

Wingra West Watershed Study Final Report

Prepared for
City of Madison
Madison, Wisconsin
March 31, 2022



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The City makes no representation about the accuracy of these records and shall not be liable for any damages.



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List of Abbreviations

1D	One-Dimensional
2D	Two-Dimensional
ATC	American Transmission Company
BC	Brown and Caldwell
cfs	cubic feet per second
CIP	Capital Improvement Plan
City	City of Madison
DCIA	directly connected impervious area
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
H&H	hydrologic and hydraulic
GI	Green Infrastructure
GIS	Geographic Information System
gpm	gallons per minute
HSG	hydrologic soil group
LiDAR	light detecting and ranging
LOS	Level of Service
MG&E	Madison Gas and Electric
MSE	Midwest/Southeast States
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanographic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PFCI	Peak Flow Control Infrastructure
PIM	Public Information Meeting
SLU	standard land use
SAS	storm access structure
SWMM	Storm Water Management Model
SWMP	stormwater management plan
SWU	Storm Water Utility
TIN	triangular irregular network
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UW	University of Wisconsin
VC	Volume Control
WDNR	Wisconsin Department of Natural Resources
WisDOT	Wisconsin Department of Transportation
WSE	water surface elevation
WWI	Wisconsin Wetland Inventory

Executive Summary

Background

The City of Madison (City) is conducting a multi-faceted approach to understand and address stormwater flooding. As one component of that approach, the City is developing comprehensive stormwater management studies for each watershed within the City. The studies are conducted in two phases. Throughout both phases, the City incorporates multiple opportunities for public involvement and interaction.

Phase 1: Development of a hydrologic/hydraulic stormwater runoff model representing the physical and drainage properties of the watershed under existing conditions. The model is then calibrated to measured runoff events and used to identify the areas of the watershed most likely to flood under various rain conditions.

Phase 2: Using the model, evaluate alternative methods and/or infrastructure improvements to eliminate or reduce flooding impacts from large rain events.

This document reports the methods, procedures, and results of the Wingra West Watershed Project. The project area covers approximately 1,763 acres (2.7 square miles) on the west side of Madison.

Figure ES-1 shows the extent of the watershed.

City's Flood Mitigation Targets

The analyses conducted for the watershed studies referred back to the City's flood mitigation targets to understand where targets were being met and where there is room for improvement. The City has the following flood mitigation targets. Please note, these targets may change in the future as more information becomes available.

1. No surcharging onto the street for up to the 10-year (10% chance event) design storm
2. Centerline of street to remain passable during 25-year (4% chance event) design storm with no more than 0.2 feet of water at the centerline
3. No home or business will be flooded during the 100-year (1% chance event) design storm.
4. Enclosed depressions to be served to the 100-year (1% chance event) design storm.
5. Greenway crossings at streets to be served to the 100-year (1% chance event) design storm.
6. Safely convey stormwater during the 500-year (0.2% chance event) design storm event.
7. Provide flooding solutions that do not negatively impact downstream properties.

Existing Conditions Results

The existing conditions analysis found the following when compared to the City's flood mitigation targets:

1. Of the 15.9 miles of storm sewer evaluated during the study, approximately 44% of them surcharge during the 10% chance event, thus not meeting the target. Of the 141 storm inlets evaluated during the study, 70% of them do not have adequate capacity during the 10% chance event.
2. Of the 41.6 miles of streets evaluated in the study, approximately 20% of them have more than 0.2 feet of water at the centerline during the 4% chance event, thus not meeting the target.

3. Of the 2,914 structures included in the watershed, approximately 167, or 6% are at risk of flooding during the 1% chance event, thus not meeting the target.
4. Of the 5 enclosed depressions evaluated during the study, 4 are served to the 1% chance event, thus meeting the target.
5. The one greenway crossing evaluated during the study, is not served to the 1% chance event, thus not meeting the target.
6. The 0.2% chance event was not explicitly evaluated during this study, however, the results of Section 6 (where the 0.2% chance event was evaluated) indicate there are areas within the watershed that do not meet this target.

Figure ES-1 shows surface flooding locations under the 4% chance storm event and how the performance of the stormwater conveyance system compares to the City's flood mitigation targets.

Proposed Solutions and Cost

Following the existing conditions analysis, an extensive process was conducted to brainstorm, evaluate, and ultimately identify solutions to meet the City's flood mitigation targets. The following table lists the solutions that were selected, along with estimated design and construction cost for each. Figures depicting each solution can be found later in this report.

Table ES-1. Proposed Solutions Stand-Alone Project Cost Estimates Wingra West Watershed Study City of Madison, WI		
Project	Estimated Design Cost	Estimated Construction Cost
Odana Hills Golf Course Detention Basin	\$457,000	\$5.7 million
Odana Pond Expansion	\$980,000	\$13.1 million
Orchard Ridge Park Detention Basin	\$615,000	\$8.7 million
University Research Park – Southeast Detention Basin	\$53,000	\$654,000
University Research Park – Southwest Detention Basin	\$47,000	\$579,000
Chippewa Drive Sewer & Swale	\$346,000	\$4.3 million
Cherokee Drive Relief Sewer	\$460,000	\$5.7 million

Proposed Solutions Results

As the proposed solutions were being evaluated, they were compared to the flood mitigation targets. The proposed conditions modeling analysis, with all solutions implemented, found the following when compared to the City's flood mitigation targets:

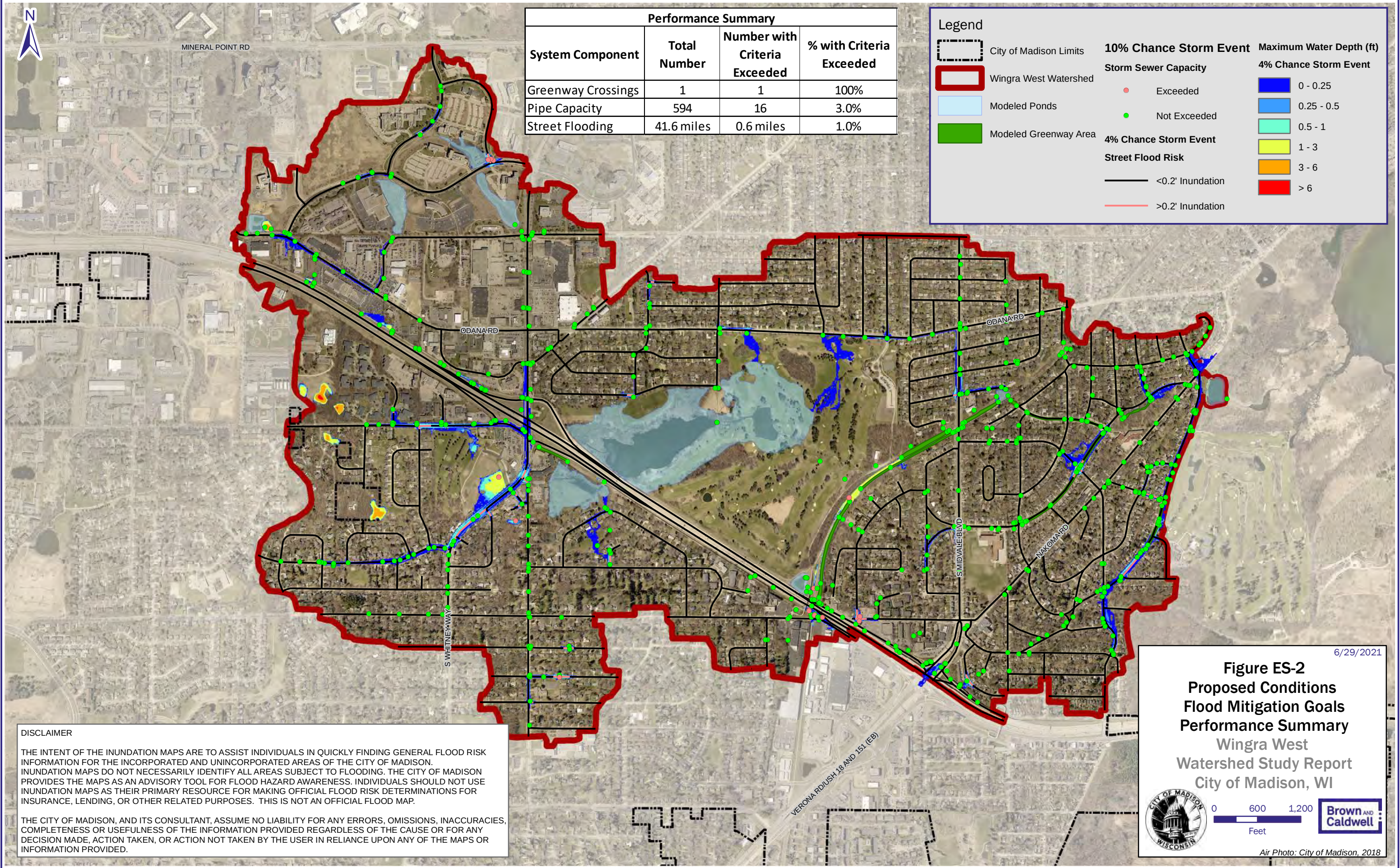
1. Of the 15.9 miles of storm sewer evaluated during the study, approximately 3% of them surcharge during the 10% chance event, thus not meeting the target. This is an improvement over existing conditions as 6.5 more miles of storm sewer are now meeting the target. Of the 141 storm inlets evaluated during the study, 100% of them have adequate capacity during the 10% chance event, and thus meet the target.

2. Of the 41.6 miles of streets evaluated in the study, approximately 1% of them have more than 0.2 feet of water at the centerline during the 4% chance event, thus not meeting the target. This is an improvement over existing conditions as 7.7 more miles of street are now meeting the target.
3. Of the 2,914 structures included in the watershed, approximately 33, or 1% are at risk of flooding during the 1% chance event, thus not meeting the target. As compared to existing conditions, 134 additional structures are now meeting the 1% chance event target.
4. Of the 5 enclosed depressions evaluated during the study, 4 are served to the 1% chance event, thus meeting the target. There is no change in the performance towards this target from existing conditions.
5. The one greenway crossing evaluated during the study, is not served to the 1% chance event, thus not meeting the target. Overtopping is eliminated for all smaller events, and the amount of overtopping is reduced during the 1% chance event.
6. The 0.2% chance event was not explicitly evaluated during this study, however, the results of Section 12.2 (where the 0.2% chance event was evaluated) indicate there are areas within the watershed that still would not meet this target.

There are still locations where the flood mitigation targets are not met. The targets cannot be met for various reasons including lack of physical space, topographic relief limitations, and land use change concerns. Detailed information can be found in Section 12 of this report.

Figure ES-2 depicts the flood control summary within the watershed with the selected solutions implemented. It shows surface flooding locations under the 4% chance storm event and how the performance of the improved stormwater conveyance system compares to City's flood mitigation targets with the selected solutions in place.

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Section 1

Introduction

1.1 Project Background and Purpose

The city of Madison has experienced increased frequency and intensity of rainfall events over the past ten to fifteen years. In August 2018, an unprecedented rainfall event occurred on the city of Madison's west side. A nearby United States Geological Survey (USGS) rain gauge recorded 10.5 inches of rain over a 12-hour period. For reference, National Oceanographic and Atmospheric Administration (NOAA) Atlas 14 statistics show the average 12-hour, 0.1% chance event at 8.92 inches for the Madison area. This event caused flash flooding, most significantly across the western half of Madison, and prompted the City of Madison (City) to begin a comprehensive watershed planning process. This process began with watersheds hardest hit by 2018 flooding and included the area identified as the Wingra West watershed. In April 2019, the City contracted with Brown and Caldwell (BC) to conduct the Wingra West Watershed study.

The overall purpose of this study is to develop a comprehensive stormwater management plan (SWMP) for the Wingra West watershed that will guide the City in meeting its flood mitigation goals.

This document generally consists of two parts. The first part, including Sections 2 through 6, describes the first of phase of the project, which was comprised of

1. The development of input parameters for the watershed's hydrologic/hydraulic model
2. Actual construction of the stormwater hydrologic and hydraulic (H&H) model
3. The calibration process for that model
4. The modeling results showing flooding under the watershed's existing physical conditions.

The second phase of the project involved:

1. The analyses of alternative flood mitigation measures
2. The flood reductions that can be expected from those mitigation measures
3. Specific recommendations for flood reduction actions

Sections 9 through 14 of this report documents the second phase of the project.

Figure 1-1 shows the location of the study area within the City. Figure 1-2 provides a more detailed view of the watershed.

1.2 Scope of Study

The project's scope of work included the tasks listed below:

1. Review existing data and provide support for field data collection
 - This task focused on analyzing existing information provided by the City and other agencies to use in the development of the hydrologic/hydraulic model. Additionally, the City conducted field survey for specific locations based on data gaps identified by BC.

2. Public engagement

- BC assisted the City in conducting several public engagement events. The events included three Public Information Meetings (PIMs) and six neighborhood focus group meetings. Appendix F contains additional information regarding these public engagement events.

3. Develop and Calibrate Existing Conditions XPSWMM™ Model for the Watershed

- The process of model development was a core component of this project. A detailed explanation of the process is provided in Sections 4 and 5 of this document.

4. Execute Existing Conditions XPSWMM™ Model

- The calibrated model was then used to model the watershed under its existing physical conditions for a series of rain events. The results of the model runs are documented in tabular and graphical formats and were presented at a Public Informational Meeting.

5. Evaluation of Flood Mitigation Measures

- Potential solutions to reduce flooding and meet the City's flood mitigation goals were developed and evaluated within the XPSWMM™ model. Solutions were developed in conjunction with City staff. Selected solutions were evaluated under a series of storm events and the results were documented. The solutions were also presented at a Public Information Meeting.

Each task is described in more detail in the remainder of this document.

1.3 Historic Flooding in Watershed

Within the Wingra West watershed there are several areas that have experienced repeated flooding in the past. Figure 1-3 depicts known flooding areas as provided by the City within the Wingra West watershed. The known flooding locations are based on reports from a variety of data sources, including resident reports, emergency services reports, City operations staff reports, and inlets with repetitive clogging history.

Known flooding locations were discussed with City staff at a meeting on March 19, 2019. Attendees were Joanna O'Brien, Richie Breidenbach, Janet Schmidt, Greg Fries, Phil Gaebler from the City of Madison, and Caroline Burger (BC at time of meeting) and Jim Bachhuber from BC. Figure 1-4 identifies the flooding locations that were discussed during the March 19, 2019 meeting and a summary of these locations is provided below:

- 6. Intersection of Midvale Boulevard and Southwest Bike Path:** Flooding frequently occurs in this area. Overland flow from the area often flows in two paths: (1) north along Midvale Boulevard to Waite Circle, or (2) into an easement south of the bike path that flows east through open channels and storm sewers towards Chippewa Drive.
- 7. Waite Circle:** Overland flow from Midvale Boulevard flows east along Waite Circle to the eastern end of the cul-de-sac. Street flooding occurs frequently, and inadequate inlet capacity is likely a factor. Severe flooding occurred during June and August 2018 and was the result of inadequate culvert capacity just downstream of Waite Circle. A stone arch culvert beneath the Southwest Bike Path (located just southeast of Waite Circle) was slip-lined with a 60-inch storm sewer in 2017 to prevent the arch from collapsing. The 60-inch storm sewer further limited the capacity of the stone arch.
- 8. Intersection of Chippewa Drive and Council Crest:** This intersection floods frequently.

9. **Intersection of Cherokee Drive, Nakoma Drive, and Manitou Way:** Overland flow along Cherokee Drive overtops Nakoma Drive and flows onto Manitou Way, towards a low point to the southwest. Stormwater ponds in the low-point and flows overland into the University of Wisconsin (UW) Arboretum and Nakoma Golf Course.
10. **Intersection of Dearholt Road and Milward Drive:** This intersection has experienced recurring flooding.
11. **Orchard Ridge Valley Park:** This park and nearby roads/houses flooded during the August 2018 storm and water stays ponded in the park for extended periods of time.
12. **Whitney Way, South of the Beltline Highway:** This area has flooded and become impassible during large rain events.

In addition to the locations identified above, numerous locations of backyard ponding have been reported to the City from residents. These areas are generally internally drained and isolated from the municipal stormwater conveyance system.

1.4 Flood Mitigation Goals

The City established consistent goals for stormwater management flood control (Level of Service or LOS) throughout the City. It is the City's policy to meet the LOS with reconstruction and new construction of its municipal stormwater conveyance system. Specifically, the LOS stormwater flood management goals are:

1. No home or business flooding during the 1%, 24-hour design storm event (6.6 inches).
2. Eliminate flooding (surcharging of the storm sewer system onto the municipal streets) for up to the 10%, 24-hour design storm event (4.1 inches), with the exception of road low-points.
3. Allow no more than 0.5-feet of stormwater ponding above storm sewer inlet rim elevations at inlet-restricted low points for the 10%, 24-hour design storm event (4.1 inches).
4. Maintain drivability of municipal streets (center of the street with no more than 0.2-feet of water) for the 4%, 24-hour design storm event (5.0 inches).
5. Enclosed depressions should provide safe storage, or overflow, of stormwater during the 1%, 24-hour design storm event (6.6 inches). Flooding should be contained within public lands (streets, greenways, easements, etc.).
6. Where greenways cross streets, there should be no road overtopping during the 1%, 24-hour design storm event (6.6 inches).
7. Flooding solutions should not negatively impact downstream properties.

It should be noted that although the City strives to meet the above goals with each of its stormwater infrastructure projects, fully achieving these goals is not always feasible because of specific site conditions, or other factors which cannot be controlled.

Section 2

Water Resources Inventory

2.1 Study Setting

The Wingra West watershed is located on the west side of the city of Madison (see Figure 1-1) and covers approximately 1,763 acres. The extent of the watershed is shown on Figure 1-2. The watershed drainage is generally west to east and outlets into the UW Arboretum at two locations:

1. The outlet from Manitou Pond, located at the corner of Manitou Way and Nakoma Road
2. A 3-foot by 6-foot box storm sewer that discharges into a flowing stream on Nakoma Golf Club property. In extreme events discharge may also flow into the UW-Arboretum.

Prominent geographic features in the watershed include:

1. Odana Pond located within the Odana Hills Golf Course. This water feature is discussed in more detail in Section 2.3.1
2. The Beltline Highway (USH 12/USH 14) passes through the watershed from northwest to southeast. There are several major culverts crossing the highway (conveying water from south to north), and the highway itself has a drainage system that is owned and operated by the Wisconsin Department of Transportation (WisDOT).
3. The Southwest Bike Path splits the watershed into an upstream and downstream area. All runoff from the area upstream (west and north) of the path crosses the path at a single culvert located near Waite Circle.

2.2 Topography

The topographic data (provided by the City) was compiled from light detecting and ranging (LiDAR) data on the North American Vertical Datum of 1988 (NAVD88). It should be noted that some data available for the project (such as past construction drawings) are in the previously used City vertical datum. The conversion factor from the historical City datum to NAVD88 was to add 845.6-feet to the City datum elevation. Data provided included two-foot contours, a digital elevation model (raster format), and LiDAR point clouds.

Elevations in the watershed range between elevations 850 and 1,130 feet, approximately. The highest elevations are located on the west and northwest sides of the watershed and lowest elevations on the eastern side near the outfall.

2.3 Drainage System

The Wingra West drainage system generally consists of a constructed urban stormwater conveyance system including a mix of open-channels, storm sewers, and detention facilities. The watershed is nearly fully urbanized with curb and gutter street drainage. A limited amount of grass swales provide drainage mainly along the Beltline Highway.

2.3.1 Natural Drainage System and Wetlands

The Wingra West watershed is 100 percent urbanized; however, there are remnants of historic drainage features.

Odana Pond: This pond is located in the central area of the watershed, mostly within the Odana Hills Golf Course. A 1917 Dane County Soils Map (Wisconsin Geologic and Natural History Survey) shows a water feature in this location; thus, the pond was a natural feature and pre-dates urban development. The pond is likely an internally drained area created by the glacial moraine blocking the pre-glacial drainage, but is now highly impacted by urban development. The pond's surface area is approximately 15 acres at normal pool elevation. The water surface extends south of the Beltline Highway through box culverts and into Orchard Ridge Park. The pond's outlet has been modified and now is a constructed outlet discharging to a 42-inch storm sewer.

Water from the pond is used by Madison Gas and Electric (MG&E) for a groundwater recharge project. In 2005, MG&E and UW-Madison began operation of a cogeneration plant which required water withdrawal from Lake Mendota. Under an agreement with the Wisconsin Department of Natural Resources (WDNR), MG&E agreed to offset a portion of the surface water withdrawal with a groundwater recharge facility located on the Odana Hills Golf Course. This project went online in 2006. During the non-winter period, water is pumped from the pond to a drain field located on the golf course. The pumping rate averages 100 gallons per minute (gpm) during this period, and the system is not operated in the winter.

Wetlands: There are areas within the watershed identified as having wetland indicators based on the WDNR's Surface Water Data Viewer (<https://dnr.wi.gov/topic/surfacewater/swdv/>). Figure 2-1 is a map showing the natural waterbodies and wetland mapping for the watershed. The map shows wetland indicators around the Odana Pond, and "wetland points" within the Odana Hills Golf Course, Vitense Golf Course, and five locations in or near the University Research Park. The Surface Water Data Viewer only provides a screening tool for wetland indicators, and field investigations would be required to confirm the presence or absence of wetlands.

It should also be noted that Natural Resources Conservation Service (NRCS) soil mapping of hydric soils shows that historic wetlands were more extensive before land development occurred. Many of the historic wetlands were filled and/or drained during the urbanization process.

2.3.2 Constructed Drainage System

To provide an overview of the major drainage systems, the Wingra West watershed can be divided into seven drainage systems which are labeled as follows:

1. University Research Park area
2. Odana Pond area
3. Orchard Ridge Valley Park area
4. Waite Circle North area
5. Waite Circle South area
6. Secret Pond area
7. Manitou Way area

These major drainage areas are displayed on Figure 2-2.

There are approximately 15.5 miles of modeled storm sewer within the Wingra West watershed that range in size from 12-inch circular pipes to 4-feet by 10-feet box culverts. Selected storm sewers were not included in the model. Storm sewers that were not necessary to accurately represent the hydraulic conditions of the project area were not incorporated into the model. Examples of sewers not represented in the model include:

- Laterals or leads that run between inlets and the main storm sewer.
- Storm sewers on private property.
- Storm sewers smaller than 18-inches.

Several prominent open channel conveyance features also exist in the project area. In total, there are 1.6 miles of open channels. These include:

1. Open channels along the Southwest Bike Path that convey runoff from the Beltline Highway area northeast to the Waite Circle culvert.
2. A channel within the median of Chippewa Drive that consists of a 6-foot wide concrete bottom and stacked rock vertical walls approximately 3-feet tall. This channel runs from the Southwest Bike Path to Cherokee Drive (approximately 1,300 feet in length). There are three crossings beneath roadways that are 4-foot by 6-foot box culverts.
3. A channel within the median of Cherokee Drive from Waban Hill to Chippewa Drive.
4. A City-constructed greenway within Nakoma Park, north of Thoreau Elementary School. This greenway channel conveys water approximately 400 feet from the intersection of Cherokee Drive and Miami Pass to a storm sewer inlet located in the park south of Cherokee Drive and Oneida Place.

Figure 2-3 displays the existing drainage system within the Wingra West Watershed.

2.4 Runoff Conditions

Stormwater runoff generated from a land surface will vary depending upon several factors, including land use, impervious surfaces, soil types, and topography. The factors within the Wingra West watershed are discussed in this section.

2.4.1 Land Use

The Wingra West watershed includes a mix of land uses, with the largest category being residential. Land use data was provided by the City that categorized the areas within the watershed into 19 different land uses. Table 2-1 provides a generalized breakdown of the land use within the watershed. A map of the generalized land use categories is shown on Figure 2-4.

Table 2-1. Existing Land Use Wingra West Watershed Study City of Madison, WI		
Land Use Type	Area (acres)	Percent (%)
Residential	756	43%
Institutional	56	3%
Commercial	240	14%
Industrial	7	0.4%
Open Space/Parks	336	19%
Street Right-of-Way	368	21%
Total	1,763	

For developing hydrologic factors, the more detailed land use categories were used, and a detailed breakdown of the categories is provided in Appendix B. The detailed land use categories were used to determine the amount of impervious area within each watershed and the portion of the impervious area that is directly connected to the municipal stormwater conveyance system. See Section 4.3.2.1 for further description of the land use categories and how the land use data was used in the development of the XPSWMM™.

2.4.2 Impervious Area

Impervious area data for various land uses was provided by the City as part of the Geographic Information System (GIS) data. The impervious area dataset was divided into three categories: (1) residential, (2) non-residential, and (3) right-of-way areas. The data provided for each area is summarized below.

- For residential parcels, the percent impervious of each parcel is incorporated into the dataset from the City. This data reported a square footage of impervious area by parcel but was not delineated within residential parcels.
- For non-residential parcels (industrial, commercial, etc.), the impervious areas are delineated, and thus, this information was used directly for hydrologic conditions. See Figure 2-5 for a map of the impervious areas provided by the City.
- The impervious area within right-of-way areas was estimated by offsetting the street centerline based on the width of the street and any sidewalk present along the roadway. This offset was completed by the City and provided to BC.

2.4.3 Soil Types

Soils in the Wingra West watershed are predominantly hydrologic soil group (HSG) B soils. The HSG classifications were used to estimate the infiltration parameters for pervious surfaces within the watershed (see Sections 4.3.2.5 and 4.3.2.6). Table 2-2 shows the areas for each soil group in the watershed and the extent of soil group areas are shown on Figure 2-6. This data was obtained directly from the City and is based on the NRCS Soil Survey for Dane County.

Table 2-2. Hydrologic Soil Groups Wingra West Watershed Study City of Madison, WI		
HSG	Area (acres)	Percent (%)
B	1,555	88%
C	76	4%
B/D	114	7%
W	18	1%
Total	1,763	

Section 3

Guidance and Data Sources

3.1 City of Madison Modeling Guidance

As part of this study, a Modeling Guidance document was developed by the City, BC, and AE2S (City consultant for Spring Harbor Watershed Study). This document was used to define consistent modeling parameters across the various watersheds that are being studied. The Modeling Guidance was developed at the onset of the project and updated throughout the study. The version of the Modeling Guidance dated December 6, 2019, was utilized as part of this study. A copy of the Modeling Guidance is included in Appendix A.

3.2 List Data Sources

The Wingra West watershed study relies on a variety of data sources, including:

1. Various datasets from the City's GIS. GIS data includes: land use, storm sewer (including associated structures), city limits, greenways and ponds, parcels, roads, and other pertinent datasets.
2. The City's GTweb system. Access to this system was provided which includes mapping of various City infrastructure including storm sewer, sanitary sewer, and water main. In some cases, this system contained information (such as pipe size or invert elevation) that was missing from the City's GIS data.
3. Construction plans provided by the City or obtained from the City's network. Of particular note are construction plans obtained from the City for the Beltline Highway, Manitou Pond, and the University Research Park ponds.
4. Photographs of greenways and ponds. Measurements of outlet structures for the Odana Golf Course pond was included. Photographs were obtained from field investigations conducted by BC and other photographs provided by the City.
5. Field Survey of selected items and locations within the watershed. As part of the model development process survey, locations were identified and the data was collected by City staff. Examples of survey locations include missing storm sewer or culvert inverts at key locations, pond overflow elevations, and cross sections of open channels.
6. Monitoring data to support this study was collected by the City, USGS, and MG&E. Monitoring data included rainfall, flow, and water level data at select locations. Additional information about the data collected and how the data was collected is provided in Section 4.2.2 for rainfall data and Section 5.1 for flow and water level data.

It should be noted that the City previously used a City vertical datum and the City is in the process of transitioning all data into the NAVD88. The watershed study was conducted in NAVD88 and data that was in the City datum was converted to NAVD88. The City provided the appropriate conversion of adding 845.6-feet to the City datum.

The specific file name and date of the file is listed in Table 3-1.

Table 3-1. Source Files Wingra West Watershed Study City of Madison, WI		
Data Type	File Name	File Date
Land Use	WinSLAMMLanduse.mdb	4/16/2019
LiDAR	Citywide_Raster_small_cell	3/12/2019
Storm Sewer	Storm_Sewer_Pipes	3/21/2019
	Storm_Sewer_Structures	3/11/2019
	Storm_Pipes_Private	1/24/2019
	Storm_Structures_Private	1/24/2019
	STO_E_PVT Graphic Line	3/19/2019
	STO_E_PVT Graphic Cell	3/19/2019
Culverts	Storm_Sewer_Pipes	3/21/2019
	Storm_Sewer_Structures	3/11/2019
Greenways	Greenways_and_Ponds	1/11/2019
	PondGwayPipes	3/14/2019
	PondGwayStructures	3/14/2019
Planimetric Data	Street_Centerlines_and_Pavement_Data	3/11/2019
	Lakes_and_Rivers	10/3/2018
	Greenways_and_Ponds	1/11/2019
	Pond_Contours	1/24/2019
	Stormwater_Impervious_Areas	2/15/2019
Aerial Imagery	WICMAD18_ReDelivery_Gen3_RDG.sid	12/3/2018

Section 4

Model Development

4.1 Modeling Software

To evaluate flooding and stormwater conveyance system capacity within the Wingra West watershed an XPSWMM™ version 2018 model was created to simulate the hydrology and hydraulics within the watershed. XPSWMM™ is a proprietary software product of Innovyze® (see www.innovyze.com/en-us). The model created for the Wingra West watershed is a combination One-Dimensional (1D)/Two-Dimensional (2D) H&H model.

4.2 Rainfall Events

The flooding analyses included an evaluation of both design storms and recorded rainfall events. A series of storm events were evaluated as part of this study to identify which event(s) result in flooding, and the severity of that flooding. Both theoretical “design storms”, as well as measured local storm events, were considered as part of the study. The rainfall events that were used in the analysis are described in the following sections.

4.2.1 Design Rain Events

The watershed flooding analysis included a series of different recurrence interval design storms (50, 20, 10, 4, 2, 1, and 0.2% chance events) with a 24-hour duration. The design storm events used rainfall depths from the NOAA Atlas 14. The Midwest/Southeast states (MSE) 4 rainfall distribution, developed by the NRCS, was used for the rainfall. Table 4-1 lists the rainfall depths that were used in the H&H modeling of this study.

Table 4-1. Design Rain Events Wingra West Watershed Study City of Madison, WI	
Annual Storm Probability (24 hour)	Rainfall Depth* (inches)
50% chance	2.8
20% chance	3.5
10% chance	4.1
4% chance	5.0
2% chance	5.7
1% chance	6.6
0.2% chance	8.8

**as reported in the City's Modelling Guidance document.*

4.2.2 Measured Rain Events

Rainfall data was collected from June 2019 through October 2019, across the west side of Madison in support of the watershed studies. The Wingra West watershed study utilized a combination of rain gauges within the watershed and near the watershed to characterize actual, measured rainfall events. Rain gauges used as part of the study and their locations are provided in Table 4-2. Figure 4-1 shows the locations of each station.

Table 4-2. Rain Gauge Locations Wingra West Watershed Study City of Madison, WI	
Gauge Location	Operated By
Southwest Bike Path, at the south end of Parman Terrace	City of Madison
Intersection of Odana Road and Hilltop Drive	USGS
intersection of Kenosha Drive and Calumet Circle	USGS
intersection of Yellowstone Drive and Gettysburg Drive	USGS
Owen Park, near the intersection of Inner Drive and Kelson Drive	USGS
Meadowood Park, near the intersection of Thrush Lane and Leland Drive	City of Madison

For gauges operated by the City, rainfall data was obtained from the Trimble Unity website, the City's partner for providing the monitoring data. Rainfall data from USGS gauges was provided via email from the USGS.

From the monitoring period, three measured rainfall events were selected to be utilized as part of the calibration process under this study. The events selected are provided in Table 4-3. A graph of each event's rainfall distribution at the Southwest Bike Path location is provided in Appendix H as Figures H-1 through H-3. These events are the largest rain events that were successfully measured and had good corresponding flow and/or water surface elevation measurements at the monitoring stations (see Sections 5.1 and 5.2). The events were selected as part of a meeting with City staff at which available rainfall and monitoring data was reviewed. A consensus was drawn for the events to be used based on the size of the storm events and successfully collecting monitoring data.

Table 4-3. Rain Events Selected for Calibration Process Wingra West Watershed Study City of Madison, WI			
Event Date	Rain Depth (inches)*	Rain Duration	Approximate Annual Exceedance Probability
August 5, 2019	1.1 - 1.2	3.5 hours	> 100%
August 11, 2019	0.9 - 1.5	4.5 hours	> 100%
October 1-2, 2019	3.0 - 3.6	19 hours	50% - 10%

* rain depth varied by station

The October storm event was the largest event that was successfully measured in 2019 at the relevant rain gauges. The October event (total rain depth and duration) falls in the range of a 50% to

10% chance event based on NOAA Atlas 14 Volume 8 Version 2 data. The August events (total rain depth and duration) both are greater than a 100% recurrence interval.

4.3 Hydrologic Model Development

This section describes the steps taken to generate the hydrologic factors used in the XPSWMM™ model.

4.3.1 SWMM Runoff Description

Hydrologic calculations were performed in the XPSWMM™ model using Storm Water Management Model (SWMM) runoff methodology. SWMM hydrology uses a combination of drainage area size and shape, slope, land cover (pervious, impervious not connected, impervious connected), and soil infiltration parameters to generate runoff from a rain event. Discussions with City staff concluded that the SWMM hydrologic method was preferred over the “curve number” approach because of the urban land cover conditions. Although the curve number method is used in urban settings, it was originally developed for application in rural/agricultural watersheds.

The calculations were performed for each subwatershed that was delineated within the watershed. The model simulates rainfall on each subwatershed and generates runoff, accounting for initial abstraction and infiltration in determining the surface runoff. The model developed a runoff hydrograph based on the input parameters and this is entered by the model into the hydraulic portion of the software at a node.

4.3.2 Subwatershed Input Data

The Wingra West watershed was divided into 164 subwatersheds. The subwatersheds are shown on Figure 4-2. Subwatersheds were delineated based on the storm sewer maps, drainage features (such as open channel versus storm sewer), land use, and topography. For each subwatershed, hydrologic input parameters were calculated. Each subwatershed included three subcatchments based on the land use within the subwatershed. The subcatchments were defined as:

1. Directly connected impervious area (DCIA): impervious areas that drain directly to the conveyance system
2. Indirectly connected impervious area: impervious areas that drain over a pervious surface prior to entering the conveyance system
3. Pervious area: vegetated land surfaces or areas with no impervious surface

The input parameters and calculation methodology for hydrologic input parameters are described below. The XPSWMM™ model input parameters for each subwatershed are listed in Table B-2.

4.3.2.1 Subwatershed and Subcatchment Areas

The area for each subwatershed was calculated using the GIS data developed for the project. Subsequently, for each subwatershed, the areas for each of the three subcatchments were calculated. Subcatchment areas were calculated using the impervious area information provided by the City (see Section 2.5.2). How each subcatchment area was calculated is described below.

1. Total impervious area for each subwatershed was calculated based on the impervious area data from the City.

- a. The DCIA was estimated using WinSLAMM Standard Land Use (SLU) files. The SLU files estimate the source areas for typical land cover conditions for a variety of land uses. The SLU impervious area conditions were originally developed based on extensive aerial photo analyses and field verifications of urban land cover in several Wisconsin cities. As part of the source area data, the SLU files identified whether a source area was directly or indirectly connected to the municipal stormwater conveyance system. For each land use, the percentage of DCIA was calculated (see Table B-1). Based on the land use present in a subwatershed, the total DCIA was calculated.
 - b. Indirectly connected impervious area was calculated by subtracting the DCIA from the total impervious area in a subwatershed.
2. Pervious area was calculated by subtracting the total impervious area from the subwatershed area.

It should be noted that the WinSLAMM SLU files incorporate the street right-of-way as part of the land use category. For example, Medium Density Single Family Residential (No Alleys) SLU data includes the impervious areas of the associated streets and sidewalks. The City's GIS land use coverage did not include street right-of-ways under a land use category and treated street right-of-ways as a separate "land use". This meant that the calculated directly connected and disconnected impervious areas for each land use had to account for this difference between the WinSLAMM and City's GIS land use categories. As such, the street areas were subtracted from the DCIA and total impervious area in the SLU files. The percentage of DCIA was calculated based on the impervious areas outside of the street areas.

Within XPSWMM™ the indirectly connected impervious area was routed onto the pervious area within each subwatershed.

4.3.2.2 Subwatershed and Subcatchment Width

In SWMM hydrology, "width" refers to the general shape of a hydrologic unit (subwatershed) and the relationship of the surface flow path to the shape of the subwatershed. A line was drawn to represent the longest typical flow path for each subwatershed. The length of this line was calculated and the subwatershed area was divided by the flow path length to calculate the overall width. This width was then pro-rated based on the DCIA of each subwatershed. The pro-rated width for indirectly connected impervious area and pervious area was the same and was equal to the overall width minus the DCIA width. For example, if a total subwatershed width of 100 feet was calculated and the DCIA were 25 percent of the subwatershed, the DCIA width was 25 feet, and the width of the indirectly connected impervious area and pervious area was 75 feet.

It should be noted that the subwatershed width was used as a calibration parameter. See Section 5 for modifications that were made to develop the calibrated existing conditions model.

4.3.2.3 Slope

A slope for the flow path described under in Section 4.3.2.2 was calculated. The elevation at the upstream and downstream end of the flow path was assigned based on the topographic data provided by the City. The elevations were used with the flow path length to calculate the slope.

4.3.2.4 Soils and Infiltration

Soils within the watershed are classified by the HSG. HSG mapping provided by the City as part of the City's "Curve Number Generator" tool was utilized in the project. The soils conditions of the watershed are represented in the hydrologic calculations through the infiltration parameters selected for the study.

The Horton soil infiltration methodology was used within XPSWMM™, and this approach is consistent with the City’s Modeling Guidance. This methodology establishes a maximum infiltration rate, a minimum infiltration rate, and the decay rate of infiltration for each HSG. Input parameters were developed for each of HSG and Table 4-4 provides the infiltration values.

Table 4-4. Horton Infiltration Parameters Wingra West Watershed Study City of Madison, WI				
HSG ¹	Maximum Infiltration Rate	Minimum Infiltration Rate	Decay Rate	Dry Days
	(inches/hour)	(inches/hour)	(1/hour)	
A	4.0	1.0	4.0	3.1
B	2.0	0.5	4.0	4.4
C	1.0	0.2	4.0	7.0
D	0.5	0.1	4.0	9.9
Water	0	0	0	0

^{a. 1}Where soils are classified as A/D, B/D, or C/D an HSG D was assumed.

The area within each subwatershed was classified by HSG. For each subwatershed composite, infiltration parameters were developed by area-weighting by each parameter based on the amount of each HSG within a subwatershed. For example, if a subwatershed is 50-percent HSG A and 50-percent HSB B, the maximum infiltration rate would be 3.0 inches/hour.

It should be noted that the values shown in Table 4-4 are the “base conditions” values. Infiltration rates that were used as a calibration parameter may be modified to better represent actual conditions. See Section 5 for modifications that were made to develop the “calibrated existing conditions” model.

4.3.2.5 Antecedent Moisture Conditions

The antecedent moisture condition represents whether there are saturated or exceptionally dry soil conditions at the start of a storm event. In saturated conditions, the maximum infiltration rate of soils would be decreased and the depressional storage may be reduced. In dry conditions, the maximum infiltration rate may be higher than typical. For this analysis, typical antecedent moisture conditions were used and are represented by the parameters listed in Table 4-4.

It should be noted that the antecedent moisture conditions for the October 1–2, 2019 storm event were considered as part of the calibration process. See Section 5 for modifications that were made to develop the calibrated existing conditions model.

4.3.2.6 Depressional Storage

Within a subwatershed, there are surface depressions that collect runoff (puddles) and reduce the amount of runoff generated from a rainfall. Depressional storage is incorporated into the runoff calculations to account for these areas. For each subwatershed, a depression storage of 0.05 inches for impervious areas and 0.15 inches for pervious areas was included. These values meet the criteria defined in the City’s Modeling Guidance.

4.3.2.7 Internally Drained Areas

Within the Wingra West watershed, there were five internally drained areas that were identified and delineated. The internally drained areas are located in the western portion of the watershed and represent areas that have significant depressions (more significant than “depressional storage”). The internally drained areas would need to fill at least 7-feet deep with runoff prior to discharging into the stormwater drainage system. For each of these areas, a subwatershed was delineated, hydrologic parameters were developed, and the runoff was incorporated into the XPSWMM™ model. The internally drained areas were part of the 2D model. Runoff was allowed to pond in the internally drained areas and overland flow either into or out of the areas was allowed. Under the storm events considered as part of this analysis, the internally drained areas remained disconnected from the remaining portions of the study area under all events except for the largest (0.2% chance event) storm. Figure 4-3 identifies the locations of the internally drained areas.

There are additional depressional areas that do not have internally drained subwatersheds delineated. These areas may consist of backyards or other small, local depressions. These depressions are accounted for in the hydrology calculations through the depressional storage parameters described in Section 4.3.2.6. It is possible that small depressions not incorporated may have localized flooding conditions (such as individual back yards); however, the scope of this study did not allow for the evaluation of each individual area.

4.4 1D Hydraulic Model Development

The 1D hydraulic portion of the XPSWMM™ model represents the storm sewers, culverts, open channels, and detention basins that comprise the drainage system within the Wingra West watershed. The hydraulic input parameters required by XPSWMM™ vary depending on the different parts of the drainage system. The source data used to compile the hydraulic model input data is summarized below. Table C-1 and C-2 in Appendix C provides hydraulic input parameters for links and nodes from the XPSWMM™ model. Figure C-1 in Appendix C shows a layout of the model network.

4.4.1 Open Channel Conveyance System

Open channels that are part of the City’s stormwater conveyance system within the Wingra West watershed are generally included as part of the 1D hydraulic model. If a modeled pipe discharges into an open channel, that channel is included as part of the 1D hydraulic model. Other channels (generally smaller channels and those located upslope from the storm sewer system) are simulated as part of the 2D hydraulic model (see Section 4.5). The 1D open channel features define the primary channel (within the top of banks). Adjacent areas (i.e., floodplain areas) were defined in the 2D hydraulic model.

Survey data was collected for open channels at selected locations within the watershed. The survey data was used in conjunction with LiDAR data, City GIS data, and available construction plans to develop cross sections and longitudinal invert elevations for open channels. Aerial photography and site photos were used to select Manning’s n values (roughness coefficients) for the open channels.

4.4.2 Closed Conduit Conveyance System – Storm Sewers and Culverts

City-owned storm sewer mains 18-inches in diameter or greater were included in the XPSWMM™ model, per the project's scope of work. Additionally, selected storm sewers that were smaller than 18 inches were included if they were deemed critical to representing the conveyance systems performance. Smaller storm sewers, private storm sewers, and inlet leads were not included in the model because this phase of the project is focused on identifying and resolving major flooding issues. Future phases of the process will likely incorporate smaller components of the conveyance system to aid in the design of specific management infrastructure.

Each storm sewer “link” requires upstream and downstream invert elevations, pipe length, and Manning's n (roughness). Additionally, hydraulic minor losses were added to the model.

The source of the closed conduit conveyance system data for the model included GIS data provided by the City and information from the City's GTviewer system, construction plans, and field surveys at select locations. Where missing data remained, assumptions were developed to fill data gaps. The assumptions made are listed below.

1. Missing invert elevations were obtained by interpolating between the nearest upstream and downstream invert elevations. Where known bounding inverts were unavailable (as in the upper most reaches of the storm sewer), the next downstream slope was continued upstream.
2. Where pipe sizes were unknown, the size of the nearest upstream pipe was used.
3. Missing pipe material was assumed to be the same as the nearest upstream pipe.

Entrance and exit losses (minor losses) were added to storm sewers and culverts based on the Modeling Guidance document. Losses were split evenly between the entry pipe and exit pipe at a storm access structure (SAS). For example, at a 90-degree SAS, a total loss of 0.5 was assigned. An exit loss of 0.25 was assigned to the influent pipe and an entry loss of 0.25 was assigned to the effluent pipe. At a tee, or cross SAS structures, a loss of 0.5 was applied to each pipe.

4.4.3 Existing Inlet Capacity

The majority of runoff in the Wingra West watershed enters the drainage system through surface inlets. Most typically, the inlets are within streets, along the curb and gutter. The inlets include a grate within the gutter and an open area within the casting along the curb face. The location and capacity of inlets can impact the stormwater conveyance systems' performance. If there is insufficient inlet capacity, runoff cannot enter the stormwater conveyance system, and may pond on the surface or flow overland to another location. The capacity of inlets within the watershed was incorporated into the model by aggregating inlets at the subwatershed level. A composite rating curve was developed to represent and aggregate inlet capacity for each subwatershed. Runoff from each subwatershed is restricted by the inlet capacity rating before it enters the storm sewer system.

Runoff may also enter the drainage system through overland flow into open channels or ponds, or through culverts. Subwatersheds that have these features were not restricted with inlet capacity.

A detailed description of the inlet capacity methodology and supporting documentation is included in Appendix E. A brief description of the inlet capacity analysis is provided below.

Existing inlets were categorized based on their inlet type (such as Neenah R-3067) and condition (sag or slope). A rating curve for each type of inlet that is present was developed using HEC-22 methodology (rating curves are included as Charts E-1 through E-11 in Appendix E). At the subwatershed level, a composite rating curve was developed based on the number and type of City inlets present within the subwatershed. Table E-1 shows the number and type of inlets within each subwatershed. Table E-2 shows the composite rating curve developed for each subwatershed.

Two tables were prepared to evaluate the inlet capacity in conjunction with the XPSWMM™ model. Table E-3 in Appendix E compares the runoff from a subwatershed to the cumulative inlet capacity. Table E-4 in Appendix E compares the capacity of existing pipes to the inlet capacity upstream of the pipe. The inlet capacity was compared at two water surface depths: 1) 0.25-feet which would be a level at which nuisance ponding/flooding may start occurring, and 2) 0.55-feet. A depth of 0.55-feet is used to approximate the water depth at which the 25-year flood control goal would not be met for a typical 36-foot wide road (0.2' above the centerline).

4.4.4 Existing Detention Ponds

Nine existing detention ponds were identified within the watershed and incorporated into the 1D component of the XPSWMM™ model. These ponds are the larger detention features and have the most impact on the Wingra West stormwater conditions. A combination of available site plans, aerial photography, LiDAR data, and site visits was used to determine the appropriate model input data for the detention ponds. Input data included the stage-area relationship to represent the storage in the pond and data to represent the pond outlet. The detention basins included under the existing conditions are summarized in Table C-2 in Appendix C. The locations of detention basins included in the XPSWMM™ model are on Figure 4-4.

There are other smaller, privately-owned detention facilities that may serve a single property within the watershed. The smaller detention ponds have minimal effect on the stormwater flooding conditions which are the focus of this project.

4.4.5 Open Water/Backwater Effects

The Wingra West watershed discharges ultimately into Lake Wingra after passing through the UW Arboretum. Based on an evaluation of Lake Wingra's water elevation, there is no backwater effect from Lake Wingra water levels on the stormwater conveyance system. The outlet of Manitou Pond is at elevation 855.7. The storm sewer outlet along Manitou Way (the second discharge point from the Wingra West watershed) is at invert elevation of 855.4. These elevations are well above the 1 percent Federal Emergency Management Agency (FEMA) floodplain elevation (848) for Lake Wingra. Additionally, the H&H analysis completed as part of the Lake Wingra Dam Investigation and Analysis (Strand, 2006), lists the 1 percent storm peak water surface elevation for Lake Wingra of 848.61.

4.5 2D Hydraulic Model Development

The 2D portion of the hydraulic model is utilized to represent the overland flow across the land's surface. The 2D model uses topographic data to simulate the overland flow which may occur throughout the watershed in areas, such as along streets, between buildings, or over undeveloped lands. The 2D model is connected to the 1D model to allow runoff to pass from the 1D elements in the model into the 2D part of the model and vice-versa. The components of the 2D model are further described in the sections below.

4.5.1 Description of Areas Modeled in 2D

Except for defined open channels (see Section 4.4.1) and detention ponds (see Section 4.4.4), all other land areas of the Wingra West watershed are modeled in 2D. Specific information on how the 2D area is modeled is provided below.

4.5.2 Topographic Data

A triangular irregular network (TIN) was created within XPSWMM™ to represent the topography within the study area. The City-provided elevation raster (Citywide_Raster_small) was used as the basis for the TIN creation. This raster file was clipped to the approximate project extents. It was converted to an Environmental Systems Research Institute (ESRI) grid format and imported into the XPSWMM™ model.

Within the Wingra West watershed, there are two areas where the TIN surface created by XPSWMM™ was modified. There are existing walls that are not depicted by the topographic data used to generate the TIN. The walls prevent runoff from flowing across the ground and were hydraulically important to the model. Within XPSWMM™, ridge breaklines were used to add the walls. Aerial photography was used to digitize the walls. The locations of the walls are described below.

1. **Beltline Highway:** There are walls along the north side, south side, and within the median of the Beltline Highway northwest of Midvale Boulevard (near where Hammersley Road is bisected by the highway). Additional walls are present in other locations along the Beltline Highway; however, they were not relevant to the drainage in the watershed and, thus, were not represented in the model.
2. **UW – Arboretum:** There is a stone wall along the south/southeast side of the intersection of Nakoma Road and Manitou Way, along the boundary of the UW-Arboretum. The wall is generally adjacent to the location of Manitou Pond, and the wall prevents overland flow from the street into the Arboretum except at one opening. Street flow also drains around the south end of the wall onto the Nakoma Golf Club property.

4.5.3 2D Grid

XPSWMM™ uses a grid comprised of squares to complete the 2D model calculations. Water enters the grid and is transferred between grid cells. Elevations are assigned to the vertices and center of each grid cell from the topographic data. The grid size for this project is 10-foot by 10-foot. The 2D grid covers the entire project area.

4.5.4 2D Land Use and Roughness Values

As part of the 2D model, the land cover is defined, and each land use is assigned a Manning's n. This factor represents the roughness of the land's surface and ability to impede flow. For the Wingra West watershed, the land cover was divided into seven categories and each category was assigned a unique Manning's n value. The land cover categories were right-of-way, commercial, park, residential, water, impervious, and pervious. The land cover was imported to XPSWMM™ from GIS data developed for the watershed.

The land cover categories were selected based on available data. For areas with impervious area delineations (non-single family residential, parcels), the data was used to classify land use as either impervious or pervious and a Manning's n was assigned.

Residential parcels, parks, and right-of-ways within the study area do not have impervious areas delineated. For residential parcels, an impervious percentage for each parcel was included as part of the City GIS database. This impervious percentage was used to estimate a composite Manning's n for residential parcels. The building areas were excluded from this calculation because there will not be overland flow across building roofs. The City provided data with the estimated impervious area within the right-of-way (streets and sidewalks). This data was used to estimate the percent impervious of the street areas and a composite Manning's n was calculated. Parks were assigned a roughness value for pervious area.

The Manning's n corresponding to each land use is provided in Table 4-5. The land use for the 2D roughness is shown in Figure 4-5.

Table 4-5. 2D Manning's Roughness Wingra West Watershed Study City of Madison, WI	
Land Use	Manning's n
Right-of-Way	0.15
Commercial	0.14
Impervious	0.1
Park	0.24
Pervious	0.24
Residential	0.2
Water	0.01

4.5.5 Inactive Areas

Inactive areas are defined as areas where surface water cannot flow because of physical barriers (such as buildings) or areas already represented by the 1D model. Inactive areas were identified and added to the 2D model to represent building footprints and areas that were represented by 1D open channels or ponds. These are areas where the 2D modeled flow will not occur. Building footprints were imported from the Dane County GIS data. Open channel and pond extents were delineated by BC to correspond with the areas modeled in 1D.

4.5.6 1D/2D Interface

The 1D and 2D models interfaced in two types of areas: (1) model nodes, and (2) 1D/2D interface lines. The interface configurations are described below.

1. **Model Nodes:** Runoff can be transferred from the 1D storm sewer network onto the 2D grids at selected nodes within the model. As described previously, inlet capacity was accounted for at the subwatershed level, and these nodes restrict the flow of runoff into and out of the 1D portions of the model. In the immediate area surrounding an inlet capacity node, other 1D nodes are "sealed" to prevent runoff from bypassing the inlet capacity node and entering or exiting the 1D system unrestricted. In addition to the inlet capacity nodes, runoff is allowed to enter/exit the 1D network at model nodes that are not in the immediate area of an inlet capacity node.
2. **1D/2D Interface Lines:** Interface lines are included around the perimeter of open channels and detention ponds that are modeled in 1D (see Sections 4.4.1 and 4.4.4). The interface lines allow runoff to transfer from the 1D area onto the 2D grid.

4.5.7 2D Boundary Conditions

The boundary of the 2D model—the perimeter of the 2D grid defined for the study—is created in the model to be closed and acts as a vertical wall. The model results were reviewed, and overland flow outfalls were added (termed by XPSWMM™ as "head boundaries") at locations where water ponded along the "edge" of the model. These are locations where overland flow leaves the study area and enters an adjacent watershed. Overland flow outfalls are listed below.



1. Along the east side of Manitou Way, adjacent to Nakoma Golf Club at the open channel at the north side of the golf course.
2. At Nakoma Road, northeast of the intersection of Nakoma Road and Manitou Way.
3. At the Southwest Bike Path, northeast Parman Terrace.
4. At Odana Road, east of Gately Terrace.
5. At Chatham Terrace, south of Tokay Boulevard.
6. At Verona Road, south of the Beltline Highway.

Each overland flow outfall was assumed to be a free outfall (no tailwater). It was also assumed that there is not overland flow that enters from any areas adjacent to the Wingra West watershed.

4.5.8 Peer Review #1

As part of the existing conditions model development process, a “Peer Review” occurred. For the peer review the XPSWMM™ model was provided to the City and AE2S (City consultant for Spring Harbor watershed study). The model was reviewed, and comments were provided to BC. The peer review was discussed at the meeting with City, AE2S, and BC staff on December 9, 2019. Based on the peer review comments, and meeting discussion, updates to the existing conditions model were made. A summary of Peer Review #1 is included in Appendix G.

4.6 Special Conditions

Unique consideration within the Wingra West watershed related to stormwater runoff hydrologic/hydraulic modeling are summarized below.

1. As mentioned in Section 2.3.1, the Odana Pond is used by MG&E as part of a groundwater recharge project. The flow rate from the pond averages 100 gpm, which is equivalent to 0.22 cubic feet per second (cfs). The flow rate is insignificant relative to the inflow and outflow rates during discrete rain events, and thus, was not factored into the XPSWMM™ model.
2. The culvert crossing under the Southwest Commuter Bike Path at Waite Circle changed configuration after October 2019. All existing conditions and calibration modeling conducted to date used the culvert opening as it existed in 2018 (a 60-inch round culvert opening). The reconfigured culvert opening (post October 2019) was designed and installed to be equivalent to the stone arch opening which existed before the 60-inch culvert was installed in 2017. Modeling analyses under “existing conditions” in the next phase of the project will need to incorporate the culvert opening as it exists today.

4.7 Existing Conditions Non-Calibrated Model Results

The XPSWMM™ model was constructed and executed for each of the design storms (identified in Section 4.2.1) and the measured storm events (identified in Section 4.2.2) under the existing land use and conveyance system conditions. Table D-1 in Appendix D summarizes the peak water surface elevation and the duration of flooding at selected locations throughout the Wingra West watershed during the design storms. Figure 4-6 provides the location of each of the reporting locations in Table D-1.

Section 5

Model Calibration

The scope of work for the calibration effort as specified in the project's contract is identified below.

“Calibration will be attempted for no more than three (3) 2019-monitored storm events. The three (3) events will be selected by City, AE2S, and BC. For purposes of this project, the model will be considered to be calibrated if the overall average model bias for water surface elevations is within +/- 5% with reasonable effort made to minimize the largest absolute error while at the same time balancing that effort with the relative importance of the model results at each monitoring site location. The largest absolute error at each monitored location is defined as +/- 25 percent. It is understood that there may be some circumstances where calibration cannot be accomplished.”

The calibration process focused on identifying consistent model input parameters that would provide reasonably comparable results for each of the three storm events. However, it is understood that the hydrologic conditions, and how runoff is generated from the land surface will vary from storm to storm. Also, it is commonly found that hydrologic factors that best represent larger rain events may not be appropriate for use in smaller rain events. The focus of the calibration effort was placed on the largest monitored storm event (October 1–2, 2019) because the goal of this study is to assess flooding from large storm events. If this model is used in the future to analyze smaller rain events, additional review of the calibration parameters should be conducted, and modifications should be considered to better represent the expected runoff from smaller storms.

As part of the model calibration process, the following steps were taken:

1. The overall watershed was evaluated with various adjustments to H&H factors to assess the impact of modifications and compare the results to the Odana Pond and Manitou Pond monitored stage data.
2. Odana Road/Hilltop Drive flow data was provided by the USGS. (This data was not available until the later stages of the calibration process.)
3. Calibration to the Odana Road/Hilltop Drive flow data was conducted.
4. Iteratively with the Odana Road/Hilltop Drive flow calibration, the overall impact to the watershed modeled results was considered and compared to the monitored locations at Odana Pond, Chippewa Drive, and Manitou Pond.

5.1 Monitored Pond Level and Flow Data

There are four monitoring locations within the Wingra West watershed that could be used in the calibration process.

1. Manitou Pond Elevation: monitored by the City, data obtained from Trimble Unity website
2. Odana Pond Elevation: monitored by MG&E, data obtained from MG&E – via the City
3. Southwest Commuter Bike Path at Waite Circle Culvert: monitored by the City, data obtained from Trimble Unity website

4. Odana Road/Hilltop Drive Storm Sewer Flow: monitored by USGS, data obtained via email from USGS

5.2 Selected Runoff Events

The rain events selected for the calibration process are defined in Section 4.2.2. The events were selected based on the completeness of recorded data and the severity of the rain event. As mentioned previously, significant flooding events did not occur during the monitoring period. The October 1–2, 2019 event was the largest rain (3.0 to 3.6 inches over 19 hours). This event (based on total rainfall depth and duration) falls within the range of a 50% to 10% recurrence interval based on NOAA Atlas 14 Volume 8 Version 2 data. The August events (total rain depth and duration) both are greater than a 100 percent annual exceedance probability.

5.3 Calibration Process

An extensive calibration process was conducted on the Wingra West watershed using the three selected measured rain events in August and October of 2019. The process is fully documented in a Technical Memo found in Appendix H. The Technical Memo contains the process, parameters modified, and results in tabular and graphical formats.

5.4 Calibration Results

Calibration results are provided in Appendix H. As a summary, Tables 5-1 through 5-4 show the calibration parameters in comparison to the measured results.

Table 5-1. Odana Rd/Hilltop Dr Calibration Results – Peak Flow Wingra West Watershed Study City of Madison, WI			
	Peak Flow Rate		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Gauged Data	9.8 cfs	7.1 cfs	10.3 cfs
Modeled Results	9.8 cfs	7.9 cfs	10.9 cfs
% Difference	0%	12%	5%

Table 5-2. Odana Rd/Hilltop Dr Calibration Results – Volume Wingra West Watershed Study City of Madison, WI			
	Volume		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Gauged Data	0.36 ac-ft	0.32 ac-ft	2.12 ac-ft
Modeled Results	0.54 ac-ft	0.50 ac-ft	2.27 ac-ft
% Difference	49%	58%	7%

Table 5-3. Odana Pond Calibration Results – Pond Level (ft)Wingra West Watershed Study
City of Madison, WI

	Peak Pond Level (ft)		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Starting Pond Level	976.8	977.0	977.5
Gauge Peak Pond Level	977.7	977.9	979.8
Modeled Peak Pond Level	978.1	978.2	980.1
Absolute Difference (ft.)	+0.4	+0.3	+0.4
% Difference (calculated based on increase in pond level)	42%	29%	16%

Table 5-4. Manitou Pond Calibration Results – Pond Level (ft)Wingra West Watershed Study
City of Madison, WI

	Peak Pond Level (ft)		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Starting Pond Level	855.7	855.7	856.1
Gauge Peak Pond Level	857.8	857.4	859.7
Modeled Peak Pond Level	858.5	858.0	860.5
Absolute Different (ft.)	+0.7	+0.7	+0.8
% Difference (calculated based on increase in pond level)	33%	39%	23%

5.5 Peer Review #2

As part of the model calibration process, a second “Peer Review” occurred. For the peer review, the calibrated XPSWMM™ model and a memo describing the calibration process was provided to the City and AE2S (City consultant for Spring Harbor watershed study). The model was reviewed and comments were provided to BC. The peer review was discussed at the meeting with City, AE2S, and BC staff on February 10, 2020. As a result of the peer review, there were no modifications made to the calibrated model. A summary of Peer Review #2 is included in Appendix I.

5.6 Calibration Conclusions

At all comparison points, the shape and timing of the model results compared well to the monitoring data. Overall, the average percent difference at the four measurement locations is 31 percent for the August 5 event, 34 percent for the August 11 event, and 13 percent for the October 1 event. For the October 1 event, the overall average difference goal of less than 5 percent is not met, however the largest percent difference (23 percent) at a monitoring location is less than the 25 percent difference goal for individual locations. These goals were not met for the August 5 and August 11 events. The focus of the calibration effort was placed on the largest monitored storm event (October 1–2, 2019) because the goal of this study is to assess flooding from large storm events. Additionally, a focus was placed on establishing calibration parameters based on the Odana Road/Hilltop Drive flow gauge. At this gauge, the peak flow target was met for each storm, and the volume matched well for the October event.

It is commonly found that hydrologic factors that best represent larger rain events may not be appropriate for use in smaller rain events, such as the August events. The calibration was considered to be accomplished because for the purposes of this study we are trying to identify a single set of parameters that can be used for large storm events, such as the October event. In this event, the individual criteria for each comparison location was met.

Section 6

Model Results

6.1 Evaluation of Design Storm Model Results

The calibrated XPSWMM™ model executed for each of the design storms. Table D-2 in Appendix D summarizes the peak water surface elevation and the duration of flooding at selected locations throughout the Wingra West watershed. Figure 4-6 provides the location of each of the reporting locations in Table D-2.

The Existing “Maximum Water Depth” maps for each modeled event are found in Figures 6-1–6-7. (rain events from the 50% chance event to the 0.2% chance event). As expected, widespread surface flooding is shown for the larger rain events (2, 1, and 0.2% chance events). It should also be noted that presence of shallow water (0 – 0.25 feet) in the street right-of-way under the smallest modeled event (50% chance event), does not necessarily indicate “flooding” or a stormwater conveyance capacity problem. Runoff water is expected in the streets during this event.

6.2 Model Results Evaluation

By reviewing the 20% and 10% chance events, the most flood-prone areas can begin to be identified. Flooding depths greater than half a foot in the 20% and 10% chance events are indications of flood-prone areas.

The areas that appear to be most flood-prone, based on a review of the 10% chance event, include:

1. Odana Road from Research Park Boulevard to Medical Circle (including Medical Circle and parts of the West Beltline Highway).
2. Odana Road from Whitney Way east to Dearholt Road.
3. Odana Road from Hilltop east to Parman Terrace.
4. Whitney Way from Hempstead Road north to Tokay Boulevard.
5. Dearholt Road from Holiday Drive south to Milward Drive.
6. Schroeder Road from Hampshire Place east to Whitney Way.
7. Midvale Boulevard from the SW Bike Path north to Waite Circle and including Waite Circle.
8. Nakoma Road from Whenona Drive northeast to Manitou Way.
9. Manitou Way from Tumalo Trail northeast to Nakoma Road.
10. The intersection of Nakoma Road and Manitou Way
11. The intersection of Cherokee Drive, Chippewa Drive, and Miami Pass

The factors causing the flooding conditions are not fully determined at this time. Several conditions can influence the flooding including inlet capacity, storm sewer capacity, overland flow from other sources, or a combination of all of these conditions. During Phase 2 of the project, these areas will be further evaluated to assess the causes and develop mitigation measures.

6.2.1 Comparison to City Flood Control Goals

The existing conditions flooding results were compared to the City’s flood control goals to quantify the performance of the stormwater conveyance system in the Wingra West watershed. The

performance of the system relative to greenway crossings, pipe capacity, inlet capacity, and street flooding were considered.

6.2.1.1 Greenway Crossings

At locations where a greenway crosses under a street, the City's goal is to safely pass the 1% chance event without overtopping the street. The crossing was determined to be overtopped if the elevation at the upstream side of the culvert is above the street crossing elevation. Within the Wingra West watershed there is one greenway crossing. The performance, whether the street is overtopped, at these locations is summarized in Table 6-1.

Table 6-1. Greenway Crossing Performance Wingra West Watershed Study City of Madison, WI		
Location	1%, 24-hr Design Storm Performance	Notes
Nakoma Road	Overtopped	Greenway located in Nakoma Park. Storm sewer within Nakoma Park is overtopped and flow continues into Nakoma Road.

6.2.1.2 Pipe Capacity

The City's goal is to eliminate surcharging from the storm sewer system onto city streets for up to the 10% chance event. The pipe capacity was determined to be exceeded if the peak water surface elevation at the upstream end of the pipe was above the ground surface elevation. Within the XPSWMM™ model, there are a total of 553 pipes, of which 245 are surcharged at the upstream end during the 10% chance event. This equates to 44 percent of the pipes not meeting the pipe capacity goal. Figure 6-10 graphically displays the pipes that have their capacity exceeded.

The 553 pipes result in a total pipe length of 83,900-feet, of which 33,100-feet are surcharged during the 10% chance event. This equates to 39 percent of the pipe length not meeting the capacity goal.

6.2.1.3 Inlet Capacity

For inlet capacity, the flood mitigation goal is to allow no more than 0.5 feet of stormwater ponding above storm sewer inlets rim elevations at inlet restricted low-points for the 10% chance event. As part of this study, inlet capacity was evaluated at the subwatershed level (see Section 4.4.3 for additional detail). Within the study area, there are 141 subwatersheds that were evaluated for inlet capacity (remaining subwatersheds were not evaluated because they drain directly to an open channel or pond). Of the 141 subwatersheds with inlet capacity incorporated, 98 (70 percent) have ponding depth of greater than 0.5 feet above the inlet rim elevation during the 10% chance event. This is graphically displayed on Figure 6-11.

6.2.1.4 Street Flooding

Within streets, the City's goal is to maintain drivability of municipal streets for the 4% chance event. Drivability is defined as having no more than 0.2 feet of flooding at the center of the street. Within the watershed there are a total of 41.6 miles of streets, of which 8.3 miles have a water depth of more than 0.2 feet at the street centerline during the 4% chance event. This equates to 20 percent of the streets not meeting the drivability goal. Street areas where the flood mitigation goal is not met are identified on Figure 6-12.

6.2.1.5 Structure Flooding

For structures (buildings), the City's goal is to prevent structure flooding for up to and including the 1% chance event. Structure flooding is defined as having 0.5 feet of more water within 5 feet of a building. To assess structure flooding the model results for maximum flooding depth were intersected with the buildings (including a 5-foot buffer) to determine if the maximum water depth is exceeded. Under existing conditions, structure flooding is identified for all storm events considered (50% chance through 0.2% chance events). Under the existing conditions for the 1% chance event there are 167 structures impacted by flooding.

6.2.2 Comparison to Known Flooding in Watershed

In Section 1-3, known flooding areas (based on City staff accounts) in the watershed were identified. The areas that were identified are shown on Figure 1-4. The model results were reviewed for these known flooding areas. Flooding is observed in the model for each of the areas. A summary of the known flooding locations (identified by City staff), and how the model depicts flooding in these areas, are described below.

1. Intersection of Midvale Boulevard and Southwest Bike Path

- a. **Flooding Description:** Flooding frequently occurs in this area. Overland flow from the area often flows in two paths: (1) north along Midvale Boulevard to Waite Circle, or (2) into an easement south of the bike path that flow east through open channels and storm sewers towards Chippewa Drive.
- b. **Model Results:** Flooding and overland flow to the north from this area begins in the 50% chance event. At the 10% chance event overland flow to the east also occurs. (See Location #10 on Figure 4-6 and Tables D-1 and D-2)

2. Waite Circle

- a. **Flooding Description:** Overland flow from Midvale Boulevard flows east along Waite Circle to the eastern end of the cul-de-sac. Street flooding occurs frequently, and inadequate inlet capacity is likely a factor. Severe flooding occurred during June and August 2018 and was the result of inadequate culvert capacity just downstream of Waite Circle. A stone arch culvert beneath the Southwest Bike Path (located just southeast of Waite Circle) was slip-lined with a 60-inch storm sewer in 2017 to prevent the arch from collapsing. The 60-inch storm sewer further limited the capacity of the stone arch.
- b. **Model Results:** Overland flow from Midvale Boulevard onto Waite Circle and flooding at the east end of Waite Circle begins occurring in the 50% chance event (flood depths up to 0.5-feet at the east end). In the 1% chance event, substantial portions of the street are inundated with flood depths of more than 1-foot. (See Location #8 on Figure 4-6 and Tables D-1 and D-2)

3. Intersection of Chippewa Drive and Council Crest

- a. **Flooding Description:** This intersection floods frequently.
- b. **Model Results:** Overland flow (depths up to 0.25-feet) is seen in this intersection during the 50% chance event. During larger events depths in excess of 0.5-feet is seen. (See Location #7 on Figure 4-6 and Tables D-1 and D-2)

4. Intersection of Cherokee Drive, Nakoma Drive, and Manitou Way:

- a. **Flooding Description:** Overland flow along Cherokee Drive overtops Nakoma Drive and flows onto Manitou Way, towards a low point to the southwest. Stormwater ponds in the low-point and flows overland into the UW Arboretum and Nakoma Golf Course.

- b. **Model Results:** In each of the design storms that were modeled, flooding in excess of 0.5 feet is seen in the intersection of Cherokee Drive and Nakoma Drive and also in the low point on Manitou Way. In the 1% chance event, depths in excess of 1-foot are seen. (See Locations #1 and 3 on Figure 4-6 and Tables D-1 and D-2)
- 5. **Intersection of Dearholt Road and Milward Drive:**
 - a. **Flooding Description:** This intersection has experienced re-occurring flooding.
 - b. **Model Results:** Flooding in the intersection of up to 0.5 feet is seen beginning in the 50% chance event. In the 10% chance event, the Odana Pond water surface elevation reaches the elevation of the intersection. (See Location #16 on Figure 4-6 and Tables D-1 and D-2)
- 6. **Orchard Ridge Valley Park:**
 - a. **Flooding Description:** This park and nearby roads/houses flooded during the August 2018 storm and water stays ponded in the park for extended periods of time.
 - b. **Model Results:** During the August 2018 storm event, surrounding roads were flooded with up to three-plus feet of water. Under the design storm events at the 4% chance event, water begins to impact the surrounding roads. Modeling shows extended draw-down period after storm events.
- 7. **Whitney Way, South of the Beltline Highway:**
 - a. **Flooding Description:** This area has flooded and become impassible during large rain events. (See Location #23 on Figure 4-6 and Tables D-1 and D-2)
 - b. **Model Results:** Under the 50% and 20% chance events, water depths of up to 0.25-feet are seen in Whitney Way. During the 25% chance event, there is up to 1.0-feet of water. (See Location # 21 on Figure 4-6 and Tables D-1 and D-2)

6.2.3 Comparison to Focus Group Flooding Reports

As part of the public engagement effort for this project, “Focus Group” meetings were conducted (see Section 7 for additional information). The focus group meetings were focused on allowing City and BC staff to gain an understanding on past flooding conditions that were experienced by residents. The flooding described by residents during focus group meetings is similar to what is depicted on the flood inundation mapping.

6.3 Discussion of Long Duration, Back-to-Back Model Results

An additional design storm model run was conducted to represent the extreme condition of “back-to-back” 1% chance events occurring. Figure 6-8 is a hyetograph of the rain event showing the peak rain intensities occurring 12 hours apart. Another way to describe this condition would be having two 6.6-inch rain events occurring within 36 hours. The modeled results of the maximum water depth map for this event is shown on Figure 6-9 and tabular results are shown in Table D-2. Under this event, extensive areas of flooding are shown with the most severe areas indicated at Whitney Way (south of the Beltline); Dearholt Road /Milward Drive; Waite Circle, Chippewa/ Cherokee Drive; and Nakoma Road/Manitou Way.

6.4 Model Uncertainty

In general, all models are approximations, and as such, there is a certain amount of uncertainty in the results. This uncertainty is due to approximations in the input data, simplification of the methods used to calculate flow and level, uncertainty in the measured flow and level data, etc. This model is built following the City's Modeling Guidance document and is calibrated to monitored storm events as described in previous sections. The model was constructed at the watershed-level and is intended to identify flooding problems at that scale. It can be used to determine if the City's flood control goals are met within the watershed. Caution should be exercised when evaluating flooding problems at finer scales, additional refinement of model input parameters may be required.

The model calibration was focused on developing a single set of input parameters that would represent large storm events. Additionally, only a limited amount of calibration data was available for this study. The number of field monitoring locations and the length of the monitoring period were limited. If this model is used in the future to analyze smaller rain events, additional review of the calibration parameters should be conducted, and modifications should be considered to better represent the expected runoff from smaller storms (storm events smaller than the design storms considered in this analysis, such as the August 2019 storm events included as part of the calibration).

Alternatively, the October 2019 storm event, which was the largest calibration event, was less than a 10-year storm event. There is uncertainty with how model input parameters and the results associated with them project to larger design storm events, such as the 1% chance event. It is believed that the calibrated model accurately depicts the impacts of flooding from large storm events because the input parameters are within accepted ranges and the model results correlate to anecdotal flooding information from both City staff and residents.

As part of the design and implementation of flood mitigation solutions, the City may wish to further evaluate the model uncertainty and consider how mitigation solutions could be impacted.

1. **Design flexibility.** To address model uncertainty, as well as uncertainty associated with changing future conditions, design flexibility could be considered. An example of design flexibility is to consider increases (or decreases) in pipe sizes as part of a storm sewer improvement flood mitigation measure. For instance, a 48-inch diameter storm sewer may be identified as the required size to provide the desired LOS (elimination of surcharging from the 10% chance event). Increased pipe sizes could be considered to determine the added LOS that is provided (i.e., is surcharging prevented in the 4% chance event?). This can then be evaluated to determine if it provides a cost-effective factor of safety/increase in LOS.
2. **Sensitivity analysis.** A sensitivity analysis could be conducted to determine how changes to model input parameters impact the model results and performance of mitigation measures. If changes to input parameters result in only limited impacts, the level of uncertainty associated with the model would be decreased.

Section 7

Public Engagement

As part of the Wingra West watershed study, the City carried out an extensive public information effort with assistance from BC. In addition to various social media and web-based communication methods, public meetings were held as summarized below.

7.1 Public Information Meeting #1

An initial PIM was held on May 1, 2019, at Cherokee Middle School. According to the sign-in sheet, 55 residents attended the meeting. The purpose of this meeting was to inform the public of the initiation of the study, provide an overview of what will be accomplished during the study, and to collect feedback from residents on flooding experienced. Residents also had the opportunity to request neighborhood “focus group” meetings with City and BC staff. Based on resident requests, focus group meetings were held with smaller groups in specific geographic areas that have experienced flooding. Additional information on the PIM and the watershed is provided on the City’s project website: <https://www.cityofmadison.com/engineering/projects/wingra-west-watershed-study>

7.2 Initial Focus Group Meetings

During the initial phase of the Wingra West watershed study, five focus group meetings were held. The meetings discussed flooding issues that residents have experienced and allowed for additional information to be collected. The location of each meeting is provided below and shown on Figure 7-1.

1. Waite Circle (June 28, 2019)
2. Nakoma Road and Manitou Way (September 12, 2019, 17 attendees)
3. Chippewa and Cherokee Drive (September 5, 2019, 21 attendees)
4. Odana Pond/Odana Hills Park (September 12, 2019, 23 attendees)
5. Orchard Ridge Valley Park (September 19, 2019, 16 attendees)

7.3 Public Information Meeting #2

A second PIM was held virtually (due to the Covid-19 pandemic) on July 23, 2020. The PIM was attended by 55 residents (based on a count of people during the presentation). The purpose of this meeting was to update the public on the status of the study, provide an overview of the work conducted to date, and to display flood inundation mapping for the watershed. The PIM included a presentation, question and answer session, and focus group break-out meetings. The focus group breakout meetings were held for each of the initial focus group areas listed in Section 7.2. These focus group meetings were held simultaneously. Flood inundation mapping for the 10%, 1%, and August 2018 storm event was shared with the focus groups. A copy of the PIM #2 presentation is available on the City’s project website listed above.

7.4 Public Information Meeting #3

The third PIM was held virtually (due to the Covid-19 pandemic) on June 17, 2021. The PIM was attended by approximately 29 residents (based on a count of people during the presentation). At this meeting, information on the selected solutions were shared with residents. The PIM included a

presentation, question and answer session, and focus group break-out meetings. The focus group breakout meetings were held for the stand-alone flood mitigation solutions described in Section 10. These focus group meetings were held simultaneously. A copy of the PIM #3 presentation is available on the City's project website listed above.

Section 8

Proposed Solutions Considerations

Upon completion of the existing conditions portion of this project (Phase 1), which is summarized in Sections 1 through 6 of this report, those portions of the report were reviewed by the City and those sections were considered “final.” The project then prepared to move into the “Phase 2” scope of work. As described in the existing agreements between the City and BC, the Phase 2 tasks are listed below. These tasks outline the general type of proposed solutions that were considered and evaluated in this study.

1. Evaluate Flood Mitigation Alternatives
 - a. Volume Control: BC evaluated the use of “Volume Control” (VC) infrastructure, also commonly referred to as Green Infrastructure (GI). These measures would be distributed throughout the watershed to provide infiltration of stormwater and ultimately work towards meeting the LOS goals for the Wingra West watershed.
 - b. Peak Flow Control: BC conducted this analysis to focus on “Peak Flow Control Infrastructure” (PFCI) and evaluate approaches to achieving the targeted LOS for stormwater management within the Wingra West watershed. Peak flow control includes a variety of approaches to convey or store runoff that is currently not being managed to the City’s performance goals. Specific components and approaches are described in detail in Section 9.
2. Public Engagement
 - a. During this phase of the project, additional opportunities for public interaction were conducted.

Section 9

Proposed Solutions Development

The proposed solutions development process focused on identifying “Peak Flow Control” (PFC) solutions to resolve flooding. PFC solutions are defined by the City of Madison as any stormwater control measure that has the ability to store or convey water but not infiltrate water.

An evaluation of the flood control benefits of volume control (VC) measures, commonly referred to as green infrastructure (GI), as a proposed solution for the Wingra West watershed was considered and is being analyzed separately.

9.1 Overall Evaluation Process Methodology

The process utilized to evaluate potential solutions, and ultimately to select solutions proposed for implementation, is described in the following sections. This section (Section 9.1) includes the process used for solution development. Section 9.2 describes various processes considered, for both solutions that were selected and not selected.

9.1.1 Data Review

To commence the solutions development process, the existing conditions results were further reviewed to identify constriction points within the watershed. Constriction points were identified by considering existing flooding conditions and identifying the cause, or causes, of flooding at individual areas. Constriction points identified included the following types of areas: where a larger storm sewer discharges into a smaller sewer, a storm sewer that is undersized, inadequate inlet capacity, and/or the lack of an overland flow path.

Additionally, pertinent data within the watershed was reviewed to further determine restrictions to implementation of potential solutions. The following restrictions were identified:

- American Transmission Company (ATC) overhead power lines are located on the south side of the Beltline Highway. Construction of solutions within the corridor along the power lines would not be considered feasible. However, there are existing storm sewers crossing under the power lines and it was assumed additional crossings could be implemented.
- A MG&E high pressure gas main is located under the Southwest Bike Path. This gas main was identified as part of the Waite Circle culvert construction and cannot be impacted/relocated.
- The UW-Arboretum is listed on the National Register of Historic Places. Impacts to the UW-Arboretum would require coordination; however, it was assumed that increases in peak flow discharges to the Arboretum would be acceptable. Without increases in peak flow into the UW-Arboretum, the flood control goals would be difficult, or impossible, to meet.

9.1.2 Solution Brainstorming

Following the initial data review, a meeting was held on May 4, 2020, with City of Madison Engineering Staff and BC to discuss the initial data review, consider various constriction points across the watershed, discuss conceptual scenarios, and identify potential opportunities for flood mitigation measures.

9.1.3 Evaluation of Potential Solutions

Following the solutions brainstorming, BC evaluated various potential solutions to flooding. The calibrated existing conditions XPSWMM™ model developed as part of Phase I of this study was utilized to evaluate the flood control performance of the various potential solutions. Within the XPSWMM™ model, the hydraulic input parameters for various components of the storm water conveyance system were modified to simulate potential improvements. The evaluation of various potential solutions is described below.

1. **Inlet Capacity Improvements:** As identified in the existing conditions analysis, there are inlet capacity limitations throughout the watershed. The first step in the analysis was to remove inlet capacity restrictions from the model.
2. **Local Storm Sewers:** Throughout the Wingra West watershed there is also flooding caused by insufficient storm sewer capacity. An initial step of the evaluation of potential solutions was to identify proposed “local” storm sewer improvements. Improvements to these storm sewers can have an impact on the sizing of other mitigation measures, such as pond improvements. Enlarged upstream storm sewers can result in increased peak flow rates into a pond and impact the pond’s peak water surface elevation. For the purposes of the Wingra West watershed, the majority of storm sewers within the system were considered local storm sewers. As part of this study, local storm sewers were defined as those that are not impacted by upstream flood solutions (such as a pond improvement). To determine potential improvements to these areas, the following steps were taken:
 - a. Based on the layout of the storm sewer system within the watershed, individual sections of storm sewer were isolated and evaluated for improvements.
 - b. Improvements were incorporated into the isolated section of storm sewer with a target of meeting the City’s 10% chance event level of service goal.
 - c. After the 10% chance event target was met, the 1% chance event was executed in the XPSWMM™ model, and the results were reviewed. Additional storm sewer enhancements were made until the 1% chance event goal of maintaining flooding within the right-of-way was met. In cases where the 1% chance event could not be maintained within the right-of-way, an alternative goal of preventing structure flooding was considered.
 - d. Subsequent sections of the storm sewer system were then analyzed until all areas of local storm sewer were evaluated.
 - e. The local storm sewer improvements were consolidated into an overall watershed XPSWMM™ model where the impacts of the local improvements, in conjunction with regional improvements, were considered. Local storm sewers were then modified iteratively with regional improvements.
3. **Waite Circle Culvert:** In 2019, a new box culvert under the Southwest Bike Path at Waite Circle was installed. The box culvert was 6-foot (rise) by 10-foot (span) and included a restriction plate on the front side to limit the flow through the culvert. The new box culvert size and restriction plate were incorporated into the potential solutions modeling. Modifications to the restriction plate were considered and evaluated as part of the process.
4. **Regional Stormwater Detention Improvements:** At various locations in the watershed (described in Section 9.2) additional stormwater detention volume was considered. The detention improvements were evaluated within the XPSWMM™ model by either modifying the stage-area relationship and outlet structure of an existing pond, or adding pertinent pond characteristics for a new pond. The detention improvements were considered after local storm sewer improvements (limited initial evaluation was started prior to local storm sewer sizing). Generally,

an initial evaluation of a detention improvement was conducted using an approximation of a potential expansion (for instance, increasing an existing stage-area relationship by 50 percent). Following the initial evaluation, a more detailed review of the potential detention grading and outlet modifications were considered and implemented into the XPSWMM™ model. In addition to considering detention improvements, the downstream storm sewer was also considered.

5. **Relief/Mainline Sewer Improvements:** After initial regional detention improvements were considered, relief storm sewer and mainline storm sewer improvements were examined. These improvements were considered in conjunction within detention improvements, as the size of relief of mainline sewer improvements are generally tied to detention improvements, and local storm sewer improvements, within the watershed.

9.1.4 Discussion of Potential Solutions with City Engineering Staff

Following the initial evaluation of potential solutions, a meeting was held with City Engineering Staff to discuss the solutions evaluated, and the corresponding modeling results. The first meeting to discuss potential solutions was held on July 31, 2020. Following that meeting, additional analysis was conducted to evaluate a range of scenarios for the Odana Pond/Odana Golf Course area and the Chippewa Drive/Cherokee Drive area. Subsequent follow-up discussions also occurred with City Engineering Staff in Summer and Fall of 2020.

9.1.5 Convergence on Solutions

As the evaluation progressed, a set of solutions (described below) were determined to provide what appeared to be the most viable path towards meeting the flood control goals for the project. This convergence of solutions was based upon performance of the solutions, technical feasibility, and the input from City Engineering Staff.

9.1.6 City Agency Meetings

Following the convergence on solutions for the Wingra West Watershed, City Engineering Staff met with various City of Madison agencies to discuss the potential solutions and challenges/obstacles to implementation of those solutions. Meetings were held with the Mayor's Office, Water Utility, Parks Department, Fire Department, Metro Transit, Planning Department, Operations Department, Streets/Forestry, Transportation Engineering, and Streets Design Division. Notes from the meetings are included in Appendix J.

9.1.7 Finalization of Solutions

Following the agency meetings, revisions were evaluated in the following locations.

1. The Odana Golf Course Pond shape and size was modified to limit the impact to golf course features (tees, greens, fairways, bridges). Additionally, the storm sewer diversion from the Southwest Bike Path to the Odana Golf Course Pond was eliminated, also due to impact to golf course features.
2. The normal water level of the Odana Pond was further considered with respect to how much the normal water level could be reduced. Additional scenarios were evaluated with various pond normal water levels.
3. As a result of the changes in the Odana Golf Course area, the sizing of the storm sewer improvements on Chippewa Drive and Cherokee Drive were reconsidered.

After the revisions were made the selected solutions were considered finalized.

9.1.8 Peer Review #3

As a final step of the solutions development process, a third “Peer Review” occurred. For the peer review, the proposed conditions XPSWMM™ model and a presentation describing the solutions development process was provided to the City and AE2S (City consultant for Spring Harbor watershed study). The model was reviewed and comments were provided to BC. The peer review was discussed at the meeting with City, AE2S, and BC staff on April 1, 2021. As a result of the peer review, there were no modifications made to the proposed solutions model. A summary of Peer Review #3 is included in Appendix K.

9.2 Description of Solutions Considered

Stormwater control measures were considered in various locations across the Wingra West watershed. Ultimately, a variety of solutions were selected for implementation, and there were a number of solutions that were reviewed, but not selected. The following sections provide information about all solutions that were considered.

9.2.1 Solutions Reviewed – Not Selected

The following flood mitigation measures were considered as part of the evaluation process; however, they were not selected for implementation. The locations of such measures are shown on Figure 9-1. It should be noted that the potential solutions which were reviewed but eliminated from consideration were not evaluated in as much detail as the selected solutions. It may be possible that, if the selected solutions cannot be implemented, these solutions could be implemented. However, there may be barriers to implementation that were not identified as a result of the less thorough evaluation.

9.2.1.1 Waite Circle Detention

1. **Conceptual Project Description:** Create an expanded stormwater storage area at the upstream end of the Southwest Bike Path culvert at Waite Circle to reduce peak flow rates downstream into the Chippewa Drive and Cherokee Drive conveyance system.
2. **Reason for Exclusion:** Concept evaluated would require the acquisition and demolition of three residential properties along the south side of Waite Circle. Detention basin would reduce the peak flow rate through the Waite Circle culvert; however, improvements downstream of the culvert would still be required to meet the City’s flood reduction goals.

9.2.1.2 Vitense Detention

1. **Conceptual Project Description:** Create a wet pond along the north side of Whitney Way, northeast of the intersection with Woodland Way (within greenspace that is currently the Vitense Golf driving range). Divert storm sewer from Whitney Way and Schroeder Road into the detention basin. Connect outlet into Whitney Way at intersection of Whitney Way and Gilbert Road.
2. **Reason for Exclusion:** Required acquisition of private land. Project would be connected to the Orchard Ridge Pond, Odana Pond, and Odana Golf Course pond. Improvements to these downstream ponds, storm sewers, and a new crossing under the beltline would still be required. Because the downstream improvements were still required it was felt there was not adequate benefits associated with this project.

9.2.1.3 Southwest Bike Path Diversion Sewer

1. **Conceptual Project Description:** Create a diversion storm sewer from the Southwest Bike Path (approximately 1,500-feet north of Beltline Highway) into the Odana Golf Course Pond. Sewer

would divert direct drainage area from the Waite Circle culvert and attenuate flow rates in the Odana Golf Course pond.

2. **Reason for Exclusion:** Sewer would run northwest through approximately 1,400-feet of Odana Golf course. Concern from golf course staff regarding the impact of this sewer crossing to the golf course. In addition to the relief sewer crossing, increased storage within Odana Pond/Odana Golf Course Pond would be required.

9.2.1.4 Odana Hills Golf Course Outlet Sewer Expansion

1. **Conceptual Project Description:** Add a second outlet sewer leaving the Odana Golf Course or increase the size of the existing outlet storm sewer (existing size is 42-inch diameter).
2. **Reason for Exclusion:** Concern from golf course staff regarding the impact of a sewer crossing to the golf course. Improvements to upstream ponds (Odana Golf Course, Odana Pond, Orchard Ridge Park) still required. To avoid pond improvements, a box culvert outlet would be required and peak flow rates to Waite Circle and downstream area would be increased.

9.2.1.5 Yuma Drive Diversion Sewer

1. **Conceptual Project Description:** Create a new storm sewer on Yuma Drive to divert runoff from Cherokee Drive to the southeast. Diversion sewer would continue on Nakoma Road, Tumalo Trail, and Manitou Way to storm sewer outfall located south of Manitou Pond.
2. **Reason for Exclusion:** Did not eliminate need for improvements to Cherokee Drive downstream of diversion. Would increase the drainage area and flow rate discharging to the storm sewer outfall along Manitou Way.

9.2.2 Solutions Reviewed – Selected

This section provides a brief description of solutions that are selected for implementation as flood mitigation measures in the Wingra West watershed. The locations of the various solutions are displayed on Figure 9-2. Further detail for each of the proposed solutions is provided in Section 10. The selected solutions generally fall into two categories: (1) local improvements (storm sewer and inlet capacity) that are dispersed across the watershed and will be implemented as part of street reconstruction projects, and (2) stand-alone solutions that will be implemented as individual CIP projects.

9.2.2.1 Local Storm Sewer Improvements

1. **Conceptual Project Description:** Improve storm sewers along various streets throughout the watershed. Improvements include increasing pipe size and/or modifying pipe elevations/slopes.
2. **Iterations Considered:** Various pipe sizes were considered.

9.2.2.2 Inlet Capacity Improvements

1. **Conceptual Project Description:** Improve inlet capacity at various locations throughout the watershed. Improvements may include increasing the number of inlets and/or modifying the type of inlets.
2. **Iterations Considered:** None.

9.2.2.3 Odana Hills Golf Course Detention Basin Expansion

1. **Conceptual Project Description:** Increase the footprint of the detention basin to increase storage volume. Lower and modify the outlet structure to improve outflow and lower the pond normal water level to increase the storage volume. Modify storm sewer intake structure, located approximately 325 feet downstream of pond in the golf course, to improve outflow from the golf course and reduce backwater impacts on the pond.

2. **Iterations Considered:** Various pond sizes, shapes, and normal water levels. Various pond outlet structures.

9.2.2.4 Odana Pond Expansion

1. **Conceptual Project Description:** Increase the footprint of the detention basin to increase storage volume. Lower and modify the outlet structure (remove existing weir plates on outlet pipes) to increase the storage volume.
2. **Iterations Considered:** Various pond sizes, shapes, and normal water levels.

9.2.2.5 Orchard Ridge Park Detention Basin Expansion

1. **Conceptual Project Description:** Increase the footprint of the detention basin to increase storage volume. Lower the pond normal water level to increase the storage volume. Add additional outlet under Beltline Highway to improve conveyance capacity.
2. **Iterations Considered:** Various pond normal water levels and outlet pipe sizes.

9.2.2.6 University Research Park–Southeast Detention Basin Modifications

1. **Conceptual Project Description:** Increase the storage volume within the existing footprint of the University Research Park–Southeast Detention Basin. Increase the size of and lower the existing outlet sewer to allow bottom of detention basin to be excavated.
2. **Iterations Considered:** None.

9.2.2.7 University Research Park–Southwest Detention Basin Modifications

1. **Conceptual Project Description:** Increase the storage volume within the existing footprint of the University Research Park–Southwest Detention basin. Increase the size of and lower the outlet sewer to allow bottom of detention basin to be excavated.
2. **Iterations Considered:** None.

9.2.2.8 Chippewa Drive Storm Sewer

1. **Conceptual Project Description:** Install a box culvert within the existing Chippewa Drive open channel between Council Crest and Cherokee Drive. Create a swale above the box culvert within the Chippewa Drive median.
2. **Iterations Considered:** Replacement of existing open channel with box culvert without a swale. Create of a relief sewer for existing open channel. Various sizes of box culverts.

9.2.2.9 Cherokee Drive Relief Sewer

1. **Conceptual Project Description:** Install a box culvert within Cherokee Drive from Chippewa Drive to Nakoma Park. Install a new box culvert crossing of Nakoma Drive into Manitou Pond.
2. **Iterations Considered:** Various sizes of box culverts.

9.2.2.10 Waite Circle Culvert

1. **Conceptual Project Description:** Remove the existing restrictor plates on the Waite Circle culvert.
2. **Iterations Considered:** Various restrictor plate sizes.

Section 10

Selected Solutions

The selected solutions were introduced in Section 9 of this report. Figure 9-1 shows an overall proposed improvement map for the Wingra West watershed identifying the locations of the various selected solutions.

In Section 10.1 to 10.8 the proposed improvements included for the Wingra West watershed are described in detail. Included is pertinent information regarding the nature of the proposed solutions, the flood reduction benefits, and other considerations.

10.1 Local Storm Sewer Improvements

Detailed Project Description

During this study, BC determined that many of the flooding issues throughout the Wingra West watershed are a result of undersized local storm sewers that are incapable of conveying peak flows during intense rainfall events. During these events, the undersized pipes operate in a surcharged condition, which pushes stormwater to the ground surface and results in overland flow and flood impacts.

To better understand and ultimately address these issues, BC split the existing conditions XPSWMM™ model for the watershed into smaller sections consisting of relatively independent stretches of storm sewer. These sections were each run separately for the 10% chance event with the model's 2D engine inactive. BC assumed each separate model was drained by a free outfall at the downstream end. Pipes were then upsized iteratively until the 10% chance event met the City's design goal of no surface flooding. Pipes were also lowered, and slopes were modified as needed to meet the flood control goals.

The individual models were then incorporated into the overall watershed model which was run with the 2D engine active. After verifying the proposed pipes continued to meet the 10% chance event design goal of no street surcharging in the combined model, BC ran the model for the 4% and 1% chance event. Where the proposed pipes did not meet the 4% and 1% chance event goals, they were further modified until City goals were generally met. It should be noted that there are some locations where goals were not met. These are described in further detail in Section 12.1.

Locations of local storm sewer improvements are shown on Figure 10-1.

Associated Flood Reduction Benefits

As a result of the local storm sewer improvements, the City's flood control goals will be met in the following known flooding locations and Focus Group areas: (1) the intersection of Midvale Boulevard and Southwest Bike Path, (2) Waite Circle, (3) the intersection of Dearholt Road and Milward Drive, and (4) Whitney Way, south of the Beltline Highway.

The level of flood reduction associated with the local storm sewer improvements varies. The local sewer improvements are spread across the watershed and the benefits related to these improvements are best described by the comparison to the City's flood reduction goals as documented in Section 11.

Project Constraints/Considerations

Because local storm sewer improvements involve the replacement of storm sewer in its existing alignment, there are relatively few project constraints. Work will be contained within City-owned right-of-way and will not impact privately owned property.

Potential conflicts with existing utilities may occur in some locations where upsized pipes must be lowered to maintain cover requirements. As part of this, there are likely to be conflicts with existing water mains and water laterals, which would need to be lowered. There were not sanitary sewer conflicts identified as clearance between storm sewer improvements and sanitary sewer was attempted to be maintained. However, it is anticipated that there will likely be sanitary sewer conflicts that are encountered due to the widespread nature of the local storm sewer improvements. Conflicts encountered can be resolved by lowering sanitary sewer, if feasible, or installing a sanitary sewer siphon.

Water Quality Benefits

Local storm sewer improvements will not provide water quality benefits.

Additional Notes/Information

Local storm sewer improvements will increase peak flows to downstream discharge locations including wet ponds (Orchard Ridge, Odana, and Odana Golf Course) and mainline storm sewers (such as in Chippewa Drive). The impact of these improvements on downstream flows have been considered and are incorporated into the selected solutions discussed later in this section.

10.2 Inlet Capacity Improvements

Detailed Project Description

The existing conditions model indicated that in some locations, insufficient inlet capacity is a factor that contributes to flooding. As part of inlet capacity improvements, additional inlets and/or inlets with a larger capacity will be installed. The exact location and type of inlets to be installed were not identified as part of this study. The inlet capacity analysis was conducted at a subwatershed level (as described in Section 4.4.3). Figure 10-2 identifies the subwatersheds where additional inlet capacity is needed. As part of the implementation process, the detailed drainage patterns of the subbasins will need to be considered and further analysis completed to determine the number and type of inlets needed.

To evaluate the impacts of improved inlet capacity, the existing conditions model was updated to eliminate the composite rating curves simulating inlet capacity restrictions. Instead, the XPSWMM™ rating curves were converted to weirs, the nodes upstream of the weirs were disconnected from the 2D surface, and the nodes downstream of the weirs were linked to 2D. The weirs were used to ensure all runoff generated at the hydrology node was transferred to the downstream storm sewer. Stormwater was only transferred to the 2D surface if the downstream pipe was in surcharge condition.

Associated Flood Reduction Benefits

Eliminating inlet capacity restrictions improved flooding within the watershed. However, additional improvements, such as storm sewer improvements, are typically needed to meet the City's goals.

The level of flood reduction associated with the inlet capacity improvements varies and the direct benefit is difficult to measure because, in most locations of the watershed, they are proposed in

conjunction with local storm sewer improvements. The benefits related to these combined improvements are best described by the comparison to the City's flood reduction goals in Section 11.

Project Constraints/Considerations

Inlet capacity improvements will be contained within City right-of-way and should not impact any nearby property owners. These improvements will likely be incorporated during the street reconstruction schedule along with local storm sewer improvements (discussed in Section 10.1). The exact location and type of new inlets will be determined during the design of the local storm sewer improvements.

Water Quality Benefits

Inlet capacity improvements will not provide any water quality benefits.

Additional Notes/Information

As with local storm sewer improvements, inlet capacity improvements will increase peak flows downstream as water is moved through the system more efficiently. The impact of these improvements is factored into the selected solutions described later in this section.

The evaluation of inlet capacity conducted as part of this study only included inlets within the City right-of-way. In some areas of the watershed, particularly areas of commercial development, there is significant private storm sewer and private inlets. As part of the design of inlet capacity improvements, the private system should be considered and incorporated into the analysis.

10.3 Odana Hills Area Detention

Increased detention within three existing ponds in the Odana Hills area is included as part of the selected solutions that are proposed for implementation. This is a prominent area within the watershed and various options for stormwater management were considered. The following section provides a detailed description of the evaluation conducted for the area and the selected measures. This area was evaluated holistically as part of the selected solutions development process because of the interconnected nature of the detention basins. Figures 10-2 through 10-10 pertain to the evaluation of, and selected solutions for, the Odana Hills area. References to each of the figures are included in the following section where applicable.

Near the middle of the Wingra West watershed is Odana Park, Odana Hills Golf Course, and Orchard Ridge Valley Park. Each of these areas include an existing pond, and the three ponds are interconnected with each other.

- The Odana Hills Golf Course Detention Basin is at the downstream end of the pond system and has a normal water level of 976.0 with a multi-stage concrete weir as an outlet. Note, there is a low-flow orifice at elevation 975.1; however, observations of the pond indicate it is more typically at the weir elevation.
- The Odana Park pond discharges into the golf course detention basin through two 24-inch by 38-inch culverts. At the upstream ends of the culverts, metal weir plates are installed to a height of approximately 18-inches. The normal water level of the pond is approximately 977.15. Additionally, in events above the 50% chance event, the berm separating the ponds is overtopped.
- Orchard Ridge Park Detention Basin is located upstream of Odana Pond on the south side of the Beltline Highway. It is connected by a 4-foot by 10-foot box culvert under the highway. The culvert is located below the normal water level and has an invert elevation of approximately 973.9.

- All runoff that drains through these ponds discharges through a 42-inch storm sewer that flows east from Odana Hills Golf Course. The entrance to the storm sewer is approximately 320-feet east of the outlet from the golf course detention basin and has an invert elevation of approximately 973.6. There is no overland flow-path that leaves the area. During large events, the 42-inch storm sewer leaving the golf course is the controlling factor for peak water surface elevations in the golf course pond and Odana Pond. In the Orchard Ridge Park pond, a “double-peak” is observed. The first peak is caused by direct local drainage into the pond and the limitation of the conveyance out of the pond. The second peak is caused by the 42-inch storm sewer backing water up from the golf course pond to Orchard Ridge Park pond.

Under existing conditions, flooding is observed in the areas surrounding the ponds, including flooding identified by City Staff at Dearholt Road and Milward Drive, Orchard Ridge Valley Park, and Whitney Way, south of the Beltline Highway (See Section 6.2.2). The flooding also corresponds with flooding reported by the Odana Pond/Odana Hills Park and Orchard Ridge Valley Park focus groups. Within the area, the ponds back-up stormwater onto adjacent streets and structure flooding begins occurring during the 10% chance event.

The flood control goal for this area is to meet the City's 1% chance event goal of no structure flooding. Meeting this goal correlates to a pond peak water surface elevation of 981.3 for the area north of the Beltline Highway and 981.4 for south of the Beltline Highway. These elevations are based on estimated building elevations using LiDAR data. The elevations are not representative of building first floor elevations, which are not known.

Initial scenario modeling

An initial step in evaluating this area was to test the performance of various scenarios within the XPSWMM™ model. This scenario testing was conducted by changing various input parameters such as enlarging outlet structures/pipes, lowering the elevation of outlet structures and pond normal water levels, and expanding pond footprints. As part of this scenario modeling, hypothetical changes were evaluated, such as doubling the size of a pond or doubling the number of outlet pipes. This analysis was conducted to gain an understanding of the magnitude of solutions that might be required to meet the flood control goals. The initial scenario modeling provided a couple of take-aways:

1. Added conveyance from south of the Beltline to north of the Beltline is required to meet flood control targets around Orchard Ridge Valley Park.
2. Lowering of the pond normal water levels (such as removing the weirs on the Odana Pond outlet culverts) would not provide enough additional storage to meet flood control goals.
3. A combination of improvements would likely be required.

With the understanding from the initial scenarios, four initial concepts for improvements in the area were developed. These concepts provide further detail as to what improvements in the area could look like and the amount of benefit that could be provided.

Initial Concepts

The initial concepts developed considered a range of scenarios to determine how much additional storage and/or conveyance would be needed to reduce flooding within the Odana Hills area.

One of the considerations is that the current Odana Hills Golf Course normal water level is approximately 2.4-feet higher than the 42-inch storm sewer discharging from the golf course. Additionally, the normal water level in Odana Pond and Orchard Valley Ridge Park pond is 1.2-feet higher than the Odana Hills Golf Course normal water level. As part of these scenarios, reducing the increase in normal water level across the pond system was considered.

A second consideration was the impact on peak flow rates at the Waite Circle culvert that would result from increased conveyance leaving the pond system. As part of the Waite Circle culvert replacement project in 2019, the culvert was sized assuming that a second 42-inch outlet pipe from Odana Hills Golf Course would be installed and that the discharge from the Odana Hills area would be doubled. A broader range of scenarios was considered under these concepts.

Pertinent information regarding the components of each of the initial concepts is listed below. The goal of the concepts was to lower pond water levels such that they would be below the target elevations described above for the 1% chance event.

- **Concept 1A – Expanded Storage and Double Outlet Sewer:** Under this scenario, the storage footprint of each detention basin was increased, and additional outlet capacity was added. A concept figure is provided as Figure 10-3.
 - A second 42-inch outlet sewer would be installed parallel to the existing outlet sewer from the golf course to Waite Circle. The intake structure at the entrance would be modified to reduce clogging and to accommodate the second pipe.
 - At Odana Golf Course, the pond normal water level would be lowered to elevation 974.0 and the footprint would be expanded. A conceptual pond layout was developed to increase the footprint to the north and southeast. The footprint was intended to minimize impacts to the golf course; however, there would be impacted tees, fairways, and a bridge.
 - The Odana Pond normal water level would be lowered to 974.5 and the pond would be expanded to the north and west. The expansion would be limited to areas that are not active park or golf course areas.
 - Orchard Ridge Valley Park pond would be expanded to utilize the entire park area and the lower normal water level would be lowered to 974.5. Additional conveyance across the Beltline Highway would be added.
 - In addition to improvements within the Odana Hills area, this concept included detention within property west of Whitney Way and south of the Beltline Highway (Vitense Golfland).
- **Concept 1B – SWU Land Storage and Added Outlet Pipe:** The expansion of detention basins was limited to only land currently under ownership of the City's Storm Water Utility (SWU). The normal water level was modified to the levels described under concept 1A above. To compensate for the reduced storage capacity provided, increased conveyance was required. A 66-inch parallel outlet sewer would be added to the existing 42-inch diameter outlet sewer and the intake structure at the entrance of the sewer would be modified. A concept figure is provided as Figure 10-4.
- **Concept 2 – Weir Removal & Added Conveyance:** No changes would occur within the Odana Hills Golf Course Pond. The metal weirs on the outlet culverts from Odana Pond would be removed, which would lower the normal water level in both Odana Pond and Orchard Ridge Valley Park Pond by approximately 18-inches. There would be no expansion/grading to any of the ponds. Additional conveyance under the Beltline Highway (two 6-foot by 8-foot box culverts) would be added and the existing 42-inch outlet sewer leaving the golf course would be replaced with a 6-foot by 10-foot box culvert from the golf course to Waite Circle. A concept figure is provided as Figure 10-5.
- **Concept 3 – Conveyance Only:** Under this alternative there would be no modifications to the existing pond footprints or water levels. There would be additional conveyance under the Beltline Highway (two 6-foot by 10-foot box culverts), and the existing 42-inch outlet sewer leaving the golf course would be replaced with a 6-foot by 12-foot box culvert from the golf course to Waite Circle. A concept figure is provided as Figure 10-6.

The four initial concepts, and their impacts, were reviewed with City Staff. Considerations included, the peak water surface elevation (WSE) of the ponds and whether they impacted structures, and the impact on Waite Circle and downstream areas. Solutions to mitigate flooding in the downstream areas were being evaluated concurrently. An outcome of the City Staff review was to evaluate additional concepts that are described below.

- **Concept 4A – Increased Storage:** This concept increased the footprint of the Odana Pond and Odana Hills Golf Course Pond that were originally developed with Concept 1A. The Vitense Pond was removed and the outlet from the golf course would be improved; however, the existing 42-inch outlet sewer would remain in place without an additional sewer. A concept figure is provided as Figure 10-7.
- **Concept 4B – Increased Storage and Southwest Bike Park Diversion Sewer:** This concept built off Concept 4A by adding a diversion sewer from the Southwest Bike Path into the Odana Hills Golf Course pond to route additional runoff into the pond and reduce the peak flow rate reaching Waite Circle. A concept figure is provided as Figure 10-8.

A summary of the performance of the initial concepts is displayed in Table 10-1. Each of these concepts meet the target water surface elevations for the Odana Pond and Orchard Ridge Valley Park ponds.

Table 10-1. Odana Hills Area Initial Concepts Comparison

Wingra West Watershed Study
City of Madison, WI

Concept	Outlet Dimensions	Added Storage Volume	Odana Pond Normal Water Level	Outlet Peak Flow Rate (cfs)		Odana Pond Peak WSE ¹ Target WSE Elevation = 981.3		Orchard Ridge Valley Park Pond Peak WSE Target WSE Elevation = 981.4	
				10% Chance Event	1% Chance Event	10% Chance Event	1% Chance Event	10% Chance Event	1% Chance Event
Existing	42" RCP	N/A	977.15	52 cfs	77 cfs	981.0	983.0	981.8	983.9
1A	2-42" RCP	151 acre-feet	974.5	81 cfs	128 cfs	978.8	980.9	978.9	981.4
1B	Ex 42" RCP & 66" RCP	66 acre-feet	974.5	232 cfs	293 cfs	979.5	981.3	979.5	981.3
2	6'x10' Box Culvert	21 acre-feet	975.65	480 cfs	676 cfs	979.8	981.1	979.9	981.2
3	6'x12' Box Culvert	N/A	977.15	601 cfs	810 cfs	979.9	981.2	980.3	981.4
4A	42" RCP	177 acre-feet	974.5	48 cfs	64 cfs	978.7	980.8	978.7	980.8
4B	42" RCP	177 acre-feet	974.5	52 cfs	66 cfs	978.7	981.3	978.7	981.3

¹Odana Hills Golf Course Detention Basin is equal to Odana Pond Peak WSE under storm events considered

As a result of the initial analysis, Concept 4B was tentatively identified as the preferred alternative due to its ability to reduce flooding in the Odana Hills area and to reduce peak flow to Waite Circle. Subsequently, City Engineering Staff discussed these options with additional City Departments. As a result of these discussions, revisions were made to the potential solutions and additional concepts were developed.

- **Concept 5A – Revised Layout with Single Outlet Sewer:** The Southwest Bike Path Diversion Sewer was eliminated, and the shape of the Odana Hills Golf Course Detention Pond expansion was revised to limit impacts to Odana Hills Golf Course. The concept was considered under two

normal water levels for Odana Pond/Orchard Ridge Valley Park Pond. The first normal water level was 975.65, which is the normal water level if the existing metal weirs are removed from the Odana Pond outlet. The second normal water level was 977.15, which is the current normal water level, and assumes that the weirs would remain in place. A concept figure is provided as Figure 10-9.

- **Concept 5B – Revised Layout with Additional Outlet Sewer:** This concept includes the same items as Concept 5A; however, it was considered with only a normal water level of 977.15. A second outlet sewer from Odana Hills Golf Course was added. Sizes of both 42-inch and 72-inch were considered. A concept figure is provided as Figure 10-10.

A summary of the performance of the revised concepts is displayed in Table 10-2.

Table 10-2. Odana Hills Area Revised Concepts Comparison

Wingra West Watershed Study
City of Madison, WI

Concept	Outlet Dimensions	Added Storage Volume	Odana Pond Normal Water Level	Outlet Peak Flow Rate (cfs)		Odana Pond Peak WSE ¹ Target WSE Elevation = 981.3		Orchard Ridge Valley Park Pond Peak WSE Target WSE Elevation = 981.4	
				10% Chance Event	1% Chance Event	10% Chance Event	1% Chance Event	10% Chance Event	1% Chance Event
Existing	42" RCP	N/A	977.15	52 cfs	77 cfs	981.0	983.0	981.8	983.9
5A	42" RCP	111 acre-feet	975.65	57 cfs	68 cfs	979.4	981.6	979.4	981.6
5A	42" RCP	65 acre-feet	977.15	62 cfs	70 cfs	980.0	982.2	980.0	982.2
5B	2-42" RCP	65 acre-feet	977.15	120 cfs	137 cfs	979.8	981.9	979.8	981.9

¹Odana Hills Golf Course Detention Basin is equal to Odana Pond Peak WSE under storm events considered

As a result of the additional analysis, Concept 5A, with the removal of the Odana Pond weirs, was selected as the preferred solution. This concept balanced flood benefits with impacts to Odana Hills Golf Course due to pond expansion. The elimination of additional inlet or outlet sewer for the pond reduced golf course impacts. Additionally, the removal of the Odana Pond weirs represents a middle-ground between maintaining the existing normal water level of 977.15 and maximum pond lowering to a normal water level of 974.5. The sections below provide additional information about the selected improvements to each of the three detention basins in this area.

10.3.1 Odana Hills Golf Course Detention Basin

Detailed Project Description

As described above, the existing golf course detention basin would be expanded, and the normal water level would be lowered. The existing pond has a normal water level of 976.0 and this level would be lowered to 974.0. The current pond normal pool area of 2.8 acres would be expanded to approximately 6.4 acres and result in an increase in storage capacity of 35 acre-feet. The pond outlet structure would be reconstructed along with the downstream structure where runoff enters the 42-inch storm sewer leaving the golf course.

The elements of the project are displayed graphically on Figure 10-11. A one-page project information sheet was also prepared to provide detailed information on the Odana Hills Golf Course Detention Basin and is included as Table M-1 in Appendix M.

Associated Flood Reduction Benefits

The pond peak WSE is reduced by 2.0-feet for the 10% chance event and by 1.4-feet for the 1% chance event. Additionally, while a larger volume of stormwater runoff is stored within the golf course detention basin (and the connected ponds), the discharge from the golf course through the existing 42-inch storm sewer is reduced for the 1% chance event (existing = 77cfs, proposed = 68cfs). This reduces the increase in peak flow rates to downstream areas. The improvements in this area also work in conjunction with the Odana Pond and Orchard Ridge Valley Park Pond to provide flood relief to areas adjacent to those ponds. Improvements in those areas are described in the sections relevant to those projects.

Project Constraints/Considerations

The following potential project constraints were identified and need to be considered as part of future project implementation.

- An existing sanitary sewer is located to the north and northeast of the existing pond. It is anticipated that this sanitary sewer would be relocated to the north to avoid the majority of the pond and pass under a narrow section of the pond on the north side. In this area the pond may be excavated to a shallower normal pool depth to increase cover of the sanitary sewer. Alternatively, a sanitary sewer siphon could be installed.
- The pond is located within Odana Hills Golf Course. The selected pond expansion was developed with an attempt to minimize impacts to golf course features. The expansion includes impacts to a golf course bridge, a tee box, fairway area, and other adjacent areas. There may also be impact to golf course irrigation and/or drainage features. Impacts to the golf course operations, both during and after construction, should be considered as part of future steps in project implementation. A golf course architect may be needed to fully consider impacts to the golf course.
- The pond expansion will result in removal of existing trees that surround the pond.

Water Quality Benefits

The expanded detention basin would provide increased storm water pollution trapping. The existing detention basin is a wet detention basin with a maximum pond depth of 6 feet. The conceptual layout for the expansion includes a 6-foot deep permanent pool consistent with City design standards. Pertinent information to allow the City to conduct a detailed evaluation of the increased water quality benefits is provided in Table M-1 in Appendix M. As described previously, this pond is in-series with Odana Pond and Orchard Ridge Park Pond, and the water quality evaluation should account for the ponds being in-series. Additionally, these areas also discharge into Manitou Pond at the downstream end of the watershed, and they are in-series with this pond as-well.

10.3.2 Odana Pond Expansion and Water Level Lowering

Detailed Project Description

As described above, the existing pond would be expanded, and the normal water level would be lowered. The existing pond has a normal water level of 977.15, and this level would be lowered to 975.65 by removing the existing weir plates installed on the outlet culverts. The current pond normal pool area of 15.4 acres would be expanded to approximately 28.3 acres and result in an increase in

storage capacity of 66 acre-feet. It is anticipated that the outlet culverts would be reconstructed as part of the pond grading.

The elements of the project are displayed graphically on Figure 10-12. A one-page project information sheet was also prepared to provide detailed information on the Odana Pond Expansion and is included as Table M-2 in Appendix M.

Associated Flood Reduction Benefits

The pond peak WSE is reduced by 1.6-feet for the 10% chance event and by 1.4-feet for the 1% chance event. As a result of the reduction in peak WSE, the pond does not cause backwater onto Milward Drive for up to, and including, the 2% chance event. In the 1% chance event, structural flooding (greater than 6-inch of water depth within 5-feet of a structure) is prevented at all buildings impacted by the pond. There are five structures that are flooded under existing conditions.

Additionally, the benefits associated with the Orchard Ridge Valley Park Pond can be achieved because of the Odana Pond and Odana Golf Course Detention Basin improvements. The reduction in Odana Pond water level reduces the tailwater impact on the Orchard Ridge Valley Park Pond and allows for greater storage and conveyance of stormwater.

Project Constraints/Considerations

The following potential project constraints were identified and need to be considered as part of future project implementation.

- It should be noted, the target water surface elevation for the pond was 981.3, which was the estimated elevation of the lowest building along Milward Drive based on LiDAR elevation data. The pond peak WSE in the 1% chance event is 981.6, which is above the estimated structure elevation. This does not meet the definition of flooding as it is less than 6-inches deep. As solutions are moved forward in the implementation process, the critical elevations should be further reviewed and verified to determine if an adequate level of flood control is provided.
- An existing sanitary sewer is located to the north of the existing pond. It is anticipated that this sanitary sewer would be relocated to the north to avoid being in conflict with the pond.
- The pond expansion on the southeast side is located within Odana Hills Golf Course. The selected pond expansion was developed with an attempt to minimize impacts to golf course features. The expansion includes impacts to fairway area, and other adjacent areas. There may also be impact to golf course irrigation and/or drainage features. Impacts to the golf course operations, both during and after construction, should be considered as part of future step in project implementation. A golf course architect may be needed to fully consider impacts to the golf course.
- There will be significant WDNR and USACE permitting for implementation of this project.
 - Wetlands are identified within the project area from the Wisconsin Wetland Inventory (See Figure 2-1).
 - Odana Pond is identified by the WDNR as an impaired waterbody classified as a shallow headwater. The pond is a natural kettle pond that is fed primarily by runoff. (Source: <https://dnr.wi.gov/water/waterDetail.aspx?wbic=3000513>)
 - As described in Section 2.3.1, water from Odana Pond is used by MG&E for a groundwater recharge project. The water level lowering component of this project removes weirs installed as part of the MG&E groundwater recharge system. The requirements of the recharge project agreement between MG&E, WDNR, and the City would need to be reviewed and revised. A copy of the agreement is included in Appendix L.

- The pond expansion will result in removal of existing trees that surround the pond.

Water Quality Benefits

The expanded pond would provide increased storm water pollution trapping. The existing pond has a maximum pond depth of 6.2 feet. The conceptual layout for the expansion includes a 6-foot deep permanent pool consistent with City design standards. Pertinent information to allow the City to conduct a detailed evaluation of the increased water quality benefits is provided in Table M-2 in Appendix M. As described previously, this pond is in-series with Odana Hills Golf Course Detention Basin and Orchard Ridge Valley Park Pond and the water quality evaluation should account for the ponds being in-series. Additionally, these areas also discharge into Manitou Pond at the downstream end of the watershed, and they are in-series with this pond, as well.

10.3.3 Orchard Ridge Valley Park Detention Basin

Detailed Project Description

As described above, the existing pond would be expanded and the normal water level would be lowered. The existing pond has a normal water level of 977.15 which is controlled by the elevation of the Odana Pond outlet structures. This level would be lowered to 975.65 by removing the existing weir plates installed on the Odana Pond outlet culverts. The current pond normal pool area of 1.2 acres would be expanded to approximately 5.5 acres and result in an increase in storage capacity of 16.8 acre-feet. The project also includes additional conveyance capacity crossing under the Beltline Highway into Odana Pond and would consist of three 60-inch diameter pipes.

The elements of the project are displayed graphically on Figure 10-13. A one-page project information sheet was also prepared to provide detailed information on the Orchard Ridge Park Detention Basin and is included as Table M-3 in Appendix M.

Associated Flood Reduction Benefits

The pond peak WSE is reduced by 2.4-feet for the 10% chance event and by 2.3-feet for the 1% chance event. This reduction in peak water surface elevation results in water levels being reduced such that they no longer impact Whitney Way, Gilbert Road, and Loruth Terrace for up to and including the 1% chance event.

Twenty structures will be removed from flooding in the 1% chance event due to the Orchard Ridge Valley Park Pond improvement, and in conjunction with the other Odana Hills area improvements and local storm sewer improvements.

Project Constraints/Considerations

The following potential project constraints were identified and need to be considered as part of future project implementation.

- There will be significant WDNR and USACE permitting for implementation of this project. Wetlands are identified within the project area from the Wisconsin Wetland Inventory (See Figure 2-1).
- ATC overhead power lines are located adjacent to the Beltline Highway on the northeast side of the pond. The project grading is anticipated to be outside of the easement for the powerlines. However, the installation of the additional storm sewers crossing the Beltline Highway will cross underneath the power lines.

- It should be noted, the target water surface elevation for the pond was 981.4, which was the estimated elevation of the lowest ground elevation adjacent to a building around the pond perimeter based on LiDAR elevation data. The pond peak WSE in the 1% chance event is 981.6, which is above the estimated structure elevation. This does not meet the definition of flooding as it is less than 6-inches deep. As solutions are moved forward in the implementation process the critical elevations should be further reviewed and verified to determine if an adequate level of flood control is provided.
- The land for Orchard Ridge Valley Park was provided to the City of Madison as a gift. The park property includes deed restrictions that the land will be used for park and recreational purposes only, and that the land will not be used as a dump or filled with rubbish.

Water Quality Benefits

The expanded pond would provide increased storm water pollution trapping. The existing pond has a maximum pond depth of less than 2-feet. The conceptual layout for the expansion includes a 6-foot deep permanent pool consistent with City design standards. Pertinent information to allow the City to conduct a detailed evaluation of the increased water quality benefits is provided in Table M-3 in Appendix M. As described previously, this pond is in-series with Odana Hills Golf Course Detention Basin and Odana Pond and the water quality evaluation should account for the ponds being in-series. Additionally, these areas also discharge into Manitou Pond at the downstream end of the watershed, and they are in-series with this pond as-well.

10.3.4 Odana Hills Area Additional Notes/Information

As described in Section 10.3.1, a number of alternatives within the Odana Hills area were considered. As additional steps are taken towards implementation of the selected solutions in the Odana Hills area there may be modifications required based on water level requirements, permitting issues, or other factors. The alternatives considered provide insight into the impact of various modifications such as increased, or decreased, storage volume, additional conveyance, or modified pond normal water levels.

The Odana Hills area ponds are connected to the Waite Circle culvert by the outlet sewer from Odana Hills golf course. Increases to the capacity of the outlet sewer could lead to negative impacts at Waite Circle, or further downstream areas. Conversely, diverting runoff into the Odana Hills area (such as through the Southwest Bike Path diversion sewer) could reduce the flows to the Waite Circle area.

The pond footprints are concepts for potential shapes/layouts of expanded stormwater detention. The footprints could be modified, and storage volume added in alternative locations within the same general vicinity. For instance, the Odana Pond footprint could be increased and other detention footprints could potentially be decreased (or vice-versa). However, to meet flood relief goals south of the Beltline Highway, additional conveyance capacity across the highway is needed.

10.4 University Research Park – Southeast Detention Basin

Detailed Project Description

Under existing conditions, the capacity of the University Research Park – Southeast Detention Basin is exceeded in the 20% chance, and greater, events. Downstream of the detention basin there is flooding observed within Whitney Way and on private property east of Whitney Way. Additionally, there are inlet capacity and storm sewer capacity constraints downstream of the detention basin that contribute to flooding within Whitney Way and adjacent areas. The flood control target for this area was to prevent the detention basin from overtopping in the 10% chance event in order to meet

the City for storm sewer conveyance and also assist in meeting the goal of eliminating structure flooding in the 1% chance event.

As part of this project, the existing dry detention basin would be lowered and re-graded to provide additional storage capacity, the outlet sewer into the intersection of Tokay Boulevard and Whitney Way would be lowered, and the pond outlet structure would be reconstructed. The conceptual pond grading maintains a dry pond with a bottom slope of approximately 0.5 percent. The outlet is lowered to maximize the storage volume, while matching the existing downstream storm sewer invert elevation in the intersection of Tokay Boulevard and Whitney Way.

Figure 10-14 shows the proposed project components, and a one-page project information sheet was also prepared to provide detailed information on the project and is included as Table M-4 in Appendix M.

Associated Flood Reduction Benefits

The pond peak WSE is reduced by 1.7-feet for the 10% chance event and by 1.2-feet for the 1% chance event. During the 10% chance event, overtopping of the pond is prevented (all runoff discharges through the pond outlet structure). In conjunction with local storm sewer improvements and inlet capacity improvements, street flooding downstream of the pond is prevented for the 10% chance event. Structure flooding is prevented for storm events smaller than the 1% chance event. Under the 1% chance event, a single structure is identified as impacted by flooding (See Section 12.1 for additional details).

Project Constraints/Considerations

The following potential project constraints were identified and need to be considered as part of future project implementation.

- The Wisconsin Wetland Inventory (WWI) identifies wetlands that are too small to delineate. It is believed the wetlands would be considered artificial based on the area being a constructed stormwater management facility.

Water Quality Benefits

The proposed project is the expansion of an existing dry pond. Potential water quality benefits were not considered as part of this study. Within the existing dry pond, and remaining after improvements, there may be infiltration of stormwater and associated water quality benefits. Infiltration was not considered as part of this analysis as it is generally not a significant impact on flooding.

Additional Notes/Information

To meet downstream flood control goals, inlet capacity and storm sewer improvements are needed. An alternative to improvements to the detention basin could be to increase the downstream improvements (i.e., further enlarge downstream storm sewers). It is possible that storm sewer improvements alone could be a more cost-effective strategy than completing both detention basin and storm sewer improvements. This option could be evaluated in the future to determine the preferred approach.

Additionally, there is open space adjacent to the pond that could be utilized to further expand the pond. Additional storage volume within the pond could reduce, or eliminate, the need for downstream storm sewer improvements.

10.5 University Research Park – Southwest Detention Basin

Detailed Project Description

Under existing conditions, the capacity of the University Research Park – Southwest Detention Basin is exceeded in the 10% chance, and greater, events. Downstream of the detention basin there is flooding observed within Tokay Boulevard and onto adjacent private property. Additionally, there are inlet capacity and storm sewer capacity constraints downstream of the detention basin that contribute to flooding within these areas. The flood control target for this area was to prevent the detention basin from overtopping in the 10% chance event in order to meet the City's goal for storm sewer conveyance and also assist in meeting the goal of eliminating structure flooding in the 1% chance event.

As part of this project, the existing dry detention basin would be lowered and re-graded to provide additional storage capacity, the outlet sewer into Tokay Boulevard would be lowered, and the pond outlet structure would be reconstructed. The conceptual pond grading maintains a dry pond with a bottom slope of approximately 0.5 percent. The outlet is lowered to maximize the storage volume, while matching the existing downstream storm sewer invert elevation in Tokay Boulevard.

The elements of the project are displayed graphically on Figure 10-15. A one-page project information sheet was also prepared to provide detailed information on the project and is included as Table M-5 in Appendix M.

Associated Flood Reduction Benefits

The pond peak WSE is reduced by 1.2-feet for the 10% chance event and by 1.0-feet for the 1% chance event. For storms up to the 2% chance event, overtopping of the pond is prevented (all runoff discharges through the pond outlet structure). In conjunction with local storm sewer improvements and inlet capacity improvements, street flooding downstream of the pond is prevented for the 10% chance event and structure flooding is eliminated for up to and including the 1% chance event.

Project Constraints/Considerations

The following potential project constraints were identified and need to be considered as part of future project implementation.

- The Wisconsin Wetland Inventory (WWI) identifies wetlands that are too small to delineate. It is believed the wetlands would be considered artificial based on the area being a constructed stormwater management facility.

Water Quality Benefits

The proposed project is the expansion of an existing dry pond. Potential water quality benefits were not considered as part of this study. Within the existing dry pond, and remaining after improvements, there may be infiltration of stormwater and associated water quality benefits. Infiltration was not considered as part of this analysis as it is generally not a significant impact on flooding.

Additional Notes/Information

To meet downstream flood control goals, inlet capacity and storm sewer improvements are needed. An alternative to improvements to the detention basin could be to increase the downstream improvements (i.e., further enlarge downstream storm sewers). It is possible that storm sewer improvements alone could be a more cost-effective strategy than completing both detention basin and storm sewer improvements. This option could be evaluated in the future to determine the preferred approach.

Additionally, there is open space adjacent to the pond that could be utilized to further expand the pond. Additional storage volume within the pond could reduce, or eliminate, the need for downstream storm sewer improvements.

10.6 Chippewa Drive Storm Sewer

Detailed Project Description

Currently, at the downstream end of the Waite Circle culvert, there is approximately 115 feet of open channel before runoff enters a 4-foot x 6-foot box culvert crossing underneath Council Crest at the northwest end of Chippewa Drive. This box culvert discharges into a concrete bottom/stacked rock-wall channel within the median of Chippewa Drive that is described in Section 2.3.2. The channel continues for the length of Chippewa Drive, with 4-foot x 6-foot box culvert crossing roads, to the southeast until it reaches Cherokee Drive. Flooding along Chippewa Drive is generally confined to the right-of-way under all storm events considered and is not caused by the existing channel. However, increased future flows due to upstream improvements dictate the need for an enhanced conveyance system along Chippewa Drive.

Three conveyance options within Chippewa Drive were considered. For each of these options, varying storm sewer sizes were considered based on the flow from the upstream portion of the watershed, which is dependent on the Odana Hills area improvements and the Southwest Bike Path relief sewer.

- Replacing the existing open channel and culverts with a storm sewer (box culvert), while removing the open channel within the median.
- Adding a second relief storm sewer (box culvert) parallel to the existing open channel and culverts. Under this scenario the existing open channel would remain in place.
- Replacing the existing open channel and culverts with a storm sewer (box culvert). In median areas there would be a swale above the storm sewer. The new swale would be shallower than the existing channel.

Each of these options could provide a similar level of performance. As the selected solution, the third option—a new storm sewer with a swale above the sewer—was chosen. The relief sewer alternative would require a new storm sewer to be installed within the right-of-way. It is believed this would create challenging logistics due to other utilities within the right-of-way. Additionally, the existing open channel requires regular maintenance due to clogging of culverts and deteriorating walls. The other two options are similar, with the difference being whether a swale is included above the culvert in the median. The option with the swale above the culvert was selected as it provides additional conveyance capacity and flexibility in the design. A 6-foot by 10-foot storm sewer size was identified based on the selected Odana Hills area improvements and the local storm sewer improvements. The new swale would be shallower and have more gentle side slopes than the existing channel. Conceptually, the swale would be approximately 1.5 feet deep, with an 8-foot bottom width, and 3:1 side slopes.

The elements of the project are displayed graphically on Figure 10-16.

Associated Flood Reduction Benefits

The Chippewa Drive storm sewer would meet the City's level of service goal for the 10% chance event with no street flooding for the entire length of the street. Under the 1% chance event, the peak flooding depth at the intersection of Chippewa Drive and Council Crest is reduced from 1.5 feet to 0.5 feet.

Project Constraints/Considerations

Chippewa Drive has an average slope of approximately 4 percent from Council Crest to Cherokee Drive. The swale above the proposed storm sewer would have a similar slope. It is anticipated that the swale will require stabilization measures such as grade control structures, temporary and/or permanent erosion control matting, and/or rip-rap.

The conceptual design for the storm sewer is to have it within the center of the median, with the swale located directly above the storm sewer. Inlets would be located within the swale and drop into the storm sewer. Additional design detail is needed to verify the conceptual layout. The location of the storm sewer and/or inlets may need to be adjusted for a variety of factors.

A sanitary sewer conflict is identified at one location. It is anticipated this conflict can be resolved by lowering sanitary sewer or installing a sanitary sewer siphon. The proposed storm sewer would cross water mains at three locations. It is assumed the water main would need to be lowered at each of these locations.

Water Quality Benefits

The Chippewa Drive storm sewer will not provide water quality benefits.

Additional Notes/Information

For modeling purposes, the swale above the new storm sewer was omitted. The swale would be shallow and was, thus, disregarded in the modeling. The swale would assist in collecting runoff and conveying it to inlets to the new storm sewer.

If there are modifications to the selected improvements upstream of the Waite Circle culvert, the proposed Chippewa Drive storm sewer size should be further evaluated. An increase, or decrease, in storage volume at the Odana Hills area may impact the peak flows to the Waite Circle culvert and, thus, the Chippewa Drive storm sewer. However, changes in the detention volume generally result in limited changes in peak flows. The more significant impact would be if an additional outlet sewer from the Odana Hills area is required to meet upstream flood relief goals. This will, in turn, increase the flows to the Chippewa Drive storm sewer. Conversely, if additional runoff is diverted to the Odana Hills area (such as the Southwest Bike Path relief sewer), the peak flows to the Chippewa Drive storm sewer may be decreased. The flows seen at the storm sewer are also impacted by local storm sewer improvements downstream of Odana Hills, which increase the peak flows (compared to existing conditions) seen in the Chippewa Drive storm sewer.

10.7 Cherokee Drive Relief Sewer

Detailed Project Description

At the downstream end of Chippewa Drive is the intersection with Cherokee Drive. At this location, the Chippewa Drive channel from the north connects with an open channel coming from the west, along Cherokee Drive, into the intersection. From the intersection, runoff is conveyed by storm sewer into Nakoma Park. This intersection is a known flooding problem, with existing flooding depths of 1.5 feet in the 50% chance event and nearly 3 feet in the 1% chance event. Runoff also overtops the right-of-way onto school district property (Thoreau Elementary School) and into Nakoma Park where there is an existing greenway. At the downstream end of the greenway, the storm sewer capacity is limited and unable to convey the 50% chance event, causing overtopping of Nakoma Road and overland flow onto Manitou Way. Structure flooding is observed in the area in all storm events considered (50% chance and larger).

This project would function as an extension of the Chippewa Drive storm sewer described above. At the intersection with Cherokee Drive, the Chippewa Drive storm sewer would connect to storm sewer, conveying runoff from the Cherokee Drive swale that enters from the west. The Cherokee Drive relief sewer would then drain to the northeast and east along Cherokee Drive as a 6-foot x 12-foot storm sewer, along the northside of Nakoma Park. At the intersection, a flow-split would be maintained, allowing some water to go through the existing storm sewer into the Nakoma Park greenway. At the intersection of Cherokee Drive and Nakoma Road, the relief sewer would connect to the existing sewer, and a single new storm sewer would be installed across Nakoma Road (6-foot x 14-foot storm sewer) and Manitou Way (6-foot x 16-foot storm sewer) into the UW-Arboretum and Manitou Pond.

The elements of the project are displayed graphically on Figure 10-17.

Associated Flood Reduction Benefits

Flood reduction benefits, as a result of the Cherokee Drive relief sewer, are observed at various locations along the length of the relief sewer. At all points along the relief sewer, the flood relief goal for the 10% chance event of no surface flooding is met. At the intersection of Chippewa Drive and Cherokee Drive in the 1% chance event, the peak flood depth is reduced from 2.8 feet to 0.8 feet. At the intersection of Cherokee Drive and Nakoma Road, it is reduced from 3.7 feet to 0.6 feet, and, within the Manitou Way low-point 400-feet south of Nakoma Road, it is reduced from 3.9 feet to 0.0 feet. Along with this reduction in flood depth within the right-of-way, the Cherokee Drive relief sewer prevents structure flooding at eight structures.

The stone wall (See Section 4.5.2) along Manitou Way is impacted by flooding under the existing conditions for all storm events considered. Runoff ponds against the wall flows through openings and also, overtops the wall. With the Cherokee Drive storm sewer, the ponding within Manitou Way will be limited and there will be no ponding against, or overtopping of, the wall for up to and including the 1% chance event.

Project Constraints/Considerations

Sanitary sewer conflicts are identified at two locations. It is anticipated these conflicts can be resolved by lowering sanitary sewer or installing a sanitary sewer siphon. An MMSD sanitary interceptor sewer is located on the north side of Cherokee Drive. Between Naheda Trail and Miami Pass, it is assumed this sewer will need to be relocated to allow adequate clearance between the storm sewer and sanitary sewer. The proposed storm sewer would cross water mains at two locations. It is assumed the water main would need to be lowered at each of these locations.

Water Quality Benefits

The Cherokee Drive relief sewer will not provide water quality benefits.

Additional Notes/Information

The Cherokee Drive relief sewer will discharge into Manitou Pond within the UW-Arboretum. As a result of the increased size of the storm sewer, and other local storm sewer improvements, the peak flow rates entering Manitou Pond will be increased. The increased inlet peak flows translate into higher peak pond water surface elevations and also, higher peak flow rates discharging from the pond. The increases are a result of storm sewer improvements downstream of Odana Pond that reduce surface ponding and more efficiently convey stormwater runoff downstream. To prevent additional flow into Manitou and then Secret Pond and also, meet flood control goals, additional storage throughout the downstream portion of the water would be required.

10.8 Waite Circle Culvert

Detailed Project Description

In 2019, the existing culvert under the Southwest Bike Path at Waite Circle was replaced with the 6-foot by 10-foot box culvert. The purpose of the project was to restore the capacity of the original culvert (a 6-foot by 6-foot stone arch) that was in-place prior to 2017, while providing capacity for future increases in flow to the area. The 6-foot by 10-foot culvert was sized to convey increased flows from the upstream portion of the watershed based on the best available hydrology and hydraulics calculations that could be completed at the time. Steel plates were installed on the front of the culvert to restrict flows to match the capacity of the stone arch culvert. The 2019 culvert installation project is documented in a technical memorandum for the project titled, “Basis of Design Report: Waite Circle Culvert Replacement” (September, 2019). The key design criteria for the culvert replacement was to prevent structure flooding at the upstream side of the culvert for the 1% chance event.

As part of the selected solutions, the restriction plates on the culvert would be removed to increase the conveyance capacity of the culvert and lower peak water surface elevations at the upstream side of the culvert.

Associated Flood Reduction Benefits

The Waite Circle culvert replacement and the removal of the restriction plates reduces maximum flood elevation in the 1% chance event by 4.5 feet and prevents structure flooding for the homes around Waite Circle.

Project Constraints/Considerations

The Waite Circle culvert is located directly upstream of the Chippewa Drive storm sewer. The improvements downstream of Waite Circle should be implemented prior to the removal of the restriction plates so that the downstream conveyance system has adequate capacity to convey increased flow rates through the culvert.

Water Quality Benefits

The Waite Circle Culvert will not provide water quality benefits.

Additional Notes/Information

The flows reaching the culvert are impacted by local storm sewer improvements and the flow through the 42-inch storm sewer leaving Odana Hills Golf Course. The local storm sewers have capacity limitations and improvements to those sewers will increase the flow rates to, and through, the Waite Circle culvert. Local storm sewer improvements were accounted for in the sizing of the culvert. The selected solutions assume there is no increase in the conveyance leaving Odana Hills Golf Course (the 42-inch storm sewer remains as the only outlet). If increased conveyance from the golf course is added, there may need to be additional capacity incorporated at the Waite Circle culvert location, such as a second culvert.

If the flows reaching the culvert are lower than anticipated—either through additional storage in the Odana Pond area, the implementation of the Southwest Bike Path diversion sewer, or other projects that arise—the restriction plates may be able to be left in place, or reconfigured to reduce downstream flows while still meeting the flood control goals in the Waite Circle area.

Section 11

Evaluation of Model Results with Selected Solutions Implemented

The XPSWMM™ model that included all of the selected solutions (“Proposed Conditions”) was executed for each of the design storms. Table N-1 in Appendix N summarizes the peak water surface elevation and the duration of flooding at selected locations throughout the Wingra West watershed. Figure 4-6 provides the location of each of the reporting locations in Table N-1. The “Maximum Water Depth” with the selected solutions implemented maps for each modeled event are found in Figures 11-1—11-7 (rain events from the 50% chance to the 0.2% chance events).

11.1 Comparison to City Flood Control Goals with Selected Solutions

The proposed conditions flooding results were compared to the City’s flood control goals to quantify the performance of the selected solutions in the Wingra West watershed. The performance of the system relative to greenway crossings, pipe capacity, inlet capacity, and street flooding were considered.

11.1.1 Greenway Crossings

At locations where a greenway crosses under a street, the City’s goal is to safely pass the 1% chance event without overtopping the street. The crossing was determined to be overtopped if the elevation at the upstream side of the culvert is above the street crossing elevation. Within the Wingra West watershed, there is one greenway crossing. With the selected solutions the target would not be met for the 1% chance event. Overtopping of the crossing is contained within the right-of-way and structure flooding is prevented. The performance—whether the street is overtopped—at this location is summarized in Table 11-1.

Table 11-1. Greenway Crossing Performance Wingra West Watershed Study City of Madison, WI		
Location	1% Chance Event Performance	Notes
Nakoma Road	Overtopped	Greenway located in Nakoma Park adjacent to Cherokee Drive. Cherokee Drive relief sewer was added to mitigate flooding in this area. Under existing conditions, crossing is overtopped in the 50% chance event. With the implementation of the selected improvements, the level of service would improve, and there would be no overtopping for up to and including the 2% chance event. In the 1% chance event, overtopping is limited to the street right-of-way and structure flooding is prevented.

11.1.2 Pipe Capacity

The City's goal is to eliminate surcharging from the storm sewer system onto city streets for up to the 10% chance event. The pipe capacity was determined to be exceeded if the peak water surface elevation at the upstream end of the pipe was above the ground surface elevation. Under existing conditions, there are 44 percent of the pipes and 39 percent of the pipe length that does not meet the pipe capacity goal (See Section 6.2.1.2).

Within the proposed conditions XPSWMM™ model, there are a total of 594 pipes, of which, 19 are surcharged at the upstream end during the 10% chance event. This equates to 3 percent of the pipes not meeting the pipe capacity goal. The 594 pipes result in a total pipe length of 92,850 feet, of which 1,790 feet are surcharged during the 10% chance event. This equates to 2 percent of the pipe length not meeting the capacity goal.

11.1.3 Inlet Capacity

For inlet capacity, the flood mitigation goal is to allow no more than 0.5 feet of stormwater ponding above storm sewer inlets rim elevations at inlet restricted low-points for the 10% chance event. As part of this study, the existing inlet capacity was evaluated at the subwatershed level (see Section 4.4.3 for additional detail). As part of the proposed solutions, it is assumed that inlet capacity improvements are incorporated such that the inlet capacity is not the limiting factor, and, thus, this goal would be met in all locations. Further detailed analysis is required to determine the exact number, type, and location of inlets required to be implemented.

11.1.4 Street Flooding

Within streets, the City's goal is to maintain drivability of municipal streets for the 4% chance event. Drivability is defined as having no more than 0.2 feet of flooding at the center of the street. Within the watershed, there are a total of 41.6 miles of streets. Under existing conditions, 8.3 miles (20 percent) of the streets do not meet the street flooding goal.

With the selected solutions implemented, the length of street that do not meet the street flooding goal is reduced to 0.6 miles (1 percent).

11.1.5 Structure Flooding

The City's goal is to eliminate structure flooding during the 1% chance event. Structure flooding is defined as having 0.5 feet or more water within 5 feet of a building. Under existing conditions, structure flooding is identified for all storm events considered (50% chance through 0.2% chance events). During the 1% chance event in existing conditions, there are 167 structures impacted by flooding. In proposed conditions, there are 33 structures impacted by flooding. It is believed that the majority of structures that are flagged to be impacted under proposed conditions are a result of nuances of the XPSWMM™ model. The locations where structure flooding was identified under the selected solutions were evaluated in further detail. The analysis conducted is described in Section 12.1.

11.2 Improvements to Known Flooding in Watershed from Selected Solutions

In Section 1-3, known flooding areas in the watershed (based on City staff accounts) were identified. The areas that were identified are shown on Figure 1-4. Additionally, focus group meetings were held in various areas of the watershed that were impacted by flooding. The location of each focus group meeting is shown on Figure 7-1. The locations of the focus groups corresponded with areas of known flooding that were reported by City staff.

The selected solutions were generally targeted at meeting the City's flood control goals throughout the Wingra West watershed. Known flooding locations were considered as part of the development of solutions. A summary of how the known flooding locations (identified by City staff) are impacted by selected solutions are described below.

1. Intersection of Midvale Boulevard and Southwest Bike Path

- a. **Solutions that Benefit Area:** Local Storm Sewer Improvements
- b. **Flood Reductions Observed:** With implementation of local storm sewer improvements, there is no flooding that occurs for the 4% chance and smaller events. There is limited overland flow within the street right-of-way for the 2% and 1% chance events; however, overland flow to the east is prevented under this scenario.

2. Waite Circle

- a. **Solutions that Benefit Area:** Waite Circle Culvert, Local Storm Sewer Improvements
- b. **Flood Reductions Observed:** During the 1% chance event, the peak water surface elevation at the east end of Waite Circle is reduced by approximately 4.5 feet and structure flooding is prevented for this event. The peak water surface elevation is maintained below the street level for the 10% chance event.

3. Intersection of Chippewa Drive and Council Crest

- a. **Solutions that Benefit Area:** Chippewa Drive Storm Sewer
- b. **Flood Reductions Observed:** Street flooding is prevented for up to the 4% chance event. In the 1% chance event, flooding depths are limited to less than 0.5 feet.

4. Intersection of Cherokee Drive, Nakoma Drive, and Manitou Way:

- a. **Solutions that Benefit Area:** Cherokee Drive Storm Sewer, Local Storm Sewer Improvements
- b. **Flood Reductions Observed:** In the 1% chance event, structure flooding is prevented and water depths on Nakoma Drive and Manitou Way area less than 0.5-feet. There is no surface flooding for the 10% chance event.

5. Intersection of Dearholt Road and Milward Drive:

- a. **Solutions that Benefit Area:** Odana Pond Expansion, Odana Golf Course Detention Basin, Local Storm Sewer Improvements
- b. **Flood Reductions Observed:** Street flooding is prevented for the 10% chance event. The Odana Pond peak water surface elevation is reduced such that it does not impact the street for the 2% chance and smaller events. In the 1% chance event, the pond peak water surface elevation is reduced by approximately 1.5 feet and structure flooding is prevented.

6. Orchard Ridge Valley Park:

- a. **Solutions that Benefit Area:** Odana Pond Expansion, Odana Golf Course Detention Basin, Orchard Ridge Park Detention Basin, Local Storm Sewer Improvements
- b. **Flood Reductions Observed:** The pond peak water surface elevation is reduced by approximately 2.3 feet, and flooding of homes and roads to the south caused by the pond is prevented for the 1% chance event.

7. Whitney Way, South of the Beltline Highway:

- a. **Solutions that Benefit Area:** Odana Pond Expansion, Odana Golf Course Detention Basin, Orchard Ridge Park Detention Basin, Local Storm Sewer Improvements

- b. **Flood Reductions Observed:** No flooding is present during the 10% chance event. The flooding depth in the 1% chance event is reduced by approximately 2.2 feet and the duration of flooding is reduced by about 11 hours.

11.3 Discussion of Long Duration, Back-to-Back Model Results

As with the existing conditions, an additional design storm model run was conducted to represent the extreme condition of “back-to-back” 1% chance events occurring (See Section 6.3). The XPSWMM™ model with the selected solutions was executed for this back-to-back storm. The modeled results of the maximum water depth map for this event is shown on Figure 11-8 and tabular results are shown in Table N-1. Under the selected solutions scenario, the flooding depth and extents during the “back-to-back” storm event scenario is reduced. The largest reductions in flooding are observed in areas where the conveyance capacity (i.e., new or enlarged storm sewers) is improved as a result of the selected solutions. Where storage volume was added, such as add Odana Pond, the reduction in flooding is not as extensive.

Section 12

Areas Flood Control Goals are Not Met

In most of the Wingra West watershed, the City's flood control goals are met. In limited locations, there are cases where the goals are not met. Further consideration of areas not meeting the 1% chance event structure flooding goal is provided in this section. Additionally, an analysis was conducted to determine the added infrastructure improvements that would be required to prevent structure flooding for the 0.2% chance event.

12.1 1% Chance Event Structure Flooding

As noted in Section 11.1.5, there are 33 structures that were identified as flooded under the selected solutions scenario. It is believed that, for the majority of these structures, the identification that they are flooded is due to specific topographic conditions within the XPSWMM™ model. Each of these locations was evaluated in greater detail to determine the nature of the flooding and the additional capacity needed to eliminate the flooding.

To attempt to quantify the additional drainage system capacity that would be required to prevent flooding, the following methodology was followed. Within the XPSWMM™ model, a new node was added to collect runoff from near the flooded structure. This node was connected to a hypothetical pipe that was given a free outfall, meaning that any runoff collected by the node was discharged directly from the model. The added pipes were given a 5-foot diameter and a 1 percent slope to allow free passage and discharge of runoff. This was a theoretical analysis and not representative of the exact size of improvements needed. The volume and peak runoff rate discharged through the outfall was measured to quantify the extent of additional capacity needed to resolve flooding.

The model was then executed for the 1% chance storm event. Based on the review of the structures impacted by flooding, the following observations were made:

- Twenty-nine of the structures are associated with local storm sewer improvements. In general, these locations are associated with a small amount of runoff. The maximum volume discharged through the added outfall is 0.6 acre-feet. Furthermore, there are 25 structures triggered for flooding with less than 0.1 acre-feet of volume.
 - The majority of these flooding locations are triggered by limitations of the XPSWMM™ 2D model. The results were observed to show that shallow overland flow becomes trapped against a building and results in triggering the flooding criteria. The 2D model uses a 10-foot grid system to simulate overland flow. The grid size is reflective of a watershed study of this nature. However, it does not have the ability to capture, and simulate, all of the nuances within an urban area. For instance, the detailed grading surrounding a building may not be captured by the grid, or the 6-inch curb depth of a road might not be fully captured.
 - In some locations there may be private storm sewer present that is not incorporated into the model. The private storm sewer may prevent flooding if accounted for in the model.

- Refinement of the model during subsequent planning, design, and implementation phases for solutions can verify pipe sizing and confirm whether structures are flooded or not. Refining the model could include revising topographic data (such as supplementing LiDAR data with survey data), decreasing the grid size in specific locations of interest, splitting subwatersheds, and/or adding additional storm sewer such as inlets, inlet leads, smaller storm sewer, or private storm sewer. Additionally, further structure elevation data (such as first floor or low opening elevations) could be obtained to verify where the structure would be flooded.
- A final possibility in these locations is that the storm sewer improvements could be refined and sizes potentially increased to provide a greater level of flood protection.
- One structure is adjacent to Orchard Ridge Valley Park detention basin. This structure was identified as the critical elevation for the Orchard Ridge Valley Park detention basin water surface elevation. The target water surface elevation could not be met based on expected limitations to modifications to Odana Pond water levels, limitations to pond expansion, and limitations to additional conveyance out of the Odana Hills area. As part of the 1% chance event analysis, an additional, free outfall was added from the Orchard Ridge Valley Park detention basin. It is estimated that an additional 24-inch diameter storm sewer with a free outfall would be required to lower the water surface elevation such that the structure would not be impacted. Additional options would be to increase the storage volume provided in the Odana Hills area (see the various concepts considered and discussed in Section 10.3).
- Three structures are associated with an internally drained area located in the western portion of the watershed. A review of this area showed there are no flood reports associated with the area. There is also uncertainty with the elevations of structures adjacent to the internally drained area. There are steep slopes adjacent to the area, and it is difficult to estimate the elevation of adjacent buildings. Additionally, the modeling does not allow water ponding on the 2D surface to infiltrate into the ground. To resolve flooding observed in the model for this area, a new storm sewer would need to be added to convey runoff from the internally drained area to the existing storm sewer system. Approximately 850 feet of storm sewer would be needed to connect to the existing storm sewer system. The conveyance system would need to provide a peak flow rate of approximately 23 cfs, and a volume of 2.7 acre-feet.

12.2 0.2% Chance Event Enhancement Scenario

Under existing conditions, there are 290 structures within the Wingra West Watershed impacted by flooding in the 0.2% chance event. With the implementation of the selected solutions, the number is reduced to 138 structures impacted. The study considered the level of effort needed to prevent structure impacts from the 0.2% chance event. To consider this evaluation, the size of the selected solutions was modified to prevent structure flooding during this storm event. The selected solutions XPSWMM™ model was utilized as the starting point for the 0.2% chance event improvement scenario. The model was updated to reflect the increased infrastructure size required to prevent structure flooding for the 0.2% chance event. Below is a summary of the changes to the selected solutions:

- The Waite Circle culvert improvements were not altered. The culvert was recently constructed and modifications were not considered.
- Modifications to the Chippewa Drive relief sewer were not required. The Cherokee Drive relief sewer size was increased from Nakoma Drive to Manitou Pond.

- The Southwest Bike Path diversion sewer into the Odana Golf Course pond was added as a mitigation measure. This diversion was needed to reduce flows to the Waite Circle culvert and prevent flooding in that area.
- Throughout the watershed, the size of local storm sewer improvements were increased. This included increases to storm sewers that were added as part of the selected improvements and also, enlargements of additional sewer that were previously not identified for improvement. The enlargement of storm sewers was conceptual in nature. Where minor flooding was observed, the pipe size was increased by one or two pipe sizes. Where more severe flooding was observed, the pipe was converted to larger elliptical or rectangular box culvert as needed to resolve flooding.
- The normal water level for Odana Pond was lowered to 974.5, which in turn would also lower the normal water level for the Orchard Ridge Valley Park Detention Basin. The Odana Pond footprint was then expanded to the north and northeast to include Odana Park, and to the southwest to include additional areas in the Odana Hills Golf Course. Approximately 130 acre-feet of storage was added at Odana Pond.
- The Odana Hills Golf Course was expanded to both the north and south and approximately 90 acre-feet of storage was added to the golf course detention basin. Additionally, a parallel 42-inch outlet sewer was added to the storm sewer traveling from Odana Hills Golf Course to Waite Circle.
- There were no modifications to the footprint of the Orchard Ridge Valley Park, University Research Park Southeast, and University Research Southwest detention basins. The footprint of these detention basins was already maximized within land owned by the City.

Figure 12-1 provides a graphical depiction of the improvements included as part of this scenario. Table O-1 in Appendix O provides the pipe size increases included in the 0.2% chance event enhancement scenario. This table identifies the existing pipe size and peak flow rate, the pipe size and peak flow rate in the selected scenario, and the pipe size and peak flow rate in the enhanced scenario. Analysis was completed to assist in determining whether additional capacity could reasonably be added to provide a higher level of protection. The pipe sizes were not optimized, and flooding may be “over solved” in some areas. The pipe sizes along with the flow rates included in the table provide insight into the relative increase needed to provide flood protection for the 0.2% chance event.

Section 13

Cost Estimating

During the course of this study, planning level cost estimates were prepared for each of the stand-alone solutions described in Section 10. The following sections describe the methodology used for estimating costs. Cost estimates were not prepared for local storm sewer or inlet capacity improvements. In general, these improvements will be implemented in conjunction with street resurfacing projects. The costs associated with these storm sewer improvements will be developed by the City as they are scheduled for implementation in the City's five-year Capital Improvement Plan (CIP).

To prepare the cost estimates, estimated quantities were developed for the project. The City provided average units costs for typical bid items included as part of storm water improvement projects. The standard unit costs were adjusted by BC based on specific project conditions that may result in higher or lower than average unit costs. Initial cost estimates were provided to the City for review and comment on unit costs prior to finalizing the estimates.

The total estimated cost for each of the stand-alone projects is provided in Table 13-1. Detailed breakdowns of the cost estimates for each project are included in Appendix P.

Table 13-1. Stand-Alone Project Cost Estimates Wingra West Watershed Study City of Madison, WI	
Project	Estimated Cost
Odana Hills Golf Course Detention Basin	\$6.2 million
Odana Pond Expansion	\$14.1 million
Orchard Ridge Park Detention Basin	\$9.3 million
University Research Park – Southeast Detention Basin	\$710,000
University Research Park – Southwest Detention Basin	\$630,000
Chippewa Drive Sewer & Swale	\$4.7 million
Cherokee Drive Relief Sewer	\$6.2 million

Section 14

Implementation Sequence

14.1 Watershed Specific Implementation Requirements

Implementation of individual selected solutions in the watershed can impact other parts of the watershed. For instance, implementing a conveyance improvement project could have a negative impact on a downstream area by increasing peak flows to the downstream area. Within the Wingra West watershed, there is some flexibility with implementing the various selected solutions. The following guidelines for implementation are provided:

1. Storm sewer improvements, including local storm sewers and relief sewers, should generally be implemented from downstream to upstream to prevent increased downstream flooding. However, these improvements will typically be implemented with road reconstruction projects. A variety of other factors contribute to the scheduling road reconstruction projects. These factors may dictate that projects be implemented outside of the preferred sequence. As part of this approach, the specific improvements can be reviewed as part of the design process to determine if any temporary measures, such as bulkheads or restriction plates, are needed to offset downstream concerns.
2. In general, the pond improvements should be implemented prior to upstream storm sewer improvements. This will prevent adverse impacts to the pond water surface elevation resulting from increased upstream conveyance. However, given the size of the watershed to the Odana Golf Course, Odana, and Orchard Valley Ridge Park ponds, limited upstream storm sewer impacts will likely have negligible or minor impacts to pond water surface elevations. This could be further considered as part of implementation, if desired.
3. Of the stand-alone solutions identified for implementation as part of this project, the following should be considered:
 - a. The University Research Park pond improvements could be implemented at any point in the implementation sequence.
 - b. The Cherokee Drive relief sewer should be implemented prior to the Chippewa Drive storm sewer.
 - c. The Cherokee Drive and Chippewa Drive improvements could occur either prior to or after the detention improvements in the Odana Hills area.
 - d. The preferred Odana Hills area detention implementation sequence is from downstream to upstream. Expanding Odana Hills Golf Course detention pond, and lowering the water level will reduce back-water effects upstream and improve construction conditions. Note that there will still be back-water effects, particularly during large storm events.

14.2 Citywide Implementation Prioritization

The City is conducting similar watershed studies for all the watersheds in the City. All watersheds are expected to have numerous recommendations resulting from the studies. The City is developing a process to rank and prioritize the order in which the solutions might be implemented if and when funding and public support are obtained. Information on this process will be shared by the City when it is available.

Section 15

Limitations

This document was prepared solely for City of Madison (City) in accordance with professional standards at the time the services were performed and in accordance with the contract between the City and Brown and Caldwell (BC) dated March 24, 2019. This document is governed by the specific scope of work authorized by the City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Further, BC makes no warranties, express or implied, with respect to this document, except for those, if any, contained in the agreement pursuant to which the document was prepared. All data, drawings, documents, or information contained this report have been prepared exclusively for the person or entity to whom it was addressed and may not be relied upon by any other person or entity without the prior written consent of BC unless otherwise provided by the Agreement pursuant to which these services were provided.

Section 16

References

Section 3.2.1 describes the specific files and data sources used in the development of the XPSWMM™ model. Below is a list of additional sources of information consulted or referenced during this study.

Dane County Land & Water Resources Department. Lake Levels and Information.

<https://lwr.d.countyofdane.com/Lake-Levels>

Strand Associates. 2006. *Lake Wingra Dam Investigation and Analysis*, Report for City of Madison, Wisconsin, November.

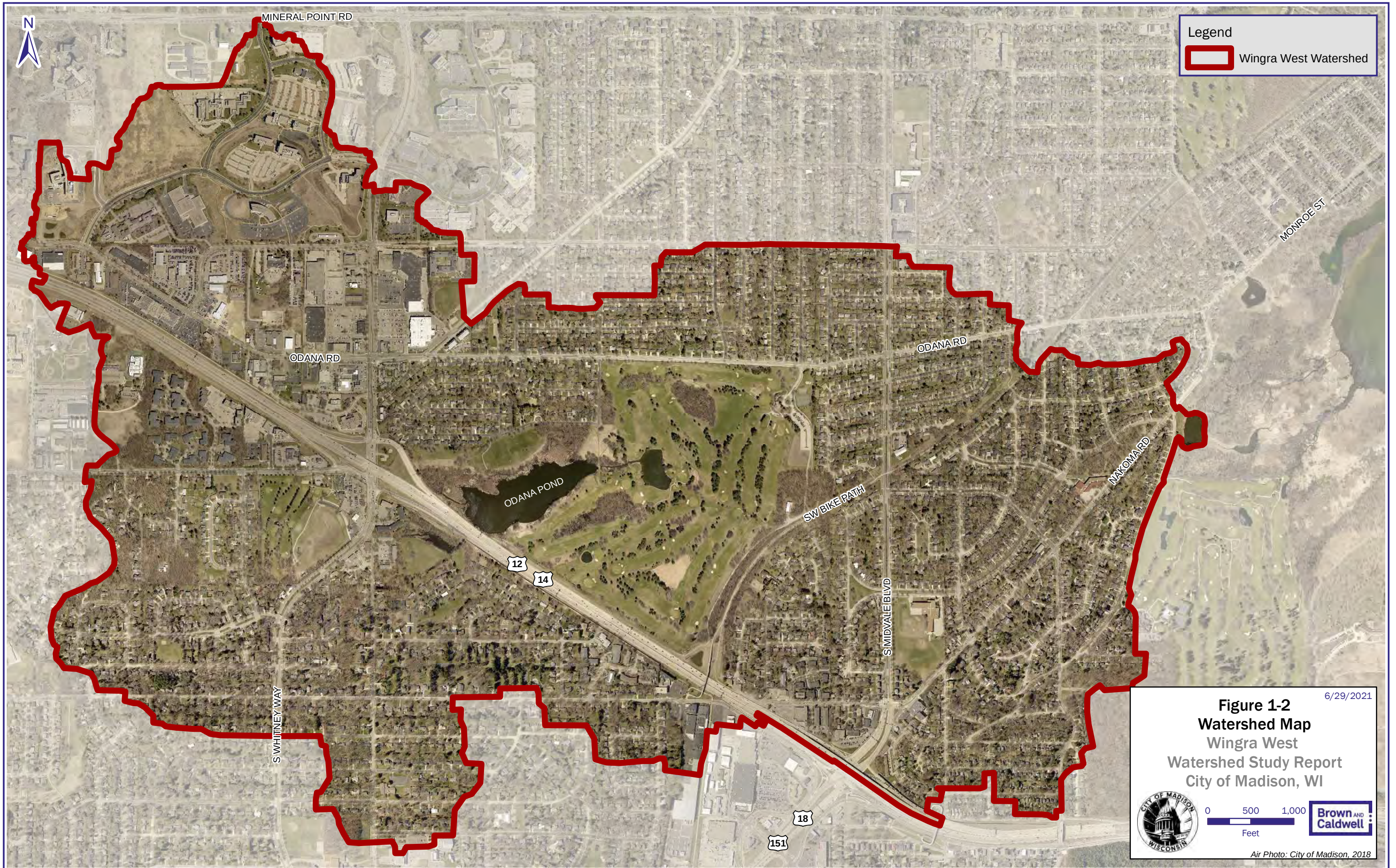
Strand Associates and Friends of Lake Wingra. 2015. *Lake Wingra Watershed Management Plan*, Report to the City of Madison, November.

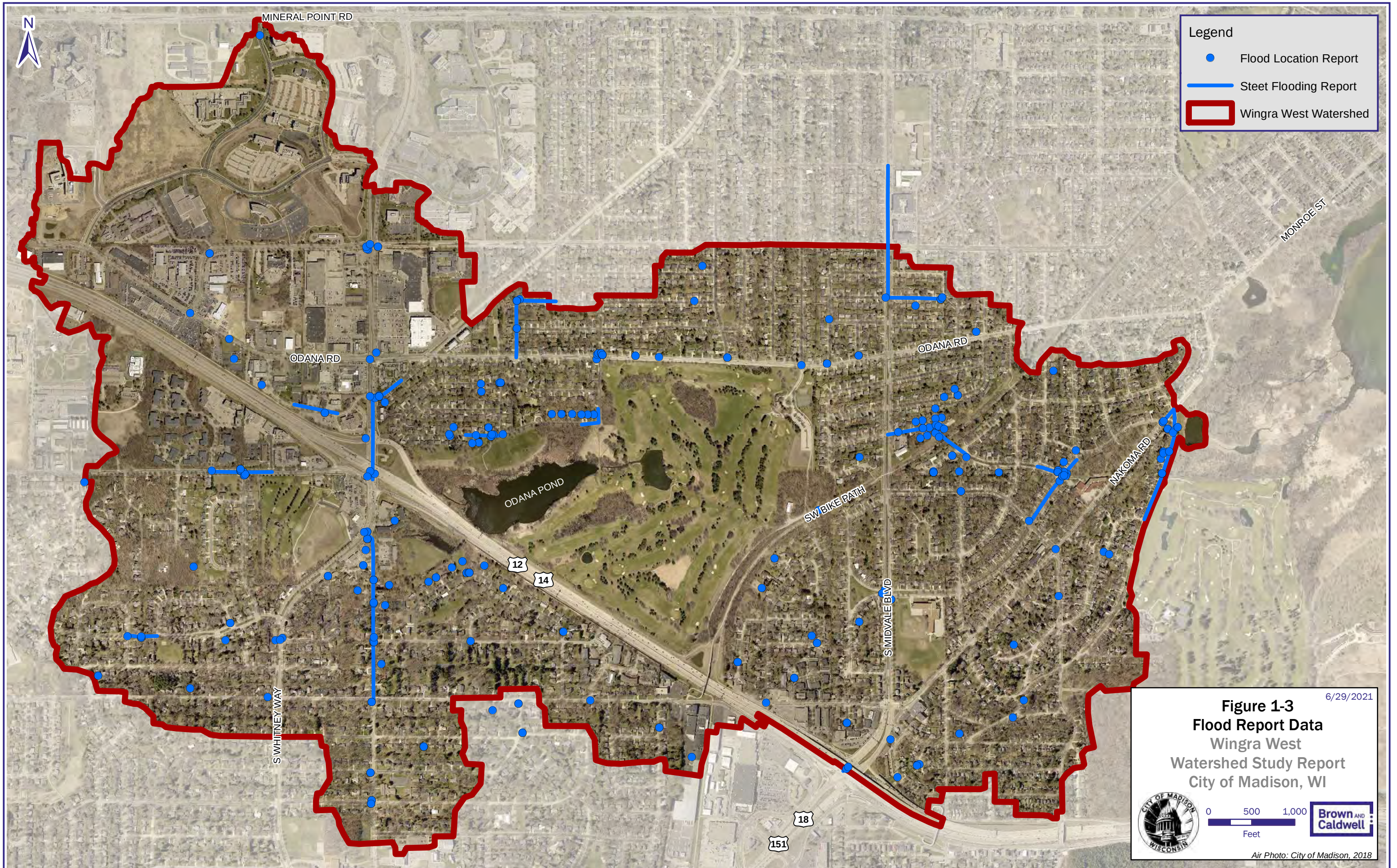
University of Wisconsin-Madison. Wisconsin Geological Geologic and Natural History Survey. Soil Survey of Dane County, Wisconsin, 1917. (<https://wgnhs.wisc.edu/pubs/000057/>)

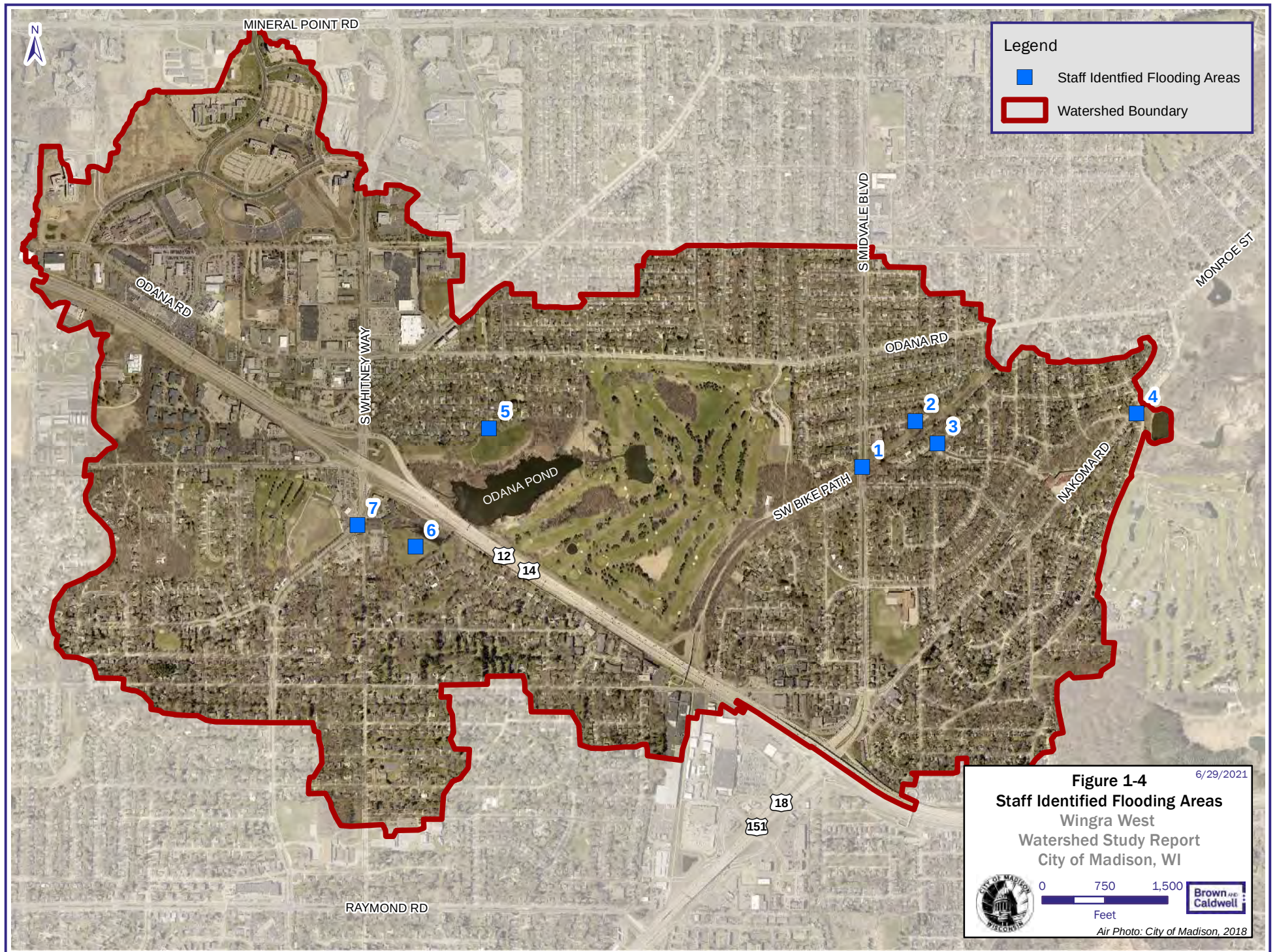
Wisconsin Department of Natural Resources. Surface Water Data Viewer.

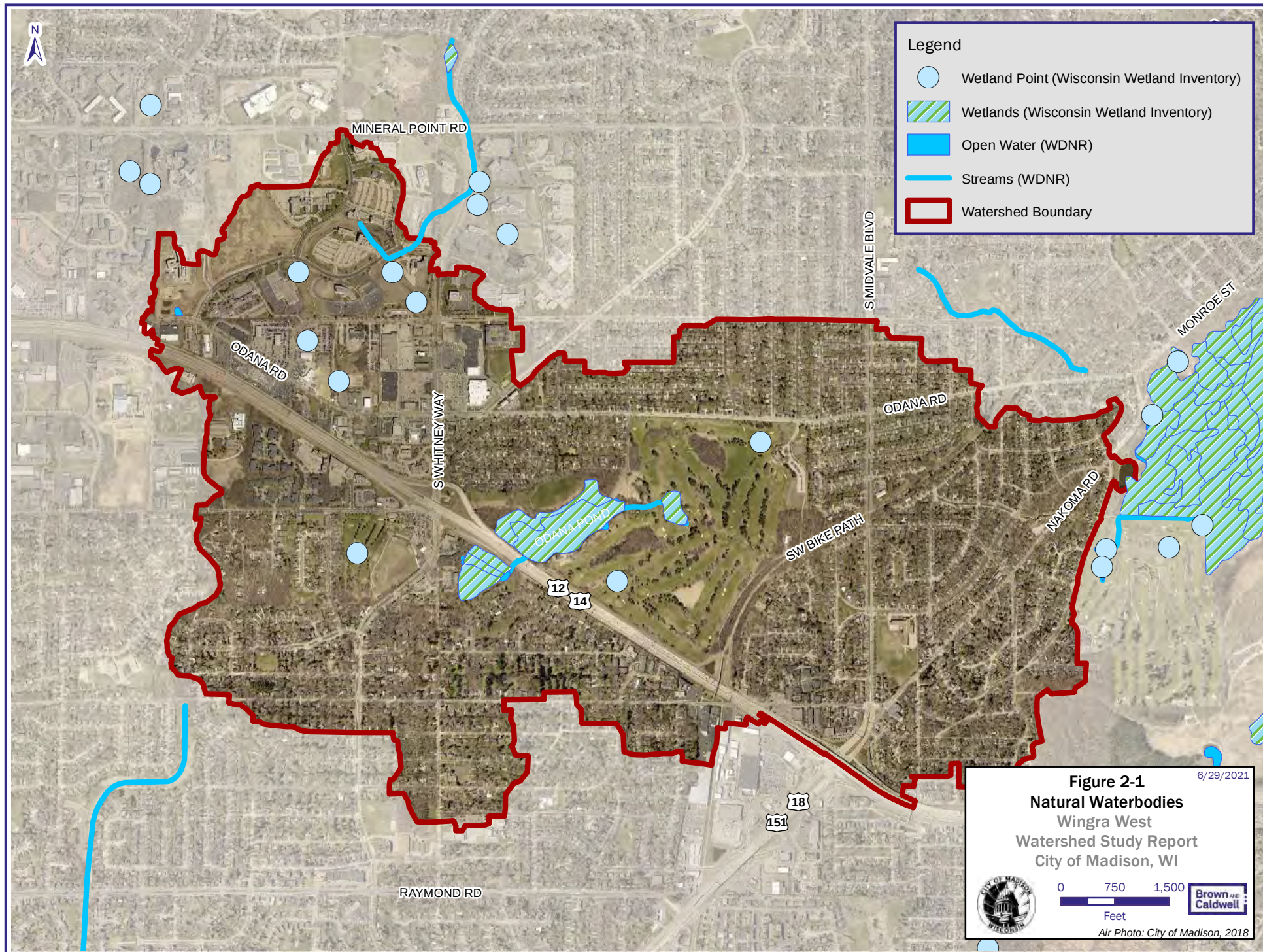
<https://dnr.wi.gov/topic/surfacewater/swdv/>

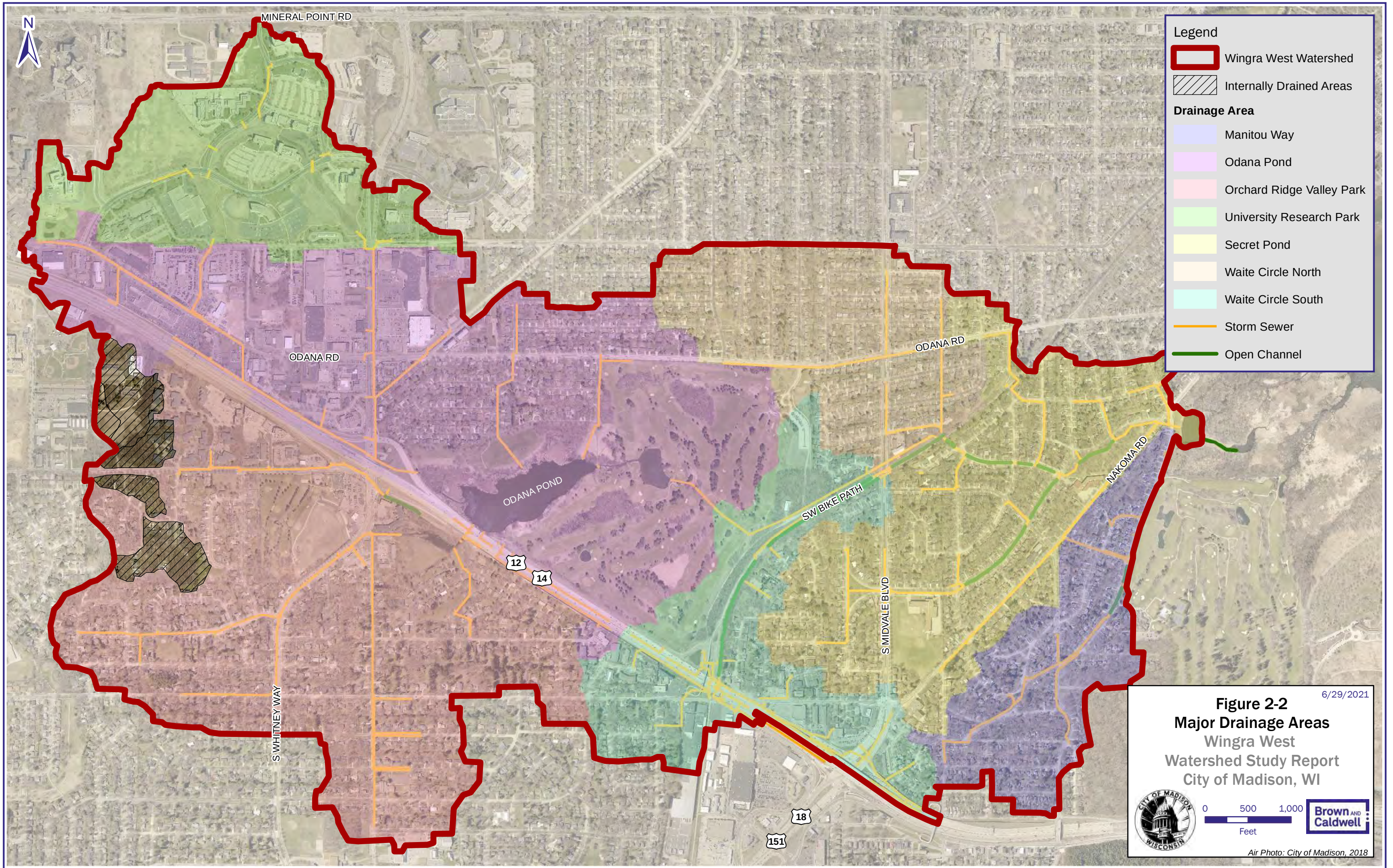
Figures



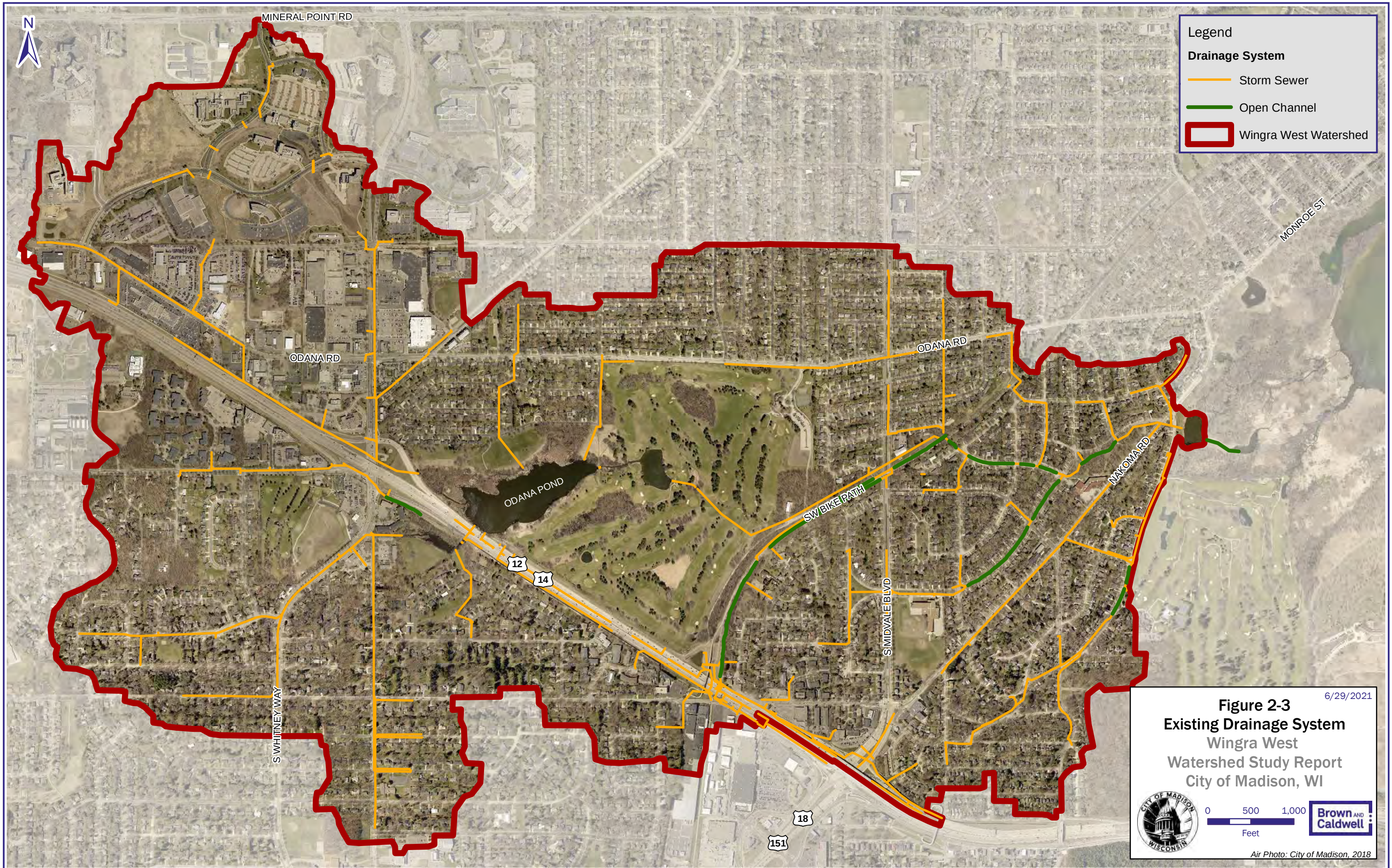


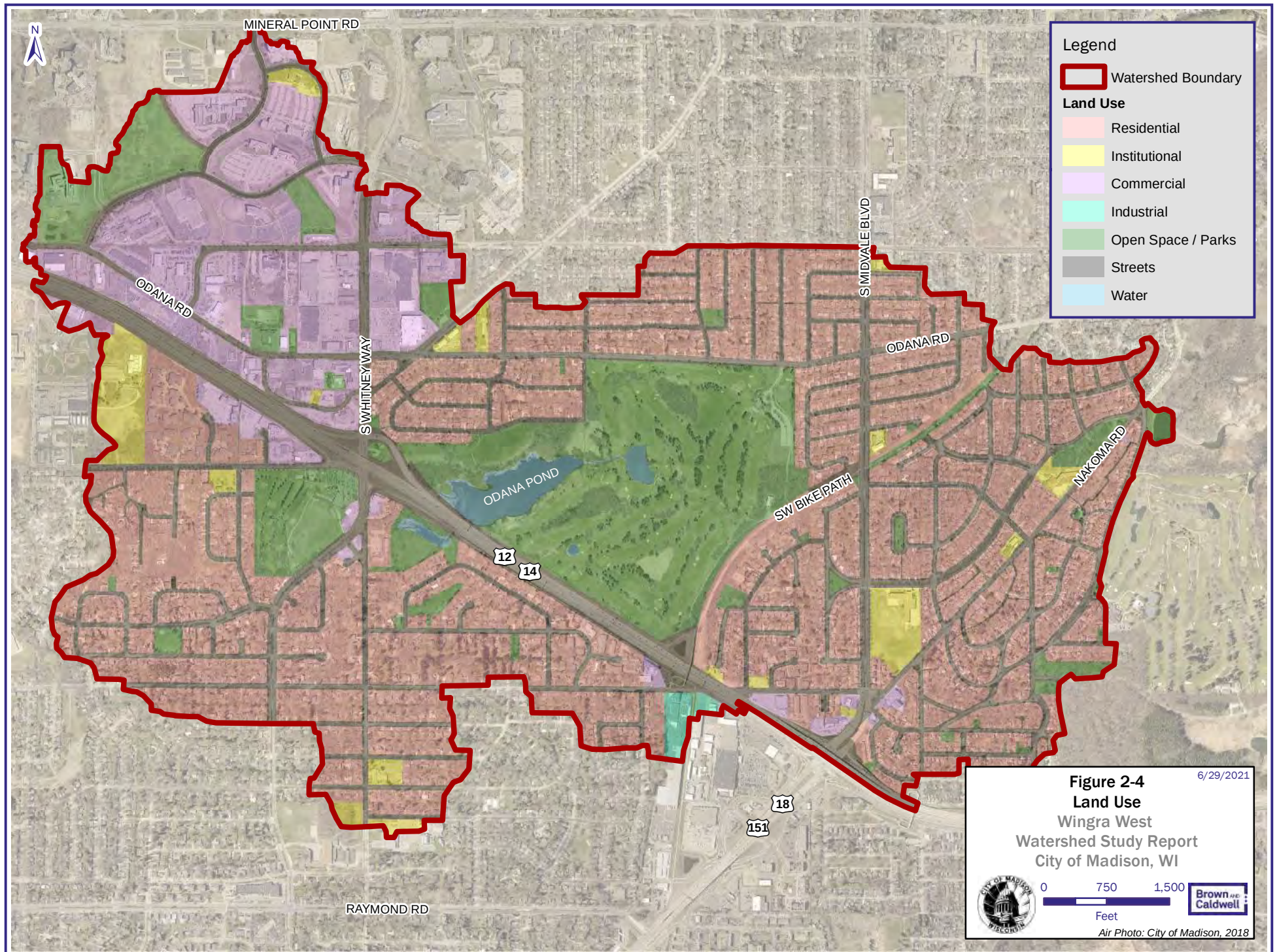


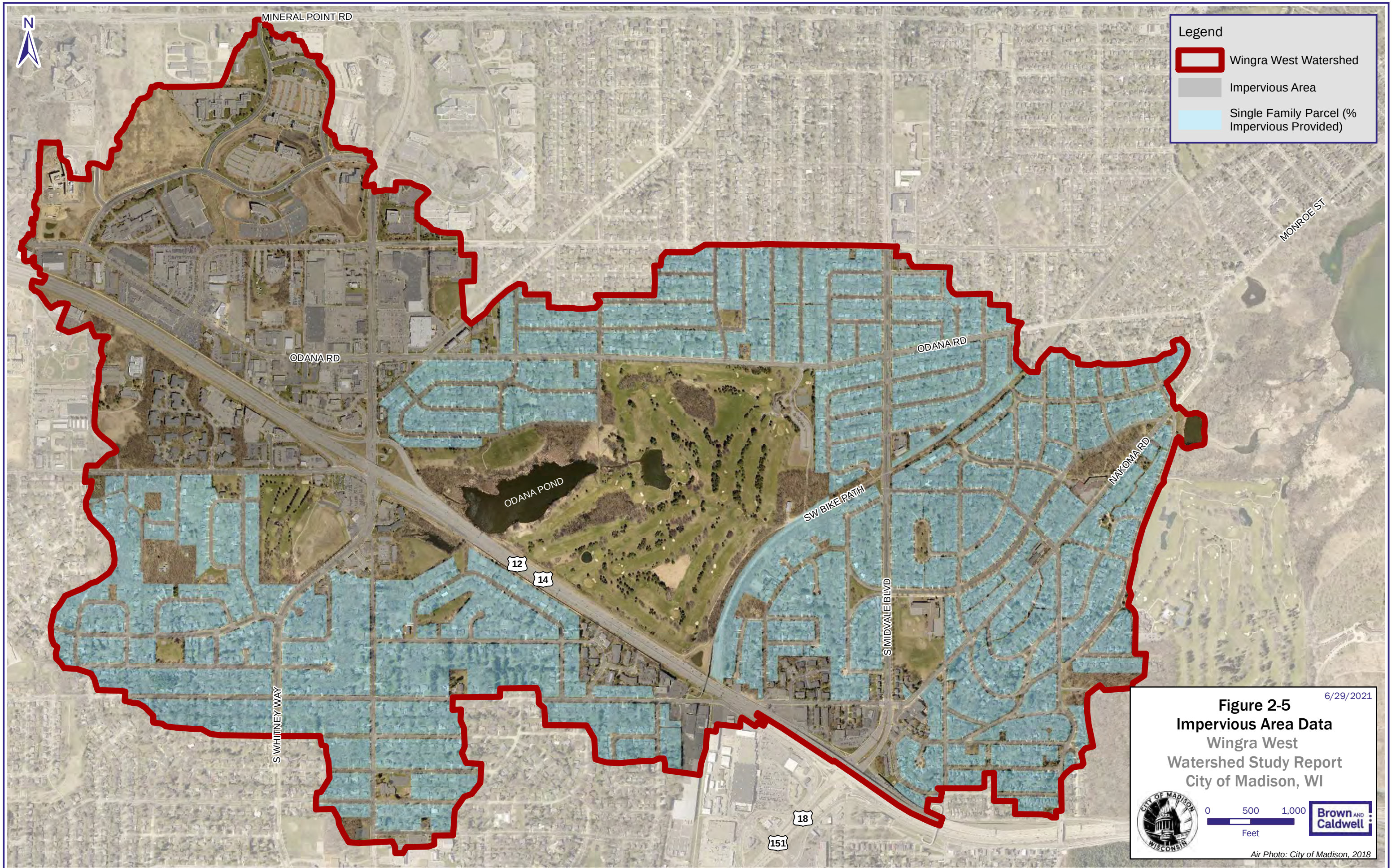


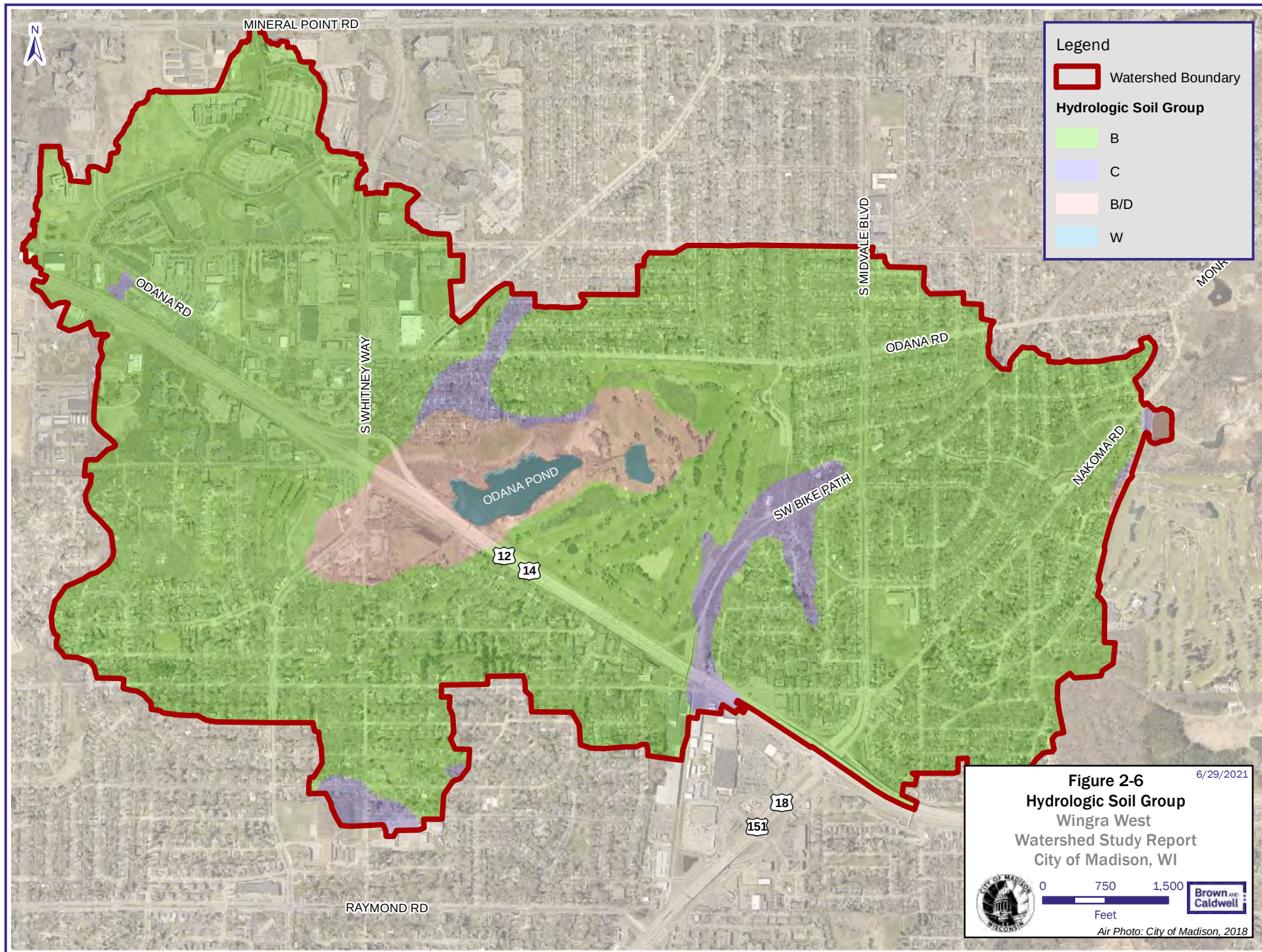


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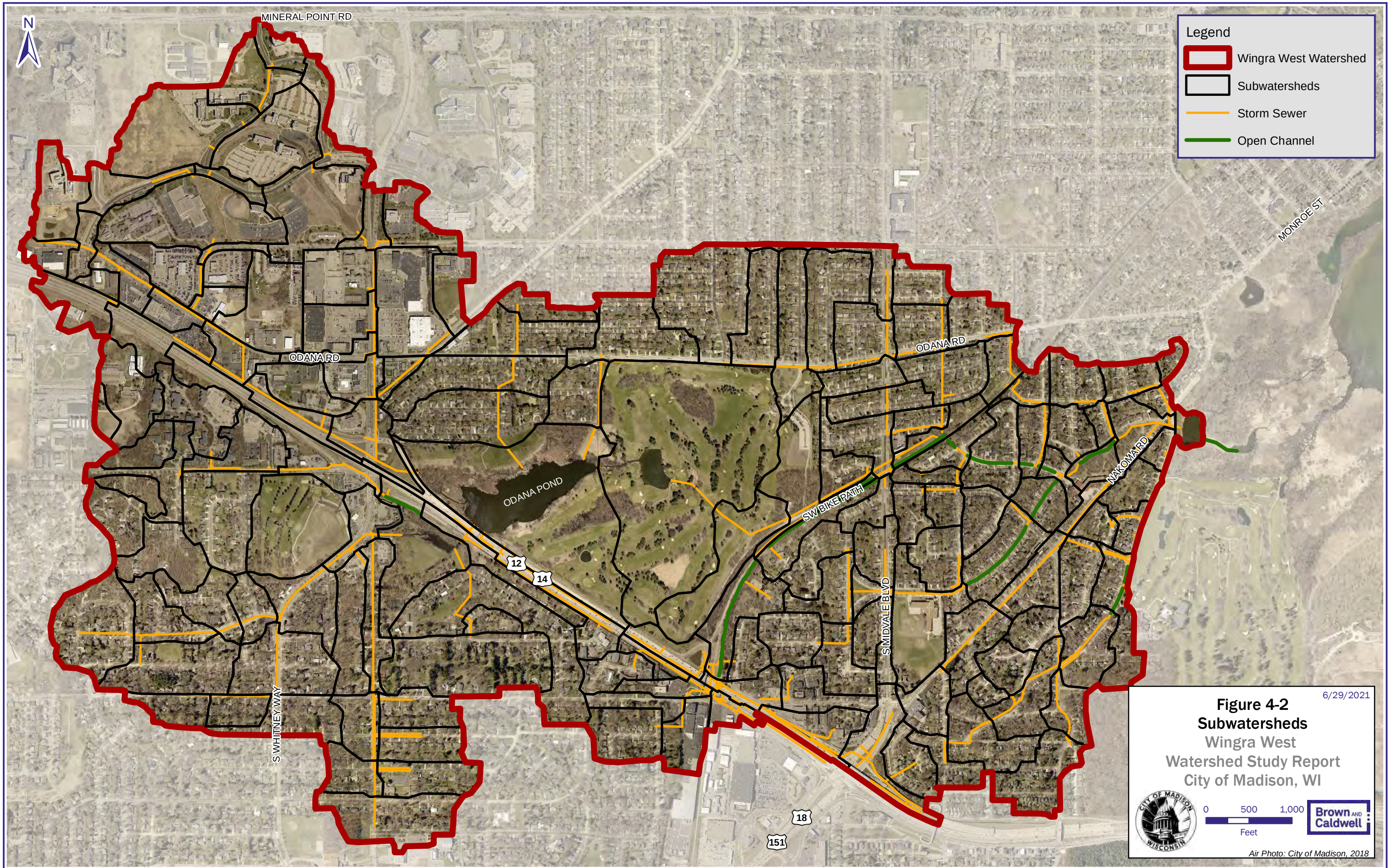


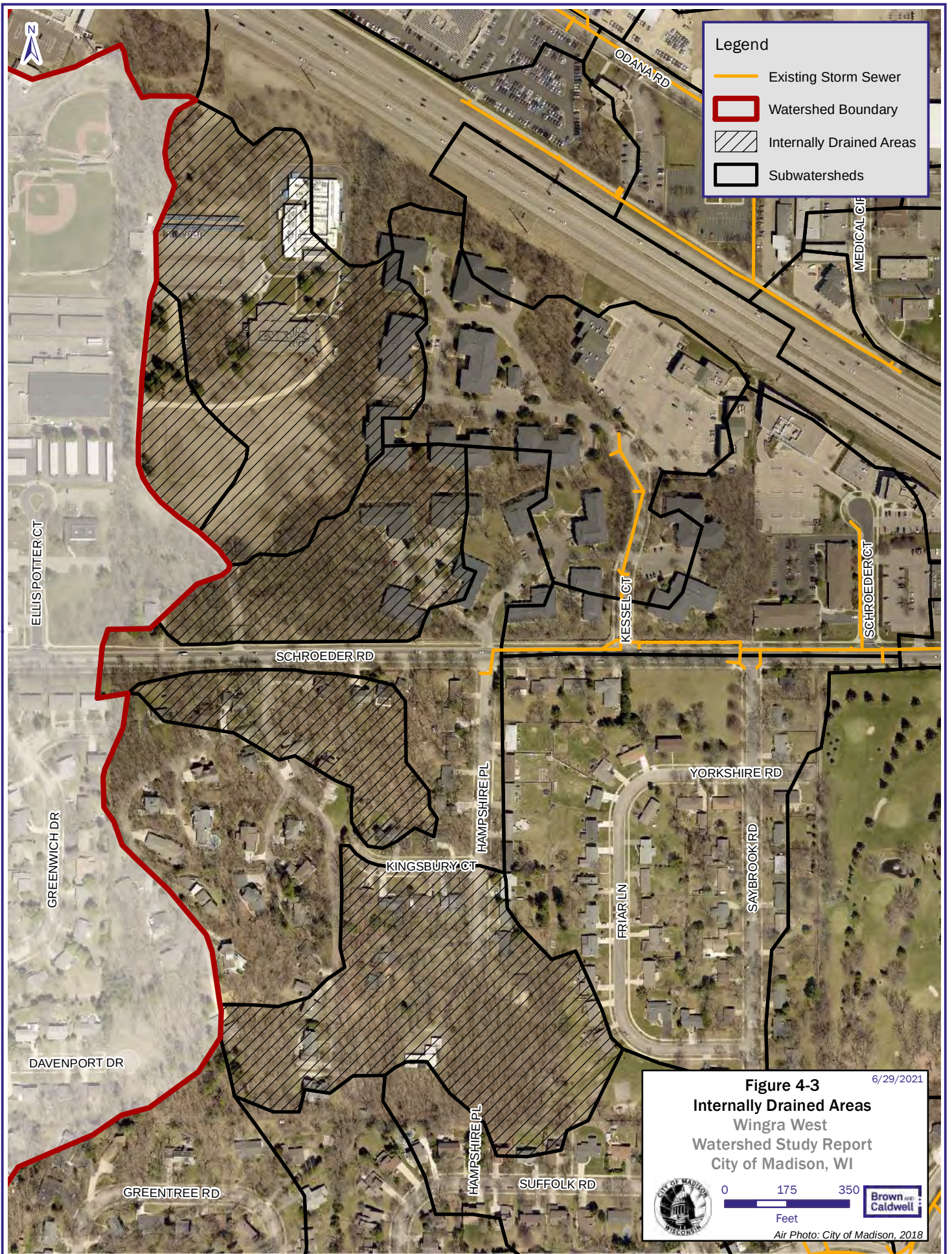




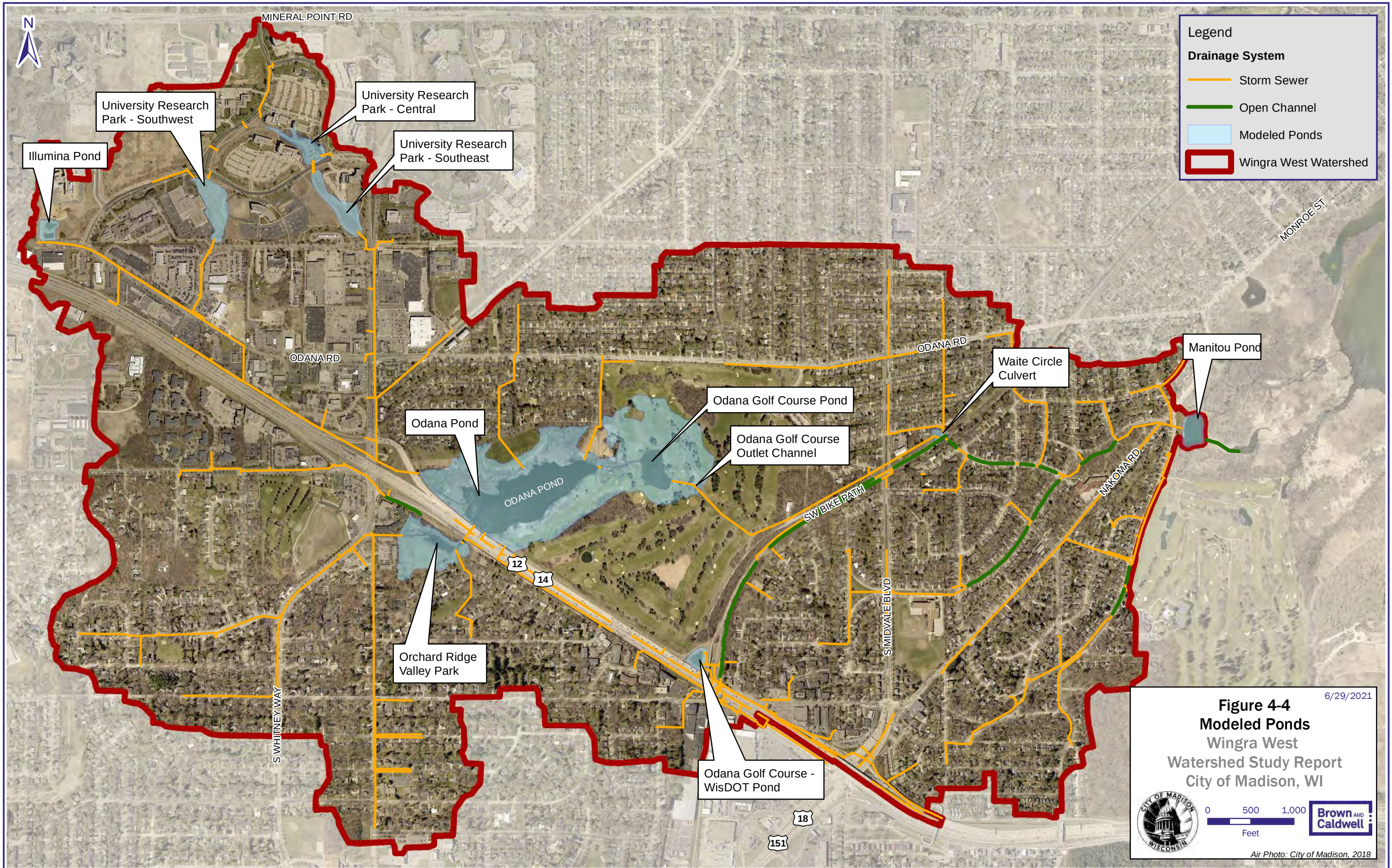


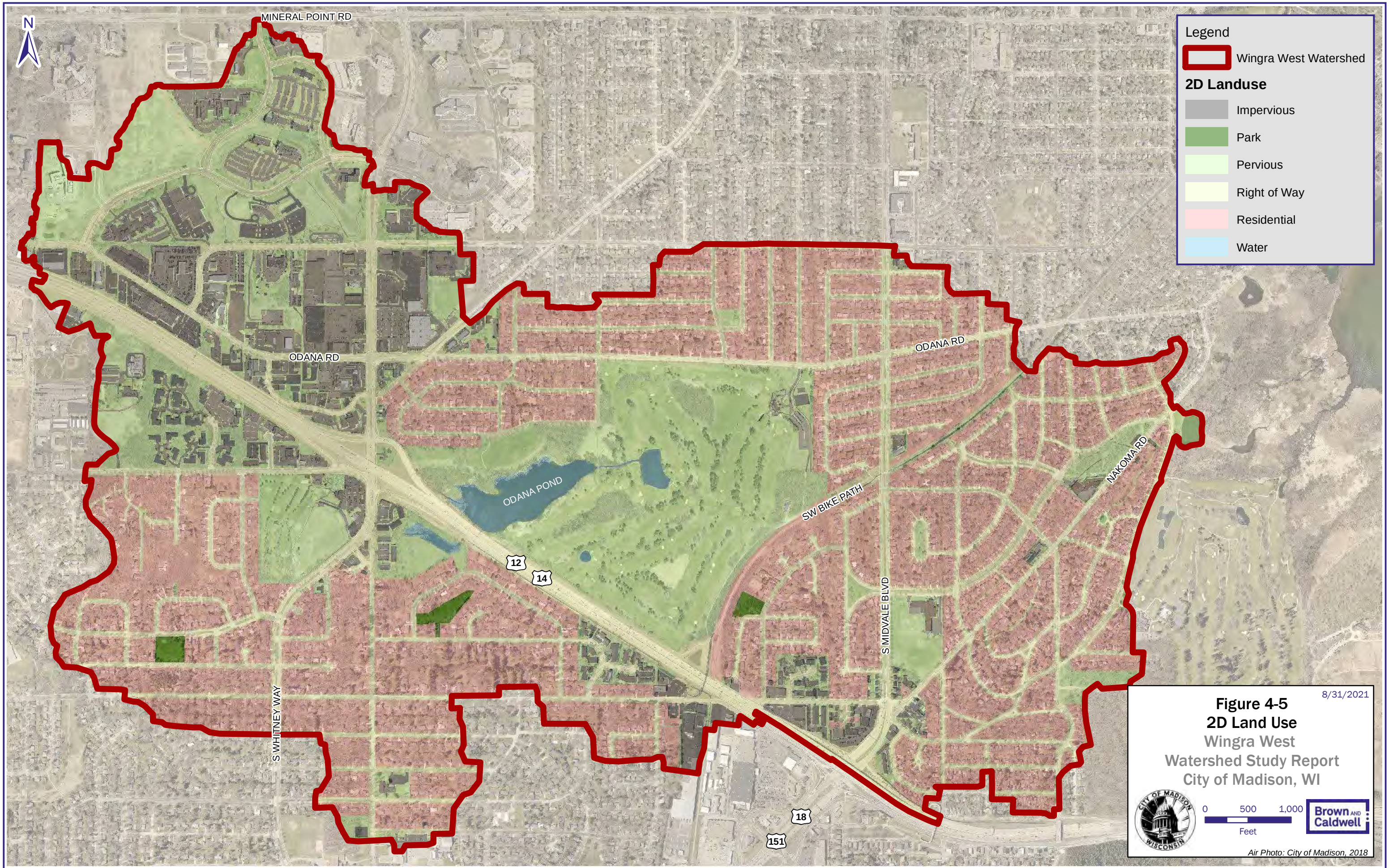


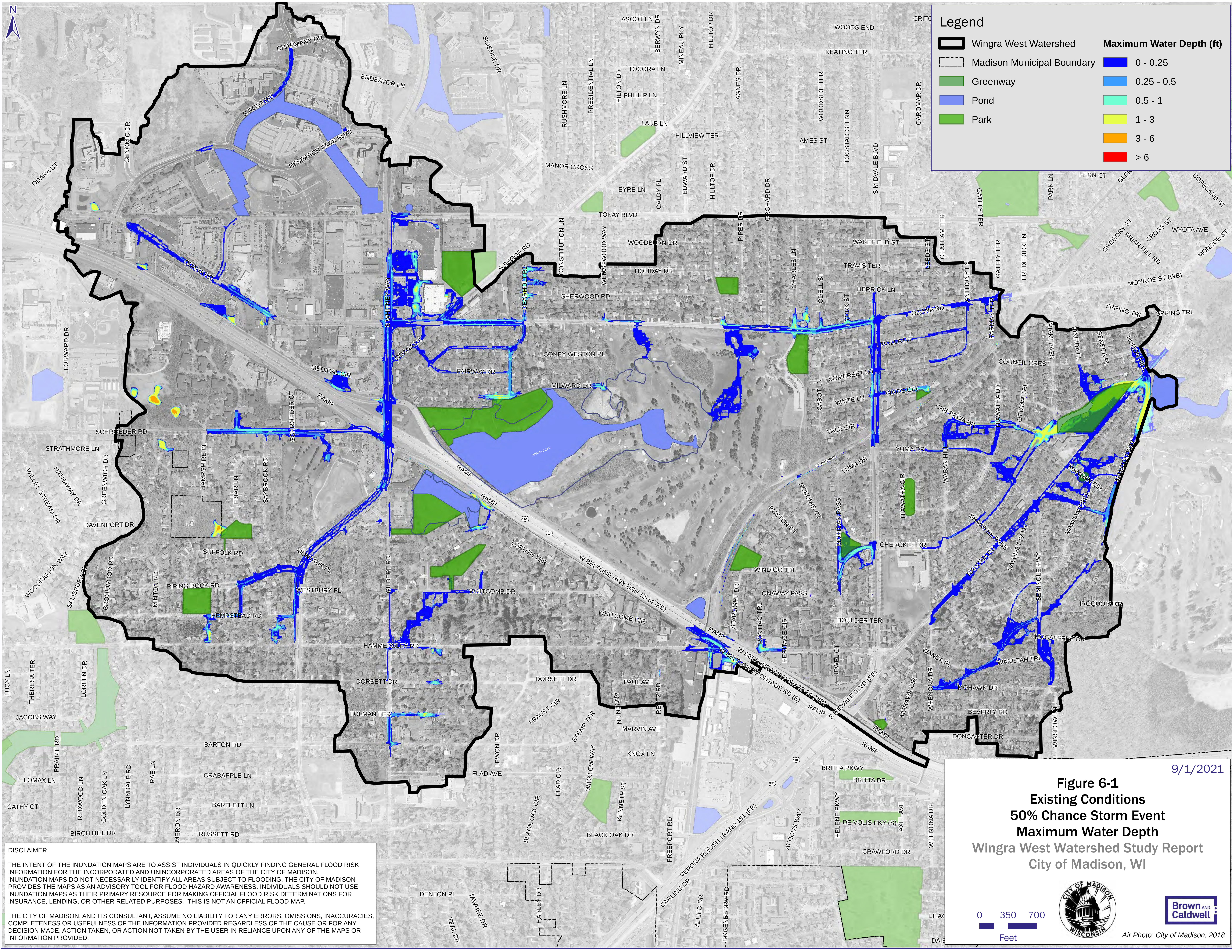




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Legend

Wingra West Watershed

Madison Municipal Boundary

Greenway

Pond

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

DISCLAIMER

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9/1/2021

Figure 6-1

Existing Conditions

50% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

City of Madison, WI

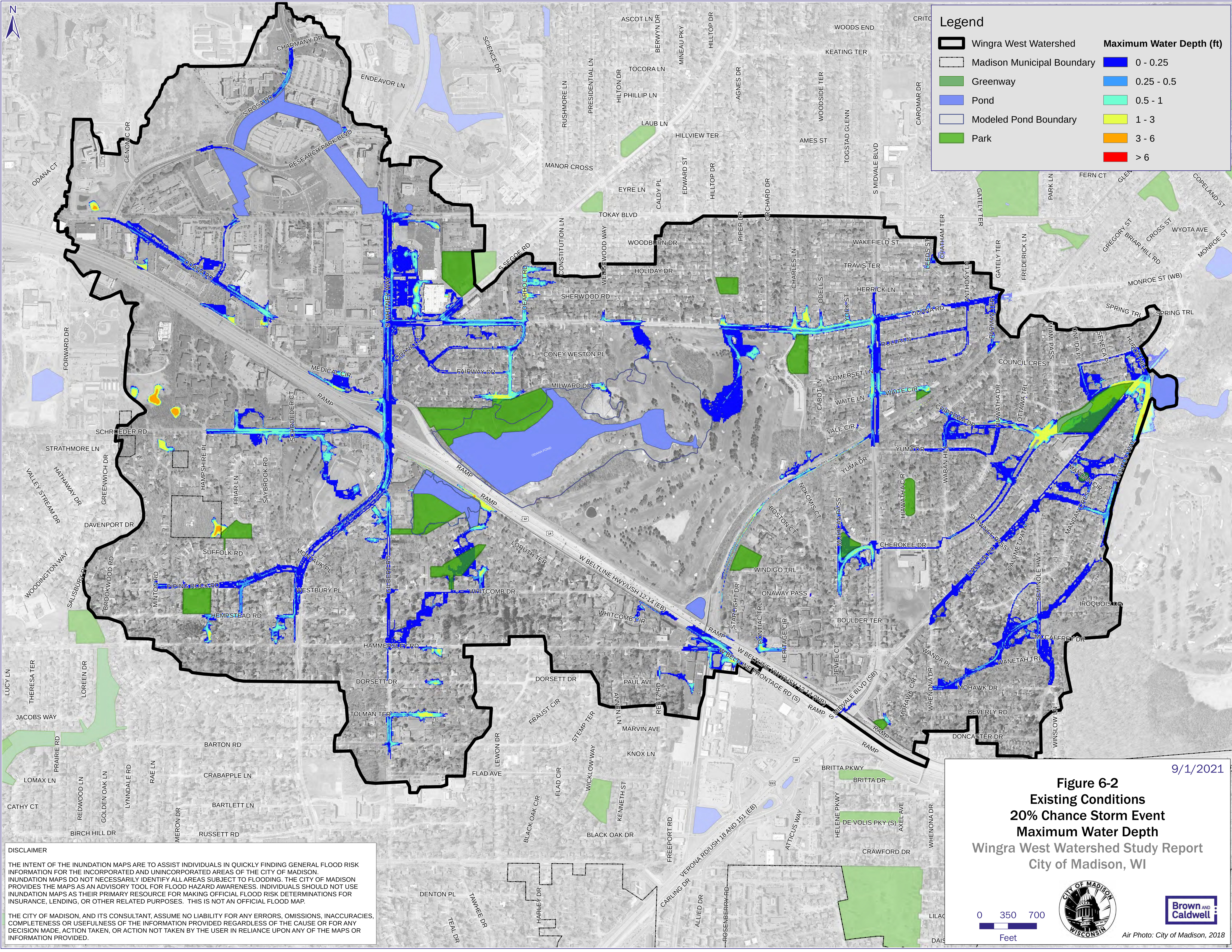
0

350

700

Feet

Air Photo: City of Madison, 2018



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Legend

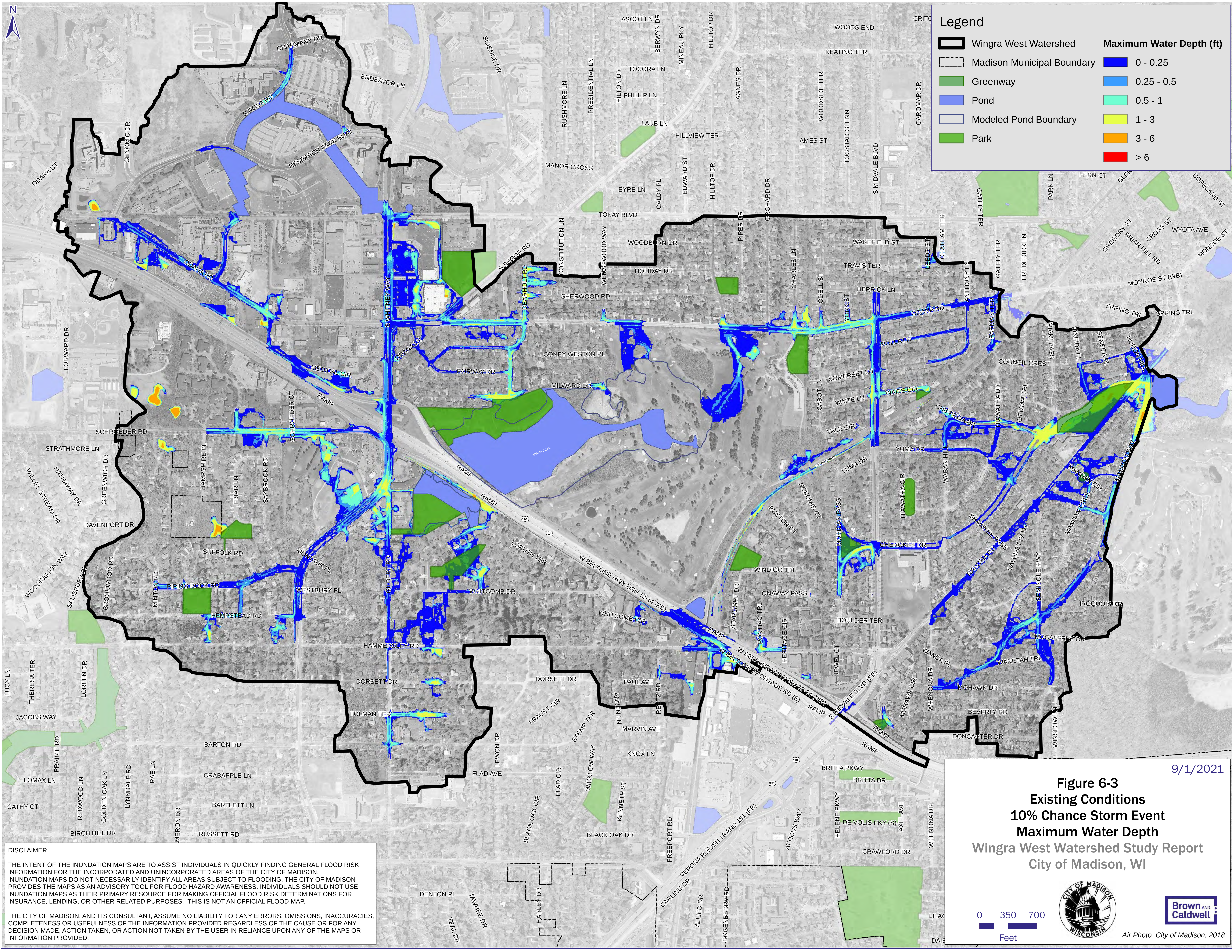
Wingra West Watershed	0 - 0.25
Madison Municipal Boundary	0.25 - 0.5
Greenway	0.5 - 1
Pond	1 - 3
Modeled Pond Boundary	3 - 6
Park	> 6

Figure 6-2
Existing Conditions
20% Chance Storm Event
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

9/1/2021

0 350 700
Feet

Air Photo: City of Madison, 2018



Legend

Wingra West Watershed

Madison Municipal Boundary

Greenway

Pond

Modeled Pond Boundary

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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9/1/2021

Figure 6-3

Existing Conditions

10% Chance Storm Event

Maximum Water Depth

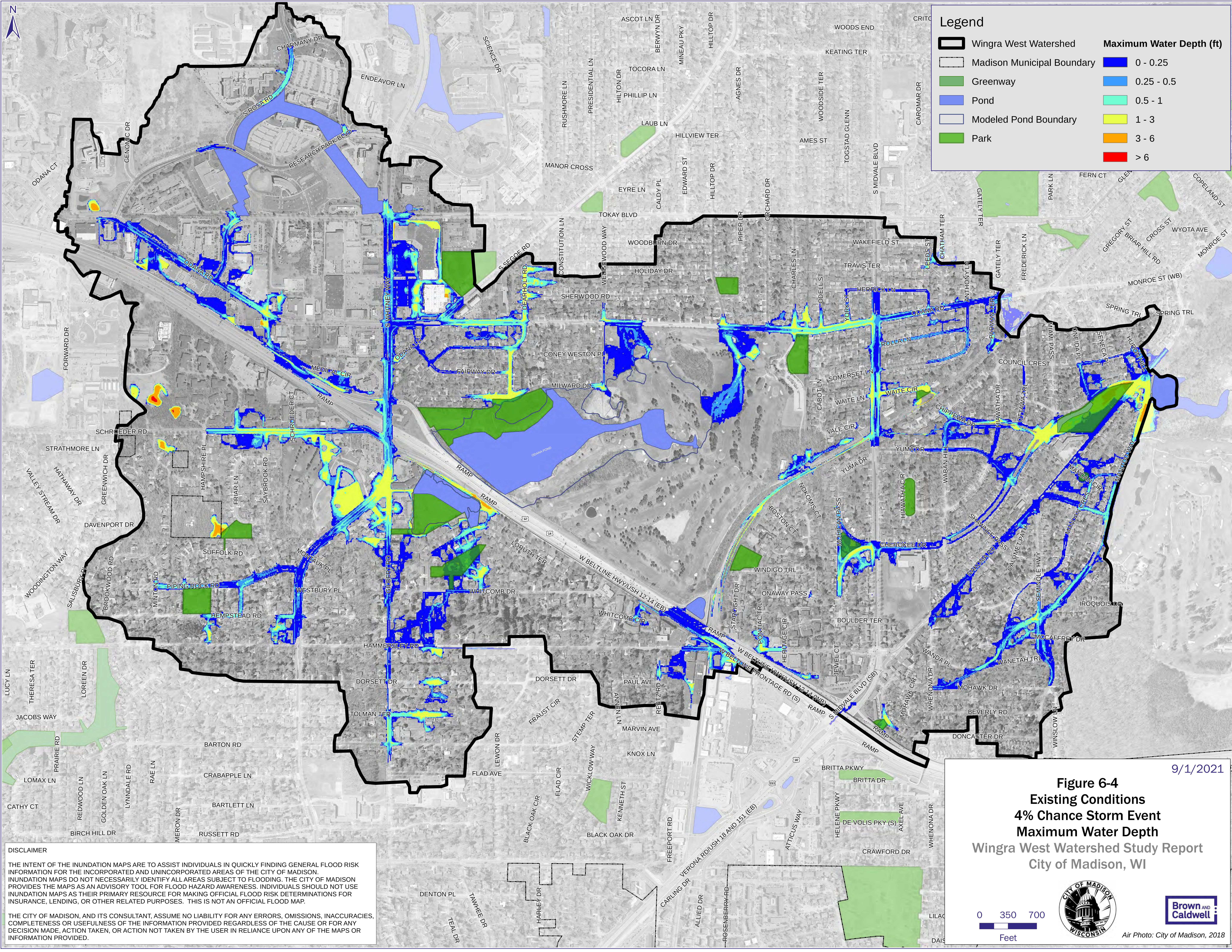
Wingra West Watershed Study Report

City of Madison, WI

0 350 700

Feet

Air Photo: City of Madison, 2018



Legend

Wingra West Watershed

Madison Municipal Boundary

Greenway

Pond

Modeled Pond Boundary

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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9/1/2021

Figure 6-4

Existing Conditions

4% Chance Storm Event

Maximum Water Depth

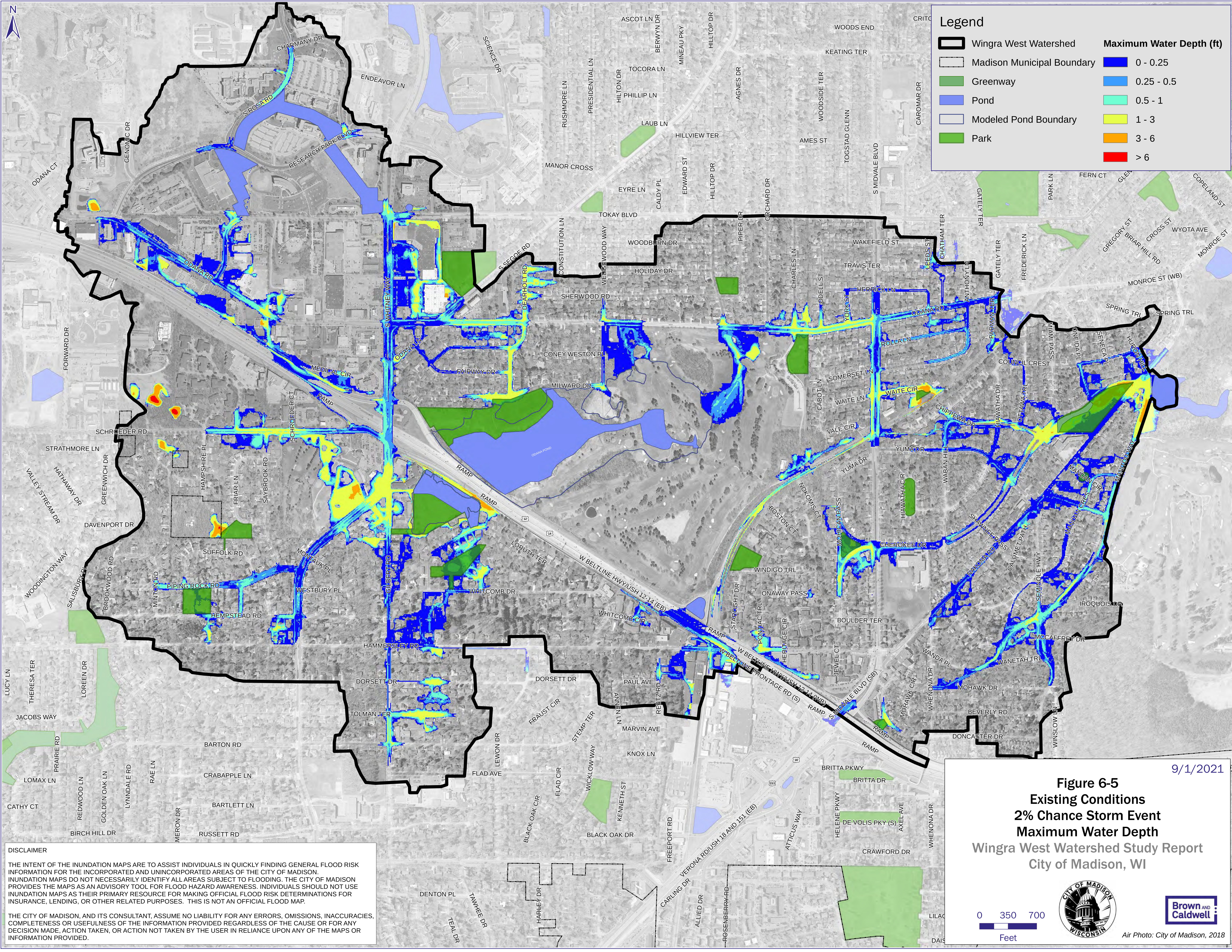
Wingra West Watershed Study Report

City of Madison, WI

0350700

Feet

Air Photo: City of Madison, 2018



Legend

Wingra West Watershed

Madison Municipal Boundary

Greenway

Pond

Modeled Pond Boundary

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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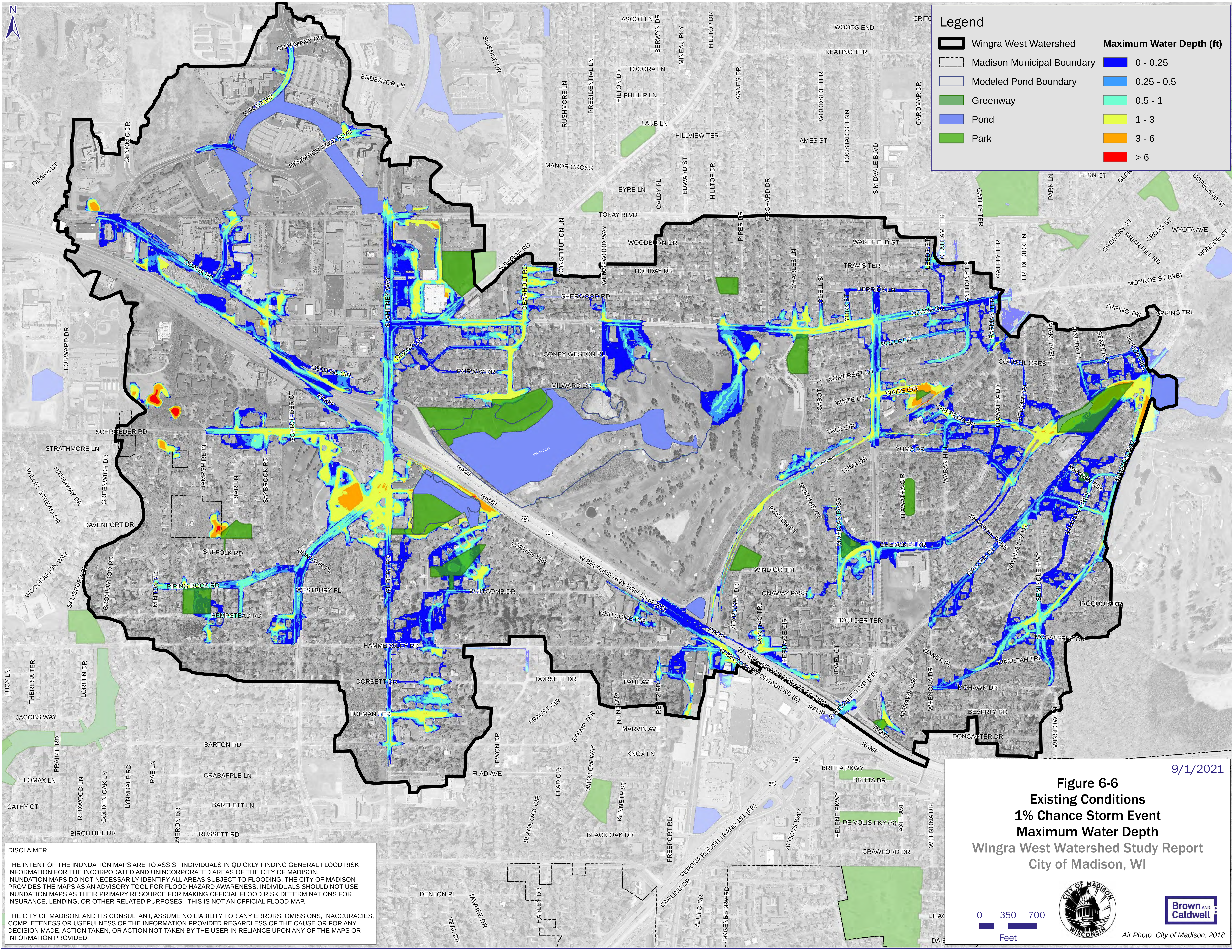
THE CITY OF MADISON, AND ITS CONSULTANT, ASSUME NO LIABILITY FOR ANY ERRORS, OMISSIONS, INACCURACIES, COMPLETENESS OR USEFULNESS OF THE INFORMATION PROVIDED REGARDLESS OF THE CAUSE OR FOR ANY DECISION MADE, ACTION TAKEN, OR ACTION NOT TAKEN BY THE USER IN RELIANCE UPON ANY OF THE MAPS OR INFORMATION PROVIDED.

9/1/2021

Figure 6-5
Existing Conditions
2% Chance Storm Event
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

0 350 700
Feet

Air Photo: City of Madison, 2018



Legend

Wingra West Watershed

Madison Municipal Boundary

Modeled Pond Boundary

Greenway

Pond

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6"/>

> 6

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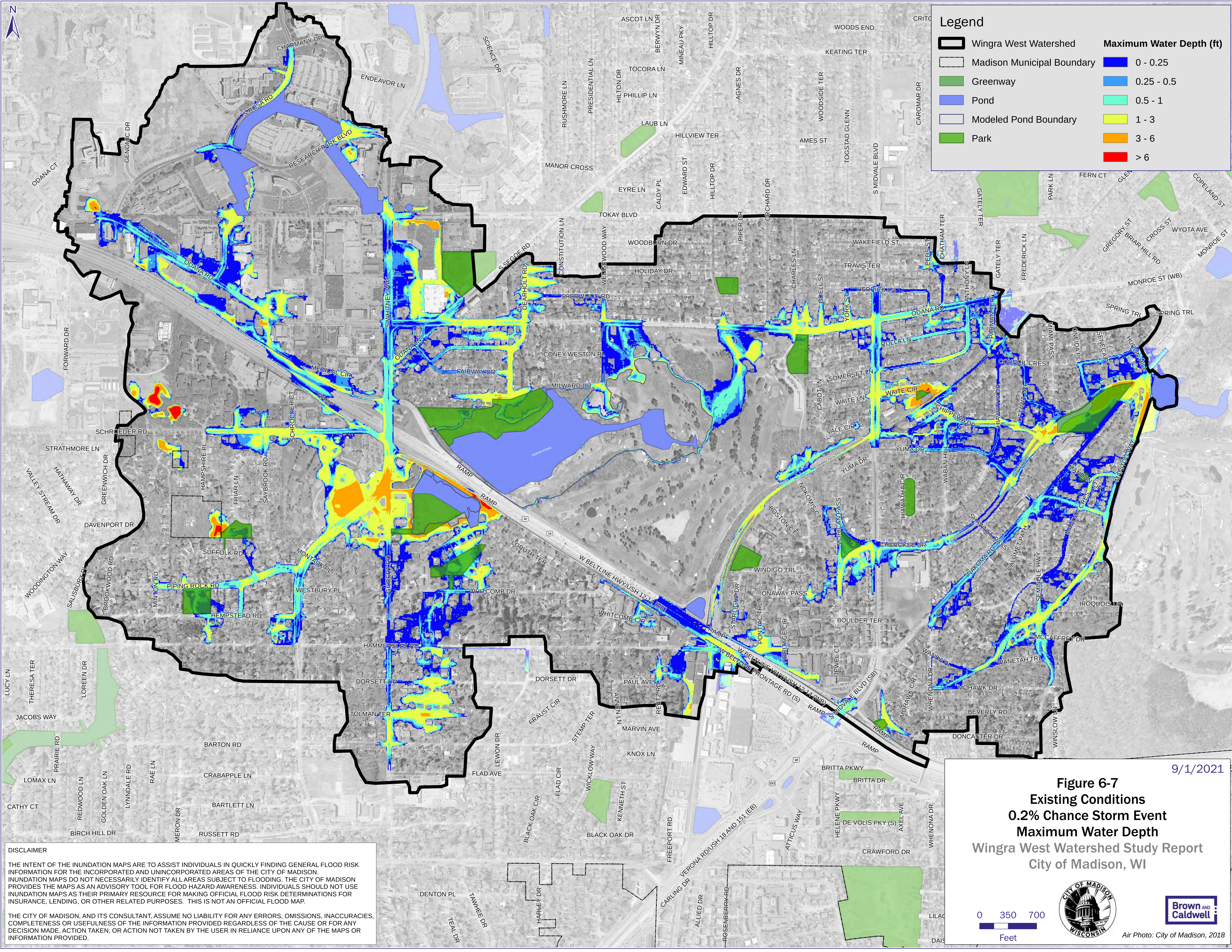
Figure 6-6
Existing Conditions
1% Chance Storm Event
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

0 350 700

Feet

9/1/2021

Air Photo: City of Madison, 2018



Legend

Wingra West Watershed

Madison Municipal Boundary

Greenway

Pond

Modeled Pond Boundary

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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9/1/2021

Figure 6-7

Existing Conditions

0.2% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

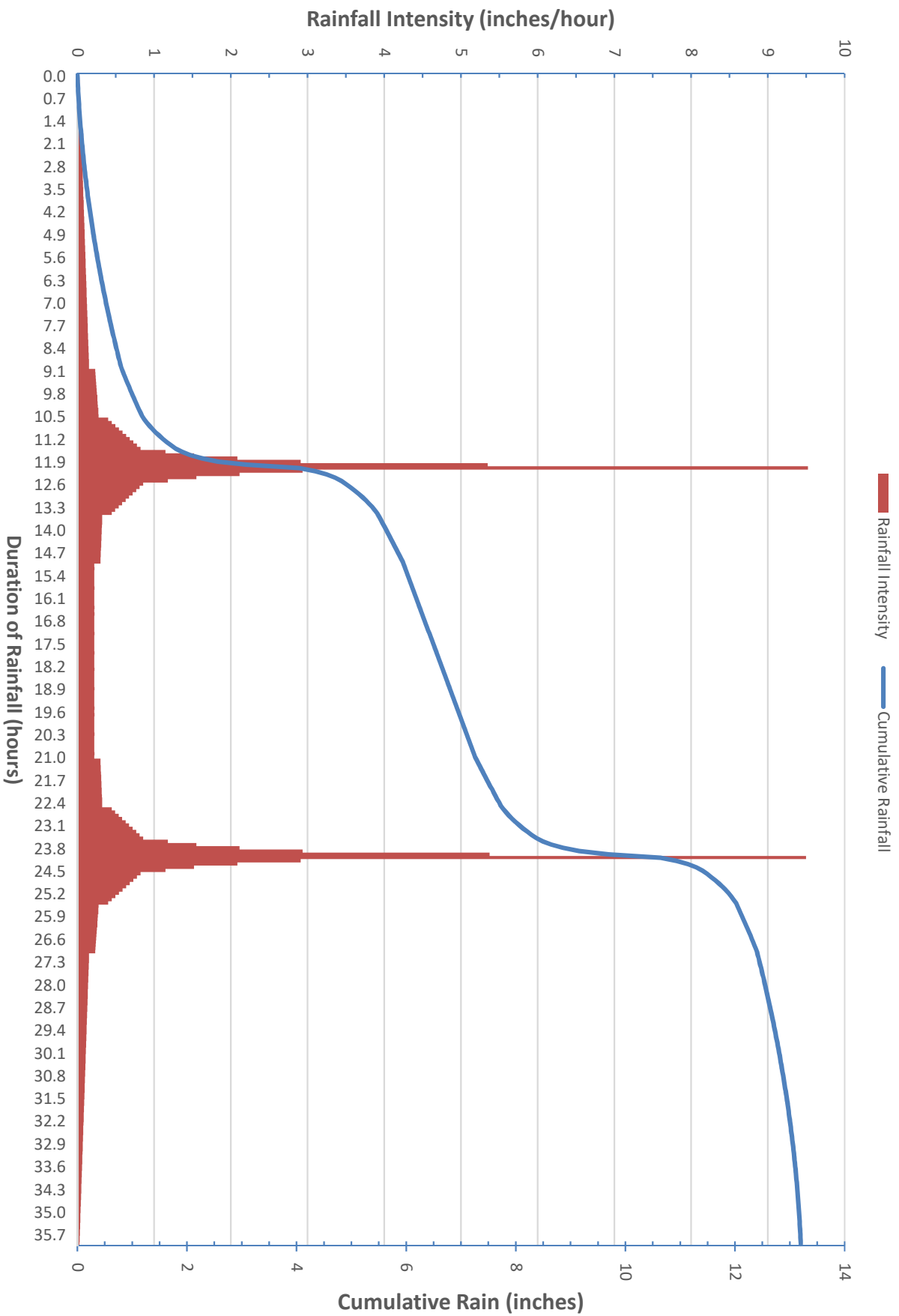
City of Madison, WI

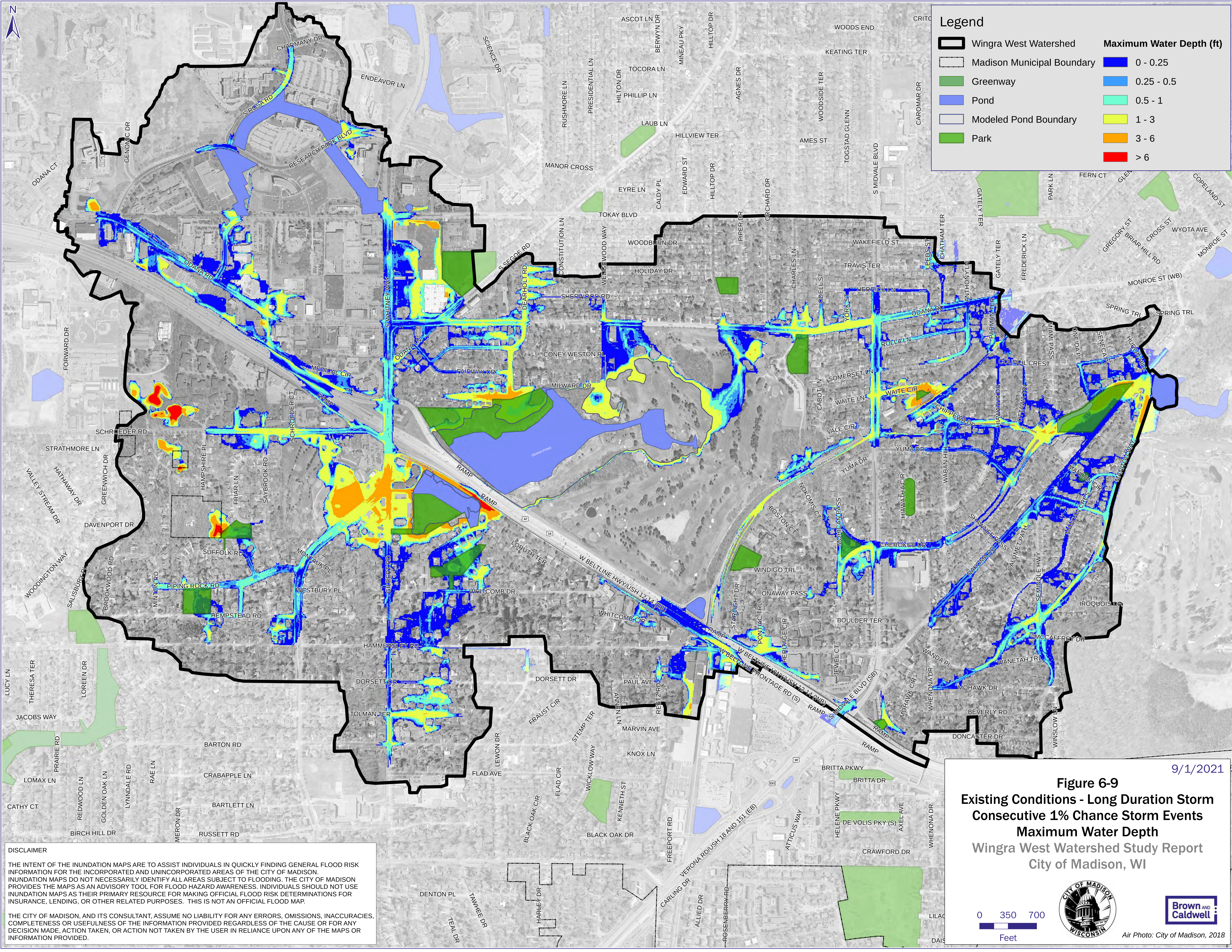
0350700

Feet

Air Photo: City of Madison, 2018

Fig. 6-8: Back to Back 100-year Rainfall Distribution





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Legend

Wingra West Watershed	0 - 0.25
Madison Municipal Boundary	0.25 - 0.5
Greenway	0.5 - 1
Pond	1 - 3
Modeled Pond Boundary	3 - 6
Park	> 6

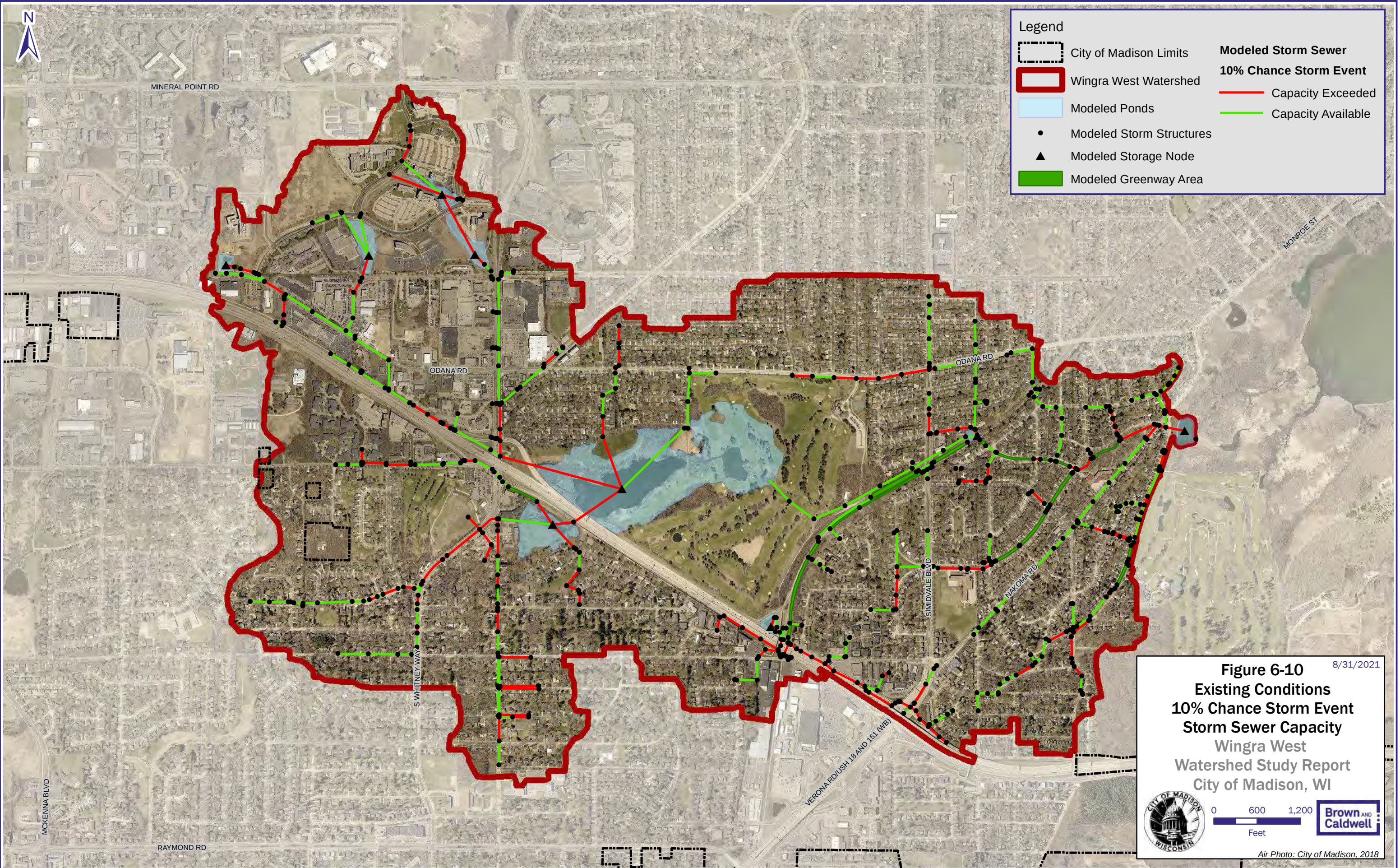
9/1/2021

Figure 6-9
Existing Conditions - Long Duration Storm
Consecutive 1% Chance Storm Events
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

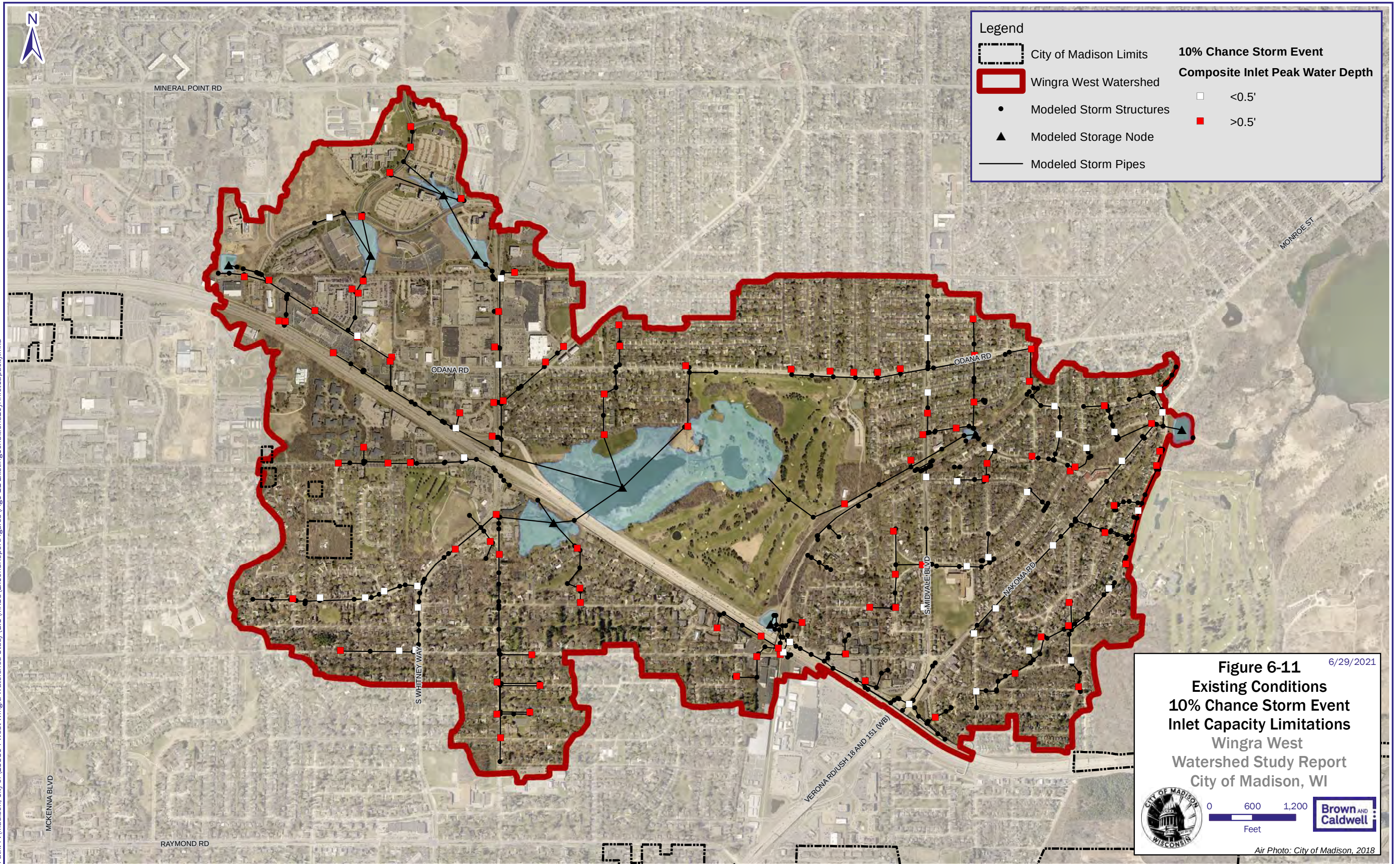
0 350 700
Feet

Air Photo: City of Madison, 2018

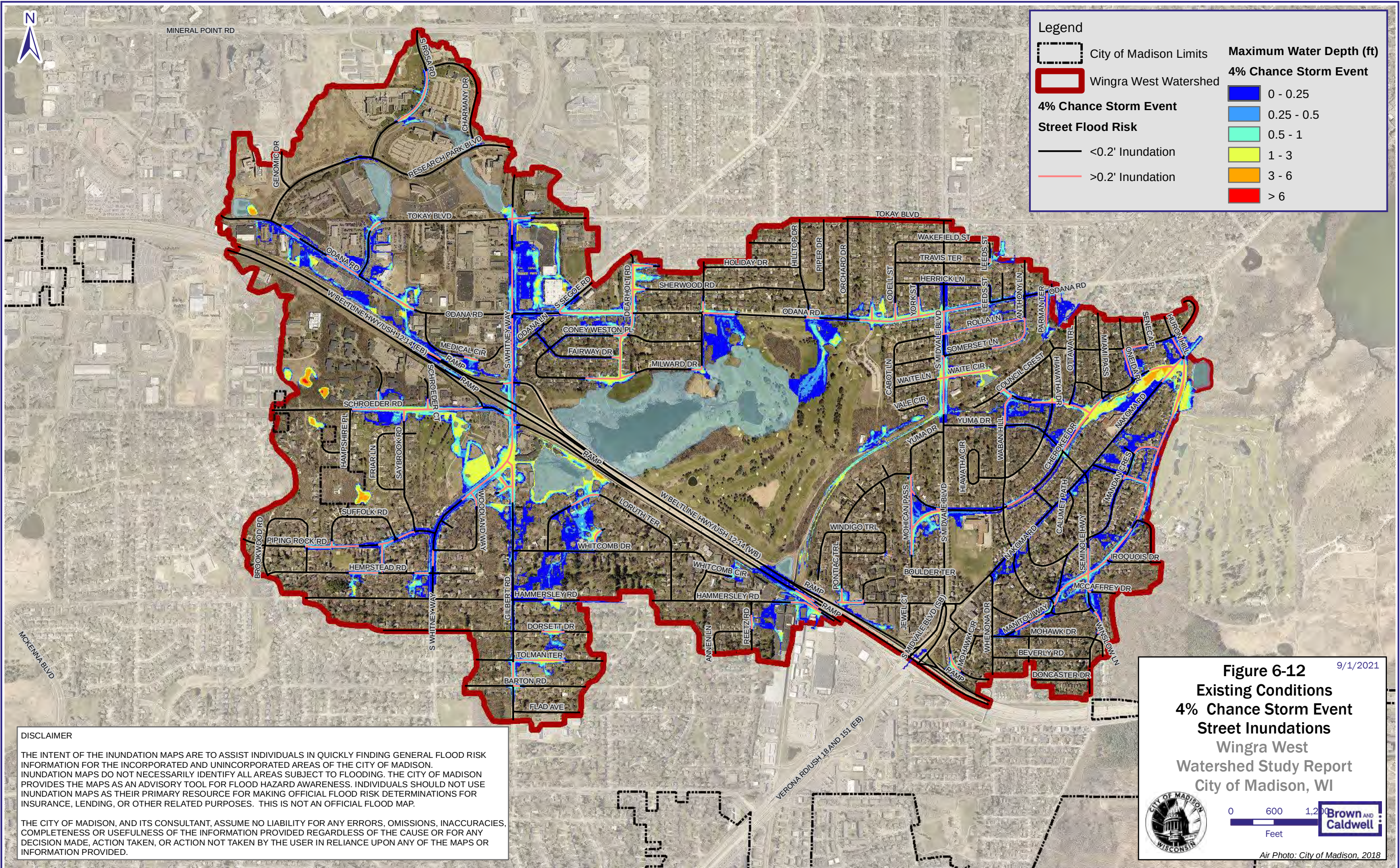
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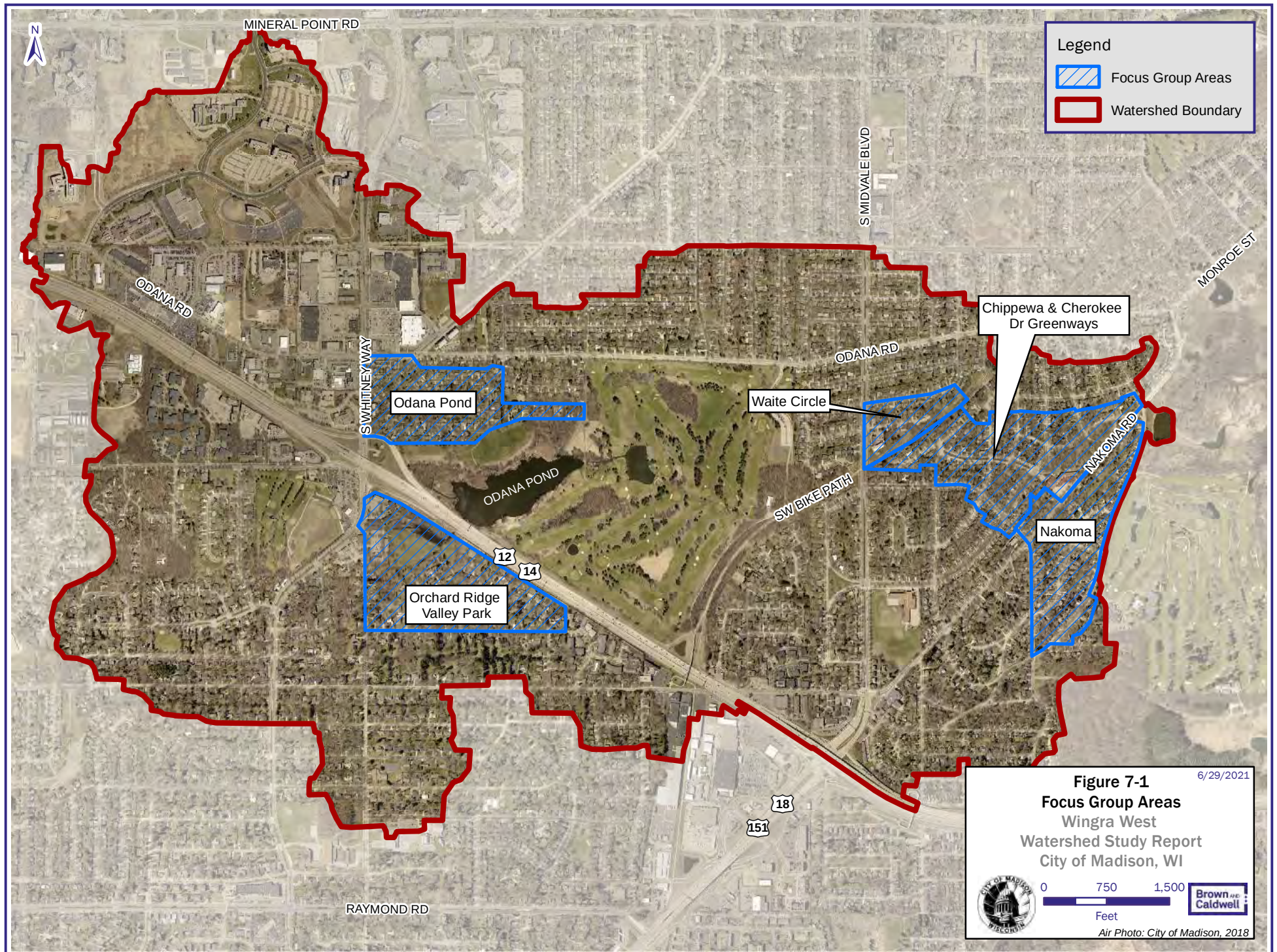


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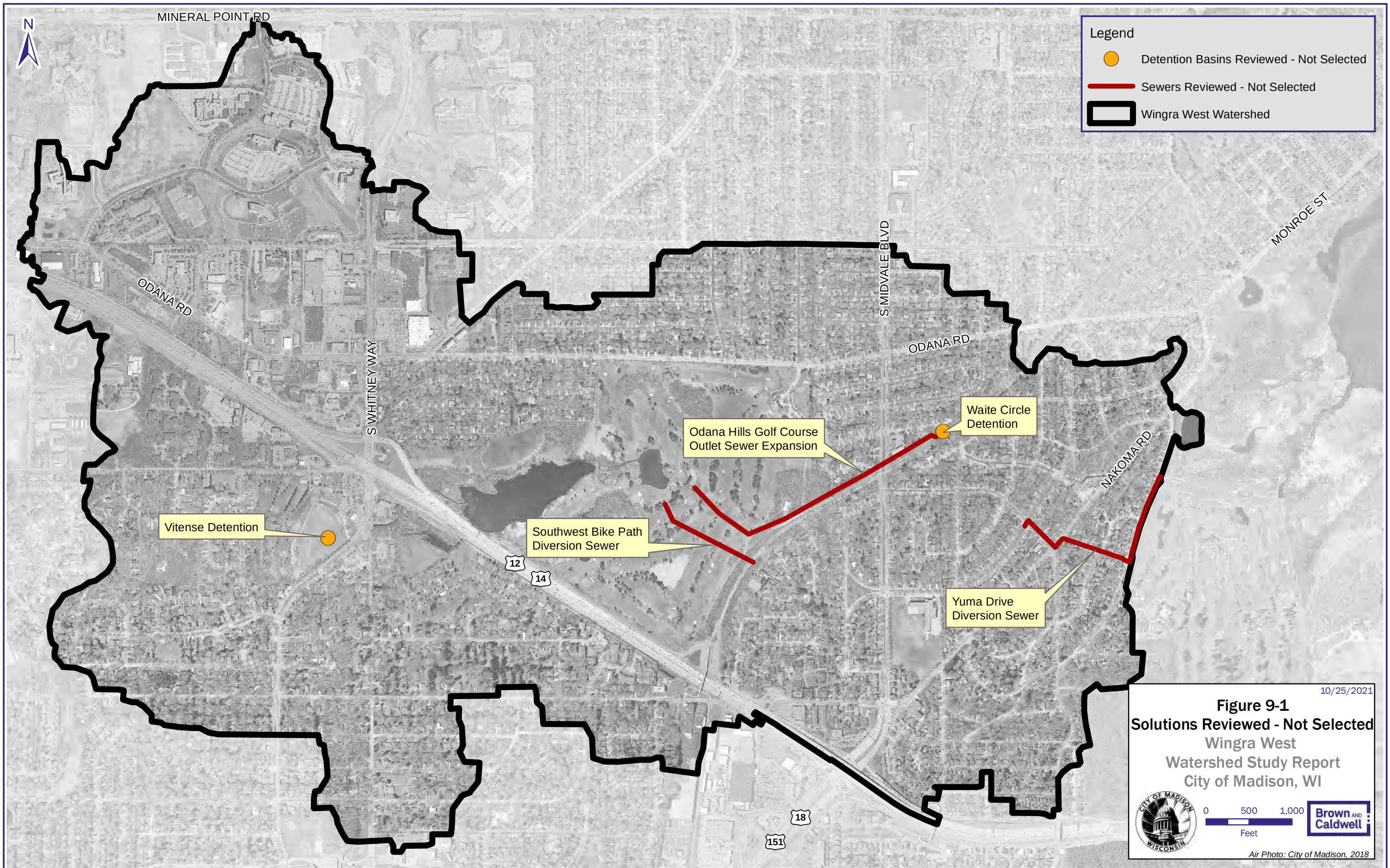


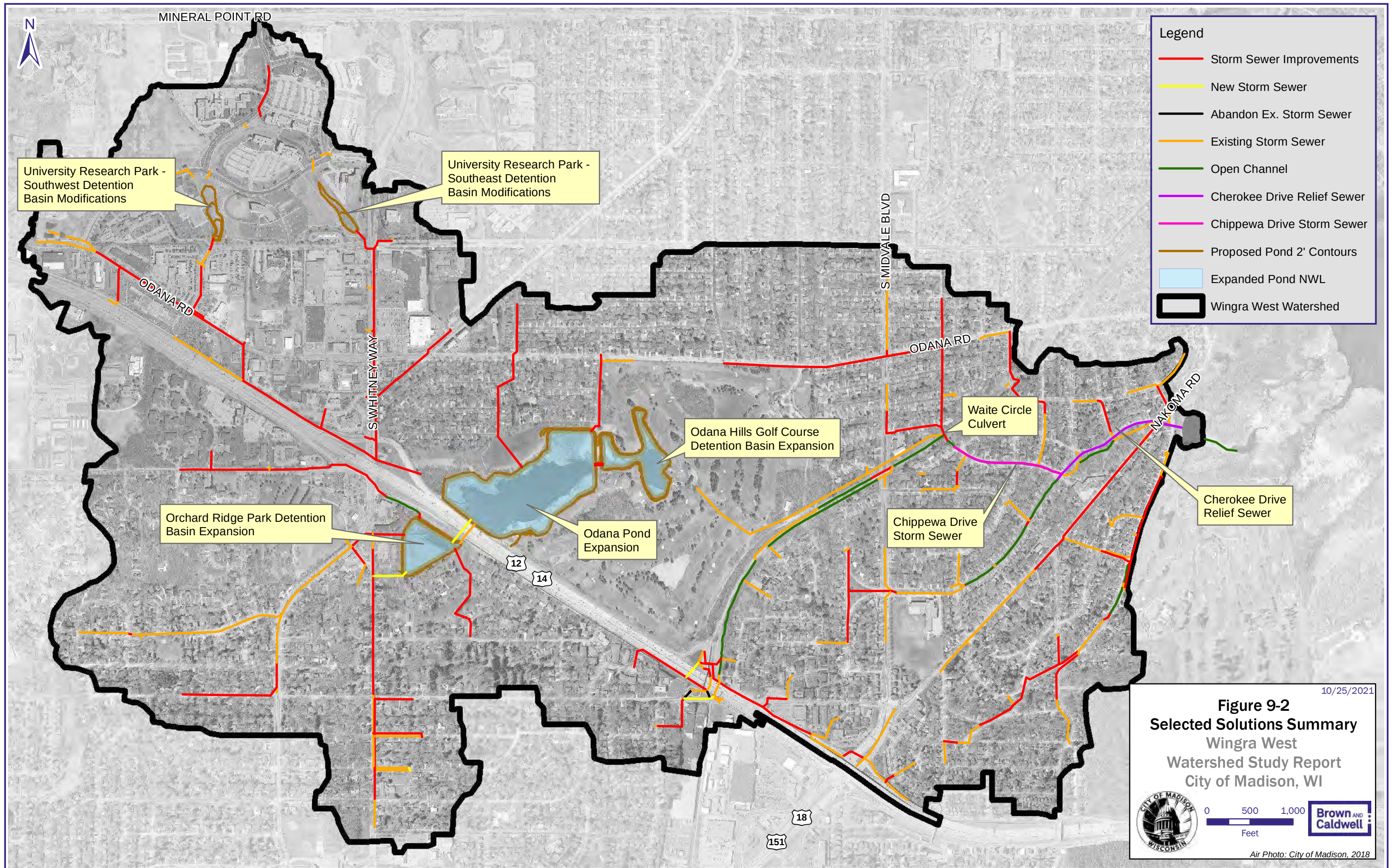
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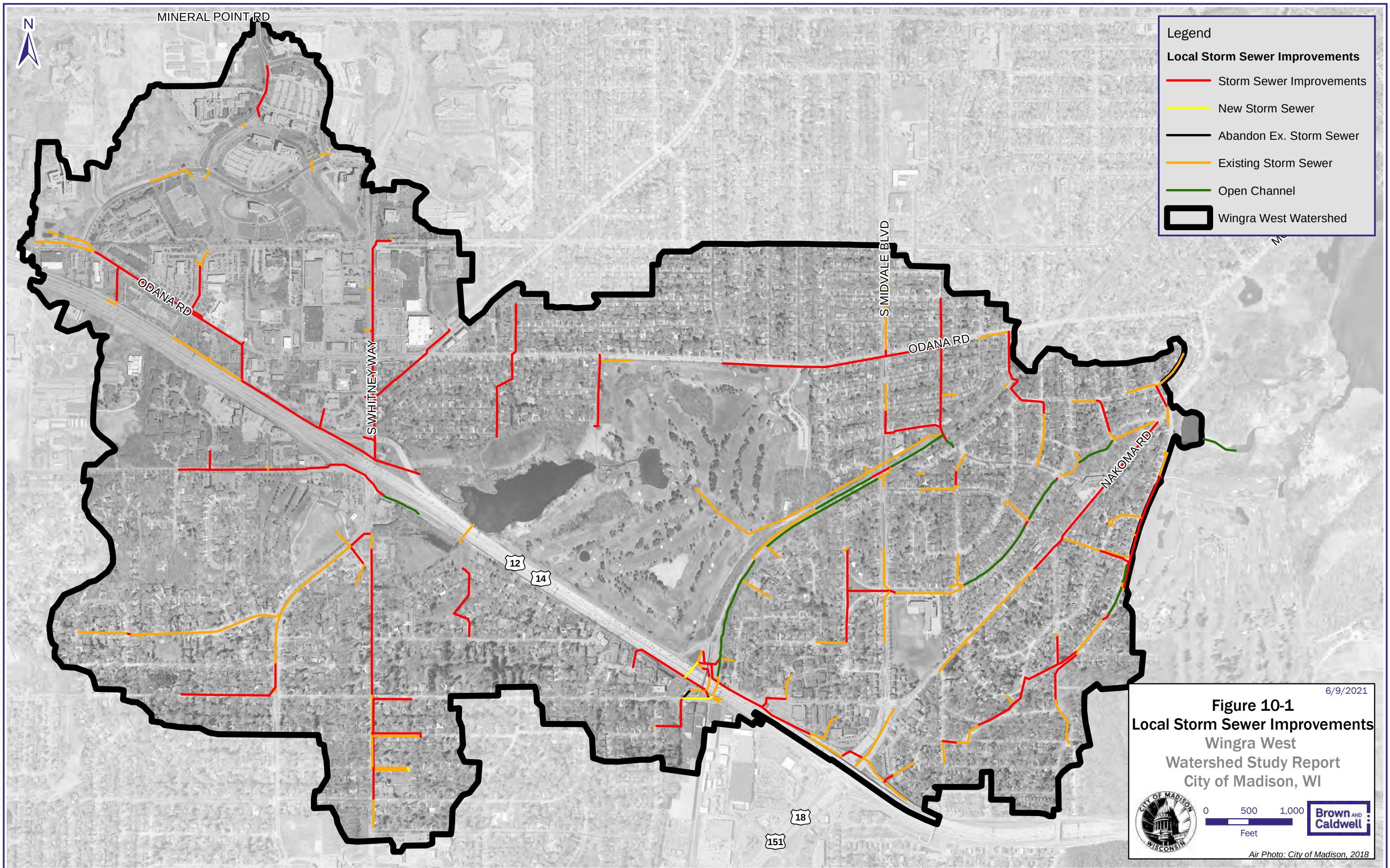


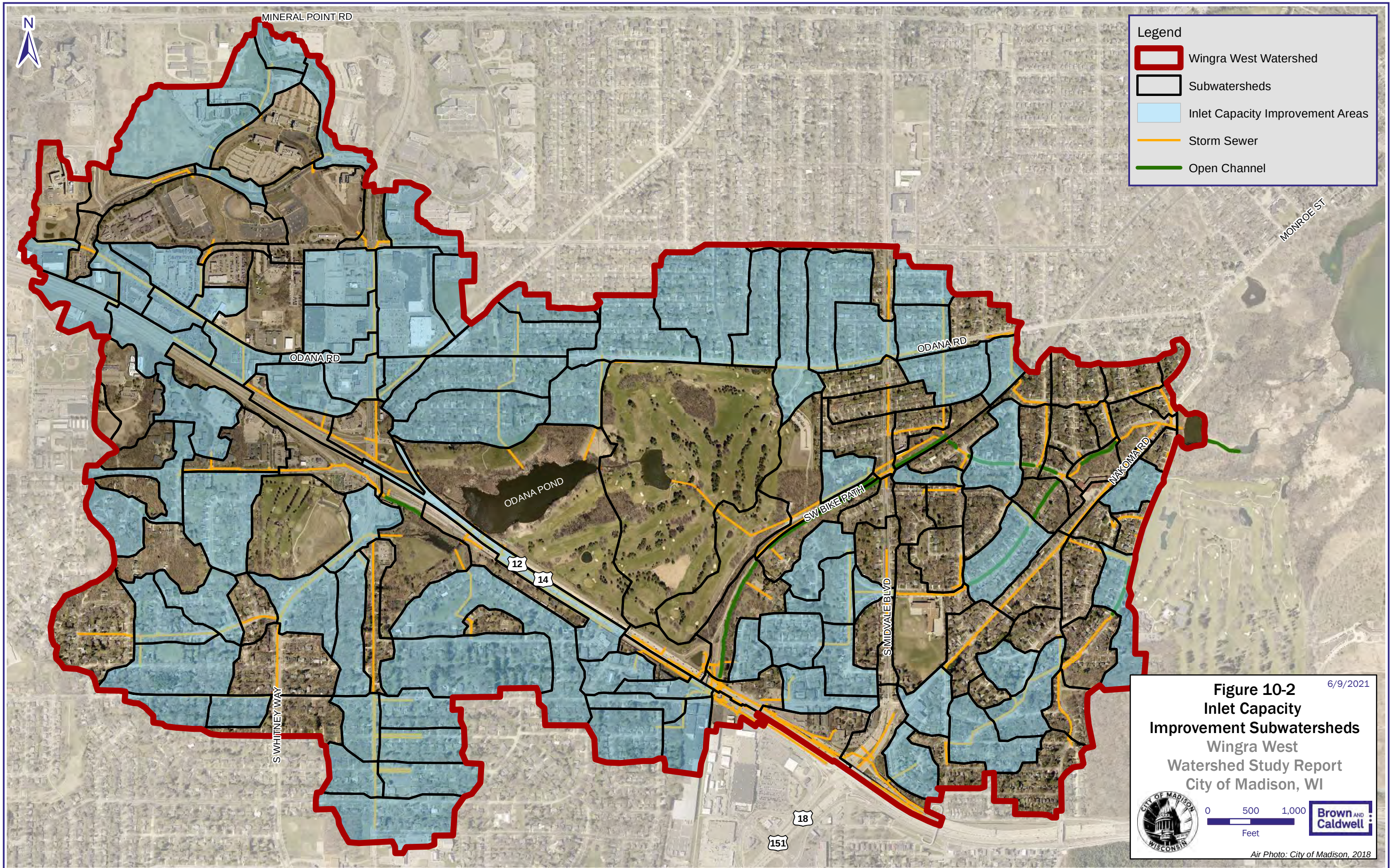
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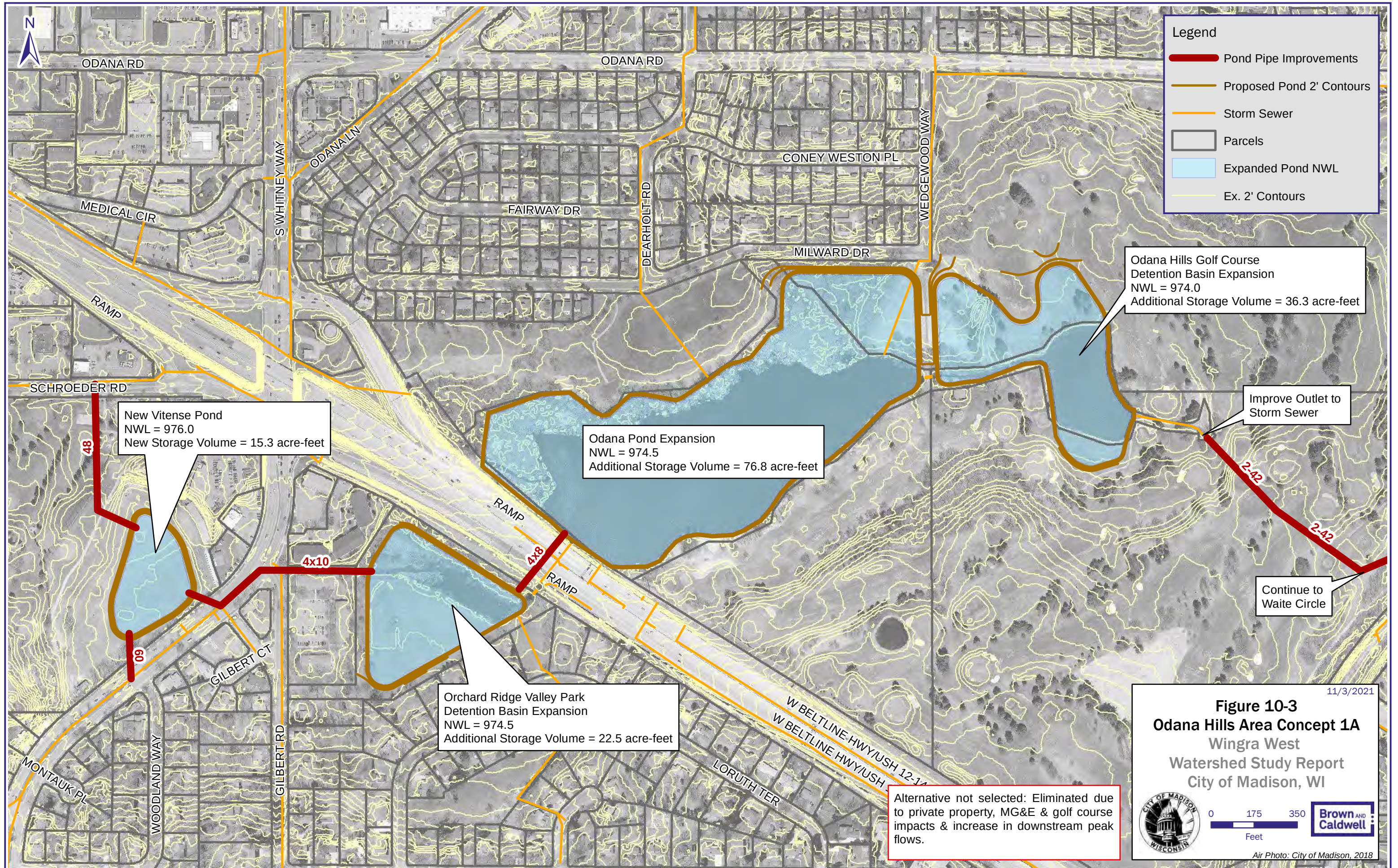
6/9/2021

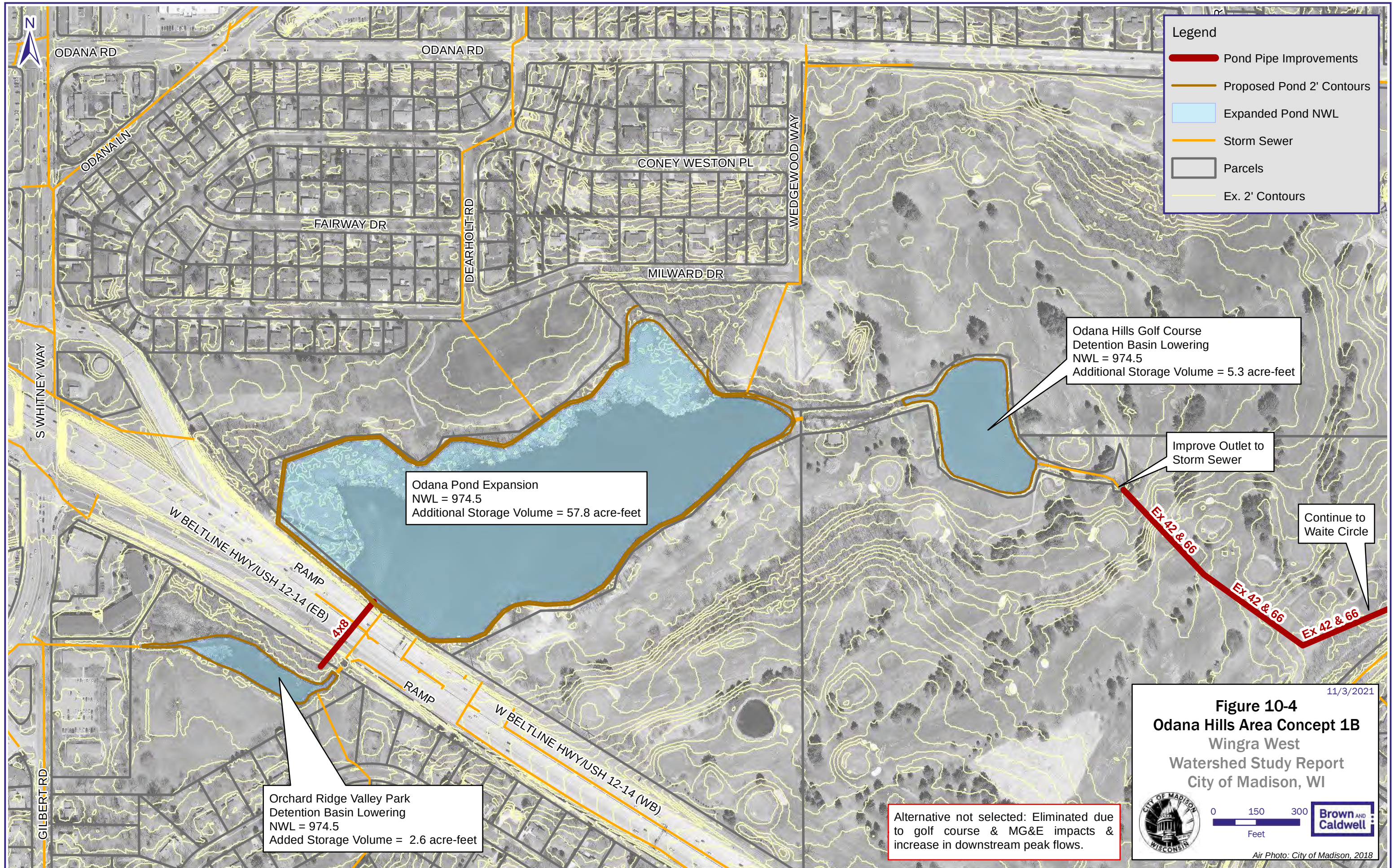
Figure 10-2
Inlet Capacity
Improvement Subwatersheds
Wingra West
Watershed Study Report
City of Madison, WI

 0 500 1,000 Feet 

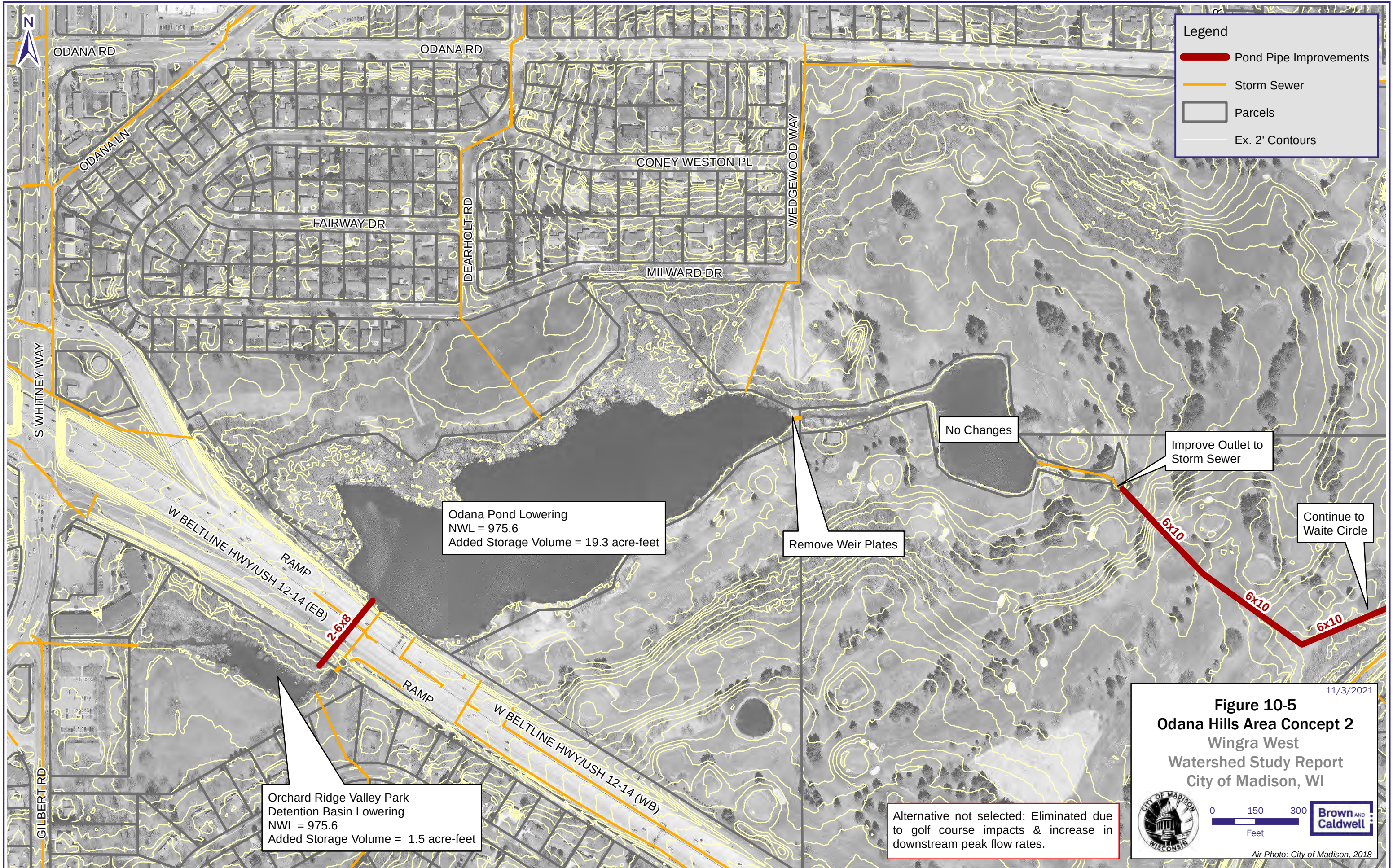
Air Photo: City of Madison, 2018

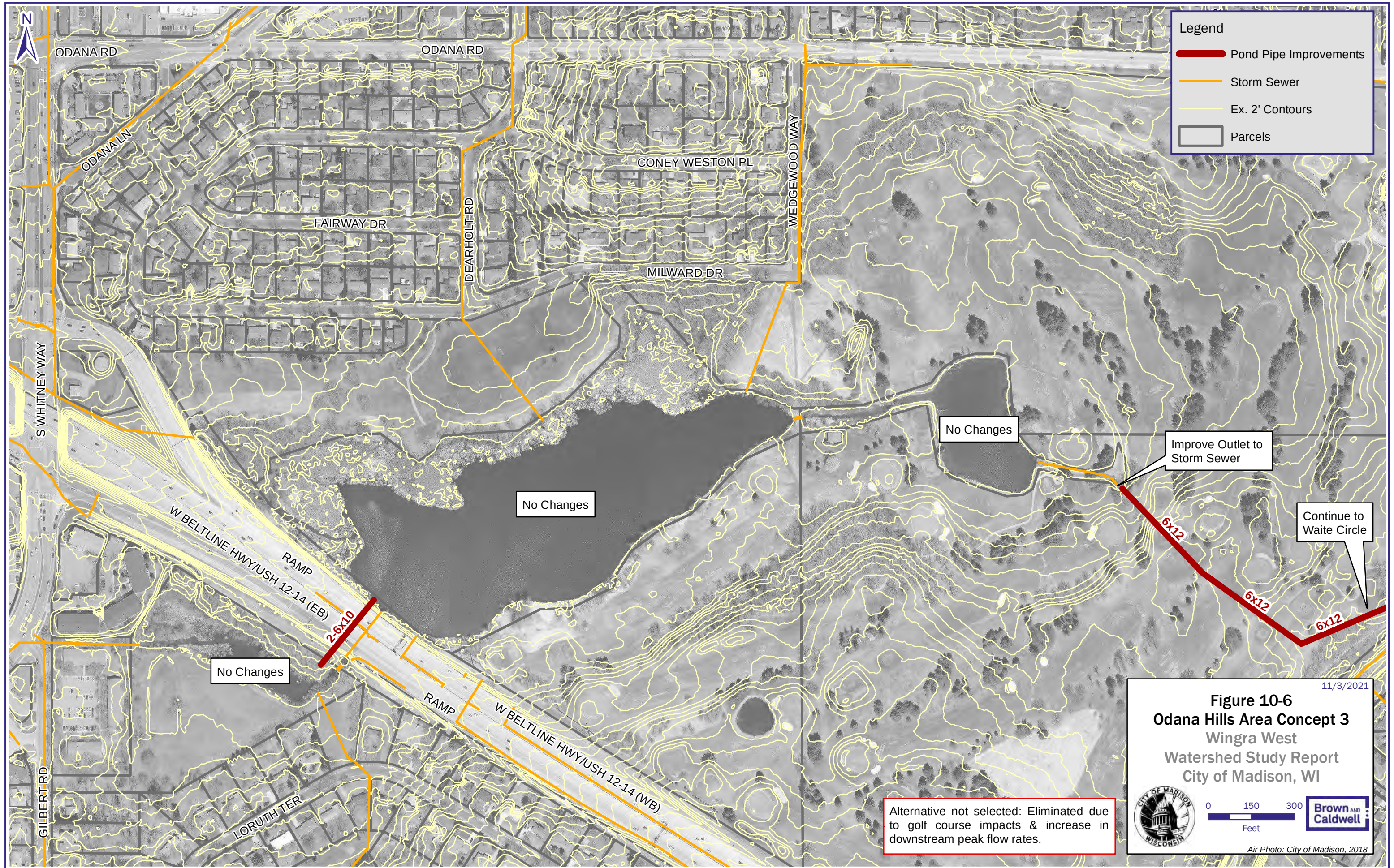
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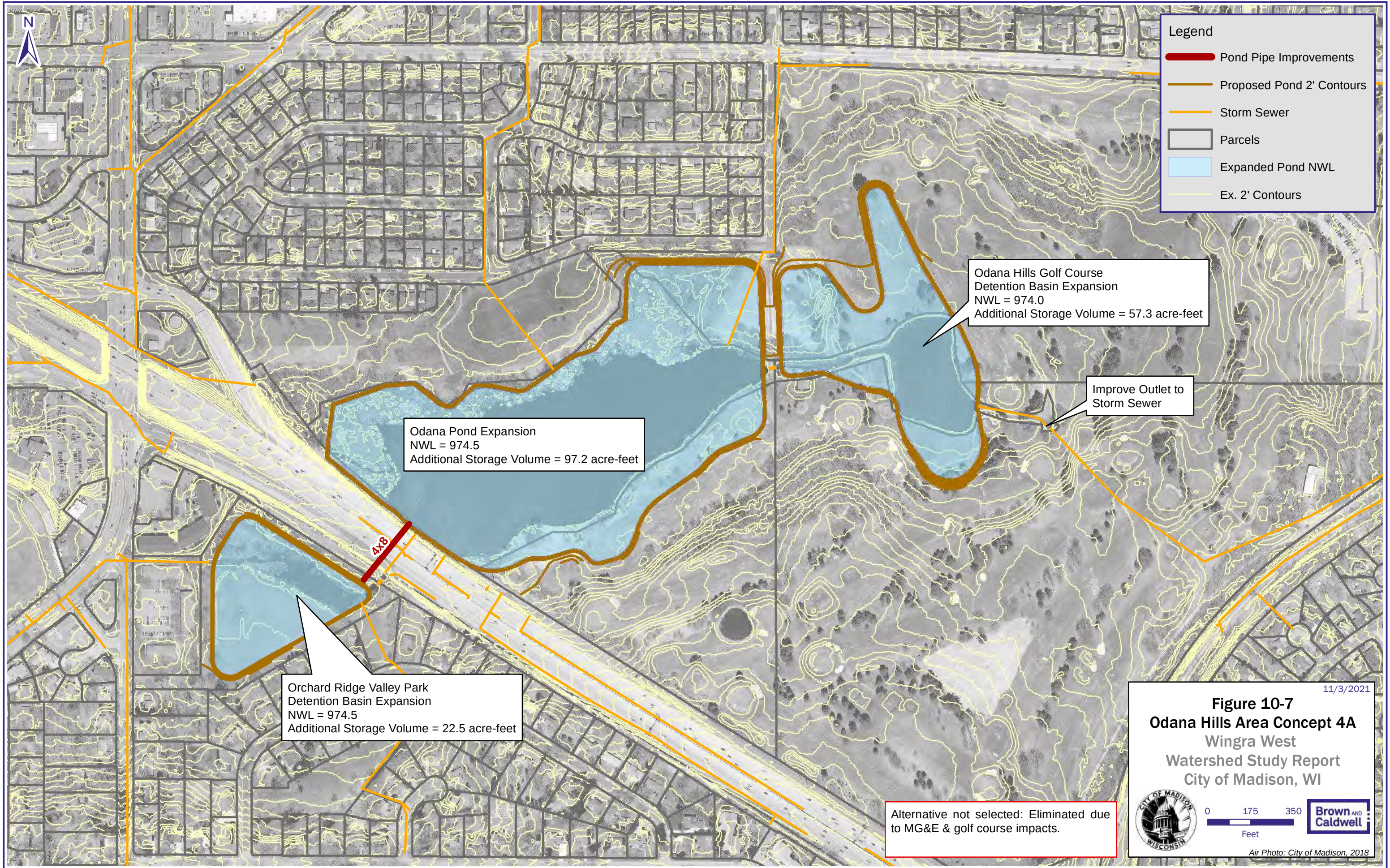


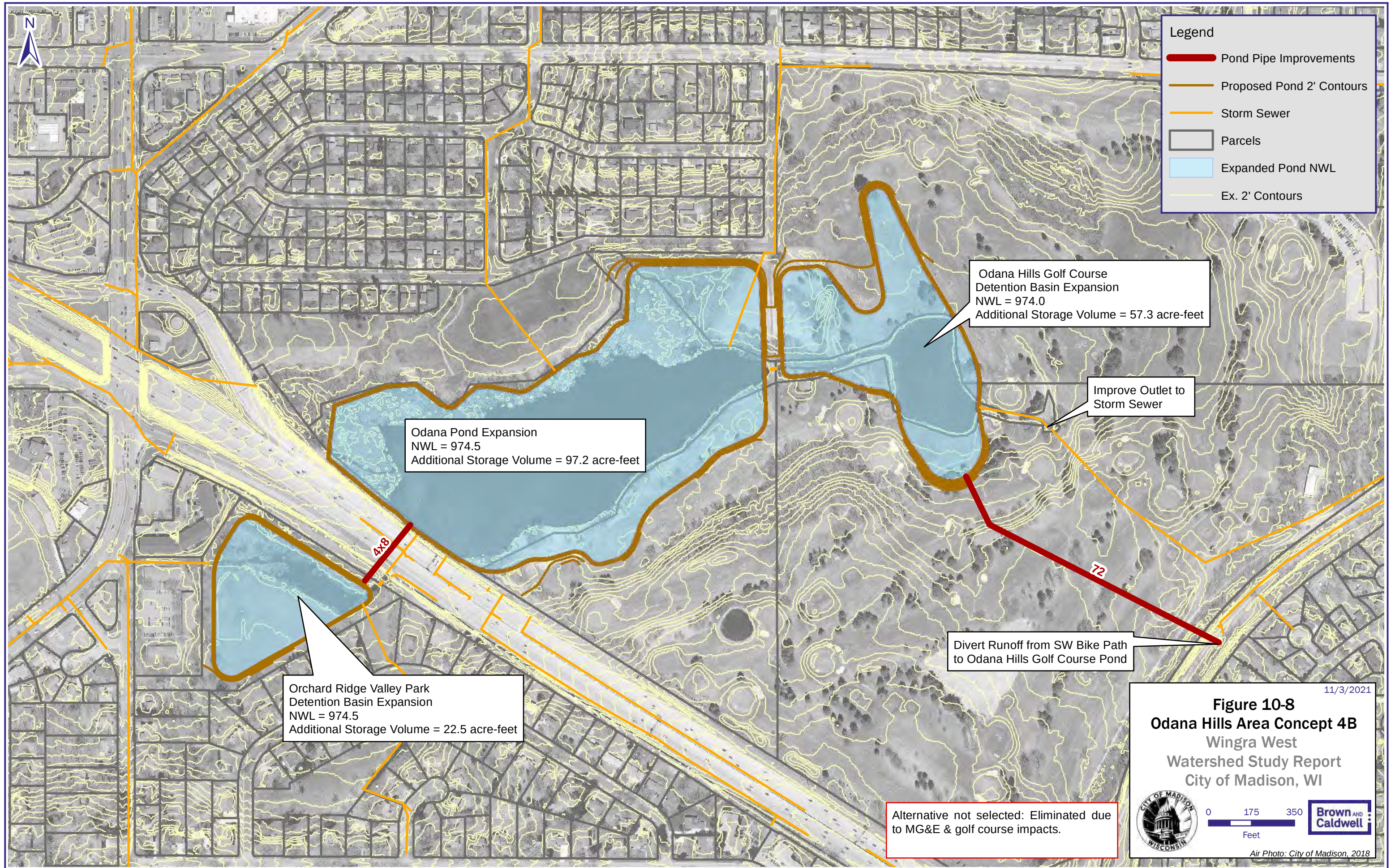


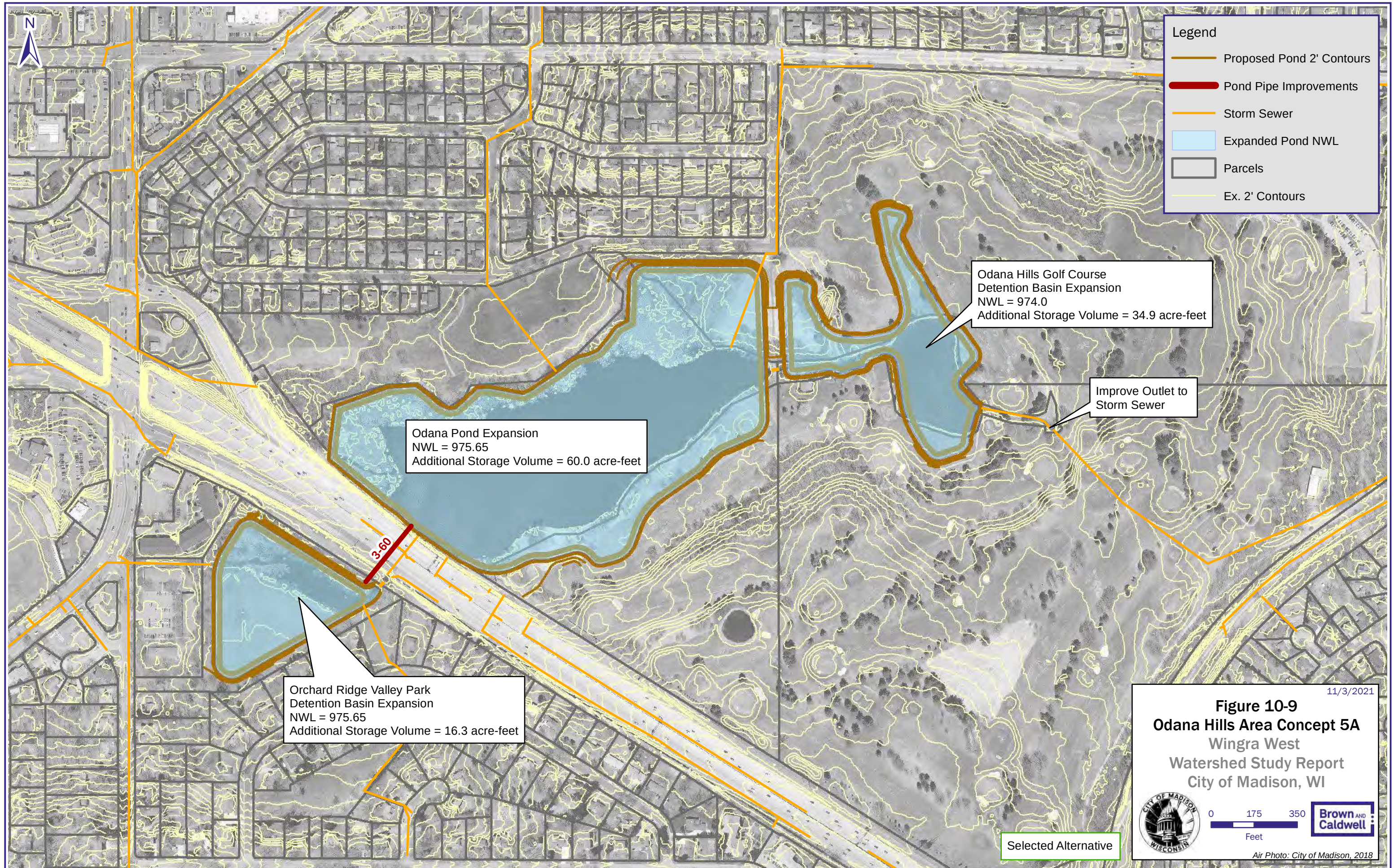
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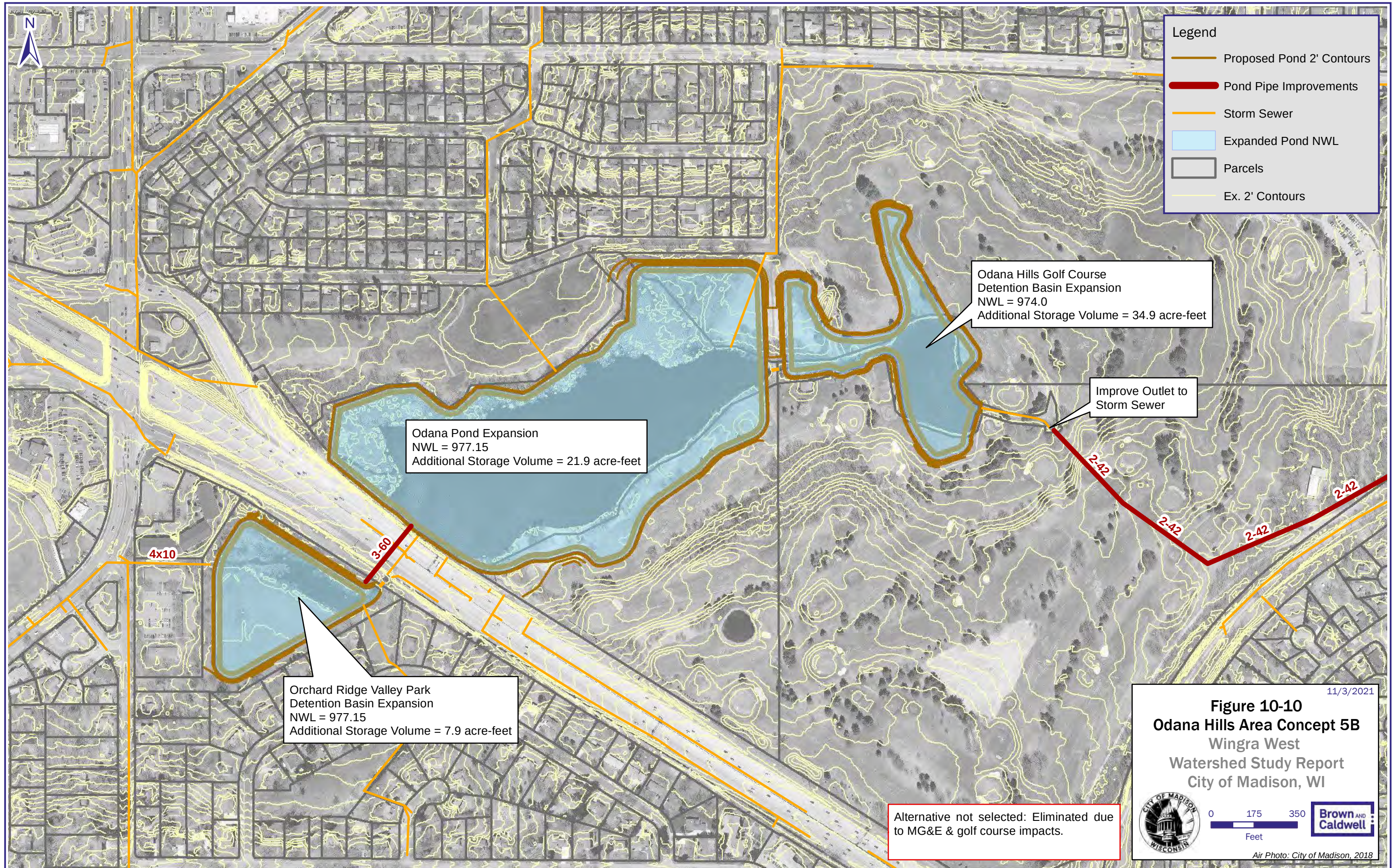








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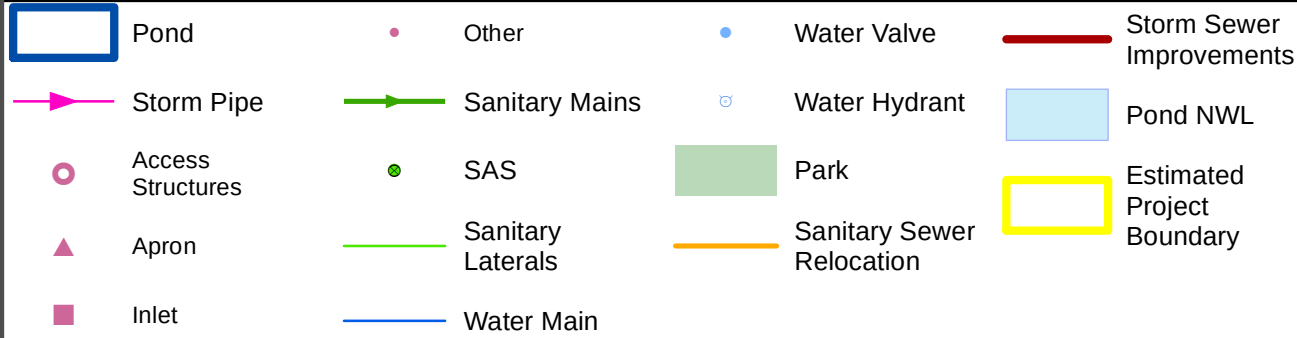
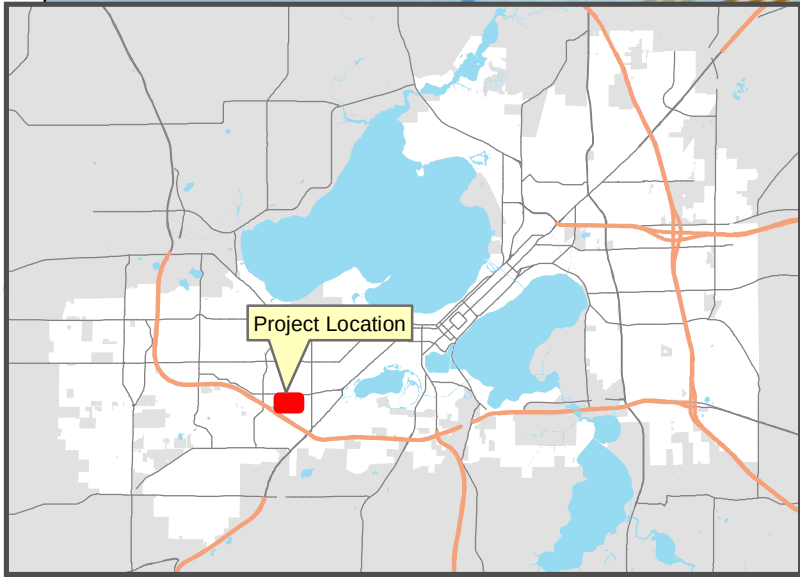
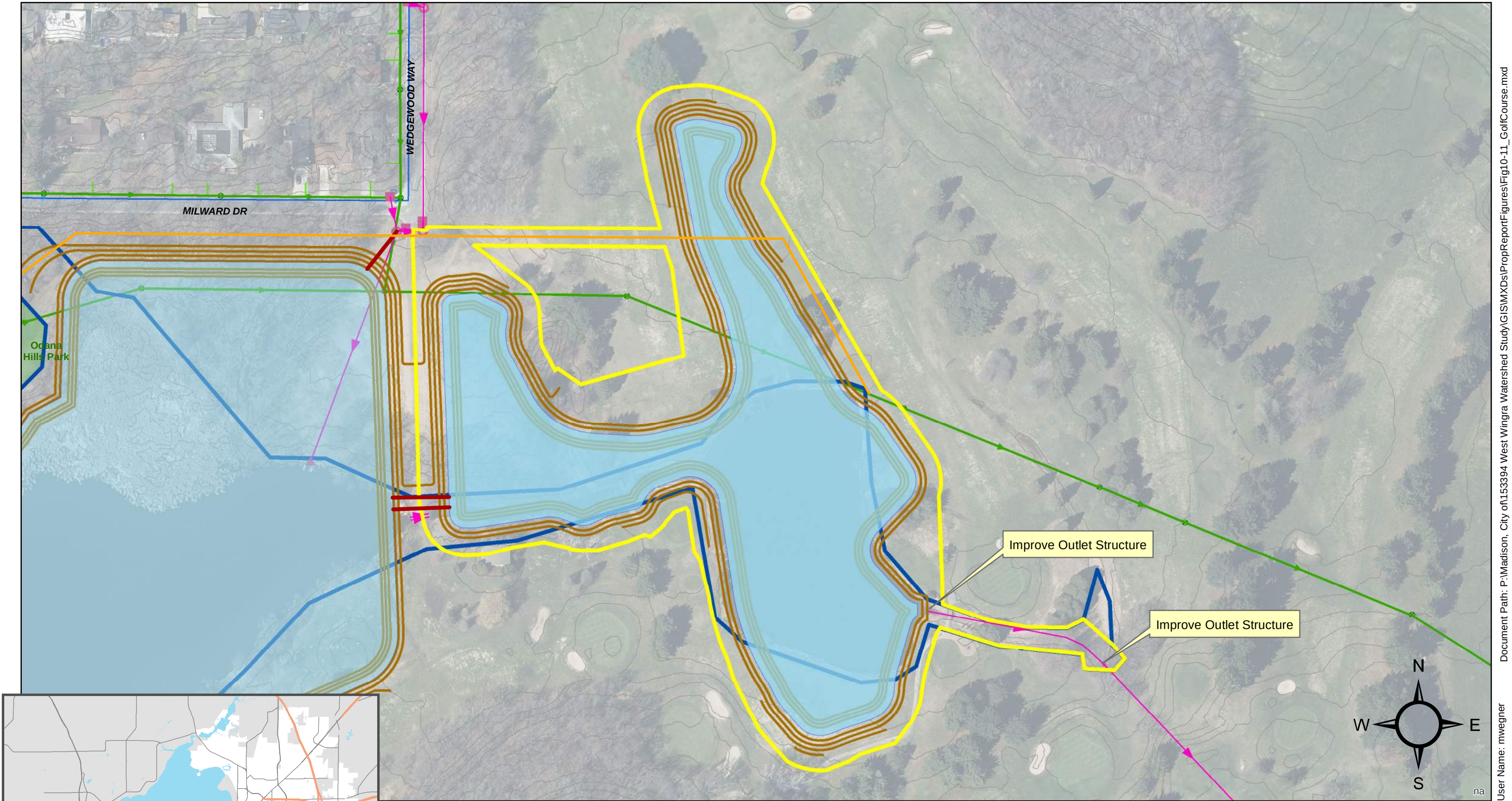
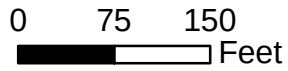


Figure 10-11: Odana Hills Golf Course Detention Basin Expansion

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:
-WDNR/USACOE Permitting for wetlands/waterways
-Coordination with golf course



Date: 6/11/2021

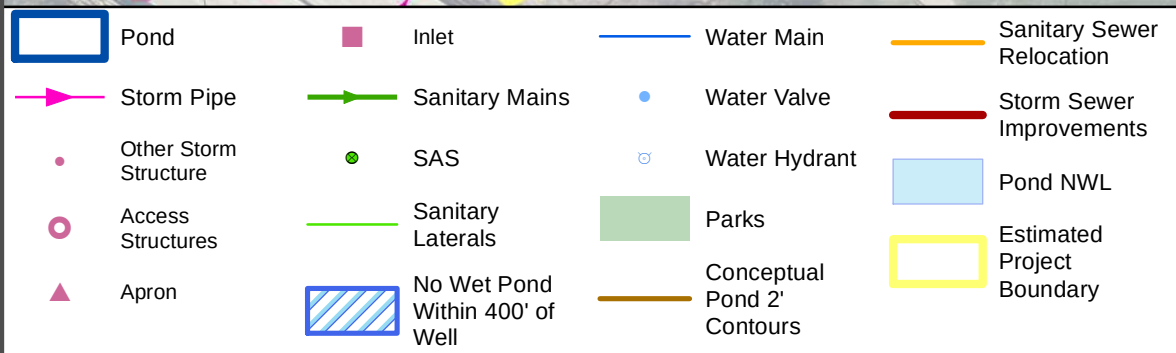
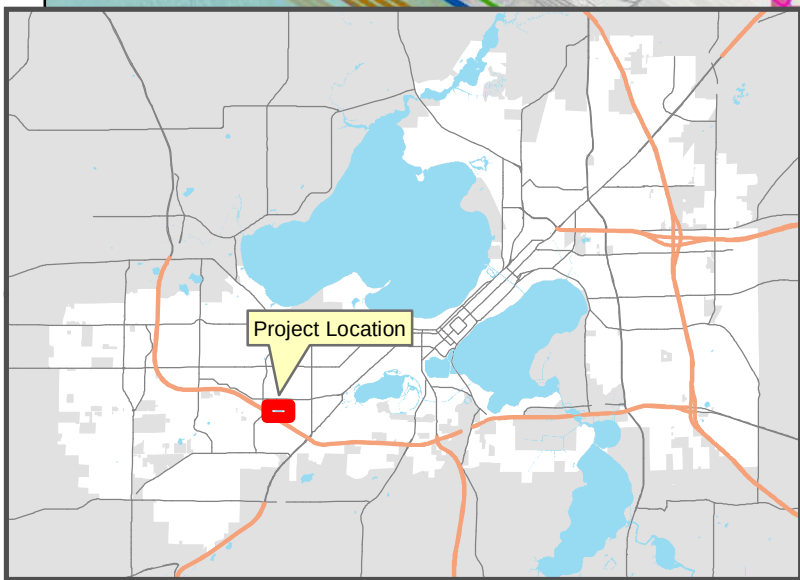
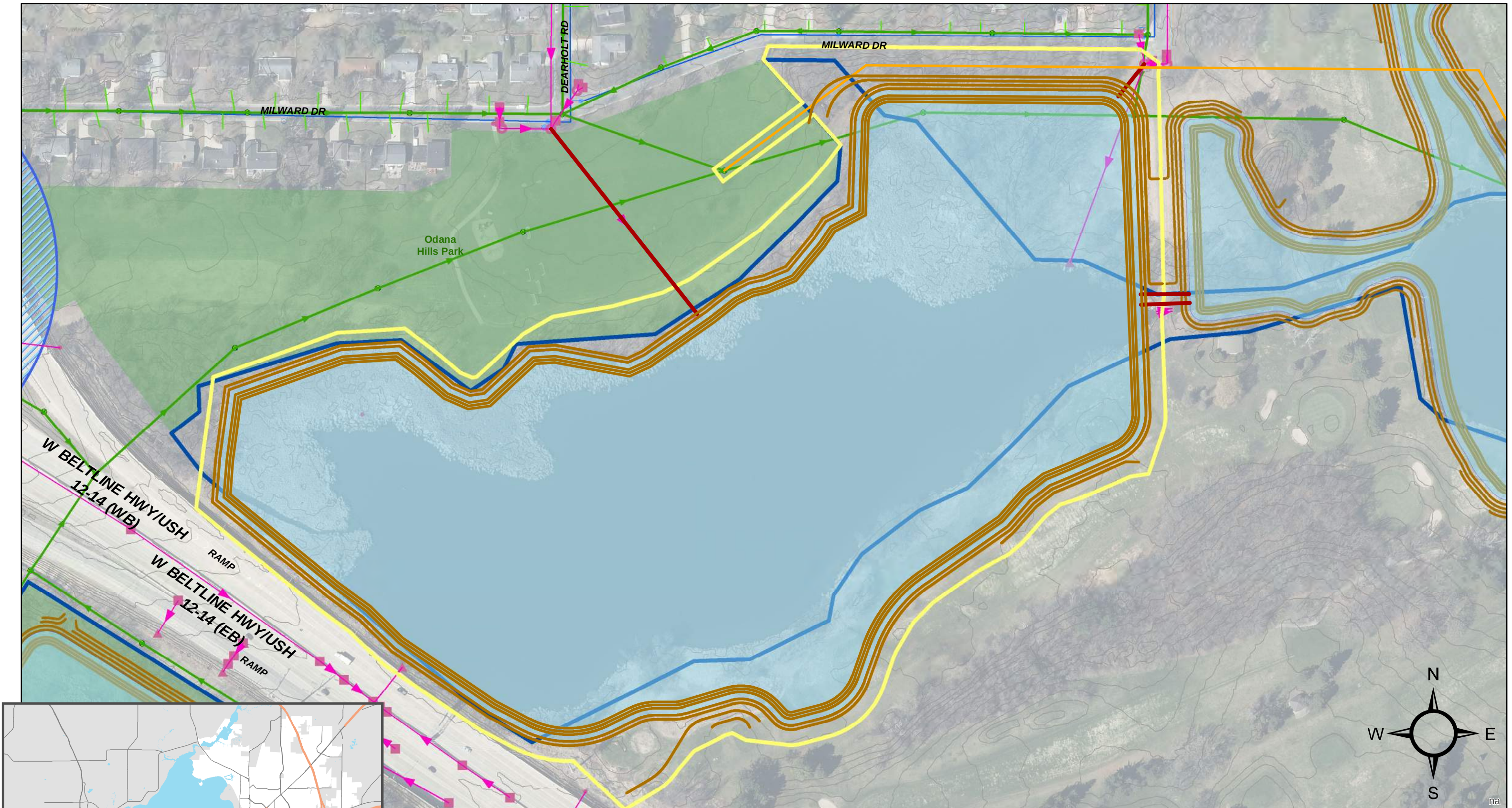
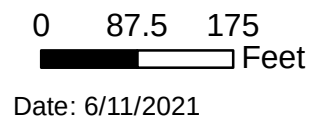


Figure 10-12: Odana Pond Expansion

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:

- WDNR/USACOE Permitting for wetlands/waterways
- Coordination with MG&E infiltration facility
- Coordination with golf course



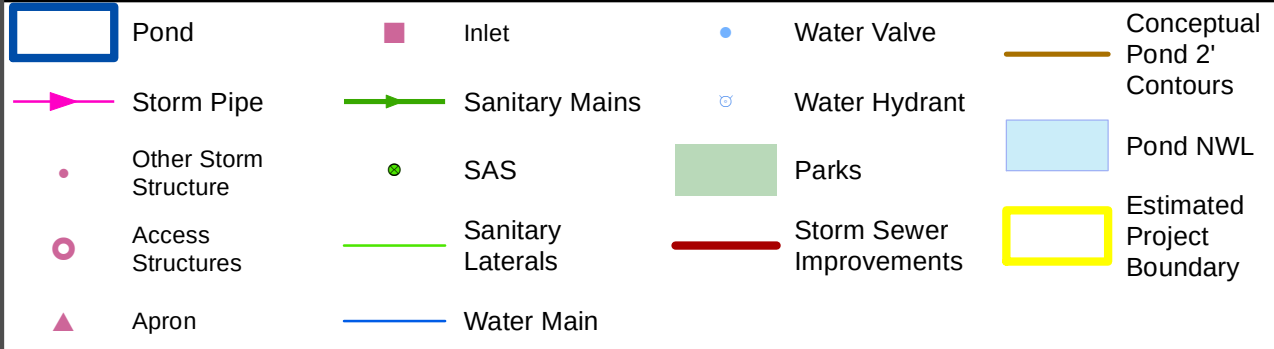
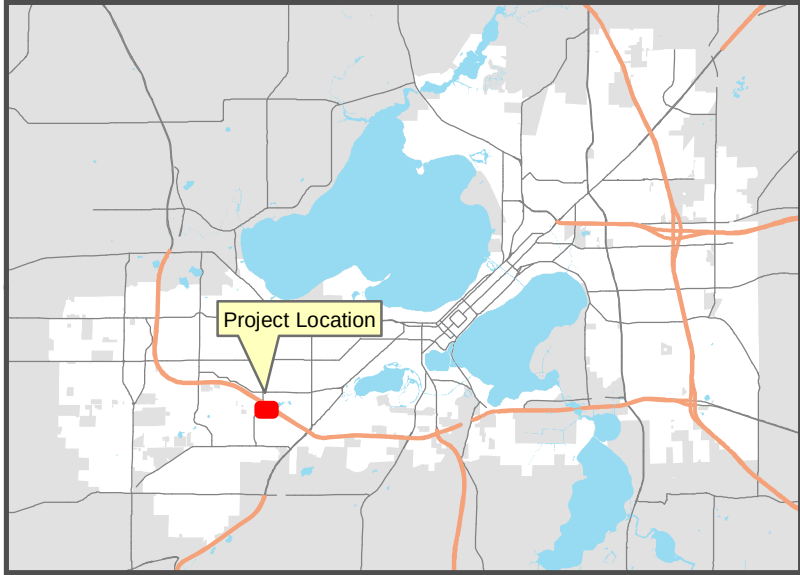
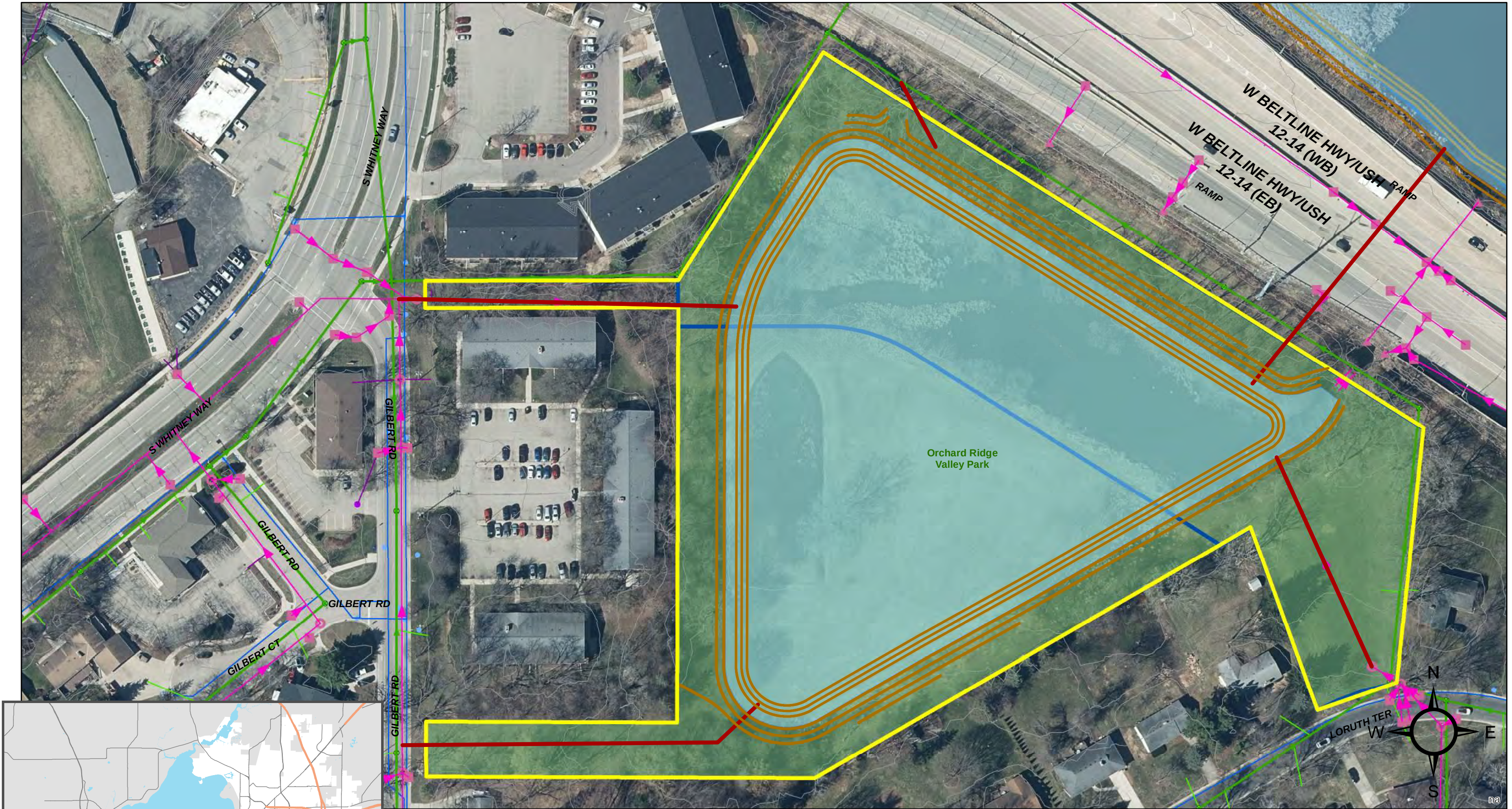
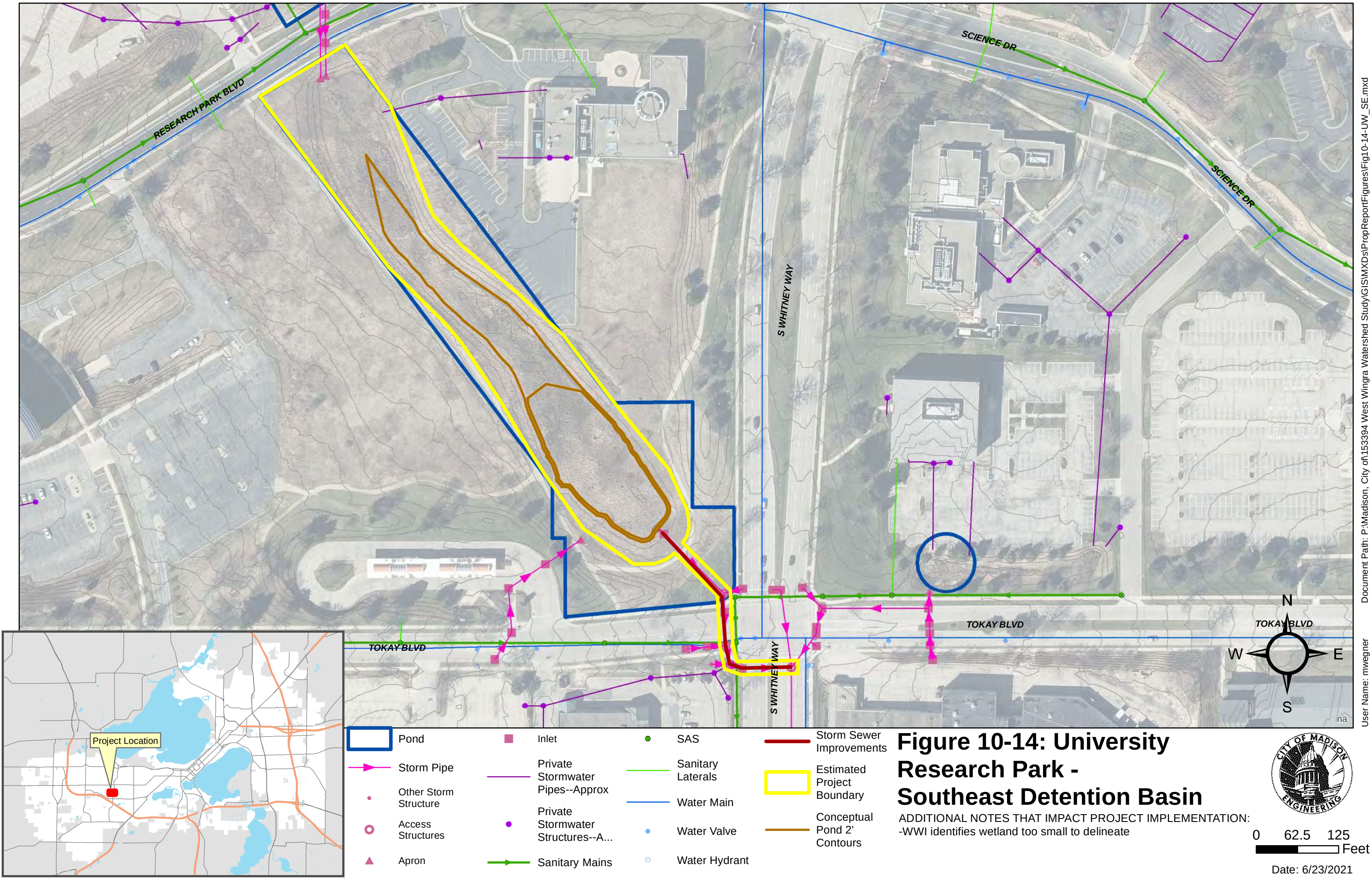
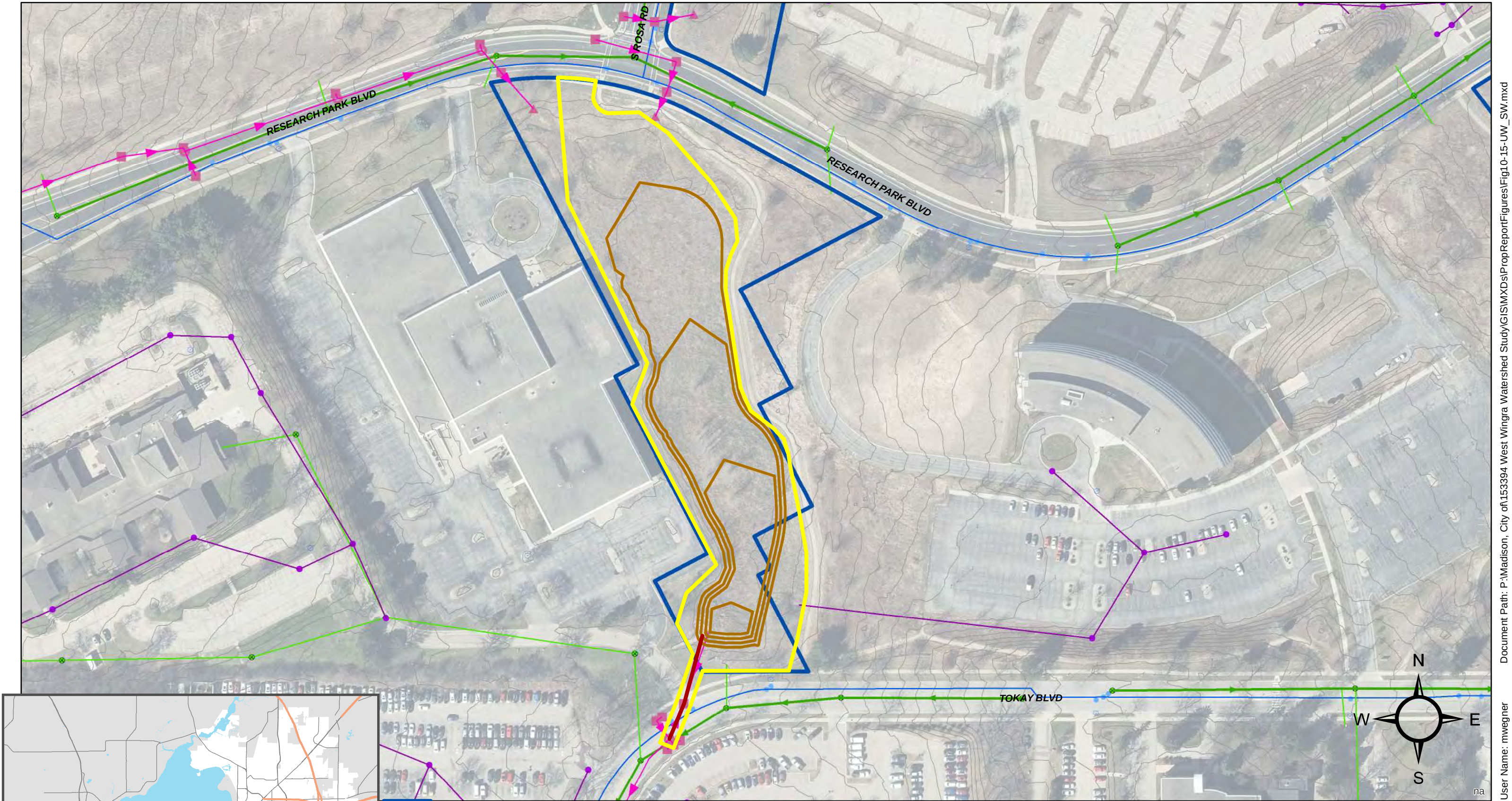


Figure 10-13: Orchard Ridge Valley Park Detention Basin Expansion

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:
-Outlet Sewer crosses ATC easement
-WDNR/USACOE Permitting for wetlands/waterways

Date: 6/10/2021

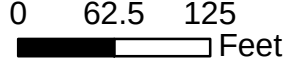




- | | | | |
|-----------------------|-------------------------------------|-------------------|-----------------------------|
| Pond | Inlet | SAS | Storm Sewer Improvements |
| Storm Pipe | Private Stormwater Pipes--Approx | Sanitary Laterals | Estimated Project Boundary |
| Other Storm Structure | Private Stormwater Structures--A... | Water Main | Conceptual Pond 2' Contours |
| Access Structures | Sanitary Mains | Water Valve | |
| Apron | | Water Hydrant | |

Figure 10-15: University Research Park - Southwest Detention Basin

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:
-WWI identifies wetland too small to delineate



Date: 6/23/2021

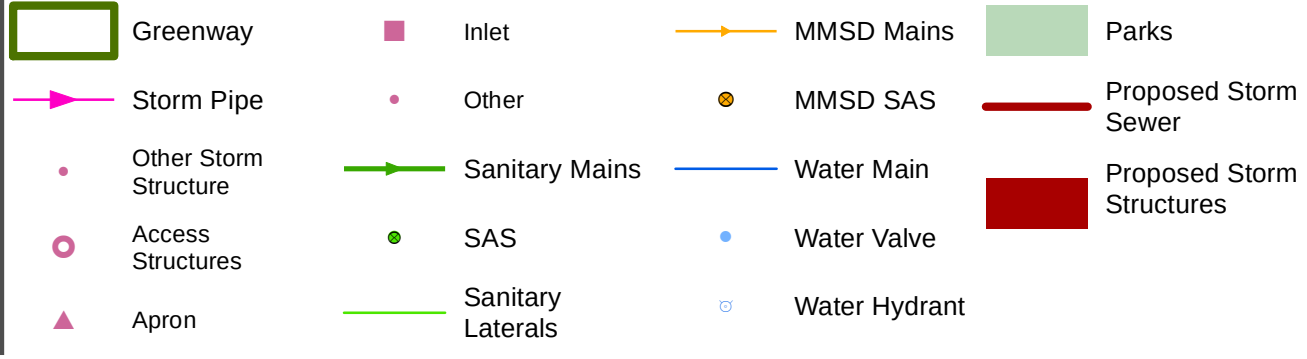
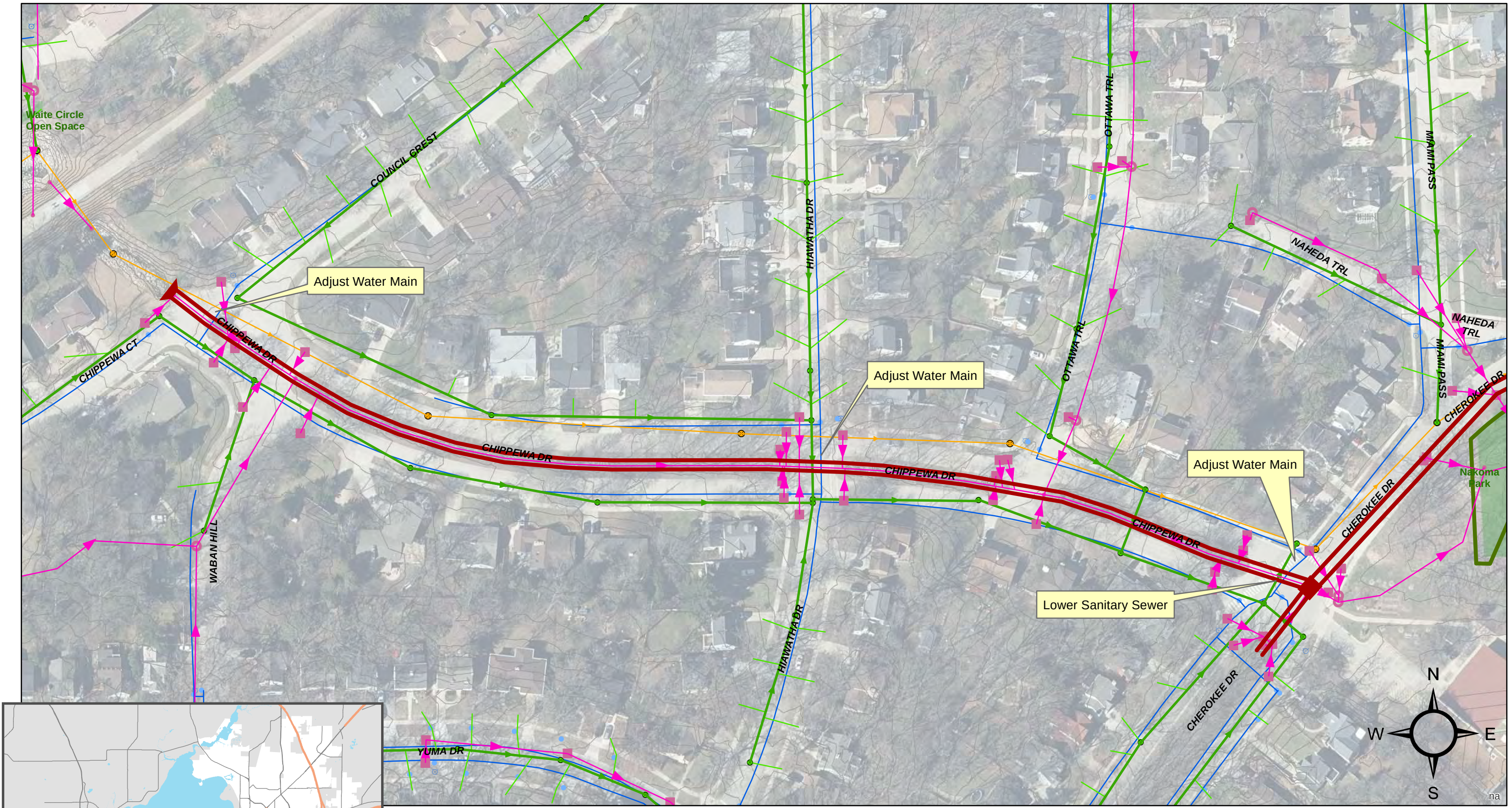


Figure 10-16: Chippewa Drive Storm Sewer

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:
-Consider utility conflicts
-Coordination with school district

Date: 6/14/2021

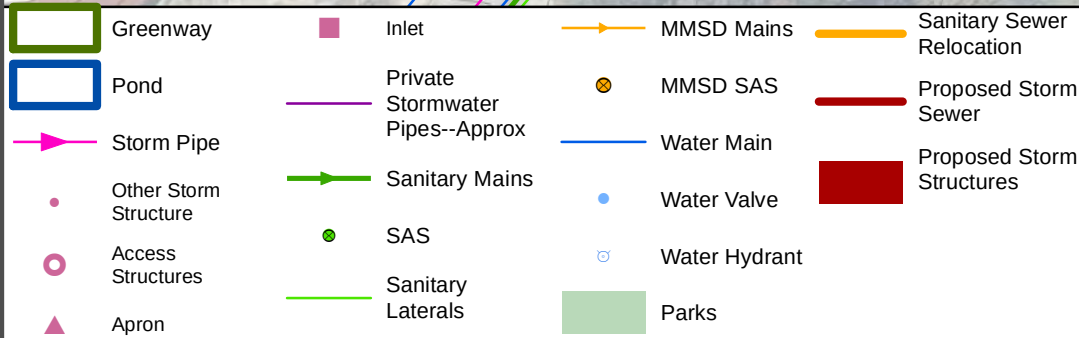
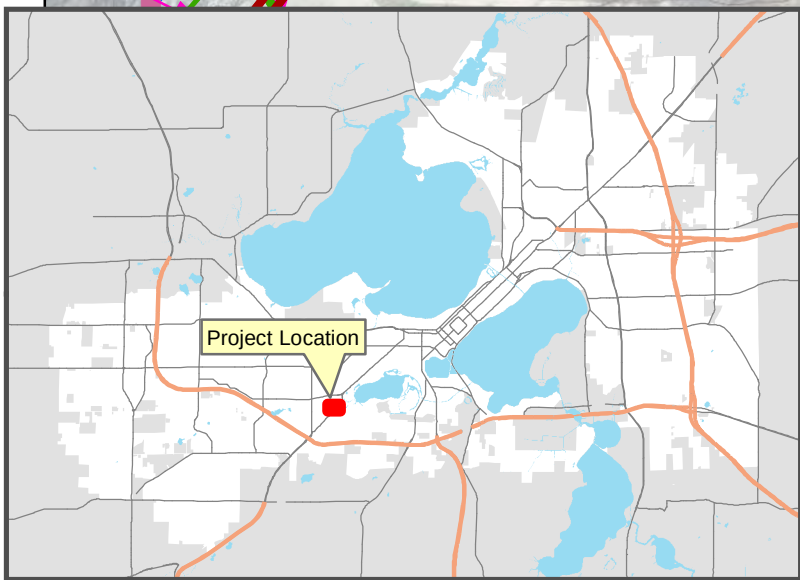
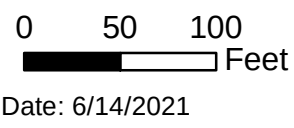
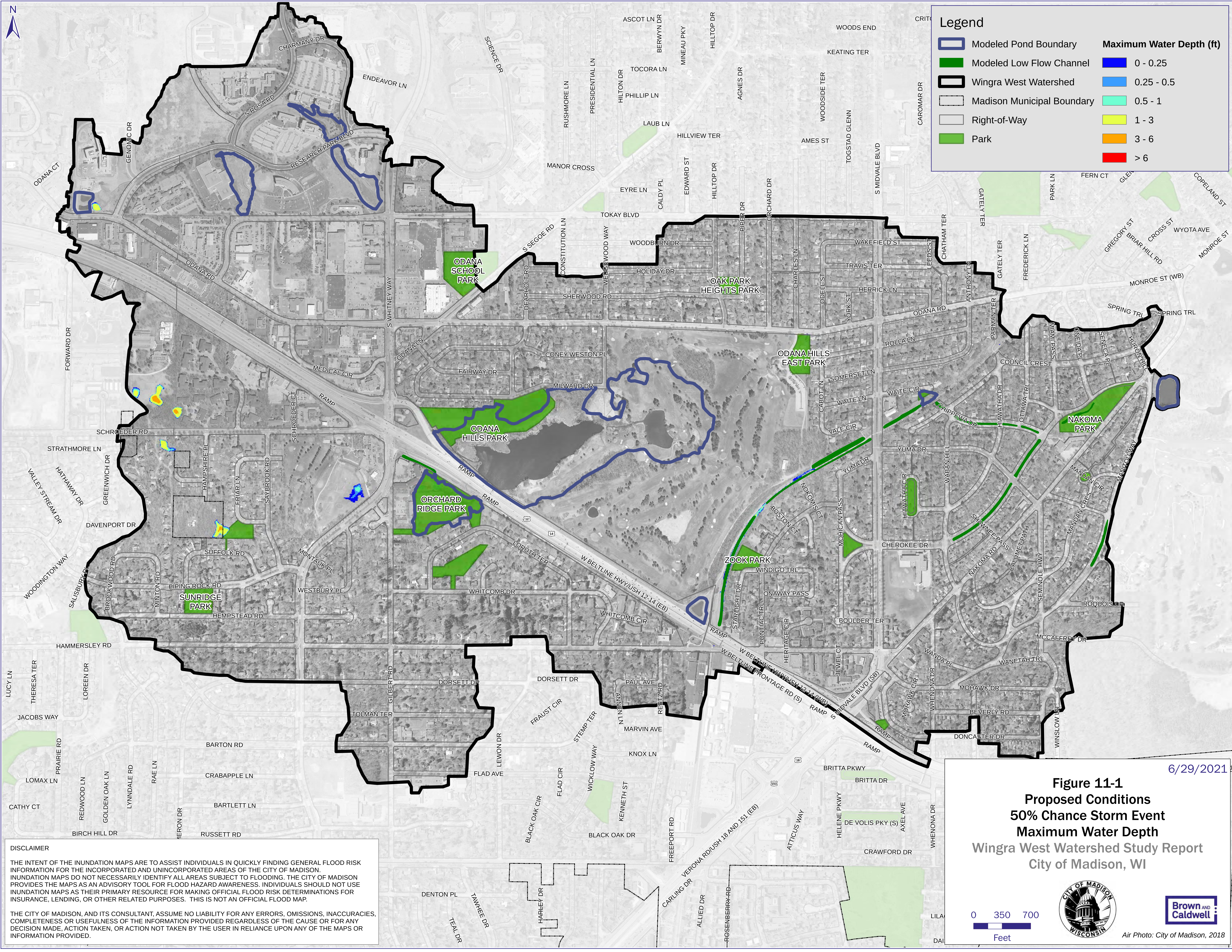


Figure 10-17: Cherokee Drive Relief Sewer

ADDITIONAL NOTES THAT IMPACT PROJECT IMPLEMENTATION:
 -Consider utility conflicts
 -Coordinate with school district
 -Coordinate with MMSD
 -Coordinate with UW Arboretum





Path: P:\Madison, City of\153394 West Wingra Watershed Study\GIS\MapDocs\PropReport\Figures\Fig11-1 WatershedInundation_Pr_2yr.mxd

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Legend

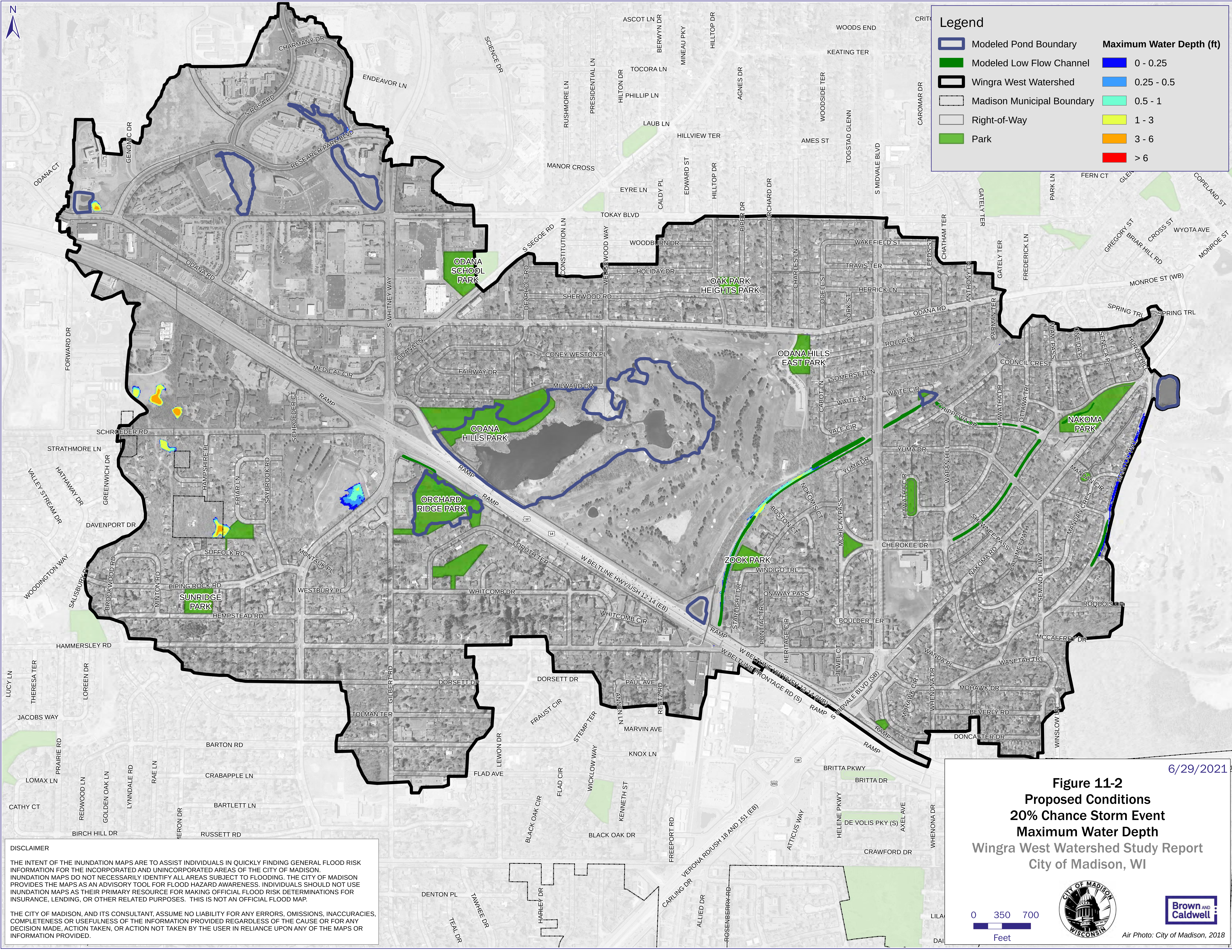
	Modeled Pond Boundary	Maximum Water Depth (ft)	
	Modeled Low Flow Channel		0 - 0.25
	Wingra West Watershed		0.25 - 0.5
	Madison Municipal Boundary		0.5 - 1
	Right-of-Way		1 - 3
	Park		3 - 6
			> 6

6/29/2021

Figure 11-1
Proposed Conditions
50% Chance Storm Event
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

0 350 700
Feet

Air Photo: City of Madison, 2018



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

6/29/2021

Figure 11-2

Proposed Conditions

20% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

City of Madison, WI

0

350

700

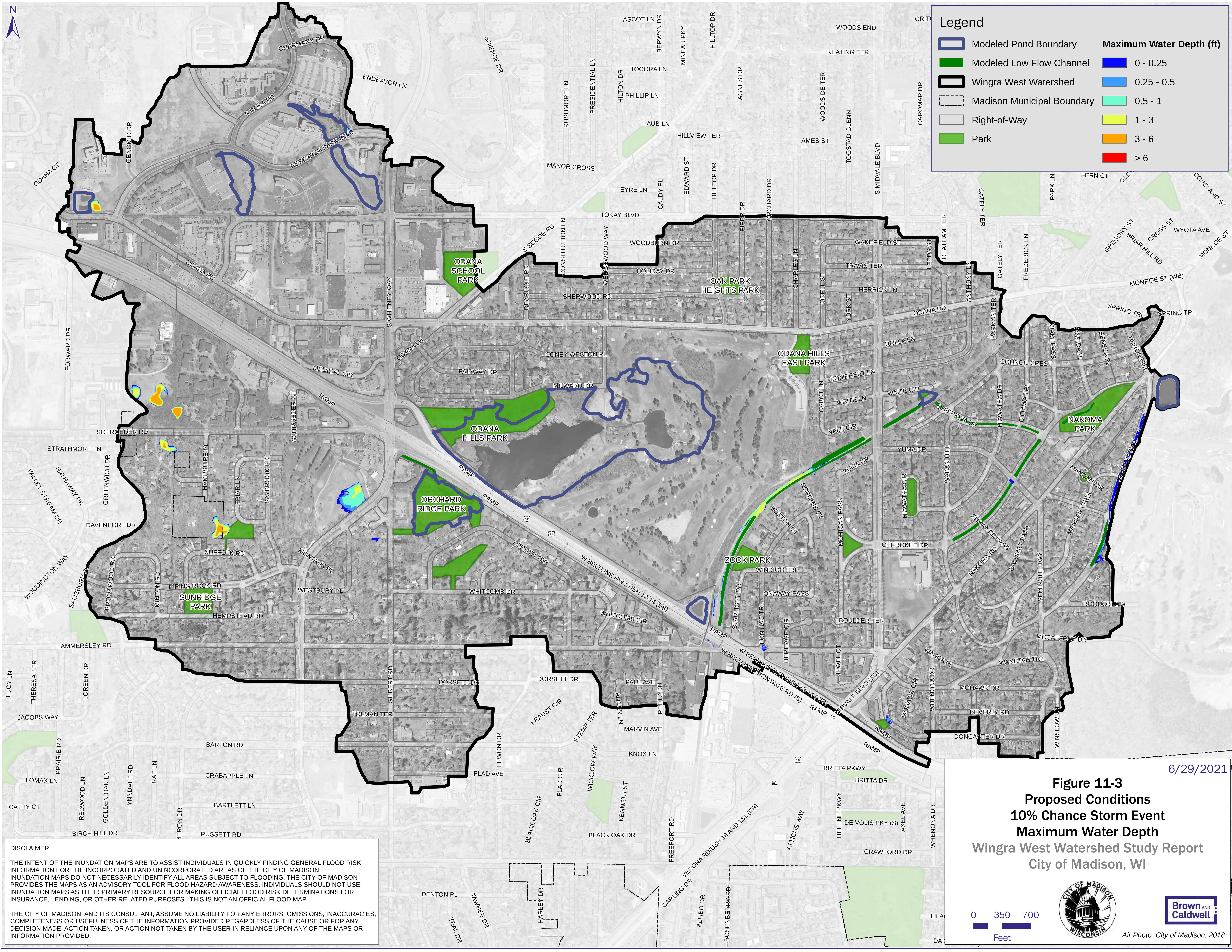
Feet

Air Photo: City of Madison, 2018

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Legend

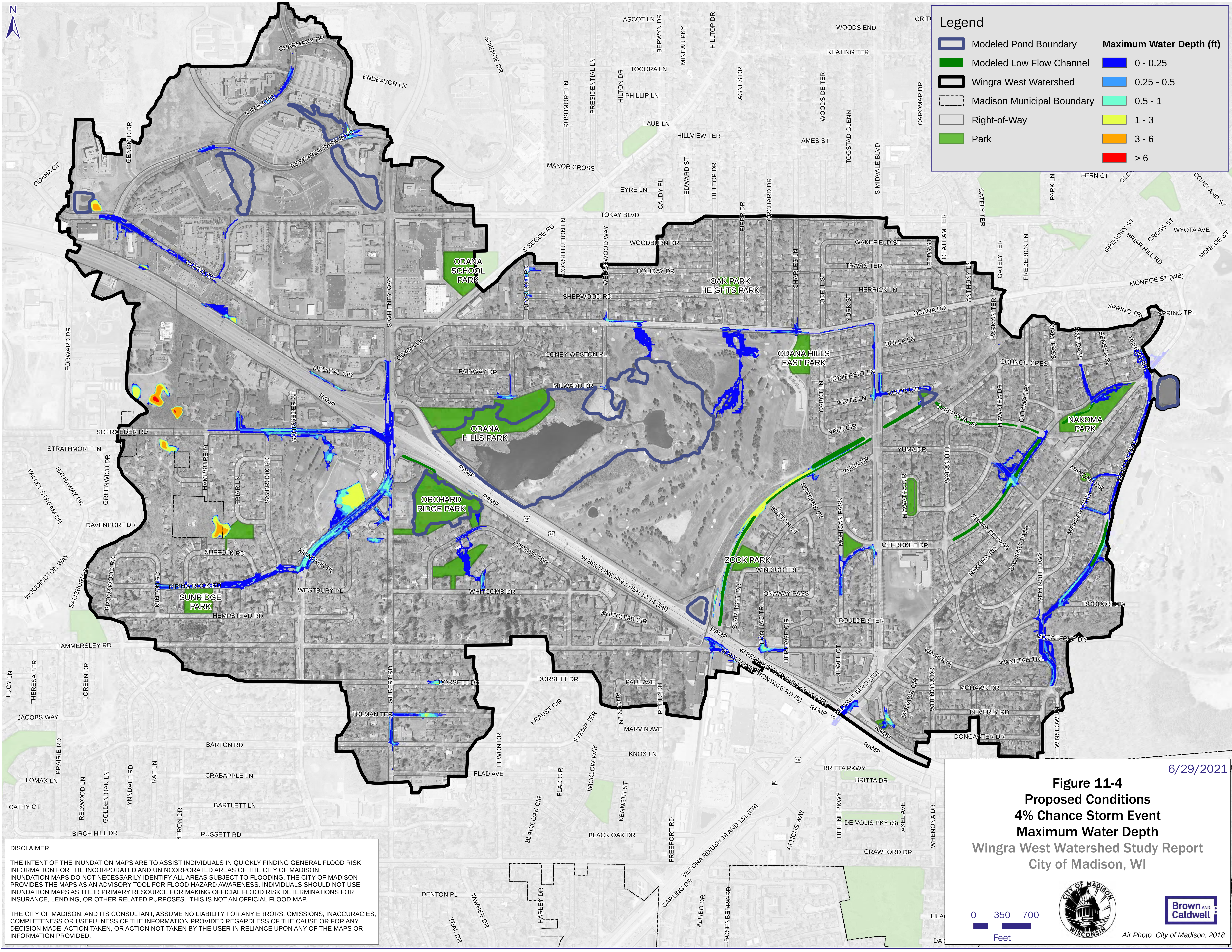
	Modeled Pond Boundary	Maximum Water Depth (ft)	
	Modeled Low Flow Channel		0 - 0.25
	Wingra West Watershed		0.25 - 0.5
	Madison Municipal Boundary		0.5 - 1
	Right-of-Way		1 - 3
	Park		3 - 6
			> 6

Figure 11-3
Proposed Conditions
10% Chance Storm Event
Maximum Water Depth
Wingra West Watershed Study Report
City of Madison, WI

6/29/2021

0 350 700
Feet

Air Photo: City of Madison, 2018



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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Figure 11-4

Proposed Conditions

4% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

City of Madison, WI

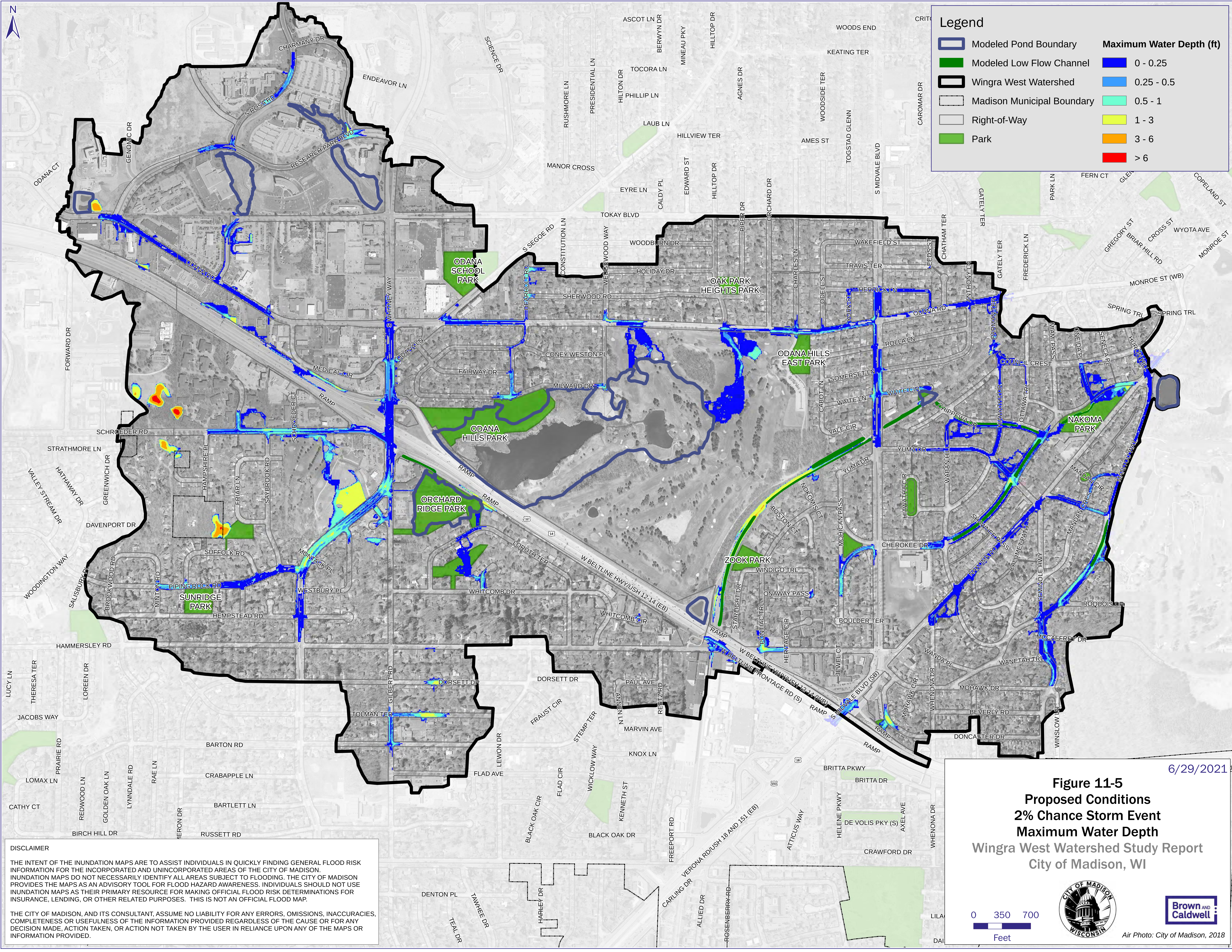
0

350

700

Feet

Air Photo: City of Madison, 2018



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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6/29/2021

Figure 11-5

Proposed Conditions

2% Chance Storm Event

Maximum Water Depth

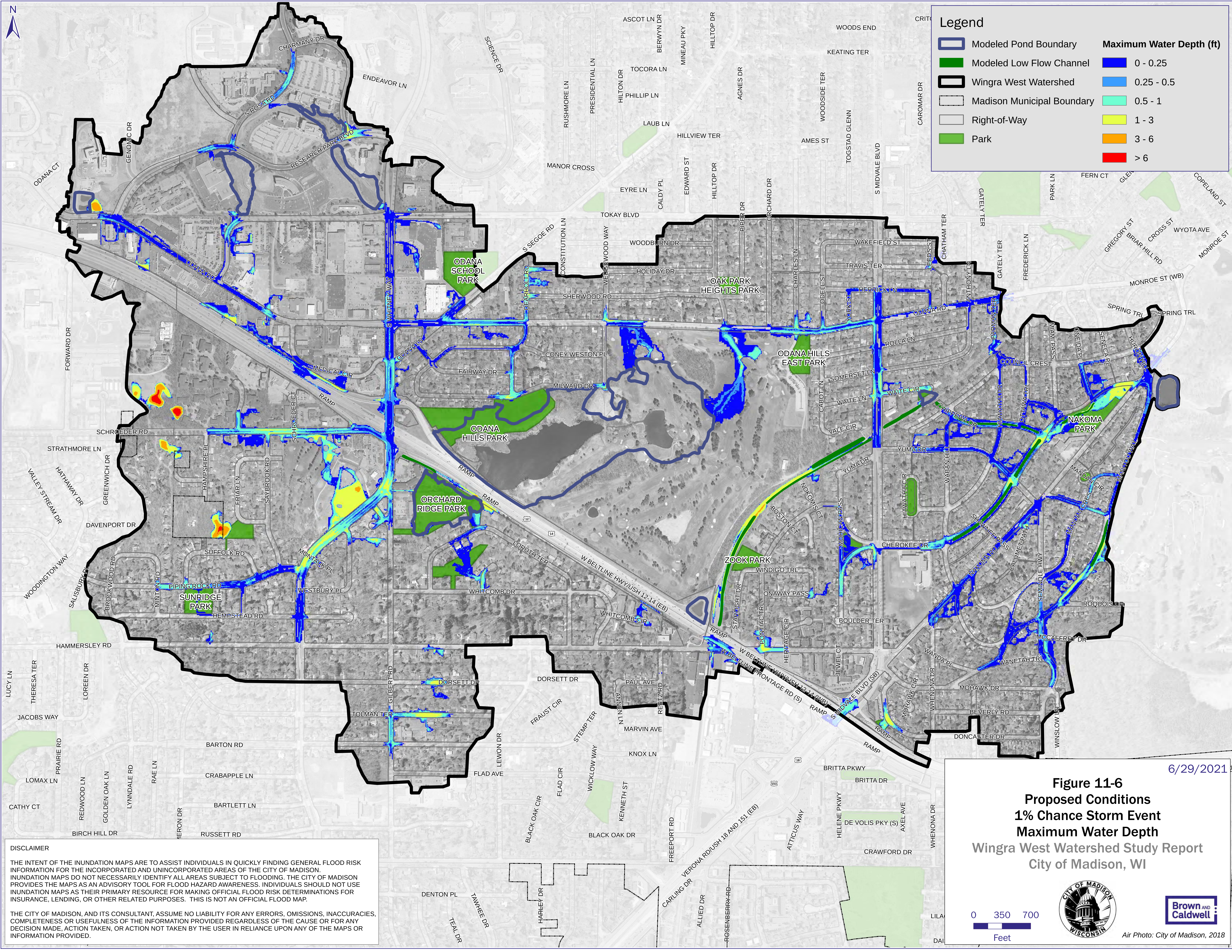
Wingra West Watershed Study Report

City of Madison, WI

0350700

Feet

Air Photo: City of Madison, 2018



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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Figure 11-6

Proposed Conditions

1% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

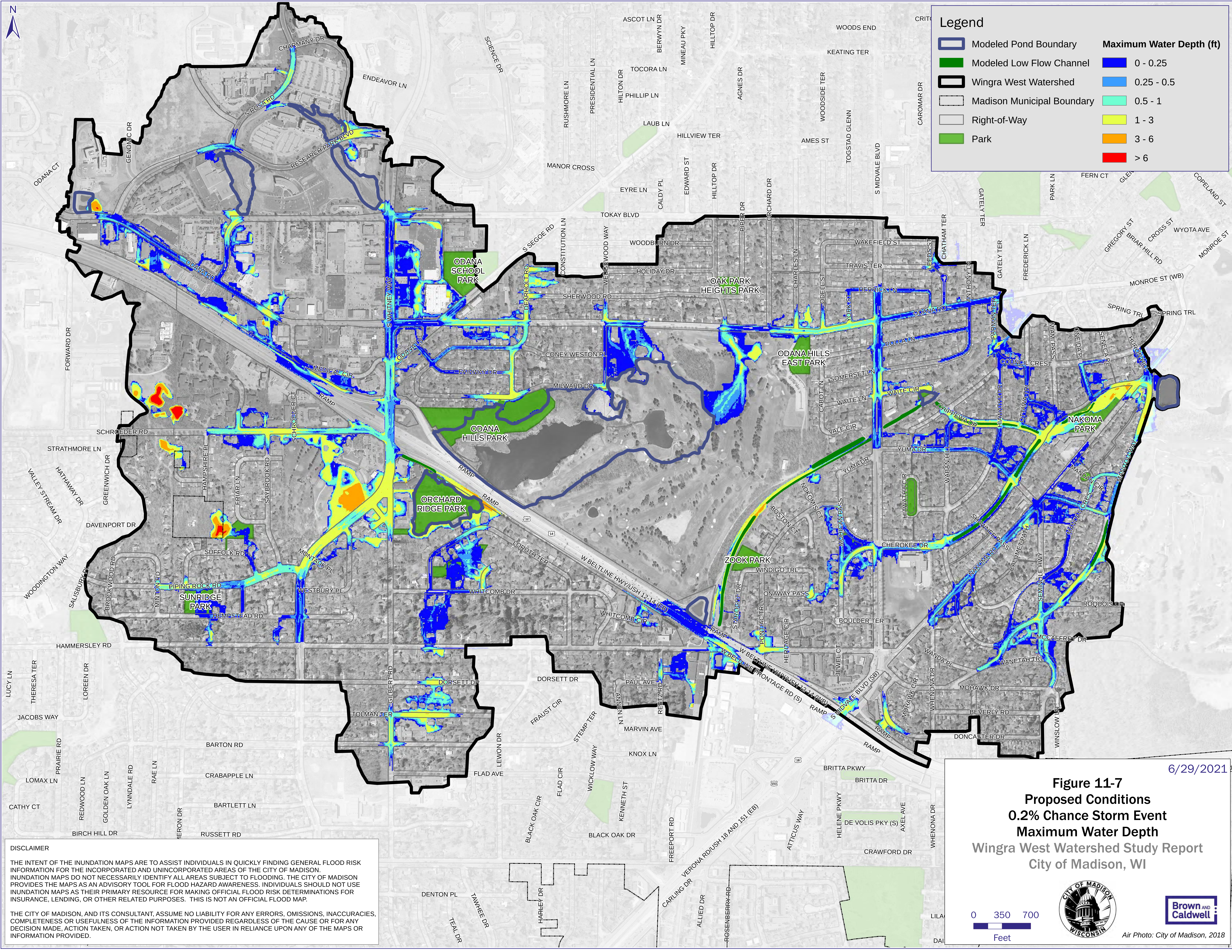
City of Madison, WI

0 350 700

Feet

Air Photo: City of Madison, 2018

Path: P:\Madison, City of\153394 West Wingra Watershed Study\GIS\MapDocs\PropReport\Figures\Fig11-6 WatershedInundation_Pr_100yr.mxd



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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Figure 11-7

Proposed Conditions

0.2% Chance Storm Event

Maximum Water Depth

Wingra West Watershed Study Report

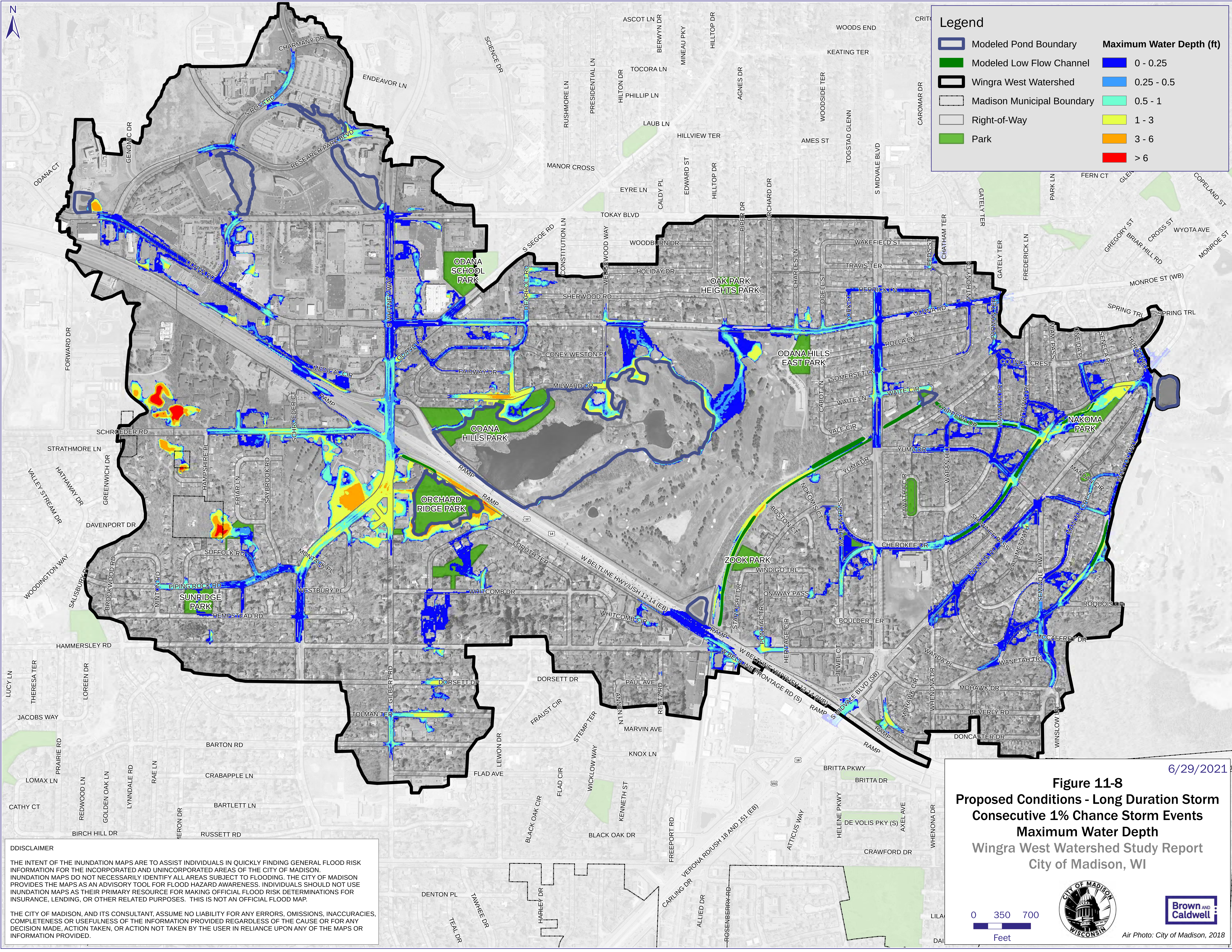
City of Madison, WI

6/29/2021

0 350 700

Feet

Air Photo: City of Madison, 2018



Legend

Modeled Pond Boundary

Modeled Low Flow Channel

Wingra West Watershed

Madison Municipal Boundary

Right-of-Way

Park

Maximum Water Depth (ft)

0 - 0.25

0.25 - 0.5

0.5 - 1

1 - 3

3 - 6

> 6

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Figure 11-8

Proposed Conditions - Long Duration Storm

Consecutive 1% Chance Storm Events

Maximum Water Depth

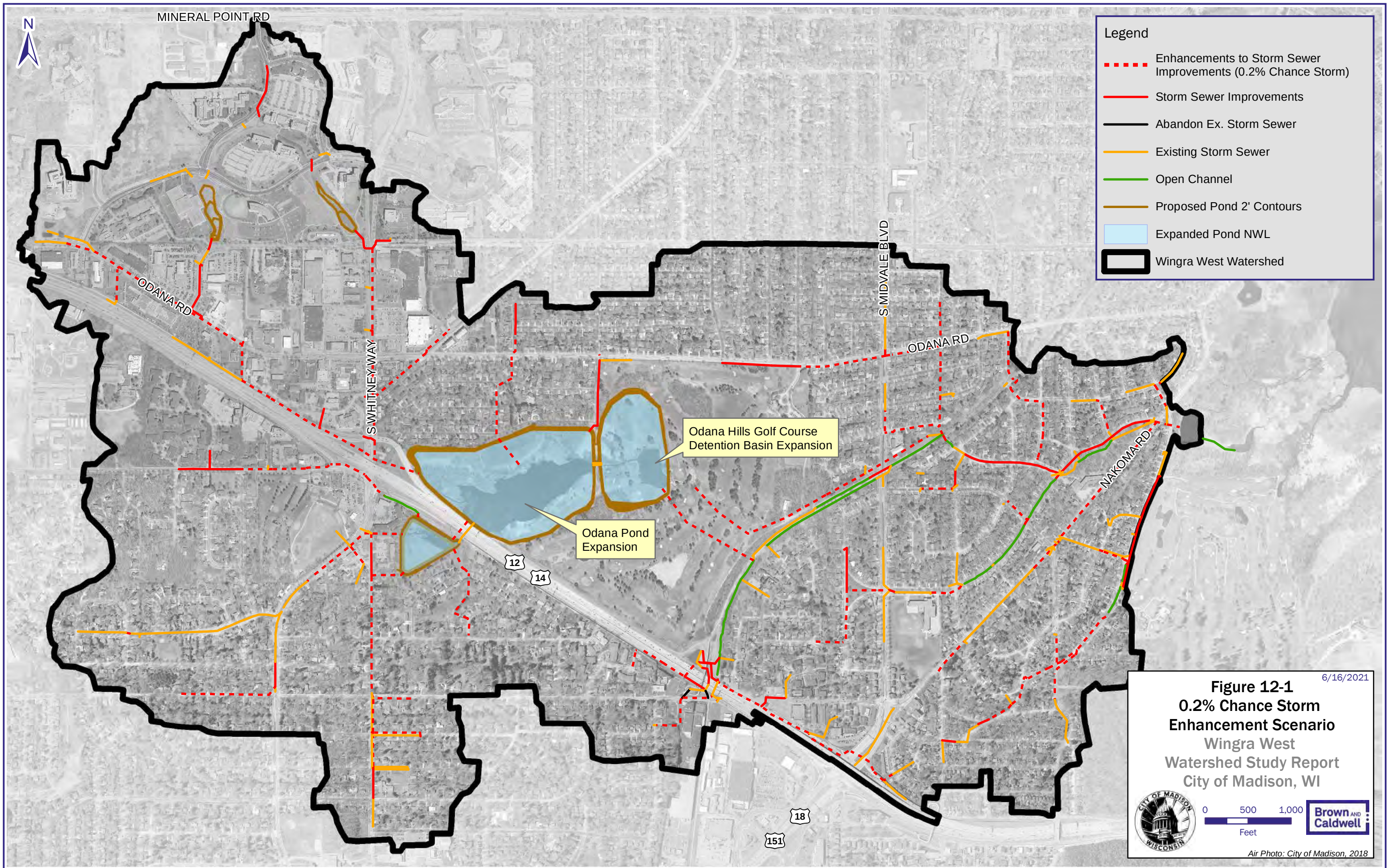
Wingra West Watershed Study Report

City of Madison, WI

0 350 700

Feet

Air Photo: City of Madison, 2018



Appendix A: Modeling Guidance

MODELING GUIDANCE

Version 2019-12-06 (DRAFT)

Latest Draft to Round 1 and Round 2 Study Consultants

The City recognizes that an important aspect of modeling is professional judgement; and it will be up to the Consultant to appropriately define parameters, variables, and methodology. However, it is in the City's best interest to aim for relative uniformity amongst all City models. Therefore, the Consultant may be expected to justify, document, and in some instances, modify various model inputs and assumptions.

City of Madison Flood Mitigation Goals

1. No home or business will be flooded during the 100-year design storm.
2. Eliminate flooding from the storm sewer system for up to the 10-year design storm; all water shall be contained within the pipes and structures (exception: low points).
3. Allow no more than 0.5 feet of water above storm sewer inlet rim at inlet-restricted low points for up to the 10-year design storm.
4. Centerline of street to remain passable during 25-year design storm with no more than 0.2 feet of water at the centerline.
 - a. Note that the Watershed Study modeling approach will not explicitly account for cross flow conditions where more gutter flow on one side of the street can overtop the crown.
5. Enclosed depressions to be served to the 100-year design storm (which can include safe overland flow within street, easements, greenways or other public lands).
6. Greenway crossings at streets to be served to the 100-year design storm.
7. Provide flooding solutions that do not negatively impact downstream properties.
8. For the purpose of the watershed studies "deficiencies" in the system shall be defined as existing infrastructure, drainage capacity or system limitations that fail to meet the goals stated in 1-7 above.

Guidance for Solutions

1. Watershed deficiencies will be reviewed, and solutions will be provided up to the 100-yr design storm.
2. In areas where flooding occurs in events exceeding the 100-year storm, those areas will not be prioritized for engineering solutions, but will be identified in existing conditions model for 500-year event storms.
3. Proposed solutions will be identified for only the publicly owned drainage system. Drainage issues that are private (water from the public infrastructure such as streets, greenways, ponds and/or easements is not the cause of the drainage issue) will not require modeling solutions but should be identified where possible in the existing conditions analysis so staff may work with property owners if necessary. (See Also Hydraulics section of Modeling Guidance for discussion on private system existing conditions modeling.)

DATA SOURCES:

In the report, document the file name and date for the following data sources:

- Land Use
- LiDAR
- Storm Sewer
- Culverts
- Greenways
- Planimetric Data
- Aerial Imagery

MODELING PARAMETERS:

Initial model parameters are the following items:

1. Model all storm sewer and culvert segments 18 inches in diameter (or equivalent) and larger, noting that the model will be required to identify all watershed deficiencies, including inlet capacity. Inclusion of smaller diameter pipes may be required to meet the goals of the model.
2. Street inlets are to be aggregated within the model to the 18-inch diameter (or equivalent) storm sewer level.
3. Incorporate existing storm water management facilities (public and private) into the model.
4. Subdivide provided outfall basins into smaller watersheds as needed in order to properly execute the model.
5. Coordinate System and Vertical Datum
 - a. Horizontal Coordinate System: Wisconsin County Coordinate System – Dane Zone NAD83 (HARN).
 - b. Vertical Datum: NAVD88 (pre 2007 adjustment) ft (City of Madison Datum + 845.6)
6. Naming convention
 - a. Names are limited to 20 characters
 - b. Subcatchments:
 - i. Begin with Subcatchments naming convention provided by the City in the Outfall Basin feature class.
 1. Add a three-digit designator to the end of the name, beginning with 000
 2. As subcatchments are subdivided, increase the added designator by 1.
 3. Example: ME04-A-0014-H (*Provided by City*) → ME04-A-0014-H-MAD-C-000 (*For the original basin*) → ME04-A-0014-H-001 (*For first subdivision*)
 - ii. Final outfall basin feature class file, including supporting files used to compute runoff timing and volume parameters shall be part of the deliverables provided to the City of Madison.
 - c. Structures and Junctions:
 - i. Node (Junction/Storage/Outfall) names for existing structures shall retain the asset identification provided by the City.
 - ii. Proposed Structure names are to be determined by the Consultant but shall be given a "logical" name that reflects general location, function, or other.
 - iii. For junctions that need to be added that are storm sewer tees as constructed, use the downstream manhole / structure with "_01" added in increasing order moving from downstream to upstream. For example, the first junction added for a tee upstream of MI3350-001 would be MI3350-001_01
 - d. Pipes:
 - i. Conduit names for existing pipes shall retain the asset identification provided by the City, except that:
 1. The first two letters (i.e AE, IN, etc) will be removed
 2. Leads with an asset ID that takes up all 20 characters can be shortened to the corresponding assigned ID. For example, 3350-032_3350-007_3350-001 can be changed to 3350-032_3350-001_01
 - ii. Proposed Pipe names are to be determined by the Consultant but shall be named in a manner similar to the City pipe naming convention, which includes the upstream and downstream structure names.
 - e. Channel/Street Flow Segments:
 - i. Conduit names for drainage-ways shall be named in a manner that identifies the greenway segment it represents by Greenway Node Number and the distance from the upstream end. Example: GR7541-062_125 would represent a channel segment that begins 125 feet into the North Door Creek Greenway – Sprecher Road Section.
 - ii. Conduit names for streets shall be named with "Rd_"[US_Node_Name]_[DS_Node_Name] and remove the first two letters in the node name similar to how pipes are named.
 - f. Natural Channels:
 - i. Natural channel transects shall be named with the same ID as the conduit name.

- ii. Street models as natural channels shall be named in a manner that is easily identifiable for the street or street type it represents.
- iii. A shapefile shall be created documenting where natural channel transects are cut.
- g. Other SWMM Features (Weirs, orifices, etc)
 - i. Other SWMM features shall have readily identifiable names corresponding to the type of feature they are trying to model. For example, an orifice for a detention pond should have an ID that is "<Detention Pond ID>_ORIF_01", keeping within a 20 character limit.
- h. Ponds
 - i.

7. Rainfall

- a. MSE4 24-hour Distribution and NOAA Atlas 14 Depths

Recurrence Interval (years)	Rainfall Depth (inches)
2	2.8
5	3.5
10	4.1
25	5.0
50	5.7
100	6.6
500	8.8

- b. Long-Duration Storm – Two 24-hour, 100-year MSE4 storm events with the time between peak rainfalls shorted from 24 hours to 12 hours.

8. Hydrology (SWMM Method with Horton Infiltration) (References: A, B, C)

- Parameters listed are default parameters and may need to be adjusted based on calibration data.
- a. Subcatchment Detail for Street Drainage
 - i. Contributing area to the existing storm sewer system that is to be modeled (Determined on a watershed by watershed basis)
 - ii. Provides information that there is or is not an issue with upstream street flooding / storm sewer capacity that would be detailed out as part of a future street improvement design project.
- b. SWMM Routing Parameters (if calibration is not available to adjust parameters)
 - i. Percent Impervious - Follow Step 1 (pages 1-3) of the "HowTo_CalculateCN" document.
 - ii. DCIA – Reference WinSLAMM Standard Land Use DCIA Spreadsheet
 - iii. Width – Estimated based on subcatchment shape. Estimation methodology shall be documented.
A single width shall be calculated for the entire subcatchment. The single width will then be prorated based on sub area acreage for each sub area. DCIA will be prorated based on the area of the DCIA sub area compared to the total subcatchment area. The prorated width for the non-DCIA sub area and pervious sub area will be the same; it will be based on the sum of the non-DCIA plus the pervious area compared to the total subcatchment area.
It is expected Width is one of the first calibration parameters for peak flow.
 - iv. Slope – Computed manually or estimated based on LiDAR. Computation or estimation methodology shall be documented.
 - v. Each subcatchment is to be split into area of (1) DCIA, (2) non-DCIA, and (3) pervious area. Within the model, the non-DCIA shall be routed to the pervious area.
- c. Horton Infiltration

- i. For typical urban pervious area (Based on range of values for different soil types, moisture conditions, and vegetation conditions found in Reference A):

HSG Group ^a	Max Infil. Rate (in/hr)	Min Infil. Rate (in/hr)	Decay Rate (1/hr)	Dry Days ^b
A	4.0	1.0	4.0	3.1
B	2.0	0.5	4.0	4.4
C	1.0	0.2	4.0	7.0
D	0.5	0.1	4.0	9.9
Water	0	0	0	0

^aFor HSG listed as A/D, B/D, C/D, the default approach will be to assume the HSG associated with the lower infiltration rate (HSG D).

^bUse equation 4-12, pg 99, SWMM Reference Manual Volume 1 – Hydrology (Revised), January 2016

- ii. Impervious Manning's n – 0.016
- iii. Pervious Manning's n – 0.20
- iv. Depression Storage for Impervious – 0.05 inches
- v. Depression Storage for Pervious – 0.15 inches
- vi. Factors for adjusting
 - 1. Forest – Multiply max and min infiltration rates by 2.
 - 2. Farmland – Divide max and min infiltration rates by 2.
 - 3. Other land uses – see reference
- vii. Area-weight the Horton Infiltration parameters for each subcatchment based on the area of each soil type within a subcatchment.
- viii. It is understood the NRCS/SCS updates the soil mapping at various times. The project teams will identify a date the soils data will be downloaded and that will be the data used for the duration of the project.

9. 1D Hydraulics (References: A, B, D, E, F)

- Dynamic mode with constant / variable timestep sufficient to model system accurately.
- Conduit lengthening shall not be used unless prior approval from City on reason.
- Parameters are default parameters and may need to be adjusted based on calibration data.
- This list is not intended to be exhaustive.
- a. System to be Modeled
 - i. Public
 - 1. Standard: 18" Pipes and Larger
 - 2. Process for Exceptions: Provide justification for reason that a pipe 18" and larger does not need to be modeled.
 - 3. Process for requiring inclusion of pipes less than 18": Necessary when they are the only pipes draining parts of the street or drainage system. For example, a 15" pipe stubbing out to a greenway from the street or a long trunk-line that is less than 18".
 - ii. Private
 - 1. Standard: Not included
 - 2. Process for requiring inclusion of private pipes:
 - a. Stormwater management detention facilities
 - b. When necessary to understand the functioning of the public system. For example, the West Towne Mall parking lot drainage system.
 - iii. All greenways and major surface drainages
 - iv. All stormwater detention facilities (public and private). Private systems may be simplified if serving a single site.
 - v. Street surface drainage, but not necessary to the block level unless needed to understand major overflow routes
- b. Loss Coefficients
 - i. Entry

Commented [BC1]: Add maximum infiltration volume in inches

1. Culverts – Select Inlet Type based on the Help File or HEC-RAS Hydraulic Reference Manual
 2. Storm Sewer (internal at MHs) = 0.1
 3. Storm Drainage Structures (MH) at 45 degree bend = 0.25
 4. Storm Drainage Structures (MH) at 90 degree bend = 0.5
 5. For culverts and entrances to storm sewer from an open channel or pond, both the energy loss coefficient and the inlet control (culvert code) shall be used.
- ii. Exit
 1. Culverts –
 - a. Exit closed conduit to open channel = 0.5
 - b. Exit closed conduit to lake or pond = 1.0
 2. Storm Sewer (internal at MHs) = 0.05
 3. Storm Drainage Structures (MH) at 45 degree bend = 0.25
 4. Storm Drainage Structures (MH) at 90 degree bend = 0.5
- c. Coefficient of Discharge
 - i. Weirs
 1. Sharp Crested – 3.0
 2. Roadway embankment – 2.6
 3. Flatter overflow – Use engineering judgment
 - ii. Orifices
 1. 0.6
 - d. Manning's n
 - i. Pipes
 1. Concrete Pipe: 0.013
 2. All other n values shall be chosen within generally acceptable ranges.
 - ii. Channels
 1. Use Chow's Open Channel Hydraulics, Reference E
 - iii. Bank Flow, including developed urban areas
 1. Use Chow's Open Channel Hydraulics, Reference E
 - e. Transect Placement and Modifiers
 - i. Splitting long open channels
 1. Changes in cross section
 2. Significant changes in slope and roughness
 3. Overflow points
 - ii. Segment Lengths
 - iii. Channel Geometry
 - iv. Provide shapefile where natural channel transects are selected along with XS Identifier
 - f. Tailwater Conditions:
 - i. Lake Mendota: one foot over Summer Maximum – 851.10
 - ii. Lake Wingra:
 - g. Inlet Clogging Factors
 - i. Continuous Slopes
 1. Street slope < 1% - 25% Clogging
 2. Street slope >= 1% - No Clogging
 - ii. Sags – 50% Clogging
10. 2D Data
- a. Surface Roughness – The average Manning's n may vary by land cover / land use. Referencing TR-55, the following roughness shall be used:
 - i. Impervious areas - 0.1
 - ii. Turf grass areas - 0.24
 - iii. Wooded – 0.4
 - iv. Prairie – 0.15
 - v. Other – reference TR-55

There is not currently a city-wide impervious area layer. The consultant may choose to delineate the impervious area for the watershed.

Or, the existing data may be utilized. The following assumptions can be made using the existing land use data:

- i. For non-residential parcels, impervious and pervious area is available, therefore, that shall be used.
- ii. A percent impervious is available for residential parcels. Calculate a composite roughness using the percent impervious area. Remove roofs from the composite roughness calculation – reference the Dane County land use for residential roofs. (roofs will be entered as blocked obstructions)
- iii. Average the roughness within the ROW based impervious and pervious area.
- b. Blocked Obstructions – enter roofs as blocked obstructions
 - i. Non-residential – use City impervious area data for roofs
 - ii. Residential – use Dane County roof layer

11. Non-Modeling Data

- a. In the Notes field, include the sources of data

12. Scenarios

- a. Scenarios shall be set up as follows:
 - a. 'Children' of the BASE scenario:
 - i. EXISTING
(grandchildren of BASE scenario, children of EXISTING)
 1. EXISTING_002_YR
 2. EXISTING_005_YR
 3. EXISTING_010_YR
 4. EXISTING_025_YR
 5. EXISTING_050_YR
 6. EXISTING_100_YR
 7. EXISTING_500_YR
 8. EXISTING_100YR_LONG_STORM
 - ii. PROP_ALT1
(grandchildren of BASE scenario, children of PROP_ALT1)
 1. PROP_ALT1_002_YR
 2. PROP_ALT1_005_YR
 3. PROP_ALT1_010_YR
 4. PROP_ALT1_025_YR
 5. PROP_ALT1_050_YR
 6. PROP_ALT1_100_YR
 7. PROP_ALT1_500_YR
 8. PROP_ALT1_100YR_LONG_STORM
 - iii. PROP_ALT2
(grandchildren of BASE scenario, children of PROP_ALT2)
 1. PROP_ALT2_002_YR
 2. PROP_ALT2_005_YR
 3. PROP_ALT2_010_YR
 4. PROP_ALT2_025_YR
 5. PROP_ALT2_050_YR
 6. PROP_ALT2_100_YR
 7. PROP_ALT2_500_YR
 8. PROP_ALT2_100YR_LONG_STORM
 - iv. PROP_ALT3
(grandchildren of BASE scenario, children of PROP_ALT3)
 1. PROP_ALT3_002_YR

Commented [BC2]: Do we know if the scenario manager works for XP-SWMM? Otherwise we can come up with a model naming convention and use global storms.

2. PROP_ALT3_005_YR
 3. PROP_ALT3_010_YR
 4. PROP_ALT3_025_YR
 5. PROP_ALT3_050_YR
 6. PROP_ALT3_100_YR
 7. PROP_ALT3_500_YR
 8. PROP_ALT3_100YR_LONG_STORM
- b. Facility for children of the BASE scenario is defined via database queries. Facility for grandchildren of the BASE scenario are defined by inheritance.
 - c. Data sets for children of the BASE scenario should be BASE except where needed to define different datasets. Data sets for the grandchildren of the BASE scenario shall be defined by inheritance except for the raingage, which should be set as defined below.
 - i. Data set naming convention should match the children of the BASE scenario. For example, if a different junction data set is needed for PROP_ALT2, the junction data set should be called "PROP_ALT2".
 - ii. Data set naming convention for raingage sets should be based on the event used in the scenario naming convention, e.g. 002_YR, 005_YR...100YR_LONGSTORM.

REFERENCES

- A. Help File
- B. Storm Water Management Model version 5.1 User's Manual. (Available at: <https://www.epa.gov/water-research/storm-water-management-model-swmm-version-51-users-manual>)
- C. SWMM reference manual volume I – hydrology (Available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NYRA.txt>)
- D. SWMM reference manual volume volume II – hydraulics (Available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100S9AS.PDF?Dockey=P100S9AS.PDF>)
- E. Chow, Open Channel Hydraulics, 1959
- F. HEC-RAS Hydraulic Reference Manual. (Available at: <https://www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS%205.0%20Reference%20Manual.pdf>)

Appendix B: Hydrology Input Parameters

Table B-1
DCIA by Land Use
Wingra West Watershed Study Report, City of Madison, WI

Land Use	Land Use Abbreviation	Area (acres)	DCIA Percentage
Suburban	SUBR	8.0	28.6%
High Density Residential No Alleys	HDRNA	27.5	66.8%
Duplex	DUP	2.5	53.3%
Medium Density Residential No Alleys	MDRNA	547.8	45.8%
Multi-Family Residential	MFR	20.9	83.9%
Low Density Residential	LDR	110.8	41.4%
High Rise Residential	HRR	38.5	97.4%
Institutional	INST	34.3	93.0%
School	SCH	21.9	97.3%
Office Park	OFFPARK	111.2	99.1%
Strip Commercial	STRIPCOM	85.2	98.1%
Shopping Center	SHOPCENT	43.4	100.0%
Light Industrial	LI	1.4	87.2%
Medium Industrial	MI	5.4	72.6%
Open Space	OPEN	47.0	100.0%
Park	PARK	267.6	64.5%
Street	STREET	290.4	100.0%
Type4 55000ADT S3 Street	Type4 55000ADT S3	78.1	35.6%
Water	WATER	21.3	100.0%
<u>Total</u>		1763	

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0186-H-MAD-C-007	AE3662-005	1	1.49	100	48	561	0.014
WI02-C-0186-H-MAD-C-007	AE3662-005	2	0.89	100	513	561	0.014
WI02-C-0186-H-MAD-C-007	AE3662-005	3	15.07	0	513	561	0.014
WI01-B-0477-H-MAD-C-004	AS7645-026	1	1.08	100	38	313	0.033
WI01-B-0477-H-MAD-C-004	AS7645-026	2	1.53	100	274	313	0.033
WI01-B-0477-H-MAD-C-004	AS7645-026	3	6.16	0	274	313	0.033
WI02-C-0186-H-MAD-C-000	BC_JCT_154	1	0.58	100	46	1100	0.025
WI02-C-0186-H-MAD-C-000	BC_JCT_154	2	0.57	100	1054	1100	0.025
WI02-C-0186-H-MAD-C-000	BC_JCT_154	3	12.78	0	1054	1100	0.025
WI02-C-0188-H-MAD-C-005	BC_JCT_167	1	3.01	100	299	1383	0.055
WI02-C-0188-H-MAD-C-005	BC_JCT_167	2	1.40	100	1084	1383	0.055
WI02-C-0188-H-MAD-C-005	BC_JCT_167	3	9.49	0	1084	1383	0.055
BM03-A-0038-H-MAD-C-001	Depression_1	1	0.31	100	25	209	0.020
BM03-A-0038-H-MAD-C-001	Depression_1	2	0.02	100	183	209	0.020
BM03-A-0038-H-MAD-C-001	Depression_1	3	2.24	0	183	209	0.020
BM03-A-0038-H-MAD-C-002	Depression_2	1	3.29	100	114	476	0.029
BM03-A-0038-H-MAD-C-002	Depression_2	2	0.22	100	362	476	0.029
BM03-A-0038-H-MAD-C-002	Depression_2	3	10.20	0	362	476	0.029
WI01-B-0184-H-MAD-C-008	Depression_3	1	1.26	100	92	474	0.050
WI01-B-0184-H-MAD-C-008	Depression_3	2	0.18	100	382	474	0.050
WI01-B-0184-H-MAD-C-008	Depression_3	3	5.03	0	382	474	0.050
WI01-B-0184-H-MAD-C-009	Depression_4	1	0.38	100	35	419	0.070
WI01-B-0184-H-MAD-C-009	Depression_4	2	0.38	100	384	419	0.070
WI01-B-0184-H-MAD-C-009	Depression_4	3	3.79	0	384	419	0.070
WI01-B-0182-H-MAD-C-008	Depression_5	1	0.73	100	49	826	0.028
WI01-B-0182-H-MAD-C-008	Depression_5	2	0.84	100	777	826	0.028
WI01-B-0182-H-MAD-C-008	Depression_5	3	10.77	0	777	826	0.028
WI02-C-0186-H-MAD-C-004	DT3662-003	1	0.57	100	36	511	0.018
WI02-C-0186-H-MAD-C-004	DT3662-003	2	0.57	100	475	511	0.018
WI02-C-0186-H-MAD-C-004	DT3662-003	3	6.87	0	475	511	0.018
WI02-C-0190-H-MAD-C-007	DT3961-049	1	0.50	100	63	587	0.069

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0190-H-MAD-C-007	DT3961-049	2	0.14	100	524	587	0.069
WI02-C-0190-H-MAD-C-007	DT3961-049	3	4.03	0	524	587	0.069
WI01-A-0179-H-MAD-C-000	OdanaNorth	1	12.53	100	372	2211	0.027
WI01-A-0179-H-MAD-C-000	OdanaNorth	2	5.37	100	1839	2211	0.027
WI01-A-0179-H-MAD-C-000	OdanaNorth	3	56.64	0	1839	2211	0.027
WI01-A-0185-H-MAD-C-002	PD_3157-013	1	9.10	100	585	1344	0.033
WI01-A-0185-H-MAD-C-002	PD_3157-013	2	0.08	100	759	1344	0.033
WI01-A-0185-H-MAD-C-002	PD_3157-013	3	11.73	0	759	1344	0.033
WI01-A-0186-H-MAD-C-000	PD_3258-008	1	7.59	100	523	1606	0.047
WI01-A-0186-H-MAD-C-000	PD_3258-008	2	0.05	100	1084	1606	0.047
WI01-A-0186-H-MAD-C-000	PD_3258-008	3	15.68	0	1084	1606	0.047
WI01-B-0477-H-MAD-C-003	PD_3362-020	1	1.60	100	113	1472	0.020
WI01-B-0477-H-MAD-C-003	PD_3362-020	2	1.03	100	1358	1472	0.020
WI01-B-0477-H-MAD-C-003	PD_3362-020	3	18.13	0	1358	1472	0.020
WI02-C-0186-H-MAD-C-003	PD_3564-028	1	0.96	100	71	512	0.012
WI02-C-0186-H-MAD-C-003	PD_3564-028	2	1.34	100	440	512	0.012
WI02-C-0186-H-MAD-C-003	PD_3564-028	3	4.58	0	440	512	0.012
WI02-U-1038-A-MAD-T-000	PD_4061-006	1	0.00	100	0	890	0.059
WI02-U-1038-A-MAD-T-000	PD_4061-006	2	0.00	100	890	890	0.059
WI02-U-1038-A-MAD-T-000	PD_4061-006	3	2.79	0	890	890	0.059
WI01-A-0183-H-MAD-C-015	PD_ILLUMINA	1	0.19	100	12	762	0.051
WI01-A-0183-H-MAD-C-015	PD_ILLUMINA	2	0.00	100	750	762	0.051
WI01-A-0183-H-MAD-C-015	PD_ILLUMINA	3	11.50	0	750	762	0.051
WI01-A-0183-H-MAD-C-009	PD3158-014	1	13.85	100	1521	3212	0.044
WI01-A-0183-H-MAD-C-009	PD3158-014	2	0.12	100	1691	3212	0.044
WI01-A-0183-H-MAD-C-009	PD3158-014	3	15.29	0	1691	3212	0.044
WI01-A-0179-H-MAD-C-007	PD3462-001	1	5.31	100	124	320	0.021
WI01-A-0179-H-MAD-C-007	PD3462-001	2	5.41	100	196	320	0.021
WI01-A-0179-H-MAD-C-007	PD3462-001	3	2.98	0	196	320	0.021
WI02-C-0186-H-MAD-C-002	STOR_12	1	2.11	100	68	3358	0.019
WI02-C-0186-H-MAD-C-002	STOR_12	2	1.11	100	3290	3358	0.019

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0186-H-MAD-C-002	STOR_12	3	100.46	0	3290	3358	0.019
WI02-C-0188-H-MAD-C-018	WAITECIRCLE	1	0.34	100	32	532	0.060
WI02-C-0188-H-MAD-C-018	WAITECIRCLE	2	0.30	100	500	532	0.060
WI02-C-0188-H-MAD-C-018	WAITECIRCLE	3	4.90	0	500	532	0.060
WI01-A-0179-H-MAD-C-001	WI01-A-0179-H-001	1	1.76	100	99	546	0.034
WI01-A-0179-H-MAD-C-001	WI01-A-0179-H-001	2	1.16	100	447	546	0.034
WI01-A-0179-H-MAD-C-001	WI01-A-0179-H-001	3	6.76	0	447	546	0.034
WI01-A-0179-H-MAD-C-002	WI01-A-0179-H-002	1	4.13	100	124	570	0.013
WI01-A-0179-H-MAD-C-002	WI01-A-0179-H-002	2	2.61	100	446	570	0.013
WI01-A-0179-H-MAD-C-002	WI01-A-0179-H-002	3	12.22	0	446	570	0.013
WI01-A-0179-H-MAD-C-003	WI01-A-0179-H-003	1	3.75	100	125	716	0.018
WI01-A-0179-H-MAD-C-003	WI01-A-0179-H-003	2	2.66	100	591	716	0.018
WI01-A-0179-H-MAD-C-003	WI01-A-0179-H-003	3	15.03	0	591	716	0.018
WI01-A-0179-H-MAD-C-004	WI01-A-0179-H-004	1	3.95	100	171	757	0.030
WI01-A-0179-H-MAD-C-004	WI01-A-0179-H-004	2	2.54	100	586	757	0.030
WI01-A-0179-H-MAD-C-004	WI01-A-0179-H-004	3	11.01	0	586	757	0.030
WI01-A-0179-H-MAD-C-005	WI01-A-0179-H-005	1	0.93	100	56	353	0.014
WI01-A-0179-H-MAD-C-005	WI01-A-0179-H-005	2	0.72	100	297	353	0.014
WI01-A-0179-H-MAD-C-005	WI01-A-0179-H-005	3	4.24	0	297	353	0.014
WI01-A-0179-H-MAD-C-006	WI01-A-0179-H-006	1	4.27	100	191	738	0.015
WI01-A-0179-H-MAD-C-006	WI01-A-0179-H-006	2	1.89	100	548	738	0.015
WI01-A-0179-H-MAD-C-006	WI01-A-0179-H-006	3	10.35	0	548	738	0.015
WI01-A-0180-H-MAD-C-000	WI01-A-0180-H-000	1	1.85	100	119	218	0.007
WI01-A-0180-H-MAD-C-000	WI01-A-0180-H-000	2	0.12	100	99	218	0.007
WI01-A-0180-H-MAD-C-000	WI01-A-0180-H-000	3	1.42	0	99	218	0.007
WI01-A-0180-H-MAD-C-001	WI01-A-0180-H-001	1	2.83	100	105	279	0.026
WI01-A-0180-H-MAD-C-001	WI01-A-0180-H-001	2	0.55	100	173	279	0.026
WI01-A-0180-H-MAD-C-001	WI01-A-0180-H-001	3	4.11	0	173	279	0.026
WI01-A-0180-H-MAD-C-002	WI01-A-0180-H-002	1	17.47	100	433	522	0.007
WI01-A-0180-H-MAD-C-002	WI01-A-0180-H-002	2	0.19	100	89	522	0.007
WI01-A-0180-H-MAD-C-002	WI01-A-0180-H-002	3	3.38	0	89	522	0.007

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-A-0183-H-MAD-C-000	WI01-A-0183-H-000	1	3.40	100	194	645	0.033
WI01-A-0183-H-MAD-C-000	WI01-A-0183-H-000	2	1.69	100	451	645	0.033
WI01-A-0183-H-MAD-C-000	WI01-A-0183-H-000	3	6.20	0	451	645	0.033
WI01-A-0183-H-MAD-C-001	WI01-A-0183-H-001	1	3.80	100	414	730	0.019
WI01-A-0183-H-MAD-C-001	WI01-A-0183-H-001	2	0.38	100	316	730	0.019
WI01-A-0183-H-MAD-C-001	WI01-A-0183-H-001	3	2.52	0	316	730	0.019
WI01-A-0183-H-MAD-C-002	WI01-A-0183-H-002	1	1.09	100	70	112	0.047
WI01-A-0183-H-MAD-C-002	WI01-A-0183-H-002	2	0.00	100	42	112	0.047
WI01-A-0183-H-MAD-C-002	WI01-A-0183-H-002	3	0.66	0	42	112	0.047
WI01-A-0183-H-MAD-C-003	WI01-A-0183-H-003	1	3.60	100	229	320	0.022
WI01-A-0183-H-MAD-C-003	WI01-A-0183-H-003	2	0.07	100	91	320	0.022
WI01-A-0183-H-MAD-C-003	WI01-A-0183-H-003	3	1.37	0	91	320	0.022
WI01-A-0183-H-MAD-C-004	WI01-A-0183-H-004	1	8.48	100	513	627	0.022
WI01-A-0183-H-MAD-C-004	WI01-A-0183-H-004	2	0.07	100	114	627	0.022
WI01-A-0183-H-MAD-C-004	WI01-A-0183-H-004	3	1.80	0	114	627	0.022
WI01-A-0183-H-MAD-C-005	WI01-A-0183-H-005	1	8.98	100	318	645	0.033
WI01-A-0183-H-MAD-C-005	WI01-A-0183-H-005	2	0.59	100	327	645	0.033
WI01-A-0183-H-MAD-C-005	WI01-A-0183-H-005	3	8.63	0	327	645	0.033
WI01-A-0183-H-MAD-C-006	WI01-A-0183-H-006	1	3.51	100	256	326	0.010
WI01-A-0183-H-MAD-C-006	WI01-A-0183-H-006	2	0.06	100	70	326	0.010
WI01-A-0183-H-MAD-C-006	WI01-A-0183-H-006	3	0.90	0	70	326	0.010
WI01-A-0183-H-MAD-C-007	WI01-A-0183-H-007	1	4.09	100	365	425	0.019
WI01-A-0183-H-MAD-C-007	WI01-A-0183-H-007	2	0.06	100	60	425	0.019
WI01-A-0183-H-MAD-C-007	WI01-A-0183-H-007	3	0.61	0	60	425	0.019
WI01-A-0183-H-MAD-C-008	WI01-A-0183-H-008	1	4.78	100	253	334	0.019
WI01-A-0183-H-MAD-C-008	WI01-A-0183-H-008	2	0.07	100	81	334	0.019
WI01-A-0183-H-MAD-C-008	WI01-A-0183-H-008	3	1.46	0	81	334	0.019
WI01-A-0183-H-MAD-C-010	WI01-A-0183-H-010	1	1.25	100	71	175	0.016
WI01-A-0183-H-MAD-C-010	WI01-A-0183-H-010	2	0.01	100	104	175	0.016
WI01-A-0183-H-MAD-C-010	WI01-A-0183-H-010	3	1.82	0	104	175	0.016
WI01-A-0183-H-MAD-C-011	WI01-A-0183-H-011	1	2.06	100	91	351	0.045

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-A-0183-H-MAD-C-011	WI01-A-0183-H-011	2	0.00	100	260	351	0.045
WI01-A-0183-H-MAD-C-011	WI01-A-0183-H-011	3	5.89	0	260	351	0.045
WI01-A-0183-H-MAD-C-012	WI01-A-0183-H-012	1	2.59	100	159	539	0.014
WI01-A-0183-H-MAD-C-012	WI01-A-0183-H-012	2	1.66	100	380	539	0.014
WI01-A-0183-H-MAD-C-012	WI01-A-0183-H-012	3	4.55	0	380	539	0.014
WI01-A-0183-H-MAD-C-013	WI01-A-0183-H-013	1	2.14	100	191	398	0.011
WI01-A-0183-H-MAD-C-013	WI01-A-0183-H-013	2	0.03	100	207	398	0.011
WI01-A-0183-H-MAD-C-013	WI01-A-0183-H-013	3	2.30	0	207	398	0.011
WI01-A-0183-H-MAD-C-014	WI01-A-0183-H-014	1	3.33	100	343	473	0.006
WI01-A-0183-H-MAD-C-014	WI01-A-0183-H-014	2	0.09	100	130	473	0.006
WI01-A-0183-H-MAD-C-014	WI01-A-0183-H-014	3	1.17	0	130	473	0.006
WI01-A-0183-H-MAD-C-016	WI01-A-0183-H-016	1	1.65	100	150	235	0.014
WI01-A-0183-H-MAD-C-016	WI01-A-0183-H-016	2	0.06	100	85	235	0.014
WI01-A-0183-H-MAD-C-016	WI01-A-0183-H-016	3	0.87	0	85	235	0.014
WI01-A-0185-H-MAD-C-000	WI01-A-0185-H-000	1	5.39	100	224	1116	0.019
WI01-A-0185-H-MAD-C-000	WI01-A-0185-H-000	2	0.01	100	892	1116	0.019
WI01-A-0185-H-MAD-C-000	WI01-A-0185-H-000	3	21.40	0	892	1116	0.019
WI01-A-0185-H-MAD-C-001	WI01-A-0185-H-001	1	3.55	100	121	256	0.027
WI01-A-0185-H-MAD-C-001	WI01-A-0185-H-001	2	0.03	100	135	256	0.027
WI01-A-0185-H-MAD-C-001	WI01-A-0185-H-001	3	3.92	0	135	256	0.027
WI01-A-0185-H-MAD-C-003	WI01-A-0185-H-003	1	2.77	100	239	459	0.027
WI01-A-0185-H-MAD-C-003	WI01-A-0185-H-003	2	0.02	100	219	459	0.027
WI01-A-0185-H-MAD-C-003	WI01-A-0185-H-003	3	2.51	0	219	459	0.027
WI01-A-0185-H-MAD-C-004	WI01-A-0185-H-004	1	4.90	100	328	723	0.018
WI01-A-0185-H-MAD-C-004	WI01-A-0185-H-004	2	0.05	100	395	723	0.018
WI01-A-0185-H-MAD-C-004	WI01-A-0185-H-004	3	5.85	0	395	723	0.018
WI01-A-0187-H-MAD-C-000	WI01-A-0187-H-000	1	3.29	100	277	942	0.026
WI01-A-0187-H-MAD-C-000	WI01-A-0187-H-000	2	1.91	100	665	942	0.026
WI01-A-0187-H-MAD-C-000	WI01-A-0187-H-000	3	5.98	0	665	942	0.026
WI01-A-0187-H-MAD-C-001	WI01-A-0187-H-001	1	2.72	100	120	172	0.020
WI01-A-0187-H-MAD-C-001	WI01-A-0187-H-001	2	0.01	100	52	172	0.020

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-A-0187-H-MAD-C-001	WI01-A-0187-H-001	3	1.18	0	52	172	0.020
WI01-A-0187-H-MAD-C-003	WI01-A-0187-H-003	1	5.36	100	278	362	0.027
WI01-A-0187-H-MAD-C-003	WI01-A-0187-H-003	2	0.39	100	83	362	0.027
WI01-A-0187-H-MAD-C-003	WI01-A-0187-H-003	3	1.22	0	83	362	0.027
WI01-A-0187-H-MAD-C-004	WI01-A-0187-H-004	1	9.56	100	787	840	0.031
WI01-A-0187-H-MAD-C-004	WI01-A-0187-H-004	2	0.00	100	53	840	0.031
WI01-A-0187-H-MAD-C-004	WI01-A-0187-H-004	3	0.64	0	53	840	0.031
WI01-A-0187-H-MAD-C-005	WI01-A-0187-H-005	1	10.16	100	751	896	0.026
WI01-A-0187-H-MAD-C-005	WI01-A-0187-H-005	2	0.00	100	146	896	0.026
WI01-A-0187-H-MAD-C-005	WI01-A-0187-H-005	3	1.98	0	146	896	0.026
WI01-A-0187-H-MAD-C-006	WI01-A-0187-H-006	1	2.07	100	121	284	0.023
WI01-A-0187-H-MAD-C-006	WI01-A-0187-H-006	2	0.01	100	163	284	0.023
WI01-A-0187-H-MAD-C-006	WI01-A-0187-H-006	3	2.77	0	163	284	0.023
WI01-A-0187-H-MAD-C-007	WI01-A-0187-H-007	1	5.18	100	382	690	0.020
WI01-A-0187-H-MAD-C-007	WI01-A-0187-H-007	2	0.04	100	308	690	0.020
WI01-A-0187-H-MAD-C-007	WI01-A-0187-H-007	3	4.13	0	308	690	0.020
WI01-A-0307-H-MAD-C-000	WI01-A-0307-H-000	1	2.73	100	119	294	0.019
WI01-A-0307-H-MAD-C-000	WI01-A-0307-H-000	2	2.32	100	175	294	0.019
WI01-A-0307-H-MAD-C-000	WI01-A-0307-H-000	3	1.69	0	175	294	0.019
WI01-A-0307-H-MAD-C-001	WI01-A-0307-H-001	1	6.59	100	447	641	0.037
WI01-A-0307-H-MAD-C-001	WI01-A-0307-H-001	2	0.11	100	194	641	0.037
WI01-A-0307-H-MAD-C-001	WI01-A-0307-H-001	3	2.75	0	194	641	0.037
WI01-B-0181-H-MAD-C-000	WI01-B-0181-H-000	1	1.08	100	67	423	0.013
WI01-B-0181-H-MAD-C-000	WI01-B-0181-H-000	2	0.75	100	357	423	0.013
WI01-B-0181-H-MAD-C-000	WI01-B-0181-H-000	3	5.04	0	357	423	0.013
WI01-B-0181-H-MAD-C-001	WI01-B-0181-H-001	1	1.90	100	89	476	0.017
WI01-B-0181-H-MAD-C-001	WI01-B-0181-H-001	2	1.01	100	387	476	0.017
WI01-B-0181-H-MAD-C-001	WI01-B-0181-H-001	3	7.19	0	387	476	0.017
WI01-B-0181-H-MAD-C-002	WI01-B-0181-H-002	1	4.59	100	199	785	0.013
WI01-B-0181-H-MAD-C-002	WI01-B-0181-H-002	2	1.92	100	586	785	0.013
WI01-B-0181-H-MAD-C-002	WI01-B-0181-H-002	3	11.60	0	586	785	0.013

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-B-0181-H-MAD-C-003	WI01-B-0181-H-003	1	1.09	100	91	746	0.016
WI01-B-0181-H-MAD-C-003	WI01-B-0181-H-003	2	0.94	100	656	746	0.016
WI01-B-0181-H-MAD-C-003	WI01-B-0181-H-003	3	6.94	0	656	746	0.016
WI01-B-0181-H-MAD-C-004	WI01-B-0181-H-004	1	1.39	100	158	856	0.036
WI01-B-0181-H-MAD-C-004	WI01-B-0181-H-004	2	0.90	100	698	856	0.036
WI01-B-0181-H-MAD-C-004	WI01-B-0181-H-004	3	5.24	0	698	856	0.036
WI01-B-0181-H-MAD-C-005	WI01-B-0181-H-005	1	1.04	100	87	711	0.009
WI01-B-0181-H-MAD-C-005	WI01-B-0181-H-005	2	0.93	100	624	711	0.009
WI01-B-0181-H-MAD-C-005	WI01-B-0181-H-005	3	6.49	0	624	711	0.009
WI01-B-0181-H-MAD-C-006	WI01-B-0181-H-006	1	2.55	100	97	350	0.044
WI01-B-0181-H-MAD-C-006	WI01-B-0181-H-006	2	0.88	100	254	350	0.044
WI01-B-0181-H-MAD-C-006	WI01-B-0181-H-006	3	5.79	0	254	350	0.044
WI01-B-0182-H-MAD-C-000	WI01-B-0182-H-000	1	0.67	100	67	565	0.073
WI01-B-0182-H-MAD-C-000	WI01-B-0182-H-000	2	0.57	100	498	565	0.073
WI01-B-0182-H-MAD-C-000	WI01-B-0182-H-000	3	4.45	0	498	565	0.073
WI01-B-0182-H-MAD-C-001	WI01-B-0182-H-001	1	1.88	100	73	439	0.028
WI01-B-0182-H-MAD-C-001	WI01-B-0182-H-001	2	1.22	100	365	439	0.028
WI01-B-0182-H-MAD-C-001	WI01-B-0182-H-001	3	8.14	0	365	439	0.028
WI01-B-0182-H-MAD-C-002	WI01-B-0182-H-002	1	1.18	100	83	447	0.037
WI01-B-0182-H-MAD-C-002	WI01-B-0182-H-002	2	0.78	100	365	447	0.037
WI01-B-0182-H-MAD-C-002	WI01-B-0182-H-002	3	4.45	0	365	447	0.037
WI01-B-0182-H-MAD-C-003	WI01-B-0182-H-003	1	3.47	100	215	1133	0.023
WI01-B-0182-H-MAD-C-003	WI01-B-0182-H-003	2	2.27	100	918	1133	0.023
WI01-B-0182-H-MAD-C-003	WI01-B-0182-H-003	3	12.57	0	918	1133	0.023
WI01-B-0182-H-MAD-C-004	WI01-B-0182-H-004	1	3.50	100	178	1049	0.051
WI01-B-0182-H-MAD-C-004	WI01-B-0182-H-004	2	2.56	100	871	1049	0.051
WI01-B-0182-H-MAD-C-004	WI01-B-0182-H-004	3	14.60	0	871	1049	0.051
WI01-B-0182-H-MAD-C-005	WI01-B-0182-H-005	1	1.51	100	52	352	0.036
WI01-B-0182-H-MAD-C-005	WI01-B-0182-H-005	2	1.16	100	300	352	0.036
WI01-B-0182-H-MAD-C-005	WI01-B-0182-H-005	3	7.64	0	300	352	0.036
WI01-B-0182-H-MAD-C-006	WI01-B-0182-H-006	1	2.37	100	79	624	0.016

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-B-0182-H-MAD-C-006	WI01-B-0182-H-006	2	1.95	100	546	624	0.016
WI01-B-0182-H-MAD-C-006	WI01-B-0182-H-006	3	14.50	0	546	624	0.016
WI01-B-0182-H-MAD-C-007	WI01-B-0182-H-007	1	0.78	100	72	612	0.068
WI01-B-0182-H-MAD-C-007	WI01-B-0182-H-007	2	0.64	100	539	612	0.068
WI01-B-0182-H-MAD-C-007	WI01-B-0182-H-007	3	5.15	0	539	612	0.068
WI01-B-0182-H-MAD-C-009	WI01-B-0182-H-009	1	1.78	100	95	546	0.044
WI01-B-0182-H-MAD-C-009	WI01-B-0182-H-009	2	1.30	100	451	546	0.044
WI01-B-0182-H-MAD-C-009	WI01-B-0182-H-009	3	7.16	0	451	546	0.044
WI01-B-0184-H-MAD-C-000	WI01-B-0184-H-000	1	5.31	100	552	855	0.012
WI01-B-0184-H-MAD-C-000	WI01-B-0184-H-000	2	0.69	100	303	855	0.012
WI01-B-0184-H-MAD-C-000	WI01-B-0184-H-000	3	2.22	0	303	855	0.012
WI01-B-0184-H-MAD-C-001	WI01-B-0184-H-001	1	2.44	100	140	748	0.034
WI01-B-0184-H-MAD-C-001	WI01-B-0184-H-001	2	1.35	100	608	748	0.034
WI01-B-0184-H-MAD-C-001	WI01-B-0184-H-001	3	9.25	0	608	748	0.034
WI01-B-0184-H-MAD-C-002	WI01-B-0184-H-002	1	1.05	100	27	312	0.030
WI01-B-0184-H-MAD-C-002	WI01-B-0184-H-002	2	1.13	100	286	312	0.030
WI01-B-0184-H-MAD-C-002	WI01-B-0184-H-002	3	10.15	0	286	312	0.030
WI01-B-0184-H-MAD-C-003	WI01-B-0184-H-003	1	1.17	100	43	986	0.016
WI01-B-0184-H-MAD-C-003	WI01-B-0184-H-003	2	0.68	100	943	986	0.016
WI01-B-0184-H-MAD-C-003	WI01-B-0184-H-003	3	24.97	0	943	986	0.016
WI01-B-0184-H-MAD-C-004	WI01-B-0184-H-004	1	4.00	100	168	744	0.029
WI01-B-0184-H-MAD-C-004	WI01-B-0184-H-004	2	1.95	100	576	744	0.029
WI01-B-0184-H-MAD-C-004	WI01-B-0184-H-004	3	11.80	0	576	744	0.029
WI01-B-0184-H-MAD-C-005	WI01-B-0184-H-005	1	3.57	100	154	848	0.026
WI01-B-0184-H-MAD-C-005	WI01-B-0184-H-005	2	2.14	100	695	848	0.026
WI01-B-0184-H-MAD-C-005	WI01-B-0184-H-005	3	14.00	0	695	848	0.026
WI01-B-0184-H-MAD-C-006	WI01-B-0184-H-006	1	7.02	100	273	508	0.045
WI01-B-0184-H-MAD-C-006	WI01-B-0184-H-006	2	0.20	100	235	508	0.045
WI01-B-0184-H-MAD-C-006	WI01-B-0184-H-006	3	5.84	0	235	508	0.045
WI01-B-0184-H-MAD-C-007	WI01-B-0184-H-007	1	6.01	100	142	419	0.024
WI01-B-0184-H-MAD-C-007	WI01-B-0184-H-007	2	3.96	100	277	419	0.024

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI01-B-0184-H-MAD-C-007	WI01-B-0184-H-007	3	7.73	0	277	419	0.024
WI01-B-0184-H-MAD-C-010	WI01-B-0184-H-010	1	6.30	100	365	659	0.014
WI01-B-0184-H-MAD-C-010	WI01-B-0184-H-010	2	0.14	100	294	659	0.014
WI01-B-0184-H-MAD-C-010	WI01-B-0184-H-010	3	4.93	0	294	659	0.014
WI01-B-0477-H-MAD-C-000	WI01-B-0477-H-000	1	2.02	100	88	1279	0.032
WI01-B-0477-H-MAD-C-000	WI01-B-0477-H-000	2	2.12	100	1191	1279	0.032
WI01-B-0477-H-MAD-C-000	WI01-B-0477-H-000	3	25.31	0	1191	1279	0.032
WI01-B-0477-H-MAD-C-001	WI01-B-0477-H-001	1	0.34	100	25	297	0.040
WI01-B-0477-H-MAD-C-001	WI01-B-0477-H-001	2	0.32	100	271	297	0.040
WI01-B-0477-H-MAD-C-001	WI01-B-0477-H-001	3	3.26	0	271	297	0.040
WI01-B-0477-H-MAD-C-002	WI01-B-0477-H-002	1	3.86	100	124	991	0.024
WI01-B-0477-H-MAD-C-002	WI01-B-0477-H-002	2	2.87	100	867	991	0.024
WI01-B-0477-H-MAD-C-002	WI01-B-0477-H-002	3	24.11	0	867	991	0.024
WI02-C-0190-H-MAD-C-001	WI01-C-0190-H-001	1	2.05	100	87	182	0.027
WI02-C-0190-H-MAD-C-001	WI01-C-0190-H-001	2	0.47	100	95	182	0.027
WI02-C-0190-H-MAD-C-001	WI01-C-0190-H-001	3	1.78	0	95	182	0.027
WI02-A-0187-H-MAD-C-000	WI02-A-0187-H-000	1	2.02	100	119	484	0.035
WI02-A-0187-H-MAD-C-000	WI02-A-0187-H-000	2	1.22	100	365	484	0.035
WI02-A-0187-H-MAD-C-000	WI02-A-0187-H-000	3	5.00	0	365	484	0.035
WI02-A-0187-H-MAD-C-001	WI02-A-0187-H-001	1	2.72	100	128	465	0.027
WI02-A-0187-H-MAD-C-001	WI02-A-0187-H-001	2	1.39	100	337	465	0.027
WI02-A-0187-H-MAD-C-001	WI02-A-0187-H-001	3	5.77	0	337	465	0.027
WI02-A-0187-H-MAD-C-002	WI02-A-0187-H-002	1	2.47	100	124	589	0.016
WI02-A-0187-H-MAD-C-002	WI02-A-0187-H-002	2	1.75	100	465	589	0.016
WI02-A-0187-H-MAD-C-002	WI02-A-0187-H-002	3	7.49	0	465	589	0.016
WI02-A-0187-H-MAD-C-003	WI02-A-0187-H-003	1	1.92	100	140	519	0.027
WI02-A-0187-H-MAD-C-003	WI02-A-0187-H-003	2	1.04	100	379	519	0.027
WI02-A-0187-H-MAD-C-003	WI02-A-0187-H-003	3	4.16	0	379	519	0.027
WI02-A-0187-H-MAD-C-004	WI02-A-0187-H-004	1	1.88	100	104	469	0.022
WI02-A-0187-H-MAD-C-004	WI02-A-0187-H-004	2	1.30	100	365	469	0.022
WI02-A-0187-H-MAD-C-004	WI02-A-0187-H-004	3	5.31	0	365	469	0.022

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-A-0187-H-MAD-C-005	WI02-A-0187-H-005	1	2.21	100	75	426	0.030
WI02-A-0187-H-MAD-C-005	WI02-A-0187-H-005	2	1.61	100	351	426	0.030
WI02-A-0187-H-MAD-C-005	WI02-A-0187-H-005	3	8.71	0	351	426	0.030
WI02-A-0187-H-MAD-C-006	WI02-A-0187-H-006	1	3.26	100	89	443	0.016
WI02-A-0187-H-MAD-C-006	WI02-A-0187-H-006	2	2.41	100	354	443	0.016
WI02-A-0187-H-MAD-C-006	WI02-A-0187-H-006	3	10.60	0	354	443	0.016
WI02-A-0187-H-MAD-C-007	WI02-A-0187-H-007	1	2.83	100	93	517	0.031
WI02-A-0187-H-MAD-C-007	WI02-A-0187-H-007	2	1.85	100	424	517	0.031
WI02-A-0187-H-MAD-C-007	WI02-A-0187-H-007	3	11.14	0	424	517	0.031
WI02-A-0187-H-MAD-C-008	WI02-A-0187-H-008	1	6.10	100	184	821	0.019
WI02-A-0187-H-MAD-C-008	WI02-A-0187-H-008	2	3.88	100	637	821	0.019
WI02-A-0187-H-MAD-C-008	WI02-A-0187-H-008	3	17.19	0	637	821	0.019
WI02-A-0187-H-MAD-C-009	WI02-A-0187-H-009	1	2.98	100	154	363	0.020
WI02-A-0187-H-MAD-C-009	WI02-A-0187-H-009	2	0.68	100	209	363	0.020
WI02-A-0187-H-MAD-C-009	WI02-A-0187-H-009	3	3.35	0	209	363	0.020
WI02-A-0187-H-MAD-C-010	WI02-A-0187-H-010	1	2.88	100	200	744	0.020
WI02-A-0187-H-MAD-C-010	WI02-A-0187-H-010	2	1.59	100	544	744	0.020
WI02-A-0187-H-MAD-C-010	WI02-A-0187-H-010	3	6.27	0	544	744	0.020
WI02-A-0187-H-MAD-C-011	WI02-A-0187-H-011	1	1.66	100	114	456	0.019
WI02-A-0187-H-MAD-C-011	WI02-A-0187-H-011	2	0.97	100	343	456	0.019
WI02-A-0187-H-MAD-C-011	WI02-A-0187-H-011	3	4.03	0	343	456	0.019
WI02-A-0187-H-MAD-C-012	WI02-A-0187-H-012	1	1.18	100	128	538	0.025
WI02-A-0187-H-MAD-C-012	WI02-A-0187-H-012	2	0.67	100	410	538	0.025
WI02-A-0187-H-MAD-C-012	WI02-A-0187-H-012	3	3.11	0	410	538	0.025
WI02-C-0186-H-MAD-C-001	WI02-C-0186-H-001	1	0.03	100	1	561	0.016
WI02-C-0186-H-MAD-C-001	WI02-C-0186-H-001	2	0.01	100	560	561	0.016
WI02-C-0186-H-MAD-C-001	WI02-C-0186-H-001	3	20.33	0	560	561	0.016
WI02-C-0186-H-MAD-C-005	WI02-C-0186-H-005	1	1.44	100	105	376	0.023
WI02-C-0186-H-MAD-C-005	WI02-C-0186-H-005	2	0.56	100	270	376	0.023
WI02-C-0186-H-MAD-C-005	WI02-C-0186-H-005	3	3.15	0	270	376	0.023
WI02-C-0186-H-MAD-C-006	WI02-C-0186-H-006	1	0.98	100	84	486	0.016

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0186-H-MAD-C-006	WI02-C-0186-H-006	2	0.51	100	402	486	0.016
WI02-C-0186-H-MAD-C-006	WI02-C-0186-H-006	3	4.16	0	402	486	0.016
WI02-C-0188-H-MAD-C-000	WI02-C-0188-H-000	1	0.88	100	106	438	0.061
WI02-C-0188-H-MAD-C-000	WI02-C-0188-H-000	2	0.41	100	332	438	0.061
WI02-C-0188-H-MAD-C-000	WI02-C-0188-H-000	3	2.36	0	332	438	0.061
WI02-C-0188-H-MAD-C-001	WI02-C-0188-H-001	1	1.36	100	96	468	0.053
WI02-C-0188-H-MAD-C-001	WI02-C-0188-H-001	2	0.87	100	371	468	0.053
WI02-C-0188-H-MAD-C-001	WI02-C-0188-H-001	3	4.37	0	371	468	0.053
WI02-C-0188-H-MAD-C-002	WI02-C-0188-H-002	1	2.47	100	220	1036	0.078
WI02-C-0188-H-MAD-C-002	WI02-C-0188-H-002	2	1.42	100	816	1036	0.078
WI02-C-0188-H-MAD-C-002	WI02-C-0188-H-002	3	7.76	0	816	1036	0.078
WI02-C-0188-H-MAD-C-003	WI02-C-0188-H-003	1	1.27	100	136	643	0.064
WI02-C-0188-H-MAD-C-003	WI02-C-0188-H-003	2	0.71	100	508	643	0.064
WI02-C-0188-H-MAD-C-003	WI02-C-0188-H-003	3	4.04	0	508	643	0.064
WI02-C-0188-H-MAD-C-004	WI02-C-0188-H-004	1	1.55	100	90	425	0.029
WI02-C-0188-H-MAD-C-004	WI02-C-0188-H-004	2	0.89	100	336	425	0.029
WI02-C-0188-H-MAD-C-004	WI02-C-0188-H-004	3	4.92	0	336	425	0.029
WI02-C-0188-H-MAD-C-006	WI02-C-0188-H-006	1	1.76	100	85	435	0.037
WI02-C-0188-H-MAD-C-006	WI02-C-0188-H-006	2	0.91	100	350	435	0.037
WI02-C-0188-H-MAD-C-006	WI02-C-0188-H-006	3	6.35	0	350	435	0.037
WI02-C-0188-H-MAD-C-007	WI02-C-0188-H-007	1	3.81	100	172	873	0.031
WI02-C-0188-H-MAD-C-007	WI02-C-0188-H-007	2	0.60	100	701	873	0.031
WI02-C-0188-H-MAD-C-007	WI02-C-0188-H-007	3	14.97	0	701	873	0.031
WI02-C-0188-H-MAD-C-008	WI02-C-0188-H-008	1	1.13	100	67	505	0.039
WI02-C-0188-H-MAD-C-008	WI02-C-0188-H-008	2	0.96	100	438	505	0.039
WI02-C-0188-H-MAD-C-008	WI02-C-0188-H-008	3	6.40	0	438	505	0.039
WI02-C-0188-H-MAD-C-009	WI02-C-0188-H-009	1	1.37	100	57	369	0.019
WI02-C-0188-H-MAD-C-009	WI02-C-0188-H-009	2	0.87	100	312	369	0.019
WI02-C-0188-H-MAD-C-009	WI02-C-0188-H-009	3	6.63	0	312	369	0.019
WI02-C-0188-H-MAD-C-010	WI02-C-0188-H-010	1	1.56	100	102	599	0.048
WI02-C-0188-H-MAD-C-010	WI02-C-0188-H-010	2	1.04	100	497	599	0.048

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0188-H-MAD-C-010	WI02-C-0188-H-010	3	6.57	0	497	599	0.048
WI02-C-0188-H-MAD-C-011	WI02-C-0188-H-011	1	0.87	100	104	374	0.015
WI02-C-0188-H-MAD-C-011	WI02-C-0188-H-011	2	0.28	100	270	374	0.015
WI02-C-0188-H-MAD-C-011	WI02-C-0188-H-011	3	1.98	0	270	374	0.015
WI02-C-0188-H-MAD-C-012	WI02-C-0188-H-012	1	1.09	100	66	393	0.027
WI02-C-0188-H-MAD-C-012	WI02-C-0188-H-012	2	0.77	100	327	393	0.027
WI02-C-0188-H-MAD-C-012	WI02-C-0188-H-012	3	4.62	0	327	393	0.027
WI02-C-0188-H-MAD-C-013	WI02-C-0188-H-013	1	1.03	100	82	172	0.065
WI02-C-0188-H-MAD-C-013	WI02-C-0188-H-013	2	0.13	100	90	172	0.065
WI02-C-0188-H-MAD-C-013	WI02-C-0188-H-013	3	0.99	0	90	172	0.065
WI02-C-0188-H-MAD-C-014	WI02-C-0188-H-014	1	1.44	100	78	415	0.018
WI02-C-0188-H-MAD-C-014	WI02-C-0188-H-014	2	0.91	100	336	415	0.018
WI02-C-0188-H-MAD-C-014	WI02-C-0188-H-014	3	5.28	0	336	415	0.018
WI02-C-0188-H-MAD-C-015	WI02-C-0188-H-015	1	2.39	100	200	824	0.027
WI02-C-0188-H-MAD-C-015	WI02-C-0188-H-015	2	1.22	100	624	824	0.027
WI02-C-0188-H-MAD-C-015	WI02-C-0188-H-015	3	6.25	0	624	824	0.027
WI02-C-0188-H-MAD-C-016	WI02-C-0188-H-016	1	0.83	100	76	431	0.036
WI02-C-0188-H-MAD-C-016	WI02-C-0188-H-016	2	0.57	100	354	431	0.036
WI02-C-0188-H-MAD-C-016	WI02-C-0188-H-016	3	3.28	0	354	431	0.036
WI02-C-0188-H-MAD-C-017	WI02-C-0188-H-017	1	1.53	100	111	502	0.050
WI02-C-0188-H-MAD-C-017	WI02-C-0188-H-017	2	0.80	100	391	502	0.050
WI02-C-0188-H-MAD-C-017	WI02-C-0188-H-017	3	4.60	0	391	502	0.050
WI02-C-0188-H-MAD-C-019	WI02-C-0188-H-019	1	0.97	100	67	465	0.051
WI02-C-0188-H-MAD-C-019	WI02-C-0188-H-019	2	0.70	100	398	465	0.051
WI02-C-0188-H-MAD-C-019	WI02-C-0188-H-019	3	5.06	0	398	465	0.051
WI02-C-0188-H-MAD-C-020	WI02-C-0188-H-020	1	2.23	100	160	658	0.026
WI02-C-0188-H-MAD-C-020	WI02-C-0188-H-020	2	1.12	100	498	658	0.026
WI02-C-0188-H-MAD-C-020	WI02-C-0188-H-020	3	5.86	0	498	658	0.026
WI02-C-0188-H-MAD-C-021	WI02-C-0188-H-021	1	0.85	100	77	508	0.046
WI02-C-0188-H-MAD-C-021	WI02-C-0188-H-021	2	0.60	100	430	508	0.046
WI02-C-0188-H-MAD-C-021	WI02-C-0188-H-021	3	4.13	0	430	508	0.046

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0188-H-MAD-C-022	WI02-C-0188-H-022	1	2.62	100	138	411	0.027
WI02-C-0188-H-MAD-C-022	WI02-C-0188-H-022	2	0.91	100	272	411	0.027
WI02-C-0188-H-MAD-C-022	WI02-C-0188-H-022	3	4.25	0	272	411	0.027
WI02-C-0188-H-MAD-C-023	WI02-C-0188-H-023	1	2.09	100	137	761	0.039
WI02-C-0188-H-MAD-C-023	WI02-C-0188-H-023	2	1.47	100	624	761	0.039
WI02-C-0188-H-MAD-C-023	WI02-C-0188-H-023	3	8.04	0	624	761	0.039
WI02-C-0188-H-MAD-C-024	WI02-C-0188-H-024	1	0.38	100	21	181	0.038
WI02-C-0188-H-MAD-C-024	WI02-C-0188-H-024	2	0.34	100	160	181	0.038
WI02-C-0188-H-MAD-C-024	WI02-C-0188-H-024	3	2.52	0	160	181	0.038
WI02-C-0190-H-MAD-C-000	WI02-C-0190-H-000	1	1.23	100	74	427	0.030
WI02-C-0190-H-MAD-C-000	WI02-C-0190-H-000	2	0.65	100	353	427	0.030
WI02-C-0190-H-MAD-C-000	WI02-C-0190-H-000	3	5.27	0	353	427	0.030
WI02-C-0190-H-MAD-C-002	WI02-C-0190-H-002	1	0.59	100	60	260	0.076
WI02-C-0190-H-MAD-C-002	WI02-C-0190-H-002	2	0.33	100	200	260	0.076
WI02-C-0190-H-MAD-C-002	WI02-C-0190-H-002	3	1.64	0	200	260	0.076
WI02-C-0190-H-MAD-C-003	WI02-C-0190-H-003	1	1.77	100	70	307	0.058
WI02-C-0190-H-MAD-C-003	WI02-C-0190-H-003	2	1.06	100	238	307	0.058
WI02-C-0190-H-MAD-C-003	WI02-C-0190-H-003	3	4.98	0	238	307	0.058
WI02-C-0190-H-MAD-C-004	WI02-C-0190-H-004	1	0.50	100	59	284	0.079
WI02-C-0190-H-MAD-C-004	WI02-C-0190-H-004	2	0.32	100	226	284	0.079
WI02-C-0190-H-MAD-C-004	WI02-C-0190-H-004	3	1.61	0	226	284	0.079
WI02-C-0190-H-MAD-C-005	WI02-C-0190-H-005	1	0.54	100	50	206	0.034
WI02-C-0190-H-MAD-C-005	WI02-C-0190-H-005	2	0.29	100	156	206	0.034
WI02-C-0190-H-MAD-C-005	WI02-C-0190-H-005	3	1.39	0	156	206	0.034
WI02-C-0190-H-MAD-C-006	WI02-C-0190-H-006	1	1.29	100	73	334	0.039
WI02-C-0190-H-MAD-C-006	WI02-C-0190-H-006	2	0.74	100	260	334	0.039
WI02-C-0190-H-MAD-C-006	WI02-C-0190-H-006	3	3.83	0	260	334	0.039
WI02-C-0191-H-MAD-C-000	WI02-C-0191-H-000	1	1.06	100	98	452	0.057
WI02-C-0191-H-MAD-C-000	WI02-C-0191-H-000	2	0.52	100	354	452	0.057
WI02-C-0191-H-MAD-C-000	WI02-C-0191-H-000	3	3.30	0	354	452	0.057
WI02-C-0191-H-MAD-C-001	WI02-C-0191-H-001	1	0.66	100	66	554	0.021

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0191-H-MAD-C-001	WI02-C-0191-H-001	2	0.58	100	487	554	0.021
WI02-C-0191-H-MAD-C-001	WI02-C-0191-H-001	3	4.28	0	487	554	0.021
WI02-C-0191-H-MAD-C-002	WI02-C-0191-H-002	1	2.20	100	114	448	0.019
WI02-C-0191-H-MAD-C-002	WI02-C-0191-H-002	2	1.25	100	334	448	0.019
WI02-C-0191-H-MAD-C-002	WI02-C-0191-H-002	3	5.20	0	334	448	0.019
WI02-C-0324-H-MAD-C-000	WI02-C-0324-H-000	1	6.53	100	282	581	0.011
WI02-C-0324-H-MAD-C-000	WI02-C-0324-H-000	2	3.03	100	299	581	0.011
WI02-C-0324-H-MAD-C-000	WI02-C-0324-H-000	3	3.91	0	299	581	0.011
WI02-C-0324-H-MAD-C-001	WI02-C-0324-H-001	1	4.52	100	262	486	0.017
WI02-C-0324-H-MAD-C-001	WI02-C-0324-H-001	2	0.48	100	224	486	0.017
WI02-C-0324-H-MAD-C-001	WI02-C-0324-H-001	3	3.38	0	224	486	0.017
WI02-C-0324-H-MAD-C-002	WI02-C-0324-H-002	1	2.05	100	98	296	0.003
WI02-C-0324-H-MAD-C-002	WI02-C-0324-H-002	2	1.16	100	198	296	0.003
WI02-C-0324-H-MAD-C-002	WI02-C-0324-H-002	3	2.96	0	198	296	0.003
WI02-C-0324-H-MAD-C-003	WI02-C-0324-H-003	1	2.03	100	134	244	0.003
WI02-C-0324-H-MAD-C-003	WI02-C-0324-H-003	2	1.31	100	111	244	0.003
WI02-C-0324-H-MAD-C-003	WI02-C-0324-H-003	3	0.37	0	111	244	0.003
WI02-C-0324-H-MAD-C-004	WI02-C-0324-H-004	1	0.99	100	91	529	0.013
WI02-C-0324-H-MAD-C-004	WI02-C-0324-H-004	2	0.64	100	439	529	0.013
WI02-C-0324-H-MAD-C-004	WI02-C-0324-H-004	3	4.17	0	439	529	0.013
WI02-C-0324-H-MAD-C-005	WI02-C-0324-H-005	1	1.43	100	57	182	0.028
WI02-C-0324-H-MAD-C-005	WI02-C-0324-H-005	2	0.99	100	125	182	0.028
WI02-C-0324-H-MAD-C-005	WI02-C-0324-H-005	3	2.12	0	125	182	0.028
WI02-C-0324-H-MAD-C-006	WI02-C-0324-H-006	1	1.33	100	52	195	0.021
WI02-C-0324-H-MAD-C-006	WI02-C-0324-H-006	2	0.79	100	143	195	0.021
WI02-C-0324-H-MAD-C-006	WI02-C-0324-H-006	3	2.89	0	143	195	0.021
WI02-C-0324-H-MAD-C-007	WI02-C-0324-H-007	1	0.75	100	36	150	0.018
WI02-C-0324-H-MAD-C-007	WI02-C-0324-H-007	2	0.59	100	114	150	0.018
WI02-C-0324-H-MAD-C-007	WI02-C-0324-H-007	3	1.80	0	114	150	0.018
WI02-C-0324-H-MAD-C-008	WI02-C-0324-H-008	1	2.86	100	176	416	0.021
WI02-C-0324-H-MAD-C-008	WI02-C-0324-H-008	2	0.58	100	240	416	0.021

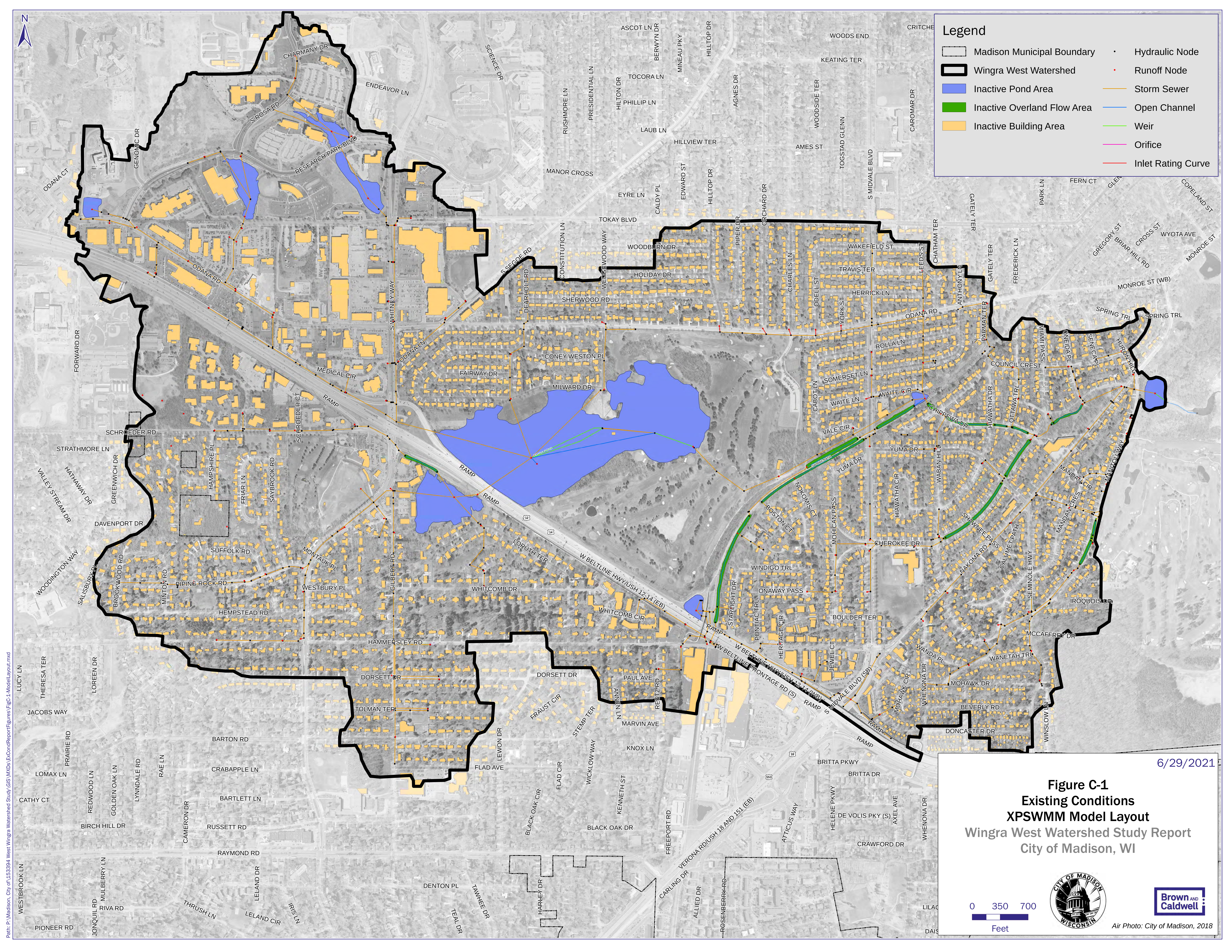
Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-C-0324-H-MAD-C-008	WI02-C-0324-H-008	3	3.33	0	240	416	0.021
WI02-C-0324-H-MAD-C-009	WI02-C-0324-H-009	1	3.24	100	157	417	0.025
WI02-C-0324-H-MAD-C-009	WI02-C-0324-H-009	2	2.02	100	260	417	0.025
WI02-C-0324-H-MAD-C-009	WI02-C-0324-H-009	3	3.36	0	260	417	0.025
WI02-C-0324-H-MAD-C-010	WI02-C-0324-H-010	1	1.71	100	111	744	0.015
WI02-C-0324-H-MAD-C-010	WI02-C-0324-H-010	2	1.40	100	633	744	0.015
WI02-C-0324-H-MAD-C-010	WI02-C-0324-H-010	3	8.37	0	633	744	0.015
WI02-C-0324-H-MAD-C-011	WI02-C-0324-H-011	1	2.51	100	164	550	0.017
WI02-C-0324-H-MAD-C-011	WI02-C-0324-H-011	2	0.90	100	386	550	0.017
WI02-C-0324-H-MAD-C-011	WI02-C-0324-H-011	3	5.00	0	386	550	0.017
WI02-C-0324-H-MAD-C-012	WI02-C-0324-H-012	1	5.62	100	500	883	0.022
WI02-C-0324-H-MAD-C-012	WI02-C-0324-H-012	2	2.02	100	382	883	0.022
WI02-C-0324-H-MAD-C-012	WI02-C-0324-H-012	3	2.27	0	382	883	0.022
WI02-D-0193-H-MAD-C-000	WI02-D-0193-H-000	1	0.63	100	33	324	0.052
WI02-D-0193-H-MAD-C-000	WI02-D-0193-H-000	2	0.54	100	291	324	0.052
WI02-D-0193-H-MAD-C-000	WI02-D-0193-H-000	3	5.10	0	291	324	0.052
WI02-D-0193-H-MAD-C-001	WI02-D-0193-H-001	1	0.61	100	60	271	0.071
WI02-D-0193-H-MAD-C-001	WI02-D-0193-H-001	2	0.25	100	211	271	0.071
WI02-D-0193-H-MAD-C-001	WI02-D-0193-H-001	3	1.88	0	211	271	0.071
WI02-D-0193-H-MAD-C-011	WI02-D-0193-H-011	1	0.92	100	46	322	0.030
WI02-D-0193-H-MAD-C-011	WI02-D-0193-H-011	2	0.71	100	276	322	0.030
WI02-D-0193-H-MAD-C-011	WI02-D-0193-H-011	3	4.84	0	276	322	0.030
WI02-D-0193-H-MAD-C-002	WI02-D-0193-H-002	1	0.94	100	106	405	0.021
WI02-D-0193-H-MAD-C-002	WI02-D-0193-H-002	2	0.48	100	299	405	0.021
WI02-D-0193-H-MAD-C-002	WI02-D-0193-H-002	3	2.16	0	299	405	0.021
WI02-D-0193-H-MAD-C-003	WI02-D-0193-H-003	1	0.61	100	77	511	0.077
WI02-D-0193-H-MAD-C-003	WI02-D-0193-H-003	2	0.43	100	434	511	0.077
WI02-D-0193-H-MAD-C-003	WI02-D-0193-H-003	3	3.01	0	434	511	0.077
WI02-D-0193-H-MAD-C-004	WI02-D-0193-H-004	1	2.04	100	90	545	0.046
WI02-D-0193-H-MAD-C-004	WI02-D-0193-H-004	2	1.19	100	455	545	0.046
WI02-D-0193-H-MAD-C-004	WI02-D-0193-H-004	3	9.13	0	455	545	0.046

Table B-2
Existing Sub-Watershed Hydrologic Parameters
Wingra West Watershed Study Report, City of Madison, WI

Sub-Watershed Name	SWMM Node Name	Subcatchment Number	Area (acres)	Percent Impervious (%)	Base Width (ft)	Calib. Width (ft)	Slope
WI02-D-0193-H-MAD-C-005	WI02-D-0193-H-005	1	1.70	100	113	600	0.069
WI02-D-0193-H-MAD-C-005	WI02-D-0193-H-005	2	1.08	100	487	600	0.069
WI02-D-0193-H-MAD-C-005	WI02-D-0193-H-005	3	6.22	0	487	600	0.069
WI02-D-0193-H-MAD-C-006	WI02-D-0193-H-006	1	1.59	100	97	686	0.059
WI02-D-0193-H-MAD-C-006	WI02-D-0193-H-006	2	1.01	100	589	686	0.059
WI02-D-0193-H-MAD-C-006	WI02-D-0193-H-006	3	8.67	0	589	686	0.059
WI02-D-0193-H-MAD-C-007	WI02-D-0193-H-007	1	1.19	100	195	1094	0.124
WI02-D-0193-H-MAD-C-007	WI02-D-0193-H-007	2	0.58	100	899	1094	0.124
WI02-D-0193-H-MAD-C-007	WI02-D-0193-H-007	3	4.90	0	899	1094	0.124
WI02-D-0193-H-MAD-C-008	WI02-D-0193-H-008	1	2.91	100	143	654	0.027
WI02-D-0193-H-MAD-C-008	WI02-D-0193-H-008	2	1.19	100	511	654	0.027
WI02-D-0193-H-MAD-C-008	WI02-D-0193-H-008	3	9.21	0	511	654	0.027
WI02-D-0193-H-MAD-C-009	WI02-D-0193-H-009	1	2.13	100	91	482	0.049
WI02-D-0193-H-MAD-C-009	WI02-D-0193-H-009	2	1.35	100	391	482	0.049
WI02-D-0193-H-MAD-C-009	WI02-D-0193-H-009	3	7.78	0	391	482	0.049
WI02-D-0193-H-MAD-C-010	WI02-D-0193-H-010	1	0.83	100	52	361	0.049
WI02-D-0193-H-MAD-C-010	WI02-D-0193-H-010	2	0.55	100	309	361	0.049
WI02-D-0193-H-MAD-C-010	WI02-D-0193-H-010	3	4.35	0	309	361	0.049
WI02-D-0193-H-MAD-C-012	WI02-D-0193-H-012	1	0.39	100	32	217	0.064
WI02-D-0193-H-MAD-C-012	WI02-D-0193-H-012	2	0.32	100	185	217	0.064
WI02-D-0193-H-MAD-C-012	WI02-D-0193-H-012	3	1.98	0	185	217	0.064
WI02-D-0193-H-MAD-C-013	WI02-D-0193-H-013	1	2.67	100	209	1009	0.041
WI02-D-0193-H-MAD-C-013	WI02-D-0193-H-013	2	1.30	100	800	1009	0.041
WI02-D-0193-H-MAD-C-013	WI02-D-0193-H-013	3	8.94	0	800	1009	0.041
WI02-D-0193-H-MAD-C-014	WI02-D-0193-H-014	1	1.66	100	103	370	0.014
WI02-D-0193-H-MAD-C-014	WI02-D-0193-H-014	2	0.60	100	267	370	0.014
WI02-D-0193-H-MAD-C-014	WI02-D-0193-H-014	3	3.71	0	267	370	0.014
Total Area			1763				

Appendix C: Hydraulic Input Parameters



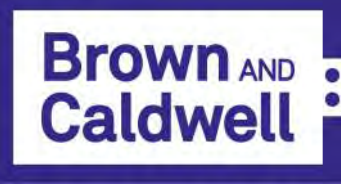
Legend

- Madison Municipal Boundary
- Wingra West Watershed
- Inactive Pond Area
- Inactive Overland Flow Area
- Inactive Building Area
- Hydraulic Node
- Runoff Node
- Storm Sewer
- Open Channel
- Weir
- Orifice
- Inlet Rating Curve

6/29/2021

Figure C-1
Existing Conditions
XPSWMM Model Layout
Wingra West Watershed Study Report
City of Madison, WI

0 350 700
Feet



Air Photo: City of Madison, 2018

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
7645-024_02_BC_JCT_106	7645-024_02_BC_JCT_106	Storm Sewer	AE7645-024_02	998.60	995.15	BC_JCT_106	997.10	994.97	55.2	0.3%	Circular	24"	0.013
7645-026_7645-027_06	7645-026_7645-027_06	Storm Sewer	AS7645-026	984.38	973.90	PD_3462-001	987.00	973.90	194.0	0.0%	Rectangular	4'x10'	0.013
7645-023_07_7645-023_08	7645-023_07_7645-023_08	Storm Sewer	IN7645-023_07	1018.00	1012.07	IN7645-023_08	1013.00	1005.57	299.6	2.2%	Circular	18"	0.013
7645-023_08_7645-023_09	7645-023_08_7645-023_09	Storm Sewer	IN7645-023_08	1013.00	1005.57	IN7645-023_09	1004.00	999.06	299.6	2.2%	Circular	18"	0.013
7645-023_09_BC_JCT_105	7645-023_09_BC_JCT_105	Storm Sewer	IN7645-023_09	1004.00	999.06	BC_JCT_105	997.30	991.93	325.8	2.2%	Circular	18"	0.013
7645-023_10_BC_JCT_106	7645-023_10_BC_JCT_106	Storm Sewer	IN7645-023_10	1003.00	1000.00	BC_JCT_106	997.10	991.97	182.4	4.4%	Circular	18"	0.013
3064-013_3164-005	3064-013_3164-005	Storm Sewer	AS3064-013	1020.00	1016.30	IN3164-005	1019.48	1016.18	20.5	0.6%	Circular	18"	0.024
3064-001_3164-026	3064-001_3164-026	Storm Sewer	AS3064-001	1023.00	1017.60	AS3164-026	1020.00	1013.50	127.9	3.2%	Circular	30"	0.013
3058-002_3059-010	3058-002_3059-010	Storm Sewer	AS3058-002	1069.00	1064.60	AS3059-010	1061.00	1056.90	332.6	2.3%	Circular	18"	0.013
3059-004_3159-016	3059-004_3159-016	Storm Sewer	AS3059-004	1053.00	1048.00	AS3159-016	1048.00	1043.00	439.7	1.1%	Circular	27"	0.013
3059-003_3059-004	3059-003_3059-004	Storm Sewer	IN3059-003	1053.00	1048.14	AS3059-004	1053.00	1048.00	33.8	0.4%	Circular	21"	0.013
3058-003_3058-002	3058-003_3058-002	Storm Sewer	IN3058-003	1072.00	1068.72	AS3058-002	1069.00	1064.60	207.5	2.0%	Circular	12"	0.013
3058-004_3058-003	3058-004_3058-003	Storm Sewer	IN3058-004	1073.00	1069.93	IN3058-003	1072.00	1068.72	154.4	0.8%	Circular	12"	0.013
3058-008_3058-009	3058-008_3058-009	Storm Sewer	IN3058-008	1067.00	1064.88	IN3058-009	1067.00	1063.35	28.1	5.4%	Circular	12"	0.013
3058-009_3058-010	3058-009_3058-010	Storm Sewer	IN3058-009	1067.00	1063.35	IN3058-010	1066.00	1062.64	21.5	3.3%	Circular	12"	0.013
3058-010_3058-011	3058-010_3058-011	Storm Sewer	IN3058-010	1066.00	1062.64	IN3058-011	1065.00	1061.23	28.4	5.0%	Circular	12"	0.013
3058-011_3059-010	3058-011_3059-010	Storm Sewer	IN3058-011	1065.00	1061.23	AS3059-010	1061.00	1056.90	119.4	3.6%	Circular	15"	0.013
3059-010_3059-004	3059-010_3059-004	Storm Sewer	AS3059-010	1061.00	1056.90	AS3059-004	1053.00	1048.00	345.4	2.6%	Circular	18"	0.013
3059-012_3059-003	3059-012_3059-003	Storm Sewer	IN3059-012	1053.00	1048.00	IN3059-003	1053.00	1048.14	35.7	-0.4%	Circular	21"	0.013
3059-013_3059-012	3059-013_3059-012	Storm Sewer	IN3059-013	1053.00	1049.07	IN3059-012	1053.00	1048.00	216.0	0.5%	Circular	21"	0.013
3059-015_BC_JCT_1	3059-015_BC_JCT_1	Storm Sewer	AS3059-015	1060.00	1048.90	BC_JCT_1	1054.00	1048.80	39.3	0.3%	Circular	21"	0.013
3059-016_3059-015	3059-016_3059-015	Storm Sewer	AS3059-016	1059.00	1049.60	AS3059-015	1060.00	1048.90	100.2	0.7%	Circular	21"	0.013
3059-019_3059-018	3059-019_3059-018	Storm Sewer	AE3059-019	1052.00	1049.70	AS3059-018	1053.00	1049.60	8.6	1.2%	Circular	21"	0.013
3064-016_3064-001	3064-016_3064-001	Storm Sewer	AS3064-016	1024.00	1020.25	AS3064-001	1023.00	1017.60	45.3	5.8%	Circular	18"	0.013
3064-018_3064-016	3064-018_3064-016	Storm Sewer	IN3064-018	1025.00	1021.27	AS3064-016	1024.00	1020.25	32.0	3.2%	Circular	18"	0.013
3064-019_3064-018	3064-019_3064-018	Storm Sewer	AS3064-019	1035.00	1031.77	IN3064-018	1025.00	1021.27	264.2	4.0%	Circular	15"	0.013
3064-020_3064-019	3064-020_3064-019	Storm Sewer	AS3064-020	1043.00	1039.10	AS3064-019	1035.00	1031.77	263.4	2.8%	Circular	15"	0.013
3256-001_3157-010	3256-001_3157-010	Storm Sewer	AS3256-001	1038.00	1033.81	AS3157-010	1036.00	1032.01	229.0	0.8%	Circular	27"	0.013
3256-004_3256-001	3256-004_3256-001	Storm Sewer	AS3256-004	1040.00	1036.33	AS3256-001	1038.00	1033.81	217.0	1.2%	Circular	21"	0.013
3256-005_3256-004	3256-005_3256-004	Storm Sewer	AS3256-005	1042.00	1037.03	AS3256-004	1040.00	1036.33	69.3	1.0%	Circular	21"	0.013
3257-007_3257-008	3257-007_3257-008	Storm Sewer	IN3257-007	1024.00	1021.19	IN3257-008	1024.00	1020.76	40.6	1.1%	Circular	18"	0.013
3257-008_3257-009	3257-008_3257-009	Storm Sewer	IN3257-008	1024.00	1020.76	IN3257-009	1024.00	1020.31	36.8	1.2%	Circular	21"	0.013
3257-009_3257-005	3257-009_3257-005	Storm Sewer	IN3257-009	1024.00	1020.31	PD_3157-013	1034.00	1020.10	58.0	0.4%	Circular	24"	0.013
3157-010_3157-009	3157-010_3157-009	Storm Sewer	AS3157-010	1036.00	1032.01	PD_3157-013	1034.00	1031.25	94.8	0.8%	Circular	27"	0.013
3158-001_3158-004	3158-001_3158-004	Storm Sewer	AS3158-001	1053.00	1049.30	AS3158-004	1043.00	1037.92	222.3	5.1%	Circular	15"	0.013
3158-004_3158-006	3158-004_3158-006	Storm Sewer	AS3158-004	1043.00	1037.92	AS3158-006	1039.00	1035.30	209.2	1.3%	Circular	21"	0.013
3158-005_3158-004	3158-005_3158-004	Storm Sewer	IN3158-005	1043.00	1038.31	AS3158-004	1043.00	1037.92	7.9	4.9%	Circular	18"	0.013
3158-006_3158-009	3158-006_3158-009	Storm Sewer	AS3158-006	1039.00	1035.30	PD_3158-015	1042.00	1034.60	107.6	0.7%	Special	24"x38"	0.013
3158-007_3158-006	3158-007_3158-006	Storm Sewer	IN3158-007	1039.00	1035.47	AS3158-006	1039.00	1035.30	8.4	2.0%	Circular	24"	0.013
3158-011_3158-012	3158-011_3158-012	Storm Sewer	IN3158-011	1038.00	1035.13	IN3158-012	1038.00	1034.94	43.5	0.4%	Circular	18"	0.013
3158-012_3158-013	3158-012_3158-013	Storm Sewer	IN3158-012	1038.00	1034.94	PD_3158-015	1042.00	1034.60	37.2	0.9%	Circular	18"	0.013
3258-002_3259-003	3258-002_3259-003	Storm Sewer	AS3258-002	1021.00	1016.88	IN3259-003	1021.00	1016.04	78.6	1.1%	Circular	24"	0.013

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3258-005_3258-002	3258-005_3258-002	Storm Sewer	IN3258-005	1024.00	1017.36	AS3258-002	1021.00	1016.88	128.4	0.4%	Circular	15"	0.013
3159-006_3159-007	3159-006_3159-007	Storm Sewer	IN3159-006	1035.00	1029.19	AS3159-007	1035.00	1029.19	52.9	0.0%	Circular	36"	0.013
3159-007_3159-008	3159-007_3159-008	Storm Sewer	AS3159-007	1035.00	1029.19	AS3159-008	1036.00	1028.63	180.1	0.3%	Special	34"x53"	0.013
3159-008_3159-011	3159-008_3159-011	Storm Sewer	AS3159-008	1036.00	1028.63	IN3159-011	1037.00	1027.55	360.4	0.3%	Circular	42"	0.013
3159-011_3159-014	3159-011_3159-014	Storm Sewer	IN3159-011	1037.00	1027.55	AS3159-014	1040.00	1026.97	195.5	0.3%	Circular	42"	0.013
3159-012_3159-013	3159-012_3159-013	Storm Sewer	IN3159-012	1037.00	1026.50	AS3159-013	1038.00	1026.38	32.4	0.4%	Circular	42"	0.013
3159-013_3160-002	3159-013_3160-002	Storm Sewer	AS3159-013	1038.00	1026.38	AS3160-002	1029.00	1022.42	556.1	0.7%	Circular	48"	0.013
3159-014_3159-012	3159-014_3159-012	Storm Sewer	AS3159-014	1040.00	1026.97	IN3159-012	1037.00	1026.50	145.7	0.3%	Circular	42"	0.013
3159-016_3159-013	3159-016_3159-013	Storm Sewer	AS3159-016	1048.00	1043.00	AS3159-013	1038.00	1026.38	699.1	2.4%	Circular	27"	0.013
3160-002_BC_JCT_21	3160-002_BC_JCT_21	Storm Sewer	AS3160-002	1029.00	1022.42	BC_JCT_21	1024.00	1015.87	399.3	1.6%	Circular	48"	0.013
3260-001_3260-002	3260-001_3260-002	Storm Sewer	IN3260-001	1015.00	1010.63	IN3260-002	1015.00	1009.59	36.5	2.9%	Circular	30"	0.013
3260-002_3360-003	3260-002_3360-003	Storm Sewer	IN3260-002	1015.00	1009.59	IN3360-003	1014.00	1009.08	18.7	2.7%	Circular	30"	0.013
3260-003_3260-001	3260-003_3260-001	Storm Sewer	AS3260-003	1016.00	1011.00	IN3260-001	1015.00	1010.63	13.0	2.8%	Circular	30"	0.013
3261-003_3361-017	3261-003_3361-017	Storm Sewer	IN3261-003	1004.00	1000.86	IN3361-017	1004.00	998.72	52.7	4.1%	Circular	18"	0.013
3261-004_BC_JCT_101	3261-004_BC_JCT_101	Storm Sewer	IN3261-004	1002.32	993.09	BC_JCT_101	1004.00	993.00	4.1	2.2%	Circular	21"	0.013
3261-008_3261-004	3261-008_3261-004	Storm Sewer	IN3261-008	1007.00	1004.20	IN3261-004	1002.32	993.09	224.3	5.0%	Circular	21"	0.013
3261-013_3261-015	3261-013_3261-015	Storm Sewer	IN3261-013	996.00	989.54	IN3261-015	996.00	989.24	11.4	2.6%	Circular	18"	0.013
3261-015_3361-013	3261-015_3361-013	Storm Sewer	IN3261-015	996.00	989.24	IN3361-013	996.20	988.76	15.3	3.1%	Circular	18"	0.013
3261-016_3261-017	3261-016_3261-017	Storm Sewer	AS3261-016	1001.00	995.70	AS3261-017	996.50	992.19	386.6	0.9%	Circular	36"	0.013
3261-017_3261-018	3261-017_3261-018	Storm Sewer	AS3261-017	996.50	992.19	AS3261-018	996.90	992.02	14.6	1.2%	Circular	36"	0.013
3261-018_3261-021	3261-018_3261-021	Storm Sewer	AS3261-018	996.90	992.02	AS3261-021	994.80	989.10	231.9	1.3%	Circular	36"	0.013
3261-021_3261-038	3261-021_3261-038	Storm Sewer	AS3261-021	994.80	989.10	AS3261-038	993.30	987.22	49.5	3.8%	Circular	36"	0.013
3261-023_3262-018	3261-023_3262-018	Storm Sewer	AS3261-023	991.50	984.10	AS3262-018	989.00	982.89	267.1	0.5%	Circular	48"	0.013
3161-003_3161-007	3161-003_3161-007	Storm Sewer	IN3161-003	1011.00	1007.60	AS3161-007	1006.00	1002.10	318.4	1.7%	Circular	21"	0.013
3161-007_3161-009	3161-007_3161-009	Storm Sewer	AS3161-007	1006.00	1002.10	IN3161-009	1005.00	1001.48	15.5	4.0%	Circular	24"	0.013
3161-008_3261-032	3161-008_3261-032	Storm Sewer	AS3161-008	1005.00	1000.67	AS3261-032	1002.00	996.23	341.7	1.3%	Circular	30"	0.013
3161-009_3161-008	3161-009_3161-008	Storm Sewer	IN3161-009	1005.00	1001.48	AS3161-008	1005.00	1000.67	6.4	12.6%	Circular	24"	0.013
3262-002_3362-045	3262-002_3362-045	Storm Sewer	AS3262-002	988.40	982.61	AS3362-045	987.10	981.97	104.6	0.6%	Circular	48"	0.013
3263-006_3263-007	3263-006_3263-007	Storm Sewer	AS3263-006	983.20	980.04	AS3263-007	983.50	979.55	196.9	0.2%	Circular	18"	0.013
3263-007_BC_JCT_10	3263-007_BC_JCT_10	Storm Sewer	AS3263-007	983.50	979.55	BC_JCT_10	983.90	979.45	66.4	0.2%	Circular	18"	0.013
3263-030_BC_JCT_23	3263-030_BC_JCT_23	Storm Sewer	IN3263-030	994.00	989.40	BC_JCT_23	993.40	988.90	53.2	0.9%	Special	95"x67"	0.013
3263-034_3263-030	3263-034_3263-030	Storm Sewer	IN3263-034	995.20	990.50	IN3263-030	994.00	989.40	118.3	0.9%	Rectangular	3.5'x7'	0.013
3163-001_BC_JCT_26	3163-001_BC_JCT_26	Storm Sewer	IN3163-001	998.60	994.60	BC_JCT_26	998.70	993.16	79.9	1.8%	Rectangular	3.5'x7'	0.013
3264-003_3264-004	3264-003_3264-004	Storm Sewer	AS3264-003	1023.00	1018.00	AS3264-004	1019.00	1015.82	60.0	3.6%	Circular	18"	0.013
3264-004_3264-005	3264-004_3264-005	Storm Sewer	AS3264-004	1019.00	1015.82	AS3264-005	1007.06	1000.31	196.2	7.9%	Circular	18"	0.013
3264-005_3264-008	3264-005_3264-008	Storm Sewer	AS3264-005	1007.06	1000.31	IN3264-008	1003.00	999.10	90.9	1.3%	Circular	18"	0.013
3264-008_3264-013	3264-008_3264-013	Storm Sewer	IN3264-008	1003.00	999.10	IN3264-013	999.40	995.00	233.9	1.8%	Rectangular	3'x7'	0.013
3264-013_BC_JCT_27	3264-013_BC_JCT_27	Storm Sewer	IN3264-013	999.40	995.00	BC_JCT_27	999.00	993.60	81.7	1.7%	Rectangular	3.5'x7'	0.013
3264-016_3263-030	3264-016_3263-030	Storm Sewer	IN3264-016	996.00	991.50	IN3263-030	994.00	989.40	149.9	1.4%	Rectangular	3.5'x7'	0.013
3264-019_3264-004	3264-019_3264-004	Storm Sewer	AS3264-019	1023.10	1016.27	AS3264-004	1019.00	1015.82	120.8	0.4%	Circular	18"	0.013
3164-005_3164-026	3164-005_3164-026	Storm Sewer	IN3164-005	1019.48	1016.18	AS3164-026	1020.00	1013.50	13.5	19.8%	Circular	18"	0.013
3164-007_BC_JCT_25	3164-007_BC_JCT_25	Storm Sewer	IN3164-007	1001.00	997.30	BC_JCT_25	1001.00	996.55	85.4	0.9%	Rectangular	3.5'x7'	0.013

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3164-008_BC_JCT_24	3164-008_BC_JCT_24	Storm Sewer	IN3164-008	1004.00	1000.30	BC_JCT_24	1003.00	999.07	83.0	1.5%	Rectangular	3.5'x7'	0.013
3164-020_3164-021	3164-020_3164-021	Storm Sewer	AS3164-020	1026.00	1022.78	AS3164-021	1029.60	1019.80	420.0	0.7%	Circular	18"	0.013
3164-021_3164-022	3164-021_3164-022	Storm Sewer	AS3164-021	1029.60	1019.80	AS3164-022	1020.53	1017.00	406.5	0.7%	Circular	18"	0.013
3164-022_3264-019	3164-022_3264-019	Storm Sewer	AS3164-022	1020.53	1017.00	AS3264-019	1023.10	1016.27	193.7	0.4%	Circular	18"	0.013
3366-004_3366-005	3366-004_3366-005	Storm Sewer	IN3366-004	1045.00	1040.00	AS3366-005	1043.00	1039.90	333.5	0.0%	Circular	12"	0.014
3366-005_3365-022	3366-005_3365-022	Storm Sewer	AS3366-005	1043.00	1039.90	AS3365-022	1042.00	1033.46	333.1	1.9%	Circular	15"	0.014
3365-001_3364-001	3365-001_3364-001	Storm Sewer	AS3365-001	1043.00	1030.40	AS3364-001	1042.00	1030.27	49.7	0.3%	Circular	36"	0.013
3365-002_3364-001	3365-002_3364-001	Storm Sewer	AS3365-002	1041.91	1032.01	AS3364-001	1042.00	1030.27	61.8	2.8%	Circular	24"	0.014
3365-002_3365-001	3365-002_3365-001	Storm Sewer	AS3365-002	1041.91	1034.21	AS3365-001	1043.00	1030.40	16.3	23.4%	Circular	24"	0.013
3365-004_3365-002	3365-004_3365-002	Storm Sewer	IN3365-004	1037.47	1033.17	AS3365-002	1041.91	1032.71	440.7	0.1%	Circular	15"	0.014
3365-005_3365-002	3365-005_3365-002	Storm Sewer	AS3365-005	1044.00	1034.15	AS3365-002	1041.91	1033.21	400.8	0.2%	Circular	21"	0.014
3365-006_3365-007	3365-006_3365-007	Storm Sewer	AS3365-006	1045.00	1031.48	AS3365-007	1045.00	1031.40	18.7	0.4%	Circular	36"	0.013
3365-007_3365-001	3365-007_3365-001	Storm Sewer	AS3365-007	1045.00	1031.40	AS3365-001	1043.00	1030.40	406.7	0.2%	Circular	36"	0.013
3365-008_BC_JCT_20	3365-008_BC_JCT_20	Storm Sewer	AS3365-008	1040.00	1035.18	BC_JCT_20	1044.00	1034.18	529.9	0.2%	Circular	15"	0.013
3365-013_3365-024	3365-013_3365-024	Storm Sewer	AS3365-013	1039.00	1034.27	AS3365-024	1042.00	1034.23	410.1	0.0%	Circular	15"	0.014
3365-014_3365-019	3365-014_3365-019	Storm Sewer	AS3365-014	1039.00	1035.37	AS3365-019	1040.00	1034.34	220.8	0.5%	Special	29"x45"	0.013
3365-019_3365-022	3365-019_3365-022	Storm Sewer	AS3365-019	1040.00	1034.34	AS3365-022	1042.00	1033.46	188.6	0.5%	Circular	36"	0.013
3365-022_3365-023	3365-022_3365-023	Storm Sewer	AS3365-022	1042.00	1033.46	AS3365-023	1042.00	1033.36	21.3	0.5%	Special	29"x45"	0.013
3365-023_3365-006	3365-023_3365-006	Storm Sewer	AS3365-023	1042.00	1033.36	AS3365-006	1045.00	1031.48	396.7	0.5%	Circular	36"	0.013
3365-024_3365-028	3365-024_3365-028	Storm Sewer	AS3365-024	1042.00	1034.23	AS3365-028	1044.00	1034.20	369.2	0.0%	Circular	18"	0.014
3364-001_3364-002	3364-001_3364-002	Storm Sewer	AS3364-001	1042.00	1030.27	AS3364-002	1032.00	1027.84	293.1	0.8%	Circular	36"	0.013
3364-002_3364-014	3364-002_3364-014	Storm Sewer	AS3364-002	1032.00	1027.84	AS3364-014	1020.00	1016.80	283.3	3.9%	Circular	24"	0.014
3364-004_BC_JCT_44	3364-004_BC_JCT_44	Storm Sewer	AS3364-004	1016.00	1011.60	BC_JCT_44	999.93	996.03	250.5	6.2%	Circular	24"	0.014
3363-001_3363-024	3363-001_3363-024	Storm Sewer	AS3363-001	984.70	979.55	AS3363-024	983.29	978.89	36.6	1.8%	Circular	24"	0.013
3363-002_3363-001	3363-002_3363-001	Storm Sewer	AS3363-002	985.12	980.72	AS3363-001	984.70	979.55	64.3	1.8%	Circular	24"	0.014
3363-003_3363-002	3363-003_3363-002	Storm Sewer	AS3363-003	991.60	985.23	AS3363-002	985.12	980.92	247.3	1.7%	Circular	24"	0.014
3363-004_3363-003	3363-004_3363-003	Storm Sewer	AS3363-004	994.00	990.00	AS3363-003	991.60	985.23	274.2	1.7%	Circular	24"	0.014
3363-005_3363-004	3363-005_3363-004	Storm Sewer	AS3363-005	997.11	991.61	AS3363-004	994.00	990.00	177.1	0.9%	Circular	24"	0.014
3362-006_3362-008	3362-006_3362-008	Storm Sewer	AS3362-006	986.80	979.96	DT3362-008	986.70	975.86	105.3	3.9%	Circular	48"	0.013
3362-012_3362-015	3362-012_3362-015	Storm Sewer	AS3362-012	982.69	977.19	PD_3362-020	990.00	975.93	314.4	0.4%	Rectangular	3'x11'	0.013
3461-006_3461-001	3461-006_3461-001	Storm Sewer	AS3461-006	983.50	980.20	AS3461-001	982.70	980.30	43.5	-0.2%	Circular	24"	0.014
3461-006_3461-020	3461-006_3461-020	Storm Sewer	AS3461-006	983.50	980.20	PD_3462-001	987.00	976.10	404.5	1.0%	Circular	24"	0.012
3461-007_3461-008	3461-007_3461-008	Storm Sewer	AS3461-007	984.20	980.60	AS3461-008	982.20	978.60	283.9	0.7%	Circular	24"	0.014
3461-008_3461-016	3461-008_3461-016	Storm Sewer	AS3461-008	982.20	978.60	PD_3462-001	987.00	974.20	449.5	1.0%	Circular	24"	0.014
3361-001_BC_JCT_48	3361-001_BC_JCT_48	Storm Sewer	AS3361-001	1002.46	997.26	BC_JCT_48	1003.00	997.05	36.0	0.6%	Circular	48"	0.013
3361-013_3361-016	3361-013_3361-016	Storm Sewer	IN3361-013	996.20	988.76	IN3361-016	995.60	987.06	48.1	3.5%	Circular	18"	0.013
3361-016_BC_JCT_16	3361-016_BC_JCT_16	Storm Sewer	IN3361-016	995.60	987.06	BC_JCT_16	995.70	986.96	218.1	0.0%	Circular	48"	0.013
3361-017_3361-006	3361-017_3361-006	Storm Sewer	IN3361-017	1004.00	998.72	IN3361-006	1003.00	997.98	18.2	4.1%	Circular	18"	0.013
3360-003_3360-001	3360-003_3360-001	Storm Sewer	IN3360-003	1014.00	1009.08	AS3360-001	1015.00	1008.60	17.9	2.7%	Circular	30"	0.013
3360-007_3360-015	3360-007_3360-015	Storm Sewer	AS3360-007	1006.00	1001.30	AS3360-015	1005.00	1000.30	429.3	0.2%	Circular	36"	0.013
3360-015_3360-016	3360-015_3360-016	Storm Sewer	AS3360-015	1005.00	1000.30	AS3360-016	1004.00	999.30	50.7	2.0%	Circular	48"	0.013
3360-016_3361-001	3360-016_3361-001	Storm Sewer	AS3360-016	1004.00	999.30	AS3361-001	1002.46	997.26	288.6	0.7%	Circular	48"	0.013

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3460-001_3460-002	3460-001_3460-002	Storm Sewer	AS3460-001	989.70	987.18	AS3460-002	990.30	987.07	60.6	0.2%	Circular	18"	0.013
3460-002_3460-003	3460-002_3460-003	Storm Sewer	AS3460-002	990.30	987.07	AS3460-003	990.10	986.60	247.0	0.2%	Circular	18"	0.013
3460-003_3460-007	3460-003_3460-007	Storm Sewer	AS3460-003	990.10	986.60	AS3460-007	989.80	986.50	56.2	0.2%	Circular	18"	0.013
3460-007_3460-008	3460-007_3460-008	Storm Sewer	AS3460-007	989.80	986.50	AS3460-008	990.00	986.10	74.3	0.5%	Circular	18"	0.014
3460-008_3460-023	3460-008_3460-023	Storm Sewer	AS3460-008	990.00	986.10	AS3460-023	988.80	982.60	210.7	1.7%	Circular	18"	0.014
3460-019_3461-001	3460-019_3461-001	Storm Sewer	AS3460-019	995.00	989.75	AS3461-001	982.70	980.30	370.1	2.6%	Circular	24"	0.014
3460-022_3461-007	3460-022_3461-007	Storm Sewer	AS3460-022	986.10	981.74	AS3461-007	984.20	980.60	296.5	0.4%	Circular	24"	0.014
3460-023_3460-022	3460-023_3460-022	Storm Sewer	AS3460-023	988.80	982.60	AS3460-022	986.10	981.74	199.7	0.4%	Circular	24"	0.014
3961-047_BC_JCT_36	3961-047_BC_JCT_36	Storm Sewer	AS3961-047	916.85	912.35	BC_JCT_36	914.60	906.24	58.9	10.4%	Circular	12"	0.013
3459-025_3460-001	3459-025_3460-001	Storm Sewer	AS3459-025	990.20	987.64	AS3460-001	989.70	987.18	243.3	0.2%	Circular	18"	0.013
3358-006_3358-008	3358-006_3358-008	Storm Sewer	IN3358-006	1020.00	1016.48	IN3358-008	1019.96	1015.96	161.3	0.3%	Circular	24"	0.013
3358-006_3358-007	3358-006_3358-007	Storm Sewer	AE3358-007	1020.00	1016.62	IN3358-006	1020.00	1016.48	24.2	0.6%	Circular	24"	0.024
3358-008_3359-005	3358-008_3359-005	Storm Sewer	IN3358-008	1019.96	1015.96	IN3359-005	1019.00	1015.33	30.0	2.1%	Circular	24"	0.013
3359-004_3359-006	3359-004_3359-006	Storm Sewer	IN3359-004	1019.00	1015.11	AS3359-006	1019.00	1014.10	63.2	1.6%	Circular	24"	0.013
3359-005_3359-004	3359-005_3359-004	Storm Sewer	IN3359-005	1019.00	1015.33	IN3359-004	1019.00	1015.11	10.2	2.2%	Circular	24"	0.013
3359-006_3359-008	3359-006_3359-008	Storm Sewer	AS3359-006	1019.00	1014.10	AS3359-008	1017.00	1011.30	460.1	0.6%	Circular	42"	0.013
3359-010_3359-008	3359-010_3359-008	Storm Sewer	IN3359-010	1017.00	1011.73	AS3359-008	1017.00	1011.30	15.6	2.8%	Circular	18"	0.013
3760-022_3860-036	3760-022_3860-036	Storm Sewer	AS3760-022	984.70	979.60	AS3860-036	981.20	976.60	162.1	1.9%	Circular	21"	0.014
3860-036_3860-037	3860-036_3860-037	Storm Sewer	AS3860-036	981.20	976.60	AS3860-037	981.60	976.15	62.4	0.7%	Circular	36"	0.014
3860-037_3760-023	3860-037_3760-023	Storm Sewer	AS3860-037	981.60	976.15	AS3760-023	978.70	973.81	250.2	0.9%	Circular	36"	0.014
3760-023_3760-024	3760-023_3760-024	Storm Sewer	AS3760-023	978.70	973.81	AS3760-024	978.85	972.55	47.6	2.6%	Circular	36"	0.014
3760-024_3760-025	3760-024_3760-025	Storm Sewer	AS3760-024	978.85	972.55	AS3760-025	972.00	965.65	280.3	2.5%	Circular	36"	0.014
3760-025_3761-055	3760-025_3761-055	Storm Sewer	AS3760-025	972.00	965.65	IN3761-056	956.80	953.00	356.1	3.6%	Circular	36"	0.013
3762-020_3763-008	3762-020_3763-008	Storm Sewer	AS3762-020	981.60	975.60	AS3763-008	973.90	968.00	493.8	1.5%	Circular	15"	0.014
3865-022_3864-028	3865-022_3864-028	Storm Sewer	AS3865-022	946.60	940.37	AS3864-028	941.80	936.10	60.5	7.1%	Circular	24"	0.013
3865-023_3865-014	3865-023_3865-014	Storm Sewer	AS3865-023	1001.55	995.70	AS3865-014	991.18	988.18	151.8	5.0%	Circular	12"	0.014
3964-003_3964-004	3964-003_3964-004	Storm Sewer	AS3964-003	915.90	911.60	IN3964-004	915.18	911.28	15.7	2.0%	Circular	24"	0.013
3964-004_3964-011	3964-004_3964-011	Storm Sewer	IN3964-004	915.18	911.18	IN3964-011	913.50	906.12	47.8	10.6%	Circular	24"	0.013
3964-006_3964-011	3964-006_3964-011	Storm Sewer	AS3964-006	926.70	920.60	IN3964-011	913.50	906.12	232.3	6.2%	Circular	30"	0.013
3963-016_BC_JCT_31	3963-016_BC_JCT_31	Storm Sewer	IN3963-016	883.00	879.75	BC_JCT_31	883.70	879.67	52.6	0.1%	Circular	18"	0.014
3259-001_3359-006	3259-001_3359-006	Storm Sewer	IN3259-001	1020.00	1014.80	AS3359-006	1019.00	1014.10	74.9	0.9%	Circular	36"	0.013
3259-002_3259-001	3259-002_3259-001	Storm Sewer	AS3259-002	1021.00	1014.98	IN3259-001	1020.00	1014.80	19.1	0.9%	Circular	36"	0.013
3259-003_3259-002	3259-003_3259-002	Storm Sewer	IN3259-003	1021.00	1016.04	AS3259-002	1021.00	1014.98	29.8	3.6%	Circular	27"	0.013
3259-007_3259-010	3259-007_3259-010	Storm Sewer	IN3259-007	1017.76	1012.96	IN3259-010	1017.00	1012.04	43.2	2.1%	Circular	18"	0.013
3259-010_3359-010	3259-010_3359-010	Storm Sewer	IN3259-010	1017.00	1012.04	IN3359-010	1017.00	1011.73	14.8	2.1%	Circular	18"	0.013
3660-005_3660-001	3660-005_3660-001	Storm Sewer	AS3660-005	991.50	987.30	AS3660-001	990.40	984.11	309.3	1.0%	Circular	24"	0.014
3660-011_3660-005	3660-011_3660-005	Storm Sewer	AS3660-011	996.50	992.10	AS3660-005	991.50	987.30	309.9	1.5%	Circular	21"	0.014
3660-015_3660-011	3660-015_3660-011	Storm Sewer	AS3660-015	1008.00	995.80	AS3660-011	996.50	992.10	298.2	1.2%	Circular	18"	0.014
3660-016_3660-015	3660-016_3660-015	Storm Sewer	AS3660-016	1010.00	1005.60	AS3660-015	1008.00	995.80	280.5	3.5%	Circular	18"	0.014
3962-034_BC_JCT_13	3962-034_BC_JCT_13	Storm Sewer	IN3962-034	893.60	889.07	BC_JCT_13	893.20	886.60	75.8	3.3%	Special	34"x53"	0.013
3962-035_3962-034	3962-035_3962-034	Storm Sewer	AE3962-035	901.10	889.17	IN3962-034	893.60	889.07	7.6	1.3%	Special	38"x60"	0.013
3560-001_3460-019	3560-001_3460-019	Storm Sewer	AS3560-001	1004.00	997.20	AS3460-019	995.00	989.75	388.8	1.9%	Circular	24"	0.014

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3560-002_3560-001	3560-002_3560-001	Storm Sewer	AS3560-002	1004.00	1000.95	AS3560-001	1004.00	997.20	71.6	5.2%	Circular	18"	0.014
3560-004_3560-001	3560-004_3560-001	Storm Sewer	AS3560-004	1001.00	997.80	AS3560-001	1004.00	997.20	370.3	0.2%	Circular	15"	0.014
3660-001_3760-009	3660-001_3760-009	Storm Sewer	AS3660-001	990.40	984.11	AS3760-009	988.90	982.50	322.0	0.5%	Circular	30"	0.014
3662-001_3762-015	3662-001_3762-015	Storm Sewer	AS3662-001	985.30	971.30	AS3762-015	978.60	969.90	553.8	0.3%	Circular	42"	0.013
3662-002_3663-006	3662-002_3663-006	Storm Sewer	AS3662-002	998.70	972.68	AS3663-006	989.15	971.75	422.8	0.2%	Circular	42"	0.013
3663-006_3662-001	3663-006_3662-001	Storm Sewer	AS3663-006	989.15	971.75	AS3662-001	985.30	971.30	468.7	0.1%	Circular	42"	0.013
3663-007_3662-008	3663-007_3662-008	Storm Sewer	AS3663-007	991.80	987.60	AE3662-008	993.70	983.14	194.0	2.3%	Circular	21"	0.014
3564-005_7645-024_02	3564-005_7645-024_02	Storm Sewer	IN3564-005	999.67	995.27	AE7645-024_02	998.60	995.15	35.7	0.3%	Circular	12"	0.013
3664-006_3664-012	3664-006_3664-012	Storm Sewer	AS3664-006	999.75	996.07	AS3664-012-1	996.67	993.10	151.2	2.0%	Circular	21"	0.013
3664-007_3664-006	3664-007_3664-006	Storm Sewer	AS3664-007	1000.15	996.17	AS3664-006	999.75	996.07	18.5	0.5%	Circular	18"	0.013
3664-011_3664-007	3664-011_3664-007	Storm Sewer	AS3664-011	1003.75	998.00	AS3664-007	1000.15	996.17	181.9	1.0%	Circular	18"	0.013
3664-023_3664-022	3664-023_3664-022	Storm Sewer	AS3664-023	997.20	993.60	BC_JCT_60	1000.50	992.60	126.2	0.8%	Circular	21"	0.013
3664-029_3664-011	3664-029_3664-011	Storm Sewer	AS3664-029	1004.23	998.85	AS3664-011	1003.75	998.00	95.6	0.9%	Circular	18"	0.013
3565-004_3565-007	3565-004_3565-007	Storm Sewer	IN3565-004	1018.00	1014.60	AS3565-007	1011.00	1007.04	295.5	2.6%	Circular	21"	0.013
3565-005_3565-004	3565-005_3565-004	Outfall/Weir	IN3565-005	1020.00	1016.69	IN3565-004	1018.00	1014.60	282.5	0.7%	Special	N/A	0.024
3565-006_3565-005	3565-006_3565-005	Outfall/Weir	IN3565-006	1020.00	1016.90	IN3565-005	1020.00	1016.69	28.6	0.7%	Special	N/A	0.024
3665-019_BC_JCT_119	3665-019_BC_JCT_119	Storm Sewer	AS3665-019	1004.00	998.01	BC_JCT_119	1002.00	996.68	212.7	0.6%	Circular	24"	0.013
3759-001_3760-022	3759-001_3760-022	Storm Sewer	AS3759-001	985.80	981.60	AS3760-022	984.70	979.60	326.0	0.6%	Circular	18"	0.014
3760-009_3760-034	3760-009_3760-034	Storm Sewer	AS3760-009	988.90	982.50	AS3760-034	986.90	979.75	389.7	0.7%	Circular	30"	0.014
3760-015_3860-037	3760-015_3860-037	Storm Sewer	AS3760-015	986.50	976.70	AS3860-037	981.60	976.15	572.5	0.1%	Circular	30"	0.014
3860-002_3860-023	3860-002_3860-023	Storm Sewer	AS3860-002	969.80	964.70	AS3860-023	960.90	956.60	464.3	1.7%	Circular	18"	0.014
3860-003_3860-002	3860-003_3860-002	Storm Sewer	AS3860-003	975.10	971.10	AS3860-002	969.80	964.70	300.3	2.1%	Circular	15"	0.014
3860-015_3760-025	3860-015_3760-025	Storm Sewer	AS3860-015	971.60	967.70	AS3760-025	972.00	965.65	131.5	1.6%	Circular	18"	0.013
3860-023_3860-040	3860-023_3860-040	Storm Sewer	AS3860-023	960.90	956.60	AE3860-040	963.49	954.58	97.1	2.1%	Circular	18"	0.013
3860-029_3860-030	3860-029_3860-030	Storm Sewer	AS3860-029	955.65	951.75	IN3860-030	955.15	947.95	139.5	2.7%	Rectangular	2.5'x3'	0.013
3860-030_3861-001	3860-030_3861-001	Storm Sewer	IN3860-030	955.15	947.95	AS3861-001	942.70	937.55	175.0	5.9%	Rectangular	2.5'x3'	0.013
3861-001_3861-002	3861-001_3861-002	Storm Sewer	AS3861-001	942.70	937.55	AS3861-002	931.55	926.70	182.4	5.9%	Rectangular	2.5'x3'	0.013
3861-002_3861-004	3861-002_3861-004	Storm Sewer	AS3861-002	931.55	926.50	AS3861-004	922.65	916.20	211.3	4.9%	Rectangular	2.5'x3'	0.013
3861-004_3861-007	3861-004_3861-007	Storm Sewer	AS3861-004	922.65	916.00	AS3861-007	917.90	909.81	237.5	2.6%	Rectangular	2.5'x3'	0.013
3861-007_3861-010	3861-007_3861-010	Storm Sewer	AS3861-007	917.90	909.81	AS3861-010	908.90	902.40	284.1	2.6%	Rectangular	2.5'x3'	0.013
3861-010_BC_JCT_12	3861-010_BC_JCT_12	Storm Sewer	AS3861-010	908.90	902.30	BC_JCT_12	903.30	897.38	87.9	5.6%	Rectangular	2.5'x3'	0.013
3861-028_BC_JCT_34	3861-028_BC_JCT_34	Storm Sewer	AS3861-028	942.20	937.10	BC_JCT_34	934.90	928.80	212.2	3.9%	Circular	30"	0.014
3761-008_3761-049	3761-008_3761-049	Storm Sewer	AS3761-008	964.40	958.53	CB3761-049	964.50	957.78	71.5	1.0%	Circular	27"	0.013
3761-018_BC_JCT_153	3761-018_BC_JCT_153	Storm Sewer	AS3761-018	957.20	951.60	WAITECIRCLE	968.23	949.69	54.7	3.5%	Circular	42"	0.013
3761-020_3761-018	3761-020_3761-018	Storm Sewer	AS3761-020	969.70	963.60	AS3761-018	957.20	951.60	391.8	3.1%	Circular	42"	0.013
3761-021_3762-001	3761-021_3762-001	Storm Sewer	AS3761-021	976.90	972.60	AS3762-001	977.70	970.60	81.4	2.5%	Circular	24"	0.013
3762-001_3761-020	3762-001_3761-020	Storm Sewer	AS3762-001	977.70	966.60	AS3761-020	969.70	963.60	494.4	0.6%	Circular	42"	0.013
3762-015_3762-001	3762-015_3762-001	Storm Sewer	AS3762-015	978.60	969.90	AS3762-001	977.70	966.60	512.0	0.6%	Circular	42"	0.013
3762-016_3763-001	3762-016_3763-001	Storm Sewer	AS3762-016	981.00	975.60	CB3763-001	971.40	966.18	433.7	2.2%	Circular	15"	0.014
3862-001_3861-028	3862-001_3861-028	Storm Sewer	AS3862-001	952.52	948.22	AS3861-028	942.20	937.10	182.5	6.1%	Circular	12"	0.014
3863-001_3863-040	3863-001_3863-040	Storm Sewer	AS3863-001	930.60	925.20	AS3863-040	926.66	920.76	186.1	2.4%	Rectangular	2.3'x3'	0.013
3863-004_3863-001	3863-004_3863-001	Storm Sewer	AS3863-004	937.50	930.60	AS3863-001	930.60	925.20	360.2	1.5%	Rectangular	2.5'x3'	0.013

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3863-005_3863-032	3863-005_3863-032	Storm Sewer	AS3863-005	951.40	943.20	AS3863-032	943.30	936.67	271.4	2.4%	Rectangular	2.5'x3'	0.013
3863-010_BC_JCT_42	3863-010_BC_JCT_42	Storm Sewer	AS3863-010	952.70	947.77	BC_JCT_42	946.10	940.99	315.6	2.1%	Circular	15"	0.014
3763-001_3763-006	3763-001_3763-006	Storm Sewer	CB3763-001	971.40	966.18	CB3763-006	968.10	962.35	98.4	3.9%	Circular	29.004"	0.013
3763-007_3762-020	3763-007_3762-020	Storm Sewer	IN3763-007	981.80	979.15	AS3762-020	981.60	975.60	45.8	7.7%	Circular	18"	0.014
3763-008_3763-016	3763-008_3763-016	Storm Sewer	AS3763-008	973.90	968.00	CB3763-016	968.20	963.78	366.9	1.2%	Circular	21"	0.014
3763-009_3763-008	3763-009_3763-008	Storm Sewer	AS3763-009	973.30	968.95	AS3763-008	973.90	968.00	141.9	0.7%	Circular	18"	0.014
3763-016_3763-006	3763-016_3763-006	Storm Sewer	CB3763-016	968.20	963.78	CB3763-006	968.10	962.35	136.4	1.0%	Special	29"x45"	0.013
3763-023_3763-006	3763-023_3763-006	Storm Sewer	CB3763-023	968.70	964.14	CB3763-006	968.10	962.35	104.4	1.7%	Special	29"x45"	0.013
3764-001_3763-023	3764-001_3763-023	Storm Sewer	AS3764-001	980.00	969.60	CB3763-023	968.70	964.14	526.2	1.0%	Circular	18"	0.014
3764-009_3864-003	3764-009_3864-003	Storm Sewer	AS3764-009	987.20	980.60	AS3864-003	980.70	976.60	115.3	3.5%	Circular	18"	0.014
3864-001_3863-005	3864-001_3863-005	Storm Sewer	AS3864-001	962.60	954.60	AS3863-005	951.40	943.20	288.0	4.0%	Rectangular	2.5'x3'	0.013
3864-003_3864-001	3864-003_3864-001	Storm Sewer	AS3864-003	980.70	976.60	AS3864-001	962.60	954.60	346.8	6.3%	Circular	18"	0.014
3864-012_3864-013	3864-012_3864-013	Storm Sewer	AS3864-012	937.70	932.90	AS3864-013	936.10	931.18	47.2	3.6%	Circular	24"	0.013
3864-013_BC_JCT_32	3864-013_BC_JCT_32	Storm Sewer	AS3864-013	936.10	931.18	BC_JCT_32	930.10	925.95	269.5	1.9%	Circular	24"	0.014
3864-016_3864-012	3864-016_3864-012	Storm Sewer	AS3864-016	946.50	942.71	AS3864-012	937.70	932.90	248.5	3.9%	Circular	24"	0.013
3864-017_3865-001	3864-017_3865-001	Storm Sewer	AS3864-017	953.00	948.60	AS3865-001	949.90	943.60	157.0	3.2%	Circular	18"	0.013
3864-025_3964-010	3864-025_3964-010	Storm Sewer	AS3864-025	930.80	925.60	IN3964-010	929.60	924.08	67.8	2.2%	Circular	24"	0.014
3864-028_3864-025	3864-028_3864-025	Storm Sewer	AS3864-028	941.80	936.10	AS3864-025	930.80	925.60	304.8	3.4%	Circular	24"	0.014
3865-001_3864-016	3865-001_3864-016	Storm Sewer	AS3865-001	949.90	943.60	AS3864-016	946.50	942.71	118.5	0.8%	Circular	24"	0.013
3865-003_3865-006	3865-003_3865-006	Storm Sewer	AS3865-003	965.55	959.10	AS3865-006	952.60	946.62	262.0	4.8%	Circular	18"	0.013
3865-006_3865-001	3865-006_3865-001	Storm Sewer	AS3865-006	952.60	946.62	AS3865-001	949.90	943.60	63.5	4.8%	Circular	18"	0.013
3865-007_3865-003	3865-007_3865-003_1	Storm Sewer	AS3865-007	973.10	969.00	AS3865-003	965.55	960.80	131.5	6.2%	N/A	N/A	N/A
3865-007_3865-003	3865-007_3865-003_2	Storm Sewer	AS3865-007	973.10	969.00	AS3865-003	965.55	959.10	141.6	7.0%	N/A	N/A	N/A
3865-008_3865-007	3865-008_3865-007	Storm Sewer	AS3865-008	981.80	974.46	AS3865-007	973.10	969.00	132.4	4.1%	Circular	24"	0.014
3865-009_3865-010	3865-009_3865-010	Storm Sewer	AS3865-009	991.77	981.37	AS3865-010	987.70	980.54	16.6	5.0%	Circular	24"	0.013
3865-010_3865-008	3865-010_3865-008	Storm Sewer	AS3865-010	987.70	980.54	AS3865-008	981.80	974.46	122.3	5.0%	Circular	24"	0.014
3865-014_3865-009	3865-014_3865-009	Storm Sewer	AS3865-014	991.18	984.88	AS3865-009	991.77	981.37	144.8	2.4%	Circular	24"	0.014
3865-016_3865-023	3865-016_3865-023	Storm Sewer	AS3865-016	1004.74	999.39	AS3865-023	1001.55	995.70	253.5	1.5%	Circular	21"	0.014
3765-003_3765-051	3765-003_3765-051	Storm Sewer	AS3765-003	1005.00	1000.40	AS3765-051	1005.65	999.80	84.7	0.7%	Circular	18"	0.013
3765-007_3766-040	3765-007_3766-040	Storm Sewer	AS3765-007	1003.00	999.28	AS3766-040	1002.17	997.96	97.7	1.4%	Circular	18"	0.013
3765-017_BC_JCT_129	3765-017_BC_JCT_129	Storm Sewer	IN3765-017	1002.70	995.58	BC_JCT_129	1003.00	994.99	154.9	0.4%	Circular	42"	0.013
3765-020_BC_JCT_123	3765-020_BC_JCT_123	Storm Sewer	AS3765-020	1004.00	994.91	BC_JCT_123	1003.00	994.75	55.2	0.3%	Circular	42"	0.013
3765-033_BC_JCT_136	3765-033_BC_JCT_136	Storm Sewer	AS3765-033	1013.00	1009.20	BC_JCT_136	1013.75	1007.07	53.7	4.0%	Circular	18"	0.014
3765-044_3765-046	3765-044_3765-046	Storm Sewer	AS3765-044	1007.00	1002.00	AS3765-046	1007.00	998.30	33.8	11.0%	Circular	18"	0.014
3765-046_3665-019	3765-046_3665-019	Storm Sewer	AS3765-046	1007.00	998.30	AS3665-019	1004.00	998.01	97.0	0.3%	Circular	21"	0.013
3961-002_3962-074	3961-002_3962-074	Storm Sewer	AS3961-002	864.60	858.10	CB3962-074	863.86	858.00	23.4	0.4%	Circular	36"	0.013
3961-006_3961-007	3961-006_3961-007	Storm Sewer	IN3961-006	862.40	858.46	IN3961-007	862.40	858.46	10.3	0.0%	Circular	24"	0.013
3961-007_3961-075	3961-007_3961-075	Storm Sewer	IN3961-007	862.40	858.46	CB3961-075	863.30	858.38	27.7	0.3%	Circular	24"	0.013
3961-009_3961-006	3961-009_3961-006	Storm Sewer	CB3961-009	862.80	858.69	IN3961-006	862.40	858.46	22.6	1.0%	Circular	24"	0.013
3961-011_3961-009	3961-011_3961-009	Storm Sewer	IN3961-011	863.00	858.78	CB3961-009	862.80	858.69	9.1	1.0%	Circular	24"	0.013
3961-012_3961-074	3961-012_3961-074	Storm Sewer	IN3961-012	862.80	858.77	AS3961-074	862.80	858.69	7.8	1.0%	Circular	24"	0.013
3961-013_3961-074	3961-013_3961-074	Storm Sewer	IN3961-013	863.00	860.20	AS3961-074	862.80	858.69	20.5	7.4%	Circular	21"	0.013

Table C-1 Existing XPSWMM™ Model Link Inputs Wingra West Watershed StudyReport, City of Madison, WI													
Link Name	Conduit Name	Type	Upstream Node Name	Upstream Rim Elevation	Upstream Invert Elevation	Downstream Node Name	Downstream Rim Elevation	Downstream Invert Elevation	Length (feet)	Slope	Pipe Shape	Size (inches)	Manning's n
3961-017_3961-075	3961-017_3961-075	Storm Sewer	IN3961-017	862.60	858.60	CB3961-075	863.30	858.38	7.7	2.9%	Circular	24"	0.013
3961-029_BC_JCT_52	3961-029_BC_JCT_52	Storm Sewer	AS3961-029	873.65	869.40	BC_JCT_52	869.80	864.20	205.9	2.5%	Rectangular	4'x6'	0.013
3961-030_3961-029	3961-030_3961-029	Storm Sewer	AS3961-030	876.38	872.08	AS3961-029	873.65	871.20	27.9	3.2%	Circular	18"	0.013
3961-031_BC_JCT_8	3961-031_BC_JCT_8	Storm Sewer	AS3961-031	927.70	923.20	BC_JCT_8	918.90	913.71	285.4	3.3%	Circular	12"	0.013
3961-043_BC_JCT_18	3961-043_BC_JCT_18	Storm Sewer	AS3961-043	894.16	887.41	BC_JCT_18	893.74	884.89	57.7	4.4%	Circular	24"	0.013
3962-003_3962-005	3962-003_3962-005	Storm Sewer	AS3962-003	872.20	863.94	AS3962-005	870.70	862.91	103.6	1.0%	Circular	60"	0.014
3962-005_BC_JCT_5	3962-005_BC_JCT_5	Storm Sewer	AS3962-005	870.70	862.91	BC_JCT_5	869.50	862.81	112.2	0.1%	Circular	60"	0.014
3962-014_3962-058	3962-014_3962-058	Storm Sewer	AS3962-014	919.20	913.95	AS3962-058	918.60	912.88	16.4	6.5%	Circular	18"	0.013
3962-014_3962-066	3962-014_3962-066	Storm Sewer	AS3962-014	919.20	913.95	AS3962-066	919.90	913.50	32.2	1.4%	Circular	30"	0.013
3963-001_3963-006	3963-001_3963-006	Storm Sewer	AS3963-001	877.90	873.97	IN3963-006	875.90	872.60	21.6	6.3%	Circular	24"	0.013
3963-002_3963-003	3963-002_3963-003	Storm Sewer	AS3963-002	875.40	871.10	AS3963-003	875.60	867.57	70.2	5.0%	Circular	21"	0.013
3963-003_3962-003	3963-003_3962-003	Storm Sewer	AS3963-003	875.60	867.57	AS3962-003	872.20	863.94	250.6	1.4%	Circular	60"	0.014
3963-004_3963-003	3963-004_3963-003	Storm Sewer	AS3963-004	876.60	867.65	AS3963-003	875.60	867.57	71.3	0.1%	Circular	60"	0.014
3963-006_3963-004	3963-006_3963-004	Storm Sewer	IN3963-006	875.90	872.60	AS3963-004	876.60	867.65	71.3	6.9%	Circular	24"	0.013
3963-007_3963-001	3963-007_3963-001	Storm Sewer	IN3963-007	876.00	871.00	AS3963-001	877.90	873.97	4.7	-62.8%	Circular	24"	0.013
3963-009_3963-001	3963-009_3963-001	Storm Sewer	AS3963-009	877.00	874.06	AS3963-001	877.90	873.97	115.5	0.1%	Circular	24"	0.014
3965-001_3865-022	3965-001_3865-022	Storm Sewer	AS3965-001	951.60	944.19	AS3865-022	946.60	940.37	53.3	7.2%	Circular	18"	0.014
3965-006_3965-001	3965-006_3965-001	Storm Sewer	AS3965-006	962.10	956.80	AS3965-001	951.60	944.19	176.0	7.2%	Circular	18"	0.014
3965-009_3965-006	3965-009_3965-006	Storm Sewer	IN3965-009	977.10	972.42	AS3965-006	962.10	956.80	216.9	7.2%	Circular	18"	0.013
3965-010_3965-009	3965-010_3965-009	Storm Sewer	IN3965-010	978.50	975.69	IN3965-009	977.10	972.42	45.4	7.2%	Circular	18"	0.013
3965-011_3965-010	3965-011_3965-010	Storm Sewer	IN3965-011	981.06	977.36	IN3965-010	978.50	975.69	22.7	7.3%	Circular	18"	0.013
3160-010_3160-009	3160-010_3160-009	Storm Sewer	IN3160-010	1032.00	1025.44	AS3160-009	1032.00	1025.34	8.3	1.2%	Circular	24"	0.013
3160-011_3160-010	3160-011_3160-010	Storm Sewer	IN3160-011	1032.00	1025.45	IN3160-010	1032.00	1025.44	8.8	0.1%	Circular	18"	0.013
3160-012_3160-010	3160-012_3160-010	Storm Sewer	AE3160-012	1032.00	1029.10	IN3160-010	1032.00	1025.44	18.3	20.0%	Circular	18"	0.013
3160-013_3160-011	3160-013_3160-011	Storm Sewer	AE3160-013	1032.00	1029.10	IN3160-011	1032.00	1025.45	18.0	20.3%	Circular	18"	0.013
3160-014_3160-009	3160-014_3160-009	Storm Sewer	AS3160-014	1033.00	1027.60	AS3160-009	1032.00	1025.34	200.0	1.1%	Circular	24"	0.013
3160-015_3160-014	3160-015_3160-014	Storm Sewer	AS3160-015	1044.00	1035.60	AS3160-014	1033.00	1027.60	295.0	2.7%	Circular	24"	0.013
3261-027_BC_JCT_96	3261-027_BC_JCT_96	Storm Sewer	AS3261-027	1016.00	1006.87	BC_JCT_96	1014.00	1005.50	61.4	2.2%	Circular	48"	0.013
3962-045_BC_JCT_5	3962-045_BC_JCT_5	Storm Sewer	IN3962-045	869.10	863.91	BC_JCT_5	869.50	862.81	58.1	1.9%	Circular	24"	0.013
3962-047_3962-045	3962-047_3962-045	Storm Sewer	IN3962-047	870.70	866.40	IN3962-045	869.10	863.91	120.6	2.1%	Circular	24"	0.013
3962-048_3962-047	3962-048_3962-047	Storm Sewer	IN3962-048	872.50	868.01	IN3962-047	870.70	866.40	80.4	2.0%	Circular	18"	0.013
3962-050_3962-048	3962-050_3962-048	Storm Sewer	IN3962-050	874.00	868.01	IN3962-048	872.50	868.01	89.4	0.0%	Circular	18"	0.013
3962-053_3963-009	3962-053_3963-009	Storm Sewer	AS3962-053	879.00	874.15	AS3963-009	877.00	874.06	106.8	0.1%	Circular	24"	0.014

Table C-2
Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AE3059-019	Conveyance	Sealed	1049.70	1052.00
AE3160-012	Conveyance	Link Spill Crest to 2D	1029.10	1032.00
AE3160-013	Conveyance	Link Spill Crest to 2D	1029.10	1032.00
AE3358-007	Conveyance	Link Spill Crest to 2D	1016.62	1020.00
AE3564-044	Conveyance	None	990.97	1000.97
AE3662-005	Runoff	Link Spill Crest to 2D	972.50	984.10
AE3662-008	Conveyance	Link Spill Crest to 2D	983.14	993.70
AE3663-017	Conveyance	Link Spill Crest to 2D	979.19	990.40
AE3761-029	Conveyance	Link Spill Crest to 2D	965.10	975.10
AE3762-023	Conveyance	Link Spill Crest to 2D	968.71	979.90
AE3762-035	Conveyance	Link Spill Crest to 2D	971.12	981.12
AE3860-040	Conveyance	Link Invert to 2D	953.49	963.49
AE3863-050	Conveyance	Link Spill Crest to 2D	938.80	949.20
AE3962-035	Conveyance	Link Spill Crest to 2D	889.17	901.10
AE3963-031	Conveyance	Link Spill Crest to 2D	887.98	899.30
AE7645-024_02	Conveyance	Link Spill Crest to 2D	995.15	998.60
AS3058-002	Conveyance	Sealed	1064.60	1069.00
AS3059-004	Conveyance	Link Spill Crest to 2D	1048.00	1053.00
AS3059-010	Conveyance	Sealed	1056.90	1061.00
AS3059-015	Conveyance	Link Spill Crest to 2D	1048.90	1060.00
AS3059-016	Conveyance	Sealed	1049.60	1059.00
AS3059-018	Conveyance	Link Spill Crest to 2D	1049.60	1053.00
AS3064-001	Conveyance	Link Spill Crest to 2D	1017.60	1023.00
AS3064-013	Conveyance	Link Spill Crest to 2D	1016.30	1020.00
AS3064-016	Conveyance	Sealed	1020.25	1024.00
AS3064-019	Conveyance	Link Spill Crest to 2D	1031.77	1035.00
AS3064-020	Conveyance	Link Spill Crest to 2D	1039.10	1043.00
AS3157-010	Conveyance	Link Spill Crest to 2D	1032.01	1036.00
AS3158-001	Conveyance	Link Spill Crest to 2D	1049.30	1053.00
AS3158-004	Conveyance	Link Spill Crest to 2D	1037.92	1043.00
AS3158-006	Conveyance	Link Spill Crest to 2D	1035.30	1039.00
AS3159-007	Conveyance	Sealed	1029.19	1035.00
AS3159-008	Conveyance	Link Spill Crest to 2D	1028.63	1036.00
AS3159-013	Conveyance	Sealed	1026.38	1038.00
AS3159-014	Conveyance	Link Spill Crest to 2D	1026.97	1040.00
AS3159-016	Conveyance	Sealed	1043.00	1048.00
AS3160-002	Conveyance	Sealed	1022.42	1029.00
AS3160-007	Conveyance	Link Spill Crest to 2D	1015.60	1023.00
AS3160-008	Conveyance	Link Spill Crest to 2D	1017.10	1024.00
AS3160-009	Conveyance	Link Spill Crest to 2D	1025.34	1032.00
AS3160-014	Conveyance	Link Spill Crest to 2D	1027.60	1033.00
AS3160-015	Conveyance	Sealed	1035.60	1044.00
AS3161-007	Conveyance	Link Spill Crest to 2D	1002.10	1006.00
AS3161-008	Conveyance	Sealed	1000.67	1005.00
AS3161-010	Conveyance	Link Spill Crest to 2D	1007.66	1012.00
AS3161-011	Conveyance	Link Spill Crest to 2D	1008.52	1012.00
AS3161-012	Conveyance	Link Spill Crest to 2D	1013.11	1017.00
AS3161-013	Conveyance	Sealed	1020.95	1024.00
AS3161-014	Conveyance	Sealed	1012.42	1017.00
AS3164-020	Conveyance	Sealed	1022.78	1026.00

Table C-2
Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AS3164-021	Conveyance	Link Spill Crest to 2D	1019.80	1029.60
AS3164-022	Conveyance	Sealed	1017.00	1020.53
AS3164-026	Conveyance	Link Spill Crest to 2D	1013.50	1020.00
AS3164-027	Conveyance	Sealed	1010.55	1016.00
AS3164-028	Conveyance	Link Spill Crest to 2D	1004.50	1011.00
AS3256-001	Conveyance	Sealed	1033.81	1038.00
AS3256-004	Conveyance	Link Spill Crest to 2D	1036.33	1040.00
AS3256-005	Conveyance	Sealed	1037.03	1042.00
AS3258-002	Conveyance	Link Spill Crest to 2D	1016.88	1021.00
AS3259-002	Conveyance	Link Spill Crest to 2D	1014.98	1021.00
AS3260-003	Conveyance	Link Spill Crest to 2D	1011.00	1016.00
AS3261-016	Conveyance	Link Spill Crest to 2D	995.70	1001.00
AS3261-017	Conveyance	Link Spill Crest to 2D	992.19	996.50
AS3261-018	Conveyance	Link Spill Crest to 2D	992.02	996.90
AS3261-021	Conveyance	Link Spill Crest to 2D	989.10	994.80
AS3261-023	Conveyance	Link Spill Crest to 2D	984.10	991.50
AS3261-027	Conveyance	Link Spill Crest to 2D	1006.87	1016.00
AS3261-032	Conveyance	Sealed	996.23	1002.00
AS3261-038	Conveyance	Sealed	987.22	993.30
AS3262-002	Conveyance	Link Spill Crest to 2D	982.61	988.40
AS3262-018	Conveyance	Link Spill Crest to 2D	982.89	989.00
AS3263-006	Conveyance	Sealed	980.04	983.20
AS3263-007	Conveyance	Link Spill Crest to 2D	979.55	983.50
AS3264-003	Conveyance	Sealed	1018.00	1023.00
AS3264-004	Conveyance	Link Spill Crest to 2D	1015.82	1019.00
AS3264-005	Conveyance	Link Spill Crest to 2D	1000.31	1007.06
AS3264-019	Conveyance	Link Spill Crest to 2D	1015.60	1023.10
AS3359-006	Conveyance	Sealed	1014.10	1019.00
AS3359-008	Conveyance	Sealed	1011.30	1017.00
AS3360-001	Conveyance	Link Spill Crest to 2D	1008.60	1015.00
AS3360-004	Conveyance	Sealed	1004.30	1013.00
AS3360-007	Conveyance	Link Spill Crest to 2D	1001.30	1006.00
AS3360-015	Conveyance	Link Spill Crest to 2D	1000.30	1005.00
AS3360-016	Conveyance	Link Spill Crest to 2D	999.30	1004.00
AS3360-019	Conveyance	Sealed	1001.48	1006.18
AS3360-020	Conveyance	Link Spill Crest to 2D	1003.85	1008.00
AS3360-021	Conveyance	Link Spill Crest to 2D	1007.39	1012.00
AS3361-001	Conveyance	Sealed	997.26	1002.46
AS3361-002	Conveyance	Link Spill Crest to 2D	997.25	1004.00
AS3362-006	Conveyance	Link Spill Crest to 2D	979.96	986.80
AS3362-012	Conveyance	Sealed	977.19	982.69
AS3362-045	Conveyance	Link Spill Crest to 2D	981.97	987.10
AS3362-059	Conveyance	Link Spill Crest to 2D	977.39	982.70
AS3363-001	Conveyance	Sealed	979.55	984.70
AS3363-002	Conveyance	Link Spill Crest to 2D	980.72	985.12
AS3363-003	Conveyance	Link Spill Crest to 2D	985.23	991.60
AS3363-004	Conveyance	Link Spill Crest to 2D	990.00	994.00
AS3363-005	Conveyance	Sealed	991.61	997.11
AS3363-024	Conveyance	Sealed	978.89	983.29
AS3363-031	Conveyance	Sealed	979.06	984.30

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AS3363-032	Conveyance	Link Spill Crest to 2D	977.66	982.40
AS3364-001	Conveyance	Link Spill Crest to 2D	1030.27	1042.00
AS3364-002	Conveyance	Link Spill Crest to 2D	1027.84	1032.00
AS3364-004	Conveyance	Link Spill Crest to 2D	1011.60	1016.00
AS3364-007	Conveyance	Link Spill Crest to 2D	992.17	997.50
AS3364-008	Conveyance	Sealed	998.19	1003.00
AS3364-014	Conveyance	Link Spill Crest to 2D	1016.80	1020.00
AS3364-016	Conveyance	Link Spill Crest to 2D	1014.00	1019.00
AS3365-001	Conveyance	Link Spill Crest to 2D	1030.40	1043.00
AS3365-002	Conveyance	Link Spill Crest to 2D	1032.01	1041.91
AS3365-005	Conveyance	Sealed	1034.15	1044.00
AS3365-006	Conveyance	Link Spill Crest to 2D	1031.48	1045.00
AS3365-007	Conveyance	Sealed	1031.40	1045.00
AS3365-008	Conveyance	Link Spill Crest to 2D	1035.18	1040.00
AS3365-013	Conveyance	Sealed	1034.27	1039.00
AS3365-014	Conveyance	Sealed	1035.37	1039.00
AS3365-019	Conveyance	Link Spill Crest to 2D	1034.34	1040.00
AS3365-022	Conveyance	Sealed	1033.46	1042.00
AS3365-023	Conveyance	Sealed	1033.36	1042.00
AS3365-024	Conveyance	Sealed	1034.23	1042.00
AS3365-028	Conveyance	Link Spill Crest to 2D	1034.20	1044.00
AS3366-005	Conveyance	Sealed	1039.90	1043.00
AS3459-025	Conveyance	Sealed	987.64	990.20
AS3460-001	Conveyance	Link Spill Crest to 2D	987.18	989.70
AS3460-002	Conveyance	Sealed	987.07	990.30
AS3460-003	Conveyance	Link Spill Crest to 2D	986.60	990.10
AS3460-007	Conveyance	Link Spill Crest to 2D	986.50	989.80
AS3460-008	Conveyance	Link Spill Crest to 2D	986.10	990.00
AS3460-019	Conveyance	Link Spill Crest to 2D	989.75	995.00
AS3460-022	Conveyance	Sealed	981.74	986.10
AS3460-023	Conveyance	Link Spill Crest to 2D	982.60	988.80
AS3461-001	Conveyance	Sealed	980.30	982.70
AS3461-006	Conveyance	Sealed	980.20	983.50
AS3461-007	Conveyance	Link Spill Crest to 2D	980.60	984.20
AS3461-008	Conveyance	Sealed	978.60	982.20
AS3560-001	Conveyance	Link Spill Crest to 2D	997.20	1004.00
AS3560-002	Conveyance	Sealed	1000.95	1004.00
AS3560-004	Conveyance	Link Spill Crest to 2D	997.80	1001.00
AS3564-031	Conveyance	None	991.17	1000.00
AS3564-033	Conveyance	Link Spill Crest to 2D	991.37	998.00
AS3564-034	Conveyance	Link Spill Crest to 2D	991.47	997.80
AS3564-038	Conveyance	Link Spill Crest to 2D	991.12	997.50
AS3564-039	Conveyance	Link Spill Crest to 2D	991.05	995.10
AS3564-041	Conveyance	None	990.75	1002.00
AS3564-042	Conveyance	None	990.95	1000.95
AS3565-007	Conveyance	Sealed	1007.04	1011.00
AS3660-001	Conveyance	Link Spill Crest to 2D	984.11	990.40
AS3660-005	Conveyance	Link Spill Crest to 2D	987.30	991.50
AS3660-011	Conveyance	Link Spill Crest to 2D	992.10	996.50
AS3660-015	Conveyance	Link Spill Crest to 2D	995.80	1008.00

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AS3660-016	Conveyance	Link Spill Crest to 2D	1005.60	1010.00
AS3662-001	Conveyance	Sealed	971.30	985.30
AS3662-002	Conveyance	Link Spill Crest to 2D	972.68	998.70
AS3663-006	Conveyance	Link Spill Crest to 2D	971.75	989.15
AS3663-007	Conveyance	Link Spill Crest to 2D	987.60	991.80
AS3663-015	Conveyance	Link Spill Crest to 2D	985.60	994.60
AS3664-006	Conveyance	Sealed	996.07	999.75
AS3664-007	Conveyance	Sealed	996.17	1000.15
AS3664-011	Conveyance	None	998.00	1003.75
AS3664-012-1	Conveyance	None	992.71	996.67
AS3664-023	Conveyance	Sealed	993.60	997.20
AS3664-029	Conveyance	None	998.85	1004.23
AS3664-044	Conveyance	Sealed	991.16	997.80
AS3664-045	Conveyance	Link Spill Crest to 2D	991.16	998.00
AS3664-047	Conveyance	Link Spill Crest to 2D	991.15	998.00
AS3664-049	Conveyance	Link Spill Crest to 2D	990.53	995.90
AS3665-019	Conveyance	Link Spill Crest to 2D	998.01	1004.00
AS3665-058	Conveyance	Link Spill Crest to 2D	991.62	998.50
AS3759-001	Conveyance	Sealed	981.60	985.80
AS3759-007	Conveyance	Sealed	991.50	996.60
AS3759-012	Conveyance	Link Spill Crest to 2D	997.50	1002.00
AS3759-017	Conveyance	Link Spill Crest to 2D	1002.50	1007.00
AS3760-009	Conveyance	Link Spill Crest to 2D	982.50	988.90
AS3760-015	Conveyance	Link Spill Crest to 2D	976.70	986.50
AS3760-022	Conveyance	Link Spill Crest to 2D	979.60	984.70
AS3760-023	Conveyance	Link Spill Crest to 2D	973.81	978.70
AS3760-024	Conveyance	Link Spill Crest to 2D	972.12	978.85
AS3760-025	Conveyance	Sealed	965.65	972.00
AS3760-034	Conveyance	Link Spill Crest to 2D	979.75	986.90
AS3760-035	Conveyance	Link Spill Crest to 2D	981.03	986.90
AS3761-008	Conveyance	Link Spill Crest to 2D	958.53	964.40
AS3761-018	Conveyance	Link Spill Crest to 2D	951.60	957.20
AS3761-020	Conveyance	Link Spill Crest to 2D	963.60	969.70
AS3761-021	Conveyance	Sealed	972.60	976.90
AS3761-030	Conveyance	Link Spill Crest to 2D	965.40	971.60
AS3761-031	Conveyance	Link Spill Crest to 2D	966.93	971.30
AS3761-032	Conveyance	Link Spill Crest to 2D	967.04	971.70
AS3761-050	Conveyance	Link Spill Crest to 2D	956.94	963.00
AS3761-051	Conveyance	Sealed	954.50	959.00
AS3761-054	Conveyance	Link Spill Crest to 2D	953.64	958.50
AS3761-059	Conveyance	Sealed	963.63	968.30
AS3761-062	Conveyance	Link Spill Crest to 2D	965.43	970.30
AS3762-001	Conveyance	Link Spill Crest to 2D	966.60	977.70
AS3762-015	Conveyance	Link Spill Crest to 2D	969.90	978.60
AS3762-016	Conveyance	Link Spill Crest to 2D	975.60	981.00
AS3762-020	Conveyance	Link Spill Crest to 2D	975.60	981.60
AS3762-024	Conveyance	Link Spill Crest to 2D	968.32	974.00
AS3762-026	Conveyance	Link Spill Crest to 2D	968.73	972.70
AS3763-008	Conveyance	Link Spill Crest to 2D	968.00	973.90
AS3763-009	Conveyance	Sealed	968.95	973.30

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AS3763-041	Conveyance	Link Spill Crest to 2D	970.35	974.50
AS3764-001	Conveyance	Sealed	969.60	980.00
AS3764-009	Conveyance	Sealed	980.60	987.20
AS3764-024	Conveyance	Sealed	972.51	977.40
AS3765-003	Conveyance	Link Spill Crest to 2D	1000.40	1005.00
AS3765-007	Conveyance	Sealed	999.28	1003.00
AS3765-020	Conveyance	Link Spill Crest to 2D	994.91	1004.00
AS3765-033	Conveyance	Link Spill Crest to 2D	1009.20	1013.00
AS3765-044	Conveyance	Link Spill Crest to 2D	1002.00	1007.00
AS3765-046	Conveyance	Link Spill Crest to 2D	998.30	1007.00
AS3765-051	Conveyance	Link Spill Crest to 2D	999.80	1005.65
AS3766-040	Conveyance	Link Spill Crest to 2D	997.96	1002.17
AS3860-002	Conveyance	Sealed	964.70	969.80
AS3860-003	Conveyance	Link Spill Crest to 2D	971.10	975.10
AS3860-015	Conveyance	Link Spill Crest to 2D	967.70	971.60
AS3860-023	Conveyance	Sealed	956.60	960.90
AS3860-029	Conveyance	Link Spill Crest to 2D	951.75	955.65
AS3860-036	Conveyance	Sealed	976.60	981.20
AS3860-037	Conveyance	Link Spill Crest to 2D	976.15	981.60
AS3861-001	Conveyance	Link Spill Crest to 2D	937.55	942.70
AS3861-002	Conveyance	Sealed	926.50	931.55
AS3861-004	Conveyance	Link Spill Crest to 2D	916.00	922.65
AS3861-007	Conveyance	Sealed	909.81	917.90
AS3861-010	Conveyance	Link Spill Crest to 2D	902.30	908.90
AS3861-028	Conveyance	Sealed	937.10	942.20
AS3862-001	Conveyance	Sealed	948.22	952.52
AS3862-003	Conveyance	Link Spill Crest to 2D	908.67	912.80
AS3862-027	Conveyance	Sealed	948.30	952.00
AS3862-036	Conveyance	Link Spill Crest to 2D	907.74	912.20
AS3863-001	Conveyance	Sealed	925.20	930.60
AS3863-004	Conveyance	Link Spill Crest to 2D	930.60	937.50
AS3863-005	Conveyance	Link Spill Crest to 2D	943.20	951.40
AS3863-010	Conveyance	Link Spill Crest to 2D	947.77	952.70
AS3863-032	Conveyance	Link Spill Crest to 2D	936.67	943.30
AS3863-040	Conveyance	Link Spill Crest to 2D	920.76	926.66
AS3863-049	Conveyance	Link Spill Crest to 2D	938.87	944.80
AS3863-051	Conveyance	Sealed	940.75	945.60
AS3864-001	Conveyance	Sealed	954.60	962.60
AS3864-003	Conveyance	Link Spill Crest to 2D	976.60	980.70
AS3864-012	Conveyance	Sealed	932.90	937.70
AS3864-013	Conveyance	Link Spill Crest to 2D	931.18	936.10
AS3864-016	Conveyance	Link Spill Crest to 2D	942.71	946.50
AS3864-017	Conveyance	Sealed	948.60	953.00
AS3864-025	Conveyance	Link Spill Crest to 2D	925.60	930.80
AS3864-028	Conveyance	Link Spill Crest to 2D	936.10	941.80
AS3864-029	Conveyance	Link Spill Crest to 2D	924.90	929.80
AS3865-001	Conveyance	Link Spill Crest to 2D	943.60	949.90
AS3865-003	Conveyance	Sealed	959.10	965.55
AS3865-006	Conveyance	Link Spill Crest to 2D	946.62	952.60
AS3865-007	Conveyance	Link Spill Crest to 2D	969.00	973.10

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
AS3865-008	Conveyance	Link Spill Crest to 2D	974.46	981.80
AS3865-009	Conveyance	Link Spill Crest to 2D	981.37	991.77
AS3865-010	Conveyance	Link Spill Crest to 2D	980.54	987.70
AS3865-014	Conveyance	Link Spill Crest to 2D	984.88	991.18
AS3865-016	Conveyance	Link Spill Crest to 2D	999.39	1004.74
AS3865-022	Conveyance	Sealed	940.37	946.60
AS3865-023	Conveyance	Sealed	995.70	1001.55
AS3960-019	Conveyance	Link Spill Crest to 2D	889.92	894.10
AS3960-032	Conveyance	Link Spill Crest to 2D	905.88	911.50
AS3961-002	Conveyance	Link Spill Crest to 2D	858.10	864.60
AS3961-029	Conveyance	Link Spill Crest to 2D	869.40	873.65
AS3961-030	Conveyance	Link Spill Crest to 2D	872.08	876.38
AS3961-031	Conveyance	Link Spill Crest to 2D	923.20	927.70
AS3961-043	Conveyance	Sealed	887.41	894.16
AS3961-047	Conveyance	Link Spill Crest to 2D	912.35	916.85
AS3961-050	Conveyance	Link Spill Crest to 2D	886.06	893.40
AS3961-054	Conveyance	Link Spill Crest to 2D	872.60	878.20
AS3961-055	Conveyance	Sealed	893.14	898.50
AS3961-074	Conveyance	Link Spill Crest to 2D	858.69	862.80
AS3962-003	Conveyance	Link Spill Crest to 2D	863.94	872.20
AS3962-005	Conveyance	Sealed	862.91	870.70
AS3962-014	Conveyance	Link Spill Crest to 2D	913.95	919.20
AS3962-053	Conveyance	Link Spill Crest to 2D	874.15	879.00
AS3962-054	Conveyance	Sealed	876.11	881.10
AS3962-055	Conveyance	Link Spill Crest to 2D	878.49	883.30
AS3962-056	Conveyance	Link Spill Crest to 2D	891.66	896.40
AS3962-058	Conveyance	Link Spill Crest to 2D	912.88	918.60
AS3962-063	Conveyance	Link Spill Crest to 2D	915.74	921.88
AS3962-066	Conveyance	Link Spill Crest to 2D	913.50	919.90
AS3962-068	Conveyance	Link Spill Crest to 2D	908.37	915.30
AS3962-071	Conveyance	Link Spill Crest to 2D	903.12	909.30
AS3963-001	Conveyance	Link Spill Crest to 2D	873.97	877.90
AS3963-002	Conveyance	Link Spill Crest to 2D	871.10	875.40
AS3963-003	Conveyance	Link Spill Crest to 2D	867.57	875.60
AS3963-004	Conveyance	Link Spill Crest to 2D	867.65	876.60
AS3963-009	Conveyance	Link Spill Crest to 2D	874.06	877.00
AS3963-030	Conveyance	Link Spill Crest to 2D	888.15	892.30
AS3964-003	Conveyance	Link Spill Crest to 2D	911.60	915.90
AS3964-006	Conveyance	Link Spill Crest to 2D	920.60	926.70
AS3964-007	Conveyance	Sealed	923.60	929.80
AS3964-008	Conveyance	Sealed	923.68	929.80
AS3964-009	Conveyance	Sealed	928.30	932.70
AS3965-001	Conveyance	Link Spill Crest to 2D	944.19	951.60
AS3965-006	Conveyance	Link Spill Crest to 2D	956.80	962.10
AS7645-026	Runoff	Link Spill Crest to 2D	973.58	984.38
BC_JCT_1	Conveyance	Link Spill Crest to 2D	1048.80	1054.00
BC_JCT_10	Conveyance	Link Spill Crest to 2D	979.45	983.90
BC_JCT_100	Conveyance	Link Spill Crest to 2D	993.73	1003.00
BC_JCT_101	Conveyance	Sealed	992.97	1004.00
BC_JCT_102	Conveyance	Sealed	992.88	1003.00

Table C-2
Existing XPSWMM™ Model Node Inputs
Wingra West Watershed Study Report, City of Madison, WI

Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
BC_JCT_104	Conveyance	Link Spill Crest to 2D	991.73	997.70
BC_JCT_105	Conveyance	Link Spill Crest to 2D	991.93	997.30
BC_JCT_106	Conveyance	Sealed	991.97	997.10
BC_JCT_108	Conveyance	Sealed	991.32	998.70
BC_JCT_11	Conveyance	Sealed	977.05	983.10
BC_JCT_113	Conveyance	Link Spill Crest to 2D	991.42	997.80
BC_JCT_114	Conveyance	Link Spill Crest to 2D	991.55	998.00
BC_JCT_115	Conveyance	Link Spill Crest to 2D	991.90	998.60
BC_JCT_116	Conveyance	Link Spill Crest to 2D	992.32	999.90
BC_JCT_117	Conveyance	Link Spill Crest to 2D	992.58	1003.00
BC_JCT_118	Conveyance	Link Spill Crest to 2D	993.30	1002.00
BC_JCT_119	Conveyance	Link Spill Crest to 2D	993.53	1002.00
BC_JCT_12	Conveyance	Link Spill Crest to 2D	897.34	903.30
BC_JCT_120	Conveyance	Link Spill Crest to 2D	993.63	1003.00
BC_JCT_121	Conveyance	Link Spill Crest to 2D	993.73	1005.00
BC_JCT_122	Conveyance	Link Spill Crest to 2D	994.51	1005.00
BC_JCT_123	Conveyance	Link Spill Crest to 2D	994.75	1003.00
BC_JCT_124	Conveyance	Link Spill Crest to 2D	997.00	1003.00
BC_JCT_125	Conveyance	Link Spill Crest to 2D	995.96	1006.00
BC_JCT_126	Conveyance	Link Spill Crest to 2D	996.01	1007.00
BC_JCT_127	Conveyance	Link Spill Crest to 2D	1000.00	1010.00
BC_JCT_129	Conveyance	Link Spill Crest to 2D	994.99	1003.00
BC_JCT_13	Conveyance	Sealed	886.60	893.20
BC_JCT_131	Conveyance	Link Spill Crest to 2D	995.94	1007.00
BC_JCT_132	Conveyance	Link Spill Crest to 2D	996.80	1006.00
BC_JCT_133	Conveyance	Link Spill Crest to 2D	997.33	1009.00
BC_JCT_134	Conveyance	Link Spill Crest to 2D	998.16	1008.00
BC_JCT_135	Conveyance	Link Spill Crest to 2D	998.60	1006.00
BC_JCT_136	Conveyance	Link Spill Crest to 2D	1002.75	1013.75
BC_JCT_138	Conveyance	Link Spill Crest to 2D	997.66	1003.98
BC_JCT_139	Conveyance	Link Spill Crest to 2D	991.16	997.93
BC_JCT_140	Conveyance	Link Spill Crest to 2D	928.36	938.80
BC_JCT_142	Conveyance	Link Spill Crest to 2D	908.46	918.30
BC_JCT_143	Conveyance	Link Spill Crest to 2D	905.19	915.19
BC_JCT_145	Conveyance	Link Spill Crest to 2D	899.66	911.66
BC_JCT_147	Conveyance	Link Spill Crest to 2D	896.48	906.48
BC_JCT_148	Conveyance	Link Spill Crest to 2D	888.84	899.20
BC_JCT_149	Conveyance	Link Spill Crest to 2D	975.32	985.32
BC_JCT_154	Runoff	Link Spill Crest to 2D	984.54	994.54
BC_JCT_16	Conveyance	Link Spill Crest to 2D	986.96	995.70
BC_JCT_163	Conveyance	Link Spill Crest to 2D	881.63	892.40
BC_JCT_166	Conveyance	Link Spill Crest to 2D	979.07	985.30
BC_JCT_167	Runoff	Link Spill Crest to 2D	926.47	934.95
BC_JCT_168	Conveyance	Link Spill Crest to 2D	925.91	935.91
BC_JCT_169	Conveyance	None	992.51	997.45
BC_JCT_17	Conveyance	Link Spill Crest to 2D	866.66	874.00
BC_JCT_18	Conveyance	Link Spill Crest to 2D	884.89	893.74
BC_JCT_20	Conveyance	Link Spill Crest to 2D	1034.18	1044.00
BC_JCT_21	Conveyance	Link Spill Crest to 2D	1015.87	1024.00
BC_JCT_22	Conveyance	Link Spill Crest to 2D	990.97	995.90

Table C-2
Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
BC_JCT_23	Conveyance	Link Spill Crest to 2D	988.90	993.40
BC_JCT_24	Conveyance	Link Spill Crest to 2D	999.07	1003.00
BC_JCT_25	Conveyance	Sealed	996.55	1001.00
BC_JCT_26	Conveyance	Link Spill Crest to 2D	993.16	998.70
BC_JCT_27	Conveyance	Link Spill Crest to 2D	993.60	999.00
BC_JCT_28	Conveyance	Sealed	984.43	988.20
BC_JCT_29	Conveyance	Link Spill Crest to 2D	985.16	990.00
BC_JCT_3	Conveyance	Link Spill Crest to 2D	866.70	871.70
BC_JCT_31	Conveyance	Link Spill Crest to 2D	879.67	883.70
BC_JCT_32	Conveyance	Link Spill Crest to 2D	925.95	930.10
BC_JCT_34	Conveyance	Link Spill Crest to 2D	928.80	934.90
BC_JCT_36	Conveyance	Link Spill Crest to 2D	906.24	914.60
BC_JCT_37	Conveyance	Link Spill Crest to 2D	885.03	900.90
BC_JCT_38	Conveyance	Link Spill Crest to 2D	885.03	900.00
BC_JCT_39	Conveyance	Link Spill Crest to 2D	894.40	907.20
BC_JCT_4	Conveyance	Link Spill Crest to 2D	873.90	878.90
BC_JCT_40	Conveyance	Link Spill Crest to 2D	895.45	907.80
BC_JCT_41	Conveyance	Link Spill Crest to 2D	904.90	913.80
BC_JCT_42	Conveyance	Link Spill Crest to 2D	940.99	946.10
BC_JCT_43	Conveyance	Sealed	885.03	889.80
BC_JCT_44	Conveyance	Link Spill Crest to 2D	996.03	999.93
BC_JCT_46	Conveyance	Link Spill Crest to 2D	892.77	898.70
BC_JCT_47	Conveyance	Link Spill Crest to 2D	890.03	896.00
BC_JCT_48	Conveyance	Link Spill Crest to 2D	997.05	1003.00
BC_JCT_49	Conveyance	Link Spill Crest to 2D	989.87	998.60
BC_JCT_5	Conveyance	Link Spill Crest to 2D	862.81	869.50
BC_JCT_50	Conveyance	Link Spill Crest to 2D	881.42	893.00
BC_JCT_51	Conveyance	Link Spill Crest to 2D	866.14	873.70
BC_JCT_52	Conveyance	Link Spill Crest to 2D	864.20	869.80
BC_JCT_53	Conveyance	None	856.00	864.40
BC_JCT_56	Conveyance	Link Spill Crest to 2D	930.19	934.10
BC_JCT_57	Conveyance	Sealed	931.76	935.10
BC_JCT_58	Conveyance	Link Spill Crest to 2D	931.83	935.30
BC_JCT_60	Conveyance	Link Spill Crest to 2D	990.50	1000.50
BC_JCT_61	Conveyance	None	990.97	1000.97
BC_JCT_62	Conveyance	Sealed	991.71	996.30
BC_JCT_63	Conveyance	Link Spill Crest to 2D	941.98	946.30
BC_JCT_64	Conveyance	Link Spill Crest to 2D	943.17	946.50
BC_JCT_65	Conveyance	Link Spill Crest to 2D	874.89	887.80
BC_JCT_66	Conveyance	Sealed	886.23	891.30
BC_JCT_67	Conveyance	Link Spill Crest to 2D	957.40	964.70
BC_JCT_68	Conveyance	Link Spill Crest to 2D	946.30	953.70
BC_JCT_69	Conveyance	Link Spill Crest to 2D	940.06	947.80
BC_JCT_7	Conveyance	Link Spill Crest to 2D	872.47	877.91
BC_JCT_70	Conveyance	Link Spill Crest to 2D	939.18	945.80
BC_JCT_71	Conveyance	Sealed	948.30	953.90
BC_JCT_72	Conveyance	Link Spill Crest to 2D	949.83	953.50
BC_JCT_73	Conveyance	Link Spill Crest to 2D	954.00	958.40
BC_JCT_74	Conveyance	Link Spill Crest to 2D	958.04	962.60
BC_JCT_75	Conveyance	Sealed	959.68	963.50

Table C-2
Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
BC_JCT_76	Conveyance	Link Spill Crest to 2D	946.84	951.50
BC_JCT_77	Conveyance	Sealed	943.68	951.10
BC_JCT_8	Conveyance	Sealed	913.71	918.90
BC_JCT_82	Conveyance	Sealed	991.39	997.00
BC_JCT_82.1	Conveyance	Sealed	991.35	995.00
BC_JCT_83	Conveyance	Link Spill Crest to 2D	993.40	998.40
BC_JCT_84	Conveyance	Link Spill Crest to 2D	993.80	998.80
BC_JCT_86	Conveyance	Link Spill Crest to 2D	991.06	1002.20
BC_JCT_9	Conveyance	Sealed	986.71	992.70
BC_JCT_96	Conveyance	Link Spill Crest to 2D	1005.50	1014.00
BC_JCT_97	Conveyance	Link Spill Crest to 2D	999.00	1006.00
BC_JCT_98	Conveyance	Link Spill Crest to 2D	994.53	1004.00
BC_JCT_99	Conveyance	Link Spill Crest to 2D	994.35	1003.00
CB3760-036	Conveyance	Link Spill Crest to 2D	981.22	987.00
CB3761-049	Conveyance	Link Spill Crest to 2D	957.78	964.50
CB3761-055	Conveyance	Link Spill Crest to 2D	953.00	958.00
CB3761-058	Conveyance	Sealed	959.00	965.50
CB3762-034	Conveyance	Link Spill Crest to 2D	967.29	972.30
CB3762-039	Conveyance	Sealed	970.06	975.20
CB3763-001	Conveyance	Sealed	966.18	971.40
CB3763-006	Conveyance	Link Spill Crest to 2D	962.35	968.10
CB3763-016	Conveyance	Sealed	963.78	968.20
CB3763-023	Conveyance	Sealed	964.14	968.70
CB3961-009	Conveyance	Link Spill Crest to 2D	858.69	862.80
CB3961-075	Conveyance	Sealed	858.38	863.30
CB3961-076	Conveyance	Sealed	858.15	864.10
CB3962-074	Conveyance	Link Spill Crest to 2D	858.00	863.86
CB3962-075	Conveyance	Link Spill Crest to 2D	861.62	868.30
Depression_1	Runoff	Link Invert to 2D	1036.90	1036.90
Depression_2	Runoff	Link Invert to 2D	1031.00	1031.00
Depression_3	Runoff	Link Invert to 2D	1019.00	1019.00
Depression_4	Runoff	Link Invert to 2D	1032.70	1032.70
Depression_5	Runoff	Link Invert to 2D	1013.50	1013.50
DT3362-008	Conveyance	Link Spill Crest to 2D	975.86	986.70
DT3662-003	Runoff	Link Spill Crest to 2D	980.50	990.97
DT3761-028	Conveyance	Link Spill Crest to 2D	956.00	968.50
DT3761-069	Conveyance	Link Invert to 2D	959.10	969.10
DT3761-070	Conveyance	Link Invert to 2D	956.33	966.33
DT3860-038	Conveyance	Link Invert to 2D	957.00	967.00
DT3860-039	Conveyance	Link Invert to 2D	956.39	966.39
DT3861-045	Conveyance	Link Spill Crest to 2D	941.52	951.52
DT3862-017	Conveyance	Link Spill Crest to 2D	906.58	917.70
DT3862-018	Conveyance	Link Spill Crest to 2D	909.77	920.70
DT3961-049	Runoff	Link Spill Crest to 2D	872.72	886.20
Dum_Inl_1	Conveyance	None	968.08	970.10
DUM_INL_11	Conveyance	Link Spill Crest to 2D	980.11	982.80
DUM_INL_12	Conveyance	Link Spill Crest to 2D	971.75	974.84
DUM_INL_14	Conveyance	Link Spill Crest to 2D	991.63	995.89
DUM_INL_15	Conveyance	Link Spill Crest to 2D	991.49	998.50
Dum_Inl_2	Conveyance	Link Spill Crest to 2D	967.99	970.10

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
Dum_Inl_3	Conveyance	Link Spill Crest to 2D	977.14	981.14
DUM_INL_8	Runoff	Sealed	979.62	980.80
GR3963-019	Conveyance	Link Spill Crest to 2D	879.90	889.90
GR3963-020	Conveyance	Link Spill Crest to 2D	879.40	889.40
GR3963-021	Conveyance	Link Spill Crest to 2D	874.86	882.20
HD3861-013	Conveyance	Link Spill Crest to 2D	933.00	945.80
IN3058-003	Conveyance	Link Spill Crest to 2D	1068.72	1072.00
IN3058-004	Conveyance	Link Spill Crest to 2D	1069.93	1073.00
IN3058-008	Conveyance	Link Spill Crest to 2D	1064.88	1067.00
IN3058-009	Conveyance	Link Spill Crest to 2D	1063.35	1067.00
IN3058-010	Conveyance	Link Spill Crest to 2D	1062.64	1066.00
IN3058-011	Conveyance	Link Spill Crest to 2D	1061.23	1065.00
IN3059-003	Conveyance	Link Spill Crest to 2D	1048.14	1053.00
IN3059-012	Conveyance	Link Spill Crest to 2D	1048.00	1053.00
IN3059-013	Conveyance	Link Spill Crest to 2D	1049.07	1053.00
IN3064-018	Conveyance	Link Spill Crest to 2D	1021.27	1025.00
IN3158-005	Conveyance	Sealed	1038.31	1043.00
IN3158-007	Conveyance	Link Spill Crest to 2D	1035.47	1039.00
IN3158-011	Conveyance	Link Spill Crest to 2D	1035.13	1038.00
IN3158-012	Conveyance	Sealed	1034.94	1038.00
IN3159-006	Conveyance	Link Spill Crest to 2D	1029.19	1035.00
IN3159-011	Conveyance	Link Spill Crest to 2D	1027.55	1037.00
IN3159-012	Conveyance	Sealed	1026.50	1037.00
IN3160-010	Conveyance	Link Spill Crest to 2D	1025.44	1032.00
IN3160-011	Conveyance	Link Spill Crest to 2D	1025.45	1032.00
IN3161-003	Conveyance	Link Spill Crest to 2D	1007.60	1011.00
IN3161-009	Conveyance	Sealed	1001.48	1005.00
IN3163-001	Conveyance	Link Spill Crest to 2D	994.60	998.60
IN3164-005	Conveyance	Link Spill Crest to 2D	1016.18	1019.48
IN3164-007	Conveyance	Link Spill Crest to 2D	997.30	1001.00
IN3164-008	Conveyance	Sealed	1000.30	1004.00
IN3257-007	Conveyance	Link Spill Crest to 2D	1021.19	1024.00
IN3257-008	Conveyance	Sealed	1020.76	1024.00
IN3257-009	Conveyance	Link Spill Crest to 2D	1020.31	1024.00
IN3258-005	Conveyance	None	1017.36	1024.00
IN3259-001	Conveyance	Link Spill Crest to 2D	1014.80	1020.00
IN3259-003	Conveyance	Link Spill Crest to 2D	1016.04	1021.00
IN3259-007	Conveyance	Link Spill Crest to 2D	1012.96	1017.76
IN3259-010	Conveyance	Link Spill Crest to 2D	1012.04	1017.00
IN3260-001	Conveyance	Sealed	1010.63	1015.00
IN3260-002	Conveyance	Link Spill Crest to 2D	1009.59	1015.00
IN3261-003	Conveyance	Sealed	1000.86	1004.00
IN3261-004	Conveyance	Sealed	993.09	1002.32
IN3261-008	Conveyance	Sealed	1004.20	1007.00
IN3261-013	Conveyance	Link Spill Crest to 2D	989.54	996.00
IN3261-015	Conveyance	Link Spill Crest to 2D	989.24	996.00
IN3261-033	Conveyance	Link Spill Crest to 2D	999.07	1002.00
IN3261-041	Conveyance	Link Spill Crest to 2D	989.95	997.40
IN3261-044	Conveyance	Sealed	991.24	995.60
IN3263-030	Conveyance	Link Spill Crest to 2D	989.40	994.00

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Existing XPSWMM™ Model Node Inputs
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Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
IN3263-034	Conveyance	Sealed	990.50	995.20
IN3264-008	Conveyance	Link Spill Crest to 2D	999.10	1003.00
IN3264-013	Conveyance	Sealed	995.00	999.40
IN3264-016	Conveyance	Link Spill Crest to 2D	991.50	996.00
IN3358-006	Conveyance	Sealed	1016.48	1020.00
IN3358-008	Conveyance	Link Spill Crest to 2D	1015.96	1019.96
IN3359-004	Conveyance	Link Spill Crest to 2D	1015.11	1019.00
IN3359-005	Conveyance	Link Spill Crest to 2D	1015.33	1019.00
IN3359-010	Conveyance	Sealed	1011.73	1017.00
IN3360-003	Conveyance	Link Spill Crest to 2D	1009.08	1014.00
IN3360-022	Conveyance	Sealed	1007.62	1012.00
IN3361-006	Conveyance	Link Spill Crest to 2D	997.98	1003.00
IN3361-013	Conveyance	Link Spill Crest to 2D	988.76	996.20
IN3361-016	Conveyance	Link Spill Crest to 2D	987.06	995.60
IN3361-017	Conveyance	Link Spill Crest to 2D	998.72	1004.00
IN3365-004	Conveyance	Sealed	1033.17	1037.47
IN3365-029	Conveyance	Sealed	1036.98	1039.00
IN3366-004	Conveyance	Link Spill Crest to 2D	1040.00	1045.00
IN3564-005	Conveyance	Sealed	995.27	999.67
IN3564-024	Conveyance	Link Spill Crest to 2D	1013.42	1020.00
IN3564-025	Conveyance	Sealed	1018.30	1022.00
IN3564-027	Conveyance	Link Spill Crest to 2D	1005.92	1009.37
IN3565-004	Conveyance	Link Spill Crest to 2D	1014.60	1018.00
IN3565-005	Conveyance	Sealed	1016.69	1020.00
IN3565-006	Conveyance	Link Spill Crest to 2D	1016.90	1020.00
IN3663-012	Conveyance	Link Spill Crest to 2D	991.85	995.80
IN3663-013	Conveyance	Link Spill Crest to 2D	991.53	996.60
IN3663-014	Conveyance	Link Spill Crest to 2D	990.89	994.90
IN3663-018	Conveyance	Link Spill Crest to 2D	980.38	984.98
IN3664-036	Conveyance	Sealed	982.51	987.40
IN3759-018	Conveyance	Link Spill Crest to 2D	1004.92	1009.00
IN3760-026	Conveyance	Sealed	974.75	979.80
IN3761-056	Conveyance	Link Spill Crest to 2D	953.00	956.80
IN3763-007	Conveyance	Sealed	979.15	981.80
IN3764-023	Conveyance	Link Spill Crest to 2D	974.04	979.20
IN3765-017	Conveyance	Sealed	995.58	1002.70
IN3860-030	Conveyance	Link Spill Crest to 2D	947.95	955.15
IN3864-034	Conveyance	Sealed	928.65	932.40
IN3864-040	Conveyance	Link Spill Crest to 2D	958.76	962.10
IN3960-020	Conveyance	Sealed	890.82	893.10
IN3960-022	Conveyance	Sealed	893.75	896.30
IN3960-031	Conveyance	Link Spill Crest to 2D	905.09	907.30
IN3961-006	Conveyance	Link Spill Crest to 2D	858.46	862.40
IN3961-007	Conveyance	Sealed	858.46	862.40
IN3961-011	Conveyance	Link Spill Crest to 2D	858.78	863.00
IN3961-012	Conveyance	Link Spill Crest to 2D	858.77	862.80
IN3961-013	Conveyance	Sealed	860.20	863.00
IN3961-017	Conveyance	Sealed	858.60	862.60
IN3961-058	Conveyance	Link Spill Crest to 2D	874.60	877.70
IN3961-059	Conveyance	Link Spill Crest to 2D	874.60	877.90

Table C-2
Existing XPSWMM™ Model Node Inputs
Wingra West Watershed Study Report, City of Madison, WI

Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
IN3961-065	Conveyance	Sealed	867.48	873.23
IN3961-068	Conveyance	Sealed	870.00	873.70
IN3962-034	Conveyance	Sealed	889.07	893.60
IN3962-038	Conveyance	Link Spill Crest to 2D	871.76	874.90
IN3962-039	Conveyance	Link Spill Crest to 2D	872.46	875.20
IN3962-040	Conveyance	Sealed	872.65	876.70
IN3962-045	Conveyance	Link Spill Crest to 2D	863.91	869.10
IN3962-047	Conveyance	Link Spill Crest to 2D	866.40	870.70
IN3962-048	Conveyance	Link Spill Crest to 2D	868.01	872.50
IN3962-050	Conveyance	Link Spill Crest to 2D	868.01	874.00
IN3962-059	Conveyance	Link Spill Crest to 2D	879.60	883.30
IN3963-006	Conveyance	Link Spill Crest to 2D	872.60	875.90
IN3963-007	Conveyance	Link Spill Crest to 2D	871.00	876.00
IN3963-016	Conveyance	Sealed	879.75	883.00
IN3963-028	Conveyance	Sealed	888.30	894.60
IN3964-004	Conveyance	Link Spill Crest to 2D	911.18	915.18
IN3964-010	Conveyance	Link Spill Crest to 2D	924.08	929.60
IN3964-011	Conveyance	Link Spill Crest to 2D	906.12	913.50
IN3965-009	Conveyance	Sealed	972.42	977.10
IN3965-010	Conveyance	Link Spill Crest to 2D	975.69	978.50
IN3965-011	Conveyance	Link Spill Crest to 2D	977.36	981.06
IN4060-014	Conveyance	Link Spill Crest to 2D	891.77	893.80
IN4060-015	Conveyance	Link Spill Crest to 2D	892.00	894.00
IN4060-016	Conveyance	Link Spill Crest to 2D	892.59	894.60
IN4060-017	Conveyance	Link Spill Crest to 2D	894.15	896.30
IN7645-023_07	Conveyance	Link Spill Crest to 2D	1012.07	1018.00
IN7645-023_08	Conveyance	Link Spill Crest to 2D	1005.57	1013.00
IN7645-023_09	Conveyance	Sealed	999.06	1004.00
IN7645-023_10	Conveyance	Link Spill Crest to 2D	1000.00	1003.00
Node639	Conveyance	Link Invert to 2D	1066.00	1076.00
Node640	Conveyance	Link Invert to 2D	1066.00	1076.00
Node812	Conveyance	None	1030.38	1034.60
OdanaNorth	Runoff	None	985.00	995.00
OFALL_10	Conveyance	None	855.44	861.30
PD_3157-013	Pond	Link Spill Crest to 2D	1019.45	1034.00
PD_3158-015	Pond	Link Spill Crest to 2D	1031.65	1042.00
PD_3258-008	Pond	Link Spill Crest to 2D	1017.40	1029.00
PD_3362-020	Pond	Link Spill Crest to 2D	972.00	990.00
PD_3462-001	Pond	Link Spill Crest to 2D	971.00	987.00
PD_3462-002	Pond	Link Spill Crest to 2D	970.00	987.00
PD_3564-028	Pond	Link Spill Crest to 2D	985.00	1003.00
PD_4061-006	Pond	Link Spill Crest to 2D	851.00	867.50
PD_ILLUMINA	Pond	None	1062.00	1077.00
PD3158-014	Runoff	Link Spill Crest to 2D	1031.60	1035.00
PD3562-001	Conveyance	None	973.58	984.00
SS3363-030	Conveyance	Link Spill Crest to 2D	982.00	991.00
SS3862-037	Conveyance	Link Spill Crest to 2D	908.77	915.00
STOR_12	Pond	Link Spill Crest to 2D	973.68	984.00
WAITECIRCLE	Pond	Link Spill Crest to 2D	943.23	968.23
WI01-A-0179-H-001	Runoff	Link Invert to 2D	982.24	982.24

Table C-2
Existing XPSWMM™ Model Node Inputs
Wingra West Watershed Study Report, City of Madison, WI

Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
WI01-A-0179-H-002	Runoff	Link Invert to 2D	984.91	984.91
WI01-A-0179-H-003	Runoff	Link Invert to 2D	981.19	981.19
WI01-A-0179-H-004	Runoff	Link Invert to 2D	1003.80	1003.80
WI01-A-0179-H-005	Runoff	Link Invert to 2D	989.64	989.64
WI01-A-0179-H-006	Runoff	Link Invert to 2D	989.48	989.48
WI01-A-0180-H-000	Runoff	Link Invert to 2D	1002.02	1002.02
WI01-A-0180-H-001	Runoff	Link Invert to 2D	1011.45	1011.45
WI01-A-0180-H-002	Runoff	Link Invert to 2D	1005.80	1005.80
WI01-A-0183-H-000	Runoff	Link Invert to 2D	1042.58	1042.58
WI01-A-0183-H-001	Runoff	Link Invert to 2D	1028.47	1028.47
WI01-A-0183-H-002	Runoff	Link Invert to 2D	1034.44	1034.44
WI01-A-0183-H-003	Runoff	Link Invert to 2D	1029.13	1028.25
WI01-A-0183-H-004	Runoff	Link Invert to 2D	1029.27	1028.80
WI01-A-0183-H-005	Runoff	Link Invert to 2D	1024.72	1018.46
WI01-A-0183-H-006	Runoff	Link Invert to 2D	1037.19	1037.19
WI01-A-0183-H-007	Runoff	Link Invert to 2D	1037.16	1037.16
WI01-A-0183-H-008	Runoff	Link Invert to 2D	1047.34	1047.34
WI01-A-0183-H-010	Runoff	Link Invert to 2D	1037.84	1037.84
WI01-A-0183-H-011	Runoff	Link Invert to 2D	1042.63	1042.63
WI01-A-0183-H-012	Runoff	Link Invert to 2D	1057.77	1057.77
WI01-A-0183-H-013	Runoff	Link Invert to 2D	1060.38	1060.38
WI01-A-0183-H-014	Runoff	Link Invert to 2D	1068.09	1068.09
WI01-A-0183-H-016	Runoff	Link Invert to 2D	1050.34	1050.34
WI01-A-0185-H-000	Runoff	Link Invert to 2D	1033.93	1033.93
WI01-A-0185-H-001	Runoff	Link Invert to 2D	1023.67	1023.67
WI01-A-0185-H-003	Runoff	Link Invert to 2D	1041.29	1041.29
WI01-A-0185-H-004	Runoff	Link Invert to 2D	1038.02	1038.02
WI01-A-0187-H-000	Runoff	Link Invert to 2D	995.48	995.48
WI01-A-0187-H-001	Runoff	Link Invert to 2D	1012.82	1012.82
WI01-A-0187-H-003	Runoff	Link Invert to 2D	1004.16	1004.16
WI01-A-0187-H-004	Runoff	Link Invert to 2D	1014.79	1014.79
WI01-A-0187-H-005	Runoff	Link Invert to 2D	1016.67	1016.67
WI01-A-0187-H-006	Runoff	Link Invert to 2D	1018.64	1018.64
WI01-A-0187-H-007	Runoff	Link Invert to 2D	1020.24	1020.24
WI01-A-0307-H-000	Runoff	Link Invert to 2D	1002.37	1002.37
WI01-A-0307-H-001	Runoff	Link Invert to 2D	1007.23	1007.23
WI01-B-0181-H-000	Runoff	Link Invert to 2D	1041.46	1041.46
WI01-B-0181-H-001	Runoff	Link Invert to 2D	1038.46	1038.64
WI01-B-0181-H-002	Runoff	Link Invert to 2D	1043.16	1043.16
WI01-B-0181-H-003	Runoff	Link Invert to 2D	1038.79	1038.79
WI01-B-0181-H-004	Runoff	Link Invert to 2D	1043.84	1043.84
WI01-B-0181-H-005	Runoff	Link Invert to 2D	1036.88	1036.88
WI01-B-0181-H-006	Runoff	Link Invert to 2D	984.10	984.10
WI01-B-0182-H-000	Runoff	Link Invert to 2D	1019.85	1019.85
WI01-B-0182-H-001	Runoff	Link Invert to 2D	1022.76	1022.76
WI01-B-0182-H-002	Runoff	Link Invert to 2D	995.04	995.04
WI01-B-0182-H-003	Runoff	Link Invert to 2D	999.55	999.55
WI01-B-0182-H-004	Runoff	Link Invert to 2D	1023.58	1023.58
WI01-B-0182-H-005	Runoff	Link Invert to 2D	1001.61	1001.61
WI01-B-0182-H-006	Runoff	Link Invert to 2D	1004.82	1004.82

Table C-2
Existing XPSWMM™ Model Node Inputs
Wingra West Watershed Study Report, City of Madison, WI

Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
WI01-B-0182-H-007	Runoff	Link Invert to 2D	1025.96	1025.96
WI01-B-0182-H-009	Runoff	Link Invert to 2D	1015.36	1015.36
WI01-B-0184-H-000	Runoff	Link Invert to 2D	981.57	981.57
WI01-B-0184-H-001	Runoff	Link Invert to 2D	985.41	985.41
WI01-B-0184-H-002	Runoff	Link Invert to 2D	982.99	982.89
WI01-B-0184-H-004	Runoff	Link Invert to 2D	1023.72	1023.72
WI01-B-0184-H-005	Runoff	Link Invert to 2D	1004.89	1004.89
WI01-B-0184-H-006	Runoff	Link Invert to 2D	1017.58	1017.58
WI01-B-0184-H-007	Runoff	Link Invert to 2D	991.15	991.15
WI01-B-0184-H-010	Runoff	Link Invert to 2D	1001.90	1001.90
WI01-B-0477-H-000	Runoff	Link Invert to 2D	1002.44	1002.44
WI01-B-0477-H-001	Runoff	Link Invert to 2D	996.60	996.60
WI01-B-0477-H-002	Runoff	Link Invert to 2D	983.98	983.98
WI01-C-0190-H-001	Runoff	Link Invert to 2D	897.94	897.94
WI02-A-0187-H-000	Runoff	Link Invert to 2D	968.34	968.34
WI02-A-0187-H-001	Runoff	Link Invert to 2D	964.55	964.55
WI02-A-0187-H-002	Runoff	Link Invert to 2D	971.09	971.09
WI02-A-0187-H-003	Runoff	Link Invert to 2D	984.44	984.44
WI02-A-0187-H-004	Runoff	Link Invert to 2D	980.98	980.98
WI02-A-0187-H-005	Runoff	Link Invert to 2D	997.53	997.53
WI02-A-0187-H-006	Runoff	Link Invert to 2D	989.50	989.50
WI02-A-0187-H-007	Runoff	Link Invert to 2D	990.70	990.70
WI02-A-0187-H-008	Runoff	Link Invert to 2D	1008.89	1008.89
WI02-A-0187-H-009	Runoff	Link Invert to 2D	996.43	996.43
WI02-A-0187-H-010	Runoff	Link Invert to 2D	987.71	987.71
WI02-A-0187-H-011	Runoff	Link Invert to 2D	979.36	979.36
WI02-A-0187-H-012	Runoff	Link Invert to 2D	958.62	958.62
WI02-C-0186-H-001	Runoff	Link Invert to 2D	985.03	985.03
WI02-C-0186-H-005	Runoff	Link Invert to 2D	974.95	974.95
WI02-C-0186-H-006	Runoff	Link Invert to 2D	975.97	975.97
WI02-C-0188-H-000	Runoff	Link Invert to 2D	892.71	892.71
WI02-C-0188-H-001	Runoff	Link Invert to 2D	893.57	893.57
WI02-C-0188-H-002	Runoff	Link Invert to 2D	913.92	913.92
WI02-C-0188-H-003	Runoff	Link Invert to 2D	916.14	916.84
WI02-C-0188-H-004	Runoff	Link Invert to 2D	934.62	934.62
WI02-C-0188-H-006	Runoff	Link Invert to 2D	944.88	944.88
WI02-C-0188-H-007	Runoff	Link Invert to 2D	951.02	951.02
WI02-C-0188-H-008	Runoff	Link Invert to 2D	972.37	972.37
WI02-C-0188-H-009	Runoff	Link Invert to 2D	979.66	979.66
WI02-C-0188-H-010	Runoff	Link Invert to 2D	977.31	977.31
WI02-C-0188-H-011	Runoff	Link Invert to 2D	967.40	967.40
WI02-C-0188-H-012	Runoff	Link Invert to 2D	967.81	967.81
WI02-C-0188-H-013	Runoff	Link Invert to 2D	978.89	978.89
WI02-C-0188-H-014	Runoff	Link Invert to 2D	970.34	970.34
WI02-C-0188-H-015	Runoff	Link Invert to 2D	930.25	930.25
WI02-C-0188-H-016	Runoff	Link Invert to 2D	953.11	953.11
WI02-C-0188-H-017	Runoff	Link Invert to 2D	937.83	937.83
WI02-C-0188-H-019	Runoff	Link Invert to 2D	893.43	893.43
WI02-C-0188-H-020	Runoff	Link Invert to 2D	987.37	987.37
WI02-C-0188-H-021	Runoff	Link Invert to 2D	963.24	963.24

Table C-2
Existing XPSWMM™ Model Node Inputs
Wingra West Watershed Study Report, City of Madison, WI

Node Name	Node Type	Ponding Type	Invert Elevation (ft)	Spill Crest Elevation (ft)
WI02-C-0188-H-022	Runoff	Link Invert to 2D	985.25	985.25
WI02-C-0188-H-023	Runoff	Link Invert to 2D	962.29	962.29
WI02-C-0188-H-024	Runoff	Link Invert to 2D	942.08	942.08
WI02-C-0190-H-000	Runoff	Link Invert to 2D	872.87	872.87
WI02-C-0190-H-002	Runoff	Link Invert to 2D	891.42	891.42
WI02-C-0190-H-003	Runoff	Link Invert to 2D	918.15	918.15
WI02-C-0190-H-004	Runoff	Link Invert to 2D	873.26	873.26
WI02-C-0190-H-005	Runoff	Link Invert to 2D	893.07	893.07
WI02-C-0190-H-006	Runoff	Link Invert to 2D	897.94	897.04
WI02-C-0191-H-000	Runoff	Link Invert to 2D	931.02	931.02
WI02-C-0191-H-001	Runoff	Link Invert to 2D	959.86	959.86
WI02-C-0191-H-002	Runoff	Link Invert to 2D	968.99	968.89
WI02-C-0324-H-000	Runoff	Link Invert to 2D	1002.56	1002.56
WI02-C-0324-H-001	Runoff	Link Invert to 2D	999.52	999.52
WI02-C-0324-H-002	Runoff	Link Invert to 2D	997.75	999.75
WI02-C-0324-H-003	Runoff	Link Invert to 2D	996.61	996.61
WI02-C-0324-H-004	Runoff	Link Invert to 2D	996.53	996.53
WI02-C-0324-H-005	Runoff	Link Invert to 2D	997.08	997.08
WI02-C-0324-H-006	Runoff	Link Invert to 2D	1010.46	1010.46
WI02-C-0324-H-007	Runoff	Link Invert to 2D	1003.73	1003.73
WI02-C-0324-H-008	Runoff	Link Invert to 2D	1021.90	1021.90
WI02-C-0324-H-009	Runoff	Link Invert to 2D	999.27	999.27
WI02-C-0324-H-010	Runoff	Link Invert to 2D	1019.86	1019.86
WI02-C-0324-H-011	Runoff	Link Invert to 2D	1001.73	1001.73
WI02-C-0324-H-012	Runoff	Link Invert to 2D	998.86	998.86
WI02-D-0193-H-000	Runoff	Link Invert to 2D	863.82	863.82
WI02-D-0193-H-001	Runoff	Link Invert to 2D	862.54	862.54
WI02-D-0193-H-002	Runoff	Link Invert to 2D	870.10	870.10
WI02-D-0193-H-003	Runoff	Link Invert to 2D	876.13	876.13
WI02-D-0193-H-004	Runoff	Link Invert to 2D	882.46	882.46
WI02-D-0193-H-005	Runoff	Link Invert to 2D	880.95	880.95
WI02-D-0193-H-006	Runoff	Link Invert to 2D	894.51	894.51
WI02-D-0193-H-007	Runoff	Link Invert to 2D	946.75	946.75
WI02-D-0193-H-008	Runoff	Link Invert to 2D	976.57	976.57
WI02-D-0193-H-009	Runoff	Link Invert to 2D	923.15	923.15
WI02-D-0193-H-010	Runoff	Link Invert to 2D	932.11	932.11
WI02-D-0193-H-011	Runoff	Link Invert to 2D	939.00	939.00
WI02-D-0193-H-012	Runoff	Link Invert to 2D	953.05	953.05
WI02-D-0193-H-013	Runoff	Link Invert to 2D	965.52	965.52
WI02-D-0193-H-014	Runoff	Link Invert to 2D	1001.18	1001.18
WW_GW_05	Conveyance	None	975.60	984.00
WW_GW_06	Conveyance	None	975.65	984.00
WW_OUTFALL_1	Conveyance	None	852.00	862.00

Table C-3
Modeled Pond Summary
Wingra West Watershed Study Report, City of Madison, WI

Pond Name	Node Name	Normal Water Elevation	Permanent Pool Area (acres)	Total Storage Volume (acre-feet)	Outlet Description	Data Sources
Manitou Pond	PD_4061-006	855.7	1.4	11.1	V-Notch Weir, Sharp-Crested Weir	As-Built Plans
University Research Park - Southwest	PD_3158-015	N/A - Dry Pond	N/A - Dry Pond	8.4	21" Pipe, Sharp-Crested Weir	As-Built Plans
University Research Park - Southeast	PD_3258-008	N/A - Dry Pond	N/A - Dry Pond	12.8	15" Pipe, Sharp-Crested Weir	As-Built Plans
University Research Park - Central	PD_3157-013	N/A - Dry Pond	N/A - Dry Pond	6.8	2-36" Pipes	As-Built Plans
Odana Golf Course - WisDOT Pond	PD_3564-028	991	0.4	4.2	6" Orifice, Sharp-Crested Weir	Construction Plans
Illumina Pond	PD_ILLUMINA	1066	0.3	2.2	12" Pipe	Construction Plans
Orchard Ridge Valley Park	PD_3362-020	977.15	1.2	35.6	2-3'x4' Box Culverts	LiDAR, Site Visit
Odana Pond	PD_3462-001	977.15	15.3	184.3	2 Sharp-Crested Weirs	LiDAR, Survey, Site Visit
Odana Golf Course Pond	PD_3462-002	976	2.8	60.3	7" Orifice, Sharp-Crested Weir	LiDAR, Survey, Site Visit
Odana Golf Course - Outlet Channel	STOR_12	N/A - Open Channel	N/A - Open Channel	26.2	7" & 4' Sharp-Crested Weirs	LiDAR, Survey, Site Visit
Waite Circle Culvert	WAITECIRCLE	N/A - Open Channel	N/A - Open Channel	2.6	60" HDPE Culvert	LiDAR, Survey, Site Visit

Appendix D: Existing Conditions Flooding Depth and Duration Results

Table D-1																															
Base (Un-Calibrated) Existing Conditions Flooding Results																															
Wingra West Watershed Study, City of Madison, WI																															
Point	XP-SWMM Node	Location	Flood Elevation	50% Chance Storm				20% Chance Storm				10% Chance Storm				4% Chance Storm				2% Chance Storm				1% Chance Storm				0.2% Chance Storm			
				Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	
					(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)	(feet)
1	WI02-D-0193-H-001	Manitou Way Low-Point - Approximately 400-ft south of Nakoma Rd	862.6	864.2	1.6	1.6		865.6	3.0	2.5		866.1	3.4	2.8		866.3	3.6	3.2		866.4	3.7	3.5		866.5	3.8	3.9		866.7	4.0	4.5	
2	WI02-D-0193-H-009	Intersection of Seminole Hwy & Manitou Way	929.3	925.5	-3.8	0.0		927.5	-1.8	0.0		929.5	0.2	0.1		930.7	1.4	0.5		930.9	1.6	0.7		931.1	1.8	0.7		931.5	2.2	1.0	
3	WI02-C-0190-H-000	Intersection of Chippewa Dr & Nakoma Rd	873.0	874.8	1.9	2.3		875.4	2.4	2.8		875.7	2.7	3.1		876.1	3.1	3.6		876.3	3.3	3.9		876.6	3.6	4.3		877.0	4.1	5.0	
4	WI02-C-0188-H-000	Intersection of Chippewa Dr & Cherokee Dr	892.8	894.2	1.4	1.5		894.6	1.7	2.0		894.8	1.9	2.3		895.0	2.2	2.7		895.2	2.4	3.1		895.5	2.7	3.5		895.9	3.1	4.5	
5	AS3862-003	Intersection of Yuma Dr & Cherokee Dr	912.8	910.8	-2.0	0.0		911.6	-1.2	0.0		912.1	-0.7	0.0		912.8	0.0	0.0		913.6	0.8	0.5		913.7	0.9	0.6		914.1	1.3	1.0	
6	WI02-C-0188-H-011	Intersection of Midvale Blvd & Cherokee Dr	967.5	968.0	0.5	2.4		968.2	0.7	3.3		968.6	1.1	12.3	**	969.0	1.5	12.4	**	969.1	1.6	12.4	**	969.3	1.8	12.5	**	969.6	2.1	12.9	**
7	WI02-C-0188-H-017	Intersection of Chippewa Dr & Council Crest	937.9	938.1	0.1	0.8		938.1	0.2	1.4		938.2	0.3	1.8		938.9	0.9	2.3		939.1	1.2	2.6		939.3	1.3	3.0		940.1	2.2	3.7	
8	IN3761-056	West end of Waite Circle	956.8	958.4	1.6	0.6		958.6	1.8	1.3		958.8	2.0	1.6		959.7	2.9	2.0		961.3	4.5	2.3		962.9	6.1	2.7		963.6	6.8	3.2	
9	AS3760-034	Intersection of Midvale Blvd & Odana Rd	986.9	986.3	-0.6	0.0		986.7	-0.2	0.0		986.8	-0.1	0.0		987.1	0.2	0.6		987.2	0.3	1.1		987.3	0.4	1.3		987.6	0.7	1.7	
10	AS3762-026	Intersection of Midvale Blvd & SW Bike Path	972.7	969.1	-3.6	0.0		970.0	-2.7	0.0		971.7	-1.0	0.0		973.0	0.3	0.4		973.3	0.6	0.7		973.5	0.8	1.0		973.9	1.2	1.6	
11	WI02-C-0324-H-000	Verona Road, Immediately North of Beltline Highway	1002.7	1002.7	0.0	0.0		1002.7	0.1	0.5		1002.7	0.1	0.6		1002.8	0.1	0.6		1003.0	0.4	0.8		1003.5	0.8	1.0		1003.9	1.3	1.5	
12	WI02-C-0324-H-005	Intersection of Hammersley Rd & Beltline Hwy - Southwest of Hwy	997.2	998.6	1.4	3.5		998.8	1.6	4.4		999.0	1.8	5.4		999.1	2.0	6.5		999.3	2.1	7.5		999.4	2.2	9.0		999.7	2.5	13.1	
13	STOR_12	Odana Golf Course - Entrance of 42" Storm Sewer	978.0	979.1	1.1	10.9	**	979.8	1.8	11.3	**	980.4	2.4	11.5	**	981.1	3.1	11.7	**	981.6	3.6	11.8	**	982.4	4.4	11.9	**	983.9	5.9	12.2	**
14	PD_3462-001	Odana Pond	980.0	979.3	-0.7	0.0		979.9	-0.1	0.0		980.4	0.4	10.4	**	981.1	1.1	11.0	**	981.7	1.7	11.2	**	982.4	2.4	11.4	**	983.9	3.9	11.7	**
15	WI01-A-0179-H-001	Intersection of Milward Dr & Wedgewood Way	982.3	983.4	1.1	1.7		983.9	1.5	2.0		984.1	1.7	2.2		984.2	1.8	2.5		984.3	1.9	2.9		984.4	2.1	10.7		984.7	2.3	13.2	**
16	WI01-A-0179-H-003	Intersection of Milward Dr & Dearholt Rd	981.3	982.4	1.1	3.3		982.7	1.4	4.0		982.9	1.7	4.5		983.3	2.0	8.7		983.6	2.3	13.2	**	983.9	2.6	13.3	**	984.4	3.1	14.1	**
17	WI01-A-0179-H-006	Intersection of Sherwood Rd & Dearholt Rd	989.6	990.6	1.0	2.7		990.9	1.3	3.7		991.1	1.5	4.4		991.3	1.7	5.2		991.4	1.9	6.0		991.6	2.0	7.2		991.9	2.4	8.6	
18	WI01-A-0180-H-002	Intersection of Odana Rd & Segoe Rd	1005.9	1006.6	0.7	13.6	**	1006.8	0.9	16.2	**	1007.0	1.1	17.3	**	1007.2	1.3	18.5	**	1007.4	1.5	19.2	**	1007.6	1.7	19.8	**	1008.0	2.1	20.8	**
19	WI01-A-0187-H-006	Intersection of Tokay Blvd & Whitney Way	1018.7	1018.8	0.1	0.6		1018.9	0.1	0.7		1018.9	0.2	2.0		1018.9	0.2	2.8		1019.0	0.3	3.0		1019.3	0.6	3.4		1019.8	1.1	4.0	
20	WI01-A-0183-H-001	Odana Rd, approximately 325-ft west of Medical Circle	1028.6	1029.5	0.9	14.8	**	1029.6	1.1	15.0	**	1029.7	1.2	16.2	**	1030.0	1.5	17.8	**	1030.2	1.6	18.8	**	1030.3	1.8	19.7	**	1030.7	2.1	21.2	**
21	PD_3362-020	Orchard Ridge Valley Park Pond	979.0	979.8	0.8	9.3		980.6	1.6	11.8	**	981.3	2.3	11.9	**	982.1	3.1	12.0	**	982.6	3.6	12.0	**	983.3	4.3	12.1	**	985.1	6.1	12.4	**
22	WI01-B-0184-H-010	Intersection of Schroeder Rd & Schroeder Ct	1002.0	1002.1	0.1	1.0		1002.2	0.2	1.3		1002.8	0.8	1.5		1003.3	1.3	1.9		1003.5	1.5	2.0		1003.7	1.7	2.4		1004.0	2.0	3.0	
23	WI01-B-0184-H-000	Intersection of Whitney Way & Gilbert Rd	981.7	982.1	0.5	10.4	**	982.2	0.5	13.0	**	982.7	1.1	13.2	**	983.9	2.2	13.3	**	984.4	2.7	13.5	**	984.8	3.1	14.0	**	985.9	4.2	14.9	**
24	WI01-B-0181-H-001	Tolman Ter low-point, approximately 425-ft east of Gilbert Rd	1038.6	1039.8	1.3	1.6		1040.5	1.9	2.5		1040.8	2.2	3.1		1041.1	2.5	3.7		1041.3	2.8	4.0		1041.7	3.2	4.6		1042.3	3.8	6.3	
25	WI01-B-0182-H-006	Intersection of Piping Rock Rd & Manhasset Pl	1004.9	1005.1	0.2	2.0		1005.2	0.2	2.5		1005.2	0.3	3.0		1005.3	0.4	3.6		1005.5	0.5	4.0		1005.6	0.7	4.4		1006.0	1.1	5.2	

**The model runtime was 24-hours. Flooding above the identified flood elevation continues at the end of the model runtime.

Table D-2																																			
Calibrated Existing Conditions Flooding Results																																			
Wingra West Watershed Study, City of Madison, WI																																			
Point	XP-SWMM Node	Location	Flood Elevation	50% Chance Storm				20% Chance Storm*				10% Chance Storm				4% Chance Storm*				2% Chance Storm				1% Chance Storm				0.2% Chance Storm				Back to Back Storms			
				Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration	Peak WSE	Flood Depth	Flooding Duration		
					(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)		(feet)	(hours)	(feet)	(hours)
1	WI02-D-0193-H-001	Manitou Way Low-Point - Approximately 400-ft south of Nakoma Rd	862.6	865.0	2.3	1.8		865.9	3.3	2.6		866.2	3.5	3.0		866.3	3.6	3.4		866.4	3.7	3.8		866.5	3.9	4.2		866.6	4.0	4.8		866.5	3.9	8.9	
2	WI02-D-0193-H-009	Intersection of Seminole Hwy & Manitou Way	929.3	929.5	0.2	2.1		929.6	0.3	2.5		930.4	1.2	0.4		930.8	1.6	0.6		931.0	1.7	0.7		931.2	1.9	4.1		931.6	2.3	5.0		931.2	1.9	9.2	
3	WI02-C-0190-H-000	Intersection of Chippewa Dr & Nakoma Rd	873.0	875.1	2.1	2.5		875.6	2.6	3.0		875.9	2.9	3.3		876.2	3.3	3.9		876.4	3.5	4.3		876.7	3.7	4.7		877.1	4.2	5.7		876.8	3.8	10.2	
4	WI02-C-0188-H-000	Intersection of Chippewa Dr & Cherokee Dr	892.8	894.3	1.5	1.6		894.7	1.9	2.1		894.9	2.1	2.5		895.2	2.4	3.2		895.4	2.6	3.6		895.6	2.8	3.9		896.0	3.2	5.1		895.7	2.9	9.4	
5	AS3862-003	Intersection of Yuma Dr & Cherokee Dr	912.8	911.3	-1.5	0.0		912.0	-0.8	0.0		912.6	-0.2	0.0		913.5	0.7	0.4		913.6	0.8	0.6		913.9	1.1	0.7		914.2	1.4	1.1		913.9	1.1	1.4	
6	WI02-C-0188-H-011	Intersection of Midvale Blvd & Cherokee Dr	967.5	968.1	0.6	2.9		968.5	1.0	8.9	**	968.8	1.3	12.4	**	969.1	1.6	9.0	**	969.2	1.7	12.6	**	969.4	1.9	12.8	**	969.7	2.2	13.2	**	969.4	1.9	36.7	**
7	WI02-C-0188-H-017	Intersection of Chippewa Dr & Council Crest	937.9	938.1	0.2	1.0		938.1	0.2	1.5		938.2	0.3	2.0		938.9	1.0	2.5		939.1	1.2	2.9		939.4	1.5	3.4		940.2	2.3	4.2		939.8	1.9	7.1	
8	IN3761-056	West end of Waite Circle	956.8	958.6	1.8	0.9		958.7	1.9	1.6		958.8	2.0	2.0		959.9	3.1	2.3		961.6	4.8	2.6		963.1	6.3	3.0		963.7	6.9	3.6		963.4	6.6	6.2	
9	AS3760-034	Intersection of Midvale Blvd & Odana Rd	986.9	986.7	-0.2	0.0		986.8	-0.1	0.0		986.9	0.0	0.0		987.2	0.3	1.0		987.3	0.4	1.2		987.4	0.5	1.4		987.7	0.8	1.8		987.5	0.6	2.9	
10	AS3762-026	Intersection of Midvale Blvd & SW Bike Path	972.7	969.2	-3.5	0.0		971.2	-1.5	0.0		972.3	-0.4	0.0		973.2	0.5	0.6		973.4	0.7	0.9		973.6	0.9	1.2		974.0	1.3	1.6		973.7	1.0	2.4	
11	WI02-C-0324-H-000	Verona Road, Immediately North of Beltline Highway	1002.7	1002.7	0.1	0.4		1002.7	0.1	0.5		1002.8	0.1	0.6		1002.9	0.3	0.8		1003.6	0.9	1.0		1003.8	1.1	1.3		1004.2	1.5	1.8		1003.8	1.1	3.0	
12	WI02-C-0324-H-005	Intersection of Hammersley Rd & Beltline Hwy - Southwest of Hwy	997.2	998.8	1.6	4.0		999.0	1.8	4.6		999.1	1.9	5.9		999.3	2.1	6.5		999.4	2.2	7.0		999.5	2.4	8.1		999.8	2.6	13.6		999.6	2.4	20.4	
13	STOR_12	Odana Golf Course - Entrance of 42" Storm Sewer	978.0	979.8	1.8	11.1	**	980.5	2.5	8.3	**	981.0	3.0	11.6	**	981.7	3.7	8.4	**	982.3	4.3	11.9	**	983.0	5.0	12.0	**	984.3	6.3	12.6	**	985.6	7.6	35.9	**
14	PD_3462-001	Odana Pond	980.0	979.8	-0.2	0.0		980.5	0.5	7.3	**	981.0	1.0	10.9	**	981.7	1.7	7.8	**	982.3	2.3	11.4	**	983.0	3.0	11.6	**	984.3	4.3	11.8	**	985.6	5.6	35.5	**
15	WI01-A-0179-H-001	Intersection of Milward Dr & Wedgewood Way	982.3	983.7	1.4	2.0		984.0	1.7	2.4		984.1	1.8	2.7		984.3	2.0	3.2		984.4	2.1	3.8		984.5	2.2	13.0	**	984.8	2.4	13.4	**	985.6	3.3	36.9	**
16	WI01-A-0179-H-003	Intersection of Milward Dr & Dearholt Rd	981.3	982.6	1.3	4.0		982.9	1.6	4.8		983.1	1.8	5.9		983.5	2.2	9.8	**	983.7	2.5	13.4	**	984.0	2.7	13.5	**	984.5	3.2	14.7	**	985.6	4.4	37.4	**
17	WI01-A-0179-H-006	Intersection of Sherwood Rd & Dearholt Rd	989.6	990.8	1.2	3.4		991.0	1.5	4.4		991.2	1.6	5.0		991.4	1.8	6.0		991.5	2.0	6.6		991.7	2.1	8.0		992.0	2.5	9.1		991.8	2.2	20.3	
18	WI01-A-0180-H-002	Intersection of Odana Rd & Segoe Rd	1005.9	1006.7	0.8	13.2		1006.9	1.0	13.3	**	1007.1	1.2	17.6	**	1007.4	1.5	15.3	**	1007.6	1.7	19.4	**	1007.8	1.9	20.0	**	1008.3	2.4	21.0	**	1007.8	1.9	43.9	**
19	WI01-A-0187-H-006	Intersection of Tokay Blvd & Whitney Way	1018.7	1018.9	0.1	0.6		1018.9	0.2	1.6		1018.9	0.2	2.6		1019.0	0.3	3.1		1019.1	0.3	3.4		1019.5	0.7	3.6		1020.0	1.3	4.5		1019.9	1.1	7.8	
20	WI01-A-0183-H-001	Odana Rd, approximately 325-ft west of Medical Circle	1028.6	1029.6	1.0	14.9	**	1029.7	1.2	11.9	**	1029.9	1.4	16.3	**	1030.2	1.6	14.5	**	1030.4	1.8	18.9	**	1030.5	2.0	19.8	**	1030.8	2.3	21.3	**	1030.5	2.0	43.7	**
21	PD_3362-020	Orchard Ridge Valley Park Pond	979.0	980.2	1.2	11.8	**	981.1	2.1	8.8	**	981.8	2.8	12.0	**	982.6	3.6	8.6	**	983.2	4.2	12.2	**	983.9	4.9	12.3	**	985.7	6.7	12.7	**	986.4	7.4	36.2	**
22	WI01-B-0184-H-010	Intersection of Shroeder Rd & Shroeder Ct	1002.0	1002.2	0.2	1.1		1002.7	0.7	1.4		1003.1	1.1	1.7		1003.5	1.5	2.0		1003.6	1.6	2.2		1003.8	1.8	2.5		1004.2	2.2	3.2		1003.8	1.8	5.1	
23	WI01-B-0184-H-000	Intersection of Whitney Way & Gilbert Rd	981.7	982.2	0.5	12.4		982.5	0.8	10.1	**	983.5	1.8	13.4	**	984.3	2.6	10.2	**	984.6	2.9	14.4	**	985.2	3.5	14.8	**	986.1	4.4	15.2	**	986.4	4.7	38.7	**
24	WI01-B-0181-H-001	Tolman Ter low-point, approximately 425-ft east of Gilbert Rd	1038.6	1040.2	1.6	2.1		1040.7	2.1	3.1		1040.9	2.4	3.6		1041.2	2.7	4.2		1041.6	3.0	4.6		1041.9	3.4	5.4		1042.5	3.9	7.0		1042.0	3.5	11.8	
25	WI01-B-0182-H-006	Intersection of Piping Rock Rd & Manhasset Pl	1004.9	1005.2	0.2	2.8		1005.2	0.3	3.5		1005.3	0.4	4.0		1005.5	0.6	4.7		1005.7	0.7	5.1		1005.8	0.9	5.6		1006.2	1.2	6.6		1005.9	0.9	13.1	

*The model execution stopped at 85% during this design storm.

**The model runtime was 24-hours. Flooding above the identified flood elevation continues at the end of the model runtime.

Appendix E: Inlet Capacity



Technical Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Prepared for: City of Madison
Project Title: Strickers Pond / Lake Mendota Watershed Study and West Wingra Watershed Study
Project No.: City: 8411/8412, BC: 153393/153394
Subject: Description of Brown and Caldwell's Inlet Capacity Approach
Date: December 6, 2019 (Updated February 12, 2020)
To: Caroline Burger PE Env S; Lauren Striegl PE, Phil Gaebler PE
From: Mike Wegner PE
Copy to: Jim Bachhuber PE, Doug Joachim PE

Prepared by: 
Mike Wegner, PE, Principal Engineer

Reviewed by: Jim Bachhuber, PH, Manager; and Doug Joachim, PE, Engineer III

Limitations:

This document was prepared solely for City of Madison in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Madison and Brown and Caldwell dated 3/25/19. This document is governed by the specific scope of work authorized by City of Madison; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Madison and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

This memo describes BC's approach for the inlet capacity analysis portion of the Stricker's / Mendota and West Wingra watershed studies. The document includes the proposed approach and supporting information.

Selected Inlet Capacity Methodologies:

BC will evaluate inlet capacity with two approaches:

1. Incorporation into the XPSWMM™ model through the use of a composite rating curve. Inlets are aggregated at the subbasin level.
 - a. In the model, a runoff node adjacent to the existing storm sewer system near the location where the runoff enters into the system will be created. The node will have an invert elevation set 0.1-feet below the ground elevation. The slight lowering of the elevation relative to the ground elevation represent the depression that occurs at a standard City inlet. A link connecting the new node to the storm sewer system will be created. The link will use an internal rating curve to simulate the composite inlet capacity for the subbasin.
 - b. Other nodes within the direct vicinity (intersection) at which the runoff is entered into the model will not have a connection to the 2D model. The ponding type will be changed to sealed.
 - c. Other nodes within the model will remain linked to 2D to allow the transfer of water from the 1D to 2D portions of the model. Flow into these nodes will be restricted through the use of the global "2D Inflow Capture" settings in XPSWMM™.
 - d. A detailed description of how the rating curve will be developed is provided below in this memo.
2. A spreadsheet analysis similar to the spreadsheets prepared for the November 26, 2019 meeting. The spreadsheets can be used in conjunction with the model to evaluate where inlet capacity may be an issue. The spreadsheet approach provides an independent analysis from the model approach described above.
 - a. Cumulative Inlet Capacity vs Subbasin Runoff Spreadsheet
 - b. Inlet Capacity vs Pipe Capacity Spreadsheet

Alternative Approaches Evaluated

Various approaches to modeling inlet capacity within XPSWMM were considered and evaluated in the software. Based on testing conducted by BC (both prior to, and after, the November 26, 2019 meeting), any use of the inlet capacity module built into XPSWMM™ (i.e. turning on the "inlet capacity" check box) results in significantly increased model runtimes. Because of this increase in model runtime, this approach was abandoned.

The approach described above (#1.), of creating a new runoff node and link to connect the runoff node to the storm sewer system resulted in a modest increase to model runtime. Table 1 provides a comparison of model run-times for various approaches that were considered.

Table-1. XPSWMM Model Runtime Comparison

Model Scenario	10-yr, 24-hr Storm Event Model Runtime (minutes)
Stricker's / Mendota Watershed Model – No Inlet Capacity	75 minutes
Reduced Model Area – Stricker's Pond Tributary area from City of Madison	27 minutes
Reduced Model Area – With “Inlet Capacity” Check Box	117 - 475 minutes
Reduced Model Area – With Rating Curve Link for Inlet Capacity	31-minutes

1.1 Available Data / Key Assumptions

During the November 26, 2019 meeting BC described the GIS data used to classify inlet type and condition. BC will continue to use this approach. The City's GIS data provided the casting type for inlets. Where the casting type was missing from the GIS, the following assumptions were made:

1. If installed after 1980, the inlet was assumed to be a Neenah R-3067 inlet. This is the most common inlet used within the City.
2. If this inlet was installed prior to 1980, it was assumed that the inlet had one-half of the capacity of a Neenah R-3067 inlet. The City indicated the inlet capacity for most inlets installed prior to 1980 have one-half of the capacity of a modern inlet.
3. Inlets that are within WisDOT right-of-way were assumed to be Neenah R 3067 inlets.

Within GIS, BC classified the inlet condition (sag or slope). For slope inlets, the slope was assigned based on the slope of the street on which the inlet is located. Private inlets were not included as part of this analysis. Data for private inlets is largely unavailable. The analysis also does not include items such as daylighted pipes that may be present within the drainage system.

1.2 Inlet Capacity Rating Curve Development

At the November 26, 2019 meeting with City staff, BC described an approach used to develop rating curves for each inlet type, under the various conditions (sag or slope) within the watersheds. Based on the number of inlets within a subbasin, the type of inlets, and the inlet conditions, a composite inlet capacity rating curve is developed.

A further evaluation of the flow capacity of individual inlets was conducted. To conduct the evaluation two typical inlet types were selected. These inlet types were each evaluated with multiple methodologies. For each methodology a rating curve for the inlet capacity was developed for the typical inlets. The selected methodologies will be used to calculate a flow capacity rating curve for the other inlet types found in the study areas. These rating curves for the various inlet types will be used to develop the consolidated rating curves at the subbasin level.

1.2.1 Sag Condition: Neenah Foundry R-3067 Type R grate

1. The following methodologies were considered. A graph (Figure 1) is attached to illustrate the rating curves calculated with the various methodologies.
 - a. Autodesk Storm and Sanitary Sewer Analysis software was used to generate a rating curve. It appears this rating curve is based on an inlet capacity calculator that was previously



available on the Neenah Foundry website. Although the source of the rating curve is not documented in the Autodesk software help manual, the observation was made by comparing the rating curve from the Autodesk software to a past project rating curve developed by BC from the Neenah Foundry website calculator and the two curves matched. The Neenah Foundry website calculator is not available at the present time. It is believed that this methodology does not include the curb opening at the rear of a typical inlet. A 50% grate clogging factor was applied to the rating curve. (Note: BC has been in contact with Neenah Foundry regarding inlet capacity tools formally available on their website. A response was not provided by Neenah Foundry.)

- b. The weir and orifice equations were used to develop a rating curve. Weir and orifice equations from HEC-22 were followed to develop a rating curve for both the grate and curb opening. A 50% clogging factor was applied to the grate rating curve. A 20% clogging factor was applied to the curb opening (Note: It is understood this factor is not consistent with the current Modeling Guidance. The back of curb clogging factor is based on the WisDOT FDM. We propose updating the Modeling Guidance to reflect a 20% clogging factor for curb openings.). In this approach flow through the curb opening was not a factor at lower depths when the inlet functions under weir flow. This is consistent with recommendations from HEC-22 and the WisDOT FDM. A weir length and open area as reported in the Neenah Foundry product catalog are used in the calculations.
 - c. Only using the weir equation with a length consistent with the inlet perimeter was considered. This approach was considered as a method to potentially simplify the analysis. A 50% clogging factor was applied by reducing the weir length.
2. Based on a review of these methodologies the combined HEC-22 weir and orifice equations approach will be used for both the grate and curb opening in sag locations. The HEC-22 and Autodesk (Neenah Foundry) rating curve produce similar results for flows through the inlet grate. The differences appear to be due to difference in the coefficients used as part of the weir and orifice equations. Because the Neenah Foundry calculator is no longer available, HEC-22 guidance was followed.

1.2.2 Slope Condition: Neenah Foundry R-3067 Type L grate

1. The following methodologies were considered. Graphs (Figures 2, 3, and 4) were prepared for different longitudinal slopes to illustrate the rating curves calculated with the various methodologies.
 - a. The methodology outlined in Section 13-25-30.3 of the WisDOT FDM was followed. The chart for the inlet "K" value was obtained from the Autodesk Storm and Sanitary Sewer Analysis software. This information formerly was available from Neenah Foundry. The information is no longer available from Neenah Foundry. For slopes less than 1% a 25% clogging factor was applied. Slopes of 1%, or greater had no clogging factor applied.
 - b. The FHWA Hydraulic Toolbox was used to calculate inlet flow based on HEC-22 methodology. For slopes less than 1% a 25% clogging factor was applied. Slopes of 1%, or greater had no clogging factor applied.
 - c. Solely using the weir equation with a length consistent with the inlet perimeter, excluding the curb side (7-feet), and just using the upstream side (2-feet) was considered. Again, the approach was considered as a method to simplify the analysis. The 7-foot length represents

- the entire perimeter (excluding the curb-side) of the typical grate (2' x 3') and the 2-foot weir length represents the grate just utilizing the upstream side for the weir.
- d. Under each methodology the curb opening was ignored under slope conditions. This is consistent with recommendations from HEC-22 and the WisDOT FDM.
 - a. Based on a review of these methodologies the FHWA Hydraulic Toolbox will be used for slope conditions. This methodology produces a higher inlet flow than the WisDOT FDM methodology. However, "K" value charts are no longer available directly from Neenah Foundry. Due to this information not being readily available we do not recommend it be used (even if it can be obtained from outside sources).
 - b. As part of this approach, BC will cap the inlet capacity at a 0.5-foot depth. In discussion with the City both parties identified that flows into an inlet at the rates seen with greater depths seemed unreasonable. Above 0.5-feet the flow would be above the top of curb and expand wider.



Chart E-1: R-3067 Inlet Rating Curve (Sag Condition)

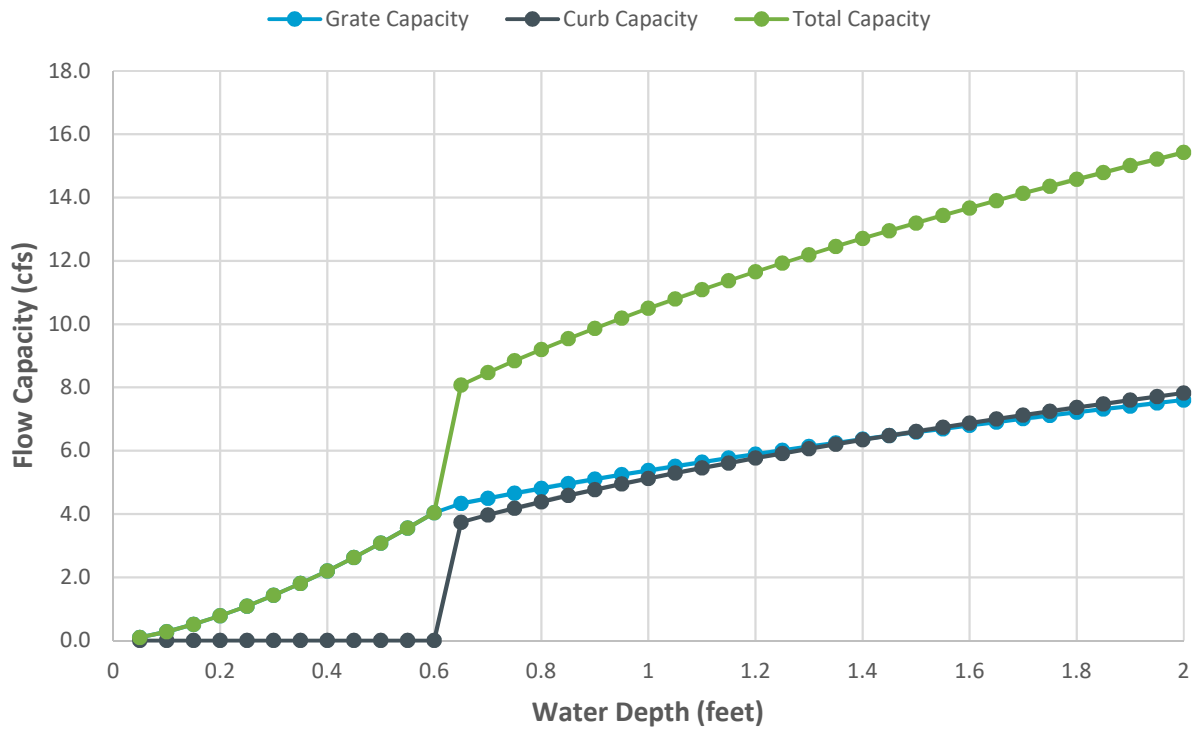


Chart E-2: R-1550 Inlet Rating Curve (Sag Condition)

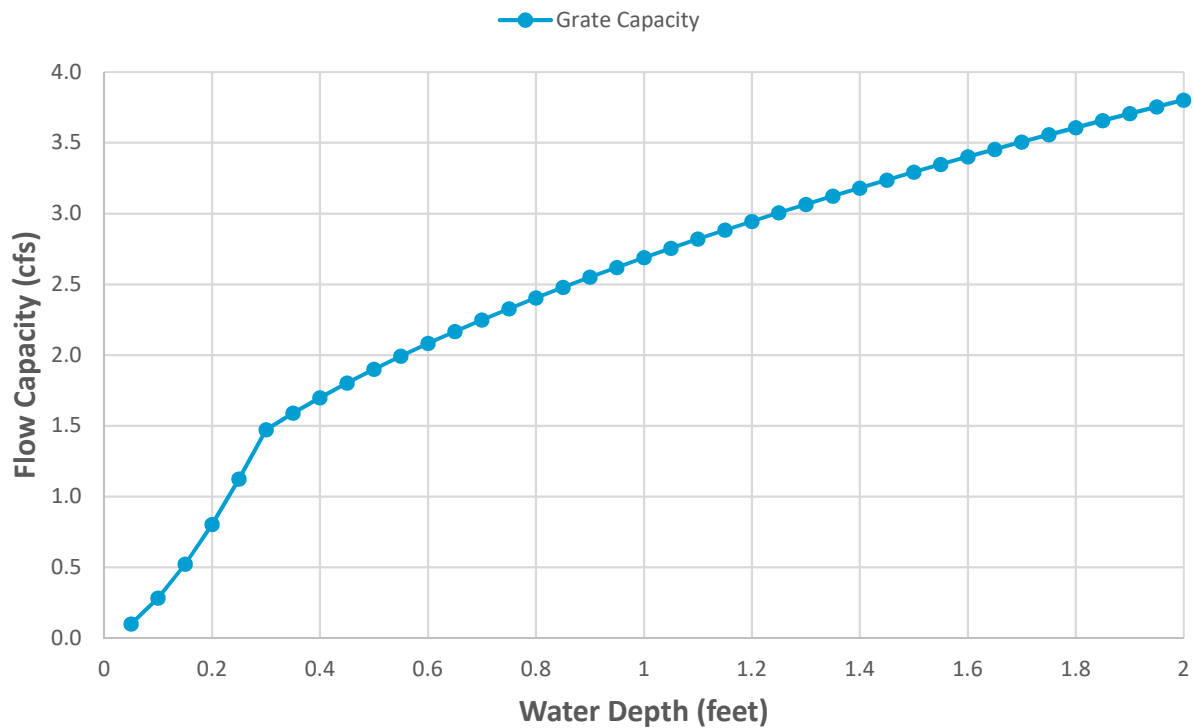


Chart E-3: R-1878-A10G Inlet Rating Curve (Sag Condition)

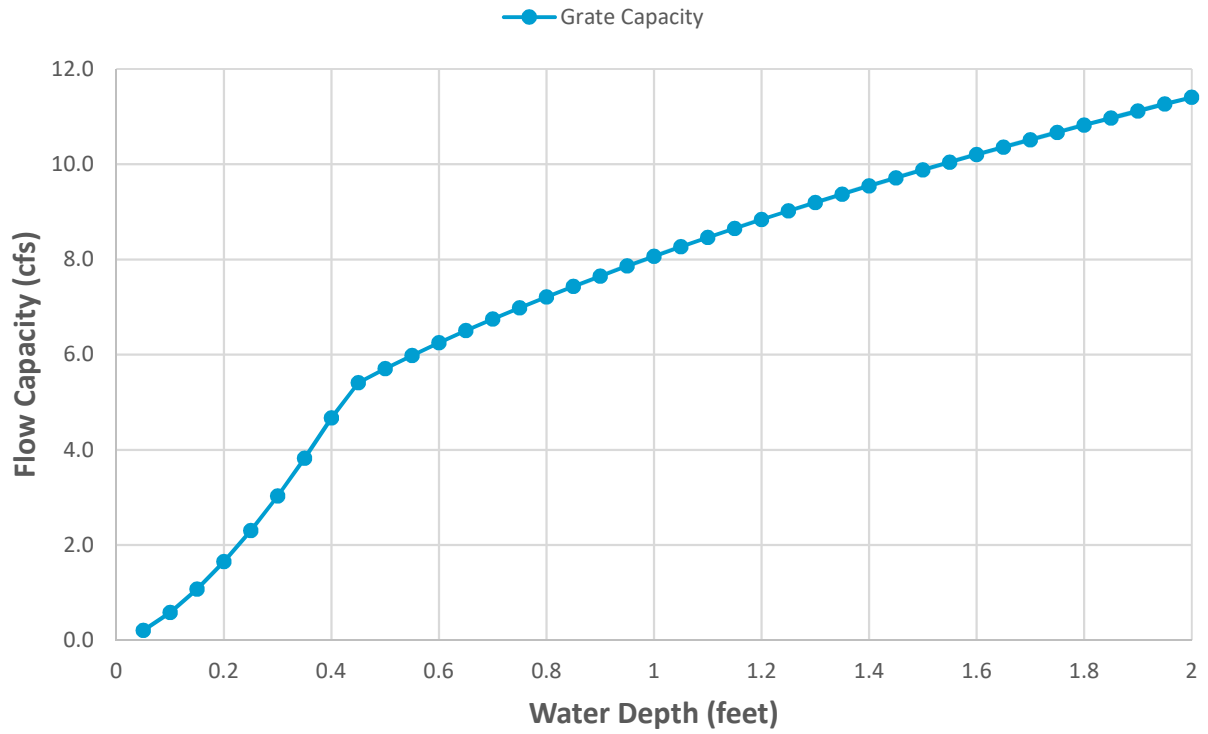


Chart E-4: R-1878-B7G Inlet Rating Curve (Sag Condition)

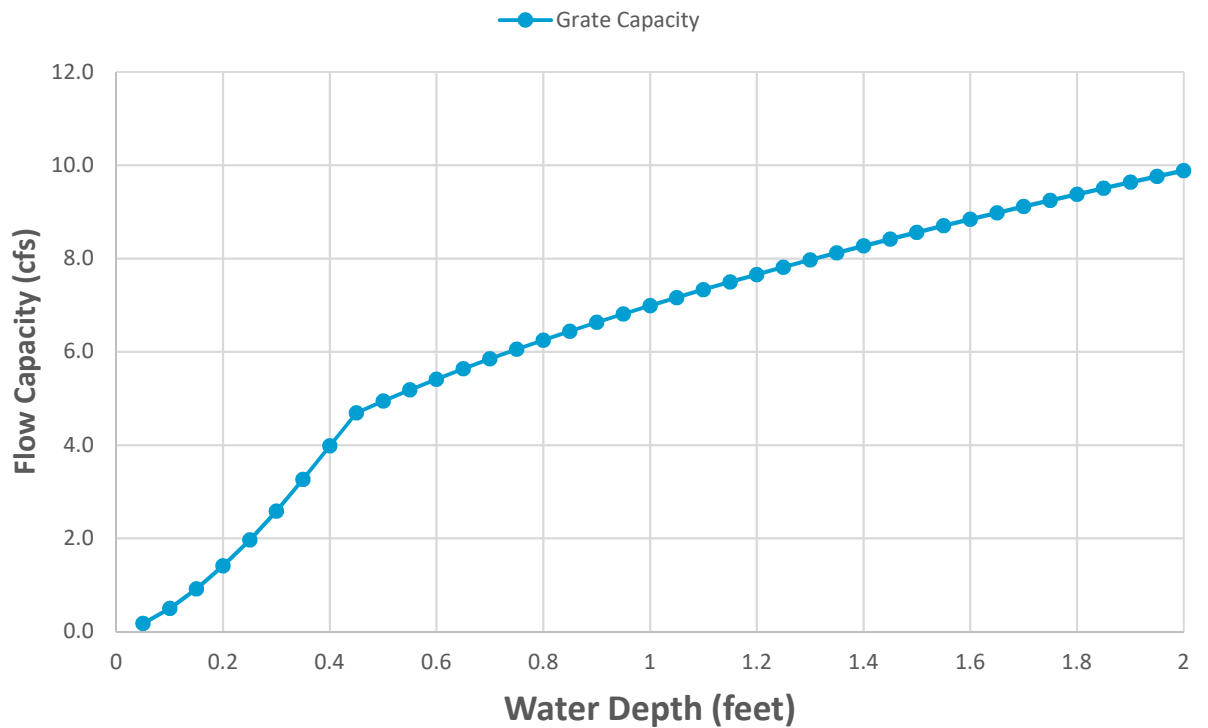


Chart E-5: R-3290-A Inlet Rating Curve (Sag Condition)

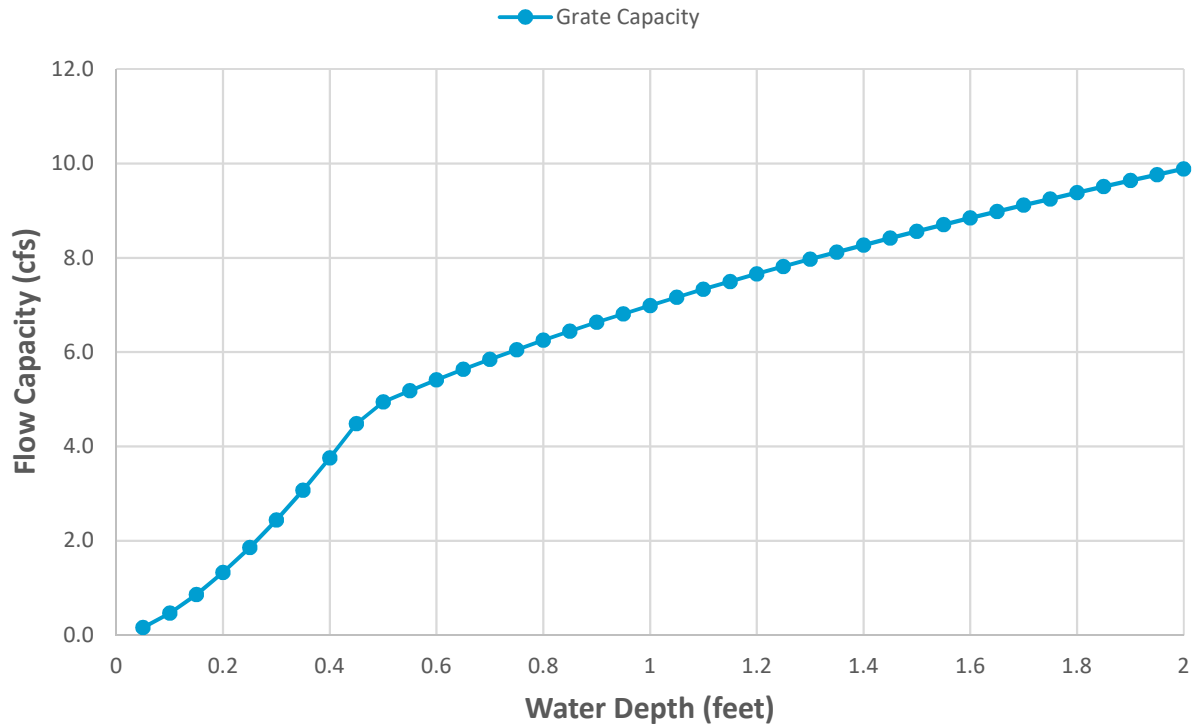


Chart E-6: Terrace Inlet Rating Curve (Sag Condition)

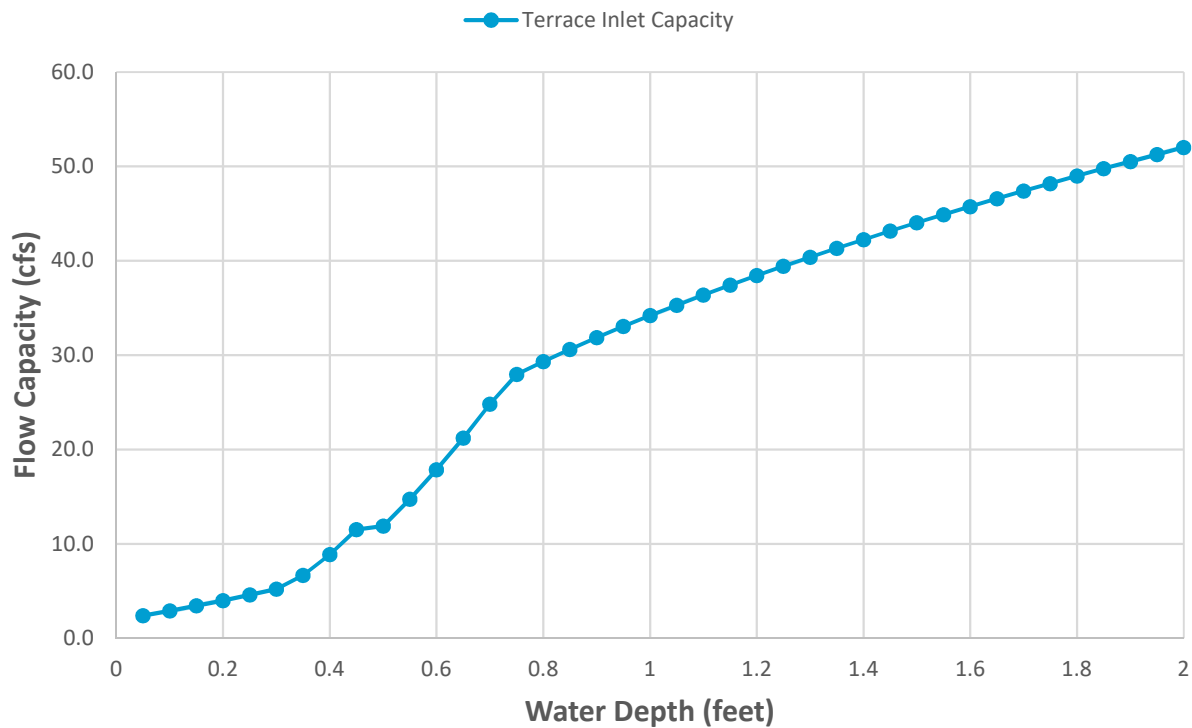


Chart E-7: R-3067-L & R-3067-V Inlet Rating Curve (Slope Condition)

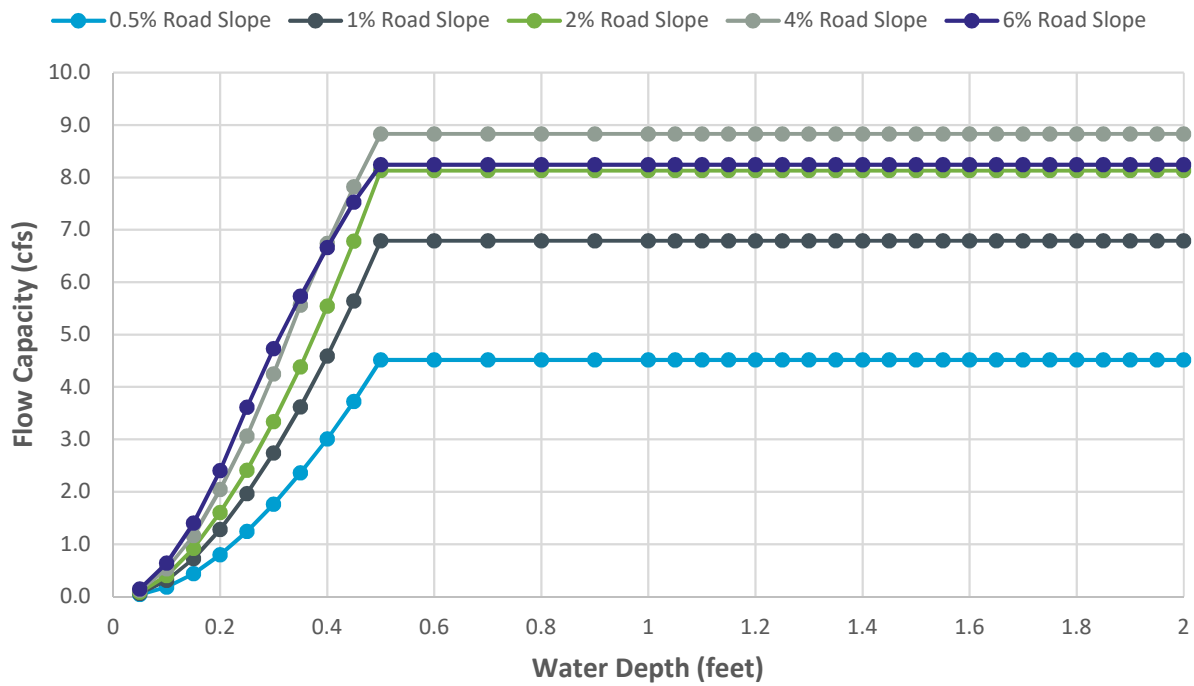


Chart E-8: R-3067 Inlet Rating Curve (Slope Condition)

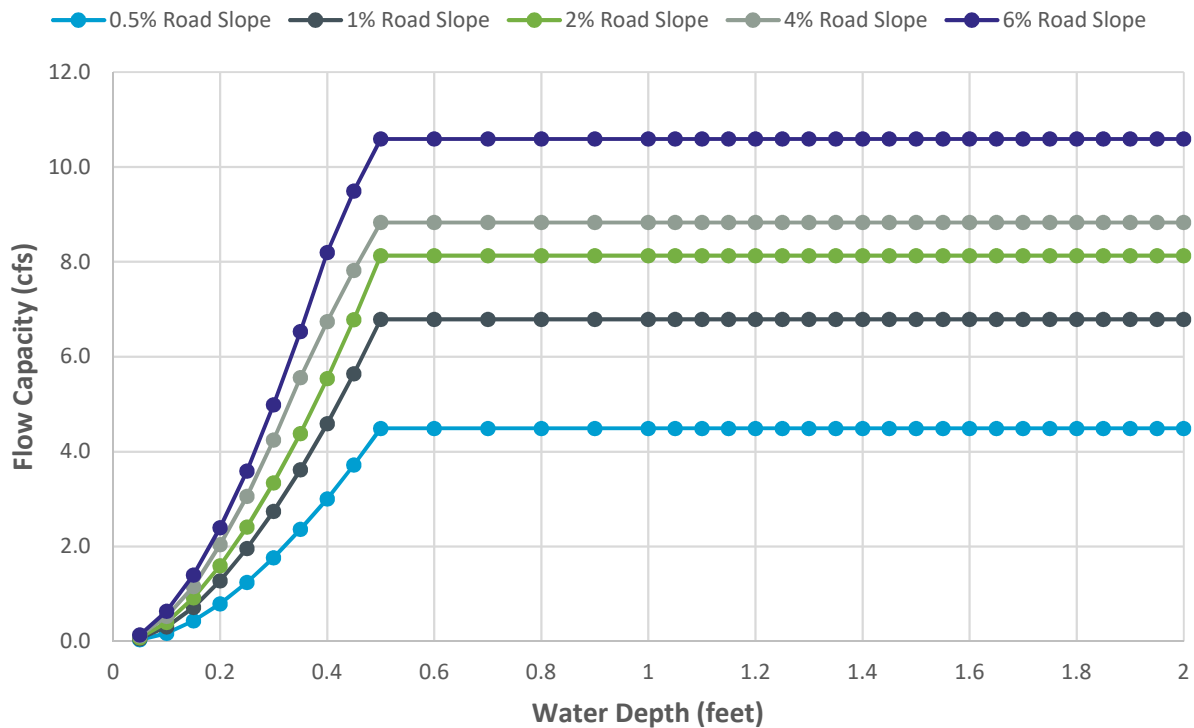


Chart E-9: R-3170 Inlet Rating Curve (Slope Condition)

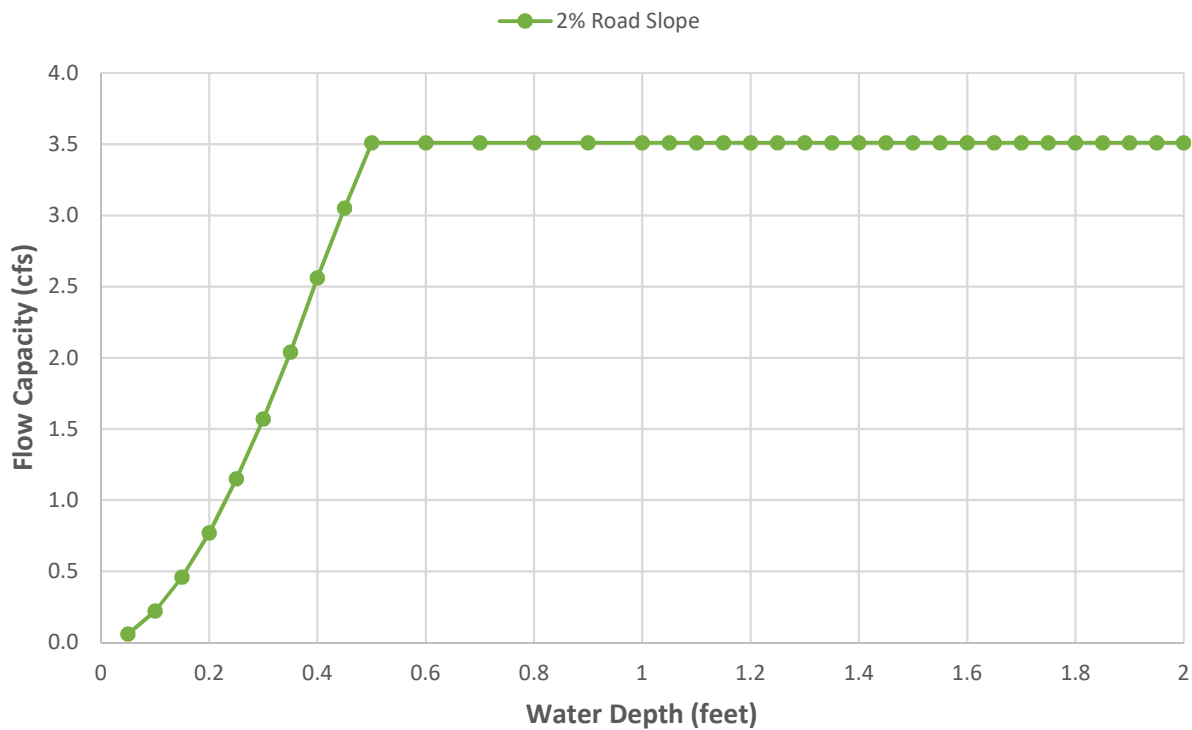


Chart E-10: R-3396 Inlet Rating Curve (Slope Condition)

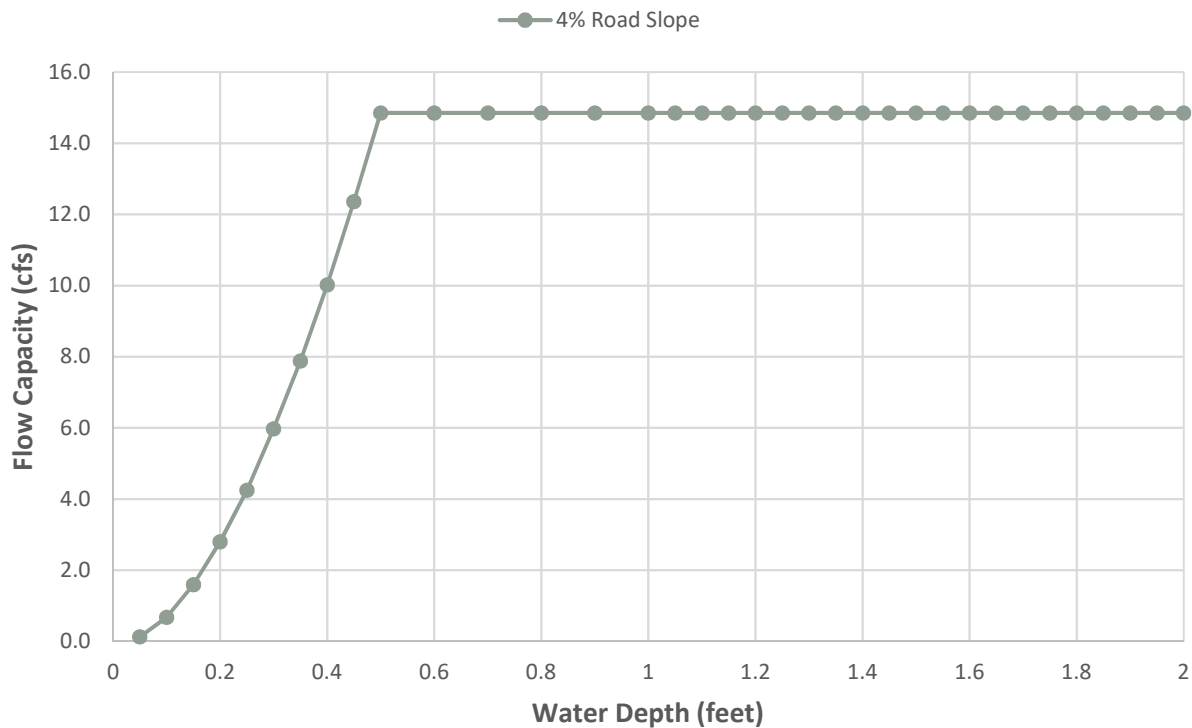


Chart E-11: R-3528 Inlet Rating Curve (Slope Condition)

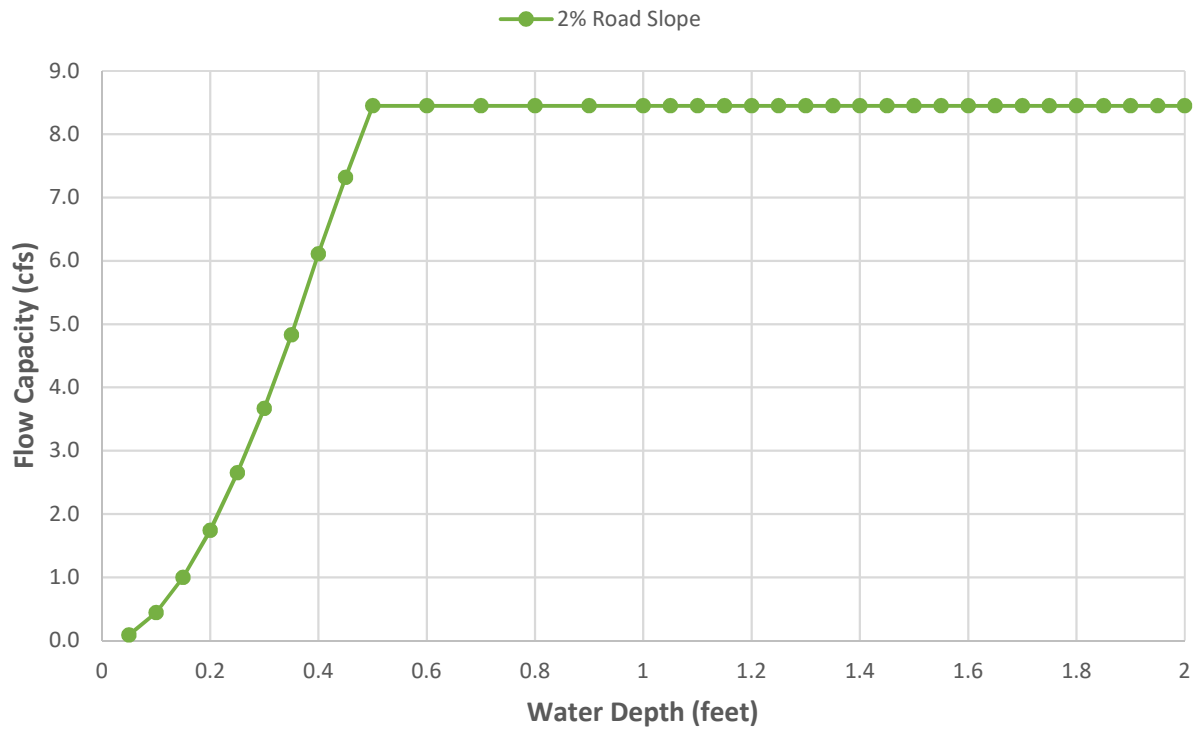


Table E-1
Inlets by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Inlet Type	Terrace	(2) R-3067 / (2) R-1550	(2) R-4482	R-1550	R-1550/R-3067	R-1550/R-3067	R-1878-A10G	R-1878-B7G	R-4490-GX	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3170	R-3290	R-3396	R-3528-V	R-4482	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	WisDOT	WisDOT	WisDOT	WisDOT	WisDOT	Total	
Condition (Sag or Slope)	Sag	Sag	Sag	Sag	Sag	Slope	Sag	Sag	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope		Slope
Slope (%)	N/A	N/A	N/A	N/A	N/A	6%	N/A	N/A	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	6%	2%	N/A	4%	2%	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	4%			
Subwatershed																																Total									
BM03-A-0038-H-MAD-C-001	No Inlet Capacity - Internally Drained Area																																								
BM03-A-0038-H-MAD-C-002	No Inlet Capacity - Internally Drained Area																																								
WI01-A-0179-H-MAD-C-000	No Inlet Capacity - Direct to Odana Pond																																								
WI01-A-0179-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	0	0	0	6		
WI01-A-0179-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	0	0	0	0	0	0	0	0	0	10		
WI01-A-0179-H-MAD-C-003	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	7		
WI01-A-0179-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	8		
WI01-A-0179-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3		
WI01-A-0179-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7		
WI01-A-0179-H-MAD-C-007	No Inlet Capacity - Direct to Odana Pond																																								
WI01-A-0180-H-MAD-C-000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3		
WI01-A-0180-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
WI01-A-0180-H-MAD-C-002	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	0	0	0	0	0	0	0	0	0	7	
WI01-A-0183-H-MAD-C-000	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	
WI01-A-0183-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	
WI01-A-0183-H-MAD-C-002	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
WI01-A-0183-H-MAD-C-003	No Inlet Capacity - Private Inlets Only																																								
WI01-A-0183-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI01-A-0183-H-MAD-C-005	No Inlet Capacity - Private Inlets Only																																								
WI01-A-0183-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	
WI01-A-0183-H-MAD-C-007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	
WI01-A-0183-H-MAD-C-008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	
WI01-A-0183-H-MAD-C-009	No Inlet Capacity - Direct of University Research Park Pond																																								
WI01-A-0183-H-MAD-C-010	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
WI01-A-0183-H-MAD-C-011	0	0	0	0	0	0	0	3	0	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
WI01-A-0183-H-MAD-C-012	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI01-A-0183-H-MAD-C-013	0	0	0	0	0	0	0	0	0	3	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
WI01-A-0183-H-MAD-C-014	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6	
WI01-A-0183-H-MAD-C-015	No Inlet Capacity - Direct to Illumina Pond																																								
WI01-A-0183-H-MAD-C-016	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI01-A-0185-H-MAD-C-000	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI01-A-0185-H-MAD-C-001	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI01-A-0185-H-MAD-C-002	No Inlet Capacity - Direct of University Research Park Pond																																								
WI01-A-0185-H-MAD-C-003	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI01-A-0185-H-MAD-C-004	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI01-A-0186-H-MAD-C-000	No Inlet Capacity - Direct of University Research Park Pond																																								
WI01-A-0187-H-MAD-C-000	0	0	0	0	0	0	1	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	7	0	0	1	0	0	0	0	17		
WI01-A-0187-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	2	0	0	0	0	0	0	0	0	7		
WI01-A-0187-H-MAD-C-003	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	7		

Table E-1 Inlets by Subwatershed Wingra West Watershed Study, City of Madison, WI																																										
Inlet Type	Terrace	(2) R-3067 / (2) R-1550	(2) R-4482	R-1550	R-1550/R-3067	R-1550/R-3067	R-1878-A10G	R-1878-B7G	R-4490-GX	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3170	R-3290	R-3396	R-3528-V	R-4482	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	WisDOT	WisDOT	WisDOT	WisDOT	WisDOT	Total		
Condition (Sag or Slope)	Sag	Sag	Sag	Sag	Sag	Slope	Sag	Sag	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope		Slope	
Slope (%)	N/A	N/A	N/A	N/A	N/A	6%	N/A	N/A	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	6%	2%	N/A	4%	2%	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%					
Subwatershed																																			Total							
WI01-A-0187-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5			
WI01-A-0187-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	6			
WI01-A-0187-H-MAD-C-006	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	13			
WI01-A-0187-H-MAD-C-007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4			
WI01-A-0307-H-MAD-C-000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	12	0	0	19			
WI01-A-0307-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3			
WI01-B-0181-H-MAD-C-000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4			
WI01-B-0181-H-MAD-C-001	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6		
WI01-B-0181-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	9			
WI01-B-0181-H-MAD-C-003	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1			
WI01-B-0181-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	5			
WI01-B-0181-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2			
WI01-B-0181-H-MAD-C-006	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	9			
WI01-B-0182-H-MAD-C-000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2			
WI01-B-0182-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	9			
WI01-B-0182-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	2	0	0	0	0	0	0	0	0	0	8			
WI01-B-0182-H-MAD-C-003	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	4	0	0	4	0	2	0	0	0	0	0	0	0	13			
WI01-B-0182-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	12			
WI01-B-0182-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	4			
WI01-B-0182-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2			
WI01-B-0182-H-MAD-C-007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2			
WI01-B-0182-H-MAD-C-008	No Inlet Capacity - Internally Drained Area																																									
WI01-B-0182-H-MAD-C-009	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0	0	0	7			
WI01-B-0184-H-MAD-C-000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	10			
WI01-B-0184-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	5	1	0	0	0	0	0	0	0	0	0	14			
WI01-B-0184-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	6			
WI01-B-0184-H-MAD-C-003	No Inlet Capacity - Private Inlets Only																																									
WI01-B-0184-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2				
WI01-B-0184-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	0	0	0	0	0	6				
WI01-B-0184-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6				
WI01-B-0184-H-MAD-C-007	0	0	1	0	0	0	1	0	0	6	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0	0	0	1	0	0	0	0	0	20			
WI01-B-0184-H-MAD-C-008	No Inlet Capacity - Internally Drained Area																																									
WI01-B-0184-H-MAD-C-009	No Inlet Capacity - Internally Drained Area																																									
WI01-B-0184-H-MAD-C-010	0	0	0	0	0	0	0	1	0	0	0	0	2	4	0	1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	11					
WI01-B-0477-H-MAD-C-000	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5				
WI01-B-0477-H-MAD-C-001	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3				
WI01-B-0477-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	6				
WI01-B-0477-H-MAD-C-003	No Inlet Capacity - Direct to Orchard Ridge Valley Park Pond																																									
WI01-B-0477-H-MAD-C-004	No Inlet Capacity - Direct to Beltline Culvert NE of Orchard Ridge Valley Park Pond																																									

Table E-1 Inlets by Subwatershed Wingra West Watershed Study, City of Madison, WI																																										
Inlet Type	Terrace	(2) R-3067 / (2) R-1550	(2) R-4482	R-1550	R-1550/R-3067	R-1550/R-3067	R-1878-A10G	R-1878-B7G	R-4490-GX	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3170	R-3290	R-3396	R-3528-V	R-4482	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	WisDOT	WisDOT	WisDOT	WisDOT	WisDOT	Total		
Condition (Sag or Slope)	Sag	Sag	Sag	Sag	Sag	Slope	Sag	Sag	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope		Slope	
Slope (%)	N/A	N/A	N/A	N/A	N/A	6%	N/A	N/A	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	6%	2%	N/A	4%	2%	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%					
Subwatershed																																				Total						
WI02-A-0187-H-MAD-C-000	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6		
WI02-A-0187-H-MAD-C-001	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	18	
WI02-A-0187-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	9	
WI02-A-0187-H-MAD-C-003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	
WI02-A-0187-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	5	
WI02-A-0187-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	
WI02-A-0187-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6
WI02-A-0187-H-MAD-C-007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6
WI02-A-0187-H-MAD-C-008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	
WI02-A-0187-H-MAD-C-009	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
WI02-A-0187-H-MAD-C-010	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	11
WI02-A-0187-H-MAD-C-011	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
WI02-A-0187-H-MAD-C-012	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
WI02-C-0186-H-MAD-C-000	No Inlet Capacity - Direct to Swale																																									
WI02-C-0186-H-MAD-C-001	No Inlet Capacity - Odana Golf Course																																									
WI02-C-0186-H-MAD-C-002	No Inlet Capacity - Direct to Odana Pond																																									
WI02-C-0186-H-MAD-C-003	No Inlet Capacity - Direct to Odana Golf Course - WisDOT Pond																																									
WI02-C-0186-H-MAD-C-004	No Inlet Capacity - Direct to Swale																																									
WI02-C-0186-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	11	
WI02-C-0186-H-MAD-C-006	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
WI02-C-0186-H-MAD-C-007	No Inlet Capacity - Direct to Swale																																									
WI02-C-0188-H-MAD-C-000	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
WI02-C-0188-H-MAD-C-001	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	10
WI02-C-0188-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	8	
WI02-C-0188-H-MAD-C-003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10	
WI02-C-0188-H-MAD-C-004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
WI02-C-0188-H-MAD-C-005	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	8
WI02-C-0188-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8
WI02-C-0188-H-MAD-C-007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
WI02-C-0188-H-MAD-C-008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5
WI02-C-0188-H-MAD-C-009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3
WI02-C-0188-H-MAD-C-010	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
WI02-C-0188-H-MAD-C-011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
WI02-C-0188-H-MAD-C-012	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
WI02-C-0188-H-MAD-C-013	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	8	
WI02-C-0188-H-MAD-C-014	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
WI02-C-0188-H-MAD-C-015	0	0	0	0	0	0	0	0	0	1	0	3	12	0	0	0	0																									

Table E-1 Inlets by Subwatershed Wingra West Watershed Study, City of Madison, WI																																											
Inlet Type	Terrace	(2) R-3067 / (2) R-1550	(2) R-4482	R-1550	R-1550/R-3067	R-1550/R-3067	R-1878-A10G	R-1878-B7G	R-4490-GX	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3170	R-3290	R-3396	R-3528-V	R-4482	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	WisDOT	WisDOT	WisDOT	WisDOT	WisDOT	Total		
Condition (Sag or Slope)	Sag	Sag	Sag	Sag	Sag	Slope	Sag	Sag	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope			
Slope (%)	N/A	N/A	N/A	N/A	N/A	6%	N/A	N/A	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	6%	2%	N/A	4%	2%	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%						
Subwatershed																																				Total							
WI02-C-0188-H-MAD-C-018	No Inlet Capacity - Direct to Waite Circle Culvert																																										
WI02-C-0188-H-MAD-C-019	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5			
WI02-C-0188-H-MAD-C-020	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4		
WI02-C-0188-H-MAD-C-021	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4		
WI02-C-0188-H-MAD-C-022	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI02-C-0188-H-MAD-C-023	0	0	0	0	0	0	0	0	0	0	0	3	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	
WI02-C-0188-H-MAD-C-024	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
WI02-C-0190-H-MAD-C-000	0	0	0	0	0	0	0	0	0	3	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	11	
WI02-C-0190-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
WI02-C-0190-H-MAD-C-002	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
WI02-C-0190-H-MAD-C-003	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	8	
WI02-C-0190-H-MAD-C-004	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
WI02-C-0190-H-MAD-C-005	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
WI02-C-0190-H-MAD-C-006	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
WI02-C-0190-H-MAD-C-007	No Inlet Capacity - Direct to Swale																																										
WI02-C-0191-H-MAD-C-000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	3	0	0	0	0	0	0	7		
WI02-C-0191-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI02-C-0191-H-MAD-C-002	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	0	0	0	0	0	0	0	8	
WI02-C-0324-H-MAD-C-000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	17	18	9	0	2		48		
WI02-C-0324-H-MAD-C-001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	
WI02-C-0324-H-MAD-C-002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	21	0	0	0	0	0	33	
WI02-C-0324-H-MAD-C-003	0	0	0	1	1	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	6	2	0	0	0	0	0	28	
WI02-C-0324-H-MAD-C-004	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI02-C-0324-H-MAD-C-005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1		
WI02-C-0324-H-MAD-C-006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1		
WI02-C-0324-H-MAD-C-007	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	9		
WI02-C-0324-H-MAD-C-008	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI02-C-0324-H-MAD-C-009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
WI02-C-0324-H-MAD-C-010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
WI02-C-0324-H-MAD-C-011	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
WI02-C-0324-H-MAD-C-012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	3	0	10	0		18			
WI02-D-0193-H-MAD-C-000																																											

Table E-1
Inlets by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Inlet Type	Terrace	(2) R-3067 / (2) R-1550	(2) R-4482	R-1550	R-1550/R-3067	R-1550/R-3067	R-1878-A10G	R-1878-B7G	R-4490-GX	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3067-V	R-3170	R-3290	R-3396	R-3528-V	R-4482	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	Pre1980	WisDOT	WisDOT	WisDOT	WisDOT	WisDOT	Total
Condition (Sag or Slope)	Sag	Sag	Sag	Sag	Sag	Slope	Sag	Sag	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Sag	Sag	Slope	Slope	Slope	Slope	Slope	Sag	Slope	Slope	Slope	Slope	Slope	
Slope (%)	N/A	N/A	N/A	N/A	N/A	6%	N/A	N/A	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%	6%	2%	N/A	4%	2%	N/A	N/A	0.5%	1%	2%	4%	6%	N/A	0.5%	1%	2%	4%			
Subwatershed																																								
WI02-D-0193-H-MAD-C-008	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	10	
WI02-D-0193-H-MAD-C-009	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
WI02-D-0193-H-MAD-C-010	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
WI02-D-0193-H-MAD-C-011	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5
WI02-D-0193-H-MAD-C-012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
WI02-D-0193-H-MAD-C-013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	1	0	0	0	0	0	0	6
WI02-D-0193-H-MAD-C-014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	1	0	2	0	0	0	0	0	0	7
WI02-U-1038-A-MAD-T-000	No Inlet Capacity - Manitou Pond																																							
TOTAL	6	1	1	3	4	1	4	7	2	127	16	23	73	41	8	17	5	26	57	8	16	2	1	1	0	2	215	32	40	45	54	35	51	49	23	14	2	1012		

Table E-2
Inlet Capacity Rating Curve by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets	Inlet Capacity Flow Rate (cfs) at Identified Depth															
		Water Depth (ft.)	0'	0.1'	0.2'	0.3'	0.4'	0.5'	0.6'	0.7'	0.8'	0.9'	1.0'	1.25'	1.5'	1.75'	2.0'
WI01-A-0179-H-MAD-C-001	6		0	1.0	3.2	6.2	9.9	14.3	16.2	25.1	26.5	27.9	29.1	32.0	34.5	36.8	39.0
WI01-A-0179-H-MAD-C-002	10		0	1.4	4.4	8.5	13.4	19.1	23.0	40.7	43.6	46.3	48.8	54.5	59.6	64.2	68.5
WI01-A-0179-H-MAD-C-003	7		0	1.2	3.5	6.4	9.9	13.8	18.2	38.1	41.4	44.4	47.2	53.7	59.4	64.6	69.4
WI01-A-0179-H-MAD-C-004	8		0	1.1	3.1	5.7	8.8	12.3	16.2	33.9	36.8	39.5	42.0	47.7	52.8	57.4	61.7
WI01-A-0179-H-MAD-C-005	3		0	0.4	1.2	2.1	3.3	4.6	6.1	12.7	13.8	14.8	15.7	17.9	19.8	21.5	23.1
WI01-A-0179-H-MAD-C-006	7		0	1.0	2.7	5.0	7.7	10.8	14.2	29.6	32.2	34.5	36.7	41.7	46.2	50.2	54.0
WI01-A-0180-H-MAD-C-000	3		0	0.6	1.6	2.9	4.4	6.2	8.1	16.9	18.4	19.7	21.0	23.9	26.4	28.7	30.9
WI01-A-0180-H-MAD-C-001	3		0	0.5	2.4	5.3	9.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WI01-A-0180-H-MAD-C-002	7		0	1.1	4.0	8.2	13.6	19.9	21.4	28.0	29.1	30.1	31.0	33.2	35.1	36.8	38.4
WI01-A-0183-H-MAD-C-000	5		0	1.7	4.8	8.7	13.5	18.0	22.4	40.6	44.0	47.1	50.1	56.7	62.7	68.1	73.1
WI01-A-0183-H-MAD-C-001	2		0	0.3	1.3	2.7	4.6	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
WI01-A-0183-H-MAD-C-002	6		0	1.7	4.7	8.6	13.2	18.5	24.3	50.8	55.2	59.2	63.0	71.6	79.2	86.1	92.6
WI01-A-0183-H-MAD-C-004	2		0	0.6	2.6	5.5	9.2	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
WI01-A-0183-H-MAD-C-006	3		0	0.8	3.2	6.9	11.5	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
WI01-A-0183-H-MAD-C-007	3		0	0.5	1.9	4.1	6.9	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
WI01-A-0183-H-MAD-C-008	4		0	0.6	2.6	5.5	9.2	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
WI01-A-0183-H-MAD-C-010	3		0	0.8	2.3	4.3	6.6	9.2	12.1	25.4	27.6	29.6	31.5	35.8	39.6	43.1	46.3
WI01-A-0183-H-MAD-C-011	9		0	3.5	11.5	22.8	36.6	50.8	54.2	64.3	67.0	69.5	71.8	77.1	81.9	86.3	90.4
WI01-A-0183-H-MAD-C-012	2		0	0.4	1.2	2.1	3.3	4.6	6.1	12.7	13.8	14.8	15.7	17.9	19.8	21.5	23.1
WI01-A-0183-H-MAD-C-013	6		0	2.2	7.6	15.2	24.4	34.3	37.2	50.5	52.7	54.7	56.6	60.9	64.7	68.2	71.4
WI01-A-0183-H-MAD-C-014	6		0	1.1	4.4	9.4	15.7	23.3	24.3	28.7	29.4	30.1	30.7	32.1	33.4	34.6	35.6
WI01-A-0183-H-MAD-C-016	2		0	0.6	1.6	2.9	3.4	3.8	4.2	4.5	4.8	5.1	5.4	6.0	6.6	7.1	7.6
WI01-A-0185-H-MAD-C-000	4		0	1.1	3.1	5.7	8.8	12.3	16.2	33.9	36.8	39.5	42.0	47.7	52.8	57.4	61.7
WI01-A-0185-H-MAD-C-001	4		0	1.1	3.1	5.7	8.8	12.3	16.2	33.9	36.8	39.5	42.0	47.7	52.8	57.4	61.7
WI01-A-0185-H-MAD-C-003	4		0	0.9	3.1	6.4	10.4	15.1	17.1	25.9	27.4	28.7	30.0	32.8	35.4	37.7	39.8
WI01-A-0185-H-MAD-C-004	4		0	0.9	3.1	6.4	10.4	15.1	17.1	25.9	27.4	28.7	30.0	32.8	35.4	37.7	39.8
WI01-A-0187-H-MAD-C-000	17		0	4.2	14.7	29.5	48.0	68.2	72.1	88.1	91.1	93.9	96.5	102.5	107.8	112.7	117.1
WI01-A-0187-H-MAD-C-001	7		0	0.9	3.6	7.4	12.3	17.9	18.9	23.3	24.1	24.7	25.4	26.8	28.1	29.2	30.3
WI01-A-0187-H-MAD-C-003	7		0	1.4	5.2	10.5	17.2	24.9	26.4	33.0	34.1	35.1	36.1	38.2	40.1	41.9	43.5
WI01-A-0187-H-MAD-C-004	5		0	0.4	2.0	4.4	7.5	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
WI01-A-0187-H-MAD-C-005	6		0	0.5	2.4	5.3	9.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
WI01-A-0187-H-MAD-C-006	13		0	2.6	8.3	16.0	25.4	36.3	42.5	71.3	76.0	80.4	84.5	93.8	102.0	109.6	116.5
WI01-A-0187-H-MAD-C-007	4		0	0.8	3.2	6.7	11.1	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
WI01-A-0307-H-MAD-C-000	19		0	5.5	20.4	42.2	69.4	101.5	107.8	136.5	141.2	145.6	149.7	159.0	167.3	174.8	181.8
WI01-A-0307-H-MAD-C-001	3		0	0.4	1.2	2.1	3.3	4.6	6.1	12.7	13.8	14.8	15.7	17.9	19.8	21.5	23.1
WI01-B-0181-H-MAD-C-000	4		0	0.6	1.6	2.9	4.4	6.2	8.1	16.9	18.4	19.7	21.0	23.9	26.4	28.7	30.9

Table E-2
Inlet Capacity Rating Curve by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets	Inlet Capacity Flow Rate (cfs) at Identified Depth															
		Water Depth (ft.)	0'	0.1'	0.2'	0.3'	0.4'	0.5'	0.6'	0.7'	0.8'	0.9'	1.0'	1.25'	1.5'	1.75'	2.0'
WI01-B-0181-H-MAD-C-001	6		0	1.5	4.7	9.2	14.8	21.3	25.2	42.9	45.8	48.5	51.0	56.7	61.8	66.5	70.7
WI01-B-0181-H-MAD-C-002	9		0	1.1	3.5	6.9	11.1	16.0	18.9	32.1	34.3	36.3	38.2	42.5	46.3	49.8	53.0
WI01-B-0181-H-MAD-C-003	1		0	2.9	4.0	5.2	8.9	11.9	17.9	24.8	29.3	31.8	34.2	39.4	44.0	48.2	52.0
WI01-B-0181-H-MAD-C-004	5		0	0.7	1.9	3.6	5.5	7.7	10.1	21.2	23.0	24.7	26.2	29.8	33.0	35.9	38.6
WI01-B-0181-H-MAD-C-005	2		0	0.3	0.8	1.4	2.2	3.1	4.0	8.5	9.2	9.9	10.5	11.9	13.2	14.4	15.4
WI01-B-0181-H-MAD-C-006	9		0	3.3	11.6	23.3	36.0	48.7	51.9	65.6	68.1	70.4	72.5	77.4	81.8	85.8	89.5
WI01-B-0182-H-MAD-C-000	2		0	0.3	0.8	1.4	2.2	3.1	4.0	8.5	9.2	9.9	10.5	11.9	13.2	14.4	15.4
WI01-B-0182-H-MAD-C-001	9		0	3.2	12.2	25.5	40.4	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
WI01-B-0182-H-MAD-C-002	8		0	1.6	6.0	12.3	20.3	29.7	31.2	37.8	38.9	39.9	40.9	43.0	44.9	46.6	48.2
WI01-B-0182-H-MAD-C-003	13		0	3.9	14.4	29.0	45.2	60.1	62.0	70.9	72.3	73.7	74.9	77.8	80.3	82.6	84.8
WI01-B-0182-H-MAD-C-004	12		0	4.9	19.0	39.8	64.1	87.2	87.2	87.2	87.2	87.2	87.2	87.2	87.2	87.2	87.2
WI01-B-0182-H-MAD-C-005	4		0	0.9	3.6	7.6	12.6	18.5	19.0	21.2	21.6	21.9	22.2	22.9	23.6	24.2	24.7
WI01-B-0182-H-MAD-C-006	2		0	0.6	2.6	5.5	9.2	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
WI01-B-0182-H-MAD-C-007	2		0	0.3	0.8	1.4	2.2	3.1	4.0	8.5	9.2	9.9	10.5	11.9	13.2	14.4	15.4
WI01-B-0182-H-MAD-C-009	7		0	1.7	6.4	13.1	21.6	31.5	32.5	36.9	37.7	38.3	39.0	40.4	41.7	42.8	43.9
WI01-B-0184-H-MAD-C-000	10		0	1.4	4.3	8.4	13.3	19.0	22.9	40.6	43.5	46.2	48.7	54.4	59.5	64.2	68.5
WI01-B-0184-H-MAD-C-001	14		0	2.1	7.1	14.2	23.0	33.3	37.2	54.9	57.8	60.5	63.0	68.7	73.8	78.5	82.8
WI01-B-0184-H-MAD-C-002	6		0	1.2	3.3	6.0	9.3	12.6	15.5	27.0	29.2	31.3	33.2	37.6	41.6	45.1	48.5
WI01-B-0184-H-MAD-C-004	2		0	0.6	2.6	5.5	9.2	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
WI01-B-0184-H-MAD-C-005	6		0	1.0	3.7	7.9	13.1	19.2	19.7	21.9	22.2	22.6	22.9	23.6	24.2	24.8	25.4
WI01-B-0184-H-MAD-C-006	6		0	2.4	9.6	20.0	33.2	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8
WI01-B-0184-H-MAD-C-007	20		0	6.0	19.9	39.3	63.2	88.9	97.6	132.1	138.9	145.1	151.0	164.3	176.2	187.0	197.1
WI01-B-0184-H-MAD-C-010	11		0	4.2	15.6	32.1	51.6	70.5	71.9	76.7	77.9	78.9	79.9	82.2	84.2	86.0	87.7
WI01-B-0477-H-MAD-C-000	5		0	1.8	6.7	13.9	22.3	32.1	33.3	37.9	38.8	39.6	40.3	42.1	43.7	45.1	46.4
WI01-B-0477-H-MAD-C-001	3		0	3.5	6.6	10.7	18.0	25.5	31.4	38.4	42.9	45.4	47.8	53.0	57.6	61.8	65.6
WI01-B-0477-H-MAD-C-002	6		0	0.8	2.3	4.3	6.6	9.2	12.1	25.4	27.6	29.6	31.5	35.8	39.6	43.1	46.3
WI02-A-0187-H-MAD-C-000	6		0	3.2	12.2	25.5	40.4	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
WI02-A-0187-H-MAD-C-001	18		0	4.5	12.8	23.6	36.3	50.8	66.7	139.7	151.7	162.8	173.2	196.8	217.8	236.9	254.6
WI02-A-0187-H-MAD-C-002	9		0	1.1	3.5	6.9	11.1	16.0	18.9	32.1	34.3	36.3	38.2	42.5	46.3	49.8	53.0
WI02-A-0187-H-MAD-C-003	5		0	0.7	1.9	3.6	5.5	7.7	10.1	21.2	23.0	24.7	26.2	29.8	33.0	35.9	38.6
WI02-A-0187-H-MAD-C-004	5		0	0.8	3.0	6.1	10.0	14.6	15.6	20.0	20.7	21.4	22.0	23.5	24.7	25.9	27.0
WI02-A-0187-H-MAD-C-005	4		0	0.8	3.2	6.7	11.1	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
WI02-A-0187-H-MAD-C-006	6		0	0.7	2.4	4.6	7.4	10.6	12.6	21.4	22.9	24.2	25.5	28.3	30.9	33.2	35.3
WI02-A-0187-H-MAD-C-007	6		0	0.7	2.4	4.6	7.4	10.6	12.6	21.4	22.9	24.2	25.5	28.3	30.9	33.2	35.3
WI02-A-0187-H-MAD-C-008	4		0	0.8	3.2	6.7	11.1	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
WI02-A-0187-H-MAD-C-009	12		0	4.8	19.2	40.1	66.5	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6

Table E-2
Inlet Capacity Rating Curve by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets	Inlet Capacity Flow Rate (cfs) at Identified Depth															
		Water Depth (ft.)	0'	0.1'	0.2'	0.3'	0.4'	0.5'	0.6'	0.7'	0.8'	0.9'	1.0'	1.25'	1.5'	1.75'	2.0'
WI02-A-0187-H-MAD-C-010	11		0	2.3	6.6	12.4	18.6	25.7	32.6	63.8	69.0	73.9	78.4	88.7	97.9	106.3	114.0
WI02-A-0187-H-MAD-C-011	8		0	3.7	14.6	30.4	49.1	67.8	67.8	67.8	67.8	67.8	67.8	67.8	67.8	67.8	67.8
WI02-A-0187-H-MAD-C-012	3		0	3.5	6.6	10.7	18.0	25.5	31.4	38.4	42.9	45.4	47.8	53.0	57.6	61.8	65.6
WI02-C-0186-H-MAD-C-005	11		0	4.5	17.6	36.7	59.2	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1	81.1
WI02-C-0186-H-MAD-C-006	5		0	0.8	2.3	4.3	6.6	9.2	12.1	25.4	27.6	29.6	31.5	35.8	39.6	43.1	46.3
WI02-C-0188-H-MAD-C-000	7		0	2.7	9.7	19.9	31.4	41.5	43.4	52.3	53.7	55.1	56.3	59.2	61.7	64.0	66.2
WI02-C-0188-H-MAD-C-001	10		0	2.7	10.1	21.1	34.9	49.2	51.1	59.9	61.4	62.7	64.0	66.9	69.4	71.7	73.9
WI02-C-0188-H-MAD-C-002	8		0	2.1	8.2	17.0	27.0	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3
WI02-C-0188-H-MAD-C-003	10		0	2.7	10.2	21.3	33.7	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2
WI02-C-0188-H-MAD-C-004	10		0	4.2	16.8	34.8	56.5	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4
WI02-C-0188-H-MAD-C-005	8		0	3.5	12.8	25.9	40.5	54.5	56.1	62.9	64.2	65.3	66.4	68.9	71.1	73.1	74.9
WI02-C-0188-H-MAD-C-006	8		0	3.0	12.0	25.0	41.4	59.4	59.4	59.4	59.4	59.4	59.4	59.4	59.4	59.4	59.4
WI02-C-0188-H-MAD-C-007	11		0	4.4	17.6	36.7	60.9	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4
WI02-C-0188-H-MAD-C-008	5		0	0.9	3.2	6.4	10.0	13.4	14.9	21.5	22.6	23.6	24.6	26.7	28.6	30.4	32.0
WI02-C-0188-H-MAD-C-009	3		0	0.4	1.7	3.5	5.7	8.3	8.8	11.0	11.4	11.7	12.0	12.8	13.4	14.0	14.5
WI02-C-0188-H-MAD-C-010	2		0	1.1	4.1	8.5	13.5	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
WI02-C-0188-H-MAD-C-011	5		0	0.7	1.9	3.6	5.5	7.7	10.1	21.2	23.0	24.7	26.2	29.8	33.0	35.9	38.6
WI02-C-0188-H-MAD-C-012	8		0	2.2	7.2	14.2	22.3	30.0	33.8	51.5	54.4	57.1	59.7	65.4	70.5	75.1	79.4
WI02-C-0188-H-MAD-C-013	8		0	3.7	14.3	29.8	47.2	61.8	61.8	61.8	61.8	61.8	61.8	61.8	61.8	61.8	61.8
WI02-C-0188-H-MAD-C-014	8		0	1.8	5.8	11.3	17.9	25.6	30.4	52.5	56.2	59.5	62.7	69.8	76.2	82.0	87.3
WI02-C-0188-H-MAD-C-015	16		0	6.0	23.8	49.7	82.5	121.0	122.0	126.4	127.1	127.8	128.4	129.9	131.1	132.3	133.4
WI02-C-0188-H-MAD-C-016	7		0	3.3	12.8	26.2	41.0	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1
WI02-C-0188-H-MAD-C-017	8		0	2.1	8.2	17.0	27.0	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3
WI02-C-0188-H-MAD-C-019	5		0	1.6	5.5	11.0	17.7	25.5	28.4	41.7	43.8	45.9	47.8	52.0	55.9	59.3	62.5
WI02-C-0188-H-MAD-C-020	4		0	3.7	6.3	9.5	15.5	21.1	30.0	50.2	56.9	61.5	65.7	75.2	83.6	91.3	98.3
WI02-C-0188-H-MAD-C-021	4		0	3.6	6.4	10.0	16.6	23.1	30.0	41.4	46.6	49.8	52.8	59.5	65.3	70.7	75.6
WI02-C-0188-H-MAD-C-022	4		0	1.8	6.4	12.8	20.8	27.3	29.3	38.1	39.6	40.9	42.2	45.0	47.6	49.9	52.0
WI02-C-0188-H-MAD-C-023	11		0	4.6	18.2	38.2	63.4	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3
WI02-C-0188-H-MAD-C-024	1		0	0.5	1.4	2.6	4.0	4.9	5.4	5.8	6.3	6.6	7.0	7.8	8.6	9.2	9.9
WI02-C-0190-H-MAD-C-000	11		0	2.3	7.9	15.8	25.6	37.0	41.8	63.9	67.6	71.0	74.1	81.2	87.6	93.4	98.7
WI02-C-0190-H-MAD-C-001	10		0	4.0	16.0	33.4	55.4	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3
WI02-C-0190-H-MAD-C-002	6		0	5.5	14.1	25.5	39.0	51.5	57.5	64.4	69.0	71.5	73.8	79.1	83.7	87.8	91.6
WI02-C-0190-H-MAD-C-003	8		0	2.9	10.9	22.7	36.6	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
WI02-C-0190-H-MAD-C-004	5		0	2.0	7.2	14.6	23.8	31.8	33.8	42.6	44.1	45.4	46.7	49.5	52.1	54.4	56.5
WI02-C-0190-H-MAD-C-005	7		0	2.1	8.0	16.6	27.4	40.1	42.0	50.9	52.3	53.7	54.9	57.8	60.3	62.7	64.8
WI02-C-0190-H-MAD-C-006	9		0	3.8	14.6	30.2	49.5	70.7	71.2	71.6	72.0	72.4	72.7	73.6	74.3	75.0	75.6

Table E-2
Inlet Capacity Rating Curve by Subwatershed
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets	Inlet Capacity Flow Rate (cfs) at Identified Depth															
		Water Depth (ft.)	0'	0.1'	0.2'	0.3'	0.4'	0.5'	0.6'	0.7'	0.8'	0.9'	1.0'	1.25'	1.5'	1.75'	2.0'
WI02-C-0191-H-MAD-C-000	7		0	1.8	6.4	13.2	21.2	27.8	28.8	33.2	33.9	34.6	35.2	36.6	37.9	39.1	40.1
WI02-C-0191-H-MAD-C-001	2		0	0.3	0.8	1.4	2.2	3.1	4.0	8.5	9.2	9.9	10.5	11.9	13.2	14.4	15.4
WI02-C-0191-H-MAD-C-002	8		0	1.5	5.8	12.0	19.8	29.0	30.5	37.1	38.2	39.2	40.2	42.3	44.2	46.0	47.6
WI02-C-0324-H-MAD-C-000	48		0	12.0	43.9	90.6	148.5	215.4	232.8	312.4	325.6	337.7	349.0	374.7	397.6	418.5	437.7
WI02-C-0324-H-MAD-C-001	5		0	0.7	1.9	3.6	5.5	7.7	10.1	21.2	23.0	24.7	26.2	29.8	33.0	35.9	38.6
WI02-C-0324-H-MAD-C-002	33		0	7.0	26.0	54.2	89.6	131.7	143.3	196.4	205.2	213.2	220.8	237.9	253.2	267.1	279.9
WI02-C-0324-H-MAD-C-003	28		0	7.8	24.6	47.8	74.9	105.5	123.9	204.3	218.2	231.1	243.1	270.4	294.7	316.9	337.4
WI02-C-0324-H-MAD-C-004	4		0	0.7	1.9	3.6	5.5	7.7	10.1	21.2	23.0	24.7	26.2	29.8	33.0	35.9	38.6
WI02-C-0324-H-MAD-C-005	1		0	0.2	0.8	1.8	3.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
WI02-C-0324-H-MAD-C-006	1		0	0.3	1.0	2.1	3.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
WI02-C-0324-H-MAD-C-007	9		0	3.8	14.0	28.6	46.7	66.8	67.7	68.6	69.4	70.2	70.9	72.5	74.0	75.4	76.7
WI02-C-0324-H-MAD-C-008	2		0	0.6	1.6	2.9	4.4	6.2	8.1	16.9	18.4	19.7	21.0	23.9	26.4	28.7	30.9
WI02-C-0324-H-MAD-C-009	4		0	0.9	2.6	4.7	7.3	9.6	11.5	18.5	20.0	21.4	22.7	25.7	28.4	30.8	33.0
WI02-C-0324-H-MAD-C-010	2		0	0.3	0.8	1.4	2.2	3.1	4.0	8.5	9.2	9.9	10.5	11.9	13.2	14.4	15.4
WI02-C-0324-H-MAD-C-011	6		0	1.2	3.5	6.4	9.9	13.8	18.2	38.1	41.4	44.4	47.2	53.7	59.4	64.6	69.4
WI02-C-0324-H-MAD-C-012	18		0	5.5	21.1	43.7	72.1	105.6	109.0	124.5	127.0	129.4	131.6	136.6	141.0	145.1	148.8
WI02-D-0193-H-MAD-C-000	3		0	1.0	3.0	5.4	8.4	11.1	13.5	22.8	24.6	26.4	28.0	31.7	35.0	38.0	40.7
WI02-D-0193-H-MAD-C-001	12		0	3.3	9.3	17.2	26.4	36.9	48.5	101.6	110.3	118.4	126.0	143.1	158.4	172.3	185.1
WI02-D-0193-H-MAD-C-002	13		0	4.4	14.9	29.3	47.1	67.1	74.4	105.8	111.3	116.4	121.1	131.9	141.6	150.4	158.5
WI02-D-0193-H-MAD-C-003	7		0	2.1	6.3	11.9	18.7	26.6	32.4	58.9	63.3	67.3	71.1	79.7	87.3	94.3	100.7
WI02-D-0193-H-MAD-C-004	9		0	2.1	6.3	12.0	18.9	26.8	33.1	61.8	66.6	70.9	75.0	84.3	92.6	100.1	107.1
WI02-D-0193-H-MAD-C-005	8		0	5.1	19.2	38.1	54.8	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
WI02-D-0193-H-MAD-C-006	4		0	2.3	8.9	18.7	30.2	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
WI02-D-0193-H-MAD-C-007	9		0	2.8	10.8	22.5	37.0	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3	49.3
WI02-D-0193-H-MAD-C-008	10		0	3.3	12.4	25.6	42.0	56.4	57.4	61.8	62.5	63.2	63.8	65.3	66.5	67.7	68.8
WI02-D-0193-H-MAD-C-009	5		0	1.7	6.5	13.6	22.5	32.9	33.9	38.3	39.0	39.7	40.3	41.8	43.0	44.2	45.3
WI02-D-0193-H-MAD-C-010	4		0	1.2	4.1	8.3	13.6	19.7	21.7	30.5	32.0	33.3	34.6	37.4	40.0	42.3	44.4
WI02-D-0193-H-MAD-C-011	5		0	0.8	2.3	4.3	6.6	9.2	12.1	25.4	27.6	29.6	31.5	35.8	39.6	43.1	46.3
WI02-D-0193-H-MAD-C-012	4		0	1.3	4.8	10.0	16.4	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
WI02-D-0193-H-MAD-C-013	6		0	1.5	5.7	11.7	18.7	24.5	25.0	27.2	27.6	27.9	28.2	28.9	29.6	30.1	30.7
WI02-D-0193-H-MAD-C-014	7		0	1.4	5.0	10.2	16.6	22.7	24.1	30.7	31.8	32.9	33.8	35.9	37.8	39.6	41.2

Table E-3
Cumulative Inlet Capacity vs. Subwatershed Runoff
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets in Subwatershed	Peak Hydrologic Runoff Rate - Model Output (cfs)		Composite Inlet Capacity in Subwatershed		Is Inlet Capacity Greater than Peak Runoff Rate?		
		Storm Event		Water Depth (ft)*		10-yr		25-yr
		10-yr	25-yr	0.25-ft	0.55-ft	0.25-ft	0.5-ft	0.55-ft
WIO1-A-0179-H-MAD-C-001	6	26.0	35.0	4.6	15.2	No	No	No
WIO1-A-0179-H-MAD-C-002	10	36.2	48.2	6.3	21.0	No	No	No
WIO1-A-0179-H-MAD-C-003	7	43.1	57.8	4.9	16.0	No	No	No
WIO1-A-0179-H-MAD-C-004	8	45.8	61.4	4.4	14.2	No	No	No
WIO1-A-0179-H-MAD-C-005	3	12.9	17.5	1.6	5.3	No	No	No
WIO1-A-0179-H-MAD-C-006	7	40.5	53.8	3.8	12.5	No	No	No
WIO1-A-0180-H-MAD-C-000	3	12.1	15.7	2.2	7.1	No	No	No
WIO1-A-0180-H-MAD-C-001	3	22.6	29.7	3.7	13.5	No	No	No
WIO1-A-0180-H-MAD-C-002	7	68.1	88.5	5.9	20.6	No	No	No
WIO1-A-0183-H-MAD-C-000	5	38.7	50.7	6.7	20.2	No	No	No
WIO1-A-0183-H-MAD-C-001	2	32.0	40.4	2.0	6.8	No	No	No
WIO1-A-0183-H-MAD-C-002	6	8.3	10.5	6.5	21.4	No	Yes	Yes
WIO1-A-0183-H-MAD-C-004	2	51.8	65.1	3.9	13.6	No	No	No
WIO1-A-0183-H-MAD-C-006	3	21.1	26.7	4.9	17.0	No	No	No
WIO1-A-0183-H-MAD-C-007	3	25.5	31.7	2.9	10.2	No	No	No
WIO1-A-0183-H-MAD-C-008	4	29.3	37.2	3.9	13.6	No	No	No
WIO1-A-0183-H-MAD-C-010	3	9.6	12.6	3.3	10.7	No	Yes	No
WIO1-A-0183-H-MAD-C-011	9	20.5	27.8	16.8	52.5	No	Yes	Yes
WIO1-A-0183-H-MAD-C-012	2	27.4	36.0	1.6	5.3	No	No	No
WIO1-A-0183-H-MAD-C-013	6	16.6	21.6	11.1	35.8	No	Yes	Yes
WIO1-A-0183-H-MAD-C-014	6	21.3	27.1	6.7	23.8	No	Yes	No
WIO1-A-0183-H-MAD-C-016	2	12.1	15.3	2.3	4.0	No	No	No
WIO1-A-0185-H-MAD-C-000	4	50.6	68.9	4.4	14.2	No	No	No
WIO1-A-0185-H-MAD-C-001	4	24.1	31.4	4.4	14.2	No	No	No
WIO1-A-0185-H-MAD-C-003	4	22.9	29.4	4.7	16.1	No	No	No
WIO1-A-0185-H-MAD-C-004	4	38.4	50.2	4.7	16.1	No	No	No
WIO1-A-0187-H-MAD-C-000	17	42.9	55.3	21.7	70.2	No	Yes	Yes
WIO1-A-0187-H-MAD-C-001	7	16.5	21.1	5.4	18.4	No	Yes	No
WIO1-A-0187-H-MAD-C-003	7	34.7	43.6	7.7	25.7	No	No	No
WIO1-A-0187-H-MAD-C-004	5	56.3	69.7	3.1	11.2	No	No	No

Table E-3
Cumulative Inlet Capacity vs. Subwatershed Runoff
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets in Subwatershed	Peak Hydrologic Runoff Rate - Model Output (cfs)		Composite Inlet Capacity in Subwatershed		Is Inlet Capacity Greater than Peak Runoff Rate?		
		Storm Event		Water Depth (ft)*		10-yr		25-yr
		10-yr	25-yr	0.25-ft	0.55-ft	0.25-ft	0.5-ft	0.55-ft
WIO1-A-0187-H-MAD-C-005	6	63.9	79.8	3.7	13.5	No	No	No
WIO1-A-0187-H-MAD-C-006	13	16.5	21.7	11.9	39.4	No	Yes	Yes
WIO1-A-0187-H-MAD-C-007	4	38.9	50.1	4.8	16.3	No	No	No
WIO1-A-0307-H-MAD-C-000	19	27.7	35.3	30.6	104.6	Yes	Yes	Yes
WIO1-A-0307-H-MAD-C-001	3	47.0	59.2	1.6	5.3	No	No	No
WIO1-B-0181-H-MAD-C-000	4	14.2	19.5	2.2	7.1	No	No	No
WIO1-B-0181-H-MAD-C-001	6	21.3	28.9	6.8	23.3	No	Maybe	No
WIO1-B-0181-H-MAD-C-002	9	43.5	57.5	5.1	17.4	No	No	No
WIO1-B-0181-H-MAD-C-003	1	20.2	28.1	4.6	14.9	No	No	No
WIO1-B-0181-H-MAD-C-004	5	27.0	35.8	2.7	8.9	No	No	No
WIO1-B-0181-H-MAD-C-005	2	16.7	23.3	1.1	3.6	No	No	No
WIO1-B-0181-H-MAD-C-006	9	27.6	36.2	17.1	50.3	No	Yes	Yes
WIO1-B-0182-H-MAD-C-000	2	19.8	26.5	1.1	3.6	No	No	No
WIO1-B-0182-H-MAD-C-001	9	22.9	31.5	18.4	53.0	No	Yes	Yes
WIO1-B-0182-H-MAD-C-002	8	19.0	25.7	8.9	30.4	No	Yes	Yes
WIO1-B-0182-H-MAD-C-003	13	47.3	64.2	21.4	61.0	No	Yes	Maybe
WIO1-B-0182-H-MAD-C-004	12	55.7	75.8	28.6	87.2	No	Yes	Yes
WIO1-B-0182-H-MAD-C-005	4	19.8	27.3	5.4	18.8	No	Maybe	No
WIO1-B-0182-H-MAD-C-006	2	27.1	37.7	3.9	13.6	No	No	No
WIO1-B-0182-H-MAD-C-007	2	21.8	29.4	1.1	3.6	No	No	No
WIO1-B-0182-H-MAD-C-009	7	27.7	37.6	9.5	32.0	No	Yes	No
WIO1-B-0184-H-MAD-C-000	10	41.5	51.7	6.2	21.0	No	No	No
WIO1-B-0184-H-MAD-C-001	14	35.1	47.4	10.5	35.3	No	Maybe	No
WIO1-B-0184-H-MAD-C-002	6	16.1	22.4	4.6	14.1	No	No	No
WIO1-B-0184-H-MAD-C-004	2	43.7	58.9	3.9	13.6	No	No	No
WIO1-B-0184-H-MAD-C-005	6	42.9	58.7	5.7	19.4	No	No	No
WIO1-B-0184-H-MAD-C-006	6	50.9	65.8	14.5	48.8	No	Maybe	No
WIO1-B-0184-H-MAD-C-007	20	48.2	63.3	29.0	93.2	No	Yes	Yes
WIO1-B-0184-H-MAD-C-010	11	43.0	55.6	23.3	71.2	No	Yes	Yes

Table E-3
Cumulative Inlet Capacity vs. Subwatershed Runoff
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets in Subwatershed	Peak Hydrologic Runoff Rate - Model Output (cfs)		Composite Inlet Capacity in Subwatershed		Is Inlet Capacity Greater than Peak Runoff Rate?		
		Storm Event		Water Depth (ft)*		10-yr		25-yr
		10-yr	25-yr	0.25-ft	0.55-ft	0.25-ft	0.5-ft	0.55-ft
WIO1-B-0477-H-MAD-C-000	5	45.0	65.2	10.1	32.7	No	No	No
WIO1-B-0477-H-MAD-C-001	3	9.5	13.3	8.5	28.5	No	Yes	Yes
WIO1-B-0477-H-MAD-C-002	6	47.6	66.3	3.3	10.7	No	No	No
WIO2-A-0187-H-MAD-C-000	6	26.1	34.6	18.4	53.0	No	Yes	Yes
WIO2-A-0187-H-MAD-C-001	18	28.8	38.2	17.9	58.7	No	Yes	Yes
WIO2-A-0187-H-MAD-C-002	9	27.8	37.5	5.1	17.4	No	No	No
WIO2-A-0187-H-MAD-C-003	5	24.2	31.9	2.7	8.9	No	No	No
WIO2-A-0187-H-MAD-C-004	5	23.0	30.9	4.5	15.1	No	No	No
WIO2-A-0187-H-MAD-C-005	4	25.6	35.0	4.8	16.3	No	No	No
WIO2-A-0187-H-MAD-C-006	6	29.1	39.2	3.4	11.6	No	No	No
WIO2-A-0187-H-MAD-C-007	6	31.9	43.5	3.4	11.6	No	No	No
WIO2-A-0187-H-MAD-C-008	4	55.8	75.0	4.8	16.3	No	No	No
WIO2-A-0187-H-MAD-C-009	12	24.7	32.1	28.9	97.6	Yes	Yes	Yes
WIO2-A-0187-H-MAD-C-010	11	34.0	45.0	9.4	29.2	No	No	No
WIO2-A-0187-H-MAD-C-011	8	20.0	26.6	21.9	67.8	Maybe	Yes	Yes
WIO2-A-0187-H-MAD-C-012	3	18.0	23.7	8.5	28.5	No	Yes	Yes
WIO2-C-0186-H-MAD-C-005	11	16.8	22.2	26.5	81.1	Yes	Yes	Yes
WIO2-C-0186-H-MAD-C-006	5	15.3	20.5	3.3	10.7	No	No	No
WIO2-C-0188-H-MAD-C-000	7	15.4	19.9	14.4	42.4	Maybe	Yes	Yes
WIO2-C-0188-H-MAD-C-001	10	22.2	29.5	15.2	50.1	No	Yes	Yes
WIO2-C-0188-H-MAD-C-002	8	45.6	59.6	12.2	35.3	No	No	No
WIO2-C-0188-H-MAD-C-003	10	24.2	31.5	15.3	44.2	No	Yes	Yes
WIO2-C-0188-H-MAD-C-004	10	20.2	27.3	25.3	81.4	Yes	Yes	Yes
WIO2-C-0188-H-MAD-C-005	8	52.5	69.0	19.0	55.3	No	Maybe	No
WIO2-C-0188-H-MAD-C-006	8	22.8	31.1	18.1	59.4	No	Yes	Yes
WIO2-C-0188-H-MAD-C-007	11	42.4	58.1	26.5	89.4	No	Yes	Yes
WIO2-C-0188-H-MAD-C-008	5	22.2	30.0	4.7	14.2	No	No	No
WIO2-C-0188-H-MAD-C-009	3	17.4	23.5	2.5	8.6	No	No	No
WIO2-C-0188-H-MAD-C-010	2	27.1	36.6	6.1	17.7	No	No	No

Table E-3
Cumulative Inlet Capacity vs. Subwatershed Runoff
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets in Subwatershed	Peak Hydrologic Runoff Rate - Model Output (cfs)		Composite Inlet Capacity in Subwatershed		Is Inlet Capacity Greater than Peak Runoff Rate?		
		Storm Event		Water Depth (ft)*		10-yr		25-yr
		10-yr	25-yr	0.25-ft	0.55-ft	0.25-ft	0.5-ft	0.55-ft
WIO2-C-0188-H-MAD-C-011	5	10.9	14.4	2.7	8.9	No	No	No
WIO2-C-0188-H-MAD-C-012	8	16.2	22.2	10.5	31.9	No	Yes	Yes
WIO2-C-0188-H-MAD-C-013	8	10.1	12.8	21.4	61.8	Yes	Yes	Yes
WIO2-C-0188-H-MAD-C-014	8	17.6	23.9	8.4	28.0	No	Yes	Yes
WIO2-C-0188-H-MAD-C-015	16	32.8	43.5	35.9	121.5	Maybe	Yes	Yes
WIO2-C-0188-H-MAD-C-016	7	15.3	20.5	19.3	57.1	Yes	Yes	Yes
WIO2-C-0188-H-MAD-C-017	8	23.5	31.2	12.2	35.3	No	Yes	Yes
WIO2-C-0188-H-MAD-C-019	5	19.3	26.3	8.1	26.9	No	Yes	Maybe
WIO2-C-0188-H-MAD-C-020	4	28.7	38.2	7.9	25.6	No	No	No
WIO2-C-0188-H-MAD-C-021	4	18.0	24.3	8.1	26.6	No	Yes	Maybe
WIO2-C-0188-H-MAD-C-022	4	25.7	33.8	9.4	28.3	No	Maybe	No
WIO2-C-0188-H-MAD-C-023	11	33.9	45.7	27.5	90.3	No	Yes	Yes
WIO2-C-0188-H-MAD-C-024	1	7.3	10.2	2.0	5.2	No	No	No
WIO2-C-0190-H-MAD-C-000	11	17.8	24.4	11.6	39.4	No	Yes	Yes
WIO2-C-0190-H-MAD-C-001	10	16.2	21.0	24.1	81.3	Yes	Yes	Yes
WIO2-C-0190-H-MAD-C-002	6	10.7	13.8	19.8	54.5	Yes	Yes	Yes
WIO2-C-0190-H-MAD-C-003	8	22.2	29.8	16.4	47.7	No	Yes	Yes
WIO2-C-0190-H-MAD-C-004	5	10.4	13.4	10.6	32.8	Maybe	Yes	Yes
WIO2-C-0190-H-MAD-C-005	7	8.1	10.6	12.0	41.1	Yes	Yes	Yes
WIO2-C-0190-H-MAD-C-006	9	17.4	23.3	21.9	70.9	Yes	Yes	Yes
WIO2-C-0191-H-MAD-C-000	7	18.2	24.0	9.5	28.3	No	Yes	Yes
WIO2-C-0191-H-MAD-C-001	2	14.6	20.2	1.1	3.6	No	No	No
WIO2-C-0191-H-MAD-C-002	8	23.6	31.4	8.7	29.8	No	Yes	Maybe
WIO2-C-0324-H-MAD-C-000	48	50.0	64.5	65.7	224.1	Yes	Yes	Yes
WIO2-C-0324-H-MAD-C-001	5	33.3	42.9	2.7	8.9	No	No	No
WIO2-C-0324-H-MAD-C-002	33	14.3	18.8	39.2	137.5	Yes	Yes	Yes
WIO2-C-0324-H-MAD-C-003	28	16.0	20.3	35.5	114.7	Yes	Yes	Yes
WIO2-C-0324-H-MAD-C-004	4	14.9	20.3	2.7	8.9	No	No	No
WIO2-C-0324-H-MAD-C-005	1	14.8	19.3	1.2	4.5	No	No	No

Table E-3
Cumulative Inlet Capacity vs. Subwatershed Runoff
Wingra West Watershed Study, City of Madison, WI

Subwatershed	Total # of Inlets in Subwatershed	Peak Hydrologic Runoff Rate - Model Output (cfs)		Composite Inlet Capacity in Subwatershed		Is Inlet Capacity Greater than Peak Runoff Rate?		
		Storm Event		Water Depth (ft)*		10-yr		25-yr
		10-yr	25-yr	0.25-ft	0.55-ft	0.25-ft	0.5-ft	0.55-ft
WIO2-C-0324-H-MAD-C-006	1	12.9	17.2	1.5	4.4	No	No	No
WIO2-C-0324-H-MAD-C-007	9	8.3	11.1	20.8	67.3	Yes	Yes	Yes
WIO2-C-0324-H-MAD-C-008	2	24.9	32.4	2.2	7.1	No	No	No
WIO2-C-0324-H-MAD-C-009	4	32.8	42.2	3.6	10.5	No	No	No
WIO2-C-0324-H-MAD-C-010	2	24.7	34.1	1.1	3.6	No	No	No
WIO2-C-0324-H-MAD-C-011	6	25.6	33.9	4.9	16.0	No	No	No
WIO2-C-0324-H-MAD-C-012	18	51.2	63.8	31.6	107.3	No	Yes	Yes
WIO2-D-0193-H-MAD-C-000	3	14.5	20.1	4.1	12.3	No	No	No
WIO2-D-0193-H-MAD-C-001	12	10.9	14.2	13.1	42.7	Yes	Yes	Yes
WIO2-D-0193-H-MAD-C-002	13	13.5	17.5	21.6	70.7	Yes	Yes	Yes
WIO2-D-0193-H-MAD-C-003	7	16.3	21.3	8.9	29.5	No	Yes	Yes
WIO2-D-0193-H-MAD-C-004	9	29.4	40.3	9.0	29.9	No	Maybe	No
WIO2-D-0193-H-MAD-C-005	8	30.0	40.0	28.9	68.3	Maybe	Yes	Yes
WIO2-D-0193-H-MAD-C-006	4	30.8	42.3	13.4	41.3	No	Yes	Maybe
WIO2-D-0193-H-MAD-C-007	9	31.2	39.7	16.2	49.3	No	Yes	Yes
WIO2-D-0193-H-MAD-C-008	10	33.1	44.8	18.5	56.9	No	Yes	Yes
WIO2-D-0193-H-MAD-C-009	5	29.0	39.4	9.8	33.4	No	Yes	No
WIO2-D-0193-H-MAD-C-010	4	15.4	21.2	6.1	20.7	No	Yes	Maybe
WIO2-D-0193-H-MAD-C-011	5	10.9	14.2	3.3	10.7	No	Maybe	No
WIO2-D-0193-H-MAD-C-012	4	8.9	12.0	7.2	21.2	No	Yes	Yes
WIO2-D-0193-H-MAD-C-013	6	41.7	55.8	8.5	24.7	No	No	No
WIO2-D-0193-H-MAD-C-014	7	16.4	21.9	7.4	23.4	No	Yes	Maybe

* Equals flow depth for slope inlets and ponding depth for sag inlets

NOTE: Yes = Inlet capacity is more than 110% of the pipe capacity.

Maybe = Inlet capacity is between 90% and 110% of pipe capacity.

No = Inlet capacity is less than 90% of pipe capacity.

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
University Research Park Central Pond - Northeast Inlet Sewer											
AS3256-005	4	3256-005_3256-004	21	15.9	0	AS3256-004	4	5.5	19.1	No	Yes
AS3256-004	0	3256-004_3256-001	21	17.1	1	AS3256-001	4	5.5	19.1	No	Yes
AS3256-001	2	3256-001_3157-010	27	27.5	1	AS3157-010	6	8.8	31.1	No	Yes
AS3157-010	2	3157-010_3157-009	27	27.7	1	PD_3157-013	8	11.0	38.2	No	Yes
University Research Park Central Pond - Southeast Inlet Sewer											
IN3257-007	2	3257-007_3257-008	18	10.8	0	IN3257-008	2	2.2	7.1	No	No
IN3257-008	1	3257-008_3257-009	21	17.5	1	IN3257-009	3	3.3	10.6	No	No
IN3257-009	3	3257-009_3257-005	24	13.6	1	PD_3157-013	6	6.5	21.3	No	Yes
University Research Park Southwest Pond - North Inlet Sewer											
IN3158-011	4	3158-011_3158-012	18	6.9	0	IN3158-012	4	4.4	14.2	No	Yes
IN3158-012	1	3158-012_3158-013	18	10.1	1	PD_3158-015	5	5.4	17.7	No	Yes
University Research Park Southwest Pond - Northwest Inlet Sewer											
AS3158-001	5	3158-001_3158-004	15	14.6	0	AS3158-004	5	9.4	27.2	No	Yes
AS3158-004	0	3158-004_3158-006	21	17.7	2	AS3158-006	5	9.4	27.2	No	Yes
AS3158-006	1	3158-006_3158-009	24x38	33.9	2	PD_3158-015	6	10.5	30.8	No	Maybe
PD_3158-015	0	BC_JCT_93_3158-014	21	11.2	2	PD3158-014	11	15.9	48.5	Yes	Yes
Odana Pond - Whitney Way Inlet											
IN3058-008	4	3058-008_3058-009	12	8.3	1	IN3058-009	4	6.8	23.7	No	Yes
IN3058-009	1	3058-009_3058-010	12	6.5	1	IN3058-010	5	7.9	27.2	Yes	Yes
IN3058-010	3	3058-010_3058-011	12	7.9	1	IN3058-011	8	12.9	44.3	Yes	Yes
IN3058-011	1	3058-011_3059-010	15	12.3	1	AS3059-010	9	15.3	52.5	Yes	Yes
IN3058-004	2	3058-004_3058-003	12	3.2	0	IN3058-003	2	2.7	9.5	No	Yes
IN3058-003	1	3058-003_3058-002	12	5.0	1	AS3058-002	3	4.4	15.5	No	Yes
AS3058-002	1	3058-002_3059-010	18	16.0	2	AS3059-010	4	5.0	17.8	No	Yes
AS3059-010	1	3059-010_3059-004	18	16.9	3	AS3059-004	14	23.4	79.1	Yes	Yes
AS3059-016	2	3059-016_3059-015	21	13.3	1	AS3059-015	2	1.6	5.3	No	No
AS3059-015	0	3059-015_BC_JCT_1	21	8.0	1	BC_JCT_1	2	1.6	5.3	No	No
BC_JCT_1	0	BC_JCT_1_3059-018	21	39.5	1	AS3059-018	2	1.6	5.3	No	No
AS3059-018	0	3059-018_3059-013	21	11.2	2	IN3059-013	2	1.6	5.3	No	No
IN3059-013	1	3059-013_3059-012	21	11.2	1	IN3059-012	3	2.8	7.3	No	No
IN3059-012	1	3059-012_3059-003	21	9.9	1	IN3059-003	4	3.9	9.3	No	Maybe
IN3059-003	1	3059-003_3059-004	21	10.2	1	AS3059-004	5	4.9	12.7	No	Yes
AS3059-004	1	3059-004_3159-016	27	33.0	2	AS3159-016	20	29.3	95.2	No	Yes
AS3159-016	2	3159-016_3159-013	27	47.8	2	AS3159-013	22	31.2	102.0	No	Yes
PD3158-014	0	3158-014_3159-006	36	73.5	2	IN3159-006	11	15.9	48.5	No	No

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
IN3159-006	1	3159-006_3159-007	36	2.1	1	AS3159-007	12	17.0	52.1	Yes	Yes
AS3159-007	5	3159-007_3159-008	34x53	59.5	2	AS3159-008	17	22.5	69.8	No	Yes
AS3159-008	2	3159-008_3159-011	42	55.1	3	IN3159-011	19	26.4	83.4	No	Yes
IN3159-011	2	3159-011_3159-014	42	54.8	1	AS3159-014	21	30.3	97.0	No	Yes
AS3159-014	1	3159-014_3159-012	42	57.2	1	IN3159-012	22	31.3	100.4	No	Yes
IN3159-012	2	3159-012_3159-013	42	61.2	2	AS3159-013	24	33.2	107.2	No	Yes
AS3159-013	1	3159-013_3160-002	48	121.2	3	AS3160-002	47	65.4	212.5	No	Yes
AS3160-002	2	3160-002_BC_JCT_21	48	184.0	3	BC_JCT_21	49	67.4	219.3	No	Yes
BC_JCT_21	0	BC_JCT_21_3160-007	48	184.7	1	AS3160-007	49	67.4	219.3	No	Yes
AS3160-015	2	3160-015_3160-014	24	37.3	1	AS3160-014	2	3.4	9.5	No	No
AS3160-014	1	3160-014_3160-009	24	24.1	1	AS3160-009	3	4.5	13.1	No	No
AS3160-009	0	3160-009_3160-008	24	32.7	2	AS3160-008	3	4.5	13.1	No	No
AS3160-008	0	3160-008_3160-007	24	36.9	1	AS3160-007	3	4.5	13.1	No	No
AS3160-007	1	3160-007_3261-027	48	230.2	2	AS3261-027	53	73.0	235.9	No	Maybe
AS3261-027	0	3261-027_BC_JCT_96	48	214.5	1	BC_JCT_96	53	73.0	235.9	No	Maybe
BC_JCT_96	2	BC_JCT_96_BC_JCT_97	48	240.2	1	BC_JCT_97	55	76.0	246.3	No	Maybe
BC_JCT_97	1	BC_JCT_97_BC_JCT_98	48	194.7	1	BC_JCT_98	56	78.0	253.1	No	Yes
BC_JCT_98	3	BC_JCT_98_BC_JCT_99	54	140.8	1	BC_JCT_99	59	81.2	263.7	No	Yes
BC_JCT_99	2	BC_JCT_99_BC_JCT_100	54	138.9	1	BC_JCT_100	61	83.4	270.8	No	Yes
BC_JCT_100	2	BC_JCT_100_BC_JCT_101	54	141.0	1	BC_JCT_101	63	87.3	284.4	No	Yes
IN3261-008	3	3261-008_3261-004	21	35.3	1	IN3261-004	3	1.6	5.3	No	No
IN3261-004	1	3261-004_BC_JCT_101	21	21.3	1	BC_JCT_101	4	2.2	7.1	No	No
BC_JCT_101	2	BC_JCT_101_BC_JCT_102	60	186.4	3	BC_JCT_102	69	93.4	305.1	No	Yes
BC_JCT_102	2	BC_JCT_102_3261-041	60	188.0	1	IN3261-041	71	97.3	318.6	No	Yes
IN3261-041	2	3261-041_BC_JCT_16	5'x5'	451.9	1	BC_JCT_16	73	102.1	332.8	No	No
IN3258-005	3	3258-005_3258-002	15	4.0	2	AS3258-002	3	7.2	24.4	Yes	Yes
AS3258-002	3	3258-002_3259-003	24	23.4	1	IN3259-003	6	9.9	33.3	No	Yes
IN3259-003	3	3259-003_3259-002	27	58.4	1	AS3259-002	9	15.3	51.3	No	No
AS3259-002	0	3259-002_3259-001	36	64.8	1	IN3259-001	9	15.3	51.3	No	No
IN3259-001	1	3259-001_3359-006	36	64.5	1	AS3359-006	10	15.9	53.1	No	No
IN3358-006	5	3358-006_3358-008	24	12.8	2	IN3358-008	5	6.0	20.3	No	Yes
IN3358-008	3	3358-008_3359-005	24	32.8	1	IN3359-005	8	7.7	25.6	No	No
IN3359-005	1	3359-005_3359-004	24	33.2	1	IN3359-004	9	8.2	27.4	No	No
IN3359-004	2	3359-004_3359-006	24	28.6	1	AS3359-006	11	9.3	31.0	No	Maybe
AS3359-006	0	3359-006_3359-008	42	78.5	3	AS3359-008	21	25.1	84.0	No	Maybe
IN3259-007	3	3259-007_3259-010	18	15.3	0	IN3259-010	3	1.9	6.7	No	No

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
IN3259-010	1	3259-010_3359-010	18	15.2	1	IN3359-010	4	2.5	9.0	No	No
IN3359-010	2	3359-010_3359-008	18	17.4	1	AS3359-008	6	3.7	13.5	No	No
AS3359-008	1	3360-001_3359-008	42	73.9	3	AS3360-001	28	29.5	99.8	No	Yes
IN3260-001	1	3260-001_3260-002	30	69.3	2	IN3260-002	1	0.6	2.2	No	No
IN3260-002	1	3260-002_3360-003	30	67.7	1	IN3360-003	2	1.2	4.5	No	No
IN3360-003	1	3360-003_3360-001	30	67.2	1	AS3360-001	3	1.9	6.7	No	No
AS3360-001	1	3360-004_3360-001	48	192.3	2	AS3360-004	32	32.0	108.7	No	No
AS3360-004	7	3360-004_3361-002	48	167.3	2	AS3361-002	39	37.4	127.2	No	No
IN3261-003	5	3261-003_3361-017	18	21.2	1	IN3361-017	5	4.0	13.5	No	No
IN3361-017	1	3361-017_3361-006	18	21.2	1	IN3361-006	6	5.2	17.5	No	No
IN3361-006	1	3361-006_3361-002	18	20.4	1	AS3361-002	7	6.5	21.6	No	Maybe
AS3361-002	0	3361-002_BC_JCT_48	48	139.4	2	BC_JCT_48	46	43.8	148.8	No	Maybe
IN3360-022	1	3360-022_3360-021	18	13.0	1	AS3360-021	1	1.7	6.0	No	No
AS3360-021	2	3360-021_3360-020	18	18.1	1	AS3360-020	3	5.0	18.0	No	Maybe
AS3360-020	0	3360-020_3360-019	18	10.8	1	AS3360-019	3	5.0	18.0	No	Yes
AS3360-019	4	3360-019_3360-007	36	36.3	2	AS3360-007	7	7.9	28.3	No	No
AS3360-007	2	3360-007_3360-015	36	32.2	1	AS3360-015	9	10.1	36.0	No	Yes
AS3360-015	0	3360-015_3360-016	48	201.8	1	AS3360-016	9	10.1	36.0	No	No
AS3360-016	0	3360-016_3361-001	48	120.8	1	AS3361-001	9	10.1	36.0	No	No
AS3361-001	3	3361-001_BC_JCT_48	48	109.7	2	BC_JCT_48	12	12.3	43.1	No	No
BC_JCT_48	1	BC_JCT_48_BC_JCT_49	48	207.5	2	BC_JCT_49	59	58.5	200.0	No	Maybe
BC_JCT_49	1	BC_JCT_49_3361-016	48	189.9	1	IN3361-016	60	60.9	208.1	No	Maybe
IN3261-044	2	3261-044_BC_JCT_22	18	15.8	1	BC_JCT_22	2	1.6	5.3	No	No
BC_JCT_22	0	BC_JCT_22_3261-013	18	17.2	1	IN3261-013	2	1.6	5.3	No	No
IN3261-013	1	3261-013_3261-015	18	17.1	1	IN3261-015	3	2.8	9.4	No	No
IN3261-015	1	3261-015_3361-013	18	18.6	1	IN3361-013	4	4.0	13.5	No	No
IN3361-013	1	3361-013_3361-016	18	19.8	1	IN3361-016	5	5.2	17.5	No	No
IN3361-016	3	3361-016_BC_JCT_16	48	30.8	2	BC_JCT_16	68	69.1	235.6	Yes	Yes
BC_JCT_16	6	BC_JCT_16_3362-018	5'x7'	847.3	2	PD_3462-001	147	177.4	588.3	No	No
Odana Pond - Dearholt Road Inlet											
AS3459-025	3	3459-025_3460-001	18	4.6	1	AS3460-001	3	1.6	5.3	No	Yes
AS3460-001	2	3460-001_3460-002	18	4.5	1	AS3460-002	5	2.7	8.9	No	Yes
AS3460-002	1	3460-002_3460-003	18	4.6	2	AS3460-003	6	3.3	10.6	No	Yes
AS3460-003	2	3460-003_3460-007	18	4.4	1	AS3460-007	8	4.4	14.2	Maybe	Yes
AS3460-007	2	3460-007_3460-008	18	7.2	1	AS3460-008	10	5.4	17.7	No	Yes
AS3460-008	2	3460-008_3460-023	18	12.6	1	AS3460-023	12	6.5	21.3	No	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3460-023	2	3460-023_3460-022	24	13.8	1	AS3460-022	14	8.5	28.1	No	Yes
AS3460-022	6	3460-022_3461-007	24	13.0	2	AS3461-007	20	11.7	38.7	Maybe	Yes
AS3461-007	2	3461-007_3461-008	24	17.6	1	AS3461-008	22	13.9	45.8	No	Yes
AS3461-008	5	3461-008_3461-016	24	20.8	2	PD_3462-001	27	16.6	54.7	No	Yes
Odana Pond - Dearholt Road Inlet											
AS3560-004	3	3560-004_3560-001	15	2.4	0	AS3560-001	3	1.6	5.3	No	Yes
AS3560-002	4	3560-002_3560-001	18	22.3	1	AS3560-001	4	2.2	7.1	No	No
AS3560-001	1	3560-001_3460-019	24	29.1	2	AS3460-019	8	4.4	14.2	No	No
AS3460-019	2	3460-019_3461-001	24	33.6	1	AS3461-001	10	6.8	22.3	No	No
AS3461-001	2	3461-006_3461-001	24	10.1	2	AS3461-006	12	7.8	25.9	No	Yes
AS3461-006	2	3461-006_3461-020	24	24.7	1	PD_3462-001	14	8.9	29.4	No	Yes
Orchard Ridge Valley Park Pond - Northwest Inlet											
AS3161-013	2	3161-013_3161-012	21	34.2	1	AS3161-012	2	3.9	13.6	No	No
AS3161-012	0	3161-012_3161-011	21	24.5	1	AS3161-011	2	3.9	13.6	No	No
AS3161-011	1	3161-011_3161-010	21	29.4	1	AS3161-010	3	6.3	21.7	No	No
AS3161-014	6	3161-014_3161-010	18	18.2	1	AS3161-010	6	14.5	48.8	No	Yes
AS3161-010	1	3161-010_3161-003	21	8.9	2	IN3161-003	10	23.9	79.3	Yes	Yes
IN3161-003	4	3161-003_3161-007	21	20.8	1	AS3161-007	14	35.4	113.9	Yes	Yes
AS3161-007	0	3161-007_3161-009	24	45.2	1	IN3161-009	14	35.4	113.9	No	Yes
IN3161-009	1	3161-009_3161-008	24	80.3	1	AS3161-008	15	36.6	118.0	No	Yes
AS3161-008	5	3161-008_3261-032	30	46.8	2	AS3261-032	20	41.3	134.0	No	Yes
IN3261-033	2	3261-033_3261-032	14x23	29.6	0	AS3261-032	2	3.1	8.7	No	No
AS3261-032	1	3261-032_3261-016	30	39.2	3	AS3261-016	23	45.4	146.2	Yes	Yes
AS3261-016	2	3261-016_3261-017	36	63.6	1	AS3261-017	25	47.3	152.9	No	Yes
AS3261-017	0	3261-017_3261-018	36	71.9	1	AS3261-018	25	47.3	152.9	No	Yes
AS3261-018	0	3261-018_3261-021	36	74.9	1	AS3261-021	25	47.3	152.9	No	Yes
AS3261-021	2	3261-021_3261-038	36	130.0	1	AS3261-038	27	49.3	159.7	No	Yes
AS3261-038	2	3261-038_BC_JCT_9	42	138.3	2	BC_JCT_9	29	54.3	173.7	No	Yes
BC_JCT_9	2	BC_JCT_9_3261-023	42	138.7	1	AS3261-023	31	58.2	187.2	No	Yes
AS3261-023	6	3261-023_3262-018	48	96.7	1	AS3262-018	37	68.4	220.4	No	Yes
AS3262-018	3	3262-018_3262-002	48	111.2	1	AS3262-002	40	71.6	231.0	No	Yes
AS3262-002	4	3262-002_3362-045	48	112.4	1	AS3362-045	44	78.0	252.4	No	Yes
AS3362-045	4	3362-045_3362-006	48	230.4	1	AS3362-006	48	85.9	279.0	No	Yes
AS3362-006	2	3362-006_3362-008	48	283.5	1	DT3362-008	50	87.9	286.0	No	Maybe
Orchard Ridge Valley Park Pond - West Inlet											
AS3064-020	6	3064-020_3064-019	15	10.8	0	AS3064-019	6	14.9	47.5	Yes	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3064-019	0	3064-019_3064-018	15	12.9	1	IN3064-018	6	14.9	47.5	Yes	Yes
IN3064-018	1	3064-018_3064-016	18	18.8	1	AS3064-016	7	17.9	56.3	Maybe	Yes
AS3064-016	4	3064-016_3064-001	18	25.4	2	AS3064-001	11	27.1	82.8	Maybe	Yes
AS3064-001	1	3064-001_3164-026	30	73.5	1	AS3164-026	12	28.6	87.2	No	Yes
IN3164-005	1	3164-005_3164-026	18	46.7	1	AS3164-026	1	1.2	4.1	No	No
AS3164-026	1	3164-026_3164-027	38x60	175.4	2	AS3164-027	14	31.0	95.4	No	No
AS3164-027	2	3164-027_3164-028	38x60	162.1	2	AS3164-028	16	32.1	98.9	No	No
AS3164-028	0	3164-028_3164-008	3'x7'	401.3	1	IN3164-008	16	32.1	98.9	No	No
IN3164-008	4	3164-008_BC_JCT_24	3.5'x7'	377.9	2	BC_JCT_24	20	40.1	126.0	No	No
BC_JCT_24	1	BC_JCT_24_3164-007	38x60	175.7	1	IN3164-007	21	42.1	132.8	No	No
IN3164-007	2	3164-007_BC_JCT_25	3.5'x7'	290.8	1	BC_JCT_25	23	43.6	138.0	No	No
BC_JCT_25	2	BC_JCT_25_3163-001	38x60	135.5	2	IN3163-001	25	47.5	151.6	No	Yes
IN3163-001	3	3163-001_BC_JCT_26	3.5'x7'	416.5	1	BC_JCT_26	28	51.7	165.8	No	No
BC_JCT_26	1	BC_JCT_26_3263-034	3.5'x7'	417.3	1	IN3263-034	29	53.6	172.6	No	No
IN3263-034	4	3263-034_3263-030	3.5'x7'	299.2	2	IN3263-030	33	56.5	182.0	No	No
AS3164-020	2	3164-020_3164-021	18	8.9	1	AS3164-021	2	1.1	3.5	No	No
AS3164-021	0	3164-021_3164-022	18	8.7	1	AS3164-022	2	1.1	3.5	No	No
AS3164-022	2	3164-022_3264-019	18	6.5	2	AS3264-019	4	2.2	7.1	No	Yes
AS3264-019	5	3264-019_3264-004	18	6.4	1	AS3264-004	9	12.9	38.0	Yes	Yes
AS3264-003	4	3264-003_3264-004	18	20.0	1	AS3264-004	4	7.7	22.1	No	Yes
AS3264-004	2	3264-004_3264-005	18	29.5	2	AS3264-005	15	27.8	76.6	Maybe	Yes
AS3264-005	4	3264-005_3264-008	18	12.1	1	IN3264-008	19	36.1	101.8	Yes	Yes
IN3264-008	3	3264-008_3264-013	3'x7'	328.3	1	IN3264-013	22	39.6	113.5	No	No
IN3264-013	2	3264-013_BC_JCT_27	3.5'x7'	406.2	2	BC_JCT_27	24	40.7	117.0	No	No
BC_JCT_27	1	BC_JCT_27_3264-016	3'x7'	324.9	1	IN3264-016	25	41.9	121.1	No	No
IN3264-016	2	3264-016_3263-030	3.5'x7'	367.3	1	IN3263-030	27	43.0	124.6	No	No
IN3263-030	1	3263-030_BC_JCT_23	43x68	196.8	2	BC_JCT_23	61	100.7	310.7	No	Yes
BC_JCT_23	2	BC_JCT_23_BC_JCT_29	3'x7'	237.3	1	BC_JCT_29	63	102.2	315.9	No	Yes
BC_JCT_29	3	BC_JCT_29_BC_JCT_28	43x68	188.6	1	BC_JCT_28	66	105.1	326.1	No	Yes
BC_JCT_28	8	BC_JCT_28_BC_JCT_10	3'x10'	349.1	2	BC_JCT_10	74	109.9	341.9	No	Maybe
AS3263-006	2	3263-006_3263-007	18	5.2	2	AS3263-007	2	1.1	3.5	No	No
AS3263-007	3	3263-007_BC_JCT_10	18	4.1	1	BC_JCT_10	5	2.8	9.3	No	Yes
BC_JCT_10	2	BC_JCT_10_BC_JCT_11	3'x10'	337.1	3	BC_JCT_11	81	114.0	355.7	No	Maybe
IN3366-004	5	3366-004_3366-005	12	0.6	0	AS3366-005	5	3.0	10.3	Yes	Yes
AS3366-005	4	3366-005_3365-022	15	8.3	2	AS3365-022	9	5.1	17.4	No	Yes
AS3365-022	1	3365-022_3365-023	29x45	47.3	2	AS3365-023	14	11.2	38.3	No	No

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3365-014	2	3365-014_3365-019	29x45	47.1	0	AS3365-019	2	2.2	7.1	No	No
AS3365-019	2	3365-019_3365-022	36	45.6	1	AS3365-022	4	5.5	19.1	No	No
AS3365-022	1	3365-022_3365-023	29x45	47.3	2	AS3365-023	14	11.2	38.3	No	No
AS3365-023	2	3365-023_3365-006	36	45.9	2	AS3365-006	30	23.4	80.1	No	Yes
AS3365-006	1	3365-006_3365-007	36	43.6	1	AS3365-007	31	24.0	81.9	No	Yes
AS3365-007	1	3365-007_3365-001	36	33.1	2	AS3365-001	32	24.5	83.7	No	Yes
AS3365-001	1	3365-001_3364-001	36	34.1	2	AS3364-001	33	25.1	85.5	No	Yes
AS3365-013	2	3365-013_3365-024	15	0.6	1	AS3365-024	2	2.2	7.1	Yes	Yes
AS3365-024	1	3365-024_3365-028	18	0.9	1	AS3365-028	3	2.7	8.9	Yes	Yes
IN3365-029	1	3365-029_3365-028	15	4.6	1	AS3365-028	1	4.6	14.7	Maybe	Yes
AS3365-028	0	3365-028_3365-005	18	4.0	2	AS3365-005	4	7.3	23.6	Yes	Yes
AS3365-008	0	3365-008_BC_JCT_20	15	2.8	0	BC_JCT_20	0	0.0	0.0	No	No
BC_JCT_20	0	BC_JCT_20_3365-005	15	2.8	1	AS3365-005	0	0.0	0.0	No	No
AS3365-005	0	3365-005_3365-002	21	7.1	2	AS3365-002	4	7.3	23.6	Maybe	Yes
AS3365-002	1	3365-002_3364-001	24	35.2	2	AS3364-001	7	8.9	28.9	No	No
IN3365-004	2	3365-004_3365-002	15	1.9	1	AS3365-002	2	1.1	3.5	No	Yes
AS3364-001	1	3364-001_3364-002	36	60.7	2	AS3364-002	41	34.5	116.2	No	Yes
AS3364-002	0	3364-002_3364-014	24	41.5	1	AS3364-014	41	34.5	116.2	No	Yes
AS3364-014	1	3364-014_3364-016	24	55.3	1	AS3364-016	42	37.6	125.0	No	Yes
AS3364-016	2	3364-016_3364-004	24	47.4	1	AS3364-004	44	41.5	138.6	No	Yes
AS3364-004	1	3364-004_BC_JCT_44	24	52.4	1	BC_JCT_44	45	43.1	143.0	No	Yes
BC_JCT_44	0	BC_JCT_44_3363-030	24	69.4	1	SS3363-030	45	43.1	143.0	No	Yes
SS3363-030	1	3363-030_3363-031	36	70.4	1	AS3363-031	46	51.4	164.7	No	Yes
AS3363-031	2	3363-031_3363-032	29x45	43.3	2	AS3363-032	48	54.5	173.5	Yes	Yes
AS3363-032	2	3363-032_3362-059	29x45	41.7	1	AS3362-059	50	55.6	177.0	Yes	Yes
AS3362-059	0	3362-059_BC_JCT_11	29x45	42.9	1	BC_JCT_11	50	55.6	177.0	Yes	Yes
BC_JCT_11	7	BC_JCT_11_3362-012	3'x10'	319.1	3	AS3362-012	138	173.9	546.9	No	Yes
AS3362-012	0	3362-012_3362-015	3'x11'	266.2	1	PD_3362-020	138	173.9	546.9	No	Yes
Orchard Ridge Valley Park Pond - Southeast Inlet											
AS3364-008	5	3364-008_3364-007	18	20.7	1	AS3364-007	5	10.1	32.7	No	Yes
AS3364-007	2	3364-007_BC_JCT_62	21	17.0	1	BC_JCT_62	7	14.0	46.3	No	Yes
BC_JCT_62	1	BC_JCT_62_3363-005	24	23.8	2	AS3363-005	8	18.6	61.0	No	Yes
AS3363-005	0	3363-005_3363-004	24	20.0	1	AS3363-004	8	18.6	61.0	Maybe	Yes
AS3363-004	0	3363-004_3363-003	24	27.7	1	AS3363-003	8	18.6	61.0	No	Yes
AS3363-003	3	3363-003_3363-002	24	27.7	1	AS3363-002	11	25.8	85.4	Maybe	Yes
AS3363-002	25	3363-002_3363-001	24	28.3	1	AS3363-001	36	82.1	273.2	Yes	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3363-001	4	3363-001_3363-024	24	30.4	2	AS3363-024	40	84.2	280.3	Yes	Yes
AS3363-024	0	3363-024_3363-025	24	16.5	1	PD_3362-020	40	84.2	280.3	Yes	Yes
Odana Golf Course - WisDOT Pond Inlet Sewer											
IN3565-006	1	3565-006_3565-005	22X36	15.9	0	IN3565-005	1	0.5	1.8	No	No
IN3565-005	1	3565-005_3565-004	22X36	15.9	2	IN3565-004	2	1.1	3.5	No	No
IN3565-004	1	3565-004_3565-007	21	25.3	1	AS3565-007	3	1.6	5.3	No	No
AS3565-007	0	3565-007_3564-027	24	42.3	2	IN3564-027	3	1.6	5.3	No	No
IN3564-027	1	3564-027_7645-023_10	18	22.0	1	IN7645-023_10	4	3.2	9.7	No	No
IN7645-023_10	0	7645-023_10_BC_JCT_106	18	22.0	1	BC_JCT_106	4	3.2	9.7	No	No
IN3564-025	2	3564-025_3564-024	18	16.8	1	IN3564-024	2	2.2	7.1	No	No
IN3564-024	32	3564-024_7645-023_07	18	15.1	1	IN7645-023_07	34	72.7	242.0	Yes	Yes
IN7645-023_07	8	7645-023_07_7645-023_08	18	15.5	1	IN7645-023_08	42	92.0	307.1	Yes	Yes
IN7645-023_08	9	7645-023_08_7645-023_09	18	15.5	1	IN7645-023_09	51	113.7	380.3	Yes	Yes
IN7645-023_09	8	7645-023_09_BC_JCT_105	18	15.5	2	BC_JCT_105	59	132.5	442.3	Yes	Yes
IN3564-005	2	3564-005_7645-024_02	12	2.1	1	AE7645-024_02	2	1.1	3.5	No	Yes
AE7645-024_02	1	7645-024_02_BC_JCT_106	24	12.9	1	BC_JCT_106	3	3.1	8.7	No	No
BC_JCT_106	0	BC_JCT_106_BC_JCT_105	24	12.3	3	BC_JCT_105	7	6.2	18.5	No	Yes
BC_JCT_105	1	BC_JCT_105_BC_JCT_104	24	12.5	2	BC_JCT_104	67	140.4	466.8	Yes	Yes
BC_JCT_104	7	BC_JCT_104_3564-034	24	12.3	1	AS3564-034	74	152.0	509.0	Yes	Yes
AS3564-034	2	3564-034_3564-033	24	7.2	1	AS3564-033	76	156.8	525.2	Yes	Yes
AS3564-033	0	3564-033_3564-031	24	13.4	1	AS3564-031	76	156.8	525.2	Yes	Yes
AS3564-031	2	3564-031_BC_JCT_85	30	23.5	1	PD_3564-028	78	160.4	535.4	Yes	Yes
BC_JCT_84	3	BC_JCT_84_3665-058	30	111.0	0	AS3665-058	3	3.3	9.1	No	No
BC_JCT_83	4	BC_JCT_83_3665-058	18	42.7	0	AS3665-058	4	4.4	14.2	No	No
AS3665-058	0	3665-058_BC_JCT_82	29x45	35.4	2	BC_JCT_82	7	7.7	23.3	No	No
BC_JCT_82	1	BC_JCT_82_BC_JCT_108	29x45	46.0	1	BC_JCT_82.1	8	9.9	28.8	No	No
BC_JCT_82.1	1	BC_JCT_82_BC_JCT_108.1	29x45	33.1	2	BC_JCT_108	9	12.2	34.8	No	Maybe
BC_JCT_108	1	BC_JCT_108_3664-045	3'x6'	62.2	2	AS3664-045	10	13.3	38.4	No	No
BC_JCT_135	10	BC_JCT_135_BC_JCT_134	24	13.4	0	BC_JCT_134	10	16.6	60.2	Yes	Yes
BC_JCT_134	4	BC_JCT_134_BC_JCT_133	24	14.3	1	BC_JCT_133	14	23.2	84.3	Yes	Yes
AS3765-003	3	3765-003_3765-051	18	8.8	0	AS3765-051	3	1.6	5.3	No	No
AS3765-051	0	3765-051_3765-007	18	5.5	1	AS3765-007	3	1.6	5.3	No	Maybe
AS3765-007	3	3765-007_3766-040	18	12.2	2	AS3766-040	6	4.9	16.0	No	Yes
AS3766-040	0	3766-040_BC_JCT_138	18	12.1	1	BC_JCT_138	6	4.9	16.0	No	Yes
BC_JCT_138	0	BC_JCT_138_BC_JCT_133	18	12.0	1	BC_JCT_133	6	4.9	16.0	No	Yes
BC_JCT_133	3	BC_JCT_133_BC_JCT_132	30	23.9	2	BC_JCT_132	23	34.5	121.1	Yes	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
BC_JCT_132	3	BC_JCT_132_BC_JCT_131	30	33.7	1	BC_JCT_131	26	40.9	142.0	Yes	Yes
BC_JCT_131	3	BC_JCT_131_3765-017	30	25.2	1	IN3765-017	29	44.2	152.6	Yes	Yes
BC_JCT_124	7	BC_JCT_124_3765-017	18	11.0	0	IN3765-017	7	7.6	24.8	No	Yes
AS3765-033	2	3765-033_BC_JCT_136	18	19.4	0	BC_JCT_136	2	1.1	3.5	No	No
BC_JCT_136	4	BC_JCT_136_BC_JCT_127	18	9.0	1	BC_JCT_127	6	8.9	30.7	Maybe	Yes
BC_JCT_127	4	BC_JCT_127_BC_JCT_126	24	25.6	1	BC_JCT_126	10	16.8	57.9	No	Yes
BC_JCT_126	2	BC_JCT_126_BC_JCT_125	24	17.8	1	BC_JCT_125	12	18.9	65.0	Maybe	Yes
BC_JCT_125	2	BC_JCT_125_3765-017	30	30.1	1	IN3765-017	14	21.1	72.1	No	Yes
IN3765-017	1	3765-017_BC_JCT_129	42	62.1	4	BC_JCT_129	51	74.0	253.1	Yes	Yes
BC_JCT_129	1	BC_JCT_129_3765-020	42	61.3	1	AS3765-020	52	75.9	259.9	Yes	Yes
AS3765-020	0	3765-020_BC_JCT_123	42	54.2	1	BC_JCT_123	52	75.9	259.9	Yes	Yes
BC_JCT_123	2	BC_JCT_123_BC_JCT_122	42	64.1	1	BC_JCT_122	54	78.1	267.0	Yes	Yes
BC_JCT_122	1	BC_JCT_122_BC_JCT_121	48	66.1	1	BC_JCT_121	55	80.5	275.1	Yes	Yes
BC_JCT_121	1	BC_JCT_121_BC_JCT_120	48	64.9	1	BC_JCT_120	56	82.9	283.2	Yes	Yes
BC_JCT_120	1	BC_JCT_120_BC_JCT_119	48	60.2	1	BC_JCT_119	57	85.3	291.4	Yes	Yes
AS3765-044	2	3765-044_3765-046	18	32.3	0	AS3765-046	2	1.1	3.5	No	No
AS3765-046	1	3765-046_3665-019	21	8.7	1	AS3665-019	3	1.6	5.3	No	No
AS3665-019	2	3665-019_BC_JCT_119	24	17.9	1	BC_JCT_119	5	6.5	21.6	No	Yes
BC_JCT_119	0	BC_JCT_119_BC_JCT_118	48	64.3	3	BC_JCT_118	62	91.8	312.9	Yes	Yes
BC_JCT_118	5	BC_JCT_118_BC_JCT_117	48	63.5	1	BC_JCT_117	67	101.2	344.4	Yes	Yes
BC_JCT_117	4	BC_JCT_117_BC_JCT_116	48	59.3	1	BC_JCT_116	71	109.3	372.7	Yes	Yes
AS3664-029	2	3664-029_3664-011	18	9.9	0	AS3664-011	2	1.1	3.5	No	No
AS3664-011	0	3664-011_3664-007	18	10.5	1	AS3664-007	2	1.1	3.5	No	No
AS3664-007	3	3664-007_3664-006	18	7.7	2	AS3664-006	5	2.7	8.9	No	Yes
AS3664-006	0	3664-006_3664-012	21	22.2	1	AS3664-012-1	5	2.7	8.9	No	No
AS3664-012-1	3	3664-012-1_JCT_169	19x30	15.3	1	BC_JCT_169	8	6.0	19.5	No	Yes
BC_JCT_169	2	BC_JCT_169_BC_JCT_116	19x30	13.7	1	BC_JCT_116	10	8.2	26.6	No	Yes
BC_JCT_116	4	BC_JCT_116_BC_JCT_115	48	64.3	2	BC_JCT_115	85	124.7	425.0	Yes	Yes
BC_JCT_115	10	BC_JCT_115_BC_JCT_114	38x60	65.3	1	BC_JCT_114	95	141.3	485.2	Yes	Yes
BC_JCT_114	6	BC_JCT_114_BC_JCT_113	38x60	62.2	1	BC_JCT_113	101	151.3	521.3	Yes	Yes
BC_JCT_113	3	BC_JCT_113_3664-044	38x60	64.1	1	AS3664-044	104	154.6	531.9	Yes	Yes
AS3664-044	2	3664-044_3664-045	38x60	4.6	2	AS3664-045	106	156.7	539.0	Yes	Yes
AS3664-045	1	3664-045_3664-047	24x38	11.6	3	AS3664-047	117	171.6	583.4	Yes	Yes
AS3664-047	1	3664-047_3564-038	24x38	8.5	1	AS3564-038	118	173.3	589.4	Yes	Yes
AS3564-038	1	3564-038_3564-039	24x38	8.8	1	AS3564-039	119	175.0	595.5	Yes	Yes
AS3564-039	0	3564-039_BC_JCT_59	24x38	8.3	1	PD_3564-028	119	175.0	595.5	Yes	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
Southwest Bike Path - Zook Park											
IN3663-012	2	3663-012_3663-013	18	7.5	0	IN3663-013	2	2.2	7.1	No	Maybe
IN3663-013	1	3663-013_3663-014	18	7.6	1	IN3663-014	3	3.3	10.6	No	Yes
IN3663-014	1	3663-014_3663-015	18	21.0	1	AS3663-015	4	4.4	14.2	No	No
AS3663-015	0	3663-015_3663-016	18	11.0	1	BC_JCT_154	4	4.4	14.2	No	Yes
Southwest Bike Path - Boston Court											
AS3663-007	3	3663-007_3662-008	21	22.3	0	AE3662-008	3	1.6	5.3	No	No
Southwest Bike Path - Vale Circle											
AS3761-021	4	3761-021_3762-001	24	35.5	1	AS3762-001	4	2.2	7.1	No	No
Southwest Bike Path - Midvale Boulevard											
CB3762-039	7	3762-039_3762-034	18	14.5	1	CB3762-034	7	16.8	48.6	Yes	Yes
CB3762-034	2	3762-034_3761-032	29x45	46.7	2	AS3761-032	9	21.7	64.8	No	Yes
AS3761-032	1	3761-032_3761-031	29x45	45.4	1	AS3761-031	10	24.1	73.0	No	Yes
AS3761-031	0	3761-031_3761-030	34x53	184.7	1	AS3761-030	10	24.1	73.0	No	No
AS3761-030	0	3761-030_3761-029	43x68	190.4	2	AE3761-029	10	24.1	73.0	No	No
Southwest Bike Path - Waite Circle											
IN3760-026	8	3760-026_3761-062	18	21.8	1	AS3761-062	8	21.9	67.8	Maybe	Yes
AS3761-062	4	3761-062_3761-059	21	24.1	1	AS3761-059	12	34.1	103.2	Yes	Yes
AS3761-059	2	3761-059_3761-043	21	20.7	2	CB3761-058	14	40.2	120.8	Yes	Yes
CB3761-058	11	3761-058_3761-008	27	40.3	2	AS3761-008	25	51.7	158.1	Yes	Yes
AS3761-008	7	3761-008_3761-049	27	31.7	1	CB3761-049	32	58.2	179.4	Yes	Yes
CB3761-049	0	3761-049_3761-050	27	62.2	1	AS3761-050	32	58.2	179.4	Maybe	Yes
AS3761-050	0	3761-050_3761-051	27	28.3	1	AS3761-051	32	58.2	179.4	Yes	Yes
AS3761-051	2	3761-051_3761-054	27	21.3	2	AS3761-054	34	62.1	193.0	Yes	Yes
AS3761-054	0	3761-054_3761-056	27	30.2	1	IN3761-056	34	62.1	193.0	Yes	Yes
AS3660-016	4	3660-016_3660-015	18	18.2	1	AS3660-015	4	4.8	16.3	No	No
AS3660-015	1	3660-015_3660-011	18	10.9	1	AS3660-011	5	6.0	20.3	No	Yes
AS3660-011	3	3660-011_3660-005	21	18.3	2	AS3660-005	8	9.6	32.5	No	Yes
AS3660-005	6	3660-005_3660-001	24	21.3	2	AS3660-001	14	13.1	44.1	No	Yes
AS3660-001	6	3660-001_3760-009	30	26.9	2	AS3760-009	20	16.5	55.7	No	Yes
AS3760-009	5	3760-009_3760-034	30	32.0	2	AS3760-034	25	19.3	65.0	No	Yes
AS3760-034	0	3760-034_3760-015	30	74.4	2	AS3760-015	42	54.2	180.6	No	Yes
IN3759-018	4	3759-018_3759-017	15	9.3	0	AS3759-017	4	9.6	32.5	Maybe	Yes
AS3759-017	0	3759-017_3759-012	15	10.8	1	AS3759-012	4	9.6	32.5	No	Yes
AS3759-012	4	3759-012_3759-007	15	9.2	1	AS3759-007	8	19.3	65.0	Yes	Yes
AS3759-007	4	3759-007_3760-036	21	27.5	2	CB3760-036	12	28.9	97.6	Maybe	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
CB3760-036	4	3760-036_3760-035	21	10.2	1	AS3760-035	16	34.4	113.7	Yes	Yes
AS3760-035	1	3760-035_3760-034	21	29.0	1	AS3760-034	17	34.9	115.5	Yes	Yes
AS3760-034	0	3760-034_3760-015	30	74.4	2	AS3760-015	42	54.2	180.6	No	Yes
AS3760-015	1	3760-015_3860-037	30	11.8	1	AS3860-037	85	109.0	362.9	Yes	Yes
AS3759-001	5	3759-001_3760-022	18	7.6	1	AS3760-022	5	2.7	8.9	No	Yes
AS3760-022	2	3760-022_3860-036	21	20.0	1	AS3860-036	7	5.1	17.0	No	No
AS3860-036	2	3860-036_3860-037	36	52.6	2	AS3860-037	9	6.2	20.6	No	No
AS3860-037	0	3860-037_3760-023	36	59.9	3	AS3760-023	94	115.2	383.5	Yes	Yes
AS3760-023	1	3760-023_3760-024	36	100.7	1	AS3760-024	95	115.8	385.7	Yes	Yes
AS3760-024	2	3760-024_3760-025	36	97.2	1	AS3760-025	97	117.1	390.2	Yes	Yes
AS3760-025	0	3760-025_3761-055	36	125.7	3	IN3761-056	97	117.1	390.2	Maybe	Yes
IN3761-056	1	3761-055_BC_JCT_151	36	134.1	2	WAITECIRCLE	132	183.8	597.9	Yes	Yes
Chippewa Drive - Waban Hill Storm Sewer											
BC_JCT_75	3	BC_JCT_75_BC_JCT_74	18	23.7	1	BC_JCT_74	3	5.7	18.3	No	No
BC_JCT_74	1	BC_JCT_74_BC_JCT_73	21	20.7	1	BC_JCT_73	4	8.1	26.4	No	Yes
BC_JCT_73	2	BC_JCT_73_BC_JCT_71	21	33.0	1	BC_JCT_71	6	12.9	42.7	No	Yes
BC_JCT_71	1	BC_JCT_71_3862-001	24	9.4	3	AS3862-001	7	15.3	50.8	Yes	Yes
AS3862-001	0	3862-001_3861-028	12	8.2	1	AS3861-028	7	15.3	50.8	Yes	Yes
AS3861-028	0	3861-028_BC_JCT_34	30	75.3	2	BC_JCT_34	7	15.3	50.8	No	No
Chippewa Drive - Ottawa Trail Storm Sewer											
DUM_INL_12	4	INL_12_3860-003	12	3.6	0	AS3860-003	4	4.0	13.7	Yes	Yes
AS3860-003	1	3860-003_3860-002	15	8.8	1	AS3860-002	5	6.0	20.5	No	Yes
AS3860-002	3	3860-002_3860-023	18	12.9	2	AS3860-023	8	8.7	29.8	No	Yes
AS3860-023	2	3860-023_3860-040	18	15.2	2	AE3860-040	10	9.8	33.3	No	Yes
AE3860-040	0	3860-040_3860-029	27	65.0	1	AS3860-029	10	9.8	33.3	No	No
AS3860-029	0	3860-029_3860-030	2.5'x3'	109.6	1	IN3860-030	10	9.8	33.3	No	No
IN3860-030	1	3860-030_3861-001	2.5'x3'	161.9	1	AS3861-001	11	11.6	38.6	No	No
AS3861-001	2	3861-001_3861-002	2.5'x3'	162.0	1	AS3861-002	13	15.2	49.2	No	No
AS3861-002	4	3861-002_3861-004	2.5'x3'	146.6	2	AS3861-004	17	19.3	61.6	No	No
AS3861-004	2	3861-004_3861-007	2.5'x3'	107.2	1	AS3861-007	19	22.4	70.4	No	No
AS3861-007	3	3861-007_3861-010	2.5'x3'	107.3	2	AS3861-010	22	27.3	84.5	No	No
AS3861-010	1	3861-010_BC_JCT_12	2.5'x3'	157.1	1	BC_JCT_12	23	28.8	88.9	No	No
Cherokee Drive - Waban Hill Storm Sewer											
IN3664-036	4	3664-036_3764-023	24	37.2	1	IN3764-023	4	7.9	25.4	No	No
IN3764-023	1	3764-023_3764-024	24	46.9	1	AS3764-024	5	10.9	34.2	No	No
AS3764-024	0	3764-024_3763-041	24	25.5	2	AS3763-041	5	10.9	34.2	No	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3763-041	3	3763-041_3763-009	24	18.3	1	AS3763-009	8	17.0	51.9	Maybe	Yes
AS3763-009	3	3763-009_3763-008	18	8.0	2	AS3763-008	11	18.7	57.2	Yes	Yes
IN3763-007	2	3763-007_3762-020	18	27.2	1	AS3762-020	2	1.5	5.2	No	No
AS3762-020	1	3762-020_3763-008	15	7.4	1	AS3763-008	3	2.5	8.6	No	Yes
AS3763-008	0	3763-008_3763-016	21	15.8	2	CB3763-016	14	21.2	65.8	Yes	Yes
CB3763-016	5	3763-016_3763-006	29x45	70.6	2	CB3763-006	19	23.9	74.6	No	Maybe
AS3762-016	2	3762-016_3763-001	15	8.8	0	CB3763-001	2	2.9	10.2	No	Yes
CB3763-001	6	3763-001_3763-006	29.004	74.0	2	CB3763-006	8	8.4	27.9	No	No
AS3764-001	8	3764-001_3763-023	18	9.9	1	CB3763-023	8	21.4	61.8	Yes	Yes
CB3763-023	8	3763-023_3763-006	29x45	90.3	2	CB3763-006	16	31.9	93.7	No	Maybe
CB3763-006	0	3763-006_BC_JCT_67	54	526.5	3	BC_JCT_67	43	64.2	196.2	No	No
BC_JCT_67	1	BC_JCT_67_BC_JCT_68	54	369.4	1	BC_JCT_68	44	66.6	204.4	No	No
BC_JCT_68	4	BC_JCT_68_BC_JCT_77	54	314.9	1	BC_JCT_77	48	76.2	236.9	No	No
BC_JCT_77	2	BC_JCT_77_BC_JCT_69	54	258.3	3	BC_JCT_69	50	81.0	253.1	No	Maybe
BC_JCT_69	2	BC_JCT_69_BC_JCT_70	54	163.0	1	BC_JCT_70	52	85.8	269.4	No	Yes
BC_JCT_70	1	BC_JCT_70_3863-049	54	151.5	1	AS3863-049	53	88.3	277.5	No	Yes
AS3863-010	2	3863-010_BC_JCT_42	15	8.8	0	BC_JCT_42	2	3.6	10.6	No	Yes
BC_JCT_42	3	BC_JCT_42_3863-051	24	17.5	1	AS3863-051	5	10.8	35.0	No	Yes
AS3863-051	0	3863-051_3863-049	24	40.7	3	AS3863-049	5	10.8	35.0	No	No
Cherokee Drive - Yuma Drive Storm Sewer											
BC_JCT_58	4	BC_JCT_58_BC_JCT_57	18	9.7	0	BC_JCT_57	4	9.6	32.5	Maybe	Yes
BC_JCT_57	2	BC_JCT_57_BC_JCT_56	18	17.9	2	BC_JCT_56	6	14.5	48.8	No	Yes
BC_JCT_56	2	BC_JCT_56_3862-037	18	31.1	1	SS3862-037	8	20.5	65.2	No	Yes
SS3862-037	2	3862-037_3862-036	24	25.8	1	AS3862-036	10	28.8	86.0	Yes	Yes
Chippewa Drive - Miami Pass Storm Sewer											
AS3961-043	4	3961-043_BC_JCT_18	24	47.3	1	BC_JCT_18	4	7.5	24.2	No	No
BC_JCT_18	3	BC_JCT_18_BC_JCT_19	24	33.4	1	BC_JCT_163	7	12.5	42.2	No	Yes
Chippewa Drive - Oneida Place Storm Sewer											
AS3961-031	4	3961-031_BC_JCT_8	12	6.5	0	BC_JCT_8	4	7.2	21.2	Yes	Yes
BC_JCT_8	3	BC_JCT_8_3961-047	12	7.7	2	AS3961-047	7	14.8	43.3	Yes	Yes
AS3961-047	1	3961-047_BC_JCT_36	12	11.5	1	BC_JCT_36	8	16.4	47.7	Yes	Yes
BC_JCT_36	0	BC_JCT_36_BC_JCT_41	9.996	8.1	1	BC_JCT_41	8	16.4	47.7	Yes	Yes
BC_JCT_41	0	BC_JCT_41_BC_JCT_40	12	11.1	1	BC_JCT_40	8	16.4	47.7	Yes	Yes
BC_JCT_40	0	BC_JCT_40_BC_JCT_39	9.996	8.0	1	BC_JCT_39	8	16.4	47.7	Yes	Yes
BC_JCT_39	0	BC_JCT_39_BC_JCT_37	12	10.8	1	BC_JCT_37	8	16.4	47.7	Yes	Yes
BC_JCT_37	0	BC_JCT_37_BC_JCT_38	9.996	0.1	1	BC_JCT_38	8	16.4	47.7	Yes	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
BC_JCT_38	0	BC_JCT_38_BC_JCT_43	12	0.1	1	BC_JCT_43	8	16.4	47.7	Yes	Yes
BC_JCT_43	3	BC_JCT_43_BC_JCT_65	24	106.9	2	BC_JCT_65	11	24.3	70.8	No	No
BC_JCT_65	1	BC_JCT_65_BC_JCT_7	27	21.6	1	BC_JCT_7	12	28.9	85.6	Yes	Yes
Chippewa Drive - Huron Hill Storm Sewer											
AS3960-032	4	3960-032_3960-031	15	4.6	0	IN3960-031	4	9.6	32.5	Yes	Yes
IN3960-031	1	3960-031_3960-022	15	16.4	1	IN3960-022	5	12.7	41.4	No	Yes
IN3960-022	4	3960-022_3960-019	15	22.7	2	AS3960-019	9	21.9	70.9	Maybe	Yes
IN4060-017	2	4060-017_4060-016	12	3.9	0	IN4060-016	2	3.9	13.6	Maybe	Yes
IN4060-016	1	4060-016_4060-015	12	2.5	1	IN4060-015	3	5.9	20.4	Yes	Yes
IN4060-015	1	4060-015_4060-014	12	2.8	1	IN4060-014	4	7.8	27.2	Yes	Yes
IN4060-014	1	4060-014_3960-020	15	5.5	1	IN3960-020	5	9.8	34.0	Yes	Yes
IN3960-020	2	3960-020_3960-019	18	11.0	2	AS3960-019	7	12.0	41.0	Maybe	Yes
AS3960-019	0	3960-019_3961-030	18	27.9	2	AS3961-030	16	33.9	112.0	Yes	Yes
AS3961-030	2	3961-030_3961-029	18	18.7	1	AS3961-029	18	41.1	133.2	Yes	Yes
AS3961-029	0	3961-029_BC_JCT_52	4'x6'	492.3	2	BC_JCT_52	18	41.1	133.2	No	No
Nakoma Road Storm Sewer											
AS3764-009	4	3764-009_3864-003	18	18.2	1	AS3864-003	4	9.4	28.3	No	Yes
AS3864-003	0	3864-003_3864-001	18	24.6	1	AS3864-001	4	9.4	28.3	No	Yes
AS3864-001	3	3864-001_3863-005	2.5'x3'	132.1	3	AS3863-005	7	18.9	57.6	No	No
AS3863-005	3	3863-005_3863-032	2.5'x3'	103.0	1	AS3863-032	10	26.2	82.0	No	No
AS3863-032	2	3863-032_3863-004	2.5'x3'	103.0	1	AS3863-004	12	31.0	98.2	No	Maybe
AS3863-004	2	3863-004_3863-001	2.5'x3'	81.3	1	AS3863-001	14	35.8	114.5	No	Yes
AS3863-001	5	3863-001_3863-040	2.3'x3'	91.5	2	AS3863-040	19	47.9	155.1	No	Yes
AS3863-040	5	3863-040_3962-063	2.3'x3'	91.0	1	AS3962-063	24	57.7	188.5	No	Yes
AS3962-063	2	3962-063_3962-014	2.3'x3'	90.9	1	AS3962-014	26	62.1	203.5	No	Yes
AS3962-014	1	3962-014_3962-058	18	26.9	1	AS3962-058	27	64.5	211.6	Yes	Yes
AS3962-066	1	3962-066_3962-068	30	50.5	1	AS3962-068	28	66.9	219.7	Yes	Yes
AS3962-068	2	3962-068_3962-071	30	50.6	1	AS3962-071	30	71.7	236.0	Yes	Yes
AS3962-071	2	3962-071_3961-055	30	69.1	1	AS3961-055	32	76.5	252.2	Yes	Yes
AS3961-055	2	3961-055_3961-054	30	87.7	2	AS3961-054	34	81.3	268.5	Maybe	Yes
AS3961-054	0	3961-054_BC_JCT_17	30	64.4	3	BC_JCT_17	34	81.3	268.5	Yes	Yes
Manitou Way Outfall											
IN3961-011	1	3961-011_3961-009	24	22.6	0	CB3961-009	1	1.1	3.5	No	No
CB3961-009	2	3961-009_3961-006	24	22.8	1	IN3961-006	3	3.3	10.6	No	No
IN3961-012	1	3961-012_3961-074	24	23.0	0	AS3961-074	1	1.1	3.5	No	No
IN3961-013	3	3961-013_3961-074	21	43.0	0	AS3961-074	3	3.3	10.6	No	No

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
AS3961-074	0	3961-074_3961-007	24	22.4	2	IN3961-007	4	4.4	14.2	No	No
IN3961-006	1	3961-006_3961-007	24	0.7	1	IN3961-007	4	4.4	14.2	Yes	Yes
IN3961-007	1	3961-007_3961-075	24	12.2	2	CB3961-075	9	9.8	31.9	No	Yes
IN3961-017	3	3961-017_3961-075	24	38.3	1	CB3961-075	3	3.3	10.6	No	No
CB3961-075	0	3961-075_3961-076	36	22.8	2	CB3961-076	12	13.1	42.6	No	Yes
CB3961-076	2	3961-076_3961-002	36	24.2	2	AS3961-002	14	15.2	49.7	No	Yes
AS3961-002	0	3961-002_3962-074	36	43.7	1	CB3962-074	14	15.2	49.7	No	Yes
AS3865-016	3	3865-016_3865-023	21	17.8	0	AS3865-023	3	2.1	6.9	No	No
AS3865-023	4	3865-023_3865-014	12	7.4	2	AS3865-014	7	7.4	23.4	Maybe	Yes
AS3865-014	1	3865-014_3865-009	24	32.7	1	AS3865-009	8	9.2	28.7	No	No
AS3865-009	0	3865-009_3865-010	24	50.5	1	AS3865-010	8	9.2	28.7	No	No
AS3865-010	1	3865-010_3865-008	24	46.8	1	AS3865-008	9	9.7	30.4	No	No
AS3865-008	0	3865-008_3865-007	24	42.7	1	AS3865-007	9	9.7	30.4	No	No
AS3865-007	2	3865-007_3865-003	18	14.2	1	AS3865-003	11	12.8	39.3	Maybe	Yes
AS3865-003	2	3865-003_3865-006	18	22.9	3	AS3865-006	13	15.9	48.1	No	Yes
AS3865-006	0	3865-006_3865-001	18	22.9	1	AS3865-001	13	15.9	48.1	No	Yes
AS3864-017	4	3864-017_3865-001	18	18.8	1	AS3865-001	4	7.2	21.2	No	Yes
AS3865-001	0	3865-001_3864-016	24	19.6	2	AS3864-016	17	23.0	69.3	Yes	Yes
AS3864-016	0	3864-016_3864-012	24	45.0	1	AS3864-012	17	23.0	69.3	No	Yes
AS3864-012	5	3864-012_3864-013	24	43.2	2	AS3864-013	22	26.3	79.9	No	Yes
AS3864-013	0	3864-013_BC_JCT_32	24	29.3	1	BC_JCT_32	22	26.3	79.9	No	Yes
BC_JCT_32	0	BC_JCT_32_3864-029	24	31.5	1	AS3864-029	22	26.3	79.9	No	Yes
AS3864-029	4	3864-029_3964-007	24	35.1	1	AS3964-007	26	35.0	109.8	Maybe	Yes
IN3864-034	4	3864-034_3964-009	18	12.1	1	AS3964-009	4	6.1	20.7	No	Yes
AS3964-009	0	3964-009_3964-008	18	12.5	1	AS3964-008	4	6.1	20.7	No	Yes
AS3964-008	1	3964-007_3964-008	18	8.6	1	AS3964-007	5	7.2	24.2	No	Yes
AS3964-007	0	3964-007_3964-006	24	54.3	3	AS3964-006	31	42.2	134.0	No	Yes
AS3964-006	0	3964-006_3964-011	30	102.4	1	IN3964-011	31	42.2	134.0	No	Yes
IN3965-011	8	3965-011_3965-010	18	28.5	0	IN3965-010	8	14.9	46.3	No	Yes
IN3965-010	1	3965-010_3965-009	18	28.2	1	IN3965-009	9	16.7	51.6	No	Yes
IN3965-009	1	3965-009_3965-006	18	28.2	2	AS3965-006	10	18.5	56.9	No	Yes
AS3965-006	2	3965-006_3965-001	18	26.1	1	AS3965-001	12	22.1	67.5	No	Yes
AS3965-001	3	3965-001_3865-022	18	26.1	1	AS3865-022	15	27.4	83.3	Maybe	Yes
AS3865-022	2	3865-022_3864-028	24	60.1	2	AS3864-028	17	31.0	93.9	No	Yes
AS3864-028	0	3864-028_3864-025	24	39.0	1	AS3864-025	17	31.0	93.9	No	Yes
AS3864-025	1	3864-025_3964-010	24	31.5	1	IN3964-010	18	32.2	98.0	Maybe	Yes

Table E-4
Inlet Capacity vs. Pipe Capacity
Wingra West Watershed Study, City of Madison, WI

Node Name	# of Directly Connected Inlets	Downstream Link Name	D/S Pipe Size (inches)	D/S Pipe Capacity (cfs)	# of U/S Links	Downstream Node Name	Total # of Inlets	Total Inlet Capacity (cfs) at Selected Water Depth (ft) *		Is Total Inlet Capacity Greater than Pipe Capacity?	
								0.25-ft	0.55-ft	0.25-ft	0.55-ft
IN3964-010	1	3964-010_3964-003	20.004	30.4	1	AS3964-003	19	34.7	106.1	Yes	Yes
AS3964-003	0	3964-003_3964-004	24	32.3	1	IN3964-004	19	34.7	106.1	Maybe	Yes
IN3964-004	1	3964-004_3964-011	24	73.6	1	IN3964-011	20	37.7	115.0	No	Yes
IN3964-011	1	3964-011_BC_JCT_46	34x53	208.0	2	BC_JCT_46	52	84.2	263.8	No	Yes
BC_JCT_46	0	BC_JCT_46_BC_JCT_47	34x53	208.1	1	BC_JCT_47	52	84.2	263.8	No	Yes
BC_JCT_47	0	BC_JCT_47_3963-028	34x53	211.7	1	IN3963-028	52	84.2	263.8	No	Yes
IN3963-028	2	3963-028_3963-030	34x53	56.2	2	AS3963-030	54	90.3	281.5	Yes	Yes
AS3963-030	0	3963-030_3963-031	34x53	57.7	1	AE3963-031	54	90.3	281.5	Yes	Yes
GR3963-021	0	3963-021_3963-004	2'x5'	318.7	1	AS3963-004	54	90.3	281.5	No	No
AS3962-056	1	3962-056_3962-055	18	27.7	1	AS3962-055	1	3.6	8.2	No	No
AS3962-055	2	3962-055_3962-054	24	50.4	2	AS3962-054	3	10.8	24.7	No	No
AS3962-054	4	3962-054_3962-053	24	38.4	2	AS3962-053	7	25.3	60.0	No	Yes
AS3962-053	0	3962-053_3963-009	24	6.1	1	AS3963-009	7	25.3	60.0	Yes	Yes
AS3963-009	1	3963-009_3963-001	24	5.9	1	AS3963-001	8	26.3	63.6	Yes	Yes
AS3963-001	1	3963-001_3963-006	24	56.9	2	IN3963-006	9	28.3	70.4	No	Yes
IN3963-006	2	3963-006_3963-004	24	59.6	1	AS3963-004	11	30.5	77.5	No	Yes
AS3963-004	0	3963-004_3963-003	60	81.0	2	AS3963-003	65	120.8	358.9	Yes	Yes
AS3963-003	2	3963-003_3962-003	60	291.1	2	AS3962-003	67	123.0	366.0	No	Yes
AS3962-003	0	3962-003_3962-005	60	241.2	2	AS3962-005	67	123.0	366.0	No	Yes
AS3962-005	2	3962-005_BC_JCT_5	60	72.2	2	BC_JCT_5	69	125.1	373.1	Yes	Yes
IN3962-040	3	3962-040_3962-039	18	5.6	1	IN3962-039	3	3.3	10.6	No	Yes
IN3962-039	2	3962-039_3962-038	18	20.4	1	IN3962-038	5	5.4	17.7	No	No
IN3962-038	1	3962-038_3962-050	18	22.7	1	IN3962-050	6	6.5	21.3	No	Maybe
IN3962-050	1	3962-050_3962-048	18	0.3	1	IN3962-048	7	8.9	29.4	Yes	Yes
IN3962-048	2	3962-048_3962-047	18	14.9	1	IN3962-047	9	13.8	45.7	Maybe	Yes
IN3962-047	1	3962-047_3962-045	24	32.5	1	IN3962-045	10	16.2	53.8	No	Yes
IN3962-045	3	3962-045_BC_JCT_5	24	31.1	1	BC_JCT_5	13	22.1	73.6	No	Yes
BC_JCT_5	0	BC_JCT_5_3962-075	60	232.7	2	CB3962-075	82	147.2	446.7	No	Yes
CB3962-075	3	3962-075_3962-074	60	232.9	1	CB3962-074	85	151.4	459.0	No	Yes
CB3962-074	1	3962-074_OFALL_10	3'x6'	1026.0	2	OFALL_10	100	168.5	513.9	No	No

* Equals flow depth for slope inlets and ponding depth for sag inlets

NOTE: Yes = Inlet capacity is more than 110% of the pipe capacity.

Maybe = Inlet capacity is between 90% and 110% of pipe capacity.

No = Inlet capacity is less than 90% of pipe capacity.

Appendix F: Focus Group Summary



Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: April 10, 2020

Prepared for: City of Madison: Phil Gaebler, PE

Subject: Wingra West Watershed – Chippewa Drive and Cherokee Drive Focus Group Meeting
Summary (Meeting Date: September 5, 2019)

Project No.: City of Madison: 8412, BC: 153394

From: Mike Wegner, PE

Copy: Jim Bachhuber, PH

General Information

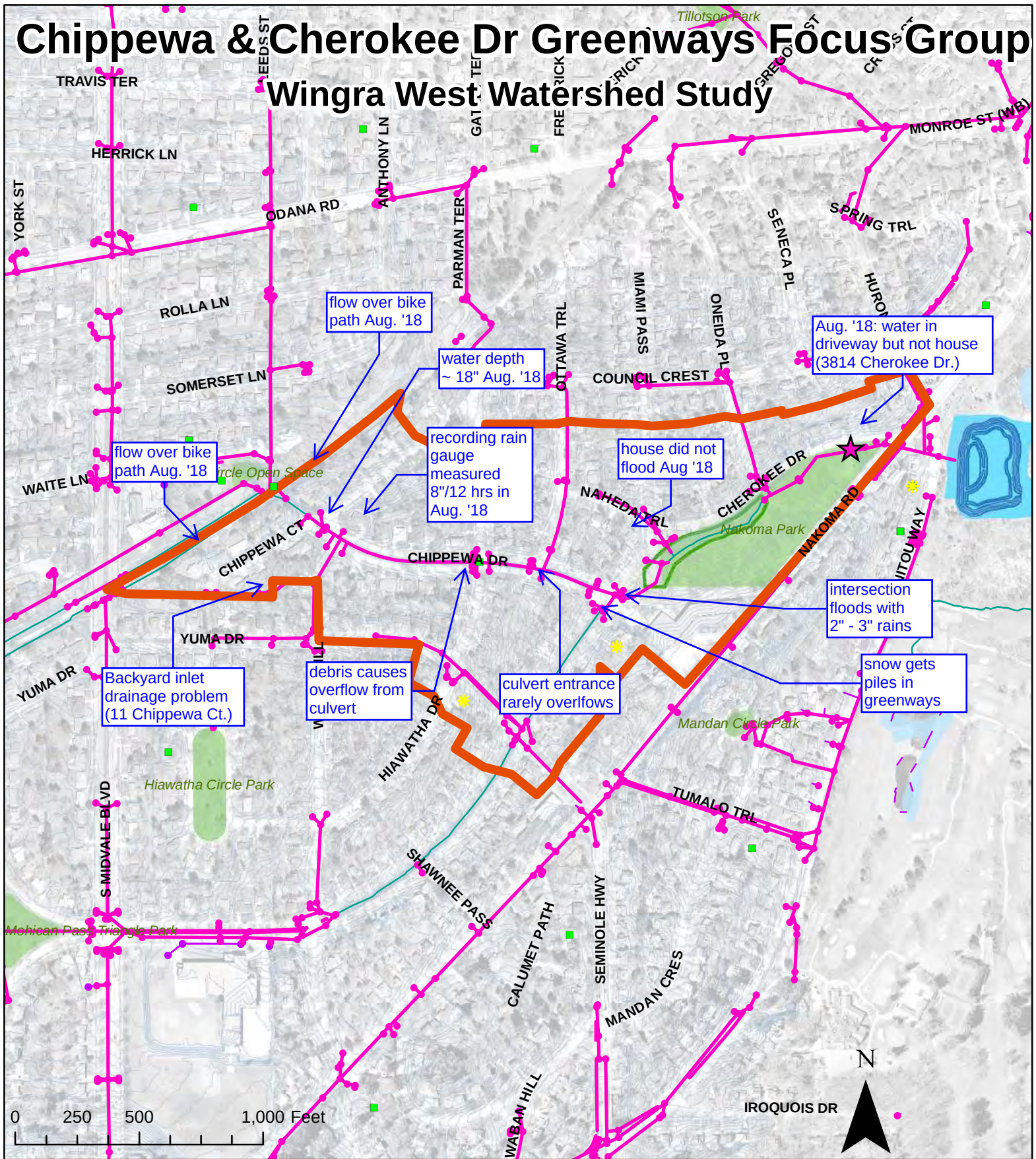
- Focus Group date: September 5, 2019
- Number of attendees: 21
- Facilitators: Jim Bachhuber, Mike Wegner, Phil Gaebler

Summary of Focus Group Discussion

1. During moderately large rain events, the Nakoma Road and Cherokee Drive intersection becomes flooded and impassable. Multiple people described having alternative routes home dependent on the amount of rain falling due to streets being impassable.
2. The grates in Nakoma park and in the drainage ways are prone to clogging and this is a source of street flooding.
3. The intersection of Chippewa Drive and Cherokee Drive floods from a 2.5- 3.0 inch, intense, rain storm. Other intersections along the Chippewa Drive channel also flooded during the August 20th event.
4. There is evidence of a former creek channel north of the Chippewa Drive and Cherokee Drive intersection
5. The invasive species / dense shrubs along the Chippewa Drive and Cherokee Drive channels cause vision issues and are concern when driving / walking in the neighborhood and increase the risk of grate clogging. There appeared to be consensus in the group that the time to address the invasive species has arrived. The Manitou Way drainage way is an example of what is a more desirable level of vegetation.
6. Pre-cleaning the grate (cleaning prior to storm events) at Chippewa Drive would be a benefit if possible.
7. Water clearly flowed over the Southwest Commuter Bike Path at multiple locations during the August 2018 storm event.
8. There is evidence of brush / yard waste being left in the street and at the intersection of Chippewa Court and Chippewa Drive. This increases the risk of clogging and contributes phosphorus to the lakes. The phosphorus results in excessive algae growth.

Chippewa & Cherokee Dr Greenways Focus Group

Wingra West Watershed Study



J. Bachhuber field notes
Focus Grp 9_5_2019





Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: April 10, 2020

Prepared for: City of Madison: Phil Gaebler, PE

Subject: Wingra West Watershed – Nakoma Road and Manitou Way Focus Group Meeting
Summary (Meeting Date: September 12, 2019)

Project No.: City of Madison: 8412, BC: 153394

From: Mike Wegner, PE

Copy: Jim Bachhuber, PH

General Information

- Focus Group date: September 12, 2019
- Number of attendees: 17
- Facilitators: Jim Bachhuber, Phil Gaebler, Hannah Mohelnitzky

Summary of Focus Group Discussion

1. At the intersection of Nakoma Road and Manitou Way, water flows to the east through the intersection during large storm events. It occurred in June and August, 2018, but also during other sizeable events. Water can be deep enough to float and move cars. The inlets are frequently clogged.
2. A house near the intersection of Nakoma Road and Manitou Way built a berm after August 2018 to prevent runoff from entering their property.
3. Ponding occurs in the low-point at Manitou Way south of Nakoma Road. Residents questioned whether it would be possible to create a curb cut to allow water in the street to flow more directly into the creek to the east (at the north end of the Nakoma Golf Course property).
4. Nakoma Golf Club is planning a project to regrade and enlarge existing ponds.
5. Water frequently pond in the intersection of Manitou Way and Mandan Crescent.

Nakoma Focus Group

Wingra West Watershed Study

J. Bachhuber Field Notes
9-12-2019 Focus Group Mtg.

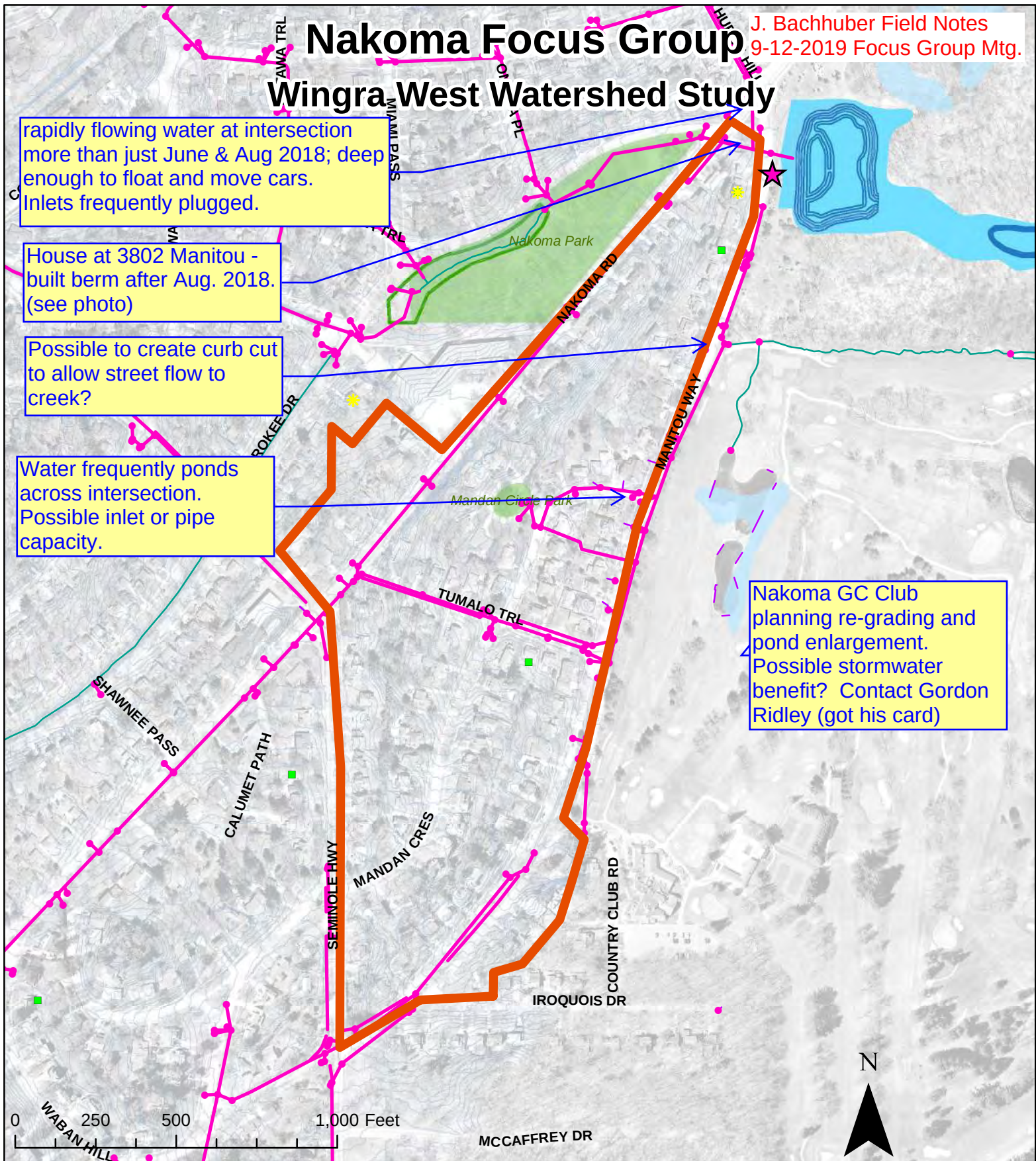
rapidly flowing water at intersection
more than just June & Aug 2018; deep
enough to float and move cars.
Inlets frequently plugged.

House at 3802 Manitou -
built berm after Aug. 2018.
(see photo)

Possible to create curb cut
to allow street flow to
creek?

Water frequently ponds
across intersection.
Possible inlet or pipe
capacity.

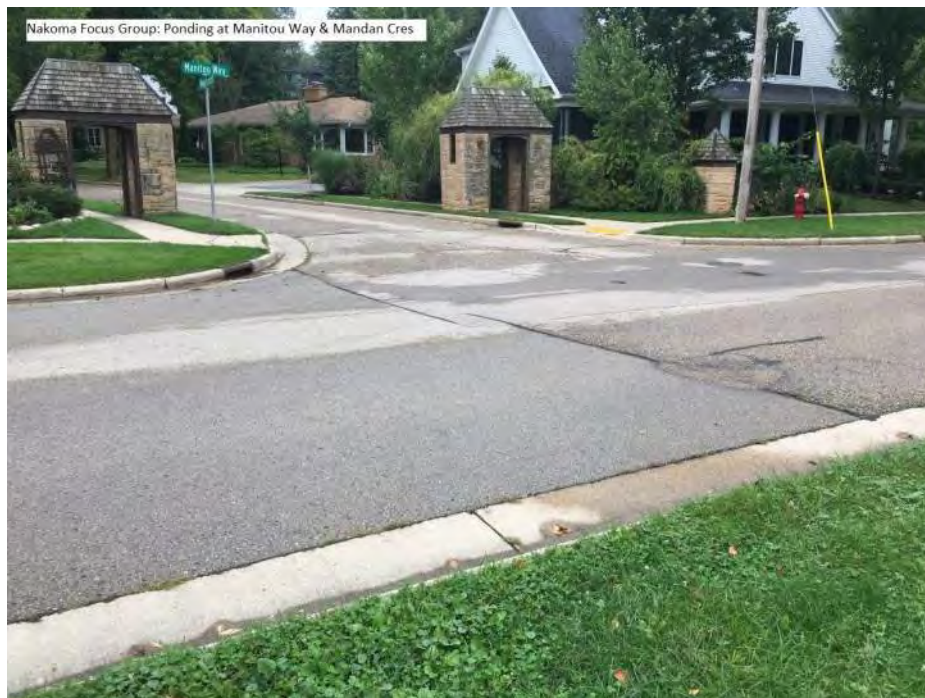
Nakoma GC Club
planning re-grading and
pond enlargement.
Possible stormwater
benefit? Contact Gordon
Ridley (got his card)



- Storm Sewer
- Storm Sewer Structures
- Private Pipes
- Private Structures
- Pond
- Greenway
- Pond Contours
- 2' Contours
- ★ Meeting Location
- Focus Group Area
- ★ Focus Group Request
- Reported Flooding Online



Photographs from Nakoma Road Focus Group Meeting (9/12/19)



Photographs from Nakoma Road Focus Group Meeting (9/12/19)





Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: April 10, 2020

Prepared for: City of Madison: Phil Gaebler, PE

Subject: Wingra West Watershed –Odana Pond / Odana Hills Park Focus Group Meeting Summary (Meeting Date: September 12, 2019)

Project No.: City of Madison: 8412, BC: 153394

From: Mike Wegner, PE

Copy: Jim Bachhuber, PH

General Information

- Focus Group date: September 12, 2019
- Number of attendees: 23
- Facilitators: Jim Bachhuber, Mike Wegner, Phil Gaebler

Summary of Focus Group Discussion

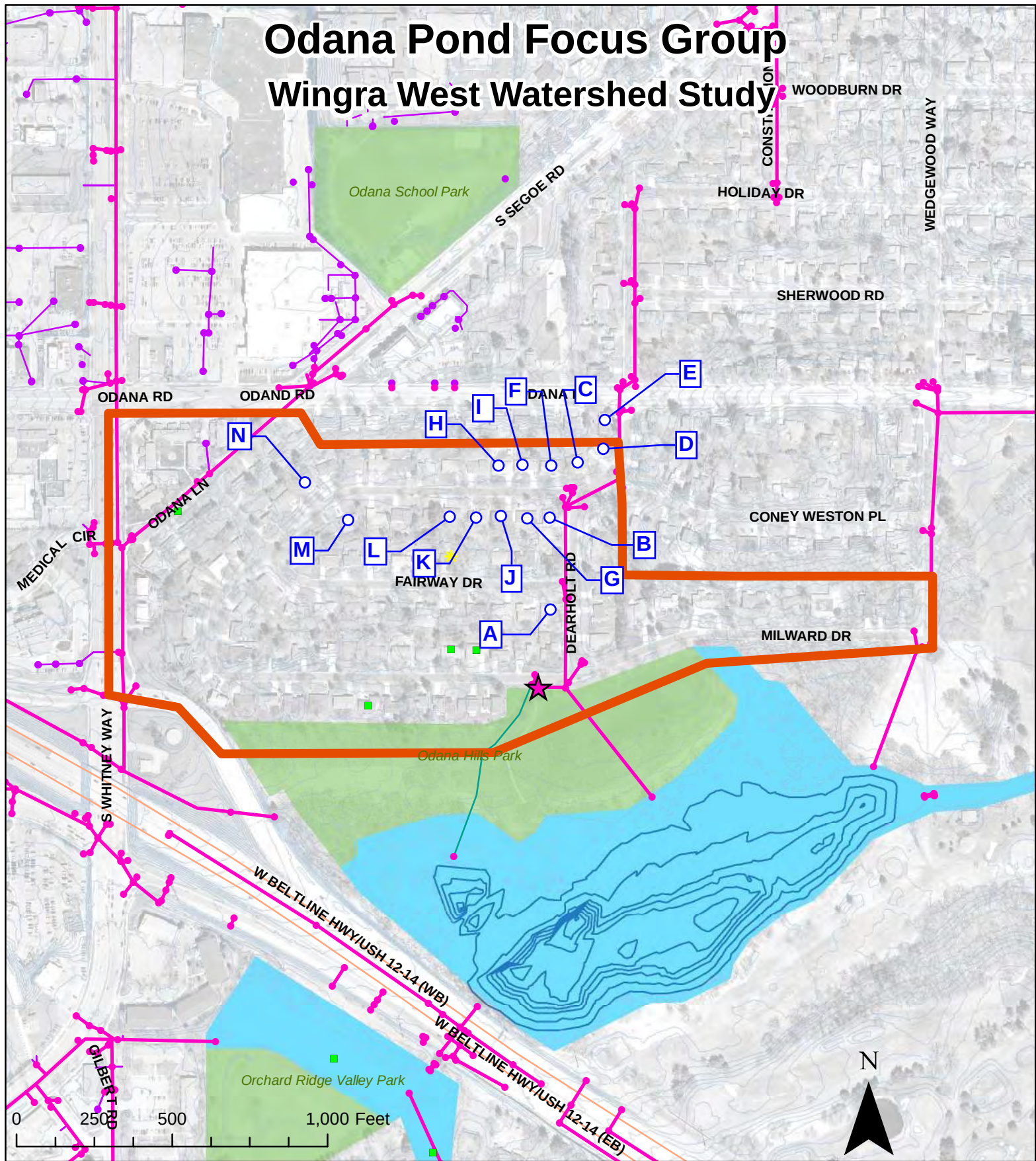
1. During the August, 2018 flood the water level from the pond reached a fire hydrant on Milward Drive approximately 550-feet west of the intersection of Dearholt Road and Milward Drive.
2. Some residents along Milward Drive reported basement flooding that occurs when the elevation in the pond rises and approaches Milward Drive. Other residents have not experienced any flooding.
3. Residents questioned whether the amount of emergent vegetation in Odana Pond impacted the flood storage capacity of the pond.
4. A resident indicated that the culvert underneath the beltline often appears to be blocked or restricted.
5. The intersection of Dearholt Road and Milward Drive flooded, and water remained on road for at least 2 days after August 20th, 2018.
6. The intersection of Dearholt Road and Fairway Drive flooded on August 20th, 2018 and water remained on road the morning of August 21st, 2018.
7. The intersection of Dearholt Road and Coney Weston Place flooded during August 2018.
8. Coney Weston Place and Fairway Drive have limited storm sewer inlets. The area drains towards Dearholt Road where there are inlets at the intersections. There is frequent ponding and overland flow in the roads. A particular issue is in the winter when there is snow / ice in the gutter, there can be lots of puddles/ice in the road and poor drainage. Overland flow has been observed during large storm events (not just August 2018) along the roads
9. There is backyard flooding in the following areas. There is poor drainage in these backyards, they are low points. Flow from roads into the backyards was not observed. Residents

reported that some neighbors had re-graded yards, put up fences, etc and blocked drainage from reaching streets

- a) South of Odana Road, North of Coney Weston Place, West of Dearholt Road
 - b) South of Coney Weston Pl, North of Fairway Dr, west of Dearhold Rd
10. Sanitary sewer backups occurred in several areas along Dearholt Road, Coney Weston Place, and Fairway Drive.
11. Basement flooding occurred in several areas along Dearholt Road, Coney Weston Place, and Fairway Drive.

Odana Pond Focus Group

Wingra West Watershed Study



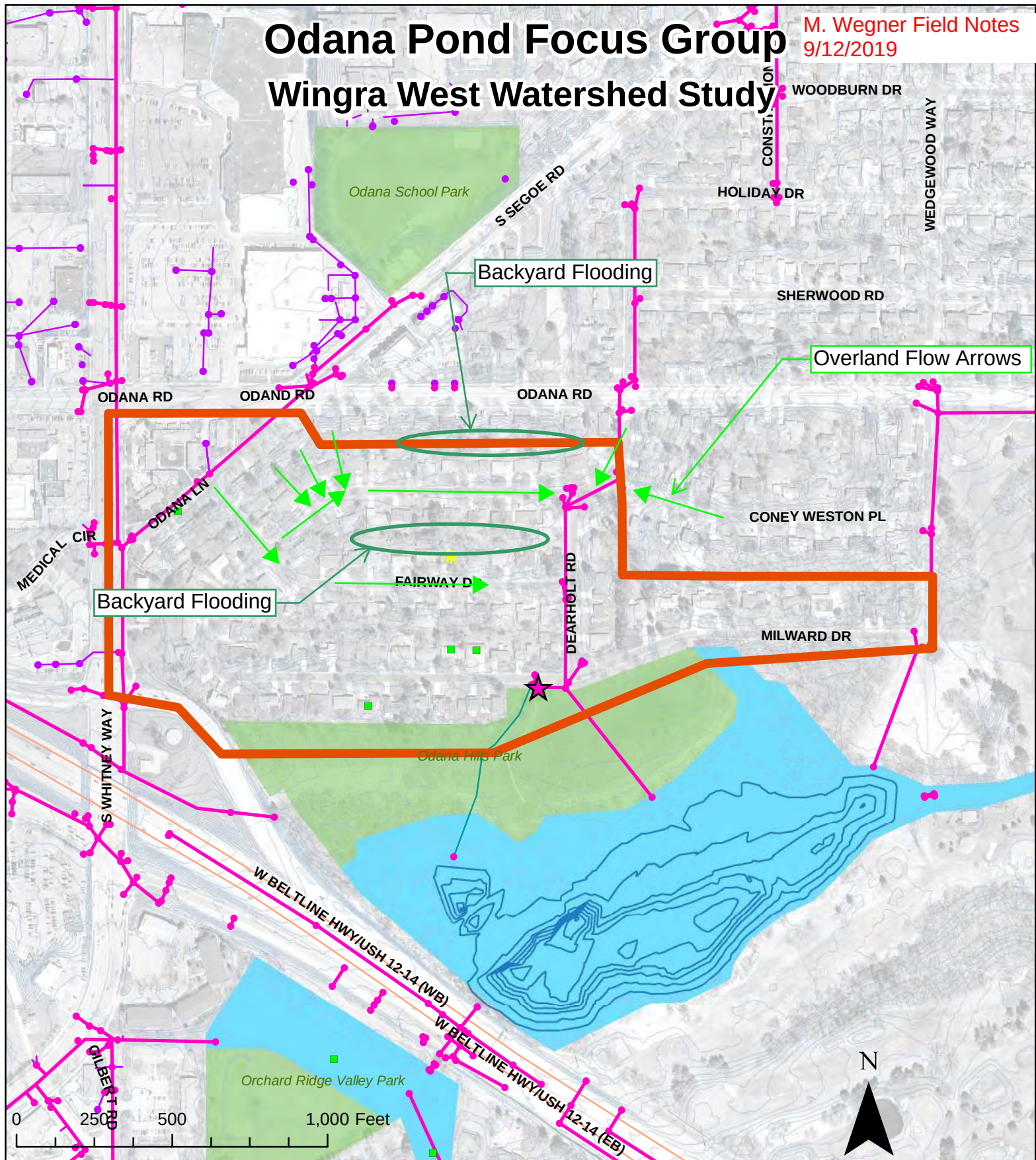
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|------------------------|---------------|--------------------------|
| Storm Sewer | Pond | Meeting Location |
| Storm Sewer Structures | Greenway | Focus Group Area |
| Private Pipes | Pond Contours | Focus Group Request |
| Private Structures | 2' Contours | Reported Flooding Online |



Odana Pond Focus Group

Wingra West Watershed Study

M. Wegner Field Notes
9/12/2019



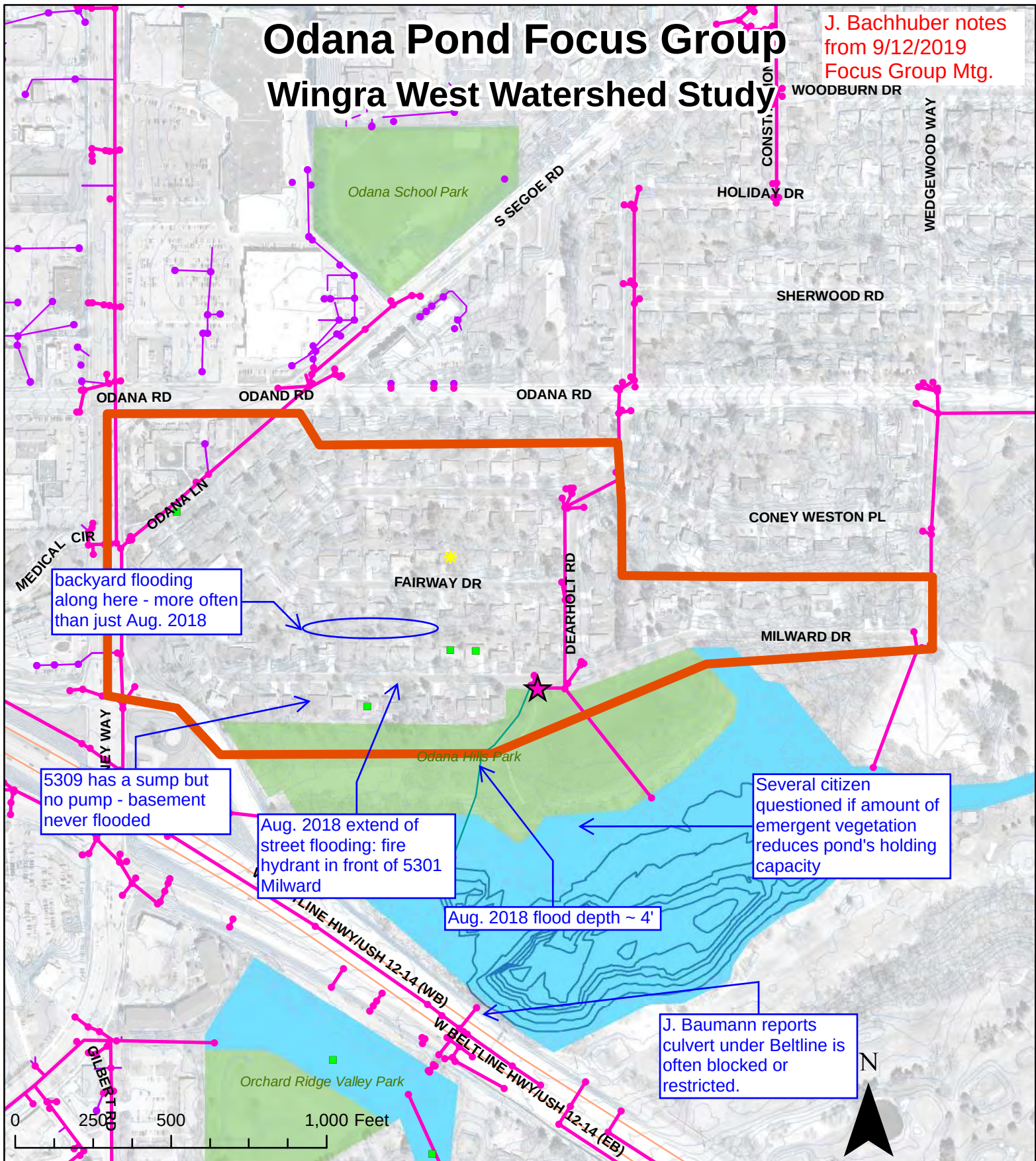
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|--------------------------|-----------------|----------------------------|
| — Storm Sewer | ■ Pond | ★ Meeting Location |
| ● Storm Sewer Structures | □ Greenway | □ Focus Group Area |
| — Private Pipes | □ Pond Contours | ★ Focus Group Request |
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Odana Pond Focus Group

Wingra West Watershed Study

J. Bachhuber notes
from 9/12/2019
Focus Group Mtg.



- Storm Sewer
- Storm Sewer Structures
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M. Wegner Notes from Odana Pond Focus Group on 9/12/2019. Met with group of residents from Fairway Dr & Coney Weston Pl. Notes correspond with maps.

- Intersection of Dearholt Rd / Milward Drive – Intersection flooded, water remained on road for at least 2 days after August 20th, 2018
- Intersection of Dearholt Rd / Fairway Dr – Intersection flooded on August 20th, 2018 and water remained on road the morning of August 21st, 2018
- Intersection of Dearholt Rd / Coney Weston Pl
 - o At peak of August 2018 water was up to this intersection from the Odana Pond.
 - o There are problems with inlets clogging / flooding in winter due to ice / snow from plows
- Coney Weston Place and Fairway Drive have limited storm sewer inlets – area drains towards Dearholt Rd where there are inlets at the intersections
 - o There is frequent ponding and overland flow in the roads
 - o A particular issue is in the winter when there is snow / ice in the gutter – there can be lots of puddles/ice in the road and poor drainage
- Overland flow has been observed during large storm events (not just August 2018) along the roads – see corresponding map.
- There is backyard flooding in the following areas (see corresponding map)
 - o South of Odana Rd, North of Coney Weston Pl, West of Dearholt Rd
 - o South of Coney Weston Pl, North of Fairway Dr, west of Dearholt Rd
 - o There is poor drainage in these backyards – they are low points
 - o Flow from roads into the backyards was not observed
 - o Residents reported that some neighbors had re-graded yards, put up fences, etc and blocked drainage from reaching streets
- Residents provided information about specific properties. Properties were labeled with a letter (see related figure) and corresponding notes are below.
 - o A: Sewage backup – August 2018
 - o B: Sewage backup, stormwater in basement – from floor & window well – August, 2018 (regraded/redirected downspout since to try to prevent the window well problem)
 - o C: Sewage backup, stormwater in basement – August 2018
 - o D: Water came up through basement floor – August 2018
 - o E: Sewage backup, stormwater in basement – August 2018
 - o F: Resident had problems (wasn't present) – neighbors indicated they knew there were issues – but unsure what they were – August 2018
 - o G: Resident had problems (wasn't present) – neighbors indicated that resident contacted City Engineering and somebody from the City came out night of August 20th, 2018
 - o H: Sewage backup, approximately 4" deep in basement – August 2018
 - o I: Lots of backyard ponding – August 2018 and other storms
 - o J: Lots of backyard ponding – has occurred repeatedly since resident moved into house in 1993 – have had basement flooding at least 5-6 times. House is a tri-level – the basement has sliding doors that are approximately 6 steps below the backyard

grade. They have a yard drain outside basement door that is connected to a large sump pump just outside basement door.

- In August 2018 water was approximately 1" below FFE – water broke sliding door into basement
 - In April 2018 water was approximately 8"-12" below FFE
 - Since August 2018 they regraded the backyard – raised the elevation, installed stone and porous pavers for storage/infiltration, created swales towards street on each side of house
- o K: Resident had problems (wasn't present) – lots of backyard ponding – neighbors indicated water flows into/through garage (multiple storm events) and had flowed into basement (August 2018, maybe others)
 - o L: Lots of backyard ponding (wasn't present)
 - o M: Lots of backyard ponding, some water in basement – didn't indicate source, Sewage backup in 2009 – hasn't occurred since
 - o N: Water flows from houses behind and through backyard/sideyards onto street. Hasn't experienced problems.



Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: April 10, 2020

Prepared for: City of Madison: Phil Gaebler, PE

Subject: Wingra West Watershed –Orchard Ridge Valley Park Focus Group Meeting Summary
(Meeting Date: September 19, 2019)

Project No.: City of Madison: 8412, BC: 153394

From: Mike Wegner, PE

Copy: Jim Bachhuber, PH

General Information

- Focus Group date: September 19, 2019
- Number of attendees: 16
- Facilitators: Mike Wegner, Phil Gaebler, Hannah Mohelnitzky

Summary of Focus Group Discussion

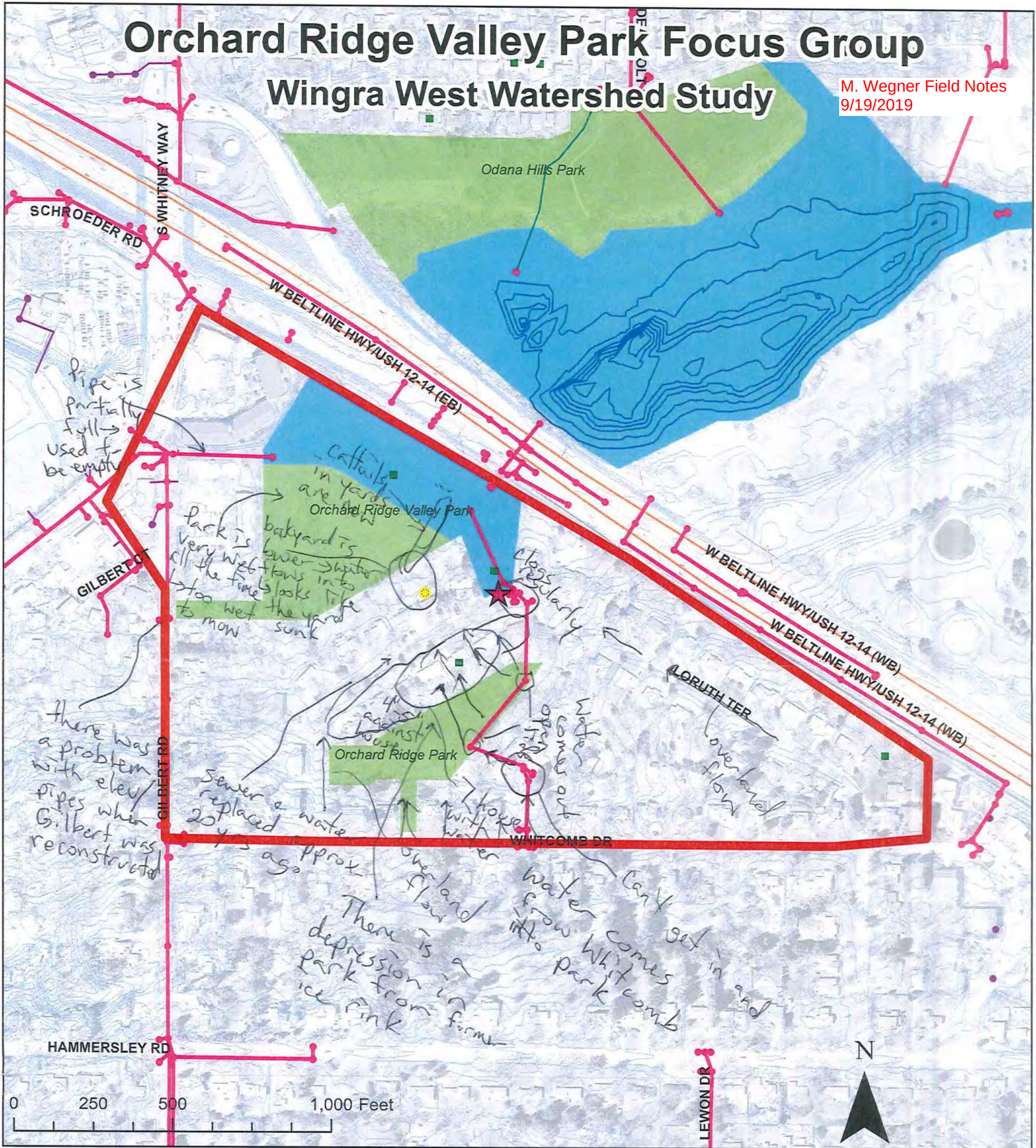
1. Orchard Ridge Valley Park pond flooded during the August, 2018 storm event and flooded homes along Loruth Terrace and nearby roads. Many of these homes also experienced sanitary sewer backups.
2. The Orchard Ridge Valley Park pond previously drained better. The pond would come out of its banks, but then drain down to be in the banks within a day. After the August 2018 storm event the draw-down is slower.
3. Orchard Ridge Valley park is very wet and difficult to even walk through at all times (even if it hasn't rained recently). It appears there was an area that sunk following the August 2018 event and there is no longer positive drainage into the pond. Part of the park is impacted and a residents backyard. There are cattails growing in the park that weren't present previously. There is an area on the west side of the park that used to be an ice rink. The area does not have positive drainage and water stands in the area for a long time causing concern that this is leading to more groundwater problems.
4. Residents indicated that the pond outlet get clogged with debris and vegetation. Residents have recently removed this debris. A new outlet was installed at the pond sometime in the 1990's. The pipe from Loruth Terrace that discharges into the pond is damaged/clogged at the outfall.
5. The pond is currently very shallow and has murky water. Long-time residents indicated the pond used to be 6- to 7-feet deep and the water was clear. Previously you could see turtles and fish in the pond.
6. Groundwater in the area is very high. Sump pumps of many homes run almost continuously. One homeowner reported that groundwater still comes up through the basement floor.

7. Loruth Terrace regularly has street flooding / standing water during large storm events (not just August 2018 flood). The inlets in Loruth Terrace regularly clog. There is a large area that drains towards to the inlets and a lot of overland flow down the street is seen.
8. Most homes along the south side of Loruth Terrace, near Orchard Ridge Valley Park, had water in the basement during August 2018. Some residents reported water coming through the floor / cracks in walls. Others had water come in through window wells. One house had the glass in a basement window break because of water against it. Some homes also experienced sanitary sewer backups. During large rain events, or rain events on snow/frozen ground residents have basements flooding problems – water through window wells or walls/floor cracks.
9. During large storms water comes out of the storm sewer inlets in Orchard Ridge Park (they are large rectangular inlets). Water flows north through the park towards homes. It flows through side yards and also towards homes. During August 2018 there was approximately 4- to 6-inches of water across backyards and the park. Runoff from yards and Whitcomb Street also flows overland into park during large storm events.
10. The sewer from Gilbert Street and Whitney Way that discharges into the Orchard Ridge Valley Park Pond is now partially full of water at all times. It used to be dry and residents could walk inside of it while growing up.
11. The intersection of Whitney Way and Gilbert Street frequently floods during large rainfall events (maybe 2"-3" of rain in a short period). This has occurred numerous times over the last 10-years and the streets are impassible. The intersection was closed for approximately 36-hours in August 2018.
12. A long-time resident reported that Odana Hills Park Pond (North of the Beltline) used to be much more open. Cattails are now growing / encroaching within the pond. Previously it was open water up to the mowed areas of the golf course / park.

Orchard Ridge Valley Park Focus Group

Wingra West Watershed Study

M. Wegner Field Notes
9/19/2019



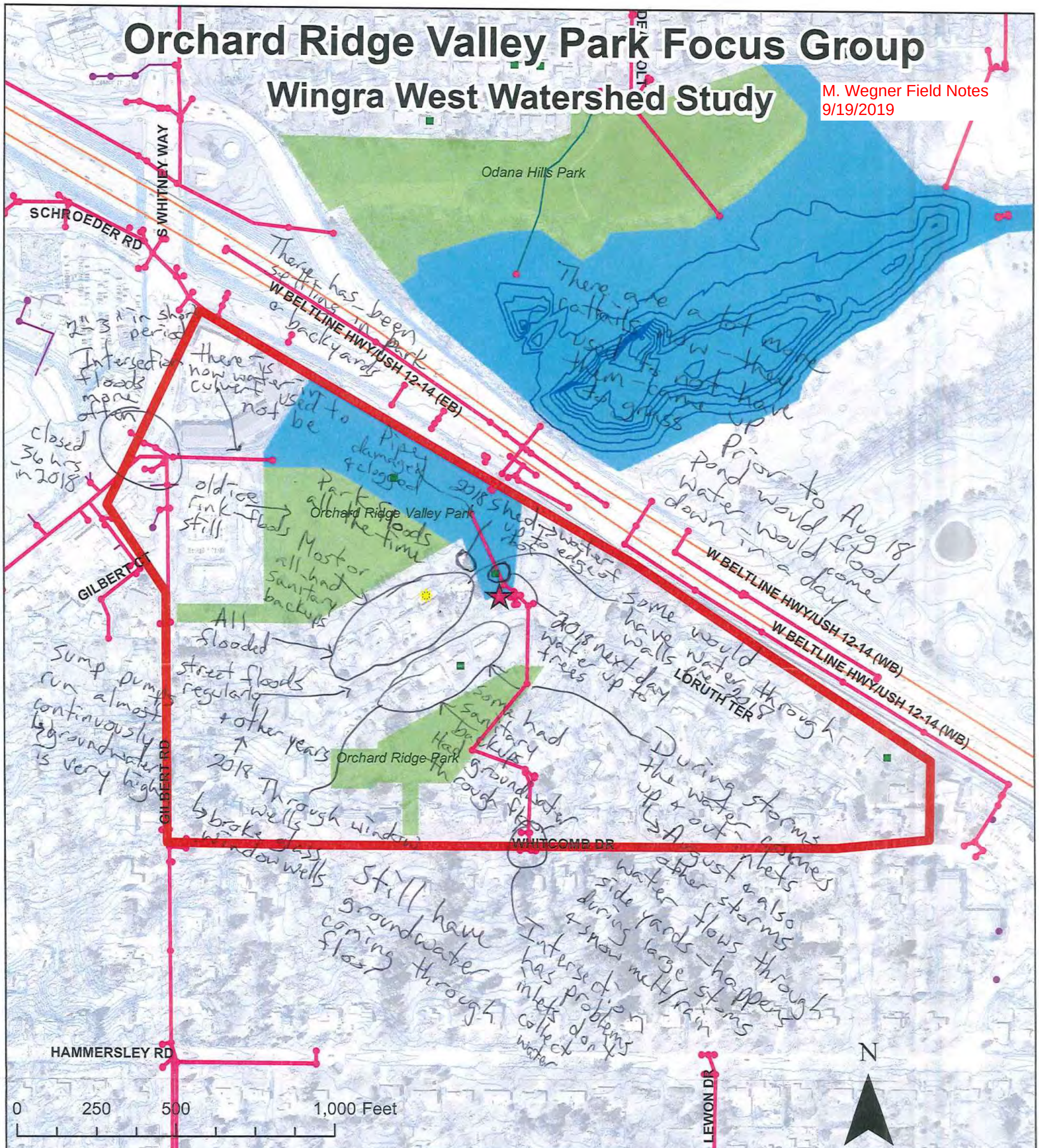
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|---|---|---|
| — Storm Sewer | Pond | ★ Meeting Location |
| • Storm Sewer Structures | Greenway | Focus Group Area |
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Orchard Ridge Valley Park Focus Group

Wingra West Watershed Study

M. Wegner Field Notes
9/19/2019



- Storm Sewer
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M. Wegner

Notes from Orchard Ridge Valley Park Focus Group on 9/19/2019. The group of residents that I met with predominantly living on Loruth Terrace with backyards abutting Orchard Ridge Valley Park (north side of street) or Orchard Ridge Park (south side of street).

- Orchard Ridge Valley Park Pond
 - o The pond previously drained better. The pond would come out of it's banks, but then drain down to be in the banks within a day. After the August 2018 storm event the draw-down is slower.
 - o The park is very wet and difficult to even walk through.
 - o It appears there was an area that sunk following the 2018 event and there is no longer positive drainage into the pond. Part of the park is impacted and one person's backyard. There are cattails growing in the park – these weren't present previously.
 - o The outlet get clogged with debris and vegetation. Residents have recently removed this debris.
 - o The pipe from Loruth Terrace that discharges into the pond is damaged/clogged at the outfall.
 - o The pond is currently very shallow and has murky water. Long-time residents indicated the pond used to be 6- to 7-feet deep and the water was clear. Previously you could see turtles and fish in the pond.
 - o A new outlet was installed at the pond sometime in the 1990's.
 - o There is an area on the west side of the park that used to be an ice rink. The area does not have positive drainage. Water stands in the area for a long time – concern this is leading to more groundwater problems.
- Groundwater in the area is very high. Sump pumps of many homes run almost continuously. One homeowner reported that groundwater still comes up through the basement floor.
- Loruth Terrace regularly has street flooding / standing water during large storm events (not just August 2018 flood). The inlets in Loruth Terrace regularly clog. There is a large area that drains towards to the inlets and a lot of overland flow down the street is seen.
- Loruth Terrace – North Side Homes
 - o Most of the houses experienced sanitary sewer backups and stormwater flooding during August 2018.
 - o The water level of the pond was high enough that water came into window wells, etc.
 - o Flooding and drainage problems for these homes are tied to the pond in the park.
- Loruth Terrace – South Side Homes / Orchard Ridge Park
 - o Most homes had water in the basement during August 2018. Some report water coming through the floor / cracks in walls. Others had water come in through window wells – one house had the glass in a basement window break because of water against it.
 - o Some homes experienced sanitary sewer backups.
 - o During large rain events, or rain events on snow/frozen ground residents have basements flooding problems – water through window wells or walls/floor cracks.
 - o During large storms water comes out of the storm sewer inlets in Orchard Ridge Park (they are large rectangular inlets). Water flows north through the park towards homes. It flows through side yards and also towards homes.

- o During August 2018 there was approximately 4- to 6-inches of water across backyards and the park.
 - o Runoff from yards and Whitcomb Street also flows overland into park during large storm events.
- The sewer from Gilbert St / Whitney Way that discharges into the Orchard Ridge Valley Park Pond is now partially full of water at all times. It used to be dry (you could walk inside of it as a boy growing up).
- The intersection of Whitney Way and Gilbert Street frequently floods during large rainfall events (maybe 2"-3" of rain in a short period). This has occurred numerous times over the last 10-years and the streets are impassible. The intersection was closed for approximately 36-hours in August 2018.
- Odana Hills Park Pond (North of the Beltline): A long-time resident reported that this pond used to be much more open. Cattails are now growing / encroaching within the pond. Previously it was open water up to the mowed areas of the golf course / park.

Appendix G: Peer Review #1 Summary

Peer Review Comments for West Wingra Watershed

Peer Review #1

Date: 2019-12-04

By: AE2S (Amber Lefers, Linda Severson, Zach Magdol)

Review Comments	City Comments	Discussion at Meeting	BC Response
Hydrology			
1. Note that different subcatchment widths are used for the directly connected impervious area vs. the indirectly connected impervious area and pervious area. It appears that the basis for this difference is so that the subcatchment "length" is the same the directly connected impervious area and the pervious area (with the indirectly connected impervious area set at the same width as the pervious area).	Note guidance at meeting; BC used approach in guidance	In Stricker's	City and BC agreed to use this approach to model subcatchment width. This approach is consistent with the latest Modeling Guidance. BC will continue with approach used in the peer reviewed model version.
2. It appears that both the water surface for Odana Golf Course Pond is included in the pervious portion of the subcatchment. Since rainfall directly on the water surface functions much more closely to impervious area, we recommend that open water be considered impervious surface.	Not mention at meeting; BC to update		BC agrees and will update impervious area calculations for the Odana Golf Course Pond subcatchment. Horton Infiltration parameters for HSG = W were included. It would be a more straight-forward approach to account for large waterbodies as impervious. BC will modify the approach.
3. It appears that for the impervious area subcatchments, Curve Number methodology is being used for computing runoff volume for impervious area. If CN value of 98 is being used, the total losses from a 3-inch rainfall is nearly 0.25 inches, which likely underestimates the total runoff potential from impervious area.	To discuss at meeting	In Stricker's	Curve number methodology was not solely being used for computing runoff volume. It was being used for infiltration parameters for impervious areas (in lieu of Horton Infiltration). Based on testing there is no difference in runoff results. A follow-up comment on this item was in Peer Review #2. Upon investigation, it was not the CN infiltration parameters that was an issue. A default setting in XPSWMM has an evaporation value of 0.1-inches per day. It appears this creates the discrepancy identified by AE2S. For clarity the infiltration parameters for impervious areas will be changed to Horton, but this will not result in a difference in runoff. Eliminating the evaporation will result in a difference.
4. There are several areas where the subcatchments are crudely delineated with respect to the LiDAR topography. We suggest that these areas be refined given the City's investment in detailed LiDAR data and that the subcatchment modeling should reflect that investment.	Not mention at meeting; Amber to provide example offline; BC update if agree		BC reviewed the subcatchment divides and we have not found significant deviations from the subcatchment boundary and the available topographic data (LiDAR) and storm sewer system. If there are specific locations where deviations occur, we would appreciate having these identified and we will adjust accordingly.
5. We recommend that the overall detail of the subcatchment modeling be significantly increased to correspond to the Modeling Guidance standards for modeling all 18-inch pipes and larger (unless a good reason not to) and including smaller pipes where these are the only pipes that drain a certain area. See also 1D Hydraulics comments.	To discuss at meeting	In Stricker's	BC has updated subcatchments such that runoff is input at the upstream-most 18-inch pipe (with limited exceptions). With the noted adjustments, we believe this level of subcatchment detail meets the intended goals of the level of analysis requested by the City.

Peer Review Comments for West Wingra Watershed

Peer Review #1

Date: 2019-12-04

By: AE2S (Amber Lefers, Linda Severson, Zach Magdol)

Review Comments	City Comments	Discussion at Meeting	BC Response
6. We recommend that as a general rule, subcatchments be routed to a surface node versus directly into the storm sewer, as that is not how runoff draining to and in the street functions.	Will be addressed in calibration model	In Stricker's	Inlet capacity was added into the model. A new node, connected to the surface, and a link with a rating curve is used to connect to the storm sewer system to simulate inlet capacity.
7. There are a few areas where streets have very long runs before the storm sewer starts, one example of that being the streets north of Odana Golf Course. It is likely that at least some of these streets do not meet current City standards for street drainage; however, the level of detail for the subcatchments cannot answer that question. We recommend that smaller subcatchments be used so that future improvements can be evaluated and recommended.	Discuss at meeting. Previously agreed upon approach resulted in BC's approach being acceptable for the watershed studies.	In Stricker's	BC is applying runoff at nodes to represent inlets. We do not believe representing flow along the street upstream of inlets is warranted for purposes of this study.
1D Hydraulics PEER Review Comments			
1. Based on a spot check of the 1D network, it appears the following parameters are consistent with the modeling guidance: a. Loss coefficients for straight pipes and bends b. Inlet control codes c. Pipe roughness values d. Stage-area relationships e. Starting WSE for storage nodes	Not mention at meeting; OK		No comment necessary
2. We recommend that all trunkline 18-inch and larger pipes be activated in the model, as they are currently turned off in the model, to reflect the Modeling Guidance standards.	Discuss at meeting	In Stricker's	BC has activated these lengths of pipe in conjunction with subcatchment refinement. (See Hydrology Response #5)
3. The Modeling Guidance also outlines that smaller than 18-inch pipes should be included as well when a smaller pipe is the only pipe draining an area. We recommend that smaller than 18-inch pipes be added to the model where they are the trunkline storm sewer in a street.	Discuss at meeting	In Stricker's	BC has activated pipes less than 18-inches in diameter where they are included in the current model.
4. There appear to be several locations in the storm sewer system where downstream inverts are higher than upstream inverts. We recommend that these areas be investigated further to confirm whether or not this is the case.	Not discuss at meeting; BC check and respond		BC spot checked the modeling. Data is consistent with City provided elevations.

Peer Review Comments for West Wingra Watershed

Peer Review #1

Date: 2019-12-04

By: AE2S (Amber Lefers, Linda Severson, Zach Magdol)

Review Comments	City Comments	Discussion at Meeting	BC Response
5. We recommend that inlets (in some way) be incorporated into the model, since the model as it currently is constructed, shows virtually no street flooding in the 2-year event, which drastically underpredicts the flooding extents that actually happen. Note that one of the deliverables for the Watershed Study is a 2-year flood inundation map, so the model needs to reasonably represent conditions for both small and large events. Further, once proposed solutions are developed, the current modeling approach would show zero inundation except for greenways and ponds.	Will be addressed in calibration model	In Stricker's	Inlet capacity was added into the model. A new node, connected to the surface, and a link with a rating curve is used to connect to the storm sewer system to simulate inlet capacity.
6. The outfalls are modeled as "Link Spill Crest to 2D" versus set at the lake level referenced in the Modeling Guidance. We recommend these outfalls be changed.	Discuss at meeting	In Stricker's	BC reviewed and it appears this approach is providing accurate results. There is not backwater from Lake Wingra - confirmed through review of available Lake Wingra information.
7. If 1D-2D interface lines are used along open channels, we recommend additional nodes be added to the 1D portion of the system to provide a more accurate 1D HGL elevation for which the 2D grid uses.	Discuss at meeting	In Stricker's	BC does not believe additional nodes are needed for accurate depiction at this time. This may be added during alternatives analysis if needed.
2D Hydraulics PEER Review Comments			
1. 1D/2D node inflow capture is turned off – therefore, exchange between surface and 1D network is not restrained by catch basin hydraulics.	Discuss at meeting	In Stricker's	Inlet capacity was added into the model as described previously. Where nodes are adjacent to inlet nodes the node is "sealed." Nodes that are in other areas (not near inlets) are restricted with the global 2D inflow capture setting.
2. We suggest that the grid orientation be set to zero or to an orientation that is perpendicular to the primary flow paths or provide a justification as to the odd orientation of "-18.048 degrees".	Discuss at meeting	In Stricker's	The grid orientations set to zero. Due to the variety of flow paths that exist it wouldn't be possible to set it perpendicular to the primary flow path.
3. While the 2D roughness values in the model are consistent with the latest modeling guidance, the roughness values in the model are more appropriate for sheet flow conditions at the inception of runoff (i.e. rain on grid) versus roughness appropriate for more open channel flow conditions such as street and greenway flow. These lower roughness values will increase velocities and may require model adjustment to provide a stable model.	Discuss at meeting	In Stricker's	BC is open to discussion on this topic. BC will follow the modeling guidance if it is updated.
4. We recommend that the model duration be extended to cover most or all of the flood event duration.	Not mention at meeting; OK		BC agrees and will model the full flood event duration in the final existing conditions deliverable.

Peer Review Comments for West Wingra Watershed

Peer Review #1

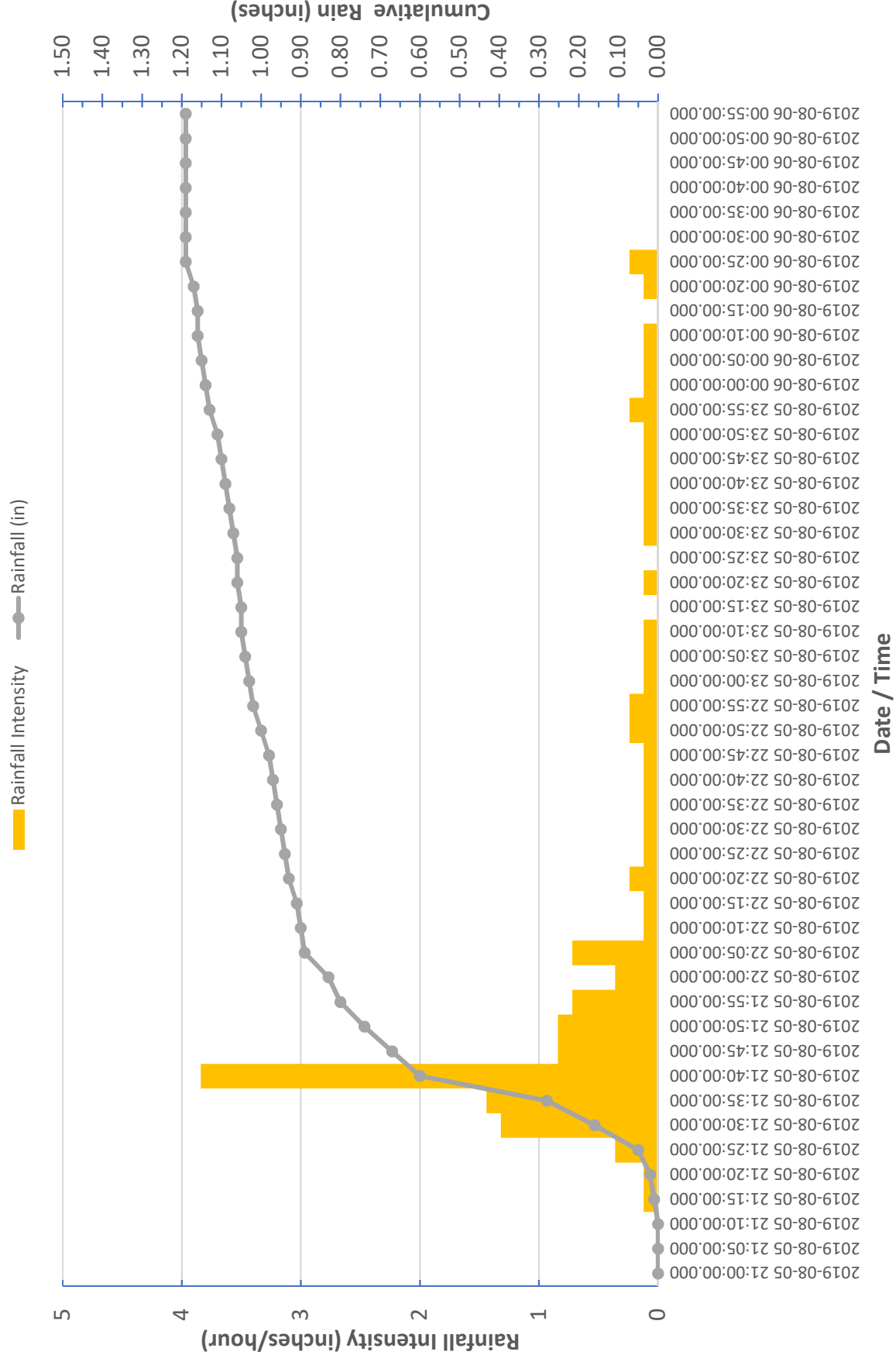
Date: 2019-12-04

By: AE2S (Amber Lefers, Linda Severson, Zach Magdol)

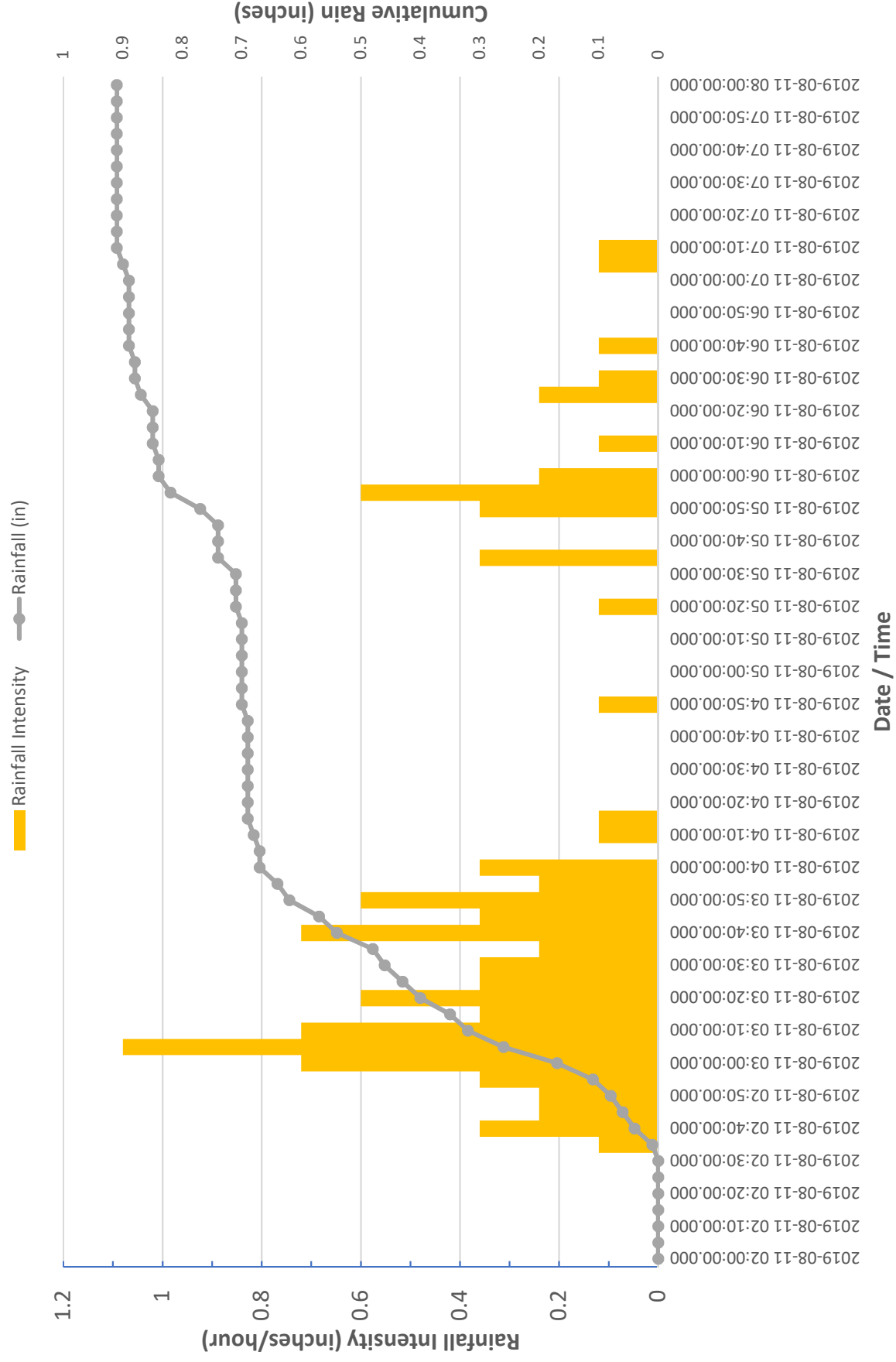
Review Comments	City Comments	Discussion at Meeting	BC Response
5. Note that the West Wingra model is not stable when using the GPU processor add-on for XP as the GPU processor also allows the "Control Number Factor" to be adjusted. The default value for the Control Number Factor did not create a stable model using the same settings; however, the standard CPU processor for XP runs fine. AE2S did not attempt to adjust the Control Number Factor to create a stable model that runs on the GPU processor add-on.	Not mention at meeting; OK	Control number factor setting that adjusts how conservative is (like Currant factor in 1D)	The model is stable as it is currently configured.
SPOT CHECK COMMENTS			
Based on a spot check of the model, it appears that the model could generally be replicated. As part of the existing conditions report preparation, we recommend that data sources, etc. for model inputs be clearly documented.	Not mention at meeting; OK		Agreed. No further comment necessary
OVERALL QUESTIONS TO BE ANSWERED			
Below are our assessments of the overall questions to be answered:			
1. In areas where there was deviation from the Model Guidance, is the reasoning documented and justified?			
a. At this point, documentation has not been provided to provide the justification for the following deviations from the modeling guidance:			
i. Storm sewer network to be modeled (18" and larger)			
ii. Watershed delineation with sufficient detail to meet the requirements of 8.a.i. and ii.			
b. One area that technically conforms to the current modeling guidance, but should be adjusted to conform to general standards of engineering practice:			
i. 2D land use roughness values that reflect open channel flow conditions (and not sheet flow).			

Appendix H: Calibration Information

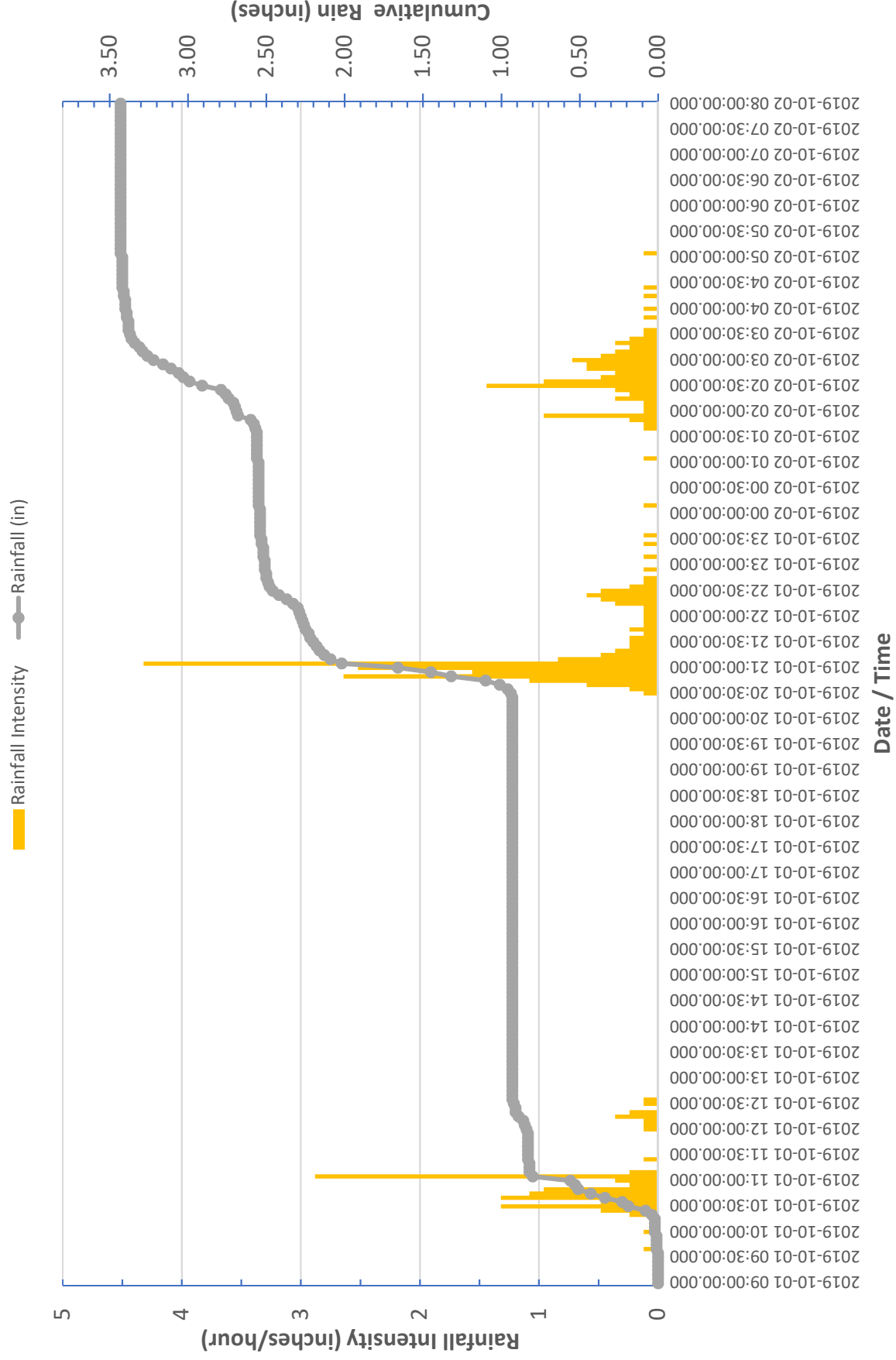
**Fig. H-1: SW Bike Path Rainfall
(Aug 5-6 2019 Event)**



**Fig. H-2: SW Bike Path Rainfall
(Aug 11, 2019 Event)**



**Fig. H-3: SW Bike Path Rainfall
(Oct 1-2, 2019 Event)**





Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: April 10, 2020

Prepared for: City of Madison: Caroline Burger, PE, Env SP
Lauren Striegl, PE
Phil Gaebler, PE

Subject: Directly Connected Impervious Area Calculations – Stricker's / Mendota Watershed Study and Wingra West Watershed Study

Project No.: City of Madison: 8411/8412, BC: 153393/153394

From: Mike Wegner, PE

Copy: Doug Joachim, PE; Bryan Rogne, PE

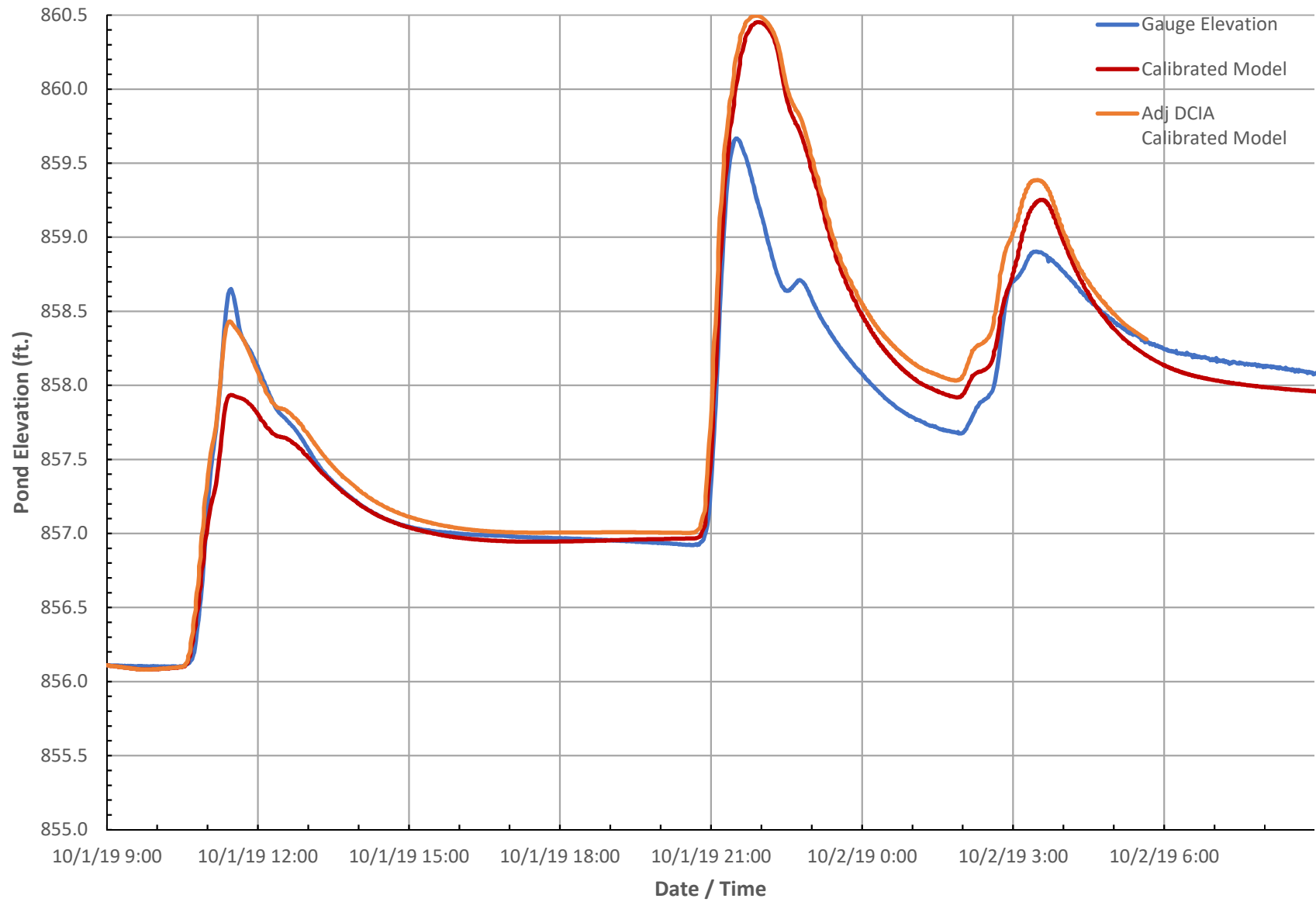
The initial existing conditions XPSWMM™ model constructed and the initial model calibration was conducted using directly connected impervious areas (DCIA) that were calculated with a methodology that was not consistent with the Modeling Guidance document. The DCIA calculations were updated to follow the Modeling Guidance. The Stricker's / Mendota Watershed XPSWMM model was executed for the calibration storm events and the design storm events. As a result of reviewing the results from the model runs, BC moved forward with using the DCIA values calculated in a methodology consistent with the Modeling Guidance. This selection was made based on:

- The purpose of this study is to evaluate flooding and large storm events. During the larger storm events (Oct 1-2, 2019 and the design storm events) that were analyzed there is minimal difference in results.
- Additionally, in some of the cases the results show a better calibration. Two specific instances are provided below.
 - o Wingra West Watershed - Manitou Pond: During the October 1, 2019 event the peak water surface elevation during the 1st peak of the storm is closer to the gauge value (see attached graph). This peak is likely driven by DCIA. With this elevation being matched more closely with the adjusted DCIA values this indicates that across the watershed the DCIA values are represented reasonably. This conclusion is drawn because Manitou Pond is located at the downstream end of the watershed.
 - o Stricker's / Mendota Watershed – Stricker's Pond: During the October 1, 2019 event the peak water surface elevation during the 1st peak of the storm, and the overall peak at the end of the storm is closer to the gauge value (see attached graph). Again, the 1st peak is likely driven by DCIA and this indicates that across the watershed the DCIA is represented reasonably. The match with the overall peak indicates the combination of all the model input parameters is representative.
- Based on the calibration effort completed, and the understanding of the watersheds that was gained, we believe that different calibration factors would be needed for smaller storms (such as the August calibration events) and larger storms (such as the October calibration

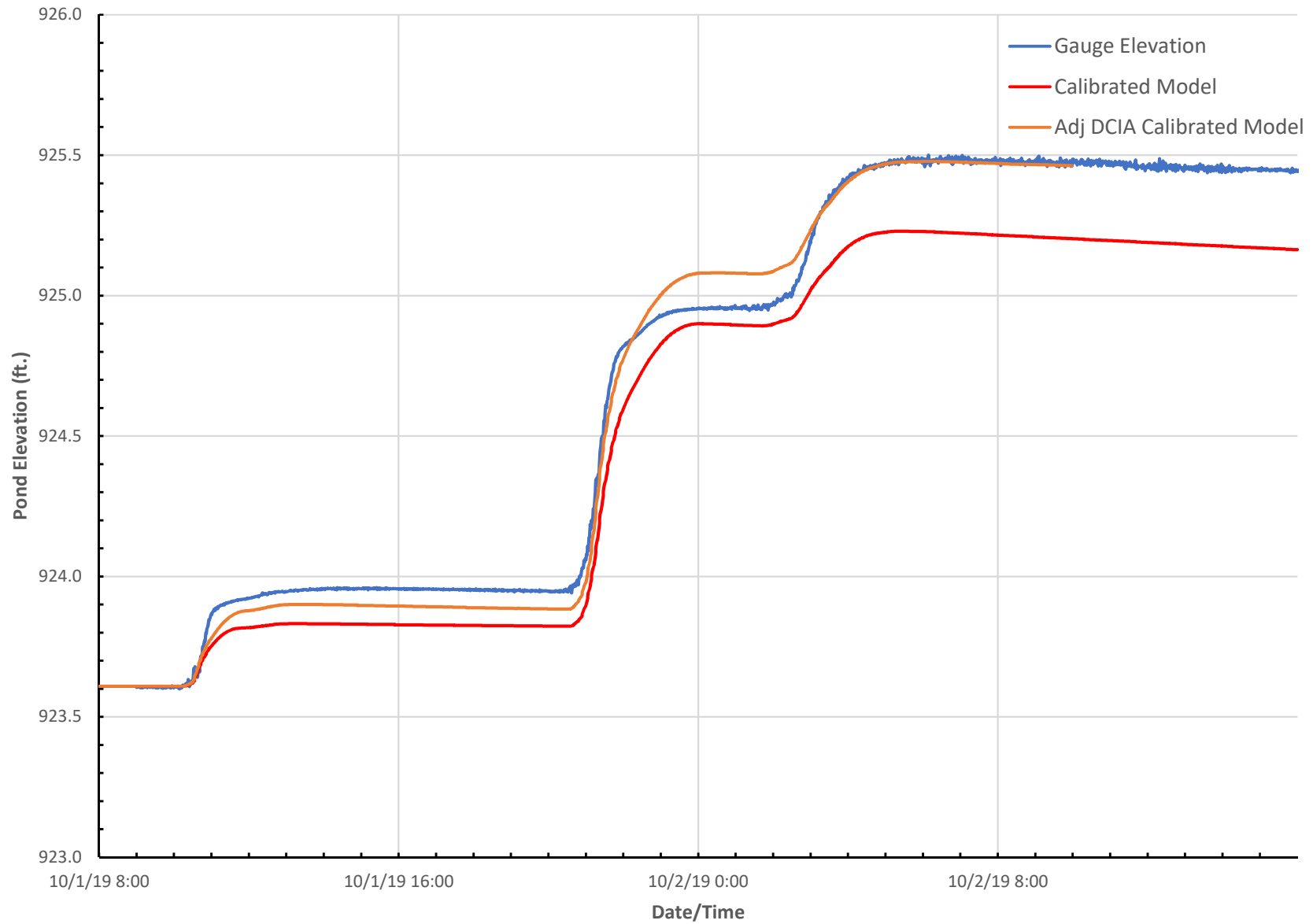
event). For the purposes of this study we are trying to identify a single set of parameters that can be used for large storm events.

- The adjusted DCIA values are consistent with the modeling guidance document.
- Other parameters adjusted during the calibration process are within acceptable ranges and are defensible.

**Fig 14: Manitou Pond October 1 -
2, 2019 Storm Event**



**Fig. 6: Stricker's Pond
October 1-2, 2019 Storm Event**





Memorandum

8383 Greenway Blvd. # 600
Middleton, WI 53562

Date: January 22, 2020 (Updated: February 11, 2020)

Prepared for: City of Madison: Caroline Burger, PE, Env SP
Lauren Striegl, PE
Phil Gaebler, PE

Subject: Wingra West Watershed – Existing Conditions Model Calibration

Project No.: City of Madison: 8412, BC: 153394

From: Mike Wegner, PE

Copy: Doug Joachim, PE; Bryan Rogne, PE; Jim Bachhuber, PH

Brown and Caldwell (BC) has calibrated the Wingra West Watershed – Existing Conditions XPSWMM model. This memo provides an overview of the calibration process. As part of the calibration the Wingra West Watershed – Existing Conditions XPSWMM™ model (Base Model) was used as the basis for creating the Wingra West Watershed – Calibrated XPSWMM™ model (Calibrated Model).

Scope of Work and Limitations

The scope of work for the calibration effort is identified below.

Calibration will be attempted for no more than three (3) 2019-monitored storm events. The three (3) events will be selected by City, AE2S, and BC. For purposes of this project, the model will be considered to be calibrated if the overall average model bias for water surface elevations is within +/- 5% with reasonable effort made to minimize the largest absolute error while at the same time balancing that effort with the relative importance of the model results at each monitoring site location. The largest absolute error at each monitored location is defined as +/- 25 percent. It is understood that there may be some circumstances where calibration cannot be accomplished.

For model calibration, the following rainfall events were selected:

- August 5th, 2019: 1.1- to 1.2-inches of rain, 3.5-hour duration.
 - August 11th, 2019: 0.9- to 1.5-inches of rain, 4.5-hour duration.
 - October 1st-2nd, 2019: 3.0- to 3.6-inches of rain, 19-hour duration.
- (NOTE: the range of rainfall for each storm reflects measurements at the rain gauges used in the modelling. Wingra West Watershed used rain gauges identified as: SW Bike Path, Odana USGS, East Kenosha USGS, Yellowstone USGS and Meadowood Park)

The October storm event was the largest event that was successfully measured in 2019 at the relevant rain gauges. The October event (rain depth and duration) falls in the range of a 5- to 10-year recurrence interval based on NOAA Atlas 14 Volume 8 Version 2 data. The overall goal of the study is to evaluate flooding, and consider mitigation of flooding, from large storm events.

The calibration process focused on identifying consistent model input parameters that would provide reasonably comparable results for each of the three storm events.

Monitoring Locations

There are four monitoring locations within the Wingra West Watershed that could be used in the calibration process.

1. Maniou Pond Elevation (monitored by City, data obtained from Trimble Unity website)
2. Odana Pond Elevation (monitored by MG&E, data obtained from MG&E – via the City)
3. Southwest Commuter Bike Path (Chippewa Drive) Culvert Flow (monitored by City, data obtained from Trimble Unity website)
4. Odana Road / Hilltop Drive Storm Sewer Flow (monitored by USGS, data obtained via email from USGS)

Calibration Steps

As part of the model calibration process the following steps were taken:

1. The overall watershed was evaluated with various scenarios to assess the impact of modifications and compare the results to the Odana Pond and Manitou Pond stage data. Both hydro-logic and hydraulic factors were evaluated.
2. Odana Road / Hilltop Drive flow data was provided by the USGS. This data was not available at the start of the calibration process.
3. Calibration to the Odana Road / Hilltop Drive flow data was conducted.
4. Iteratively with the Odana Road / Hilltop Drive flow calibration the overall impact to the watershed modeled results was considered and compared to the monitored locations at Odana Pond, Chippewa Drive, and Manitou Pond.

Initial Calibration Considerations

Based on the initial calibration process (prior to the Odana Road / Hilltop Drive data) the following conclusions were made.

Manitou Pond Outlet: Design drawings for the pond show the outlet structure at an invert elevation of 856.0. The monitoring data showed that during periods of dry weather (and no upstream flow from Odana Pond) the water surface elevation decreased to 855.7. Thus, it is believed that the actual invert of the outlet structure is 855.7 and the structure elevation was adjusted in the model. In addition, the outlet structure is a v-notch weir. XPSWMM does not allow a v-notch weir to be directly modeled. The weir is being represented as a series of sharp-crested weirs. During the calibration process the inputs for these weirs were reviewed and modified to more closely match the expected flow through the v-notch weir, particularly at low flows.

Odana Pond Outlet: The outflow from Odana Pond was overestimated in the model compared to the measured flows. The Odana Pond outlet consists of two 24-inch x 38-inch HERCP culverts with metal plates attached to the front of the end-sections. The XPSWMM model originally included a 6-foot weir length to account for the metal plate in front of the culverts and the cut away sides of the culvert end-section. This resulted in the pond drawing down faster than observed. As a result, the weir length was reduced to 3-feet to represent a clogging factor. During previous site visits debris and obstructions in front of the weir were observed. It is also believed that there are additional losses and reduction in effective weir length along the sides of the culvert end sections. A 3-foot weir length better represented the pond draw down when compared to measured data.

Odana Golf Course Inlet Structure: Within Odana Golf Course there is a staged concrete structure (downstream from Odana Pond) that conveys water into a 42-inch storm sewer. During a site visit this structure was observed to be substantially clogged. City staff indicated that clogging occurs frequently, and debris removal is required after most substantial rain events. The weir lengths associated with this structure were reduced to represent the clogged condition and to better match the water levels observed in Odana Pond and Manitou Pond. The flow capacity of this structure can impact the water level in Odana Pond during large events (such as the October event). During smaller events it appears that this structure may have a larger impact on the Manitou Pond elevation. When the weir lengths were reduced the level in Manitou Pond following an event (as the pond draws down) is more closely represented. The modifications to this structure to represent the reduced flow due to clogging were: 1) the low flow weir was changed from 7-inches to 3-inches, 2) the mid-level weir was removed, and 3) the top of the structure was reduced from an 8-foot weir to 3-feet.

Southwest Commuter Bike Path Culvert (Chippewa Drive): Measured flows at this location are suspected as being faulty for several reasons as summarized below and displayed on Figures 1 through 5.

- During the August 5th event, the XPSWMM model displays a stage lower than the measured stage at the peak of the event, and a stage higher than the measured stage during the tail of the event. Based on a comparison of the stage elevations the measured peak flow should be higher than the modeled peak flow. However, the reported measured peak flow is lower (approximately 32 cfs) than the modeled peak flow (approximately 65 cfs).
- For the August 11th event the measured data shows no distinct rising hydrograph. The highest flow measured for this event was approximately 8.6 cfs and this was over 6 hours after the initiation of rain. The Odana Road / Hilltop Dr station measured a peak flow of 7 cfs immediately after the initiation of the rain event. The Odana Road / Hilltop gauge measures runoff from a 27 acre watershed, and the SW Commuter Bike Path station is measuring runoff from a 1,385 acre watershed, including 330 acres of land that drain to the culvert without flowing through Odana Pond. The relative peak flow measurements, and the shape of the SW Commuter Bike Path station is indicative of measurement errors.
- For the October 1st-2nd storm event the USGS reported there was a battery failure, and there are no flow measurements until noon on October 2nd (this is well past the major portion of the rain event).

Based on these results, it appears that there is inconsistency with the measured values at this station. Further evaluation of the raw field data may be necessary to verify and/or correct the measured data. The calibration did not consider the flow data from this location. The shape general timing of the stage data collected from the gauge was considered, however, the modeled stage was not compared numerically to the monitored stage.

Rainfall Timing: The Wingra West watershed utilizes rainfall data from both USGS and City of Madison (Trimble Unity) rain gauges. The USGS rainfall data was provided directly by the USGS via email. The City data was downloaded from the Trimble Unity website. Rainfall data provided by the USGS was in Central Standard Time. Rainfall data downloaded from the Trimble Unity site was in local time (August through October was Central Daylight Time). The USGS rainfall data was adjusted to be local time and match the Trimble Unity data.

Odana Road / Hilltop Drive Flow Gauge

This flow gauge monitors a single subbasin with homogeneous land use within the Wingra West watershed. The drainage area tributary to the gauge is approximately 27-acres and it is composed of medium density single-family residential land-use. The soils within the tributary area are hydrologic

soil group B. There is estimated to be 37-percent impervious area and 44-percent of the impervious area is directly connected. The flow gauge is located within an 18-inch storm sewer in the south terrace of Odana Road, that is the upstream limit of modeled storm sewer within this part of the project area. Upstream of the flow gauge is a 15-inch storm sewer that crosses Odana Road to the north and 12-inch inlet leads from inlets on the northeast and northwest sides of the intersection.

To reduce model runtimes the Odana Road / Hilltop Drive portion of the watershed model was isolated from the overall Wingra West model. Downstream conditions do not appear to impact the storm sewer and a free outfall from the area was assumed approximately 575-feet downstream of the gauge.

Because of the gauge location and well-defined drainage area and land use, this gauge was used to help better calibrate hydrologic factors that could then be applied to other areas of the Wingra West Watershed with similar characteristics.

The analysis conducted at this gauge is summarized below.

1. The initial modeling showed the model was under-predicting peak flow rates during the August storm events and over-predicting the peak flow from the October event. The volume was over-predicted during the August storm events and under-predicted from the October event.
2. Initial testing of the hydrologic parameters indicated that peak flow rates were sensitive to changes in the SWMM subcatchment width parameter.
3. As part of this analysis it appeared that there may be a hydraulic restriction within the minor storm sewer system upstream of the flow gauge.
 - a. The gauge measured flows up to approximately 10 cfs during the August 5th and October 1st-2nd storm event.
 - b. The peak flow during the August 11th event was 7 cfs. This flow rate could be simulated in the model by increasing the subcatchment width.
 - c. When increasing the width to approximate the August 11th peak flow rate, the simulated peak flow rates from the August 5th and October 1st-2nd event were substantially higher than the monitored flow rates.
 - d. As a result, it was suspected that the storm sewer system was limiting the flow to 10 cfs, or less. See below for further explanation.
4. A detailed XPSWMM model for the Odana Road / Hilltop Drive area was created. The model included all storm sewer upstream of the flow gauge.
 - a. Limited data was available for the storm sewer above the flow gauge. Assumptions included: 1) the 12-inch storm sewer was vitrified clay (matches 15-inch and 18-inch pipe material), and 2) a 1-percent storm sewer slope was assumed.
 - b. The tributary area was split into two drainage basins. A basin was delineated for both the set of inlets on the west side and the east side of Hilltop Drive at the intersection with Odana Road.
 - c. Inlet capacity was not incorporated as part of the detailed model.
 - d. The inlet on the south side of Odana Road was not separately incorporated into the model. Runoff from this area was input into the system at the northwest corner of the Odana Road / Hilltop Drive intersection.
5. The detailed model showed that flows of approximately 10 cfs resulted in ponding and overland flow that leaves the Odana Road / Hilltop Drive intersection and flows east along Odana Road. Reviewing the model results confirmed that the 15-inch storm sewer crossing Odana Road is a constraint and limits flow to a maximum of about 10 cfs. Since the gauge shows there is 10 cfs in the 18-inch storm sewer, and the capacity of the 15-inch sewer is

estimated to be 10 cfs it is believed that inlet capacity is not the a limiting factor in this location.

6. The initial detailed models resulted in the peak flow rate being under-predicted and the volume being over-predicted for the August storm events. In the October event the modeled peak flow rates match and the volume is under-predicted compared to measured values.
7. Various changes to hydrologic parameters were considered within the detailed model. Changes considered included: 1) increasing or decreasing subcatchment width, 2) decreasing the depression storage for impervious areas, 3) increasing the impervious area zero detention percentage, 4) reducing the minimum infiltration rate, 5) increasing the maximum infiltration rate, and 6) reducing the percent of directly connected impervious area.
8. During the course of considering model modifications within the Odana Road / Hilltop Drive area, changes to parameters were evaluated in the overall watershed models (Stricker's and Wingra West) to evaluate impacts on other gauged locations.
9. After reviewing the impacts of the various parameter changes the following modifications were selected as providing the best overall calibration to the flow data. Emphasis was placed on the October 1st-2nd storm event. Consistent parameters were also selected to best fit across the three events (different parameters for each event were not considered).
 - a. The maximum infiltration rate was increased to 3.0 inches/hour (original value was 2.0 inches/hour).
 - b. The minimum infiltration rate was decreased to 0.3 inches/hour (original value was 0.5 inches/hour). This is within the range for HSG B soils recommended by the XPSWMM help menu and the SWMM reference manual.
 - c. The soil was assumed to be partially saturated during the October storm event. The prior rainfall event ended approximately 1.6 days prior to the start of the October 1st event. Soils were assumed to be saturated at the end of the prior event and the regeneration of the infiltration rate was considered. A maximum infiltration rate of 2.34 inches/hour was calculated for the start of the October event.
 - d. The subbasin width was doubled, and the same width was used for each subcatchment. Note: When the subbasin width was updated for the split subbasin it resulted in a width approximately ½ of the original subbasin width. Thus, it is believed that the original subbasin width is appropriate for use in the watershed model.
 - e. The monitored rainfall data for the August 5th and October 1st-2nd rainfall events includes very small rainfall depths that occur at the start of the rainfall. For instance, the October event includes 0.02-inches of rain over a 25-minute period at the start of the event. This initial rainfall starts the Horton Infiltration decay curve. It is believed that this small rainfall amount at the start of the event is not representative of when the infiltration decay curve should begin. Thus, initial small rainfall depths were removed from the start of the events.

The calibrated results from the Odana Road / Hilltop Drive flow gauge are shown in Tables 1 and 2. Graphs (see Figures 1, 2, and 3) attached to this memo also show the calibrated results compared to the monitored data.

Table 1. Odana Rd / Hilltop Dr Calibration Results – Peak Flow			
	Peak Flow Rate		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Gauged Data	9.8 cfs	7.1 cfs	10.3 cfs

Modeled Results	9.8 cfs	7.9 cfs	10.9 cfs
% Difference	0%	12%	5%

Table 2. Odana Rd / Hilltop Dr Calibration Results – Volume			
	Volume		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Gauged Data	0.36 ac-ft	0.32 ac-ft	2.12 ac-ft
Modeled Results	0.54 ac-ft	0.50 ac-ft	2.27 ac-ft
% Difference	49%	58%	7%

Calibration Parameter Selection

The calibration parameters described in the previous section were combined in the watershed-scale model and include the following:

1. Maximum infiltration rate for HSG C soils was increased to 3.0 inches/hour. For October 1st-2nd a partially saturated soil condition was used. The maximum infiltration rate for other soil groups was not modified.
2. The minimum infiltration rate for all soils was reduced to be equal to values listed in the XPSWMM help file and the SWMM reference manual.
3. The same width factor was used for each subcatchment. The width was calculated by dividing the total subbasin area by the delineated flow path length.
4. Rainfall depths of 0.01-inches that occurred over 5-minute or longer time periods at the start of rainfall events were eliminated (applicable to only the August 5th and October 1st-2nd events).
5. The outlets from Odana pond, Manitou Pond, and Odana Golf Course were modified to better represent clogging, and other factors.

Comparison of Simulated Results to Monitored Data

The calibrated results from the Odana Pond and Manitou Pond level gauges are shown in Tables 3 and 4. Graphs attached to this memo (see Figures 6 through 14) also show the calibrated results compared to the monitored data.

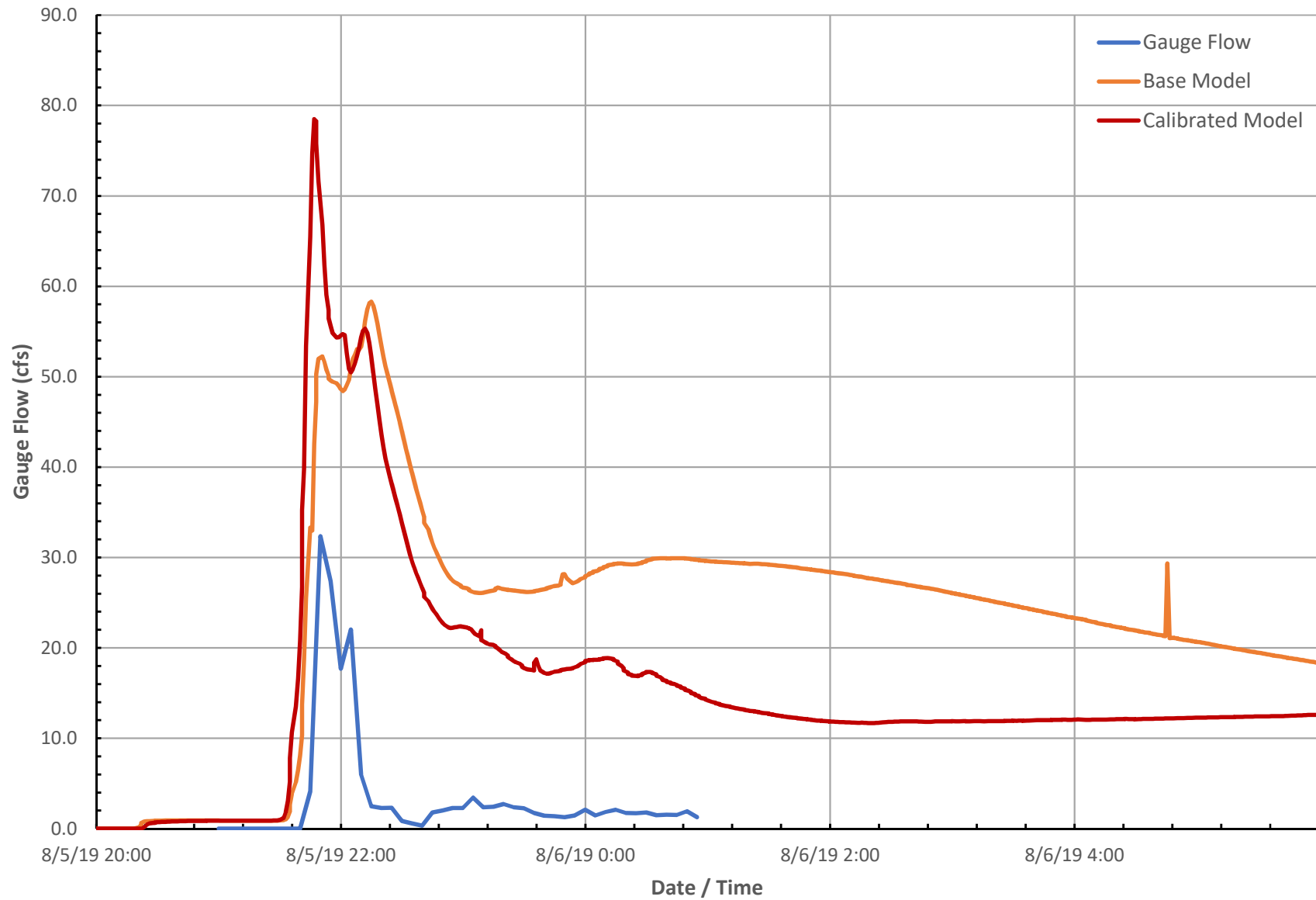
Table 3. Odana Pond Calibration Results – Pond Level (ft.)			
	Peak Pond Level (ft.)		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Starting Pond Level	976.8	977.0	977.5
Gauge Peak Pond Level	977.7	977.9	979.8
Modeled Peak Pond Level	978.1	978.2	980.1
Absolute Difference (ft.)	+0.4	+0.3	+0.4
% Difference (calculated based on increase in pond level)	42%	29%	16%

Table 4. Manitou Pond Calibration Results – Pond Level (ft.)			
	Peak Pond Level (ft.)		
	8/5/2019 Storm	8/11/2019 Storm	10/1/2019 Storm
Starting Pond Level	855.7	855.7	856.1
Gauge Peak Pond Level	857.8	857.4	859.7
Modeled Peak Pond Level	858.5	858.0	860.5
Absolute Different (ft.)	+0.7	+0.7	+0.8
% Difference (calculated based on increase in pond level)	33%	39%	23%

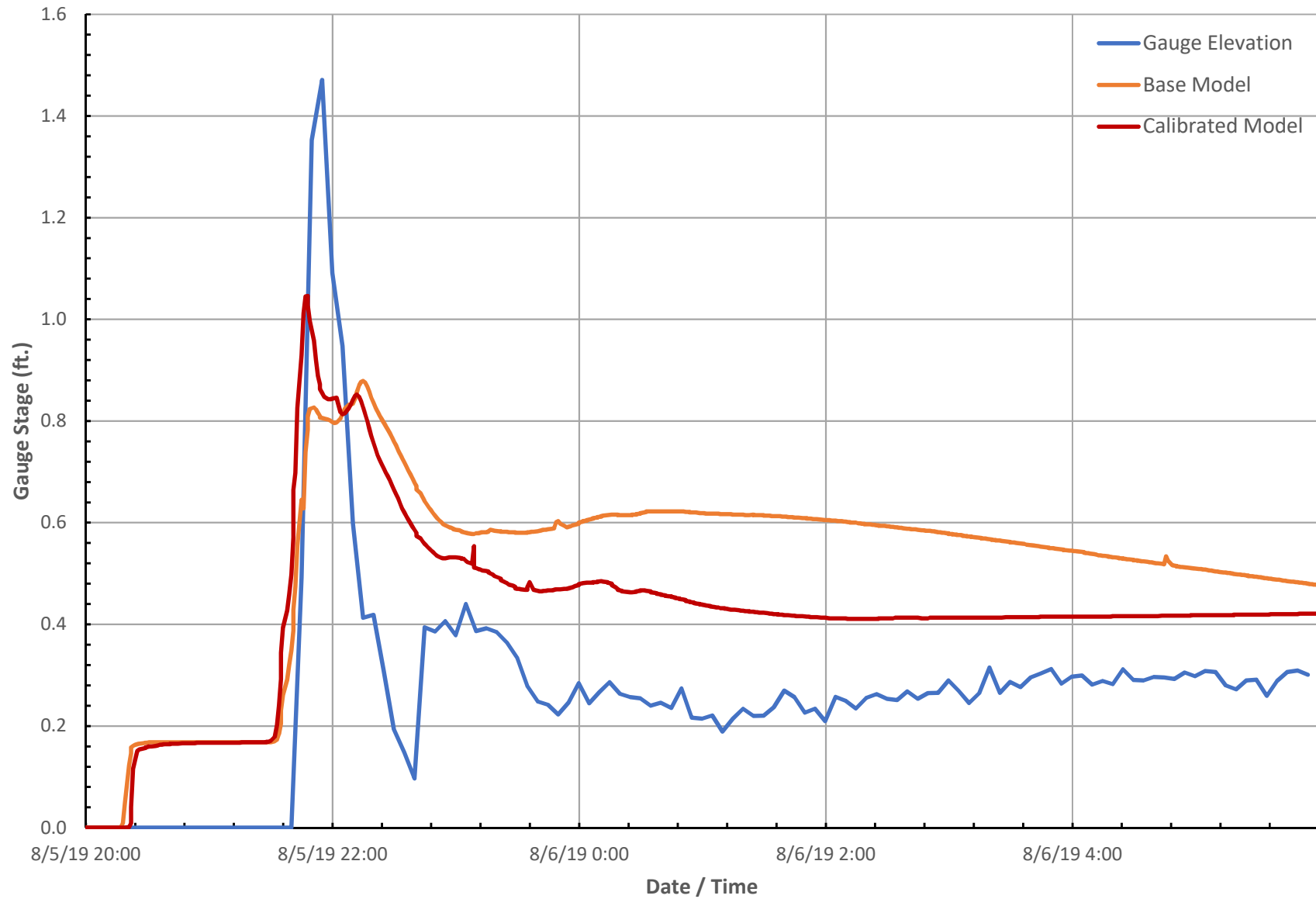
It is important to note that the Odana pond level increase during the August 5th event and August 11th event is about 0.9-feet. The modeled results are approximately 0.4-feet above the August 5th gauge peak level and 0.3-feet above the August 11th gauge peak level. In comparing the modeled versus measured differences, the absolute level difference should be considered and not just the percent error.

During the Chippewa Drive / Cherokee Drive focus group meeting residents indicated that flooding at the intersection of Chippewa Drive and Cherokee Drive occurred during storm events of approximately 2-inches or more. Based on this information it was expected that street flooding in this area would occur during the October 1st-2nd event. Model results show approximately 18-inches of ponding within the intersection. This comparison to observed conditions helps to validate the calibrated model results.

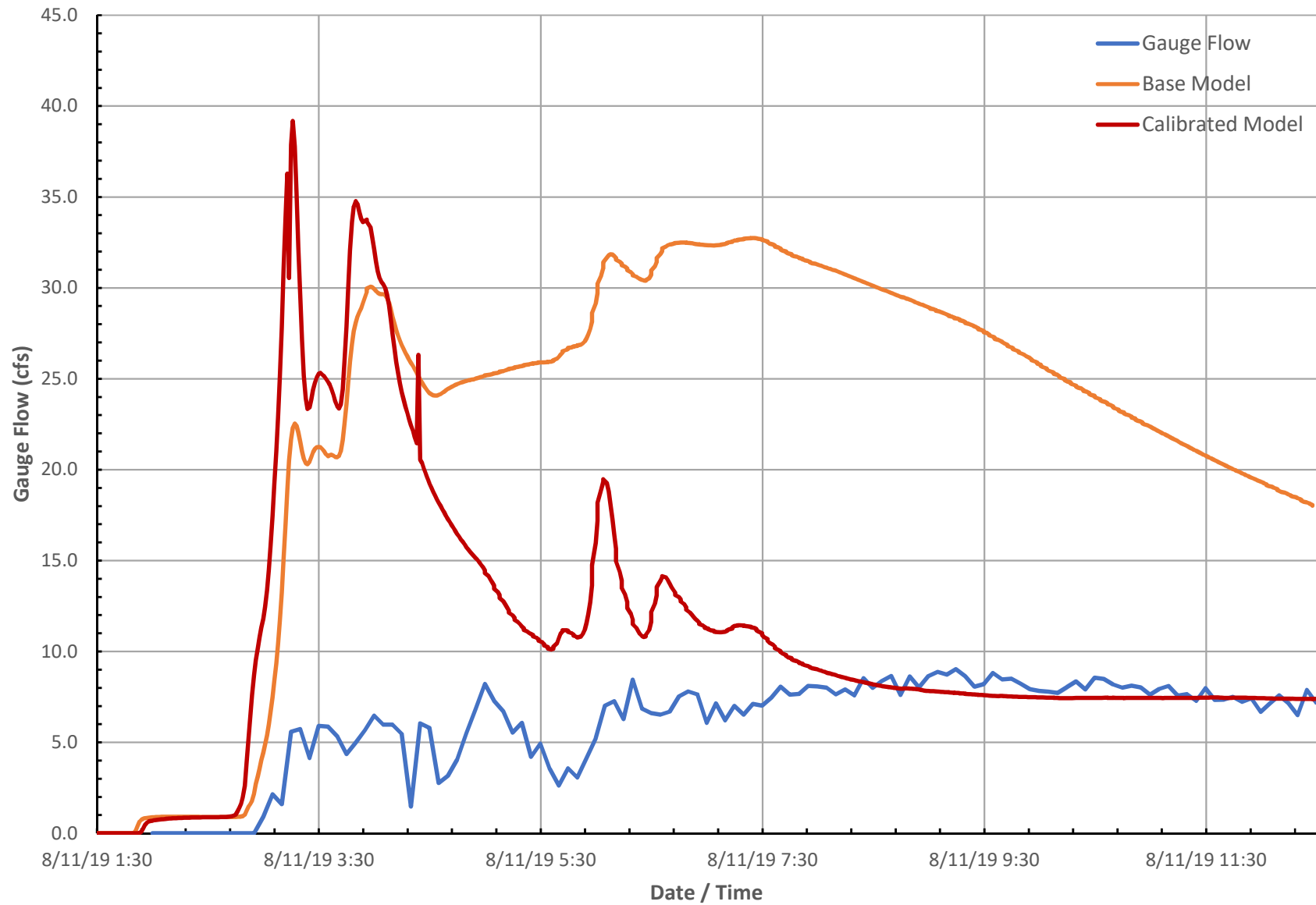
**Fig. 1: Chippewa Drive Flow
August 5, 2019 Storm Event**



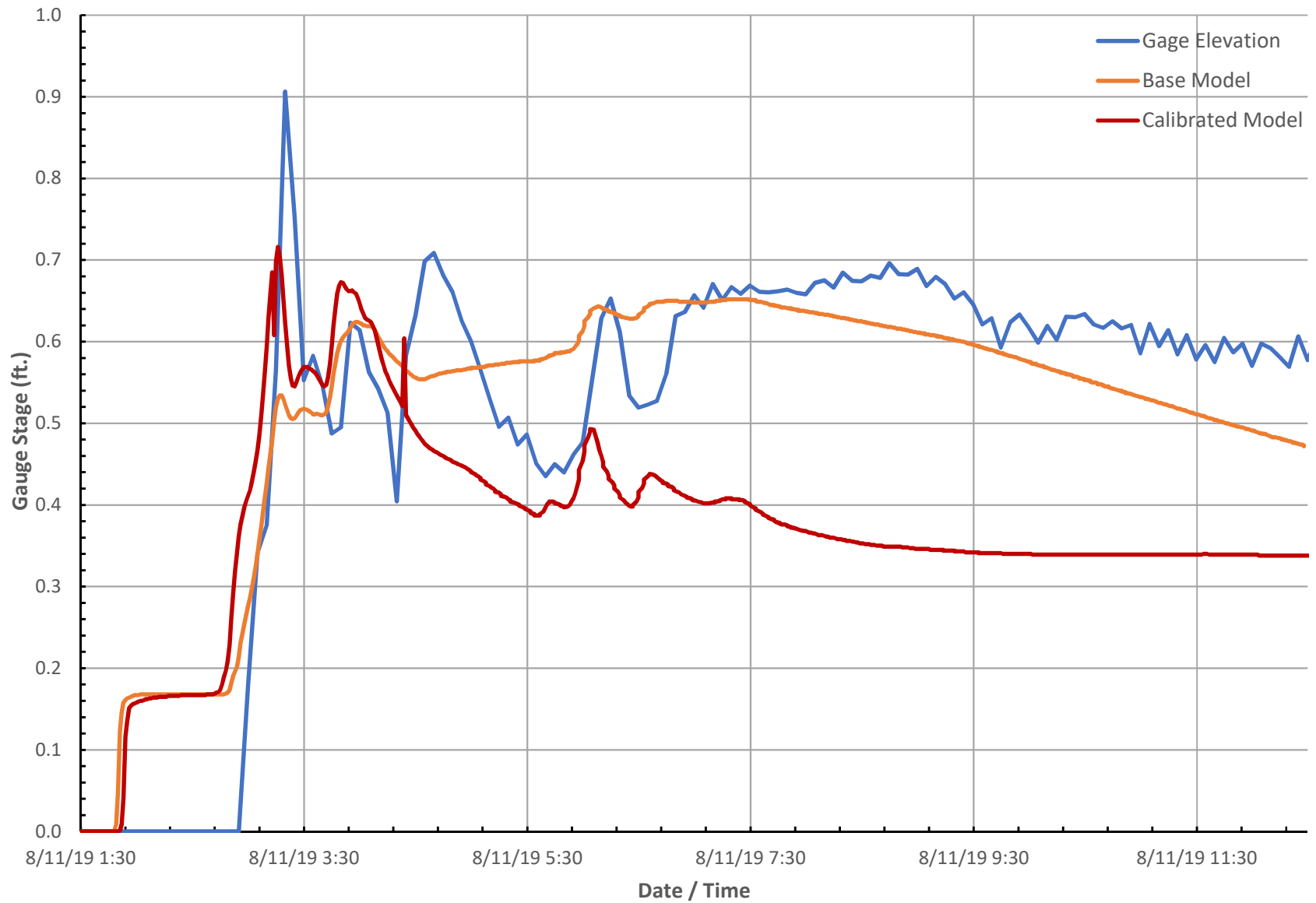
**Fig. 2: Chippewa Drive Stage
August 5, 2019 Storm Event**



**Fig. 3: Chippewa Drive Flow
August 11, 2019 Storm Event**



**Fig. 4: Chippewa Drive Stage
August 11, 2019 Storm Event**



**Fig. 5: Chippewa Flow Gauge Response
(Oct 1-2, 2019 Event)**

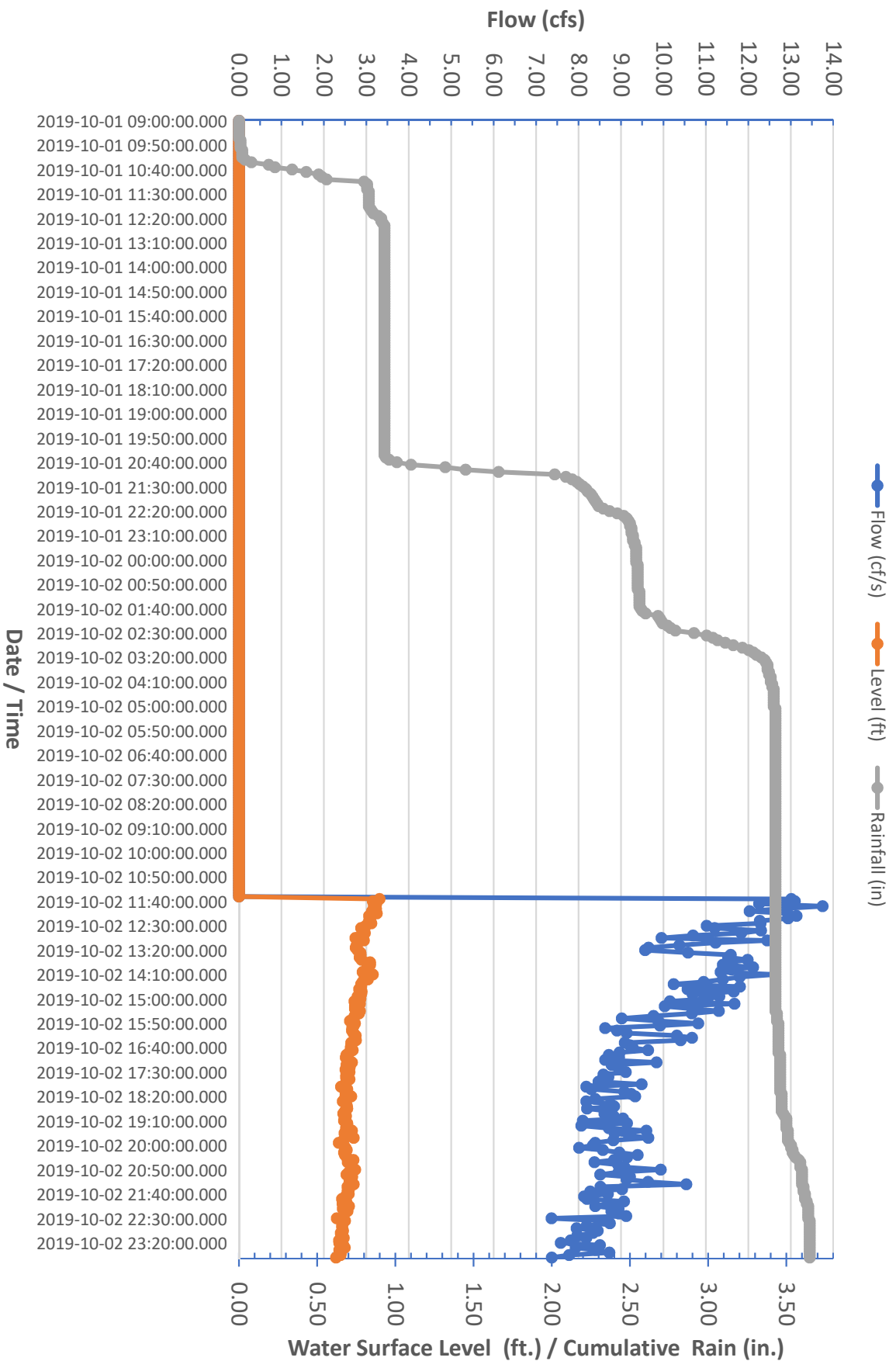


Fig 6: Odana Road / Hilltop Drive Flow Gage

August 5, 2019 Storm Event

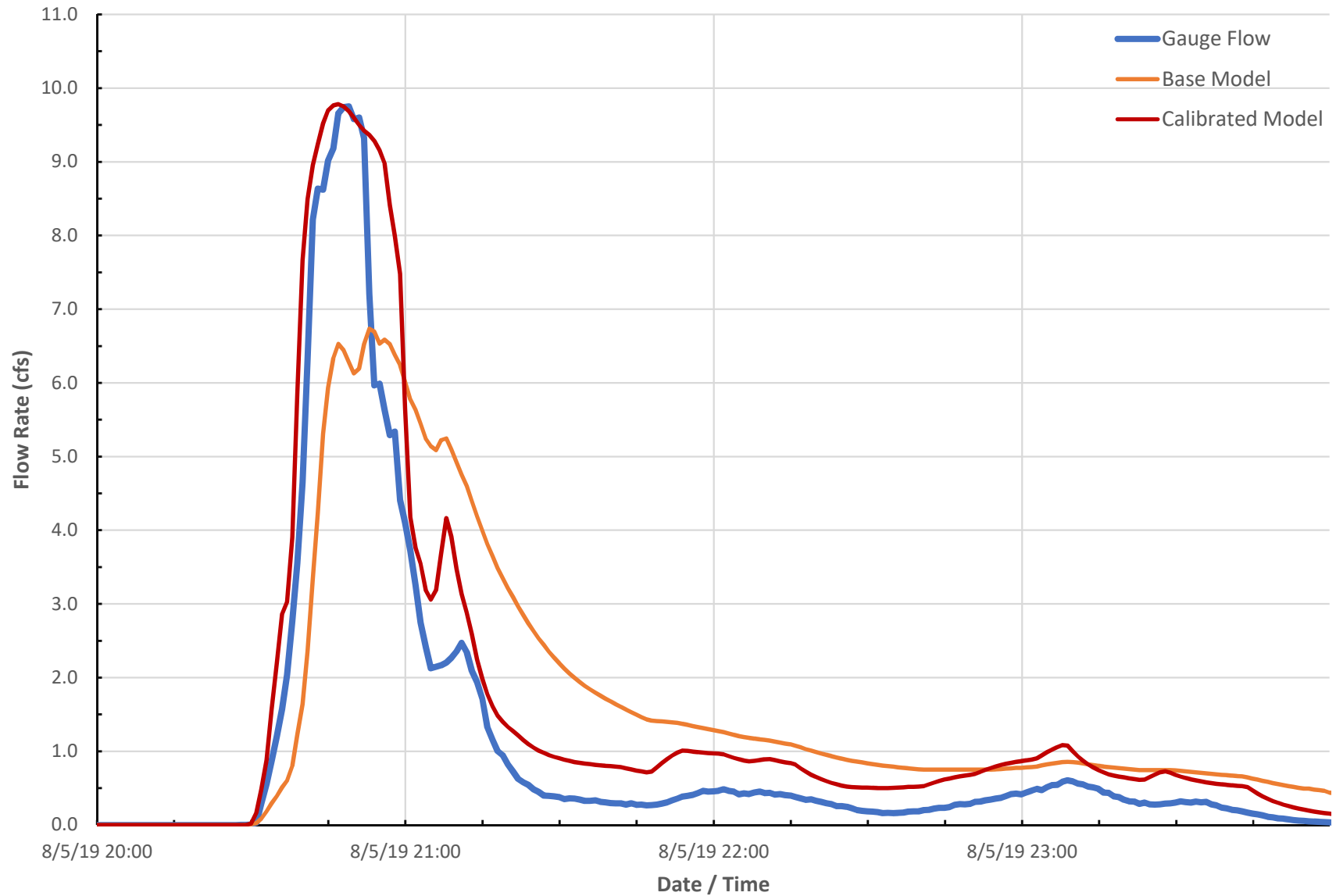


Fig 7: Odana Road / Hilltop Drive Flow Gage
August 11, 2019 Storm Event

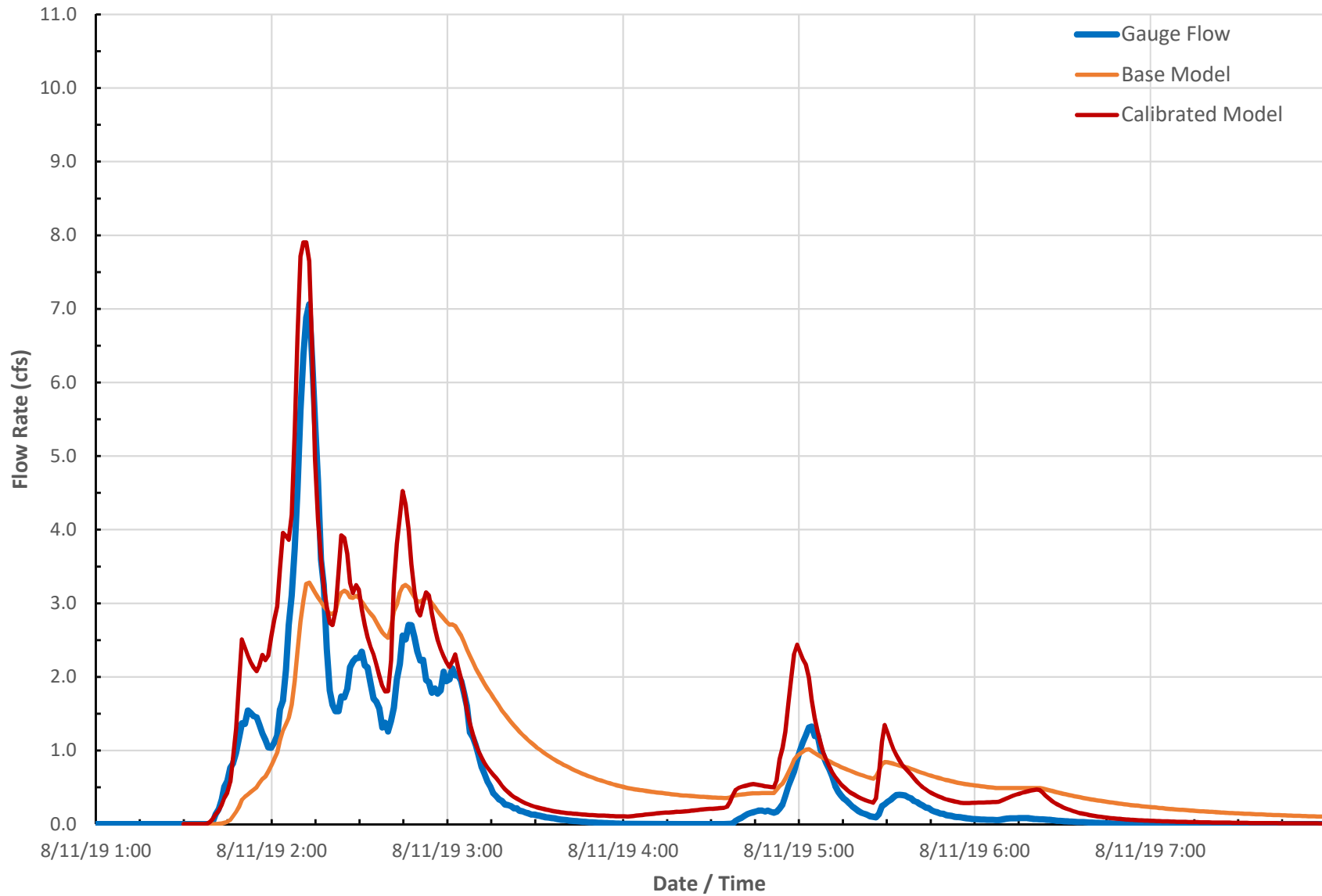


Fig 8: Odana Road / Hilltop Drive Flow Gage
October 1-2, 2019 Storm Event

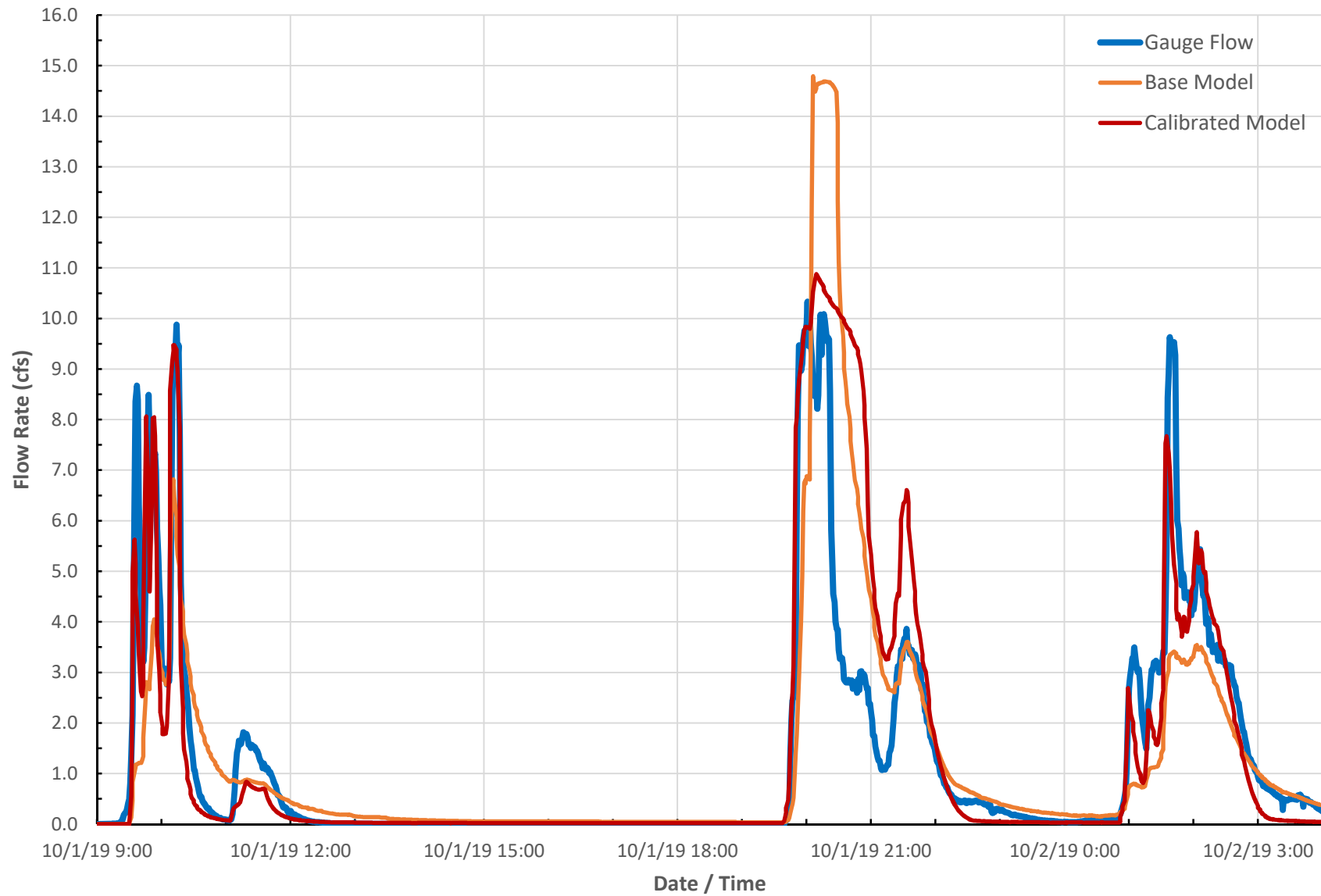
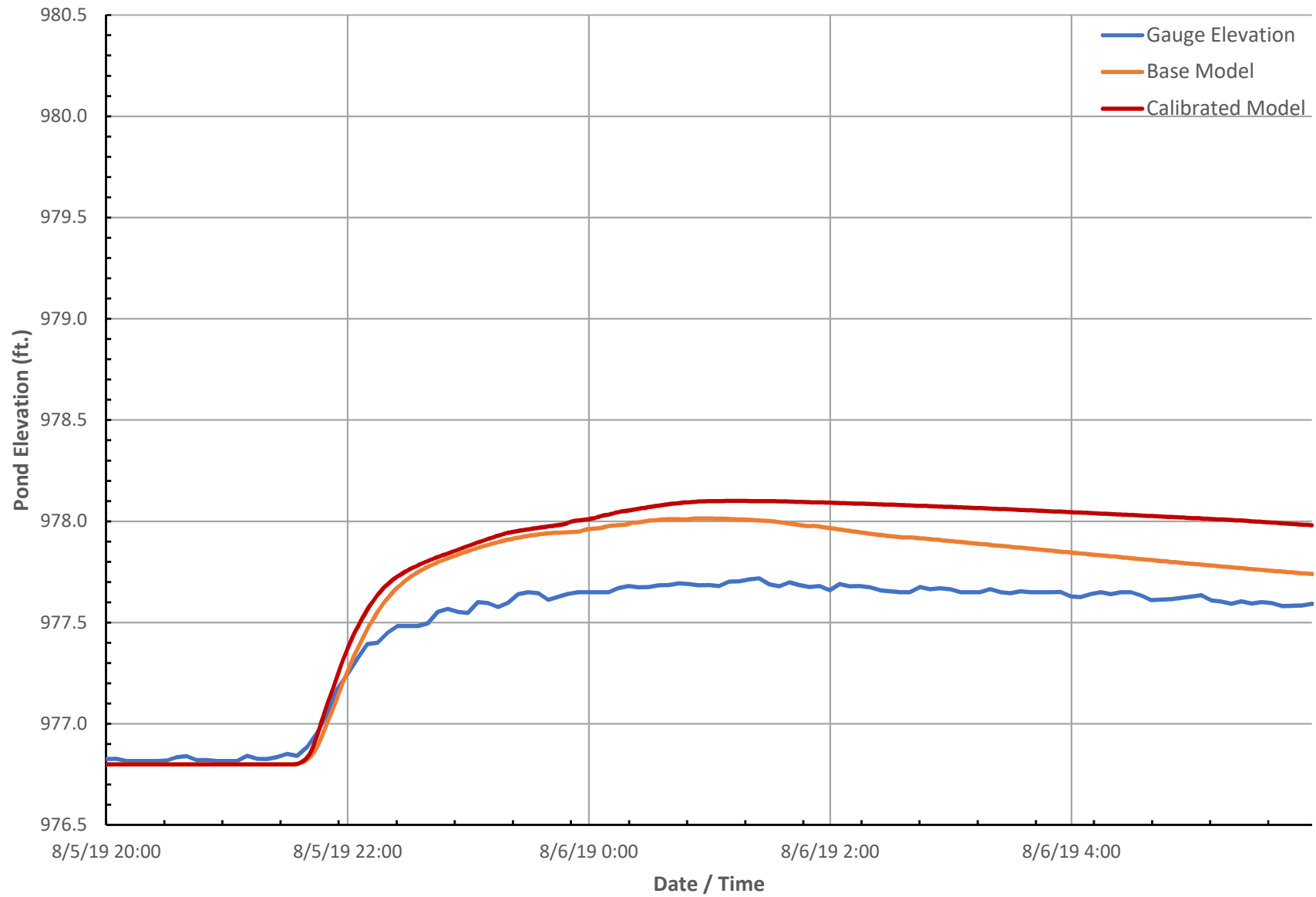
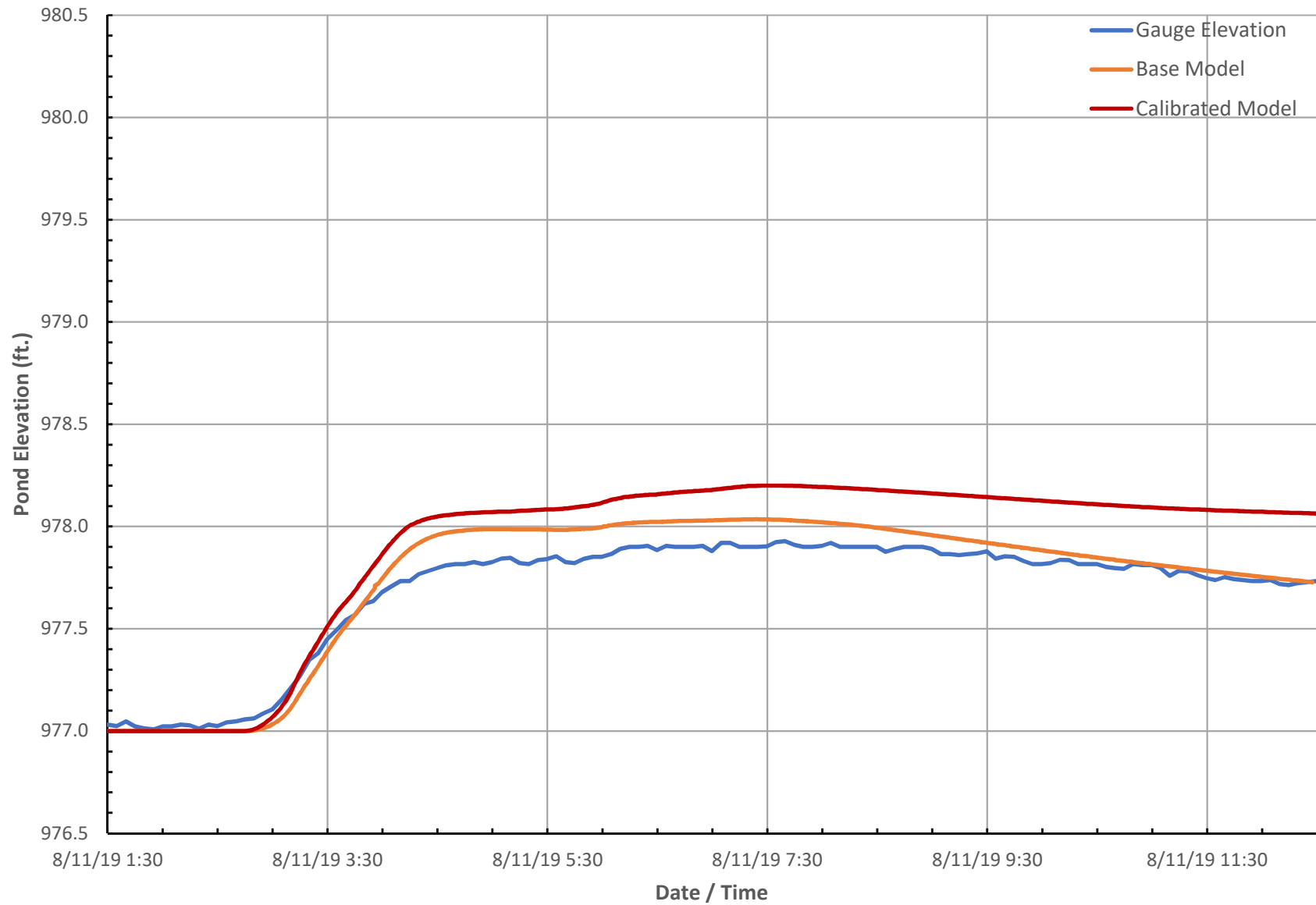


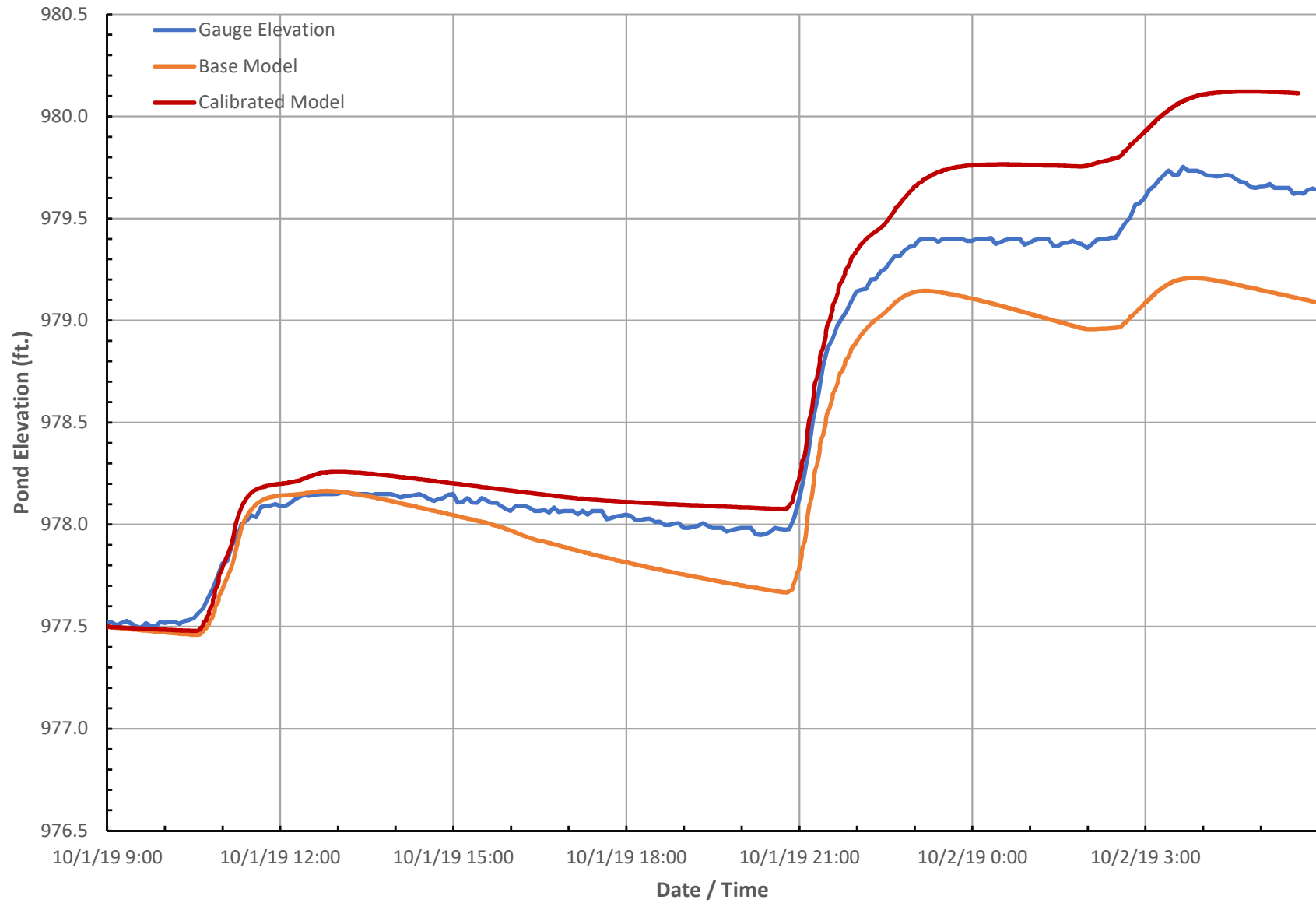
Fig. 9: Odana Pond
August 5, 2019 Storm Event



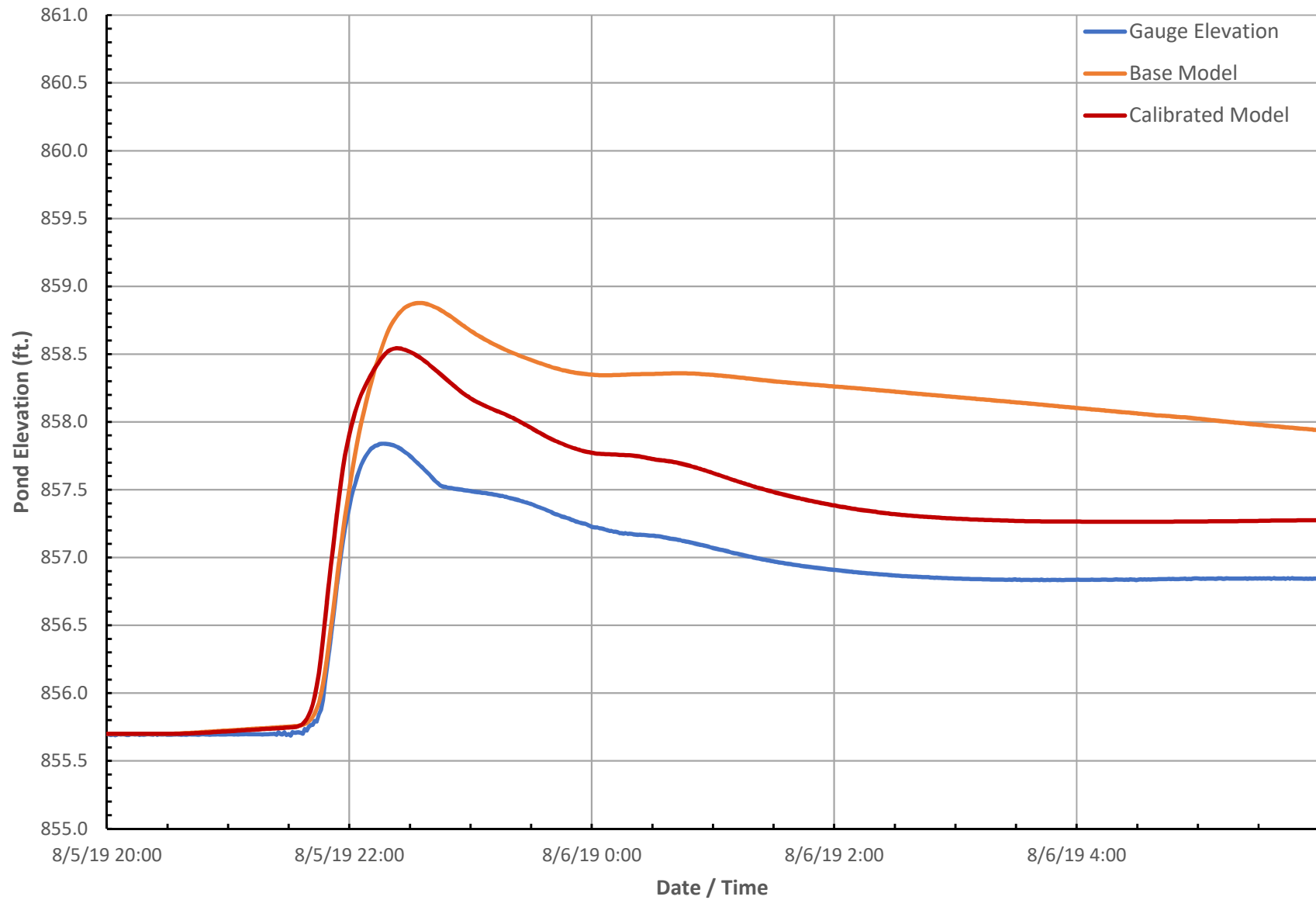
**Fig. 10: Odana Pond
August 11, 2019 Storm Event**



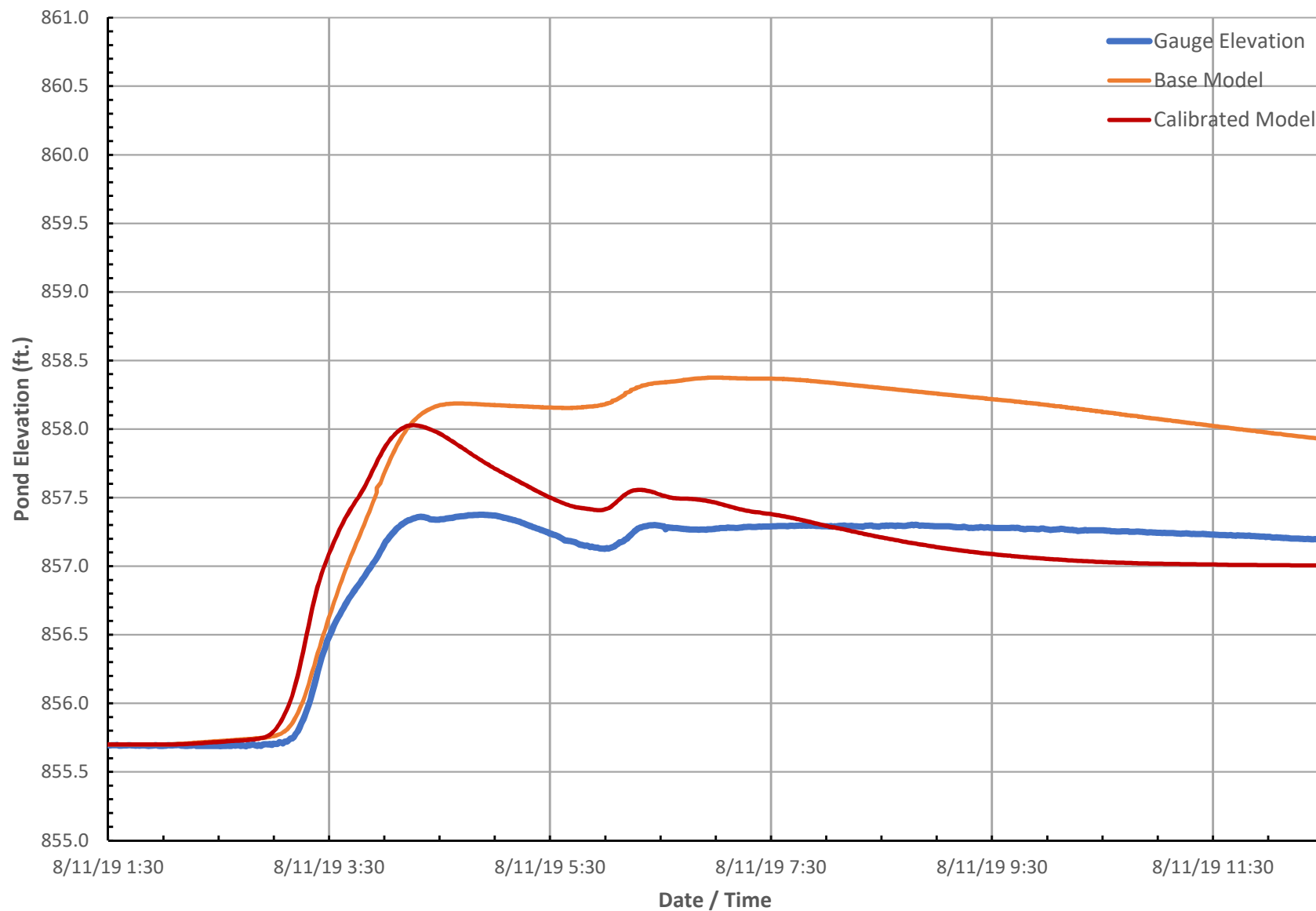
**Fig. 11: Odana Pond
October 1-2, 2019 Storm Event**



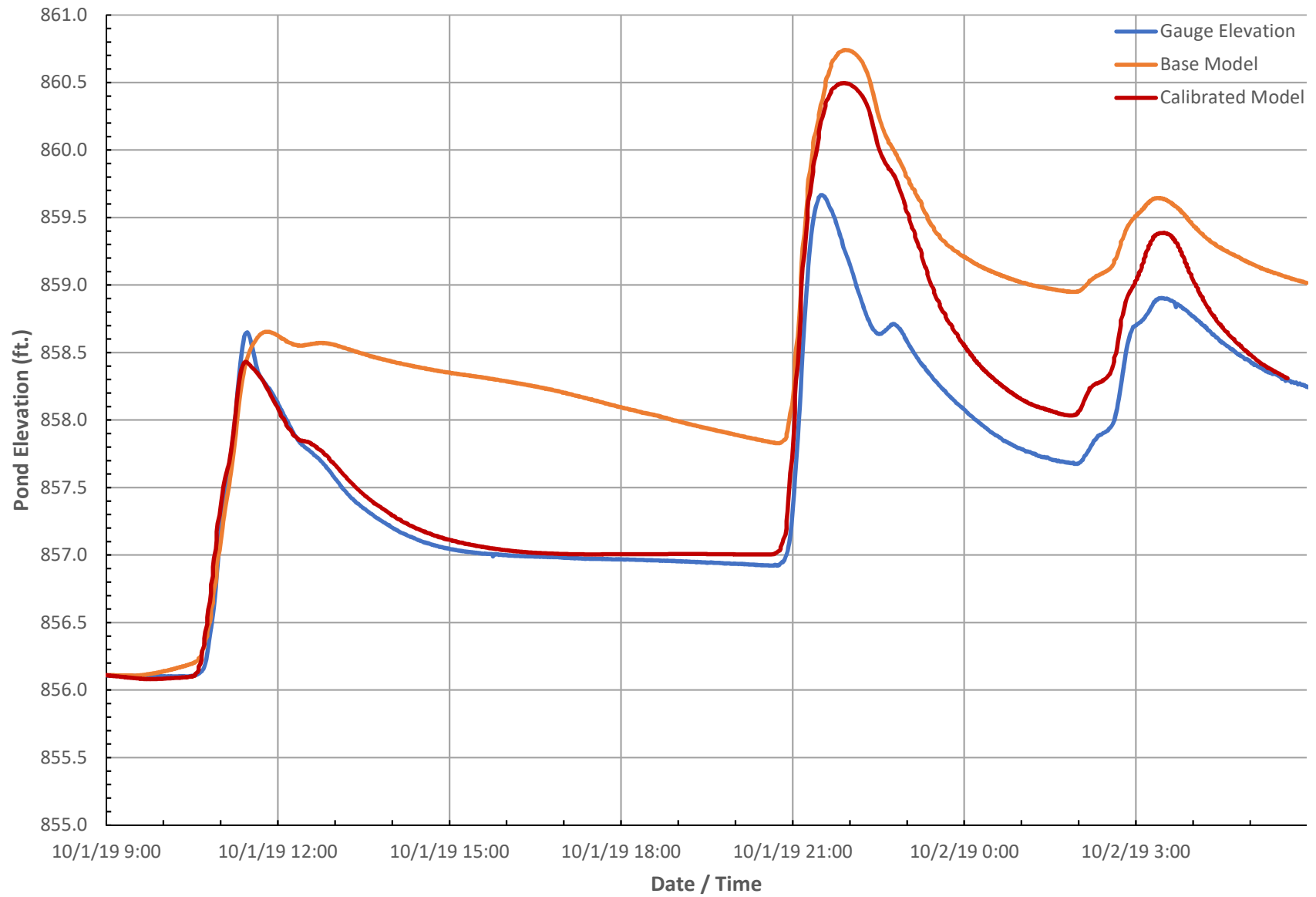
**Fig. 12: Manitou Pond August 5,
2019 Storm Event**



**Fig. 13: Manitou Pond August 11,
2019 Storm Event**



**Fig 14: Manitou Pond October 1 -
2, 2019 Storm Event**



Appendix I: Peer Review #2 Summary

Peer Review Comments for West Wingra Watershed

Peer Review #2

Date: 2020-02-05

By: AE2S (Amber Lefers, Linda Severson)

<u>Review Comments</u>	<u>BC Response</u>
Hydrology Review Comments	
Below are our review comments on the hydrologic analysis portion of the XP-SWMM model:	
<u>Carry-over recommendations</u>	
1. It appears that for the impervious area subcatchments, Curve Number methodology is being used for computing runoff volume for 75% of the impervious area (25% is set as "zero depression storage"). We performed a separate spreadsheet calculation and confirmed that the model is indeed using Curve Number methodology, which is confirmed by the 1D .out file, which lists all impervious subcatchments as using "Curve Number". The CN approach underpredicts runoff volume compared to the Modeling Guidance. For example, the October 1 storm had a rainfall depth of 3.25 inches. The Modeling Guidance would result in a runoff depth of 3.20 inches (0.05 inches of depressional storage) from directly connected impervious area, whereas the model is computing just over 3.1 inches – which is a depression storage more similar to pervious surfaces rather than impervious surface. We recommend that the modeling approach be switched to be consistent with the Modeling Guidance and to avoid mixing and matching runoff modeling approaches. See pdf of Strickers-Mendota memo for screenshots of XP-SWMM output documenting computations.	This comment was first provided as part of Peer Review #1. Curve number methodology was not solely being used for computing runoff volume. It was being used for infiltration parameters for impervious areas (in lieu of Horton Infiltration). Based on testing there is no difference in runoff results. A follow-up comment on this item was in Peer Review #2. Upon investigation, it was not the CN infiltration parameters that was an issue. A default setting in XPSWMM has an evaporation value of 0.1-inches per day. It appears this creates the discrepancy identified by AE2S. For clarity the infiltration parameters for impervious areas will be changed to Horton, but this will not result in a difference in runoff. Eliminating the evaporation will result in a difference.
2. Although the detail of the hydraulic pipe networks has been modified to include all 18" pipes and larger, the corresponding subcatchments are sometimes routed downstream of the updated network-leaving these sections effectively inactive (see example below). We recommend splitting the subcatchment at the upstream node and modeling the most upstream set of inlets.	For the majority of pipe network there are subwatersheds located at the upstream-most node. There were a minor number of outliers where the subwatershed to the upstream most point would be significantly smaller than other subwatersheds in the network.
<u>Carry-over Suggestions</u>	
1. There are several areas where the subcatchments are crudely delineated with respect to the LiDAR topography. We suggest that these areas be refined given the City's investment in detailed LiDAR data and that the subcatchment modeling should reflect that investment.	BC reviewed the subcatchment divides and we have not found significant deviations from the subcatchment boundary and the available topographic data (LiDAR) and storm sewer system. If there are specific locations where deviations occur, we would appreciate having these identified and we will adjust accordingly.
2. There are a few areas where streets have very long runs before the storm sewer starts, one example of that being the streets north of Odana Golf Course. It is likely that at least some of these streets do not meet current City standards for street drainage; however, the level of detail for the subcatchments cannot answer that question. We recommend that smaller subcatchments be used so that future improvements can be evaluated and recommended.	BC is applying runoff at nodes to represent inlets. We do not believe representing flow along the street upstream of inlets is warranted for purposes of this study.
<u>1D Hydraulics Peer Review Comments</u>	
Based on a spot check of the 1D network, it appears parameters are consistent with the modeling guidance.	

Peer Review Comments for West Wingra Watershed

Peer Review #2

Date: 2020-02-05

By: AE2S (Amber Lefers, Linda Severson)

<u>Review Comments</u>	<u>BC Response</u>
<u>2D Hydraulics Peer Review Comments</u>	
Below are our review comments on the 2D hydraulic analysis portion of the XP-SWMM model:	
<u>Carry-over recommendations</u>	
1. While the 2D roughness values in the model are consistent with the latest modeling guidance, the roughness values in the model are more appropriate for sheet flow conditions at the inception of runoff (i.e. rain on grid) versus roughness appropriate for more open channel flow conditions such as street and greenway flow. We recommend that roughness values be adjusted to reflect engineering practice for roughness values used in open channel flow conditions. Note that these lower roughness values will increase velocities and may require model adjustment to provide a stable model.	BC is open to discussion on this topic. BC will follow the modeling guidance if it is updated.
<u>New Recommendations</u>	
1. The downstream end of the model has both a natural channel and a 2D surface, but no inactive area set for the 2D model, which could create a situation where the model is double routing flow through this segment. We recommend that either the 2D terrain be used or an inactive flow area set for the 2D surface.	The downstream end of the model is outside of the active area, thus an inactive areas is not needed. No modifications will be made.
<u>Calibration Peer Review Comments</u>	
Below are our review comments related to the calibration event:	
1. We agree with your assessment that the Chippewa Drive flow data appears suspect and should not be used for model calibration. However, what is unclear is whether the stage data itself is also suspect, or whether the depth in the storm sewer could be used to calibrate that portion of the model.	The stage data was compared to the modeled results for shape and timing. Given some of the irregularities that occurred a direct numerical comparison was not made.
2. Notwithstanding how the hydrology and 2D model review comments could affect calibration, it appears that the model represents the physical conditions in the watershed to a sufficient degree to provide a useful tool for making decisions about future improvements.	

Appendix J: City Agency Meeting Notes



Watershed Study Agency Meetings

Round 1

City Engineer (Rob) – 11/4/2020

Mayor's Office (Christie) – 11/19/2020

PWI – 12/3/2020

All Agencies – 12/14/2020

Individual Agencies -

Water Utility – 1/4/2021

- Larson, Alan alarson@madisonwater.org
- Belshaw, Jeff JBelshaw@madisonwater.org
- Braselton, Peter PBraselton@madisonwater.org
- Holmgren, Peter PHolmgren@madisonwater.org
- Miess, Kelly kmiess@madisonwater.org
- Renaud, David DRenaud@madisonwater.org
- Wiederhoeft, Adam awiederhoeft@madisonwater.org

Meeting summary sent 1/6/2020

Follow-up email on 2/9/2021

"Wisconsin Administrative Code, Chapter NR 811.12 (5) (d) 6 requires a minimum setback of 400 feet from a well and storm water retention or detention pond. I request that the contours of the planned pond expansion not encroach on this required 400-foot buffer between the well and pond. This restriction would require an estimated 300' X 200' exclusion in the northeast corner of the parcel. Please note these modifications are being requested in addition to the clay liner already recommended for the expanded pond. These requests are to mitigation potential future water quality impacts (sustained increases in chloride and sodium) that are already observed at Well 16."

City of Madison Parks – 1/12/2021

- Freiwald, Ann AFreiwald@cityofmadison.com
- Knepp, Eric eknepp@cityofmadison.com
- Laschinger, Lisa llaschinger@cityofmadison.com
- Genin, Greg GGenin@cityofmadison.com
- Lerner, Sarah slerner@cityofmadison.com
- Close, Sarah SClose@cityofmadison.com
- Kane, Kathleen kkane@cityofmadison.com
- Stelljes, Corey cstelljes@cityofmadison.com
- Sturm, Michael msturm@cityofmadison.com

Meeting summary sent 1/14/2021

City of Madison Fire Department – 1/12/2021

- Denise DeSerio (sets up meeting – prefers 8:30 am Tuesday briefing time)
- Jerome Buechner
- Tracy Burrus
- Christopher Carbon
- Nicole Marie Hall
- Michael Popovich
- Arthur Price
- Edwin Ruckriegel
- Che Stedman
- Julie Trimbell
- Timothy Mrowiec
- Liza Tatar
- Steven Davis
- Scott Bavery
- Paul Ripp
- Cynthia Schuster

Meeting summary sent 1/12/2021

City of Madison Metro

- Timothy Sobota
- Drew Beck
- Crystal Martin

Email feedback – 12/15/2020

Metro Transit does not have specific concerns or feedback, for the three initial watershed study areas.

Metro Transit does have existing property infrastructure (West Transfer Point bus facility) on the NW corner of S Whitney & Tokay – and may have future infrastructure along the Mineral Point Road corridor, related to Bus Rapid Transit (including parcels near the S Rosa and S Junction intersection areas).

Metro Transit did pilot the use of permeable bus passenger boarding pad surface treatments (i.e. “shall be firm, stable, and slip resistant”, between curb and sidewalk), as part of the Toepfer Avenue reconstruction project – and does not foresee any issues at this time with expanded use of this material (versus concrete), as may be needed by storm water terrace treatment demands.



City of Madison Planning – Provided vocal feedback during 12/14/2020 agency meeting; followed up with email 12/17/2020

1. University Research Park: Is there a way that the “Tokay West” stormwater improvements in URP (between 5801 and 5901 Research Park Blvd) could be done to preserve the possibility of a future Rosa Road connection to Tokay? The connection is no longer part of current BRT planning, but we are trying to create more connectivity to and through URP, and that is a major connection. URP is on board with the idea.
2. Odana Golf Course: as the golf course pond expansion is considered can anything be done to, at a minimum, not make it more difficult to create a bike path connection from Whitney Way to the SW path along the north side of the Beltline? Ideally any pond improvements could help facilitate that future connection, but ultimately it will likely take WisDOT involvement and funding to make that connection happen.
3. West Towne ponds: We’re looking at a potential bike path extension from the existing Beltline underpass at Grand Canyon north to Mineral Point Road. An option to avoid seven driveways would be to take the path along the border between the West Towne pond property and the businesses to the east. Is there any room to make that option feasible as the improvements to the ponds are considered?

City of Madison Operations – email feedback 12/21/2020

What would OPS be responsible for relating to each reconstruction project (I assume most projects would be performed by contractors,) is this broken down to what OPS would be responsible for vs. contractor? When discussing installing thousands of feet of box culvert near/under high volume roads, expanding ponds, and upsizing large runs of storm pipe, maintenance is always a concern, as well as how this would affect our other utilities.

What would be the maintenance expectations for structures, cleaning, televising, mowing, grate clearing etc. going forward?

City of Madison Streets/Forestry – meeting on 1/27/2021

Marla Eddy
Charlie Romines

Bryan Johnson
Craig Klinke

No comments on proposed solutions.

Transportation Engineering –email feedback 1/12/2021

Yang Tao
Renee Calloway
Thomas Lynch
Thomas Mohr
Mark Winter
Scott Kerr

Traffic Engineering does not have concerns at this time and a meeting is not necessary for now.

One of TE team members discussed with Greg on the potential idea to add storm water management system under bike path and bike lanes, and we do understand that it may or may not be feasible due to added cost and other challenges.

City of Madison Street Design –email feedback 1/13/2021

Chris Petykowski
James Wolf
Christy Bachmann

Only comment I have is to continue coordinating with us to delay our street projects if needed (such as Old Middleton). Janet has been doing a good with that.

Meeting with Water Utility about Proposed Flood Control Projects from Spring Harbor, Stricker's/Mendota, and Wingra West Watershed Studies

January 4, 2021

Engineering and the Water Utility met via Zoom on January 4, 2021 to discuss comments and concerns about the proposed flood control projects for the Spring Harbor, Stricker's/Mendota, and the Wingra West watershed studies.

Attendees included:

- Jeff Belshaw, Water Utility
- Peter Braselton, Water Utility
- Caroline Burger, Engineering
- Greg Fries, Engineering
- Phil Gaebler, Engineering
- Peter Holmgren, Water Utility
- Alan Larson, Water Utility
- Kelly Miess, Water Utility
- Jojo O'Brien, Engineering
- David Renaud, Water Utility
- Janet Schmidt, Engineering
- Lauren Striegl, Engineering
- Adam Wiederhoeft, Water Utility

The following was discussed:

- Currently the Water Utility owns a land asset near Garner Park. The land is being held for a future, potential well. There is a potential the future well may include the reduction of the footprint of the current Garner Park Pond. The proposed watershed study solution for Garner Park Pond was removed from the selected alternatives early in the proposed solutions analysis. Therefore, Engineering has no plans to impact the Water Utility-owned land near Garner Park.
- Engineering will be including the wellhead protection zones on the mapping for the proposed solutions. Engineering understands that any flood control measures within the wellhead protection zones will need to be reviewed by Water Utility for impact on their well. Additionally, stormwater ponds in these areas will need to be lined to prevent infiltration of stormwater into the groundwater.
- Engineering is currently piloting a distributed green infrastructure program. Stormwater measures that purposely infiltrate stormwater (outside wellhead protection zones) create concerns for Water Utility infrastructure. In general:
 - Pervious sidewalks are okay because they are not located above a water main
 - Pervious terraces are okay (for the most part), also, because they are not located above a water main.
 - Pervious pavement causes concern because it is directly above the water mains; water main has clearance requirements that must be met when constructing water main. Water main in these areas may need to be reconstructed, thus adding additional costs to projects in areas where the water main was not planned to be reconstructed.
- Engineering is planning to reconstruct many of the greenway crossings in the watersheds to meet flood program goals. Many times, water main can be near these crossings. Large water main near these crossings can be costly to reconstruct. Engineering will reach out to the Water Utility for cost estimates for these components.
- A spreadsheet is included with this meeting summary listing the flood control measures for Water Utility staff to comment on

Meeting with Madison Fire Department about Proposed Flood Control Projects from Spring Harbor, Stricker's/Mendota, and Wingra West Watershed Studies

January 4, 2021

Engineering and the Madison Fire Department met via Zoom on January 12, 2021 to discuss comments and concerns about the proposed flood control projects for the Spring Harbor, Stricker's/Mendota, and the Wingra West watershed studies.

Invited Attendees:

- Scott Bravery, MFD
- Jerome Buechner, MFD
- Caroline Burger, Engineering
- Tracy Burrus, MFD
- Christopher Carbon, MFD
- Steven Davis, MFD
- Denise DeSerio, MFD
- Greg Fries, Engineering
- Phil Gaebler, Engineering
- Sarah Lerner, Engineering
- Nicole Marie Hall, MFD
- Timothy Mrowiec, MFD
- Jojo O'Brien, Engineering
- Michael Popovich, MFD
- Arthur Price, MFD
- Paul Ripp, MFD
- Edwin Ruckriegel, MFD
- Janet Schmidt, Engineering
- Cynthia Schuster, MFD
- Lauren Striegl, Engineering
- Liza Tatar, MFD
- Julie Trimbell, MFD

The following was discussed:

- Engineering presented the power point presentation describing how the studies are carried out and gave an overview of the proposed solutions for each watershed.
- MFD asked if there are solutions where purchasing of property will be more cost-effective than constructing/reconstructing infrastructure to reduce the property flooding. Engineering has started the process to evaluation that, but the process is in its infancy. Once Engineering has a proposed process, they will share it with interested agencies in the City.
- MFD asked about cooperation with communities that border the City of Madison regarding flooding and flood reduction. As Engineering starts a study, it contacts the adjacent communities that could be affected. To date, the City of Middleton, Town of Middleton, Village of Shorewood Hills, and the City of Fitchburg could be affected by current watershed studies. Engineering has met with City of Middleton representatives and has meetings scheduled with Village of Shorewood representatives. The Town of Middleton has been very cooperative regarding providing data for areas that discharge into the City Madison. No impacts are currently projected for the City of Fitchburg.
- Engineering asked if MFD is okay with pervious pavement being used in the Fire Lanes; recent discussions with Developers indicate they are looking at that to help meet stormwater requirements. Engineering will contact Bill Sullivan from MFD to understand the equipment needs regarding aerial ladder pad loadings.
- MFD asked for an update on marking street signs to indicate water depth during storm events. Engineering has been discussing various approaches. Now that Engineering has a key hire on board, they will be using the inundation mapping generated during the watershed studies to identify areas to pilot a program. Engineering will keep MFD updated on the progress of this effort.

- Engineering asked who handles the contract where cars are towed after flood events. Madison Police Department administers that contract. Engineering will reach out to the contacts given for that information.
- MFD did not raise any red flags during the meeting regarding the proposed solutions presented. MFD should reach out to Engineering if something arises so the concern can be accounted for in the solution(s).

Meeting with Planning about Proposed Flood Control Projects from Spring Harbor, Stricker's/Mendota, and Wingra West Watershed Studies

January 15, 2021

Engineering and the Planning Division met via Zoom on January 14, 2021 to discuss comments and concerns about the proposed flood control projects for the Spring Harbor, Stricker's/Mendota, and the Wingra West watershed studies.

Invited Attendees:

- Heather Bailey, Planning
- Sherry BonDurant, Planning
- Zia Brucaya, Planning
- Caroline Burger, Engineering
- Julie Cleveland, Planning
- Rebecca Cnare, Planning
- Breana Collins, Planning
- Patrick Empey, Planning
- Ruth Ethington, Planning
- Kevin Firchow, Planning
- Greg Fries, Engineering
- William Fruhling, Planning
- Phil Gaebler, Engineering
- Janine Glaeser, Planning
- Brian Grady, Planning
- Jeffrey Greger, Planning
- Lauren Heiser-Ertel, Planning
- Colleen Hoesly, Planning
- William Holloway, Planning
- Linda Horvath, Planning
- Ryan Jonely, Planning
- David Kanning, Planning
- Kirstie Laatsch, Planning
- Sarah Lerner, Engineering
- Benjamin Lyman, Planning
- Urvashi Martin, Planning
- Daniel McAuliffe, Planning
- Jojo O'Brien, Engineering
- Timothy Parks, Planning
- Sydney Prusak, Planning
- Angela Puerta, Planning
- Colin Punt, Planning
- William Schaefer, Planning
- Janet Schmidt, Engineering
- Daniel Seidensticker, Planning
- Heather Stouder, Planning
- Lauren Striegl, Engineering
- Jule Stroick, Planning
- Chris Wells, Planning
- Karin Wolf, Planning
- Benjamin Zellers, Planning

The following was discussed:

- Engineering gave a brief overview of the timing of the studies, the existing conditions inundation mapping, and the draft proposed solutions for the first three watersheds
- An example of project issues and coordination was described regarding the Research Park Southwest Detention pond Improvements and the proposed BRT route.
- Planning asked how areas that are outside the current City of Madison Boundary but may be incorporated into the City or may be impacted by the studies are accounted for. There are generally three main categories and they are accounted for differently:
 - Developed municipalities (e.g. City of Middleton) that discharge stormwater into a City of Madison watershed: For these areas, stormwater is evaluated and routed to City of Madison infrastructure, but inundation mapping is not created for these areas and proposed solutions are not developed
 - Developed municipalities (e.g. Village of Shorewood Hills) where the City of Madison discharges stormwater to them: For these areas, the adjacent communities are brought into the watershed study project team and coordination meetings occur throughout the duration of the watershed study

- Municipalities that will be annexed: These areas are modeled in the same manner as the areas inside the current City of Madison municipal boundary. Inundation mapping will be created and proposed solutions will be developed.
- One of the outcomes of these studies is to determine where existing developed land needs to be purchased or undeveloped land needs to be reserved for stormwater infrastructure.
- The currently adopted stormwater ordinance and its impact on development was discussed. The ordinance:
 - Allows the City to require developers to meeting watershed-specific goals. Engineering is not going to enforce that, unless a situation necessitates it, at this time.
 - Requires developers account for the existing unintended detention on their site. Engineering is enforcing that at this time.
 - Requires developers to manage up to the 200-year (.5% change) event. Engineering is going to enforce that at this time.
- Engineering is going to start determining where land needs to be reserved for future stormwater infrastructure.
- The inundation mapping will provide target low building openings for areas of infill development (e.g. Westgate Mall)
- A preview of the inundation mapping ArcOnline was given. The tool shows the watershed study schedule, existing conditions inundation mapping, and links the watersheds to the watershed study website for each project.
 - Jojo will work with Pat Empey to determine if additional tools can be added to help make the tool more intuitive.

Meeting with Parks about Proposed Flood Control Projects from Spring Harbor, Stricker's/Mendota, and Wingra West Watershed Studies

January 12, 2021

Engineering and the Parks met via Zoom on January 11, 2021 to discuss comments and concerns about the proposed flood control projects for the Spring Harbor, Stricker's/Mendota, and the Wingra West watershed studies.

Attendees included:

- Caroline Burger, Engineering
- Sarah Close, Parks
- Ann Freidwald, Parks
- Greg Fries, Engineering
- Phil Gaebler, Engineering
- Kathleen Kane, Parks
- Eric Knepp, Parks
- Lisa Laschinger, Parks
- Sarah Lerner, Engineering/Parks
- Jojo O'Brien, Engineering
- Janet Schmidt, Engineering
- Corey Stelljes, Parks
- Lauren Striegl, Engineering
- Michael Sturm, Parks

The following was discussed:

Spring Harbor Watershed

- West Towne Ponds
 - The City has a contract with the 56ers for use of the soccer fields. Loss of any soccer fields in the City is a concern; therefore coordination with stakeholders should occur to understand impacts.
 - Other than the soccer use, Parks did not have concerns
- Owen Park Drainage Swale and Adjacent Flood Wall
 - Parks is supportive of the project
 - There are mature trees along the swale that should be avoided if possible
 - Parks requested that bike path connectivity be explored from Inner Drive through the Southern Park of Owen Park and to the connecting bike paths
 - Eric provided contact names for residents that Engineering could work with in the neighborhood
- Glen Oak Hills Park
 - Parks asked what dry detention would look like and requested that detention be graded to provide more of a natural, meandering channel with areas to explore nature-based play as much as possible
 - There are numerous mature trees in the park and potential detention footprint
 - Parks is not opposed to the project but understands there will be concern regarding mature tree removal

Stricker's/Mendota Watershed

- Stricker's Park
 - Engineering should coordinate with Parks regarding the proposed grading for the project; there may be desires to modify the existing grading over the proposed relief pipe

Wingra West Watershed

- Orchard Ridge Valley Park
 - Park does not have a lot of recreational value and pond expansion could enhance the City of Madison
 - The park is marshy, inaccessible, and has no amenities, therefore it seems like a good fit for a flood control infrastructure
 - The park could benefit from turf walking trails or raised trail/boardwalk
 - Parks has had complaints from neighbors regarding wet pond overtopping
 - Eric: park does not have a high recreational value. Pond could enhance the value of the park (maybe?) or would enhance the City of Madison
- Odana Hills Park & Golf Course
 - Coordination is needed so that the project is mutually beneficial; if the project can be designed to be mutually beneficial, Parks can provide support and help with coordination
 - Eric would like to be involved in the coordination
 - Tree impacts will be minimal
 - The current footprint shown would impact the cross country ski trail
 - The current footprint shown would impact the routing and playability of the golf course
 - Hole 15 (Par 5) is frequently soggy and failing; revised drainage could improve the hole.
 - The 13th green and T box for 16 hole would be impacted
 - Clients need to get to T from each hole to the fairway (without swimming through the pond)
 - The outlet by the channel is an area that is not in play
 - Engineering should set up a meeting with Eric, Theran Steindl, and Ryan Brinza to go over potential grading/pond footprints
- Chippewa Dr/Cherokee Dr Improved Conveyance
 - Parks indicated the plan seems favorable
 - The improved conveyance will help keep the playground in the park from flooding
 - The historic steps in the park are at risk from existing flooding; the conveyance improvements will help protect the stairs by redirecting the runoff
 - Forestry should be coordinated with regarding the street trees

Parks recommended that the improvements for Odana Hills Golf Course should be prioritized first. There is an option for private funding that could cost-share the construction of the improvements.

Prior to public input meetings, it is recommended that Engineering intentionally reach out to the Board of Parks Commissioners (BPC) via email to let them know proposed plan. Indicate we look forward to talking to the public so we can bring all that feedback to BPC.

If Parks has other projects in planning that would mesh well with flood reduction projects, please reach out to Engineering so we can coordinate.

A spreadsheet is included with this meeting summary listing the flood control measures for Parks staff to provide comment on

Meeting with Parks – Golf Course - about Proposed Flood Control Projects from Wingra West Watershed Study – Odana Hills Golf Course Ponds

February 3, 2021

Engineering and the Parks met via Zoom on January 11, 2021 to discuss comments and concerns about the proposed flood control projects for the Spring Harbor, Stricker's/Mendota, and the Wingra West watershed studies.

Attendees included:

- Ryan Brinza, Parks
- Caroline Burger, Engineering
- Ann Freidwald, Parks
- Greg Fries, Engineering
- Phil Gaebler, Engineering
- Eric Knepp, Parks
- Janet Schmidt, Engineering
- Theran Steindl, Parks

The following was discussed:

- Engineering showed proposed solutions
- Golf Course Pond
 - Parks originally thought of increasing Golf Course Pond to shape shown except for west part of pond
 - Need new bridge
 - Move pump station for golf course irrigation
 - Review cart paths and possibly modify
 - Narrow channel so that golfing over the hole is available to most golfer
 - Archaeological site on Hole 5?
 - Could expand pond into wet part of Hole 12
 - Construct forward tee for Hole 16?
- Odana Hills Park & Golf Course
 - Will level be as high in proposed conditions?
 - City pursue removal of weirs
 - Negotiate agreement with WDNR for MG&E infiltration system
 - Shift south side of the pond a little more to the north to not impact fairway as much
- Use excavated material to fill low areas in golf course
 - Build up fairway for Hole 15 – pond level has increased since MGE put in weirs
 - Would want the material scraped off the top for excavation rather than soil deeper in excavation
- Drain area – Golf Course has plans to address drainage to make it more efficient
- Bike path along Beltline?
 - Run parallel to Beltline
- Relief pipe
 - Runs thru irrigation lines which would need repair
 - Construction of pipe could cause issues with golf course due to hole closure during construction and restoration
 - Perhaps build retention pond near bike path instead of running water across golf course
- Engineering can provide scaled figure and Ryan and Theran can measure golf shots
- Are there areas of the golf course that could have water only during large events but not permanent standing water?

Appendix K: Peer Review #3 Summary

Peer Review Comments for West Wingra Watershed

Peer Review #3

Date: 2021-03-25

By: AE2S (Amber Lefers, Linda Severson)

Local Improvement Peer Review Comments	BC Response
Below are our review comments on the local improvements portion of the XP-SWMM model:	
<u>Recommendations</u>	
1. There are several locations where there are long runs of street flow prior to reaching the current extents of the storm sewer system. Two examples are 1) Saybrook Road from Friar Lane to Schroeder Road and 2) residential streets north of Odana Road / Odana Golf Course. We recommend that the subcatchment be split and storm sewer extended to reflect the need to extend storm sewer past its current extent in order to meet the 25-Year criterion.	This circumstance was discussed as part of earlier peer reviews. BC is applying runoff at the existing storm sewer system. We do not believe representing flow upstream of the existing inlets is warranted for purposes of this study. If future, roadway improvements are done, storm sewer could be extended and sized at that time.
<u>Regional Improvement Peer Review Comments</u>	
Below are our review comments on Regional Improvements portion of the XP-SWMM model:	
<u>Odana Pond System</u>	
1. No modeling approach / design comments.	No response required.
2. No additional ideas on potential alternatives beyond what were looked at.	No response required.
<u>UW Research Park SE & Whitney Way Storm Sewer</u>	
1. Confirm that the buildings meet the <6 inches within 5' of the building. (Slide 20)	These improvements were sized to meeting 10% and 1% flood control goals. In the 1% chance storm event there is overland flow that leaves the ROW and potential impacts to a building east of Whitney Way. The impact is at a current loading dock area and the site is being redeveloped. The flow and volume of water impacting the building is small. There is model uncertainty with respect to ground elevations along the ROW. It is believed the intent of the goals are met. As part of future design the area should be further evaluated to confirm the sizing.
2. Only other potential idea would be downstream conveyance improvements since improvements are recommended already for local drainage improvements. But incremental cost may be more \$\$ than the recommended plan.	Increasing storm sewer improvements in lieu of the detention pond improvement is a potential solution. It is likely that modifications to the pond, at least to the outlet structure would be required to prevent the pond from overtopping in the 10% chance event. This alternative could be further evaluated by the City if desired.
<u>UW Research Park SW</u>	
1. No modeling approach / design comments.	No response required.

Peer Review Comments for West Wingra Watershed

Peer Review #3

Date: 2021-03-25

By: AE2S (Amber Lefers, Linda Severson)

2. Only other potential idea would be downstream conveyance improvements since improvements are recommended already for local drainage improvements. But incremental cost may be more \$\$ than the recommended plan.	Increasing storm sewer improvements in lieu of the detention pond improvement is a potential solution. It is likely that modifications to the pond, at least to the outlet structure would be required to prevent the pond from overtopping in the 10% chance event. This alternative could be further evaluated by the City if desired.
<u>Chippewa Storm Sewer / Swale</u>	
1. Confirm that the plan is to run the box storm sewer under the street to get sufficient cover. The multi-links that connect the box to the box storm - what do those physically represent (inlet?), and will they work if the box is not running directly underneath the swale?	Limited cover is a challenge for the project and will need to be further reviewed/considered as part of future design work. The multi-links connecting the swale to the storm sewer represent inlet capacity. The design/layout of inlets and how they connect to the storm sewer will need to be considered as part of future design. In the final modeling the swale above the storm sewer was eliminated due to the limited size and to be conservative in the evaluation. The future design work will need to further refine and add detail to the modeling.
2. Confirm that flooding did not get worse at Manitou and Secret Pond (or if it does, that it is not a concern for the Arboretum).	Flows into Manitou Pond and the UW-Arboretum are increased and the peak WSE in Manitou Pond is higher in proposed conditions. It is likely that revisions to the pond, pond outlet structure, and/or the downstream channel will be required as part of further implementation. These items will need to be considered as part of future design work.
3. No additional ideas on potential alternatives beyond what were looked at.	No response required.

Appendix L: Odana Pond / MG&E Agreement

6601 Res Vac

0709-293-1101-0

0709 293
304
311
322

**STORM WATER INFILTRATION SYSTEM
EASEMENT AGREEMENT**

THIS STORM WATER INFILTRATION SYSTEM EASEMENT AGREEMENT (the "Agreement") is made and entered into to be effective this 8th day of DECEMBER, 2005, and by and among the City of Madison, a Wisconsin municipal corporation (the "City"), Board of Regents of the University of Wisconsin System (the "University"), MGE Power West Campus, LLC, a Wisconsin limited liability company ("MGE Power") and Madison Gas and Electric Company ("MGE"). The University, MGE Power and MGE are hereinafter collectively referred to as "Grantee".

RECITALS

- A. City is the fee holder of certain real property in the City of Madison, Dane County that comprises the Odana Hills Golf Course (the "Golf Course").
- B. The University, MGE Power and MGE are respectively the co-owners and operator of the West Campus Cogeneration Facility, a new steam, chilled water, and electric cogeneration plant located immediately north of the existing University Walnut Street Heating Plant in Madison, Wisconsin, (the "Facility") which was constructed by MGE Construct LLC, an Affiliate of MGE ("MGE Construct").
- C. In connection with the operation of the Facility and the Walnut Street Heating Plant, surface water will be withdrawn from Lake Mendota and groundwater will be withdrawn from the Yahara River watershed both in connection with the operation of the Facility and the Walnut Street Heating Plant and to augment flow in the Yahara River.
- D. Pursuant to that certain State of Wisconsin Department of Natural Resources Conditional Water Loss Approval to the University of Wisconsin Madison and Madison Gas & Electric No. 3-SC-2003-13-314LR dated October 10, 2003 ("the Water Loss Approval") MGE and the University have the obligation to implement mitigation measures, including providing one or more infiltration sites designed to collectively achieve storm water infiltration of 80.4 million gallons per year.

DANE COUNTY
REGISTER OF DEEDS

DOCUMENT #
4143776

12/16/2005 10:08AM

Trans. Fee:
Exempt #:

Rec. Fee: 55.00
Pages: 23

000268

Return to:
Michael J. Allen
P.O. Box 27
Sun Prairie, WI 53590

Parcel Identification No.
251-0709-293-1101-0

23/55

- E. The required infiltration will be achieved by utilizing a storm water infiltration system, including a water intake, filter house, pumps, filter units, distribution pipe, infiltration field, secondary electric service line and other facilities connected therewith (the "Infiltration System") to be located on lands that facilitate the infiltration of water into the Yahara River Watershed.
- F. Locating the Infiltration System on the Golf Course, with the water intake located in the Odana Hills Pond will be mutually beneficial to the City and Grantee for the following reasons among others:
- a. The Infiltration System will benefit public storm water management, groundwater quantity and quality, and will enhance the storm water function and quality of the adjacent Odana Hills Pond;
 - b. The Infiltration System will:
 - i. help replenish the groundwater aquifer that supplies Lake Wingra and area springs, thereby re-establishing the more natural system that existed before the area was developed;
 - ii. reduce excess sediments and nutrients that flow out of Odana Pond through storm sewers into Lake Wingra, which will help improve water quality;
 - iii. manage the water level of the Odana Hills Pond, aiding restoration of native wetland vegetation that has been impacted by years of increasing storm water runoff and rising water levels; and
 - iv. demonstrate the benefits of storm water infiltration; and
 - c. The Golf Course has storm flow and infiltration capacity that exceeds the design amount required of MGE and the University under the Water Loss Approval
- G. To enable MGE Construct LLC and its agents to construct and install the Infiltration System upon a small portion of the Golf Course, to enable MGE Power and the University as co-owners of the Infiltration System (except for the secondary electric service line, which will be owned by MGE) to locate the Infiltration System in its installed location and to enable MGE and its agents to operate, maintain and repair the Infiltration System, Grantee desires to obtain an easement over, under, through and on a portion of the Golf Course owned by the City and the City desires to grant such easement to Grantee on the terms and conditions contained in this Agreement.

H. Within this Agreement, the term "Affiliate" shall mean (i) any Person that directly or indirectly, through one or more intermediaries, controls, is controlled by, or is under common control with a party, and (ii) any Person that, directly or indirectly, is the beneficial owner of five percent (5%) or more of any class of equity securities of, or other ownership interests in, a party or of which the party is directly or indirectly the owner of five percent (5%) or more of any class of equity securities or other ownership interests. "Person" shall mean any individual, partnership, corporation, association, business, trust, government or political subdivision thereof, governmental agency or other entity.

AGREEMENT

NOW THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties agree as follows:

1. **Grant of Easement.** City grants to Grantee and to Grantee's authorized Affiliates, authorized agents, invitees, subcontractors and suppliers (collectively, "Agents") the right to enter and have access to the property described as follows: a part of Parcel No. 251-0709-293-1101-0. , whose location is shown on the attached Exhibit A and legally described as follows:

Construction Easement Area. See Exhibit A.

Permanent Easement Area. See Exhibit A.

The Permanent Easement is granted over the Permanent Easement Area for the purpose of the construction, reconstruction, installation, maintenance, repair and operation of the Infiltration System and all improvements related thereto constructed by or on behalf of Grantee, its Affiliates or Agents. Grantee, its Affiliates and Agents shall have the right to do the following within the Permanent Easement Area: (a) trench, excavate, grade, backfill and remove soil as needed to install the Infiltration System; provided, however, that Grantor and Grantee acknowledge that the locations of several of the pipe/utility routes were selected based upon the assumption that the pipe/utilities could be installed using directional drilling methods. Grantor and Grantee agree that if any open trench installations are needed, the portion of the Permanent Easement Area that relates to the such installations shall be modified in a manner that is reasonable and mutually agreeable to Grantor and Grantee; (b) construct and carry out all activities reasonably related to the construction of the Infiltration System, including erecting security fencing and signage, reasonable trimming and removal of vegetation to permit access, and water, erosion and sediment control; (c) pump water from Odana Hills Pond in accordance with the terms of any applicable permits or approvals issued by the Wisconsin Department of Natural

Resources; and (d) service and maintain the Infiltration System and all its components, including repairing and replacing such components as necessary. All of the foregoing activities shall collectively be known as the "Permitted Activities". The foregoing Permanent Easement also includes reasonable access over the Golf Course to the Permanent Easement Area and includes reasonable laydown space on adjacent areas of the Golf Course on a temporary basis after the initial construction and installation of the Infiltration System as may be necessary to accomplish the Permitted Activities. Reasonable access and reasonable laydown space shall be defined as being mutually agreeable between the Golf Supervisor and MGE, after notice by MGE to the Golf Supervisor of the need for access onto or across the Golf Course for reconstruction, maintenance or repair.

In addition to the Permanent Easement granted above, the City also grants to Grantee, its Affiliates and its Agents a Construction Easement over the Construction Easement Area, as designated on the attached Exhibit A for the purposes of mobilizing necessary equipment needed for the construction of the Infiltration System and conducting the Permitted Activities, storing equipment and materials, mobilizing and directing construction activities and generally using the Construction Easement Area for staging during the period of initial construction of the Infiltration System. This Construction Easement shall end upon the earlier of: (a) thirty (30) days after Grantee notifies the City of the completion of the Infiltration System; or (b) one (1) year from the effective date of this Agreement.

Notwithstanding the representations on the attached Exhibit A with respect to the location of various components of the Infiltration System, Grantee shall be permitted to move or relocate such components in the future if Grantee determines such relocation to be necessary, advisable or appropriate for Grantee's purposes so long as such relocation is wholly within the Permanent Easement Area. Notwithstanding the foregoing, Grantee shall notify the City of any such relocation at least ten (10) days prior to any such relocation.

2. **Grantee Responsibilities.** Grantee shall exercise its rights under this Agreement so as to minimize its interference with other park purposes, including but not limited to golf, carried on at the Golf Course. Grantee shall further be responsible for all costs and expenses associated with, related to or arising from conduct of the Permitted Activities, including loss of revenue if golf is disrupted. Grantee shall also be responsible for maintenance of all aspects of the Infiltration System, including prompt response to damage by vandalism, tagging or Acts of God. Grantee agrees to hold the City harmless from any and all claims arising from any breach of this Agreement or any negligent act, negligent omission, or intentional tort of Grantee, or its Affiliates or Agents (as provided under state statute) including, but not limited to liability associated with, related to or arising from construction and operation of the Infiltration System and conduct of the Permitted Activities.

Notwithstanding the foregoing, Grantee shall not be responsible for any liability arising from preexisting hazardous substances, pollution or contamination as those terms are defined by the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), Wisconsin statutes or other applicable federal or state laws governing hazardous substances, wastes or materials.

3. **Ownership Warranty.** The City warrants that it is the sole owner of the Construction Easement Area and Permanent Easement Area, with full power and authority to enter into this Agreement, and that no consent of any mortgagee or lienholder is necessary for the granting of the rights granted hereunder.

4. **Rights and Responsibilities of City.** City retains any rights with regard to the use of the Permanent Easement Area that are not inconsistent with the terms of this Agreement. However City shall not: (a) interfere with the Permitted Activities of Grantee or Grantee's Affiliates or Agents; (b) construct or install upon the Permanent Easement Area any structures; or (c) endanger or create any hazard to the Infiltration System. The City shall further cooperate in good faith with Grantee's efforts to carry out the Permitted Activities, including providing Grantee timely access as necessary to facilitate Grantee's efforts to promptly schedule and implement necessary maintenance and repairs to and any necessary replacement of any part of the Infiltration System.

5. **Restoration of Surface.** Grantee shall restore the surface disturbed by any construction or maintenance of any equipment located within the Construction Easement Area and Permanent Easement Area to its condition before the disturbance.

6. **Covenants Run with Land.** All of the terms and conditions in this Agreement, including the benefits and burdens, shall run with the land described herein and shall be binding upon, inure to the benefit of, and be enforceable by City and Grantee and their respective successors and assigns, but no interest in this Agreement shall be assigned without the written consent of the other parties. Notwithstanding the foregoing, or anything in this Agreement to the contrary, any party to this Agreement shall be entitled to assign its interests in this Agreement to an Affiliate or in connection with any merger, consolidation or restructuring transaction involving any of the persons comprising Grantee or any of their Affiliates upon written notice to the other parties to this Agreement.

7. **Non-Use.** Non-use or limited use of the Easement rights granted in this Agreement shall not prevent the benefiting party from later use of the Easement rights to the fullest extent authorized in this Agreement.

8 **Non-Discrimination, Workforce Utilization and Affirmative Action.**

a. **Non-Discrimination.** In the performance of the Work under this Agreement, Grantee agrees not to discriminate against any employee or applicant because of race, religion, marital status, age, color, sex, handicap, national origin or ancestry, income level or source of income, arrest record or conviction record, less than honorable discharge, physical appearance, sexual orientation, political beliefs, or student status. Grantee further agrees not to discriminate against any subcontractor or person who offers to subcontract under this Agreement because of race, religion, color, age, disability, sex or national origin.

b. **Workforce Utilization.** Grantee agrees that, within thirty (30) days after the effective date of this Agreement, Grantee will provide to the City of Madison Department of Affirmative Action certain workforce utilization statistics, using a form to be furnished by the City.

If the Agreement is still in effect, or if the City enters into a new agreement with Grantee, within one year after the date on which the form was required to be provided, Grantee will provide updated workforce information using a second form, also to be furnished by the City. The second form will be submitted to the City Department of Affirmative Action no later than one year after the date on which the first form was required to be provided.

Grantee further agrees that, for at least twelve (12) months after the effective date of this Agreement, it will notify the City of Madison Department of Affirmative Action of each of its job openings at facilities in Dane County for which applicants not already employees of Grantee are to be considered. The notice will include a job description, classification, qualifications, and application procedures and deadlines. Grantee agrees to interview and consider candidates referred by the Department of Affirmative Action if the candidate meets the minimum qualification standards established by Grantee, and if the referral is timely. A referral is timely if it is received by Grantee on or before the date stated in the notice.

c. **Affirmative Action Articles**

ARTICLE I. Grantee shall take affirmative action in accordance with the provisions of this Agreement to insure that applicants are employed, and that employees are treated during employment without regard to race, religion, color, age, marital status, disability, sex or national origin and that the employer shall provide harassment-free work environment for the realization of the potential of each employee. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation and selection for training including apprenticeship insofar as it is within the control of

Grantee. Grantee agrees to post in conspicuous places available to employees and applicants notices to be provided by the City setting out the provisions of the nondiscrimination clauses in this Agreement.

ARTICLE II. Grantee shall in all solicitations or advertisements for employees placed by or on behalf of Grantee state that all qualified or qualifiable applicants will be employed without regard to race, religion, color, age, marital status, disability, sex or national origin.

ARTICLE III. Grantee shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding a notice to be provided by the City advising the labor union or workers representative of Grantee's equal employment opportunity and affirmative action commitments. Such notices shall be posted in conspicuous places available to employees and applicants for employment.

ARTICLE IV. (This article applies only to non-public works contracts.) Grantee agrees that it will comply with all provisions of the Affirmative Action Ordinance of the City of Madison including the contract compliance requirements. Grantee warrants and certifies that, of the following two paragraphs, paragraph A or B is true (check one):

- A. It has prepared and has on file an affirmative action plan that meets the format requirements of Federal Revised Order No. 4, 41 CFR part 60-2, as established by 43 FR 51400 November 3, 1978, including appendices required by City of Madison ordinances or it has prepared and has on file a model affirmative action plan approved by the Madison Common Council.
- B. Within thirty (30) days after the effective date of this Agreement, it will complete an affirmative action plan that meets the format requirements of Federal Revised Order No. 4, 41 CFR Part 60-2, as established by 43 FR 51400, November 3, 1978, including appendices required by City of Madison ordinance or within thirty (30) days after the effective date of this Agreement, it will complete a model affirmative action plan approved by the Madison Common Council.

MG+5 AA plan
approved per
AAD records
11/29/05
MDD.

ARTICLE V. (This article omitted as it applies only to public works contracts.)

ARTICLE VI. Grantee will maintain records as required by Section 3.58(9)(f) of the Madison General Ordinances and will provide the City's Department of Affirmative Action with access to such records and to persons who have relevant and necessary

information, as provided in Section 3.58(9)(f). The City agrees to keep all such records confidential, except to the extent that public inspection is required by law.

ARTICLE VII. In the event of Grantee's or subcontractor's failure to comply with the Equal Employment Opportunity and Affirmative Action Provisions of this Agreement or Sections 3.23 and 3.58 of the Madison General Ordinances, it is agreed that the City at its option may do any or all of the following:

1. Cancel, terminate or suspend this Agreement in whole or in part.
2. Declare Grantee ineligible for further City contracts until the Affirmative Action requirements are met.
3. Recover on behalf of the City from Grantee 0.5 percent of the Agreement award price for each week that such Party fails or refuses to comply, in the nature of liquidated damages, but not to exceed a total of five percent (5%) of the Agreement price, or five thousand dollars (\$5,000), whichever is less. Under public works contracts, if a subcontractor is in noncompliance, the City may recover liquidated damages from Grantee in the manner described above. The preceding sentence shall not be construed to prohibit Grantee from recovering the amount of such damage from the noncomplying subcontractor.

ARTICLE VII. (This article omitted as it applies only to public works contracts.)

ARTICLE IX. Grantee shall allow the maximum feasible opportunity to small business enterprises to compete for any subcontracts entered into pursuant to this Agreement and shall document all good faith efforts. (In federally funded contracts the terms "DBE, MBE, and WBE" shall be substituted for the term "small business" in this article.)

Notwithstanding anything in this Section 8 to the contrary, the references in this Section 8 to "Grantee" shall not apply to the University, who is exempt from the requirements of the City's Affirmative Action ordinance under Section 3.58(9)(a)2.h of the Madison General Ordinances.

9. **Governing Law.** This Agreement shall be construed and enforced in accordance with the laws of the State of Wisconsin.

10. **Entire Agreement.** This Agreement sets forth the entire understanding of the parties and may not be amended except by a written document executed and acknowledged by all parties to this Agreement or their successors and assigns, and duly recorded in the office of the Register of Deeds of Dane County, Wisconsin.

11. **Invalidity.** If any term or condition of this Agreement, or the application of this Agreement to any person or circumstance, shall be deemed invalid or unenforceable, the remainder of this Agreement, or the application of the term or condition to persons or circumstances other than those to which it is held invalid or unenforceable, shall not be affected thereby, and each term and condition shall be valid and enforceable to the fullest extent permitted by law.

12. **Waiver.** No delay or omission by any party in exercising any right or power arising out of any default under any of the terms or conditions of this Agreement shall be construed to be a waiver of the right or power. A waiver by a party of any of the obligations of the other party shall not be construed to be a waiver of any breach of any other terms or conditions of this Agreement.

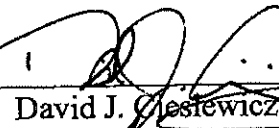
13. **Enforcement.** Enforcement of this Agreement may be by proceedings at law or in equity against any person or persons violating or attempting or threatening to violate any term or condition in this Agreement, either to restrain or prevent the violation or to obtain any other relief.

14. **No Public Dedication.** Nothing in this Agreement shall be deemed to be a gift or dedication of any portion of the Permanent Easement Area granted hereunder to the general public or for any public purposes whatsoever.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the date set forth above.

CITY

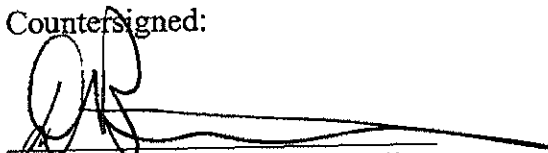
CITY OF MADISON, a Dane County, Wisconsin,
municipal corporation

By: 

David J. Cieslewicz, Mayor

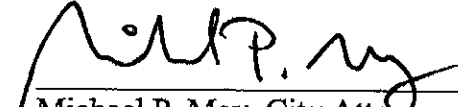

Ray Fisher, City Clerk

Countersigned:


Dean Brasser, City Comptroller

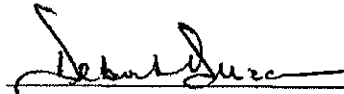
Approved as to Form

000277

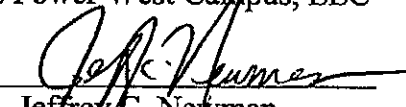

Michael P. May, City Attorney

GRANTEE

Board of Regents of the University of Wisconsin
System

By: 
Deborah A. Durcan
Vice President - Finance

MGE Power West Campus, LLC

By: 
Jeffrey C. Newman
Manager

Madison Gas and Electric Company

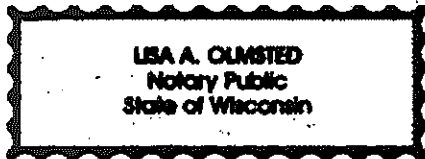
By: 
Terry A. Hanson
Vice President & Chief Financial Officer

ACKNOWLEDGEMENT

000278

STATE OF WISCONSIN
COUNTY OF DANE

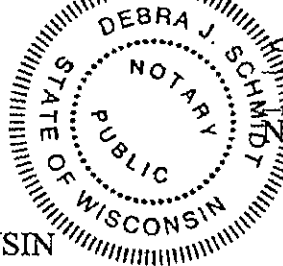
This instrument was acknowledged before me on this 30th day of November, 2005, the above named David J. Cieslewicz, to me known to be the Mayor of the City of Madison, who executed the foregoing Agreement in such capacity on behalf of the City.



Lisa A. Olmsted
LISA A. Olmsted
Notary Public
My commission 2/3/06

STATE OF WISCONSIN
COUNTY OF DANE

This instrument was acknowledged before me on this 22 day of November, 2005, the above named ^{Mike Fisher} Ray Fisher, to me known to be ^{acting for} the City Clerk of the City of Madison, who executed the foregoing Agreement in such capacity on behalf of the City.



Debra J. Schmidt
Debra J. Schmidt
Notary Public
My commission 8/5/07

STATE OF WISCONSIN
COUNTY OF DANE

This instrument was acknowledged before me on this 29th day of November, 2005, the above named Dean Brasser, to me known to be the City Comptroller of the City of Madison, who countersigned the foregoing Agreement in such capacity on behalf of the City.

Susan L. Aiello
SUSAN L. AIELLO
Notary Public
My commission 06-04-07

STATE OF WISCONSIN
COUNTY OF DANE

000279

This instrument was acknowledged before me on this 29th day of Nov., 2005,
the above named Michael P. May, to me known to be the City Attorney of the City of
Madison, who executed and approved the foregoing Agreement as to form in such
capacity on behalf of the City.

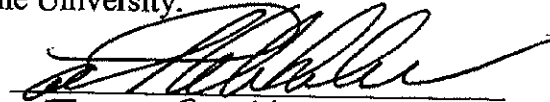

Laura M. Mainella

Notary Public

My commission is permanent.

STATE OF WISCONSIN
COUNTY OF DANE

This instrument was acknowledged before me on this 8th day of DECEMBER, 2005,
the above named Deborah A. Durcan, to me known to be the Vice President - Finance of
Board of Regents of the University of Wisconsin System, who executed the foregoing
Agreement as such officer on behalf of the University.


Edward S. Alchuler

Notary Public

My commission is PERMANENT.

ACKNOWLEDGEMENT

STATE OF WISCONSIN
COUNTY OF DANE

This instrument was acknowledged before me on this 2nd day of December, 2005,
the above named Jeffrey C. Newman to me known to be the Manager of MGE Power
West Campus, LLC, a Wisconsin limited liability company, who executed the foregoing
Agreement in such capacity on behalf of the Company.


Siri A. Weston

Notary Public

My commission 05/04/08.

ACKNOWLEDGEMENT

STATE OF WISCONSIN
COUNTY OF DANE

This instrument was acknowledged before me on this 2nd day of December, 2005, the above named Terry A. Hanson to me known to be the Vice President and Chief Financial Officer of Madison Gas and Electric Company, a Wisconsin corporation, who executed the foregoing Agreement in such capacity on behalf of the Company.

Siri A. Weston
Siri A. Weston
Notary Public
My commission 05/04/08.

This instrument drafted by:
Michael J. Allen
P.O. Box 27
Sun Prairie, WI 53590

EXHIBIT A

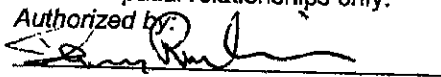
See Attached

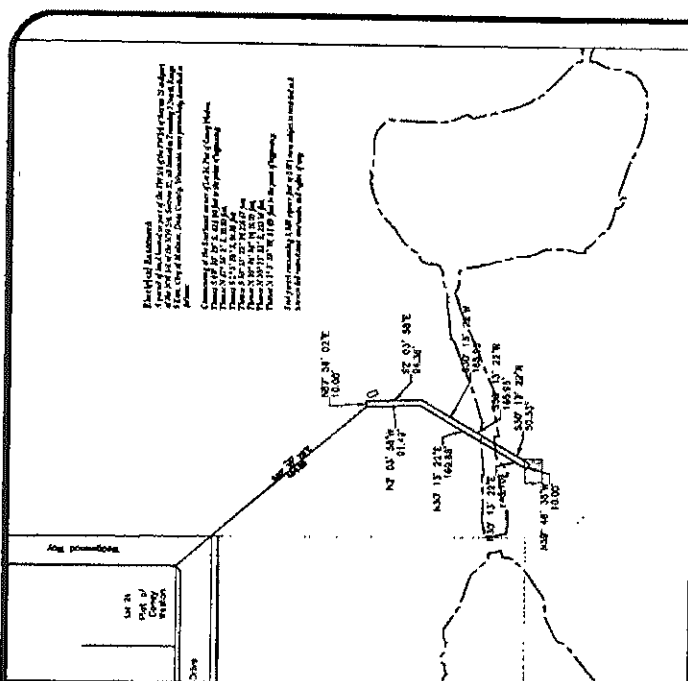
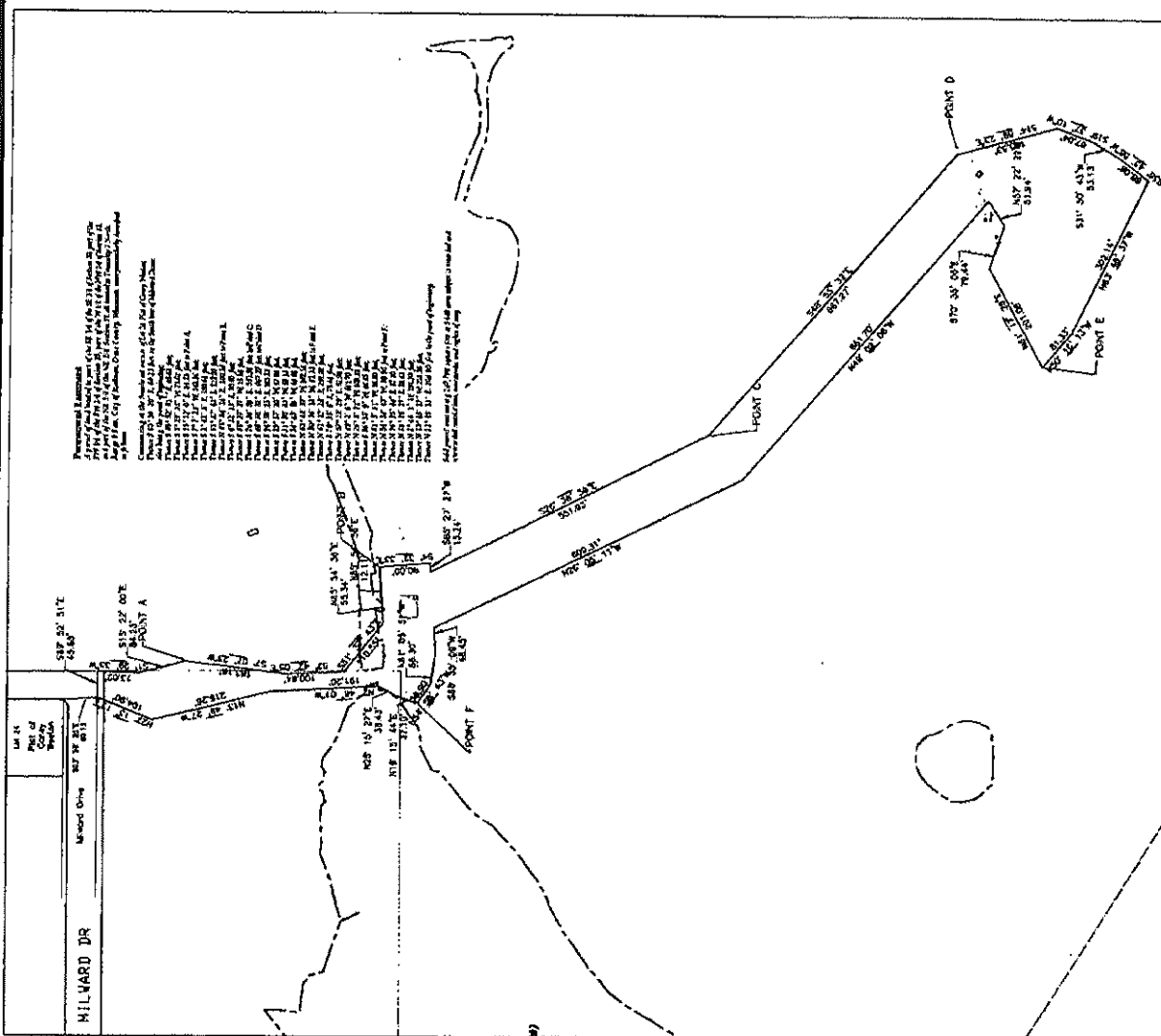
000281

all pages:

Viewers are advised to ignore the
illegible text on this map. It is presented
to show spatial relationships only.

Authorized by:





DRAFT

Permanent and Electrical Easement Locations

Odana Hills Recharge System

SCALE: 1" = 100'	Drawing No. 1503-XX	11-11-05	172
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Montgomery Associates, Inc.
10000 Wilshire Blvd., Suite 1000
Beverly Hills, CA 90210
Tel: (310) 277-1000
Fax: (310) 277-1001
www.montgomeryassociates.com

Abstract

000284

Exhibit A
Permanent Easement Area & Construction Easement Area

Permanent Easement Area

Electrical Easement

A parcel of land located in part of the SW 1/4 of the SW 1/4 of Section 29 and part of the NW 1/4 of the NW 1/4, Section 32, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Commencing at the Southeast corner of Lot 24, Plat of Coney Weston;
Thence S 40° 30' 29" E, 424.90 feet to the point of beginning;
Thence N 87° 56' 2" E, 10.00 feet;
Thence S 2° 3' 58" E, 94.38 feet;
Thence S 30° 13' 22" W, 216.47 feet;
Thence N 59° 46' 38" W, 10.00 feet;
Thence N 30° 13' 22" E, 213.58 feet;
Thence N 2° 3' 58" W, 91.49 feet to the point of beginning.

Said parcel containing 3,080 square feet or 0.071 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Permanent Easement

A parcel of land located in part of the SE 1/4 of the SE 1/4 of Section 30, part of the SW 1/4 of the SW 1/4 of Section 29, part of the W 1/2 of the NW 1/4 of Section 32, and part of the NE 1/4 of the NE 1/4, Section 31, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Commencing at the Southeast corner of Lot 24, Plat of Coney Weston;
Thence S 03° 36' 20" E, 60.13 feet to the South line of Milward Drive,
also being the point of beginning;
Thence S 89° 52' 51" E, 45.68 feet;
Thence S 1° 29' 35" W, 73.02 feet;
Thence S 15° 22' 0" E, 84.23 feet to Point A;
Thence S 7° 7' 23" W, 183.16 feet;
Thence S 2° 42' 5" E, 100.64 feet;
Thence S 51° 37' 43" E, 110.55 feet;
Thence N 85° 54' 36" E, 100.56 feet to Point B;
Thence S 4° 32' 33" E, 90.00 feet;
Thence S 85° 27' 27" W, 15.24 feet;
Thence S 26° 36' 59" E, 551.93 feet to Point C;

Thence S 48° 55' 32" E, 667.27 feet to Point D;
 Thence S 14° 59' 23" E, 183.53 feet;
 Thence S 19° 37' 10" W, 67.04 feet;
 Thence S 31° 50' 43" W, 53.13 feet;
 Thence S 36° 43' 58" W, 68.08 feet;
 Thence N 63° 48' 37" W, 302.14 feet;
 Thence N 50° 16' 13" W, 81.33 feet to Point E;
 Thence N 61° 17' 28" E, 201.08 feet;
 Thence S 70° 35' 6" E, 79.44 feet;
 Thence N 57° 22' 29" E, 51.94 feet;
 Thence N 49° 2' 6" W, 661.70 feet;
 Thence N 26° 5' 11" W, 609.31 feet;
 Thence S 86° 35' 9" W, 46.45 feet;
 Thence N 81° 5' 51" W, 56.30 feet;
 Thence N 54° 58' 43" W, 39.90 feet to Point F;
 Thence N 16° 15' 44" E, 37.10 feet;
 Thence N 28° 15' 27" E, 38.43 feet;
 Thence N 2° 46' 1" W, 191.20 feet;
 Thence N 13° 49' 27" W, 216.26 feet;
 Thence N 22° 13' 13" E, 104.90 feet to the point of beginning.

Said parcel containing 247,794 square feet or 5.689 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Construction Easement Area

Wedgewood Laydown (temporary)

A parcel of land located in part of the SE 1/4 of the SE 1/4 of Section 30, and part of the SW 1/4 of the SW 1/4 of Section 29, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point A;
 Thence S 46° 39' 2" E, 209.62 feet;
 Thence S 28° 37' 15" W, 87.72 feet;
 Thence N 73° 36' 49" W, 138.76 feet;
 Thence N 7° 7' 23" E, 183.16 feet to the point of beginning.

Said parcel containing 21,433 square feet or 0.492 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Pumphouse SW (temporary)

A parcel of land located in part of the NW 1/4 of the NW 1/4 of Section 32, and part of the NE 1/4 of the NE 1/4, Section 31, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point F;
 Thence S 54° 58' 43" E, 39.90 feet;
 Thence S 81° 5' 51" E, 56.30 feet;
 Thence N 86° 35' 9" E, 46.45 feet;
 Thence S 26° 5' 11" E, 79.32 feet;
 Thence S 70° 30' 47" W, 21.02 feet;
 Thence S 75° 48' 50" W, 69.56 feet;
 Thence N 63° 4' 49" W, 54.02 feet;
 Thence N 18° 53' 41" W, 105.37 feet to the point of beginning.

Said parcel containing 11,402 square feet or 0.262 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Pumphouse East (temporary)

A parcel of land located in part of the SW 1/4 of the SW 1/4 of Section 29, part of the NW 1/4 of the NW 1/4 of Section 32, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point B;
 Thence N 85° 54' 36" E, 28.47 feet;
 Thence S 4° 5' 24" E, 106.31 feet;
 Thence S 60° 49' 23" W, 33.55 feet;
 Thence N 26° 36' 59" W, 32.93 feet;
 Thence N 85° 27' 27" E, 15.24 feet;
 Thence N 4° 32' 33" W, 90.00 feet to the point of beginning.

Said parcel containing 3,435 square feet or 0.079 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Infiltration Area Laydown/Golf Course Driveway (temporary)

A parcel of land located in part of the SE 1/4 of the SW 1/4 of Section 29, and part of the NW 1/4 of Section 32, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point D;
 Thence N 48° 55' 32" W, 35.81 feet;
 Thence N 44° 21' 55" E, 41.46 feet;

Thence S 77° 14' 12" E, 48.77 feet;
Thence N 21° 47' 56" E, 56.60 feet;
Thence N 46° 24' 9" E, 127.09 feet;
Thence S 4° 38' 30" E, 162.72 feet;
Thence S 26° 17' 33" W, 267.88 feet;
Thence S 9° 47' 36" E, 49.20 feet;
Thence S 25° 26' 13" E, 167.58 feet;
Thence S 34° 40' 41" E, 95.77 feet;
Thence S 27° 32' 47" E, 170.92 feet;
Thence S 47° 30' 40" E, 26.25 feet;
Thence N 88° 7' 55" E, 24.15 feet;
Thence N 68° 16' 20" E, 21.28 feet;
Thence N 27° 55' 23" E, 29.56 feet;
Thence N 21° 18' 55" E, 52.93 feet;
Thence N 25° 11' 54" E, 70.97 feet;
Thence N 29° 58' 15" E, 64.61 feet;
Thence N 28° 48' 27" E, 83.41 feet;
Thence N 29° 44' 29" E, 68.61 feet;
Thence N 28° 6' 1" E, 80.17 feet;
Thence N 28° 42' 10" E, 59.46 feet;
Thence N 32° 16' 19" E, 55.98 feet;
Thence N 33° 20' 59" E, 70.73 feet;
Thence N 38° 4' 31" E, 145.09 feet;
Thence N 40° 52' 52" E, 196.72 feet;
Thence N 46° 16' 59" E, 166.45 feet;
Thence N 61° 55' 47" E, 154.58 feet;
Thence N 63° 25' 22" E, 151.31 feet;
Thence N 62° 23' 34" E, 192.42 feet;
Thence N 59° 0' 32" E, 182.30 feet;
Thence N 10° 45' 43" E, 192.50 feet;
Thence N 24° 53' 36" W, 240.55 feet;
Thence N 0° 20' 55" W, 315.59 feet;
Thence N 10° 57' 22" W, 10.35 feet;
Thence N 84° 41' 54" W, 117.35 feet;
Thence N 1° 16' 48" E, 114.47 feet;
Thence N 11° 18' 30" W, 39.12 feet;
Thence N 25° 20' 36" W, 26.88 feet;
Thence N 61° 29' 33" E, 76.54 feet;
Thence N 28° 30' 27" W, 27.92 feet;
Thence N 43° 59' 49" W, 191.83 feet;
Thence N 22° 31' 48" W, 42.72 feet;
Thence N 7° 32' 58" W, 139.62 feet;
Thence N 14° 37' 49" E, 45.40 feet;

000288

Thence N 30° 15' 47" E, 174.79 feet;
Thence N 17° 1' 31" E, 57.98 feet;
Thence N 2° 14' 49" W, 55.10 feet to the South right of way line of Odana Road;
Thence along said South right of way line S 87° 25' 59" E, 30.11 feet;
Thence S 2° 14' 49" E, 57.67 feet;
Thence S 17° 1' 31" W, 66.55 feet;
Thence S 30° 15' 47" W, 174.15 feet;
Thence S 14° 37' 49" W, 35.41 feet;
Thence S 7° 32' 58" E, 129.79 feet;
Thence S 22° 31' 48" E, 33.23 feet;
Thence S 44° 1' 1" E, 190.03 feet;
Thence S 28° 30' 27" E, 110.77 feet;
Thence S 10° 57' 22" E, 180.09 feet;
Thence S 0° 20' 55" E, 311.85 feet;
Thence S 24° 53' 36" E, 243.67 feet;
Thence S 10° 45' 43" W, 215.58 feet;
Thence S 59° 0' 32" W, 196.62 feet;
Thence S 62° 23' 34" W, 193.58 feet;
Thence S 63° 25' 22" W, 151.19 feet;
Thence S 61° 55' 47" W, 150.07 feet;
Thence S 46° 16' 59" W, 160.92 feet;
Thence S 40° 52' 52" W, 194.57 feet;
Thence S 38° 4' 31" W, 144.36 feet;
Thence S 33° 15' 50" W, 67.95 feet;
Thence S 32° 16' 19" W, 54.78 feet;
Thence S 28° 42' 10" W, 58.37 feet;
Thence S 28° 6' 1" W, 80.44 feet;
Thence S 29° 44' 29" W, 68.79 feet;
Thence S 28° 48' 27" W, 83.47 feet;
Thence S 29° 58' 15" W, 63.67 feet;
Thence S 25° 11' 54" W, 68.71 feet;
Thence S 21° 18' 55" W, 53.65 feet;
Thence S 27° 55' 23" W, 42.32 feet;
Thence S 68° 16' 20" W, 37.55 feet;
Thence S 88° 7' 55" W, 41.63 feet;
Thence N 47° 30' 40" W, 43.76 feet;
Thence N 27° 32' 47" W, 174.33 feet;
Thence N 34° 40' 41" W, 96.33 feet;
Thence N 25° 26' 13" W, 174.13 feet;
Thence N 9° 47' 36" W, 47.66 feet;
Thence N 19° 37' 10" E, 56.44 feet;
Thence N 14° 59' 23" W, 183.53 feet to the point of beginning.

Said parcel containing 181,376 square feet or 4.164 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Boring Pit East (temporary)

A parcel of land located in part of the NW 1/4 of the NW 1/4 of Section 32, Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point C;
 Thence N 26° 36' 59" W, 31.01 feet;
 Thence N 60° 30' 18" E, 15.93 feet;
 Thence S 35° 16' 36" E, 100.00 feet;
 Thence S 55° 40' 17" W, 3.31 feet;
 Thence N 48° 55' 32" W, 72.95 feet to the point of beginning.

Said parcel containing 1,390 square feet or 0.032 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Boring Pit Access and Laydown (temporary)

A parcel of land located in part of the NW 1/4 of the NW 1/4 of Section 32, and part of the NE 1/4 of the NE 1/4, Section 31, all located in Township 7 North, Range 9 East, City of Madison, Dane County, Wisconsin, more particularly described as follows:

Beginning at previously described Point E;
 Thence S 76° 21' 52" W, 198.27 feet;
 Thence N 82° 59' 31" W, 48.09 feet;
 Thence S 68° 18' 54" W, 143.86 feet;
 Thence N 83° 39' 32" W, 44.61 feet;
 Thence N 28° 36' 24" W, 33.99 feet;
 Thence N 9° 30' 57" W, 304.08 feet;
 Thence N 32° 16' 19" E, 48.67 feet;
 Thence N 59° 19' 9" E, 114.45 feet;
 Thence N 53° 52' 37" E, 71.78 feet;
 Thence N 47° 33' 35" E, 71.64 feet;
 Thence N 24° 1' 19" E, 70.85 feet;
 Thence N 23° 18' 1" W, 31.88 feet;
 Thence S 76° 4' 37" W, 519.47 feet;
 Thence N 50° 34' 14" W, 72.75 feet;
 Thence N 69° 0' 59" E, 234.67 feet;
 Thence N 77° 20' 56" E, 342.64 feet;
 Thence S 26° 5' 114" E, 81.44 feet;

000290

Thence S 49° 2' 64" E, 47.10 feet;
Thence S 60° 13' 40" W, 33.43 feet;
Thence S 28° 13' 49" W, 74.83 feet;
Thence S 47° 33' 35" W, 76.45 feet;
Thence S 53° 52' 37" W, 73.84 feet;
Thence S 59° 19' 9" W, 110.59 feet;
Thence S 32° 16' 19" W, 36.23 feet;
Thence S 9° 30' 57" E, 293.08 feet;
Thence S 28° 36' 24" E, 20.20 feet;
Thence S 83° 39' 32" E, 29.19 feet;
Thence N 68° 18' 54" E, 143.99 feet;
Thence S 82° 59' 31" E, 49.47 feet;
Thence N 75° 48' 31" E, 203.27 feet;
Thence S 79° 34' 11" E, 30.15 feet;
Thence S 61° 17' 28" W, 37.35 feet to the point of beginning.

Said parcel containing 70,018 square feet or 1.607 acres subject to recorded and unrecorded restrictions, easements, and rights of way.

Appendix M: Proposed Solutions Summary Tables

**Table M-1. Odana Hills Golf Course Detention Basin Expansion
Wingra West Watershed Study
City of Madison, WI**

Solution Name	Odana Hills Golf Course Detention Basin Expansion				
Solution Type	Wet Pond Expansion				
Solution Description	Increase the footprint of the detention basin to increase storage volume. Lower and modify the outlet structure to improve outflow and lower the pond normal water level to increase the storage volume. Modify storm sewer intake structure, approximately 325-feet downstream of pond in the golf course to improve outflow from the golf course and reduce backwater impacts on the pond.				
Land Ownership	City of Madison Parks (Odana Golf Course) & City of Madison Stormwater Utility				
Utility Conflicts	Sanitary Sewer Golf Course Features				
Other Known Concerns	WWI identifies open water.				
Anticipated Permits	City of Madison Erosion Control, WDNR Construction Site Disturbance, WDNR/USACE Permit for Wetland Disturbance (Possibly also Artificial Wetland Permit & WDNR/USACE Permit for Dredging a Navigable Waterway)				
Water Quality Impact	Yes				
Drainage Area	1,036	acres			
Footprint	11.4	acres			
Normal WSE	974				
Peak WSE	981.6	Peak WSE during 1% chance storm event			
Critical WSE	981.3 to 981.5	Estimated lowest adjacent structure elevation (5206 Milward Drive Garage Elevation)			
Stage-Area Relationship					
Existing Conditions			Proposed Conditions		
<u>Stage</u>	<u>Elevation</u>	<u>Existing Area (acres)</u>	<u>Stage</u>	<u>Elevation</u>	<u>Proposed Area (acres)</u>
0	970	0.02	0	968	4.26
2	972	0.30	6.00	974	6.38
5	975	1.89	7.00	975	6.72
6	976	2.80	8.00	976	7.07
8	978	3.51	9.00	977	7.42
9	979	5.85	10.00	978	7.78
10	980	10.06	11.00	979	9.12
11	981	12.39	12.00	980	12.67
12	982	15.02	13.00	981	14.67
13	983	17.84	14.00	982	16.93
			15.00	983	19.24
Peak Storage Volume	70.5 acre-feet @ 1% chance storm peak WSE				
Outlet Description					
Primary	6' Weir @ elev. 974.0				
Secondary	6' Weir @ elev. 976.0, 3.5' Weir @ elev. 977.0				
Overflow	23' Weir @ elev. 979.0				

**Table M-2. Odana Pond Expansion
Wingra West Watershed Study
City of Madison, WI**

Solution Name	Odana Pond Expansion				
Solution Type	Wet Pond Expansion				
Solution Description	Increase the footprint of the detention basin to increase storage volume. Lower and modify the outlet structure (remove existing weir plates on outlet pipes) to increase the storage volume.				
Land Ownership	City of Madison Parks (Odana Golf Course, Odana Hills Park) & City of Madison Stormwater Utility				
Utility Conflicts	Sanitary Sewer Golf Course Features				
Other Known Concerns	WWI identifies wetlands and open water.				
Anticipated Permits	City of Madison Erosion Control, WDNR Construction Site Disturbance, WDNR/USACE Permit for Wetland Disturbance, WDNR/USACE Permit for Dredging a Navigable Waterway, Modifications/Negotiations Regarding MG&E Permitting for Infiltration System				
Water Quality Impact	Yes				
Drainage Area	932	acres			
Footprint	35.2	acres			
Normal WSE	975.6				
Peak WSE	981.6	Peak WSE during 1% chance storm event			
Critical WSE	981.3 to 981.5	Estimated lowest adjacent structure elevation (5206 Milward Drive Garage Elevation)			
Stage-Area Relationship					
Existing Conditions			Proposed Conditions		
Stage	Elevation	Existing Area (acres)	Stage	Elevation	Proposed Area (acres)
0	971	0.00	0	969.60	25.41
6	977	15.34	6.0	975.6	28.30
7	978	15.92	6.4	976	28.46
8	979	27.40	7.4	977	28.94
9	980	32.41	8.4	978	29.41
10	981	36.50	9.4	979	31.89
11	982	39.47	10.4	980	35.34
12	983	43.11	11.4	981	38.00
			12.4	982	40.19
			13.4	983	42.56
Peak Storage Volume	193.4 acre-feet @ 1% chance storm peak WSE				
Outlet Description					
Primary	2 - 24"x38" HERCP culverts @ elev. 975.6				
Secondary	None				
Overflow	Broad-crested weir @ 978.9 (road overflow)				

**Table M-3. Orchard Ridge Valley Park Detention Basin Expansion
Wingra West Watershed Study
City of Madison, WI**

Solution Name	Orchard Ridge Valley Park Detention Basin Expansion				
Solution Type	Wet Pond Expansion				
Solution Description	Increase the footprint of the detention basin to increase storage volume. Lower the pond normal water level to increase the storage volume. Add additional outlet under Beltline Highway to improve conveyance capacity.				
Land Ownership	City of Madison Parks (Orchard Ridge Valley Park) & City of Madison Stormwater Utility (inlet sewer from Loruth Terrace)				
Utility Conflicts	ATC Power Lines/Easements				
Other Known Concerns	WWI identifies wetlands and open water.				
Anticipated Permits	City of Madison Erosion Control, WDNR Construction Site Disturbance, WDNR/USACE Permit for Wetland Disturbance (Possibly also Artificial Wetland Permit & WDNR/USACE Permit for Dredging a Navigable Waterway)				
Water Quality Impact	Yes				
Drainage Area	411	acres			
Footprint	9.7	acres			
Normal WSE	975.6 (normal water surface elevation controlled by Odana Pond)				
Peak WSE	981.6	Peak WSE during 1% chance storm event			
Critical WSE	981.4	Estimated lowest adjacent structure elevation (1001 Gilbert Road)			
Stage-Area Relationship					
Existing Conditions			Proposed Conditions		
Stage	Elevation	Existing Area (acres)	Stage	Elevation	Proposed Area (acres)
0	972	0.00	0	969.60	4.38
5	977	1.21	5.0	974.6	5.02
6	978	2.35	6.0	975.6	5.52
7	979	3.84	6.4	976	5.59
8	980	5.64	7.4	977	5.78
9	981	8.29	8.4	978	5.97
10	982	9.59	9.4	979	6.17
11	983	10.59	10.4	980	6.30
			11.4	981	8.29
			12.4	982	9.59
			13.4	983	10.59
Peak Storage Volume	38.6 acre-feet @ overflow elevation				
Outlet Description					
Primary	2 - 3'x4' Box Culvert @ elev. 973.9				
Secondary	3 - 60" RCP @ elev. 974.0				
Overflow	None				

**Table M-4. University Research Park - Southeast Detention Basin Retrofit
Wingra West Watershed Study
City of Madison, WI**

Solution Name	University Research Park - Southeast Detention Basin				
Solution Type	Dry Pond Retrofit				
Solution Description	Increase the storage volume within the existing footprint of the University Research Park – Southeast Detention Basin. Increase the size of and lower the existing outlet sewer to allow bottom of detention basin to be excavated.				
Land Ownership	Private (Parcels 070930204056, 070930204064) - City holds easement for existing pond.				
Utility Conflicts	No known conflicts.				
Other Known Concerns	WWI includes designation for wetland too small to delineate. Assume wetlands are exempt - need to confirm with WDNR.				
Anticipated Permits	City of Madison Erosion Control, WDNR Construction Site Disturbance, Artificial Wetland Permit				
Water Quality Impact	No				
Drainage Area	95	acres			
Footprint	2.9	acres			
Normal WSE	N/A - Dry pond				
Peak WSE	1022.4	Peak WSE during 1% chance storm event			
Critical WSE	1025	Estimated lowest adjacent structure elevation (5501 Research Park Blvd)			
Stage-Area Relationship					
Existing Conditions			Proposed Conditions		
Stage	Elevation	Existing Area (acres)	Stage	Elevation	Proposed Area (acres)
0	1017.4	0.00	0	1016.50	0.00
0.6	1018	0.72	0.5	1017	0.56
2.6	1020	1.77	1.5	1018	1.13
4.6	1022	2.50	3.5	1020	1.77
6.6	1024	3.33	5.5	1022	2.50
			7.5	1024	3.33
Peak Storage Volume		8.2 acre-feet @ overflow elevation			
Stage-Area Notes					
Outlet Description					
Primary		15" RCP @ elev. 1016.5			
Secondary		10-ft weir @ elev 1020.0 (box outlet structure top)			
Overflow		Broad-crested weir @ 1022.2 (no change)			

**Table M-5. University Research Park - Southwest Detention Basin Retrofit
Wingra West Watershed Study
City of Madison, WI**

Solution Name	University Research Park - Southwest Detention Basin				
Solution Type	Dry Pond Retrofit				
Solution Description	Increase the storage volume within the existing footprint of the University Research Park – Southwest Detention basin. Increase the size of and lower the outlet sewer to allow bottom of detention basin to be excavated.				
Land Ownership	Private (Parcels 070930204014, 070930204022) - City holds easement for existing pond.				
Utility Conflicts	No known conflicts.				
Other Known Concerns	WWI includes designation for wetland too small to delineate. Assume wetlands are exempt - need to confirm with WDNR.				
Anticipated Permits	City of Madison Erosion Control, WDNR Construction Site Disturbance, Artificial Wetland Permit				
Water Quality Impact	No				
Drainage Area	40	acres			
Footprint	2.9	acres			
Normal WSE	N/A - Dry pond				
Peak WSE	1035.1	Peak WSE during 1% chance storm event			
Critical WSE	1038.5	Estimated lowest adjacent structure elevation (5901 Research Park Blvd)			
Stage-Area Relationship					
Existing Conditions			Proposed Conditions		
Stage	Elevation	Existing Area (acres)	Stage	Elevation	Proposed Area (acres)
0	1031.65	0.00	0	1029.75	0.00
2.35	1034	2.13	0.25	1030	0.05
4.35	1036	3.80	1.25	1031	0.37
			2.25	1032	0.94
			3.25	1033	1.70
			4.25	1034	2.54
			6.25	1036	3.80
Peak Storage Volume		7.2 acre-feet @ overflow elevation			
Stage-Area Notes					
Outlet Description					
Primary		21" RCP @ elev. 1029.75			
Secondary		15-ft weir @ elev 1034.42 (box outlet structure top, no change)			
Overflow		Broad-crested weir @ 1035 (adjacent driveway, no change)			

Appendix N: Proposed Conditions Flooding Depth and Duration Results

Table N-1 Flooding Results with Selected Solutions Implemented Wingra West Watershed Study, City of Madison, WI																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Point	XP-SWMM Node	Location	Flood Elevation	50% Chance Storm				20% Chance Storm				10% Chance Storm				4% Chance Storm				2% Chance Storm				1% Chance Storm				0.2% Chance Storm				Back to Back Storms																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
				Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)		Peak WSE	Flood Depth (feet)	Flooding Duration (hours)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

*The model runtime was 24-hours. Flooding above the identified flood elevation continues at the end of the model runtime.

**The model runtime was 48-hours. Flooding above the identified flood elevation continues at the end of the model runtime.

Appendix O: 0.2% Chance Storm Event Pipe Enlargement Summary

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3365-008_BC_JCT_20	15	5.1	24	17.6	24x38	29.8
3365-005_3365-002	21	13.4	36	55.7	3x4	103.9
3365-004_3365-002	15	5.5	24x38	25.7	29x45	46.6
3365-002_3364-001	24	21.4	36	77.6	3x4	150.3
3862-003_3862-036	4x6	204.0	4x6	266.2	4x6	261.6
3862-036_3862-017	4x6	186.4	4x6	297.4	4x6	302.0
3962-035_3962-034	38x60	34.2	4x8	289.0	4x8	315.2
3962-034_BC_JCT_13	34x53	38.1	4x8	318.4	4x8	351.8
3363-002_3363-001	24	16.2	42	86.1	4x4	136.4
BC_JCT_16_3362-018	5x7	462.5	6x8	946.9	8x16	1579.0
3261-041_BC_JCT_16	5x5	294.7	84	495.8	7x7	747.9
3461-008_3461-016	24	18.0	38x60	125.0	4x6	257.2
3460-008_3460-023	18	12.1	36	58.7	3x4	98.1
3460-023_3460-022	24	12.1	36	58.7	3x6	100.9
3461-006_3461-001	24	-21.9	42	-81.1	42	-81.1
3460-019_3461-001	24	26.9	36	53.9	36	64.9
3560-001_3460-019	24	26.8	30	53.8	30	64.8
3560-002_3560-001	18	26.0	24	53.6	30	67.7
3460-007_3460-008	18	11.6	36	58.0	3x4	100.1
3460-003_3460-007	18	8.3	36	51.8	3x4	100.6
3460-002_3460-003	18	8.3	29x45	51.8	34x53	100.7
3460-001_3460-002	18	5.4	19x30	32.3	19x30	35.2
3459-025_3460-001	18	4.1	19x30	19.6	19x30	21.7
3360-007_3360-015	36	46.1	43x68	122.1	4x6	236.7
3359-006_3359-008	42	72.9	48x76	178.9	53x83	205.6
3258-005_3258-002	15	12.3	38x60	139.2	38x60	141.1
3259-001_3359-006	36	38.5	38x60	141.5	38x60	142.1
3259-002_3259-001	36	33.2	38x60	140.5	38x60	142.0
3259-003_3259-002	27	29.3	38x60	140.6	38x60	142.0
3258-002_3259-003	24	27.5	38x60	140.7	38x60	142.0
3359-004_3359-006	24	35.4	42	56.1	42	82.3
3359-005_3359-004	24	32.7	42	57.2	42	82.4
3358-008_3359-005	24	22.5	42	60.8	42	82.4
3664-006_3664-012	21	18.7	24x38	35.6	24x38	41.6
3664-007_3664-006	18	18.7	24x38	41.8	24x38	43.7
3865-023_3865-014	12	9.3	24	42.6	24	43.0
3865-003_3865-006	18	25.0	30	97.6	34x53	157.0
3865-006_3865-001	18	25.8	36	97.5	34x53	154.1
3864-028_3864-025	24	40.4	30	78.7	29x45	134.8
3864-016_3864-012	24	34.3	36	106.4	34x53	162.6
3865-001_3864-016	24	39.1	36	107.3	34x53	163.3
3864-012_3864-013	24	38.2	34x53	134.7	38x60	202.7
3864-003_3864-001	18	26.2	18	28.4	30	62.0
3764-009_3864-003	18	25.6	18	28.9	24	62.0
3861-010_BC_JCT_12	2.5x3	112.9	2.5x3	129.9	3x4	183.1
3861-004_3861-007	2.5x3	70.6	2.5x3	83.1	3x4	128.8
3861-002_3861-004	2.5x3	70.6	30	88.8	29x45	131.3
3861-001_3861-002	2.5x3	43.6	24	51.8	24x38	85.2
3860-030_3861-001	2.5x3	43.6	24	51.8	24x38	85.2
3860-023_3860-040	18	20.0	24	48.6	24x38	84.8
3860-002_3860-023	18	13.2	24	30.6	24x38	55.3
3760-015_3860-037	30	39.5	48x76	230.7	58x91	332.3
3760-009_3760-034	30	34.1	48x76	206.8	58x91	304.3
3660-001_3760-009	30	27.6	43x68	178.6	53x83	241.2
3860-037_3760-023	36	74.0	48x76	299.4	58x91	447.6

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3760-023_3760-024	36	74.4	48x76	299.4	58x91	447.7
3760-024_3760-025	36	75.5	48x76	299.8	58x91	447.9
3761-055_BC_JCT_151	36	98.9	72	436.3	84	604.8
3760-022_3860-036	21	10.9	24x38	33.5	29x45	62.7
3759-001_3760-022	18	11.1	22x34	33.6	29x45	62.6
3263-006_3263-007	18	7.2	24	15.9	34x53	50.5
BC_JCT_11_3362-012	3x10	246.0	4x10	406.5	5x14	629.6
BC_JCT_10_BC_JCT_11	3x10	211.4	4x10	307.1	5x12	474.2
3362-045_3362-006	48	152.6	60	246.4	5x5	301.2
3362-006_3362-008	48	155.1	60	247.0	5x5	301.1
3261-023_3262-018	48	129.2	60	237.8	5x5	301.2
3261-023_3262-018	48	129.2	43x68	238.3	48x76	301.2
BC_JCT_9_3261-023	42	128.1	43x68	238.4	48x76	301.2
3261-021_3261-038	36	68.9	43x68	163.1	48x76	207.2
3261-018_3261-021	36	68.8	43x68	163.2	48x76	208.5
3261-017_3261-018	36	68.8	43x68	163.2	48x76	207.1
3664-036_3764-023	24	38.2	24	39.5	24x38	68.4
3763-009_3763-008	18	12.7	34x53	92.8	43x68	177.3
3762-020_3763-008	15	7.5	24	26.8	24	31.5
3961-030_3961-029	18	26.4	21	38.1	24x38	69.4
3962-075_3962-074	60	210.1	5x8	430.2	5x8	447.0
3962-005_BC_JCT_5	60	179.2	5x6	405.4	5x6	427.5
3963-021_3963-004	2x5	66.6	60	278.8	60	283.3
3963-009_3963-001	24	28.0	24x38	56.8	34x53	95.4
3962-003_3962-005	60	149.5	5x6	384.0	5x6	398.7
3963-003_3962-003	60	147.1	5x6	383.9	5x6	398.7
3963-004_3963-003	60	115.4	5x6	372.1	5x6	397.4
3963-006_3963-004	24	45.9	24x38	58.6	34x53	87.0
3064-016_3064-001	18	36.8	24	62.8	24	62.8
BC_JCT_1_3059-018	21	13.4	21	24.4	29x45	30.7
3059-012_3059-003	21	15.5	30	43.4	38x60	71.9
3059-010_3059-004	18	18.1	27	50.0	34x53	97.3
3059-003_3059-004	21	19.0	30	46.9	38x60	72.0
3059-013_3059-012	21	15.5	30	43.4	38x60	71.4
3059-004_3159-016	27	35.0	42	93.9	4x4	158.8
3865-007_3865-003	N/A	N/A	24	41.6	24	41.8
3258-004_3258-005	N/A	N/A	15	32.4	15	32.4
BC_JCT_82_BC_JCT_108.1	29x45	106.1	29x45	145.7	3x6	193.1
BC_JCT_139_BC_JCT_86	6x3	185.5	2-3x6	279.5	5x12	429.7
BC_JCT_122_BC_JCT_121	48	54.4	48	65.5	4x8	150.4
BC_JCT_82_BC_JCT_108	29x45	22.7	29x45	75.3	3x6	132.3
3665-058_BC_JCT_82	29x45	22.8	29x45	-9.9	38x60	-13.5
3860-036_3860-037	36	34.6	36	75.9	38x60	115.2
BC_JCT_29_BC_JCT_28	43x68	263.8	43x68	262.7	3x7	320.6
3263-030_BC_JCT_23	43x68	243.5	43x68	258.8	3x7	314.7
Link751	18	23.5	18	29.9	30	64.3
3362-059_BC_JCT_11	29x45	48.1	29x45	37.7	48x76	70.8
3363-032_3362-059	29x45	48.1	29x45	32.5	48x76	70.8
BC_JCT_28_BC_JCT_10	3x10	231.1	3x10	304.4	5x10	416.0
3058-002_3059-010	18	15.8	18	19.8	30	51.1
3863-040_3962-063	2.3x3	93.7	34x53	141.5	38x60	192.2
Link749	18	46.5	36	93.3	36	164.9
BC_JCT_169_BC_JCT_116	19x30	-29.1	24x38	40.6	24x38	43.4
3664-012-1_JCT_169	19x30	-24.9	24x38	37.5	24x38	42.8
3962-074_OFALL_10	3x6	340.8	5x8	430.1	5x8	447.0

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3961-065_BC_JCT_17	43x68	211.7	6x14	1445.6	6x20	1803.8
3059-018_3059-013	21	13.7	24x38	35.8	38x60	68.2
BC_JCT_148_BC_JCT_13	4x6	164.6	6x10	1144.9	6x10	1200.5
BC_JCT_147_BC_JCT_148.1	N/A	N/A	6x10	1145.0	6x10	1200.6
BC_JCT_147_BC_JCT_148	Open	644.2	6x10	1145.0	6x10	1200.6
BC_JCT_145_BC_JCT_12	4x6	235.0	6x10	1028.4	6x10	1046.4
BC_JCT_143_BC_JCT_145.1	N/A	N/A	6x10	1028.4	6x10	1046.4
BC_JCT_143_BC_JCT_145	Open	611.3	6x10	1028.0	6x10	1046.2
BC_JCT_142_BC_JCT_143	4x6	245.1	6x10	1027.8	6x10	1045.7
BC_JCT_140_BC_JCT_142.1	N/A	N/A	6x10	968.3	6x10	979.5
BC_JCT_140_BC_JCT_142	Open	594.0	6x10	968.3	6x10	979.4
BC_JCT_138_BC_JCT_133	18	23.2	27	31.7	36	46.8
BC_JCT_133_BC_JCT_132	30	23.3	30	30.7	36	46.9
BC_JCT_132_BC_JCT_131	30	23.3	30	30.4	36	47.0
BC_JCT_131_3765-017	30	23.3	30	31.3	36	47.0
3765-017_BC_JCT_129	42	56.4	48	67.6	48x76	149.1
BC_JCT_129_3765-020	42	54.5	48	65.4	48x76	149.2
BC_JCT_114_BC_JCT_113	38x60	64.8	48x76	137.6	4x10	267.5
BC_JCT_115_BC_JCT_114	38x60	64.8	48x76	137.6	4x10	267.5
BC_JCT_116_BC_JCT_115	48	64.8	48x76	137.7	4x10	267.5
BC_JCT_117_BC_JCT_116	48	86.2	54	143.9	4x10	263.3
BC_JCT_118_BC_JCT_117	48	86.2	54	143.9	4x10	263.1
BC_JCT_119_BC_JCT_118	48	86.2	54	143.9	4x10	262.9
BC_JCT_120_BC_JCT_119	48	54.3	48	65.5	4x8	151.0
BC_JCT_121_BC_JCT_120	48	54.4	48	65.5	4x8	150.8
BC_JCT_123_BC_JCT_122	42	54.4	48	65.4	4x8	149.8
3765-020_BC_JCT_123	42	54.4	48	65.4	4x8	149.5
BC_JCT_113_3664-044	38x60	64.8	48x76	137.6	4x10	267.5
BC_JCT_104_3564-034	24	20.7	30	24.5	30	25.3
3261-004_BC_JCT_101	21	23.7	30	88.7	30	72.5
BC_JCT_101_BC_JCT_102	60	294.7	72	494.7	6x8	752.4
BC_JCT_100_BC_JCT_101	54	208.8	72	411.0	6x8	621.6
BC_JCT_102_3261-041	60	294.7	84	496.5	7x7	746.8
BC_JCT_99_BC_JCT_100	54	200.0	72	379.5	6x8	621.9
BC_JCT_98_BC_JCT_99	54	205.7	66	367.3	6x7	634.3
BC_JCT_97_BC_JCT_98	48	186.5	66	360.5	6x7	640.4
BC_JCT_96_BC_JCT_97	48	201.6	66	402.0	6x7	664.2
3564-024_7645-023_07	18	16.5	24	32.0	30	59.8
7645-023_07_7645-023_08	18	16.0	24	32.2	30	58.6
7645-023_08_7645-023_09	18	18.2	24	33.0	30	58.4
7645-023_09_BC_JCT_105	18	14.2	24	20.4	24	21.1
3664-044_3664-045	38x60	96.0	48x76	175.0	4x12	306.6
3564-034_3564-033	24	20.7	30	24.4	30	25.3
3564-033_3564-031	24	20.7	30	24.4	30	25.2
WAITECIRCLE_3861-045	60	407.4	6x10	1009.3	6x10	986.5
BC_JCT_77_BC_JCT_69	54	242.0	54	263.9	4x6	391.2
3363-031_3363-032	29x45	48.8	34x53	50.9	34x53	70.7
3363-030_3363-031	36	50.7	34x53	139.8	4x6	218.1
BC_JCT_44_3363-030	24	50.5	29x45	139.7	4x4	216.8
3364-016_3364-004	24	49.8	36	138.6	4x4	216.7
3364-014_3364-016	24	49.8	36	138.6	4x4	216.7
BC_JCT_74_BC_JCT_73	21	23.3	21	23.4	24x38	39.8
BC_JCT_73_BC_JCT_71	21	28.2	21	27.8	24x38	40.3
BC_JCT_71_3862-001	24	9.8	24	47.1	24x38	76.6
3863-049_3863-050	54	160.2	48x76	279.1	4x8	401.9

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
BC_JCT_70_3863-049	54	188.3	54	244.2	4x6	369.9
BC_JCT_69_BC_JCT_70	54	222.2	54	248.9	4x6	376.0
3763-006_BC_JCT_67	54	183.2	54	263.4	54	326.7
3565-007_3564-027	24	26.9	36	79.9	48	111.5
3358-006_3358-008	24	17.2	42	61.1	42	82.5
BC_JCT_62_3363-005	24	25.7	42	101.3	42	164.4
3364-007_BC_JCT_62	21	18.8	27	56.1	29x45	111.0
BC_JCT_61_3564-042	24x38	27.1	34x53	55.5	34x53	52.5
3564-042_3564-041	24x38	27.1	34x53	55.5	34x53	52.5
3564-041_3664-049	24x38	27.1	34x53	55.5	34x53	52.5
3664-049_BC_JCT_60	24x38	27.1	34x53	55.5	34x53	52.5
3564-039_BC_JCT_59	24x38	15.6	42	26.8	42	-34.2
3564-038_3564-039	24x38	22.1	42	28.8	42	33.3
3664-047_3564-038	24x38	22.2	42	28.9	42	33.3
3664-045_3664-047	24x38	22.2	42	28.9	42	33.3
BC_JCT_57_BC_JCT_56	18	22.5	18	24.8	24x38	57.6
BC_JCT_56_3862-037	18	22.5	18	24.8	24x38	57.6
3862-037_3862-036	24	24.9	24	34.3	24x38	56.8
3364-008_3364-007	18	19.0	24	48.5	29x45	117.3
3964-010_3964-003	20	35.5	24x38	86.5	29x45	135.5
3864-025_3964-010	24	33.8	30	82.0	29x45	134.8
3964-004_3964-011	24	64.8	24	57.0	29x45	136.2
3964-003_3964-004	24	60.1	24	57.2	29x45	135.8
3766-040_BC_JCT_138	18	22.4	27	33.2	36	46.8
3765-007_3766-040	18	15.7	27	29.6	36	46.7
3760-025_3761-055	36	112.1	48x76	378.2	58x91	526.6
BC_JCT_5_3962-075	60	210.1	5x6	431.7	5x6	447.0
BC_JCT_52_PD_4061-006	4x6	328.5	6x16	1601.3	6x20	1965.1
BC_JCT_51_BC_JCT_52	4x6	358.1	6x14	1568.1	6x20	1924.9
3961-054_BC_JCT_17	30	49.1	34x53	127.2	38x60	194.4
BC_JCT_17_BC_JCT_51	43x68	307.5	6x14	1548.7	6x20	1920.4
3862-001_3861-028	12	9.7	24x38	47.1	24x38	76.5
3361-006_3361-002	18	18.1	29x45	39.7	29x45	54.7
3360-004_3361-002	48	150.5	48x76	300.0	58x91	455.2
3360-001_3359-008	42	89.1	48x76	212.7	58x91	334.6
3360-004_3360-001	48	126.6	48x76	268.3	58x91	420.4
3360-003_3360-001	30	52.2	36	75.2	36	91.3
3261-013_3261-015	18	13.5	36	58.2	36	81.3
3361-013_3361-016	18	13.4	36	57.7	36	81.1
3261-015_3361-013	18	13.4	36	57.9	36	81.1
BC_JCT_49_3361-016	48	174.3	58x91	412.2	5x10	762.1
BC_JCT_48_BC_JCT_49	48	169.2	53x83	411.5	5x10	763.1
3361-001_BC_JCT_48	48	53.8	43x68	151.0	4x8	259.8
3361-002_BC_JCT_48	48	140.8	48x76	291.3	5x8	505.5
3261-003_3361-017	18	18.1	19x30	40.1	19x30	54.9
3361-017_3361-006	18	18.1	29x45	39.9	29x45	54.8
3360-015_3360-016	48	44.1	43x68	122.0	4x8	234.7
3360-016_3361-001	48	42.6	43x68	119.5	4x8	233.3
3461-007_3461-008	24	15.1	38x60	89.0	4x6	176.2
3460-022_3461-007	24	16.7	38x60	107.4	4x6	192.3
3360-022_3360-021	18	13.5	24	36.2	24x38	58.1
3360-019_3360-007	36	46.5	43x68	143.8	4x6	236.5
3565-005_3565-004	22x36	22.5	27	48.1	36	76.5
3565-004_3565-007	21	22.5	27	47.4	36	76.4
3461-006_3461-020	24	21.9	42	86.2	42	88.6

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3763-016_3763-006	29x45	59.4	34x53	145.0	3x6	219.5
3862-018_3862-003	4x6	158.3	4x6	252.1	4x6	248.4
3363-003_3363-002	24	26.7	42	111.8	4x4	162.1
3363-004_3363-003	24	26.7	42	111.8	4x4	160.9
3363-005_3363-004	24	25.7	42	111.2	4x4	163.9
3360-021_3360-020	18	14.8	24	35.1	24x38	58.2
3360-020_3360-019	18	12.0	36	36.6	34x53	58.4
3963-030_3963-031	34x53	201.7	38x60	251.5	4x6	453.0
3963-028_3963-030	34x53	217.5	38x60	281.1	4x6	515.7
BC_JCT_47_3963-028	34x53	182.4	34x53	209.4	48x76	429.8
BC_JCT_46_BC_JCT_47	34x53	187.9	34x53	197.9	48x76	435.5
3964-011_BC_JCT_46	34x53	172.7	34x53	207.4	48x76	454.3
3763-041_3763-009	24	18.2	29x45	64.3	38x60	124.9
3764-024_3763-041	24	28.5	30	60.7	34x53	125.4
3764-023_3764-024	24	26.3	24	32.3	24x38	61.2
3763-007_3762-020	18	7.5	18	26.7	24	35.3
3363-024_3363-025	24	17.0	48	154.4	4x4	210.9
3363-001_3363-024	24	17.1	48	186.6	4x4	239.6
3161-014_3161-010	18	19.4	27	53.0	27	58.5
3261-027_BC_JCT_96	48	201.6	66	402.0	6x7	663.4
3160-007_3261-027	48	201.6	66	402.2	6x7	665.2
BC_JCT_21_3160-007	48	172.5	60	369.6	5x7	630.0
3964-009_3964-008	18	10.2	21	18.9	24x38	43.9
3964-007_3964-008	18	-10.2	21	-21.3	24x38	-43.9
BC_JCT_32_3864-029	24	34.7	34x53	141.5	38x60	201.4
3864-029_3964-007	24	38.6	34x53	152.9	38x60	201.5
3964-007_3964-006	24	74.8	34x53	211.3	48x76	329.1
3760-036_3760-035	21	13.6	36	28.2	36	33.1
3760-035_3760-034	21	11.1	36	33.6	36	35.6
3760-034_3760-015	30	39.8	48x76	230.8	58x91	332.3
3364-004_BC_JCT_44	24	50.5	29x45	139.5	4x4	216.8
3364-001_3364-002	36	73.4	42	139.7	4x4	216.6
3364-002_3364-014	24	48.3	36	138.6	4x4	216.7
BC_JCT_38_BC_JCT_43	12	12.9	18	29.1	24x38	62.9
3763-008_3763-016	21	20.8	34x53	118.2	3x6	200.5
3365-028_3365-005	18	9.1	36	36.8	3x4	66.9
BC_JCT_20_3365-005	15	6.4	24	17.6	24x38	29.8
3564-025_3564-024	18	15.4	21	31.9	30	60.0
3761-059_3761-043	21	17.4	24x38	48.9	38x60	96.3
3761-058_3761-008	27	34.3	36	83.5	43x68	173.2
BC_JCT_8_3961-047	12	9.4	18	25.6	24x38	62.4
BC_JCT_36_BC_JCT_41	10	9.3	18	27.4	24x38	62.5
BC_JCT_41_BC_JCT_40	12	9.0	18	27.3	24x38	62.6
BC_JCT_40_BC_JCT_39	10	10.3	18	27.7	24x38	62.6
BC_JCT_39_BC_JCT_37	12	10.0	18	27.9	24x38	62.7
BC_JCT_37_BC_JCT_38	10	11.2	18	27.8	24x38	62.7
3961-047_BC_JCT_36	12	9.1	18	27.3	24x38	62.5
3861-007_3861-010	2.5x3	112.9	2.5x3	130.2	3x4	183.6
BC_JCT_34_BC_JCT_140	4x6	306.2	6x10	968.2	6x10	979.3
3860-040_3860-029	27	37.3	24	50.7	24x38	85.2
3860-029_3860-030	2.5x3	43.6	24	51.4	24x38	85.2
3761-030_3761-029	43x68	171.6	5x8	418.6	5x8	257.8
3762-024_3761-030	38x60	129.0	5x8	418.6	5x8	257.7
3762-023_3762-024	38x60	124.9	5x8	418.7	5x8	257.7
3961-055_3961-054	30	80.9	34x53	129.2	38x60	201.3

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3962-071_3961-055	30	56.5	36	89.6	38x60	161.9
3962-068_3962-071	30	56.1	36	89.6	38x60	161.9
3962-066_3962-068	30	56.6	36	89.6	38x60	162.1
3962-014_3962-066	30	57.4	36	89.8	38x60	162.4
3261-044_BC_JCT_22	18	13.6	29x45	57.4	29x45	80.0
3261-038_BC_JCT_9	42	128.1	43x68	233.7	48x76	294.6
3962-063_3962-014	2.3x3	89.8	34x53	138.9	38x60	192.2
3863-040_3962-063	2.3x3	93.7	34x53	128.1	38x60	192.7
3863-001_3863-040	2.3x3	91.6	36	131.3	38x60	192.7
3261-032_3261-016	30	65.7	38x60	169.1	48x76	237.9
3161-013_3161-012	21	14.8	24	54.6	24	56.5
3161-012_3161-011	21	23.0	30	62.9	30	63.1
3864-013_BC_JCT_32	24	31.3	34x53	134.6	38x60	201.3
3262-018_3262-002	48	133.6	60	241.5	5x5	301.2
3960-019_3961-030	18	26.4	21	38.0	24x38	69.4
3960-022_3960-019	15	12.8	15	19.4	19x30	48.5
3960-020_3960-019	18	14.4	18	15.6	19x30	20.8
3262-002_3362-045	48	142.8	60	245.2	5x5	301.2
3963-001_3963-006	24	45.3	24x38	58.1	34x53	87.4
3660-015_3660-011	18	15.2	30	63.7	30	66.0
3660-016_3660-015	18	15.2	30	64.4	30	66.2
3660-011_3660-005	21	18.8	36	90.9	36	108.2
3660-005_3660-001	24	19.3	43x68	131.8	53x83	181.6
Link806	N/A	N/A	24	42.6	24	42.3
3964-006_3964-011	30	90.2	34x53	211.3	48x76	328.9
3362-012_3362-015	3x11	246.0	4x10	406.3	5x16	629.7
3257-001_3258-006	2-36	131.9	48	139.5	48	140.6
3256-004_3256-001	21	14.9	30	30.8	30	30.8
3256-005_3256-004	21	18.8	27	41.0	27	41.0
3256-001_3157-010	27	31.8	29x45	72.6	29x45	72.6
3157-010_3157-009	27	44.1	29x45	79.7	29x45	79.7
3761-054_3761-056	27	23.3	34x53	100.3	43x68	154.7
3761-051_3761-054	27	28.3	34x53	100.5	43x68	154.9
3761-050_3761-051	27	31.1	34x53	89.2	43x68	173.4
3761-049_3761-050	27	32.9	36	82.5	43x68	173.3
3761-008_3761-049	27	34.7	36	83.3	43x68	173.3
3962-054_3962-053	24	41.7	24x38	72.7	34x53	110.7
3962-053_3963-009	24	29.1	24x38	59.5	34x53	110.7
3264-019_3264-004	18	8.4	36	83.7	34x53	103.6
3164-022_3264-019	18	6.9	29x45	83.7	34x53	105.3
3164-021_3164-022	18	8.4	30	37.1	34x53	57.5
3164-020_3164-021	18	8.4	30	37.0	29x45	58.3
3264-005_3264-008	18	23.0	29x45	121.9	29x45	141.0
3264-004_3264-005	18	25.4	36	121.8	36	140.9
3263-007_BC_JCT_10	18	-10.3	24	20.5	34x53	50.5
3261-016_3261-017	36	72.0	43x68	191.8	48x76	247.5
3161-008_3261-032	30	40.5	38x60	134.7	48x76	218.2
3361-016_BC_JCT_16	48	168.6	58x91	466.4	5x10	832.6
BC_JCT_22_3261-013	18	13.7	29x45	58.4	29x45	81.6
3261-008_3261-004	21	22.1	30	65.8	30	72.7
3160-002_BC_JCT_21	48	173.3	60	369.6	5x7	630.0
3159-013_3160-002	48	124.9	60	250.0	5x6	401.6
3159-016_3159-013	27	44.6	42	129.3	4x4	227.5
3159-011_3159-014	42	76.8	48	97.7	48	104.3
3159-012_3159-013	42	79.2	60	110.0	60	135.1

Table O-1
0.2% Chance Storm Pipe Enhancement Summary
Wingra West Watershed Study, City of Madison, WI

Link Name	Existing Conditions		Proposed Conditions		0.2% Chance Enhanced Conditions	
	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event	Pipe Size	Peak Flow Rate - 0.2% Chance Storm Event
3159-014_3159-012	42	76.8	60	98.0	60	102.2
3159-006_3159-007	36	61.1	36	80.0	36	75.3
3158-014_3159-006	36	55.5	36	66.9	36	66.2
3366-005_3365-022	15	9.8	30	42.7	30	48.6
3365-024_3365-028	18	4.9	36	32.6	3x4	62.6
3159-008_3159-011	42	76.0	48	97.7	48	102.7
3662-001_3762-015	42	72.5	42	82.3	2-42	137.2
3662-002_3663-006	42	68.6	42	73.8	2-42	129.7
3663-006_3662-001	42	68.6	42	73.8	2-42	129.7
3761-018_BC_JCT_153	42	77.1	42	110.4	2-42	160.4
3761-020_3761-018	42	87.8	42	110.4	2-42	160.5
3762-001_3761-020	42	87.9	42	110.6	2-42	160.8
3762-015_3762-001	42	80.2	42	82.5	2-42	137.3
3562-001_3662-002	42	68.6	42	73.8	2-42	129.7
Link1225	N/A	N/A	36	88.1	48	150.7
Link1224	N/A	N/A	36	80.0	48	112.0
Link1302	N/A	N/A	3-60	384.3	4-60	604.7
Link1345	N/A	N/A	34x53	119.4	34x53	121.3
Link917	N/A	N/A	48x76	161.7	4x6	216.4
Link916	N/A	N/A	43x68	161.7	4x6	216.5
Link635	N/A	N/A	2-48	212.6	3-48	294.9
Link805	N/A	N/A	19x30	18.8	19x30	30.0
Link804	N/A	N/A	24	27.7	3x3	57.0
Link803	N/A	N/A	24	-25.7	24	-26.6
Link839	N/A	N/A	6x12	1139.9	6x12	1309.3
Link814	N/A	N/A	6x12	1272.7	6x12	1342.6
Link813	N/A	N/A	6x12	1220.1	6x12	1275.6
Link812	N/A	N/A	6x12	1184.7	6x12	1242.4
Link808	N/A	N/A	24	33.8	30	58.7
BC_JCT_93_3158-014	N/A	N/A	21	52.8	21	53.8
Link1300	N/A	N/A	N/A	N/A	72	291.5

Appendix P: Cost Estimates

Table P-1
Conceptual Cost Estimate - Odana Hills Golf Course Detention Basin Expansion
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 217,225	\$ 217,225	Adjusted to be 5% of other bid items.
20101	EXCAVATION CUT	78,262	C.Y.	\$ 25	\$ 15	\$ 1,173,930	Revised due to proximity to beltline as per City direction.
20221	TOPSOIL	28,300	S.Y.	\$ 9.50	N/A	\$ 268,850	
20235	HEAVY RIPRAP - GLACIAL FIELD STONE	100	C.Y.	\$ 160	N/A	\$ 16,000	
20705	DETENTION BASIN SEEDING	24,150	S.Y.	\$ 3	N/A	\$ 72,450	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	24,150	S.Y.	\$ 3.50	N/A	\$ 84,525	
50305	18 INCH PVC SANITARY SEWER PIPE	990	L.F.	\$ 260	N/A	\$ 257,400	
50701	4' DIA. SANITARY SAS	3	EACH	\$ 4,500	N/A	\$ 13,500	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	\$ 60,000	\$ 60,000	Increased because of connection to Odana Pond.
WW3	DETENTION BASIN OUTLET STRUCTURE	2	EACH	\$ 10,000	N/A	\$ 20,000	
WW4	CLAY LINER	23,955	C.Y.	\$ 40	N/A	\$ 958,193	
WW5	DREDGING	20,528	C.Y.	\$ 45	N/A	\$ 923,760	
WW6	PLANT PLUGS	4,570	EACH	\$ 4	N/A	\$ 18,280	
WW26	PEDESTRIAN BRIDGE - 160 LF	1	EACH	\$ 400,000	N/A	\$ 400,000	
WW29	CLEARING & GRUBBING	3	ACRE	\$ 15,000	N/A	\$ 42,616	
				Subtotal		\$ 4,562,000	
				Contingency	25%	\$ 1,141,000	
				Design	10%	\$ 457,000	
				Total		\$ 6,160,000	
				Land Acquisition		\$ -	
				Wetland Mitigation	\$80,000 per Acre	\$ -	Assume no mitigation. WWI includes designation for wetlands as open water. Assume exemption because of constructed stormwater facility.
				Total Total		\$ 6,160,000	

Table P-2
Conceptual Cost Estimate - Odana Pond Expansion
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 466,252	\$ 466,252	Adjusted to be 5% of other bid items.
20101	EXCAVATION CUT	188,210	C.Y.	\$ 25	\$ 15	\$ 2,823,150	Revised due to proximity to beltline as per City direction.
20221	TOPSOIL	38,990	S.Y.	\$ 9.50	\$ 5	\$ 194,950	Reduced cost because assumed re-use of on-site topsoil
20235	HEAVY RIPRAP - GLACIAL FIELD STONE	40	C.Y.	\$ 160	N/A	\$ 6,400	
20705	DETENTION BASIN SEEDING	33,330	S.Y.	\$ 3	N/A	\$ 99,990	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	33,330	S.Y.	\$ 3.50	N/A	\$ 116,655	
50305	18 INCH PVC SANITARY SEWER PIPE	865	L.F.	\$ 260	N/A	\$ 224,900	
50410	42 INCH TYPE I RCP STORM SEWER PIPE	100	L.F.	\$ 185	N/A	\$ 18,500	
50420	24 INCH X 38 INCH TYPE I HERCP STORM SEWER PIPE	190	L.F.	\$ 140	N/A	\$ 26,600	
50423	38 INCH X 60 INCH TYPE I HERCP STORM SEWER PIPE	450	L.F.	\$ 300	N/A	\$ 135,000	
50469	42 INCH RCP AE	1	EACH	\$ 2,300	N/A	\$ 2,300	
50483	24 INCH X 38 INCH HERCP AE	4	EACH	\$ 2,500	N/A	\$ 10,000	
50486	38 INCH X 60 INCH HERCP AE	1	EACH	\$ 3,500	N/A	\$ 3,500	
50609	42 INCH RCP AE GATE	1	EACH	\$ 1,750	N/A	\$ 1,750	
50626	38 INCH X 60 INCH HERCP AE GATE	1	EACH	\$ 2,500	N/A	\$ 2,500	
50701	4' DIA. SANITARY SAS	3	EACH	\$ 4,500	N/A	\$ 13,500	
50726	6'X6' STORM SAS	2	EACH	\$ 9,500	N/A	\$ 19,000	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	\$ 60,000	\$ 60,000	Increased because of size and likely duration of project.
WW5	DREDGING	120,900	C.Y.	\$ 45	N/A	\$ 5,440,500	
WW6	PLANT PLUGS	6,220	EACH	\$ 4	N/A	\$ 24,880	
WW29	CLEARING & GRUBBING	4	ACRE	\$ 15,000	N/A	\$ 65,975	
				Subtotal		\$ 9,792,000	
				Contingency	25%	\$ 2,448,000	
				Design	10%	\$ 980,000	
				Total		\$ 13,220,000	
				Land Acquisition		\$ -	
				Wetland Mitigation	\$80,000 per Acre	\$ 844,000	Assume 1.7:1 mitigation ratio, Area of wetlands from WWI, exclude open water area
				Total Total		\$ 14,064,000	

Table P-3
Conceptual Cost Estimate - Orchard Ridge Valley Park Detention Basin Expansion
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 292,852	\$ 292,852	Adjusted to be 5% of other bid items.
20101	EXCAVATION CUT	56,573	C.Y.	\$ 25	\$ 15	\$ 848,595	Revised due to proximity to beltline as per City direction.
20221	TOPSOIL	23,510	S.Y.	\$ 9.50	\$ 5	\$ 117,550	Reduced cost because assumed re-use of on-site topsoil
20235	HEAVY RIPRAP - GLACIAL FIELD STONE	130	C.Y.	\$ 160	N/A	\$ 20,800	
20705	DETENTION BASIN SEEDING	21,370	S.Y.	\$ 3	N/A	\$ 64,110	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	21,370	S.Y.	\$ 4	N/A	\$ 74,795	
50225B	UTILITY TRENCH PATCH TYPE III - GREATER THAN 48"	149	T.F.	\$ 100	N/A	\$ 14,875	
50225C	UTILITY TRENCH PATCH TYPE III - BOX CULVERT	79	T.F.	\$ 120	N/A	\$ 9,450	
50411	48 INCH TYPE I RCP STORM SEWER PIPE	250	L.F.	\$ 200	N/A	\$ 50,000	
50424	43 INCH X 68 INCH TYPE I HERCP STORM SEWER PIPE	345	L.F.	\$ 350	N/A	\$ 120,750	
50425	48 INCH X 76 INCH TYPE I HERCP STORM SEWER PIPE	50	L.F.	\$ 380	N/A	\$ 19,000	
50470	48 INCH RCP AE	1	EACH	\$ 2,500	N/A	\$ 2,500	
50472	60 INCH RCP AE	6	EACH	\$ 3,600	N/A	\$ 21,600	
50488	48 INCH X 76 INCH HERCP AE	1	EACH	\$ 4,500	N/A	\$ 4,500	
50610	48 INCH RCP AE GATE	1	EACH	\$ 2,000	N/A	\$ 2,000	
50611	54 INCH RCP AE GATE	6	EACH	\$ 3,000	N/A	\$ 18,000	
50628	48 INCH X 76 INCH HERCP AE GATE	1	EACH	\$ 3,500	N/A	\$ 3,500	
50726	6'X6' STORM SAS	1	EACH	\$ 9,500	N/A	\$ 9,500	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	\$ 60,000	\$ 60,000	Increased because of connection to Odana Pond.
WW4	CLAY LINER	19,099	C.Y.	\$ 40	N/A	\$ 763,956	
WW5	DREDGING	19,107	C.Y.	\$ 45	N/A	\$ 859,815	
WW6	PLANT PLUGS	2,350	EACH	\$ 4	N/A	\$ 9,400	
WW9	4'x10' BOX CULVERT	315	L.F.	\$ 1,600	N/A	\$ 504,000	
WW17	4'x10' BOX CULVERT WING WALLS	2	EACH	\$ 37,000	N/A	\$ 74,000	
WW21	4'x10' BOX CULVERT GATES	1	EACH	\$ 5,000	N/A	\$ 5,000	
WW23	JUNCTION STRUCTURE	1	EACH	\$ 20,000	N/A	\$ 20,000	
WW24	SAS - 10' DIA	2	EACH	\$ 9,000	N/A	\$ 18,000	
WW25	60" STORM SEWER - TRENCHLESS INSTALLATION	975	L.F.	\$ 1,400	\$ 2,000	\$ 1,950,000	Increased due to difficult access on Odana Pond side.
WW25A	60" STORM SEWER - TRENCHLESS INSTALLATION - BORE PI	2	EACH	\$ 50,000	\$ 60,000	\$ 120,000	Increased due to difficult access on Odana Pond side.
WW29	CLEARING & GRUBBING	2	ACRE	\$ 15,000	N/A	\$ 36,349	
				Subtotal		\$ 6,150,000	
				Contingency	25%	\$ 1,538,000	
				Design	10%	\$ 615,000	
				Total		\$ 8,303,000	
				Land Acquisition		\$ -	
				Wetland Mitigation	\$80,000 per Acre	\$ 1,019,000	Assume 1.7:1 mitigation ratio, Area of wetlands from WWI
				Total Total		\$ 9,322,000	

Table P-4
Conceptual Cost Estimate - University Research Park - Southeast Detention Basin Expansion
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 47,493	\$ 47,493	Adjusted to be 10% of other bid items.
20101	EXCAVATION CUT	1,750	C.Y.	\$ 25	N/A	\$ 43,750	
20221	TOPSOIL	14,080	S.Y.	\$ 9.50	\$ 5	\$ 70,400	Reduced cost because assumed re-use of on-site topsoil
20705	DETENTION BASIN SEEDING	14,080	S.Y.	\$ 3	N/A	\$ 42,240	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	14,080	S.Y.	\$ 3.50	N/A	\$ 49,280	
50225B	UTILITY TRENCH PATCH TYPE III - GREATER THAN 48"	166	T.F.	\$ 100	N/A	\$ 16,550	
50423	38 INCH X 60 INCH TYPE I HERCP STORM SEWER PIPE	331	L.F.	\$ 300	N/A	\$ 99,300	
50726	6'X6' STORM SAS	5	EACH	\$ 9,500	N/A	\$ 47,500	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	N/A	\$ 50,000	
WW3	DETENTION BASIN OUTLET STRUCTURE	1	EACH	\$ 10,000	N/A	\$ 10,000	
WW29	CLEARING & GRUBBING	1	ACRE	\$ 15,000	N/A	\$ 10,907	
				Subtotal		\$ 523,000	
				Contingency	25%	\$ 131,000	
				Design	10%	\$ 53,000	
				Total		\$ 707,000	
				Land Acquisition		\$ -	
				Wetland Mitigation		\$ -	Assume no mitigation. WWI includes designation for wetland too small to delineate. Assume exemption because of constructed stormwater facility.
				Total Total		\$ 707,000	

Table P-5
Conceptual Cost Estimate - University Research Park - Southwest Detention Basin Expansion
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 42,002	\$ 42,002	Adjusted to be 10% of other bid items.
20101	EXCAVATION CUT	4,230	C.Y.	\$ 25	N/A	\$ 105,750	
20221	TOPSOIL	14,040	S.Y.	\$ 9.50	\$ 5	\$ 70,200	Reduced cost because assumed re-use of on-site topsoil
20705	DETENTION BASIN SEEDING	14,040	S.Y.	\$ 3	N/A	\$ 42,120	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	14,040	S.Y.	\$ 3.50	N/A	\$ 49,140	
50225A	UTILITY TRENCH PATCH TYPE III - 24" TO 48"	78	T.F.	\$ 75	N/A	\$ 5,813	
50409	36 INCH TYPE I RCP STORM SEWER PIPE	155	L.F.	\$ 175	N/A	\$ 27,125	
50725	5'X5' STORM SAS	2	EACH	\$ 7,000	N/A	\$ 14,000	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	N/A	\$ 50,000	
WW3	DETENTION BASIN OUTLET STRUCTURE	1	EACH	\$ 10,000	N/A	\$ 10,000	
WW29	CLEARING & GRUBBING	1	ACRE	\$ 15,000	N/A	\$ 10,872	
				Subtotal		\$ 463,000	
				Contingency	25%	\$ 116,000	
				Design	10%	\$ 47,000	
				Total		\$ 626,000	
				Land Acquisition		\$ -	
				Wetland Mitigation		\$ -	Assume no mitigation. WWI includes designation for wetland too small to delineate. Assume exemption because of constructed stormwater facility.
				Total Total		\$ 626,000	

Table P-6
Conceptual Cost Estimate - Chippewa Drive Storm Sewer
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	N/A	\$ 10,000	
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 159,053	\$ 159,053	Adjusted to be 5% of other bid items.
20221	TOPSOIL	2,260	S.Y.	\$ 9.50	N/A	\$ 21,470	
20231	MEDIUM RIPRAP - GLACIAL FIELD STONE	585	C.Y.	\$ 160	N/A	\$ 93,600	
20704	INFILTRATION SEEDING	2,260	S.Y.	\$ 3	N/A	\$ 6,780	
21073	EROSION MATTING, CLASS II, TYPE C - ORGANIC	2,260	S.Y.	\$ 3.50	N/A	\$ 7,910	
21092	TERRACE RESTORATION	1,120	S.Y.	\$ 5	N/A	\$ 5,600	
40101	CRUSHED AGGREGATE BASE COURSE, GRADATION NO. 1	1,140	TON	\$ 23	N/A	\$ 26,220	
40102	CRUSHED AGGREGATE BASE COURSE, GRADATION NO. 2 OR NO. 3	1,040	TON	\$ 23	N/A	\$ 23,920	
40202	HMA PAVEMENT 4 LT 58-28 S	190	TON	\$ 100	N/A	\$ 19,000	
40381	REMOVE AND REPLACE CONCRETE CURB & GUTTER,	4,115	L.F.	\$ 15	N/A	\$ 61,725	
50307	24 INCH PVC SANITARY SEWER PIPE	75	L.F.	\$ 310	N/A	\$ 23,250	
50403	18 INCH TYPE I RCP STORM SEWER PIPE	880	L.F.	\$ 115	N/A	\$ 101,200	
50741	TYPE "H" INLET	44	EACH	\$ 3,500	N/A	\$ 154,000	
50407	30 INCH TYPE I RCP STORM SEWER PIPE	25	L.F.	\$ 160	N/A	\$ 4,000	
50410	42 INCH TYPE I RCP STORM SEWER PIPE	25	L.F.	\$ 185	N/A	\$ 4,625	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	N/A	\$ 50,000	
WW12	6'x10' BOX CULVERT	1,298	L.F.	\$ 1,900	N/A	\$ 2,466,200	
WW15	6'X10' BOX CULVERT WING WALLS	1	EACH	\$ 40,000	N/A	\$ 40,000	
WW19	6'x10' BOX CULVERT GATES	1	EACH	\$ 12,000	N/A	\$ 12,000	
WW27	CHANNEL DEMOLITION	1,298	L.F.	\$ 39	N/A	\$ 50,622	
WW28	SADDLED DITCH INLET STRUCTURE	1	EACH	\$ 6,500	N/A	\$ 6,500	
WW30	MISCELLANEOUS STORM SEWER CONNECTION ALLOWANCE	15	EACH	\$ 2,500	N/A	\$ 37,500	
WW31	UTILITY CONFLICT ALLOWANCE	1	LUMP SUM	45,000	N/A	\$ 45,000	
				Subtotal		\$ 3,456,000	
				Contingency	25%	\$ 864,000	
				Design	10%	\$ 346,000	
				Total		\$ 4,666,000	
				Land Acquisition		\$ -	
				Wetland Mitigation		\$ -	
				Total Total		\$ 4,666,000	

Table P-7
Conceptual Cost Estimate - Cherokee Drive Relief Sewer
Wingra West Watershed Study, City of Madison, WI

DRAFT

Item #	Item	Quantity	Unit	"Average" Unit Cost	Revised Unit Cost	Cost	Reason for Adjustment
10701	TRAFFIC CONTROL	1	LUMP SUM	\$ 10,000	\$ 25,000	\$ 25,000	Increased because of Nakoma Road.
10911	MOBILIZATION	1	LUMP SUM	\$ 145,000	\$ 218,710	\$ 218,710	Adjusted to be 5% of other bid items.
21092	TERRACE RESTORATION	730	S.Y.	\$ 5	N/A	\$ 3,650	
40381	REMOVE AND REPLACE CONCRETE CURB & GUTTER,	1,310	L.F.	\$ 15	N/A	\$ 19,650	
40391	REMOVE AND REPLACE 5 INCH CONCRETE SIDEWALK - RESURFACING	1,275	S.F.	\$ 12	N/A	\$ 15,300	
50225C	UTILITY TRENCH PATCH TYPE III - BOX CULVERT	1,530	T.F.	\$ 120	N/A	\$ 183,600	
50301	8 INCH PVC SANITARY SEWER PIPE	57	L.F.	\$ 155	N/A	\$ 8,835	
50304	15 INCH PVC SANITARY SEWER PIPE	100	L.F.	\$ 240	N/A	\$ 24,000	
50307	24 INCH PVC SANITARY SEWER PIPE	378	L.F.	\$ 310	N/A	\$ 117,180	
50403	18 INCH TYPE I RCP STORM SEWER PIPE	640	L.F.	\$ 115	N/A	\$ 73,600	
50405	24 INCH TYPE I RCP STORM SEWER PIPE	103	L.F.	\$ 125	N/A	\$ 12,875	
50701	4' DIA. SANITARY SAS	2	EACH	\$ 4,500	N/A	\$ 9,000	
50702	5' DIA. SANITARY SAS	7	EACH	\$ 6,500	N/A	\$ 45,500	
50741	TYPE "H" INLET	40	EACH	\$ 3,500	N/A	\$ 140,000	
50767	TERRACE INLET TYPE 2	4	EACH	\$ 7,000	N/A	\$ 28,000	
WW1	EROSION CONTROL	1	LUMP SUM	\$ 25,000	N/A	\$ 25,000	
WW2	SITE DEWATERING / STORM CONTROL	1	LUMP SUM	\$ 50,000	N/A	\$ 50,000	
WW8	4'x8' BOX CULVERT	76	L.F.	\$ 1,200	N/A	\$ 91,200	
WW13	6'x12' BOX CULVERT	1,288	L.F.	\$ 2,000	N/A	\$ 2,576,000	
WW14	6'x14' BOX CULVERT	166	L.F.	\$ 2,300	N/A	\$ 381,800	
WW32	6'x16' BOX CULVERT	126	L.F.	\$ 2,500	N/A	\$ 315,000	
WW16	4'X8' BOX CULVERT WING WALLS	1	EACH	\$ 35,000	N/A	\$ 35,000	
WW18	6'x16' BOX CULVERT WING WALLS	1	EACH	\$ 55,000	N/A	\$ 55,000	
WW20	4'X8' BOX CULVERT GATES	1	EACH	\$ 8,000	N/A	\$ 8,000	
WW22	6'x16' BOX CULVERT GATES	2	EACH	\$ 8,000	N/A	\$ 16,000	
WW23	JUNCTION STRUCTURE	3	EACH	\$ 20,000	N/A	\$ 60,000	
WW30	MISCELLANEOUS STORM SEWER CONNECTION ALLOWANCE	10	EACH	\$ 2,500	N/A	\$ 25,000	
WW31	UTILITY CONFLICT ALLOWANCE	1	LUMP SUM	30,000	N/A	\$ 30,000	
Note: Cost do not include improvements to UW Arboretum wall or ponds.				Subtotal		\$ 4,593,000	
				Contingency	25%	\$ 1,149,000	
				Design	10%	\$ 460,000	
				Total		\$ 6,202,000	
				Land Acquisition		\$ -	
				Wetland Mitigation		\$ -	
				Total Total		\$ 6,202,000	

Appendix Q: Public Comment

Wingra West Public Comment

February 4, 2022 – March 4, 2022

Q1: Are the ponds (odana pond) filling in with sediment? Water table rising?

Response 1: The ponds are a filling with sediment but this is not the cause of the all the flooding as this sediment is below the water surface. The flood reduction capacity is measured as the air above the watersurface and inside the banks of the pond. The raising of the upstream pond to allow for pumping has filled some of the available space for flood control.

Q2: Is the original drain line (Odana golf pond outlet pipe) big enough to handle the extreme rain events?

Response 2: The 42” pipe that serves as the only outlet for the Odana Pond complex is not adequate to prevent structure flooding based on the current size of the pond. Expanding the available storage in the pond by excavating the banks and lowering the water level has the potential to reduce flood risk to the 1% storm without increasing the peak flow rate from the pond complex.

Q3: Drainage on the course (Odana Golf) needs to be examined as a large area to the north free flows to the drain grate under No 11 tee box. Flooding occurs because all the pond water also has to empty into the grate to the drainage line.

Response 3: Noted. The detailed design of this area will include improvements to this area.

Q4: Will making the ponds (Odana golf pond and odana pond larger (seeing plan) keep the course from flooding or just raise the water table causing continued issues on a larger scale?

Response 4: The plan is to lower the water surface and use some of the pond expansion soil to raise the fairway to the south of the pond. This should improve the soggy condition of the fairway.

Q5: With climate change causing bigger climate events, what is the projection your proposed changes will offer effective solutions. 10 / 20 / 30 years?

Response 5: The proposed plan is to expand the pond to prevent flooding of adjacent homes for the current 1% probability storm (6.66 inches) This is a significant increase in flood protection. The improvement will let this pond handle future larger events better than now, but if the 1% storm depth increases (which is predicted), the most cost effective option will be to lower the water surface of the pond. The models will allow for the optimum level to be set based on increased intense storms. We have looked at both the 1% probability storm (6.66 inches in 24 hours) based on historic data. (1850 – present) and rainfall probabilities looking at smaller windows in the past. We made a decision to use the current 1% probability event from NOAA Atlas 14 as city wide goal of no flooded structures. Additionally we looked at predicted changes and lower probability storms (0.2 % aka 500-yr event). Utilizing some of the work that UW has produced, we felt confident that the 0.2% storm (8.94 in/ 24 hours) is a valid event to evaluate in impact of changing rain patterns. Section 12.2 details the additional work that would be needed to

- o The City has also added the 200-yr and 500-yr events to our stormwater regulations for new development.
- o https://library.municode.com/wi/madison/codes/code_of_ordinances?nodeId=COORMAWIVOIVCH32--45_CH37THPUSTSYINERCO

Q6: Question about the failed MGE water pumping project. Will the pump house be used to lower water levels or removed during this upcoming revision. There is also the issue of all the styrofoam pellets in the ground in the drainage area between the 6th and 8th fairways. MGE problem?

Response 6: MGE is continuing to use the infiltration field to fulfill permit requirements. One of the concerns with the final design of the pond is to address MGEs infiltration requirement concerns. The plan at this phase is showing the potential flood reductions under different pond scenarios. There is not a need to lower the pond with the pump, the main concern would be the ecological impact of drawing down the pond past a specific (yet to be determined elevation) inorder for MG&E to meet permit requirements. Keeping the pond lower and then pumping water to the infiltration bed, would provide additional benefit for storm management, but it may negatively impact aquatic wildlife.

- Would the installation of a well to supply irrigation for the golf course help with water levels in the surrounding soils? This should happen to take the golf course irrigation off our city drinking water supply.
 - o A well for irrigation may impact shallow ground water. This will likely have a minimal impact on the fairway conditions

Q7: Comment:

The ponds are an asset to the community and the parks department/golf course. Migratory birds and many different species call it home in the middle of our city. We need to preserve the ponds and make them a clean, free flowing resource that will not flood the surrounding area.

Response 7: Noted

Q8: I could not find any reference to climate change in the modeling of storm events. I would expect that in anticipating future storms and flood events we would not just look at historical data but would also include some statistical modeling on the likelihood of climate related increases in storm severity and frequency. After doing so I would expect to see how the proposed solution would perform in various climate change scenarios. Can you please clarify how you considered climate change in your modeling?

Response 8: We have looked at both the 1% probability storm (6.66 inches in 24 hours) based on historic data.(1850 – present) and rainfall probabilities looking at smaller windows in the past. We made a decision to use the current 1% probability event from NOAA Atlas 14 as city wide goal of no flooded structures. Additionally we looked at predicted changes and lower probability storms (0.2 % aka 500-yr event). Utilizing some of the work that UW has produced, we felt confident that the 0.2% storm (8.94 in/ 24 hours) is a valid event to evaluate in impact of changing rain patterns. Section 12.2 details the additional work that would be needed to

The City has also added the 200-yr and 500-yr events to our stormwater regulations for new development.

Q9: The expansion of the Odana Hills expands into the existing area on the north east side of the pond that is heavily wooded. Am I reading correctly that the Odana Hills pond expansion will lead to the removal of this forested area? If so, what is included in the plan as far as new plantings? I would hate to see a large section of forest removed with no plan for replanting anywhere else in the park.

Response 9: The proposed solutions are at a pretty high level and really intended to be a guide at this level. As the proposed solutions move towards implementation phase additional detail will go into the design. The loss of high quality trees in the area mentioned would definitely need to be addressed/ mitigated and or pond contours changed to avoid impacting as many trees.

Q10: If the trees north of the pond are removed there will be a significant impact on the surrounding neighborhood in regards to noise pollution. The highway updates that were completed in recent years removed many trees from the south side of the pond while also building a sound barrier wall on the south side of the highway that further reflects highway noise into the neighborhood north of the pond. If the remaining trees on the north side of the pond are lost during the pond expansion then there will be no sound barrier at all between the beltline highway and the neighborhood north of the Odana Hills pond. Even worse will be the fact that the sound barrier on the south side of the highway will further reflect noise into the neighborhood north of the pond. If many of these trees will be removed for the expansion of this pond then

there should be a consideration for how this will impact noise pollution and I would like to see a proposal for how such pollution will be effectively mitigated.

Response 10: Noise pollution was only minimally discussed but I am sure this will be a design consideration. As with the response to #2. The design of the pond will be refined to best meet the flood goals and the needs of the community. There are alternative grading options for the pond that will lessen the impacts on the trees. The trade off may be increased excavation costs, but this will be part of the next phase of design.

Q11: The cross country ski trails currently pass through the area of the Odana Hills pond expansion. This path is what connects the trails in Odana Hills Golf Course to the Odana Hills Ark. I saw in the appendices that this was noted but there was no information on what would be done about it. What considerations/plans were made in regards to the impacts on the cross country skiing in the Odana Golf Course and the Odana Hills Park?

Response 11: Maintaining ski path connectivity was a priority of the Parks Department and community members.

Q11: Why a maximum depth of 6ft for the Odana Hills pond? Could many of the benefits of increased water storage not also be achieved by keeping the same pond footprint while increasing the depth?

Response 11: One of the main alternative analyses done was to understand the benefit of lowering the pond water, modifying the outlet of the pond to increase flow out, and excavating around the pond to have more storage. I think the 6 feet refers to the water quality benefits section on page 64. The 6 foot depth is the depth of water in the pond. This is important for water quality as it helps limit resuspension of sediment during a storm, but not important for reducing the peak elevation during an intense event. In order to impact the peak elevation in rain storms, only the storage above the normal water surface helps as this is the storage that is filled when the pond fills up. We explored holding the water level in Odana Pond at 3 different levels and selected the 975.65 and the compromise elevation. The lowest the pond could be is 974.5 without having to add a new outlet pipe through the golf course (this is difficult and expensive). So to answer your question. The normal water level could be lowered, this would allow for more storage in the existing footprint but there would be tradeoffs with both the water utility (there is a well nearby and excavating the pond after lowering would require a liner to be installed) and MGE (infiltration opportunities would be significantly altered) and the type of excavation would be more expensive/difficult (pond muck instead of mostly soil). See figure 1.

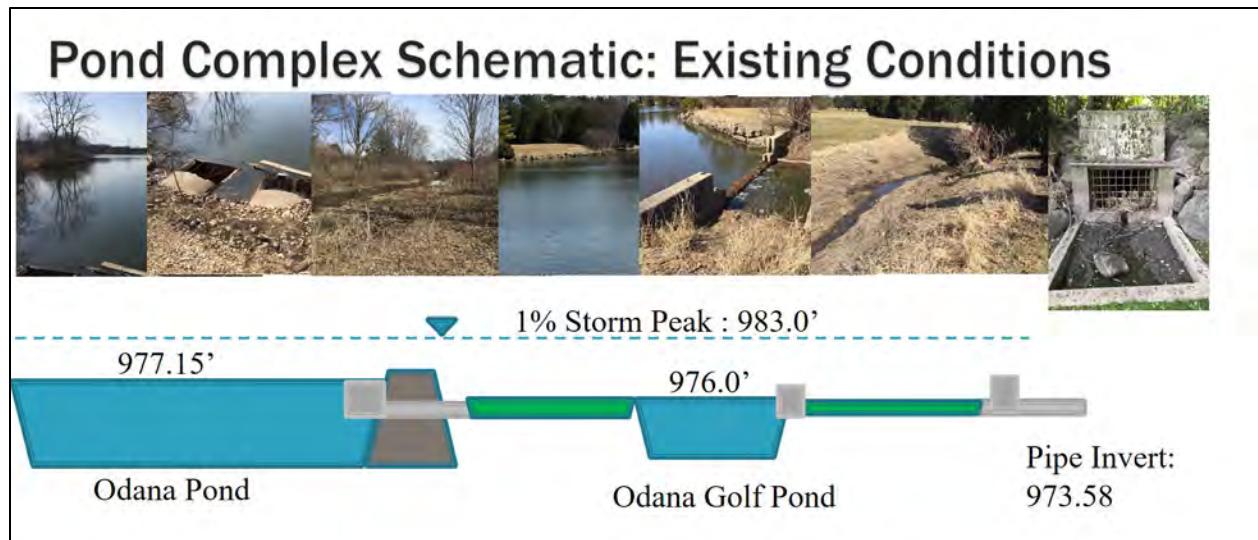


Figure 1: Schematic of Odana pond complex

Wingra West Watershed Study Report - Draft

Prepared for: City of Madison

November 3, 2021

Document Comments – David S. Liebl, February 2022

General Comment:

Adding links between the Table of Contents and the chapter headings, sections and figures will facilitate navigation through the pdf.

Throughout:

There is confusion in the place names “Manitou Pond” and “Secret Pond”. Manitou Pond is a recently constructed in-line detention pond at the downstream boundary of the study area. Secret Pond is an abandoned historic siltation pond in wetlands downstream of Manitou Pond and outside the study area. (For example, 4.4.5: the Manitou Pond outlet elevation is 855.7, whereas Secret Pond drains to the West Wingra marsh directly at a lower elevation).

Nakoma Road written as Nakoma Drive (e.g.6.2.2-4)

Response: These have been corrected.

Other Comments:

2.1: “2. A 3-foot by 6-foot box storm sewer that discharges into the UW Arboretum east of Manitou Way, approximately 700 feet south of the intersection with Nakoma Road.”

This outfall discharges into a flowing stream on Nakoma Golf Club property. In extreme events, discharge may also flow overland into the UW-Arboretum.

Response: This has been modified in the report.

2.3.1: *“The pond is likely a kettle feature from the glacier period but is now highly impacted by urban development.”*

Odana Pond is likely an internally drained area created by the glacial moraine blocking the pre-glacial drainage.

Response: This has been modified in the report.

4.5.2: *“ The wall is generally adjacent to the location of Secret Pond, and the wall prevents overland flow from the street into the Arboretum except at specific openings.”*

There is only one opening in the wall that passes water from Manitou Way. Street flow also drains around the south end of the wall onto the Nakoma Golf Club property.

Response: This has been modified in the report.

4.5.7: *“1. Along the east side of Manitou Way, adjacent to Nakoma Golf Club and the open channel at the north side of the golf course.”*

This would like read more accurately as “...adjacent to Nakoma Golf Club **at** the open channel at the north”. I’ve not seen overland flow onto the golf course south of that point.

Response: This has been modified in the report.

6.2: *“9. Manitou Way from Seminole Highway northeast to Nakoma Road.”*

This would likely read more accurately as “Manitou Way from Tumalo Trail...”.

Response: This has been modified in the report.

9.1.1: *“• The UW-Arboretum is listed on the National Register of Historic Places. Impacts to the UW-Arboretum would require coordination; however, it was assumed that increases in peak flow discharges to the Arboretum would be acceptable. Without increases in peak flow into the UW-Arboretum, the flood control goals would be difficult, or impossible, to meet.”*

What is the basis for this assumption and assertion? Section 9.1.7 gives the impression that a trade-off is made between utilizing the Odana Golf Course for detention vs. using the UW-Arboretum for discharge.

Response: The tradeoff is between diverting additional flow into Odana pond or allowing it to flow un-detained under Midvaie boulevard and then through the Waite circle. The impact of the decision is 220 cfs out of the available capacity of 993 cfs. As proposed the flow through the culvert would be 840 cfs vs a minimum of 626 cfs. Both scenarios result in an increase in flow at Waite Circle as compared to existing conditions. Additionally, there are very minimal opportunities for detention upstream of Manitou pond and downstream of Waite Circle.

10.7: **“Additional Notes/Information** The Cherokee Drive relief sewer will discharge into Secret Manitou Pond within the UW-Arboretum. As a result of the increased size of the storm sewer, and other local storm sewer improvements, the peak flow rates entering Secret Pond will be increased. The increased inlet peak flows translate into higher peak pond water surface elevations and also, higher peak flow rates discharging from the pond. The increases are a result of storm sewer improvements downstream of Odana Pond that reduce surface ponding and more efficiently convey stormwater runoff downstream. To prevent additional flow into Secret Pond and also, meet flood control goals, additional storage throughout the downstream portion of the water would be required.”

The City has provided the following estimate of peak discharge rates (cfs) to Manitou Pond from the proposed relief sewer:

	Existing Conditions	Proposed Conditions
2-yr	246	563
5-yr	265	879
10-yr	295	1035
25-yr	305	1304
50-yr	310	1423
100-yr	315	1491
500-yr	328	1601

What will be the impact of the increased flows upon the structure of the pond outlet and the downstream conveyance?

Response: This is a specific task for the Wingra Proper Watershed Study. The study is tasked with analyzing the impact and determining an adequate solution to this issue.

Pg. 365: **Peer Review Comments for West Wingra Watershed, Peer Review #3, Date: 2021-03-25** 2. Confirm that flooding did not get worse at Secret Pond (or if it does, that it is not a concern for the Arboretum). - Flows into Secret Pond and the UW-Arboretum are increased and the peak WSE in Secret Pond is higher in proposed conditions. It is likely that revisions to the pond, pond outlet structure, and/or the downstream channel will be required as part of further implementation. These items will need to be considered as part of future design work. The feasibility of these items need to be considered prior to moving forward with the proposed changes to stormwater management in the West Wingra Watershed.

Response: This is a specific task for the Wingra Proper Watershed Study. The study is tasked with analyzing the impact and determining an adequate solution to this issue.