APPENDIX F:
Land and Water Resource Inventory

Introduction

This Land and Water Resource Inventory (LWRI) is intended to catalog and briefly summarize the data available for Brown's Creek Watershed District (BCWD). The name, location, and publisher or agency of any relevant datasets are included within each section of the LWRI. Datasets can be accessed through the URL links provided in the Datasets Referenced section or through inquiring at the agency websites or offices. In many cases, hyperlinks to referenced reports are provided in the body of the text. This section of the plan conforms to the requirements of Chapter 8410.0060 Land and Water Resource Inventory as revised January 30, 2024.

Contents

1 Physical Environment

1.1 Location

Brown's Creek Watershed District is in Washington County, Minnesota. It was formed from the Brown's Creek Watershed Management Organization in October of 1997. It includes portions of the City of Grant, the City of Hugo, the City of Lake Elmo, May Township, the City of Oak Park Heights, the City of Stillwater, and Stillwater Township. Table F1 identifies each city and township, its total population, and how much of its area is in BCWD. These areas were determined using the legal boundary of the district, last updated in February 2023.

Table F1. Communities located in Brown's Creek Watershed District

City/Township	Total Population (2020 Census)	Area in BCWD [Acres]	Area in BCWD [Square Miles]	Percentage of Total BCWD Area [%]
Grant	3,970	9,353	14.6	51
Hugo	15,766	2,133	3.3	12
Lake Elmo	11,335	225	0.4	1
May Township	2,670	2,023	3.2	11
Oak Park Heights	4,849	328	0.5	2
Stillwater	19,394	3,172	5.0	17
Stillwater Township	1,866	1,041	1.6	6
Total	**59,850**	**18,276**	**28.6**	**100**

1.2 Climate and Precipitation

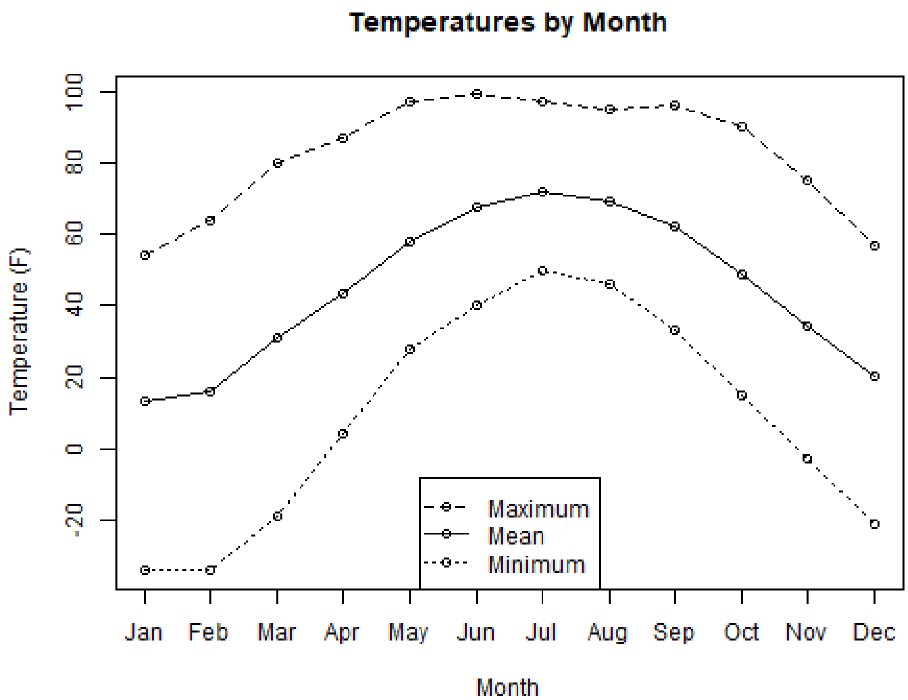
The climate of the Brown's Creek watershed is consistent with the climate for the seven-county metropolitan area. In Washington County, the average summer temperature is 70 degrees Fahrenheit while the average winter temperature is 18 degrees Fahrenheit. The average annual temperature is 45 degrees Fahrenheit. The average annual precipitation of the county is 34.4 inches. On average the county has 83 days annually with a snow cover depth greater than one inch.

The previous long-term trend analysis relied on daily weather data from the National Weather Service station STILLWATER 1 SE[(1)], covering the period from 1959 to 2005. That analysis was included in the 2017 - 2026 Water Management Plan. Since this station ended operation in 2006, a new station STILLWATER 2 SW[(1)], located about three miles away at Long Lake within the district boundary has been used. This new station began operating in July 2006, and its data were used to complete the most recent trend analysis through 2024. The recent trends are generally similar to those observed in the earlier long-term analysis, but because the record is shorter, the results are not as strongly supported by the statistical data. Similarly, a longer record of precipitation and general climate data (current annual and monthly precipitation records as well as historic precipitation records) can be obtained from the Minnesota Climatology Working Group[(2)]. Climate data, including long-term trends, can be obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center[(3)]. The Minnesota Geospatial Commons also contains data on climate and precipitation from local stations across Minnesota[(4)].

1.2.1 Analysis of Near-Term Trends (2006-2024): Temperature

A near-term analysis of temperature data recorded in the watershed was performed to assess trends related to climate change. Figure F1 averages the monthly temperature observations from 2006 to 2024 taken from the National Weather Service station STILLWATER 2 SW. The warmest month on average is July and the coldest month on average is January. For the period of record, the average annual temperature was 45.0 degrees F. Observed daily extremes were 99 degrees F and -34 degrees F.

Figure F1. Monthly temperature statistics at the National Weather Service station (2006-2024)



The main findings of the temperature trend analysis are highlighted below. An extensive summary of climate and precipitation trends within the watershed is available in Appendix B of the plan.

- Air temperatures were observed to increase over the periods of record (2006-2024), but the evidence is not strong enough to conclude that the trends are statistically significant.
- Winter temperatures appear to be warming, especially for average winter temperatures, though the signal is not strong enough to say with certainty.

1.2.2 Analysis of Near-Term Trends: Precipitation

A near-term analysis of precipitation data recorded in the watershed was performed to assess trends related to climate change. Figure F2 averages the monthly precipitation observations from 2006 to 2024 taken from the National Weather Service station STILLWATER 2 SW. For precipitation, an 18-year (2007-2024) record was available for annual analysis. Rainfall data for 2006 were only available starting in July and are therefore excluded from the annual analysis. For the period of record, the average annual rainfall was 29.7 inches and ranged from 23.8 inches (2017) to 37.0 inches (2016).

Figure F2. Monthly rainfall statistics at the National Weather Service station (2006-2024)

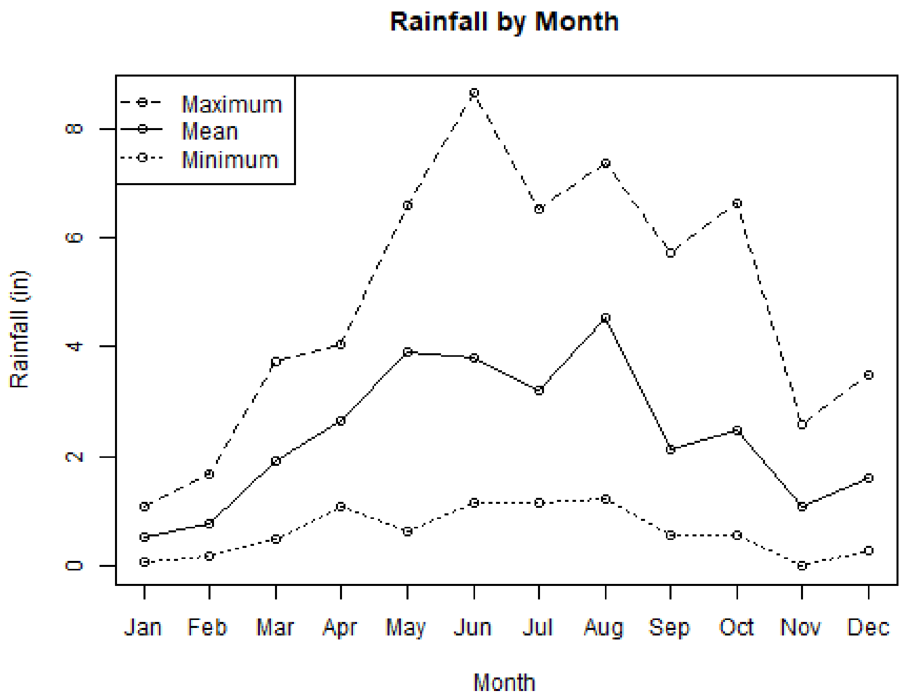
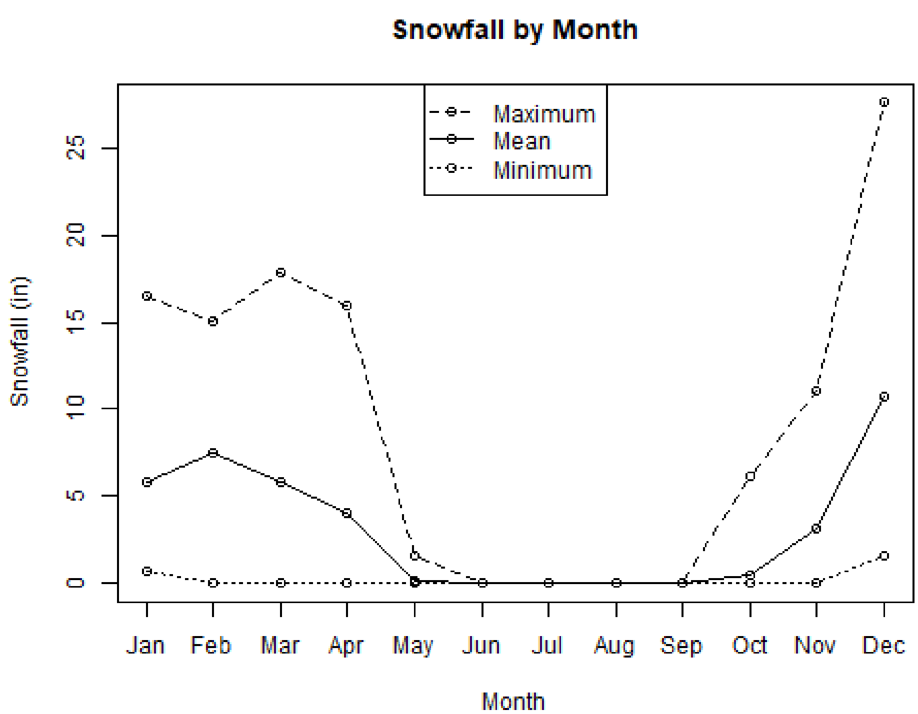


Figure F3 averages the monthly snowfall observations from 2006 to 2024 taken from the National Weather Service station STILLWATER 2 SW. Most snowfall occurs in December and January. Average annual snowfall for the same period of record (2006-2024) was 38.6 inches and ranged from 20.9 inches (2017) to 58.2 inches (2013).

Figure F3. Monthly snowfall statistics at the National Weather Service station (2006-2024)



The main findings of the precipitation trend analysis for this period are highlighted below. Overall, the results are consistent with the previous long-term analysis, though based on a shorter record. An extensive summary of climate and precipitation trends within the watershed is available in Appendix B.

- Rainfall amounts show a slight tendency to increase over time. Monthly patterns suggest that spring months (March-May) and late autumn (November) show the strongest signals of increasing rainfall.
- Some measures of maximum amounts of rainfall during 1-, 2-, 3- and 5-day wet periods (periods of consecutive wet days) also suggest a possible increase, though the evidence is not conclusive for the 2006–2024 period, especially considering the short length of record.
- Longer dry spells appear to have remained about the same over time, with no clear pattern of becoming longer or shorter.
- Both the total amount of snow and the deepest snow each year have remained fairly steady, with no clear long-term change.

1.2.3 Climate Change

In the foreseeable future, the approach to watershed management could shift because of climate change. As local monitoring data indicates, BCWD is already experiencing shifts in temperature and precipitation. Washington County identifies climate hazards including winter storms, tornadoes, and wildfire as high and medium priorities primarily due to the destructive potential of these hazards and their implications on recovery(5). Winter storms and wildfire hazards are closely tied to temperature and precipitation trends, while there is inconclusive evidence on the impact of climate change to the formation of tornadoes. Hazards such as flooding, extreme heat, and drought are directly connected to climate changes related to Brown's Creek's water resources.

Climate modeling from the Minnesota Climate Adaptation Partnership (MCAP) utilizes dynamically downscaled data from the Climate Intercomparison Project 6 (CMIP6) to provide high resolution data (2.5-mile spatial scale) to simulate climate change at regional or city scales. This process helps produce more localized, relevant, and usable data for anticipating future climate scenarios and undertaking adaptation planning. Late century (2060-2079) projections under the intermediate emissions scenario (SSP 245) and very high emissions scenario (SSP 585) provide a useful window of the range of changes anticipated in Washington County. These changes include(6):

- Increased annual precipitation with seasonal variation resulting in more precipitation in the Spring and Fall seasons, and less precipitation in the summer season.
- More days per year where daily precipitation exceeds one inch and two inches (representing major precipitation events).
- Fewer days annually below 32°F and overall warmer winter temperatures, fewer days of snow cover, and warmer lake bottom temperatures.
- More consecutive days of less than 0.01 inches of precipitation.
- More days exceeding 90°F.

While Appendix B summarizes the projected changes to Washington County's precipitation and temperature due to climate change, this trend of increased extreme rainfall events is expected to continue and is exceeding climate model projections. Evidence suggests precipitation may be twice as sensitive to warming as is reflected by models. Climate scientists do not anticipate a significant reduction in the uncertainty of long-term climate projections(5).

1.3 Geology and Topographic Data

The topography of the Brown's Creek watershed was formed by glacial and post-glacial processes. The significant geomorphologic formations in the watershed are Brown's Creek and the St. Croix Moraine, which is characterized by glacial moraine and glacial lake deposits. Brown's Creek gently meanders through the northern and middle portions of the watershed. Within its lower reach, Brown's Creek descends over 200 feet through what can be characterized as a narrow rock gorge. Bedrock is often exposed along the lower gorge portion of the creek. Geomorphologic and topographic data, including LiDAR and topographic maps, can be obtained from the Minnesota Department of Natural Resources and Minnesota Geospatial Commons. Additional sources include maps released by the Minnesota Geologic Survey(7) and the Washington County Geologic Atlas(8).

The entire watershed was covered by glacial sediments, termed Quaternary deposits, which range from zero to 150 feet in thickness and consist of unsorted sediment including boulders, gravel, clay, sand and silt. As a result, depth to bedrock throughout the watershed ranges from approximately zero feet to 150 feet(8). The Northern Washington County Groundwater Study(9), drillers' logs available through the Minnesota Well Index(10), and the Department of Transportation's Geotechnical log website contain technical information on the surficial depositional materials and hydrogeology(8).

Bedrock units in the Brown's Creek watershed are (from youngest to oldest):

- St. Peter Sandstone (this has been eroded away in most areas except the western part of the watershed district)
- Prairie du Chien Formation
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group/Wonewoc Formation, formerly known as the Franconia/Ironton/Galesville Formation
- Eau Claire Formation (Aquitard)
- Mt. Simon/Hinckley Formation

The watershed sits on the eastern edge of the "Twin Cities Basin," resulting in bedrock formations that dip slightly to the west. Erosion in the St. Croix Valley has removed some of the upper bedrock layers found in other parts of the basin. Consequently, the watershed is one of only a few areas in the Twin Cities where deeper bedrock formations such as the Tunnel City/Wonewoc are exposed at the ground surface. Additional GIS data for these geologic features and others, such as hydrogeologic assessment, aggregate resources, karst, and peat, are available through the Minnesota Geospatial Commons(4). Similar data, including shapefiles for bedrock geology, surficial geology and aggregate resources, geophysics, and geochemistry, is available through the Minnesota Minerals Coordinating Committee(8).

1.4 Soils

Soils in the Brown's Creek watershed are typically characterized as unconsolidated glacial lake deposits of sand, gravel, clay, and silt. Soil data are available from the database for Washington County at SSURGO by the Natural Resources Conservation Service (NRCS)(11). The hydrologic soil groups documented in the watershed are summarized in Table F2.

Table F2. Description and distribution of hydrologic soil groups in the Brown's Creek Watershed

Hydrologic Soil Group	Description	Percent Distribution							
		BCWD	Grant	Hugo	Lake Elmo	May Township	Oak Park Heights	Stillwater	Stillwater Township
A	Soils having high infiltration rates when thoroughly wet (low runoff potential). Deep, well drained to excessively drained sand or gravelly sand.	21.1%	71.2%	8.4%	0.5%	5.4%	0.4%	10.3%	3.8%
B	Soils having a moderate infiltration rate when thoroughly wet. Moderately deep or deep, moderately well drained or well drained with moderate to moderately coarse texture.	28.1%	35.0%	10.7%	2.6%	12.7%	3.9%	24.4%	10.7%
C	Soils having a slow infiltration rate when thoroughly wet: soils have a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.	24.3%	58.9%	14.4%	0.8%	8.3%	1.3%	13%	3.3%
D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.	<0.1%	0%	0%	0%	0%	0%	100%	0%
A/D	Soils having very slow rates of infiltration when thoroughly wet (high runoff potential): soils consist of clays with high shrink-swell potential; soils have a high permanent water table; soils that have a claypan or clay layer at or near the surface and soils that are shallow over nearly impervious material, mixed with soils of another hydrologic soil group.	4.2%	71.0%	3.2%	0%	1.6%	0%	12.7%	11.5%
B/D		10.4%	47.8%	14.2%	0.1%	19.7%	0.9%	14.4%	2.9%
C/D		4.3%	31.7%	10.7%	4.2%	29.5%	1.4%	9.5%	13.0%
N/A	Areas without enough information.	7.5%	35.3%	17.2%	1%	12.7%	0.5%	32.7%	0.6%

Source: Soil Survey of Ramsey and Washington Counties, 1977

1.5 Land Cover

Land cover impacts what happens to precipitation when it hits the landscape. Vegetation intercepts precipitation, slows the rate at which it travels, and returns moisture to the atmosphere via transpiration. Water use by different types of vegetation varies significantly. Trees and native grasses have extensive root systems that allow more water to soak into the soil, resulting in less runoff than pastures or lawns with very shallow roots. Impervious surfaces significantly increase the volume of water that runs off the landscape and the rate at which this water enters downstream waterbodies.

The Minnesota Land Cover Classification System (MLCCS)[12] is a tool that provides valuable data for natural resource managers and planners by categorizing the landscape in terms of its land cover. Between 2024 and 2025, BCWD updated its hydrologic and hydraulic model using TCMA 1-meter land cover data (2015) but has historically used MLCCS land cover data. This information has been used to conduct natural resource inventories and to define input parameters for the district's hydrologic and hydraulic models. The percentage breakdown of land cover within the watershed is shown in Figure F4[12] and Figure F5[13]. Prominent land covers present in the TCMA dataset for the watershed include Grass/Shrub (29.98%) and Deciduous Tree Canopy (29.58%). Impervious surfaces account for a total of 9.48% of the watershed with most of the development located in the southeast portion of the watershed.

Major changes in land cover since the previous plan include:

- Increase in areas with over 10 percent imperviousness from 13 to 23 percent of the watershed.
- Decrease in wetland area from 16 to 12 percent of the watershed.

Figure F4. Land cover types in the Brown's Creek Watershed based on 2024 MLCCS

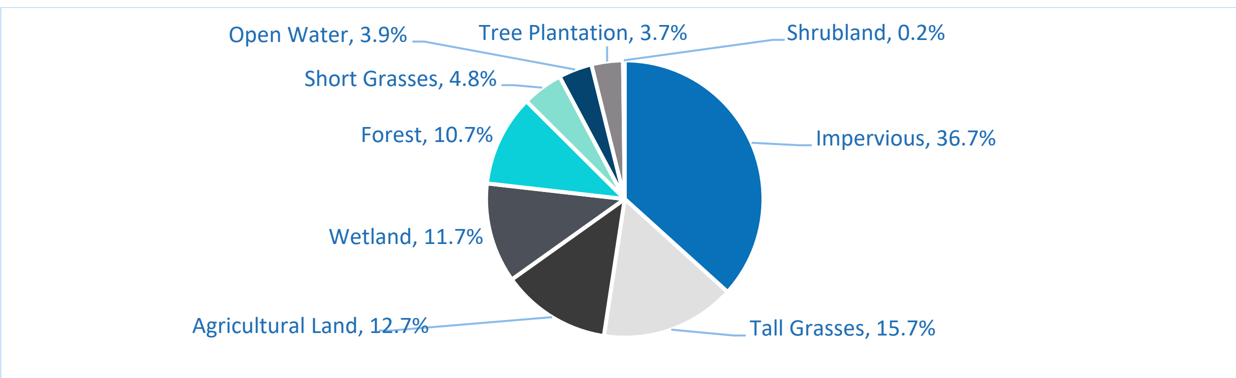
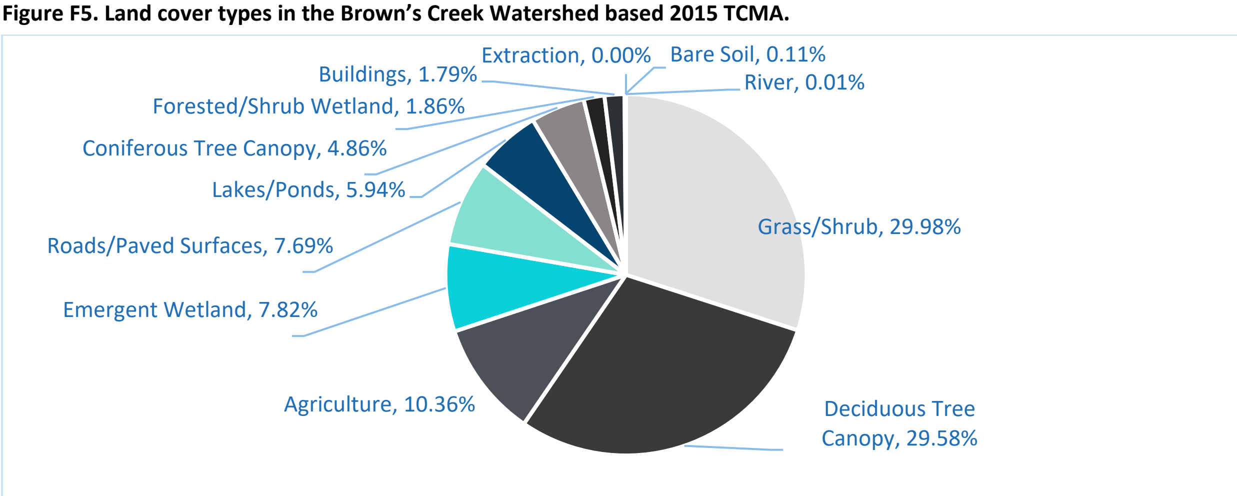


Figure F5. Land cover types in the Brown's Creek Watershed based 2015 TCMA.



1.6 Unique Features and Scenic Areas

The Brown's Creek watershed contains unique features and scenic areas which contribute to the overall quality of life within the watershed. Due to its location within an area of historic settlements and diverse ecosystems, there are unique historic and natural areas within the district, as summarized in Table F3. Additional data for unique features and scenic areas include Scientific and Natural Areas (SNAs), Natural Area Registry, Wild and Scenic Rivers, Minnesota Biological Survey (MBS) Sites of Biodiversity Significance, all of which is available through the Minnesota Geospatial Commons[(4)].

Table F3. Summary of unique features and scenic areas in the Brown's Creek Watershed

Feature	Description
12 Minnesota Biological Survey Sites of Biodiversity Significance	Minnesota Biological Survey ranks each site of biodiversity significance. One site was ranked as "high", three as "moderate", and eight as "below", which indicates areas of conservation value at the local level.
Brown's Creek	Minnesota Department of Natural Resources designated trout stream, Washington County Priority Conservation Area, and State Aquatic Management Area.
Brown's Creek Nature Preserve	Included within the Brown's Creek State Trail, the preserve is adjacent to approximately two miles of Brown's Creek and includes historical markers and educational signage.
Brown's Creek State Trail	5.9-mile multiple-use paved trail connecting to local parks and trails.
City of Stillwater	On the National Registry of Historic Places and is known as the birthplace of Minnesota.
City of Stillwater Trails	Paved, multi-use trails along Boutwell and McKusick roads that parallel lake and wetland habitats.
Gateway State Trail	18.3-mile multiple-use paved trail as part of the Rail-to-Trail Program.
Locations of Indigenous Cultural Significance	The St. Croix watershed is the traditional territory of the Ojibwe and Dakota nations. The watershed may contain archaeological records and culturally significant places associated with the past and present connection to the area's land and waters as a source of shelter, spirituality, food, community, and more.
Lower Gorge	Portion of Brown's Creek characterized by steep side slopes and valuable trout habitat.
Old Stone Bridge	A historic roadway bridge on the National Registry of Historic Places is located on private property and can be viewed from the Brown's Creek State Trail.
St. Croix River	Wild and Scenic Waterway administered by the National Park Service.
Tripoli clay	A poorly drained loamy clay that was mined commercially for polish sometimes used by dentists; most notably by Minnesota Tripoli Co., established 1866.
Washington County Trails	Paved, multi-use trails along CR 12 and CR 55 that connect with the Gateway and Brown's Creek State Trail systems.

2 Hydrologic System

2.1 Surface Water Resources

The Brown's Creek watershed contains valuable water resources including streams, lakes, ponds, and wetlands. The distinction between them is somewhat arbitrary as is seen in the narrative that follows. Refer to the figures at the end of this document for the surface water resources in the watershed.

2.1.1 Streams

The primary resource of the watershed is its namesake Brown's Creek, a Minnesota Department of Natural Resources designated trout stream. While many are familiar with the steep gradients of the lower reaches of Brown's Creek, the resources are quite diverse. There are several distinct reaches of the stream that extend from its mouth at the St. Croix River upstream to the headwaters region. The reaches of Brown's Creek have been grouped by their character and functional assessment into two main sections; the main branch and the north branch. Refer to Figure F11 and Figure F12 (at the end of the Land and Water Resource Inventory) for the reaches of Brown's Creek and its tributaries. The length of Brown's Creek and its tributaries are as follows:

- Brown's Creek is 7.92 miles long.
- Long Lake Tributary is 1.1 miles long.
- South Central Tributary is 2.6 miles long.
- Zephyr Tributary is 0.9 miles long.

2.1.1.1 North Branch Brown's Creek

The north branch of Brown's Creek consists of eight distinct reaches. The reaches are defined by changes in geomorphology or segmentation of the creek by road crossings. The north branch begins with two reaches above 110th Street. Reach one generally runs through the center of a shrub carr/emergent wetland, which is an area of groundwater discharge. Reach two runs through a dense, disturbed lowland hardwood forest and appears to be degraded, displaying moderate erosion. The specific path of the creek in this reach appears to be continually changing in response to changes within the wetland. There is evidence of past ditching within the wetland. Two tributary reaches from Goggins Lake (Goggins tributary reaches one and two) drain to north branch reach one. Goggins tributary reach two is similar in nature to north branch reach one. The Goggins tributary reach one runs through a relatively steep wooded ravine and has intermittent flow. BCWD built three infiltration basins at the outlet of Goggins Lake to alleviate local flooding issues, promote groundwater recharge, and decrease water temperatures in the north branch of Brown's Creek as part of the Trout Habitat Preservation Project (THPP). In 2006, an infiltration trench was added to increase recharge rates. These THPP projects created partially landlocked areas that are hydrologically connected only during large precipitation events.

Downstream of 110th Street, the north branch starts as a moderate-gradient stream, flowing for about one-quarter mile through a narrow floodplain of shrub swamp and mixed hardwood swamp (reach three). The north branch then enters a large emergent marsh wetland complex where it crosses the Gateway Trail (reach four). Downstream from the Gateway Trail, Brown's Creek reenters a mixed hardwood-tamarack swamp (reaches five and six). It then flows for approximately one mile before crossing Manning Avenue (reach seven). Downstream of Manning Avenue (Manning reach of the north branch), the creek flows through a ditched wetland where it joins the Mendel Road tributary. This tributary provides the outlet for the large wetland complex to the north, along the east side of Manning

Avenue. Both the Manning reach of the north branch and the Mendel Road tributary flow through ditches that were excavated through the Mendel wetland complex in the early 1900s.

2.1.1.2 Main Branch Brown's Creek

The main branch of Brown's Creek flows through a deep valley where the creek channel has cut into the Tunnel City Group bedrock formation. It is within these reaches that cold groundwater discharge provides a major component of the baseflow to Brown's Creek, thus providing one of the key elements necessary to support a cold-water fishery. The main branch has been subdivided into twelve distinct reaches extending from Highway 96 near Manning Avenue east to the St. Croix River. The McKusick reach runs from Highway 96 to the intersection of McKusick Road, where it winds through sedge meadow and shrub carr wetlands. Downstream of the McKusick Reach, the Minnesota Department of Natural Resources' reach nine runs from McKusick Road to Neal Avenue. Below Neal Avenue, the main branch is divided into the Neal Avenue reach and the golf course realignment reach. This reach was realigned by the Minnesota Department of Natural Resources in 1999 to replace a reach of the creek running through the Lake McKusick wetland. The purpose of the realignment was to improve fisheries habitat and reduce thermal pollution. Below the golf course realignment reach, the main branch is divided into seven reaches (Minnesota Department of Natural Resources reaches one through seven). This portion of Brown's Creek is bordered by steeply sloped hardwood forests and is impaired for aquatic life due to lack of cold-water assemblage and high turbidity and is impaired for aquatic recreation due to elevated levels of *E. coli*.

2.1.1.3 Brown's Creek Tributaries

In addition to the tributaries described above, there are several small tributaries in the southern portion of the watershed, including four reaches of the Long Lake tributary, two reaches of the south central tributary, and the Zephyr tributary. Long Lake tributary reach one flows from Highway 12 to Boutwell Road, and reach two flows from Boutwell Road to the confluence with the south central and Zephyr tributaries. The Zephyr tributary flows in from the west and has the least amount of discharge.

The south central tributary runs from the intersection of Manning Avenue and County Road 12 towards the northeast. South central tributary reach one is a very small tributary that winds through a wetland that stretches from County Road 12 to Boutwell Road. Reach two begins downstream of Boutwell Road and flows to the confluence with the Long Lake and Zephyr tributaries. At this point, the south central and Zephyr tributaries combine with Long Lake tributary reaches three and four and flow downstream to the Lake McKusick diversion structure located at the former railroad bed (City of Stillwater Trout Stream Mitigation Project – TSMP). Additional information about the TSMP can be found in section 2.4 Stormwater System.

Additional information about the specific reaches of Brown's Creek can be found in the BCWD Natural Resource Inventory Report[14]. A summary of the Rosgen assessment and information on fisheries can be found in the Brown's Creek Stream Classification Geomorphic Survey and Analysis[15]. More current information can be found in the routine visual (drone flight) stream assessments[16,17] and the geomorphic stream survey conducted at historic locations to monitor channel change over time[18].

2.1.1.4 Stream and Tributary Water Quality

The main water quality concerns for Brown's Creek and its tributaries are total suspended solids (TSS), total phosphorus (TP), thermal loads, and *E. coli* bacteria. The Brown's Creek and Long Lake Trend Analysis (2020) reviewed these water quality parameters and showed that concentrations of these pollutants exceeded standards for each reach during the time period for which each standard applies (e.g., Class 2A or Class 2B standards). Total suspended solids concentrations were above the regional water quality standard (10 mg/L for Class 2A stream reaches, 30 mg/L for Class 2B) in 27% to 79% of water quality samples taken at various sampling stations along the creek; total phosphorus concentrations were above the water quality standard (0.1 mg/L) in 19% to 59% of the samples; and *E. coli* concentrations were above the water quality standard (126 org/100 mL) in 60% to 90% of the samples. Temperatures exceeded the daily maximum critical temperature for trout (23.9C) two to 38 times a year from 2007 through 2014. Temperatures also exceeded the daily mean critical temperature for trout (23.9C) three to five times in 2011 and 2012.

While water quality is a concern and BCWD is working to address the load reduction targets assigned in the TMDL Implementation Plan, it's important to remember that the creek is impaired for aquatic recreation and aquatic life due to low levels of dissolved oxygen, lack of a cold-water fish assemblage, and high levels of *E. coli* (*Escherichia coli*) bacteria. Data from BCWD's macroinvertebrate sampling program (2015-2024) indicates an overall improving trend in stream health and macroinvertebrate community quality. section 3 Biological Environment describes the trends in macroinvertebrate community quality by region.

The Washington Conservation District has collected water quality samples at the diversion structure since 2006 to measure pollutant loads to Lake McKusick. In addition to characterizing nutrient loads, this sampling identified the episodic presence of heavy metals. In 2025, BCWD conducted a water quality analysis of the data collected in the drainage area to the diversion structure. This analysis found that both the phosphorus and heavy metals are associated with particulate sources, and that concentrations have decreased from 2020-2024 because of the work done to address erosion within the drainage area. The metals, which are concentrated in the Zephyr tributary drainage area and Long Lake tributary reach four area, are likely due to contamination from the historic railroad[(19)].

2.1.2 Lakes, Ponds, and Wetlands

In addition to Brown's Creek and its tributaries, the watershed includes lakes, large ponds, and wetlands.

2.1.2.1 Lakes

The most prominent lakes in the watershed are Long Lake in Stillwater, Lake Masterman in Grant, and North and South School Section Lakes in Hugo. Lesser-known lakes include Bass Lake East and West, Benz Lake, Goggins Lake, Kismet Basin, Lynch Lake, Pat Lake, and Plaisted Lake. Table F4 includes a summary of the physical characteristics of the lakes in the watershed.

Many of BCWD's lakes, ponds, and wetlands are included in the Minnesota Department of Natural Resources' Public Waters Inventory (PWI). These resources include public waters, which are all water basins and watercourses that meet the criteria set forth in Minnesota Statutes, Section 103G.005, subd. 15 that are identified on PWI maps authorized by Minnesota Statutes, Section 103G.201. These are what would typically be considered "lakes." In BCWD, the following water bodies are identified as public waters in the PWI: Long Lake, South School Section Lake, Lynch Lake, and North School Section Lake. There are also several large ponds and open water wetlands that provide many of the same recreational and aesthetic benefits as lakes, and in many cases are locally referred to and managed as lakes. These resources include Lake Masterman, Bass Lake East and Bass Lake West, Benz Lake, Goggins Lake, Kismet Basin, Pat Lake, and Plaisted Lake.

2.1.2.2 Ponds

The ponds and open water wetlands that provide recreational and aesthetic benefits and are also locally referred to and managed as lakes include Brewers Pond, Heifort Pond, July Avenue Pond, and Sinnets Pond (formerly the Jackson WMA). Table F6 includes a summary of the physical characteristics of these natural ponds and open water wetlands. In addition to these resources, there are 21 other named and unnamed ponds and open water wetlands in the watershed (see Figure F13).

2.1.2.3 Aquatic Vegetation Management

BCWD has conducted point-intercept aquatic plant surveys on several of its lakes and ponds. This method is considered the standard protocol by Minnesota Department of Natural Resources for sampling macrophytes because it offers a methodology that is quantitative (e.g., frequency of occurrence), repeatable (can be used to track trends in aquatic plant communities over time), and georeferenced (can be used to compare plant communities within different areas of a lake). From this data, a Floristic Quality Index (FQI) is calculated to measure the diversity and health of the aquatic plant community. The FQI calculation is based on both the quantity of species observed (species richness) and the quality of each individual species. Every aquatic plant in Minnesota has been assigned a coefficient of conservatism value (c-value) ranging from zero to 10. The c-value of all aquatic plants sampled from a lake is used to determine the FQI for a given lake. Species with a c-value of zero include non-native species such as curly-leaf pondweed (*Potamogeton crispus*) that are indicative of a highly disturbed environment. In comparison, the native species Oakes pondweed (*Potamogeton oakesainus*) has a c-value of 10.

Recent aquatic plant surveys have resulted in the discovery of snailseed pondweed (*Potamogeton bicupulatus*), a state-listed endangered aquatic plant, in at least two waterbodies. Including BCWD waters, snailseed pondweed has only been documented at 16 sites out of over 2,000 surveyed by the Department of Natural Resources in the entire state. Out of these 16 sites, BCWD lakes represent the southernmost populations of snailseed pondweed in Minnesota. In addition to snailseed pondweed, point-intercept surveys and wetland surveys have documented additional rare and unique aquatic plant species in small lakes and ponds. These include county records of slender naiad (*Najas gracillima;* state-listed special concern), Vasey's pondweed (*Potamogeton vaseyii*; former state-listed special concern) and forked stonewort (*Nitella furcata)* along with regional rarities such as spiny coontail (*Ceratophyllum echinatum;* state-listed watch list) and spiral pondweed (*Potamogeton spirillus*). These species share the common trait of affinity for lakes and ponds with soft water chemistry (low alkalinity), and the Brown's Creek Watershed represents the southern range extent for most of these plants. Additional lakes and ponds within the watershed likely support these species, but the drivers of their habitat are not well understood. It appears there may be unique geology and/or water chemistry that can support these species within the watershed. The presence of these rare and uncommon species is a testament to the biodiversity value of district waters, but further knowledge of their distribution within the watershed and suitable environmental conditions is necessary to best preserve and protect these unique species for the future.

2.1.2.4 Lake Water Quality

Overall lake water quality in the Brown's Creek watershed appears relatively stable. According to the Lake Water Quality Summary provided in the 2024 Baseline Monitoring Report, the lake grades have remained within certain grade ranges over the last 10 years (e.g., A and B, C and D, or D and F), as follows. Further description of lake water quality can be found in section 2.3 Impairments and TMDL.

- Five of the lakes' water quality grades have remained consistently within the A-B range, indicating sustained high water quality [Bass Lake East, Bass Lake West, Lake Masterman, Plaisted Lake, and Wood Pile Lake]
- Seven of the lakes' water quality grades have remained within the B-C range, suggesting moderate but stable conditions [Benz Lake, Sinnets Pond, Kismet Basin, Long Lake, North School Section Lake, Pat Lake, and South School Section Lake]
- Six of the lakes' water quality grades have stayed within the C-D or the D-F range, reflecting persistently poor water quality without significant change [Brewer's Pond, Goggins Lake, Heifort Pond, July Avenue Pond, Lynch Lake South, and Lynch Lake North]

2.1.2.5 Lake Management Plans

BCWD has developed management plans for all its lakes and ponds (see Table F5 and Table F7). Each plan included an assessment of the lake and its watershed and a stakeholder engagement process that included a series of meetings with lakeshore residents. Residents were educated on lake and watershed management issues, were asked to provide first-hand observations related to the condition of their lake, and helped define future lake management objectives.

In the 2017-2026 Watershed Management Plan, the district adopted a strategy to develop management plans for large ponds and wetlands that residents' value and, in some cases, utilize as lakes. Given the size of the resources, public access, and the number of landowners using these resources, these management plans are a scaled-down version of a typical lake management plan and focus on reducing watershed nutrient loading and internal phosphorous loading.

Most recently, the district identified the need to re-engage with residents living on previously evaluated lakes. Some of the residents involved in the original planning efforts are no longer living on the lakes, and new residents have moved in. District staff have noted that the new residents have not been educated on shallow lake dynamics and have expressed concerns about the abundance of aquatic plants within the lakes. Many of the lakes that had been previously assessed were revisited to provide outreach and updated lake assessment data. In addition, the district has updated their approach to developing lake management plans to include a flood risk assessment element (see Table F13).

2.1.2.6 Wetlands

The watershed is also home to numerous small wetland basins. The PWI also includes public waters wetlands, which include all type 3, type 4, and type 5 wetlands (as defined in U.S. Fish and Wildlife Service Circular No. 39, 1971 edition) that are 10 acres or more in size in unincorporated areas or 2.5 acres or more in size in incorporated areas. These are wetlands that would typically be referred to as large ponds. Refer to Appendix A of the plan for a complete listing of the district resources that are included in the PWI. These resources are also shown in Figure F13 (at the end of the Land and Water Resource Inventory).

Beyond the PWI wetlands, there are 619 smaller wetlands throughout the watershed mapped by the National Wetland Inventory (NWI). These include 293 wetlands >1 acre, and 326 wetlands < 1 acre. Many large wetland complexes comprised of several wetland types and likely do not include smaller, seasonally flooded/saturated wetlands undocumented by the NWI. To document the wetland resources within the watershed, the district conducted a wetland inventory and assessment in 1998 with an update in 2005 and 2024 (see Figure F14 through Figure F17 at the end of the Land and Water Resource Inventory). Each of these inventories are described below:

- The wetland function and value assessment conducted in 1998 was based on the Minnesota Routine Assessment Method (MnRAM) for evaluating wetland functions - Version 2.0 developed by the Minnesota Interagency Wetlands Group. Wetland communities greater than 2.5 acres were selected for inclusion in the function and value assessment portion of the inventory. All wetlands below 2.5 acres were included within the inventory, but a function and value assessment was not performed. The methodology used assessed nine functions or values of wetland communities including vegetative diversity and integrity, maintenance of characteristic hydrologic regime, flood and stormwater storage/attenuation, water quality protection, shoreline protection, ground-water interaction, wildlife habitat: maintenance of characteristic animal communities, fishery habitat, and aesthetics/recreation/education/cultural and science.
- For the 2005 inventory, all wetlands within the watershed regardless of their size were inventoried using aerial photography and existing wetland databases and inventories (including NWI). The wetlands were mapped and field verified as needed. In addition to the mapping, a function and value assessment (FVA) was conducted on all wetlands over one acre in size. The FVA evaluated the general conditions of wetlands in terms of the functions they serve on the landscape and the value they provide. The information from the FVA was used to develop a management classification system which is used in the district's regulatory program.
- In 2024, an update to the FVA was conducted using the Board of Water and Soil Resources' and Wisconsin Department of Natural Resources' draft Wisconsin-Minnesota Rapid Assessment Method (RAM). The use of this tool provided additional function and value categories through which wetland areas could be refined. Twelve wetlands were assessed using the RAM protocol and then extrapolated across the watershed to update the management classifications of all wetlands greater than one acre in size within the watershed according to existing district rules (See Figure F14 through Figure F17).

Table F4. Physical Characteristics of BCWD Lakes and Ponds

Waterbody	PWI #	PWI Classification	Lake/Pond Size [Acres]	Maximum Depth [feet]	% Littoral Area	Eutrophication Status	Aquatic Invasive Plant Presence
Bass Lake East	82-0124-00	Wetland	29	18	99	Mesotrophic	Unknown
Bass Lake West	82-0123-00	Wetland	72	15	100	NA	None
Benz Lake	82-0120-00	Wetland	36	7	100	Hypereutrophic	CLP
Goggins Lake	82-0077-00	Wetland	54	15	100	NA	CLP, EWM
Kismet Western & Eastern Basins	82-0333-00 & 82-0334-00	Wetland	70	11	100	Eutrophic	Unknown
Long Lake	82-0021-00	Water	110	21	95	NA	EWM
Lynch Lake North	82-0042-00	Water	14	6	100	Hypereutrophic	Unknown
Lynch Lake South	82-0042-00	Water	32	16	100	Hypereutrophic	Unknown
Lake Masterman	82-0126-00	Wetland	40	7	100	NA	EWM
North School Section Lake	82-0149-00	Water	72	12	100	NA	Unknown
Pat Lake	82-0125-00	Wetland	20	16	99	Eutrophic	CLP
Plaisted Lake	82-0148-00	Wetland	41	11	100	Bordering on Hypereutrophic	CLP, EWM
South School Section Lake	82-0151-00	Water	109	12	50	NA	CLP, EWM
Wood Pile Lake	82-0132-00	Wetland	15	27	8	Mesotrophic	CLP

Table F5. BCWD Lakes and Ponds Management Summary

Waterbody	DNR Shoreland Management Classification	BCWD Lake Management Plan	MPCA Assessed	Applicable WQ Standard	Aquatic Recreation Use	BCWD Monitored	Meets Standard	3-year Average WQ Grade (22-24)	Watershed Load Reduction Target (lbs/year)	Internal Load Reduction Target (lbs/year)
Bass Lake East	NA	2022 Bass East & West Management Plan	Y	Shallow	FS	Y	Meets	B+	NA	NA
Bass Lake West	NA	2022 Bass East & West Management Plan	Y	Shallow	FS	Y	Meets	B+	NA	NA

Waterbody	DNR Shoreland Management Classification	BCWD Lake Management Plan	MPCA Assessed	Applicable WQ Standard	Aquatic Recreation Use	BCWD Monitored	Meets Standard	3-year Average WQ Grade (22-24)	Watershed Load Reduction Target (lbs/year)	Internal Load Reduction Target (lbs/year)
Benz Lake	Natural Environment	2009 Benz Lake Management Plan 2024 Assessment Update	Y	Shallow	NS	Y	Greatly exceeds Nutrient Impairment	B-	NA	NA
Goggins Lake	NA	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	N	NA	NA	Y	Greatly exceeds	C+	55.1	37
Kismet Western & Eastern Basins	NA	2024 District-Wide Pond Management Plan	Y Y		Nutrient Impairment			B+	NA	NA
Long Lake	Recreational Development	2006 Long Lake Management Plan 2024 Assessment Update	Y	Shallow	FS	Y	Meets	B+	157	NA
Lynch Lake North	Natural Environment	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	Y	Shallow	FS	Y	Meets	D	5.5	108.4
Lynch Lake South	Natural Environment	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	Y	Shallow	NS	Y	Greatly exceeds Nutrient Impairment	C+	3.5	172.1
Lake Masterman	Natural Environment	2010 Masterman Lake Management Plan 2024 Assessment Update	N	NA	NA	Y	Greatly exceeds Nutrient Impairment	B+	NA	NA
North School Section Lake	Natural Environment	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	N	Shallow	FS	Y	Meets	B+	15.1	4.9

Waterbody	DNR Shoreland Management Classification	BCWD Lake Management Plan	MPCA Assessed	Applicable WQ Standard	Aquatic Recreation Use	BCWD Monitored	Meets Standard	3-year Average WQ Grade (22-24)	Watershed Load Reduction Target (lbs/year)	Internal Load Reduction Target (lbs/year)
Pat Lake	NA	2024 District-Wide Pond Management Plan	Y	Shallow	NS	Y	Exceeds Chloride & Nutrient Impairment	B	NA	NA
Plaisted Lake	Natural Environment	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	Y	Shallow	NS	Y	Greatly exceeds Nutrient Impairment	B+	18.7	0
South School Section Lake	Natural Environment	2015 Northern Chain of Lakes Watershed Restoration & Protection Plan 2024 Assessment Update	Y	Shallow	NS	Y	Greatly exceeds Nutrient Impairment	B-	10.6	22.3
Wood Pile Lake	NA	2011 Woodpile Lake Management Plan 2024 Assessment Update	Y	Shallow	FS	Y	Meets	A	NA	NA

Table F6. Physical Characteristics of BCWD Natural Ponds and Open Water Wetlands*

Waterbody	PWI #	PWI Classification	Lake/Pond Size [Acres]	Maximum Depth [feet]	% Littoral Area	Eutrophication Status	Aquatic Invasive Plant Survey
Brewers Pond	82-0022-00	Wetland	9	15	100%	Eutrophic	None
Heifort Pond	82-0485-00	Wetland	6	8	100%	Hypereutrophic	None
July Ave Pond	82-0318-00	Wetland	12	9	100%	Hypereutrophic	None
Sinnits Pond (Jackson WMA)	82-0305-00	Wetland	14	7	100%	Eutrophic	EWM

***This table includes information for the natural ponds and open water wetlands that are being monitored for water levels only.**

Table F7. BCWD Natural Ponds and Open Water Wetlands Management Summary*

Waterbody	DNR Shoreland Management Classification	BCWD Lake Management Plan	MPCA Assessed	Applicable WQ Standard	Aquatic Recreation Use	BCWD Monitored	Meets Standard	3-year Average WQ Grade	Watershed Load Reduction Target	Internal Load Reduction Target	Aquatic Plant Management
Brewers Pond	NA	2024 District-Wide Pond Management. Plan	N	NA	NA	N	Not Assessed	D+	NA	NA	
Heifort Pond	NA	2024 District-Wide Pond Management. Plan	N	Shallow	NA	Y	Greatly exceeds	D	NA	NA	
July Ave Pond	NA	2024 District-Wide Pond Management. Plan	N	Shallow	NA	Y	Nearly meets	D	NA	NA	
Sinnits Pond (Jackson WMA)	NA	2024 District-Wide Pond Management. Plan	Y	Shallow	FS	Y	Nearly meets	B	NA	NA	

*** This table includes information for the natural ponds and open water wetlands that are being monitored for water levels only.**

Table F8. Critical Event Analysis for Lakes and Ponds assessed in 2024 District-Wide Pond Management Plan

Waterbody	PWI #	Critical Event	HWL [feet]	Buildings (#)		Wells (#)		Septic Systems (#)		Roads/Driveways (LF/Depth)
				HWL Footprint	w/in 15 ft	HWL Footprint	w/in 15 ft	HWL Footprint	w/in 15 ft	HWL Footprint
Bass Lake East	82-0124-00	10-day Snowmelt	963.7	0	1	0	0	0	0	90/1.0
Benz Lake	82-0120-00	100-year 24-hour	956.51	0	0	1	1	0	0	0
Long Lake	82-0021-00	100-year 24-hour	895.1	5	8	0	0	0	0	380/1.3
Lynch Lake North	82-0042-00	100-year 24-hour	1008.65	1	1	0	0	0	0	0
Lynch Lake South	82-0042-00	100-year 24-hour	1008.65	0	0	0	1	0	0	0
Lake Masterman	82-0126-00	100-year 24-hour	965.4	0	0	0	0	0	0	225/1.6
Plaisted Lake	82-0148-00	10-day Snowmelt	974.5	0	1	0	0	0	0	2780/2.8
Wood Pile Lake	82-0132-00	100-year 24-hour	972.5	2	3	0	0	1	2	1450/2.5
South School Section Lake	82-0151-00	10-day Snowmelt	974.5	0	0	0	0	0	0	1070/1.4
North School Section Lake	82-0149-00	10-day Snowmelt	974.5	0	0	0	0	0	0	0
Bass Lake West	82-0123-00	10-day Snowmelt	957	0	957	0	0	0	0	0
Goggins Lake	82-0077-00	10-day Snowmelt	974.5	0	0	3	5	0	0	1070/1.4
Kismet Western & Eastern Basins	82-0333-00 82-0334-00	100-year 24-hour	946.81	3	4	1	1	0	0	280/0.3
Pat Lake	82-0125-00	10-day Snowmelt	948.61	0	0	0	0	0	0	0
Sinnits Pond (Jackson WMA)	82-0305-00	100-year 24-hour	894.94	0	0	0	0	0	0	0
July Ave Pond	82-0318-00	10-day Snowmelt	980.66	3	4	0	0	0	0	490/2.2
Heifort Pond	82-0485-00	100-year 24-hour	887.62	1	1	0	0	0	0	0
Brewers Pond	82-0022-00	100-year 24-hour	894.1	1	1	0	0	0	0	0

2.2 Landlocked Basins

BCWD defines a landlocked basin as a basin or localized depression that does not have a natural outlet at or below the water elevation of the 10-day precipitation event with a 100-year return frequency. Approximately 71 percent of the watershed flows overland to the St. Croix River. The remaining 29 percent of the watershed is composed of landlocked and semi-landlocked basins producing no regular overland flow. Of the landlocked areas, 66 percent of this area is located along the western border of the watershed, 16 percent is located in the central portion of the watershed, 12 percent is located in the northern portion of the watershed and 6 percent is located in the lower portion of the watershed (see Figure F18 at the end of the Land and Water Resource Inventory).

Landlocked basins can only lose water through evaporation, transpiration, and infiltration. As a result, landlocked basins are a special concern because conditions such as alterations in land use or a changing climate can result in drastic and lasting alterations to water surface elevations. As water tables rise during periods of above-average precipitation, seepage out of landlocked basins cannot compensate for the increase in volume, and structures and property below the natural outlet elevation may be at risk of flooding. Continuous seepage from landlocked basins plays an important role in the hydrologic cycle by providing groundwater recharge. While outlets could be provided to address issues related to high water levels, they may result in impacts to the downstream hydrological conditions of the system (e.g., flooding on downstream waterbodies as more water is transferred from one depression to the next, infrastructure capacity and drainage issues, and lower groundwater elevations).

A Landlocked Basin Study was first completed in 2006 to guide decisions on balancing flooding, property rights, and environmental considerations while maintaining natural hydrology[20]. That study used the 100-year, 10-day rainfall event (10.8 inches) to identify landlocked basins within the watershed. It determined that 28 subwatersheds were landlocked and led to the development of a policy for structures and outlets in these areas. The analysis was updated in 2015 using the district's revised H/H model[21]. This update applied the Atlas 14 depth of 9.83 inches along with the NRCS MSE3 rainfall distribution over 10 days. The results were generally consistent with the 2006 study, though additional LiDAR-based detail revealed that portions north of the gorge area should also be classified as landlocked. With these refinements, the total number of landlocked subwatersheds increased to 53. Subwatershed boundaries were also modified to reflect outcomes from lake management studies and permitted developments.

A new landlocked basin analysis was completed in 2024 using the most recent H/H model. The updated model produced results very similar to the 2015 analysis, with only minor boundary adjustments based on higher-resolution LiDAR data. In addition, catchment delineations were refined, resulting in 86 landlocked subwatersheds being identified in the updated model, covering a total area of 30%.

It is the policy of the district to minimize the connectivity of impervious surfaces to stormwater conveyance systems and preserve the natural hydrology of landlocked basins to minimize basin and downgradient flood risk. This policy is implemented through the application of BCWD's Stormwater and Floodplain and Drainage Alteration Rules. With this, the volume control rule 2.4.1 prohibits increases of runoff volume to landlocked basins for events up to the 5-year 24-hour rainfall. Similarly, the district's Floodplain and Drainage Alteration Rule require additional freeboard for buildings being constructed within a landlocked basin. Additional information regarding the district's landlocked basin policy is available in BCWD's Rules (Appendix E).

2.3 Impairments and TMDLs

2.3.1 Inventory of Impairments and TMDL Schedule

The watershed contains four stream reaches and six lakes that are included on the MPCA 2024 303d (Impaired Waters) list(22). Both branches of Brown's Creek, the north branch (from 110th Street to Manning Avenue) and main branch (Highway 96 near Manning Avenue to the St. Croix River) are impaired for aquatic recreation and aquatic life due to low levels of dissolved oxygen, lack of a cold-water fish assemblage, and high levels of *E. coli* (*Escherichia coli*) bacteria. The north branch is also impaired due to a low score of the Minnesota Macroinvertebrate Index of Biological Integrity (M-IBI). The reach of the Long Lake tributary (-767) impaired for aquatic recreation stretches from 80th Street North/Boutwell Road to the diversion structure, and the reach of the Long Lake tributary (-765) impaired for aquatic life stretches from the ravine south of 62nd Street to Long Lake.

Table F9. Impaired Reaches of Brown's Creek as Identified on the MPCA 2024 Impaired Waters List

Reach Name	Reach Description	Reach ID	Affected Use[1]	Approved Plan[2]	Needs Plan[3]
Brown's Creek North Branch	T30 R21W S12, north line, to T30 R21W S13, east line	07030005-587	AQR, AQL	None	M-IBI, E. coli, LCWA, DO
Brown's Creek Main Branch	T30 R20W S18, west line to the St. Croix River	07030005-520	AQR, AQL	LCWA, T	E. coli, DO
Long Lake Tributary	T30 R20W S19, south line to underground diversion	07030005-767	AQR	None	E. coli
Long Lake Tributary	Unnamed cr to Long Lk (82-0021-00)	07030005-765	AQL	None	Chloride

Benz Lake, Long Lake, Lynch Lake, South School Section Lake, and Goggins Lake are all impaired for aquatic recreation due to high levels of nutrients. Long Lake is also impaired for aquatic life due to high chloride concentrations. According to the Brown's Creek and Long Lake 2020 Trend Analysis(23), Long Lake may be eligible for delisting as it is meeting the North Central Hardwoods Shallow Lake standard with total phosphorus and Secchi depth transparency meeting the standard. Chlorophyll-a concentrations remain above the water quality standard as does chloride concentrations.

In 2022, the Minnesota Department of Natural Resource removed Plaisted Lake's impairment for aquatic recreation due to high levels of nutrients.

Table F10. Impaired Lakes of Brown's Creek Watershed as Identified on the MPCA 2024 Impaired Waters List.

Lake Name	Lake ID	Water Quality Impairment[4]	Approved Plan	Needs Plan
Benz	82-0120-00	AQR	None	Nutrients
Long	82-0021-00	AQR, AQL	None	Nutrients, Chloride
Lynch	82-0042-00	AQR	None	Nutrients
South School Section	82-0151-00	AQR	None	Nutrients
Unnamed (Goggins)	82-0077-00	AQR	None	Nutrients

[1] AQR = aquatic recreation; AQL = aquatic life
[2] T = turbidity; LCWA = lack of cold-water assemblage
[3] DO= dissolved oxygen; M-IBI = aquatic macroinvertebrate bioassessments; LCWA = lack of cold-water assemblage
[4] AQR = aquatic recreation; AQL = aquatic life

2.3.2 Brown's Creek TMDL and Implementation Plan

In October 2010, BCWD completed the Brown's Creek Impaired Biota TMDL Report and Stressor Identification(24). Through the stressor identification process, the primary stressors to the biota in the impaired reach of Brown's Creek were identified as high suspended solids, high temperatures, and high copper concentrations. The TMDL is based on total suspended solids, which also serves as the surrogate measure for the turbidity impairment, and thermal load, which addresses the temperature stressor. Due to uncertainties related to the reliability of the copper monitoring data, copper loading allocations were not developed. The TMDL report was approved by the Environmental Protection Agency (EPA) in December 2010.

In February 2012, BCWD completed the Brown's Creek TMDL Implementation Plan(25). This document presents the implementation plan for the Brown's Creek Impaired Biota TMDL and is intended to assist member communities in meeting the goals for waste load allocations (WLAs) and load allocations (LAs). BCWD has been tracking progress towards meeting the goals established in the TMDL Implementation Plan by periodically checking in with member communities and maintaining a TSS accounting spreadsheet.

2.3.3 Lake St. Croix TMDL

Lake St. Croix, the lower 25 miles of the St. Croix Basin between Stillwater, MN and Prescott, WI, was designated as an impaired water body in 2008 for excess phosphorus. A TMDL for phosphorus in Lake St. Croix was developed through a collaborative effort among the Minnesota Pollution Control Agency (MPCA), the Wisconsin Department of Natural Resources (WDNR) and the Basin Team. The Lake St. Croix Nutrient TMDL underwent public notice, review and comment, and agency approval (approved by EPA in August 2012). The primary components of the TMDL were based on the results of past lake and nutrient loading studies. The entire report and supplemental reports are available at the MPCA TMDL website(26).

To meet the goals for Lake St. Croix and improve water quality throughout the watershed, communities and landowners in the St. Croix Basin need to reduce phosphorus in wastewater treatment facility discharges and stormwater runoff from urban, residential, agricultural, and forestry land. The Lake St. Croix Implementation Plan(15) recommends implementation activities to restore Lake St. Croix and its tributary streams from the impacts of excessive phosphorus loadings. This plan also calls for a baseline load reduction of 1,947 pounds of phosphorous for BCWD based on the area of the watershed and a baseline phosphorous export coefficient. This recommended load reduction has since been adjusted to reflect the nine years of BCWD monitoring data, which indicate that the actual phosphorous loading is less than half of the baseline estimate and excludes the landlocked (non-contributing) portion of the watershed. This revised phosphorous load reduction is 848 pounds per year. In addition to prioritizing local best management practice (BMP) retrofits, this plan emphasizes civic engagement and adaptive management as critical components to implementation.

2.3.4 Lake McKusick TMDL

The McKusick and Lily Lake Management Plan(27) was developed by the City of Stillwater and Brown's Creek Watershed District to provide a framework for the restoration and protection of Lily, Long, and McKusick Lakes. This plan is available on the City of Stillwater website. As a component of this project, water quality data from 1994 to 2006 were assessed for Lake McKusick, and a computer model on phosphorous loading was generated. The model identified areas prone to high phosphorous loading and future pollution reduction projects. During plan development, the city convened several meetings with government agencies and area residents to develop management objectives and implementation activities.

Lake McKusick has a surface area of 45 acres, an average depth of three feet, and a total drainage area of approximately 6,800 acres. Of this drainage area, 5,670 acres reside in the Brown's Creek Watershed and is comprised of the tributaries conveying flow to the Lake McKusick diversion structure (McKusick Direct – 30 acres, Zephyr tributary – 190 acres, Long Lake tributary – 2,290 acres, and southwest tributary – 3,160 acres). A significant portion of the western drainage area in the watershed is landlocked for the 100-year, 10-day rainfall event, and therefore does not contribute runoff to Lake McKusick. The remaining drainage comes from Lily Lake as well as that which is directly connected via storm sewer.

The McKusick and Lily Lake Management Plan stated that Lake McKusick had, in general, fairly good water clarity for an urban shallow lake. However, both total phosphorus and chlorophyll-a exceeded the state standards over the ten years before the plan was published. Water clarity was likely maintained by the presence of a relatively healthy aquatic vegetation and zooplankton community. Lake McKusick was listed on the 303(d) impaired waters list for nutrient concentration which inhibits aquatic recreation for Minnesota in 2006.

The McKusick and Lily Lake Management Plan establishes the load reductions needed to meet the state standard for total phosphorus. These load reductions are assigned to the various drainage areas contributing to the lakes. The load reduction assigned to BCWD comes from what the plan refers to as the "annexed areas" which is the drainage area to the diversion structure. This load reduction is 148 lbs. of total phosphorus. The management activities listed in the plan are a set of capital projects and ongoing maintenance and operations activities slated to achieve the management goals. Some of the activities are scheduled to be completed by the City of Stillwater, while many other recommendations are provided to supplement BCWD's watershed management plan. Most of the plan's implementation activities within the BCWD boundary have been completed or are scheduled for implementation. While Lake McKusick has since been delisted, it is important that BCWD and additional stakeholders continue to work to maintain or improve the water quality in the lake and ensure that it is not relisted.

2.4 Stormwater System

Beginning at the top of the watershed and working towards the outlet to the St. Croix River, the stormwater system as it exists today can be described as follows. The rural and landlocked nature of the northern and western portions of the watershed has resulted in limited constructed stormwater management features. Impervious coverage in these areas is primarily conveyed via roadside ditches, centerline crossing culverts, and driveway culverts where flow accumulates in the landscape. Roadway centerline culvert crossings of County Road 57, 110th Street, the Gateway Trail, Manning Avenue, and Trunk Highway 96 are the creek conveyances of significance. Constructed stormwater ponds and storm sewer systems are encountered where Brown's Creek enters the Stillwater orderly annexation area south of Trunk Highway 96. A detailed description of the stormwater treatment and conveyance systems can be found in the Local Surface Water Management Plans identified in Table F11. Most of Brown's Creek and tributary conveyance structures are included in the 2025 BCWD H/H Model. Portions of municipal systems located within the watershed are also included in the 2025 BCWD H/H Model but only to the degree that information has been made available through development reviews, district studies, and district projects. Regional stormwater management facilities are listed in Appendix A.

Table F11. Stormwater System Area Reference

Municipality	Publication	Stormwater System Section
City of Grant	2019 Comprehensive Plan Update	Appendix B: Surface Water Management Plan
City of Hugo	2019 Comprehensive Plan	Chapter 8: Surface Water Management
City of Lake Elmo	2030 Comprehensive Local Surface Water Management Plan	Figure 16B: Storm Water System (NE Area)
City of Oak Park Heights	2009 Local Surface Water Management Plan	Map 1: Storm Sewer System Map
City of Stillwater	2007 Local Surface Water Management Plan	Appendix D: Local Surface Water Management Plan
May Township	2024 Comprehensive Plan	Surface Water Management Plan
Stillwater Township	2013 Local Water Management Plan	Section 3: Land and Water Resource Inventory

Major alterations to the hydrology of the watershed are described below in chronological order:

- In 1955, the Minnesota Department of Natural Resources fisheries managers decided to reroute Brown's Creek from Lake McKusick to relieve temperature stress on the trout population. Subsequent projects continued to target stream temperature reductions.
- In 1999, the Minnesota Department of Natural Resources rerouted the creek along the Minnesota Zephyr Rail Line and through the Oak Glen Golf Course. This reduced the water temperature by shortening the stream length and reducing the water residence and solar exposure time.
- In 2000, BCWD modified the drainage system with the Trout Habitat Preservation Project (THPP). This project involved building three infiltration basins at the outlet of Goggins Lake to alleviate flooding while reducing impacts to the headwaters of Brown's Creek. This was accomplished by promoting groundwater recharge and decreasing water temperatures in the North Branch of Brown's Creek. To enhance recharge rates, an infiltration trench was added to the basins in 2005-2006. The THPP created partially landlocked areas that are hydrologically connected to the stream system during extreme precipitation events. Most of the time this area is connected to Brown's Creek by infiltrating the water that drains to this portion of the watershed, thereby recharging the groundwater system.
- In 2002, BCWD constructed a controlled outlet to provide flood attenuation throughout the series of wetlands that make up the Kismet Basin in the central portion of the watershed. This project conveys flow beneath Lansing Avenue North to Brown's Creek just north of the Gateway Trail. Additional details on this project are available on the BCWD website.
- In 2003, the City of Stillwater built the Lake McKusick diversion structure that rerouted stormwater runoff and altered the hydrologic connectedness of the Long Lake, South Central, and Zephyr Tributary areas. The diversion pipe channels the runoff from storms with a magnitude of three inches or less into Lake McKusick instead of Brown's Creek. In addition, the environmental review report *Stillwater Annexation Area Alternative Urban Areawide Review (May 1997)* for the City of Stillwater provides valuable information related to the Stillwater Annexation Area. This report is available at the district and city offices.

2.5 Water Quantity, Watershed Loading, and In-Lake Water Quality Modeling

To further define the hydrologic and hydraulic system of the watershed, BCWD has prepared water quantity electronic models (see Table F12). The first of these models, the Hydrologic and Hydraulic XP-SWMM model (H/H model), was developed in 1998. Over time, the H/H model has been updated to reflect land use changes in the watershed that occurred since the original publication. Many of the updates to the H/H model have been born out of development reviews for the district's stormwater rule. In addition, modifications have been made to reflect newly acquired survey data and higher resolution topographic and land cover data. BCWD is committed to performing routine updates to the H/H model to maintain as realistic and up to date a model of the system as possible. The timeline and a brief description of these revisions are provided below.

BCWD's H/H Model has been used to assist in the district's permitting program, to design water quantity and water quality improvement projects, to update the county's flood hazard map, and to conduct scenario planning to address flood impacts. District and member community staff frequently request model results for several purposes including assessing capital improvement project feasibility and design, as well as assisting with management decisions through the BCWD permitting process. The 2025 H/H Study describes modeling methodology, water resource management issues, and potential impacts from future development activities. A copy of this study can be obtained from the BCWD office.

- The H/H Model was upgraded in 2003 to evaluate the impact of the district's capital improvement projects and development in the watershed, and to further refine the existing model using new landform and landcover data developed by Washington County and the Minnesota Department of Natural Resources. The study presents water management issues resulting from past land use changes and seeks to define the impact of future changes in land use while recommending how BCWD can address these changes. A copy of this study can be obtained from the district office.
- In 2015, BCWD conducted a major overhaul of the model, basing catchment areas and hydraulics on the 2011 LiDAR elevation data and NRCS terrain analysis tools. The model platform was changed from XP-SWMM to the EPA SWMM5 Engine. Its runoff methodology was also updated from SCS Curve Number to utilizing Green-Ampt based on soil texture. The purpose of these transitions in model platform and runoff method was to more easily facilitate the transfer of model information to outside entities as well as to more accurately model soil moisture response during long-term simulations and back-to-back events.
- Aligning with the district's goal to maintain and share updated hydrologic, hydraulic, and floodplain data, in 2025 the model was updated with the 2022 LiDAR elevation data, the 2015 Twin Cities Metro Area 1-meter land cover data supplemented with development land cover changes in the district to date, and to include hydraulic structures and stormwater features that have been permitted within the watershed. It was calibrated and validated to 2020 and 2022 growing seasons and thereafter run for design events and the upper bound of the 90 percent confidence interval for the 100-year 24-hour event (9.5 inches).

To define the cleanliness of the stormwater runoff being generated in the watershed and discharged to waterbodies, BCWD has prepared water quality models to estimate pollutant loads (see Table F12).

Watershed loading models have been constructed in support of the district's lake management plans. A P8 watershed loading model was built for Long Lake and PLoad models were built for all other Lakes. The P8 model is better suited to urban/developed watersheds where impervious surfaces are the primary driver of water quality. Its strength lies in its ability to simulate the performance of water quality treatment practices such as detention basins and swales. PLoad is a model that relies upon literature values for pollutant contributions generated off various land cover and is more appropriate for the rural areas of the watershed. The Long Lake P8 Model was originally built for the Long Lake Management Plan. It was updated in 2012 to include several water quality practices and was calibrated to water quality monitoring data. The model was refined based on more detailed information collected as part of the Oak Park Heights Retail Subwatershed Study. A P8 model was built by the City of Stillwater to characterize the drainage area to Lake McKusick including that portion of its watershed that is within the Brown's Creek Watershed.

Models have also been constructed that simulate the nutrient dynamic that occur within lakes. WiLMS and BATHTUB Models have been developed for many of the lakes in the watershed as shown in Table F12 during the development of lake management plans. These models characterize the internal loading of nutrients within the lake which assists in developing appropriate nutrient reduction strategies.

Table F12. Summary of District Models

Model	Model Platform	Date of last update	Update Frequency	Scale/Size
Water Quantity Models				
H&H Model	EPA-SWMM	2025	Annually	Entire Watershed
Watershed Loading Models				
Long Lake Watershed Loading Model	P8	2014	As-needed	Lake shed
Woodpile Lake Watershed Loading Model	PLoad	2011	As-needed	Lake shed
Benz Lake Watershed Loading Model	PLoad	2008	As-needed	Lake shed
Masterman Lake Watershed Loading Model	PLoad	2010	As-needed	Lake shed
Northern Chain of Lakes Watershed Loading Model	PLoad	2015	As-needed	Northern Lake sheds
Brown's Creek Thermal Model		2015	Initial construction 2015	Creek contributing drainage area south of 110th Street.
McKusick Lake Watershed Loading Model (City of Stillwater)	P8	2007	NA	McKusick Lake shed
In-Lake Water Quality Models				
Long Lake	WiLMS	2006	As-needed	Lake
Benz Lake	BATHTUB	2008	As-needed	Lake
Masterman Lake	WiLMS	2010	As-needed	Lake
Woodpile Lake	WiLMS	2011	As-needed	Lake
Northern Chain of Lakes	BATHTUB	2015	As-needed	Lake

2.6 Floodplain and Shoreland

A flood hazard map was developed by the Washington Conservation District in conjunction with the development of the first watershed management plan (September 1990). This map, which consists of the Federal Emergency Management Agency (FEMA) map reconstructed over an aerial map of the watershed, identified the 100-year flood plain along the stream corridor and for the major lakes and water bodies of the watershed. A copy of this map can be obtained from the Washington Conservation District.

Washington County, with BCWD's input having recently completed the 2004 Hydrologic and Hydraulic Study, completed an evaluation of flood elevations for all the Minnesota Department of Natural Resources' protected water bodies in the county as part of the FEMA map revision which became effective 2010. The Washington County Flood Insurance Study (FIS) supersedes previous flood insurance maps for the area. All flood related studies, revisions, and mapping are available through FEMA's Flood Map Service Center (http://msc.fema.gov/).

BCWD has addressed known flooding issues through its capital improvement projects, such as the THPP and Kismet Basin Outlet, and recently completed a flood vulnerability assessment identifying areas of greater risk for localized flooding, in addition to the Minnesota Department of Natural Resources' protected waterbodies that are included in the FEMA study. The district has also collected conveyance structure information through permitting, lake management plans, and capital improvement projects. The extent of the district's structure inventory is not comprehensive in all areas within the watershed. Since flood-prone areas in the watershed are known through current publications, the impetus to complete a structure inventory is born out of its usefulness for current district programs and would assist in more accurately describing flooding at the local level or for longer duration rainfall simulations. It is reasonable to assume a three-year window for completion of this database, which presumably is ahead of future FEMA map publication.

In 2013, the National Weather Service Hydrometeorological Design Studies Center released NOAA Atlas 14, Volume 8. This volume supersedes precipitation frequency estimates contained in Technical Paper 40 and 49 for Minnesota. In 2015, NOAA developed the MSE3 MN type rainfall distribution for a dimensionless unit hydrograph to replace the NRCS Type II used in previous flood studies. In general, these changes result in higher peak intensity and a greater 100-year 24-hour depth of rainfall than was considered in previous studies. NOAA is in the process of developing Atlas 15 which will serve as the new authoritative, spatially continuous National Precipitation Frequency Atlas of the United States. As with previous precipitation frequency atlases, NOAA Atlas 15 will provide spatially independent estimates of expected precipitation depth (or intensity) for a specified storm duration (e.g., six hours) at a particular location of interest (e.g., Stillwater, Minnesota). In contrast to NOAA Atlas 14, NOAA Atlas 15 will, for the first time, account for future temporal trends through the year 2100. It is anticipated that NOAA Atlas 15 will be published within the timeframe of this watershed management plan. When published, NOAA Atlas 15 will be the authoritative source for precipitation frequency information across the United States.

The BCWD rules reference design events based on the frequency of occurrence and do not specify the depth or rainfall distribution. Since the release of new information by NOAA, the district has applied the revised standards to new development and redevelopment for which the stormwater and floodplain and drainage alteration rules are triggered.

The available 100-year flood levels and peak discharges in the watershed are included in Table F13. Revision of flood profiles and elevations at the FEMA level will be necessary to reflect the information in NOAA Atlas 14, Volume 8, and the district will be well positioned to assist in this effort. However, the FEMA map revision timeline is not known at the time of writing. The existing flood insurance study can be viewed using the FEMA Flood Map Service Center at: https://msc.fema.gov/portal.

Table F13. Available Flood Level Studies

Entity	Source Data	Year
MnDOT	S.P. 8210-70,71 Effect of 100 Year Flood – Vicinity of T.H. 95 & T.H. 96 Washington County	1986
BCWD	BCWD Hydrologic & Hydraulic Study Appendix C:XP-SWMM Output/Results	2004
FEMA	Flood Insurance Study, Washington County, MN	2010

Table F14. Status of approved shoreland ordinances in the watershed

City or Township	Floodplain Ordinance	Shoreland Ordinance Required	State Approved Shoreline Ordinance	Within St. Croix Riverway Boundary	Comments
City of Grant	Current to 2023 Chapter 14	Yes	Chapter 12, Art VII Adopted in 2003 – DNR approval status unknown	No	Adopted and not approved by state
City of Hugo[5]	Sec. 90-137 Current to 2025	Yes	Sec. 90-138 Approved in 1995 – updates in progress.	No	Adopted and approved in 1995. Changes have been made since 1995 approval that have not been approved by MNDNR.
City of Lake Elmo[6]	Title 100 Current to 2010	Yes	Title 105.04-XIII Approved as amended in 2017	No	Adopted and approved in 1993.
May Township	Art. 803 Current to 2023	Yes	Art. 806 Adopted – DNR approval status unknown	No	Township is regulated under Washington County Lower St. Croix Bluffland and Shoreland Management Ordinance (updated July 2018).
City of Oak Park Heights[7]	Sec. 401.34 Current to 2023	No	Sec. 401.34 Approved	Yes	DNR last approved an ordinance in 1979 that sets minimum zoning standards aligning with the Lower St. Croix Riverway rules. Contains only one designated public water in the municipal boundary
City of Stillwater	Sec. 28-296 Current to 2025	Yes	Sec. 28-296 Approved in 2002	Yes	DNR last approved an ordinance in 1989 that sets minimum zoning standards aligning with the statewide shoreland and the Lower St. Croix Riverway rules.
Stillwater Township	Current to 2017	Yes	Ord. 107 Adopted in 1993 - approved	Yes	Township is regulated under Washington County Lower St. Croix Bluffland and Shoreland Management Ordinance (updated July 2018).

[5] City is a priority 2 community for the Shoreland Program
[6] City is a priority 1 community for the Shoreland Program
[7] City is a priority 4 community for the Shoreland Program

2.7 Groundwater Resources

The groundwater system within the watershed is complicated and dynamic. Unlike the surface watershed, the groundwatershed does not always follow watershed boundaries. Therefore, it is important to first understand regional geology and hydrogeology before focusing on local groundwater resources. Basic information on the groundwater system is summarized in the following sections.

2.7.1 Aquifers

Aquifers in the Brown's Creek watershed can be classified as either Quaternary (glacial) or bedrock. The Quaternary aquifer is typically the shallowest aquifer throughout the watershed. An important exception is the area around the lower reaches of Brown's Creek where bedrock is exposed. The Quaternary aquifer has some residential wells, but it is usually bypassed in favor of the deeper bedrock aquifers.

The uppermost bedrock aquifer is the St. Peter Sandstone, but it is present only in limited areas in the western portion of the watershed. The Prairie du Chien Group underlies the St. Peter. This unit is found in most of the watershed except for areas where erosion has cut into deeper bedrock. The Prairie du Chien Group is underlain by the Jordan Sandstone. Both the Prairie du Chien and Jordan are significant drinking water aquifers, and they are often listed on well logs as a single hydrologic unit. Below the Prairie du Chien-Jordan is the St. Lawrence Formation that is generally considered an aquitard but can be used as an aquifer where it has been fractured and eroded. Below the St. Lawrence is the Tunnel City Group. It is used as an aquifer in areas where the more productive Prairie du Chien-Jordan is not present. Below the Tunnel City Group is the Eau Claire Formation (aquitard) and the Mount Simon-Hinckley Formation. Both are regionally important aquifers but have very few, if any, wells within Brown's Creek watershed.

There are two reports that use groundwater contours to delineate the groundwatersheds of the two primary aquifers that discharge groundwater to Brown's Creek. The *Watershed hydrology of Valley Creek and Brown's Creek: Trout streams influenced by agriculture and urbanization in eastern Washington County, Minnesota, 1998-99* report delineated the groundwatershed of the water table aquifer using 50 foot contours from the Washington County Geologic Atlas[8]. The *Brown's Creek Groundwatershed Report*[28] delineated the groundwatersheds for both the surficial aquifer and Prairie du Chien- Jordan aquifer. The delineated groundwatersheds are approximations of the groundwatersheds and were created to resolutions obtainable using existing available data. The groundwater contours and groundwatersheds developed for these maps and reports were primarily generated from groundwater elevation data provided in the Minnesota Well Index.

The Minnesota Department of Natural Resources observation well network monitors groundwater elevation of aquifers throughout the state with the observation well program. Groundwater level data is collected from wells in the observation well program to determine trends in aquifer level over time, to determine impacts from groundwater and surface water appropriations, and to determine the interaction of aquifers with each other (for use in the determination of groundwater flow). The observation well program currently has four active observation wells within the Brown's Creek watershed. One of the wells, well 83039, is set in the Prairie Du Chien aquifer and has a period of record from 1994 to 2011. The other well, 82047, is set in the Tunnel City Group aquifer and has a period of record from 2000 to 2011. The Minnesota Department of Natural Resources monitored a well set in the St. Peter aquifer within the Brown's Creek watershed boundary, well 82009, from 1977 through 1981. The Minnesota Department of Natural Resources monitors an additional well, 82032, set in the Prairie Du Chien aquifer located outside of the district boundary in the northwest near Hugo. The period of record for this well is 1984 - 2010.

2.7.2 Groundwater Flow

Groundwater flow in the watershed is characterized by the Quaternary and bedrock aquifer systems. Both systems provide for the movement of groundwater toward discharge areas.

A portion of the groundwater within the Quaternary system discharges to surface water bodies supplying "base flow" to the surface water system. Brown's Creek above the historic Old Stone Bridge maintains a base flow mostly from Quaternary aquifer groundwater discharge. Direct measurement of water levels from sampling points in portions of the upper stream have shown strong upward gradients which is an indication of groundwater discharge. Quaternary aquifers discharge to the bedrock aquifers in regions where connections exist between the two. The principal bedrock aquifer that would receive groundwater from the Quaternary system would be the Prairie Du Chien Group. This would occur in areas where the Prairie Du Chien is the uppermost bedrock beneath permeable Quaternary sediment.

The bedrock aquifers of principal importance in the Brown's Creek watershed are the combined Prairie Du Chien - Jordan and the Tunnel City Group**.** These formations are a major source of drinking water and also provide discharge to lower Brown's Creek and the St. Croix River.

The recharge zone for the Prairie Du Chien-Jordan aquifer occurs both within and outside the surface watershed. As noted above, recharge to the Prairie Du Chien-Jordan Aquifer occurs where this formation is the uppermost bedrock beneath coarse-grained Quaternary sediment. The general groundwater flow within the Prairie Du Chien-Jordan aquifer is from the central part of Washington County east and south across the watershed to the St. Croix River. Deflection of flow is noted in areas where large pumping centers are located (Stillwater and Oak Park Heights Municipal wells). Flow is also deflected towards the lower gorge of Brown's Creek where discharge occurs.

Groundwater from the bedrock aquifers discharges to the St. Croix River, to Brown's Creek, and to private and municipal wells. Stillwater and Oak Park Heights use bedrock wells for their water supply.

2.7.3 Groundwater Quality and Quantity

The Washington County Groundwater Plan identifies contaminants above established health risks in several aquifers, specifically perfluoro-alkyl substances (PFAS), volatile organic compounds (VOCs) and nitrates[(29)]. Chloride is a much more present contaminant across the County in well and spring samples.[(30)] Groundwater modelling under theoretical steady state conditions shows that pumping may result in portions of the County experiencing 20 to 30 feet of groundwater drawdown over the next 20 years – this is generally concentrated in higher population, faster growing areas of the County such as Cottage Grove, Oakdale, Woodbury, and Hugo[(29)]. The Brown's Creek watershed has not experienced groundwater quality or quantity problems to the extent that have been observed in other parts of Washington County.

The quantity of groundwater flowing to groundwater-dependent natural resources is the subject of several ongoing studies. The Drinking Water Supply Management Area (DWSMA) for the Stillwater Municipal Water Supply wells include areas within the Brown's Creek watershed. Low water levels in nearby White Bear Lake have prompted the Metropolitan Council, the Minnesota Department of Natural Resources, and United States Geological Survey to study groundwater recharge, groundwater flow, and groundwater pumping throughout northern Washington County. Groundwater flow to Brown's Creek is important for maintaining its thermal regime. Studies are ongoing to determine whether reduced groundwater discharges have contributed to the lack of cold-water assemblage in the creek.

There are two DWSMAs located within the Brown's Creek watershed, Stillwater (DWSMA ID 1024) and Oak Park Heights (DWSMA ID 645). The Minnesota Department of Health has identified southern portions of the BCWD watershed as a moderate-to-high vulnerability to contamination[(31)]. Projects that improve surface water quality can present opportunities for co-benefits to groundwater and drinking water. More information on the mapped extent of these DWSMAs and their Source Water Assessments (SWA) is available through the [Minnesota Department of Health's Source Water Protection Web Map Viewer](#).

In 2023, the City of Stillwater learned that some of its drinking water wells produce water that exceeds the Minnesota Department of Health's Health Based Guidance Values (HBVs) and the Maximum Contaminant Levels (MCLs) for per- and polyfluoroalkyl substances (PFAS) established by the Environmental Protection Agency (EPA). Two wells, Well #6 (located within the Brown's Creek Watershed) and Well #10 (located just outside the Brown's Creek Watershed) contain PFAS at levels above the EPA's drinking water standards. Other Stillwater municipal supply wells show PFAS at levels just below these standards. Three wells are currently inactive and are not providing water for the community. To meet the community's water demands and provide the safest drinking water possible, the city is taking quick, proactive action on a short-term solution while also taking a strategic approach to long-term water treatment needs. A temporary treatment facility at Well #10 will ensure this well can safely be put back into service.

Groundwater resource data includes groundwater/well water quality data that is available from the Minnesota Pollution Control Agency(32). The Washington County Hydrogeologic Atlas is available from the Minnesota Geological Survey (MGS)(7). Groundwater level data is available from the Minnesota Climatology Working Group(2). The Minnesota Department of Health provides maps and data for wellhead protection areas and the Minnesota well index(10). BCWD has compiled information about many local groundwater-related projects into a comprehensive "Groundwater State of Knowledge Report".

2.7.4 Groundwater-Dependent Natural Resources

Groundwater function within the watershed supports a viable cold-water trout fishery by discharging cool water to the surface stream environment, thus Brown's Creek is groundwater-dependent. Lakes are classified as groundwater-dependent based on the "Lake Data and Groundwater Function" table from the report *Integrating Groundwater and Surface Water Management – Northern Washington County*.

Groundwater seepage to the surface environment provides highly specialized hydrologic conditions that support numerous plant species and natural communities, in addition to ecosystem functions such as surface water supply and thermoregulation (e.g., discharge of cold water). In the upper watershed, groundwater seepage areas in wetlands create favorable conditions for hardwood seepage swamps, fens, wet meadows, shrub swamps, tamarack swamps, and floating sedge mats. These wetlands often harbor unique and regionally rare plant communities. In the lower creek gorge stretch of Brown's Creek, specialized natural communities, including trout populations, are dependent on groundwater seepage.

BCWD's rules define groundwater-dependent wetlands based on expression of a groundwater dependent plant community. Table F15 lists the Minnesota Land Cover Classification System (MLCCS) plant communities that are considered groundwater-dependent for purposes of the BCWD rules. BCWD recognizes that this vegetation-based definition lacks clarity when stressors - such as invasive species, vegetation clearing (e.g., cultivation), or historical overgrazing – degrade the plant community. Plant communities may be dominated by plants (e.g., cattails) that do not necessarily indicate groundwater dependency but conversely do not rule out the wetland's groundwater-dependent hydrology. It is important to account for these "masked" groundwater dependent wetlands, as they still provide other ecosystem functions independent of vegetation and may harbor small remnants of groundwater-dependent plant communities or have potential as high-quality restorations. For example, the 2024-2025 Brown's Creek stream restoration integrated buckthorn removal within seepage wetlands that would have not have met the plant community standard for groundwater-dependent wetlands.

The 2024 Wetland Function and Value and Groundwater Dependent Reclassification study used multiple sources to better define likelihood of watershed wetlands' groundwater dependence. These sources included groundwater dependency classifications from the 2007 function and value assessment, National Wetland Inventory Hydrogeomorphic Classification, Minnesota Department of Natural Resources Native Plant Community mapping, the MLCCS dataset, and the 2003 North Washington Groundwater Study. Based on composite scoring using this source data, wetlands were scored as "likely groundwater-dependent", "partially groundwater-dependent", or "surface water-dependent" (Figure F20 through Figure F23 serves as a preliminary classification of groundwater dependence. The actual groundwater dependence of a particular wetland should be assessed on a case-by-case basis.

Table F15. Groundwater Dependent Natural Resource Types According to Existing District Rules (following MLCCS protocol).

Groundwater-Dependent Wetlands	Groundwater and Surface Water-Dependent Wetlands
• Shrub fen • Poor fen shrub subtype • Rich fen shrub subtype • Shrub swamp seepage subtype • Wet meadow shrub subtype* • Willow swamp* • Wet prairie seepage subtype • Poor fen* • Poor fen sedge subtype • Rich fen • Rich fen sedge subtype • Wet meadow* • Sedge meadow* • Seepage meadow* • Shallow emergent marsh* • Mixed emergent marsh* • Deep emergent marsh* • Trout stream • Lake* • Limnetic open water* • Shallow open water* • Shallow open water with floating vascular vegetation*	• Lowland hardwood forest • Mixed hardwood swamp seepage subtype • Willow swamp - saturated soils • Wet meadow shrub subtype* • Willow swamp* • Mesic prairie • Wet meadow* • Cattail marsh • Poor fen* • Sedge meadow* • Seepage meadow* • Shallow emergent marsh* • Mixed emergent marsh* • Deep emergent marsh* • Shallow creeks* • Lake* • Limnetic open water* • Shallow open water* • Shallow open water with floating vascular vegetation*

***These wetland types can be either completely "Groundwater-Dependent" or "Both" groundwater and surface water-dependent and therefore are listed in both categories.**

2.8 Surface Water and Groundwater Appropriations

Water appropriations in the Brown's Creek watershed are primarily from groundwater. No surface water appropriations are large enough to require a Minnesota Department of Natural Resources Appropriations Permit (10,000 gallons per day or 1,000,000 gallons per year). The largest groundwater appropriations in the Brown's Creek watershed come from municipal water supply wells and golf course irrigation wells. The municipal water supply wells are part of the Stillwater municipal water system, which has wells both inside and outside of the watershed. Much of the watershed is outside of the Stillwater water system service area. Residents and businesses in those areas have private wells.

Groundwater appropriations affect groundwater levels below groundwater dependent natural resources. In 2014, a BCWD groundwater appropriations study found that large pumping wells were lowering groundwater levels in bedrock aquifers below Brown's Creek by more than two feet(33). Further studies are required to determine the connection between the creek and the bedrock aquifers and the effect of the pumping on groundwater dependent natural resources.

Active water use permit information can be accessed online through the Minnesota Department of Natural Resources Minnesota Permitting and Reporting System (MPARS)(34) which can be categorized according to municipality, permitted water use type, among additional attributes. Table F16 identifies the active water use permits located in the Brown's Creek watershed.

Table F16. Summary of Water Appropriations Permits in the BCWD (No surface water permits)

Permit Number	Well Unique ID Number	Permittee	Well Number	Aquifer	Maximum Pumping [MGY]	Maximum Pumping [GPM]
Municipal Wells						
1975-6207	127284	STILLWATER CITY WELL	9	MTPL	72.00	137.0
1975-6207	208785	STILLWATER CITY WELL	1	UNKNOWN	45.76	87.1
1975-6207	208786	STILLWATER CITY WELL	5	MTPL	86.46	164.5
1975-6207	208787	STILLWATER CITY WELL	6	CJDN	224.46	427.1
1975-6207	224608	STILLWATER CITY WELL	8	CJDN	69.95	133.1
1975-6207	481662	STILLWATER CITY WELL	10	MTPL	82.00	156.0
1975-6207	580338	STILLWATER CITY WELL	11	CJDN	358.00	681.1
1975-6207	686297	STILLWATER CITY WELL	12	CJDN	52.00	98.9
Golf Course Wells						
2005-3012	515171	APPLEWOOD HILLS GC	1	OPDC	35.30	160.2
1990-6325	504168	SAWMILL GOLF CLUB	1	OPDC	14.70	66.7
1990-6325	242819	SAWMILL GOLF CLUB	2	CJDN	12.20	55.4
1990-6325	566145	SAWMILL GOLF CLUB	3	OPDC	29.50	133.9
1990-6325	151581	OAK GLEN COUNTRY CLUB	2	CTCE	13.80	62.6
1990-6325	151580	OAK GLEN COUNTRY CLUB	1	CJSL	32.10	145.7
1990-6325	208038	STILLWATER COUNTRY CLUB	1	CSTL/CMTS	26.30	119.4
1986-6106	208515	MOGROW, INC (INDIAN HILLS)	1	OPDC	37.41	169.8

2.9 Monitoring

BCWD has a comprehensive monitoring program that consists of flow and water quality measurements throughout Brown's Creek, its tributaries, and in-lake sampling on all the prominent lakes in the watershed (see Figure F19 at the end of the Land and Water Resource Inventory). BCWD also has a weather station, which it installed at the City of Stillwater's public works facility in 2011 to collect local climate data (precipitation, air temperature, dew point, relative humidity, solar radiation, wind speed, gust speed, and wind direction) in support of future modeling efforts. In addition to its routine monitoring program, the district undertakes special monitoring activities to address specific issues and to answer watershed management questions as needed. For example, the district began collecting in-stream temperature data upon completing the Brown's Creek TMDL Implementation Plan. The objective of this monitoring effort is to better understand in-stream temperature patterns related to shading, directly connected ponds and stormwater management facilities, groundwater pumping, and untreated impervious areas. Over time, the district has also developed a groundwater monitoring program to better understand and evaluate baseflow contributions to its groundwater-dependent natural resources.

While the district's water quality data is summarized annually by the Washington Conservation District and made available on BCWD's website, a more comprehensive, analytical review of the data collected to date was conducted in 2014 and completed in 2015. This evaluation was conducted to provide a critical review of the data, determine if statistically valid trends can be detected and to evaluate the factors that are likely causing the trends in water quality. This trend analysis was updated for Brown's Creek and Long Lake in 2020. Table F17 through Table F21 summarize the district's existing monitoring activities.

Groundwater elevation monitoring is important for identifying changes in groundwater quantity and flow patterns over time. The Minnesota Department of Natural Resources maintains three observation wells in the watershed, but that is not enough information for planning purposes. In 2002, BCWD established a network of residential and golf course wells for measuring water levels as part of the North Washington Groundwater Study. Water levels in the wells have been measured annually since 2012 in August and September and analyzed in annual reports. Table F21 summarizes the programs that have provided information on groundwater resources in the watershed.

Table F17. Lake Monitoring Data Inventory

Lake ID	Lake Management Plan	Aquatic Plant Survey	DO & Temperature	Total Phosphorus	Chlorophyll-*a*	Secchi Depth
Bass Lake East 82-0124-00	2022	2019	2006-2025	2006-2025	2006-2025	2006-2025
Bass Lake West 82-0123-00	2022	2019	2006-2025	2006-2025	2006-2025	2006-2025
Benz Lake 82-0120-00	2009	2008, 2022, 2025	1998, 2005-2025	2005-2025	2005-2025	1998, 2005-2025
Goggins Lake 82-0077-00	2015	2014, 2022, 2025	1999-2025	1999-2025	2001-2025	1999-2025
Sinnits Pond 82-0305-00	2023	2009	2010-2025	2010-2025	2010-2025	2010-2025
July Ave Pond 82-0318-00	2023		2006-2025	2006-2025	2006-2025	2006-2025
Kismet Basin 82-0334-00	2023		2007-2025	2007-2025	2007-2025	2007-2025

Lake ID	Lake Management Plan	Aquatic Plant Survey	DO & Temperature	Total Phosphorus	Chlorophyll-*a*	Secchi Depth
Long Lake 82-0021-00	2006	2009, 2025	1998-2025	1995-2025	2001-2025	1987, 1989, 1991-2025
Lynch Lake North 82-0267-00	2015	2014, 2019	2010-2025	2010-2025	2010-2025	2010-2025
Lynch Lake South 82-0042-00	2015	2014, 2019	2006-2025	2006-2025	2006-2025	2006-2025
Lake Masterman 82-0126-00	2010	2009	2006-2025	2006-2025	2006-2025	2006-2025
Pat Lake 82-0125-00	2023		2006-2025	2006-2025	2006-2025	2006-2025
Plaisted Lake 82-0148-00	2015	2014	2008-2025	2008-2025	2008-2025	2008-2025
South School Section Lake 82-0151-00	2015	2014, 2022, 2025	1998, 2005-2025	1995, 1996, 1998, 2005-2025	2005-2025	1995, 1996, 1998, 2005-2025
Wood Pile Lake 82-0132-00	2011	2009	2006-2025	2006-2025	2006-2025	2006-2025

Table F18. Stream monitoring stations by stream reach in BCWD, 1999-2024

Stream Reach/AUID	Reach Description	Reach Length (mi)	Use Class	Water Quality Monitoring Station(s)	Biological Monitoring Station(s)
Brown's Creek (Lower) 07030005-520	T30 R20W S18, west line to St. Croix River	2.3	2A	S004-719 S006-114 S004-925 S006-528 S004-457 S006-113	99SC002 99SC006 06SC055 07SC002 11SC010
Brown's Creek (Upper) 07030005-586	Headwaters to T30 R21W S1, south line	3.25	2B	S004-458	n/a
Brown's Creek (Middle) 07030005-587	T30 R21W S12, north line to T30 R21W S13, east line	2.36	2A	S001-974 S004-726 S004-456	07SC001 96SC066
Unnamed Creek (Trib to Long Lake) 07030005-765	T30N/R20W/S31	1.09	2B	S004-473	n/a
Unnamed Creek (Trib to Lake McKusick) 07030005-767	T30 R20W S19, south line to underground diversion	0.68	2A	S004-475	n/a

Table F19. Inventory of flow data records for streams in BCWD

Year	WOMP	Stone-bridge	McKusick Rd	Hwy 15 (Manning Ave)	Gateway Trail	Headwaters , 110th	Diversion Structure	Inlet #1 to Long LK (62nd St)	Inlet #2 to Long Lake (Marketplace)
2000	Aug-Dec		May-Oct						
2001	Jan-Dec*		Mar-Nov						
2002	Jan-Dec		Mar-Nov						
2003	Jan-Dec		Mar-Nov						
2004	Jan-Dec		Mar-Nov						
2005	Jan-Dec		Mar-Nov	Mar-Nov					Apr-Nov
2006	Jan-Dec		Mar-Oct	Mar-Oct			Apr-Oct		May-Oct
2007	Jan-Dec		Mar-Oct	Mar-Oct	Apr-Jun	Apr-Oct	Mar-Oct		Apr-Oct
2008	Jan-Dec	Apr-Nov	Apr-Nov	Apr-Nov		Apr-Nov	May-Nov		Apr-Nov
2009	Jan-Dec	Apr-Nov	Apr-Nov	Apr-Nov			Sep-Nov		Apr-Nov
2010	Jan-Dec	Mar-Nov	Mar-Nov	Mar-Nov			Mar-Nov		Apr-Aug
2011	Jan-Dec	Apr-Nov	Apr-Oct	Apr-Nov			Apr-Nov		Apr-Nov
2012	Jan-Dec	Mar-Nov	Mar-Nov	Mar-Nov			Mar-Nov	Mar-Nov	Mar-Nov
2013	Jan-Dec	Apr-Nov	Apr-Nov	Apr-Nov			Apr-Nov	Apr-Nov	Apr-Oct
2014	Jan-Dec	Apr-Nov	May-Nov	Apr-Nov			Apr-Oct	Apr-Oct	Apr-Oct
2015	Jan-Dec	Apr-Oct	Apr-Oct	Apr-Oct			Apr-Oct	Apr-Oct	Apr-Oct
2016	Jan-Dec	Apr-Oct	Mar-Oct	Mar-Oct			Mar-Nov	Apr-Nov	Apr-Nov
2017	Jan-Dec	Apr-Oct	Apr-Oct	Apr-Oct			Apr-Oct	Mar-Oct	Apr-Oct
2018	Jan-Dec	May-Oct	May-Oct	May-Oct			Apr-Oct	May-Oct	Apr-Oct
2019	Jan-Dec	Mar-Oct	Apr-Oct	Apr-Oct			May-Oct	Apr-Oct	May-Oct
2020	Jan-Dec	Apr-Nov	Apr-Nov	Apr-Nov			Apr-Nov	Apr-Oct	May-Nov
2021	Jan-Dec	Apr-Oct	Apr-Oct	Apr-Oct			Apr-Oct	Apr-Oct	Apr-Oct
2022	Jan-Dec	Apr-Oct	May-Oct	Apr-Oct			Apr-Oct	Apr-Oct	May-Oct
2023	Jan-Dec	Apr-Oct	Apr-Oct	Apr-Oct			May-Oct	Apr-Oct	May-Oct
2024	Jan-Dec	Apr-Oct	Apr-Oct	Apr-Oct			May-Oct	Apr-Oct	May-Oct

Table F20. Stream Temperature Monitoring Stations Along Brown's Creek and Adjacent Stormwater BMPs

Stream Location	Year(s)	Monitoring Goals
Headwaters	2011-2015	Monitor long-term changes in stream temperature
110th Street	2001, 2003-2009, 2011	Monitor long-term changes in stream temperature
Gateway Trail	2011-2015	Monitor long-term changes in stream temperature
Highway 96	2011-2015	Monitor long-term changes in stream temperature
Millbrook Pond	2013-2015	Determine potential thermal impacts from Millbrook pond discharge
Downstream Millbrook Pond	2011-2015	Determine potential thermal impacts from Millbrook pond discharge

Oak Glen East Pond	2010-2015	Determine potential thermal impacts from East Pond discharge
Downstream Oak Glen East Pond	2011-2015	Determine potential thermal impacts from East Pond discharge
Shaded Control	2011-2015	Stream temperature control site in a shaded reach
Oak Glen West Pond	2010-2015	Determine potential thermal impacts from West Pond discharge
Downstream Oak Glen Ponds	2012-2015	Determine potential thermal impacts downstream of East and West pond discharge sites
Open Control	2011-2015	Stream temperature control site in a non-tree canopy "open" reach
Oak Glen Stormwater Pond	2010-2015	Determine potential thermal impacts from a stormwater pond
Stormwater Swale Confluence	2010-2015	Determine potential thermal impacts downstream of stormwater pond swale discharge

Table F21. Summary of BCWD Groundwater Monitoring Activities

Name	Data Collection Points	Year(s)	Monitoring Goals
Brown's Creek Dye Study	Brown's Creek lower reaches	1998	Determine groundwater inflows to Brown's Creek
N. Washington County Groundwater Study	Wells, springs, lakes	2002	Identify groundwater flow patterns and groundwater-dependent natural resources.
Identifying Trends in Groundwater Flow	Residential wells	2012-2025	Track changes in groundwater levels over time
Identifying Trends in Groundwater Flow	Golf course wells	2012-2025	Track changes in groundwater levels over time
Brown's Creek In-Stream Piezometers	Piezometers	2015, 2018	Determine gaining and losing reaches of the Creek
Springs near Brown's Creek	Piezometers	2015	Determine thermal impacts of groundwater discharges
Oak Glen Golf Course	Golf course wells	2024	Install flow monitors
Diversion Structure Groundwater Study	Soil borings	2020	Calculate groundwater contribution to flow through the diversion structure

3 Biological Environment

In 2015, Brown's Creek Watershed District conducted a unique species inventory to assess the quantity and quality of natural habitat in the watershed. The goal of the unique species inventory was to better characterize the flora and fauna found in the Brown's Creek corridor so that watershed management decisions could be made taking the ecological health of the entire system into consideration. Given that the watershed can be broken into unique landforms (areas that have very different qualities due to geologic and topographic features), the unique species inventory was performed to characterize the flora and fauna found in the Brown's Creek corridor within these distinct areas.

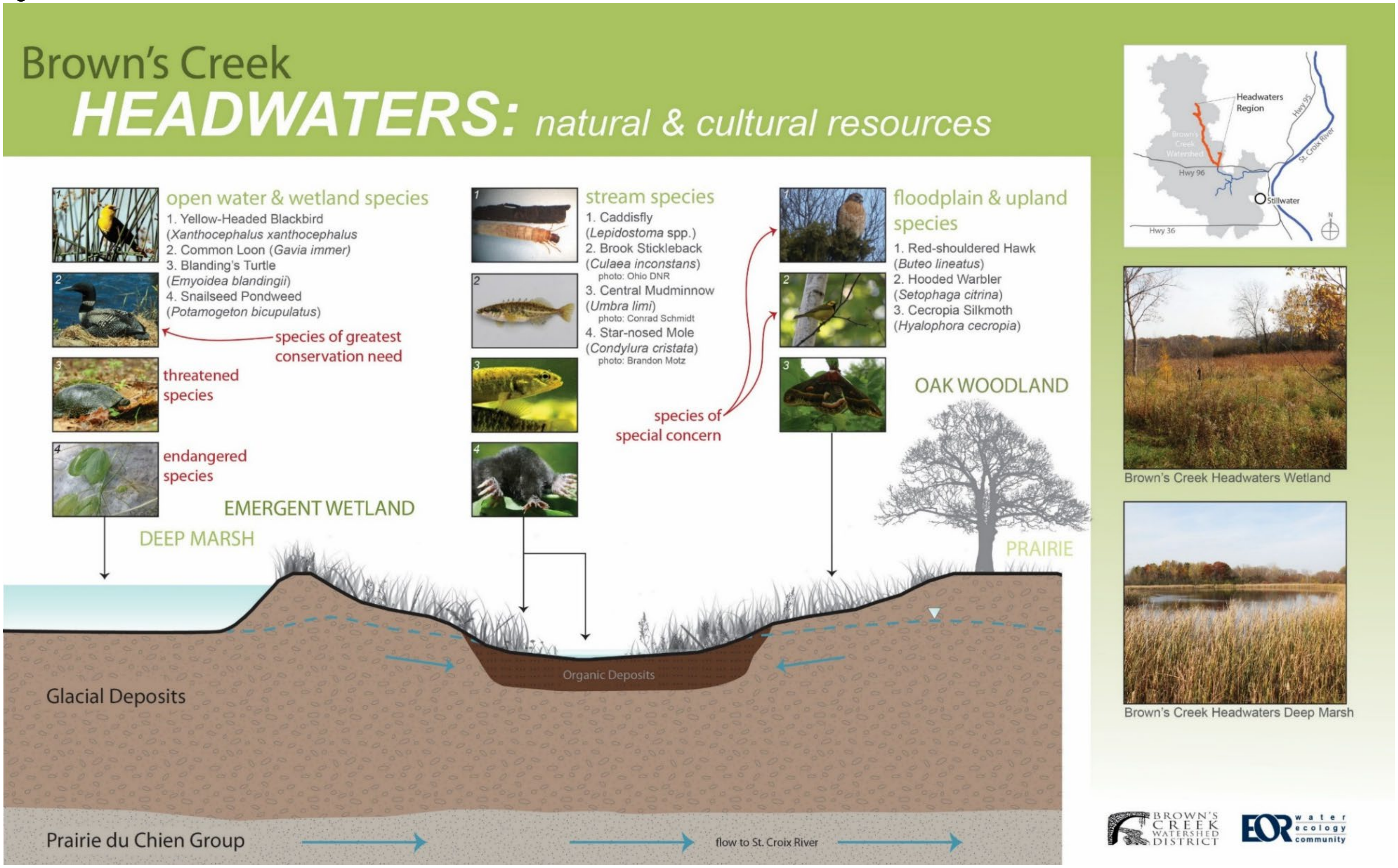
The Brown's Creek watershed has four distinct landforms: Brown's Creek Headwaters, Central or Middle Brown's Creek, Lower Brown's Creek Ravine (Gorge) and the Long Lake Tributary areas (see Figure F11and Figure F12. The unique species inventory placed emphasis on the three landform regions directly connected to the creek, with limited resources placed on the Long Lake Tributary area which periodically contributes to Brown's Creek following the installation of the diversion structure. The boundary of these four landforms can generally be described as follows:

- **Headwaters Region of Brown's Creek**: This area includes the northern portion of the watershed from Minnesota State Highway 96 to the Goggins-School Section Chain-of-Lakes (Figure F6).
- **Brown's Creek Middle Reach**: This area includes the Brown's Creek corridor in the central portion of the watershed south of Minnesota State Highway 96 to County Road 5 (Figure F7).
- **Long Lake Tributary Area**: This area includes the drainage area to the four tributaries described in section 2.1.1.3 including Long Lake tributary, two reaches of the South Central Tributary and the Zephyr Tributary.
- **Brown's Creek Gorge**: This area includes the Brown's Creek corridor and its drainage area downstream of County Road 5 to the St. Croix River (Figure F8).

The following is a discussion of each of the four landform areas as it relates to the biological environment. For those landforms directly connected to the creek and part of the unique species inventory, cross sections have been developed to display the unique attributes of these regions. Additional sources of information describing the Brown's Creek watershed's natural environment include: Brown's Creek Unique Species Inventory (2015); BCWD Natural Resource Inventory (2001); MLCCS mapping and continued data collection by the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources.

Northern leopard frog in the water.

Figure F6. Brown's Creek Headwaters



3.1 Brown's Creek Headwaters

The headwaters includes the northernmost portion of the watershed with its many lakes and the peripheral landlocked and semi landlocked areas. The topography in the area is characterized by a mostly level to gently rolling landscape with numerous depressions. Soils are highly variable, ranging from well-drained sand to deep, poorly drained peat within wetlands and drainage swales.

3.1.1 Native Plant Community Description

The headwaters area contains numerous large, forested communities with the most prevalent being oak-dominated forests and woodlands. Other wooded communities include conifer plantations, maple-basswood, and aspen-dominated forests. The natural communities are typically adjacent to lakes and large wetlands and provide significant habitat and form a wildlife corridor. Natural communities benefit the lakes by providing groundwater recharge, preventing erosion of steep slopes, and providing water quality treatment. The many depressional lakes and wetlands provide for significant recharge to the water table, which, in turn, supports flows in Brown's Creek. At least two lakes support populations of snailseed pondweed, a state-listed endangered aquatic plant species. Lakes and open water wetlands in the area support additional rare and unique aquatic and wetland plant species typically found farther north and east, with the Brown's Creek watershed occupying the southern and/or western limit of their range.

The broad lowland corridor contains a variety of high-quality wetland communities, including hardwood swamp, emergent marsh, hardwood seepage swamp, and tamarack swamp. Associated with these wetlands are several wooded upland communities, especially oak forest and oak woodland. Several of these are in good condition, and do not contain a dense understory of buckthorn that frequently characterizes oak communities within the region.

Many communities within this area are mapped on the Washington County Map of Natural Communities and Rare Features that was produced by the Minnesota Department of Natural Resources, and there are Blanding's turtle records within the area. In addition, because of the quality and size of the wetland communities, the potential for additional rare species is high. In 2015 three sites in the headwaters area were surveyed. Table F22 summarizes the findings of these surveys.

Table F22. Headwaters Natural Communities Surveyed in 2015

Site ID (as identified in 2001 NRI)	2015 Site Description	Results/2001 to 2015 Comparative Analysis[8]
1H		Site determined to be low quality in 2001 and of similar quality in 2015 due to presence of buckthorn. Ongoing buckthorn management is helping to improve community quality and species diversity.
3B	Near site 3B on an esker west of Brown's Creek	Site was free of buckthorn but did contain two other invasive species; smooth brome and reed canary grass. Since the 2015 plot was not within the boundary of site 3B surveyed in 2001, no comparative analysis can be made.
4I		Site described in 2001 to have buckthorn but also exhibiting a significant amount of oak regeneration and a diverse vegetative community. 2015 survey confirms a robust assemblage of native species persist at this site along with continued presence of buckthorn. Invasive Garlic mustard was found in the 2015 survey.

[8] Three Minnesota Department of Natural Resources data sheets including natural community descriptions and plant species lists document findings of the 2015 survey. These data sheets can be found in the Unique Species Inventory (2016).

3.1.2 Bird Habitat Description

The mosaic of lake, wetland, forest, and grassland communities within the headwaters region provides important breeding and foraging habitats for many resident and migratory bird species. Bird surveys conducted along the Gateway Trail have identified 88 species of birds in 2015, including the red-shouldered hawk, which is listed as a species of special concern by the Minnesota Department of Natural Resources. Mature forested areas around lakes provide suitable nesting habitat for red-shouldered hawks and this species likely nests in the headwaters region of the watershed. A male prothonotary and hooded warbler were photographed along the Gateway Trail approximately ¼ mile north of Highway 96. Hooded warblers are classified as a "Rare Regular" species by the Minnesota Ornithologists Union (MOU). In 2013, yellow-headed blackbirds were observed nesting in one of the wetlands in the Trout Habitat Preservation Project (THPP) located near the town of Withrow. This is the first known breeding record for this species in Washington County. Trumpeter swan, a species of greatest conservation need, has been observed at Goggins Lake as recently as 2024 and may be nesting in the lake.

A periodic birding survey has been carried out annually at the 13-acre BCWD 110th Street property since 2018. Unique species have included field and clay-colored sparrows, eastern kingbirds, eastern towhee, ovenbirds, Swainson's and hermit thrush, and ruby crowned and gold crowned kinglets.

3.1.3 Macroinvertebrate Habitat Description

Macroinvertebrates were sampled from several habitat types downstream of 110th Street. Of the three sites sampled for the unique species inventory (Headwaters, Central, and Gorge), the headwaters site contained the highest taxon richness (39 taxa represented). The headwaters site contained one lepostomatidae caddisfly, glossosomatidae caddisflies, and many limnephilidae caddisflies. These taxa have a low pollution tolerance and are indicative of good water quality and sufficient dissolved oxygen. The single lepostomatidae caddisfly was the only specimen collected from all three sites and had the lowest pollution tolerance of all the specimens collected during this study.

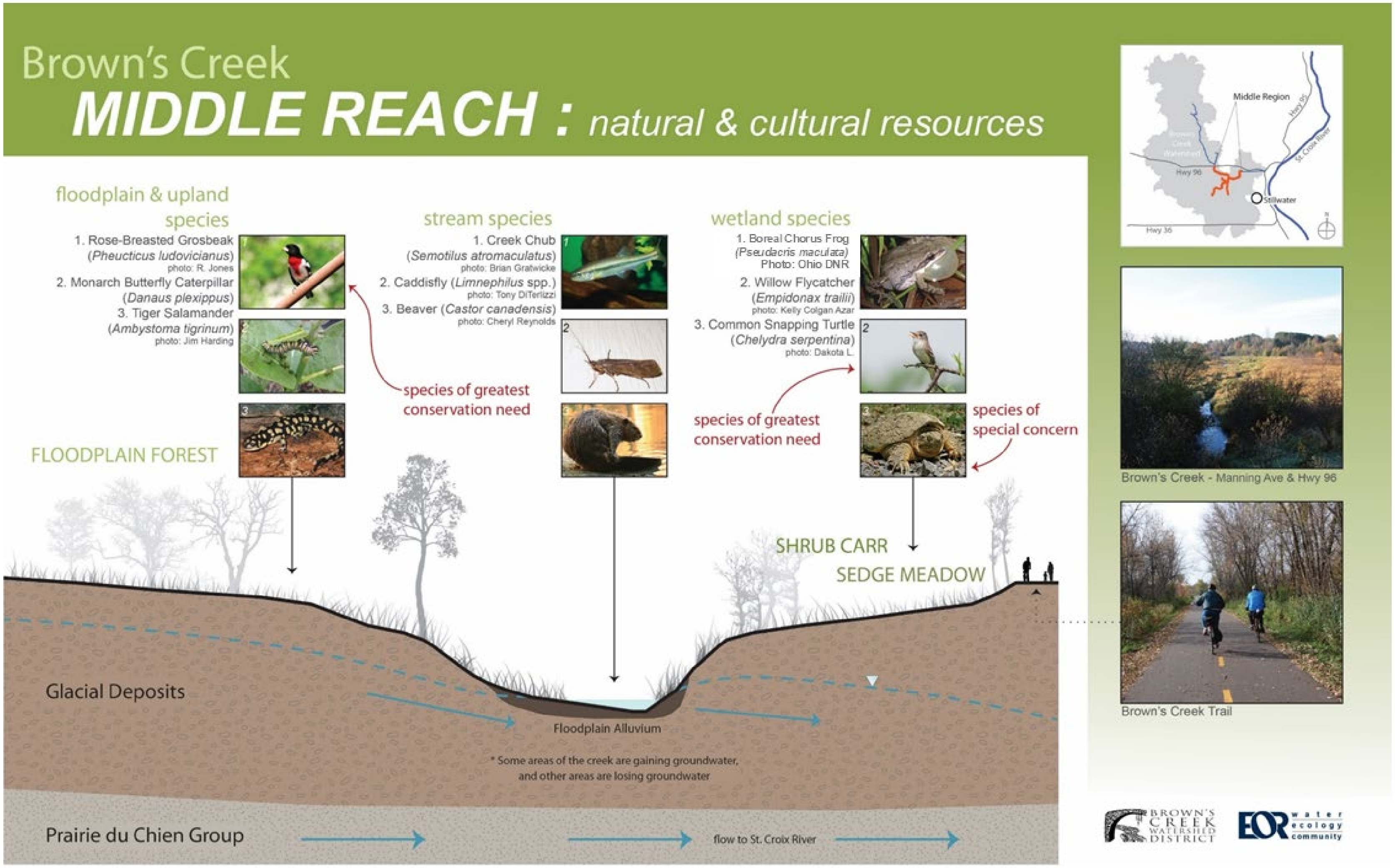
3.1.4 Fish and Fresh Water Mussel Habitat Description

Fish surveys conducted by the Minnesota Department of Natural Resources for the headwaters area of Brown's Creek are limited to a short reach just north of 110th Street. Within this reach, brook stickleback, a species associated with clear, cool streams are found. Another fish species documented in this reach and often found in cool bog streams is central mudminnow. Two other fish species, fathead minnow and creek chub, have also been documented in the upper reach. No trout species have been observed in the upper reach by Minnesota Department of Natural Resources Fisheries. Although water temperatures in the upper reach are generally cool enough to support trout, the low gradient and peaty substrates characteristic to most of this reach provide for poor trout habitat.

3.1.5 Amphibian and Reptile Habitat Description

Blanding's turtles have been found in numerous locations within the Brown's Creek watershed with the most sightings in the headwaters area. The large wetlands and shallow lakes provide excellent habitat for Blanding's turtles. These aquatic habitats also support healthy populations of painted and snapping turtles, and several species of herptiles including wood frog, boreal chorus frog, green frog, northern leopard frog, gray tree frog, American toad, and tiger salamander.

Figure F7. Brown's Creek Middle Reach



3.2 Central or Middle Brown's Creek

The topography in the central area is characterized by a gently rolling to level landscape with numerous depressional wetlands and seeps at the base of slopes near the creek. Much of the area is currently residential development with some wetlands bordering Brown's Creek. The Oak Glen golf course is in this reach downstream of Neal Avenue. The geographic scope for the central area is defined by the Brown's Creek Reach spanning from Manning Avenue to Norrell Avenue.

3.2.1 Native Plant Community Description

The central area contains scattered forested communities with the most prevalent being oak-dominated. Other wooded communities include conifer plantations, maple-basswood, and aspen-dominated forests. No native plant communities have been identified in this area. The creek restoration projects at Brown's Creek Park and Oak Glen golf course provide excellent examples of how natural resource restoration projects can be incorporated into a developed landscape.

3.2.2 Bird Habitat Description

The wetland and shrub-carr communities within the central region provide important breeding and foraging habitats for many resident and migratory bird species. Open water habitat is also an important component utilized by waterfowl and shorebirds. Although no specific bird surveys were conducted in this area, ring-necked duck, mallard, green heron, broad-winged hawk, killdeer, pileated woodpecker, chimney swift, alder flycatcher, great-crested flycatcher, American redstart and barn swallow have been observed in this area.

3.2.3 Macroinvertebrate Habitat Description

Macroinvertebrates were sampled from several habitat types downstream of Highway 96. Of the three sites sampled for the unique species inventory (Headwaters, Central, and Gorge), the central site contained the second highest taxon richness (33 taxa represented). The central site contained glossosomatidae caddisflies and many limnephilidae caddisflies. These taxa have a low pollution tolerance and are indicative of good water quality and sufficient dissolved oxygen.

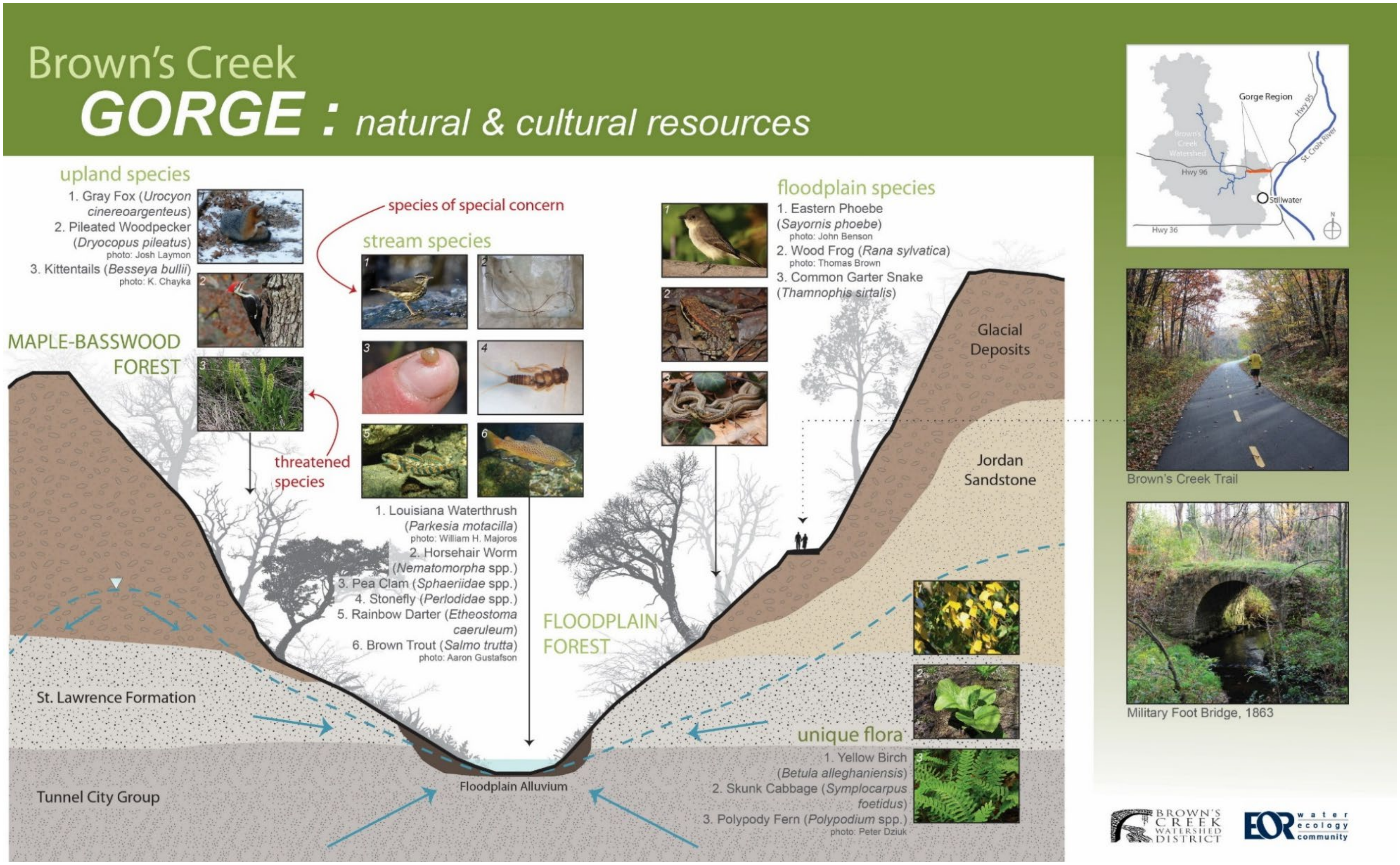
3.2.4 Fish and Fresh Water Mussel Habitat Description

Surveys and assessments in this reach have identified brook stickleback, central mudminnow, fathead minnow, creek chub, and several warm water species including black bullhead, pumpkinseed, and hybrid sunfish. The presence of warm water species reflects the sluggish characteristics of Brown's Creek within this reach. Fingernail clams have been observed in riffle habitat downstream of Highway 96 and within the Oak Glen golf course.

3.2.5 Amphibian and Reptile Habitat Description

Common herptile species such as painted turtle, common garter snake, green frog, boreal chorus frog, and northern leopard frog occupy the various wetland complexes along this reach.

Figure F8. Brown's Creek Lower Reach/Ravine



3.3 Lower Brown's Creek Ravine (Gorge)

The gradient of Brown's Creek changes dramatically as it descends into the St. Croix Valley downstream of the historic Stone Arch Bridge. Within this reach, Brown's Creek flows through a steep, wooded valley where the creek channel has cut into the Tunnel City Group bedrock formation, hence the name Lower Gorge. It is within this reach that cold groundwater provides a major component of the base flow to Brown's Creek, thus providing one of the key elements necessary to support a cold-water fishery. The direct drainage area within this subwatershed is limited to a relatively small drainage area adjacent to Brown's Creek. Most of this drainage area is forested with low density large-lot residential development. The lower gorge generally consists of two types of vegetative communities: maple-basswood forest and mixed hardwood seepage swamp.

3.3.1 Native Plant Community Description

Five native plant communities occur within the ravine: dry bedrock bluff prairie, red oak - white oak - (sugar maple) forest, sugar maple - basswood - (bitternut hickory) forest, willow - dogwood shrub swamp, and black ash - (red maple) seepage swamp. These natural communities support high biodiversity and ecological value in the lower gorge and help protect Brown's Creek by preventing erosion of the steep slopes and by shading the water.

The rare features value for this reach of the creek is high. Several communities within the ravine are mapped on the Natural Communities and Rare Species Map for Washington County and support a small population of kittentails, a state-listed threatened plant. In 2015, surveys were conducted in high-quality vegetation communities identified in the MLCCS mapping and at site 6D in the 2001 NRI. Table F23 summarizes the findings of the survey at site 6D.

In 2025, site 6D was revisited to assess the population of kittentails and four individuals were documented. Woody invasive species continue to degrade this area and will require management to protect the kittentails population at this location.

Table F23. Lower Ravine Natural Communities Surveyed in 2015

Site ID (as identified in the 2001 NRI)	2015 Site Description	Results/2001 to 2015 Comparative Analysis[9]
6D		In 2015, one sample site was selected based on landscape position and ease of access. Two MNDNR releve data sheets including natural community descriptions and plant species lists document findings of the 2015 survey. Vegetation data from 2015 confirm a diverse plant community exists although buckthorn and Tartarian honeysuckle were found in 2015 which were not documented in the 2001 survey.

3.3.2 Bird Habitat Description

Three bird species that prefer mature forests associated with streams include the Louisiana waterthrush, Acadian flycatcher, and cerulean warbler. These three species are listed by the Minnesota Department of Natural Resources as "species of special concern" and also listed as Species of Greatest Conservation Need (SGCN). In 1988, the Minnesota County Biological Survey (MCBS) documented a pair of Louisiana waterthrushes along the Brown's Creek gorge. Although no nest was found during the survey, the surveyors concluded there was good evidence of breeding occurring in the area. In May 2019, EOR staff

[9] Two Minnesota Department of Natural Resources data sheets including natural community descriptions and plant species lists document findings of the 2015 survey. These data sheets can be found in the Unique Species Inventory (2016).

found an active Louisiana waterthrush nest in the middle of the gorge with two adults tending to the nest, and another pair was observed in this area in 2024, but no nest was found. Additionally, tufted titmice have been wintering over in the gorge area. Wood pewee and wood thrush have also been observed.

There has been no documented evidence of Acadian flycatchers and cerulean warblers in the lower gorge, but it is possible sufficient habitat exists to support them during the breeding season. It should be noted that all three of these species have been observed at Falls Creek SNA in northern Washington County. Falls Creek SNA is like the Brown's Creek gorge since both areas contain steep wooded ravines with swift-flowing creeks. The relative proximity of these two areas increases the likelihood of these species utilizing the Brown's Creek corridor during the breeding season and migration.

3.3.3 Macroinvertebrate Habitat Description

Macroinvertebrates were sampled from several habitat types within the Brown's Creek Gorge. Of the three sites sampled during the 2015 unique species inventory (Headwaters, Central, and Gorge), the gorge site contained the lowest taxon richness (26 taxa represented). It contained one Perlodidae stonefly and large numbers of Uenoidae and Limnephilidae caddisflies. These taxa have a low pollution tolerance and are indicative of good water quality and sufficient dissolved oxygen. The single Perlodidae stonefly was the only specimen collected from all three sites.

BCWD has been conducting routine fish and macroinvertebrate assessments since 2015 to monitor changes in the biological community of Brown's Creek following implementation of several water quality projects in the watershed. Data collected from 2015-2023 indicate an overall upward (improving) trend in stream health and macroinvertebrate community quality.

The calculated IBI scores from all three sites indicate a stable and improving macroinvertebrate community from 2015 to 2023, with most macroinvertebrate IBI scores occurring between the general use and exceptional use thresholds for the Southern Coldwater Streams region. In particular, the gorge IBI scores have improved the most during the study and have remained above the exceptional use threshold since 2019. Of the 17 samples that have scored above the exceptional use threshold over the course of the project, 14 of those samples have occurred since 2019. Most notably, all three fall 2019 samples were above the exceptional use threshold.

The total number of taxa sampled from 2015-2023 indicates a diversity of species present across all three sites (140 unique taxa, with the three most dominant taxa having a medium-level tolerance to pollution. However, good numbers of intolerant taxa (species intolerant of pollution) are also present, indicating ample stream habitat and water quality to support these sensitive species. The Perlodid stonefly has been collected every year from the gorge site, indicating the creek provides ample habitat and oxygen levels for this pollution-intolerant species. Perlodid stoneflies were also collected from the middle reach from 2020-2022.

The average pollution tolerance score has decreased since 2015, indicating the creek is supporting a greater number of species that are considered intolerant to pollution. This trend is also reflective in the population size of intolerant species, with the number of pollution intolerant specimens steadily increasing since 2015. Pollution intolerant taxa are present in good numbers at all three sampling sites and suggest Brown's Creek is providing suitable habitat and water quality for macroinvertebrates throughout the creek corridor.

3.3.4 Fish and Fresh Water Mussel Habitat Description

The Minnesota Department of Natural Resources has conducted fish population assessments in the lower gorge dating back to 1966. Fish species documented over the years have included northern pike, creek chub, white sucker, burbot, brook stickleback, central mudminnow, bluntnose dace, longnose dace, fathead minnow, rainbow darter, green sunfish, pumpkinseed, bluegill, rainbow trout, and brown trout. Interestingly, while conducting the mussel survey in 2015, a rainbow darter was captured and photographed in the lower gorge. This individual represents only the 2nd record of this species in Brown's Creek. The first known record of a rainbow darter in Brown's Creek was sampled by the Minnesota Department of Natural Resources in 1976.

The Minnesota Department of Natural Resources began stocking brook trout in the creek in 1951 with a second stocking effort conducted in 1955. The success of this initial stocking was apparently low, so they switched to stocking brown trout starting in the 1960's. Since this time, the brown trout population had been supported by routine stocking efforts as little natural reproduction occurred in the creek. However, over the last decade, evidence of naturally reproducing brown trout was documented in the lower gorge, so they switched to stocking rainbow trout to bolster recreational fishing opportunities in the creek. In addition, Stillwater Area High School recently began raising fingerling rainbow trout to release in the creek based on input from the Minnesota Department of Natural Resources. However, with the thermal reductions measured in the creek since 2021, BCWD has requested that the Minnesota Department of Natural Resources start stocking Minnesota native strain brook trout when sufficient stock is available.

A mussel survey was conducted in the lower gorge on October 13, 2015. Survey efforts focused on riffles where the potential for mussel occurrence would be greatest due to proximity of the St. Croix River. No live specimens of mussels were found, but numerous fingernail clams in the family Sphaeriidae were observed in the riffles. This is a common species found in many Minnesota streams. Interestingly, an old mussel valve (shell) was found upstream of the Highway 96 box culvert. Regional malacologists from the Minnesota Department of Natural Resources concluded that the identity of this specimen was likely a plain pocketbook. The origin of this specimen is unknown, but it is possible Brown's Creek once supported at least one species of native mussel in the lower gorge. If host fish from the St. Croix River can freely swim upstream into Brown's Creek, it is possible glochidia (young mussles) from certain mussel species could be dispersed by their fish hosts and colonize the riffles that occur in the lower gorge.

3.3.5 Amphibian and Reptile Habitat Description

The steep wooded bluffs, rock outcroppings, riparian wetlands, and groundwater seeps provide cool, moist conditions that support herptiles such as wood frog, gray tree frog, American toad, and tiger salamander but generally do not support overwintering habitat for turtles.

The Brown's Creek Gorge

3.4 Long Lake Tributary Area

Predominant land-uses in the Long Lake Tributary drainage area include old fields, row crops, forest and low to moderate density residential. South of Long Lake, along the Highway 36 corridor, land-use includes a mixture of light industrial and office space, along with retail business. The Highway 36 corridor has experienced the highest amount of urban growth in the Brown's Creek watershed.

3.4.1 Native Plant Community Description

The natural communities within the Long Lake Tributary are limited to the areas adjacent to Long Lake and two small areas to the west of Manning Avenue. The natural communities in this area face pressure from development and are likely to decrease in quality. The largest natural community within this area, a mesic oak forest, is currently being developed into residential housing. In addition to this area, there are small conifer plantations and oak woodlands of varying quality. These natural communities provide an excellent buffer for Long Lake.Rare features value for the oak forest on the west side of Long Lake is high. The 2001 NRI identified this site as 8B. This community is mapped on the Natural Communities and Rare Species Map for Washington County.

As documented in the 2001 Groundwater Dependent Natural Resource Management Plan, a fen is located on a sloping, east facing hillside in the southwestern portion of Section 26 of Township 30, Range 21. This shallow wetland community is dominated by sedges and grasses on a deep (>2 feet) peat substrate. The ground layer is dominated by tussock sedge, lake sedge, wooly sedge, and other sedges and grasses along with swamp saxifrage, water hemlock, and sensitive fern. Although a generally open community, this fen also contains pockets of woody shrubs including willows and dogwoods. This fen has retained its status as being high quality and high functioning. However, several areas of this fen have been partially degraded where scattered pockets of reed canary grass, an invasive plant species, occur. Iron-rich groundwater discharges at the base of the slope where the fen is located. This is an indication of groundwater discharging into the fen. In total over 50 native plant species have been documented at the site during numerous field visits, making it one of the most diverse wetlands in the Brown’s Creek watershed. Most of the plant species found within the wetland are not encountered in any other wetland in the watershed, and many of the species are somewhat unique to rich fens. The drainage area to the fen is currently being developed into single-family residential area. While the fen is being protected by the district’s rules, BCWD will continue to monitor the quality of the fen through its vegetation management activities.

3.4.2 Bird Habitat Description

No bird surveys were conducted in this area.

3.4.3 Macroinvertebrate Habitat Description

No macroinvertebrate work was conducted in this area.

3.4.4 Fish and Fresh Water Mussel Habitat Description

No fish or mussel work was conducted in this area.

3.4.5 Amphibian and Reptile Habitat Description

Like the developed central reach of Brown’s Creek, common herptile species such as common garter snakes and northern leopard frogs are most likely to be prevalent here. The lakes and wetlands also provide habitat for common turtle species such as the painted turtle and snapping turtle. There are no Blanding’s turtle records in this area of the watershed.

3.5 Exotic and Invasive Species

Exotic and invasive species are an on-going threat in the Brown's Creek watershed which can degrade native plant communities, wildlife habitat, and water quality. Table F24 was developed from the Minnesota Department of Natural Resources terrestrial and aquatic invasive species database. The terrestrial species database is an inventory across the Minnesota Department of Natural Resources (MNDNR) administered lands of selected invasive terrestrial plants derived from a multi-divisional effort to collect consistent information across all MNDNR-administered lands. The aquatic species are derived from a MNDNR effort to record the locations of aquatic invasive species in waterbodies throughout the state. To develop the table below, the GIS database for both terrestrial and aquatic species was queried for Washington County and intersected with the watershed boundary to identify documented species in the watershed. There are several species documented in Washington County that are likely present in the watershed for which the MNDNR does not have a record.

Table F24. List of Exotic and Invasive Species Documented by the Minnesota Department of Natural Resources in Washington County and BCWD. Species listed as unregulated and/or added by EOR for known presence but not listed in MNDNR dataset are noted with *.

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Absinth Wormwood	Y		Y	
Alsike Clover	Y		Y	
Amur Maple	Y	Y	Y	
Amur Silvergrass	Y		Y	
Annual Sowthistle	Y		Y	
Asiatic Dayflower	Y	Y	Y	
Asparagus	Y	Y	Y	
Autumn Olive	Y		Y	
Banded Mystery Snail	Y			Y
Barnyard Grass	Y		Y	
Biennial Campion	Y		Y	
Bighead Carp	Y			Y
Bigleaf Lupine	Y		Y	
Bird Vetch	Y		Y	
Birdsfoot Trefoil	Y	Y	Y	
Bittersweet Nightshade	Y	Y	Y	
Black Bullhead	Y			Y
Black Locust	Y	Y	Y	
Black Medic	Y	Y	Y	
Black Mustard	Y		Y	
Black Swallowwort; Black dog-strangling vine	Y		Y	
Bladder Campion	Y		Y	
Bohemian Knotweed; Hybrid Japanese	Y	Y	Y	
Bouncingbet	Y		Y	

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Bristly Bellflower	Y		Y	
Bristly Locust	Y	Y	Y	
Brown Knapweed	Y		Y	
Brown Marmorated Stink Bug	Y	Y	Y	
Brown Trout*	Y	Y		Y
Bull Thistle	Y	Y	Y	
Bullfrog*	Y	Y		Y
Burnet-Saxifrage	Y		Y	
Canada Bluegrass	Y		Y	
Canada Thistle	Y	Y	Y	
Carpetweed	Y		Y	
Catnip	Y	Y	Y	
Cheatgrass Grass; Downy Brome	Y	Y	Y	
Chickpea Milkvetch; Cicer	Y		Y	
Chicory	Y		Y	
Chinese Mystery Snail	Y			Y
Chukar*	Y		Y	
Common Buckthorn	Y	Y	Y	
Common Burdock	Y		Y	
Common Carp	Y			Y
Common Chickweed	Y		Y	
Common Comfrey	Y		Y	
Common Earthworm	Y		Y	
Common Flax	Y		Y	
Common Groundsel	Y		Y	
Common Hempnettle	Y		Y	
Common Mallow	Y		Y	
Common Mouse-ear Chickweed	Y		Y	
Common Mullein	Y	Y	Y	
Common Purslane	Y		Y	
Common Selfheal	Y	Y	Y	
Common Speedwell	Y		Y	
Common St. Johnswort	Y	Y	Y	
Common Tansy	Y	Y	Y	
Common Valerian	Y	Y	Y	
Common Vetch	Y		Y	

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Common Yarrow	Y	Y	Y	
Corn Speedwell	Y	Y	Y	
Cow Vetch	Y	Y	Y	
Creeping Bellflower	Y	Y	Y	
Creeping Charlie	Y	Y	Y	
Creeping Yellow Loosestrife; Creeping Jenny	Y		Y	
Crimson Clover	Y		Y	
Curly Dock	Y	Y	Y	
Curly-Leaf Pondweed	Y	Y		Y
Cutleaf Teasel	Y		Y	
Cypress Spurge	Y		Y	
Dame's Rocket	Y	Y	Y	
Dandelion	Y		Y	
Deptford Pink	Y		Y	
Dock Broadleaf	Y		Y	
Dotted Loosestrife	Y		Y	
Dutch Elm*	Y	Y	Y	
Elecampane	Y		Y	
Emerald Ash Borer	Y	Y	Y	
Eurasian and Northern Watermilfoil Hybrid	Y			Y
Eurasian Watermilfoil	Y	Y		Y
European common reed, Phragmites	Y	Y		Y
European Starling	Y	Y*	Y	
Everlasting Peavine	Y		Y	
False Strawberry	Y		Y	
Field Bindweed	Y		Y	
Field Pennycress	Y	Y	Y	
Flat Peavine	Y	Y	Y	
Flowering Rush	Y			Y
Freshwater Golden Clam	Y			Y
Garlic Mustard	Y	Y	Y	
Giant Chickweed	Y			Y
Giant Foxtail	Y	Y	Y	
Glossy Buckthorn	Y	Y	Y	
Golden Chamomile	Y		Y	
Goldfish	Y			Y

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Goutweed	Y	Y	Y	
Grass Carp	Y			Y
Gray partridge*	Y		Y	
Great Burdock	Y		Y	
Greater Celandine	Y		Y	
Grecian Foxglove	Y	Y	Y	
Green Bristlegrass	Y		Y	
Green Foxtail	Y		Y	
Hairy Galinsoga	Y	Y	Y	
Hairy Vetch	Y	Y	Y	
Hedge Bindweed	Y		Y	
Helleborine	Y	Y	Y	
Herb-Robert	Y		Y	
Hoary Alyssum	Y	Y	Y	
Hop Clover	Y		Y	
House Sparrow*	Y	Y	Y	
Hybrid Barberry	Y		Y	
Japanese Angelica Tree	Y		Y	
Japanese Barberry	Y	Y	Y	
Japanese Beetle	Y	Y	Y	
Japanese Brome	Y		Y	
Japanese Hedge-Parsley; Erect Hedge-Parsley	Y		Y	
Japanese Hop	Y		Y	
Japanese Knotweed	Y	Y	Y	
Japanese Lilac Tree	Y		Y	
Jimsonweed	Y		Y	
Jumping Worm	Y	Y	Y	
Kentucky Bluegrass	Y		Y	
Knapweed Weevil	Y	Y	Y	
Ladysthumb	Y		Y	
Lambsquarters	Y		Y	
Large Clover	Y		Y	
Large Crabgrass	Y		Y	
Leafy Spurge	Y	Y	Y	
Lesser Knapweed Flower Weevil	Y		Y	
Lily Leaf Beetle	Y		Y	

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Lily of the Valley	Y		Y	
Little Starwort	Y		Y	
Littleleaf Linden	Y		Y	
Longleaf Speedwell	Y		Y	
Low Cudweed	Y		Y	
Meadow Foxtail	Y		Y	
Meadow Salsify	Y		Y	
Morrow's Honeysuckle	Y		Y	
Moth Mullein	Y		Y	
Motherwort	Y	Y	Y	
Mugwort	Y		Y	
Multicolored Asian Lady Beetle	Y		Y	
Muscovy Duck	Y		Y	
Musk Thistle; Nodding	Y	Y	Y	
Mute Swan*	Y			Y
Narrowleaf Bittercress	Y		Y	
Narrowleaf Hawksbeard	Y		Y	
Narrow-Leaved Cattail	Y			Y
Norway Maple	Y	Y	Y	
Oak Wilt	Y	Y	Y	
Oakleaf Goosefoot	Y		Y	
Orange Hawkweed	Y	Y	Y	
Orchardgrass	Y	Y	Y	
Oxeye Daisy	Y	Y	Y	
Perennial Sowthistle	Y	Y	Y	
Pineapple-Weed	Y	Y	Y	
Plantain Broadleaf	Y		Y	
Plantain Buckhorn	Y		Y	
Poison Hemlock	Y		Y	
Prickly Lettuce	Y	Y	Y	
Prostrate Knotweed	Y		Y	
Purple Carrot-Seed Moth	Y		Y	
Purple Crown Vetch	Y	Y	Y	
Purple Loosestrife	Y	Y		Y
Quackgrass	Y	Y	Y	
Rabbitfoot Clover	Y	Y	Y	

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Rainbow Smelt	Y			Y
Rainbow Trout*	Y			Y
Red Clover	Y	Y	Y	
Red Hailstone	Y		Y	
Red Sorrel	Y	Y	Y	
Redtop	Y		Y	
Reed Canary Grass	Y	Y		Y
Ring-necked Pheasant*	Y	Y	Y	
Rock Dandelion	Y		Y	
Rock Pigeon*	Y	Y	Y	
Round Leaf Bittersweet	Y	Y	Y	
Russian Olive	Y		Y	
Russian Thistle	Y		Y	
Rusty Crayfish	Y			Y
Scots Pine	Y		Y	
Shepherd's-Purse	Y	Y	Y	
Siberian Elm	Y	Y	Y	
Siberian Peashrub	Y		Y	
Silver Carp	Y			Y
Silvery Cinquefoil	Y		Y	
Small-Leaf Bramble	Y	Y	Y	
Smooth Brome	Y	Y	Y	
Spiny Plumeless Thistle	Y		Y	
Spotted Knapweed	Y	Y	Y	
Spotted-Wing Drosophila	Y	Y	Y	
Squill	Y	Y	Y	
Stinging Nettle	Y	Y	Y	
Sulfur Cinquefoil	Y	Y	Y	
Sweetwilliam	Y		Y	
Tall Buttercup	Y		Y	
Tar Spot of Corn	Y	Y	Y	
Tatarian Honeysuckle	Y	Y	Y	
Tawny Daylily	Y	Y	Y	
Thymeleaf Speedwell	Y	Y	Y	
Timothy	Y		Y	
True Forget-me-not	Y	Y	Y	

Species Common Name	Washington County	BCWD	Terrestrial	Aquatic
Velvetleaf	Y		Y	
Venice Mallow	Y		Y	
Viburnum Cranberry; European highbush	Y		Y	
Wallflower Mustard	Y		Y	
Watercress	Y			Y
Western Salsify	Y	Y	Y	
White Cabbage; Imported Cabbage Worm	Y		Y	
White Campion	Y	Y	Y	
White Clover	Y	Y	Y	
White Mulberry	Y	Y	Y	
White Poplar	Y	Y	Y	
White Sweetclover	Y	Y	Y	
Wild Buckwheat	Y	Y	Y	
Wild Carrot Queen Anne's Lace	Y	Y	Y	
Wild Mustard	Y		Y	
Wild Parsnip	Y	Y	Y	
Winged Burning Bush	Y	Y	Y	
Woodland Forget-me-not	Y		Y	
Woolly Cupgrass	Y		Y	
Yellow Clover	Y	Y	Y	
Yellow Flag Iris; Pale Yellow Iris	Y			Y
Yellow Foxglove	Y		Y	
Yellow Foxtail	Y	Y	Y	
Yellow Iris*	Y		Y	
Yellow Nutsedge	Y		Y	
Yellow Rocket	Y	Y	Y	
Yellow Toadflax	Y	Y	Y	
Zebra Mussel	Y			Y

Data from the vegetation surveys conducted in the Brown's Creek watershed for the unique species inventory were analyzed to develop a baseline assessment of invasive species abundance. In the 696 (mostly wetland) vegetation data points within the watershed, 65% of them had one or more invasive species identified. Reed canary grass was present in 49% of the plots and the second-most common species was glossy buckthorn at 12%. Common buckthorn was also found in 8% of the plots, but it should be noted that most of the plots were within wetlands and that common buckthorn is more prevalent in upland sites. Past and ongoing vegetation surveys in the Brown's Creek watershed confirm that smooth and glossy buckthorn are a problematic invasive species.

4 Human Environment

Humans have inhabited the watershed for thousands of years. Prior to the arrival of European settlers and the establishment of Minnesota in 1858, the Dakota and Ojibwe were the primary stewards of these lands. A series of land cessions in 1837, 1842, 1854, and the Dakota Expulsion Act of 1863 led to increased exploitation of the watershed's resources and widespread neglect by government of treaty obligations to Indigenous rights.

Indigenous peoples shaped their environment to sustain their communities through practices such as controlled fires to improve oak savanna habitat for game and foraging grounds for bison. Rivers, streams, lakes, and wetlands provided important corridors for transportation and food from fish, *manoomin* (wild rice), and other food sources. Settlement by Europeans and subsequent waves of migrants has dramatically reshaped the environment of the St. Croix watershed through forestry, agriculture, and expansion of built-up areas such as cities, suburbs, and towns.

Today, many communities call the watershed home and have varying interests in its future. An enhanced engagement effort begun in 2023 identified and mapped stakeholder groups considering their representation, type, reach, level of interaction with the environment, and their impact on the environment. Groups were sorted by level of interest and level of influence in watershed decision-making. The enhanced engagement effort's stakeholder mapping provides the basis for ongoing engagement with watershed communities aimed at broadening awareness and involvement in watershed activities.

4.1 Demographics

The 2020 Decennial Census included tabulations of housing units, total population, and adult population by race and Hispanicity, which is available at the Minnesota Geospatial Commons(4). In addition, the Metropolitan Council has published files for 2020 blocks, block groups, and tracts.

The total population of Minnesota is projected to grow from 5.78 million in 2024 to 6.11 million in 2075. Washington County is one of the counties projected to experience the most significant population growth with the addition of 110,647 individuals or an approximately 41% increase in this same timeframe. This projected growth may increase further due to the emerging phenomenon of climate migration to the state. By 2075, Minnesota's population in the over 65+ age group will more than double, while the population in the younger age groups (0-19 years) will remain stable/decline slowly. Black and Indigenous communities and other communities of color are projected to grow at a faster rate than the white population.

Table F25. Population Growth by Municipality

Community	2020[10]	2030 (Projected)	2040 (Projected)
Grant	3,970	4,160	4,260
Hugo	15,766	22,800	29,900
Lake Elmo	11,355	18,480	22,450
May Township	2,670	3,490	3,950
Oak Park Heights	4,894	5,300	5,700
Stillwater	19,394	22,240	23,240
Stillwater Township	1,866	2,230	2,360

[10] Source: U.S. Census, Metropolitan Council

4.2 Historical Land-Use

The Historical Generalized Land Use dataset encompasses the seven county Twin Cities (Minneapolis and St. Paul) Metropolitan Area in Minnesota, which is available at the Minnesota Geospatial Commons(4) . The dataset was developed by the Metropolitan Council, and the data were interpreted from 1984, 1990, 1997, 2000, 2005, 2010, 2016, and 2020 air photos and other source data, with additional assistance from county parcel data and assessor's information.

4.3 Present Land-Use

Land-use data can be obtained from a multitude of geospatial datasets available at Minnesota Geospatial Commons(4) and the respective agency websites. The National Land Cover Database (NLCD), 2021(35) and the Minnesota Land Cover Classification System (MLCCS)(12) provide similar land use information first published in 2014 with various updates as recent as August 2024. The USDA Cropland Data Layer, 2023, which can be attained through Minnesota Geospatial Commons(4) provides land-use information as it relates to agriculture, which occupies approximately 9.4% percent of land cover within the Brown's Creek watershed. Metropolitan Council Local Planning Handbook(36), provides present land use related to development types.

4.4 Future Land-Use

The Minnesota State Demographic publishes population data from the U.S. Census Bureau's American Community Survey in 1-, 3-, or 5- year estimates based on Minnesota city, township, and county(37). Also provided are population projections and a variety of trend analyses. Population projections for Washington County for the time frame of this plan, 2027-2036, indicate a 32% growth in population between 2015 and 2040.

This significant projected growth for Washington County implicates additional development and redevelopment within Brown's Creek watershed. The Metropolitan Council's 2050 Land Use Policy(38) identifies most the watershed in its diversified rural policies. Diversified rural areas are primarily concerned with cost-effective expansion of urban infrastructure, and the protection of natural and water resources. The comprehensive plans for BCWD cities and townships contain more information about future development and redevelopment areas. Several cities within the watershed have completed comprehensive plans that forecast how their cities will look by the year 2040. Table F26 lists each city, township, and county that lies within the watershed and the date of its most current comprehensive plans.

Table F26. Status of Local Comprehensive Plans in the Brown's Creek Watershed

City or Township	Planning Horizon	Date Plan Approved
Grant	2040	Submitted 2019; no approval date listed
Hugo	2040	Adopted November 18, 2019
Lake Elmo	2040	Approved and adopted November 5, 2019
May Township	2040	Updated January 5, 2025; no approval date listed
Oak Park Heights	2040	Dated February 2020; no approval date listed
Stillwater	2040	Completed 2018; no approval date listed
Stillwater Township	2040	Adopted May 10, 2018
Washington County	2040	Adopted by County Board 9 January 7, 2020.

Future and planned land-use data within the Brown's Creek watershed can be attained through two outlets. The Metropolitan Council provides a compilation of individual land use plans and plan amendments from communities within the seven county metropolitan area, which is available through the Minnesota Geospatial Commons[(4)]. The Metropolitan Urban Service Area (MUSA) composite dataset depicts current and future boundaries of the Urban Service Areas (sewer service areas) based on communities' comprehensive plans for the seven-county metropolitan area. The dataset does not depict the precise location of current urban services, however, it provides a framework in which known urban development and anticipated future development can exist with adequate sewer capacity at efficient service levels. This dataset provides a good metric for the potential of future land use within areas planned for development. Both the 2030 and 2040 MUSA within the Brown's Creek watershed is limited to the City of Stillwater and Oak Park Heights. Future development in the watershed is therefore anticipated to be unsewered in the diversified rural areas.

4.5 Water-Based Recreation Areas

There are no lakes within the watershed with a public boat ramp. No Minnesota Department of Natural Resources fishing piers are located within the Brown's Creek watershed. Public access is available to Long Lake, Brewers Pond, and Brown's Creek through the City of Stillwater parks. Public access is available to Bass Lake West and a wetland north of 101st Street through the City of Grant parks. Public access is available for much of the trout stream portion of Brown's Creek through public land and easements. The exception is the private property on either side of the stone arch bridge. The Department of Transportation maintains parking places for anglers in the lower portion of the stream near the intersection of Highway 96 and Highway 95. Data for water-based recreation areas is available through Minnesota Geospatial Commons[(5)].

4.6 Open Space and Recreational System

All municipalities within the watershed have at least one public park or recreational space, and the specific locations of these open spaces are not available on a universal database. Each city website and comprehensive plan was consulted for public park information as it relates to BCWD. Table F27 lists the public parks and open spaces within the watershed and does not include public waters. Most parks listed are within the City of Stillwater and additional information on these parks can be attained at the City of Stillwater Parks website.

Biker in the watershed

Table F27. Recreational spaces and locations within the Brown's Creek Watershed

Recreational Space	Agency	Location
Autumn Hills	Oak Park Heights	Norwich parkway, Hugo MN
Bass Lake Park	City of Grant	May Ave N and 150th St N, Grant, MN
Benson Park	City of Stillwater	North side of West Orleans Street, Stillwater, MN
Bergman Park Bergmann Drive	City of Stillwater	Judd Trail and Timber Way, Stillwater, MN
Brown's Creek Park	City of Stillwater	South of McKusick Road on Neal Avenue N, Stillwater, MN
Brown's Creek Reserve	City of Stillwater	McKusick Road and Neal Avenue, Stillwater, MN
Brown's Creek State Trail	MnDNR	Dellwood Road moving east to hwy 95
Creekside Park	City of Stillwater	Creekside Crossing and Creekside Circle, Stillwater, MN
Croixwood Open Space	City of Stillwater	Nightingale Boulevard, north of Marine Circle, Stillwater, MN
Gateway State Trail	MnDNR	Hwy 36 moving northeast to Norrell Avenue
Heritage Square Park	City of Stillwater	Liberty Parkway and Heritage Court, Stillwater, MN
Legends Gazebo	City of Stillwater	Legends Boulevard and Ilo Way, Stillwater, MN
Legends Park	City of Stillwater	Barons Way and Delano Way, Stillwater, MN
Liberty Square	City of Stillwater	Settlers Way & New England Place, Stillwater, MN
Long Lake Nature Area	City of Stillwater	Staples and Sawyers Place, Stillwater, MN
Long Lake Open Space	City of Stillwater	South end of Nightingale Boulevard, Stillwater, MN
Millbrook Open Space	City of Stillwater	Hwy 96 and Millbrook Circle, Stillwater, MN
Millbrook Park	City of Stillwater	Hwy 96 and Millbrook Circle, Stillwater, MN
Millbrook West Fields	City of Stillwater	SE corner of Hwy 96 and Manning Avenue, Stillwater MN
Nightingale Park Open Space	City of Stillwater	Nightingale Blvd and Northland Avenue, Stillwater, MN
Northland Park	City of Stillwater	25 Northland Avenue (County Road 12), Stillwater, MN
Prairie Park	City of Stillwater	Macey Way in Settlers Glen Development, Stillwater, MN
Public Works Park	City of Stillwater	3325 Boutwell Avenue, Stillwater, MN
Schulenberg Park	City of Stillwater	N. 2nd Street and Hazel Street, Stillwater, MN
Settlers Park	City of Stillwater	Rutherford Rd and Settlers Way in Liberty Development, Stillwater, MN
St. Croix Sanctuary Park	City of Lake Elmo	11544 58th St N, Lake Elmo, MN
Sunrise Park	City of Stillwater	Sunrise Avenue and Hidden Valley Lane, Stillwater, MN
Withrow School	City of Hugo	10158 122nd St N, Hugo, MN

5 Land Conservation and Greenway Corridors

In 2008, BCWD initiated the development of land conservation priorities and explored options for developing a Land Conservation Program. Priorities identified by BCWD were approved by the Board of Managers in 2009 and submitted to Washington County for inclusion in its Land and Water Legacy Program Conservation Priorities[(39)]. The conservation priorities outlined in this plan include a Priority Land Protection Areas Map, which identifies the highest priority land protection areas for the Land and Water Legacy Program. As a component to this program, Washington County included Brown's Creek Central as one of the top ten Conservation Priority Areas. Washington County also has several planned regional trails that lie within or traverse the watershed. These planned trail corridors are specified in the parks and open spaces section of the 2040 comprehensive plan[(40)]. In 2017, BCWD acquired property on 110th Street as a conservation easement. The property borders Brown's Creek and serves as a demonstration site of improvements that can be made to manage stormwater runoff and erosion and improve the ecological quality of the landscape.

Additional Conservation Priorities have been mapped by the Minnesota Department of Natural Resources as a component to the 2007 Natural Resources Conservation Corridors Program[(41)]. Metro Conservation Corridors is modeled on the Minnesota Habitat Corridors Partnership funded through the Legislative-Citizen Commission on Minnesota Resources starting in 2001 for focus areas outside of the metro area. More than 8,000 acres of Minnesota Department of Natural Resources Conservation Corridors land lies within the Brown's Creek watershed.

6 Pollutant Sources

There are Minnesota Pollution Control Agency (MPCA)-permitted sites, hazardous waste generators, and contaminated sites within the Brown's Creek watershed. The MPCA maintains a database of these sites, which includes permitted sites (air, industrial stormwater, construction stormwater, and wastewater discharge), hazardous waste generating sites, leak sites, petroleum brownfields, tank sites, unpermitted dump sites, and sites enrolled in the Voluntary Investigation and Cleanup (VIC) program. This information can be accessed from the MPCA What's in My Neighborhood Database[(42)]. The location of these potentially contaminated or hazardous waste sites should be considered as sites are redeveloped and stormwater best management practices (BMPs) are implemented. While there are a limited number of feedlots in the watershed, data on feedlots can be obtained from the Minnesota Geospatial Commons[(4)].

In addition to localized sources of pollutants (commonly referred to as point sources), non-point source pollution is a major contributor of pollutants. Non-point source pollution cannot be traced to a single source or pipe and are carried from land to water in stormwater or snowmelt runoff, seepage through the soil, and atmospheric transport. Where point sources frequently discharge continuously throughout the year, non-point sources discharge in response to precipitation or snowmelt events. Some areas of the Brown's Creek watershed are served by subsurface sewage treatment systems (SSTS). Non-compliant SSTS is also considered a non-point source of pollutants. The MPCA and Washington County implement SSTS regulatory programs to manage the environmental and public health impacts related to SSTS.

6.1 Contaminants of Emerging Concern

Recent advancements in analytical characterization have led to the identification of new chemicals and pathogens that are commonly referred to as contaminants of emerging concern (CEC). Contaminants of emerging concern generally fall into one of three areas: endocrine disrupting chemicals, pharmaceuticals, or pathogens. The primary concern is the effect that these chemicals, which mimic the actions of naturally occurring hormones, may have on the hormone regulation of aquatic organisms, especially fish. However, identifying these contaminants and their effect on organisms is in its infancy.

Due to the complexity of understanding these contaminants and the large amount of capital needed to characterize them, the primary investigators of CECs tend to be state agencies, research institutions, and federal agencies. The Minnesota Department of Health (MDH) currently develops human health-based guidance for contaminants that have already been found in groundwater in Minnesota. Under the CEC program, MDH is able to take a proactive approach to the protection of drinking water by considering contaminants that have been found in groundwater, surface water, or soil, or have the potential to enter our waters. This CEC program is also informed by the MPCA groundwater monitoring and assessment program[32] A list of the most recent studies by federal agencies related to Endocrine-active compounds (EACs), or chemicals that can affect organismal hormones, can be found in an article on the MPCA website.

Washed up pharmaceuticals in the watershed

Figure F9. Map of the Brown's Creek Watershed

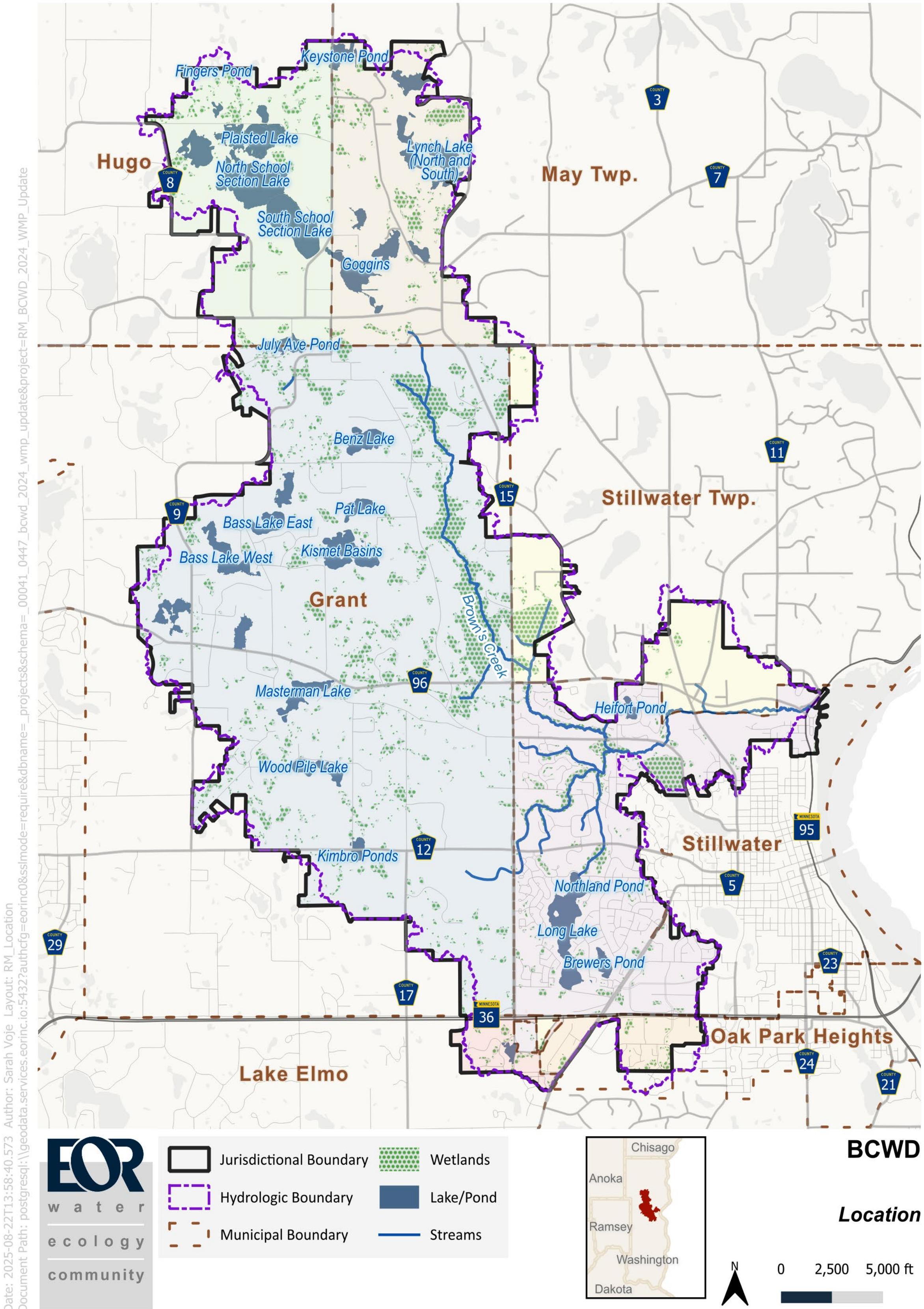


Figure F10. Surface Waters of the Brown's Creek Watershed

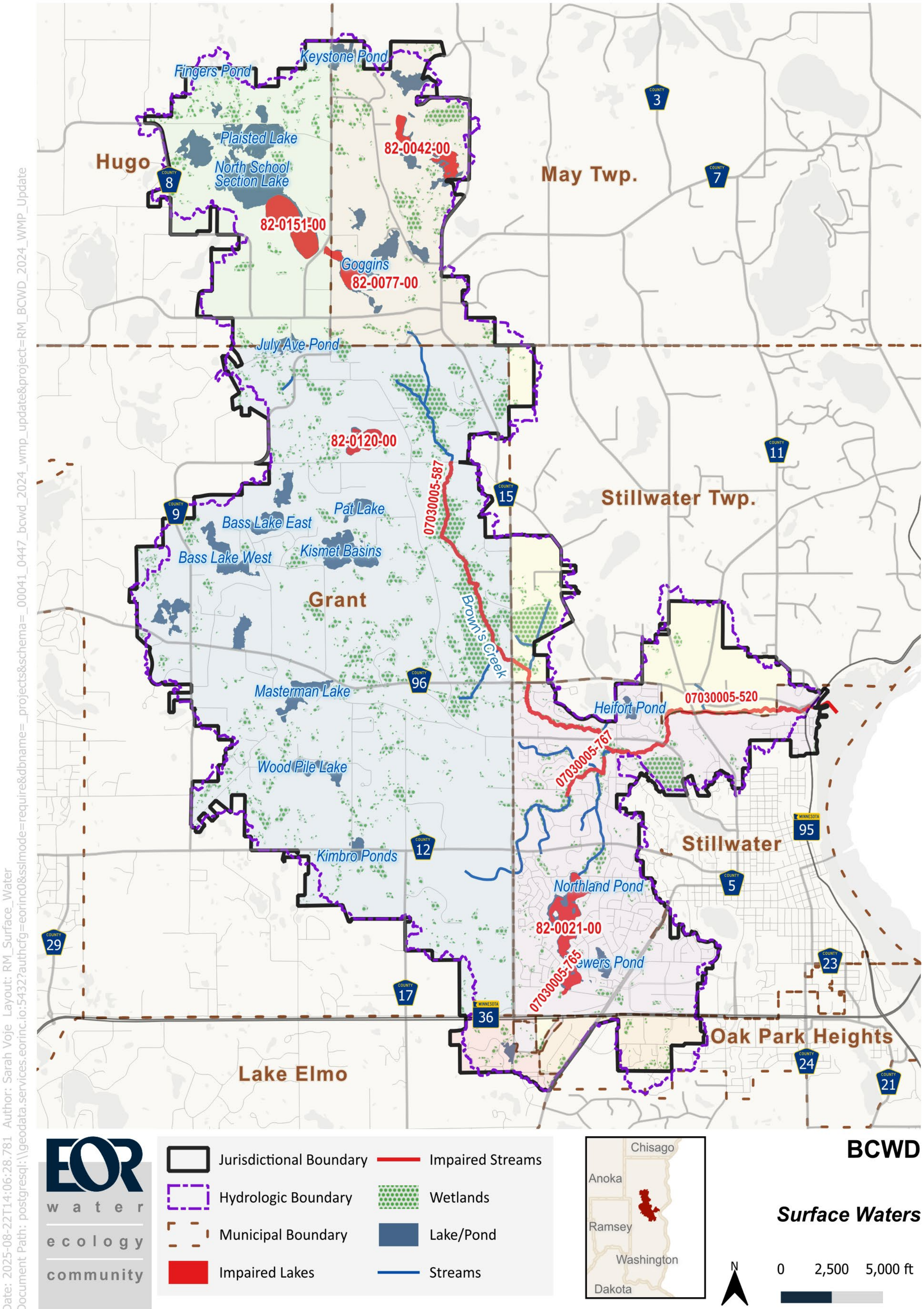


Figure F11. Reaches of Brown's Creek and its Tributaries (Headwaters Region – North Branch)

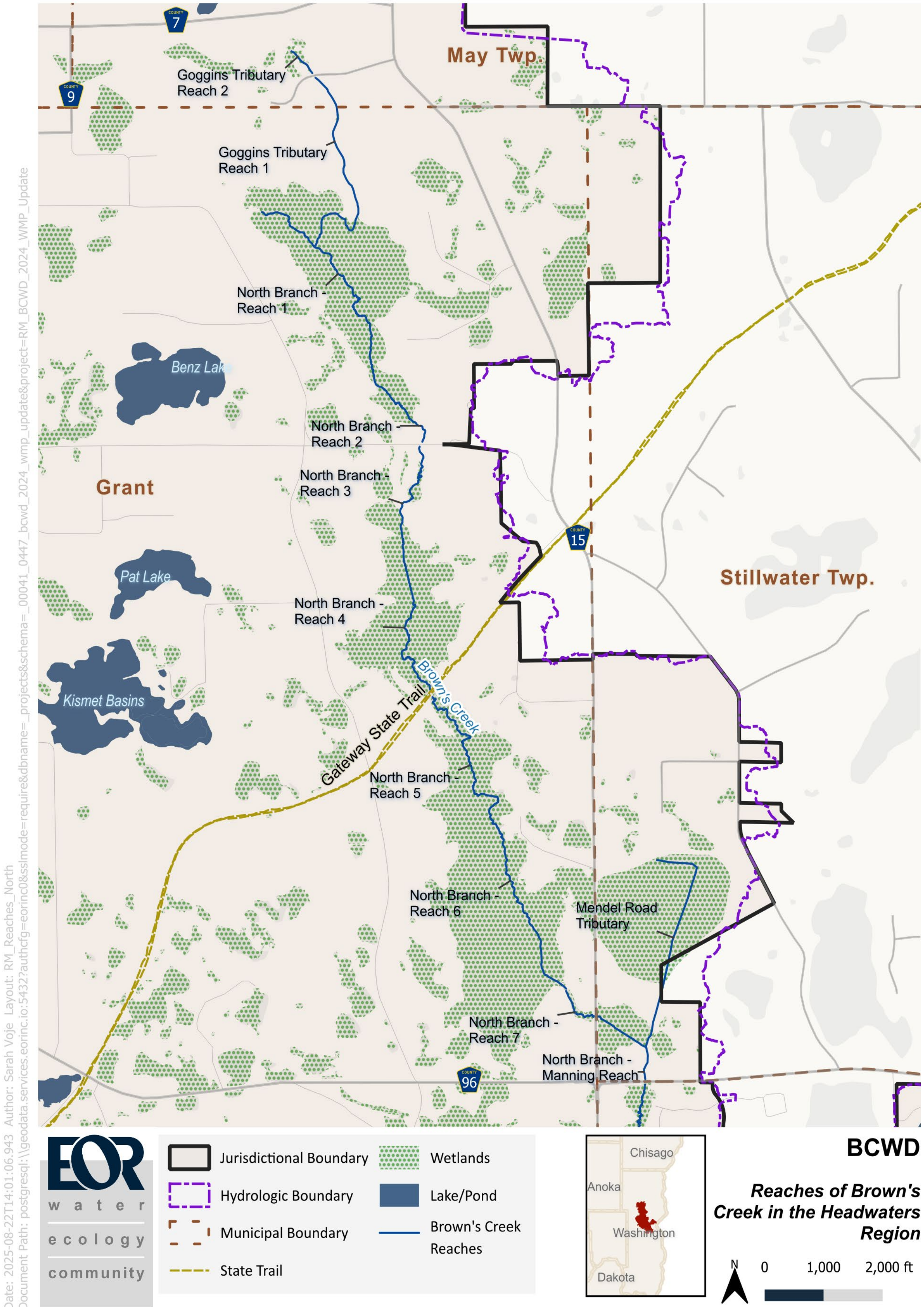


Figure F12. Reaches of Brown's Creek and its Tributaries (Middle Section, Long Lake Tributary, & Gorge Regions – Main Branch)

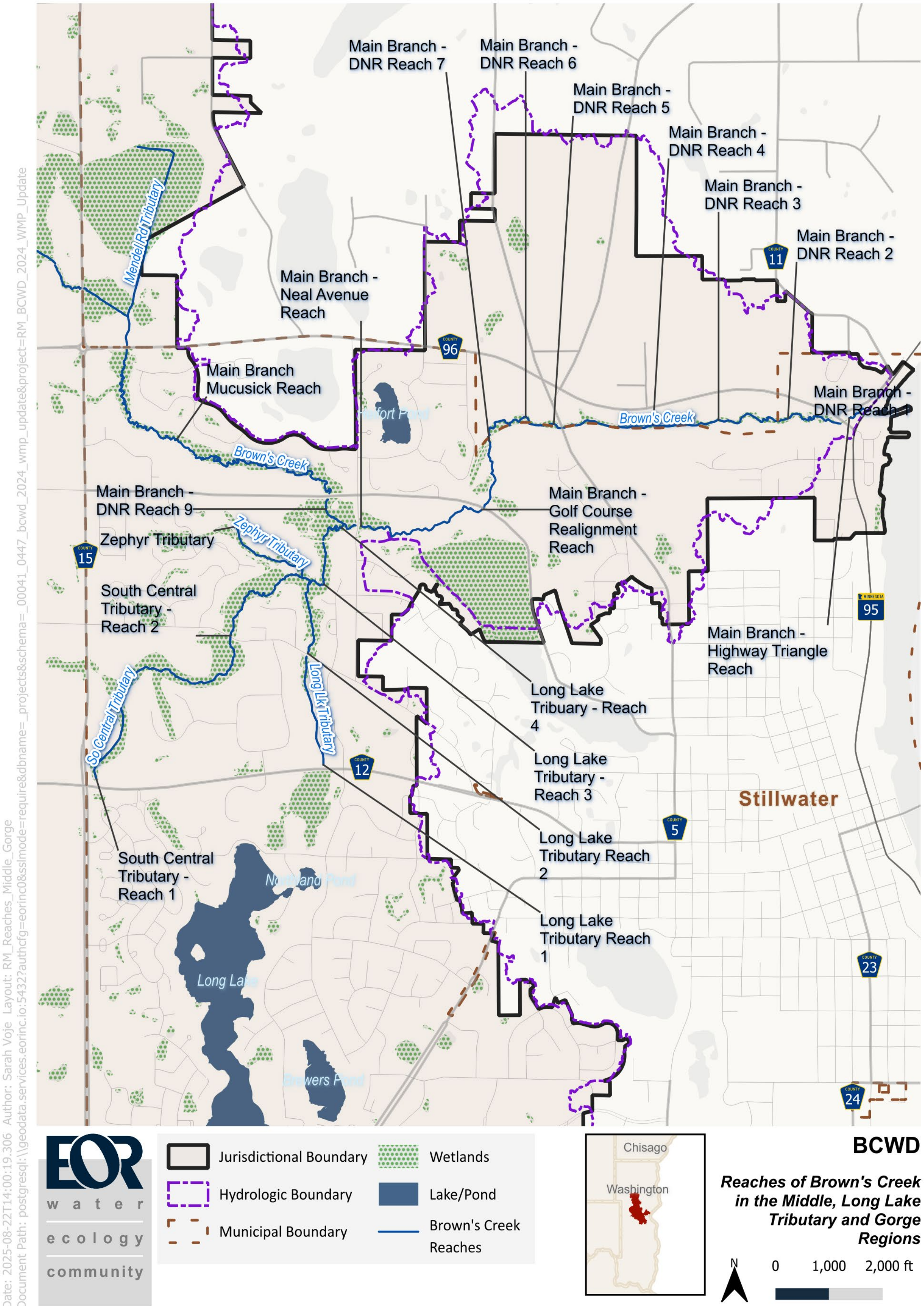


Figure F13. Public Waters and Public Waters Wetlands within the Brown's Creek Watershed

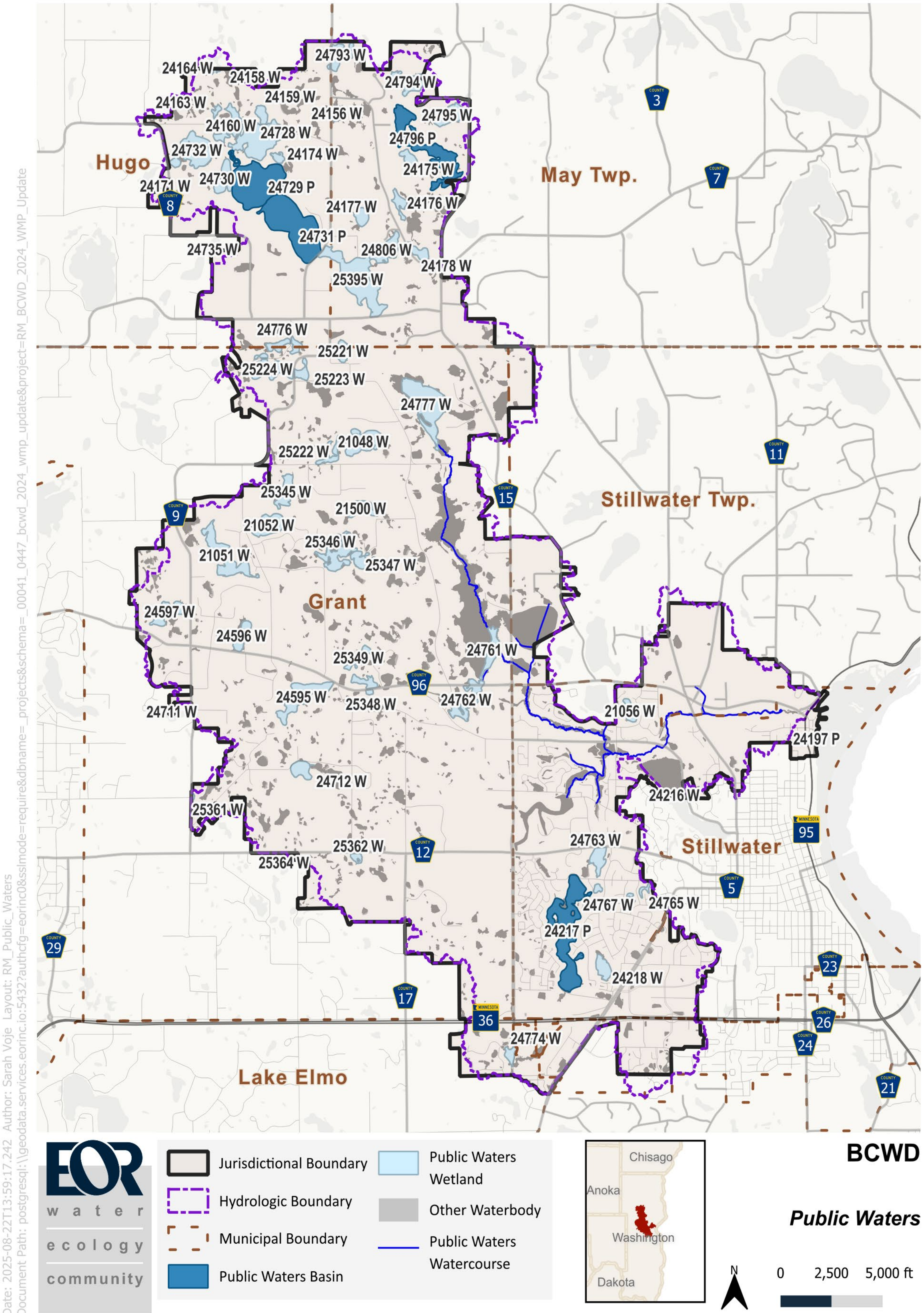


Figure F14. Brown's Creek Watershed Wetland Inventory and Assessment (Full Map)

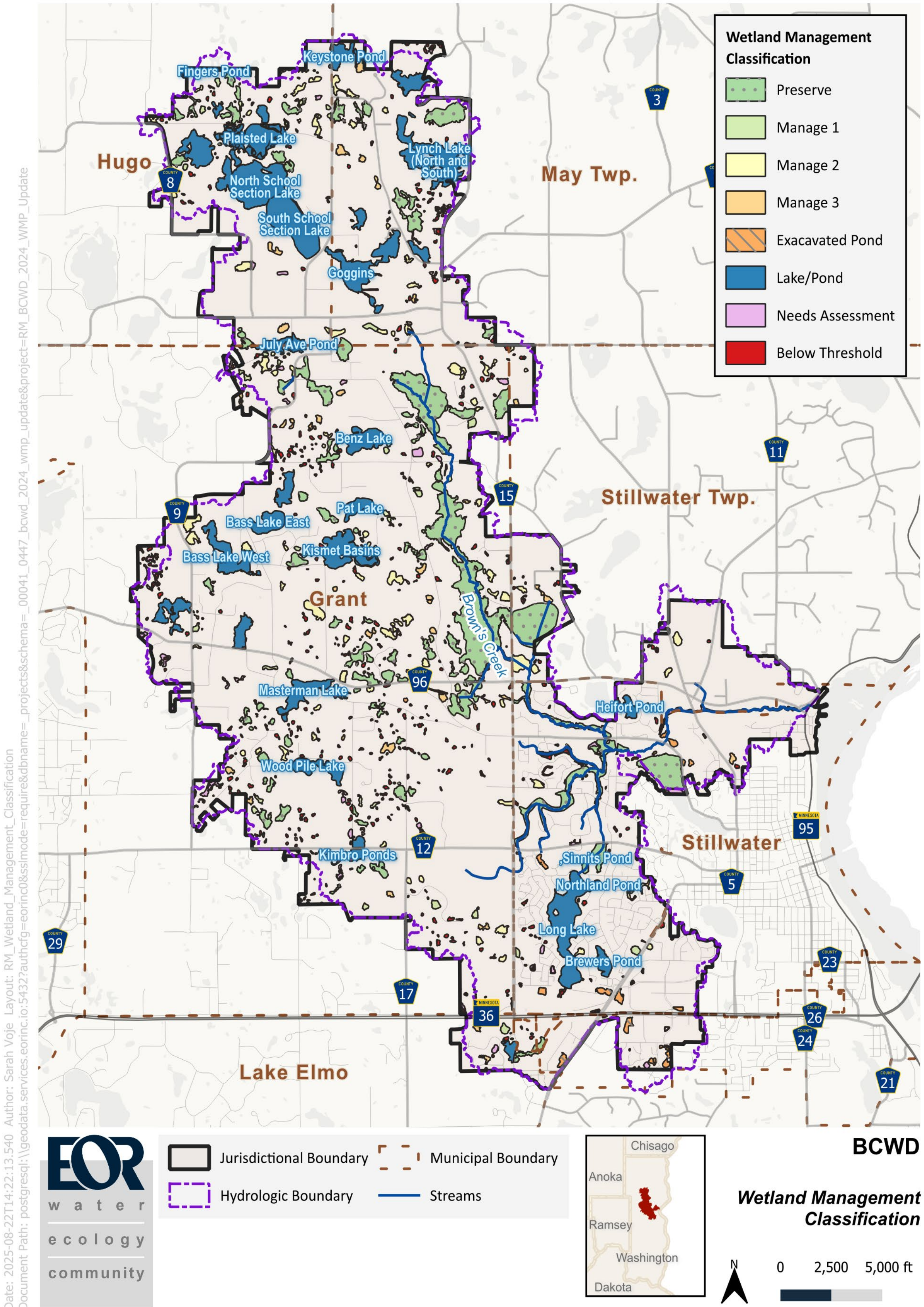


Figure F15. Brown's Creek Watershed Wetland Inventory and Assessment (Partial Map A)

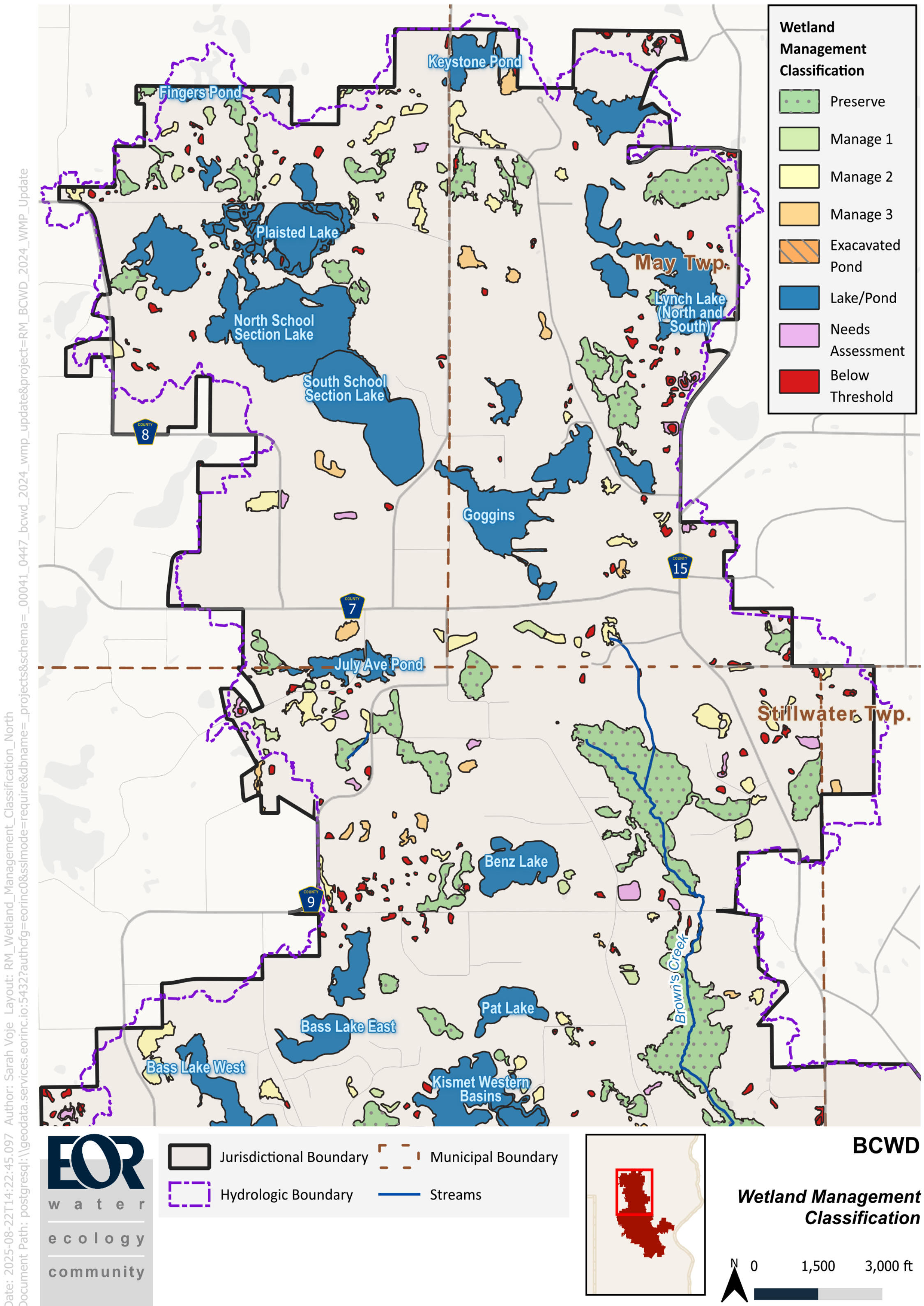


Figure F16. Brown's Creek Watershed Wetland Inventory and Assessment (Partial Map B)

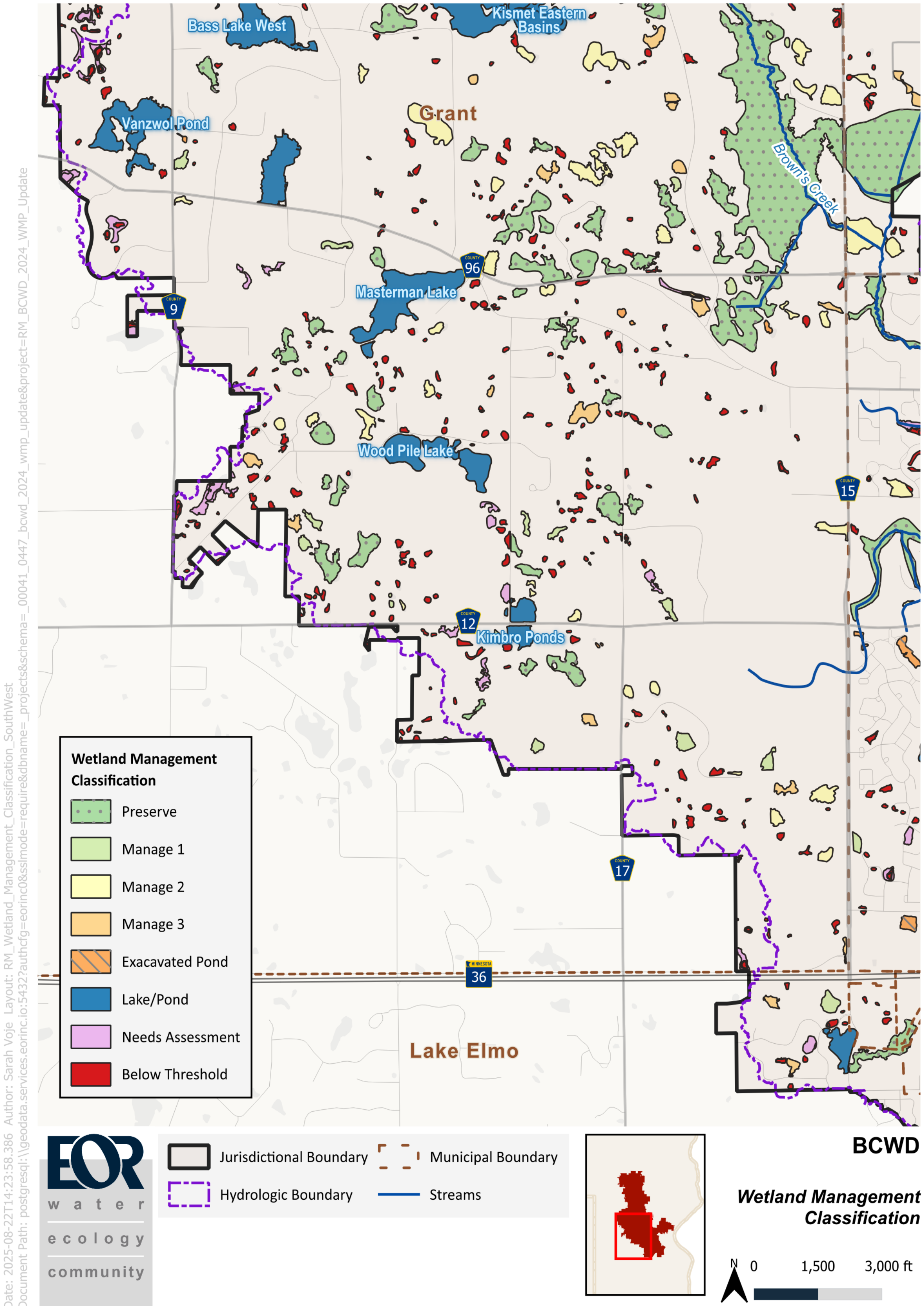
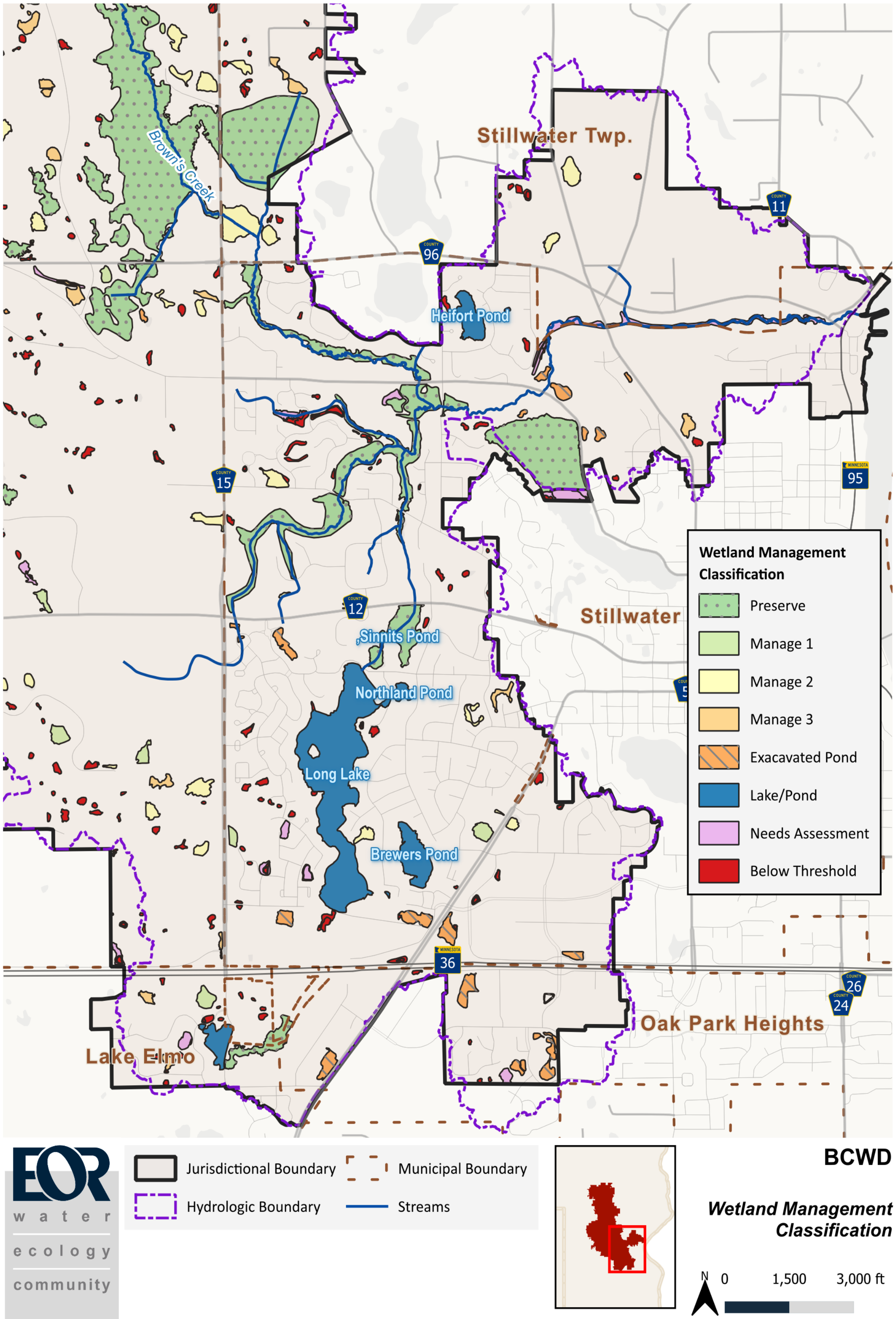


Figure F17. Brown's Creek Watershed Wetland Inventory and Assessment (Partial Map C)



Date: 2025-08-22T14:23:23.173 Author: Sarah Voje Layout: RM_Wetland_Management_Classification_SouthEast
Document Path: postgresql:\\geodata.services.eorinc.io:54322?authcfg=eorinc08sslmode=require&dbname=_projects&schema=_00041_0447_bcwd_2024_wmp_update&project=RM_BCWD_2024_WMP_Update

Figure F18. Landlocked Basins in the Brown's Creek Watershed

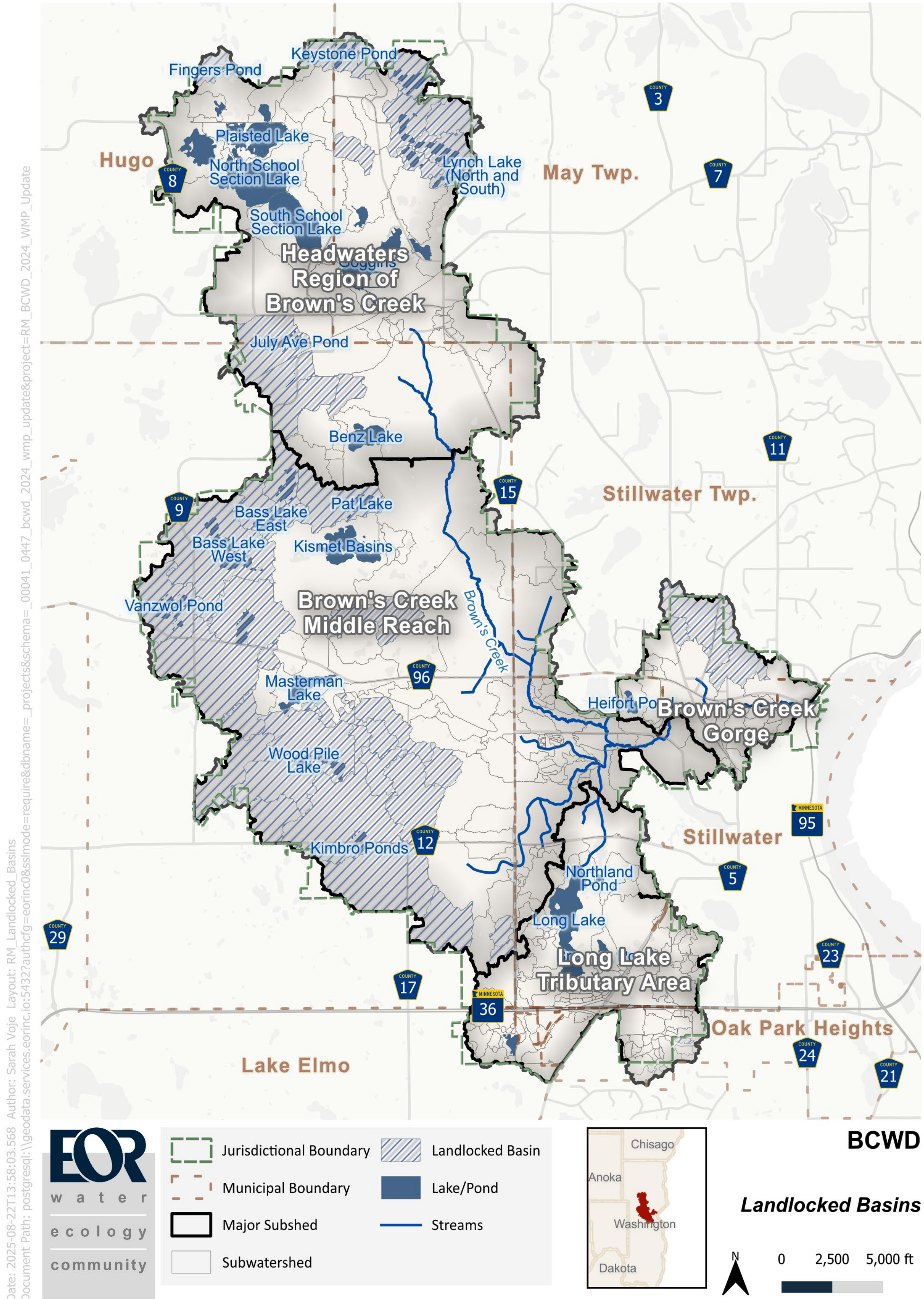


Figure F19. Location of Lake and Water Quality Monitoring Stations in the Watershed

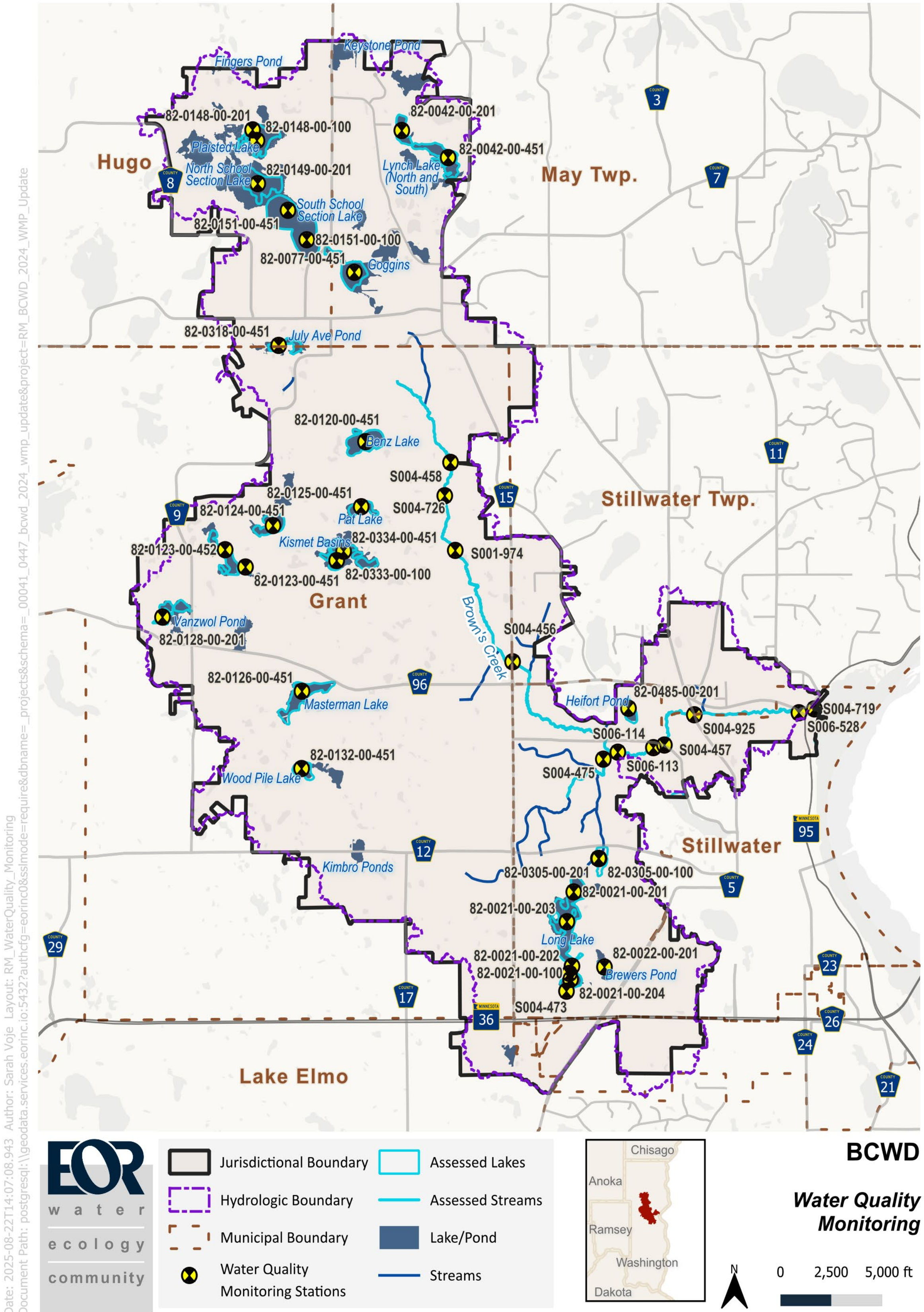


Figure F20. Groundwater-dependent Natural Resources in the Brown's Creek Watershed (Full Map)

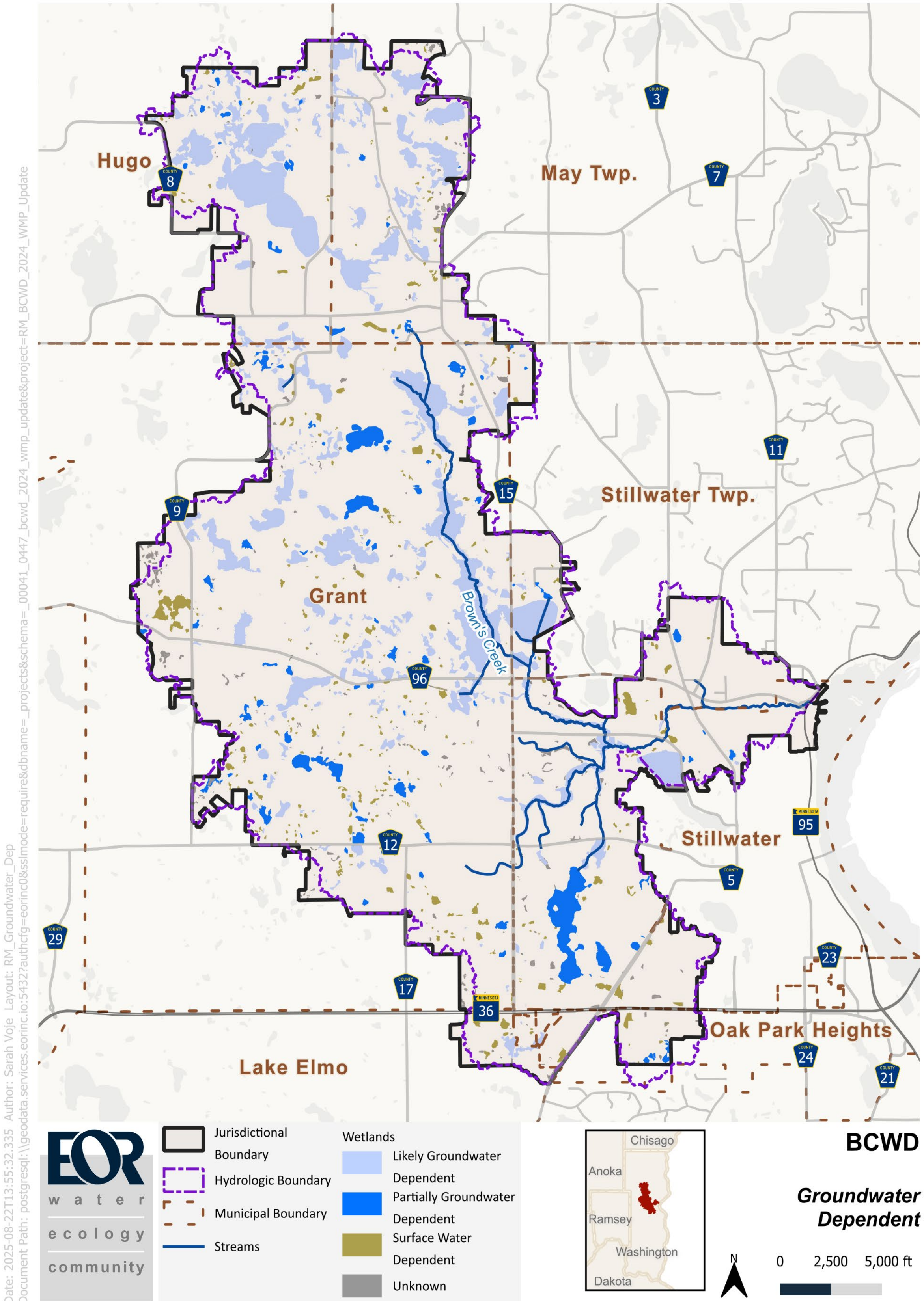


Figure F21. Groundwater-dependent Natural Resources in the Brown's Creek Watershed (Partial Map A)

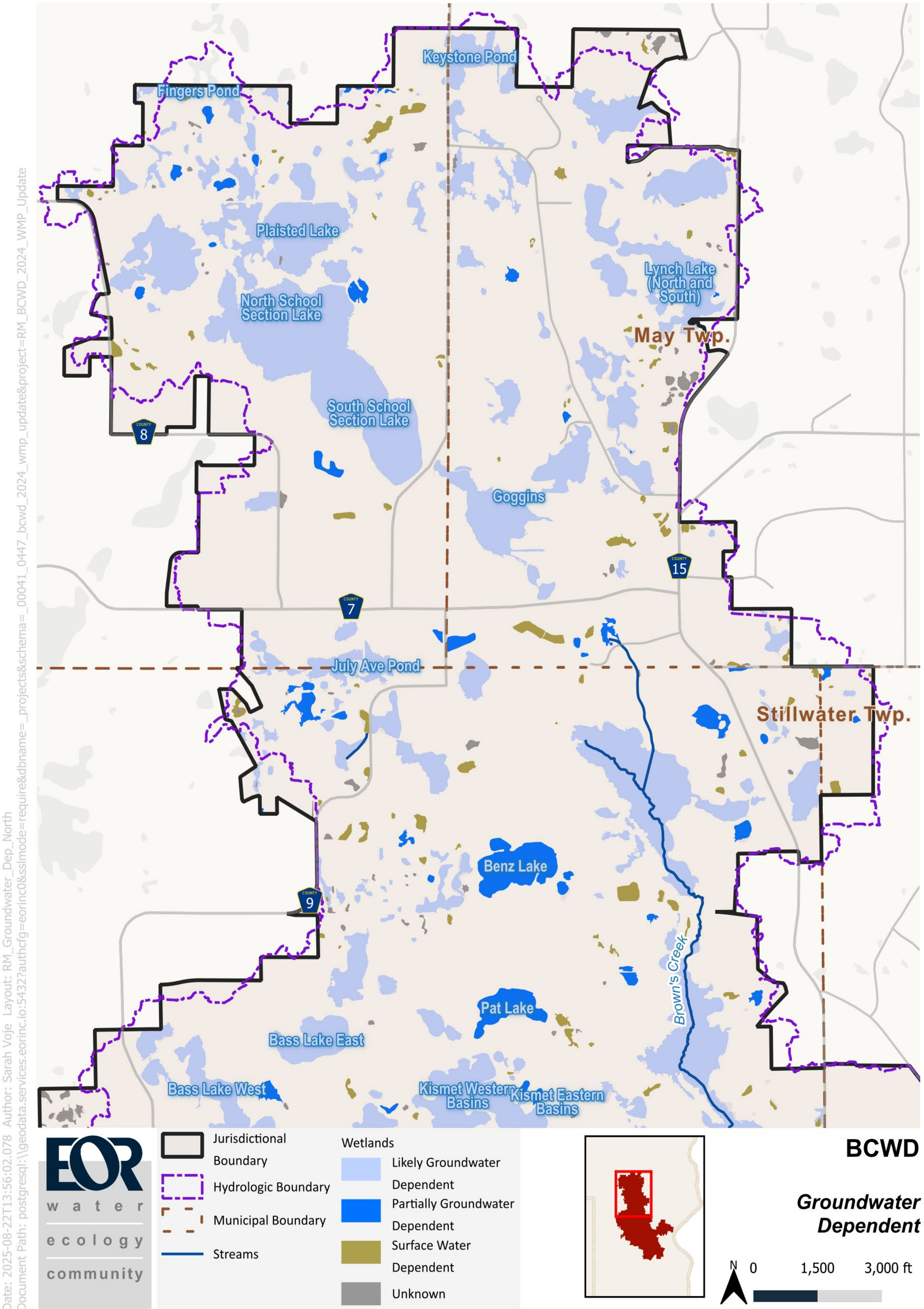


Figure F22. Groundwater-dependent Natural Resources in the Brown's Creek Watershed (Partial Map B)

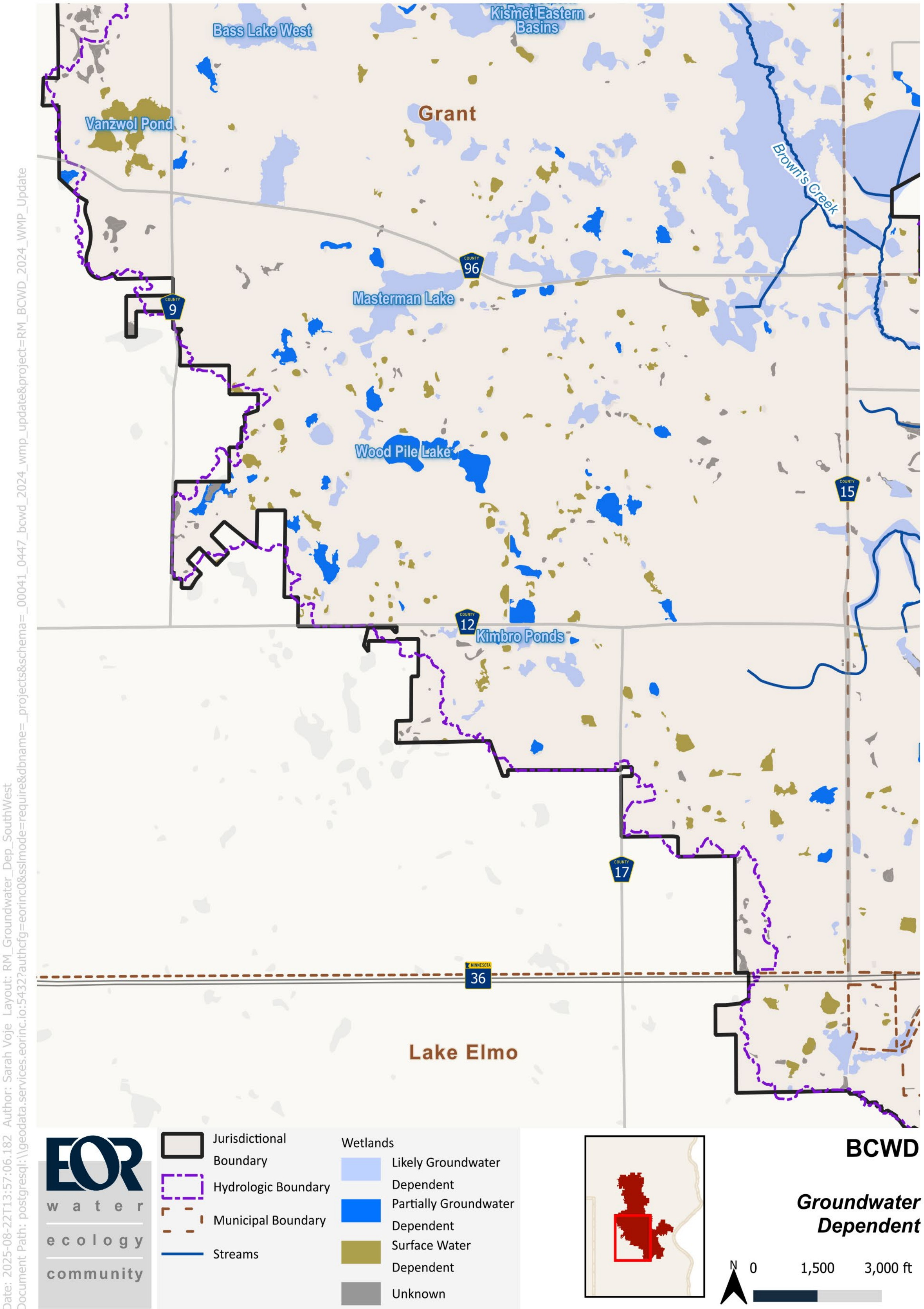


Figure F23. Groundwater-dependent Natural Resources in the Brown's Creek Watershed (Partial Map C)

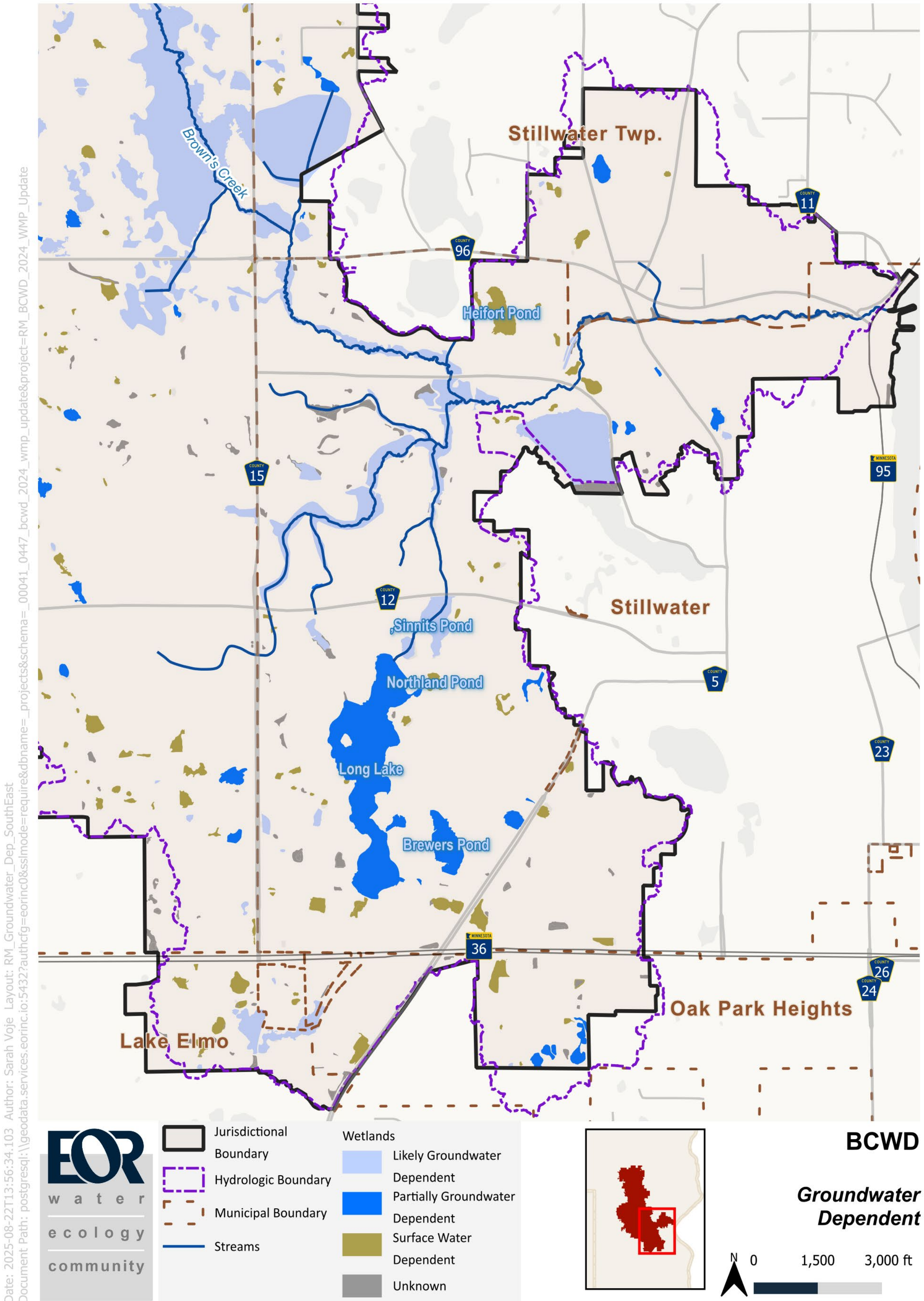


Figure 24. Drinking Water Supply Management Areas (DWSMAs) in the Brown's Creek Watershed

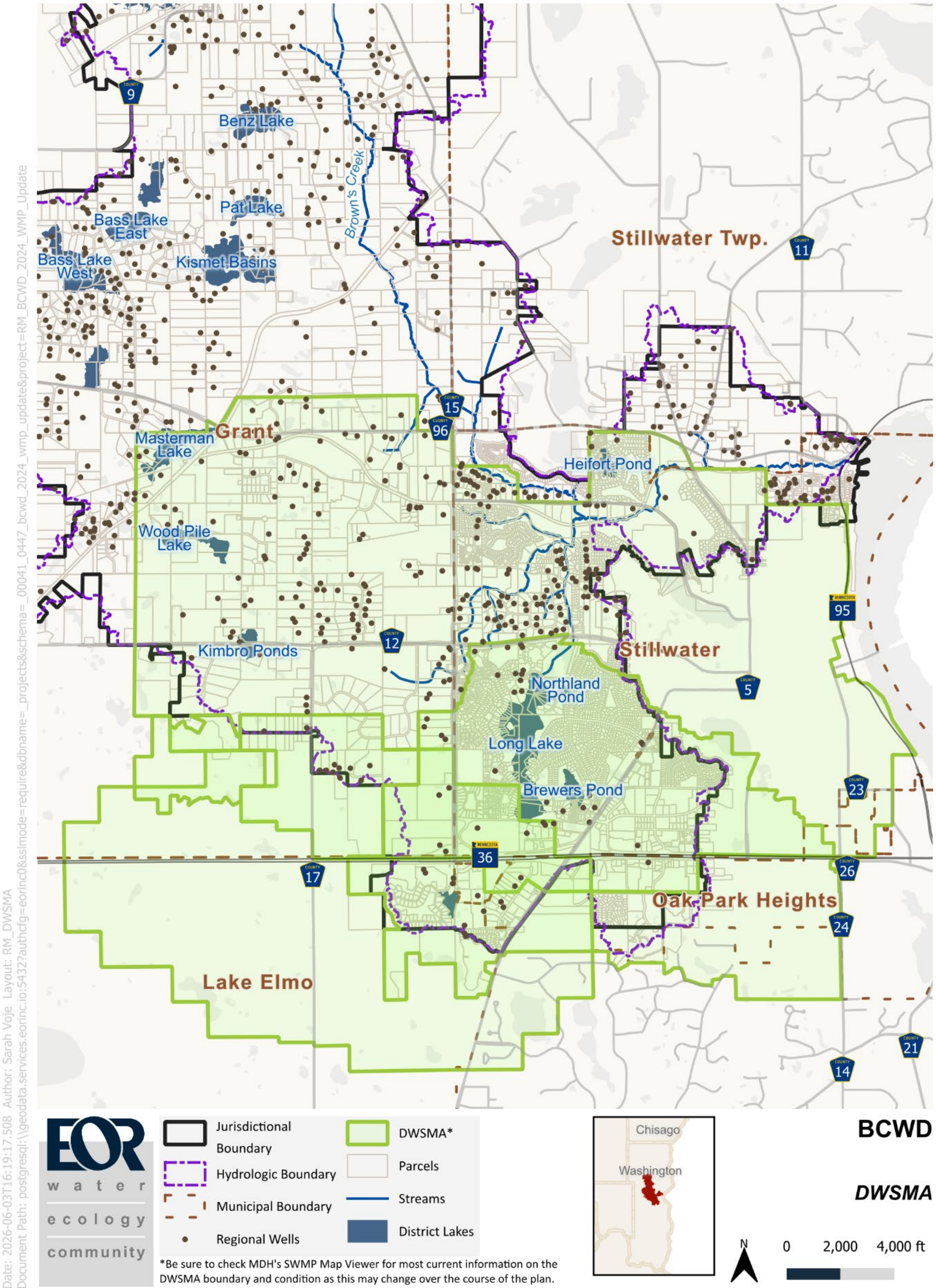
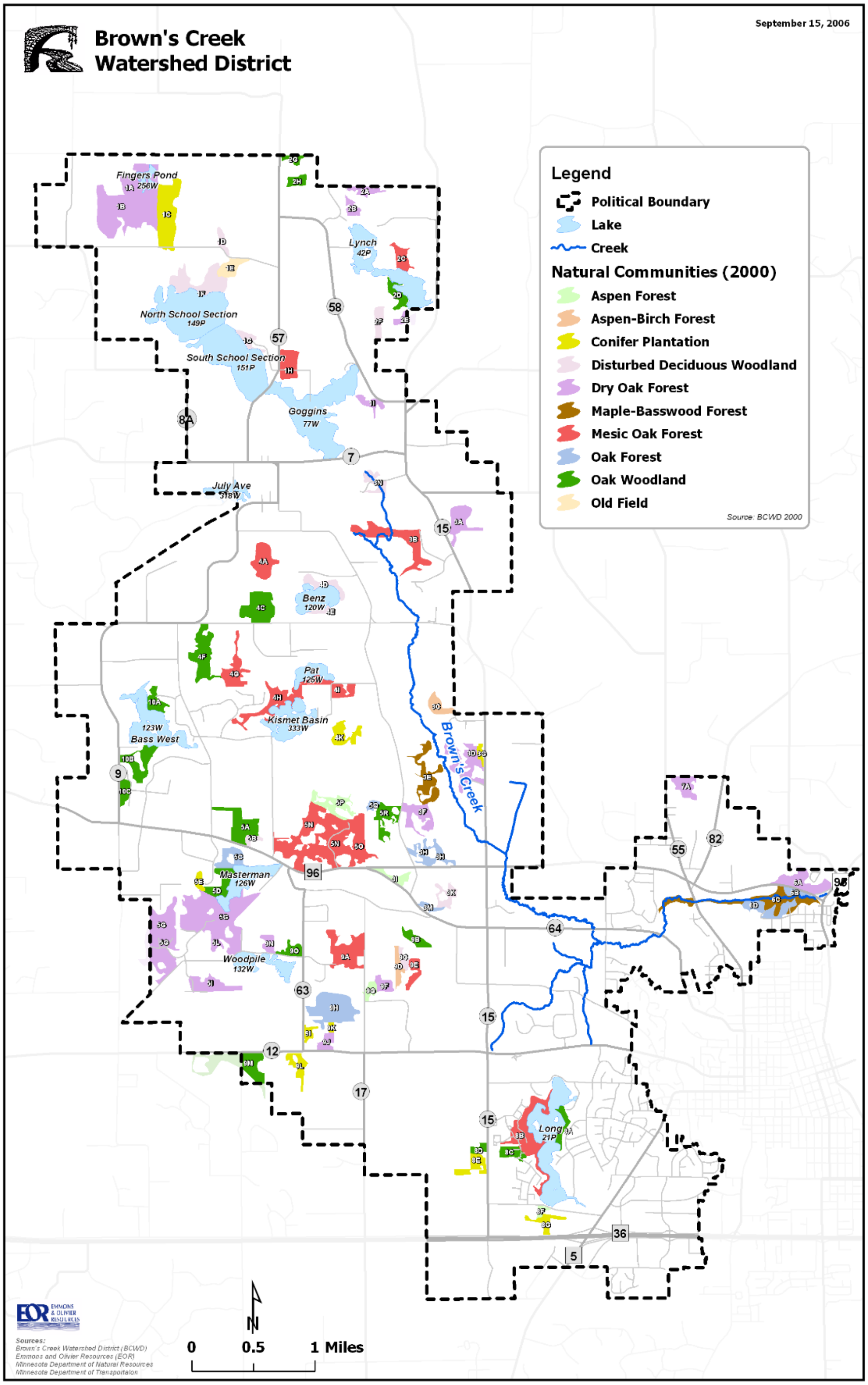


Figure F25. Natural Communities Identified in 2000



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