City of Madison, Wisconsin

Central Isthmus Watershed Study - Existing Condition and Mitigation Alternatives Model Report

Tetra Tech Project Number 200-166078-20001
October 2025

TETRA TECH

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Approved April 22, 2026 by City of Madison Board of Public Works, Legistar File #92774

TETRA TECH

ACKNOWLEDGMENTS

Tetra Tech appreciates the valuable contribution of the following people to the success of this project.

City of Madison

- Jojo O'Brien, Project Manager
- Caroline Burger, Project Coordinator
- Richie Breidenbach, Engineer
- Hannah Mohelnitzky; Public Information Officer
- Janet Schmidt, Principal Engineer
- Greg Fries, Assistant City Engineer

EXECUTIVE SUMMARY

Background

Recognizing the changing rain patterns, and the likelihood of more frequent future large rain events, the City of Madison (City) is conducting a multi-faceted approach to 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 includes the development of a hydrologic/hydraulic stormwater runoff model representing the physical and drainage properties of the watershed under existing conditions. The model is used to identify the areas of the watershed most likely to flood under various rain conditions.

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

The improvements documented in this report are not meant to be full design-level efforts; they are conceptual solutions that help the City's Engineering Division understand the magnitude of solutions needed in each area to meet the targets. As projects are looked at further, and if they move to the point where they are contemplated for programming, then projects will then go into a more detailed design phase.

This document reports the methods, procedures, and results of the Central Isthmus Watershed Study. The project area covers approximately 107 acres (0.17 square miles) in downtown Madison. Figure ES-1 shows the extent of the project area.

City's Flood Mitigation Targets

The analyses use the City's flood mitigation targets, which may change in the future as more information becomes available. The flood mitigation targets include:

- No storm sewer surcharging onto the street for up to the 10 percent Annual Exceedance Probability (AEP) design storm.
- The centerline of the street to remain passable during a 4 percent AEP design storm with no more than 0.2 feet of water at the centerline.
- No home or business will be flooded during the 1 percent AEP design storm, which includes model-projected flooding of 6 inches or more within a 5-foot buffer of buildings.
- Enclosed depressions to be served to the 1 percent AEP design storm.
- Greenway crossings at streets to be served to the 1 percent AEP design storm.
- Safely convey stormwater during the 0.2 percent AEP design storm.
- 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:

- Of the 3.1 miles of storm sewer evaluated during the study, approximately 0.3 miles (10 percent) were projected to surcharge to grade during the 10 percent AEP design storm, thus not meeting the target. Projected surcharging is solely based on pipe capacity because inlet capacity was not evaluated.
- Of the 5.0 miles of streets evaluated in the study, approximately 0.3 miles (6 percent) were projected to have more than 0.2 feet of water at the centerline during the 4 percent AEP design storm, thus not meeting the target.
- Of the 252 buildings in the watershed, eleven, or 4 percent, are projected to be at risk of flooding during the 1 percent AEP design storm, thus not meeting the target. An additional 40 structures have less than 6 inches of projected water depth within the 5-foot buffer.
- There are no enclosed depressions or greenway crossings in the watershed.
- The 0.2 percent AEP design storm was not explicitly evaluated for impact on private property or safety during this study. However, overland flow is limited to streets and the defined channel along the WSOR tracks, and therefore, no specific areas of unsafe conveyance beyond the other Level of Service (LoS) Targets are identified.

Figure ES-1 shows surface flooding locations during the 4 percent AEP design storm and how the performance of the stormwater conveyance system compares to the City's flood mitigation targets.

Recommended Solutions

Following the existing conditions analysis, an extensive process was conducted to brainstorm, evaluate, and identify solutions to meet the City's flood mitigation targets. Fifteen mitigation solutions were developed and using different combinations of the solutions, three alternatives were evaluated. Design and construction cost opinions were not included in the project scope. Figures depicting each solution are provided later in the report.

- **Mitigation Solution A:** Replace 580 feet of existing 24-inch sewer on S. Broom Street between W. Doty and W. Wilson Streets with a 29-inch by 45-inch elliptical sewer.
- **Mitigation Solution B:** Install 560 feet of new 36-inch sewer on W. Wilson Street between S. Henry and S. Broom Streets.
- **Mitigation Solution C:** Replace 60 feet of existing 18-inch sewer on W. Wilson Street near the intersection with S. Broom Street with a 36-inch sewer to match the recommended upstream sewer from Mitigation Solution B.
- **Mitigation Solution D:** Redirect the existing 12- and 21-inch sewers from the existing S. Hamilton Street sewer to the recommended W. Wilson Street sewer (Mitigation Solution B).
- **Mitigation Solution E:** Redirect the existing 24-inch sewers from the existing S. Hamilton Street sewer to the recommended W. Wilson Street sewer (Mitigation Solution B).
- **Mitigation Solution F:** Replace 180 feet of existing 15-inch sewer on S. Pinckney Street near the intersection with E. Doty Street with an 18-inch sewer.
- **Mitigation Solution G:** Replace 120 feet of existing 15-inch sewer on S. Pinkney Street between E. Doty and E. Wilson Streets with a 21-inch sewer.

- **Mitigation Solution H:** Replace 40 feet of existing 15-inch sewer on S. Pinckney Street upstream of the intersection with E. Wilson Street with a 24-inch sewer.
- **Mitigation Solution I:** Replace 70 feet of existing 12-inch sewer on S. Pinckney Street downstream of the intersection with E. Wilson Street with an 18-inch sewer.
- **Mitigation Solution J:** Replace 76 feet of existing variable sized (15-21 inch) sewer on S. Hamilton Street upstream of the intersection with W. Wilson and S. Henry Streets with a 24-inch sewer.
- **Mitigation Solution K:** Replace 277 feet of existing 21-inch and 395 feet of existing 24-inch pipes on S. Hamilton Street downstream of the Wilson Street intersection with a 36-inch sewer. (This solution is not part of Alternative 3, the recommended alternative)
- **Mitigation Solution L:** Replace 120 feet of existing 12-inch sewer on E. Wilson Street near the intersection with King and S. Butler Streets with a 15-inch sewer.
- **Mitigation Solution M:** Replace 70 feet of existing 12-inch sewer on W. Doty Street near the intersection with S. Hamilton Street with an 18-inch sewer.
- **Mitigation Solution N:** Redirect the existing 12- and 15-inch sewers at the intersection of S. Hamilton, W. Wilson, and S. Henry streets from the existing S. Hamilton sewer to the recommended W. Wilson Street sewer (Mitigation Solution B).
- **Mitigation Solution O:** Replace 560 feet of existing 29-inch by 45-inch elliptical sewer along S. Broom Street from W. Wilson Street to the outfall with a 43-inch by 68-inch elliptical sewer.

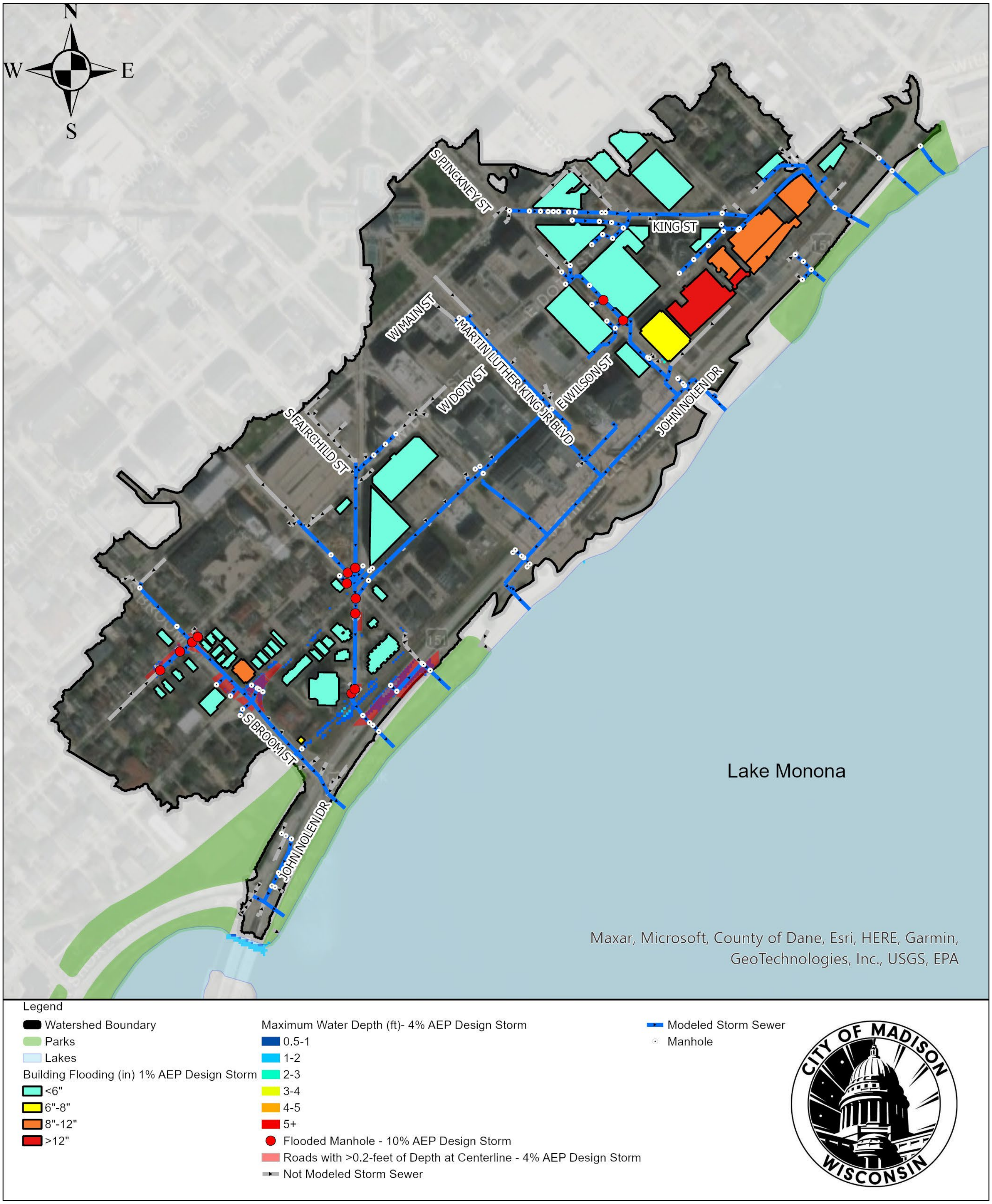
Recommended Solutions Results

As the recommended solutions were being evaluated, they were compared to the flood mitigation targets. The analysis found that all flood mitigation targets were met with the recommended solution, including the following specific elements:

- All sewers are projected to meet the surcharge target during the 10 percent AEP design storm.
- All streets are projected to meet the drivability target during the 4 percent AEP design storm.
- No buildings are projected to flood during the 1 percent AEP design storm.
- The 0.2 percent AEP design storm was not explicitly evaluated for impact on private property or safety during this study, however, a significant reduction in flooding was achieved.

Figure ES-2 shows the recommended solution, Alternative 3, and the proposed mitigation solutions. Figure ES-3 depicts the flood control summary within the watershed with the recommended solutions implemented. It shows surface flooding locations during the 4 percent AEP design storm and how the performance of the improved stormwater conveyance system compares to the City's flood mitigation targets with the selected solutions in place. Additional schematics depicting mitigation solutions can be found in Appendix E.

Figure ES-1: Existing Conditions - Flood Mitigation Goals



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ACRONYMS

Term	Definition
1D	one dimensional
2D	two dimensional
AEP	Annual Exceedance Probability
ASCII	American Standard Code for Information Interchange
CRS	Coordinate Reference System
DCIA	Directly Connected Impervious Area
DNR	Department of Natural Resources
GIS	Geographic Information System
HARN	High Accuracy Reference Network
HEC-SSP	Hydrologic Engineering Center Statistical Software Package
HGL	Hydraulic Grade Line
HSG	Hydrologic Soil Group
LoS	Level of Service
MSE	Midwest South East
NAD	North American Datum
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OHWM	Ordinary High-Water Mark
PFC	Peak Flow Control
ROW	Right-of-Way
SLU	Standard Land Use
SWMM	Storm Water Management Model
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VC	Volume Control
WinSLAMM	Windows Source Loading and Management Model
WSOR	Wisconsin and Southern Railroad

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND AND PURPOSE

Over the last several years, the City of Madison has been evaluating its storm sewer system to understand potential flooding risks caused by large rainfalls and developing alternatives to mitigate the risk. The studies are being conducted by watershed. The focus of this evaluation is the Central Isthmus watershed, which was completed concurrently with the larger, adjacent East Isthmus and Yahara River Isthmus (East Isthmus) watershed. Figure 1-1 shows the extent of the Central Isthmus watershed. The East Isthmus watershed study is documented in a separate report.

1.2 RAINFALL EVENT NOMENCLATURE

The watershed study includes evaluating potential flood risks for multiple statistical rainfalls ranging from the 50 percent annual exceedance probability (AEP) to the 0.2 percent (AEP). Statistical rainfalls are based on both the magnitude and duration of the event. Statistical rainfalls have a defined nomenclature, but the same event can be described in multiple ways.

For example, a 1 percent AEP rainfall is also called the 100-year storm because, on average, the recurrence or return interval between a rainfall of that size is 100 years. However, encountering a 100-year storm in one year does not decrease the chance of a second 100-year storm occurring in that same year or any following year. In other words, there is a 1 in 100 or 1 percent chance that a storm will reach this intensity in any given year. Likewise, a 50-year rainfall event has a 1 in 50 or 2 percent chance of occurring in a year.

Table 1-1 Rainfall Event Nomenclature

Annual Exceedance Probability (AEP)	Recurrence Interval or Return Period (year)	Probability of Occurrence in any Given Year
50%	2	1 in 2
20%	5	1 in 5
10%	10	1 in 10
4%	25	1 in 25
2%	50	1 in 50
1%	100	1 in 100
0.5%	200	1 in 200
0.2%	500	1 in 500

1.3 SCOPE OF STUDY

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

1. Review and Update Collection System Data. This task reviewed the city's GIS data to identify missing or potentially erroneous data and updated as necessary based on available drawings and field investigation. Record drawings were provided by the city. In cases where record documents could not verify data, assumptions were made (see Section 4.4.2 for more detail).
2. Develop Existing Conditions Model. Model development included calculating model inputs and building the model in XPSWMM™. Hydrologic inputs were based on the adjacent East Isthmus watershed since watershed specific model calibration was not performed in the Central Isthmus.
3. Execute the Existing Conditions Model. The model was then solved for a range of design storm events (0.2- to 50% AEP) for existing conditions to predict the collection system's performance. Predicted flood inundation maps were shared with the public and stakeholders during the public information meeting to obtain feedback on system performance and areas of flooding.
4. Evaluate Flood Mitigation Measures. Mitigation alternatives were developed for locations of concern, which included areas of flooding observed by City staff and the existing condition model results. Mitigation alternatives followed the City's flood mitigation targets and a hydraulic justification for each proposed measure. The recommended solutions were shared with the public and stakeholders during the public information meeting.

The Central Isthmus Watershed Study was completed on a compressed timeline in comparison to other watershed studies so that recommended solutions from the study could be built with a reconstruction project at Wilson and Broom Streets. Completing the study on a compressed timeline was feasible because of the small size of the watershed, limited known flooding issues, and the fact that the watershed is fully urbanized, so the primary solutions involved increasing pipe sizes. The main differences between the Central Isthmus Watershed Study and other studies are:

1. The City hosted one public information meeting instead of the typical three. The public information meeting presented the existing conditions and proposed solutions and discussed how the solutions would be incorporated into upcoming projects.
2. No flow monitoring was conducted, so a watershed-specific calibration did not occur. Calibration parameters from the neighboring watershed, the East Isthmus watershed, were applied to the Central Isthmus watershed.

Figure 1-1: Central Isthmus Watershed Location Map

1.4 HISTORIC FLOODING IN WATERSHED

Historic flooding has occurred predominantly in the lower elevations of the watershed, particularly along S. Broom and S. Hamilton Streets, which are shown on Figure 1-3. Historically three areas have been reported as significant areas of concern for flooding. These include:

1. The parking lot and first floor elevations of the Nolen Shore Condominiums (shown in Figure 1-2), at the dead end of S. Hamilton Street, adjacent to the Wisconsin and Southern Railroad (WSOR) train tracks and John Nolen Drive, are lower than the street and sidewalk. During heavy rainfall, stormwater from the intersection of S. Hamilton, S. Henry, and W. Wilson streets can flow south along S. Hamilton Street into the Nolen Shore Condominium parking lot and first floor of the building.

Figure 1-2: Nolen Shore Condominiums

2. A low point on S. Hamilton Street between W. Wilson Street and the dead end, adjacent to the Nolen Shore Condominiums.
3. The intersection of S. Broom and W. Wilson streets is a local low point. Stormwater runoff from the intersection of S. Broom and W. Doty Streets, as well as the intersection of S. Hamilton, S. Henry, and W. Wilson Streets, flows overland towards this location due to limited sewer and inlet capacity.

Figure 1-3: Reported Flood Locations

1.5 SUMMARY OF PAST STUDIES

There are no past studies of the Central Isthmus watershed.

1.6 COORDINATE SYSTEM AND VERTICAL DATUM

The hydraulic model and mapping data shown in this report use the North American Datum (NAD) 1983 HARN Wisconsin CRS Dane (US Feet) coordinate system. Elevations utilize the North American Vertical Datum of 1988 (NAVD88). Some record documents reference elevations in the City of Madison Datum, which is 845.60 feet below NAVD88 (City of Madison Datum = NAVD88 – 845.60 feet).

1.7 FLOOD MITIGATION LEVEL OF SERVICE TARGETS

The City has the following flood mitigation Level of Service (LoS) targets. These targets may change in the future as more information becomes available. Table 1-2 lists the flood mitigation LoS targets.

Table 1-2 Flood Mitigation LoS Targets

LoS Target	Focus	Description	AEP
1	Collection System	No storm sewer surcharging of the collection system onto the street	10%
2	Passable Streets	Street to remain passable to automobiles with no more than 0.2 feet of water at the centerline.	4%
3	Building Flooding	No home or business will be flooded and enclosed depressions and greenway crossings at streets will be served.	1%
4	Safe Conveyance	Safely convey stormwater runoff.	0.2%
5	Downstream Impacts	Provide flooding solutions that do not negatively impact downstream properties	All

2.0 WATER RESOURCES INVENTORY

2.1 STUDY SETTING

The Central Isthmus watershed is approximately 107 acres and is fully urbanized. The watershed is approximately 80 percent impervious. The watershed borders the East Isthmus watershed to the northeast, Lake Monona to the southeast, and the Near West watershed on the other sides. Stormwater conveyed by the public drainage system discharges into Lake Monona. The extent of the watershed relative to Lake Monona and the East Isthmus watershed is depicted in Figure 1-1.

Prominent geographic features within the watershed include:

- Lake Monona, discussed further in Section 2.3.1.
- John Nolen Drive (US-151), which is a 6-lane road parallel to the Wisconsin and Southern Railroad (WSOR) tracks and Lake Monona shoreline. The major outfalls in the watershed cross the road and WSOR rights-of-way (ROW), presenting constructability constraints for conveyance improvements.

Infrastructure mentioned by city staff that is susceptible to flooding within the watershed:

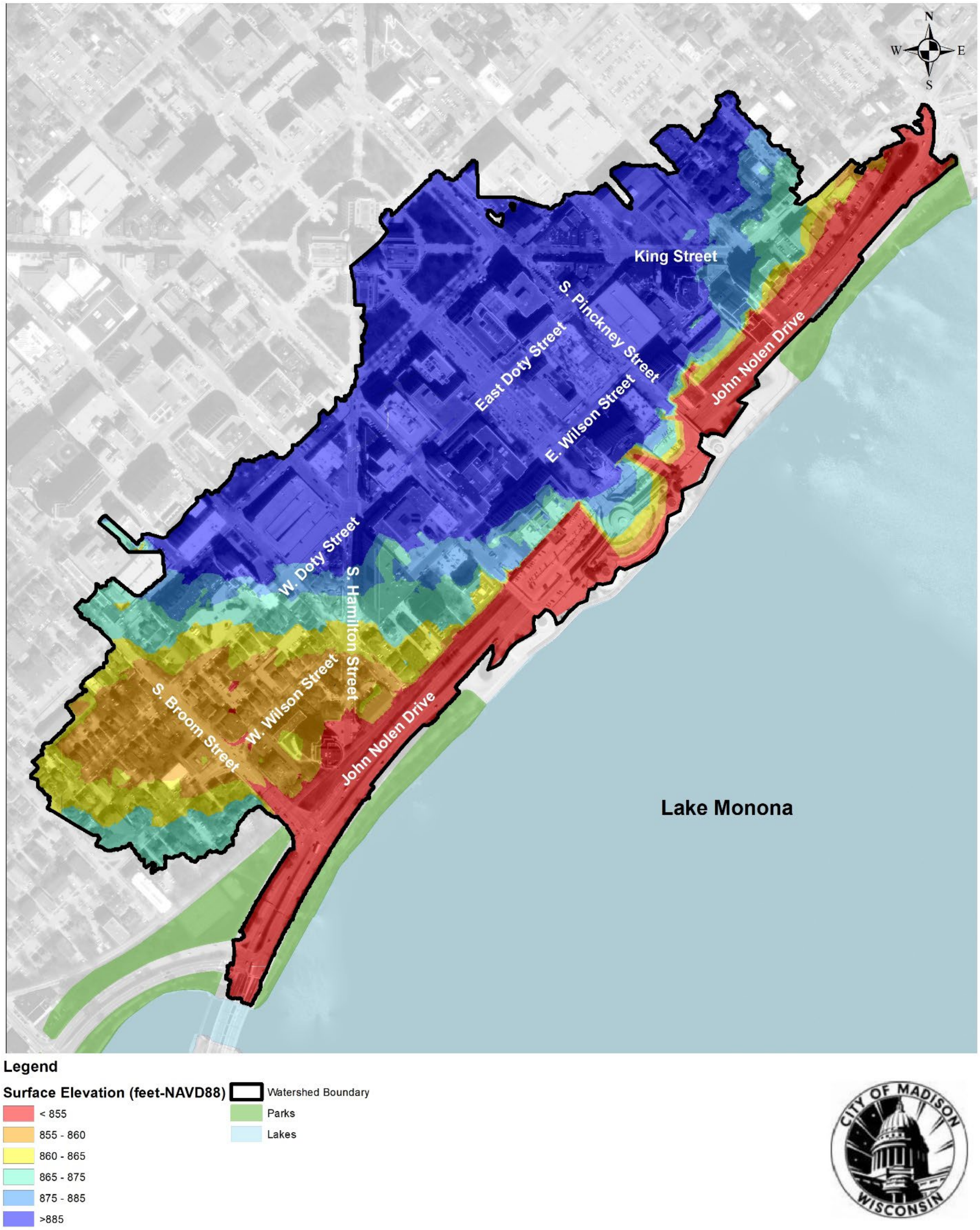
- Nolen Shore Condominiums at the dead end of S. Hamilton Street near John Nolen Drive.
- Municipal Buildings on E. Wilson Street northeast of the intersection with S. Pinckney Street.

2.2 TOPOGRAPHY

The City's 2016 Lidar data is the source of ground elevations used in the study. The terrain on the south quadrant of the intersection of E. Doty and S. Pinckney Streets was manually adjusted to match the adjacent elevations because of a hole in the data caused by building construction. Most of the area that was adjusted is now within a building footprint and was treated the same in the 2D portion of the model as other buildings.

Elevations in the watershed range from 849 feet to 924 feet, with a consistent downward slope from northwest to southeast toward Lake Monona, as shown in Figure 2-1. Over the span of approximately 1,000 linear feet on S. Hamilton Street from E. Doty Street to the dead end, the elevation drops over 55 feet, which characterizes the steep grades present in the watershed.

Figure 2-1: Central Isthmus Watershed Topography



2.3 DRAINAGE SYSTEMS

The Central Isthmus watershed is fully urbanized. As such, the drainage system predominately consists of a constructed urban stormwater conveyance system with curb and gutter and storm sewers. An open channel drainage ditch runs parallel to the WSOR tracks and adjacent to John Nolen Drive. The drainage ditch is relevant to the flooding issues at the south end of Hamilton Street.

2.3.1 Natural System

The only natural drainage features within the Central Isthmus watershed is Lake Monona, which is the receiving waterbody for all drainage in the Central Isthmus watershed.

Lake Monona water surface levels have been tracked and documented by USGS since 1915. High water recurrence intervals are estimated from the 1990 to 2020 subset of the USGS gauging station 05429000 data. Earlier water surface elevations are not included because of changes in lake level management methods and watershed urbanization that have occurred. The lake level return intervals were calculated using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's Statistical Software Package (HEC-SSP). Table 2-1 lists the regulatory and flood water surface elevations for Lake Monona.

Table 2-1: Lake Monona Water Surface Elevations

	Water Surface Elevation (feet)
Target Winter Minimum†	842.0
Target Summer Maximum†	845.0
Ordinary High Water Mark†	845.62
1% AEP (100-year) Flood	847.49
Record High Lake Level (2018)	848.31

† *Dane County Lake Level Management Guide for the Yahara Chain of Lakes*, page 5, Table 1.
Elevations converted from NGVD29 to NAVD88.

2.3.2 Constructed System

Stormwater is conveyed entirely through 10 storm sewer outfalls discharging into Lake Monona, all of which are either fully or partially submerged below the lake's ordinary high-water mark (OHWM). Five of the outfalls have an upstream storm sewer system that provides drainage solely for John Nolen Drive. The other five outfalls serve the remainder of the watershed. Table 2-2 summarizes the storm sewer outfalls. The tributary drainage areas for each outfall are depicted in Figure 2-2.

Table 2-2: Storm Sewer Outfalls

Location	Shape	Size (inches)	Invert Elevation (feet)	Drainage Area (acres)
N. Shore Drive	Circular	24	844.35	2.1
S. Broom Street	Elliptical	29 x 45	844.35	26.4

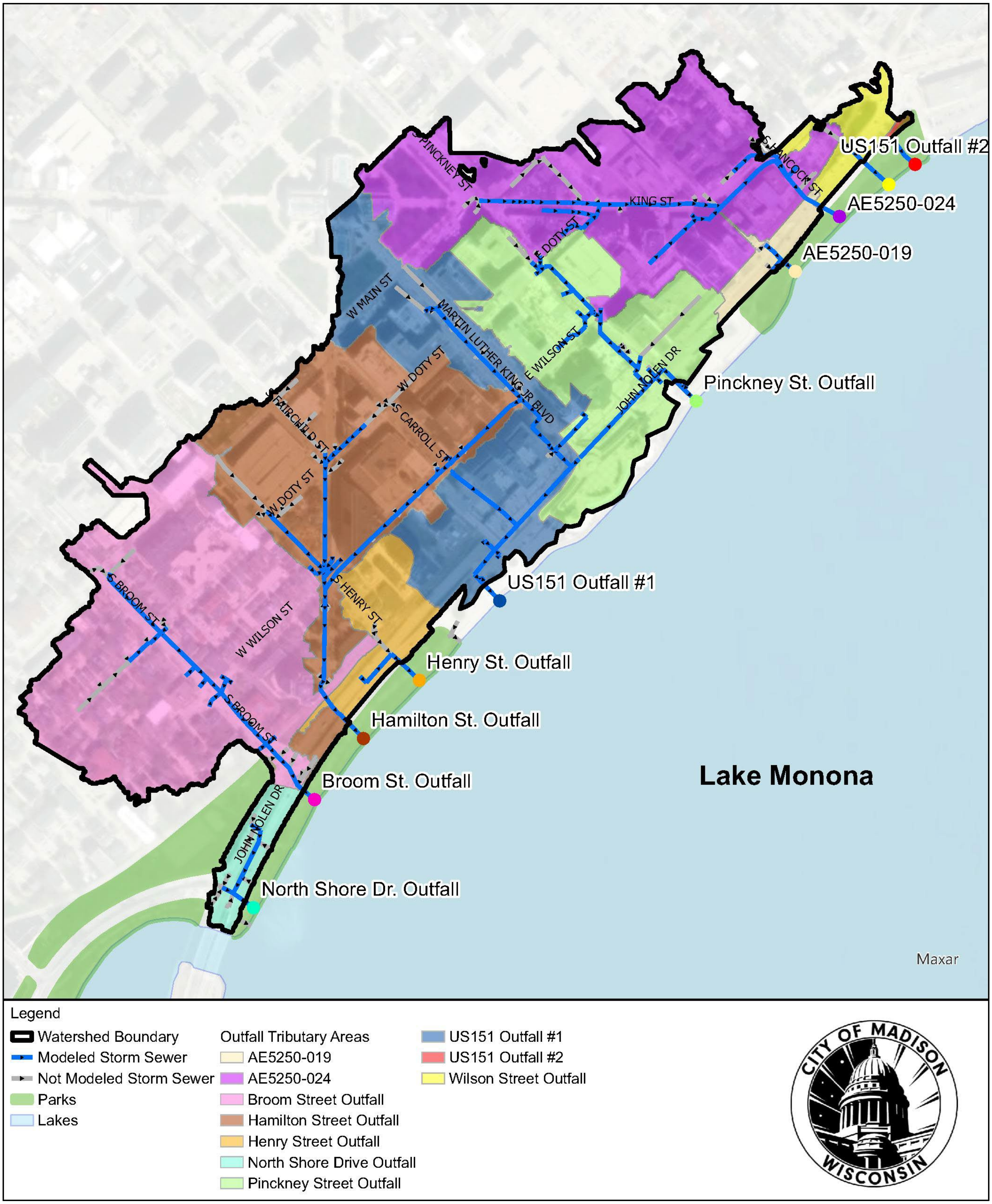
Location	Shape	Size (inches)	Invert Elevation (feet)	Drainage Area (acres)
S. Hamilton Street	Circular	21	843.60	19.1
S. Henry Street	Circular	21	844.35	3.8
Between S. Henry and S. Pinckney Streets	Box	36 x 72	843.24	15.2
S. Pinckney Street	Elliptical	29 x 45	843.12	14.5
S. Butler Street	Circular	24	844.10	1.4
S. Hancock Street	Circular	36	843.85	21.9
S. Franklin Street	Circular	30	843.00	2.0
S. Blair Street	Circular	18	843.00	0.1

Except for an approximately 200-foot-long ditch running parallel to the WSOR tracks from S. Hamilton to S. Broom Streets, the system contains only storm sewers ranging in size from 6 inches in diameter to 36- x 72-inch elliptical sewers. The existing storm sewer network has approximately 4.3 miles of storm sewer, of which approximately 3.1 miles are evaluated in the hydraulic model. Table 2-3 summarizes the length of sewer evaluated in the hydraulic model by size and shape. Figure 2-2 shows modeled and non-modeled sewers.

Table 2-3: Storm Sewer Summary

Size (inches)	Shape	Length Evaluated in Model (feet)	Length not Evaluated in Model (feet)	Total Length (feet)
8	Circular	119	213	332
10	Circular	61	60	121
12	Circular	1,743	4,467	6,210
15	Circular	1,638	1,624	3,262
18	Circular	4,396	0	4,396
20	Circular	104	0	104
21	Circular	1,726	0	1,726
24	Circular	2,753	0	2,753
27	Circular	396	0	396
30	Circular	778	0	778
36	Circular	557	0	557
14 x 23	Box	163	0	163
36 x 72	Box	416	0	416
19 x 30	Elliptical	250	0	250
24 x 38	Elliptical	20	0	20
29 x 45	Elliptical	942	0	942
34 x 53	Elliptical	15	0	15
38 x 60	Elliptical	407	0	407

Figure 2-2: Constructed Drainage System Map



2.4 RUNOFF CONDITIONS

Stormwater runoff generated from the land surface varies with the magnitude of impervious area, soil type, and topography.

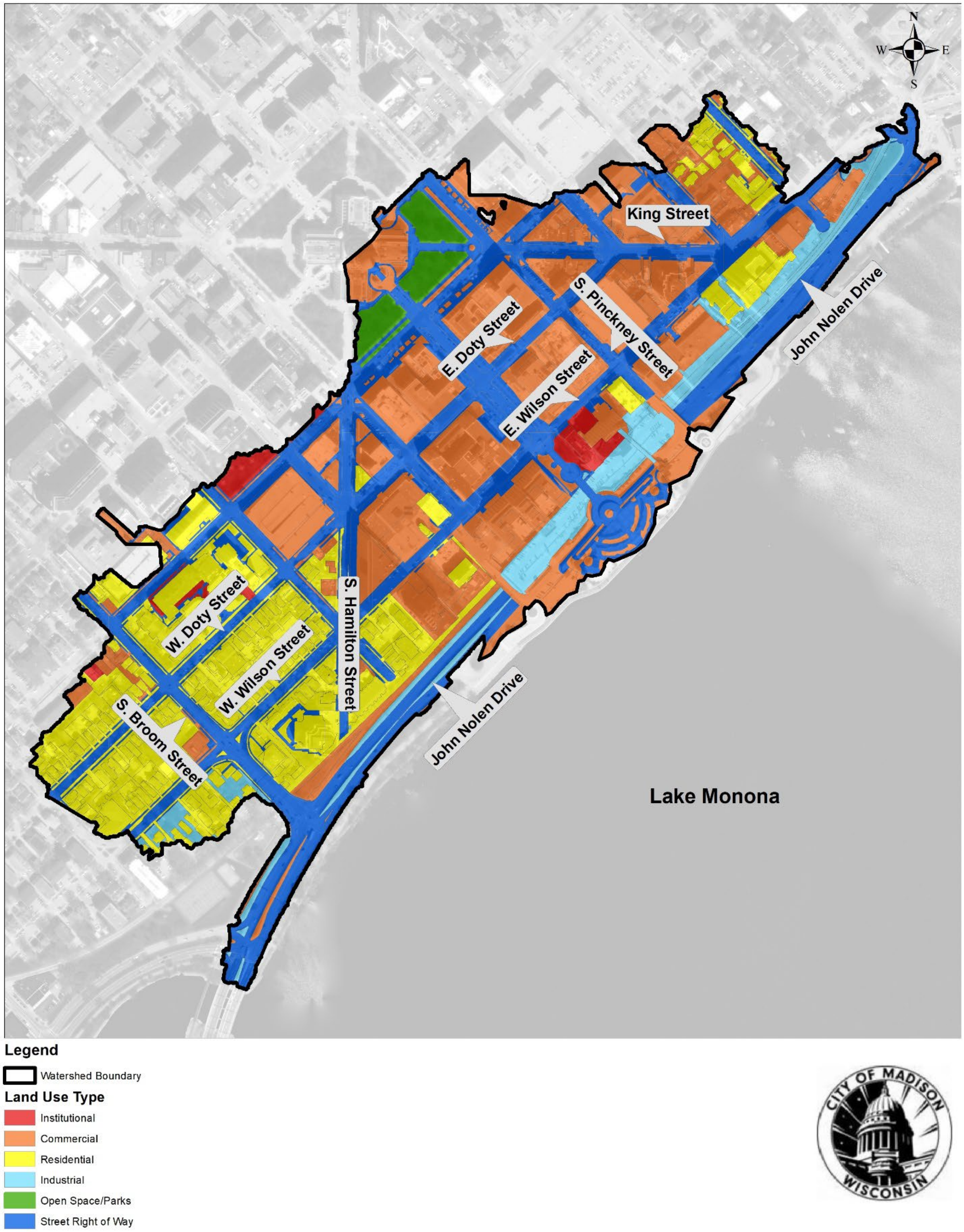
2.4.1 Land Use

The Central Isthmus watershed is a highly developed urban area. Land use data provided by the City, categorizes areas into 19 different land uses. This information was simplified into six general land use types. Table 2-4 summarizes the land use within the watershed. Figure 2-3 shows land use within the watershed. Appendix B includes additional detail on the land use categories.

Table 2-4: Existing Land Use

Land Use Type	Area (acres)	Percent (%)
Residential	24.1	23
Institutional	1.8	2
Commercial	36.4	34
Industrial	6.8	6
Open Space/Parks	2.1	2
Street Right of Way	35.6	33
Total	**106.8**	**100**

Figure 2-3: Watershed Land Use Types



2.4.2 Impervious Area

The City of Madison's 2020 Impervious Cover layer was used to define pervious and impervious areas. The watershed is approximately 80 percent impervious, including streets, parking lots, and building roofs. Table 2-5 summarizes the watershed imperviousness.

Table 2-5: Watershed Surface Type

Surface Type	Area (acres)
Pervious	21.3
Impervious	85.5
Total	**106.8**

2.4.3 Soil Type

Hydrologic Soil Group (HSG) classifications from the Natural Resources Conservation Service (NRCS) Soil Survey for Dane County are used in the model to estimate infiltration parameters for pervious surfaces. The Central Isthmus watershed has HSG soil types B, C and D and are summarized in Table 2-6.

Table 2-6: Summary of Hydraulic Soil Groups for Pervious Surfaces

HSG	Pervious Area (acres)	Percent of Pervious Area (%)
A	0.0	0.0
B	10.5	49.1
C	3.5	16.2
D	7.4	34.7
Total	**21.4**	**100**

Note: Table excludes impervious areas.

3.0 GUIDANCE AND DATA SOURCES

3.1 MODELING GUIDANCE DOCUMENT

The hydraulic model and flood mitigation solutions were developed following the City's Modeling Guidance for Round 3 Study Consultants dated July 14, 2020. The Modeling Guidance defines acceptable modeling methods and input parameters. The Modeling Guidance is provided in Appendix A.

3.2 DATA SOURCES

The data sources used for this watershed study include:

- GIS datasets from the City including reported flood locations, land use, impervious area, building footprints, public and private storm sewer infrastructure, city limits, greenways, ponds, lakes, rivers, parks, and roads.
- The City's GTWeb viewer, which contains infrastructure mapping.
- Construction plans for Monona Terrace and John Nolen Drive.
- Field surveys for unknown inverts at critical drainage structures within the watershed. Areas surveyed for this project included the W. Wilson and S. Broom Street area and all outfalls.
- City's 2016 LiDAR data. Section 2.2 summarizes the manual edit to the terrain file at the south quadrant of the intersection of E. Doty and S. Pinckney Streets.
- NRCS Soil Survey for Dane County.

Table 3-1 summarizes the digital source files that were used. Changes to the source data after the date shown in the table are not incorporated into the watershed study.

Table 3-1: Digital Source Files

Data Type	Source Data Set	File Name	File Date
Land Use	2020 Impervious Cover	Task5_CityLanduseData.gdb (Task5_WinSLAMM_Central feature class)	10/22/2021
Building Footprints *(for Level of Service Target #3 Analysis)*	2020 Impervious Cover	Building_Flooding.shp	10/22/2021
Storm Sewer	City of Madison Public and Private Pipes and Structures Database	Stm_Cntrl_10182021.gdb StmPvt_10222021.gdb	10/18/2021 10/22/2021
Lakes and Rivers	City Database	Lakes_and_Rivers.shp	2/20/2020

Data Type	Source Data Set	File Name	File Date
Greenways and Ponds	City Database	Greenways_and_Ponds.shp	2/20/2020
Parks	City Database	Parks.shp	2/20/2020
Elevation	2016 Lidar data (3.125- by 3.125-foot grid)	aoi_asc.asc (merger of Lidar tiles)	6/1/2020
Soils	NRCS	NRCS_HSG_Madison_02-03-2021	2/3/2021
Reported Flood Locations	City Database	FloodReports_ForConsultants.gdb	8/20/2020

4.0 MODEL DEVELOPMENT

4.1 MODELING SOFTWARE

XPSWMM™ version 2020.1 by Innovyze® was used to simulate the watershed hydrology and hydraulics. The model includes one-dimensional (1D) sewer flow and two-dimensional (2D) overland flow.

4.2 RAINFALL FILES

The hydraulic model includes several 24-hour design rainfall events to evaluate the flood risk in accordance with the City's flood mitigation targets. All design storms evaluated as a part of this study have 24 hour durations.

4.2.1 Measured Rain Events

Rainfall monitoring was not completed as part of this study.

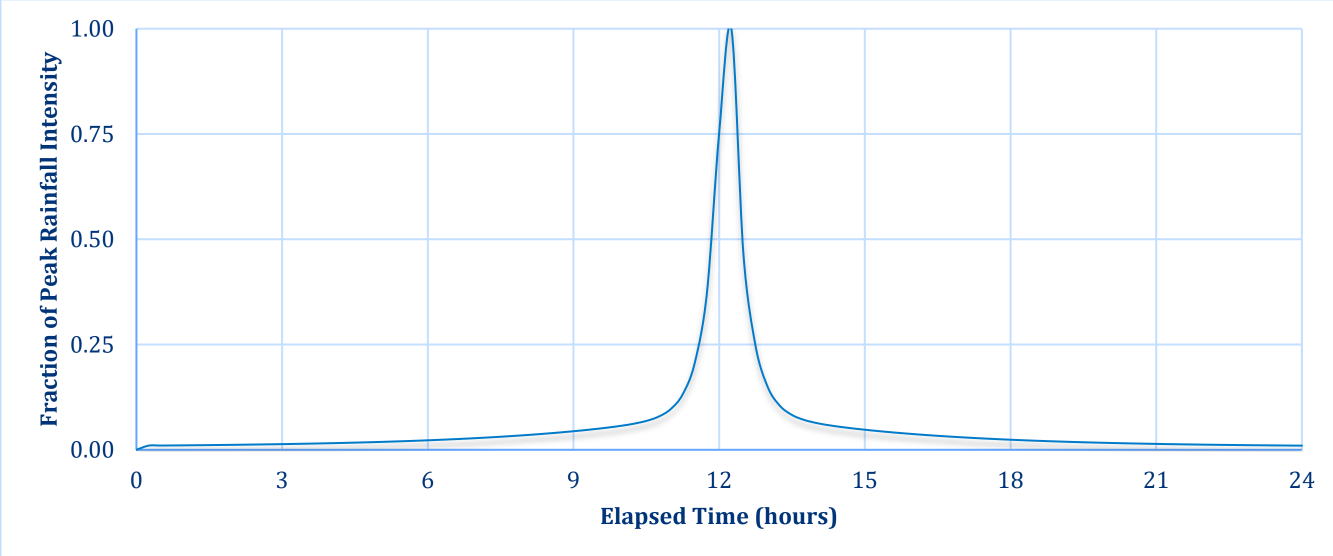
4.2.2 Design Rain Events

All the design rainfall events use the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall depths listed in the City's Modeling Guidance with the MSE 4 24-hour rainfall distribution in 15-minute increments. The MSE rainfall distribution is a nested distribution in which the rainfall intensity for each smaller increment of time is nested within each other (e.g., the 1 percent AEP, 15-minute rainfall is nested within the 1 percent AEP, 30-minute rainfall, which is nested within the 1 percent AEP, 60-minute rainfall, etc.). Table 4-1 lists the modeled design storms, their 24-hour rainfall depth, and their peak rainfall intensity. Figure 4-1 shows the unit design storm hyetograph applied to the design rainfall depths.

Table 4-1: Design Storm Rainfall Depths

AEP	Rainfall Depth (inches)	Peak 15-minute Rainfall Intensity (in/hr)
50%	2.8	1.9
20%	3.5	2.4
10%	4.1	2.8
4%	5.0	3.4
2%	5.7	3.9
1%	6.6	4.5
0.2%	8.8	6.0

Figure 4-1: Design Storm Hyetograph



4.3 HYDROLOGIC MODEL DEVELOPMENT

Hydrology is the relationship between rainfall and runoff. The basis for the hydrologic method and the acceptable range of model inputs is defined in the City's Modeling Guidance.

4.3.1 SWMM Runoff Description

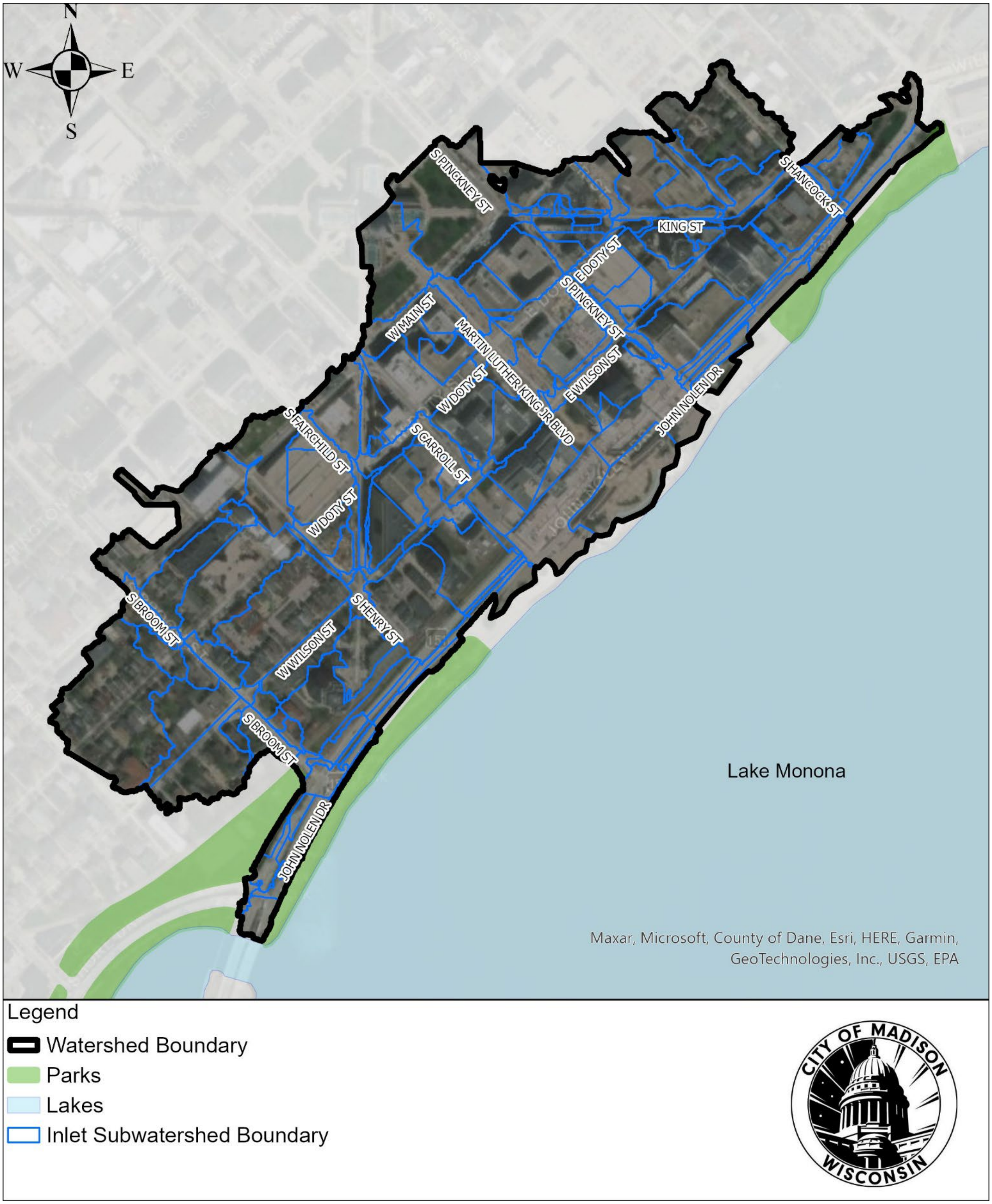
Hydrologic calculations for each subcatchment in the model were executed in the hydraulic model using the Storm Water Management Model (SWMM) runoff non-linear reservoir method. The non-linear reservoir method uses drainage area size, width, slope, imperviousness, and soil infiltration parameters to calculate runoff for a rain event. Runoff is loaded to nodes in the 1D portion of the hydraulic model.

4.3.2 Subwatershed Input Data

A drainage area was defined for every inlet in the Central Isthmus watershed using the City's Lidar data and an automated delineation process in GIS. The automated drainage area delineations were reviewed and modified as needed. After the initial delineation, drainage areas tributary to private or non-modeled inlets were merged with the closest downstream modeled inlet area. The Central Isthmus hydraulic model includes 153 subwatersheds shown in Figure 4-2. Two small areas within the northwest portion of the watershed are tributary to private inlets that discharge to sewers outside the watershed. For that reason, those areas are excluded from the Central Isthmus subwatersheds.

The subwatershed hydrologic model inputs were derived from the 2020 Impervious Cover Layer. The parameters used in hydrologic model calculations are described below. Appendix B lists the modeled inputs for each subwatershed.

Figure 4-2: Delineated Inlet Subwatersheds



4.3.2.1 Area

The subwatershed delineation yielded the spatial polygons shown in Figure 4-2. The subwatersheds range in size from 0.1 to 4.9 acres, with a median area of 0.5 acres.

4.3.2.2 Impervious Area

Impervious area was calculated using the land cover data in theTask5_WinSLAMM data in the Task5_CityLanduse geodatabase. The layer included the type of impervious surface (roof, road ROW, landscaped area, etc), whether the area was connected/disconnected, and the type of soil. For each subwatershed, which were divided into three subcatchments based on surface type and runoff routing, including:

- Directly connected impervious area (DCIA). Impervious area that drains directly to a storm sewer, typically street areas but also roof areas or parking lots plumbed to the public storm sewer.
- Indirectly connected impervious area (non-DCIA). Impervious area that drains over a pervious surface prior to entering a storm sewer.
- Pervious area. Areas that allow infiltration, such as lawn area.

Table 4-2 summarizes DCIA and non-DCIA areas within the watershed.

Table 4-2: Directly and Indirectly Connected Impervious Area Summary

Impervious Area Type	Impervious Area (acres)	Portion of Impervious Area (%)
DCIA	49.0	57.4
non-DCIA	36.4	42.6
Total	**85.4**	**100.0**

4.3.2.3 Width

The subcatchment width defines the general shape of a subwatershed and the maximum distance runoff travels to reach the subwatershed outlet and primarily impacts peak flow rate predicted by the model. Each of the three subcatchments (DCIA, non-DCIA, and pervious areas) that comprise the subwatershed area have the same width. Widths would typically be developed through model calibration, but calibration was not performed in the Central Isthmus because there was no flow monitoring data collected to which to calibrate.

The widths in the Central Isthmus model were derived by dividing the DCIA by the flow length, which was calculated using the Flow Length function in GIS. Outlier widths that deviated significantly were adjusted, if necessary, based on a manual review of the subcatchment. Some outliers were retained because they reflected drainage from surfaces other than streets (e.g. large roofs or parking areas). The average subcatchment width in the model is 20 feet, which is approximately the average subcatchment width for the post-calibration East Isthmus watershed model. Therefore, the subwatershed widths used in the Central Isthmus model are considered to be consistent with the neighboring East Isthmus area.

4.3.2.4 Slope

The subwatershed slope defines how quickly runoff reaches the subwatershed outlet. Like the width, the slope primarily impacts peak flow rate, but is more well defined than the width. A slope for each subwatershed, uniformly assigned to all three subcatchments, was calculated by dividing the difference between the high and low elevation points along the longest flow path within the subwatershed by the flow path length.

4.3.2.5 Antecedent Moisture Conditions

Antecedent moisture conditions define the initial saturation levels of the soil at the beginning of a storm event. In conditions where the soil is saturated at the beginning of an event, maximum infiltration rates and depression storage are reduced. Conversely, in dry conditions the maximum infiltration rate and depression storage are higher than normal. For the purposes of this study, typical antecedent moisture conditions are assumed and are represented by the parameters in Table 4-3.

4.3.2.6 Infiltration

The pervious subcatchment of each subwatershed was assigned infiltration characteristics based upon an area weighted composite HSG soil type for the subwatershed. The City's Modeling Guidance requires the Horton infiltration method to be used. The composite infiltration parameters were added to the model in 10 percent increments (e.g., 10 percent HSG B and 90 percent HSG C or 30 percent HSG C and 70 percent HSG D, etc.). Table 4-3 shows the base Horton infiltration parameters used to develop the area-weighted composite parameters. Appendix B summarizes the composite soil group parameters in the Modeled Horton Infiltration Data Table.

Table 4-3: Horton Infiltration Parameters

HSG Group	Maximum Infiltration Rate (in/hr)	Minimum Infiltration Rate (in/hr)	Decay Rate (1/hr)	Dry Days
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	0.0	0.0

4.3.2.7 Depression Storage

Surface depressions can store runoff and are accounted for in the hydraulic model in the depression storage input. The amount of runoff volume is reduced by the amount of depression storage. For design rainfall events, typical depression storage inputs generally do not impact the peak runoff rate. The City's Modeling Guidance requires each subcatchment to have a depression storage of 0.05 inches for impervious areas and 0.15 inches for pervious areas, and 25 percent of the subcatchment area to have zero depression storage.

4.3.2.8 Internally Drained Areas

An internally drained area is an area without a drainage outlet. There are no internally drained areas in the Central Isthmus watershed.

4.3.2.9 Runoff Routing

Runoff from DCIA and pervious subcatchments are loaded directly to a node in the 1D model network. Runoff from the non-DCIA subcatchment is routed to the pervious area subcatchment, before being loaded to the 1D network, allowing for infiltration of disconnected impervious area runoff (see Section 4.3.2.2).

4.3.3 Evaporation

Evaporation is assumed to be zero for the design rainfall events.

4.4 1D HYDRAULIC MODEL DEVELOPMENT

The 1D portion of the hydraulic model includes storm sewers, manholes, inlets, and outfalls. There are no 1D channels in the hydraulic model. The hydraulic model only includes storm sewers 18 inches in diameter or greater, plus smaller pipes that are necessary for model connectivity. The 1D hydraulic input parameters used in the hydraulic model are summarized in Tables 1 and 2 in Appendix B. Figure 2-2 shows the model network.

4.4.1 Open Channel Conveyance System

No open channel conveyance systems were modeled in 1D as part of this study.

4.4.2 Closed Conduit Conveyance System

The City provided GIS storm sewer data that included alignment, invert elevations, shape, pipe size and material, as well as node data that included inlet and manhole locations. Record drawings were used to fill in missing data not found in the GIS data. If the required data was not found in either data source, the following assumptions were made to fill in the gaps:

- Missing invert elevations were interpolated between the nearest known upstream and downstream invert elevations, assuming a constant slope between the known points.
- The nearest known upstream pipe size was used when pipe sizes were missing.

Entrance and exit losses represent energy losses at manholes and inlets caused by the contraction and expansion of flow. In the model, the entrance and exit losses are added to storm sewers based on the manhole or inlet configuration. Table 4-4 summarizes the entrance and exit losses from the City's Modeling Guidance. Pipes discharging to outfalls at Lake Monona were assigned an exit loss of 1.0 to represent the expansion of flow into a still body of water.

Table 4-4: Entrance and Exit Losses

Configuration	Entrance Loss in Effluent Sewer	Exit Loss in Influent Sewer
Straight-through manhole	0.05	0.05
45-degree bend manhole	0.25	0.25
90-degree bend manhole	0.5	0.5
Tee manhole	0.5	0.5
Cross manhole	0.5	0.5
Blind Tap	0.5	0.5

4.4.3 Inlet Capacity Analysis

Storm sewer systems include inlets, primarily along street curbs, that allow runoff from the ground surface into the storm sewer. Inlet capacity defines the maximum rate of runoff that can be conveyed into the storm sewer. In most storm sewer systems, the inlet capacity is designed to have the same level of service as the storm sewer, but that is not always the case. The number of inlets, their location, and debris on the inlet can impact observed flooding because when there is insufficient inlet capacity, runoff will collect on the street and either bypass the inlet (if on a slope) and continue as overland flow or pond if the inlet is at a low point.

Following the Modeling Guidance, inlet capacity was not evaluated as part of this study. It is possible that portions of the existing network are limited by inlet capacity and not conveyance capacity, hence are not captured by the model. Therefore, it is possible that flooding predicted by the model (or lack thereof) would underestimate actual flooding. Furthermore, mitigation improvements that increase conveyance capacity may need to be paired with inlet capacity improvements.

4.4.4 Detention Pond Analysis

There are no detention ponds in the Central Isthmus watershed.

4.4.5 Outfall Boundary Conditions

All sewers within the watershed drain to Lake Monona. Lake Monona's OHWM was applied to all outfalls in the model for all design storms.

This boundary condition was established with a sensitivity analysis whereby the 1 percent AEP design storm rainfall was simulated using three lake elevations: 845.62 feet (OHWM), 847.5 feet (100-year lake level), and 848.5 feet (0.2 feet above the record high). The model results showed that sewers located downstream of John Nolen Drive had significantly more flooding with higher lake levels, but the higher lake levels had a minimal impact on street inundation or building flooding because no streets or buildings are situated between John Nolen Drive and Lake Monona. Differences in the predicted flooding upstream of John Nolen Drive were negligible because the ground elevation increases significantly away from the shoreline.

Furthermore, using the lower lake level also allowed the pipe conveyance restrictions to be more readily distinguished from flooding caused solely by the lake level.

4.5 2D HYDRAULIC MODEL DEVELOPMENT

The 2D portion of the hydraulic model is used to represent overland flow, both along the streets and through other man-made or natural conveyance routes. The entire watershed is included in the 2D portion of the model. The 2D model utilizes topographic data and 2D land use characteristics to simulate the overland flow.

4.5.1 Topographic Data

All areas of the watershed are included in the 2D portion of the model by referencing an ASCII grid file containing the 2016 Lidar data within the 2D Job Control settings. Referencing the topography file externally instead of creating a digital terrain model within the hydraulic model allows for faster run times. The Lidar data has a 3.125- by 3.125-foot grid.

4.5.2 2D Grid

The 2D grid is used to complete the 2D calculations and display the flooding results. XPSWMM uses square grid cells, but the grid can be rotated to align with overland channels, predominantly streets in this watershed. Water that enters the grid moves between grid cells based on the elevations assigned to the grid cell. A 10- by 10-foot grid was used, which allows for multiple grid cells to span the ROW, providing more precise overland flow calculations and creating more detailed flooding results along streets and near buildings.

4.5.3 2D Roughness Values

Land use was georeferenced into the model and defined throughout the 2D grid as one of four 2D land use classifications from the City's SLU dataset: roadway, non-roadway impervious, pervious silty soil (HSG Type C), and pervious clay soil (HSG Type D). There are no pervious sandy soils (HSG Type A/B) within the watershed. Each land use was assigned a roughness coefficient representing the effectiveness of overland flow. The lower the roughness coefficient the more effective overland flow conveyance. Table 4-5 shows the 2D land use roughness coefficients used in the model.

Table 4-5: 2D Land Use Roughness Coefficients

2D Land Use	Manning's Roughness Coefficient
Roadway	0.016
Non-roadway Impervious	0.100
Buildings	Inactive/No Overland Conveyance
Pervious Silty Soil	0.240
Pervious Clay Soil	0.240

4.5.4 2D Infiltration

The 2D infiltration feature was not used in the model because this effectively doubles the infiltration of pervious areas when using the traditional subcatchment hydrology (see Section 4.3).

4.5.5 Inactive Areas

Inactive areas are portions of the hydraulic model that cannot convey flow. Physical barriers, such as buildings or walls, are common inactive areas. Stormwater flowing along the 2D surface redirects around inactive areas. Building footprints from the 2020 Impervious Cover Layer were added to the model as inactive areas.

4.5.6 1D/2D Interface

All runoff is loaded to the 1D portion of the model, but water can be exchanged between the 1D and 2D portions of the model in both directions at 1D model nodes and at 1D/2D interface lines (there are no 1D/2D interface lines in this model). At 1D model nodes, water in the 1D system spills onto the 2D grid when the 1D hydraulic grade line (HGL) exceeds the spill crest of a structure, assuming the structure is not sealed. Water can flow back from the 2D grid to the 1D system when there is inundation within a grid cell containing an inlet and capacity within the storm sewer to convey additional flow.

4.5.7 Boundary Conditions

A ridge between John Nolen Drive and Lake Monona typically prevents overland flow from the Central Isthmus watershed to Lake Monona but for cases where water overtops that ridge, a 2D boundary was included to allow flow out of the model and into Lake Monona. Section 4.4.5 describes the 1D boundary condition at Lake Monona.

4.5.8 Special Conditions

No special conditions were considered as part of the Central Isthmus watershed evaluation.

5.0 MODEL CALIBRATION

Calibration is the process by which model inputs are adjusted such that model results reasonably match the measured data. A calibrated model has less uncertainty than an un-calibrated model. No flow or rainfall monitoring was completed in the Central Isthmus watershed because of the compressed timeline of the study, and no calibration specific to the watershed was performed. The hydrologic components, while derived using slightly different methods, were compared and adjusted based on the calibration done for the neighboring East Isthmus Yahara watershed. The East Isthmus Yahara watershed was calibrated to the following events (all rainfalls are reported using the rain gauge at McPike Park, which was the closest rain gauge in the East Isthmus watershed to the Central Isthmus watershed):

- 1.13-inch total rainfall with 0.74-inch peak hour rainfall on May 3, 2021
- 1.83-inch total rainfall with 1.09-inch peak hour rainfall on June 18, 2021
- 1.46-inch total rainfall with 1.41-inch peak hour rainfall on August 7, 2021

Additional information about the calibration done for the East Isthmus Yahara watershed is included in Appendix E.

As specified in the City's Modeling Guidance, subcatchment width is the primary hydrologic input that is adjusted to calibrate the modeled peak flow rates. Subcatchment widths were not specifically calibrated, but Section 4.3.2.3 describes how the widths were derived.

Although Central Isthmus Watershed model specific calibration was not performed, the results of the model were reviewed with City staff to ensure that the results approximated past flood event observations. The model predicts flooding in all the areas where flooding has been observed.

6.0 RESULTS EVALUATION

The hydraulic model was used to predict areas of storm sewer surcharging and surface flooding during each of the design storms.

6.1 EVALUATION APPROACH

The model results were evaluated against the City's flood mitigation targets to identify flood-prone areas.

Existing condition flood maps were created for each of the design storms referenced in Table 4-1. Results were exported as ASCII raster files with cell sizes equal to the modeled grid cell size of 10 feet.

6.2 SUMMARY OF HISTORICAL FLOODING COMPARISON

The model predicted flooding in the historical flood locations identified in Section 1.4. The cause of flooding in these areas was insufficient pipe capacity causing the HGL to rise above grade. Table 6-1 summarizes model predicted flood depths for design storms associated with LoS Targets at the three historical flood locations.

Table 6-1: Model Predicted Existing Condition Results for Historical Flood Locations

Design Storm	Point 1 (350 S. Hamilton Street) Flood Depth (feet)	Point 2 (325 S. Hamilton Street) Flood Depth (feet)	Point 3 (W. Wilson and S. Broom Streets) Flood Depth (feet)
10 percent AEP	0.1	0.3	0.4
4 percent AEP	0.4	0.4	0.9
1 percent AEP	0.4	0.5	1.3
0.2 percent AEP	0.5	0.6	1.6

6.3 SURCHARGING TO GRADE (LEVEL OF SERVICE TARGET #1)

Level of Service Target #1 requires the storm sewer to convey the 10 percent AEP design storm without surcharging to grade.

The model predicts storm sewer surcharging to grade to occur at thirteen manholes and inlets at the following locations, which also are shown in Figure 6-1:

- E. Doty Street, at and west of S. Broom Street
- S. Hamilton Street, at and south of W. Wilson Street
- S. Pickney Street between E. Doty and E. Wilson Streets

Approximately 0.2 miles of the 3.1 miles of storm sewer evaluated surcharged to grade during the 10 percent AEP design storm. This equates to 6 percent of storm sewers not meeting LoS Target #1. Only the sewers immediately downstream of the manholes predicted to surcharge to grade were considered in the length of sewer not meeting LoS Target #1, although sewers further downstream may contribute to the high HGL.

Figure 6-1: Projected Existing Condition Surcharging to Grade during 10 percent AEP Design Storm

6.4 STREET CENTERLINE FLOODING (LEVEL OF SERVICE TARGET #2)

Level of Service Target #2 requires all streets be drivable during the 4 percent AEP design storm. The City defines a non-drivable street as one with more than 0.2 feet of water depth at the street centerline.

The model predicts more than 0.2 feet of flooding at the street centerline at the following locations, which are also shown in Figure 6-2.

- John Nolen Drive near S. Hamilton Street (extended).
- S. Hamilton Street south of the intersection with W. Wilson Street.
- Intersection of W. Wilson and S. Broom Streets.
- Intersection of W. Doty and S. Broom Streets.

Approximately 0.3 miles of the 5.0 miles of streets evaluated in the study have more than 0.2 feet of water at the centerline during the 4 percent AEP design storm. This equates to 6 percent of streets not meeting LoS Target #2. The length of street with centerline flooding exceeding 0.2 feet is approximate based on visual review of the model results because the 2D grid cells do not always align with the street centerline.

Figure 6-2: Projected Existing Condition Non-Drivable Streets during 4 percent AEP Design Storm

6.5 BUILDING FLOODING (LEVEL OF SERVICE TARGET #3)

Level of Service Target #3 requires that no buildings are flooded during the 1 percent AEP design storm. There are no enclosed depressions or greenway crossings in the watershed, so those parts of LoS Target #3 are not considered.

Building flooding was estimated by utilizing a spatial join between exported flood rasters and the building footprint feature class. Due to the inherent uncertainty in the models and the desire to take a conservative approach, a building is assumed to be flooded if the model shows more than 6 inches of flooding within a 5-foot buffer of the building footprint.

Eleven buildings are projected to be flooded during the 1 percent AEP design storm, including:

- Building 11, located at 215 S Hamilton St.
- Building 17, located at 114 W Wilson St.
- Building 31, located at 101 E Wilson St.
- Building 34, located at 117 E Wilson St.
- Building 44, located at 323 E Wilson St.
- Building 56, located at 231 S. Broom St.
- Building 78, located at 350 W Wilson St.
- Building 92, located at 137 E Wilson St.
- Building 93, located at 151 E Wilson St.
- Building 103, located at 137 E Wilson St.
- Building 104, located at 149 E Wilson St.

Figure 6-3 shows the buildings that are projected to flood during the 1 percent AEP design storm. A list of buildings that are projected to be flooded is in Table 4 and Figure 1 of Appendix D, respectively.

A building at 321 S. Broom Street (Building 56) that was projected to be within the 5-foot flooding buffer was excluded from the list of buildings at risk for flooding. The building is adjacent to the side slope of the WSOR ditch that runs from S. Hamilton Street to S. Broom Street but is approximately 3.5 feet higher in elevation than 1 percent AEP water surface elevation. The relatively steep side slopes of the ditch and 10-foot grid cell size make it appear in the hydraulic model that the building is closer to flooding than it is.

An additional 40 buildings are not considered to be at-risk of flooding based on the City's LoS Target #3 but are within a 5-foot buffer of flooding less than 6 inches. These buildings are primarily located immediately adjacent to the sidewalk where less than 6 inches of flooding would be contained below the top of curb and not flood the building.

Figure 6-3: Projected Existing Condition Building Flooding during 1 percent AEP Design Storm

6.6 SAFELY CONVEY STORMWATER (LEVEL OF SERVICE TARGET #4)

Level of Service Target #4 requires safe conveyance of stormwater during the 0.2 percent AEP design storm. In the Central Isthmus, overland flow is limited to streets and the defined channel along the WSOR tracks, and therefore, no specific areas of unsafe conveyance beyond the other LoS Targets are identified within the model. Figure 6-4 shows the projected flood extents during the 0.2 percent AEP design storm.

6.7 AVOID EXACERBATING DOWNSTREAM FLOODING (LEVEL OF SERVICE TARGET #5)

Level of Service Target #5 requires mitigation solutions to not negatively impact downstream properties.

Figure 6-4: Projected Existing Condition Flooding During 0.2 percent AEP Design Storm

6.8 POINT FLOODING DEPTH AND DURATION

The City identified 15 indicator points near areas of past flooding within the watershed. The indicator points were defined to characterize the projected flooding during the design storms. Figure 6-5 shows the indicator points, and Table 6-2 shows the inundation peak depth and duration of flooding at the indicator points for the four design storms corresponding to level of service targets (10-, 4-, 1-, and 0.2 percent AEP)

The indicator points show a short duration of flooding (generally less than two hours), which correlates well with the steep terrain and relatively small drainage areas. The short duration of flooding also indicates that mitigation solutions to improve capacity, rather than storage, would be more effective at meeting level of service targets.

Figure 6-5: Point Flooding Timeseries Location Map

Table 6-2: Point Inundation Maximum Depth-Duration Timeseries Data

	Point #	Ground Surface Elevation (feet)	10 percent AEP (LoS #1)	4 percent AEP (LoS #2)	1 percent AEP (LoS #3)	0.2 percent AEP (LoS #4)
Peak Flood Depth (feet)	1	850.48	0.0	0.0	0.2	0.4
	2	858.99	0.0	0.0	0.0	0.0
	3	875.83	0.0	0.1	0.2	0.4
	4	887.60	0.1	0.1	0.2	0.3
	5	897.22	0.2	0.4	0.5	0.7
	6	909.98	0.0	0	0.4	0.5
	7	860.74	0.2	0.4	0.6	0.7
	8	855.28	0.0	0.0	0.0	0.0
	9	849.65	1.0	1.0	1.1	1.2
	10	851.21	0.4	0.4	0.5	0.5
	11	856.11	0.2	0.4	0.6	0.7
	12	855.17	0.1	0.7	1.0	1.4
	13	852.13	0.0	0.1	0.4	0.7
	14	856.32	0.3	0.5	0.8	1.0
	15	856.38	0.3	0.5	0.7	0.9
Flood Duration (hours)	1	850.48	0.0	0.0	0.6	0.9
	2	858.99	0.0	0.3	0.7	0.9
	3	875.83	0.5	0.8	1.2	1.4
	4	887.60	0.6	1.0	1.3	1.5
	5	897.22	0.4	0.7	1.0	1.2
	6	909.98	0.0	0	0.6	1.1
	7	860.74	0.4	0.7	1.1	1.3
	8	855.28	0.0	0.0	0.4	0.6
	9	849.65	2.5	2.8	3.0	3.1
	10	851.21	0.7	0.9	1.2	1.5
	11	856.11	0.6	0.8	1.2	1.3
	12	855.17	0.7	1.5	1.6	2.0
	13	852.13	0.0	0.8	0.7	1.1
	14	856.32	0.8	1.2	1.6	2.0
	15	856.38	1.1	1.4	1.9	2.3

6.9 LIMITATIONS

The hydraulic model was built in accordance with the City's Modeling Guidance to maintain the standard used by the City to understand flood risks and prioritize alternatives. Even so, models have limitations, and their output has some uncertainty so models should be understood to be approximations of actual flooding that could occur. Approximations in input data, simplifications of methods to calculate flow rate and HGL, exclusion of inlet capacity, and no model calibration are examples of potential sources of uncertainty.

6.9.1 Hydrologic Uncertainty

Actual conditions that differ from the inputs in the model can lead to higher or lower flooding than predicted by the model. Furthermore, although the model was reviewed against known areas of flooding, this model was not calibrated and may not represent flooding conditions as accurately or precisely as a calibrated model. Other hydrologic factors that could impact the flood results are weather and/or soil conditions that are higher or lower than average values used in the model. Future changes to land use, especially redevelopment that includes stormwater control on private property, could reduce flooding relative to the model prediction.

6.9.2 Inlet Capacity

Inlet capacity was not considered as part of this study. As such, the inlets were assumed to have no constraint on the modeled 1D inflows and inlet capacity must be analyzed independently during design to ensure inlet capacity at least matches, if not exceeds, pipe capacity. It is possible that inlet capacity limitations in the watershed lead to flooding not predicted by the model.

6.9.3 Building First Floor Elevations

Building first floor elevations were assumed to match the fronting ground surface elevation because first floor elevations were not available. Buildings with a first-floor elevation or other point of entry that does not match the model assumption may or may not flood as predicted by the model.

6.10 HYDRAULIC PERFORMANCE SUMMARY

Table 6-3 summarizes the storm sewer surcharging (LoS Target #1), street centerline flooding (LoS Target #2) and building flooding (LoS Target #3) for all design storms.

Table 6-3: Hydraulic Performance Summary

Design Storm	Length of Storm Sewer Surcharged to Grade (feet)	Length of Street Centerline with >0.2 of Flooding (feet)	Buildings At Risk for Flooding (Flooding Depth > 6 inches)	Buildings adjacent to Flooding Depth < 6 inches
50 percent AEP	50	10	0	0
20 percent AEP	770	340	0	2
10 percent AEP	**920 (LoS Target #1)**	660	0	10
4 percent AEP	1,740	1,100	3	33
2 percent AEP	2,480	**1,410 (LoS Target #2)**	7	45
1 percent AEP	28,50	2,370	**11 (LoS Target #3)**	40
0.2 percent AEP	3,570	4,570	34	82
Total in Watershed	**16,480**[†]	**26,000**	**252**	**252**

[†] Total sewer length represents modeled pipes only.

6.10.1 Sewers

The City's LoS Target #1 is to eliminate storm sewer surcharging to grade during the 10 percent AEP design storm. Approximately 0.2 miles of 3.1 miles of modeled sewer are projected to surcharge to grade at 13 of the 227 modeled structures in the watershed during the 10 percent AEP design storm. This equates to 6 percent of sewers not meeting the LoS Target #1.

6.10.2 Streets

The City's LoS target is to maintain drivability during the 4 percent AEP design storm. Drivability is defined as having no more than 0.2 feet of flooding at the center of the street. Approximately 0.3 miles of the 5.0 miles of streets within the watershed have a projected centerline water depth exceeding 0.2 feet. This equates to 6 percent of streets not meeting LoS Target #2.

6.10.3 Buildings

The City's LoS target is to prevent building flooding during the 1 percent AEP design storm. Of the 252 buildings within the watershed, the model predicts eleven do not meet LoS Target #3. An additional 40 buildings are projected to have flooding within a 5-foot buffer, but less than 6 inches of depth, and therefore, do not meet the flooding criteria for LoS Target #3 and are not included in the count. The excluded buildings are primarily located immediately adjacent to the sidewalk where less than 6 inches of flooding would be contained below the top of curb and not flood the building.

7.0 PUBLIC ENGAGEMENT

As part of the Central Isthmus watershed study, the City conducted a virtual public information meeting. No focus groups were conducted.

7.1 PUBLIC INFORMATION MEETING

The public information meeting was conducted on September 1, 2022. Study background was presented including historical precipitation, design storms, urban flood dynamics, and an overview of the flood mitigation targets. The existing conditions flood mapping was presented and verified by residents. Additionally, the design approach and recommended mitigation solutions were shared. Implementation schedules were discussed in relation to upcoming budgeted street reconstruction projects.

Additional public information is provided on the City's project website: www.cityofmadison.com/engineering/projects/central-isthmus-watershed-study.

A 30-day Public Comment Period was held for the public to review and comment on the Final Draft Central Isthmus Watershed Study Report. The Public Comment Period ended January 13, 2026. The City did not receive any comments on the report.

8.0 SOLUTIONS DEVELOPMENT

Flood mitigation solutions were developed to address areas where LoS targets were not met. Flood mitigation measures are classified by the City as either Volume Control (VC) or Peak Flood Control (PFC). No volume control solutions were considered because of the density of the development in this area, the lack of open area large enough upstream of areas of concern for surface detention, and underground detention is limited by utilities, steep terrain, and cost. Since only PFC solutions were considered, they will be referred to as mitigation solutions. A specific group of mitigation solutions will be referred to as a mitigation alternative.

8.1 ALTERNATIVES DEVELOPMENT APPROACH

Three alternatives to mitigate flooding were developed using the City's LoS targets (refer to Section 1.7) and input from City staff throughout the duration of the project. Each mitigation alternative was developed into a hydraulic model with the same hydrologic inputs as the existing model.

The alternatives development approach began by identifying locations that were projected to not meet the City's first four LoS targets (see Section 6.0) while ensuring that mitigation solutions would not exacerbate downstream flooding (LoS Target #5). Once the areas were defined, the following general steps were taken:

- Where storm sewer surcharging was projected to reach the ground surface, the downstream capacity was increased, or flows redirected to other sewers until nominal capacities exceeded the design flow rate (LoS #1 Collection System).
- Upon compiling a set of mitigation solutions that the met collection system LoS target (LoS #1), the models were run for the 4 percent AEP design storm to check on meeting the street flooding limits (LoS #2). All three alternatives that met the collection system target (LoS #1) also satisfied the street flooding target (LoS #2) without additional modifications.
- One (1) percent AEP design storm simulations were run to evaluate compliance of not flooding buildings (LoS #3). Some sewers sized for LoS Targets #1 and #2 were not adequate for meeting LoS Target #3, and sewer sizes were increased accordingly. Mitigation solutions that were expanded after meeting the street flooding target (LoS #2) to avoid flooding buildings (LoS #3) are listed as having a design recurrence interval of 100 years in the mitigation summaries in Tables 1-3 of Appendix D.
- The 0.2 percent AEP design storm was simulated to ensure that no additional improvements were necessary to safely convey stormwater (LoS Target #4). Since LoS Target #4 was met in the existing condition and conveyance capacity was increased downstream of areas that did not meet the other LoS targets, it was confirmed to have been met in each of the mitigation alternatives.
- Lastly, the PFC Solutions model results were compared to the existing conditions results to verify that no locations experienced an increase in flooding due to mitigation solutions (LoS Target #5).

8.2 MITIGATION ALTERNATIVES SUMMARY

The three mitigation alternatives are comprised of a set of mitigation solutions that address flooding concerns in individual areas. The primary difference between the alternatives is the capacity and location of the sewers that cross the WSOR tracks and John Nolen Drive.

- Alternative 1 does not include improvements across the railroad and John Nolen Drive.
- Alternatives 2 and 3 include larger sewers crossing the railroad and John Nolen Drive at S. Hamilton Street and S. Broom Street, respectively.

Alternatives 2 and 3 are more effective at achieving LoS targets than Alternative 1 because of the additional capacity provided at the downstream end of the collection system. Alternative 1 avoids the more difficult sewer construction under the WSOR tracks and John Nolen Drive. The hydraulic benefits of Alternatives 2 and 3 should be considered in conjunction with the constructability benefits of Alternative 1.

Alternatives 1 and 3 also include a new storm sewer along W. Wilson Street between S. Henry and S. Broom Streets to divert flow away from the S. Hamilton Street outfall, which is under capacity in the existing conditions. The remaining mitigation solutions overlapped in all three alternatives.

Schematics depicting proposed sewers and summary tables showing capacities and design flow rates for all three alternatives are in Appendix D. Mitigation solutions were assigned a reference letter that corresponds with the mitigation schematic maps and summary table in Appendix D.

8.2.1 Common Mitigation Solutions

The following mitigation solutions are included in all three alternatives (see Appendix D – Mitigation Schematics for location of mitigation solution designation):

- **Mitigation Solution A** – The 10 percent AEP model predicted flooding at the intersection of S. Broom Street and W. Doty Street because of insufficient downstream capacity in the S. Broom Street sewer. By upsizing the existing 24-inch sewer to match the downstream 29- by 45-inch elliptical sewer, and evenly distributing the slope between the four pipe segments, the sewer capacity was increased to meet 10 percent AEP design flows (LoS Target #1). Mitigation Solution A is to replace 580 feet of existing 24-inch sewer on S. Broom Street between W. Doty and W. Wilson Streets with 29-inch by 45-inch elliptical sewer.
- **Mitigation Solutions F, G, H and I** – The model predicts flooding at manholes on S. Pinckney Street between E. Doty and E. Wilson Streets during the 1 percent AEP storm. Due to the slope of E. Wilson Street towards the intersection with King Street, the resulting overland flow along the southeastern curb line is projected to flood several buildings along E. Wilson Street. The sewers on S. Pinckney Street were upsized to meet the 1 percent AEP design flows and is projected to mitigate building flooding (LoS Target #3) using the existing invert elevations and alignment. These mitigation solutions include:
    - Replacing 180 feet of existing 15-inch sewer on S. Pinckney Street near the intersection with E. Doty Street with 18-inch sewer.

- Replacing 120 feet of existing 15-inch sewer on S. Pinkney Street between E. Doty and E. Wilson Streets with 21-inch sewer.
- Replacing 40 feet of existing 15-inch sewer on S. Pinckney Street upstream of the intersection with E. Wilson Street with 24-inch sewer.
- Replacing 70 feet of existing 12-inch sewer on S. Pinckney Street downstream of the intersection with E. Wilson Street with 18-inch sewer.

- **Mitigation Solution J** –The sewer immediately downstream of IN5051-057 is undersized causing flooding at IN5051-057 during the 10 percent AEP design storm. Replace 21 feet of 15-inch sewer on S. Hamilton Street upstream of the intersection with W. Wilson and S. Henry Streets with 24-inch sewer. The next two downstream pipes will also need to be upsized. Replace 30 feet of 18-inch sewer and 25 feet if 21-inch sewer with 24-inch pipe.
- **Mitigation Solution L** – Two 12-inch sewers upstream of structure AS5250-005 on E. Wilson Street merge into a single 12-inch sewer, causing downstream capacity constraints that leads to significant flooding in the 1 percent AEP design storm. The model predicts that the overland flow would flood buildings on the southeast side of E. Wilson Street between S. Butler and S. Hancock Streets given their low elevation relative to the adjacent street. Upsizing two downstream sewer segments from 12 inches to 15 inches in diameter increases the capacity and is projected to mitigate building flooding during the 1 percent AEP design storm (LoS Target #3).
- **Mitigation Solution M** – Sewer MI5151-054_IN5151-053 is 12 inches in diameter but the upstream and downstream sewers are 18 inches in diameter. Manhole MI_151-054 surcharges to the ground surface in the existing condition 1 percent AEP design storm, inundating the intersection of S. Hamilton and W. Wilson Streets and contributing to building flooding at the intersection of W. Wilson and S. Broom Streets via overland flow. Replace 70 feet of existing 12-inch sewer on W. Doty Street near the intersection with S. Hamilton Street with 18-inch sewer.

8.2.2 Alternative 1 – Retain Existing Sewers under WSOR and John Nolen Drive

Alternative 1 includes mitigation solutions upstream of the WSOR right-of-way but retains the existing sewers under the WSOR tracks and John Nolen Drive, which is beneficial from a constructability perspective. This alternative meets LoS Targets #1, #2, and #4. One building at 350 W Wilson St. is projected to be at risk for flooding during the 1 percent AEP design storm, so Alternative 1 does not meet LoS #3. Since no outfall improvements are associated with this alternative, flow was redirected from sewers with limited capacity to sewers with excess capacity. As such, additional mitigation solutions to resolve the building flooding would exacerbate downstream flooding relative to the existing condition, hence failing to meet LoS Target #5.

Individual components of Alternative 1 include:

- All common mitigation solutions listed in Section 8.2.1.
- The existing condition 10 percent AEP model predicts flooding at the dead end of S. Hamilton Street because of insufficient downstream capacity while the S. Broom Street outfall pipe has excess

capacity. To improve the hydraulic performance without increasing the capacity of individual sewers near the outfalls, flow was redirected from the sewer on S. Hamilton Street with limited capacity to the sewer on S. Broom Street with excess capacity via a new 560 foot, 36-in sewer on W. Wilson Street **(Mitigation Solution B)**.

- An existing 18-inch pipe on W. Wilson Street, just northeast of the intersection with S. Broom Street, conveys the flow of two catch basins. To accommodate the additional flow from the 36-inch W. Wilson Street diversion sewer, replace 60 feet of existing 18-inch sewer on W. Wilson Street near the intersection with S. Broom Street with a 36-inch sewer. **(Mitigation Solution C)**.
- An existing 24-inch pipe in W. Wilson Street northeast of the S. Hamilton Street intersection, as well as 12-inch and 21-inch pipes in N. Henry Street, were redirected from the S. Hamilton Street sewer to the proposed sewer on W. Wilson Street **(Mitigation Solution D and E)**.

8.2.3 Alternative 2 – Increased Sewer Capacity along S. Hamilton Street

Alternative 2 includes mitigation solutions centered around increasing the capacity of the S. Hamilton Street sewer from the intersection with N. Henry and W. Wilson Streets to the outfall. This mitigation solution would require replacing or paralleling the sewer beneath the WSOR tracks and John Nolen Drive, presenting potential constructability complications.

Individual components of Alternative 2 include:

- All common mitigation solutions listed in Section 8.2.1.
- The existing model predicted flooding on the S. Hamilton Street sewer between the intersection with W. Wilson and N. Henry Streets to the dead end, in both the 10 percent AEP and 1 percent AEP design storms. Due to the road slope towards the dead end, stormwater accumulates near the dead end and causes building flooding. By upsizing the S. Hamilton Street sewer from 21-inch and 24-inch sewers to 672 feet of 36-inch sewer, LoS Targets #1 and #3 are met. Furthermore, this negates the need to redirect flow to a new sewer on W. Wilson Street, as in Alternatives 1 and 3. Due to the steep street grade, additional inlets are likely to be required as well to mitigate flooding **(Mitigation Solution K)**.

8.2.4 Alternative 3 – Increased Sewer Capacity along S. Broom Street

Alternative 3 increases the capacity of the S. Broom Street sewer from the intersection with W. Wilson Street to the outfall and includes the same proposed sewer on W. Wilson Street described in Alternative 1**.** Due to the increased S. Broom Street outfall capacity, additional flow would be able to be redirected from the S. Hamilton Street outfall.

Individual components of Alternative 3 include:

- All common mitigation solutions listed in Section 8.2.1 (from Section 8.2.1).
- **Mitigation Solution B**. Same justification as in Alternative 1.
- **Mitigation Solution C**. Same justification as in Alternative 1.
- **Mitigation Solutions D and E**. Same justification as in Alternative 1.

- Without capacity constraints on the S. Broom Street sewer downstream of the proposed W. Wilson Street sewer, additional flow can be rerouted from S. Hamilton Street **(Mitigation Solution N).**
- In Alternative 1, flooding on S. Broom Street between the intersections with W. Doty Street and W. Wilson Street, caused buildings to flood at the local low point near the intersection of S. Broom and W. Wilson Streets. By upsizing 560 feet of pipe downstream of the W. Wilson Street diversion sewer connection point from a 29-inch by 45-inch horizontal ellipse to a 43-inch by 68-inch horizontal ellipse, the system has enough drainage capacity to prevent building flooding in the area **(Mitigation Solution O)**.
- In Alternative 3, to mitigate excessive stormwater from the intersection of Hamilton, Wilson, and Henry Street, from flowing down the Hamilton Street cul-de-sac, a raised multi-path crossing is included with this solution. The City plans construct a counterflow multi-use path at this intersection. A raised crossing which would have both stormwater and safety benefits.

9.0 SELECTED ALTERNATIVE

Results from each of the three mitigation alternatives were evaluated using the flood mitigation LoS targets with additional consideration for historical flood locations and buildings with lesser projected flooding. The selected alternative is based upon hydraulic performance only, but non-hydraulic constraints are considered in Section 9.2. Costs are prepared by City staff.

9.1 HYDRAULIC COMPARISON

Since all three alternatives were projected to eliminate flooding during the 10 percent AEP design storm (LoS Target #1) and street centerline flooding exceeding 0.2 feet during the 4 percent AEP design storm (LoS Target #2), these were not included mitigation results comparison. Table 9-1 compares the number of model-predicted buildings flooded during the 1 percent AEP design storm (LoS Target #3) and projected flood depths at reported flood locations for both the 1- and 0.2 percent AEP design storms. Alternatives 2 and 3 yield comparable results for all locations apart from reported flood location #3, located at the intersection of W. Wilson Street and S. Broom Street. Without upsizing the S. Broom Street sewer downstream of W. Wilson Street, the lesser conveyance capacity causes more flooding of the intersection.

Table 9-1: Mitigation Results Comparison

	Buildings At Risk for Flooding LoS Target #3	Buildings adjacent to Flooding Depth < 6 inches	Reported Flood Location Projected 1 percent AEP Depth (feet)			Reported Flood Location Projected 0.2 percent AEP Depth (feet)		
			Location 1	Location 2	Location 3	Location 1	Location 2	Location 3
Existing	11	40	0.39	0.51	1.30	0.47	0.64	1.57
Alt. 1	1	18	0	0.17	1.15	0.13	0.34	1.66
Alt. 2	0	7	0	0	0.49	0.07	0.31	1.12
Alt. 3	0	10	0	0	0	0	0	0.58

9.2 OTHER CONSIDERATIONS

The primary non-hydraulic consideration are sewer constructability constraints underneath the WSOR track and John Nolen Drive.

Alternative 1, which does not include any work under the railroad or John Nolen Drive, includes the fewest potential constructability constraints, but also provides the least effective mitigation of flooding. While both Alternative 2 and Alternative 3 include sewer construction under the railroad and John Nolen Drive, the City staff have expressed interest in potentially incorporating a larger S. Broom Street sewer into already planned roadway construction. Since the S. Hamilton Street outfall downstream of the dead end is not within a roadway ROW, incorporating Alternative 2 sewer reconstruction into a future road project is not possible.

9.3 SELECTION SUMMARY

Alternative 3 is recommended. Alternative 3 provides better hydraulic performance compared to Alternative 1 and similar hydraulic results compared to Alternative 2, as well as better constructability considerations, especially if the work can be constructed in conjunction with the planned road construction on S. Broom Street. Schematics and tabular summaries of Alternative 3, and other alternatives, can be reviewed in Appendix D.

9.4 AREAS IN WHICH LOS TARGETS ARE NOT MET

For the selected alternative, all LoS targets are met.

9.5 CITY-WIDE PRIORITY

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.

10.0 ADDITIONAL FIGURES

Figure 10-1: Impervious Areas - Connected vs Disconnected

Figure 10-2: Surface Roughness Values

APPENDIX A: HYDRAULIC MODELING GUIDANCE

MODELING GUIDANCE

Version 2020_07_14 (DRAFT)

Round 3 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 have relative uniformity amongst City models. This guidance document was developed to provide uniformity. Where inputs and assumptions differ from those outlined in this document, the Consultant will be expected to justify and document the differences and reasons for the differences.

The purpose of the watershed modeling is to construct planning-level models of the watershed to identify locations with significant conveyance system deficiencies. The identified solutions will be conceptual solutions, not design-level solutions. Characterization of localized street flooding is not a focus.

City of Madison Flooding Level of Service Goals

1. 10-year design storm event:
    a. No surcharging onto the street for up to the 10-year design storm; water shall be contained within the pipes and structures.
    b. There are locations within the City where low points exist that pond water; these low points are excluded from this goal and will be addressed as streets are redesigned.
    c. For locations limited by known inlet capacity, allow no more than 0.5 feet of water above storm sewer inlet rim.
2. 25-year design storm event:
    a. Centerline of street to remain passable during 25-year design storm with no more than 0.2 feet of water at the centerline.
    b. 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.
3. 100-year design storm event:
    a. No home or business will be flooded during the 100-year design storm.
    b. 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).
    c. Greenway crossings at streets to be served to the 100-year design storm.
4. 500-year design storm event:
    a. Safely convey stormwater; i.e. limited impact on private property
5. Provide flooding solutions that do not negatively impact downstream properties.

Due to the inherent variability and complexity of stormwater conveyance systems, it is understand it may not be practical to meet the above level of service goals in all areas of the City.

Guidance for Solutions

1. 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 1-5 above.
2. Watershed deficiencies will be reviewed, and solutions will be provided up to, the 100-yr design storm.
3. 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.
4. Proposed solutions will be identified for only the publicly owned drainage system.
5. 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 noted, 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.)

Emergency Vehicle Allowable Flood Depths (email from Fleet on 5/12/2020)

1. SUVs – up to 6-inches
2. Large Trucks – up to 3-feet
3. Ambulances, vans, and pick-up trucks – between 6-inches and 3-feet

MODELING PARAMETERS:

Initial model parameters are the following items:

1. Include storm sewers and culvert segments for the trunk line drainage system and major conveyance to that system. Additional conveyance components may be included if felt necessary by the modeler to understand the conveyance system drainage.
2. Inlet capacity will not be included in the model. It is assumed that sufficient inlets are present accommodate stormwater. In areas where there is known chronic flooding that has been reported to Engineering, additional detail may be requested.
3. Incorporate significant 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)
    c. Various data sources have different horizontal and vertical datums, check datum for each data source prior to use.
6. Monitoring Data Time Zone: Different sources of monitoring data use different time zones. Also, some adjust for daylight savings time whereas others do not. When using the monitoring data, check both the time zone and if the data is adjusted for daylight savings time.
7. Monitoring Data Review: Familiarize yourself with the location of the monitoring gage at each site. Also, visit the monitoring site following a rain event to review the site conditions for things that would impact the measurements. For example, is there debris clogging anything?
8. Naming convention
    a. Names are limited to 20 characters where possible. Both PC-SWMM and XP-SWMM can take lengthy names but both indicate shorter is better for avoiding truncating names.
    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) can be removed
        2. Leads with an asset ID that takes up all 20 characters can be shortened to the corresponding assigned ID. For example, IN3350-032_AS3350-007_3350-001 can be changed to 3350-032_3350-001_001
    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. Use the pond name identifier from GT-Viewer combined with a common name. For example, the ponds at Odana Hills Golf Course would be "PD3461-001_OdanaHills"
    ii. Use abbreviation of name if unofficial full name creates a model name longer than 20 characters.

i. Non-City owned infrastructure
    i. Consultant may choose name if consistent naming convention is not created by entity that owns infrastructure
    ii. If Consultant chooses name, all infrastructure owned by another entity shall start with the same few characters. For example, DOT infrastructure could all start with "DOT-" or Fitchburg owned infrastructure could start with "Fit-"

9. 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.

10. Hydrology (SWMM Method with Horton Infiltration) (References: A, B, C, J)
    - 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)
    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 and used for all three sub-areas.
        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. In XP-SWMM, 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.
        vi. In PC-SWMM, indicate the percent being routed to pervious in the subcatchment attribute.
    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]	Maximum Infiltration Volume (in)
A	4.0	1.0	4.0	3.1	
B	2.0	0.5	4.0	4.4	sandy
C	1.0	0.2	4.0	7.0	silty
D	0.5	0.1	4.0	9.9	clayey
Water	0	0	0	0	

[a]For 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).
[b]Use 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. Zero Depression Storage – 25 percent
        vii. Factors for adjusting
            1. Forest – Multiply max and min infiltration rates by 2.
            2. Farmland (row crops) – Multiply max and min infiltration rates by 1.2.
            3. Farmland (close crops) - Multiply max and min infiltration rates by 1.8.
            4. Other land uses – discuss with City staff
        viii. Area-weight the Horton Infiltration parameters for each subcatchment based on the area of each soil type within a subcatchment. Remove impervious area from area-weighting.
        ix. 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.

d. Evaporation: Turn off evaporation from calibration and design storm event runs.

11. 1D Hydraulics (References: A, B, D, E, F, G)
    - 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: Trunk line and major conveyance components to trunk line.
            2. Process for Exceptions: Provide justification for conveyance components not included.
            3. Use engineering judgement for inclusion of additional detail beyond this standard.
        ii. Private
            1. Standard: Not included
            2. Process for requiring inclusion of private pipes:
                a. Stormwater management detention facilities providing significant detention
                b. When necessary to understand the functioning of the public system. For example, the West Towne Mall parking lot drainage system.
        iii. Greenways and major surface drainages
        iv. Significant stormwater detention facilities (public and private).
            1. Private systems may be simplified if serving a single site.
            2. Provide justification for detention facilities not included.
    b. Loss Coefficients (see drawing at end of document)
        i. Entry
            1. Culverts – Select Inlet Type based on the Help File or HEC-RAS Hydraulic Reference Manual
            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
            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. 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 Monona: TBD
    iii. Lake Wingra (100-year WSE): 848.0
    iv. Yahara River between Lakes Mendota and Monona: TBD

g. Inlet Clogging Factors
    i. Continuous Slopes
        1. Street slope < 1% - 25% Clogging
        2. Street slope >= 1% - No Clogging
    ii. Sags – 50% Clogging

12. 2D Data (References: A, G, H, I)
    a. Surface Roughness – The average Manning's n may vary by land cover / land use. Referencing TR-55, the following roughness can be used for sheet flow conditions. Choose based on professional judgement and document in the report.
        i. Impervious areas - 0.1
        ii. Turf grass areas - 0.24
        iii. Wooded – 0.4
        iv. Prairie – 0.15
        v. Other – reference TR-55
    b. Channel Roughness: Where the 2D surface experiences channel flow, rather than sheet flow, utilize the Manning's n values for open channels
    c. 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.
    d. Blocked Obstructions – enter roofs as Inactive Areas in XP-SWMM and Obstructions in PC-SWMM
        i. Non-residential – use City impervious area data for roofs
        ii. Residential – use Dane County roof layer
    e. Grid cell/mesh size: Use size that balances model run time and sufficient 2D overland flow detail.
    f. Grid/mesh orientation: Where possible, align grid/mesh with major channel flow direction. If not practical, then use orientation that minimizes run time.

13. Non-Modeling Data
    a. When utilizing XP-SWMM, provide attributed describing the source of data in the representative GIS feature classes

   b. When utilizing PC-SWMM, also add attributes to the entities describing their data sources.

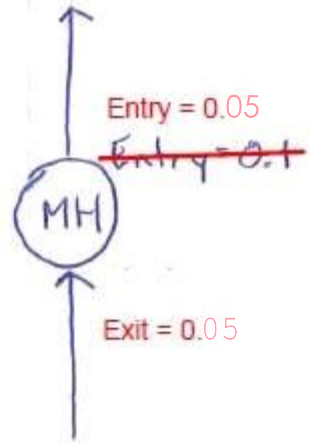
14. Solutions
    a. Analysis – what are the underlying causes of flooding in:
        i. Areas reported in the “Flood Download” from City staff
        ii. Other flooded areas in the modeling not identified in the “Flood Download”
            1. If more than 10 total areas, work with City staff to prioritize locations to evaluate
        iii. City to identify suggested solutions and provide to Consultant for consideration
        iv. Consultant to identify solutions independently and take lead on overall solutions for watershed
    b. Prioritize Solutions
        i. Property Damage
        ii. Major arterials where emergency vehicles cannot get through
        iii. More criteria - TBD
    c. Displaying solutions/Order of solutions
        i. Show each solution independently and then combined
        ii. Order
            1. Property/pipe owned by Stormwater Utility
            2. Pipe size needed to solve remainder of issues
            3. Other public properties
                a. Janet will provide areas where there are non-starters in Parks
            4. Private properties
    d. Overlay TIP map with inundation mapping to understand where immediate future project opportunities are
    e. Freeboard – City does not have a minimum freeboard requirement
    f. Properties adjacent to greenway and new greenway crossings – Current ordinance states property low building opening must be 4’ above invert of downstream greenway street structure crossing. Therefore, may need to make structures wider, instead of deeper, to not flood upstream properties

REFERENCES

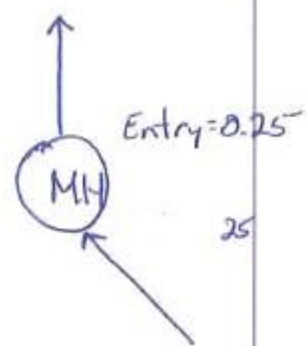
A. Model Help Files and User Forums
B. Storm Water Management Model version 5.1 User’s Manual. (Available at: https://www.epa.gov/water-research/storm-water-management-model-swmm-version-51-users-manual)
C. SWMM reference manual volume I – hydrology (Available at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NYRA.txt)
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)
G. ASCE Two-Dimensional Modeling Using HEC-RAS, Lecture 8 – Troubleshooting and Reviewing, Page 31; 2017.
H. Australian Rainfall & Runoff Revision Projects, Project 15: Two Dimensional Modeling in Urban and Rural Floodplains, November 2012.
I. FLO-2D Reference Manual, FLO-2D Software, 2012.
J. ASCE Manual of Engineering Practice No 28.

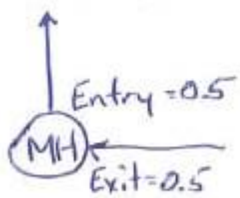
References/Notes

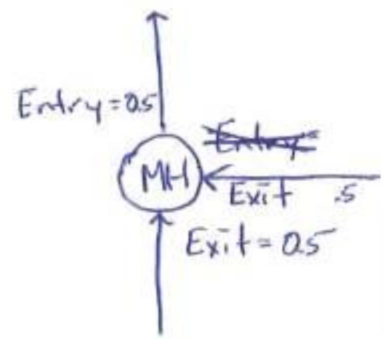
Straight-Through Manhole

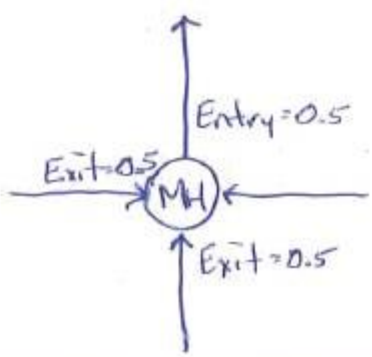


45° Bend Manhole

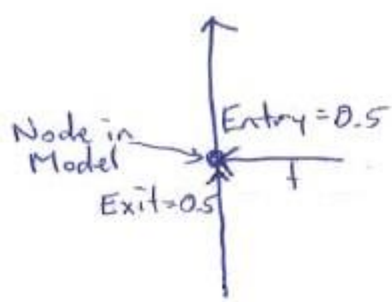








TEE (No Manhole)



APPENDIX B: HYDROLOGIC AND HYDRAULIC INPUT PARAMETERS

Table 1. Link XP-Table Input Data

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Diameter (Height) ft	Bottom Width ft	Special Conduit Shape	Length ft	Shape	Roughness	Entrance Loss	Exit Loss
IN5052-081_AS5052-080	IN5052-081	AS5052-080	848.66	846.28	1.25	1.25		23	Circular	0.013	0.05	0.5
AS5249-051_AS5249-053	AS5249-051	AS5249-053	858.53	848.39	1.67	1.667		104	Circular	0.013	0.25	0.5
AS5249-053_IN5249-086	AS5249-053	IN5249-086	848.39	844.85	3	3		108	Circular	0.013	0.5	0.05
AS5249-056_AS5249-053	AS5249-056	AS5249-053	859.24	848.39	2.25	2.25		95	Circular	0.013	0.5	0.5
AS5249-057_AS5249-056	AS5249-057	AS5249-056	868.6	859.24	2.25	2.25		270	Circular	0.013	0.25	0.25
AS5249-058_AS5249-057	AS5249-058	AS5249-057	869.44	868.6	2.5	2.5	Horizontal Ellipse	19	Special	0.013	0.05	0.25
AS5249-066_AS5249-053	AS5249-066	AS5249-053	849.1	848.39	1.75	1.75		66	Circular	0.013	0.05	0.5
IN5249-071_IN5249-072	IN5249-071	IN5249-072	846.15	844.86	2.5	2.5	Horizontal Ellipse	70	Special	0.013	0.05	0.05
IN5249-072_LKMON	IN5249-072	WilsonStOutfall	844.86	843	2.5	2.5		134	Circular	0.013	0.05	1
IN5249-073_LKMON	IN5249-073	US151Outfall2	844.86	843	1.5	1.5		135	Circular	0.013	0.05	1
AS5249-083_CB5249-088	AS5249-083	CB5249-088	879.8	874.06	2	2		104	Circular	0.013	0.05	0.05
AS5149-047_AS5149-095	AS5149-047	AS5149-095	893.6	889	1.75	1.75		80	Circular	0.013	0.5	0.05
AS5149-048_AS5249-083	AS5149-048	AS5249-083	885.69	879.8	2	2		131	Circular	0.013	0.05	0.05
IN5149-050_IN5149-103	IN5149-050	IN5149-103	909.5	907.35	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5249-086_AE5250-024	IN5249-086	AE5250-024	844.85	843.85	3	3		158	Circular	0.013	0.05	1
CB5249-088_AS5249-090	CB5249-088	AS5249-090	874.06	873.58	2	2		12	Circular	0.013	0.05	0.05
AS5249-090_AS5249-058	AS5249-090	AS5249-058	873.58	869.44	2.5	2.5	Horizontal Ellipse	70	Special	0.013	0.05	0.05
AS5053-032_AE5053-053	AS5053-032	NorthShoreDrOutfall	844.81	844.35	2	2		91	Circular	0.013	0.5	1
AS5051-014_TP5051-016	AS5051-014	TP5051-016	897.77	893.74	1.5	1.5		53	Circular	0.013	0.25	0.05
AS5051-028_CB5051-063	AS5051-028	CB5051-063	860.1	858.89	1.5	1.5		19	Circular	0.013	0.05	0.25
AS5052-037_AS5052-109	AS5052-037	AS5052-109	846.83	846.15	1.75	1.75		16	Circular	0.013	0.05	0.25
AS5150-024_AS5150-025	AS5150-024	AS5150-025	849.56	848.04	1.5	1.5		27	Circular	0.013	0.05	0.5
AS5150-025_AS5151-001	AS5150-025	AS5151-001	848.04	846.84	1.5	1.5		138	Circular	0.013	0.5	0.05
AS5150-028_AS5150-027	AS5150-028	AS5150-027	847.49	846.5	1.5	1.5		52	Circular	0.013	0.25	0.5
IN5150-030_IN5250-003	IN5150-030	IN5250-003	886.6	882.4	1	1		77	Circular	0.013	0.05	0.05
IN5150-044_AS5150-136	IN5150-044	AS5150-136	905.12	902.52	1	1		72	Circular	0.013	0.05	0.5
AS5150-027_AS5150-049	AS5150-049	AS5150-027	879.7	846.5	2	2		90	Circular	0.013	0.5	0.5
AS5150-052_AS5150-049-01	AS5150-052	AS5150-049-01	884.4	880.58	1.75	1.75		125	Circular	0.013	0.25	0.5
AS5150-052_AS5150-049	AS5150-052	AS5150-049	884.4	879.7	1	1		125	Circular	0.013	0.05	0.05
AS5150-057_AS5150-122	AS5150-057	AS5150-122	894.36	894.02	1	1		34	Circular	0.013	0.05	0.5
IN5150-072_AS5150-136	IN5150-072	AS5150-136	905.85	902.52	1	1		50	Circular	0.013	0.05	0.5
IN5250-003_IN5250-004	IN5250-003	IN5250-004	882.4	879.9	1	1		83	Circular	0.013	0.05	0.05
IN5250-004_IN5250-029	IN5250-004	IN5250-029	879.9	876.15	1	1		83	Circular	0.013	0.05	0.05
AS5151-001_AS5151-004	AS5151-001	AS5151-004	846.84	846.16	2.5	2.5		50	Circular	0.013	0.05	0.5
AS5151-004_MI5151-006	AS5151-004	AS5151-038	846.16	846.17	4.417	4.417	Horizontal Ellipse	15	Special	0.013	0.5	0.05
AS5151-008_AS5151-009	AS5151-008	AS5151-009	847.59	845.22	1.75	1.75		45	Circular	0.013	0.05	0.05
AS5151-009_AS5151-034	AS5151-009	AS5151-034	845.22	844.98	1.75	1.75		80	Circular	0.013	0.05	0.5
IN5151-013_AS5051-055	IN5151-013	AS5051-055	858.35	854.6	1.25	1.25		76	Circular	0.013	0.05	0.25
AS5151-019_AS5151-008	AS5151-019	AS5151-008	881.6	847.59	1.25	1.25		230	Circular	0.013	0.5	0.05
AS5151-020_AS5151-019	AS5151-020	AS5151-019	881.72	881.6	1.25	1.25		20	Circular	0.013	0.05	0.5
AS5052-044_MI5052-045	AS5052-044	MI5052-045	852.34	852.3	2	2		13	Circular	0.013	0.5	0.05
IN5052-046_AS5052-044	IN5052-046	AS5052-044	852.81	852.26	2.5	2.5	Horizontal Ellipse	62	Special	0.013	0.5	0.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Diameter (Height) ft	Bottom Width ft	Special Conduit Shape	Length ft	Shape	Roughness	Entrance Loss	Exit Loss
AS5052-047_IN5052-046	AS5052-047	IN5052-046	852.87	852.81	2.5	2.5	Horizontal Ellipse	4	Special	0.013	0.5	0.5
IN5052-049_AS5052-047	IN5052-049	AS5052-047	853.51	852.87	1.917	1.917	Horizontal Ellipse	111	Special	0.013	0.05	0.5
IN5051-034_AS5052-044	IN5051-034	AS5052-044	853.1	852.34	1.917	1.917	Horizontal Ellipse	29	Special	0.013	0.05	0.5
AS5051-038_IN5051-048	AS5051-038	IN5051-048	873.1	865.97	1.5	1.5		144	Circular	0.013	0.05	0.05
AS5051-039_AS5051-038	AS5051-039	AS5051-038	875.85	873.1	1.5	1.5		47	Circular	0.013	0.05	0.05
IN5051-048_IN5051-049	IN5051-048	IN5051-049	865.97	860.6	1.5	1.5		97	Circular	0.013	0.05	0.05
IN5051-049_AS5051-050	IN5051-049	AS5051-050	860.6	859.8	1.25	1.25		38	Circular	0.013	0.05	0.5
AS5051-050_AS5051-055	AS5051-050	AS5051-055	859.8	854.6	1.75	1.75		25	Circular	0.013	0.25	0.05
IN5051-052_IN5051-083	IN5051-052	IN5051-083	861.66	860.09	1	1		42	Circular	0.013	0.05	0.25
AS5053-049_AS5053-032	AS5053-049	AS5053-032	845.54	844.81	1.5	1.5		47	Circular	0.013	0.05	0.5
IN5053-054_AS5053-032	IN5053-054	AS5053-032	845.17	844.81	1.75	1.75		72	Circular	0.013	0.5	0.5
IN5053-056_IN5053-054	IN5053-056	IN5053-054	845.33	845.17	1.5	1.5		60	Circular	0.013	0.05	0.5
IN5053-057_IN5053-054	IN5053-057	IN5053-054	845.87	845.17	1.5	1.5		15	Circular	0.013	0.05	0.5
AS5052-061_IN5053-056	AS5052-061	IN5053-056	845.61	845.33	1.5	1.5		100	Circular	0.013	0.05	0.05
IN5052-062_AS5052-061	IN5052-062	AS5052-061	845.84	845.61	1.5	1.5		47	Circular	0.013	0.5	0.05
IN5052-063_IN5052-1111	IN5052-063	IN5052-111	846.07	845.97	1.5	1.5		45	Circular	0.013	0.05	0.05
IN5152-009_IN5152-010	IN5152-009	IN5152-010	844.51	844.3	1.75	1.75		35	Circular	0.013	0.05	0.05
IN5152-010_AS5152-014	IN5152-010	AS5152-014	844.3	844.27	1.75	1.75		5	Circular	0.013	0.05	0.05
IN5152-011_IN5152-012	IN5152-011	IN5152-012	844.22	844.05	1.75	1.75		35	Circular	0.013	0.05	0.05
IN5152-012_AE5152-013	IN5152-012	HamiltonStOutfall	844.05	843.6	1.75	1.75		90	Circular	0.013	0.05	1
AS5152-014_IN5152-011	AS5152-014	IN5152-011	844.27	844.22	1.75	1.75		10	Circular	0.013	0.05	0.05
IN5152-015_IN5152-016	IN5152-015	IN5152-016	846.35	846.17	1.5	1.5		36	Circular	0.013	0.05	0.5
IN5152-016_IN5152-018	IN5152-016	IN5152-018	846.17	845.14	1.5	1.5		156	Circular	0.013	0.5	0.5
IN5152-018_IN5152-019	IN5152-018	IN5152-019	845.14	845.1	1.75	1.75		7	Circular	0.013	0.5	0.05
IN5152-019_IN5152-020	IN5152-019	IN5152-020	845.1	844.91	1.75	1.75		37	Circular	0.013	0.05	0.05
IN5152-020_AE5152-021	IN5152-020	HenryStOutfall	844.91	844.35	1.75	1.75		112	Circular	0.013	0.05	1
AS5151-025_TP5151-042	AS5151-025	TP5151-042	844.15	844.05	3	6		32	Rectangular	0.013	0.5	0.5
IN5151-026_IN5151-030	IN5151-026	IN5151-030	845.22	844.88	1.5	1.5		15	Circular	0.013	0.05	0.5
IN5151-027_IN5151-031	IN5151-027	IN5151-031	844.55	844.75	1.5	1.5		15	Circular	0.013	0.05	0.5
IN5151-028_AS5151-032	IN5151-028	AS5151-032	844.6	844.55	1.75	1.75		7	Circular	0.013	0.05	0.5
IN5151-029_IN5151-028	IN5151-029	IN5151-028	844.64	844.6	1.75	1.75		5	Circular	0.013	0.05	0.05
IN5151-030_IN5151-029	IN5151-030	IN5151-029	844.88	844.64	1.75	1.75		40	Circular	0.013	0.5	0.05
IN5151-031_AS5151-032	IN5151-031	AS5151-032	844.75	844.55	1.75	1.75		32	Circular	0.013	0.5	0.5
AS5151-032_AS5151-025	AS5151-032	AS5151-025	844.55	844.15	3	6		133	Rectangular	0.013	0.5	0.5
AS5151-034_AS5151-032	AS5151-034	AS5151-032	844.95	844.55	3	6		135	Rectangular	0.013	0.5	0.5
AS5151-035_AS5151-034	AS5151-035	AS5151-034	844.98	844.95	5	5	Horizontal Ellipse	10	Special	0.013	0.05	0.5
AS5151-037_AS5151-035	AS5151-037	AS5151-035	845.93	844.98	5	5	Horizontal Ellipse	317	Special	0.013	0.5	0.05
AS5151-038_AS5151-037	AS5151-038	AS5151-037	846.17	845.93	5	5	Horizontal Ellipse	80	Special	0.013	0.05	0.5
IN5250-009_AS5250-026	IN5250-009	AS5250-026	844.35	843.97	3.75	3.75	Horizontal Ellipse	108	Special	0.013	0.05	0.5
AS5250-010_IN5250-009	AS5250-010	IN5250-009	844.51	844.35	3.75	3.75	Horizontal Ellipse	108	Special	0.013	0.5	0.05
AS5250-011_AS5250-010	AS5250-011	AS5250-010	844.74	844.51	3.75	3.75	Horizontal Ellipse	46	Special	0.013	0.5	0.5
AS5150-076_AS5250-011	AS5150-076	AS5250-011	844.97	844.74	3.75	3.75	Horizontal Ellipse	47	Special	0.013	0.05	0.5
IN5250-012_AS5250-011	IN5250-012	AS5250-011	845.07	844.74	1.5	1.5		33	Circular	0.013	0.05	0.5
AS5150-077_AS5150-076	AS5150-077	AS5150-076	845.14	844.97	2	2		54	Circular	0.013	0.05	0.5
AS5150-079_AS5150-076	AS5150-079	AS5150-076	845.34	844.97	2.5	2.5		74	Circular	0.013	0.5	0.5
IN5250-013_AS5250-011	IN5250-013	AS5250-011	844.81	844.74	1.75	1.75		7	Circular	0.013	0.05	0.5

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Diameter (Height) ft	Bottom Width ft	Special Conduit Shape	Length ft	Shape	Roughness	Entrance Loss	Exit Loss
IN5250-014_IN5250-013	IN5250-014	IN5250-013	845.13	844.81	1.5	1.5		6	Circular	0.013	0.05	0.05
IN5150-080_IN5250-014	IN5150-080	IN5250-014	845.62	845.13	1.5	1.5		40	Circular	0.013	0.05	0.05
IN5250-017_IN5250-018	IN5250-017	IN5250-018	845.77	844.83	1.5	1.5		55	Circular	0.013	0.05	0.5
IN5250-018_AE5250-019	IN5250-018	AE5250-019	844.83	844.1	2	2		73	Circular	0.013	0.5	1
IN5250-020_IN5250-018	IN5250-020	IN5250-018	845.44	844.83	1.75	1.75		44	Circular	0.013	0.05	0.5
IN5250-021_IN5250-020	IN5250-021	IN5250-020	845.78	845.44	1.75	1.75		43	Circular	0.013	0.05	0.05
AS5052-073_AE5052-075	AS5052-073	BroomStOutfall	845.12	844.35	3.75	3.75	Horizontal Ellipse	91	Special	0.013	0.25	1
AS5052-074_AS5052-073	AS5052-074	AS5052-073	845.66	845.12	3.75	3.75	Horizontal Ellipse	82	Special	0.013	0.25	0.25
AS5052-078_AS5052-074	AS5052-078	AS5052-074	845.93	845.68	3.75	3.75	Horizontal Ellipse	62	Special	0.013	0.05	0.25
AS5052-080_AS5052-078	AS5052-080	AS5052-078	846.28	845.93	3.75	3.75	Horizontal Ellipse	70	Special	0.013	0.5	0.05
IN5052-082_AS5052-080	IN5052-082	AS5052-080	848.51	846.28	1.5	1.5		35	Circular	0.013	0.05	0.5
AS5052-083_AS5052-080	AS5052-083	AS5052-080	847.42	846.28	3.75	3.75	Horizontal Ellipse	100	Special	0.013	0.05	0.5
AS5052-085_AS5052-083	AS5052-085	AS5052-083	848.23	847.4	3.75	3.75	Horizontal Ellipse	77	Special	0.013	0.05	0.05
AS5052-087_AS5052-085	AS5052-087	AS5052-085	849.47	848.25	3.75	3.75	Horizontal Ellipse	77	Special	0.013	0.5	0.05
IN5052-088_AS5052-087	IN5052-088	AS5052-087	852.04	850.37	1.25	1.25		50	Circular	0.013	0.25	0.5
IN5052-089_IN5052-088	IN5052-089	IN5052-088	852.2	852.06	1	1		27	Circular	0.013	0.05	0.25
IN5052-090_AS5052-087	IN5052-090	AS5052-087	851.58	849.51	1.5	1.5		60	Circular	0.013	0.5	0.5
IN5052-091_IN5052-090	IN5052-091	IN5052-090	851.64	851.64	1.25	1.25		7	Circular	0.013	0.05	0.5
IN5052-092_IN5052-091	IN5052-092	IN5052-091	852.11	851.66	1.25	1.25		19	Circular	0.013	0.05	0.05
IN5052-093_IN5052-090	IN5052-093	IN5052-090	852.01	851.62	1.25	1.25		26	Circular	0.013	0.05	0.5
AS5052-094_AS5052-087	AS5052-094	AS5052-087	850.77	849.59	2	2		84	Circular	0.013	0.5	0.5
IN5052-096_AS5052-094	IN5052-096	AS5052-094	852.2	850.55	1.25	1.25		45	Circular	0.013	0.05	0.5
5052-097_5052-094_001	IN5052-097	AS5052-094-01	852.7	850.55	1	1		55	Circular	0.013	0.05	0.5
AS5051-053_AS5051-054	AS5051-053	AS5051-054	888.94	878.42	1.25	1.25		115	Circular	0.013	0.05	0.05
AS5051-054_IN5051-057	AS5051-054	IN5051-057	878.22	863.22	1.25	1.25		206	Circular	0.013	0.05	0.05
AS5051-055_AS5051-056	AS5051-055	AS5051-056	854.6	853.1	2	2		46	Circular	0.013	0.05	0.25
AS5052-106_AS5052-037	AS5052-106	AS5052-037	847.01	846.83	2.25	2.25		31	Circular	0.013	0.05	0.05
AS5052-107_AS5052-106	AS5052-107	AS5052-106	850.82	847.01	2	2		160	Circular	0.013	0.05	0.25
AS5051-056_AS5051-069	AS5051-056	AS5051-069	853.1	851.87	2	2		66	Circular	0.013	0.25	0.05
SS5151-041_TP5151-043	SS5151-041	TP5151-043	843.85	843.76	3	3		10	Circular	0.013	0.5	0.5
SS5250-025_AS5250-027	SS5250-025	AS5250-027	844.1	843.75	3	3		10	Circular	0.013	0.5	0.5
AS5250-026_AS5250-027	AS5250-026	AS5250-027	844.11	845.3	3.75	3.75	Horizontal Ellipse	8	Special	0.013	0.5	0.5
AS5250-026_SS5250-025	AS5250-026	SS5250-025	844.36	844.1	3	3		10	Circular	0.013	0.5	0.5
AS5250-027_LKMON	AS5250-027	PinckneyStOutfall	843.75	843.12	3.75	3.75	Horizontal Ellipse	66	Special	0.013	0.5	1
AS5052-109_IN5152-009	AS5052-109	IN5152-009	846.15	844.51	1.75	1.75		86	Circular	0.013	0.25	0.05
IN5051-057_MI5051-002	IN5051-057	MI5051-002	863.22	860.75	1.25	1.25		206	Circular	0.013	0.05	0.05
CB5051-063_IN5051-064	CB5051-063	IN5051-064	858.89	854.25	1.5	1.5		218	Circular	0.013	0.25	0.05
IN5051-064_AS5052-044	IN5051-064	AS5052-044	854.25	852.34	1.75	1.75		89	Circular	0.013	0.05	0.5
AS5051-068_AS5052-107	AS5051-068	AS5052-107	851.7	850.82	2	2		110	Circular	0.013	0.05	0.05
AS5051-069_AS5051-068	AS5051-069	AS5051-068	851.87	851.7	2	2		28	Circular	0.013	0.05	0.05
AS5150-091_AS5150-087	AS5150-091	AS5150-087	897.48	894.62	2.5	2.5		38	Circular	0.013	0.05	0.05
AS5150-094_AS5150-091	AS5150-094	AS5150-091	904.44	897.48	2.5	2.5		173	Circular	0.013	0.05	0.05
AS5150-099_AS5150-094	AS5150-099	AS5150-094	907.48	904.44	2.5	2.5		157	Circular	0.013	0.05	0.05
AS5150-103_AS5150-099	AS5150-103	AS5150-099	909.28	907.48	2.5	2.5		104	Circular	0.013	0.5	0.05
IN5150-106_AS5150-103	IN5150-106	AS5150-103	910.7	909.28	2	2		33	Circular	0.013	0.25	0.5
AS5051-076_AS5051-014	AS5051-076	AS5051-014	898.79	897.77	1.25	1.25		45	Circular	0.013	0.05	0.05

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Diameter (Height) ft	Bottom Width ft	Special Conduit Shape	Length ft	Shape	Roughness	Entrance Loss	Exit Loss
AS5151-050_AS5051-014	AS5151-050	AS5051-014	897.74	897.77	1.5	1.5		28	Circular	0.013	0.25	0.25
AS5151-052_AS5151-050_1	AS5151-052	AS5151-050	898.53	897.74	1	1		35	Circular	0.013	0.25	0.25
IN5151-053_AS5151-052	IN5151-053	AS5151-052	899.33	898.53	1.5	1.5		41	Circular	0.013	0.05	0.25
AS5151-056_AS5151-079	AS5151-056	AS5151-079	885.07	883.88	1.5	1.5		28	Circular	0.013	0.05	0.25
IN5149-091_IN5149-049	IN5149-091	IN5149-049	898.29	897.56	1.5	1.5		15	Circular	0.013	0.05	0.05
IN5149-049_AS5149-047	IN5149-049	AS5149-047	897.56	893.6	1.5	1.5		101	Circular	0.013	0.5	0.5
IN5149-098_IN5149-091	IN5149-098	IN5149-091	901.9	898.29	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-099_IN5149-098	IN5149-099	IN5149-098	903	901.9	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-100_IN5149-099	IN5149-100	IN5149-099	904.44	903	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-101_IN5149-100	IN5149-101	IN5149-100	905.34	904.44	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-102_IN5149-101	IN5149-102	IN5149-101	906.29	905.34	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-103_IN5149-102	IN5149-103	IN5149-102	907.35	906.29	1.5	1.5		295	Circular	0.013	0.05	0.05
IN5149-051_IN5149-050	IN5149-051	IN5149-050	912.75	909.5	1.5	1.5		82	Circular	0.013	0.05	0.05
IN5150-110_MI5150-112	IN5150-110	MI5150-112	900.74	898.94	1	1		35	Circular	0.013	0.05	0.05
IN5150-111_AS5150-113	IN5150-111	AS5150-113	898.94	896.2	1	1		63	Circular	0.013	0.05	0.5
IN5150-114_AS5150-113_2	IN5150-114	AS5150-113	896.2	896.2	0.67	0.667		15	Circular	0.013	0.05	0.5
IN5150-115_IN5150-114	IN5150-115	IN5150-114	896.51	896.2	1.25	1.25		61	Circular	0.013	0.5	0.05
IN5150-116_IN5150-115	IN5150-116	IN5150-115	897.2	896.51	1	1		44	Circular	0.013	0.5	0.5
IN5150-117_IN5150-116	IN5150-117	IN5150-116	899.9	897.2	0.83	0.833		61	Circular	0.013	0.05	0.5
IN5052-1111_IN5052-062	IN5052-111	IN5052-062	845.97	845.84	1.5	1.5		45	Circular	0.013	0.05	0.5
IN5150-046_IN5150-110	IN5150-046	IN5150-110	904.2	900.2	1	1		111	Circular	0.013	0.05	0.05
IN5150-124_IN5150-125	IN5150-124	IN5150-125	887.8	883.75	1.5	1.5		7	Circular	0.013	0.05	0.5
5150-125_5150-049_001	IN5150-125	AS5150-049-01	883.75	880.58	1.5	1.5		5	Circular	0.013	0.5	0.5
IN5250-006_AS5250-005	IN5250-006	AS5250-005	879	875.66	1	1		40	Circular	0.013	0.25	0.25
IN5250-028_AS5249-057	IN5250-028	AS5249-057	871.68	868.6	1	1		65	Circular	0.013	0.05	0.05
IN5250-029_AS5250-005	IN5250-029	AS5250-005	876.15	875.66	1	1		15	Circular	0.013	0.05	0.25
IN5151-062_MI5151-054	IN5151-062	MI5151-054	900.73	900.67	1.5	1.5		28	Circular	0.013	0.05	0.05
IN5151-063_IN5151-062	IN5151-063	IN5151-062	901.88	900.73	1.5	1.5		62	Circular	0.013	0.05	0.05
IN5150-133_AS5150-023	IN5150-133	AS5150-023	893	892.52	2.5	2.5		19	Circular	0.013	0.5	0.05
IN5150-133_AS5150-135	IN5150-133	AS5150-135	893	895.69	2	2		54	Circular	0.013	0.05	0.5
AS5149-095_AS5149-048	AS5149-095	AS5149-048	889	885.69	1.75	1.75		58	Circular	0.013	0.05	0.05
AS5249-092_AS5249-050	AS5249-092	AS5249-051	862.57	858.53	0.67	0.667		104	Circular	0.013	0.25	0.25
AS5249-093_AS5249-092	AS5249-093	AS5249-092	866.19	862.57	1.5	1.5		56	Circular	0.013	0.05	0.25
AS5249-094_AS5249-093	AS5249-094	AS5249-093	866.24	866.19	1.5	1.5		40	Circular	0.013	0.05	0.05
AS5150-113_AS5149-047	AS5150-113	AS5149-047	896.2	893.6	1.25	1.25		50	Circular	0.013	0.5	0.5
AS5150-122_AS5150-052	AS5150-122	AS5150-052	894.02	884.4	1	1		67	Circular	0.013	0.5	0.25
AS5250-005_IN5250-028	AS5250-005	IN5250-028	875.66	871.68	1	1		55	Circular	0.013	0.25	0.25
AS5150-128_IN5150-106	AS5150-128	IN5150-106	910.76	910.7	2	2		20	Circular	0.013	0.05	0.25
AS5150-129_AS5150-103	AS5150-129	AS5150-103	910.49	909.28	2.5	2.5	Horizontal Ellipse	25	Special	0.013	0.05	0.5
AS5150-087_IN5150-133	AS5150-087	IN5150-133	894.62	893	2.5	2.5		29	Circular	0.013	0.05	0.5
AS5150-023_AS5150-134	AS5150-023	AS5150-134	892.52	891.97	3	3		87	Circular	0.013	0.05	0.5
AS5150-134_AS5151-064	AS5150-134	AS5151-064	891.97	891	3	3		53	Circular	0.013	0.5	0.5
AS5151-064_AS5151-065	AS5151-064	AS5151-065	891	885.4	3	3		99	Circular	0.013	0.5	0.25
AS5151-065_ND5151-066	AS5151-065	ND5151-066	885.4	885.3	3	3		12	Circular	0.013	0.25	0.25
ND5151-066_AS5151-004	ND5151-066	AS5151-004	885.3	846.16	2	2		25	Circular	0.013	0.25	0.5
MI5051-002_AS5051-050	MI5051-002	AS5051-050	860.65	859.8	1.5	1.5		30	Circular	0.013	0.05	0.25

Name	Upstream Node Name	Downstream Node Name	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Diameter (Height) ft	Bottom Width ft	Special Conduit Shape	Length ft	Shape	Roughness	Entrance Loss	Exit Loss
TP5051-016_AS5051-053	TP5051-016	AS5051-053	893.74	888.99	1.25	1.25		46	Circular	0.013	0.05	0.05
MI5052-045_AS5052-094-01	MI5052-045	AS5052-094-01	852.3	851.55	2	2		247	Circular	0.013	0.05	0.5
PL5151-039_AS5151-037	PL5151-039	AS5151-037	846.15	845.93	1.5	1.5		44	Circular	0.013	0.05	0.5
PL5151-040_AS5150-077	PL5151-040	AS5150-077	846.19	845.14	1.75	1.75		350	Circular	0.013	0.05	0.05
TP5151-042_TP5151-043	TP5151-042	TP5151-043	845.08	843.76	3	6		8	Rectangular	0.013	0.5	0.5
TP5151-042_SS5151-041	TP5151-042	SS5151-041	845.08	843.85	3	3		10	Circular	0.013	0.5	0.5
TP5151-043_LKMON	TP5151-043	US151Outfall	843.76	843.24	3	6		108	Rectangular	0.013	0.5	1
MI5151-054_IN5151-053	MI5151-054	IN5151-053	899.88	899.33	1	1		65	Circular	0.013	0.05	0.05
IN5151-067_IN5151-013	IN5151-067	IN5151-013	858.45	858.35	1.25	1.25		17	Circular	0.013	0.05	0.05
IN5051-083_AS5051-050	IN5051-083	AS5051-050	859.93	859.69	1	1		35	Circular	0.013	0.25	0.5
IN5151-068_MI5151-069	IN5151-068	MI5151-069	863.23	862.88	1	1		15	Circular	0.013	0.05	0.25
MI5151-069_AS5051-050	MI5151-069	AS5051-050	862.88	859.8	1	1		60	Circular	0.013	0.25	0.25
IN5151-070_AS5051-056	IN5151-070	AS5051-056	855.2	852.3	2	2		89	Circular	0.013	0.05	0.25
AS5151-071_IN5151-070	AS5151-071	IN5151-070	863.14	855.26	2	2		194	Circular	0.013	0.05	0.05
AS5151-073_AS5151-071	AS5151-073	AS5151-071	870.56	863.17	2	2		145	Circular	0.013	0.05	0.05
AS5151-076_AS5151-073	AS5151-076	AS5151-073	874.69	870.63	2	2		110	Circular	0.013	0.05	0.05
AS5151-079_AS5151-076	AS5151-079	AS5151-076	878.81	874.69	2	2		120	Circular	0.013	0.25	0.05
AS5151-080_AS5151-079	AS5151-080	AS5151-079	883.41	878.86	2	2		74	Circular	0.013	0.5	0.25
IN5151-081_AS5151-080	IN5151-081	AS5151-080	885.19	884.65	1	1		10	Circular	0.013	0.5	0.5
IN5151-082_AS5151-080	IN5151-082	AS5151-080	883.83	883.58	1	1		24	Circular	0.013	0.5	0.5
IN5151-083_IN5151-082	IN5151-083	IN5151-082	886.68	883.86	1	1		22	Circular	0.013	0.5	0.5
AS5151-084_AS5151-080	AS5151-084	AS5151-080	885.93	883.43	2	2		70	Circular	0.013	0.05	0.5
AS5150-135_AS5151-084	AS5150-135	AS5151-084	895.61	886.09	2	2		263	Circular	0.013	0.05	0.05
AS5150-136_AS5150-138	AS5150-136	AS5150-138	902.52	901.95	1.25	1.25		27	Circular	0.013	0.5	0.25
IN5150-137_AS5150-136	IN5150-137	AS5150-136	904.03	902.77	1	1		27	Circular	0.013	0.05	0.5
AS5150-138_IN5150-139	AS5150-138	IN5150-139	901.95	899.96	1.25	1.25		70	Circular	0.013	0.25	0.05
IN5150-139_IN5150-140	IN5150-139	IN5150-140	899.96	897.75	1.25	1.25		84	Circular	0.013	0.05	0.5
IN5150-140_IN5150-142	IN5150-140	IN5150-142	897.75	894.78	1.25	1.25		115	Circular	0.013	0.5	0.5
IN5150-141_IN5150-140	IN5150-141	IN5150-140	898.51	898	1	1		54	Circular	0.013	0.05	0.5
IN5150-142_AS5150-143	IN5150-142	AS5150-143	894.78	894.49	1.25	1.25		16	Circular	0.013	0.5	0.05
AS5150-143_AS5150-122	AS5150-143	AS5150-122	894.24	894.02	1.5	1.5		24	Circular	0.013	0.05	0.5
IN5150-144_IN5150-142	IN5150-144	IN5150-142	894.99	894.49	1.25	1.25		46	Circular	0.013	0.5	0.5
IN5150-145_IN5150-144	IN5150-145	IN5150-144	895.67	895.24	1	1		46	Circular	0.013	0.05	0.5
AS5150-146_IN5150-144	AS5150-146	IN5150-144	895.3	895.24	1	1		36	Circular	0.013	0.25	0.5
AS5150-147_AS5150-146	AS5150-147	AS5150-146	895.39	895.3	1	1		72	Circular	0.013	0.25	0.25
AS5150-148_AS5150-147	AS5150-148	AS5150-147	895.65	895.45	1	1		83	Circular	0.013	0.05	0.25
AS5052-094-01_AS5052-094	AS5052-094-01	AS5052-094	851.55	850.78	2	2		247	Circular	0.013	0.5	0.5
AS5150-049-01_AS5150-049	AS5150-049-01	AS5150-049	880.58	879.7	1.75	1.75		125	Circular	0.013	0.5	0.05
MI5150-112_IN5150-111	MI5150-112	IN5150-111	898.94	898.94	1	1		16	Circular	0.013	0.05	0.05
IN5052-081-01_IN5052-081	IN5052-081-01	IN5052-081	849.17	848.66	1.17	1.917		23	Rectangular	0.013	0.05	0.05

Table 2. Node XP-Table Input Data

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
AS5249-051	1	AS5249-051	858.53	863.87	1.176	0.038	100	15.401	Type 1, Free Outfall	0
AS5249-051	2				1.041	0.038	100	15.401		
AS5249-051	3				0.82	0.038	0	15.401		
AS5249-053	1	AS5249-053	848.39	854.77	0.121	0.044	100	13.699	Type 1, Free Outfall	0
AS5249-053	2				0.04	0.044	100	13.699		
AS5249-053	3				0.06	0.044	0	13.699		
AS5249-056	1	AS5249-056	859.24	863.97	0.405	0.029	100	33.591	Type 1, Free Outfall	0
AS5249-056	2				0.031	0.029	100	33.591		
AS5249-056	3				0.033	0.029	0	33.591		
AS5249-057		AS5249-057	868.6	874.04	0	0	0	0	Type 1, Free Outfall	0
AS5249-058	1	AS5249-058	869.44	875.34	0.352	0.047	100	39.008	Type 1, Free Outfall	0
AS5249-058	2				0.098	0.047	100	39.008		
AS5249-058	3				0.068	0.047	0	39.008		
AS5249-066	1	AS5249-066	849.1	854.67	0.009	0.004	100	10	Type 1, Free Outfall	0
AS5249-066	2				0.4	0.004	100	10		
AS5249-066	3				0.135	0.004	0	10		
IN5249-071	1	IN5249-071	846.15	850.29	0.866	0.011	100	37.515	Type 1, Free Outfall	0
IN5249-071	2				0.177	0.011	100	37.515		
IN5249-071	3				0.539	0.011	0	37.515		
IN5249-072	1	IN5249-072	844.86	850.35	0.42	0.006	100	45.074	Type 1, Free Outfall	0
IN5249-072	3				0.162	0.006	0	45.074		
IN5249-073		IN5249-073	844.85	850.88	0	0	0	0	Type 1, Free Outfall	0
AS5249-083	1	AS5249-083	879.8	885.22	0.412	0.019	100	24.956	Type 1, Free Outfall	0
AS5249-083	2				0.986	0.019	100	24.956		
AS5249-083	3				0.234	0.019	0	24.956		
AS5149-047	1	AS5149-047	893.6	899.17	0.33	0.022	100	36.743	Type 1, Free Outfall	0
AS5149-047	2				0.207	0.022	100	36.743		
AS5149-047	3				0.022	0.022	0	36.743		
AS5149-048		AS5149-048	885.69	892.21	0	0	0	0	Type 1, Free Outfall	0
IN5149-050	1	IN5149-050	909.5	913.54	0.059	0.023	100	22.049	Type 1, Free Outfall	0
IN5149-050	2				0.005	0.023	100	22.049		
IN5149-050	3				0.004	0.023	0	22.049		
IN5249-086	1	IN5249-086	844.85	851.5	0.482	0	100	38.91	Type 1, Free Outfall	0
IN5249-086	2				0.786	0	100	38.91		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5249-086	3				0.183	0	0	38.91		
CB5249-088	1	CB5249-088	870.05	878.5	0.019	0.033	100	20.939	Type 1, Free Outfall	0
CB5249-088	3				0.002	0.033	0	20.939		
AS5249-090	1	AS5249-090	873.58	878.23	0.496	0.023	100	33.113	Type 1, Free Outfall	0
AS5249-090	2				0.309	0.023	100	33.113		
AS5249-090	3				0.111	0.023	0	33.113		
AS5053-032	1	AS5053-032	844.81	851.48	0.397	0.006	100	27.461	Type 1, Free Outfall	0
AS5053-032	2				0.002	0.006	100	27.461		
AS5053-032	3				0.047	0.006	0	27.461		
AS5051-014	1	AS5051-014	897.77	902.11	0.495	0.038	100	48.906	Type 1, Free Outfall	0
AS5051-014	2				0.003	0.038	100	48.906		
AS5051-028	1	AS5051-028	860.1	866.44	0.045	0.008	100	10	Type 1, Free Outfall	0
AS5051-028	2				0.161	0.008	100	10		
AS5051-028	3				0.042	0.008	0	10		
AS5052-037	1	AS5052-037	846.83	851.69	0.635	0.024	100	41.005	Type 1, Free Outfall	0
AS5052-037	2				0.269	0.024	100	41.005		
AS5052-037	3				0.195	0.024	0	41.005		
AS5150-024	1	AS5150-024	849.56	883.57	0.09	0.083	100	19.809	Type 1, Free Outfall	0
AS5150-024	2				0.089	0.083	100	19.809		
AS5150-025		AS5150-025	848.04	887.69	0	0	0	0	Type 1, Free Outfall	0
AS5150-027		AS5150-027	846.5	869.88	0	0	0	0	Type 1, Free Outfall	0
AS5150-028	1	AS5150-028	847.49	872.25	0.084	0.022	100	10	Type 1, Free Outfall	0
AS5150-028	2				1.44	0.022	100	10		
AS5150-028	3				0.253	0.022	0	10		
IN5150-030	1	IN5150-030	886.6	889.3	0.214	0.01	100	11.81	Type 1, Free Outfall	0
IN5150-030	2				0.393	0.01	100	11.81		
IN5150-030	3				0.085	0.01	0	11.81		
IN5150-044	1	IN5150-044	905.12	907.4	0.263	0.025	100	12.894	Type 1, Free Outfall	0
IN5150-044	2				0.155	0.025	100	12.894		
IN5150-044	3				0.028	0.025	0	12.894		
AS5150-049	1	AS5150-049	879.7	888.09	0.044	0.004	100	25.644	Type 1, Free Outfall	0
AS5150-052	1	AS5150-052	884.4	897.06	0.708	0.011	100	34.133	Type 1, Free Outfall	0
AS5150-052	2				0.618	0.011	100	34.133		
AS5150-052	3				0.197	0.011	0	34.133		
AS5150-057	1	AS5150-057	889.6	897.32	0.074	0.022	100	10	Type 1, Free Outfall	0
AS5150-057	2				0.042	0.022	100	10		
AS5150-057	3				0.002	0.022	0	10		
IN5150-072	1	IN5150-072	905.85	907.7	0.197	0.025	100	12.048	Type 1, Free Outfall	0

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5150-072	2				1.182	0.025	100	12.048		
IN5150-072	3				0.014	0.025	0	12.048		
IN5250-003	1	IN5250-003	882.4	886.64	0.065	0.041	100	10	Type 1, Free Outfall	0
IN5250-003	2				0.575	0.041	100	10		
IN5250-003	3				0.005	0.041	0	10		
IN5250-004		IN5250-004	879.9	883.5	0	0	0	0	Type 1, Free Outfall	0
AS5151-001		AS5151-001	846.84	884.6	0	0	0	0	Type 1, Free Outfall	0
AS5151-004		AS5151-004	846.16	868.11	0	0	0	0	Type 1, Free Outfall	0
AS5151-008		AS5151-008	847.59	851.75	0	0	0	0	Type 1, Free Outfall	0
AS5151-009		AS5151-009	845.22	850.87	0	0	0	0	Type 1, Free Outfall	0
IN5151-013	1	IN5151-013	858.35	865.48	0.072	0.065	100	13.871	Type 1, Free Outfall	0
IN5151-013	2				0.004	0.065	100	13.871		
AS5151-019	1	AS5151-019	881.6	887.92	0.338	0.038	100	41.194	Type 1, Free Outfall	0
AS5151-019	2				0.302	0.038	100	41.194		
AS5151-019	3				0.07	0.038	0	41.194		
AS5151-020		AS5151-020	881.72	888.5	0	0	0	0	Type 1, Free Outfall	0
AS5052-044		AS5052-044	852	856.4	0	0	0	0	Type 1, Free Outfall	0
IN5052-046	1	IN5052-046	852.81	856.62	0.159	0.011	100	20.679	Type 1, Free Outfall	0
IN5052-046	2				0.226	0.011	100	20.679		
IN5052-046	3				0.17	0.011	0	20.679		
AS5052-047	1	AS5052-047	852.87	856.38	0.322	0.029	100	42.391	Type 1, Free Outfall	0
AS5052-047	2				0.183	0.029	100	42.391		
AS5052-047	3				0.097	0.029	0	42.391		
IN5052-049	1	IN5052-049	853.51	856.4	1.279	0.016	100	21.756	Type 1, Free Outfall	0
IN5052-049	2				2.147	0.016	100	21.756		
IN5052-049	3				1.46	0.016	0	21.756		
IN5051-034	1	IN5051-034	853.1	856.57	1.01	0.046	100	34.38	Type 1, Free Outfall	0
IN5051-034	2				1.161	0.046	100	34.38		
IN5051-034	3				0.649	0.046	0	34.38		
AS5051-038	1	AS5051-038	873.1	879.52	1.017	0.065	100	32.207	Type 1, Free Outfall	0
AS5051-038	2				0.419	0.065	100	32.207		
AS5051-038	3				0.057	0.065	0	32.207		
AS5051-039	1	AS5051-039	875.85	883.62	1.352	0.05	100	37.172	Type 1, Free Outfall	0
AS5051-039	2				0.002	0.05	100	37.172		
AS5051-039	3				0.73	0.05	0	37.172		
IN5051-048	1	IN5051-048	865.97	869.72	0.204	0.1	100	41.564	Type 1, Free Outfall	0
IN5051-048	2				0.127	0.1	100	41.564		
IN5051-048	3				0.24	0.1	0	41.564		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5051-049	1	IN5051-049	860.6	864.47	0.094	0.09	100	20.05	Type 1, Free Outfall	0
IN5051-049	2				0.098	0.09	100	20.05		
IN5051-049	3				0.108	0.09	0	20.05		
AS5051-050		AS5051-050	859	863.82	0	0	0	0	Type 1, Free Outfall	0
IN5051-052	1	IN5051-052	861.66	864.72	0.115	0.052	100	16.275	Type 1, Free Outfall	0
IN5051-052	2				0.015	0.052	100	16.275		
IN5051-052	3				0.056	0.052	0	16.275		
AS5053-049	1	AS5053-049	845.54	852.85	0.081	0.013	100	14.314	Type 1, Free Outfall	0
AS5053-049	3				0.026	0.013	0	14.314		
IN5053-054	3	IN5053-054	845.17	851.1	0.005	0.011	0	0	Type 1, Free Outfall	0
IN5053-056	1	IN5053-056	845.33	851.65	0.035	0	100	20.899	Type 1, Free Outfall	0
IN5053-056	3				0.017	0	0	20.899		
IN5053-057	1	IN5053-057	845.87	851.62	0.183	0	100	36.075	Type 1, Free Outfall	0
IN5053-057	3				0.036	0	0	36.075		
AS5052-061	1	AS5052-061	845.61	851.29	0.442	0.002	100	28.814	Type 1, Free Outfall	0
AS5052-061	3				0.108	0.002	0	28.814		
IN5052-062	1	IN5052-062	845.84	851.11	0.157	0.004	100	34.118	Type 1, Free Outfall	0
IN5052-062	3				0.019	0.004	0	34.118		
IN5052-063	1	IN5052-063	846.07	850.67	0.022	0.013	100	10	Type 1, Free Outfall	0
IN5052-063	2				0.077	0.013	100	10		
IN5052-063	3				0.119	0.013	0	10		
IN5152-009	1	IN5152-009	844.51	850.33	0.208	0.006	100	31.129	Type 1, Free Outfall	0
IN5152-009	2				0.104	0.006	100	31.129		
IN5152-009	3				0.027	0.006	0	31.129		
IN5152-010	1	IN5152-010	844.3	851.13	0.067	0	100	12.139	Type 1, Free Outfall	0
IN5152-010	3				0.044	0	0	12.139		
IN5152-011	1	IN5152-011	844.22	851.72	0.127	0	100	23.013	Type 1, Free Outfall	0
IN5152-011	3				0.029	0	0	23.013		
IN5152-012	1	IN5152-012	844.05	851.96	0.108	0.005	100	13.892	Type 1, Free Outfall	0
IN5152-012	3				0.007	0.005	0	13.892		
AS5152-014		AS5152-014	844.27	851.08	0	0	0	0	Type 1, Free Outfall	0
IN5152-015	1	IN5152-015	846.35	849.65	0.104	0.004	100	10	Type 1, Free Outfall	0
IN5152-015	2				0.165	0.004	100	10		
IN5152-015	3				0.195	0.004	0	10		
IN5152-016	1	IN5152-016	846.17	850.3	0.172	0.009	100	46.334	Type 1, Free Outfall	0
IN5152-016	3				0.022	0.009	0	46.334		
IN5152-018	1	IN5152-018	845.14	851.04	1.091	0.039	100	34.253	Type 1, Free Outfall	0
IN5152-018	2				0.992	0.039	100	34.253		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5152-018	3				0.541	0.039	0	34.253		
IN5152-019	1	IN5152-019	845.1	850.34	0.17	0.006	100	31.213	Type 1, Free Outfall	0
IN5152-019	3				0.075	0.006	0	31.213		
IN5152-020	1	IN5152-020	844.91	850.34	0.274	0.005	100	47.202	Type 1, Free Outfall	0
IN5152-020	3				0.028	0.005	0	47.202		
AS5151-025		AS5151-025	844.15	850.11	0	0	0	0	Type 1, Free Outfall	0
IN5151-026	1	IN5151-026	845.22	849.18	0.332	0.051	100	21.313	Type 1, Free Outfall	0
IN5151-026	2				1.038	0.051	100	21.313		
IN5151-026	3				0.5	0.051	0	21.313		
IN5151-027	1	IN5151-027	844.55	849.63	0.3	0.001	100	58.509	Type 1, Free Outfall	0
IN5151-027	3				0.063	0.001	0	58.509		
IN5151-028	1	IN5151-028	844.6	849.38	0.099	0.006	100	11.712	Type 1, Free Outfall	0
IN5151-028	3				0.068	0.006	0	11.712		
IN5151-029	1	IN5151-029	844.64	849.38	0.102	0.003	100	12.266	Type 1, Free Outfall	0
IN5151-029	3				0.031	0.003	0	12.266		
IN5151-030	1	IN5151-030	844.88	849.1	0.035	0.263	100	11.662	Type 1, Free Outfall	0
IN5151-030	2				0.067	0.263	100	11.662		
IN5151-030	3				0.05	0.263	0	11.662		
IN5151-031	1	IN5151-031	844.75	849.1	0.005	0.02	100	17.142	Type 1, Free Outfall	0
AS5151-032		AS5151-032	844.55	849.63	0	0	0	0	Type 1, Free Outfall	0
AS5151-034	1	AS5151-034	844.95	850.01	2.197	0.001	100	115.843	Type 1, Free Outfall	0
AS5151-034	3				0.105	0.001	0	115.843		
AS5151-035		AS5151-035	844.98	850.04	0	0	0	0	Type 1, Free Outfall	0
AS5151-037		AS5151-037	845.93	873.19	0	0	0	0	Type 1, Free Outfall	0
AS5151-038		AS5151-038	846.17	851.2	0	0	0	0	Type 1, Free Outfall	0
IN5250-009		IN5250-009	843.5	849.76	0	0	0	0	Type 1, Free Outfall	0
AS5250-010	1	AS5250-010	844.51	849.78	0.218	0.015	100	33.211	Type 1, Free Outfall	0
AS5250-010	3				0.095	0.015	0	33.211		
AS5250-011		AS5250-011	844.74	849.63	0	0	0	0	Type 1, Free Outfall	0
AS5150-076		AS5150-076	844.97	849.74	0	0	0	0	Type 1, Free Outfall	0
IN5250-012	1	IN5250-012	845.07	849.1	0.265	0.003	100	26.792	Type 1, Free Outfall	0
IN5250-012	3				0.009	0.003	0	26.792		
AS5150-077	1	AS5150-077	845.14	849.9	1.763	0.028	100	120.06	Type 1, Free Outfall	0
AS5150-077	2				0.112	0.028	100	120.06		
AS5150-077	3				0.046	0.028	0	120.06		
AS5150-079		AS5150-079	845.34	873.07	0	0	0	0	Type 1, Free Outfall	0
IN5250-013	1	IN5250-013	844.81	849.38	0.168	0.01	100	33.273	Type 1, Free Outfall	0
IN5250-014	1	IN5250-014	845.13	849.38	0.194	0.005	100	19.867	Type 1, Free Outfall	0

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5150-080	1	IN5150-080	845.62	849.1	0.197	0.005	100	11.269	Type 1, Free Outfall	0
IN5150-080	2				0.001	0.005	100	11.269		
IN5150-080	3				0.087	0.005	0	11.269		
IN5250-017	1	IN5250-017	845.77	850.36	0.485	0.004	100	29.278	Type 1, Free Outfall	0
IN5250-017	3				0.005	0.004	0	29.278		
IN5250-018	1	IN5250-018	844.83	850.58	0.288	0.003	100	42.526	Type 1, Free Outfall	0
IN5250-018	3				0.019	0.003	0	42.526		
AE5250-019		AE5250-019	844.1	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
IN5250-020	1	IN5250-020	845.44	850.73	0.238	0.005	100	37.954	Type 1, Free Outfall	0
IN5250-021	1	IN5250-021	845.78	850.13	0.283	0.003	100	12.042	Type 1, Free Outfall	0
IN5250-021	2				0.047	0.003	100	12.042		
IN5250-021	3				0.071	0.003	0	12.042		
AE5250-024		AE5250-024	843.85	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
AS5052-073	1	AS5052-073	845.12	853.03	0.384	0.003	100	21.71	Type 1, Free Outfall	0
AS5052-073	2				0.004	0.003	100	21.71		
AS5052-073	3				0.015	0.003	0	21.71		
AS5052-074	1	AS5052-074	845.59	851.96	0.059	0.006	100	23.693	Type 1, Free Outfall	0
AS5052-078	1	AS5052-078	845.93	852.21	0.139	0.005	100	37.228	Type 1, Free Outfall	0
AS5052-078	3				0.012	0.005	0	37.228		
AS5052-080		AS5052-080	846.28	852.44	0	0	0	0	Type 1, Free Outfall	0
IN5052-081	1	IN5052-081	848.66	852.66	0.112	0.03	100	25.424	Type 1, Free Outfall	0
IN5052-081	2				0.052	0.03	100	25.424		
IN5052-081	3				0.032	0.03	0	25.424		
IN5052-082	1	IN5052-082	848.08	852.31	0.317	0.015	100	23.077	Type 1, Free Outfall	0
IN5052-082	2				0.134	0.015	100	23.077		
IN5052-082	3				0.182	0.015	0	23.077		
AS5052-083	1	AS5052-083	847	854.8	0.046	0.041	100	16.969	Type 1, Free Outfall	0
AS5052-083	2				0.043	0.041	100	16.969		
AS5052-083	3				0.017	0.041	0	16.969		
AS5052-085		AS5052-085	848	855.75	0	0	0	0	Type 1, Free Outfall	0
AS5052-087	1	AS5052-087	849	855.87	0.113	0.002	100	24.207	Type 1, Free Outfall	0
AS5052-087	2				0.003	0.002	100	24.207		
AS5052-087	3				0.091	0.002	0	24.207		
IN5052-088	1	IN5052-088	851.26	856.1	0.642	0.018	100	42.15	Type 1, Free Outfall	0
IN5052-088	2				0.529	0.018	100	42.15		
IN5052-088	3				0.752	0.018	0	42.15		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5052-089	1	IN5052-089	851.71	856.53	0.061	0.047	100	10.464	Type 1, Free Outfall	0
IN5052-089	2				0.068	0.047	100	10.464		
IN5052-089	3				0.116	0.047	0	10.464		
IN5052-090	1	IN5052-090	851.09	855.74	0.1	0.024	100	10	Type 1, Free Outfall	0
IN5052-090	2				0.002	0.024	100	10		
IN5052-090	3				0.015	0.024	0	10		
IN5052-091	1	IN5052-091	851.45	855.81	0.01	0.083	100	10	Type 1, Free Outfall	0
IN5052-092	1	IN5052-092	851.77	855.31	0.548	0.007	100	40.539	Type 1, Free Outfall	0
IN5052-092	2				0.278	0.007	100	40.539		
IN5052-092	3				0.347	0.007	0	40.539		
IN5052-093	1	IN5052-093	851.67	855.17	1.238	0.019	100	57.84	Type 1, Free Outfall	0
IN5052-093	2				1.294	0.019	100	57.84		
IN5052-093	3				0.806	0.019	0	57.84		
AS5052-094	1	AS5052-094	850.55	855.53	0.262	0.004	100	34.76	Type 1, Free Outfall	0
AS5052-094	2				0.187	0.004	100	34.76		
AS5052-094	3				0.129	0.004	0	34.76		
IN5052-096	1	IN5052-096	851.96	855.72	0.53	0.022	100	40.487	Type 1, Free Outfall	0
IN5052-096	2				0.534	0.022	100	40.487		
IN5052-096	3				0.576	0.022	0	40.487		
IN5052-097	1	IN5052-097	852.21	856.18	0.254	0.003	100	45.136	Type 1, Free Outfall	0
IN5052-097	2				0.043	0.003	100	45.136		
IN5052-097	3				0.06	0.003	0	45.136		
AS5051-053		AS5051-053	888.94	894.79	0	0	0	0	Type 1, Free Outfall	0
AS5051-054		AS5051-054	878.22	883.57	0	0	0	0	Type 1, Free Outfall	0
AS5051-055		AS5051-055	854.6	862.5	0	0	0	0	Type 1, Free Outfall	0
AS5052-106		AS5052-106	847.01	852	0	0	0	0	Type 1, Free Outfall	0
AS5052-107		AS5052-107	850.82	856	0	0	0	0	Type 1, Free Outfall	0
AS5051-056		AS5051-056	852	860.84	0	0	0	0	Type 1, Free Outfall	0
SS5151-041		SS5151-041	843.85	850.16	0	0	0	0	Type 1, Free Outfall	0
SS5250-025		SS5250-025	844.1	849.86	0	0	0	0	Type 1, Free Outfall	0
AS5250-026		AS5250-026	843.5	849.76	0	0	0	0	Type 1, Free Outfall	0
AS5250-027		AS5250-027	843.75	849.85	0	0	0	0	Type 1, Free Outfall	0
AS5052-109	1	AS5052-109	846.15	851.8	0.007	0.012	100	10	Type 1, Free Outfall	0
AS5052-109	3				0.005	0.012	0	10		
IN5051-057	1	IN5051-057	863.22	866.77	0.155	0.095	100	21.283	Type 1, Free Outfall	0
IN5051-057	2				0.007	0.095	100	21.283		
IN5051-057	3				0.087	0.095	0	21.283		
CB5051-063	1	CB5051-063	856	865.64	1.707	0.027	100	20.895	Type 1, Free Outfall	0

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
CB5051-063	2				0.706	0.027	100	20.895		
CB5051-063	3				0.49	0.027	0	20.895		
IN5051-064	1	IN5051-064	854.25	857.6	0.287	0.089	100	40.921	Type 1, Free Outfall	0
IN5051-064	2				0.769	0.089	100	40.921		
IN5051-064	3				0.375	0.089	0	40.921		
AS5051-068	1	AS5051-068	851.7	858.18	0.28	0.023	100	22.761	Type 1, Free Outfall	0
AS5051-068	3				0.026	0.023	0	22.761		
AS5051-069		AS5051-069	851.87	858.81	0	0	0	0	Type 1, Free Outfall	0
AS5150-091	1	AS5150-091	897.48	903.97	0.667	0.031	100	35.807	Type 1, Free Outfall	0
AS5150-091	2				0.002	0.031	100	35.807		
AS5150-091	3				0.222	0.031	0	35.807		
AS5150-094	1	AS5150-094	904.44	910.45	0.503	0.016	100	41.301	Type 1, Free Outfall	0
AS5150-094	2				0.007	0.016	100	41.301		
AS5150-094	3				0.02	0.016	0	41.301		
AS5150-099	1	AS5150-099	907.48	912.88	0.565	0.008	100	46.486	Type 1, Free Outfall	0
AS5150-099	2				0.089	0.008	100	46.486		
AS5150-099	3				0.001	0.008	0	46.486		
AS5150-103		AS5150-103	909.28	916.03	0	0	0	0	Type 1, Free Outfall	0
IN5150-106	1	IN5150-106	910.7	915.72	0.299	0.014	100	31.208	Type 1, Free Outfall	0
IN5150-106	2				0.227	0.014	100	31.208		
IN5150-106	3				0.003	0.014	0	31.208		
AS5051-076	1	AS5051-076	898.79	904.21	0.766	0.033	100	21.829	Type 1, Free Outfall	0
AS5051-076	2				0.59	0.033	100	21.829		
AS5051-076	3				0.01	0.033	0	21.829		
AS5151-050		AS5151-050	897.74	903	0	0	0	0	Type 1, Free Outfall	0
AS5151-052	1	AS5151-052	898.53	903.53	0.336	0.051	100	43.101	Type 1, Free Outfall	0
AS5151-052	2				0.264	0.051	100	43.101		
IN5151-053	1	IN5151-053	899.33	904.38	0.028	0.06	100	15.944	Type 1, Free Outfall	0
IN5151-053	2				0.053	0.06	100	15.944		
AS5151-056	1	AS5151-056	883.88	887.6	0.603	0.054	100	35.545	Type 1, Free Outfall	0
AS5151-056	2				0.159	0.054	100	35.545		
AS5151-056	3				0.035	0.054	0	35.545		
IN5149-091	1	IN5149-091	898.29	903.57	0.066	0.026	100	22.043	Type 1, Free Outfall	0
IN5149-091	2				0.001	0.026	100	22.043		
IN5149-049	1	IN5149-049	897.56	903.06	0.628	0.023	100	24.441	Type 1, Free Outfall	0
IN5149-049	2				0.741	0.023	100	24.441		
IN5149-049	3				0.061	0.023	0	24.441		
IN5149-098	1	IN5149-098	901.9	906.96	0.018	0.049	100	10	Type 1, Free Outfall	0

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5149-098	2				0.04	0.049	100	10		
IN5149-099	1	IN5149-099	903	907.89	0.027	0.044	100	11.796	Type 1, Free Outfall	0
IN5149-099	2				0.012	0.044	100	11.796		
IN5149-100	1	IN5149-100	904.44	909.14	0.016	0.066	100	11.77	Type 1, Free Outfall	0
IN5149-100	2				0.014	0.066	100	11.77		
IN5149-101	1	IN5149-101	905.34	909.9	0.182	0.033	100	23.323	Type 1, Free Outfall	0
IN5149-101	2				0.16	0.033	100	23.323		
IN5149-101	3				0.002	0.033	0	23.323		
IN5149-102	1	IN5149-102	906.29	910.79	0.02	0.027	100	19.914	Type 1, Free Outfall	0
IN5149-103	1	IN5149-103	907.35	911.89	0.032	0.035	100	26.408	Type 1, Free Outfall	0
IN5149-103	2				0.007	0.035	100	26.408		
IN5149-051	1	IN5149-051	912.75	916.58	2.058	0.01	100	28.381	Type 1, Free Outfall	0
IN5149-051	2				0.488	0.01	100	28.381		
IN5149-051	3				1.803	0.01	0	28.381		
IN5150-110	1	IN5150-110	900	903.85	0.095	0.021	100	16.191	Type 1, Free Outfall	0
IN5150-110	2				0.008	0.021	100	16.191		
IN5150-111	1	IN5150-111	898.94	902.54	0.047	0.033	100	12.357	Type 1, Free Outfall	0
IN5150-111	2				0.056	0.033	100	12.357		
IN5150-114	1	IN5150-114	896.2	900.92	0.052	0.021	100	18.442	Type 1, Free Outfall	0
IN5150-114	2				0.001	0.021	100	18.442		
IN5150-115	1	IN5150-115	896.51	903.04	0.16	0.018	100	27.484	Type 1, Free Outfall	0
IN5150-115	2				0.008	0.018	100	27.484		
IN5150-116		IN5150-116	897.2	903.67	0	0	0	0	Type 1, Free Outfall	0
IN5150-117	1	IN5150-117	899.9	905.1	0.049	0.033	100	10	Type 1, Free Outfall	0
IN5150-117	2				0.211	0.033	100	10		
IN5150-117	3				0.002	0.033	0	10		
IN5052-111	1	IN5052-111	845	850.44	0.245	0.012	100	30.358	Type 1, Free Outfall	0
IN5052-111	2				0.024	0.012	100	30.358		
IN5052-111	3				0.079	0.012	0	30.358		
IN5150-046	1	IN5150-046	904.2	917.38	0.025	0.033	100	6.56	Type 1, Free Outfall	0
IN5150-046	2				0.03	0.033	100	6.56		
IN5150-124	1	IN5150-124	887.8	891	0.135	0.059	100	22.194	Type 1, Free Outfall	0
IN5150-124	2				0.037	0.059	100	22.194		
IN5150-124	3				0.032	0.059	0	22.194		
IN5150-125	1	IN5150-125	883.75	890.31	0.026	0.006	100	10	Type 1, Free Outfall	0
IN5150-125	3				0.001	0.006	0	10		
IN5250-006	1	IN5250-006	878.99	880.16	0.193	0.037	100	21.14	Type 1, Free Outfall	0
IN5250-006	2				0.042	0.037	100	21.14		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5250-028	1	IN5250-028	871.68	876.49	0.576	0.013	100	27.605	Type 1, Free Outfall	0
IN5250-028	2				1.059	0.013	100	27.605		
IN5250-028	3				0.541	0.013	0	27.605		
IN5250-029	1	IN5250-029	876.15	879.61	0.109	0.033	100	18.669	Type 1, Free Outfall	0
IN5250-029	2				0.111	0.033	100	18.669		
IN5151-062	1	IN5151-062	900.73	905.44	0.014	0.01	100	14.072	Type 1, Free Outfall	0
IN5151-062	2				0.015	0.01	100	14.072		
IN5151-063	1	IN5151-063	901.88	905.69	0.977	0.021	100	24.338	Type 1, Free Outfall	0
IN5151-063	2				1.02	0.021	100	24.338		
IN5151-063	3				0.031	0.021	0	24.338		
IN5150-133	1	IN5150-133	893	901.64	0.138	0.001	100	38.215	Type 1, Free Outfall	0
IN5150-133	3				0.01	0.001	0	38.215		
AS5149-095	1	AS5149-095	889	895.12	0.102	0.037	100	25.167	Type 1, Free Outfall	0
AS5149-095	2				0.037	0.037	100	25.167		
AS5249-092		AS5249-092	862.57	866.82	0	0	0	0	Type 1, Free Outfall	0
AS5249-093		AS5249-093	866.19	868.72	0	0	0	0	Type 1, Free Outfall	0
AS5249-094	1	AS5249-094	866.24	870.14	0.457	0.026	100	41.377	Type 1, Free Outfall	0
AS5249-094	2				0.333	0.026	100	41.377		
AS5249-094	3				0.051	0.026	0	41.377		
AS5150-113		AS5150-113	896.2	899.74	0	0	0	0	Type 1, Free Outfall	0
AS5150-122		AS5150-122	894.02	897.78	0	0	0	0	Type 1, Free Outfall	0
AS5250-005		AS5250-005	875.66	879.36	0	0	0	0	Type 1, Free Outfall	0
AS5150-128	1	AS5150-128	910.76	916.83	0.675	0.007	100	65.014	Type 1, Free Outfall	0
AS5150-128	2				0.909	0.007	100	65.014		
AS5150-128	3				0.071	0.007	0	65.014		
AS5150-129	1	AS5150-129	910.49	916.24	0.619	0.012	100	15.442	Type 1, Free Outfall	0
AS5150-129	2				1.284	0.012	100	15.442		
AS5150-129	3				0.869	0.012	0	15.442		
AS5150-087		AS5150-087	894.62	902.09	0	0	0	0	Type 1, Free Outfall	0
AS5150-023	1	AS5150-023	892.52	901.77	0.539	0.038	100	65.638	Type 1, Free Outfall	0
AS5150-023	2				0.481	0.038	100	65.638		
AS5150-023	3				0.111	0.038	0	65.638		
AS5150-134	1	AS5150-134	891.97	901.4	0.254	0.003	100	51.997	Type 1, Free Outfall	0
AS5150-134	2				0.094	0.003	100	51.997		
AS5150-134	3				0.326	0.003	0	51.997		
AS5151-064		AS5151-064	891	897	0	0	0	0	Type 1, Free Outfall	0
AS5151-065	1	AS5151-065	885.4	889.6	0.182	0.038	100	22.143	Type 1, Free Outfall	0
AS5151-065	2				0.162	0.038	100	22.143		

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
AS5151-065	3				0.038	0.038	0	22.143		
ND5151-066		ND5151-066	885.3	888.5	0	0	0	0	Type 1, Free Outfall	0
MI5051-002		MI5051-002	860.65	865.15	0	0	0	0	Type 1, Free Outfall	0
TP5051-016	1	TP5051-016	893.74	898.74	0.399	0.023	100	37.949	Type 1, Free Outfall	0
TP5051-016	2				0.05	0.023	100	37.949		
TP5051-016	3				0.001	0.023	0	37.949		
MI5052-045		MI5052-045	852	856.07	0	0	0	0	Type 1, Free Outfall	0
PL5151-039		PL5151-039	846.15	874.31	0	0	0	0	Type 1, Free Outfall	0
PL5151-040	2	PL5151-040	846.19	874.3	0.127	0.008	100	0	Type 1, Free Outfall	0
PL5151-040	3				1.987	0.008	0	0		
TP5151-042		TP5151-042	844	850.08	0	0	0	0	Type 1, Free Outfall	0
TP5151-043		TP5151-043	843.76	850.26	0	0	0	0	Type 1, Free Outfall	0
MI5151-054		MI5151-054	899.88	904.64	0	0	0	0	Type 1, Free Outfall	0
IN5151-067	1	IN5151-067	858	865.73	0.48	0.056	100	30.611	Type 1, Free Outfall	0
IN5151-067	2				1.131	0.056	100	30.611		
IN5151-067	3				0.06	0.056	0	30.611		
IN5051-083	1	IN5051-083	859.93	862.92	0.053	0.023	100	29.1	Type 1, Free Outfall	0
IN5051-083	3				0.005	0.023	0	29.1		
IN5151-068	1	IN5151-068	863.23	867.23	0.366	0.068	100	34.917	Type 1, Free Outfall	0
IN5151-068	2				0.008	0.068	100	34.917		
MI5151-069		MI5151-069	862.88	865.46	0	0	0	0	Type 1, Free Outfall	0
IN5151-070	1	IN5151-070	855.2	870.73	0.191	0.035	100	38.02	Type 1, Free Outfall	0
IN5151-070	3				0.027	0.035	0	38.02		
AS5151-071	1	AS5151-071	863.14	870.73	0.139	0.045	100	46.539	Type 1, Free Outfall	0
AS5151-071	2				0.013	0.045	100	46.539		
AS5151-071	3				0.01	0.045	0	46.539		
AS5151-073	1	AS5151-073	870.56	877.18	0.39	0.026	100	24.194	Type 1, Free Outfall	0
AS5151-073	2				0.554	0.026	100	24.194		
AS5151-073	3				0.011	0.026	0	24.194		
AS5151-076	1	AS5151-076	874.69	882.07	0.188	0.029	100	38.122	Type 1, Free Outfall	0
AS5151-076	2				0.002	0.029	100	38.122		
AS5151-076	3				0.012	0.029	0	38.122		
AS5151-079		AS5151-079	878.81	886.15	0	0	0	0	Type 1, Free Outfall	0
AS5151-080		AS5151-080	883.41	889.03	0	0	0	0	Type 1, Free Outfall	0
IN5151-081	1	IN5151-081	885.19	889	0.071	0.03	100	22.853	Type 1, Free Outfall	0
IN5151-081	2				0.001	0.03	100	22.853		
IN5151-081	3				0.019	0.03	0	22.853		
IN5151-082	1	IN5151-082	883.83	890.16	0.083	0.052	100	10	Type 1, Free Outfall	0

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
IN5151-082	2				1.199	0.052	100	10		
IN5151-082	3				0.012	0.052	0	10		
IN5151-083	1	IN5151-083	886.68	889.84	0.046	0.047	100	17.542	Type 1, Free Outfall	0
IN5151-083	2				0.017	0.047	100	17.542		
AS5151-084	1	AS5151-084	885.93	891.77	0.626	0.05	100	47.203	Type 1, Free Outfall	0
AS5151-084	2				0.323	0.05	100	47.203		
AS5151-084	3				0.133	0.05	0	47.203		
AS5150-135		AS5150-135	895.61	900.82	0	0	0	0	Type 1, Free Outfall	0
AS5150-136		AS5150-136	902.52	906.72	0	0	0	0	Type 1, Free Outfall	0
IN5150-137	1	IN5150-137	904.03	907.51	0.433	0.015	100	53.991	Type 1, Free Outfall	0
IN5150-137	2				0.593	0.015	100	53.991		
IN5150-137	3				0.162	0.015	0	53.991		
AS5150-138		AS5150-138	901.95	906.57	0	0	0	0	Type 1, Free Outfall	0
IN5150-139	1	IN5150-139	899.96	904.99	0.06	0.023	100	10	Type 1, Free Outfall	0
IN5150-139	2				0.638	0.023	100	10		
IN5150-139	3				0.01	0.023	0	10		
IN5150-140	1	IN5150-140	897.75	902.01	0.056	0.026	100	10	Type 1, Free Outfall	0
IN5150-140	2				0.447	0.026	100	10		
IN5150-140	3				0.013	0.026	0	10		
IN5150-141	1	IN5150-141	898.51	903.03	0.123	0.021	100	10.791	Type 1, Free Outfall	0
IN5150-141	2				0.085	0.021	100	10.791		
IN5150-141	3				0.049	0.021	0	10.791		
IN5150-142	1	IN5150-142	894	898.68	0.118	0.025	100	33.759	Type 1, Free Outfall	0
IN5150-142	2				0.014	0.025	100	33.759		
IN5150-142	3				0.007	0.025	0	33.759		
AS5150-143		AS5150-143	894.24	897.96	0	0	0	0	Type 1, Free Outfall	0
IN5150-144	1	IN5150-144	894.99	898.87	0.205	0.013	100	29.267	Type 1, Free Outfall	0
IN5150-144	2				0.035	0.013	100	29.267		
IN5150-144	3				0.031	0.013	0	29.267		
IN5150-145	1	IN5150-145	895.67	900.19	0.011	0.014	100	5.887	Type 1, Free Outfall	0
IN5150-145	2				0.035	0.014	100	5.887		
AS5150-146		AS5150-146	895.3	899.19	0	0	0	0	Type 1, Free Outfall	0
AS5150-147		AS5150-147	895	900.99	0	0	0	0	Type 1, Free Outfall	0
AS5150-148	1	AS5150-148	895.65	902.15	0.104	0.017	100	14.623	Type 1, Free Outfall	0
AS5150-148	2				0.783	0.017	100	14.623		
AS5150-148	3				0.127	0.017	0	14.623		
NorthShoreDrOutfall		NorthShoreDrOutfall	844.35	848.51	0	0	0	0	Type2, Fixed Backwater	845.62

Name	Subcatchment	Node Name	Invert Elevation ft	Ground Elevation (Spill Crest) ft	Area acres	Slope ft/ft	Impervious Percentage %	Width ft	Type of Outlet Control	Outlet Control Backwater ft
BroomStOutfall		BroomStOutfall	844.35	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
HamiltonStOutfall		HamiltonStOutfall	843.6	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
HenryStOutfall		HenryStOutfall	844.35	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
WilsonStOutfall		WilsonStOutfall	842.99	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
US151Outfall2		US151Outfall2	842.99	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
US151Outfall		US151Outfall	843.23	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
PinckneyStOutfall		PinckneyStOutfall	843.11	848.51	0	0	0	0	Type2, Fixed Backwater	845.62
AS5052-094-01		AS5052-094-01	850.5	855.19	0	0	0	0	Type 1, Free Outfall	0
AS5150-049-01		AS5150-049-01	879.5	889.65	0	0	0	0	Type 1, Free Outfall	0
MI5150-112		MI5150-112	898.94	902.79	0	0	0	0	Type 1, Free Outfall	0
IN5052-081-01	1	IN5052-081-01	848.66	852.66	0.293	0.008	100	15.957	Type 1, Free Outfall	0
IN5052-081-01	2				0.657	0.008	100	15.957		
IN5052-081-01	3				0.912	0.008	0	15.957		

Table 3. Subcatchment XP-Table Input Data

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5249-051	1	1.176	100	0.038	15.401	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-051	2	1.041	100	0.038	15.401	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-051	3	0.82	0	0.038	15.401	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5249-053	1	0.121	100	0.044	13.699	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-053	2	0.04	100	0.044	13.699	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-053	3	0.06	0	0.044	13.699	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5249-056	1	0.405	100	0.029	33.591	10C90D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-056	2	0.031	100	0.029	33.591	10C90D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-056	3	0.033	0	0.029	33.591	10C90D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5249-057		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-058	1	0.352	100	0.047	39.008	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-058	2	0.098	100	0.047	39.008	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-058	3	0.068	0	0.047	39.008	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5249-066	1	0.009	100	0.004	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-066	2	0.4	100	0.004	10	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-066	3	0.135	0	0.004	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5249-071	1	0.866	100	0.011	37.515	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5249-071	2	0.177	100	0.011	37.515	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5249-071	3	0.539	0	0.011	37.515	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5249-072	1	0.42	100	0.006	45.074	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5249-072	3	0.162	0	0.006	45.074	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5249-073		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-083	1	0.412	100	0.019	24.956	10C90D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-083	2	0.986	100	0.019	24.956	10C90D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-083	3	0.234	0	0.019	24.956	10C90D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5149-047	1	0.33	100	0.022	36.743	10B90C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5149-047	2	0.207	100	0.022	36.743	10B90C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5149-047	3	0.022	0	0.022	36.743	10B90C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5149-048		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-050	1	0.059	100	0.023	22.049	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-050	2	0.005	100	0.023	22.049	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-050	3	0.004	0	0.023	22.049	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5249-086	1	0.482	100	0	38.91	20B80D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5249-086	2	0.786	100	0	38.91	20B80D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5249-086	3	0.183	0	0	38.91	20B80D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
CB5249-088	1	0.019	100	0.033	20.939	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
CB5249-088	3	0.002	0	0.033	20.939	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5249-090	1	0.496	100	0.023	33.113	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-090	2	0.309	100	0.023	33.113	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-090	3	0.111	0	0.023	33.113	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5053-032	1	0.397	100	0.006	27.461	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5053-032	2	0.002	100	0.006	27.461	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5053-032	3	0.047	0	0.006	27.461	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-014	1	0.495	100	0.038	48.906	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-014	2	0.003	100	0.038	48.906	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5051-028	1	0.045	100	0.008	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-028	2	0.161	100	0.008	10	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5051-028	3	0.042	0	0.008	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-037	1	0.635	100	0.024	41.005	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-037	2	0.269	100	0.024	41.005	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-037	3	0.195	0	0.024	41.005	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-024	1	0.09	100	0.083	19.809	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-024	2	0.089	100	0.083	19.809	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-025		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-027		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-028	1	0.084	100	0.022	10	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-028	2	1.44	100	0.022	10	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-028	3	0.253	0	0.022	10	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-030	1	0.214	100	0.01	11.81	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-030	2	0.393	100	0.01	11.81	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-030	3	0.085	0	0.01	11.81	No Pervious Area	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-044	1	0.263	100	0.025	12.894	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-044	2	0.155	100	0.025	12.894	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-044	3	0.028	0	0.025	12.894	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-049	1	0.044	100	0.004	25.644	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-052	1	0.708	100	0.011	34.133	90B10D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-052	2	0.618	100	0.011	34.133	90B10D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-052	3	0.197	0	0.011	34.133	90B10D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-057	1	0.074	100	0.022	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-057	2	0.042	100	0.022	10	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-057	3	0.002	0	0.022	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-072	1	0.197	100	0.025	12.048	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-072	2	1.182	100	0.025	12.048	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-072	3	0.014	0	0.025	12.048	No Pervious Area	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-003	1	0.065	100	0.041	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-003	2	0.575	100	0.041	10	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5250-003	3	0.005	0	0.041	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-004		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-001		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-004		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-008		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-009		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-013	1	0.072	100	0.065	13.871	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-013	2	0.004	100	0.065	13.871	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5151-019	1	0.338	100	0.038	41.194	70B30C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-019	2	0.302	100	0.038	41.194	70B30C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-019	3	0.07	0	0.038	41.194	70B30C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-020		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-044		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-046	1	0.159	100	0.011	20.679	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-046	2	0.226	100	0.011	20.679	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-046	3	0.17	0	0.011	20.679	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-047	1	0.322	100	0.029	42.391	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-047	2	0.183	100	0.029	42.391	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-047	3	0.097	0	0.029	42.391	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-049	1	1.279	100	0.016	21.756	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-049	2	2.147	100	0.016	21.756	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-049	3	1.46	0	0.016	21.756	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-034	1	1.01	100	0.046	34.38	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-034	2	1.161	100	0.046	34.38	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-034	3	0.649	0	0.046	34.38	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-038	1	1.017	100	0.065	32.207	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-038	2	0.419	100	0.065	32.207	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5051-038	3	0.057	0	0.065	32.207	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-039	1	1.352	100	0.05	37.172	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-039	2	0.002	100	0.05	37.172	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5051-039	3	0.73	0	0.05	37.172	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-048	1	0.204	100	0.1	41.564	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-048	2	0.127	100	0.1	41.564	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-048	3	0.24	0	0.1	41.564	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-049	1	0.094	100	0.09	20.05	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-049	2	0.098	100	0.09	20.05	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-049	3	0.108	0	0.09	20.05	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-050		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-052	1	0.115	100	0.052	16.275	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-052	2	0.015	100	0.052	16.275	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-052	3	0.056	0	0.052	16.275	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5053-049	1	0.081	100	0.013	14.314	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5053-049	3	0.026	0	0.013	14.314	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5053-054	3	0.005	0	0.011	0	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1	1	
IN5053-056	1	0.035	100	0	20.899	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5053-056	3	0.017	0	0	20.899	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5053-057	1	0.183	100	0	36.075	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5053-057	3	0.036	0	0	36.075	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-061	1	0.442	100	0.002	28.814	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-061	3	0.108	0	0.002	28.814	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-062	1	0.157	100	0.004	34.118	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-062	3	0.019	0	0.004	34.118	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
IN5052-063	1	0.022	100	0.013	10	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-063	2	0.077	100	0.013	10	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-063	3	0.119	0	0.013	10	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-009	1	0.208	100	0.006	31.129	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	0	
IN5152-009	2	0.104	100	0.006	31.129	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5152-009	3	0.027	0	0.006	31.129	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-010	1	0.067	100	0	12.139	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-010	3	0.044	0	0	12.139	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-011	1	0.127	100	0	23.013	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-011	3	0.029	0	0	23.013	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-012	1	0.108	100	0.005	13.892	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-012	3	0.007	0	0.005	13.892	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5152-014		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-015	1	0.104	100	0.004	10	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-015	2	0.165	100	0.004	10	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5152-015	3	0.195	0	0.004	10	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-016	1	0.172	100	0.009	46.334	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-016	3	0.022	0	0.009	46.334	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-018	1	1.091	100	0.039	34.253	10B90D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-018	2	0.992	100	0.039	34.253	10B90D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5152-018	3	0.541	0	0.039	34.253	10B90D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-019	1	0.17	100	0.006	31.213	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-019	3	0.075	0	0.006	31.213	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5152-020	1	0.274	100	0.005	47.202	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5152-020	3	0.028	0	0.005	47.202	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-025		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-026	1	0.332	100	0.051	21.313	40B60D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-026	2	1.038	100	0.051	21.313	40B60D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-026	3	0.5	0	0.051	21.313	40B60D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-027	1	0.3	100	0.001	58.509	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-027	3	0.063	0	0.001	58.509	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-028	1	0.099	100	0.006	11.712	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-028	3	0.068	0	0.006	11.712	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-029	1	0.102	100	0.003	12.266	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-029	3	0.031	0	0.003	12.266	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-030	1	0.035	100	0.263	11.662	60B40D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-030	2	0.067	100	0.263	11.662	60B40D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-030	3	0.05	0	0.263	11.662	60B40D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-031	1	0.005	100	0.02	17.142	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-032		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-034	1	2.197	100	0.001	115.843	70B30D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-034	3	0.105	0	0.001	115.843	70B30D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-035		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-037		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5151-038		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-009		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5250-010	1	0.218	100	0.015	33.211	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5250-010	3	0.095	0	0.015	33.211	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5250-011		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-076		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-012	1	0.265	100	0.003	26.792	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-012	3	0.009	0	0.003	26.792	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-077	1	1.763	100	0.028	120.06	10B90D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-077	2	0.112	100	0.028	120.06	10B90D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-077	3	0.046	0	0.028	120.06	10B90D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-079		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-013	1	0.168	100	0.01	33.273	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-014	1	0.194	100	0.005	19.867	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-080	1	0.197	100	0.005	11.269	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-080	2	0.001	100	0.005	11.269	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-080	3	0.087	0	0.005	11.269	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-017	1	0.485	100	0.004	29.278	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-017	3	0.005	0	0.004	29.278	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-018	1	0.288	100	0.003	42.526	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-018	3	0.019	0	0.003	42.526	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AE5250-019		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-020	1	0.238	100	0.005	37.954	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-021	1	0.283	100	0.003	12.042	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-021	2	0.047	100	0.003	12.042	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5250-021	3	0.071	0	0.003	12.042	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AE5250-024		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-073	1	0.384	100	0.003	21.71	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-073	2	0.004	100	0.003	21.71	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-073	3	0.015	0	0.003	21.71	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-074	1	0.059	100	0.006	23.693	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-078	1	0.139	100	0.005	37.228	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-078	3	0.012	0	0.005	37.228	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-080		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-081	1	0.112	100	0.03	25.424	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-081	2	0.052	100	0.03	25.424	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-081	3	0.032	0	0.03	25.424	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-082	1	0.317	100	0.015	23.077	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-082	2	0.134	100	0.015	23.077	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-082	3	0.182	0	0.015	23.077	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-083	1	0.046	100	0.041	16.969	50B50D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-083	2	0.043	100	0.041	16.969	50B50D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-083	3	0.017	0	0.041	16.969	50B50D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-085		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5052-087	1	0.113	100	0.002	24.207	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-087	2	0.003	100	0.002	24.207	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-087	3	0.091	0	0.002	24.207	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-088	1	0.642	100	0.018	42.15	80B20D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-088	2	0.529	100	0.018	42.15	80B20D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-088	3	0.752	0	0.018	42.15	80B20D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-089	1	0.061	100	0.047	10.464	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-089	2	0.068	100	0.047	10.464	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-089	3	0.116	0	0.047	10.464	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-090	1	0.1	100	0.024	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-090	2	0.002	100	0.024	10	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-090	3	0.015	0	0.024	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-091	1	0.01	100	0.083	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-092	1	0.548	100	0.007	40.539	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-092	2	0.278	100	0.007	40.539	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-092	3	0.347	0	0.007	40.539	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-093	1	1.238	100	0.019	57.84	20B80D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-093	2	1.294	100	0.019	57.84	20B80D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-093	3	0.806	0	0.019	57.84	20B80D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5052-094	1	0.262	100	0.004	34.76	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-094	2	0.187	100	0.004	34.76	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5052-094	3	0.129	0	0.004	34.76	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-096	1	0.53	100	0.022	40.487	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-096	2	0.534	100	0.022	40.487	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-096	3	0.576	0	0.022	40.487	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-097	1	0.254	100	0.003	45.136	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-097	2	0.043	100	0.003	45.136	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-097	3	0.06	0	0.003	45.136	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-053		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-054		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-055		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-106		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-107		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-056		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
SS5151-041		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
SS5250-025		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5250-026		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5250-027		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-109	1	0.007	100	0.012	10	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-109	3	0.005	0	0.012	10	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-057	1	0.155	100	0.095	21.283	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-057	2	0.007	100	0.095	21.283	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-057	3	0.087	0	0.095	21.283	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
CB5051-063	1	1.707	100	0.027	20.895	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
CB5051-063	2	0.706	100	0.027	20.895	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
CB5051-063	3	0.49	0	0.027	20.895	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-064	1	0.287	100	0.089	40.921	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-064	2	0.769	100	0.089	40.921	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5051-064	3	0.375	0	0.089	40.921	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-068	1	0.28	100	0.023	22.761	50B50D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-068	3	0.026	0	0.023	22.761	50B50D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-069		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-091	1	0.667	100	0.031	35.807	10B90C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-091	2	0.002	100	0.031	35.807	10B90C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-091	3	0.222	0	0.031	35.807	10B90C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-094	1	0.503	100	0.016	41.301	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-094	2	0.007	100	0.016	41.301	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-094	3	0.02	0	0.016	41.301	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-099	1	0.565	100	0.008	46.486	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-099	2	0.089	100	0.008	46.486	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-099	3	0.001	0	0.008	46.486	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-103		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-106	1	0.299	100	0.014	31.208	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-106	2	0.227	100	0.014	31.208	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-106	3	0.003	0	0.014	31.208	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5051-076	1	0.766	100	0.033	21.829	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5051-076	2	0.59	100	0.033	21.829	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5051-076	3	0.01	0	0.033	21.829	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-050		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-052	1	0.336	100	0.051	43.101	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-052	2	0.264	100	0.051	43.101	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-053	1	0.028	100	0.06	15.944	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-053	2	0.053	100	0.06	15.944	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-056	1	0.603	100	0.054	35.545	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-056	2	0.159	100	0.054	35.545	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-056	3	0.035	0	0.054	35.545	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5149-091	1	0.066	100	0.026	22.043	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-091	2	0.001	100	0.026	22.043	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-049	1	0.628	100	0.023	24.441	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-049	2	0.741	100	0.023	24.441	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-049	3	0.061	0	0.023	24.441	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5149-098	1	0.018	100	0.049	10	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-098	2	0.04	100	0.049	10	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-099	1	0.027	100	0.044	11.796	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-099	2	0.012	100	0.044	11.796	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-100	1	0.016	100	0.066	11.77	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-100	2	0.014	100	0.066	11.77	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-101	1	0.182	100	0.033	23.323	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
IN5149-101	2	0.16	100	0.033	23.323	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-101	3	0.002	0	0.033	23.323	No Pervious Area	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5149-102	1	0.02	100	0.027	19.914	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-103	1	0.032	100	0.035	26.408	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-103	2	0.007	100	0.035	26.408	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-051	1	2.058	100	0.01	28.381	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5149-051	2	0.488	100	0.01	28.381	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5149-051	3	1.803	0	0.01	28.381	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-110	1	0.095	100	0.021	16.191	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-110	2	0.008	100	0.021	16.191	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-111	1	0.047	100	0.033	12.357	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-111	2	0.056	100	0.033	12.357	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-114	1	0.052	100	0.021	18.442	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-114	2	0.001	100	0.021	18.442	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-115	1	0.16	100	0.018	27.484	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-115	2	0.008	100	0.018	27.484	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-116		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-117	1	0.049	100	0.033	10	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-117	2	0.211	100	0.033	10	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-117	3	0.002	0	0.033	10	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5052-111	1	0.245	100	0.012	30.358	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-111	2	0.024	100	0.012	30.358	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-111	3	0.079	0	0.012	30.358	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-046	1	0.025	100	0.033	6.56	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-046	2	0.03	100	0.033	6.56	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-124	1	0.135	100	0.059	22.194	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-124	2	0.037	100	0.059	22.194	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-124	3	0.032	0	0.059	22.194	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-125	1	0.026	100	0.006	10	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-125	3	0.001	0	0.006	10	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-006	1	0.193	100	0.037	21.14	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-006	2	0.042	100	0.037	21.14	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5250-028	1	0.576	100	0.013	27.605	50B50D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-028	2	1.059	100	0.013	27.605	50B50D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5250-028	3	0.541	0	0.013	27.605	50B50D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5250-029	1	0.109	100	0.033	18.669	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5250-029	2	0.111	100	0.033	18.669	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-062	1	0.014	100	0.01	14.072	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-062	2	0.015	100	0.01	14.072	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-063	1	0.977	100	0.021	24.338	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-063	2	1.02	100	0.021	24.338	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-063	3	0.031	0	0.021	24.338	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-133	1	0.138	100	0.001	38.215	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-133	3	0.01	0	0.001	38.215	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
AS5149-095	1	0.102	100	0.037	25.167	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5149-095	2	0.037	100	0.037	25.167	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-092		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-093		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-094	1	0.457	100	0.026	41.377	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5249-094	2	0.333	100	0.026	41.377	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5249-094	3	0.051	0	0.026	41.377	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-113		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-122		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5250-005		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-128	1	0.675	100	0.007	65.014	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-128	2	0.909	100	0.007	65.014	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-128	3	0.071	0	0.007	65.014	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-129	1	0.619	100	0.012	15.442	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-129	2	1.284	100	0.012	15.442	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-129	3	0.869	0	0.012	15.442	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-087		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-023	1	0.539	100	0.038	65.638	70B30D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-023	2	0.481	100	0.038	65.638	70B30D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-023	3	0.111	0	0.038	65.638	70B30D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-134	1	0.254	100	0.003	51.997	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-134	2	0.094	100	0.003	51.997	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-134	3	0.326	0	0.003	51.997	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-064		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-065	1	0.182	100	0.038	22.143	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-065	2	0.162	100	0.038	22.143	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-065	3	0.038	0	0.038	22.143	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
ND5151-066		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
MI5051-002		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
TP5051-016	1	0.399	100	0.023	37.949	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
TP5051-016	2	0.05	100	0.023	37.949	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
TP5051-016	3	0.001	0	0.023	37.949	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
MI5052-045		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
PL5151-039		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
PL5151-040	2	0.127	100	0.008	0	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3	1	
PL5151-040	3	1.987	0	0.008	0	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
TP5151-042		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
TP5151-043		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
MI5151-054		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-067	1	0.48	100	0.056	30.611	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-067	2	1.131	100	0.056	30.611	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-067	3	0.06	0	0.056	30.611	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5051-083	1	0.053	100	0.023	29.1	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5051-083	3	0.005	0	0.023	29.1	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
IN5151-068	1	0.366	100	0.068	34.917	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-068	2	0.008	100	0.068	34.917	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
MI5151-069		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-070	1	0.191	100	0.035	38.02	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-070	3	0.027	0	0.035	38.02	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-071	1	0.139	100	0.045	46.539	70B30D	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-071	2	0.013	100	0.045	46.539	70B30D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-071	3	0.01	0	0.045	46.539	70B30D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-073	1	0.39	100	0.026	24.194	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-073	2	0.554	100	0.026	24.194	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-073	3	0.011	0	0.026	24.194	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-076	1	0.188	100	0.029	38.122	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-076	2	0.002	100	0.029	38.122	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-076	3	0.012	0	0.029	38.122	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5151-079		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-080		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-081	1	0.071	100	0.03	22.853	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-081	2	0.001	100	0.03	22.853	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-081	3	0.019	0	0.03	22.853	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-082	1	0.083	100	0.052	10	10B90C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-082	2	1.199	100	0.052	10	10B90C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5151-082	3	0.012	0	0.052	10	10B90C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5151-083	1	0.046	100	0.047	17.542	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5151-083	2	0.017	100	0.047	17.542	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-084	1	0.626	100	0.05	47.203	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5151-084	2	0.323	100	0.05	47.203	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5151-084	3	0.133	0	0.05	47.203	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-135		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-136		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-137	1	0.433	100	0.015	53.991	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-137	2	0.593	100	0.015	53.991	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-137	3	0.162	0	0.015	53.991	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-138		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-139	1	0.06	100	0.023	10	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-139	2	0.638	100	0.023	10	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-139	3	0.01	0	0.023	10	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-140	1	0.056	100	0.026	10	100Percent Type C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-140	2	0.447	100	0.026	10	100Percent Type C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-140	3	0.013	0	0.026	10	100Percent Type C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-141	1	0.123	100	0.021	10.791	10B90C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-141	2	0.085	100	0.021	10.791	10B90C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-141	3	0.049	0	0.021	10.791	10B90C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-142	1	0.118	100	0.025	33.759	70B30C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-142	2	0.014	100	0.025	33.759	70B30C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		

Name	Subcatchment	Area acres	Impervious Percentage %	Slope ft/ft	Width ft	Infiltration Reference	Rainfall Reference	Runoff Redirection Type	Runoff Redirection Drain To Subcatchment Number	Active in Runoff Layer	Runoff Redirection Drain To Node
IN5150-142	3	0.007	0	0.025	33.759	70B30C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
AS5150-143		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-144	1	0.205	100	0.013	29.267	90B10C	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-144	2	0.035	100	0.013	29.267	90B10C	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5150-144	3	0.031	0	0.013	29.267	90B10C	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
IN5150-145	1	0.011	100	0.014	5.887	No Pervious Area	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5150-145	2	0.035	100	0.014	5.887	No Pervious Area	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-146		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-147		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-148	1	0.104	100	0.017	14.623	100Percent Type B	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-148	2	0.783	100	0.017	14.623	100Percent Type B	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
AS5150-148	3	0.127	0	0.017	14.623	100Percent Type B	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		
NorthShoreDrOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
BroomStOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
HamiltonStOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
HenryStOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
WilsonStOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
US151Outfall2		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
US151Outfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
PinckneyStOutfall		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5052-094-01		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
AS5150-049-01		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
MI5150-112		0	0	0	0	No DA to Structure	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-081-01	1	0.293	100	0.008	15.957	100Percent Type D	100yr-24hr_1440m	No Redirection	Outlet	1	
IN5052-081-01	2	0.657	100	0.008	15.957	100Percent Type D	100yr-24hr_1440m	Impervious Runoff to Pervious	SubCatchment 3		
IN5052-081-01	3	0.912	0	0.008	15.957	100Percent Type D	100yr-24hr_1440m	Pervious Runoff to Impervious	SubCatchment 1		

Table 4. Composite Soil Group Infiltration XP-Table Input Data

Name	Inch (Impervious Area) Input in	Inch (pervious Area) Input in	Manning's "n" (Impervious Area) Input	Manning's "n" (Pervious Area) Input	Zero Detention (%) Input	Max Infiltration Rate Input in/hr	Min (Asymptotic) Infiltration in/hr	Decay Rate of Infiltration 1/sec	Maximum Infiltration Volume mm;inch
100Percent Type B	0.05	0.15	0.016	0.2	25	2	0.5	0.07	0
100Percent Type C	0.05	0.2	0.016	0.2	25	1	0.2	0.07	0
100Percent Type D	0.05	0.15	0.016	0.2	25	0.5	0.1	0.07	0
10B90C	0.05	0.2	0.016	0.2	25	1.1	0.23	0.07	0
10B90D	0.05	0.15	0.016	0.2	25	0.65	0.14	0.07	0
10C90D	0.05	0.15	0.016	0.2	25	0.55	0.11	0.07	0
20B80C	0.05	0.15	0.016	0.2	25	0.6	0.12	0.07	0
20B80D	0.05	0.15	0.016	0.2	25	0.8	0.18	0.07	0
40B60D	0.05	0.15	0.016	0.2	25	1.1	0.26	0.07	0
50B50D	0.05	0.15	0.016	0.2	25	1.25	0.3	0.07	0
60B40D	0.05	0.15	0.016	0.2	25	1.4	0.34	0.07	0
70B30C	0.05	0.15	0.016	0.2	25	1.7	0.41	0.07	0
70B30D	0.05	0.15	0.016	0.2	25	1.55	0.38	0.07	0
80B20C	0.05	0.15	0.016	0.2	25	1.8	0.44	0.07	0
80B20D	0.05	0.15	0.016	0.2	25	1.7	0.42	0.07	0
90B10C	0.05	0.15	0.016	0.2	25	1.9	0.47	0.07	0
90B10D	0.05	0.15	0.016	0.2	25	1.85	0.46	0.07	0
No DA to Structure	0	0	0	0	0	50	10	0.001	0
No Pervious Area	0.05	0.15	0.016	0.2	25	0.01	0.01	0.01	0
30B70C	0.05	0.15	0.016	0.2	25	1.3	0.29	0.07	0
20C80D	0	0	0.03	0.03	25	50	10	0.001	0
30B70D	0	0	0.03	0.03	25	50	10	0.001	0
30C70D	0	0	0.03	0.03	25	50	10	0.001	0
40B60C	0	0	0.03	0.03	25	50	10	0.001	0
40C60D	0	0	0.03	0.03	25	50	10	0.001	0
50B50C	0	0	0.03	0.03	25	50	10	0.001	0
50C50D	0	0	0.03	0.03	25	50	10	0.001	0
60B40C	0	0	0.03	0.03	25	50	10	0.001	0
60C40D	0	0	0.03	0.03	25	50	10	0.001	0
70C30D	0	0	0.03	0.03	25	50	10	0.001	0
80C20D	0	0	0.03	0.03	25	50	10	0.001	0
90C10D	0	0	0.03	0.03	25	50	10	0.001	0

Table 5. WinSLAMM Land Use Parcels within Watershed

OBJECTID *	Permeability	LUDesc	LUDedit	SADesc	SADedit	RoofType	Roofedit	ConnEdit	ConnType	SoilType	AreaPerRatio	SHAPE_Length	SHAPE_Area
188318	Impervious	Institutional	Institutional	Roofs 1	Roof	Flat	Roof		Connected	0	11.747768	206.594775	2357.985696
188354	Impervious	Institutional	Institutional	Roofs 1	Roof	Flat	Roof		Connected	0	21.252395	511.108142	10862.2788
188370	Impervious	Institutional	Institutional	Roofs 1	Roof	Flat	Roof		Connected	0	42.411474	542.885879	2940.549032
189396	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	18.963734	331.576993	6287.93672
189407	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	6.864648	168.017212	1153.376542
189408	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	10.852081	221.42949	2332.984703
189414	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	10.819027	187.316435	2026.579839
189416	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	31.987185	664.171665	21245.01254
189419	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	9.381511	122.773246	1151.796696
189420	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	5.722718	92.318277	528.311913
189421	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	34.623135	798.441355	27644.50475
189422	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	35.584419	0.279474	0.003349
189425	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	26.501865	680.598259	18037.16444
189426	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	21.881378	464.608066	2868.849871
189427	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	7.867715	92.248672	564.892761
189433	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	9.605001	124.316438	1194.059649
189435	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	43.011114	790.156266	33985.49061
189437	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	27.400171	1505.79488	41258.97608
189438	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	9.798802	176.669079	1731.143486
189439	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	15.610241	333.691161	5208.981064
189443	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	32.214375	493.865222	15909.54289
189446	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	13.591868	249.5932	3392.408351
189447	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	28.548165	574.771813	16408.69736
189448	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	65.532702	1048.86418	68734.93647
189452	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	23.293777	692.578073	16132.75346
189460	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	13.540463	206.237729	1250.450026
189464	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	42.375585	777.822834	32960.70237
189466	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	40.94485	907.640962	37221.2186
189469	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	34.996993	712.120969	24917.75298
189470	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	14.301956	301.118115	4331.974608
189475	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	37.503923	621.249891	23299.29401
189480	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	19.869135	496.347516	9917.933801
189489	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	45.172525	803.424585	36292.72235
189492	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	39.444644	897.635285	35406.86053
189497	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	16.568498	300.328874	4976.007049
189505	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	49.931309	1181.617887	59010.85774
189507	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	14.088444	359.726493	5067.991622
189508	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	73.708906	1222.900736	90138.70979
189509	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	32.267927	591.258901	19078.68085
189510	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	8.821372	199.893435	1763.337383
189511	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	14.953378	264.537886	3955.733938
189513	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	32.939111	739.195481	24348.44209
189539	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	19.429463	317.090719	6160.899028
189543	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	30.435507	497.69072	15147.49164
189545	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	9.955868	176.483979	1757.045194

189547	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	23.37927	804.277308	18803.42112
189550	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	9.527948	219.573259	2092.083817
189556	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	14.51917	249.975481	3629.443494
189557	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	43.009609	719.727906	30955.21175
189564	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	8.129507	72.540757	216.267091
189575	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	40.09516	964.692243	19888.90204
189576	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	10.306535	218.774602	2103.462892
189586	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	49.788586	1460.534599	27924.77719
189589	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	25.715546	459.836099	8764.550326
189594	Impervious	Commercial	Commercial	Roofs 1	Roof	Flat	Roof		Connected	0	13.753359	55.767972	146.755714
219497	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	12.240106	234.732793	1222.219768
219509	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	8.274387	206.591182	1709.413227
219510	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	8.797123	240.462838	2115.376804
219513	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	16.959024	294.781649	4999.200881
219516	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	13.417615	165.930619	1038.057207
219526	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	1.896397	44.100138	83.633674
219530	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	17.558217	311.862189	5475.740336
219536	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	7.430818	192.937491	1433.690592
219540	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	3.056199	96.961293	296.330379
219541	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	8.852722	166.874651	1477.289357
219544	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	14.280401	287.267127	4102.292982
219547	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	3.618345	60.324025	218.272927
219549	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	20.764829	355.50485	7381.985525
219550	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	11.939897	205.827283	1577.909148
219551	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	30.07039	2277.098621	68473.28985
219559	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	14.875804	41.836535	47.194708
219560	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	21.69427	386.085372	8375.840593
219562	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	27.108789	746.760011	19325.77021
219566	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	14.358925	275.65978	3958.179078
219581	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	22.126346	407.910997	9025.561772
219589	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	19.197727	459.545755	8822.222705
219591	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	34.433896	696.946632	23998.57174

219594	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	15.127555	329.482543	4984.260998
219597	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	16.322964	25.946617	34.338029
219600	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	14.623584	56.423823	145.054489
219606	Impervious	Residential	Residential	Roofs 3	Roof	Flat	Roof		Disconnected	Silty	14.328867	74.885493	74.375915
221037	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	29.09909	496.222769	14439.66009
221040	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	13.500223	399.673749	5395.675929
221053	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	16.627461	298.396666	4961.5824
221054	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	7.808691	132.366456	1033.60742
221063	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	1.341485	135.617502	181.938087
221128	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	11.698889	276.354227	3233.046006
221131	Impervious	Residential	Residential	Roofs 4	Roof	Flat	Roof		Disconnected	Clayey	18.794879	725.427705	13634.34351
222616	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	24.28111	776.748522	6775.322888
222617	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	7.046576	135.412371	954.1898
222618	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	9.068348	171.454143	1402.748749
222622	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	16.277498	250.277957	4073.901965
222625	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	8.364247	29.150775	19.530541
222626	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	8.341429	178.284584	1487.148185
222627	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	10.373285	197.030519	2043.848138
222628	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	8.280438	107.410083	889.402448
222629	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	10.13985	96.399197	237.258877
222634	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	1.744676	31.138274	54.325431
222669	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	57.232182	980.688968	35382.72247
222672	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	4.749871	119.02042	565.336992
222682	Impervious	Commercial	Commercial	Roofs 7	Roof	Pitched	Roof		Connected	0	9.591971	13.995904	6.306729
223446	Impervious	Industrial	Industrial	Roofs 7	Roof	Pitched	Roof		Connected	0	13.939434	151.163694	403.003679
223459	Impervious	Industrial	Industrial	Roofs 7	Roof	Pitched	Roof		Connected	0	3.491498	62.210579	217.212383
223463	Impervious	Industrial	Industrial	Roofs 7	Roof	Pitched	Roof		Connected	0	7.489	421.573276	3157.146064
223464	Impervious	Industrial	Industrial	Roofs 7	Roof	Pitched	Roof		Connected	0	3.735954	66.053668	246.773088
244001	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	3.868265	58.500187	217.652276
244106	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.185588	165.479565	1520.026988
244144	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.24688	186.40993	1693.801472
244177	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.959067	210.975148	1630.452626
244206	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.661763	174.061982	1507.682331
244228	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.137047	178.459693	958.233474
244244	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.745019	180.948862	1401.449519

244303	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	10.843638	199.488053 2163.172659
244327	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.075626	165.755998 1344.711194
244355	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.806167	173.135048 1524.651414
244367	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.483349	155.526973 1319.389374
244371	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	24.298596	551.718589 12495.38056
244395	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	12.051159	174.48995 1514.433054
244398	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	10.181854	178.292508 1815.352457
244405	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.743874	205.574911 1797.526888
244428	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.08314	177.925553 1616.120792
244459	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.383233	209.781984 1968.437913
244471	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	12.044775	312.885598 3768.643807
244472	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	5.957085	98.084026 584.296504
244479	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.073284	153.272961 1390.688725
244484	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	10.994584	211.841493 2013.094736
244510	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.722433	203.363671 1773.823994
244519	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	7.760762	149.359547 1159.137932
244538	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.654071	169.731636 1638.601974
244573	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.026403	158.724175 1409.708664
244588	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.156525	171.259802 1568.141324
244594	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	12.353313	206.480694 2550.725739
244598	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.760662	140.846058 1233.903133
244602	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	10.627033	199.364197 2118.652944
244633	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	9.101806	167.74162 1526.746223
244635	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.778732	158.511561 1391.530743
244667	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.115301	146.110183 1185.730797
244684	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	8.139153	162.745085 1308.285249
244705	Impervious	Residential	Residential Roofs 9	Roof	Pitched Roof		Disconnected Silty	6.836072	145.359921 938.335134

244714	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	5.742948	150.010338	861.498416
244747	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.314642	186.563086	1737.76103
244758	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	5.387121	123.946651	667.714917
244791	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.801391	178.471551	1570.800371
244801	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.073421	230.986664	1864.848925
244813	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.410955	164.986082	1552.677484
244833	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.177563	194.500704	1785.034642
244869	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.254653	163.935176	1517.16234
244882	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.288434	150.650718	1248.656724
244900	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	6.789594	147.760851	1003.238758
244919	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.141135	155.135229	1262.975669
244933	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	4.883637	82.183978	401.356174
244957	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.676659	149.477494	1147.486088
244965	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.999871	159.376901	1274.992576
244981	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.217546	146.003354	1199.790941
244990	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.931075	197.894841	1965.31052
245038	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.156808	166.412334	1357.395841
245044	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.242345	154.682081	1274.946106
245081	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.9799	160.132222	1277.836039
245084	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.703304	165.089641	1436.824178
245110	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.536705	154.313257	1317.32756
245145	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.955958	163.930201	1468.156808
245165	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.904155	150.597105	1340.942016
245196	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.372406	139.487333	1028.359538
245204	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.287677	176.958629	1820.493225
245224	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.069257	163.956053	1486.966417
245245	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.896399	162.698419	1447.433085

245282	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.062439	152.36772	1228.460099
245284	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.920577	161.65635	1442.067883
245323	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.6004	175.789915	1687.658157
245345	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.049687	153.129191	1232.640402
245350	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.475636	175.297989	1661.059027
245366	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.977045	378.515273	3776.471135
245372	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.938022	145.776695	1157.179337
245416	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.840092	153.608227	1204.296968
245447	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	6.290116	121.169918	762.169229
245451	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.496677	199.802896	2097.269122
245468	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.159684	164.849932	1509.969951
245547	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.606246	175.272623	1508.439884
245556	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.814566	149.994868	1322.139039
245563	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	6.518522	131.299731	855.875032
245598	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.200952	148.227761	1215.607475
245607	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.055167	180.715654	1636.408825
245629	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.189292	129.481826	930.884863
245650	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.54229	186.112776	1589.82896
245654	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	4.835137	77.405017	374.266584
245705	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.055884	174.450134	1405.345532
245716	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.31431	135.444866	990.685684
245733	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	21.530658	408.304315	8791.057349
245748	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.613197	176.382914	1519.215443
245761	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.761214	165.49412	1449.938065
245787	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.58326	166.753009	1431.282559
245802	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.20779	184.112617	1511.151123
245859	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.507126	160.70499	1367.138073

245875	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.212615	172.645735	1590.519253
245918	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.253644	196.199445	2011.765912
245927	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.938736	144.264189	1145.27244
245946	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.292646	130.770322	953.663871
245967	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.816687	167.215915	1641.506298
245982	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.535184	168.304166	1604.812652
245987	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.53483	158.04957	1506.975821
246023	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	11.653961	199.667493	2326.921658
246030	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.768797	182.937568	1604.142172
246034	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.151168	174.177808	1419.746882
246075	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.091459	16.928996	6.465239
246077	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.200889	170.015349	1394.273894
246083	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	21.140151	878.40583	18569.61865
246095	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.97982	166.13797	1325.758566
246141	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.375138	148.230784	1241.454122
246150	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.254968	190.369997	1761.868299
246159	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.501416	6.145035	0.866527
246174	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.961301	150.813702	1200.672916
246195	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.234115	158.948504	1149.856532
246269	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.173324	156.174331	1432.637331
246321	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.763046	186.84012	1637.279768
246479	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.780904	183.150767	1608.239142
246522	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.142677	141.847075	1155.013888
246916	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.952003	165.155609	1313.319511
249557	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	12.543257	319.955221	4013.285892
249570	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	12.057061	227.342178	2741.072179
249586	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.747637	196.92794	1919.589783

249632	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.610017	186.21769	1789.553606
249719	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	14.799615	332.052268	4914.232553
249732	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.712221	124.086226	493.0084
249762	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.956455	125.637656	507.778259
249775	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.950803	182.557655	1634.032065
249796	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.540924	222.759612	2348.089304
249813	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.212437	117.398294	328.258317
249823	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.528537	163.112692	1391.119232
249893	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	7.918333	144.077093	1140.84475
249902	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	6.669872	12.041291	3.112651
249951	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.426453	236.25529	2463.308329
249971	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	10.700915	121.443696	718.184614
249999	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.507727	17.989667	8.745611
250025	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.984065	22.29393	19.859019
250108	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	9.369318	105.664135	202.657664
250159	Impervious	Residential	Residential	Roofs 9	Roof	Pitched	Roof		Disconnected	Silty	8.523116	96.817513	477.28238
203733	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	5.730588	91.698463	525.486884
203812	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	7.344894	124.932672	917.619893
203813	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	8.286623	164.47329	1362.932076
203841	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	7.345003	124.934363	917.651738
203894	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	19.46628	303.556326	5909.11302
204113	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	10.904988	213.859231	2332.13145
204116	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	8.124782	168.293932	1367.345084
204157	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	9.880602	183.565758	1813.741388
204171	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	9.671523	162.63114	1572.890241
204178	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	17.565414	606.54631	10654.23627
204204	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	5.309037	86.390314	458.649637

204220	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	13.437528	279.275153	3752.768686
204257	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	9.191229	185.432684	1704.356413
204284	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	8.394505	158.832469	1333.320021
204320	Impervious	Residential	Residential	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	6.219987	152.176596	946.533003
218800	Impervious	Other Urban	Other Roof	Roofs 10	Roof	Pitched	Roof		Disconnected	Clayey	15.836714	359.26707	5689.610034
181390	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	18.422922	216.055626	1243.003978
181393	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	11.291787	343.638742	3880.287415
181394	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	12.510887	260.509224	3259.218721
181399	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	13.397628	251.960802	3375.680948
181400	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	14.416333	245.43981	3538.344527
181404	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	12.630257	6.349091	1.728713
181405	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	10.026039	197.049837	1975.620658
181411	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	10.948548	828.721577	9073.286221
181414	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	18.76257	608.53499	11417.71019
181420	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	17.672708	388.409848	6864.247328
181421	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	18.515276	150.394801	229.908019
181425	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	14.866695	359.744449	5348.202765
181426	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	9.418408	158.760777	1495.268626
181427	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	5.145558	233.512909	1201.550149
181434	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	11.524513	275.242503	3172.026096
181436	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	16.063096	269.366602	4326.864353
181439	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	20.515112	404.769834	8303.890589
181440	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	18.684039	406.533849	7595.681414
181441	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	17.416218	370.357878	6450.228437
181447	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	11.989226	203.493862	2439.73566
181458	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	17.813139	284.305881	5064.38527
181461	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	40.589068	784.225821	11012.43638
181593	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	5.574607	106.646249	594.506416
181611	Impervious	Residential	Residential	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	13.653115	234.827125	3206.126898
185018	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	6.859909	359.357823	2465.162418
185021	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	28.858971	568.035284	14354.84331
185022	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	4.097162	307.927282	1261.627944
185025	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	5.336509	91.82521	490.025181
185026	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	5.842696	101.855945	602.70344
185028	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	20.620732	652.747702	13460.13906
185032	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	18.474131	538.392452	9946.365348
185035	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	55.963167	918.412916	51397.28186
185039	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	30.052037	514.224962	14138.11856
185040	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	1.568399	121.233037	190.142099
185075	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	8.676296	324.311597	2813.814435
185085	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	13.172175	263.93002	3476.533234
185094	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	15.573522	314.062701	4891.061326
185097	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	13.955883	315.017043	4396.336888
185098	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	15.563885	308.889688	4807.523148
185121	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	26.527706	163.176942	754.397131
185122	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	19.350298	969.737282	18764.70681
185136	Impervious	Commercial	Commercial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	15.822025	314.065681	4701.647998
186743	Impervious	Industrial	Industrial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	44.46775	1170.681294	52060.9362

186745	Impervious	Industrial	Industrial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	34.300707	725.58358	24888.00153
186746	Impervious	Industrial	Industrial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	34.316891	709.576274	24350.44739
186757	Impervious	Industrial	Industrial	Paved Parking 1	Parking	0	<Null>	Connected	Connected	0	19.482931	824.157908	16057.03605
187382	Impervious	Other Urban	Other Parking	Paved Parking 3	Parking	0	<Null>	Disconnected	Disconnected	Silty	10.486273	290.981883	3051.314147
187383	Impervious	Other Urban	Other Parking	Paved Parking 3	Parking	0	<Null>	Disconnected	Disconnected	Silty	20.665427	579.219673	11969.82273
187594	Impervious	Other Urban	Other Parking	Paved Parking 4	Parking	0	<Null>	Disconnected	Disconnected	Clayey	20.171179	536.450853	10820.8574
187599	Impervious	Other Urban	Other Parking	Paved Parking 4	Parking	0	<Null>	Disconnected	Disconnected	Clayey	22.225633	614.779958	13663.86359
353589	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	11.870017	334.502698	1790.262634
353591	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	10.06308	190.040051	1844.603086
353592	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	11.075211	192.803857	2135.341343
353593	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	12.623838	184.385373	2076.643676
353599	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	15.022801	302.672058	4546.976192
353600	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	8.68564	311.848355	2708.612869
353601	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	18.562422	315.468804	5855.872157
353602	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	14.229789	252.218136	3589.021223
353603	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	14.822159	242.566381	3595.359616
353604	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	15.251594	247.000229	3767.14914
353606	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	11.635698	184.164729	2142.888225
353615	Pervious	Residential	Residential	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	9.76777	388.164593	3791.505738
353665	Pervious	Commercial	Commercial	Unpaved Parking 3	Parking	0	<Null>		Disconnected	Sandy	6.166924	573.83245	3538.764397
354045	Impervious	Industrial	Industrial	Unpaved Parking 4	Parking	0	<Null>		Disconnected	Clayey	10.714292	2868.034437	30641.79288
354046	Impervious	Industrial	Industrial	Unpaved Parking 4	Parking	0	<Null>		Disconnected	Clayey	3.385001	21.007791	13.815901
354126	Impervious	Other Urban	Other Parking	Unpaved Parking 4	Parking	0	<Null>		Disconnected	Clayey	11.531779	967.047815	4403.379897
354127	Impervious	Other Urban	Other Parking	Unpaved Parking 4	Parking	0	<Null>		Disconnected	Clayey	2.620229	72.31222	189.472677
354128	Impervious	Other Urban	Other Parking	Unpaved Parking 4	Parking	0	<Null>		Disconnected	Clayey	11.171108	3142.364826	35103.67253
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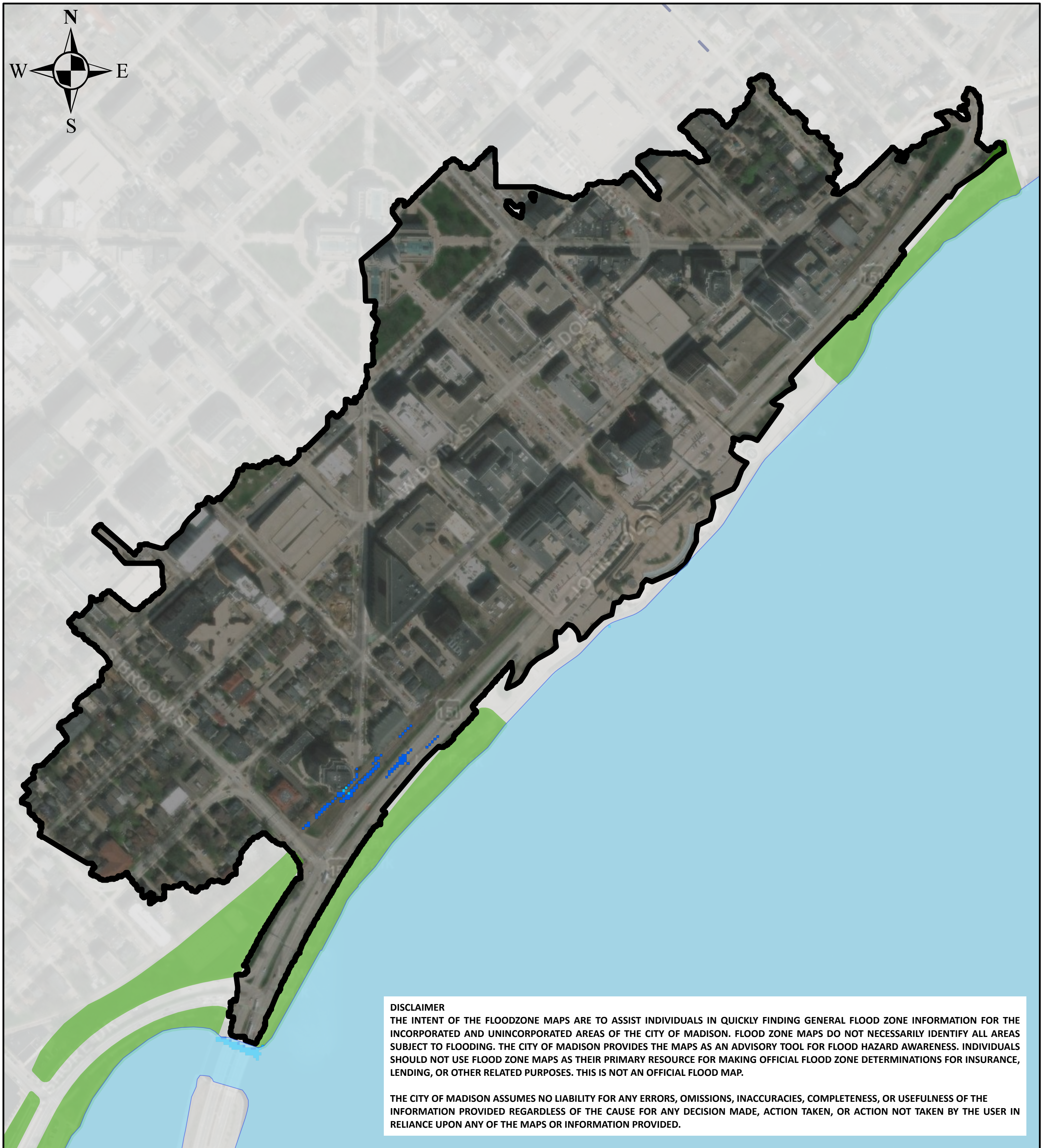
APPENDIX C: FLOOD MAPS



DISCLAIMER

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Legend

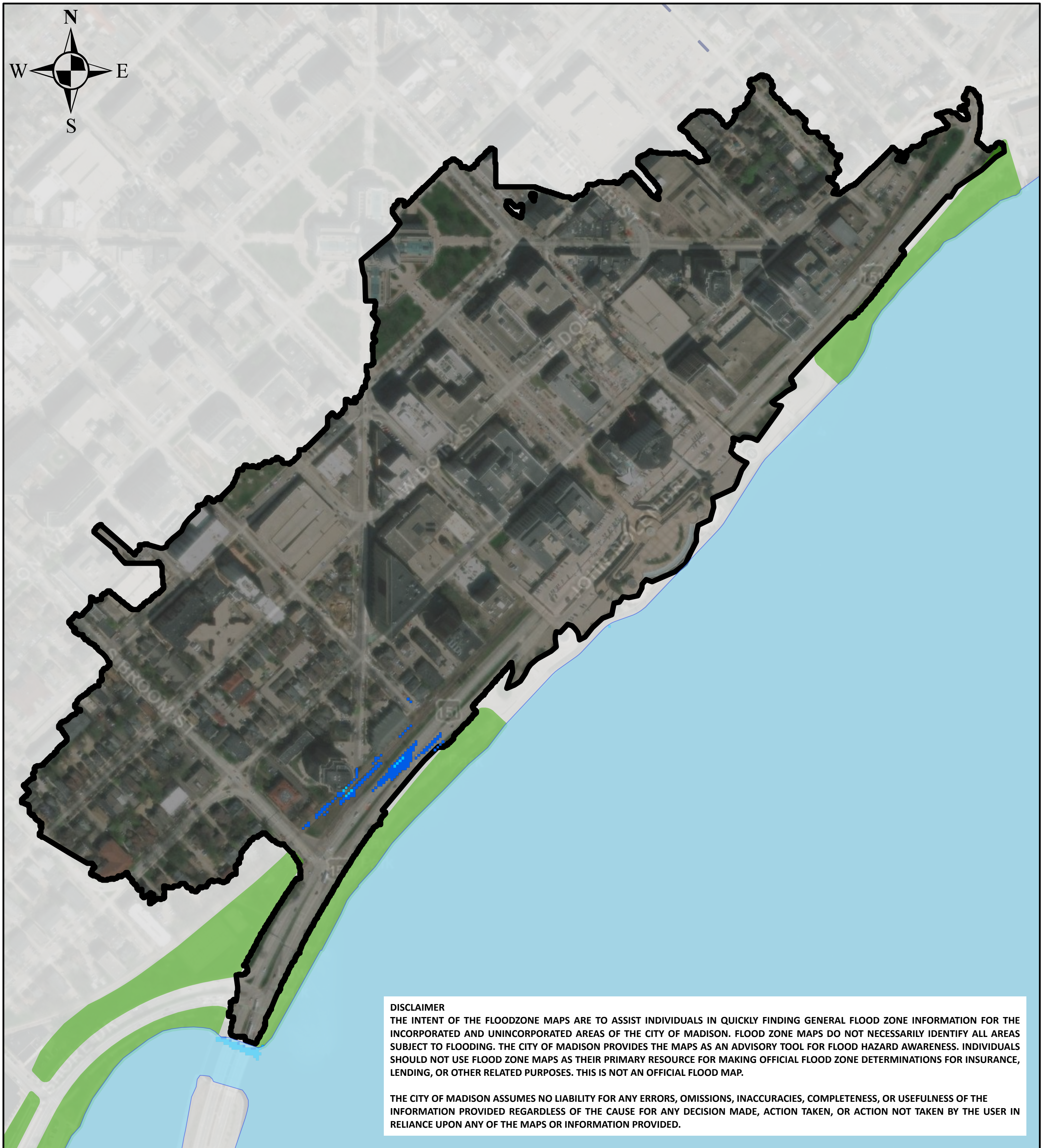
- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed Existing Conditions 2-year, 24-hour Storm Event Lake Level: 845.62' (OHWM) Maximum Water Depth

CITY OF MADISON WISCONSIN



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Legend

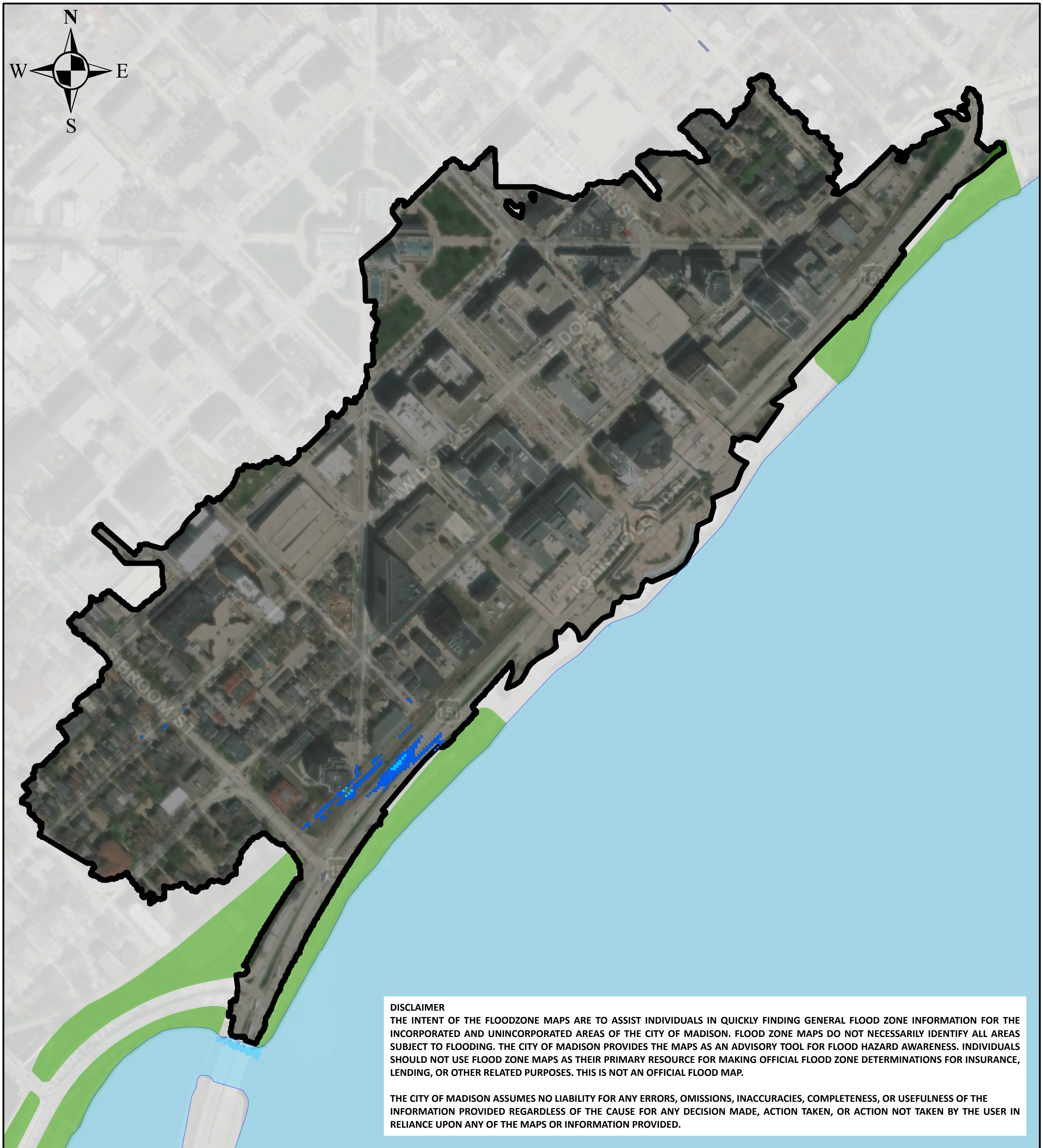
- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed Existing Conditions 5-year, 24-hour Storm Event Lake Level: 845.62' (OHWM) Maximum Water Depth

CITY OF MADISON WISCONSIN



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Legend

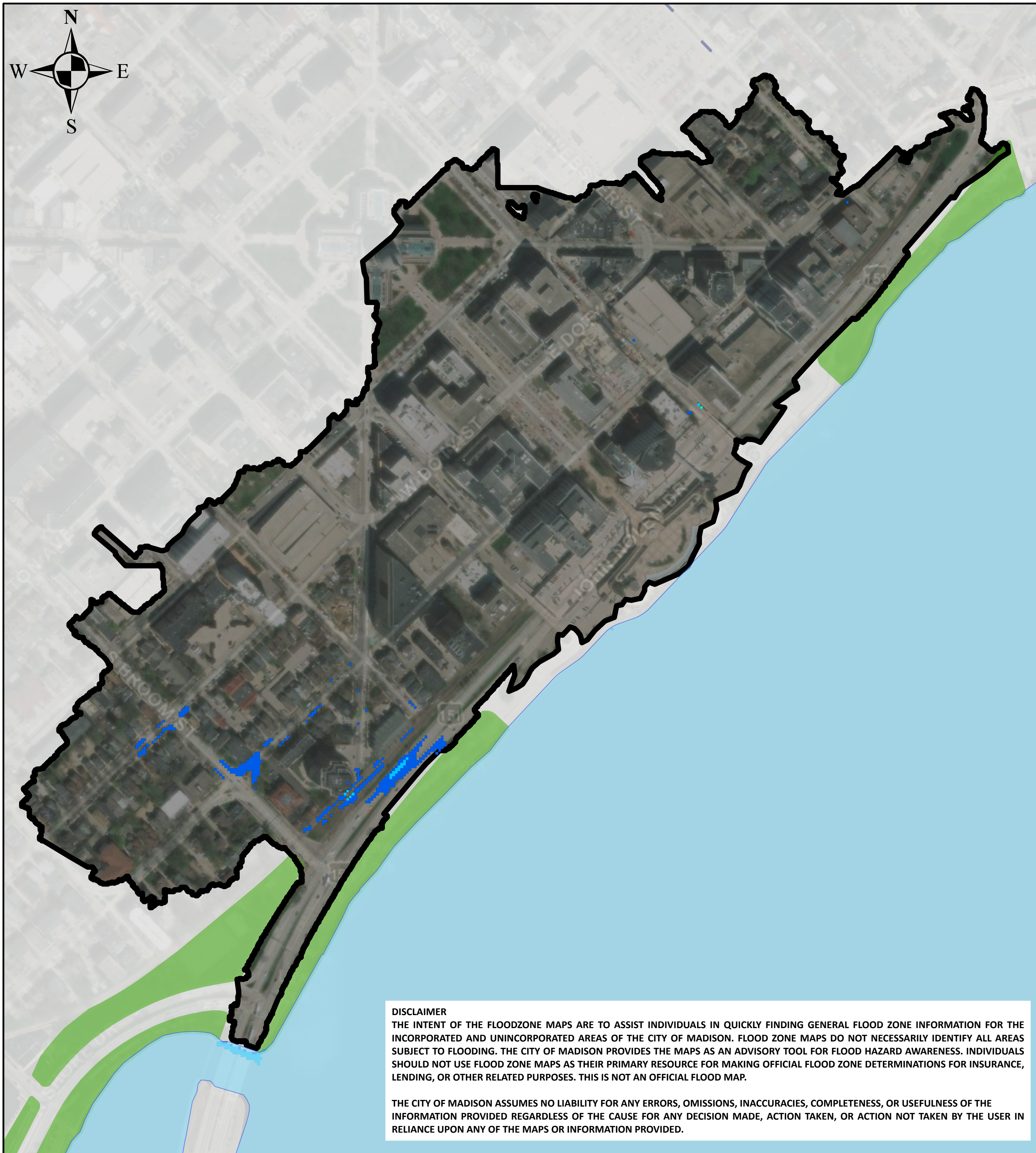
- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Existing Conditions
10-year, 24-hour Storm Event
Lake Level: 845.62' (OHWM)
Maximum Water Depth

CITY OF MADISON WISCONSIN



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Legend

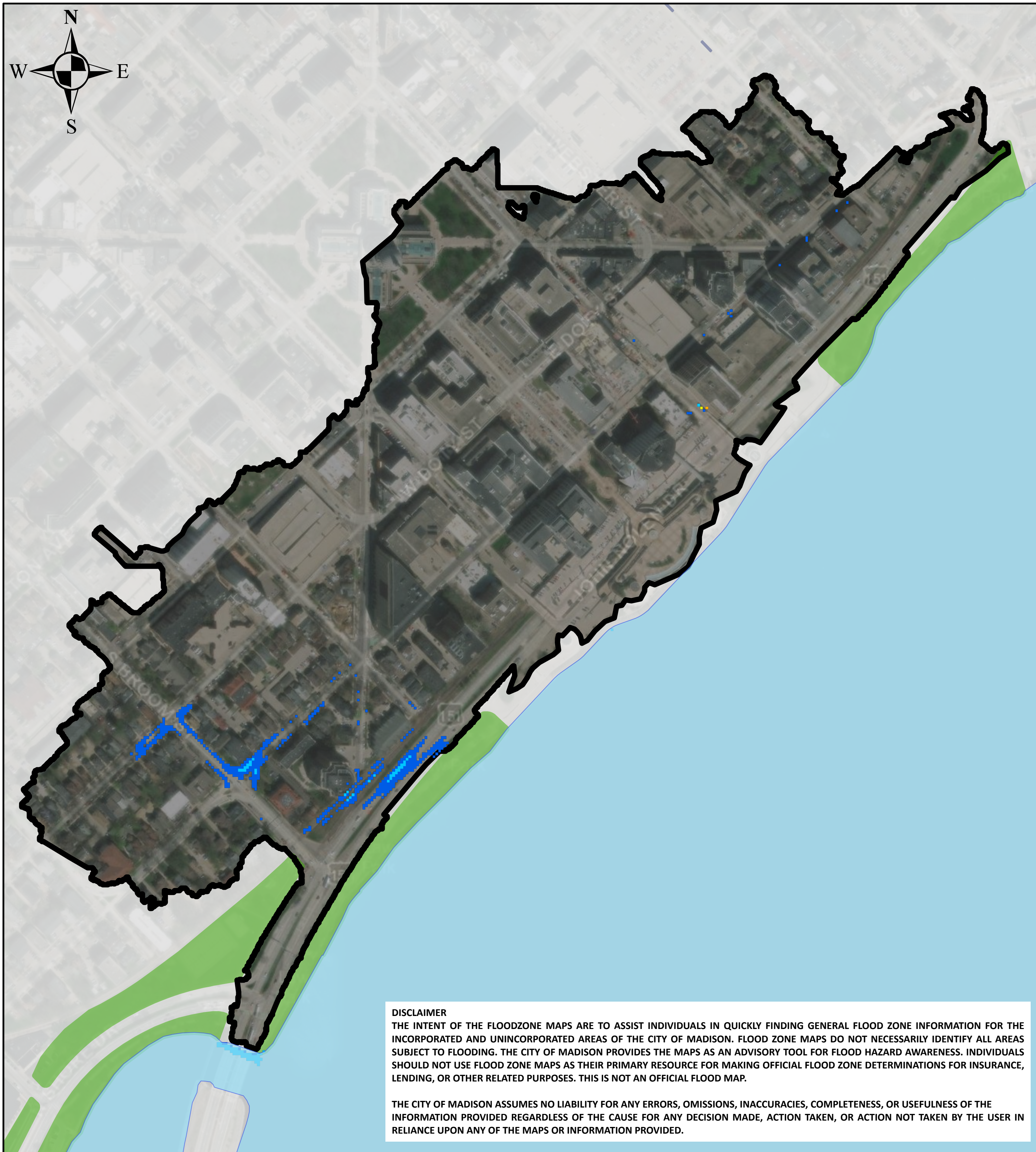
- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Existing Conditions
25-year, 24-hour Storm Event
Lake Level: 845.62' (OHWM)
Maximum Water Depth

CITY OF MADISON WISCONSIN



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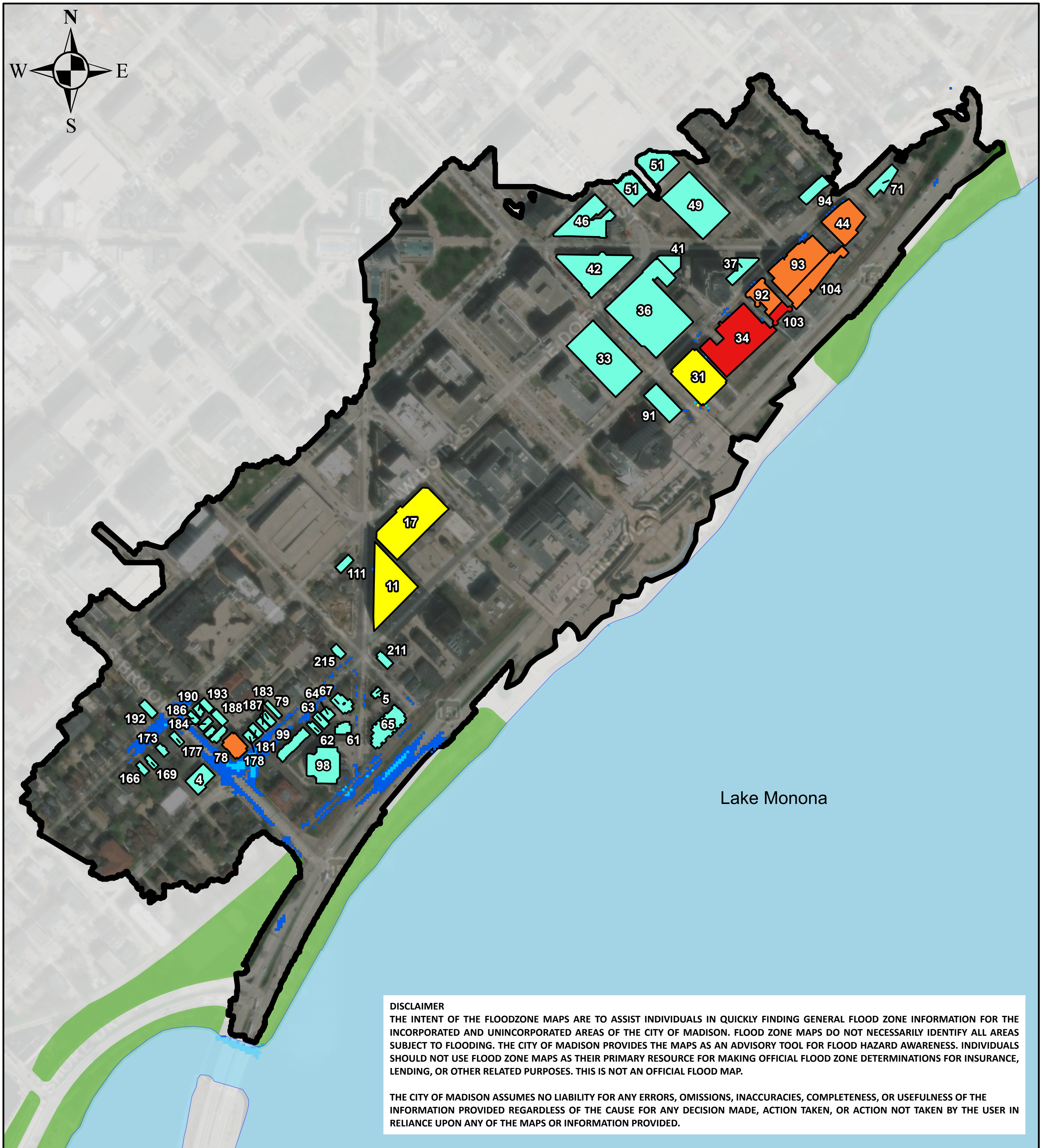
Legend

Watershed Boundary
Greenway
Pond
Park
Lakes and Rivers

Maximum Water Depth (ft)
- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Existing Conditions
50-year, 24-hour Storm Event
Lake Level: 845.62' (OHWM)
Maximum Water Depth

CITY OF MADISON WISCONSIN



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Legend

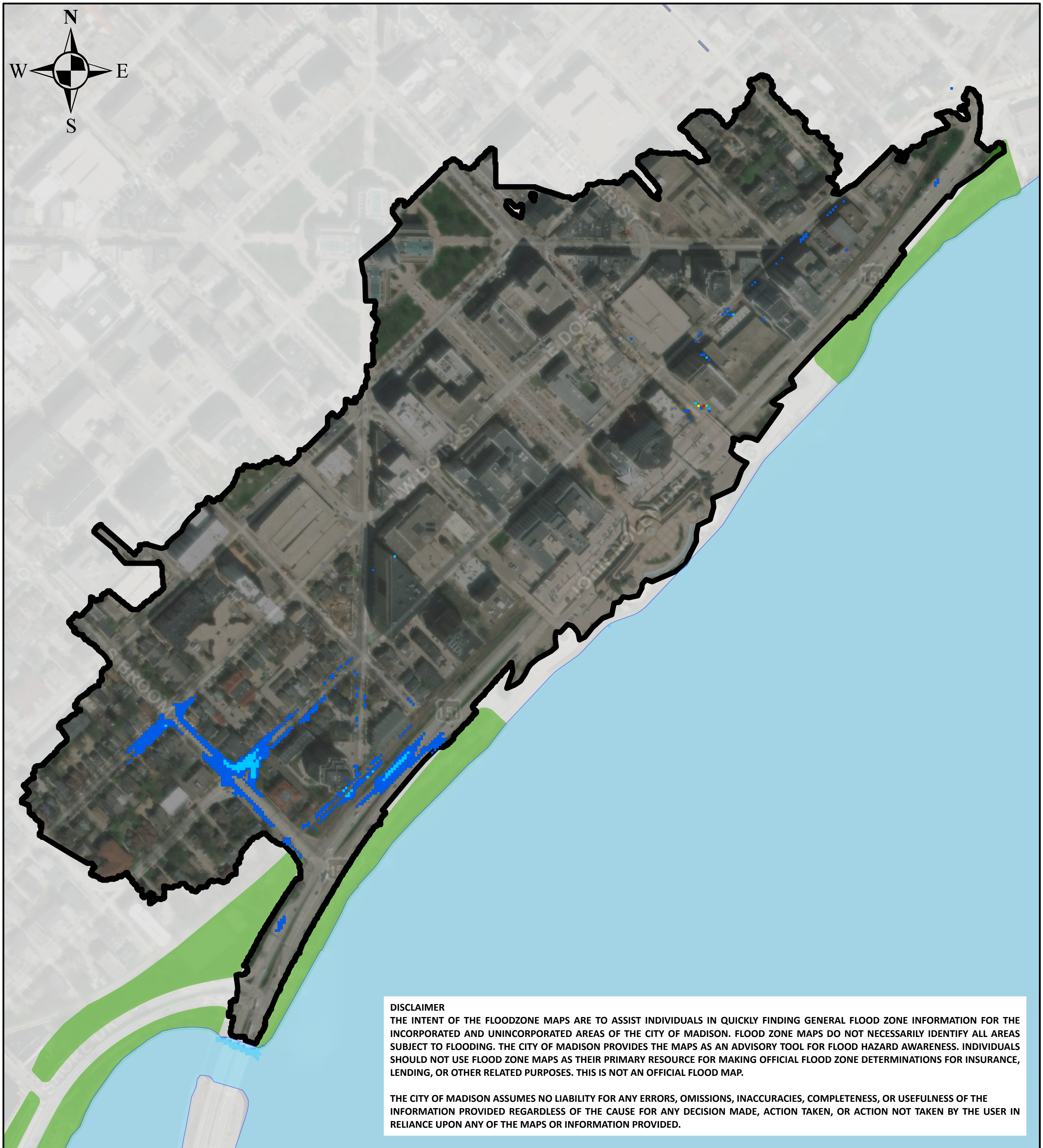
Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Building Flooding (in)
- <6"
- 6"-8"
- 8"-12"
- >12"

Central Isthmus Watershed
Existing Conditions
100-year, 24-hour
Maximum Water Depth &
Maximum Building Flooding

CITY OF MADISON WISCONSIN



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Legend

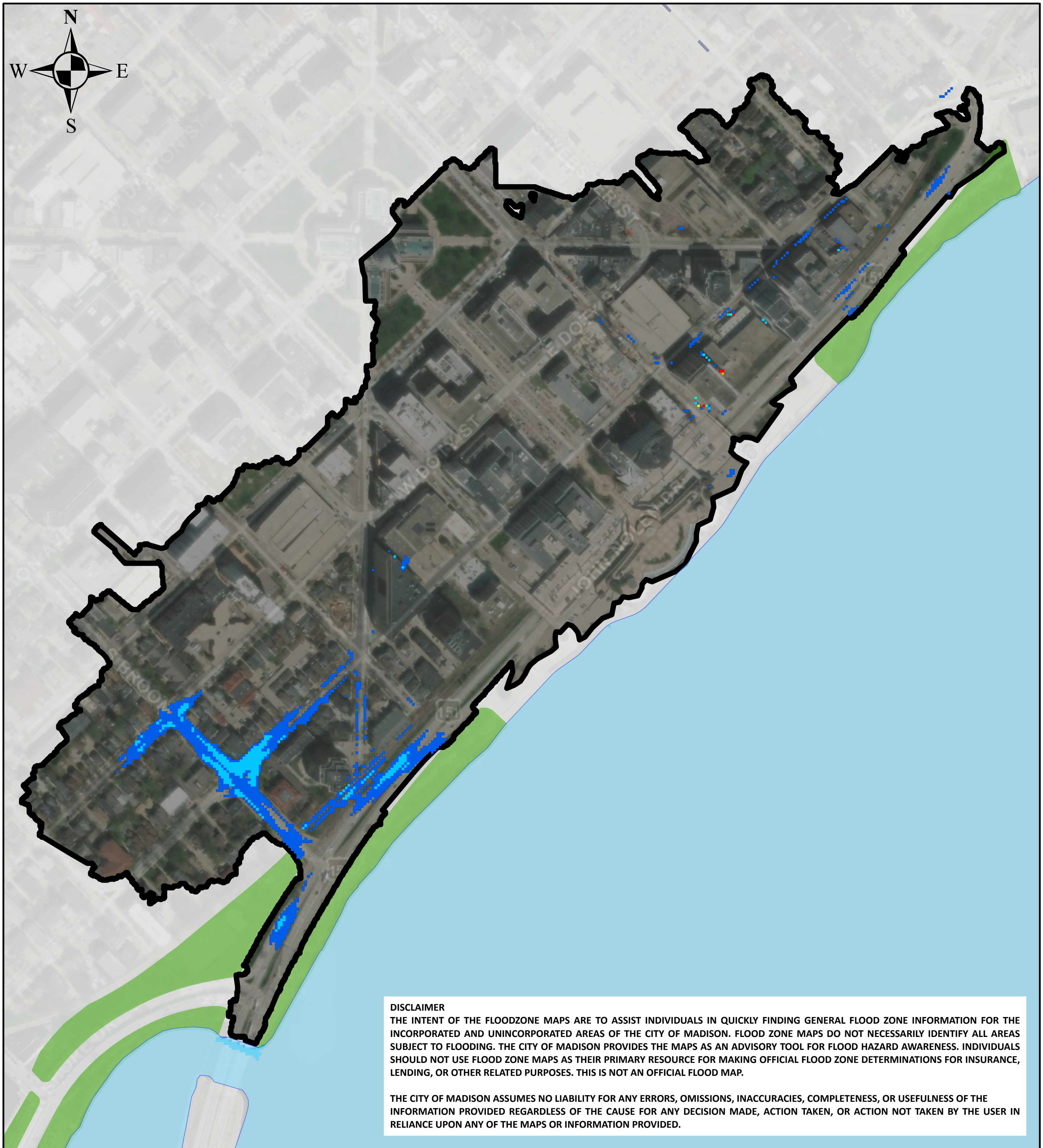
- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Existing Conditions
100-year, 24-hour Storm Event
Lake Level: 845.62' (OHWM)
Maximum Water Depth

CITY OF MADISON WISCONSIN



Legend

- Watershed Boundary
- Greenway
- Pond
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Existing Conditions
500-year, 24-hour Storm Event
Lake Level: 845.62' (OHWM)
Maximum Water Depth

CITY OF MADISON WISCONSIN

APPENDIX D: MITIGATION ALTERNATIVES

Legend

- Watershed Boundary
- Parks
- Lakes and Rivers
- Inlet
- Existing Pipe - Not Modeled
- Existing Pipe - Modeled
- Proposed or Modified

Central Isthmus Watershed Proposed Mitigation Alternative 1 Schematic*

**Not Chosen Alternative*

CITY OF MADISON WISCONSIN

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Legend

- Watershed Boundary
- Parks
- Lakes and Rivers
- Inlet
- Existing Pipe - Not Modeled
- Existing Pipe - Modeled
- Proposed or Modified

Central Isthmus Watershed Proposed Mitigation Alternative 2 Schematic*

**Not Chosen Alternative*

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Legend
- Watershed Boundary
- Lakes and Rivers
- Existing Pipe - Not Modeled
- Existing Pipe - Modeled
- Proposed or Modified

Central Isthmus Watershed Proposed Mitigation Alternative 3 Schematic
(Chosen Alternative)

CITY OF MADISON WISCONSIN

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Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
2-year, 24-hour
Maximum Water Depth

**Alternative Not Chosen*
**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN

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Legend

Watershed Boundary
Park
Lakes and Rivers

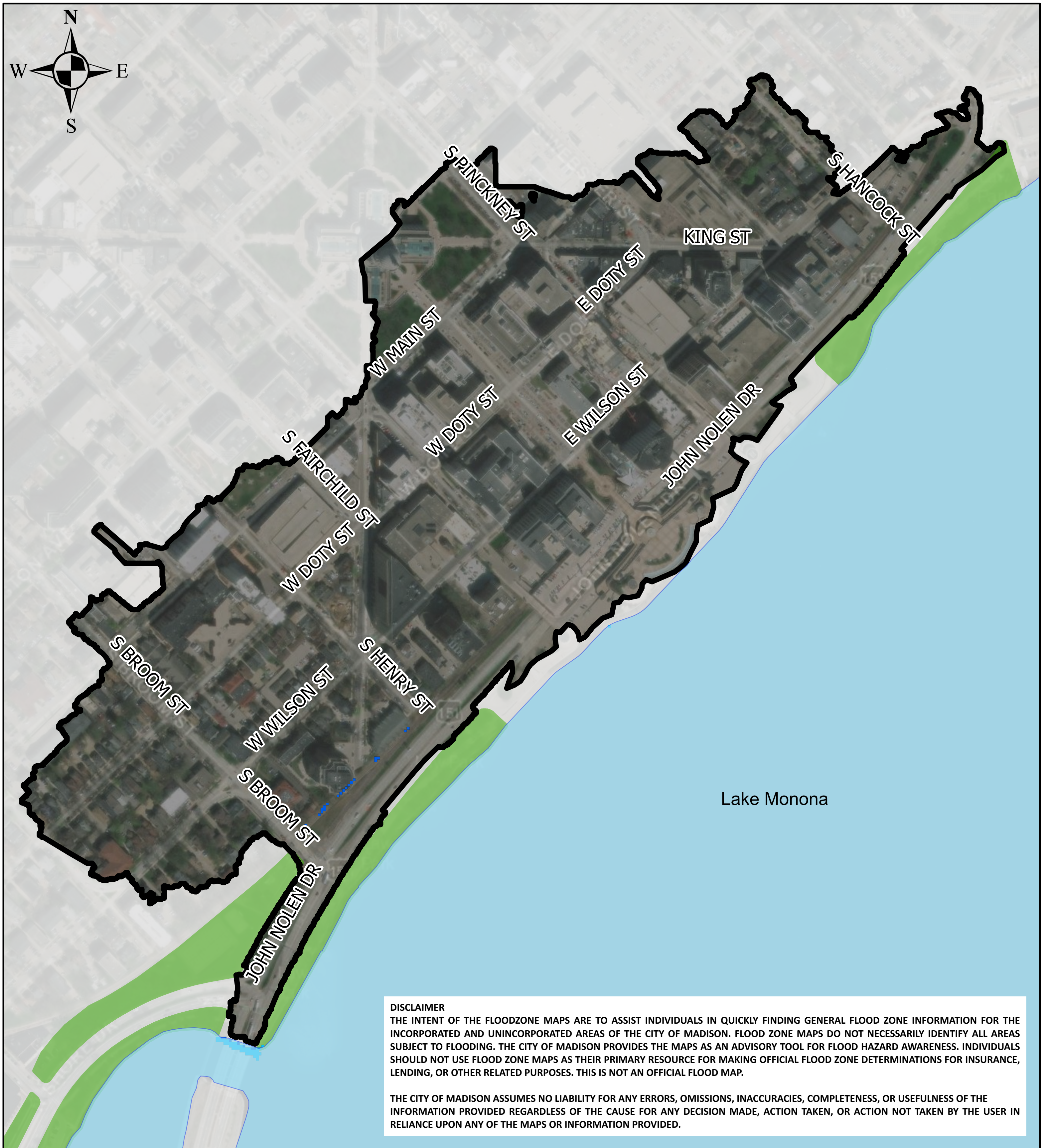
Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
5-year, 24-hour
Maximum Water Depth

**Alternative Not Chosen*

**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN



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Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
10-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

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Legend

Watershed Boundary

Park

Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
25-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

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Legend
- Watershed Boundary
- Park
- Lakes and Rivers

Maximum Water Depth (ft)
- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
50-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

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Legend

- Watershed Boundary
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
100-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

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Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 1 Mitigation Results
500-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

Legend

- Watershed Boundary
- Park
- Lakes and Rivers

Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed
Alternative 2 Mitigation Results
2-year, 24-hour
Maximum Water Depth

**Alternative Not Chosen*
**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN

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Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 2 Mitigation Results
5-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*
**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN

DISCLAIMER

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Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 2 Mitigation Results
10-year, 24-hour
Maximum Water Depth

**Alternative Not Chosen*
**No flooding predicted during this storm event.*

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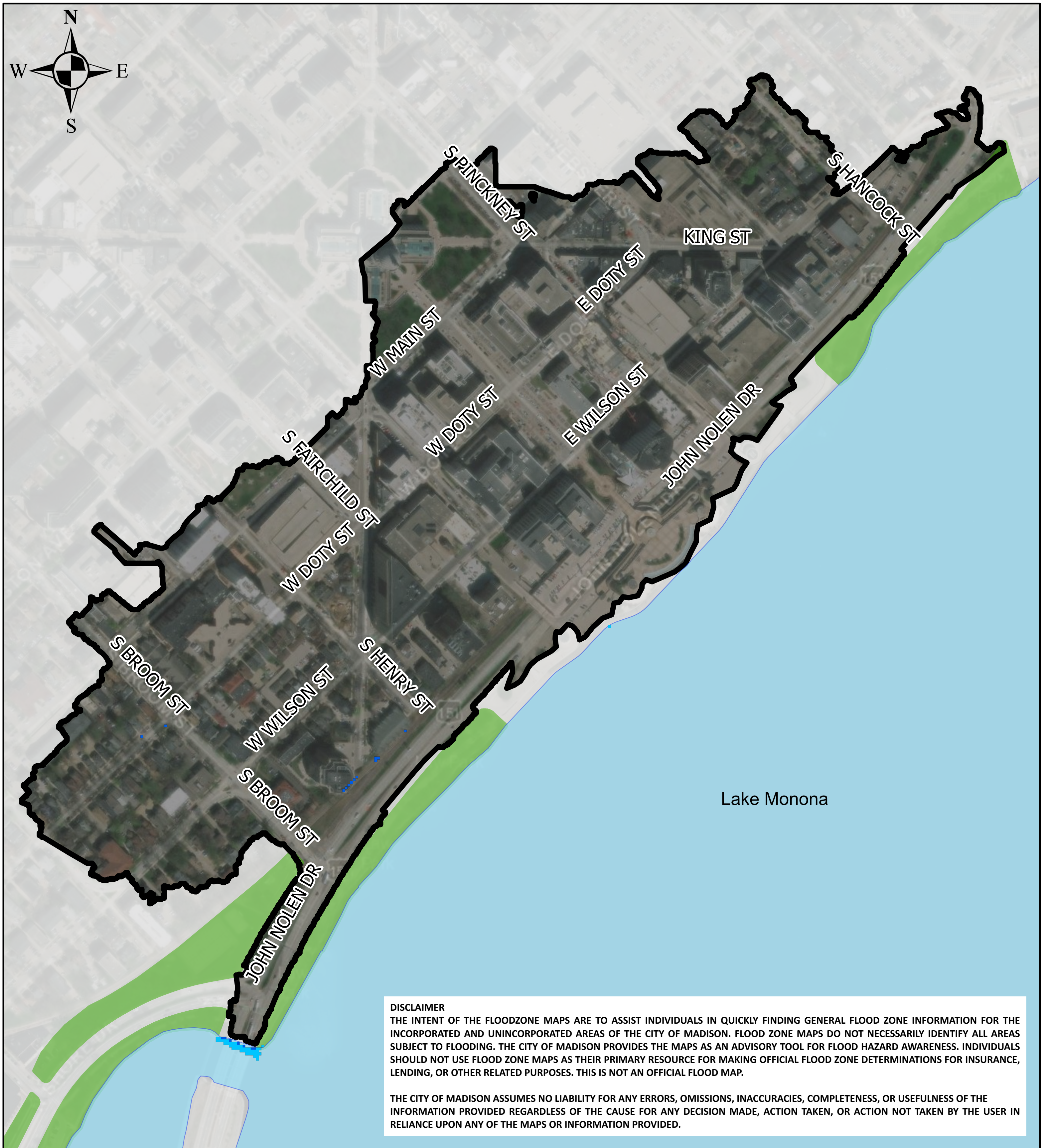
Legend

Watershed Boundary
Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
2-3
3-4
4-5
5+

Central Isthmus Watershed
Alternative 2 Mitigation Results
25-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*
**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN



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Legend

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Park
Lakes and Rivers

Maximum Water Depth (ft)
0.5-1
1-2
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5+

Central Isthmus Watershed
Alternative 2 Mitigation Results
50-year, 24-hour
Maximum Water Depth
**Alternative Not Chosen*

CITY OF MADISON WISCONSIN

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Central Isthmus Watershed
Alternative 2 Mitigation Results
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Maximum Water Depth
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CITY OF MADISON WISCONSIN

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Central Isthmus Watershed
Alternative 2 Mitigation Results
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Maximum Water Depth

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- Park
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Maximum Water Depth (ft)

- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Central Isthmus Watershed Alternative 3 Mitigation Results 2-year, 24-hour Maximum Water Depth

**Chosen Alternative*

**No flooding predicted during this storm event.*

CITY OF MADISON WISCONSIN

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Central Isthmus Watershed
Alternative 3 Mitigation Results
5-year, 24-hour
Maximum Water Depth

**Chosen Alternative*

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CITY OF MADISON WISCONSIN

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Central Isthmus Watershed
Alternative 3 Mitigation Results
10-year, 24-hour
Maximum Water Depth
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CITY OF MADISON WISCONSIN

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Alternative 3 Mitigation Results
25-year, 24-hour
Maximum Water Depth

**Chosen Alternative*
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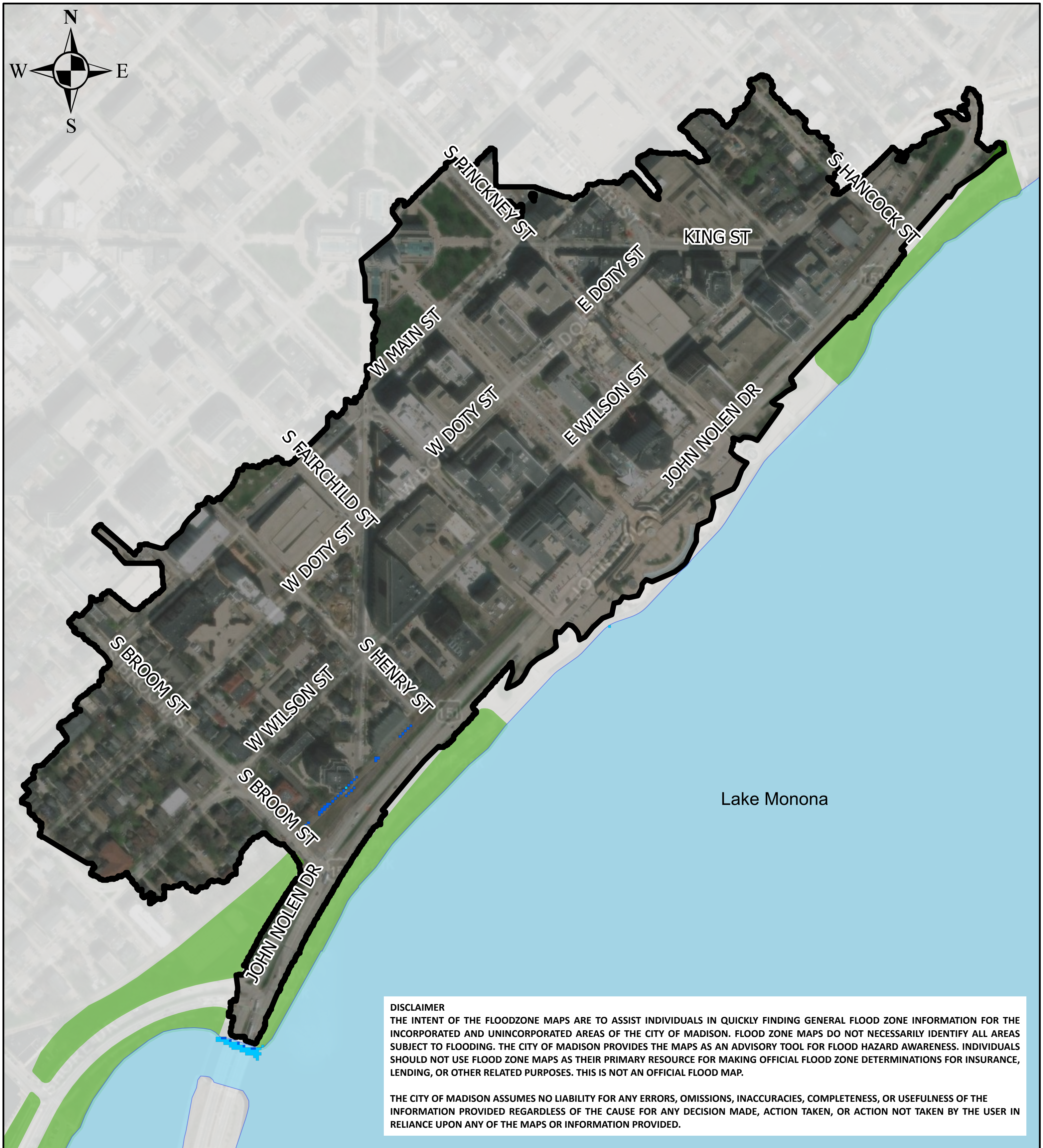
CITY OF MADISON WISCONSIN



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Central Isthmus Watershed
Alternative 3 Mitigation Results
50-year, 24-hour
Maximum Water Depth

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- Park
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Maximum Water Depth (ft)

- 0.5-1
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Central Isthmus Watershed
Alternative 3 Mitigation Results
100-year, 24-hour
Maximum Water Depth
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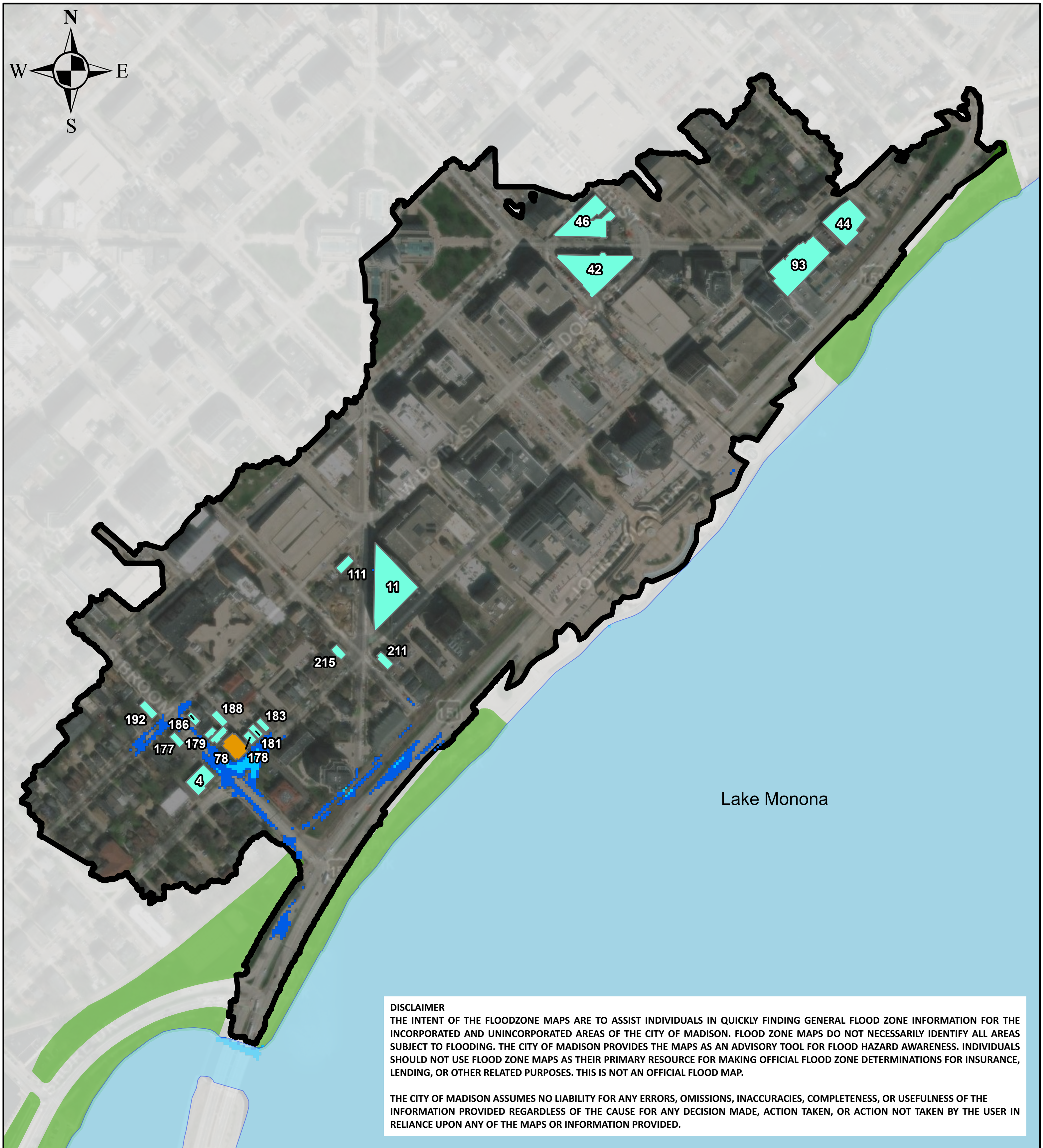
Central Isthmus Watershed
Alternative 3 Mitigation Results
500-year, 24-hour
Maximum Water Depth
**Chosen Alternative*

CITY OF MADISON WISCONSIN



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Park
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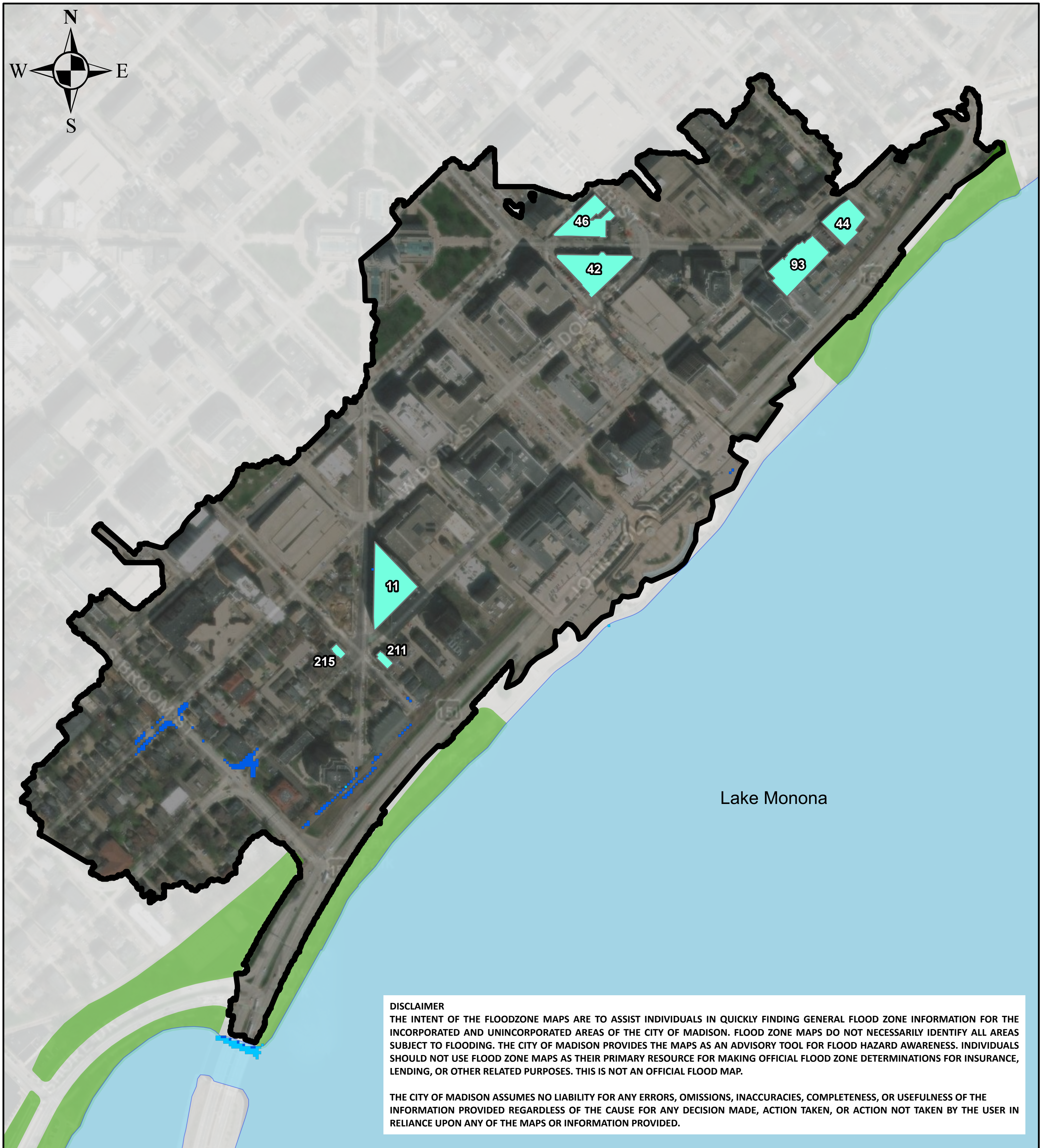
Maximum Water Depth (ft)
- 0.5-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

Building Flooding (in)
- <6"
- 6"-8"
- 8"-12"
- >12"

Note: Buildings flooding 6" and less are considered meeting the City's flood goals.

Central Isthmus Watershed Mitigation Alternative 1 100-year, 24-hour Maximum Water Depth & Maximum Building Flooding

CITY OF MADISON WISCONSIN



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Park
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0.5-1
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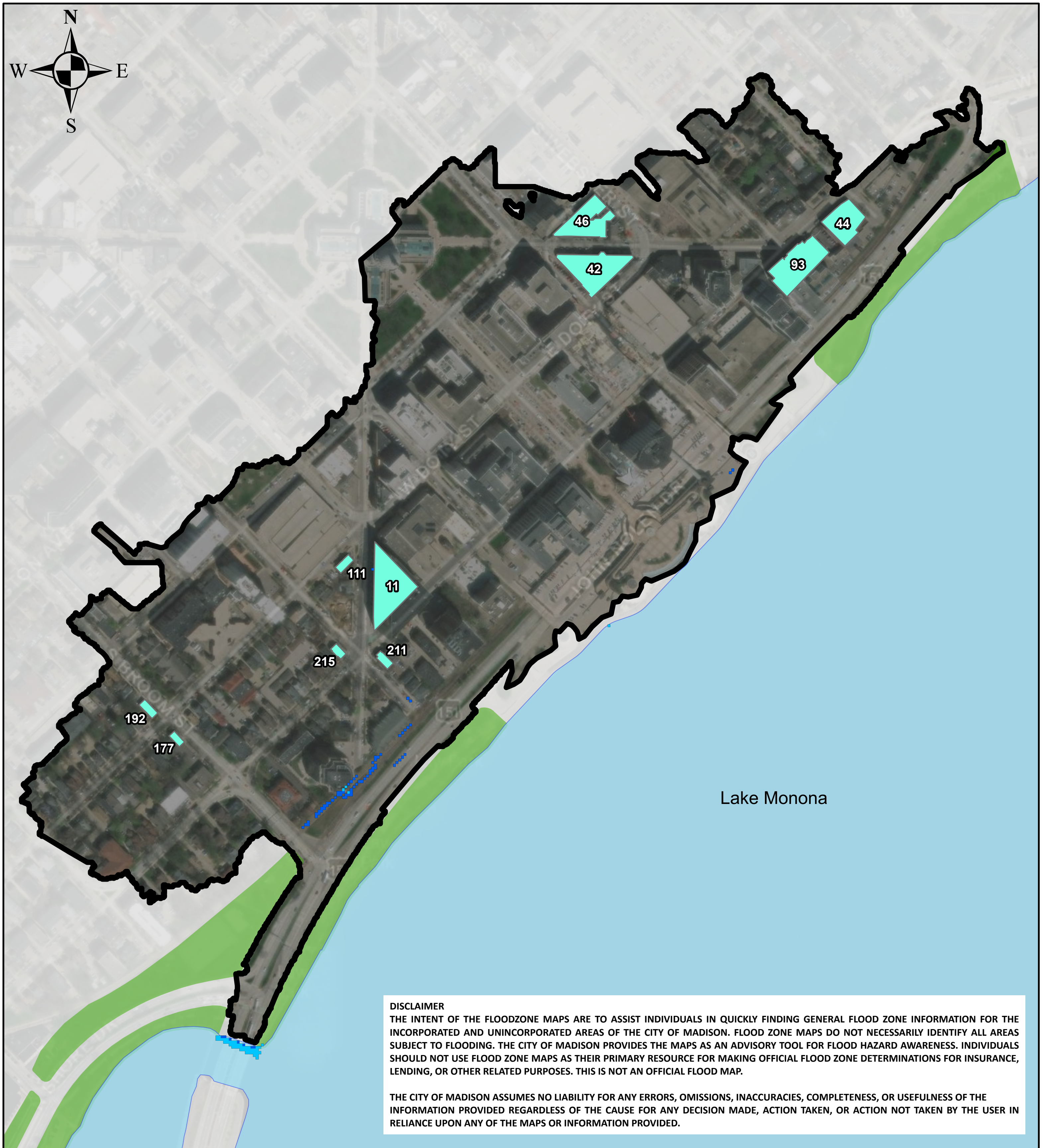
5+

Building Flooding (in)
<6"
6"-8"
8"-12"
>12"

Note: Buildings flooding 6" and less are considered meeting the City's flood goals.

Central Isthmus Watershed Mitigation Alternative 2 100-year, 24-hour Maximum Water Depth & Maximum Building Flooding



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Building Flooding (in)
<6"
6"-8"
8"-12"
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Note: Buildings flooding 6" and less are considered meeting the City's flood goals.

Central Isthmus Watershed Mitigation Alternative 3 100-year, 24-hour Maximum Water Depth & Maximum Building Flooding

CITY OF MADISON WISCONSIN

Table 1. Alternative 1 Mitigation Summary

Table 1. Alternative 1 Mitigation Summary

Schematic Ref	Location Ref	Existing Size	Proposed Size	US Node ID	DS Node ID	Pipe ID	Existing					Proposed							Notes
							US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	Design Flow Rate, CFS	Design Recurrence Interval, Years	
A	S Broom between W Doty & W Wilson	24	29x45	AS5052-044	MI5052-045	AS5052-044_MI5052-045	852.34	852.30	13	0.31%	12.6	852.34	852.30	13	0.31%	25.2	22.7	10	Existing condition 10yr24hr model predicts more than 10,000 CF of manhole surcharge volume (Level of Service Goal #1) at intersection of W Broom Street & W Doty Street as a result of insufficient capacity of downstream S Broom Street sewer.
		24	29x45	MI5052-045	AS5052-094-01	MI5052-045_AS5052-094-01	852.30	851.55	247	0.30%	12.5	852.28	851.55	247	0.30%	37.5	22.7	10	
		24	29x45	AS5052-094-01	AS5052-094	AS5052-094-01_AS5052-094	851.55	850.78	247	0.31%	12.7	851.08	849.97	247	0.45%	46.2	22.5	10	
		24	29x45	AS5052-094	AS5052-087	AS5052-094_AS5052-087	850.77	849.59	84	1.40%	26.9	849.96	849.59	84	0.44%	45.8	26.3	10	
B	W Wilson between S Henry & S Broom	New	36	Prop.MH-1	IN5052-090	Prop.MH-1_IN5052-090	New					855.95	850.13	564	1.03%	67.8	39.9	100	Existing condition 10yr24hr model predicts more than 30,000 CF of manhole surcharge volume at the dead end of S Hamilton Street as a result of insufficient capacity of downstream S Hamilton Street sewer. Rerouting flow to a new sewer in W Wilson Street was chosen over upsizing the S Hamilton Street sewer/outfall due to feasibility constraints associated with John Nolen Drive & train tracks. **The W Wilson sewer was modeled at 36" instead of 24" to reduce flooding at the intersection of Wilson/Henry/Hamilton. The upstream invert of the proposed pipe was dropped to maintain adequate cover and to provide additional capacity (more slope) to IN5051-049_Prop.MH-1 which was surcharging into the intersection and contributing to flooding on S Hamilton dead end apartment building.**
C	W Wilson near S Broom intersection	18	36	IN5052-090	AS5052-087	IN5052-090_AS5052-087	851.58	849.51	60	3.45%	19.5	850.13	849.51	60	1.03%	67.8	34.7	100	Upsizing to match size of proposed 36" W Wilson sewer.
D	W Wilson near S Henry intersection	15	15	IN5051-049	Prop.MH-1	IN5051-049_Prop.MH-1	860.60	859.80	38	2.11%	9.4	860.59	855.95	78	5.95%	15.8	10.6	10	No changes to pipes hydraulically but rerouting to proposed new 24" W Wilson sewer. See improvement B notes above for justification.
		12	12	IN5051-083	Prop.MH-1	IN5051-083_Prop.MH-1	859.93	859.69	35	0.69%	3.0	859.92	859.17	41	1.83%	4.8	0.6	10	
E	S Henry near W Wilson intersection	24	24	AS5151-071	IN5151-070	AS5151-071_IN5151-070	863.14	855.26	194	4.06%	45.7	863.14	860.27	194	1.48%	27.5	12.2	10	Rerouting flow that was previously routed to the Hamilton Street outfall. The upstream pipe (AS5151-071_IN5151-070) was also replaced with new invert elevations such that sufficient slope could be provided to the new tie in point at Prop.MH-1.
		24	24	IN5151-070	Prop.MH-1	IN5151-070_Prop.MH-1	855.20	852.30	89	3.26%	40.9	860.26	855.95	71	6.07%	55.7	12.8	10	
F	S Pinckney near E Doty intersection	15	18	AS5150-136	AS5150-138	AS5150-136_AS5150-138	902.52	901.95	27	2.11%	9.4	902.52	901.95	27	2.11%	14.5	12.6	100	Existing condition 100yr24hr model predicted ~12,000 CF of manhole surcharge volume on S Pinckney Street between E Doty Street & E Wilson Street. Due to the steep downward grade on E Wilson Street, the surcharged stormwater flows NE towards S Hancock Street and substantially floods the E Wilson municipal buildings along with other buildings near the intersection of E Wilson & King Street (Level of Service Goal #3). The sewers were sized based on model predicted cumulative flow rates and assuming the usage of existing invert elevations/alignment. Pipes with steep gradients, such as AS5150-122_AS5150-050 (Schematic Ref I), required a smaller pipe size to convey the same amount of flow as pipes with flatter gradients such as AS5150-143_AS5150-122 (Schematic Ref H).
		15	18	AS5150-138	IN5150-139	AS5150-138_IN5150-139	901.95	899.96	70	2.84%	10.9	901.95	899.96	70	2.84%	17.7	12.5	100	
		15	18	IN5150-139	IN5150-140	IN5150-139_IN5150-140	899.96	897.75	84	2.63%	10.5	899.96	897.75	84	2.63%	17.0	15.4	100	
G	S Pinckney between E Doty & E Wilson	15	21	IN5150-140	IN5150-142	IN5150-140_IN5150-142	897.75	894.78	115	2.58%	10.4	897.75	894.78	115	2.58%	25.5	18.7	100	
H	S Pinckney near E Wilson intersection	15	24	IN5150-142	AS5150-143	IN5150-142_AS5150-143	894.78	894.49	16	1.81%	8.7	894.78	894.49	16	1.81%	22.2	24.3	100	
		15	24	AS5150-143	AS5150-122	AS5150-143_AS5150-122	894.24	894.02	24	0.92%	6.2	894.24	894.02	24	0.92%	19.4	24.3	100	
I	S Pinckney & E Wilson intersection	12	18	AS5150-122	AS5150-052	AS5150-122_AS5150-052	894.02	884.40	67	14.36%	13.5	894.02	884.40	67	14.36%	39.8	24.8	100	
J	S Hamilton near W Wilson/S Henry intersection	15	24	IN5051-057	MI5051-002	IN5051-057_MI5051-002	863.22	860.75	21	11.76%	22.2	863.22	860.75	21	11.76%	77.6	20.8	100	Flooding was predicted at IN5051-057 and it is recommended to upsize the existing pipe to 24-inch pipes. The next two pipes downstream are also recommended to be upsized since they were smaller than 24-inch.
		18	24	MI5051-002	AS5051-050	MI5051-002_AS5051-050	860.65	859.80	30	2.83%	17.7	860.65	859.80	30	2.83%	38.1	21.2	100	
		21	24	AS5051-050	AS5051-055	AS5051-050_AS5051-055	859.80	854.60	25	20.80%	72.3	859.80	854.60	25	20.80%	103.0	37.9	100	
L	E Wilson near intersection of King & S Butler	12	15	AS5250-005	IN5250-028	AS5250-005_IN5250-028	875.66	871.68	55	7.24%	9.6	875.66	871.68	55	7.24%	17.4	7.5	100	Two 12" pipes upstream of AS5250-005 merge into a single 12" pipe. In the 100yr24hr storm the pipe downstream of AS5250-005 surcharges as it does not have the capacity to handle the 2 upstream pipes of the same diameter. In the existing condition, more than 12,000 CF of water surcharge from AS5250-005 and flood the buildings downhill of E Wilson street.
		12	15	IN5250-028	AS5249-057	IN5250-028_AS5249-057	871.68	868.6	65	4.74%	7.8	871.68	868.60	65	4.74%	14.1	14.2	100	
M	W Doty near S Hamilton intersection	12	18	MI5151-054	IN5151-053	MI5151-054_IN5151-053	899.88	899.33	65	0.85%	3.3	900.30	899.33	65	1.49%	12.8	8.9	100	Upstream and downstream pipes are 18", but MI5151-054_IN5151-053 is 12". In the 100yr24hr storm, MI5151-054 surcharges about 6,500 CF of stormwater, flooding buildings to the east & southeast of the intersection.

Table 2. Alternative 2 Mitigation Summary

Table 2. Alternative 2 Mitigation Summary

Schematic Ref	Location Ref	Existing Size	Proposed Size	US Node ID	DS Node ID	Pipe ID	Existing					Proposed							Notes
							US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	Design Flow Rate, CFS	Design Recurrence Interval, Years	
A	S Broom between W Doty & W Wilson	24	29x45	AS5052-044	MI5052-045	AS5052-044_MI5052-045	852.34	852.30	13	0.31%	12.6	852.34	852.30	13	0.31%	25.2	22.6	10	Existing condition 10yr24hr model predicts more than 10,000 CF of manhole surcharge volume (Level of Service Goal #1) at intersection of W Broom Street & W Doty Street as a result of insufficient capacity of downstream S Broom Street sewer.
		24	29x45	MI5052-045	AS5052-094-01	MI5052-045_AS5052-094-01	852.30	851.55	247	0.30%	12.5	852.30	851.55	247	0.30%	38.0	22.5	10	
		24	29x45	AS5052-094-01	AS5052-094	AS5052-094-01_AS5052-094	851.55	850.78	247	0.31%	12.7	851.55	850.78	247	0.31%	38.5	23.5	10	
		24	29x45	AS5052-094	AS5052-087	AS5052-094_AS5052-087	850.77	849.59	84	1.40%	26.9	850.78	849.59	84	1.42%	82.1	27.7	10	
F	S Pinckney near E Doty intersection	15	18	AS5150-136	AS5150-138	AS5150-136_AS5150-138	902.52	901.95	27	2.11%	9.4	902.52	901.95	27	2.11%	14.5	12.6	100	Existing condition 100yr24hr model predicted ~12,000 CF of manhole surcharge volume on S Pinckney Street between E Doty Street & E Wilson Street. Due to the steep downward grade on E Wilson Street, the surcharged stormwater flows NE towards S Hancock Street and substantially floods the E Wilson municipal buildings along with other buildings near the intersection of E Wilson & King Street (Level of Service Goal #3). The sewers were sized based on model predicted cumulative flow rates and assuming the usage of existing invert elevations/alignment. Pipes with steep gradients, such as AS5150-122_AS5150-050 (Schematic Ref I), required a smaller pipe size to convey the same amount of flow as pipes with flatter gradients such as AS5150-143_AS5150-122 (Schematic Ref H).
		15	18	AS5150-138	IN5150-139	AS5150-138_IN5150-139	901.95	899.96	70	2.84%	10.9	901.95	899.96	70	2.84%	17.7	12.5	100	
		15	18	IN5150-139	IN5150-140	IN5150-139_IN5150-140	899.96	897.75	84	2.63%	10.5	899.96	897.75	84	2.63%	17.0	15.4	100	
G	S Pinckney between E Doty & E Wilson	15	21	IN5150-140	IN5150-142	IN5150-140_IN5150-142	897.75	894.78	115	2.58%	10.4	897.75	894.78	115	2.58%	25.5	18.7	100	
H	S Pinckney near E Wilson intersection	15	24	IN5150-142	AS5150-143	IN5150-142_AS5150-143	894.78	894.49	16	1.81%	8.7	894.78	894.49	16	1.81%	22.2	24.3	100	
		15	24	AS5150-143	AS5150-122	AS5150-143_AS5150-122	894.24	894.02	24	0.92%	6.2	894.24	894.02	24	0.92%	19.4	24.3	100	
I	S Pinckney & E Wilson intersection	12	18	AS5150-122	AS5150-052	AS5150-122_AS5150-052	894.02	884.40	67	14.36%	13.5	894.02	884.40	67	14.36%	39.8	24.8	100	
J	S Hamilton near W Wilson/S Henry intersection	15	24	IN5051-057	MI5051-002	IN5051-057_MI5051-002	863.22	860.75	21	11.76%	22.2	863.22	860.75	21	11.76%	77.6	20.8	100	Flooding was predicted at IN5051-057 and it is recommended to upsize the existing pipe to 24-inch pipes. The next two pipes downstream are also recommended to be upsized since they were smaller than 24-inch.
		18	24	MI5051-002	AS5051-050	MI5051-002_AS5051-050	860.65	859.80	30	2.83%	17.7	860.65	859.80	30	2.83%	38.1	21.2	100	
		21	24	AS5051-050	AS5051-055	AS5051-050_AS5051-055	859.80	854.60	25	20.80%	72.3	859.80	854.60	25	20.80%	103.0	37.9	100	
K	S Hamilton from N Henry /W Wilson intersection to Outfall	24	36	AS5051-056	AS5051-069	AS5051-056_AS5051-069	853.10	851.87	66	1.86%	91.2	853.10	851.87	66	1.86%	91.1	66.3	100	Upsize the Hamilton Street sewer and outfall downstream of the intersection with N Henry Street & W Wilson Street to an uniform 3ft diameter circular pipe. Upsizing this pipe and outfall relieves the need for a W Wilson diversion sewer or any work with intersection of Hamilton. While the pipes are being design tot he 100yr 24-hr storm, they do not need to have the capacity for full flow. Surcharging at the end segments of the Hamilton sewer does not cause building flooding.
		24	36	AS5051-069	AS5051-068	AS5051-069_AS5051-068	851.87	851.70	28	0.61%	52.1	851.87	851.70	28	0.61%	50.2	66.3	100	
		24	36	AS5051-068	AS5052-107	AS5051-068_AS5052-107	851.70	850.82	110	0.80%	59.8	851.70	850.82	110	0.80%	59.7	67.7	100	
		24	36	AS5052-107	AS5052-106	AS5052-107_AS5052-106	850.82	847.01	160	2.38%	103.1	850.82	847.01	160	2.38%	102.9	67.7	100	
		27	36	AS5052-106	AS5052-037	AS5052-106_AS5052-037	847.01	846.83	31	0.58%	50.9	847.01	846.83	31	0.58%	50.8	58.2	100	
		21	36	AS5052-037	AS5052-109	AS5052-037_AS5052-109	846.83	846.15	16	4.25%	137.8	846.83	846.15	16	4.25%	100.4	61.9	100	
		21	36	AS5052-109	IN5152-009	AS5052-109_IN5152-009	846.15	844.51	86	1.91%	92.3	846.15	844.51	86	1.91%	92.1	62.0	100	
		21	36	IN5152-009	IN5152-010	IN5152-009_IN5152-010	844.51	844.30	35	0.60%	51.8	844.51	844.30	35	0.60%	51.7	62.0	100	
		21	36	IN5152-010	AS5152-014	IN5152-010_AS5152-014	844.30	844.27	5	0.60%	51.8	844.30	844.27	5	0.60%	21.1	62.2	100	
		21	36	AS5152-014	IN5152-011	AS5152-014_IN5152-011	844.27	844.22	10	0.50%	47.3	844.27	844.22	10	0.50%	27.2	62.2	100	
		21	36	IN5152-011	IN5152-012	IN5152-011_IN5152-012	844.22	844.05	35	0.49%	46.6	844.22	844.05	35	0.49%	46.5	62.8	100	
		21	36	IN5152-012	AE5152-013	IN5152-012_AE5152-013	844.05	843.60	90	0.50%	47.3	844.05	843.60	90	0.50%	47.2	63.3	100	
L	E Wilson near intersection of King & S Butler	12	15	AS5250-005	IN5250-028	AS5250-005_IN5250-028	875.66	871.68	55	7.24%	9.6	875.66	871.68	55	7.24%	17.4	7.5	100	Two 12" pipes upstream of AS5250-005 merge into a single 12" pipe. In the 100yr24hr storm the pipe downstream of AS5250-005 surcharges as it does not have the capacity to handle the 2 upstream pipes of the same diameter. In the existing condition, more than 12,000 CF of water surcharge from AS5250-005 and flood the buildings downhill of E Wilson street.
		12	15	IN5250-028	AS5249-057	IN5250-028_AS5249-057	871.68	868.6	65	4.74%	7.8	871.68	868.60	65	4.74%	14.1	14.2	100	
M	W Doty near S Hamilton intersection	12	18	MI5151-054	IN5151-053	MI5151-054_IN5151-053	899.88	899.33	65	0.85%	3.3	900.30	899.33	65	1.49%	12.8	8.9	100	Upstream and downstream pipes are 18", but MI5151-054_IN5151-053 is 12". In the 100yr24hr storm, MI5151-054 surcharges about 6,500 CF of stormwater, flooding buildings to the east & southeast of the intersection.

Table 3. Alternative 3 Mitigation Summary

Table 3. Alternative 3 Mitigation Summary

Schematic Ref	Location Ref	Existing Size	Proposed Size	US Node ID	DS Node ID	Pipe ID	Existing					Proposed							Notes
							US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	US Inv	DS Inv	Length, LF	Slope, %	Capacity, CFS	Design Flow Rate, CFS	Design Recurrence Interval, Years	
A	S Broom between W Doty & W Wilson	24	29x45	AS5052-044	MI5052-045	AS5052-044_MI5052-045	852.34	852.30	13	0.31%	12.6	852.34	852.28	13	0.46%	30.8	22.6	10	Existing condition 10yr24hr model predicts more than 10,000 CF of manhole surcharge volume (Level of Service Goal #1) at intersection of W Broom Street & W Doty Street as a result of insufficient capacity of downstream S Broom Street sewer.
		24	29x45	MI5052-045	AS5052-094-01	MI5052-045_AS5052-094-01	852.30	851.55	247	0.30%	12.5	852.28	851.09	247	0.48%	47.9	22.5	10	
		24	29x45	AS5052-094-01	AS5052-094	AS5052-094-01_AS5052-094	851.55	850.78	247	0.31%	12.7	851.08	849.97	247	0.45%	46.2	23.5	10	
		24	29x45	AS5052-094	AS5052-087	AS5052-094_AS5052-087	850.77	849.59	84	1.40%	26.9	849.96	849.59	84	0.44%	45.8	27.7	10	
B	W Wilson between S Henry & S Broom	New	36	Prop.MH-1	IN5052-090	Prop.MH-1_IN5052-090	New					855.95	850.13	564	1.03%	62.9	47.2	100	Existing condition 10yr24hr model predicts more than 30,000 CF of manhole surcharge volume at the dead end of S Hamilton Street as a result of insufficient capacity of downstream S Hamilton Street sewer. Rerouting flow to a new sewer in W Wilson Street was chosen over upsizing the S Hamilton Street sewer/outfall due to feasibilty constraints associated with John Nolen Drive & train tracks. **The W Wilson sewer was modeled at 36" instead of 24" to reduce flooding at the intersection of Wilson/Henry/Hamilton. The upstream invert of the proposed pipe was dropped to maintain adequate cover and to provide additional capacity (more slope) to IN5051-049_Prop.MH-1 which was surcharging into the intersection and contributing to flooding on S Hamilton dead end apartment building.**
C	W Wilson near S Broom intersection	18	36	IN5052-090	AS5052-087	IN5052-090_AS5052-087	851.58	849.51	60	3.45%	19.5	850.13	849.51	60	1.03%	67.8	64.5	100	Upsizing to match size of proposed 36" W Wilson sewer.
D	W Wilson near S Henry intersection	15	15	IN5051-049	Prop.MH-1	IN5051-049_Prop.MH-1	860.60	859.80	38	2.11%	9.4	860.59	855.95	78	5.95%	14.6	10.6	10	No changes to pipes hydraulically but rerouting to proposed new 24" W Wilson sewer. See improvement B notes above for justification.
		12	12	IN5051-083	Prop.MH-1	IN5051-083_Prop.MH-1	859.93	859.69	35	0.69%	3.0	859.92	857.95	41	4.80%	7.3	0.6	10	
E	S Henry near W Wilson intersection	24	24	AS5151-071	IN5151-070	AS5151-071_IN5151-070	863.14	855.26	194	4.06%	45.7	863.14	860.27	194	1.48%	27.5	12.2	10	Rerouting flow that was previously routed to the Hamilton Street outfall. The upstream pipe (AS5151-071_IN5151-070) was also replaced with new invert elevations such that sufficient slope could be provided to the new tie in point at Prop.MH-1.
		24	24	IN5151-070	Prop.MH-1	IN5151-070_Prop.MH-1	855.20	852.30	89	3.26%	40.9	860.26	855.95	71	6.07%	51.8	18.5	10	
F	S Pinckney near E Doty intersection	15	18	AS5150-136	AS5150-138	AS5150-136_AS5150-138	902.52	901.95	27	2.11%	9.4	902.52	901.95	27	2.11%	14.5	12.6	100	Existing condition 100yr24hr model predicted ~12,000 CF of manhole surcharge volume on S Pinckney Street between E Doty Street & E Wilson Street. Due to the steep downward grade on E Wilson Street, the surcharged stormwater flows NE towards S Hancock Street and substantially floods the E Wilson municipal buildings along with other buildings near the intersection of E Wilson & King Street (Level of Service Goal #3). The sewers were sized based on model predicted cumulative flow rates and assuming the usage of existing invert elevations/alignment. Pipes with steep gradients, such as AS5150-122_AS5150-050 (Schematic Ref I), required a smaller pipe size to convey the same amount of flow as pipes with flatter gradients such as AS5150-143_AS5150-122 (Schematic Ref H).
		15	18	AS5150-138	IN5150-139	AS5150-138_IN5150-139	901.95	899.96	70	2.84%	10.9	901.95	899.96	70	2.84%	17.7	12.5	100	
		15	18	IN5150-139	IN5150-140	IN5150-139_IN5150-140	899.96	897.75	84	2.63%	10.5	899.96	897.75	84	2.63%	17.0	15.4	100	
G	S Pinckney between E Doty & E Wilson	15	21	IN5150-140	IN5150-142	IN5150-140_IN5150-142	897.75	894.78	115	2.58%	10.4	897.75	894.78	115	2.58%	25.5	18.7	100	
H	S Pinckney near E Wilson intersection	15	24	IN5150-142	AS5150-143	IN5150-142_AS5150-143	894.78	894.49	16	1.81%	8.7	894.78	894.49	16	1.81%	22.2	24.3	100	
		15	24	AS5150-143	AS5150-122	AS5150-143_AS5150-122	894.24	894.02	24	0.92%	6.2	894.24	894.02	24	0.92%	19.4	24.3	100	
I	S Pinckney & E Wilson intersection	12	18	AS5150-122	AS5150-052	AS5150-122_AS5150-052	894.02	884.40	67	14.36%	13.5	894.02	884.40	67	14.36%	39.8	24.8	100	
J	S Hamilton near W Wilson/S Henry intersection	15	24	IN5051-057	MI5051-002	IN5051-057_MI5051-002	863.22	860.75	21	11.76%	22.2	863.22	860.75	21	11.76%	77.6	20.8	100	Flooding was predicted at IN5051-057 and it is recommended to upsize the existing pipe to 24-inch pipes. The next two pipes downstream are also recommended to be upsized since they were smaller than 24-inch.
		18	24	MI5051-002	AS5051-050	MI5051-002_AS5051-050	860.65	859.80	30	2.83%	17.7	860.65	859.80	30	2.83%	38.1	21.2	100	
		21	24	AS5051-050	AS5051-055	AS5051-050_AS5051-055	859.80	854.60	25	20.80%	72.3	859.80	854.60	25	20.80%	103.0	37.9	100	
L	E Wilson near intersection of King & S Butler	12	15	AS5250-005	IN5250-028	AS5250-005_IN5250-028	875.66	871.68	55	7.24%	9.6	875.66	871.68	55	7.24%	17.4	7.5	100	Two 12" pipes upstream of AS5250-005 merge into a single 12" pipe. In the 100yr24hr storm the pipe downstream of AS5250-005 surcharges as it does not have the capacity to handle the 2 upstream pipes of the same diameter. In the existing condition, more than 12,000 CF of water surcharge from AS5250-005 and flood the buildings downhill of E Wilson street.
		12	15	IN5250-028	AS5249-057	IN5250-028_AS5249-057	871.68	868.6	65	4.74%	7.8	871.68	868.60	65	4.74%	14.1	14.2	100	
M	W Doty near S Hamilton intersection	12	18	MI5151-054	IN5151-053	MI5151-054_IN5151-053	899.88	899.33	65	0.85%	3.3	900.30	899.33	65	1.49%	12.8	8.9	100	Upstream and downstream pipes are 18", but MI5151-054_IN5151-053 is 12". In the 100yr24hr storm, MI%151-054 surcharges about 6,500 CF of stormwater, flooding buildings to the east & southeast of the intersection.
N	W Wilson near intersection with S Hamilton & S Henry	15	15	IN5151-067	IN5151-013	IN5151-067_IN5151-013	858.45	858.35	17	0.59%	5.0	860.96	860.86	17	0.59%	3.7	7.4	100	With the Broom Street outfall being upsized, all flow previously routed to the S Hamilton sewer was diverted to the proposed W Wilson diversion sewer. In Alt1, flow from the West side of the intersection was diverted to the W Wilson sewer (Schematic Ref D), but in Alt3 intersection flow from the East side of the interesction was also diverted.
		15	15	IN5151-013	IN5151-070	IN5151-013_IN5151-070	858.35	857.93	77	0.55%	4.8	860.86	860.26	40	1.50%	7.3	7.7	100	
		12	12	MI5151-069	IN5151-070	MI5151-069_IN5151-070	862.88	859.8	60	5.13%	8.1	862.88	860.26	50	5.24%	7.6	1.7	100	
O	S Broom from W Wilson intersection to Outfall	29x45	43 x 68	AS5052-087	AS5052-085	AS5052-087_AS5052-085	849.47	848.25	77	1.58%	83.2	849.47	848.25	77	1.58%	255.4	119.1	100	Upsized existing 29"x45" horizontal ellipse sewer to a 34"x53" horizontal ellipse sewer. While the model did not predict surcharging of this sewer extent in the existing condition, significant additional flow was added via the 36" W Wilson diversion sewer as well as by upsizing the upstream sewer between W Doty & W Wilson.
		29x45	43 x 68	AS5052-085	AS5052-083	AS5052-085_AS5052-083	848.23	847.4	77	1.08%	68.6	848.23	847.40	77	1.08%	210.7	119.0	100	
		29x45	43 x 68	AS5052-083	AS5052-080	AS5052-083_AS5052-080	847.42	846.28	100	1.14%	70.6	847.42	846.28	100	1.14%	216.7	119.5	100	
		29x45	43 x 68	AS5052-080	AS5052-078	AS5052-080_AS5052-078	846.28	845.93	70	0.50%	46.7	846.28	845.93	70	0.50%	143.5	126.0	100	
		29x45	43 x 68	AS5052-078	AS5052-074	AS5052-078_AS5052-074	845.93	845.68	62	0.40%	42.0	845.93	845.68	62	0.40%	128.9	126.7	100	
		29x45	43 x 68	AS5052-074	AS5052-073	AS5052-074_AS5052-073	845.66	845.12	82	0.66%	53.6	845.66	845.12	82	0.66%	164.7	126.9	100	
		29x45	43 x 68	AS5052-073	AE5052-075	AS5052-073_AE5052-075	845.12	844.35	91	0.85%	60.8	845.12	844.35	91	0.85%	186.7	128.6	100	

Table 4. Flooded Buildings Summary (100-year, 24-hour Storm - LOS#3)							
Building ID	Existing Peak Flooding (inches)	Alt 1 Peak Flooding (inches)	Alt2 Peak Flooding (inches)	Alt3 Peak Flooding (inches)	Alt1 Reduction from Existing	Alt2 Reduction from Existing	Alt3 Reudction from Existing
4	1	1	0	0	0	1	1
5	2	0	0	0	2	2	2
11	7	3	1	2	4	6	5
17	7	0	0	0	7	7	7
31	7	0	0	0	7	7	7
33	1	0	0	0	1	1	1
34	12	0	0	0	12	12	12
36	5	0	0	0	5	5	5
37	1	0	0	0	1	1	1
41	1	0	0	0	1	1	1
42	2	1	1	1	1	1	1
44	8	3	3	3	5	5	5
46	1	1	1	1	0	0	0
49	1	0	0	0	1	1	1
51	1	0	0	0	1	1	1
56	7	0	0	0	7	7	7
61	1	0	0	0	1	1	1
62	4	0	0	0	4	4	4
63	4	0	0	0	4	4	4
64	1	0	0	0	1	1	1
65	5	0	0	0	5	5	5
67	5	0	0	0	5	5	5
71	2	0	0	0	2	2	2
78	11	9	0	0	2	11	11
79	1	0	0	0	1	1	1
91	1	0	0	0	1	1	1
92	8	0	0	0	8	8	8
93	9	3	3	3	6	6	6
94	1	0	0	0	1	1	1
98	4	0	0	0	4	4	4
99	1	0	0	0	1	1	1
103	16	0	0	0	16	16	16
104	10	0	0	0	10	10	10
111	1	1	0	1	0	1	0
166	1	0	0	0	1	1	1
169	1	0	0	0	1	1	1
173	1	0	0	0	1	1	1
177	5	3	0	2	2	5	3
178	3	1	0	0	2	3	3
179	4	2	0	0	2	4	4
181	3	1	0	0	2	3	3
183	5	3	0	0	2	5	5
184	3	0	0	0	3	3	3
186	5	2	0	0	3	5	5
187	4	0	0	0	4	4	4
188	5	4	0	0	1	5	5
190	2	0	0	0	2	2	2
192	5	3	0	1	2	5	4
193	1	0	0	0	1	1	1
211	1	1	1	1	0	0	0
215	2	1	1	1	1	1	1

APPENDIX E: EAST ISTHMUS YAHARA WATERSHED STUDY CALIBRATION

Excerpt from the East Isthmus Yahara Watershed Study Report - 5.0 MODEL CALIBRATION

Calibration is the process by which model inputs are adjusted such that model results reasonably match the measured data. A calibrated model has less uncertainty than an un-calibrated model.

Flow and rainfall monitoring was completed in the East Isthmus Yahara watershed to provide data for calibration. Calibration was completed for flow volume, rate, and depth at two locations and for depth at three locations.

5.1 BASEFLOW CONDITIONS

The baseflow simulated in the sewers at the calibration locations is zero based on the flow monitoring data.

5.2 RECORDED RAINFALL AND FLOW DATA

5.2.1 Monitoring Locations

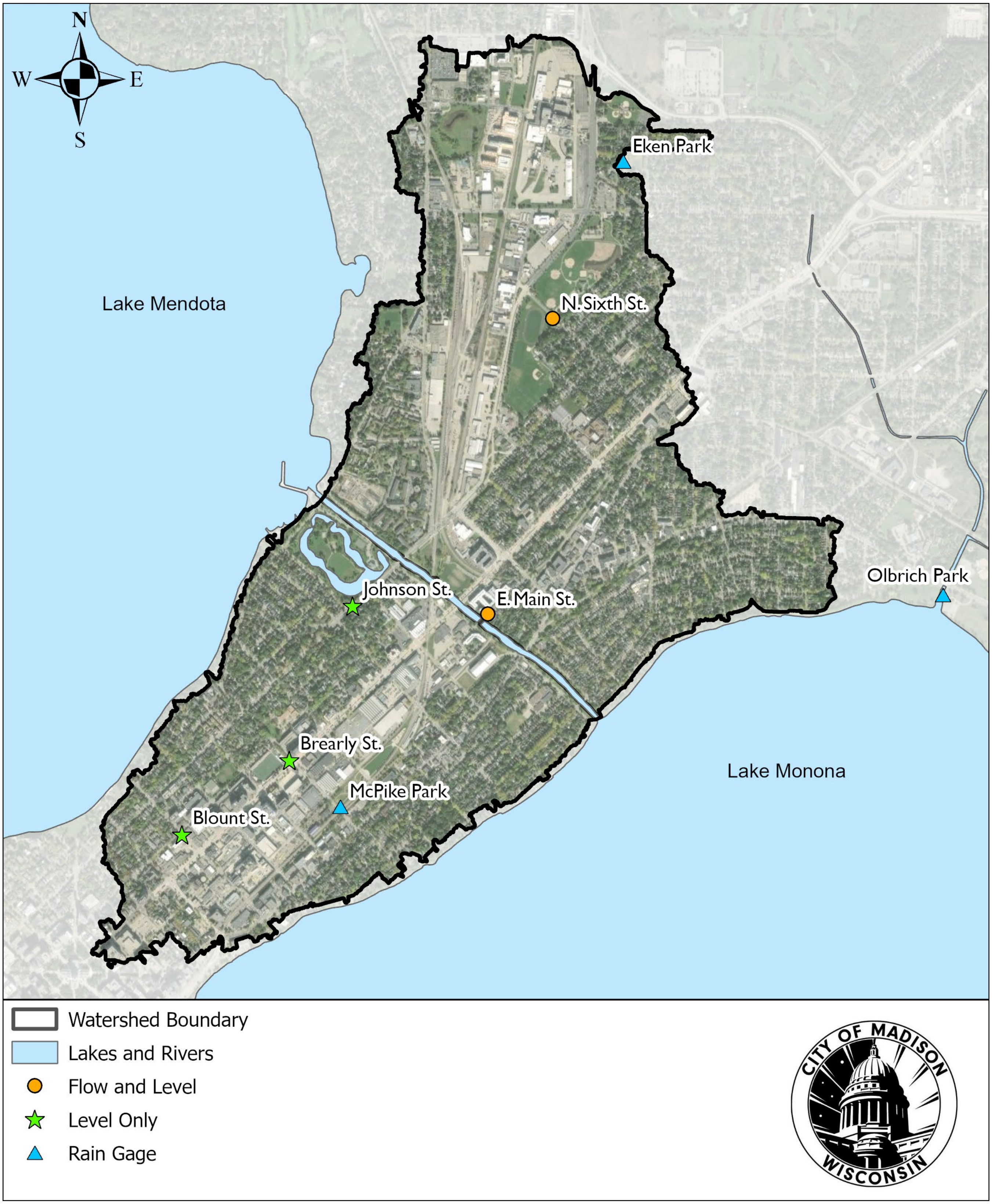
Flow meters were placed in five locations within the watershed to provide data for calibration. Three rain gauges in and near the watershed were used to correlate the measured flow data to rainfall. The flow monitoring locations were chosen in areas of historical flooding or because the location represented a relatively uniform location representative of the general characteristics of the watershed.

Monitoring occurred from June 2020 to September 2021, exclusive of the winter months from November through March. Level recorders were added at Blount, Brearly, and Johnson Streets southwest of the Yahara River and two area/velocity probes were installed on East Main and North Sixth Streets on the northeast side of the Yahara River. Table 5-1 lists the flow and rainfall monitoring locations.

Table 5-1. Flow and Rainfall Monitoring Locations

Monitoring Location	Meter Name	Tributary Area (acres)	Data Collected
Blount Street	--	30	Water Level
Brearly Street	EIY03	11	Water Level
Johnson Street	EIY07	55	Water Level
East Main Street	EIY02	26	Flow, Velocity, Water Level
North Sixth Street	EIY01	22	Flow, Velocity, Water Level
McPike Park	--	--	Rainfall
Eken Park	--	--	Rainfall
Olbrich Park	--	--	Rainfall

Figure 5-1. Map of Flow and Rainfall Monitoring Locations



5.2.2 Calibration Events

Three storms were chosen as calibration events based on rainfall depth, peak rainfall intensity, and quality of flow monitoring data. Since the monitoring period in 2020 was characterized by dry conditions with limited rainfall and flow monitoring difficulties, all three storms that were selected, May 3, June 18, and August 7, occurred in 2021.

Rainfall can vary significantly across a larger watershed, so rainfall from three rain gages was used in calibration. Each modeled subwatershed was assigned to the nearest rain gauge using a Theissen polygon approach, shown in Figure 14-9 in Section 14.0. Table 5-2 summarizes the rainfall data from the three gages for the calibration events.

Table 5-2. Rainfall Data for Calibration Events

Event	Total Rainfall (inches)			Peak Hour Rainfall Intensity (inches per hour)			Approx. Recurrence Interval+
	McPike Park	Eken Park	Olbrich Park	McPike Park	Eken Park	Olbrich Park	McPike Park
May 3, 2021	1.13	0.80	-*	0.74	0.50	-*	100% annual chance
June 18, 2021	1.83	1.70	1.83	1.09	1.10	1.11	50% annual chance
August 7, 2021	1.46	0.87	1.20	1.41	0.83	0.87	100% annual chance

* The rain gage at Olbrich Park did not log a rain event on May 3, 2021. Subwatersheds assigned to the Olbrich Park rain gauge for the other calibration events were assigned to one of the remaining gauges for this event.
+ Approximate Recurrence Intervals were estimated using the peak rainfall intensity.

5.2.3 USGS Data

Flooding in the East Isthmus Yahara watershed is known to be impacted by flows in the Yahara River and the level of Lake Monona. Data recorded by the United States Geological Survey (USGS) was used to approximate the flows in the Yahara River and the level of Lake Monona for each calibration event. Table 5-3 lists the Yahara River discharge and Lake Monona water surface elevation for the calibration events. The flow rates and lake levels added to the model are the daily mean on the days of the events. The model dynamically routes runoff from the watershed through the Yahara River adding to the discharge input at the upstream end of the river entering from Lake Mendota. While Lake Monona levels fluctuate, they typically fluctuated over a period of days rather than hours as simulated in the model.

Table 5-3. USGS Gage Data for Yahara River and Lake Monona

Event	Yahara River Daily Mean Discharge (cfs) USGS Gaging Station 05428500	Lake Monona Daily Mean WSE (feet NAVD88) USGS Gaging Station 054290000
May 3, 2021	92.7	844.76
June 18, 2021	48.5	844.91
August 7, 2021	67.5	844.84

5.3 CALIBRATION PROCESS

For stormwater collection systems, the calibration process begins by calibrating the hydrology (flow volume and peak flow rate) first. Then the hydraulic calibration, the flow depth or hydraulic grade line, is calibrated.

The two locations where both depth and velocity were recorded were calibrated first to establish the hydrologic conditions in the metered areas, which were the applied to the un-metered areas of the watershed.

Once the hydrologic conditions were applied throughout the watershed, the flow depth at all five monitoring locations could be calibrated. Modeled depth may be impacted by pipe and channel roughness coefficients, minor losses at manholes, and sediment depth in the sewers. At the level meters on Blount Street, Brearly Street, Johnson Street, the sewer invert was below the water surface elevation of either the Yahara River or Lake Monona. In these cases, the water depths measured when the meters were installed, were used to confirm the depths recorded at the meters during no rainfall conditions. Adjustments of up to 0.5 feet were made at the Brearly Street meter so that the depth and boundary condition matched during no rainfall conditions.

Each of the model inputs and the adjustments made during calibration are summarized in the list below.

5.3.1 Model Inputs Adjusted during Calibration

- Area. Drainage areas were initially delineated to all individual catch basins in the City's GIS dataset. During calibration, the delineation and subsequent areas were only adjusted to account for private catch basins not in the City's GIS dataset or to keep individual buildings within a single subwatershed.
- Width. The width was used to calibrate peak flow rate. Madison's modeling guidance requires the width of all three subcatchments within a subwatershed to have the same width. The width of the directly connected impervious area is most important to the peak flow rate.
- Maximum and minimum infiltration rates. Infiltration rates were area-weighted and were based on the City's modeling guidance. Maximum infiltration rates were not adjusted but minimum infiltration rates were adjusted to aid in the calibration of flow volume. Many of the soils in the watershed are classified as urban soils by NRCS, which may not be similar to neighboring soils that have hydrologic soil group classifications.

5.3.2 Model Inputs Not Adjusted during Calibration

- Imperviousness (Total). Not adjusted because impervious cover mapping available in the watershed.
- Directly connected impervious area. Based on the impervious cover mapping. Not adjusted as part of the calibration.
- Slope. Not adjusted during calibration because it is a term in the same equation as the width and the average slope data estimated from topographic data are more accurate than the width.
- Impervious and pervious area Manning roughness coefficients. Set to 0.016 and 0.20, respectively based on the City's modeling guidance. These values were not changed during the calibration.

- Impervious and pervious area depression storage. Set to 0.05 and 0.15 inches, respectively, based on the City's modeling guidance. The City's modeling guidance sets the fraction of impervious area with zero depression storage at 25%. These values were not changed during the calibration.
- Subarea routing. The non-directly connected impervious area was routed to the pervious area as defined in the hydraulic modeling guidance. These values were not changed during calibration as it was based on the impervious cover mapping.
- Infiltration decay constant. Set to 4.0 in/hr based on the City's modeling guidance.
- Manning roughness coefficients for pipes and channels. Selected based on pipe material or channel condition following the City's modeling guidance. No adjustments were made during the calibration.
- Pipe sedimentation. Many of the pipes in the watershed are known to have sediment deposition. Pipe sedimentation was evaluated during the process of building the model, but ultimately it was decided that there was not enough data to incorporate a standard level of sedimentation across the pipe network. See section 4.4.2 for more details. No adjustments were made during the calibration.

While several of the variables were adjusted slightly, the subwatershed widths had to be reduced significantly to match the measured peak flow rate. The widths were systematically reduced by 50% until the widths were approximately 15 to 30 feet, which corresponds to the typical width of a street. The street comprises most of the directly connected impervious area and factors greatly into the modeled peak flow rate.

In the upper NE corner of the watershed, the widths were increased. After discussions with the City, it was decided that the model was not predicting the flooding that had been observed. Therefore, the previously calibrated widths were increased by 25% in this section of the watershed.

5.4 CALIBRATION RESULTS

For purposes of this project, the model is considered well 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%. Where the calibration could not be achieved within these tolerances, the reasons and potential impacts were described.

Calibration results at each monitoring location are included in Table 5-4 through Table 5-8 and in Figure 5-2 through Figure 5-10. The figures show an overview of calibration by plotting the measured data versus the modeled data. On these figures, a perfect calibration would show all the data points on the blue diagonal (1:1 line) where measured and modeled values are equal.

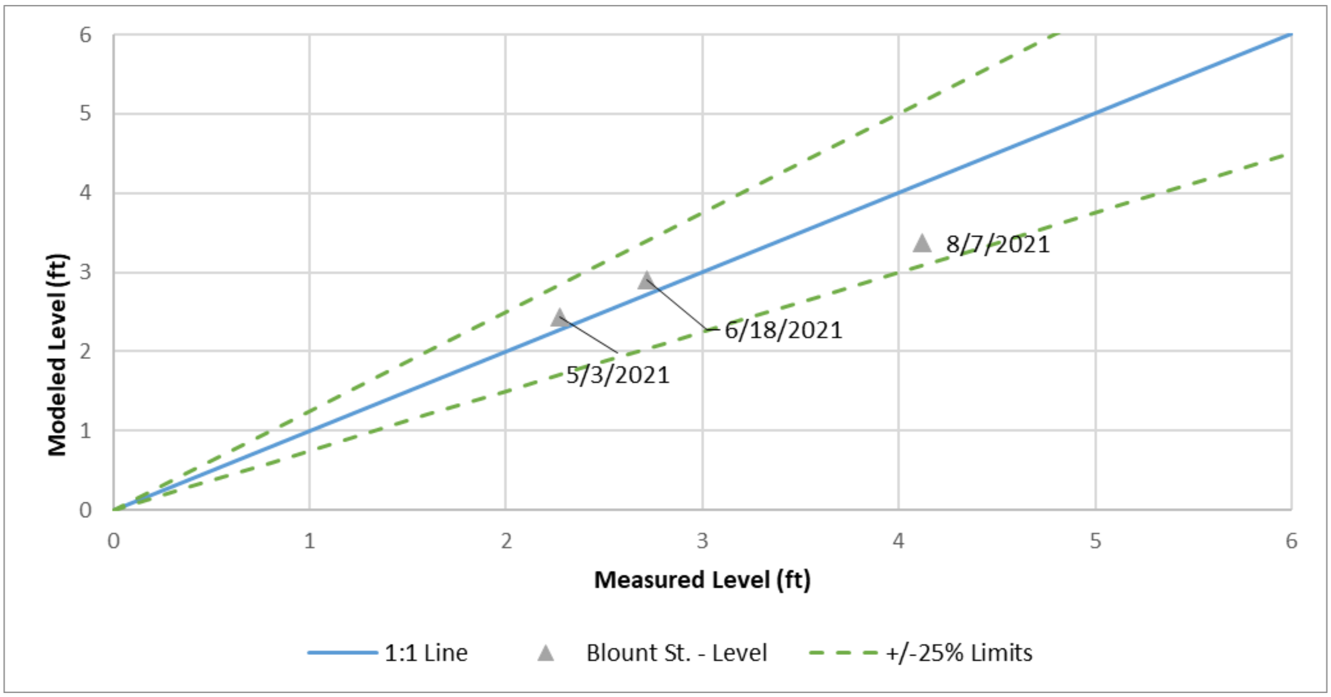
5.4.1 Blount Street

The Blount Street meter recorded level only and was greatly impacted by the Lake Monona water surface elevation because the meter elevation was similar to the lake's water surface elevation. The tributary area to the meter was 30 acres. The model overestimated depth at the site for two of the three storms; however, all three events were withing the +/- 25% tolerance.

Table 5-4. Blount Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	2.27	2.72	4.12
Modeled Peak Level (feet)	2.44	2.90	3.37
Difference (%)	+7	+7	-18

Figure 5-2: Blount Street Level Calibration Plot



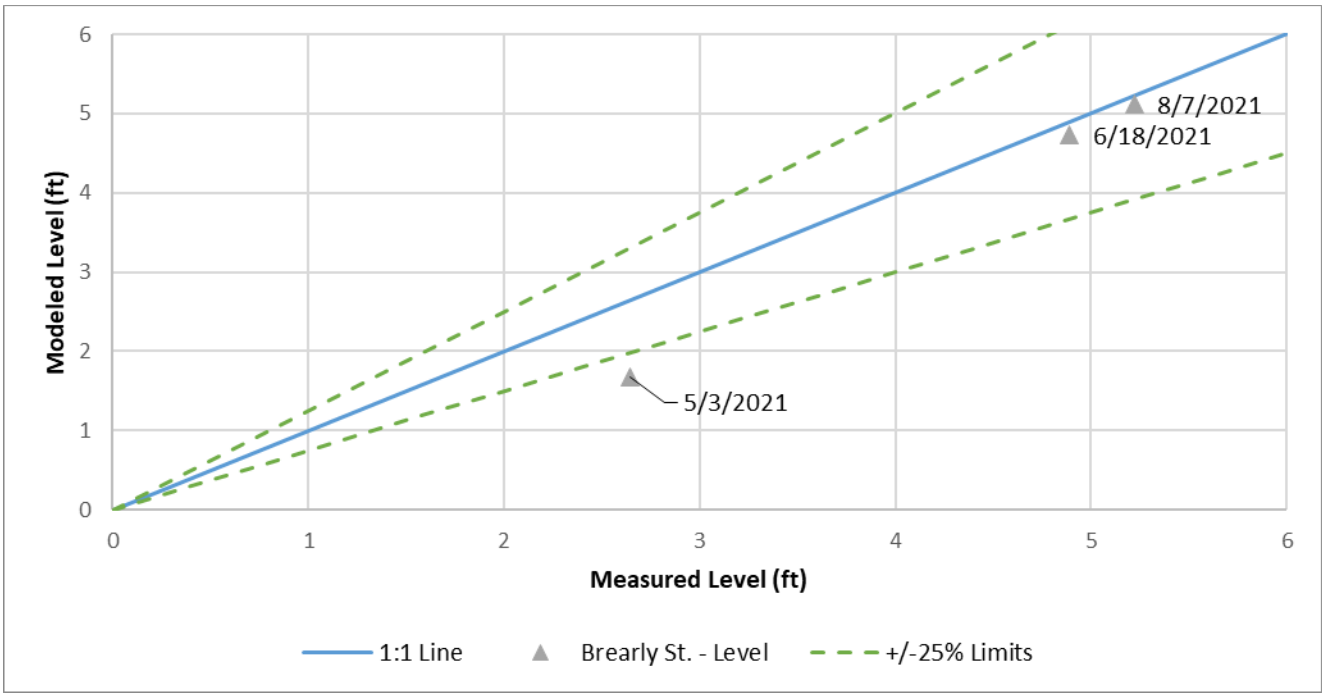
5.4.2 Brearly Street

The Brearly Street meter recorded level only and the tributary area to the meter was approximately 11 acres. During the May 3, 2021 event, the model underestimated depth at the site resulting in less projected flooding once the hydraulic grade line reaches the ground surface. The model results had a similar shape as the metered results however the peak depth was lower in the modeled results.

Table 5-5. Brearly Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	2.64	4.89	5.22
Modeled Peak Level (feet)	1.68	4.73	5.12
Difference (%)	-36	-3	-2

Figure 5-3: Brearly Street Level Calibration Plot



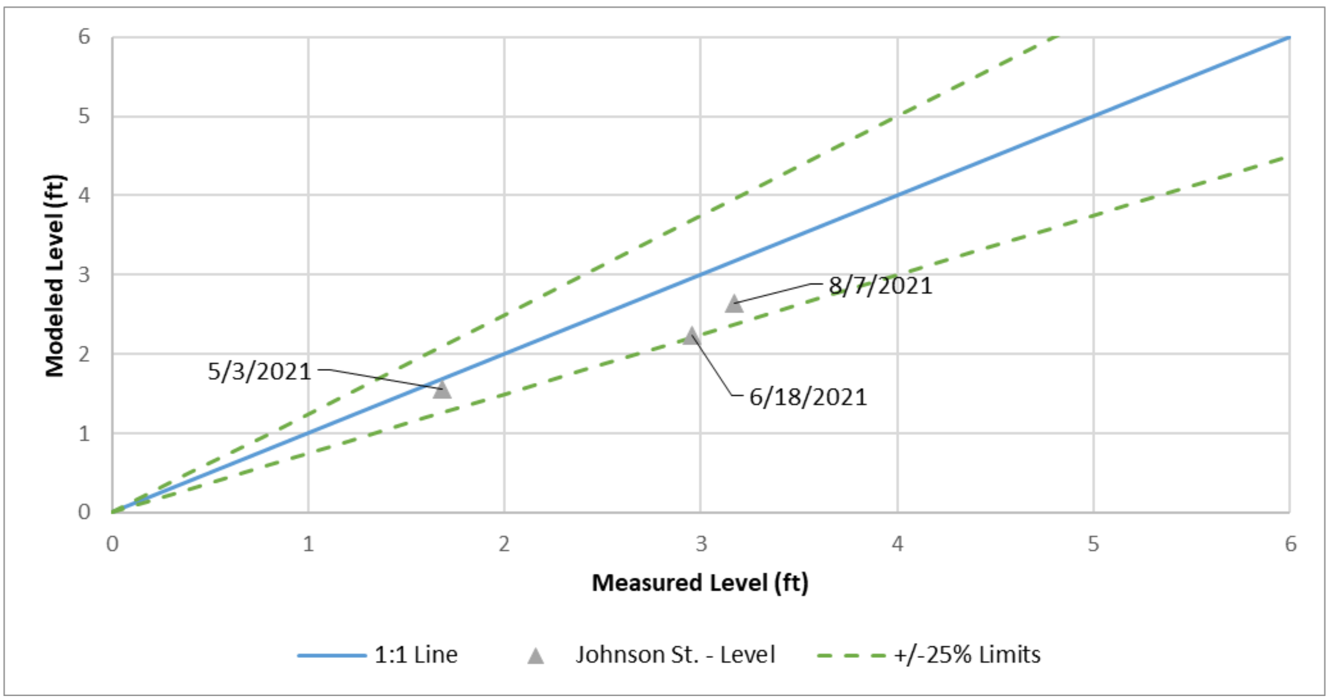
5.4.3 Johnson Street

The Johnson Street meter recorded level only and had a tributary area of approximately 55 acres. The model underestimated depth at the site but the modeled and measured levels were all within the calibration tolerances.

Table 5-6. Johnson Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	1.68	2.96	3.17
Modeled Peak Level (feet)	1.56	2.24	2.64
Difference (%)	-7	-24	-17

Figure 5-4: Johnson Street Level Calibration Plot



5.4.4 East Main Street

Both velocity and depth were recorded at the East Main Street meter and were used to calculate a measured flow rate and volume. The tributary area to the meter is 26 acres.

The data collected for the May 3 event was difficult to calibrate as the rain gage assigned to most of the tributary area, Olbrich Park, did not log this event. For the June 18 and August 7 events, the depth at the monitoring location was tied closely to the Yahara River level as was well calibrated. However, only the June 18 event provided quality volume and flow rate data for calibration because the flow rates and volume measured during the August 7 storms were unrealistically low for the contributing drainage area and the amount of rainfall received. No level of calibration was able to match all three events.

Table 5-7. East Main Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Volume (cubic feet)	54,700	42,000	5,700
Modeled Volume (cubic feet)*	27,500	58,400	41,000
Difference (%)	-50	+39	+619
Measured Peak Flow Rate (cfs)	10.97	9.48	4.44
Modeled Peak Flow Rate (cfs)	6.7	8.79	13.61
Difference (%)	-39	-7	+206
Measured Peak Level (feet)	1.52	1.93	2.05
Modeled Peak Level (feet)	1.08	2.08	2.08
Difference (%)	-29	+8	+2

**Modeled volumes do not include volume past the peak time of measured data*

Figure 5-5: East Main Street Volume Calibration Plot

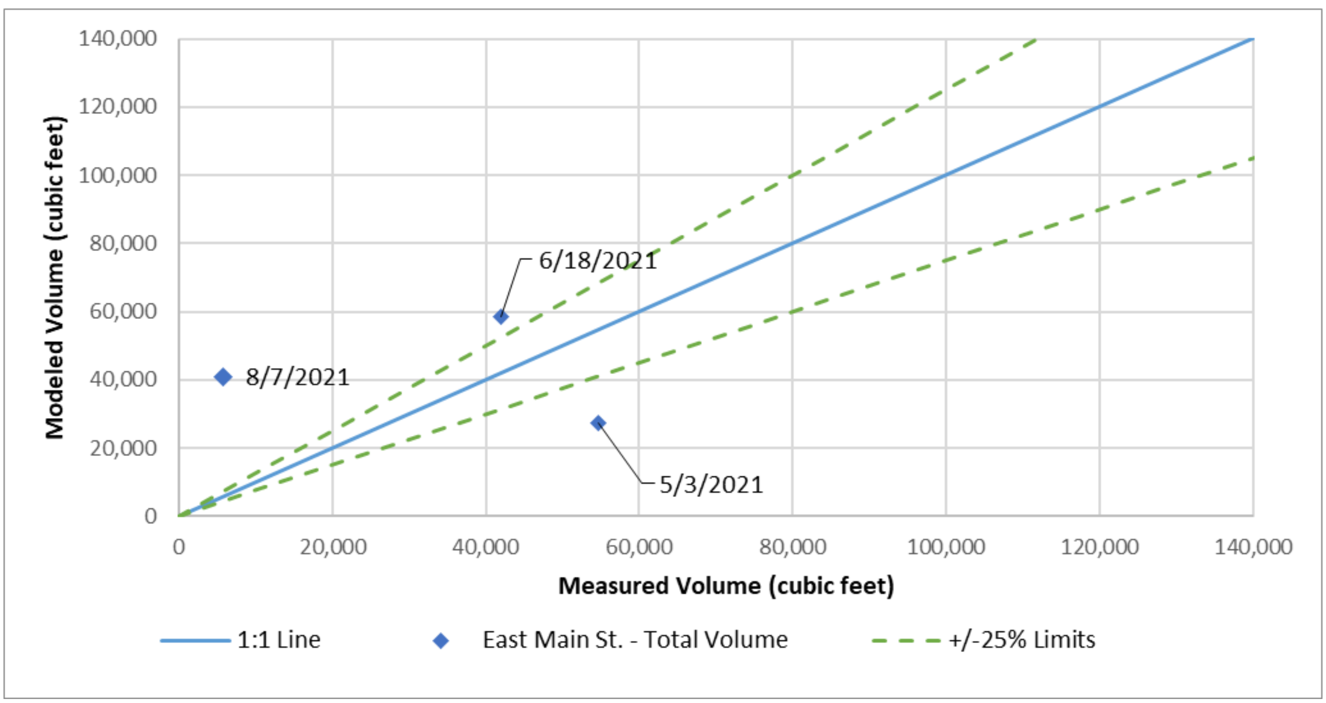


Figure 5-6: East Main Street Peak Flow Rate Calibration Plot

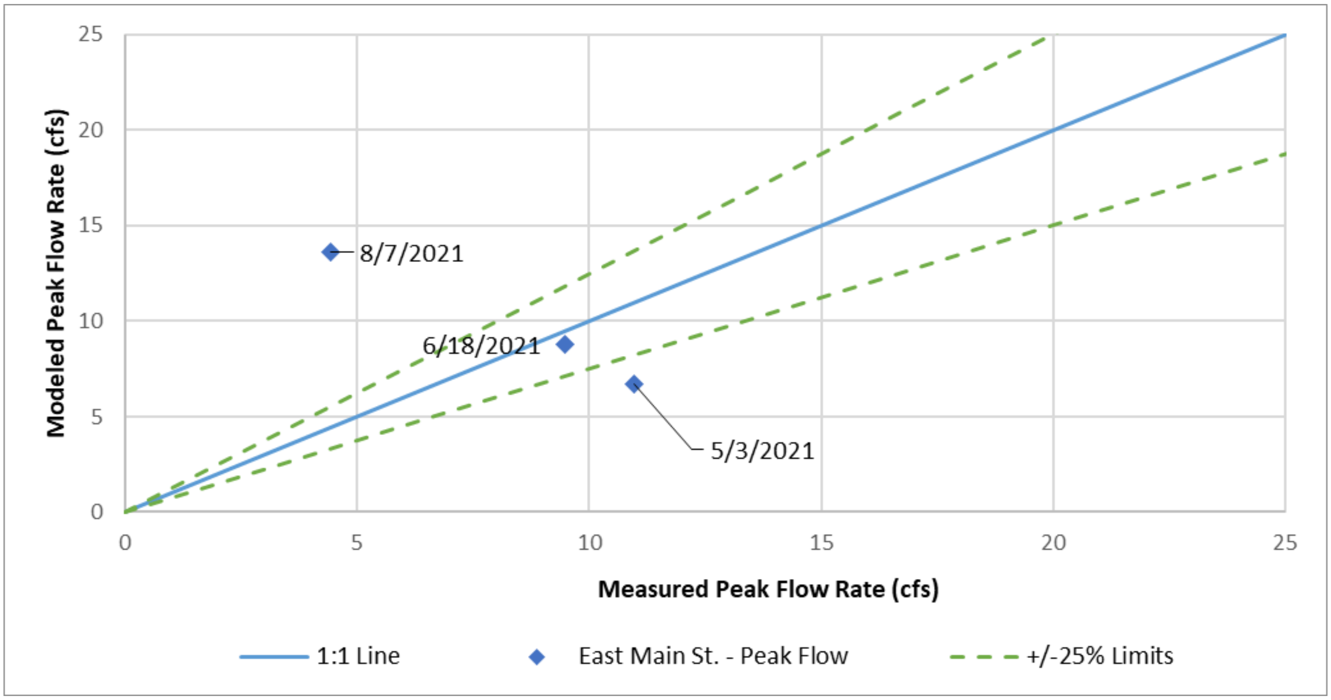
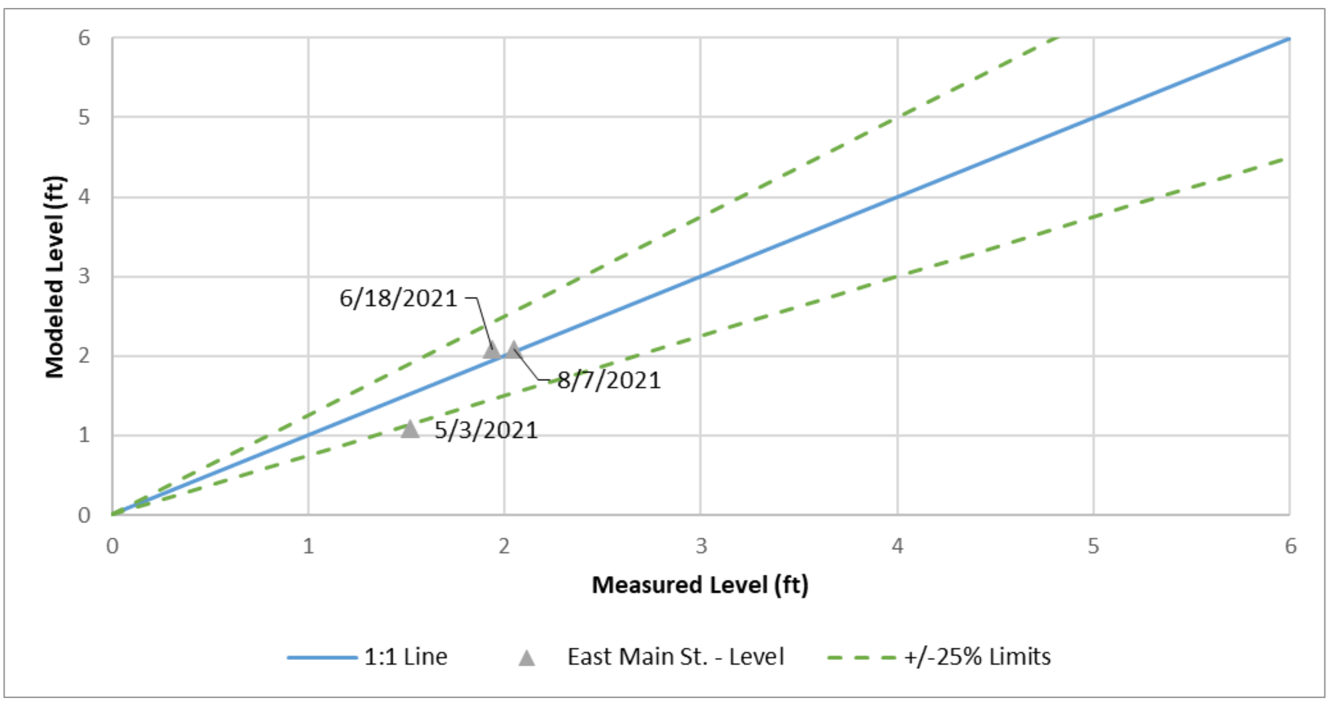


Figure 5-7: East Main Street Level Calibration Plot



5.4.5 North Sixth Street

Both velocity and depth were recorded at the North Sixth Street meter and were used to calculate a measured flow rate and volume. The tributary area to the meter is 22 acres.

The August 7 storm was calibrated within the acceptable tolerances for the volume, flow rate, and level. Two of the three storm events were calibrated within the acceptable tolerances for volume and level. No level of calibration was able to match all three events.

Table 5-8. North Sixth Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Volume (cubic feet)	5,700	13,700	37,300
Modeled Volume (cubic feet) *	4,200	13,800	31,800
Difference (%)	-26	+1	-15
Measured Peak Flow Rate (cfs)	10.26	13.28	20.23
Modeled Peak Flow Rate (cfs)	6.19	19.30	19.55
Difference (%)	-40	45	-3
Measured Peak Level (feet)	1.48	3.54	2.24
Modeled Peak Level (feet)	1.42	2.16	2.20
Difference (%)	-4	-39	-2

**Modeled volumes do not include volume past the peak time of measured data*

Figure 5-8: North Sixth Street Volume Calibration Plot

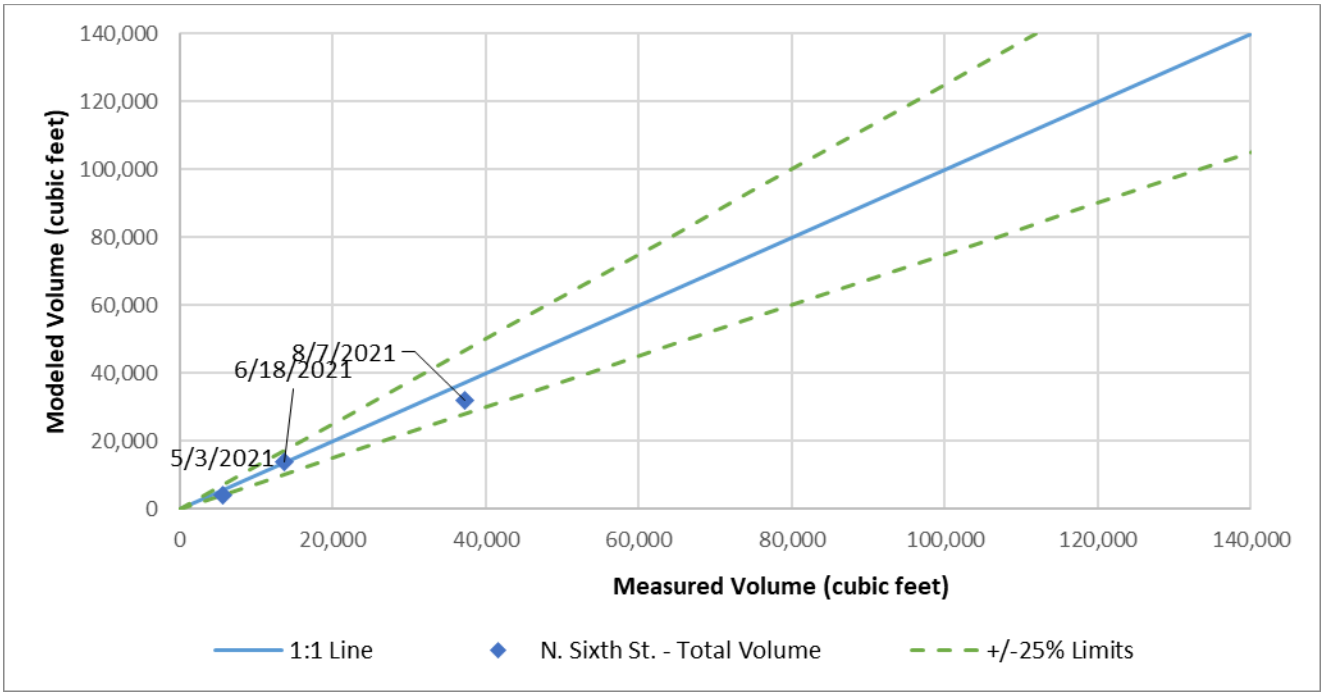


Figure 5-9: North Sixth Street Peak Flow Rate Calibration Plot

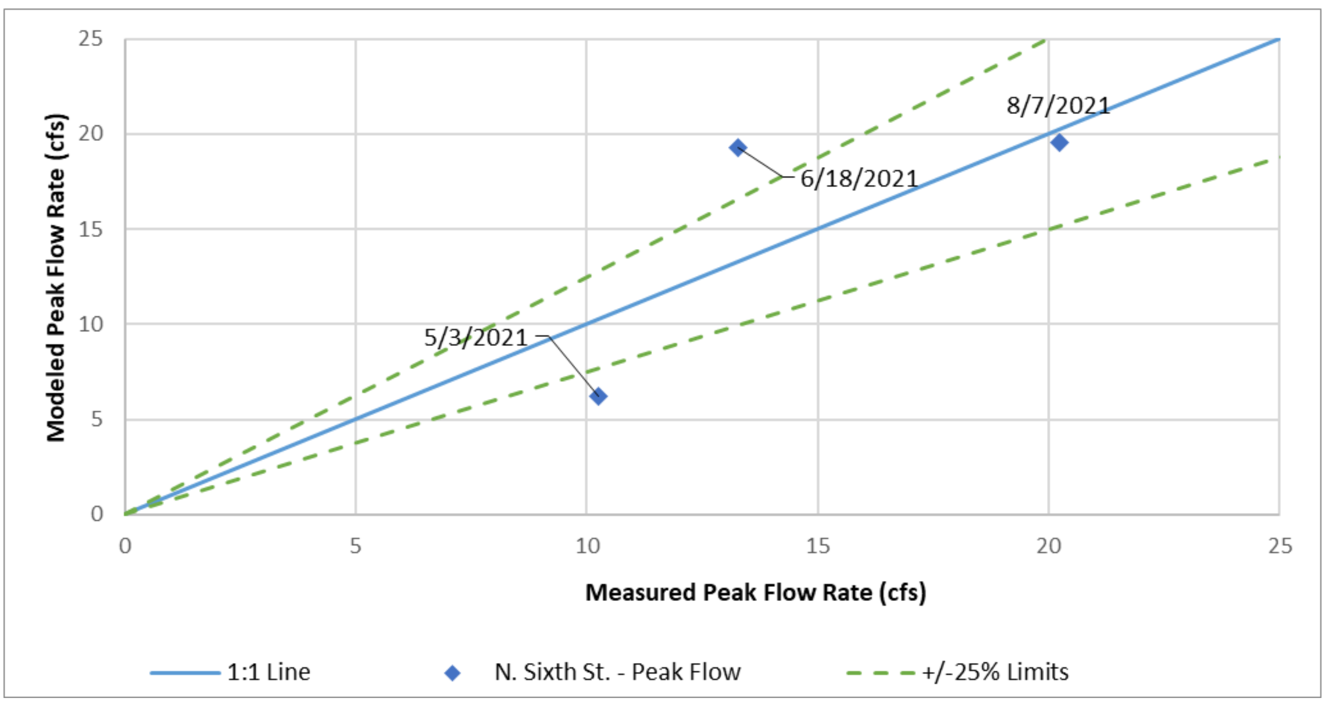
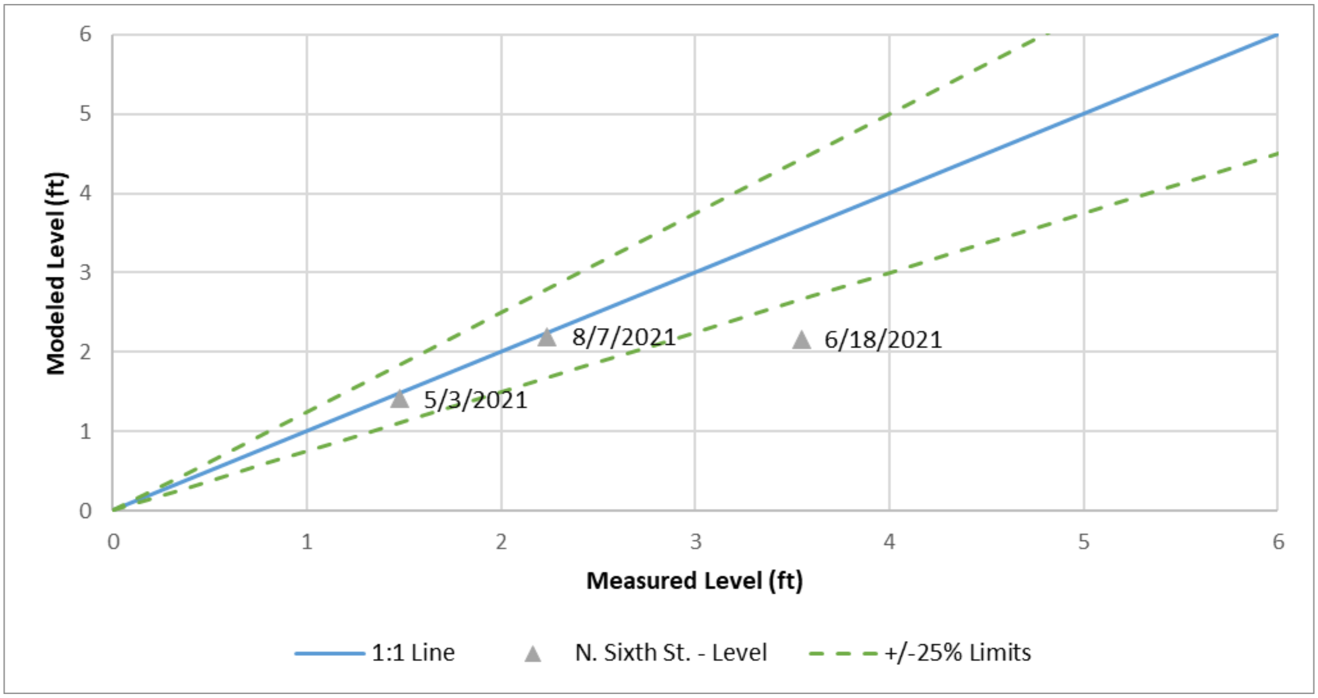


Figure 5-10: North Sixth Street Level Calibration Plot



5.5 CALIBRATION CONCLUSIONS

The North Sixth and East Main Street meters were used to define the hydrologic parameters of the watershed. The calibration for both locations resulted in a consistent subwatershed width, which nicely represented the typical width of a street. For the storm events that had quality measured data, the model calibration was within specified tolerances for volume, peak flow rate, and depth. The calibrated hydrology was applied to the un-metered areas of the watershed.

At the three monitoring locations with levels, the shape of the model outputs is very similar to the monitoring results. The modeled depths are typically within 25% of the measured depths for at least two of the three storms at every level location.

TETRA TECH

Memo

To:	Jojo O'Brien, Alaina Baker (City of Madison)
From:	Dan Christian; Justin Voss (Tetra Tech)
Date:	March 10, 2023
Subject:	East Isthmus Calibration Review

Flow monitoring within the East Isthmus and Yahara River watershed was conducted in 2020 and 2021. The flow monitoring included three level sensors and two depth-velocity meters. Tetra Tech completed the model calibration in 2021 after the end of flow monitoring. Since the model was calibrated, several changes have been made to the model, including:

- Upgrading XPSWMM to version 2021.3 to avoid a bug in the software that prevented batch simulations.
- Simulating manhole entrance and exit losses in the conduit factors dialog.
- Making changes along the Yahara River to reduce model instability.

The purpose of this memorandum is to summarize the impacts of the changes on the original model calibration.

While the precise peak flow rates, volumes, and levels changed somewhat from the initial calibration, the calibration overall is very similar to what it was previously. Additional calibration details will be presented in the Watershed Study Existing Conditions Report.

Given the limited data set for calibration, an upper and lower bound of 25 percent was identified as a calibration tolerance. At least two of the three events had to fall within this calibration tolerance.

Tetra Tech
3497 Coolidge Road, East Lansing, Michigan 48823
Tel +1.517.316.3940 | tetratech.com

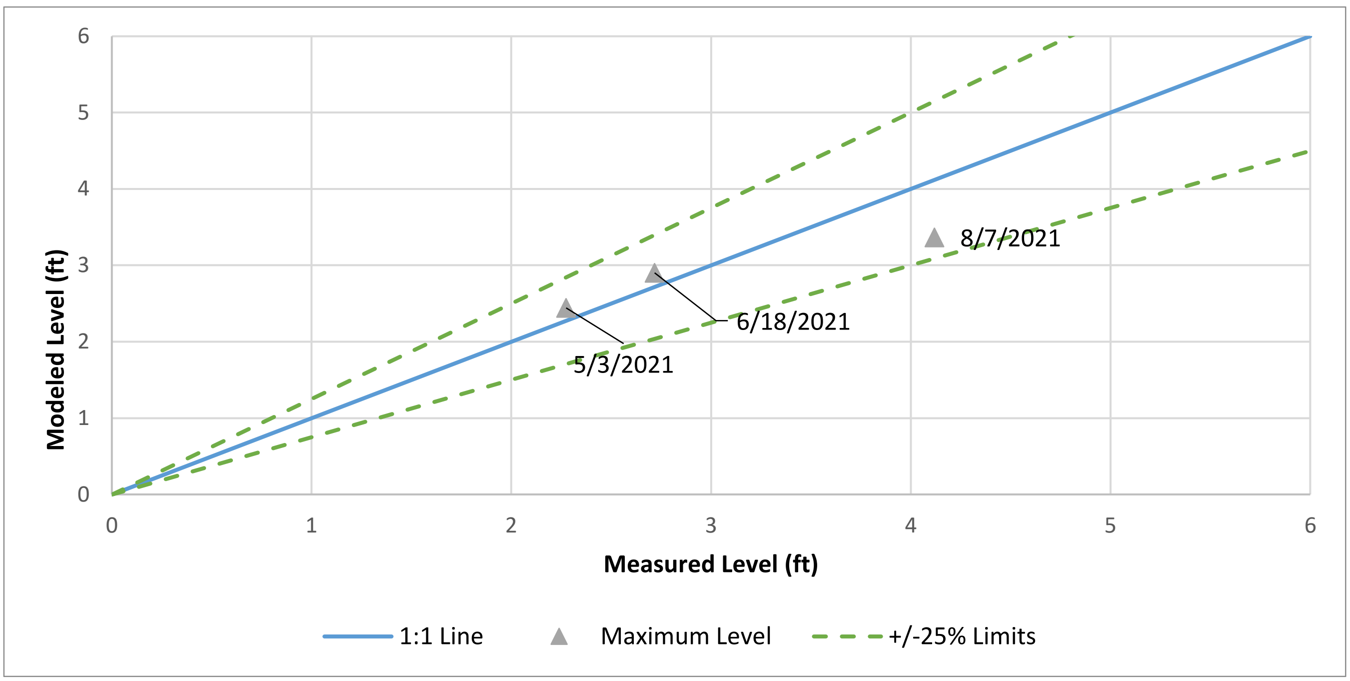
1.0 BLOUNT STREET LEVEL SENSOR

The changes to the model, likely primarily the additional entrance and exit losses, moved the model from slightly underestimating the measured levels to slightly overestimating the levels, on average. The model calibration is within the acceptable tolerances. Table 1-1 and Figure 1-1 summarize the model calibration results.

Table 1-1. Blount Street Level Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	2.27	2.72	4.12
Modeled Peak Level (feet)	2.44	2.90	3.37
Difference	+7%	+7%	-18%

Figure 1-1: Blount Street Level Calibration Plot



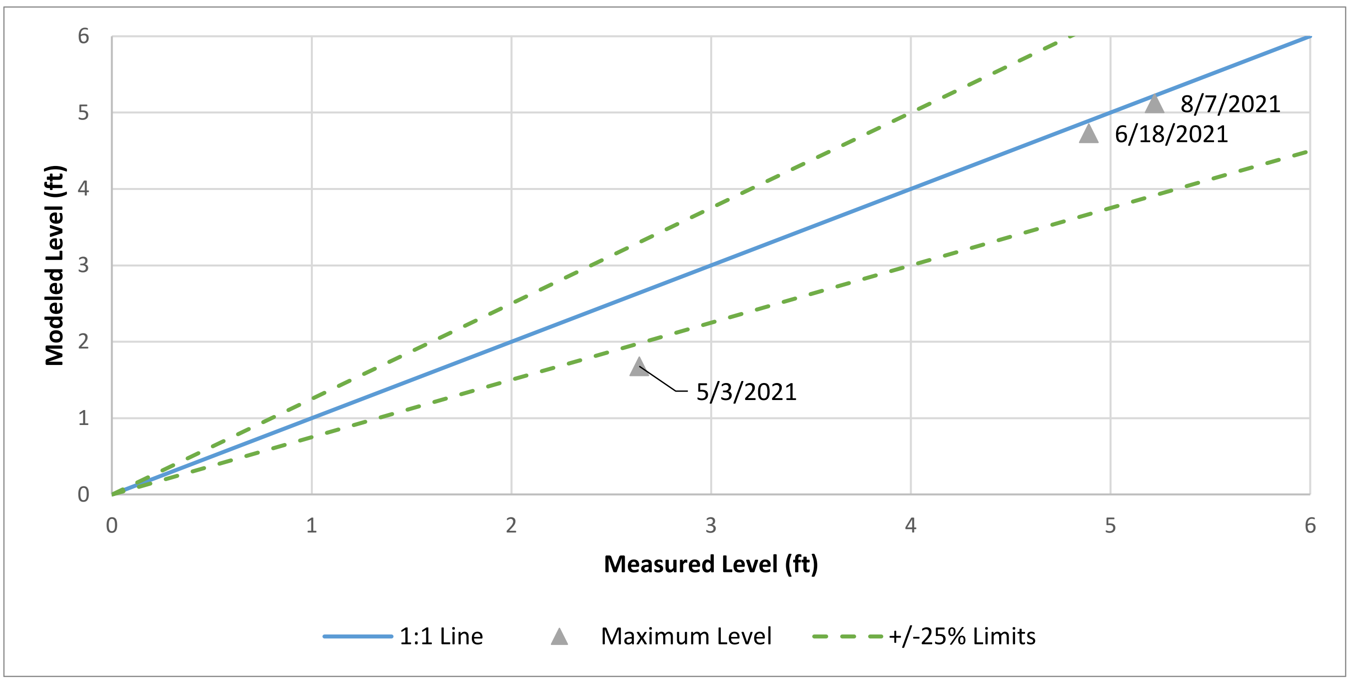
2.0 BREARLY STREET LEVEL SENSOR

The changes to the model did not substantially impact the June 18 or August 7 model results, but the modeled level decreased for the May 3 event. The model calibration is within the acceptable tolerances. Table 2-1 and Figure 2-1 summarize the model calibration results.

Table 2-1. Brearly Street Level Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	2.64	4.89	5.22
Modeled Peak Level (feet)	1.68	4.73	5.12
Difference	-36%	-3%	-2%

Figure 2-1: Brearly Street Level Calibration Plot



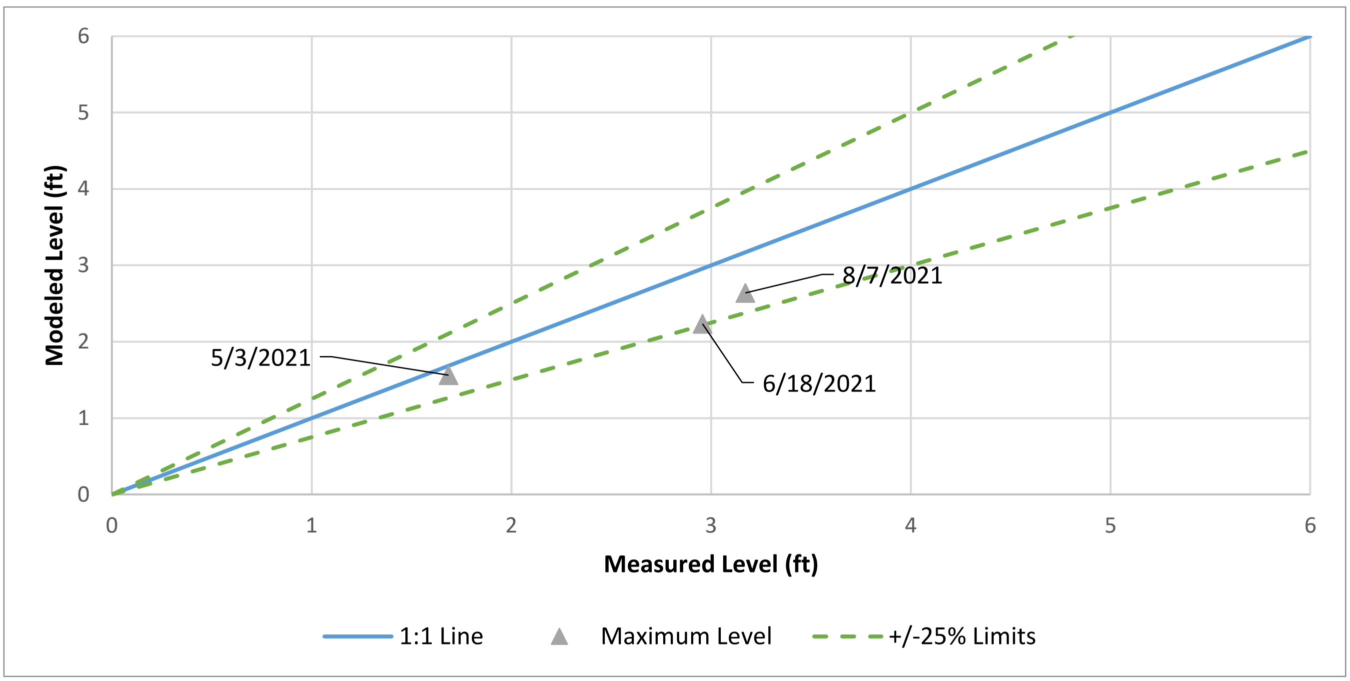
3.0 JOHNSON STREET LEVEL SENSOR

The model underestimates depth at the Johnston Street monitoring location, which is the same as before. The modeled levels are lower than before but still within the acceptable tolerances. Table 3-1 and Figure 3-1 summarize the model calibration results.

Table 3-1. Johnson Street Level Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Peak Level (feet)	1.68	2.96	3.17
Modeled Peak Level (feet)	1.56	2.24	2.64
Difference	-7%	-24%	-17%

Figure 3-1: Johnson Street Level Calibration Plot



4.0 E. MAIN STREET FLOW METER

Previously, the model generally overestimated the measured peak flow rate and volume at the E. Main Street flow meter and matched the level closely. The model now predicts a more neutral volume and peak flow rate relative to the measure data (i.e. points are more evenly over and underestimating the calibration parameters), but the points are generally outside the 25 percent tolerance. Given that the model overestimates some calibration points and underestimates others, the peak flow rate and volume calibration is more balanced than before, but there is still limited confidence in the calibration, in part due to the limitations of the monitoring data, particularly the peak flow and volume data. The level was not impacted by the changes to the model. Table 4-1 summarizes the model calibration results. Figure 4-1, Figure 4-2, and Figure 4-3 show the measured and modeled volume, peak flow rate, and level.

Table 4-1. E. Main Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Volume (cubic feet)	54,700	42,000	5,700
Modeled Volume (cubic feet)	27,500	58,400	41,000
Difference	-50%	+39%	+619%
Measured Peak Flow Rate (cfs)	10.97	9.48	4.44
Modeled Peak Flow Rate (cfs)	6.70	8.79	13.61
Difference	-39%	-7%	+206%
Measured Peak Level (feet)	1.52	1.93	2.05
Modeled Peak Level (feet)	1.08	2.08	2.08
Difference	-29%	8%	2%

Figure 4-1: E. Main Street Volume Calibration Plot

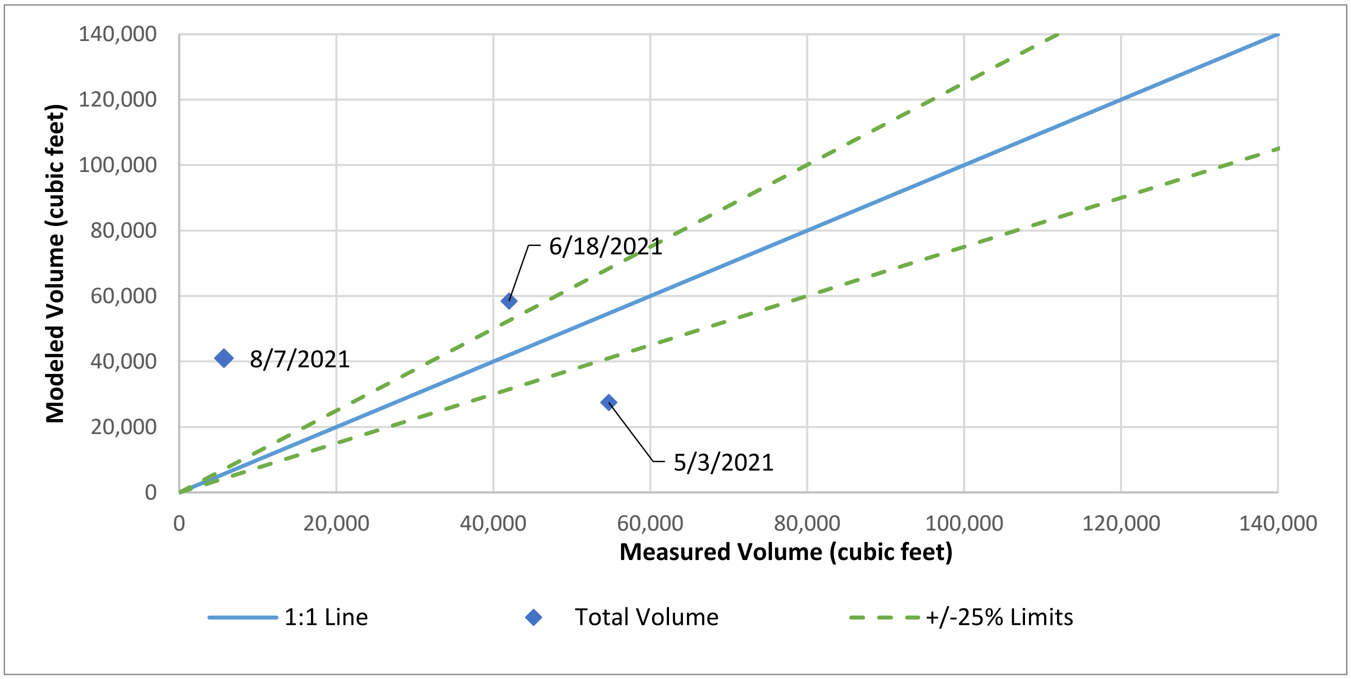


Figure 4-2: E. Main Street Peak Flow Rate Calibration Plot

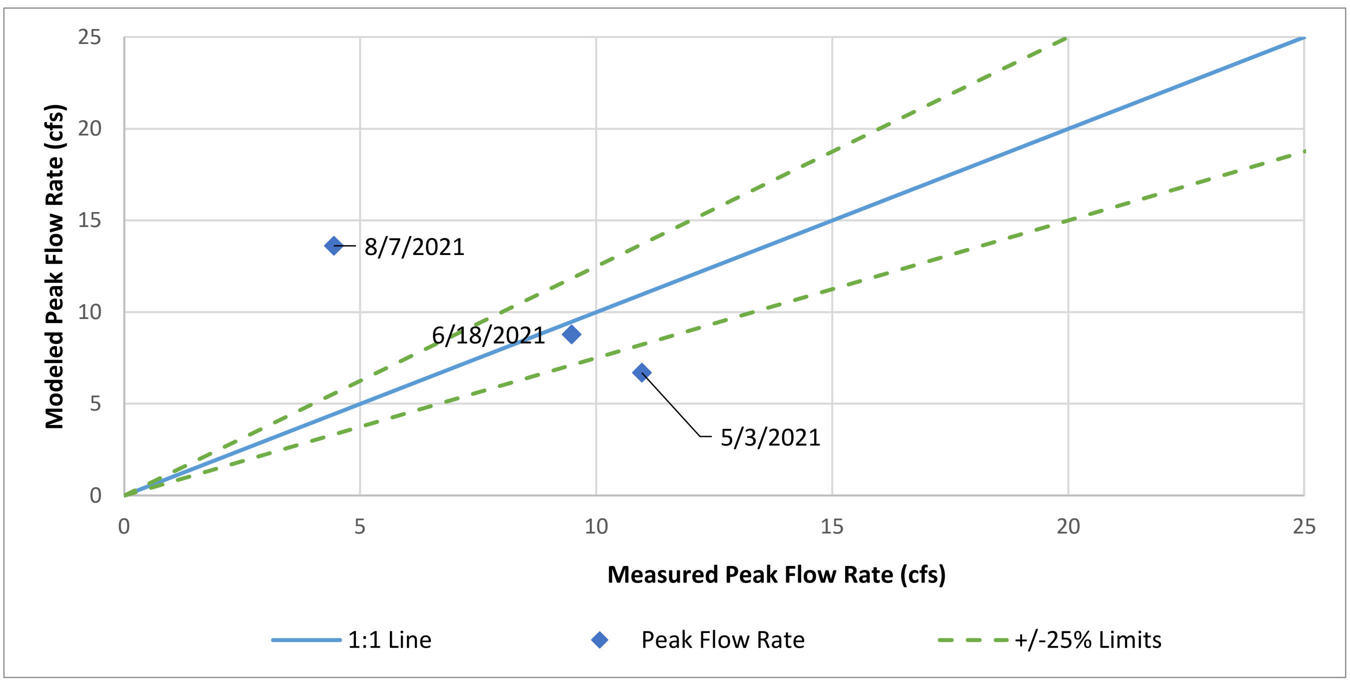
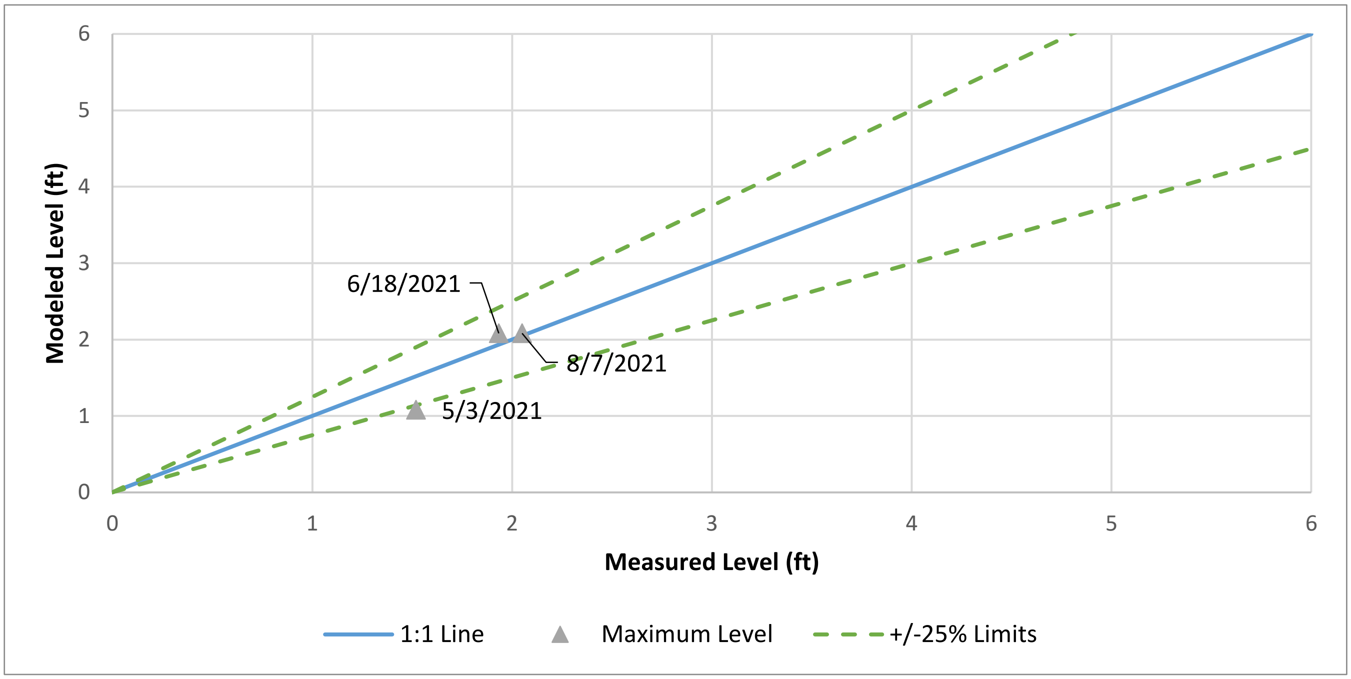


Figure 4-3: E. Main Street Level Calibration Plot



5.0 N. SIXTH STREET FLOW METER

The N. Sixth Street flow meter dropped out immediately after the peak of the storm during the events, so the volume calibration was only evaluated up to the peak of the event and there is limited confidence in the tail event. Since there are no detention practices expected to evaluated in the East Isthmus and Yahara River watershed, the volume in the tail of the hydrology likely will not impact the flood evaluations or flooding mitigation solutions.

The changes to the model improved the volume calibration and brought them within the calibration tolerances but created more spread in the peak flow calibration. Even though there is more spread in the peak flow calibration the model predictions are approximately evenly over and underestimated the measured data for the three events. The modeled level is approximately the same as it was previously. Table 5-1 summarizes the model calibration results. Figure 5-1, Figure 5-2, and Figure 5-3 show the measured and modeled volume, peak flow rate, and level.

Table 5-1. N. Sixth Street Calibration Results

	May 3, 2021	June 18, 2021	August 7, 2021
Measured Volume (cubic feet)†	5,700.00	13,700.00	37,300.00
Modeled Volume (cubic feet)†	4,200.00	13,800.00	31,800.00
Difference	-26%	+1%	-15%
Measured Peak Flow Rate (cfs)	10.26	13.28	20.23
Modeled Peak Flow Rate (cfs)	6.19	19.30	19.55
Difference	-40%	+45%	-3%
Measured Peak Level (feet)	1.48	3.54	2.24
Modeled Peak Level (feet)	1.42	2.16	2.20
Difference	-4%	-39%	-2%

† Comparison is only made up to the peak of the event.

Figure 5-1: N. Sixth Street Volume Calibration Plot

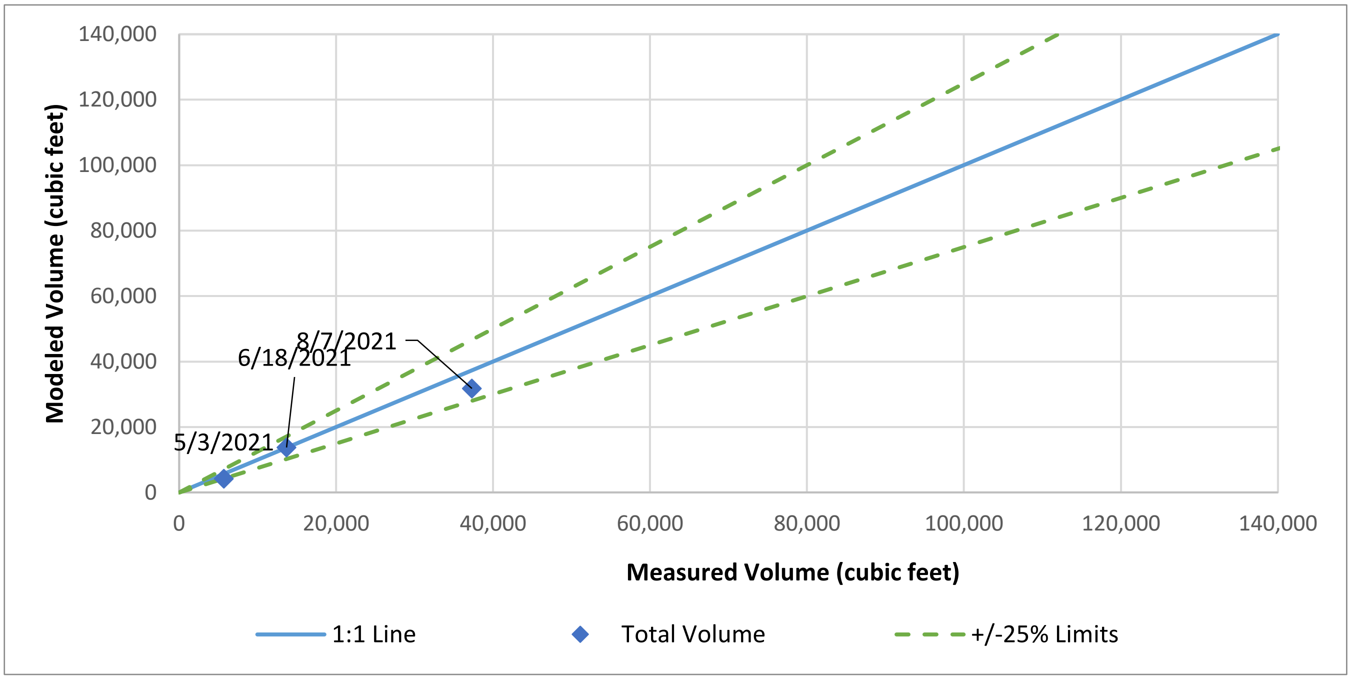


Figure 5-2: N. Sixth Street Peak Flow Rate Calibration Plot

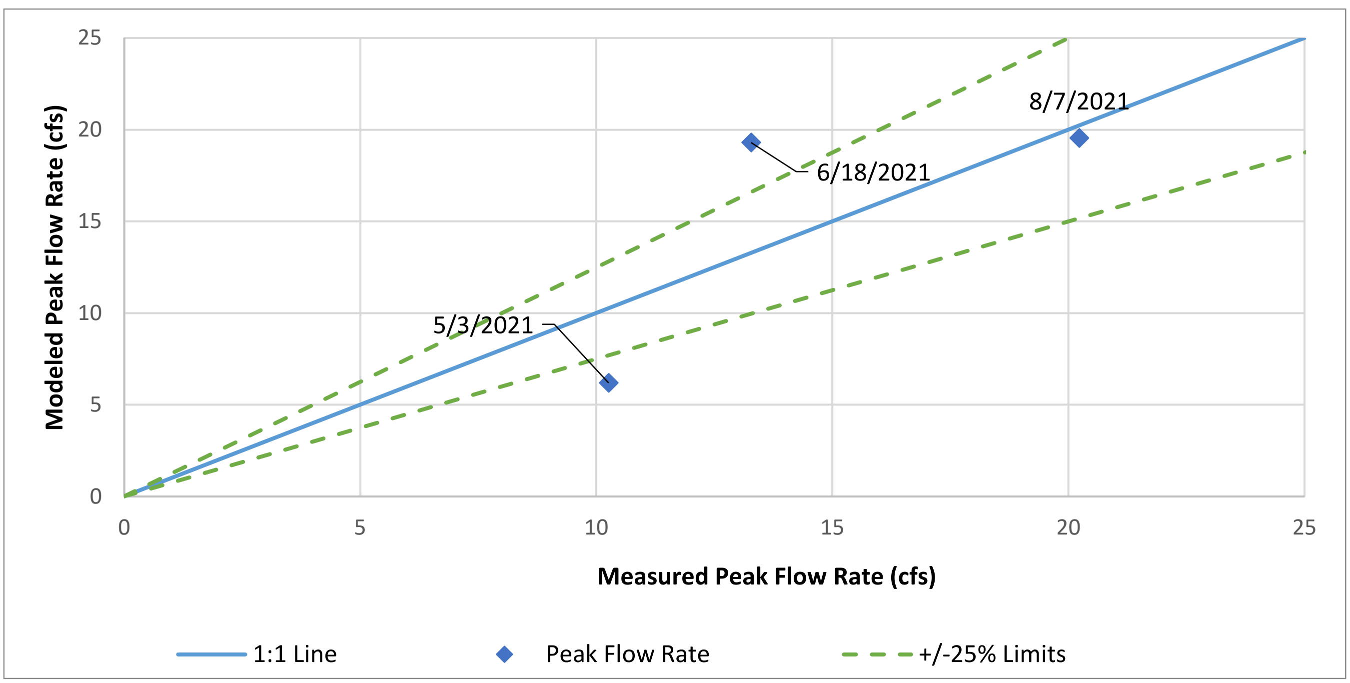


Figure 5-3: N. Sixth Street Level Calibration Plot