IDENTIFYING PRIORITY AREAS FOR RECHARGE PROTECTION AND ENHANCEMENT ACTIVITIES IN THE TWIN CITIES METROPOLITAN REGION, MINNESOTA

December 2024

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Introduction

Within the Twin Cities seven-county metropolitan area, groundwater is an important water source for drinking, irrigation, and industrial use. Groundwater is also an important part of the water balance for many lakes, streams, and wetlands. The goal of this study is to leverage publicly available datasets to identify and rank areas within the seven-county metropolitan area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties) where changes in land use may have greater potential to alter the quantity and quality of groundwater recharge, thereby affecting the groundwater and surface water systems and the supported water supplies in the region. In particular, many of the datasets used for this study assist with identifying areas where the groundwater system is most vulnerable to impacts associated with changes in land use, land cover, and pollution.

This memo describes the process to compile relevant datasets that describe surface and near surface conditions related to water movement into and through the ground. These data are influenced by a combination of naturally occurring and human-influenced conditions. The attributes of the relevant datasets described in this memo were assigned a “weight” where a higher weight indicates areas where changes in land use and management may have the potential to influence the groundwater system more rapidly and to a greater extent. The weights for the individual datasets were then added to develop an overall “prioritization score”, which provides a holistic, qualitative measure of areas where changes in land use may have greater potential to alter the groundwater system. However, lower scores do not indicate that the groundwater system cannot or will not be impacted by development, redevelopment, or land management decisions, Rather, the “prioritization scores” imply a potential sensitivity of the groundwater system to negative impacts, and therefore where investments in protection activities may be most effective. This is a regional assessment that should include local surface and groundwater conditions, land practices, and community needs when making local decisions. The spatial distribution of the prioritization score allows for the identification of areas where investment in recharge protection and enhancement activities are more likely to produce a greater benefit.

The datasets used to identify these priority recharge protection and enhancement areas (areas where land use changes may have greater potential to influence the groundwater system) included:

- Pollution sensitivity of near-surface materials,
- Pollution sensitivity of the bedrock surface,
- Depth to bedrock,
- Drinking water supply management areas and emergency response areas,
- Recharge and flow-through surface water features,
- Surface water catchment areas (level 9 catchments, smallest available from MN DNR) associated with recharge and flow-through surface water,
- Potential for interaction between surface water and bedrock aquifers, and
- Regional aquifer recharge and discharge areas.

This information can help to build a shared understanding among regional water planning partners and service providers, inform the Metro Area Water Supply Plan, the Water Policy Plan, System Statements, and other regional and local approaches to groundwater protection.

Methodology

The methodology used in this study closely follows that used in a related study conducted for Washington County (DeRusha, 2021), although it includes some additional but closely related datasets. The Washington County Study identified priority recharge protection and enhancement areas and primarily uses county-scale datasets.

The approach described in this memo spans several counties and thus uses regional datasets, where available, to minimize discrepancies across county boundaries. Conditions at the community or parcel scale may not be adequately captured by the resolution of the input datasets, and detailed consideration of groundwater levels, surface water routing, and development pressures should be included in the analysis of investments in recharge protection and enhancement activities.

The process used to identify priority recharge protection and enhancement areas for this study included the following steps:

1. Attributes of the spatial datasets listed in Section 1 were classified and given a weight between 1 and 4, where a higher weight indicates greater potential to influence groundwater. Areas with no information for a given dataset were assigned a weight of 1. Assigning a minimum weight of 1 was done to avoid producing areas with a weight of 0, which could be misinterpreted as areas where potential impacts to groundwater could be ignored, which is not the intention.
2. The datasets were converted to rasters of equal size and resolution (50m by 50m) through either conversion of polygons to rasters or re-sampling of existing rasters. The raster resolution was chosen to capture sufficient detail from the input datasets without implying a higher level of precision than the data can provide. Each dataset's raster values represent the weights.
3. The individual weighted rasters were summed to generate an overall prioritization score raster.
4. The overall prioritization scores were simplified into five categories (very low, low, moderate, high, and very high) for prioritizing recharge protection and enhancement actions.

Data and Weighting Overview

Pollution sensitivity of near surface materials

The dataset for pollution sensitivity of near-surface materials estimates how quickly water infiltrated at the surface reaches a depth of 10 feet. This data is useful for prioritization of recharge protection and enhancement areas because areas with faster infiltration are assumed to have a greater potential to impact groundwater resources than areas with slower infiltration.

Data sources

The pollution sensitivity of the near-surface materials dataset provided with more recent county geologic atlases (part B) is based on the estimated time for water to infiltrate from the land surface to a depth of 10 feet (Adams, 2016). The assessment assumes the top three feet of the near-surface materials are defined by a hydrologic soil group classification (USDA, 2023) and surficial geology defines the physical conditions of the underlying seven feet (3 to 10 feet). The vertical travel time for water is calculated using Darcy's law, assigning a vertical hydraulic conductivity to the near-surface materials and assuming a unit gradient. This vertical travel time is converted to a sensitivity using the classifications presented in Table 1.

Table 1 Near-surface Pollution Sensitivity and Vertical Travel Time

Near-Surface Pollution Sensitivity	Vertical Time of Travel [hours]	Description
High	≤ 170	Hours to a week
Moderate	>170–430	A week to weeks
Low	>430–1600	Weeks to months
Very Low	>1600–8000	Months to a year
Ultra Low	>8000	More than a year
Special Conditions: including karst and bedrock at or near surface	variable	variable

Note that special consideration is given to situations where bedrock is shallow and/or karstic. These situations are addressed in Section 3.1.2.

The pollution sensitivity of the near-surface materials was provided in the Part B county geologic atlases for the following counties:

- Anoka (Berg, 2016)
- Carver (Petersen, 2014)
- Hennepin (Berg, J.A., 2021)
- Washington (Berg, J.A, 2019)

For the four counties listed above, the pollution sensitivity of the near-surface materials datasets were used without modification.

At the time of this study, the following counties have older county geologic atlases and either do not provide the pollution sensitivity of the near-surface materials or calculate it using a different methodology.

- Dakota (Balaban, et al., 1990)
- Ramsey (Meyer, et al., 1992)
- Scott (Tipping, et al., 2008)

For the above three counties, the pollution sensitivity of the near-surface materials was calculated using the most current methodology described above. The hydrologic soil groups as mapped by USDA (2023) and regional surficial geology from Meyer (2007) were used. These regional datasets were chosen over county-specific datasets to minimize the potential for mapped discrepancies at the county borders.

The four existing pollution sensitivity of the near-surface datasets from the recent county geologic atlases and the pollution sensitivity generated for Dakota, Ramsey, and Scott counties were merged to develop a dataset covering the entire study area.

Assigning weights

The combined attributes of the seven-county pollution sensitivity of near-surface materials dataset were then assigned weights (Table 2).

Table 2 Near-surface Pollution Sensitivity Weights

Near-Surface Materials, Pollution Sensitivity	Weight
High	3
Moderate	2
Low	1
Very Low	1
Ultra Low	1
Karst or bedrock at the surface or undifferentiated surficial materials	4
Water	1

Areas with identified karst or bedrock near the surface were assigned a weight of 4, because transport to the groundwater system is assumed to be rapid in these areas. Areas with undifferentiated surficial materials were also assigned a prioritization weight of 4 to conservatively address uncertainty about water movement through those materials. Surface water areas were assigned a weight of 1. Groundwater – surface water interaction is accounted for through other datasets (see Section 3.5).

A comparison of the pollution sensitivity of the near-surface materials and weighted attributes is presented in Figure 1.

Pollution Sensitivity of the Bedrock Surface

The pollution sensitivity of the bedrock dataset provides an estimate of how quickly water infiltrated at the ground surface reaches bedrock. Similar to the pollution sensitivity of the near-surface materials dataset, this data is useful for prioritization of recharge protection and enhancement areas because areas with faster infiltration are assumed to have a greater potential to impact groundwater resources than areas with slower infiltration.

Data sources

The pollution sensitivity of the bedrock surface has been determined using different methods in different counties. For more recent county geologic atlases (Anoka, Carver, Hennepin, and Washington Counties), the pollution sensitivity of bedrock surface is based on the cumulative thickness of the fine-grained sediments above the bedrock surface (Adams, 2016) and is provided in Part B of the atlases. Fine-grained sediment thickness attribute classifications are presented in Table 3.

Table 3 Bedrock Surface Pollution Sensitivity and Cumulative Fine-Grained Sediment Thickness

Pollution Sensitivity of the Bedrock Surface	Cumulative Fine-Grained Sediment Thickness [ft]
Very High	0 to 10
High	>10 to 20
Moderate	>20 to 30
Low	>30 to 40
Very Low	>40

Older county geologic atlases (Dakota, Scott, and Ramsey Counties) use varying methods to calculate the pollution sensitivity of the bedrock surface or did not provide this information. For these counties, a pollution sensitivity of the bedrock surface was calculated using the most current methodology (“Cumulative Fine-Grained Sediment Thickness”) described above. The cumulative fine-grained sediment thickness and type were obtained from a regional three-dimensional gridded point dataset of unconsolidated geology (Tipping, 2011), which was converted into a series of rasters as part of the Metro Model 3 development (Metropolitan Council, 2014). These rasters were used to develop a cumulative thickness of fine-grained sediments across the study area. The cumulative thickness of fine-grained sediments was then classified to pollution sensitivity of the bedrock surface (Table 3). The datasets from the more recent county geologic atlases and the dataset developed as part of this study were merged to obtain a single dataset covering the entire study area.

Assigning weights

The combined pollution sensitivity of the bedrock surface dataset was then assigned weights (Table 4).

Table 4 Near-Surface Pollutions Sensitivity Weights

Pollution Sensitivity of the Bedrock Surface	Weight
Very High	4
High	3
Moderate	2
Low	1
Very Low	1

A comparison of the pollution sensitivity of the bedrock surface and weighted attributes is presented in Figure 2.

Depth to bedrock

Bedrock aquifers are an important part of the groundwater resources in the Twin Cities Metropolitan Area. Depth to bedrock data was included in this assessment because within areas where there is a greater distance between the surface and bedrock aquifers, the aquifers are assumed to be less rapidly influenced by land use and management practices than areas where the depth to bedrock is shallow.

Data sources

Like the near-surface and bedrock pollution sensitivity datasets, more recent county geologic atlases provide datasets of depth to bedrock, and older county geologic atlases do not. Therefore, a single regional dataset of the bedrock elevation was used to define the depth to bedrock (Mossler, 2013) instead of the individual county datasets. This was done to avoid mapped discrepancies across county boundaries. The source dataset provided bedrock elevation contours, which were then converted to a bedrock elevation raster. This raster was then subtracted from a ground surface elevation raster to develop a depth to bedrock raster. Visual comparison of the 2013 regional contour dataset to newer county geologic atlas datasets produced after its publication (Anoka, Carver, Hennepin, and Washington counties) show that the datasets are generally very similar, with only small differences near the edges of the counties and near areas of high relief in the bedrock surface. For the purposes and scale of this study, these differences are deemed to be insignificant.

Assigning weights

Depth to bedrock was classified to a weight (Table 5).

Table 5 Depth to Bedrock Weights

Depth to Bedrock	Weight
Less than 50 feet	3
50 to 100 feet	2
Greater than 200 feet	1

Areas of shallow bedrock (less than 50 feet) were assigned a relatively high weight of 3, while areas of deep bedrock (greater than 200 feet) were assigned a relatively low eight of 1.

A comparison of the depth to bedrock and weighted attributes is presented in Figure 3.

Drinking water supply management and emergency response areas

Wellhead protection areas are included in the prioritization of recharge protection and enhancement areas because these delineations represent areas where infiltration of contaminated recharge may impact public water supplies.

Data sources

Drinking water supply management areas (DWSMAs) and emergency response areas (ERAs) were included in the analysis. A DWSMA denotes the extent of the legal boundaries encompassing the capture area of a public supply well. A ten-year time of travel is typically used to define these capture zones. An ERA denotes the one-year time of travel to the well. The most recent DWMSAs and ERAs datasets were obtained (Minnesota Department of Health, 2024) and used in the analysis.

While DWSMAs are assessed for vulnerability, this vulnerability information was not considered in this analysis. Only the presence or absence of a DWSMA or ERA was used to define a weight.

Assigning weights

The DWSMAs and ERAs were classified to a weight (Table 6).

Table 6 Wellhead Protection Weights

Wellhead Protection Area	Weight
ERA	4
DWSMA	2
No data	1

ERAs were assigned a relatively high weight of 4, as ERAs signify areas where surficial activities are more likely to impact groundwater resources and public water supplies quickly. DWSMAs were assigned a lower weight of 2, as DWSMAs signify areas where surficial activities are less likely to impact water suppliers quickly, compared to ERAs.

A comparison of the DWSMAs and ERAs and weighted attributes is presented in Figure 4.

Surface water – groundwater connection

Surface water features that discharge to, or mix with, groundwater are included in the prioritization of recharge protection and enhancement areas because these features have the potential to influence groundwater resources.

Data Sources

Information on the surface water – groundwater interaction was obtained from datasets provided in the study *Evaluation of Groundwater and Surface-Water Interaction: Guidance for*

Resource Assessment (Metropolitan Council, 2010). These datasets classify connections between surface waters and groundwater based on the stage and depth of the waterbody, and the elevation of the water table. The regional surface water dataset used in this study includes streams, wetlands, and lakes, whereas the county-scale dataset used in the Washington County study only included lakes. Classifications of groundwater and surface-water interactions in the report were reclassified to simplified categories consistent with those used in the Washington County Study as specified below:

- Recharge or indeterminate lakes/wetlands and losing or indeterminate streams were classified as recharge surface water features,
- Flow-through lakes/wetlands were classified as flow-through surface water features, and
- Discharge lakes/wetlands, disconnected lakes/wetlands with deep water tables, graining streams, and disconnected streams with deep water tables were classified as discharge or disconnected surface water features

Additionally, watersheds for surface features that recharge or mix with the groundwater system were identified and incorporated in the study, as activities within these watersheds are assumed to have a greater potential to influence groundwater, than those identified as disconnected from the groundwater system. To provide the most detailed representation of local conditions surrounding groundwater system connected surface waters, the smallest watershed delineations available in the Minnesota Department of Natural Resources dataset were used (level 9) (MNDNR, 2023).

Assigning weights

The identified surface water features and associated watersheds were assigned a weight (Table 7).

Table 7 Surface Water – Groundwater Connection Weights

Surface Water and Watershed Criteria	Weight
Recharge surface water	4
Flow-through surface water	3
Discharge or disconnected surface water	1
Recharge surface water - watershed	3
Flow-through surface water - watershed	2
No data	1

Surface water features that recharge the groundwater system were given a relatively high weight of 4. The watersheds connected to these features were given a weight of 3. Surface water features which mix with the groundwater system were given a weight of 3. The watersheds connected to these features were given a weight of 2. Surface water features that receive discharge from the groundwater system were given a weight of 1 and the watersheds of these features were not identified and, therefore received the default minimum weight of 1.

A comparison of the surface water – groundwater connection and associated watersheds and the weighted attributes is presented in Figure 5.

Potential for connection between the bedrock surface and surface waters

Similar to the data discussion in Section 3.5, the dataset used in this section seeks to prioritize recharge protection and enhancement areas based on surface water–groundwater interaction. However, whereas the analysis presented in Section 3.5 considered surface water features that were likely to contribute water to the groundwater system, this analysis takes a broader approach – looking at the physical and chemical properties of surficial geology and the distance between the water table and bedrock surface to assess where bedrock aquifers are likely to be influenced by surface water. In this way, this analysis incorporates some aspects of transport within the groundwater system.

Data sources

Datasets presented in Metropolitan Council (2020) were used to inform the potential for hydraulic connection between the bedrock surface aquifers and surface water. These data use estimated travel times from the water table to the bedrock surface and groundwater chemistry data from samples taken within 20 feet of the bedrock surface to confirm if there is a high, low, or intermediate potential for a hydraulic connection between the bedrock surface and surface water. Areas where subsurface materials suggest short travel times between the surface and the bedrock surface aquifers, or water quality data indicate anthropogenic signatures, were assumed to have higher potential for a hydraulic connection. Conversely, areas with longer travel times and where no anthropogenic signatures were identified were assumed to have a lower potential for a hydraulic connection.

Assigning weights

The potential for hydraulic connection between bedrock and surface waters as presented in Metropolitan Council (2020) was classified to a weight (Table 8).

Table 8 Potential for Hydraulic Connection Between the Bedrock Surface and Surface Water Weights

Potential for Hydraulic Connection Between the Bedrock Surface and Surface Waters	Weight
High	3
Intermediate	2
Low	1
No data	1

Areas with a high potential for hydraulic connection between the groundwater and surface water were given a relatively high weight of 4. Regions with a low potential were given a relatively low weight of 1.

A comparison of the potential for hydraulic connection between the bedrock surface and surface waters dataset and assigned weights is presented in Figure 6.

Regional bedrock aquifer recharge and discharge areas

For the purposes of this study, bedrock aquifer recharge and discharge areas were identified based on the difference between the water table elevation and the potentiometric surface of the bedrock aquifers. Within areas identified as potential zones of recharge for bedrock aquifers, activities at the surface may influence the water quantity or quality of the bedrock aquifer. Within areas identified as potential zones of discharge from bedrock aquifers, activities at the surface are less likely to influence water quality and quantity in the bedrock.

Data sources

Bedrock aquifer recharge and discharge areas were identified using a regional dataset of the differences in hydraulic head between regional bedrock aquifers and the water table (Tipping, 2011). This dataset provides gridded point data over the study area for two periods, March and August 2008. The average hydraulic head differences for these two time periods was used. Positive values indicate areas where the water table elevation is greater than the hydraulic head in the bedrock (i.e., downward gradient). Within these areas, there is greater potential for recharge from the surface to reach the deeper bedrock aquifers. Negative values indicate a potential groundwater discharge area, where the water table elevation is less than the hydraulic head of the bedrock (i.e., upward gradient). Within these areas there is less potential for recharge from the surface to reach the deeper bedrock aquifers.

Assigning weights

The average head differences between the water table and the bedrock aquifer was classified to a weight using the classification presented in Table 9.

Table 9 Regional Aquifer Recharge and Discharge Areas Weights

Regional Aquifer Recharge and Discharge Areas	Weight
Recharge areas (water table elevation above bedrock aquifer hydraulic head)	2
Discharge areas (water table elevation below bedrock aquifer hydraulic head)	1

Recharge areas were given a weight of 2, as they have more potential to influence the groundwater system. Discharge areas were given a weight of 1, as they have less potential to influence the groundwater system. A comparison of the potential for hydraulic connection between the groundwater and surface water dataset and assigned weights is presented in Figure 7.

Results: Prioritized Recharge Protection and Enhancement Areas

Classification of recharge protection and enhancement areas

An overall prioritization score was calculated for each 50m x 50m raster cell in the study area using the composite sum of all weighted rasters developed using the methodologies described above in Section 3. Due to the use of a minimum weight of 1 (even for areas with no data), the minimum prioritization score possible is 7. The maximum possible score is 24. The following classification was selected to summarize the prioritization score into simplified groupings (Table 10).

Table 10 Prioritization Score and Classification of Recharge Protection and Enhancement Areas

Prioritization Score	Recharge Protection and Enhancement Area Priority Classification
7	Very Low
8-10	Low
11-13	Moderate
14-16	High
17-24	Very High

This classification was selected for consistency with the Washington County study (DeRusha, 2021) and to provide a reasonable distribution of classifications. A comparison of the prioritization score and the prioritization of recharge protection and enhancement areas classification (henceforth referred to as priority classification) is presented in Figure 8.

Additional considerations

An overlay of mapped faults (Mossler, 2013), perennial streams and waterbodies (Minnesota Department of Natural Resources, 2024), and regional bedrock confining units (Mossler, 2013) are shown in Figure 9. These features may influence the groundwater system through processes not explicitly addressed in this study and conceptual consideration of these features may provide additional insights on best management practices. Municipal and civil township boundaries (Minnesota Department of Transportation and Minnesota Geospatial Information Office, 2024) and watershed management organization boundaries (Natural Resources Research Institute, 2024) within the study area are shown in Figure 10. A summary of the distribution of priority classifications for Municipal and Civil Township boundaries and watershed management organization are provided in Attachment A and Attachment B, respectively.

Comparison to previous studies

The methodology and weights used in this study were generally based on those used in the Washington County study (DeRusha, 2021).However, the different scales of the studies (county vs regional) required different datasets to be used in some cases, as described in sections 3.3, 3.5, and 3.7. Additionally, some modifications were made to the weighting used in the Washington County Study, most notably the decision to use a minimum weight of 1 rather than 0. Additionally, for this study, near-surface bedrock was assigned the highest weight in the pollution sensitivity of the near-surface materials dataset (Section 3.1). The Washington County Study assigned near-surface bedrock the lowest weight. This study also used the regional aquifer recharge and discharge areas (Section 3.7) as a weight in the calculation of the prioritization score, whereas the Washington County study used a similar dataset as a mask, not a weight.

Conclusions

This study leveraged publicly available datasets and accepted methodology to prioritize areas for recharge protection and enhancement activities in the metro. Datasets related to geology, surface water, groundwater, water quality, and wellhead protection were used to develop a holistic qualitative prioritized classification of land for recharge protection and enhancement activities. This information can help to build a shared understanding among regional water planning partners and service providers, inform the Metro Area Water Supply Plan, the Water Policy Plan, Local Water Plans, Community Comprehensive Plans, and other regional and local approaches to groundwater protection.

Generally, areas with a recharge protection and enhancement priority classifications of high and very high are more prevalent in the eastern half of the Metro Region. This result is likely due to the type and thickness of the unconsolidated sediments and the presence of karstic features in these areas. Many of the datasets used to calculate prioritization scores directly or indirectly incorporate this data. Therefore, areas with shallow karstic bedrock (including northern Scott County along the Minnesota River, eastern Hennepin County, east-central Ramsey County, south and west Washington County, and much of Dakota County) have greater proportions of high and very high recharge protection and enhancement priority classifications.

Protecting land and water at the surface is essential everywhere. The results of the prioritization scoring and categorization exercise do not imply that recharge protection or enhancement are not viable, useful, or important in all parts of the metro. Rather, these results demonstrate that in some areas where groundwater is potentially more vulnerable to changes in land use, land cover, land and water management practices, and pollution, recharge protection and enhancement activities are likely to have a more immediate impact on the quality and quantity of groundwater. Whereas, in areas with lower priority scores, the benefits of recharge protection and enhancement activities are likely to be measured over longer periods of time.

Local environmental conditions along with those associated with development, redevelopment, and water demand should help guide land and water protection decisions at the parcel level, and caution should be taken not to over-interpret the results of this analysis. However, this summary prioritization assessment can both point to areas where additional investment in recharge protection and enhance are valuable and be built upon with additional data and information to inform specific scenarios, local needs, and priorities.

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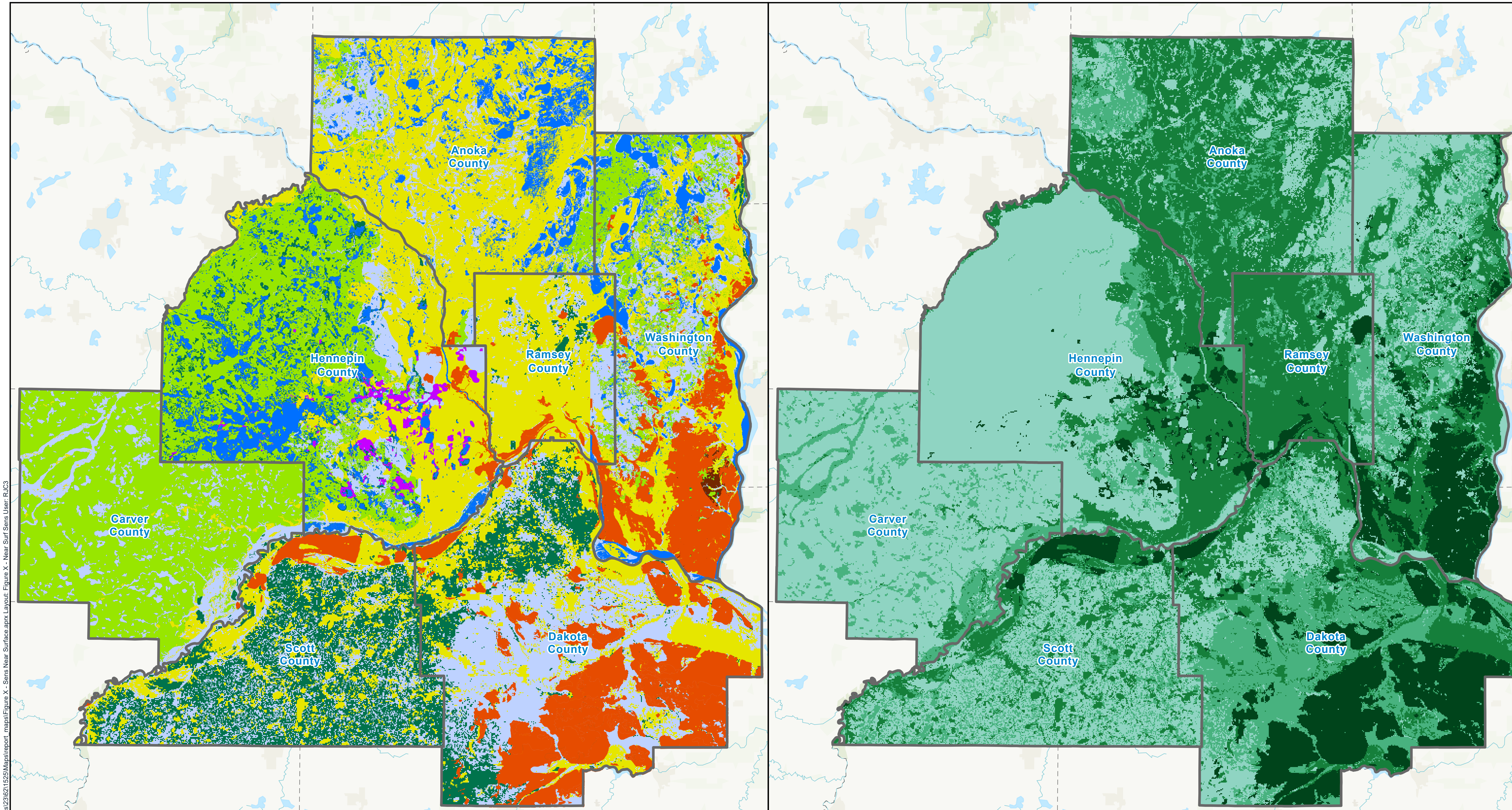

Seven County Metro Boundaries

Pollution Sensitivity of the Near Surface Materials

- Very Low
- Low
- Moderate
- High
- Karst
- Undifferentiated
- Water
- Bedrock

<u>County Geologic Atlas Data Sources:</u>

Berg, J.A. 2019. Groundwater Atlas of Washington County, Minnesota: Minnesota Department of Natural Resources, County Atlas Series C-39, Part B, Report and Plates 7–9. 2019.

Berg, J.A. 2021. Groundwater Atlas of Hennepin County, Minnesota: Minnesota Department of Natural Resources, County Atlas Series C-45, Part B, report, 3 pls., GIS files. 2021.

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<u>Regional Data Computed from:</u>

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Weighted Pollution Sensitivity of Near Surface Materials

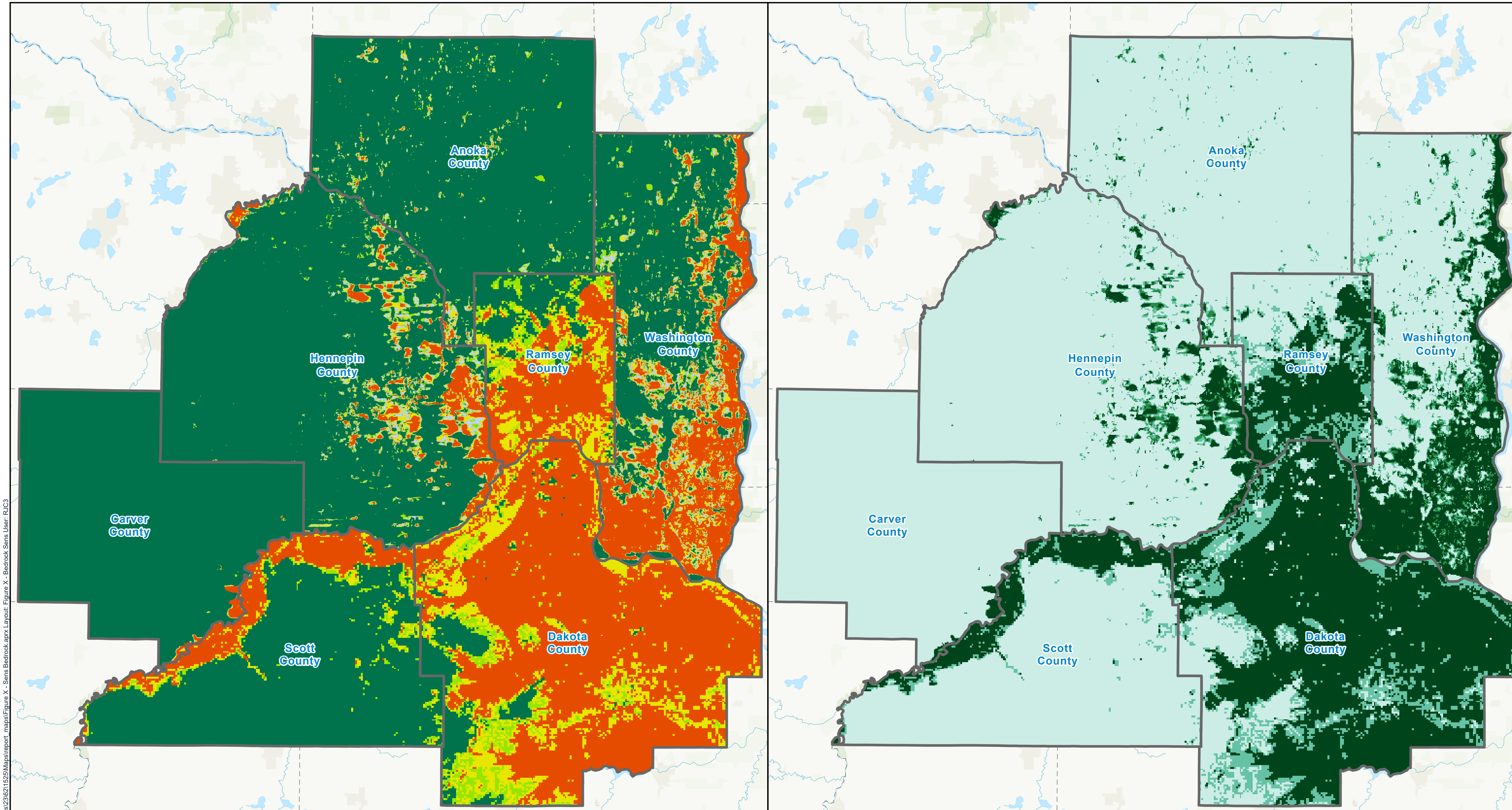
- 1
- 2
- 3
- 4

Pollution Sensitivity of Near-Surface Materials (left) and Weighted Attributes (right)

Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota

FIGURE 1

BARR



Seven County Metro Boundaries

Pollution Sensitivty of the Bedrock Surface

- Very Low
- Low
- Moderate
- High
- Very High

<u>County Geologic Atlas Data Sources:</u>

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Berg, J.A. 2021. Groundwater Atlas of Hennepin County, Minnesota: Minnesota Department of Natural Resources, County Atlas Series C-45, Part B, report, 3 pls., GIS files. 2021.

Berg, James A. 2016. Geologic Atlas of Anoka County, Minnesota; County Atlas Series C-27 Part B: Hydrogeology. s.l. : Minnesota Department of Natural Resources, 2016.

Petersen, Todd A. 2014. County Atlas Series Carver County Atlas C-21, Part B, Plate 9 Of 9 Pollution Sensitivity. s.l. : Minnesota Department of Natural Resources, 2014.

<u>Regional Data Computed from:</u>

Adams, R. 2016. Pollution Sensitivity of the Bedrock Surface: St. Paul, Minnesota Department of Natural Resources, Minnesota Hydrogeology Atlas Series HG-01, v. 2. 2016.

Metropolitan Council. 2014. Twin Cities Metropolitan Area Regional Groundwater Flow Model, Version 3.0; Prepared by Barr Engineering. Metropolitan Council: Saint Paul, MN. 2014.

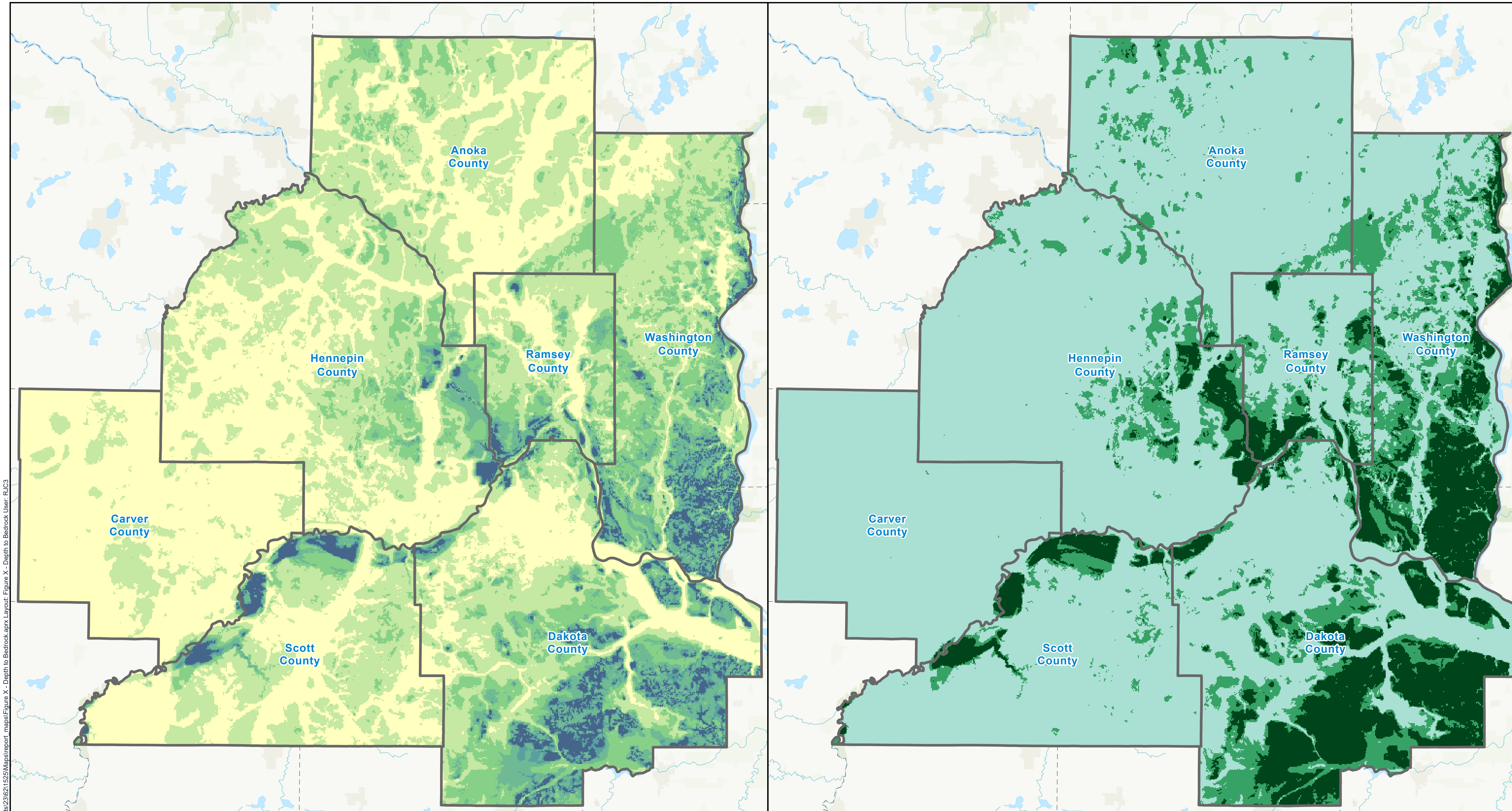
Tipping, R.G. 2011. Distribution of vertical recharge to upper bedrock aquifers, Twin Cities metropolitan area. Minnesota Geological Survey report submitted to Metropolitan Council. 2011.

Weighted Pollution Sensitivity of the Bedrock Surface

- 1
- 2
- 3
- 4

Pollution Sensitivity of Bedrock Surface (left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 2

BARR



Seven County Metro Boundaries

Depth to Bedrock [ft]

- ≤10
- >10 - ≤20
- >20 - ≤50
- >50 - ≤100
- >100 - ≤200
- >200

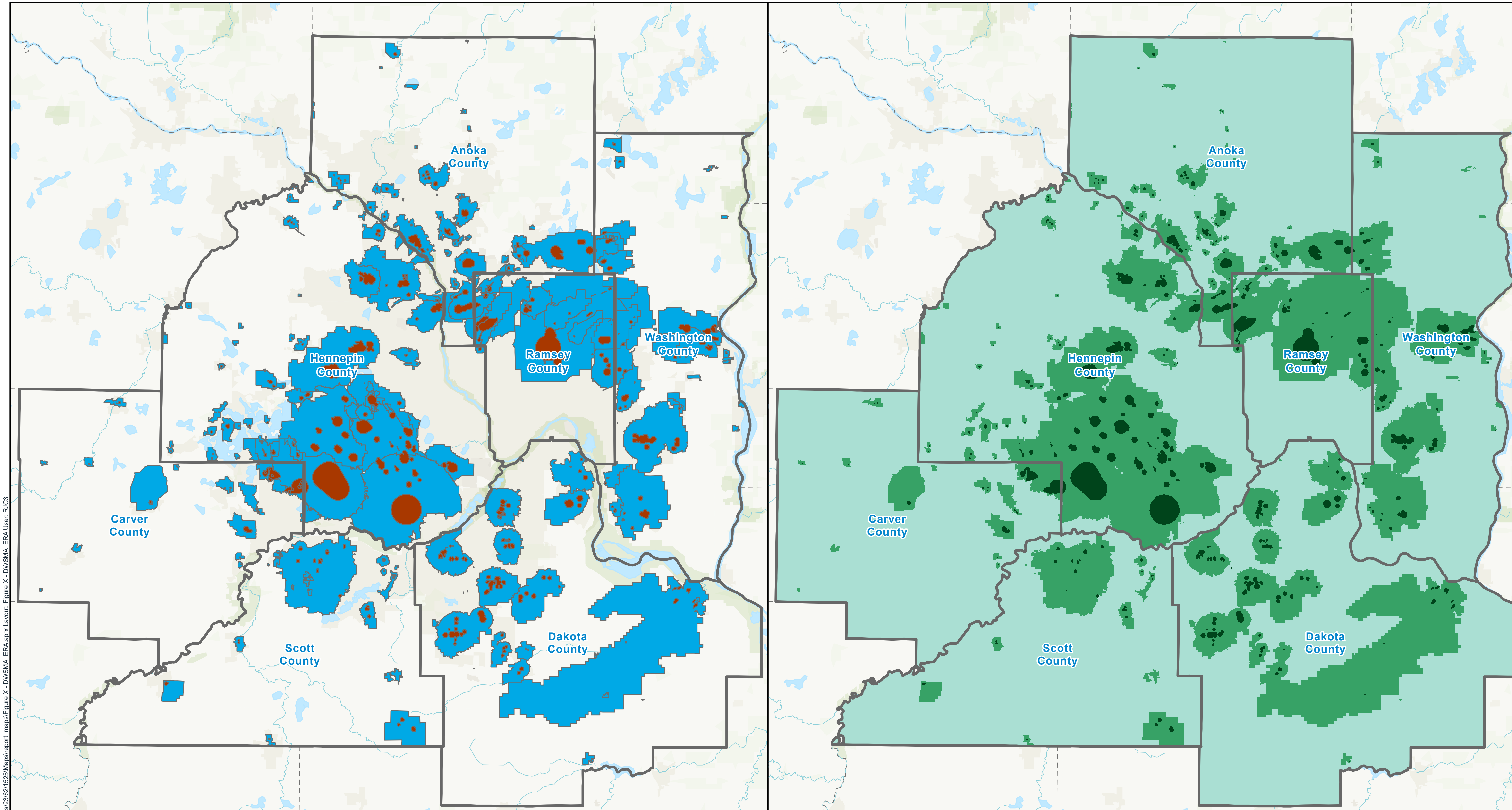
Data Source:
Mossler, John H. 2013. M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University Digital Conservancy, 2013.

Weighted Depth to Bedrock [ft]

- 1
- 2
- 3

Depth to Bedrock (left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 3

BARR



Seven County Metro Boundaries

Sourcewater Protection Areas

Drinking Water Supply Management Areas (DWSMA)

Emergency Response Areas (ERA)

Data Sources:
Minnesota Department of Health. 2024. Drinking Water Supply Management Areas. Minnesota Geospatial Commons. 2024.
Minnesota Department of Health. 2024. Emergency Response Areas. Minnesota Geospatial Commons. 2024.

Weighted Sourcewater Protection Areas

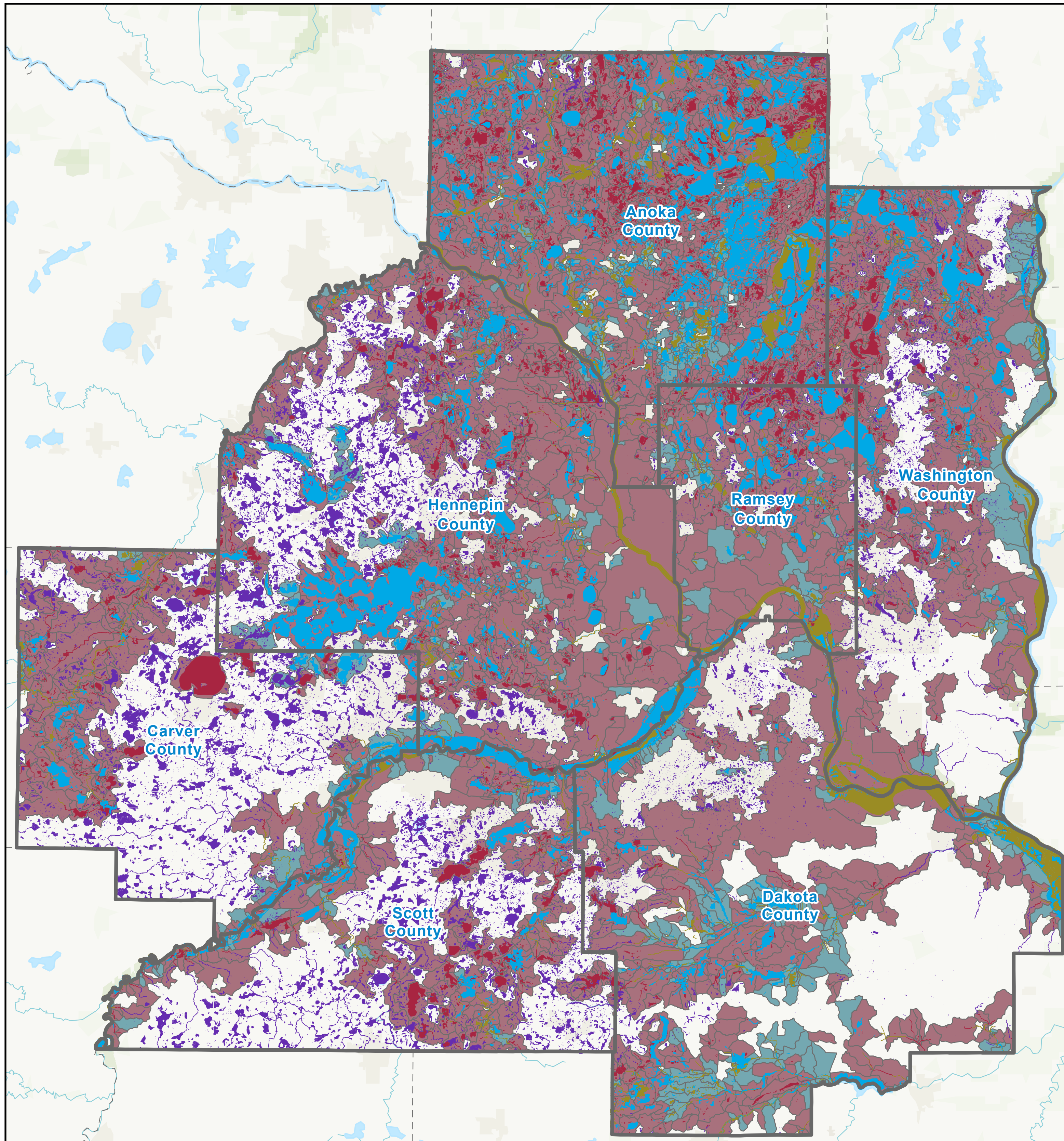
1

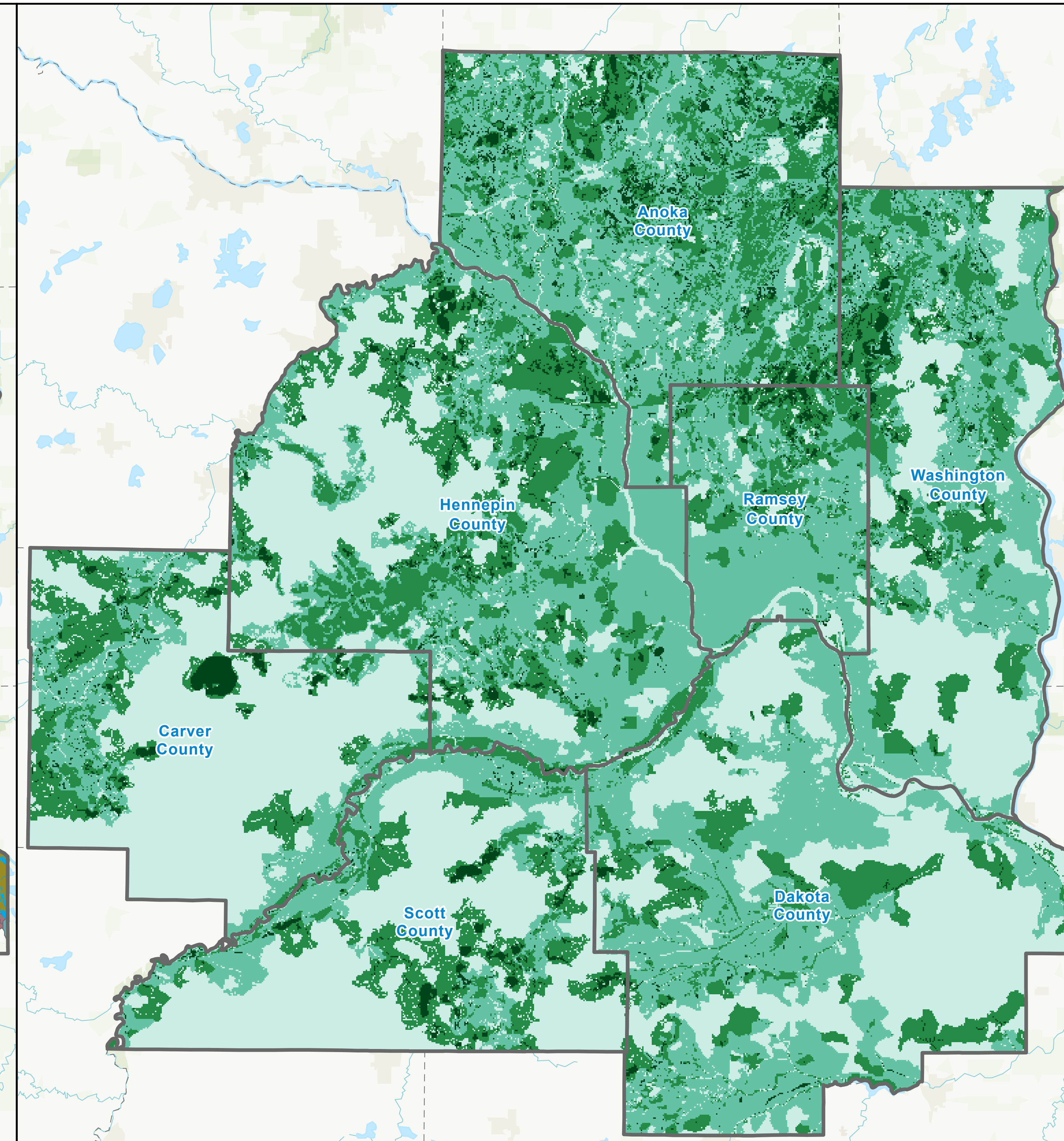
2

4

Wellhead Protection Areas (left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 4

BARR





Seven County Metro Boundaries

Subwatersheds for Groundwater Connected Surface Water Features

- Flow Through
- Recharge / Indeterminate

Surface Water - Groundwater Connection

- Discharge
- Disconnected
- Flow Through
- Recharge / Indeterminate

Data Sources:
Metropolitan Council. 2010. Evaluation of Groundwater and Surface-Water Interaction: Guidance for Resource Assessment. Twin Cities Metropolitan Area, Minnesota. 2010.
MNDNR. 2023. MNDNR Watershed Suite. DNR Watersheds - DNR Level 09 - DNR AutoCatchments. 2023.

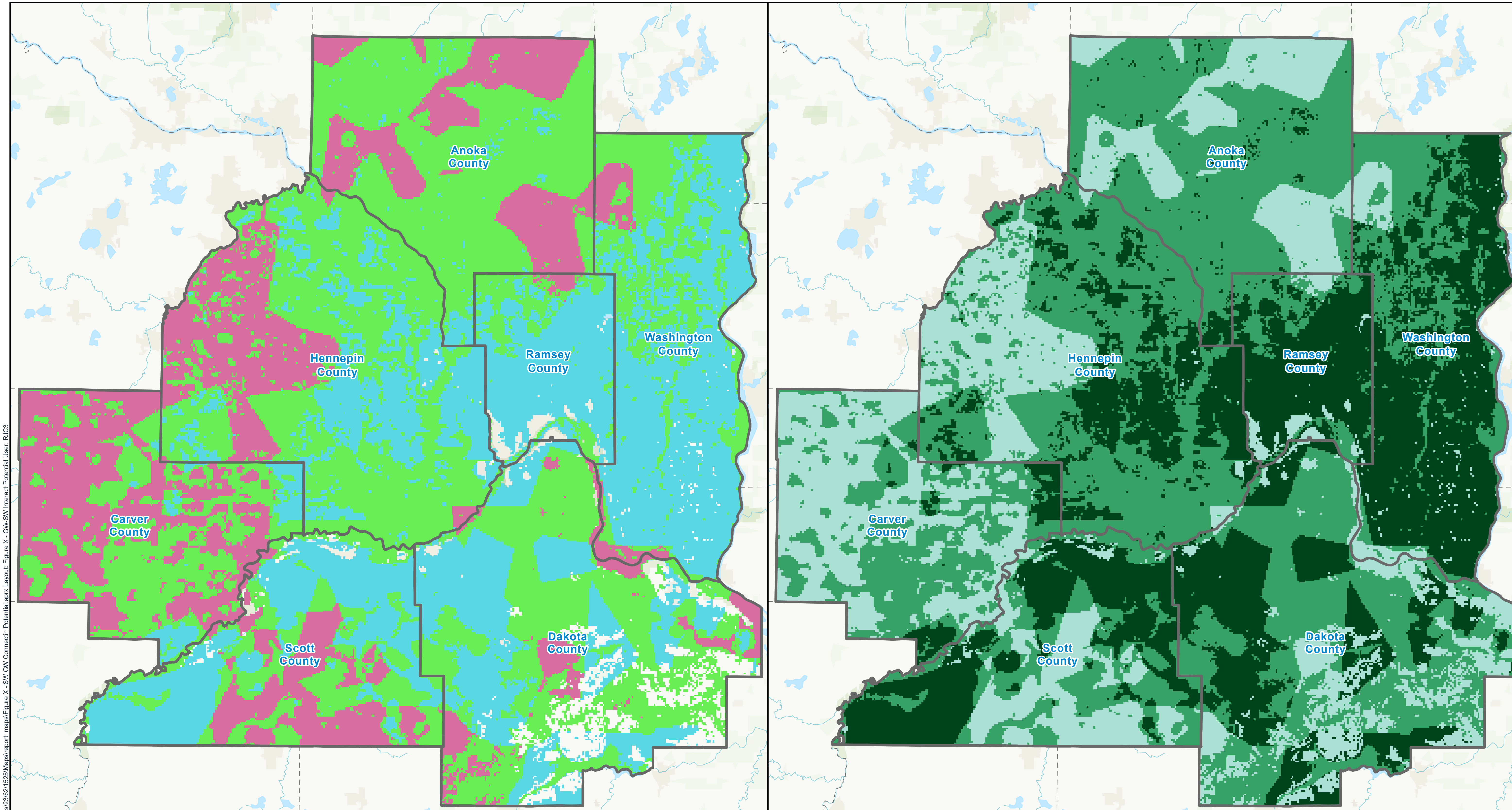
Weighted Groundwater Connected Surface Water Features and Subwatersheds

- 1
- 2
- 3
- 4

Surface Water-Groundwater Connection and Subwatersheds(left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 5

BARR

Barr footer:



Seven County Metro Boundaries

Potential for Hydraulic Connection Between Surface Water and Bedrock Surface

- Low
- Intermediate
- High

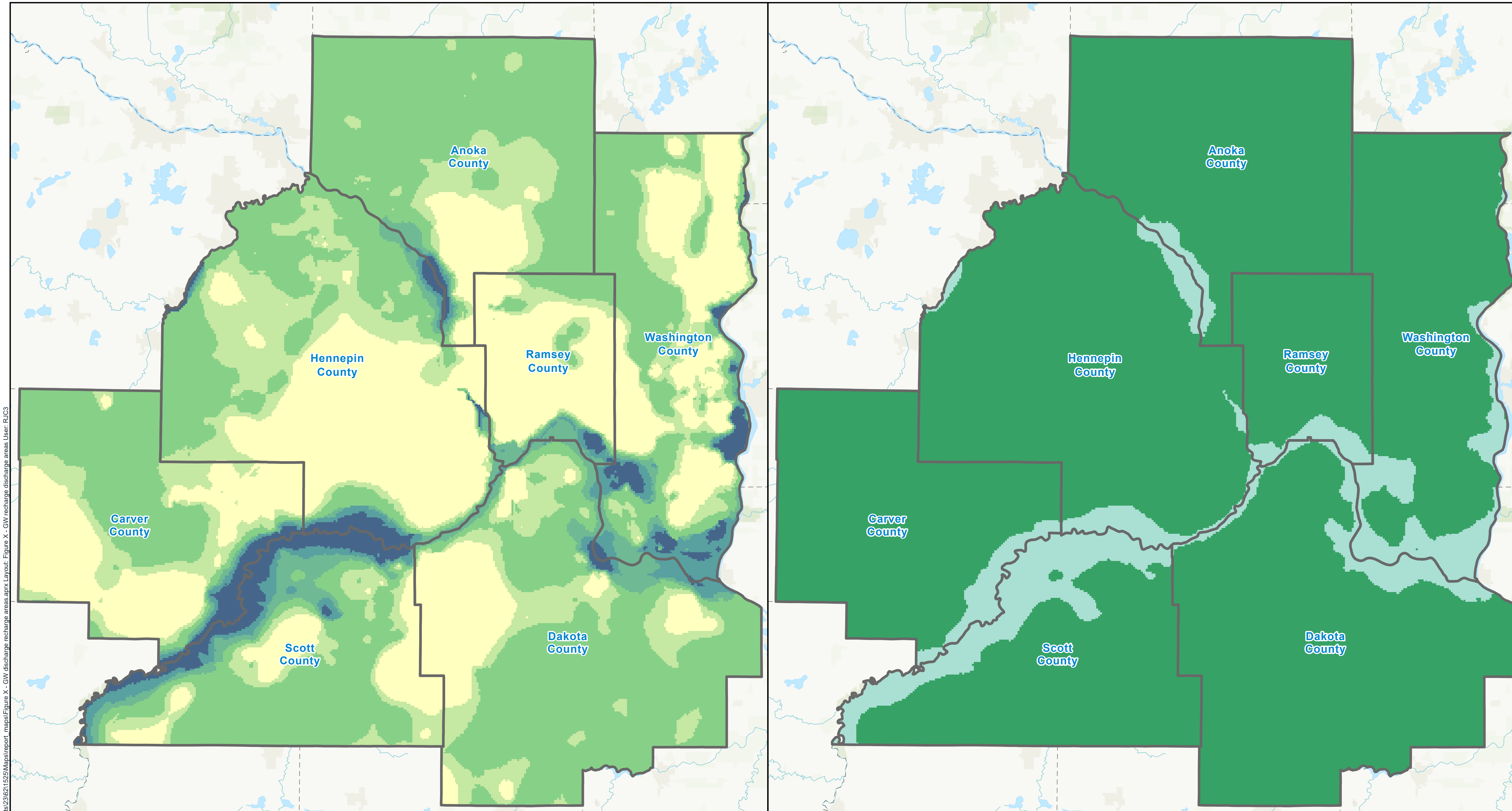
Data Sources:
Metropolitan Council Environmental Services: Water Supply Planning. 2020. Interactions of Groundwater and Surface Water Resources. Phase 1: Potential hydraulic connections between bedrock aquifers and surface water in the Twin Cities Metropolitan Region. 2020.

Weighted Potential for Hydraulic Connection Between Surface Water and Bedrock Surface

- 1
- 2
- 3

Potential for Hydraulic Connection Between Surface Water and Bedrock Surface(left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 6

BARR



Seven County Metro Boundaries

Watertable - Bedrock Vertical Head Difference (ft)

- ≤-20
- >-20 - ≤-10
- >-10 - ≤0

Discharge Area

- >0 - ≤10
- >10 - ≤20
- >20

Recharge Area

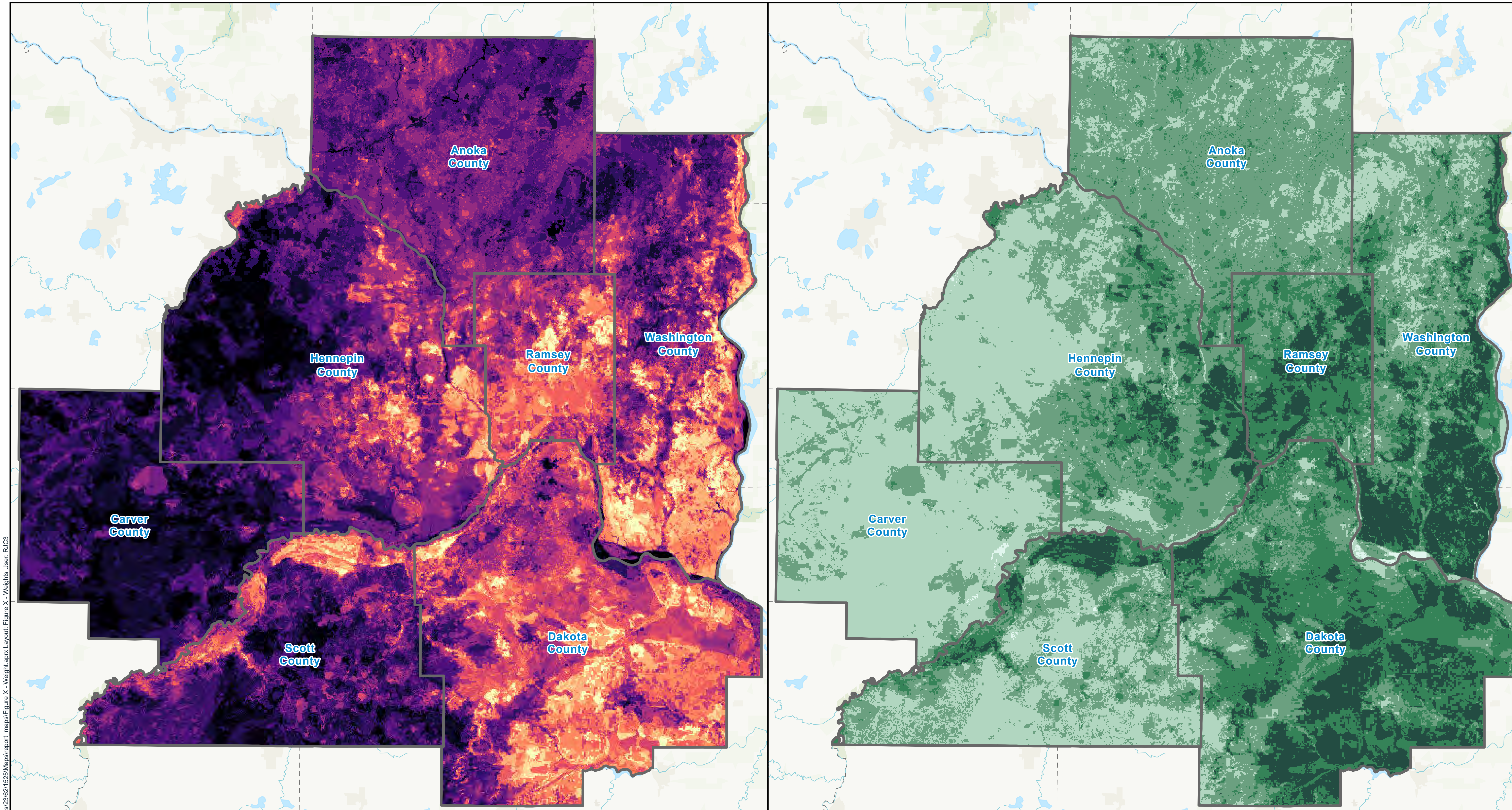
Data Sources:
Tipping, R.G. 2011. Distribution of vertical recharge to upper bedrock aquifers, Twin Cities metropolitan area. Minnesota Geological Survey report submitted to Metropolitan Council. 2011.

Weighted Recharge and Discharge Areas

- 1
- 2

Aquifer Recharge and Discharge Areas (left) and Weighted Attributes (right)
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 7

BARR



Seven County Metro Boundaries

Prioritization Score

24

7

Recharge Protection and Enhancement Area Priority Classification

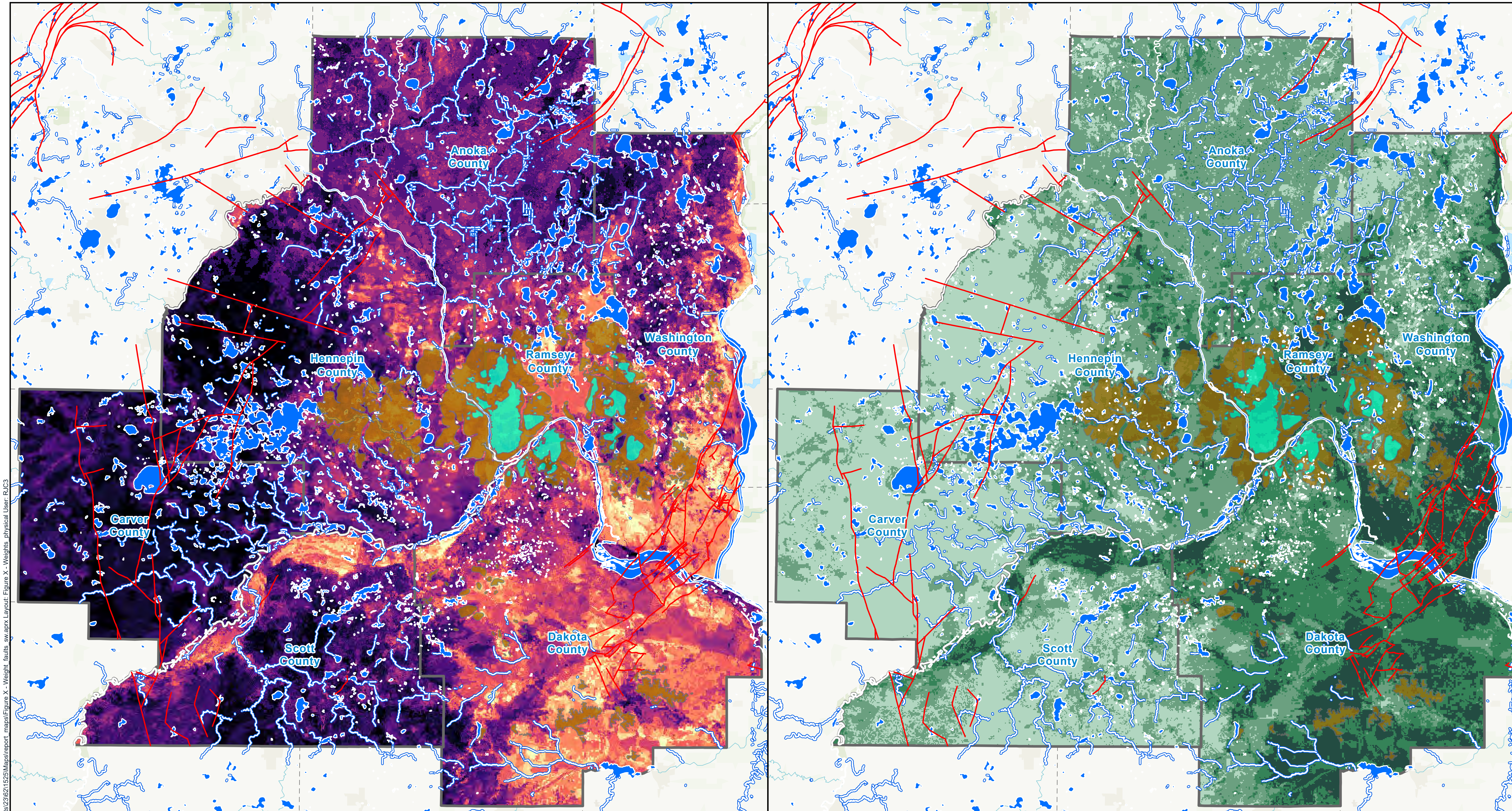
- Very low (7)
- Low (8 - 10)
- Moderate (11 - 13)
- High (14 - 16)
- Very high (>16)

Prioritization Score (left) and Recharge Protection and Enhancement Area Priority Classification (right)

Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota

FIGURE 8

BARR



Seven County Metro Boundaries
Faults
Perennial Streams
Waterbodies

Confining Units
Decorah Shale
Platteville Formation and Glenwood Formation

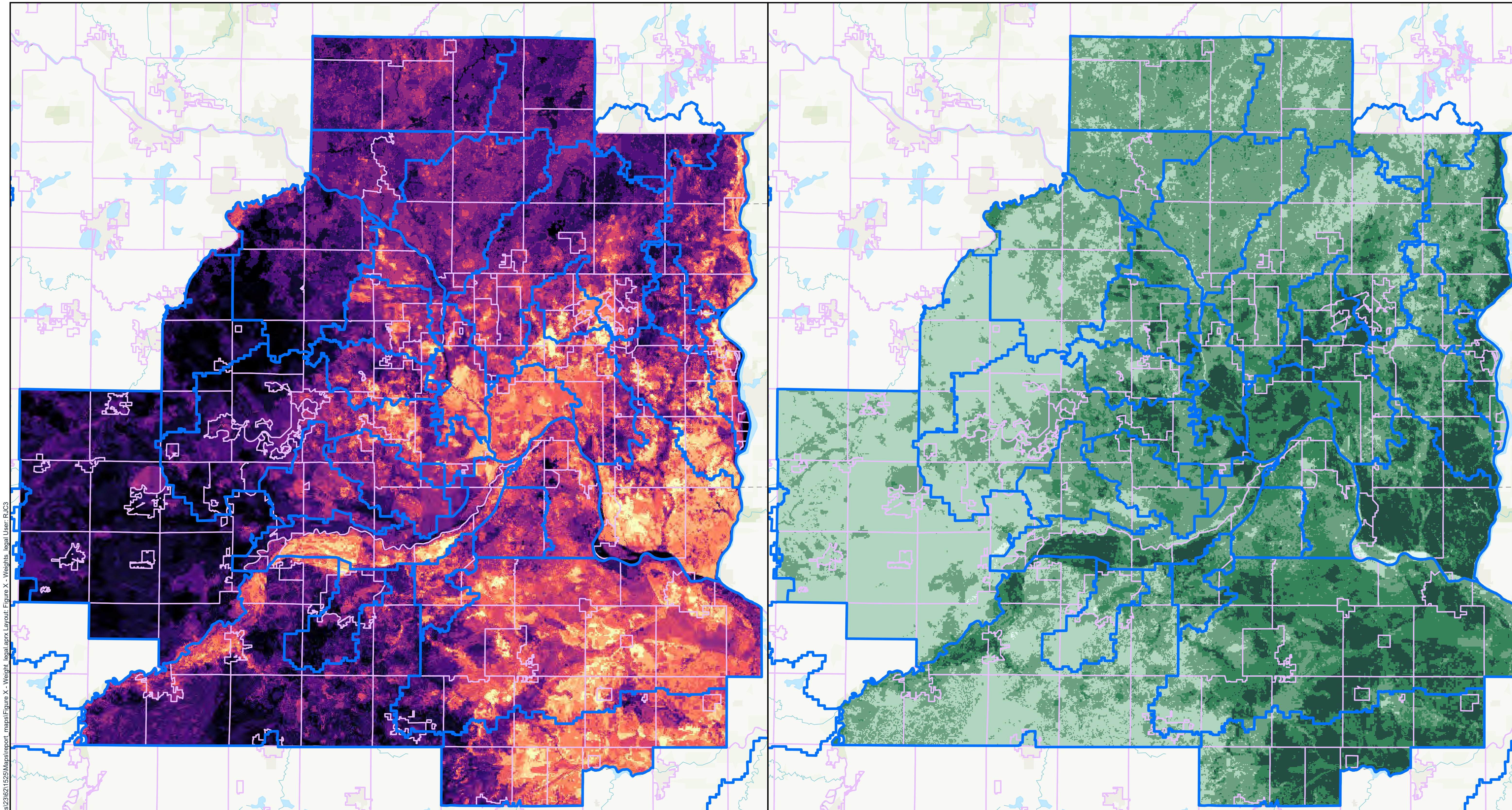
Prioritization Score
24
7

<u>Data Sources:</u>
Minnesota Department of Natural Resources. 2024. Minnesota Hydrography Dataset. Minnesota Geospatial Commons. 2024.
Mossler, John H. 2013. M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University Digital Conservancy, https://hdl.handle.net/11299/154925. 2013.

Recharge Protection and Enhancement Area Priority Classification
Very low (7)
Low (8 - 10)
Moderate (11 - 13)
High (14 - 16)
Very high (>16)

Prioritization Score (left) and Recharge Protection and Enhancement Area Priority Classification (right) - Physical Features
Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota
FIGURE 9

BARR



Municipal and Township Boundaries

Watershed Management Districts and Organizations

Prioritization Score

24

7

Data Sources:

Minnesota Department of Transportation and Minnesota Geospatial Information Office. 2024. City, Township, and Unorganized Territory in Minnesota. 2024. Natural Resources Research Institute. 2024. Minnesota Natural Resource Atlas. Watershed Management Districts and Organizations. 2024.

Recharge Protection and Enhancement Area Priority Classification

- Very low (7)
- Low (8 - 10)
- Moderate (11 - 13)
- High (14 - 16)
- Very high (>16)

Prioritization Score (left) and Recharge Protection and Enhancement Area Priority Classification (right) - Legal Boundaries

Identifying Priority Areas for Recharge Protection and Enhancement Activities in the Twin Cities Metropolitan Region, Minnesota

FIGURE 10

Attachment A - Distribution of Recharge Protection and Enhancement Area Priority Classification for Municipal and Civil Township Boundaries

Identifying Priority Areas for Recharge Protection and Enhancement Activities

Name	Area Type	Very Low	Low	Moderate	High	Very High
Afton	CITY	0.0%	2.6%	10.4%	25.1%	61.9%
Andover	CITY	0.0%	10.0%	84.7%	5.2%	0.0%
Anoka	CITY	0.0%	6.6%	87.1%	6.2%	0.1%
Apple Valley	CITY	0.0%	0.1%	14.7%	49.5%	35.6%
Arden Hills	CITY	0.0%	1.2%	58.2%	37.2%	3.4%
Bayport	CITY	0.0%	0.8%	21.4%	42.5%	35.3%
Baytown	TOWNSHIP	0.1%	7.4%	34.1%	35.4%	23.1%
Belle Plaine	TOWNSHIP	0.0%	60.7%	37.8%	1.5%	0.0%
Belle Plaine	CITY	0.0%	7.0%	65.2%	27.5%	0.2%
Benton	TOWNSHIP	0.0%	97.9%	2.1%	0.0%	0.0%
Bethel	CITY	0.0%	1.6%	73.9%	24.5%	0.0%
Birchwood Village	CITY	0.0%	0.0%	12.0%	59.7%	28.3%
Blaine	CITY	0.0%	9.7%	83.8%	6.4%	0.1%
Blaine	CITY	0.0%	0.0%	73.1%	26.9%	0.0%
Blakeley	TOWNSHIP	0.0%	38.7%	52.1%	8.7%	0.4%
Bloomington	CITY	0.0%	15.5%	70.1%	14.1%	0.3%
Brooklyn Center	CITY	0.0%	1.7%	55.1%	39.4%	3.8%
Brooklyn Park	CITY	0.0%	3.8%	53.4%	36.3%	6.5%
Burnsville	CITY	0.0%	1.9%	32.7%	40.3%	25.1%
Camden	TOWNSHIP	0.0%	87.3%	12.7%	0.0%	0.0%
Carver	CITY	2.5%	86.8%	10.4%	0.3%	0.0%
Castle Rock	TOWNSHIP	0.0%	0.8%	19.3%	30.8%	49.2%
Cedar Lake	TOWNSHIP	0.0%	61.0%	35.8%	3.3%	0.0%
Centerville	CITY	0.0%	13.4%	72.9%	13.7%	0.0%
Champlin	CITY	0.0%	6.5%	69.6%	18.6%	5.2%
Chanhassen	CITY	0.0%	13.3%	53.8%	32.9%	0.0%
Chanhassen	CITY	0.0%	47.8%	46.0%	6.2%	0.0%
Chaska	CITY	3.6%	82.4%	12.5%	1.4%	0.0%
Circle Pines	CITY	0.0%	1.3%	76.4%	21.6%	0.7%
Coates	CITY	0.0%	0.0%	11.1%	70.3%	18.6%
Cologne	CITY	0.0%	100.0%	0.0%	0.0%	0.0%
Columbia Heights	CITY	0.0%	7.1%	54.9%	32.5%	5.5%
Columbus	CITY	0.0%	16.9%	79.7%	3.4%	0.0%

Name	Area Type	Very Low	Low	Moderate	High	Very High
Coon Rapids	CITY	0.0%	8.9%	84.4%	6.7%	0.0%
Corcoran	CITY	0.0%	77.6%	22.3%	0.0%	0.0%
Cottage Grove	CITY	5.7%	4.4%	9.6%	22.1%	58.2%
Credit River	CITY	0.0%	36.2%	54.5%	8.8%	0.5%
Crystal	CITY	0.0%	3.9%	53.3%	25.5%	17.2%
Dahlgren	TOWNSHIP	0.5%	81.5%	17.9%	0.1%	0.0%
Dayton	CITY	0.0%	38.6%	60.1%	1.3%	0.0%
Deephaven	CITY	0.0%	11.8%	77.8%	10.2%	0.2%
Dellwood	CITY	0.0%	4.2%	71.0%	23.8%	1.0%
Denmark	TOWNSHIP	0.1%	3.7%	5.4%	23.2%	67.6%
Douglas	TOWNSHIP	0.0%	0.1%	7.5%	51.7%	40.7%
Eagan	CITY	0.0%	3.9%	52.6%	40.4%	3.2%
East Bethel	CITY	0.0%	16.4%	81.2%	2.4%	0.0%
Eden Prairie	CITY	0.0%	25.1%	60.2%	13.8%	0.9%
Edina	CITY	0.0%	1.3%	54.2%	36.8%	7.7%
Elko New Market	CITY	0.0%	66.3%	32.0%	1.7%	0.0%
Empire	TOWNSHIP	0.0%	0.8%	20.9%	59.3%	19.0%
Eureka	TOWNSHIP	0.0%	17.5%	32.8%	34.5%	15.2%
Excelsior	CITY	0.0%	71.3%	28.7%	0.0%	0.0%
Falcon Heights	CITY	0.0%	3.8%	28.0%	61.5%	6.7%
Farmington	CITY	0.0%	1.2%	19.6%	64.0%	15.2%
Forest Lake	CITY	0.0%	45.9%	51.8%	2.2%	0.0%
Fort Snelling	UNORGANIZED TERRITORY	0.0%	0.1%	41.6%	24.3%	34.0%
Fridley	CITY	0.0%	6.4%	53.1%	35.7%	4.8%
Gem Lake	CITY	0.0%	0.0%	69.2%	24.6%	6.2%
Golden Valley	CITY	0.0%	13.5%	49.1%	25.5%	11.9%
Grant	CITY	0.0%	23.4%	59.3%	15.4%	1.9%
Greenfield	CITY	0.9%	90.7%	7.8%	0.5%	0.0%
Greenvale	TOWNSHIP	0.0%	20.1%	57.5%	17.2%	5.2%
Greenwood	CITY	0.0%	26.8%	73.2%	0.0%	0.0%
Grey Cloud Island	TOWNSHIP	5.1%	19.0%	15.7%	13.2%	47.0%
Ham Lake	CITY	0.0%	4.2%	89.5%	6.2%	0.1%
Hamburg	CITY	0.0%	93.2%	6.8%	0.0%	0.0%
Hampton	TOWNSHIP	0.0%	1.8%	15.0%	45.7%	37.5%
Hampton	CITY	0.0%	0.0%	6.8%	31.5%	61.7%
Hancock	TOWNSHIP	0.0%	99.5%	0.5%	0.0%	0.0%

Name	Area Type	Very Low	Low	Moderate	High	Very High
Hanover	CITY	0.0%	67.1%	26.0%	6.6%	0.3%
Hastings	CITY	0.0%	59.4%	30.1%	9.8%	0.6%
Hastings	CITY	0.0%	0.4%	13.2%	31.4%	55.0%
Helena	TOWNSHIP	0.0%	77.3%	21.8%	1.0%	0.0%
Hilltop	CITY	0.0%	11.7%	88.3%	0.0%	0.0%
Hollywood	TOWNSHIP	0.0%	79.4%	20.6%	0.0%	0.0%
Hopkins	CITY	0.0%	0.5%	8.3%	75.2%	16.1%
Hugo	CITY	0.0%	20.7%	52.6%	23.0%	3.7%
Independence	CITY	0.0%	94.5%	5.5%	0.0%	0.0%
Inver Grove Heights	CITY	0.0%	3.7%	42.5%	51.4%	2.4%
Jackson	TOWNSHIP	0.0%	27.7%	53.6%	13.5%	5.2%
Jordan	CITY	0.0%	20.9%	17.3%	46.5%	15.2%
Lake Elmo	CITY	0.0%	3.6%	43.7%	38.2%	14.5%
Lake Saint Croix Beach	CITY	0.0%	38.0%	10.5%	50.8%	0.6%
Lakeland	CITY	0.0%	19.0%	24.5%	52.5%	3.9%
Lakeland Shores	CITY	0.0%	42.7%	28.2%	29.0%	0.0%
Laketown	TOWNSHIP	0.0%	86.0%	13.5%	0.5%	0.0%
Lakeville	CITY	0.0%	15.8%	42.8%	33.2%	8.1%
Landfall	CITY	0.0%	0.0%	31.3%	66.3%	2.5%
Lauderdale	CITY	0.0%	2.3%	79.2%	18.5%	0.0%
Lexington	CITY	0.0%	0.0%	95.1%	4.9%	0.0%
Lilydale	CITY	0.0%	3.5%	26.6%	54.9%	15.0%
Lino Lakes	CITY	0.0%	24.1%	68.4%	7.4%	0.1%
Linwood	TOWNSHIP	0.0%	26.7%	71.8%	1.5%	0.0%
Little Canada	CITY	0.0%	0.0%	10.5%	43.6%	45.8%
Long Lake	CITY	0.0%	81.1%	18.9%	0.0%	0.0%
Loretto	CITY	0.0%	98.6%	1.4%	0.0%	0.0%
Louisville	TOWNSHIP	0.0%	21.2%	44.0%	20.4%	14.4%
Mahtomedi	CITY	0.0%	1.5%	43.3%	43.1%	12.1%
Maple Grove	CITY	0.0%	32.8%	56.4%	8.7%	2.1%
Maple Plain	CITY	0.0%	97.7%	2.3%	0.0%	0.0%
Maplewood	CITY	0.0%	2.4%	23.8%	45.8%	28.0%
Marine on Saint Croix	CITY	0.0%	0.1%	15.1%	43.1%	41.6%
Marshan	TOWNSHIP	0.0%	0.0%	6.3%	57.1%	36.6%
May	TOWNSHIP	0.0%	10.0%	54.4%	26.0%	9.6%
Mayer	CITY	0.0%	82.2%	17.8%	0.0%	0.0%
Medicine Lake	CITY	0.0%	14.8%	61.0%	23.6%	0.5%

Name	Area Type	Very Low	Low	Moderate	High	Very High
Medina	CITY	0.0%	98.9%	1.1%	0.0%	0.0%
Mendota	CITY	0.0%	0.0%	29.8%	55.3%	14.9%
Mendota Heights	CITY	0.0%	4.1%	31.2%	56.4%	8.2%
Miesville	CITY	0.0%	0.0%	0.9%	62.6%	36.5%
Minneapolis	CITY	0.0%	1.3%	35.2%	34.3%	29.3%
Minnetonka	CITY	0.0%	1.8%	65.9%	29.0%	3.4%
Minnetonka Beach	CITY	0.0%	79.1%	20.3%	0.6%	0.0%
Minnetrista	CITY	0.0%	67.3%	32.5%	0.2%	0.0%
Mound	CITY	0.0%	52.8%	44.3%	2.9%	0.0%
Mounds View	CITY	0.0%	0.0%	59.9%	38.8%	1.3%
New Brighton	CITY	0.0%	0.0%	31.5%	58.6%	9.9%
New Germany	CITY	0.0%	89.2%	10.8%	0.0%	0.0%
New Hope	CITY	0.0%	14.5%	80.1%	5.4%	0.0%
New Market	TOWNSHIP	0.0%	58.3%	37.8%	3.8%	0.1%
New Prague	CITY	0.0%	96.7%	3.3%	0.0%	0.0%
New Trier	CITY	0.0%	0.0%	41.2%	53.6%	5.2%
Newport	CITY	0.7%	2.8%	15.2%	24.3%	57.0%
Nininger	TOWNSHIP	0.0%	5.9%	35.3%	48.1%	10.8%
North Oaks	CITY	0.0%	0.9%	48.5%	48.1%	2.5%
North Saint Paul	CITY	0.0%	0.0%	9.8%	58.4%	31.7%
Northfield	CITY	0.0%	28.3%	48.6%	19.8%	3.3%
Norwood Young America	CITY	0.0%	87.9%	12.1%	0.0%	0.0%
Nowthen	CITY	0.0%	19.8%	77.9%	2.3%	0.0%
Oak Grove	CITY	0.0%	10.0%	79.2%	10.6%	0.1%
Oak Park Heights	CITY	0.1%	5.6%	33.8%	27.0%	33.6%
Oakdale	CITY	0.0%	1.6%	58.8%	30.8%	8.8%
Orono	CITY	0.0%	69.0%	30.8%	0.1%	0.0%
Osseo	CITY	0.0%	0.0%	60.2%	39.0%	0.8%
Pine Springs	CITY	0.0%	17.5%	71.2%	10.0%	1.4%
Plymouth	CITY	0.0%	39.0%	50.0%	9.2%	1.8%
Prior Lake	CITY	0.9%	31.5%	50.6%	16.2%	0.8%
Ramsey	CITY	0.0%	13.3%	82.3%	4.1%	0.3%
Randolph	CITY	0.0%	0.0%	1.1%	32.9%	66.0%
Randolph	TOWNSHIP	0.0%	0.0%	0.0%	30.9%	69.1%
Ravenna	TOWNSHIP	0.0%	2.9%	33.8%	55.4%	8.0%
Richfield	CITY	0.0%	0.1%	60.5%	34.6%	4.8%
Robbinsdale	CITY	0.0%	7.5%	56.8%	23.0%	12.7%

Name	Area Type	Very Low	Low	Moderate	High	Very High
Rockford	CITY	2.6%	90.5%	6.9%	0.0%	0.0%
Rogers	CITY	0.0%	51.3%	36.6%	11.4%	0.7%
Rosemount	CITY	0.0%	3.8%	10.9%	75.1%	10.2%
Roseville	CITY	0.0%	0.0%	15.8%	53.5%	30.6%
Saint Anthony	CITY	0.0%	0.0%	9.5%	69.6%	20.8%
Saint Anthony	CITY	0.0%	0.0%	70.3%	27.1%	2.5%
Saint Bonifacius	CITY	0.0%	42.6%	48.6%	8.8%	0.0%
Saint Francis	CITY	0.0%	20.5%	67.3%	11.9%	0.3%
Saint Lawrence	TOWNSHIP	0.0%	10.1%	29.8%	44.9%	15.3%
Saint Louis Park	CITY	0.0%	0.0%	7.3%	46.4%	46.2%
Saint Marys Point	CITY	0.0%	0.2%	32.5%	67.2%	0.0%
Saint Paul	CITY	0.0%	0.8%	11.2%	62.2%	25.8%
Saint Paul Park	CITY	2.9%	7.4%	5.2%	6.1%	78.4%
San Francisco	TOWNSHIP	0.0%	65.5%	26.7%	7.6%	0.1%
Sand Creek	TOWNSHIP	0.5%	52.9%	36.2%	9.5%	1.0%
Savage	CITY	0.0%	15.2%	46.8%	27.9%	10.1%
Scandia	CITY	0.0%	17.6%	59.3%	15.9%	7.3%
Sciota	TOWNSHIP	0.0%	0.1%	3.2%	31.1%	65.7%
Shakopee	CITY	0.0%	12.2%	20.5%	26.2%	41.1%
Shoreview	CITY	0.0%	0.9%	43.4%	45.4%	10.4%
Shorewood	CITY	0.0%	100.0%	0.0%	0.0%	0.0%
Shorewood	CITY	0.0%	39.0%	60.0%	0.9%	0.0%
South Saint Paul	CITY	0.0%	4.4%	15.6%	45.8%	34.2%
Spring Lake	TOWNSHIP	0.0%	67.7%	30.6%	1.8%	0.0%
Spring Lake Park	CITY	0.0%	0.0%	69.7%	30.2%	0.1%
Spring Lake Park	CITY	0.0%	0.0%	34.0%	66.0%	0.0%
Spring Park	CITY	0.0%	69.3%	30.0%	0.7%	0.0%
Stillwater	TOWNSHIP	0.0%	4.8%	44.5%	29.3%	21.5%
Stillwater	CITY	0.0%	3.7%	42.9%	32.5%	20.9%
Sunfish Lake	CITY	0.0%	24.3%	59.8%	15.9%	0.0%
Tonka Bay	CITY	0.0%	80.3%	19.6%	0.1%	0.0%
Vadnais Heights	CITY	0.0%	0.0%	19.8%	41.0%	39.2%
Vermillion	CITY	0.0%	0.0%	0.3%	73.2%	26.6%
Vermillion	TOWNSHIP	0.0%	0.0%	2.3%	44.2%	53.5%
Victoria	CITY	0.0%	79.3%	20.1%	0.6%	0.0%
Waconia	TOWNSHIP	0.0%	82.1%	17.4%	0.5%	0.0%
Waconia	CITY	0.0%	87.4%	12.4%	0.1%	0.0%

Name	Area Type	Very Low	Low	Moderate	High	Very High
Waterford	TOWNSHIP	0.0%	0.0%	3.8%	33.2%	63.0%
Watertown	CITY	0.0%	69.1%	30.0%	0.9%	0.0%
Watertown	TOWNSHIP	0.0%	85.8%	14.2%	0.0%	0.0%
Wayzata	CITY	0.0%	4.3%	76.8%	18.7%	0.2%
West Lakeland	TOWNSHIP	0.0%	1.5%	16.1%	37.3%	45.1%
West Saint Paul	CITY	0.0%	15.3%	13.5%	68.8%	2.4%
White Bear	TOWNSHIP	0.0%	1.2%	29.6%	40.0%	29.2%
White Bear Lake	CITY	0.0%	0.0%	0.0%	44.7%	55.3%
White Bear Lake	CITY	0.0%	0.0%	4.6%	24.8%	70.6%
Willernie	CITY	0.0%	0.0%	96.9%	3.1%	0.0%
Woodbury	CITY	0.0%	2.7%	31.8%	34.1%	31.5%
Woodland	CITY	0.0%	0.0%	45.7%	54.3%	0.0%
Young America	TOWNSHIP	0.0%	77.1%	22.9%	0.0%	0.0%
White Bear Lake	CITY	0.0%	0.0%	0.0%	44.7%	55.3%
White Bear Lake	CITY	0.0%	0.0%	6.0%	33.1%	61.0%
Willernie	CITY	0.0%	0.0%	96.9%	3.1%	0.0%
Woodbury	CITY	0.0%	2.7%	31.8%	34.1%	31.5%
Woodland	CITY	0.0%	0.0%	45.7%	54.3%	0.0%
Wyoming	CITY	0.0%	0.0%	100.0%	0.0%	0.0%
Young America	TOWNSHIP	0.0%	77.1%	22.9%	0.0%	0.0%

Attachment B - Distribution of and Recharge Protection and Enhancement Area Priority Classification for Watershed Management Organizations

Identifying Priority Areas for Recharge Protection and Enhancement Activities

Name	Very Low	Low	Moderate	High	Very High
Bassett Creek WMO	0.0%	19.7%	51.9%	21.6%	6.8%
Black Dog WMO	0.0%	5.0%	39.2%	41.6%	14.3%
Browns Creek WD	0.0%	19.7%	57.2%	19.6%	3.5%
Buffalo Creek WD	0.0%	84.7%	5.9%	0.0%	0.0%
Capitol Region WD	0.0%	0.0%	4.3%	59.3%	36.3%
Carnelian-Marine-St. Croix WD	0.0%	8.0%	52.7%	25.3%	13.8%
Carver County COU	0.3%	83.7%	15.2%	0.8%	0.0%
Comfort Lake Forest Lake WD	0.0%	27.8%	48.2%	4.0%	0.4%
Coon Creek WD	0.0%	8.3%	85.4%	6.2%	0.1%
Eagan-Inver Grove WMO	0.0%	4.0%	55.2%	38.8%	1.9%
Elm Creek WMO	0.0%	56.7%	39.6%	3.5%	0.2%
Lower Minnesota River WD	0.2%	15.4%	36.7%	23.1%	24.6%
Lower Mississippi River WMO	0.0%	5.2%	34.8%	53.7%	6.3%
Lower Rum River WMO	0.0%	10.3%	85.0%	4.5%	0.2%
Middle St. Croix WMO	0.0%	11.4%	21.3%	36.7%	30.1%
Minnehaha Creek WD	0.0%	46.4%	34.9%	12.4%	6.3%
Mississippi WMO	0.0%	2.1%	29.1%	38.6%	30.2%
Nine Mile Creek WD	0.0%	8.1%	63.5%	26.4%	2.0%
North Cannon River WMO	0.0%	6.3%	21.1%	35.0%	37.5%
Pioneer-Sarah Creek WMO	0.3%	90.5%	9.0%	0.2%	0.0%
Prior Lake-Spring Lake WD	0.4%	52.9%	36.7%	7.3%	2.7%
Ramsey-Washington Metro WD	0.0%	2.3%	26.7%	46.7%	24.3%
Rice Creek WD	0.0%	17.1%	56.7%	22.2%	4.0%
Richfield-Bloomington WMO	0.0%	0.1%	87.0%	10.9%	2.0%
Riley-Purgatory-Bluff Creek WD	0.0%	27.8%	57.8%	13.6%	0.8%
Scott COU	0.1%	48.6%	38.7%	9.5%	2.6%
Shingle Creek WMO	0.0%	10.3%	53.7%	26.9%	9.1%
South Washington WD	2.2%	3.8%	13.8%	24.7%	55.5%
Sunrise River WMO	0.0%	17.9%	79.5%	2.6%	0.0%
Upper Rum River WMO	0.0%	17.2%	75.9%	6.8%	0.1%
Vadnais Lake Area WMO	0.0%	0.8%	34.3%	38.0%	26.9%
Valley Branch WD	0.0%	4.6%	31.7%	31.5%	32.0%
Vermillion River COU	0.0%	6.8%	20.2%	47.7%	25.3%
West Mississippi WMO	0.0%	6.6%	54.8%	32.1%	6.5%

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