APPENDIX I – CLASSIFYING PREDOMINANT HYDROLOGIC INFLUENCE

The movement of water and pollutants within the plan boundary is complex, driven by the hydrogeology of the area which includes karst formations. Within some areas, a relatively small amount of time is require for surface water runoff to reach groundwater. Within other areas, most of the precipitation leaves the landscape as runoff, and enters a stream or river. In some cases, water moving downstream encounters a “stream sink” which reintroduces the water in the subsurface aquifer, contributing water to a spring.

In order to implement strategies that accomplish the intended measurable goals for surface and groundwater, methods were needed to classify locations with the plan area according to their predominant hydrologic influence. Areas ranging in size up to approximately 140 acres (i.e., catchments) within the plan area were classified as: 1) predominantly surface water; 2) predominately groundwater; or 3) both surface and groundwater hydrologic influence. This qualitative classification of catchments is intended to be useful for guiding implementation and as a tool to describe whether sediment and nutrients leaving the landscape reach primarily surface or groundwater and the probable resources where the benefits of implementing BMPs may be realized. This analysis was conducted using the best available public information.

Limited fiscal resources were available for the development of the method. Input from Mr. Jeffrey A. Green, Minnesota DNR, Rochester office, help frame some of the concepts and ideas for the classification method. Although imperfect, the classification method appears to provide reasonable results, based current springshed studies and dye tracing results. Because of the limitations, using the approach to quantify the estimate load reduction by resource were avoided. As research continues in this area, and our understanding of hydrogeology within the plan area grows, these methods should be revisited and improved where possible.

The remainder of this Appendix describes the methods and data used to classify catchments based upon the predominant hydrologic influence.

1.1 TIERED PROCESS FOR ESTIMATING PREDOMINANT HYDROLOGIC INFLUENCE

A sequential process was used to classify the predominant hydrologic influence of catchments within the plan boundary (**Figure 1**). Step 1 was used to establish an initial classification of the predominant hydrologic influence of each catchment based on specific factors and scientific evidence. Each subsequent step was then used to adjust the previous classification, based on additional specific factors and scientific evidence. The methods used for each of the steps in **Figure 1** are described below using an example from the South Fork of the Root River.

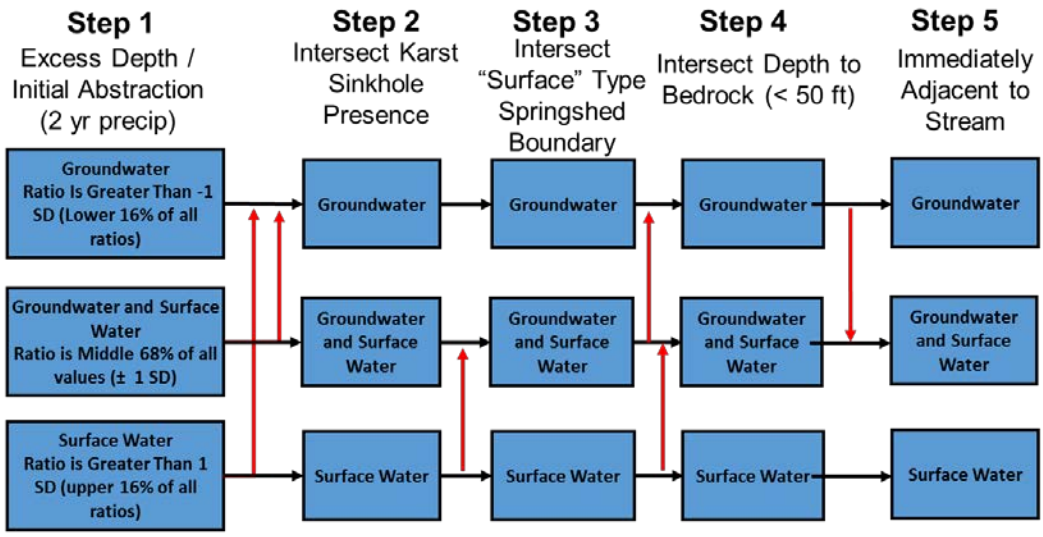


Figure 1. Tiered process for estimating the predominant hydrologic influence of catchments within the Root River plan boundary.

1.1.1 STEP 1 – CLASSIFY CATCHMENTS BASED RATIO OF EXCESS PRECIPITATION DEPTH AND INITIAL ABSTRACTION

Information on initial abstraction and excess depth for a 2-year, 24-hour precipitation event were extracted from outputs generated by the Prioritize, Targeted, and Measure Application (PTMApp) Desktop for catchments within the plan boundary. PTMApp Desktop uses the curve number method to estimate initial abstraction (i.e., infiltration potential) and excess precipitation depths (i.e., runoff potential) for different storm events. A ratio of the excess precipitation depth to the initial abstraction was then calculated for each catchment. A preliminary hydrologic influence was then assigned based upon the ratio of excess precipitation depth to initial abstraction as follows:

- < 1 standard deviation = Groundwater
- ± 1 standard deviation = Groundwater and Surface Water
- > 1 standard deviation = Surface Water

Figure 2 shows the results of Step 1 for the South Fork of the Root River.

1.1.2 STEP 2 – RECLASSIFY CATCHMENTS BASED ON PRESENCE OF KARST SINKHOLES

Karst Sinkholes from the Minnesota Department of Natural Resource's Karst database (available online at https://gisdata.mn.gov/dataset/geos-karst-feature-inventory-pts) were intersected with the catchment boundary data from Step 1 (see *section 1.1.1*). All catchments intersecting Karst features were adjusted or kept as a groundwater hydrologic influence (**Figure 3)**.

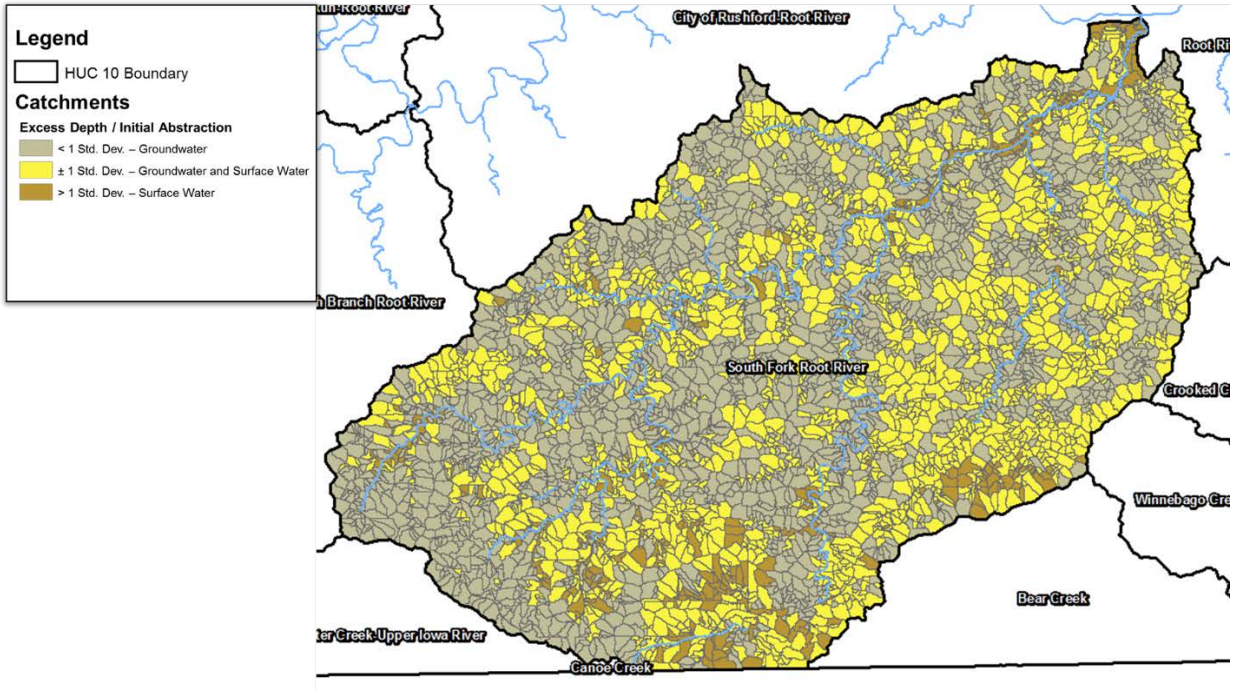


Figure 2. Ratio of excess precipitation depth (surface runoff) to initial abstraction (infiltration) based upon the curve number method used in PTMApp Desktop for the South Fork of the Root River.

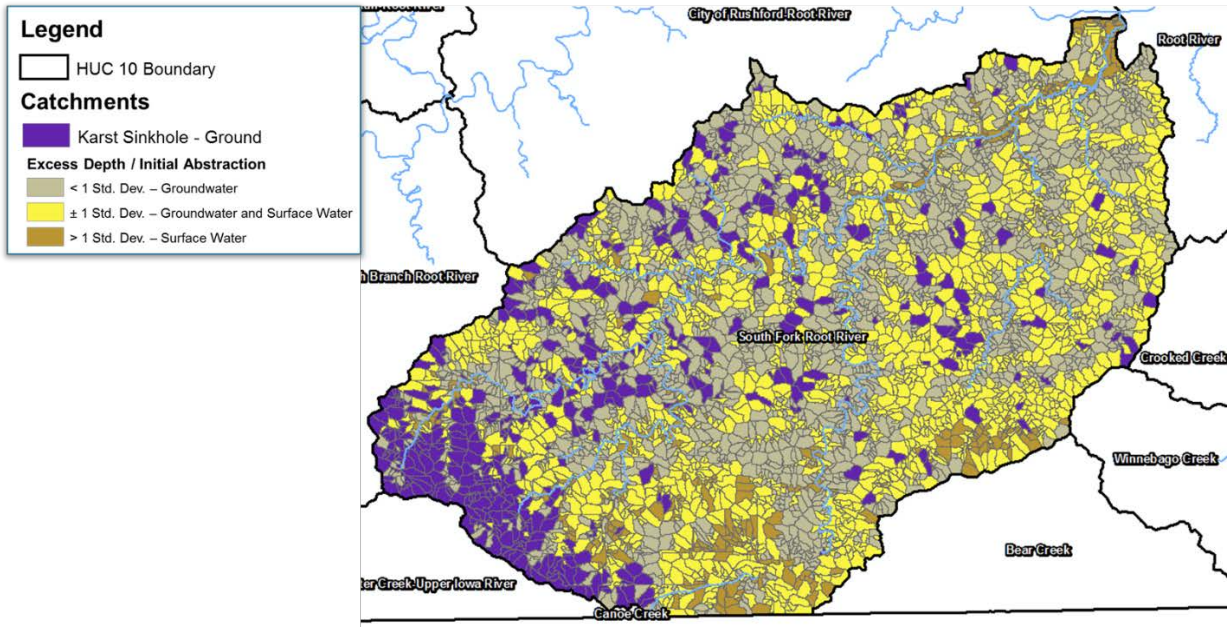


Figure 3. Reclassification of catchments within the South Fork of the Root River containing karst features (purple areas) that were assigned a groundwater hydrologic influence during Step 2.

1.1.3 STEP 3 – RECLASSIFY CATCHMENTS BASED ON PRESENCE OF SURFACE TYPE SPRINGSHEDS

The data from Step 2 (*see section 1.1.2*) was intersected with "Surface" type spring sheds from the Minnesota Department of Natural Resources (http://www.dnr.state.mn.us/waters/groundwater_section/mapping/springshed.html). Catchments classified as predominantly surface water influence at the end of Step 2 (*see section 1.1.2*) were reclassified as surface and groundwater influence (**Figure 4**) if interested by a surface type springshed.

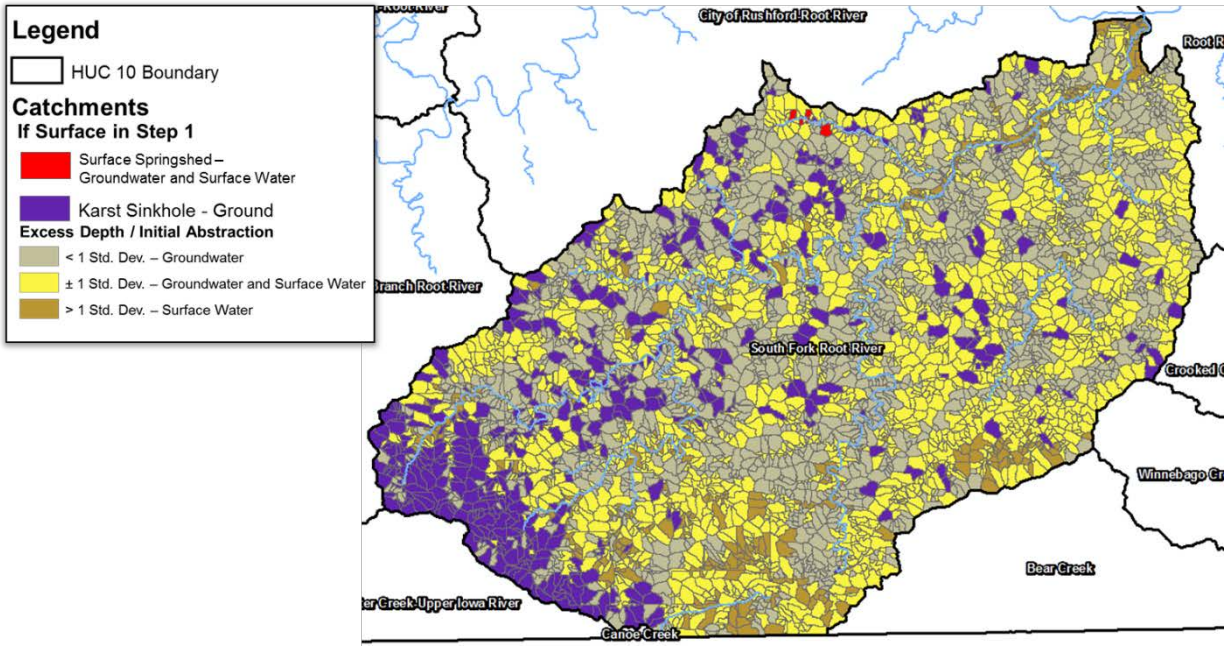


Figure 4. Catchments within the South Fork of the Root River that were reclassified as surface and groundwater influence (red areas) based upon intersection with "Surface" type springsheds.

1.1.4 STEP 4 – RECLASSIFY CATCHMENTS BASED ON DEPTH TO BEDROCK

Catchments that intersected areas with a less than 50 foot depth to bedrock were reclassified to groundwater influence or surface and groundwater influence if they were classified as surface and groundwater influence or surface water influence in Step 3 (*see section 1.1.3*), respectively (**Figure 5**). The Minnesota Geological Survey Depth to Bedrock data was used to estimate the depth to bedrock for catchments (http://www.mngeo.state.mn.us/chouse/metadata/dpthbdrk.html).

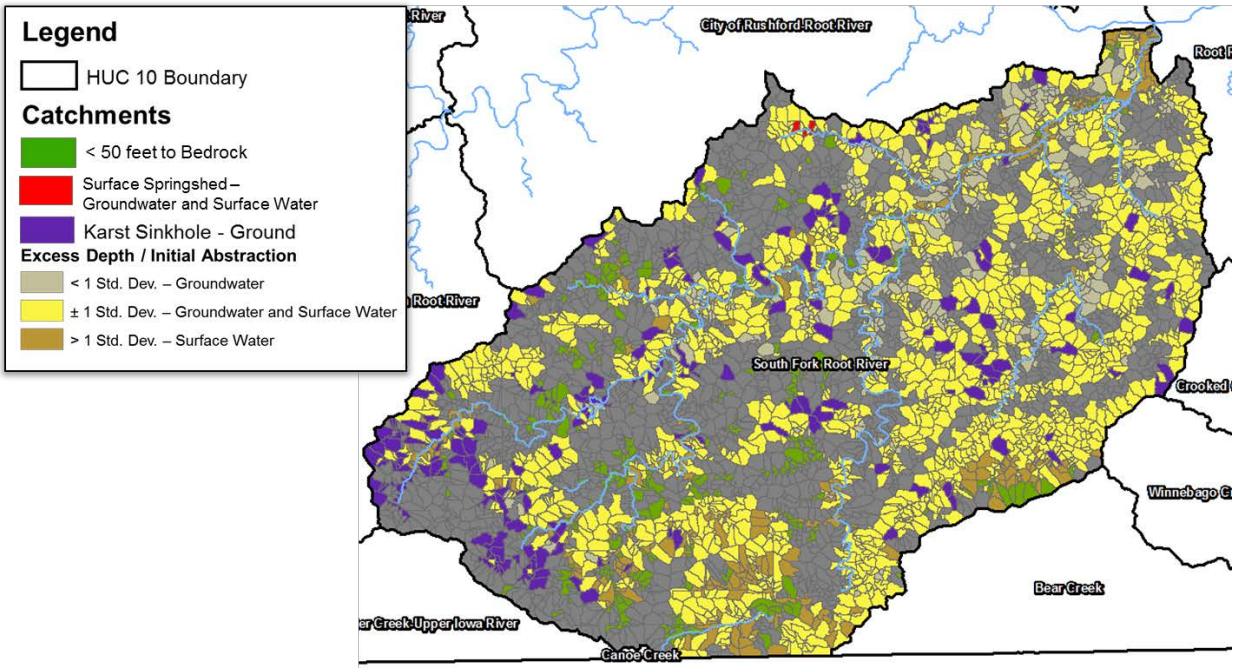


Figure 5. Catchments within the South Fork of the Root River that were reclassified (green areas) to groundwater influence or surface and groundwater influence initially classified as surface and groundwater influence or surface water influence in Step 4.

1.1.5 STEP 5 – RECLASSIFY CATCHMENTS BASED ON STREAM CHANNEL ADJACENCY

The final step was to reclassify catchments adjacent to streams as surface and groundwater influence (**Figure 6**) if they were classified as groundwater influence in Step 4 (*see section 1.1.4*). The National Hydrography Dataset (NHD) flowlines were used to designate streams (available online at http://nhd.usgs.gov/data.html).

1.2 SUMMARY OF THE RESULTS

This sequential process (see **Figure 1**) following testing using the South Fork of the Root River, was applied to the entire plan area (**Figure 7**). The results will enable practitioners to estimate where benefits will accrue (i.e. surface water, groundwater, or both) from implementing targeted projects and practices. We anticipate the classification will be used during the implementation process to qualitative assess pollutant sources and the potential benefits of BMPs. **Figure 8** shows the results of the predominant hydrologic influence classification superimposed on those areas with the greatest catchment total nitrogen yields (from PTMApp). **Figure 8** provides some guidance about whether these loads leaving the landscape reach groundwater, surface water or both surface and groundwater. **Figure 9** shows the results of the predominant hydrologic influence classification superimposed on those areas where the results from PTMApp suggest the feasibility of Best Management Practices. **Figure 9** provides some guidance about whether groundwater, surface water or both surface and groundwater will realize some benefit from placing a BMP at that location.

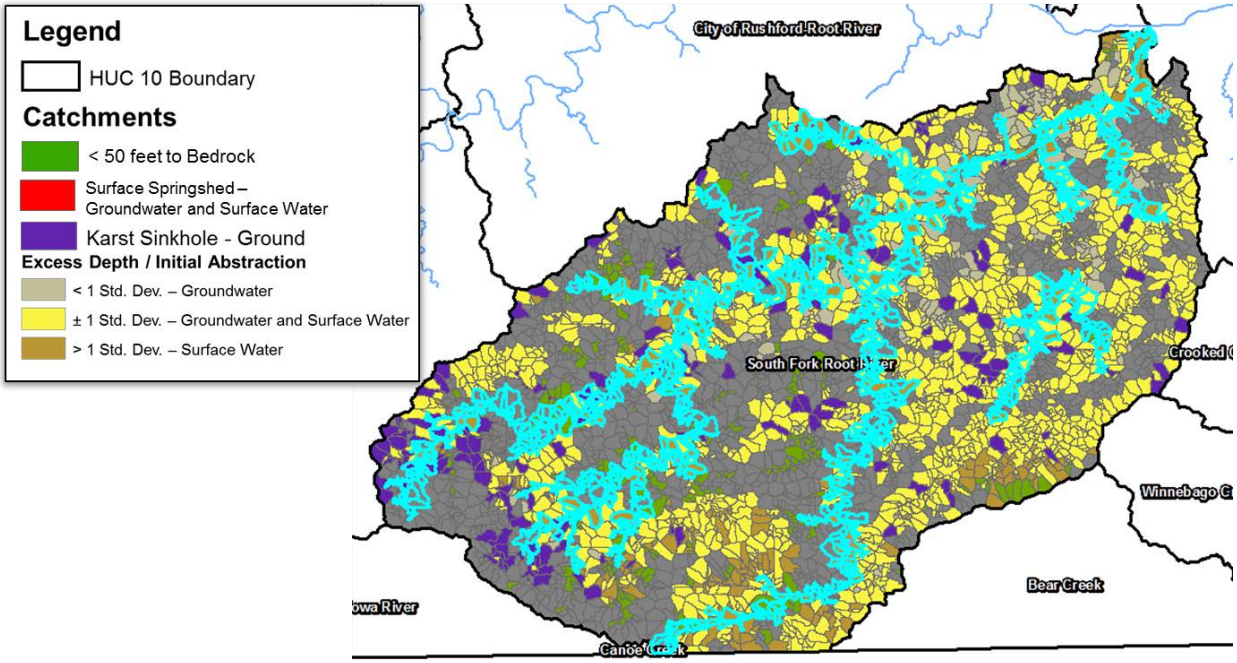


Figure 6. Groundwater predominate hydrologic influence catchments within the South Fork of the Root River that were reclassified (blue areas) to surface and groundwater influence during Step 5.

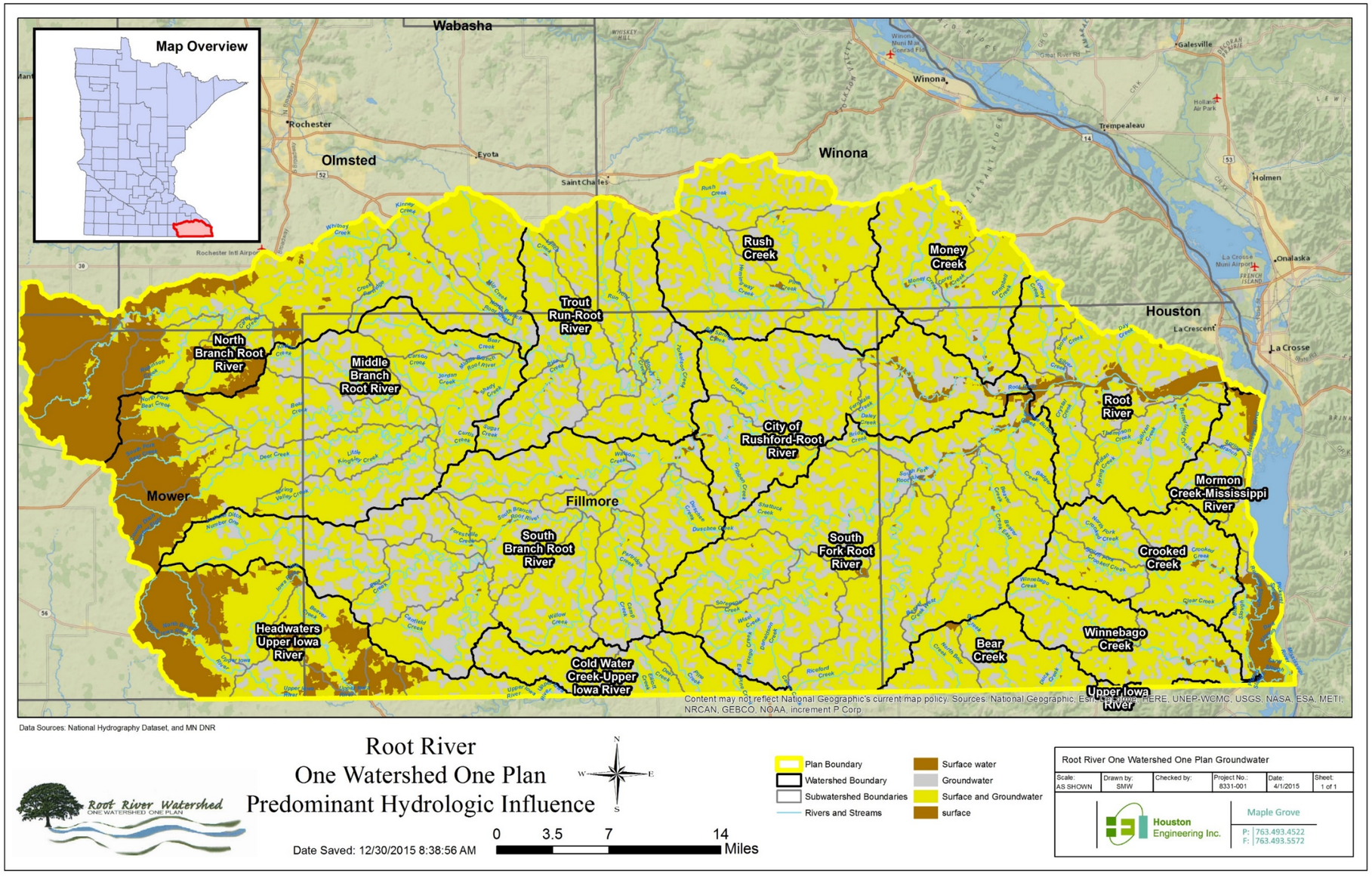
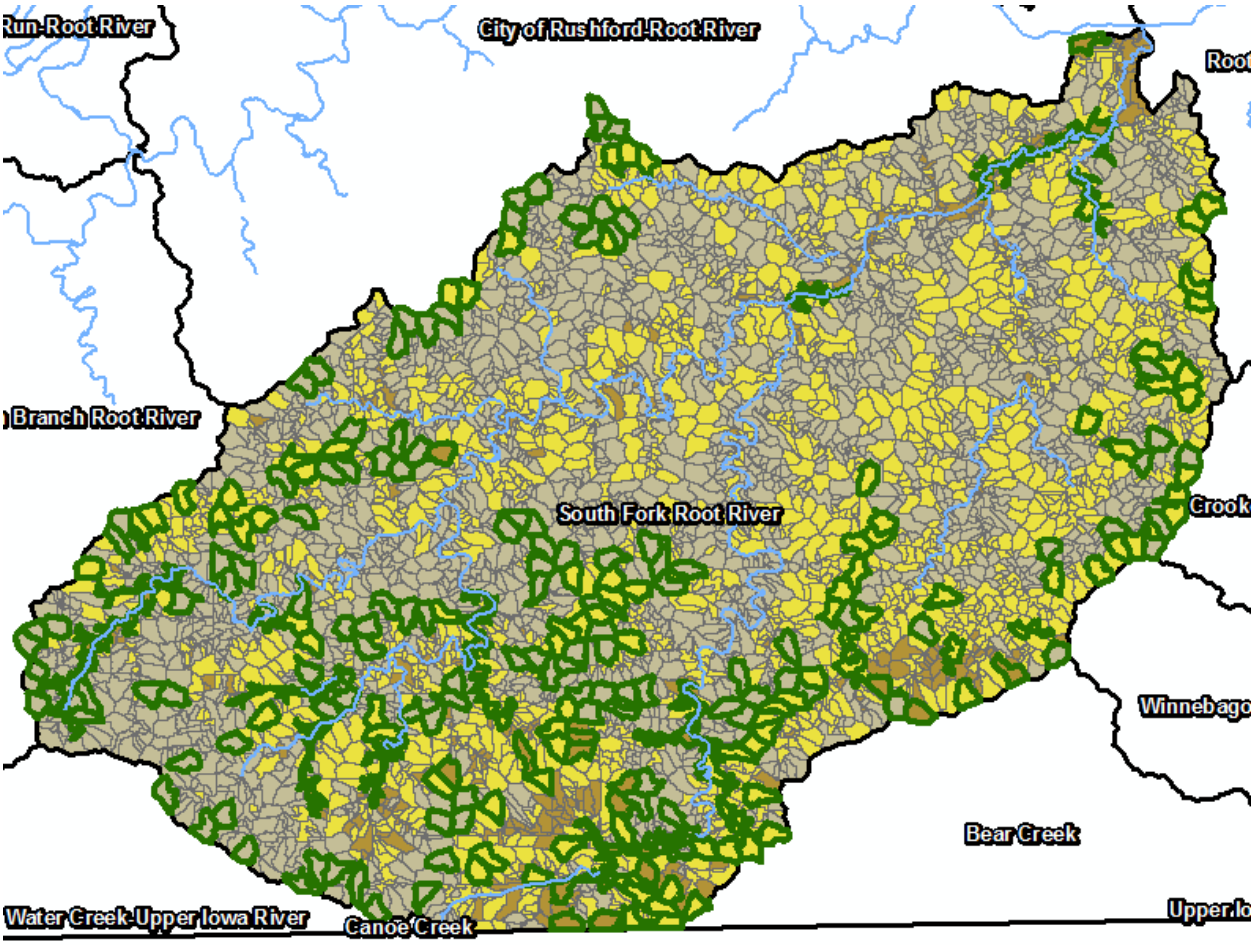


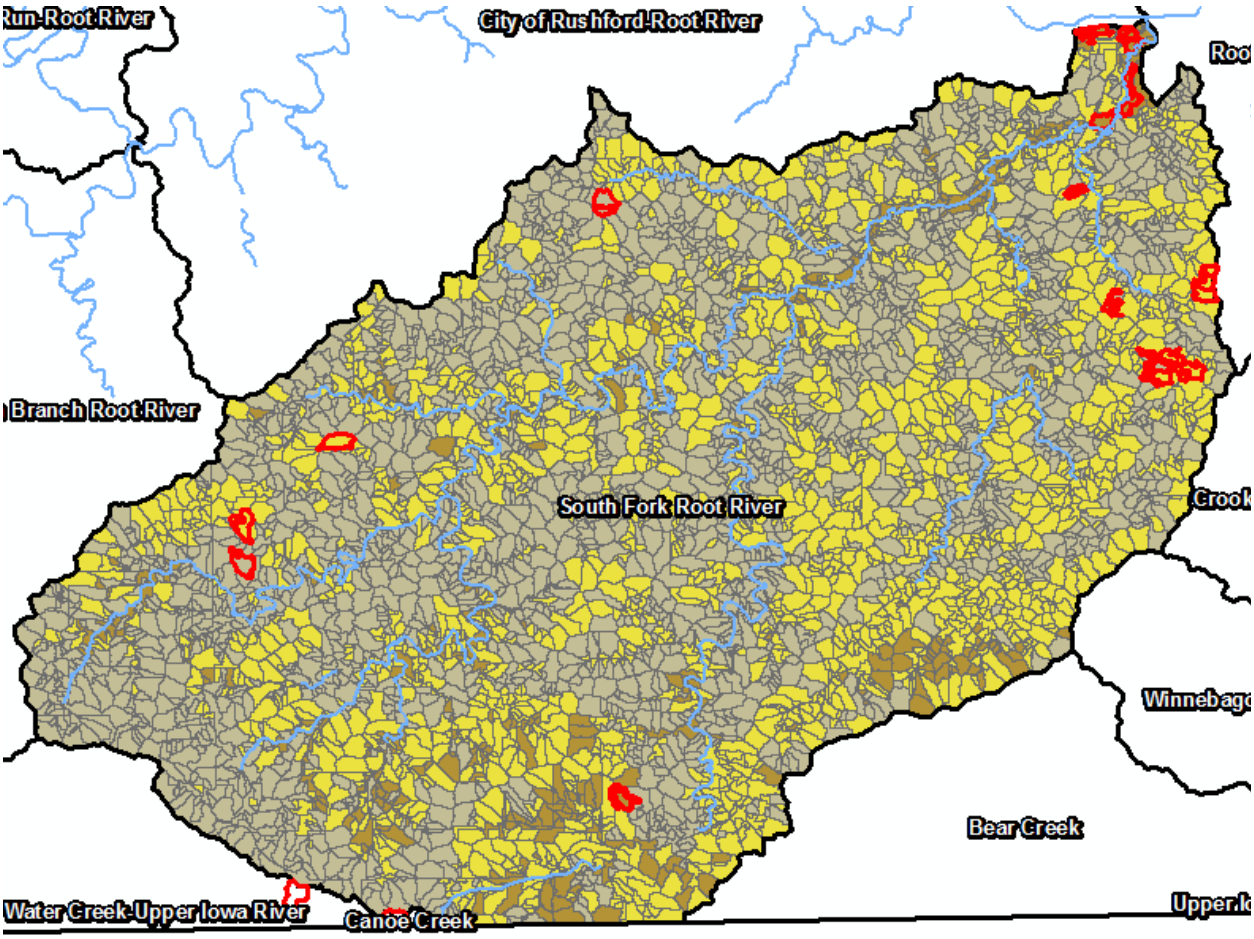
Figure 7. Predominant hydrologic influence classification for the plan area.



Predominant Hydrologic Influence Classification

- Groundwater
- Groundwater and Surface Water
- Surface Water
- TN to Catchment (highest 5%)

Figure 8. Illustration of the use of predominate hydrologic influence classification for evaluating total nitrogen sources. The catchments represented by green polygons are catchments within the upper 5% for their total nitrogen yield based on the prioritize, target and measure application. Those nitrogen from catchments with a predominate hydrologic influence of groundwater are most likely to affect drinking water supplies.



Predominant Hydrologic Influence Classification

- Groundwater
- Groundwater and Surface Water
- Surface Water
- Potential BMPs

Figure 9. Illustration of the use of predominate hydrologic influence classification for evaluating potential best management practice benefits. The catchments represented by the polygons are catchments where best management practices are feasible, based on the prioritize, target and measure application. Those with a predominate hydrologic influence of groundwater are most likely to benefit drinking water supplies while those with a surface water classification are most likely to benefit streams and rivers.