Minnehaha Creek Watershed District *REQUEST FOR BOARD ACTION*

MEETING DATE: December 17, 2015

TITLE: Acceptance of the 2014 MCWD Flood Report

RESOLUTION NUMBER: 15-101

PREPARED BY: Tiffany Schaufler

E-MAIL: tschaufler@minnehahacreek.org **TELEPHONE:** 952-641-4513

REVIEWED BY: ☐Administrator ☐ Counsel ☐ Program Mgr. (Name):_____
☐ Board Committee ☐ Engineer ☐ Other

WORKSHOP ACTION:

☐ Advance to Board mtg. Consent Agenda. ☐ Advance to Board meeting for discussion prior to action.

☐ Refer to a future workshop (date):_____ ☐ Refer to taskforce or committee (date):_____

☐ Return to staff for additional work. ☐ No further action requested.

☒ Other (specify): Not Reviewed at Workshop. Seeking approval at December 17, 2015 Board Meeting.

PURPOSE or ACTION REQUESTED:
The Board of Managers is requested to accept the 2014 MCWD Flood Report prepared by District staff and Wenck Associates.

PROJECT/PROGRAM LOCATION:
District wide.

PROJECT TIMELINE:
- June 2014: High water update to Board of Managers
- September 2014: Contracted with Wenck Associates to assist in drafting flood report and perform stream assessment
- October 2014: Performed stream assessment
- January 2015: Presented draft flood report to Board
- February – December 2015: Coordinated with DNR to create maps that evaluated the data collected during 2014 against current models
- December 2015: Board accept flood report

PAST BOARD ACTIONS:
- September 11, 2014: RES 14-074 – Authorization to contract with Wenck Associates to develop a 2014 Flood Report

SUMMARY:

The Minnehaha Creek Watershed District experienced record setting precipitation during the first half of 2014, which led to unprecedented flooding across the entire watershed. The District's role during the flooding was to coordinate information and collect data. Establishing itself as an information broker allowed the District to efficiently disseminate information to local communities and Hennepin County Emergency Management, which allowed them to provide direct emergency response and assistance.

As a result of this historic event, the District has aggregated all of the information gathered and has summarized it within the 2014 MCWD Flood Report. The report includes summaries on the flooding event, the effects of high water on the resource, the organization impact across the District's departments, external agency coordination, and recommended next steps. The District plans to leverage the information within the report, along with the experiences gained during the flooding event, to memorialize protocols and procedures to be implemented during a future flood event.

In summary, the report aims to documents the extent of the flooding and the impacts to the resources, it evaluates the organizational impacts across departments, and will be used to inform and develop a response plan which will detail how the District should respond during future flood events.

A draft version of the report was presented to the Board of Managers on January 29, 2015. Since then, staff has revised the report to reflect comments received by the Board. One major revision is the result of staff coordinating with the DNR to utilize grant funding available to evaluate the current FEMA and Atlas-14 models against the data collected during the 2014 flooding. The DNR has compiled three sets of maps that compare the FEMA model and Atlas-14 model to the 2014 measured data along Minnehaha Creek. More information on these maps can be viewed on page 15 within the report and the maps themselves can be viewed as Maps 8, 9 and 10 within the Maps section of the report.

ATTACHMENT:
2014 MCWD Flood Report, December 14, 2015

RESOLUTION

RESOLUTION NUMBER: 15-101

TITLE: Acceptance of the 2014 MCWD Flood Report

WHEREAS, the January 1, 2014 through June 30, 2014 timeframe was the wettest on record and resulted in sustained high water conditions throughout the Minnehaha Creek Watershed District (MCWD); and;

WHEREAS, the District's role during the high water event was to monitor lake levels, collect data, and coordinate with local communities and emergency response services to share data; and

WHEREAS, on September 11, 2014 the Board of Managers authorized retaining Wenck Associates in an amount not to exceed $32,780 to assist in developing a 2014 flood report which included performing an assessment for the six major creeks within the District; and

WHEREAS, District staff with assistance by Wenck Associates has aggregated all of the information gathered during the 2014 flooding event and summarized it within the 2014 MCWD Flood Report; and

WHEREAS, on January 29, 2015 MCWD staff presented a draft version of the 2014 MCWD Flood Report to the Board of Managers; and

WHEREAS, staff has refined the 2014 MCWD Flood Report to reflect comments received by the Board of Managers at the January 29, 2015 meeting.

NOW, THEREFORE, BE IT RESOLVED that the Minnehaha Creek Watershed District Board of Managers hereby accepts the 2014 MCWD Flood Report dated December 14, 2015.

Resolution Number 15-101 was moved by Manager _____, seconded by Manager _____. Motion to adopt the resolution ___ ayes, ___ nays, ___abstentions. Date: _____.

_____ Date:_____

Secretary

December 14, 2015

2014 MCWD Flood Report

MINNEHAHA CREEK
WATERSHED DISTRICT

WENCK
ASSOCIATES
Responsive partner.
Exceptional outcomes.

Prepared in coordination with:

WENCK Associates, Inc.
1800 Pioneer Creek Center
Maple Plain, MN 55359
Phone: 763-479-4200
Fax: 763-479-4242

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1.0 Executive Summary

In the spring and early summer of 2014, the Minnehaha Creek Watershed District (District) experienced a record amount of precipitation resulting in various flooding issues throughout the District. The late winter snow pack and ice out were coupled with record precipitation between January 1 and June 30 to create record stream flows, record high water levels, various street flooding events, land flooding issues, stormwater infrastructure issues, and over $1 million worth of damages along the six main streams of the District. An overview of the flooding across the District can be viewed in Map 1.

Table 1: 2014 Flood Event Overview

Locations where record stream flows were recorded	19
Lakes where record high water levels were recorded	16
Reported street flooding issues	34
Reported land flooding issues	7
Reported Stormwater Infrastructure Issues	17
Reported slope failures and erosion issues	8
Stream sites with flood damage reported to FEMA	126
Estimated amount to repair stream flood damage	$1,217,000
Estimated amount the District has spent to date responding to flooding: • Engineering - $40,800 • Stream Assessment & Flood Report - $32,780 • Legal - $3,700 • Repairs - $6,500 • Flooding Aerials - $4,500 • Water Quality Equipment - $16,500 • Additional Water Quality Monitoring - $5,500	$110,280

Damages from slope failures, erosion, failing stormwater infrastructure, and flooding of backyards resulted in over 300 phone calls to the District related to high water and dam operations, over 40 permits related to the high water or flood damages, and hundreds of staff hours fielding questions from the public and media, surveying the flood damage and assessing the extent of the damage.

The District's role during the flooding was to coordinate information and collect data. Establishing itself as an information broker allowed the District to efficiently disseminate information to local communities and Hennepin County Emergency Management, which allowed them to provide direct emergency response and assistance.

As a result of this historic event, the District has aggregated all of the information gathered and has summarized it within this report. The District plans to leverage the information within this report, along with the experiences gained during the flooding event, to memorialize protocols and procedures to be implemented during a future flood event.

In summary, this report aims to:

- Document the extent of the flooding event and its impacts to the resource,
- Evaluate the organizational impacts across all Departments, and
- Be used to develop a plan detailing how the District should respond during future flood events.

WATER, WATER EVERYWHERE

COORDINATED RESPONSE TO HISTORIC FLOODING

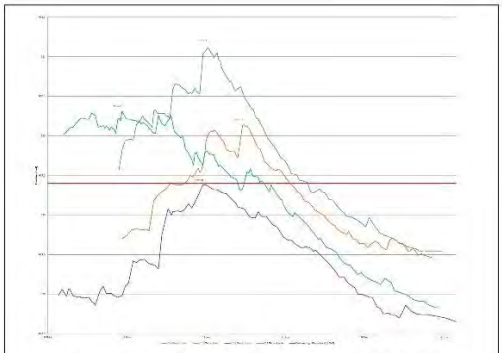
A SPRING TO REMEMBER

In 2014 the Twin Cities saw the wettest first half of the year, by far, since modern-day record keeping began in 1871. Coupled with a long winter and late snow melt, this extreme precipitation led to record water levels and more than $1 million worth of damages along the six main streams in the District.

Working with city, state, federal, nonprofit, and private partners, the MCWD served as a key conduit of information regarding water levels, safety, projections, water quality, and more. It was "all hands on deck" at the MCWD as the District received more than 300 flood-related phone calls, closely monitored water levels, issued more than 30 flood-related permits, fielded more than 50 requests from local and national press, and created a detailed guide for future responses.

BY THE NUMBERS

4.13	The inches of rain on June 19, the sixth wettest day ever recorded in the Twin Cities
931.11	The feet above sea level reached by Lake Minnetonka on June 23, more than 7 inches higher than it had ever been recorded before 2014
889	The flow of Minnehaha Creek, in cubic feet per second, shattering its previous record
26	The number of lakes and streams in the District that set all-time records for elevation or flow
83	Consecutive days that the Gray's Bay dam was inundated, keeping it from being able to control water levels on Lake Minnetonka or Minnehaha Creek
300+	Number of flood-related phone calls received by the MCWD
74	Flood-related news stories involving MCWD



LAKE MINNETONKA WATER LEVELS, 2011 TO 2014

Flooding poster created by District staff

2.0 Summary of 2014 Spring/Summer Precipitation

The spring and early summer of 2014 became the wettest January 1-June 30 period for the Minnehaha Creek Watershed District since modern-day record keeping began in 1871. Additionally, June 2014 was the second wettest June on record and the rain event on June 19th was documented as the sixth wettest day on record in the Twin Cities. The late winter snow pack and ice out were coupled with consistent heavy spring rains. The total precipitation in the Twin Cities between January 1 and June 30 was greater than 25 inches, surpassing the 2001 record of 21 inches, according to the National Weather Service. This historic rainfall led to record water levels and flows in water bodies throughout the District including Lake Minnetonka and Minnehaha Creek.

2.1 PRECIPITATION

Precipitation patterns from January to June were characterized by a heavy winter snow pack, which did not begin to runoff until April, coupled with three months of consistent rainfall until the large rain event on June 19. Total rainfall varied across the watershed, with higher rainfall amounts occurring in the upper portions of the watershed around Lake Minnetonka and lower amounts downstream along Minnehaha Creek (Figure 1, 2 and Table 2). Not only did the upper watershed receive more precipitation between January 1 and June 30, but it also received more rainfall during the five day span from June 14-19. This finally led to record water levels throughout the District.

Figure 1: District Rainfall Totals from January 1 to June 30

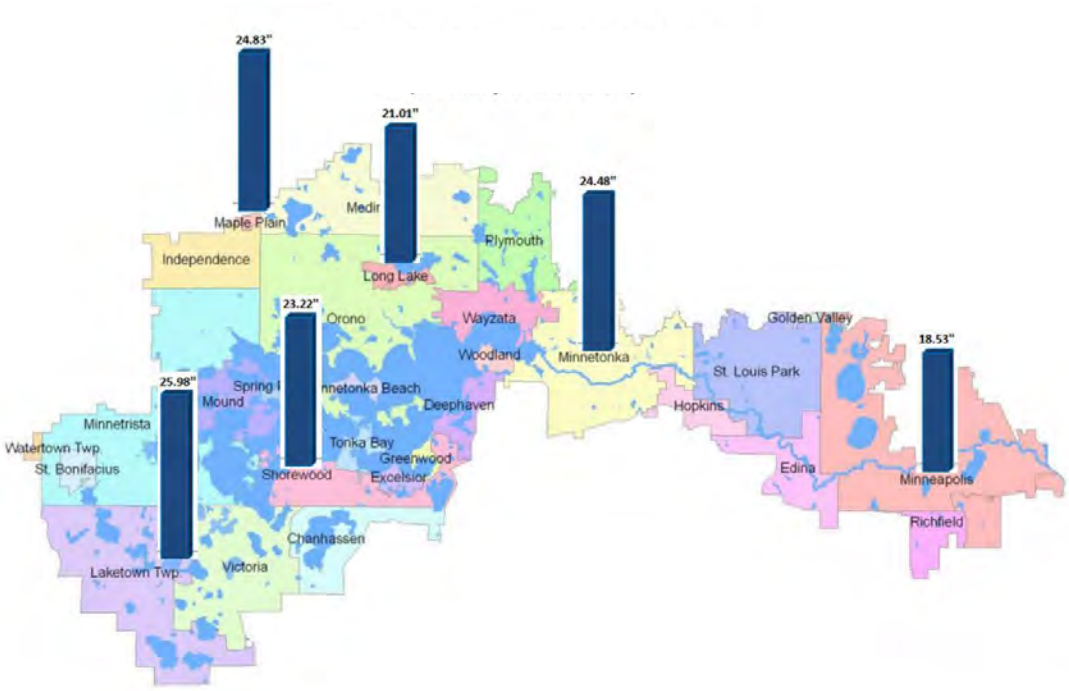
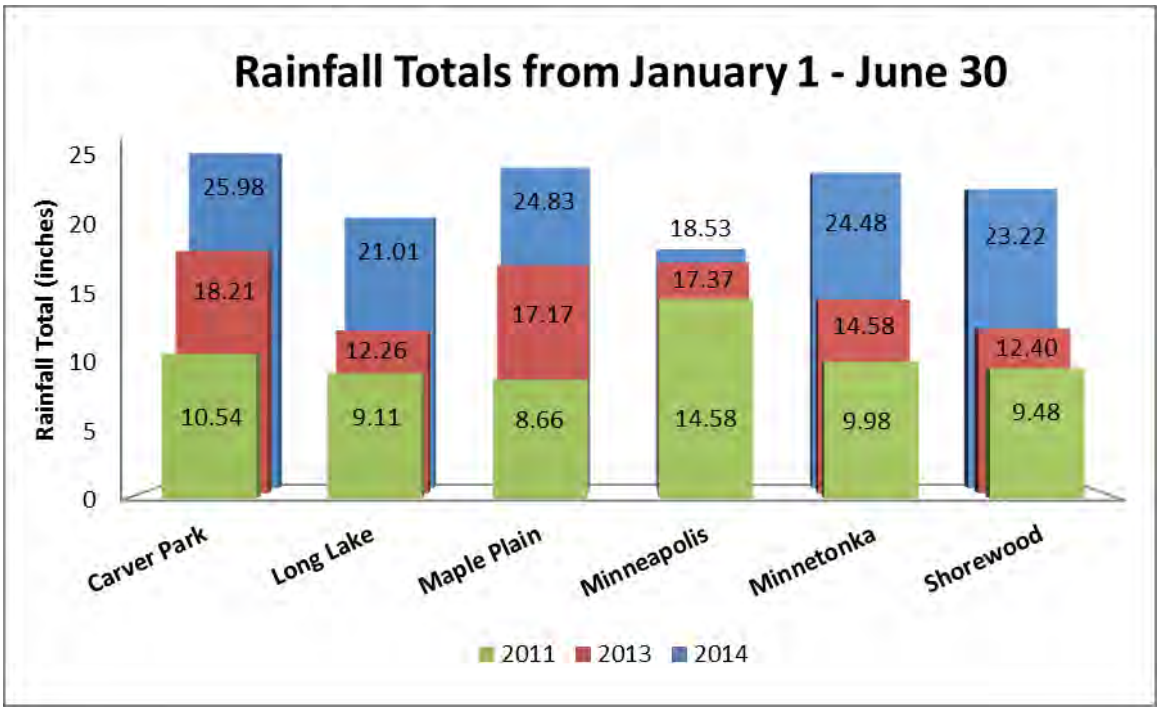


Figure 2: Rainfall Totals from January 1 to June 30 for 2011, 2013, and 2014.



The precipitation totals in Table 2 show the large precipitation event that occurred on June 19 and the additional precipitation that had already saturated the ground since June 14th. The saturated conditions of the spring/early summer of 2014 caused these large rain events to not infiltrate and much of the storage capacity in many lakes, wetlands, and ponds had been consumed prior to the June 14-19 event. Additional precipitation ran off to lakes, streams and stormwater best management practices (BMPs) that were still trying to hold, treat, or convey the previous rain, which caused many water bodies to reach record levels. For instance, 7.63 inches of rain fell in Minnetonka in a 5-day span and a total of 24.48 inches had fallen between January 1 and June 30 (average is 13.87 inches), which is a new record for the area.

Table 2: District Precipitation Totals (inches)

Location	Station ID	2014			2013	2011
		JUNE 19	JUNE 14 - 19	JAN 1 - JUNE 30	JAN 1 - JUNE 30	JAN 1 - JUNE 30
Carver Park	PCA01	4.87	7.13	25.98	18.21	10.54
Long Lake	PLO01	3.07	5.32	21.01	12.26	9.11
Maple Plain	PME02	2.93	4.51	24.83	17.17	8.66
Minneapolis	PMP06	2.17	4.44	18.53	17.37	14.58
Minnetonka	PMA01	4.70	7.63	24.48	14.58	9.98
Shorewood	PSW01	3.86	6.24	23.22	12.40	9.48

The result of these record rainfall totals was flooding throughout the District, resulting in damage to many of the lakes, streams, properties and public infrastructure throughout the District. The details of this will be discussed throughout the remaining sections of this report.

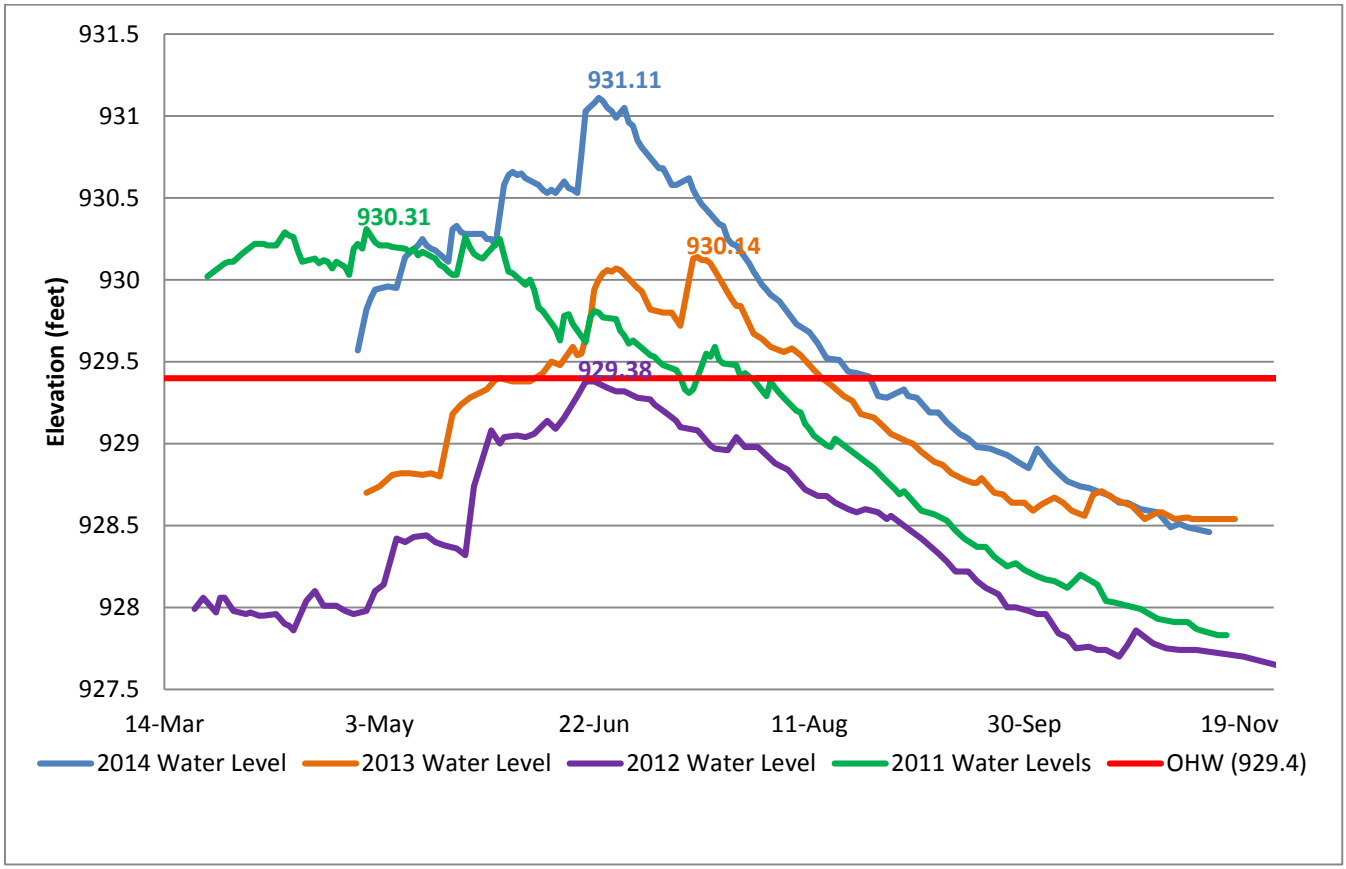
2.2 LAKE FLOODING

Many lakes throughout the District reached their highest levels on record in 2014. Lake Minnetonka surpassed the previous high water level set in 2002 by over 7-inches. Nine lakes across the District even experienced water levels above their 100-year high water elevation.

2.2.1 Lake Minnetonka Flooding

Historic rainfall depths seen in the upper watershed resulted in record water levels on Lake Minnetonka. Figure 3 shows Lake Minnetonka's all-time record high water elevation occurred shortly after the June 14-19th storm event. Figure 3 also shows that it took Lake Minnetonka approximately two months to fall below its ordinary high elevation (OHW) after its peak elevation of 931.11 occurred. For comparison Figure 3 also shows the water levels for Lake Minnetonka over the past four years and the lake's OHW (929.4 feet). All four years show similar trends with the lake reaching its peak elevation in late spring/early summer then slowly decreasing in elevation throughout the summer and fall. The consistent decrease in lake levels during the summer and fall months is a result of the lake being able to regain its storage capacity. The ability to regain storage capacity in the lake coupled with consistent dam operations allows rainfall events to be better managed and lake levels to slowly be brought down from August until November.

Figure 3: Lake Minnetonka water levels from 2011 to 2014



(Source: minnehahacreek.org)

As Figure 3 shows, the 2014 precipitation resulted in the highest recorded level (931.11 feet) on Lake Minnetonka. The high stage and long duration above the OHW was due to the upstream storage basins being at or above capacity resulting in a greater portion of precipitation contributing to runoff as opposed to infiltration by the soil or stored in upstream water basins.

In addition to the peak elevation, the lake also experienced a long period of high water. A summary of Lake Minnetonka's high water events the past four years is shown in Table 3.

Table 3: Lake Minnetonka Water Level and Dam Information

Year	Highest recorded water (ft.)	Days above OHW	Days of dam discharge	Days of dam discharge ≥300 CFS
2014	931.11	119	179	82
2013	930.14	65	154	3
2012	929.38	0	84	0
2011	930.31	111	162	19

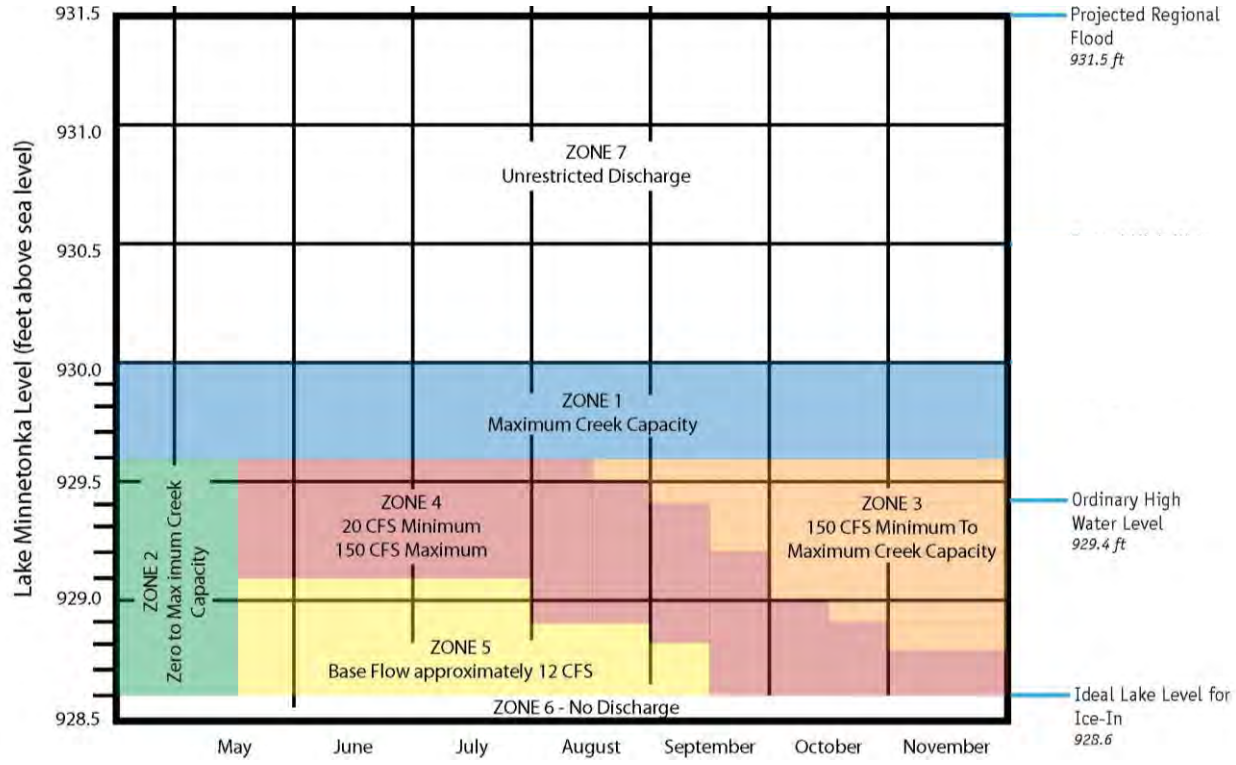
(Source: minnehahacreek.org)

Table 3 not only highlights the high water level experienced in 2014, but also the volume of water which moved through Lake Minnetonka. This is highlighted by the fact that the flow out of Minnetonka was at or above 300 cubic feet per second (cfs) for a record 82 days.

2.2.2 Grays Bay Dam Operations

The Headwaters Control Structure (Grays Bay Dam) is an adjustable structure that controls Lake Minnetonka levels and lake discharge into Minnehaha Creek. The dam is operated by District staff in accordance with operating procedures outlined in the Headwaters Control Structure Management Policy and Operating Procedures and Minnesota Department of Natural Resources (DNR) Permit #76-6240. The operating plan was developed by MCWD and approved by local municipalities and the DNR. The operating range for the control of discharges at the Grays Bay Dam is when the lake levels are between 928.6 and 930.0. Elevation 928.6 marks the legal natural runout elevation for Lake Minnetonka, and elevation 930.0 is the crest of the 202-foot long fixed-elevation emergency spillway located north of the dam structure itself. Figure 4 below shows a graphical representation of the written Headwaters Control Structure Management Policy and Operating Procedures.

Figure 4: Discharge Zones and Allowable Discharge Rates



For lake levels between the natural runout elevation of 928.6 and elevation 930.0 (top of emergency spillway), the operating plan allows discretion for setting discharge rates depending upon the time of year and the deviation of the actual lake level from averages. For levels higher than 930.0, the operating plan calls for unrestricted discharges from Lake Minnetonka to Minnehaha Creek for two primary reasons:

1. The ability of the Grays Bay Dam to physically control flows stops at elevation 930.0 when the lake spills over the emergency spillway. As the lake level continues to increase above elevation 930.0, discharge increases until the structure becomes submerged by the tailwater elevation of Minnehaha Creek, which is formed by the restriction of the downstream concrete box culverts under McGinty Road, near where Minnehaha Creek crosses I-494.

2. At lake levels in this range, recreational use on Lake Minnetonka is restricted as severe shoreline damage occurs from wave action.

On June 19, 2014, the Minnetonka area received over four-inches of rain causing the level of Lake Minnetonka to reach 930.88 and the tailwater elevation of Minnehaha Creek to reach 930.82. This meant that the available head differential between the lake and the creek was less than one-inch. This ultimately led to the emergency spillway becoming submerged by the creek tailwater elevation. The photos below show the emergency spillway visible on May 1, 2014 and completely submerged on June 20, 2014.

Emergency Spillway May 1, 2014

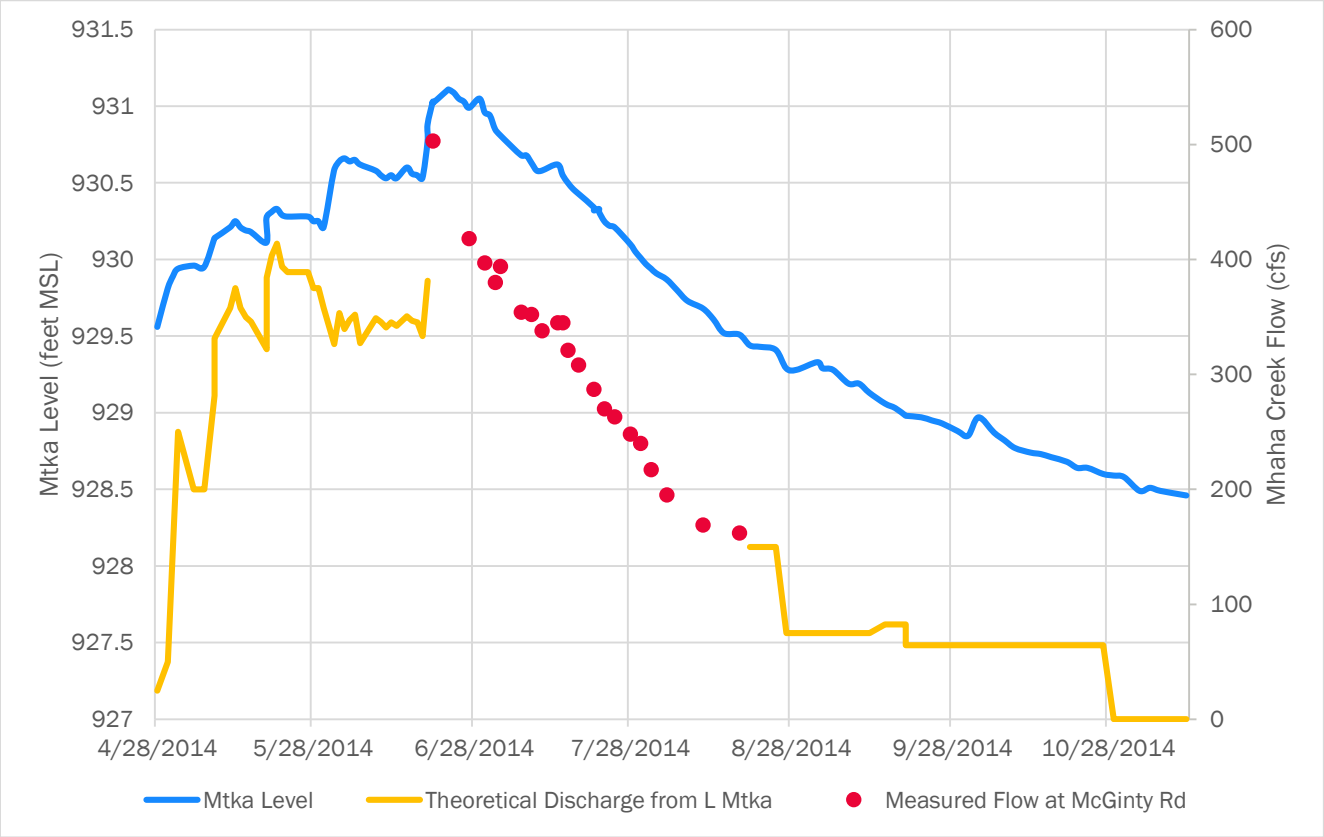
Emergency Spillway June 20, 2014

The emergency spillway was submerged for approximately 40-days from June 19 until July 31. Under these circumstances, it was nearly impossible and certainly impractical to estimate or measure flow out of the Grays Bay Dam structure. In Figure 5 below, this uncertainty is shown in the sudden drop in theoretical flow from Minnetonka as the lake was hitting its highest elevations. The theoretical discharge from the lake is calculated based on a rating curve developed for three tainter gates in the dam assuming free flow conditions with no backwater conditions. The drop in theoretical discharge is associated with backwater affects due to the next downstream crossing, McGinty Road, serving as the controlling structure for the lake. The photos below show Grays Bay Dam with measurable flow on May 1, 2014 and submerged on June 20, 2014.

Grays Bay Dam May 1, 2014

Grays Bay Dam June 20, 2014

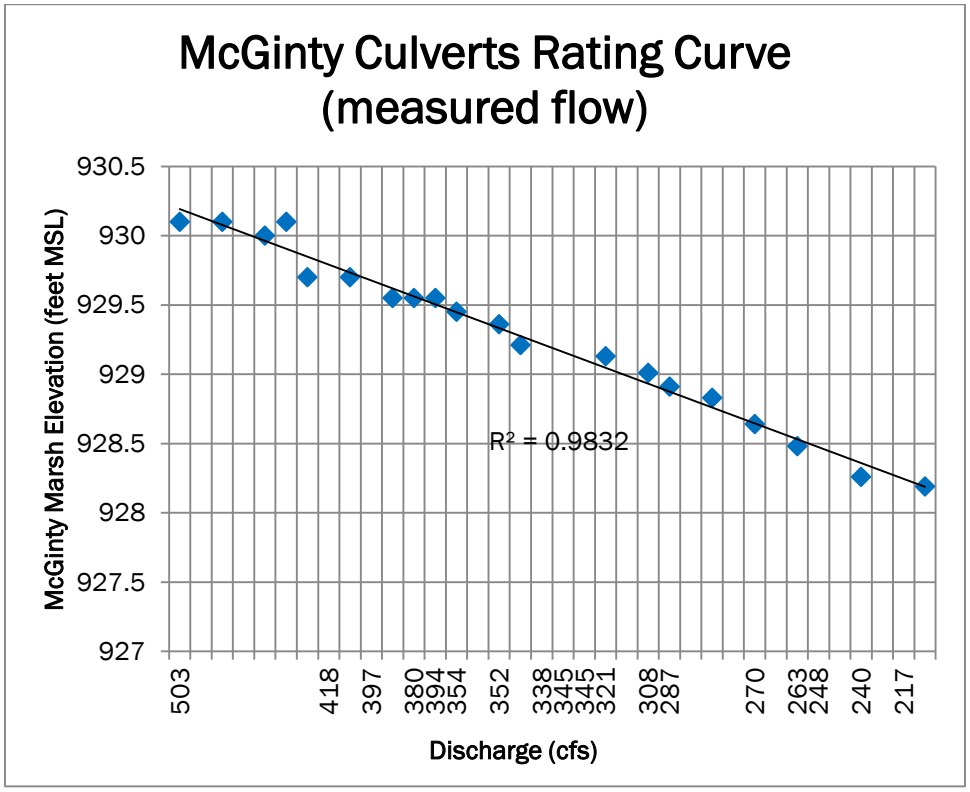
Figure 5: 2014 Lake Level and Discharge



As a means of acquiring data about discharges for Lake Minnetonka, a pressure transducer was installed temporarily in a standpipe/wet-well at the upstream area of the two box-culverts under McGinty Road to collect elevation information. Flow was also measured safely at the McGinty Road culverts throughout this 40-day period. On June 20, the day following the large rain event of over 4-inches, the peak discharge at McGinty Road in 2014 was measured at 503 cubic feet per second (cfs).

A linear regression of twenty individual measurements (shown in Figure 6 below) yields a R^2 value near 1 indicating a very strong correlation. The strong correlation indicates that the District can have confidence that the flow measurements taken at the culverts are correct, and that the flow at the culvert does not experience tailwater conditions.

Figure 6: 2014 McGinty Road Discharge Rate Regression



By developing the above rating curve, the District will now be able to easily calculate flows at the McGinty Road crossing by simply doing a tape down measurement to the water surface elevation, ultimately reducing staff time needed to conduct flow measurements during times of high water. As a result of these measurements, the District was able to better predict flow rates out of Lake Minnetonka, which allowed staff to better estimate lake level drawdown and potential peak flow rates during these times of high water.

2.2.3 Lake Minnetonka Lake Level Predictions

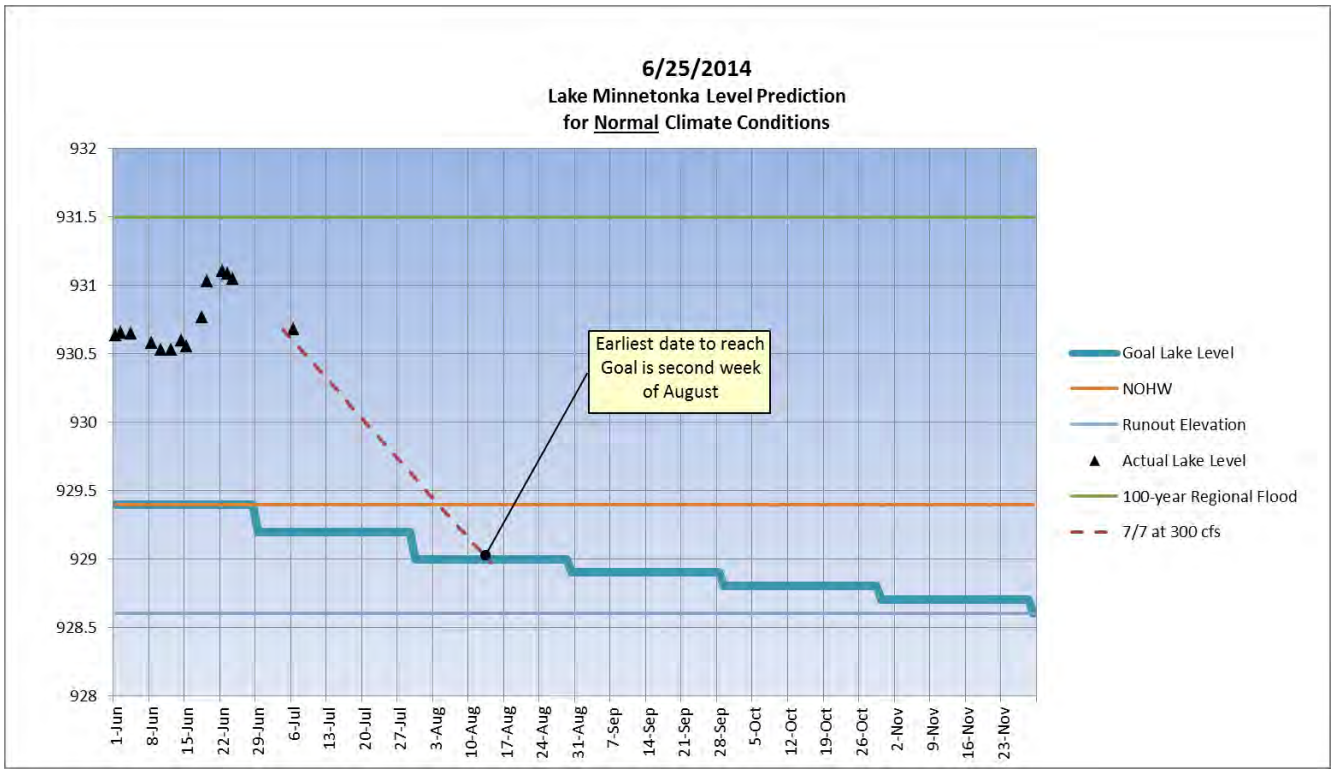
In 2014, Lake Minnetonka remained above elevation 930.0 feet for 82 consecutive days. This, in turn, had an impact on recreation across Lake Minnetonka as the Lake Minnetonka Conservation District (LMCD) implemented the following minimum wake restrictions:

- May 13-June 4: High Water Declaration—minimum wake restrictions implemented 600′ from shoreline for all of Lake Minnetonka and on specified bays
- June 5-July 24: Lake wide minimum wake restrictions implemented
- July 25-August 4: Lake wide minimum wake restrictions removed, High Water Declaration re-implemented

The implementation of the minimum wake restrictions by the LMCD caused the citizens around Lake Minnetonka to watch the lake level closely. A common inquiry from residents was, "How long will it take to get Lake Minnetonka below the 930.0 elevation?" This question was not only raised by Lake Minnetonka residents but also by residents along Minnehaha Creek, who were looking also looking for relief from the flooding along the creek. In an effort to answer this question and help manage expectations in the short-term,

District staff coordinated with the District engineer to perform lake level predictions. The District engineer created a water balance spreadsheet to efficiently predict lake level changes and trends, at one day intervals, based on assumed direct precipitation, runoff and average evaporation rates (the loss or gain between the lake and groundwater is ignored). This worked well for short-term predictions of trends or changes in the lake level. See Figure 7 below for an example of a Lake Minnetonka Level Prediction graph. The graph was continually updated throughout the summer as actual lake elevations were incorporated into the calculation. The use of the lake level predictor graph was successful during 2014 and will provide an efficient communication tool for staff and residents during future high water events.

Figure 7: Lake Minnetonka Level Prediction Graph



2.2.4 Watershed Lakes

In addition to Lake Minnetonka, numerous lakes and locations throughout the watershed also saw historic high water levels. Table 4 below shows the 16 lakes that experienced historic water elevations during the summer of 2014. Most of these historic elevations were experienced a day or a few days after the large rain event on June 19, 2014. In addition to Lake Minnetonka, three additional lakes within the District had minimum wake restrictions implemented. They were Lake Minnewashta, Christmas Lake, and Long Lake.

Table 4: 2014 Lake Level Records[1]

Subwatershed	Lake	Date of Record High Water Level	Record High Water Level (ft.)	100-yr HWL (ft.)	OHW (ft.)
Christmas Lake	Christmas	6/19/2014	932.85	933.65	932.77
Dutch Lake	Dutch	6/20/2014	**940.19**	940.19	939.20
Lake Minnetonka	Galpin	6/20/2014	944.54	946.66	943.14
	Minnetonka	6/23/2014	931.11	931.50	929.40
	Shaver	7/11/2014	931.40	933.87	929.30
Lake Virginia	Minnewashta	6/20/2014	**946.26**	945.89	944.50
	St. Joe	6/20/2014	**947.28**	947.06	945.20
	Tamarack	6/20/2014	**968.15**	966.86	965.50
Long Lake Creek	Holy Name	6/20/2014	994.52	996.70	993.70
	Lydiard	7/18/2014	**973.03**	972.53	970.90
Minnehaha Creek	Calhoun	6/30/2014	**855.58**	854.95	853.00
Six Mile Creek	Church	6/20/2014	950.42	951.01	Unknown
	Parley	6/20/2014	**931.64**	930.59	930.60
	Wassermann	6/20/2014	**946.98**	946.33	944.30
	Sunny	7/03/2014	944.91	945.38	943.30
	Zumbra	7/03/2014	**944.91**	943.30	943.30

[1] All elevations in NGVD29

At or above 100-year

The impact of the higher precipitation depths in the upper watershed are seen in the number of upper watershed lakes (15 total) which experienced record high water levels, whereas Lake Calhoun was the only lake in the lower portion of the watershed to experience a record high water level. Map 2 identifies the locations of the lakes that set new high water elevations in 2014.

2.3 STREAM FLOODING

There are six major streams within the District and all of them experienced high water levels and above-normal flows at some point during the spring/early summer of 2014. The following section summarizes flows monitored on the main stem of Minnehaha Creek and many of the tributaries to Lake Minnetonka.

During the high water event, record flows were recorded in many reaches of Minnehaha Creek. Figure 8 shows Minnehaha Creek flows at Hiawatha Avenue which exceeded the 100-year event by over 30% to become a new high flow record for the gauge. Flows also continued to remain high throughout the summer due to the continual release of water from Lake Minnetonka and drainage of wetlands along the creek.

Figure 8: 2014 Minnehaha Creek Flows (Hiawatha Ave - USGS)

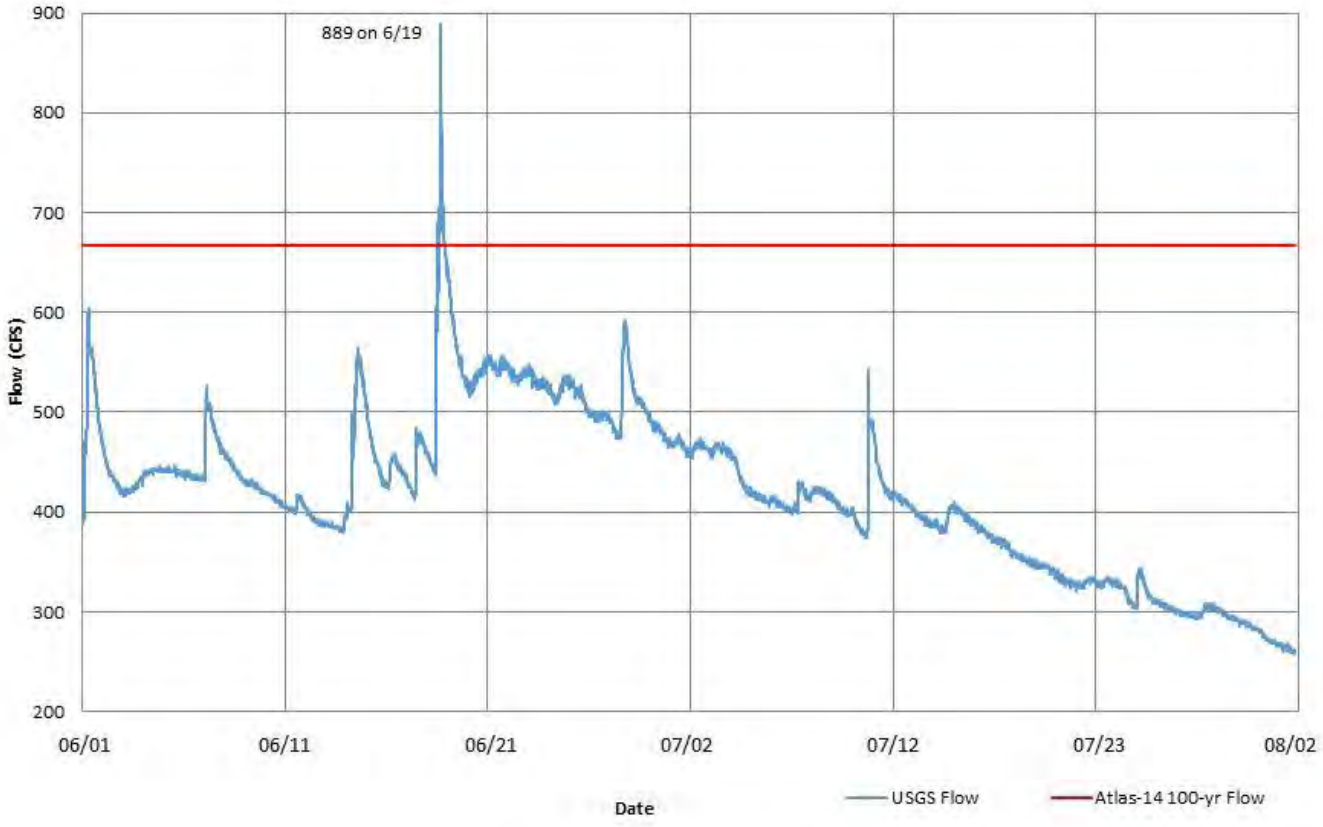


Table 5 below lists all the stream sites that experienced historic flows during 2014 and compares the 2014 flows to the DNR's 2014 FEMA XPSWMM flows.

Table 5: Historic Stream Gauging Locations

Subwatershed	Site Description	Date of Record High Flow	Record High Flow (CFS)	100-year flow (CFS)[1]
Christmas Lake	Christmas Lake inlet	4/28/2014	9.5	NM
Dutch Lake	Dutch Lake outlet	6/3/2014	30.0	NM
Gleason Lake	Gleason Lake inlet	4/30/2014	24.9	NM
	Gleason Lake outlet	4/30/2014	13.2	NM
Lake Minnewashta	Lake Minnewashta outlet	6/23/2014	**31.0**	18.8
Langdon Lake	Langdon Lake outlet	6/3/2014	12.6	25.2
Long Lake Creek	Tanager inlet	4/30/2014	81.8	NM
Minnehaha Creek	Minnehaha-behind city offices at crossbridge	6/25/2014	505.6	580.3
	Minnehaha-Aquilla	6/25/2014	441.1	591.3
	Minnehaha-Browndale Dam	6/25/2014	494.7	590.6
	Minnehaha-West 56th St.	6/25/2014	441.6	590.0
	Minnehaha-Xerxes Ave.	6/25/2014	518.1	594.1
	Minnehaha-28th Ave	6/25/2014	510.7	665.0
	Minnehaha-right before Minnehaha Falls	6/19/2014	**889.0**	667.0
Painter Creek	Painters Creek- CR 26	4/30/2014	96.3	313.7
	Painters Creek-Painters Dr.	6/4/2014	82.8	306.6
Schutz Lake	Schutz Lake inlet	4/28/2014	40.8	NM
Six Mile Creek	Turbid Lake outlet	4/28/2014	**17.1**	14.1
	Pierson's Lake outlet	6/23/2014	**25.0**	14.0

[1]100-year flow rates from the DNR's 2014 FEMA XPSWMM Model
NM = Not Modeled
>100-year modeled flow

Several tributaries in the upper watershed experienced new record flow levels associated with the higher precipitation events, the location of these measurements can be viewed in Map 2. In addition, the data demonstrates that greater than a 100-year flow event occurred on two of the District's major creeks, Minnehaha Creek and Six Mile Creek.

2.4 HIGH-WATER MONITORING

After the June 14-19 precipitation event staff worked diligently to capture the aerial extents of the event along with garnering high water elevation measurements to establish benchmarks for the District to use on future planning efforts.

The District contracted with Erdahl Aerial Photos to complete a fly over of the District after the June 19th rain event. Erdahl Aerial Photos was able to capture over 350 images of high water throughout the District on June 20, 2014. Some example pictures which show the extent of the flooding are provided below.

Flooding along Minnehaha Creek in Edina along Wood End Drive

Flooding at Methodist Hospital and Meadowbrook Lake

In conjunction with the aerial imaging, the District collected numerous high water elevations at flood prone areas. This information will help calibrate and verify elevations seen in the aerial imaging and inform future District planning and project activities. Actual elevations are provided in Appendix A and can be viewed on Maps 5, 6 and 7.

2.4.1 2014 Flood Measurements versus Existing Models

The District utilized DNR modeling grants to evaluate the current FEMA model and the Atlas-14 model against the high water data the District collected along Minnehaha Creek. There are three sets of maps that spatially layout where the 2014 flooding occurred compared to the current FEMA model and Atlas-14 model. The following maps can be viewed as Maps 8, 9 and 10 within the Maps Section:

- Map 8: 100-yr FEMA Flood Event versus 2014 Flood Event
- Map 9: 100-yr Atlas-14 Flood Event versus 2014 Flood Event
- Map 10: 100-yr FEMA Flood Event versus 100-yr Atlas-14 Flood Event

The District will utilize these maps to see where the current modeling is off and investigate those areas further in an effort to calibrate the model.

2.5 MUNICIPAL INFRASTRUCTURE

A majority of the cities within the District experienced flooding issues. The District received many phone calls from residents and City officials noting road flooding, road closures, slope failures, and other stormwater infrastructure issues. The District noted more than 70 locations across the District that were known to have issues due to flooding (see Maps 1 and 3). Table 6 lists an overview of the flooding issues that were tabulated in detail in Appendix B.

Table 6: City Flooding Issues Overview

Road Flooding/standing water	34
Road Closures	13
Stormwater Infrastructure Issues	17
Slope Failures	9
Erosion Issues	3

As identified in Maps 1 and 3 the majority of the municipal infrastructure issues were concentrated around Lake Minnetonka and surrounding tributary areas. Additionally, local municipalities distributed sandbags to citizens and businesses to prevent flood damage to structures. Table 7 below lists a summary of how many sandbags were distributed for each city listed.

Table 7: City Sandbag Distribution

City	**# of Sandbags**
Edina	11,000
Minneapolis	100 for Burroughs School; 9 other requests
St. Louis Park	50,000
Wayzata	300
Victoria	3,000

3.0 Resource Impacts

In addition to high water levels throughout the District there were numerous resource impacts associated with the high water levels and large runoff volumes experienced by the District.

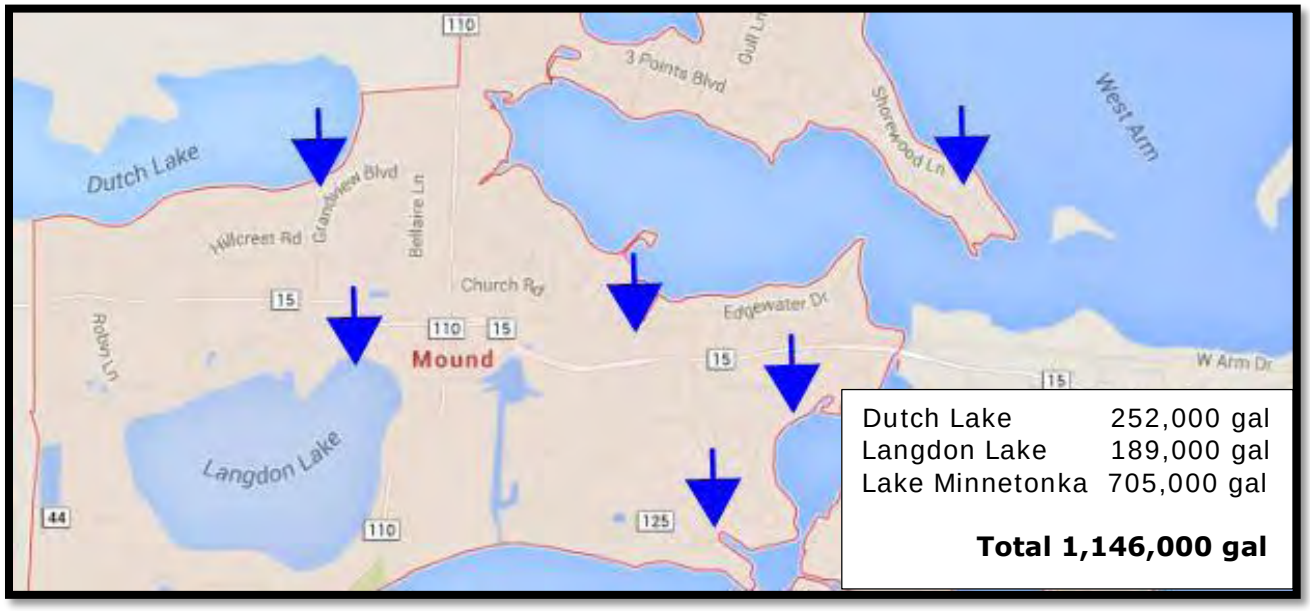
3.1 LAKES IMPACTS

3.1.1 Sanitary Discharge

The City of Mound had two emergency bypass events during 2014. The condition that caused the discharge of sewage and water to Lake Minnetonka was excessive infiltration of shallow groundwater into the sewage collection system, not only locally, but upstream as well. The capacity of lift station pumps in the City of Mound was limited, and the pumps were not able to overcome the head pressure in the interceptor resulting from high flow. Sanitary sewer collection systems often experience infiltration of shallow groundwater into the collection pipes during wet weather conditions. This effect was not unique to the City of Mound and was reported to have happened in many dozens of Minnesota cities at the same time Mound experienced problems.

Sewer bypasses were routed to adjacent stormsewer systems which routed flows to adjacent water bodies. The locations of the discharge points and volumes are shown in Figure 9. It is possible that the flows were diluted with as much as 5:1 clear water infiltration which would have reduced the actual sewage volume to roughly 200,000 gallons.

Figure 9: 2014 Mound Sanitary Bypass Locations



Since backups into living spaces presents direct exposure to sewage and results in unknown, but substantial, property damage, discharges to the waterbodies were deemed more protective of human health and property. The impact to the lake is mitigated by

dilution and natural degradation of bacteria in the environment. It is a difficult and unenviable circumstance of high water, but the public health threat and property damage was minimized.

The City of Mound conducted monitoring in coordination with the Minnesota Department of Health using Minnesota Pollution Control Agency prescribed methodology. Samples taken had levels of bacteria below level of concern.

Estimated loading to adjacent water bodies is provided below in Table 8.

Table 8: Sewer Bypass Loading to Area Lakes

	Discharge Load (lbs)			
	Lake Minnetonka	**Langdon**	**Dutch**	**Total**
Total Solids	735	197	263	**1,194**
Dissolved Solids (TDS)	514	138	184	**836**
Suspended Solids	220	59	79	**358**
Nitrogen (as N)	66	18	24	**107**
Phosphorus (TP)	15	4	5	**24**
Chloride (summer)	73	20	26	**119**
Alkalinity (as $CaCO_3$)	73	20	26	**119**
Grease	110	30	39	**179**
BOD_5	220	59	79	**358**

Sources: City of Mound discharge volume estimates
Food and Agriculture Association
Wenck Associates, Inc. Hydrodata Reports for MCWD

The loading to these waterbodies was considered insignificant since it represented less than 1% of the total annual loading. Testing by Metropolitan Council Environmental Services after the bypass determined no further health risk shortly after the event.

3.1.2 Slope Failures

There were nine reported slope failures around Lake Minnetonka. Six were located in the City of Minnetrista, one in Orono, one in Shorewood, and one on Big Island. Slope failures were typical around the lake as high bluff areas became saturated due the large rain events, became unstable, and would slide. The impacts of these slides is a sudden load of sediment into the lake decreasing water clarity and providing a sudden pulse of nutrients. All of the slides were stabilized to limit the potential for future failures.

Slope Failure on Lake Minnetonka near Woodside Lane in Shorewood

3.2 STREAM IMPACTS

3.2.1 Flood Damage

The six main stem streams experienced flood damage including bank erosion, bank undercutting, slope failure, culvert/crossing damage, and downed trees. The District carried out a stream assessment to inspect damages which resulted in 126 sites being identified with flood damage. Table 9 lists the amount of damage to sites by stream and the estimated flood and mitigation costs submitted for each stream to FEMA.

Table 9: Stream Flood Damage Overview

Stream and Project	Flood Damage Sites	Flood Repair Subcosts	Mitigation Repair Subcosts	Total Cost
Classen Creek				
Project 1: Reach 1	23	$66,772.00	$ 36,880.00	$107,577.00
Project 2: Reach 3	6	$32,770.00	$6,000.00	$81,945.00
Painter Creek				
Project 1: All	6	$ 23,390.00	$13,950.00	$37,340.00
Six Mile Creek				
Project 1: Crossings	3	$20,000.00	$20,150.00	$40,150.00
Gleason Lake Creek				
Project 1: Reach 5	10	$12,420.00	$6,650.00	$19,070.00
Long Lake Creek				
Project 1: Reach 3	5	$11,550.00	$1,800.00	$13,350.00
Project 2: Reach 2	4	$30,000.00	$31,800.00	$61,800.00
Project 3: Reach 5	4	$18,190.00	$5,400.00	$23,590.00
Minnehaha Creek				
Project 1: Reach 16 - 11	9	$40,300.00	$17,040.00	$57,340.00
Project 2: Reach 11 - 4	41	$113,900.00	$61,140.00	$175,040.00
Project 3: Reach 4 - 1	15	$ 460,793.00	$139,200.00	$599,993.00
TOTALS	**126**	**$ 830,085.00**	**$340,010.00**	**$1,217,195.00**

Streams with the most extensive damage were Classen Creek and Minnehaha Creek, especially below Minnehaha Falls where high water and flows disrupted many of the trails and recent projects that were constructed over the past several years. Map 4 provides an overview of the flood damages along the District's six major streams. Figures 4.1-4.10 within the Maps section provide a map for each stream and the location of the identified flood damage.

Erosion along Minnehaha Creek near Portland Ave S in Minneapolis

3.2.2 Nutrient Loading

Flooding and erosion also resulted in higher nutrient loading in the main stem of Minnehaha Creek and the majority of Lake Minnetonka tributaries. Loading increases are typical with flooding conditions as eroded soil and flooded areas carry additional nutrients. Loading values for the main streams in the District are provided in Table 10. The red text highlights the highest load recorded in the stream during the past four years.

Table 10: Phosphorus Loading at MCWD Stream Monitoring Locations

			Load (lbs) of Total Phosphorus				
Stream	**Site**	**Location**	**Annual (10-yr) Average**	**2011**	**2012**	**2013**	**2014**
Classen	CCL01	Bayside Rd.	327	231	91	**364**	260
Gleason	CGL01	Holly Lane	97	79	21	88	**141**
Long Lake	CLO03	Brown Rd.	781*	1,036	701	2,079	**2,630**
Painter	CPA05	CR 110	2,330*	2,092	1,820	5,164	**6,289**
Six Mile	CSI02	Highland Rd.	2,424	2,531	2,509	3,697	**4,661**
Minnehaha	CMH03	Browndale Dam	3,700	5,774	2,237	6,103	**8,037**
	CMH15	Xerxes Ave.	3,724**	6,435	2,735	6,151	**9,829**
	CMH24	21st Ave.	3,938**	7,112	3,415	6,796	**10,423**
	CMH06	Hiawatha Ave.	5,628	8,584	4,321	6,255	**16,524**

* 9 year average (2005-2013)

** 7 year average (2007-2013)

Highest Load between 2011-2014

The results of the monitoring highlight the fact that loading in Minnehaha Creek was greater due to the flood conditions on Lake Minnetonka, as well as Gleason Lake Creek, Long Lake Creek, Painter Creek, and Six Mile Creek. Monitoring also indicated significant loading from Lake Hiawatha and the surrounding drainage area. Loading increased over 6,000 lbs from the 21st Avenue to Hiawatha Avenue stations.

3.3 MINNEHAHA CREEK GOLF COURSES

Hiawatha and Meadowbrook Golf Courses, which are adjacent to Minnehaha Creek, were significantly impacted as a result of the high water flows in 2014. Both courses were forced to close for the year due to the prolonged high water and sustained flood damage. The extent of the flooding can be seen in the aerial photographs below taken on June 20, 2014.

Hiawatha Golf Course

Meadowbrook Golf Course

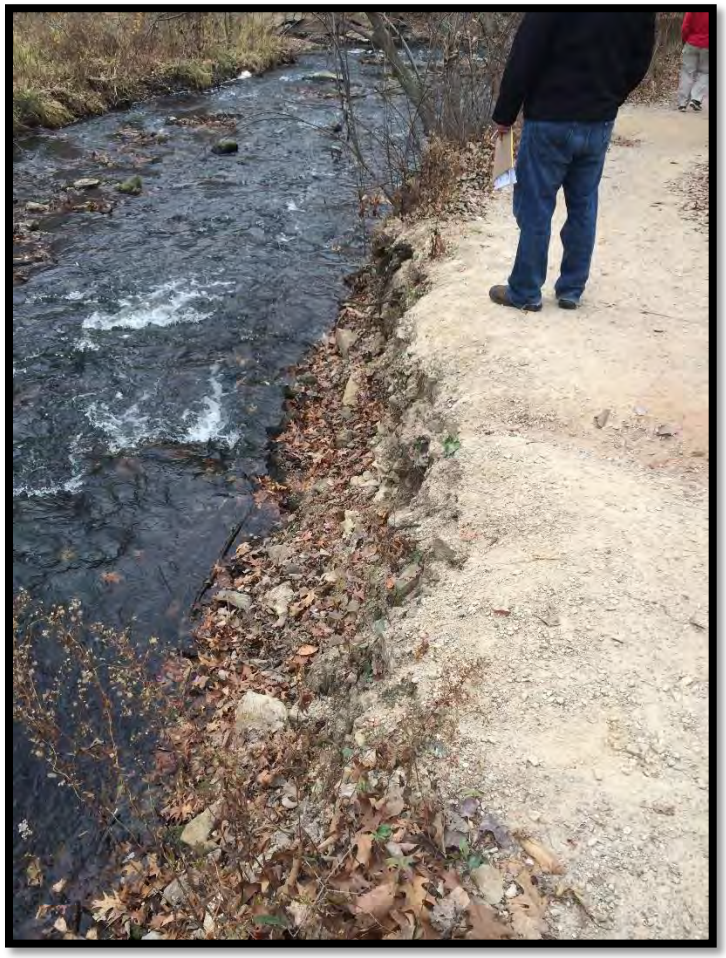
Minneapolis Park and Recreation Board (MPRB) has submitted these damages to FEMA and is currently evaluating future plans for both golf courses. The District has been working collaboratively with MPRB to identify permanent solutions which allow for the best use of the space given their proximity to Minnehaha Creek.

3.4 DISTRICT PROJECTS

Overall the projects and infrastructure installed by the District held up well throughout the flooding event. The high water levels and flow damaged three active capital projects which are currently in their establishment phase. This damage is discussed in more detail within Section 4.4 under Planning and Projects. Below is a brief summary of past District projects that were impacted by the high water.

Minnehaha Falls and Glen Restoration

The District's streambank stabilization practices held up well, however areas that were not previously bioengineered saw significant bank erosion. The trails adjacent to this project sustained surface erosion down to the geotextile fabric. The locations of the damaged site can be viewed in Figure 4.10 within the Maps section. Repairs for this flood damage have been coordinated with the Minneapolis Park and Recreation Board (MPRB) and with FEMA to obtain federal and state monies for the repairs.



Streambank erosion below Minnehaha Falls downstream of bridge 2

Lake Nokomis Weir

MPRB staff installed sandbags on top of the weir to prevent peak Minnehaha Creek flows from entering Lake Nokomis. According to MPRB staff, Minnehaha Creek did not breach the Nokomis Weir. The picture below shows a very flooded Lake Nokomis flowing over the weir's stop logs into Minnehaha Creek.

Nokomis Weir: Lake Nokomis flowing into Minnehaha Creek on June 25, 2015

Minnehaha Creek Reach 8 Restoration

These bio-engineered streambank stabilization projects performed well under the high and sustained flows along Minnehaha Creek. The techniques used for this project should be highlighted and used as an example for future streambank restorations projects.

Mooney Lake Pumping

The City of Plymouth initiated pumping at Mooney Lake due to high water levels and pumped approximately 30,480,000 gallons of water out of Mooney Lake. The pumping was coordinated between the City of Plymouth, City of Wayzata, and MCWD. Future pumping will follow the "Mooney Lake Operating Plan for Emergency Pumping" dated March 24, 2011.

4.0 Department Impacts

All Departments at the District were impacted during and after the flooding event. Coordination between the departments was done efficiently in 2014 and allowed the District to remain responsive. This section provides a summary of the actions that each department implemented. Each department section ends with a set of recommendations to be carried out the next time there is a flood event. These recommendations will be reviewed and translated into a Response Plan which is discussed more detail in Section 6.2.

4.1 COMMUNICATION & EDUCATION DEPARTMENT

The Communications and Education Departments played a key role in helping disseminate vital information to stakeholders about the high water, its impacts, and response efforts. This outreach effort, which kept people updated on what to expect and directed them to the resources available to help protect their safety and property, helped improve people's understanding of the situation and the District's role, and reinforced the District's credibility as a trusted source of information and inter-agency coordinator/partner.

Since the floodwaters subsided, the Communications and Education Departments have been using the high water event as a teachable moment. They have been developing messaging and programming on the importance of effective stormwater management in reducing the volume of water running off the landscape and the damage it can cause. With the 2014 flooding fresh in the public's mind, it's a key opportunity to educate people on where the water from their property flows and how they can help prevent flooding in the future.

The Cost Share Grant Program has been following up on numerous inquiries about assisting residents with repairs to their damaged property. These grants are a key tool the District can provide people in the wake of the 2014 high water event.

2014 IMPACTS & ACTIONS

1. Email Updates to Communities:
    a. Prior to the May 31-June 1, 2014 precipitation event, the District proactively reached out to each community within the District to alert them to the predicted rain forecast and the potential for localized flooding. (See May 30, 2014 email titled, "Flooding Potential in MCWD this Weekend" in Appendix D)

    b. Weekly Updates: On a weekly basis, the District also sent targeted email messages to communities, emergency responders and other partners in the MCWD directly impacted by the high water. Among the recipients were city administrators, city clerks/communications managers, local emergency responders, park board staff, Hennepin County Emergency Management and Public Affairs, LMCD, and marina operators. Four main themes were present through the District's high water messaging:
        i. Factual information about weather (forecast, rain totals, etc.), water levels, dam discharge
        ii. Public safety and protection of property – Minimum wake restrictions, safety tips including no paddling on creek, recommendations on where to get sandbags, wastewater discharge information.

iii. Managing expectations – Water levels will remain high for some time, projections from District engineer
iv. Dam Operations – Educating people about the function of the dam, how it's operated and the impact of record rainfall. Transparent communication providing links to the operating plan on the District website.

2. Website, Social Media, Splash e-newsletter Updates:
   a. The District issued 3 news releases, 9 e-newsletters to its Splash subscriber list, and posted daily website, Twitter and Facebook updates throughout the period.

   b. An update on high water was the top story on the website from June 2, 2014 through August 18, 2014. The front page was viewed 57,491 times during that period, which was four-times more visits for the same timeframe in 2013. The 42 flood-related messages that were posted on the District's Facebook page reached 41,103 people and the 54 flood-related posts on the District's Twitter account reached 44,550 people during that period.

3. Media Requests
   a. The Communications Director was the key media contact regarding flooding and the District's response, providing information to reporters and granting interviews.

   b. District staff fielded approximately 60 requests from local and national media outlets for information regarding the flooding. Those requests resulted in at least 74 news stories by at least 26 media outlets from May 22, 2014 through October 8, 2014 when the final flood-related article was published. The breakdown of the coverage is as follows:
      i. Newspapers: 45 stories, 18 different newspapers, 4.9 million impression
      ii. TV: 29 stories, 4 broadcast stations and 1 cable channel, 1.4 million viewers
      iii. Radio: Three radio stations aired numerous stories and at least three live interview segments

Telly Mamayek on Kare 11 news May 23, 2014

4. Internal Communication:
    a. Developed talking points for staff, board, and CAC members to ensure all District representatives provided consistent, accurate messages and information. Updated them as needed to reflect changing conditions.

    b. For internal communication during the flood event and in the weeks and months after, regular e-mails were sent to internal stakeholders (MCWD Managers, CAC and staff) to keep them informed about water levels and the District's response, pertinent emails from partner agencies on flood-related matters, and talking points to help them field questions from the public.

5. Cost Share Grant Inquiries:
    a. Staff received several requests for information about grant funding for streambank and shoreline stabilization projects in the wake of the 2014 flooding. The number of requests increased throughout the fall and winter as residents assessed the damage to their property and made plans for repairs in 2015. Properties impacted by high water that have inquired about Cost Share assistance can be view in Map 1.

    b. Staff met with many residents on site to assist in damage assessment and educated many of the residents on the water quality and aesthetic benefits of biological engineering along their shoreline/streambank. This was done by showing examples of past projects that have gone through the Cost Share program, giving the residents flyers and information about the program, and explaining the District rules and regulations that would apply regardless of District funding. In some cases there was internal department collaboration on these inquires. For example, when permitting staff received inquiries about a permit for restoring flood-damaged shorelines/streambanks that may be a candidate for District funding, they directed the homeowner to cost share program staff for more information.

RECOMMENDED FUTURE PROCEDURES

1. Communications Director assumes role as spokesperson for District flood response, receiving and responding to all media calls, allowing District staff to focus on flood control work.

2. In anticipation of high water, coordinate with Project Maintenance Department staff on dam operations and other response efforts.

3. At the first indication that high water is expected, email District communities with proactive message and pertinent information to help them prepare.

4. Continue to provide timely, regular updates to communities on weather forecasts, flood projections and response efforts via email to list of key contacts.

5. Develop talking points for staff early and update them regularly throughout the high water event. Also provide them to CAC and Board of Managers.

6. Coordinate with Hennepin County Emergency Management or other appropriate entity in charge of coordinating the regional emergency response. Among pertinent information they can provide are:

a. Weather forecasts; rainfall projections
b. Resources for communities (i.e. sandbags)
c. Safety tips

7. Coordinate with Hennepin County Public Affairs office and individual affected communities on media outreach.

8. Use District website as primary communications vehicle. Update it daily with the most current information. Use it as a clearing house for flood-related information including, but not limited to:
    a. Current water levels
    b. Precipitation forecast
    c. Dam operations
    d. Safety tips
    e. Wake restrictions
    f. Road closures
    g. Flood insurance
    h. Sand bag distribution and disposal
    i. AIS disposal

9. Compile a library of resources for flood-related information including, but not limited to, the following:
    a. Safety tips for walking/driving near high water – Hennepin County Emergency Management
    b. Safety tips for cleaning up areas damaged by high water – Minnesota Department of Health
    c. Proper disposal of sandbags – Minnesota Pollution Control Agency
    d. Flood insurance – Federal Emergency Management Agency
    e. Road closures – Hennepin County
    f. Lake Minnetonka wake restrictions – Lake Minnetonka Conservation District
    g. Minnehaha Creek flows – U.S. Geological Survey
    h. Beach closures – Hennepin County Public Health, Minneapolis Park and Recreation Board
    i. Sanitary sewer overflows – Met Council, individual cities
    j. Aquatic invasive species disposal – MN Department of Natural Resources

10. Coordinate and collect photos of the high water event and its impact.

4.2 OPERATIONS & SUPPORT SERVICES DEPARTMENT

The Operations and Support Services Department played a key role in responding to requests for information and determining the appropriate internal and external resources. Many inquiries were seeking basic information, and the Operations and Support Services staff were able to quickly respond, which lessened the workload of other staff. Staff also coordinated to develop new tools for tracking flood related costs and preparing for FEMA reporting.

2014 IMPACTS & ACTIONS TAKEN

1. Phone Calls: By the end of June, approximately 200 phone calls related to high water or dam operations were fielded. Staff coordinated with Communications and Project Maintenance staff to develop quick and factual responses to public inquires.

2. Invoice Coding: In coordination with Project Maintenance department, staff developed two new activity codes to track high water and FEMA expenses.
    a. Activity code 4247: High Water
    b. Activity code 4248: FEMA

3. Preparing for Emergency Board Meetings:
    a. Coordinated with Legal Counsel to set and post the agenda as quickly as possible.
    b. Coordinated with Communication staff for assistance with public outreach.
    c. Set-up Board room, prepared technology, coordinated meal if applicable.

RECOMMENDED FUTURE PROCEDURES

1. Phone Calls:
    a. Designate a special phone number for flood related calls
    b. In coordination with other Departments develop a contact list for Agencies/Emergency Response groups to provide to callers as a resource.
    c. Coordinate with Communications and Project Maintenance staff to develop a quick and factual response to public comments/concerns.
    d. Create and manage a detailed log of every phone call and email received.
    e. Regular meetings with Departments to stay current with existing conditions.
    f. Listening to callers is key, most of them just want their concerns to be heard.

2. Coordinate with Auditor if FEMA Money is to be Received:
    a. If the District receives federal funds over a certain threshold, a more complex, time consuming, and costly audit will be required.
    b. Alert Auditor to discuss if an additional (federal) audit and Audit engagement letter will need to be added to the process. Expenditures of FEMA funds will count in determining whether the District must have an audit performed under Office of Management and Budget (OMB) Circular A-133. Currently, $500,000 of federal awards expended during an entity's fiscal year triggers an audit.
    c. Coordinate with Project Maintenance staff to track and document the amount of total expenditures submitted to FEMA.
    d. Advise Auditor if/when an award letter is received by the District
    e. If an award letter from FEMA has been received, advise the Auditor of the total amount of revenue or reimbursement that FEMA has authorized/approved.

3. Financial
    a. Work with all District departments to provide tracking and coding for high water event expenses
    b. In cases of emergency, expenses can paid for by credit card or manual check.

4. Insurance:
    a. Initiate an expense tracking report as early as possible, and inform staff to update it on a weekly basis with all tangible assets affected by the event.
    b. Contact the insurance agent and review existing insurance guidelines for submittal. Notify agent of the flooding scenario, and review the District deductible. Set up a process for turning in claims, either one at a time or after a designated time period (e.g., once a month) as part of a bigger loss claim.
    c. Track the expense report and review for items that are able to be submitted to the insurance carrier as a loss claim.
    d. Submit claims as determined in communication with the insurance agent in line 4.b above.

4.3 PERMITTING DEPARTMENT

The Permitting Department played a key role in gathering flooding information across the District. Permitting staff worked with local communities and contractors to identify and evaluate infrastructure issues associated with high water, provided technical advice, issued permits for repair work, and performed routine site inspections to make sure active sites were in compliance after large rain events. Permitting staff worked closely with local municipalities to understand the background of a particular issue identified during the flooding. Permitting staff found it important to clearly document how District rules applied to particular situations. This was accomplished by Permitting staff coordinating with other District staff, legal counsel, and the District engineer to understand the historical knowledge of similar situations.

2014 IMPACTS & ACTIONS TAKEN

1. Emergency Permits: During the extended period of flooding experienced by much of the region from the months of May through September, the District issued six permits deemed "emergency work". Permitted projects ranged in scope and size and included:
    a. Shoreline and streambank repair
    b. Slope failures on Lake Minnetonka
    c. Fill on roadways that within the 100-year flood zone
    d. Land adjacent to lakes and streams that were under water for an extended amount of time

2. High Water Permits
    a. Shoreline & Streambank Stabilization – Lakes and streams that experienced water levels above the OHW for an extended period presented numerous cases of shoreline erosion. While several streambanks and shorelines were affected, the District encountered an extremely high volume of permits for the repair, replacement, or maintenance of established rip-rap. Water over-topping banks caused undercutting and displacement of existing hard armor leading to 30+ permit applications for shoreline and streambank stabilization. Staff expects additional permits related to shoreline repair in the coming calendar year due to flooding. Due to the high volume of projects, District staff must examine the specifications of each application and ensure that the proposals are adequate and contain all pertinent information.

    b. Floodplain Alteration – Commercial and residential properties throughout the District reported extensive damage due to flooding. High water encroaching on yards and adjacent vegetation resulted in soil loss on private property. Staff worked with the District engineers to determine if applicants were allowed to replace lost soil material on their property to an extent previously recorded via survey. In all, 12 Floodplain Replacement permits were received for repair of damaged or degraded property. Floodplain replacement can be difficult to document; applicants are required to re-survey to prove material loss from their property. Permitting staff advise meeting with the applicant to outline the requirements of rule and providing clear and consistent information.

3. City/Public Inquiries: Permitting staff spent approximately 140 hours on phone calls, site visits, and other flood related issues in response to inquiries from residents and municipalities. Many of these concerns were related to shoreline damage, improper pumping or drainage of sites and/or wetlands, drainage concerns, wastewater discharge, and property damage. Permitting staff often coordinated with municipal authorities, on large scale issues that required the issuance of emergency work permits. Between June and August, several questions arose related to repairing property damages caused by flooding including, but not limited to:
    a. Shoreline restoration
    b. Replacing sod/fill within or near the regulated floodplain
    c. Maintenance of existing rip-rap

4. Agency & Private Coordination
    a. Municipal
        i. Debris Removal (downed trees along Minnehaha Creek)
    b. MPCA
        i. Wastewater Discharge to surface water
    c. Private Contractors
        i. Erosion and sediment control on active construction sites

RECOMMENDED FUTURE PROCEDURES

1. Protocol for Emergency Permits
    a. A goal that District staff has discussed is to add a provision into the District's Procedural Requirements rule that would allow District staff, in coordination with the District engineer and legal counsel, to be able to issue emergency permits, as required.
    b. If proposed work is deemed "emergency", District staff, under the advisement of the District Administrator and Program Director, needs to consult with the District engineer and legal counsel immediately to assess the proposed work/project and identify an appropriate course of action.
    c. If an emergency permit is issued, staff will notify the Board of Managers and report to them the details of the permit.

2. Flood Damage & Agency Coordination
    a. District staff will document all known sites that have been damaged by elevated water levels. If work on private property is proposed, staff at that particular city should be updated, the timeline should be assessed, and the need for city permits should be identified.

3. Slope Failures
    a. In extended high water levels, slope failures tend to increase. Locations of slope failures should be documented. Generally, soil and vegetation that has entered a body of water due to slope failures should be removed within 7 days of the slope failure.
    b. Historically, shoreline contractors have kept District staff informed of locations of slope failures.
    c. When District shoreline permits are issued, the permit is approving the shoreline restoration work, but not approving the engineering or proposed work for stabilizing the location of the slope failure. Generally, the municipality approves the work to stabilize the slope failure.

4.4 PLANNING & PROJECTS DEPARTMENT

Knowledge of District projects and lands allowed staff an awareness of potentially vulnerable sites and positioned them to assist with the coordination of short- and long-term repairs. Planning staff will work with Project Maintenance and Land Management department staff to prioritize repairs, mitigate damaged areas, and where possible layer new projects with planned repairs.

2014 IMPACTS & ACTIONS TAKEN

The primary focus for the Planning & Projects Department during this record flood event was to document the extent of flooding and impacts to inform future project planning; and evaluate damage to active District projects and plan for repairs.

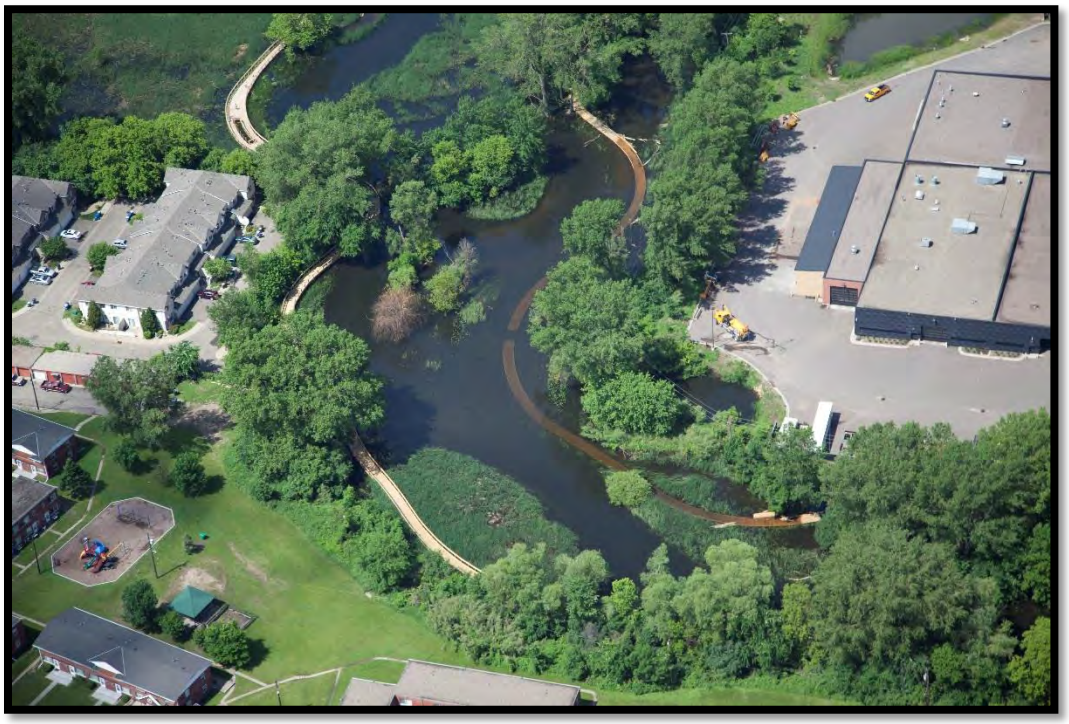
1. Flooding Impacts:
Planning & Projects staff coordinated with the Project Maintenance & Land Management and Research & Monitoring departments to document the extent of flooding through aerial photography and surveying of high water marks throughout the watershed. This documentation will be useful for ground truthing model predictions, evaluating project priorities, and demonstrating the need for changes to land management in certain locations. For instance, this flood event resulted in significant erosion along Minnehaha Creek, primarily in areas managed as turf grass. Staff will use this information to work with cities, the Minneapolis Park and Recreation Board, and residents to promote native riparian buffers in flood-prone areas.

2. Active Capital Projects:
As noted in Section 3.4, there were three active capital projects in the construction or establishment phase that experienced flood damage. Two active District projects located along Minnehaha Creek were effected by flooding. These projects were located in Reach 14 and Reach 20. The third active District project was located on Big Island. All three of these projects present challenges in terms of plant selection for sites with broadly fluctuating water levels.

   a. Reach 14:
   The Reach 14 Streambank Restoration project, which was a stream buffer project between France Avenue and W 54th Street in Edina along Minnehaha Creek reached final completion in the spring of 2014 just prior to high water. The 16 sites on private property were primarily seeded and planted with plugs of native species. The seed and plants had not yet established, which made them vulnerable to high water conditions. As a result, the majority of the streambank vegetation was lost to the current of Minnehaha Creek or to the prolonged inundation. Erosion control materials that were installed with initial construction performed well and remain in place.

   Staff is currently working with the project engineer and construction contractor to implement repair work. The sites have been hydro-seeded with an enhanced cover crop and will be replanted with larger plants in the spring of 2015. Moving forward, sites that are especially vulnerable to high water conditions and water level bounce would benefit from the installation of larger plant material and vegetated mats. These plant materials provide rapid establishment and better resiliency in fluctuating water conditions. Total cost for Reach 14 repair work related to the 2014 flooding is $66,456

b. Reach 20:
The Reach 20 Stream Re-meander Project was under construction during the prolonged high water of 2014. The boardwalk portion of the trail system reached substantial completion in early June 2014 and performed well under high water conditions. Construction of the bituminous trail system, while delayed by high water, is nearing completion. Locations of plants selected for the site have been revised in response to a new understanding of where water tends to pool on site and areas that better support upland vegetation. Plant installation was completed in the fall of 2014, and the site will begin a three-year warranty period in 2015. The estimated total cost for Reach 20 repair work replanted to the 2014 flooding is $50,000.



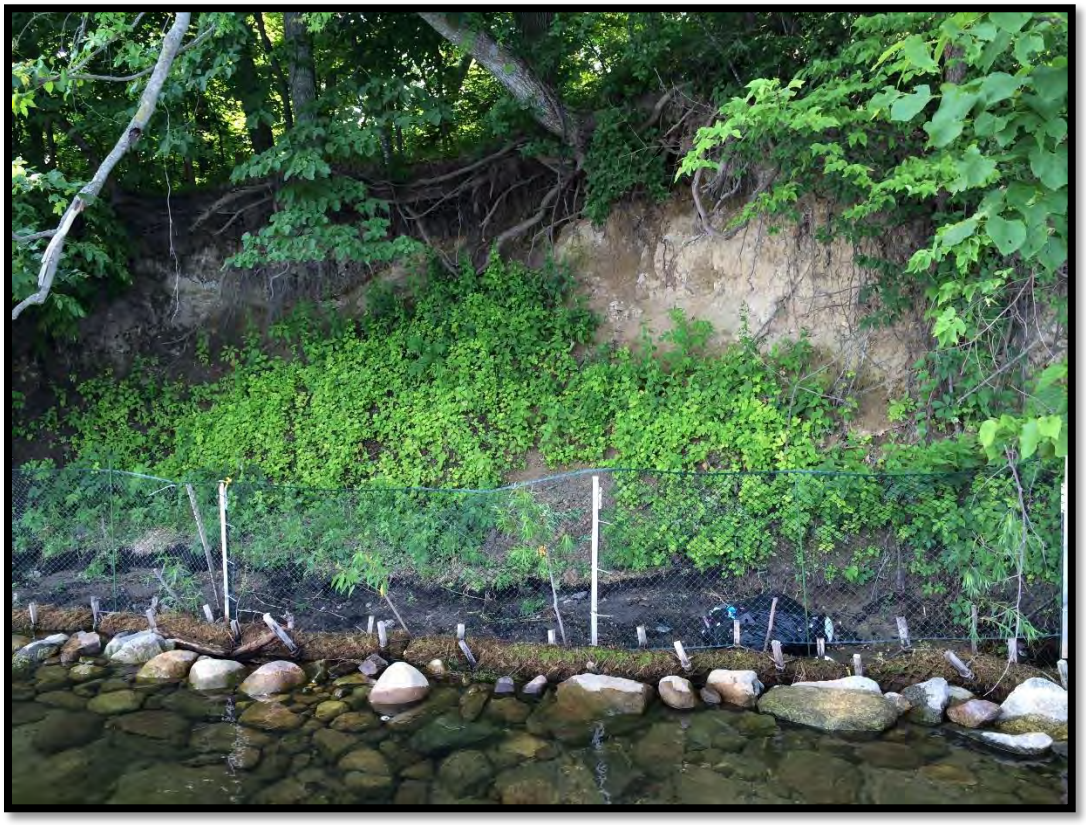
Boardwalk under water on June 20, 2014

c. Big Island Phase II:
A July inspection of the second phase work on the shoreline of Big Island in Lake Minnetonka revealed that all locations with biologs and fascines incurred some topsoil erosion behind the bioengineering as wave action likely lifted soil off each stabilization site. Despite the topsoil erosion, all biologs and fascines remained intact as originally installed and riprap appeared to be in generally good condition. Many seeded species germinated in 2014 and were present during the July inspection, and the installed live stakes looked vigorous, as well. Red-twigged dogwood, riverbank willow, and black willow live stakes managed the inundation very well.

Needed repairs were completed in the fall of 2014 included the replacement of topsoil and stabilization with additional fascines. The new topsoil was seeded and mulched according to original construction plans. This area totaled approximately 100 square yards. Trees washed away by high lake

levels were also replaced with Three Rivers Park District, who supplied the additional trees.

Due to the high water conditions in 2014, the site will be monitored throughout 2015 for plant dieback, weed invasion, and response to 2014 repair work. Re-seeding and plant replacement will be completed as necessary and as plant establishment is assessed.



Topsoil erosion behind biologs at Big Island on July 14, 2014.

RECOMMENDED FUTURE PROCEDURES

1. As we work towards building projects with greater resiliency, staff will fine-tune designs by selecting plants and materials with a broader range in soil moisture tolerance and faster establishment.
2. Review this completed flood report to fully understand where the District was most impacted and use that information to inform future project planning and the next generation Comprehensive Plan.

4.5 PROJECT MAINTENANCE & LAND MANAGEMENT DEPARTMENT

The Project Maintenance & Land Management Department took the lead in coordinating the District's high water response internally and externally for District. This involved emergency coordination, developing messages to share with the public, and developing a plan for additional data collection during high water. Post-flooding this department took the lead to identify flood damage and coordinate repairs with local municipalities and with FEMA.

2014 IMPACTS & ACTIONS TAKEN

1. Dam Operations
    a. Website: When the Lake Minnetonka water level was greater than 930.0, dam operations included daily lake elevation readings. The MCWD website home page was updated daily (Monday-Friday) with a Lake Minnetonka level and the actual or estimated discharge from the Gray's Bay Dam into Minnehaha Creek. Actual discharge was posted when the dam was operated without flow over the emergency spillway, which was prior to May 9. After May 9, Lake Minnetonka elevation exceeded 930.0, and discharge into Minnehaha Creek was estimated based on flow at McGinty Road. On July 31, staff began operating the dam again as Lake Minnetonka dropped below 930.0 on July 29. Discharge out of the dam was reduced to 200 cubic feet per second (cfs) on July 31 to provide some flood relief along Minnehaha Creek, though high water conditions persisted into August as wetlands along the creek continued to drain into the creek.

    b. Lake Minnetonka levels above 930.0 for greater than 5 days and lake levels above 930.25 are reported to the Lake Minnetonka Conservation District.

    c. Paddling conditions: Minnehaha Creek paddling conditions are considered "good" when flow is between 75-150 cfs. Flows greater than 150 cfs are considered dangerous and paddling is not advised. While MCWD does not regulate paddling on the creek, the District advises the public on safe paddling conditions. As creek flow exceeded 150 cfs, a sign was posted at the Headwaters and Hopkins Crossroads canoe landings that warned potential paddlers of high creek flow and unsafe paddling conditions. Not only were high rates of flow a concern, but due to the prolonged flooding, much debris had washed into the creek. High water obscured the debris, and rapid flows decreased paddlers' reaction times to navigate around debris.

2. Coordination
    a. External: Coordinated with Hennepin County Emergency Services, the National Weather Service, and local communities to identify flood risks. Closely coordinated with St. Louis Park and Edina Fire Departments to assess the need for sand bags to protect structures from flooding.

    b. Internal: Coordinated with the Communications Department to share information gleaned from external coordination efforts. Coordinated with Operations and Support Services staff to develop quick facts to help answer public inquiries.

Telly Mamayek and Tiffany Schaufler participating in flood press conference with Hennepin County Emergency Management on June 19, 2014

3. Project Inspections
    a. Typically, District projects are inspected twice annually, in the spring and fall, to monitor vegetation characteristics and check the condition of infrastructure to ensure that the projects are operating as designed. Understanding that prolonged high water during June, July, and August of 2014 was stressing many District projects, staff completed two additional rounds of inspections in July and September to evaluate vegetation response to prolonged inundation, check various structures for needed maintenance, and begin to document damage.

    b. Generally, no emergency repairs were necessary. The primary immediate needs were the removal of debris from Minnehaha Creek and Painter Creek. Trees and tree limbs fell into the creek causing obstructions and the accumulation of additional debris which was obstructing flow. Paddlers were a good source for this information, as were property owners along the creek. If the obstruction was identified as a tree limb, it was necessary to determine if the limb caused an impediment to navigation or normal flow path of the creek. Limbs not causing a problem for navigation or flow were left to provide enhanced habitat. If trees or other material caused obstructions, the District first determined the responsible party. Trees or tree limbs originating from private property were the responsibility of individual property owners to remove. If the debris originated from city property, that municipality was responsible for its removal. In one case, the District coordinated with the City of Minnetonka and the Conservation Corps of Minnesota to remove a large tree that had fallen into the creek from private property.

4. District Infrastructure
    a. Staff recognized specific vulnerability of infrastructure installed at various District projects and identified the need to monitor these sites during and after high water. Generally, staff monitored sites that would exacerbate flooding if their infrastructure was not functioning properly. This included sites with weirs, inlets and outlets, culverts, dams, erosion control features, trails, signage, known areas of ponding or poor drainage, and infrastructure known to accumulate debris. A list of projects that should be top priority to monitor during high water can be viewed in Appendix C.

5. "Other" Infrastructure: The poor function of two sites within the District required a high degree of communication and coordination during and after high water.

    a. Painter Creek crosses under two private driveways at 4650 and 4680 Creekwood Trail in Orono. The District received a high volume of phone calls and emails regarding these crossings due to very high water backing up on the upstream sides of the culverts that go under these two private driveways. District staff continues to coordinate with property owners on Creekwood Trail and on the east side of Katrina Marsh on Hunt Farm Road to determine the root cause of poor drainage in this area. The District's engineer has surveyed elevations of culverts along Painter Creek from CR-6 to the private crossings along Creekwood Trail, and is currently analyzing the capacity of the system to determine if the culverts are sized appropriately.

    b. A drainage channel that flow into the Steiger Wetland Restoration project widened and pooled which caused some localized ponding on District's property at 8000 Narcissus Court and on the southeast corner of private property at 7960 Narcissus Court. District staff is working with the adjacent homeowners and a contractor to correct the elevation of the channel and direct water to properly flow through the channel and into the wetland.

6. Flood Damage/FEMA Coordination: A mainstem stream assessment completed in September and October 2014 determined flood and high flow related damage on Painter, Six Mile, Gleason, Classen, Long Lake, and Minnehaha Creeks. The largest extent of damage occurred within Reaches 1 and 3 of Classen Creek, Reaches 4 and 7-11 of Minnehaha Creek, and Minnehaha Falls. Damage on Classen and Minnehaha Creeks generally consisted of bank sloughing, undercutting, and slope failures resulting from sustained high flows and poorly vegetated banks and upland areas. Damage to Minnehaha Falls included accumulated debris in the creek contributing to erosion, bank undercutting below boardwalk trails and walls, and exacerbated erosion of slopes with inadequate vegetation. Currently staff is working with FEMA to finalize damage repair cost estimates.

7. Tracked High Water Expenses: Coordinated with Operations & Support Services staff to create two new activity codes to help track the costs of high water.
    a. Initial high water expenses were allocated to Activity Code 4247 (High Water)
    b. Expenses known to be reimbursable through FEMA funding were allocated to Activity Code 4248 (FEMA Repairs)

RECOMMENDED FUTURE PROCEDURES

1. Lead Project Manager for District: Manage and coordinate District's response internally.

2. Emergency Coordination: The Project Maintenance and Land Department will manage and coordinate emergency response and repairs for future flood events with local and state emergency responders and with FEMA.

3. Procedures that were instituted in 2014, including specific additions to dam management, additional site inspections, and coordinating with engineers and other agencies, can be implemented more seamlessly in the event of future flooding.

4. FEMA damage assessment and reporting can be initiated during the flood event and contributed to by all departments.

5. High water expenses will be coded to Activity Code 4247. Expenses to be reimbursed by FEMA funding will be coded to Activity Code 4248. Specific documentation required by FEMA for reimbursement includes estimates with costs set by industry standards and specific locations where removed debris was taken.

6. Information frequently requested by the public can be gathered in advance and made available to all staff to alleviate workload and provide consistent messaging.

4.6 RESEARCH & MONITORING/ AQUATIC INVASIVE SPECIES (AIS) DEPARTMENTS

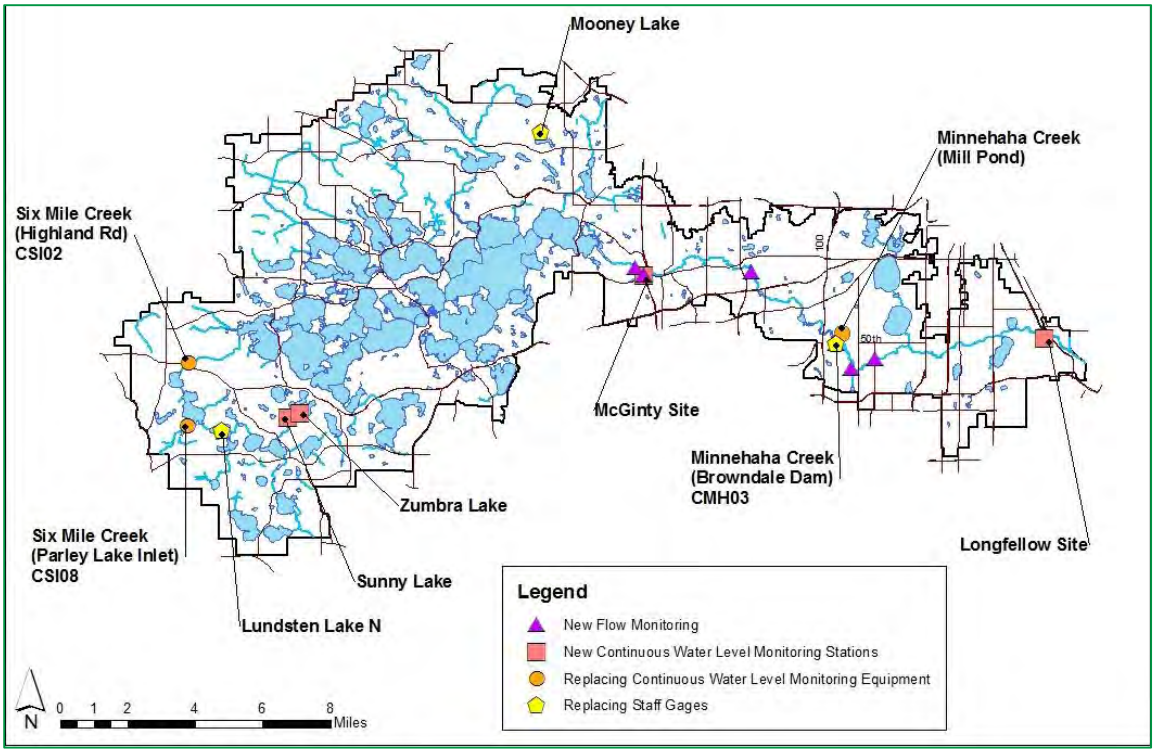
The Research & Monitoring Department was instrumental in gathering additional monitoring data during the flood event. Staff purchased additional monitoring equipment and created new monitoring sites to ensure that all the critical data was being gathered. The AIS department staff also had to carryout additional AIS monitoring due to threat of high water causing backflows into uninfested waters.

2014 IMPACTS & ACTIONS TAKEN

1. New Equipment Purchased/Installed:
    a. Flowmate: Existing equipment required staff to enter the water to collect flow data, but high and fast conditions in Minnehaha Creek made it dangerous for staff to do so. A new Flowmate was purchased which allows staff to collect flow readings over a bridge deck during these high-water periods. This assures staff safety and prevents high flow data gaps.

2. Additional Monitoring:
    a. The June 19 rain event pushed water levels throughout the District's systems to their peak. Staff from across all departments coordinated to capture high water elevations and photographs in the field on June 19. The map below in Figure 10 shows where additional monitoring equipment has been installed.

Figure 10: Additional Monitoring Equipment & Locations



    b. Surveyed benchmarks: Staff flagged water elevations along the creek and throughout the upper watershed to measure for record high water levels. For locations, please see Tables A-1 and A-2 in Appendix A.

c. Installed additional lake gages: Temporary gages were needed at Lundsten Lake and Mooney Lake because the original gages were underwater and impossible to locate. The gage at Browndale Dam on Minnehaha Creek needed to be replaced as high flow swept it away. Five gages were installed in Plymouth to monitor the effects of Mooney Lake pumping on downstream waterbodies.

d. Installation of trolls at Zumbra and Sunny Lakes: The gage at Zumbra Lake was underwater. In addition, there were homeowner concerns that Sunny Lake was raising Zumbra Lake levels and causing residential basements to be inundated with lake water. The trolls installed on both Zumbra and Sunny Lakes recorded water levels every 15 minutes to determine if Sunny Lake was raising Zumbra's lake levels.

e. McGinty Road Flow Monitoring: As noted in Section 2.2.2, the Gray's Bay Dam discharge was not able to be measured when water levels of Lake Minnetonka and the adjacent wetland equalized. At this time, the discharge of Lake Minnetonka was a function of the capacity of the dual box culverts at McGinty Road. Monitoring staff first used a Flowmate supplied by Wenck Associates to measure flows at McGinty Road and later purchased a new Flowmate for District use. Flows at McGinty Road were measured approximately every other day from June 25 to July 30. Data was shared with Communication and Project Maintenance staff to be used to update the District's website and provide information to the public.

f. AIS Monitoring: One additional zebra mussel veliger monitoring survey took place in Christmas Lake, Lake Virginia and Langdon Lake. All of these lakes have connections to Lake Minnetonka and are susceptible to back-flow from Minnetonka.

3. Perceived Spread of AIS due to No-Wake Restriction on Lake Minnetonka:
   a. The Lake Minnetonka Conservation District implemented a lake-wide minimum wake restriction on Lake Minnetonka from June 5, 2014 to July 24, 2014. Concern has been expressed among those interested in AIS that many took their boats off of Lake Minnetonka to go to other lakes where there were not wake restrictions in place. There were notably higher numbers of intercepts of AIS plants (e.g., Eurasian watermilfoil) and animals (e.g., zebra mussels) on boats/trailers at public launches at area lakes. It is very common to find zebra mussels attached to aquatic vegetation, in addition to the hull of boats or on engines/propellers. This is an anecdotal correlation at this point. If nothing else, it underscores the importance of Lake Minnetonka as a source lake for AIS—especially zebra mussels—that may be exacerbated by high water flow and use restrictions.

4. Perceived Lake Minnetonka "backflow" into Christmas Lake, Lake Virginia & Langdon Lake:
   a. There was concern expressed about water backing up from Lake Minnetonka into other waterbodies, most notably into Christmas Lake, and that AIS that may be in that water could be introduced to the upstream waterbody. In terms of Christmas Lake, Wenck Associates (Chris Meehan and Mike Panzer) looked into the elevation difference and determined that even with this year's record high elevation on Lake Minnetonka (930.11 feet), the water remained

flowing from Christmas Lake to Lake Minnetonka. The water overtopped the weir at the Christmas Lake outlet, and the water elevation was high in Christmas Lake and remained flowing through the ±0.25-mile storm sewer pipe to Saint Albans Bay.

5. AIS Communication:
    a. Coordinated with District staff and MPRB staff regarding water levels in Minnehaha Creek and Lake Nokomis.

    b. Potential existed for water from the Minnehaha Creek to overtop the Nokomis Weir and possibly introduce zebra mussels to Nokomis. This did not occur; the Minneapolis Parks and Recreation Board added sandbags around the weir and this helped prevent creek water and AIS from entering Nokomis.

RECOMMENDED FUTURE PROCEDURES

1. Develop a Flood Monitoring Plan detailing priorities, methodology, etc.

2. Install pressure transducer annually at McGinty Road
    a. Measure flow twice throughout season to ensure the regression remains valid

3. Flooding locations to be monitored during high water
    a. McGinty Road (CMH01) flow monitored weekly and tape down measurements taken 3 times per week.
    b. Repeat locations monitored in Maps 5-7.

4. AIS spread in Minnehaha Creek: High water conditions likely moved AIS, especially zebra mussels, further downstream. Monitoring/surveying throughout 2015 and 2016 should provide answers on the spread of AIS throughout Minnehaha Creek.

5. Locations to monitor for potential AIS movement during high water
    a. Monitor for potential backflow from all zebra mussel infested waterbodies.
    b. Monitor water levels in Minnehaha Creek and Lake Nokomis. Nokomis weir prevents creek water from entering the lake and possibly introducing zebra mussels.
    c. Monitor no-wake restrictions that may be put in place on area lakes.

6. If spring flooding is predicted, extend the height of lake gages at the beginning of the season (work with MNDNR).

7. If flooding occurs due to precipitation event(s) and lake gages become too submerged to measure via inner tube, Monitoring staff should install a new lake gage to continue readings.

8. In the event that additional monitoring equipment is needed, inquire with Wenck Associates, Three Rivers Park District (TRPD), Fodriest Rentals, YSI, and Tech Sales to rent.

9. Prioritize monitoring tasks when immediate emergency sampling needs occur. Staff should focus on gathering water level data, and reassigning some of the routine sampling/equipment downloading as a second priority.

10. Increase communication with outside organizations when high water begins. Contact MPRB and TRPD at the beginning and the end of the high water period to prevent duplication of work and/or obtaining additional data.

11. Monitoring staff should meet with Project Maintenance and Planning Staff weekly to discuss areas of concern (work in cooperation with other departments as needed (i.e., Zumbra-Sunny flooding).

5.0 External Coordination

5.1 AGENCY COORDINATION

The District's main role during the flooding was to gather data and share the information to help inform local communities' response. Table 11 below lists the different agencies with whom District staff coordinated with during the 2014 flood event, the agency's point person, the agency's role, and MCWD's role.

Table 11: Agency Coordination

Agency	Agency's Point Person	Agency's Role	MCWD's Role
Army Corps of Engineers	Regulatory Program Manager for Hennepin & Carver Counties	Emergency Permitting	District's Rules: Floodplain & Shoreline/Streambank
Hennepin County Emergency Management	Director	Coordinates and maintains public and private disaster resources in the County	Provide updated flooding information across the District
Hennepin County Environmental Services	Website Fact Sheet	Beach Closures	Sharing beach closure information
Fire Department: Edina, St. Louis Park	Fire Chief	Provide sand bags to citizens	Alert Fire Chief on Minnehaha Creek conditions
Lake Minnetonka Conservation District	Executive Director	Regulate the use of Lake Minnetonka	Provide Lake Minnetonka water level readings
Metropolitan Council	Information Officer	Sanitary Sewer overflows	Sharing Met Council's press releases
Minneapolis Park & Rec Board	Maintenance Foreman; Water Resources Supervisor	Operate Nokomis Weir, Beach closures	Notify MPRB if changing dam discharge; Sharing beach closure information
Minnesota DNR	Area Hydrologist-West Metro	Authorize Dam operating plan	Implement Dam operating plan; Shared information on proper AIS disposal
Minnesota Pollution Control Agency	MPCA Emergency Responder	Regulate wastewater treatment operations	Shared information about proper sandbag disposal;
National Weather Service	Service Hydrologist	Provide local forecasts	Share forecasts with the public
Public Affairs (Communities)	Communication Directors	Communicate flood information within their community	Share technical data with communities
Public Works (Communities)	Public Works Directors	Prepare their community for the potential of flooding	Share technical data
USGS	Hydrologic Networks & Data Chief, MN	Operates the Hiawatha gage on Minnehaha Creek	Providing funding to USGS for Hiawatha gage

6.0 Moving Forward

6.1 NEXT STEPS

Each department will review this Flood Report and develop a list of items that will need to be discussed and/or need to be in place prior to the next flooding event. Carrying out these identified tasks will ensure that the District is able to respond effectively to high water conditions and provide the public with the best technical expertise. These tasks include, but are not limited to the following:

- Entering into a partnership with the USGS for continuous Lake Minnetonka water level readings
- Development of Education & Outreach materials
- Incorporation of monitoring data into policy and planning considerations
- Review DNR model maps to determine where the model needs to be calibrated
- Forming a partnership with the National Weather Service to provide detailed weather forecast and flood predictions along Minnehaha Creek
- Developing procedures to efficiently navigate the FEMA process
- Identify future monitoring locations
- Installing additional continuous monitoring equipment

6.2 RESPONSE PLAN

The District navigated the unprecedented high water of 2014 through extensive internal and external coordination despite lacking a formal response plan. The District intends to use the 2014 flood experience and this flood report as an opportunity to capitalize on the valuable learning experience and use it to inform a response plan to be better prepared for a future flood event. The response plan will define the District's role during a flooding event and after a flooding event. It is important to understand what the District's role is because there are many public agencies to coordinate with and understanding each's other role will allow the District to identify where it can add the most value. The response plan will be a follow-up companion to the 2014 MCWD Flood Report, will be coordinated with Hennepin County Emergency Management, and will be rolled into the next generation Comprehensive Planning effort.

Appendix A

High Water Monitoring Locations – Several locations were identified as critical measurement points throughout the watershed based on the high water levels experienced throughout the District. A list of these sites is provided below along can be viewed in Maps 5-7 in the Maps Section of the Report.

Table A-1: Upper Watershed high water elevations

Site	Description	Elevation(NVGD 88)
		6/23/2014
East Auburn	Inlet under HWY 11	943.153
CCH01	Christmas Lake Weir	932.39
Zumbra	At boat launch	944.859
Sunny	At culvert under bike path	944.853
Lundsten North	Next to outlet weir	938.448
CSI01	Stream side, Lundsten North outlet	931.602
CSI02	Six Mile Creek-Highland Rd	931.001
CPA06	Painters Dr	939.61
CPA04	Upstream of new weir	940.693
Mooney	Near public access	989.59
Chelsea Pond	Upstream of weir	955.581
Gleason	Outlet	945.141

Table A-2: Minnehaha Creek high water elevations

Minnehaha Creek Site (Lower Watershed)	Elevation (NVGD 88)
Grays Bay	930.957
Wetland just after Grays Bay	930.744
McGinty Upstream	930.202
Minnetonka Blvd before 169	904.501
Downstream of 169	904.076
Upstream of Target Knollwood	902.535
Downstream of Target Knollwood	901.492
Blake Road Left Bank	900.095
Blake Road Right Bank	900.216
Downstream of Meadowbrook Rd	891.656
Upstream of Meadowbrook Rd	892.106
Upstream of Louisiana Blvd	890.248
Downstream of Louisiana Blvd	889.516
Downstream of Excelsior Blvd	888.973
Upstream of Excelsior Blvd	889.454
Mill Pond	886.209
Downstream of Browndale Dam	876.943
Reach 14 Project	858.708
Reach 14 Project	859.025
Reach 14 Project	858.777
Reach 14 Project	860.245
West 54th St	850.807
Chicago Ave	822.837
Cedar Ave	818.142
Creek side of Nokomis Weir	818.372
Nokomis side of Weir	819.156
Hiawatha outlet at 28th Ave	815.712
Hiawatha outlet at 28th Ave	816.001
Longfellow Pond	810.707

Appendix B

City	Flooding Location	Flooded Roadway (Y/N)	Roadway Closure (Y/N)	Stormwater Infrastructure notes	Areas of Severe Erosion	Planned/Completed Repairs	Water Level Monitoring	Add'l Measures taken
Deephaven	Old Log Theater	N/A		The city has ongoing drainage problems with several culverts and Public Works is working on the cleaning them out.	No	No	Informal monitoring via MCWD website	None
	Meadville Street	Y - two areas	Y					
	Vine Ridge Court	Y	N					
	City-wide	N/A						
Excelsior	Gideons' Bay houses	N/A		No	Some erosion along Excelsior Commons, nothing severe.	No	City has always watched the water level and will continue to do so. They do not intend to use equipment to monitor.	Worked with Hennepin County Emergency Services to help direct people to materials for possible flood efforts.
	Excelsior Commons Park	N/A						
	Layfayette Street	Y	N					
	Division (in Shorewood)	Y	N					
Laketown Township	All Farm fields	N/A		SW infrastructure problems on Abbywood Rd, Worms Cartway, Jersey, Ave Knight Ave, Shady Point Rd and others.	Little Ave. between 140th and 102nd street.	Yes. All are in process on a priority basis.	By sight and flow through culverts (visual).	Emergency Lift Station Pumping
	Township site	N/A						
	Little Ave. (140th-102nd)	Y	Y					
Long Lake	"The City of long Lake is located primarily on high ground so we had no major flooding issues. We did however have localized back yard flooding but to my knowledge no homes were flooded. The Lake itself, Long Lake, has been at high water level since early this spring, currently at 946.025 and with a new wake ordinance in effect at 945.0 lake use has been limited. We have experienced some swimming beach erosion."							
Medina	Starkey Road (in Orono)	Y	N	Starkey Road was underwater for a month cutting off access to Medina residents and Painter Creek Culverts near Townline Rd. are thought to be undersized.	No	No	No	None
	Tamarack Dr	Y	N					
	Townline Road (in Orono)	N	N					
Minnetrista	Enchanted Lane	Y - two areas	N	Flooding at Enchanted Ln (between 3770 & 3850 Enchanted Ln / between 4120 & 4205 Enchanted Ln).	Numerous small areas of washouts on or gravel roads throughout the City.	The flooding on Enchanted Island has had a temporary raised road installed through it. Road repair requirements will have to be evaluated once the water has receded. The drainage pipes are being evaluated for re-lining. The overflow structure is being taken care of MNDoT. This is because the structure is owned by the City, but the outlet pipe that was plugged (and caused the problem) is owned by the State.	The City checks the condition of the temporary roadway on Enchanted Island daily, and note where the water depth is on sand bags placed around the garage at 3830 Enchanted Ln.	None
	Lee Rd	Y	N	Flooding on Lee Rd (in front of 3700 Lee Rd)				
	East Shore Dr.	Y	N	Flooding on East Shore Dr (area just past the secondary driveway at 3470 Tuxedo Rd)				
	Morningview Dr.	N/A		A drainage pipe that flows from Morningview Dr to the lake.				
	Cty Rd 44 & Loring Dr	N/A		A drainage pipe that flows from a holding pond located between Cty Rd 44 & Loring Dr to the lake				
	St. HWY 7 & Merrywood Ln.	N/A		An overflow structure blow out near State Highway 7 And Merrywood Ln. The culvert pipe plugged up and the water going into the overflow structure washed out the surrounding support area.				
	5840 Hardscrabble Cir.	N/A		Culvert and old cement drain tile issue at 5840 Hardscrabble Cir. This water flows throw the culvert on Hardscrabble Cir and overland through the property at 5840. It enters an old cement drain tile (which is now collapsed) and then flows to the lake. This collapse caused water to flow over their property to the lake.				
	Jennings Cove park	N/A		Pond at Jennings Cove park that floods out the house at 1040 West Cove Ln.				
	Trillium Ln West.	N/A		Drainage way washout between 4395 & 4405 Trillium Ln West.				
	Halstead Ave.	N/A		Culvert and drainage problems at the "T" intersection of Halstead Ave which floods out the home owner at 6689 Halstead Ave.				
Orono	Baldur Park Road	Y	Y	These are streets with flooding issues.	Concordia Avenue Casco Point Road Dahl Road	Not specified	No	Providing residents with assistance of manpower and materials in conjunction with neighborhood volunteers Sandbags/sand from the City
	Rest Point	Y	N					
	East Lake Street	Y	N					
	East Long Lake Road	Y	Y					
	West Ferndale Rd	Y	N					
	Kelly Avenue	Y	Y					
	Starkey Road	Y	Y					
	Crestview Ave	N/A		These are streets and areas with culvert and/or stormwater infrastructure drainage problems.				
	Stubbs Bay Road N	N/A						
	Orchard Park Rd	N/A						
	Watertown Road	N/A						
	Concordia Avenue	N/A		These are areas of areas of severe erosion/washout/slope failure associated with the recent rains and high water				
	Casco Point Road	N/A						
	Dahl Road	N/A						
Shorewood, Tonka Bay, Woodland	Shorewood Oaks Drive	N/A		These are roads and areas experiencing high water	Not specified	Not specified	Not specified	Not specified
	Bracketts Road	N/A						
	West 62nd Street	N/A						
	Woodside Rd.	N/A						
	Birch Bluff Rd.	N/A						
	Edgewood Road	Y	N	These are roads the are experiencing flooding				
	Nobles Road	Y	N					
	Elm Ridge Road	Y	N					
	Mound Ave.	Y	N					
	Lakeview Ave.	Y	N					
	Woodpecker Ridge Road	Y	N					
	West Point Road	Y	Y					
	West Point Drive	Y	Y					
	Breezy Point Road	Y	Y					
	County Road 101	Y	Y					
Spring Park	Channel Rd	Y	N	Channel Rd drainage area has been plugged by the city to stop backflow from the lake.	No	No	No	Pumping and sandbagging of flooded areas.
Wayzata	City marina			None	No	No	No	Sandbagging of 4 homes on Ridgeview Drive.
	Lake Street Parking Lots	Y	N					
	Ferndale Road/Peavey Lane	Y	N					
	Ridgeview Drive	Y	N					
	Far Hill Road	Y	N					
	Bushaway Road	Y	Y					
	Grove Lane	Y	Y					

Appendix C

SITE	FEATURES TO MONITOR	INSPECTION INTERVAL
Minnehaha Falls Gorge	Boardwalk stability, WPA walls, slopes	During and following bankfull events
Nokomis Weir	Structure stability and function, stop log condition, vegetation and erosion control materials around weir	During and following bankfull events
Nokomis Knoll Pond	Inlet and outlet structures, vegetation condition	During and following bankfull events
Nokomis Amelia Pond	Inlet and outlet structures, vegetation condition	During and following bankfull events
Nokomis Gateway Pond	Inlet and outlet structures, vegetation condition	During and following bankfull events
60th & 1st Pond	Inlet and outlet structures, vegetation condition	Spring, fall, and following heavy precipitation
Minnehaha Creek Reach 14 Streambank Restoration	Erosion control materials, vegetation condition, bank stability	During and following bankfull events
Pamela Park Ponds	Weirs (2), inlet and outlet structures, beaver activity	During and following bankfull events
SW Calhoun Pond	Inlet and outlet structures, vegetation condition	Spring, fall, and following heavy precipitation
Twin Lakes Park Pond	Weir stability, vegetation condition, inlet structure	Spring, fall, and following heavy precipitation
Methodist Creek Re-meander	Stability and condition of boardwalk, vegetation condition	During and following bankfull events
Minnehaha Creek Reach 20 Creek Re-meander	Stability and condition of boardwalk, condition of bituminous trail, vegetation condition	During and following bankfull events
Gray's Bay Dam	Stability of dam, debris in dam mechanisms, vegetation condition, flow over weir, vegetation on weir, dock stability, signage to indicate paddling conditions	Continuously during high water periods.
Headwaters Shoreline Restoration	Vegetation condition	Spring, fall, and following heavy precipitation
Lakeside Pond	Vegetation condition, debris, inlet and outlet structures	Spring, fall, and following heavy precipitation

SITE	FEATURES TO MONITOR	INSPECTION INTERVAL
Gleason Lake Outlet	Weir condition, debris at outflow	Spring, fall, and following heavy precipitation
Gleason Ponds	Vegetation condition, weir condition	Spring, fall, and following heavy precipitation
Chelsea Woods Channel Restoration	Vegetation condition, culvert condition, overflow condition, condition of erosion control around overflow, preferred path of overland flow to northeast of overflow structure	During and following bankfull events
Deer Hill Pond Weir	Weir condition, condition of culverts	Spring, fall, and following heavy precipitation
Long Lake Pond North	Inlet and outlet structures, vegetation condition	Spring, fall, and following heavy precipitation
Long Lake Pond South	Inlet and outlet structures, vegetation condition	Spring, fall, and following heavy precipitation
Long Lake Shoreline Restoration	Shoreline stabilization, vegetation condition	Spring, fall, and following heavy precipitation
Big Island Restoration Phase 1	Slope condition, vegetation condition, live stakes, fascine and VRSS condition, riprap condition	Spring, fall, and following heavy precipitation
Big Island Restoration Phase 2	Slope condition, vegetation condition, live stakes, fascine and VRSS condition, riprap condition	Spring, fall, and following heavy precipitation
Excelsior Point Shoreline Restoration	Vegetation condition, debris accumulation, shoreline stabilization	Spring, fall, and following heavy precipitation
Old Orchard Park Shoreline Restoration	Vegetation condition, debris accumulation, shoreline stabilization	Spring, fall, and following heavy precipitation
Gideon Glen	Trail condition in area prone to washout, vegetation condition, inlet condition	Spring, fall, and following heavy precipitation
Swan Lake Pond	Inlet and outlet structures, debris accumulation, dam condition, overall proper drainage	Spring, fall, and following heavy precipitation
Lake Katrina Outlet	Outlet structure, culvert, debris accumulation	Spring, fall, and following heavy precipitation
South Katrina Pond and Weir	Weir condition, overall proper drainage, erosion or ponding at downstream culverts (Creekwood Trail)	Spring, fall, and following heavy precipitation

SITE	FEATURES TO MONITOR	INSPECTION INTERVAL
Independence Wetland	Vegetation condition	Spring, fall, and following heavy precipitation
Painter Marsh Pond	Overall proper drainage	Spring, fall, and following heavy precipitation
Painter Creek Weir	Weir condition, overall proper drainage	Spring, fall, and following heavy precipitation
County Rd 26 Re-meander	Weir condition, overall proper drainage	Spring, fall, and following heavy precipitation
Painter Marsh Weir	Weir condition, overall proper drainage, cattail bog presence	Spring, fall, and following heavy precipitation
Painter Drive Fish Barrier	Structure stability and function, debris accumulation, overall proper drainage, debris in creek up- and downstream of fish barrier	Spring, fall, and following heavy precipitation
Centerview Park Shoreline Restoration	Vegetation condition, debris accumulation, shoreline stabilization	Spring, fall, and following heavy precipitation
Saunders Raingardens	Vegetation condition, proper drainage, sediment accumulation, displaced mulch	Once monthly during growing season through 2015 and after heavy precipitation
Six Mile Marsh Prairie Restoration	Overall proper drainage, especially SW of barn on property line with 3759 Turtle Creek Road	Spring, fall, and following heavy precipitation
Steiger Wetland Restoration	Weir condition, preferred flow paths, overall proper drainage, condition of inlets, known areas of erosion	Spring, fall, and following heavy precipitation
Cottageville Park	Bank stabilization, vegetation condition	During and following bankfull events
Minnehaha Creek segment adjacent to Cold Storage Facility	Bank stabilization, vegetation condition, debris in stream, especially around large willow	During and following bankfull events

Appendix D

From: Telly Mamayek
Sent: Friday, May 30, 2014 4:58 PM
To: Telly Mamayek
Subject: Flooding Potential in MCWD this weekend

Greetings -

With up to 2 inches of rain forecasted for the Twin Cities through Monday, June 2, the Minnehaha Creek Watershed District is advising communities about the potential for localized flooding. Currently, Lake Minnetonka's water level is 930.21 feet and per the DNR-approved operating procedure, the MCWD is discharging water from the Gray's Bay Dam at a rate of 300 cubic feet per second into Minnehaha Creek. Due to high lake levels, water is also flowing over the emergency spillway north of the dam, which has an elevation of 930 feet. As a result of heavy rains this spring, the lake level has been at or above 930 since May 9 and there is no additional capacity in the lake or Minnehaha Creek for more rainfall, increasing the likelihood for flooding in some areas.

According to the National Weather Service, the Twin Cities has received 13.82 inches of rain so far in 2014 (4.24 inches more than normal), ranking it the fourth wettest year-to-date since record-keeping began in 1871. (For more detail, see the attached graphics from Hennepin County Emergency Management and the National Weather Service.)

As of today, here is the projected timing of the approaching weather system:

Showers will begin Saturday afternoon on and off with a distinct line of storms moving through on Saturday night throughout the overnight hours. Sunday should be rain most of the day on and off in large clusters. Another larger line of storms will move in again for the overnight hours into Monday morning. Total precipitation forecast is around 2 inches of rain by early next week. This system, for the last few model runs, has been slowing a bit which could give us rain farther into the day Monday if that trend continues. However, this should not affect the overall total rain amount to change much.

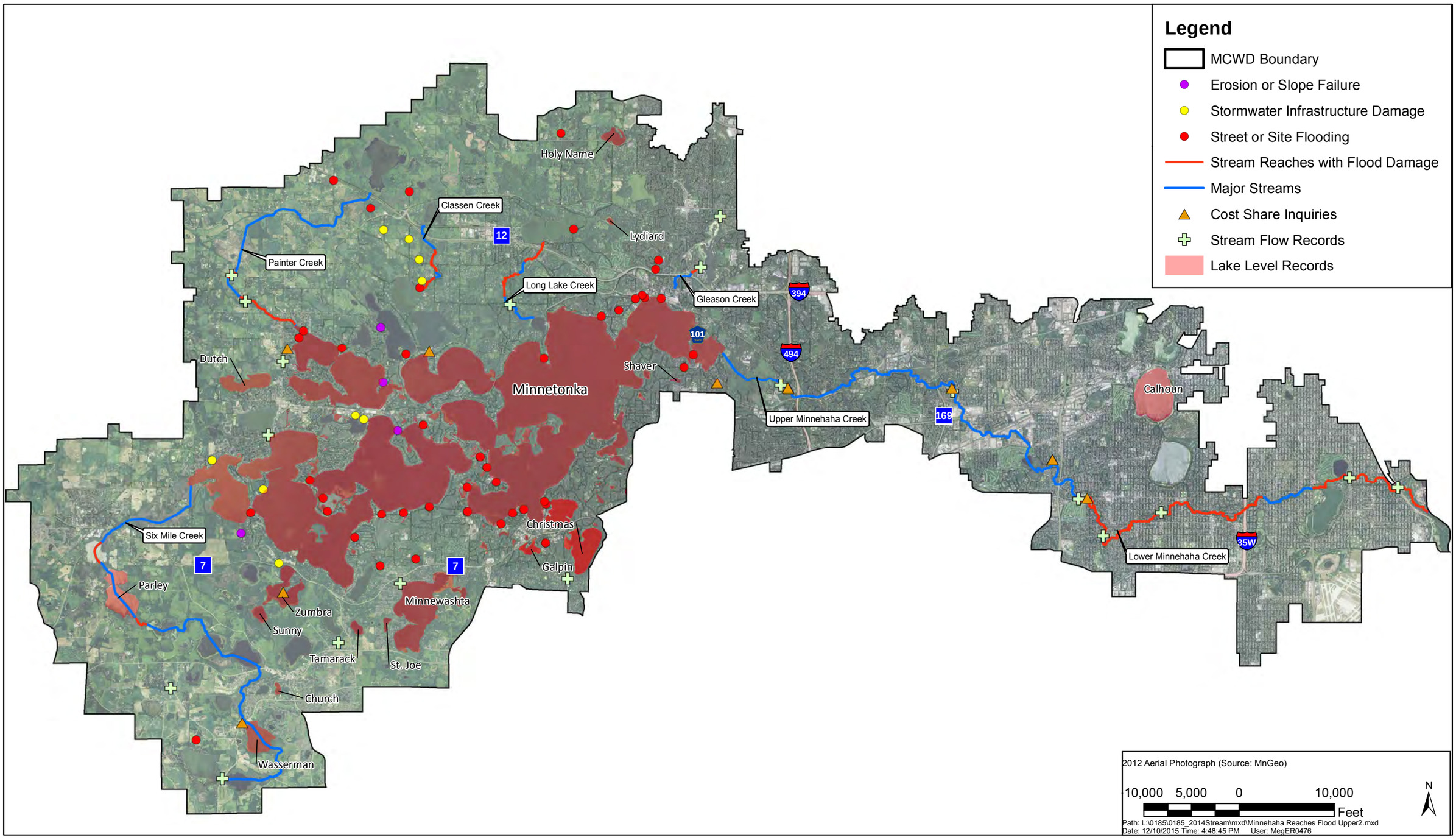
Here are some flood safety tips from Hennepin County Emergency Management:

1. Do not walk through moving water.
2. Six inches of moving water can make you fall. If you have to walk in water, walk where the water is not moving.
3. Do not drive into flooded areas – if you can't see the road you cannot be sure the road is still completely intact.

The high water declaration for Lake Minnetonka remains in effect, requiring watercraft operators to adhere to additional minimum wake restrictions. For more information on those restrictions, visit the Lake Minnetonka Conservation District's website www.lmcd.org. Also, Minnehaha Creek is not safe for paddling due to high, fast-moving water, downed trees and other debris, and limited clearance at some bridge underpasses.

As the weather system moves through, Minnehaha Creek Watershed District staff will be monitoring water levels and coordinating with the National Weather Service, Hennepin County Emergency Management and local communities. For the latest on water levels in the MCWD, visit the District's website www.minnehahacreek.org.

Maps



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Watershed Flood Overview

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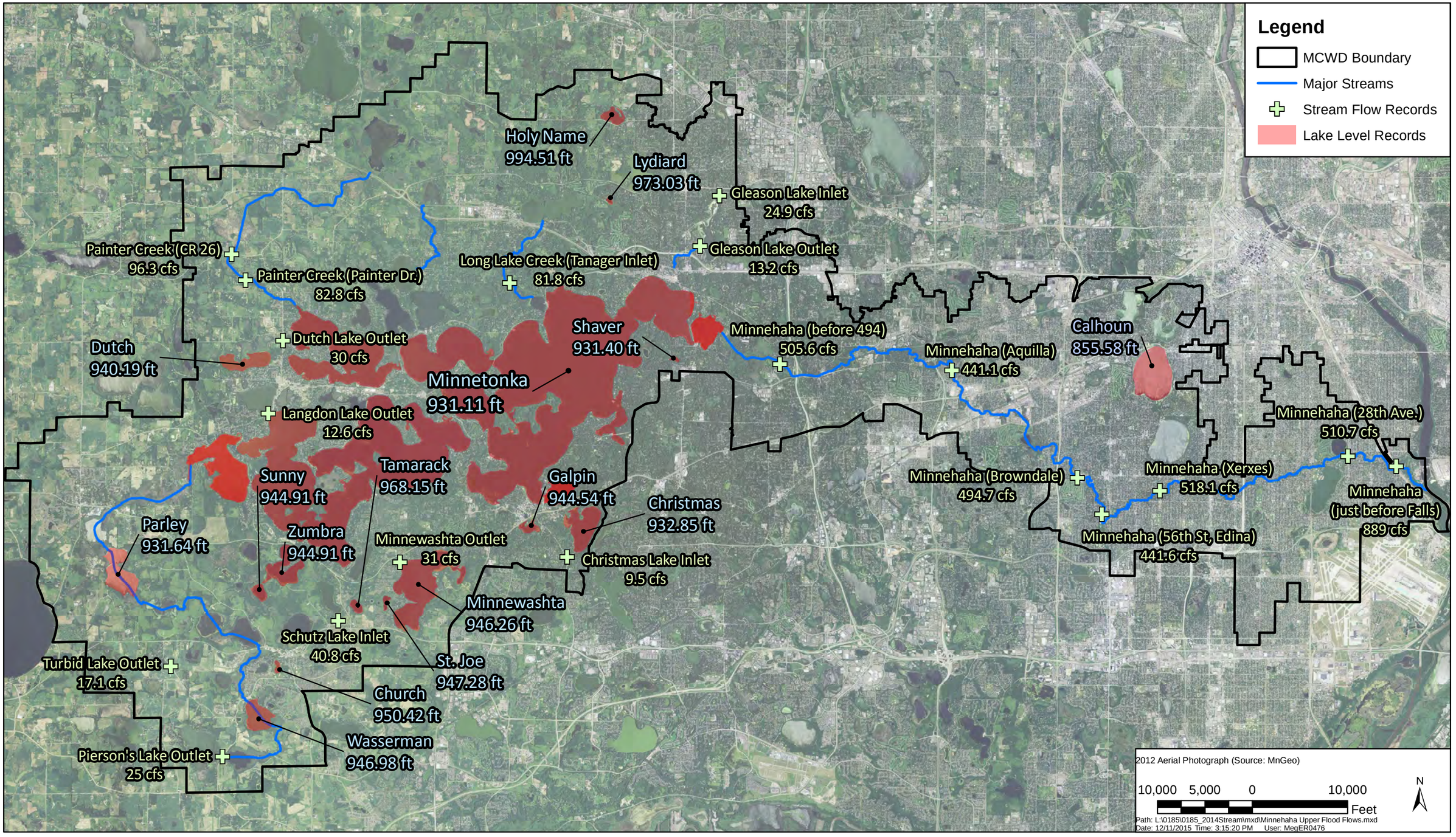
Map 1



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Watershed Flood Elevations and Flows

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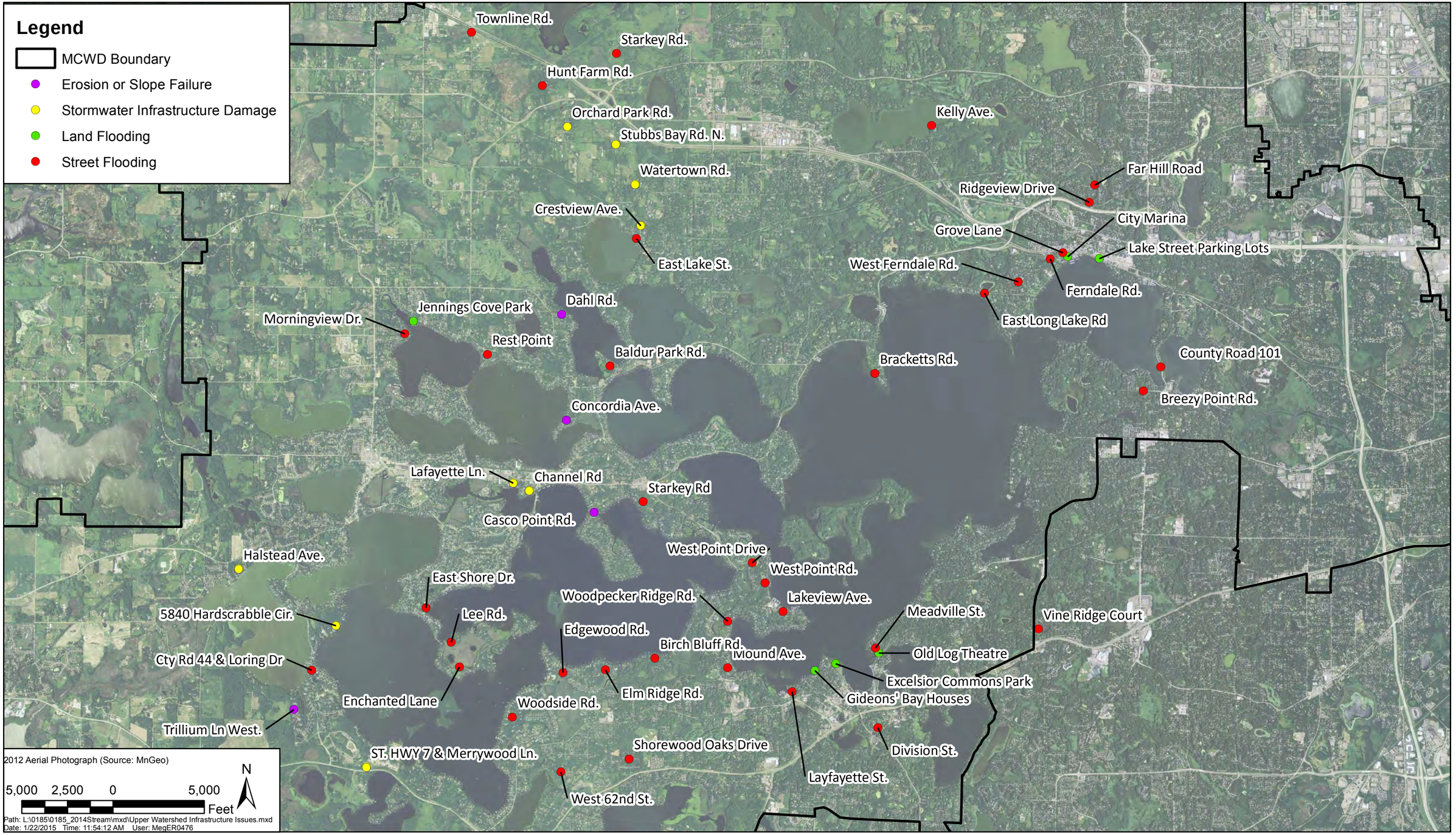
Map 2



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Reported Flood Areas

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Map 3

Legend

- MCWD Boundary
- Stream Reaches with Extensive Flood Damage
- Major Streams

Classen Creek
(Figs. 4.1 & 4.2)

Gleason Creek
(Fig 4.6)

Painter Creek
(Fig. 4.3)

Long Lake Creek
(Figs. 4.4 & 4.5)

Minnehaha Creek
(Figs. 4.8, 4.9, & 4.10)

Six Mile Creek
(Fig. 4.7)

2012 Aerial Photograph (Source: MnGeo)

10,000 5,000 0 10,000 Feet

N

Path: L:\0185\0185_2014Stream\mxd\FEMA Flood Damage Overview.mxd
Date: 1/19/2015 Time: 11:42:41 AM User: MegER0476

MINNEHAHA CREEK WATERSHED DISTRICT

2014 FEMA Flood Area Overview

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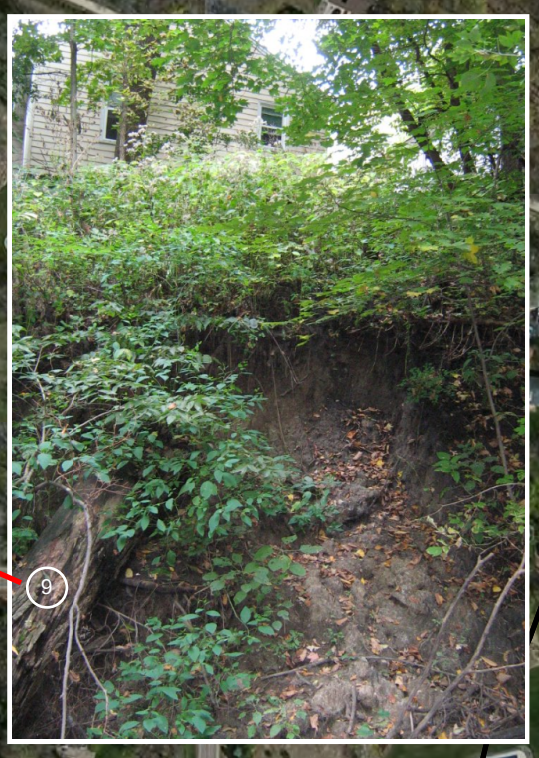
Map 4

Legend

- Road Crossing
- Reach Break
- Stream Reach
- 2014 Classen Creek Stream Assessment Reaches
- H&H Subwatersheds



Reach 1

Reach 2

Tonka Ave

Cygnet Pl

2012 Aerial Photograph (Source: ESRI)

200 100 0 200 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Classen Creek Stream Reaches.mxd
Date: 10/13/2014 Time: 2:01:06 PM User: MegER0476

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Classen Creek Stream Assessment Reach 1

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Figure 4.1

Legend

- Road Crossing
- Reach Break
- Stream Reach
- 2014 Classen Creek Stream Assessment Reaches
- H&H Subwatersheds

Reach 3

Reach 2

68+00
67+00
66+00
65+00
64+00
63+00
62+00
61+00
60+00
59+00
58+00
57+00
56+00
55+00
54+00
53+00
52+00
51+00
50+00
49+00
48+00
47+00
46+00
45+00
44+00
43+00
42+00
41+00
40+00
39+00
38+00
37+00
36+00
35+00
34+00
33+00

1
2
3
4
5
6


Fig. 3


Fig. 4


Fig. 2


Fig. 1

Station	Reach	Notes	Figures
43+00 to 44+00	3	Over 70 LF of bank erosion and erosion/scour at Leaf St. Crossing (44+50)	Fig. 1-2
49+50		Erosion around failing structure US of Watertown/High Lane crossing	Fig. 3
50+00 to 52+00		Various locations of down trees and build-up of branches	Fig. 4

2012 Aerial Photograph (Source: ESRI)

200 100 0 200 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Classen Creek Stream Reaches.mxd
Date: 10/13/2014 Time: 3:24:39 PM User: MegER0476

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

High La
Leaf St
Cygnet Pl

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Classen Creek Stream Assessment Reach 3

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Figure 4.2

Legend

- Reach Break
- Stream Reach
- GPS Flood Damage Points
- Road Crossing
- H&H Subwatersheds

Turner Rd
Drake Dr
Ingerson Rd
Town Line Rd
Starkey Rd
Meadley Rd
Waterfown Rd
W Branch Rd
Red Oak La
Blair Rd
North A

Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
Reach 8
Reach 9

2012 Aerial Photograph (Source: ESRI)

1,800 900 0 1,800 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Painter Reaches.mxd
Date: 10/21/2014 Time: 5:11:53 PM User: MegER0476

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Painter Creek Stream Assessment Reaches

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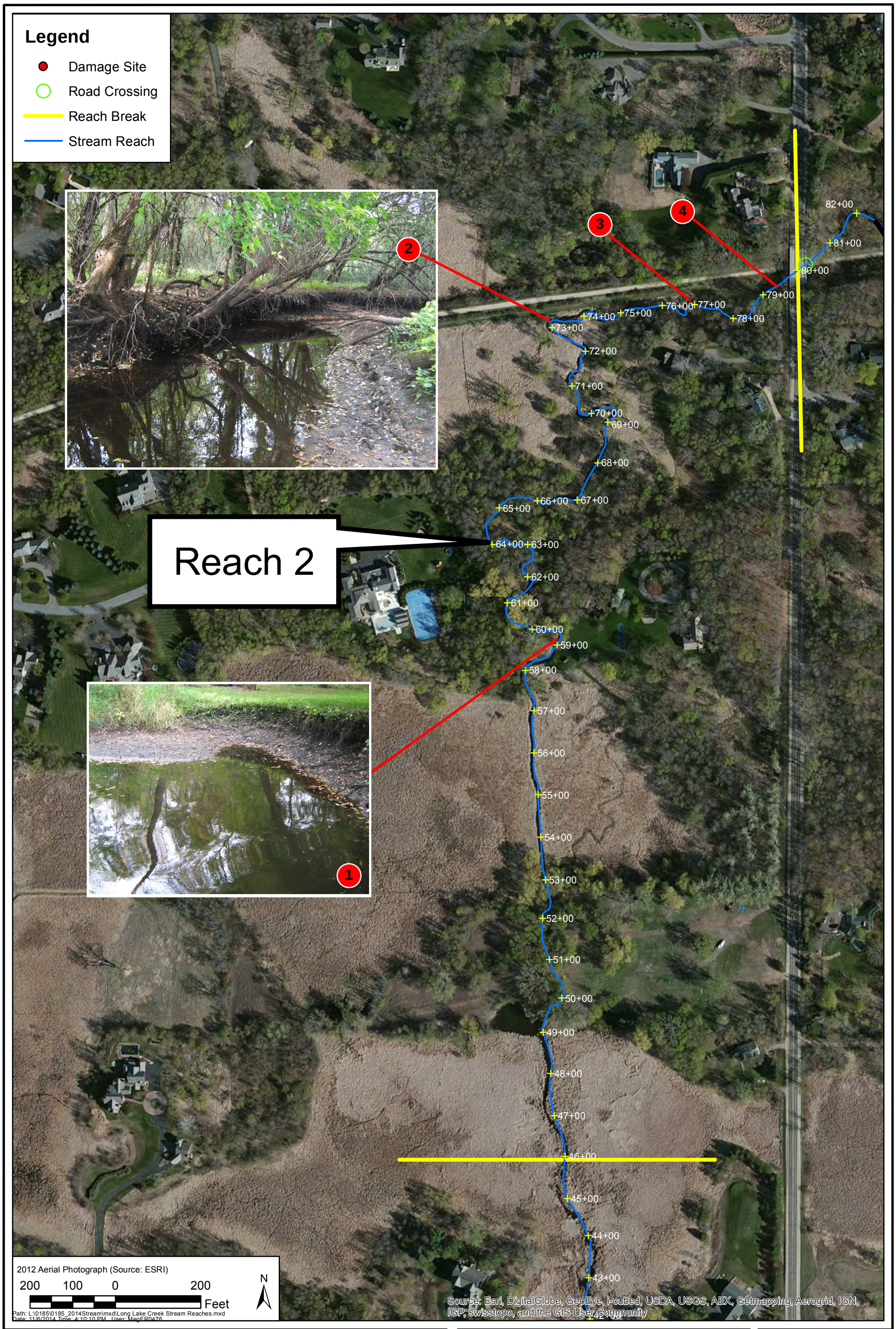
Figure 4.3



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Long Lake Creek Stream Assessment Reach 2

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Figure 4.4

Legend

- 2014 Long Lake Creek Stream Assessment Reaches
- Road Crossing
- Reach Break
- Stream Reach
- H&H Subwatersheds

Station	Reach	Note	Figure
120+00 to 122+00	5	Scour pool DS of Orono Orchard and more than 70 LF of bank erosion	1
117+00 to 119+00		Fallen Trees and 30 LF of bank erosion.	2
82+00 to 86+00	3	Down trees and bank erosion	3
88+00		Inlet/Ditch/Ravine from tennis court and construction	4


Fig. 1


Fig. 4


Fig. 2


Fig. 3

Reach 5

Reach 4

Reach 3

Orchard La
May St
Grand Ave
Watertown Rd
Cemetery Rd
146

2012 Aerial Photograph (Source: ESRI)

500 250 0 500 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Long Lake Creek Stream Reaches.mxd
Date: 10/13/2014Time: 6:48:35 PM User: MegER0476

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Long Lake Creek Stream Assessment Reach 3 & 5

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Figure 4.5

Legend

- Road Crossing
- Reach Break
- Stream Reach
- 2014 Gleason Lake Creel Stream Assessment Reaches
- GPS Flood Damage Points
- H&H Subwatersheds


Fig. 5


Fig. 4

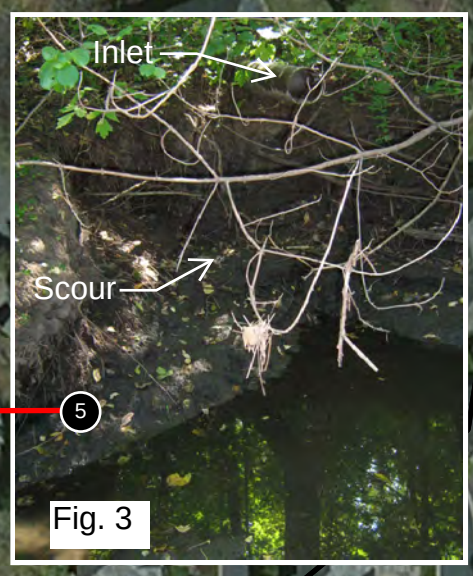

Fig. 3


Fig. 2


Fig. 1

Station	Reach	Notes	Figures
32+00	5	North twin culverts of HWY 12: build-up of tree branches and brush.	1
34+00 to 35+50		Bank Erosion and undercutting.	2
36+00 to 41+00		Down trees at two locations and two scour pools at inlets.	3-4
43+00		clog/build-up with scour pool	5

2012 Aerial Photograph (Source: ESRI)

150 75 0 150 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Gleason Lake Creek Stream Reaches.mxd
Date: 10/13/2014 Time: 5:03:03 PM User: MegER0476

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Gleason Lake Creek Stream Assessment Reach 5

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Figure 4.6

Legend

- 2014 Six Mile Creek Stream Assessment Reaches
- Reach Break
- Stream Reach
- Road Crossing
- 1/2 Mile Stationing
- H&H Subwatersheds

Crossing	Reach	Field Notes
Dam at Carver Preserve	6	Eroded, unprotected outlet pool forming; definitely exasperated by high flows(60' circumference scour pool), eroded through the side of the berm
Marsh Lake Road	13	Outlet is in rough shape; bowl is scoured out.

Reach 2 · Reach 4 · Reach 6 · Reach 7 · Reach 8 · Reach 9 · Reach 10 · Reach 11 · Reach 12 · Reach 13 · Reach 14 · Reach 15 · Last 350' Reach 8

2012 Aerial Photograph (Source: ESRI)

2,500 1,250 0 2,500 Feet

N

Path: L:\0185\0185_2014Stream\mxd\Six Mile Creek Reaches.mxd
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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Six Mile Creek Stream Assessment Reaches

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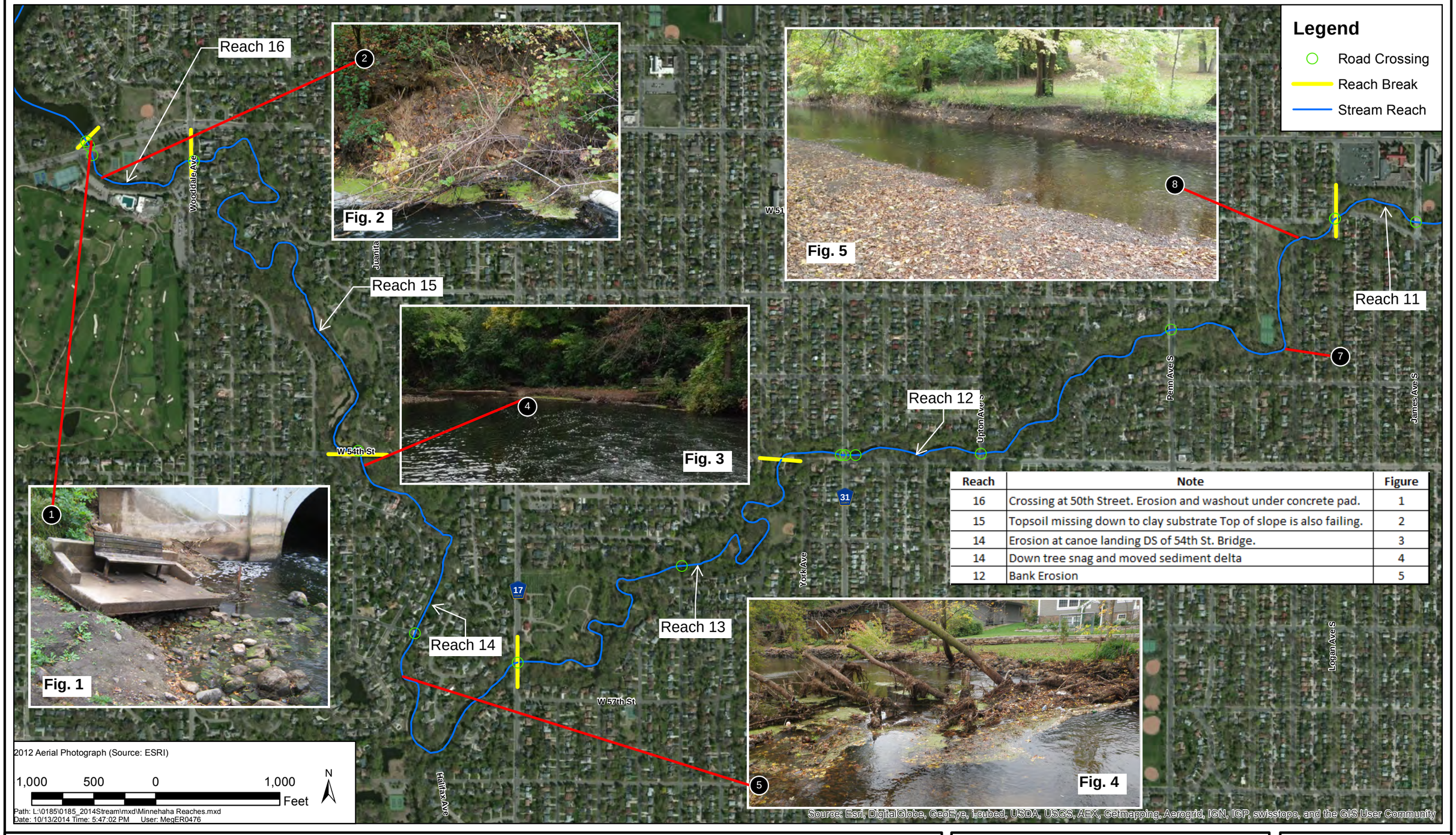
Figure 4.7



Reach	Note	Figure
16	Crossing at 50th Street. Erosion and washout under concrete pad.	1
15	Topsoil missing down to clay substrate Top of slope is also failing.	2
14	Erosion at canoe landing DS of 54th St. Bridge.	3
14	Down tree snag and moved sediment delta	4
12	Bank Erosion	5

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Minnehaha Creek Stream Assessment Reach 11 to 16

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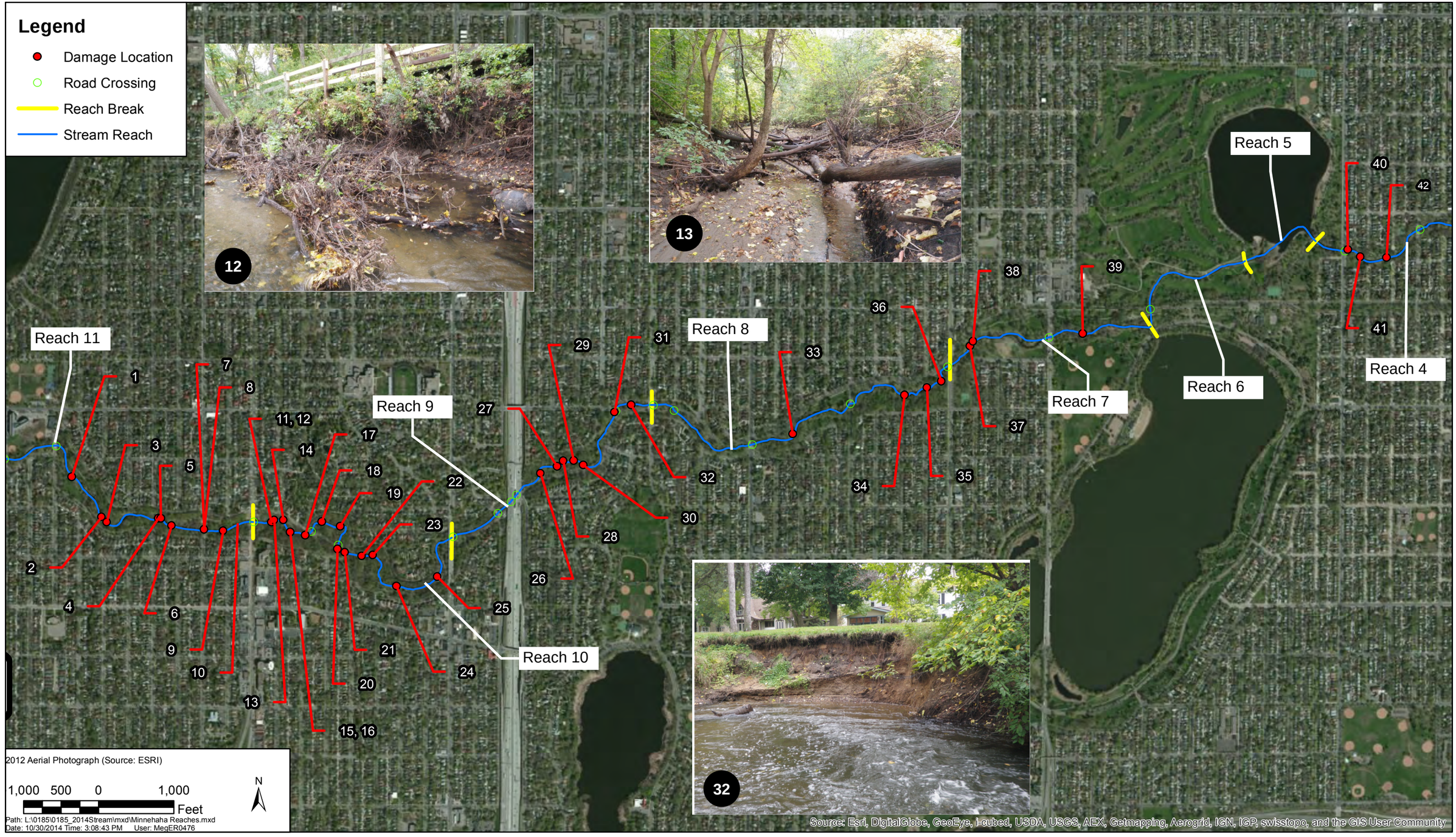
Figure 4.8



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Minnehaha Creek Stream Assessment Reach 4 to 11

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Figure 4.9

Legend

- Damage Locations
- Road Crossing
- Reach Break
- Stream Reach

1 2 3 4 6 7 5 8 9 10 11 12 13 14 15

2012 Aerial Photograph (Source: ESRI)

500 250 0 500 Feet

N

Path: L:\1240\1240-118 639W Monitoring\Minnehaha Reaches 4-11.mxd
Date: 11/6/2014 Time: 2:31:51 PM User: MegER0476

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

MINNEHAHA CREEK WATERSHED DISTRICT

2014 Minnehaha Creek Stream Assessment Reach 1 to 4

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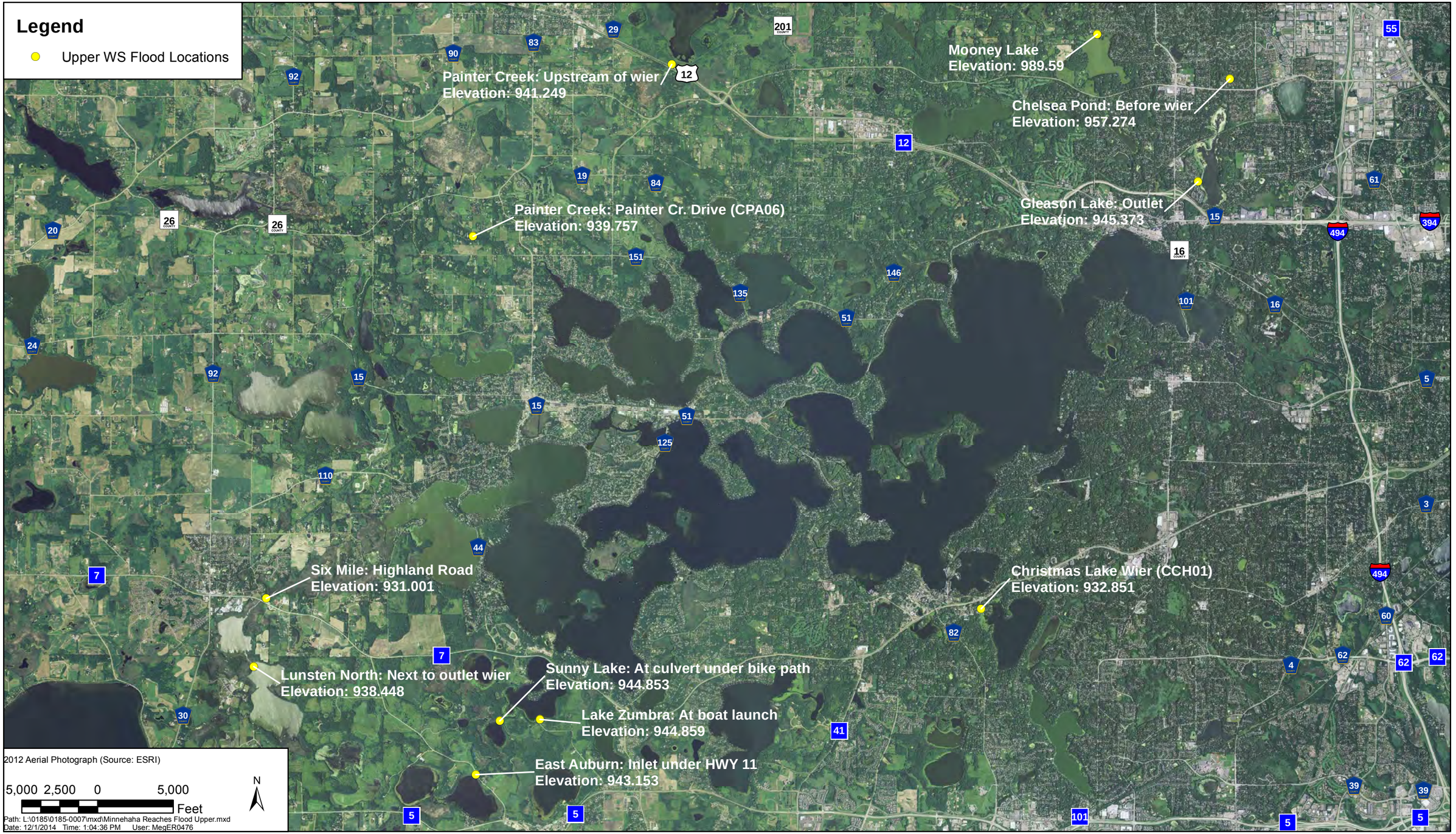
Figure 4.10



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Upper Watershed Flood Elevations and Locations

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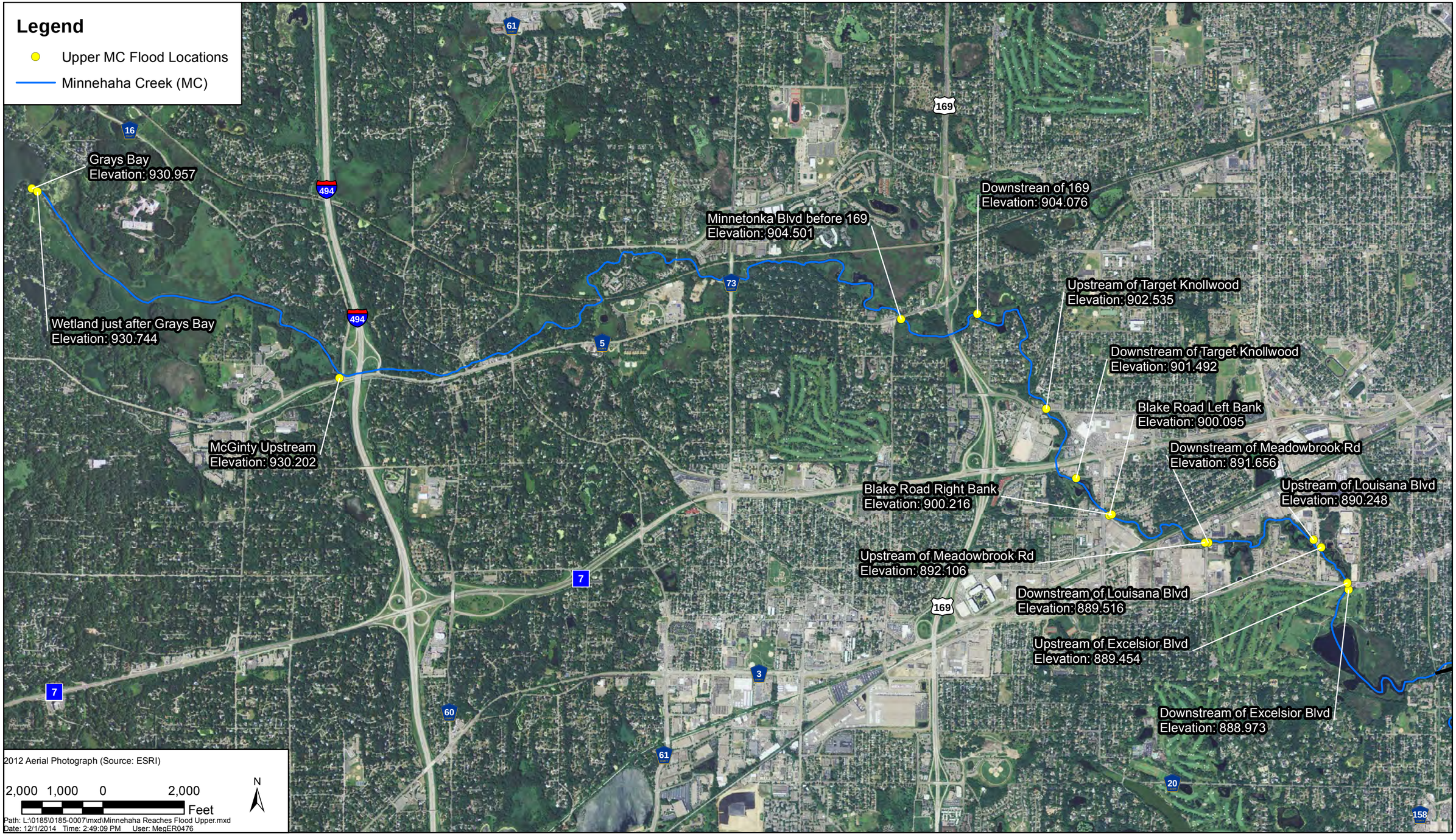
Map 5



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Upper Minnehaha Creek Flood Elevations and Locations

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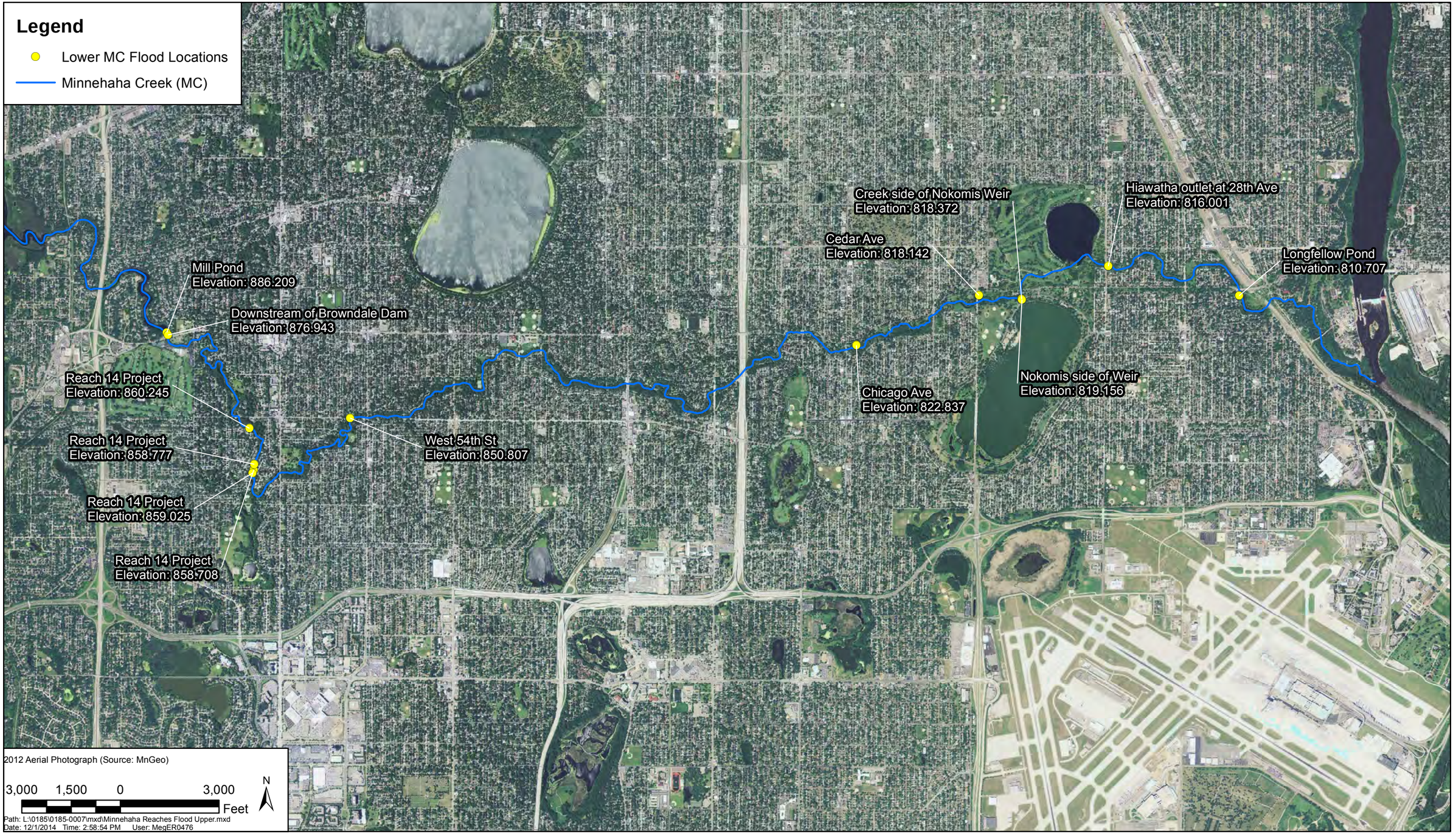
Map 6



MINNEHAHA CREEK WATERSHED DISTRICT

2014 Lower Minnehaha Creek Flood Elevations and Locations

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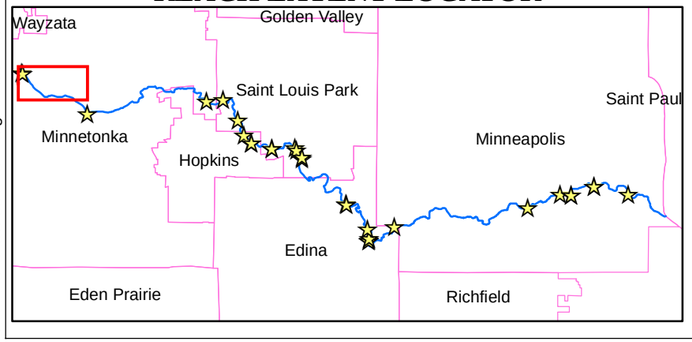
MAP 7

REACH EXTENT LOCATOR



1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 1 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

RiskMAP

Increasing Resilience Together

Risk Mapping, Assesment, and Planning (Risk MAP)

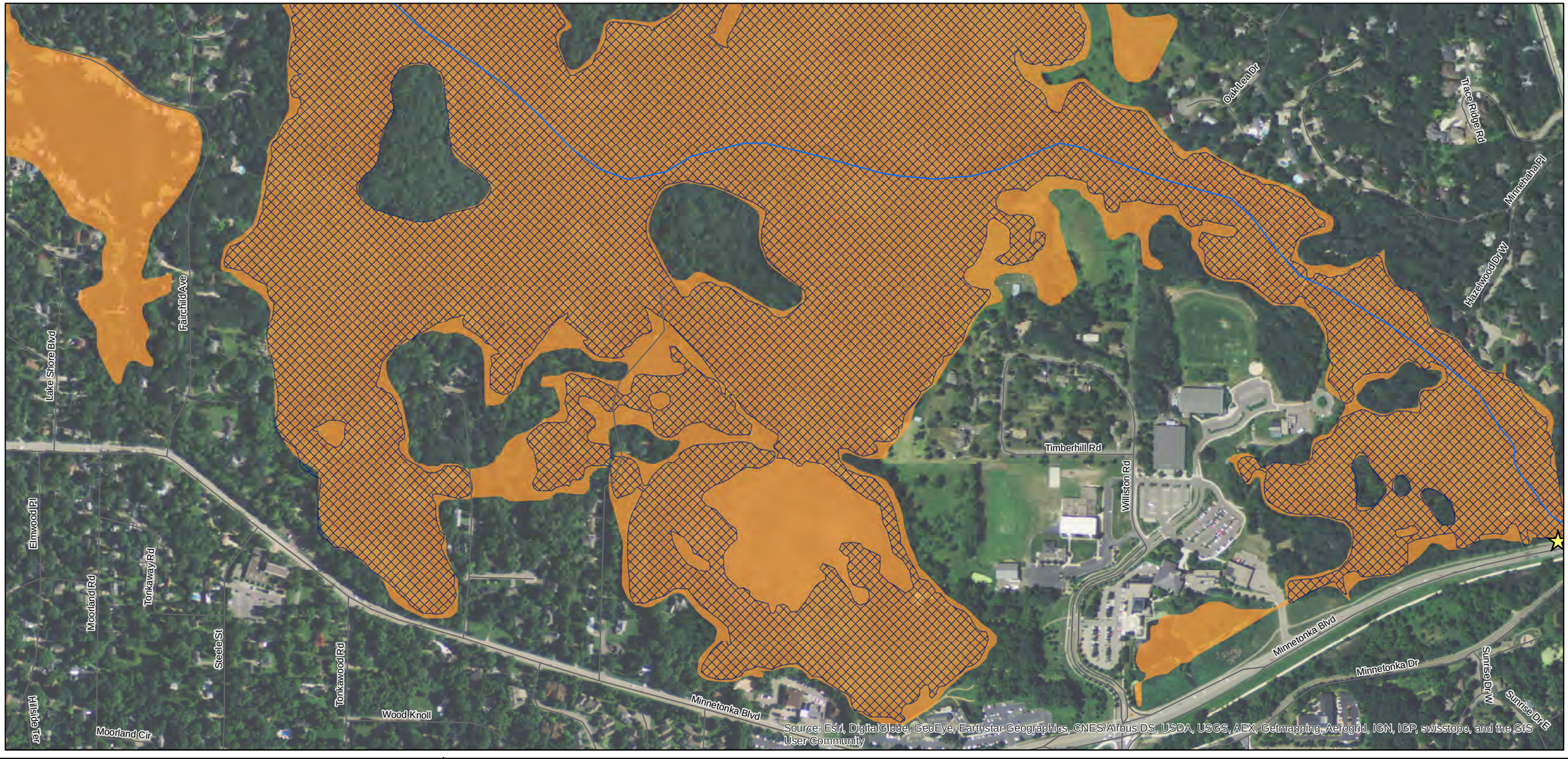
About this map:

This map shows a comparison of flood extents between the 2014 Flood event and FEMA's effective 1-percent-annual-chance (100-year) flood event. The 2014 Flood inundation area was developed using measured high water elevations taken at various locations along the stream.

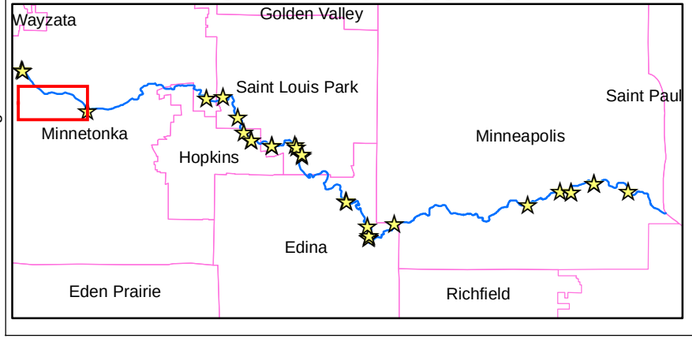
The effective 1-percent-annual-chance inundation area is the effective FEMA floodplain shown on the Digital Flood Insurance Rate Maps.

Map 8

D:\MinnehahaCreek\Non-Regs\Atlas14vsHWM.mxd User Name: riweaver Date: 12/9/2015



REACH EXTENT LOCATOR



1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 2 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

RiskMAP

Increasing Resilience Together

Risk Mapping, Assesment, and Planning (Risk MAP)

About this map:

This map shows a comparison of flood extents between the 2014 Flood event and FEMA's effective 1-percent-annual-chance (100-year) flood event. The 2014 Flood inundation area was developed using measured high water elevations taken at various locations along the stream.

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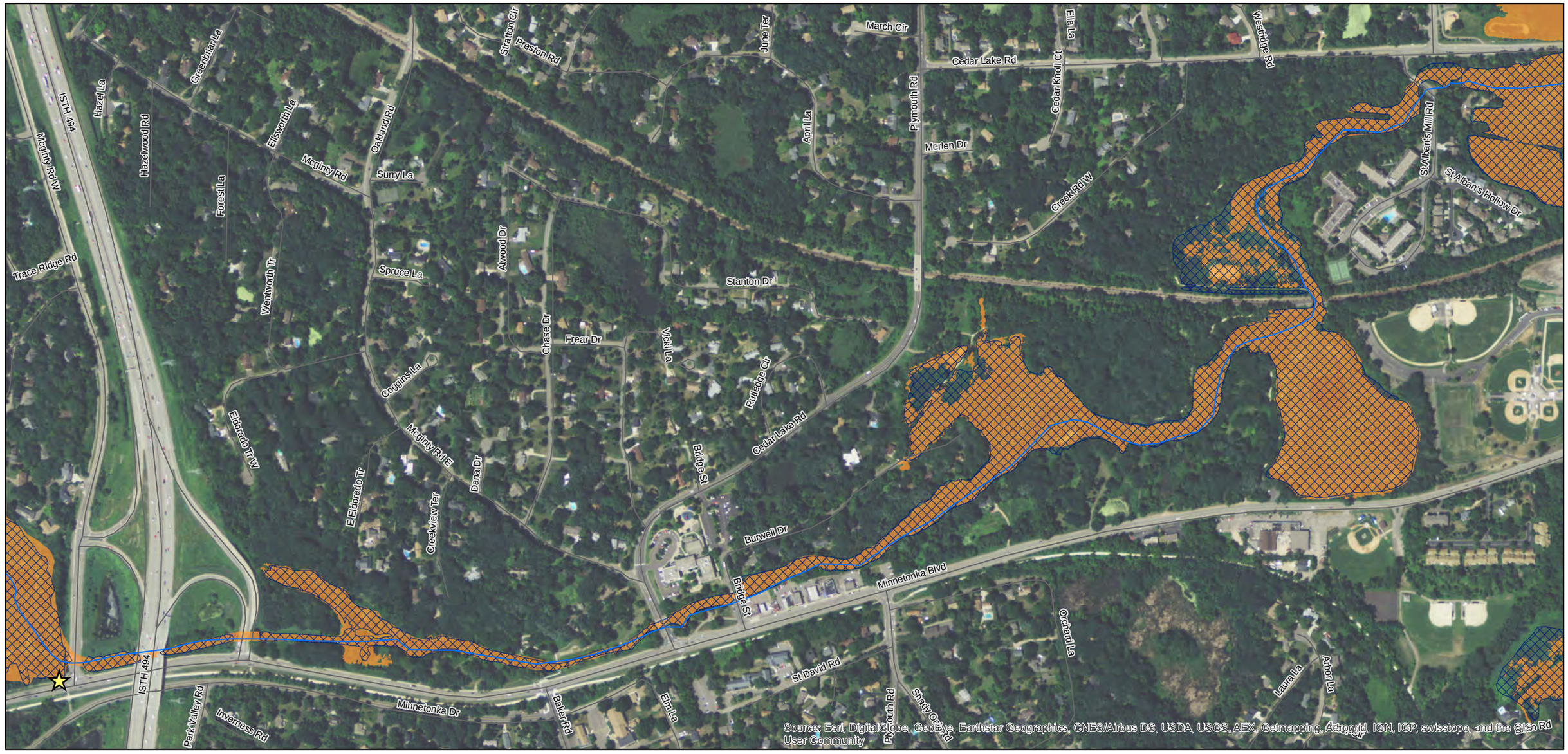
Map 8

D:\MinnehahaCreek\Non-Regs\Atlas14vsHWM.mxd User Name: riweaver Date: 12/9/2015



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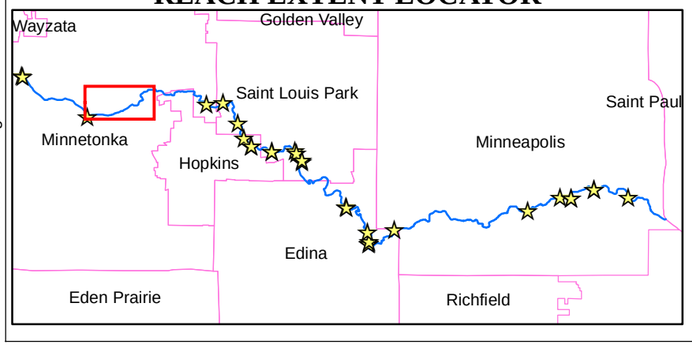

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 3 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

RiskMAP

Increasing Resilience Together

Risk Mapping, Assesment, and Planning (Risk MAP)

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Map 8

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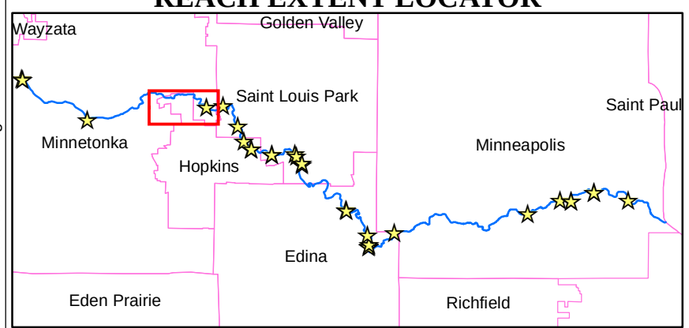

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 4 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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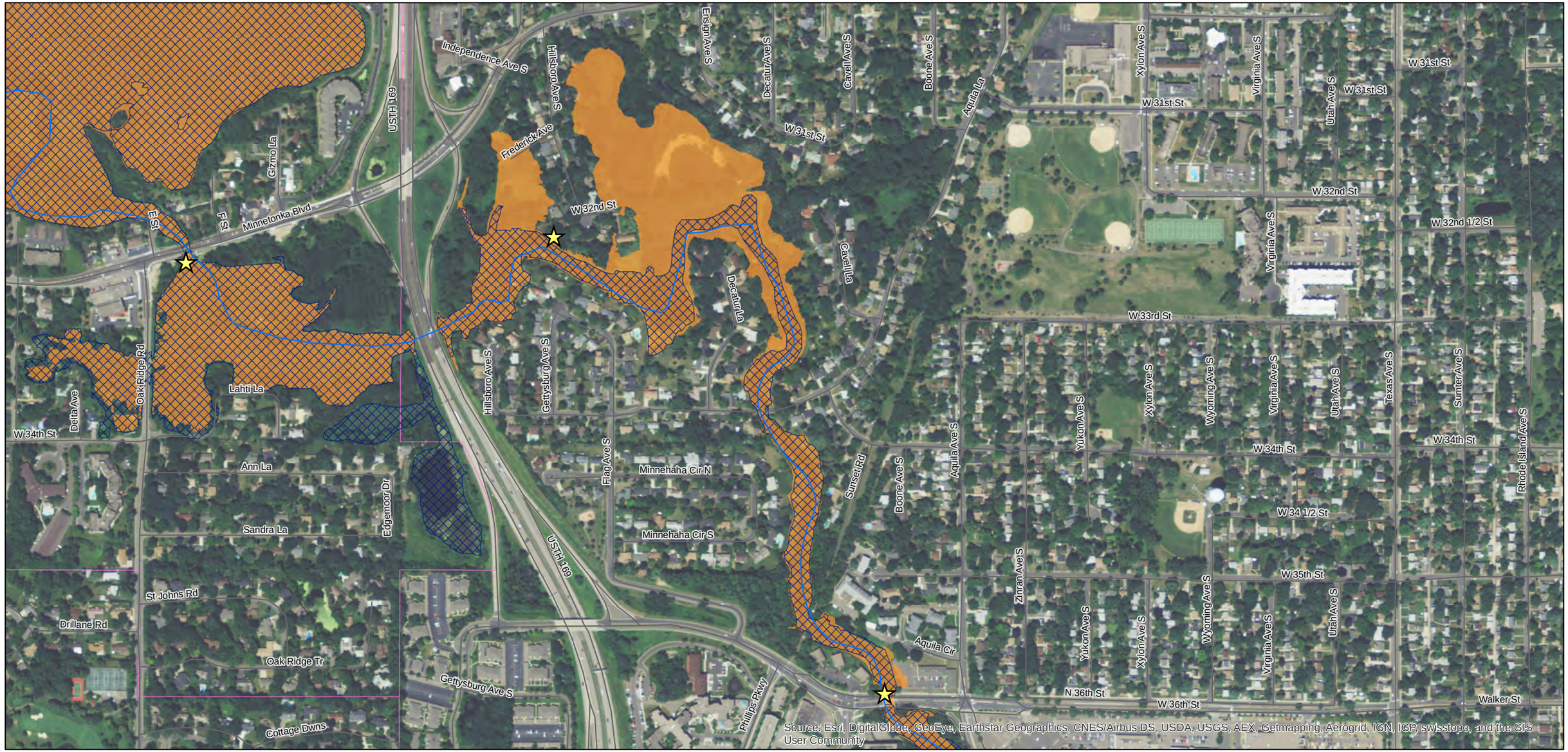

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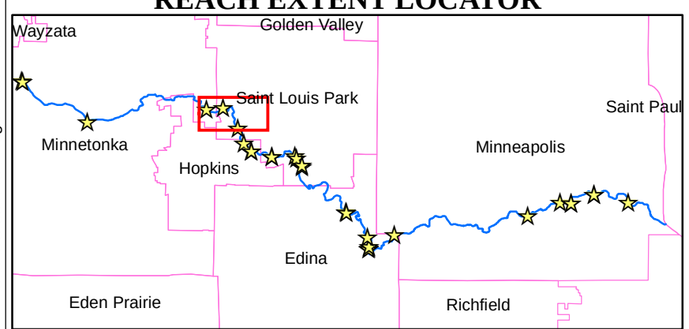

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 5 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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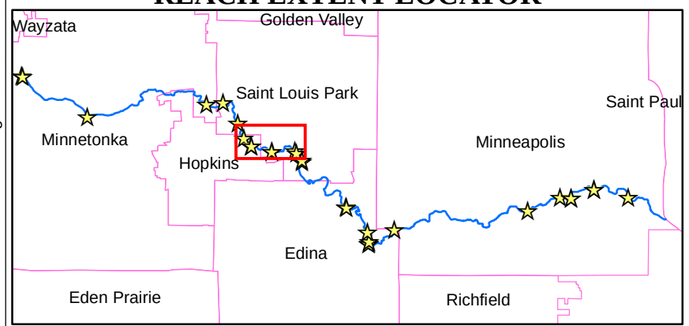

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 6 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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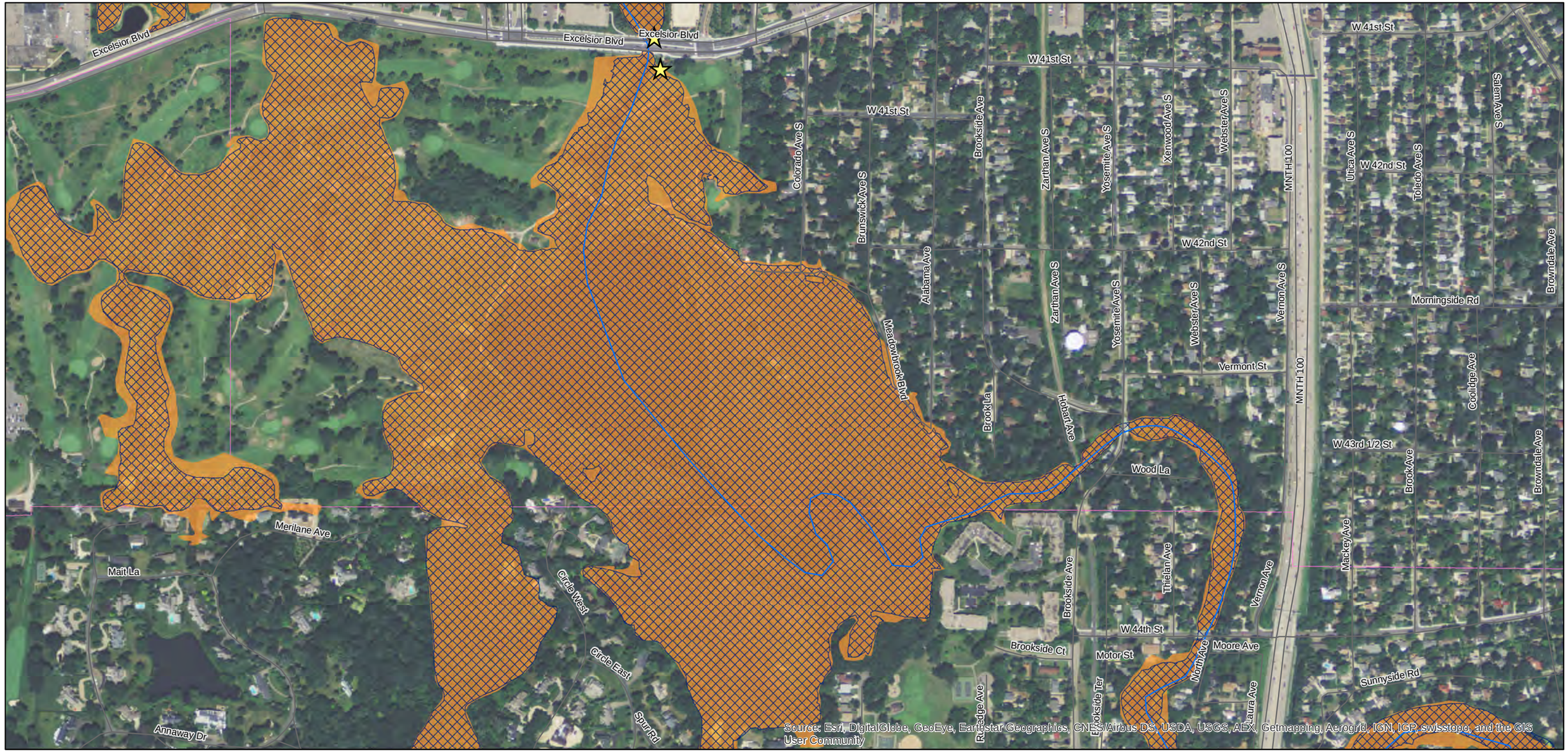

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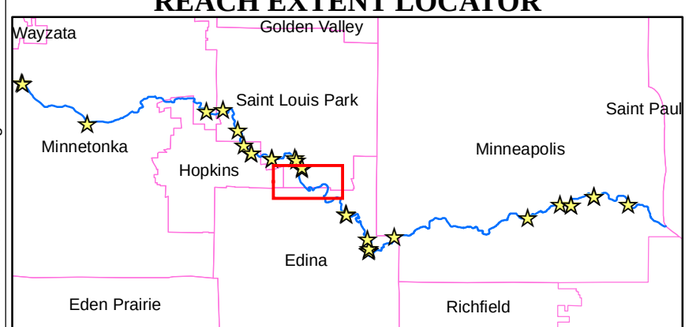

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 7 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Risk Mapping, Assesment, and Planning (Risk MAP)

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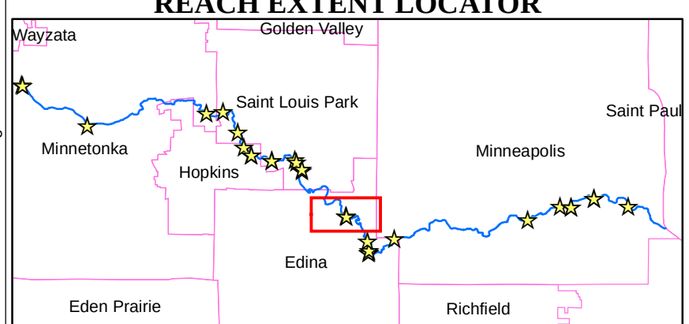

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 8 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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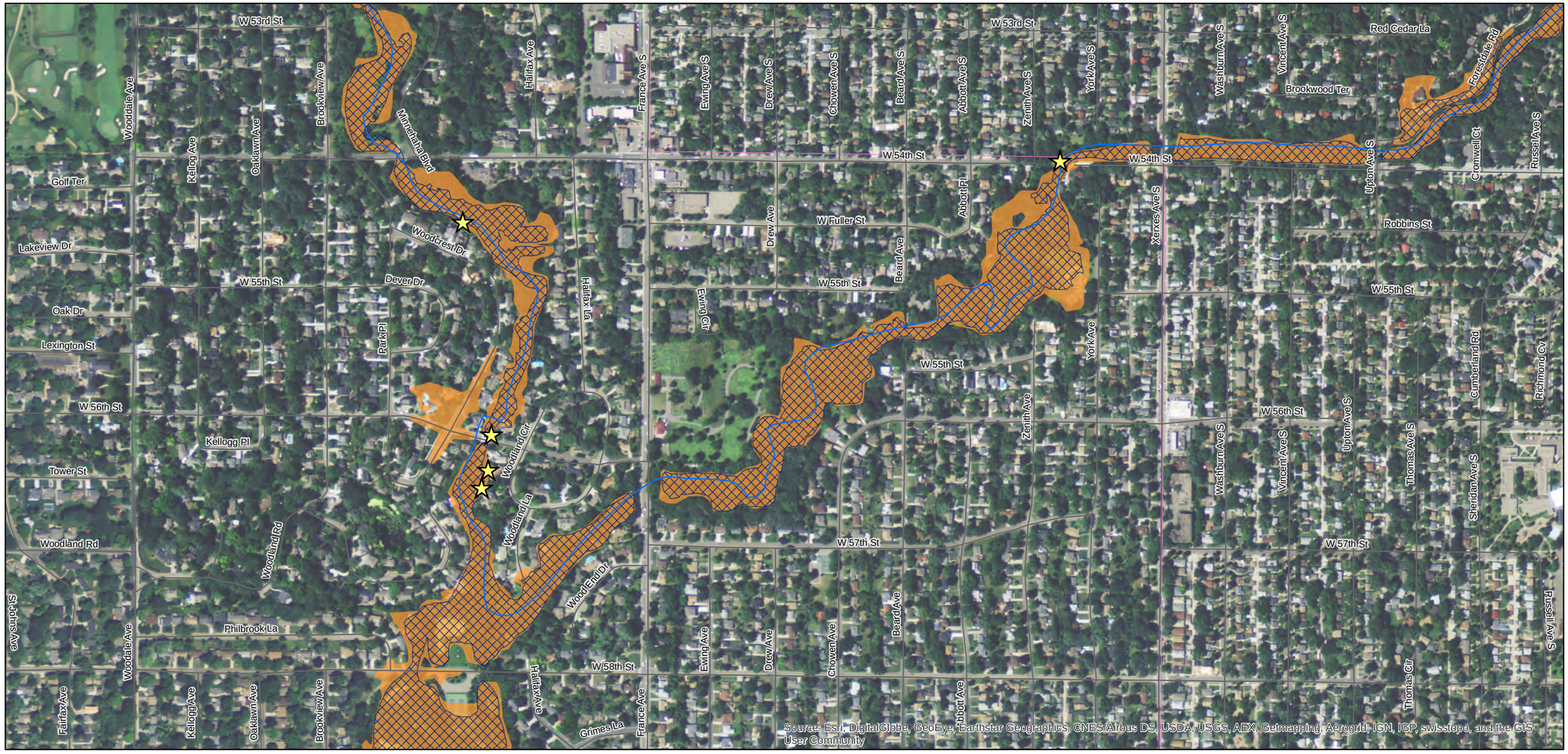

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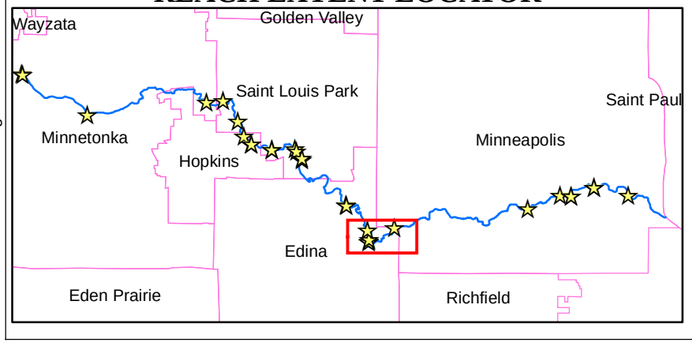

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 9 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Risk Mapping, Assesment, and Planning (Risk MAP)

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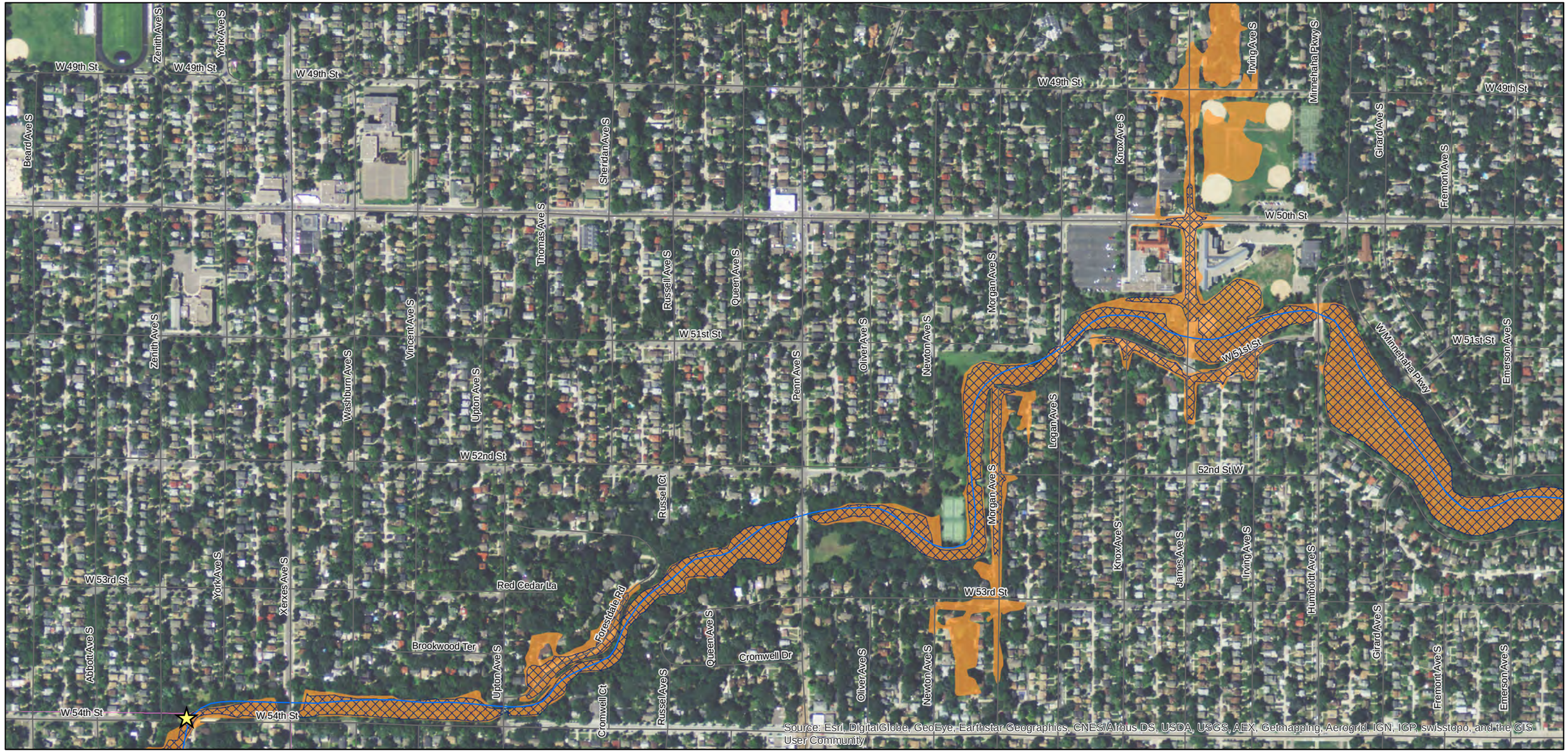

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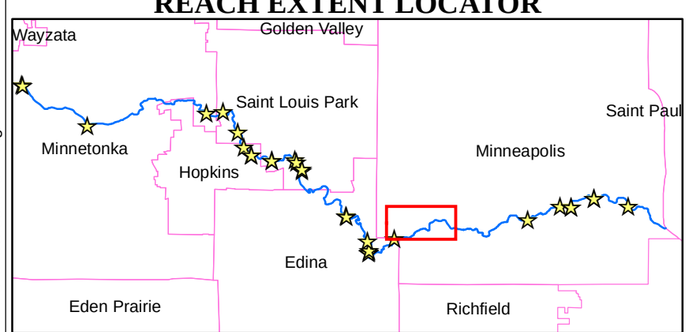

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 10 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Risk Mapping, Assesment, and Planning (Risk MAP)

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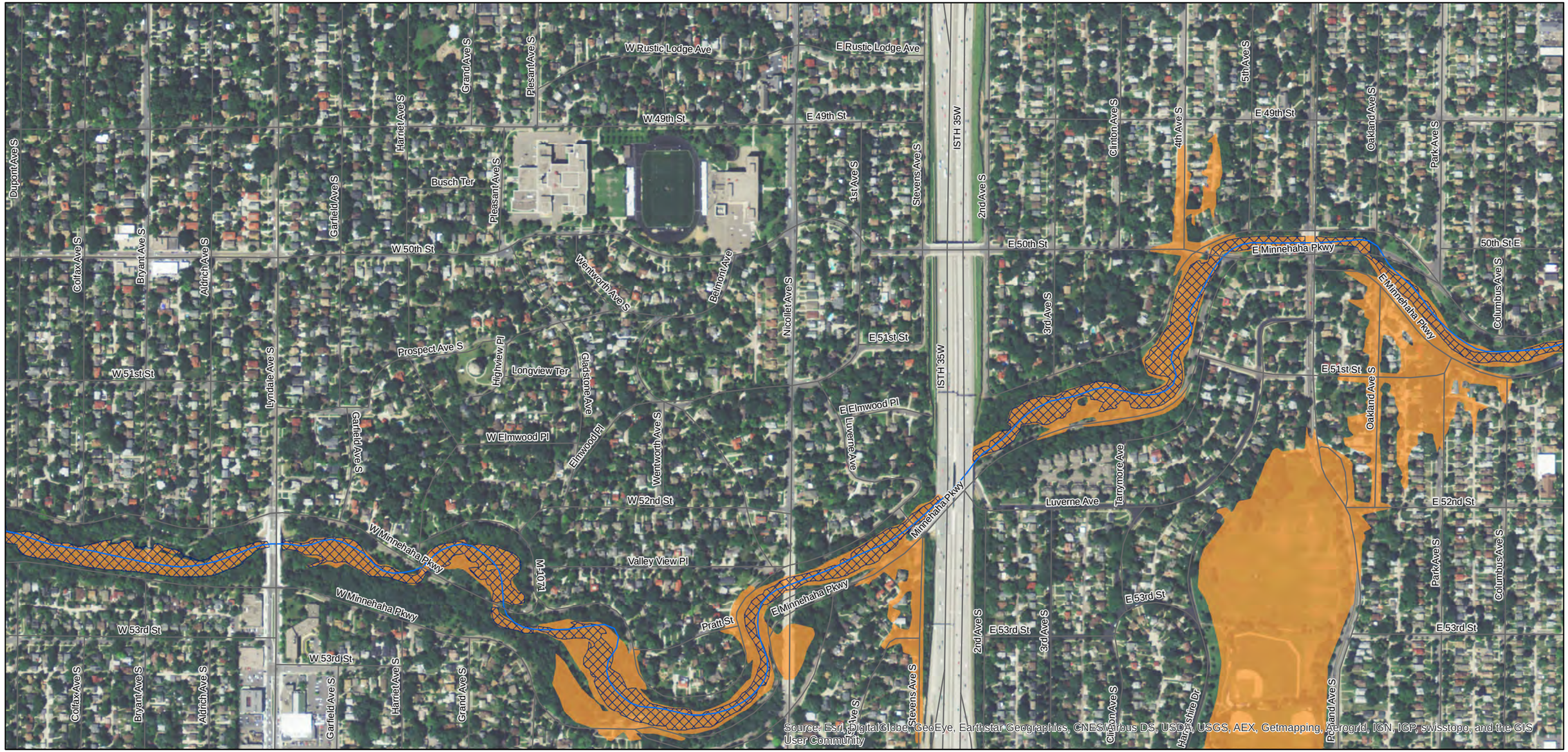

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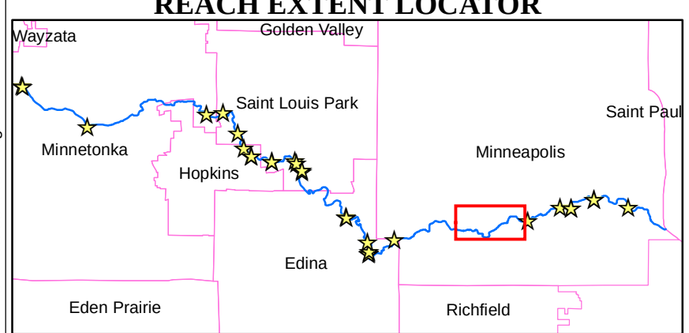

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 11 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

MNDNR

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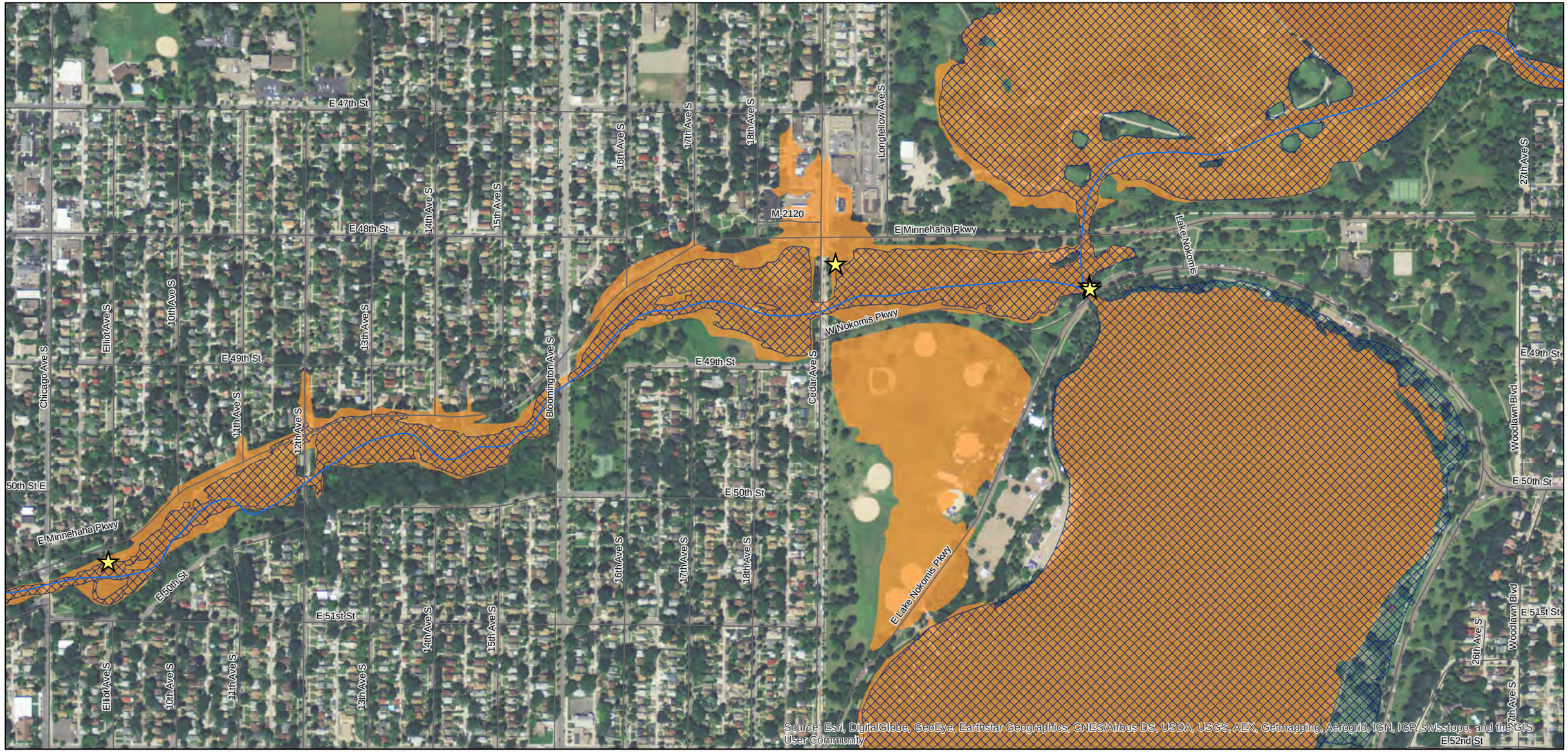

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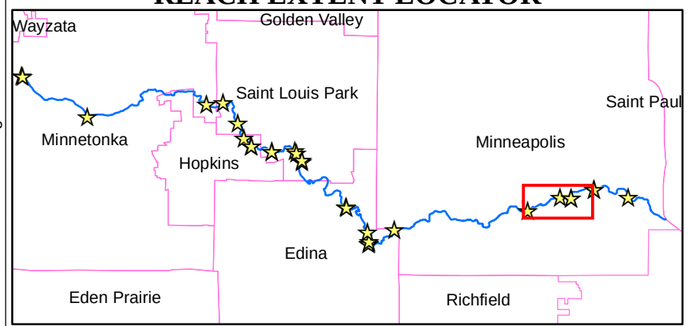

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 12 of 14

- Measured High Water Elevations
- Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- 2014 Flood Event
- City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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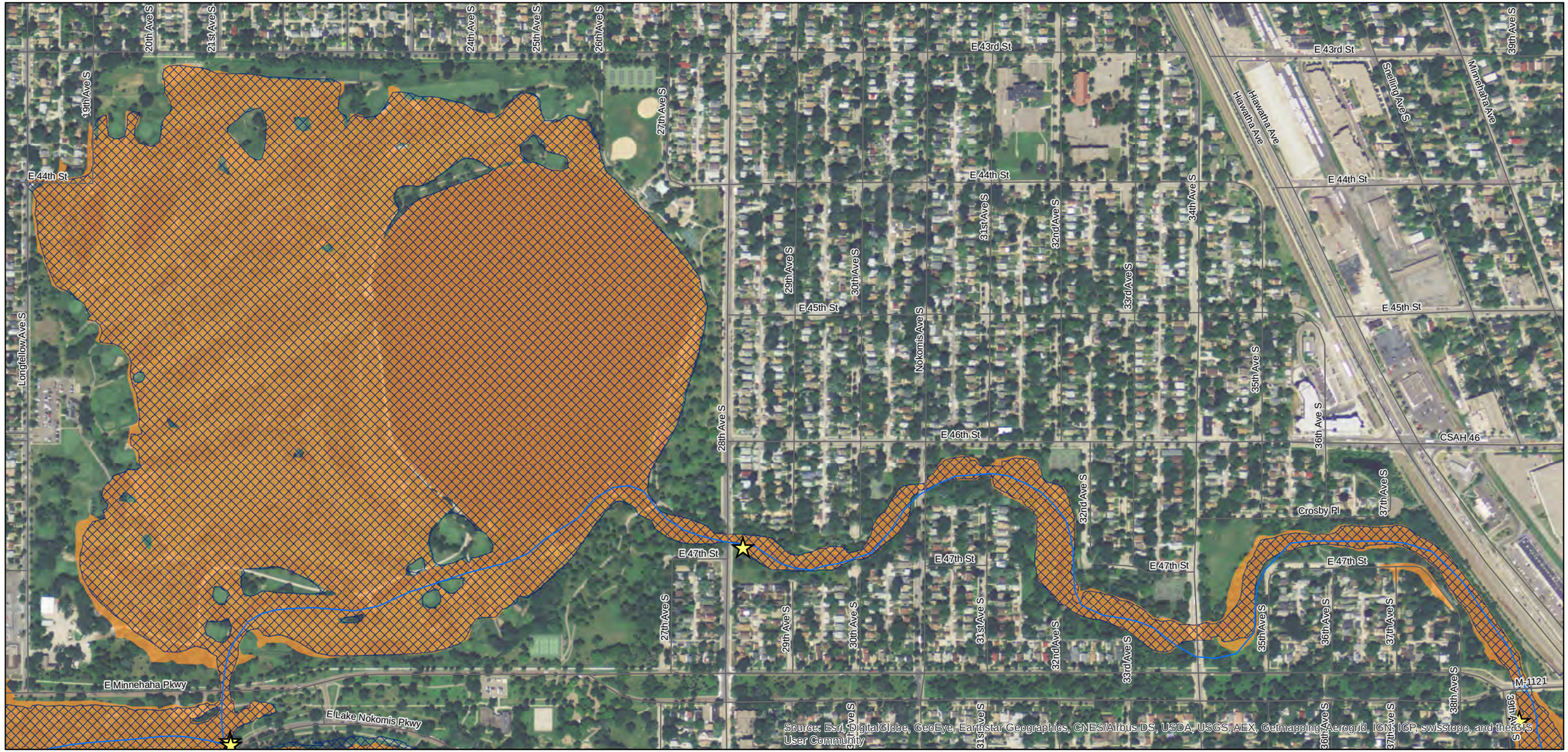

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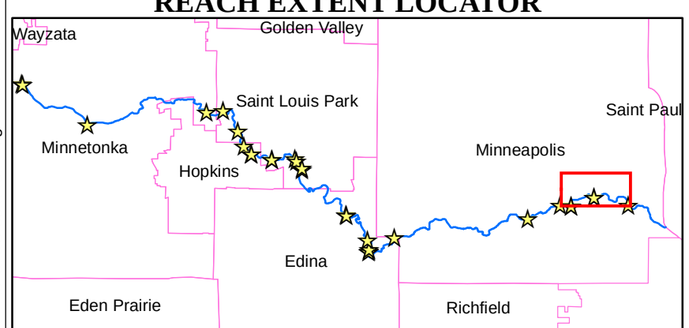

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 13 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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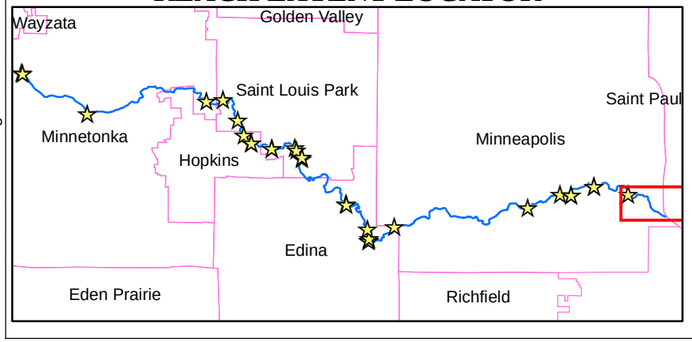

1-Percent-Chance (Effective) and 2014 Flood Inundation Areas

Map 14 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

Effective 1-percent-annual-chance event

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

MNDNR

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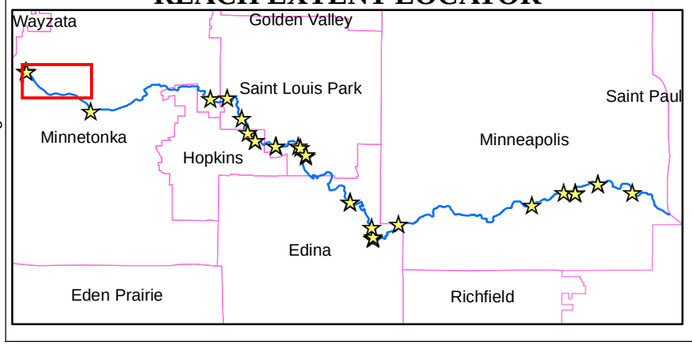

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 1 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

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Map 9

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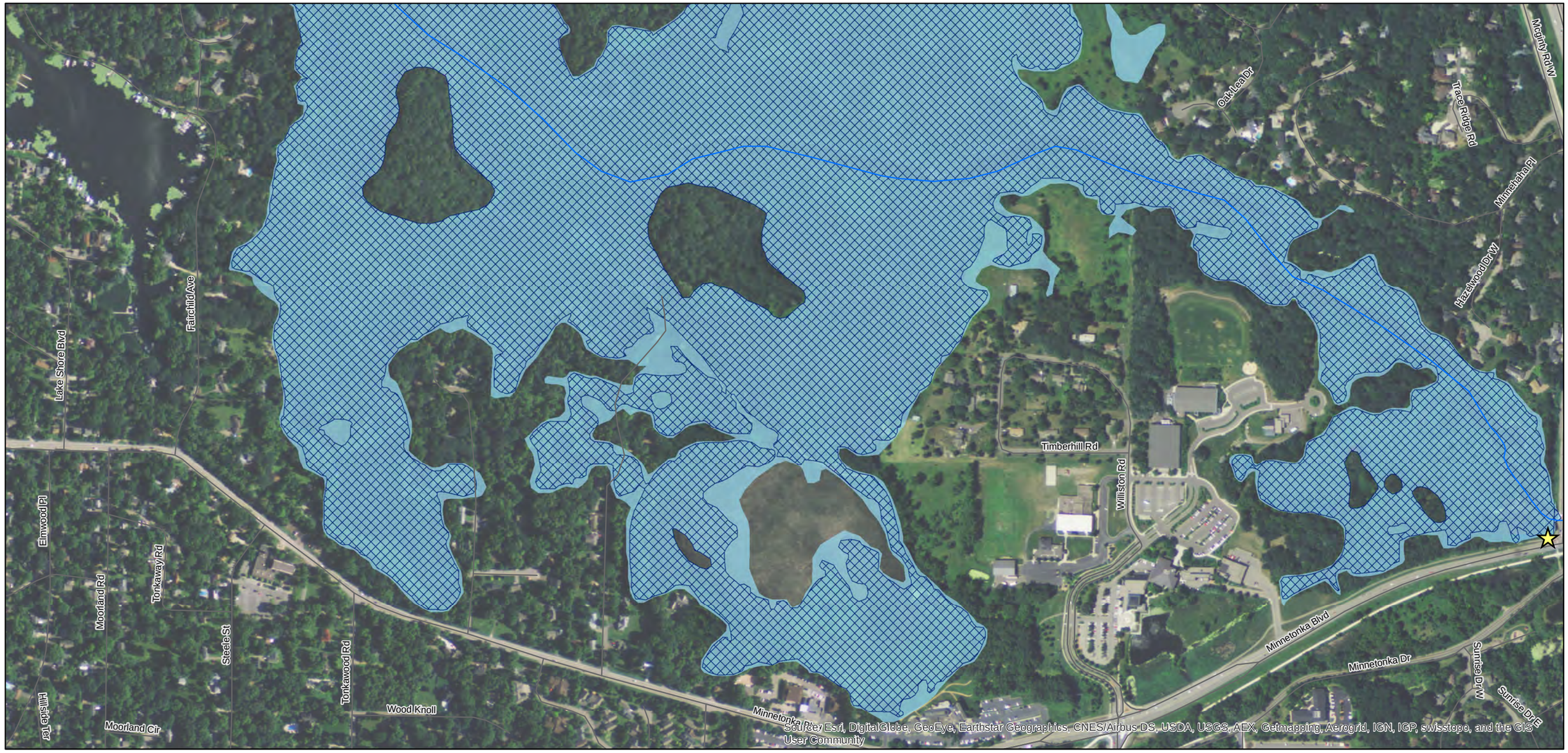

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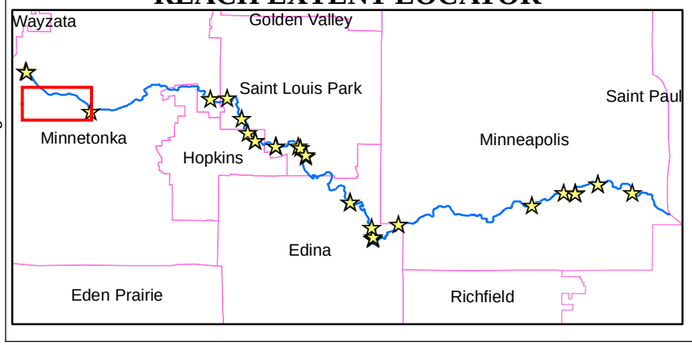

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 2 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

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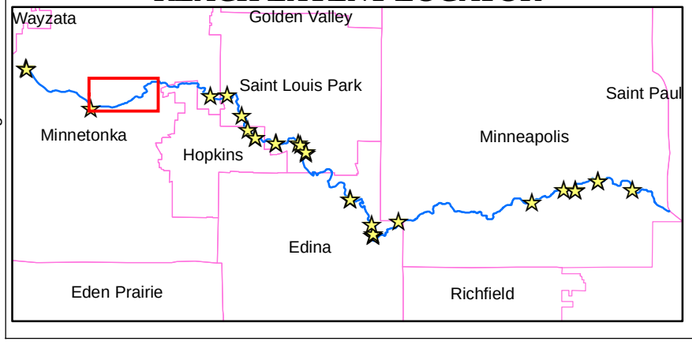

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 3 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

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Map 9

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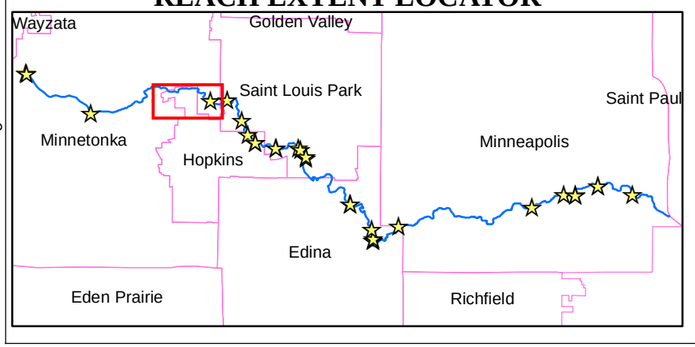

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 4 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

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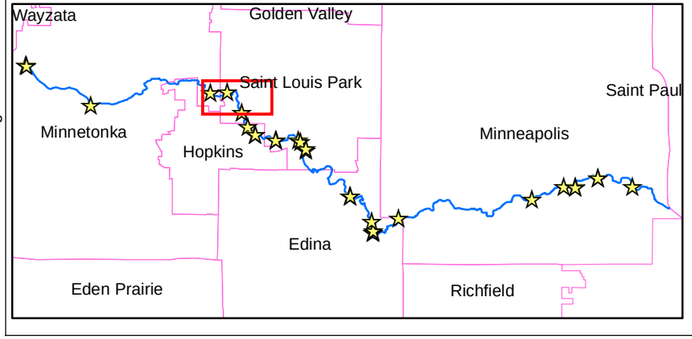

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 5 of 14

- Measured High Water Elevations
- Minnehaha Creek

N

Inundation Areas

- 1-percent-annual-chance event (Atlas-14)
- 2014 Flood Event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Risk Mapping, Assesment, and Planning (Risk MAP)

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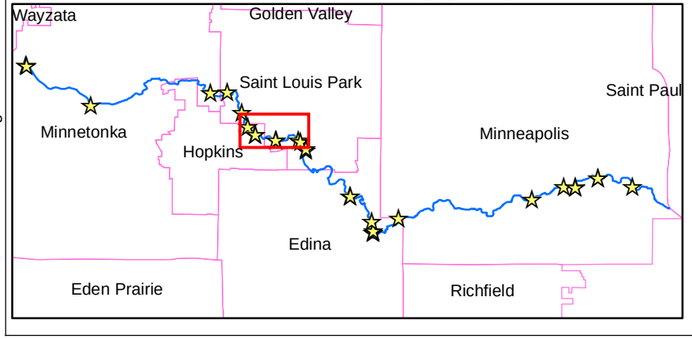
Map 9

D:\MinnehahaCreek\Non-Regs\Atlas14vsHWM.mxd User Name: riweaver Date: 12/9/2015

REACH EXTENT LOCATOR



1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 6 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

RiskMAP
Increasing Resilience Together

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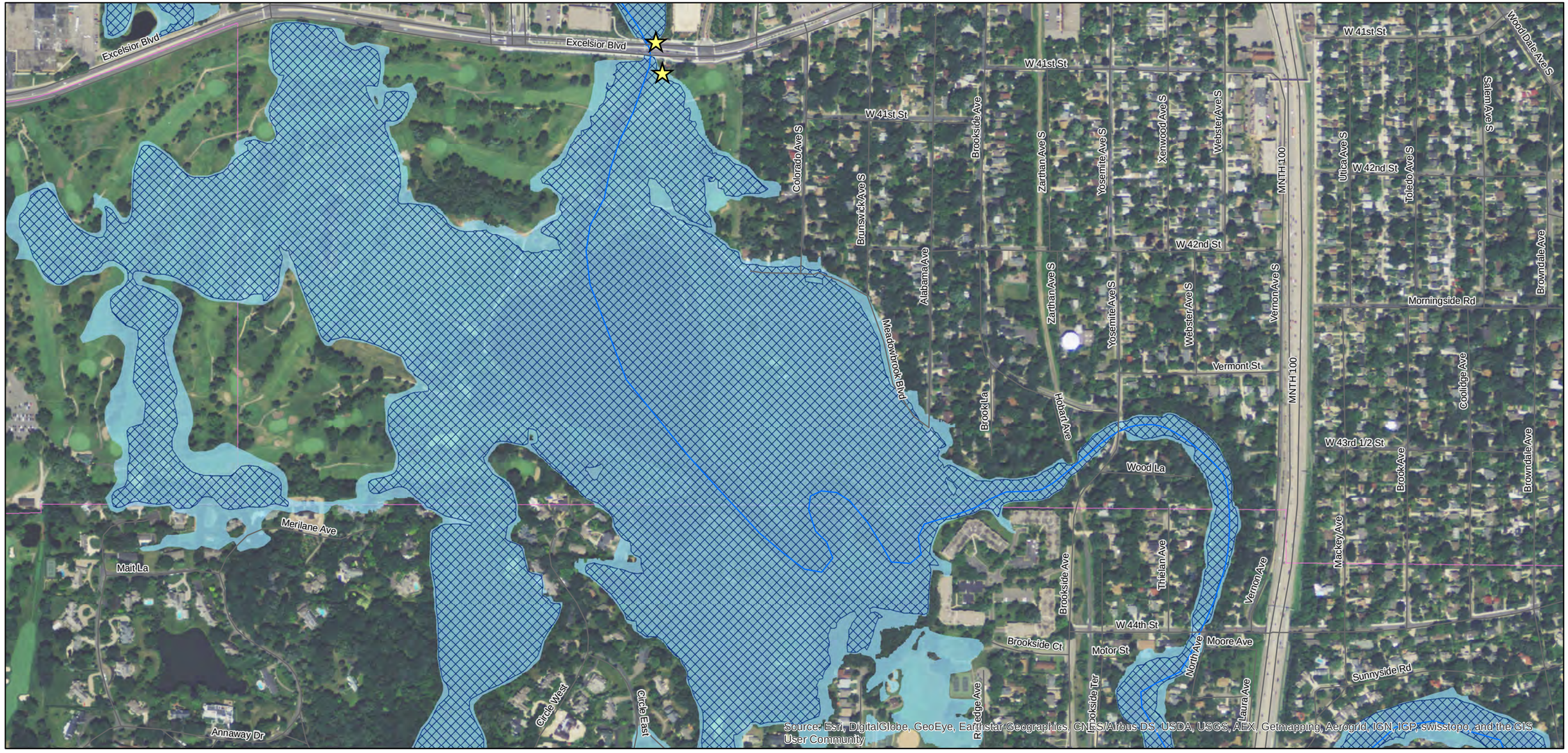

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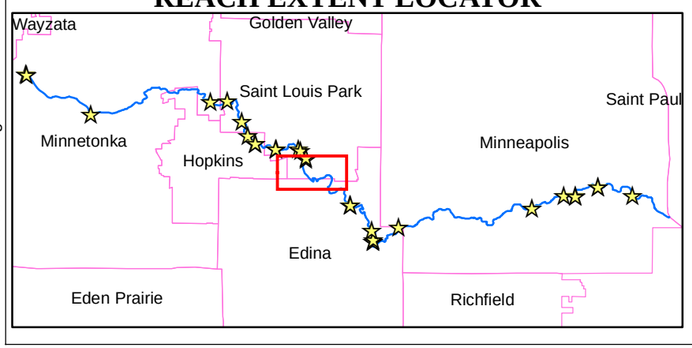

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 7 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Map 9

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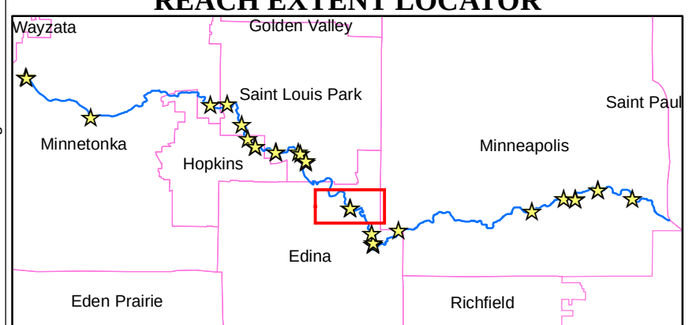
REACH EXTENT LOCATOR



1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 8 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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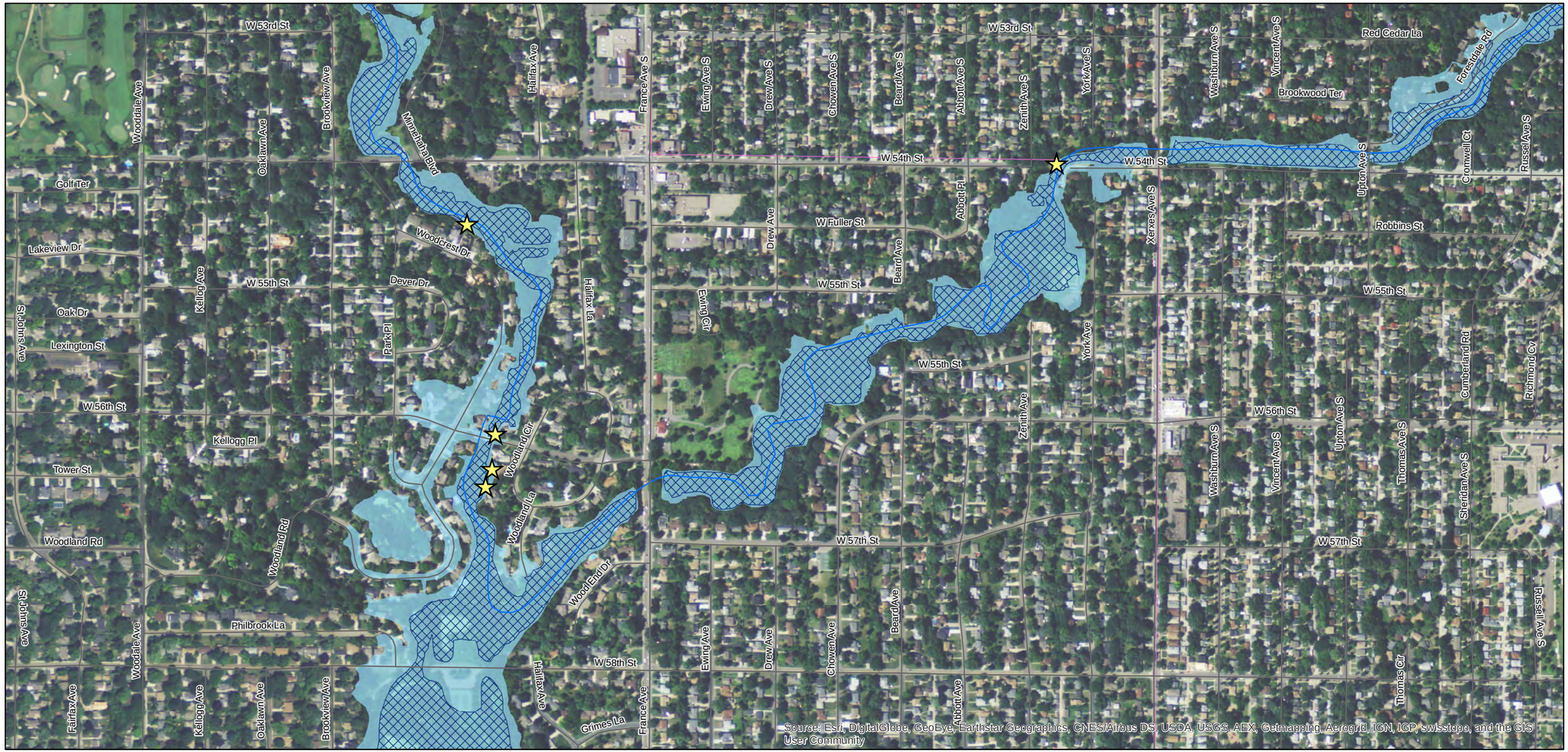

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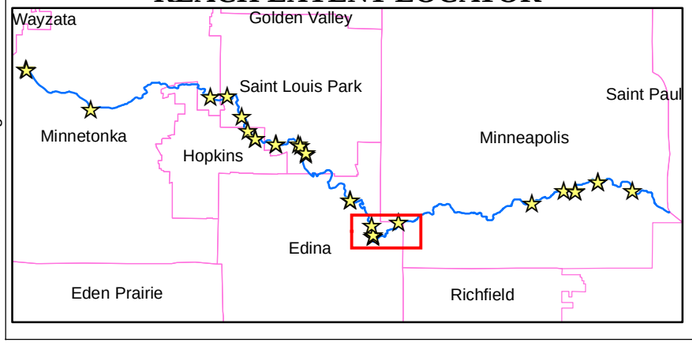

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 9 of 14

Measured High Water Elevations

Minnehaha Creek

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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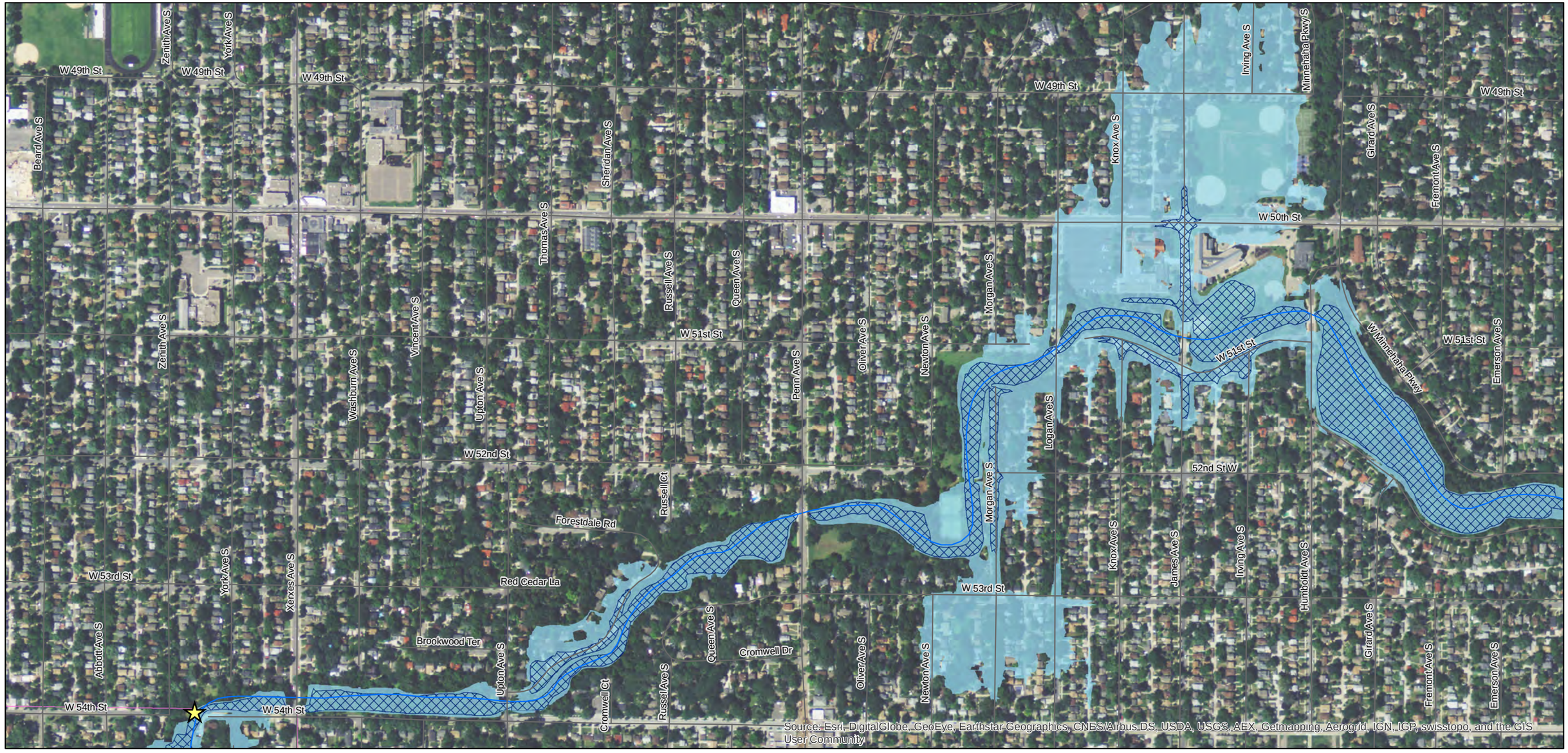

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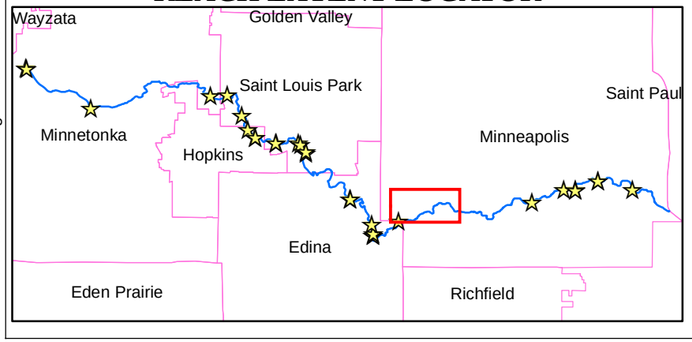

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 10 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

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MINNEHAHA CREEK WATERSHED DISTRICT

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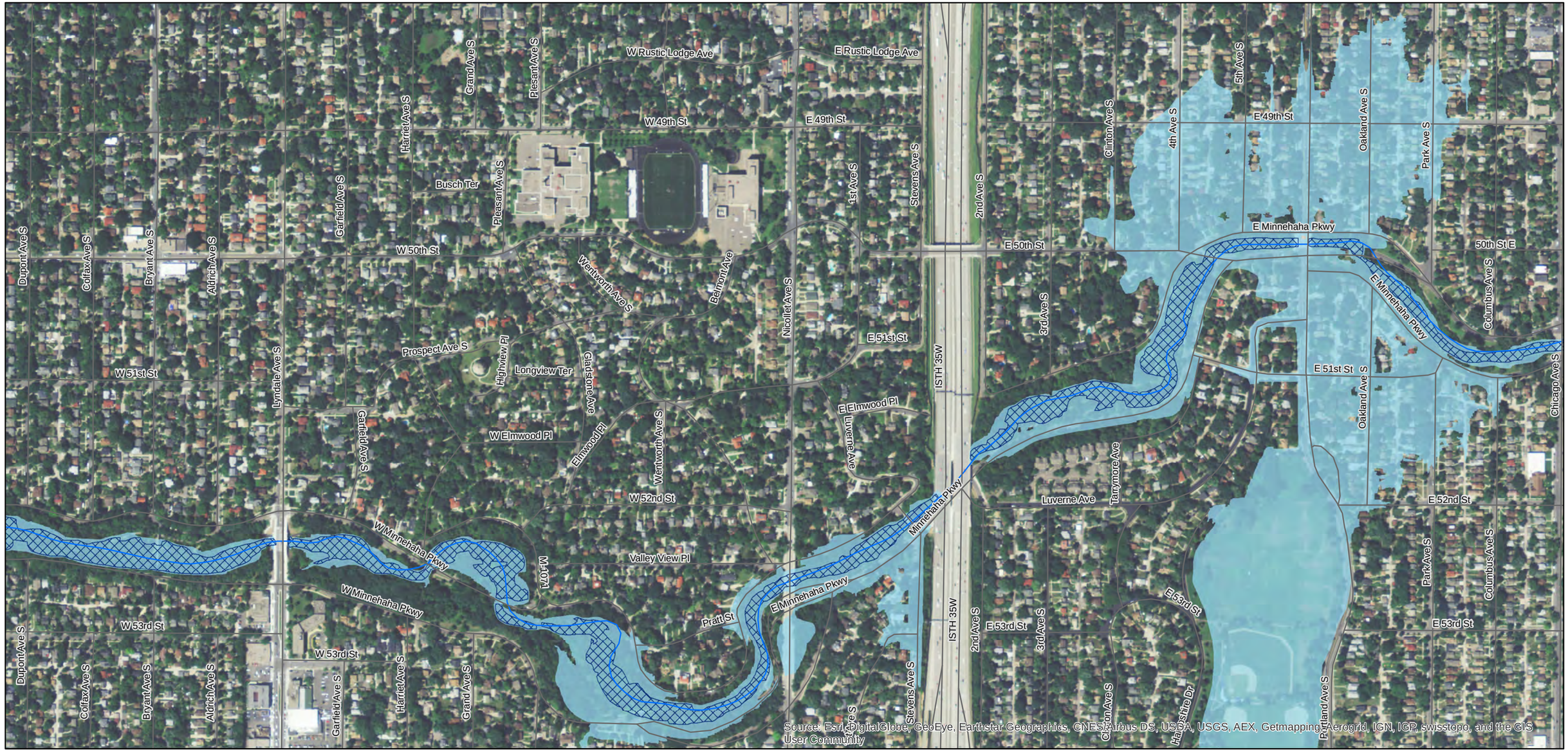

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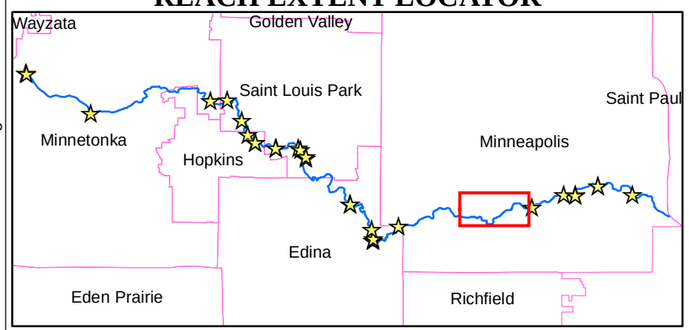

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 11 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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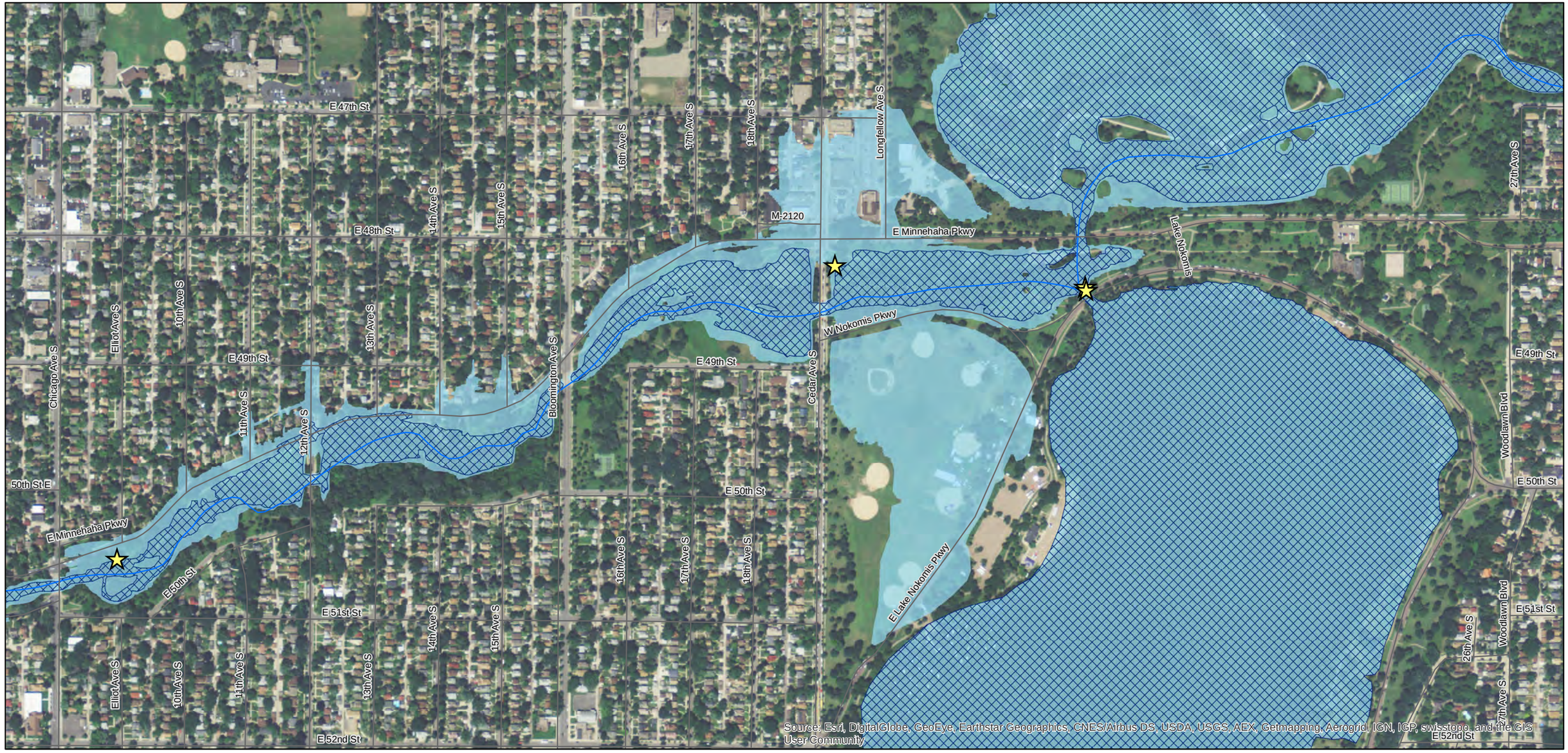
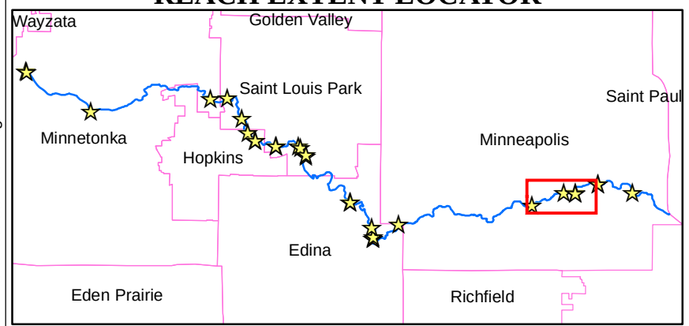


REACH EXTENT LOCATOR



1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 12 of 14

- Measured High Water Elevations
- Minnehaha Creek

Inundation Areas

- 1-percent-annual-chance event (Atlas-14)
- 2014 Flood Event
- City Boundaries

N

0 250 500 1,000 Feet

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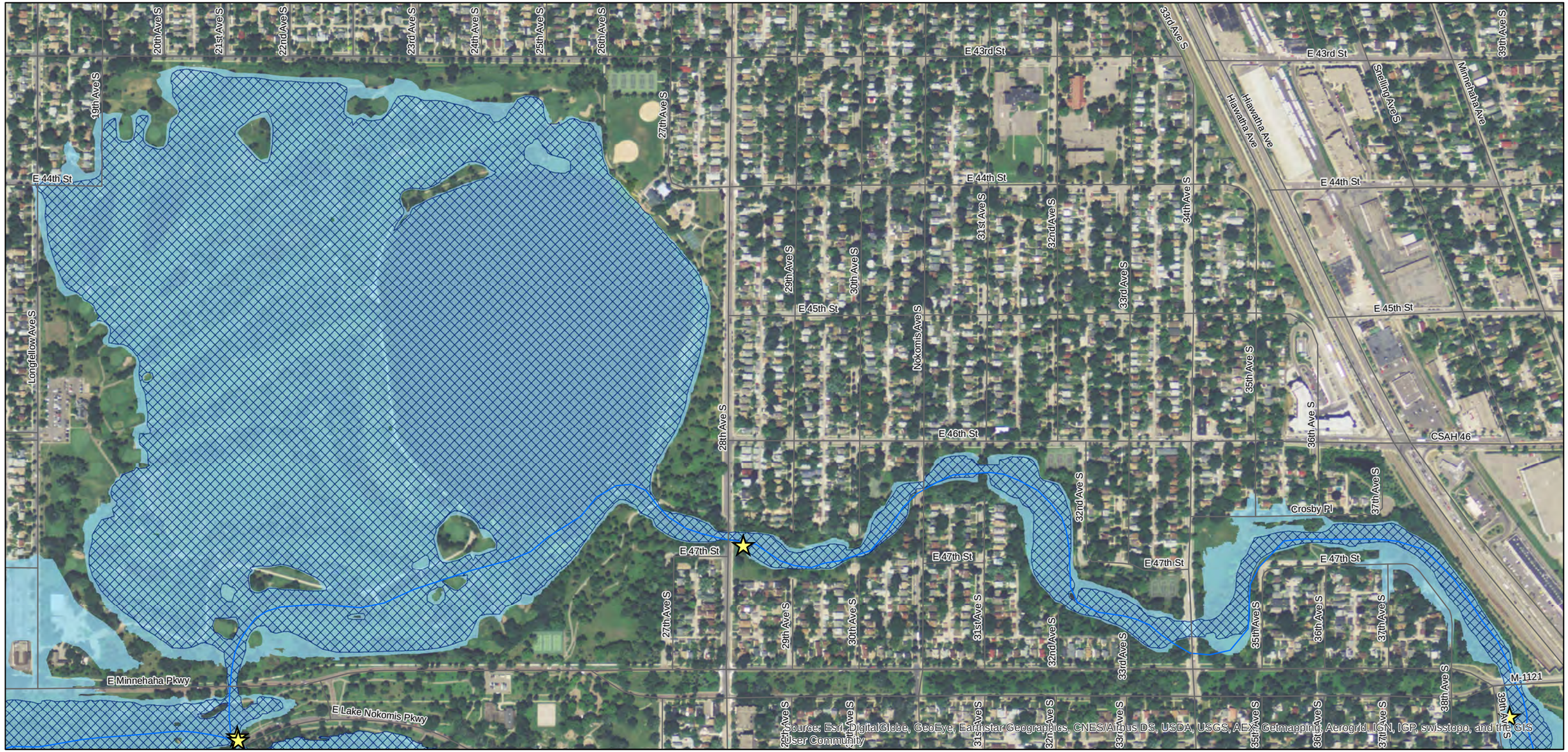

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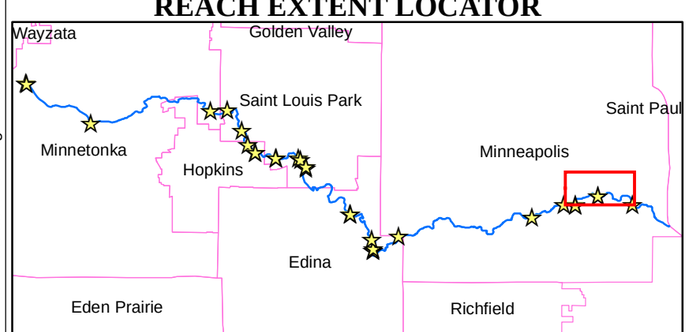

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 13 of 14

Measured High Water Elevations

Minnehaha Creek

N

Inundation Areas

1-percent-annual-chance event (Atlas-14)

2014 Flood Event

City Boundaries

0 250 500 1,000 Feet

MNDNR

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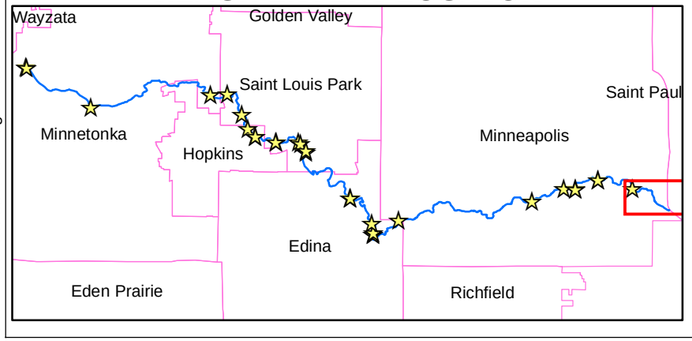

1-Percent-Chance (Atlas-14) and 2014 Flood Inundation Areas

Map 14 of 14

- Measured High Water Elevations
- Minnehaha Creek

Inundation Areas

- 1-percent-annual-chance event (Atlas-14)
- 2014 Flood Event
- City Boundaries

N

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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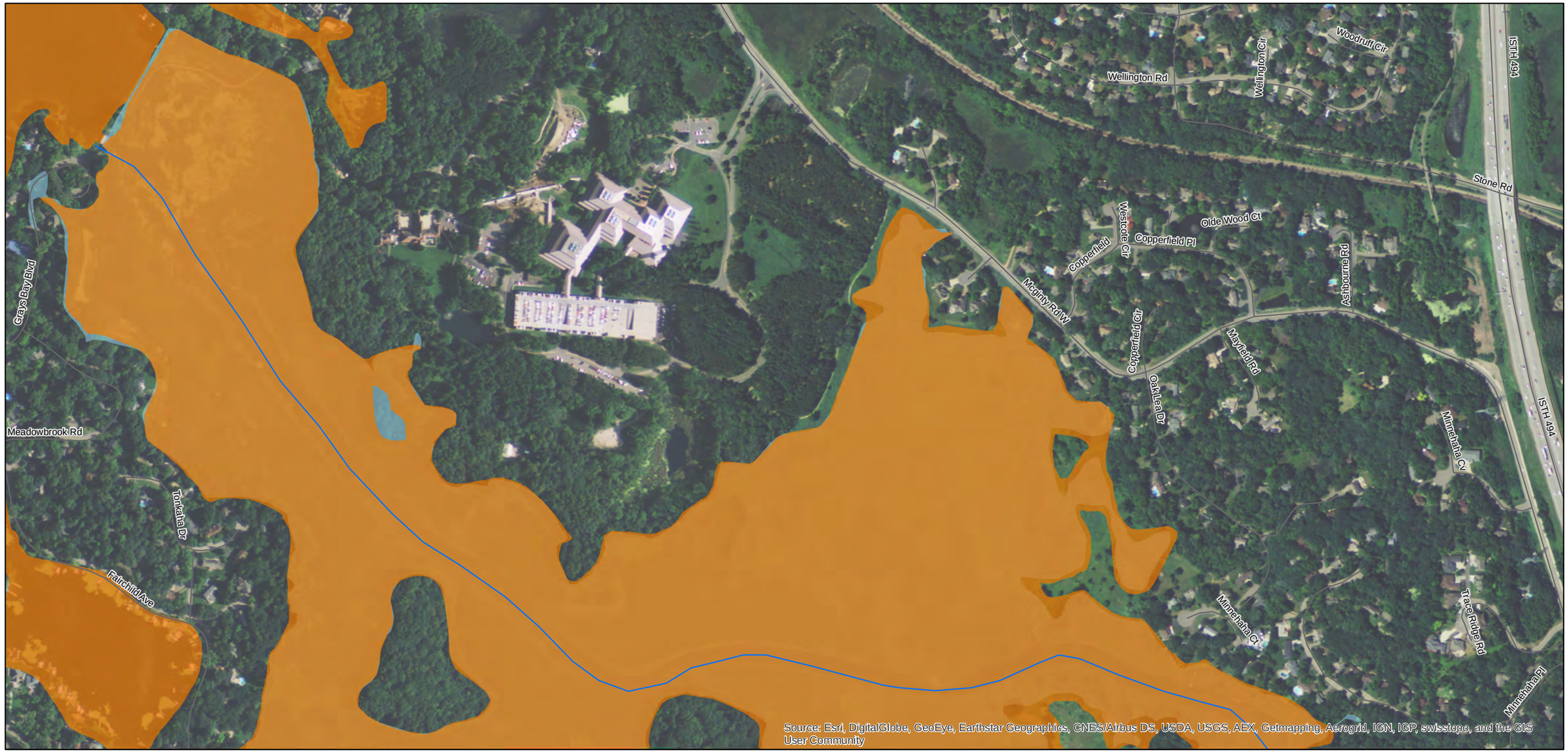

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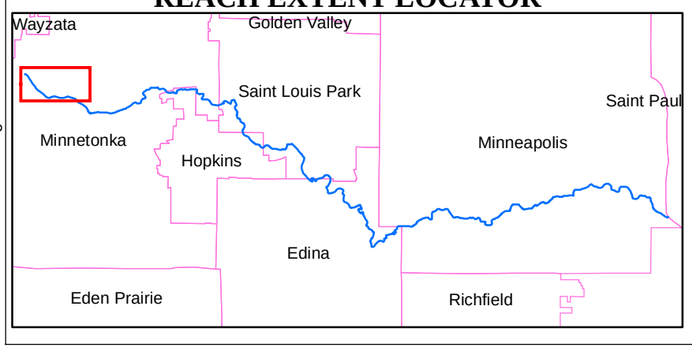

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 1 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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Map 10

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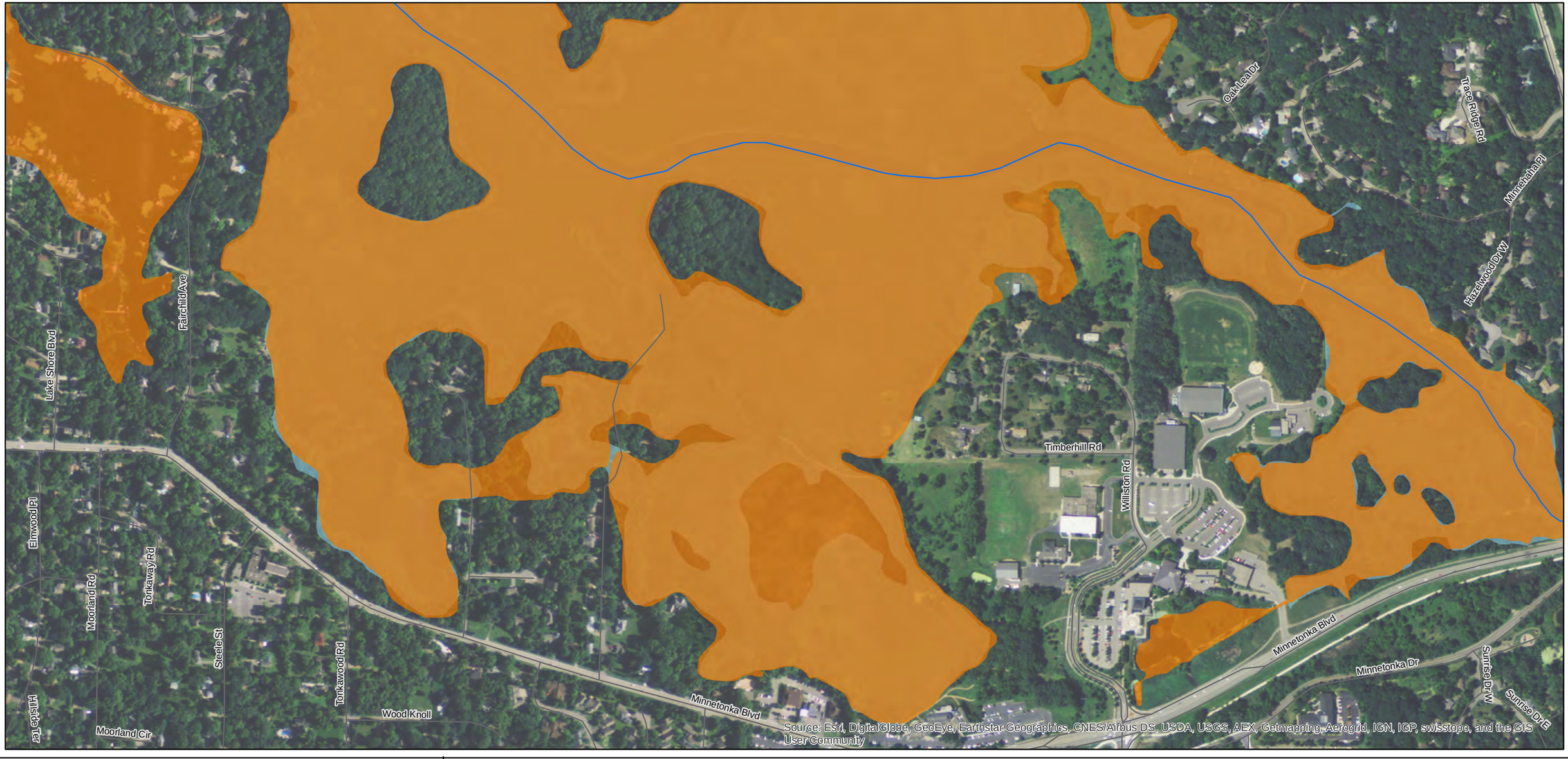

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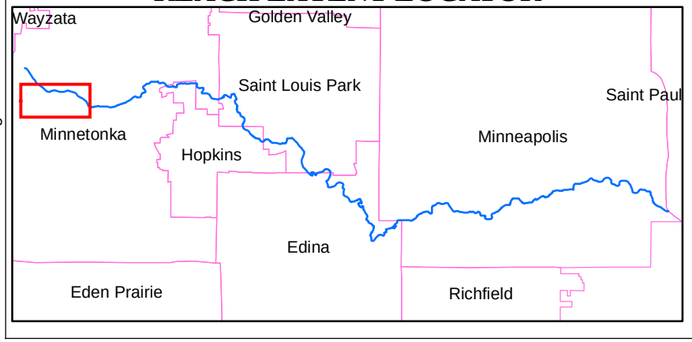

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 2 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

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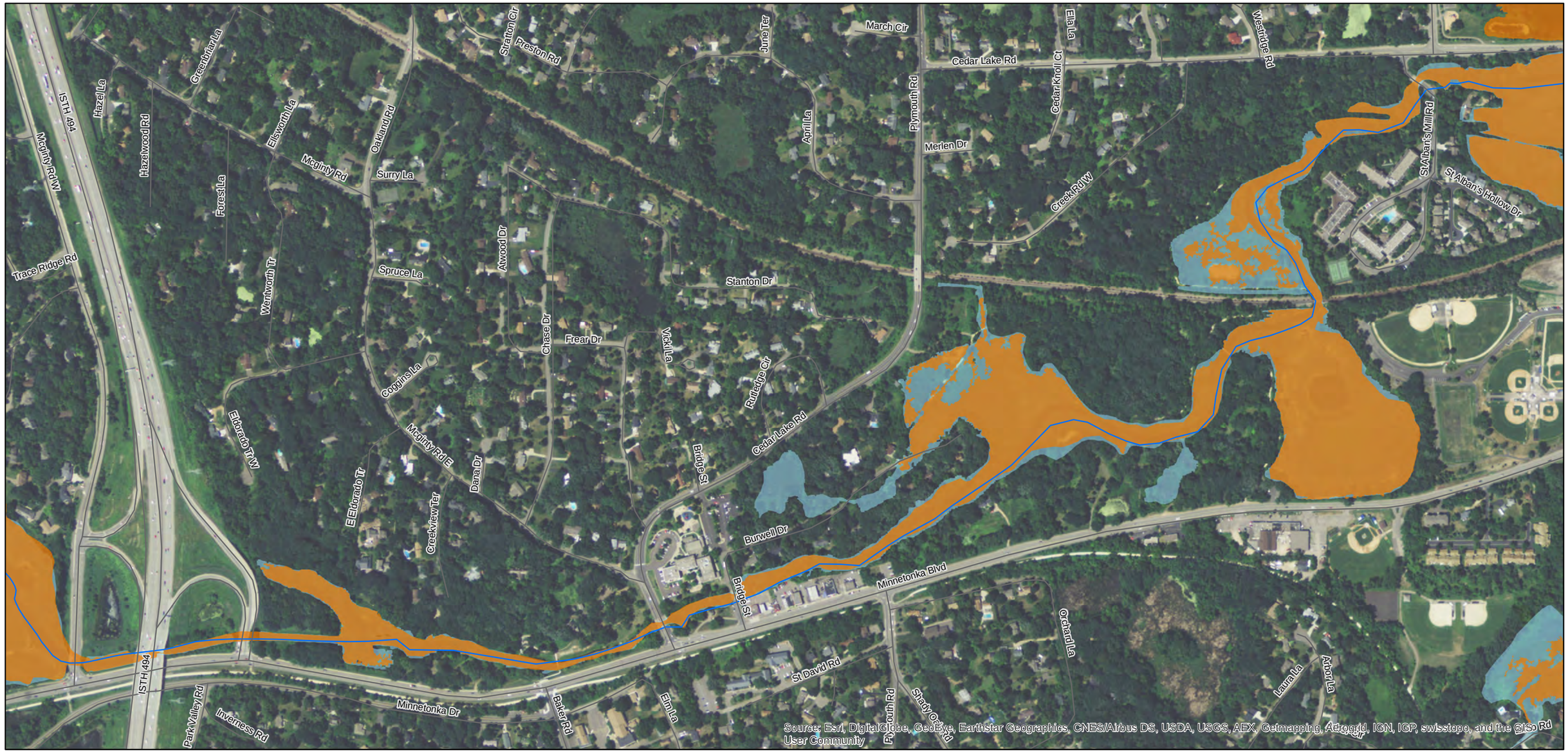

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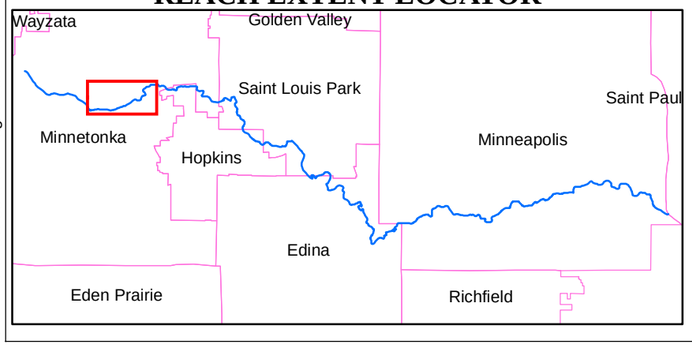

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 3 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

MNDNR

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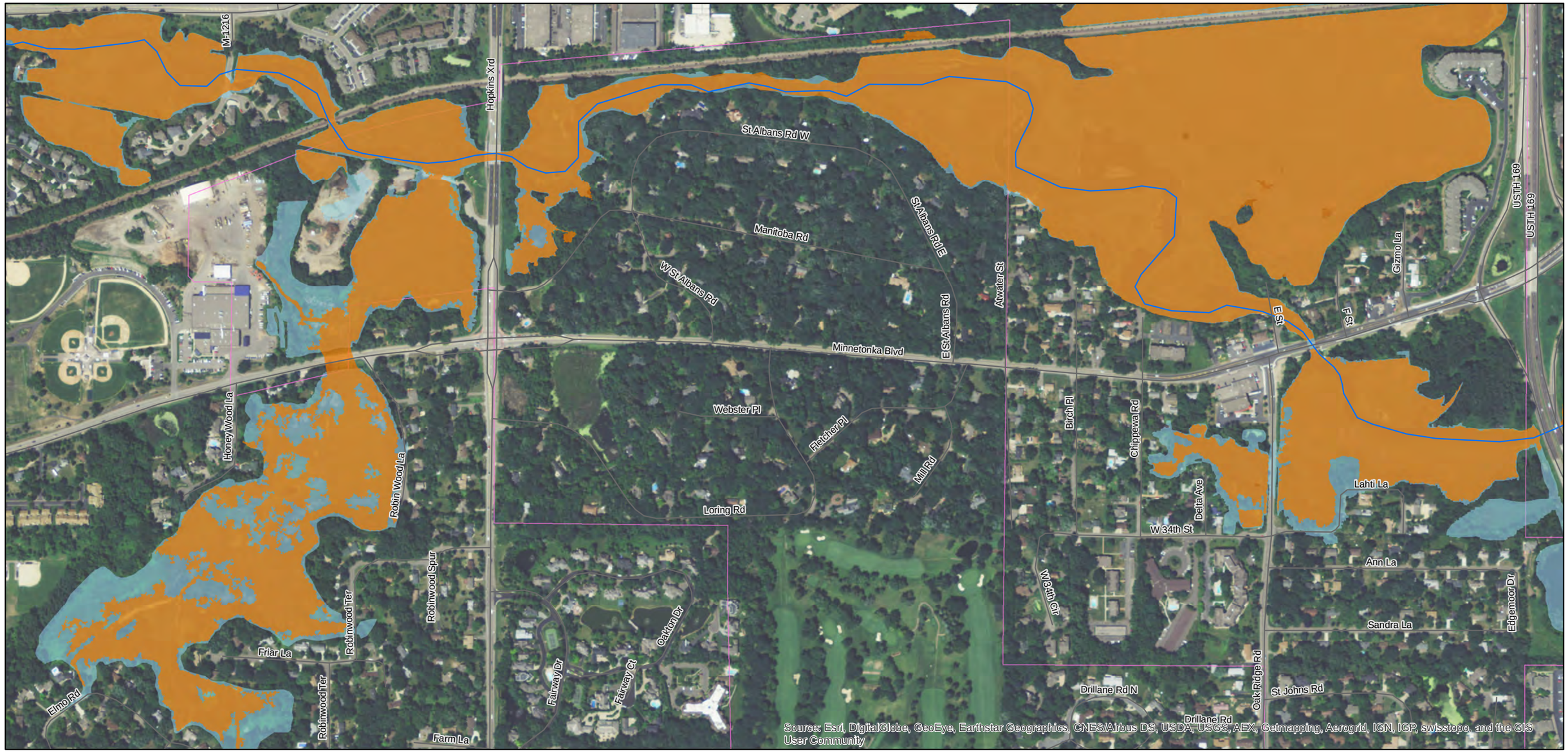

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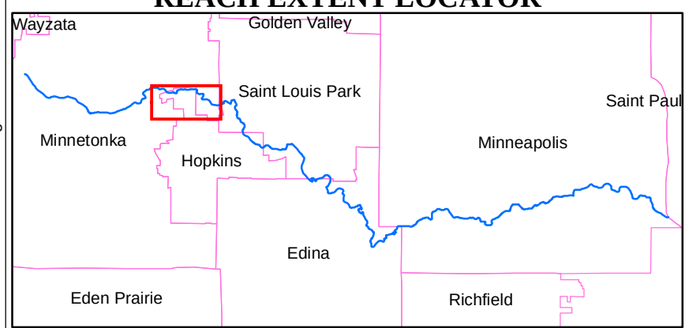

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 4 of 14

Minnehaha Creek

N

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

MINNEHAHA CREEK WATERSHED DISTRICT

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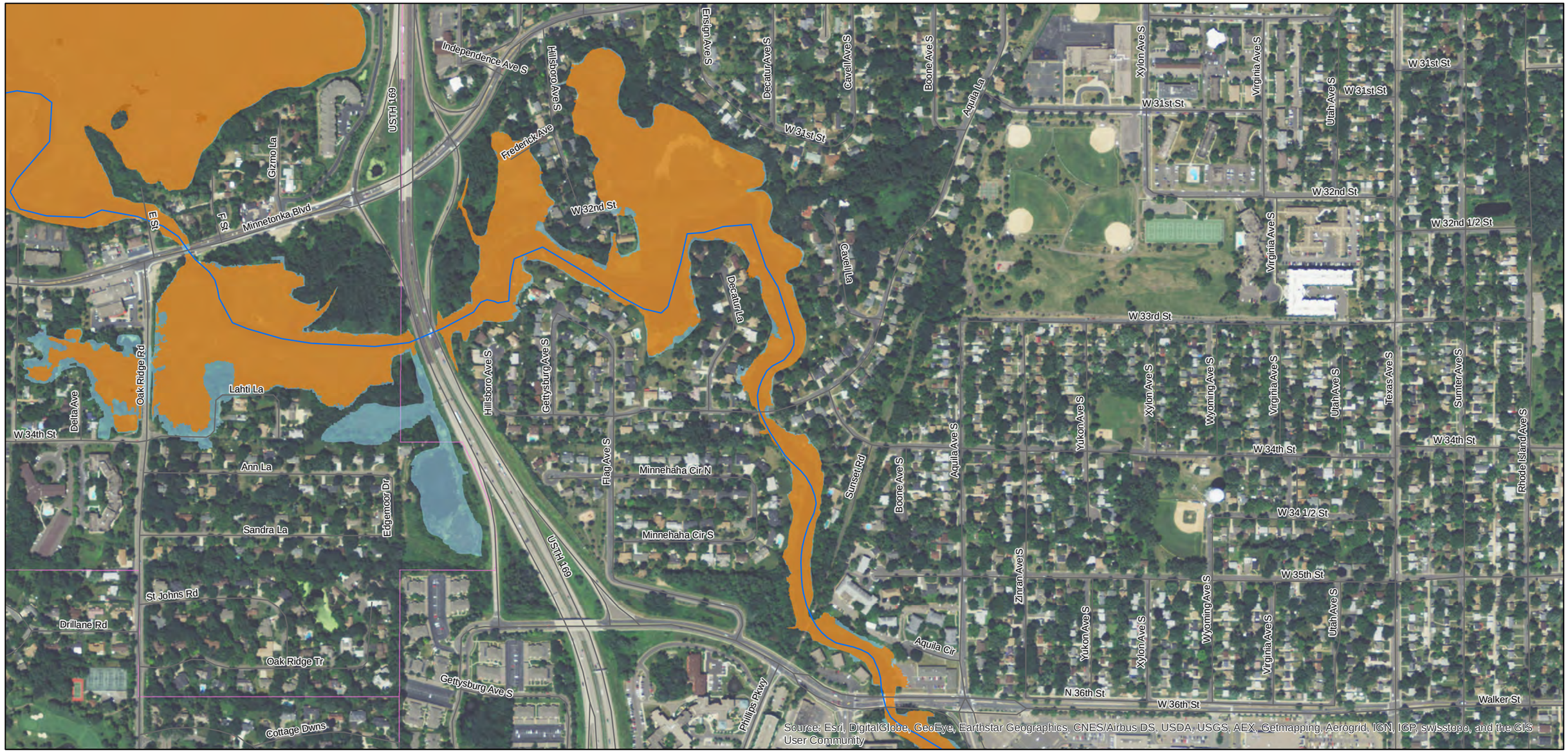

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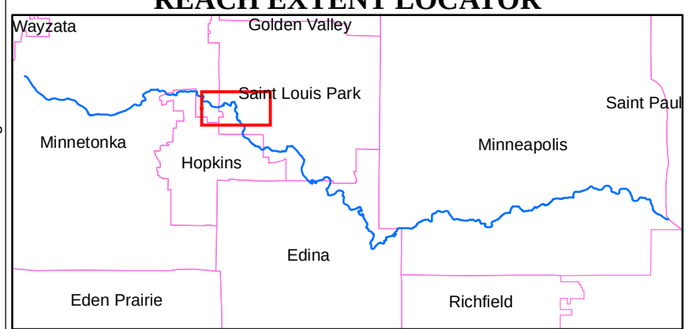

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 5 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

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Map 10

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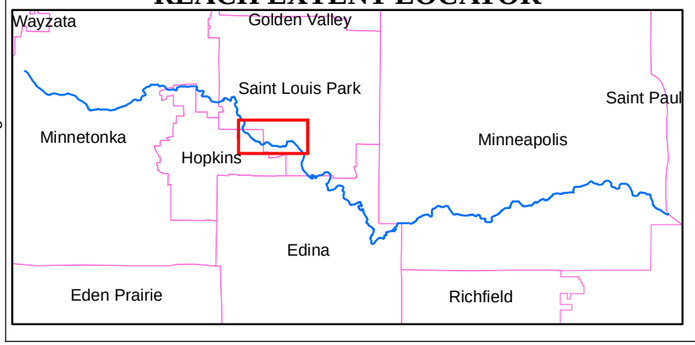
REACH EXTENT LOCATOR



Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 6 of 14

Minnehaha Creek

N

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

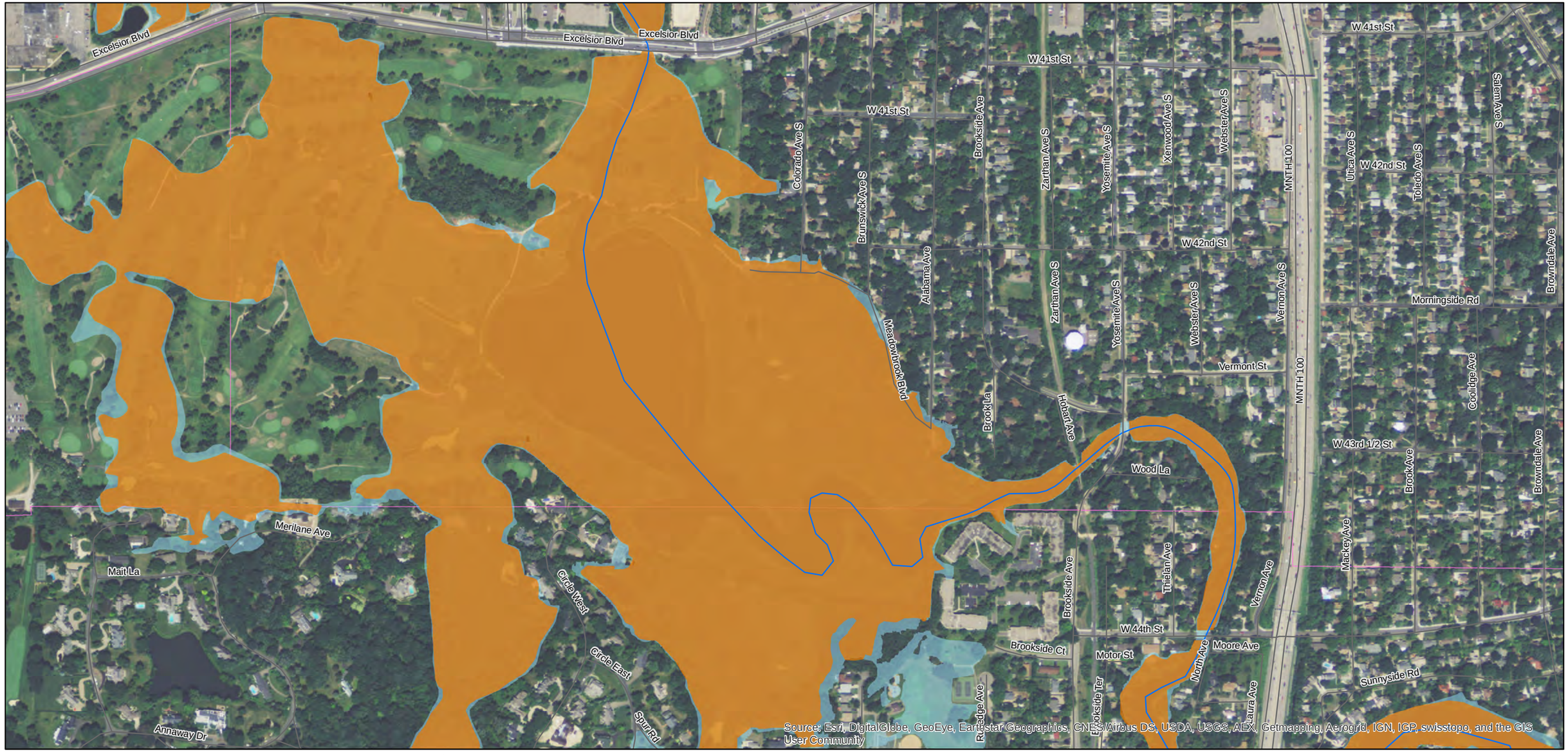
MINNEHAHA CREEK WATERSHED DISTRICT

RiskMAP
Increasing Resilience Together

Risk Mapping, Assesment, and Planning (Risk MAP)

About this map:
This map shows a comparison of flood extents between FEMA's effective 1-percent-annual-chance (100-year) flood event and the Atlas-14 1-percent-annual-chance flood event.
The Atlas-14 inundation area assumes 7.2-inches of rainfall on the watershed downstream of Lake Minnetonka, while the effective map inundation area assumes 5.0-inches of rainfall on the watershed downstream of Lake Minnetonka. Both events assume the 1-percent peak flow rate out of Lake Minnetonka.

Map 10



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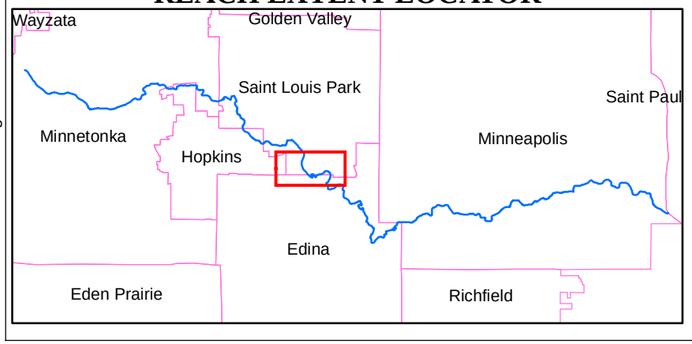
REACH EXTENT LOCATOR



Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 7 of 14

Minnehaha Creek

N

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

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Map 10

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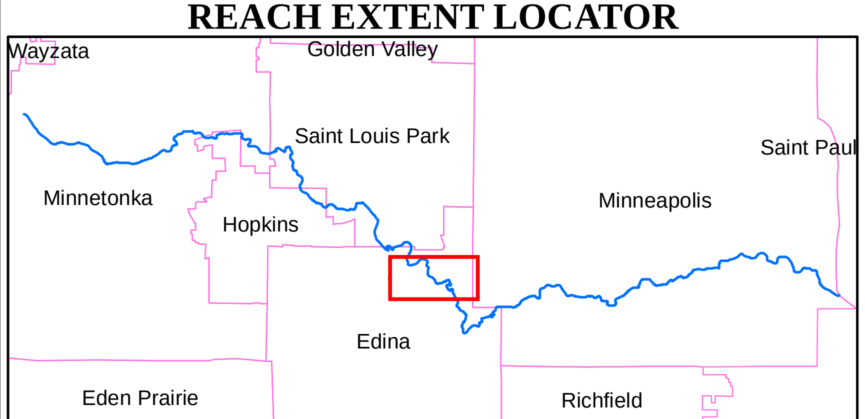
REACH EXTENT LOCATOR



Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 8 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MNDNR

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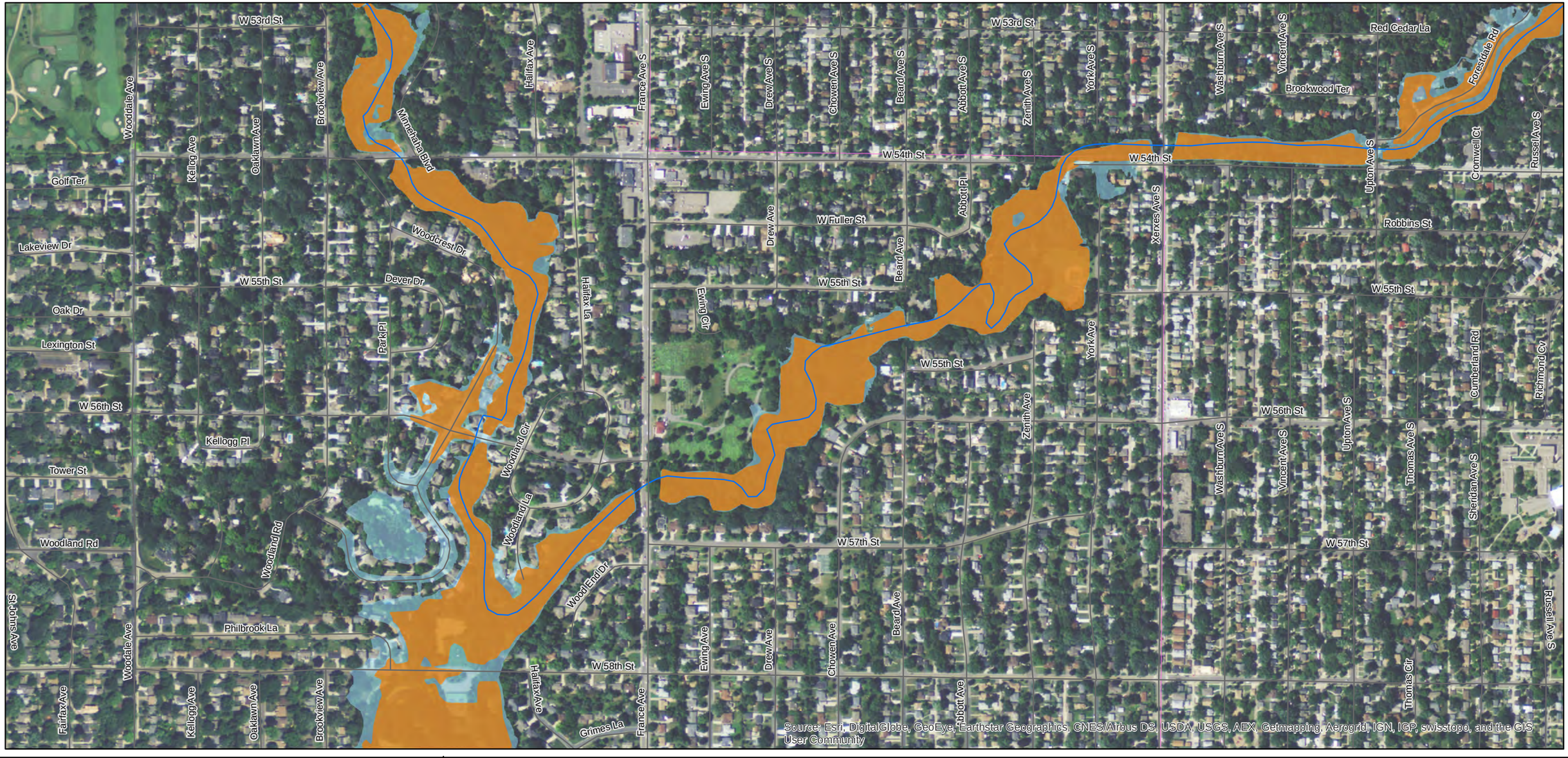
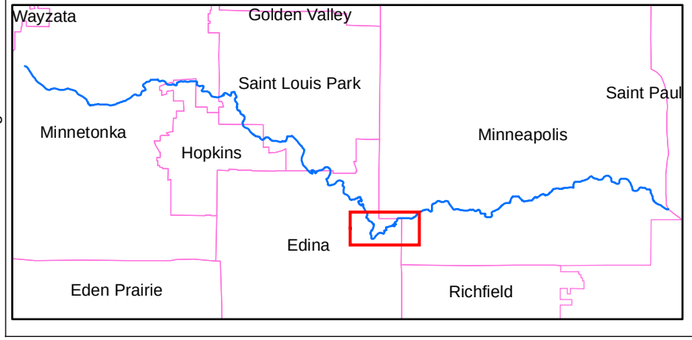


REACH EXTENT LOCATOR



Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 9 of 14

Minnehaha Creek

N

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

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Map 10

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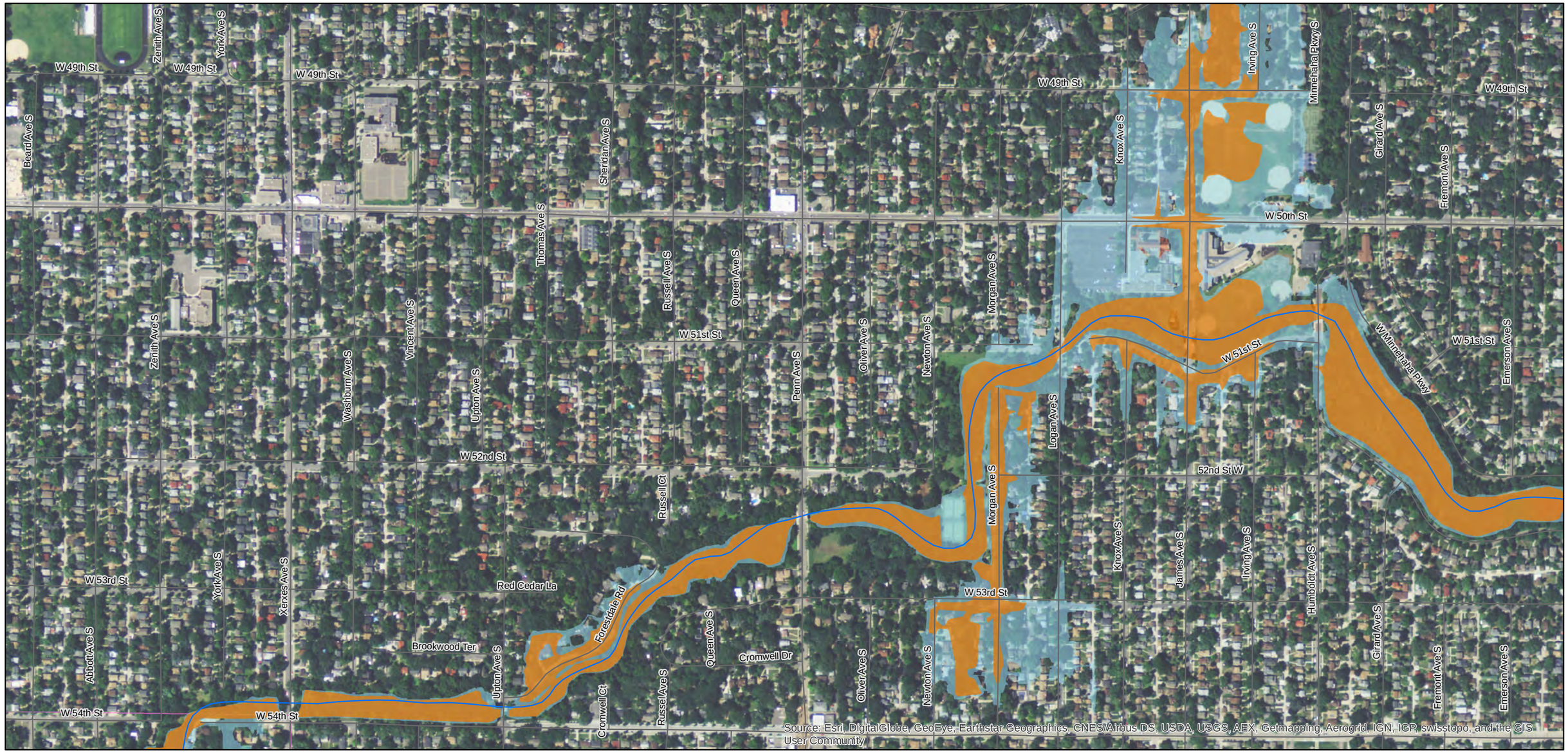

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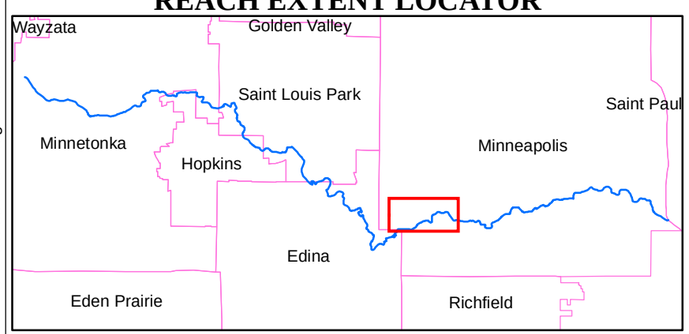

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 10 of 14

Minnehaha Creek

N

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

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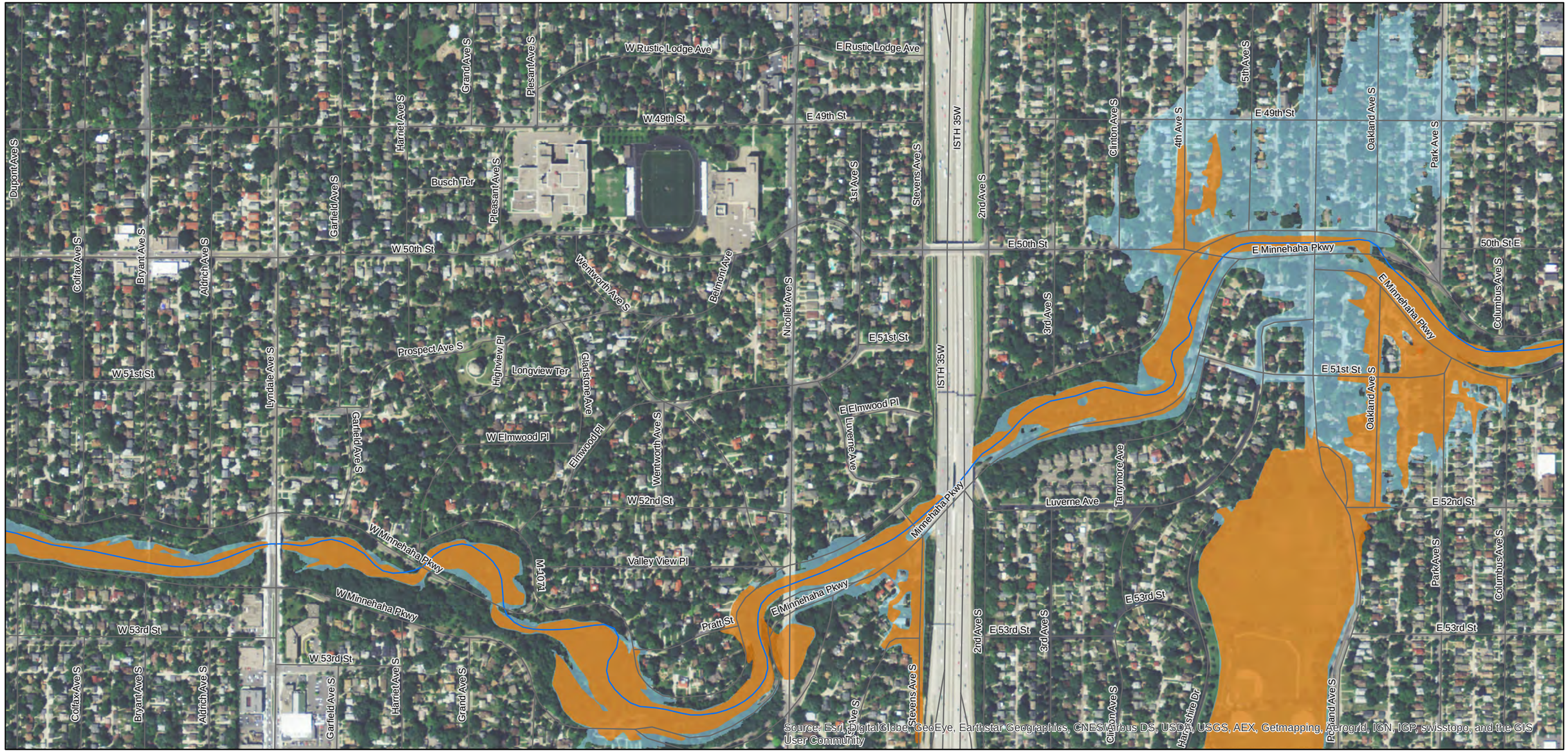

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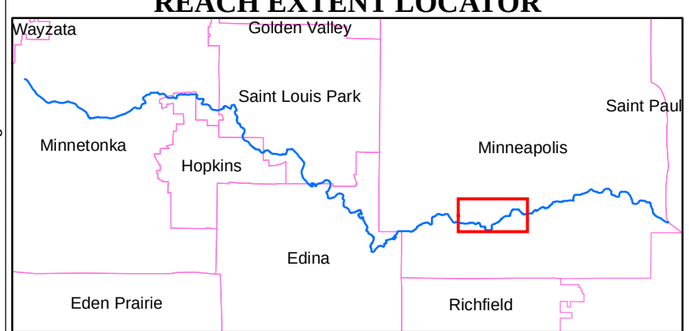

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 11 of 14

N

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

0 250 500 1,000 Feet

MINNEHAHA CREEK WATERSHED DISTRICT

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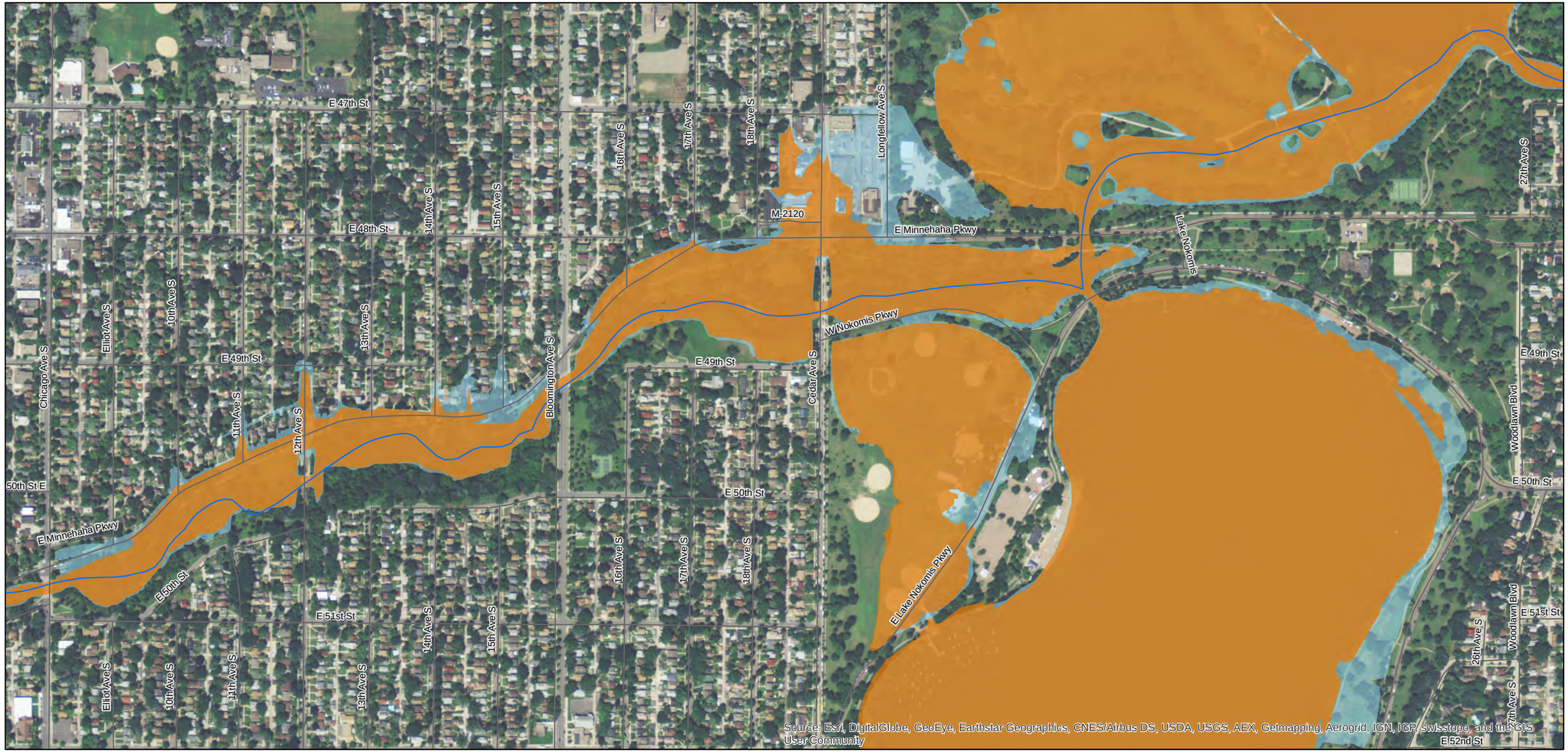

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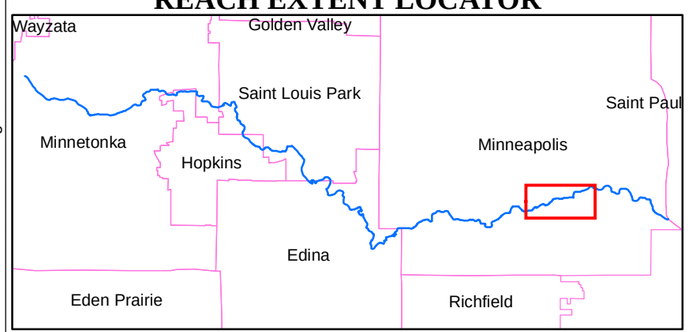

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 12 of 14

Minnehaha Creek

Inundation Areas

- Effective 1-percent-annual-chance event
- Atlas-14 1-percent-annual-chance event
- City Boundaries

N

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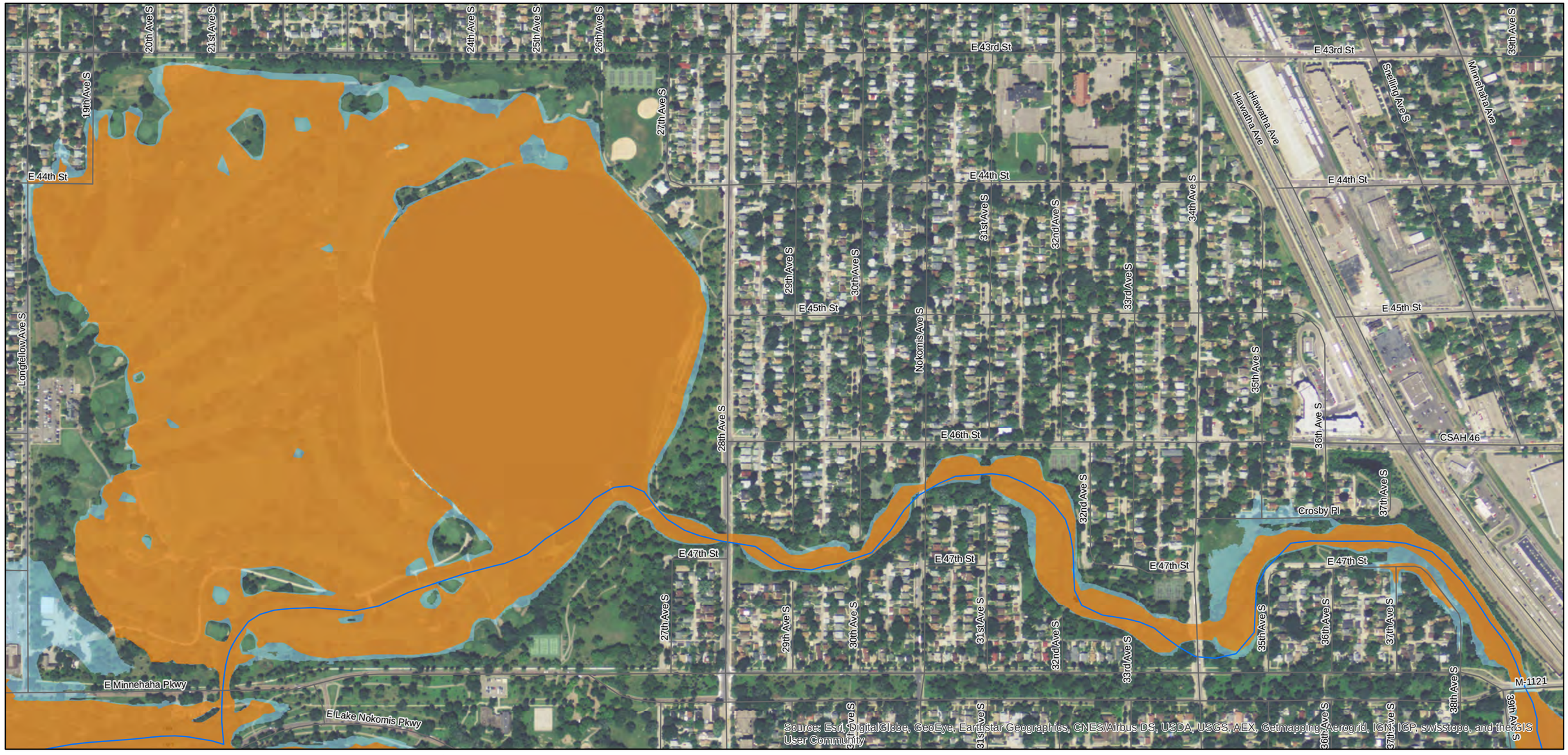

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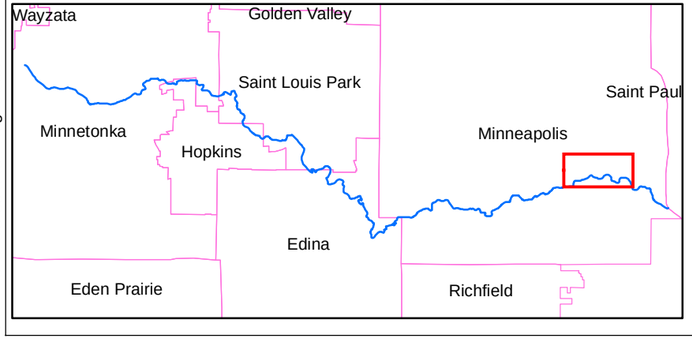

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 13 of 14

Minnehaha Creek

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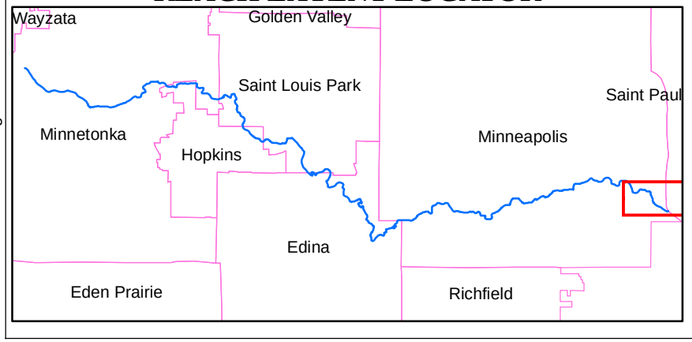

Effective 1-Percent-Chance and Atlas-14 1-Percent-Chance Inundation Areas

Map 14 of 14

Minnehaha Creek

N

Inundation Areas

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