How TMDL and MS4 Urban Analyses Compare

2013 Storm Water Workshop

Waukesha County
April 10, 2013

Presented by:
Jim Bachhuber, P.H.
AECOM

Topics to Cover

- TMDL Process
- TMDL Results & Waste Load Allocations for MS4s
- Comparison of TMDL and "NR216"
  - Input Data
  - Results
- Current "To Do" List of TMDL Stormwater TAC

Wisconsin TMDLs

Wisconsin completed 2 major river basin TMDLs and submitted to EPA August 30, 2011

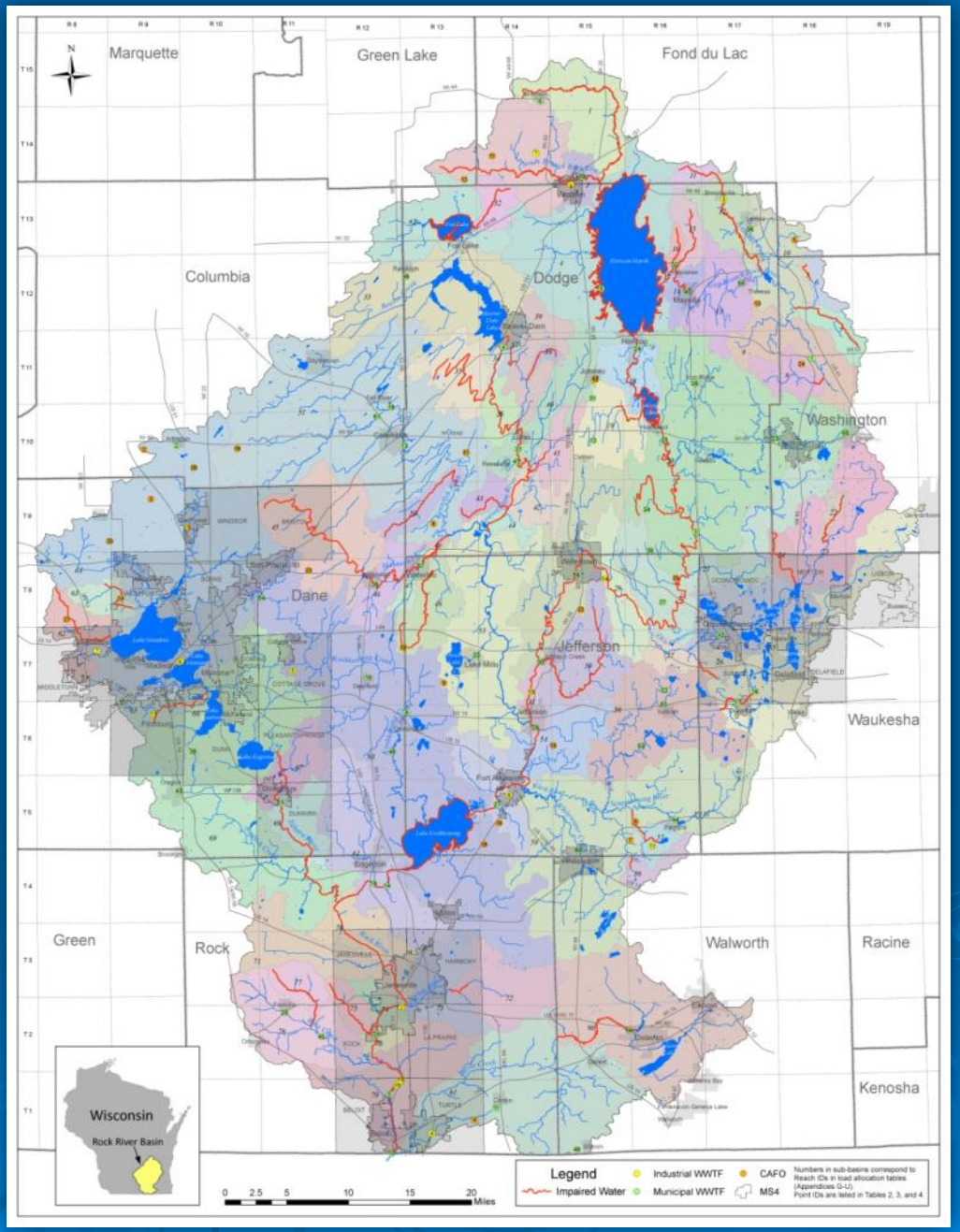
- Lower Fox River Basin
- Rock River Basin
- Milwaukee River (soon?)

Lower Fox River Basin

- Northeast Wisconsin
- 641 square miles
- 27 listed waters for TSS, TP or both
- 45 TMDLs
- 29 MS4s
- 34 permitted WWTFs
  - 20 industrial,
  - 14 municipal
- 15 CAFO's

Rock River Basin

- South Central Wis.
- 3,750 square miles
- 62 listed waters for TSS, TP, or both
- 101 TMDLs
- 49 MS4s
- 76 permitted WWTFs
  - 15 industrial,
  - 61 municipal
- 27 CAFO's



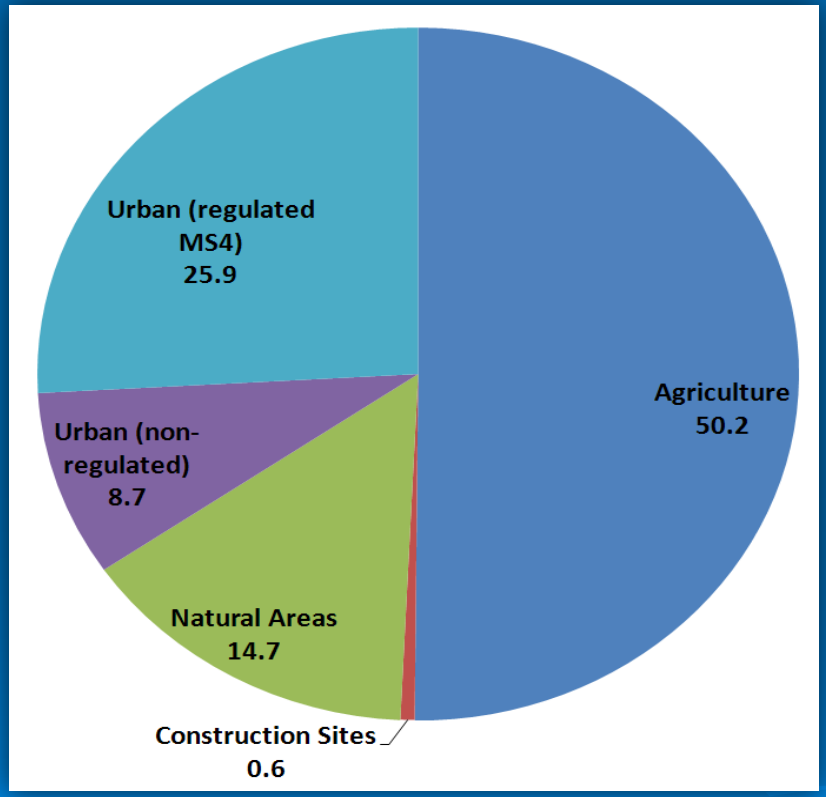
TMDL Analysis Components

Loading Analysis consisted of:

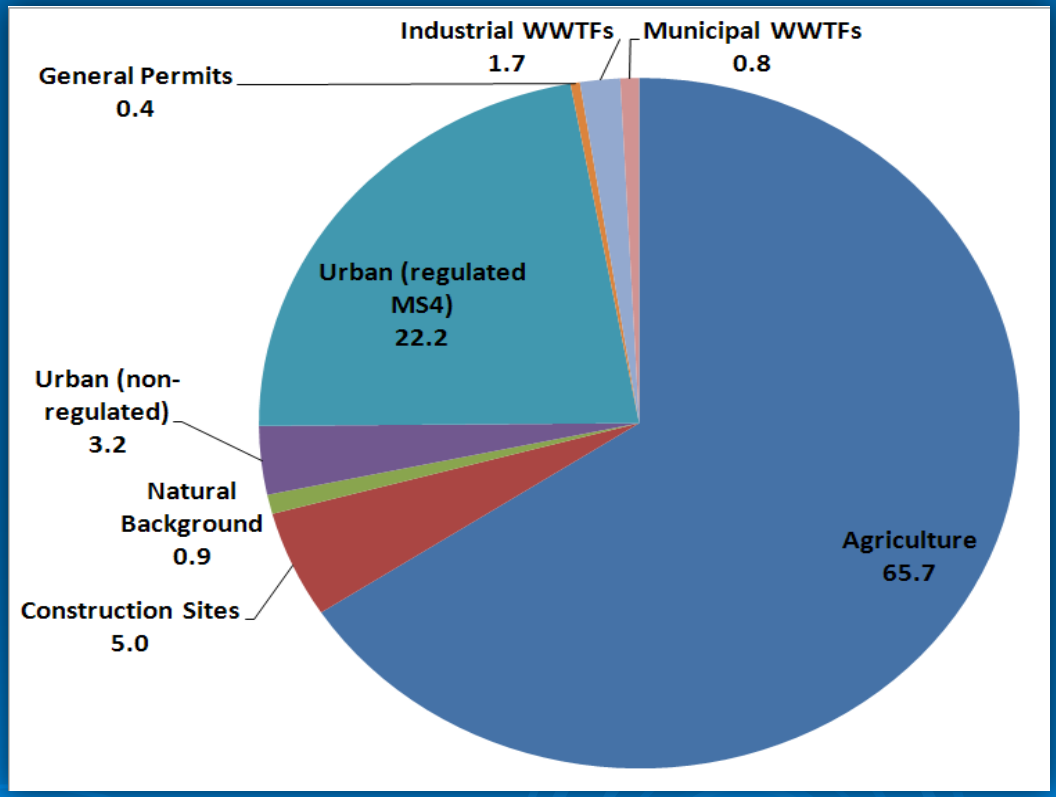
- *Agricultural Runoff* : SWAT modeling
- *CAFO's*: assume 0 load
- *WWTFs* (public & private):
  - Lower Fox River - DMRs
  - Rock River – Permit Limits
- *MS4s*
  - Lower Fox River:
    - Urban routine in SWAT "calibrated" to match WinSLAMM
    - TMDL "base" = MS4 (WinSLAMM) "base"
  - Rock River
    - Unit Loads based on WinSLAMM (NR216) results
    - TMDL "base" = 40% TSS control
- Lower Fox River accounted for upstream (L. Winnebago)

Land Use and TSS Sources – Lower Fox River TMDL

Land Use (%)

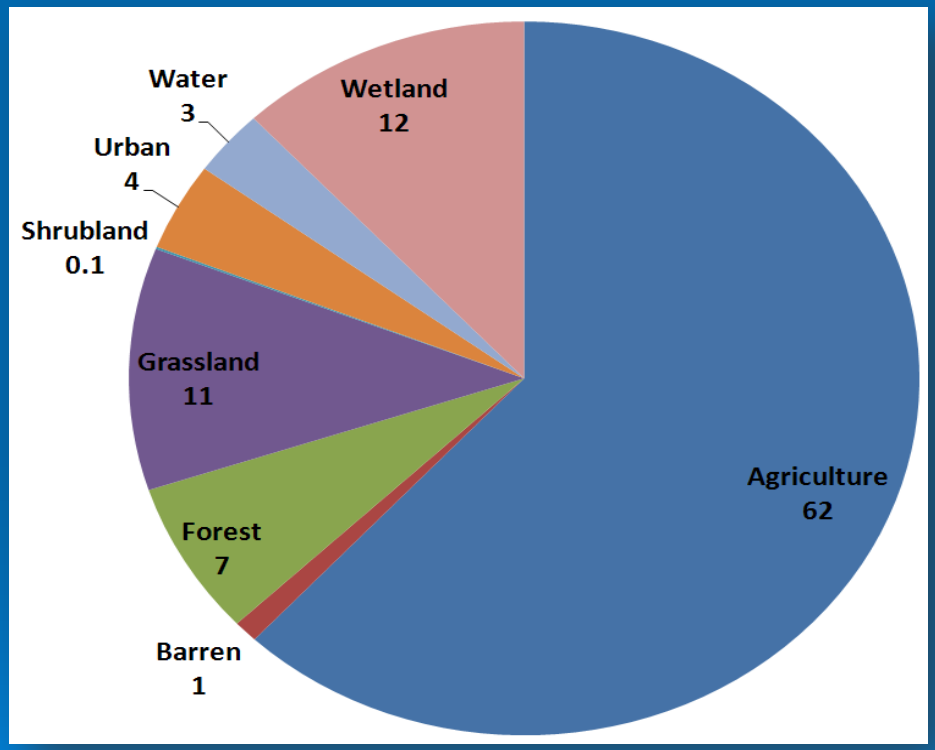


TSS Base Load (%)

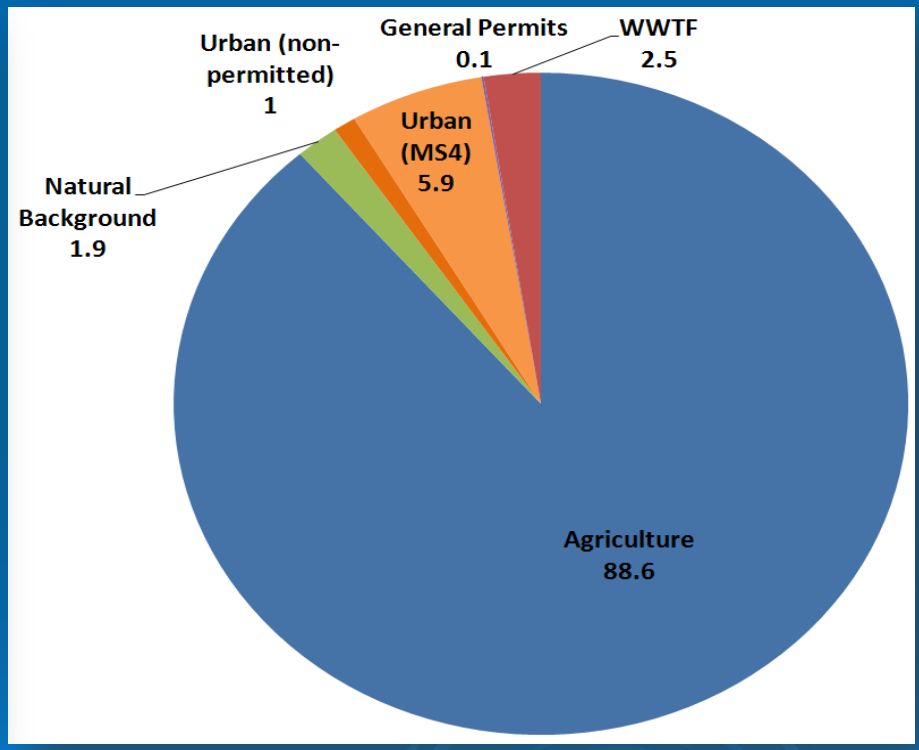


Land Use and TSS Sources – Rock River TMDL

Land Use (%)



TSS Base Load (%)



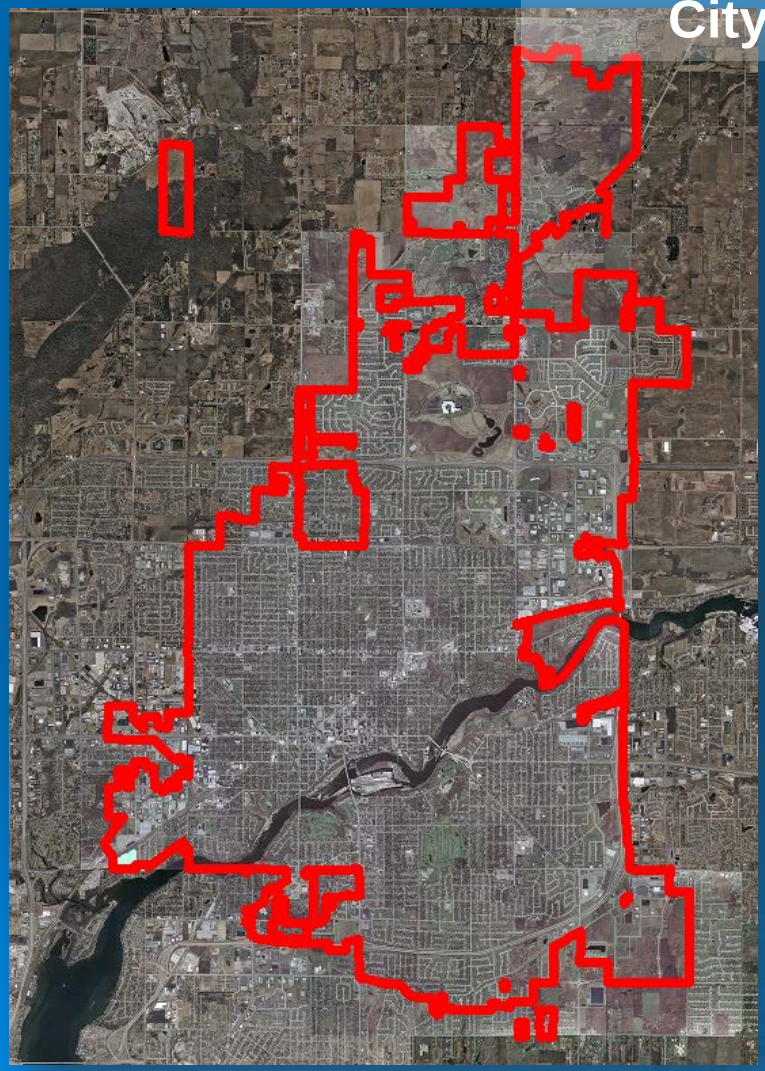
Example MS4 WLAs – L. Fox

Appleton (Lower Fox)		Apple Cr.	Garners Cr.	Mud Cr.	Lower Fox River
TSS	Base Load (tns/yr)	318	74	187	1,515
	WLA (tns/yr)	191	37	134	527
	% Reduct.	40%	50%	28%	65%
Phosphorus	Base Load (lbs/yr)	1,617	313	725	5,239
	WLA (lbs/yr)	1,132	115	442	3,667
	% Reduct.	30%	63%	39%	30%

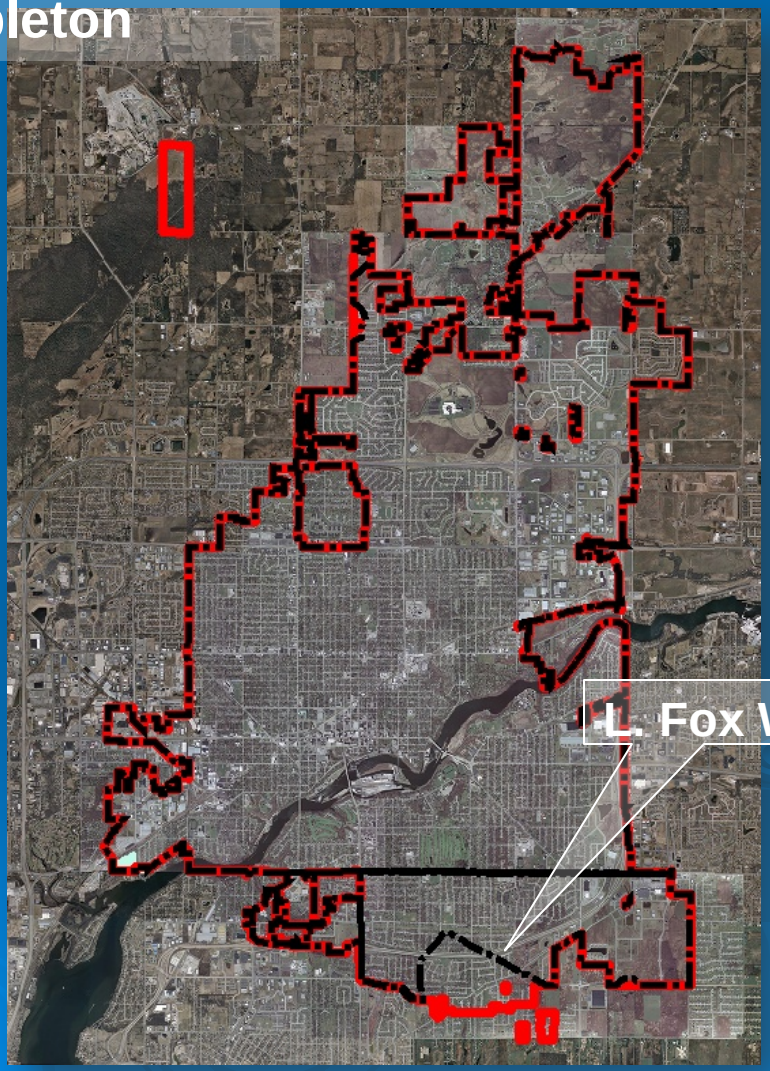
Example MS4 WLAs – Rock R.

Janesville (Rock River)		Rock R. (71)	Blackhawk Cr. (73)	Rock R. (74)	Rock R. (76)
	Area (ac)	3,687	5,845	2,458	837
TSS	Base Load (tns/yr)	283	448	188	64
	WLA (tns/yr)	166	148	173	39
	% Red.	41%	67%	8%	40%
Phosphorus	Base Load (lbs/yr)	2,864	4,542	1,910	650
	WLA (lbs/yr)	1,668	1,165	1,845	72
	% Red.	42%	74%	3%	89%

Comparison of TMDL and “NR216” Input Data – Municipal Boundary

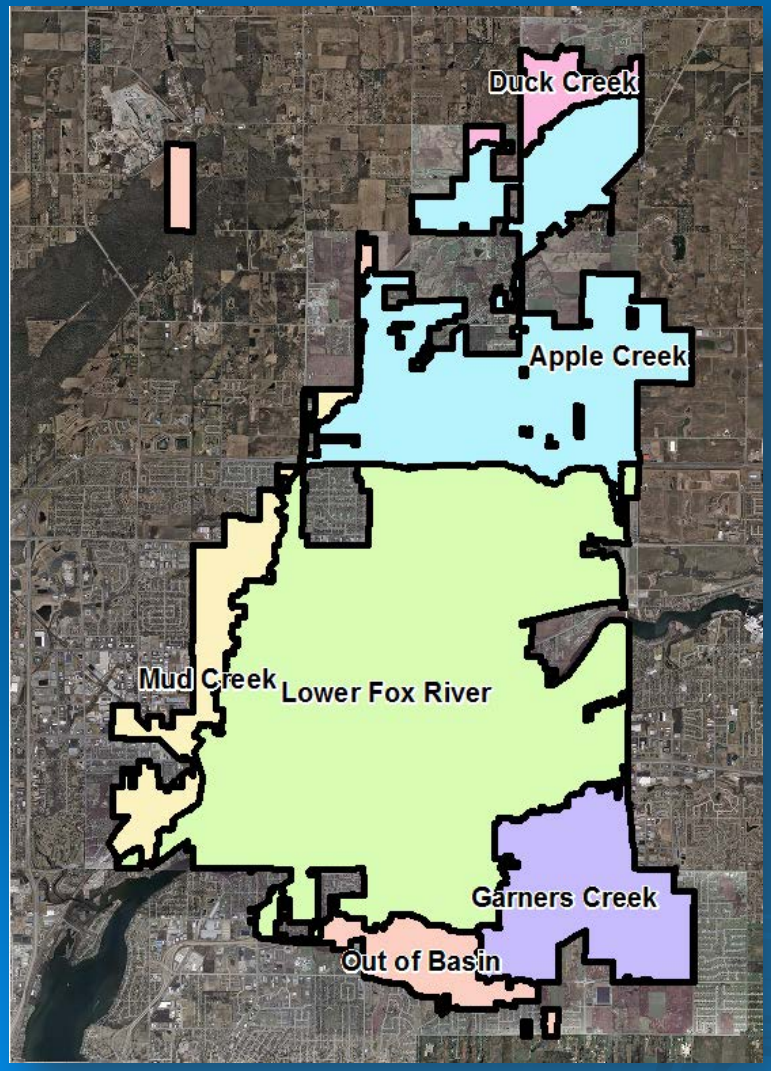


NR 216



TMDL

Comparison of TMDL and "NR216" Input Data – Subbasins



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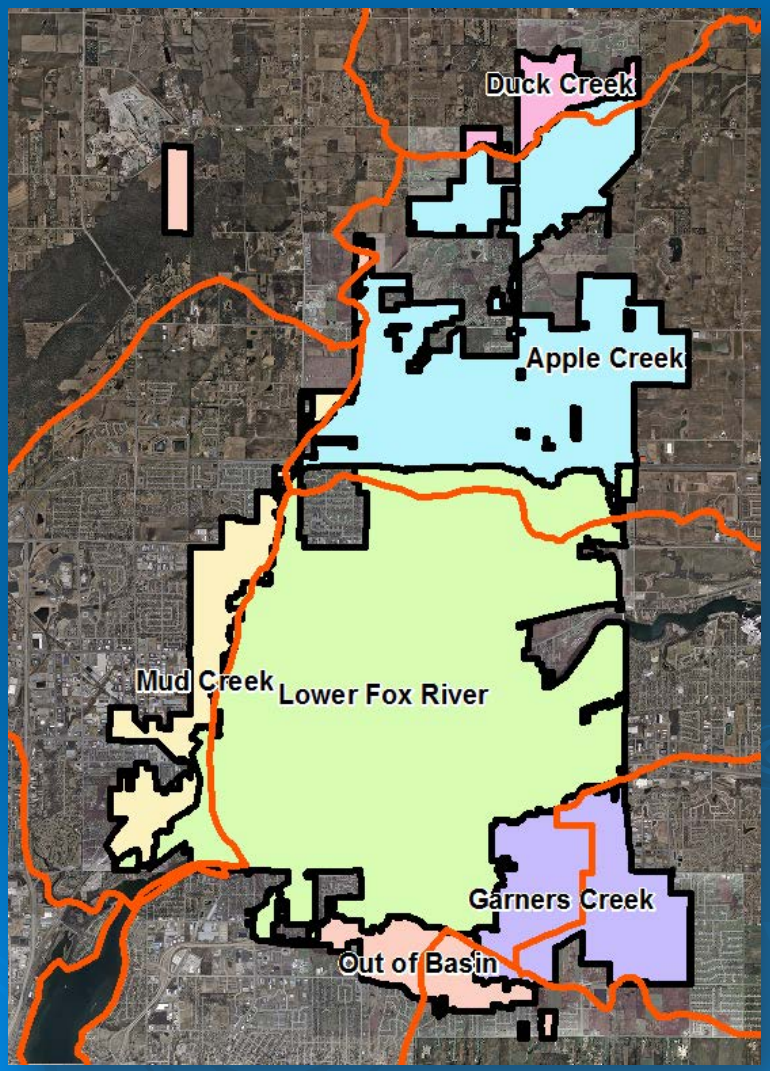
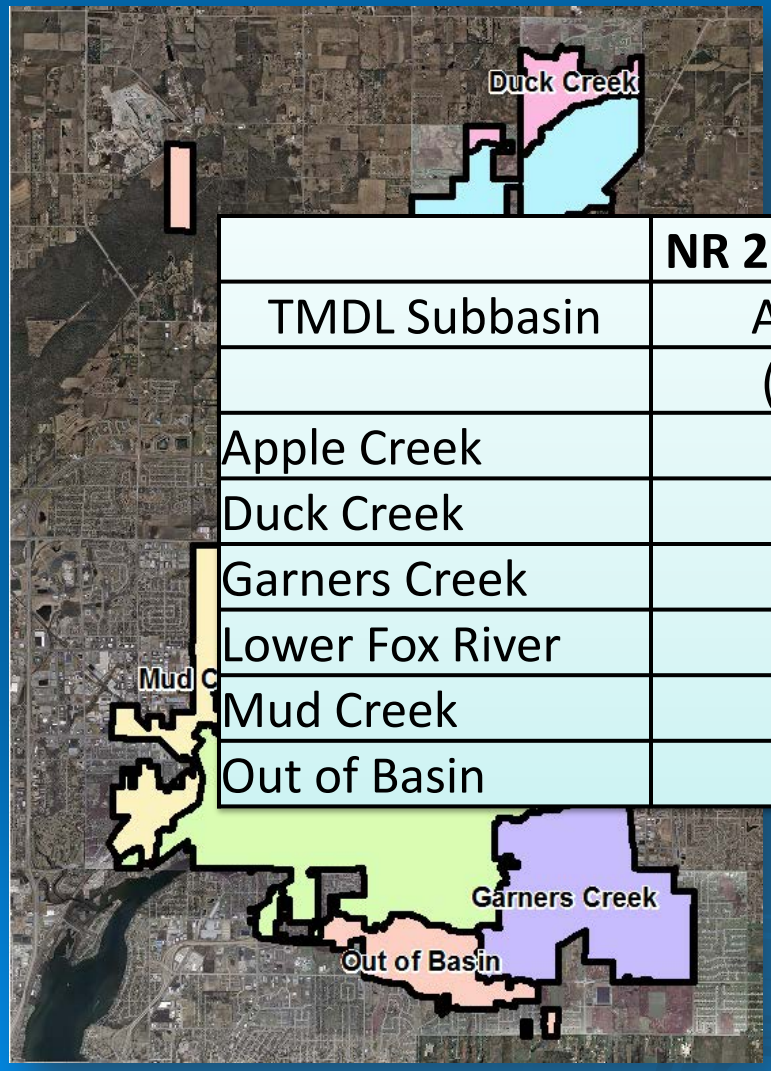


TMDL Added

Comparison of TMDL and "NR216" Input Data – Subbasins

TMDL Subbasin	NR 216 Data Area (ac)	TMDL Data Area (ac)	Difference (%)
Apple Creek	3,698	4,181	13%
Duck Creek	373	434	16%
Garners Creek	1,617	917	43%
Lower Fox River	8,285	8,411	2%
Mud Creek	1,095	1,359	24%
Out of Basin	779	546	30%



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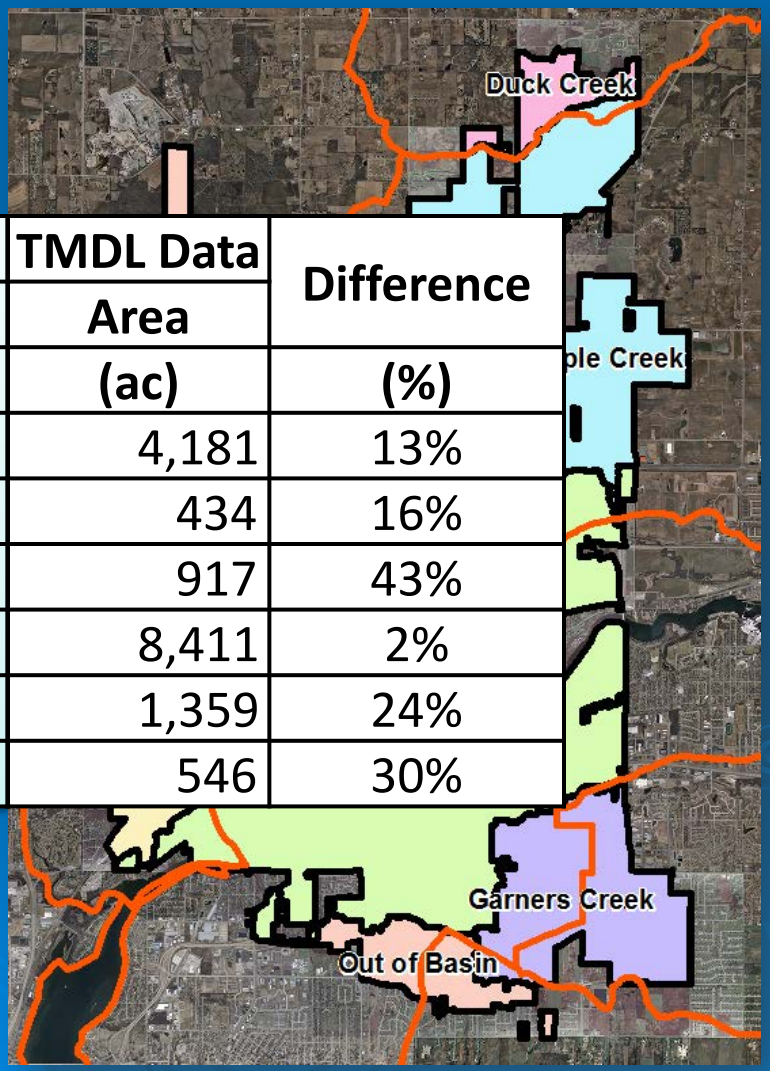
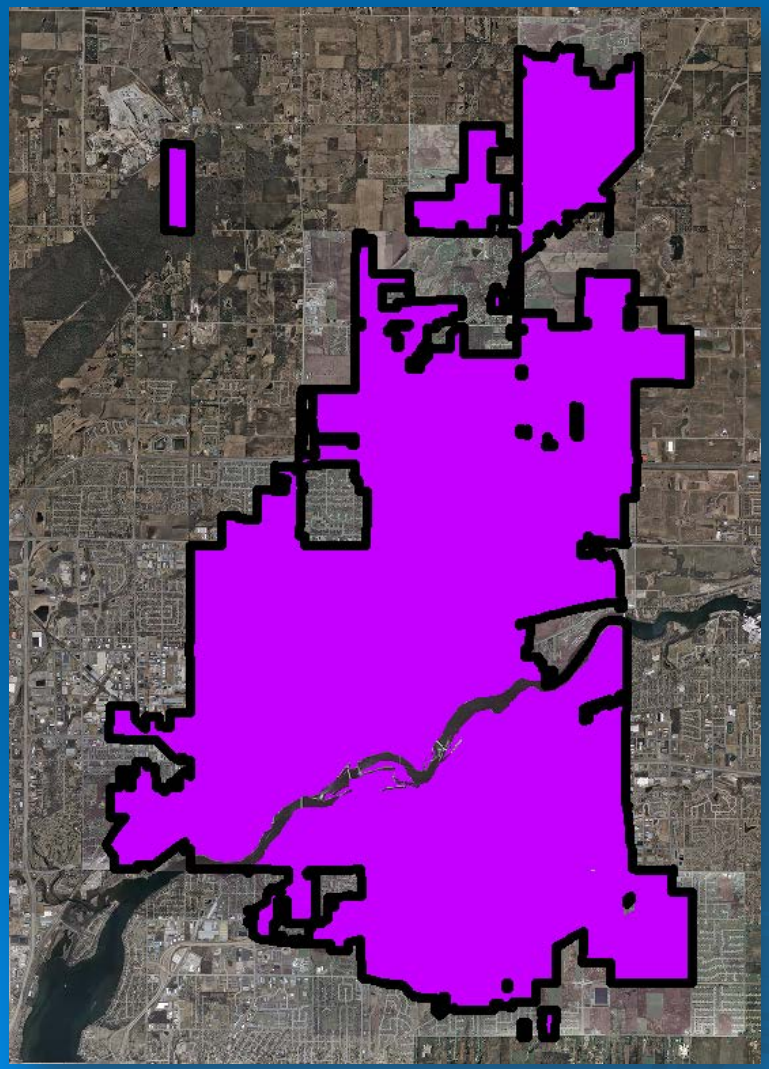


TMDL Added

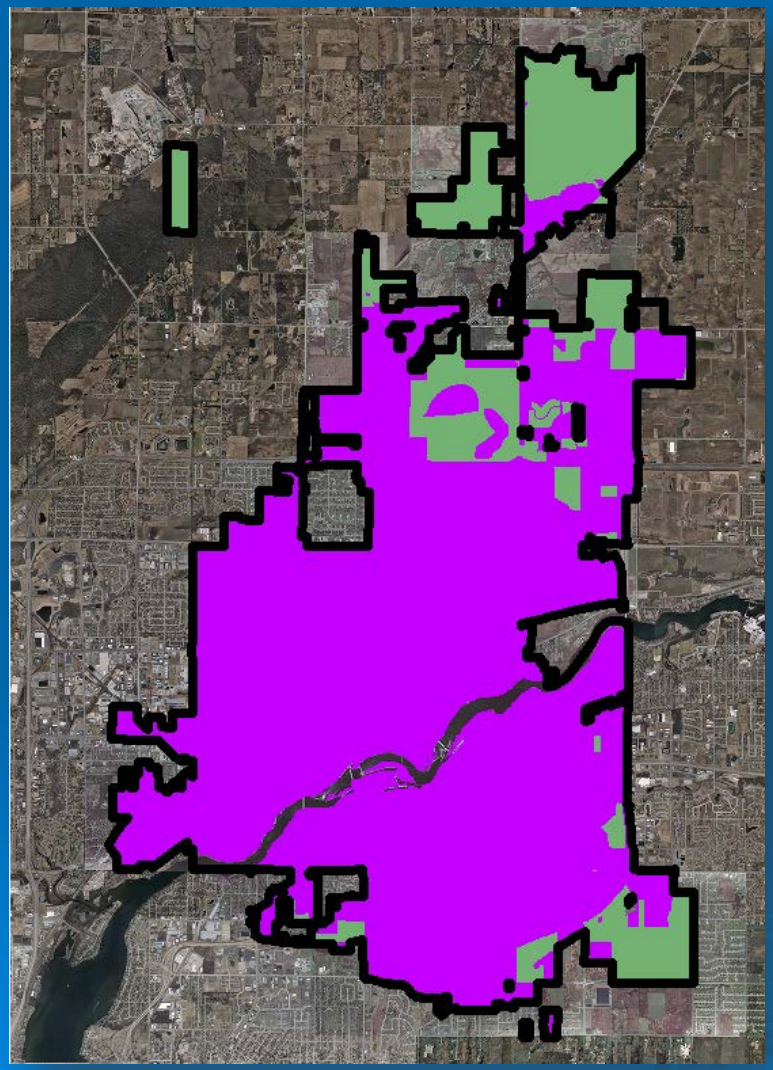
Comparison of TMDL and “NR216” Input Data – “Analyzed” Area



NR 216

- Begin with all lands within Municipal Boundary

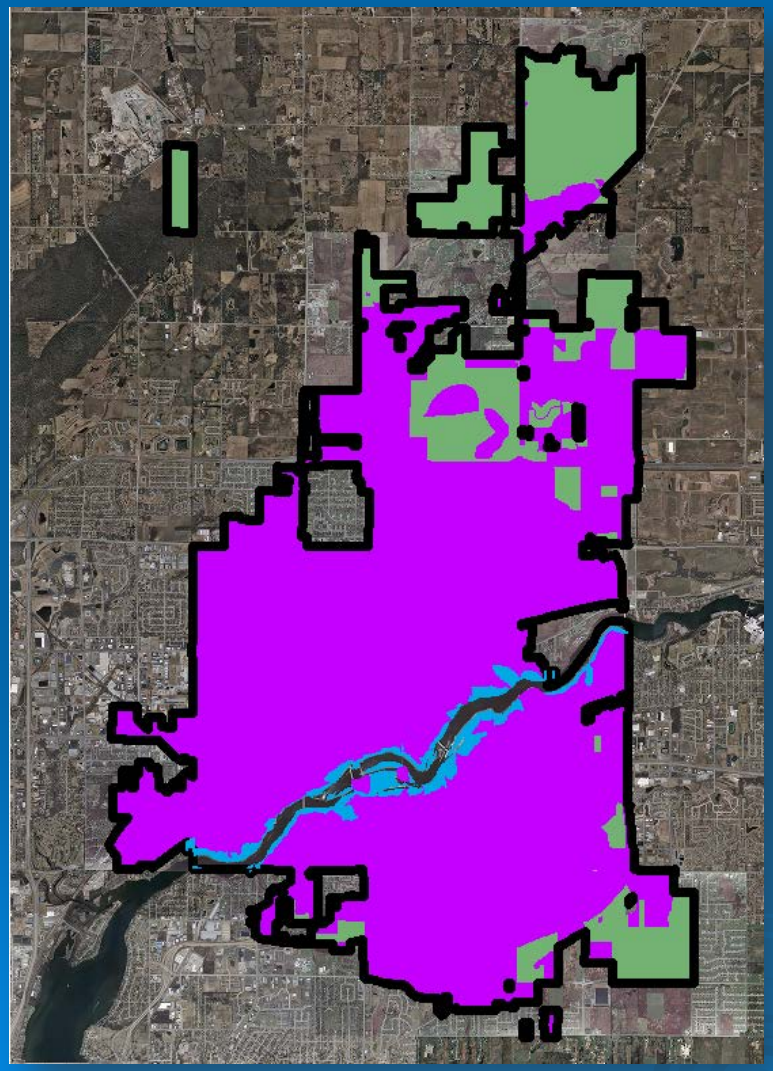
Comparison of TMDL and “NR216” Input Data – “Analyzed” Area



NR 216

- Undeveloped Areas
  - Agricultural
  - Open Space > 5 acres

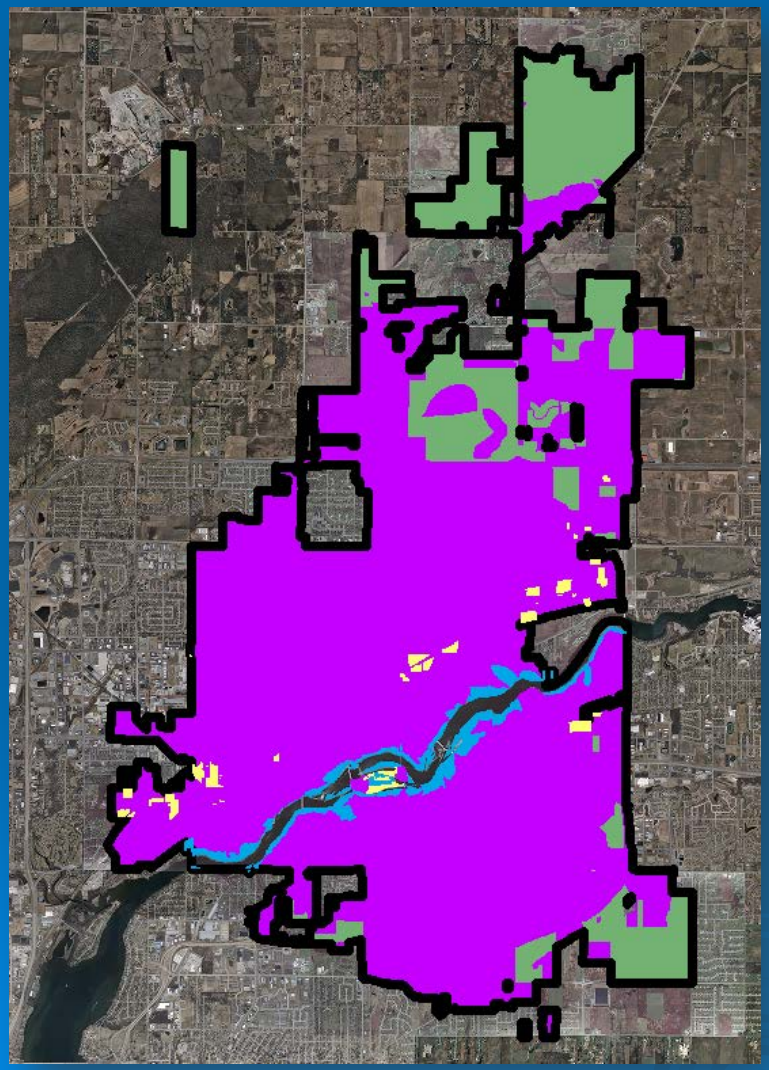
Comparison of TMDL and “NR216” Input Data – “Analyzed” Area



NR 216

- Riparian
- Undeveloped Areas
  - Agricultural
  - Open Space > 5 acres

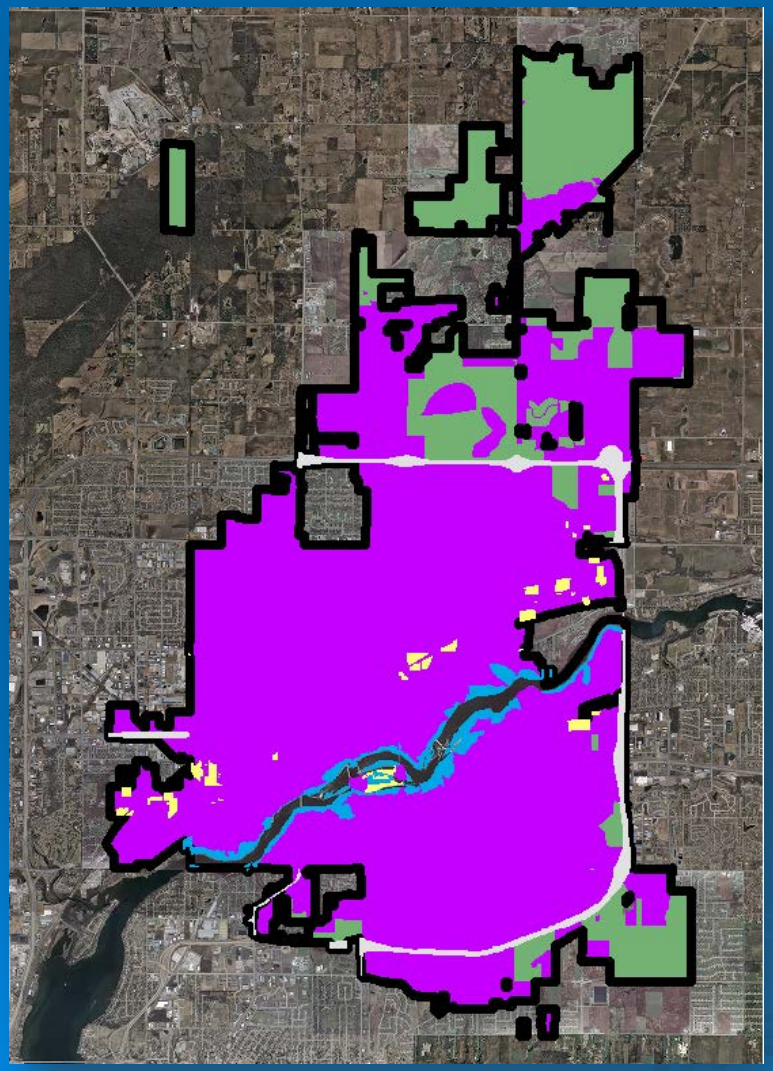
Comparison of TMDL and “NR216” Input Data – “Analyzed” Area



NR 216

- Industrial Permitted Properties
- Riparian
- Undeveloped Areas
  - Agricultural
  - Open Space > 5 acres

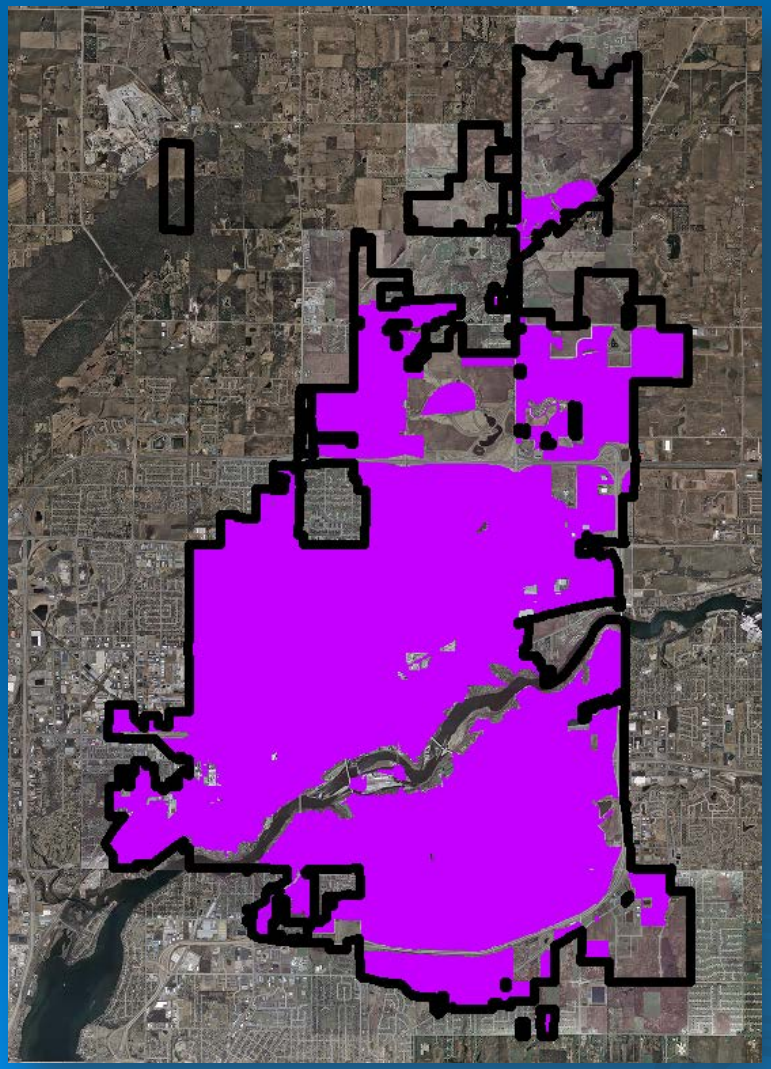
Comparison of TMDL and “NR216” Input Data – “Analyzed” Area



NR 216

- Wisconsin DOT Highways
- Industrial Permitted Properties
- Riparian
- Undeveloped Areas
  - Agricultural
  - Open Space > 5 acres

Comparison of TMDL and "NR216" Input Data – "Analyzed" Area



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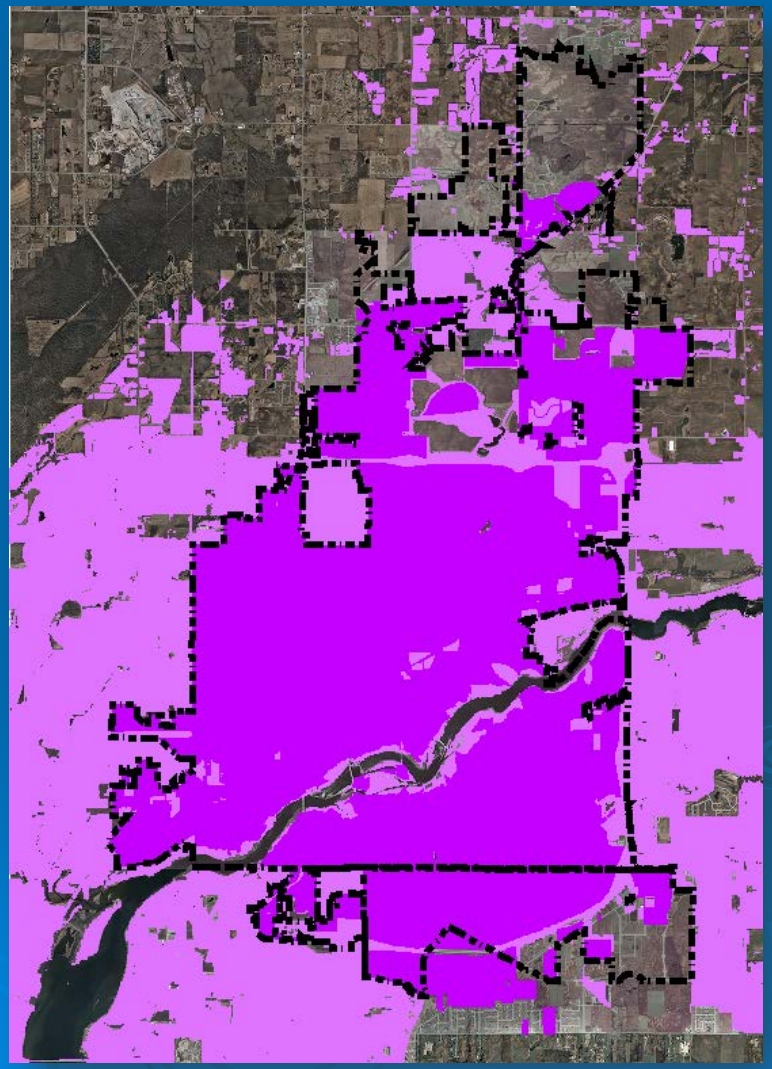

TMDL Added

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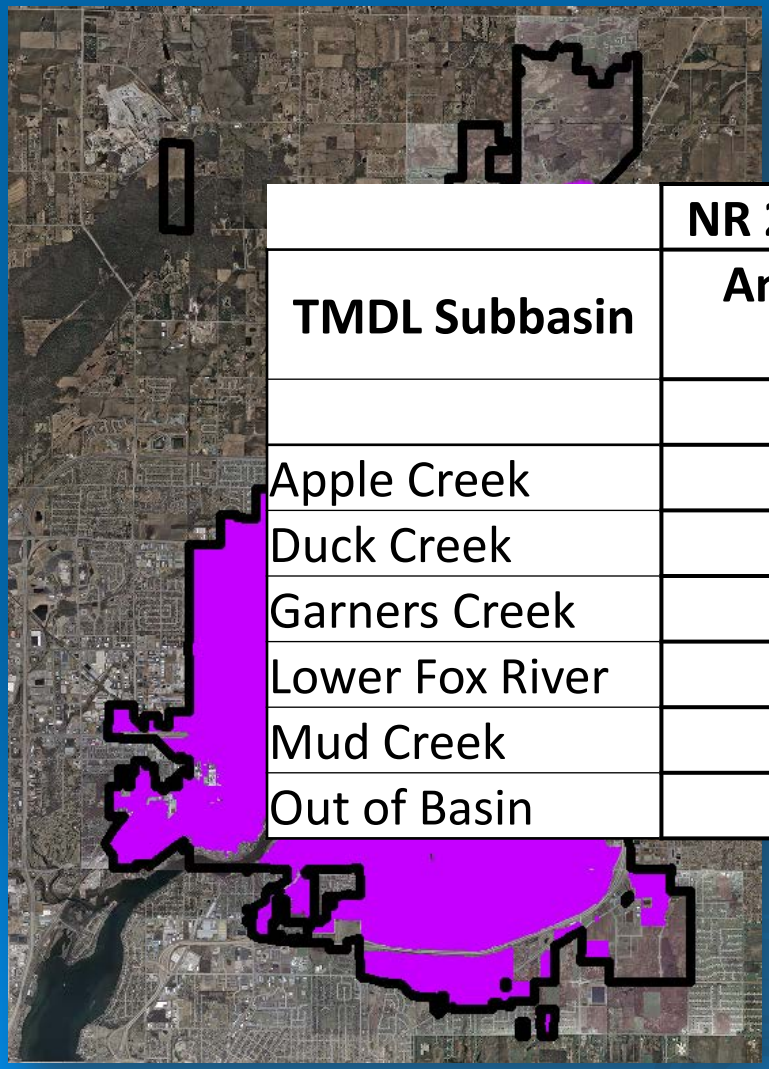

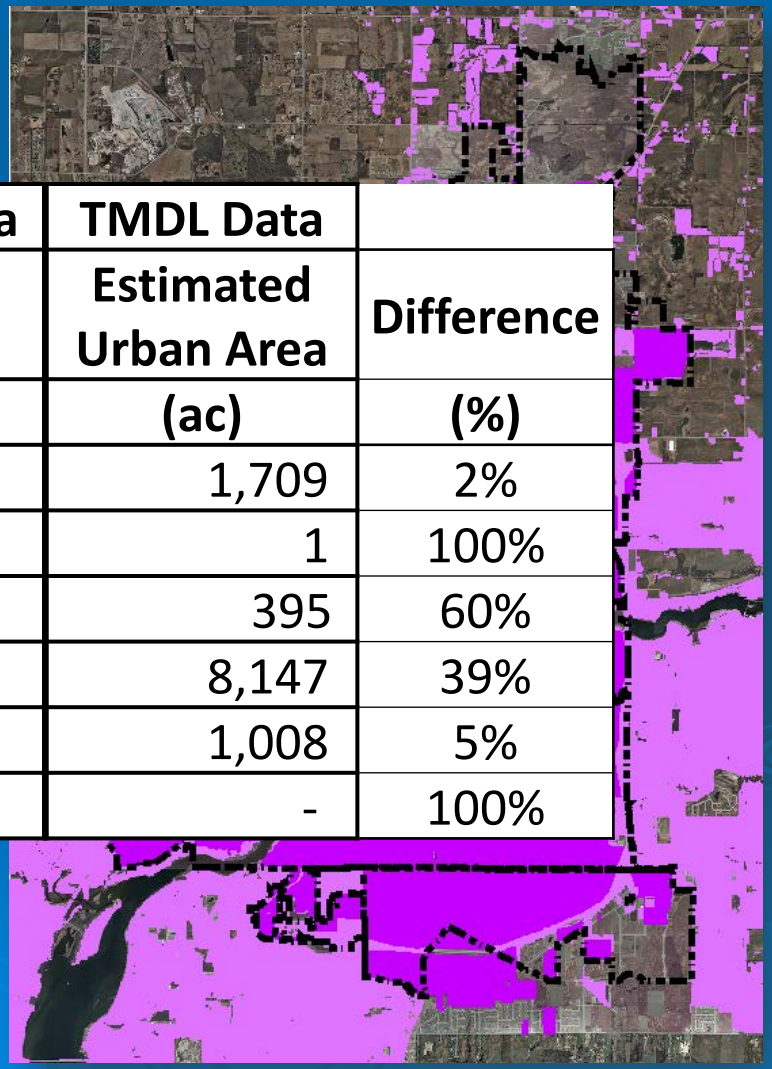

	NR 216 Data	TMDL Data	
TMDL Subbasin	Analyzed Area	Estimated Urban Area	Difference
	(ac)	(ac)	(%)
Apple Creek	1,749	1,709	2%
Duck Creek	-	1	100%
Garners Creek	988	395	60%
Lower Fox River	5,850	8,147	39%
Mud Creek	1,058	1,008	5%
Out of Basin	1,944	-	100%

NR 216

TMDL Added

Comparison of TMDL and "NR216" Results

Total Suspended Solids – Annual Loads
Comparison to NR216 Base Conditions

	TMDL				NR216
Subbasin	**Baseline**	**Allocated**	**Reduction**	**% Reduction from Baseline**	**Base Conditions**
	(tons/yr)	**(tons/yr)**	**(tons/yr)**	**(%)**	**(tons/yr)**
Apple Creek	318	191	127	40.0%	203
Duck Creek	0.23	0.14	0.09	40.0%	-
Garners Creek	74	37	37	49.9%	133
Lower Fox River	1,515	527	988	65.2%	834
Mud Creek	187	134	53	28.5%	174
Out of Basin	-	-	-	-	260
Total	**2,094**	**889**	**1,205**	**42.4%**	**1,604**

Comparison of TMDL and "NR216" Results

Total Phosphorus – Annual Loads
Comparison to NR216 Base Conditions

	TMDL				NR216
Subbasin	**Baseline**	**Allocated**	**Reduction**	**% Reduction from Baseline**	**Base Conditions**
	(lbs/yr)	**(lbs/yr)**	**(lbs/yr)**	**(%)**	**(lbs/yr)**
Apple Creek	1,617	1,132	485	30.0%	1,351
Duck Creek	2	1	1	30.0%	-
Garners Creek	313	115	198	63.1%	837
Lower Fox River	5,239	3,667	1,572	30.0%	4,976
Mud Creek	725	442	283	39.0%	901
Out of Basin	-	-	-	-	1,733
Total	**7,896**	**5,358**	**2,538**	**67.9%**	**9,797**

Comparison of TMDL and "NR216" Results

Total Suspended Solids – Annual Loads
NR216 Plan Compared to Allocation

Subbasin	NR216					TMDL
	Base Cond.	Existing Cond.	Existing - Percent Reduction	Future Cond.	Future - Percent Reduction	Allocation
	(tns/yr)	(tns/yr)	(%)	(tns/yr)	(%)	(tns/yr)
Apple Creek	203	48	76%	47	77%	191
Duck Creek	-	-	-	-	-	0.14
Garners Creek	133	28	79%	28	79%	37
Lower Fox River	834	758	9%	529	37%	527
Mud Creek	174	164	5%	143	18%	134
Out of Basin	260	250	4%	213	18%	-
Total	**1,604**	**1,248**	**22%**	**960**	**40%**	**889**

How will Compliance be Measured?

1. (?) Multiply the TMDL Base Load by the BMPs pollution reduction effectiveness

Or

2. (?) Directly Compare the NR216 Load to the WLA

Or…

Total Suspended Solids – Annual Loads

	TMDL		NR216		
Subbasin	Baseline	Allocation	Future - Percent Reduction	Resulting Load	NR216 Future Conditions
	(tons/yr)	(tons/yr)	(%)	(tons/yr)	(tons/yr)
Apple Creek	318	191	77%	74	47
Duck Creek	0.23	0.14	-	0.23	-
Garners Creek	74	37	79%	16	28
Lower Fox River	1,515	527	37%	961	529
Mud Creek	187	134	18%	155	143
Out of Basin	-	-	18%	-	213
Total	**2,094**	**889**	**40%**	**1,204.7**	**960**

Current “To Do” List of TMDL / MS4 TAC

- Members:
  - Municipal Representatives
  - Consultants
  - WDNR staff
- Reconcile Differences - TMDL Urban Analysis and NR216 Analysis
  - Political Boundary
  - Regulated Areas removed from NR216 Analysis
    - Internally Drained
    - Permitted Entities
    - Open Space > 5 acres
    - Agricultural
    - Riparian
  - Urban Modeling Approach
    - NR216 (P8 or WinSLAMM) versus SWAT
    - Unit load per urban area
- If reconciliation of data modifies TMDL Baseline Load, will the TMDL model be rerun?

Current “To Do” List of TMDL Stormwater TAC

- How is New Development handled?
- How is Annexation handled?
- Accounting for “non-traditional” stormwater control measures
  - Leaf Pick-Up
  - Information and Education Programs
  - Streambank Restoration
  - Nutrient Management Programs
- How Compliance will be Measured?
  - Scale
    - MS4-wide?
    - Per TMDL Subbasin?
    - At Impaired Water Body?
  - Calculation Approach Options:
    - BMP effectiveness % applied to TMDL load?
    - Direct comparison of TMDL WLA to NR216 load reductions?
    - BMP lbs reduced subtracted from TMDL load?
    - Calibrate NR216 model to SWAT model and model BMPs?

Discussion/Questions?

Comparison of Regional and Dispersed Stormwater Management Practices

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Common Approaches to Achieving a Pollution Reduction Goal

Lowest $/Unit

Highest $/Unit

General Steps

1. Evaluate Least Cost Measures First
    - Non Structural (example: Street Sweeping)
2. Enhance Existing Practices
3. Identify Potential New Structural Measures

Comparison of “Regional” vs “Dispersed” Practices

Regional Examples:

- Conversion of dry to wet stormwater ponds
- Construction of new wet stormwater pond

Dispersed Examples:

- Engineered swales
- Biofilters (treatment of non-residential properties)
- Rain gardens (treatment of 1-family residential)

“Regional” Practices

Cost Comparisons – Stormwater Ponds

Location & BMP	Type of Pond	Planning Level Cost Estimates	Actual Bid & Land Costs	% Difference
		Construction	Construction	
City 1, Pond 1	New	$1,400,000	$607,053	-57%
City 1, Pond 2	New	$1,000,000	$552,383	-45%
City 1, Pond 3	Retrofit	$1,640,000	$1,009,365	-38%
City 1, Pond 4	New	$2,160,000	$1,095,039	-49%
City 2, Pond 1	New	$514,000	$386,817	-25%
City 2, Pond 2	New	$407,000	$275,030	-32%
City 3, Pond 1	Retrofit	$30,000	$75,399	151%
City 3, Pond 2	New & Lift Station	$515,000	$893,687	74%
City 3, Pond 3	New & Lift Station	$398,000	$885,781	123%
City 3, Pond 4	New	$255,000	$472,839	85%
City 4, Pond 5	New & Lift Station	$826,000	$1,288,436	56%

“Regional” Practices

Cost Comparisons – Stormwater Ponds – $ / Acre Treated

Location & BMP	Type of Pond	Actual Bid & Land Costs Construction	Watershed Treated (acres)	$/Watershed Acre	
City 1, Pond 1	New	$607,053	220	$2,759	
City 1, Pond 2	New	$552,383	103	$5,363	
City 1, Pond 3	Retrofit	$1,009,365	835	$1,209	
City 1, Pond 4	New	$1,095,039	164	$6,677	Max.
City 2, Pond 1	New	$386,817	91	$4,251	
City 2, Pond 2	New	$275,030	90	$3,052	
City 3, Pond 1	Retrofit	$75,399	104	$725	Min.
City 3, Pond 2	New & Lift Station	$893,687	207	$4,326	
City 3, Pond 3	New & Lift Station	$885,781	334	$2,655	
City 3, Pond 4	New	$472,839	188	$2,514	
City 4, Pond 5	New & Lift Station	$1,288,436	427	$3,017	

Average: **$ 3,323**

“Regional” Practices

Cost Comparisons – Stormwater Ponds – $ / Ton TSS

Location & BMP	Type of Pond	Actual Bid & Land Costs Construction	Watershed Treated (acres)	$/ Ton TSS	
City 1, Pond 1	New	$607,053	220	$ 28,907	
City 1, Pond 2	New	$552,383	103	$ 42,491	Max.
City 1, Pond 3	Retrofit	$1,009,365	835	$ 11,451	Min.
City 1, Pond 4	New	$1,095,039	164	$ 33,798	
City 2, Pond 1	New	$386,817	91	$ 30,220	
City 2, Pond 2	New	$275,030	90	$ 33,954	
City 3, Pond 1	Retrofit	$75,399	104	$ 11,781	
City 3, Pond 2	New & Lift Station	$893,687	207	$ 26,519	
City 3, Pond 3	New & Lift Station	$885,781	334	$ 36,754	
City 3, Pond 4	New	$472,839	188	$ 34,768	
City 4, Pond 5	New & Lift Station	$1,288,436	427	$ 28,907	

Average: $ **29,064**

“Regional” Practices

Cost Comparisons – Stormwater Ponds – $ / lb TP

Location & BMP	Type of Pond	Actual Bid & Land Costs Construction	Watershed Treated (acres)	$/ Ton TSS	
City 1, Pond 1	New	$607,053	220	$ 6,390	
City 1, Pond 2	New	$552,383	103	$ 14,164	Max.
City 1, Pond 3	Retrofit	$1,009,365	835	$ 2,843	
City 1, Pond 4	New	$1,095,039	164	$ 12,665	
City 2, Pond 1	New	$386,817	91	$ 11,911	
City 2, Pond 2	New	$275,030	90	$ 6,577	
City 3, Pond 1	Retrofit	$75,399	104	$ 2,636	Min.
City 3, Pond 2	New & Lift Station	$893,687	207	$ 9,387	
City 3, Pond 3	New & Lift Station	$885,781	334	$ 6,975	
City 3, Pond 4	New	$472,839	188	$ 6,576	
City 4, Pond 5	New & Lift Station	$1,288,436	427	$ 6,390	

Average: **$ 8,012**

“Dispersed” Practices

Raingardens (residential treatment)

ANNUAL TSS REMOVAL (per 100 acres of treated watershed)			
Ratio of per Parcel	**Number of**	**% TSS Reduction**	**Tons TSS Removed**
100% of Single Family House	400	1.27%	0.14
50% of Single Family Houses	200	0.63%	0.07
25% of Single Family Houses	100	0.32%	0.03

Assumptions:

1) Medium density residential land use
2) Average TSS loading (per SLAMM) = 11 tons TSS / 100 acres / year
3) ¼ of each treated parcel’s roof drains to rain garden
4) Rain garden sized to infiltrate 100% of runoff from treated roof area

400 raingardens @ $50 each = $142,850 / ton TSS removed

Raingardens have more value for volume reduction

“Dispersed” Practices

Biofilters – Sizing & Load Reduction

BIO-FILTRATION ANNUAL TSS REMOVAL (per acre treated)				
Land Use	**TSS Load / Acre (tons / year)**	**Biofilter Size * (sq/ ft.)**	**% TSS Reduction ***	**Tons TSS Removed (per acre)**
Commercial	0.19	900	80%	0.15
Industrial	0.26	700	80%	0.21
Institutional	0.18	575	80%	0.14

* Assumptions:

1) Biofilters sized to treat 1 acre of selected land use
2) 90% TSS reduction rate water passing through engineered soil
3) Biofilter Design
   - maximum 12” ponding depth
   - engineered soil depth = 3’
   - perforated collection pipe at 3’ depth
   - engineered soil infiltration rate = 2.5 in / hr

“Dispersed” Practices

Biofilters – Costs

BIOFILTRATION COST / TSS REMOVAL (per acre treated)				
Land Use	**Biofilter Size (sq/ ft.)**	**Tons TSS Removed (per acre)**	**Cost / Biofilter**	**$ / Ton TSS Removed**
Commercial	900	0.15	$15,000	$100,000
Industrial	700	0.21	$12,000	$57,100
Institutional	575	0.14	$10,000	$71,500

Summary

Practice	$ / Acre of Watershed Treated	$ / Ton TSS Removed
Pond	$3,323 ($725 - 6,677)	$29,064 ($11,451 - $42,491)
Rain Garden	$200	$142,850
Biofilter	$10,000 - $15,000	$57,100 - $100,000

Other Factors to Consider

- Maintenance Costs / Staffing Needs
- Land Costs
- Flood Control Needs
- Safety
- Aesthetics
- Public Acceptance
- Volume Control / Groundwater Recharge

Discussion / Questions