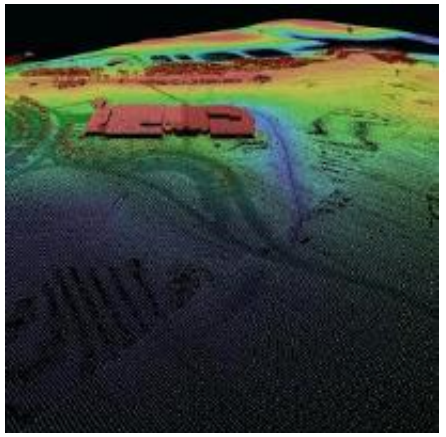
Using NHDPlus HR Value-Added Attributes to Create Useful Analytical Tools



Al Rea, Karen Adkins, and Michele (Mike) Basile

National Geospatial Program

July 31, 2019

CUAHSI HydroInformatics Conference

Today's Agenda

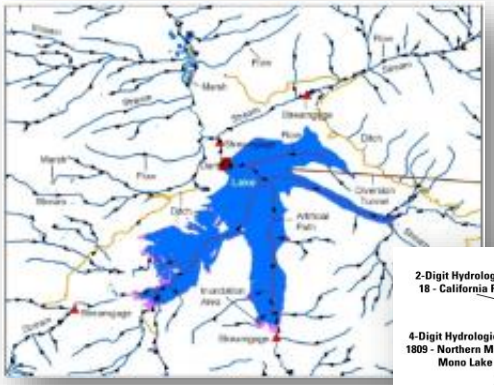
- Introduction – Al Rea
  - General Overview of Hydro Datasets
  - NHDPlus concepts and applications
  - NHDPlus High Resolution (NHDPlus HR)
  - Value-Added Attributes (VAAs) Basics
- VAA Navigator Tool Demo – Karen Adkins
- VAA Navigation Tutorial – Mike Basile

USGS National Hydrography Datasets

Hydrologic networks, units, catchments, and more…

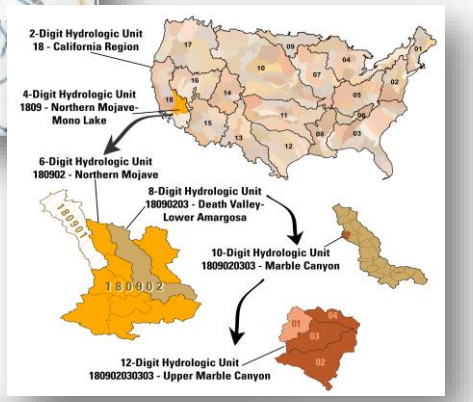
National Hydrography Dataset (NHD)

- The **drainage network** with features such as rivers, streams, canals, lakes, ponds, and stream gages



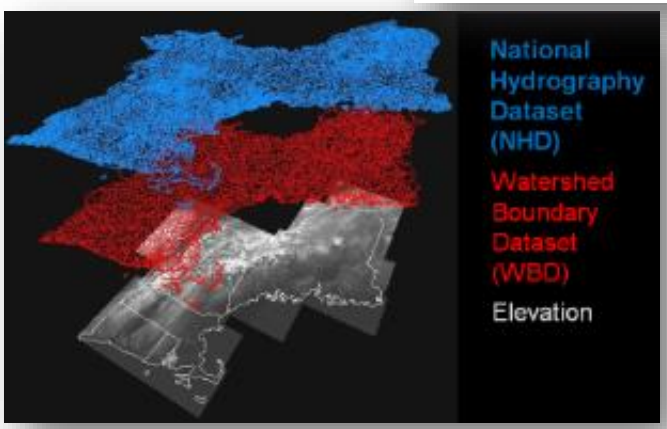
Watershed Boundary Dataset (WBD)

- **Hydrologic units** at 8 scales of a nested hierarchy; defines all or part of the areal **extent of surface water drainage** to a point



NHDPlus High Resolution

- Incorporates features of the NHD, WBD and 3DEP elevation data to create a **networked hydrography framework that incorporates the entire landscape**

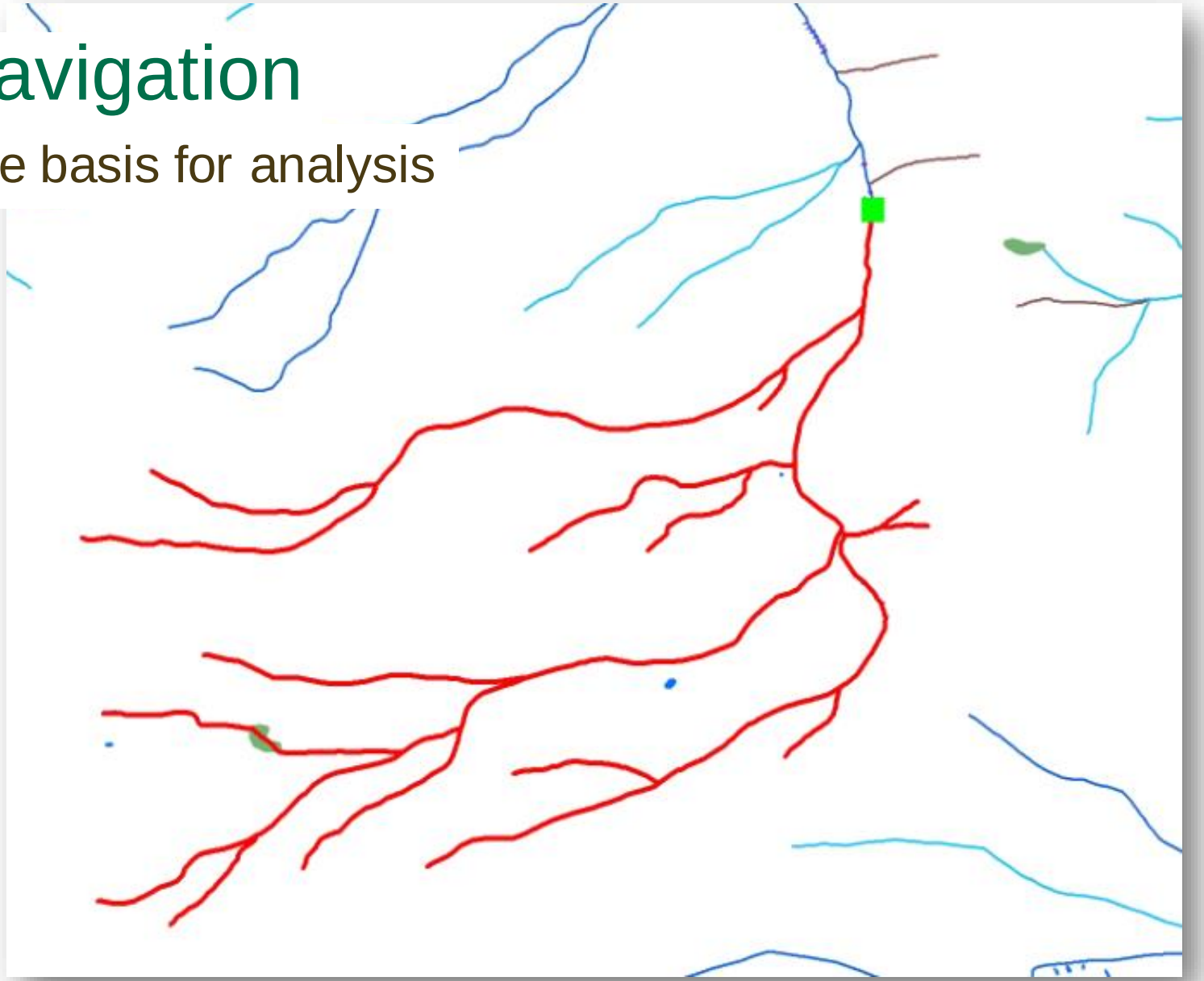


Flow Direction

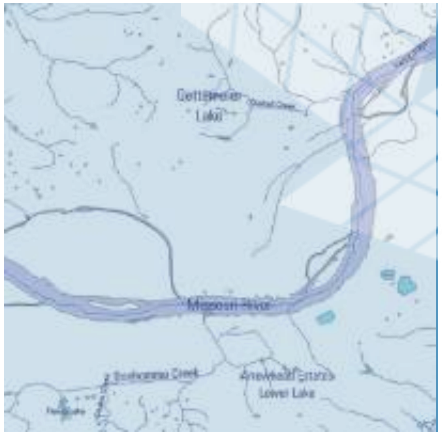
A key piece of intelligence

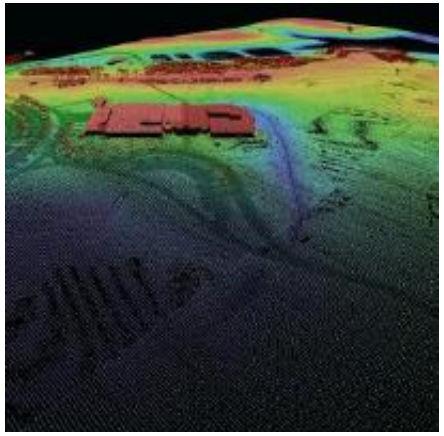
Navigation

The basis for analysis



NHDPlus





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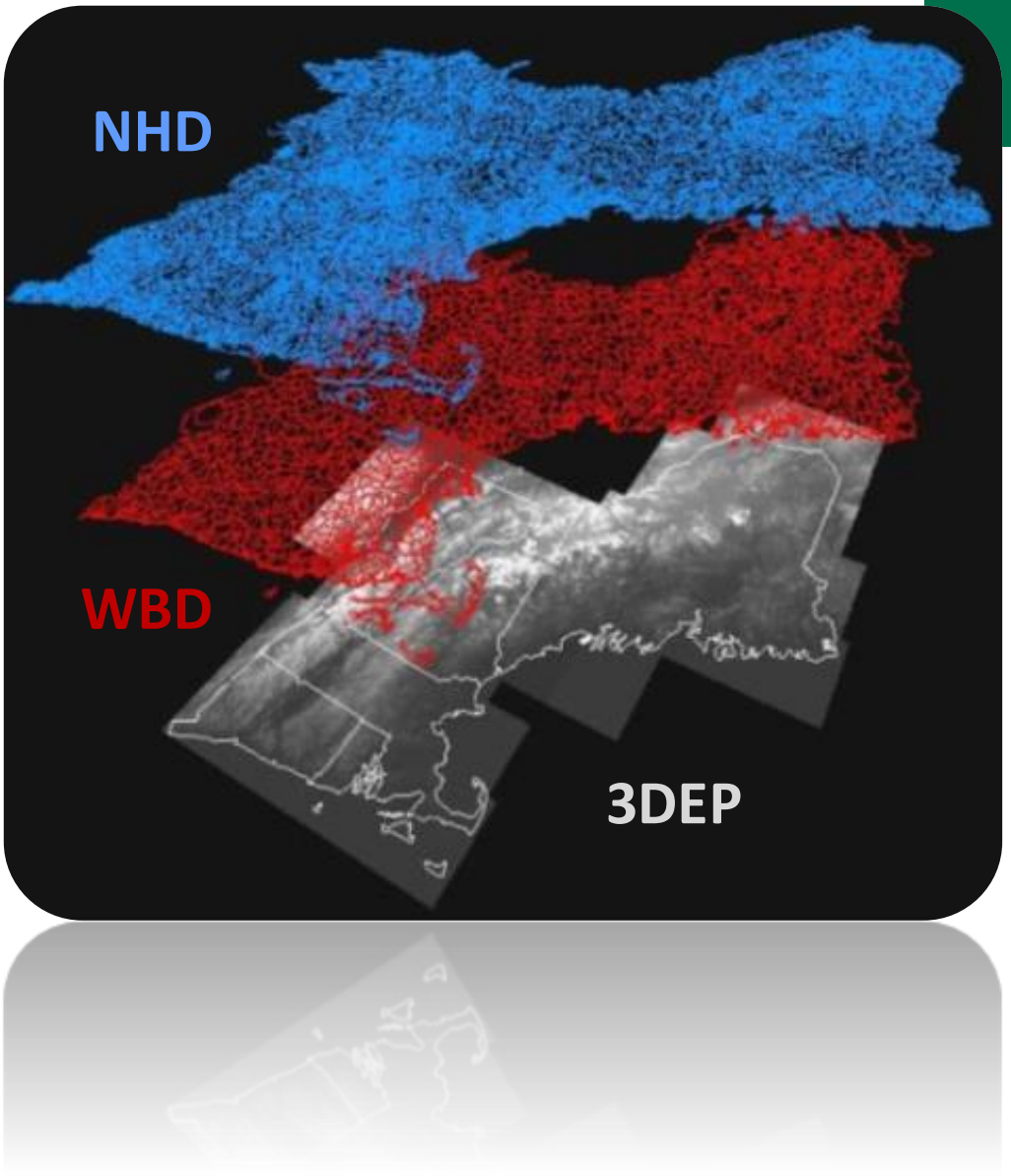
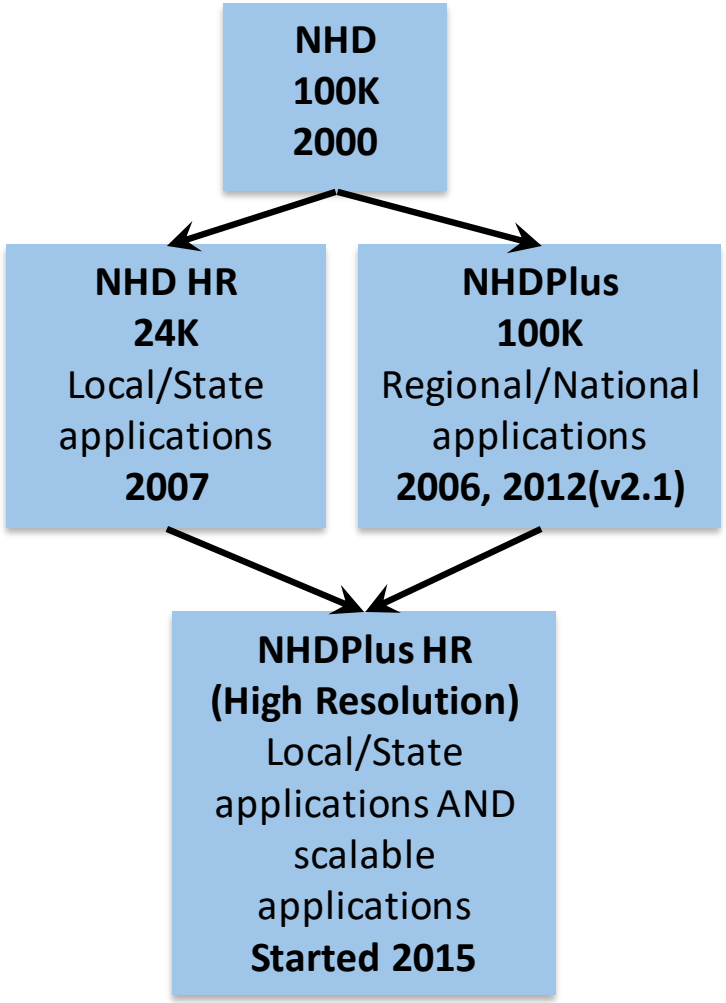
NHDPlus

- Medium Resolution completed for CONUS (1:100,000)
- High Resolution in work for CONUS and AK (1:24,000)
- Incorporates NHD, WBD and 3DEP data



Evolution of NHDPlus HR

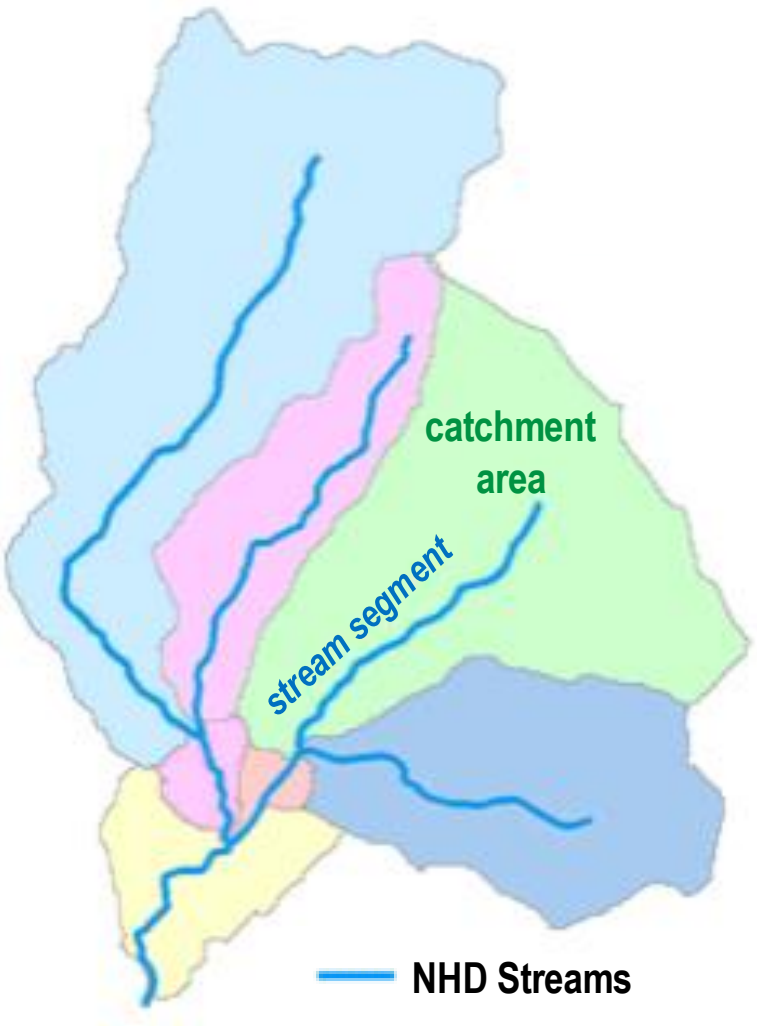
Taking NHDPlus v2 (Med Res) to a new level



- The best of NHDPlus and NHD HR (24K or better) data
- Addresses the need for a single hydrographic frame of reference
- Link data to one network and generalize to many different scales

NHDPlus includes…

- A nationally seamless network of stream reaches
- Value-added attributes for stream network navigation and analysis
- Flow surfaces in raster format
- Elevation-based catchment areas for each stream segment that
  - Create a seamless, scalable hydrologic framework
  - Enable modeling of water flow across the landscape, linking terrestrial characteristics to the stream network

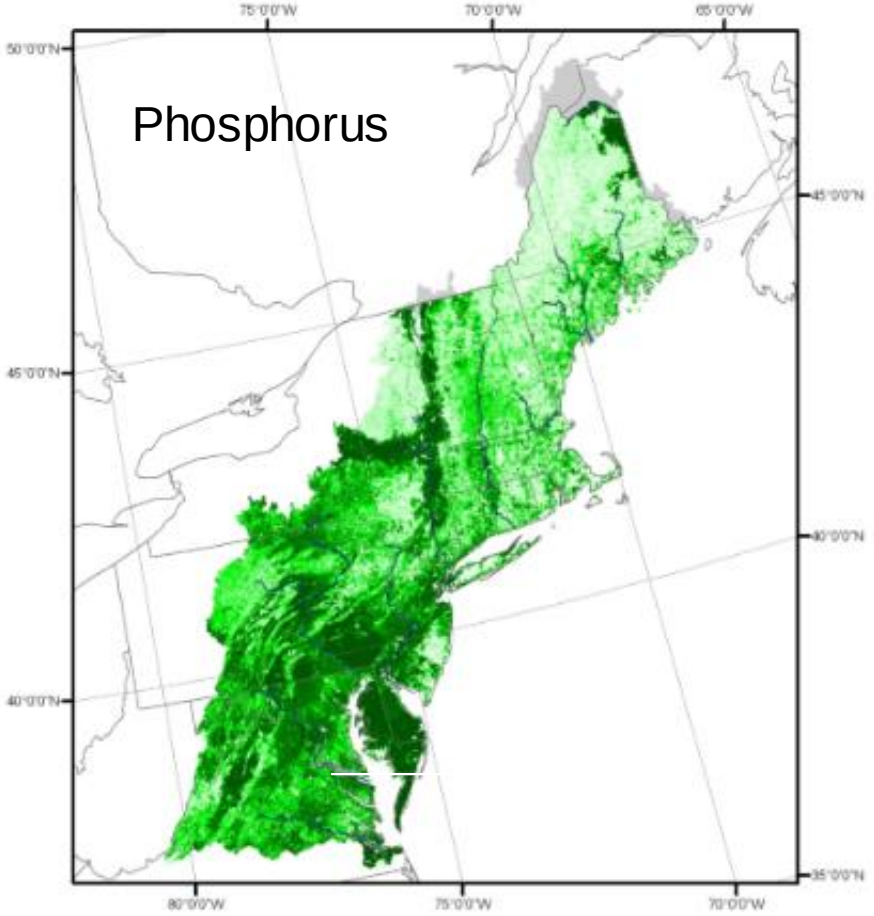


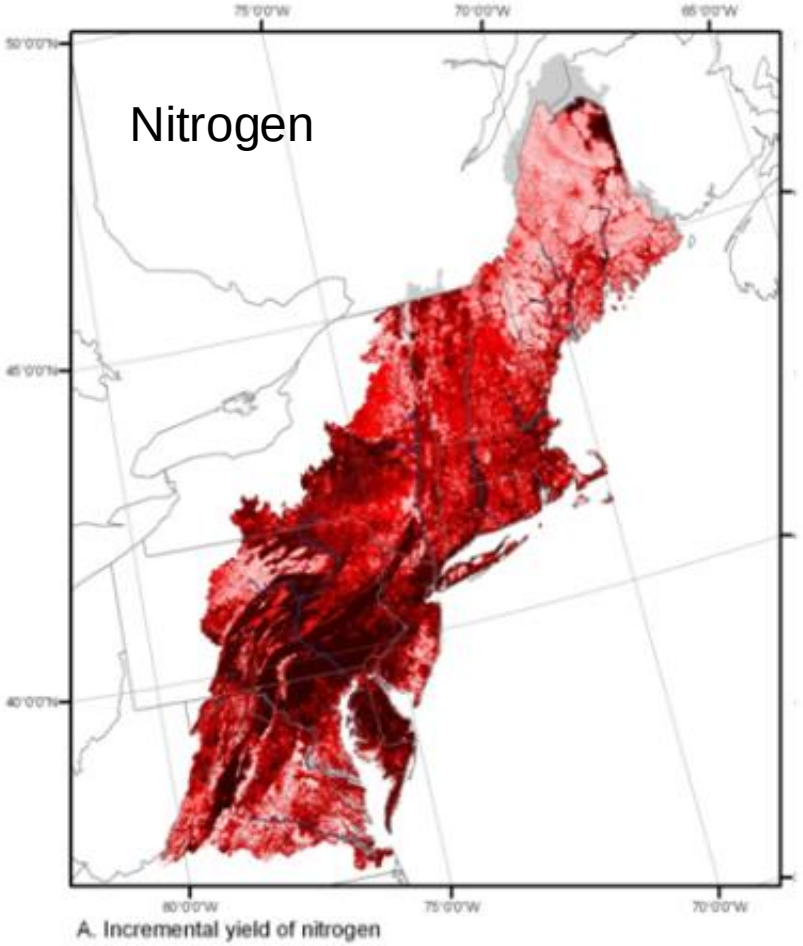
NHDPlus **Medium Resolution** Applications Sampler

A few examples to inspire ideas...

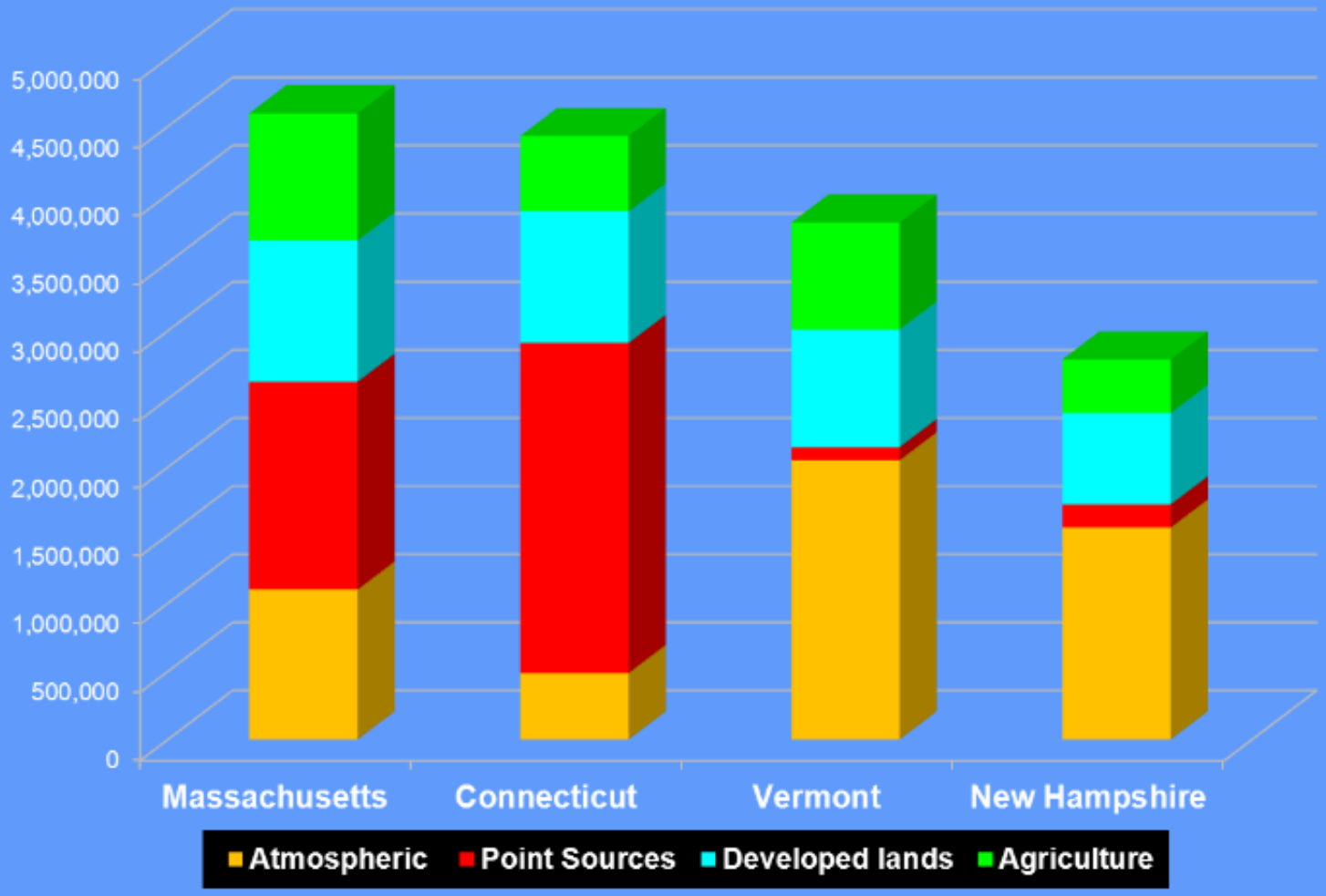
For a listing of ~150 more applications, see
https://www.epa.gov/waterdata/nhdplus-applications

Phosphorus and Nitrogen yields predicted by the Northeastern and Mid-Atlantic regions SPARROW model.

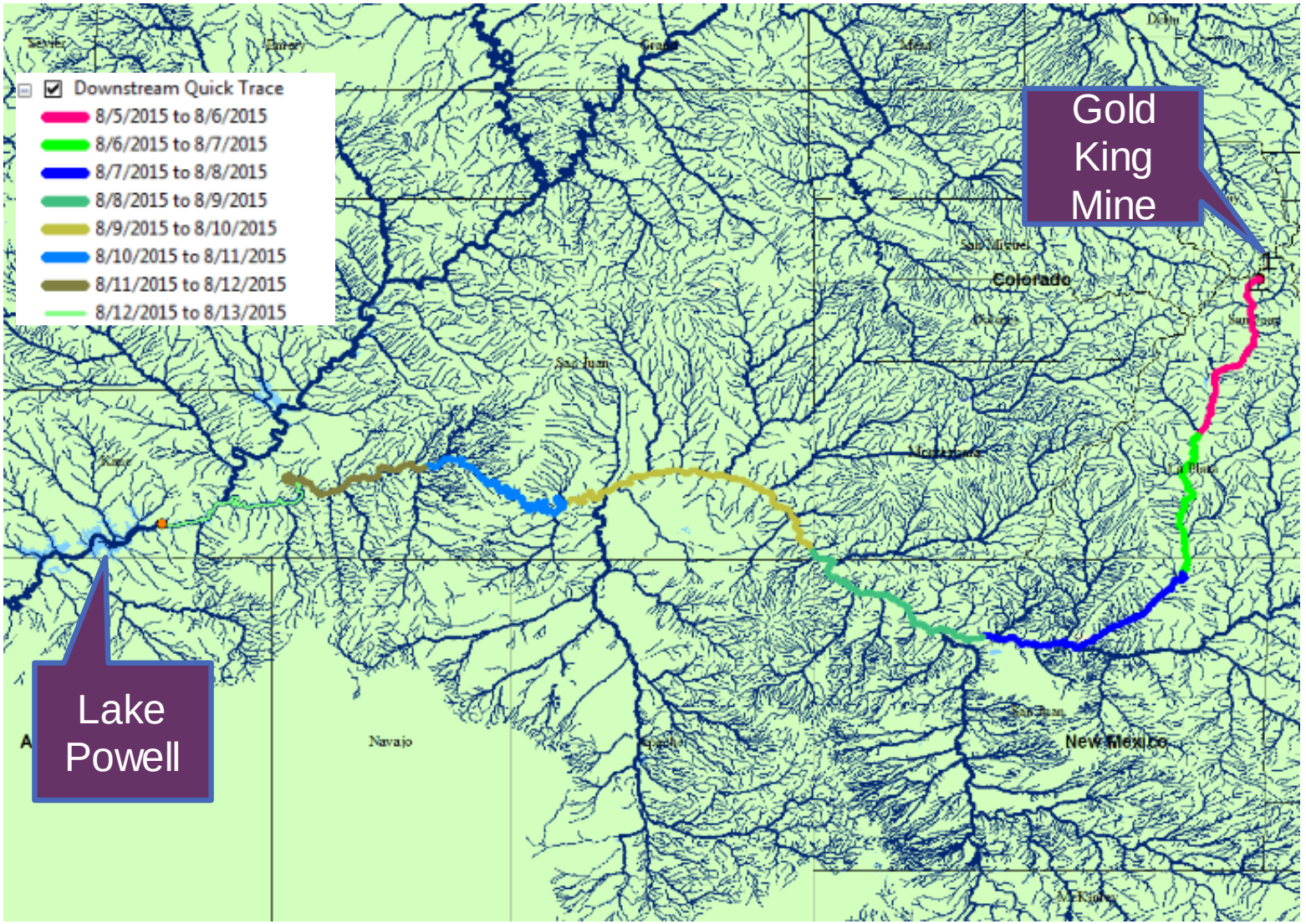




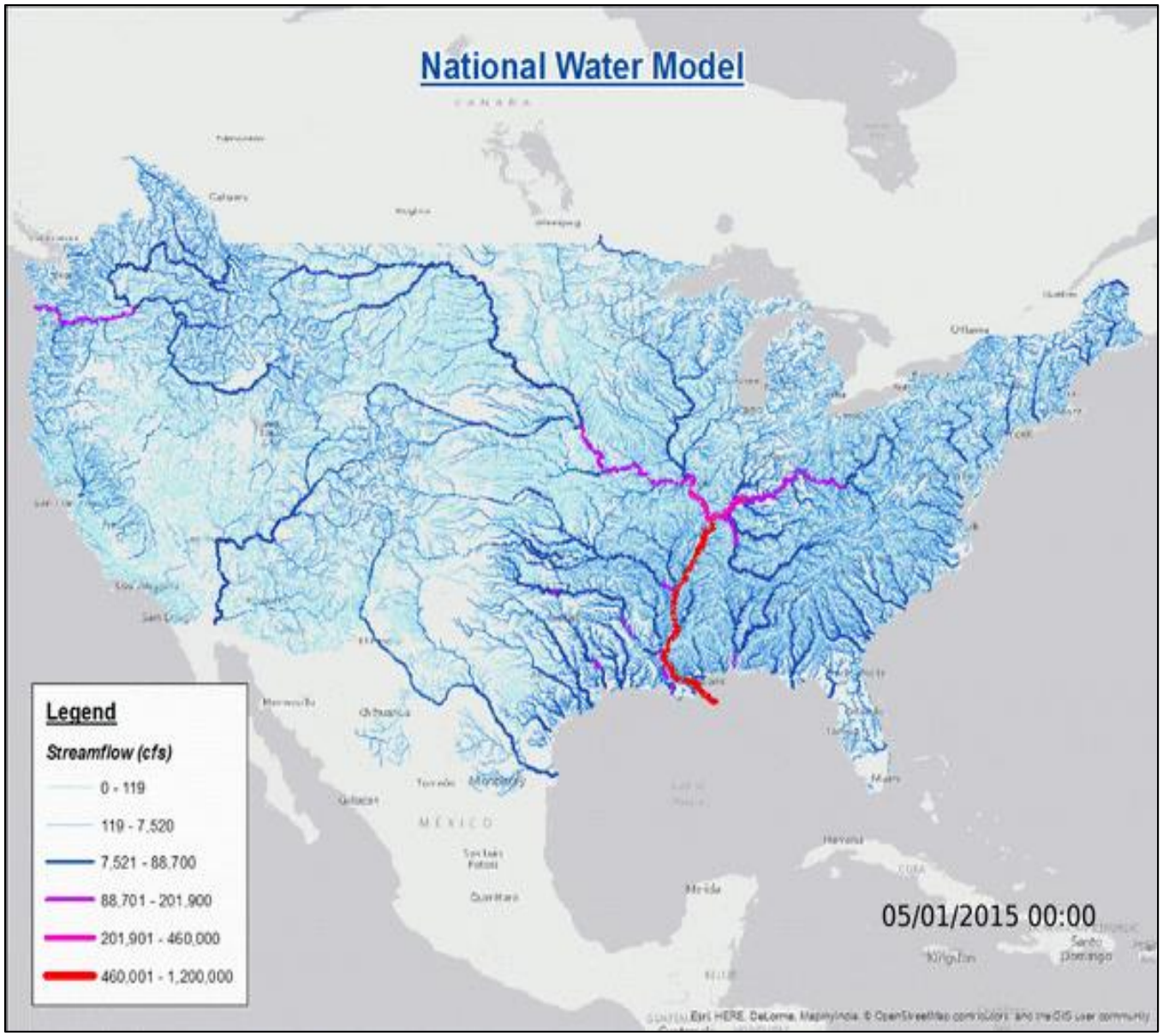
Predicted Nitrogen Load (kg/year) Delivered to Long Island Sound from States within the Connecticut River Watershed



ICWater QuickTrace – 8 day travel time



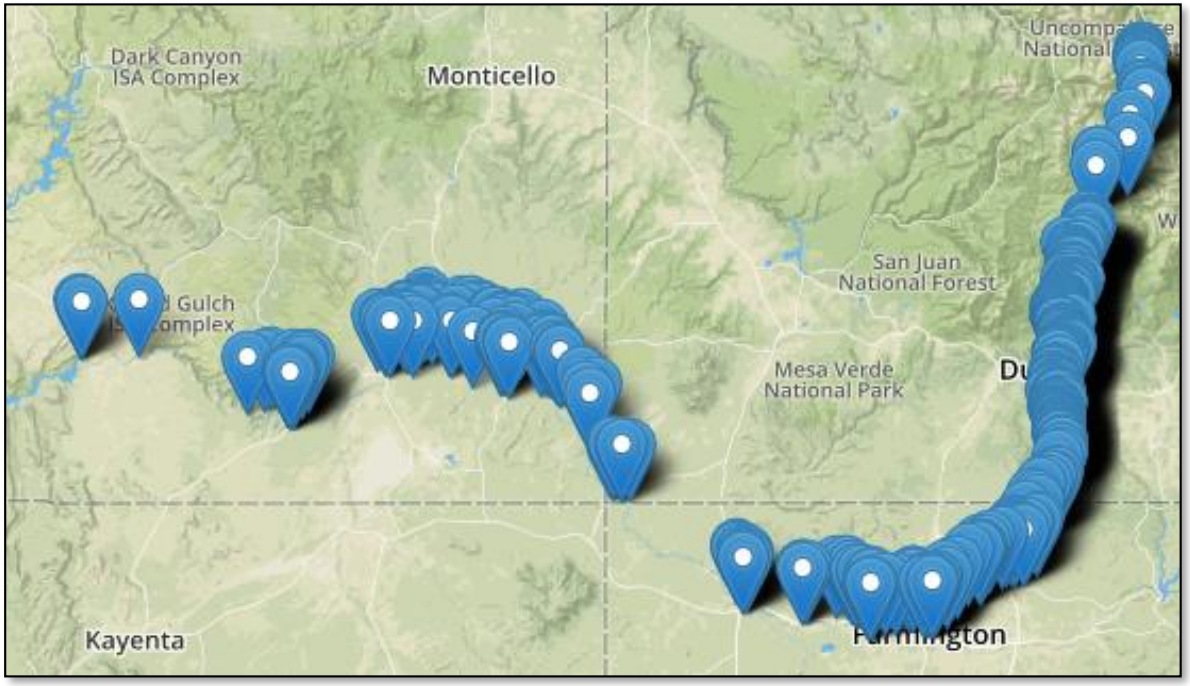
ICWater Preliminary Results: William B. Samuels, samuelsw@leidos.com



National Water Model simulation: Fernando Salas, NOAA-NWS

Catalog, Search, and Discover Prototype

- Allows network search of addressed data
- Upstream and downstream
- With or without tributaries or divergences
- Built into the Water Quality Portal https://www.waterqualitydata.us/



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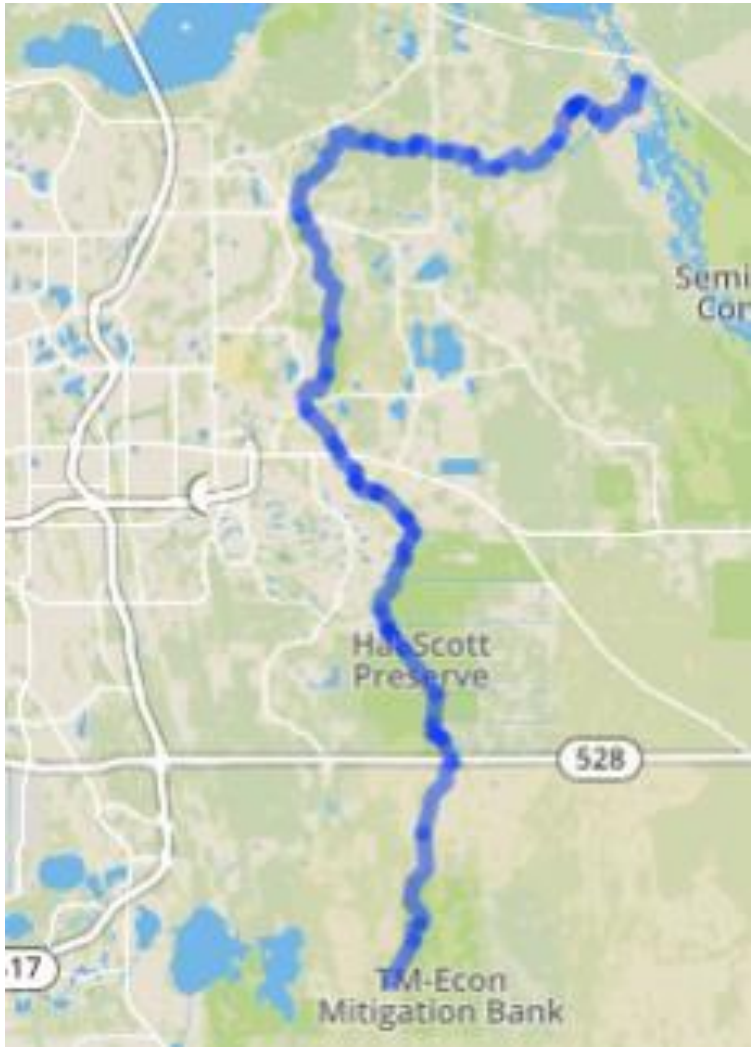

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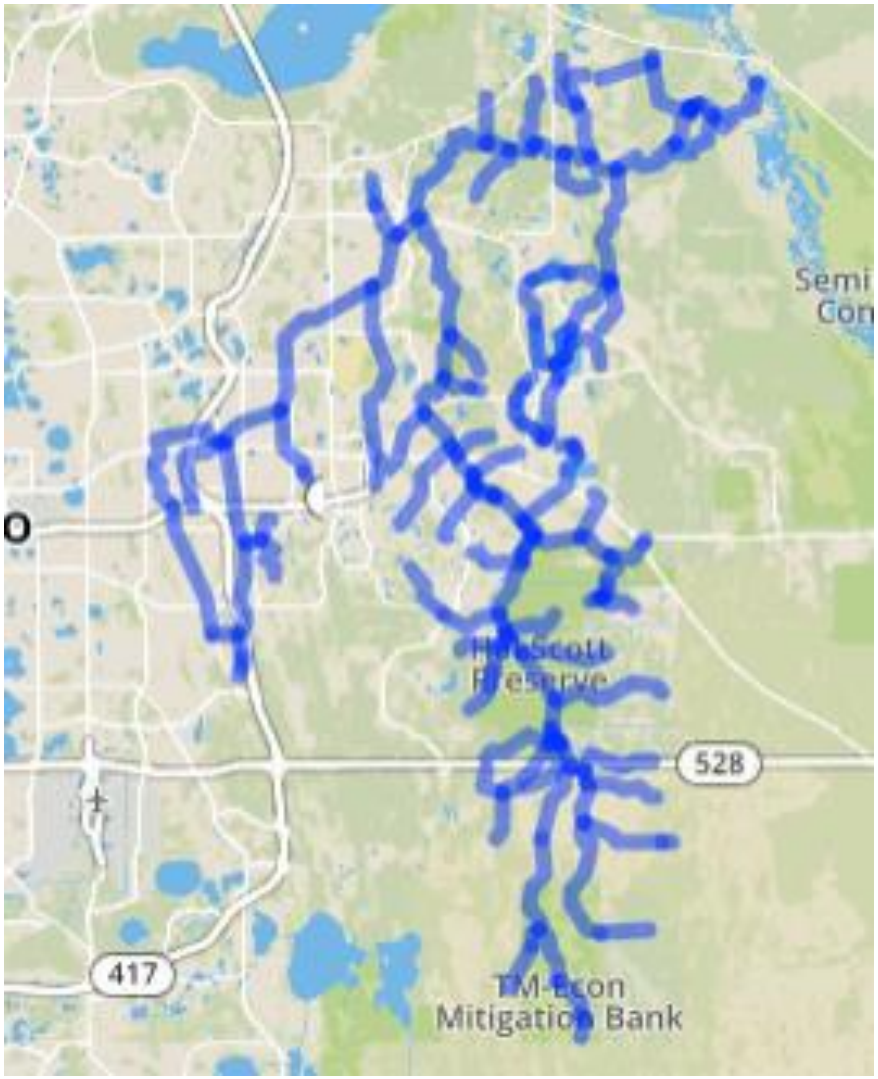

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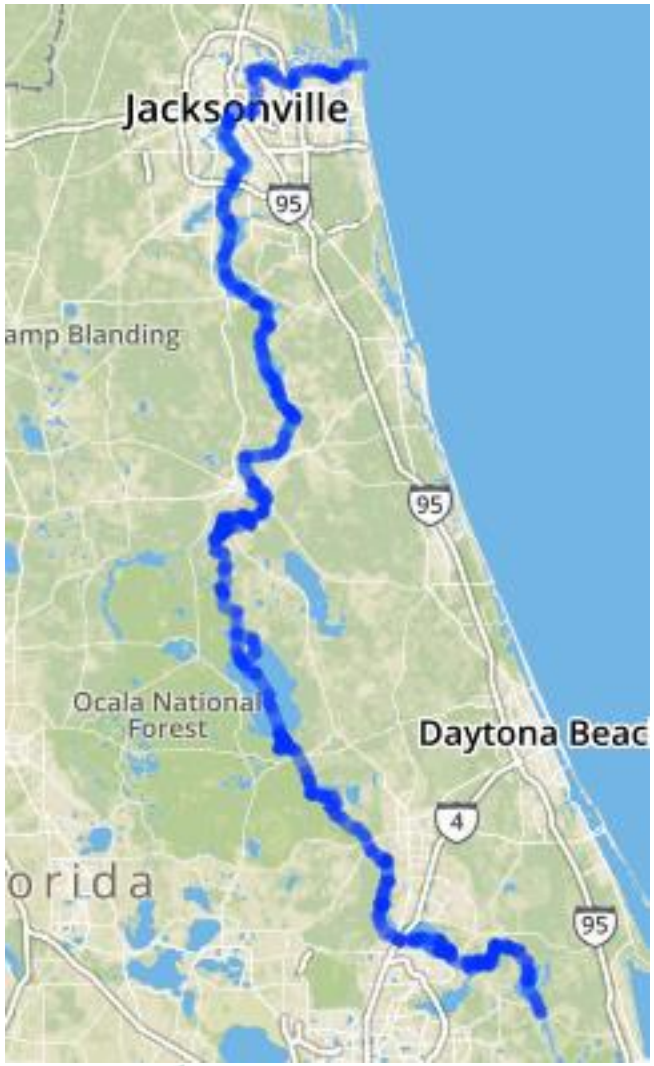

Zoomed In

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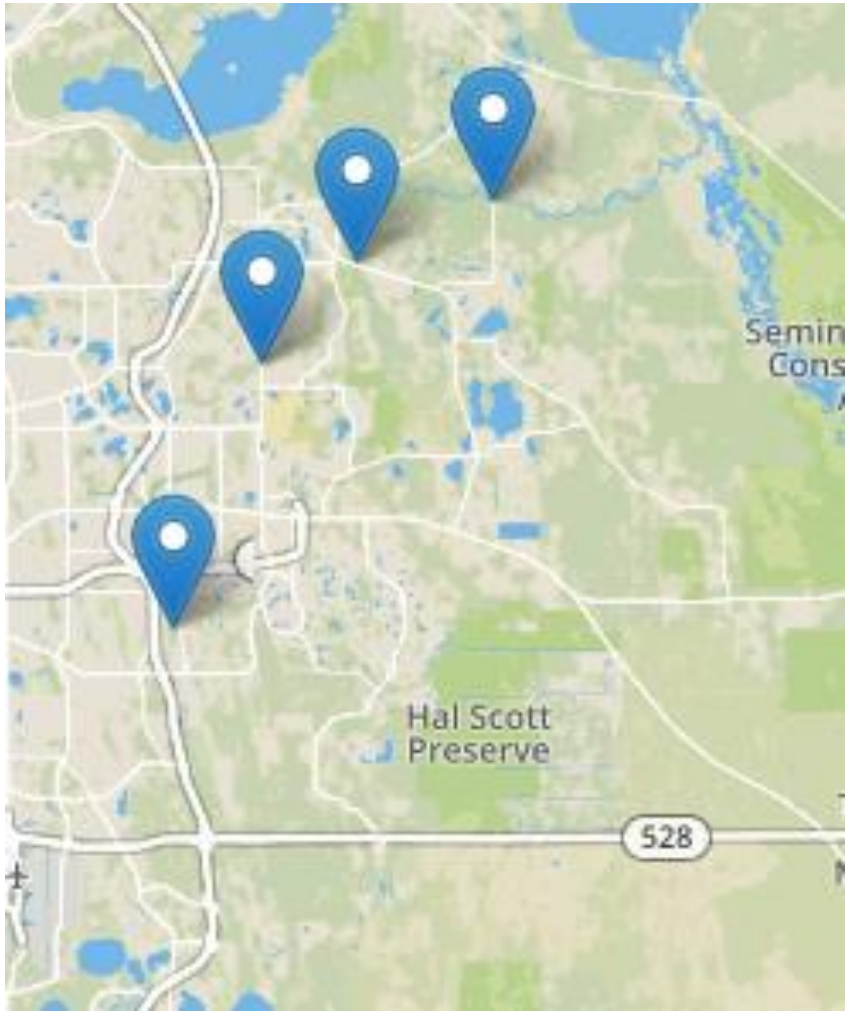

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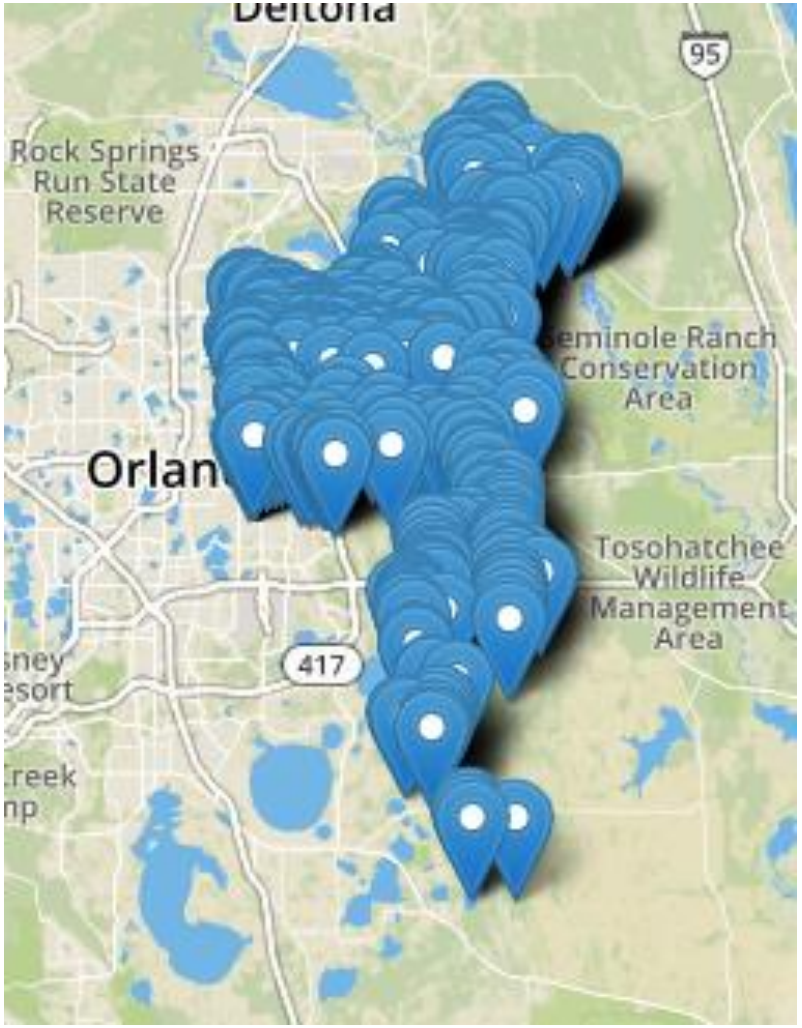

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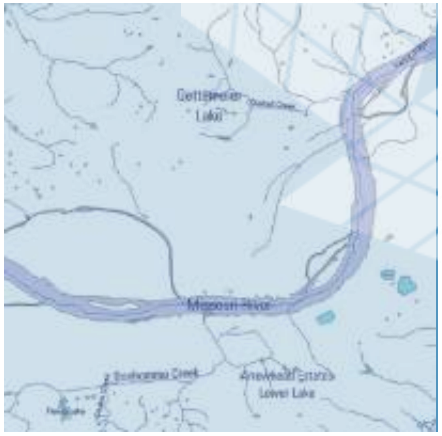
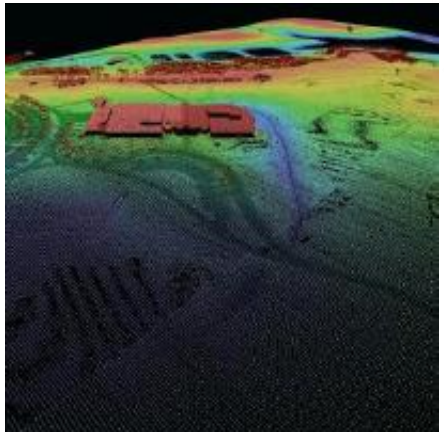
NLDI Additional Information

- https://owi.usgs.gov/blog/nldi-intro/
- https://cida.usgs.gov/nldi/about

- jkreft@usgs.gov
- dblodgett@usgs.gov

NHDPlus HR





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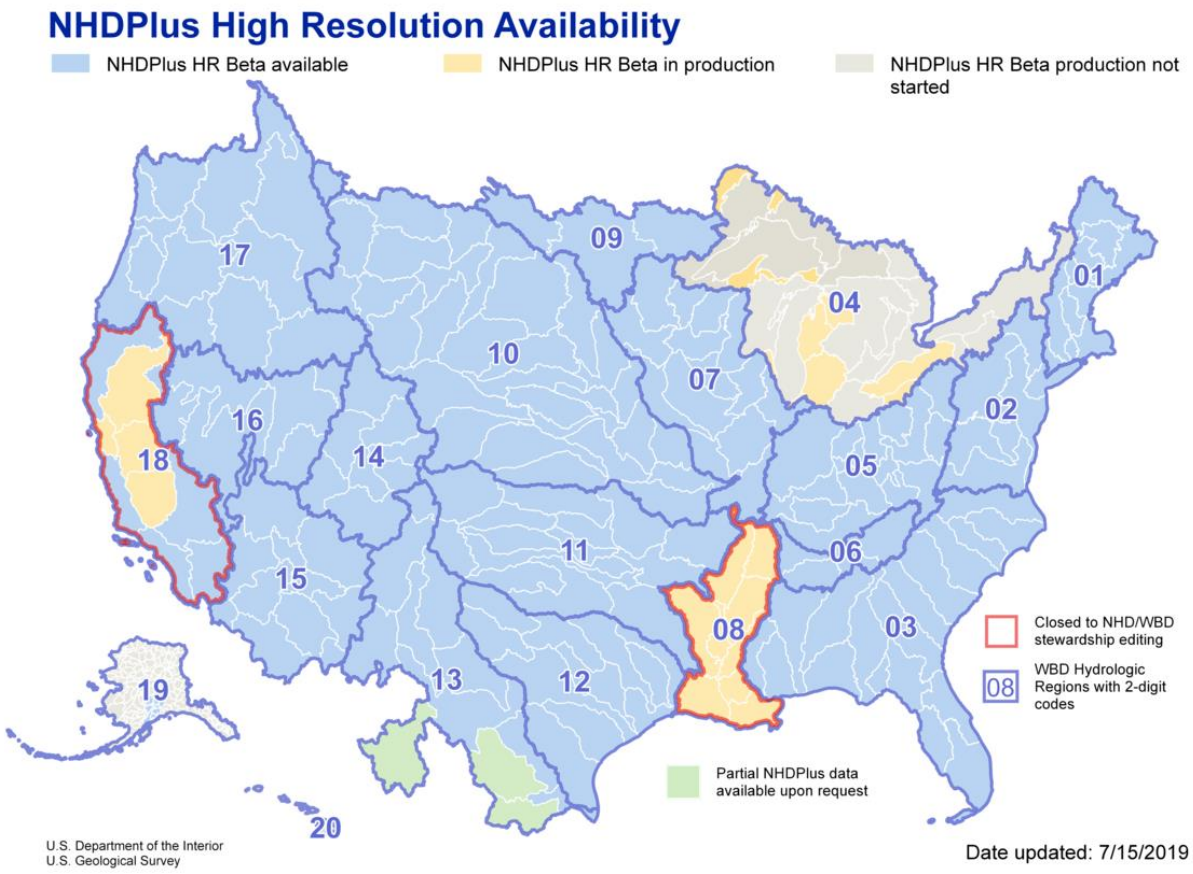
NHDPlus HR Status

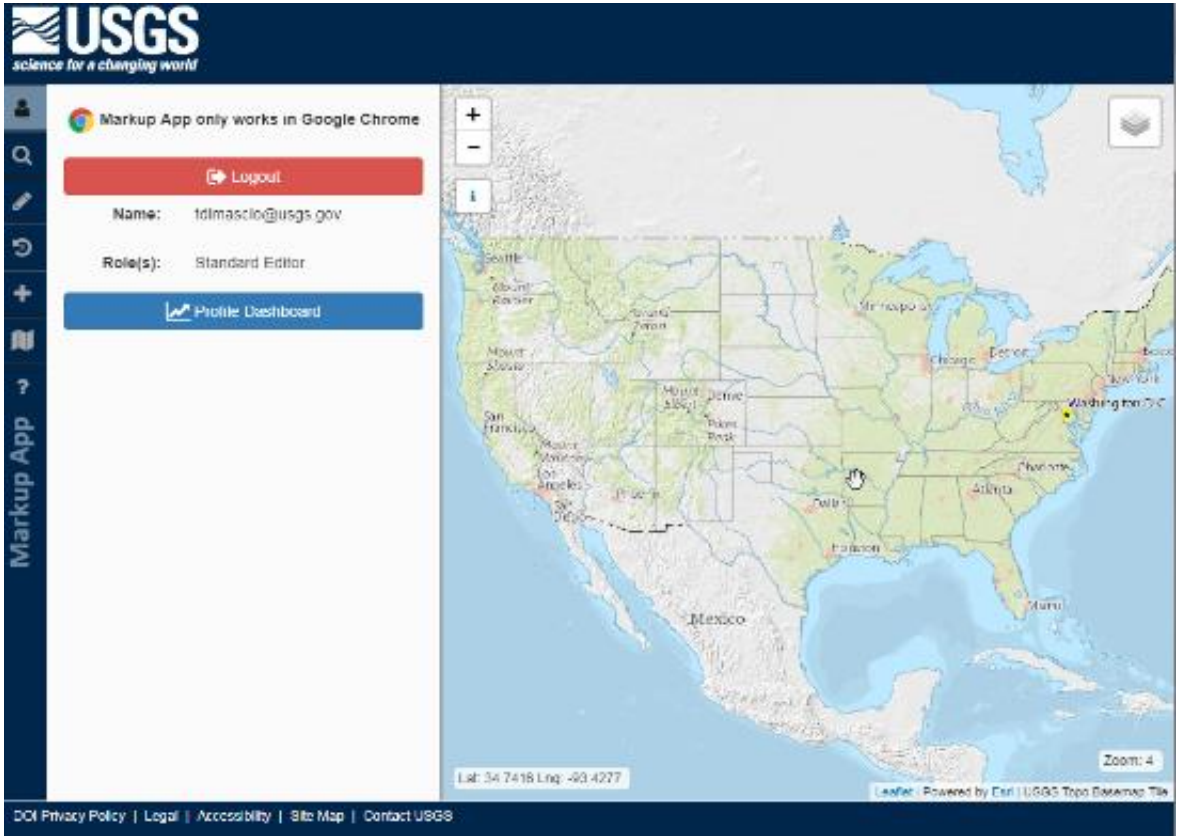
- NHDPlus HR Beta will be completed in 2020 for the conterminous U.S., HI and territories, followed by AK in later years
- Users are invited to review and provide feedback to the Beta version datasets
- Feedback will be used to update and improve the refreshed data release, beginning in late 2019



Markup App

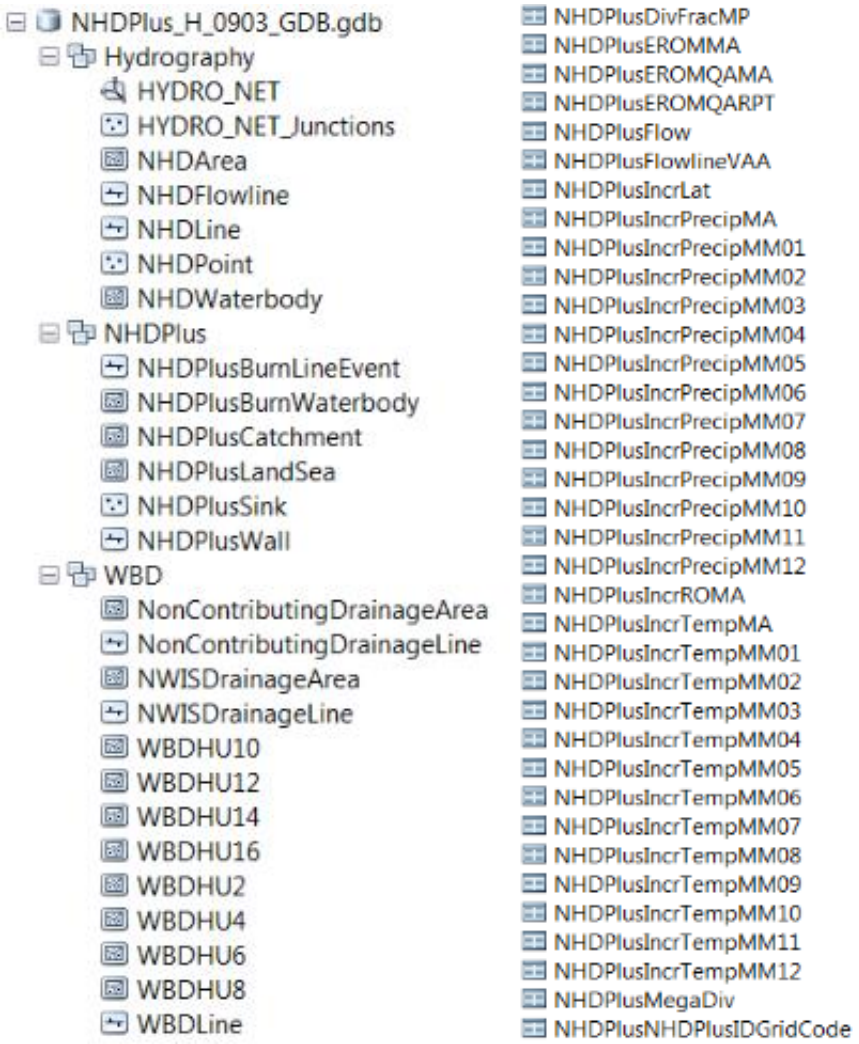
https://edits.nationalmap.gov/markup-app

- Suggest edits to NHD, WBD, and NHDPlus HR
- Requirements: Gmail or ArcGIS Online account and Google Chrome

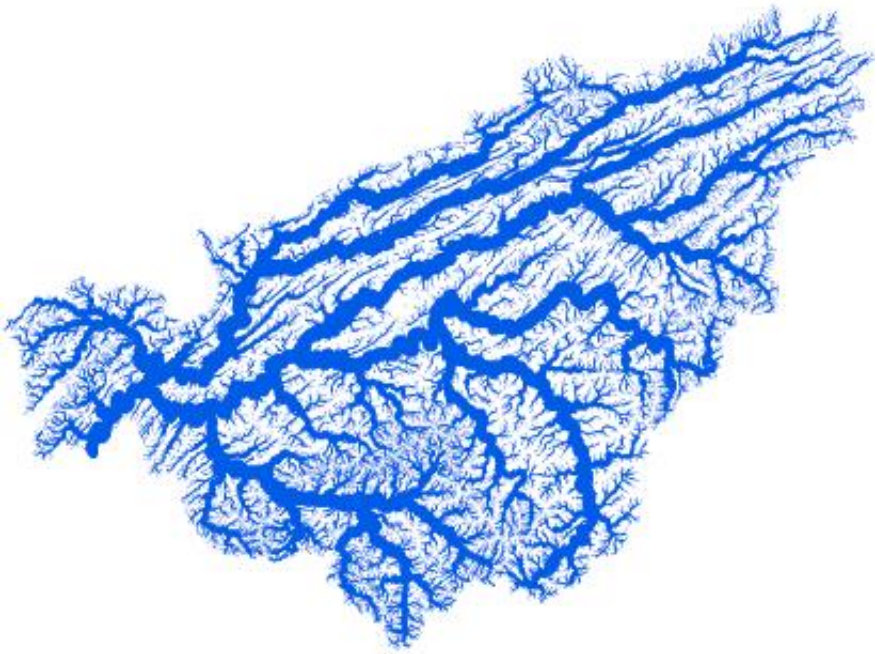


Vector Data

- NHD features
- NHDPlus features
- WBD features
- Value Added Attribute (VAA) tables



Vector Data



- NHDPlus_H_0903_GDB.gdb
  - Hydrography
    - HYDRO_NET
    - HYDRO_NET_Junctions
    - NHDArea
    - NHDFlowline
    - NHDLine
    - NHDPoint
    - NHDWaterbody
  - NHDPlus
    - NHDPlusBurnLineEvent
    - NHDPlusBurnWaterbody
    - NHDPlusCatchment
    - NHDPlusLandSea
    - NHDPlusSink
    - NHDPlusWall
  - WBD
    - NonContributingDrainageArea
    - NonContributingDrainageLine
    - NWISDrainageArea
    - NWISDrainageLine
    - WBDHU10
    - WBDHU12
    - WBDHU14
    - WBDHU16
    - WBDHU2
    - WBDHU4
    - WBDHU6
    - WBDHU8
    - WBDLine

- NHDPlusDivFracMP
- NHDPlusEROMMA
- NHDPlusEROMQAMA
- NHDPlusEROMQARPT
- NHDPlusFlow
- NHDPlusFlowlineVAA
- NHDPlusIncrLat
- NHDPlusIncrPrecipMA
- NHDPlusIncrPrecipMM01
- NHDPlusIncrPrecipMM02
- NHDPlusIncrPrecipMM03
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- NHDPlusIncrPrecipMM11
- NHDPlusIncrPrecipMM12
- NHDPlusIncrROMA
- NHDPlusIncrTempMA
- NHDPlusIncrTempMM01
- NHDPlusIncrTempMM02
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- NHDPlusIncrTempMM11
- NHDPlusIncrTempMM12
- NHDPlusMegaDiv
- NHDPlusNHDPlusIDGridCode

Vector Data

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65000300030296	7	1	1	0.6497	0.6497	35918	35417
65000300052711	8	1	1	0.88560002	0.88560002	-9998	46668
65000300014858	5	3	3	47.51939998	23.90860021	-9998	33046
65000300106445	6	4	4	215.67509921	215.67509921	-9998	46913
65000300096895	7			17.77670014	17.77670014	-9998	35848
65000300035863	8			0.70980006	0.70980006	-9998	39196
65000300065594	10			0.17109994	0.17109994	46193	45684
65000300105411	6			2003.84179784	2003.45979789	-9998	42342
65000300041488	8			0.76219994	0.76219994	-9998	42614
65000300085887	7			33.79639983	33.79639983	-9998	33847
65000300098802	7			1.30610012	1.30610012	-9998	40096
65000300031773	5			735.78720027	735.78720027	-9998	37635
65000300104158	9			4.53500008	4.53500008	-9998	42347
65000300009816	9			0.72749996	0.72749996	46323	44884
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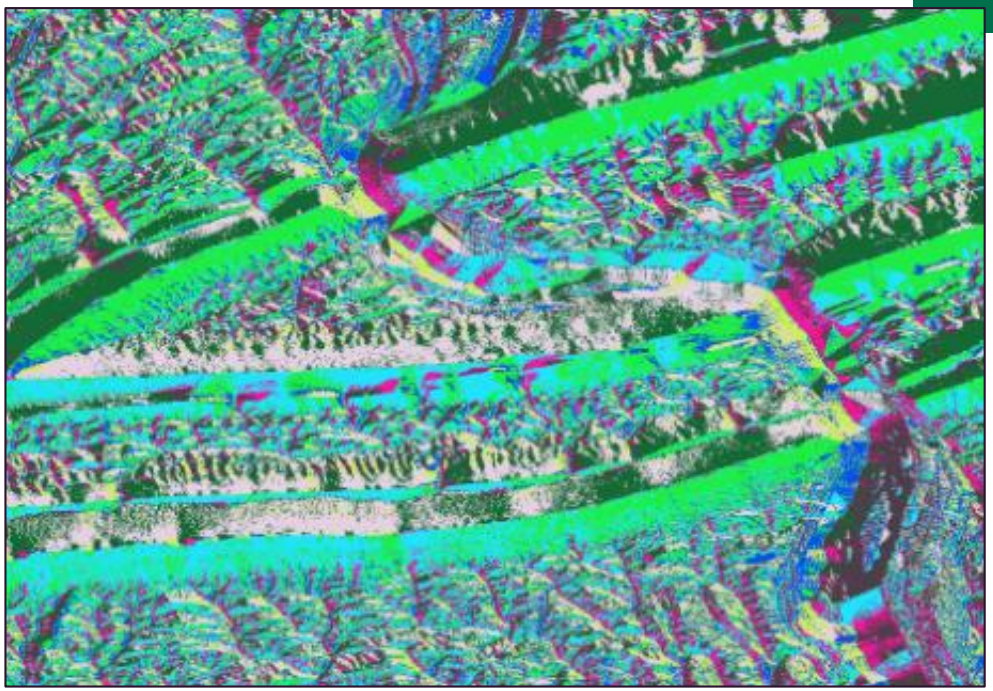
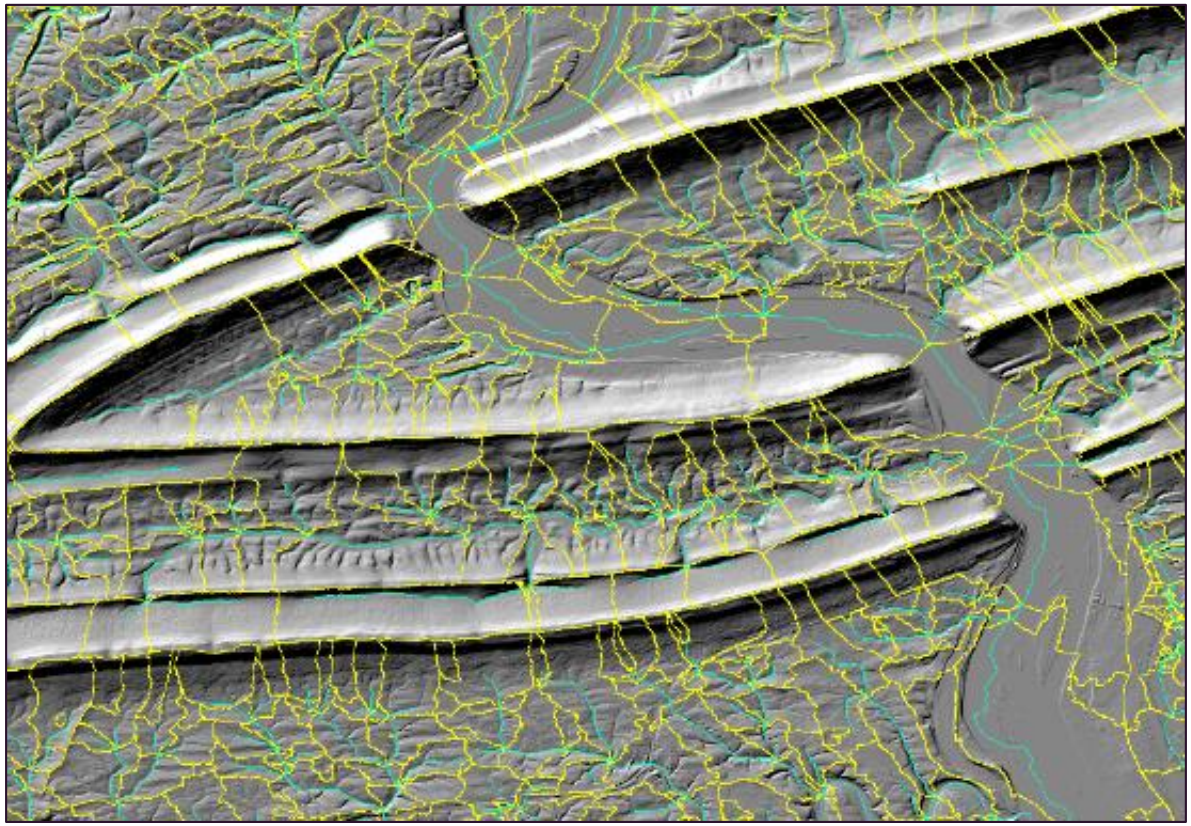
65000300009320	6						

Raster Data

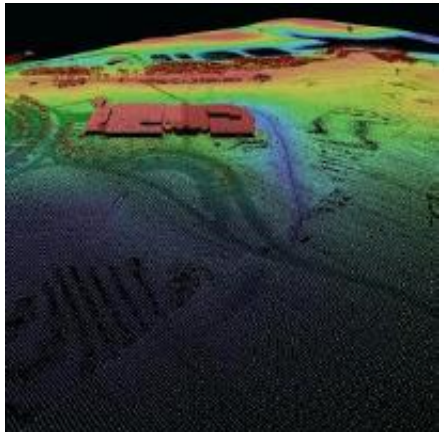
- HRNHDPlusRasters0601
  - elev_source.gdb
  - cat.tif
  - catseed.tif
  - elev_cm.tif
  - fac.tif
  - facmask.tif
  - fdr.tif
  - fdroverland.tif
  - filldepth.tif
  - hydrodem.tif
  - shdrelief.jp2
  - swnet.tif.xml



Raster and Vector Data



VAAs



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NHDPlus Value Added Attributes (VAAs)

- NHDPlus is built though an automated process that analyzes NHD, WBD, and 3-DEP elevation.
- This analysis produces a set of value added geospatial layers and hundreds of attributes.
- Many of the attributes are computed from the analysis of the NHD network.
- These attributes are designed to make the NHD network more powerful and easier to use.
- See https://usgs.gov/NatHydroVAAs

NHDPlus HR Value Added Attributes (VAAs)

NHDPlus Analysis VAAs

- StreamOrder
- StreamCalculator
- ArbolateSum
- ReturnDivergence
- PathLength

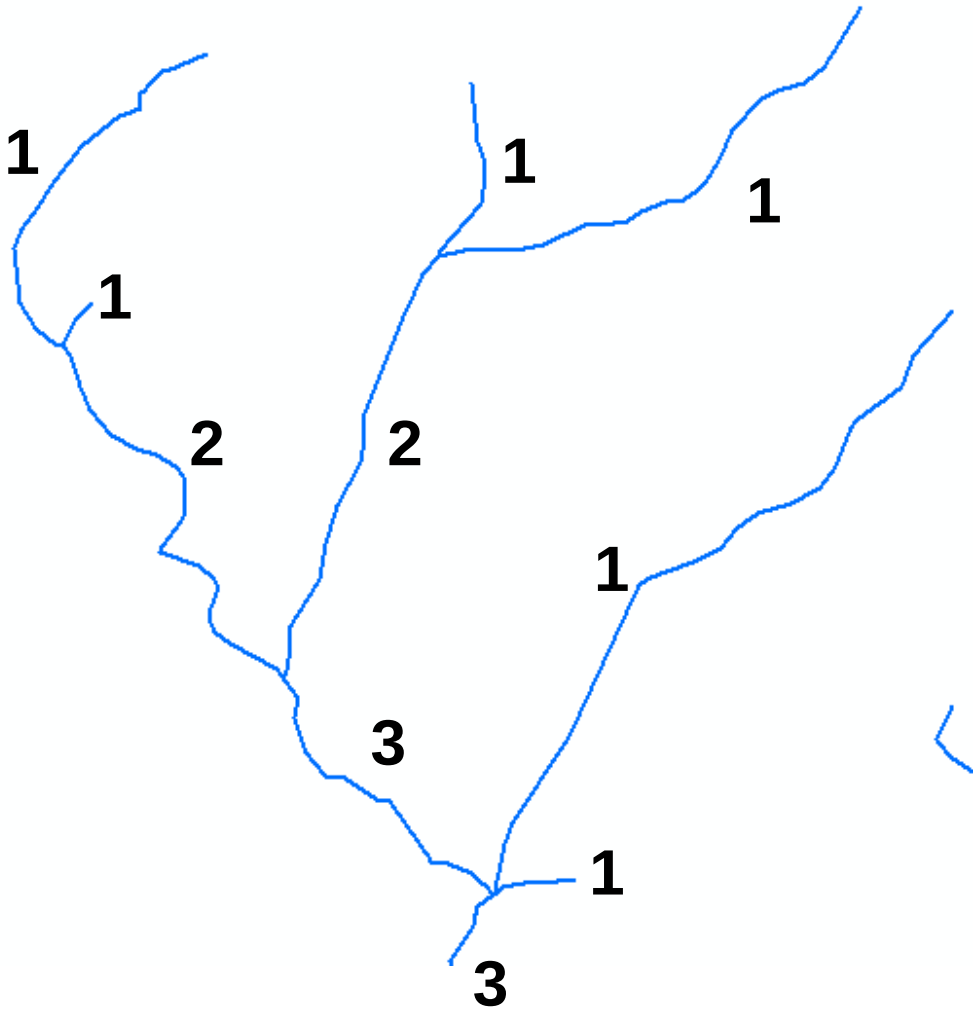
NHDPlus Navigation VAAs

- FromNode/ToNode
- Hydroseq
- LevelPathID
- TerminalPathID
- StreamLevel
- Divergence
- StartFlag
- TerminalFlag
- VPUIn/VPUOut
- UpLevelPathID
- UpHydroSeq
- DnStreamLevel
- DnLevelPathID
- DnMinorHydroseq
- DnDrainCount

NHDPlus Value Added Attributes (VAAs)

Strahler Stream Order

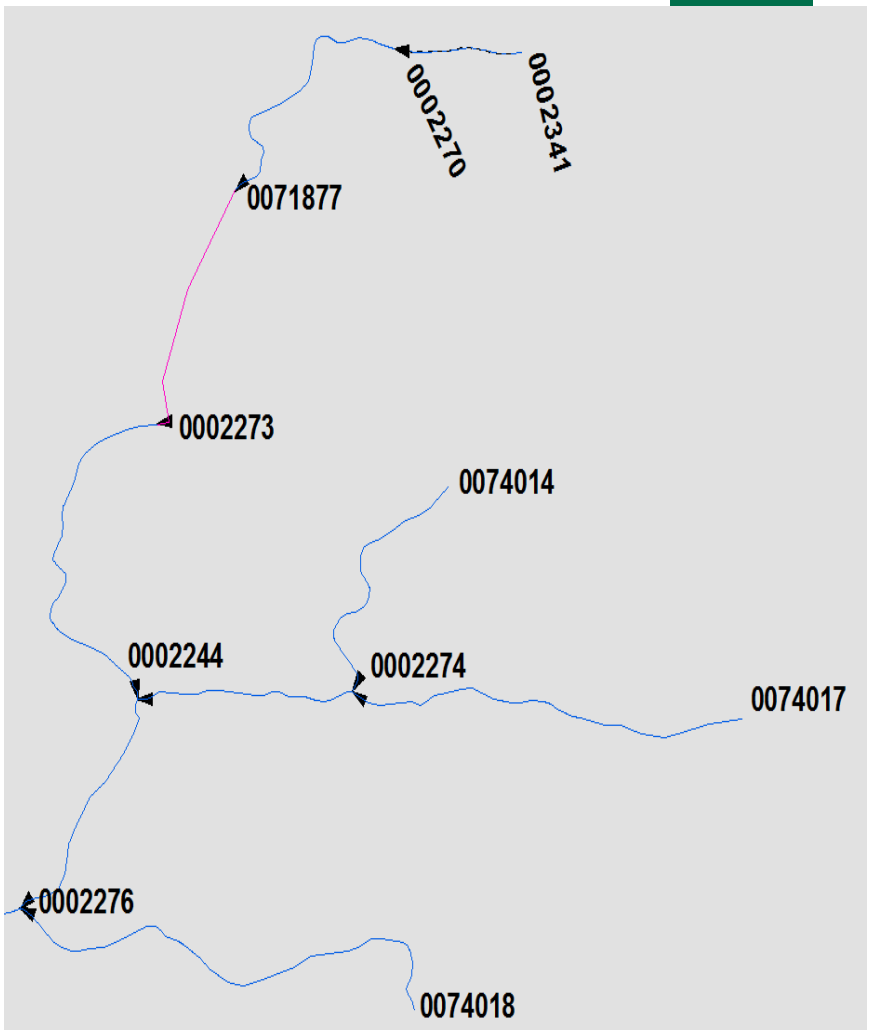
- A surrogate for stream size
- A popular analysis attribute.



NHDPlus Value Added Attributes (VAAs)

FromNode/ToNode

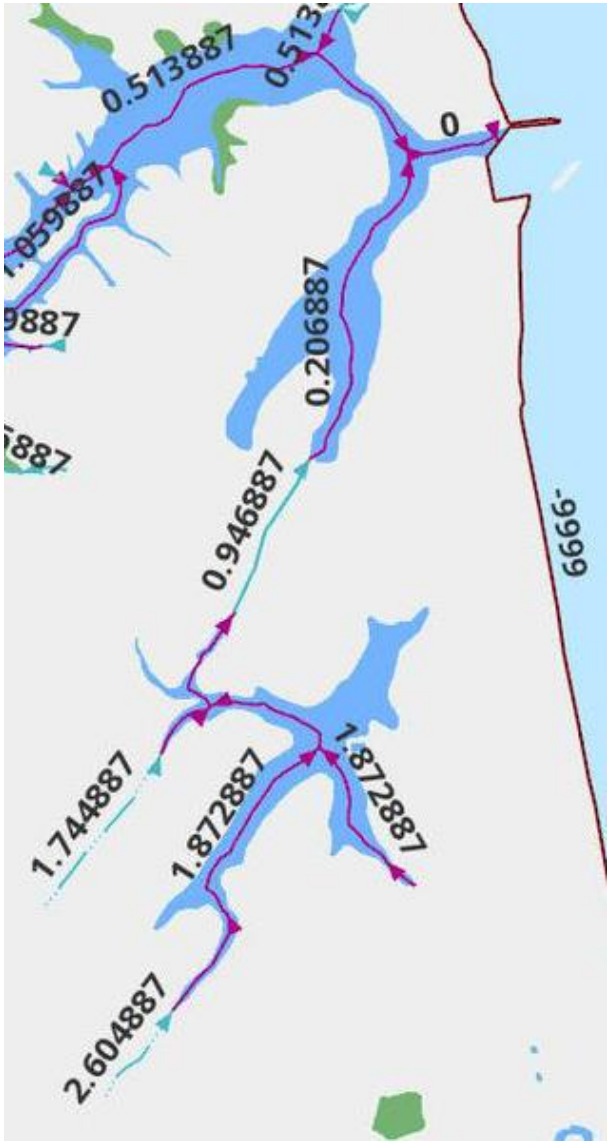
- A set of nationally unique identifiers for the node endpoints of the flowlines
- This supports the many models that use linked node navigation
- Note there is no actual node feature class



NHDPlus Value Added Attributes (VAAs)

PathLength

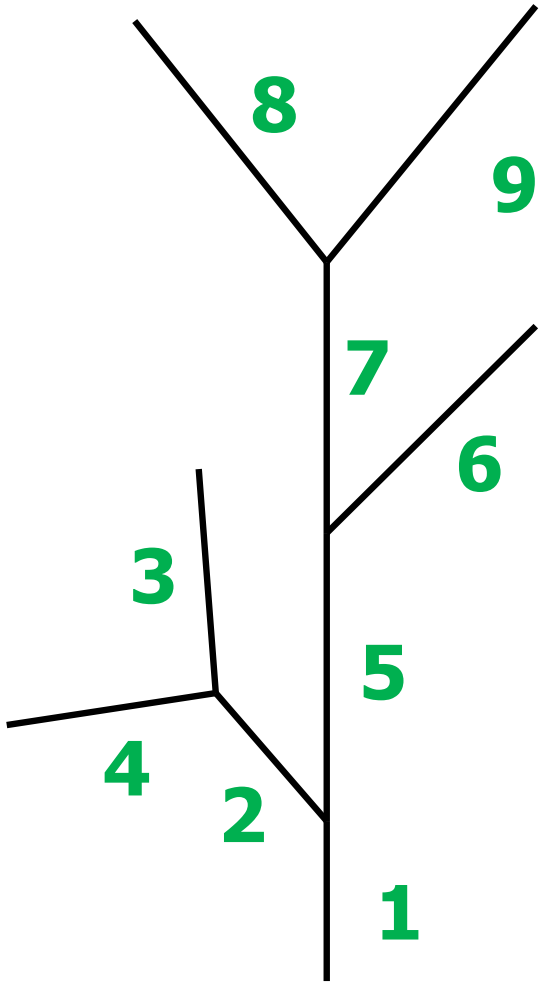
- The distance downstream to the network terminus



NHDPlus Value Added Attributes (VAAs)

Hydrologic Sequence Number (HYDROSEQ)

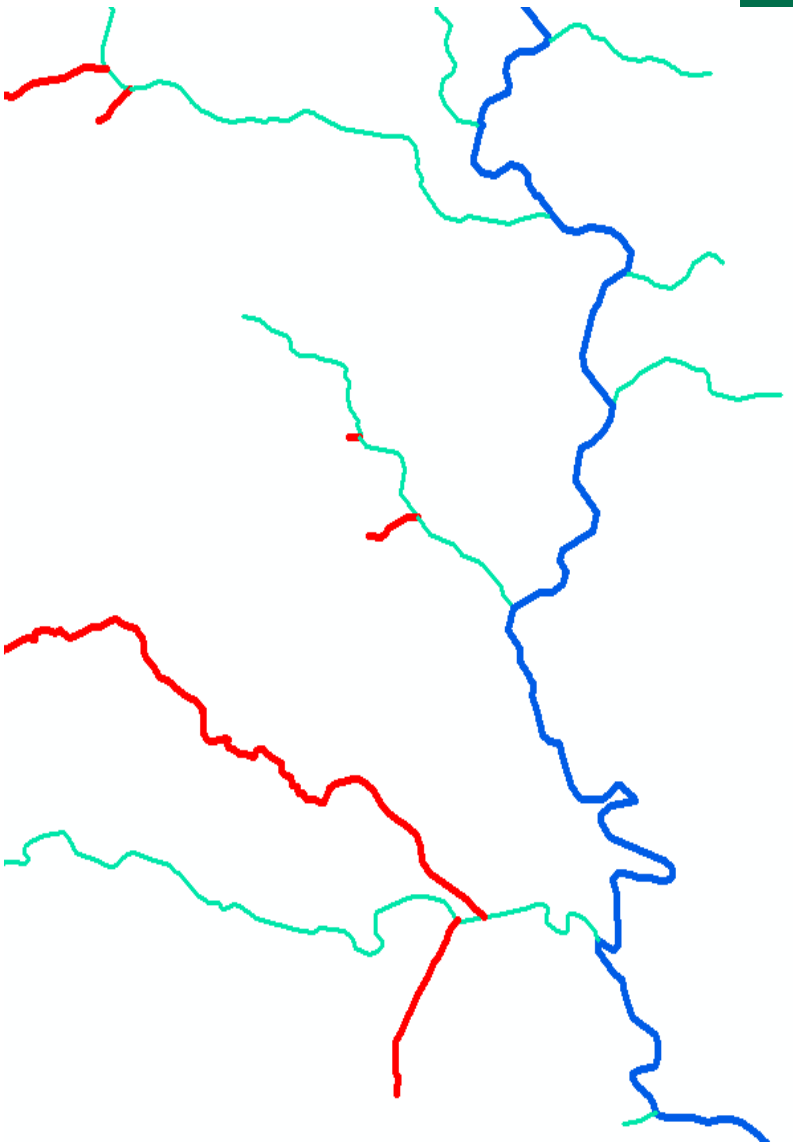
- A nationally unique sequence number that places NHD flowline features in hydrologic sequence
  - Ascending = downstream to up
  - Descending = upstream to down
- Enables models to process the network in a tabular manner without using geometry flowlines



NHDPlus Value Added Attributes (VAAs)

StreamLevel

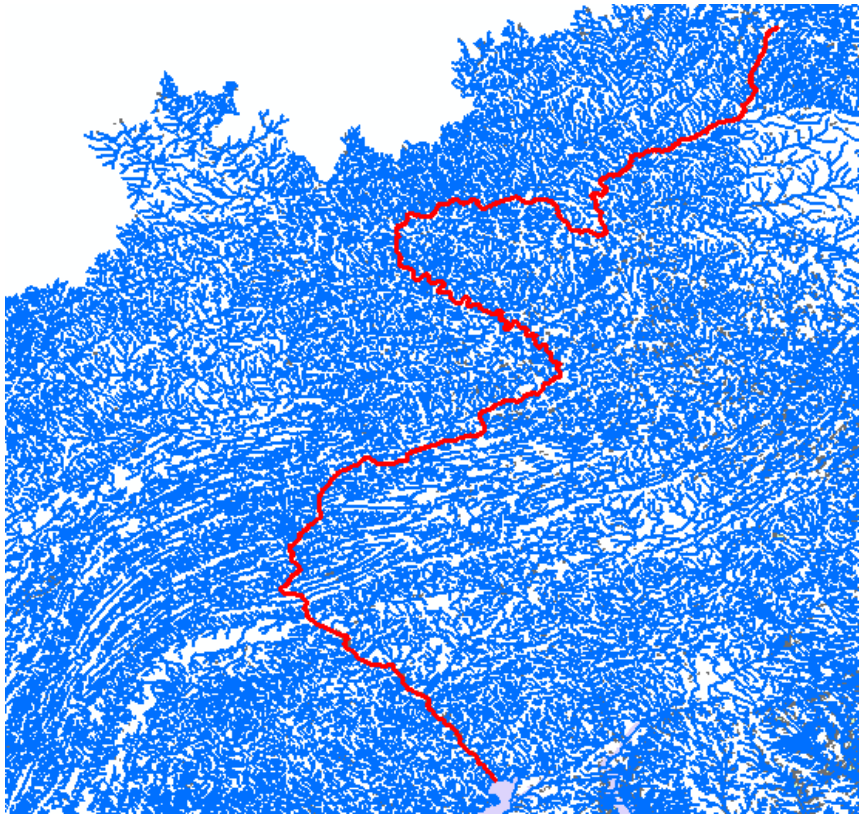
- Provides the information necessary to determine the main path upstream at each confluence
  - **Blue** = StreamLevel 1
  - **Green** = StreamLevel 2
  - **Red** = StreamLevel 3
- This supports upstream navigation of a river mainstem



NHDPlus Value Added Attributes (VAAs)

LevelPathIdentifier

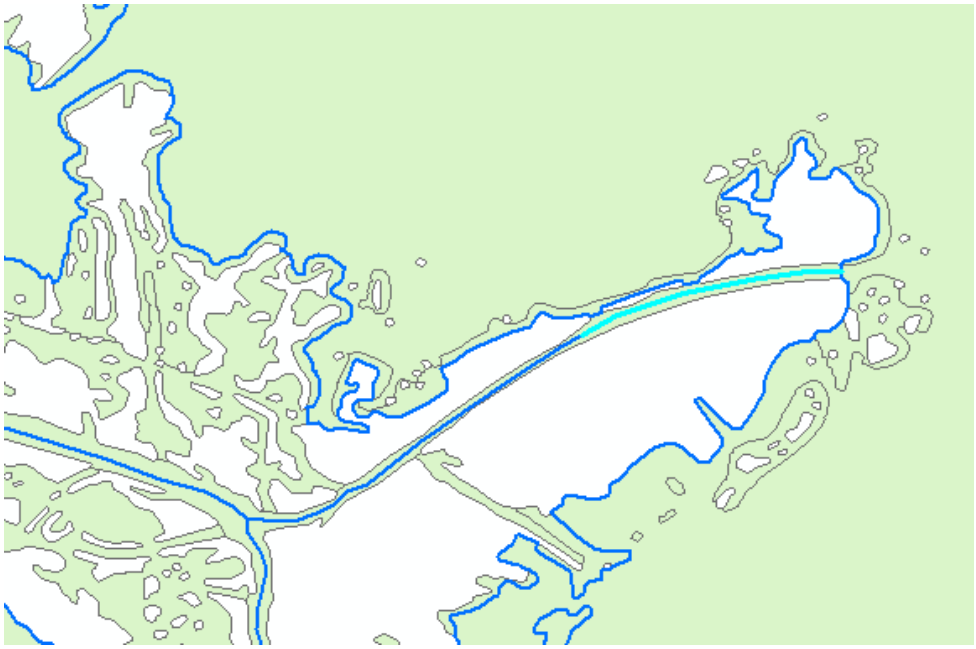
- The identifier (HydroSeq) for all the flowlines on a level path from mouth to headwaters
- River Main Stem



NHDPlus Value Added Attributes (VAAs)

TerminalPathIdentifier

- The identifier (HydroSeq) for the terminal flowline in this network



NHDPlus Value Added Attributes (VAAs)

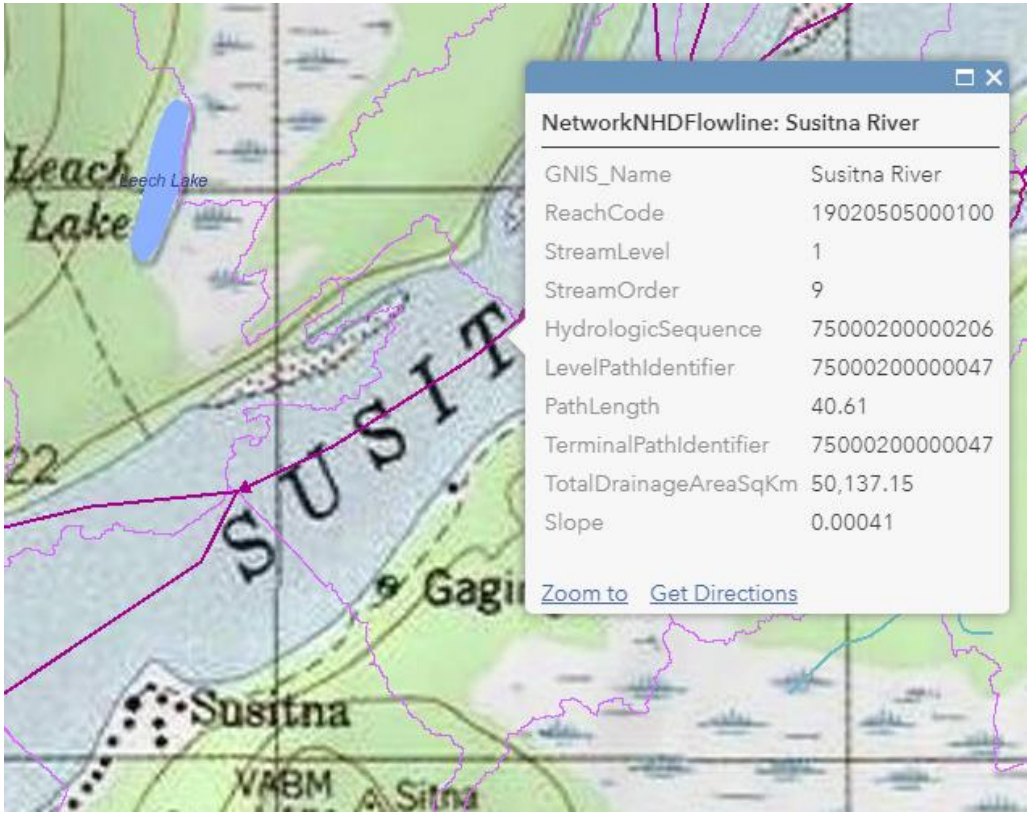
Total Upstream Drainage Network

- A simple select TerminalPathIdentifier to identify the upstream drainage network

NHDPlus Value Added Attributes (VAAs)

Total Upstream Drainage Area

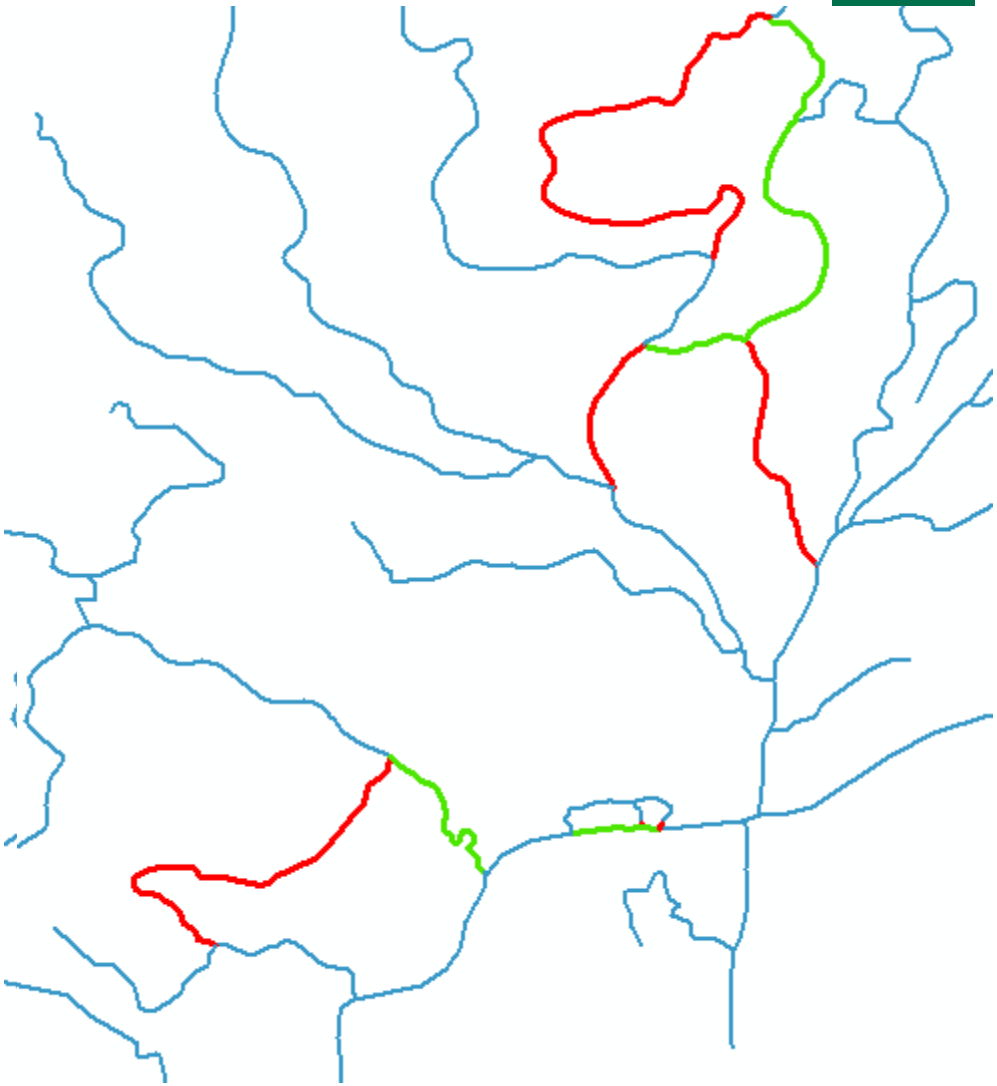
- Each flowline has total upstream drainage area already computed
- Plus… many other attributes



NHDPlus Value Added Attributes (VAAs)

DivergenceCode

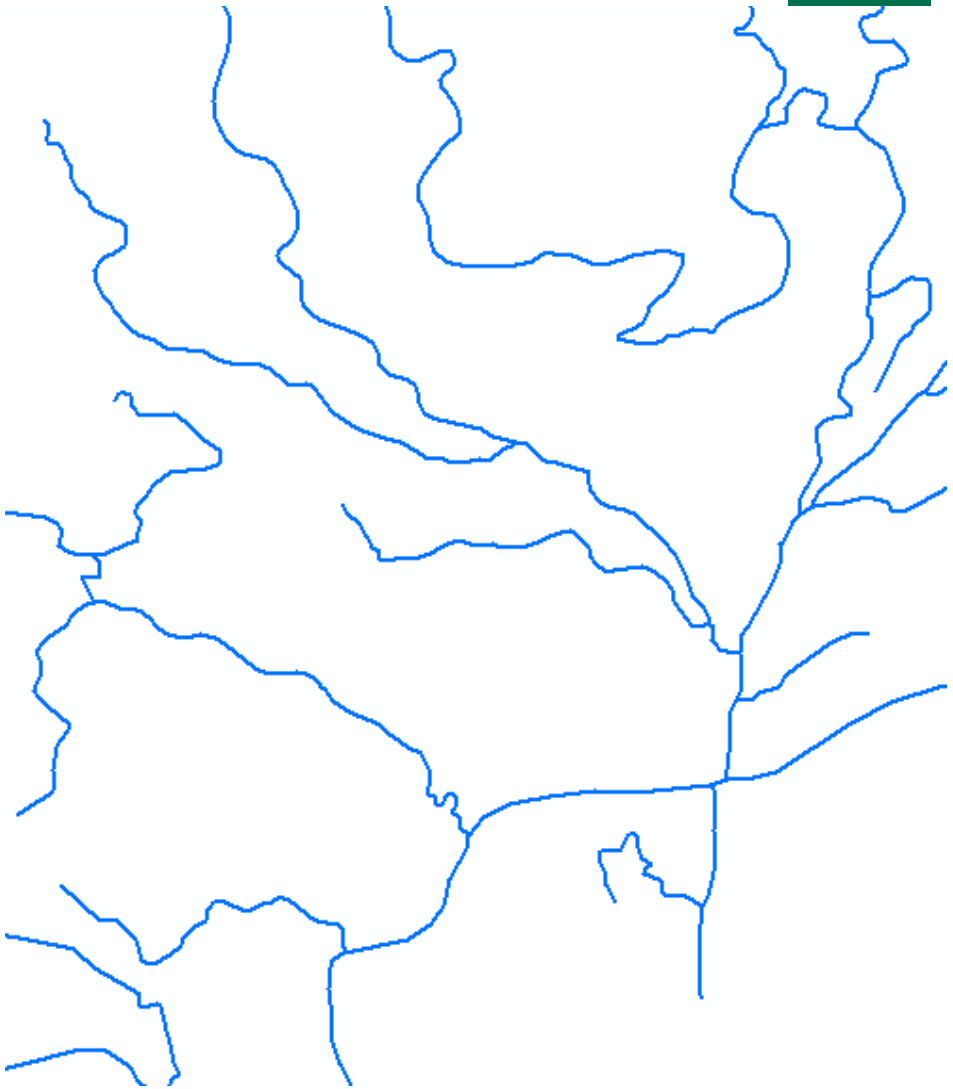
- A flag which defines the major and minor branches of a flow split (divergence)
- This supports downstream navigation of the network mainstem



NHDPlus Value Added Attributes (VAAs)

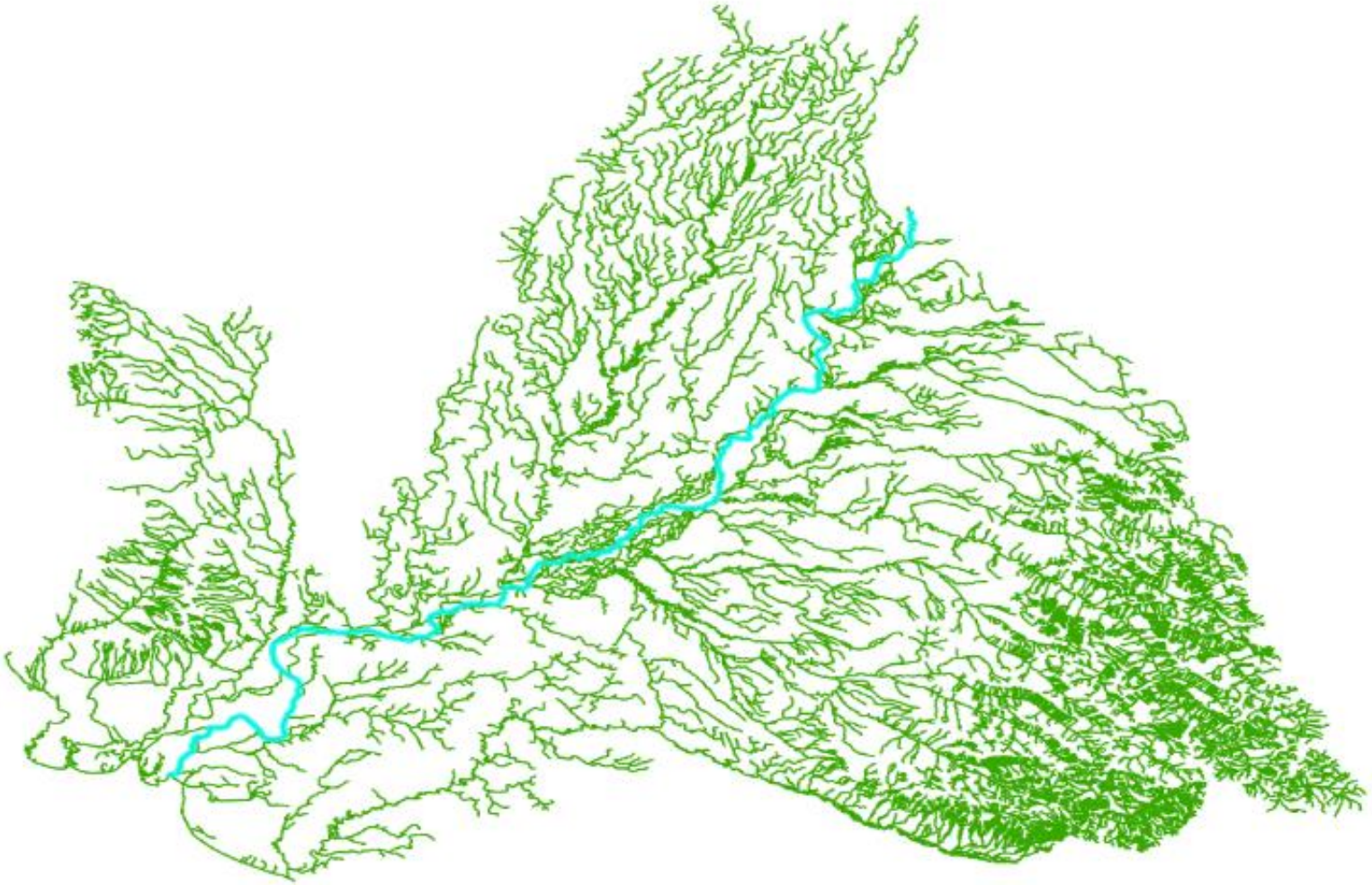
Dendrite

- Remove divergence minor paths and create a dendritic network
- Some models require a dendritic network
- Select for **StreamOrder = StreamCalc**



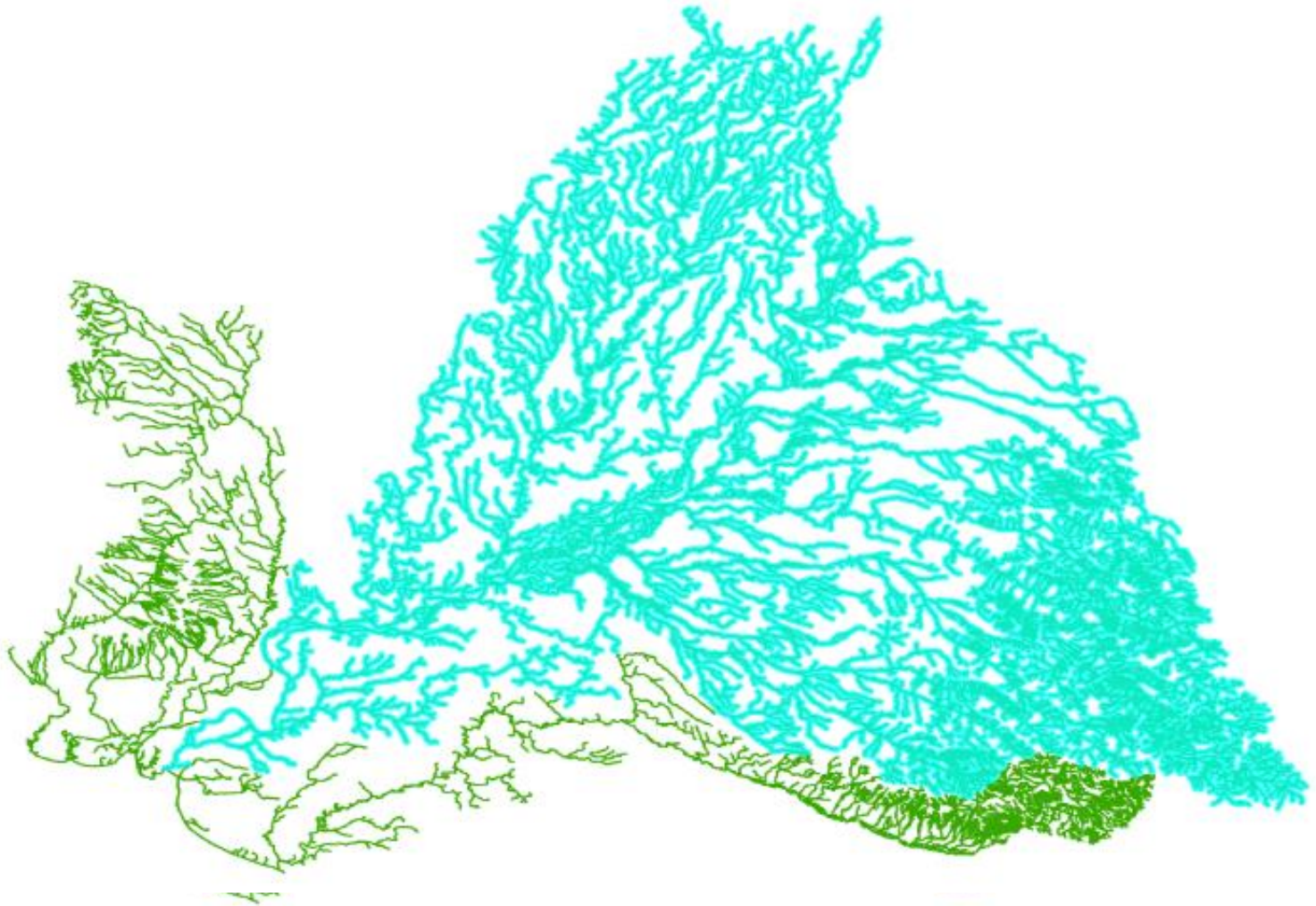
Putting it all together

LevelPathID: Selects the Susitna River



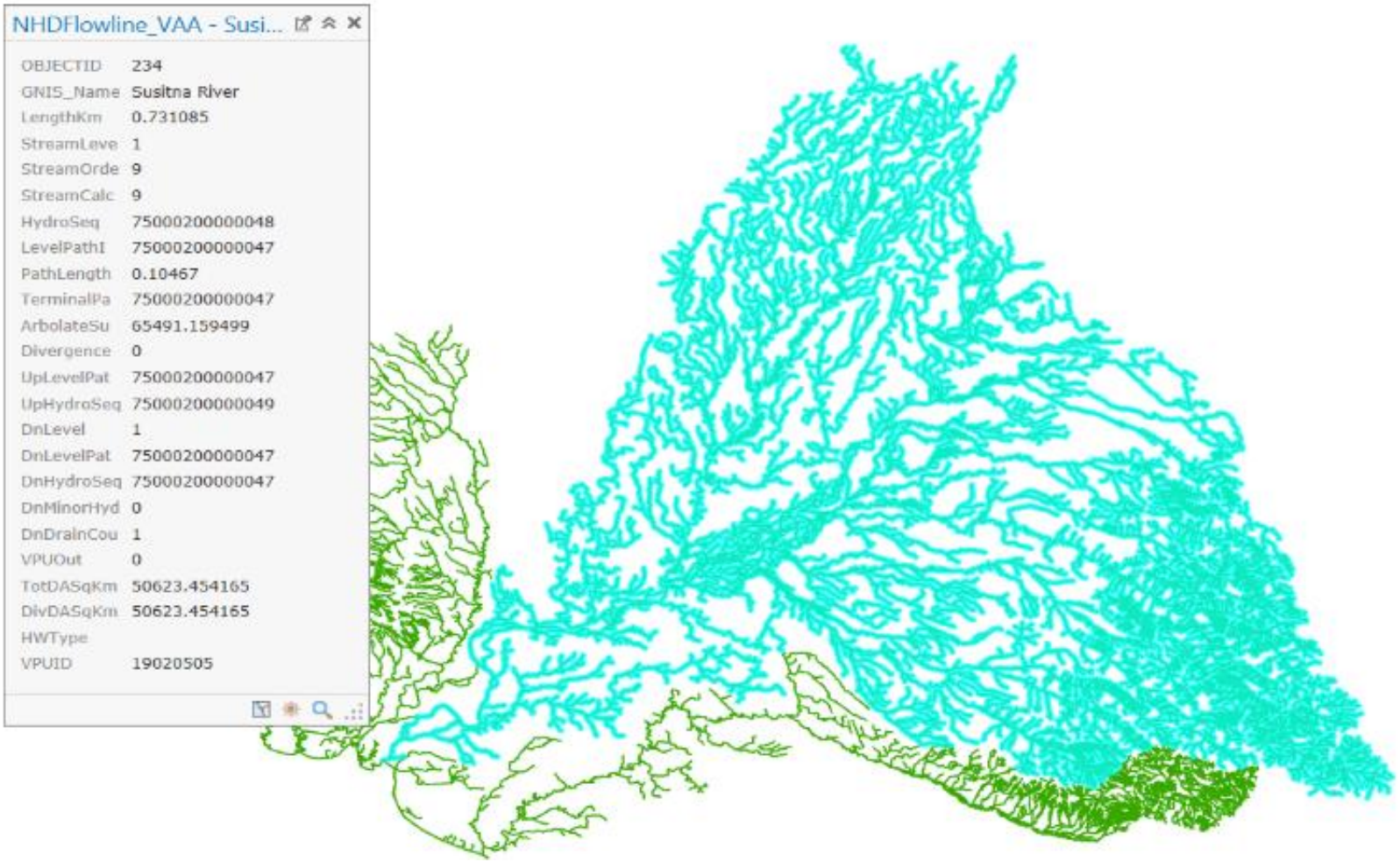
Putting it all together

TerminalPathIdentifier: Selects everything upstream of the Susitna River



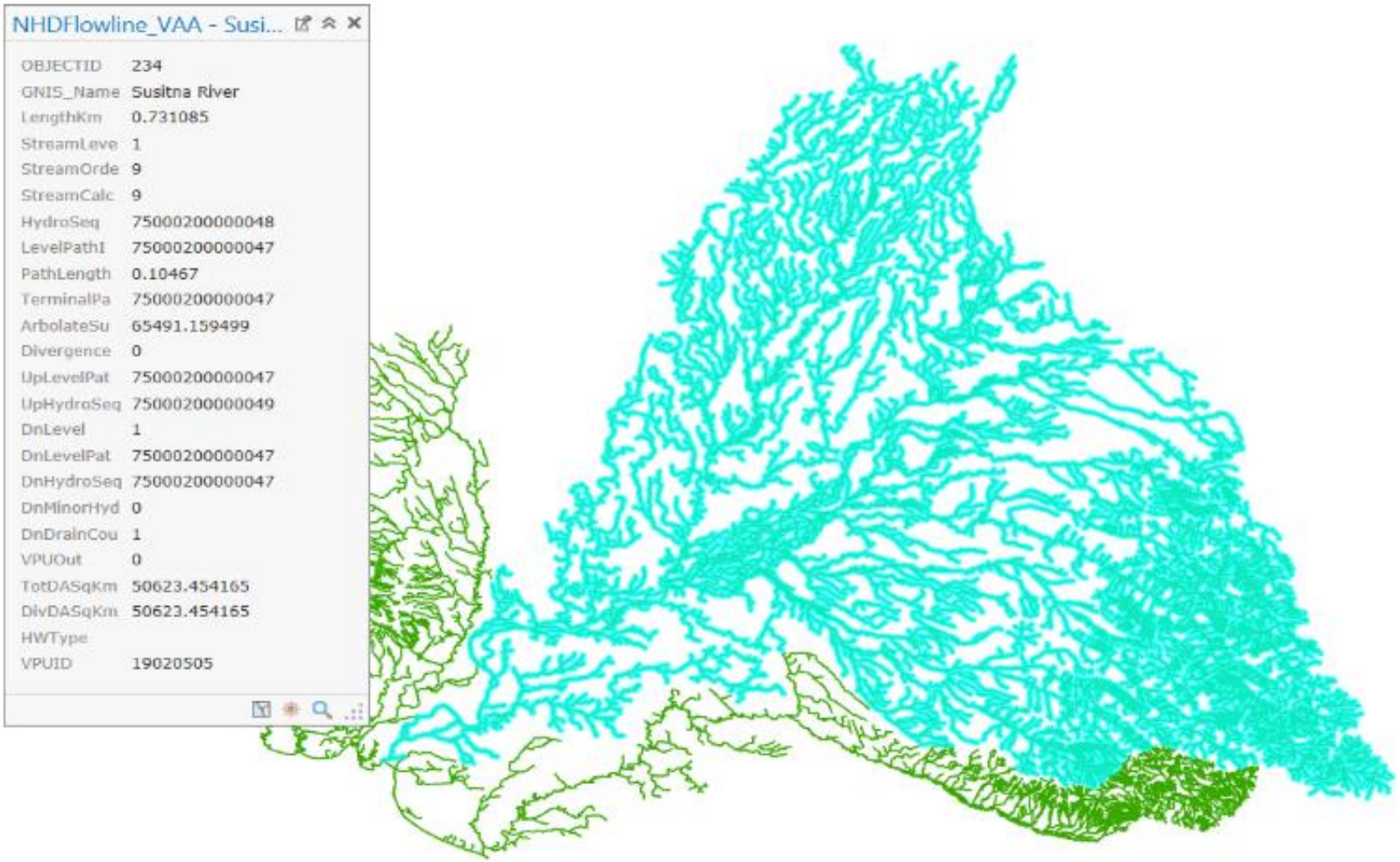
Putting it all together

ArbolateSum (UpstreamCumulativeStreamKm): 65,491 km



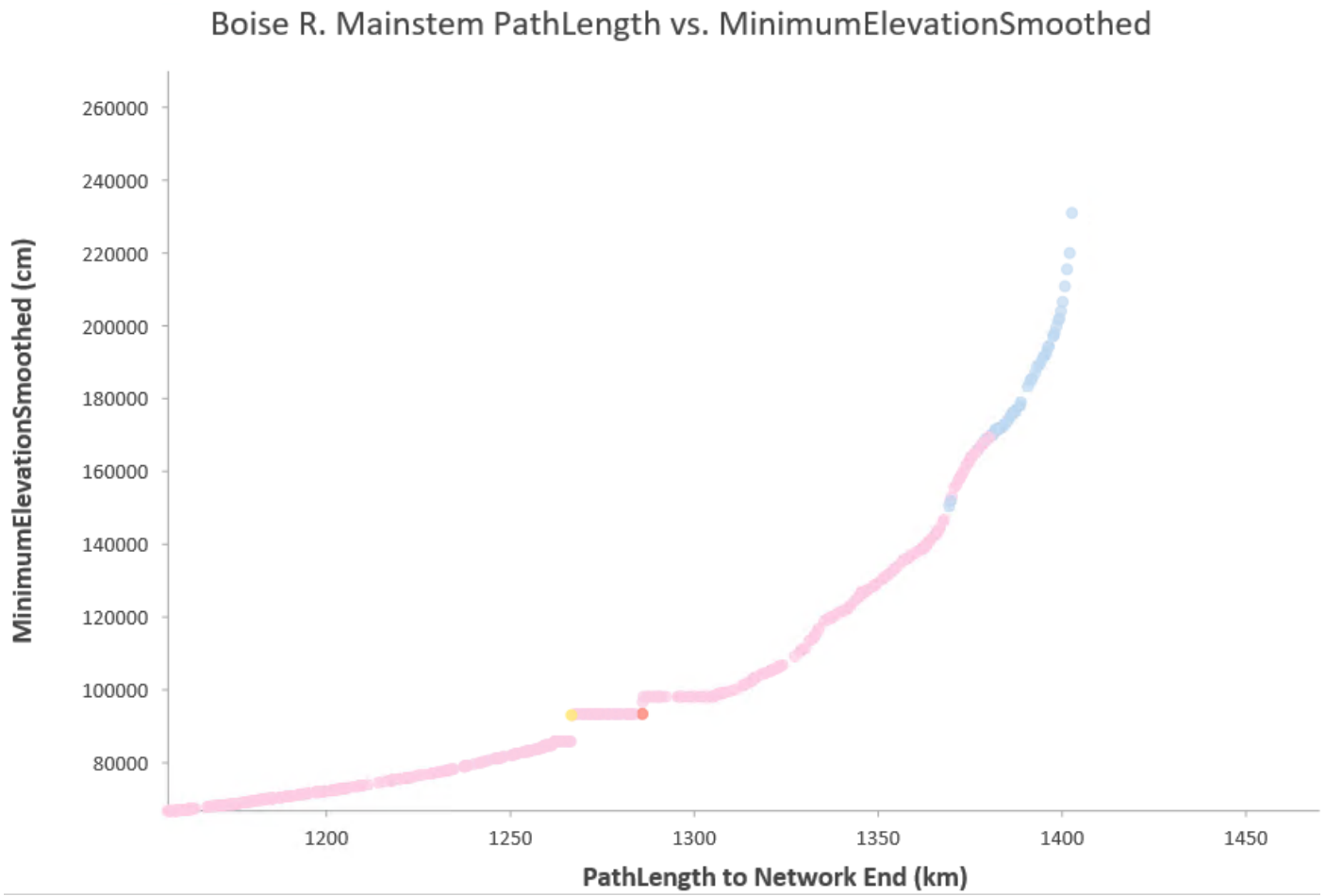
Putting it all together

TotalDrainageAreaSqKM: 50,623 sqkm



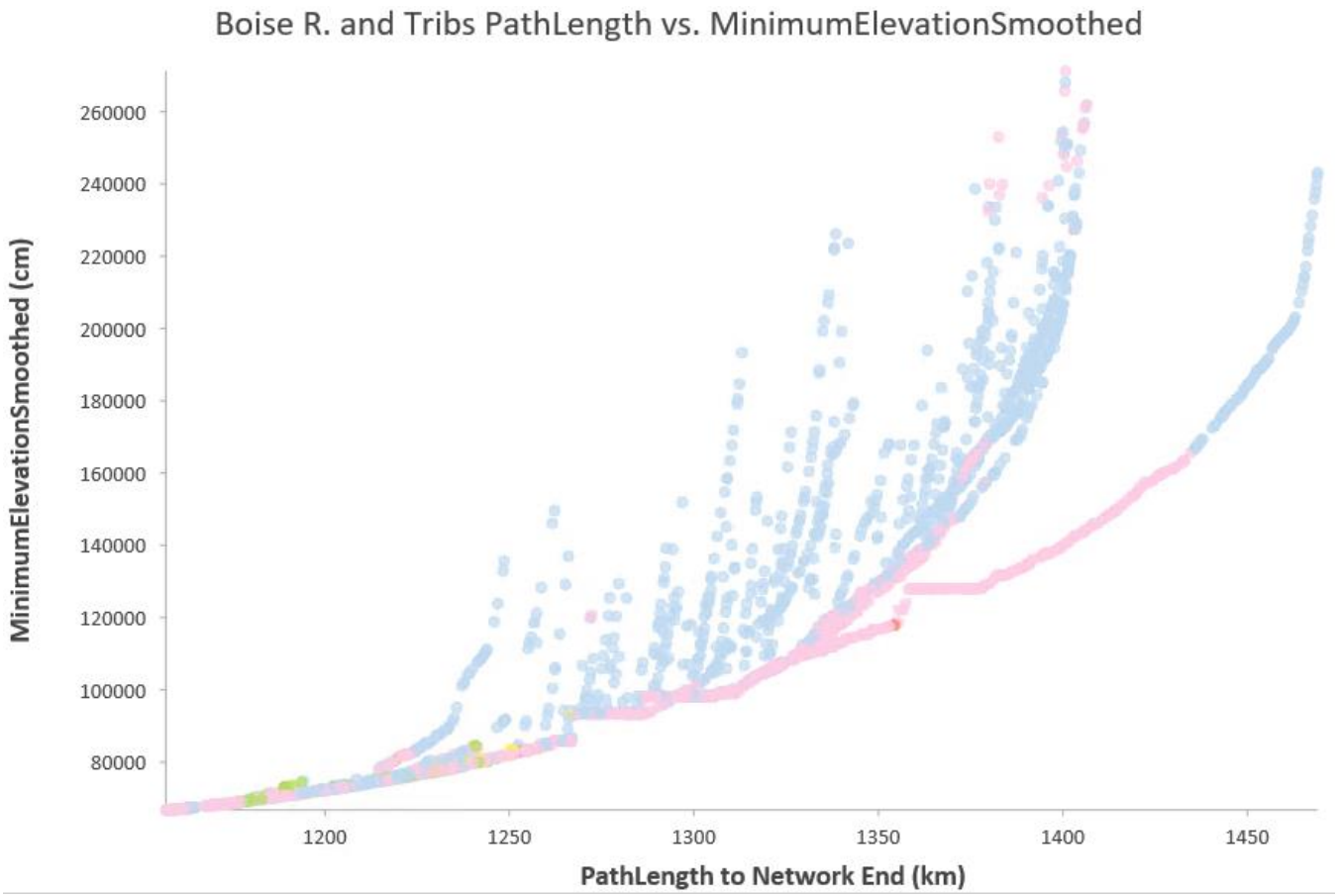
Longitudinal Profile from NHDPlus HR

Plot MinimumElevationSmoothed vs PathLength for a selected LevelPathID



Longitudinal Profile from NHDPlus HR

Plot MinimumElevationSmoothed vs PathLength for selected NHDFlowlines



Resources

- See VAA web page https://usgs.gov/NatHydroVAAs
- User Guide for NHDPlus HR is coming soon. The NHDPlus V2 User Guide is a good reference for now: https://s3.amazonaws.com/nhdplus/NHDPlusV21/Documentation/NHDPlusV2_User_Guide.pdf
- New GitHub Repository: https://github.com/ACWI-SSWD/nhdplushr_tools
- NHDPlus HR web page: https://usgs.gov/NatHydroNHDPlus-HR

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