

Advancing Urban Flood Resilience Through Hydraulic Simulation and Infrastructure Planning in New Jersey



Viravid (Gunn) Na Nagara ¹, Ahmad Ibrahim ¹, Subal Vinayan ¹,
Tamjidul Islam Illin ¹, Md Azmain Rahman ¹, Michel Boufadel ¹,
Christopher Testa ², Dinan Amin ²

¹ Center for Natural Resources, Department of Civil and Environmental Engineering,
New Jersey Institute of Technology, Newark, NJ, United States; <http://cnr.njit.edu>

² NJ Office of Emergency Management, Trenton NJ




Director



Dr. Michel Boufadel
Distinguished Professor


[View Profile](#)

Affiliated Faculty




Dr. Ashish Borgaonkar
Assistant Professor

ashish.borgaonkar@njit.edu




Dr. Abdallah Kreishah
Professor

abdallah.kreishah@njit.edu




Dr. Salam Daher
Assistant Professor

salam.daher@njit.edu



Dr. Taha Marhaba
Distinguished Professor and Chairman, Civil & Environmental Engineering





























taha.f.marhaba@njit.edu



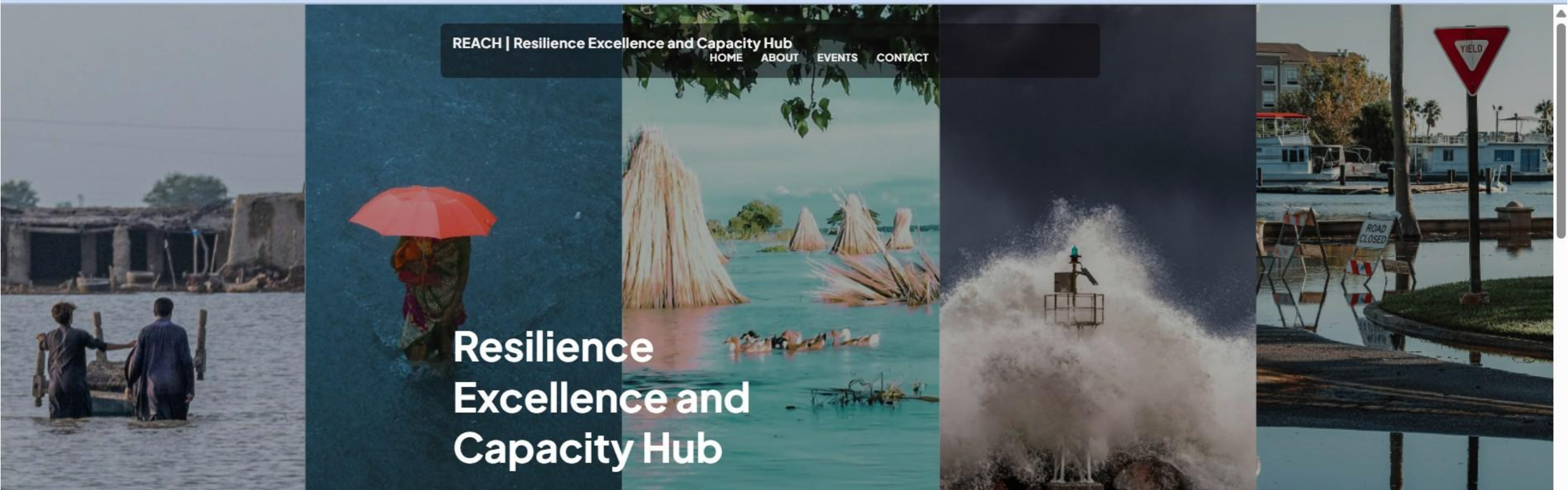
Dr. Wunmi Sadik
Distinguished Professor, Vice Provost for Faculty Affairs and Director of BioSMART Center

wunmi.sadik@njit.edu

Research Team

 <p>Dr. Wen Ji Postdoctoral Researcher wenji@njit.edu</p>	 <p>Dr. Viravid (Gunn) Na Nagara Postdoctoral Researcher viravid.nanagara@njit.edu</p>	 <p>Dr. Meghana Parameswarappa Jayalakshamma Postdoctoral Researcher mp848@njit.edu</p>	 <p>Abdul Razzak Doughan Ph.D. Candidate ayd3@njit.edu</p>	 <p>Husam Al-Kuran Ph.D. Candidate ha558@njit.edu</p>	 <p>Jacqueline Esimike Ph.D. Candidate jre5@njit.edu</p>	 <p>Md Refat Jahan Rakib Ph.D. Student mr2328@njit.edu</p>	 <p>Gregory Mendez Master's Student gm36@njit.edu</p>	 <p>Vedika Dinesh Desai Master's Student vd392@njit.edu</p>	 <p>Pola A Szwaczka Undergraduate Student pas8@njit.edu</p>
 <p>Dr. Rong Mao Postdoctoral Researcher rong.mao@njit.edu</p>	 <p>Dr. Cui Fangda Postdoctoral Researcher fangda.cui@njit.edu</p>	 <p>Dr. Dang Khoi Le Postdoctoral Researcher</p>	 <p>Rohit Antwal Ph.D. Student ra868@njit.edu</p>	 <p>Md. Azmain Rahman Ph.D. Student azmain@njit.edu</p>	 <p>Zhaonian (John) Qu Ph.D. Student zq8@njit.edu</p>	 <p>Abul Hassan Fatemi Master's Student ahf@njit.edu</p>	 <p>Abhijai Suresh Master's Student as323@njit.edu</p>	 <p>Bhakti Dhoria Master's Student bd353@njit.edu</p>	
 <p>Dr. Anirban Dhulia Research Analyst ad793@njit.edu</p>	 <p>Jianyun (Jolene) Li Ph.D. Candidate jl2349@njit.edu</p>	 <p>Ahmad Ibrahim Ph.D. Candidate ai352@njit.edu</p>	 <p>Elie Khoury Ph.D. Student ekhoury@njit.edu</p>	 <p>Tamjidul Islam Illin Ph.D. Student tli@njit.edu</p>	 <p>Maria Nour Assi Ph.D. Student mnassi@njit.edu</p>	 <p>Samantha Berkenbosch Undergraduate Student sb432@njit.edu</p>	 <p>Arushi Chouhan Undergraduate Student ac2767@njit.edu</p>	 <p>Ahmed Farooq Umar Undergraduate Student au253@njit.edu</p>	

The REACH established at NJIT based on funding from the NJ OEM



REACH | Resilience Excellence and Capacity Hub
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Resilience Excellence and Capacity Hub

Empowering action, building community through care

At REACH, we believe in the power of community to create lasting change. Join our network of passionate individuals committed to building resilience, supporting each other, and shaping a safer, stronger future.


Flood Preparedness

Equip your community


Emergency Assistance

Get immediate support


Infrastructure Solutions

Collaborate with experts


Community Workshops

Join our hands on



Current Partnering Municipalities

1. Dover
2. Totowa
3. Paterson
4. Woodland Park
5. Little Falls
6. Cedar Grove
7. Verona
8. Westwood
9. Ridgewood
10. Englewood
11. Leonia
12. Irvington
13. Scotch Plains
14. Plainfield
15. Rahway
16. Stafford



Project Phases



Obtaining background information and identifying flood prone areas



Installing flood monitoring cameras



Conducting a site survey using a drone



Developing and Improving the flood model



Validating the model with real storm events



Evaluating potential mitigation



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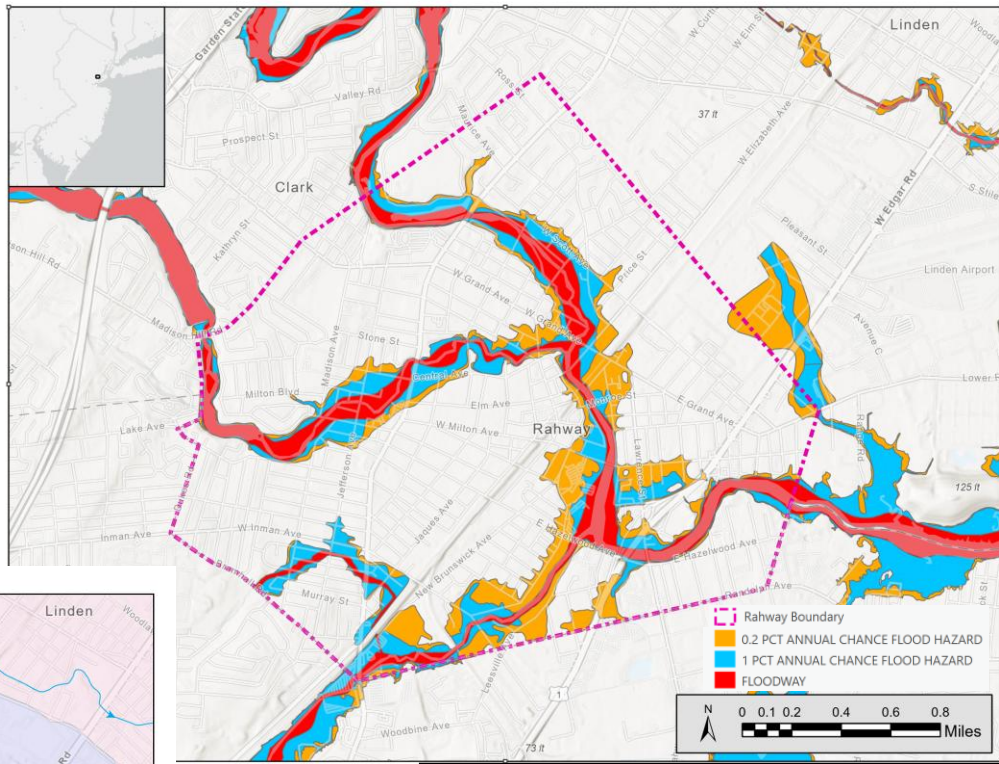


Evaluating potential mitigation

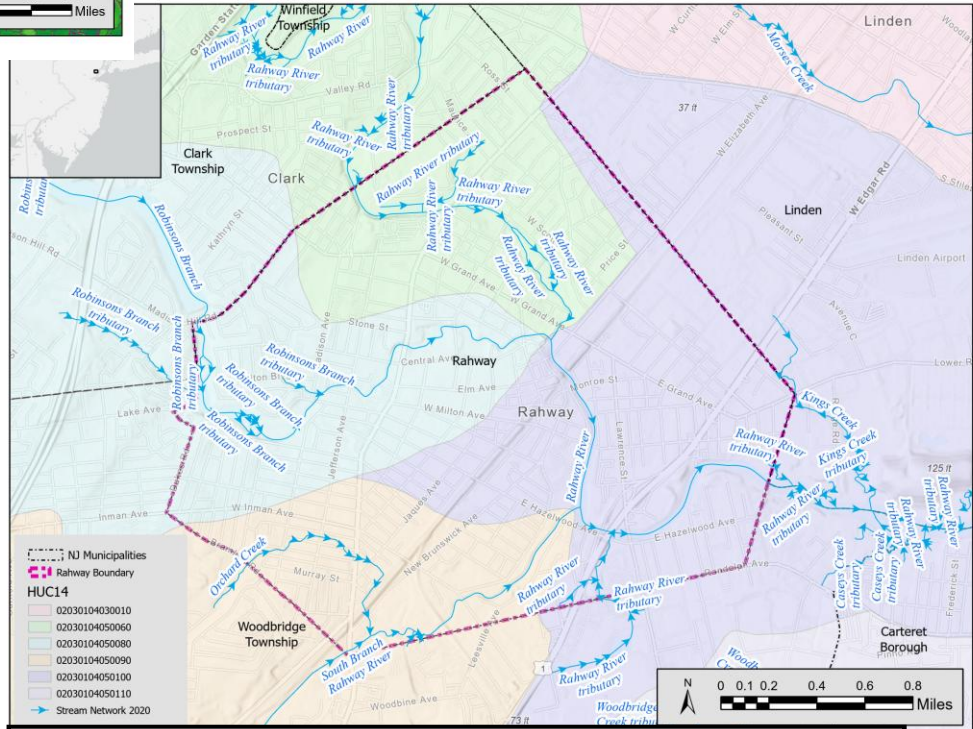




Elevation



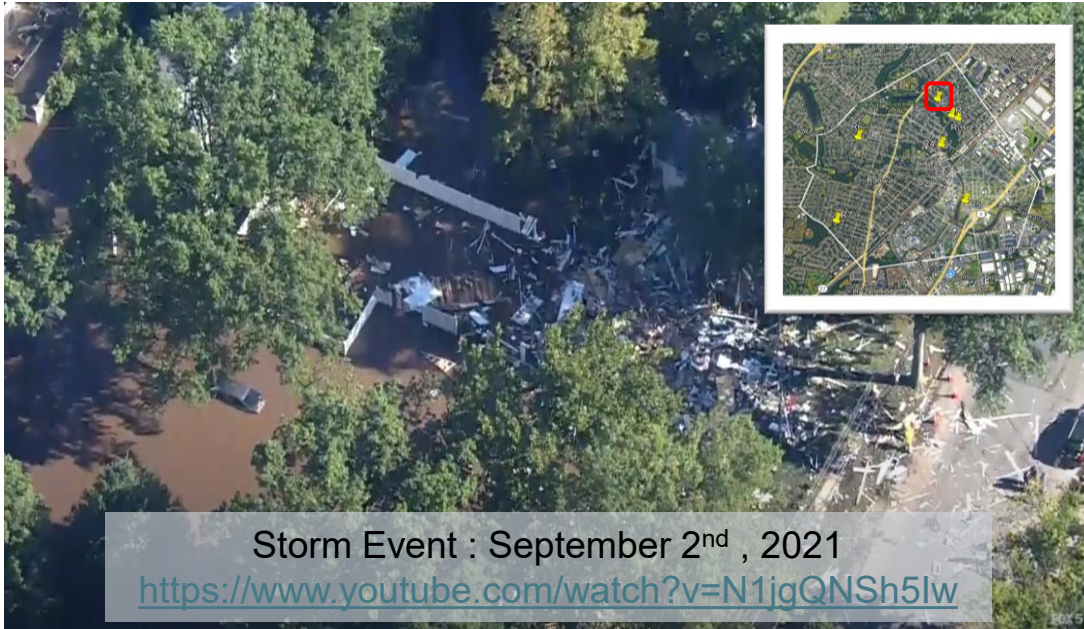
FEMA's National Flood Hazard Layer (NFHL)



Streams and watershed delineation

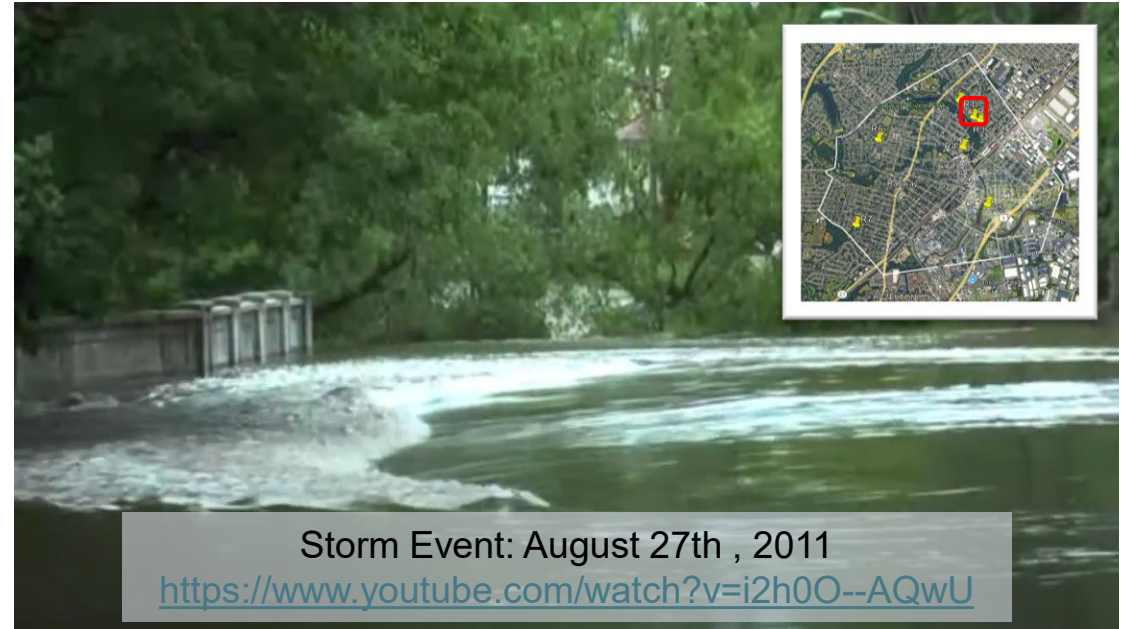


Flood-Prone Areas



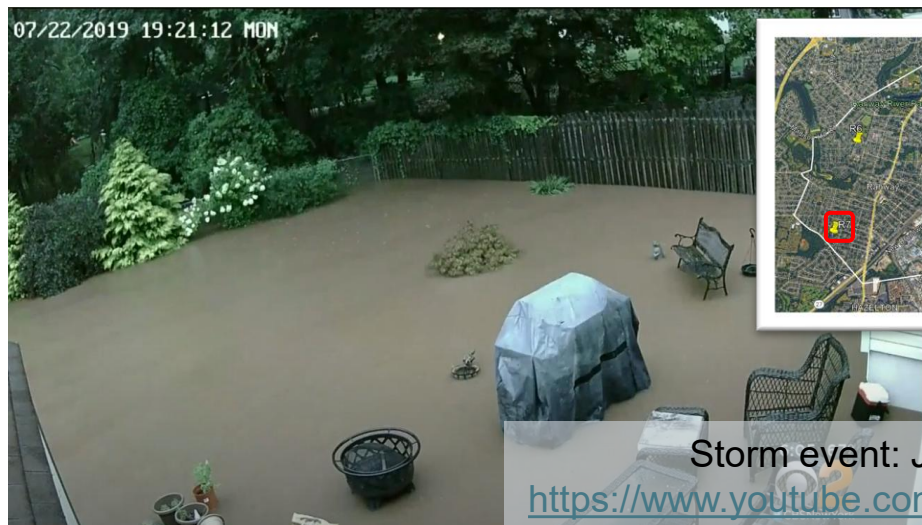
Storm Event : September 2nd , 2021

<https://www.youtube.com/watch?v=N1jgQNSh5lw>



Storm Event: August 27th , 2011

<https://www.youtube.com/watch?v=i2h0O--AQwU>



07/22/2019 19:21:12 MON

Storm event: July 22nd , 2019

https://www.youtube.com/watch?v=SKbuFtlG_8g

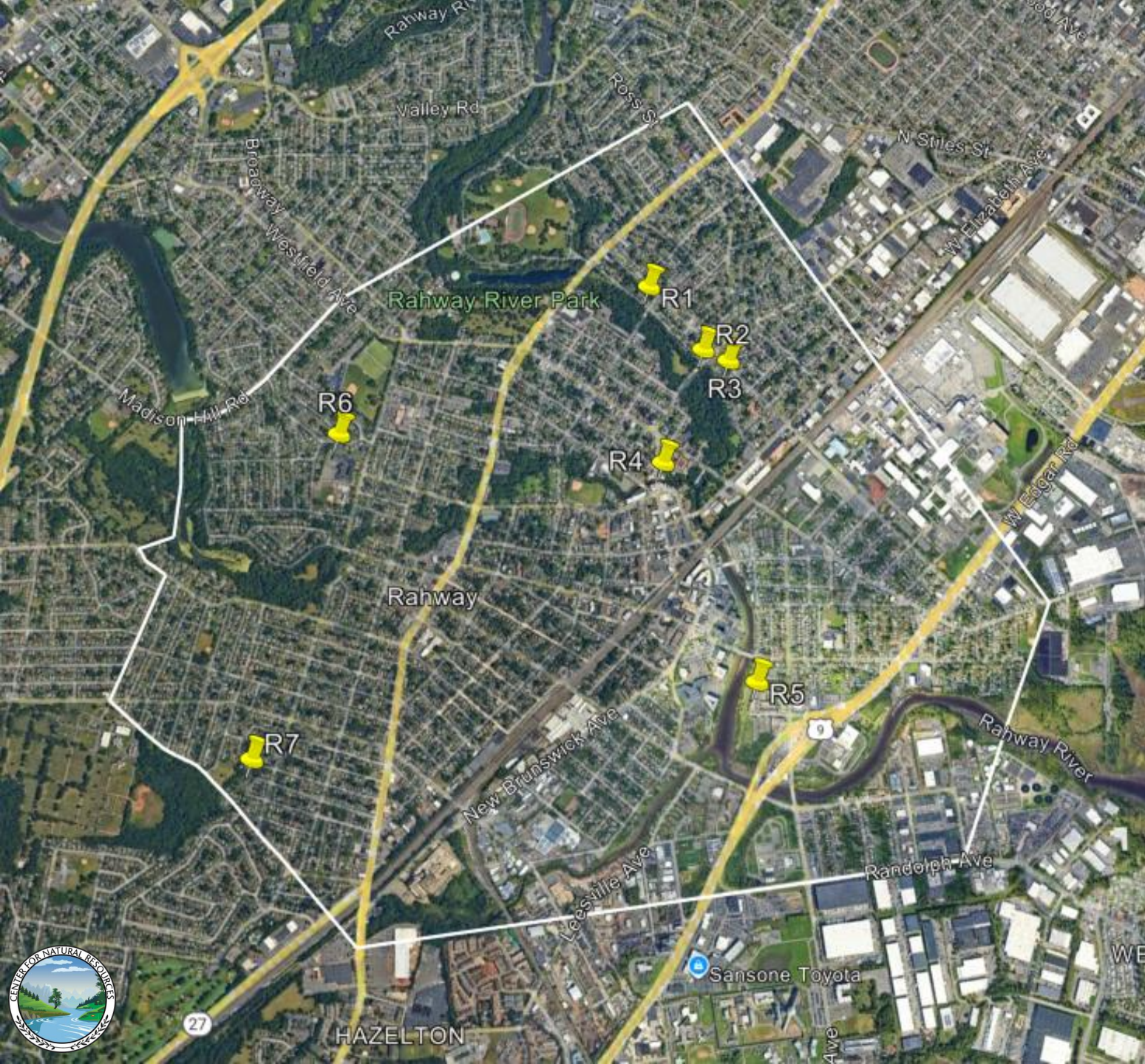


19:53:38 MON



Examples of Flood-Prone Areas in Rahway

- R1 - River Road
- R2 - Whittier St & W Scott Ave
- R3 - Egolf Dr
- R4 - Irving St
- R5 - Riverwalk
- R6 - Rahway High School
- R7 - Lenz court



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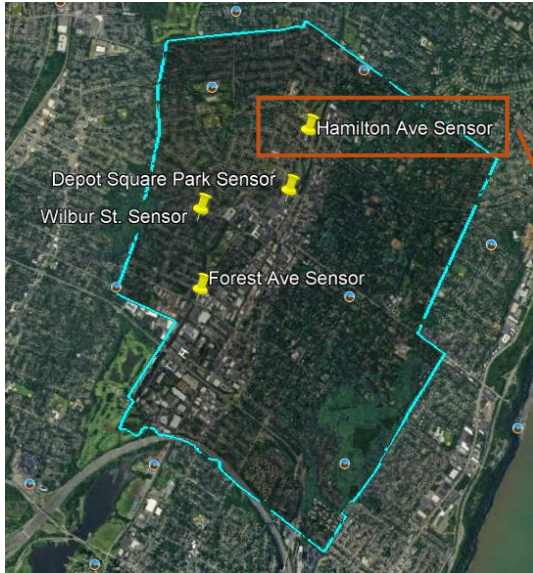
Photos of the water level sensors (Englewood, NJ)



Photos of cameras (Englewood, NJ)



Video recording from the storm event on August 18, 2024 in Englewood, NJ



Hamilton Ave

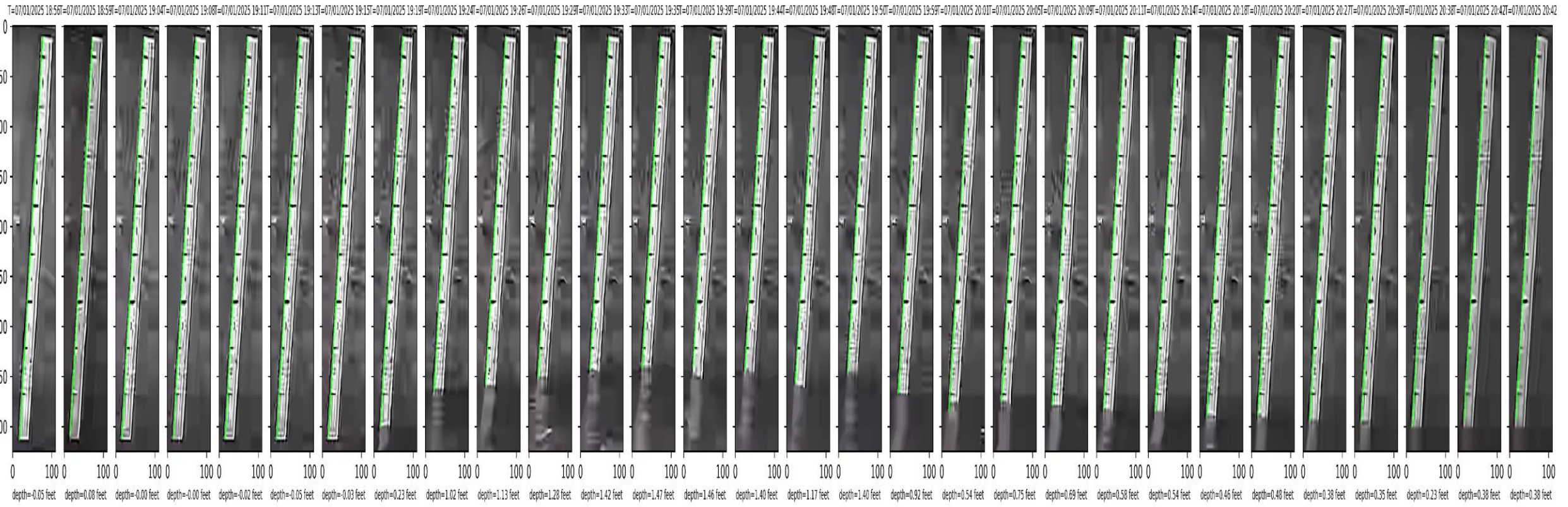


Water Level Detection from Camera Imagery cont.

Irvington – Chancellor Park
August 17, 2025 Storm



Machine Learning (AI) to read the water level on the rod



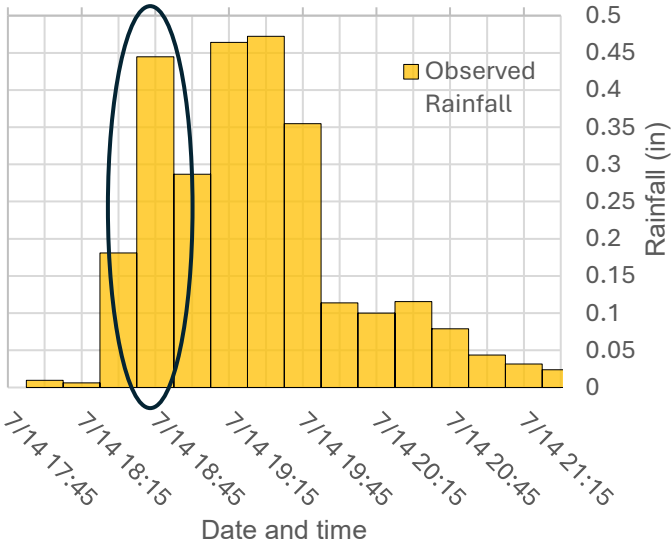
Water level monitoring

Location: Broad Ave

Storm event: July 14, 2025

Time: 18:36

Flooding was highly dynamic.



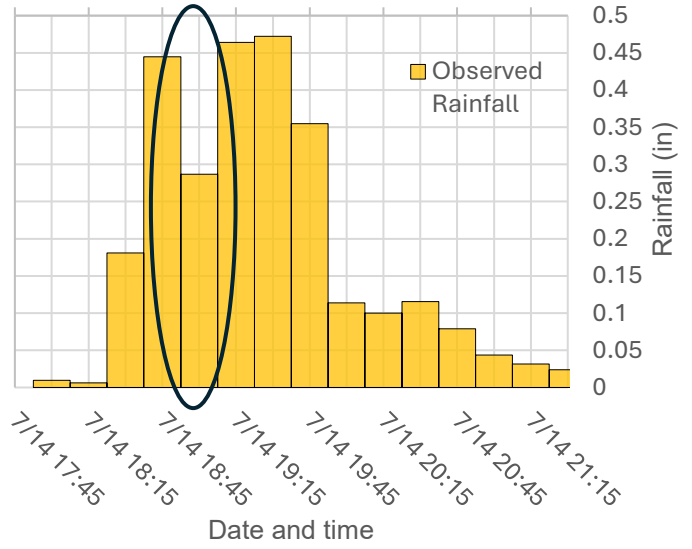
Water level monitoring

Location: Broad Ave

Storm event: July 14, 2025

Time: 18:50

After about fifteen minutes, rainfall intensity decreased, leading to a substantial reduction in runoff.



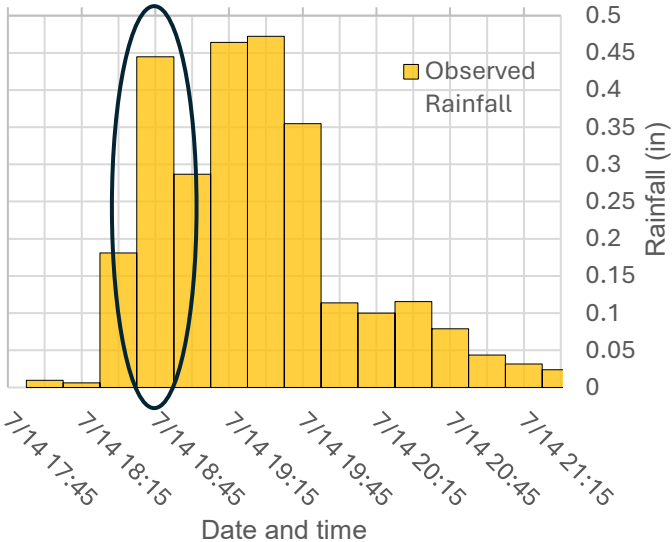
Water level monitoring

Location: Church culvert

Storm event: July 14, 2025

Time: 18:37

At the beginning of this period, some runoff accumulated in the church backyard.



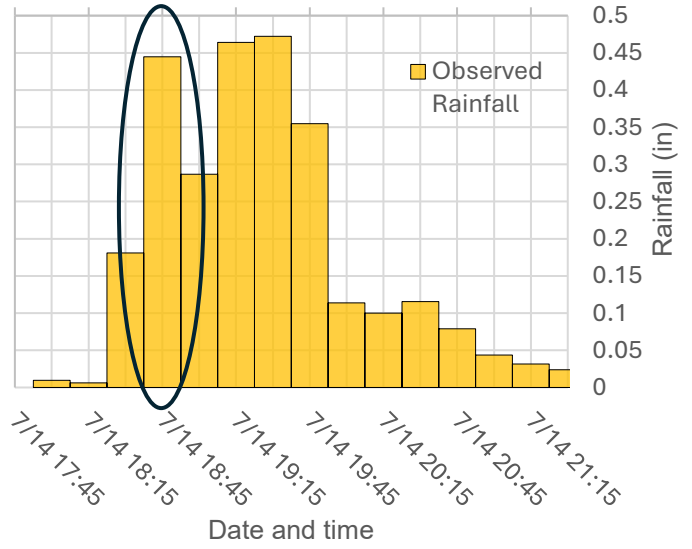
Water level monitoring

Location: Church culvert

Storm event: July 14, 2025

Time: 18:43

Within six minutes, the water level increased rapidly.



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Site Surveying: LiDAR Equipped Drone



► DJI Matrice 350 RTK:

► RTK Positioning Accuracy:

- 1 cm (horizontal)
- 1.5 cm (vertical)

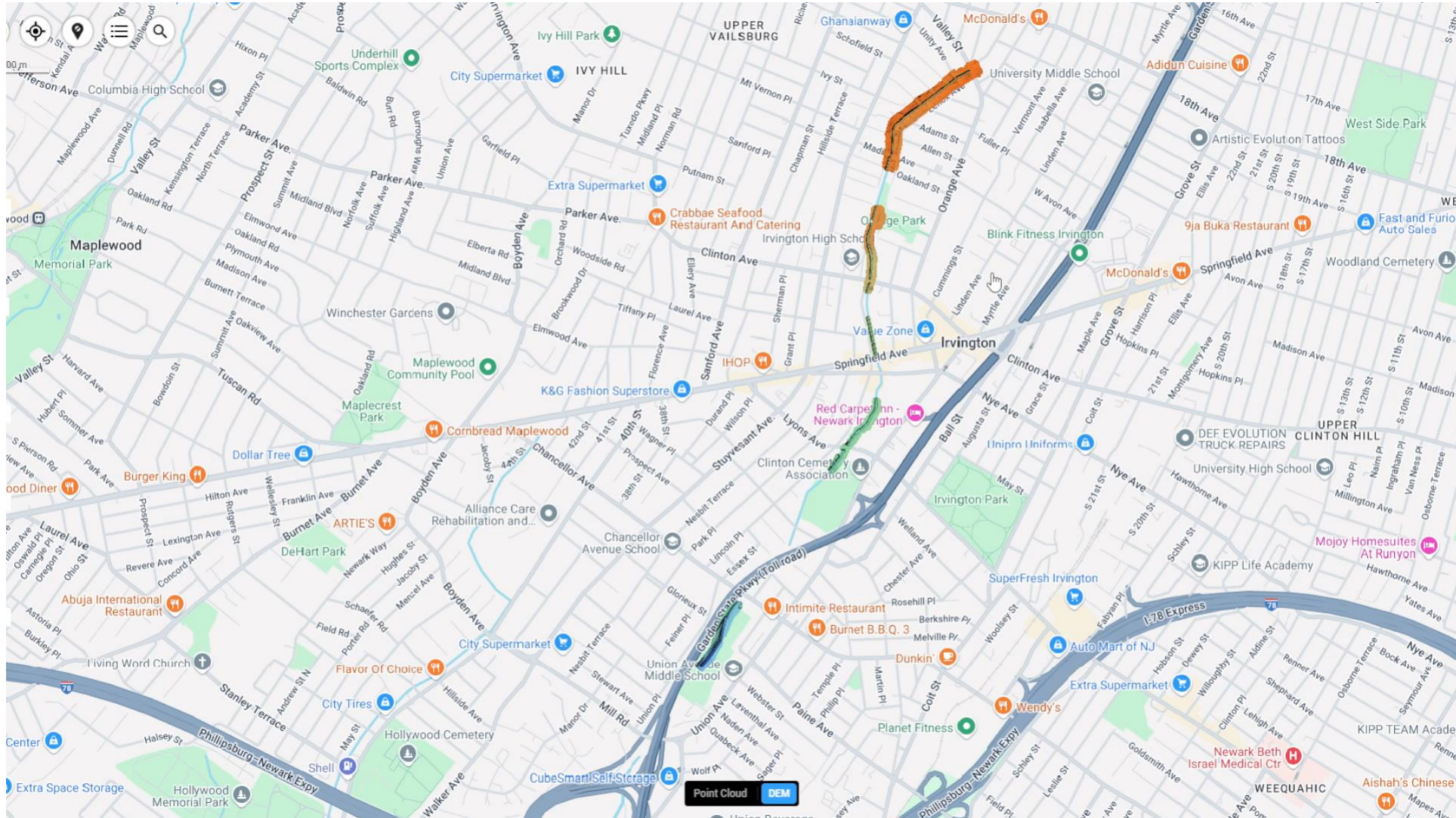
► Zenmuse L2:

At 150 m height:

- 4 cm elevation accuracy
- 5 cm plane accuracy



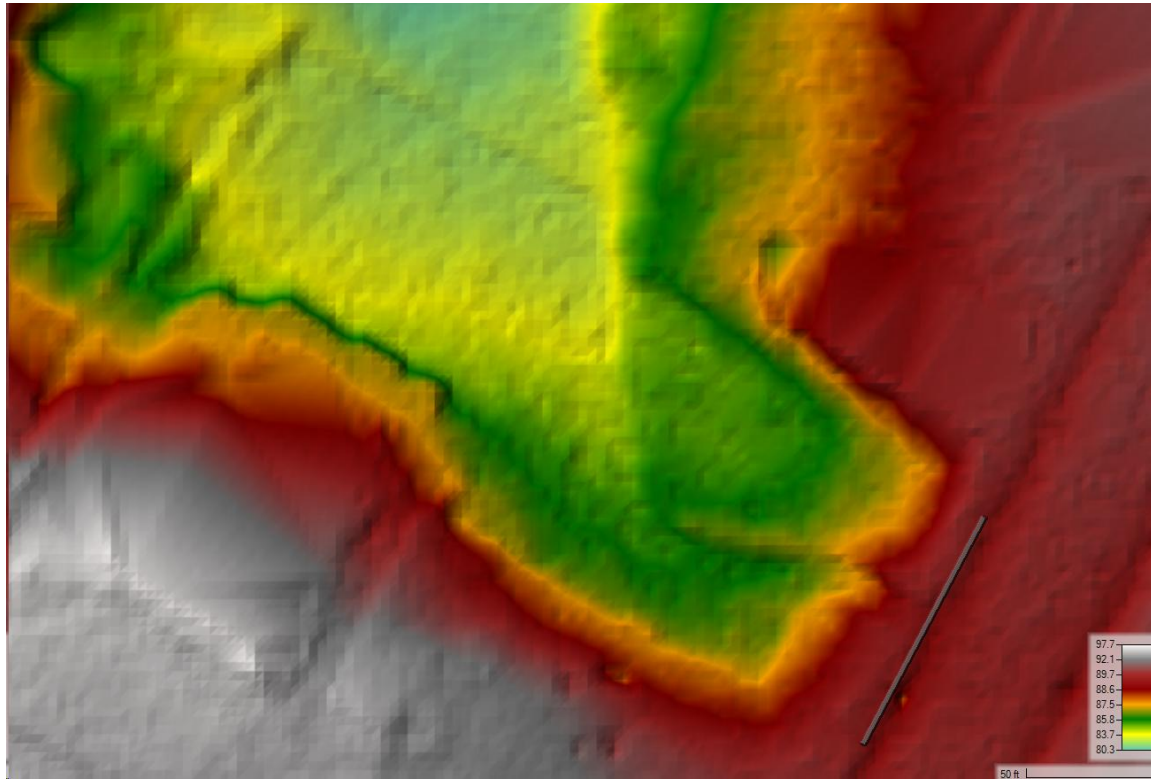
Site Surveying: Channel and infrastructure survey in Irvington, NJ



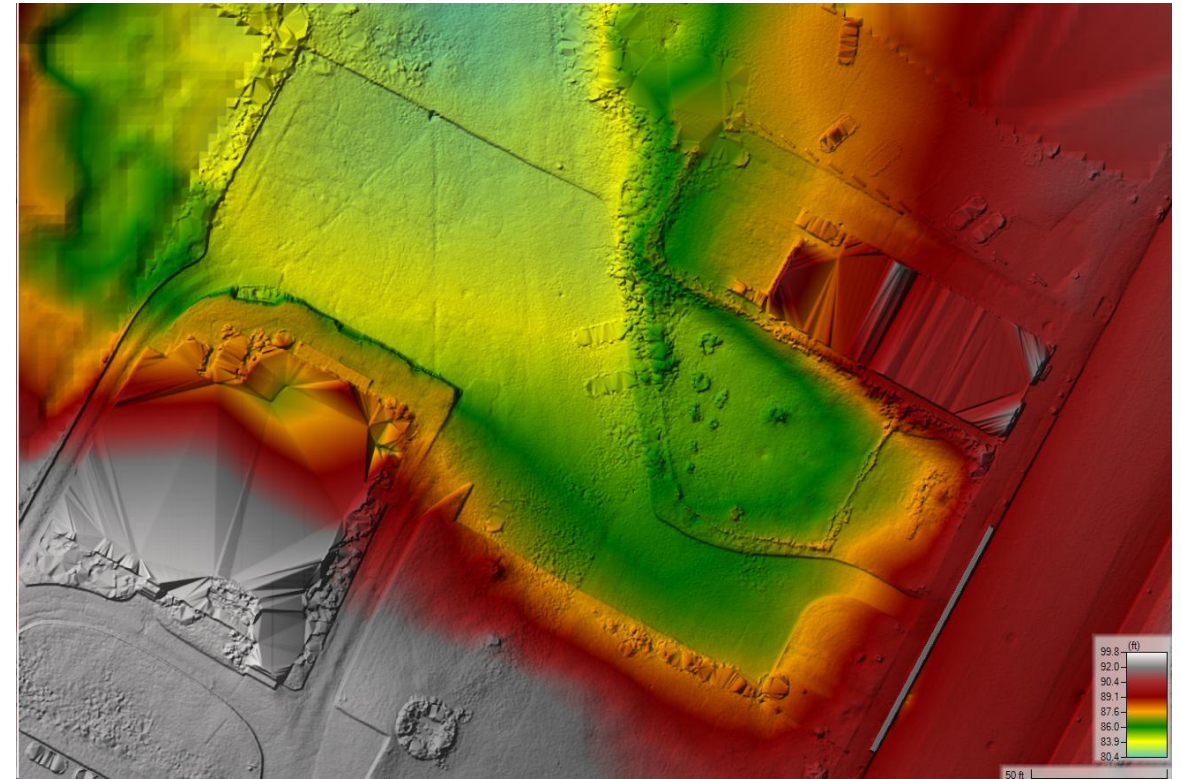
Site Surveying: Terrain Data Preparation

Base terrain data

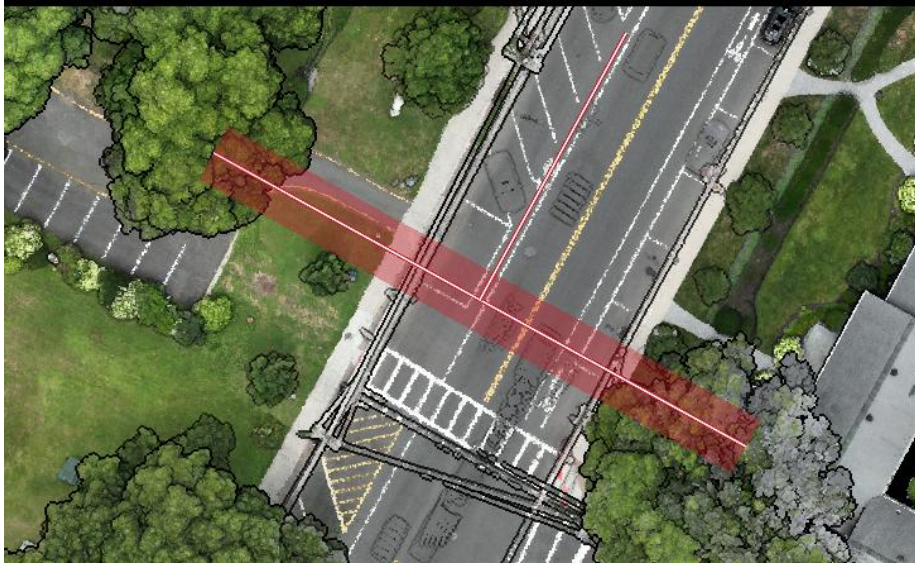
USGS 3D Elevation Program (1-m resolution)



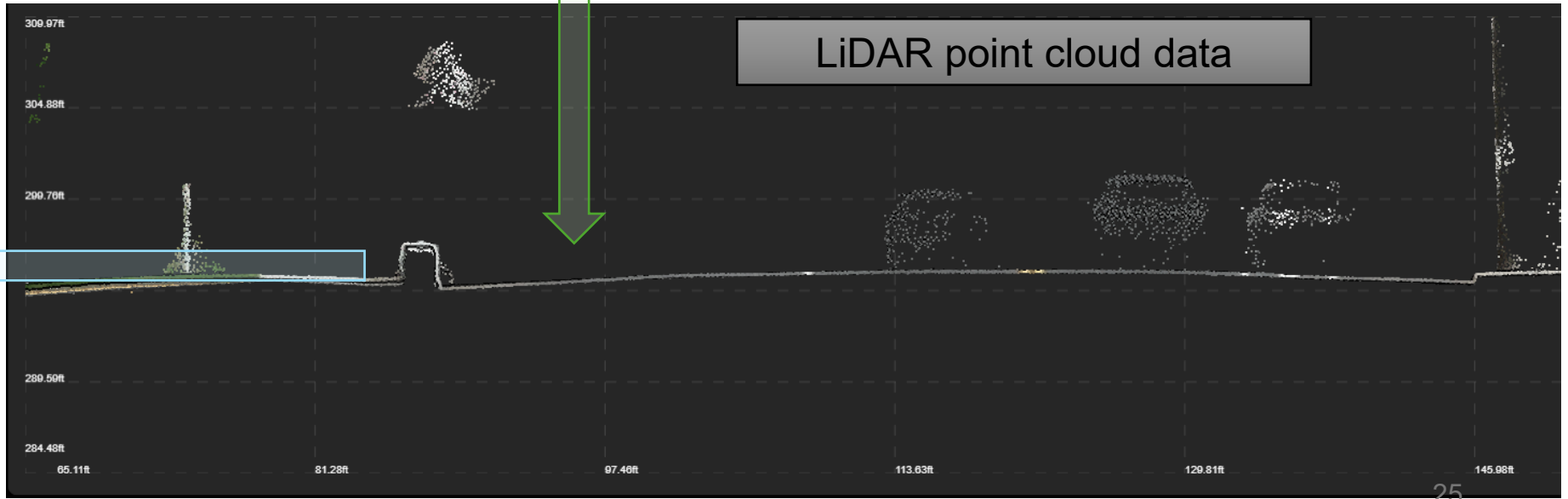
LiDAR-enhanced terrain data



Water level extraction



Horizontal position of the water level



Vertical depth

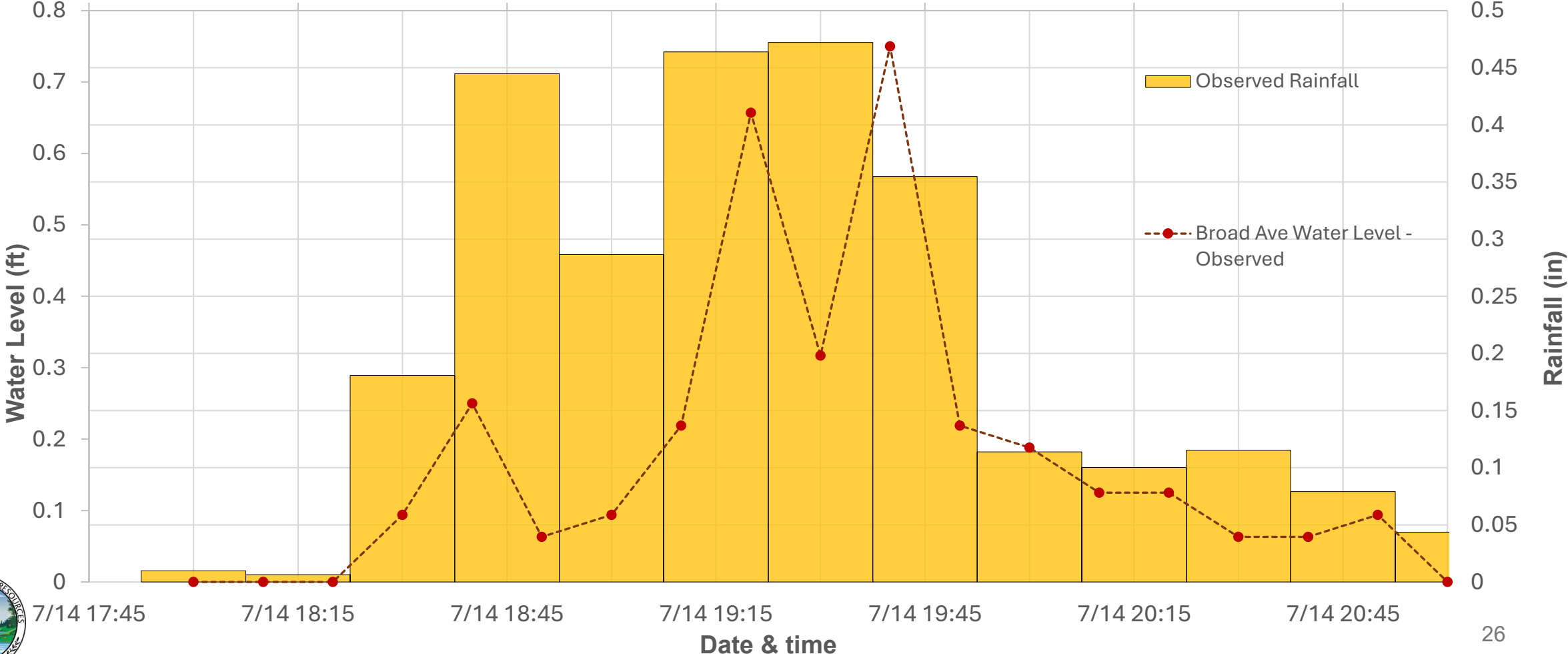


Baseline Calibration

Location: Broad Ave



Infiltration parameters directly affect the response time and water depth.



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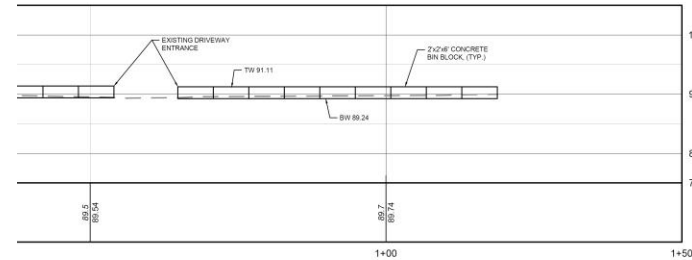
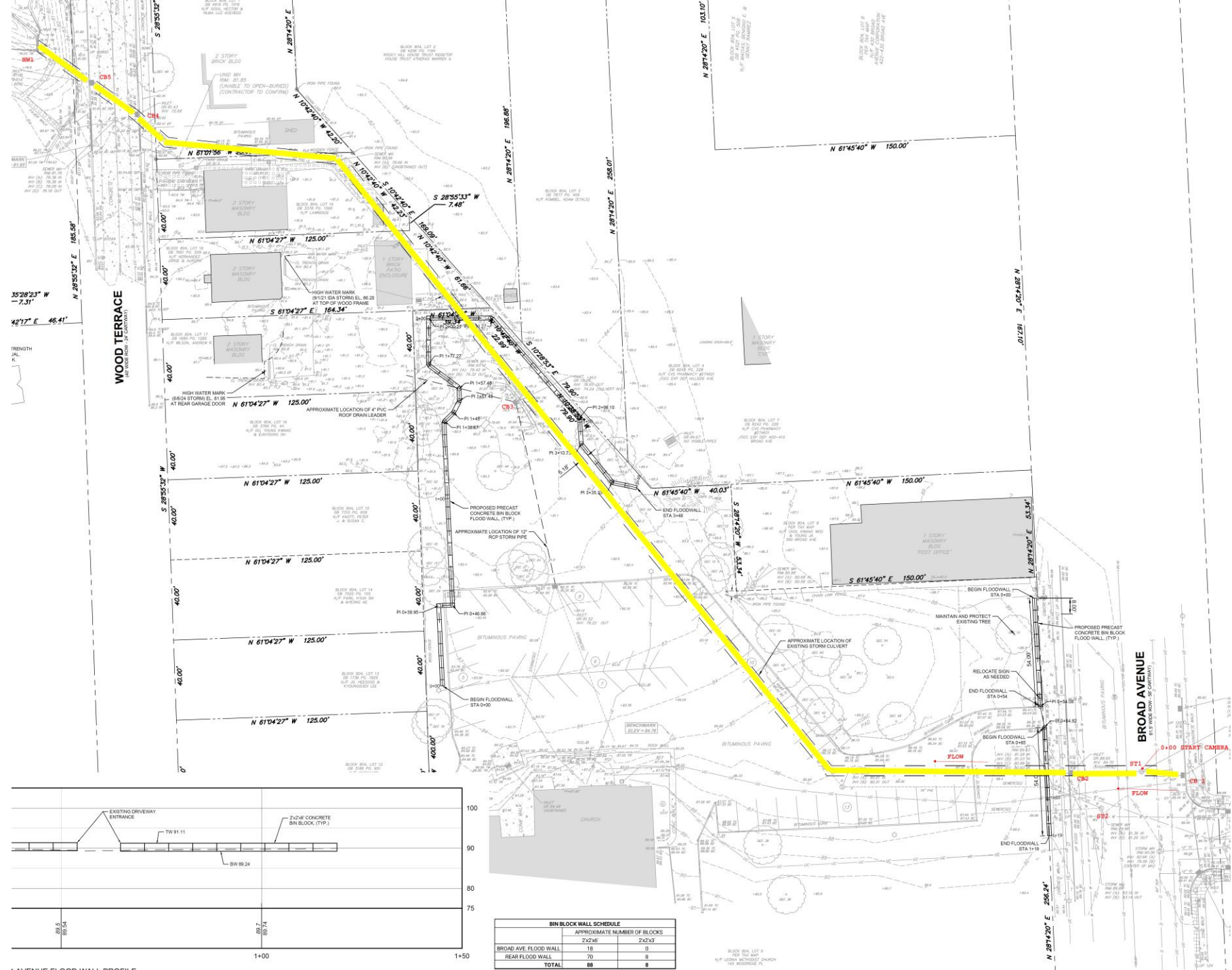
Validating the model with real storm events



Evaluating potential mitigation



Drainage system



BIN BLOCK WALL SCHEDULE		
	APPROXIMATE NUMBER OF BLOCKS	
	Z22X6	Z22X2
BROAD AVE. FLOOD WALL	18	0
REAR FLOOD WALL	70	8
TOTAL	88	8



Precipitation Data Processing

Data source:

- Multi-Radar Multi-Sensor 1-hr (NOAA, NCEP)

NEXRAD radars, plus data from satellites, surface rain gauges, and weather models

- Radar-Only 15-min (NOAA, NCEP)

NEXRAD data only

Result:

High temporal resolution rainfall with high accuracy

Multi-Radar Multi-Sensor



High accuracy

Radar-only



High temporal resolution

Sources: <https://www.nssl.noaa.gov/projects/mrms/>
<https://mrms.ncep.noaa.gov/>
<https://www.ncei.noaa.gov/products/radar/next-generation-weather-radar>



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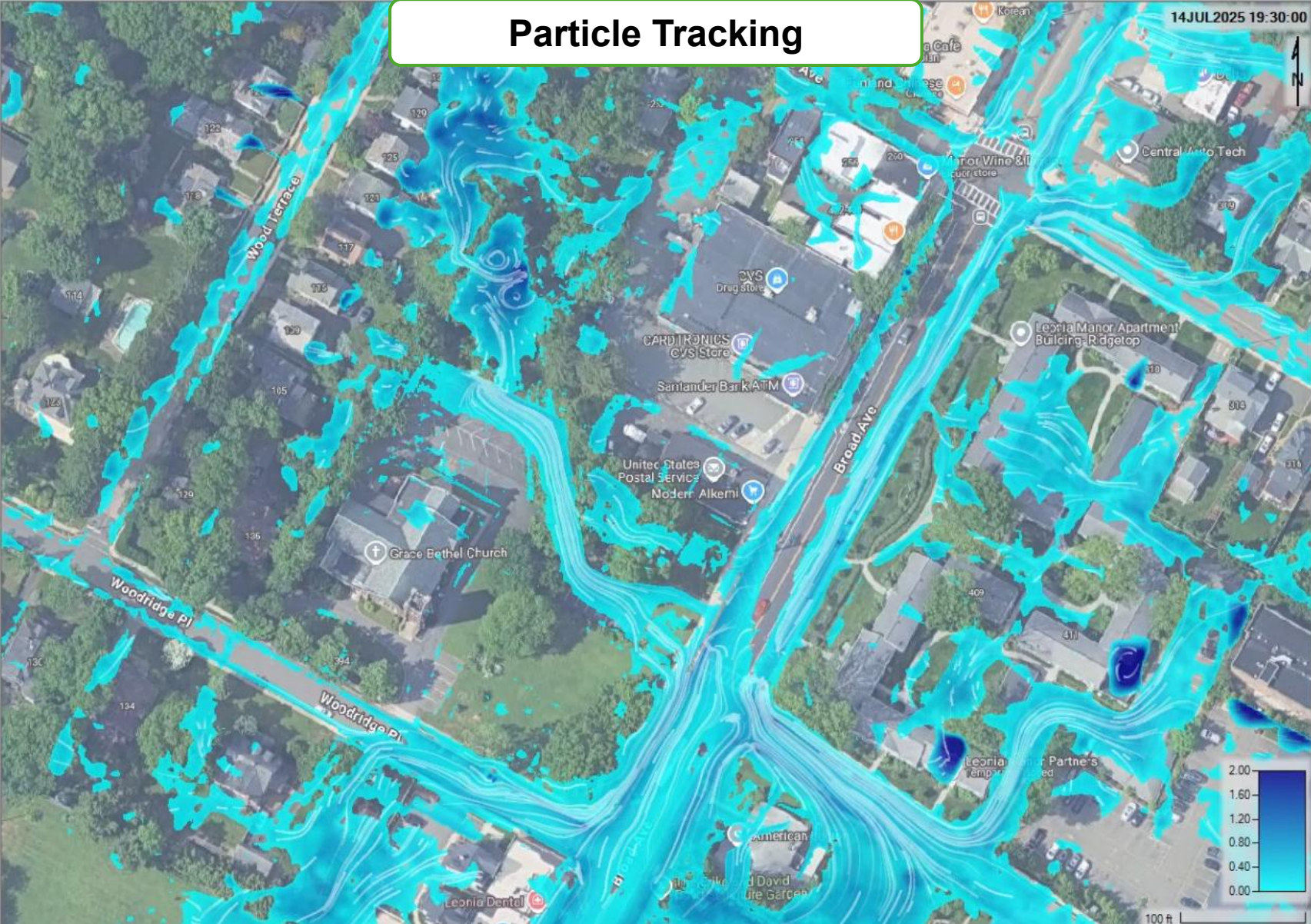
Evaluating potential mitigation



Simulation Results

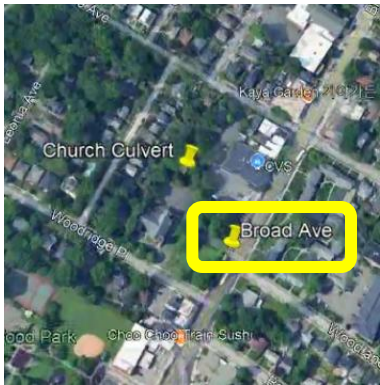


Simulation Results

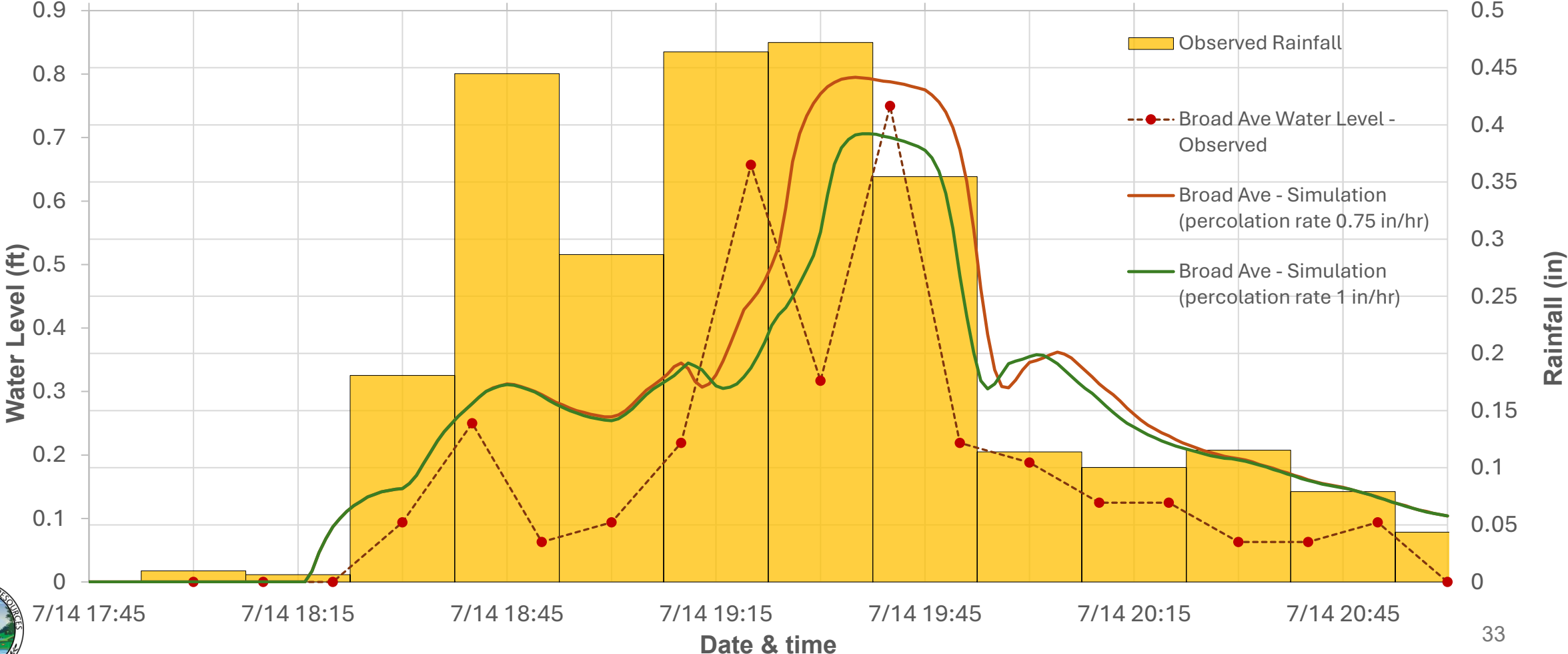


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Location: Broad Ave



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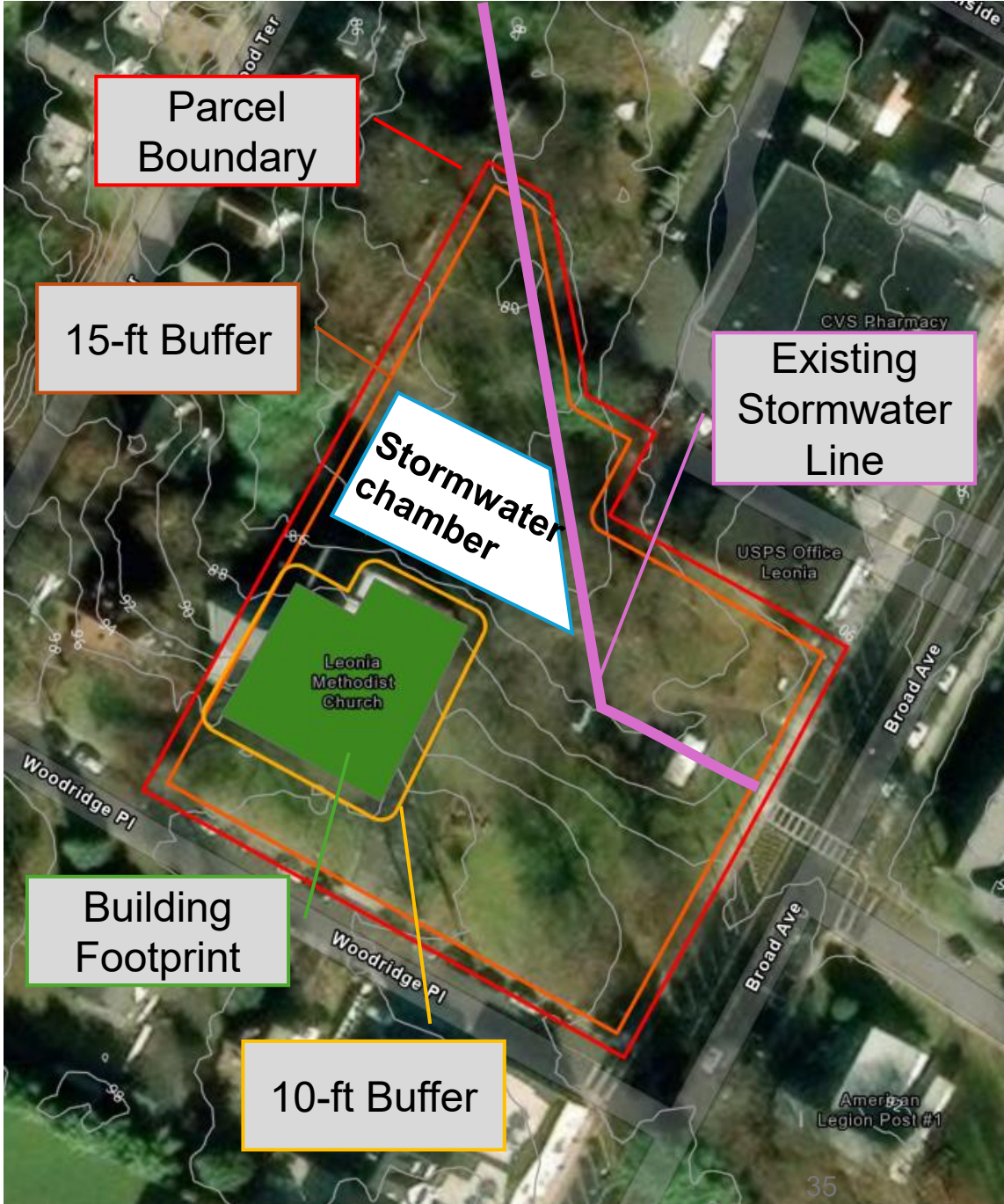
Validating the model with real storm events



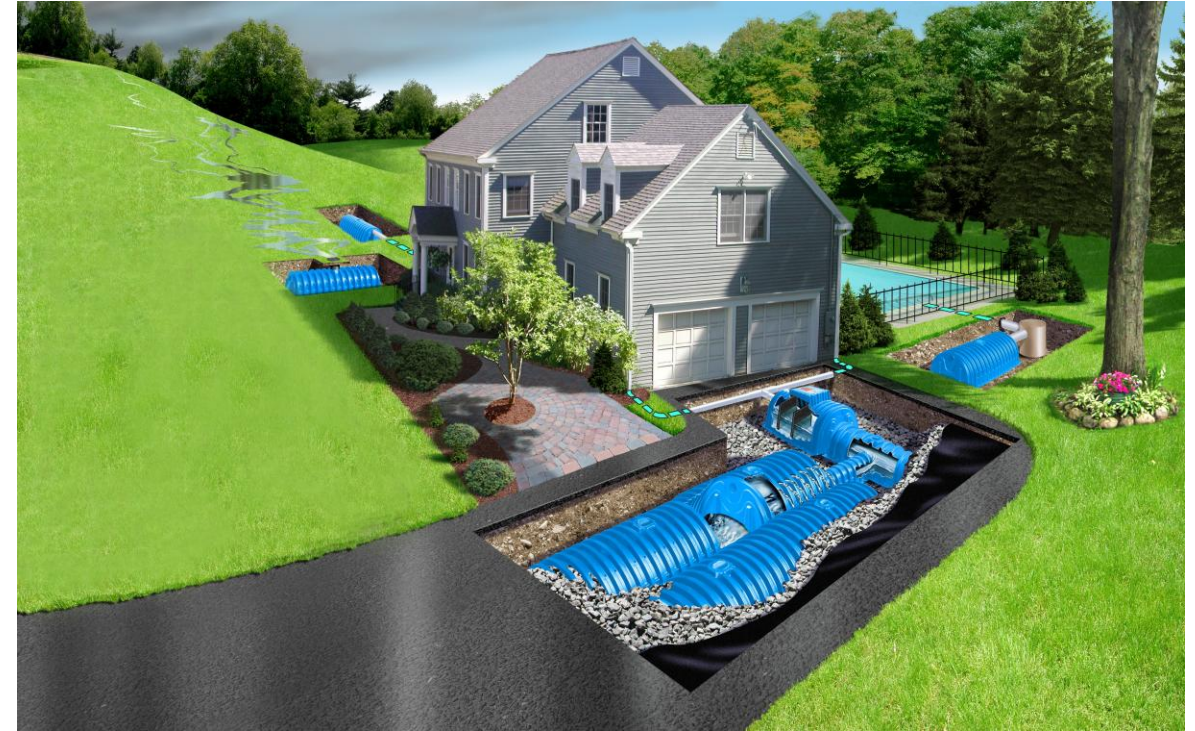
Evaluating potential mitigation



Potential location for the underground storage



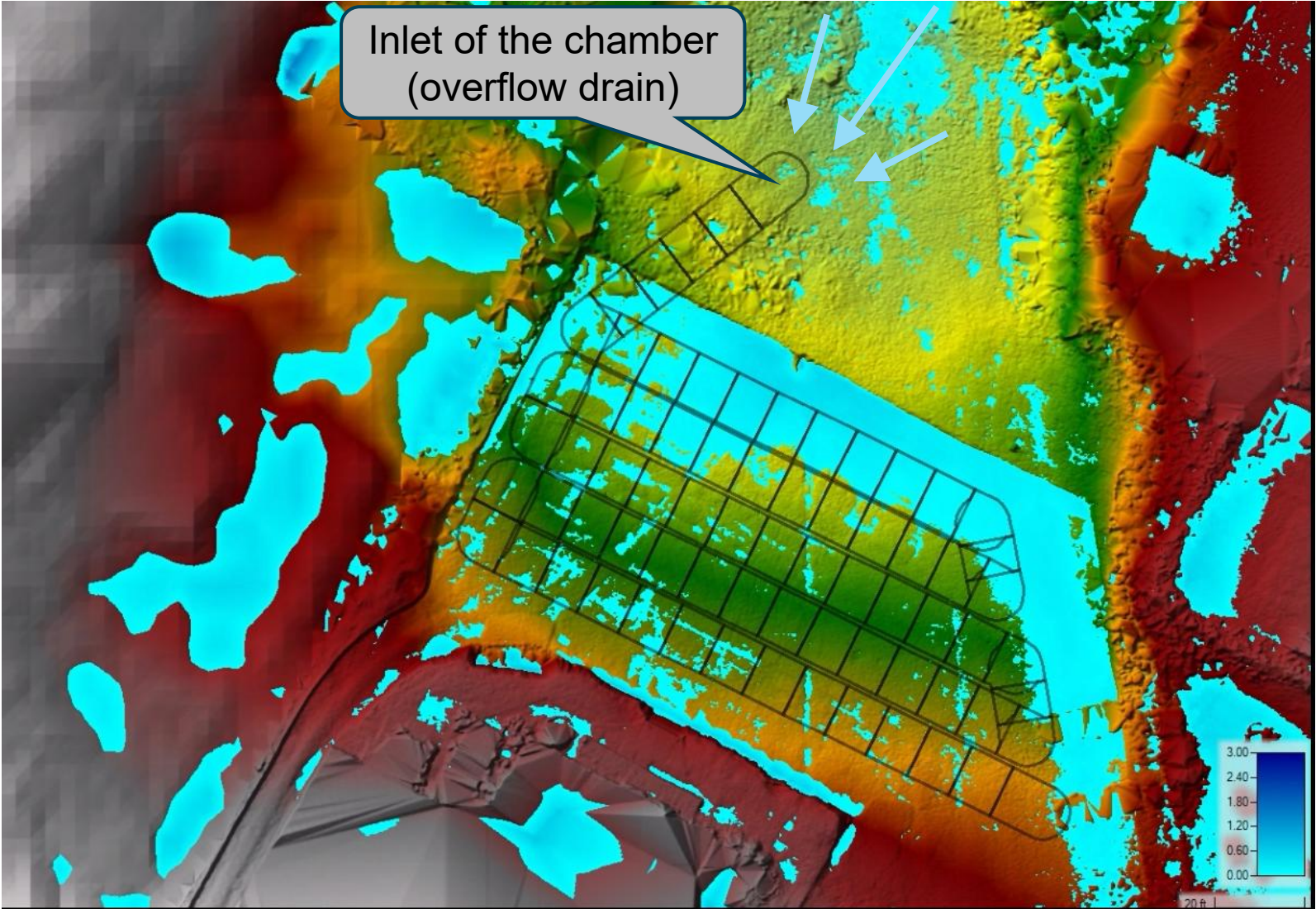
Evaluating Potential Solution: Underground storage/Stormwater chamber



Source: <https://cultec.com/stormwater-systems/>



Simulation Results

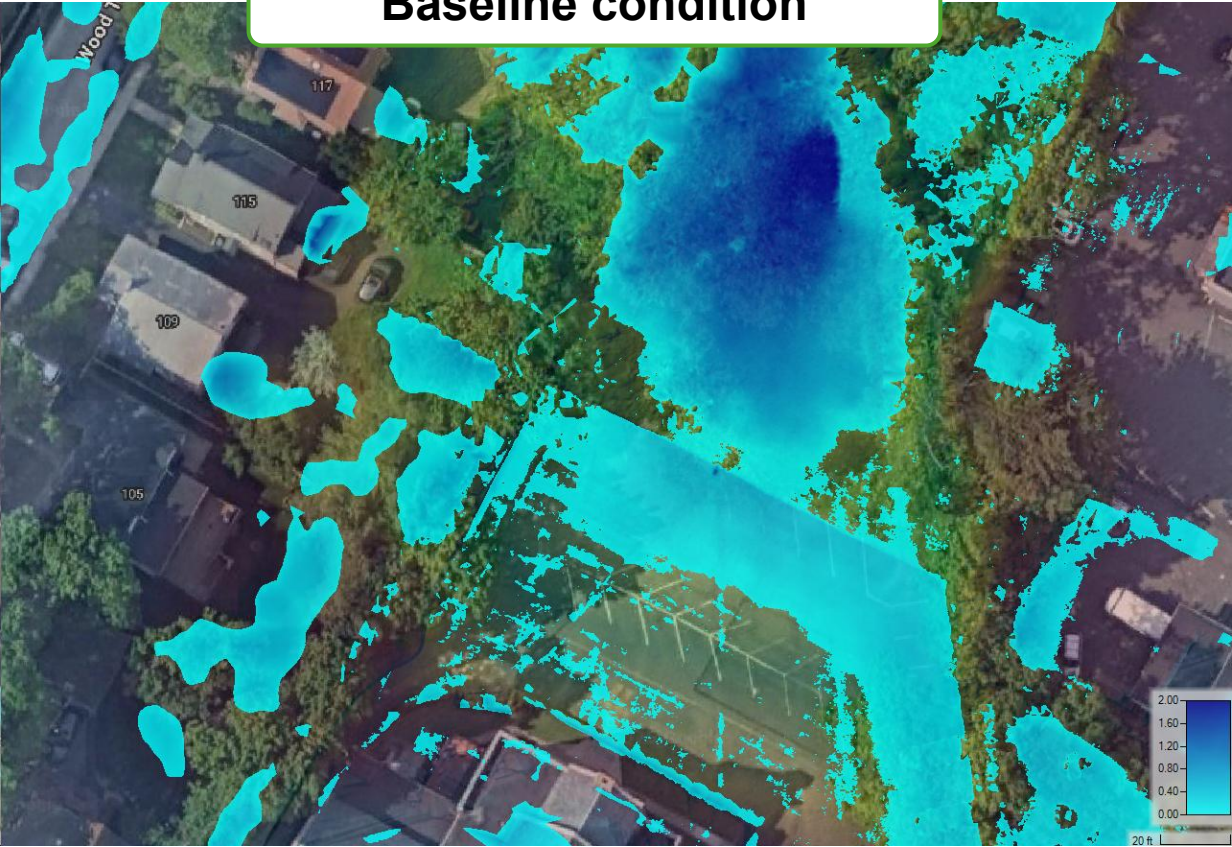


Runoff overflows into the underground storage once the water level reach the inlet elevation

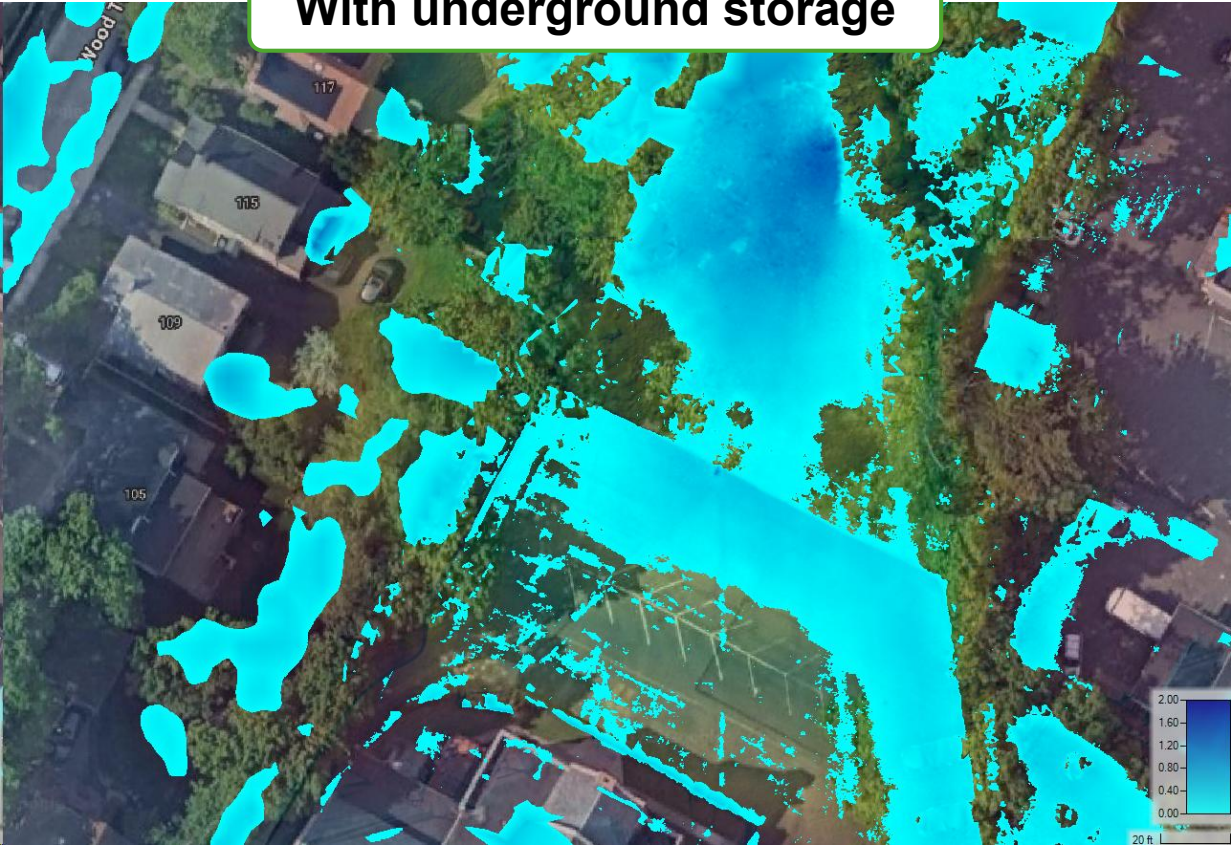


Simulation Results

Baseline condition



With underground storage



Water depth and flood extent decreases substantially after the underground storage was implemented.



Detention basin

Detention basin

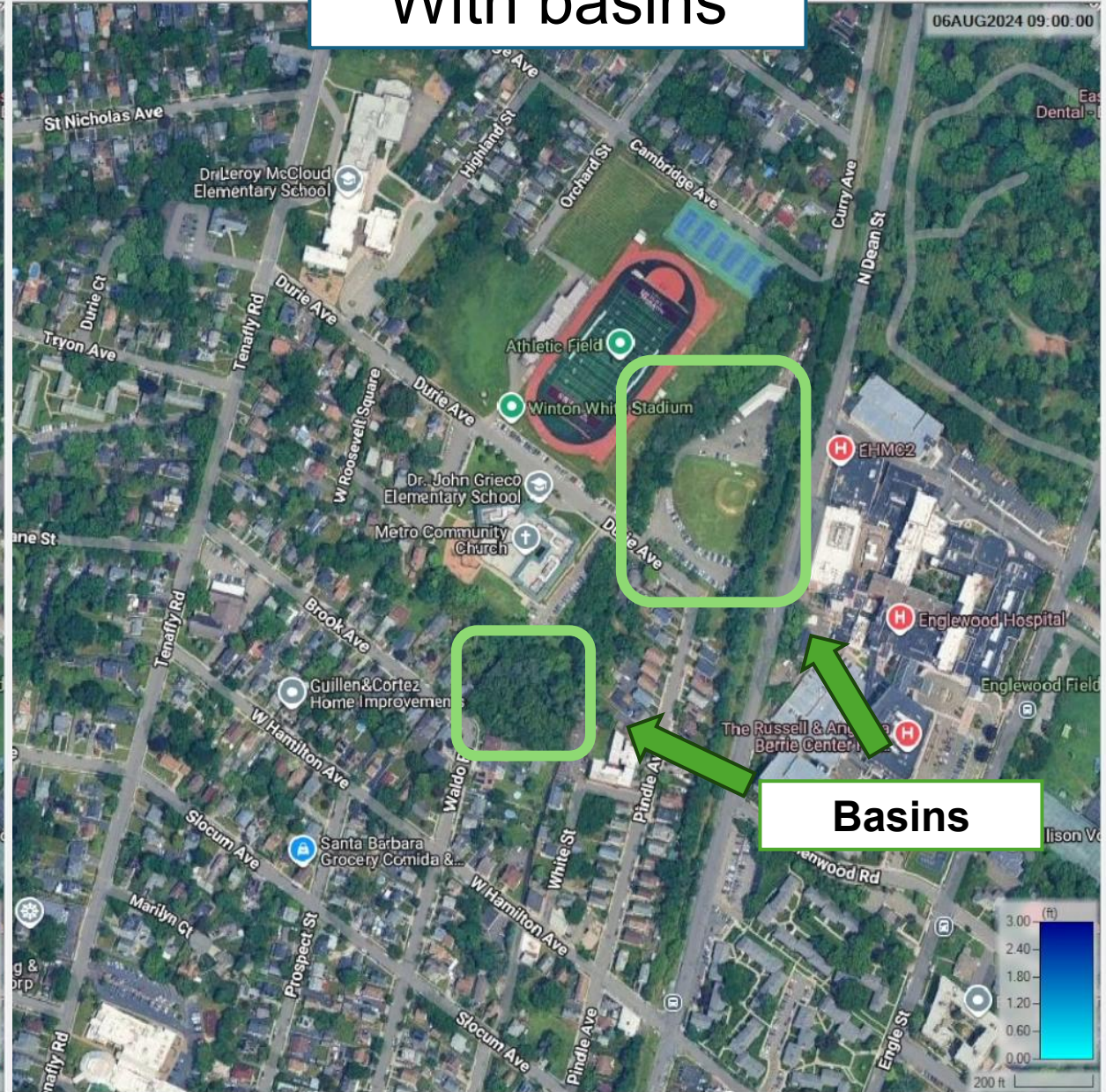


2-Y Storm

Existing conditions



With basins



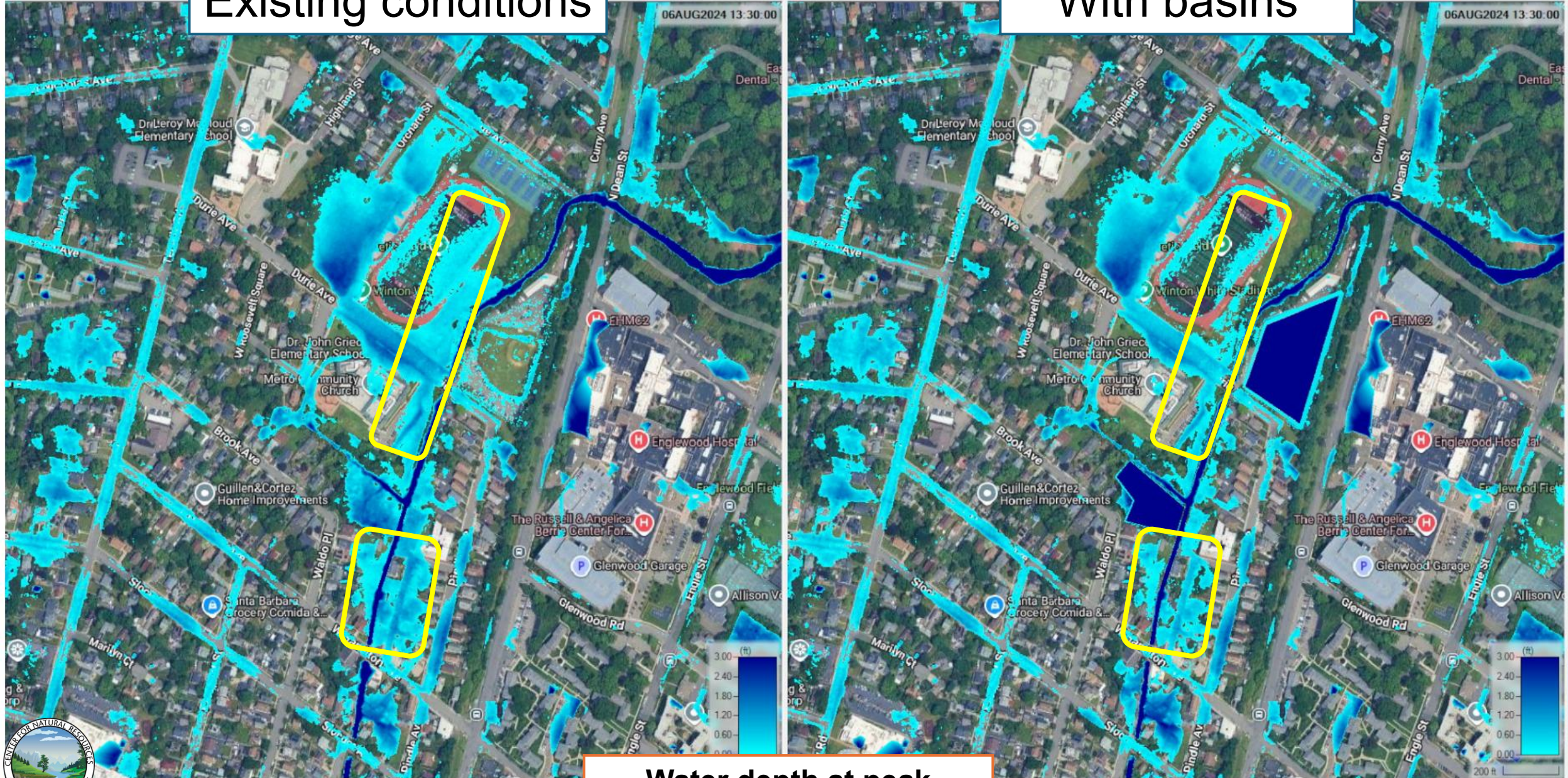
Basins



2-Y Storm

Existing conditions

With basins



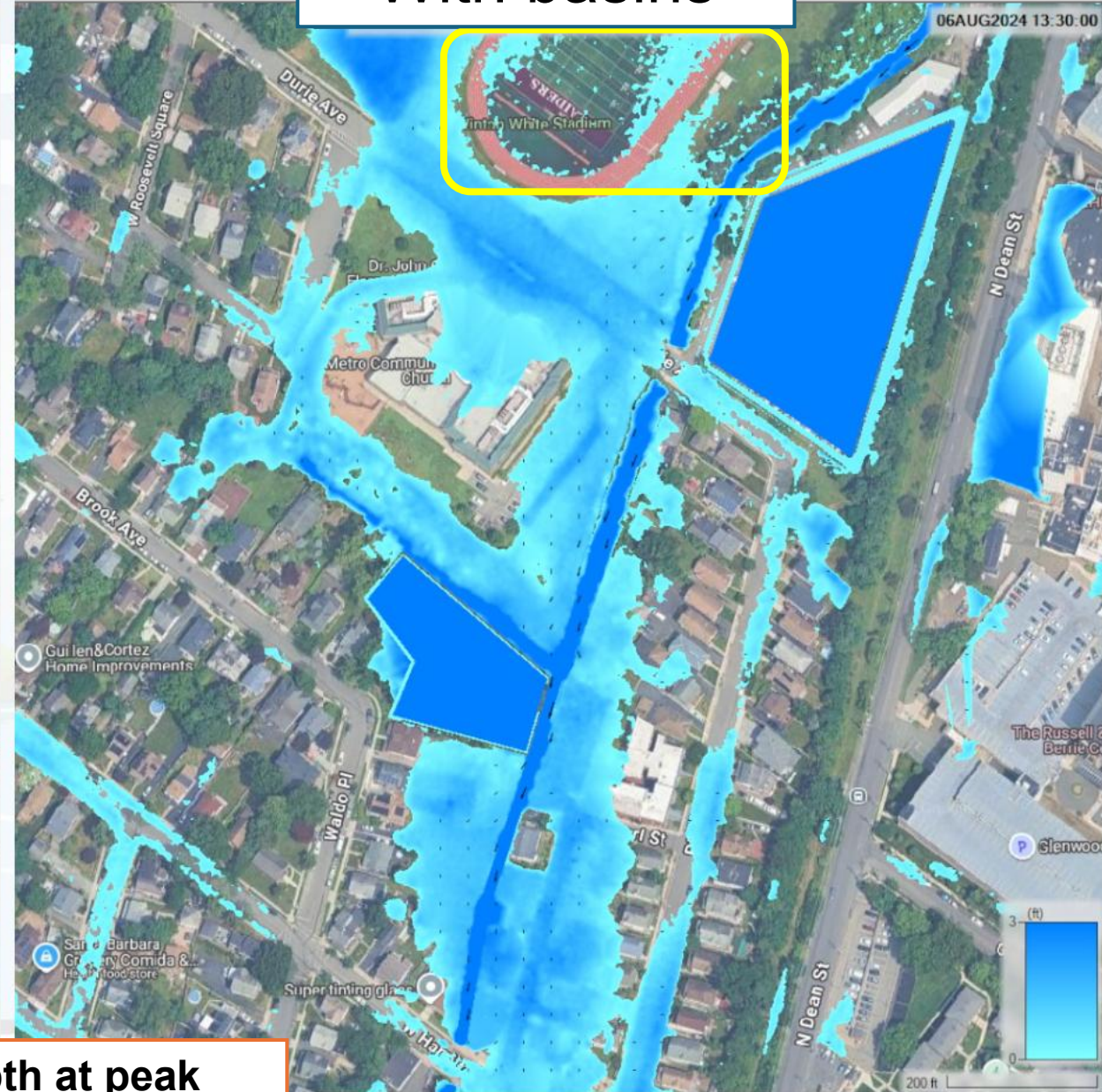
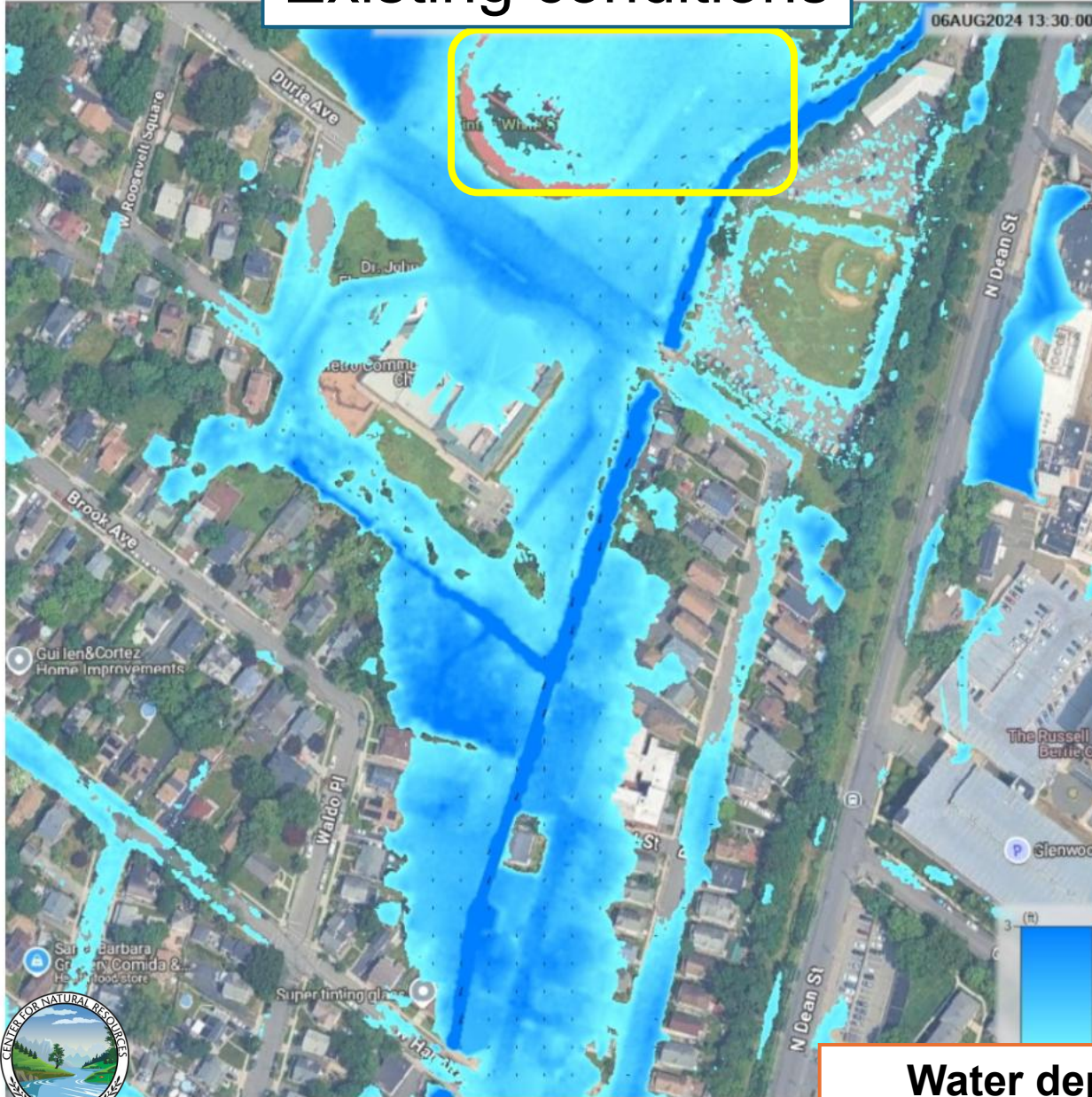
Water depth at peak rainfall



5-Y Storm

Existing conditions

With basins



Water depth at peak rainfall

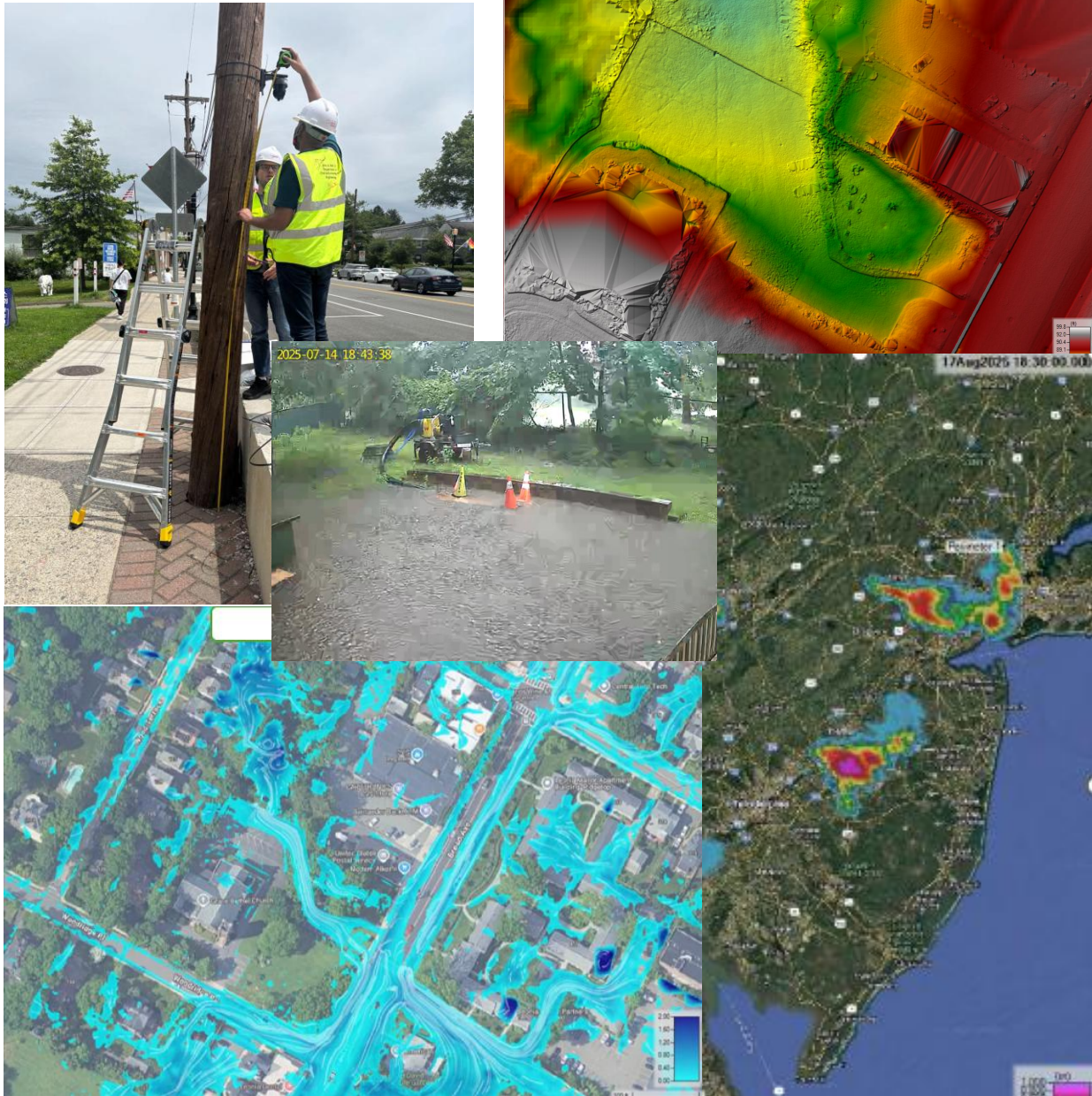


Conclusion

Field-validated hydraulic modeling, supported by comprehensive data (e.g., LiDAR, water level, high-resolution precipitation, existing infrastructures) provides a reliable basis for understanding and mitigating urban flooding.

Integrating community and municipal input strengthens resilience planning and scalability

This framework provides a scalable pathway for strengthening climate resilience across New Jersey, enabling municipalities to better anticipate, withstand, and recover from increasingly severe flooding.



Thank you



Center for Natural Resources

New Jersey Institute of Technology
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