East Isthmus and Yahara River Watershed Study Solutions

City of Madison Engineering Division
Board of Public Works
April 22, 2026

Link to Final Report
(Or can be found on the project page:
www.cityofmadison.com/IsthmusYaharaWatershed)

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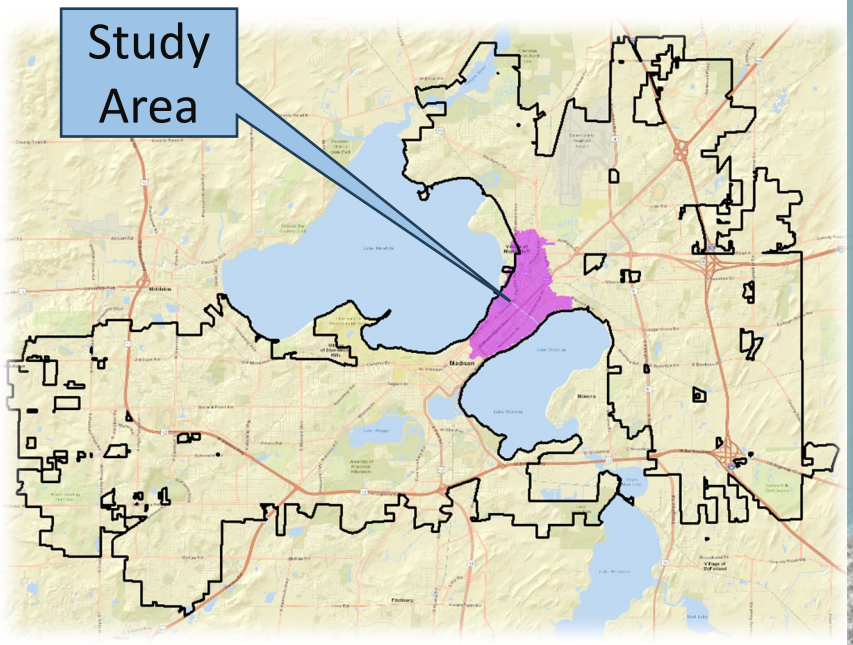
East Isthmus and Yahara Watershed Study



Lake Mendota

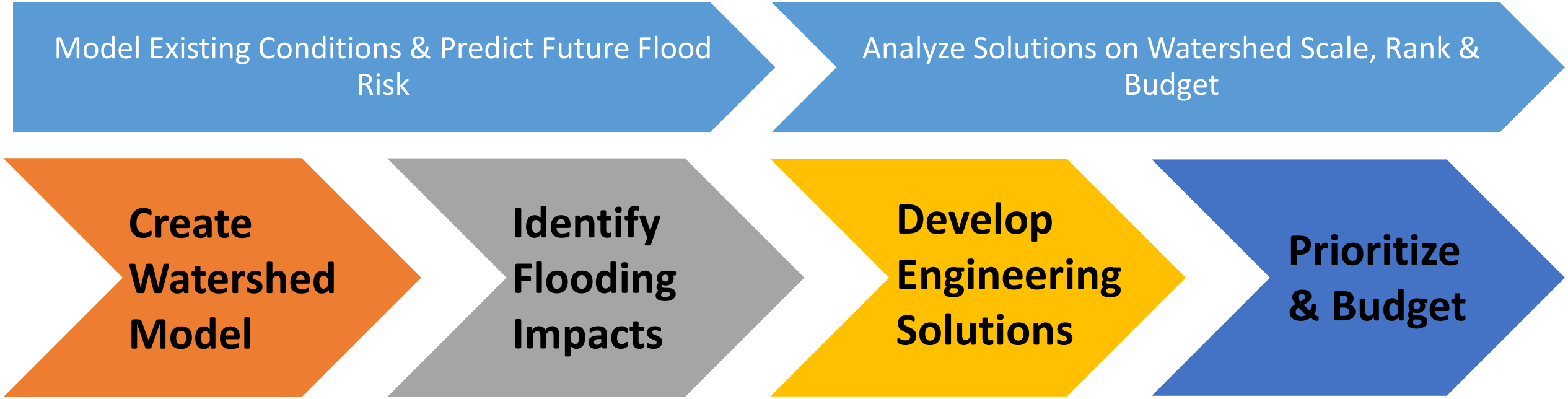
Yahara River

Starkweather Creek

Lake Monona

Watershed Study Area

Watershed Study Process



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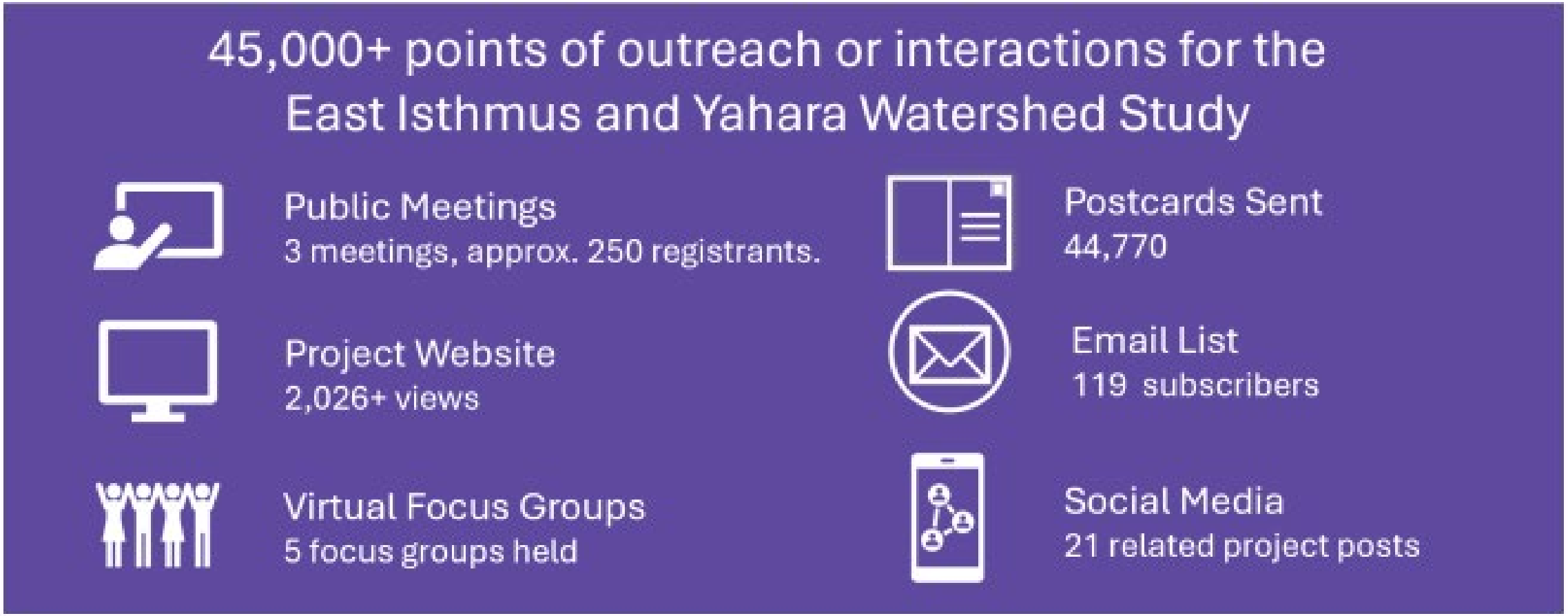
East Isthmus Yahara Watershed Study Milestones

- PIM 1: 8/26/20
- PIM 2: 10/6/22
- Public Works Improvements: 6/5/25
- Informational to BPC: 9/10/25
- PIM 3: 7/3/25
- Report Public Comment Period: 12/2/25-1/13/26
- BPC: 4/15/26
- BPW: 4/22/26
- FINAL REPORT: https://www.cityofmadison.com/engineering/documents/projects/East_Isthmus-Yahara_Final_Report-11-13-2025.pdf

Public Outreach



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Flood Mitigation Targets

10% Chance Event

- No surcharging of storm sewer onto roadway (storm sewer pipes are sized to carry storm)

4% Chance Event

- 0.2’ at Centerline of Road (roads passable for emergency vehicles)

1% Chance Event

- No structure (home/building) flooding
- No greenway crossing overflow (stormwater does not come out of greenway and flow over the road)

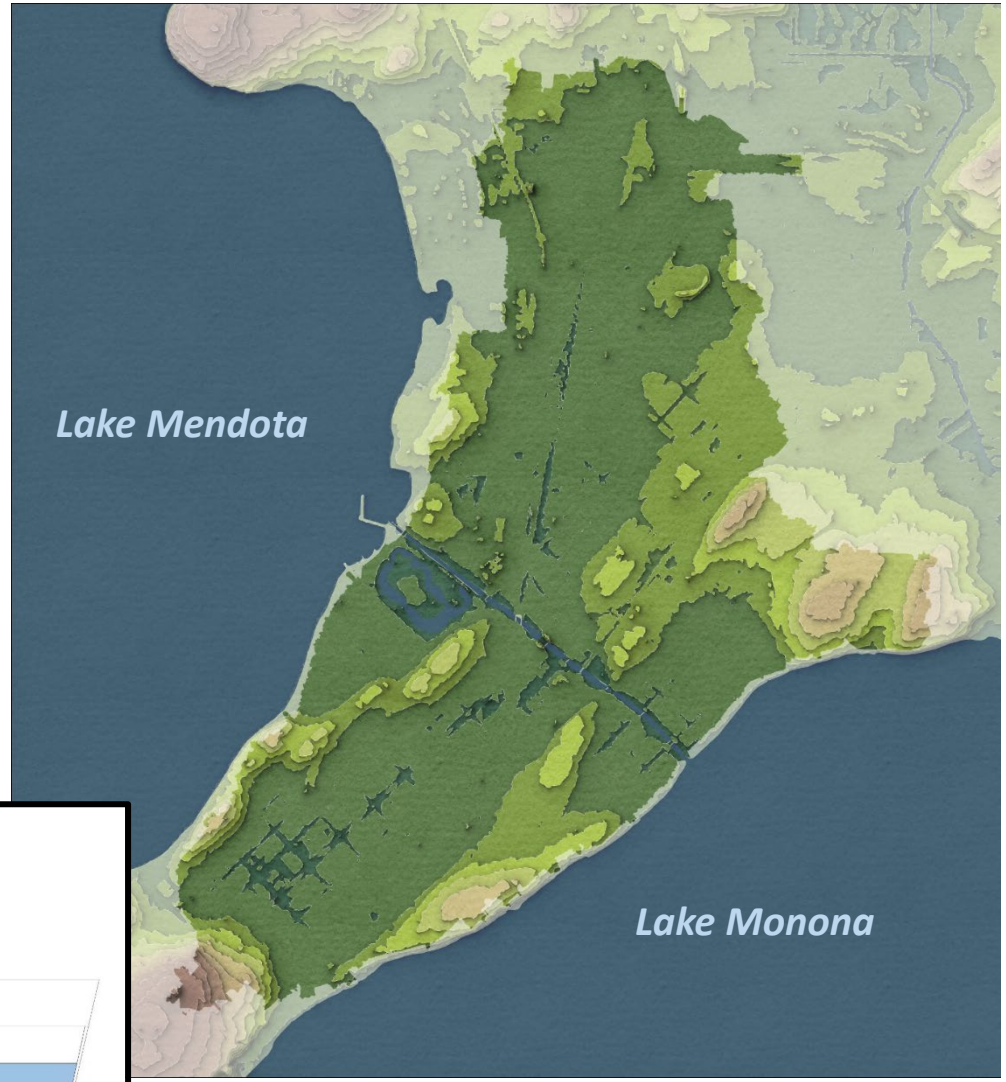
0.2% Chance Event

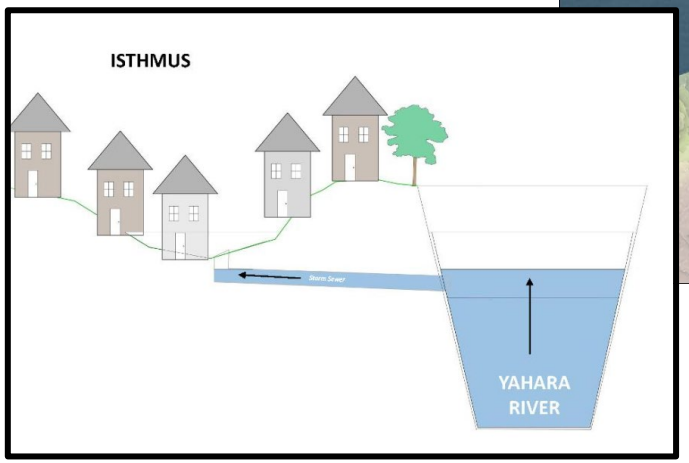
- Safe conveyance of overflow

% Annual Chance	24-hr rainfall depth
10%	4.09 in
4%	4.98 in
1%	6.66 in
0.2%	8.94 in

Lake and River Levels Matter for Flooding on the Isthmus

- The Yahara River flows between Lake Mendota and Lake Monona through downtown Madison.
  - Many storm sewers drain to the Yahara River
- When lake levels are high, stormwater has nowhere to go — drains can back up, and flooding worsens.
- River and lake levels affect how fast water can drain from streets, homes, and businesses.
  - Even light rain can cause problems if lake levels are high.





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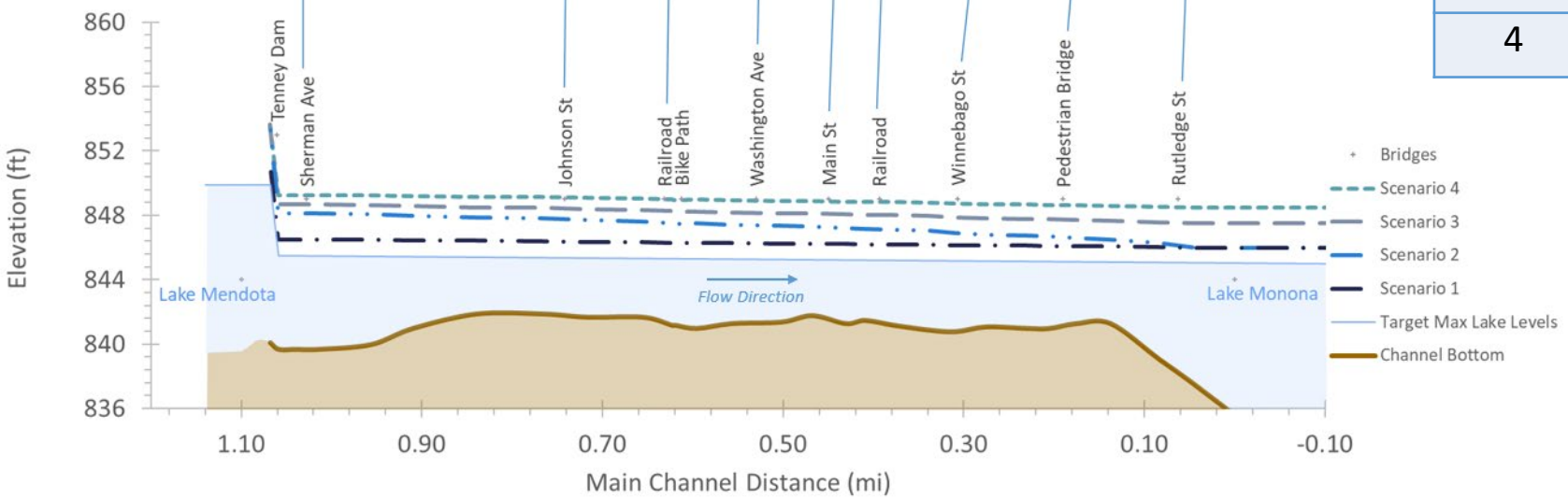
Variety of Lake Levels Considered in Study



Scenario	Yahara River Discharge (cfs)	Lake Monona Elevation (ft)
1	250	846.0
2	700	846.0
3	700	847.5
4	700	848.5

Less likely to occur, more conservative

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Proposed Local Storm Sewer Improvements

- ~56,500 feet of local storm sewer improvements
- Coordinated with future street reconstruction projects
- Recently rebuilt streets likely won't see upgrades for many years

All Proposed Storm Sewer Improvements

- Local storm sewer improvements (green) +

<u>Standalone Projects (yellow)</u>

1. Capital City Trail (Brearly St to Livingston St)
2. Wilson St (Few St to Brearly St)
3. Pennsylvania Ave
4. Commercial Ave
5. E Johnson St
6. Paterson Relief
7. Blount St

Feasibility Constraints

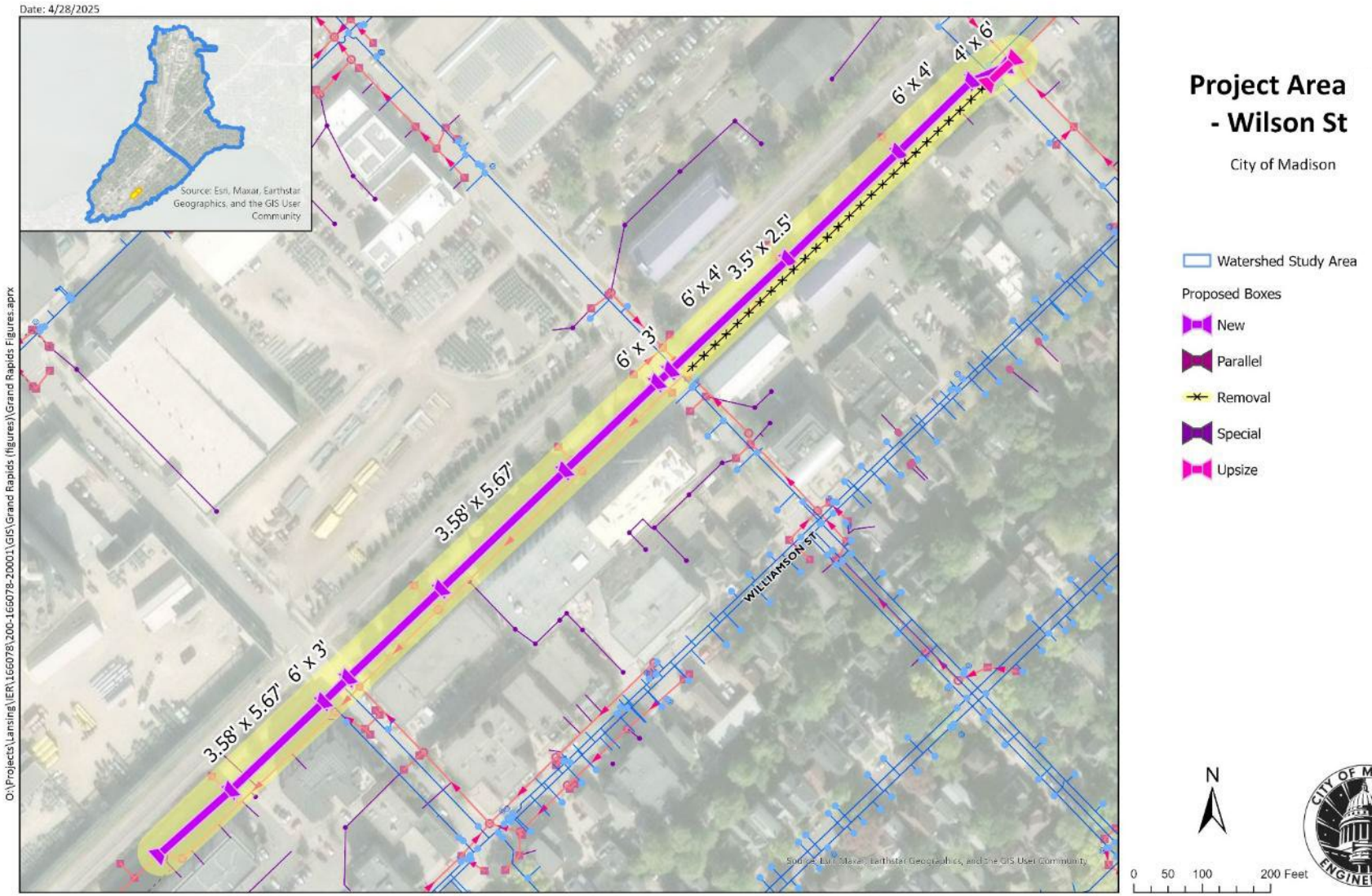
Spaghetti of utilities under major street corridors make fitting very larger box culverts challenging, and often impossible in some locations.

Photo: installing a sanitary sewer with Wilson St project.

For example, we know we placed the biggest box culvert we could fit under culvert under E Washington Ave last time it was constructed, so we didn't propose upsizing it in this study, because that isn't feasible.

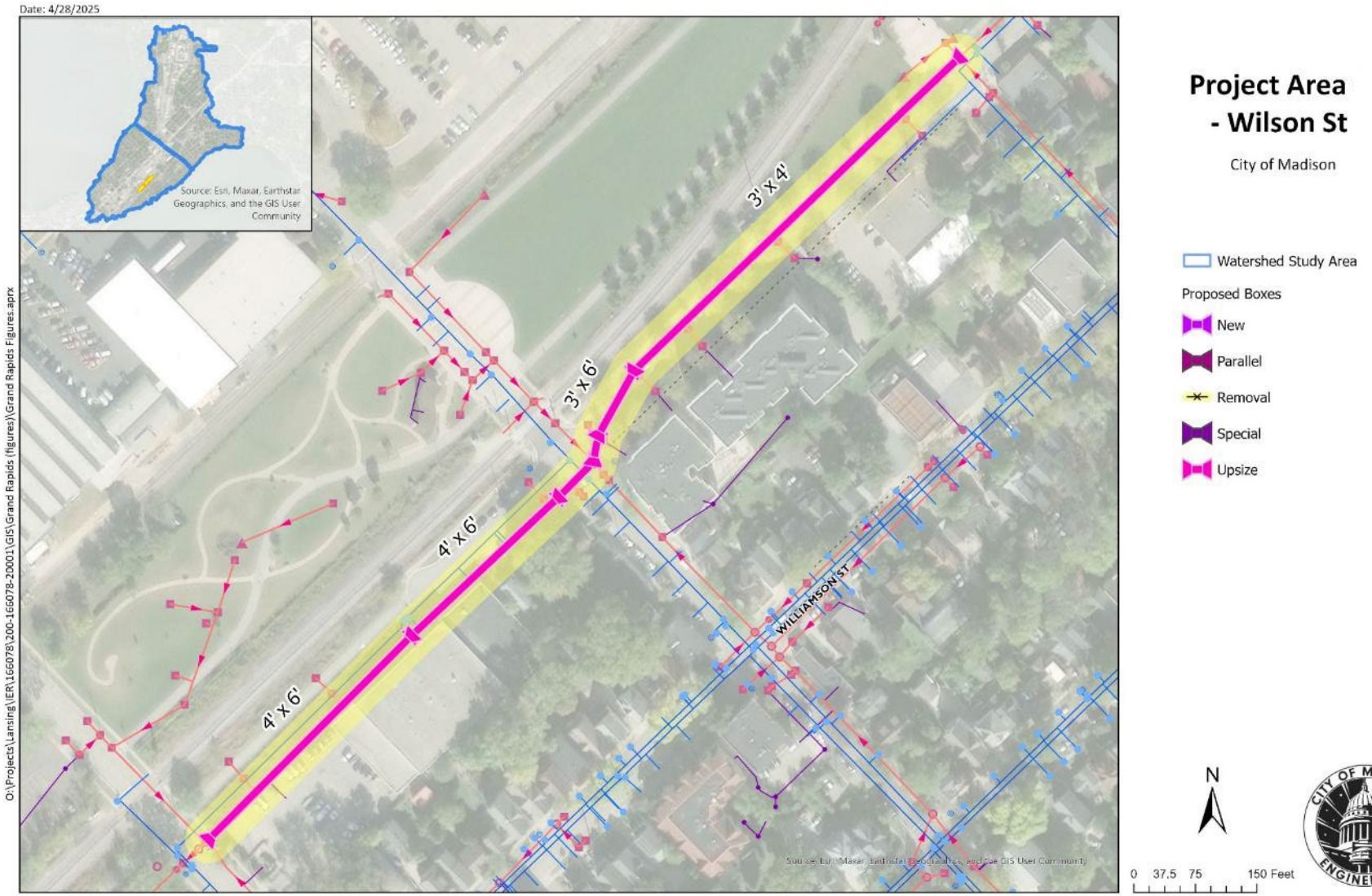
1. Capital City Trail (Brearly St to past Livingston St) – Complete!

- Replace failing pipes and increase conveyance along trail.
- Construction in 2025-26
  - Box installed 2025
  - Restoration in 2026
- Cost $2.4M



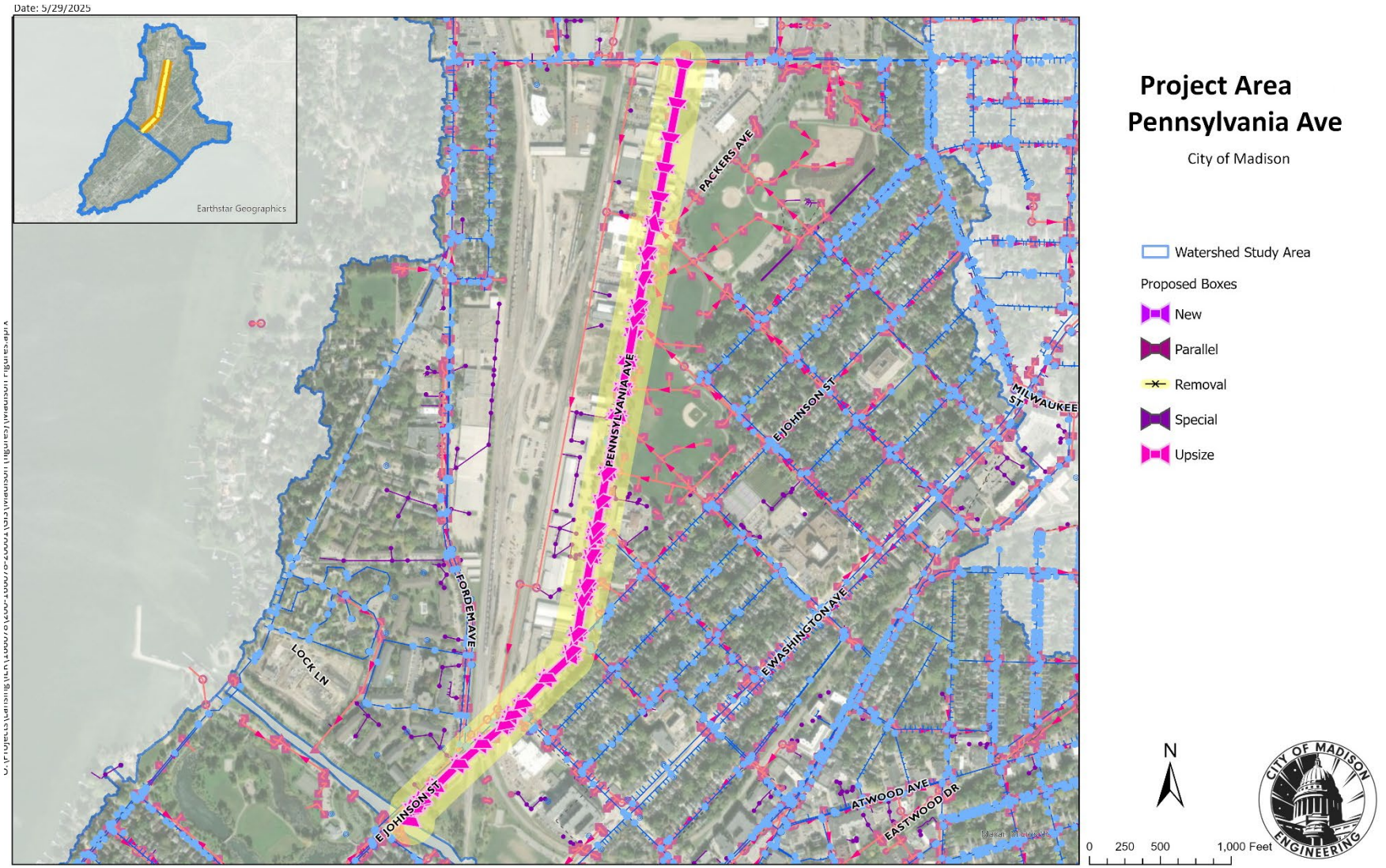
2. Wilson Street (Few St to Brearly St)

- Replace older pipes and increase conveyance along Capitol City Trail and on Wilson St.
- Est. Cost $1.5M



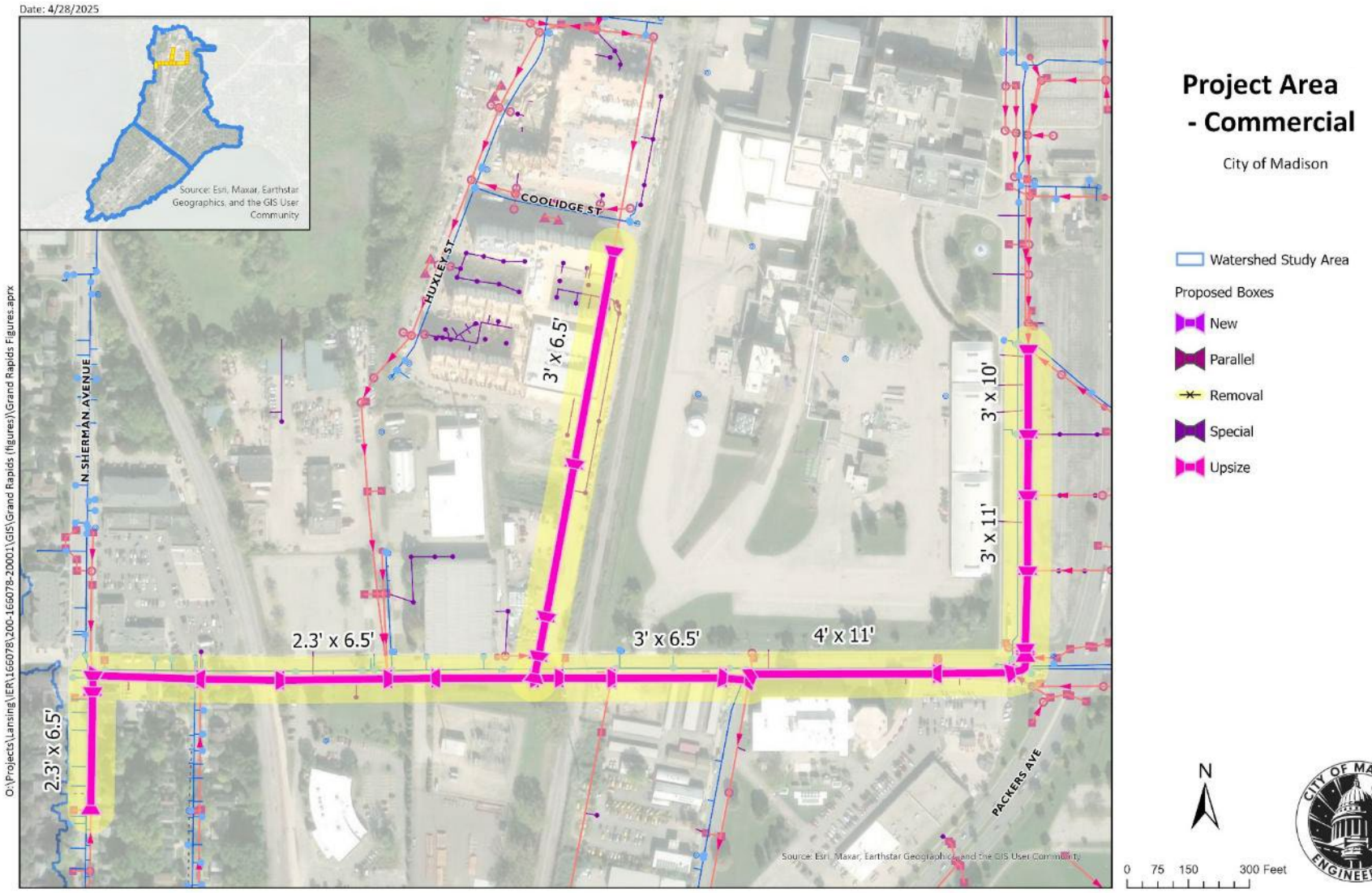
3. Pennsylvania Avenue (Commercial Ave to Yahara River)

- Increase conveyance along Pennsylvania Ave to Yahara River.
- Dual 5’ by 12’ box culverts.
- Relieves flooding on Johnson and Third St.
- Est. Cost $33.2M



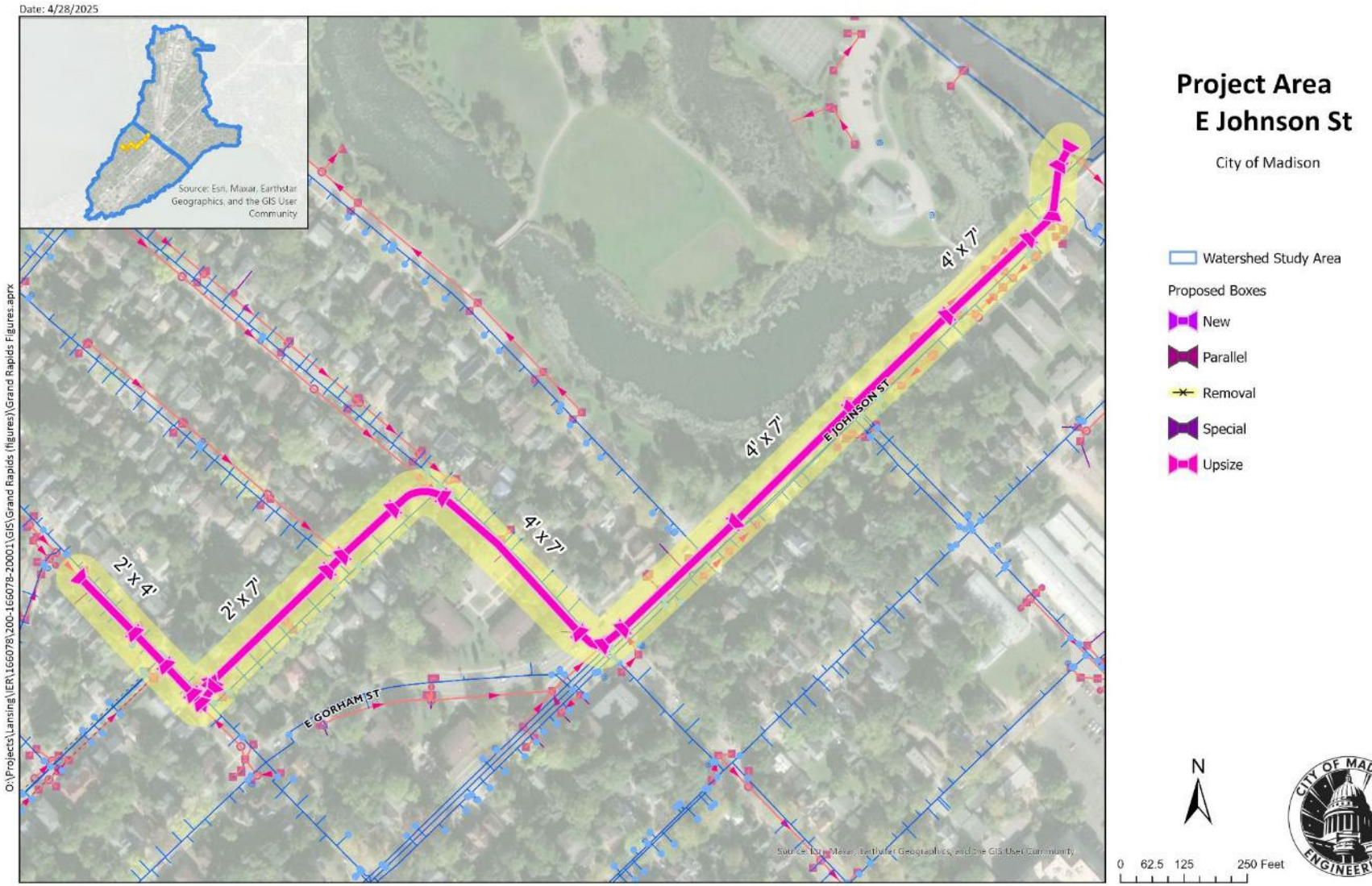
4. Commercial Avenue (Sherman Ave to Oscar Ave)

- Increase conveyance to reduce upstream flooding
- Est. Cost $8.2M



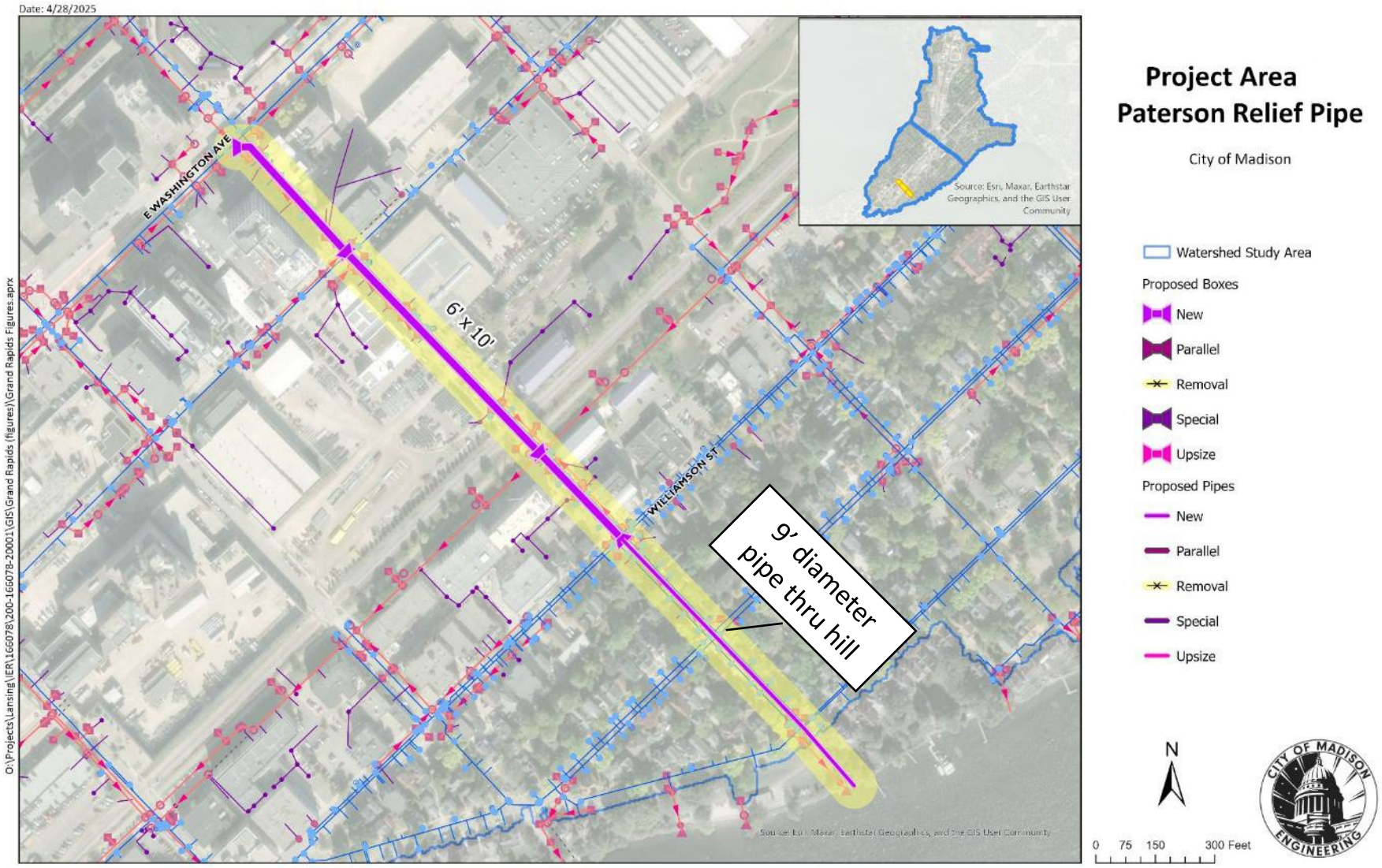
5. East Johnson St (Few St to Yahara River)

- Reduce flooding in upstream neighborhood adjacent to Tenney Park.
- Est. Cost $ 3.9M



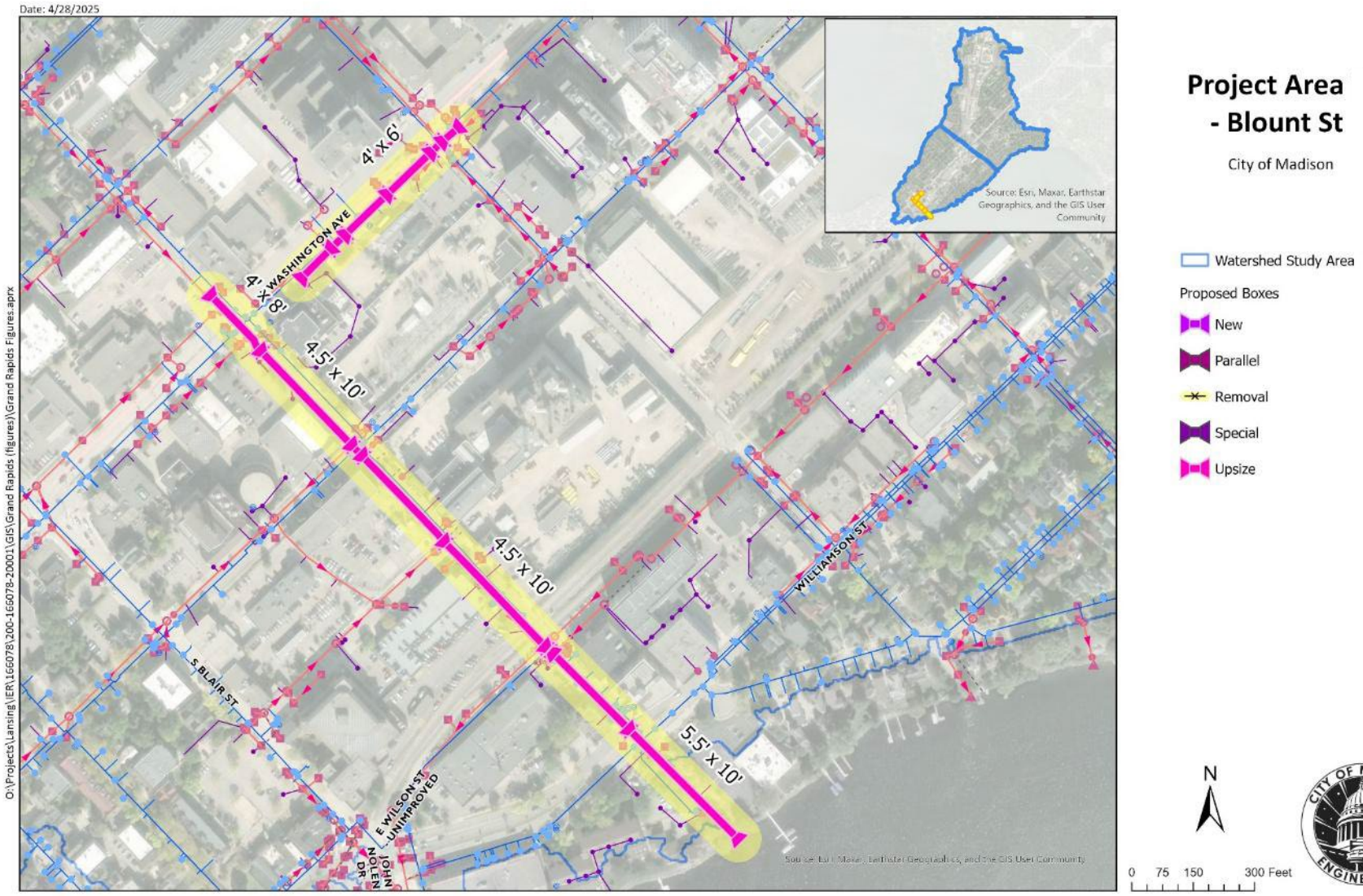
6. Paterson Relief Pipe (E Washington Ave to Lake Monona)

- Primary relief pipe for flooding on E Washington
  - Relieves flooding at Mifflin and Livingston as well
- 9’ diameter pipe - depths require tunneling
- Est. Cost $8.8 M



7. Blount Street (E Washington Ave to Lake Monona)

- Increase conveyance to Lake Monona to help drain low areas.
- Est. Cost $6M



Recommended Implementation Order and Cost

Project	Estimated Total Cost	Note
1. Capital City Trail	$2.4 M	*Bid and construction underway*
2. Wilson St (Few to Brearly)	$1.5 M	*Can be constructed after Project 1.*
3. Pennsylvania Ave	$33.3 M	*Downstream of Project 4 and should be constructed first.*
4. Commercial Ave	$8.2 M	*Project 3 is downstream and should be constructed first.*
5. East Johnston St	$3.9 M	
6. Paterson Relief	$8.8 M	
7. Blount St	$6.0 M	
Standalone Projects Subtotal	**$64.1 M**	

Existing Conditions Inundation Mapping

10% Chance Event
(4.09 inches in 24 hours)

Scenario 1
Yahara Flow: 250 cfs
Lake Level: 846.0 ft

Scenario 4
Yahara Flow: 700 cfs
Lake Level: 848.5 ft

Lake Mendota

Lake Monona

Scenario 1. **315 out of 1051** stormwater structures do not meet 10% target

Scenario 4. **413 out of 1051** stormwater structures do not meet 10% target

Watershed Study Area

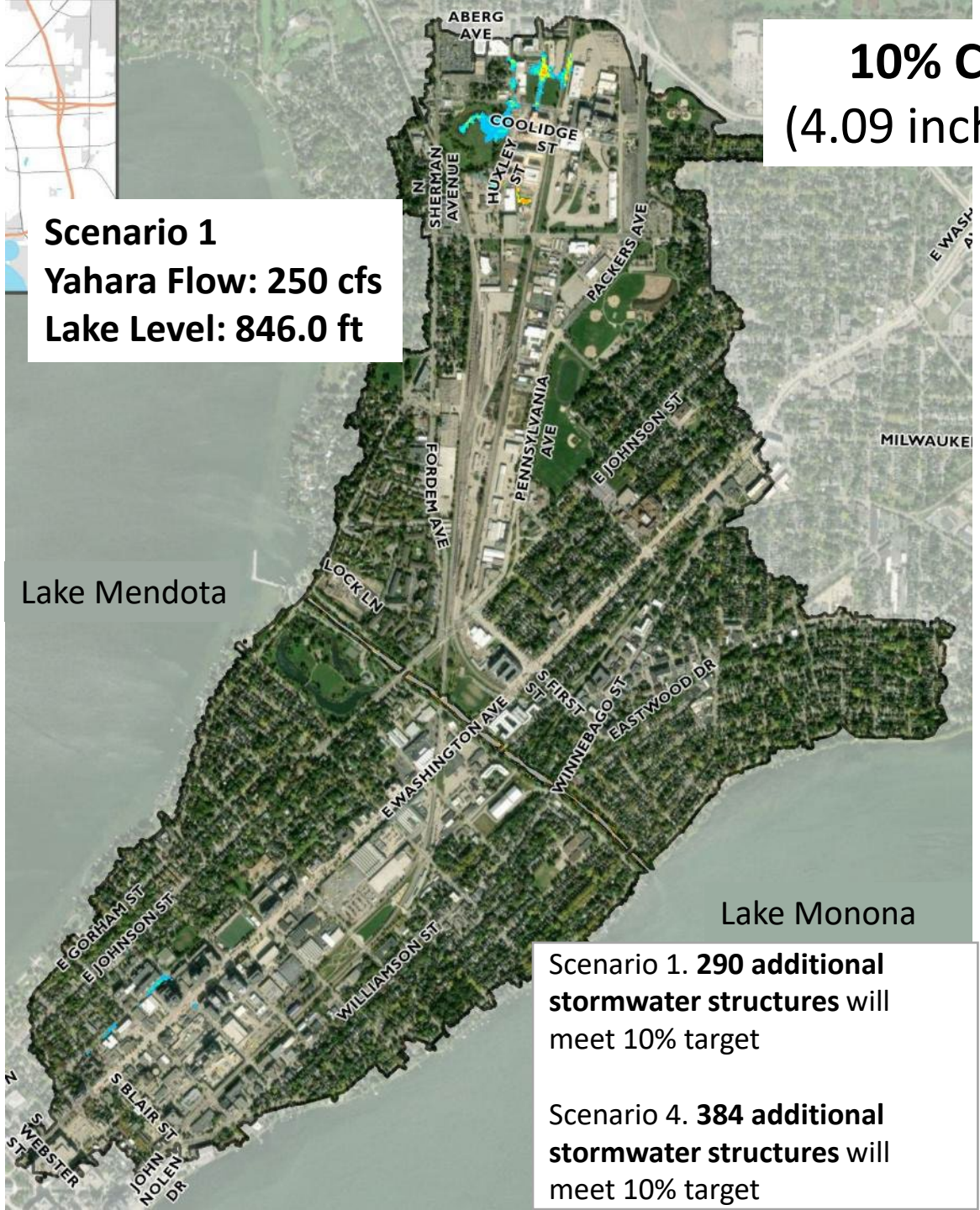
Flooding Map

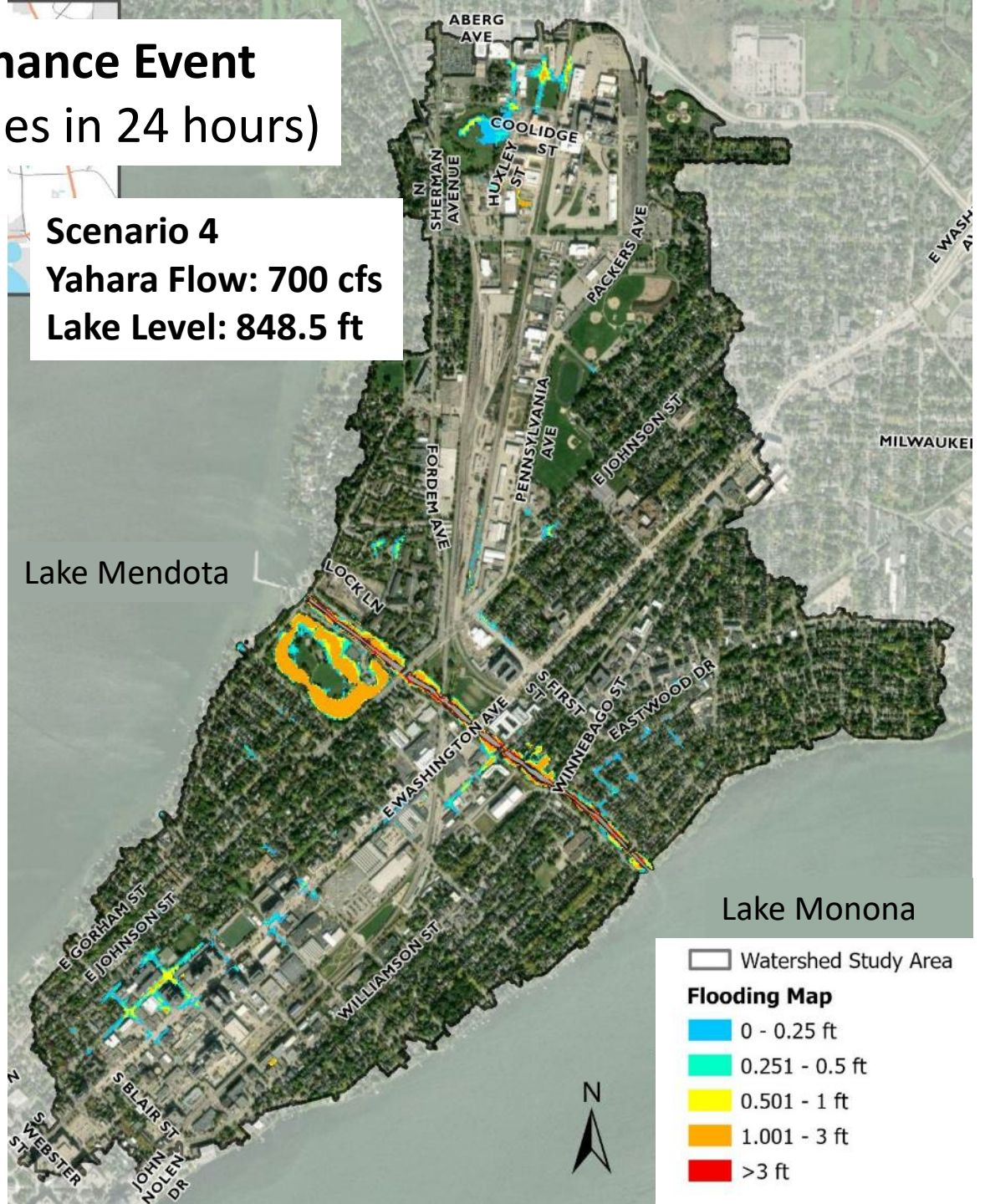
- 0 - 0.25 ft
- 0.251 - 0.5 ft
- 0.501 - 1 ft
- 1.001 - 3 ft
- >3 ft

N

Proposed Conditions Inundation Mapping

10% Chance Event
(4.09 inches in 24 hours)





Scenario 1. **290 additional stormwater structures** will meet 10% target

Scenario 4. **384 additional stormwater structures** will meet 10% target

Existing Conditions Inundation Mapping

1% Chance Event
(6.66 inches in 24 hours)

Scenario 1
Yahara Flow: 250 cfs
Lake Level: 846.0 ft

Scenario 4
Yahara Flow: 700 cfs
Lake Level: 848.5 ft

Lake Mendota

Lake Monona

Scenario 1. **100 out of 7,421** buildings do not meet 1% target

Scenario 4. **135 out of 7,421** buildings do not meet 1% target

Watershed Study Area

Flooding Map

- 0 - 0.25 ft
- 0.251 - 0.5 ft
- 0.501 - 1 ft
- 1.001 - 3 ft
- >3 ft

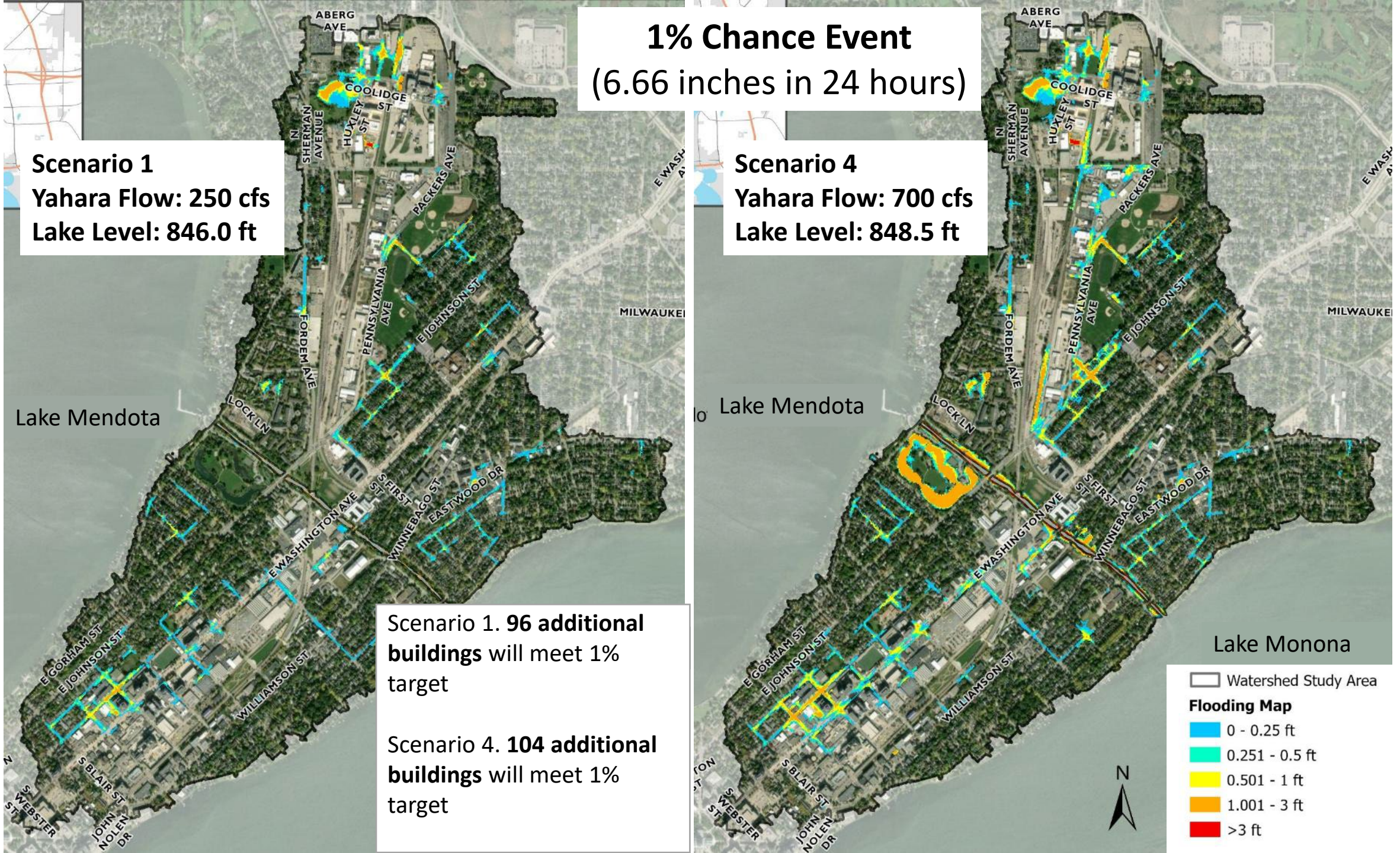
N

Proposed Conditions Inundation Mapping

1% Chance Event
(6.66 inches in 24 hours)

Scenario 1
Yahara Flow: 250 cfs
Lake Level: 846.0 ft

Scenario 4
Yahara Flow: 700 cfs
Lake Level: 848.5 ft



Scenario 1. **96 additional buildings** will meet 1% target

Scenario 4. **104 additional buildings** will meet 1% target

Solutions Impact

Design Storm Event	Target	Watershed-wide metric	Existing Conditions	Recommended Solutions
10% Annual Chance	No surcharging onto street	1,051 modeled structures	301 structures impacted (28.6%)	22 structures impacted (2.1%)
25% Annual Chance	Centerline of Street Passable	56.1 miles of road	3.0 miles of roads impacted (5.3%)	0.1 miles of roads impacted (0.2%)
1% Annual Chance	No home or business will be flooded	7,421 buildings/ structures	100 buildings impacted (1.3%)	4 buildings impacted (0.1%)
	Enclosed Depression Served	2 enclosed depressions	2 enclosed depression that impacts private property when overflowing	1 enclosed depression that impacts private property when overflowing
	Greenway Crossing at Streets served	*No greenway crossings are present in this watershed*		
0.2% Annual Chance	Safely Convey Stormwater, i.e. limited impact on private property	7,421 buildings/ structures	216 buildings impacted (2.9%)	121 buildings impacted (1.6%)

Solutions not recommended

- Dredging the Yahara River between Lake Mendota and Lake Monona
  - Only had small impact on small storms
- Flood storage
  - Limited storage was expensive, would impact open spaces, and was less effective than pipe conveyance
- Widespread Green Infrastructure to meet flood targets
  - Would require 30% of all pervious area to become GI
  - >$500 million in capital costs (+annual maintenance)
- Localized GI to reduce frequent flooding at Johnson and Third
  - Area's soils don't infiltrate quickly
  - Low-lying area limits pipe conveyance
  - Limited space to infiltrate water in the right-of-way

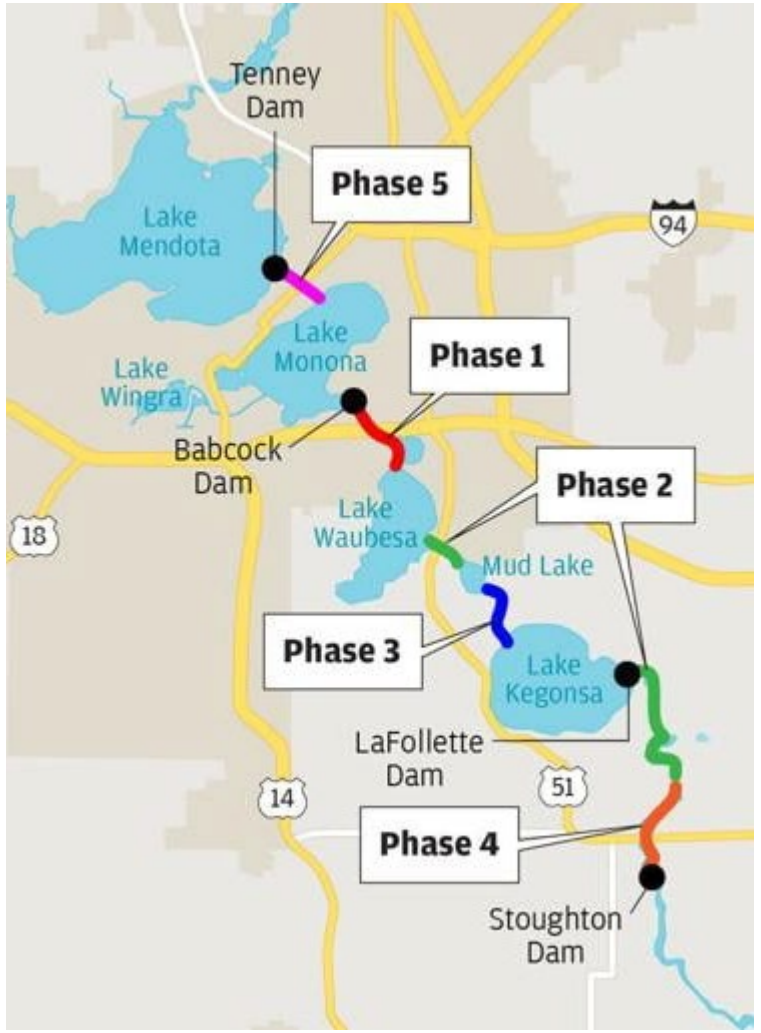
Questions/Discussion

The rest of the slides are informational for reference only

Dredging and Lake Levels Updates

Dane County is leading a dredging effort from Lake Monona to Stoughton

- Phases 1 and 2 are complete. Phases 3 and 4 are in different phases of planning and construction
- Impact: 2024 data shows nearly double the flow through the Yahara River out of Waubesa in comparison to 2008 and 2018, from both dredging and aquatic plant removal.
- Learn more at:
  - Nov 2024 Dane Co Lakes & Watershed Commission Meeting Recording: https://dane.granicus.com/player/clip/4321?view_id=1&redirect=true
  - Project webpage: https://lwrd.danecounty.gov/CurrentProjects/Detail/Yahara-River-Sediment-Removal-Project
  - Lake level management contact: John Reimer, reimer.john@danecounty.gov



Map from The Cap Times article What Dane County is learning from its Yahara River Dredging project - Created by Brandon Raygo

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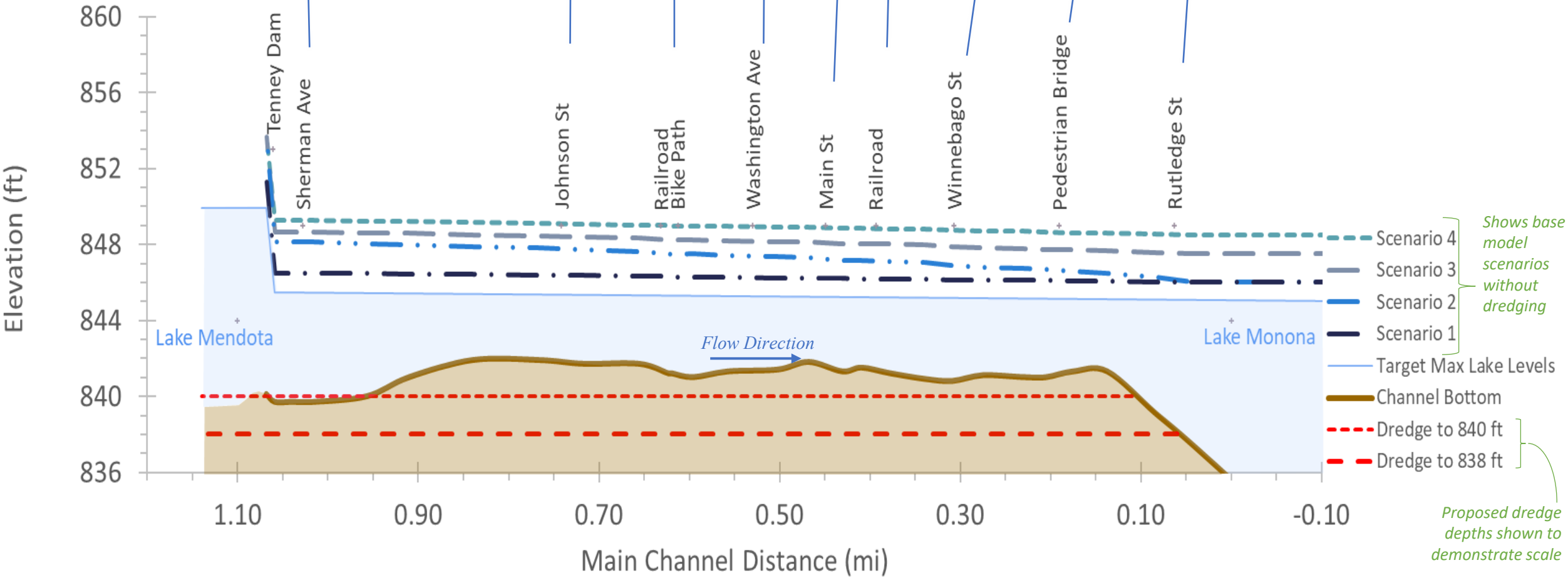
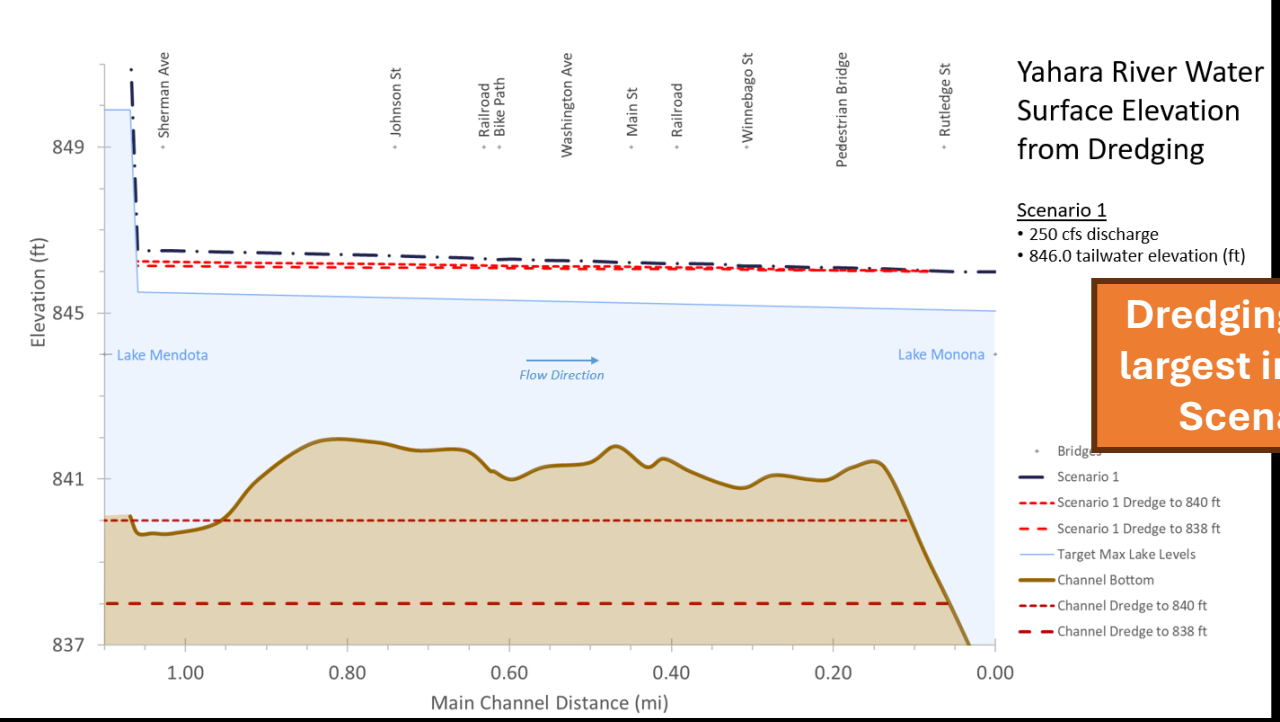
Solution Considered – Dredging on Yahara River thru Isthmus

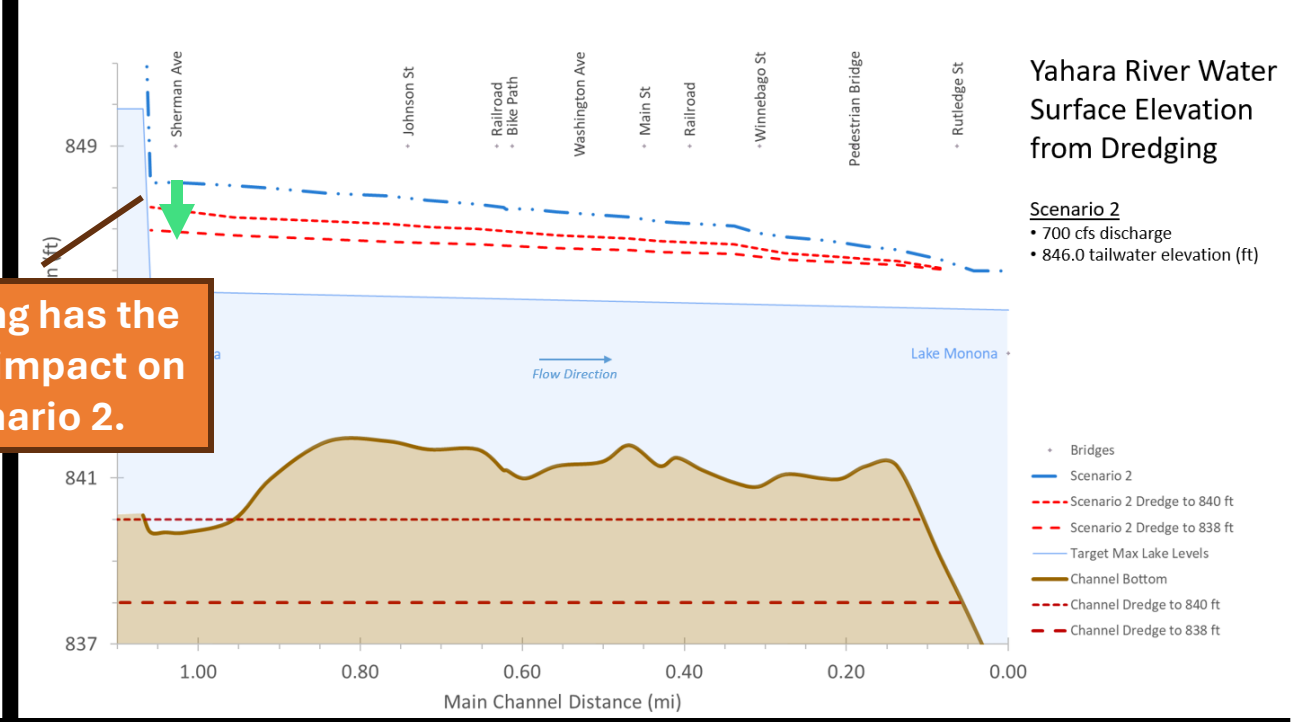
- Modeled impact of dredging from Lake Mendota to Lake Monona to assess benefits from a flash flooding perspective with the watershed study.
- Looked at the impact of dredging the river to 840’ (average cut of 1.5’ of bed material, totaling ~8,700 CY)
- Looked at the impact of dredging the river to 838’ (average cut of 3.5’ of bed material, totaling ~20,000 CY)
- Ran both dredging depths on all 4 lake level/river scenarios in our flood models to see the impact the dredging has on flash flooding around isthmus

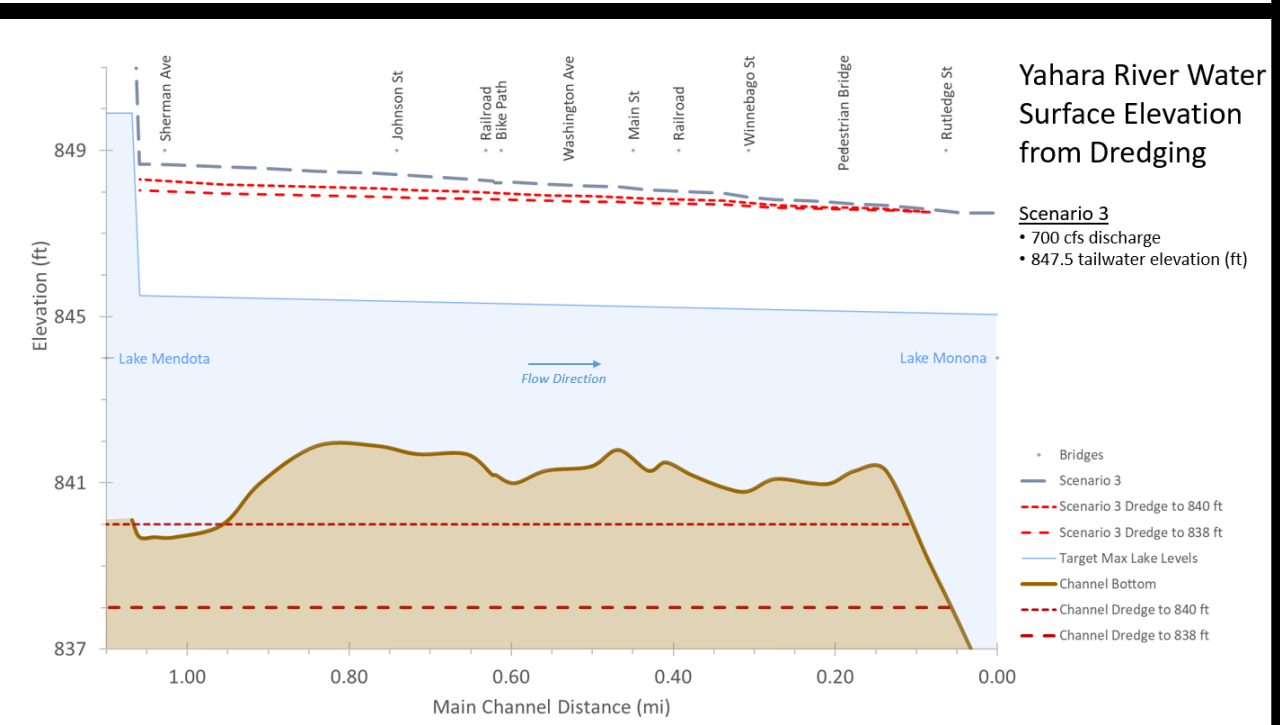
Scenario	Yahara River Discharge (cfs)	Lake Monona Elevation (ft)
1	250	846.0
2	700	846.0
3	700	847.5
4	700	848.5

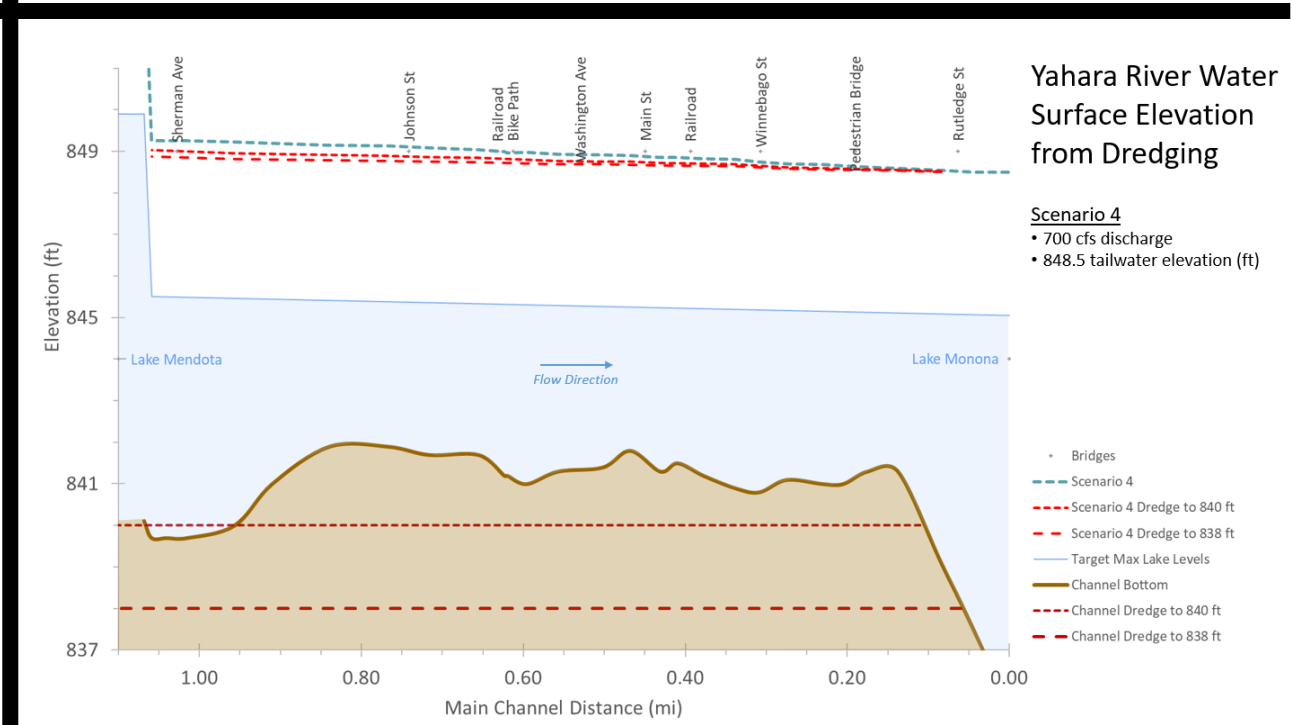

Mendota
Monona
N
N Thornton Ave
Johnson St
Railroad
Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Clemons Ave
Riverside Dr
S Thornton Ave
Stevens St


860
856
852
848
844
840
836
Elevation (ft)
Tenney Dam
Sherman Ave
Johnson St
Railroad Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Lake Mendota
Lake Monona
Flow Direction
1.10
0.90
0.70
0.50
0.30
0.10
-0.10
Main Channel Distance (mi)
Scenario 4
Scenario 3
Scenario 2
Scenario 1
Target Max Lake Levels
Channel Bottom
Dredge to 840 ft
Dredge to 838 ft
Shows base model scenarios without dredging
Proposed dredge depths shown to demonstrate scale


Yahara River Water Surface Elevation from Dredging
Scenario 1
• 250 cfs discharge
• 846.0 tailwater elevation (ft)
Sherman Ave
Johnson St
Railroad Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Lake Mendota
Lake Monona
Flow Direction
Elevation (ft)
849
845
841
837
1.00
0.80
0.60
0.40
0.20
0.00
Main Channel Distance (mi)
Bridges
Scenario 1
Scenario 1 Dredge to 840 ft
Scenario 1 Dredge to 838 ft
Target Max Lake Levels
Channel Bottom
Channel Dredge to 840 ft
Channel Dredge to 838 ft


Yahara River Water Surface Elevation from Dredging
Scenario 2
• 700 cfs discharge
• 846.0 tailwater elevation (ft)
Dredging has the largest impact on Scenario 2.
Sherman Ave
Johnson St
Railroad Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Lake Monona
Flow Direction
849
841
837
1.00
0.80
0.60
0.40
0.20
0.00
Main Channel Distance (mi)
Bridges
Scenario 2
Scenario 2 Dredge to 840 ft
Scenario 2 Dredge to 838 ft
Target Max Lake Levels
Channel Bottom
Channel Dredge to 840 ft
Channel Dredge to 838 ft


Yahara River Water Surface Elevation from Dredging
Scenario 3
• 700 cfs discharge
• 847.5 tailwater elevation (ft)
Sherman Ave
Johnson St
Railroad Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Lake Mendota
Lake Monona
Flow Direction
Elevation (ft)
849
845
841
837
1.00
0.80
0.60
0.40
0.20
0.00
Main Channel Distance (mi)
Bridges
Scenario 3
Scenario 3 Dredge to 840 ft
Scenario 3 Dredge to 838 ft
Target Max Lake Levels
Channel Bottom
Channel Dredge to 840 ft
Channel Dredge to 838 ft


Yahara River Water Surface Elevation from Dredging
Scenario 4
• 700 cfs discharge
• 848.5 tailwater elevation (ft)
Sherman Ave
Johnson St
Railroad Bike Path
Washington Ave
Main St
Railroad
Winnebago St
Pedestrian Bridge
Rutledge St
Lake Mendota
Lake Monona
Flow Direction
Elevation (ft)
849
845
841
837
1.00
0.80
0.60
0.40
0.20
0.00
Main Channel Distance (mi)
Bridges
Scenario 4
Scenario 4 Dredge to 840 ft
Scenario 4 Dredge to 838 ft
Target Max Lake Levels
Channel Bottom
Channel Dredge to 840 ft
Channel Dredge to 838 ft

Results - Dredging on Yahara Thru Isthmus

- **Dredging to 838' has the largest impact on Scenario 2.** This is because Monona's level is low enough that not all storm sewers are completely backwatered, and dredging helps move high flows through the Yahara with a lower profile. This improves storm sewer capacity on the north side of the isthmus.
  - **Eliminates flooding on E Washington Ave in small storms**
    - **Small storms means** 100% annual chance (or 1-year) and most of the 50% annual chance (2-year) storms
  - Does *not* significantly reduce flooding in small storms at:
    - Johnson/Third
    - Wilson near McPike Park
    - Mifflin and Livingston (but does reduce flooding more than at other 2 locations)
  - **Reduces flooding at centerline** of E Washington Ave **in 20% annual chance (5-year) storm**
  - **Little impact 10% chance (10-year) storm and larger**
- There's **less flood reduction** in **Scenarios 1, 3 and 4**

→ All these benefits can be achieved with proposed pipe improvements, while <u>also</u> reaching flood mitigation targets for larger storms

Challenges – Dredging

- The entire shoreline of the Yahara River in this section is a **Historic Landmark Parkway**, on the **National Register of Historic Places**
- **Low bridge clearances** will limit equipment access via the water – will likely need multiple equipment launches, heavily disturbing more portions of the parkway
- **Material dewatering and disposal** will be a huge undertaking, and very expensive
  - Dewatering nearby would be very challenging and have major impacts to adjacent residents and parkway users
  - Pumping the material is not an easy answer (no logical location to pump material to that isn't heavily used, and pumping is expensive)
- Some unknowns could **significantly increase the cost**
  - **Contamination** – if landfilled, tipping fees will be cost prohibitive
  - Extensive **relocation of utilities** located under the river will be necessary, and City will likely need to pay for that work

A ballpark estimate for dredging cost: **~$10M** (cost could be **significantly** higher)

Prioritization - Dredging

From a flash flooding perspective, the benefits of dredging do not make it viable at this time.

Dredging has the biggest impact on very small storms on E Washington Ave flash flooding during Scenario 2.

We can achieve these benefits, and a higher flood resiliency in larger storms as well, with the other proposed projects.

Mechanical Dredging Example

Photo: Dane Co Land and Water Resources – Yahara River Sediment Removal – Update #8

Solutions Considered - Stormwater Storage

The study assessed storage options, which are limited on isthmus:

- Looked at adding underground storage to parks near flooded areas (Reynolds Park, Demetral Park)
- Results showed higher costs, and lesser benefits than the pipe improvements, and had negative short-term impacts to park recreation
    - Ex: 25’ deep underground storage needed at Reynolds Park (and would need to be pumped out)

→ Pipe improvements were more effective way to meet flood mitigation targets

What is Green Infrastructure (GI)

- GI is smaller infrastructure that **filters and absorbs stormwater where it falls**.
- GI uses plant or soil systems, permeable pavement or other permeable surfaces to **store, infiltrate, or evapotranspirate stormwater** and **reduce flows** to sewer systems or to surface waters.
- The City encourages GI use through the stormwater ordinance, the rain garden program, and a GI Pilot Study.

A rain garden on private property treats and infiltrates stormwater on-site and provides wildlife habitat

Terrace Rain Garden

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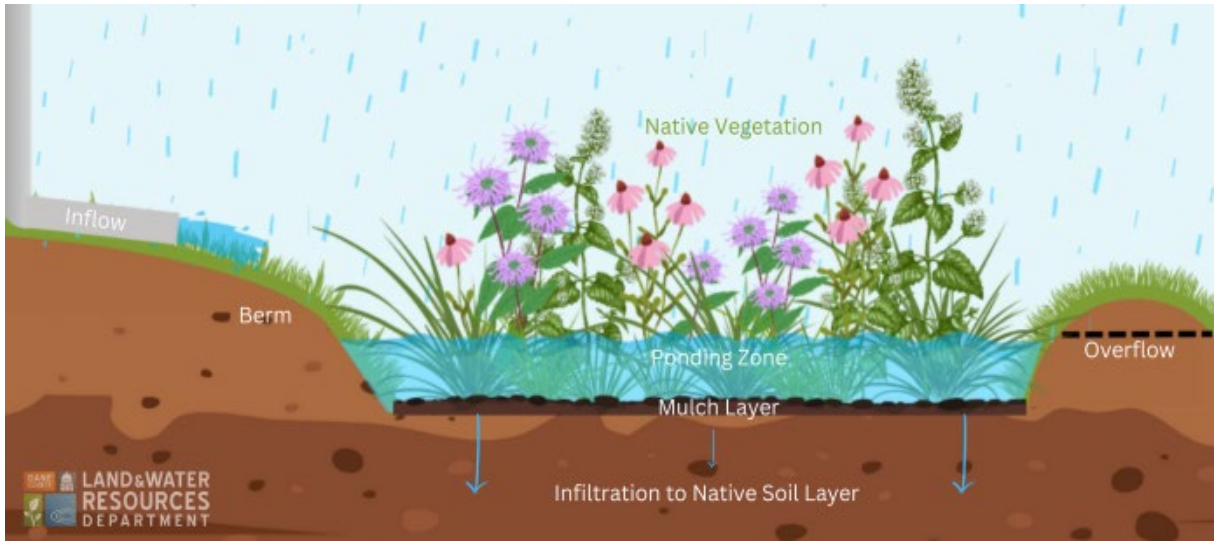
How Green Infrastructure (GI) Works

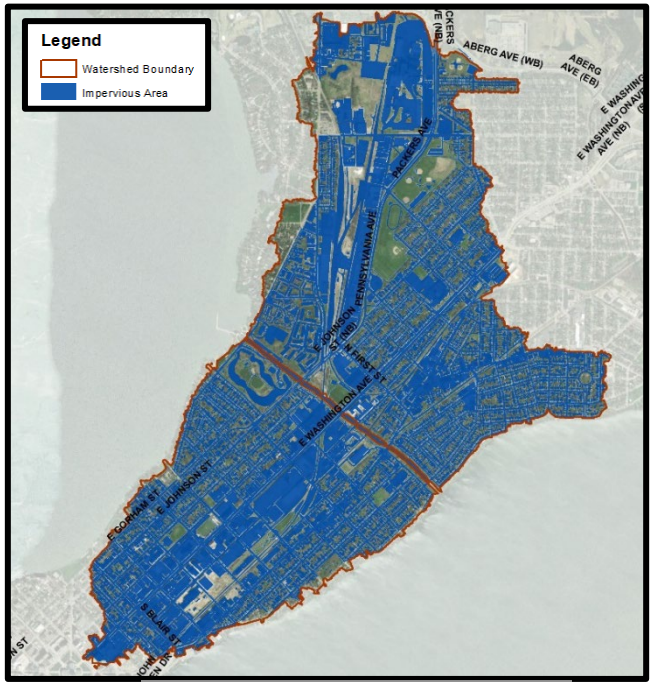


- GI is like a cup. It is typically designed to capture small storms (1-year storms or ~1") that occur the most frequently to infiltrate that small amount of stormwater
  - The most effective way to clean stormwater that enters our waterways is collecting water from regularly occurring storms that flush pollutants and debris into our waterways each time it rains
- When more water is directed to the GI than it can handle, it overflows, much like adding water to a full cup, and pours downstream

Solutions Considered - Green Infrastructure

High-level analysis to see if GI could solve 1% chance flooding:

- During a 1% chance storm event, there is ~ **4.8 million cubic feet** of water ponding on the isthmus
  - That's equivalent to water **100 feet deep (10 stories) on a football field**
  - If we want to utilize GI to hold the ponded water, ~105 square feet of green infrastructure space is needed for every 1,000 square feet of contributing impervious surface.
- To use GI to meet 1% chance flooding target, **~187 acres of land is needed**, which is **~30% of the pervious area*** in the watershed.
  - Would mean 30% of single-family yards, terraces, Parks, etc.
  - The capital costs would be ~$500 million plus annual operation and maintenance needs.
  - **assumes average soil infiltration and low ground water so you can pond water in GI 12" deep – not the case thru a large portion of the isthmus*
- Following this analysis, we focused on conveyance (pipes) and storage solutions



<u>Impervious Area</u>
979 acres
60% of watershed

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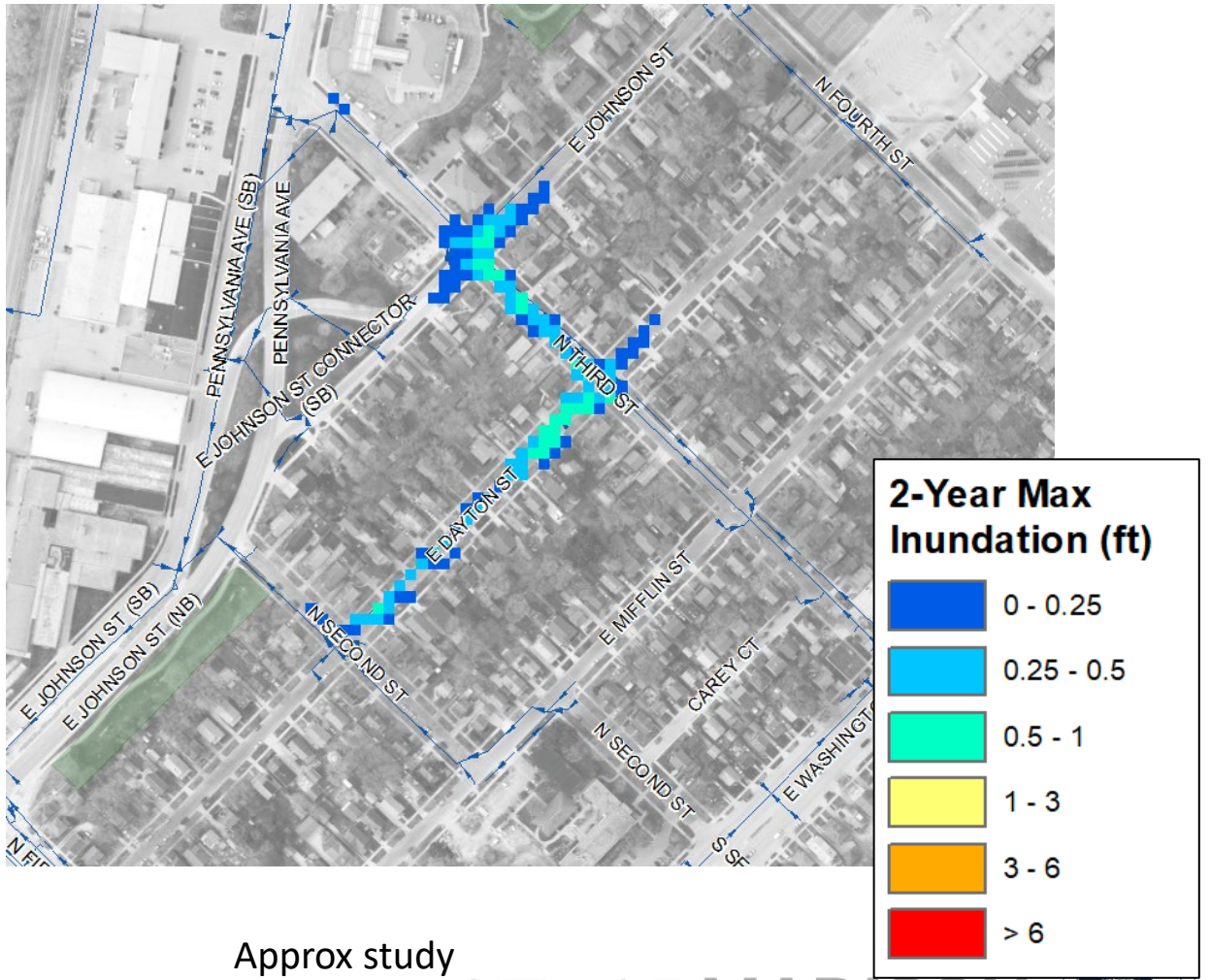
Solutions Considered - Green Infrastructure Analysis for Small storms

Consultant used model to assess what level of GI would be needed to **mitigate smaller storm (50% chance, 2-year) flooding** at **E Johnson and Third Street**.

*Note, this is not the intent of the flood study which is to find solutions for flooding in large storms

- Volume of flooding predicted during 50% chance storm: 17,904 CF
- Tributary characteristics
  - 26.3 ac
  - Directly Connected Impervious (Streets, sidewalks, driveways): 10.5 ac
  - Non-directly connected impervious (houses, back patios, garages): 4.9 ac
  - Pervious: 10.9 ac

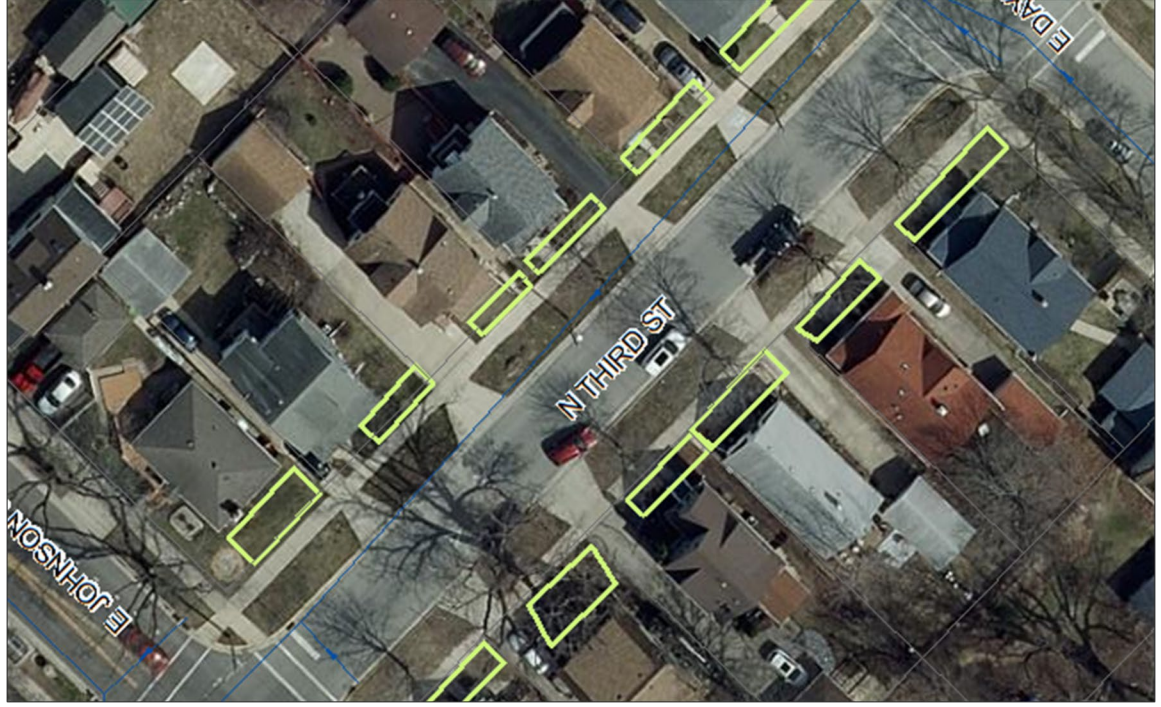


Approx study area

Small Storm Green Infrastructure Analysis

Finding 1: If all neighbors draining to this area installed a rain garden encompassing their entire front yard and part of their backyards (550 SF) → ~60% flood reduction in 2-year

- Mifflin St average front yard – 237 SF
- Third St average front yard – 251 SF



Small Storm Green Infrastructure Analysis

Finding 2: More than twice the current terrace space is needed to mitigate 2-year flooding with terrace rain gardens (assuming all current terraces can be 12” deep rain garden)

- Less space needed than for private rain gardens because terrace rain gardens would capture street and driveway runoff
- Significant tree and utility conflict issues
  - ~85% of terraces currently have a street tree

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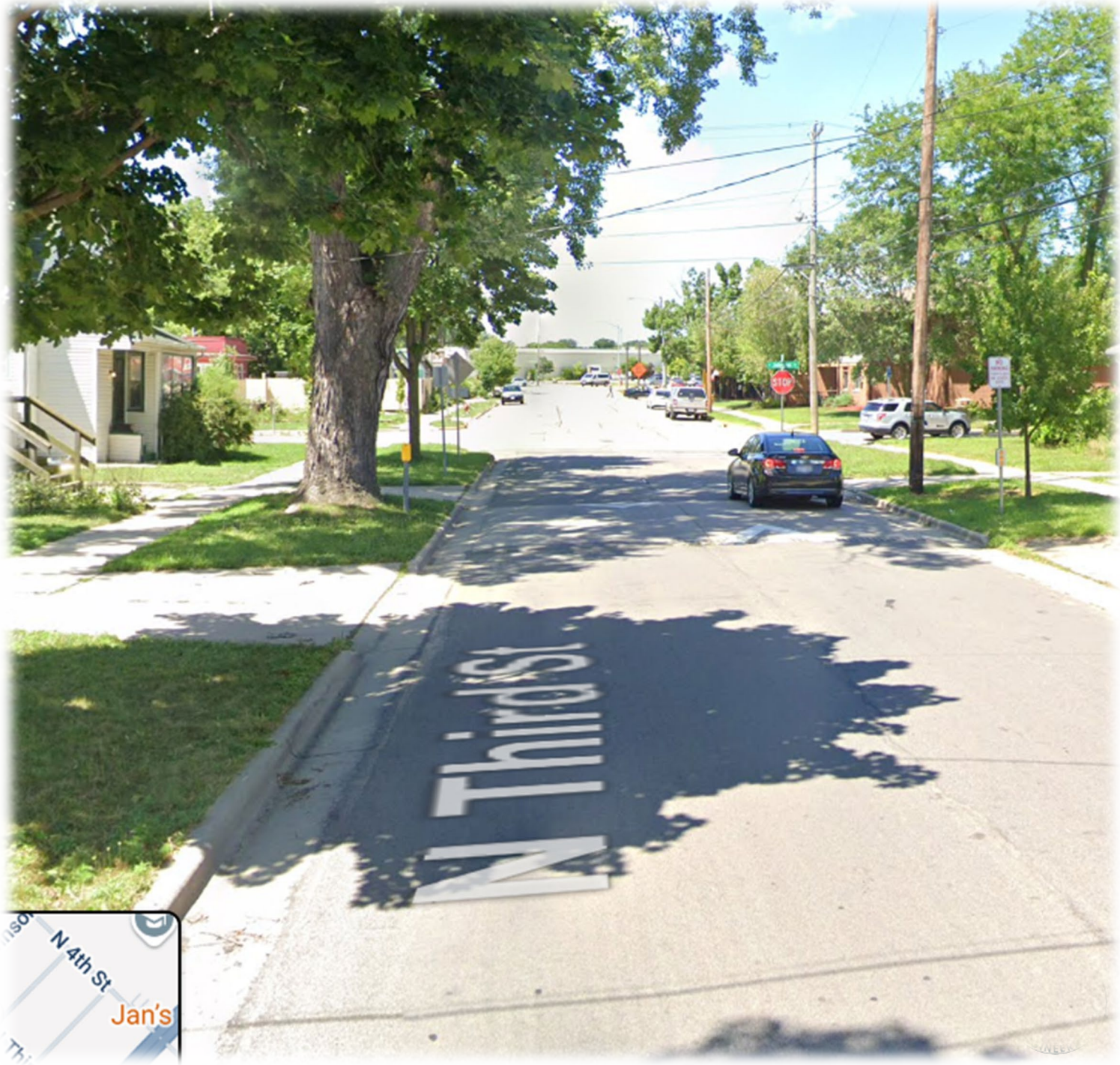
Small Storm Green Infrastructure Analysis

Finding 3: Installing pervious pavement as green infrastructure did not mitigate flooding in the 2-year storm (fills up too early in the storm).

- Limited infiltration benefits described in following slides

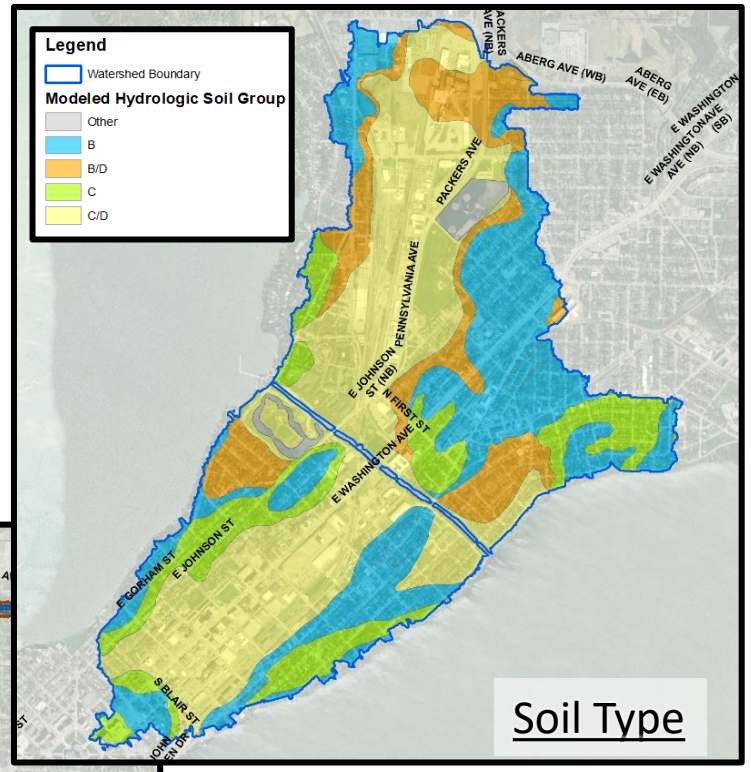
Pervious pavement could be used as peak flood storage along Third Street for small events but wouldn't have infiltration benefits.

- Street & curb are in good condition and unlikely to be reconstructed in the next 30 years.

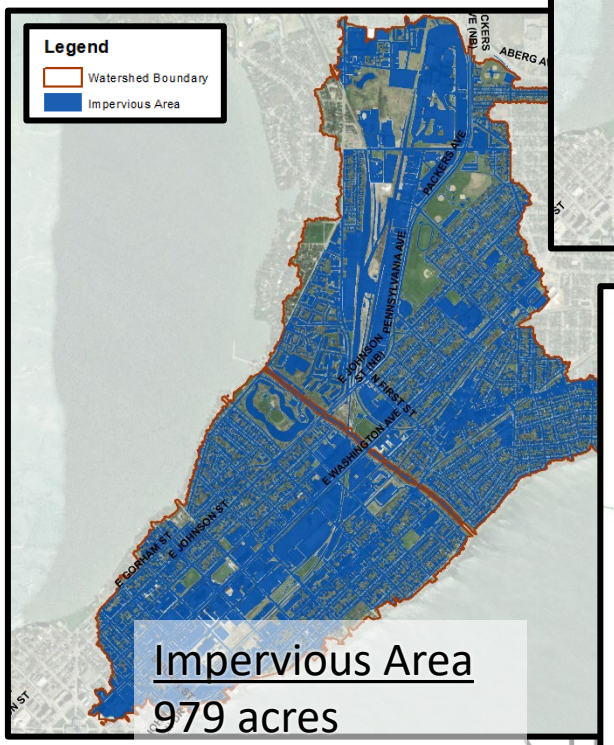


Challenges – Green Infrastructure

- **Low-lying area**. Pipe draining area is <3’ tall and connects into outgoing relief pipe on Pennsylvania Ave at elevation 844’.
  - During standard summer when lake levels are usually at elevations 845’ to 846’, the **pipe is already half full of lake water prior to it beginning to rain.**
  - **High ground water** limits effectiveness of GI
- **Majority of flooding** in 2-year storm **is from streets, sidewalks and driveways** that are **harder to treat** due to competing interests and limited space in right-of-way (trees, parking etc)
- **GI is less effective in areas with poor soils.** When GI can’t infiltrate stormwater effectively, it fills up more quickly and therefore more GI area is needed to mitigate flooding
  - Area is primarily C/D soils, B/D soils (yellow and orange) have infiltration rate that is **>4x less** than type B (blue)
  - Type D soils infiltrate 0.1 – 0.5 in/hr, and high ground water means soils saturate quickly



Soil Type



Impervious Area
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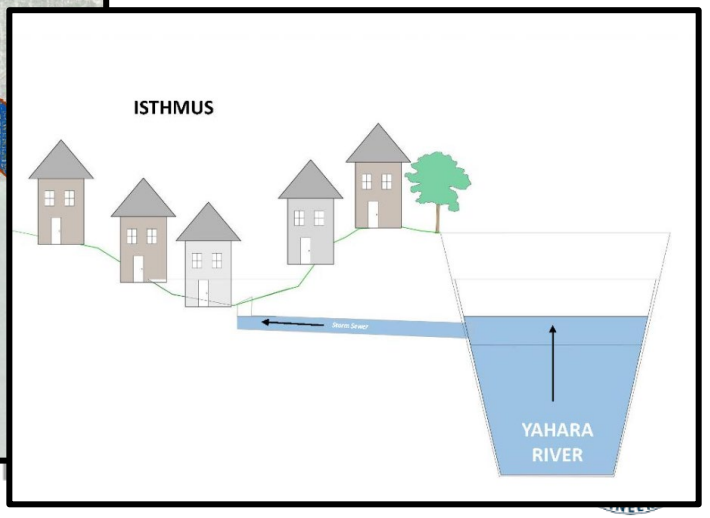
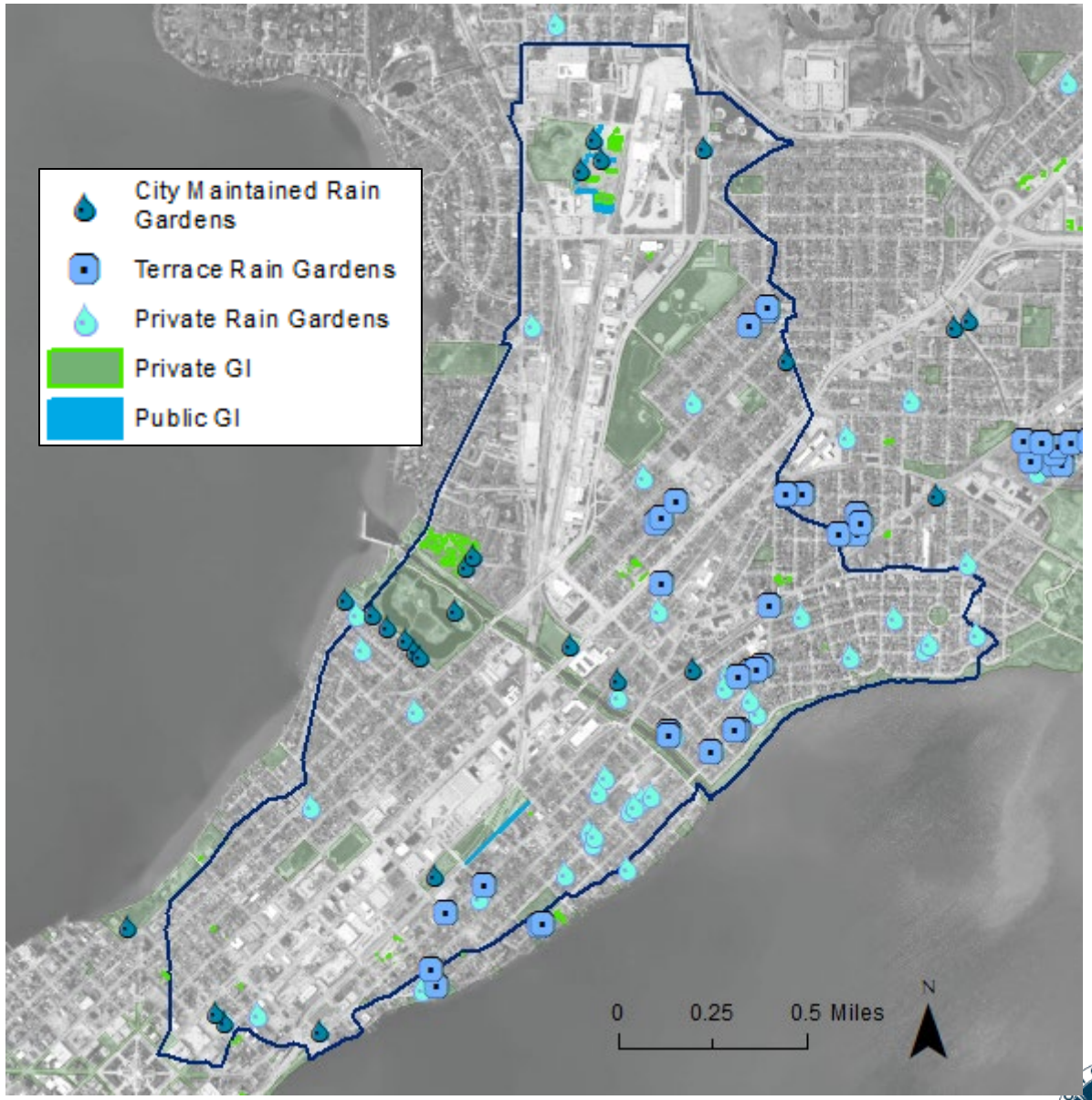


Putting GI into context

- In other areas, GI can have a bigger impact, but there aren't many areas that flood as frequently as at Johnson and Third St.
  - City is investigating ways we can maintain public safety in the near-term.
- We are **continuing to install GI** wherever possible with a variety of programs, and **Complete Green Streets framework** helps minimize impervious surfaces and install GI within the ROW
- GI will continue to **add resiliency** to system, and has a variety of other benefits
  - Water Quality and volume control
  - Native habitat and biodiversity
  - Beautification
- Hosted GI breakout room during PIM #3 for anyone interested in installing GI on their property and provided GI education as part of presentation



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