City-wide Stormwater Analysis

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(City of La Crosse)

with Rob Montgomery, & Michael Schwar (Montgomery Associates)

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Resource Solutions, LLC

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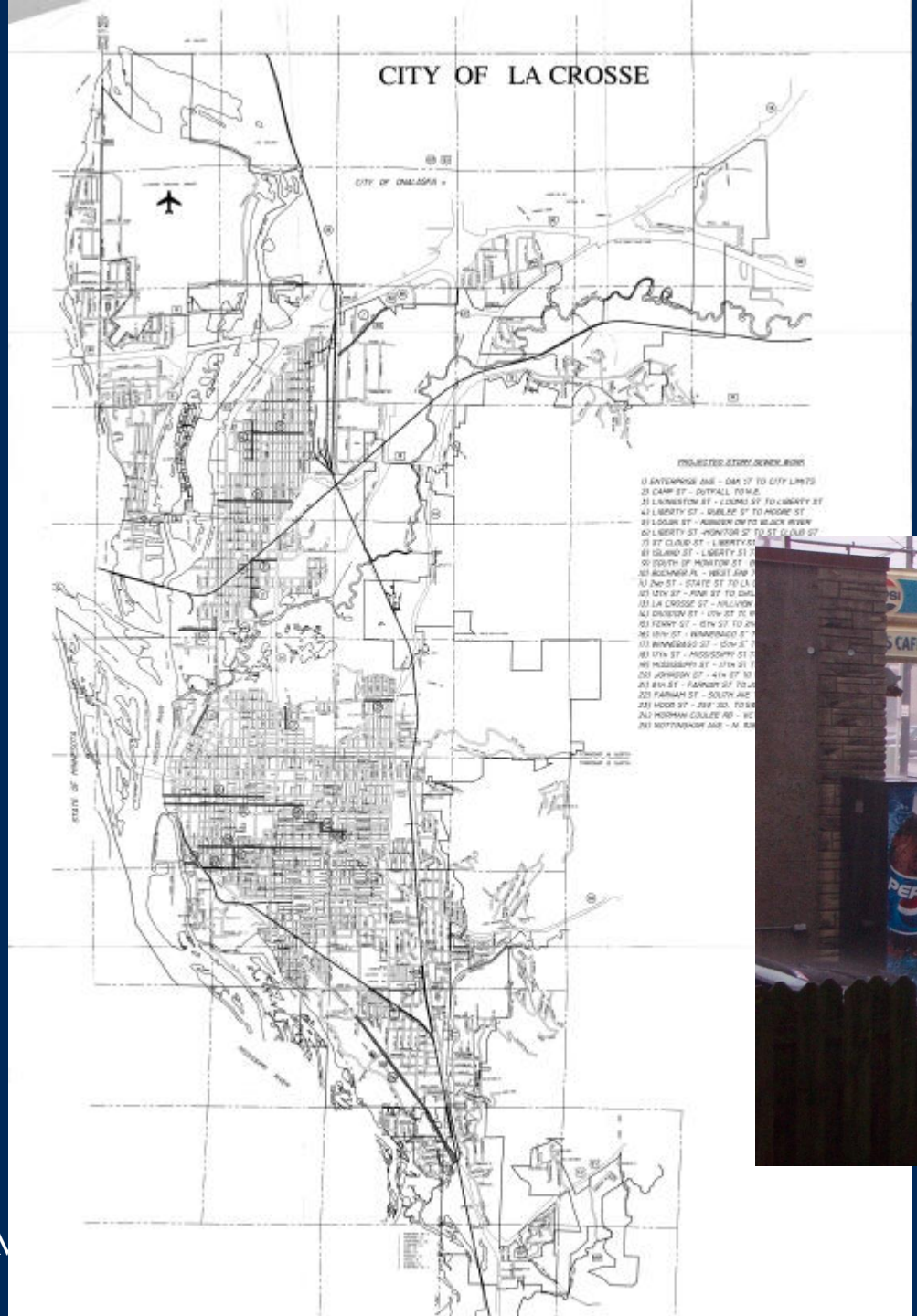
Stormwater Issues



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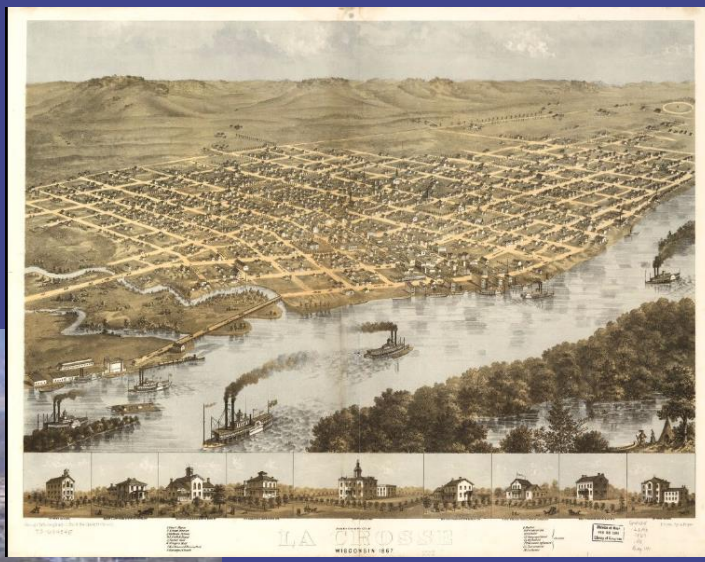
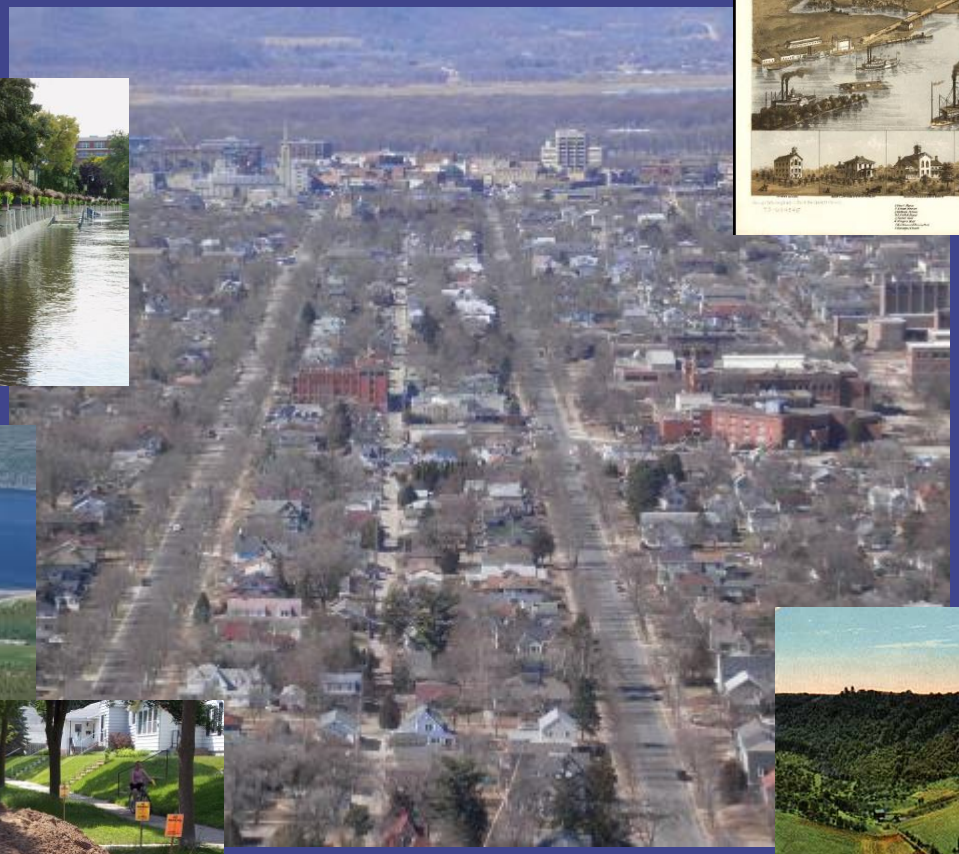
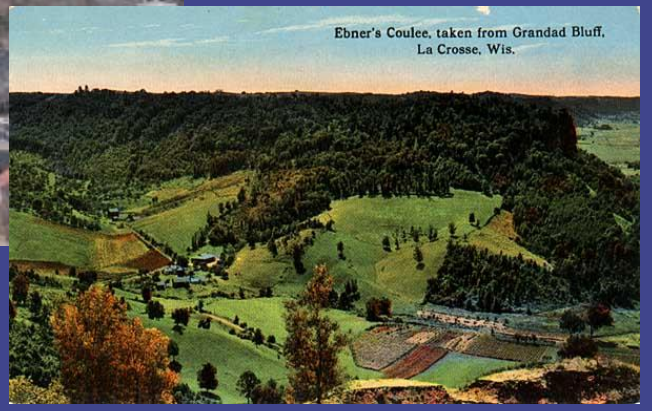
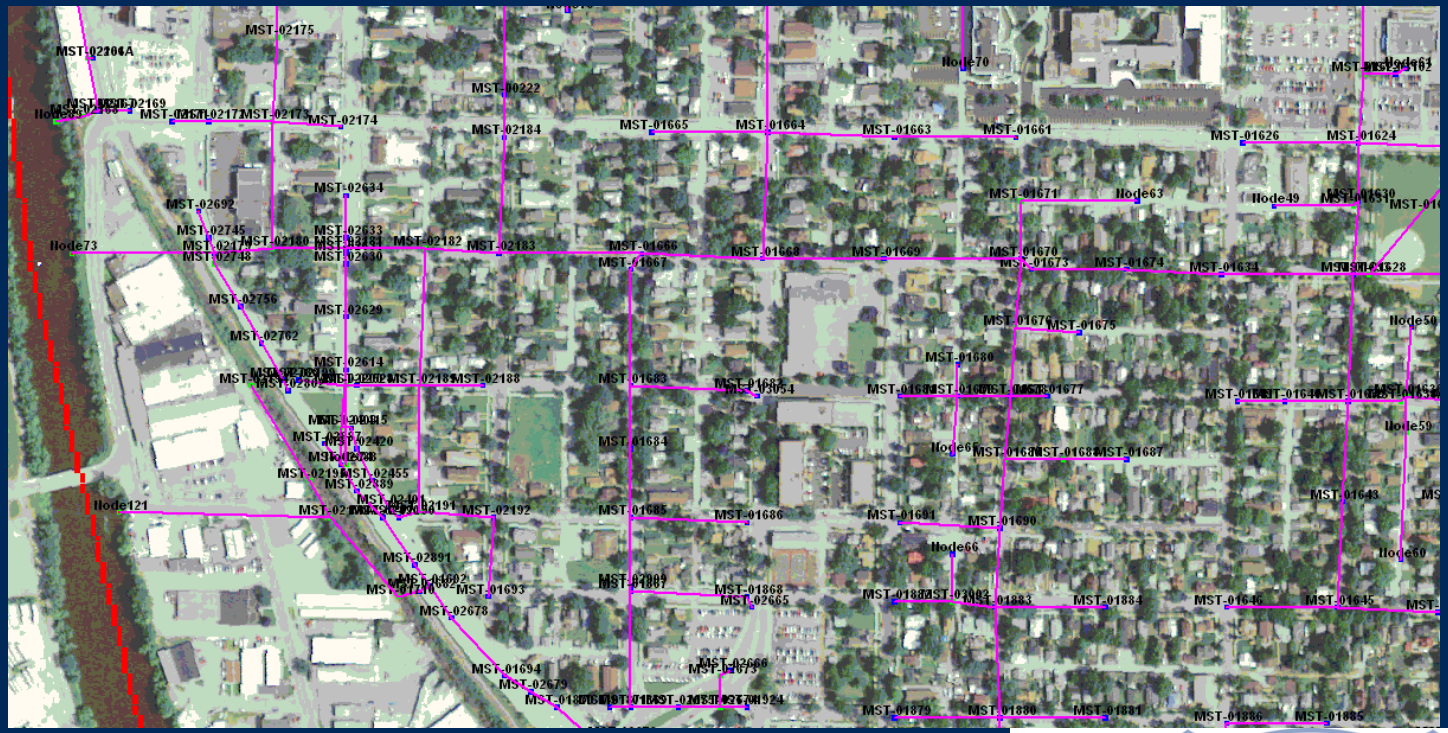
Hydraulic Driven Need







Complex, interconnected storm systems developed over time



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- Overflows from system to system

Contributing areas often change over the course of events

Why was modeling the system necessary?

- Complexity of the storm sewer system, including cross-connections
- Surface flow and flooding conditions require integrated hydrology and hydraulic simulation
- Tool for evaluating potential solutions

System Model

- FLO-2D/EPA-SWMM combination

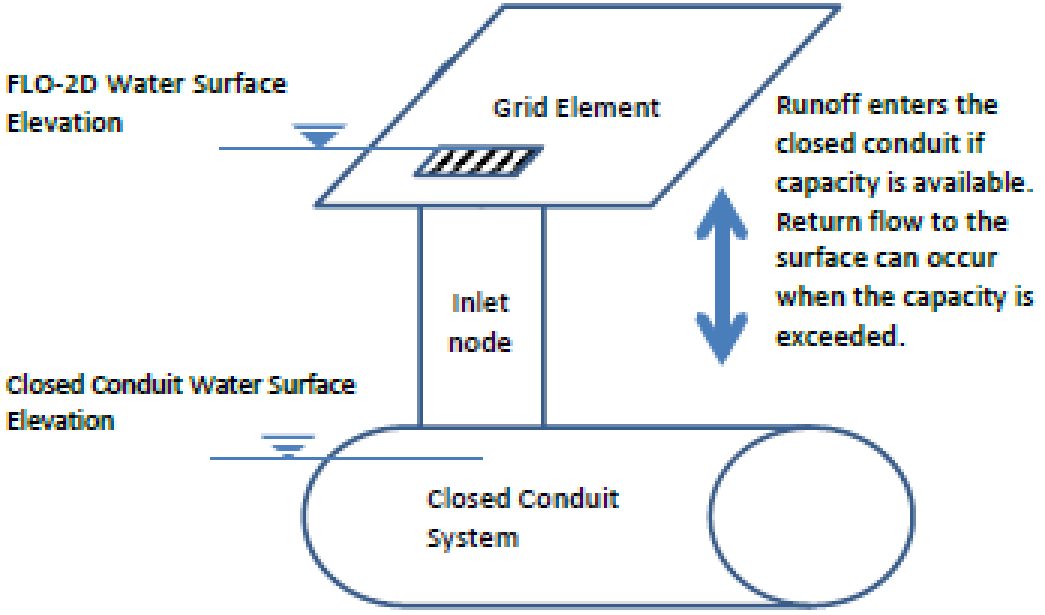


Figure 9. Surface and Closed Conduit Flow Exchange

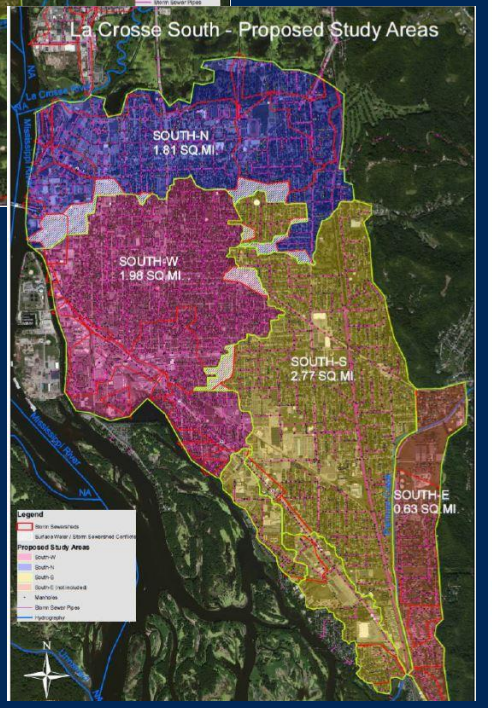
2-D surface flow modeling using digital elevation data provided by the City at a 15-ft grid size – roads represented within DEM, buildings added as a separate layer

Approach

- **Analysis of flooding problem areas**
  - **Identify five watersheds**
  - **Determine critical rain return intervals**
  - **Agree on performance criteria for evaluating problem areas**
- Detailed analyses of five watersheds:
  - Existing conditions analysis – ground-truthing with city staff
  - Problem areas identified
  - Typically five problem areas evaluated for gray infrastructure alternative solutions plus for green infrastructure
- Prioritization and detailed models
  - Consider other factors
  - Develop a 10-year plan

Watersheds Defined

- Five watershed plans (detailed models)
  - North Industrial Park
  - North Watershed
  - Pine Street Watershed
  - Johnson St Watershed
  - Pammel Creek Watershed



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Design Criteria

- Goals:
  - **10 -year event** -Keep water in pipes
  - **25 -year event** -Reduce standing water in the street to 6 inches or less prevent intersection closures and eliminate ponding on adjacent properties
  - **100-Year event** – "Safe" outlet

Rainfall Intensity Tested

Table 3-1. La Crosse Design Storm Rainfall Totals

	Storm Recurrence (years)				
Duration (hr)	1	2	10	25	100
0.5	0.83	1.08	1.63	1.95	2.55
1	1.05	1.37	2.07	2.48	3.23
2	1.29	1.69	2.55	3.06	3.99
3	1.43	1.87	2.82	3.38	4.40
6	1.67	2.19	3.30	3.96	5.16

Approach

- Analysis of flooding problem areas
  - Identify five watersheds
  - Determine critical rain return intervals
  - Develop goals to achieve
- **Detailed analyses of five watersheds:**
  - **Existing conditions analysis – ground-truthing with city staff**
  - **Problem areas identified**
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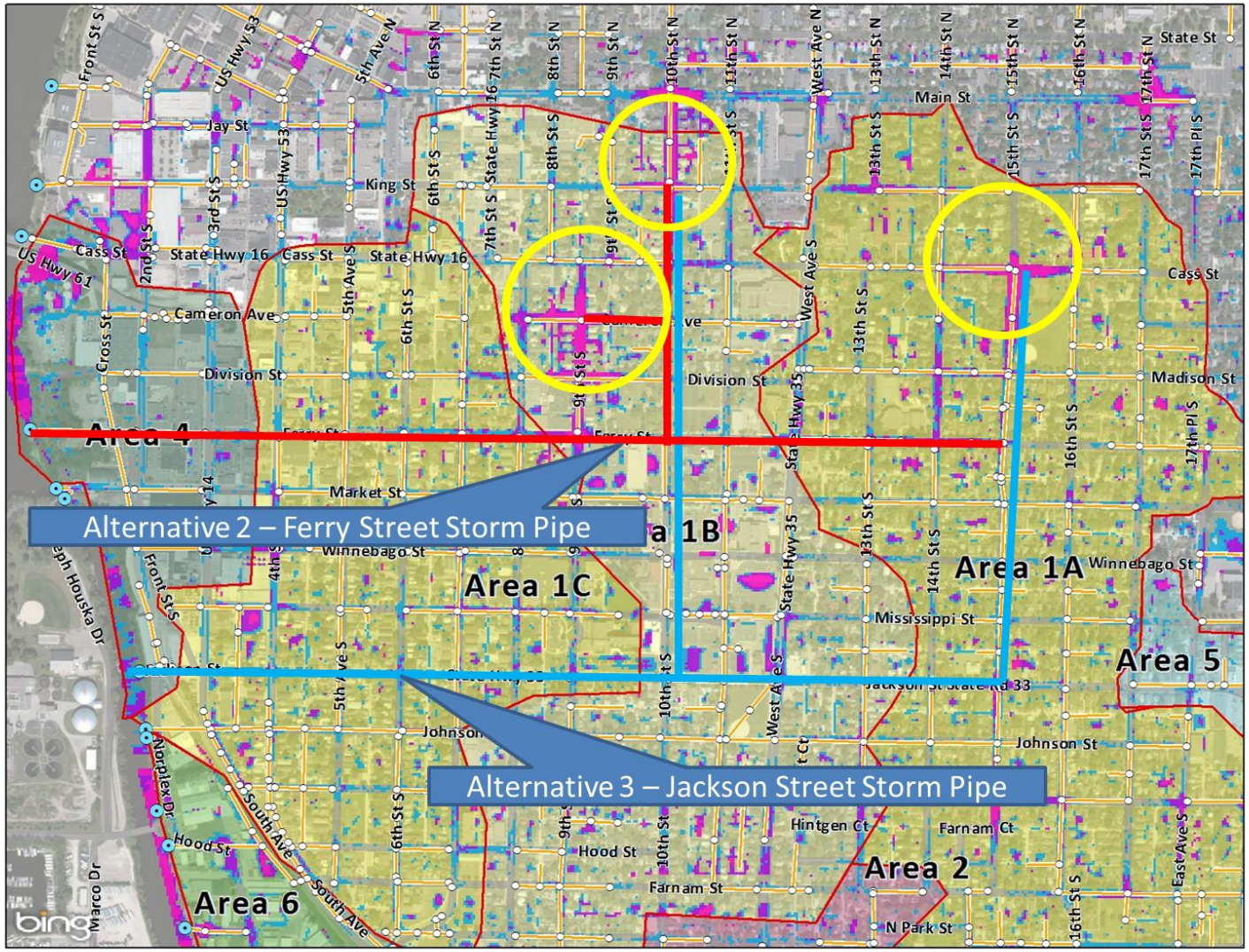
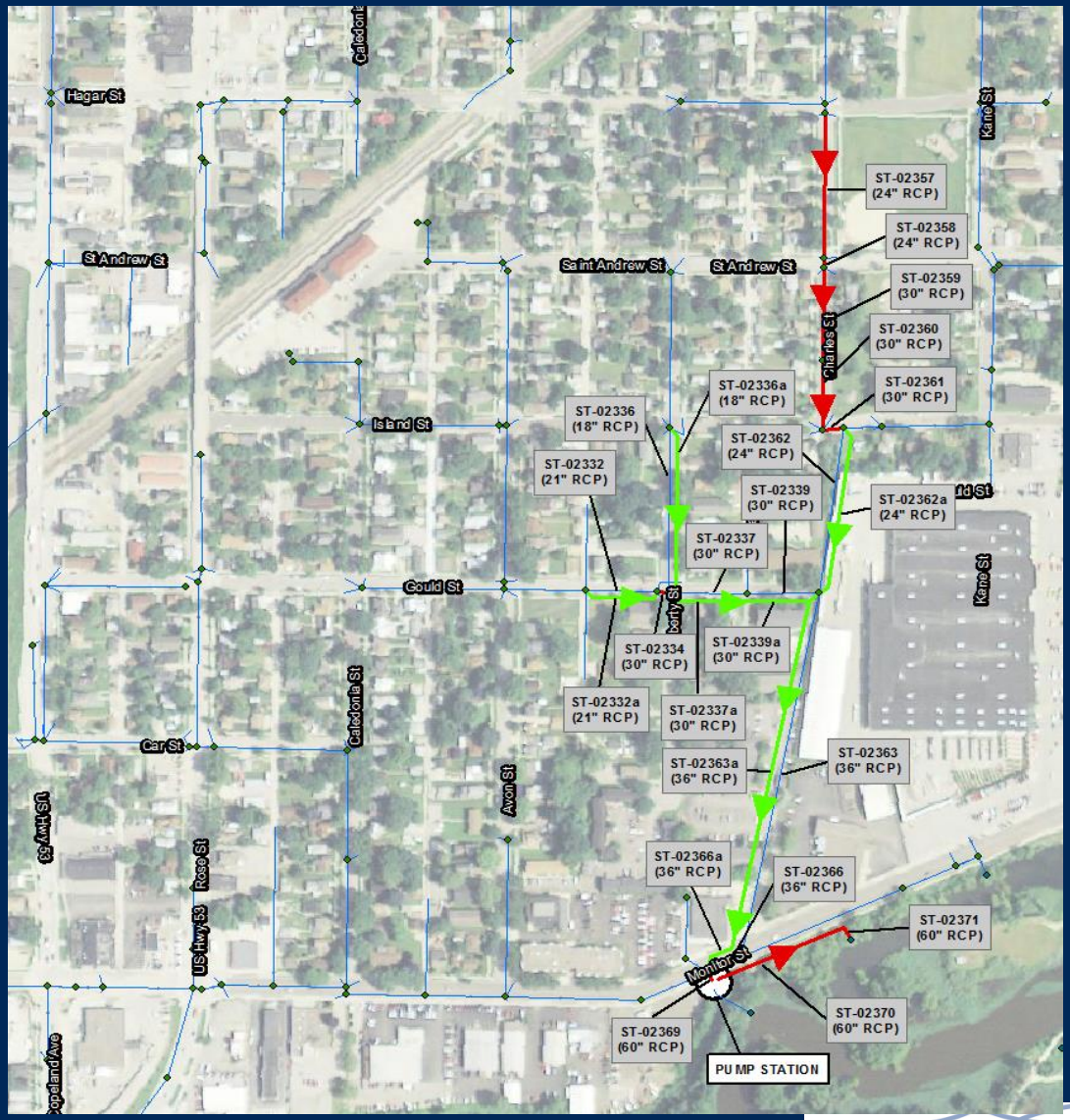
Johnson Street Watershed



Solutions – Island Street



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Identify Solutions – Island Street

- Alternatives:
  - Alternative 4a ($1,030,000)
  - Alternative 4b ($1,180,000)

No.	Item	Unit	Est. Qty	Unit Price	Total	Sources and Assumptions
1	Remove Existing 12" RCP	LF	835	$20	$16,700	Depth - 6 or less feet
2	Remove Existing 24" RCP	LF	123	$25	$3,075	Depth - 6 to 10 feet
3	Remove Existing 42" RCP	LF	370	$25	$9,250	Depth - 6 or less feet
4	Remove Existing Manholes	EA.	5	$300	$1,500	Depth - 6 or less feet
5	Remove Existing Manholes	EA.	5	$400	$2,000	Depth - 6 to 10 feet
6	Install 24" RCP	LF	395	$60	$23,700	Depth - 6 or less feet
7	Install 30" RCP	LF	465	$130	$60,450	Depth - 6 or less feet
8	Install 30" RCP	LF	465	$140	$65,100	Depth - 6 to 10 feet
9	Install 60" RCP	LF	395	$180	$71,100	Depth - 6 or less feet
10	Install 36" RCP	LF	1025	$150	$153,750	Depth - 10 + feet
11	Install 24" RCP	LF	440	$70	$30,800	Depth - 6 to 10 feet
12	Install 18" RCP	LF	610	$60	$36,600	Depth - 6 or less feet
13	Install 48" Stormwater Manholes	EA.	4	$2,500	$10,000	Depth - 6 or less feet
14	Install 48" Stormwater Manholes	EA.	1	$2,750	$2,750	Depth - 6 to 10 feet
15	Install 60" Stormwater Manholes	EA.	2	$4,750	$9,500	Depth - 6 to 10 feet
16	Install 60" Stormwater Manholes	EA.	3	$5,000	$15,000	Depth - 10 + feet
17	Install 72" Stormwater Manholes	EA.	1	$5,750	$5,750	Depth - 6 to 10 feet
18	Install 84" Stormwater Manholes	EA.	1	$6,750	$6,750	Depth - 6 to 10 feet
19	Install 84" Stormwater Manholes	EA.	2	$7,000	$14,000	Depth - 10 + feet
20	Install 96" Stormwater Manholes	EA.	1	$8,500	$8,500	Depth - 6 or less feet
21	Install 96" Stormwater Manholes	EA.	1	$9,000	$9,000	Depth - 10 + feet
22	Install 120" Stormwater Manholes	EA.	1	$13,000	$13,000	Depth - 6 or less feet
23	Install Outfall Structure (60" RCP)	EA.	1	$2,000	$2,000	Depth - 6 or less feet
24	Upgrade Pump Station	EA.	1	$98,800	$98,800	
25	Upgrade Pump Station	LS	1	$103,330	$103,330	Provided by xylem, Pewaukee, WI
26	Stormwater Bypass	LS	1	$20,000	$20,000	
	Contingency (30%)				$237,722	
	Total Project Costs				**$1,030,000**	

Draft Estimated Costs – City Wide (Gray Infrastructure Solutions)

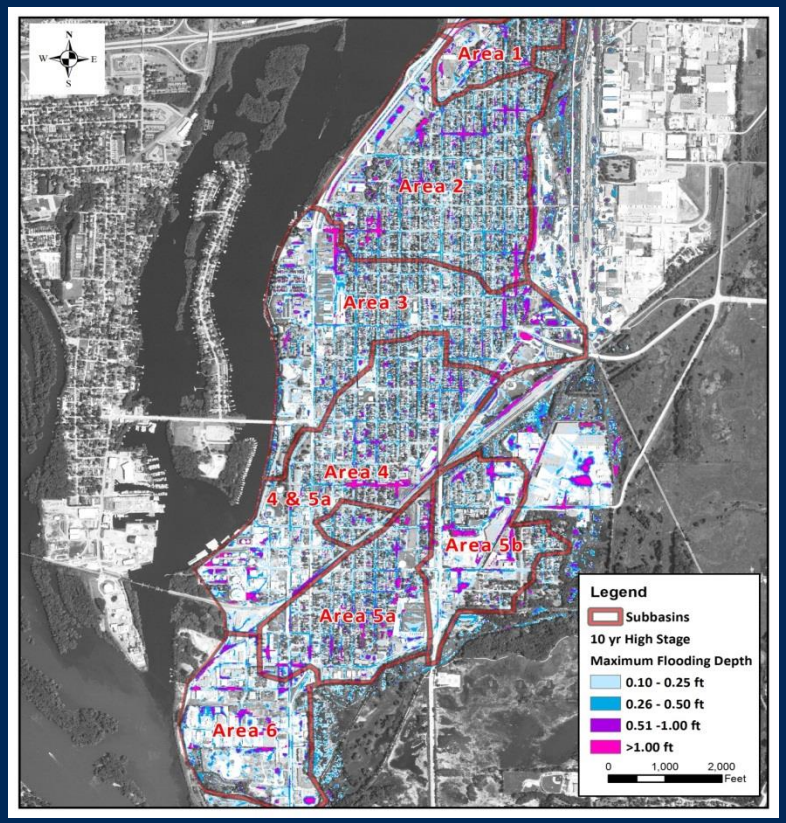
- North Industrial Park – $600,000
- North Watershed – $2,900,000
- Pine Street Watershed – $2,300,000
- Johnson Street Watershed – $5,300,000
- Pammel Creek Watershed – $9,400,000
- Total = $20,500,000

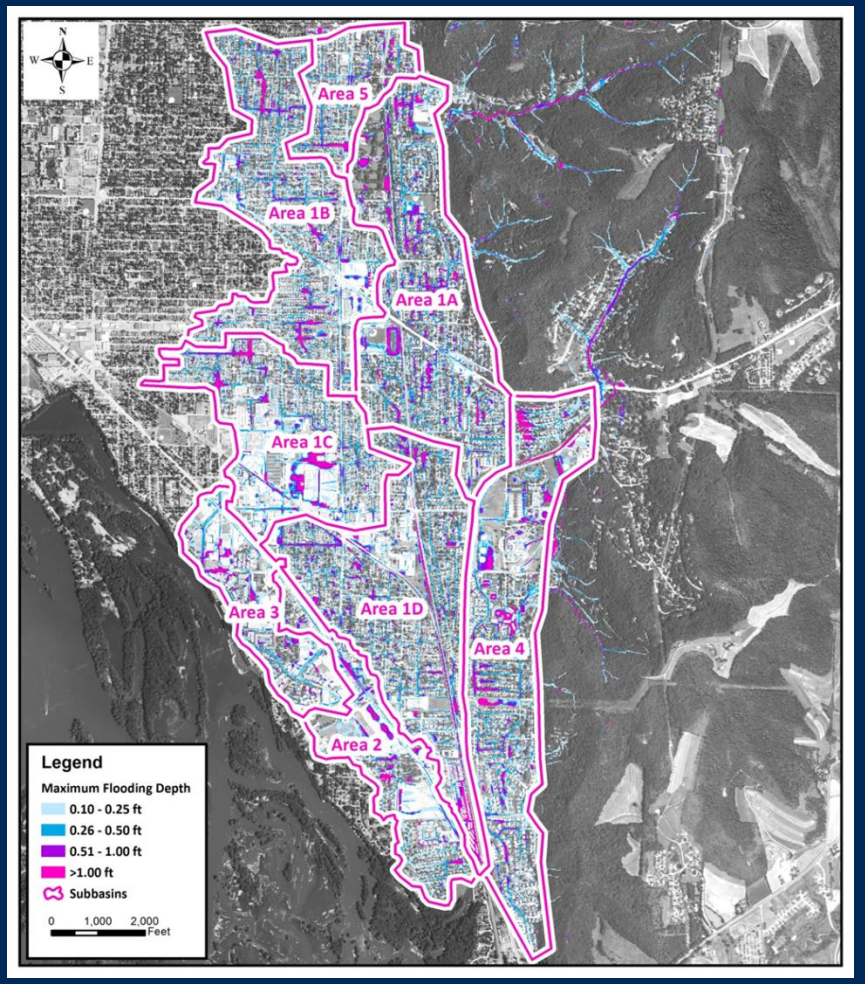
(Subject to revision)

Draft Estimated Costs – City Wide (Gray Infrastructure Solutions)

- Things to Remember:
  - These are the costs for stormwater components only
    - Assumed to be done as part of a larger CIP project (street, water, sewer)
    - If done as stand-alone, costs may escalate by 2-3x or more
  - Different alignments could increase costs
  - Implementation of green infrastructure can reduce need/size of projects

Results





5 or 7 Alternatives X
5 Watersheds =
36 Possible Projects

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Approach

- Analysis of flooding problem areas
  - Identify five watersheds
  - Determine critical rain return intervals
  - Develop goals to achieve
- **Detailed analyses of five watersheds:**
  - **Existing conditions analysis – ground-truthing with city staff**
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  - **Typically five problem areas evaluated for gray infrastructure alternative solutions plus for green infrastructure**
- Prioritization and detailed models
  - Consider other factors
  - Develop a 10-year plan

Prioritization – Engineering Criteria

- Public Property Impacts
- Private Property Impacts
- Benefits to Street Flooding
- Benefits to Private Property Flooding
- Benefits to Intersection Closure
- Street Condition
- Water Main Condition
- Sanitary Sewer Condition
- Sustainability
- Cost

Prioritization – Engineering Criteria

Table 5-2. Ratings of Effective Alternative Projects

	Rating Objects								
Alternative	Probable Cost	Public Property Construction Impacts	Private Property Construction Impacts	Street Flooding Benefits	Private Property Flooding Benefits	Intersection Closure Benefits	Coordination with other CIP Projects	Sustainability	Rating Total
Maximum Points	15	5	5	20	20	20	5	10	100

60% on Benefits of Mitigation

Only 5% on Coordination with CIP

Prioritization

		Maximum Points	Alternative A	Alternative B	Alternative C
Ratings Objects	Public Property Construction Impacts	5	1	1	5
	Private Property Construction Impacts	5	5	4	4
	Street Flooding Benefits	20	12	12	4
	Private Property Flooding Benefits	20	8	12	0
	Intersection Closure Benefits	20	16	20	20
	Coordination with other CIP Projects	20	20	20	4
	Sustainability	10	2	2	2
	Rating Total	100	64	71	39
	Construction Cost ($100,000)		20	25	15
	Cost Effectiveness		3.2	2.84	2.6

Used model output to quantify flooding benefits

Coordinate with reconstruction of aging streets and pipes

Green Infrastructure

Contrasting approach to gray infrastructure (pipes and pumps)

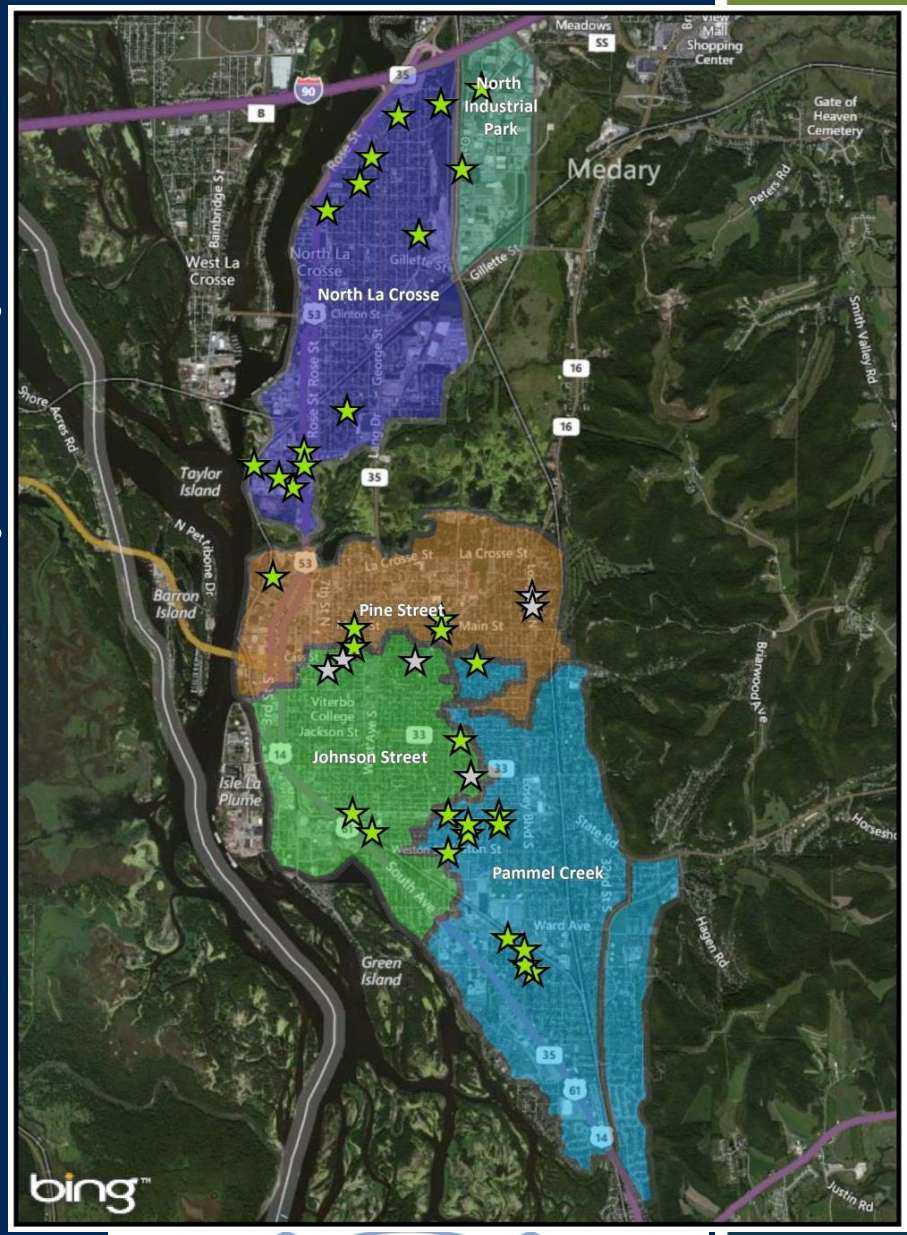
- Reduce flows by controlling water at source
  - Pervious pavement
  - Bio-retention
  - Implement through SWU on private side
- Cumulative effects – benefits grow over time
- Benefits occur for all storms and throughout watershed, not just one or two intersections
- Additional benefits (water quality-nutrients, sediments, heat plus groundwater recharge)

Factors that Influence the Cost of GI to the City

- Constructed opportunistically
  - As a portion of work already being constructed
  - Over time through numerous projects
- SWU credits lead to private investment
  - Owners determine if it is better to construct GI or pay SWU fees
- MS4 compliance
  - Double credits

Green Infrastructure

- GI more effective in some areas
  - Widespread flooding driven by large volumes
  - Long pipe runs needed to address issues
- Gray infrastructure more effective in others
  - Flooding only in specific areas
  - Flooding due to relatively short constrictions
- Requires 40% implementation to be effective



What have we gained from this modeling effort?

- Better understand the mechanisms/causes of stormwater run-off flooding
- Quantified the problem
- Have an analytically derived prioritization scheme based on engineering criteria
- Integrated hydrology/hydraulic model to use as a basis for final design

Recommended Plan Based On……..

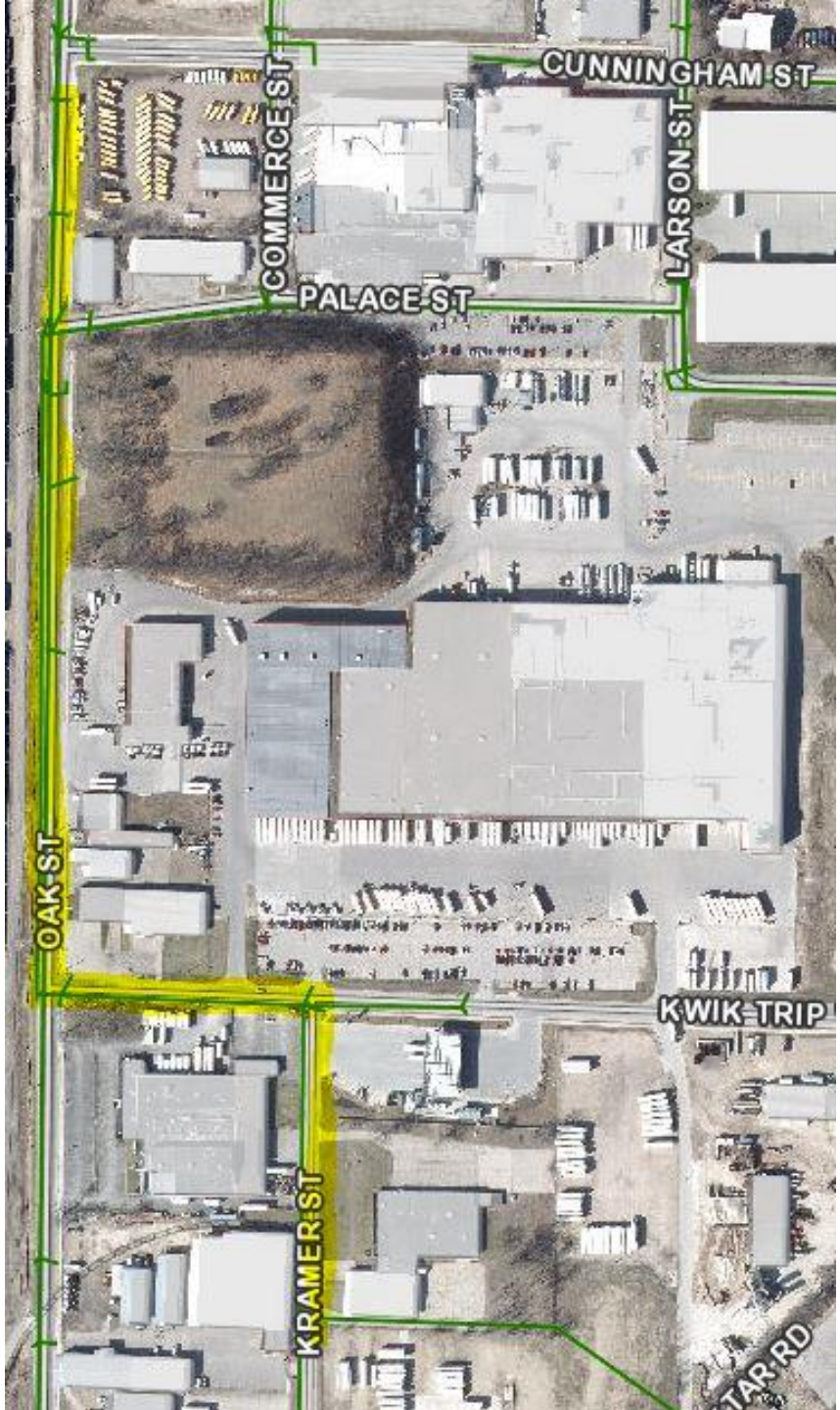
- Evaluate alternative solutions
- Street condition/repair need
- Condition of the other City utilities
- Look at other private facilities in ROW
- Field experience/institutional knowledge
- Bring in non-engineering criteria

Plan to be implemented through C.I.P.

alternative	Cost	#	of blocks	CIP project year	Notes	Lenz Rank	Streets by Block Order	Curb Rating Pacer rating
Alt		850,000	1.5	2016	DONE	0	Kiwk Trip @ Oak to Kramer, Kramer @ Kwik Trip to 1/2 Rublee	G,G 10,2
North Alt 2		443,000	2	2016	DONE	0	Bridgeview @ Palace to Moore	G,G,G 8,9,4
Johnson Phase 1		1,590,000	9	2017	DONE soon	0	Ferry from outfall to 6th; 6th from Ferry to Cass; Cass from 5th to 7th	-- --
Johnson Phase 2 hybred of 1a and 2		220,000	3	2018		1	Cass 8th to 10th	F,F,F 5,5,5
Pammel Alt 6		800,000	16	2018	Best Approach to Diagonal Rd. Lots of bad roads now	1	GI	P-G 3-4
North Alt 1		4,000	5	In Phases 2018/2019/2020	started in 2017 with Camp and WDOT	2	George @ Stoddard to Interchange, Onalaska @ Stoddard to Taylor, Taylor @ Onalaska to Harvey, Harvey @ Taylor to Camp, Camp @ Harvey to Hamilton	G,F,F,G,F 9,5,3,7,4
North Alt 5		539,000	5	2019	Re-design with Mobil Oil Expansion /w TIF	2	Causeway @ Sumner to Copeland, Causeway @ Kraft to Milwaukee, Milwaukee @ Causeay to Buchner, Buchner @ Milwaukee to Dead End	F,F,G,G,G 3,6,6,7,7
North Alt 2-Phase 2		80,000	1	2019	Finish by upsizing Livingston	1	Livingstone from Caladonia to Rose Court	
Johnson Phase 3 hybred of 1a and 2		700,000	4		Gets us to Mayo and big pipe from north	1	Ferry 6th to 10th; 10th Ferry to King	
Pine Alt 1c		236,000	2	2019	rai[illegible]er surface	1	Front @ Vine to Dead End	G,G 4,6
North Alt 1	$1 to $2 million		--	2019	[illegible]st not calcul[illegible]	2	Redo Tyler St lift Station	
Pine Alt 4		469,000	4	2020	[illegible] 2017 [illegible]st thru campus	3	Main @ 17th Pl to 17th St, 17th St @ Main to State, 16th @ Main to Vine	G,F,G,G 10,2,7,7
North Alt 3		217,000	7	2020	Feeders to im[illegible]e Moor[illegible] Main (might ne[illegible] [illegible]mp a[illegible]	4	Hayes @ Liberty to Kane, Moore @ Prospect to Onalaska, Onalaska @ Moore to Gohres	F,F,G,G,F,G,G 5,3,7,5,5,6,9
North Alt 4		1,180,000	6	2020		[illegible]	Charles @ Hagar to Island, Liberty @ Island to Gould, Gould @ Avon to Dead End, Monitor @ Rose to 1/2 Lang	G,G,G,G,F,P, 6,6,6,7,3,6,
Pammel Alt 3		1,490,000	14	2021		4	Green Bay @ East to 22nd, 22nd @ Green Bay to Denton, Denton @ 22nd to Losey, Losey @ Denton to Farnam, Farnam @ Losey to 27th	F,F,F,G,G,F,G,G,G,G,G 4,4,4,5,3,7,8,8,6, ,G,G,F 5,4,4,4,3
Pammel Alt 4		1,440,000	15	2022		5	[illegible]ey @ [illegible]ompson to Chase, 21st @ To[illegible]eston, Weston @ [illegible]b East, East @ Weste[illegible] Horton, 20th @ Weste[illegible] Hyde, Trave[illegible] @ East to 20th	G,G,F,G,F,G,G,G,G,G, 6,10,6,6,3,9,9,9, F,F,F,G,G 9,9,6,6,5,4,7
Johnson Alt 5		929,000	6	2023	Find better route. Removing too many pipes that are good	4	Green Bay @ 10[illegible] Sims Pl, [illegible] Pl @ Green Bay to Wollen, W[illegible] @ Sims Pl to 7th, 7th @ Wollen to Cook, Cook @ 7th to Steele	G,G,x,x,G,G 4,9,x,x,10,4
Johnson Phase 3 hybred of 1a and 2		1,500,000		2024		5	Ferry from 10th to 15th; 15th from Ferry to Cass	
N.I.P. Alt 4 - 48 in		630,000	3	2025	bad idea during high water	5	Cunningham from Larson to Marsh	x,G,G[illegible],7
Johnson Alt 4		875,000	7	2025	Find better route. Removing too many pipes that are good	5	Johnson @ 15th to 16th, 16th @ Johnson to Farnam, Farnam @ 16th to 20th	P,G,F,G,[illegible] G 5,7,7,[illegible]10,10
N.I.P. Alt 3		40,000	0	2026	not under road	5		G 3
Pine Alt 2a		911,000	6	2026	Move from 24th to Losey and do with Losey in 10 years	4	Losey @ Vine to Pine, Pine @ Losey to 24th, 24th @ Pine to Dead End (North)	G,G,F,F,G,P 8,8,7,7,7,[illegible]
Pine Alt 3		666,000	4	2026	wait to do with road resurface need	3	10th @ Pine to King	G,G,G,F 8,9,9,4
Pine Alt 2b		1,826,000	16	2027 2018 (2 blks)	Move from Cass to Madison or King?	3	Cass @ 20th to 24th, 24th @ Cass to Dead End, Losey @ Vine to Pine, Pine @ Losey to 24th	G,G,G,G,G,G,G,F,F,F,F 7,7,7,7,7,7,7,7, ,F,G,P,G,G 7,7,7,7,3,8,8
Johnson Alt 6		3,750,000		ON-GOING	ALREADY STARTED	do with roads	GI	
North Alt 6		3,750,000		ON-GOING		do with roads	GI	
Pine Alt 6		25,716,000		ON-GOING	BEST APPROACH- vs Alt 2	do with roads	GI	
N.I.P. Alt 7		1,826,000		ON-GOING	ALREADY STARTED	do with roads	GI	

Oak Street, Kwik Trip Way, and Kramer

***Included adding a pump at Gillette St lift Station**



Bennet Street / Townsend

Rose Street

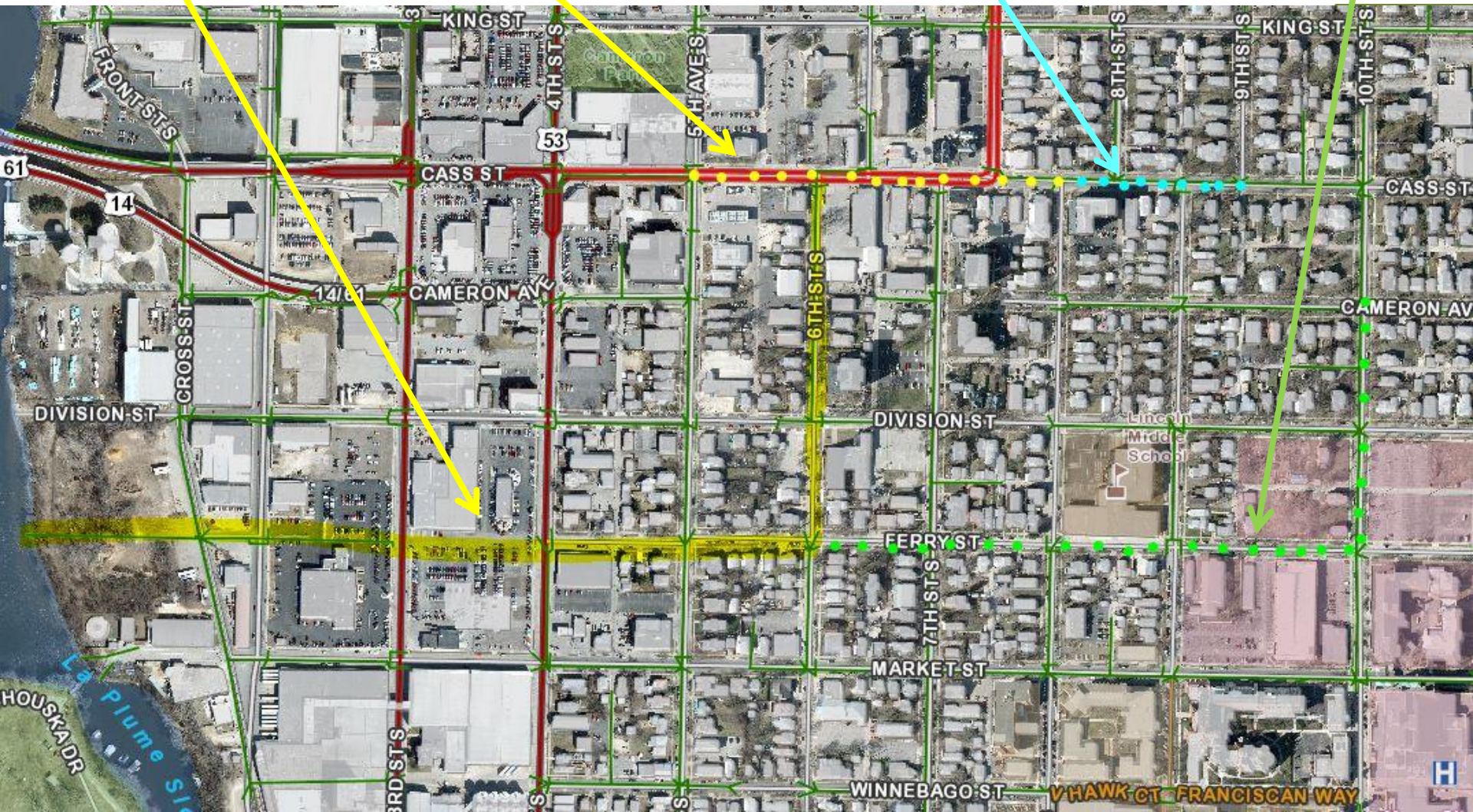
*** also removed Palace St lift station**

2017- Ferry and 6th Streets

2018- Cass Street

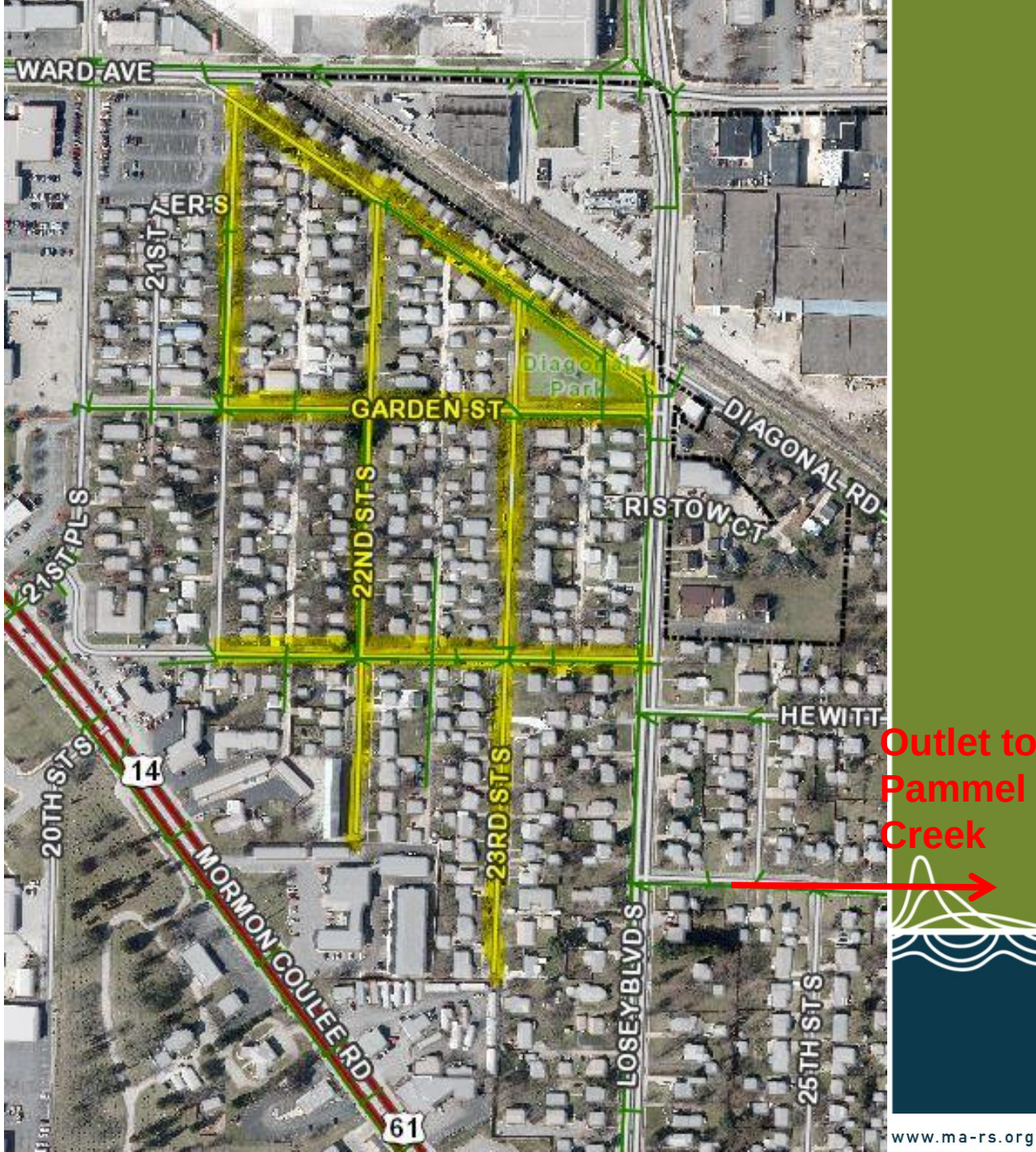
2017- Cass Street (by WDOT)

2019- Ferry and 10th Streets



Diagonal Road Area:

Adding 16 blocks of porous pavement



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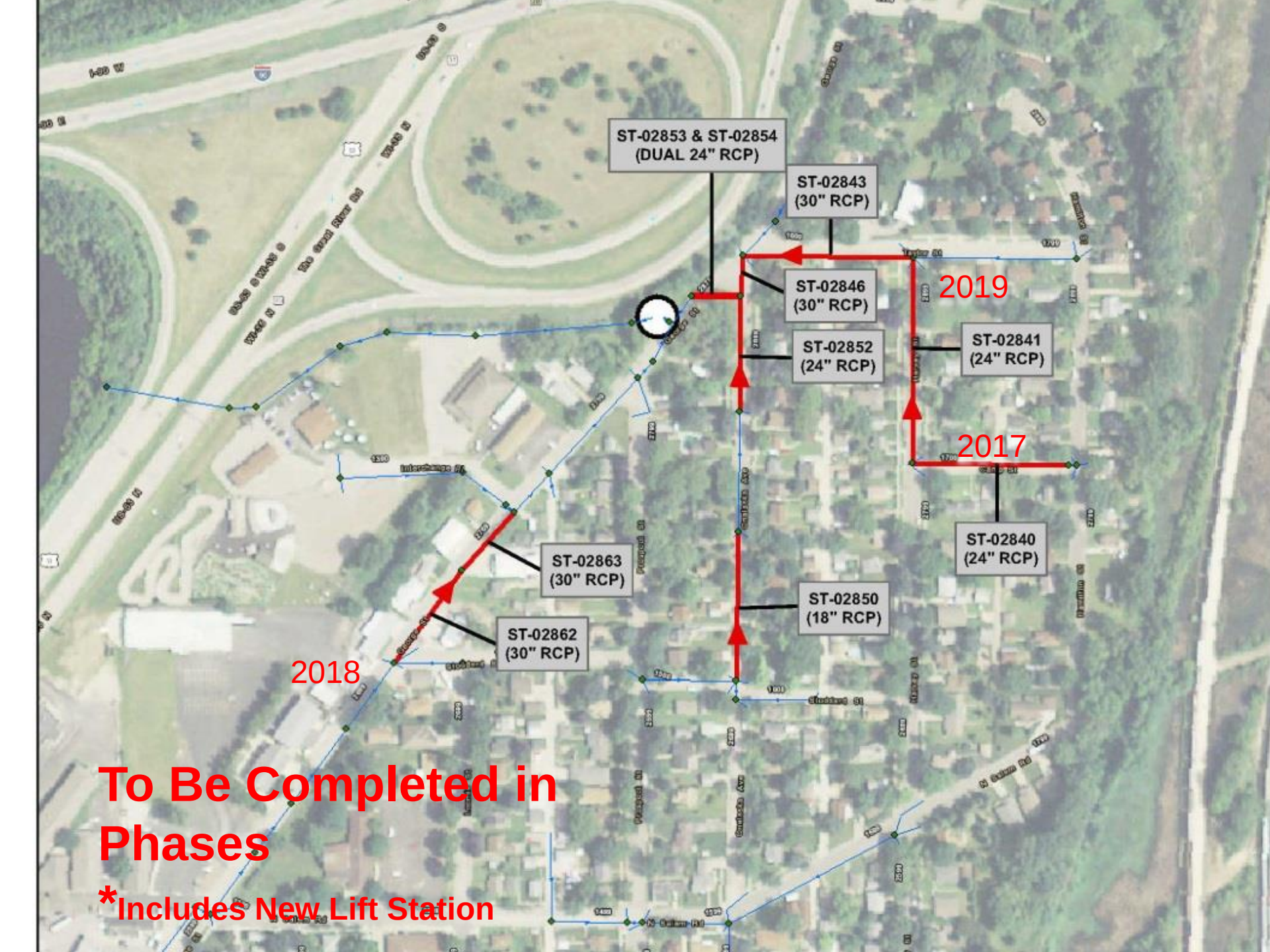
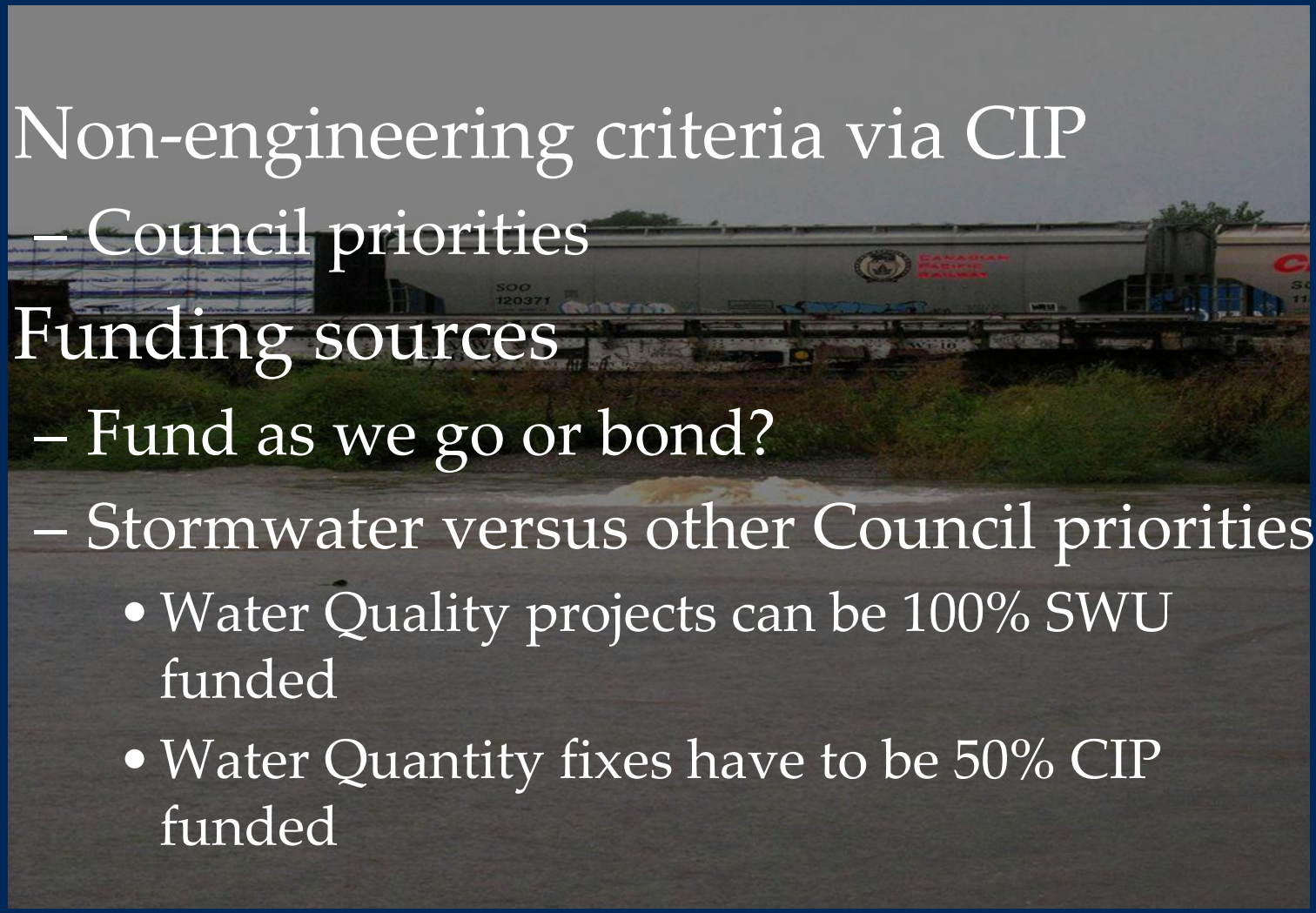

ST-02853 & ST-02854
(DUAL 24" RCP)
ST-02843
(30" RCP)
ST-02846
(30" RCP)
ST-02852
(24" RCP)
ST-02841
(24" RCP)
2019
2017
ST-02840
(24" RCP)
ST-02863
(30" RCP)
ST-02862
(30" RCP)
ST-02850
(18" RCP)
2018
To Be Completed in Phases
*Includes New Lift Station

Council Direction Needed



- Non-engineering criteria via CIP
  - Council priorities
- Funding sources
  - Fund as we go or bond?
  - Stormwater versus other Council priorities
    - Water Quality projects can be 100% SWU funded
    - Water Quantity fixes have to be 50% CIP funded

General & Historical information

- Storm water/sewer system & responsibility part of Sewer Department
- Pre 1991 - Wastewater and storm "departments" part of City budget (tax funded)
- Sanitary Sewer Utility implemented by City in 1991; storm water/sewer remained part of City budget

General & Historical information - continued

- All storm system-related projects considered, prioritized and funded as part of C.I.P. program, including some large projects…."recent" examples:
  - Boxpipe;
  - City share of Pammel Creek project;
  - Outfalls & storm sewers to address problem areas:
    - West Avenue & South Avenue
    - Ward Avenue & Losey Boulevard
    - 16th & Bennett/Trane Plant 2 area
    - Jay Street
- Rose Street lift station and storm sewer extensions

Challenges

- Stormwater Quality:
  - Compliance & reporting requirements under MS4 permit
  - City Municipal Code
  - Maintenance of storm water quality-related BMPs
- Problem areas – Historical as compared to model
- Solving problems at difficult locations:
  - Onalaska Avenue
  - 20th & Cass Sts.
- Losey Boulevard & Pine Street

Funding

- Stormwater Utility (SWU) approved by Common Council in 2011; first bills sent last two quarters of 2012
- Per current Municipal Code:
  - Projects related to Stormwater Quality are 100% funded by SWU.
  - Projects related to Stormwater Quantity are 50%/50% funded by SWU/City.
- Summary of Utility expenditures and fund balance follows……

Storm Water Utility Funds

History and Project Fund Balance

Year	Fund Balance	Capital Expenditures
2012	$415,100	
2013	$2,147,300	
2014	$3,605,300	$158,000
2015	$4,085,000	$966,000
2016	$5,007,000	$74,000
EST. 2017*	$6,243,000	$1,150,000

* - Considers 2017 operating budget and C.I.P projects

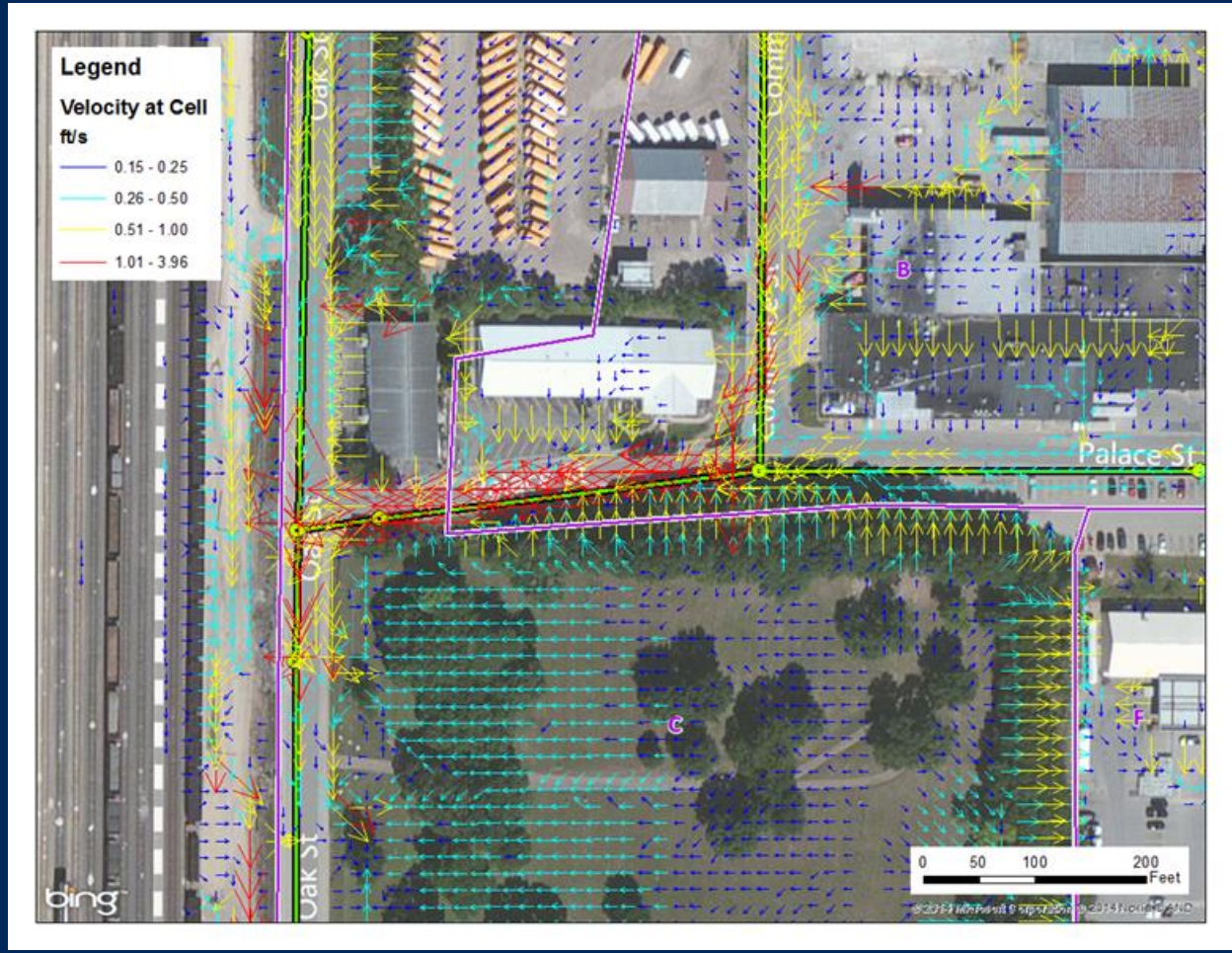
Per ordinance:

Stormwater Quality projects funded 100% by SWU

Stormwater Quantity projects funded 50%/50% by SWU/City

Council Discussion

Results – North Industrial Park



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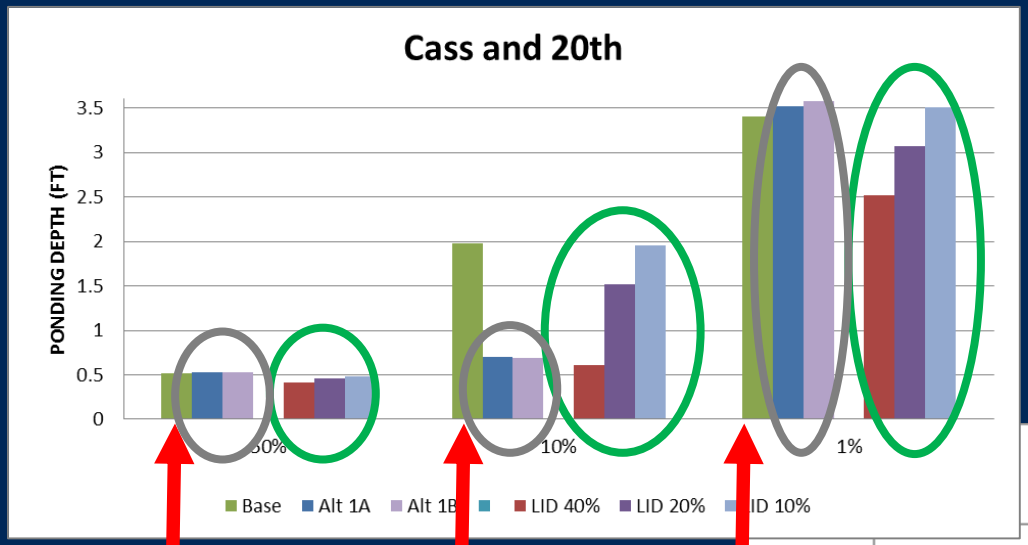
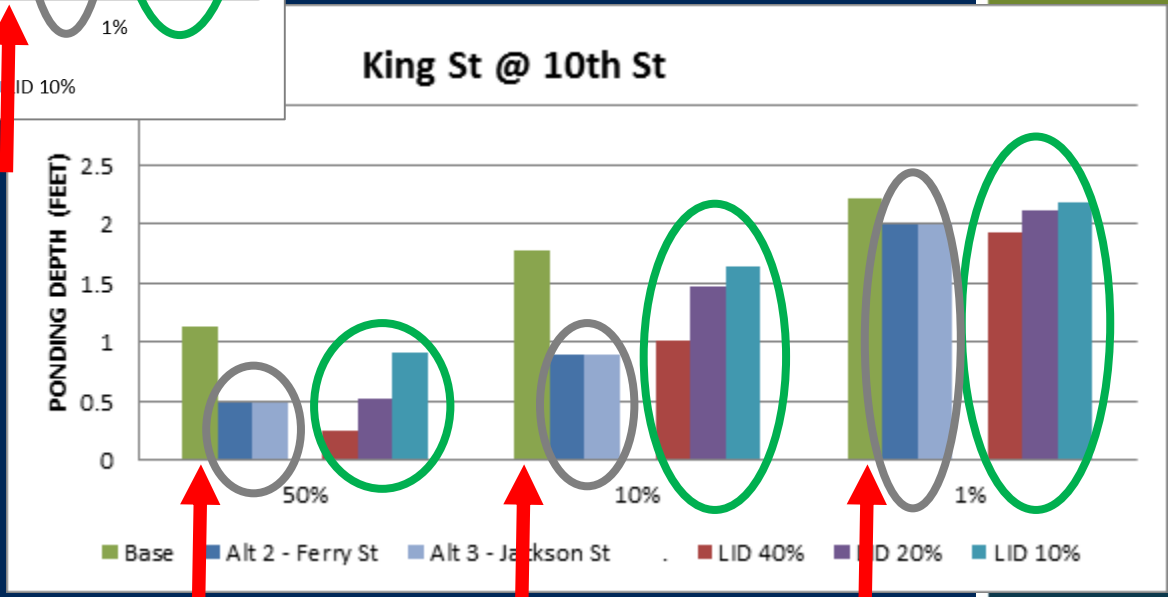
Stormwater Issues in the City of La Crosse

- Sandy, well-infiltrating soils and subsoils

Implementing green infrastructure (GI) approaches through stormwater utility

Results – Effectiveness of GI





Montgomery Associates:
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