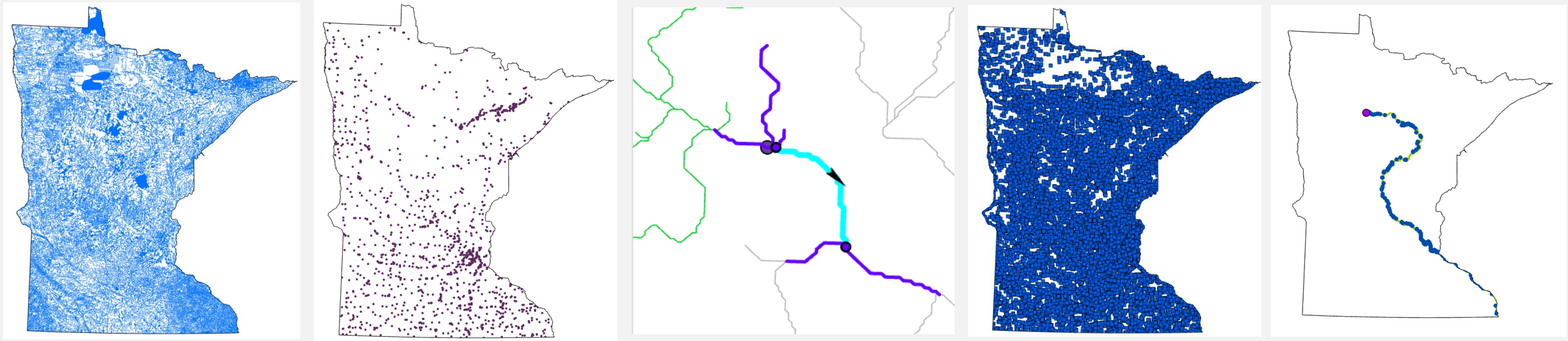

An Integrated View of NPDES Permits, Impaired Waters, and Other Water Assessment Data with GIS Routing Tools

MINNESOTA POLLUTION CONTROL AGENCY

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Overview

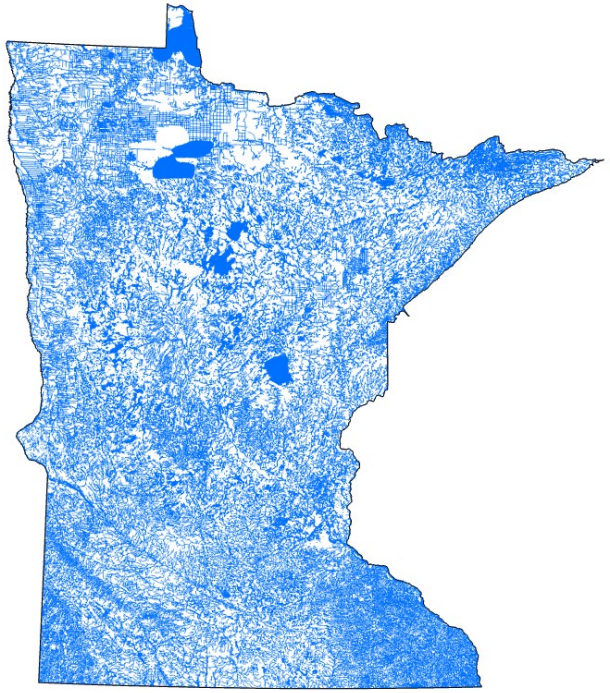
- Tracing river mile distances on a stream network with GIS routing tools
- Sequencing assessment units in downstream order
- Geoprocessing tools on ArcGIS for enterprise

- The business needs and questions we answer
  - How many facilities are upstream of a feature of interest?
  - What monitoring data do we have for those facilities?
  - How many facilities are within some river milage of a feature of interest?
  - How many river miles from this facility to the feature of interest?

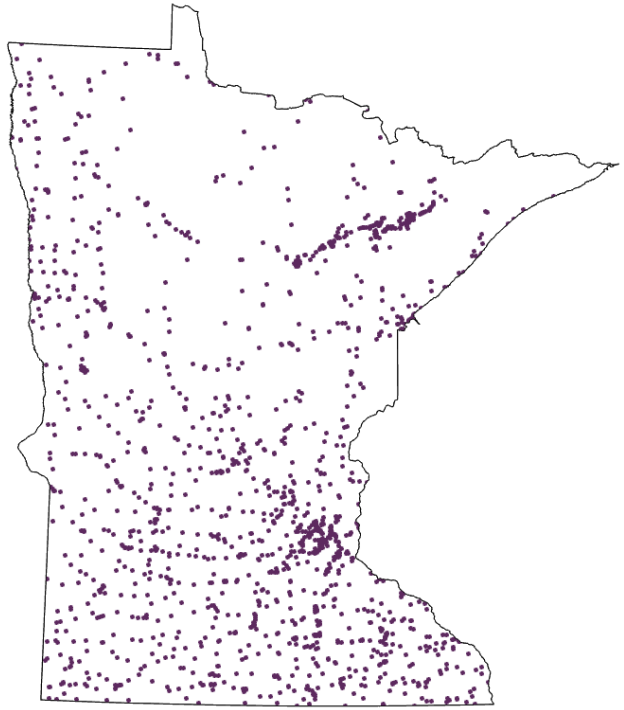
Data and tools to meet the business need

- We can use NHDPlus products to create a network for measuring up and downstream river miles between points.

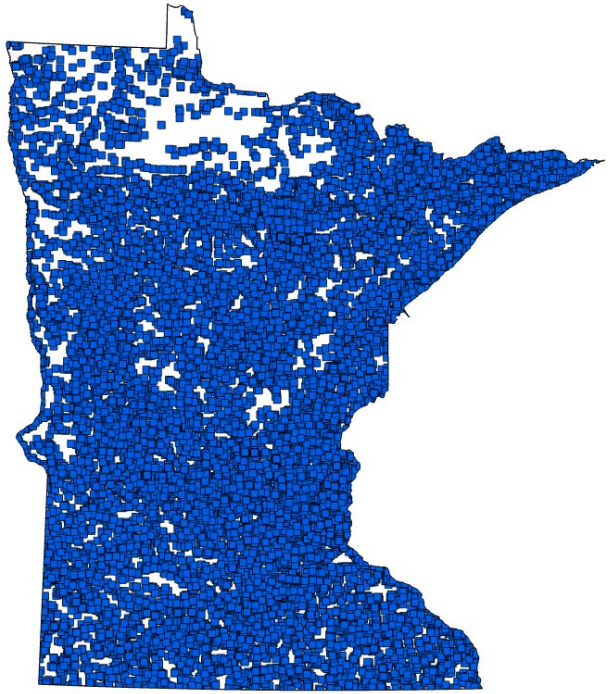
- Stream network



- NPDES outfalls



- Ambient monitoring



Check the NHD or NHD Plus

- The NHDPlus network is an excellent resource!
- Trace tools snap points to a network.
- Snapping points to the NHD has some unexpected results.
- We used the flow accumulation raster to make a network with a line in every 40-acre grid.
- Snapping results improved with the increased number of flow paths.

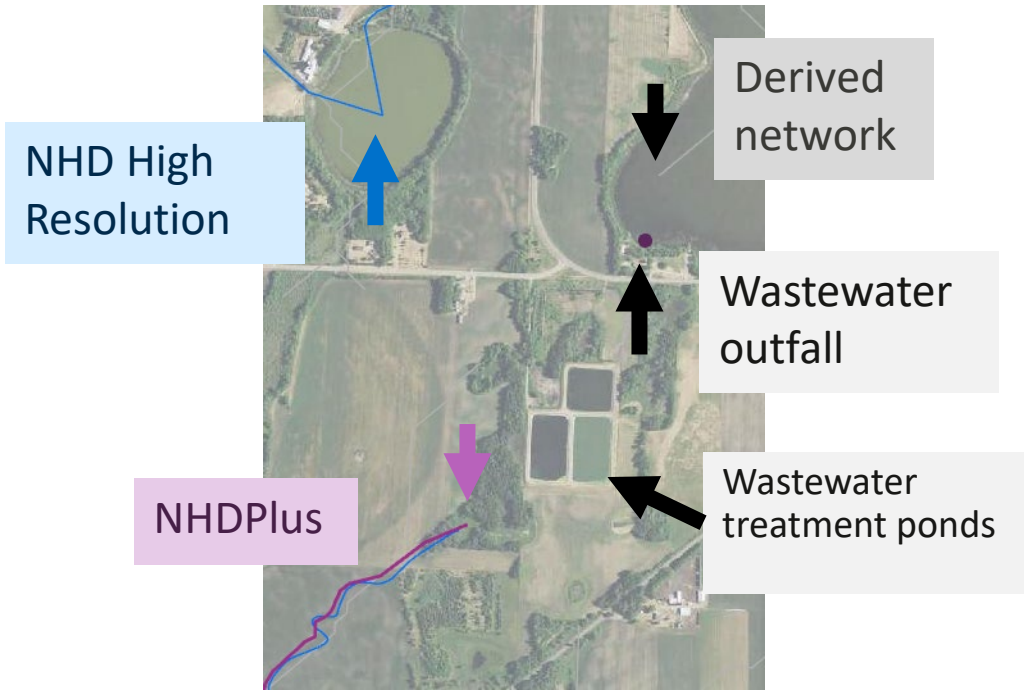
NHDPlusV2 consists of the following components:

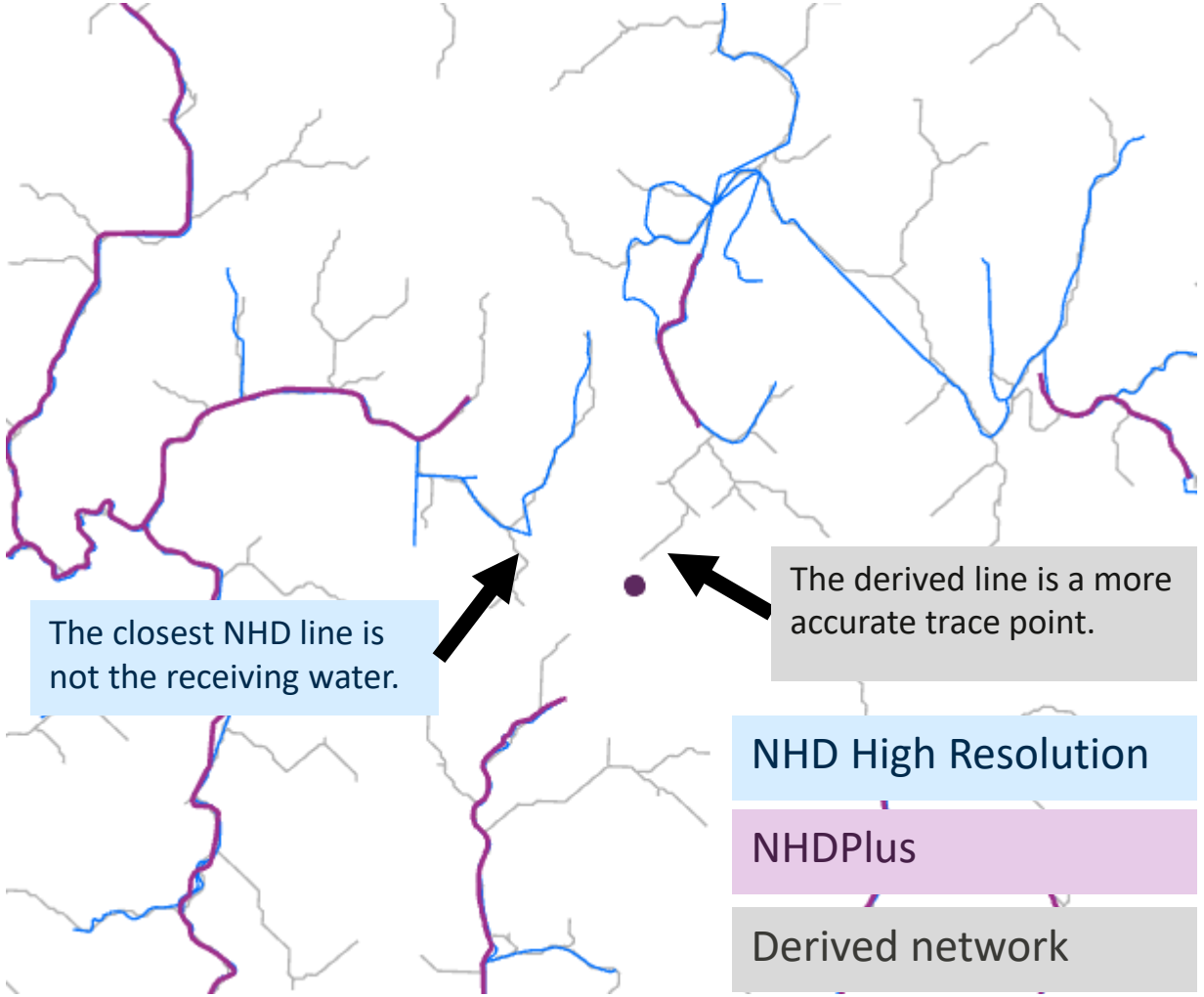
- Greatly improved 1:100K National Hydrography Dataset (NHD).
- Greatly improved 30 meter National Elevation Dataset (NED).
- Nationally complete Watershed Boundary Dataset (WBD).
- A set of value added attributes to enhance stream network navigation, analysis and display.
- An elevation-based catchment for each flowline in the stream network.
- Catchment characteristics.
- Headwater node areas.
- Cumulative drainage area characteristics.
- Flow direction, flow accumulation and elevation grids.
- Flowline min/max elevations and slopes.
- Flow volume & velocity estimates for each flowline in the stream network.
- Catchment attributes and network accumulated attributes.
- Various grids from the hydro-enforcement process including the hydro-enforced DEM.

https://www.epa.gov/waterdata/get-nhdplus-national-hydrography-dataset-plus-data

An example for the denser flow network

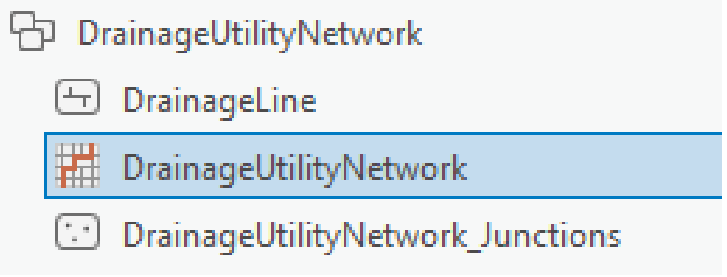
- The outfall for this facility is near multiple NHD lines.
- The derived network has more flow paths and improves the trace point accuracy.

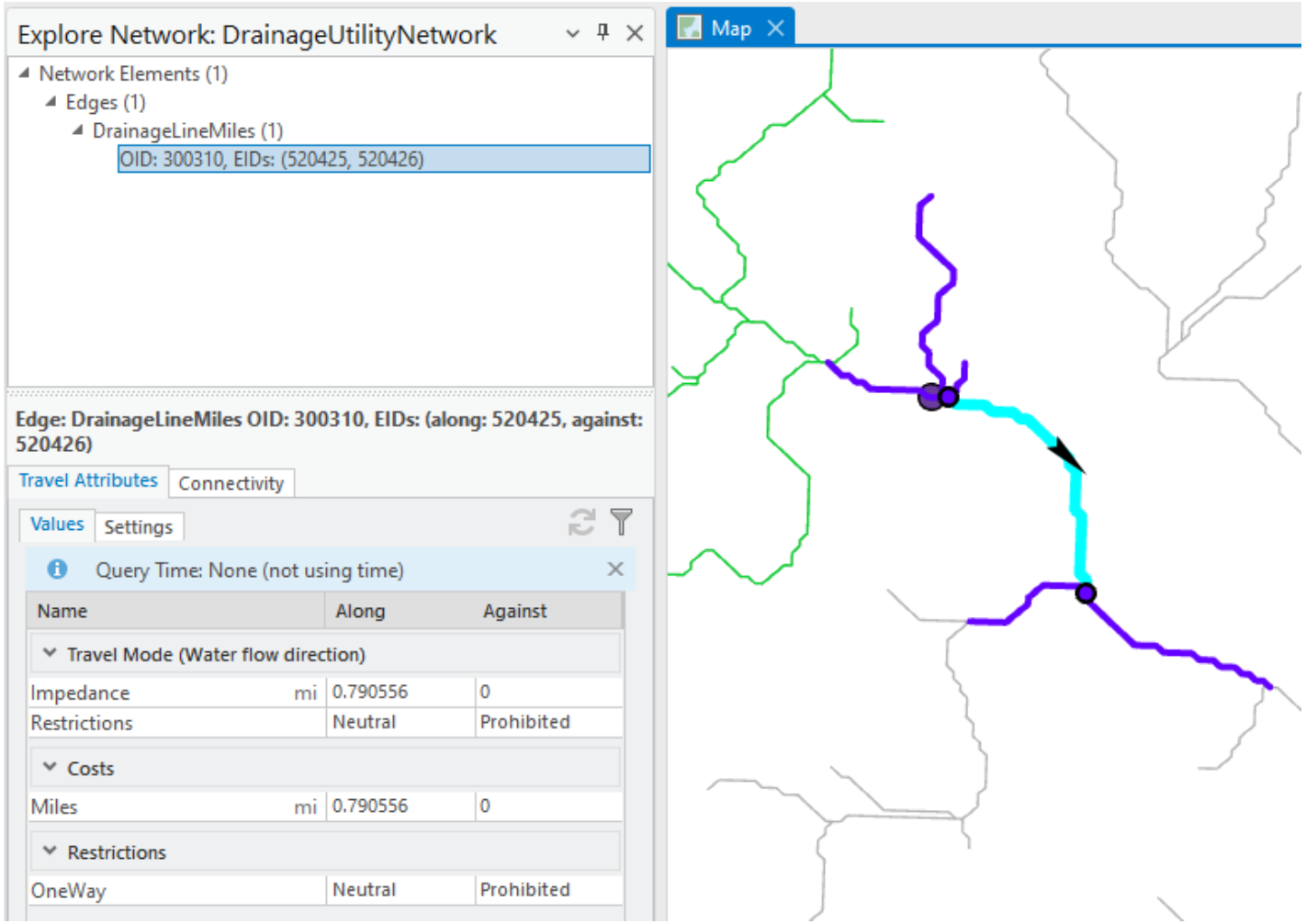




Create the Utility Network

- Create a line feature class from the flow accumulation raster
- Create the drainage network based on the feature class
- Utility Network
  - Configure the travel direction.
  - Set travel as “one way”
  - The tutorial below helps. There are some subtle steps in this process.

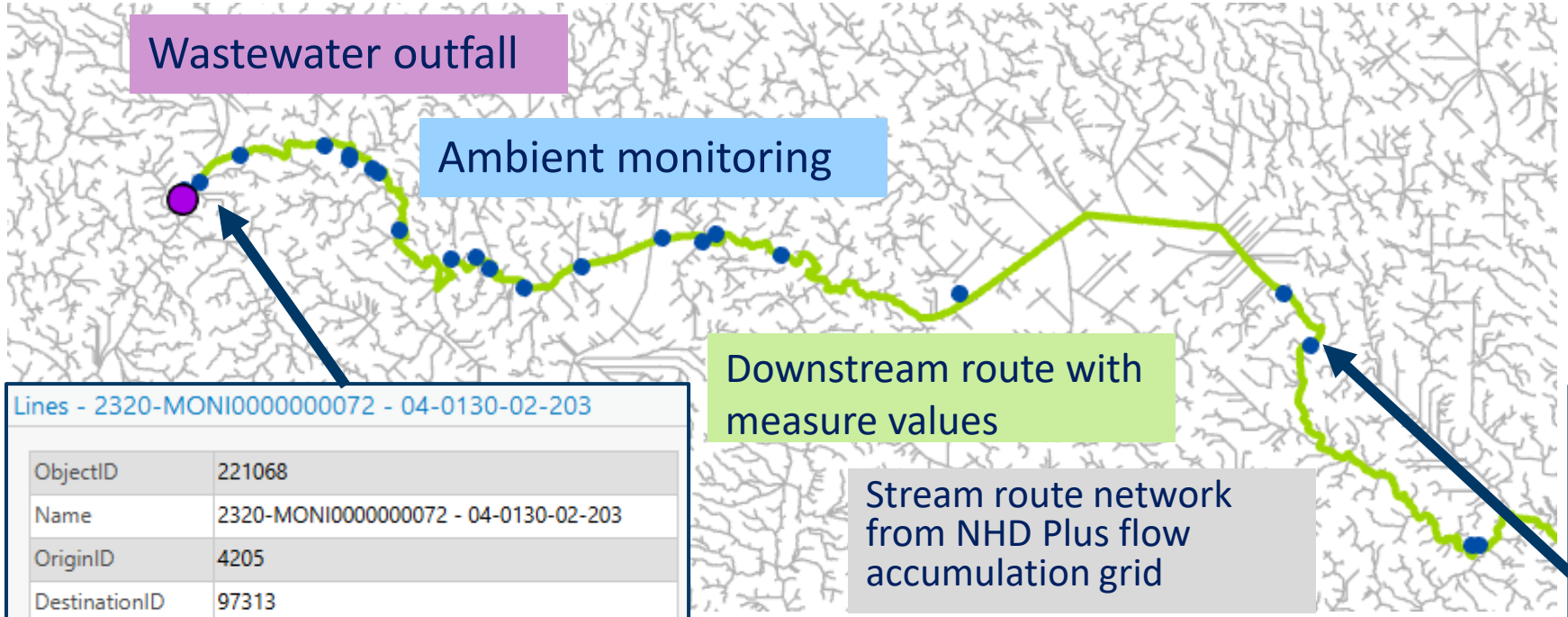


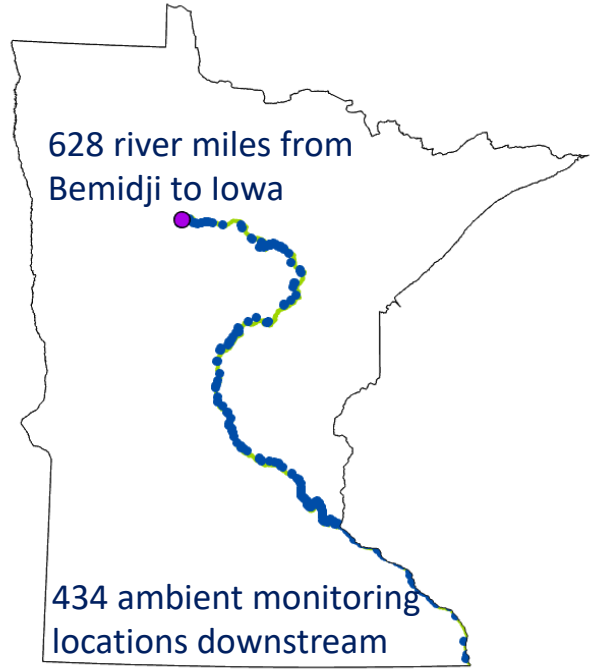


https://pro.arcgis.com/en/pro-app/latest/help/analysis/networks/how-to-create-a-usable-network-dataset.htm

Downstream river mile calculations – Origin Destination Matrix

- Combine the outputs from the Origin-Destination and Service Area tools to create a downstream path with points sequenced by river distance.





Lines - 2320-MONI0000000072 - 04-0130-02-203

ObjectID	221068
Name	2320-MONI0000000072 - 04-0130-02-203
OriginID	4205
DestinationID	97313
DestinationRank	5
Total_Length	1911.705678
Shape_Length	1843.479578

1,843 meters or 1.1 miles

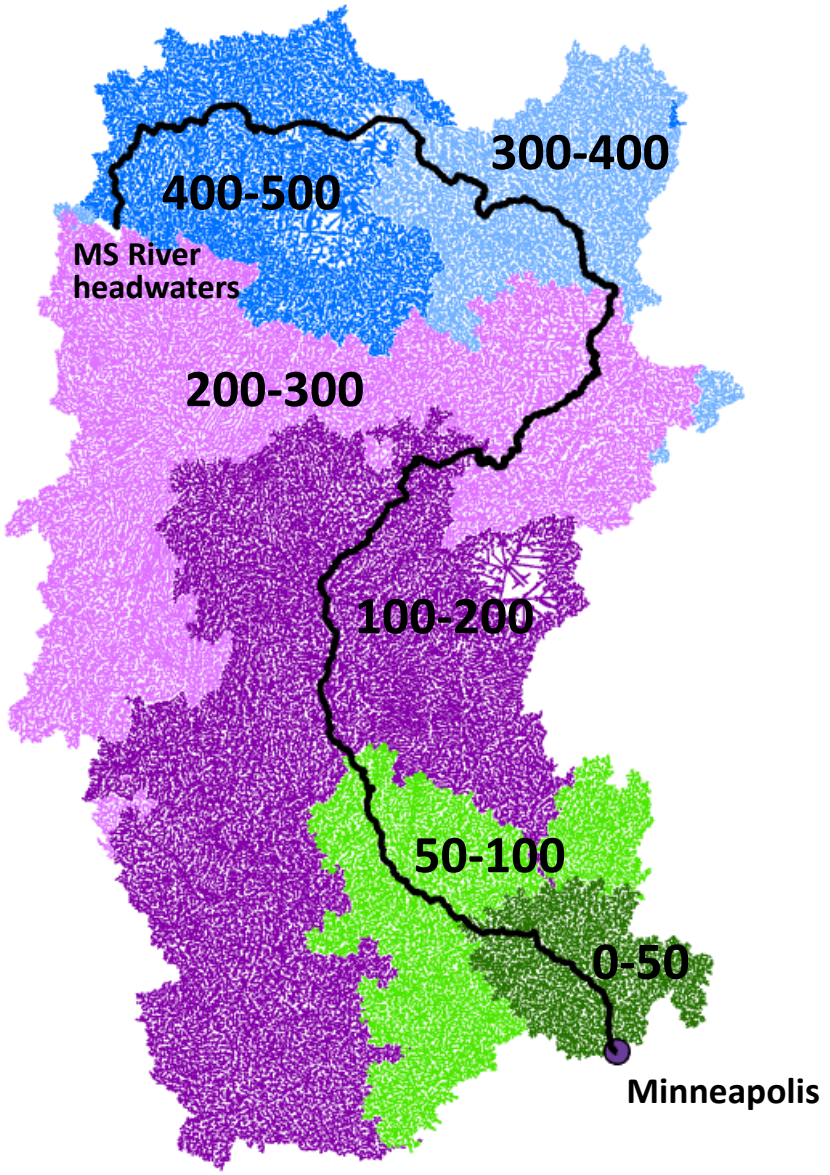
Lines - 2320-MONI0000000072 - 31-0850-00-100

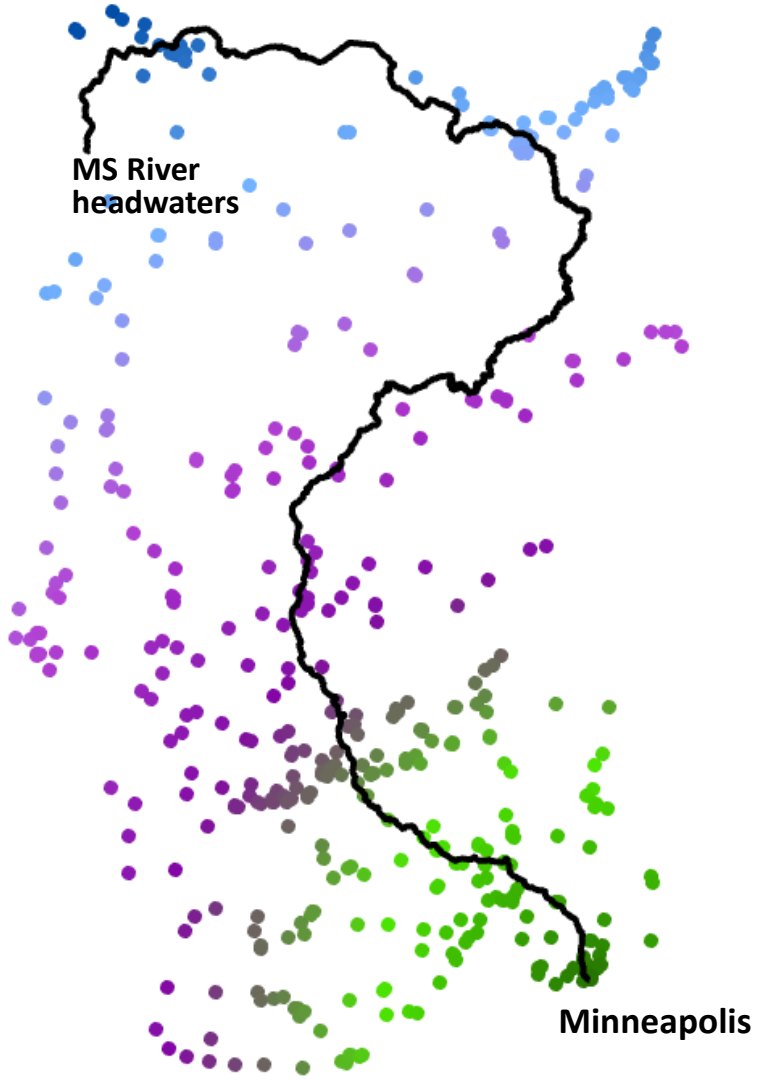
ObjectID	221089
Name	2320-MONI0000000072 - 31-0850-00-100
OriginID	4205
DestinationID	99948
DestinationRank	26
Total_Length	93241.34379
Shape_Length	64536.527143

64,536 meters or 40.1 miles

Upstream river mile calculations – Service Area

- Service Area analysis
- Computing miles along route toward or away from a point.
- Points can be facilities, sensitive features, drinking water intakes, etc.
- Left map – Drainage network upstream of Minneapolis by river mile.
- Right map – Wastewater discharges upstream of Minneapolis by river mile.



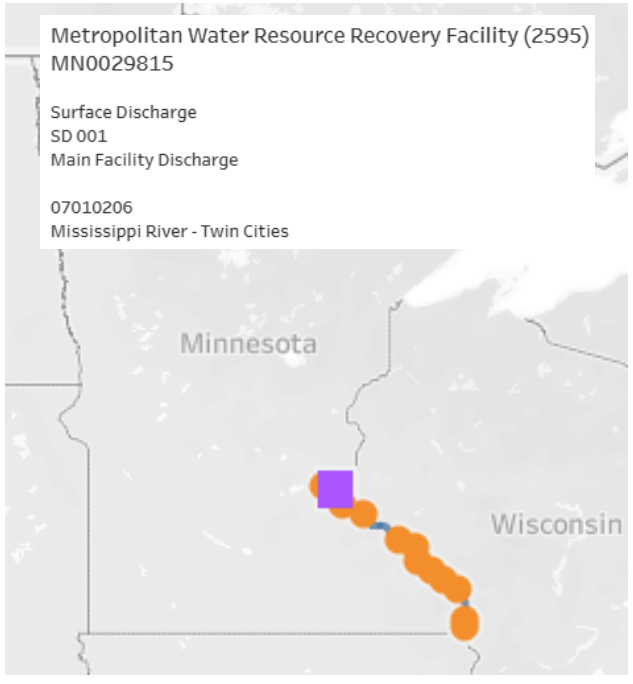


Tabular water unit sequencing

- Water unit IDs / Assessment unit IDs
- Next downstream attribute
- Each water has a downstream path to the state line iterating the ‘next downstream’ attribute.
- Create tabular dataset of downstream waters in hydrologic order
- Enterprise data object created with SQL (connect by root)
- Allows downstream data summaries with non-spatial business intelligence tools

	ROOT_WID	GROUP_ORDER	DOWNSTREAM_WID
1	07010101-754	0	07010101-754
2	07010101-754	1	07010101-755
3	07010101-754	2	07010101-756
4	07010101-754	3	07010103-707
5	07010101-754	4	07010103-708
6	07010101-754	5	07010104-655
7	07010101-754	6	07010104-656
8	07010101-754	7	07010104-657
9	07010101-754	8	07010104-658
10	07010101-754	9	07010201-631
11	07010101-754	10	07010203-728
12	07010101-754	11	07010203-729
13	07010101-754	12	07010206-805
14	07010101-754	13	07010206-814
15	07010101-754	14	07040001-531
16	07010101-754	15	07040003-627
17	07010101-754	16	07040006-515
18	07010101-754	17	07060001-509
19	07010101-754	18	Iowa

Join assessment data, TMDL attributes, and other information



Join attributes to downstream water units

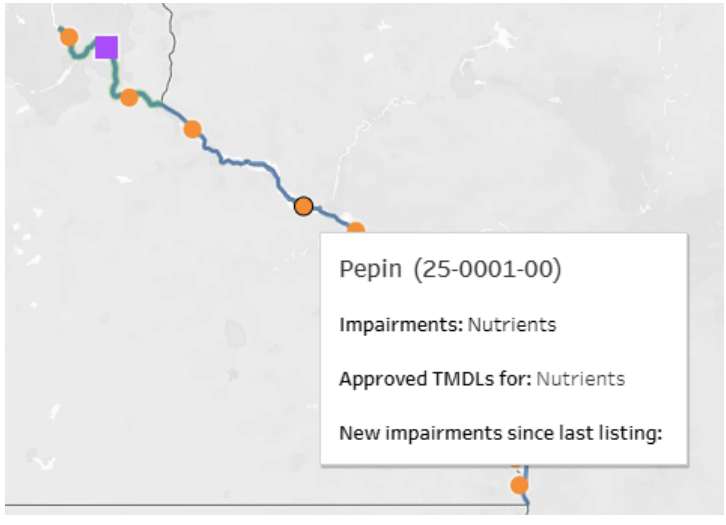
- Impaired waters
  - Parameter by status (approved plan, needs plan)
- TMDL task tracking
- Relevant TMDL wasteload allocations
- Stressor ID results
- Waters used for production of wild rice
- Lakes on a stream Water ID

The base reach is:
Mississippi River (07010206-814)

The impairments could be on the stream or lake WIDs.
Impairments: Aluminum; Fecal coliform; Mercury in fish tissue; Mercury in water column; Nutrients; PCBs in fish tissue; Perfluorooctane sulfonate (PFOS); Perfluorooctane sulfonate (PFOS) in fish tissue; Total suspended solids (TSS)

Approved TMDLs for: Mercury in fish tissue; Mercury in water column; Nutrients; Total suspended solids (TSS)

New impairments since last listing:



Joined attributes in a filterable dashboard reviewed at permit reissuance

This is a list and count of impairments downstream of selected stations.

Name and station	Station desc	Selected WID	Selected water name	Watershed name	Moving Sum of Count of Wid (Im..	Downstream impairment list
Met Council - Metropolitan WWTP (2595) SD 001	Main Facility Discharge	07010206-814	Mississippi River	Mississippi River - Twin Cities	24	Aluminum, Fecal coliform, Mercury in fish tissue, Mercury in water column, Nutrients, PCBs in fish tissue, Perfluorooctane sulfonate (PFOS), Perfluorooctane sulfonate (PFOS) in fish tissue, Sulfate, Total suspended solids (TSS).

This table contains downstream waters and impairments (2024). See the TMDL sheets for more project information.

Latest Wid	Reach Order	WID	Water name	Reach desc	Use Subclass List Main	Imp Param	4A - Approved	4B - Likely meeting	4C - Non Pollutant	4D - Natural background	4E - Additional monitoring	5 - Needs Pln	New Impair	Wild rice water
Met Council - Metropolitan WWTP, 2595, MN0029815, SD 001, Main Facility Discharge, Has valid wid, 07010206-814, 07010206-814	0	07010206-814	Mississippi River	Upper St Anthony Falls to St Croix R	2Bg	AI; FC; Hg-F; Hg-W; Nutrients; PCB-F; PF..	Hg-F; Hg-W; Nutrients; ..	Null	Null	Null	Null	AI; FC; PCB-F; P..	Null	
		27-0003-00	U.S. Lock & Dam #1 Pool	AT MINNEAPOLIS MN	2B	Null	Null	Null	Null	Null	Null	Null	Null	
	1	07040001-531	Mississippi River	St Croix R to Chippewa R (WI)	2Bg	AI; Hg-F; Hg-W; PCB-F; TSS	Hg-F; Hg-W; TSS	Null	Null	Null	Null	AI; PCB-F	Null	
		25-0001-00	Pepin	AT LAKE CITY	2B	Nutrients	Nutrients	Null	Null	Null	Null	Null	Null	
	2	07040003-627	Mississippi River	Chippewa R (WI) to L & D #6	2Bg	AI; Hg-F; PCB-F; SO4	Hg-F	Null	Null	Null	Null	AI; PCB-F; SO4	Null	Wild rice water
		85-0001-00	U.S. Lock & Dam #7 Pool	4.3 MI NW OF DAKOTA, MN	2B	Null	Null	Null	Null	Null	Null	Null	Null	
	3	07040006-515	Mississippi River	L & D #6 to Root R	2Bg	Hg-F; PCB-F	Hg-F	Null	Null	Null	Null	PCB-F	Null	
	4	07060001-509	Mississippi River	Root R to MN/IA border	2Bg	Hg-F; PCB-F; SO4	Hg-F	Null	Null	Null	Null	PCB-F; SO4	Null	Wild rice water

Consistent enterprise data storage

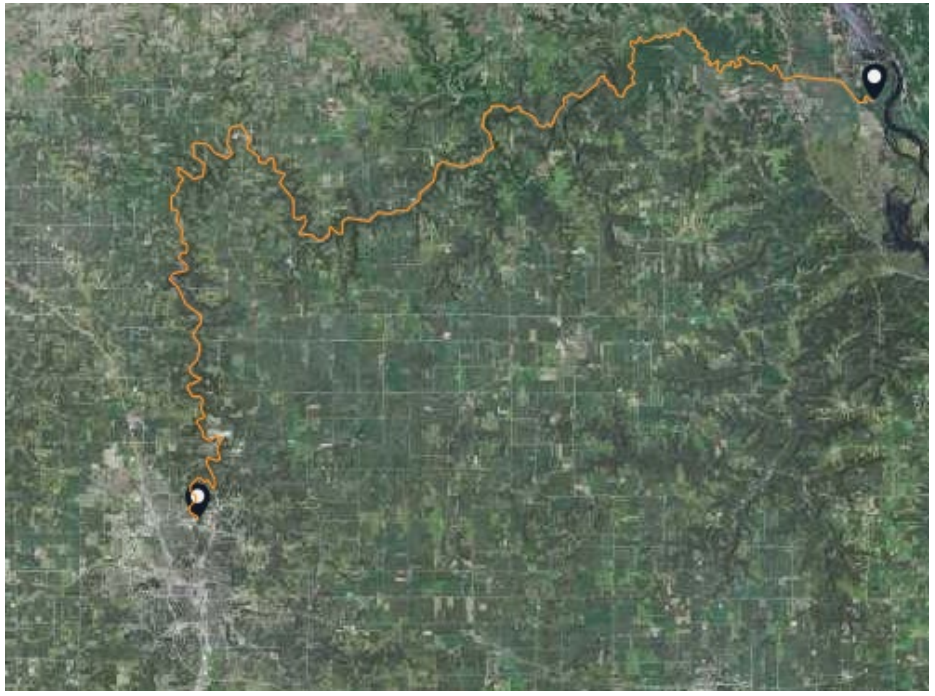
This was a large effort from many people over the years.

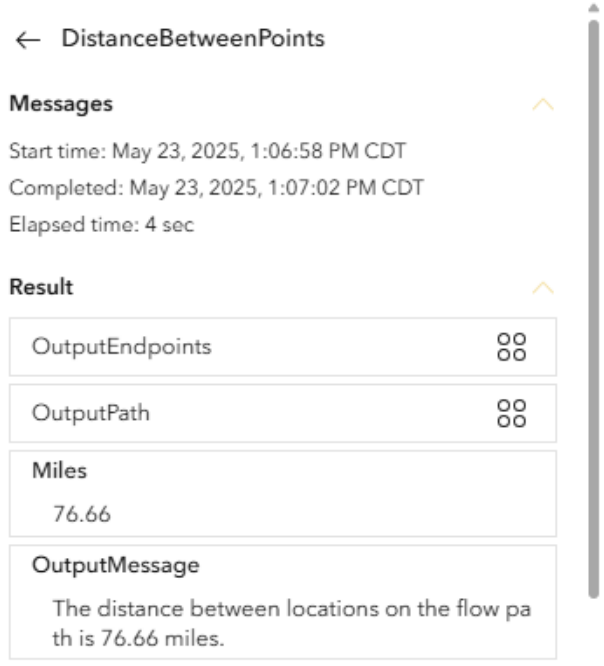
- Water quality assessment data
  - Loaded from data deliverables to enterprise storage
- Stream, lake, and wetland impairment determination
  - Large IT project to convert from a desktop to enterprise database with custom user interface.
- TMDL wasteload allocations
  - Watershed staff enter these in the permitting database.
- Permit limits and monitoring requirements
  - Wastewater permit writers load requirements.
- Water unit creation and maintenance
- Next downstream for each water unit
  - Water unit database administrator started tracking next downstream attributes in 2005.

Adding tools to GIS server

More use of internal GIS server applications for looking up attributes

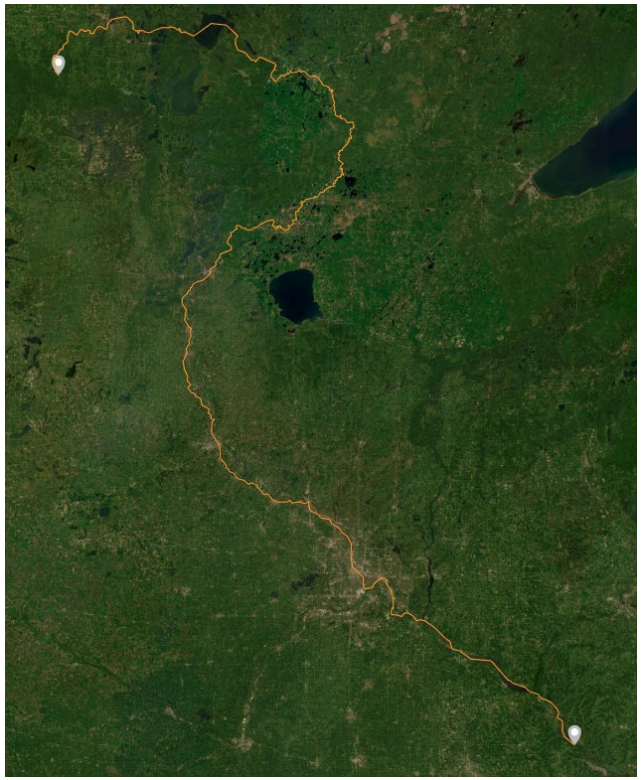
- Distance between two points or trace full path to state border
- Delineate upstream catchments (Credit to Sean Vaughn, MDNR, and MNIT)





Thank you!

Mississippi River at
Lake Itasca State Park



609 miles downstream

Mississippi River at Latsch State Park.