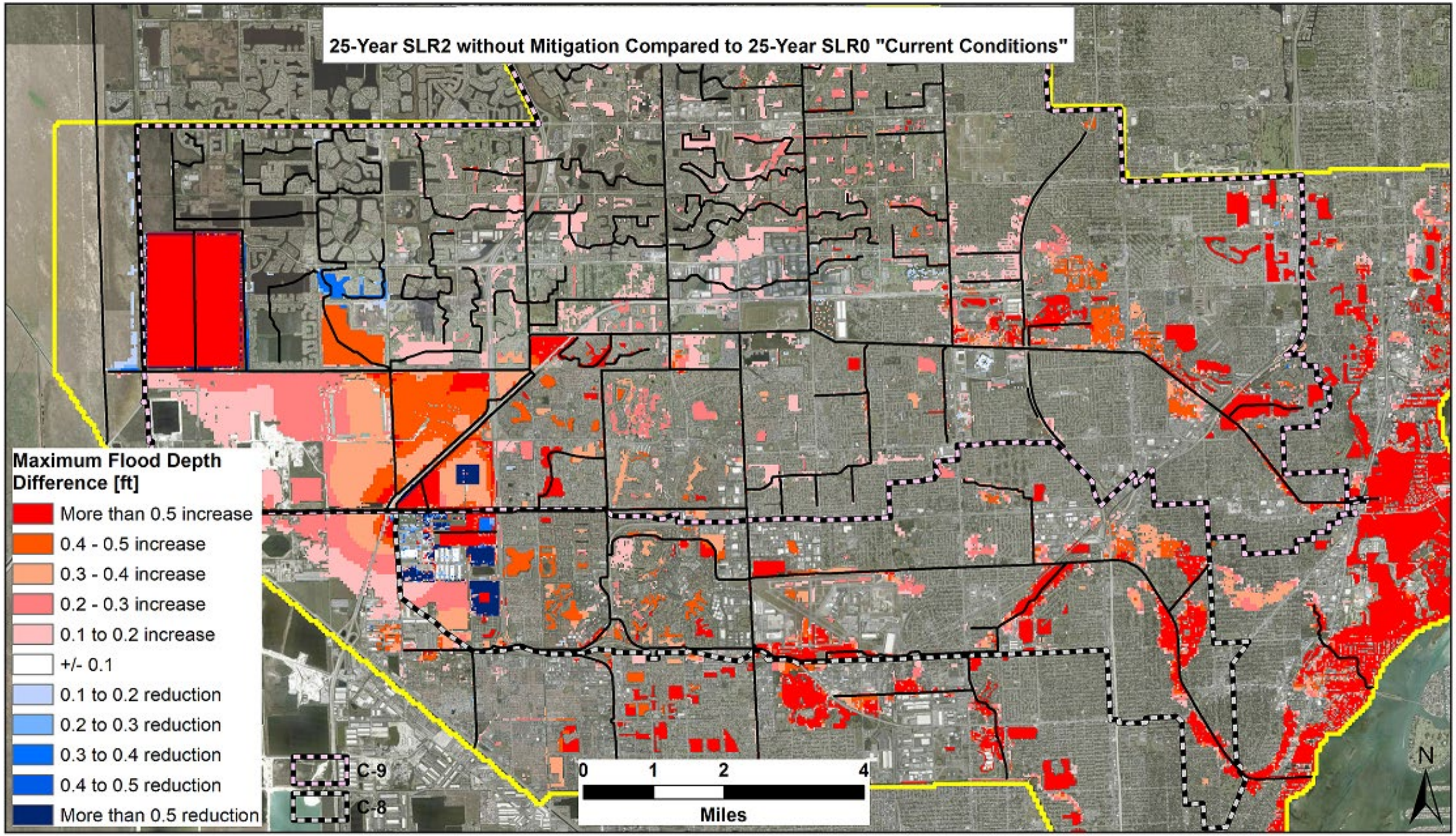
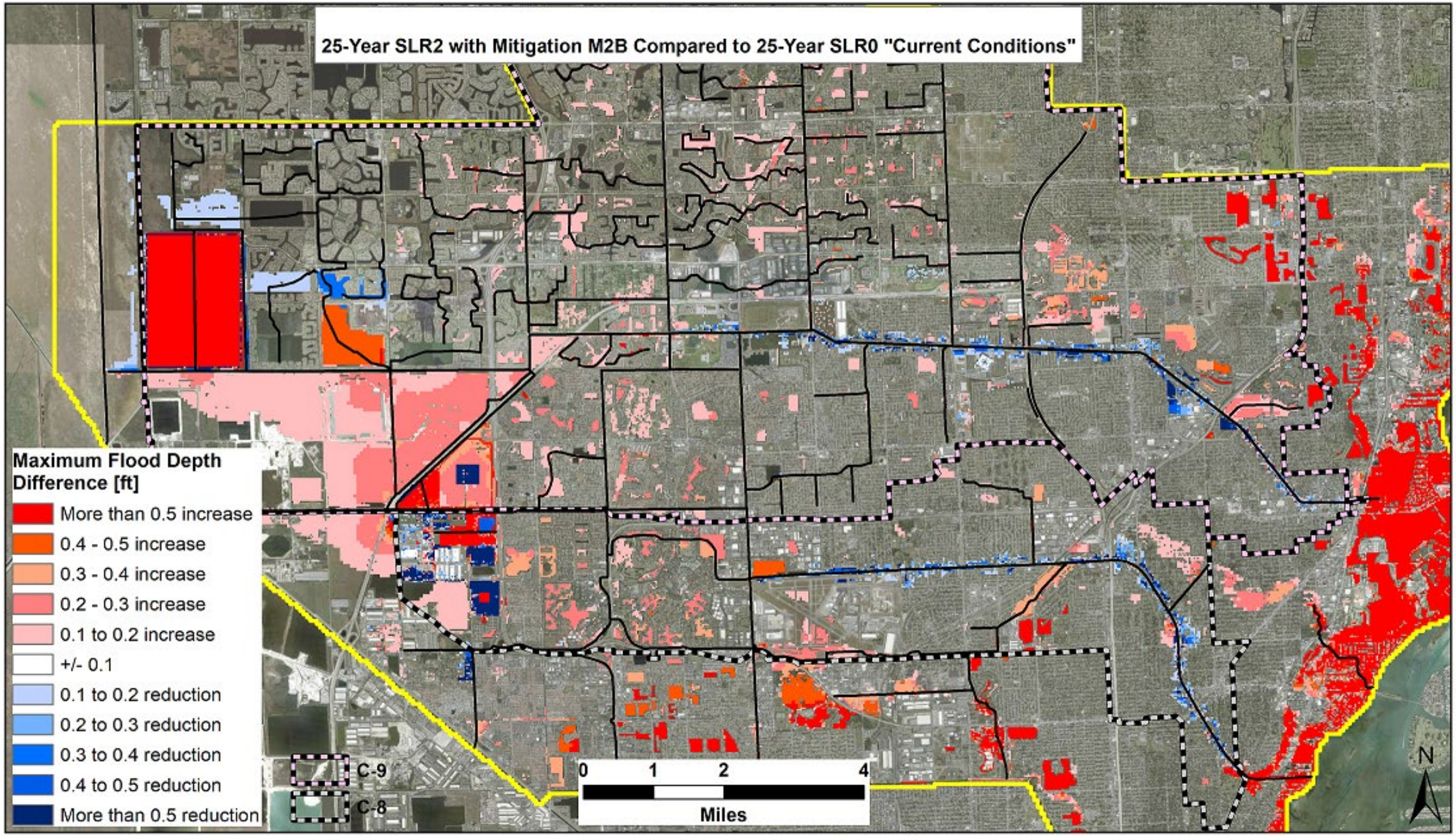
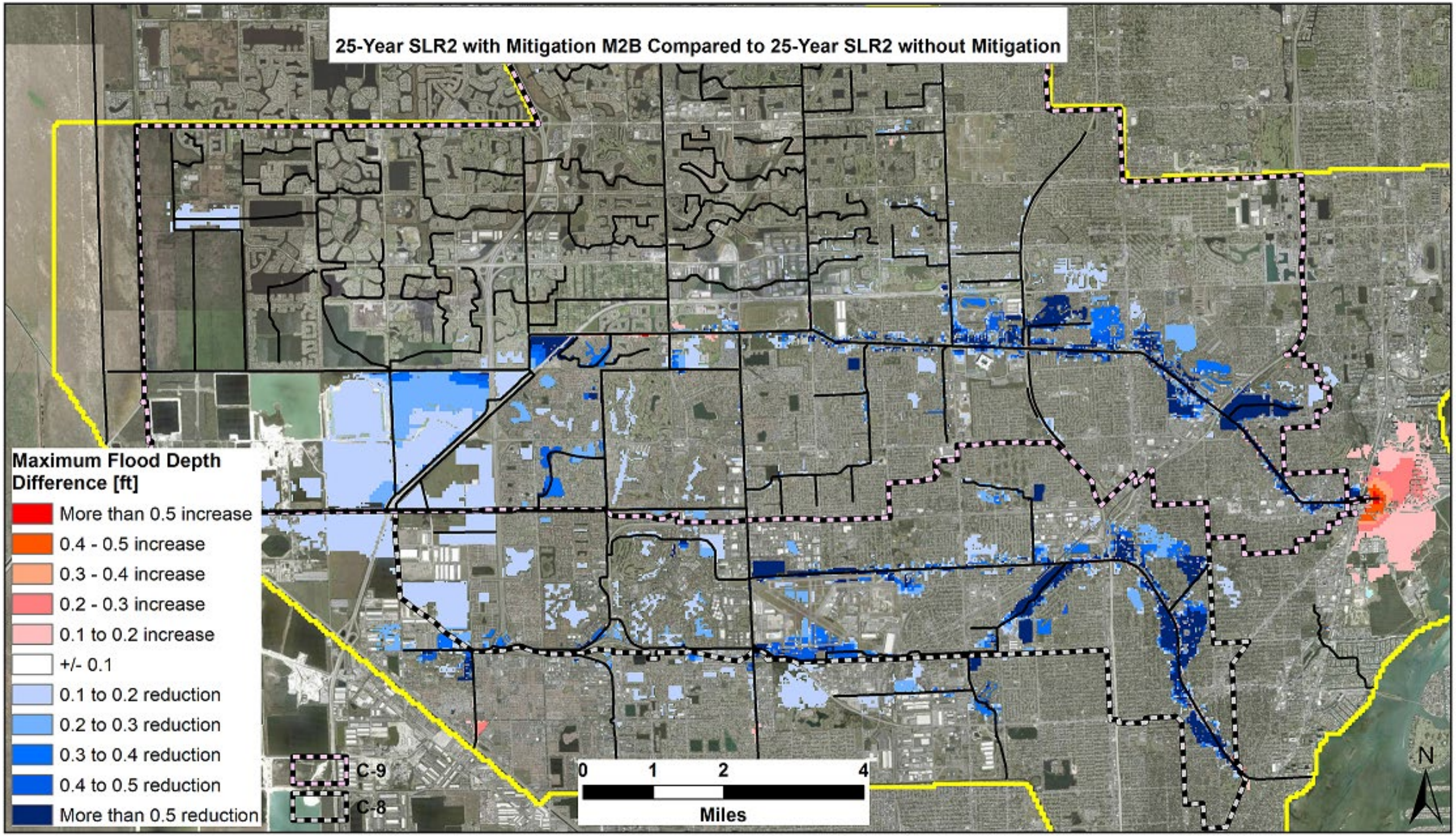
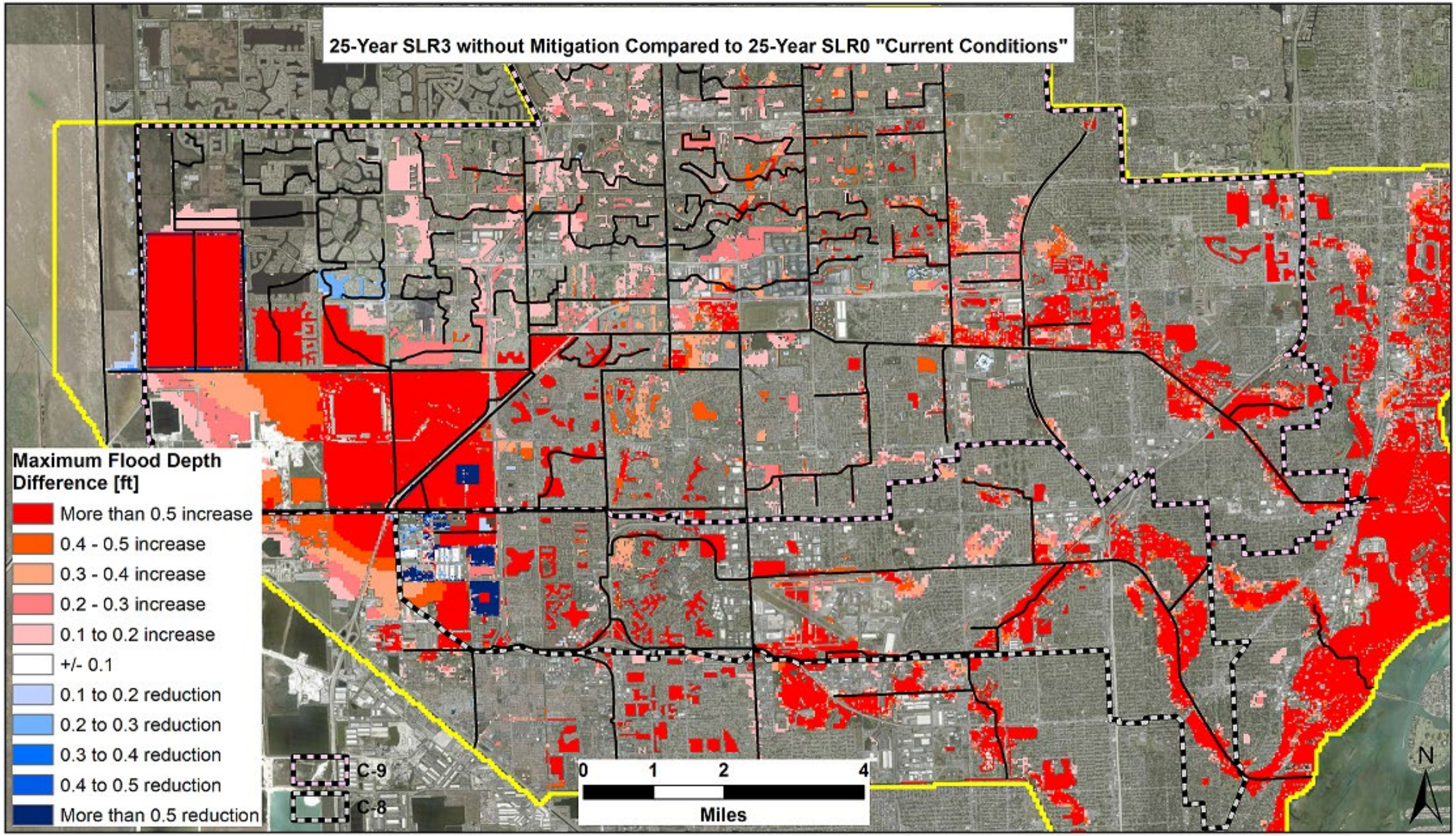
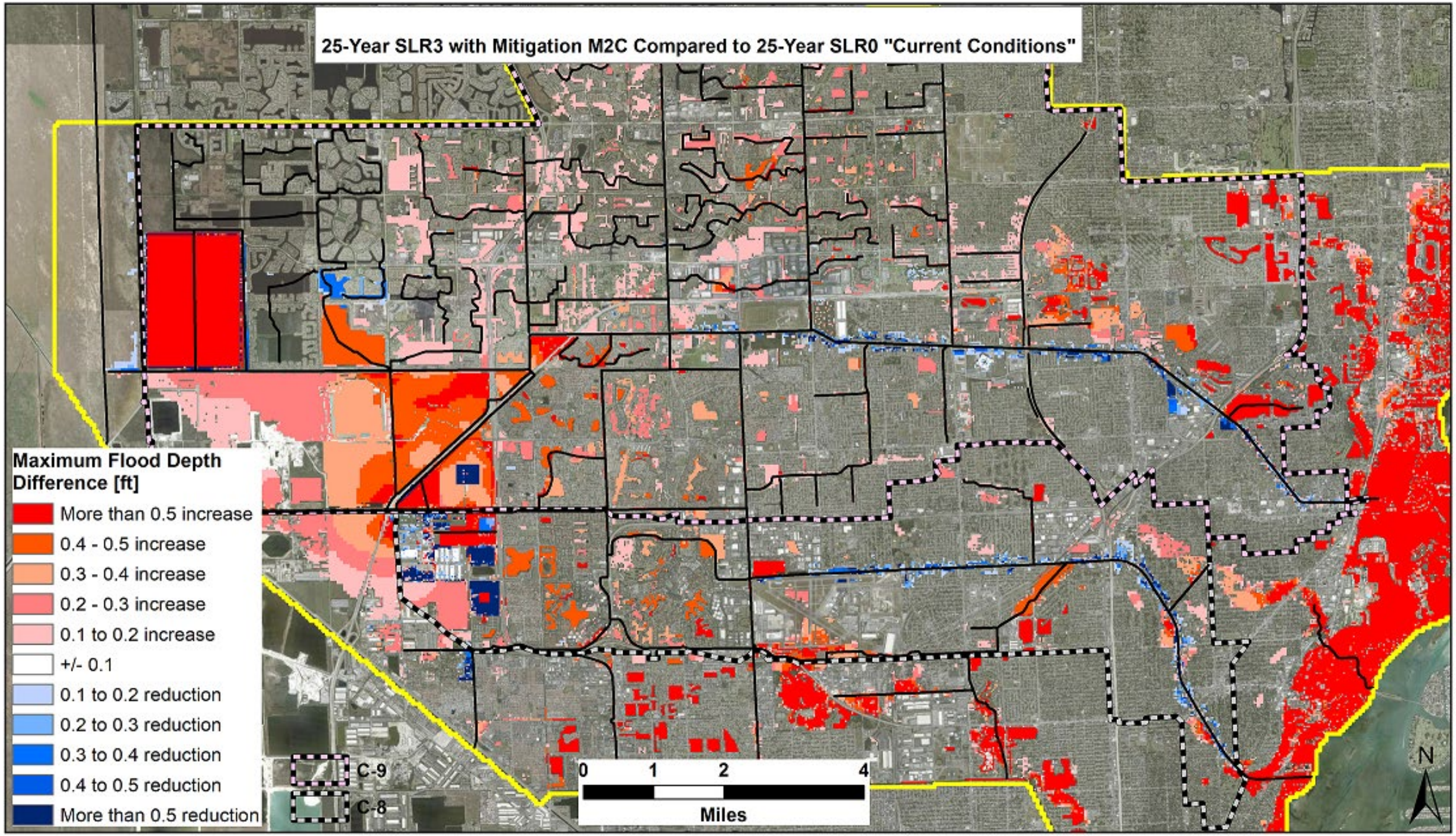
Miles
N

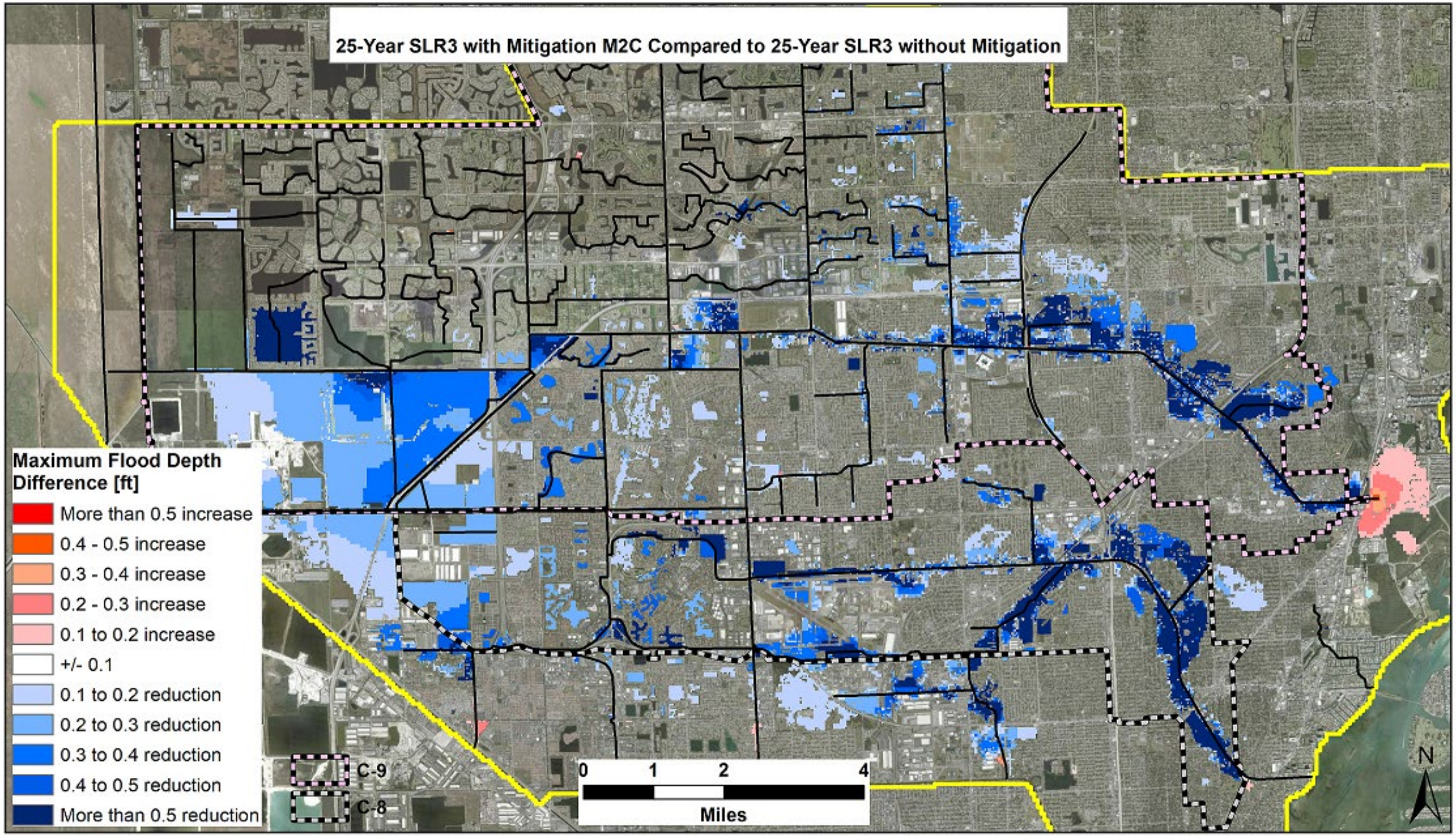

25-Year SLR2 without Mitigation Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N


25-Year SLR2 with Mitigation M2B Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N


25-Year SLR2 with Mitigation M2B Compared to 25-Year SLR2 without Mitigation
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N


25-Year SLR3 without Mitigation Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N


25-Year SLR3 with Mitigation M2C Compared to 25-Year SLR0 "Current Conditions"
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N


25-Year SLR3 with Mitigation M2C Compared to 25-Year SLR3 without Mitigation
Maximum Flood Depth Difference [ft]
More than 0.5 increase
0.4 - 0.5 increase
0.3 - 0.4 increase
0.2 - 0.3 increase
0.1 to 0.2 increase
+/- 0.1
0.1 to 0.2 reduction
0.2 to 0.3 reduction
0.3 to 0.4 reduction
0.4 to 0.5 reduction
More than 0.5 reduction
C-9
C-8
0 1 2 4
Miles
N

moffatt & nichol

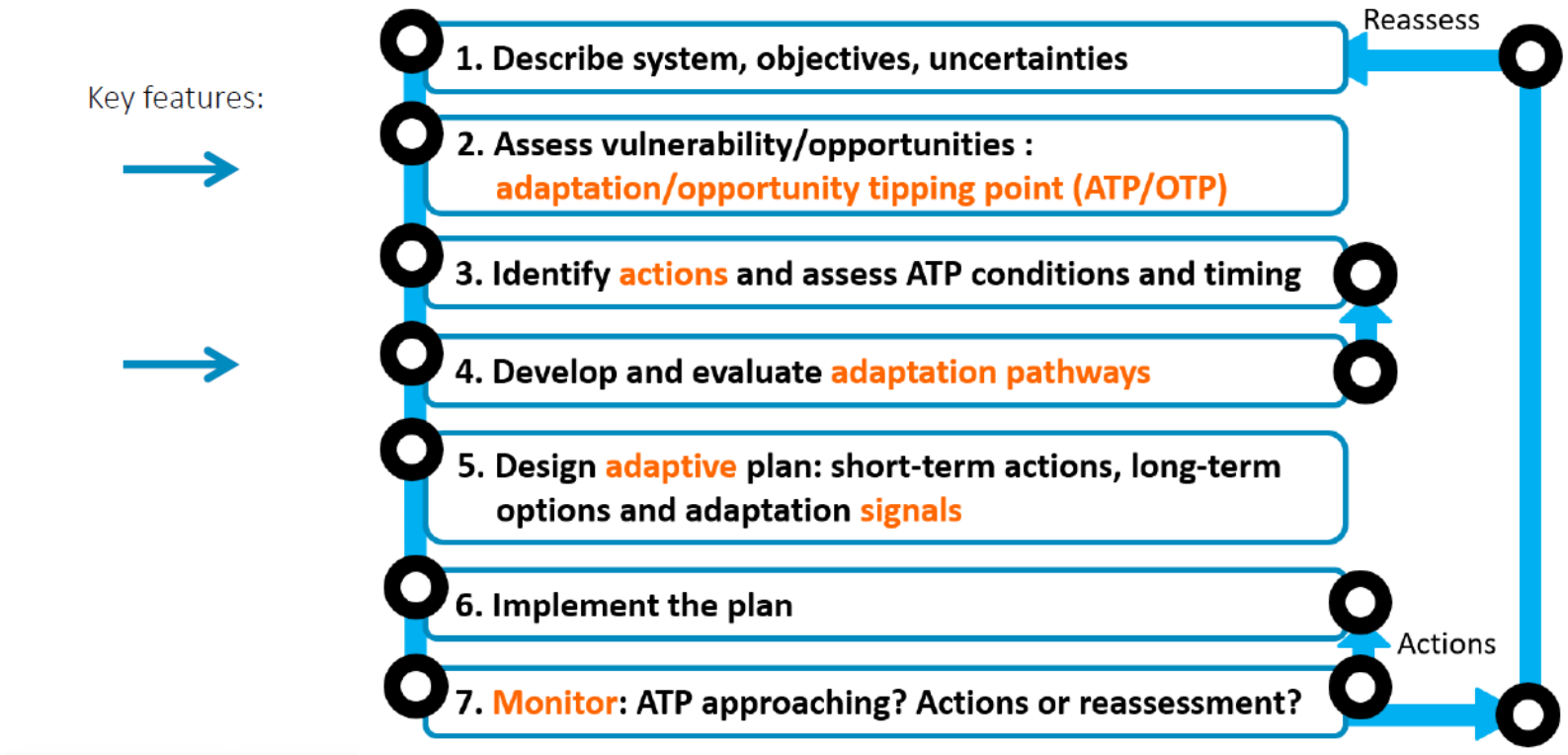
Approach C8 and C9 Basins, South Florida Water Management District

Dynamic Adaptive Policy Pathways (DAPP), Deltares and TU Delft

Goals of DAPP

- Systems are dynamic and need a decision-making tool that is adaptive over time.
- Decision making tool that creates a sequence of “pathways” or decision points along the way with uncertainty.
- Creates a systematic framework to help planners focus on important planning strategies and decision points with uncertainty (i.e., sea level rise).

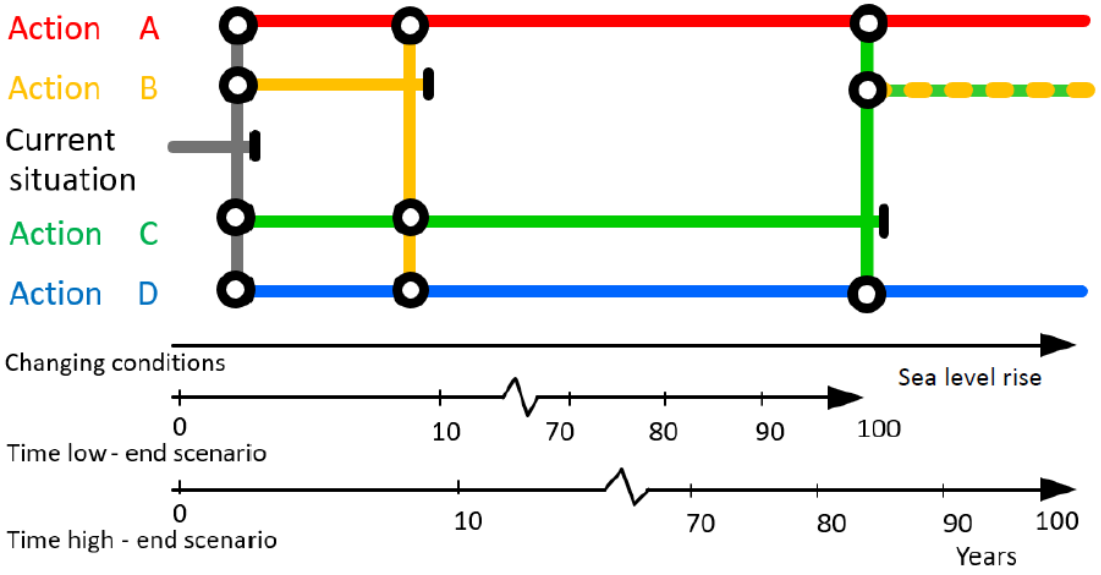
Systematic framework of DAPP



Adaptation Pathways

With sea-level and up to which the flood mitigation strategies perform acceptably are known, various pathways (sequences of mitigation strategies) can be explored.

Adaptation pathways maps



Time horizon 100 years

Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
2	+++++	0	0
3	+++	0	0
4	+++	0	0
5	0	0	-
6	++++	0	-
7	+++	0	-
8	+	+	---
9	++	+	---

Transfer station to new policy action
Adaptation Tipping Point of a policy action (Terminal)
Policy action effective

The maps (left) show different possible sequences of decisions to achieve objectives. A scorecard (right) helps to evaluate the pathways and decisions.

Inputs and Use

- **Mitigation Measure Scenarios** → For each DAPP pathway scenario
- **Thresholds of Expected Annual Damage (EAD)** → Act as Tipping points for DAPP at Sea Level Rise points
- **Sea Level Rise Elevations** → Used to determine the Tipping points for each scenario when compared to the EAD.
- **Simulated Sea Level Rise Scenarios** → Sea-Level Rise thresholds for intervention using "performance criteria" for each mitigation alternative.
- **Simulated Flood Risk (EAD)** for current sea level and other sea level scenarios is needed (assuming risk increases linearly).

Example Performance Criteria:

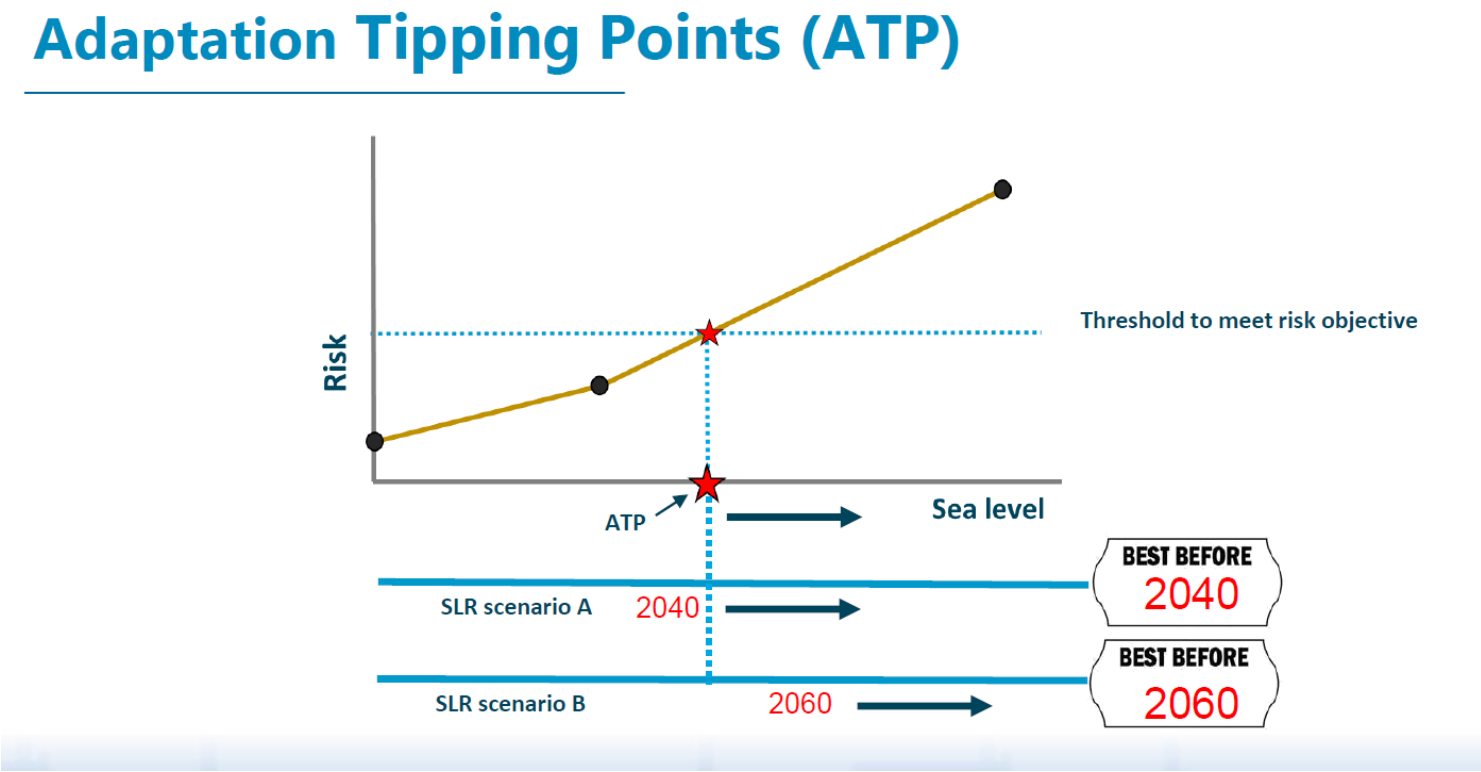
- Flood Damages per return period;
- Expected Annual damages (EAD);
- Efficiency Criteria –
  - Efficiency based on minimizing total costs of flood risk and risk reduction measures;
  - Nuisance flooding;
  - Other flood impacts and costs - indirect damages, costs from injuries/loss of life, environmental pollution, etc.

Tipping Points or Thresholds

An **adaptation tipping point** is reached when the magnitude of external change is such that a policy no longer can meet its objectives.

The **timing** of this point (is scenario dependent.

A plan can **easily adapt** in case of new information on changing conditions such as new (climate) scenarios; in which case only the timing of actions needs to be adapted.



Threshold Example

Example Simulated SLR Scenarios:

- Once SLR occurs flood mitigation strategy is needed to reduce EAD level to current or below.
- Once a mitigation strategy is implemented and the EAD degrades again to below current level, performance is deemed unacceptable and additional measures are needed.

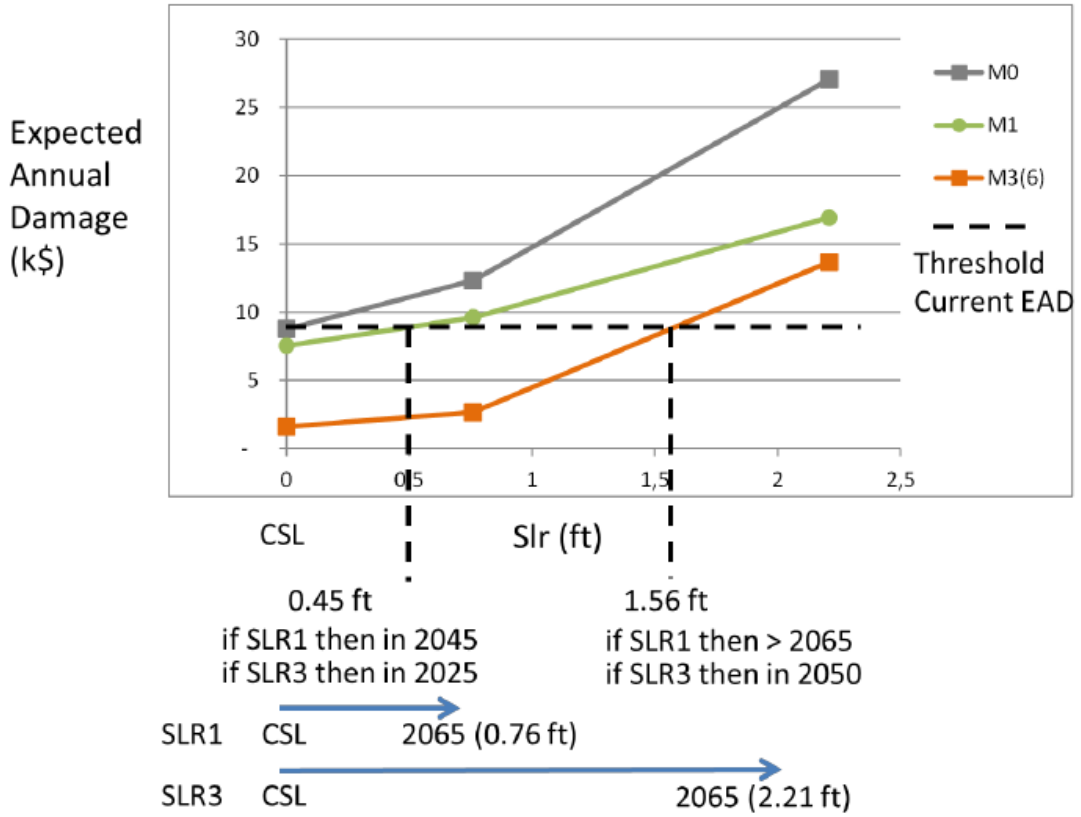


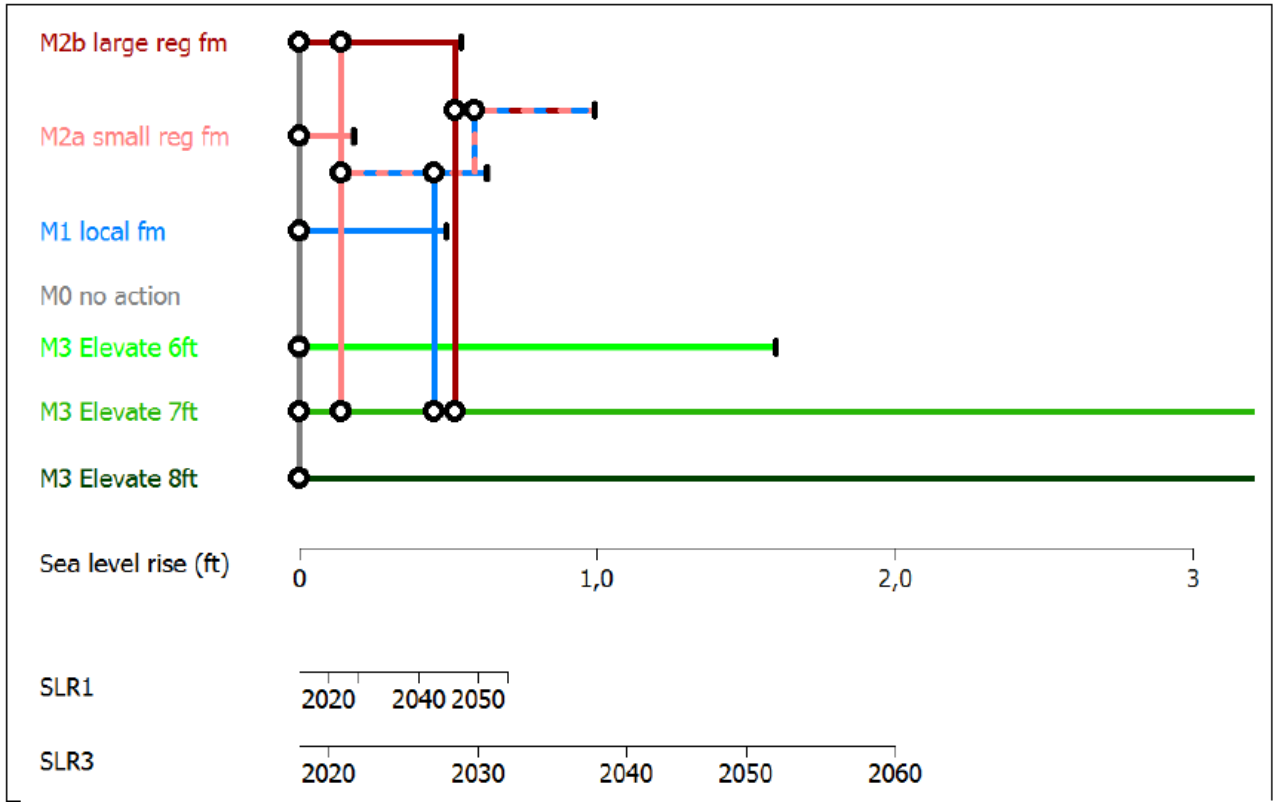
Figure 8.2 The sea-level rise at which current risk is reached is calculated assuming linear increase of risk between the current sea-level (CSL) and the two simulated sea level rise scenarios (SLR1 and SLR3).

Example from Basin C-7 Report

Example

Table 8.1 Sea-level rise (ft) at which the flood mitigation strategy or combination of strategies reaches the specified current EAD level, a 5% increase or 10% increase of this level. >> indicates that the strategy or combination of strategies can accommodate more than 3 ft of sea-level rise.

Mitigation strategy	Threshold current EAD	5% Risk increase	10% Risk increase
M0	0.00	0.09	0.19
M1	0.55	0.66	0.77
M2A	0.14	0.30	0.47
M2B	0.50	0.79	0.95
M3(6ft)	1.56	1.62	1.68
M3(7ft)	>>	>>	>>
M3(8ft)	>>	>>	>>
M3(6ft)+M1	2.52	2.65	2.77
M3(7ft)+M1	>>	>>	>>
M3(8ft)+M1	>>	>>	>>
M3(6ft)+M2a	2.44	2.56	2.67
M3(7ft)+M2a	>>	>>	>>
M3(8ft)+M2a	>>	>>	>>
M3(6ft)+M2b	>>	>>	>>
M3(7ft)+M2b	>>	>>	>>
M3(8ft)+M2b	>>	>>	>>



Example From Basin C-7 Report