Appendix G – SPARROW How-To Guide

Last Revised: March 2026

1.1 Introduction

The SPARROW (Spatially Referenced Regressions On Watershed Attributes) Model, created by the United States Geological Survey, provides estimates of phosphorus (P), nitrogen (N), and total suspended solids (TSS) transport between upstream and downstream waterbodies. One component of the model, delivery fraction, is used to calculate the delivery factor in trade ratios when pollutant reductions occur upstream from a credit user's location.

Why use delivery fractions?

Delivery fractions account for the mass of pollutant removed by natural attenuation processes within rivers, lakes, and reservoirs. By using delivery fractions in trade ratios, permittees ensure their trades offset a sufficient amount of pollutant required to protect water quality at the downstream reach or outfall.

SPARROW informational webpage (USGS): https://water.usgs.gov/nawqa/sparrow/#

1.2 SPARROW Basics

SPARROW is a catchment-based model. The land's surface is divided into watersheds, and all SPARROW values apply to the waterbodies contained within a given catchment. There are over 50,000 SPARROW catchments fully or partially within the borders of Wisconsin. Each one has a specific delivery fraction, calculated using regression equations from monitoring data.

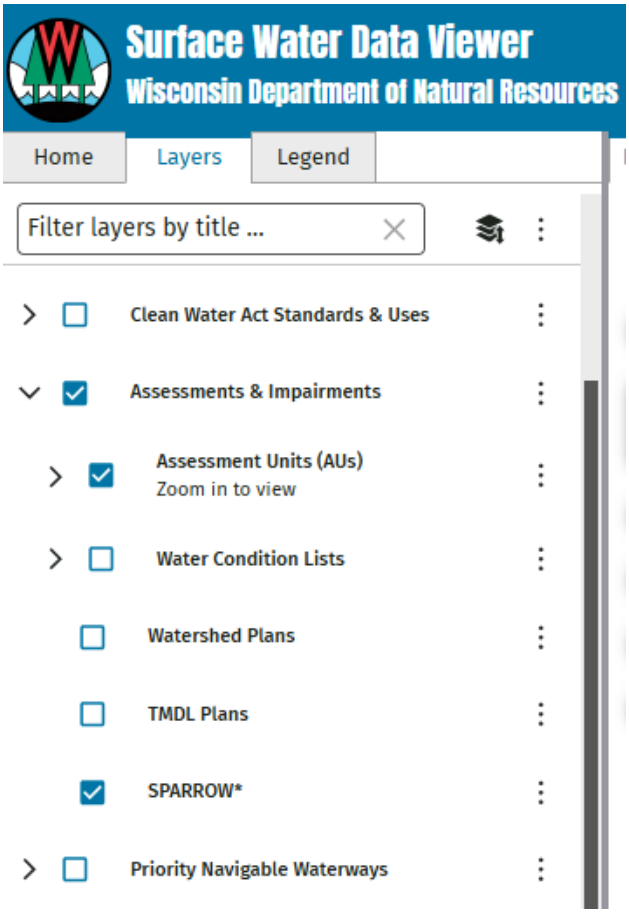
All delivery fractions are based upon downstream connectivity to a final target. In Wisconsin, downstream targets are either Lake Superior, Lake Michigan, or the Upper Mississippi River. When a credit user does not directly discharge to one of these targets, the relative difference between the credit user and credit generator watershed determines the delivery factor. Using specific delivery fractions for credit generator and credit user locations, as explained later, provides a value tailored to unique project locations.

2 Using SPARROW for your Water Quality Trading Project

SPARROW data can be accessed at two locations:

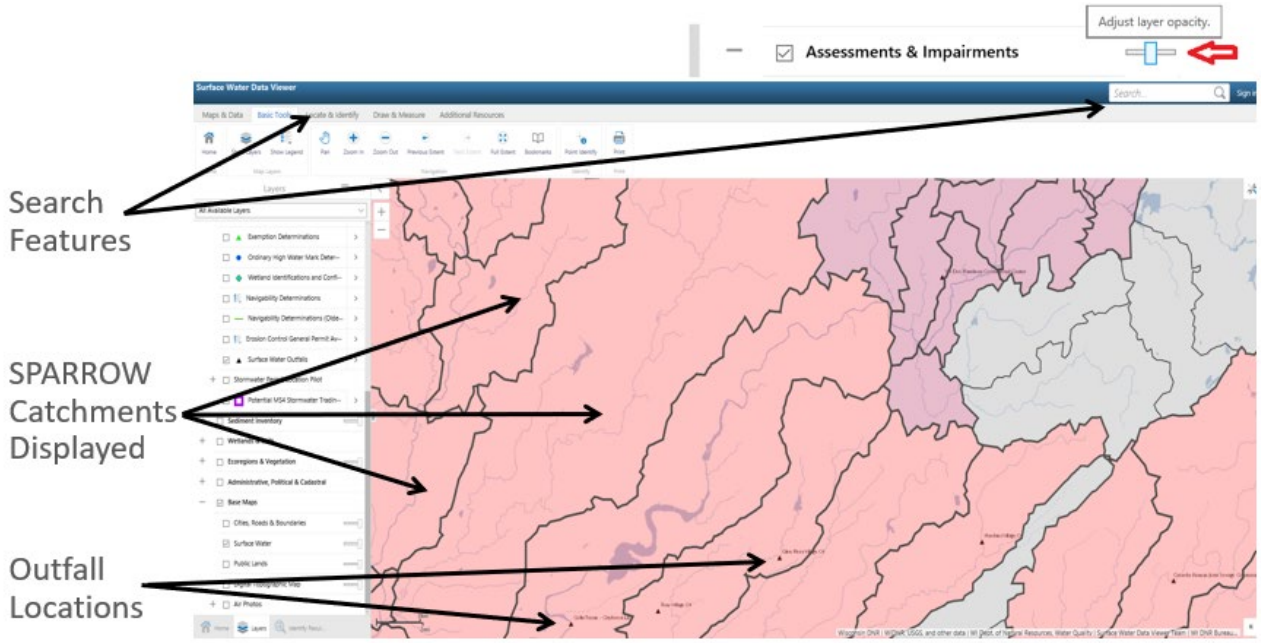
WDNR Surface Water Data Viewer: Quickly find your facility, credit generation location, and respective SPARROW delivery fractions at: WDNR Surface Water Viewer (https://dnrmaps.wi.gov/H5/?Viewer=SWDV)

Shapefile Download (for use with GIS software): Users with GIS capabilities may wish to import the SPARROW catchment shapefile, available at: SPARROW catchment shapefile (https://widnr.widen.net/s/z42lqfnj5z)

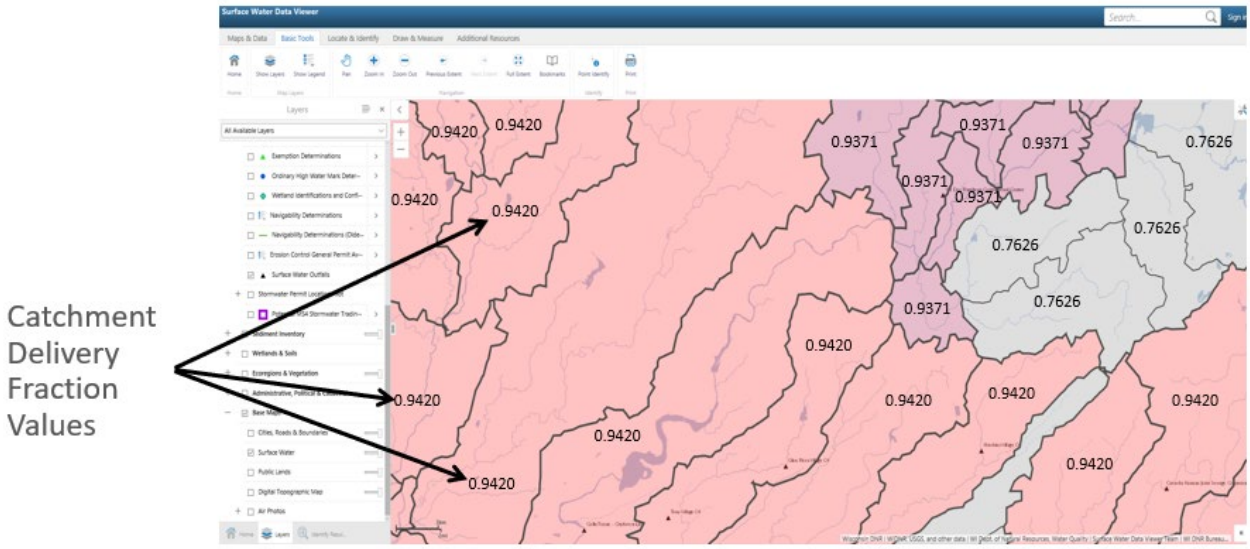


When using Surface Water Data Viewer, select the "Layers" tab. Scroll to and expand/select the "Assessments & Impairments" layer class by clicking on the arrow and checkbox. Select the "SPARROW" layer checkbox. The map view may need to be zoomed in before SPARROW catchments are visible. Surface Water Data Viewer has functions that aid locating WPDES facilities and other relevant features.

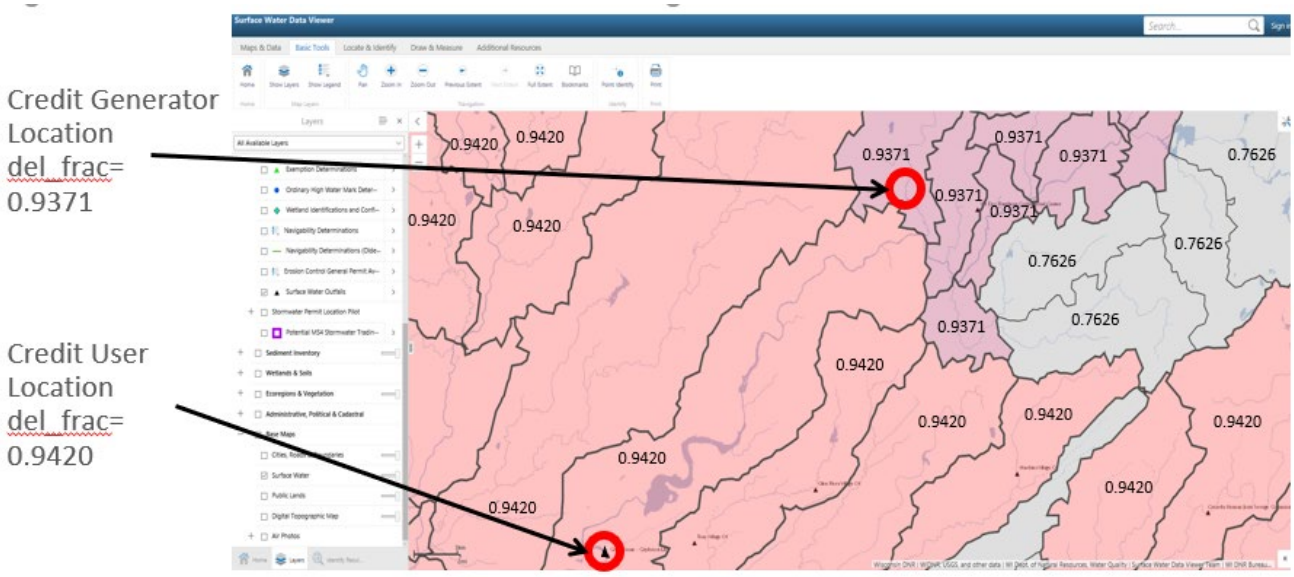
Once SPARROW catchments are displayed (either in Surface Water Data Viewer or other GIS program), navigate to the location where your credit generator(s) and credit user(s) are located.



Each SPARROW catchment has an associated delivery fraction, labeled on the Surface Water Data Viewer map. For users who imported the SPARROW layer into an alternative GIS, delivery fractions are found in field “del_frac”. Note the delivery fractions pertaining to the credit generator location and the credit user location.



The following example shows values derived for project locations circled in red:



Once delivery fraction values have been identified for the upstream and downstream locations, use them in the following equation:

$$Delivery\ Fraction = 1 - \frac{(user\ del\_frac - generator\ del\_frac)}{user\ del\_frac}$$

By using values derived for each catchment (0.9420 and 0.9371), delivery can be calculated using the equation:

$$Delivery\ Fraction = 1 - \frac{(0.9420 - 0.9371)}{0.9420} = 0.994$$

A delivery fraction of 0.994 means that 99.4% of pollutants (TSS, N, or P) entering waterways in the credit generator's catchment will be delivered to the credit user's catchment. Incorporating this fraction into the trade ratio ensures that natural attenuation of pollutants is accounted for, thereby protecting downstream water quality when trading. The delivery fraction must first be converted to a delivery factor, as shown on the next page.

To obtain the Delivery Factor (used in the trade ratio), use the following equation:

$$Delivery\ Factor = \frac{1}{Delivery\ Fraction} - 1$$

$$Delivery\ Factor = \frac{1}{0.994} - 1 = 0.006$$

$$Delivery\ Factor = 0.006$$

<u>Important points to remember:</u>

- Delivery fractions are tied to a specific catchment, encompassing all waterbodies in that catchment, regardless of stream order.
- Delivery factors calculated by SPARROW are 0 if credit generation and use occurs within the same catchment.
- Raw SPARROW delivery fraction values estimate delivery percentage through a stream's entire flow path to a Great Lake or the Mississippi River. Using specific generator and user delivery fractions, as explained here, provide a value tailored to a specific project location.
- Some SPARROW catchments have a delivery fraction of 0, or no value shown in Surface Water Data Viewer. These areas are thought to be internally drained and/or incapable of yielding phosphorus to a downstream waterbody. More in-depth analyses would be needed before credit generation can occur in these areas.
- SPARROW is a valuable tool for estimating delivery across large spatial scales. Fine-scale factors such as small lakes, impoundments, or other connectivity issues may influence delivery and will need to be accounted for separately from the model.