

# GROUNDWATER AVAILABILITY EVALUATION REPORT

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St. Croix and Pierce Counties, Wisconsin

May 2024

FIRM PROJECT NO.: 078038.001



Prepared for:  
River Falls Municipal Utilities



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## Introduction

Groundwater is a critical resource in Wisconsin to meet water consumption needs in both statewide and county regions. Groundwater accounts for 95 percent of drinking water in Wisconsin communities. In St. Croix and Pierce Counties, the groundwater reservoir (or aquifer) also sustains lake levels, provides the base flow to rivers and aquatic habitats, and comprises a major source of water for domestic, municipal, and industrial water users. However, groundwater is susceptible to depletion in quantity as well as deterioration in quality and requires diligent planning and management by public water suppliers and private users to protect it.

To plan for anticipated increasing water demands within its water system service area, River Falls Municipal Utilities (RFMU) hired Gannett Fleming, Inc. (GF) to complete an evaluation to estimate sustainable groundwater resources available in River Falls. The groundwater availability evaluation required thorough review of hydrogeologic information including, published and unpublished geologic and groundwater related reports and maps, wellhead protection planning documents, local river and stream basin limits and flow characteristics, aerial imagery and parcel land use data, WDNR's water well database, and recent RFMU water supply well usage rates. The following report documents results of the long-term groundwater availability evaluation and fulfills the scope of services described in GF's February 28, 2024, proposal to RFMU.

## Study Area Setting

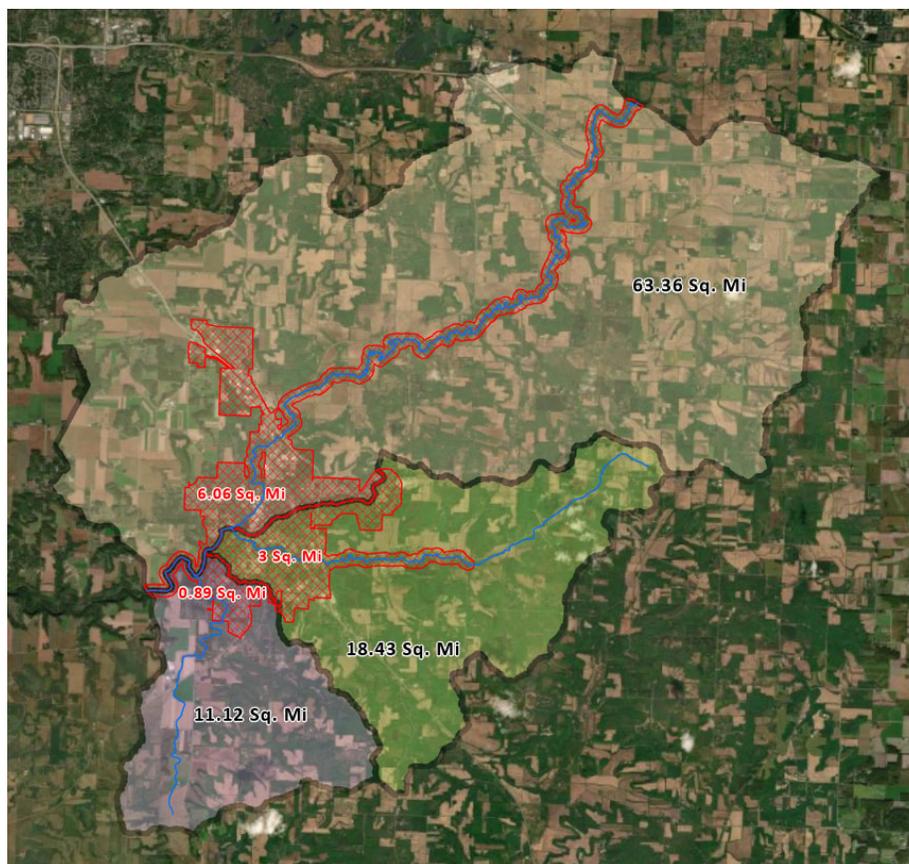
The City of River Falls and its surrounding area is located about 30 miles east of Minneapolis/St. Paul in northwestern Wisconsin. The city is within both St. Croix and Pierce Counties, which are adjacent to and on the east side of the St. Croix River. Land cover in these two counties is dominated by agriculture and grasslands, but substantial forested and urban acreage also is present. The study area is within the Western Upland geographical region that is characterized by broad uplands interrupted by distinct valleys where erosion has removed the relatively thin glacial deposits and much of the underlying sedimentary bedrock. The Main Branch of the Kinnickinnic River, known as the "Kinni" generally flows from northeast to southwest through River Falls, and it is the primary drain of stormwater and groundwater in the study area. The Kinnickinnic River flows into the St. Croix River about seven miles southwest of the study area.

To complete the groundwater availability evaluation a study area had to be defined by first understanding the limits of River Falls, which has an area of 6.6 square miles, and the limits of the middle reach of the Main Branch Kinnickinnic River drainage basin. The study area was also defined by the South Fork Kinnickinnic River and the Rocky Branch drainage basins, because these rivers flow into the Main Branch within and just southwest of the city limits. These three drainage basins form about a 93-square-mile study area (see Inset A and Figure 1). The limits of the drainage basins are defined by the upland watersheds around and northeast of the city. These uplands have top elevations ranging from about 1,060 to 1,220 feet mean sea level (MSL). The lowest ground elevation in the study area is along the western edge at the Main Branch Kinnickinnic River. The maximum topographic relief within the study area is about 440 feet.

According to the United States Geological Survey (USGS), the middle reach of the Main Branch Kinnickinnic River has perennial water flow, and therefore, it is considered an aquifer drain most of the

time. During prolonged periods of heavy rain or snow melt when higher water flows exist, the river water temporarily recharges the local riverbanks and underlying aquifer (Young and Hindal, 1973). The South Fork of the Kinnickinnic River also has perennial flow in about the lower half of its length. Therefore, this lower reach of the South Fork is also considered an aquifer drain most of the time. The upper reach of the South Fork is reported to have intermittent flow and when flowing could have influent (aquifer recharge) conditions, most of the time. The entire length of Rocky Branch is reported to have intermittent flow and is assumed to allow aquifer recharge over most of its length, most of the time.

River water base flows (i.e., groundwater discharge) in the Main Branch and South Fork Kinnickinnic Rivers have been measured in River Falls and reported by the USGS. More recently measurements in 1996 and 1997 indicate river base flow rates are as low as 50 and 9.3 cubic feet per second (cfs) in the Main Branch and South Fork Kinnickinnic Rivers, respectively (USGS StreamStats Website, 2024). Higher flow rates in these two rivers during the same period are reported up to 420 cfs and 158 cfs, respectively. The USGS reports nine flow rate measurements in Rocky Branch between 1965 and 2020. The reported flow rates range from 1.4 cfs and 3,420 cfs, although, seven of the nine measurements are rates less than 85 cfs. In 2000, Short Elliott Hendrickson, Inc. (SEH) reported estimated observed Rocky Branch flows ranging from 1 to 5 cfs, which likely better represent its intermittent base flow rate.



*Inset A – Estimated Limits of Groundwater Recharge Area for River Falls*

## Geology

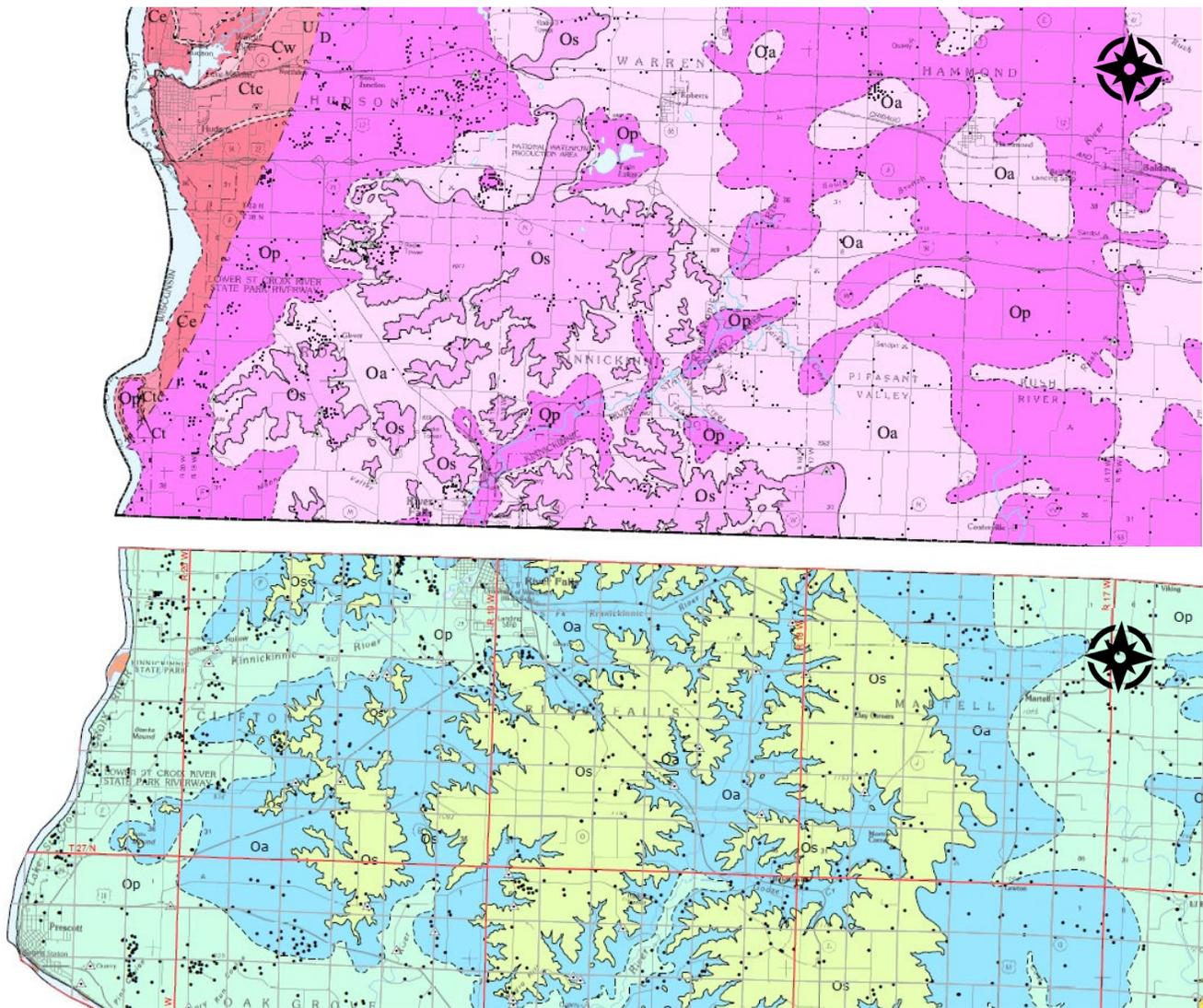
The bedrock and soils that control the movement and storage of groundwater withdrawn in the study area range from the older Cambrian age (490 to 523 million years) and Ordovician age (443 to 490 million years) bedrock formation to Quaternary age (2.5 million years to present) glaciofluvial sediments, alluvium, and other residual soils. Bedrock is overlain by a thin deposit of glacial sediments over much of the upland areas. Several tens of feet of alluvium, colluvium, and glaciofluvial sediments exist in the river valleys of the study area. The bedrock, from oldest to youngest, includes Cambrian age sandstone and Ordovician age dolomite and sandstone.

The relevant geologic groups in the study area include the Sinnipee Group, Ancell Group, Prairie du Chien Group, and Trempealeau Group. The younger three groups consist of Ordovician age sedimentary rocks and the Trempealeau Group consist of older Cambrian age sedimentary rocks.

The Sinnipee Group (Os) contains up to 100 feet of dolomite and shale rocks of the Platteville and Decorah Formations, commonly averages less than 20 feet where present. These rocks lie at higher elevations in the study area, above the groundwater surface elevation. The Ancell Group (Oa) consists of a thin layer of shale, siltstone and fine-grained sandstone of the Glenwood Formation and up to 75-foot thickness of fine- to medium-grained, well sorted sandstone of the St. Peter Formation. The Sinnipee and Ancell Groups (Os & Oa) have been extensively eroded in the study area and occur only in upland ridges and mounds. Shallowest levels of the study area aquifer can exist within sandstone of the St. Peters Formation.

The Prairie du Chien Group (Op) consists of the Shakopee and Oneota Formations, which contain fine- to medium- grained dolomitic sandstone, sandy dolomite and dolomite, and is about 200 feet thick where it is not eroded below glacial deposits. The Prairie du Chien Group (Op) is susceptible to fracturing and weathering, which can produce solution cavities and conduits associated with karst aquifers. Groundwater in the conduits can flow rapidly over hundreds of thousands of feet. The largest conduits generally occur in the uppermost sections of the Prairie du Chien Group, and groundwater flow through the fractures and conduits generally is controlled by the size and degree of connection among the individual conduits or conduit zones. All the Ordovician age rocks in the study area are reported to have a shallow westward dip. The bottom surface of the Prairie du Chien Group rocks range in elevation from 1,100 feet MSL along the eastern St. Croix County line to less than elevation 600 feet MSL at the St. Croix River. This represents less than a one percent slope of the bottom surface.

The Trempealeau Group (Ct) consists of the Jordan and St. Lawrence Formations. The Jordan Sandstone contains friable to well cemented, very fine- to coarse-grained quartzose sandstone and siltstone that is 80 to 90 feet thick. The St. Lawrence Formation contains dolomitic siltstone and very fine-grained sandstone that is about 30 feet thick (Evans, Cordua, and LePain, 2007). Images of the bedrock formation group mapping for the study area are shown in Inset B.



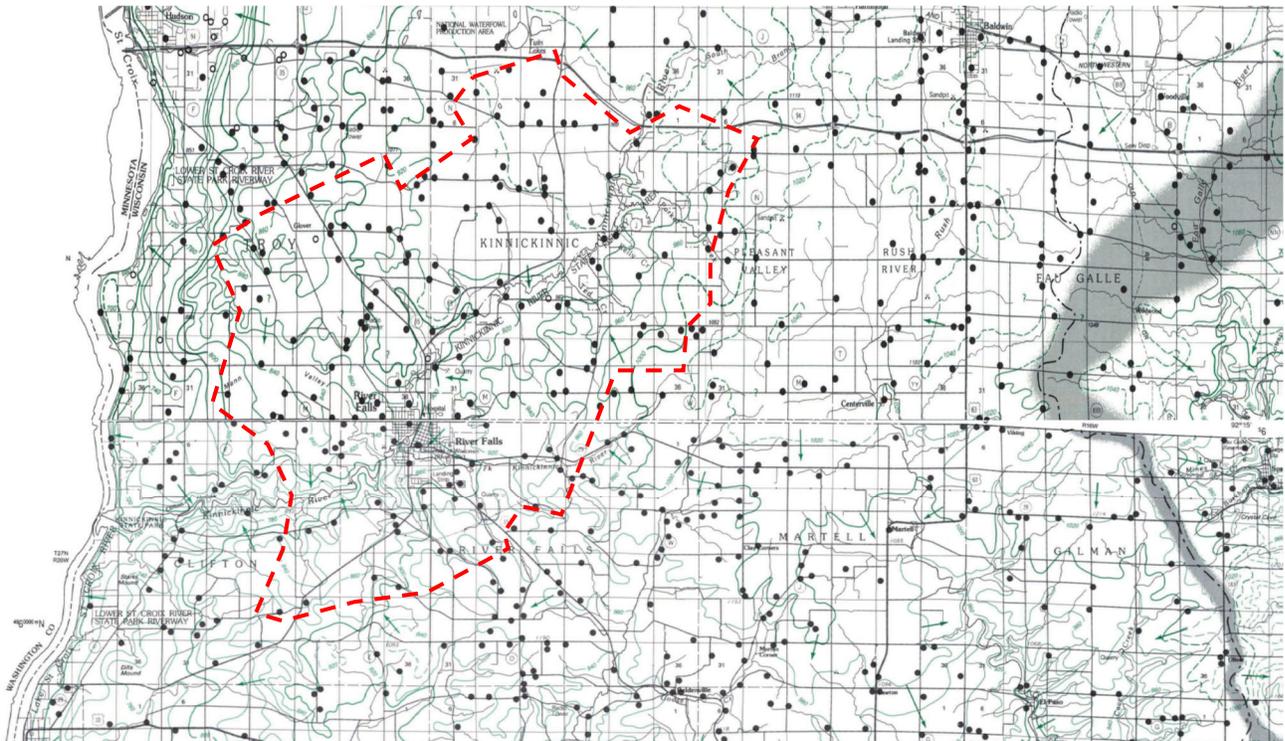
*Inset B – Images of Geologic Mapping in St. Croix and Pierce Counties, WI*

### Hydrogeologic Conceptual Model

Gravity and solar energy play active roles in a continuous water recycling process called the water cycle (Lippelt, 1990). Precipitation is the source of all groundwater in the study area. Water falling on the land surface can flow downhill as runoff, evaporate, transpire through plants, and infiltrate into the ground. Infiltrating water percolates downward through pore spaces in the soil and open cracks or fractures in the bedrock. When these pores or fractures are filled with water, the material is saturated with groundwater. The surface of the groundwater is often referred to as the water-table where it has a hydraulic pressure equal to the atmospheric pressure.

In the study area, the St. Peter Sandstone is partly saturated and can yield some groundwater to wells. However, the Prairie du Chien Group dolomite and sandstone and the underlying Jordan Sandstone are the major groundwater-yielding bedrock units in the region. The Prairie du Chien Group is used extensively for private residential water supplies. Deeper portions of the Prairie du Chien Group and the underlying Jordan Formation are the principal source of water for municipal supplies. Groundwater in these aquifers above the St. Laurence Formation are under water-table (i.e., unconfined) conditions (Borman, R.G., 1976).

Gravity moves groundwater slowly through the bedrock openings from higher elevation areas to lower elevation areas until it is either diverted to pumping wells or it naturally discharges to stream, lakes and rivers. Natural groundwater discharge to surface water bodies can then be evaporated back into the atmosphere by solar energy, thus continuing the water cycle. Both Borman (1976) and Lippelt (1990) have reported generalized water-table elevation maps of St. Croix County. Both maps show River Falls favorably located at a lower elevation in a relatively large groundwater basin that has its higher surface elevations and a groundwater divide roughly 15 to 20 miles east and northeast of River Falls (see Inset C). The general groundwater flow direction in the basin is westward toward the St. Croix River. However, within the 93-square-mile study area, the groundwater surface flows southwestward along and in multiple directions toward the Main Branch of the Kinnickinnic River because it is the primary drain in the study area. Groundwater surface elevations range from about 1,040 feet to 800 feet MSL. This surface relief represents only about a 0.3 percent groundwater flow gradient, but local gradients can range from about 0.5 to 3 percent.



*Inset C – Generalized Water Table Elevation Map of St. Croix and Pierce Counties (Lippelt, 1990)*

According to Juckem (2009), in general, much of the precipitation that recharges the groundwater surface flows at a gentle slope through openings in the shallower portions of the bedrock aquifer and discharges to nearby rivers. Precipitation that recharges in areas with steeper vertical gradients moves deeper into the aquifer(s) before returning to the shallower aquifer near major groundwater drains, such as the St. Croix and Mississippi Rivers. Groundwater flow velocities in the study area bedrock aquifer are expected to be variable because of the nature of flow through fractures and conduits in the Prairie du Chien Group and, to a less extent, in the Trempealeau Group. For example, Cobb (2007) measured a range of local velocities from about 12 to 340 feet/day through fractures in the Prairie du Chien Group. A flow velocity of about 190 feet/day suggests groundwater in the Prairie du Chien Group that does not first discharge to the Kinnickinnic River would pass through the study area from northeast to southwest over about a one-year period.

## **Groundwater Availability Evaluation**

GF completed a groundwater availability evaluation to estimate the net groundwater resources available to RFMU over a one-year period. The evaluation was completed by first defining a reasonable study area that can contribute groundwater to water supply wells located within or in adjacent areas of the River Falls corporate limits. A published groundwater recharge rate, from annual precipitation, was then selected and used to calculate the total quantity of groundwater available in the study area in a one-year period. The net available resource was determined by estimating the current total groundwater withdrawn from water supply wells and discharged to surface water on an annual basis. Details and results of the evaluation are presented in the following section.

### Groundwater Recharge Area

As previously described, an area of approximately 93 square miles was delineated as the groundwater recharge area for River Falls (see Figure 1, Estimated Groundwater Recharge Area). The USGS StreamStats Website was used to consider the limits of the estimated recharge area. The USGS already defined water drainage areas of the middle section of the Main Branch Kinnickinnic River, South Fork Kinnickinnic River, and Rocky Branch. The watersheds of these basins were defined by topography and, in the case of the middle section of the Main Branch, the approximate upstream limits of perennial flow. Further, the middle section of the Main Branch forms the primary groundwater drain in River Falls and the upstream study area, therefore, most of the available groundwater in the study area is flowing toward it. The South Fork and Rocky Brain drainage basins were included in the study area because these river basins discharge into the Main Branch Kinnickinnic River at and just southwest of River Falls. As shown on Figure 1, the areas of the Main Branch Kinnickinnic River, South Fork Kinnickinnic River, and Rock Branch drainage basins in the study area are 63.4, 18.4, and 11.1 square miles, respectively.

A small portion (i.e., 10 square miles) of the study area was excluded from the estimated groundwater recharge area due to the lower probability of it allowing groundwater recharge. The excluded areas were identified as having higher concentrations of impervious services and proximity to rivers. The excluded areas were conservatively estimated to include most of the city and a 1,000-foot buffer around perennial flow reaches of the Main Branch and South Fork Kinnickinnic Rivers (see Figures 2 and 3). The identified excluded areas were judged to allow nearly all precipitation to runoff into the rivers without infiltrating into the underlying aquifer, either through manmade stormwater management facilities or as a result of proximity to the river channels.

It should be noted that the groundwater recharge area estimated for River Falls does not include about 65 square miles of an upgradient groundwater basin defined by Lippelt (1990). River Falls is favorably positioned at a lower elevation about 15 to 20 miles west and southwest of the estimated groundwater basin divide (see Inset C). Some groundwater from the upgradient area likely moves into and supplements resources within the recharge area estimated for River Falls. However, several other communities, such as Hammond, Baldwin, and Woodville, are within the upgradient groundwater basin and may significantly use and need these resources to meet their own current and growing demands. Therefore, this area was not included in the groundwater availability evaluation for River Falls.

### Groundwater Recharge Rate

Multiple annual groundwater recharge rates applicable to the study area were found in multiple hydrogeologic publications and plans. Study area references and mean annual groundwater recharge rates are presented in Table 1 below.

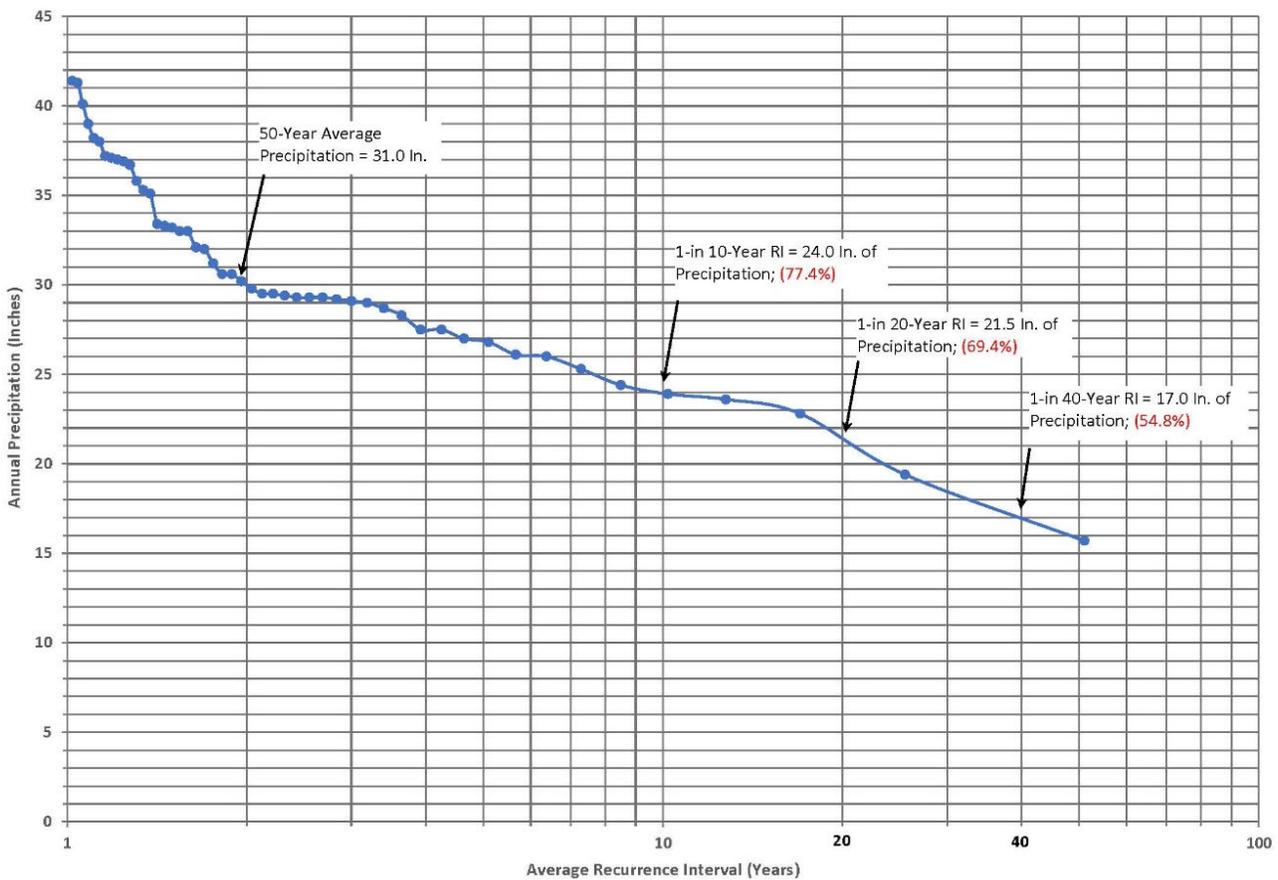
**Table 1 – Reported Annual Groundwater Recharge Rates**

<b>Study Area</b>	<b>Authors and Year</b>	<b>Estimated Mean Annual GW Recharge Rate (In./Yr.)</b>
Water Resources of Wisconsin-St. Croix River Basin, St. Croix and Pierce Counties	USGS, H.L. Young and S.M. Hindall, 1973	5 to 6
Groundwater Resources and Geology of St. Croix County	USGS, R.G. Borman, 1976	1 to 10
River Falls M.A. Well Head Protection Plan, 2-D Model Simulation	SEH, Inc., 2000	6
St. Croix River Basin, Kinnickinnic River Basin GFLOW Model Simulation	USGS, P.F. Juckem, 2007	8.1
Simulation of the Groundwater Flow System in Pierce, Polk, and St. Croix Counties. Inset Models	USGS, P.F. Juckem, 2009	8.2 to 16.8

The mean annual groundwater recharge rate of 8.1 inches/year reported by P. F. Juckem in 2007 appears to be the most defensible rate identified for the study area because it was estimated by modeling surface water flow and groundwater elevations within the Kinnickinnic River basin and is one of the more recent estimates. Therefore, a groundwater recharge rate of 8.1 inches/year was used to estimate the total annual recharge within the study area. As shown in Table 2, the 8.1 inches/year (i.e., 0.675 feet/year) recharge rate was multiplied by the total recharge area of about 83 square miles, which resulted in a total mean annual groundwater recharge rate of about 11.672 billion gallons per year.

Historical annual precipitation rate data collected in River Falls was reviewed and plotted to estimate below average or drought recurrence intervals in the study area (see Graph 1). Based on the data, the average annual rainfall over the past 50 years in River Falls is 31.0 inches. Graph 1 shows the annual precipitation data plotted against the average recurrence interval, and 1-in 10-year, 1 in 20-year and 1-in 40-year drought recurrence intervals were identified on the graph. These three below average rainfall rate intervals represent about 77.4, 69.4, and 54.8 percent of the average annual precipitation rate and were used to calculate three below average groundwater recharge rates for the study area. Therefore, total annual groundwater recharge rates were calculated to estimate available resources during years with below average precipitation/recharge (see Table 2 for calculation results).

**Graph 1**  
**Annual Precipitation Recurrence, (1974 through 2023)**  
**River Falls, WI**



### Existing Groundwater Withdrawal

The existing annual groundwater withdrawal rate in the recharge area was considered by estimating the number of property parcels with buildings and higher capacity water supply wells within it. Six different types of groundwater use in the area were selected and compiled using property parcel and building data, 2009 USGS-reported high-capacity wells, and municipal water supply wells operated by RFMU.

To assess groundwater water usage rates outside the RFMU public water supply system, GIS-formatted parcel and existing building data from the University of Wisconsin – Madison, and aerial imagery were used to identify four different land and consumptive groundwater use categories. The selected groundwater use categories were designated as agricultural, high usage; agricultural, low usage; commercial usage; and residential usage. Estimated daily consumptive groundwater use rates were identified as 4,000, 1,000, 1,000, and 100 gallons per day (gpd), respectively (see Table 2). Note that the daily residential water usage rate was assumed to be 200 gpd, but only 50 percent of this rate was conservatively assumed to be consumptive use. The other 50 percent was assumed to return to the aquifer via private septic systems. In addition to these uses, the USGS (2009) reported five high-capacity well withdrawals within the study area. These wells are reported to withdraw 1,300 to 50,000 gpd or 474,825 gallons to 18,262,500 gallons per year (GPY).

Lastly, recent groundwater withdrawal rates from RFMU's five water supply wells were included in the evaluation. RFMU provided well water usage data from 2022 and 2023. Based on this data, more groundwater was withdrawn in 2023 at a rate of 486.787 million GPY. As shown in Table 2, the total estimated annual groundwater withdrawal rate within the study area is about 749.877 million GPY.

### Surface Water Base Flow

Surface water flow rates measured by the USGS and others in the Main Branch Kinnickinnic River, South Fork Kinnickinnic River, and Rocky Branch were reviewed to understand river base flow (i.e., natural groundwater discharge) rates in the study area. Although the surface water base flow is not necessarily significant for human consumption, it is responsible to minimize groundwater withdrawal impacts that may diminish existing environmental habitats and recreational area in and adjacent to the surface water bodies.

The available recorded river flow data show a wide range of discharge rates in each of the three rivers that represent examples of peak and recession flows after storm events and base flow during normal or below normal precipitation periods. Lower river flow rates recorded during years with an average annual precipitation rate were considered and used in the groundwater availability evaluation (see Table 2). These base flow rate estimates of natural groundwater discharge were judged to be unavailable to groundwater withdraw to maintain surface water flow conditions in the study area. Note that in the case of the Main Branch Kinnickinnic River, the reported base flow rate had to be proportionally adjusted (i.e., reduced) so to only identify flow from the middle section of the river that is within the study area. The measured and reported rates for the Main Branch included flow from upper reaches of the river outside the study area.

## Groundwater Availability Evaluation Results

Table 2 shows the results of the estimated annual groundwater available in River Falls. The annual availability rates are presented for years with normal precipitation, and for years with 1 in 10-year, 1 in 20-year, and 1 in 40-year drought conditions. Under each estimated annual precipitation condition there is a surplus of groundwater. Currently the surplus groundwater is moving downgradient of the study area to either water supply wells or surface water bodies. The results indicate that even during years with a 1 in 40-year drought there is sufficient groundwater to support the existing population and the environment. In fact, there is an additional one billion gallons per year available to meet future demands in the RFMU water supply system.

### **Summary and Conclusion**

River Falls is located within the St. Croix River and Kinnickinnic River drainage basins. Its relatively low topographic position in these basins provides a favorable groundwater recharge area where annual precipitation rates can support ample groundwater withdrawal rates. The Ordovician and Cambrian age bedrock aquifers in River Falls and the surrounding area include sedimentary dolomite and sandstone bedrock units that can store and transport groundwater to wells at rates over 1,000 gpm.

The estimated groundwater recharge area defined for River Falls is about 83 square miles and includes the middle section of the Main Branch Kinnickinnic River, South Fork Kinnickinnic River, and Rocky Branch drainage basins. Groundwater generally flows from northeast to southwest and towards the Main Branch Kinnickinnic River, which is the primary groundwater drain in the study area. A mean annual groundwater recharge rate of 8.1 inches per year was estimated by Juckem (2007) of the USGS during surface water and groundwater level modeling of the Kinnickinnic River basin.

The estimated groundwater recharge area and published mean recharge rate were used to estimate a total annual groundwater recharge rate of 11.672 billion gallons per year. The estimated total annual rate of groundwater withdrawal via water supply wells (0.750 billion gallons) and the estimated total annual mean groundwater discharge rate to rivers (8.411 billion gallons) were subtracted from the annual recharge rate to estimate a total annual groundwater surplus of about 2.511 billion gallons during years with an average precipitation rate of 31 inches/year.

A drought recurrence interval evaluation shows that with a 1 in 40-year drought, which is only 17 inches per year, there is a groundwater surplus of about 1.037 billion gallons per year in and adjacent to River Falls. An additional groundwater withdrawal at this 1 in 40-year drought rate is sustainable without impacting the current annual needs of the population and environment within the study area. The groundwater availability estimates were completed using industry standard methods and the results are considered conservative. The availability evaluation accounted for conservative estimates of existing groundwater withdrawals and natural groundwater discharge to the Kinnickinnic River and its tributaries, which currently support highly valued recreational opportunities, and Class 1 trout and other aquatic life habitats.

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## **TABLE 2**

River Falls Groundwater Availability Evaluation Calculations

**Table 2 - Groundwater Availability Evaluation Calculations, RFMU**

Estimated groundwater recharge area for the River Falls city limits and adjacent area.

Identified average annual groundwater recharge rate for the study area.

Estimated total annual groundwater withdrawal and discharge from the defined recharge area.

Reviewed River Falls precipitation data to evaluate annual precipitation/drought recurrence rates.

Estimated Average Annual Groundwater Recharge in the middle Kinnickinnic River Study Area		Main Branch	South Fork	Rocky Branch	Total Area
Total Basin Drainage Area (Sq Mi)		63.36	18.43	11.12	92.91
Total Excluded Recharge Area (Sq Mi)		6.06	3.04	0.89	9.99
Estimated Net GW Recharge Area (Sq Mi)		57.30	15.39	10.23	82.92
Estimated Net GW Recharge Area (Sq Ft)		1,597,380,968	429,092,484	285,080,114	2,311,553,566
	Recharge Rate (Ft/Yr)	Area Rate (Cu. Ft/Yr)	Area Rate (Cu. Ft/Yr)	Area Rate (Cu. Ft/Yr)	
Average GW Recharge Rate, 8.1 in/yr (Juckem, 2007)		0.675	1,078,232,153	289,637,427	192,429,077
		Area Rate (GPY)	Area Rate (GPY)	Area Rate (GPY)	Total Recharge (GPY)
<b>Total Average Annual GW Recharge (GPY)</b>		8,065,737,188	2,166,638,566	1,439,469,557	<b>11,671,845,310</b>
<b>1 in 10 year Drought (77.4% of Average)</b>					<b>9,034,008,270</b>
<b>1 in 20-Year Drought (69.4% of Average)</b>					<b>8,100,260,645</b>
<b>1 in 40-Year Drought (54.8% of Average)</b>					<b>6,396,171,230</b>

Estimated Groundwater Consumptive Use Rate Outside of City (Based on Property Use Type, Parcels with Structures, and Inside the Recharge Basins)						
Type of Private Groundwater Use	Consumptive Use (GPD)	Consumptive Use (GPY)	Well Withdrawals	Well Withdrawals	Well Withdrawals	Total Rate (GPY)
Ag. - High Usage	4,000	1,461,000	30	5	7	61,362,000
Ag. - Low Usage	1,000	365,250	155	51	28	85,468,500
Commercial	1,000	365,250	10	9	1	7,305,000
Residential	100	36,525	1,162	282	266	62,457,750
Subtotal						<b>216,593,250</b>
<b>Private High-Capacity Wells (USGS, 2009)</b>						
1	1,300					474,825
6	17,000					6,209,250
9	26,000					9,496,500
12	33,000					12,053,250
18	50,000					18,262,500
Subtotal						<b>46,496,325</b>
<b>Estimated City Well Groundwater Withdrawal Rate (Based on 2023 Annual Supply Well Usage, RFMU,20:</b>						
Well 2	308,975					112,776,000
Well 3	159,603					58,255,000
Well 4	307,304					112,166,000
Well 5	371,970					135,769,000
Well 6	185,811					67,821,000
Subtotal						<b>486,787,000</b>
<b>Total Annual Groundwater Withdrawal (GPY)</b>						<b>749,876,575</b>

**Table 2 - Groundwater Availability Evaluation Calculations, RFMU**

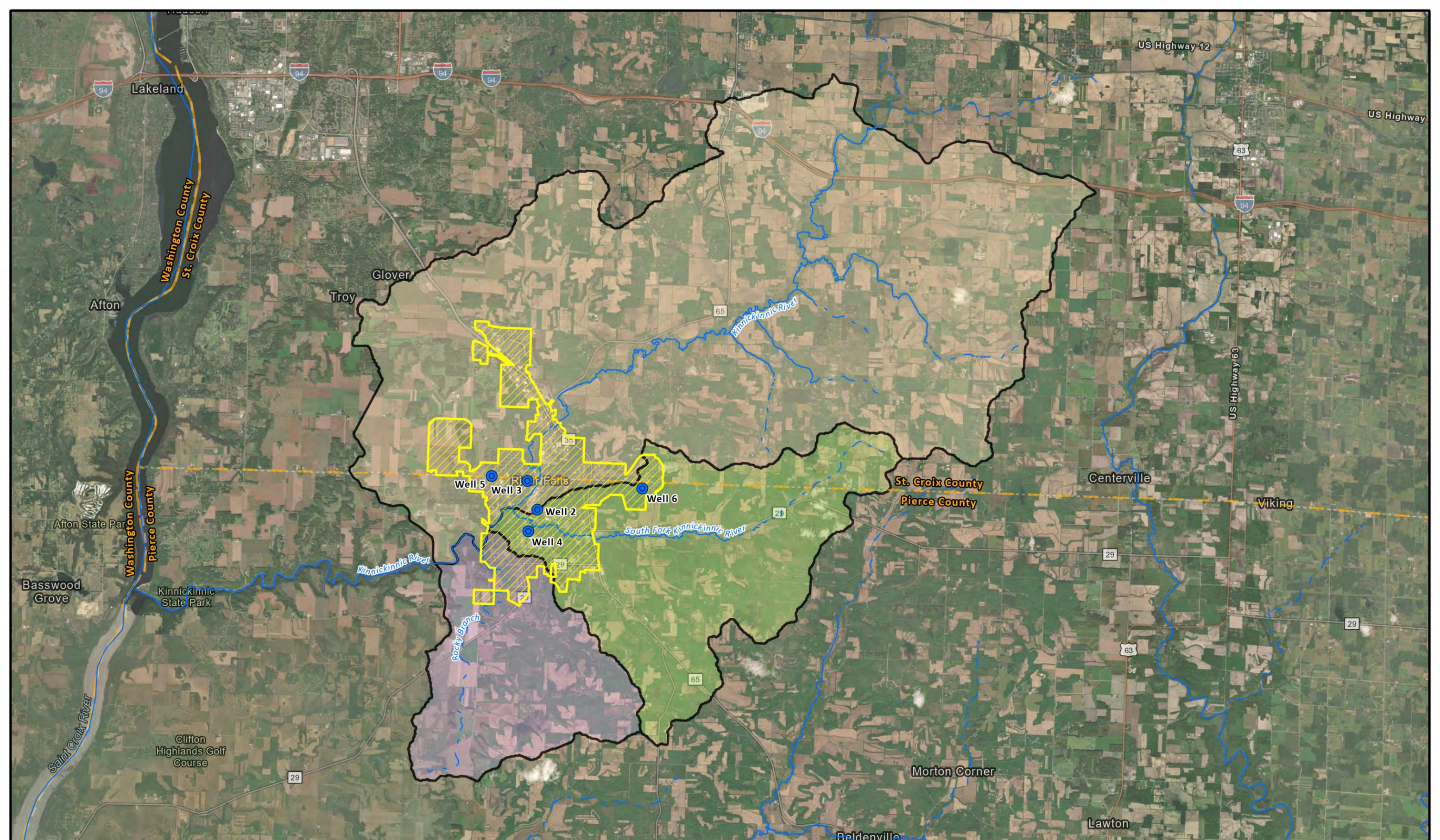
<b>USGS Measured River Discharge Rates</b>	<b>Est. Base Flow (CFS)</b>	<b>Est. Base Flow (GPD)</b>	<b>Est. Base Flow (GPY)</b>	<b>Precipitation Conditions</b>
Kinnickinnic River (115 Sq. Mi., M. Branch, Aug. 1969)	22.7	14,671,393	5,358,726,382	1 in 20-year drought in 1969 (21.8 in.)
Kinnickinnic River (115 Sq. Mi., M. Branch, Oct 1996)	50.0	32,315,844	11,803,362,076	Above normal annual precip.in 1996 (35.3 in.)
South Fork Kinnickinnic River (Aug. 1969)	5.8	3,748,638	1,369,190,001	1 in 20-year drought in 1969 (21.8 in.)
South Fork Kinnickinnic River (Oct. 1996)	9.28	5,997,821	2,190,704,001	Above normal annual precip.in 1996 (35.3 in.)
<b>SEH Measured River Discharge Rates (SHE, 2000)</b>				
Rocky Run (Used avg. of reported range, 1-5 CFS)	3.0	1,938,951	708,201,725	Normal precip. rate in 2000 (30.6 in.)
<b>Calculated Kinnickinnic River Discharge for Study Area</b>				
Kinnickinnic River (M. Branch, 53.7 Sq. Mi. or 46.7% of 115)	23.35	15,091,499	5,512,170,089	In Years with Normal Precip. Rate (31 in.)
<b>Estimated Annual River Discharge Rate in Study Area</b>	35.63	23,028,271	<b>8,411,075,815</b>	In Years with Normal Precip. Rate (31 in.)

<b>Estimated Annual Groundwater Availability</b>	<b>Average Rate (GPY)</b>	<b>1 in 10-Year Drought Rate (GPY)</b>	<b>1 in 20-Year Drought Rate (GPY)</b>	<b>1 in 40-Year Drought Rate (GPY)</b>
- Groundwater Recharge (Assumes 8.1 in/yr average)	11,671,845,310	9,034,008,270	8,100,260,645	6,396,171,230
- Estimated Groundwater Withdrawal	749,876,575	749,876,575	749,876,575	749,876,575
- Estimated Perennial River Baseflow (Aquifer Drainage)	8,411,075,815	6,510,172,681	5,837,286,616	4,609,269,547
<b>Available Surplus of Groundwater Resources</b>	<b>2,510,892,920</b>	<b>1,773,959,014</b>	<b>1,513,097,455</b>	<b>1,037,025,108</b>

\* Estimated 1 in 40-year surplus GW available in River Falls is over 2 times the City's 2023 water supply demand rate.

**FIGURE 1**

Estimated Groundwater Recharge Area



**Legend**

- City Water Supply Well
- Perennial Flow River
- - - Intermittent Flow River
- River Falls Corporate Limits
- County Boundary

**Estimated Groundwater Recharge Basins**

- Kinnickinnic River Basin, 63.4 sq. mi.
- South Fork Kinnickinnic River Basin, 18.4 sq. mi.
- Rocky Branch Basin, 11.1 sq. mi.

N

0      1.5      3      6

Miles

1 inch equals 1.5 miles

**GANNETT FLEMING**

Rivers: WI DNR  
 Corporate Limits: City of River Falls  
 County Boundaries: Esri

**ESTIMATED GROUNDWATER RECHARGE AREA**

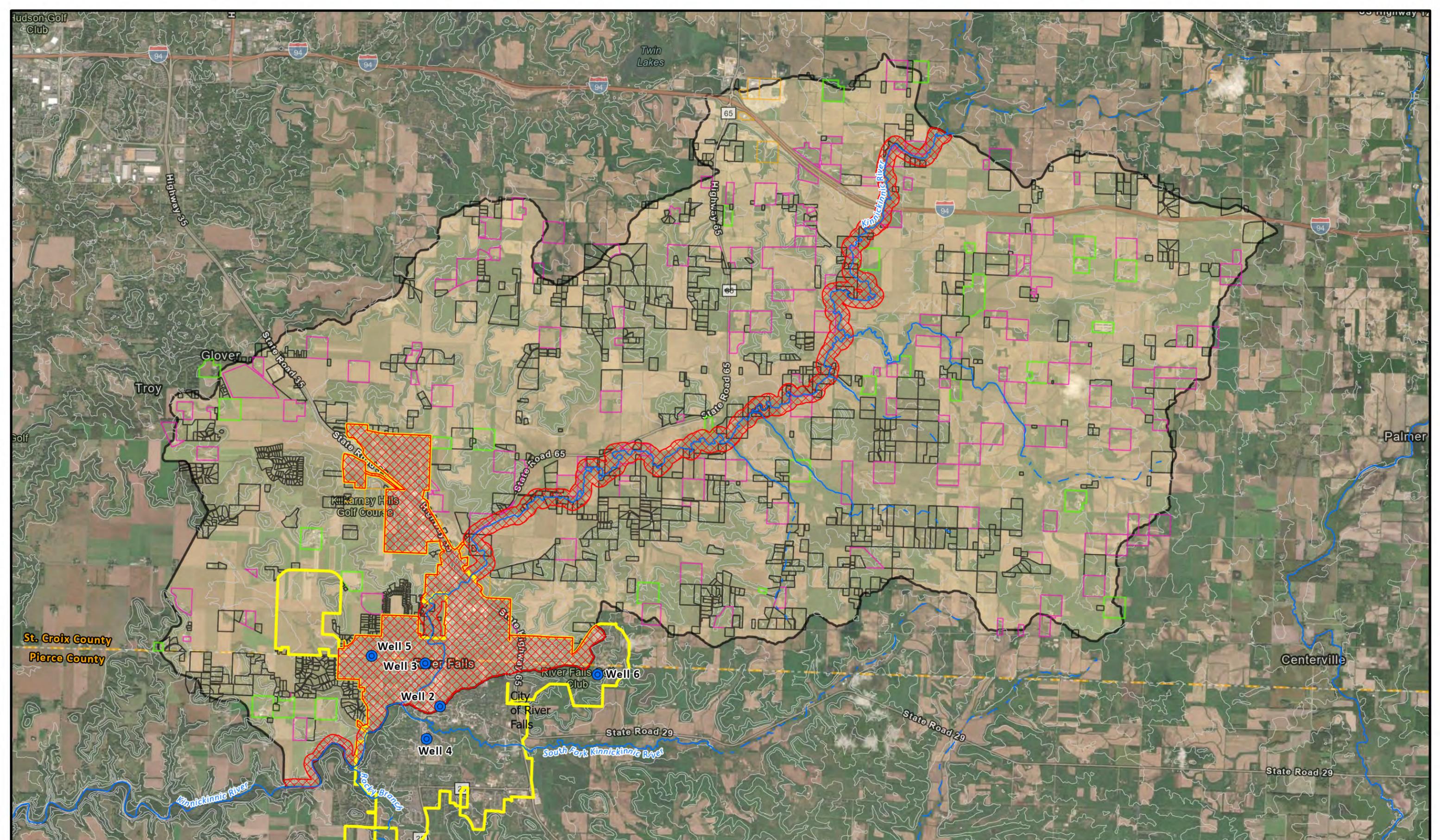
River Falls Municipal Utilities  
 River Falls, WI

May 2024

**FIGURE 1**

**FIGURE 2**

Kinnickinnic River Recharge Basin

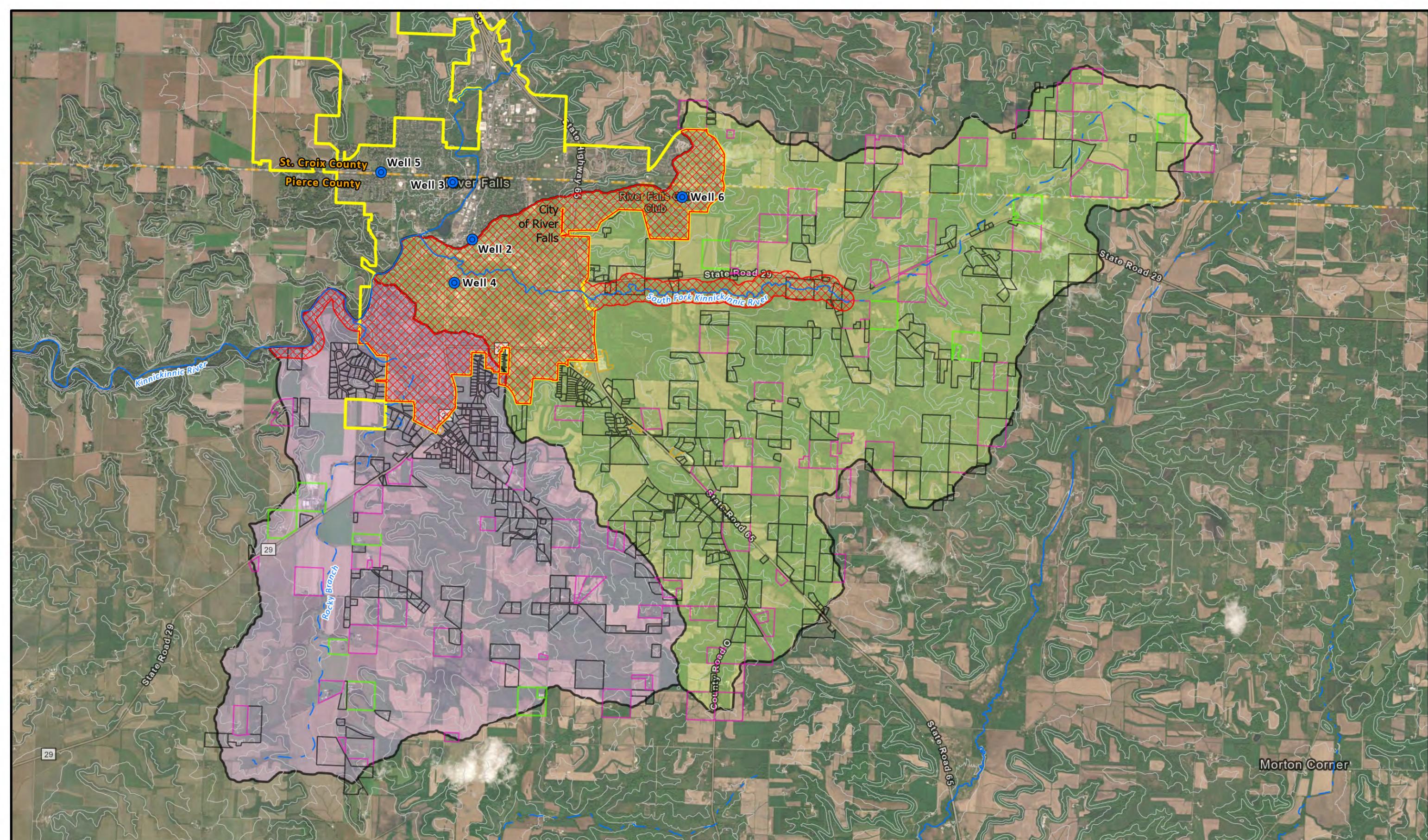


<b>Legend</b> <ul style="list-style-type: none"> <li><span style="color: blue;">●</span> City Water Supply Well</li> <li><span style="color: blue;">—</span> Perennial Flow River</li> <li><span style="color: blue;">- - -</span> Intermittent Flow River</li> <li><span style="color: grey;">—</span> 50-ft Contours</li> </ul>		<ul style="list-style-type: none"> <li><span style="border: 1px solid orange; display: inline-block; width: 10px; height: 10px;"></span> County Boundary</li> <li><span style="border: 2px solid yellow; display: inline-block; width: 10px; height: 10px;"></span> River Falls Corporate Limits</li> <li><span style="background-color: red; border: 1px solid red; display: inline-block; width: 10px; height: 10px;"></span> Excluded from Estimated GW Recharge Area</li> <li><span style="border: 1px solid orange; display: inline-block; width: 10px; height: 10px;"></span> Kinnickinnic River Recharge Basin</li> </ul>		<b>Estimated Groundwater Usage Rate Parcels</b> <ul style="list-style-type: none"> <li><span style="border: 1px solid green; display: inline-block; width: 10px; height: 10px;"></span> Ag. High Usage - 30</li> <li><span style="border: 1px solid pink; display: inline-block; width: 10px; height: 10px;"></span> Ag. Low Usage - 155</li> <li><span style="border: 1px solid orange; display: inline-block; width: 10px; height: 10px;"></span> Commercial - 10</li> <li><span style="border: 1px solid grey; display: inline-block; width: 10px; height: 10px;"></span> Residential - 1,162</li> </ul>		 0 1 2 4 Miles 1 inch equals 1 mile		 <b>GANNETT FLEMING</b> Rivers: WI DNR Corporate Limits: City of River Falls County Boundaries and Contours: Esri Parcels: UW-Madison		<b>KINNICKINNIC RIVER RECHARGE BASIN</b> River Falls Municipal Utilities River Falls, WI May 2024 <span style="float: right;"><b>FIGURE 2</b></span>	
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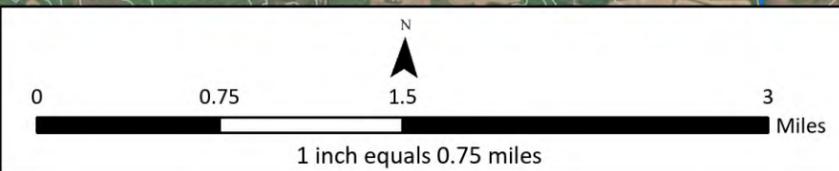
**FIGURE 3**

South Fork Kinnickinnic River and Rocky Branch Ba





Legend			
	City Water Supply Well		County Boundary
	Perennial Flow River		Excluded from Estimated GW Recharge Area
	Intermittent Flow River		South Fork Kinnickinnic River Recharge Basin
	50-ft Contours		Rocky Branch Recharge Basin
			Ag. High Usage - 12
			Ag. Low Usage - 79
			Commercial - 10
			Residential - 548



**GANNETT FLEMING**  
 Rivers: WI DNR  
 Corporate Limits: City of River Falls  
 County Boundaries and Contours: Esri  
 Parcels: UW-Madison

SOUTH FORK KINNICKINNIC RIVER AND ROCKY RUN BASINS	
River Falls Municipal Utilities River Falls, WI	
May 2024	FIGURE 3