CITY OF Hollywood FLORIDA

A Resilient Stormwater Management Plan for the City of Hollywood Florida

FSA Winter Conference
Presentation
12/4/2025

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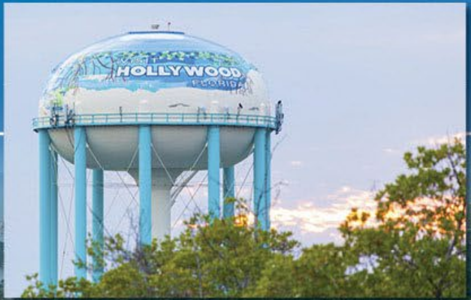


CDM Smith

Presentation Agenda

1. Constraints and Stormwater Flooding in the City
2. SWMP Program Goals
3. Stormwater Models
4. Proposed Capital Improvements and Implementation Strategies
5. Comparison of 1D and 2D models

Hollywood Stormwater Issues and Constraints

- **Low, relatively flat terrain**
- **High groundwater table**
- **Near build-out, impervious**
- **Homes in low-lying areas**
- **Little available area for storage**
- **Increasing high tides, rising sea levels and tidal surge, tidal flooding**
- **Lack of existing systems**

- Aging stormwater system with increasing O&M needs
- Runoff into City from offsite areas
- Saltwater intrusion and aquifer protection
- Waterway discharge limits
- Water quality regulations
- Recharge wells limited to salinity zone
- Exfiltration and wells limits:
  - Higher elevations (> 6 ft-NAVD)
  - No known contamination
  - No potable wellfield cones

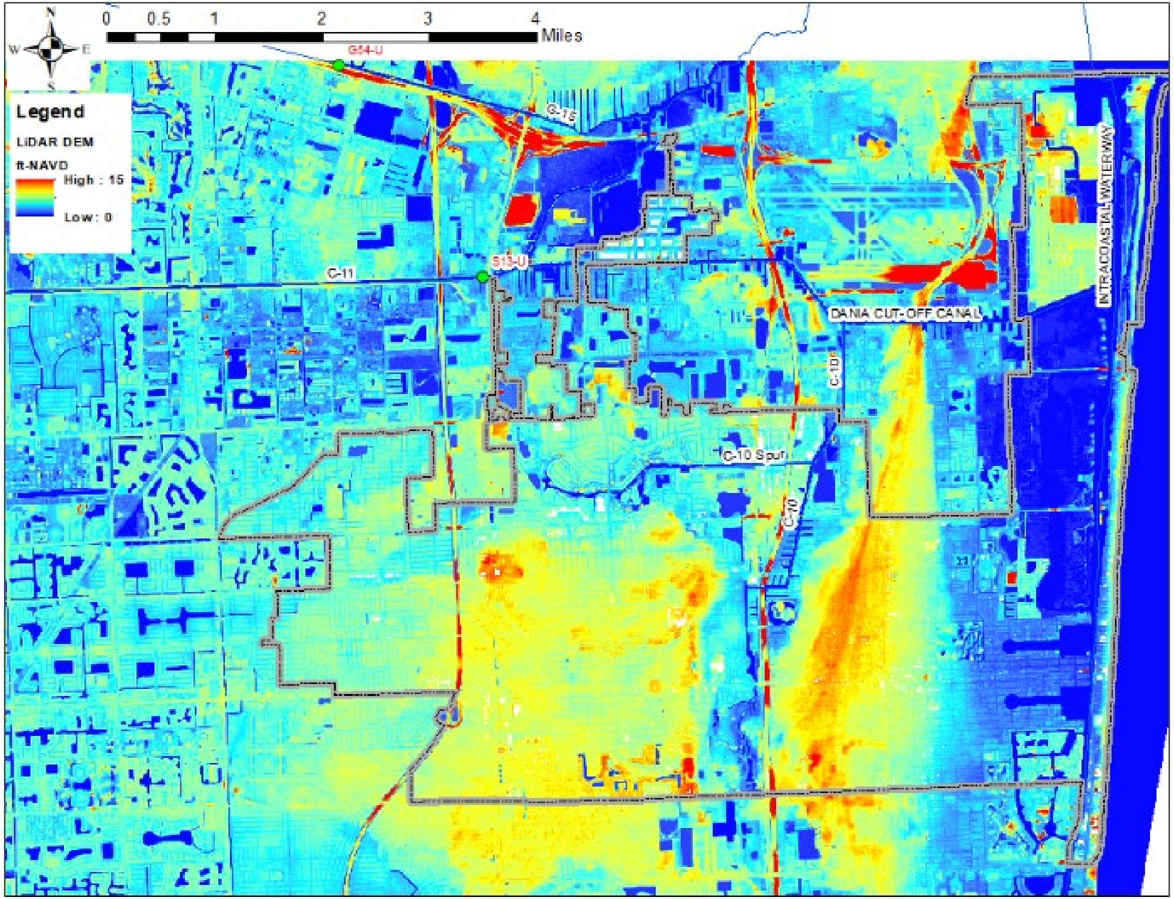
SWMP Goals Are Consistent with Regulatory Requirements and Establish the Metrics for Success

- ✓ Flood Control
- ✓ Water Quality Protection
- ✓ Aquifer Recharge and Water Supply
- ✓ Conservation and Reuse
- ✓ Operation and Maintenance
- ✓ Stormwater Utility Sufficiency
- ✓ Long Term Financing
- ✓ Community Acceptance

Levels of Service

- Adaptability
- Resiliency
- Sustainability
- Equity

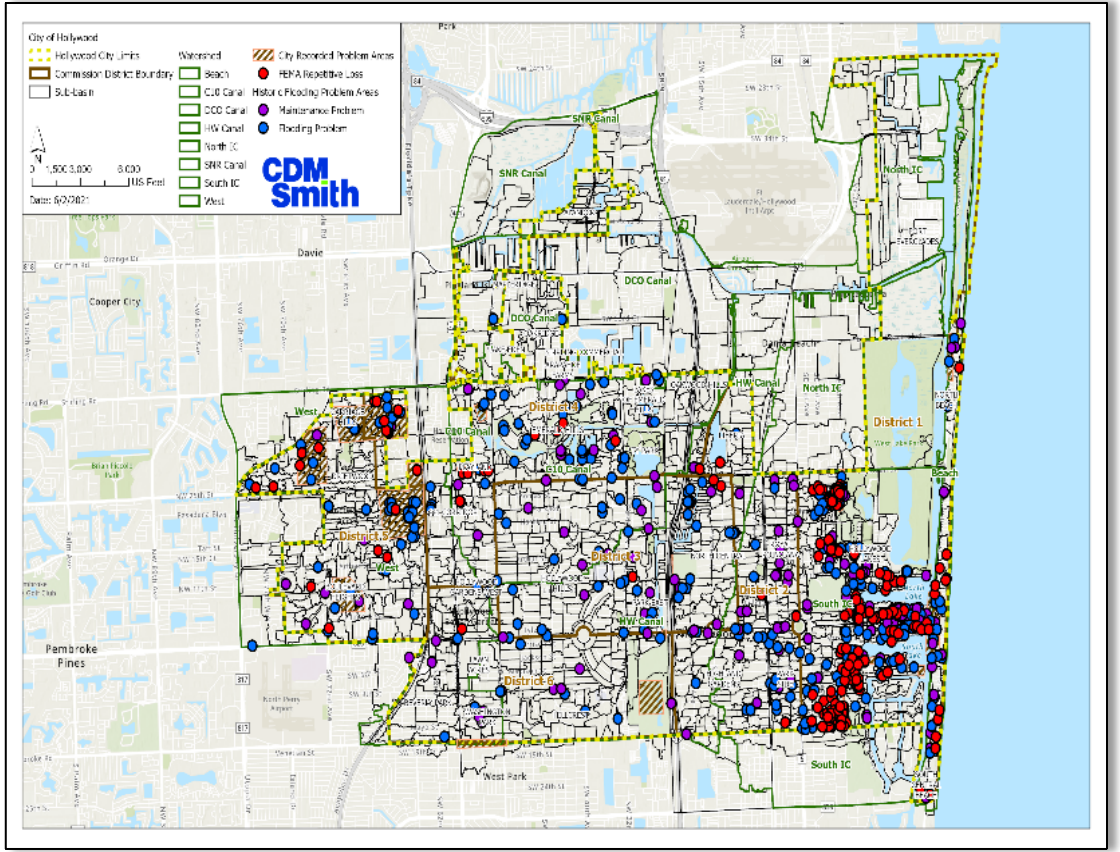
Topography & Canal System



Stormwater Problem Areas Identification

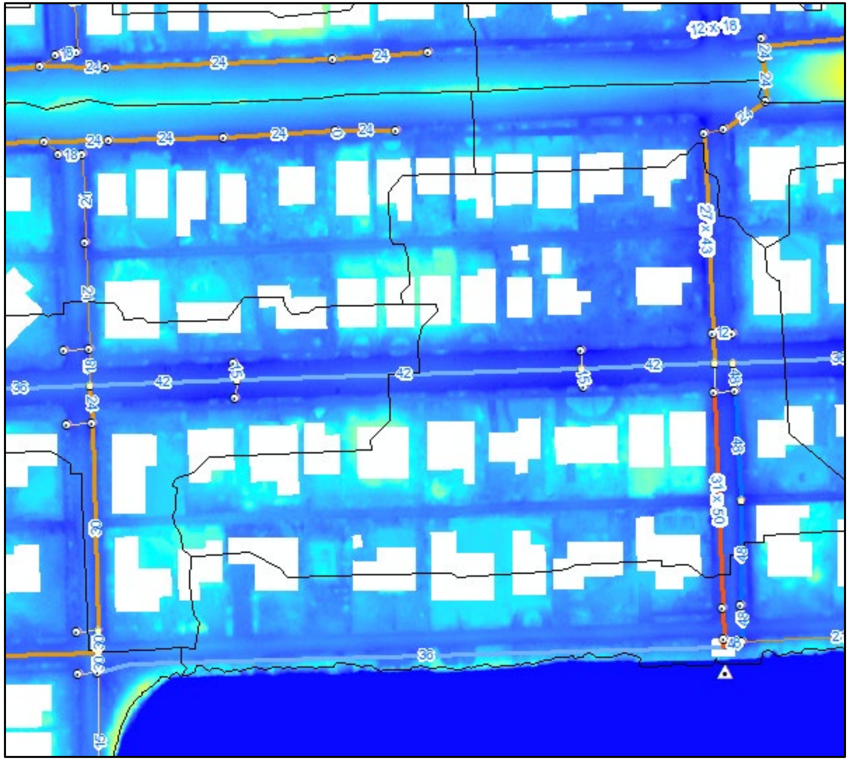
Flood Complaint Data from:

- Resident Flooding Problem Area Workshops
- Commission Flooding Problem Area Workshops
- Department of Public Utilities O&M Workshops
- FEMA Floodplains and Repetitive Loss Data
- City Flood Complaint Database
- County Complaint Data
- First Responder/ Media Coverage



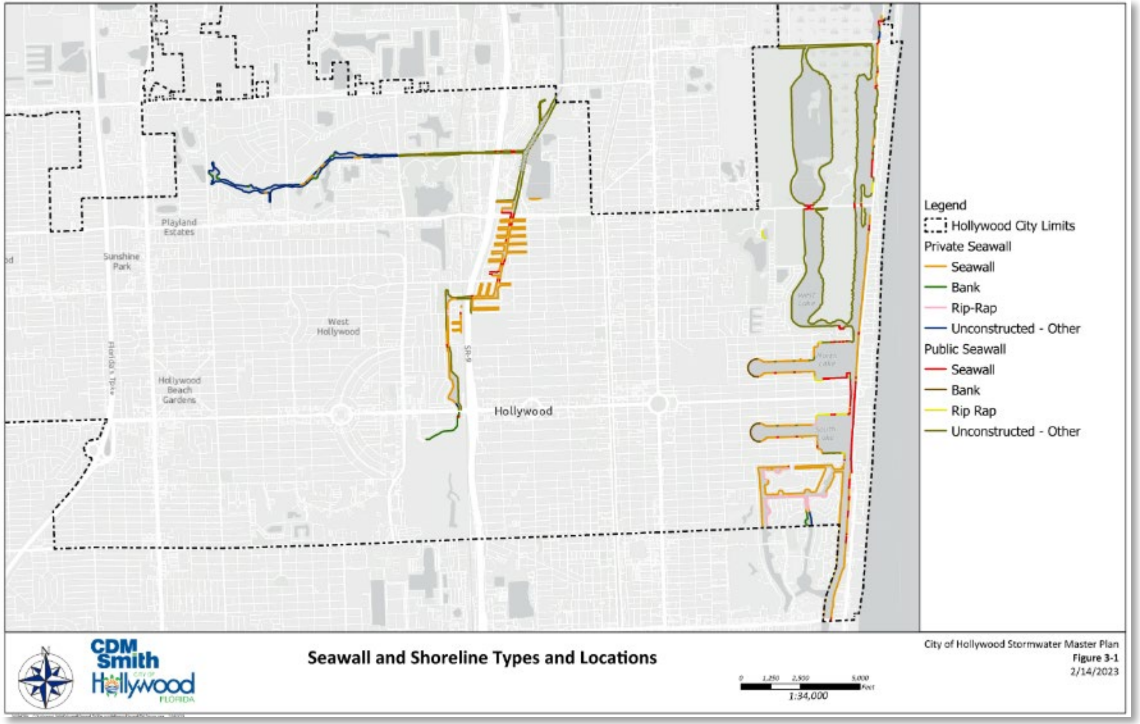
USEPA SWMM of Hollywood Stormwater System

GIS Schematic



Model Schematic

City Seawall Inventory – Special Purpose Shoreline LiDAR



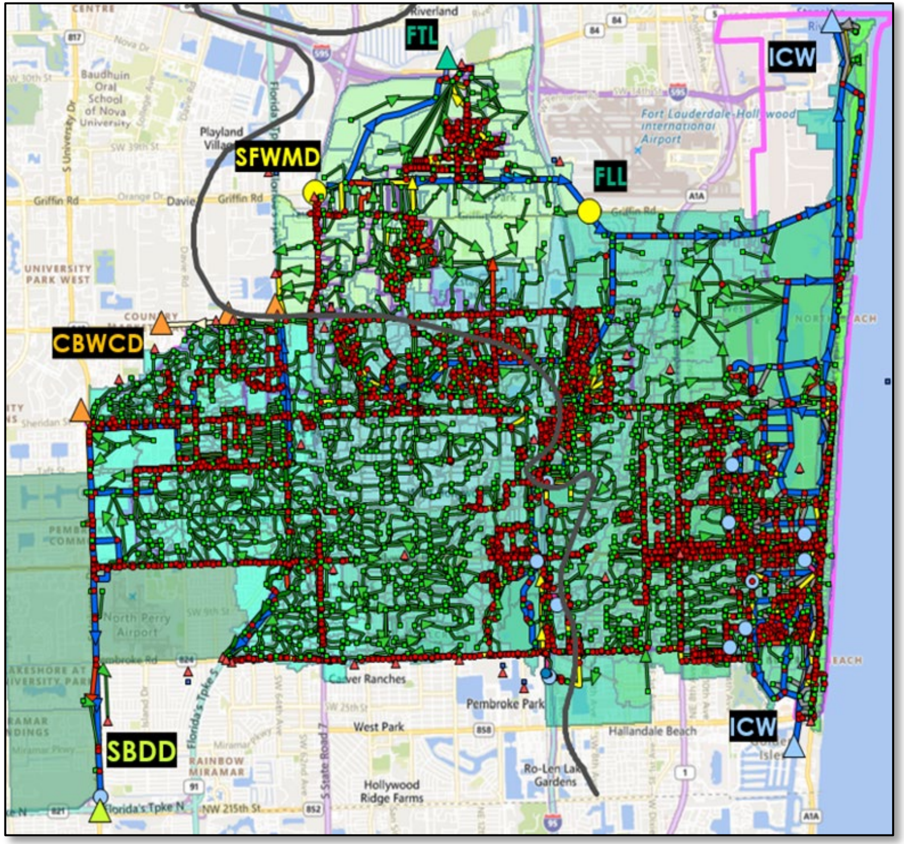
Statistics:

- 36 miles total shoreline in City limits
- 13 of 29 miles is unimproved shoreline
- 16 of 29 miles (65%) is armored
  - 5% of 29 miles of armoring (~1 mile) is City-owned seawalls
  - Unarmored City Shoreline ~1.5 miles
  - Total of ~2.5 miles City responsibility
- 96% of City owned seawall mile is below initial 4 ft ordinance height
- 11% of City owned is currently below King Tide (2+ ft)
- 81% of Private/other owned seawall (~16 miles) is below 4-ft initial ordinance height
- Unarmored others shoreline 8.5 miles

USEPA SWMM of Hollywood Stormwater System

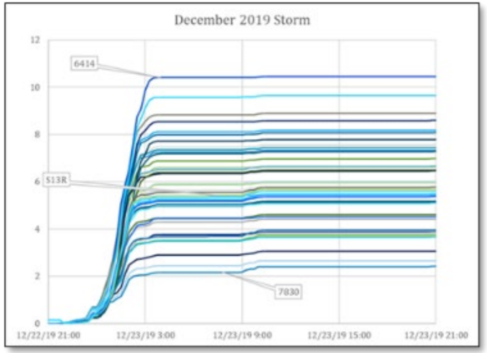
- **Subbasins to a "neighborhood" level of detail (5-7 Ac)**
- **Simulated 2D overland flow channel connections**
- 45 sq. mile study area in and outside of City limits
- 12 pump stations, 217 miles of stormwater pipe
- 29 miles of canals and 250 existing outfalls
- SFWMD, FDOT, SBDD, CBWCD and BC control structures

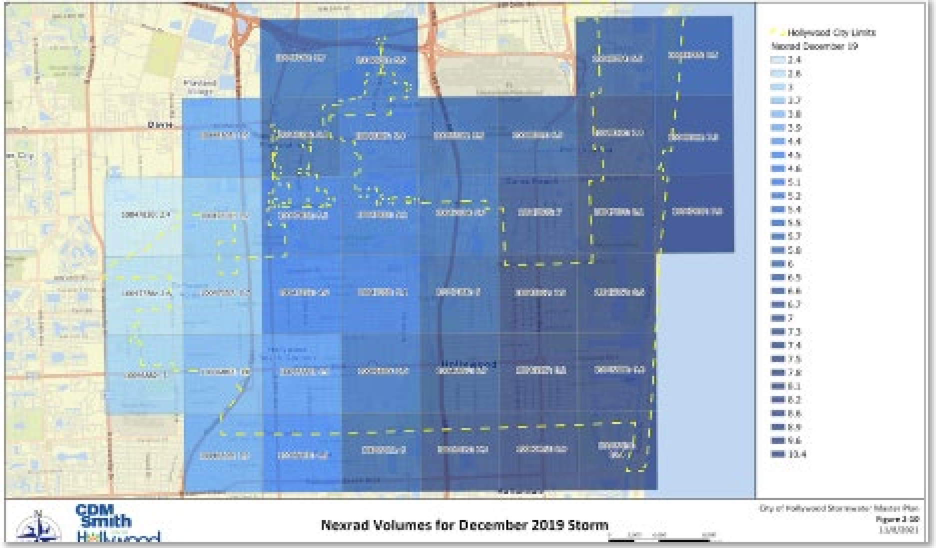
- ✓ **Calibrated model to historical rainfall and flood data events**
- ✓ Addresses Compound rainfall and tidal surge (King Tide)
- ✓ Addresses Climate change sea level rise and rainfall considered
- ✓ Public domain tools
- ➢ Continually updated and refined to new data as available



Rainfall Model Verification Storms

- ✓ Two Separate Verification Storms:
  - ✓ December 2019 (Eastside)
  - ✓ Hurricane Eta 2009 (Westside)
- ✓ Sources For Estimates of Current Flooding:
  - ✓ Historic Photos / City Photos
  - ✓ News Articles / Weather Reports
  - ✓ Social Media Posts
- ✓ Adjusted Model Parameters to Match Depth and Extent of Flooding
  - ✓ High Confidence in Results



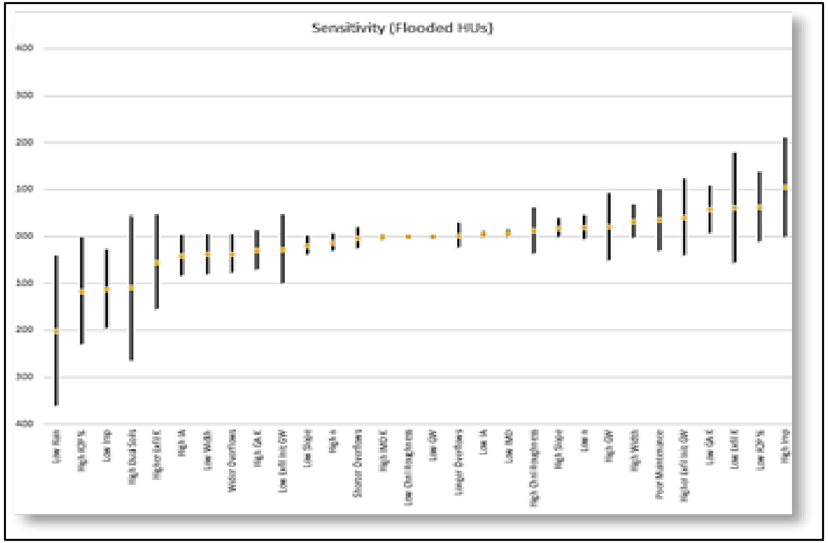


Spatial array of rainfall gauges from NexRad grid provides variations in rainfall and more accurate local flooding projections

Existing Conditions Model Validation

Comparison of Model Predictions to Actual Conditions

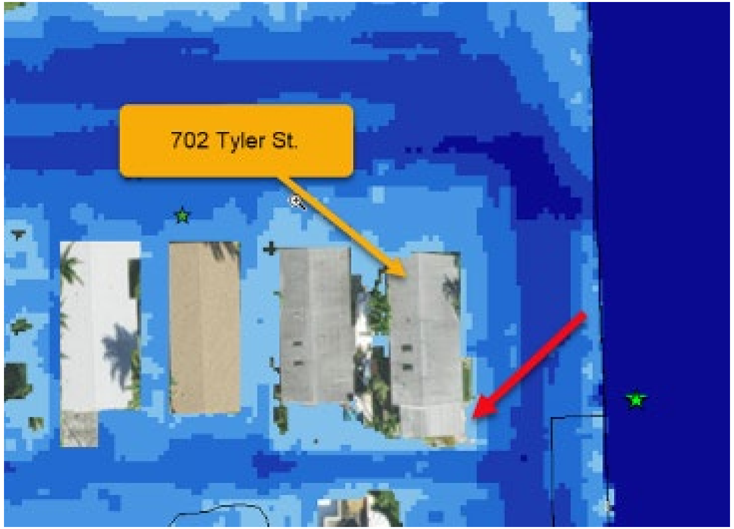
- ✓ **Accuracy** of results is **High**
- ✓ Model Parameters Were Adjusted Repetitively to Match Actual Conditions
- ✓ Process is repeated Citywide Where Flooding Evidence Was Available.
- ✓ Flooding Data Sources:
  - ✓ Public Utilities
  - ✓ Local News
  - ✓ First Responders
  - ✓ Social Media
  - ✓ Weather Reports
  - ✓ Citizens Flooding Workshop, Commission Flooding Workshop



Comparison of Model Predictions to Actual Conditions

14th Ave & Fletcher Dec 2019

Drone Footage Hollywood Lakes Dec 19



Design Storm Modeling

Design Storm Volumes and Intensities

Storm	Rainfall Depth (inches)	Peak Hour (inches)
5-year, 24-hour	7.4	3.0
10-year, 24-hour	9.0	3.7
10-year, 72-hour	12.2	3.7
25-year, 72-hour	15.5	4.7
100-year, 72-hour	21.2	6.5

Boundary Conditions:

- Annual Tide – Fixed 2.5 ft-NAVD in ICWW
- C-11 Inflows From CBWCD
- SBDD PS Capacity
- City of Fort Lauderdale and Airport Models provide inflows at boundaries

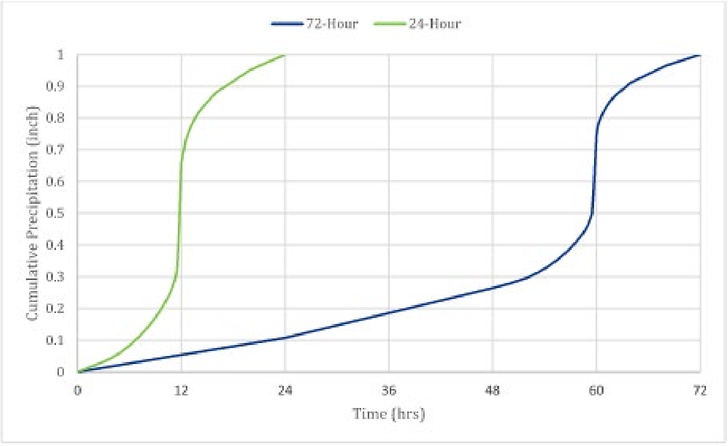


Figure 2-2
Cumulative SFWMD Unit Hydrographs

City-Desired Level of Service Goals

Two LOS goals for CIP provides wider range of implementation affordability

1. Alternative 1 LOS
   - Up to 3-inches over road crown in the 10/24 for major roadways and identified evacuation routes
   - Up to 3-inches above road crown in the 5/24 for residential streets
   - Flooding maintained below building finished-floor elevations in the 100-year design storm wherever practicable

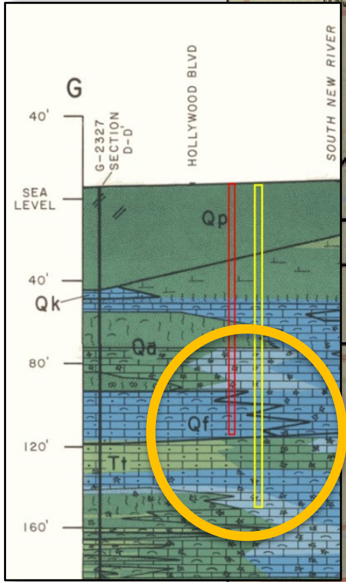
2. Alternative 2 LOS (more affordable)
   - Short duration, up to 6-inches over road crown in the 10/24 for evacuation routes
   - Short duration, up to 6-inches over road crown for a 5/24 for residential streets
   - Flooding maintained below building finished-floor elevations in the 100-year design storm wherever practicable

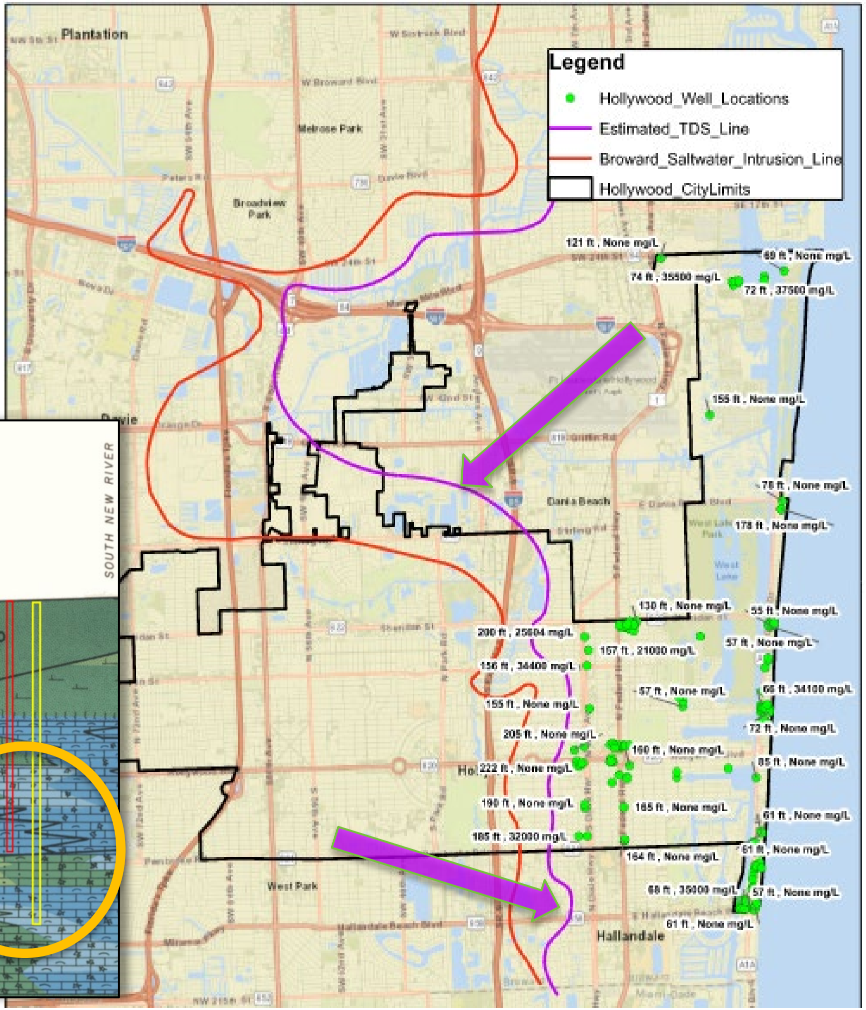
Not Meeting LOS

Allowable for Short Duration

Discharge to Biscayne Aquifer

- ✓ Exfiltration Systems (French Drains)
  - ✓ > 5.5 ft-NAVD
  - ✓ Avoid Wellfield Protection Zones & Contamination Zones
- ✓ Groundwater Recharge Wells (Gravity and Injection) East of 10,000 TDS Line
  - ✓ FDEP Class V Well Data
  - ✓ Depth Range of bore hole estimated 100-150 ft BLS range
  - ✓ Generally East of I-95 in the South, East of 441 in the North

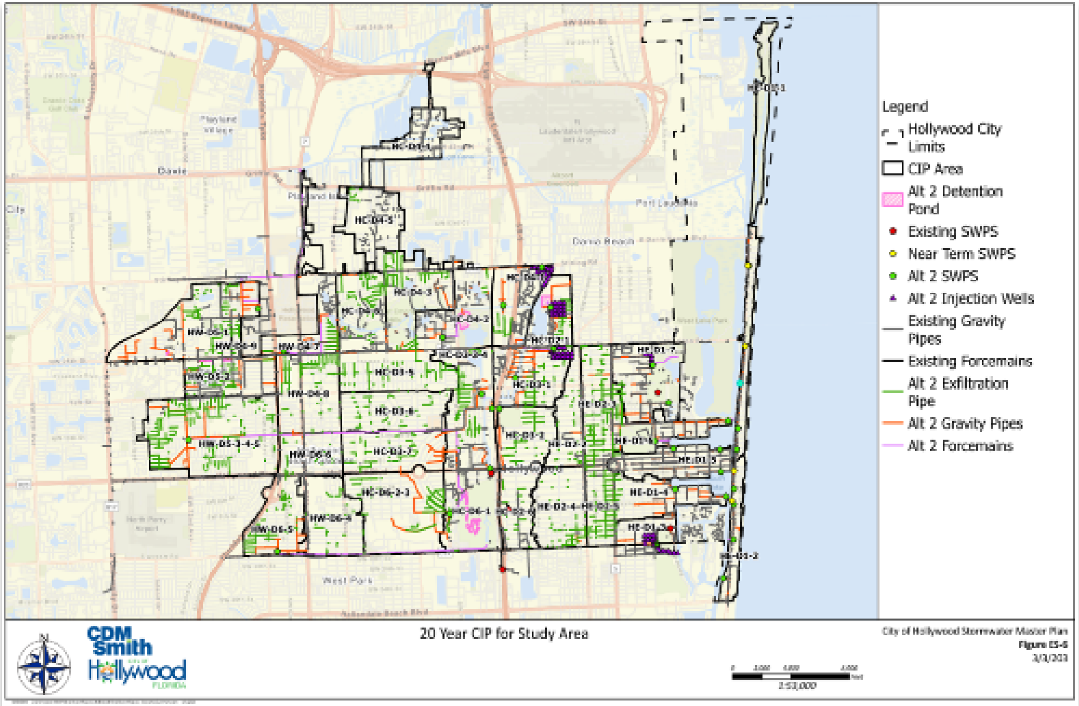




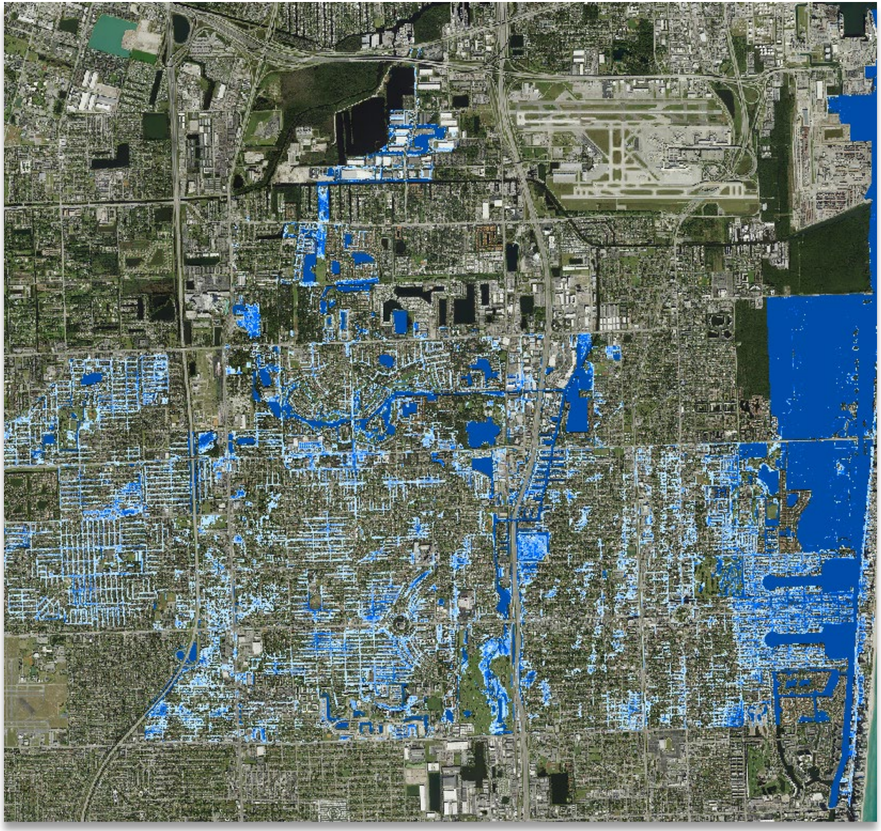
SWMP Citywide CIP Components

Approx 35 CIP areas Citywide:

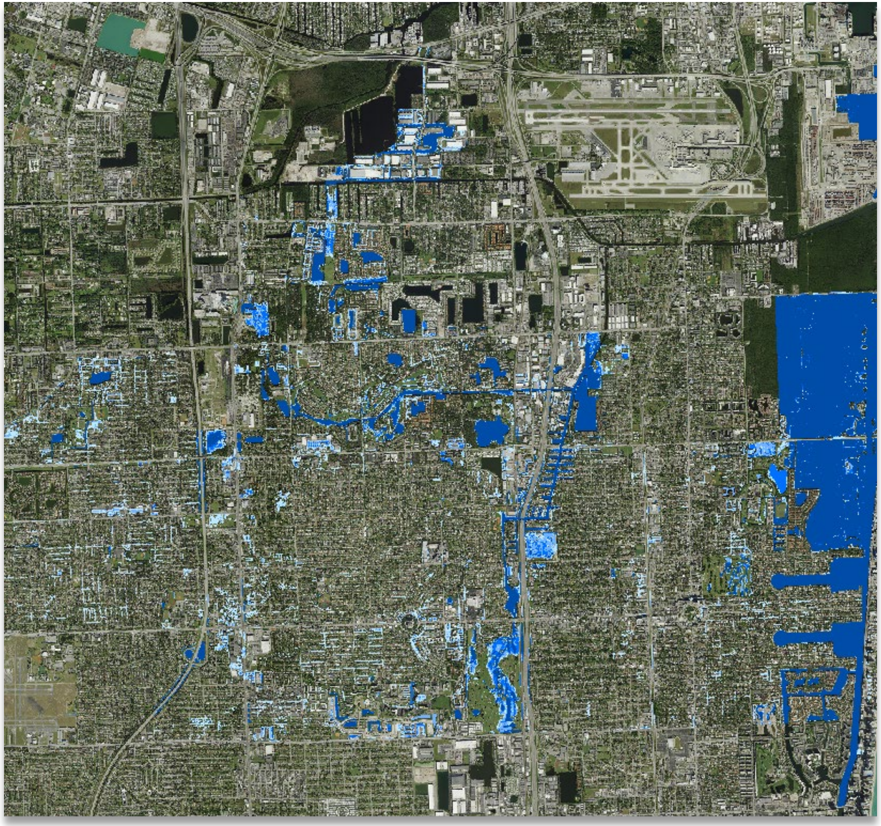
- 30+ new pump stations
- 45+ new outfalls
- 45+ miles new stormwater pipe
- 60+ miles new exfiltration systems
- New stormwater detention areas



Citywide Flood Inundation Reduction Map Post CIP Program



10 YR STORM CURRENT CONDITIONS FLOOD MAP



10 YR STORM POST CIP FLOOD MAP

Climate Change Considerations

- Sea level rise tailwater and future groundwater table conditions
- "Climate change" storm run
- Coincident tidal influence and surge
  - 1-yr stillwater, King Tide
- Fluctuating groundwater routine during tides and storms for accuracy
- Seawall Improvements Flooding Analysis

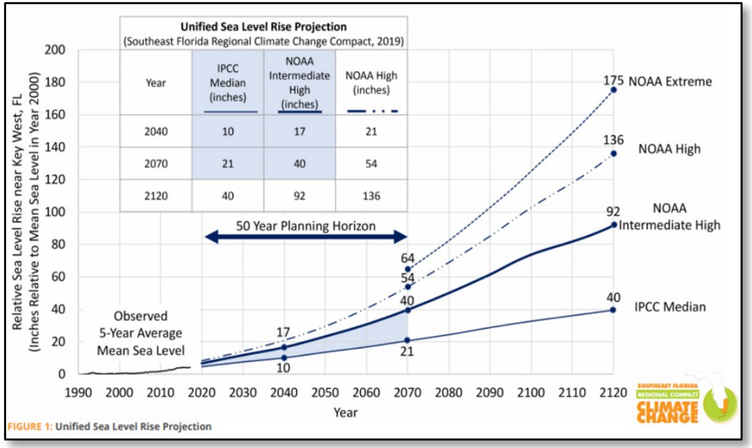
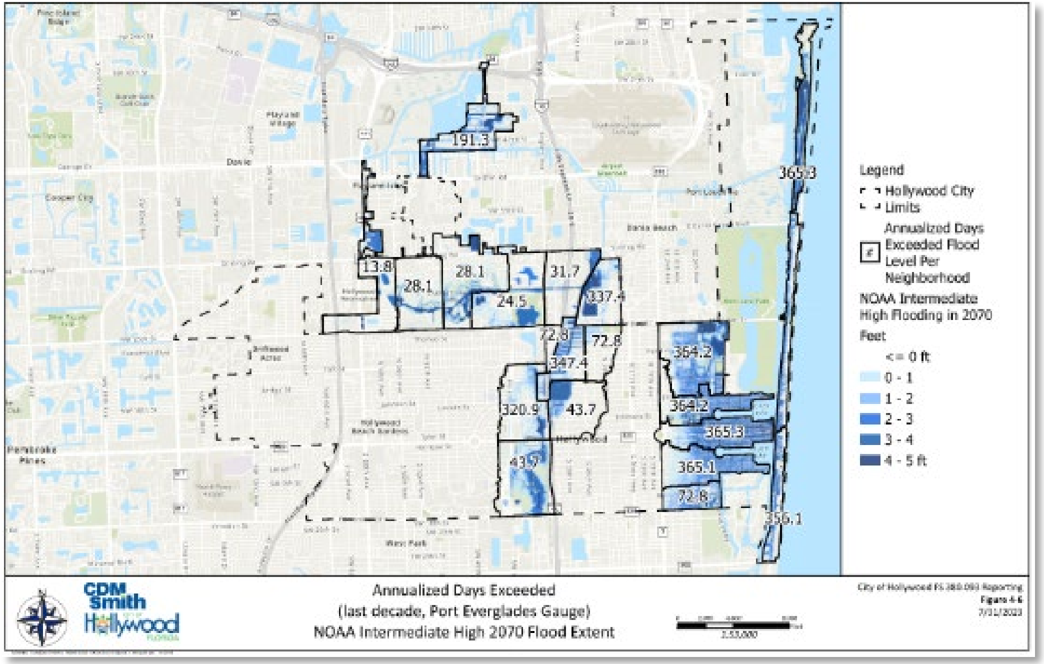


FIGURE 1: Unified Sea Level Rise Projection

- Plan considers sea level rise changes for FS 380.093 sea level scenarios:
  - NOAA Intermediate High and Low
  - 2040 and 2070
  - 0.4, 0.8, 0.9, and 2.6 ft rise above 2020
- Future tailwater and water table conditions
- Tidal influence and surge
- ~50 yr planning horizon

Vulnerability Analysis - SWMP Model Use

- Scenario evaluations developed and run in the model for required FS 380.093 Florida Resiliency reporting of:
  - ✓ Annualized days of tidal flooding
  - ✓ Storm surge flooding
  - ✓ Rainfall induced flood analysis
  - ✓ Compound flooding analysis
- Results Included in Vulnerability Analysis



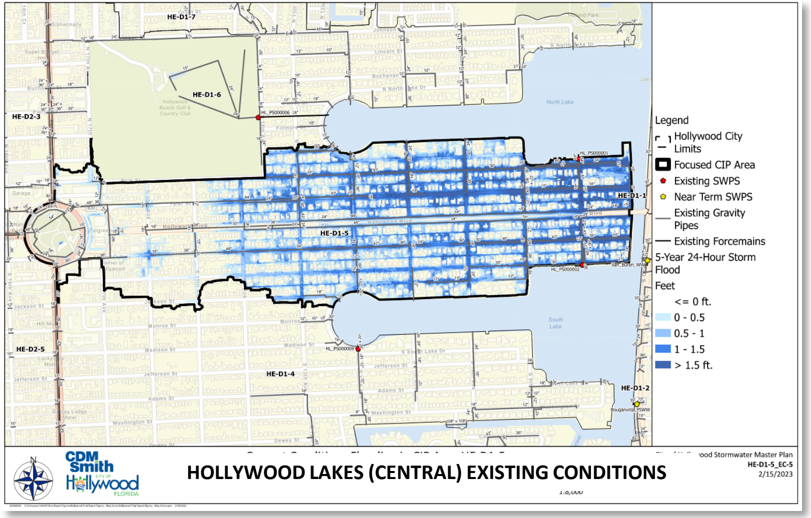
SWMP Implementation - Example CIP Area

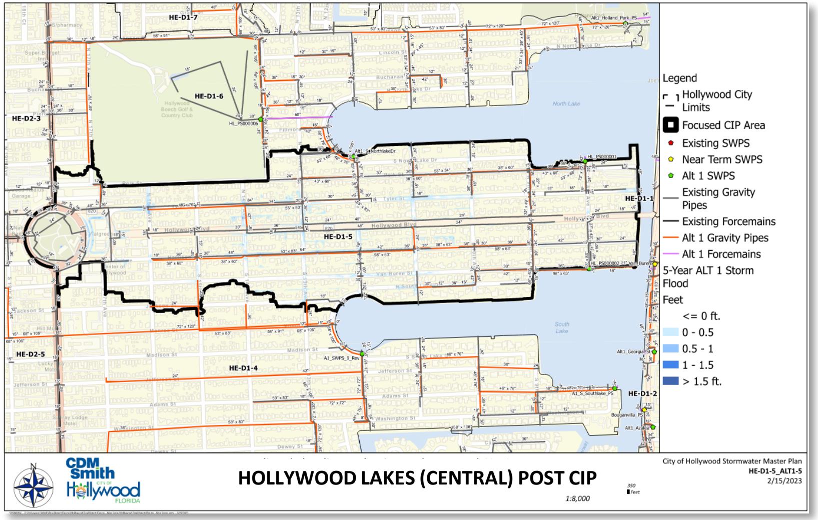
(Approximately 40 CIP areas identified Citywide)

- Inlets and piped collection systems
- Pump stations and outfalls
- Exfiltration systems to capture water “uphill”
- Gravity and pumped aquifer recharge wells
- Swales and detention ponds in parks
- Shoreline protection seawalls/backflow preventers

➢ **Coordination with Vulnerability Analysis Recommendations**

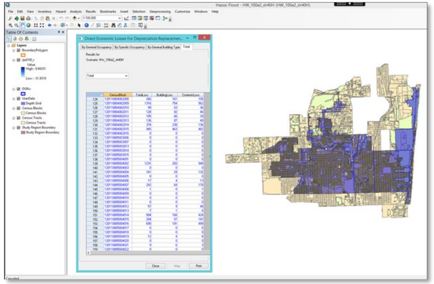
- ✓ Diminishing Point of Return for CIP
- ✓ Combination of Solutions for Critical Assets Resiliency

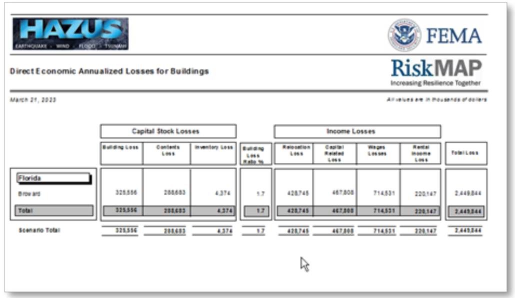




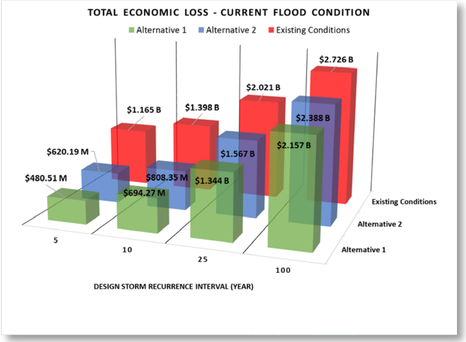
FEMA HAZUS Citywide Analysis – Flood Damage Avoidance

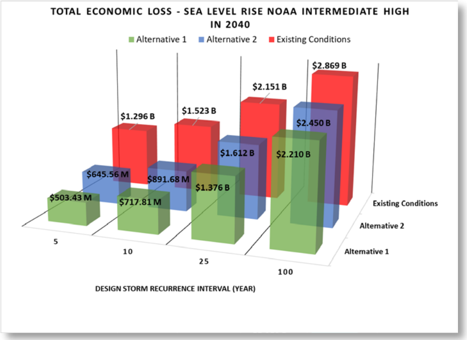
- Alt 1 Benefit Cost Ratio (BCR) = 1.7
- **Alt 2 BCR = 2.5 for full program of ~$1B, 2021 Dollars**
  - ✓ Includes Citywide cost of seawalls in CIP (Public/Private)
  - ✓ FEMA Hazard US (HAZUS) tool considers flood damages and basic economic loss
  - ✓ Compare flood damage and avoidance to the CIP costs and calculates BCR over 50 years
  - ✓ BCR used to determine the economic viability of the SWMP CIP
  - ✓ BCR greater than 1.0 will deliver a positive net present value




HAZUS
FEMA
Direct Economic Annualized Losses for Buildings
RiskMAP
Increasing Resilience Together
March 21, 2023
All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Broward	325,556	288,683	4,374	1.7	428,745	467,808	714,531	220,147	2,449,844
Total	325,556	288,683	4,374	1.7	428,745	467,808	714,531	220,147	2,449,844
Scenario Total	325,556	288,683	4,374	1.7	428,745	467,808	714,531	220,147	2,449,844

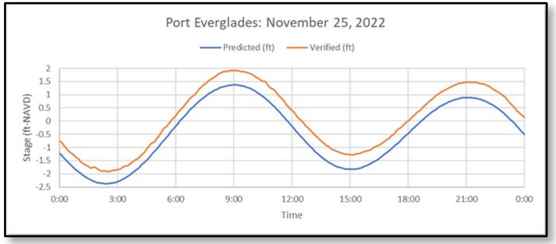


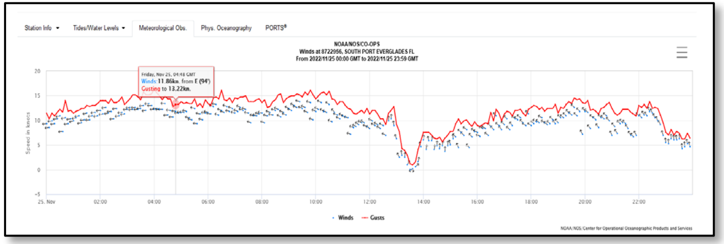


SWMP Model Use - King Tide Flood Prediction Tool

SWMP model adjusted to use fluctuating tidal boundary conditions (9 levels, from 1 – 3 NAVD) and calibrated to King Tide events and a series of flood maps developed

1. Forecast wind and rain at high tide (1 to 2 days ahead of time)
2. Select the “adjusted” appropriate tidal flooding map considering tide, wind, and rain effects
3. Select “alert locations” from the flood map predictions
4. Deploy barricades, signage, and temporary pumps accordingly
5. Post tidal flooding hotspots map on website/social media
6. Coordinate with first responders and office of emergency management
7. Use results to identify required immediate action capital improvements for:
    1. Leaking seawalls
    2. Leaking backflow preventers
    3. Infiltrating pipes
    4. Roadway base seepage

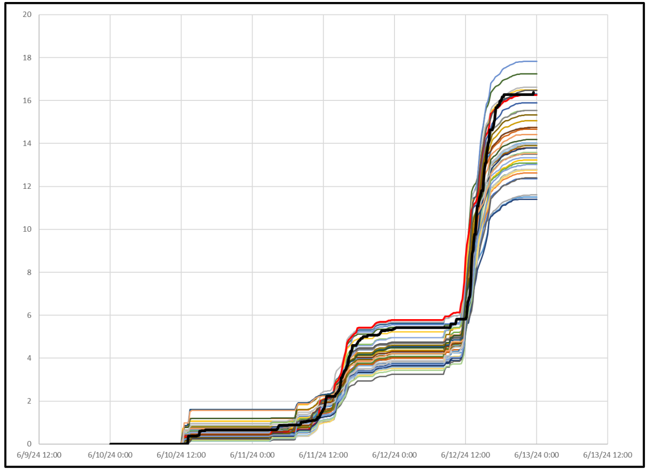




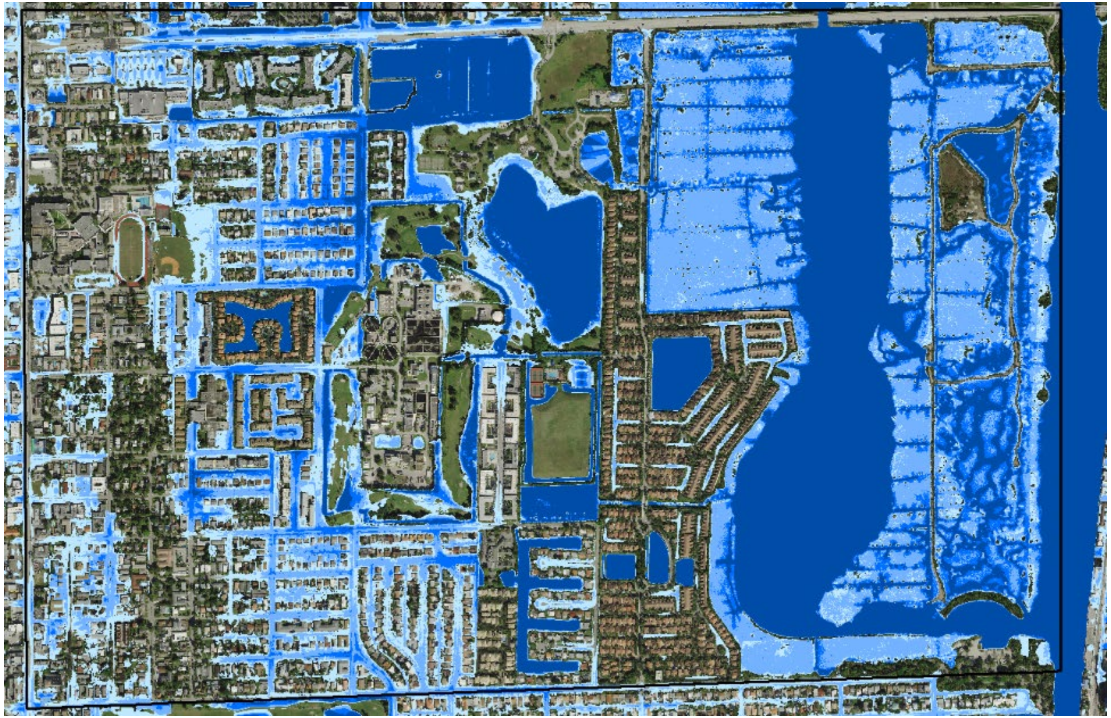
SWMP Model 1D vs 2D Models: June 2024 Storm

Northeast Hollywood Lakes Neighborhood

1. ~ 15-inches of rain over 2 days; ~ 10 inches over 12 hours on 2nd day (50-year storm)
2. Relatively low tide (peak ~ 1 ft NAVD)



Rainfall Data



SWMP Model 1D vs 2D Models: June 2024 Storm

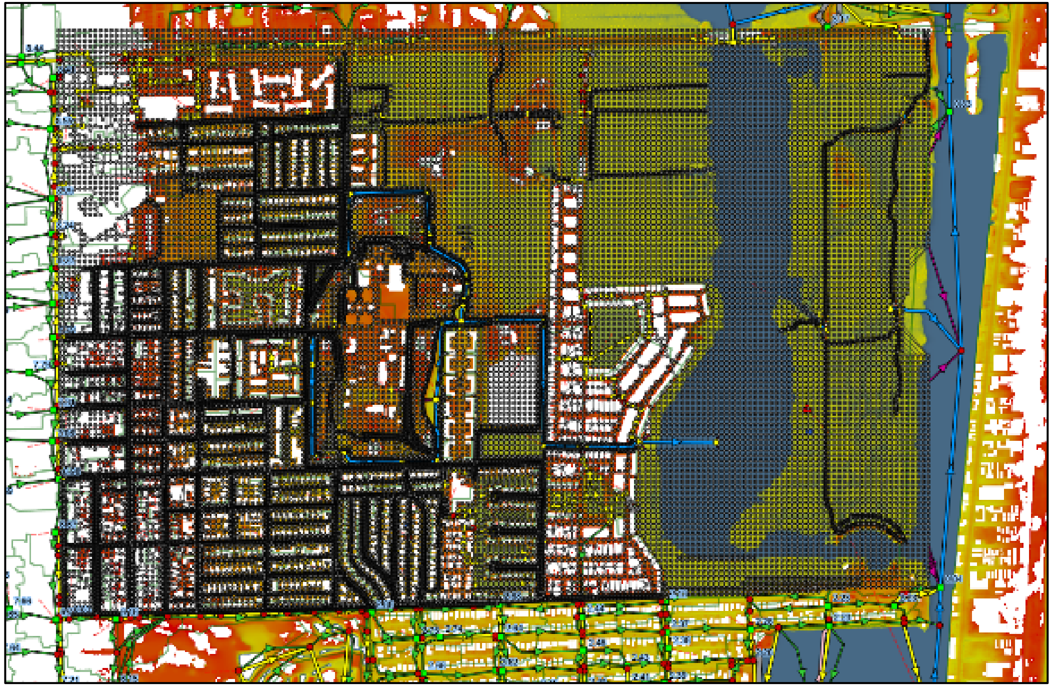
1. PC-SWMM 2D (Builds EPA SWMM model)
2. Variable Grid Spacing

Existing Condition: 5-Year Storm

Alternative 2: 5-Year Storm

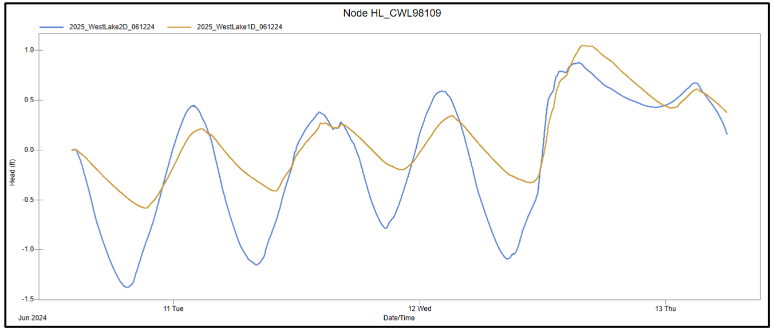
SWMP Model 1D vs 2D Models: June 2024 Storm

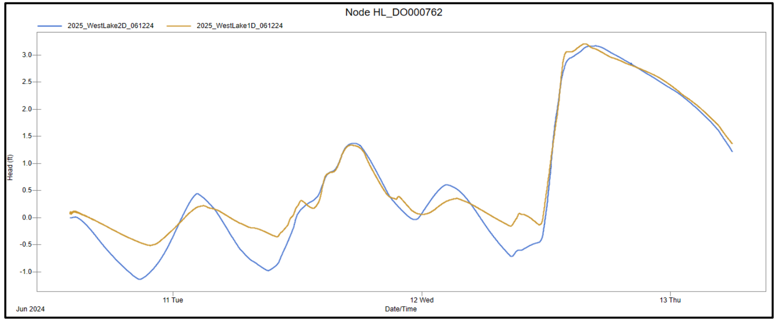
1. PC-SWMM 2D (Builds EPA SWMM model)
2. Variable Grid Spacing

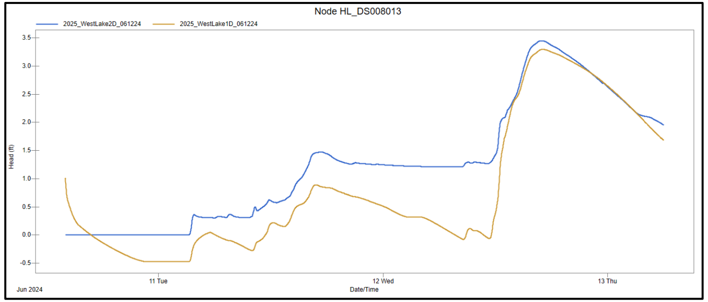


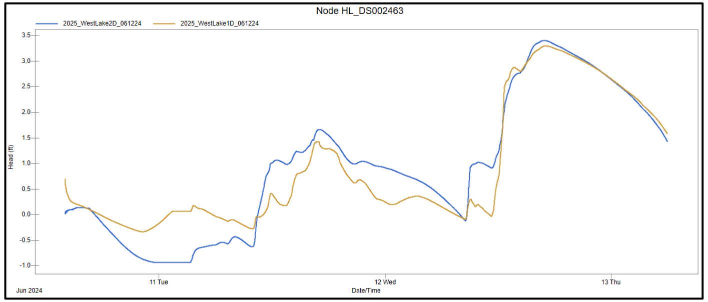
SWMP Model 1D vs 2D Models: June 2024 Storm

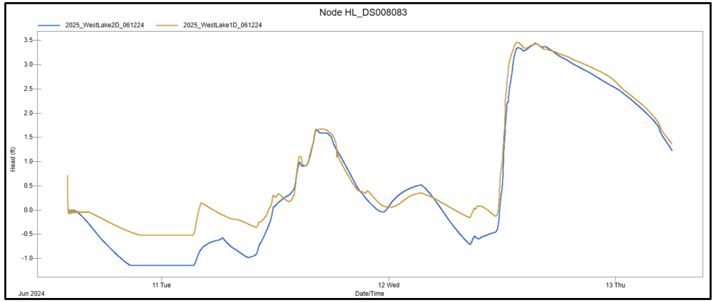
1. Results are similar – 85% peak stages < 3 in difference (better at critical low roads)
2. Tide less damped in shallow marsh for 2D







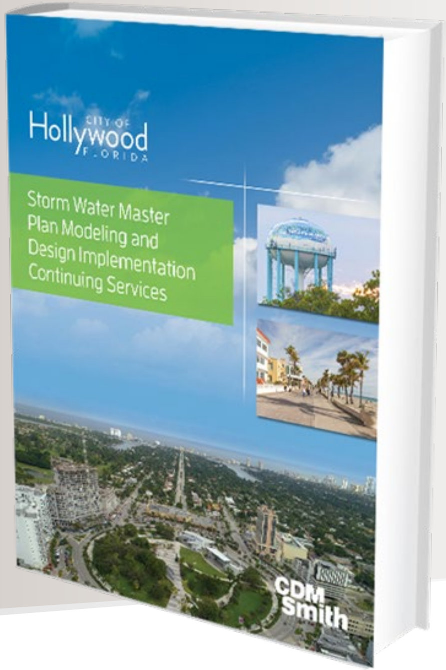




SWMP Model 1D vs 2D Models: Conclusions

1. Results are similar if both models are detailed.
2. 2D can be faster to set up, but as more detail is added, the setup times converge.
3. Implementing CIP alternatives can take longer in 2D models if grading is part of the project.
4. 2D models take significantly longer to run (hours versus minutes).
   - Calibration can take much longer (or stopped before a good match is found).
   - Sensitivity tests of model parameters can take much longer.
   - Real time/ predictive modeling take much longer to get a result.
   - CIP/ Alternative modeling will likely be less optimized.

Questions and Discussion: nyete@cdmsmith.com



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