

2018 Madison Flood and Design

City of Madison, WI



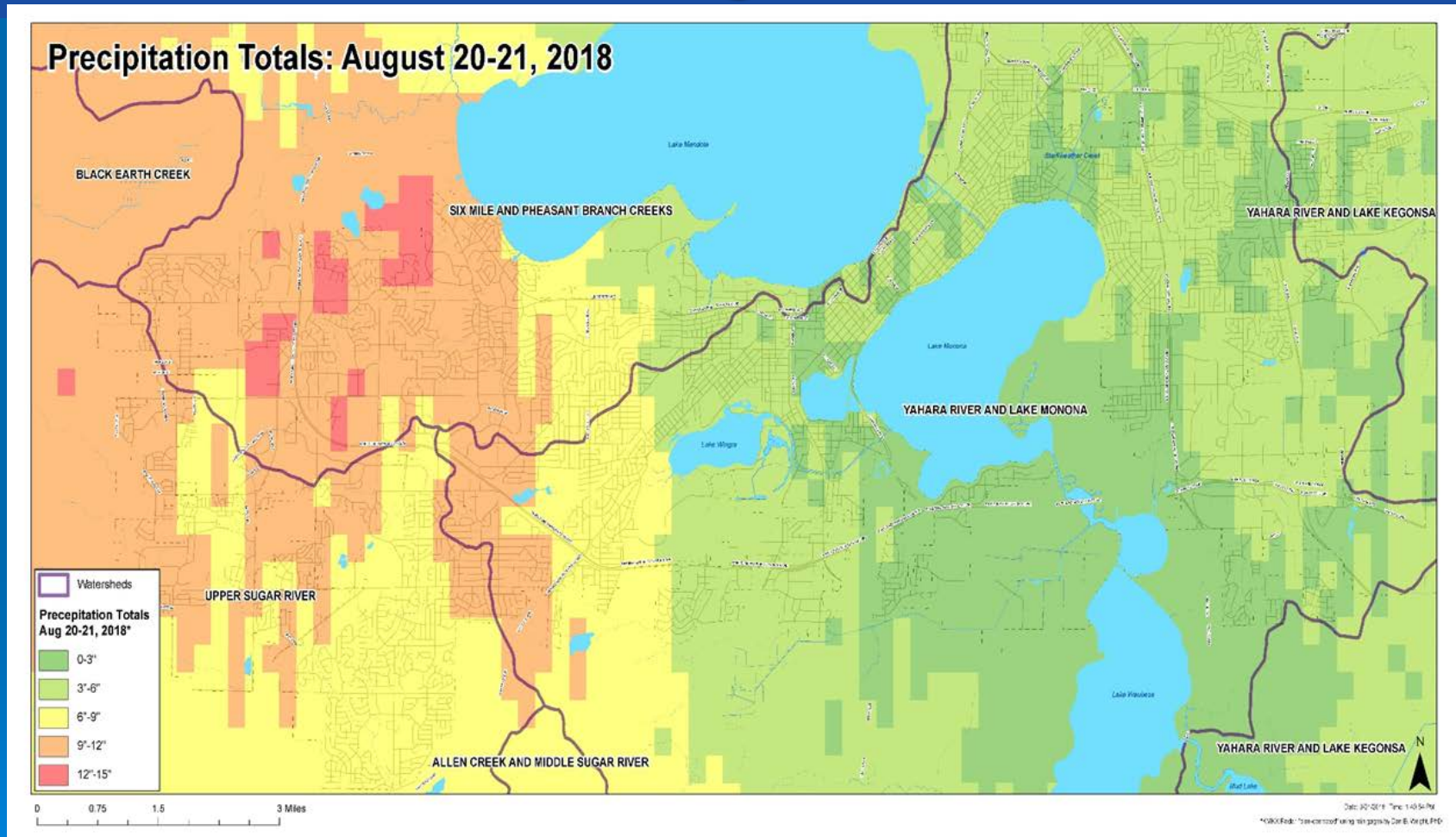
City Engineering
Janet Schmidt P.E.

Presentation Overview

- Historic Flooding - August 2018
 - Flash Flooding
 - Lake Level Flooding
- City of Madison Response to Flooding
 - Short, Mid and Long Term Goals
 - Design Changes & Ordinance Modifications
 - Watershed Studies
- What does the Future Hold?
 - Climate Change Concerns
 - Infrastructure Upgrades
 - Green Infrastructure

Historic Flooding: Flash Flooding

Rainfall totals August 20-21, 2018



KMKX Radar that was
"bias corrected" using
rain gauges by UW
Professor Dan Wright

Historic Flooding: Flash Flooding



Recurrence Interval

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)¹

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.381 (0.327-0.447)	0.437 (0.373-0.511)	0.531 (0.453-0.623)	0.613 (0.520-0.722)	0.732 (0.605-0.889)	0.829 (0.670-1.02)	0.929 (0.728-1.16)	1.04 (0.782-1.32)	1.18 (0.861-1.54)	1.30 (0.922-1.71)
10-min	0.559 (0.478-0.654)	0.639 (0.547-0.749)	0.777 (0.663-0.912)	0.898 (0.761-1.06)	1.07 (0.886-1.30)	1.21 (0.981-1.49)	1.36 (1.07-1.70)	1.52 (1.14-1.93)	1.73 (1.26-2.25)	1.90 (1.35-2.50)
15-min	0.681 (0.583-0.798)	0.780 (0.667-0.913)	0.948 (0.808-1.11)	1.10 (0.928-1.29)	1.31 (1.08-1.59)	1.48 (1.20-1.81)	1.66 (1.30-2.07)	1.85 (1.40-2.36)	2.11 (1.54-2.75)	2.32 (1.65-3.05)
30-min	0.939 (0.804-1.10)	1.08 (0.921-1.26)	1.31 (1.12-1.54)	1.52 (1.29-1.79)	1.82 (1.50-2.20)	2.06 (1.66-2.52)	2.30 (1.81-2.88)	2.57 (1.94-3.27)	2.93 (2.13-3.81)	3.21 (2.28-4.22)
60-min	1.19 (1.02-1.40)	1.38 (1.18-1.62)	1.71 (1.46-2.01)	1.99 (1.69-2.35)	2.40 (1.99-2.92)	2.74 (2.21-3.36)	3.09 (2.42-3.85)	3.45 (2.60-4.40)	3.96 (2.88-5.15)	4.36 (3.09-5.72)
2-hr	1.45 (1.25-1.69)	1.69 (1.46-1.97)	2.11 (1.81-2.45)	2.47 (2.11-2.88)	2.99 (2.49-3.61)	3.42 (2.78-4.17)	3.87 (3.05-4.80)	4.34 (3.30-5.49)	4.99 (3.66-6.46)	5.51 (3.94-7.18)
3-hr	1.60 (1.39-1.86)	1.88 (1.62-2.17)	2.35 (2.03-2.73)	2.77 (2.37-3.22)	3.38 (2.83-4.07)	3.88 (3.17-4.72)	4.41 (3.49-5.46)	4.97 (3.79-6.28)	5.75 (4.24-7.42)	6.37 (4.57-8.28)
6-hr	1.89 (1.65-2.17)	2.20 (1.91-2.53)	2.75 (2.38-3.16)	3.24 (2.79-3.74)	3.98 (3.36-4.78)	4.60 (3.79-5.56)	5.26 (4.20-6.48)	5.97 (4.60-7.51)	6.98 (5.18-8.96)	7.79 (5.62-10.1)
12-hr	2.20 (1.93-2.51)	2.52 (2.21-2.87)	3.10 (2.71-3.54)	3.64 (3.16-4.18)	4.47 (3.82-5.36)	5.19 (4.32-6.25)	5.96 (4.81-7.31)	6.81 (5.28-8.52)	8.02 (6.01-10.3)	9.02 (6.55-11.6)
24-hr	2.51 (2.21-2.84)	2.87 (2.53-3.25)	3.53 (3.10-4.00)	4.14 (3.62-4.71)	5.08 (4.36-6.03)	5.88 (4.93-7.03)	6.76 (5.48-8.23)	7.71 (6.02-9.58)	9.08 (6.84-11.5)	10.2 (7.46-13.0)

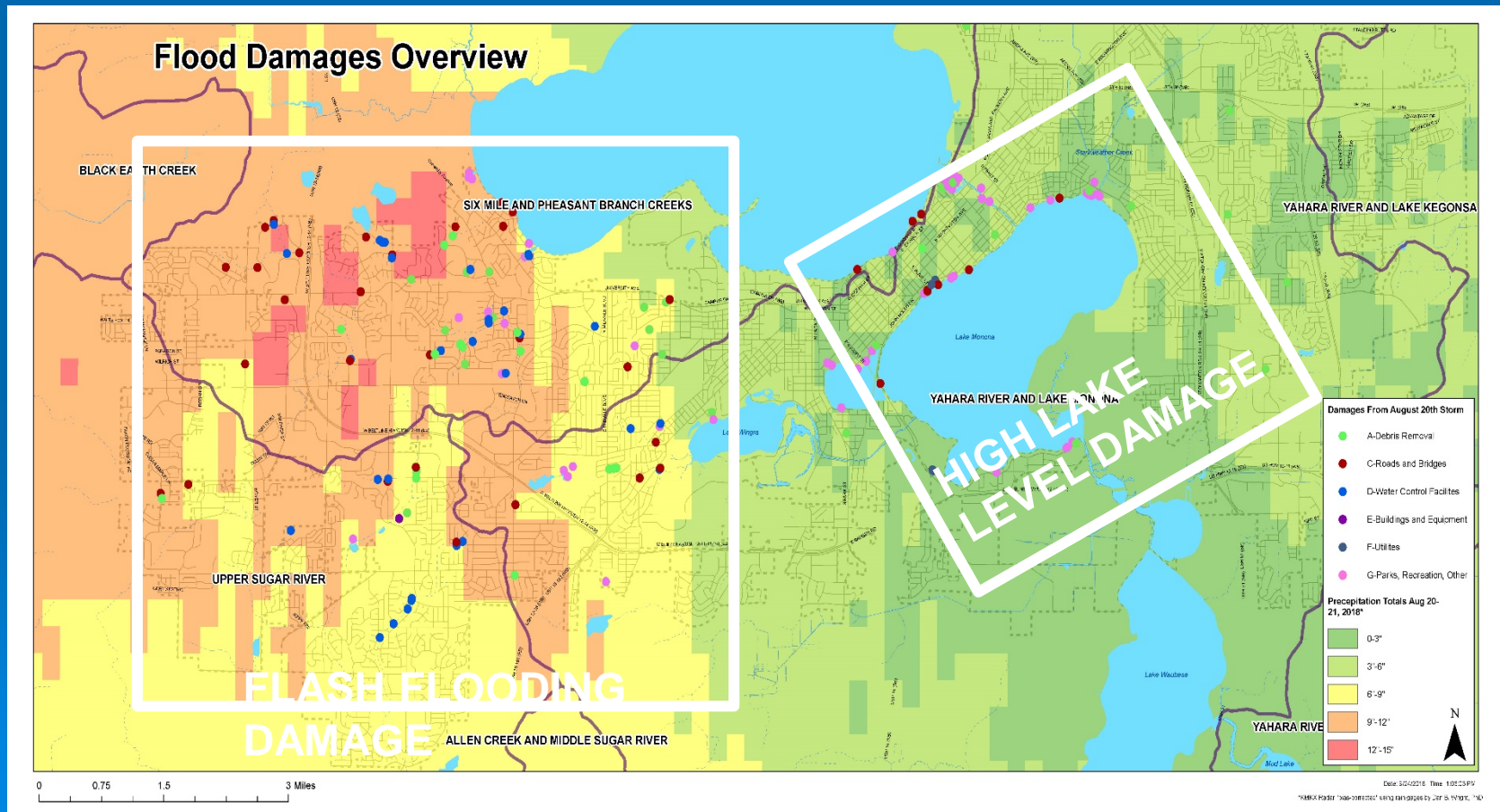
Flooding in Madison as a result of August 20, 2018 storm event had two parts:

- 1) Urban Flash Flooding
 - 2) Lake Level Flooding
- 

Historic Flooding:

1- FLASH FLOOD

2- LAKE LEVEL FLOODING



Historic Flooding: Flash Flooding

- Recent storms have amplified known inadequacies
- Recent storms have revealed new storm sewer deficiencies
- Result: flood damage



Deming Way, Madison, WI

Historic Flooding: Flash Flooding

Damage

- Public infrastructure: \$4 million
- Private property: reported \$17.5 million, estimated **\$30 million**



Odana Road (above), Glenwood
Children's Park (right), Madison, WI

Historic Flooding: Flash Flooding



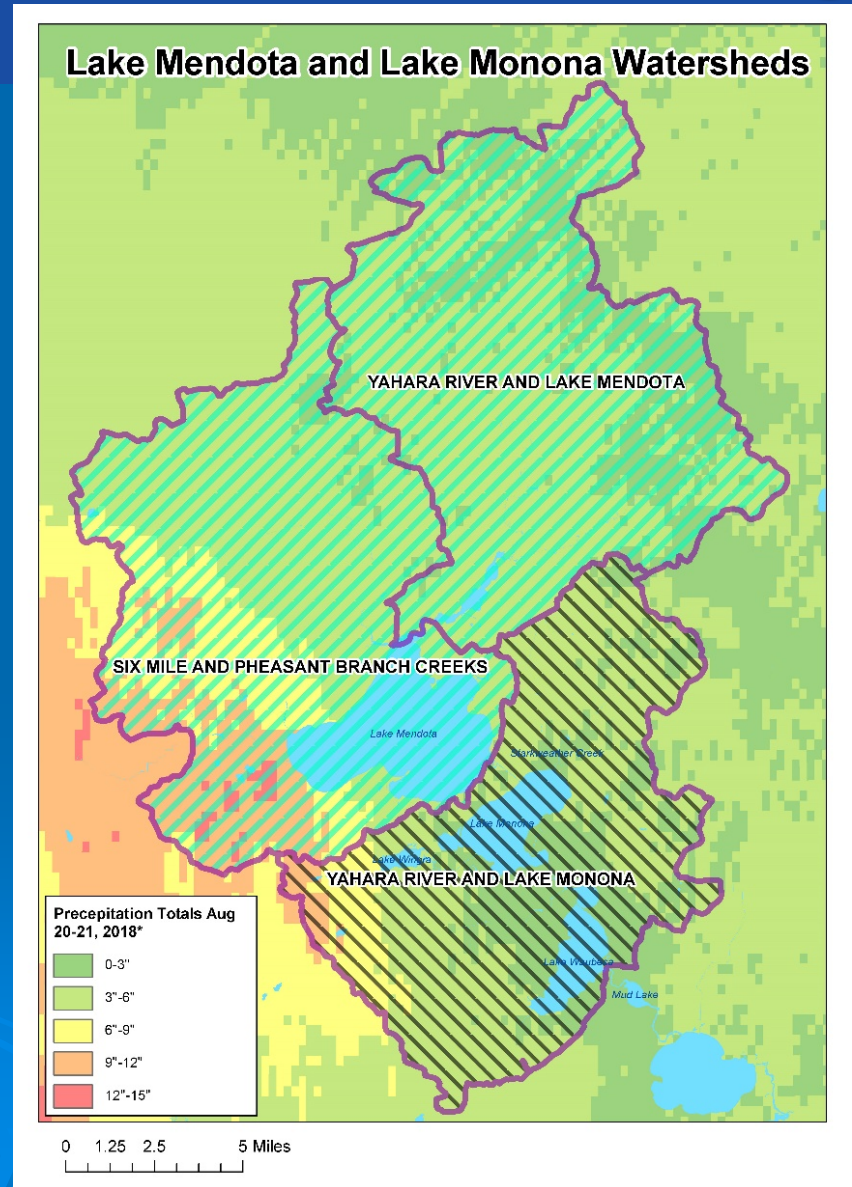
Odana Golf Course, Madison, WI



Commerce Dr, Madison, WI

Historic Flooding: Lake Level Flooding

- It typically takes about 3 days for water from the watershed to get to Lake Mendota
- Generally - 1 inch of rainfall equals 3" in lake rise on Lake Mendota



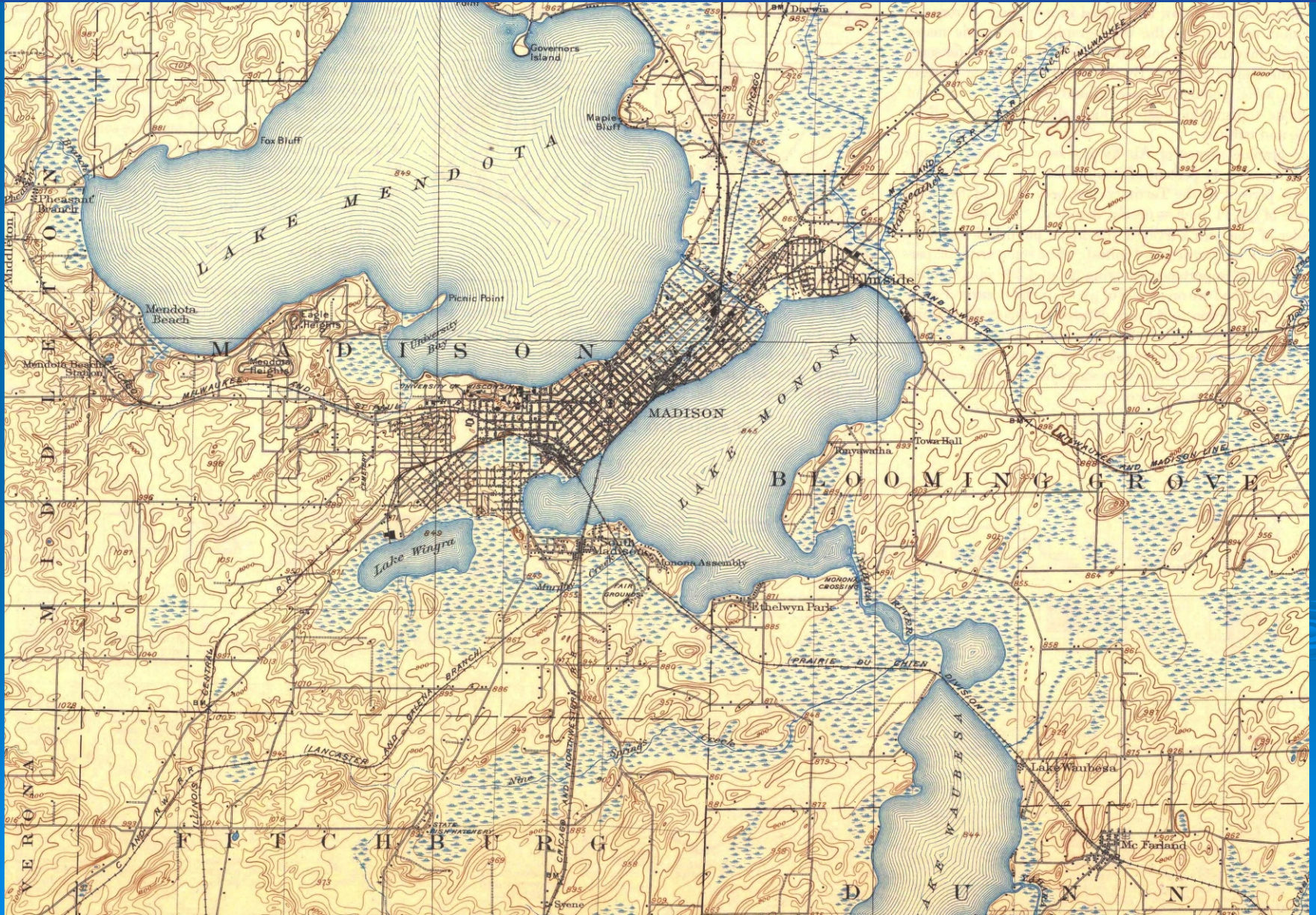
Historic Flooding: Lake Level Flooding

The Issues:

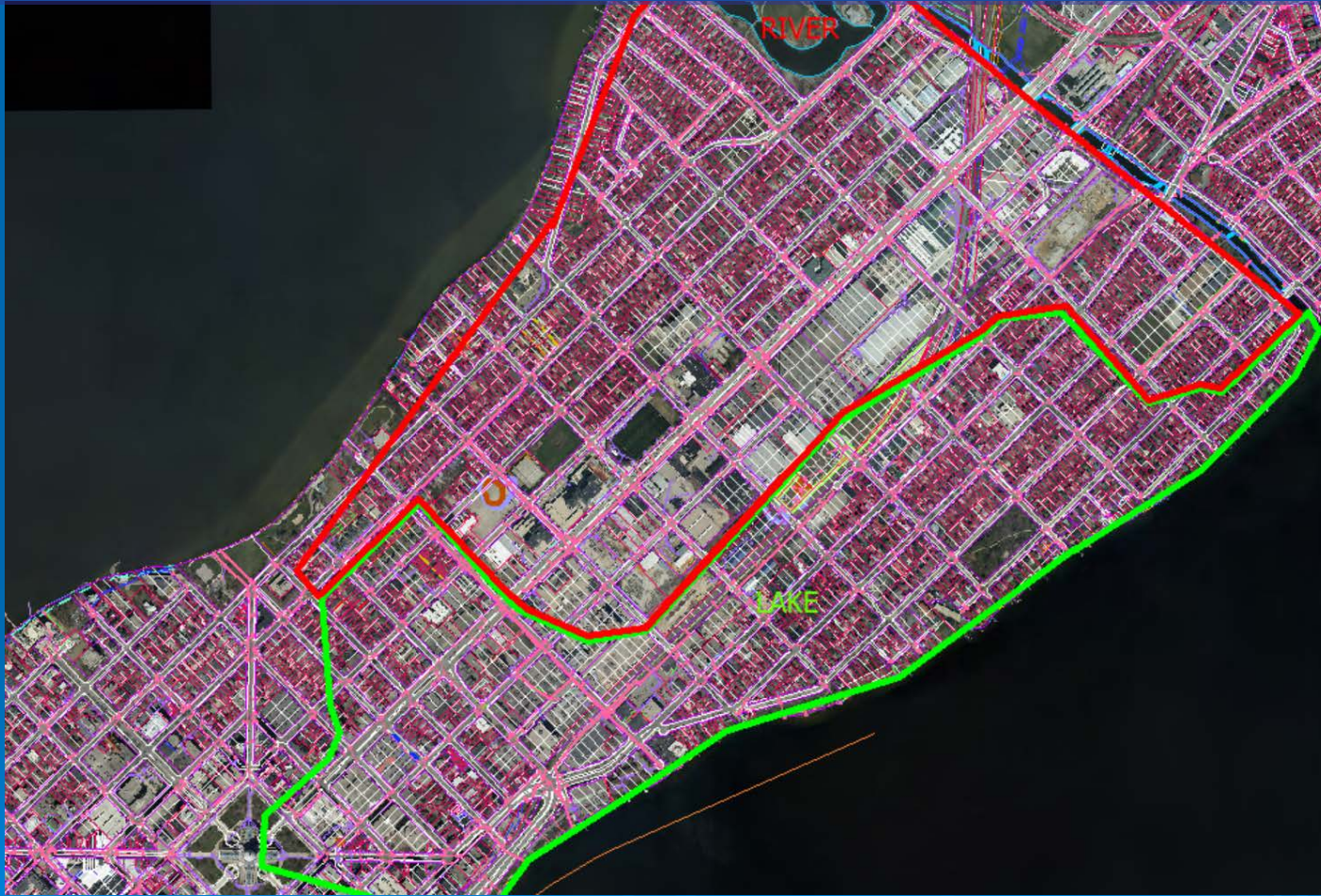
- Low and Enclosed Areas
- Submerged Storm Sewer System
- Historic Wetlands



Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding



- These low areas became a backwater of Lake Monona and the Yahara River

Historic Flooding: Lake Level Flooding



City of Madison - Current Hydric Soils + Low Lying Areas



Historic Flooding: Lake Level Flooding

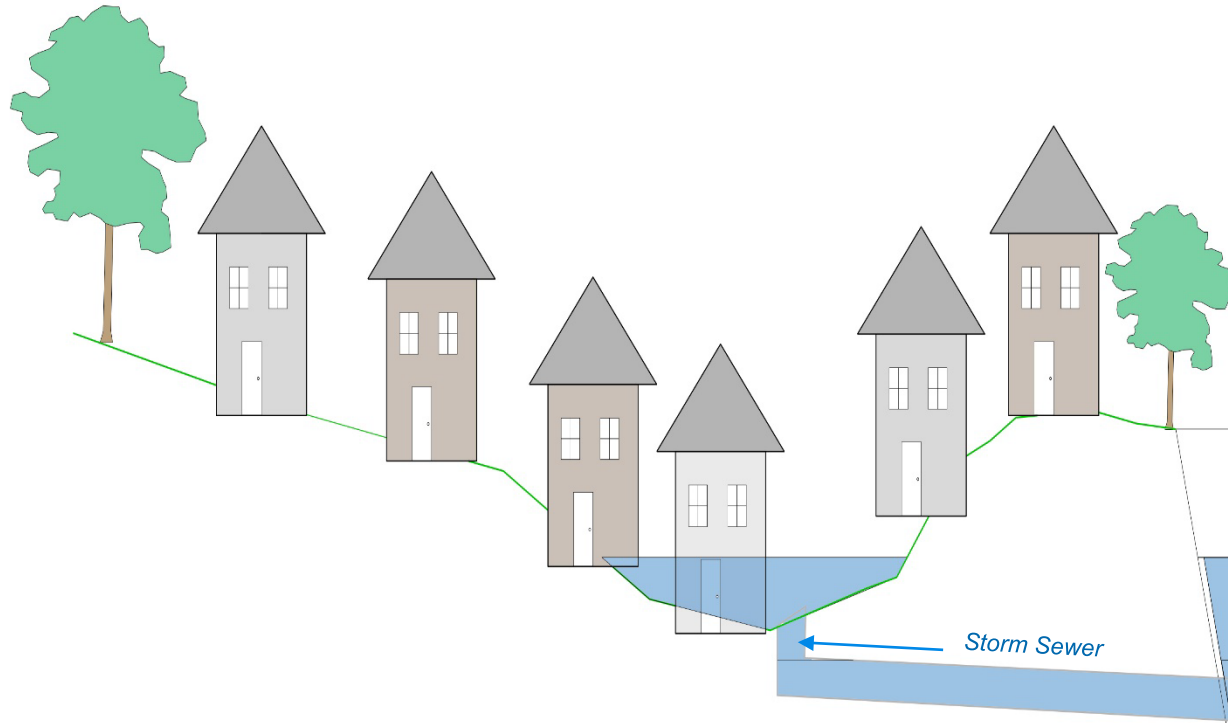
The Issues:

- Low and Enclosed Areas
- Submerged Storm Sewer System
- Historic Wetlands

The Consequences:

- Surface Water Flooding
- Groundwater and Basement Flooding
- Infiltration into Sanitary Sewer

Historic Flooding: Lake Level Flooding



- Storm sewers drain Isthmus during rain events
- Large amounts of water released from Mendota → higher water levels in Yahara River
- Sewers act in reverse, water travels "up" them
- Water standing in isthmus is part of the lake



Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding



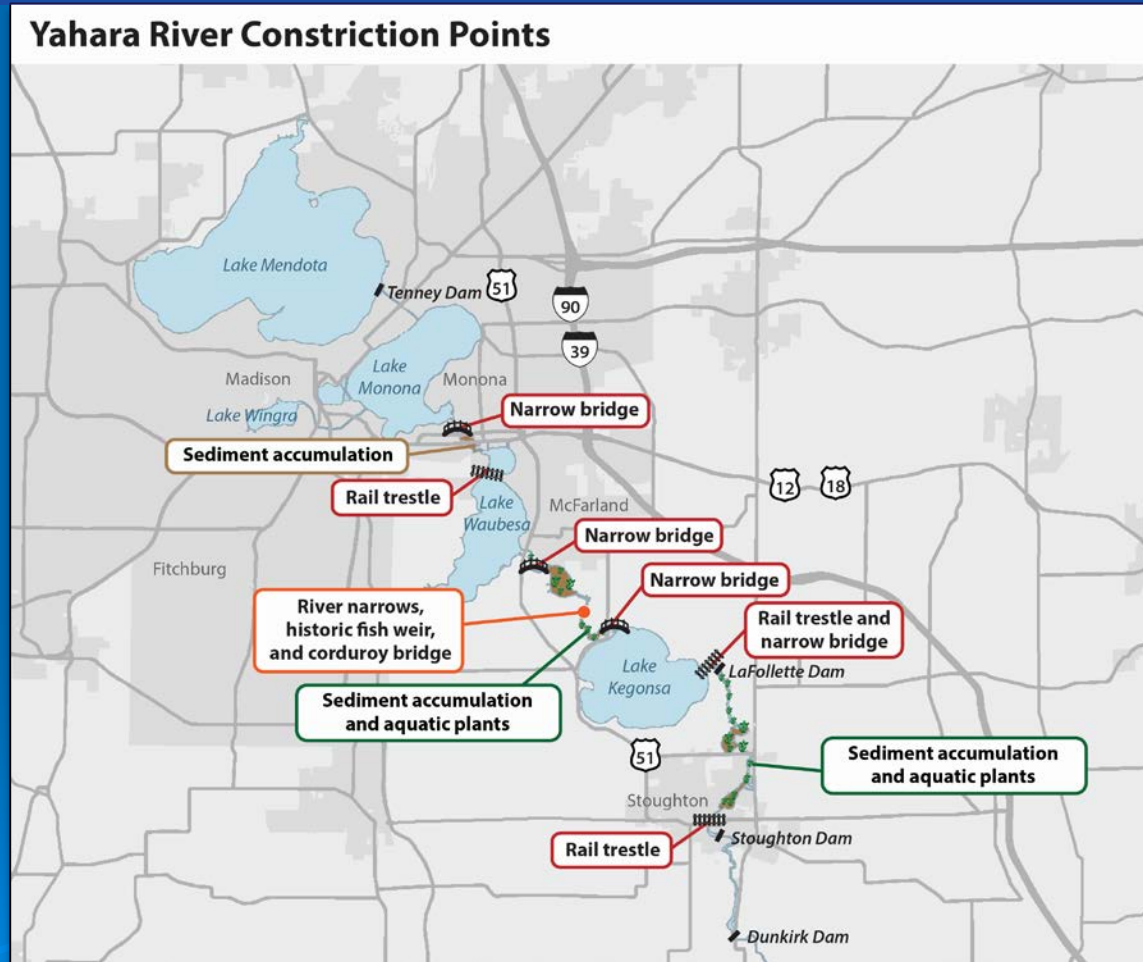
Historic Flooding: Lake Level Flooding



Historic Flooding: Lake Level Flooding

Lake Level Management

- Dane County technical group
 - Options to allow the lakes to be better controlled.
 - Technical hydraulics and hydrology look at the system for only flood control.



Historic Flooding: Lake Level Flooding

Lake Level Management

➤ Immediate need – Look at ways to move the water out of Monona, Waubesa and Kegonsa faster.

- Dredging
- Aquatic Plant Management
- Dam management
- Structural changes at Tenney Lock house



Tenney Locks

Historic Flooding: Lake Level Flooding

Lake Level Management

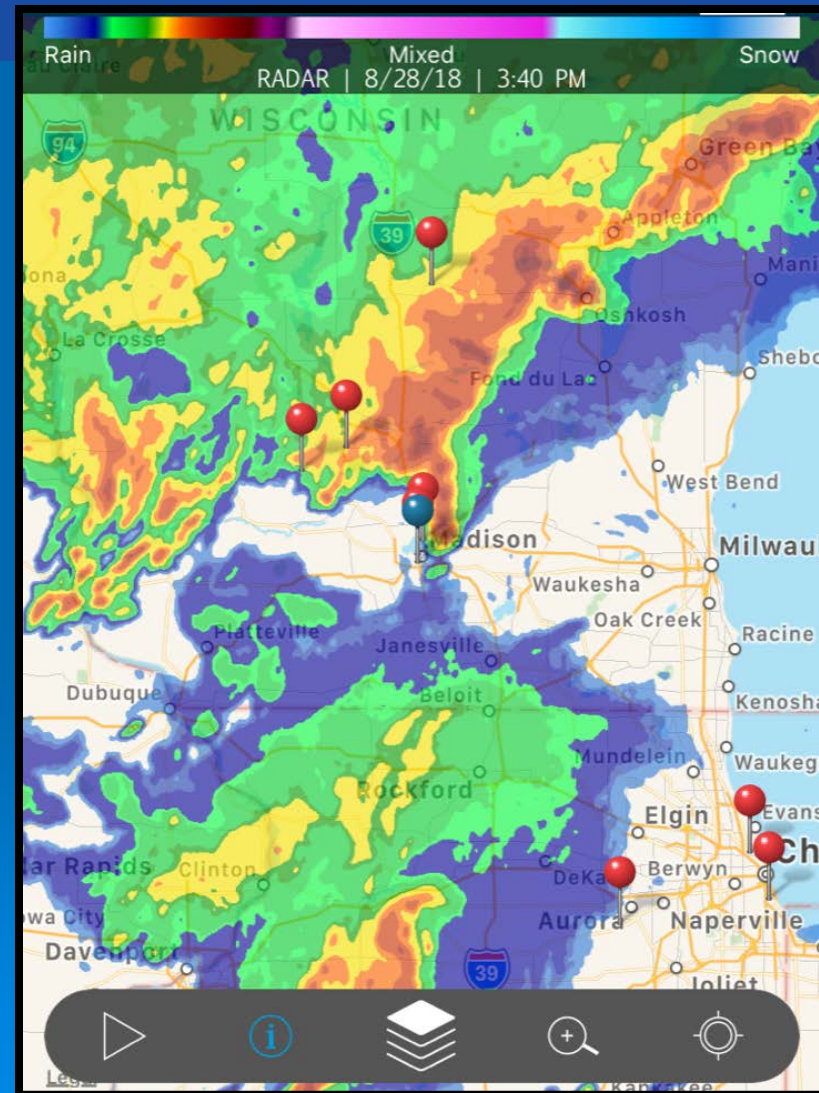
- Long term – Changes to how much water the lakes get during a storm (volume controls/infiltration)
 - Pumping
 - Lake Levels
 - Lake Level Management Guide
 - Stormwater and Infiltration
- *We have to find a way not to recreate the problem so in a generation we are not back here with a new group of people at the table and the same exact problems.*



We Need to Prepare!

8/28/2018 - Major storm
just missed Madison

This storm resulted in
10+ inches of rain
towards Baraboo -
almost closing I-90
about a week later.



City of Madison Response to Flooding

- Short, Mid and Long Term Goals
- Design Changes & Ordinance Modifications
- Watershed Studies



City of Madison Response to Flooding

➤ Short-Term Goals

- Data collection
- Emergency response for safety issues
- Emergency repairs
- Self-reporting for residents and owners:

www.cityofmadison.com/reportflooding



City of Madison Response to Flooding

➤ Mid-Term Goals

- Outreach: Public Meetings, Waterways newsletter, website
- Kick-off of *Watershed Studies*
- Build on City's Flooding Emergency Preparedness Plan
- Create standardized flood reporting system for City Agencies
- Dane County-led Lake Level Technical Group for high lake level flooding

City of Madison Response to Flooding

➤ Long-Term Goals

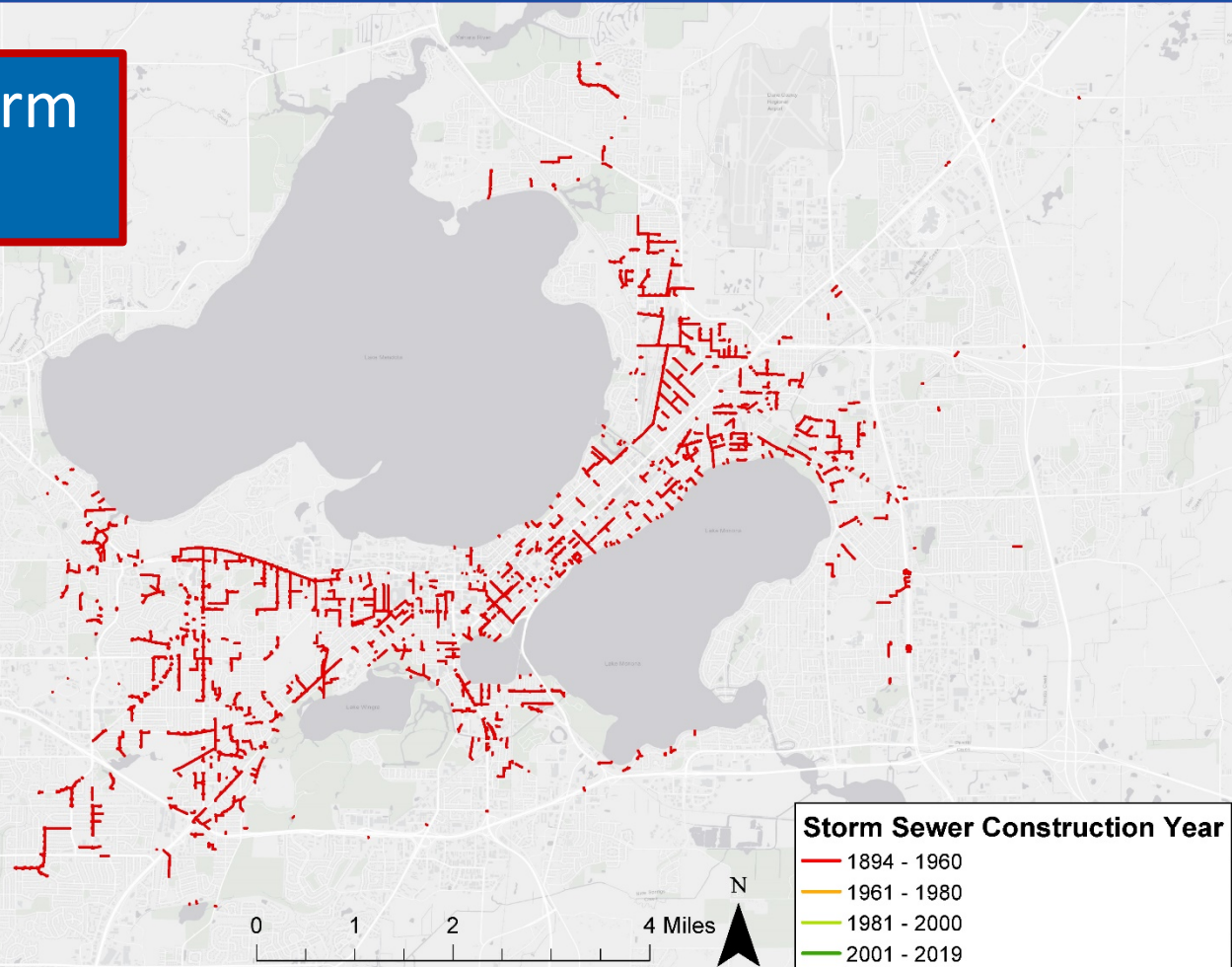
- Complete *Watershed Studies* to identify deficiencies
- Continue *Watershed and Flood Studies* for other areas in the city
- Work with development community to build a more resilient city

➤ ***Watershed Studies* are a large portion of building flood resilience**

City of Madison Response to Flooding: Design Changes and Ordinance Modifications

City of Madison Storm Sewer: 1894-1960

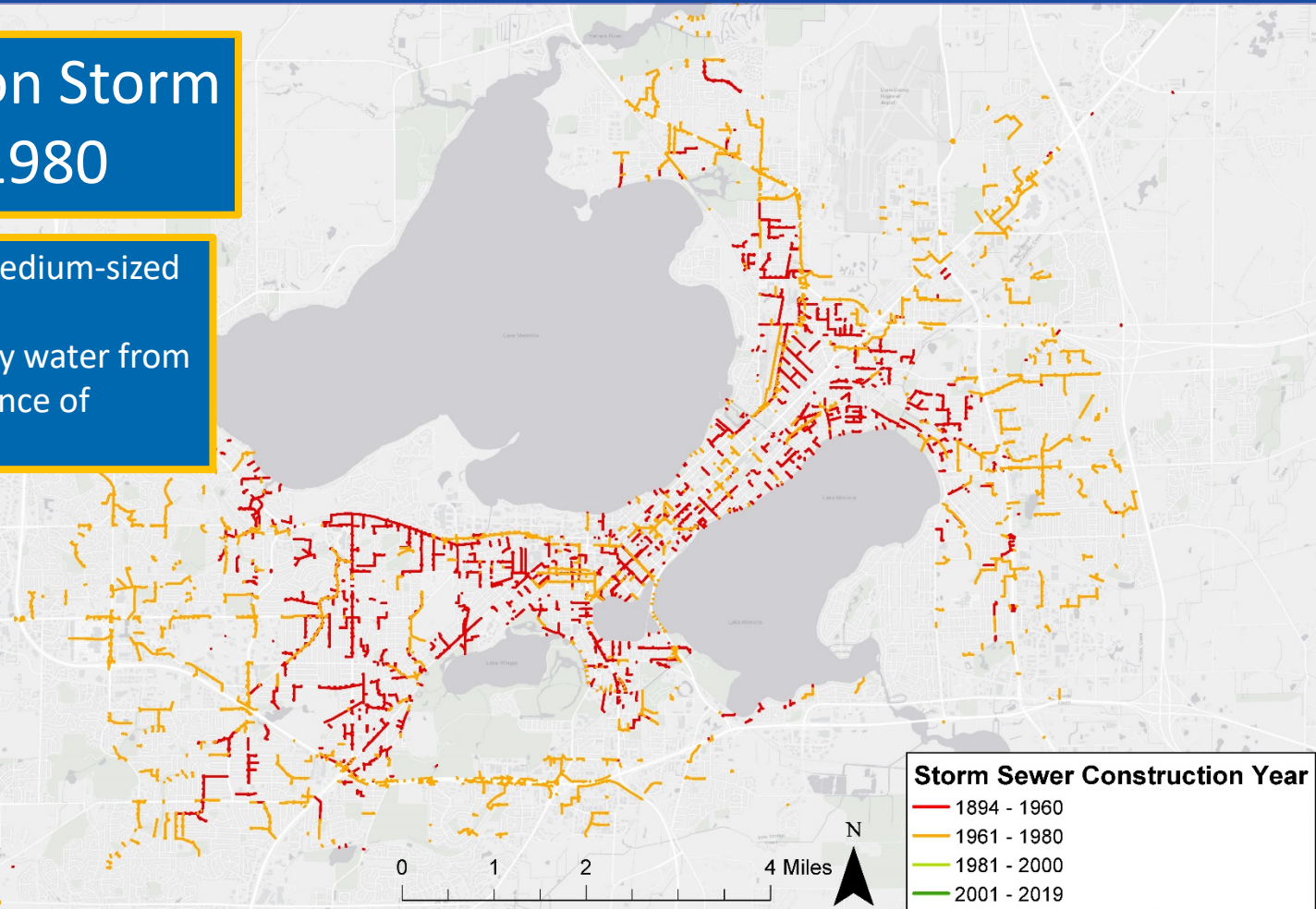
- Rule of thumb design
- No flood control



City of Madison Response to Flooding: Design Changes and Ordinance Modifications

City of Madison Storm Sewer: 1961-1980

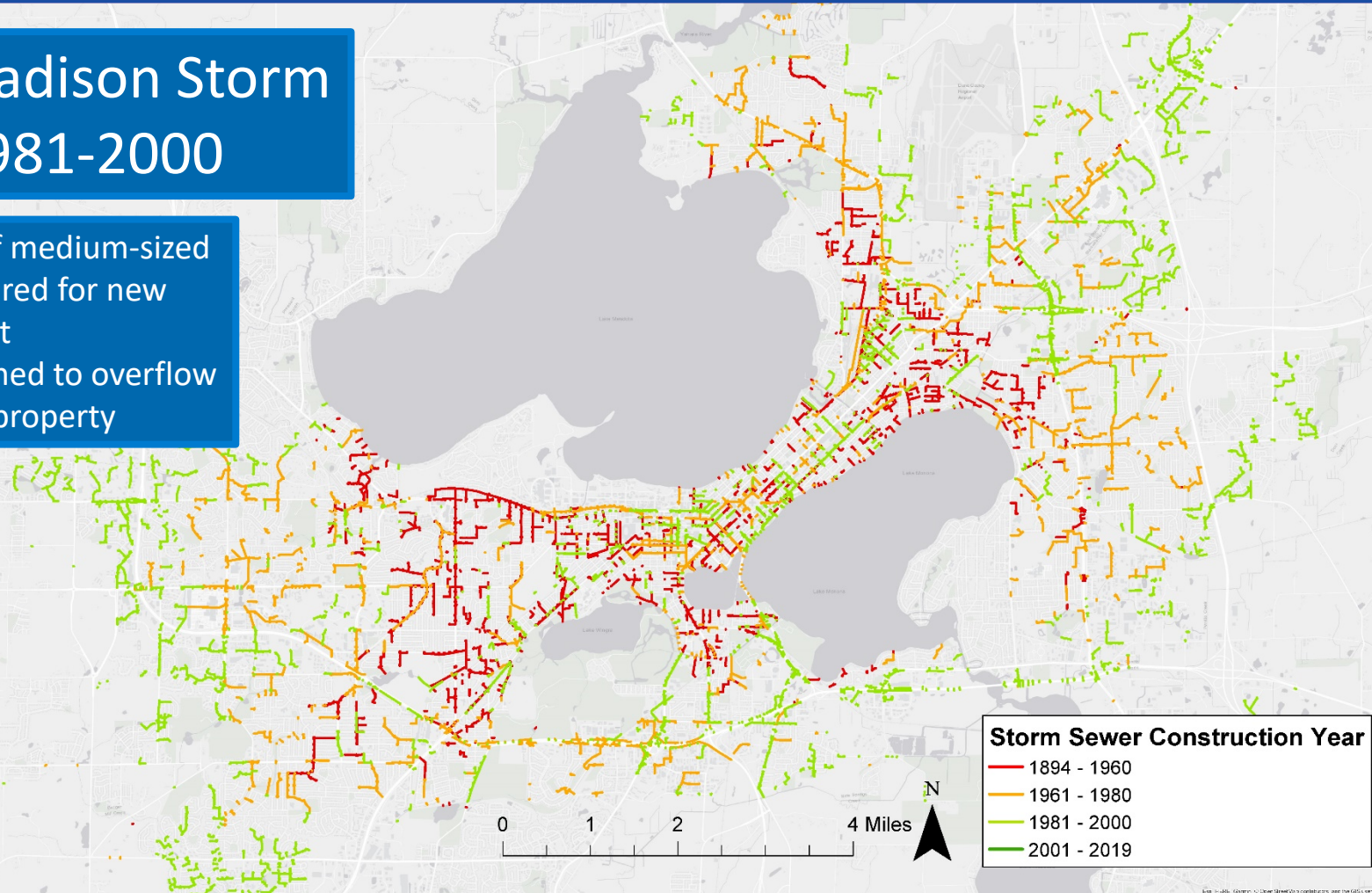
- Pipes designed for medium-sized storms
- Culverts sized to carry water from storms with 10% chance of occurring each year



City of Madison Response to Flooding: Design Changes and Ordinance Modifications

City of Madison Storm Sewer: 1981-2000

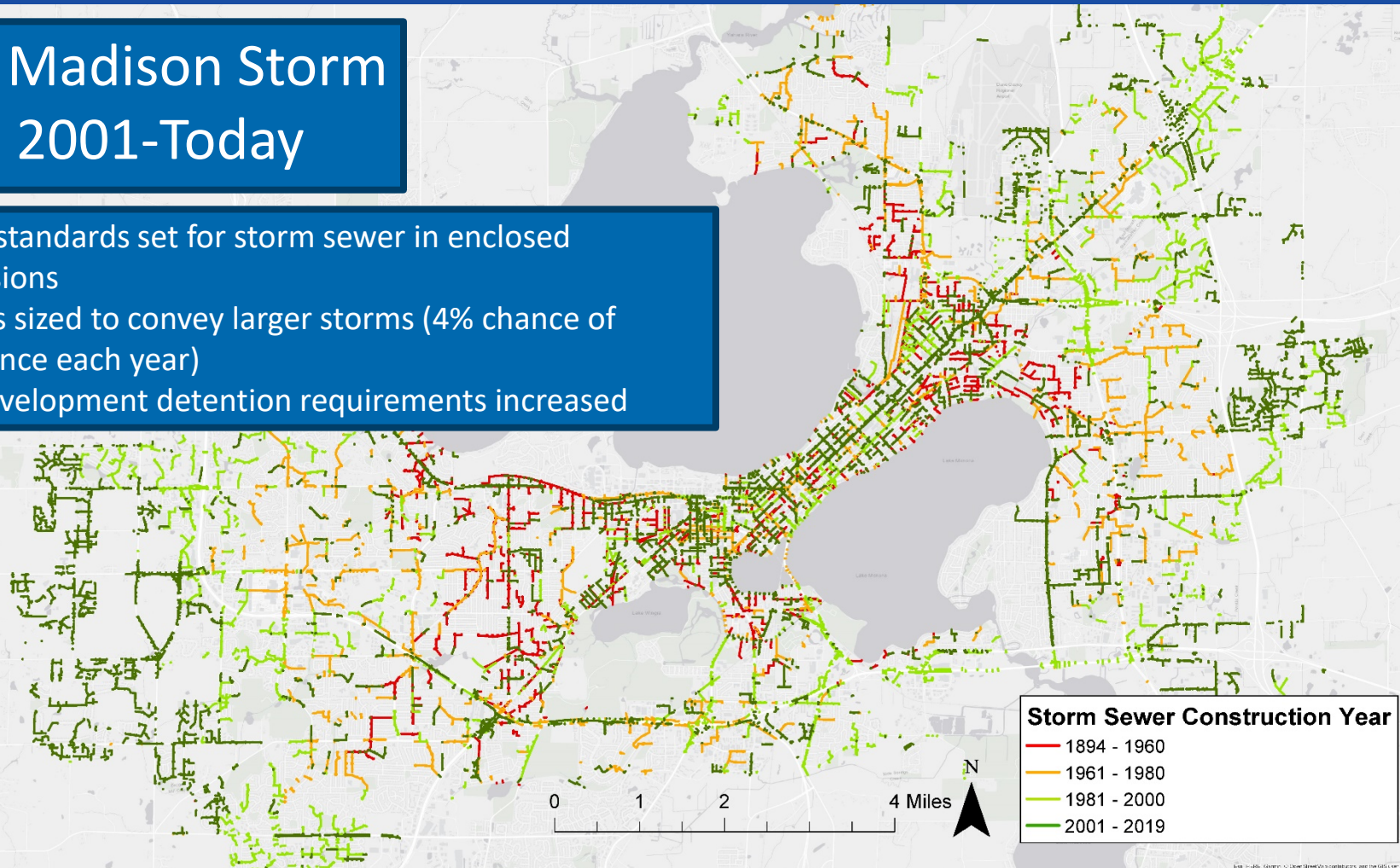
- Detention of medium-sized storms required for new development
- Ponds designed to overflow onto public property



City of Madison Response to Flooding: Design Changes and Ordinance Modifications

City of Madison Storm Sewer: 2001-Today

- Design standards set for storm sewer in enclosed depressions
- Culverts sized to convey larger storms (4% chance of occurrence each year)
- New development detention requirements increased



We still have a lot of existing and older infrastructure!

City of Madison Response to Flooding: Design Changes & Ordinance Modifications

Current Madison Design Standards for New Development:

- Storm Sewer Pipes – 10 Year Event
- Culverts under a road - 25 or 50-Year Event
- Drainage of enclosed depressions – 100 Year Event
- Roads are expected to act as overflow during extreme events



City of Madison Response to Flooding: Design Changes & Ordinance Modifications

Current Madison Design Standards for New Development:

- Storm Sewer Pipes – 10 Year Event
- Culverts under a road - 25 or 50-Year Event
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Why doesn't this always work?

- First floor elevations are not set by standards or regulated
- Forced exposures create vulnerabilities
- Inlets clog and don't function as designed

City of Madison Response to Flooding: Design Changes & Ordinance Modifications

Proposed Madison Design Standards for New Development:

- Storm Sewer Pipes – 10 Year Event
- Culverts under a road – 100 Event
- Drainage of enclosed depressions – 100 Year Event
- Roads are expected to act as overflow during extreme events



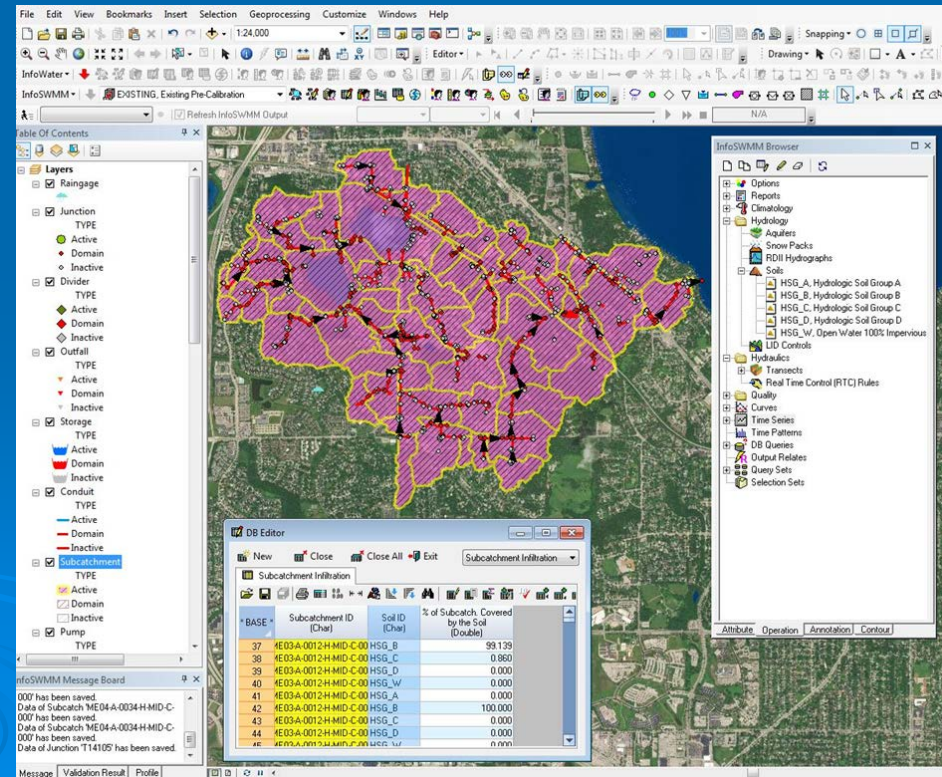
City of Madison Response to Flooding: Design Changes & Ordinance Modifications

Proposed Madison Design Standards for New Development:

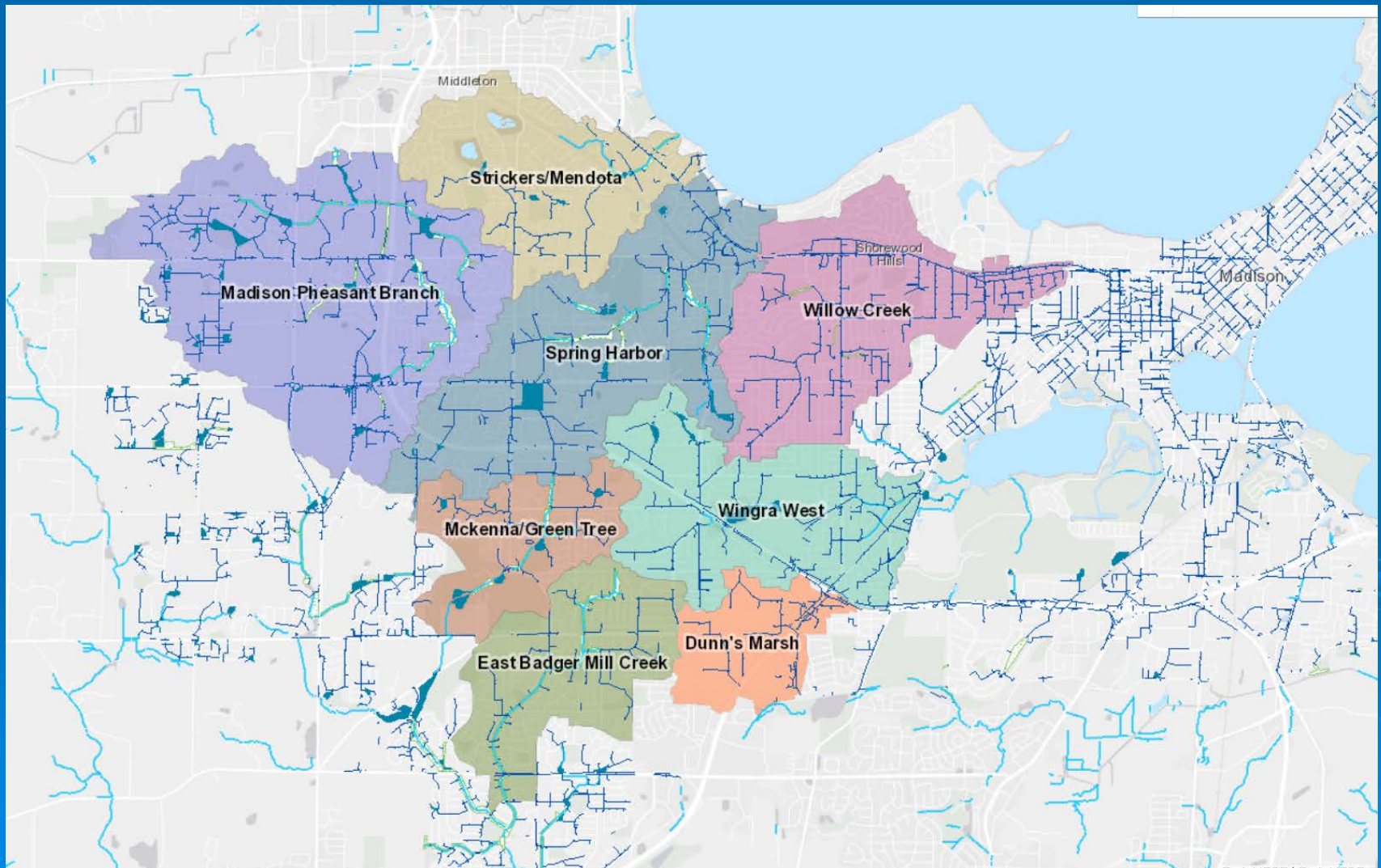
- No water leaves ROW or public property in 100 Year Event
- Model for 200-year event in flood prone areas
- 500 year event – water may leave ROW or public lands but no structure flooding
- Deed restrict properties for minimum opening elevation on buildings
- Rate and volume requirements for redevelopment sites

City of Madison Response to Flooding: Watershed Studies

- 2019 Completing 8 Studies (\$2M +)
- Continue Studies for next 5-8 years
- Total 23+ Studies for Madison

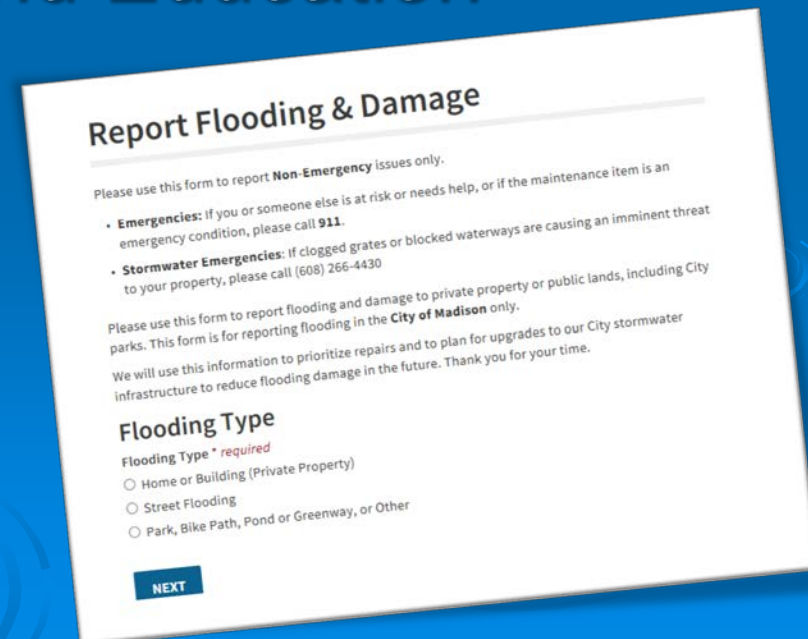


City of Madison Response to Flooding: Watershed Studies



City of Madison Response to Flooding: Watershed Studies

- Dedicated Flooding Website
- Online Self Reporting Tools
- Educational Information for Residents
- Heightened Outreach and Education



Report Flooding & Damage

Please use this form to report **Non-Emergency** issues only.

- **Emergencies:** If you or someone else is at risk or needs help, or if the maintenance item is an emergency condition, please call **911**.
- **Stormwater Emergencies:** If clogged grates or blocked waterways are causing an imminent threat to your property, please call (608) 266-4430

Please use this form to report flooding and damage to private property or public lands, including City parks. This form is for reporting flooding in the **City of Madison** only.

We will use this information to prioritize repairs and to plan for upgrades to our City stormwater infrastructure to reduce flooding damage in the future. Thank you for your time.

Flooding Type

Flooding Type * *required*

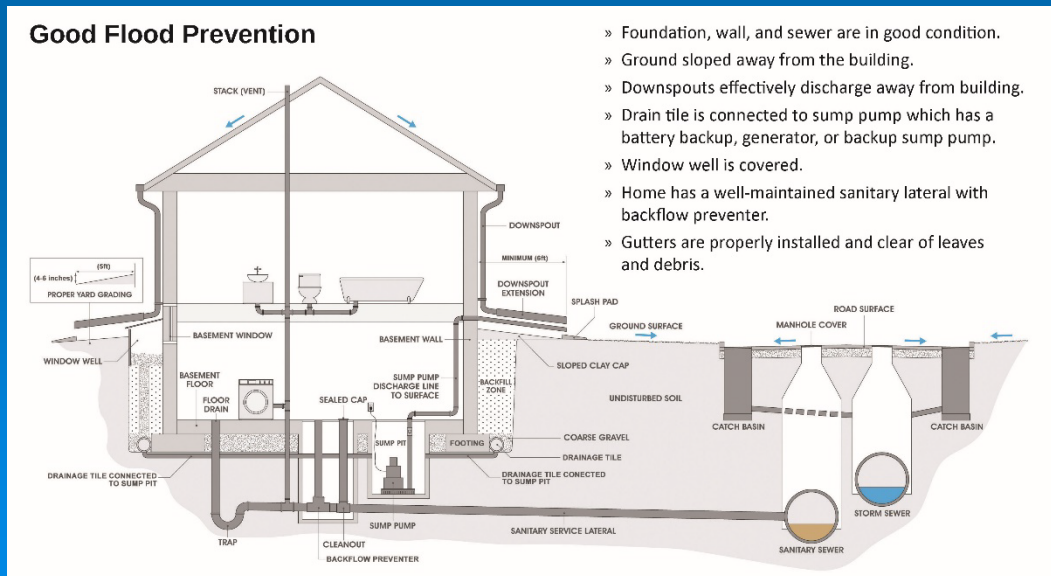
- ☐ Home or Building (Private Property)
- ☐ Street Flooding
- ☐ Park, Bike Path, Pond or Greenway, or Other

NEXT

City of Madison Response to Flooding: Watershed Studies

Property Owner Responsibilities:

- Self-report Online Survey
- Understand how to protect your property
- Install backflow preventers and sump pumps
- Consider supplemental insurance



City of Madison Response to Flooding: Watershed Studies

Model Existing Conditions & Predict
Future Flood Risk

Analyze Solutions on Watershed
Scale, Rank & Budget

Create
Drainage
Model

Identify
Flooding
Impacts

Develop
Engineering
Solutions

Prioritize
& Budget



City of Madison Response to Flooding: Watershed Studies

- Design Solutions:
 - ▶ Must be holistic
 - ▶ Not “move the problem elsewhere”
 - ▶ Account for climate change
 - ▶ Look at **trending increases** in storm frequency and intensity
 - ▶ Consider long term maintenance needs
 - ▶ Provide benefits relative to cost

City of Madison Response to Flooding: Watershed Studies

- What are some general options?
 - Improve pipe and/or inlet capacity
 - Safe overflow paths
 - Reroute flow
 - Increase storage / detention
 - Flood-proof buildings
 - Local landscaping / grading
 - Solutions on private property to buildings or land

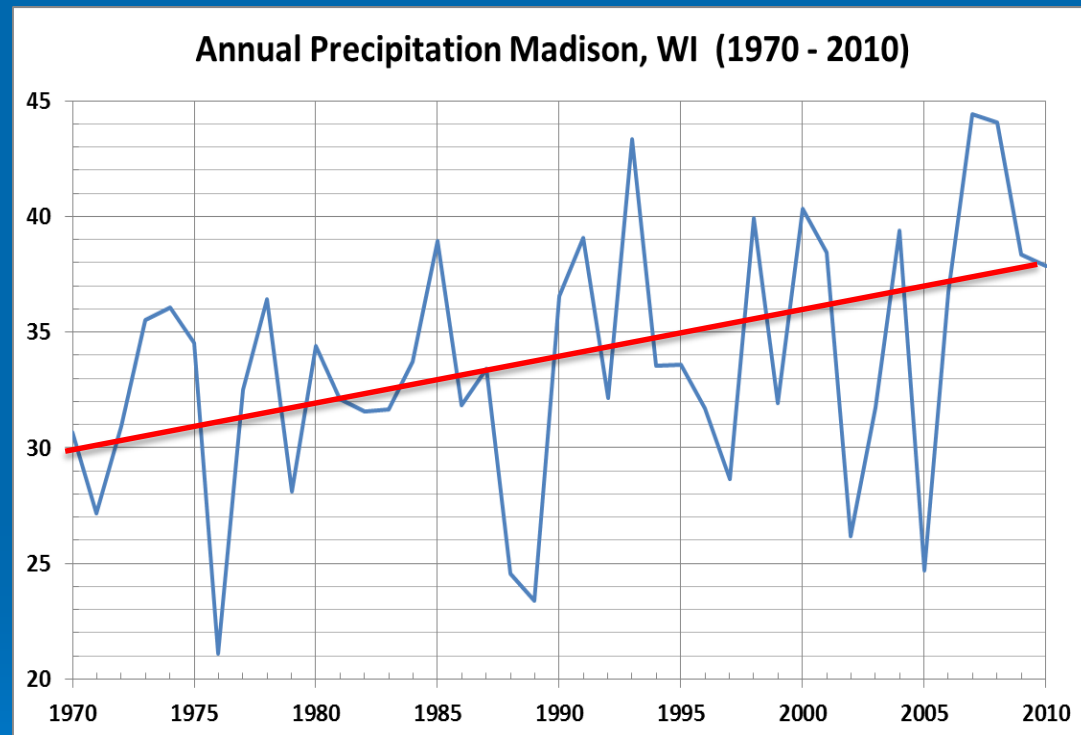
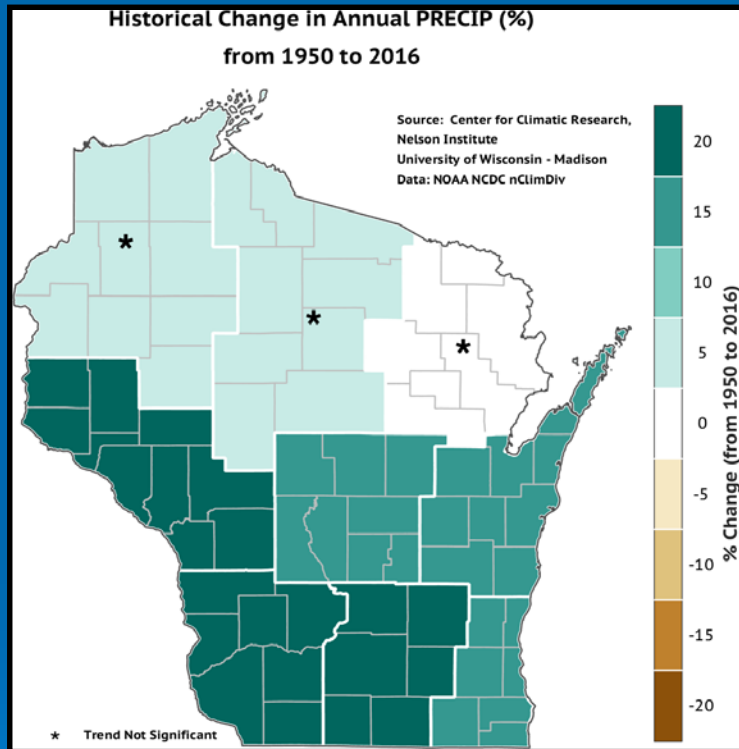
What Does the Future Hold?

- Climate Change Concerns
- Infrastructure Upgrades
- Green Infrastructure



What Does the Future Hold?

Climate Change Concerns

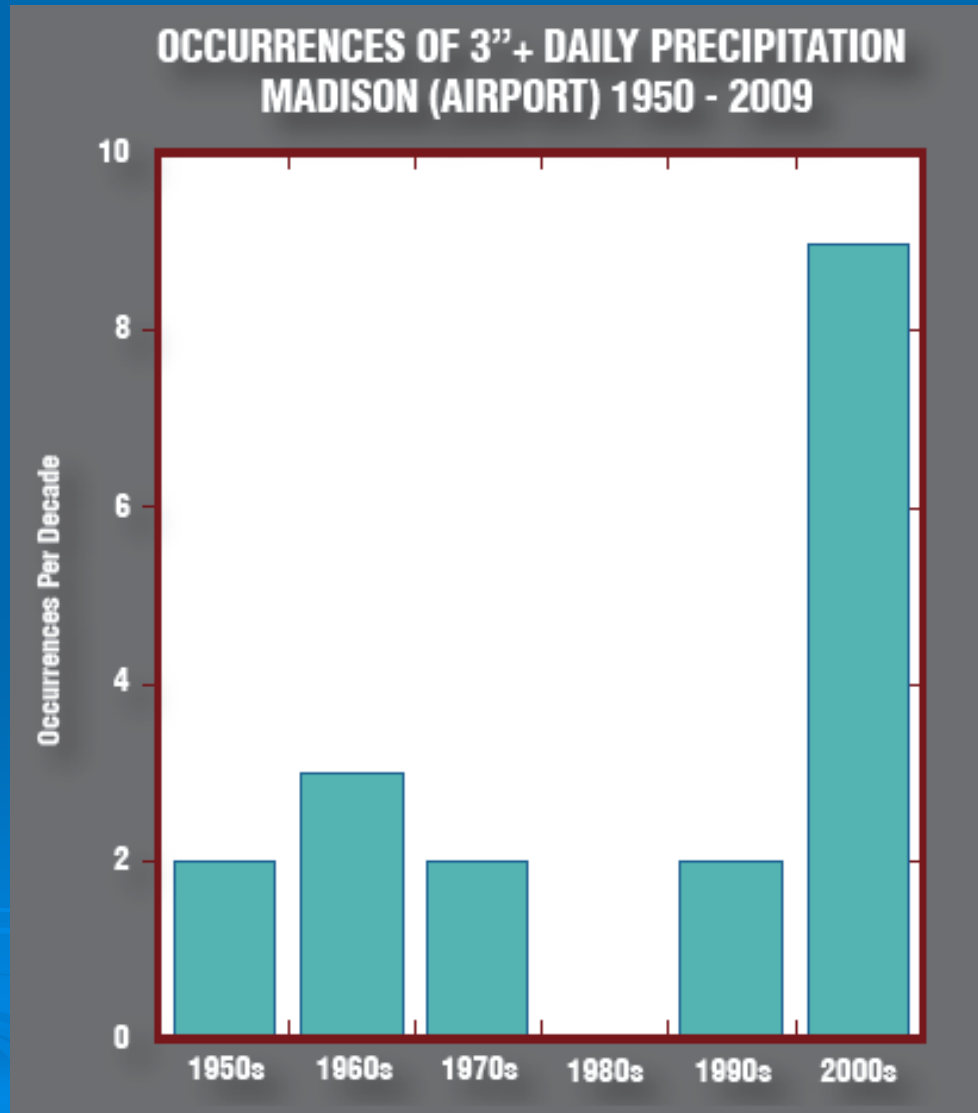


Rain and snow has increased
by 15% since 1950

What Does the Future Hold?

Climate Change Concerns

- More rain
- More rain events greater than 3"



What Does the Future Hold?

Climate Change Concerns

- Consider the use of a Madison specific Intensity, Duration, Frequency (IDF) curve



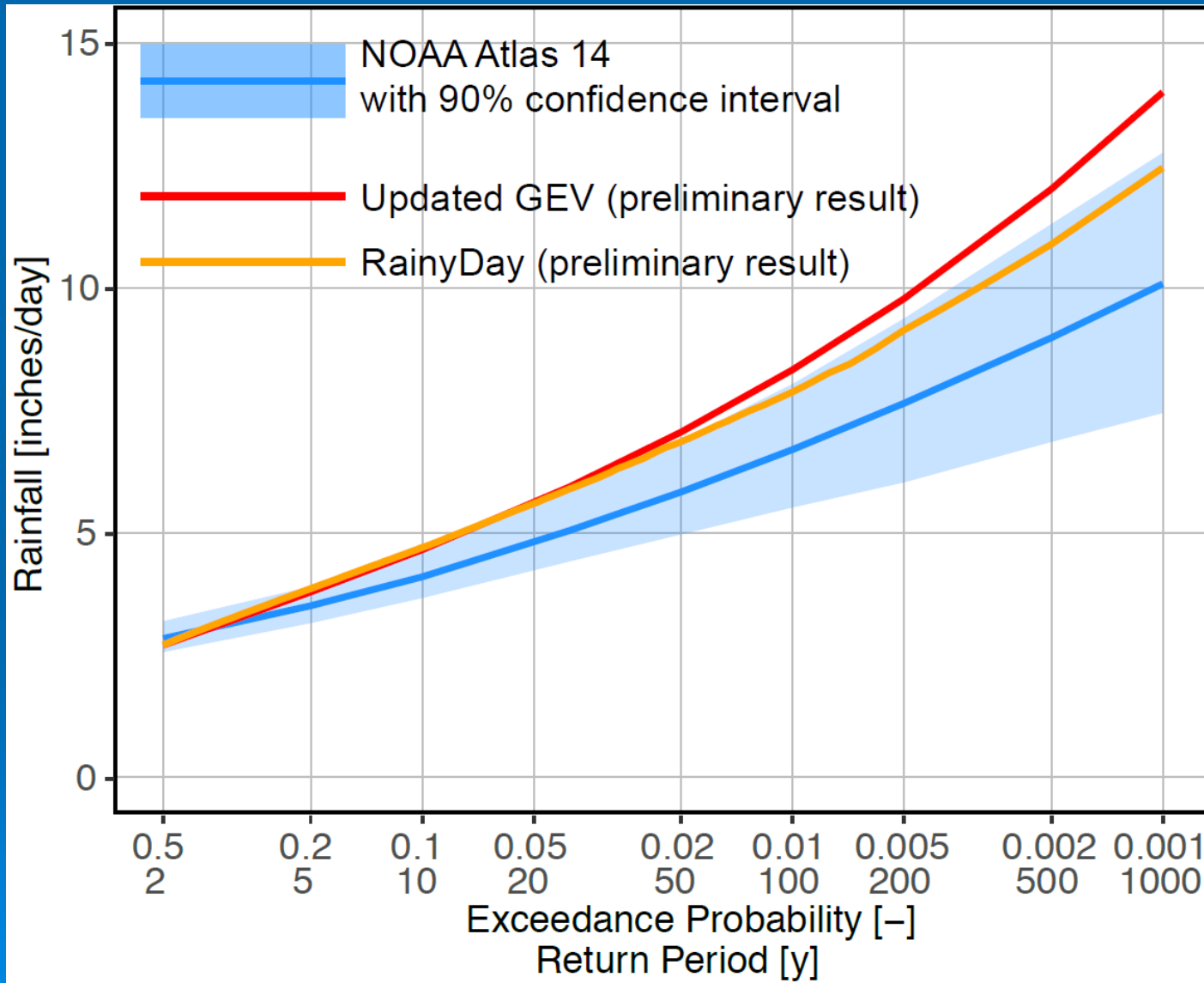
Professor Wright – RainyDay

24-hour rainfall
return periods:

Blue = NOAA
Atlas 14

Orange from
RainyDay

Red is based on
our analysis of
roughly 60 years
of data from the
"Charmany Farm"
rain gage, which
is off Mineral
Point near S.
Rosa Rd.



What Does the Future Hold?

Infrastructure Upgrades

- Road reconstruction, storm sewer is expensive but long-lasting
 - Road reconstruction cost = approximately \$500-\$2,000/ft
 - 2% City infrastructure is upgraded annually
 - Average life:
 - Street=30-50 years
 - Pipes=50-100 years



96" pipe tunneling on University Ave, Madison, WI (2013)

What Does the Future Hold? Infrastructure Upgrades

➤ Storm Water Utility Bill

- 2018 increased 2.3% (avg. residential increase of \$2.15/year)
- 2019 increased 10.1% (avg. residential increase of \$9.60/year)
- **Will continue to increase to fund infrastructure improvements in the future.**

What Does the Future Hold? Infrastructure Upgrades

- 2019 Flood Mitigation Projects
 - \$8.8M Public Works Projects Under Construction
 - Total Flood Mitigation budget for 2019 to date \$11.2M


What Does the Future Hold?

Green Infrastructure

Green Roofs – Proposed Ordinance Language

In redevelopment sites, rate and volume reduction of first ½" must utilize green infrastructure

Expect to see this in the Isthmus and high density areas where typical green infrastructure is not achievable.



What Does the Future Hold?

Green Infrastructure

Private Rain Gardens

- Look at street to identify locations for terrace rain gardens
- Rain gardens become the responsibility of the property owner
- Average costs including planting is about \$2000
- The property owner is required to pay a max of 400 or $\frac{1}{4}$ of the cost whichever is less.



What Does the Future Hold?

Green Infrastructure

Public Rain Gardens

- Coordinate with other City agencies to construct at least one public rain garden every year
- Often these are constructed by our operations crews.



What Does the Future Hold?

Green Infrastructure

- Pervious pavement pilot constructing approximately 500 feet of pervious sidewalk
- Precast pervious sidewalk
- Test site for a pervious pavement test site being monitored by the USGS and the WDNR.
- Pervious pavement in alleys
- Private property installations
- **LOOK FOR OTHER APPLICATIONS!!**



What Does the Future Hold?

Green Infrastructure

- Investigating grant programs for rain garden and green infrastructure installations
- Need to engage the public – City can't achieve flood mitigation goals solely on public property.



Questions and Discussion

