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# 3D NHD: Considerations and complexities of elevation derived hydrography

NV5 Geospatial (previously Quantum Spatial)

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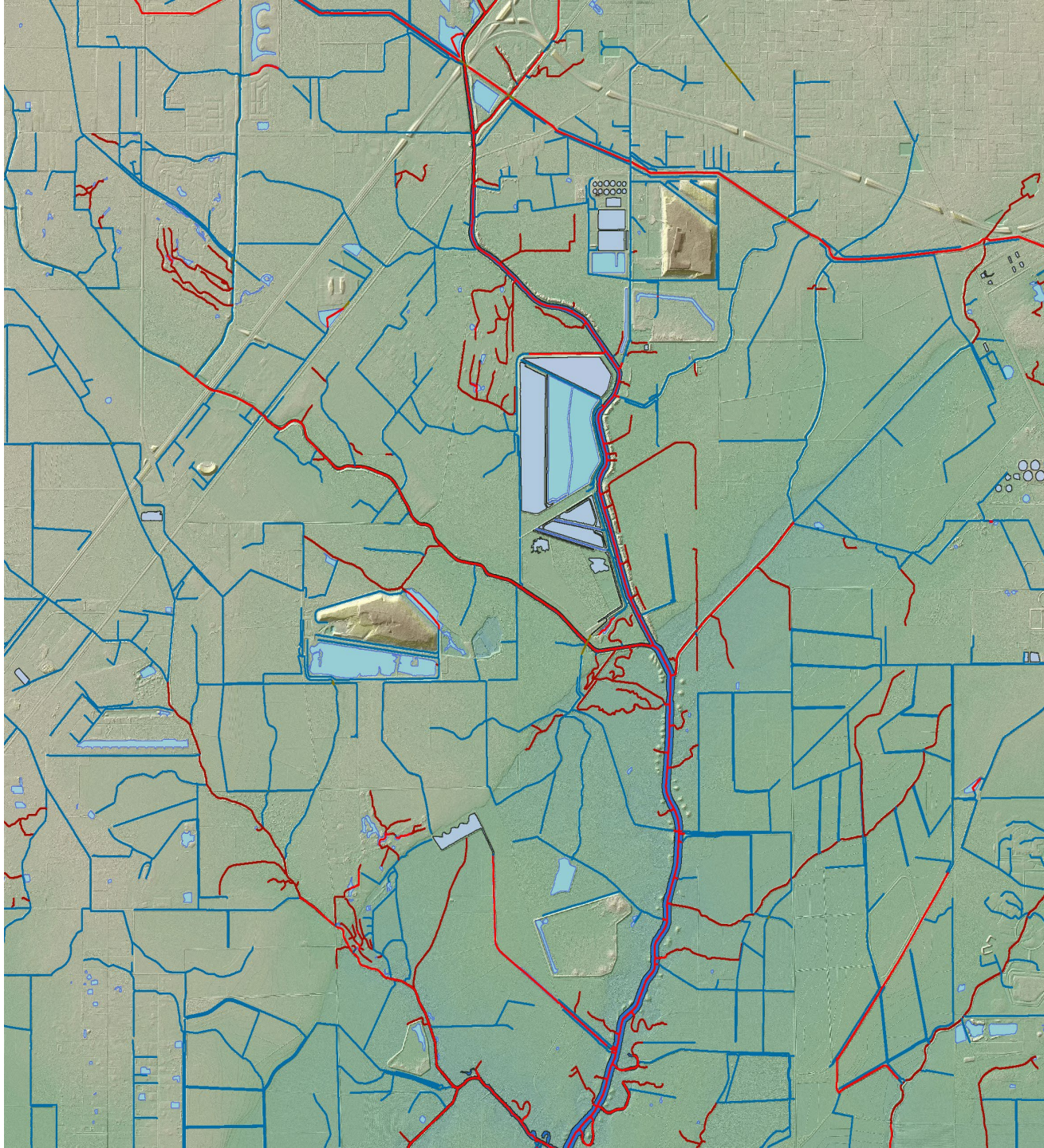
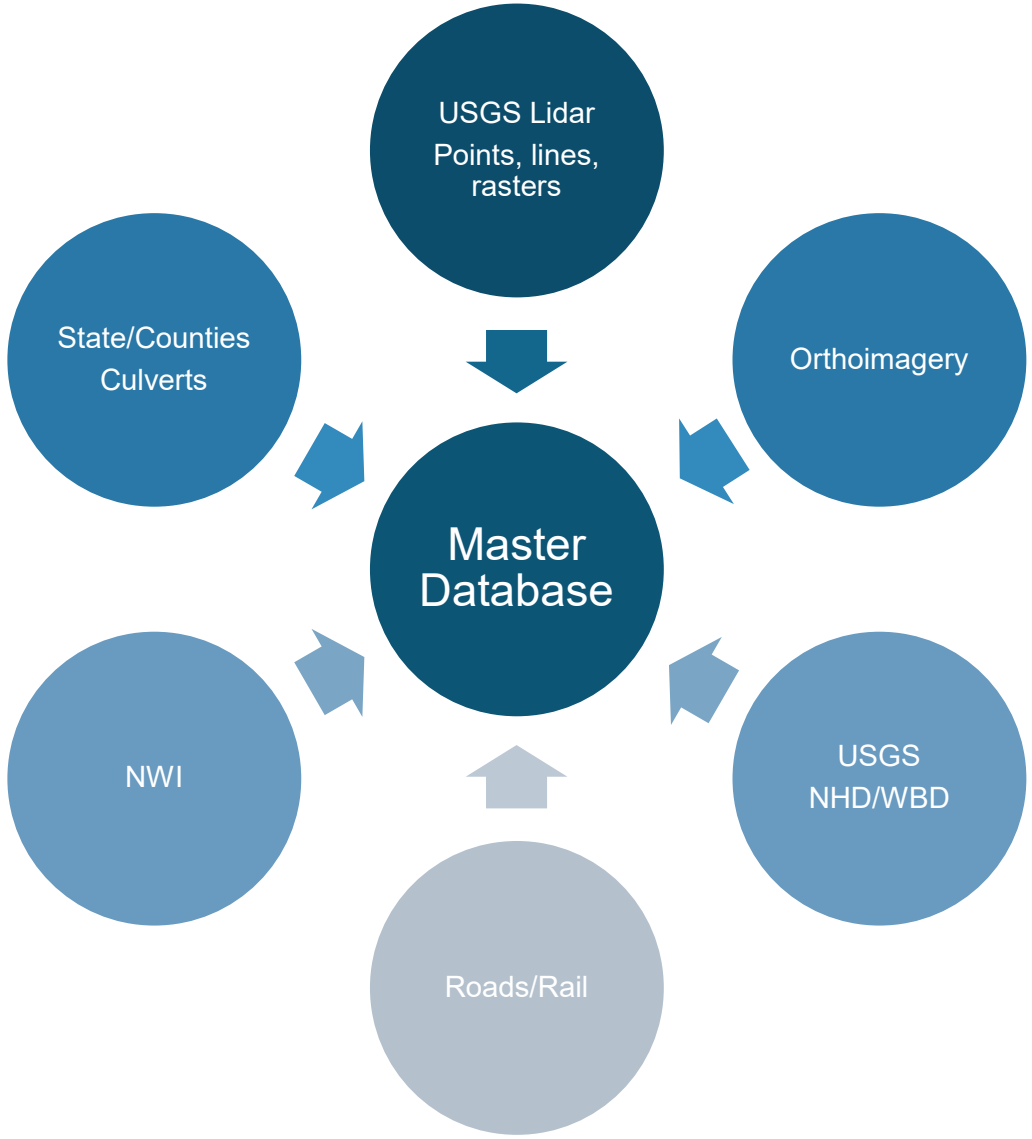
# Presentation Outline

- DATA CONSOLIDATION AND MANAGEMENT
- DATA SCHEMA DEVELOPMENT
- CAPTURE SPECIFICATIONS
- OPEN WATER DELINEATION
- GEOMORPHIC INDICATORS
- HYDRO ENFORCEMENT
- LINEWORK DERIVATION
- FEATURE SMOOTHING REQUIREMENTS
- NETWORK INTEGRATION AND FINALIZATION
- STAKEHOLDER FEEDBACK AND REVIEW
- OTHER CONSIDERATION

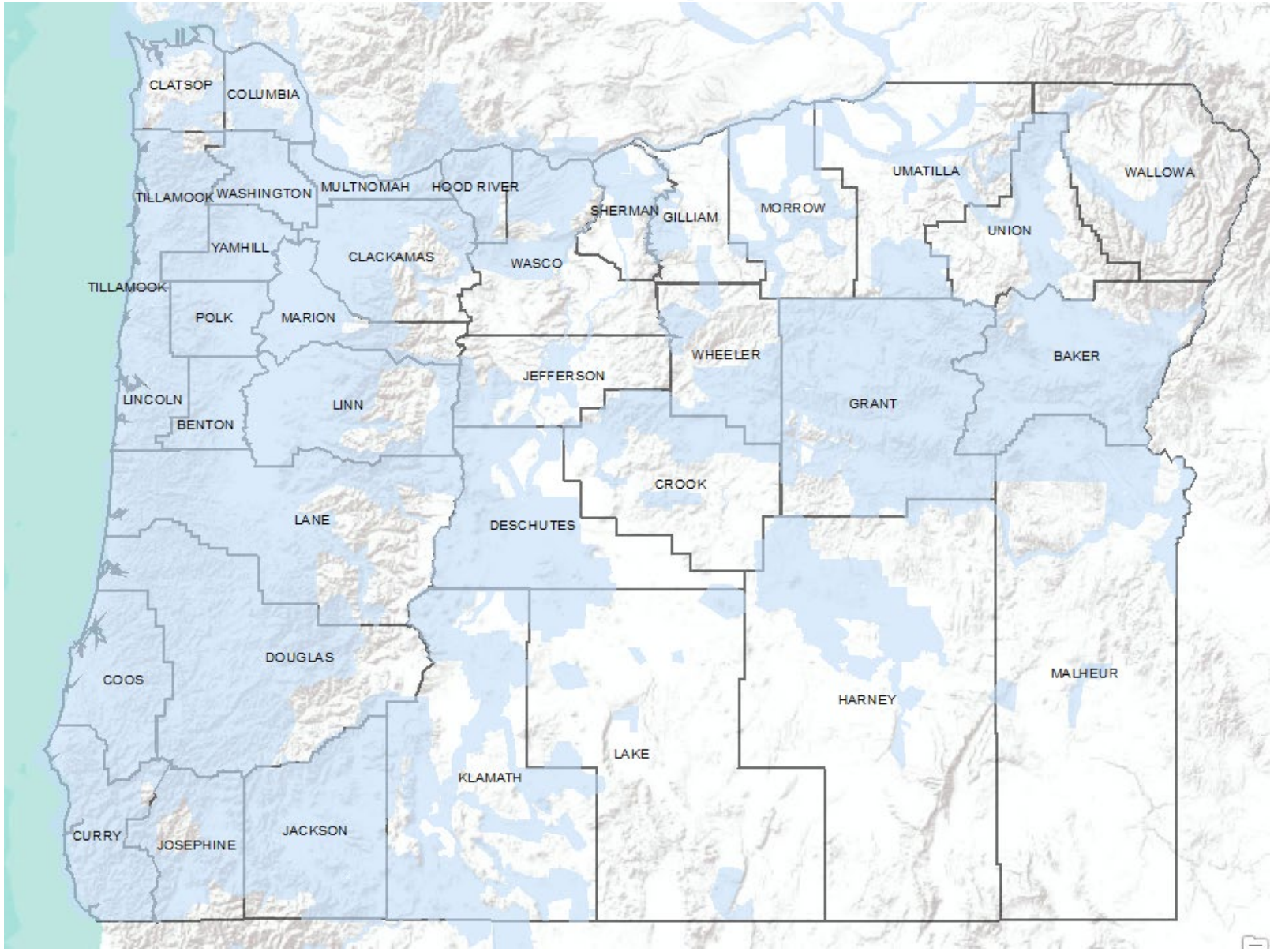


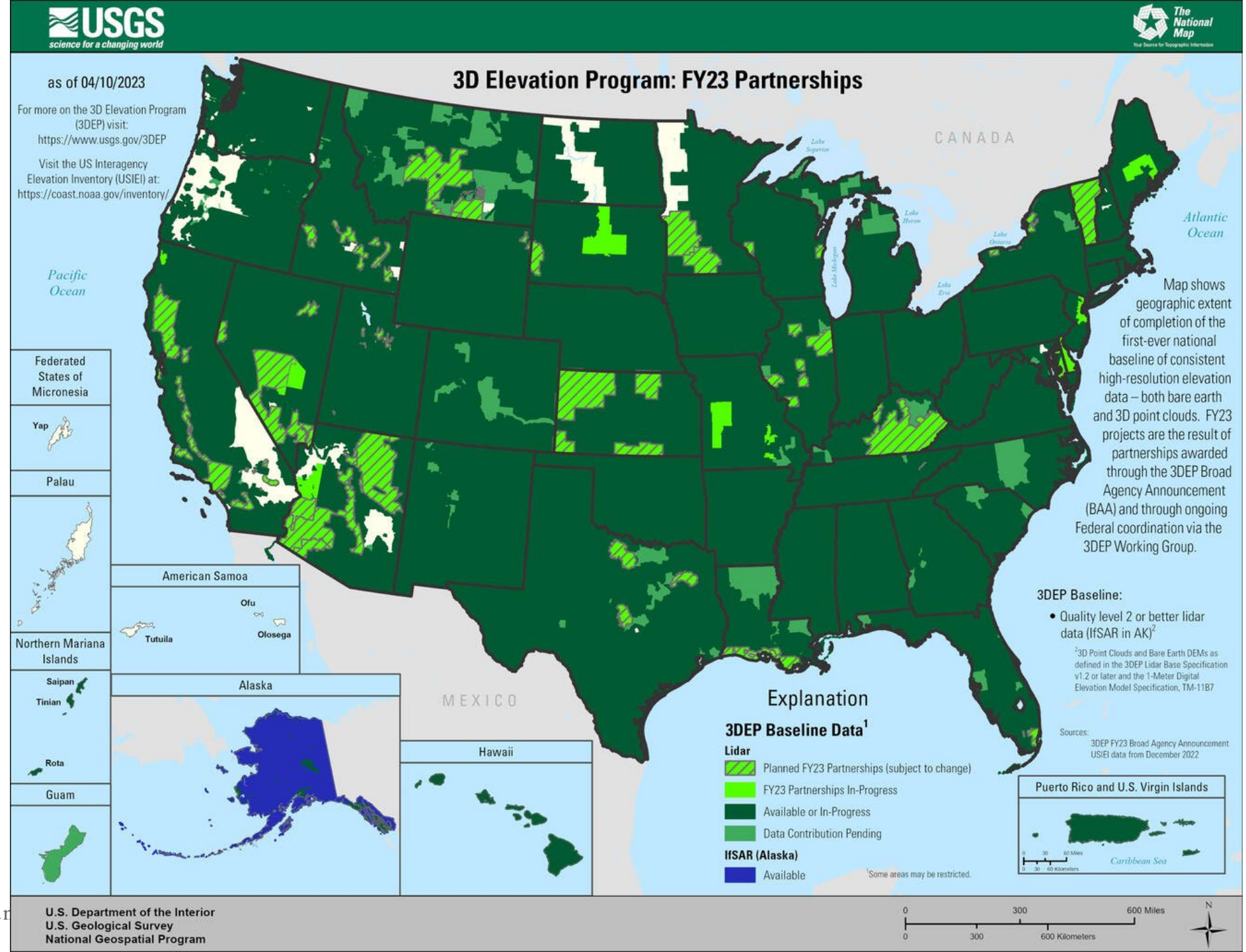
# Source Data Consolidation and Management

- Data downloaded or accessed via streaming services.
- Evaluated for currency, accuracy, completeness, and agreement with all other datasets.
- Arranged into projects by individual processing unit (typically HUC12)
- Buffering, Clipping, and Re-Projection, Standardization



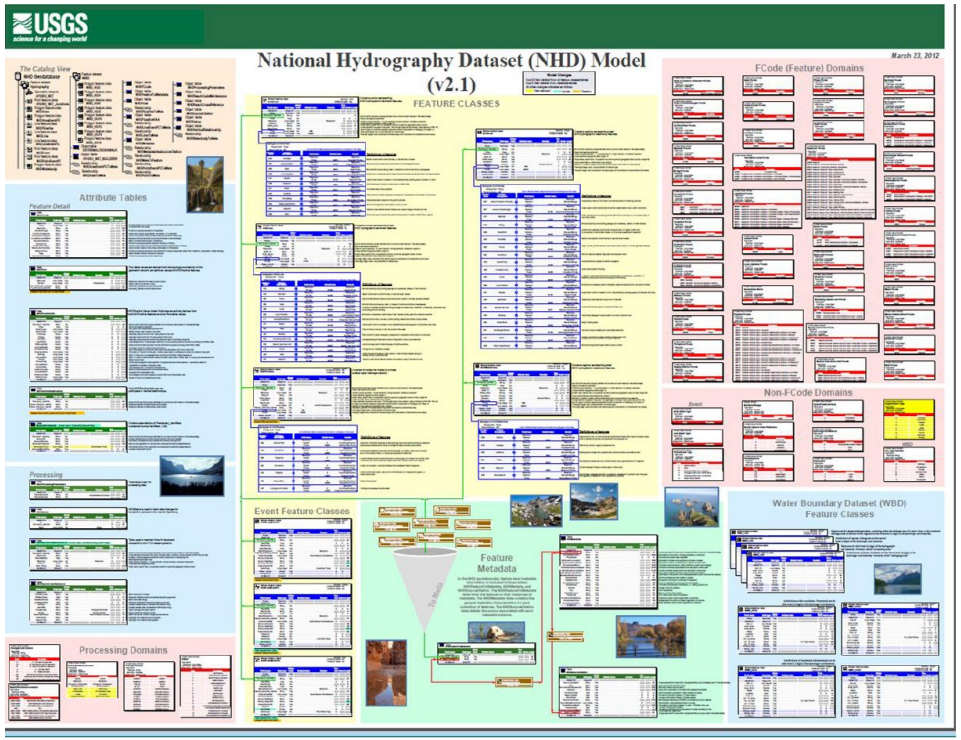
# Oregon lidar coverage (QSI/NV5)- 2002-present

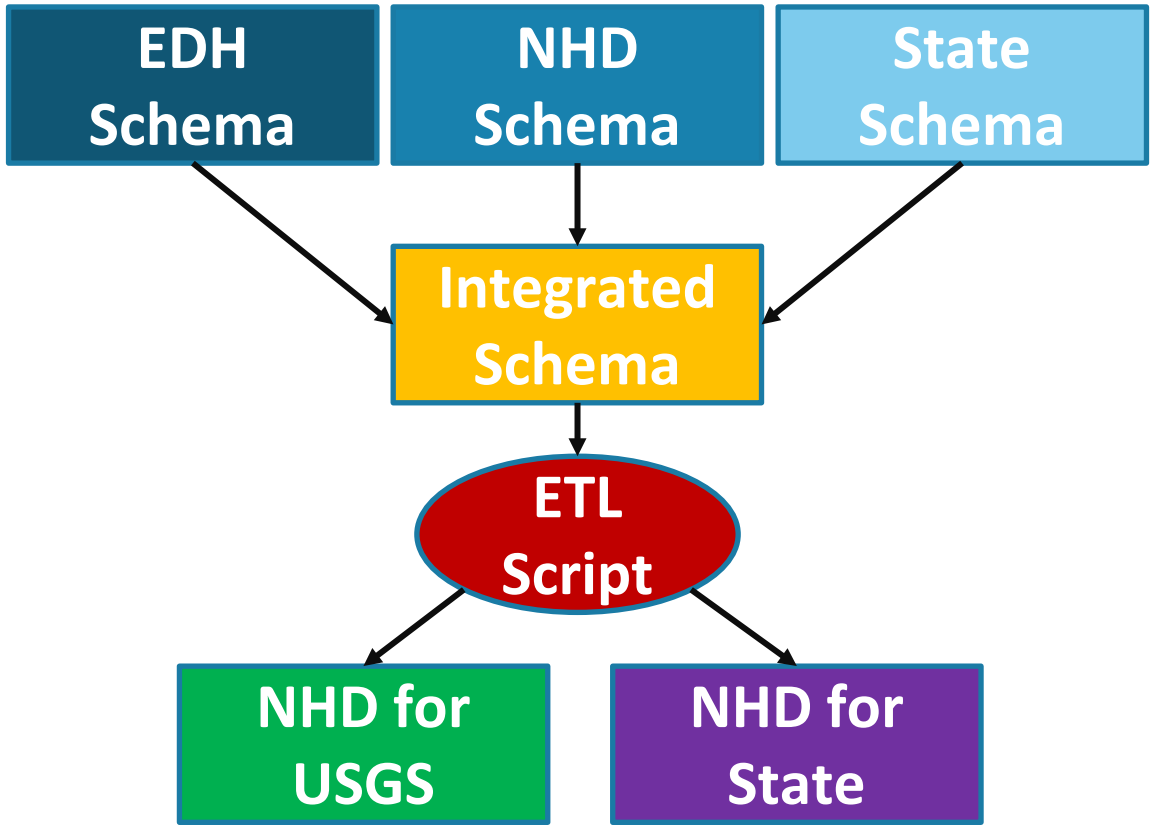



USGS
science for a changing world
The National Map
3D Elevation Program: FY23 Partnerships
as of 04/10/2023
For more on the 3D Elevation Program (3DEP) visit:
https://www.usgs.gov/3DEP
Visit the US Interagency Elevation Inventory (USIEI) at:
https://coast.noaa.gov/inventory/
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Lake Superior
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
Map shows geographic extent of completion of the first-ever national baseline of consistent high-resolution elevation data – both bare earth and 3D point clouds. FY23 projects are the result of partnerships awarded through the 3DEP Broad Agency Announcement (BAA) and through ongoing Federal coordination via the 3DEP Working Group.
3DEP Baseline:
• Quality level 2 or better lidar data (IfSAR in AK)[2]
[2]3D Point Clouds and Bare Earth DEMs as defined in the 3DEP Lidar Base Specification v1.2 or later and the 1-Meter Digital Elevation Model Specification, TM-11B7
Sources:
3DEP FY23 Broad Agency Announcement
USIEI data from December 2022
Explanation
3DEP Baseline Data[1]
Lidar
Planned FY23 Partnerships (subject to change)
FY23 Partnerships In-Progress
Available or In-Progress
Data Contribution Pending
IfSAR (Alaska)
Available
[1]Some areas may be restricted.
Federated States of Micronesia
Yap
Palau
American Samoa
Ofu
Tutuila
Olosega
Northern Mariana Islands
Saipan
Tinian
Rota
Guam
Alaska
Hawaii
Puerto Rico and U.S. Virgin Islands
Caribbean Sea
U.S. Department of the Interior
U.S. Geological Survey
National Geospatial Program
0 300 600 Miles
0 300 600 Kilometers
N

# Data Schema Development

- Stakeholder engagement supports identification of State needs when compared to USGS 3D HD
- Hydrology data schema developed to preserve the combined complexity of USGS and State
- ETL scripts utilized to reduce complexity and finalize dataset for each use case…USGS/State



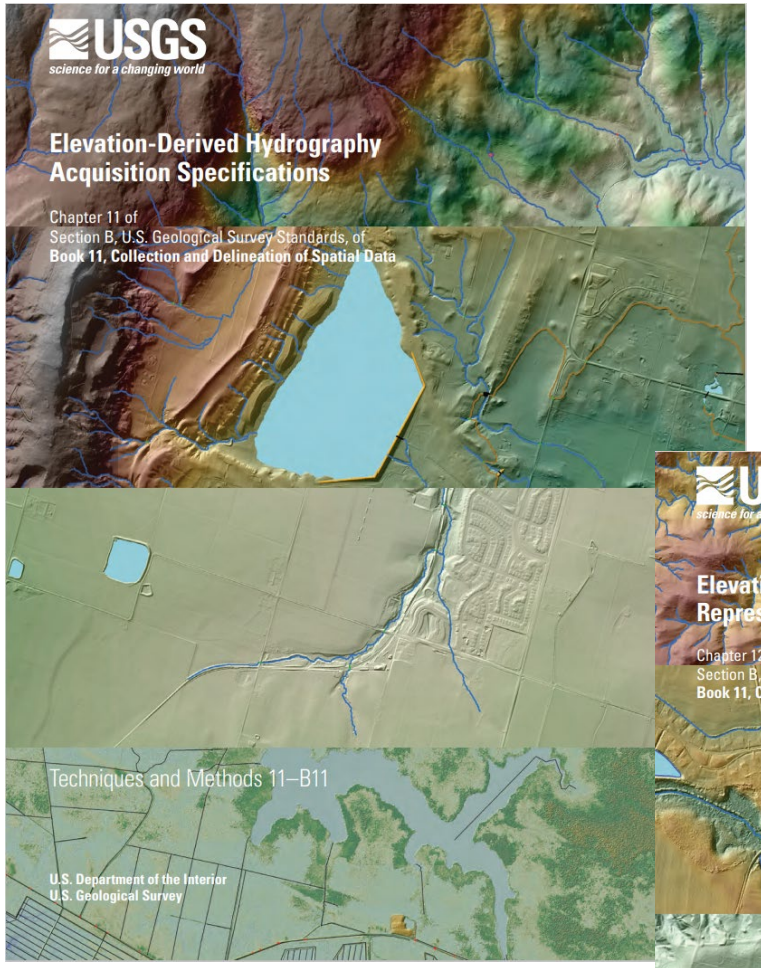



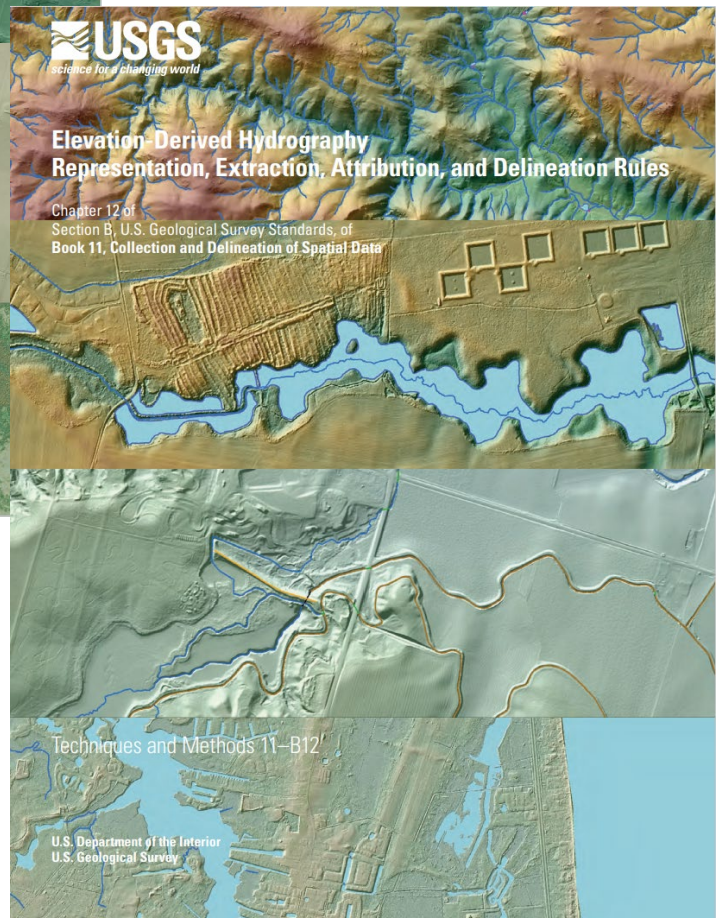
# Capture specification

- Elevation data reduces subjective interpretation
- Strict guidelines on topology and data agreement
- Specific feature classification rules

- Ensure you vendor and/or partners fully understand data specifications and have a method to address

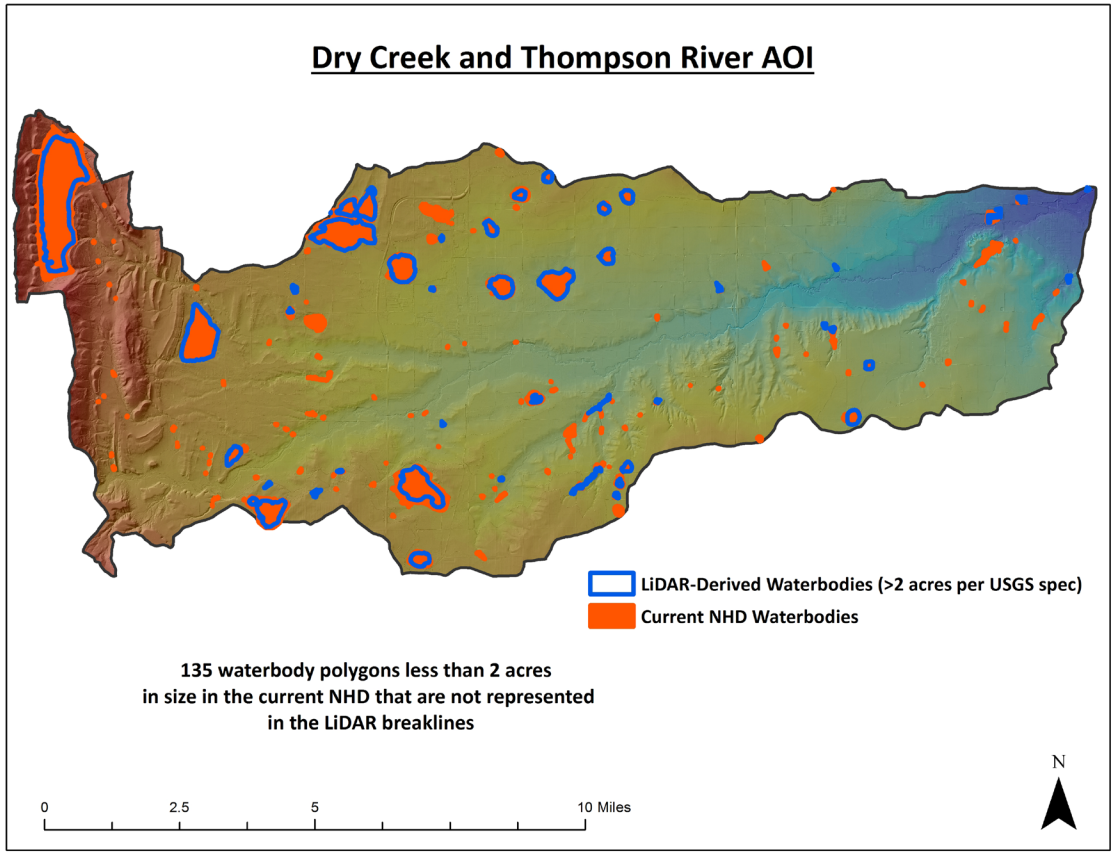
- REQUIRES AUTOMATION FOR DERIVATION AND QC

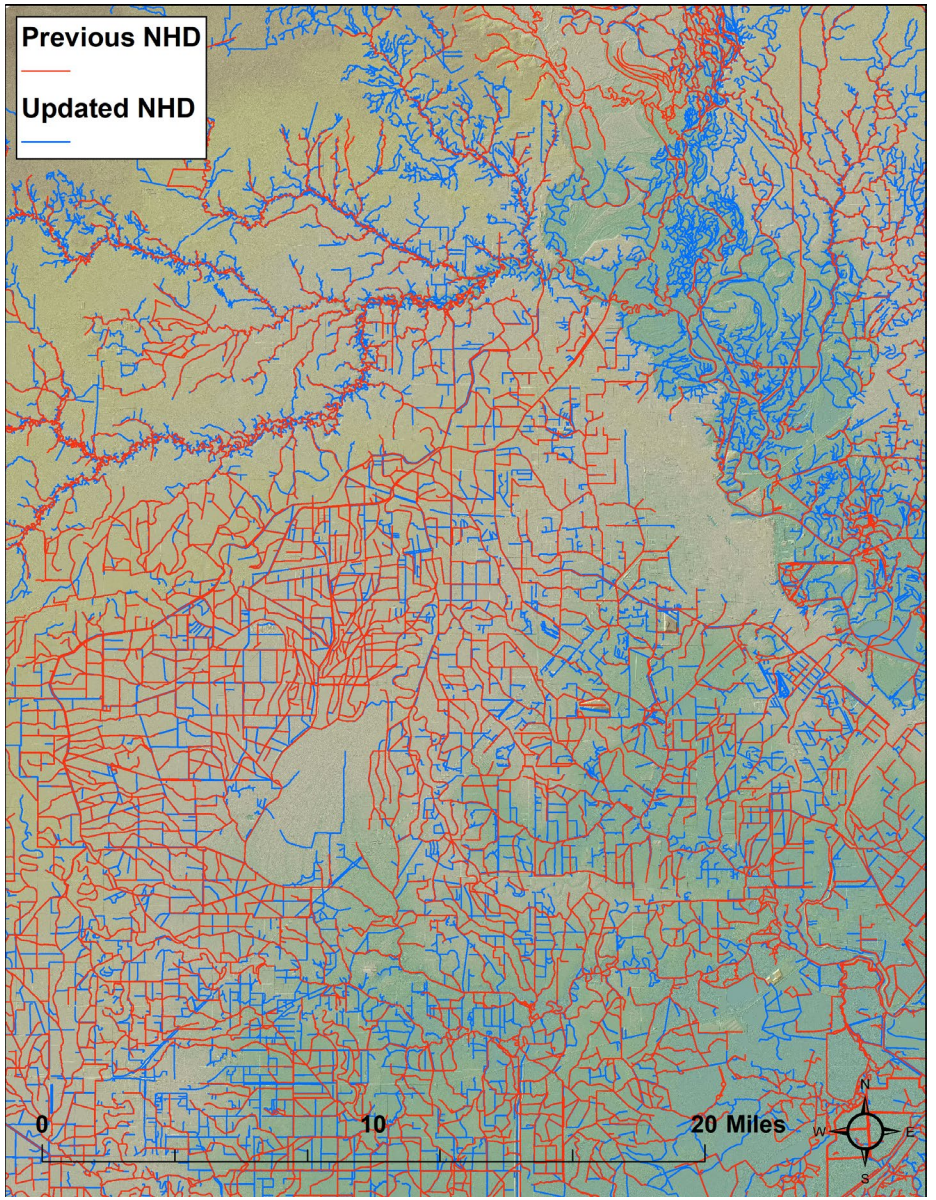


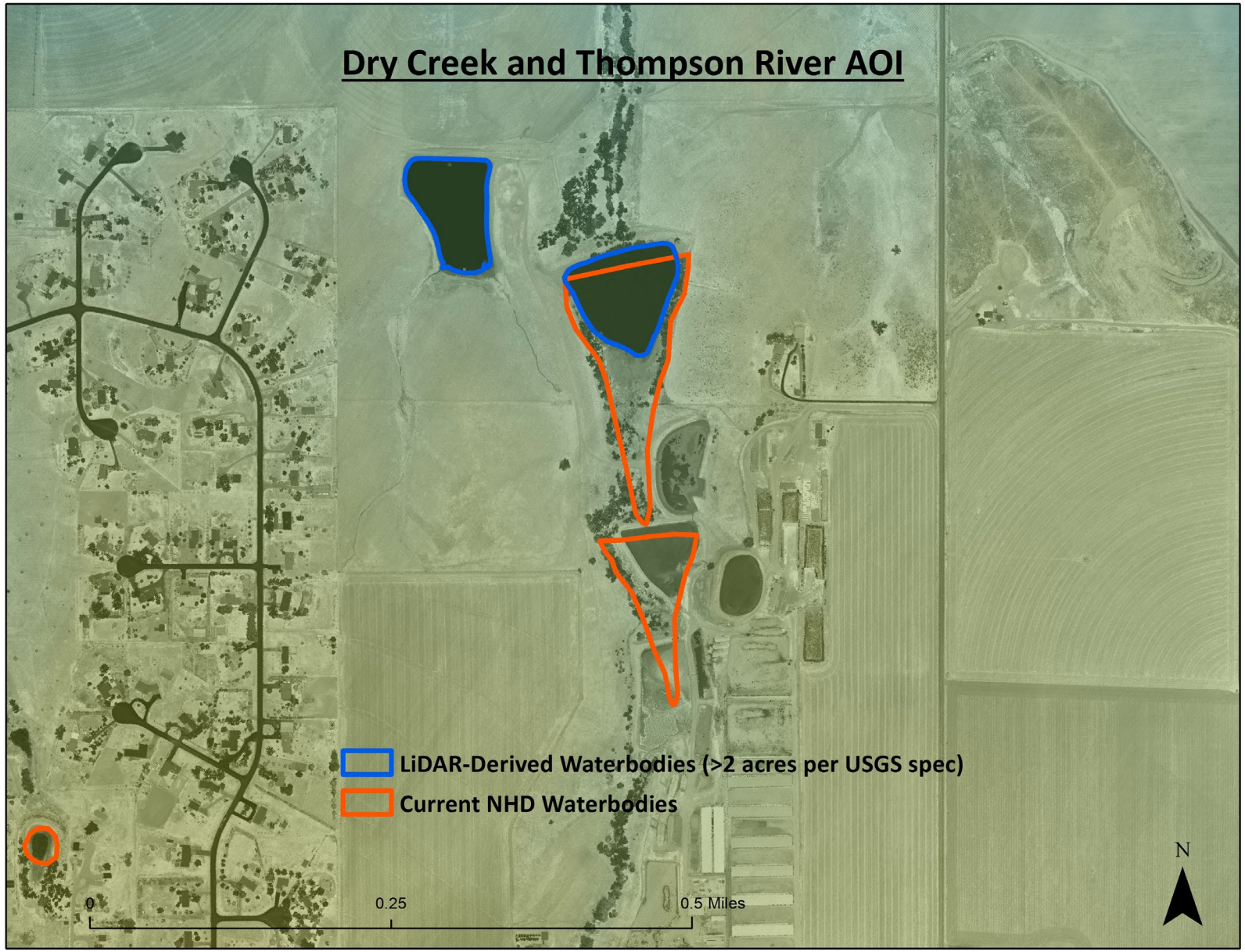
# Feature Density

- 0.5 acre ponds
- Variable stream density (2-5x)
- Landscape dependent LOE



# Data currency

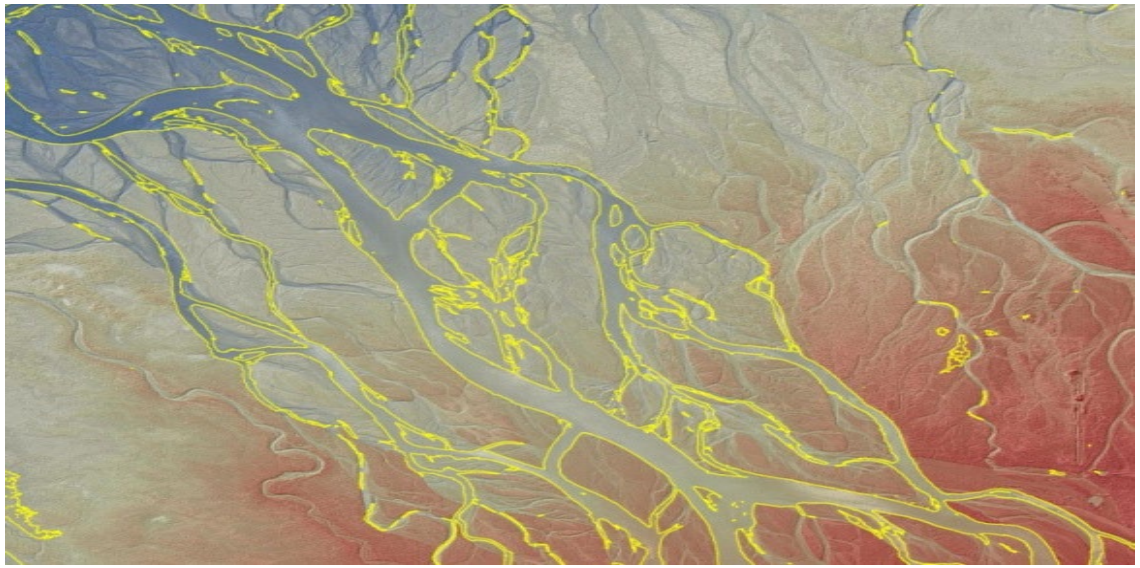


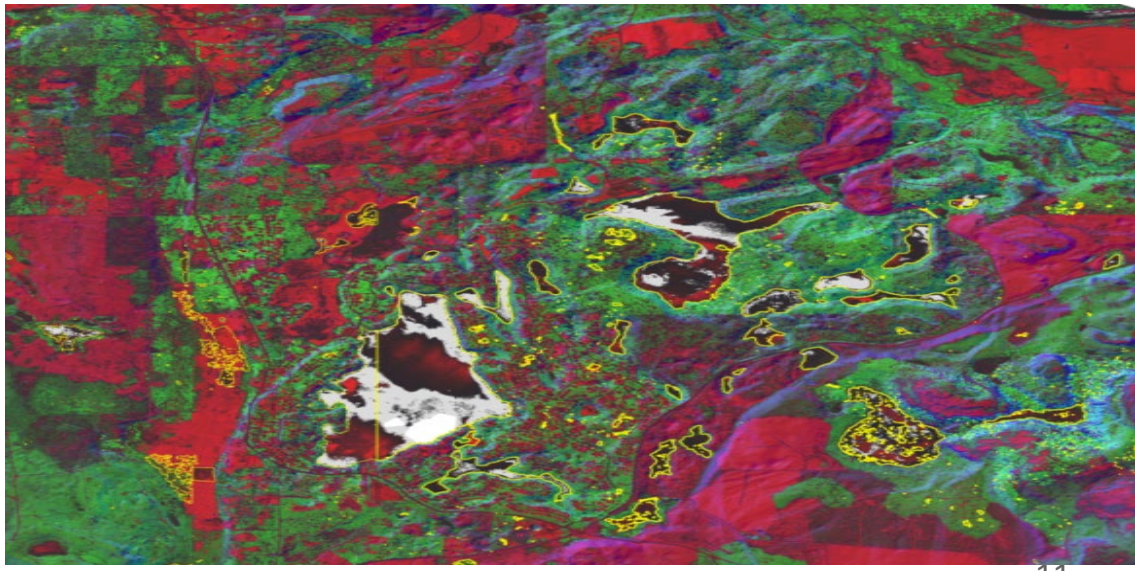
# Open Water Delineation

Lidar derived breaklines will provide some of the boundaries, additional water delineation is required.

## Object Based Image Analysis (OBIA)

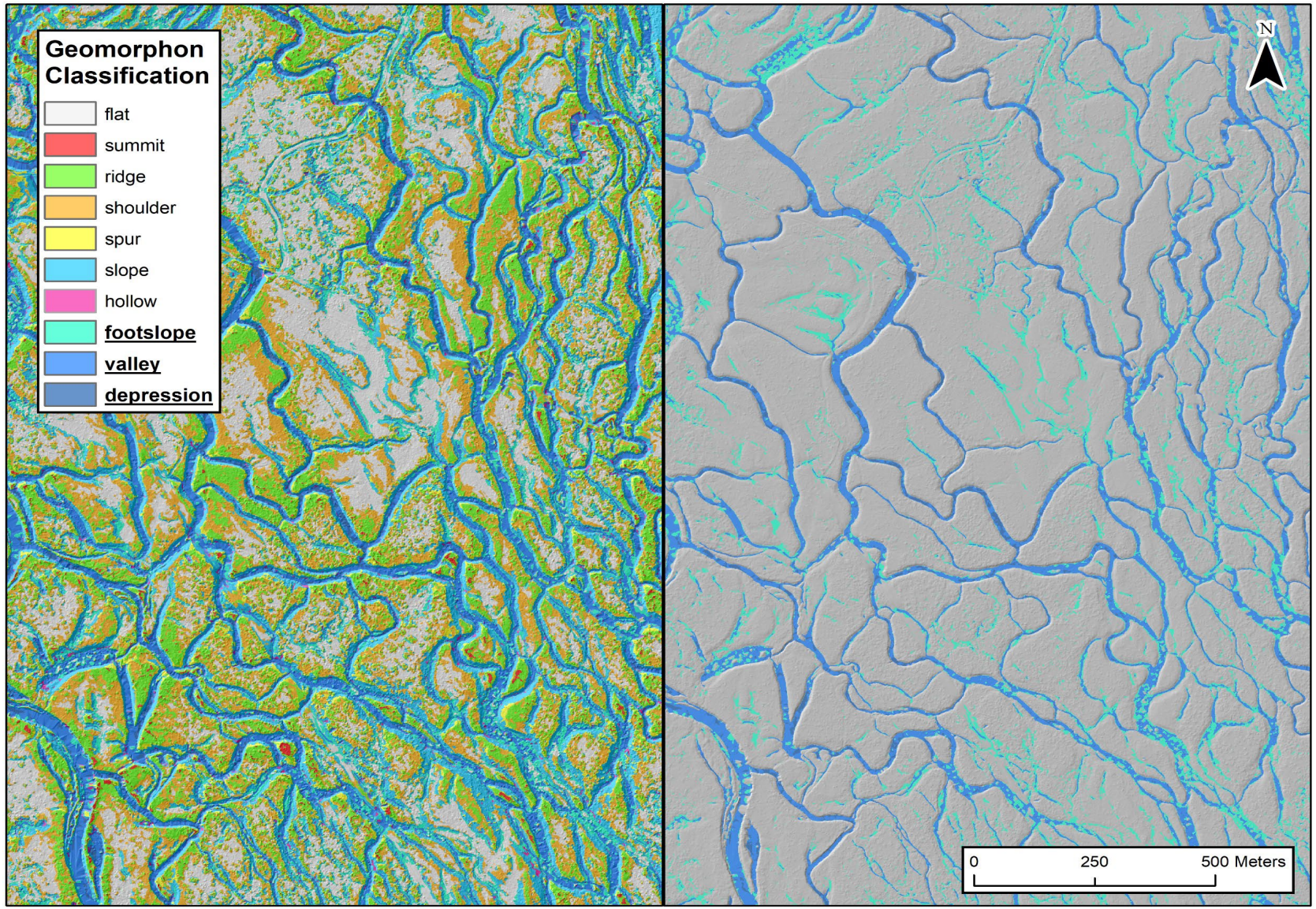
- Lidar derived layers
  - Terrain descriptors
  - Lidar descriptors
- Initial Segmentation
  - Homogenous objects (Slope, Intensity)
- Initial Classification
  - Finds known water (Native Density)
  - Finds known land (Slope)
- Contextual Classification
  - Iteratively classifies water
  - Spatial relationship to known water
  - Unknown areas (nDSM, GD)
- Consistent and Reproducible





# Geomorphic Indicators

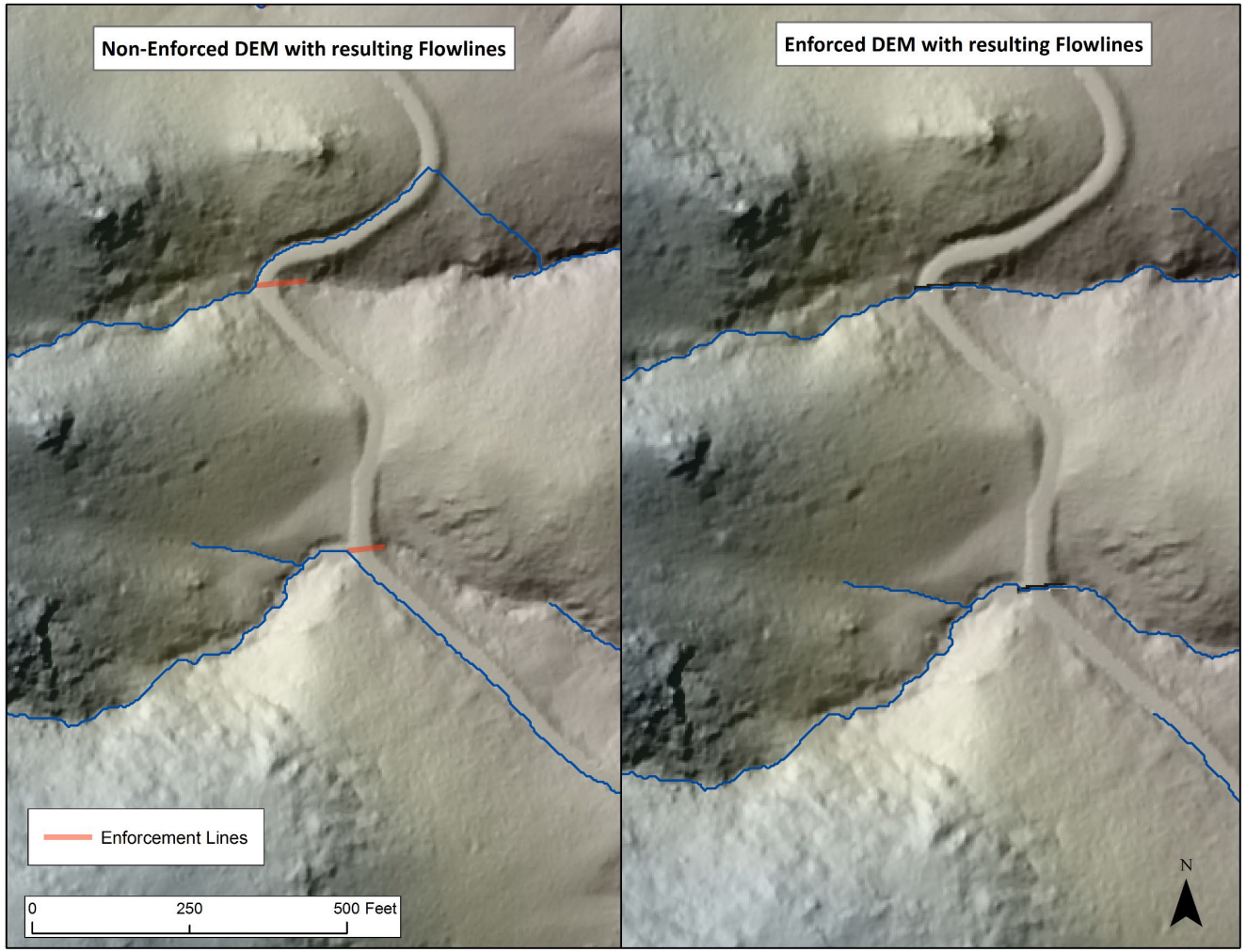
- DEM Filtering
- Geomorphon Classification
- Topographic Openness
- Black Top Hat
- Curvature
- Sinks



# Hydro-enforcement

- Iterative process to remove false obstruction to flow.
- Enforce known culverts
- Identify unmapped road crossings
- Evaluate sinks and GMs for channel signatures.

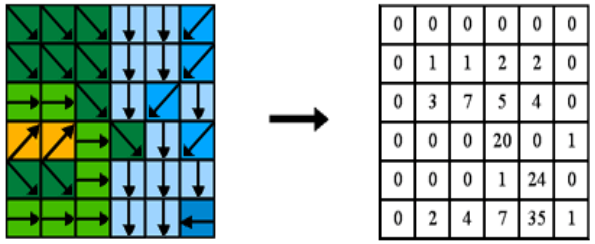
- **Each enforcement classified as culvert (including "false" culverts)**



# Stream Derivation

Run Flow Dir/Acc Routines → Examine the resulting stream definition for areas where flow appears artificially impeded → Create Hydro-Enforcement Breaklines → Enforce Breaklines in Model → Iterate Routines → Apply GMIs and filter features

1) Fill Sinks
2) Calculate Flow Direction Grid
3) Calculate Flow Accumulation Grid
4) Define Stream Definition Threshold

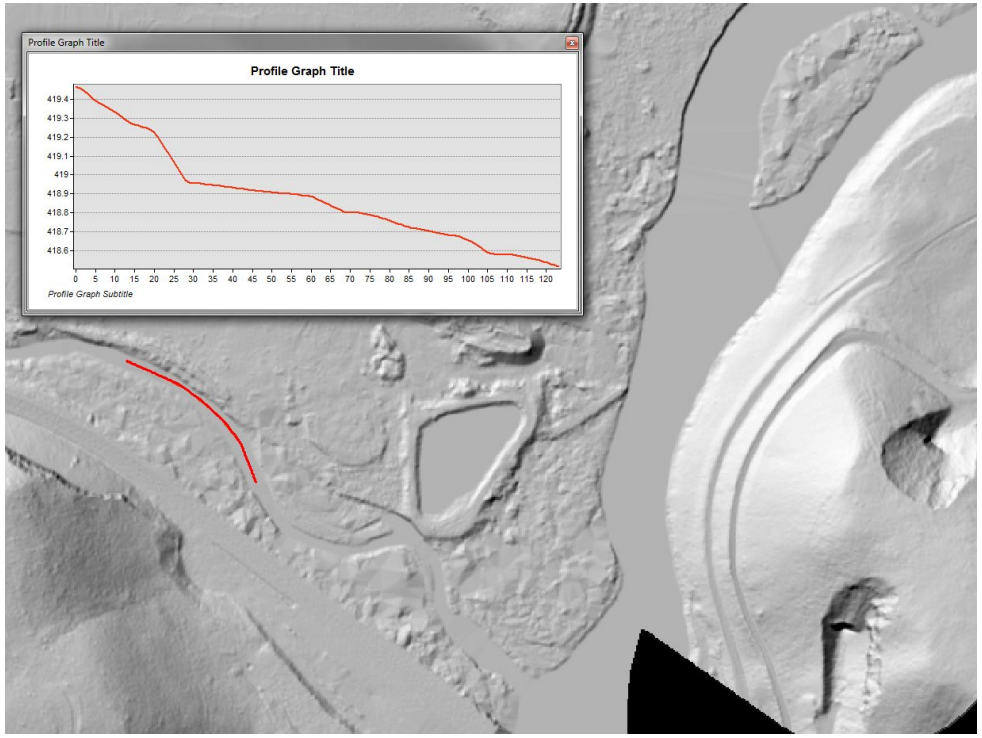


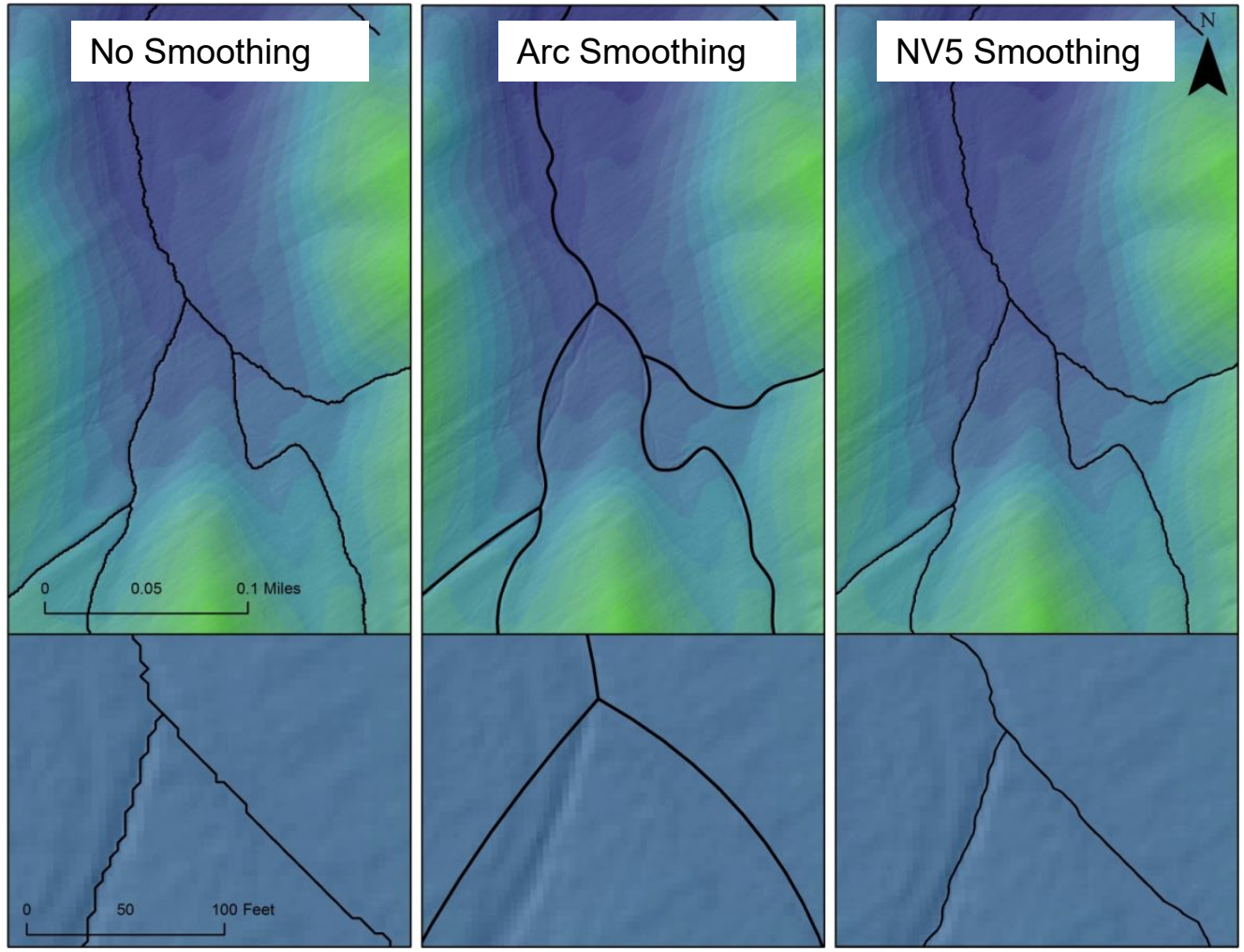

*Determining the accumulation of flow*

**Automated Flowlines ready for manual QC and editing as necessary**

# Smoothing Requirements (XYZ)

- Custom smoothing utilities required



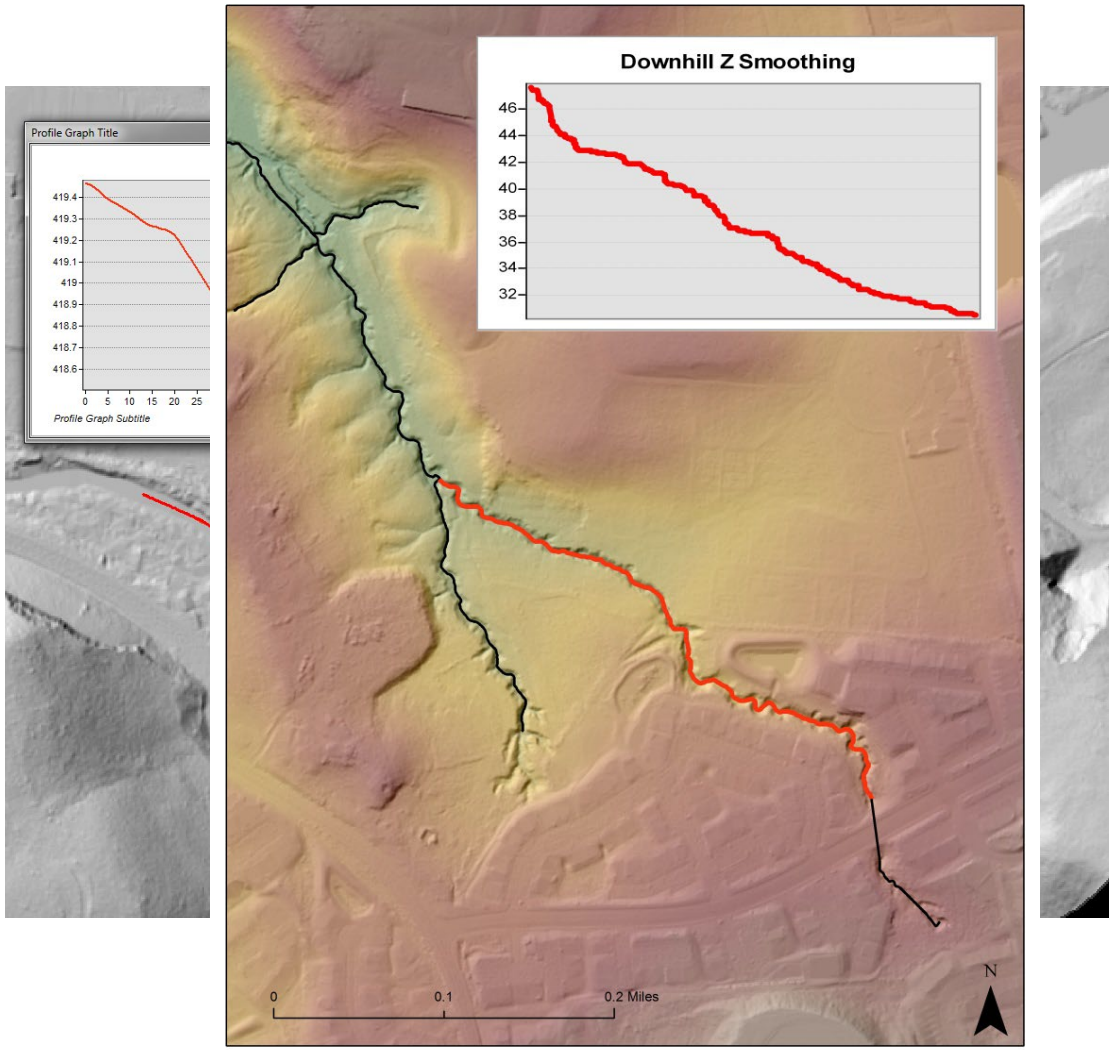
# Z Values

-Extract values from LiDAR data

-Enforce downstream flow and line direction for all single flowlines/double line streams

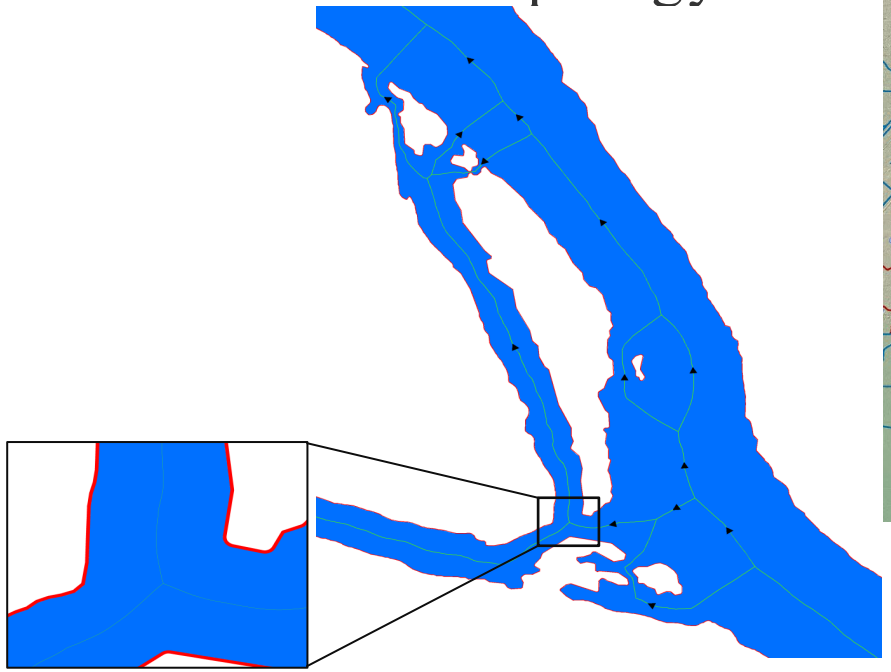
-Assign single elevation for all lakes and reservoirs

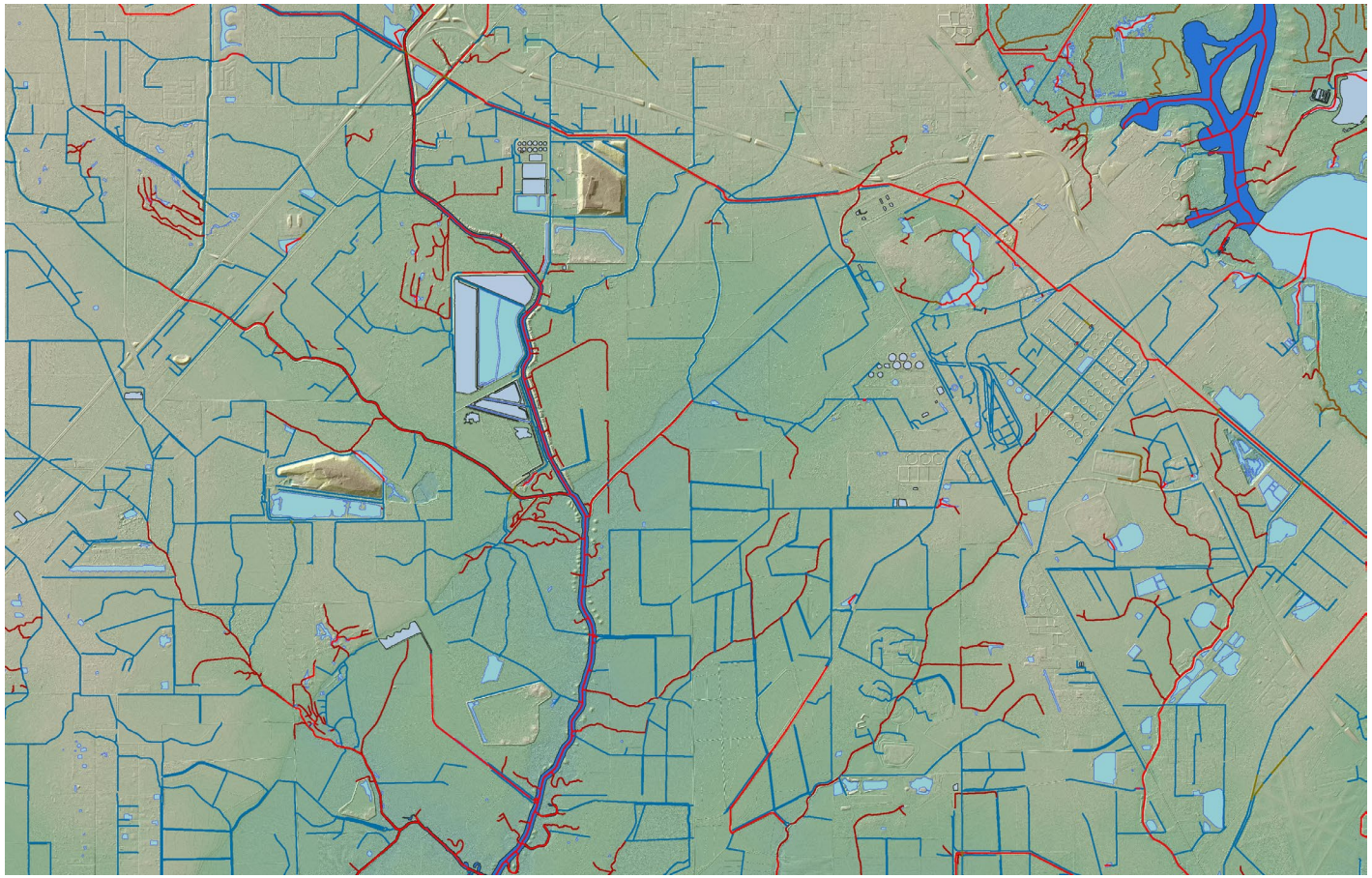
-Monotonic flow propagated through network



# Creation of Complete Networks

- Generate artificial flow paths
- Integrate all features
- Ensures correct feature classification and topology

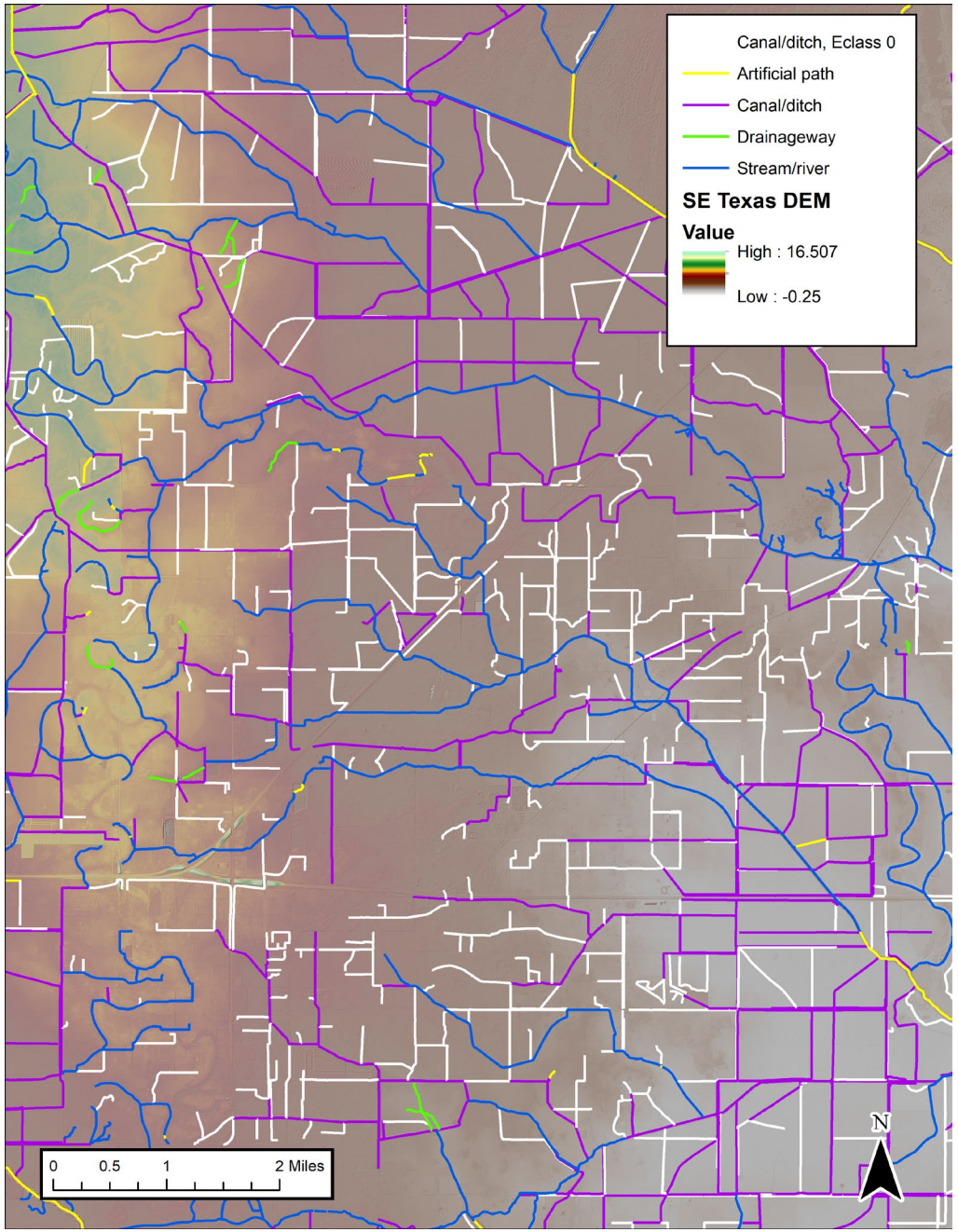




# Agriculture Canals

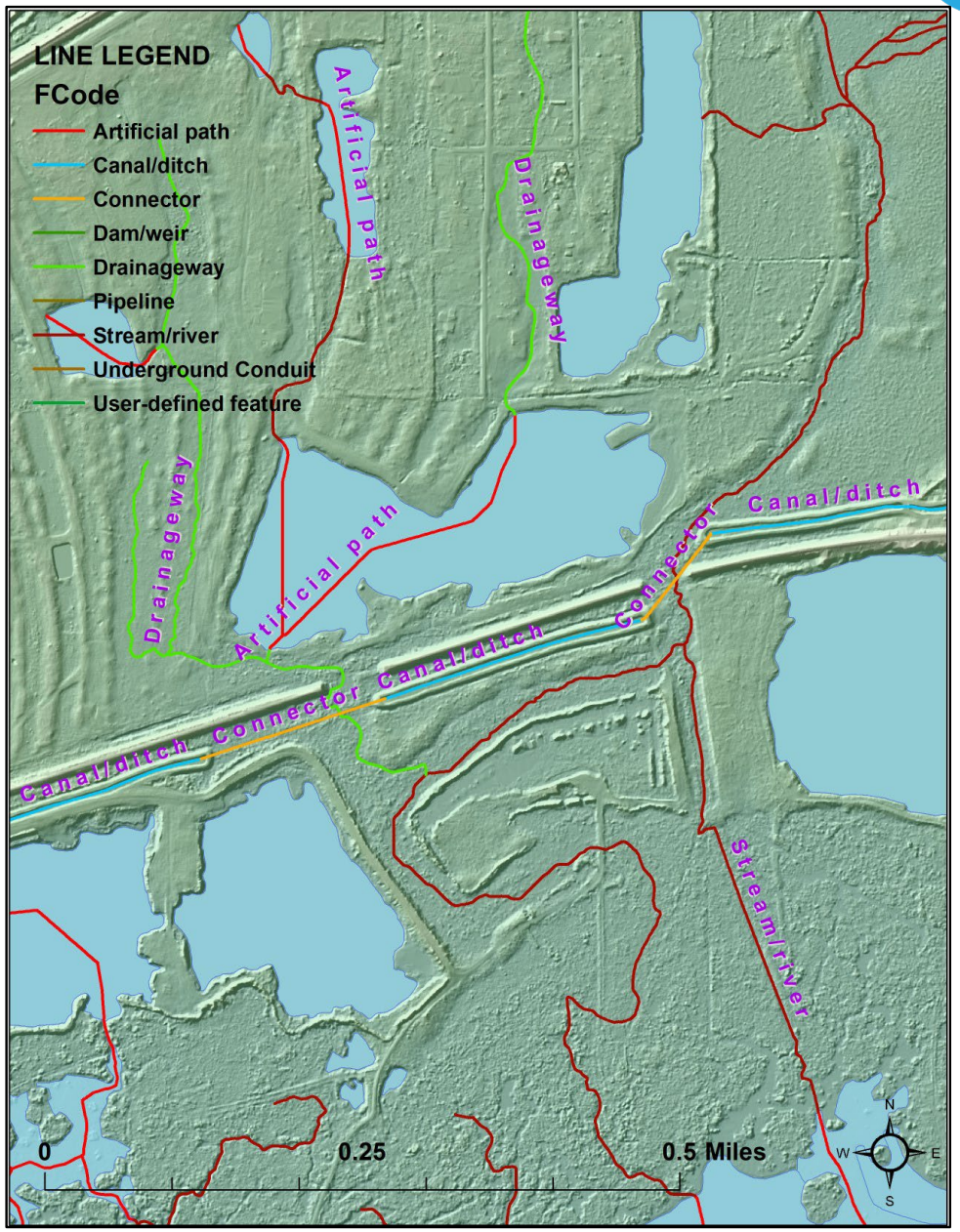
- Non directional
- Super high density
- Lots of enforcement

- Requires selection for inclusion

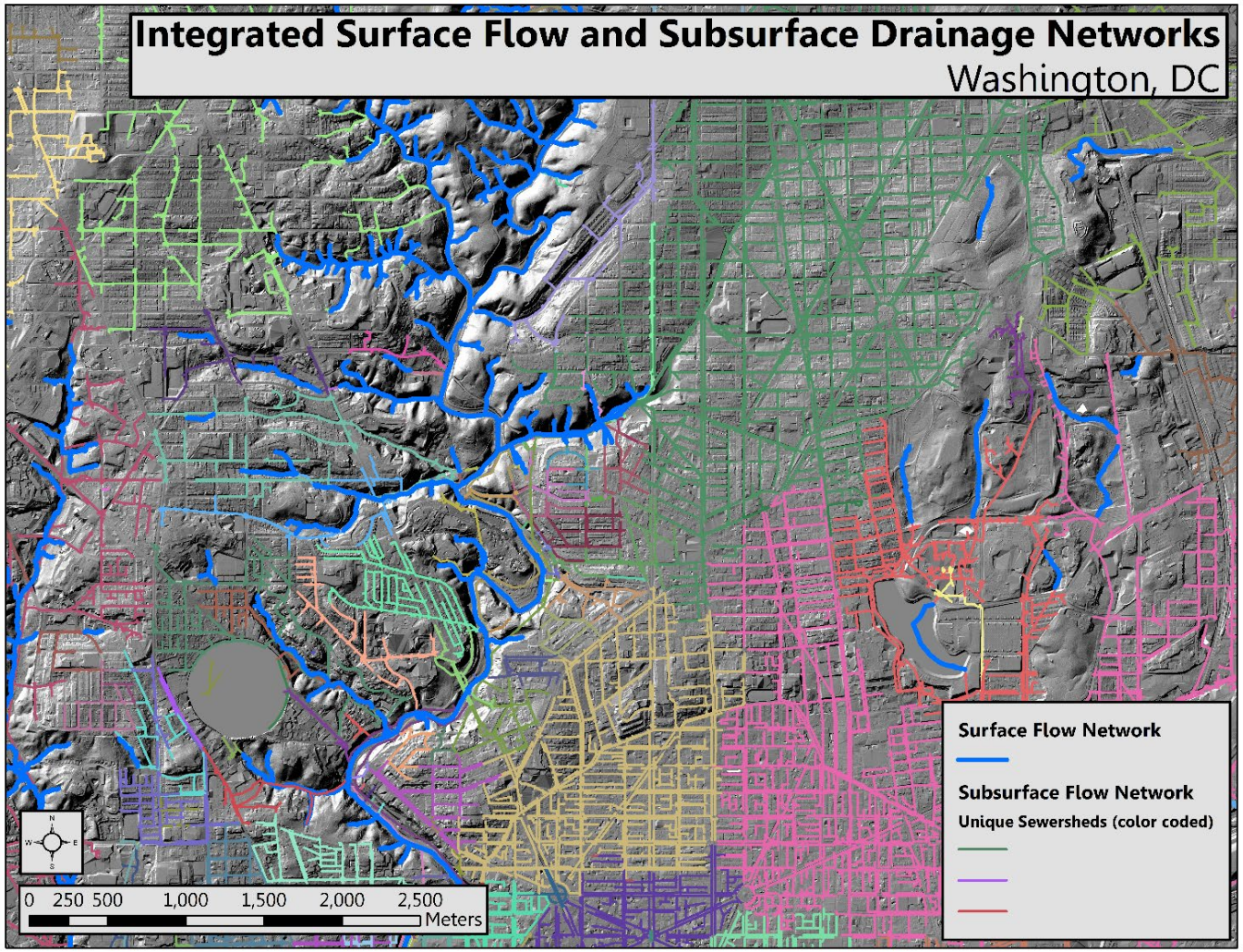


# Non-intersecting crossing

- Pipes/conduits
- Elevation separation
- Impacts
  - Connectivity
  - Elevational smoothing
  - Node placement/agreement



# Subsurface Network Integration




**CSO Networks are dynamic and complex!**

**Therefore…**

**It is important to establish the goal of the integration.**

Should all features be retained?

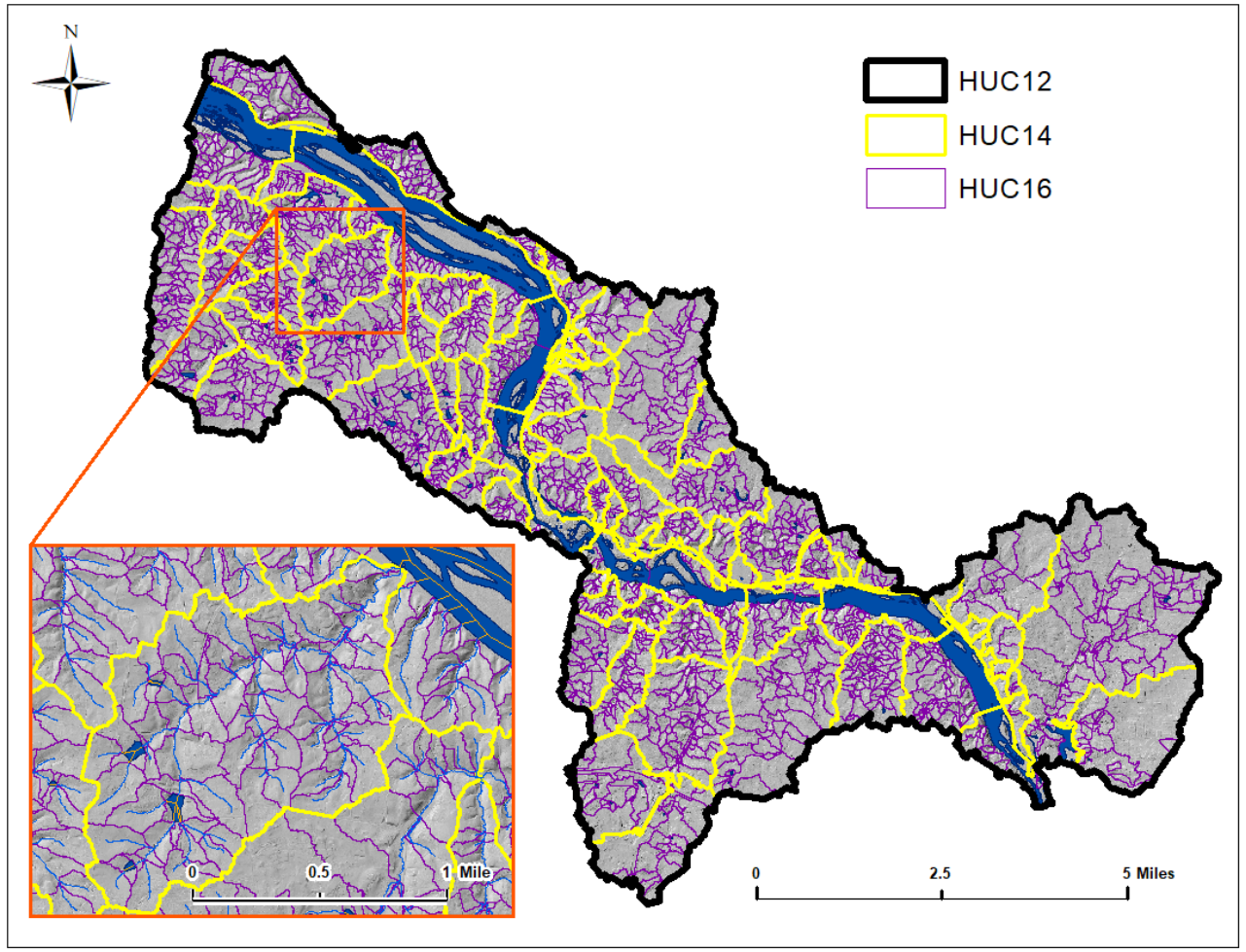
**For DC's purposes ->YES**

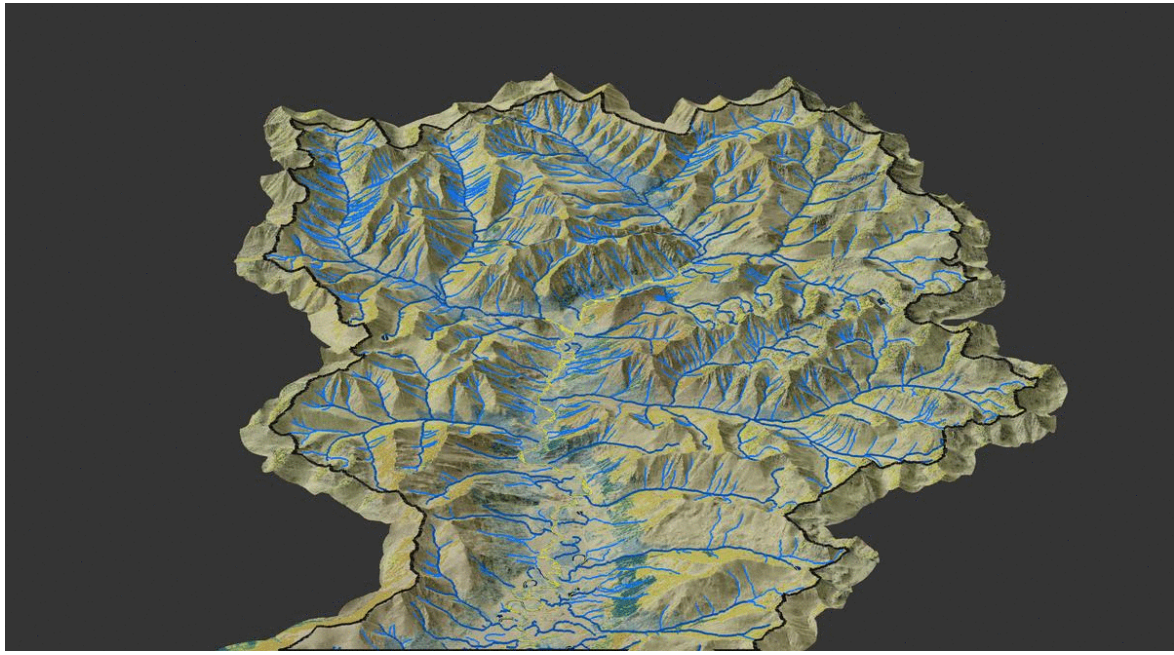
End Goal -> Trace inlets to all possible outlets and vice versa

**For NHD Purposes and Framework ->NO**

End Goal -> map *major* flow routes making sure all areas of the city are represented

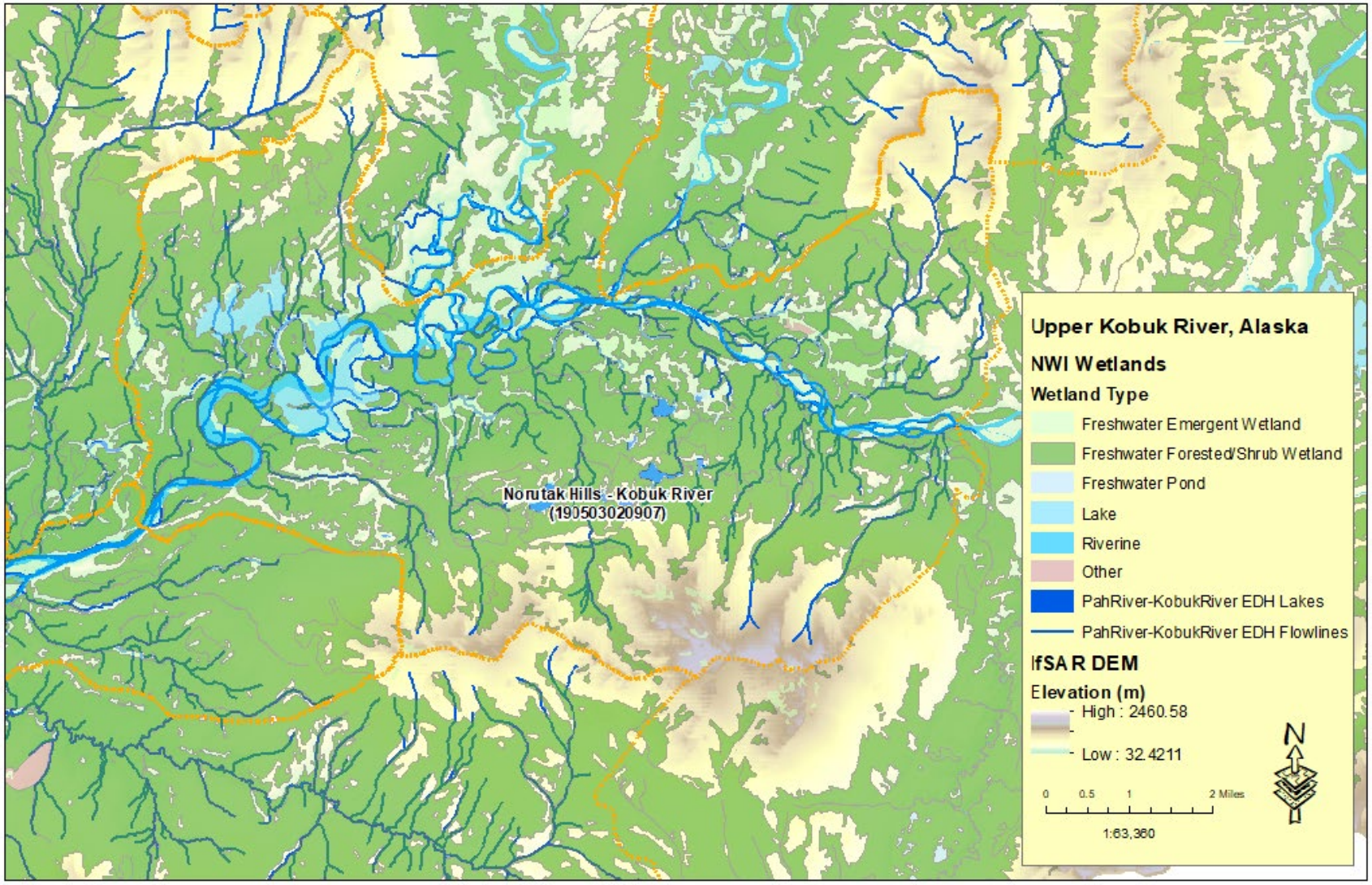
# Watershed Boundaries



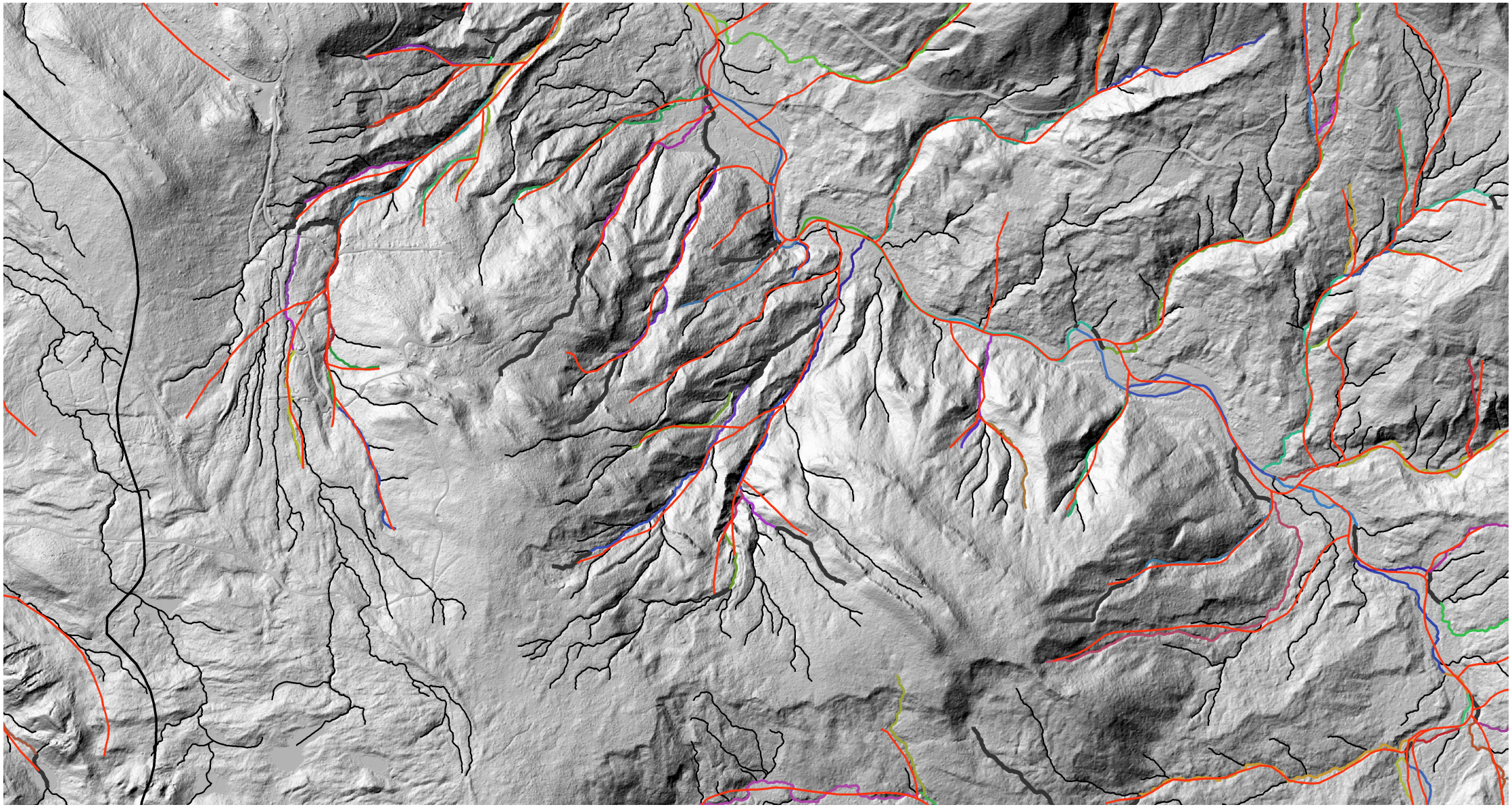



# Other Considerations

- Conflation into National Database
- 3D NHD only one component of hydrology
  - NWI
  - Flow and Inundation
  - Water quality
- **Unified authoritative hydrologic datasets**



# Conflation issues



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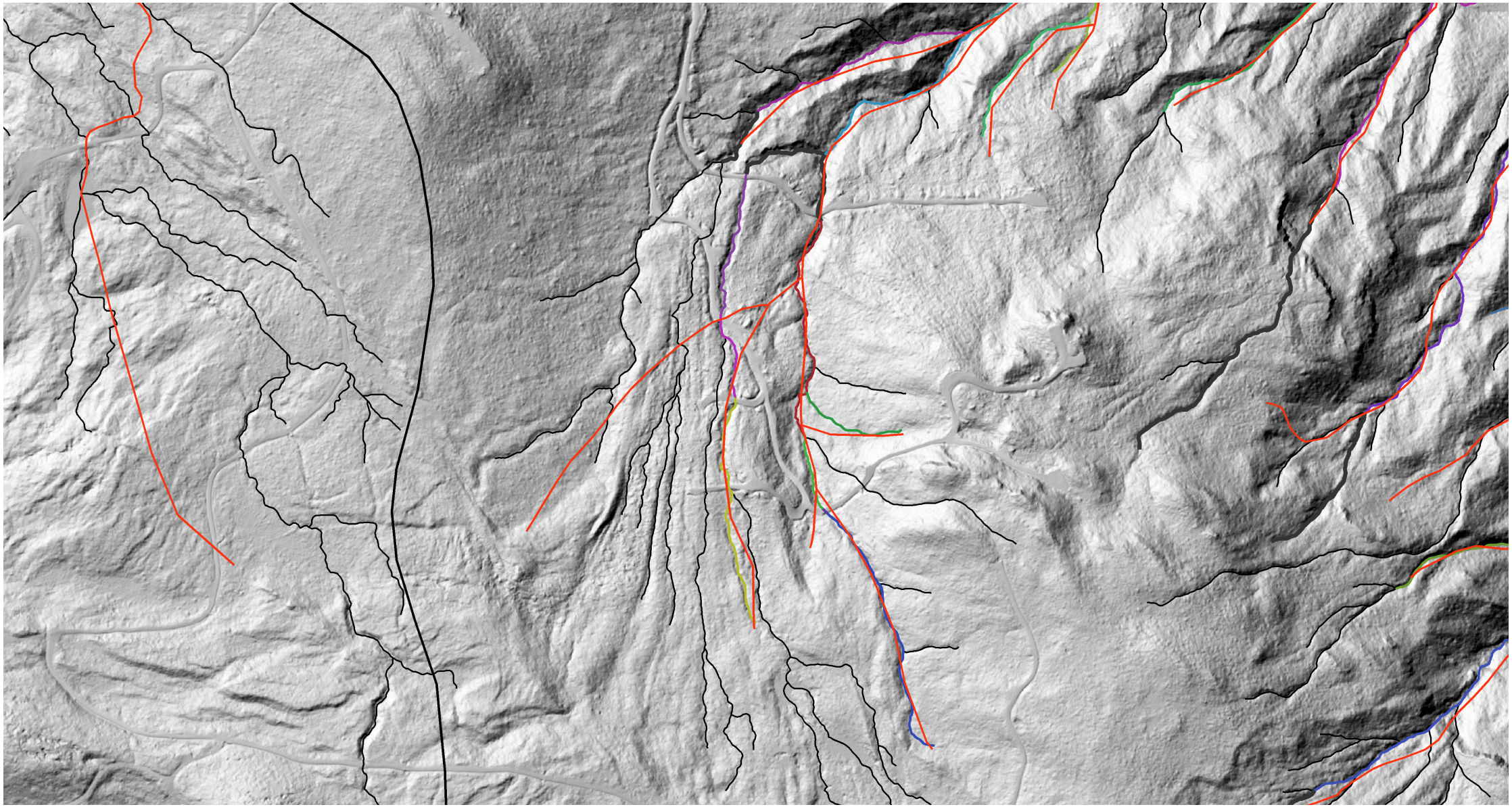

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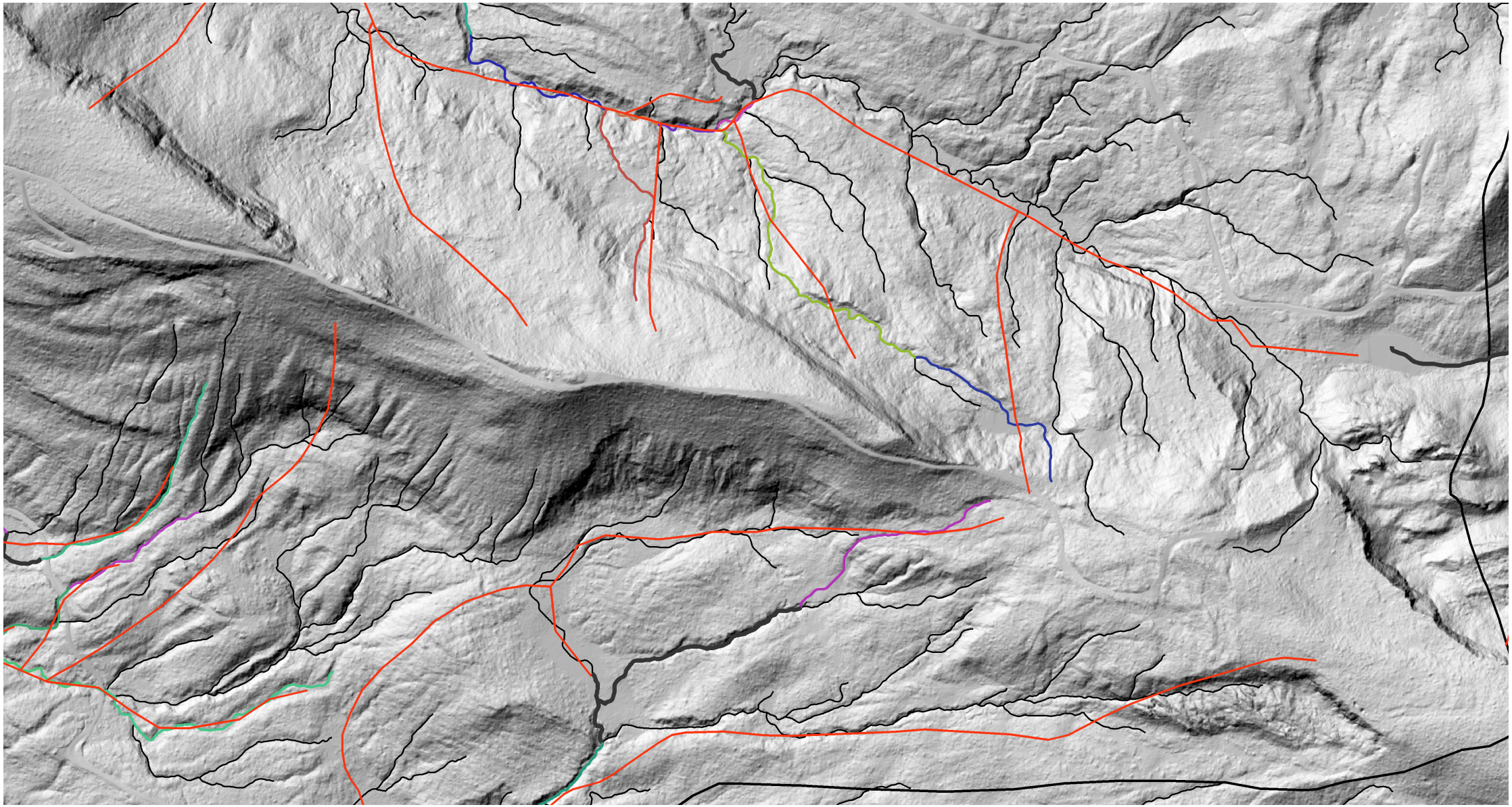
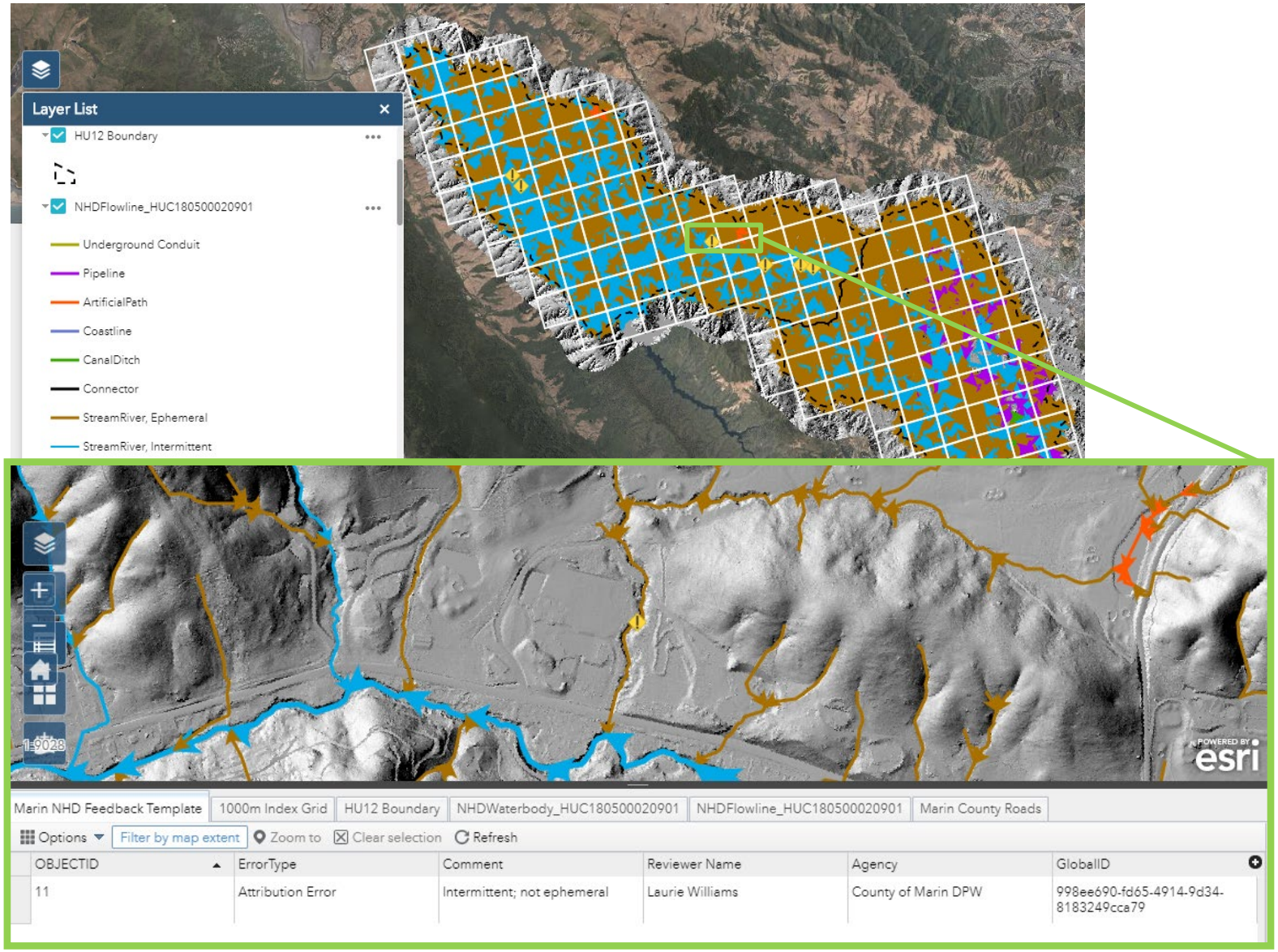


# Stakeholder Engagement and Review

- Web interface
- Comment and feedback utility
- Facilitates ingestion of local knowledge
- **Stakeholder involvement ensures understanding and buy-in.**



# Thank You

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