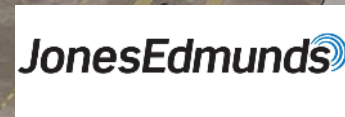


Community Co-Design of Green Stormwater Infrastructure for Coastal Resilience

Eban Bean, PhD, PE
Jessica Brusco, MS

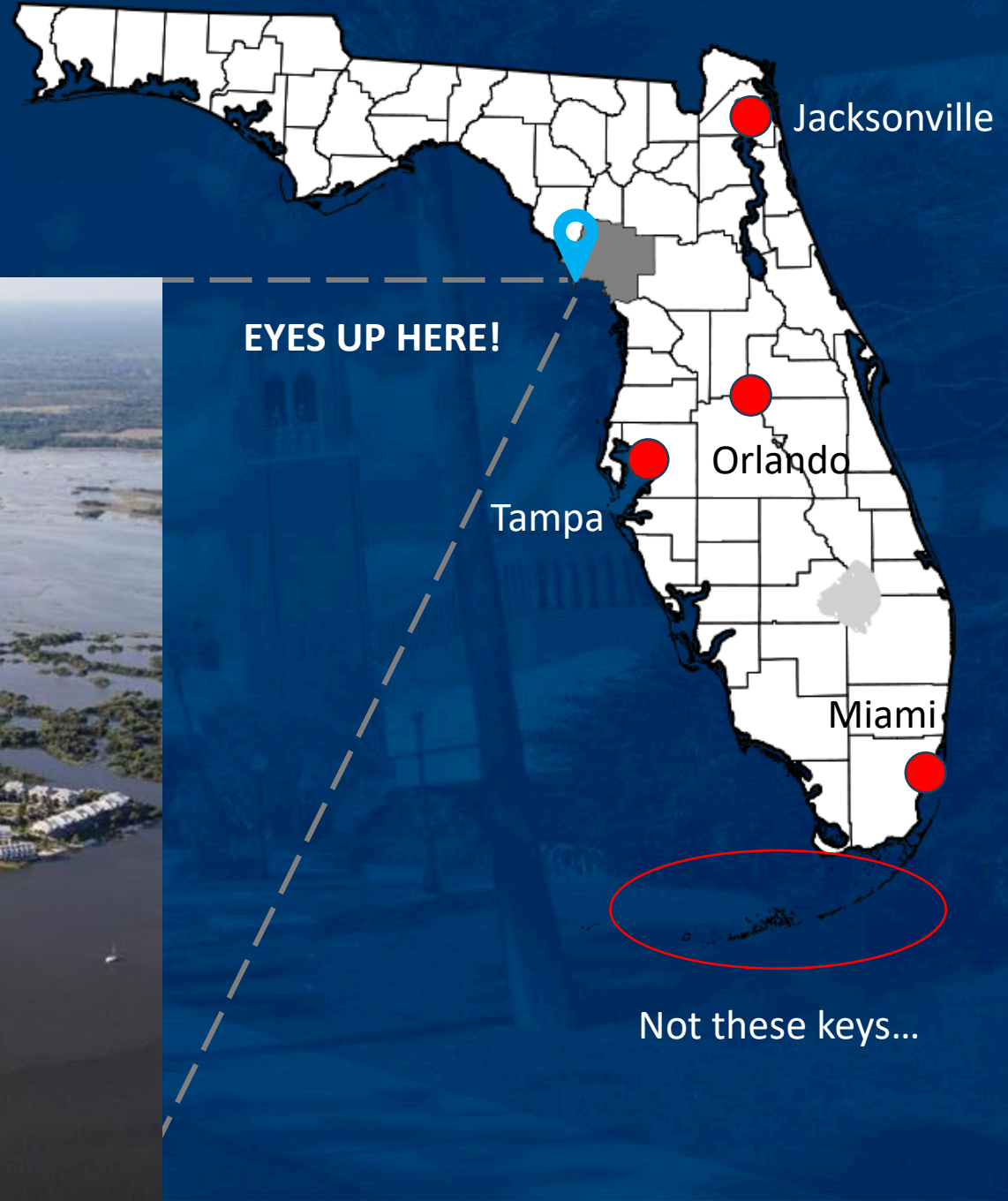


Cedar Key ShOREs

NATIONAL
ACADEMIES *Sciences
Engineering
Medicine*




Focus Area






Legend

 Watershed Boundary


USGS 2018 LiDAR DEM

Elevation (Ft NAVD88)

High : 33.32



Low : -1.2



0 200 400

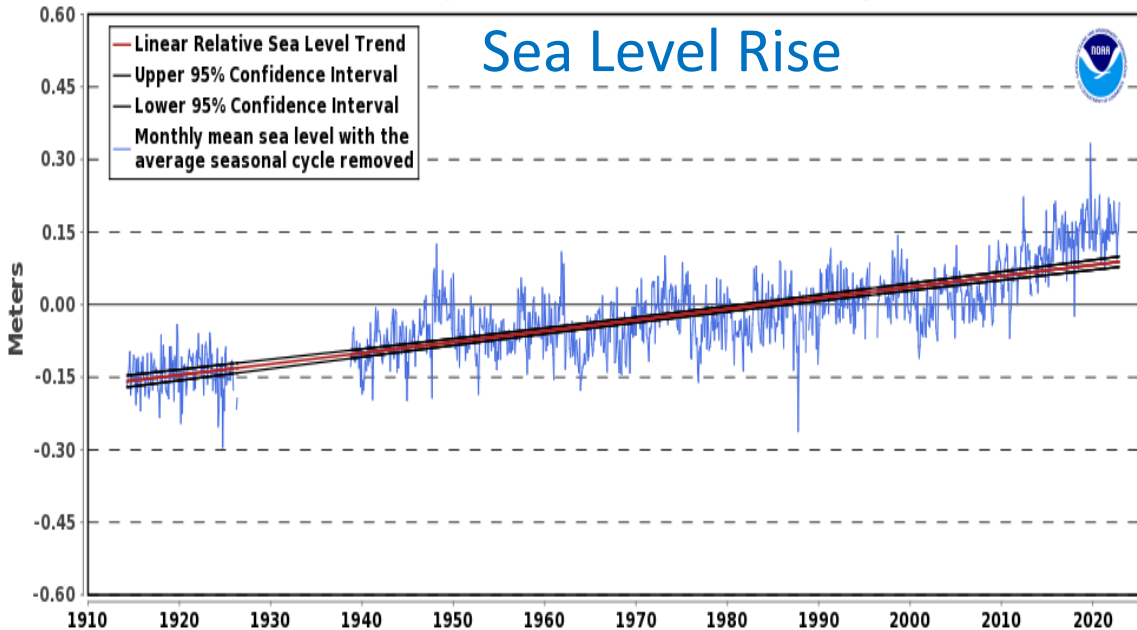
Feet

1:4,800

8727520 Cedar Key, Florida

2.27 +/- 0.18 mm/yr

Sea Level Rise



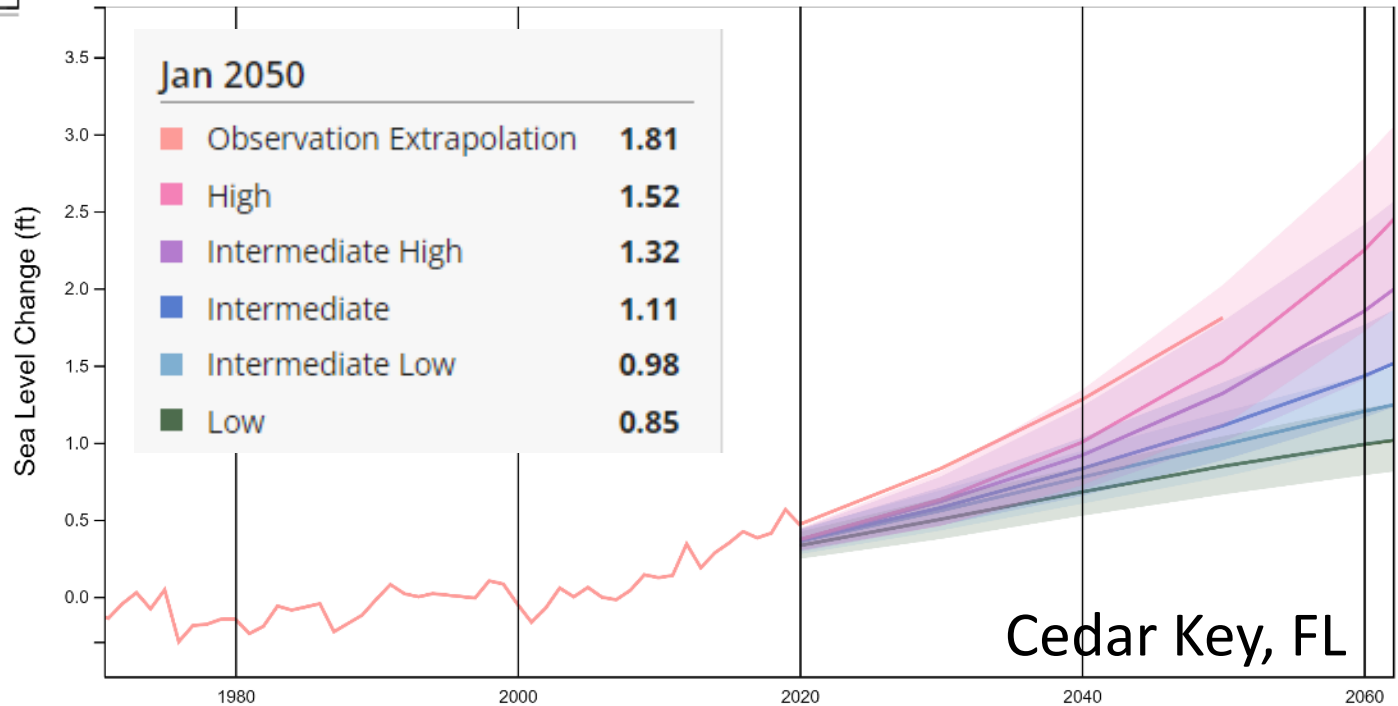
30 cm (11.8 inches)
 4th fastest SLR
 acceleration in the
 USA (NOAA)

Sea-level Rise & High Hazard Exposure

Extrapolation of observed sea level trends **outpaces even the extreme scenario** from models



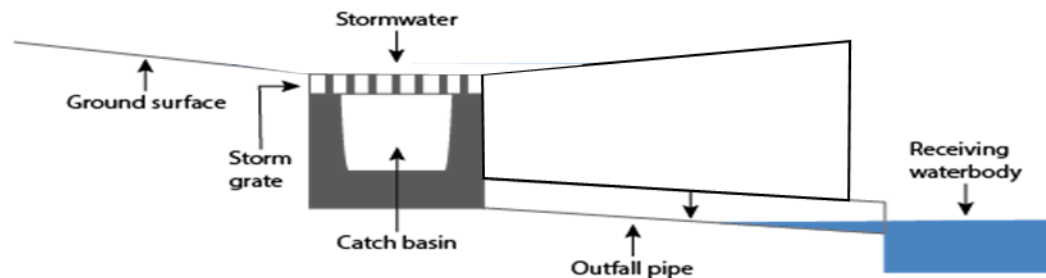
Sunny Day flooding



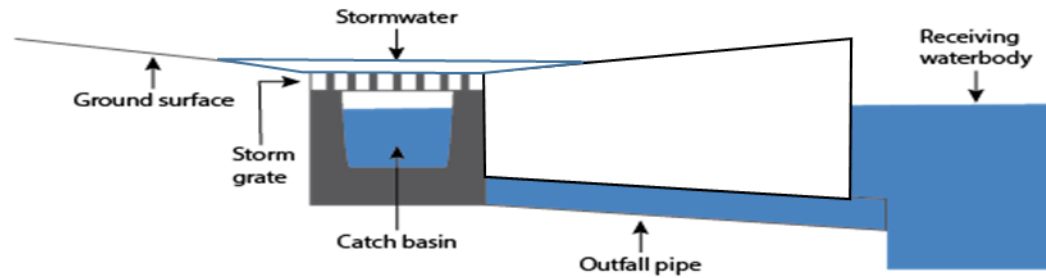
Cedar Key, FL

Impact of Rising Sea-Level on Stormwater Management Infrastructure

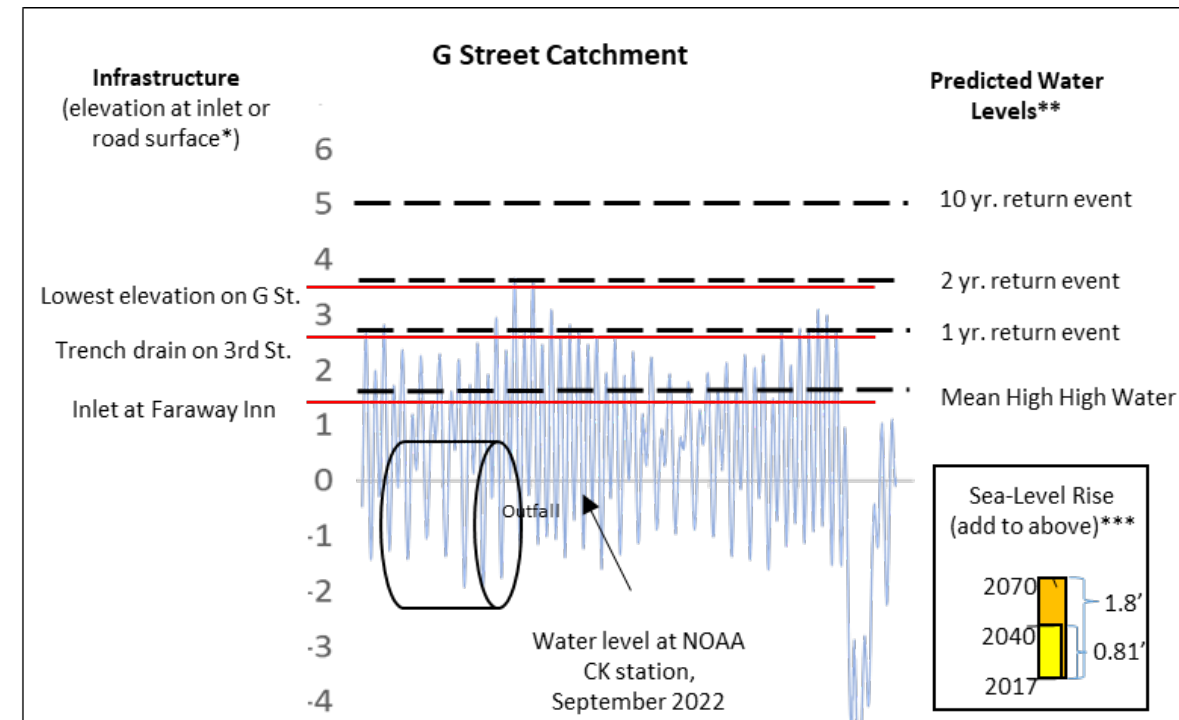
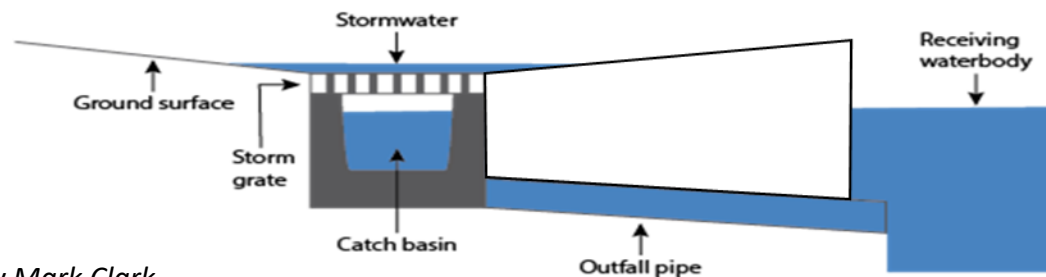
LOW TIDE SCENARIO



HIGH TIDE SCENARIO



Extreme event and impact of Sea-Level Rise



*Elevation datum in feet NAVD88

** MHHW and extreme event predictions are referenced to 1983-2001 National Tidal Epoch

*** Sea-Level Rise prediction from NOAA Technical Report NOS CO-OPS 083

Salt Tolerant Species & Corrosion











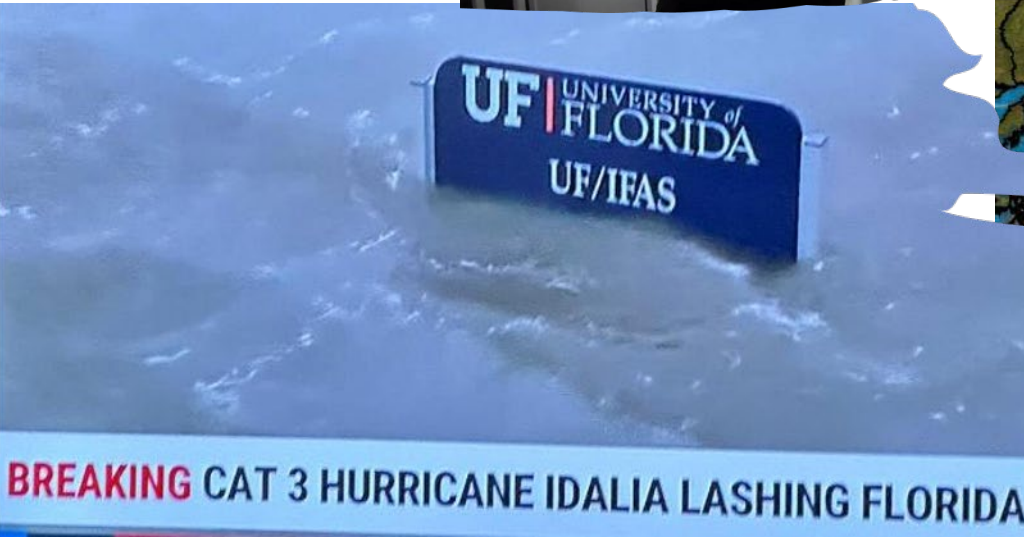
Hurricane Idalia

Category 4
Late August 2023
9 ft Storm Surge



■ Hurricane Idalia Landfall

Aug. 30, 2023
7:45 AM EDT
Near Keaton Beach, FL
Category 3



Hurricane low
PRESSURE
957 mb

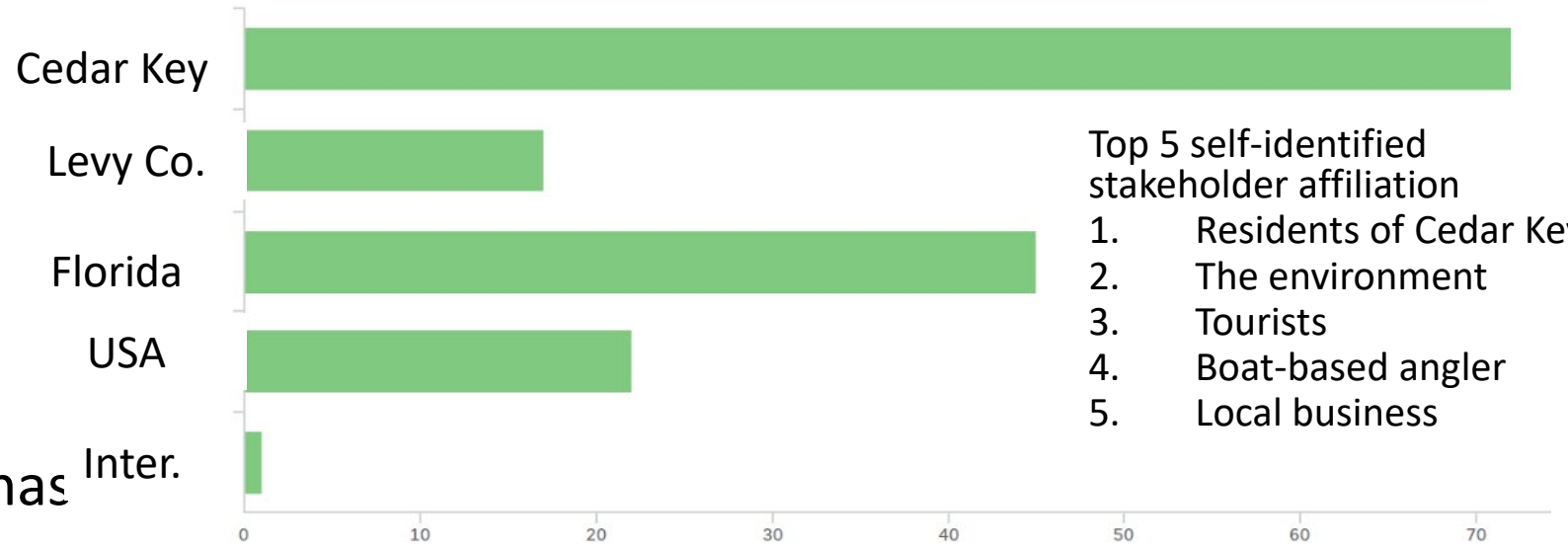
Phase I

- Site Visits
- 3 Workshops
- Survey on NBS
- Conceptual Co-Design
- Proposal for Phase II



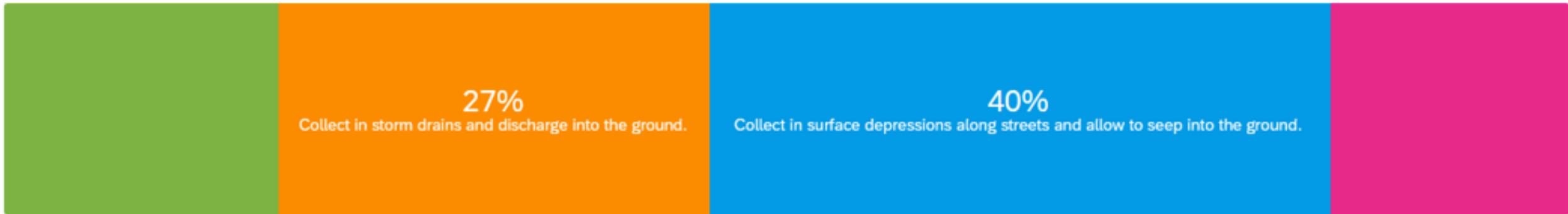
Co-design process

- Intercept survey (n = 157)
- Workshop series
 - Stormwater concepts
 - Shoreline concepts
 - Final conceptual design
- Deliverable: full proposal to Phas



Survey

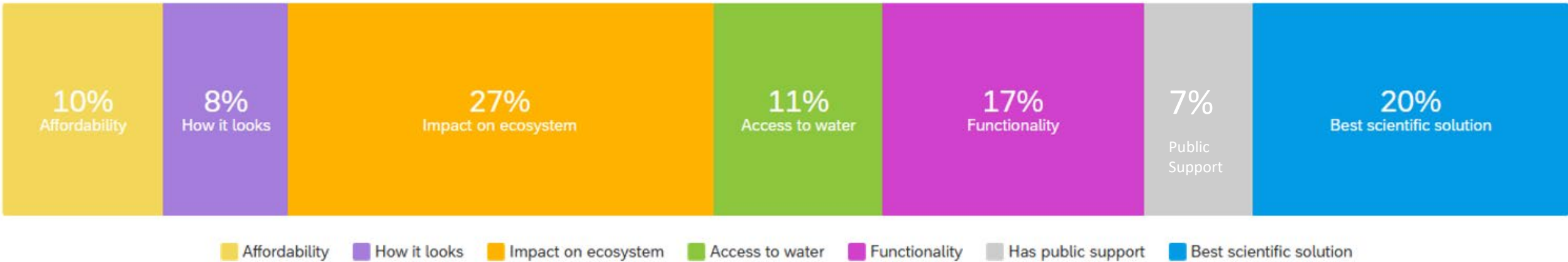
“What is the best way to manage stormwater runoff?”



■ Collect in storm drains and discharge directly to the ocean. ■ Collect in storm drains and discharge into the ground. ■ Collect in surface depressions along streets and allow to seep into the ground.

■ Let streets temporarily flood in spots during a storm and allow water to slowly seep into the ground.

“What priorities should direct coastal infrastructure in Cedar Key?”



“Whose needs should be prioritized?”

Highest:

1. Residents of Cedar Key
2. The environment
3. Clam aquaculture workforce

Lowest:

10. Inland residents (Levy County)
11. State government
12. Developers

***“Make It
Work!!!!”***

***“Save the
environment,
flora, and
fauna”***

*“Would be
interested to see
the results”*

*“Would love to see
the outcome data”*

“Best of Luck”

*“Thank you. Please don’t
let humans ruin our
planet.”*

***“Keep On
Trying!!!”***

*“Maintain this beautiful
island!”*

Workshop 1: Stormwater Concepts

OPTION 3: BIOSWALES

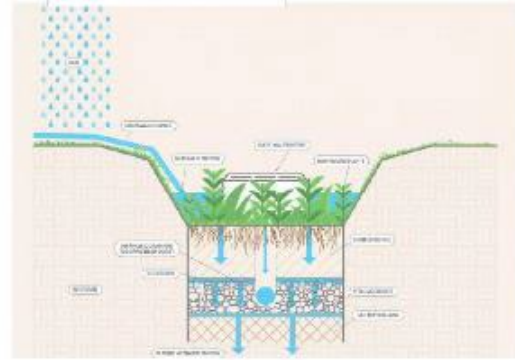
Description

Long, channeled depression or trench that receives runoff and has a vegetation such as grass and other plants; some swales serve as conveyance and detention



Applications

Right-of-Ways, between sidewalks and curbs, road medians, long and narrow spaces



Favored:

- Bioswale
- Tree box filter
- In-line check valve

Less Favored:

- Underground storage

OPTION 5: TREE BOX FILTER

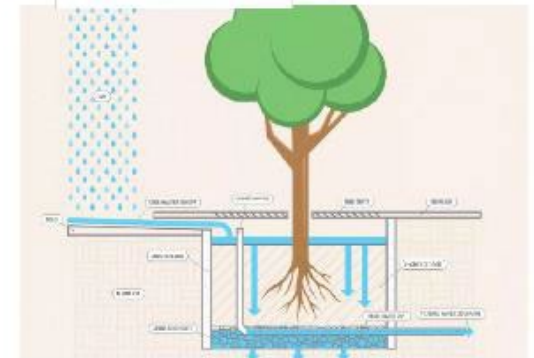
Description

Small areas of plantings with vertical walls and either open or closed bottoms to collect runoff from streets, sidewalks, and parking lots

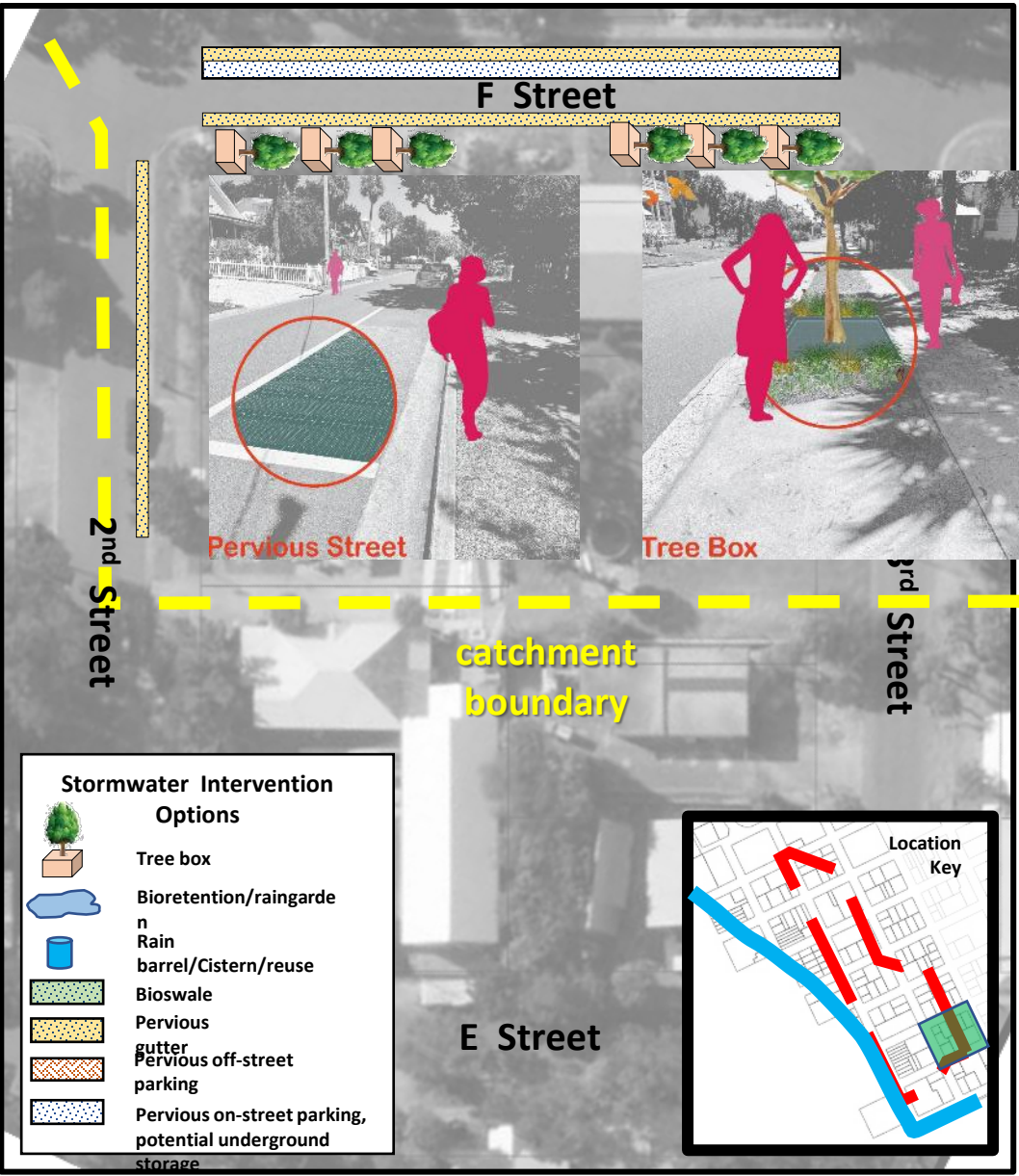


Applications

Downtown areas, areas with limited space, city streets, Right-of-Ways

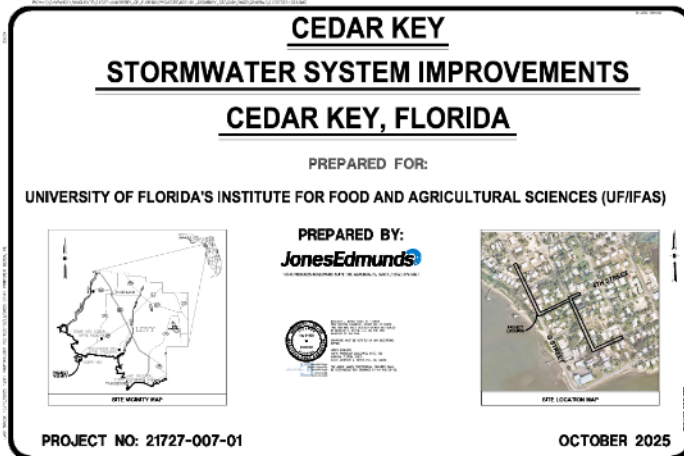


Workshop 2: Conceptual Designs

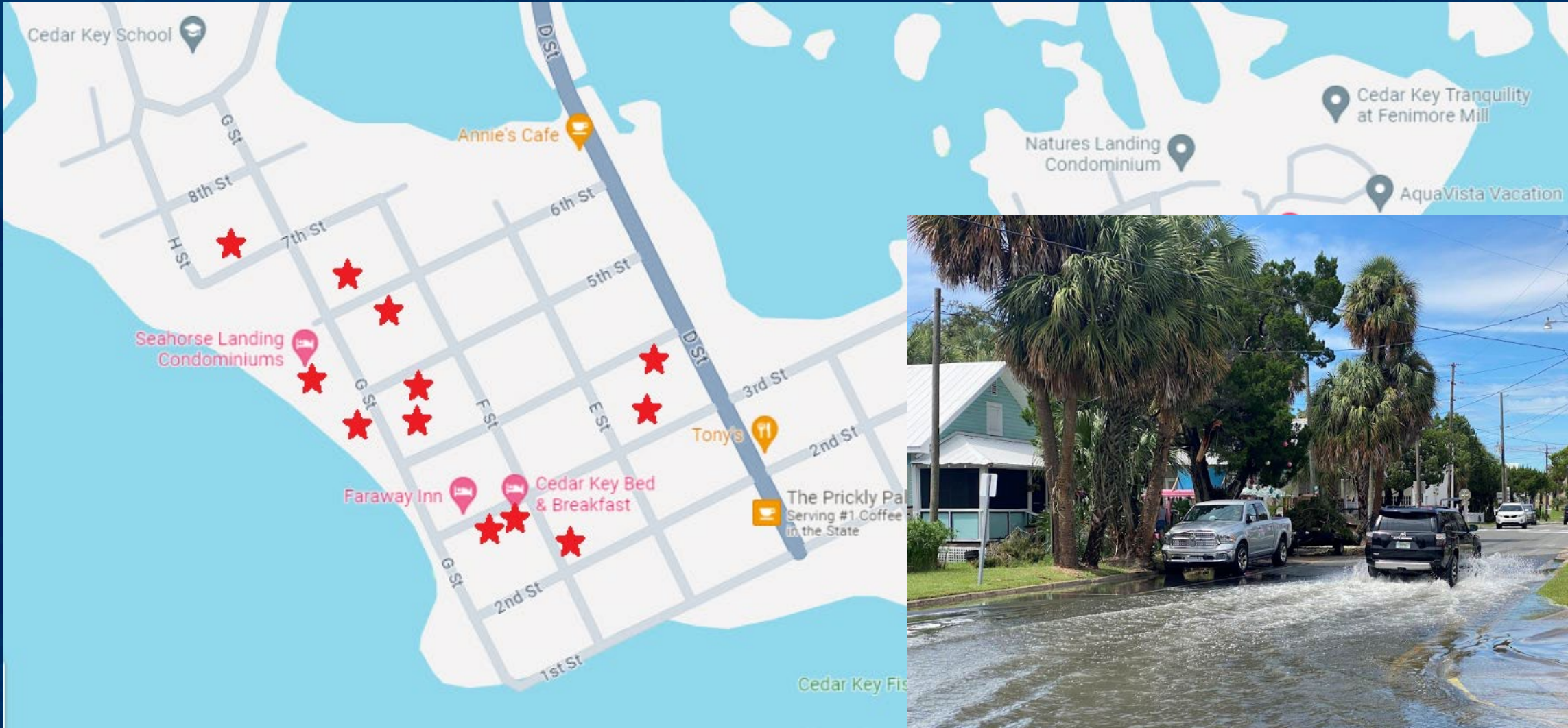


Cedar Key ShOREs: Phase II

- Hydrodynamic & stormwater models
- Continual refinement through co-design
- Interviews & workshops with the Community
- Design for stormwater
 - 30%, 60%, 90%, Final
- Legal/permitting work



Stormwater Interviews



Locations of visits in CK



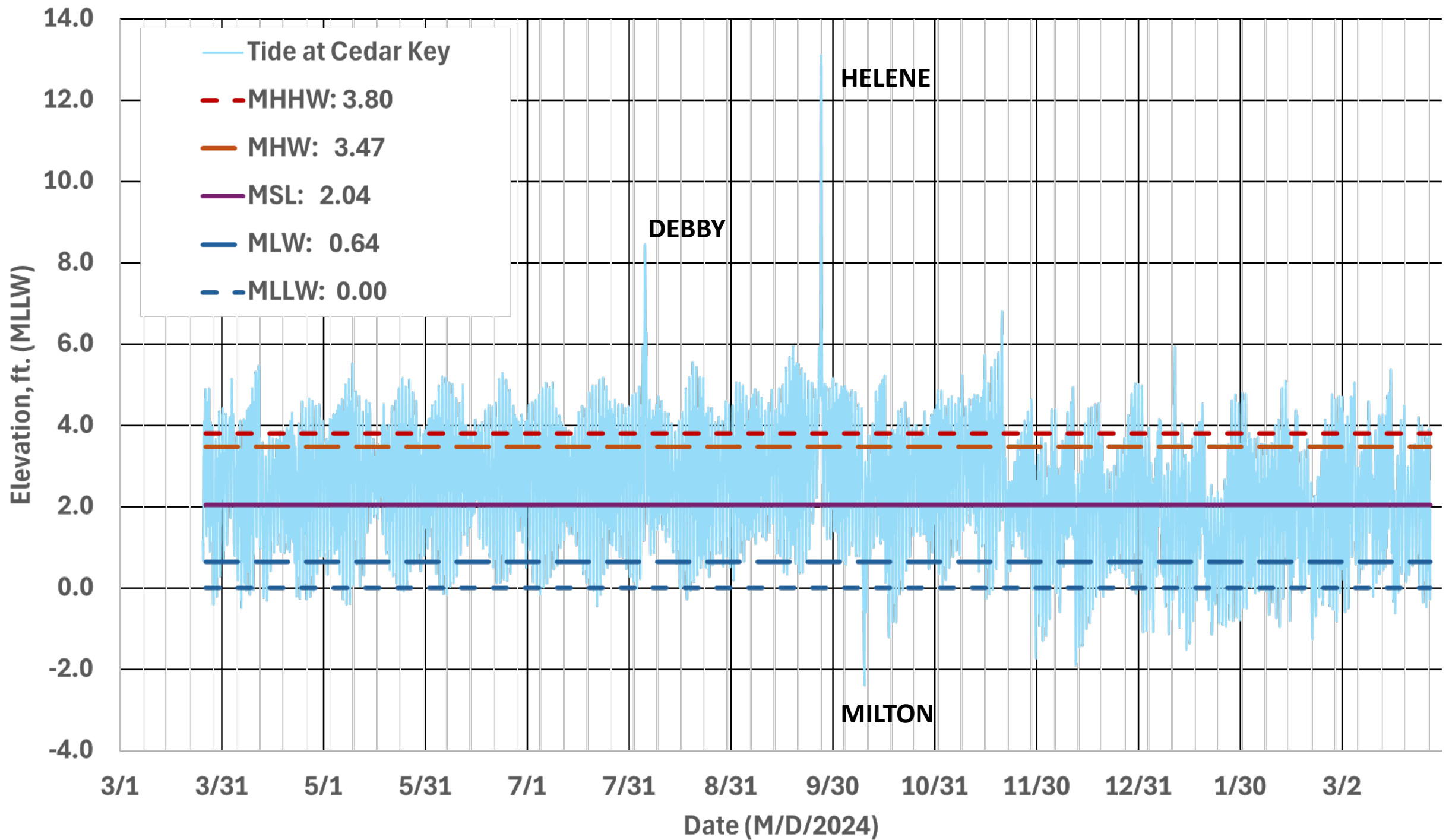
Legend

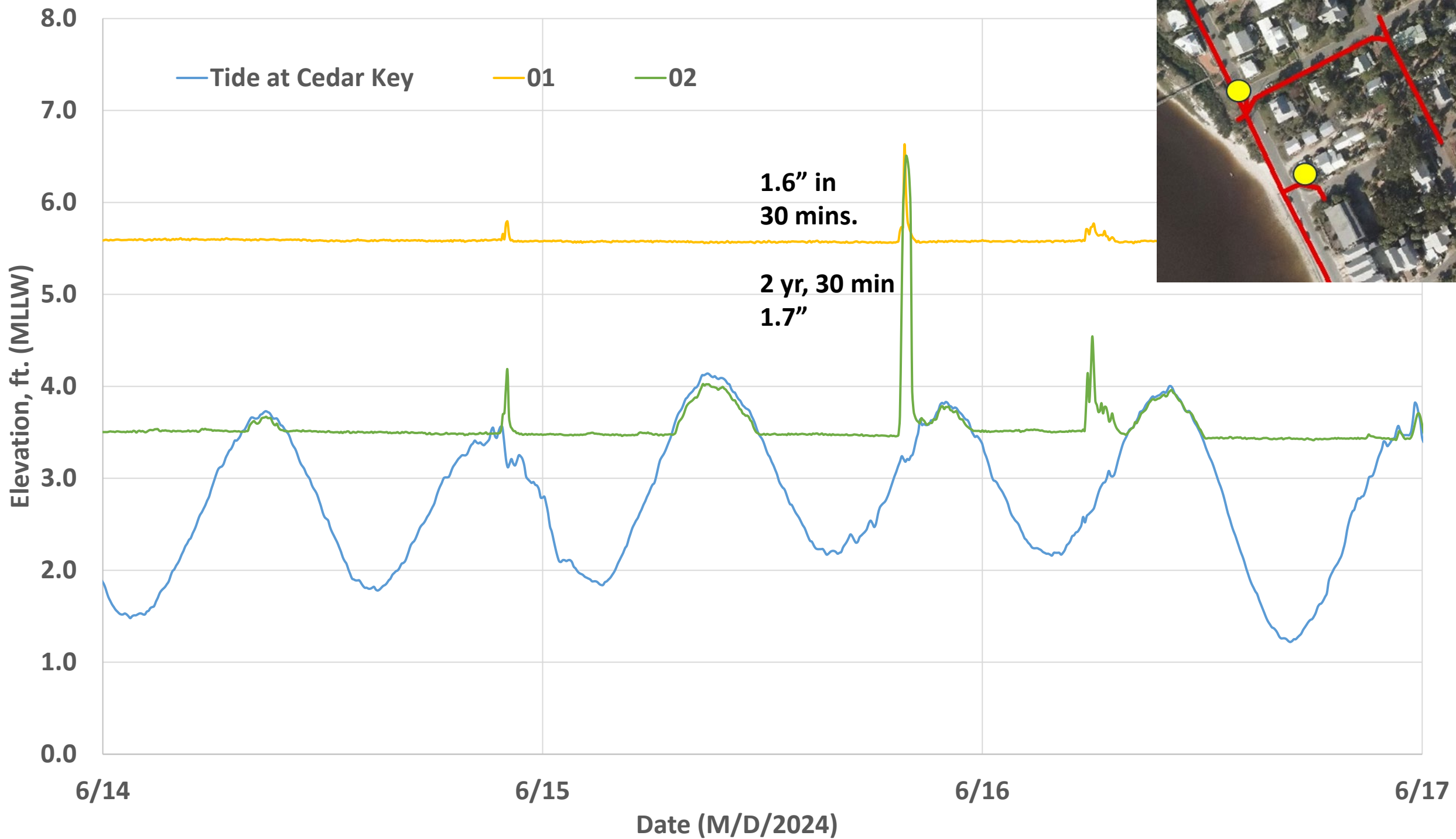
— Storm ● Monitoring

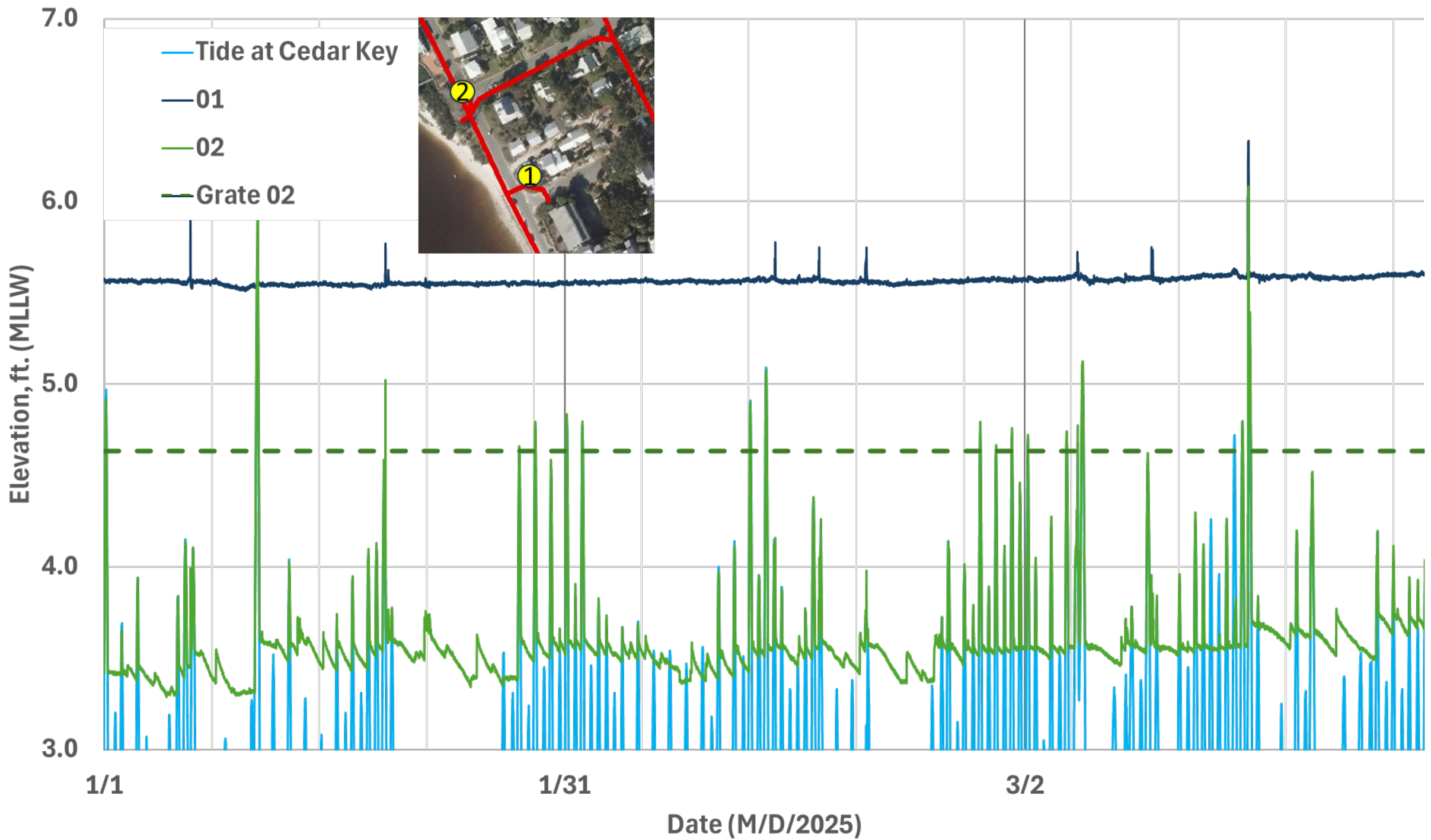
N
W E S

0 175 350

Feet
1:4,200



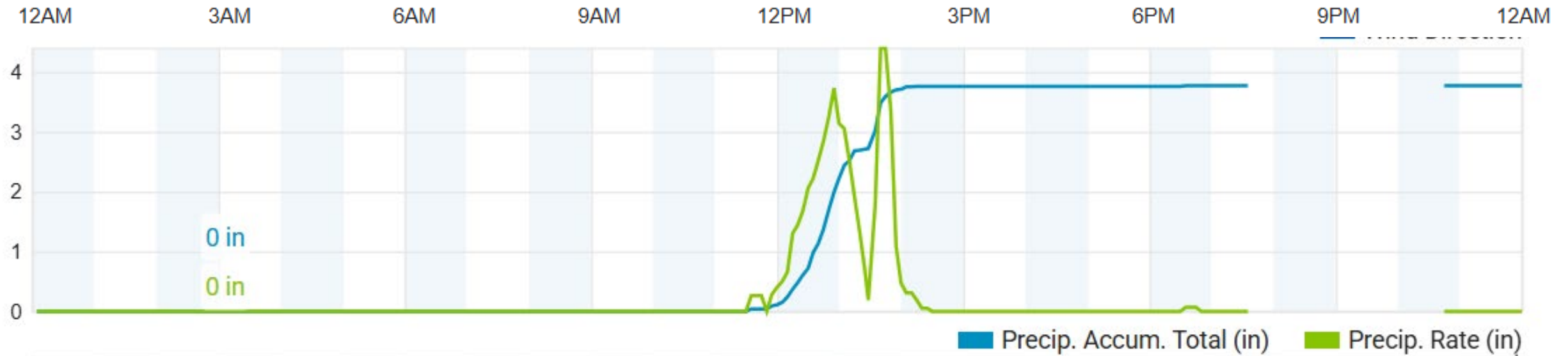


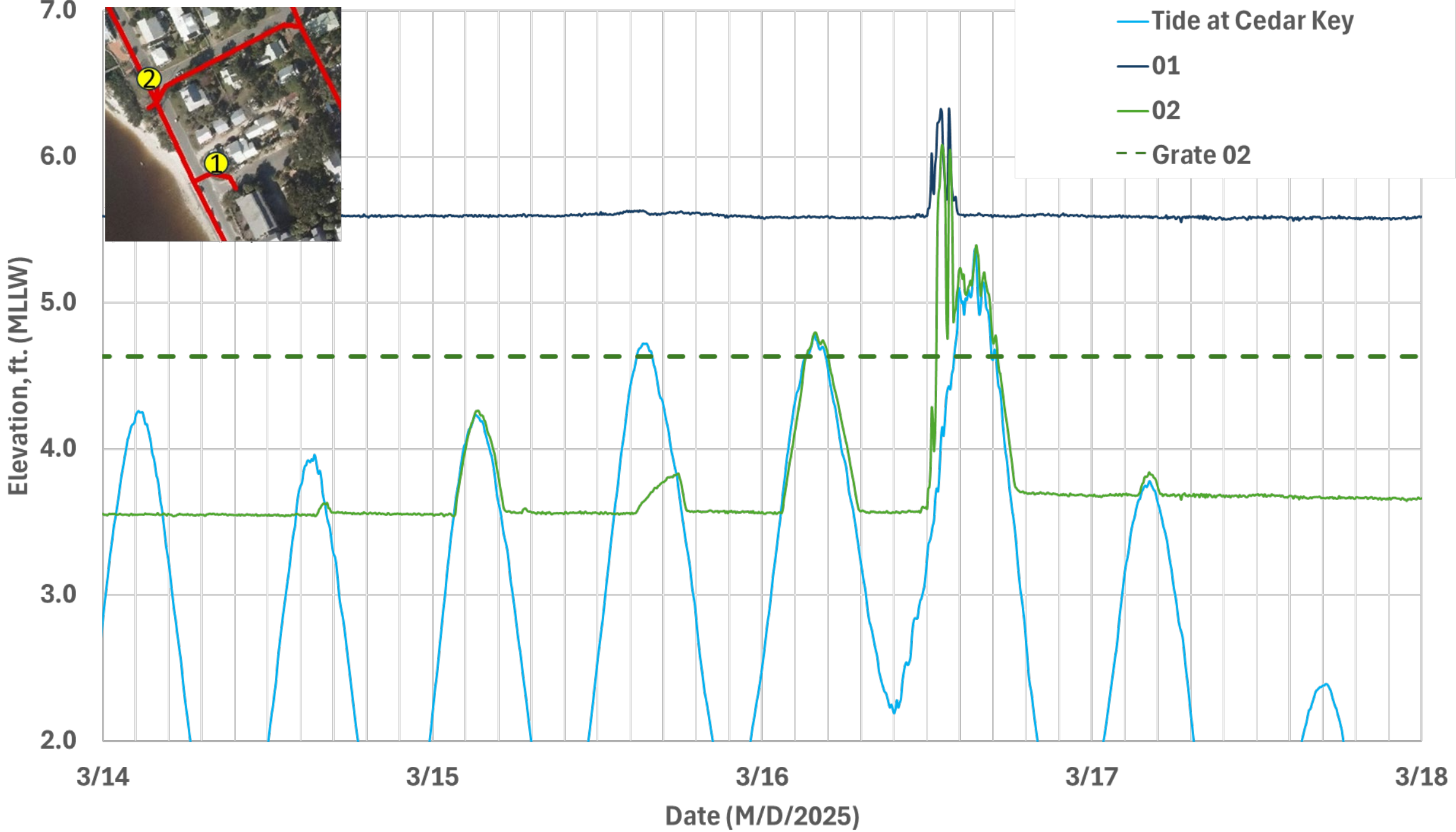


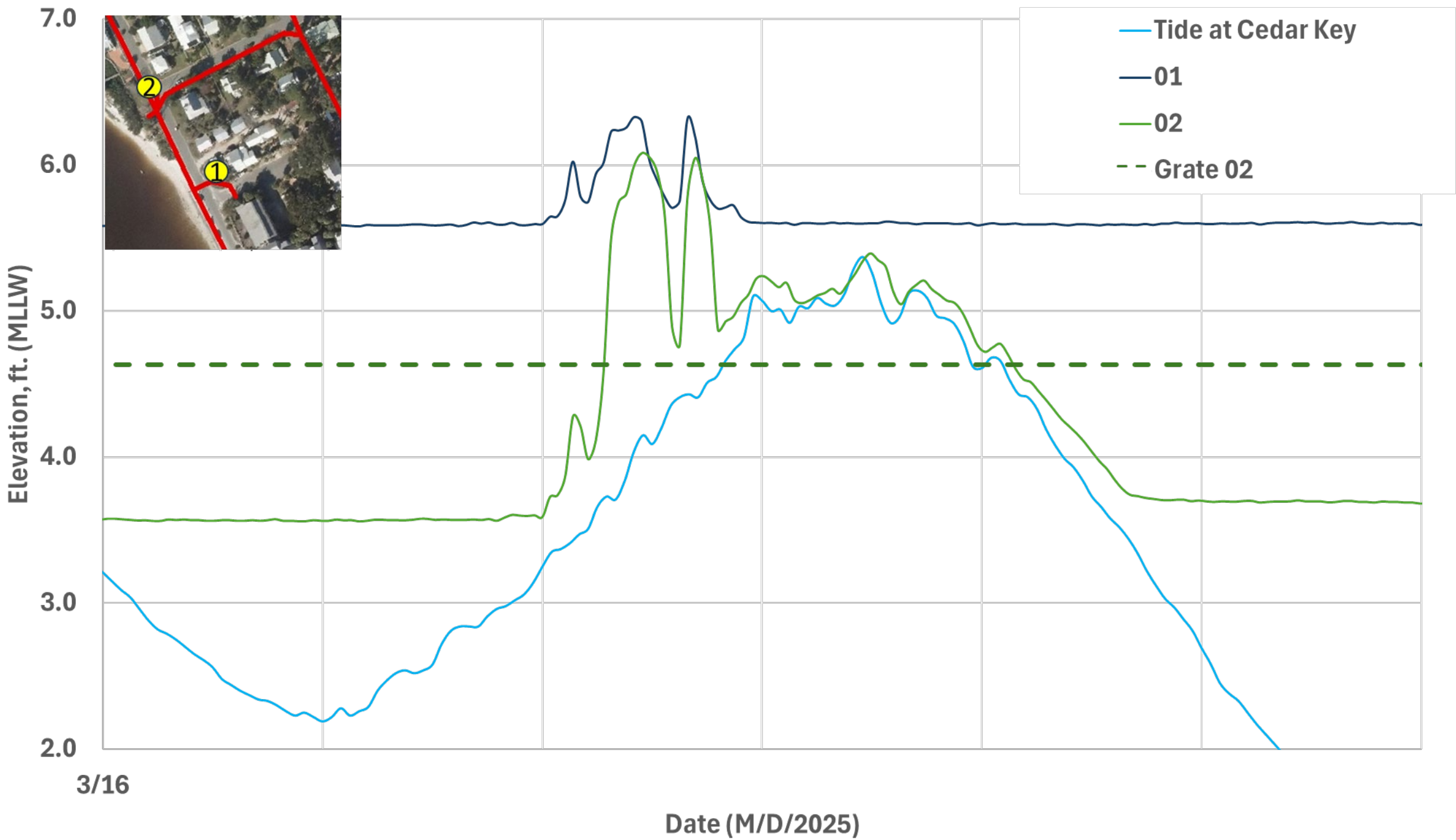
Compound Flood Event

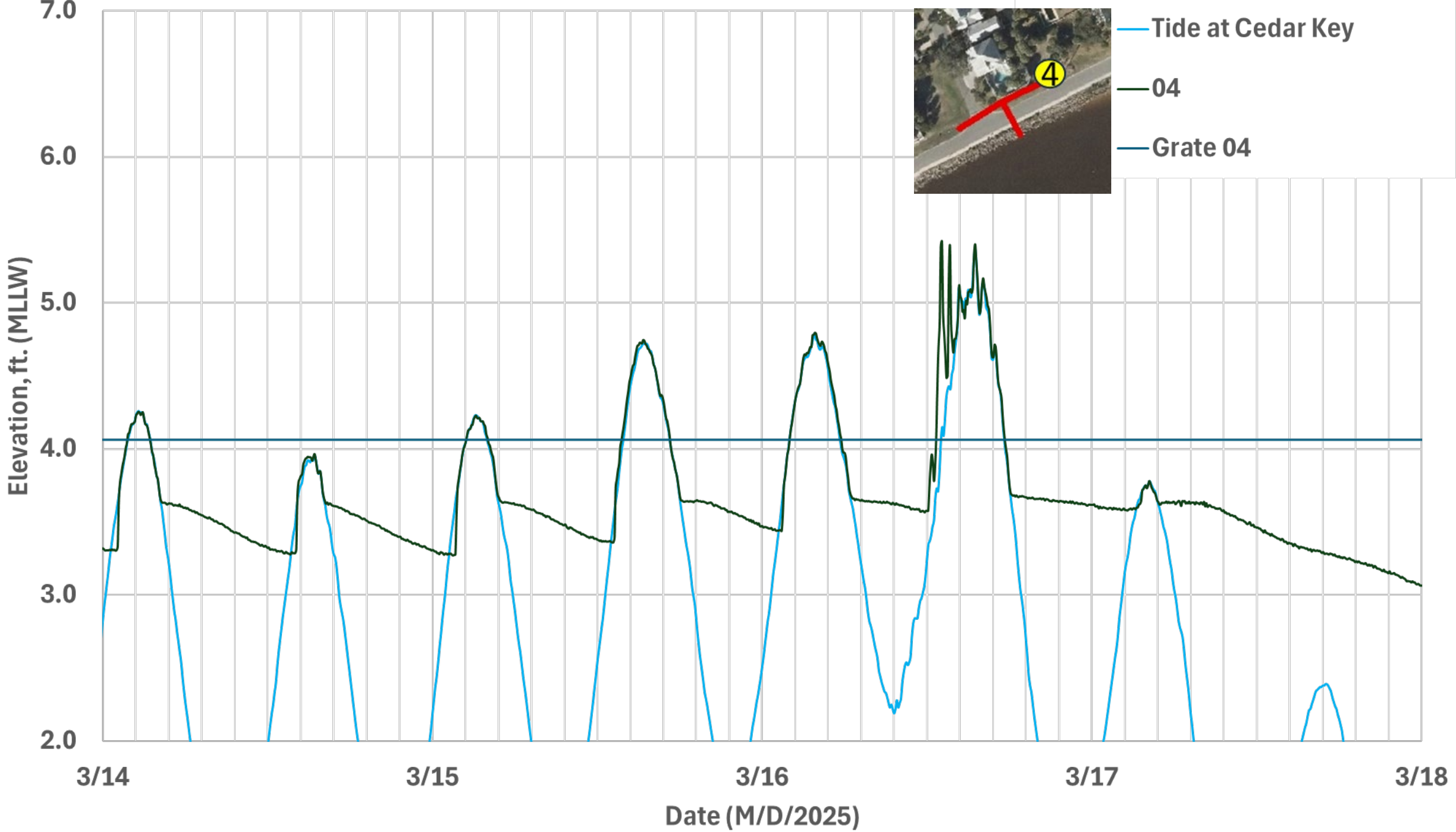
- 3.76 in. (Sunset Point)
- 11:34 – 2:14 ~ 3 h (just before high tide)
- 5 yr, 3 h event: 3.66 in.

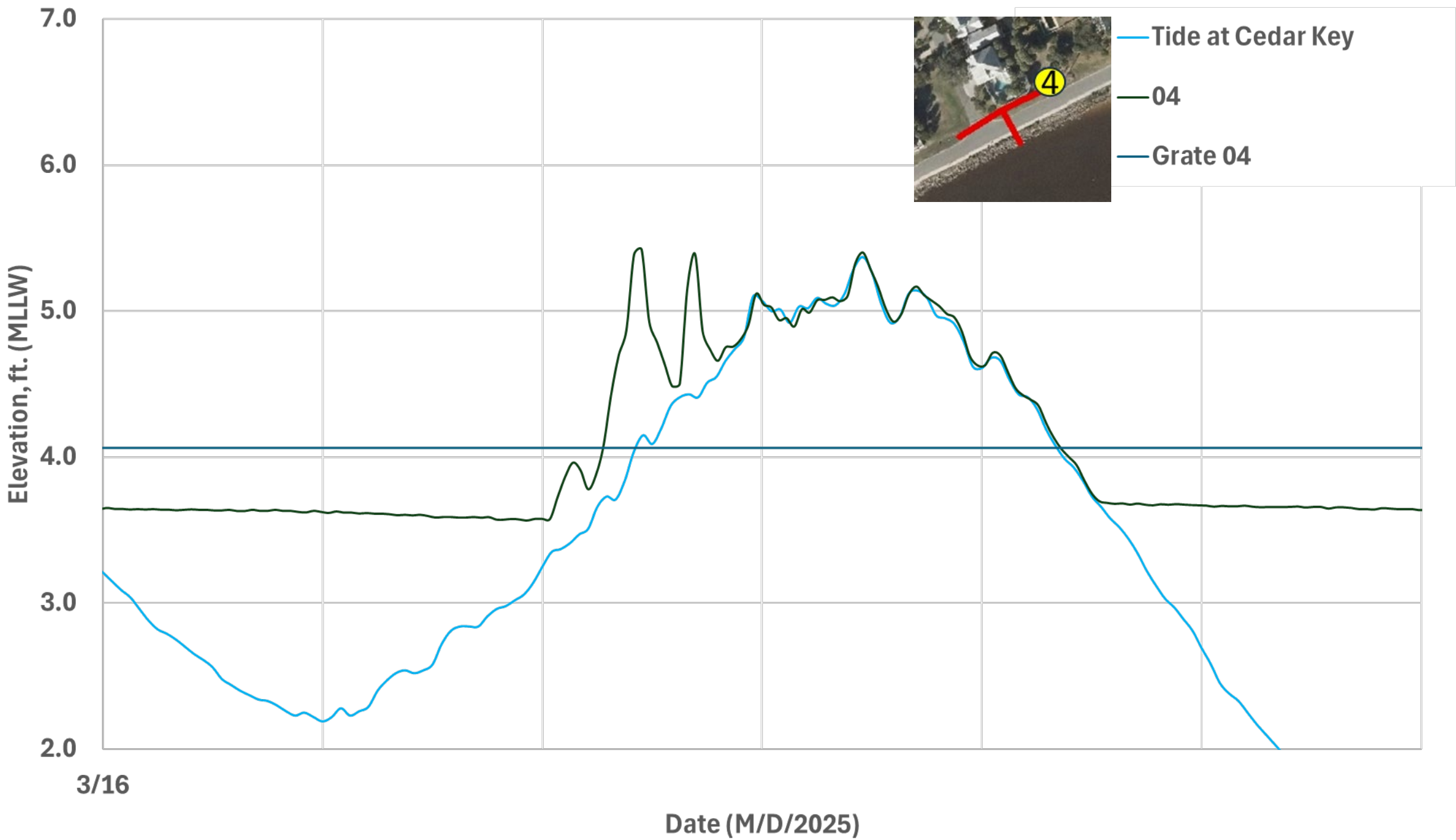
March 16, 2025









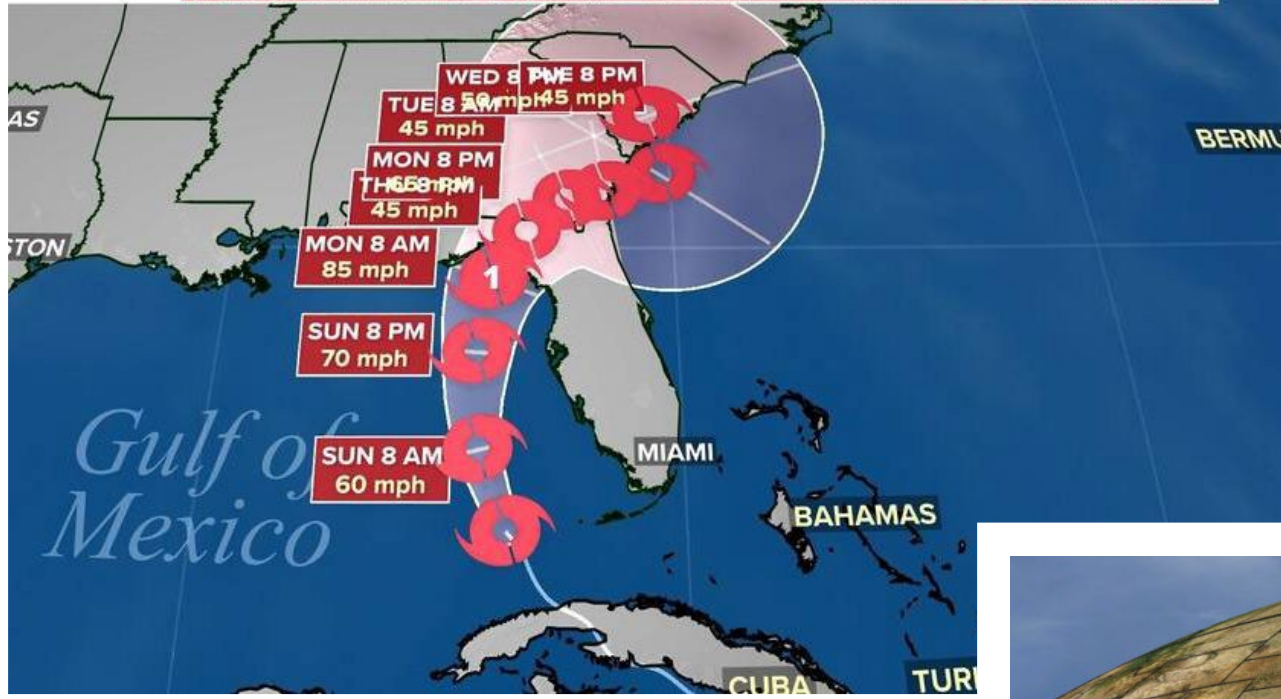


WEATHER
IMPACT
ALERT

TROPICAL STORM DEBBY

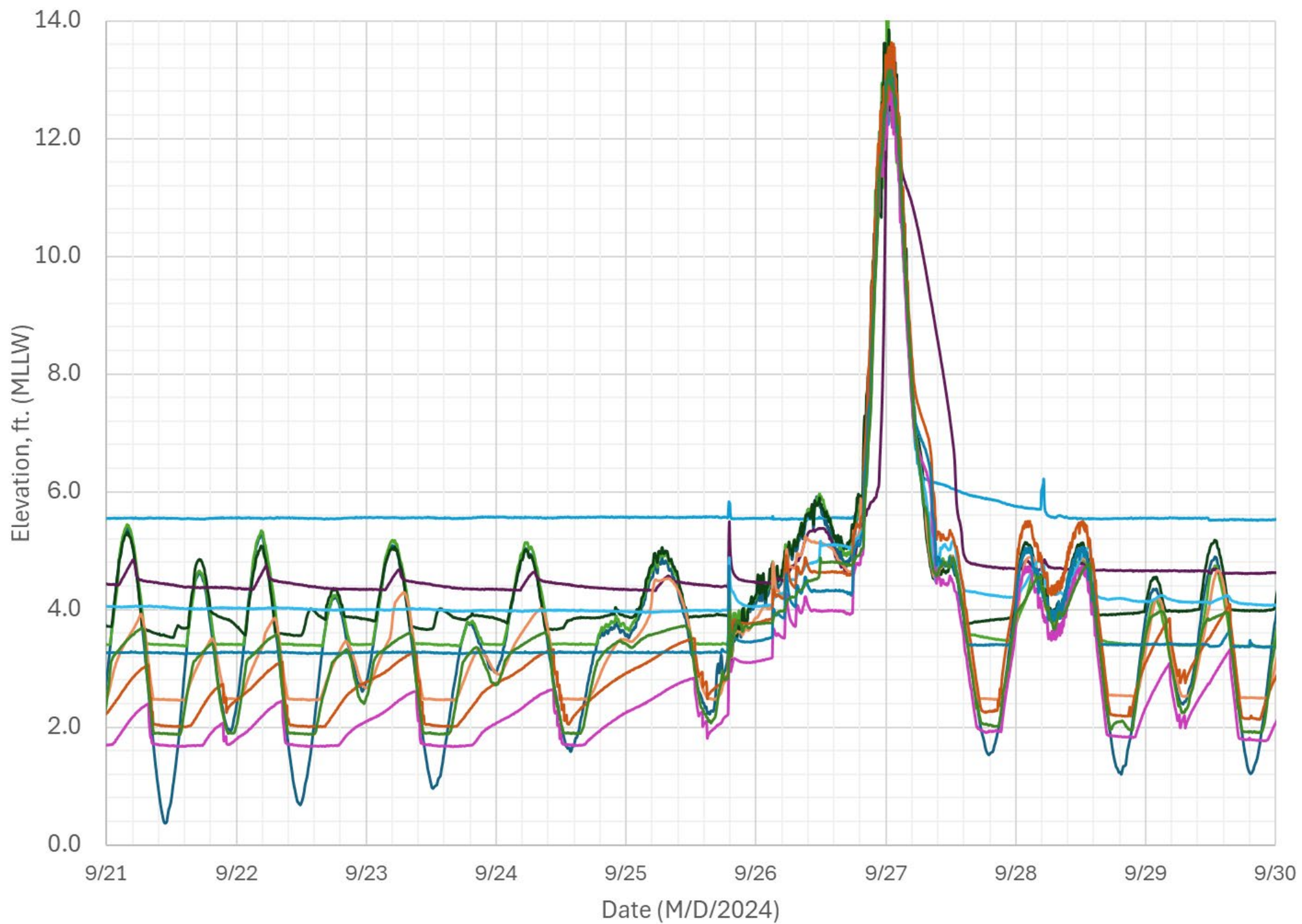
ADVISORY
11:00 PM

WINDS: 45 MPH PRES: 1003 mb MOV: NW at 14 MPH LOC: 24.4°N, 83.6°W

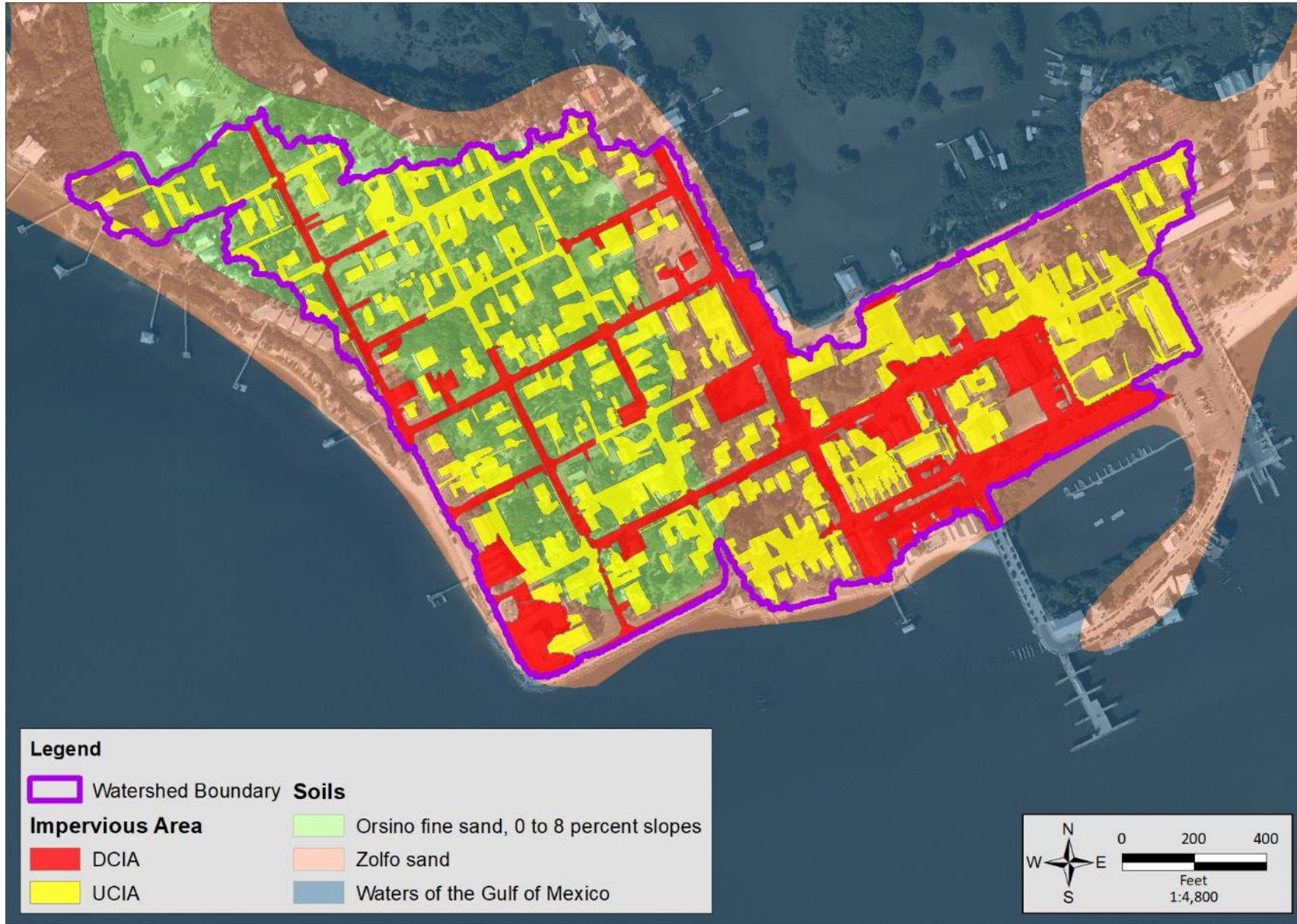




Stormwater Monitoring



Helene







For Informational Purposes Only Document Path: Q:\21727_UF\007-01_Cedar_Key_GSI\mxd\For_UF\Watershed.mxd

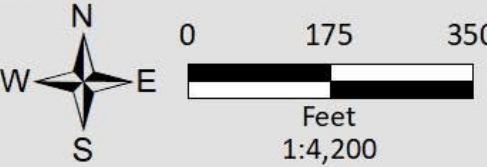


Legend

-  June 2024 Inundation
-  100-yr/24-hr Inundation



0 175 350



Feet
1:4,200

A north arrow with cardinal directions (N, S, E, W) and a scale bar showing 0, 175, and 350 feet. The scale bar is a black horizontal line with white markings.



Legend

Estimated Nitrogen Loading
kg/yr

- 1-10
- 11-20
- 21-33

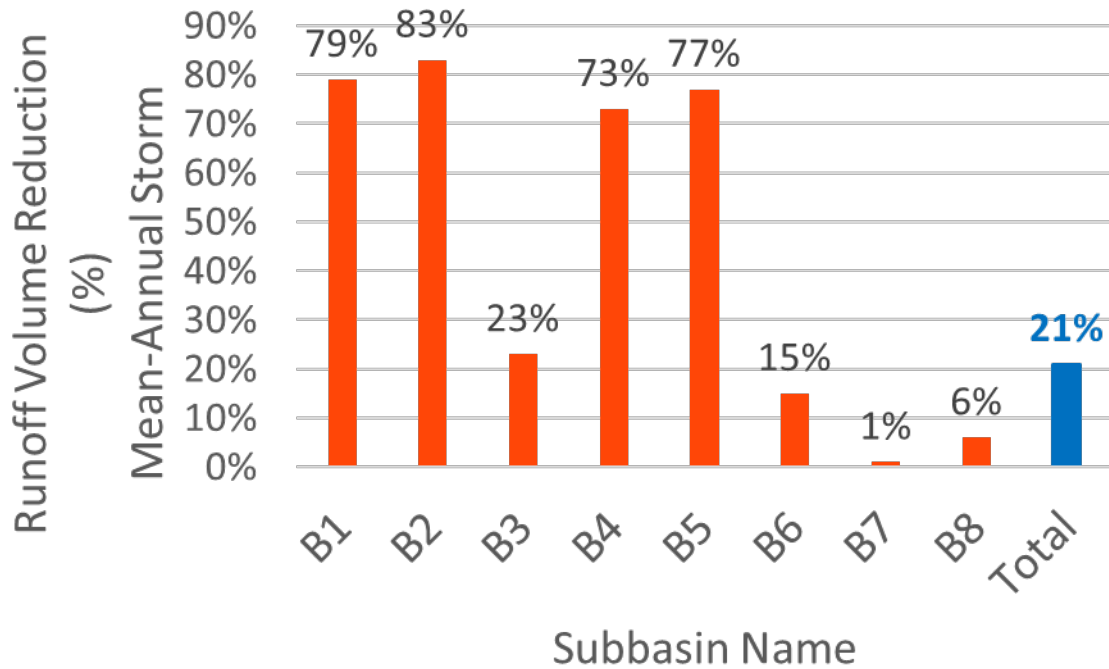
0 175 350

Feet
1:4,200

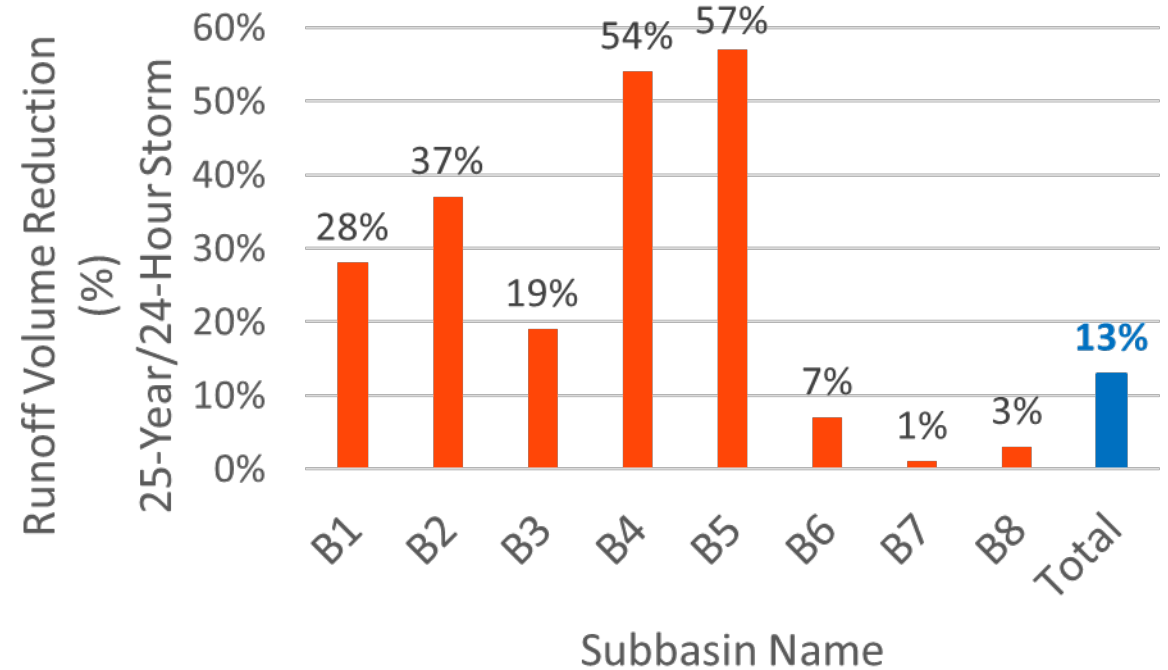
JonesEdmunds



- ✓ Mean-Annual, 24-Hour Storm
- ✓ Recurrence Frequency: 2.33 years
- ✓ Depth: 5.14 inches



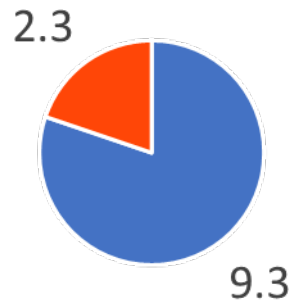
- ✓ 25-year, 24-Hour Storm
- ✓ Recurrence Frequency: 25 years
- ✓ Depth: 9.57 inches



BMP Trains Model Results for Nutrient Removal Based on Proposed GSI

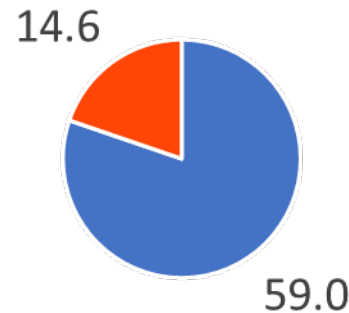
Nutrient	Current Condition Load (pounds/year)	Future Condition Load (pounds/year)	Load Reduction (pounds/year)	Load Reduction (%)
TN	73.6	59.0	14.5	19.8
TP	11.6	9.3	2.3	19.8

Total Phosphorus



- Remaining Nutrient Load
- Load Removed by Proposed GSI

Total Nitrogen

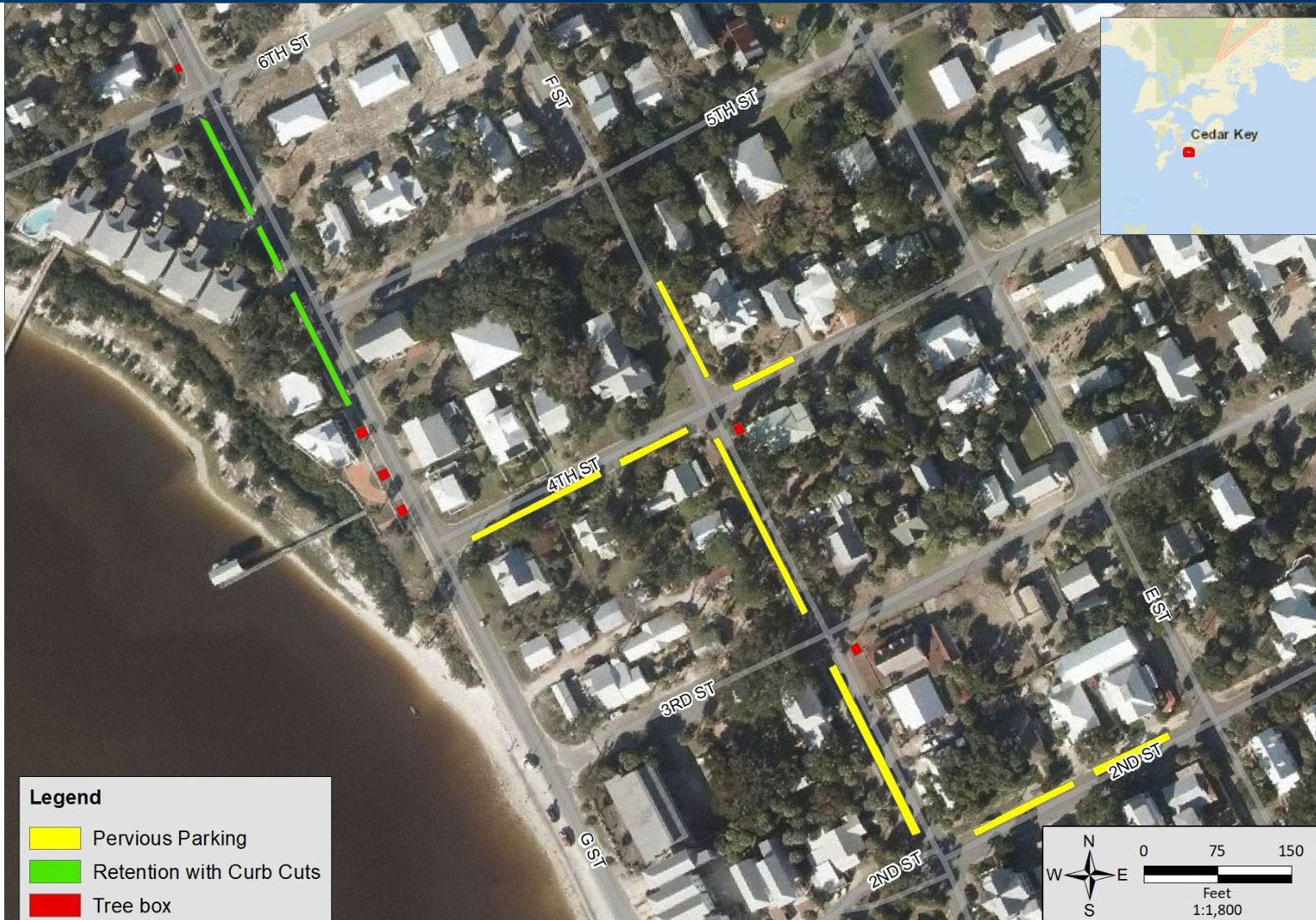


- Remaining Nutrient Load
- Load Removed by Proposed GSI



Stormwater Green Infrastructure Design

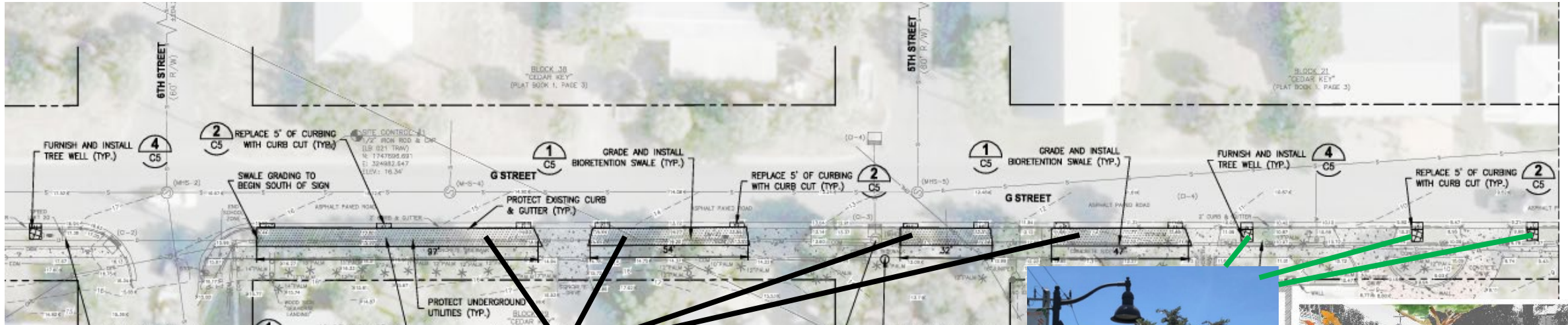
Areas of Need + Areas of Opportunity + Local Knowledge = Areas of Implementation



BMPs Recommended:

- Pervious Pavement
- Tree Wells
- Bioretention Swales

G Street between 4th St and 6th St



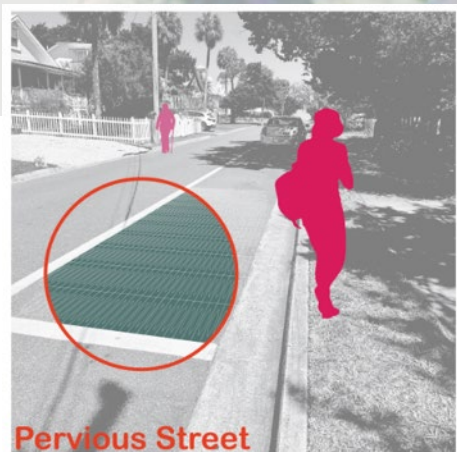
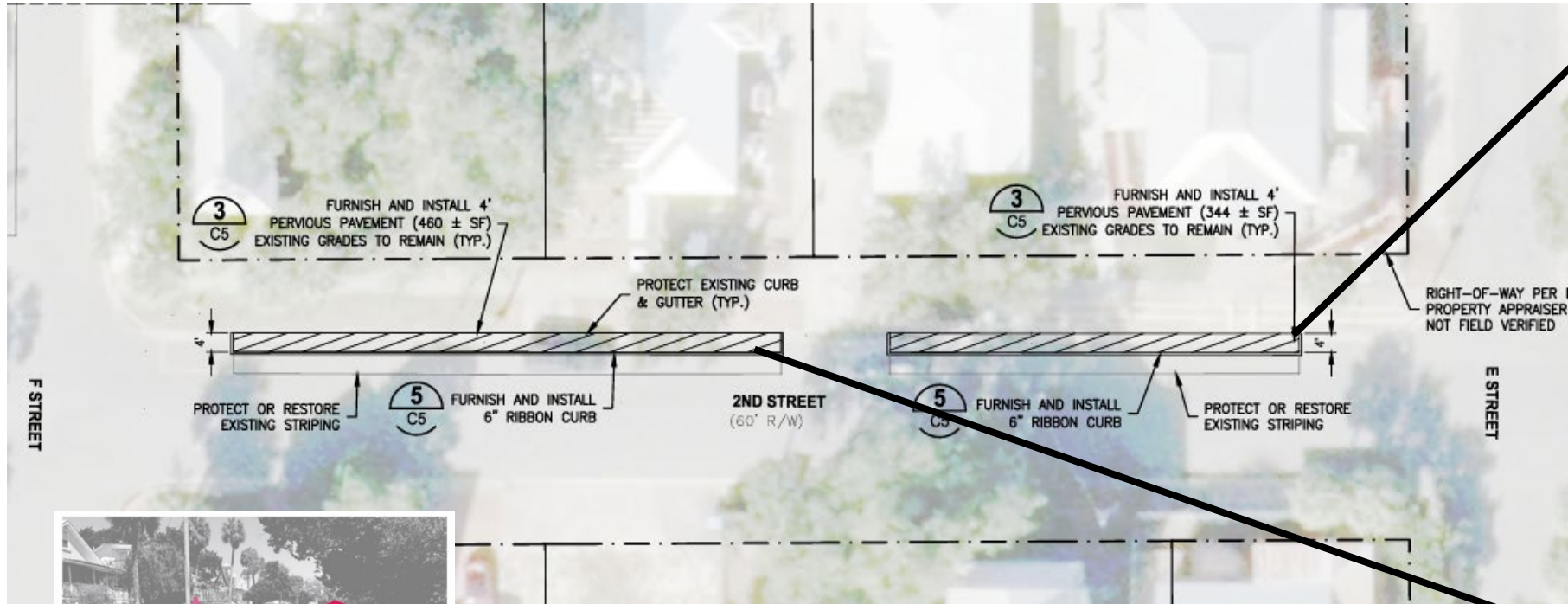
Bioretention Swale



Tree Well



2nd St between F St and E St



Pervious Pavement



RUNOFF FROM STREET

PERMEABLE PAVERS

CURB RESTRAINT

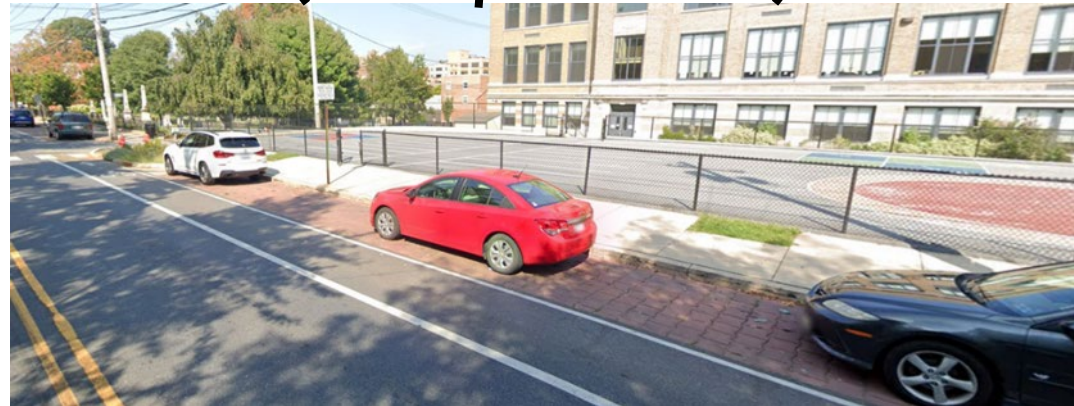
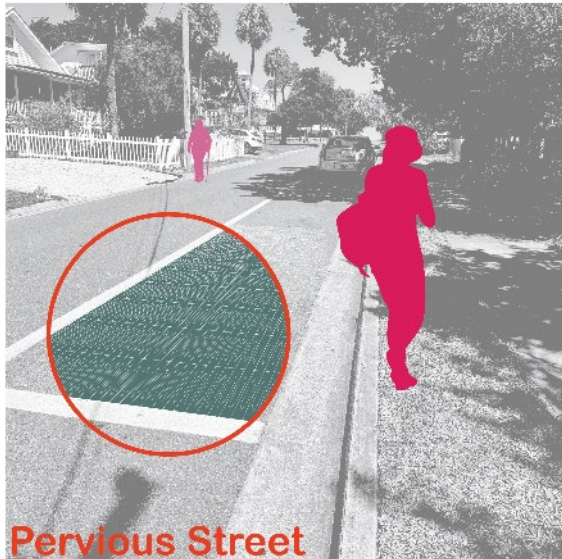
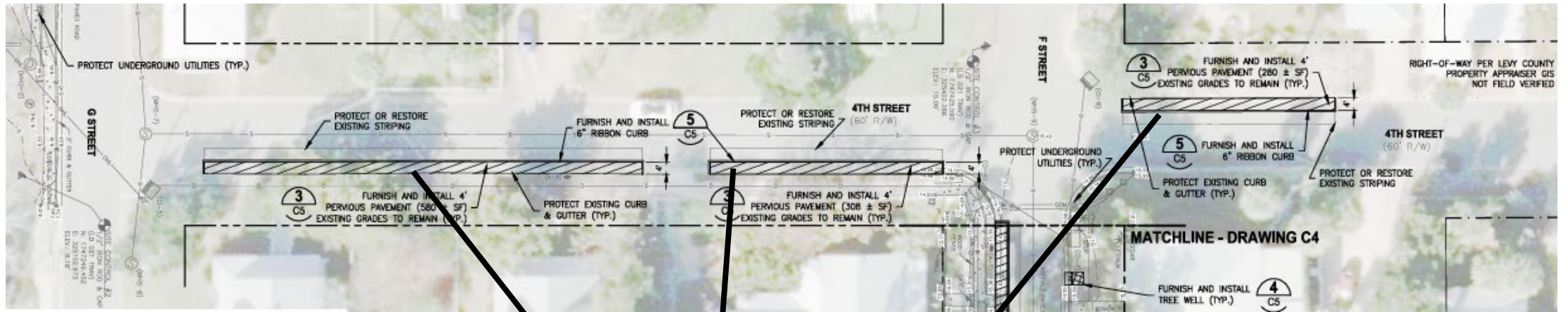
OPTIONAL UNDERDRAIN

OPEN GRADED BEDDING COURSE

OPEN GRADED BASE COURSE

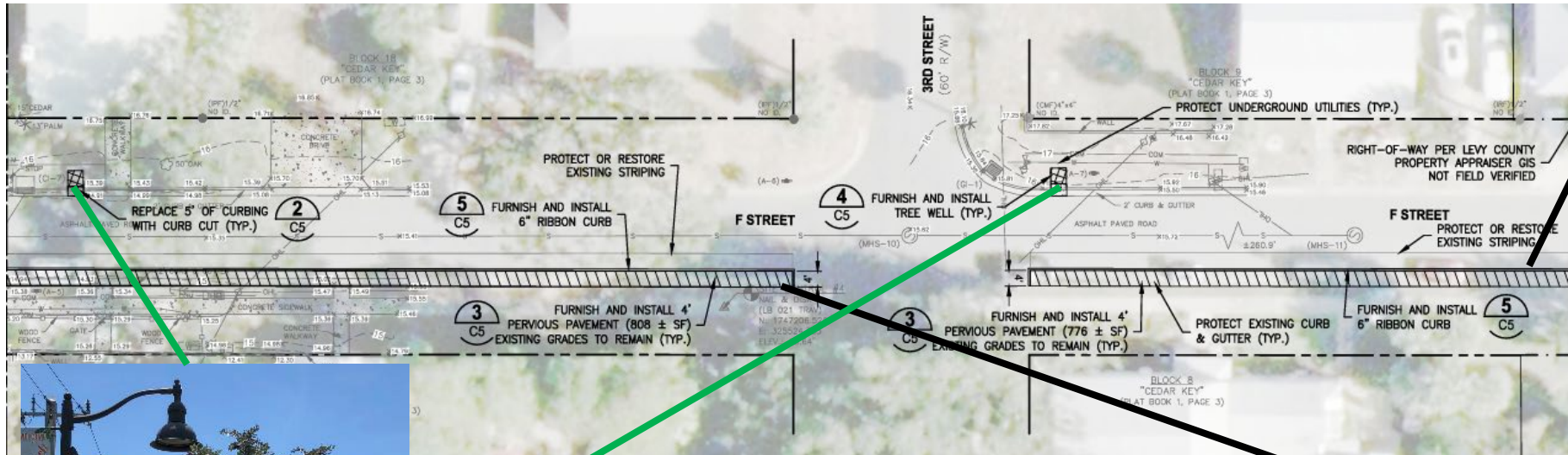
OPEN GRADED SUB BASE COURSE

4th St between G St and E St



 Pervious Pavement

F St between 4th St and 2nd St



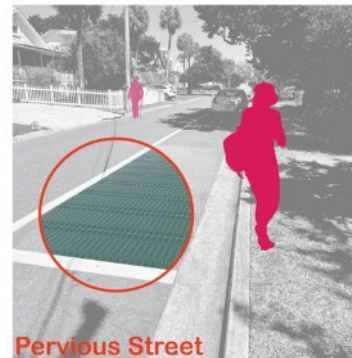
Tree Box



Pervious Pavement



Tree Well



Pervious Street



WAX MYRTLE

RUNOFF FROM SIDEWALK

RUNOFF FROM STREET

TREE GRATE

OVERFLOW PIPE

FILTERED WATER DISCHARGE

ENGINEERED SOIL

STONE AGGREGATE

Workshop Outcomes

- Show community findings from data
- Display preliminary plans for feedback
- Interactive samples of materials
- More listening!
- Final Designs



Co-design Tips for Success

- Work through trusted brokers
 - e.g., Sea Grant extension, community leader
- Listen first, listen more
- Seek to genuinely add (not extract) value
- Be in it for the long haul
- Compensate stakeholders (\$)
- Interdisciplinary approach
- Add science



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Medicine*

GULF RESEARCH PROGRAM



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