Stormwater Management Plan

VILLAGE-WIDE STORMWATER QUALITY MANAGEMENT PLAN

Prepared For The

VILLAGE OF FOX CROSSING

WINNEBAGO COUNTY, WISCONSIN

AUGUST 21, 2018

McM. No. F0057-9-17-00221.01

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1.0 INTRODUCTION

At the request of the Village of Fox Crossing, McMahon Associates, Inc. prepared the following Village-Wide Stormwater Quality Management Plan update to include the proposed Plan of Action.

The purpose of the plan is to provide the Village with the long-term guidance necessary to comply with Wisconsin Administrative Code NR 216 stormwater regulations and improve water quality in receiving waters. Pursuant to NR 216, the Village obtained a WPDES Municipal Stormwater Discharge Permit from the Wisconsin Department of Natural Resources (WDNR) on October 13, 2006. The WDNR anticipates renewing the Village's WPDES Municipal Stormwater Discharge Permit during 2019. The purpose of the permit is to regulate discharges from municipal separate storm sewer systems (MS4) and reduce urban non-point source pollution.

Relationship to Other Plans

This Stormwater Quality Management Plan compliments and is part of efforts to implement recommendations contained in several existing resource management plans. These related resource management plans include the following:

- The Lower Green Bay Remedial Action Plan (RAP) recommends 50% Total Phosphorus (TP) reduction for the Green Bay Area of Concern. The RAP also recommends a reduction in other urban stormwater pollutants such as sediment, heavy metals, toxics, and bacteria. The RAP was finalized by WDNR in 1993. The RAP recommends that municipalities develop and implement programs for construction site erosion control, post-construction stormwater management, illicit discharges, and shoreland/wetland zoning. The RAP also recommends

that municipalities develop and implement programs that preserve, restore and enhance environmental corridors, shoreline buffers, wetlands, habitat, and public access for shoreline fishing, boating and other water-based recreation. To meet these goals, the RAP recommends planning and implementation of Best Management Practices (BMP) to reduce nonpoint source pollutants. The RAP also recommends that municipalities seek innovative and alternative ways to achieve nonpoint source goals.

- The Total Maximum Daily Load (TMDL) developed for the Lower Fox River Basin identifies Total Suspended Solids (TSS) and TP allocations for urban stormwater, wastewater, and agricultural sources located within the Lower Fox River Basin. The TMDL was approved by the U.S. Environmental Protection Agency (EPA) in 2012. More specifically, the TMDL identifies allocations for urban stormwater in the Fox River, Mud Creek and Neenah Slough Sub-Basins.

- The Comprehensive Plan for the Village of Fox Crossing contains several recommendations related to natural resource and stormwater management: (1) adopt ordinances that protect environmental corridors including shoreland zoning; (2) protect and enhance wetlands, woodlands, wildlife habitat, open space, lakes, rivers, streams and groundwater; (3) work with other municipalities to develop a plan for the Fox River, Little Lake Buttes des Morts and other waterways; (4) adopt urban design standards for new development; (5) require stormwater management for development; (6) maintain and update the Village's 5-Year Capital Improvement Plan; (7) work cooperatively and enter into agreements with other municipal entities; (8) promote economy and equity in the delivery of urban services; (9) provide open space and foster recreational opportunities; and (10) pursue funding for stormwater management and state regulations.

2.0 OVERVIEW OF STUDY AREA

The study area for this Stormwater Management Plan is depicted in Figure 1. The study area contains approximately 8,476 acres which is the municipal boundary. The Village of Fox Crossing is located in Winnebago County, Wisconsin. As shown in Figure 2, several Municipal Separate Storm Sewer System (MS4) jurisdictions are located within and directly adjacent to the Village. The 2017 population for the Village is estimated at 18,892. The Village of Fox Crossing is part of the Appleton Urbanized Area as determined by the US Census Bureau.

Basins

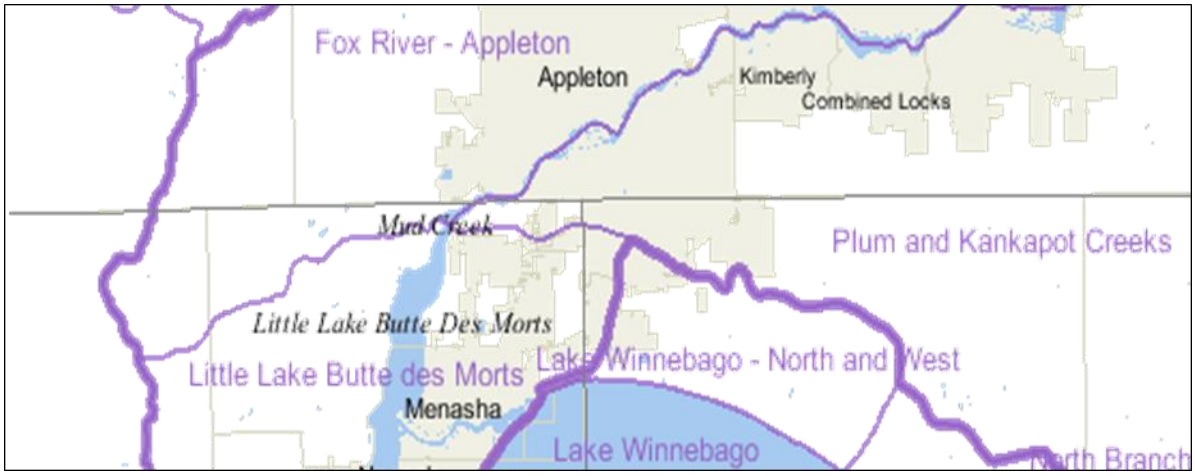
The WDNR divided the state into 24 basins or Water Management Units (WMU). The Village's study area is located in the Lower Fox River Basin and Upper Fox River Basin. The basin boundaries are similar to the federally designated 8-digit Hydrologic Unit Code (HUC) boundaries.

Exhibit 2-1: Lower & Upper Fox River

Watersheds

The WDNR divided the Lower Fox River Basin into six watersheds and the study area is located in three of these watersheds: Plum & Kankapot Creeks (LF03 -113), Fox River – Appleton (LF04 -113), and Little Lake Butte des Morts Watershed (LF06 -113). The WDNR divided the Upper Fox River Basin into 15 watersheds and the study area is located in one of these watersheds: Lake Winnebago - North and West (UF01 -111).

Exhibit 2-2: Little Lake Butte des Morts & Lake Winnebago - North and West Watersheds



Sub-Watersheds

For purposes of this stormwater management plan, the study area was divided into four sub-watersheds. The sub-watersheds are depicted in Figure 3 and summarized in Table 2-1. The sub-watersheds were delineated after considering the locally designated stormwater planning boundaries, federally designated 12-digit Hydrologic Unit Code (HUC) boundaries, and state designated TMDL sub-basin boundaries.

Table 2-1

Sub-Watersheds

Sub-Watershed	HUC-12	TMDL Sub-Basin Name
Fox River	Little Lake Butte des Morts 040302040201 Mud Creek 040302040202 Garners Creek-Fox River 040302040205	Lower Fox River Main Stem
Mud Creek	Mud Creek 040302040202	Mud Creek
Neenah Slough	Little Lake Butte des Morts 040302040201	Neenah Slough
Lake Winnebago	-	-

Natural Resources

Natural resource features include surface waters (lakes, rivers, streams), wetlands, and endangered or threatened resources. Natural resource features located in the study area are depicted in Figure 4. Some of these natural resource features are protected with a special regulatory designation such as outstanding resource water, exceptional resource water, 303(d) impaired water, endangered species, and threatened species. Natural resource features located in the study area with one of these special regulatory designations are identified below.

Outstanding and exceptional resource waters are pristine surface waters which are not significantly impacted by human activities and provide valuable fisheries, unique hydrological or geological features, outstanding recreational opportunities, or unique environmental settings. For example, cold water trout streams and natural waterfalls are typically classified as outstanding or exceptional resource waters. The Village of Fox Crossing does not discharge stormwater runoff into any outstanding resource waters or exceptional resource waters.

Impaired water bodies are degraded surface waters which are not meeting water quality standards or their potential uses, such as fishing and swimming, due to pollutants and poor water quality. The US EPA requires each state to update its 303(d) impaired waters list every two years, including Wisconsin. The Village of Fox Crossing discharge stormwater runoff into four 303(d) impaired waters:

- FOX RIVER - The Fox River is a 303(d) impaired water body due to contaminated sediment and a blend of point and non-point source pollution. Pollutants of concern include total phosphorus and polychlorobiphenyls. Impairments include low dissolved oxygen and contaminated fish tissue. The attainable use for the Fox River is fish and aquatic life. Currently, the Fox River is not supporting its attainable use.

- MUD CREEK - Mud Creek is a 303(d) impaired water body due to a blend of point and non-point source pollution. Pollutants of concern include total phosphorus. Impairments include degraded habitat. The attainable use for Mud Creek is fish and aquatic life. Currently, Mud Creek is not supporting its attainable uses.

- NEENAH SLOUGH - The Neenah Slough is a 303(d) impaired water body due to contaminated sediment and a blend of point and non-point source pollution. Pollutants of concern include polychlorobiphenyls and total phosphorus. Impairments include contaminated fish tissue and low dissolved oxygen. The attainable use for Neenah Slough is fish and aquatic life. Currently, the Neenah Slough is not supporting its attainable uses.

- LAKE WINNEBAGO - Lake Winnebago is a 303(d) impaired water body due to atmospheric deposition, contaminated sediment, and non-point source pollution. Pollutants of concern include mercury, polychlorobiphenyls, sediment/total suspended solids, and total phosphorus. Impairments include contaminated fish tissue, low dissolved oxygen, eutrophication, water quality use restrictions, and turbidity. The attainable use for Lake

Winnebago is fish and aquatic life. Currently, Lake Winnebago is not supporting its attainable uses.

Endangered and threatened resources are wild animal and plant species which are either in danger of extinction throughout all or a significant portion of its range or likely to become endangered in the foreseeable future. Typically, the location of an endangered or threatened species is tracked in Wisconsin's Natural Heritage Inventory and is only identified by municipality. Sensitive species that are particularly vulnerable to collection or disturbance are only identified by county. The Natural Heritage Inventory maps and species lists are routinely updated by WDNR. To prevent collection or disturbance of sensitive species, known endangered and threatened resources are depicted in Figure 4.

Cultural Resources

Cultural resources are places of cultural significance. Some cultural resources are protected with a special regulatory designation such as archeological sites and historical sites. Cultural resource features located in the study area with one of these special regulatory designations are identified below.

Archeological sites may be located within the study area, but cannot be disclosed by law. The State of Wisconsin maintains maps and a computer database on the location and nature of archaeological sites. Special permission is required to view these maps and databases. The location of archaeological sites is exempt from public disclosure to prevent collection or disturbance of valuable artifacts.

The Wisconsin Historical Society's register indicates there are no historical sites located within the Village's study area.

Remediation & Waste Disposal Sites

Remediation sites are places where cleanup of environmental soil or groundwater contamination is ongoing or completed. Remediation sites may involve hazardous wastes, underground storage tanks, or other contaminant sources. Waste disposal sites are places where solid wastes are stored. Understanding the location of remediation and waste disposal sites is an important consideration when evaluating potential stormwater retrofit locations. The approximate location of WDNR identified remediation sites (open and closed sites) and waste disposal sites (not archived) are depicted in Figure 4.

Soils

Soil information is from the *Winnebago County Soil Survey,* Natural Resource Conservation Service, U.S. Department of Agriculture. The U.S. Department of Agriculture has classified soil types into four Hydrologic Soil Groups (HSG). The four hydrologic soil groups (i.e. A, B, C and D) are classified according to the minimum infiltration rate of the soil column. Group A soils have the highest permeability rate or lowest runoff potential, whereas Group D soils have the lowest permeability rate or highest runoff potential. Hydrologic soil groups are depicted in Figure 5.

MS4 System

The municipal separate storm sewer system (MS4) consists of publicly owned or operated conveyance systems including streets, curbs, gutters, catch basins, storm sewers, swales, channels, culverts, and occasionally bridges. The MS4 system is depicted in Figure 6.

The MS4 system contains several structural BMPs. The structural BMPs are depicted in Figure 7 and summarized in Table 2-2. Structural BMPs include wet detention ponds, dry detention ponds, biofilters, proprietary devices, and other devices. Some of these structural BMPs are publicly owned and others are privately owned.

The MS4 system is based on available records. The MS4 system contains three different types of surface drainage: curb & gutter, grass swales, and no controls. The types of surface drainage are depicted in Figure 8. Figure 8 also depicts riparian areas that discharge directly into the Fox River or Lake Winnebago without passing through the Village's MS4.

Table 2-2

Structural BMPs

BMP ID	BMP Name	Type of Structural BMP	BMP Owner	Maintenance Agreement
B2	Fox Landing Condos Pond	Dry Pond	Private	No
C2a2-1	Pheifer Brothers Pond	Dry Pond	Private	No
C2a2-2	Vel Corp Ponds	Dry Ponds	Private	No
C2b1-1	Springetti's Landscaping Pond	Wet Pond	Private	No
C2b1-2	RestorU Biofilters	Biofilters	Private	No
C2b1-3	Century Oaks Residential Care Pond	Wet Pond	Private	No
C2b2a	DOT Pond 1	Wet Pond	State	No
C2b3-1	Redtail Crossing Pond	Dry Pond	Private	No
C2b3-2	Redtail Crossing Pond	Dry Pond	Private	No
C2b4	Golf Village Wet Pond	Wet Pond	Private	No
C2b5	Golf Village Dry Pond	Dry Pond	Private	No
C3c	New Hope Lutheran Church Pond	Wet Pond	Private	No
C3e	Shady Lane Pond	Wet Pond	Village	N/A
C3e2-1	Shady Lane Estates Pond	Wet Pond	Private	No
C3h2-1	Golf Bridge Drive Apts Ponds	Dry Ponds	Private	No
C4c-1	Subway Pond	Dry Pond	Private	No
C4d1	Creekside Apts Ponds	Dry Ponds	Private	No
C5e	Neuroscience Center Pond	Wet Pond	Private	No
C5f	Tom's Drive In Pond	Wet Pond	Private	No
C6a2-1	Master Lube Pond	Dry Pond	Private	No
C6b3	CFCU Pond	Wet Pond	Private	Yes
C6b3	Gateway Square Pond	Wet Pond	Private	No
C6d1	Kwik Trip Pond	Dry Pond	Private	No
C7b	Jacobsen Creek Condo Pond 2	Wet Pond	Private	No
C7c	Jacobsen Creek Condo Pond 1	Wet Pond	Private	No
C8e	Wildlife Heights Pond 1	Dry Pond	Village	N/A
C9b	Wildlife Heights Pond 2	Dry Pond	Private	No
C10e1	O'Hauser Park Dry Pond	Dry Pond	Village	N/A
C10e2	O'Hauser Park Biofilter	Biofilter	Village	N/A
C11a2a	KC West STH II Site Pond 1	Dry Pond	Private	No
C11b2a	KC West STH II Site Pond 2	Wet Pond	Private	No
C11b5	KC West STH II Site Pond 3	Wet Pond	Private	No
C11b6a	KC West STH II Site Pond 4	Wet Pond	Private	No
C16a3	High Plains Meadows, 3rd Add. Pond	Wet Pond	Village	N/A
C16a7	High Plains Meadows, 1st Add. Pond	Dry Pond	Private	No
C16b	High Plains Meadows Pond	Dry Pond	Private	No
C17g1	Shady Springs VI Detention Ditch	Dry Ditch	Private	No

Table 2-2

Structural BMPs

BMP ID	BMP Name	Type of Structural BMP	BMP Owner	Maintenance Agreement
C19a2	Municipal Building Pond	Dry Pond	Village	N/A
C19c	Bryce Drive Pond	Wet Pond	Private	No
C19d	Cottagewood Condos Pond	Wet Pond	Private	No
C20a1	Irish Road Apartments Pond 1	Dry Pond	Private	No
C20b2a	Secura East Ponds	Wet Pond	Private	No
C20b2b1	Secura West Pond	Wet Pond	Private	No
C20e1d	Ashford Place, 1st Addition Device	Proprietary	Private	No
C20e2	Irish Road Apartments Pond 5	Dry Pond	Private	No
C22a1	Meadow Heights Pond 1	Wet Pond	Private	No
C22c3	Prairie Lake Estates Pond	Wet Pond	Private	No
C22d2	Prairie Lake Condos Pond	Wet Pond	Private	No
D3d-1	Boy Scouts Pond	Wet Pond	Private	No
D3d-2	Harp Gallery Pond	Wet Pond	Private	No
D4b	Touchmark Pond	Wet Pond	Private	No
D14b	First Business Center Device	Proprietary	Private	No
D19a-1	Red D Mix Pond	Wet Pond	Private	No
D19a-2	US Cellular Pond	Dry Pond	Private	No
D21a	Alaskan Acres Ponds	Dry Ponds	Private	No
D21c3	Winding Creek Estates Pond 1	Wet Pond	Private	No
D21d	Winding Creek Estates Pond 2	Wet Pond	Private	No
D23d	Gateway Meadows Pond 1	Dry Pond	Village	N/A
D23e	Gateway Meadows Pond 2	Dry Pond	Village	N/A
D26a-1	Roehl Transport Pond 1	Wet Pond	Private	No
D26a-2	Roehl Transport Pond 2	Wet Pond	Private	No
E2a1	DOT Pond 2	Wet Pond	State	No
E4	Page's Sunset Shores Pond	Dry Pond	Private	No
F4a	Palisades Pond	Wet Pond	Village	N/A
G1f1	KC-Chapman Facility (east)	Dry Pond	Private	No
G2d-1	KC-Chapman Facility (west)	Dry Pond	Private	No
G2d-2	Theda Care Neenah Clinic	Wet Pond	Private	No
G3a1	KC Telecommunication Pond	Wet Pond	Private	No
G3a4-1	Hayes Manufacturing Ponds	Dry Ponds	Private	No
G3a4-2	Constitution Drive Warehouse Ponds	Wet Ponds	Private	No
G3a5	Independence Pond	Wet Pond	Village	N/A
G4a5	Parkside West Pond	Dry Pond	Private	No
G4a5a-1	Affinity Health System Pond	Wet Pond	Private	No
G4a5a-2	Theda Care East Pond	Wet Pond	Private	No

Table 2-2

Structural BMPs

BMP ID	BMP Name	Type of Structural BMP	BMP Owner	Maintenance Agreement
G4a5a-3	Theda Care Wet Pond	Wet Pond	Private	No
I1c1	DOT Pond 7	Wet Pond	State	No
I2a2	DOT Pond 6	Wet Pond	State	No
I3a2	Miron Office Expansion Biofilters	Biofilters	Private	No
I3a3-1	Grand Central Station Pond	Wet Pond	Private	No
I3a3-2	Miron Office Ponds	Dry Pond	Private	No
I3a3-3	Miron Office East Parking Lot	Biofilter	Private	No
I3b4	KC Femcare Plant Ponds	Wet Ponds	Private	No
I3b7	Cold Spring Pond	Wet Pond	Village	N/A
I4a1	St. Mary Central High School Pond	Dry Pond	Private	No
L3a1	Wheeler Pond	Wet Pond	Private	No
L3a3-1	Xerium Stowe Pond	Wet Pond	Private	No
M1a1-1	Valley Road Apartments Pond	Dry Pond	Private	No
M1a4-1	Menasha Laundry & Car Wash Biofilter	Biofilter	Private	No
M1b1	Midway Crossing Apartments Ponds	Dry Ponds	Private	No
M1b3	Midway Pond	Wet Pond	State	Yes
P1a3-1	O'Reilly Auto Parts Sump	Catch Basin	Private	No
P1a4	Tayco Pond Expansion	Wet Pond	Village	N/A
P1a5d1	Lake Breeze Condominiums Pond	Wet Pond	Private	No
Q2a	Gateway Meadows Pond 1	Wet Pond	Private	No
Q2b	Gateway Meadows Pond 2	Dry Pond	Village	N/A
Q3d	Meadow Heights Pond 2	Wet Pond	Private	No
S1b2-1	Cedar Lake Sand & Gravel Pond	Wet Pond	Private	No
S1c5-1	Great Northern Pond	Dry Pond	Private	No
S1e-1	Pitney Bowes Pond 1	Dry Pond	Private	No
S2a2-1	Penske Pond	Wet Pond	Private	No
S2a2-2	Minimax Storage Pond	Wet Pond	Private	No
S2a2-3	Pitney Bowes Pond 2	Dry Pond	Private	No
S2b3-1	Bridgeview Gardens Ponds	Dry Ponds	Private	No
W8a	Warehouse Specialists Pond	Wet Pond	Private	No

WPDES Industrial Permits

As shown in Figure 9 and summarized in Table 2-3, there are 27 industrial operations with coverage under a WPDES Industrial Permit that are currently located within the Village of Fox Crossing. WPDES Industrial Permits are regulated by the WDNR. Some WPDES Industrial Permits may allow discharges into the MS4 system during dry weather. Understanding the

location of the WPDES Industrial Permitted sites is important to effective implementation of the Village's stormwater program.

Table 2-3

WPDES Industrial Permits

I.D.	Facility Name	Facility Address	WPDES Permit No.
1	Arcways Inc.	1076 Ehlers Road	S067849
2	AZCO Inc.	2150 Holly Road	S067857
3	Badger Highways Co Inc. Menasha Yard	Hwy 47 and 9th Street	46515
4	CelluTissue Corp dba Clearwater Paper	249 N Lake Street	S067849
5	Con Way Freight XNM Neenah	1020 Ehlers Road	S067857
6	Contrx Industries Inc.	1377 Kimberly Dr.	S067857
7	County Materials Corporation	3019 W Prospect Ave.	S067857
8	Estes Express Lines	1495 Kimberly Drive	S067857
9	Great Northern Corporation	395 Stroebe Road	S067857
10	Insurance Auto Auctions	2591 S Casaloma Dr.	S058831
11	Jahnke Auto Parts Inc.	1047 Valley Road	S059145
12	JJ Plank Corp	728 Watermark Ct.	S067857
13	Michels Materials Dietz No 189	Shady Lane	46515
14	Michels Materials JJ Schulz/Curtis 154	W1/2 NW 1/4 S2 T20N R17E	46515
15	Michels Materials Jorgenson No 296	Hwy BB (20 17 08)	46515
16	Neenah Paper Inc. Finishing Center	1376 Kimberly Drive	S067857
17	Northeast Asphalt - Cold Spring C64	SE 1/4 NE 1/4 S5 T10N R17E	S067857
18	Northeast Asphalt - Cold Spring Aggr.	2500 Cold Spring Road	46515
19	Oshkosh Corporation Defense	1040 Chapman Avenue	S067857
20	Pierce Manufacturing Inc. American Dr.	2600 American Drive	S067857
21	R+L Carriers + GBA	2100 Holly Road	S067857
22	Red D Mix Concrete Inc.	2575 Kisser Court, Appleton	S067857
23	SCA Tissue North America LLC Neenah	984 Winchester Road	S067857
24	Sonoco Products	1200 Independence Drive	S067857
25	Stowe Woodward	912 Haase Street	S067857
26	Sun Chemical	450 Milwaukee Street	S067857
27	Wisconsin Cycle Salvage, Inc.	1038 Winchester Road	S067857

Drinking Water System

The Village obtains drinking water from groundwater aquifers using municipal wells, as well as purchasing water from the City of Menasha. The municipal wells are depicted in Figure 9.

The Village's system is susceptible to contamination by Volatile Organic Compounds (VOCs), Ethylene Dibromide (EDB), and nitrate. The system has moderate susceptibility to

contamination by Synthetic Organic Compounds (SOCs). The system has low susceptibility to Inorganic Compounds (IOCs) and microbes. There is a wellhead protection plan and/or an ordinance to protect Well #3 (OR451), Well #4 (BH538), Well #6 (NQ885), and Well #8 (RL260). Protection activities should focus on whether there is a need to update the plan or the ordinance to further protect the recharge area around these wells. This may include obtaining additional information on any new potential sources of contamination to evaluate their risk to the water supply and identifying and managing improperly abandoned wells or other features that may provide direct pathways for contamination of the aquifer. Protection activities should focus on obtaining additional information on the potential sources of contamination in the area to evaluate and manage their risk. Other efforts should include implementing a wellhead protection plan, and identifying and managing improperly abandoned wells or other features that may provide direct pathways for contamination to enter the aquifer.

Land Uses

The location of publicly owned parks, recreational areas, open lands, and municipal facilities are depicted in Figure 9. Understanding the location of publicly owned land is important to effective implementation of the municipal stormwater program.

Land uses on or before October 1, 2004 are depicted in Figure 10. The Village of Fox Crossing achieved the 20% required by NR 151.13 by 2008. The 2004 land use map is provided for informational purposes only.

2012 land uses are depicted in Figure 11 and summarized in Table 2-4 for the study area. For purposes of the TMDL pollutant analysis, the undeveloped in-fill sites are shown as agriculture, grass, woods, wetland or another undeveloped open space, as appropriate.

Future land uses are depicted in Figure 12 and summarized in Table 2-4 for the study area. For purposes of the TMDL pollutant analysis, the future land uses generally match the 2012 land uses, except the appropriate undeveloped sites are converted to a future land use based on adjoining land uses and information from the Village.

Table 2-4

Land Uses

Land Use	2012 Land Use (acres)	2012 Land Use (%)	Future Land Use (acres)	Future Land Use (%)
Residential				
High Density	12	0.1%	12	0.1%
High Rise	14	0.2%	14	0.2%
Low Density	635	7.5%	703	8.3%
Med Density	1,989	23.5%	2,099	24.8%
Mobile Home	68	0.8%	69	0.8%
Multi-Family	268	3.2%	283	3.3%

Table 2-4

Land Uses

Land Use	2012 Land Use (acres)	2012 Land Use (%)	Future Land Use (acres)	Future Land Use (%)
Suburban	36	0.4%	38	0.4%
Commercial				
Commercial Strip	241	2.8%	324	3.8%
Office Park	206	2.4%	291	3.4%
Shopping Center	14	0.2%	14	0.2%
Institutional				
Hospital	18	0.2%	35	0.4%
Misc. Institutional	66	0.8%	116	1.4%
School	24	0.3%	24	0.3%
Industrial				
Light Industrial	834	9.8%	956	11.3%
Medium Industrial	98	1.2%	105	1.2%
Open Space				
Cemetery	36	0.4%	36	0.4%
[1]Park	335	4.0%	358	4.2%
Railroad	107	1.3%	107	1.3%
Quarry	252	3.0%	252	3.0%
[2]Undeveloped	2,633	31.1%	2,050	24.2%
Highway/Freeway	589	7.0%	589	7.0%
Total	8,476	100.0%	8,476	100.0%

[1]Includes grass and water associated with stormwater ponds/facilities.

[2]Undeveloped land includes agriculture, grass, woods, wetlands, and open water.

3.0 TMDL POLLUTANT ANALYSIS

A TMDL is the maximum amount of a pollutant that a water body can receive and still meet water quality standards. A TMDL for excess TP and TSS (e.g. sediment) pollutants was developed by the WDNR for the Lower Fox River Basin. The TMDL for the Lower Fox River Basin was approved by the EPA on May 18, 2012.

The Lower Fox River Basin has 14 streams and rivers that are impaired by phosphorus and/or sediment pollutants. Excessive amounts of these pollutants cause poor water clarity, increase algae, impact swimming, and degrade aesthetics. The top photograph depicts Fox River algae during 2008 (WDNR photo) and the bottom photograph depicts sediment discharging into Green Bay during 2011 (Steve Seilo photo).

The Lower Fox River Basin TMDL was calibrated and developed using stream, river and lake monitoring data collected by the United States Geological Survey, WDNR, University of Wisconsin-Green Bay, UW-Milwaukee, and NEW Water (Green Bay MSD).

As shown in Figure 6, the Village's storm sewer system discharges to three impaired Lower Fox River Basin waterways: Fox River, Mud Creek and Neenah Slough. The Fox River, Mud Creek, and Neenah Slough are specifically included in the Lower Fox River Basin TMDL.

Performance Standard

The TMDL Report developed for the Lower Fox River Basin identifies waste load allocations for permitted Urban MS4 areas. The TP and TSS waste load allocations identified in the TMDL Report for the Village's municipal boundary are summarized in Tables 3-1 and 3-2, respectively.

Table 3-1

Phosphorus Allocations from TMDL Report

TMDL Sub-Basin	Village Urban Area (acres)	Total Phosphorus (TP)			
		Baseline (lbs/yr)	Allocated (lbs/yr)	Reduction (lbs/yr)	Reduction (%)
Fox River	5,357	3163	2,214.1	948.9	30.0%
Mud Creek	93	53	32.34	20.66	39.0%
Neenah Slough	0	0	0	0	30.0%
Total	5,450	3,216	2,246	970	30.1%

Table 3-2

Sediment Allocations from TMDL Report

TMDL Sub-Basin	Village Urban Area (acres)	Total Suspended Solids (TSS)			
		Baseline (lbs/yr)	Allocated (lbs/yr)	Reduction (lbs/yr)	Reduction (%)
Fox River	5,357	1,743,480	606,709	1,136,771	65.2%
Mud Creek	93	25,558	18,277	7,281	28.5%
Neenah Slough	0	0	0	0	40.0%
Total	5,450	1,769,038	624,986	1,144,052	64.7%

As shown in Tables 3-1 and 3-2, the TMDL Report expresses the MS4 allocation as both a load reduction (pounds per year) and a percent reduction. Based on WDNR guidance, the TMDL's percent reduction should be used for MS4 permit compliance, rather than the TMDL's load reduction (pounds per year). However, the TMDL's percent reduction requires adjustment to a "no controls" condition before using for MS4 permit compliance. WDNR guidance describes the TMDL adjustment methodology in greater detail.

Table 3-3 summarizes the adjusted TP and TSS percent reductions for the Village. The adjusted TMDL percent reductions in Table 3-3 are based on the "no-controls" condition and are used for evaluating alternatives for MS4 permit compliance.

Table 3-3

Adjusted TMDL Percent Reductions

TMD Sub-Watershed	Adjusted TP Reduction from No-Controls	Adjusted TSS Reduction from No-Controls
Fox River	40.5%	72.2%
Mud Creek	48.2%	42.8%
Neenah Slough	40.5%	52.0%

Methodology

The TMDL pollutant analysis uses the Source Loading and Management Model for Windows (WinSLAMM Version 10). WinSLAMM is a stormwater quality model that predicts runoff volumes and non-point source pollution loads for urban land uses. WinSLAMM also calculates the amount of pollutant removal provided by BMPs such as street sweeping, catch basin cleaning, grass swales, grass filter strips, biofiltration, infiltration basins, wet ponds, wetland systems, proprietary devices, and other BMPs.

The TMDL pollutant analysis uses the series of small rainfall events that occurred between March 29, 1968 and November 25, 1972 in Green Bay, Wisconsin. For purposes of MS4 Permit

compliance, this 5-year rainfall series was determined by the WDNR to represent an average annual rainfall condition for municipalities located in Northeast Wisconsin.

The TMDL pollutant analysis uses data files developed by the United States Geological Survey (USGS) and WDNR for the WinSLAMM model. The data files identify typical runoff volumes, pollutant concentrations, pollutant distributions, pollutant deliveries, and pollutant particle size distributions for typical urban stormwater runoff. The WinSLAMM data files obtained from the USGS and used in the TMDL pollutant analysis are as follows:

- WisReg - Green Bay Five Year Rainfall.ran
- WI_GEO02.ppdx
- v10 WI_SL06 Dec06.rsv
- WI_avg01.pscx
- WI_Res and Other Urban Dec06.std
- WI_Com Inst Indust Dec06.std
- Freeway Dec06.std
- Nurp.cpz

The TMDL pollutant analysis is based on the standard land use files developed by the WDNR for WinSLAMM. The standard land use files identify the amount of roof, parking lot, driveway, sidewalk, street, and lawn source areas which are typical for each standard land use. The standard land use files also identify the amount of connected imperviousness for each source area.

The TMDL pollutant analysis uses the study area depicted in Figure 1, the Sub-Watersheds depicted in Figure 3, and the 2012 land uses depicted in Figure 11. Of the 8,476 acre study area, 4,500 acres are exclusions and the remaining 57 acres in the Lake Winnebago Sub-Watershed are excluded from the analysis. The exclusions are described on pages 18 and 19. Lake Winnebago is excluded as it is not included in the Lower Fox River TMDL. As such, the TMDL allocations apply to 3,919 acres of developed urban area in the Fox River, Mud Creek, and Neenah Slough Sub-Watersheds. The WDNR is currently developing TMDL and WinSLAMM modeling guidance to assist with MS4 Permit compliance. This TMDL pollutant analysis will likely require updating after the WDNR guidance documents are completed.

Baseline Load

The TMDL baseline loads using WinSLAMM for the Fox River, Mud Creek, Neenah Slough and Lake Winnebago Sub-Watersheds are summarized by land use in Table 3-4 and Exhibit 3-1. These baseline or “no control” loads exclude the pollutant reduction benefits of existing BMPs.

Table 3-4

TMDL Baseline Loads by Land Use (WinSLAMM)

Land Use	Area (acres)	Area (%)	TP (lbs/yr)	TP (%)	TSS (lbs/yr)	TSS (%)
Residential	2,415	62%	1,948	64%	516,565	52%
Commercial	288	7%	272	9%	123,180	12%
Industrial	592	15%	495	16%	291,837	29%
Institutional	91	2%	76	2%	27,915	3%
Open Space	534	14%	230	8%	43,159	4%
Total	3,919		3,021		1,002,656	

Exhibit 3-1: TMDL Baseline Loads by Land Use (WinSLAMM)

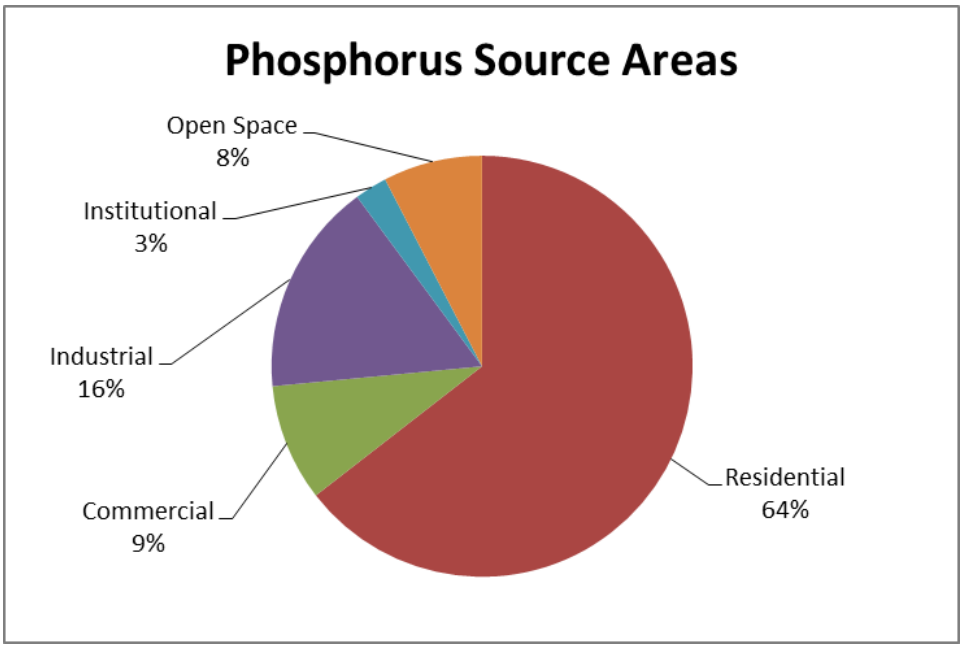
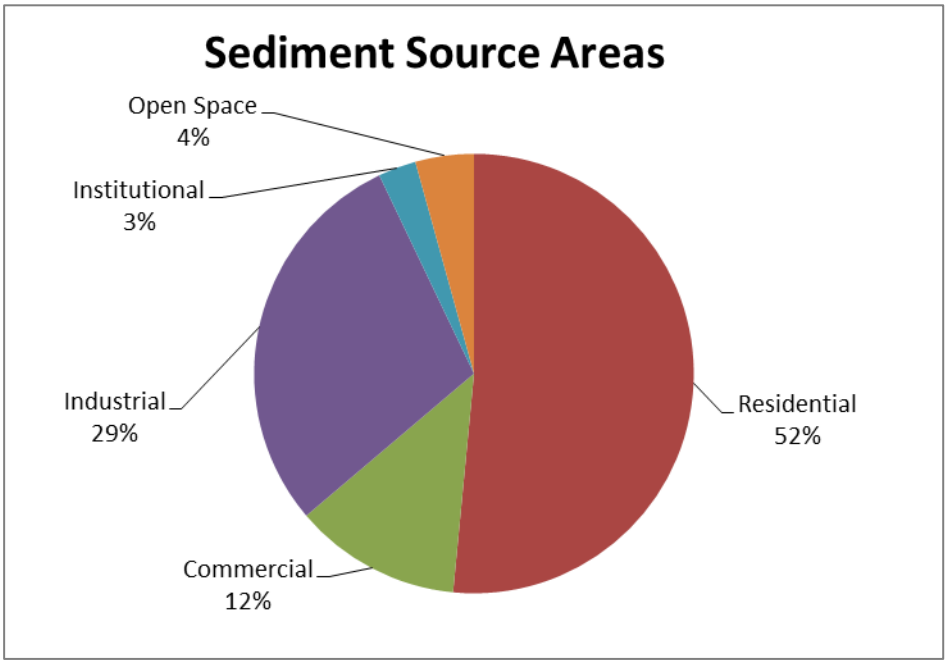


Exhibit 3-1: TMDL Baseline Loads by Land Use (WinSLAMM) (cont.)



Appendix A contains a list of TMDL baseline pollutant yields (pounds per acre per year) and loads (pounds per year) from WinSLAMM for total phosphorus and total suspended solid pollutants. The baseline pollutant yields and loads are ranked by drainage area from highest to lowest within the Fox River, Mud Creek, and Neenah Slough Sub-Watersheds.

The TMDL pollutant analysis is based on the sub-watershed areas and WinSLAMM baseline pollutant loads contained in Table 3-5.

Table 3-5

TMDL Pollutant Analysis - Baseline Condition

Sub-Watershed	Village MS4 (acres)	Total Phosphorus			Total Suspended Solids		
		Baseline Load (lbs/yr)	Load Reduction Required		Baseline Load (lbs/yr)	Load Reduction Required	
			(lbs/yr)	(%)		(lbs/yr)	(%)
Fox River	3,899	3,000.4	1,224.2	40.5%	995,359	718,649	72.2%
Mud Creek	11	10.1	4.9	48.2%	3,245	1,389	42.8%
Neenah Slough	9	10.3	4.2	40.5%	4,053	2,107	52.0%
Total	3,919	3,020.9	1,224.2	40.5%	1,002,656	722,145	72.0%

Allocation Analysis

Each MS4 permitted entity located within the Village's municipal boundary is anticipated to receive a portion of the phosphorus and sediment waste load allocations contained in the TMDL Report. These MS4 permitted entities include the Village of Fox Crossing, Winnebago County Highway Department, and Wisconsin Department of Transportation (WisDOT). In addition to the MS4 permitted entities, riparian properties located along the Fox River, Mud Creek, and Neenah Slough that do not drain through the permitted portion of Village's MS4 system are also anticipated to receive a portion of the allocations.

The TMDL pollutant analysis uses the study area depicted in Figure 1, the Sub-Watersheds depicted in Figure 3, and the 2012 land uses depicted in Figure 11. For purposes of the TMDL analysis, the study area contains 8,476 acres. The TMDL pollutant analysis uses the developed urban area within the Village's municipal boundary. Per WDNR guidance, the following areas are either prohibited from inclusion or classified as optional for inclusion in the TMDL pollutant analysis.

- AGRICULTURAL AREAS - Lands zoned for agricultural use and operating as such are optional to include in the TMDL pollutant analysis. Of the 8,476 acres within the study area, 1,054 acres are classified as agriculture and consequently, are excluded from the analysis.

- INTERNALLY DRAINED AREAS - Internally drained areas with natural infiltration are prohibited from inclusion in the TMDL pollutant analysis. Of the 8,476 acres within the study area, 252 acres are internally drained areas which consist of quarries.

- WATERS OF THE STATE - Waters of the state are optional for inclusion in the TMDL pollutant analysis. Lakes, rivers, streams and mapped wetlands are classified as "waters of the state". Of the 8,476 acres within the study area, 906 acres are classified as "waters of the state" and consequently, are excluded from the analysis.

- STATE & COUNTY HIGHWAYS - State freeways, state truck highways, and county highways are typically excluded from the TMDL pollutant analysis. The WisDOT is responsible for pollutant loads from state freeway and state trunk highway right-of-ways and Winnebago County is responsible for pollutant loads from county highway right-of-ways. The only time the Village is responsible for pollutant loads from a state or county highway right-of-way is if the highway is classified as a "connecting highway" by the WisDOT or if the Village has a bridge structure that allows a Village street to cross over the state or county highway. Of the 8,476 acres within the study area, 509 acres are State (WisDOT) MS4 jurisdiction and 135 acres are County MS4 jurisdiction. The combined 644 acres of state and county highway right-of-way are excluded from the analysis.

- RIPARIAN AREAS - Riparian areas are optional to include in the TMDL pollutant analysis. Riparian areas are private properties that do not discharge runoff into the Village's MS4, but rather discharge directly into a river, stream, or lake. Riparian areas that discharge directly

into the Fox River, Mud Creek, Neenah Slough, Lake Winnebago or other navigable streams without passing through the Village's MS4 are depicted in Figures 4 and 8. Of the 8,476 acres within the study area, 1,053 acres are classified as riparian and consequently, are excluded from the analysis.

- MS4 "A" TO "B" - Areas that discharge into an adjacent municipality's MS4 (Municipality B) without passing through the Village's MS4 (Municipality A) are optional to include in the TMDL pollutant analysis. Many of these areas are located along state and county right-of-ways where runoff from private property drains directly into a State or County MS4 and then discharges directly into a river, stream, or lake. Of the 8,476 acres within the study area, 591 acres are classified as MS4 "A" to "B" and consequently, are excluded from the analysis.

- WPDES INDUSTRIAL PERMITS - The TMDL pollutant analysis includes the pollutant load for industrial areas with coverage under a WDPES Industrial Permit if the permitted area is located within the urban planning boundary. These industrial permitted areas are included in the analysis for the following reasons: the Village has legal authority to regulate stormwater runoff; the Village has legal authority to charge a stormwater utility fee; it is difficult to determine which portions of an industrial site are covered by a WPDES Industrial Permit; and the pollutant load is the Village's responsibility if the WPDES Industrial Permit is terminated or certified "No Exposure" in the future. For these reasons, the TMDL pollutant analysis includes the pollutant load for industrial permitted areas, except quarries which are excluded from the Village's jurisdiction.

Based on the prohibited and optional areas mentioned above, the remaining developed urban area located in the Village of Fox Crossing is 3,976 acres. The Lower Fox River TMDL does not include areas within the Lake Winnebago sub-watershed. The Lower Fox River TMDL pollutant analysis will apply to the remaining 3,919 acres of developed urban areas that existed in 2014 (for the Fox River, Neenah Slough and Mud Creek sub-watersheds).

2017 Best Management Practices

Several BMPs qualified for TMDL pollutant reduction credit in 2017: high efficiency street sweeping (twice per month, no parking controls), grass swales, Palisades Pond, Cold Spring Pond, Community First Credit Union (CFCU) Pond, Shady Lane Pond, Tayco Pond, Independence Pond, and O'Hauser Park Biofilter. Grass swales owned or operated by County and State MS4 jurisdictions are not included in the TMDL pollutant analysis. The 2017 BMPs are depicted in Figure 13.

- FOX RIVER - Table 3-6 indicates the 2017 BMPs provided a 38.8% TP reduction within the Fox River Sub-Watershed, which does not satisfy the 40.5% TP reduction required in Table 3-3. Also, Table 3-6 indicates the 2017 BMPs provided a 44.2% TSS reduction within the Fox River Sub-Watershed, which does not satisfy the 72.2% TSS reduction required in Table 3-3. As such, additional BMPs are needed within the Fox River Sub-Watershed to target phosphorus and sediment pollutants.

- MUD CREEK - Table 3-6 indicates the 2017 BMPs provided a 56.0% TP reduction within the Mud Creek Sub-Watershed, which satisfies the 48.2% TP reduction required in Table 3-3. Also, Table 3-6 indicates the 2017 BMPs provided a 61.0% TSS reduction within the Mud Creek Sub-Watershed, which satisfies the 42.8% TSS reduction required in Table 3-3. As such, the Village's 2017 BMPs satisfy the TMDL phosphorus and sediment reductions for the Mud Creek Sub-Watershed.

- NEENAH SLOUGH - Table 3-6 indicates the 2017 BMPs provided a 46.5% TP reduction within the Neenah Slough Sub-Watershed, which satisfies the 40.5% TP reduction required in Table 3-3. Also, Table 3-6 indicates the 2017 BMPs provided a 53.9% TSS reduction in the Neenah Slough Sub-Watershed, which satisfies the 52.0% TSS reduction required in Table 3-3. As such, the Village's 2017 BMPs satisfy the TMDL phosphorus and sediment reductions for the Neenah Slough Sub-Watershed.

Table 3-6

TMDL Pollutant Analysis With 2017 BMPs (WinSLAMM)

Sub-Watershed	Village MS4 (acres)	Total Phosphorus			Total Suspended Solids		
		Baseline Load (lbs/yr)	Load Reduction (lbs/yr)	(%)	Baseline Load (lbs/yr)	Load Reduction (lbs/yr)	(%)
Fox River	3,899	3,000.4	1,162.77	38.8%	995,359	439,625	44.2%
Mud Creek	11	10.1	5.66	56.0%	3,245	1,979	61.0%
Neenah Slough	9	10.3	4.81	46.5%	4,053	2,184	53.9%
Total	3,919	3,020.9	1,173.23	38.8%	1,002,656	443,788	44.3%

More detailed water quality results are provided in Appendix B for the 2017 BMPs.

4.0 POLLUTANT REDUCTION ANALYSIS

WinSLAMM (Version 10) was used in conjunction with national literature to analyze the stormwater quality benefits and cost-effectiveness of proposed urban stormwater BMPs such as street sweeping, catch basin cleaning, grass swales, grass filter strips, biofiltration, infiltration basins, wet detention ponds/wetland systems, proprietary devices, and mechanical / biological treatment facilities. The results of the pollutant reduction analysis are summarized herein. More detailed water quality results are provided in Appendix B.

The capital costs contained in Tables 4-1 through 4-6 are the estimated present value capital costs for the BMP. The capital costs include an allowance for construction, land acquisition, engineering, legal, and contingency costs. The 20-year costs provided in the tables are the estimated present value costs per pound of TSS removed during a 20-year period. The 20-year

costs include an allowance for capital costs and long-term operation and maintenance costs. The 20-year period was determined to be a reasonable life cycle or planning period for evaluating BMP cost-effectiveness. A longer planning period would improve the cost-effectiveness of structural BMPs (e.g. wet detention pond) as compared to non-structural BMPs (e.g. street sweeping).

Street Sweeping

Street sweeping is effective at collecting large sediment particles (sand sized particles), trash, debris and leaves. Limited pollutant removal occurs for fine-grained particles such as silt, clay, metals and nutrients. Research indicates that street pollutants tend to accumulate within 3 feet of the street's curb and gutter. Wind turbulence from traffic tends to blow pollutants toward the curb. The curb acts as a barrier and traps pollutants. For streets without curb, wind turbulence generated by a passing vehicle tends to blow pollutants onto the adjacent grass area. As such, for street sweeping to be effective, the street must have curb.

The effectiveness of a municipal street sweeping program depends on the type of street sweeper, number of curb-miles, sweeping frequency, traffic volume, time of year, rainfall, and operator knowledge. In addition, the benefits of sweeping are significantly reduced when vehicles are parked along the curb. Whenever a street sweeper needs to maneuver around a parked car, the pollutants under the car are not removed. As such, the more cars parked along a street, the less pollutant removal.

There are two types of street sweeper: mechanical and high efficiency. Mechanical street sweepers use a broom to remove pollutants from the street surface and high efficiency street sweepers use a vacuum system to remove pollutants. Typically, the high efficiency sweeper is more effective at removing pollutants as compared to the mechanical sweeper. Table 4-1 summarizes typical street sweeping costs.

- Mechanical (M.) Street Sweeper – The Village currently does not own a mechanical street sweeper.

- High Efficiency (H.E.) Street Sweeper – The Village currently owns a high efficiency street sweeper. The Village currently sweeps twice per month with no parking controls. In the future, the Village plans to adopt a parking control ordinance to restrict parking along the street during sweeping operations.

Table 4-1

Street Sweeping & Catch Basin Cleaning

BMP	Pollutant Load Reduction TSS (%)	Pollutant Load Reduction TP (%)	Avg. Annual TSS Cost ($/lb)
M. Sweeper (Every 2 Weeks, No Parking Ordinance)	3%	2%	$5.4
M. Sweeper (Every 2 Weeks, With Parking Ordinance)	6%	4%	$2.5
H.E. Sweeper (Every 4 Weeks, No Parking Ordinance)	2%	1%	$3.5
H.E. Sweeper (Every 4 Weeks, With Parking Ordinance)	6%	4%	$1.2
H.E. Sweeper (Every 2 Weeks, No Parking Ordinance)	5%	3%	$2.9
H.E. Sweeper (Every 2 Weeks, With Parking Ordinance)	13%	8%	$1.2
H.E. Sweeper (Every Week, No Parking Ordinance)	10%	6%	$2.9
H.E. Sweeper (Every Week, With Parking Ordinance)	22%	14%	$1.4
Catch Basin Cleaning	12%	9%	$1.7

Catch Basin Cleaning

Catch basin cleaning is effective at collecting large sediment particles (sand sized particles), trash, debris and leaves. Limited pollutant removal occurs for fine-grained particles such as silt, clay, metals and nutrients. Catch basin sumps are effective for parking lots and streets that serve a small drainage area (less than 1 acre). Ideally, a catch basin sump has a minimum 3 foot depth to prevent scouring of previously settled pollutants during a rainfall.

Approximately 5% of the Village's MS4 system contains catch basin sumps. Catch basin sumps are dispersed throughout the Village and are not mapped. Village owned catch basin sumps are cleaned as needed.

Based on WDNR Guidance, the Village cannot obtain water quality credit for both catch basin cleaning and street sweeping. In the Village, street sweeping is a priority since sweeping helps maintain aesthetics, reduces public complaints, and reduces catch basin grate clogging. For these reasons, the Village prefers street sweeping as compared to catch basin cleaning.

Routine maintenance costs are high since catch basin sumps need to be cleaned in order to permanently dispose of trapped pollutants in the sump. As shown in Table 4-1, street sweeping every 2 weeks with a high efficiency street sweeper and adoption of a parking control ordinance provides about the same pollutant reduction as catch basin cleaning, but is more cost effective.

Grass Swales

Grass swales remove pollutants from concentrated stormwater by filtration through the grass and infiltration into the soil. The filtering capacity depends on the flow depth in the swale as compared to the grass height. Typically, when the flow depth is above the grass, filtering is

minimal and scouring of previously settled pollutants is a concern. The water quality benefits of a grass swale are largely determined by the infiltrating capacity of underlying soils and depth to groundwater. For instance, a grass swale located in sandy soil has a much higher pollutant removal as compared to a grass swale located in clay soil. Other factors influencing grass swale performance include longitudinal swale slope, swale cross section, and flow volume. WDNR Technical Standard 1005 – Vegetated Infiltration Swale discusses design criteria for grass swales.

As shown in Figure 5, soils in the Village are predominately clay (HSG C and D), but there are areas of silty soils to the west of Little Lake Butte des Morts. Table 4-2 summarizes the cost and water quality benefits of retrofitting grass swales along an existing curb and gutter street with clay soils. Grass swale costs are lower if the curb and gutter removal is completed as part of an already scheduled street reconstruction project. It is not practicable to remove existing curb and gutter along many streets due to limited right-of-way width, poor drainage, and/or current traffic volumes, on-street parking, bike lanes, multi-use trails, or sidewalks. The costs contained in Table 4-2 can be compared to the other BMP costs contained in Tables 4-1, 4-3, 4-4, 4-5 and 4-6.

Grass Filter Strips

Grass filter strips remove pollutants from stormwater by filtration through the grass and infiltration into the soil. The filtering capacity of a grass filter strip depends on its longitudinal slope, length and grass density. The water quality benefits of a grass filter strip are largely determined by the infiltrating capacity of underlying soils. A grass filter strip located in sandy soil has a higher pollutant removal as compared to a grass filter strip located in clay soil.

Grass filter strips are effective for parking lots that serve small drainage areas (less than 1 acre). Typically, grass filter strips need to be a minimum of 20 feet long, but at least as long as the contributing impervious surface length. A 64 foot wide parking lot would typically require a 64 foot long grass filter strip. As such, grass filter strips require a significant amount of land area as compared to other BMPs.

In order for a grass filter strip to be effective, the stormwater flowing into the filter strip cannot be concentrated within a swale, ditch, channel, gutter, or other similar conveyance system. Rather, the stormwater must be flowing across the surface of a parking lot, lawn or other ground surface in a very thin sheet of dispersed water.

As shown in Figure 8, the Village does not currently have any grass filter strips. As shown in Figure 5, soils in the Village are predominately clay (HSG C and D), but there are areas of silty soils to the west of Little Lake Butte des Morts. Due to the land requirements and predominately clay soils in the Village, the construction and land costs to retrofit a grass filter strip are high as compared to the water quality benefit provided. Table 4-2 summarizes the cost and water quality benefits of a grass filter strip retrofit. The costs contained in Table 4-2 can be compared to the other BMP costs contained in Tables 4-1, 4-3, 4-4, 4-5 and 4-6.

Table 4-2

Grass Swales & Grass Filter Strips

BMP	Pollutant Load Reduction TSS (%)	Pollutant Load Reduction TP (%)	Avg. Annual TSS Cost ($/lb)
Grass Swales – Retrofit C&G Streets (clay soil)	15%	10%	$178.0
Grass Filter Strips – Retrofit Parking Lot	98%	98%	$11.2

Biofiltration

Biofiltration devices remove pollutants from stormwater by filtration through an engineered soil mixture. Typically, the engineered soil is three feet deep and consists of a sand, compost, peat, and/or topsoil mixture. A diverse mix of prairie flowers, grasses, shrubs and/or trees are typically planted in a mulch layer located above the engineered soil. During a rainfall, stormwater is temporarily stored above the mulch layer until it can be filtered through the engineered soil. A perforated underdrain pipe located beneath the engineered soil collects the filtered water and discharges it into an adjacent storm sewer or other conveyance system. Biofiltration devices are effective for small drainage areas (less than 2 acres).

Biofiltration devices are called a "bioretention" device when the native soils located beneath the engineered soil layer are permeable and the majority of stormwater infiltrates into the native soils. In sandy soils, it may be feasible to eliminate the perforated underdrain pipe to further increase infiltration. Bioretention devices are used to recharge groundwater and improve stormwater quality, whereas biofiltration devices are primarily used to improve stormwater quality. WDNR Technical Standard 1004 – Bioretention for Infiltration discusses design criteria for bioretention and biofiltration.

Bioretention devices are sometimes called a "rain garden" if the device does not contain an engineered soil layer. Rain gardens are typically installed for groundwater recharge purposes rather than stormwater pollutant removal. Often, runoff from a residential roof, patio, sidewalk or driveway is directed to a rain garden. These residential source areas have a low pollutant load but generate a significant amount of runoff volume. Whenever a source area has a high pollutant load (i.e. street or parking lot), an engineered soil layer is recommended to provide a higher capacity filter media. A high capacity filter media reduces the device's surface area, ponding duration, and clogging potential. If stormwater is allowed to pond on the surface of a rain garden, bioretention device, or biofiltration device for more than 24 hours, the plants may become diseased or die due to wet conditions or poor system hydrology.

Biofiltration devices are sometimes called a "bio-swale" if the device contains a longitudinal slope to facilitate flow conveyance. Typically, a bio-swale has a linear configuration. Bio-swales are typically installed within parking lots or along streets. Bio-swales can be used to recharge

groundwater and/or improve stormwater quality. As such, a bio-swale may or may not include a perforated underdrain pipe.

As shown in Figure 5, soils in the Village are predominately clay (hydrologic soil group C and D), but there are areas of silty soils to the west of Little Lake Butte des Morts. Due to the predominately clay soils, biofiltration is more practicable for high load source areas as compared to a rain garden or bioretention device that relies on infiltration.

The costs to incorporate biofiltration into a street retrofit project or a street reconstruction project are summarized in Table 4-3. Typically, it is more cost-effective to incorporate biofilters into a street reconstruction project, as compared to a street retrofit project. The costs contained in Table 4-3 can be compared to the other BMP costs contained in Tables 4-1, 4-2, 4-4, 4-5 and 4-6.

Table 4-3

Street Biofiltration

Street Corridor Land Use	Pollutant Load Reduction		Avg. Annual TSS Cost ($/lb)			
			Retrofit		Reconstruct	
	TSS (%)	TP (%)	Sand	Clay	Sand	Clay
Commercial Corridors	80%	71%	$5.5	$17.6	$4.4	$14.2
Industrial Corridors	80%	49%	$3.4	$11.6	$2.8	$9.3
Institutional Corridors	80%	72%	$3.8	$12.0	$3.1	$9.7
Residential Corridors	80%	66%	$6.7	$20.7	$5.4	$16.7
Open Space Corridors	80%	66%	$6.1	$20.1	$4.9	$16.2

The costs to incorporate biofiltration into a parcel retrofit project or a parcel reconstruction project are summarized in Table 4-4. Typically, it is more cost-effective to incorporate biofilters into a parcel or site reconstruction project, as compared to a parcel or site retrofit project. The costs contained in Table 4-4 can be compared to the other BMP costs contained in Tables 4-1, 4-2, 4-3, 4-5 and 4-6.

Table 4-4

Parcel Biofiltration

Parcel Land Use	Pollutant Load Reduction		Avg. Annual TSS Cost ($/lb)			
	TSS (%)	TP (%)	Retrofit		Reconstruct	
			Sand	Clay	Sand	Clay
Commercial Downtown	80%	69%	$65.0	$81.8	$52.5	$66.1
Hospital	80%	68%	$53.0	$76.2	$42.9	$61.6
Institutional	80%	66%	$38.0	$57.1	$30.7	$46.2
Light Industrial	80%	55%	$14.6	$17.7	$11.8	$14.3
Medium Industrial	80%	69%	$23.9	$35.7	$19.4	$28.9
Multi-Family Residential	80%	60%	$38.9	$71.6	$31.4	$57.9
Office Park	80%	67%	$35.4	$51.5	$28.6	$41.7
Schools	80%	63%	$33.6	$52.5	$27.2	$42.5
Shopping Center	80%	69%	$39.3	$51.8	$31.8	$41.9
Strip Commercial	80%	69%	$44.0	$57.6	$35.6	$46.6

Infiltration Basins

An infiltration basin is a water impoundment constructed over a highly permeable soil. The purpose of an infiltration basin is to temporarily store stormwater and allow it to infiltrate through the bottom and sides of the infiltration basin. Pollutants are removed by the filtering action of the underlying soil. The primary functions of an infiltration basin are to provide groundwater recharge, reduce runoff volumes, and reduce peak discharge rates. The secondary function of an infiltration basin is water quality. WDNR Technical Standard 1003 – Infiltration Basin discusses design criteria for infiltration basins.

Infiltration basins require pretreatment to prevent clogging and failure. WDNR Technical Standard 1003 - Infiltration Basin requires a pretreatment system to reduce the TSS load entering an infiltration basin by 60% for a residential land use and 80% for a commercial, industrial, or institutional land use. Typically, a wet detention pond or biofiltration device is used as the pretreatment system. The pretreatment system prevents the infiltration basin from failing and helps reduce the risk of groundwater contamination due to pollutants contained in stormwater. Not all stormwater runoff should be infiltrated due to concern for groundwater contamination.

In order for an infiltration basin to be feasible, the depth to groundwater typically needs to be 5 feet or more and the soil needs to be a loam, silt or sand. As shown in Figure 5, soils in the Village are predominately clay (HSG C and D). Silty soils (HSG B) in the Village are generally located west of Little Lake Butte des Morts. As such, the feasibility of an infiltration basin is very limited within the Village.

Finally, a significant amount of the water quality benefit is provided by the infiltration basin's pretreatment system. Typically, the pretreatment system is a wet detention pond or biofiltration device. From a water quality perspective, an infiltration basin is not cost effective after considering the pretreatment costs. As such, infiltration basin costs are not included in the analysis; rather pretreatment system costs are included in the analysis (i.e. wet detention ponds and biofiltration devices).

Wet Detention Ponds / Wetland Systems

Wet detention ponds and wetland systems are effective at removing sediment, nutrients, heavy metals, oxygen demanding compounds (BOD), hydrocarbons, and bacteria. Pollutant removal within a wet pond and wetland system is primarily due to gravity settling of particulate pollutants and sediment. Filtration, adsorption and microbial decomposition also remove pollutants, particularly within a wetland system. WDNR Technical Standard 1001 – Wet Detention Pond discusses design criteria for wet detention ponds.

Typically, a wet detention pond or wetland system must contain a minimum water depth of 5 feet within a portion of the permanent pool to minimize re-suspension of pollutants during a rainfall event. The WDNR requires that wet detention ponds and wetland systems be sized using the National Urban Runoff Project (NURP) particle size distribution. To achieve an 80% reduction in TSS, a wet detention pond or wetland system typically needs to remove the 3 to 5 micron sediment particle.

Existing dry detention ponds located in the Village were evaluated to determine the feasibility of converting into wet detention ponds. Currently, WDNR does not allow water quality credit for dry detention ponds. Existing dry detention ponds located within the Village are depicted in Figure 7 and summarized in Table 2-2. Generally, wet detention ponds are not recommended for small watersheds (less than 15 to 20 acres in clay soil). A wet detention pond located in a small watershed may develop stagnation problems and become a public nuisance. Public acceptance of stormwater BMPs is important to the success of the Village's stormwater program.

A cost analysis was completed to determine the most cost-effective retrofits within the Village. As part of the analysis, aerial photographs were used to identify potential undeveloped properties that could be used for a retrofit. The location of storm sewer pipes and the watershed size in relation to the undeveloped property was also considered. Table 4-5 summarizes the cost and water quality benefits of those wet detention ponds / wetland systems analyzed for the Village (partial list of analyzed ponds). The costs contained in Table 4-5 can be compared to the other BMP costs contained in Tables 4-1, 4-2, 4-3, 4-4 and 4-6.

Table 4-5

Potential Wet Detention Ponds / Wetland Systems

Wet Detention Pond / Wetland System	Drainage Area (acres)	Pollutant Reduction TSS (%)	Pollutant Reduction TP (%)	Capital Costs	Capital & O&M Costs Over 20 Years	Avg. Annual TSS Cost ($/lb)
Holly Pond	238	65%	47%	$582,000	$132,238	$1.19
Holly Pond w/Enhanced Settlement	238	90%	85%	$791,707	$957,924	$1.92
SCA Lake Pond	51	82%	59%	$490,000	$117,693	$2.28
SCA Lake South Pond	26	83%	59%	$285,000	$83,589	$2.40
Midway Pond (DOT Pond 4), Future Expansion	258	82%	61%	$100,000	$397,354	$2.51
Auto Pond	88	82%	61%	$720,000	$190,005	$2.56
Fox Inn Pond	24	79%	63%	$230,000	$66,900	$2.87
Midway Pond (DOT Pond 4)	258	82%	61%	$5,000	$547,740	$3.15
Bengal Pond	37	83%	58%	$265,000	$98,102	$3.56
SCA Office Pond Modification	22	83%	66%	$165,000	$82,864	$3.62
SCA Lake North Pond Modification	16	74%	53%	$192,000	$25,889	$3.66
Manitowoc Road Pond	165	77%	54%	$301,750	$149,953	$3.88
Deerpath Pond	29	81%	59%	$235,000	$51,779	$3.93
Plaza Pond	21	84%	71%	$235,000	$85,041	$4.05
Tumblebrook Pond	53	80%	59%	$500,000	$83,589	$4.37
Independence Pond w/Enhanced Settlement	169	90%	85%	$194,687	$909,589	$4.65
CTH BB Pond	52	83%	60%	$425,000	$132,238	$4.94
Christopher Pond	58	80%	60%	$385,000	$86,492	$5.16
South American Drive Pond	60	82%	54%	$290,000	$105,358	$5.35
Manitowoc Road North Pond	125	79%	56%	$415,000	$106,083	$5.37
Bodoh Pond	48	81%	61%	$360,000	$116,242	$5.60
Schildt Park Pond	51	77%	57%	$580,000	$79,961	$5.61
Hope Pond	85	80%	58%	$720,000	$103,906	$5.62
Manitowoc Road Pond w/Enhanced Settlement	165	90%	85%	$466,569	$755,218	$6.27
High Plains Meadows, 3rd Add.	17	84%	53%	$150,000	$66,175	$6.29
Tayco Pond Expansion w/Enhanced Settlement	1315	90%	85%	$300,662	$1,841,648	$6.39
Blair Pond	13	80%	59%	$232,600	$66,175	$6.44
Joy Pond	20	82%	60%	$242,400	$76,333	$8.53
Dublin Pond	20	81%	64%	$200,000	$46,601	$8.57
Cold Spring Pond w/Enhanced Settlement	157	90%	85%	$191,261	$953,609	$10.91

Table 4-5

Potential Wet Detention Ponds / Wetland Systems

Wet Detention Pond / Wetland System	Drainage Area (acres)	Pollutant Reduction TSS (%)	Pollutant Reduction TP (%)	Capital Costs	Capital & O&M Costs Over 20 Years	Avg. Annual TSS Cost ($/lb)
Green Bay Road Pond	40	80%	62%	$310,000	$70,528	$11.54
Clayton Pond	26	85%	57%	$125,000	$59,546	$11.93
Palisades Pond w/Enhanced Settlement	72	90%	85%	$110,199	$471,608	$12.72
Irish North Pond	26	80%	55%	$279,400	$86,492	$13.98
Weatherwood Pond	23	84%	62%	$250,000	$59,546	$14.01
Sand Point Pond	257	86%	60%	$2,000,000	$203,099	$16.00
Jacobsen Pond	180	81%	59%	$510,000	$159,196	$18.27
Hildebrand Pond	35	84%	61%	$295,000	$71,254	$18.60
Sand Point Pond w/Enhanced Settlement	257	90%	85%	$2,136,915	$671,344	$18.75
Sand Point Pond - Alt 2 w/Enhanced Settlement	306	90%	85%	$2,148,538	$633,578	$18.85
Taft Pond	65	80%	64%	$109,500	$109,711	$20.52
Sand Point Pond - Alt 2	306	80%	55%	$2,000,000	$86,492	$21.29
Shady Lane Pond w/Enhanced Settlement	51	90%	85%	$118,250	$489,932	$22.47
Frances Pond	20	69%	50%	$197,300	$25,889	$23.98
Kimball Pond	23	81%	59%	$320,000	$69,077	$24.05
American Drive West Pond	25	83%	64%	$560,000	$107,535	$24.55
STH 150 Pond w/Enhanced Settlement	127	90%	85%	$949,531	$656,366	$26.58
Symphony Pond	30	83%	61%	$130,000	$65,449	$28.31
Tayco Pond Expansion	1,315	68%	48%	$0	$569,334	$28.40
STH 150 - Alt 2 w/Enhanced Settlement	154	90%	85%	$1,169,890	$738,426	$33.34
Gateway Pond	62	82%	66%	$5,000	$401,210	$33.64
Irish Middle Pond	12	80%	55%	$210,900	$86,492	$50.48
District Pond	20	80%	58%	$289,000	$64,723	$52.47
STH 150 Pond	127	75%	54%	$796,500	$108,986	$57.81
Deerwood Pond	35	80%	60%	$325,000	$69,077	$88.05
Fischer Pond	14	80%	55%	$5,000	$392,727	$195.5
Chapman Pond	34	82%	55%	$514,250	$135,319	$212.6
Woodward Pond	29	84%	59%	$325,000	$95,925	$230.3

In the 2002 version of the NR 151 rule, BMPs associated with post-construction sites containing new development may not be located in navigable waters to receive credit for meeting any performance standard in Chapter NR 151. This restriction has been retained in the revised rule. Also in the 2002 version of the rule, best management practices for existing development, re-development or in-fill development could receive water quality credit for wet detention ponds / wetland systems constructed within both perennial and intermittent streams if all applicable permits are received. As of January 1, 2011, NR 151.003 only allows water quality credit for newly constructed wet detention ponds / wetland systems constructed within intermittent streams for which all applicable permits are received.

In the future, the Village may elect to investigate the feasibility of utilizing enhanced settling such as adding polymers or flocculants to wet detention ponds to enhance pollutant removal efficiencies. Polymer or flocculent additions will likely require installation of mechanical injection systems. Due to WDNR environmental concerns, polymer and flocculent costs were not evaluated for this study. The WDNR is currently discussing if Wisconsin will allow the use of polymers and flocculants in wet detention ponds. This TMDL pollutant analysis will likely require updating after WDNR guidance documents regarding the use of polymer and flocculants in ponds is completed.

Concept drawings for the Table 4-5 facilities are provided in Appendix D.

Proprietary Devices

Several private companies have developed proprietary stormwater quality treatment devices. These underground treatment devices are advantageous within ultra-urban watersheds where there is not land available for wet detention ponds, wetland systems, or biofiltration devices. Some of the devices are based on simple hydraulics and residence times, and others devices are based on complex hydrodynamics or the use of different filter materials. Maintenance activities vary from vacuum truck suctioning of pollutants to replacing filter media in cartridges. The WDNR Technical Standard 1006 - Proprietary Sedimentation Devices discusses design criteria for proprietary sedimentation devices.

Several proprietary devices were analyzed using WinSLAMM. For purposes of this analysis, various proprietary devices and drainage areas were evaluated to determine the device's cost effectiveness. McMahon contacted a local proprietary device supplier and asked the supplier to size the proprietary devices using their design methodology. McMahon then used the WinSLAMM model and unit size selected by the supplier to evaluate water quality benefits. Table 4-6 summarizes the costs and water quality benefits of those proprietary devices. The costs contained in Table 4-6 can be compared to the other BMP costs contained in Tables 4-1, 4-2, 4-3, 4-4 and 4-5.

Table 4-6

Proprietary Devices

Structural BMP	Drainage Area (acres)	Pollutant Load Reduction TSS (%)	Pollutant Load Reduction TP (%)	Capital Costs	Capital & O&M Costs Over 20 Years	Avg. Annual TSS Cost ($/lb)
Vortechnic VX-11000 Unit	16.59	17%	14%	$60,000	$96,694	$4.61
Vortechnic VX-7000 Unit	10.42	22%	16%	$44,125	$72,665	$5.69
Vortechnic VX-9000 Unit	6.36	24%	18%	$44,250	$76,867	$9.89
Vortechnic VX-4000 Unit	6.36	20%	14%	$37,750	$62,213	$9.90

Mechanical / Biological Treatment Facilities

Mechanical/biological treatment facilities are not currently used in Wisconsin, with the exception of combined sewer systems that treat wastewater and stormwater. A mechanical/ biological treatment facility would be difficult to implement for stormwater given the number of storm sewer outfalls located within the Village. Significant storm sewer pumping would likely be needed to convey stormwater from each outfall to a regional stormwater treatment facility, similar to a wastewater treatment facility. As a result, stormwater treatment facilities are not typically cost effective BMPs. A mechanical/biological treatment facility and associated pumping systems are estimated to have an average annual cost that is well above $20 per pound of TSS removed. In addition, diverting low flows from all storm sewer outfalls to a regional treatment facility may dry up existing wetlands and streams located near the Village's current storm sewer outfalls.

5.0 PLAN OF ACTION

The Village is responsible for reducing phosphorus and sediment discharges to comply with the waste load allocations for the developed urban area. A Plan of Action was developed to satisfy the TMDL allocations. The Plan of Action identifies a combination of existing and proposed BMPs that satisfies TMDL allocations for the Village's MS4.

The Plan of Action is a living document, which may change in the future as implementation progresses. The Plan of Action provides an anticipated implementation schedule, including projected costs. The Plan of Action is depicted in Figure 14 and includes the following:

- Street sweeping with a high efficiency street sweeper and parking controls to improve pollutant reduction benefits. Street sweeping occurs twice per month. Weather permitting, street sweeping begins March 29th and ends November 25th of each calendar year.

- Obtaining Maintenance Agreements on existing privately owned ponds including: Secura East Pond, Secura West Pond, DOT Pond 1, DOT Pond 2, DOT Pond 6, DOT Pond 7, Golf Village Pond, New Hope Lutheran Pond, Jacobsen Creek Condo Pond 2, Jacobsen Creek Condo Pond 1, Bryce Pond, Cottagewood Condos Pond, Meadow Heights Pond, Meadow Heights North Pond, Prairie Lake Estates Pond, Prairie Lake Condos Pond, Red D Mix Pond, Winding Creek Estates Pond, Winding Creek Estates South Pond and Wheeler Pond.

- Adding an enhanced settling treatment system to existing ponds including: Independence Pond and Tayco Pond.

- Proposed pond construction projects required to meet the TMDL goals include: Irish North Pond, Irish Middle Pond, STH 150 Pond, Jacobsen Pond, Schildt Park Pond, American Drive West Pond, Sand Point Pond alternative 2, Gateway Pond, Midway Pond Future Expansion, Holly Pond with Enhanced Settlement, Auto Pond, Fox Inn Pond, Bengal Pond, SCA Office Pond Modification, Deerpath Pond, SCA Lake North Pond Modification, SCA Lake Pond, Plaza Pond, Tumblebrook Pond, CTH BB Pond, Christopher Pond, South American Drive Pond and Hope Pond.

- Future development was also considered as part of the TMDL Plan of Action. The future development areas are based on the Village's Comprehensive plan trends. These areas will have 80% TSS reduction in the developed condition. The future development component assumes 26 acres of development annually for 20 years.

It is of note that the proposed ponds as part of the Plan of Action may change due to opportunities as site become available and as development occurs. Concepts for the proposed water quality BMPs are provided in Appendix D.

Costs associated with the proposed structural BMPs are provided in Table 5-1. The capital costs include an allowance for construction, land, engineering, and contingency costs. The Village's 35-year Capital Improvement Plan (CIP), developed for the Plan of Action is included in Appendix C.

Table 5-1

Plan of Action

Structural BMP	Opinion of Probable Cost
Irish North Pond	$ 284,988
Irish Middle Pond	$ 215,118
STH 150 Pond	$ 812,430
Jacobsen Pond	$ 520,200
Secura East Pond Maintenance Agreement	$ 5,000
Secura West Pond Maintenance Agreement	$ 5,000
Schildt Park Pond	$ 591,600
American Drive West Pond	$ 643,264
Sand Point Pond - Alt 2	$ 2,437,989
DOT Pond 1 Maintenance Agreement	$ 5,000
DOT Pond 2 Maintenance Agreement	$ 5,000
DOT Pond 6 Maintenance Agreement	$ 5,000
DOT Pond 7 Maintenance Agreement	$ 5,000
Golf Village Wet Pond Maintenance Agreement	$ 5,000
New Hope Lutheran Pond Maintenance Agreement	$ 5,000
Jacobsen Creek Condo Pond 2 Maintenance Agreement	$ 5,000
Jacobsen Creek Condo Pond 1 Maintenance Agreement	$ 5,000
Bryce Pond Maintenance Agreement	$ 5,000
Cottagewood Condos Maintenance Agreement	$ 5,000
Meadow Heights Pond Maintenance Agreement	$ 5,000
Meadow Heights North Pond Maintenance Agreement	$ 5,000
Prairie Lake Estates Pond Maintenance Agreement	$ 5,000
Prairie Lake Condos Pond Maintenance Agreement	$ 5,000
Red D Mix Pond Maintenance Agreement	$ 5,000
Winding Creek Estates Pond Maintenance Agreement	$ 5,000
Winding Creek Est. South Pond Maintenance Agreement	$ 5,000
Wheeler Pond Maintenance Agreement	$ 5,000
Gateway Pond	$ 5,000
Midway Pond Future Expansion	$ 124,337
Holly Pond with Enhanced Settlement	$ 1,004,076
Auto Pond	$ 931,397
Fox Inn Pond	$ 297,530
Bengal Pond	$ 342,806
SCA Office Pond Modification	$ 213,445
Deerpath Pond	$ 310,078
SCA Lake North Pond Modification	$ 253,340
SCA Lake Pond	$ 659,475

Table 5-1

Plan of Action

Structural BMP	Opinion of Probable Cost
Plaza Pond	$ 316,279
Tumblebrook Pond	$ 686,393
Independence Pond with Enhanced Settlement	$ 267,264
CTH BB Pond	$ 583,434
Christopher Pond	$ 539,093
South American Drive Pond	$ 406,070
Tayco Pond Expansion with Enhanced Settlement	$ 429,420
Hope Pond	$ 1,028,337
Total	$ 14,003,362

6.0 STREAM & SHORELINE STABLIZATION

Stream and shoreline erosion can result in a significant amount of sediment and phosphorus pollutants being discharged into the Fox River, Mud Creek, Neenah Slough, and Lake Winnebago. Stream, shoreline and channel stabilization projects can reduce sediment and phosphorus loads being discharged into these water bodies. Stream stabilization projects and future stream stabilization needs within the Village are not mapped. Also, the estimated sediment and phosphorus loads associated with the existing stream or shoreline erosion problems have not been estimated as part of this study, but should be considered during implementation of the stormwater quality management plan and development of the Plan of Action. Grant funding is available to assist with stream, shoreline and channel stabilization projects. In addition to the water quality benefits, these projects provide an opportunity to improve habitat, remove invasive species, and potentially restore wetland areas.

7.0 IMPLEMENTATION & RECOMMENDATIONS

Below are various recommendations for the Village to consider when implementing the Plan of Action and working toward MS4 Municipal Stormwater Permit compliance. The goal of the Plan of Action is to achieve long-term urban stormwater quality requirements established in the Lower Fox River Basin TMDL.

Operation & Maintenance

It is recommended that the Village continue to operate and maintain its current stormwater management system. Operation and maintenance is needed in order for the stormwater system to perform as designed. It is recommended that the Village monitor sediment depths within Village-owned wet detention ponds. Sediment accumulation rates can be used to predict future dredging activities.

Capital Improvement Plan

It is recommended that the Village manage and update its capital improvement plan. The capital improvement plan should include ample time for public input, grant applications, BMP design, regulatory permits, financing, and construction. The capital improvement plan should also take into consideration the timing of other local capital improvement projects, such as street reconstruction projects, utility projects, and private development projects. The Village developed an initial capital improvement plan to assist with planning and implementation. The Village established a 35-year CIP for the TMDL Plan of Action and is provide in Appendix C.

Public Education & Involvement

Public education and public involvement are recommended during development and implementation of the Plan of Action. Potential stakeholders include the general public, elected officials, Village Staff, developers, regulatory entities, individual property owners and other regulated entities. Although this stormwater quality management plan includes a cost versus benefit analysis, the plan does not take into consideration intangibles such as public sentiment, public opinion, land availability, etc.

Municipal Leaf Collection Program

It is recommended that the Village consider contributing stormwater utility funds to future leaf collection scientific research. The League of Municipalities, WDNR, and USGS plan to initiate a second leaf collection study during 2018 or 2019 to further quantify phosphorus reductions for urban source areas and drainage systems. The second study is anticipated occur over a 2 to 3 year period. The WDNR will use the study results to develop additional leaf collection and phosphorus reduction guidance for municipalities. The municipal leaf collection/phosphorus reduction studies may reduce future wet detention pond costs for the Village.

As new scientific research and guidance is released, it is recommended that the Village review and update pollutant reduction credits for its municipal leaf collection program.

Financing Plan

It is recommended that the Village develop a financing plan. Currently the Village has a stormwater utility to generate funds. Other financing plans will allow the Village to implement its Plan of Action and 10 and 35-year Capital Improvement Plans. Below is a discussion of various funding sources which may be available to the Village. Depending on the project, funding options may be used individually or in combination.

- Debt/Bonds- General obligation and revenue bonds may be used to secure funding for stormwater projects. Property taxes and revenue fees are used for long-term debt payments.

- Tax Incremental Financing (TIF) District - TIF Districts may be used by Cities and Villages to fund stormwater projects that benefit property located within the District. Property value

increases within the TIF District generate additional tax revenue that is used for long-term debt payments.

- Stormwater Utility - Stormwater utilities are similar to sanitary and water utilities. Stormwater utilities generate revenue for stormwater related projects by charging property owners an annual service fee. Annual service fees are based upon the amount of runoff generated by a specific property. Properties with more impervious area (i.e. roofs, parking lots, driveways, etc.) are charged a higher fee as compared to properties with less impervious area. All properties, including tax exempt properties, pay the service fee. Rate adjustments are recommended as needed to fund the municipal stormwater program.

- Grants/Loans - State and federal grant / loans are available for certain stormwater projects. Typically, only a certain percent of the total project cost is eligible for grant / loan money with remaining revenues to be generated by the applicant. Below are a few grant / loan programs which the Village may or may not be familiar with. Grant applications are recommended.
  - Urban Non-Point Source and Stormwater Construction Grant
  - Targeted Runoff Management Construction Grant
  - Great Lakes Basin Program

Inter-Governmental Agreements

It is recommended that the Village evaluate inter-governmental agreements when developing and implementing the Plan of Action. It may be more cost effective to work together with adjoining municipal jurisdictions, such as the WisDOT or Winnebago County Highway Department. Also, it may be beneficial to work together with adjoining cities, villages and townships to construct a mutually beneficial stormwater BMP, share equipment, restore a wetland, or improve water quality using other methods.

Redevelopment Sites

It is recommended that the Village evaluate public/private partnerships with landowners when developing and implementing its Plan of Action. As required by NR 151.12 and the Village's Post-Construction Stormwater Management Ordinance, redevelopment sites with 1 acre or more of land disturbance are required to achieve a TSS reduction. Compliance with the TSS reduction is only required when a construction project occurs on the site. As such, these redevelopment sites do not have a specific timeline for achieving a TSS reduction. Nonetheless, when redevelopment occurs on commercial, industrial, institutional and multi-family residential parcels, stormwater quality improvements will be required. Public/private partnerships provide an opportunity to work together such that both the landowner and Village benefit.

For example, redevelopment of a 20 acre shopping center may provide an opportunity to increase the site's TSS reduction to 80% or provide an opportunity to provide water quality treatment for other nearby properties or streets. In some instances, cost sharing can be used as a financial incentive or the Village cost share through of public/private partnership with the

landowners. Typically, it is more cost effective to incorporate stormwater quality improvements into an already planned construction project as compared to retrofitting a BMP without considering other construction activities in the watershed.

Water Quality Trading

It is recommended that the Village evaluate the feasibility and cost effectiveness of water quality trading when developing and implementing its Plan of Action. The cost for achieving compliance with TMDL allocations is not uniform among dischargers and source areas. As such, compliance with TMDL allocations may be more cost-effectively achieved by trading with other dischargers. Water quality trading is allowed between wastewater treatment facilities, agricultural landowners, and other urban stormwater dischargers. In order to be eligible for water quality trading, specific criteria needs to be satisfied. The WDNR recently developed a water quality trading framework for Wisconsin. This framework has led to two additional guidance documents for trading implementation.

Stream & Shoreline Erosion

It is recommended that the Village undertake high priority stream, shoreline and channel stabilization projects to reduce the discharge of sediment and phosphorus pollutants associated with bed, bank or steep slope erosion. In addition to the water quality benefits, stabilization projects provide an opportunity to improve habitat, remove invasive species, and potentially restore wetland areas. Grant funding is available to assist with stabilization projects.

Resource Management Plans

Several resource management plans were discussed in Section 1.0 of this report. It is recommended that the priorities and recommendations contained in these resource management plans be incorporated into this Plan of Action by reference.

Town of Greenville

Town of Grand Chute

Outagamie County
Winnebago County

BB

CB

41

Mud Creek

Fox River

47

City of Appleton

P

10

441

AP

Little Lake Butte des Morts

Village of Fox Crossing

441

P

10

10

CB

City of Menasha

114

47

Town of Clayton

II

II

41

CB

O

114

Town of Neenah

Neenah Slough

City of Neenah

114

CB

Lake Winnebago

FOX CROSSING
BRIDGING THE FOX CITIES

Study Area

Other Mapped Features

- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline
- Stream
- Surface Water

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

NOT TO SCALE

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ENGINEERS ARCHITECTS
McMAHON ASSOCIATES, INC.

FIGURE 1
STUDY AREA
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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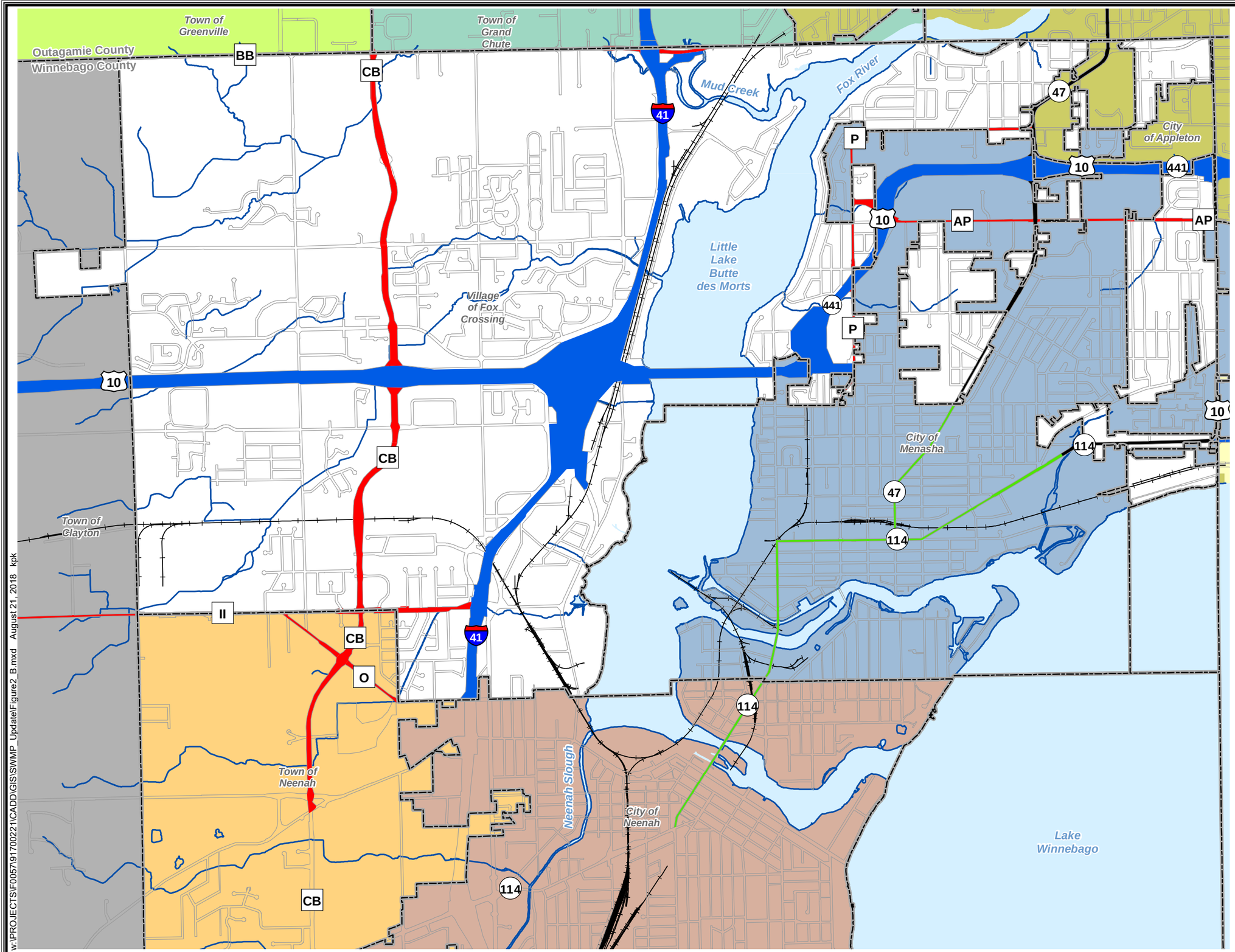

FOX CROSSING
BRIDGING THE FOX CITIES

Municipal Jurisdiction

- City of Appleton
- Town of Clayton
- Town of Grand Chute
- Town of Greenville
- Village of Fox Crossing
- Village of Harrison
- City of Menasha
- City of Neenah
- Town of Neenah

Highway Jurisdiction

- Connecting Highway
- County Trunk Highway
- State Freeway
- State Trunk Highway

Other Mapped Features

- Railroad Centerline
- Right-of-Way Line
- Stream
- Surface Water

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-17.

Disclaimer: The property lines, right-of-way lines, and other property information on this drawing were developed or obtained as part of the County Geographic Information System or through the County property tax mapping function. McMAHON ASSOCIATES, INC. does not guarantee this information to be correct, current, or complete. The property and right-of-way information are only intended for use as a general reference and are not intended or suitable for site-specific uses. Any use to the contrary of the above stated uses is the responsibility of the user and such use is at the user's own risk.

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McMAHON ASSOCIATES, INC.

FIGURE 2
MS4 JURISDICTION
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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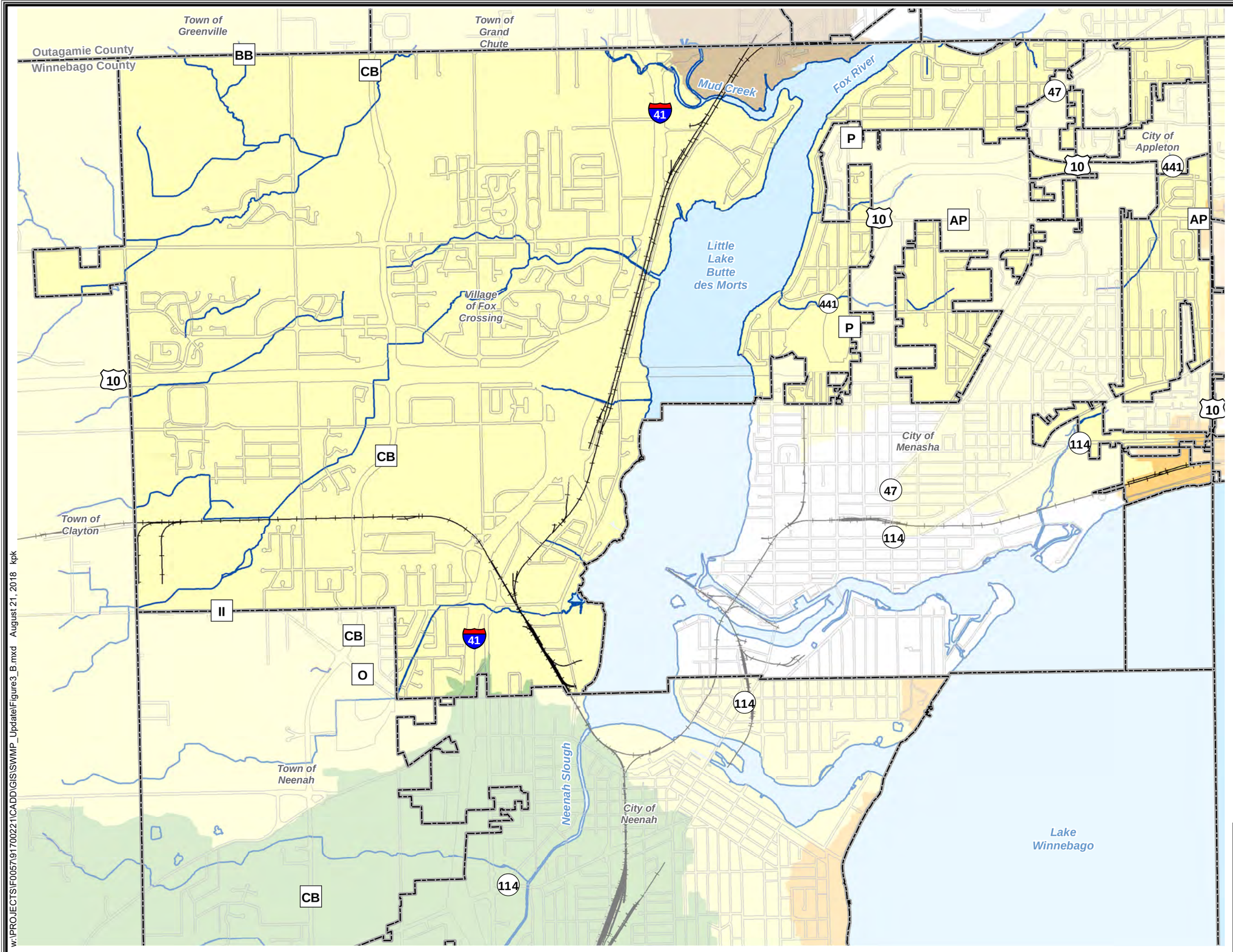

FOX CROSSING
BRIDGING THE FOX CITIES

Sub-Watersheds

- Fox River
- Lake Winnebago
- Mud Creek
- Neenah Slough

Other Mapped Features

- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline
- Stream
- Surface Water

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

Disclaimer: The property lines, right-of-way lines, and other property information on this drawing were developed or obtained as part of the County Geographic Information System or through the County property tax mapping function. McMAHON ASSOCIATES, INC. does not guarantee this information to be correct, current, or complete. The property and right-of-way information are only intended for use as a general reference and are not intended or suitable for site-specific uses. Any use to the contrary of the above stated uses is the responsibility of the user and such use is at the user's own risk.

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McMAHON ASSOCIATES, INC.

FIGURE 3
SUB-WATERSHEDS
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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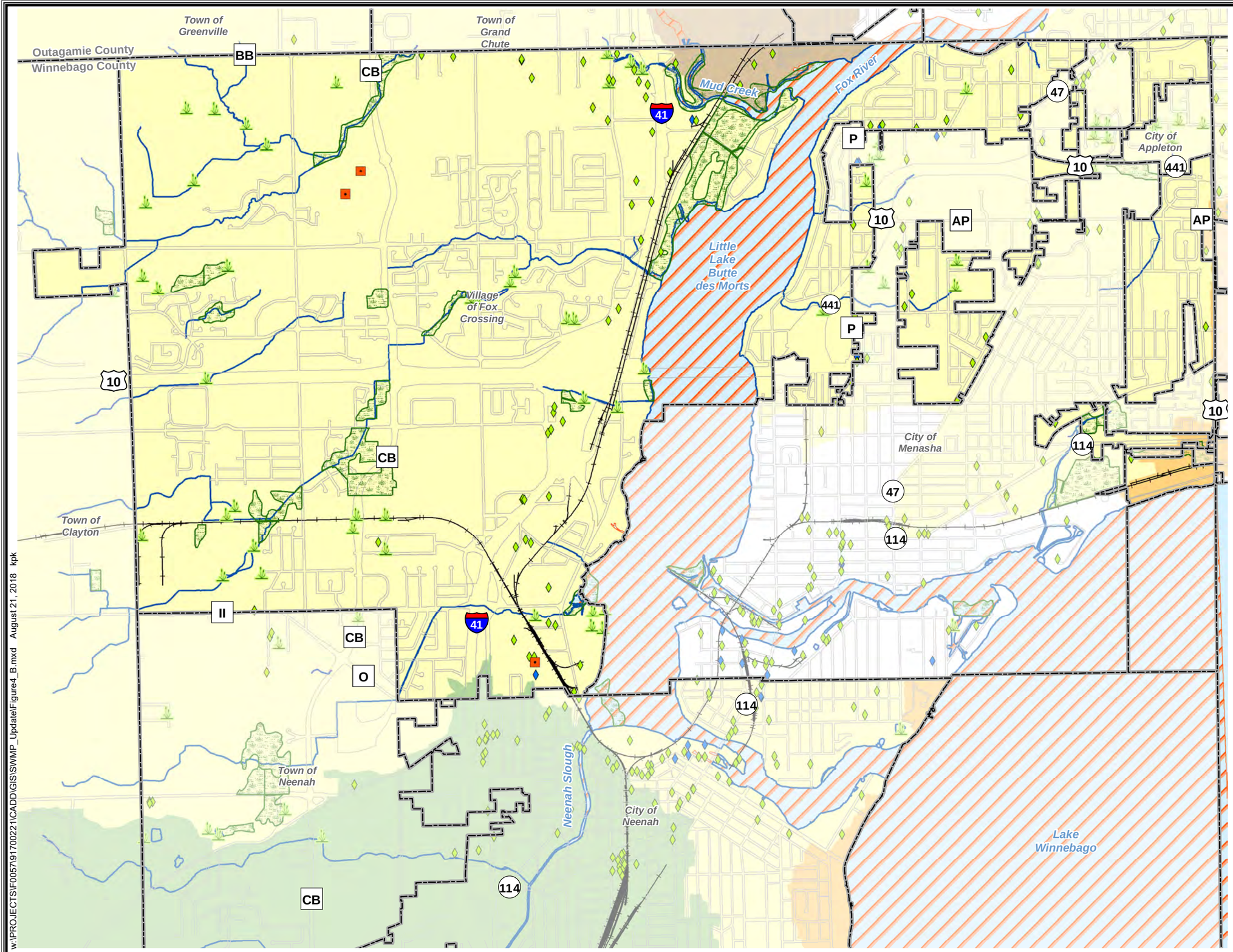

FOX CROSSING
BRIDGING THE FOX CITIES

Natural Resources

- WDNR Wetland Inventory (Less Than 2 Acres)
- WDNR Wetland Inventory (2 Acres and Greater)
- 303(d) Impaired Waters
- Stream
- Surface Water

Sub-Watersheds

- Fox River
- Lake Winnebago
- Mud Creek
- Neenah Slough

Other Mapped Features

- Historical Waste Disposal Site
- Open DNR Remediation Site
- Closed DNR Remediation Site
- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline

Source: Winnebago County, 2007-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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FIGURE 4
NATURAL RESOURCES
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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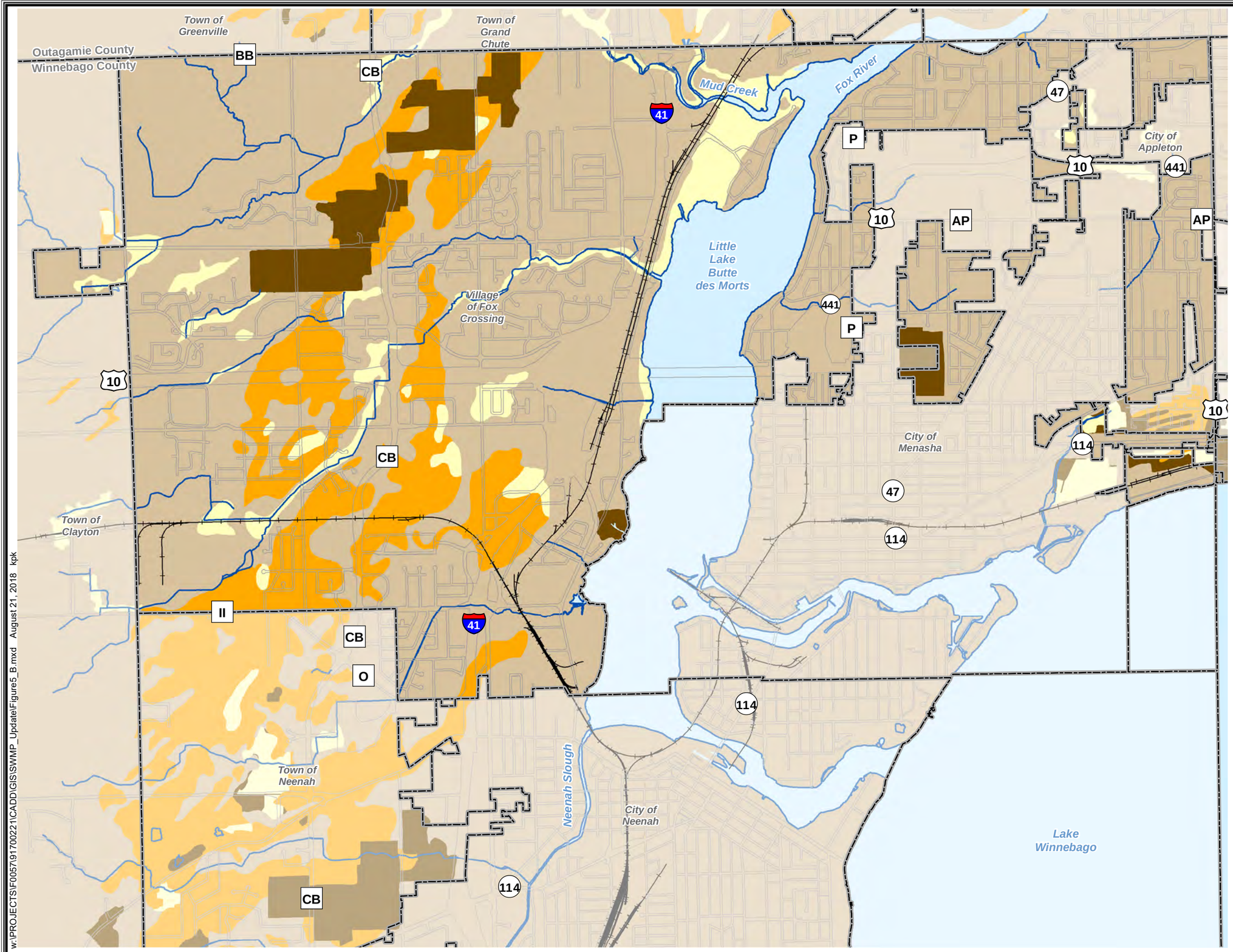

FOX CROSSING
BRIDGING THE FOX CITIES

Hydrologic Soil Group (HSG)

- HSG A
- HSG B
- HSG C
- HSG D

Other Mapped Features

- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline
- Stream
- Surface Water

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18; USDA, 2004-10.

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FIGURE 5
SOILS
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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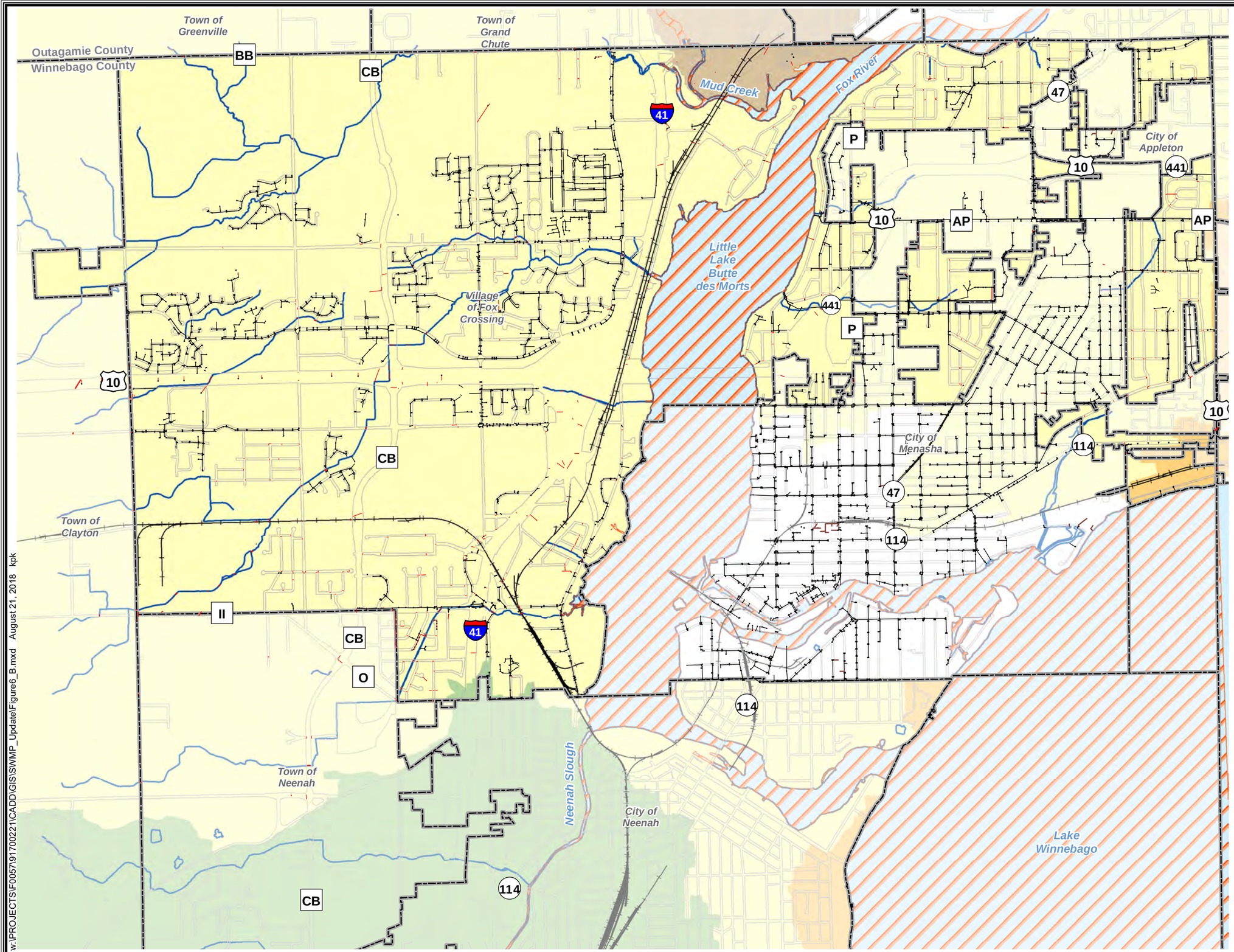

FOX CROSSING
BRIDGING THE FOX CITIES

MS4 Drainage System

- Bridge or Culvert
- Storm Sewer System

Sub-Watersheds

- Fox River
- Lake Winnebago
- Mud Creek
- Neenah Slough

Other Mapped Features

- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline
- Stream
- Surface Water
- 303(d) Impaired Waters

Source: Winnebago County, 2007-18; Outagamie County, 2015-18; Calumet County, 2014-18; City of Menasha, 2006.

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FIGURE 6
MS4 SYSTEM
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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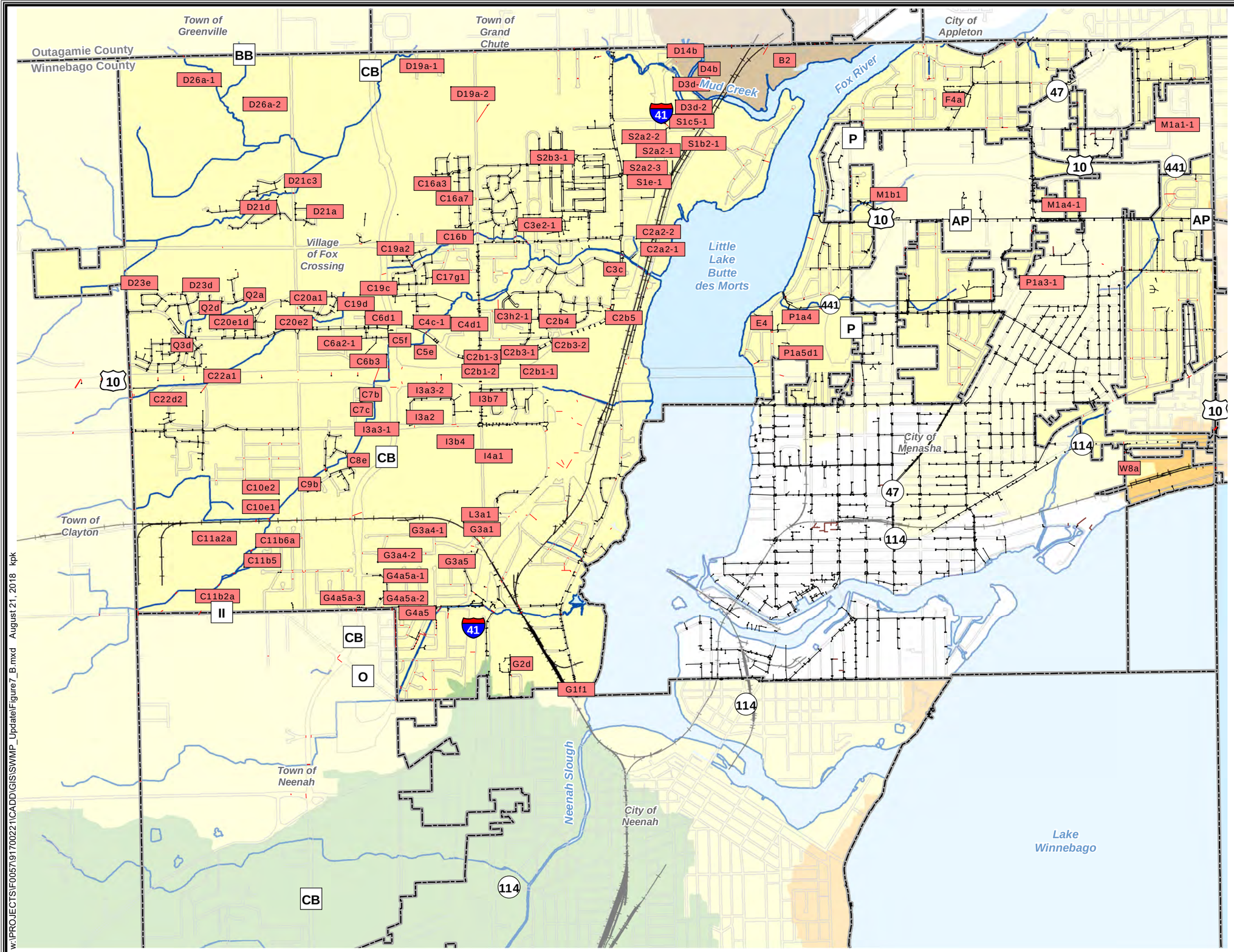

MS4 Drainage System

- C5e — Structural BMP ID
- Bridge or Culvert
- Storm Sewer System

Sub-Watersheds

- Fox River
- Lake Winnebago
- Mud Creek
- Neenah Slough

Other Mapped Features

- Municipal Boundary
- Right-of-Way Line
- Railroad Centerline
- Stream
- Surface Water

Source: Winnebago County, 2007-18; Outagamie County, 2015-18; Calumet County, 2014-18; City of Menasha, 2006.

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FIGURE 7
STRUCTURAL BMPs
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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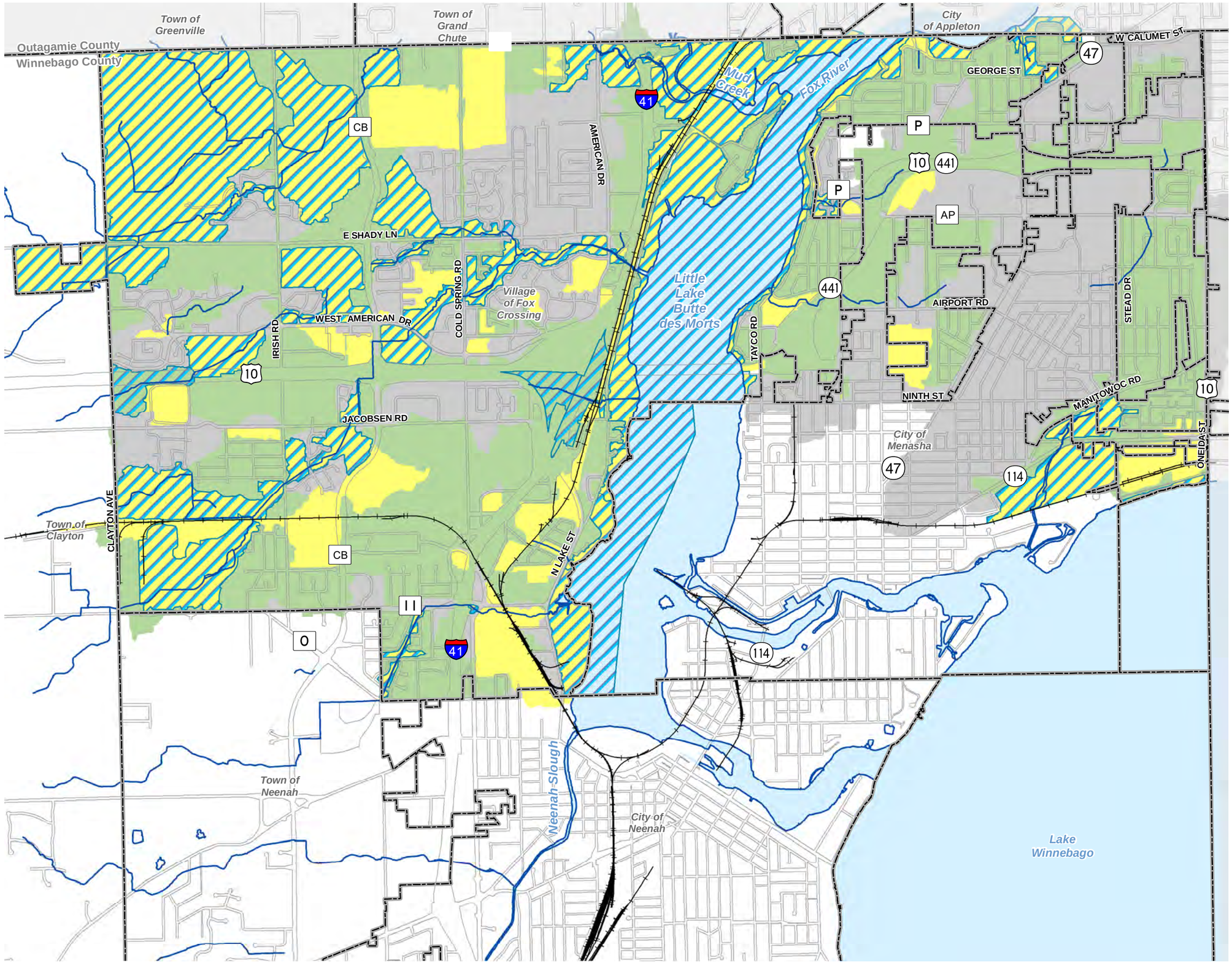

FOX CROSSING
BRIDGING THE FOX CITIES

Surface Drainage

- Curb and Gutter
- No Controls
- Grass Swale

Other Mapped Features

- Municipal Boundary
- Road Centerline
- Railroad Centerline
- Stream
- Surface Water
- Riparian Area

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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FIGURE 8
SURFACE DRAINAGE
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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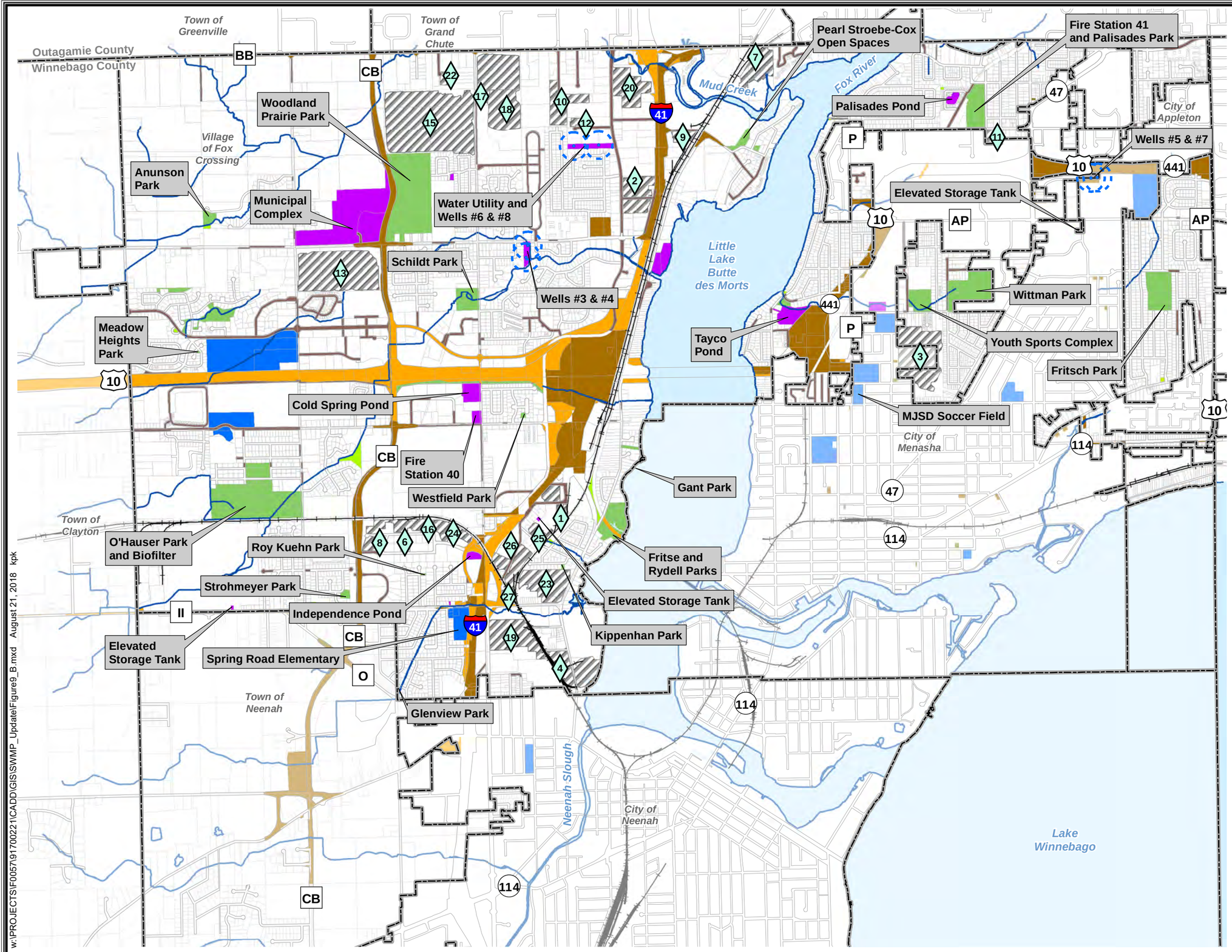

WPDES Industrial Permits

- WPDES Industrial Permit ID
- Areas Covered by WPDES Industrial Permit

Publically Owned Property

- School District Property
- Public Park and Recreation Area
- Village of Fox Crossing Open Space
- Municipal Facility
- Winnebago County Owned Lands
- State Owned Lands
- Municipal Well (400 foot radius buffer)

Other Mapped Features

- Municipal Boundary
- Right-of-Way/Parcel Line
- Railroad Centerline
- Stream
- Surface Water

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18; Wisconsin Department of Natural Resources, 2013.

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McMAHON ASSOCIATES, INC.

FIGURE 9
WPDES INDUSTRIAL PERMIT
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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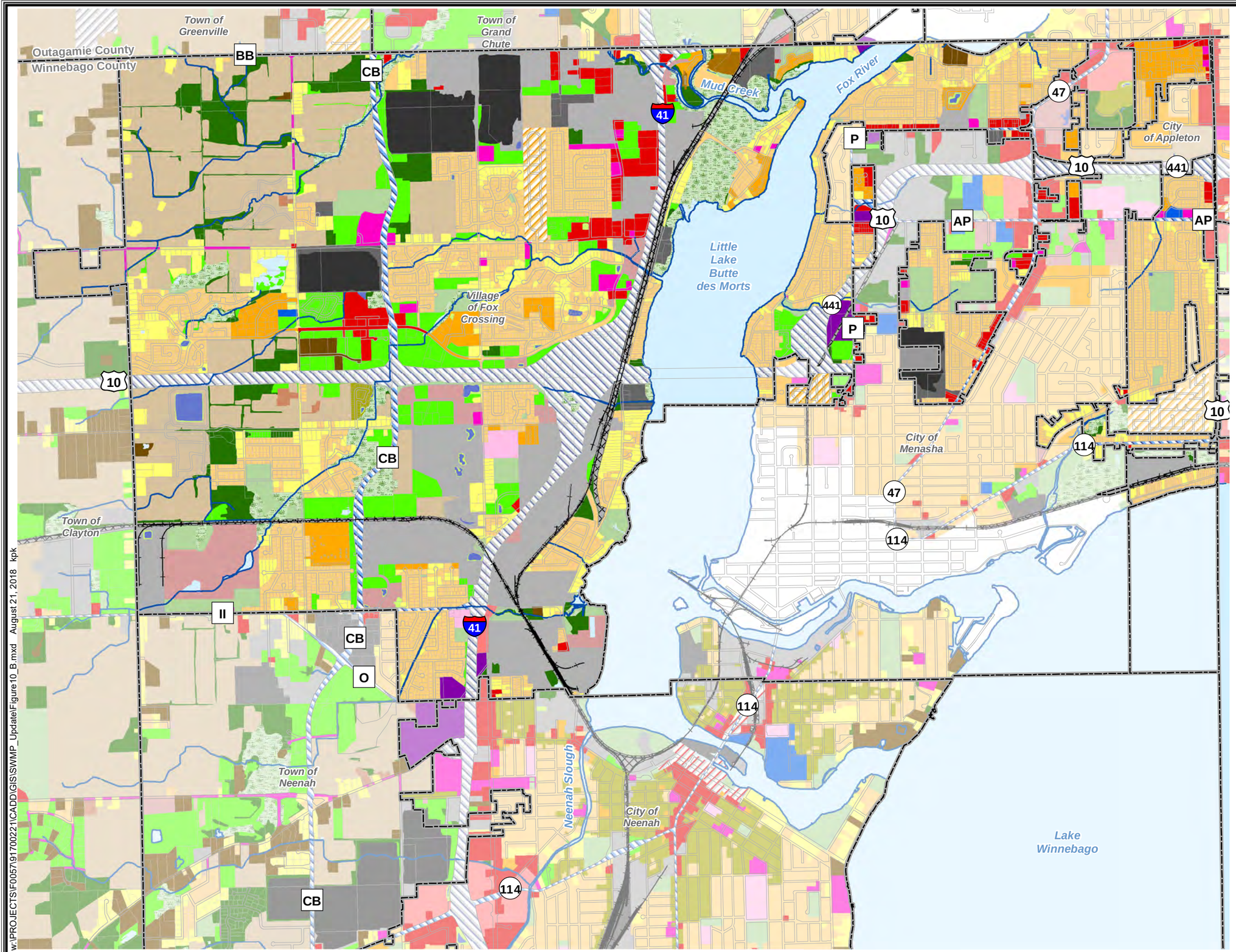

FOX CROSSING
BRIDGING THE FOX CITIES

SLAMM Standard Land Uses

Residential
- LDR - Low Density Single Family Residential (0.5 acre to 1.5 acre lots)
- MDR - Medium Density Single Family Residential (0.25 acre to 0.5 acre lots)
- MDRA - Medium Density Single Family Residential w/Alleys (0.25 acre to 0.5 acre lots)
- HDR - High Density Single Family Residential (0.125 acre lots or smaller)
- HDRA - High Density Single Family Residential w/Alleys (0.125 acre lots or smaller)
- MFR - Multi-Family Residential (3 or more families, 1-3 story height)
- HRR - High Rise Residential (1.5 acre to 5 acre lots, > 3 story)
- SUBR - Suburban Residential (1.5 acre to 5 acre lots)
- MOBR - Mobile Home or Trailer Park Residential

Institutional
- SCHOOL - Public or Private School
- UNIV - University, College, Technical School, etc.
- HOSP - Medical Facilities including Nursing Homes, Hospitals, etc.
- MISC - Miscellaneous Facilities (Churches, Institutional Property)

Commercial
- CDNTN - Downtown Commercial and Institutional Areas
- CSTRIP - Strip Commercial Areas (Courthouses, Police Stations, etc.)
- SHCNTR - Shopping Centers (parking lot is 2.5 times building area)
- OFFPRK - Office Parks (non-retail, multi-story, insurance, government)

Industrial
- LIGHTI - Light Industrial Areas (storage and distribution of goods for retail or sale)
- MEDI - Medium Industrial Areas (lumber, junk, or auto salvage yard, ag., co-op, oil tank farm, coal and salt storage, slaughter house)
- QUARRY - Aggregate extraction and excavation
- AIRPRT - Airport Facilities

Open Space
- CEM - Cemeteries, including grounds, roads, and buildings)
- PARK - Outdoor Recreational Areas (golf course, arboretums, botanical gardens, municipal playgrounds, and natural areas)
- RAIL - Railroad ROW (Excludes road ROW, storage yards)
- FRMSTD - Farmsteads, including limited houses, buildings, driveways and parking areas
- AGRIC - Agriculture fields
- GRASS - Undeveloped land that is vegetated (Excludes road ROW)
- GRASS_SWPOND - Vegetated land around a stormwater pond (Excludes road ROW)
- WOODS - Undeveloped Land that is Vegetated with Woods
- WETLND - DNR Wetland Inventory Map
- WATER - Waters of the State and Other Open Waters
- WATER_SWPOND - Open water associated with stormwater pond

Transportation
- FREE - Limited Access Highways and Interchanges, including vegetated ROW
- HWY - State or County Highway

Other Mapped Features
- Municipal Boundary
- Parcel Lines
- Railroad Centerline
- Stream

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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FIGURE 10
2004 LAND USE
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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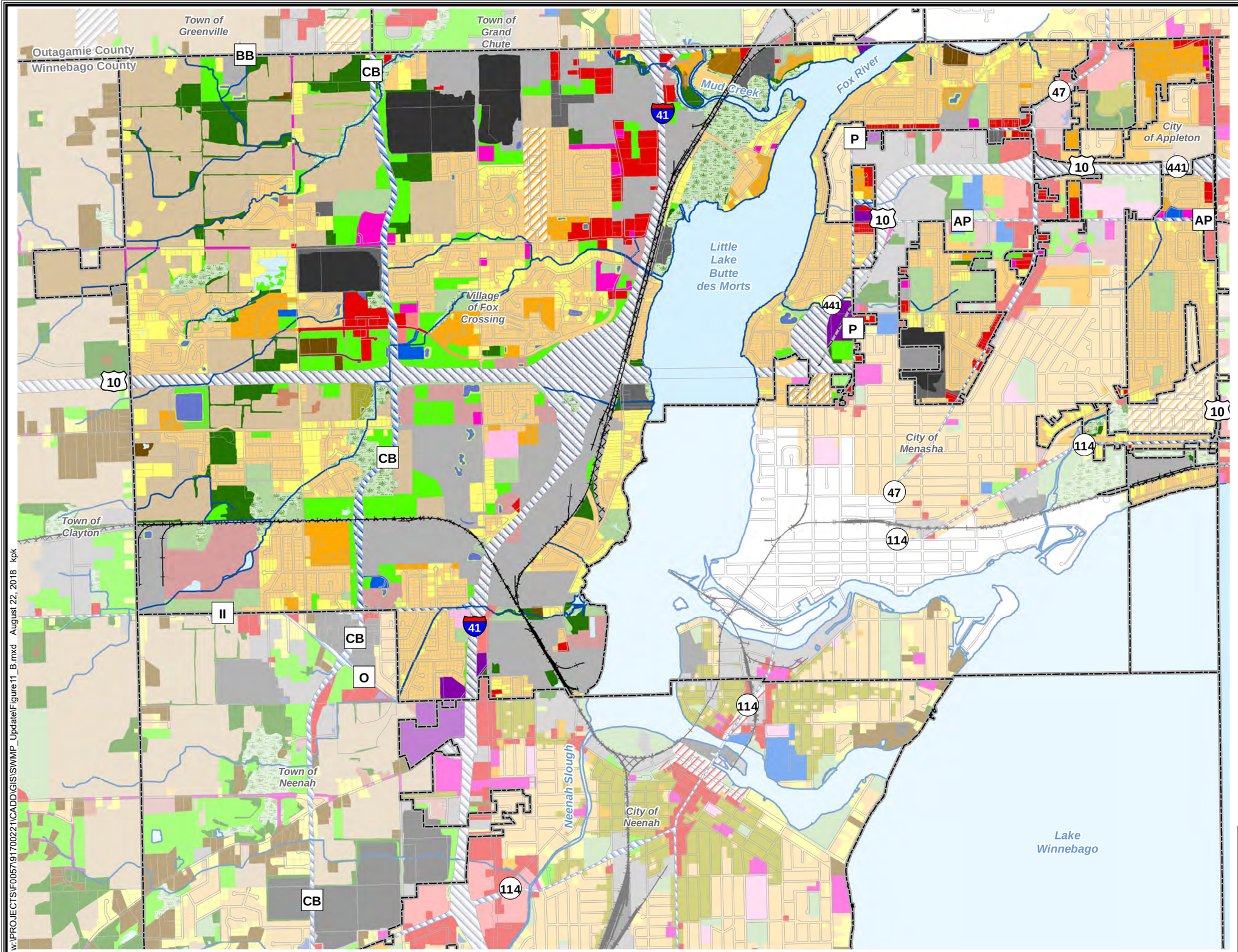

FOX CROSSING
BRIDGING THE FOX CITIES

SLAMM Standard Land Uses

Residential
- LDR - Low Density Single Family Residential (0.5 acre to 1.5 acre lots)
- MDR - Medium Density Single Family Residential (0.25 acre to 0.5 acre lots)
- MDRA - Medium Density Single Family Residential w/Alleys (0.25 acre to 0.5 acre lots)
- HDR - High Density Single Family Residential (0.125 acre lots or smaller)
- HDRA - High Density Single Family Residential w/Alleys (0.125 acre lots or smaller)
- MFR - Multi-Family Residential (3 or more families, 1-3 story height)
- HRR - High Rise Residential (1.5 acre to 5 acre lots, > 3 story)
- SUBR - Suburban Residential (1.5 acre to 5 acre lots)
- MOBR - Mobile Home or Trailer Park Residential

Institutional
- SCHOOL - Public or Private School
- UNIV - University, College, Technical School, etc.
- HOSP - Medical Facilities including Nursing Homes, Hospitals, etc.
- MISC - Miscellaneous Facilities (Churches, Institutional Property)

Commercial
- CDNTN - Downtown Commercial and Institutional Areas
- CSTRIP - Strip Commercial Areas (Courthouses, Police Stations, etc.)
- SHCNTR - Shopping Centers (parking lot is 2.5 times building area)
- OFFPRK - Office Parks (non-retail, multi-story, insurance, government)

Industrial
- LIGHTI - Light Industrial Areas (storage and distribution of goods for retail or sale)
- MEDI - Medium Industrial Areas (lumber, junk, or auto salvage yard, ag., co-op, oil tank farm, coal and salt storage, slaughter house)
- QUARRY - Aggregate extraction and excavation
- AIRPRT - Airport Facilities

Open Space
- CEM - Cemeteries, including grounds, roads, and buildings)
- PARK - Outdoor Recreational Areas (golf course, arboretums, botanical gardens, municipal playgrounds, and natural areas)
- RAIL - Railroad ROW (Excludes road ROW, storage yards)
- FRMSTD - Farmsteads, including limited houses, buildings, driveways and parking areas
- AGRIC - Agriculture fields
- GRASS - Undeveloped land that is vegetated (Excludes road ROW)
- GRASS_SWPOND - Vegetated land around a stormwater pond (Excludes road ROW)
- WOODS - Undeveloped Land that is Vegetated with Woods
- WETLND - DNR Wetland Inventory Map
- WATER - Waters of the State and Other Open Waters
- WATER_SWPOND - Open water associated with stormwater pond

Transportation
- FREE - Limited Access Highways and Interchanges, including vegetated ROW
- HWY - State or County Highway

Other Mapped Features
- Municipal Boundary
- Parcel Lines
- Railroad Centerline
- Stream

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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FIGURE 11
2012 LAND USE
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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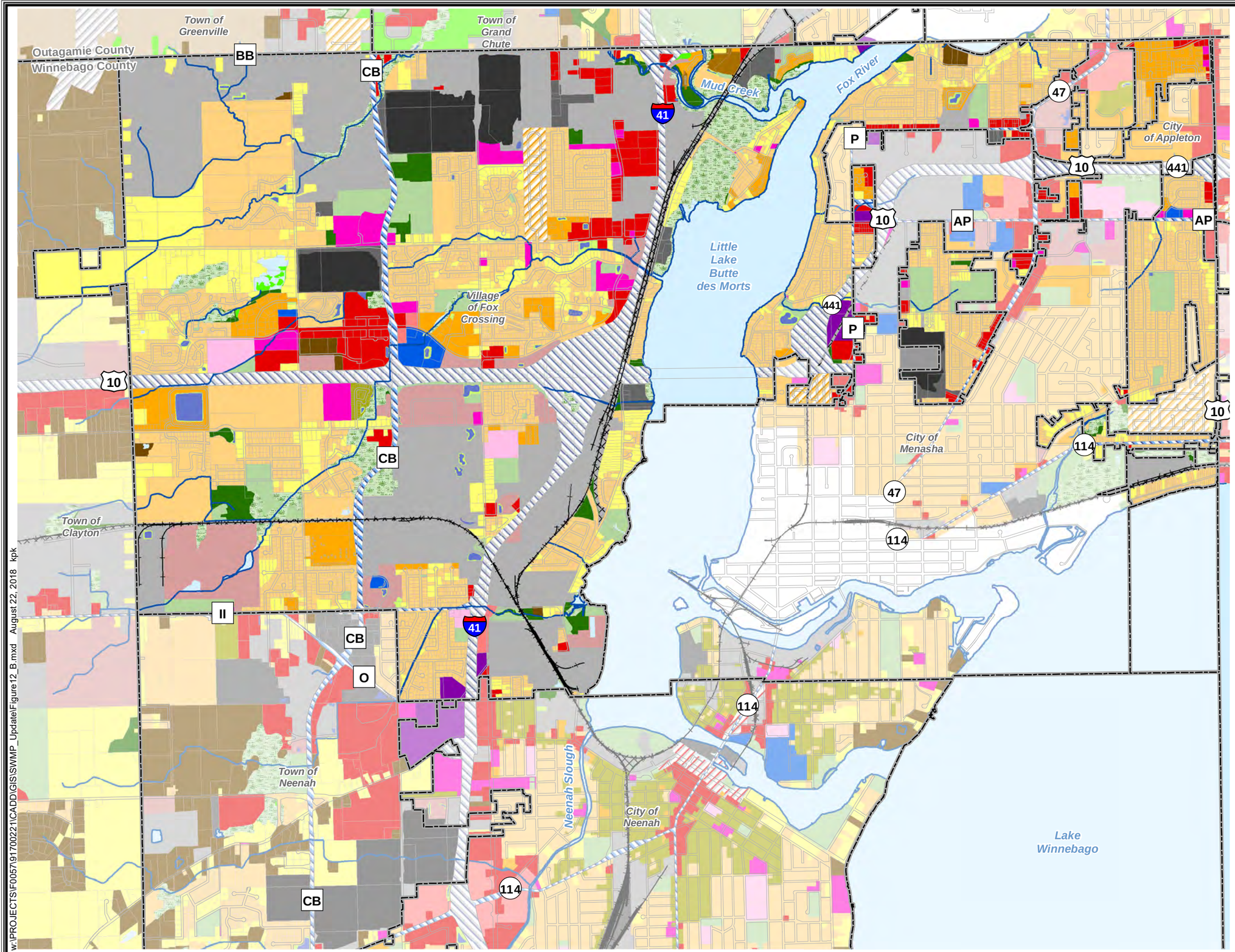

FOX CROSSING
BRIDGING THE FOX CITIES

SLAMM Standard Land Uses

Residential
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- MDR - Medium Density Single Family Residential (0.25 acre to 0.5 acre lots)
- MDRA - Medium Density Single Family Residential w/Alleys (0.25 acre to 0.5 acre lots)
- HDR - High Density Single Family Residential (0.125 acre lots or smaller)
- HDRA - High Density Single Family Residential w/Alleys (0.125 acre lots or smaller)
- MFR - Multi-Family Residential (3 or more families, 1-3 story height)
- HRR - High Rise Residential (1.5 acre to 5 acre lots, > 3 story)
- SUBR - Suburban Residential (1.5 acre to 5 acre lots)
- MOBR - Mobile Home or Trailer Park Residential

Institutional
- SCHOOL - Public or Private School
- UNIV - University, College, Technical School, etc.
- HOSP - Medical Facilities including Nursing Homes, Hospitals, etc.
- MISC - Miscellaneous Facilities (Churches, Institutional Property)

Commercial
- CDNTN - Downtown Commercial and Institutional Areas
- CSTRIP - Strip Commercial Areas (Courthouses, Police Stations, etc.)
- SHCNTR - Shopping Centers (parking lot is 2.5 times building area)
- OFFPRK - Office Parks (non-retail, multi-story, insurance, government)

Industrial
- LIGHTI - Light Industrial Areas (storage and distribution of goods for retail or sale)
- MEDI - Medium Industrial Areas (lumber, junk, or auto salvage yard, ag., co-op, oil tank farm, coal and salt storage, slaughter house)
- QUARRY - Aggregate extraction and excavation
- AIRPRT - Airport Facilities

Open Space
- CEM - Cemeteries, including grounds, roads, and buildings)
- PARK - Outdoor Recreational Areas (golf course, arboretums, botanical gardens, municipal playgrounds, and natural areas)
- RAIL - Railroad ROW (Excludes road ROW, storage yards)
- FRMSTD - Farmsteads, including limited houses, buildings, driveways and parking areas
- AGRIC - Agriculture fields
- GRASS - Undeveloped land that is vegetated (Excludes road ROW)
- GRASS_SWPOND - Vegetated land around a stormwater pond (Excludes road ROW)
- WOODS - Undeveloped Land that is Vegetated with Woods
- WETLND - DNR Wetland Inventory Map
- WATER - Waters of the State and Other Open Waters
- WATER_SWPOND - Open water associated with stormwater pond

Transportation
- FREE - Limited Access Highways and Interchanges, including vegetated ROW
- HWY - State or County Highway

Other Mapped Features
- Municipal Boundary
- Parcel Lines
- Railroad Centerline
- Stream

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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FIGURE 12
FUTURE LAND USE
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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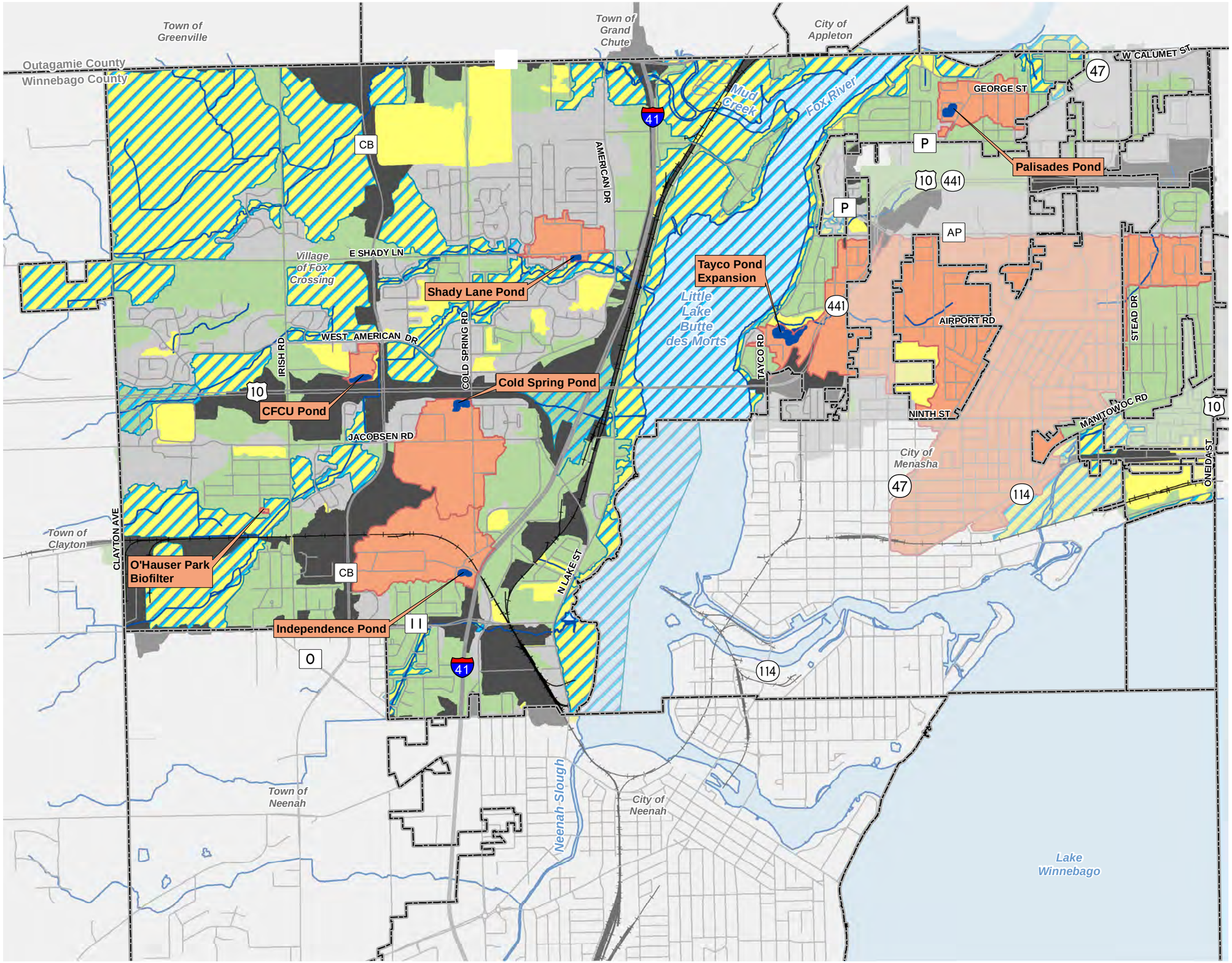

FOX CROSSING
BRIDGING THE FOX CITIES

Structural BMPs

- Existing BMP Watershed
- Permanent Pool or BioFilter

Surface Drainage

- Curb and Gutter (Street Sweeping Twice Per Month With HE Sweeper with No Parking Controls)
- No Controls
- Grass Swale

Other Mapped Features

- Municipal Boundary
- Road Centerline
- Railroad Centerline
- Stream
- Surface Water
- Riparian Area
- MS4 "A' to 'B'

Source: Winnebago County, 2014-18; Outagamie County, 2015-18; Calumet County, 2014-18.

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McMAHON ASSOCIATES, INC.

FIGURE 13
2017 BMPs
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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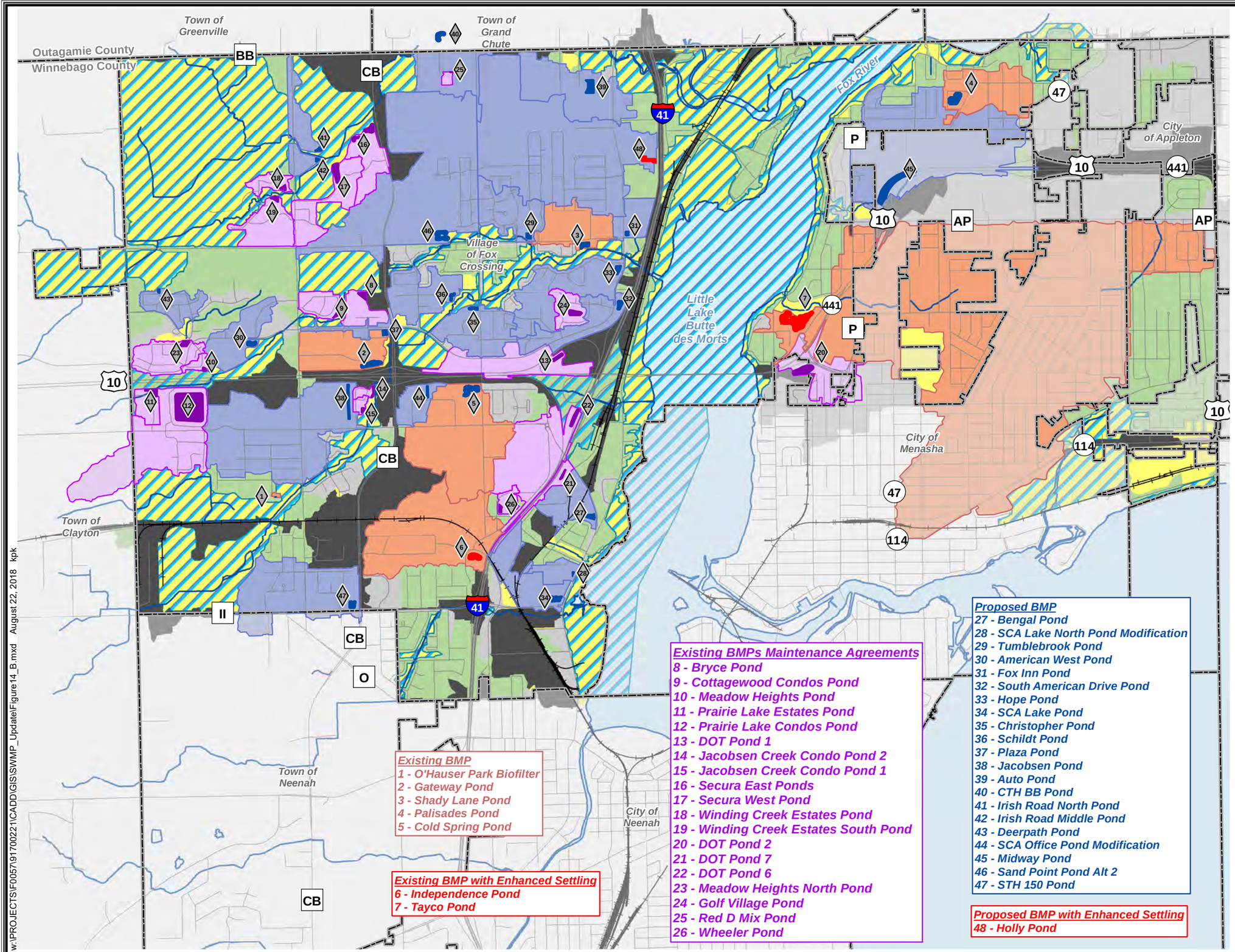

Existing BMP
1 - O'Hauser Park Biofilter
2 - Gateway Pond
3 - Shady Lane Pond
4 - Palisades Pond
5 - Cold Spring Pond

Existing BMP with Enhanced Settling
6 - Independence Pond
7 - Tayco Pond

Existing BMPs Maintenance Agreements
8 - Bryce Pond
9 - Cottagewood Condos Pond
10 - Meadow Heights Pond
11 - Prairie Lake Estates Pond
12 - Prairie Lake Condos Pond
13 - DOT Pond 1
14 - Jacobsen Creek Condo Pond 2
15 - Jacobsen Creek Condo Pond 1
16 - Secura East Ponds
17 - Secura West Pond
18 - Winding Creek Estates Pond
19 - Winding Creek Estates South Pond
20 - DOT Pond 2
21 - DOT Pond 7
22 - DOT Pond 6
23 - Meadow Heights North Pond
24 - Golf Village Pond
25 - Red D Mix Pond
26 - Wheeler Pond

Proposed BMP
27 - Bengal Pond
28 - SCA Lake North Pond Modification
29 - Tumblebrook Pond
30 - American West Pond
31 - Fox Inn Pond
32 - South American Drive Pond
33 - Hope Pond
34 - SCA Lake Pond
35 - Christopher Pond
36 - Schildt Pond
37 - Plaza Pond
38 - Jacobsen Pond
39 - Auto Pond
40 - CTH BB Pond
41 - Irish Road North Pond
42 - Irish Road Middle Pond
43 - Deerpath Pond
44 - SCA Office Pond Modification
45 - Midway Pond
46 - Sand Point Pond Alt 2
47 - STH 150 Pond

Proposed BMP with Enhanced Settling
48 - Holly Pond

FOX CROSSING
BRIDGING THE FOX CITIES

Plan of Action
- Permanent Pool or BioFilter
- Permanent Pool with Enhanced Settling
- Permanent Pool Without Maintenance Agreement
- Existing BMP Watershed
- Proposed BMP Watershed
- Existing BMP Watershed (Obtain Maintenance Agreement)

Surface Drainage
- Curb and Gutter (Street Sweeping Twice Per Month With HE Sweeper with Parking Controls)
- No Controls
- Grass Swale

Other Mapped Features
- Municipal Boundary
- Road Centerline
- Railroad Centerline
- Stream
- Surface Water
- Riparian Area
- MS4 "A' to 'B'

Source: Winnebago County, 2014-18.

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McMAHON ASSOCIATES, INC.

FIGURE 14
PROPOSED PLAN OF ACTION
STORMWATER MANAGEMENT PLAN
VILLAGE OF FOX CROSSING
WINNEBAGO COUNTY, WISCONSIN

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