When is Enough *Really* Enough?

Resiliency vs. Adaptation as Storm Events Change

2018 SESWA Conference

01 Issues facing Fort Lauderdale

02 Early Action Strategies

03 Organizationally-driven Approach

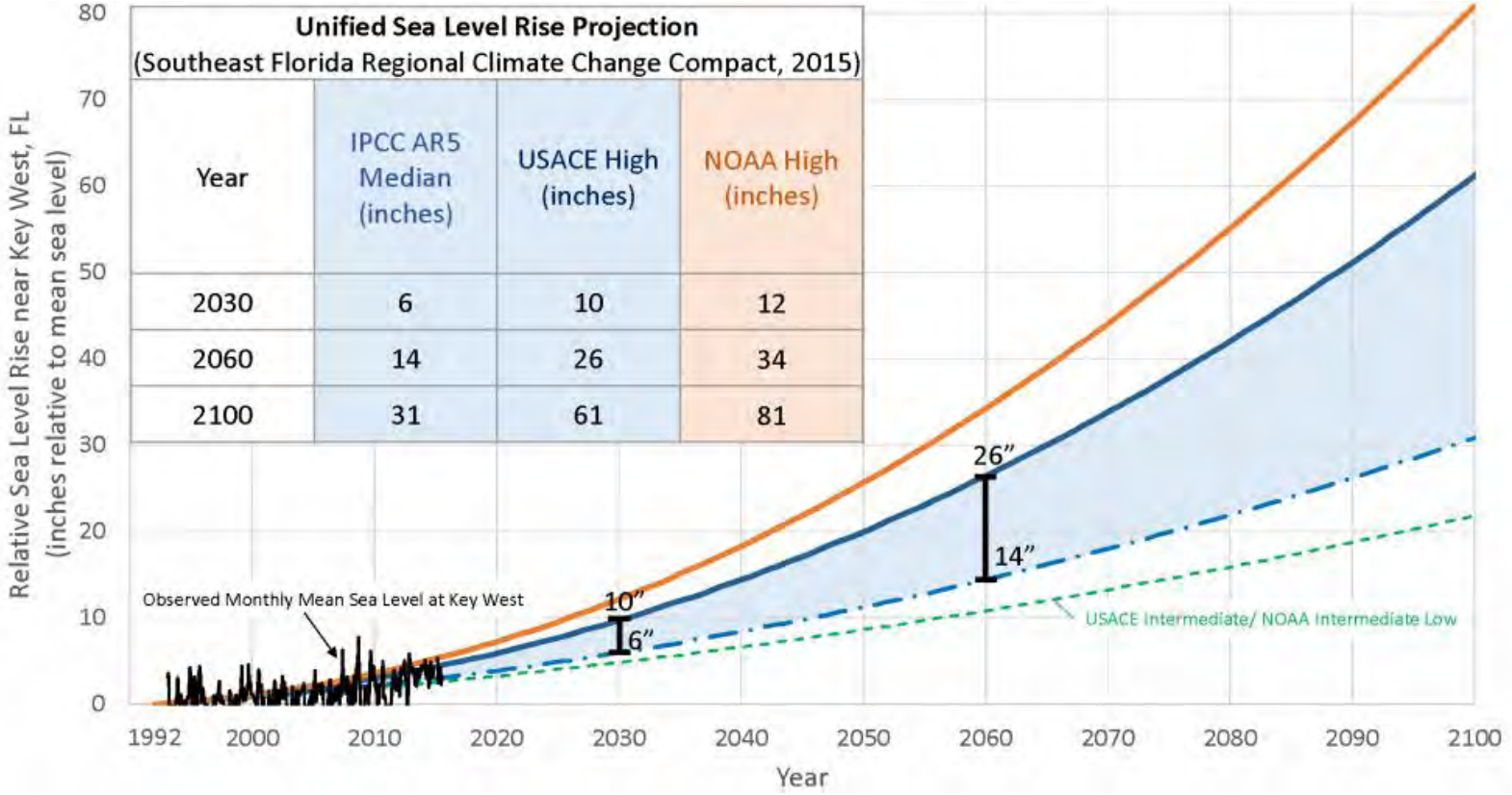
04 City-wide Modeling Using ICPRv4

Issues Facing Fort Lauderdale

- Sea level rise
- High groundwater
- Extreme rain events
- Sunny day high tides
- Built-out neighborhoods
- Low-lying urban areas
- Traditional enterprise utility
- 160 miles of shoreline

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

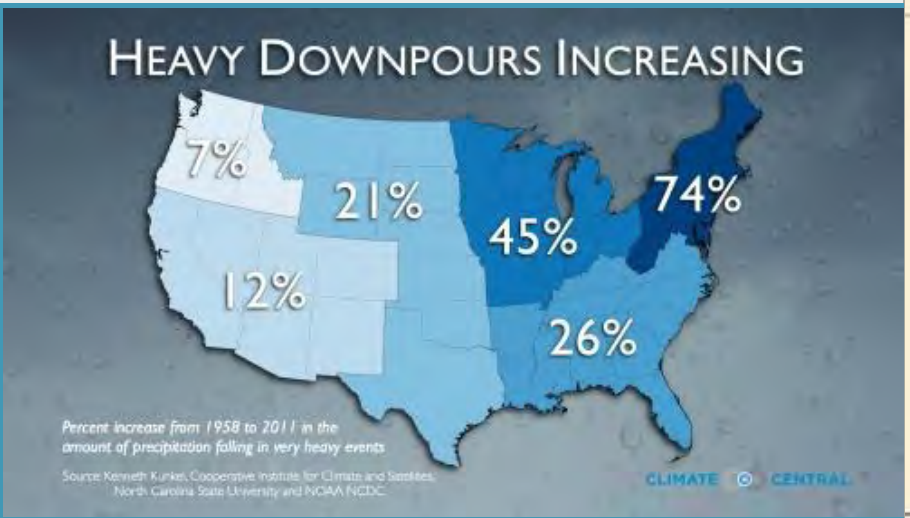
Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

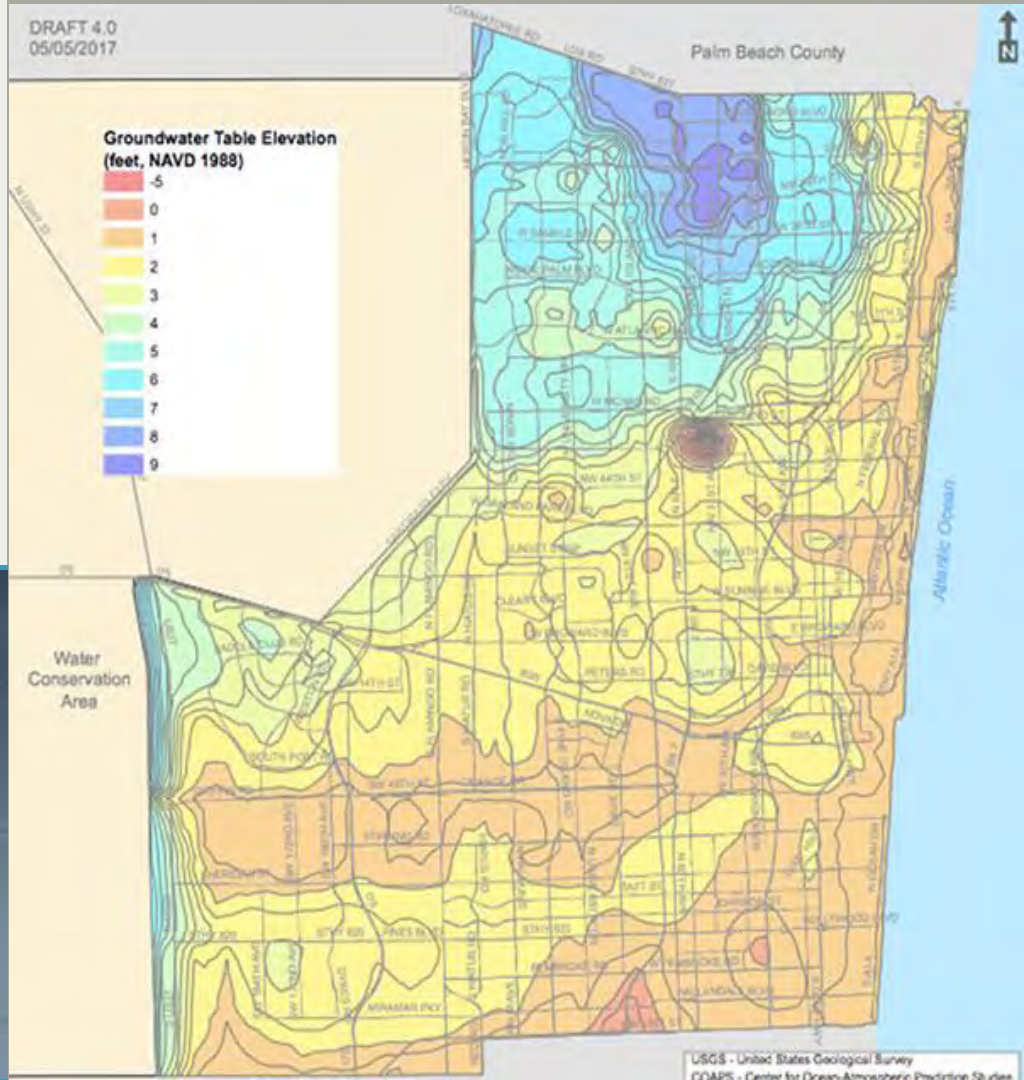


Sea Level Rise

High Groundwater

Extreme Rain Events



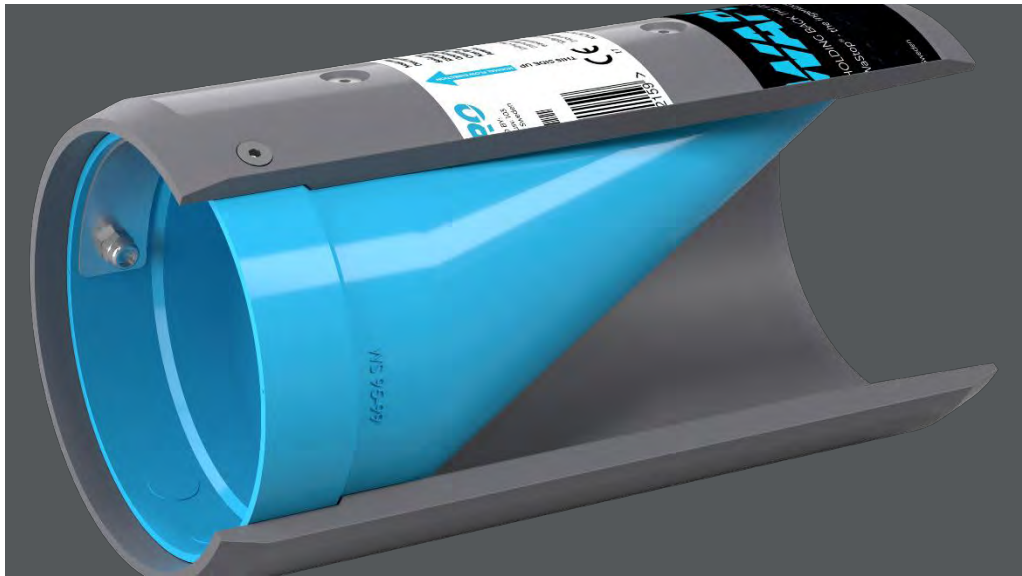


Sunny Day High Tides

- King Tides
  - Dependent on lunar cycle

Early Action Strategies

- Tidal Flooding Retrofits
  - Tidal gates/valves (147 to date)
  - Electrical panels raised on PS
- Sea Wall Increase
  - New ordinance raising minimum height
- Phase 1 CIP
  - 37 CIP projects
- Phase 2
  - City-wide modeling
  - 7 priority neighborhood CIPs



Organizationally Driven Approach

- Adaptive ppproach
- Prioritization
- Fully understand the unique dynamics of the region
- Show progress early and often
  - City-wide master planning
  - Priority neighborhood design/construction

Hazen

Collective Water Resources

HDR

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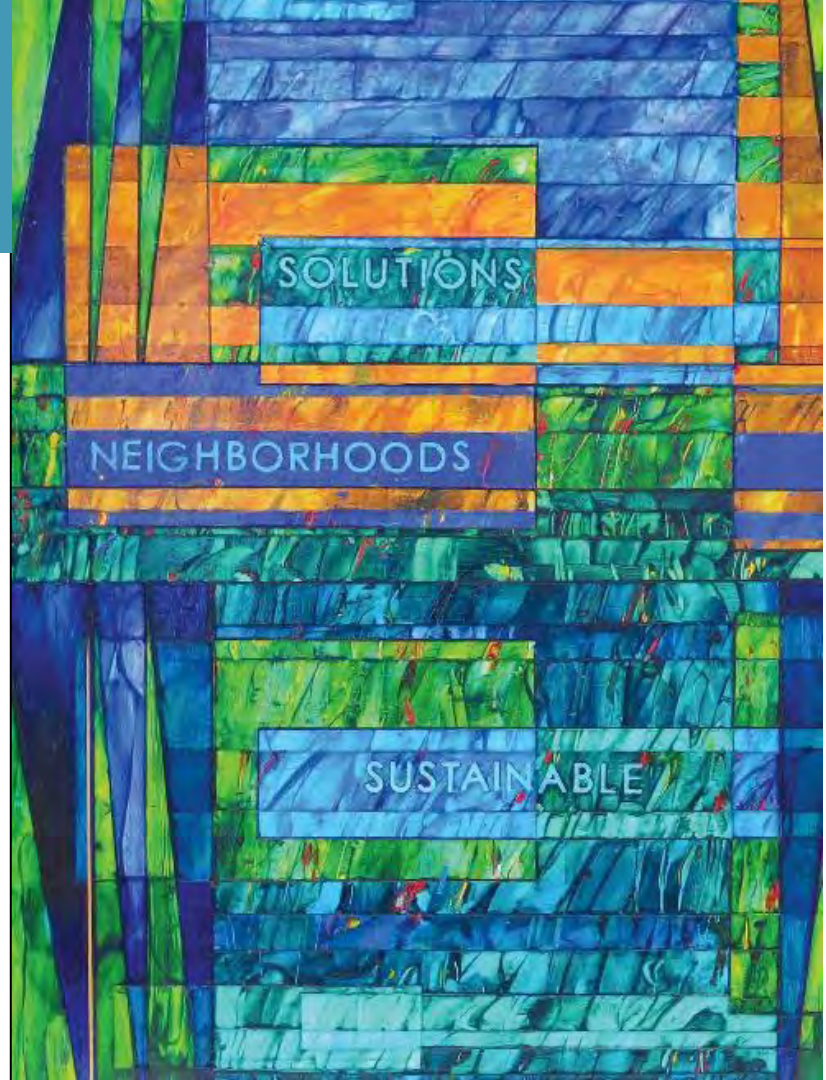
CHEN·MOORE &ASSOCIATES

RAND CORPORATION



City-wide Modeling Using ICPRv4

01 Data Collection

02 Model Development

03 Boundary Conditions

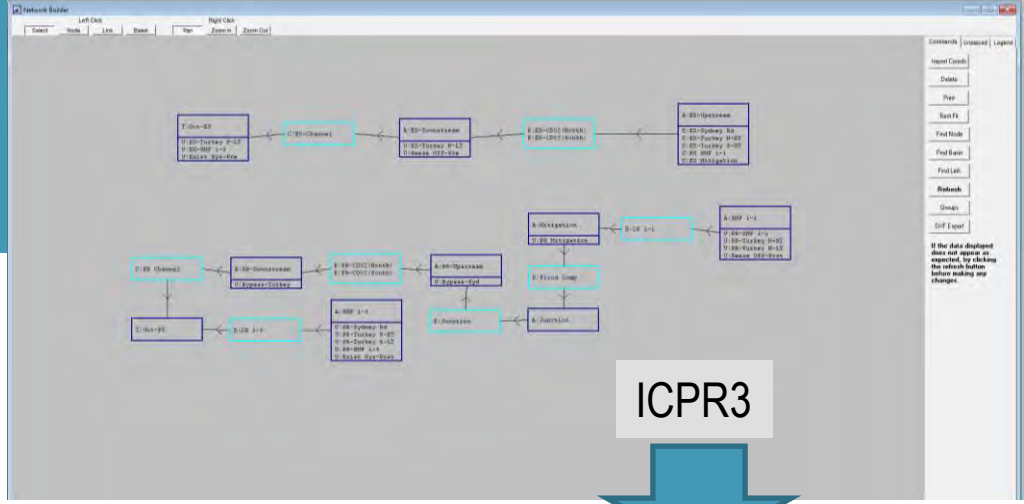
04 Scenario Simulation and Results

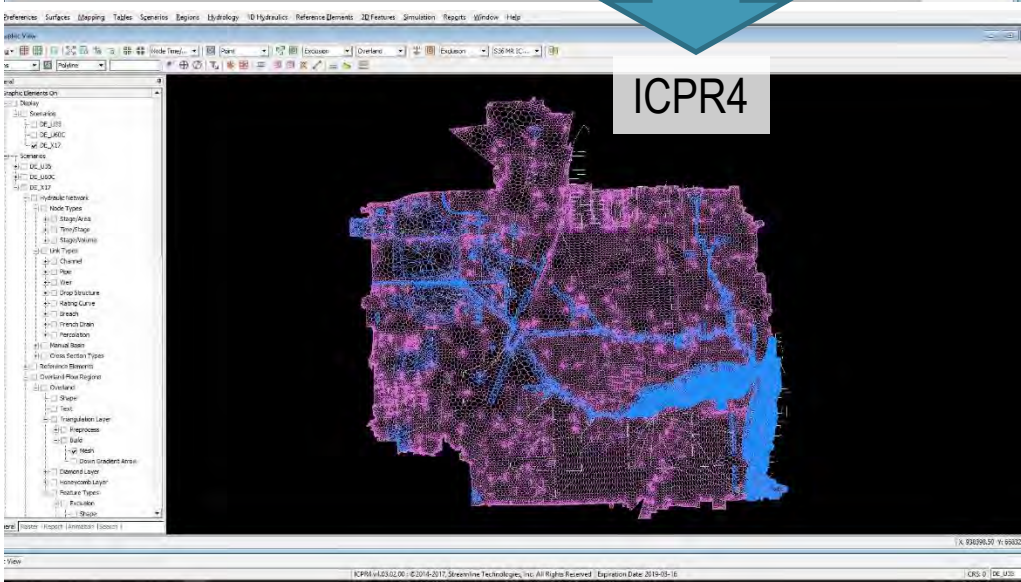
Data Collection

- Many sources, many needs
  - High-density LiDAR
  - Stormwater asset data surveyed
  - Other sources
    - Environmental resource permits,
    - State and County roadway plans,
    - Stormwater inventory from surrounding communities

ICPR4

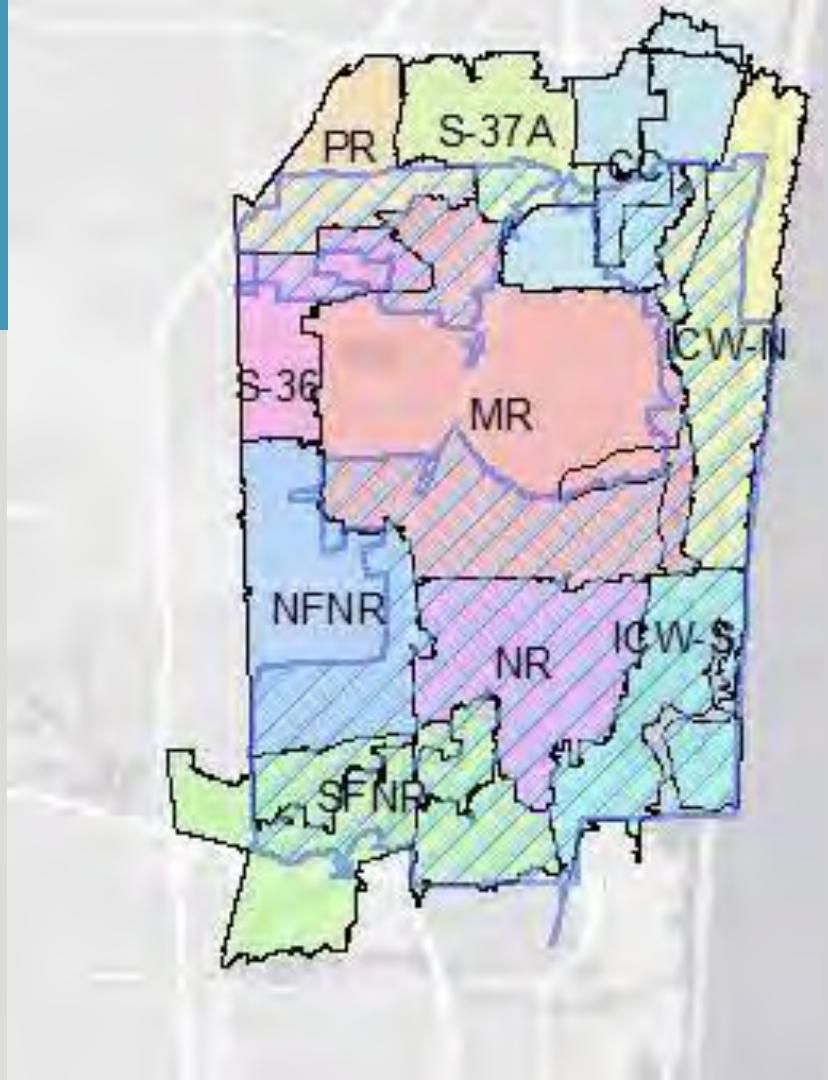
- Major changes from ICPR3 to ICPR4 include:
  - Fully integrated 1D/2D surface water model
  - 2D groundwater component





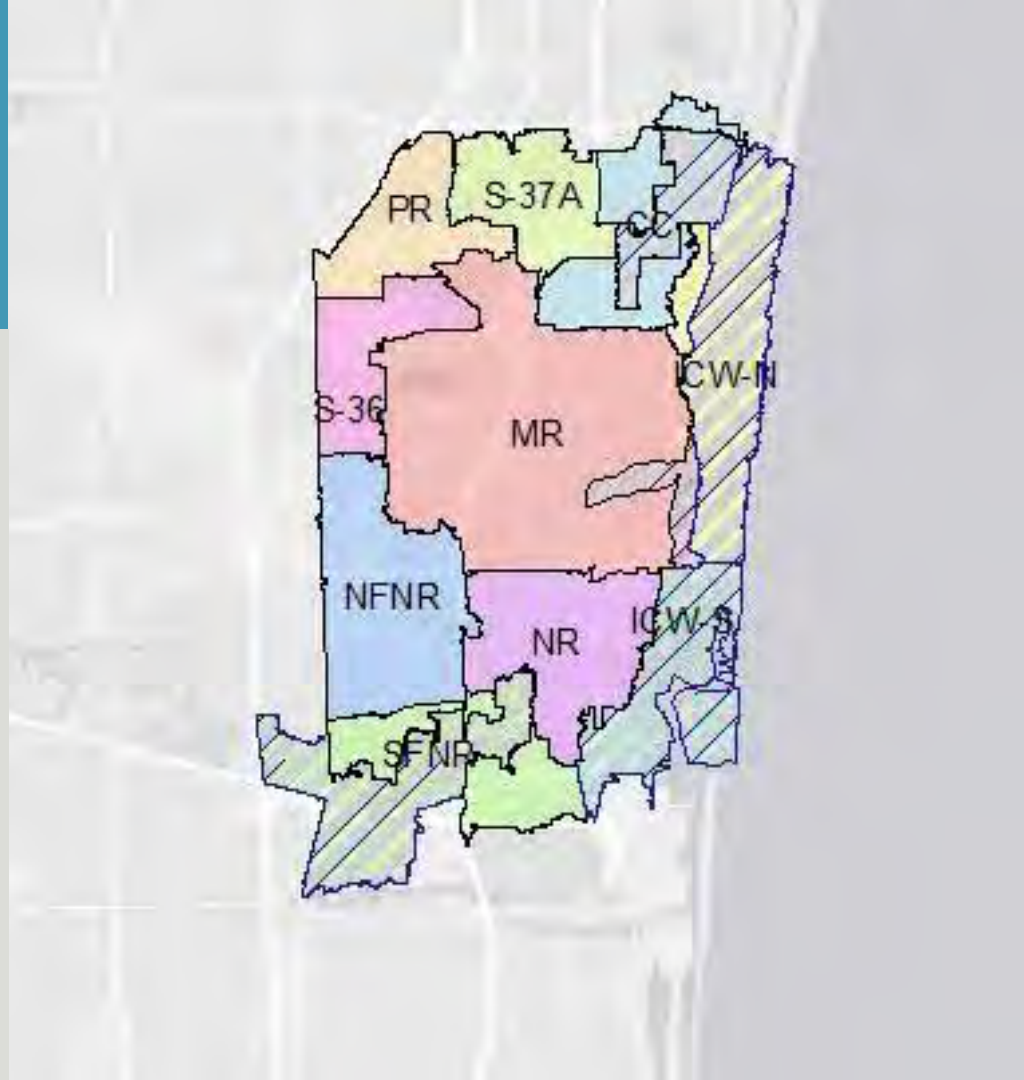
Model Development Using ICPR4

10 watersheds within city limits

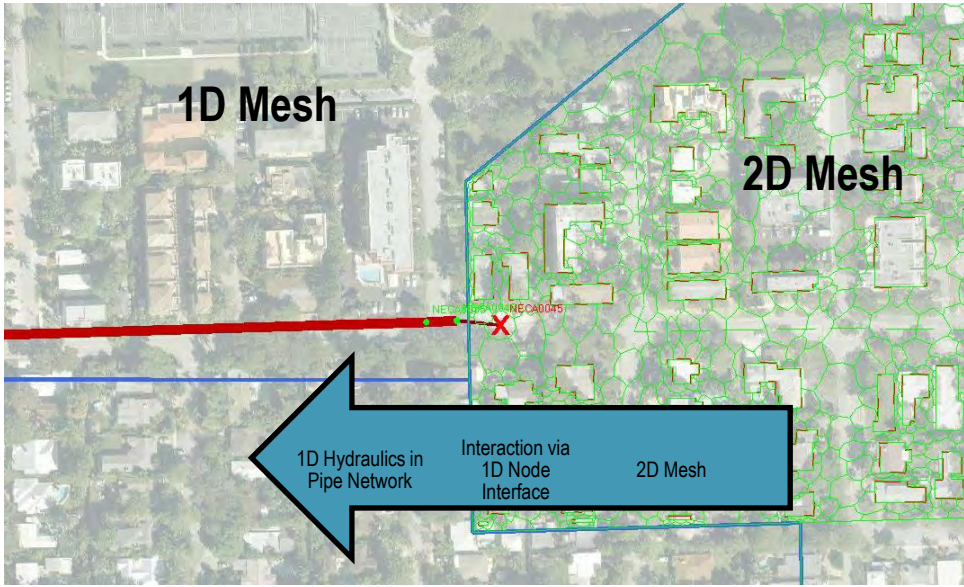


Model Development 1D/2D Areas

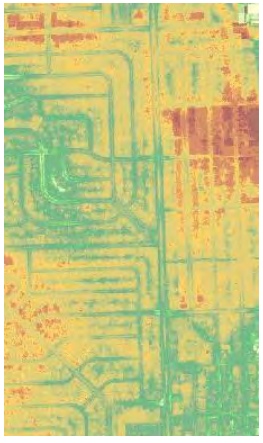
Areas selected based on level of complexity for modeling as a 1D or 2D area



1D/2D Surface Hydraulics



2D Groundwater Modeling in ICPR4

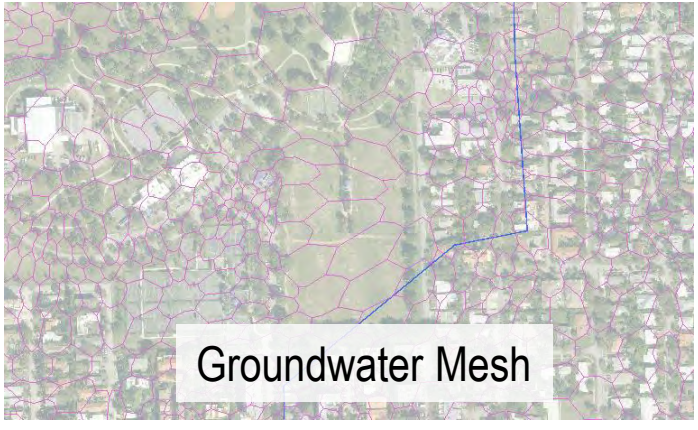


Ground Surface

Soil Properties

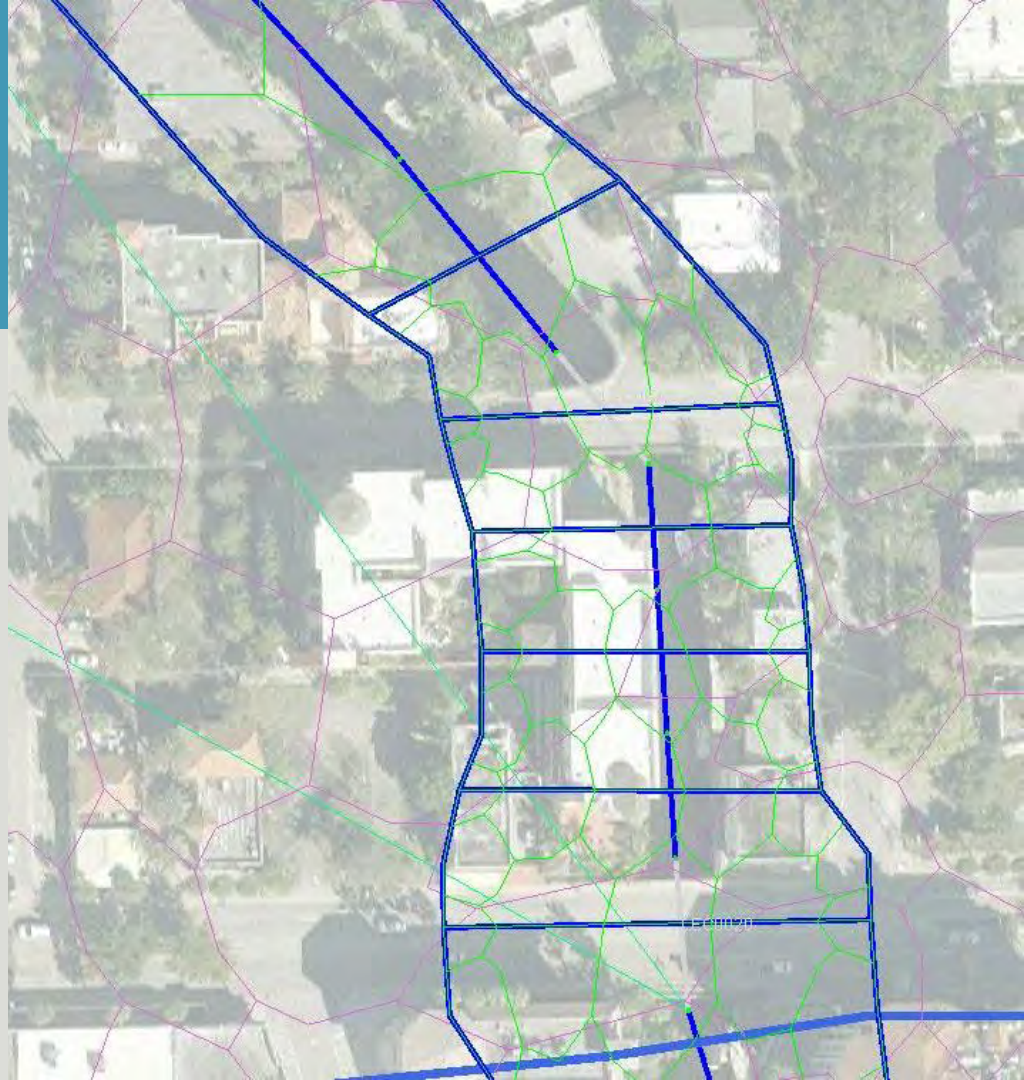
Bottom of Aquifer

Initial Water Table



2D Groundwater Modeling in ICPR4

Groundwater mesh linked to surface hydraulics



Inter-Watershed Boundaries

- Each watershed developed as an independent model
- Coordination at watershed interfaces was important
- Mostly needed at canal connections but some needed along watershed boundaries

Event and Scenario Simulation

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

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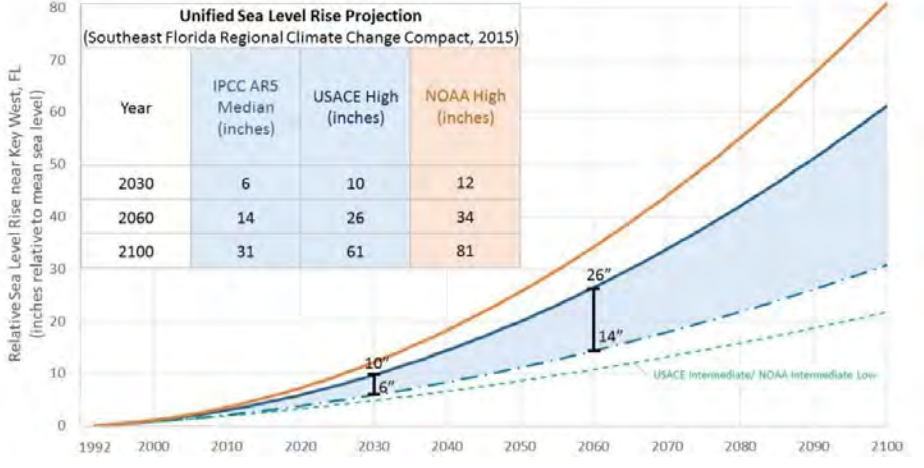
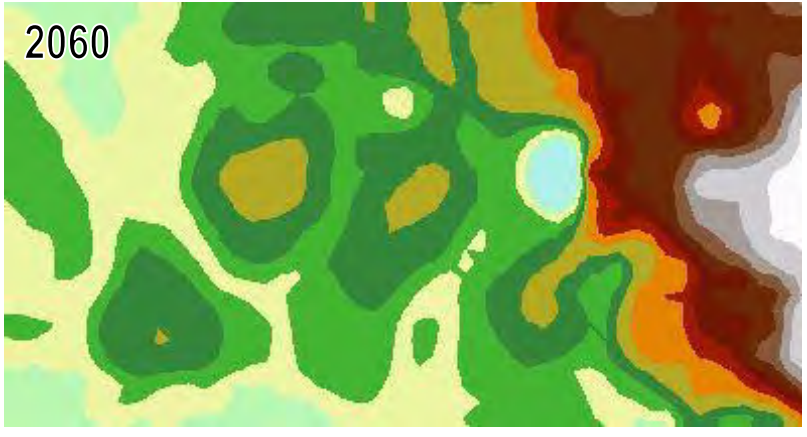
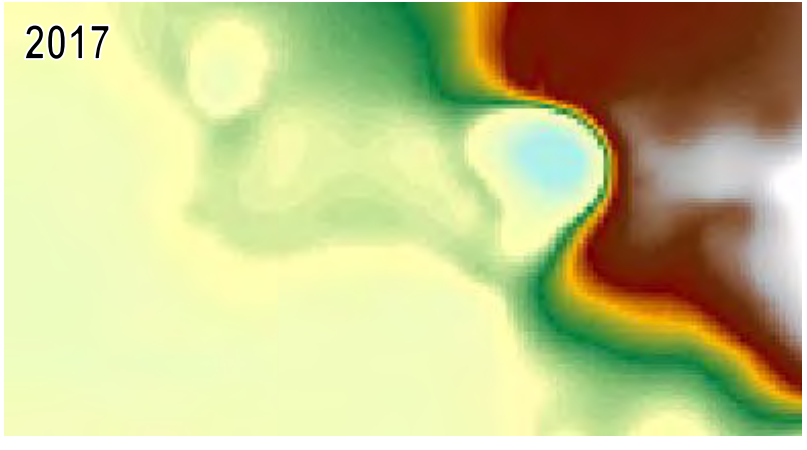


Groundwater Elevations

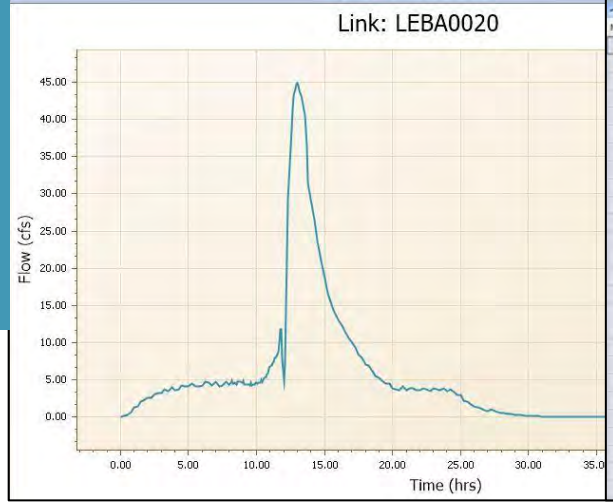


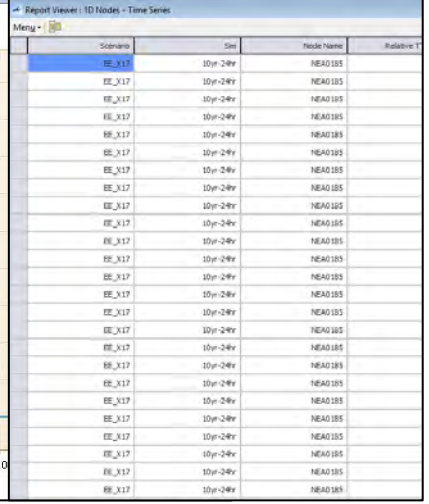


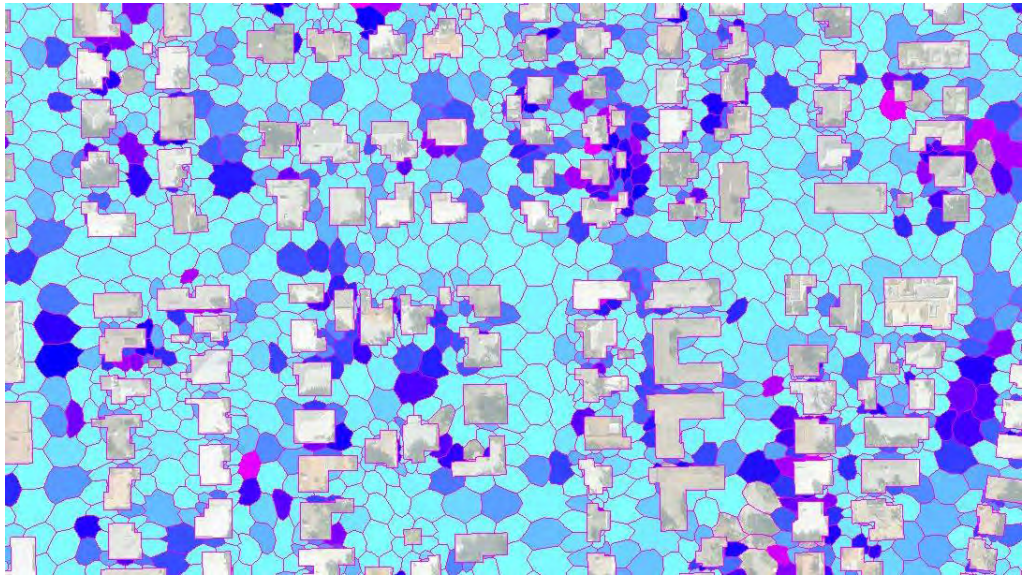
Model Output and Inundation Mapping

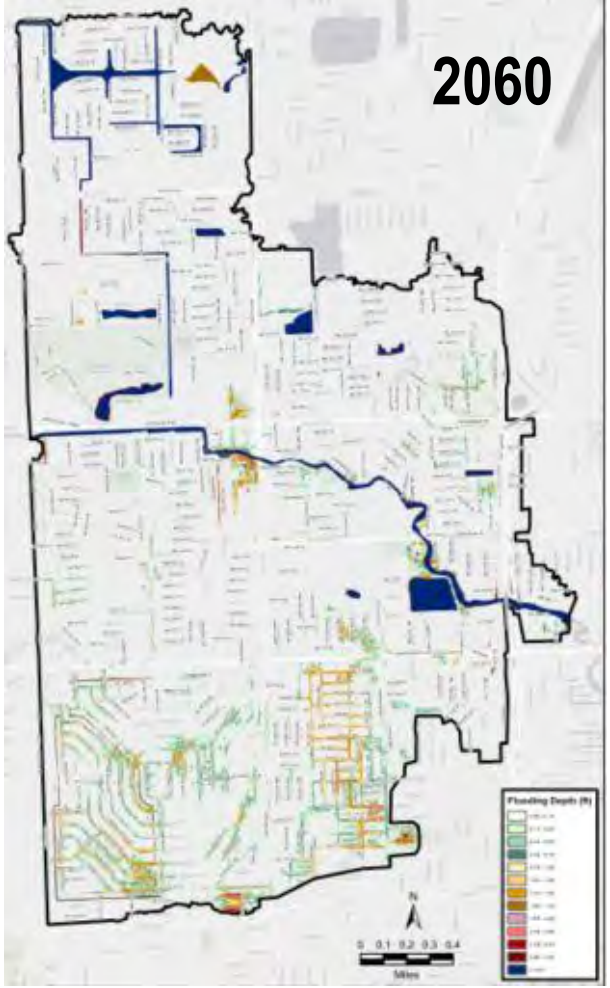
- Results from ICPR4
  - Charts
  - Tables
  - Rasters

- Inundation mapping
  - Peak stages in basins for 1D areas
  - Maximum stage in 2D cells

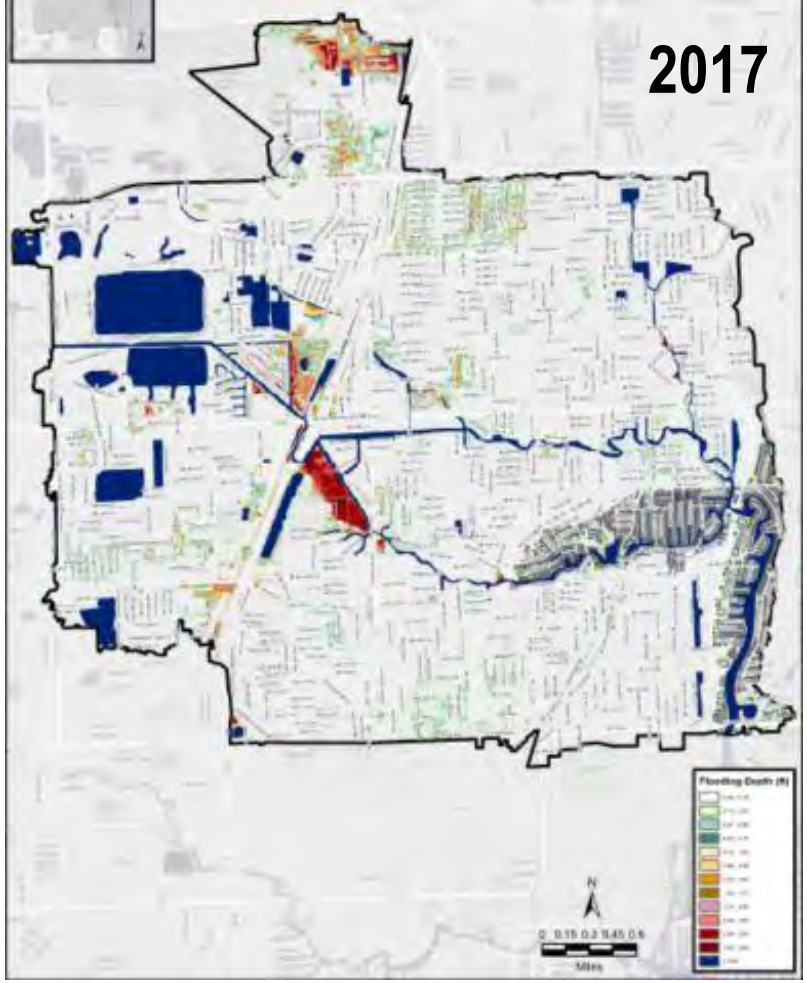


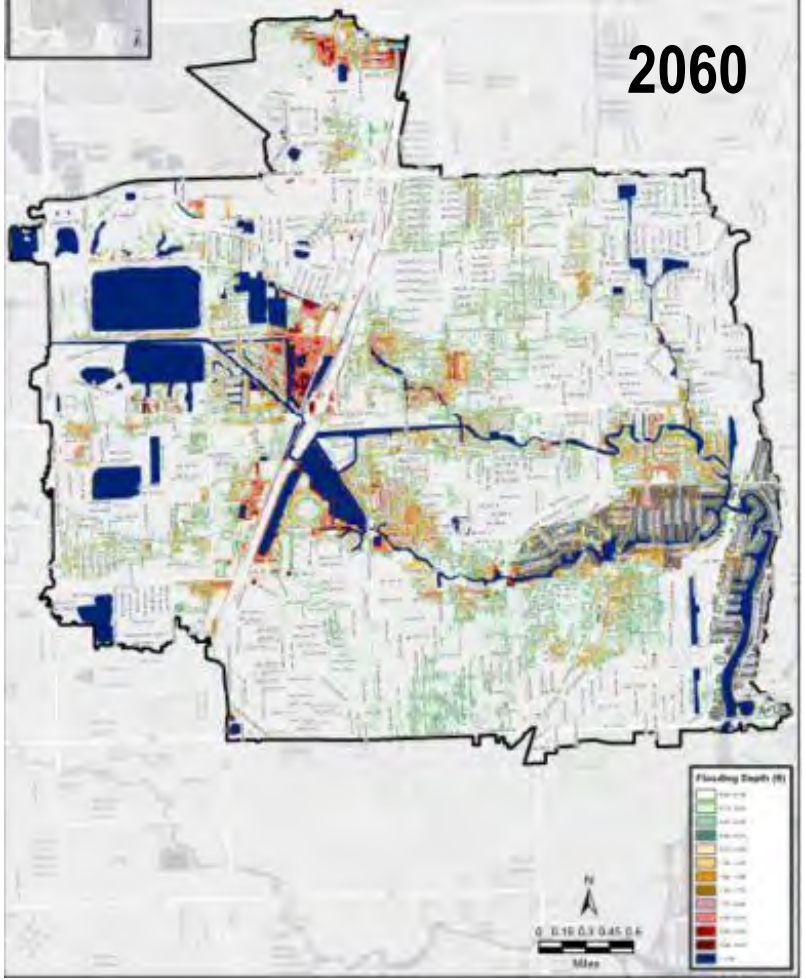




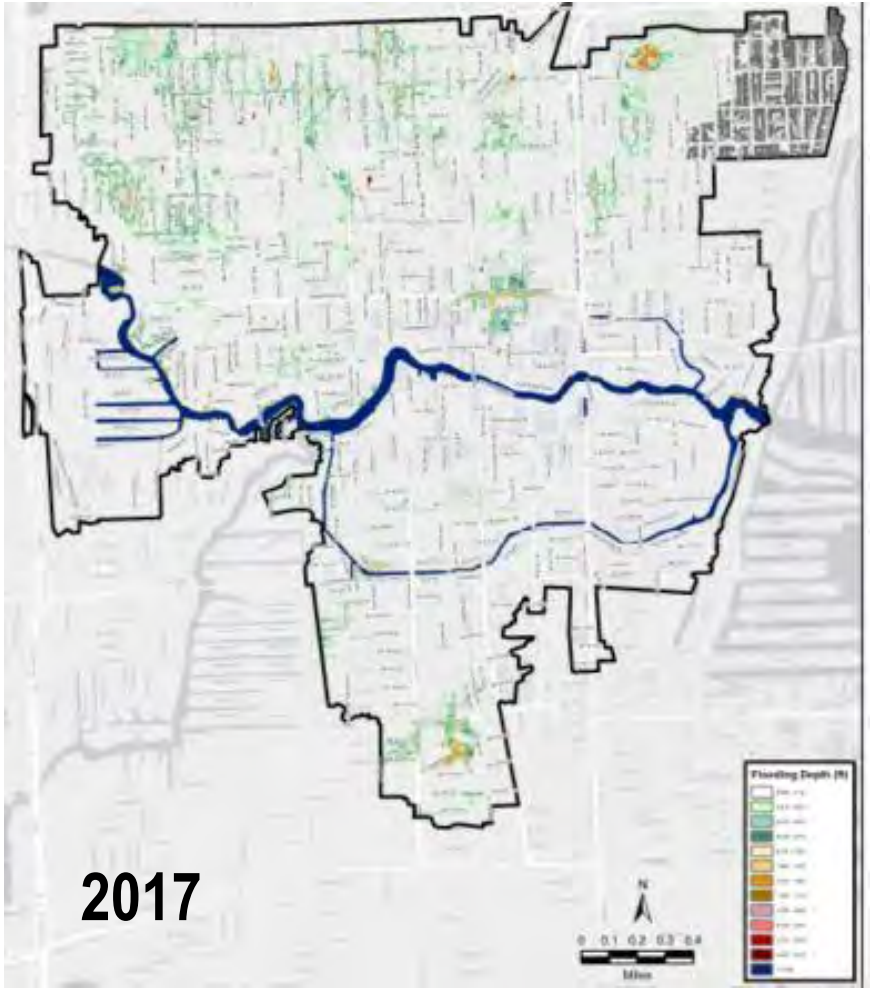


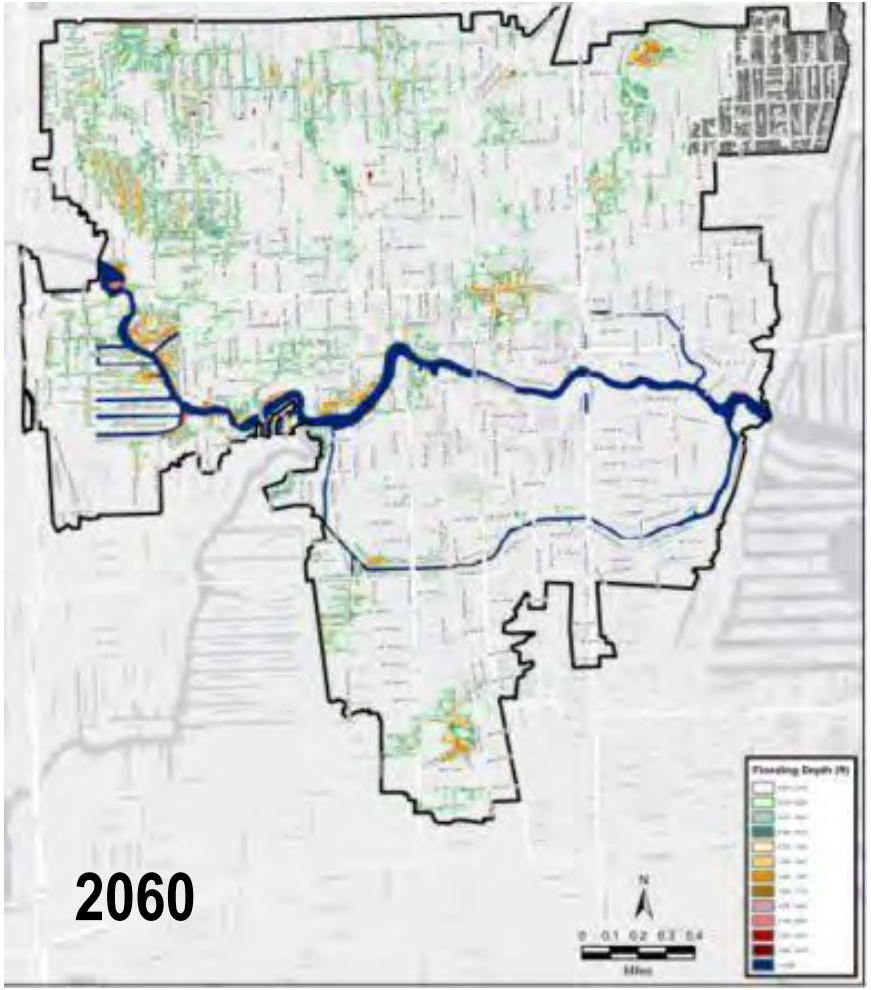
North Fork New River-10-yr 24hr





Middle River-10-yr 24-hr

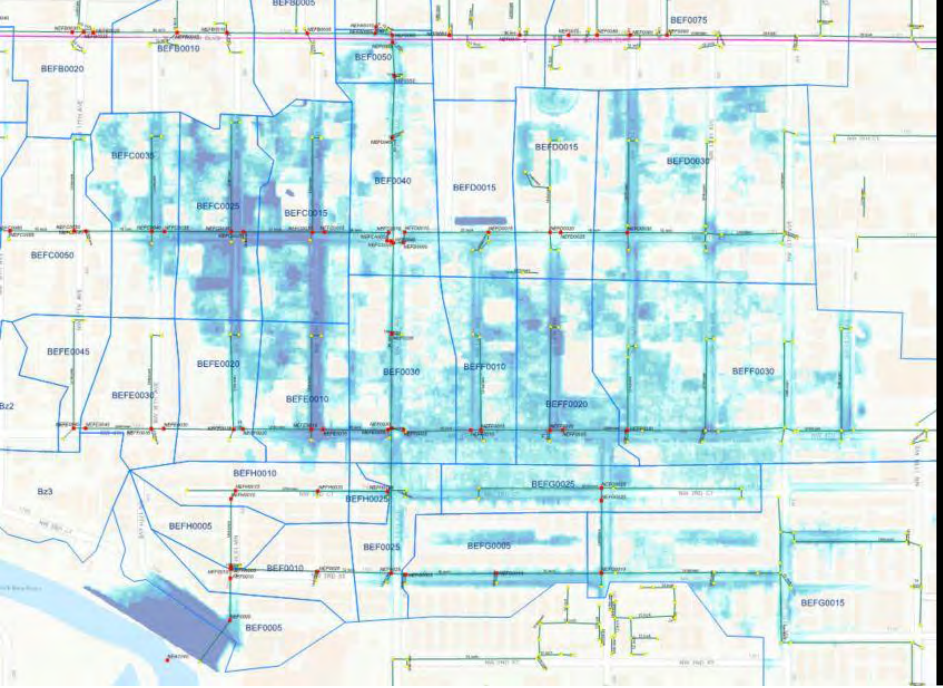


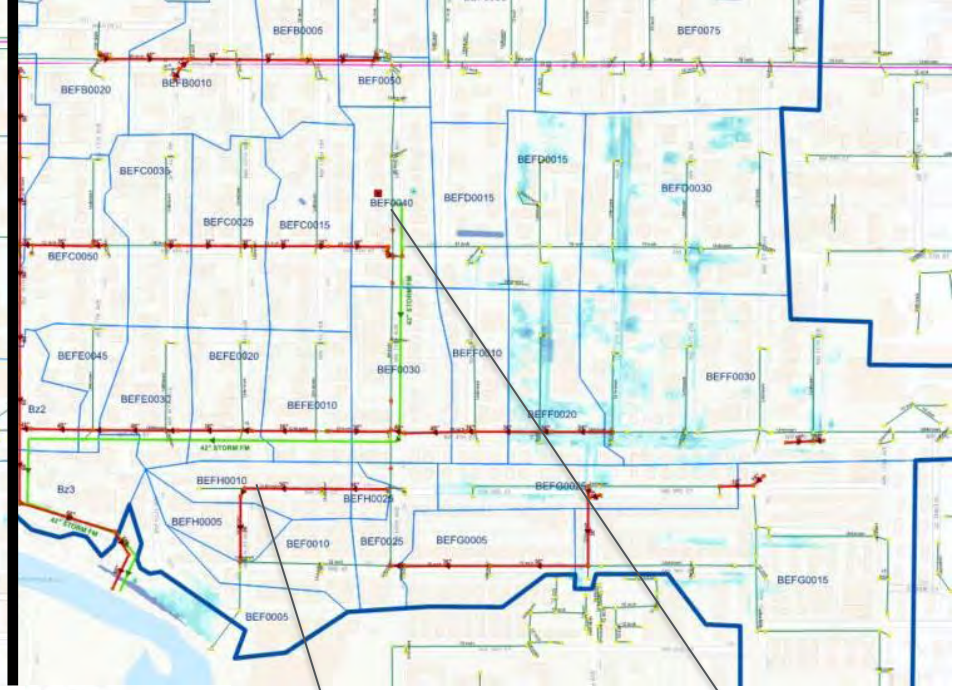


New River- 10-yr 24-hr

Neighborhood Improvements – Pre/Post Analysis

- Seven priority neighborhoods - $140M in improvements
- Wide range of problems
  - Aged and undersized infrastructure
  - Low-lying areas
  - Limited stormwater infrastructure





Storm Event - 1d -10yr

Flood Depth (in feet)

- 0ft
- 0ft – 0.25ft
- 0.25ft - 0.50ft
- 0.50ft - 0.75ft
- 0.75ft - 1.0ft
- > 1.0ft
- Buildings
- Parcels

Legend

- Node
- Proposed Pump Station
- Pipe
- Proposed Pipe - FM
- Proposed Water Quality Structure
- Existing Outfall
- Existing Drainage Well
- Existing Inlet
- Existing Manhole
- Existing Drainage Pipe
- Dorsey_Basins_Dissolve
- Dorsey – Basins
- Dorsey Riverbend Neighborhood Limits

Increased Pipe Capacity

Added a Pump Station and Force Main

Lessons Learned

Keep things simple

Have processes in place

Questions?

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