AGENDA

1. Project Overview

2. Methodology

3. Key Findings

4. Scenarios

5. TAC Recommendations

6. Next Steps

Purpose and Context

Why This Assessment Matters

- Funded through *FDEP's Resilient Florida Program*
- Meets state statutory requirements for vulnerability assessments
- Provides eligibility for future adaptation funding
- Identifies risks from *flooding and heat* through 2100

Project Overview

AtkinsRéalis

city simulator

How the Study Was Conducted

- Consultant + city staff + external stakeholders
- Built a digital twin of Clearwater using City Simulator
- Simulated city growth and climate hazards (2020–2100)
- Focus hazards:
  - Tidal, riverine, pluvial flooding
  - Storm surge
  - Heat stress

~31,000 Structures

Building footprints, to include representations of critical assets for the model
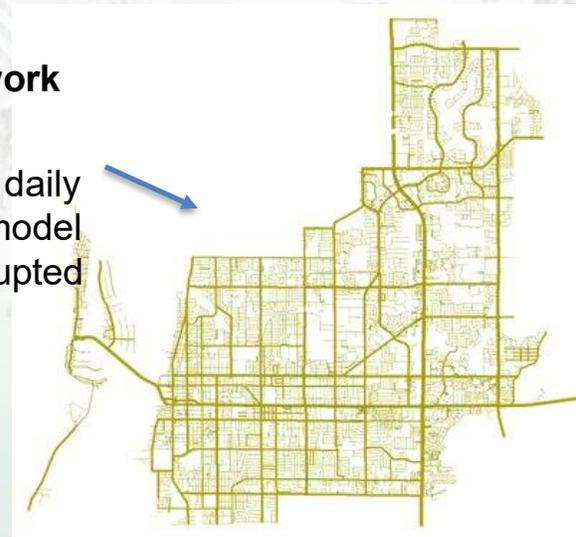
Road Network

Used to approximate daily trips and to model the trips disrupted
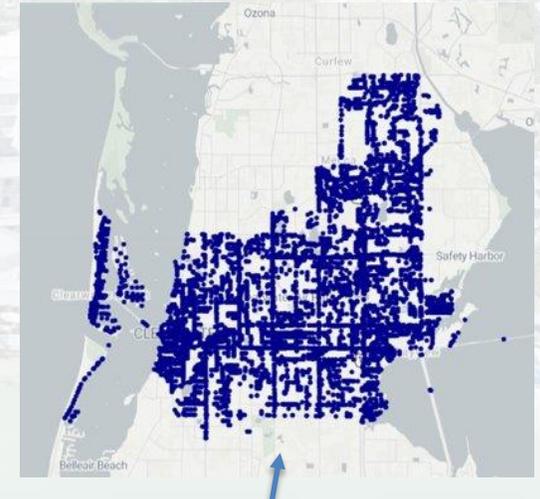
~8,000 Stormwater Nodes

Those nodes along transportation features used to model travel disruption

Methodology

Scientific Approach

- Used high-resolution geospatial modeling
- Combined local historical data with global climate models
- Sea level rise projections: NOAA 2017 (Intermediate-Low/High) + 2022 update
- Flood exposure modeled for 2040, 2070 and 2100
- Heat exposure
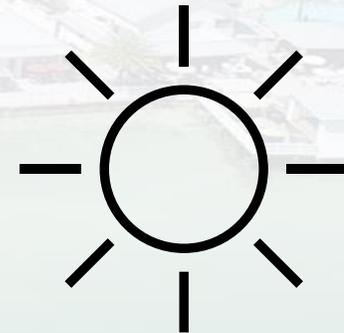
Methodology
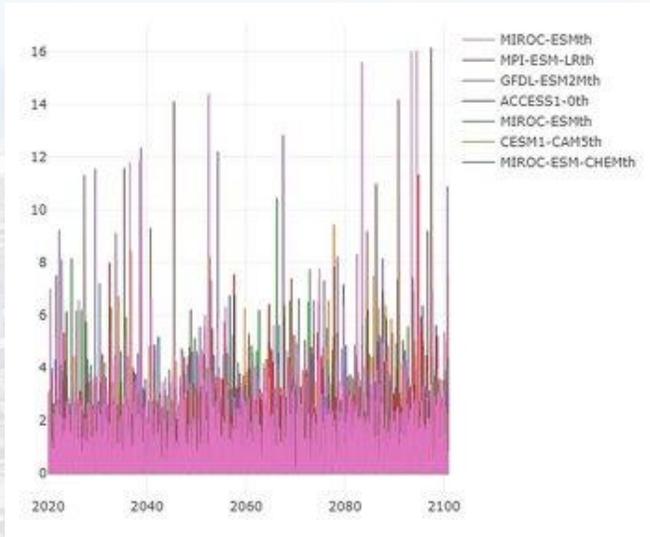
Future Rain

24% ↑ in 100-year
24-hour rainstorm
by 2100
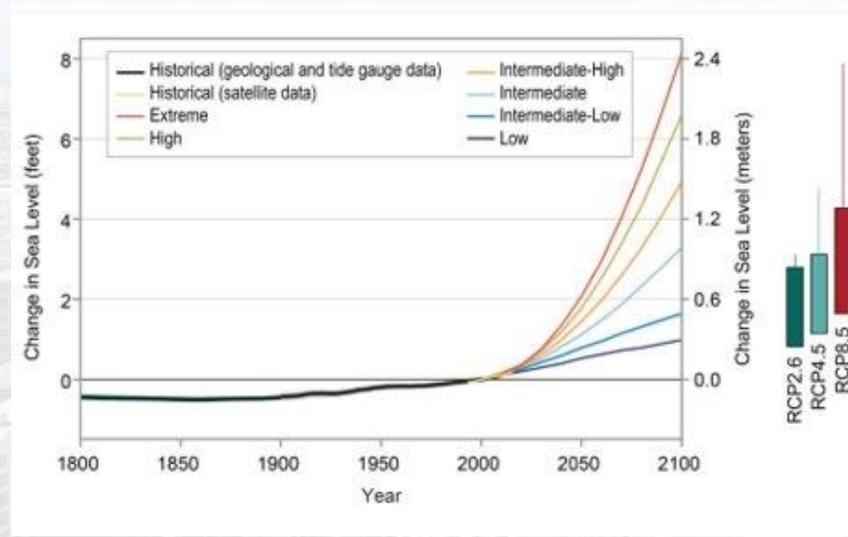
Future Sea Level

2017 intermediate-low and
intermediate-high projections
for 2040, 2070 and 2100

Future Temperature

300% ↑ in days per year
where temperature is 90°+

Key Findings: Tidal Flooding

Growing Flood Risks

- By 2100 - 3,000+ parcels may flood 300+ days/year

- Coastal areas are especially vulnerable, including barrier islands and downtown (p. 35-40)

3.1.1.6   2100 Intermediate-High Projection
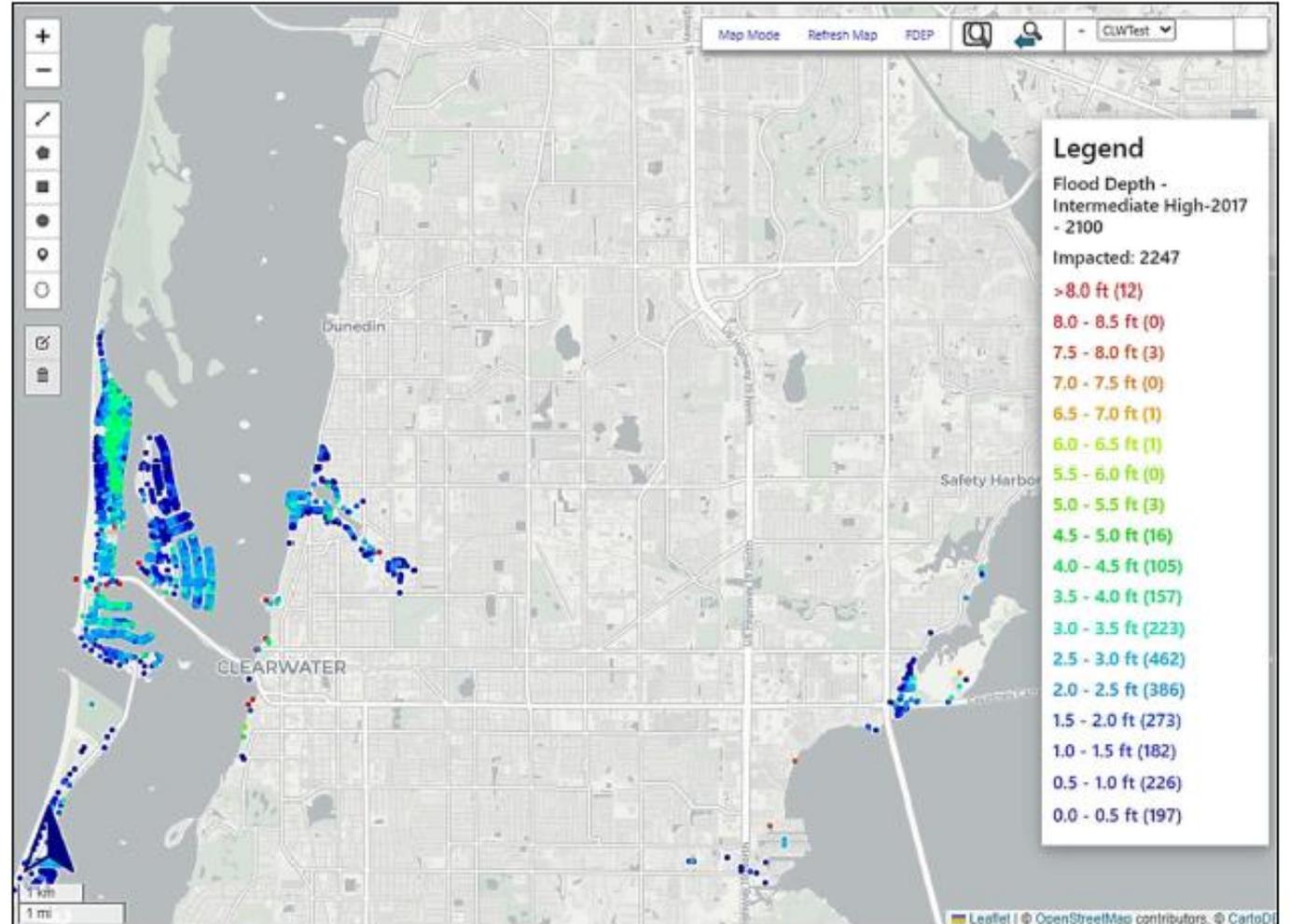
Figure 3-8 - 2100 Intermediate-High Projection (2017) - Representative Depths and Extents of Tidal Only

Key Findings: Flooding – Large Rainfall Events

Growing Flood Risks

- By 2100, using the intermediate-high SLR projection, 3,000+ parcels may flood 300+ days/year.

3.1.2.3 2100 Planning Horizon – Pluvial Flooding; 100-Yr-Event

Legend | 2100 18.21 in.
Flood Depth (ft)
>8.0 ft. (39)
7.5 - 8.0 ft. (9)
7.0 - 7.5 ft. (21)
6.5 - 7.0 ft. (22)
6.0 - 6.5 ft. (29)
5.5 - 6.0 ft. (35)
5.0 - 5.5 ft. (25)
4.5 - 5.0 ft. (33)
4.0 - 4.5 ft. (52)
3.5 - 4.0 ft. (48)
3.0 - 3.5 ft. (51)
2.5 - 3.0 ft. (62)
2.0 - 2.5 ft. (72)
1.5 - 2.0 ft. (63)
1.0 - 1.5 ft. (67)
0.5 - 1.0 ft. (72)
0.0 - 0.5 ft. (86)
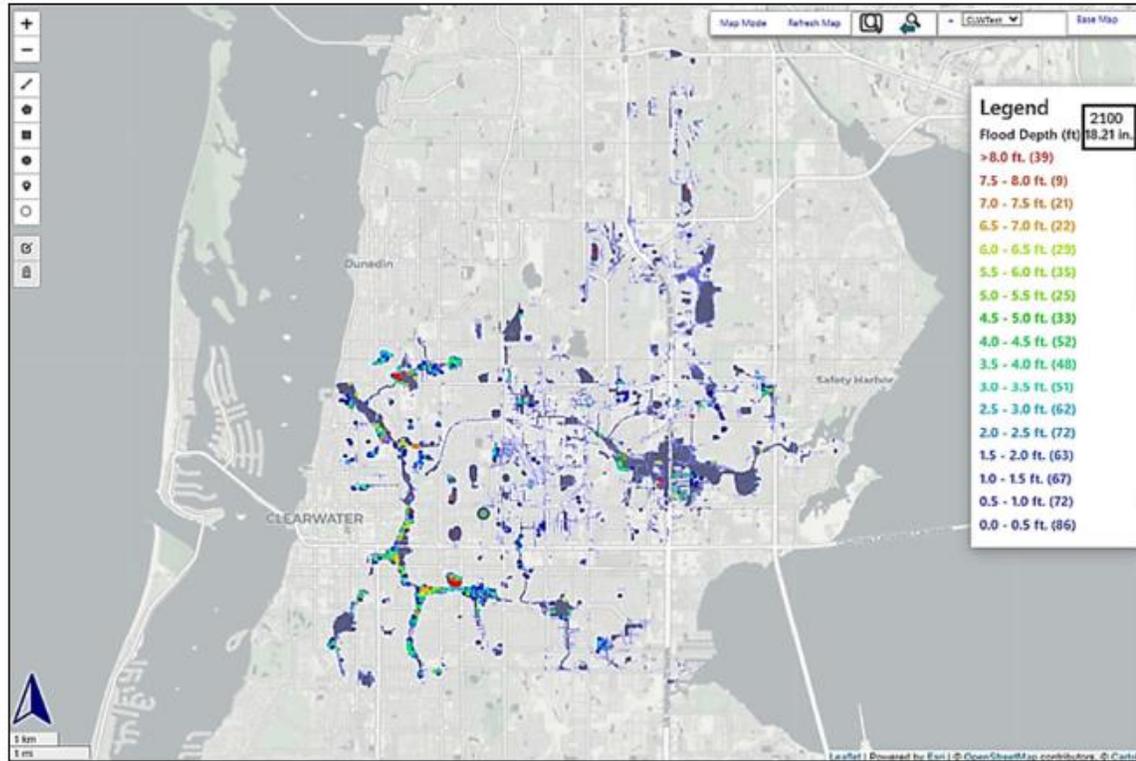
Figure 3-11 - Existing 100-year flood depth grid with locations (circles) representing flood depths and extents of the modeled 2100 rainfall event (18.21 inches in 24-hour period)

100-YEAR RAINFALL EVENT
1% CHANCE IN A GIVEN YEAR

500-YEAR RAINFALL EVENT
0.2% CHANCE IN A GIVEN YEAR

500-year rainfall depth:
15.3 ft. → 20.4 ft.
(2040)   (2100)

100-year rainfall depth:
13.7 ft. → 14.3 ft.
(2040)   (2100)
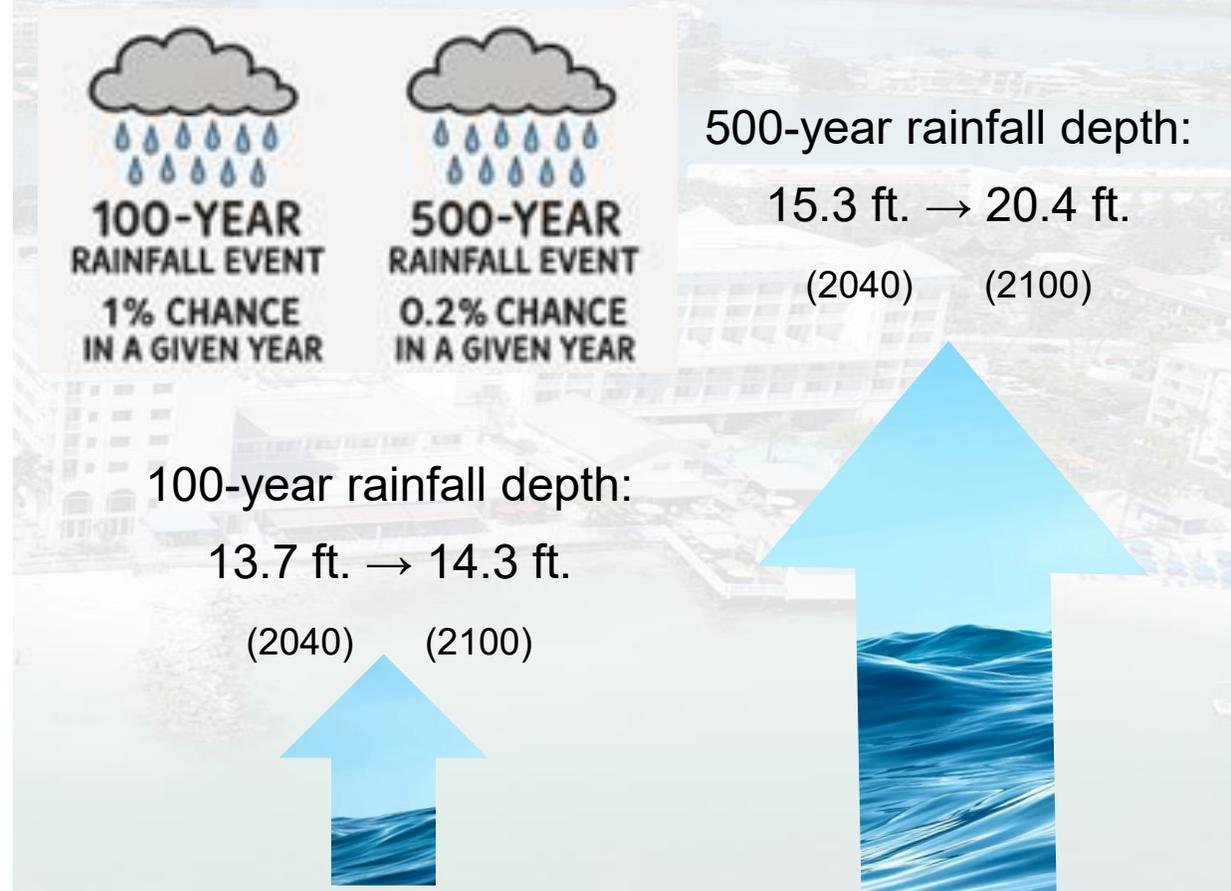
Key Findings: Flooding – Storm Surge Events

Growing Flood Risks

- Maximum projected surge depth increases from 17.1 ft. (2040) to 22.7 ft. (2100) (p. 48)

- Heavily affects coastal and low-lying neighborhoods (p.54).
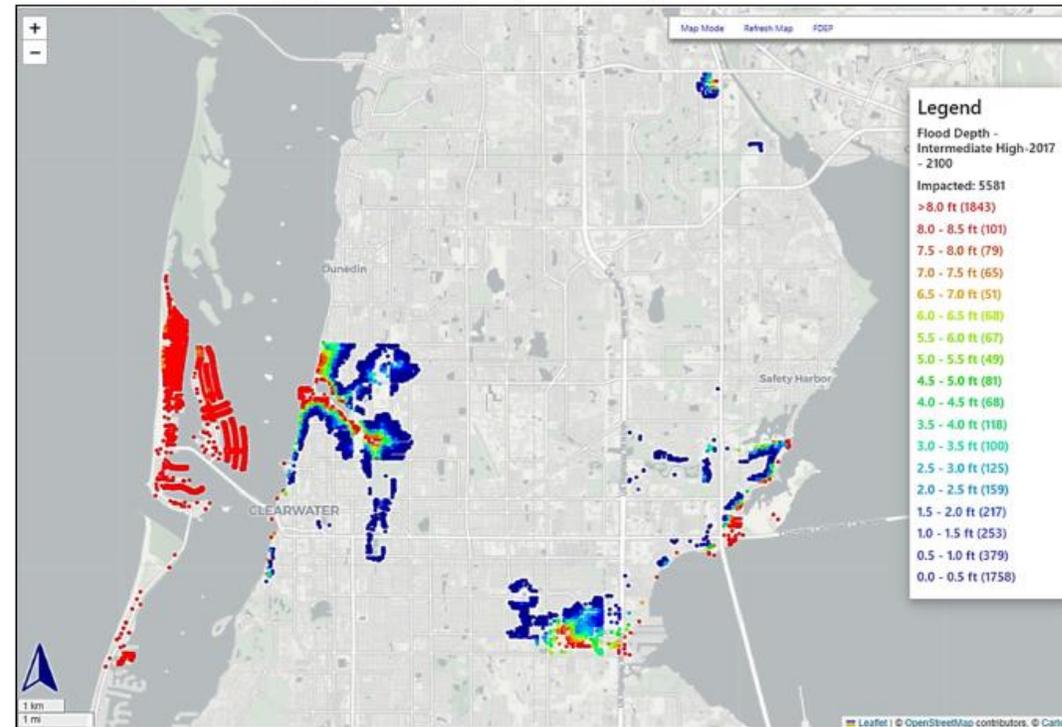
Figure 3-20 - 2100 Intermediate-High (2017) - Storm Surge Extent and Depths

Surge depth: 17.1 ft → 22.7 ft. by 2100

Key Findings: Heat Exposure

Rising Temperatures Across Clearwater

Days above 90°F:

- 1–25 days (2040) → up to 200 days (2100)
- By 2100 -17,000+ locations face increased heat exposure
- Strong correlation with low tree coverage

Key Findings: Heat Exposure

Figure 3-23 - Heat impacts at building locations using the 2017 projections (Year 2040).

Figure 3-25 - Heat impacts at building locations using the 2017 projections (Year 2100).
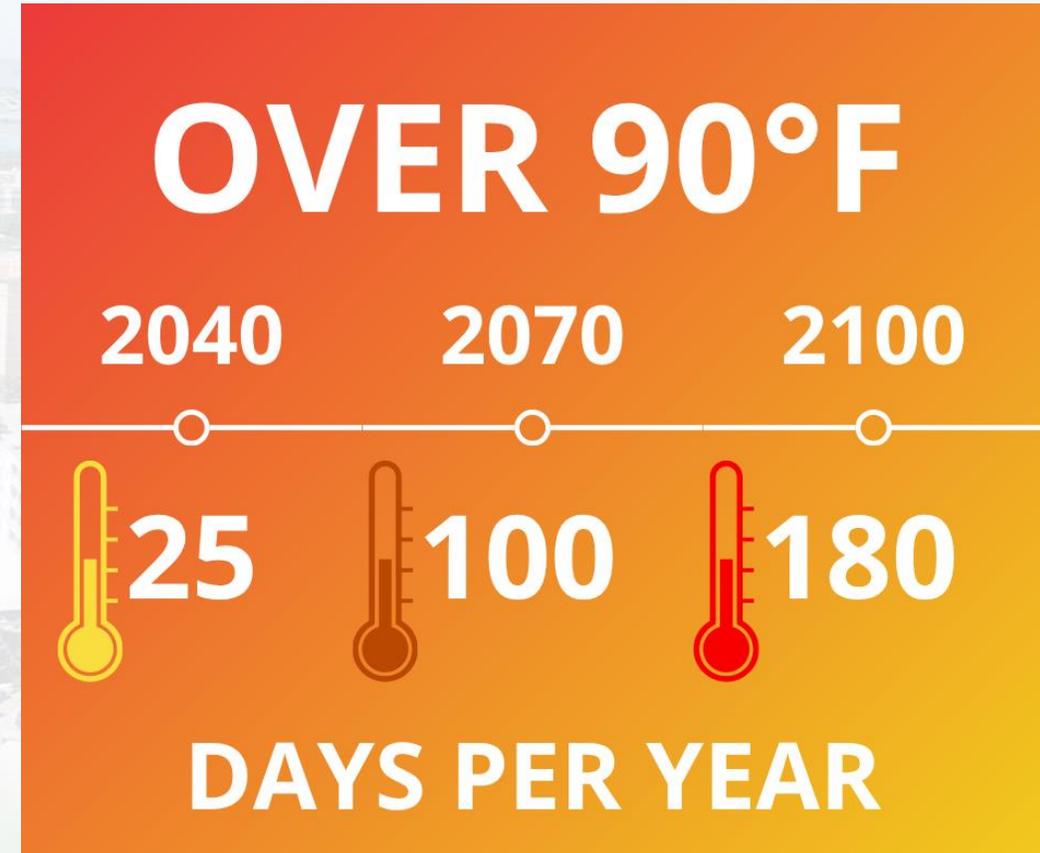
Key Findings: Heat Exposure

Year 2040 Locations with Days Greater than 90 Degrees (2017 Projections)
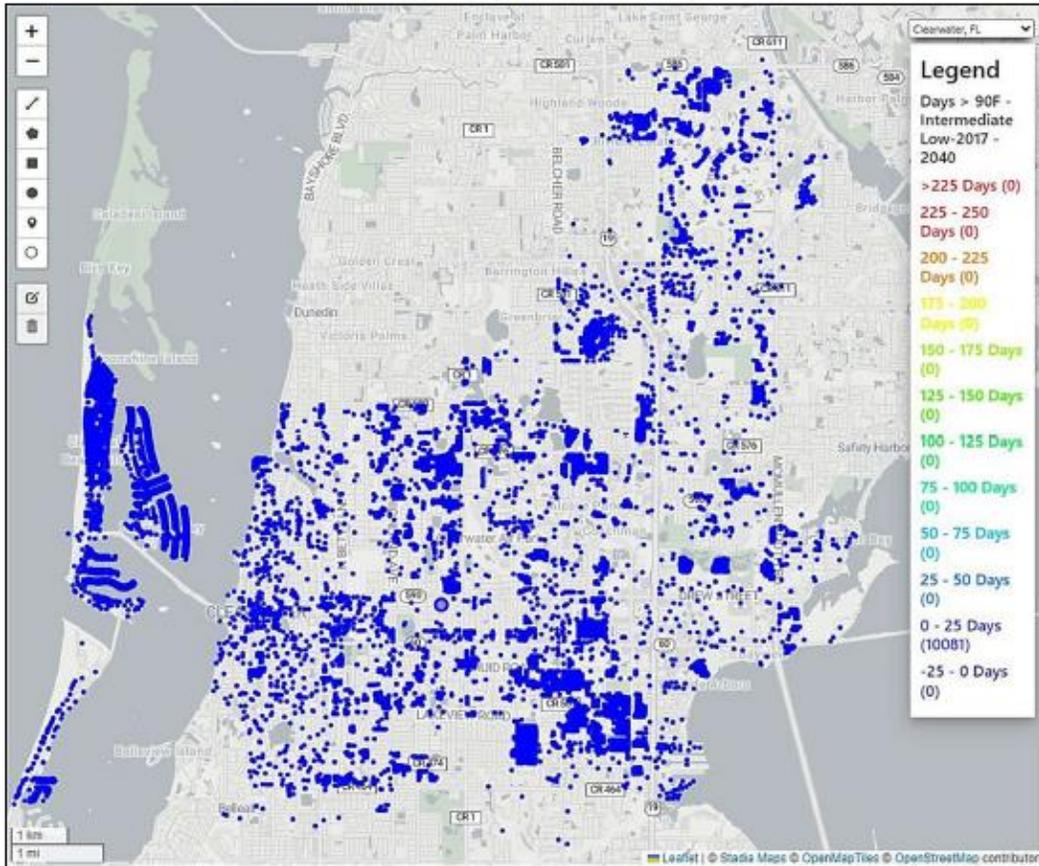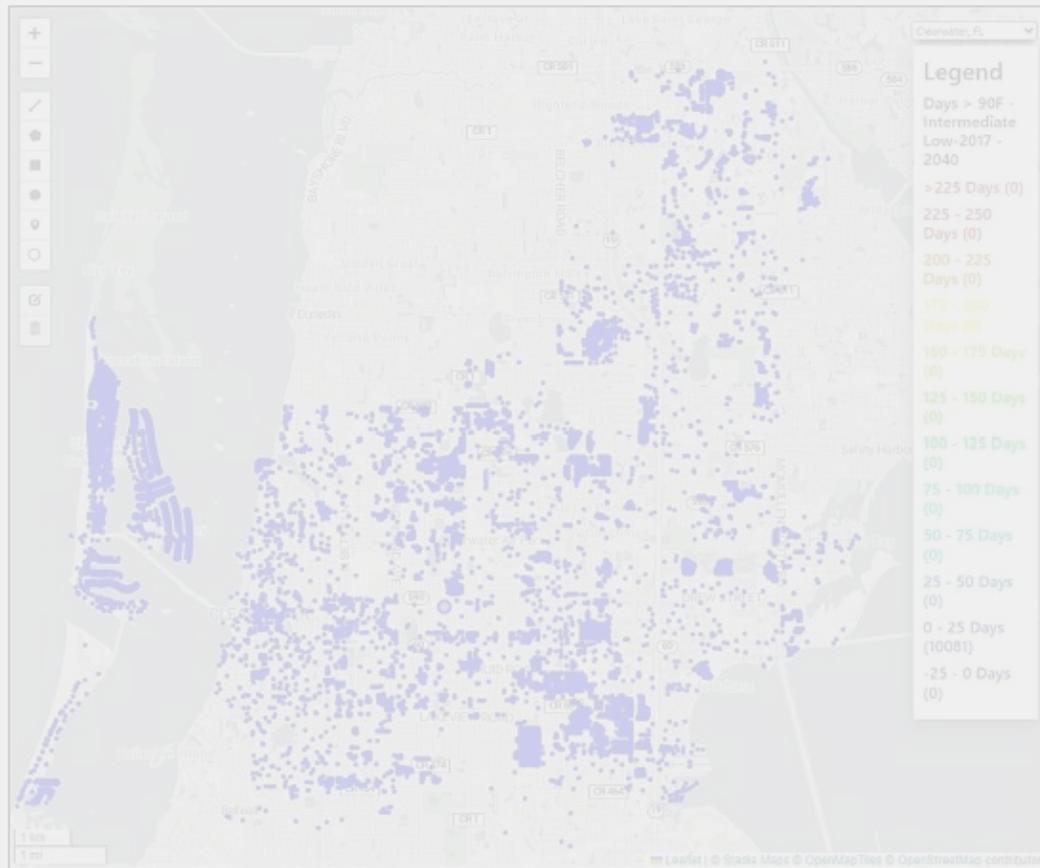
Figure 3-23 - Heat impacts at building locations using the 2017 projections (Year 2040).

Year 2100 Locations with Days Greater than 90 Degrees (2017 Projections))
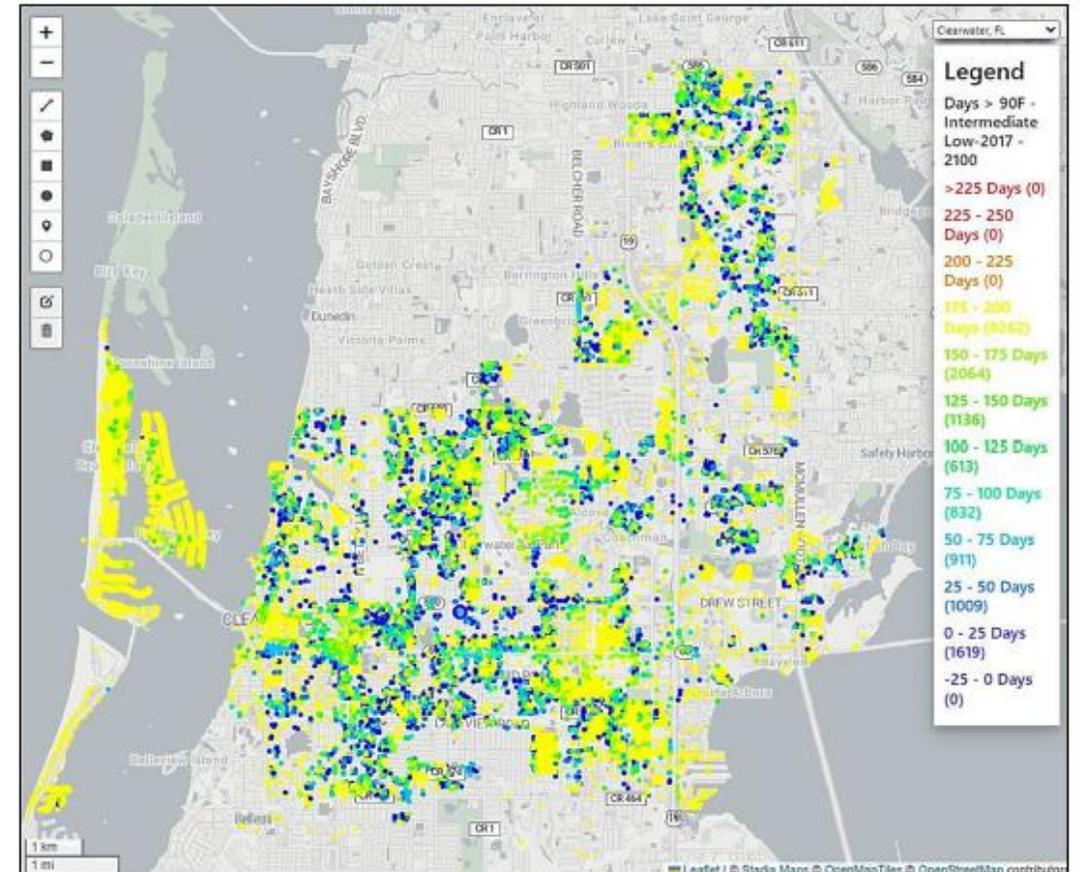
Figure 3-25 - Heat impacts at building locations using the 2017 projections (Year 2100).

Modeled Adaptation Scenarios

10 Initial Adaptation Scenarios (Based on ROI) were tested

Some examples:

- Stevenson Creek: $200M → $297M avoided
  - ROI 1.48
- Tree Planting: $3.6M → $5.1M avoided
  - ROI 1.41
- Coastal Zone 3: $70M → $213M avoided
  - ROI 3.74
- Barrier Islands Elevation: $88M → $240M avoided
  - ROI 2.73
- Citywide Acquisition: $1.5B → $2.45B avoided
  - ROI 1.63

Elevate Roads

Elevate Structures

Acquire Houses

Add Coastal Barrier

Plant Trees

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios

Scenario 1: Stevenson Creek

Scenario 1 (Stevenson Creek) Baseline: Buildings with Flood Exposure within the Area of Interest (AOI)
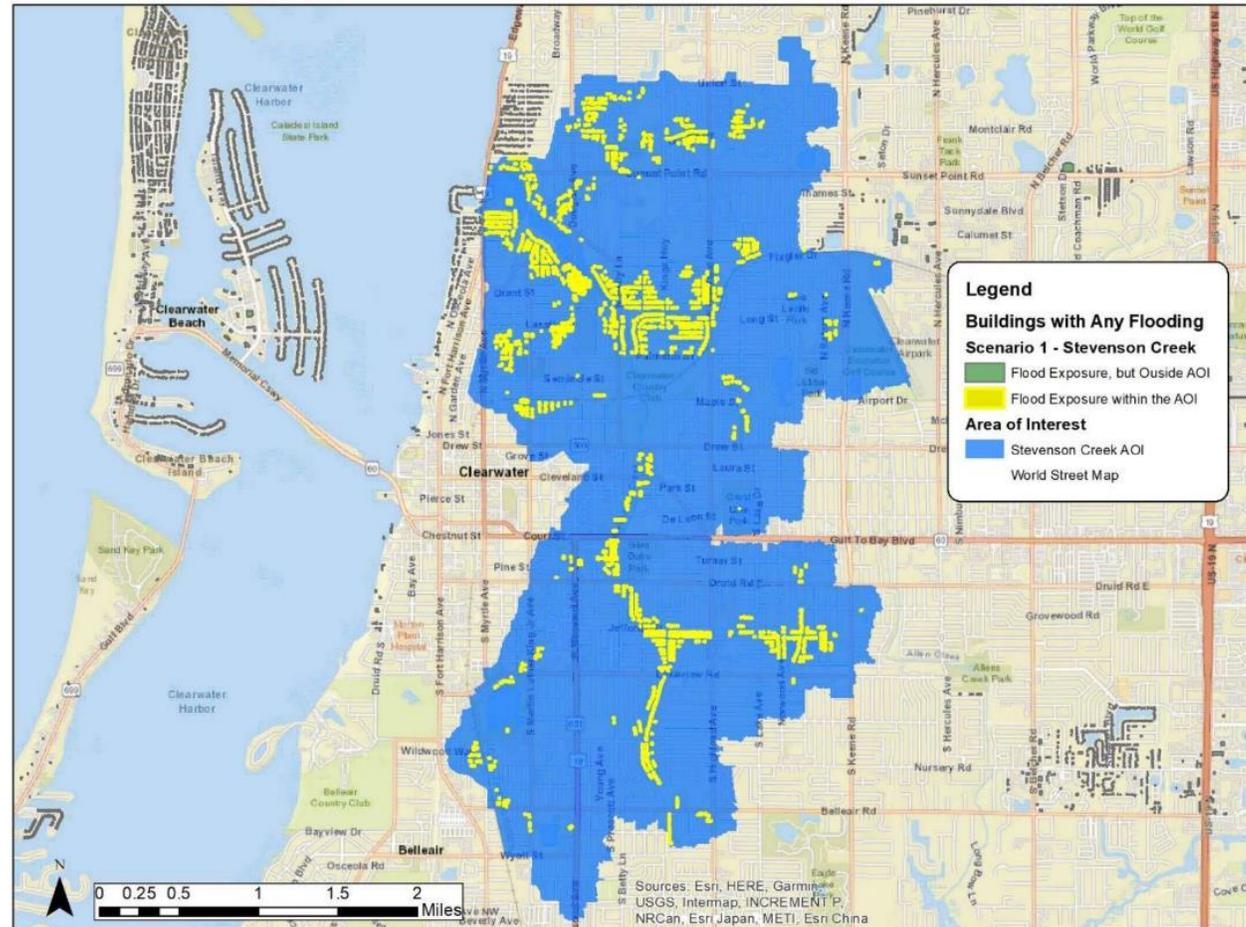
Focused on elevating roads and acquiring structures to improve drainage in a flood-prone watershed. The scenario showed strong ROI from targeted acquisitions and infrastructure improvements (e.g., culverts, outfalls).

ROI ratio = $297M / $200M = 1.485

- 8 road elevation
- 71 building acquisition

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios

Scenario 2: Increase Tree Coverage (Citywide)
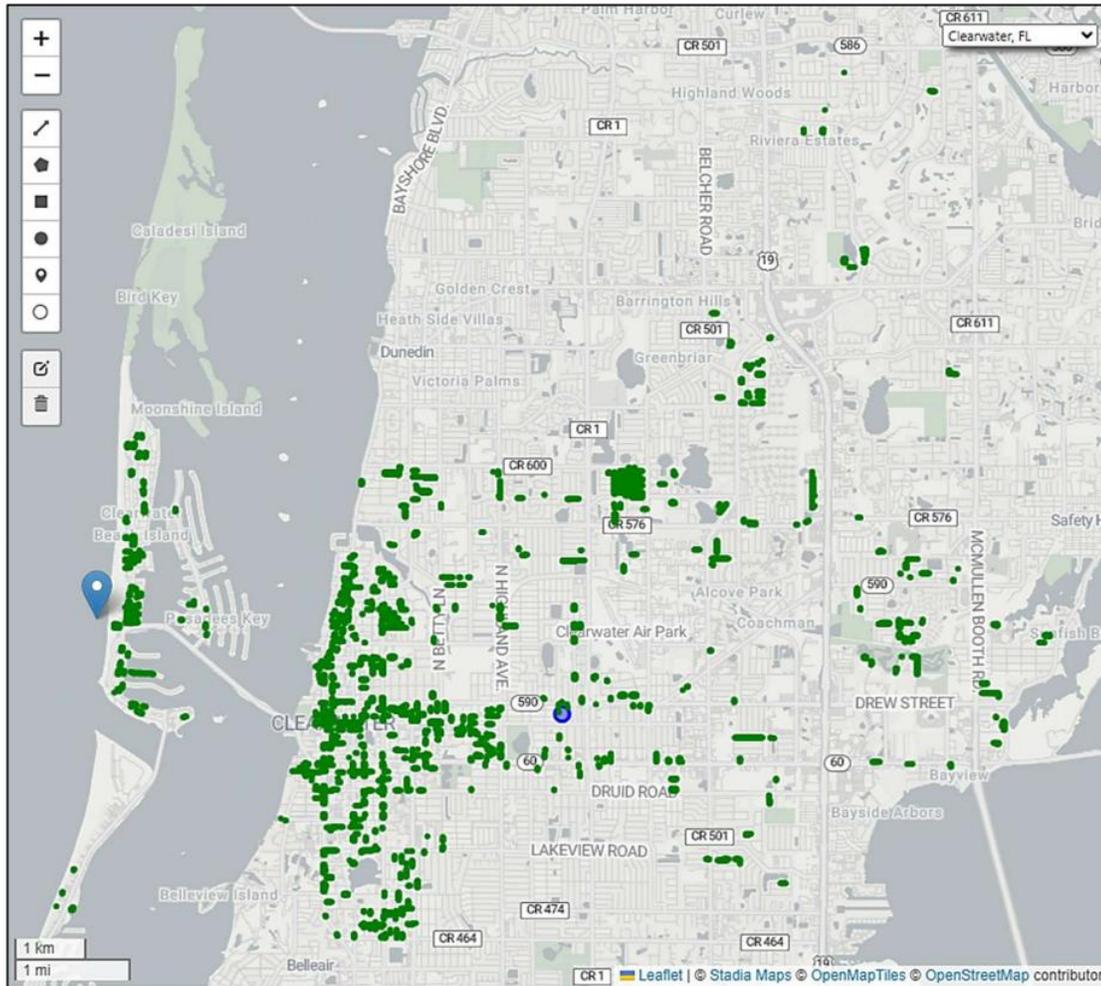
Figure 5-8 - Tree plantings investments citywide (100% budget)

Assessed citywide benefits of increasing urban tree canopy to reduce heat impacts. This scenario offers insight into where shade may be most beneficial based on local demographic data. * Results showed tree planting has high ROI, especially when targeted in "tree deserts" and disadvantaged communities.

ROI ratio = $5.1M / $3.62M = 1.41
- 7,248 planting locations

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered. **Recommended tree planting locations would need to be further evaluated before implementation, as some sites may be unsuitable due to physical constraints or professional guidance.**

Modeled Adaptation Scenarios

Scenario 3: Elevate Seawalls (North Beach to Island Estates)

Scenario 3 (Barrier Islands) Baseline: Elevate Seawalls

Legend

Buildings with Any Flooding
Scenario 3 - Elevate Seawalls
- Flood Exposure, but Outside AOI
- Flood Exposure within the AOI
- Barrier Islands AOI
- World Street Map

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

Figure 5-10 - Structures within the Barrier Islands Area of Interest that are exposed to future flooding.

Modeled elevation of seawalls in Clearwater Beach. *Provided moderate ROI in reducing tidal flooding impacts for coastal properties, with varying benefits by location segment. Cost estimates are highly variable.

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered. **Most of the seawalls are private and not owned/maintained by the city therefore making a large-scale use of seawall modification difficult to implement.**

Modeled Adaptation Scenarios

Scenario 4: Coastal Zone 3

Scenario 4 (Coastal Zone 3) Baseline: Elevate Roads

Legend

Buildings with Any Flooding
Scenario 4 - Elevate Roads
- Flood Exposure, but Outside AOI
- Flood Exposure within the AOI
- CoastalZone3

Tracking Point - Annualized Trips Disrupted
AATD_2100_Combined
- 1 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 - 12,500
- 12,501 - 25,000
- 25,001 - 50,000
- 50,001 - 90,132

World Street Map

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

Figure 5-15 - Structures and tracking points within the Coastal Zone 3 Watershed that are exposed to future flooding

Modeling elevating Bayshore Blvd. near the Old Tampa Bay coastline showed reduced flooding and high ROI.

ROI ratio = $213M / $70M = 3.04
- 3 priority projects w/ greatest ROI at 25% budget

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios

Scenario 5: Elevate Structures on Barrier Islands
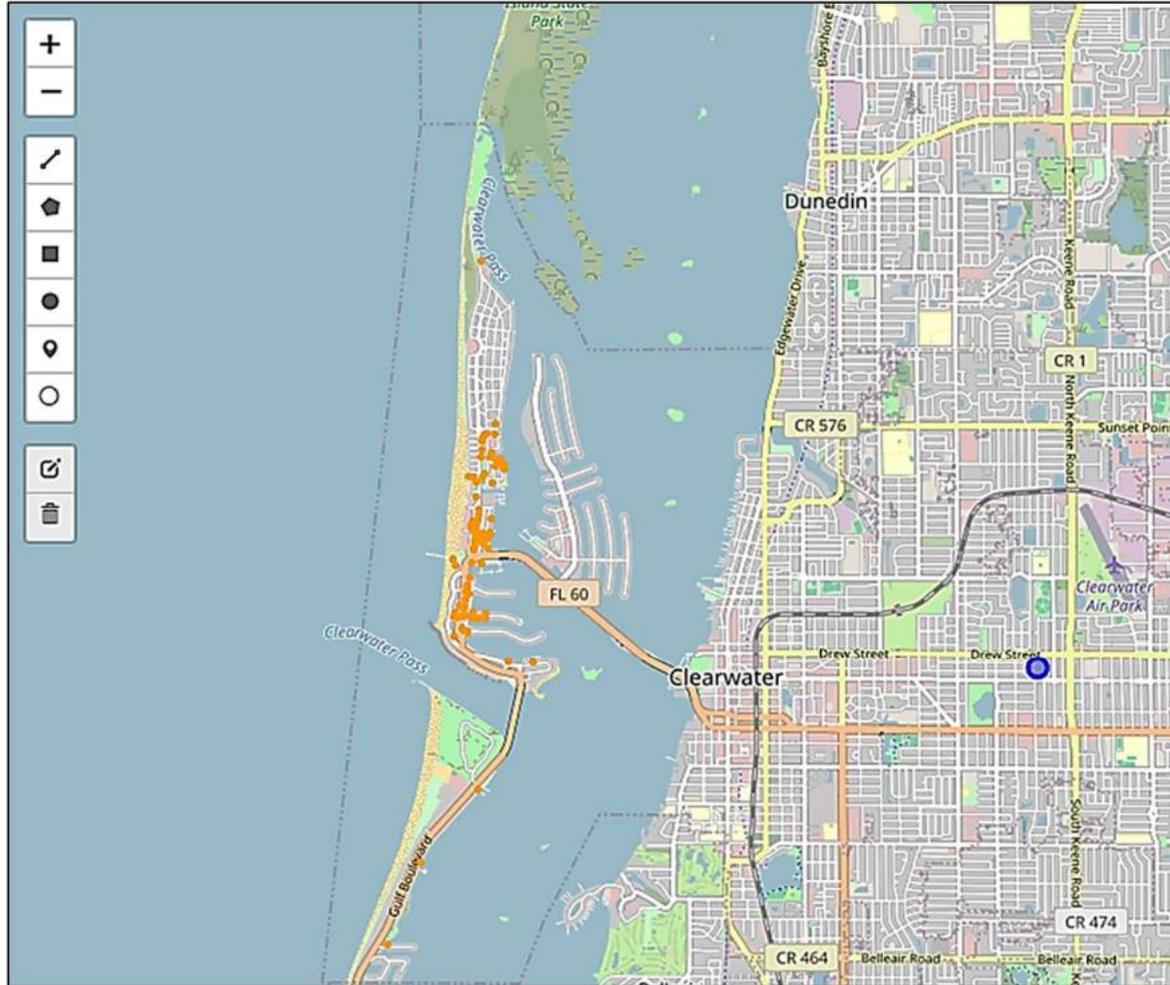
Figure 5-19 - 25% budget recommendation for Scenario 5 (Elevate structures on the Barrier Islands)

Assessed elevating residential structures on the beach barrier islands. High benefit in terms of avoided flood damage, especially with phased or budget-limited approaches.

ROI ratio = $240M / $88M = 2.73
- 602 projects

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

# Modeled Adaptation Scenarios
Scenario 6: Acquisition of Structures Citywide

Citywide Baseline: Buildings with Flood Exposure (Tidal and Precipitation)

Legend
Buildings with Any Flooding
☐ Buildings with Any Flooding
World Street Map

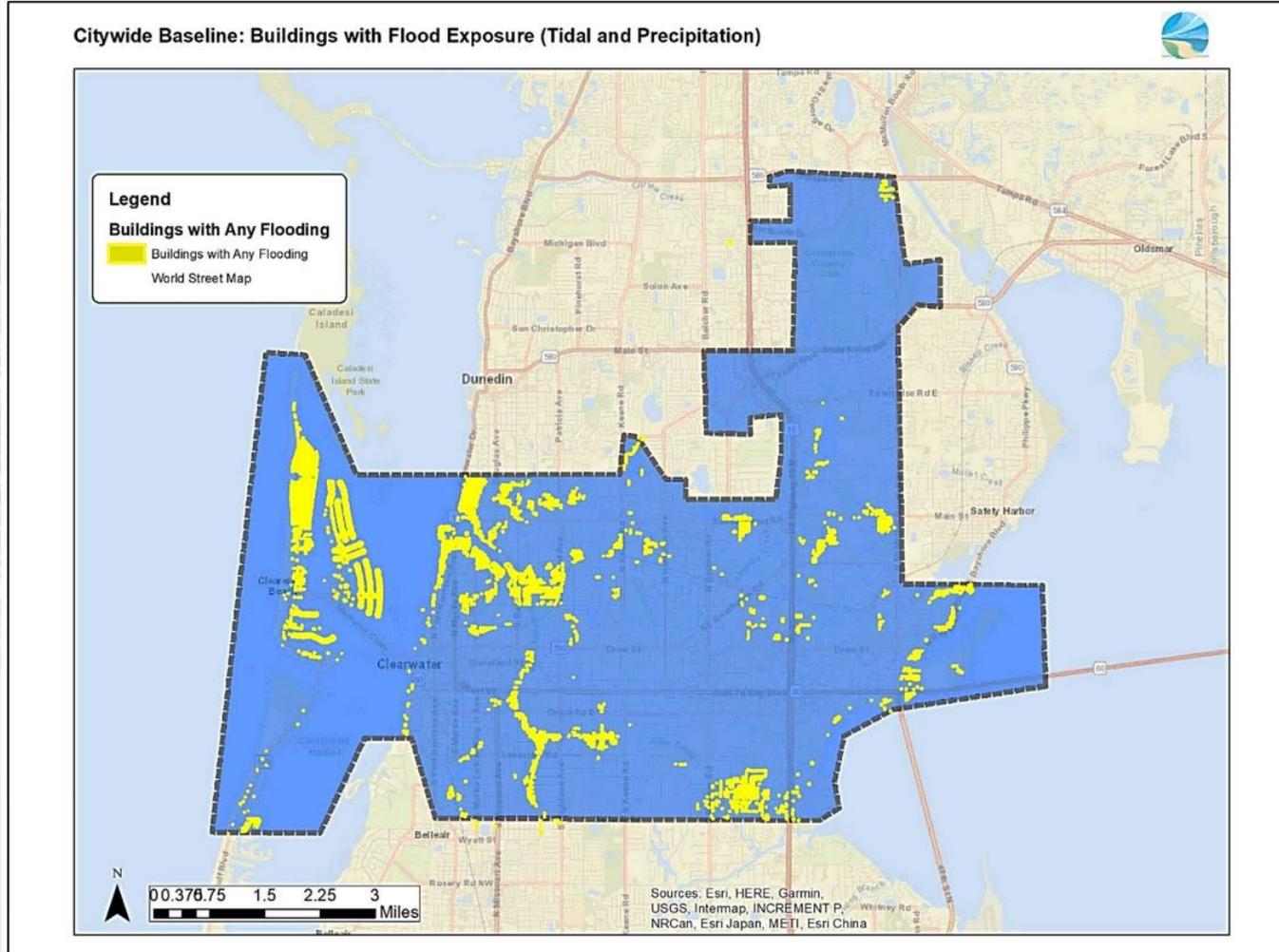Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

Figure 5-20-Citywide structures that are exposed to future flooding.

Modeled a citywide buyout program based on ROI of individual properties. Found this to be one of the most effective long-term strategies for reducing overall flood exposure.

ROI ratio = $2.45B / $1.5B = 1.63
• 1,282 projects

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios

Scenario 7: Hercules and US 19 Corridors

Figure 5-23 - Structures within the US 19 and Hercules economic development areas that are exposed to future flooding.
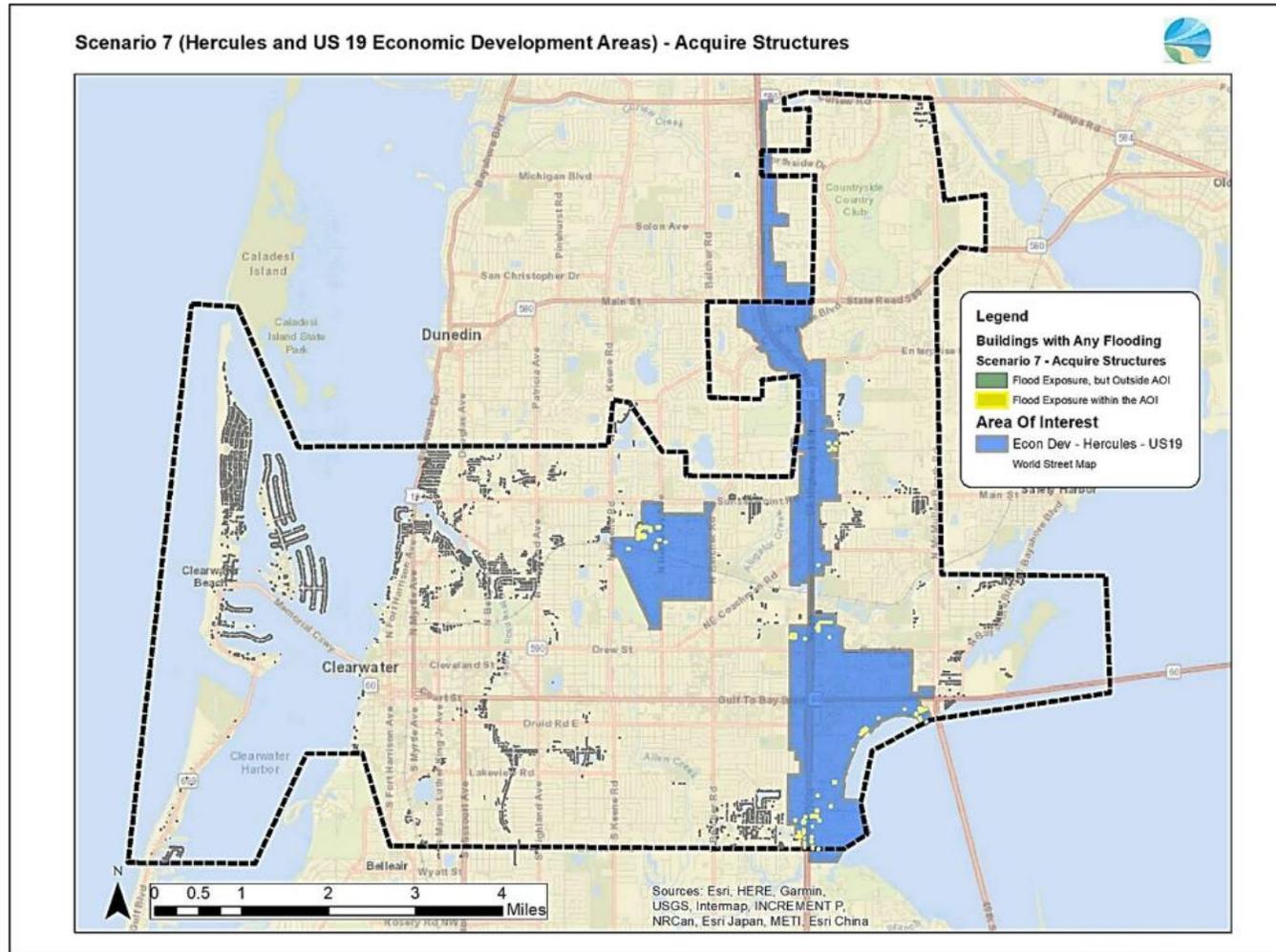
Focused on acquiring structures in economic development corridors prone to flooding. The scenario showed strong ROI from targeted acquisitions on a cost to benefit curve.

ROI ratio = $43.17M / $26.35M = 1.64
- 8 acquisition projects

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios
Scenario 8: Coastal Zone 1, Central Business District (downtown) and North Greenwood

Scenario 8 (N. Greenwood CRA, Downtown District, & Coastal Zone 1) Baseline:
Buildings with Flood Exposure within the Area of Interest (AOI)

Legend

Buildings with Any Flooding
Scenario 8 - N. Greenwood, Downtown, Coastal Zone 1

- Flood Exposure within the AOI
- Flood Exposure, but Outside AOI
- World Street Map

Area Of Interest
- Income - Coastal Zone 1 - Downtown - N Greenwood

0 0.25 0.5   1   1.5   2
Miles

Sources: Esri, HERE, Garmin,
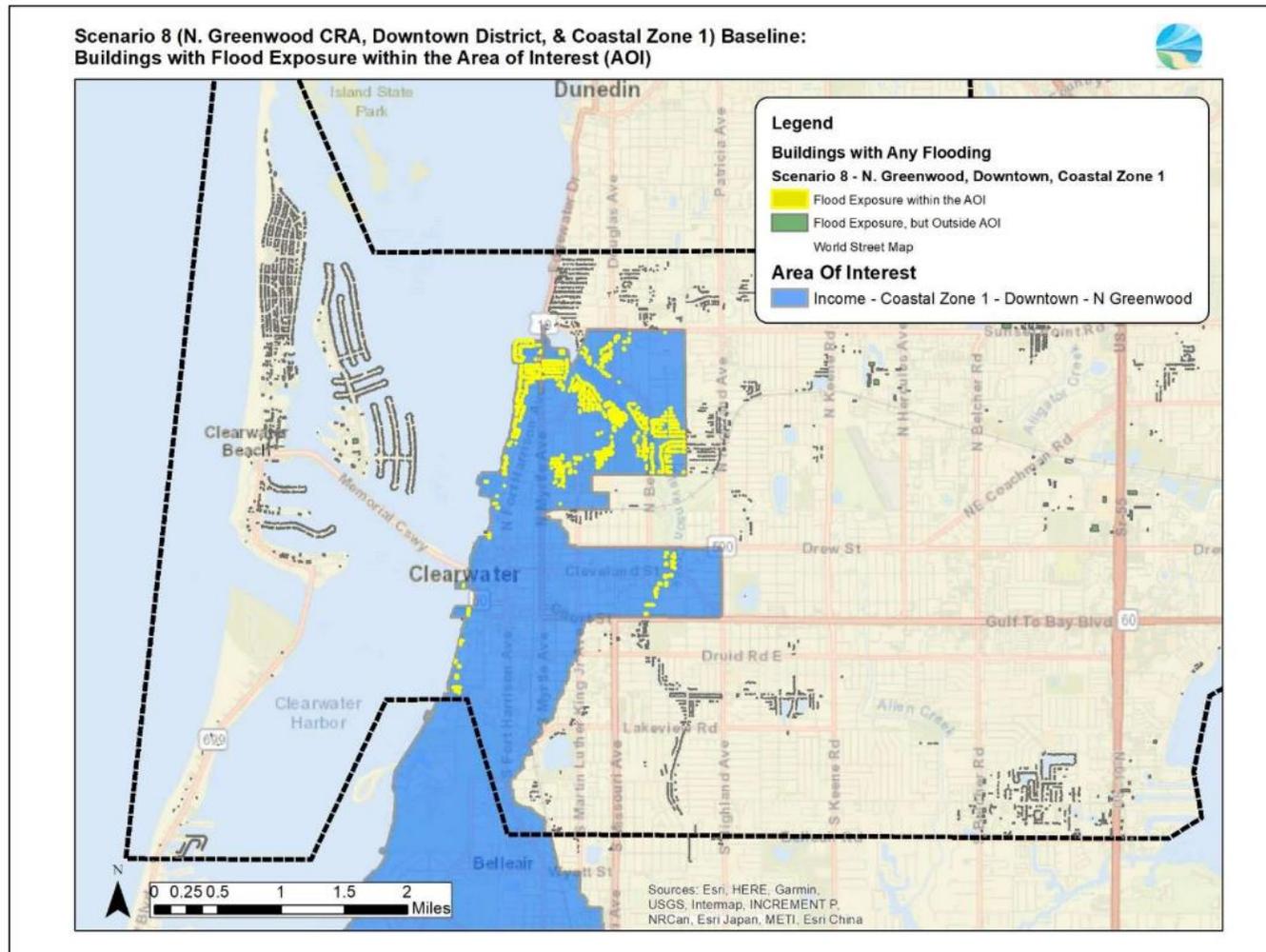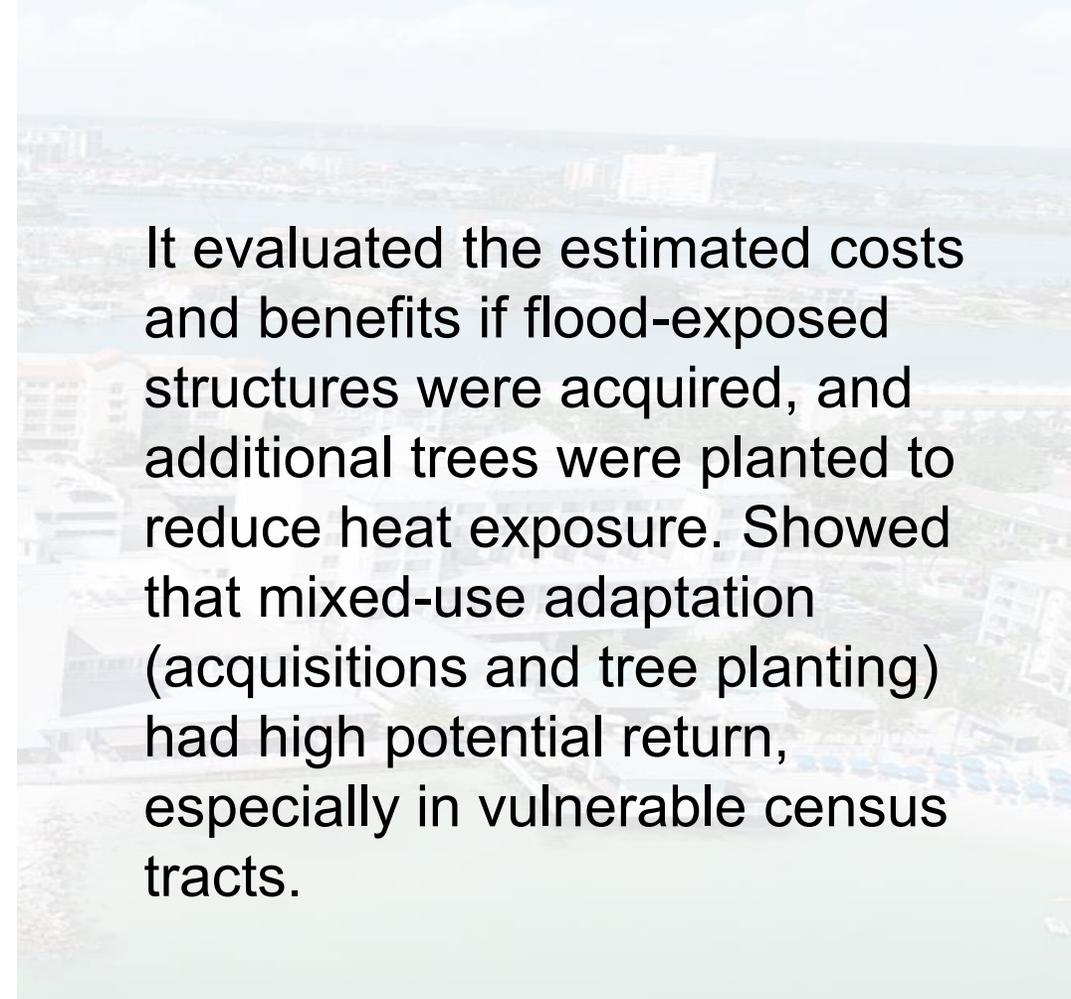USGS, Intermap, INCREMENT P,
NRCan, Esri Japan, METI, Esri China

Figure 5-25 - Structures within the N. Greenwood/Downtown/Coastal Zone 1 AOI that are exposed to future flooding.

It evaluated the estimated costs and benefits if flood-exposed structures were acquired, and additional trees were planted to reduce heat exposure. Showed that mixed-use adaptation (acquisitions and tree planting) had high potential return, especially in vulnerable census tracts.

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Modeled Adaptation Scenarios
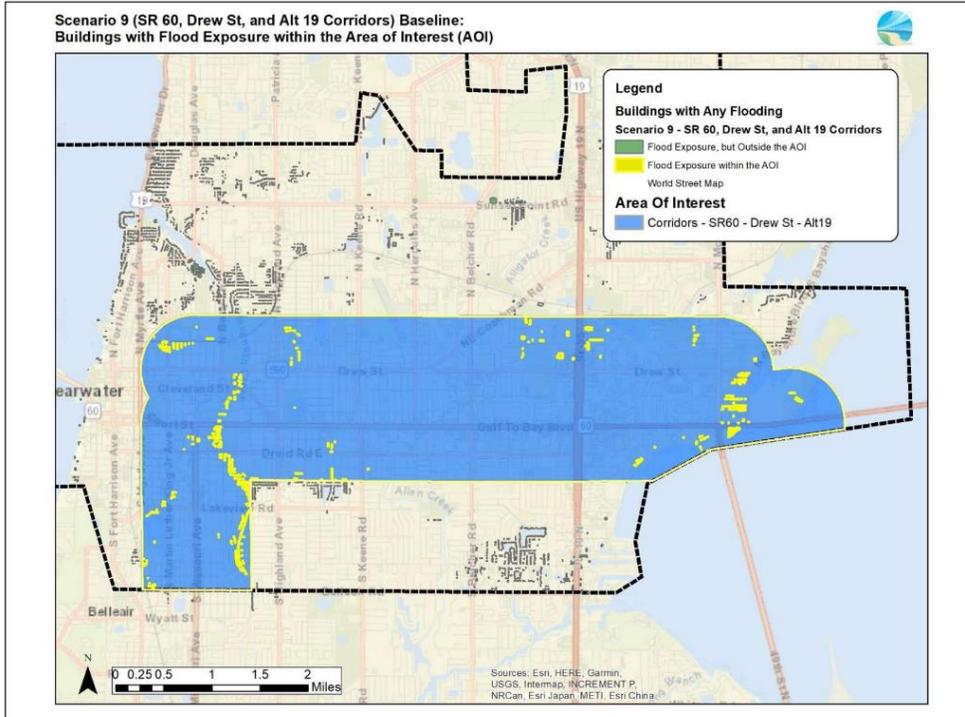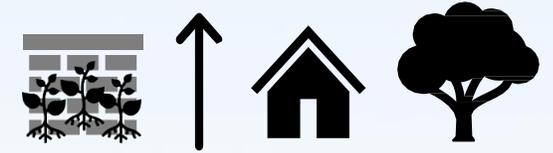## Scenario 9: SR 60, Drew St. and S Missouri (Alt 19)

Figure 5-26 - Structures within the SR60, Drew St, and US 19 corridors that are exposed to future flooding.
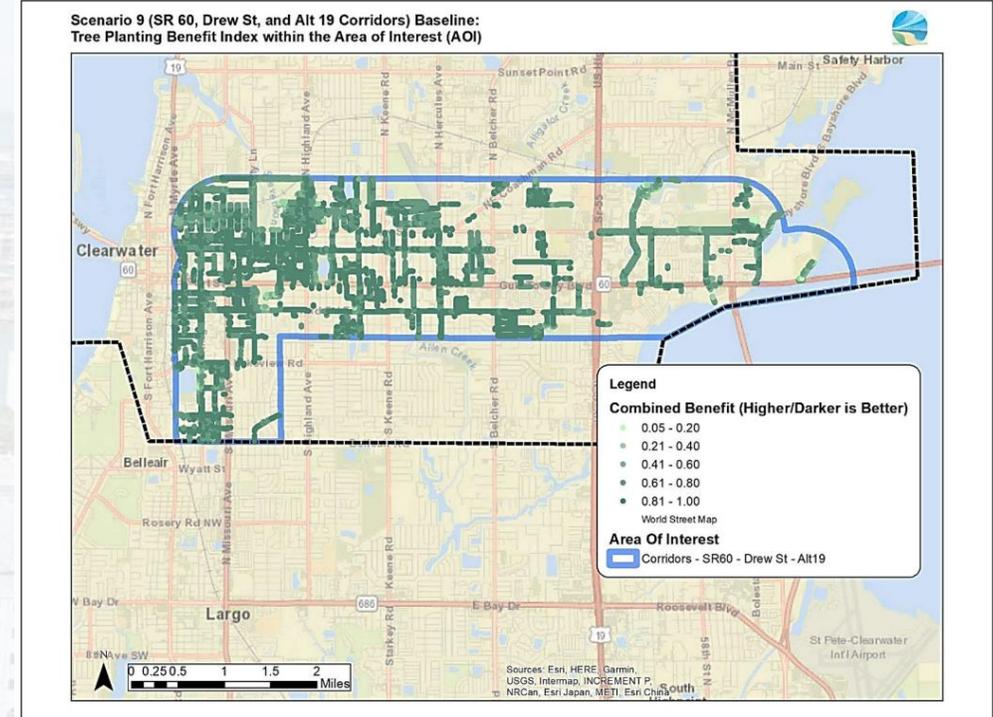

Figure 5-27 - Tree Benefit Index within the Scenario 9 (Investment Corridors) AOI

This scenario was intended to evaluate stormwater improvements, density changes and tree coverage of future investment corridors. The model was not able to accurately evaluate the mix of soft and hard mitigation strategies; however, flooding exposure and tree planting benefit analyses were demonstrated.

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Modeled Adaptation Scenarios
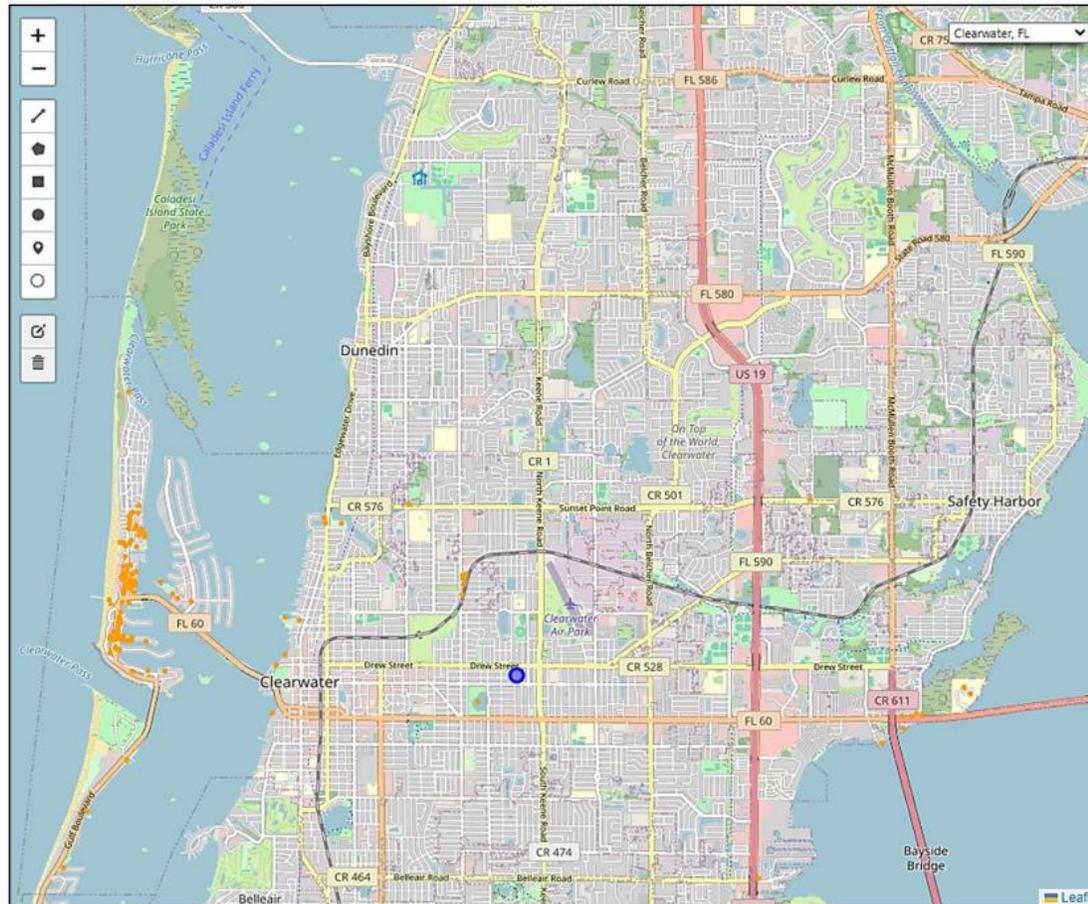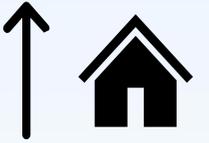
Scenario 10: Elevate Structures Citywide

Figure 5-29 - Structures (orange dots) with the highest ROI for the 25% budget citywide acquisition scenario.

A broad scenario assessing the benefits of elevating all vulnerable buildings. Results showed this approach is costly but impactful, with the best ROI in the high-exposure zones of Clearwater Beach, Stevenson Creek and near the Old Tampa Bay coast.

ROI ratio = $389.3M / $141.1M = 2.76
- 837 elevation projects

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

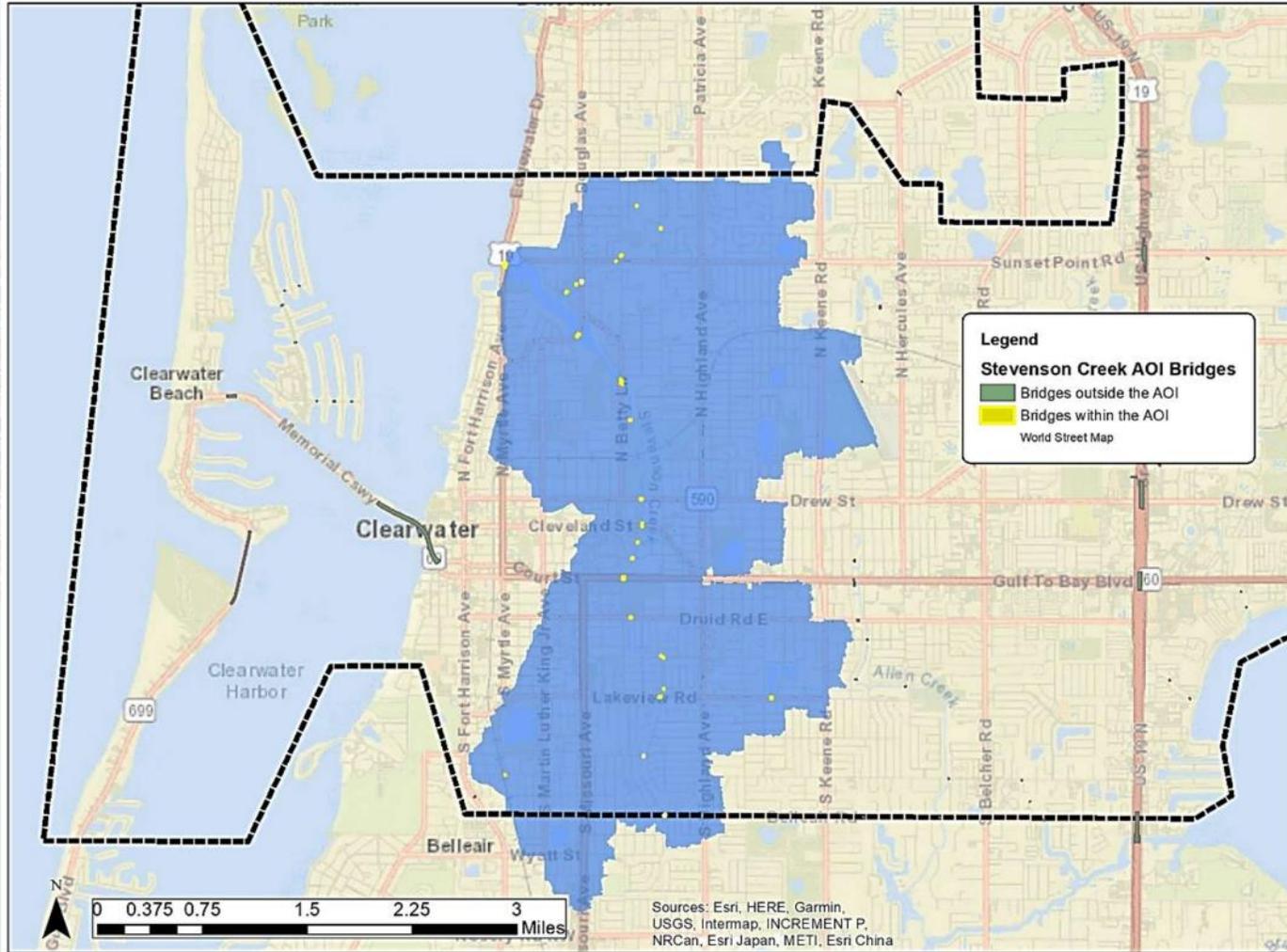# Refined Scenarios – Scenario 1

Stevenson Creek with Bridges
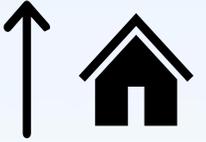
Revised Scenario 1 - Assessment of Bridges within the Stevenson Creek Area of Interest (AOI)

Legend

Stevenson Creek AOI Bridges
- Bridges outside the AOI
- Bridges within the AOI
- World Street Map

The scenario identified three bridges (Belleview Blvd/Stevenson Creek; Belleair Road/Rice Lake; Douglas Ave/Stevenson Creek) that would be good candidates for upgrades, with further analysis (planning, design and cost information) and coordination with county, state and federal agencies needed.

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Refined Scenarios – Scenario 8a

North Greenwood

Figure 6-2: Cost to benefit curve scenario 8a.

- Targeted acquisitions and tree planting in this socially vulnerable neighborhood.
- There is a high ROI due to building exposure, community vulnerability and limited shade coverage.

ROI ratio = $98M / $76M = 1.29
- 1,184 projects
  - 1,141 tree plantings
  - 43 building acquisitions

Refined Scenarios – Scenario 8b

Central Business District (downtown)

Figure 6-4: Cost to benefit curve generated for scenario 8b.

- Focused on tree planting and a few critical acquisitions. Found to improve walkability and reduce urban heat while offering modest flood mitigation benefits.
- The study also included a map of 25% budget scenario that highlights tree planting (919) and building acquisition (33) that returns the highest ROI.

ROI ratio = $17.8M / $9M = 1.98
- 1,572 projects
  - 1,568 tree plantings
  - 4 building acquisitions

Refined Scenarios – Scenario 8c

Coastal Zone 1 (mainland west coast)

2111 Actions. Total Cost: $65.04M
Acquire Building Actions: 53 | Plant
Trees Actions: 2058 |

Figure 6-6 - Cost to benefit curve generated for scenario 8c.

- Focused on tree planting and a few critical acquisitions.
- Provided strong benefits for long-term risk reduction and resilience.

ROI ratio = $120.36M / $65M = 1.85
- 2,111 projects
  - 2,058 tree plantings
  - 53 building acquisitions

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

Refined Scenarios – Scenario 11

Identify Tree Deserts

Scenario 2 (Citywide): Tree Planting Benefit Index within the Area of Interest (AOI)

Legend

World Street Map

TreePlantingLocations
Combined Benefit Index (Higher/Darker is Better)

- 0.05 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China
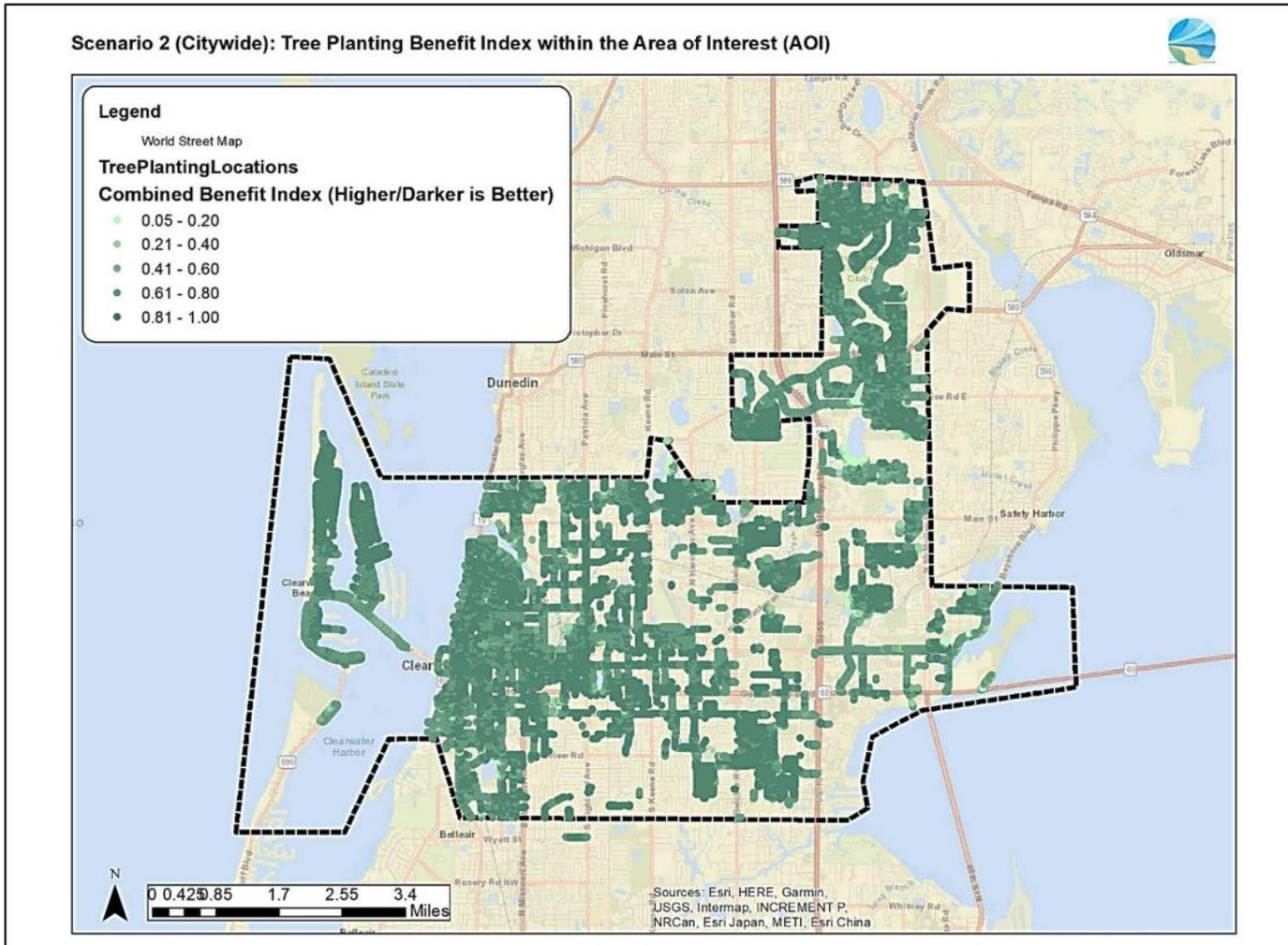
Figure 6-8 - Structures within the Stevenson Creek Watershed that are exposed to future flooding.

- Further refined Scenario 2 and developed the tree planting benefit index, based on the city's parcel fabric and demographics to estimate relative benefits to tree planting locations.
- Identified priority areas for tree planting with the highest cooling potential.

*Note: Graphics and scenarios shown are not meant to imply that the City would take these actions. This is a planning-level tool that lets the City select adaptation actions and geographies of interest to help inform future strategic actions that may be considered.

TAC Recommendations

Expert Committee Guidance

- Use St. Petersburg tide station for regional consistency

- Integrate surface water and groundwater modeling

- Expand public engagement and neighborhood-scale solutions

- Include land acquisition for stormwater retention

- Pursue grants for visualization and education tools

Recommended Adaptation/Mitigation Actions

The following portfolio of actions could be considered to minimize the flooding and heat vulnerabilities identified within the vulnerability assessment.

Increase Awareness	Policy/Planning	General Infrastructure Improvement	Physical Countermeasures to Climate Change
• Resilience Awareness Campaign • Public Surveys • Additional Sensors in Flood-prone Areas • Obtain Finished Floor Elevations • Neighborhood Programs • **Encourage/Purchase Flood Insurance**	• Clearwater 2045 • Reduce Building in Floodplain • Reduce Building in Coastal Buffer • Land Acquisition • Resiliency Bond Financing • Position for Grants • Incentivize DIY Flood Protection • Improve Community Rating System Score	• **Improve Stormwater Quality** • Add Stormwater Park • **Apply Greenprint 2.0** • **Add Rain Gardens** • **Add Native Plants** • **Living Shorelines** • **Reduce Pollutant Loading to Waterways** • Constructed Wetlands • **Permeable Pavements** • **Urban Forestation** • **Rooftop Runoff Storage**	• **Elevate Buildings** • Acquire Flood-prone Structures • Raise Streets • **2nd Floor Conversion** • **Add Living Shoreline/Seawall** • **Raise Seawall** • **Floodproofing** • Improve Culvert/Bridge • **Tree Plantings**

Bold green text represents actions that could potentially be performed by the public as well

Next Steps

From Assessment to Action

- Prioritize high-ROI adaptation projects (e.g., Stevenson Creek, coastal zones)
- Expand tree canopy in vulnerable areas (North Greenwood, Downtown)
- Enhance data collection for future modeling
- Engage the community in resilience planning
- Pursue grant funding for implementation
- Integrate findings into city planning documents (Comp Plan, Greenprint, CIP)

Questions?

Sustainability & Environmental Division

Email: *sustainability@myclearwater.com*

Thank you!