HYDROLOGIC, HYDRAULIC, AND WATER QUALITY MODELING FOR THE CITY OF ST. LOUIS PARK

TOPICAL REPORT RSI-2858

PREPARED FOR

City of St. Louis Park
5005 Minnetonka Boulevard
St. Louis Park, Minnesota 55416

FEBRUARY 2019

RESPEC

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EXECUTIVE SUMMARY

As part of the Metropolitan Surface Water Management Act, all communities in the metropolitan area are required to prepare Surface Water Management Plans in response to their governing watershed district plans. Minnesota Statutes require, in part, that these local plans define drainage areas, volumes, rates, and paths of stormwater runoff. This report documents the hydrologic and hydraulic modeling used to delineate the drainage areas and quantify the stormwater runoff from the City of St. Louis Park (City).

The City is part of the Minnehaha Creek Watershed District and the Bassett Creek Watershed Management Commission, which provide oversight of stormwater runoff and water quality in the City. Stormwater runoff from the City enters the cities of Edina, Golden Valley, Minneapolis, and Minnetonka. This report documents the rates of runoff entering the City's neighboring communities, as well as identifying constraints in the existing storm sewer system and flood-prone areas within the City.

The City also has three impaired waterbodies within its limits: Cobblecrest Lake, Minnehaha Creek, and Twin Lake. The City intends to manage its water resources to improve the water quality of all of its lakes, wetlands, and streams, not just those that are impaired. This report identifies areas that are contributing to the pollutant loading of the City's natural resources.

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1.0 BACKGROUND

The goal of this project was to develop comprehensive models for the entirety of the City using available data and existing models as a starting point and establish the rate and quantity of stormwater. The City is covered by a total of eight models, including off-site drainages from the cities of Edina, Minnetonka, Plymouth, and Minneapolis, as well as runoff from Minnesota Department of Transportation (MnDOT) right-of-way. The City is within the Minnehaha Creek Watershed District (MCWD) and the Bassett Creek Watershed Management Commission (BCWMC). The stormwater runoff from the City generally discharges either in Minnehaha Creek or Bassett Creek, both of which discharge into the Mississippi River.

The City is divided into the following eight drainage districts, based on the larger waterbodies within the City.

- Bass Lake
- Edina
- Golden Valley
- Hannan Lake
- Minneapolis
- Minnehaha Creek
- Twin Lake
- Westwood Lake.

The City also receives and discharges runoff from neighboring communities, including the following:

- Edina
- Golden Valley
- Minneapolis
- Minnetonka
- Plymouth
- MnDOT right-of-way.

1.1 EXISTING MODELS

The City had access to several models that were developed by MCWD and BCWMC, including the following:

- Beltline
- Twin Lake
- BCWMC Phase 2 Regional Model
- MCWD Regional Model.

1.2 CURRENT MODEL

The US Environmental Protection Agency's (EPA's) Storm Water Management Model 5 (SWMM5) was selected as the platform to model the City. SWMM5 is flexible, open-source, and unlimited in multiple features that may be modeled. SWMM5 is used throughout the world for planning, analysis and design related to stormwater runoff, particularly in urban areas, and the propriety PCSWMM (which runs on the SWMM5 engine) was used to develop the models for this study. Where possible, the new models were evaluated against existing observed data, including the July 1987 flood event.

1.2.1 BASS LAKE

The Bass Lake model includes 403 subcatchments across 1,362 acres within the City, primarily the Lenox, Sorensen, Elmwood, Triangle, and Wolfe Park neighborhoods. This drainage district discharges to the City of Minneapolis' storm sewer along France Avenue and into the Minikahda Club Golf Course. Major waterbodies in this model include the Bass Lake Preserve, Klodt Pond, Wolfe Lake, and Cattail Pond, and many stormwater ponds for private and public development, including MnDOT right-of-way ponds and the newly constructed Carpenter Park underground stormwater storage facility.

1.2.2 EDINA

The Edina model includes 113 subcatchments across 497 acres in the Minikahda Vista and Browndale neighborhoods of St. Louis Park, as well as the Cities of Edina and Minneapolis. This model discharges into the City of Edina storm sewer system primarily at Vale Gardens Park and reenters the City south of Minikada Vista Park, before discharging into the City of Minneapolis' storm sewer under France Avenue. Major waterbodies in this model include Browndale Pond and Weber Pond in Edina.

1.2.3 GOLDEN VALLEY

The Golden Valley model includes 38 subcatchments across 219 acres from the Pennsylvania Park and Eliot neighborhoods, which discharge to MnDOT I-394 right-of-way in the City of Golden Valley along the City's north border. Major waterbodies in this model include Hampshire Pond (i.e., Otten Pond South) and Otten Pond. This drainage district is part of the Bassett Creek Watershed and followed the model methodology outlined in the BCWMC *Bassett Creek Hydrologic and Hydraulic Analyses – Phase 2 XPSWMM Model Report*.

1.2.4 HANNAN LAKE

The Hannan Lake model includes 47 subcatchments across 605 acres from the City and City of Minnetonka. Stormwater runoff from a small portion of the St. Louis Park Kilmer Pond neighborhood enters the City of Minnetonka to the west of US 169 and reenters the City at the land-locked wetland to the east of US 169 in the Crestview neighborhood and to the south at Cedar Manor Lake in the Cedar Manor neighborhood. The connection under US 169 is confirmed to exist; however, the size and type of pipe is unknown. Major waterbodies include land-locked wetland, Cedar Manor Lake, and Hannan Lake in the City and Windsor Lake (impaired for nutrients) in the City of Minnetonka.

1.2.5 MINNEAPOLIS

This model includes portions of the Triangle, Fern Hill, Lake Forest, Cedarhurst, and Blackstone and neighborhoods in the City, which discharges to the north into the MnDOT I-394 right-of-way and east into Brownie and Cedar Lakes, which are both impaired for mercury and located in the City of Minneapolis. This model includes 89 subcatchments across 649 acres from both cities, and major waterbodies include Candlestick Pond and Blackstone Park Pond. A stormwater lift station is located at Candlestick Pond along West 16th Street.

1.2.6 MINNEHAHA CREEK

The Minnehaha Creek model was built off of the MCWD regional XPSWMM model and uses existing off-site drainage areas from the Cities of Hopkins and Minnetonka to estimate the flows entering the City from upstream communities. This model includes 406 subcatchments, covering a total of 3,783 acres from many neighborhoods in the City. Major waterbodies include Lake Victoria, Westling Pond, Cobblecrest Lake (impaired for nutrients), Amhurst Ponds, Oak Pond, Oregon & 32nd Pond, Summer Sediment Basin, South Oak Pond, Meadowbrook Lake, and Minnehaha Creek, which is impaired for dissolved oxygen. This drainage district also includes seven stormwater lift stations to move stormwater and prevent flooding on Cobblecrest Lake, Lake Victoria, Westling Pond, South Oak Pond (two lift stations), Oregon Pond, and the Maryland Avenue Pond.

1.2.7 TWIN LAKE

The Twin Lake model includes 286 subcatchments across 1,636 acres in the City. This model covers the neighborhoods of Pennsylvania Park, Willow Park, Eliot View, Blackstone, Bronx Park, Birchwood, Lake Forest, and Fern Hill. Major waterbodies include Utah Pond, Lamplighter Pond, Boneyard Ditch, Natchez Pond, Twin Lakes Sediment Basin, and Twin Lake (impaired for nutrients). This district drains to Twin Lake, which discharges to the northeast into the Minneapolis drainage district. This drainage district includes stormwater lift stations at Lamplighter Pond and Nelson Park to move stormwater from these low-laying areas.

1.2.8 WESTWOOD LAKE

The Westwood Lake model was built using the BCWMC regional XPSWMM model as a foundation and uses existing off-site drainage areas from the Cities of Plymouth and Golden Valley to estimate the runoff entering the City from upstream communities. The model includes 93 subcatchments across 739 acres in the Shelard Park, Kilmer Pond, Westdale, Crestview, and Westwood Hills neighborhoods of the City, as well as portions of Minnetonka, Plymouth and Golden Valley. Major waterbodies in this drainage district include Shelard Sedimentation Basin, Kilmer Pond, Westwood Lake, and the Minneapolis Golf Course basins. This drainage district ultimately discharges to the Bassett Creek, which is impaired because of chloride and *E. coli* bacteria and the City of Golden Valley storm sewer system, which discharges to Bassett Creek. This drainage district is part of the Bassett Creek Watershed and followed the model methodology outlined in the BCWMC *Bassett Creek Hydrologic and Hydraulic Analyses – Phase 2 XPSWMM Model Report*.

2.0 METHODOLOGY

The procedures and methodology used in this study are outlined in *XP-SWMM Hydrology and Hydraulics Model Development Guidance Manual for the City of Minneapolis*, for all of the models within the Minnehaha Creek watershed. For all of the models within the Bassett Creek Watershed (Golden Valley and Westwood Drainage Districts only), the procedures and methodology outlined in the *Bassett Creek Hydrologic and Hydraulic Analyses – Phase 2 XPSWMM Model Report* are used. This additional step was done to simplify the future transmittal of data between the City and watershed districts.

2.1 DATA SOURCES

The Storm Water Management Plan (SWMP) modeling relies on data from multiple sources, which include the following:

- **City of St. Louis Park:** as-built records, GIS data, survey data, and existing XPSWMM modeling
- **Hennepin County:** 2017 aerial imagery
- **BCWMC:** regional XPSWMM model
- **MCWD:** regional XPSWMM model
- **Metropolitan Council:** 2016 Generalized Land Use dataset
- **Minnesota Department of Natural Resources:** Hennepin County LiDAR data
- **MnDOT:** HydInfra database, construction plans for I-394, TH 7, TH 100, and US 169
- **Federal Emergency Management Agency (FEMA):** 2016 Hennepin County Flood Insurance Study
- **US Geological Survey Soil (USGS):** Soil Survey Data for Twin Cities, Minnesota.

After reviewing these datasets, converting the vertical datums to a consistent value for the purposes of this study was determined to be necessary. The listed datasets varied depending on whether the data used a local datum or used NGVD29 or NAVD88. After discussions with City staff, NGVD29 was used for this study because the majority of the City's data and data from neighboring communities, review agencies, and FEMA reference this datum.

The first conversion used converts the local datum from the City's local vertical datum to the National Geodetic Vertical Datum of 1929 (NGVD29). This conversion is presented below:

Local Datum + 710.3 = NGVD29

We also established the conversion between NGVD29 and the North American Vertical Datum of 1988 (NAVD88) by examining the shift at five locations across the City, using National Oceanic and Atmospheric Administration's (NOAA's) VertCon website. The average of all five locations was used to convert the NAVD88 elevations to NGVD29 in this study; the conversion is presented below:

NAVD88 – 0.18 = NGVD29

2.2 RAINFALL DATA

As requested by the City, the following events have been included in the updated models.

Table 2-1. Design Storm Depths Used in the City of St. Louis Park Storm Water Management Plan Modeling

Storm	Duration (hours)	Depth (in)	Source
10-year	24	4.1	NOAA TP-40
10-year	24	4.29	NOAA Atlas 14
100-year	24	5.9	NOAA TP-40
100-year	24	7.47	NOAA Atlas 14

in = inches.

Rainfall data were determined using the NOAA's Technical Paper 40 (TP-40) maps published in May 1961 and used until recently for most stormwater design. Rainfall data from NOAA's 2013 revised Atlas 14, Volume 8 were also used in this modeling effort to evaluate present and future conditions.

2.3 SUBWATERSHEDS

Using the Minnesota Department of Natural Resources (MnDNR) light and detection ranging (LiDAR) elevation dataset combined with the City's storm sewer infrastructure GIS data and recent MnDOT construction plans, subwatersheds were delineated to each 18-inch or larger pipe in the City, as well as the direct drainage to all waterbodies and local sinks. Individual catch basins and lead pipes were not modeled in this effort, nor was inlet capacity of the storm sewer system. A total of 1,475 separate subwatershed were delineated as part of this study and are shown in Appendix A.

2.4 HYDROLOGY PARAMETERS

In the EPA's SWMM5 model, the following parameters are needed to quantify runoff: impervious land cover, watershed slope, catchment width, and soil infiltration.

2.4.1 IMPERVIOUS COVER

The process for determining the directly connect impervious area (DCIA) was based on the Basset Creek WMC regional model report. Using the 2016 Generalized Landuse dataset from Metropolitan Council, we separated areas of the city that are traditionally "heavily impervious areas," including classifications of: Industrial and Utility, Institutional, Major Highways, Manufactured Housing Parks, Mixed Use Commercial, Mixed Use Industrial, Mixed Use Residential, Multifamily, Office, Open Water, Railways and Retail and Other Commercial. These areas were assumed to have 100 percent of the total impervious area identified as directly-connected impervious. Using the Twin Cities Metropolitan Area 1-meter Land Cover Classification developed by the University of Minnesota, Twin Cities, we extracted roads and buildings as the directly impervious surface in "heavily impervious areas" and only roads for the remainder of the City. DCIA was the area of directly-connected impervious cover as a percent of the total subwatersheds area.

For residential and open-space areas, we followed the City of Minneapolis's XPSWMM Manual recommendations to include a reduction for impervious areas that flow onto pervious areas, such as gutters from rooftops or the surface area of lakes.

2.4.2 WATERSHED SLOPE

By using the MnDNR LiDAR elevation dataset, the average slope for each subwatershed was calculated in GIS, including for existing off-site subcatchments for consistency.

2.4.3 CATCHMENT WIDTH

The catchment width factor is a parameter that controls how quickly water travels from one end of the subcatchment to the outlet, which is similar to the time of concentration in other hydrology methods. In SWMM, the width factor is often used as calibration parameter, and in these models, the width factor was generally estimated by dividing the drainage area by the longest overland flow. Because most of the City is heavily urbanized, this flow length was assumed to be 100–300 feet (ft) (before water enters the storm sewer system); this parameter will likely need to be modified in future modeling efforts as calibration data was not readily available for all watersheds.

2.4.4 SOIL INFILTRATION

The City is covered by two watershed districts and each watershed district's regional XPSWMM model. To incorporate the City's models into the larger regional models in the future, the overlying regional model soil infiltration methodology was used. For the Bassett Creek models (Golden Valley and Westwood drainage districts), these models used the Horton infiltration parameters outlined in the *Bassett Creek Hydrologic and Hydraulic Analyses – Phase 2 XPSWMM Model Report*. For the Minnehaha Creek models, the Green-Ampt parameters estimated in the City of Minneapolis's *XP-SWMM Hydrology and Hydraulics Model Development Guidance Manual for the City of Minneapolis* were used.

2.5 HYDRAULICS

After parameterizing the subcatchments, SWMM routes the storm hydrographs through the modeled storm sewer, stream, and overland drainage networks to determine the water surface elevations and depths at ponding locations.

2.5.1 STORM SEWER NETWORK

GIS data and as-built records of the storm sewer network were obtained from the City and cities of Minnetonka and Edina. The MnDOT also provided their as-built GIS database and construction plans for the recently reconstructed TH 7, TH 100, I-394, and US 169. The City also provided supplemental survey data for inverts and pipes that were not provided in the GIS data. A total of 2,483 manholes, catchbasins, and junctions are included in the model.

Multiple pipe sizes, shapes, and materials make up the 83.2 miles of storm sewer modeled. Pipe material and Manning's roughness value are provided in Table 2-2.

Table 2-2. Pipe Material Hydraulic Coefficients Used in the City of St. Louis Park SWMP Modeling

Pipe Material	Manning's n-value	Hazen-Williams Coefficient
DIP/Cast Iron	0.013	140
VCP	0.014	—
RCP	0.013	—
CMP/PVC	0.024	130
PP/PVC	0.010	—
Steel Pipe	0.012	—
Clay Drain Tile	0.013	—

Because discrepancies occurred in the data, the original as-designed data were used for modeled development and a note was appended to the model data to identify any assumptions made. When no data existed for a node invert or pipe diameter, the values were estimated based on the nearest up and downstream data and our professional judgement.

2.5.2 STORMWATER STORAGE AREAS AND SINKS

Using the MnDNR LiDAR elevation dataset and the 2011 *Stormwater Pond Evaluation and Prioritization – Assessment of Twenty-Six Basins* report, available flood storage for each pond above the normal water surface elevation was determined and combined with the dead storage provided in the report. These data were incorporated into the model to evaluate the flood detention and water quality benefits of the City's existing ponds and lakes. Using the LiDAR dataset, low-laying areas with a depth of more than 2-ft were identified and incorporated in the modeling. These areas are typically low points in backyards or intersections and provide live storage during flood events when the storm sewer system is at capacity and surcharges into streets or out of the system. Locations where the subsurface system surcharges are connected to the subsurface system via drainage pathways that occur in streets or swales and allow stormwater to reenter the subsurface system at a downstream point. A total of 390 storage areas were included in the models.

2.6 WATER QUALITY

EPA SWMM5 can also model water quality and pollutant loading. This module was added to establish the existing loading from watersheds and roughly estimate the reduction occurring from the City's waterbodies and regional best management practices (BMPs).

The event mean concentration (EMC) data from the Minnesota Pollution Control Agency's (MPCA) *Minnesota Stormwater Manual* was incorporated into the SWMM models to evaluate the watershed loading rates for total phosphorus (TP) and total suspended solids (TSS), shown in Table 2-3.

To evaluate the pollutant mass loading from the City, the models were run using a 10-year daily rainfall record developed from precipitation data at Minneapolis-St. Paul International Airport. These data are shown in Table 2-4.

Table 2-3. Total Phosphorus and Total Suspended Solids Event Mean Concentrations by Land Use in St. Louis Park

Land Use	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
Low Density Residential	0.5	150
Medium Density Residential	0.3	120
High Density Residential	0.4	140
Mixed Use	0.4	140
Commercial	0.25	140
Industrial	0.25	150
Office/Business Park	0.25	140
Civic	0.3	140
Park and Open Space	0.2	90
Highway and Rail Right-of-Way	0.04	135
Streets	0.5	135

mg/L = milligrams per liter.

Table 2-4. Total Precipitation at Minneapolis-St. Paul Airport (2008–2017)

Year	Precipitation
2008	22.38
2009	24.8
2010	32.89
2011	26.91
2012	29.59
2013	32.77
2014	35.4
2015	36.14
2016	40.32
2017	32.36
Mean Annual	31.36

Areas outside of the City, including the MnDOT right-of-way, are not included in this analysis. The pollutant removal efficiencies of existing stormwater facilities were not incorporated into this study; however, the existing facilities within the City were estimated to provide the removal efficiencies shown in Table 2-5.

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Table 2-5. Pollutant Removal Efficiencies for Stormwater Best Management Practices in St. Louis Park

Practice	Total Phosphorus (%)	Total Suspended Solids (%)
Constructed Wet Pond	50	84
Constructed Wetland	38	73
Biofiltration With Underdrain	80	85
Structural Pollutant Removal Devices	N/A	Varies by manufacturer

3.0 RESULTS

3.1 JULY 1987 FLOOD EVENT

The hydrology and hydraulic components of the SWMM models were compared to high water elevations collected during the July 23–25, 1987, storm event. The 15-minute rainfall record at Golden Valley COOP Station 213202 was collected from NOAA's Climate Data Online clearinghouse. This precipitation record was run in all of the final models to evaluate how well the model predicted the observed high water conditions. In general, the model overestimated high water elevations by approximately 0.26 percent on average, with a maximum error of 2.91 percent at the intersection of Lake Street and Hamilton Street (SA-7-045) in the Bass Lake model. This area has been redeveloped and may no longer reflect the 1987 conditions. No observed hydrograph data were available for calibration, and future modeling efforts are recommended to include collecting the data necessary for calibration.

3.2 HYDRAULIC RESULTS

The model results for all of the events were exported to GIS and analyzed to evaluate the approximate extents of surface flooding and pipe capacities in the City. The results of these analyses are presented in Appendix A. Areas of excessive flooding, which are defined as more than 2-ft deep even during the 10-year event, include the following:

- City Hall parking lot
- Edgewood Industrial Area
- Franklin Avenue and Lamplighter Pond area
- Franklin Avenue and Louisiana Avenue
- Minnetonka Boulevard and Georgia Avenue
- Minnetonka Boulevard and Highway 7
- Morningside Road and Browndale Avenue
- Nelson Park
- West 26th Street and Raleigh Avenue
- West 27th Street and Zarthan Avenue
- West 28th Street and Jersey Avenue
- West 29th Street and Vernon Avenue
- West 34th Street and Xylon Avenue
- West 39th Street and Kipling Avenue.

The large waterbodies in the City were evaluated for freeboard under TP-40 and Atlas 14 rainfall events for both the 100-year and 10-year events. A comprehensive list of modeled water surface elevations for all events is provided in Appendix B. All modeled lake elevations increased with the change from NOAA's TP-40 to Atlas 14 rainfall depths and as a result, all lakes show a decrease in available freeboard between the lowest primary structure elevation and the 10- and 100-year water surface elevation. Some lakes actually have negative freeboard, indicating the potential for the flooding of residential structures. Lakes with negative freeboard (i.e. flooding) are shown in Table 3-2 for all four of the modeled events. The models were used to summarize the stormwater runoff leaving the City. The peak discharges and locations are summarized in Table 3-3.

Table 3-1. Model Results and Comparison With July 1987 Observed Data

Node Name	Location	1987 Peak Flood Elevation	Modeled Elevation	Difference (ft)	Difference (%)
CE-16K-06	4725 Highway 7	878.83	880.07	1.24	0.14
SA-7-045	Lake Street and Hamilton Street	892.18	918.11	25.93	2.91
SA-7-058	Beltline Road & West 35th Street	877.83	880.05	2.22	0.25
SA-7-BassLake	Bass Lake Outlet	877.98	880.05	2.07	0.24
SA-2-OttenPond	Otten Pond	876.72	878.37	1.65	0.19
Cedar_Manor_Lake	Cedar Manor Lake	898.46	900.39	1.93	0.21
Hannan_Lake	Hannan Lake	897.87	899.57	1.7	0.19
Landlocked	Landlocked Basin	900.15	903.37	3.22	0.36
SA-6-CandlestickPond	Candlestick Pond	879.02	880.6	1.58	0.18
4-CC-09J-12	3100 Oregon Avenue South	897.14	896.8	–0.34	-0.04
4-MC-56UFN14	Upstream 37th St Bridge	901.03	903.08	2.05	0.23
4-SC-11N-05	Louisiana Street and Oxford Street	891.24	891.72	0.48	0.05
4-SC-10N-21	Oregon Street and Lake Street	892.42	892.37	–0.05	-0.01
SA-4-032	Oak Hill Park	895.71	896.81	1.1	0.12
SA-4-CobblecrestLake	Cobblecrest Lake	899.64	896.91	–2.73	-0.30
SA-4-MC-53	Minnehaha Creek Wetlands	899.49	903.6	4.11	0.46
SA-4-MC-54	Upstream 34th Street Bridge	902.34	903.6	1.26	0.14
SA-4-MC-69	Upstream Excelsior Boulevard	888.58	891.51	2.93	0.33
SA-4-OakPond	Oak Lake	892.21	893.12	0.91	0.10
SA-4-WestingPond	Westling Pond	897.62	899.58	1.96	0.22
SA-5-004	7520 Cedar Lake Road and Oregon Court Sink	885.09	886.4	1.31	0.15
SA-5-Boneyard	Boneyard Ditch	879.38	882.36	2.98	0.34
SA-5-Lamplighter	Lamplighter Pond	885.32	886.34	1.02	0.12
SA-5-Natchez	Natchez Pond	874.51	874.36	–0.15	–0.02
SA-5-TwinLakes	Twin Lake	875.68	874.2	–1.48	–0.17
SA-1-KilmerLake	Kilmer Pond	905.72	910.34	4.62	0.51
SA-1-WestwoodLake	Westwood Lake	888.45	888.7	0.25	0.03

3.3 WATER QUALITY RESULTS

Using the EMC data collected for the various land use types in the City and a 10-year rainfall record, the watershed loading rates were calculated in the models.

Table 3-2. City of St. Louis Park Lakes With Modeled Negative Freeboard

Lake	10-Year Technical Paper-40	100-Year Technical Paper-40	10-Year Atlas 14	100-Year Atlas 14
Bass Lake		●	●	●
Browndale Pond				●
Candlestick Pond				●
Kilmer Pond				●
Lamplighter Pond				●
Natchez Pond		●		●
Oak Pond		●		●
Oregon Pond	●	●	●	●
Otten Pond		●		●
Rhino Pond				●
South Oak Pond	●	●	●	●
Sumter Pond				●

Table 3-3. Intercommunity Peak Outflows From the City of St. Louis Park

Receiving Cities	Drainage District	10-Year Technical Paper-40	100-Year Technical Paper-40	10-Year Atlas 14	100-Year Atlas 14
Minneapolis	Bass Lake	85	177	141	365
Edina	Edina	208	299	243	410
Minneapolis	Edina	127	190	153	276
Golden Valley/MnDOT	Golden Valley	177	256	218	322
Minneapolis/Storm Sewer	Minneapolis	82	114	101	169
Minneapolis/Cedar Lake	Minneapolis	128	156	137	177
Minneapolis/MnDOT	Minneapolis	145	201	164	244
Plymouth (Bassett Creek)	Westwood	247	294	274	353
Golden Valley	Westwood	69	99	83	143

Note that all units are in cubic feet per second (cfs).

Given the significant area occupied by state highways in the City, the pollutant loading from MnDOT right-of-way was separated out along I-394, Trunk Highways 7 and 100, and US 169. Loading rates from the watershed were allocated to each entity based on their proportional areas in each subwatershed. The results are provided in Table 3-5. The loads within the drainage areas of the three impaired lakes in the City are included in Table 3-6. Note that a very small part of the Bass Lake drainage area is located within the City of Minneapolis.

Table 3-4. City of St. Louis Park Modeled Pollutant Loading

	Model Total	St. Louis Park Only
Area (ac)	9,489	6,864
Annual TP Load (2008-2017) (lb/yr)	11,465	8,538
TP Loading Rate (lb/ac/yr)	1.21	1.24
Annual TSS Load (2008-2017) (lb/yr)	4,079,726	3,068,247
TSS Loading Rate (lb/ac/yr)	429.94	447.04

ac = acres.
lb/yr = pounds per year.
lb/ac/yr = pounds per acre per year.

Table 3-5. Allocated Watershed Loading From the City of St. Louis Park and Minnesota Department of Transportation

	City of St. Louis Park	Minnesota Department of Transportation
Area (ac)	6,645	219
Annual TP Load (2008-2017) (lb/yr)	7,989	549
TP Loading Rate (lb/ac/yr)	1.20	2.51
Annual TSS Load (2008-2017) (lb/yr)	2,893,431	174,816
TSS Loading Rate (lb/ac/yr)	435.45	798.84

Table 3-6. Annual Total Phosphorus Load (2008–2017) to Nutrient-Impaired Waters in St. Louis Park

Impaired Water	City of St. Louis Park (lb/yr)	MnDOT (lb/yr)	External to St. Louis Park (lb/yr)
Bass Lake	1,975.7	276.7	0.5 (City of Minneapolis)
Cobblecrest Lake	327.6	0.1	n/a
Twin Lake	2,303.9	28.1	n/a

lb/yr = pounds per year.

4.0 CONCLUSIONS

4.1 HYDRAULIC RECOMMENDATIONS

As the City is well-aware, multiple flood-prone areas exist in the City. The areas identified in this study should be verified against the Public Works' maintenance records or resident complaints to validate the model results, in absence of calibration data. Additional efforts are recommended and include the following:

- Establishing a monitoring and data collection network for future calibration efforts. Because the models appear to be overestimating runoff, the catchment width factor should be closely reviewed during any calibration effort.
- Reviewing model assumptions. Some of these locations may indicate the need for future City maintenance, given the high groundwater table and underlying soils in the City.
- Reviewing surface inundation areas with the City Engineer and Public Works Department to validate these problem areas against citizen complaint and/or maintenance records.
- Confirming pump operations with the Public Works Department. Available as-built data were used, but the records were incomplete, and in many cases, pump size and rules were assumed.
- Reviewing intercommunity and inter-model flows and assumptions. The inflow hydrographs from Minnehaha Creek could not be obtained in the time frame for finalizing this report; however, the model results have been verified against the current FEMA mapping and are consistent with FEMA's results in the creek.
- Coordinating routine street reconstruction projects with flood improvement projects to maximize opportunities to improve drainage.

4.2 WATER QUALITY RECOMMENDATIONS

The model results indicate that the City contributes nearly 8,000 pounds of TP and 4 million pounds of TSS annually. The City intends to improve these numbers and has made progress toward that goal with projects such as the Carpenter Park Underground Stormwater Facility. The watershed loading identified in this study is recommended to prioritize the siting of future regional water quality projects and modeling efforts. Future work includes:

- Refining the models to allow for long-term simulation of flow routing and water quality data and establishing the City's reductions and contributions to meeting existing total maximum daily loads (TMDLs).
- Incorporating private BMPs. These BMPs were not generally included in this modeling effort, but they do play a role in improving water quality.
- Combining maintenance projects in the Birchwood, Bronx Park, Fern Hill, and Elliot View neighborhoods with water quality improvement projects, as the runoff from these neighborhoods contributes to the nutrient-impaired Twin Lake.
- Coordinating with future private and public developments in the Aquila and Meadowbrook neighborhoods to look for enhanced water quality improvements to benefit the impaired Minnehaha Creek.

RESPEC

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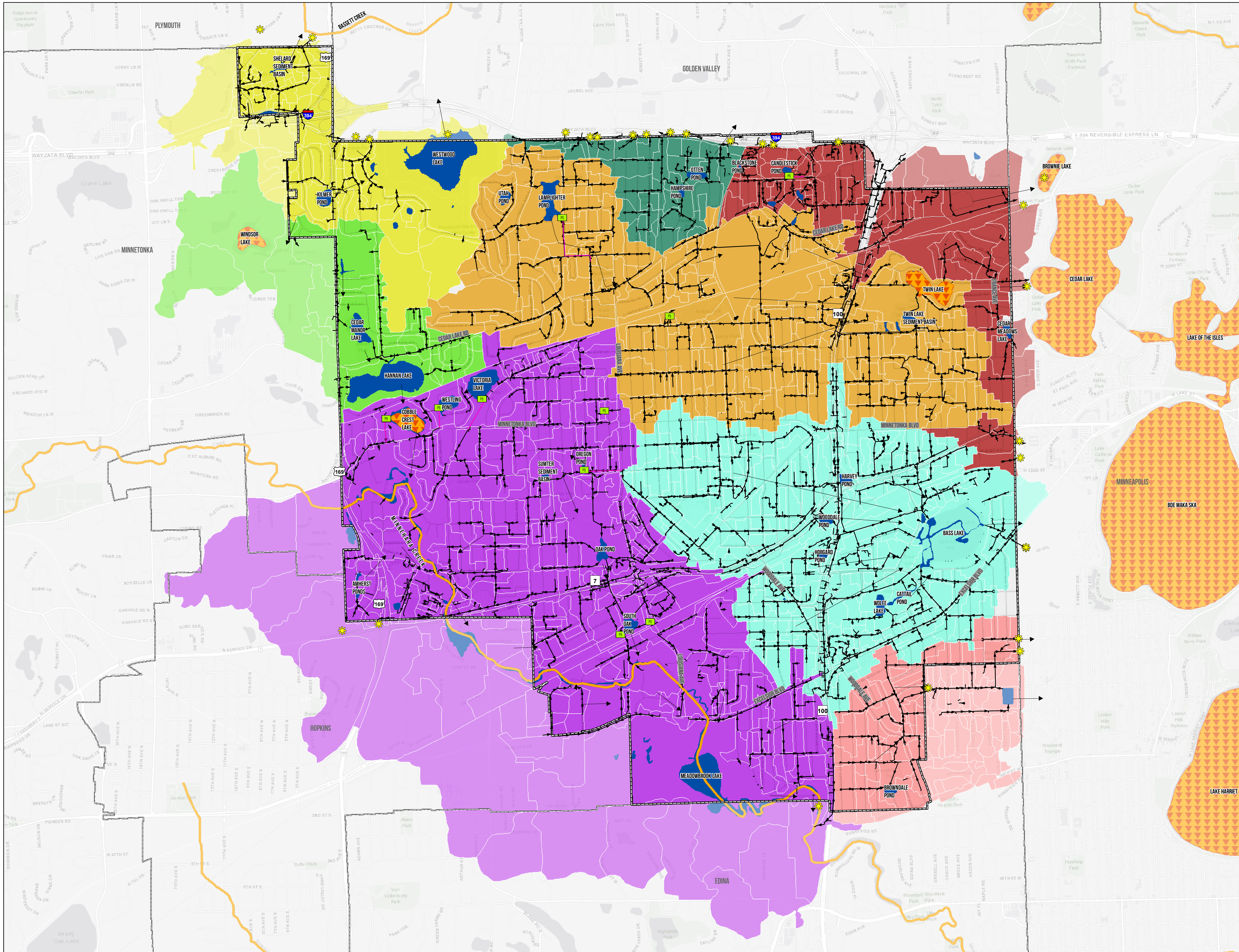
APPENDIX A

FIGURES



St. Louis Park
MINNESOTA

FIGURE A-1: STORM SEWER CONVEYANCE SYSTEM AND IMPAIRED WATERBODIES

LEGEND

- Intercommunity Flow Locations
- Stormwater Lift Stations
- Stormwater Discharge Points
- Storm Mains (Pressure)
- Storm Mains (Gravity)
- Flow Arrows
- 01-Westwood Lake District (740 acres)
- 02-Golden Valley District (219 acres)
- 03-Hannan Lake District (605 acres)
- 04-Minnehaha Creek District (3,783 acres)
- 05-Twin Lake District (1,636 acres)
- 06-Minneapolis District (649 acres)
- 07-Bass Lake District (1,362 acres)
- 08-Edina District (497 acres)
- Impaired Streams
- Impaired Lakes
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES

Scale: As Shown	
Drawn By: KAT	
Checked By:	
Proj. #: 03259	
Date: 2018.11.08	

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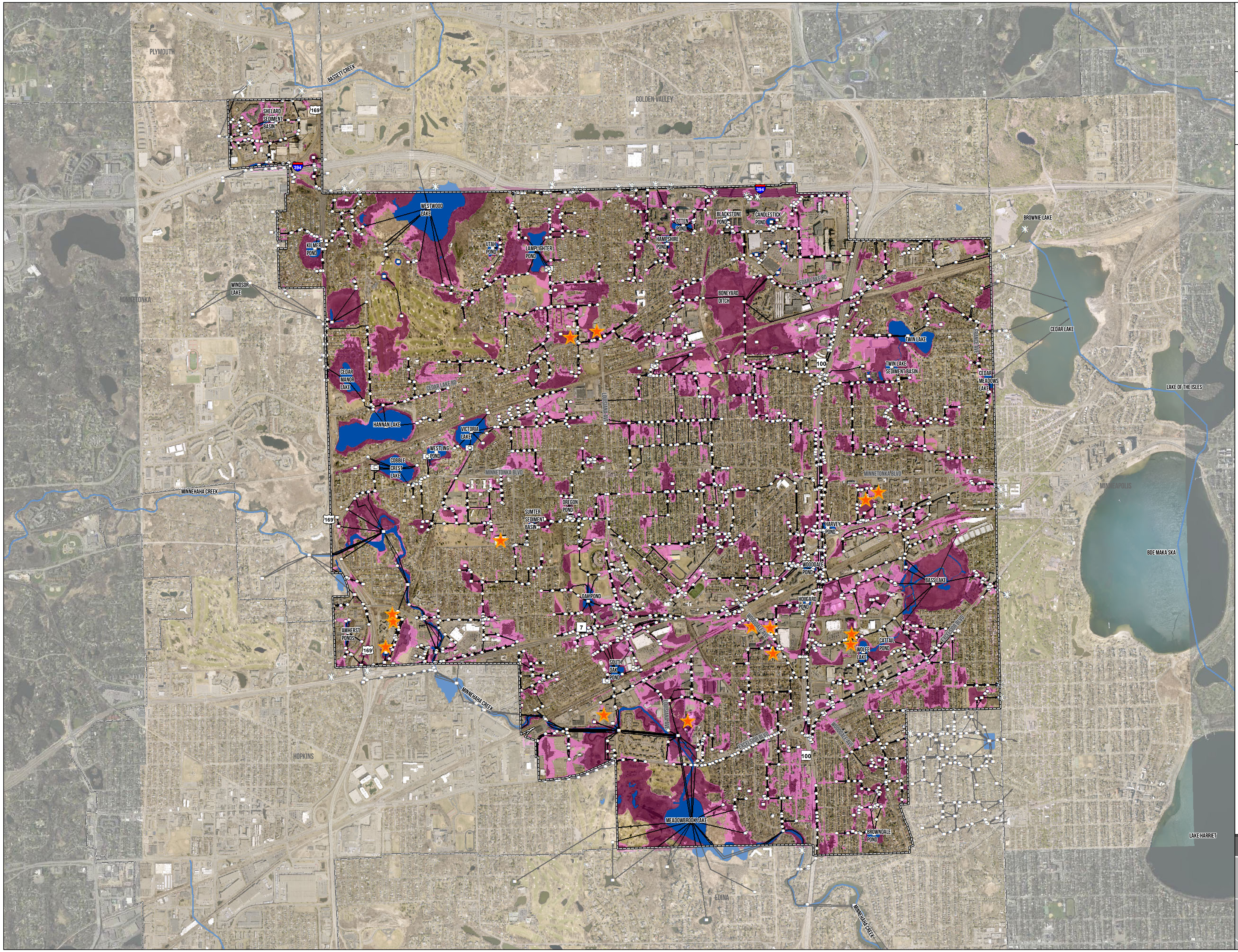


St. Louis Park
MINNESOTA

FIGURE A-2: NOAA ATLAS 14 100-YEAR 24-HOUR SURFACE FLOODING

LEGEND

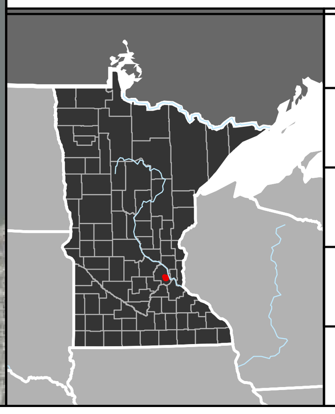
- Critical Infrastructure
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Modeled Storm Mains

Depth of Flooding

- No Flooding
- 0 - 2-ft
- > 2-ft
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES



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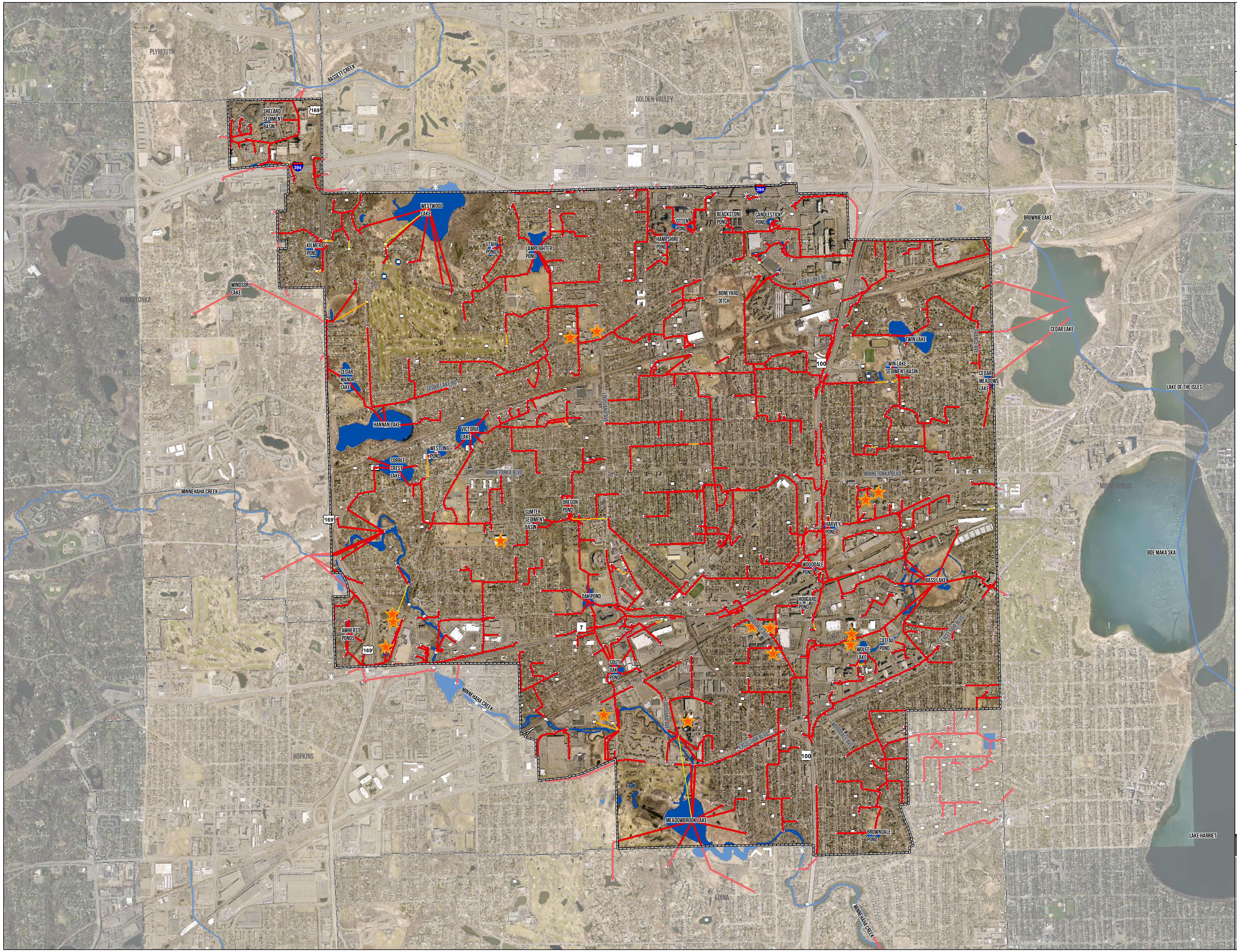
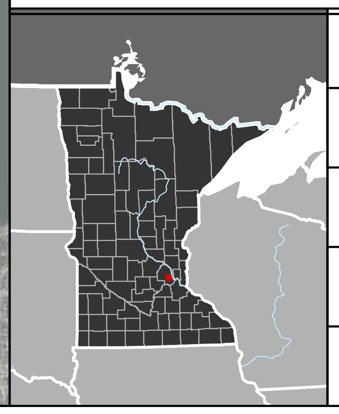


St. Louis Park
MINNESOTA

FIGURE A-3: NOAA ATLAS 14
100-YEAR 24-HOUR SYSTEM CAPACITY

LEGEND

- Critical Infrastructure
- Modeled Conduits Percent Full
  - 0% - 25%
  - 26% - 50%
  - 51% - 75%
  - 76% - 100%
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Creeks
- Lakes
- City Boundary



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Date: 2018.11.08

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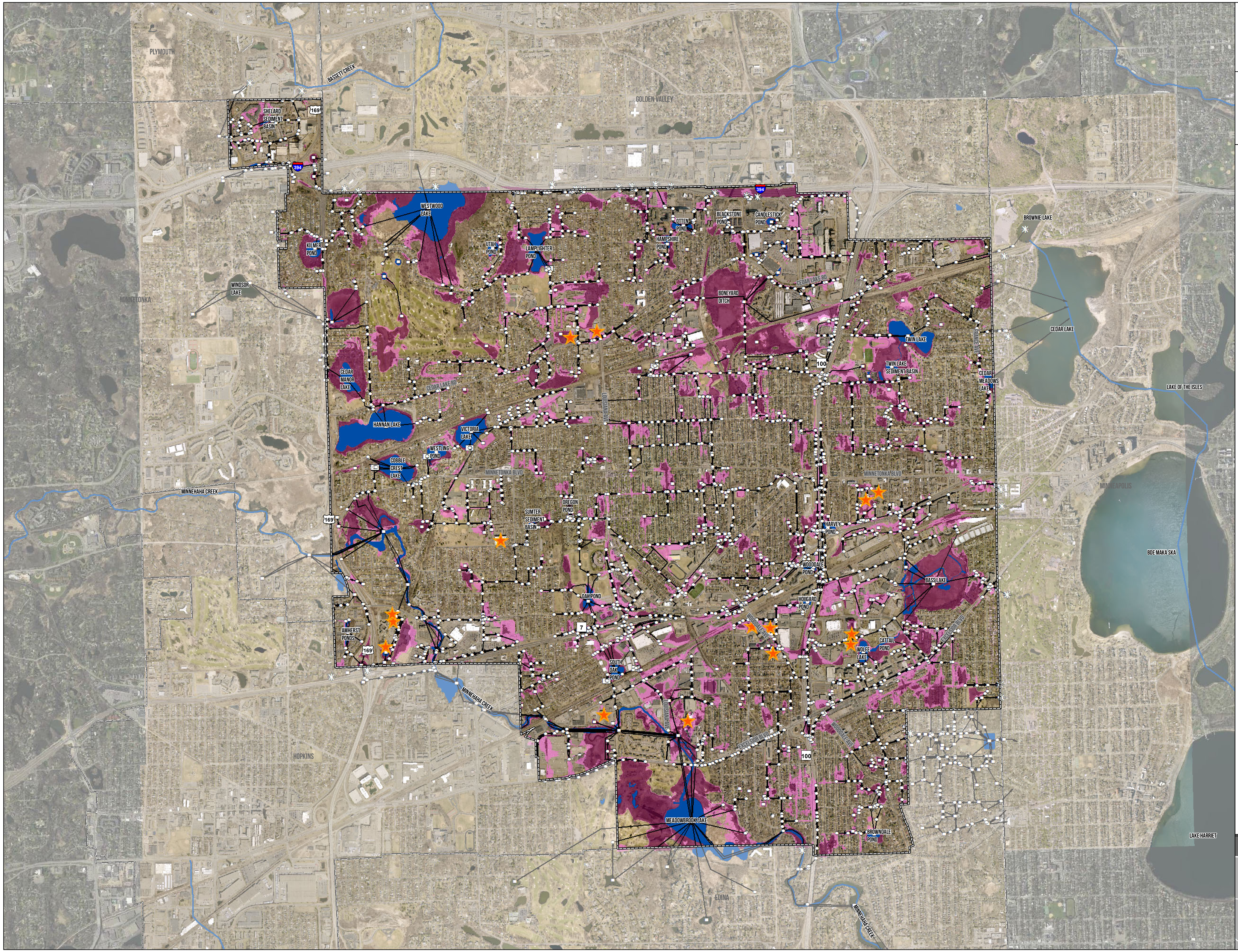

St. Louis Park
MINNESOTA

FIGURE A-4: NOAA ATLAS 14 10-YEAR 24-HOUR SURFACE FLOODING

LEGEND

- Critical Infrastructure
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Modeled Storm Mains

Depth of Flooding

- No Flooding
- 0 - 2-ft
- > 2-ft
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES

Scale: As Shown	
Drawn By: KAT	
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Proj. #: 03259	
Date: 2018.11.08	

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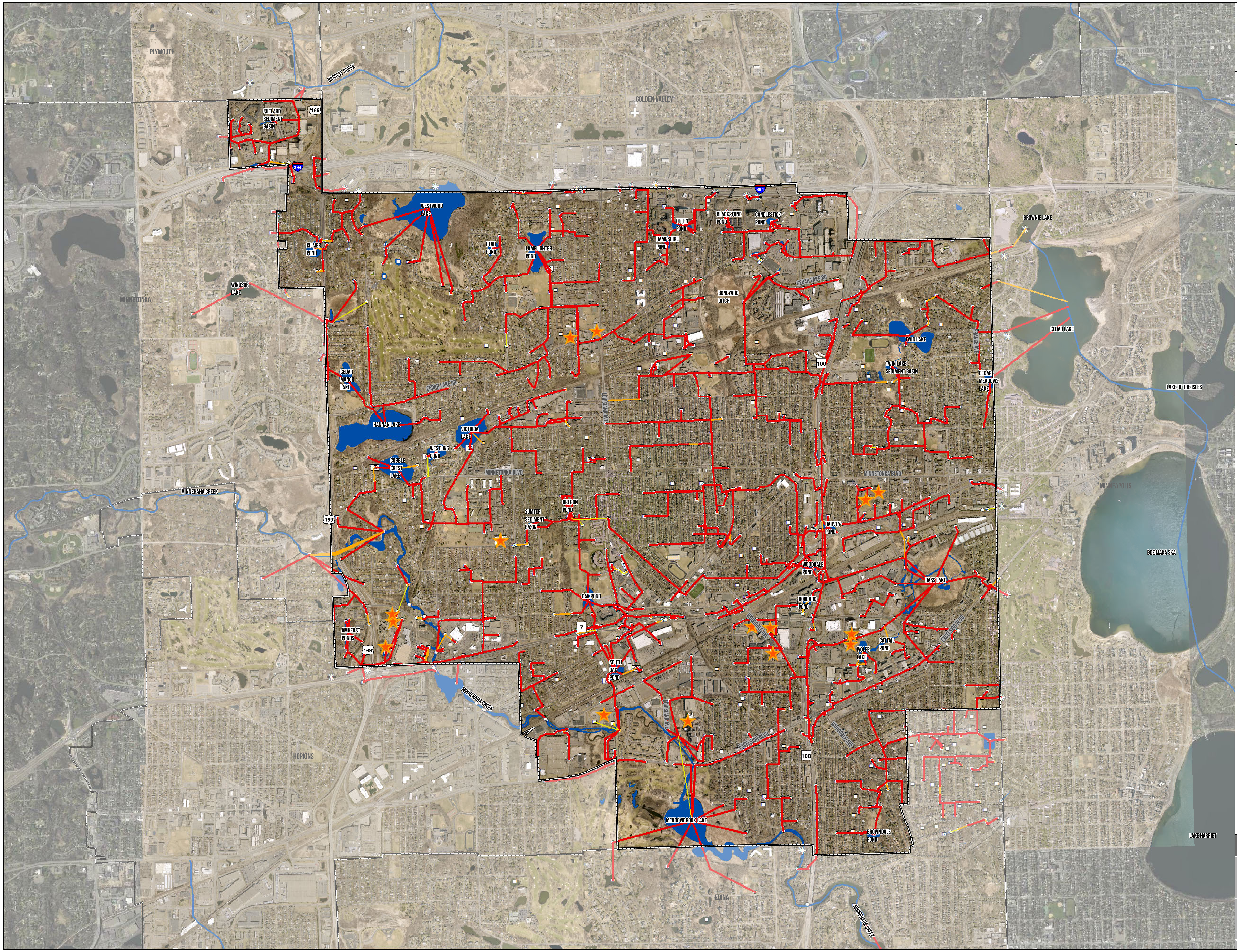
St. Louis Park
MINNESOTA

FIGURE A-5: NOAA ATLAS 14 10-YEAR 24-HOUR SYSTEM CAPACITY



LEGEND

- Critical Infrastructure
- **Modeled Conduits Percent Full**
  - 0% - 25%
  - 26% - 50%
  - 51% - 75%
  - 76% - 100%
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES

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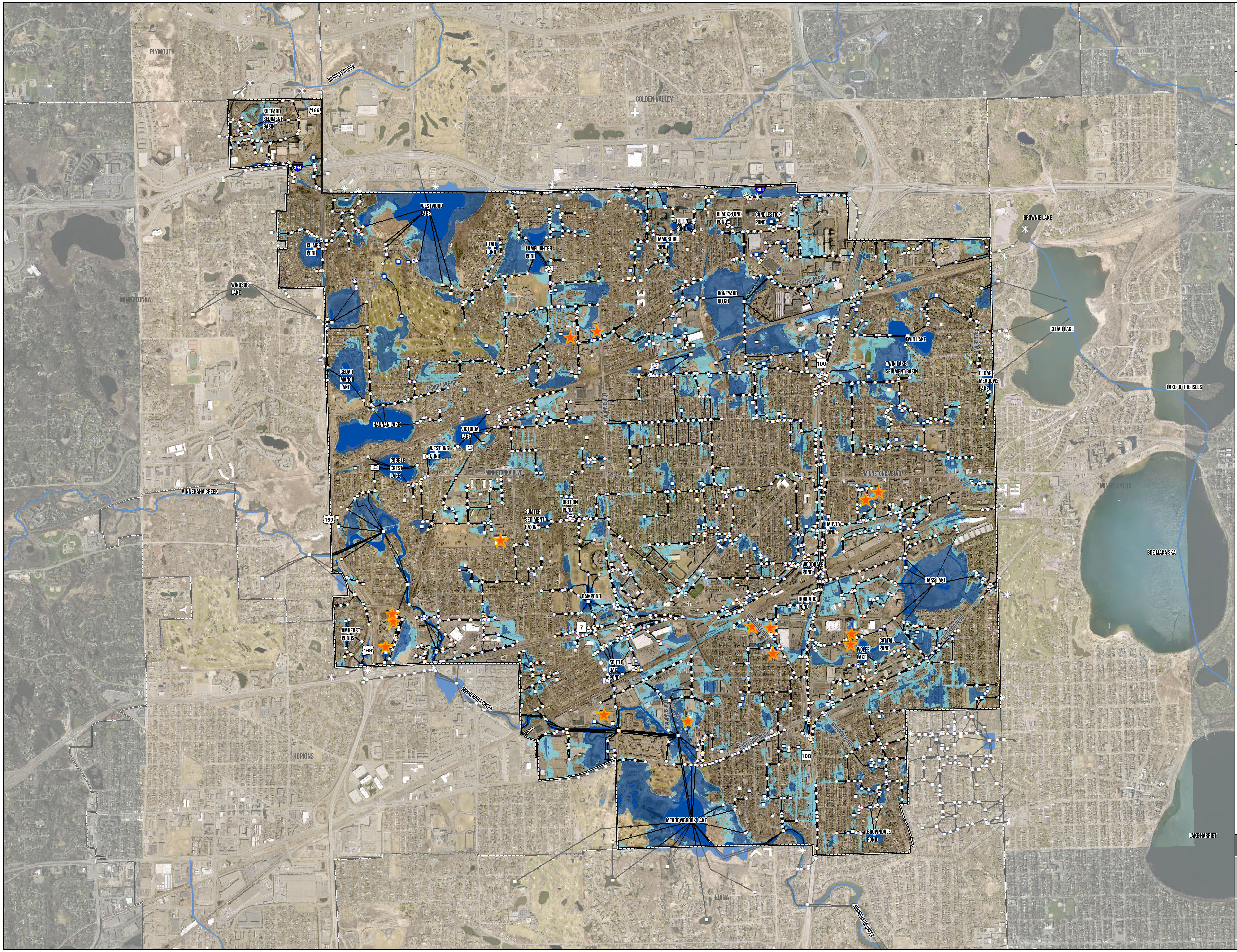

St. Louis Park
MINNESOTA

FIGURE A-6: NOAA TP-40 100-YEAR 24-HOUR SURFACE FLOODING

LEGEND

- Critical Infrastructure
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Modeled Storm Mains

Depth of Flooding

- No Flooding
- 0 - 2-ft
- > 2-ft
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES
1 INCH = 0.25 MILES

Scale: As Shown
Drawn By: KAT
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Proj. #: 03259
Date: 2018.11.08

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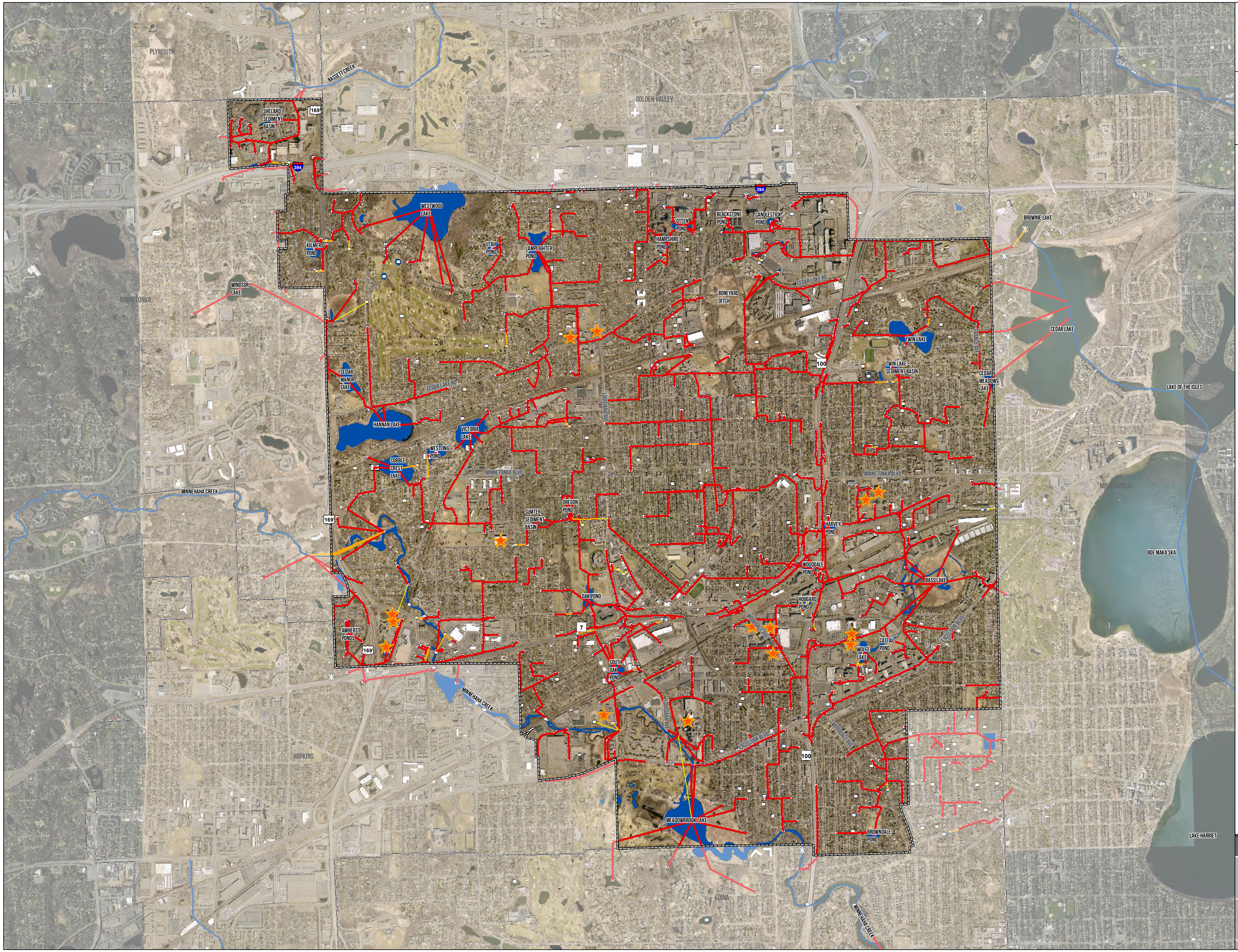
MINNESOTA

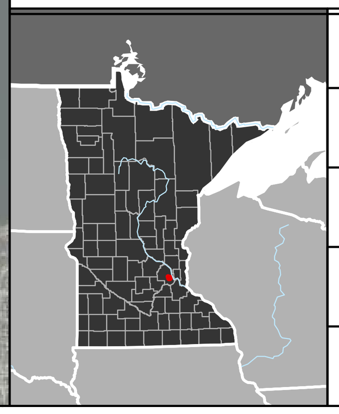
FIGURE A-7: NOAA TP-40 100-YEAR 24-HOUR SYSTEM CAPACITY



LEGEND

- Critical Infrastructure
- **Modeled Conduit Percent Full**
  - 0% - 25%
  - 26% - 50%
  - 51% - 75%
  - 76% - 100%
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Creeks
- Lakes
- City Boundary

N
0 0.25 0.5 1 MILES
1 INCH = 0.25 MILES



Scale: As Shown	RESPEC
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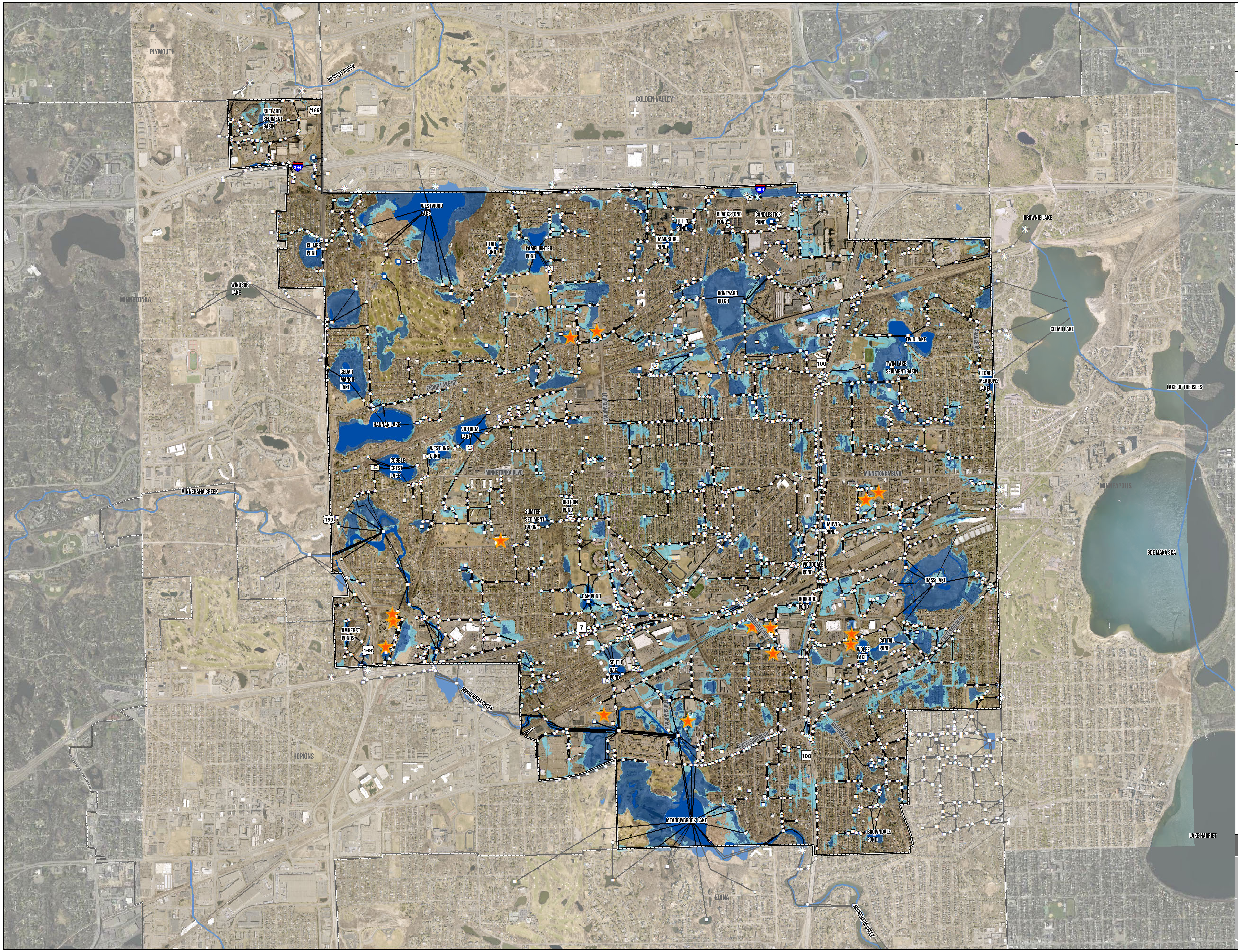

St. Louis Park
MINNESOTA

FIGURE A-8: NOAA TP-40 10-YEAR 24-HOUR SURFACE FLOODING

LEGEND

- Critical Infrastructure
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Modeled Storm Mains

Depth of Flooding

- No Flooding
- 0 - 2-ft
- > 2-ft
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES

Scale: As Shown	
Drawn By: KAT	
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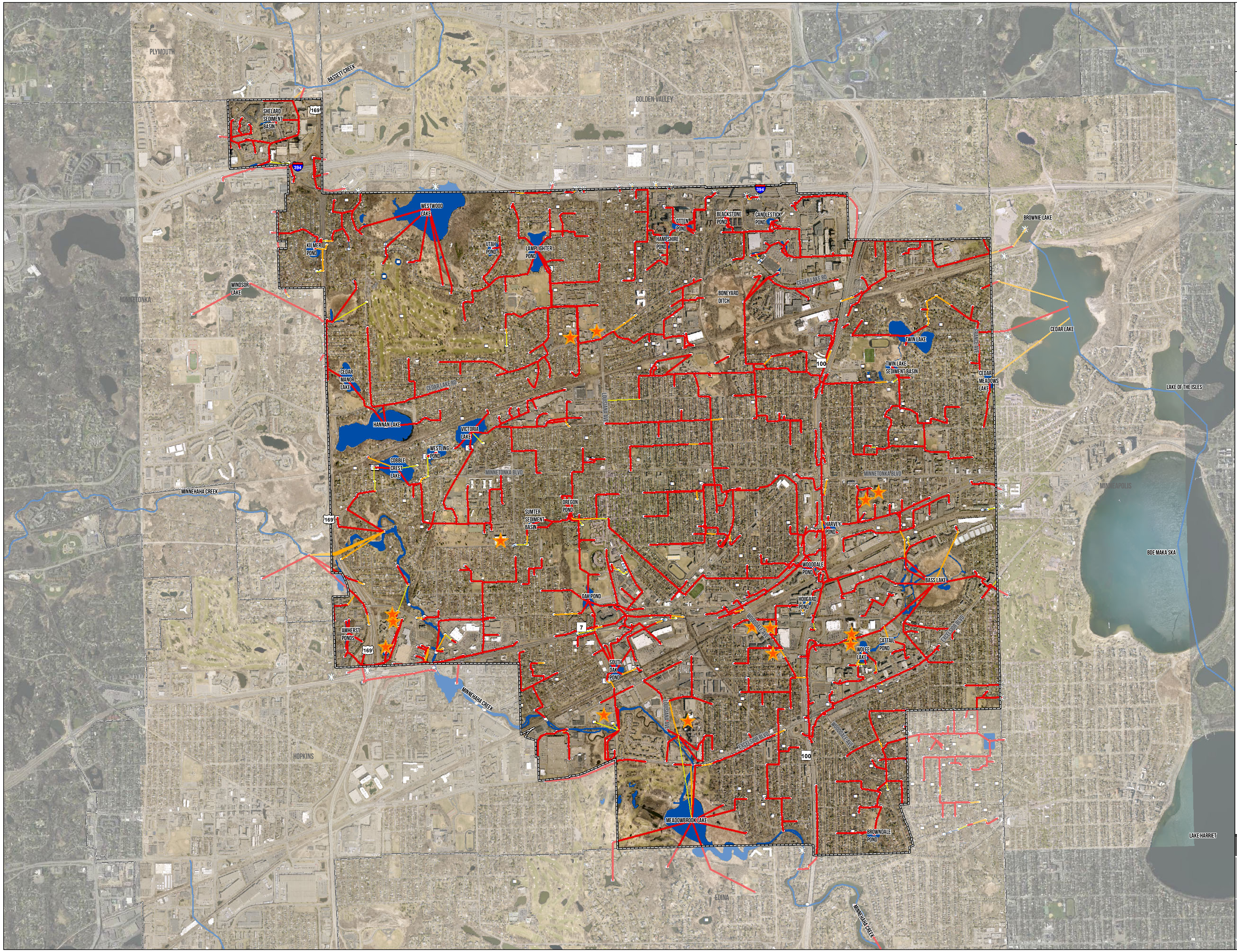


St. Louis Park
MINNESOTA

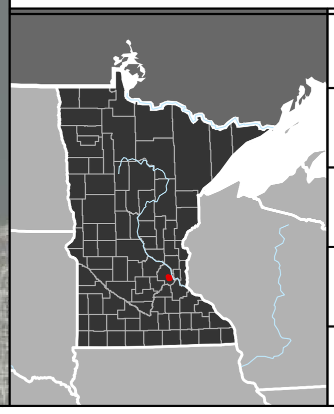
FIGURE A-9: NOAA TP-40 10-YEAR 24-HOUR SYSTEM CAPACITY

LEGEND

- Critical Infrastructure
- Modeled Conduit Percent Full
  - 0% - 25%
  - 26% - 50%
  - 51% - 75%
  - 76% - 100%
- Modeled Junctions
- Modeled Storage Nodes
- Stormwater Lift Stations
- Model Outfalls
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES



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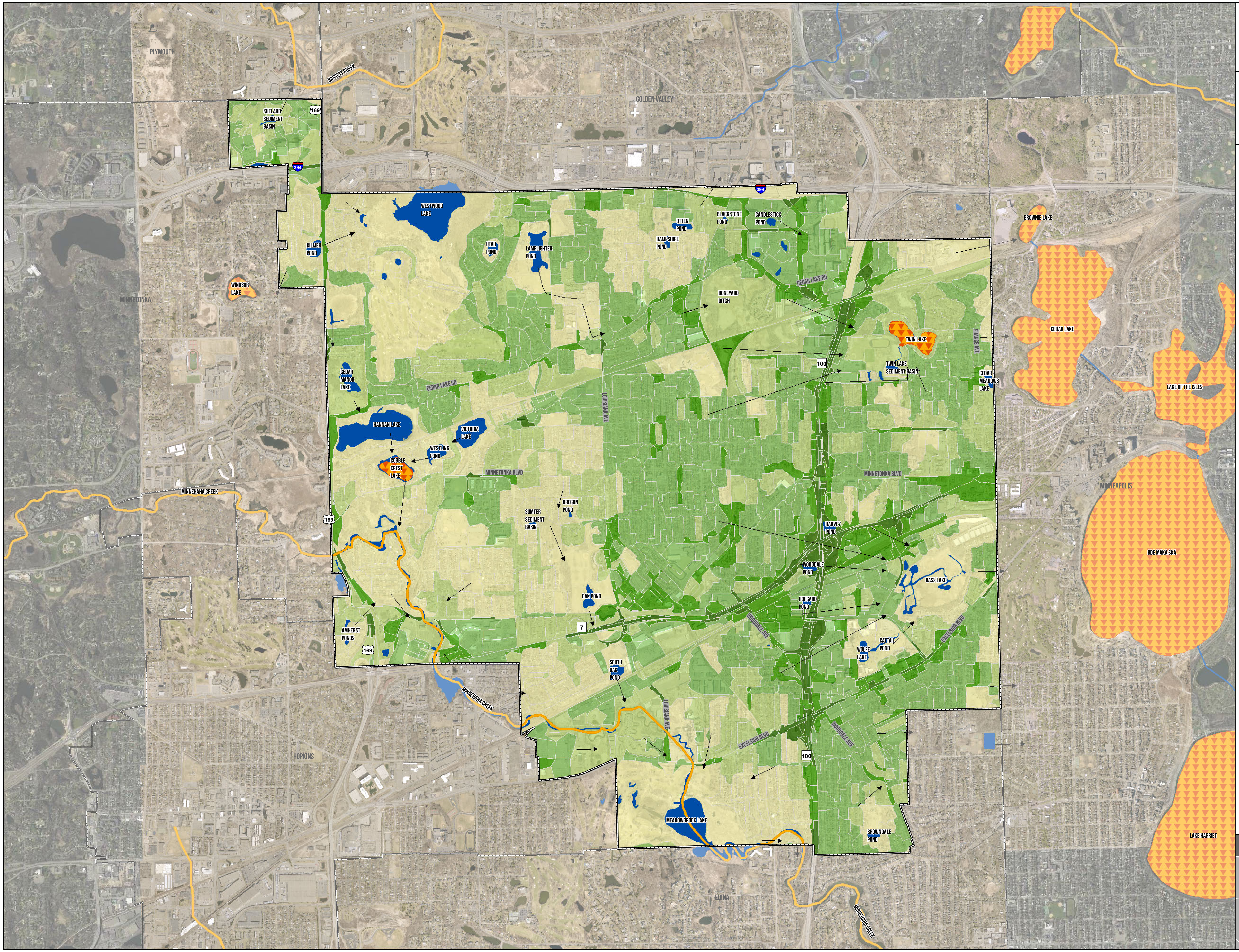
St. Louis Park
MINNESOTA

FIGURE A-10: TOTAL PHOSPHORUS MASS LOADING



LEGEND

- Flow Arrows
- Impaired Streams
- Impaired Lakes

Annual Loading (lb/ac/yr)

- 0.00 - 0.78
- 0.79 - 1.43
- 1.44 - 1.99
- 2.00 - 2.76
- 2.77 - 3.50
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES

Scale: As Shown	
Drawn By: KAT	
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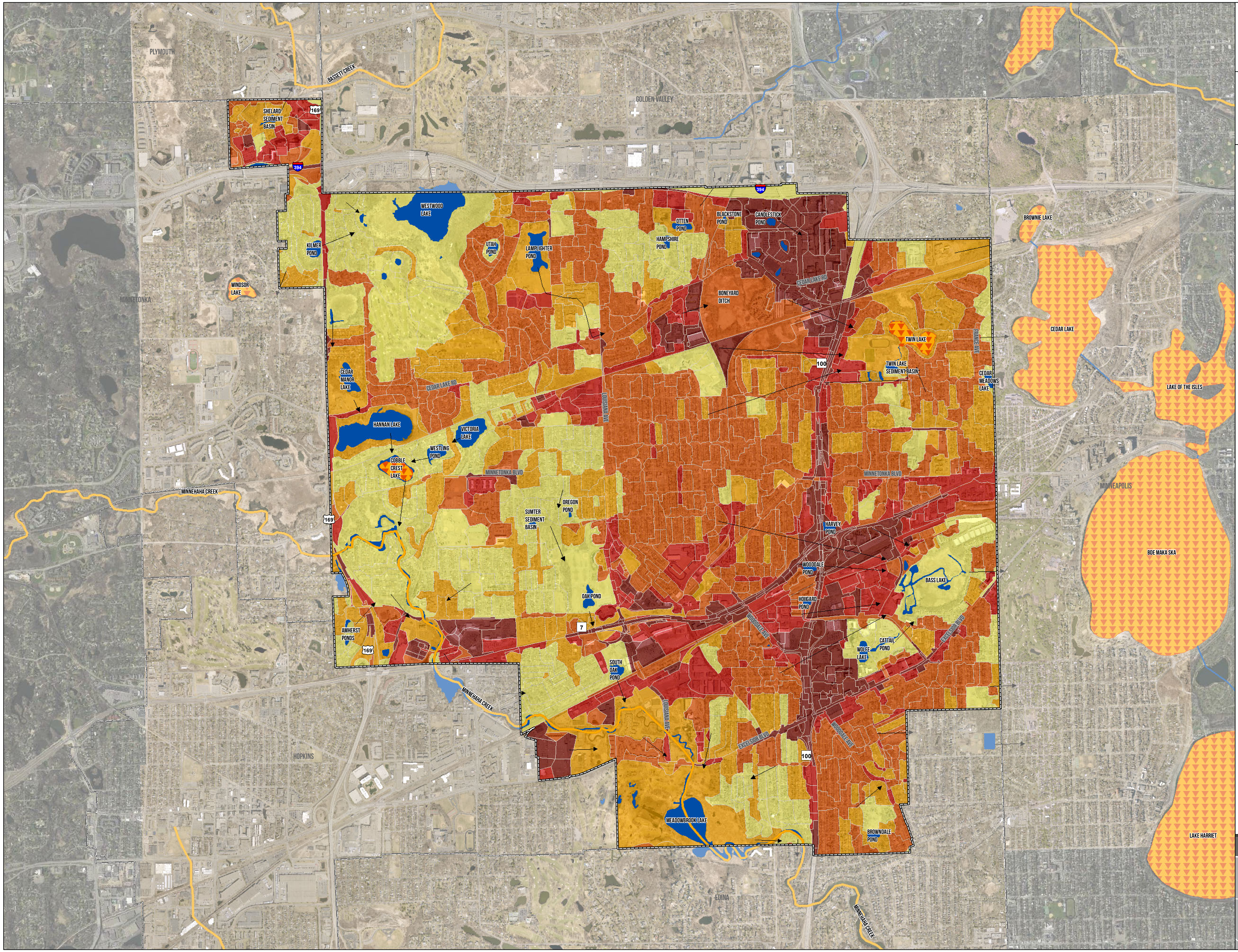


St. Louis Park
MINNESOTA

FIGURE A-11: TOTAL SUSPENDED SOLIDS MASS LOADING

LEGEND

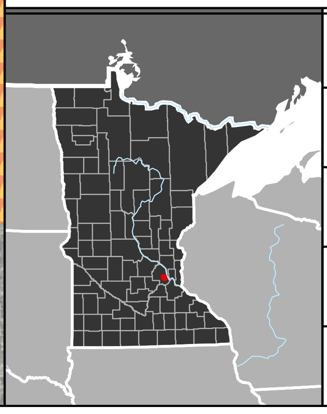
- Flow Arrows
- Impaired Streams
- Impaired Lakes

Annual Loading (lb/ac/yr)

- 0 - 236
- 237 - 439
- 440 - 640
- 641 - 869
- 870 - 1,213
- Creeks
- Lakes
- City Boundary

0 0.25 0.5 1 MILES

1 INCH = 0.25 MILES



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APPENDIX B

LAKE RESULTS

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APPENDIX B: MODELED LAKE RESULTS

For all of the tables in this appendix, the Lowest Adjacent Grade was determined from the nearest light and detection ranging (LiDAR) contour to the lowest primary residential structure.

B.1 BASS LAKE MODEL LAKE RESULTS

Table B-1. Bass Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	876.58	877.08	+0.5
100-year, 24-hour Water Surface Elevation	878.51	879.85	+1.34
Lowest Adjacent Grade	877.00		
Minimum Freeboard (10-year, 24-hour)	0.42	–0.08	–0.5
Minimum Freeboard (100-year, 24-hour)	–1.51	–2.85	–1.34

ft = feet.

Table B-2. Cattail Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	877.58	877.66	+0.08
100-year, 24-hour Water Surface Elevation	878.48	879.8	+1.32
Lowest Adjacent Grade	880.00		
Minimum Freeboard (10-year, 24-hour)	2.42	2.34	–0.08
Minimum Freeboard (100-year, 24-hour)	1.52	0.20	–1.32

Table B-3. Harvey Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	881.6	881.75	+0.15
100-year, 24-hour Water Surface Elevation	882.16	883.15	+0.99
Lowest Adjacent Grade	886.00		
Minimum Freeboard (10-year, 24-hour)	4.40	4.25	–0.15
Minimum Freeboard (100-year, 24-hour)	3.84	2.85	–0.99

Table B-4. Hoiigaard Pond

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	887.01	887.07	+0.06
100-year, 24-hour Water Surface Elevation	887.31	887.7	+0.39
Lowest Adjacent Grade	898.00		
Minimum Freeboard (10-year, 24-hour)	10.99	10.93	–0.06
Minimum Freeboard (100-year, 24-hour)	10.69	10.30	–0.39

Table B-5. Roxbury Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	898.24	898.55	+0.31
100-year, 24-hour Water Surface Elevation	899.4	902.53	+3.13
Lowest Adjacent Grade	904.00		
Minimum Freeboard (10-year, 24-hour)	5.76	5.45	–0.31
Minimum Freeboard (100-year, 24-hour)	4.60	1.47	–3.13

Table B-6. Wolfe Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	876.63	877.05	+0.42
100-year, 24-hour Water Surface Elevation	878.48	879.8	+1.32
Lowest Adjacent Grade	880.00		
Minimum Freeboard (10-year, 24-hour)	3.37	2.95	–0.42
Minimum Freeboard (100-year, 24-hour)	1.52	0.20	–1.32

Table B-7. Wooddale Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	880.9	881.18	+0.28
100-year, 24-hour Water Surface Elevation	881.84	882.77	+0.93
Lowest Adjacent Grade	889.00		
Minimum Freeboard (10-year, 24-hour)	8.10	7.82	–0.28
Minimum Freeboard (100-year, 24-hour)	7.16	6.23	–0.93

B.2 EDINA MODEL LAKE RESULTS

Table B-8. Browndale Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	876.97	877.33	+0.36
100-year, 24-hour Water Surface Elevation	877.98	879.22	+1.24
Lowest Adjacent Grade	878.00		
Minimum Freeboard (10-year, 24-hour)	1.03	0.67	–0.36
Minimum Freeboard (100-year, 24-hour)	0.02	–1.22	–1.24

B.3 GOLDEN VALLEY MODEL LAKE RESULTS

Table B-9. Otten Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	876.3	876.46	+0.16
100-year, 24-hour Water Surface Elevation	877.12	878.37	+1.25
Lowest Adjacent Grade	877.00		
Minimum Freeboard (10-year, 24-hour)	0.70	0.54	–0.16
Minimum Freeboard (100-year, 24-hour)	–0.12	–1.37	–1.25

B.4 HANNAN LAKE MODEL LAKE RESULTS

Table B-10. Cedar Manor Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	898.7	899.09	+0.39
100-year, 24-hour Water Surface Elevation	899.62	900.27	+0.65
Lowest Adjacent Grade	902.00		
Minimum Freeboard (10-year, 24-hour)	3.30	2.91	–0.39
Minimum Freeboard (100-year, 24-hour)	2.38	1.73	–0.65

Table B-11. Hannan Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	898.02	898.24	+0.22
100-year, 24-hour Water Surface Elevation	898.81	899.58	+0.77
Lowest Adjacent Grade	907.00		
Minimum Freeboard (10-year, 24-hour)	8.98	8.76	–0.22
Minimum Freeboard (100-year, 24-hour)	8.19	7.42	–0.77

B.5 MINNEAPOLIS MODEL LAKE RESULTS

Table B-12. Blackstone Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	878.15	878.79	+0.64
100-year, 24-hour Water Surface Elevation	879.99	881.35	+1.36
Lowest Adjacent Grade	882.82		
Minimum Freeboard (10-year, 24-hour)	4.67	4.03	–0.64
Minimum Freeboard (100-year, 24-hour)	2.83	1.47	–1.36

Table B-13. Candlestick Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	876.22	876.92	+0.7
100-year, 24-hour Water Surface Elevation	879.02	880.33	+1.31
Lowest Adjacent Grade	879.82		
Minimum Freeboard (10-year, 24-hour)	3.60	2.90	-0.70
Minimum Freeboard (100-year, 24-hour)	0.80	–0.51	–1.31

B.6 MINNEHAHA CREEK MODEL LAKE RESULTS

Table B-14. Amhurst Ponds Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	918.52	918.77	+0.25
100-year, 24-hour Water Surface Elevation	919.25	919.83	+0.58
Lowest Adjacent Grade	920.00		
Minimum Freeboard (10-year, 24-hour)	1.48	1.23	–0.25
Minimum Freeboard (100-year, 24-hour)	0.75	0.17	–0.58

Table B-15. Cobblecrest Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	894.33	894.77	+0.44
100-year, 24-hour Water Surface Elevation	895.89	897.63	+1.74
Lowest Adjacent Grade	907.00		
Minimum Freeboard (10-year, 24-hour)	12.67	12.23	–0.44
Minimum Freeboard (100-year, 24-hour)	11.11	9.37	–1.74

Table B-16. Oak Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	891.3	891.58	+0.28
100-year, 24-hour Water Surface Elevation	892.22	893.14	+0.92
Lowest Adjacent Grade	892.00		
Minimum Freeboard (10-year, 24-hour)	0.70	0.42	–0.28
Minimum Freeboard (100-year, 24-hour)	–0.22	–1.14	–0.92

Table B-17. Oregon Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	894.13	894.69	+0.56
100-year, 24-hour Water Surface Elevation	895.34	896.65	+1.31
Lowest Adjacent Grade	894.00		
Minimum Freeboard (10-year, 24-hour)	–0.13	–0.69	–0.56
Minimum Freeboard (100-year, 24-hour)	–1.34	–2.65	-1.31

Table B-18. Rhino Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	914.06	914.43	+0.37
100-year, 24-hour Water Surface Elevation	914.77	915.39	+0.62
Lowest Adjacent Grade	915.00		
Minimum Freeboard (10-year, 24-hour)	0.94	0.57	–0.37
Minimum Freeboard (100-year, 24-hour)	0.23	–0.39	–0.62

Table B-19. South Oak Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	891.3	891.54	+0.24
100-year, 24-hour Water Surface Elevation	892.18	892.76	+0.58
Lowest Adjacent Grade	890.00		
Minimum Freeboard (10-year, 24-hour)	–1.30	–1.54	–0.24
Minimum Freeboard (100-year, 24-hour)	–2.18	–2.76	–0.58

Table B-20. Sumter Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	893.84	894.53	+0.69
100-year, 24-hour Water Surface Elevation	895.32	897.32	+2.00
Lowest Adjacent Grade	896.00		
Minimum Freeboard (10-year, 24-hour)	2.16	1.47	–0.69
Minimum Freeboard (100-year, 24-hour)	0.68	–1.32	–2.00

Table B-21. Victoria Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	901.1	901.48	+0.38
100-year, 24-hour Water Surface Elevation	902.47	903.77	+1.3
Lowest Adjacent Grade	905.00		
Minimum Freeboard (10-year, 24-hour)	3.90	3.52	–0.38
Minimum Freeboard (100-year, 24-hour)	2.53	1.23	–1.3

Table B-22. Westling Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	898.64	898.78	+0.14
100-year, 24-hour Water Surface Elevation	899.02	899.57	+0.55
Lowest Adjacent Grade	900.00		
Minimum Freeboard (10-year, 24-hour)	1.36	1.22	–0.14
Minimum Freeboard (100-year, 24-hour)	0.98	0.43	–0.55

B.7 TWIN LAKE MODEL LAKE RESULTS

Table B-23. Boneyard Ditch Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	881.28	881.5	+0.22
100-year, 24-hour Water Surface Elevation	882.09	882.85	+0.76
Lowest Adjacent Grade	887.00		
Minimum Freeboard (10-year, 24-hour)	5.72	5.50	–0.22
Minimum Freeboard (100-year, 24-hour)	4.91	4.15	–0.76

Table B-24. Lamplighter Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	883.73	884.4	+0.67
100-year, 24-hour Water Surface Elevation	885.57	886.77	+1.2
Lowest Adjacent Grade	886.00		
Minimum Freeboard (10-year, 24-hour)	2.27	1.60	–0.67
Minimum Freeboard (100-year, 24-hour)	0.43	–0.77	–1.2

Table B-25. Natchez Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	871.8	872.03	+0.23
100-year, 24-hour Water Surface Elevation	871.14	874.44	+1.3
Lowest Adjacent Grade	873.00		
Minimum Freeboard (10-year, 24-hour)	1.20	0.97	–0.23
Minimum Freeboard (100-year, 24-hour)	–0.14	–1.44	–1.3

Table B-26. Twin Lake Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	874.1.8	874.31	+0.21
100-year, 24-hour Water Surface Elevation	874.89	875.38	+0.49
Lowest Adjacent Grade	877.00		
Minimum Freeboard (10-year, 24-hour)	2.90	2.69	–0.21
Minimum Freeboard (100-year, 24-hour)	2.11	1.62	–0.49

Table B-27. Utah Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	915.64	915.7	+0.06
100-year, 24-hour Water Surface Elevation	915.81	916.04	+0.23
Lowest Adjacent Grade	917.00		
Minimum Freeboard (10-year, 24-hour)	1.36	1.30	–0.06
Minimum Freeboard (100-year, 24-hour)	1.19	0.96	–0.23

B.8 WESTWOOD LAKE MODEL LAKE RESULTS

Table B-28. Kilmer Pond Modeled Water Surface Elevations

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	905.15	905.96	+0.81
100-year, 24-hour Water Surface Elevation	907.27	909.51	+2.24
Lowest Adjacent Grade	909.00		
Minimum Freeboard (10-year, 24-hour)	3.85	3.04	–0.81
Minimum Freeboard (100-year, 24-hour)	1.73	–0.51	–2.24

Table B-29. Westwood Lake Modeled Water Surface Elevations*

	TP-40 Results (NVGD29) (ft)	Atlas 14 Results (NGVD29) (ft)	Change (ft)
10-year, 24-hour Water Surface Elevation	887.82	887.89	+0.07
100-year, 24-hour Water Surface Elevation	888.2	888.56	+0.36
Lowest Adjacent Grade	889.00		
Minimum Freeboard (10-year, 24-hour)	1.18	1.11	–0.07
Minimum Freeboard (100-year, 24-hour)	0.80	0.44	–0.36

Please note, elevations presented in these tables are for information and planning purposes only. Contact Minnehaha Creek Watershed District or Bassett Creek Watershed Management Commission for the regulatory floodplain elevations, as they may be higher than presented in this study. The SWMM modeling assumed clean and as-built conditions in order to evaluate the existing system's capacity and may result in locally lower flood elevations in some areas. For example, sediment build up in the outlet channel of Westwood Lake has been shown to affect the water elevations in the lake. As a result, BCWMC has adopted an elevation of 889.8 NGVD29 for the regulatory 100-year flood elevation of Westwood Lake, due to the outlet channel sedimentation.