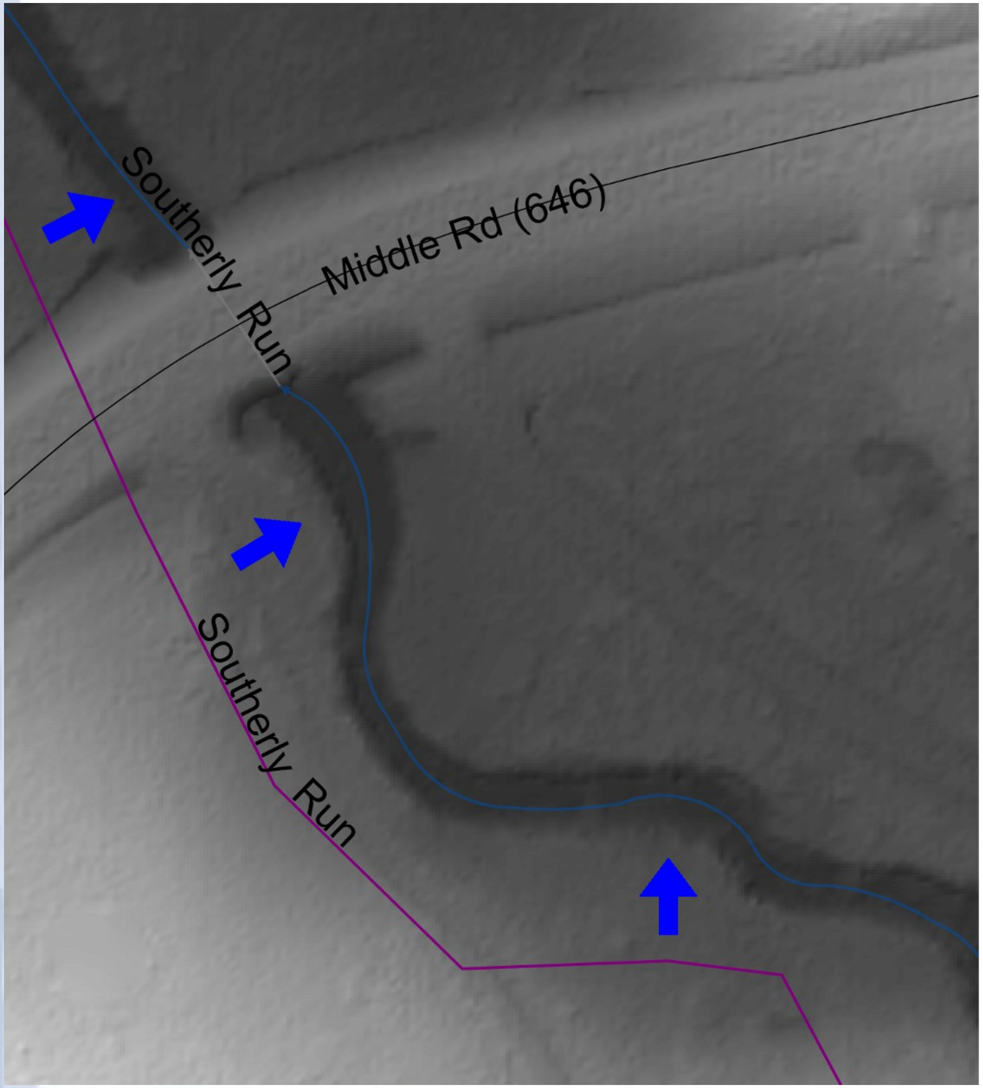
Stream Correction for Local Government GIS: Project Proposal



Nicholas McKenny

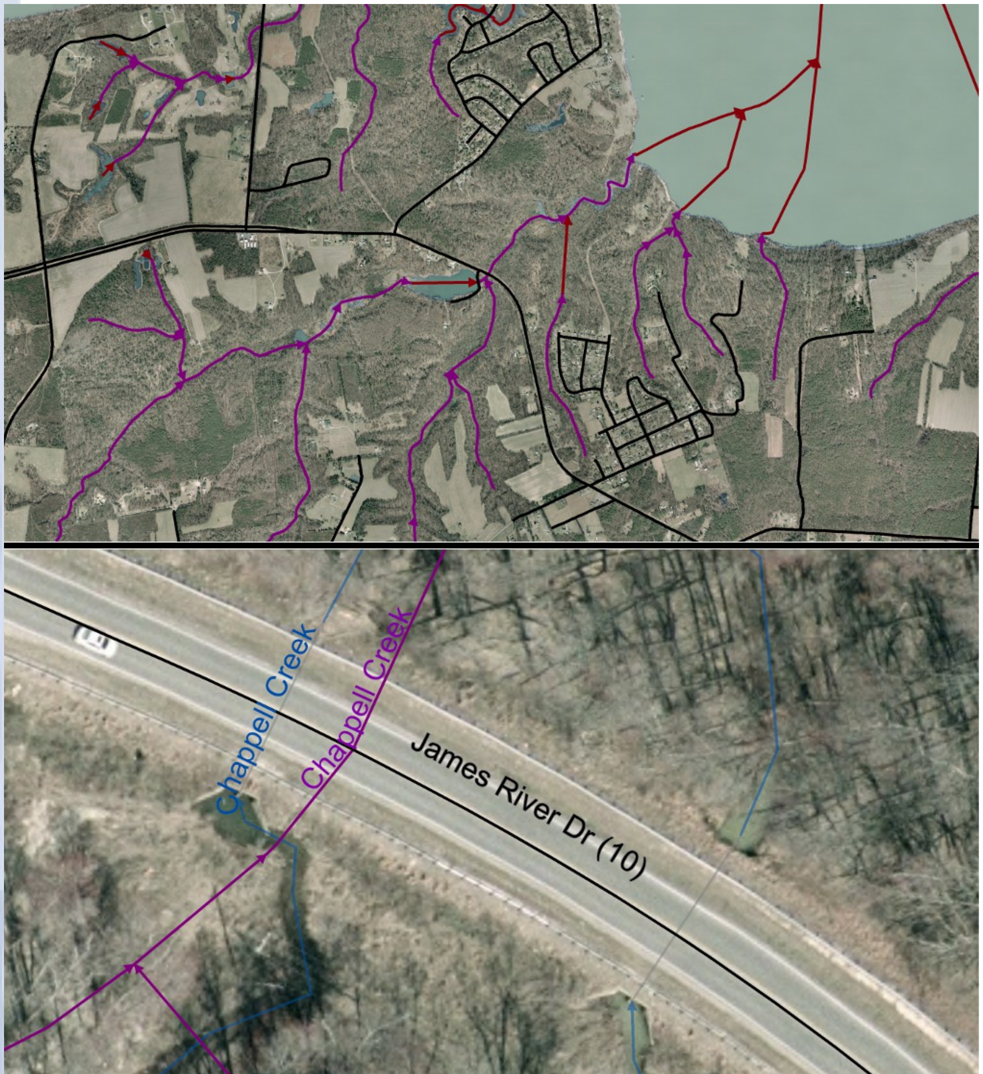
MGIS Capstone, Penn State, Fall II 2014

Adviser: James O'Brien

Presentation Outline

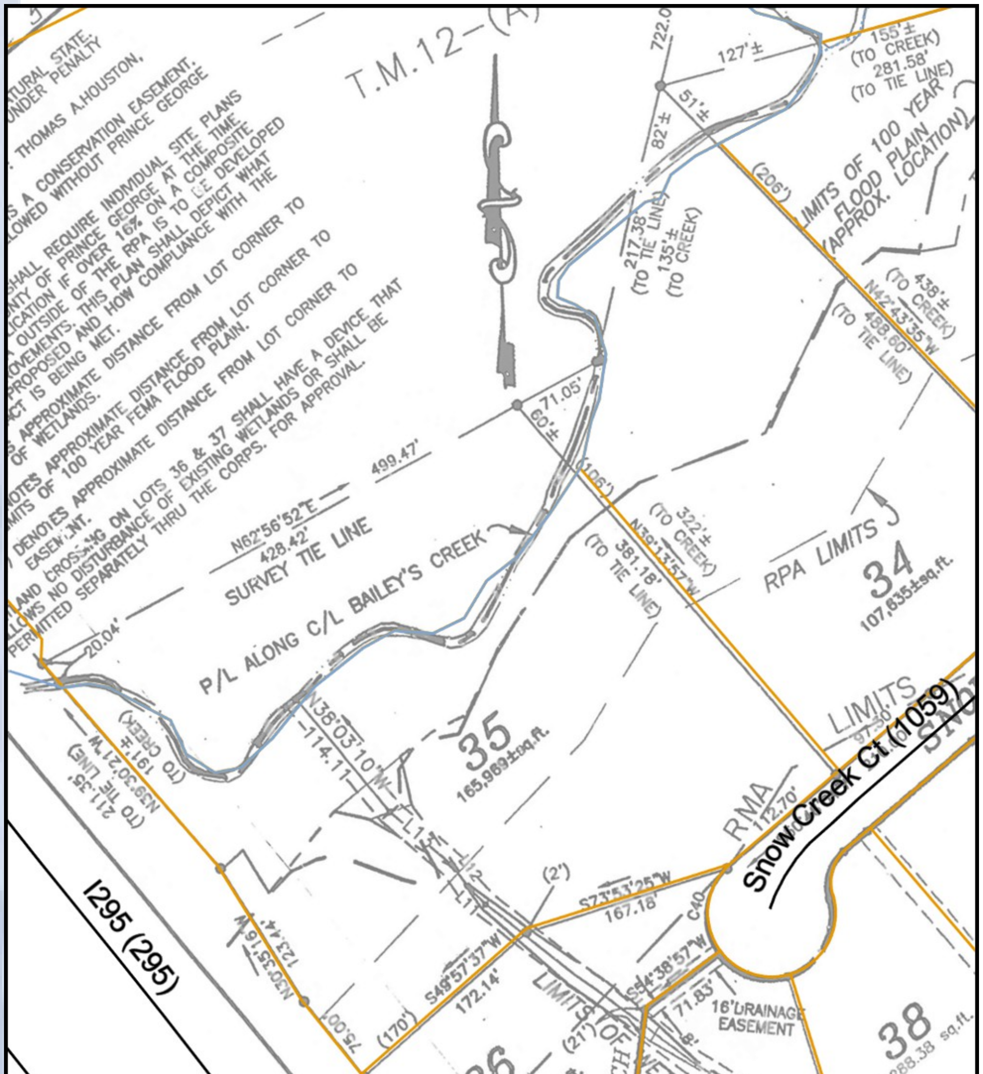
- Value and Potential Applications
- Research Approach
  - Data Sources
  - Network Generation
  - Populate Attributes
  - Smooth Features
  - Evaluate Results
  - Produce Guide
- Project Timeline

Value and Potential Applications



- Project Focus on Cartographic Value
  - As Map Reference
  - As Natural Property Boundaries
- USGS NHD Intended for 1:24K Scale

Value and Potential Applications



- Local Government
  - Needs Higher Resolution Data
  - May Find Software, Manpower, Time, and Money In Short Supply
- Process Guide
  - Aims to be No Cost
  - Removes Mystery

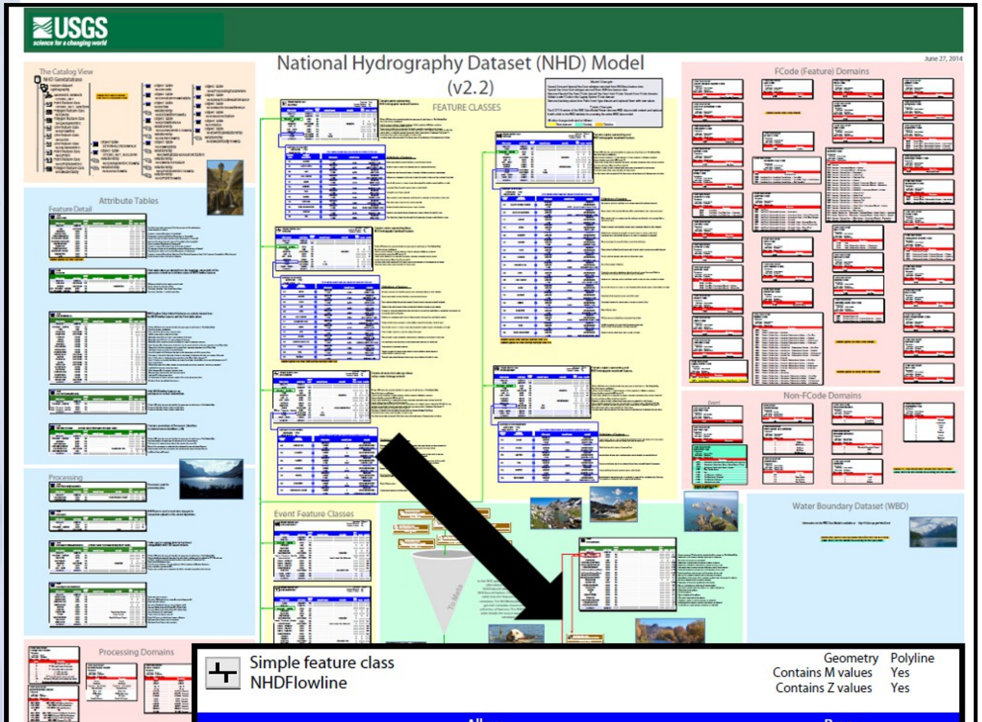
Research Approach Overview

1. Identify sources of public GIS data
2. Generate a hydrographic flow network
3. Populate the generated network's features with attributes
   3a. Apply smoothing/generalization
4. Evaluate results for accuracy and visual appeal
5. Document how to perform steps two, three, and three-a using free, open-source tools

Step 1: Data Sources

- Primary
  - Line Network of Surface Water Flow
  - High-Resolution Digital Elevation Models (DEMs)
- Reference (Optional, but Important)
  - Waterbody Polygons or Boundaries
  - High-Resolution Aerial Orthoimagery

Step 1: Data Sources



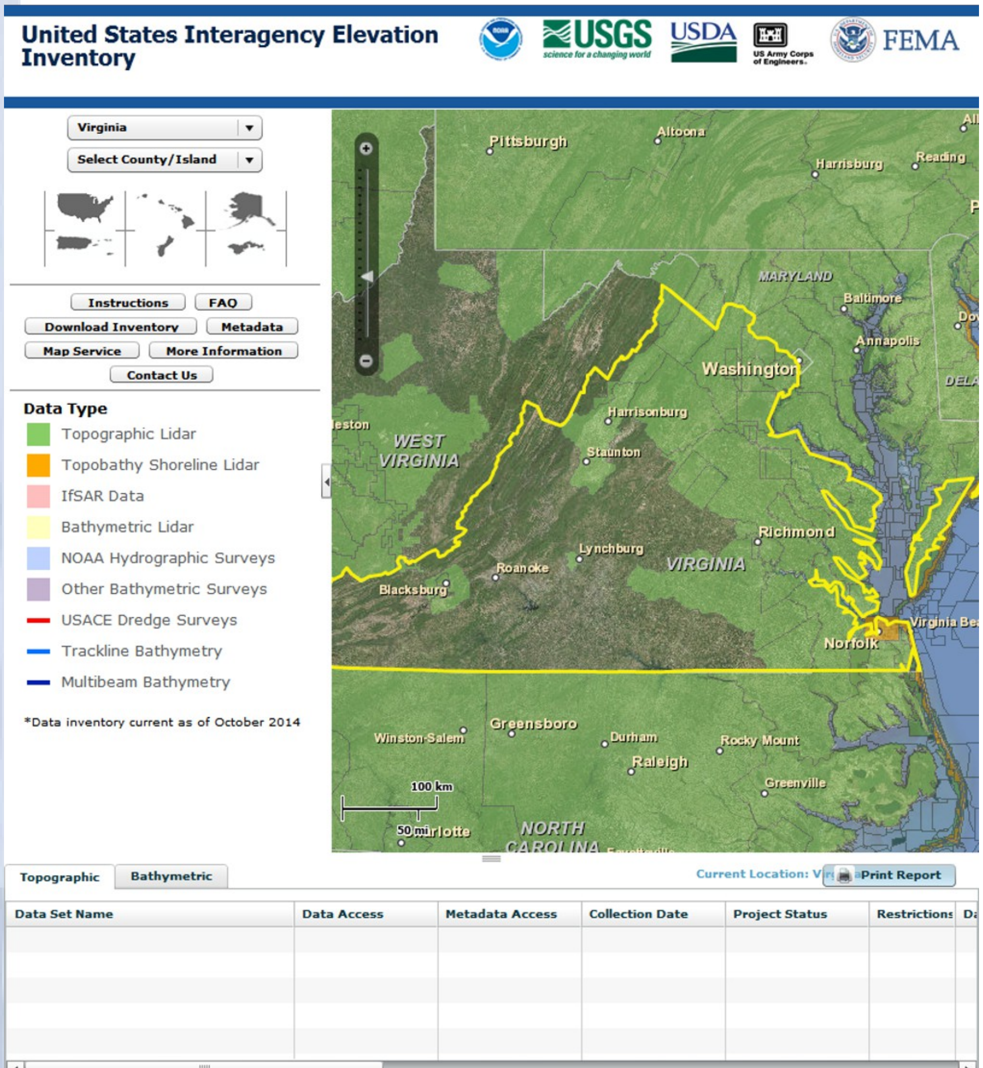
Simple feature class
NHDFlowline

Geometry: Polyline
Contains M values: Yes
Contains Z values: Yes

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID						
Shape	Geometry	Yes					
Permanent_Identifier	String	No					40
FDate	Date	No			0	0	8
Resolution	Long integer	No		Resolution	0		
GNIS_ID	String	Yes					10
GNIS_Name	String	Yes					65
LengthKM	Double	Yes			0	0	
ReachCode	String	Yes					14
FlowDir	Long integer	No	0	HydroFlowDirections	0		
WBArea_Permanent_Identifier	String	Yes					40
FType	Long integer	No	460		0		
FCode	Long integer	Yes	46003		0		
Shape_Length	Double	Yes			0	0	
GLOBALID	Global ID						

- USGS National Hydrography Dataset (NHDFlowlines)
  - National Scope
  - Attributes
  - Network Relationships
  - Maintained

Step 1: Data Sources



- Lidar-based DEMs
- Highest Quality U.S. Coverage Incomplete
  - USIEI (Federal)
  - Some State and County Sources
  - Might Consider Contracting in the Future

Step 2: Generate New Network

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HYDROGRAPHY CHANGE DETECTION: THE USEFULNESS OF SURFACE CHANNELS DERIVED FROM LIDAR DEMS FOR UPDATING MAPPED HYDROGRAPHY[1]

Sandra K. Poppenga, Dean B. Gesch, and Bruce B. Worstell[2]

ABSTRACT: The 1:24,000-scale high-resolution National Hydrography Dataset (NHD) mapped hydrography flow lines require regular updating because land surface conditions that affect surface channel drainage change over time. Historically, NHD flow lines were created by digitizing surface water information from aerial photography and paper maps. Using these same methods to update nationwide NHD flow lines is costly and inefficient; furthermore, these methods result in hydrography that lacks the horizontal and vertical accuracy needed for fully integrated datasets useful for mapping and scientific investigations. Effective methods for improving mapped hydrography employ change detection analysis of surface channels derived from light detection and ranging (LiDAR) digital elevation models (DEMs) and NHD flow lines. In this article, we describe the usefulness of surface channels derived from LiDAR DEMs for hydrography change detection to derive spatially accurate and time-relevant mapped hydrography. The methods employ analyses of horizontal and vertical differences between LiDAR-derived surface channels and NHD flow lines to define candidate locations of hydrography change. These methods alleviate the need to analyze and update the nationwide NHD for time relevant hydrography, and provide an avenue for updating the dataset where change has occurred.

(KEY TERMS: LiDAR DEMs; LiDAR surface channels; National Hydrography Dataset; hydrography change detection; surface water; hydrography; remote sensing; geospatial analysis.)

Poppenga, Sandra K., Dean B. Gesch, and Bruce B. Worstell, 2013. Hydrography Change Detection: The Usefulness of Surface Channels Derived from LiDAR DEMs for Updating Mapped Hydrography. *Journal of the American Water Resources Association* (JAWRA) 49(2):371-389. DOI: 10.1111/jawr.12027

INTRODUCTION

The United States Geological Survey (USGS) National Hydrography Dataset (NHD) 1:24,000-scale flow lines (Kelmelis, 2003; Kelmelis *et al.*, 2003; Simley, 2006) need to be improved to reflect current topographic conditions (Colson *et al.*, 2006; Sheng *et al.*, 2007; Kloiber and Hinz, 2008; Kaiser *et al.*, 2010; Ducey *et al.*, 2012; Quinn and López-Torrijos, 2012).

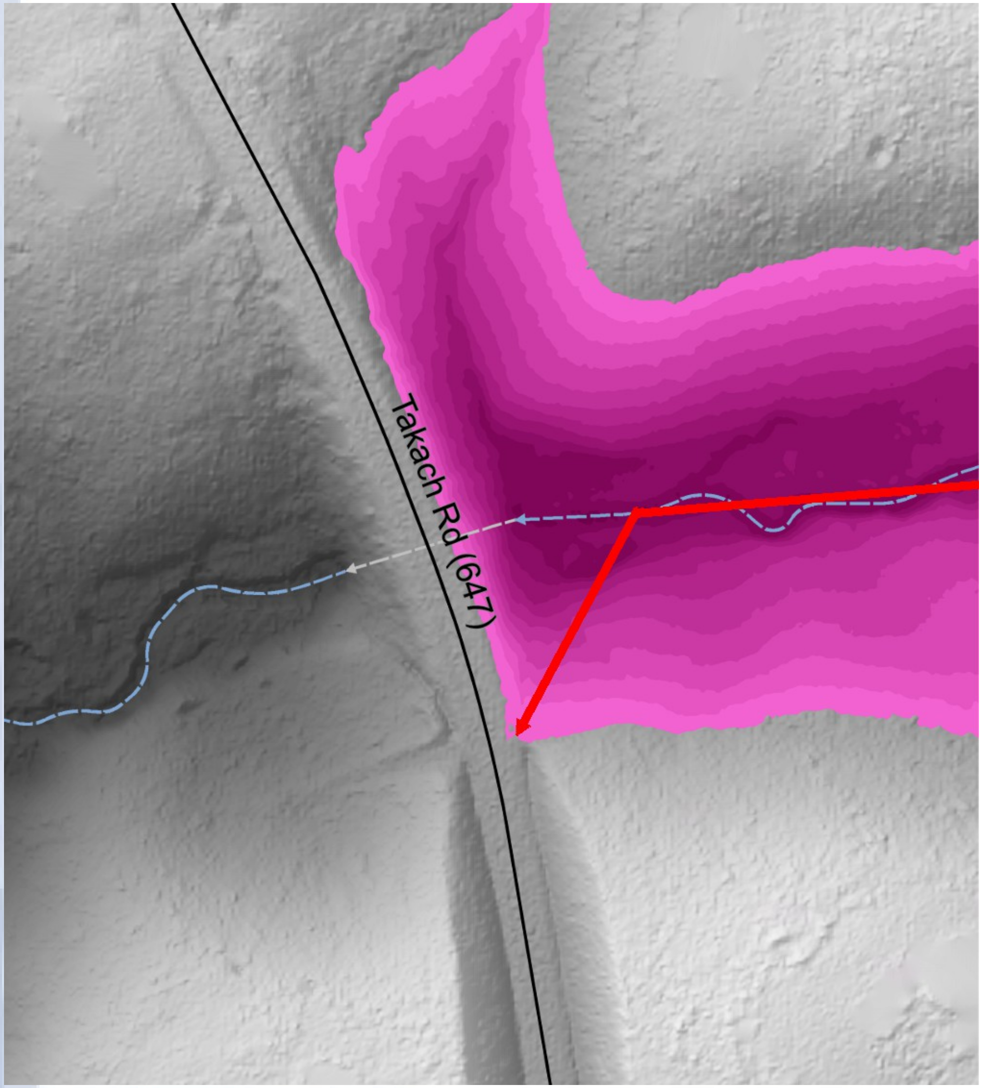
These mapped hydrography updates are needed because of temporal changes in surface channels. The USGS NHD 1:24,000-scale dataset, also known as high-resolution NHD, is a digital vector dataset containing hydrographic features and is the surface water component of *The National Map* (Kelmelis *et al.*, 2003). Although vector NHD flow lines are frequently used in geographic information systems (GIS), the tools used for collaborative maintenance of the dataset are quite complex (Kloiber and Hinz,

[1]Paper No. JAWRA-12-0013-P of the *Journal of the American Water Resources Association* (JAWRA). Received January 17, 2012; accepted October 31, 2012. **Discussions are open until six months from print publication.**

[2]Respectively, Geographer, Topographic Science, U.S. Geological Survey (USGS), Earth Resources Observation and Science (EROS) Center, 47914 252nd Street, Sioux Falls, South Dakota 57198; Research Physical Scientist, Topographic Science, USGS EROS, Sioux Falls, South Dakota; and Senior Scientist, Topographic Science, Stinger Ghaffarian Technologies (SGT), Inc. contractor for the USGS EROS, Sioux Falls, South Dakota (E-Mail/Poppenga: spoppenga@usgs.gov).

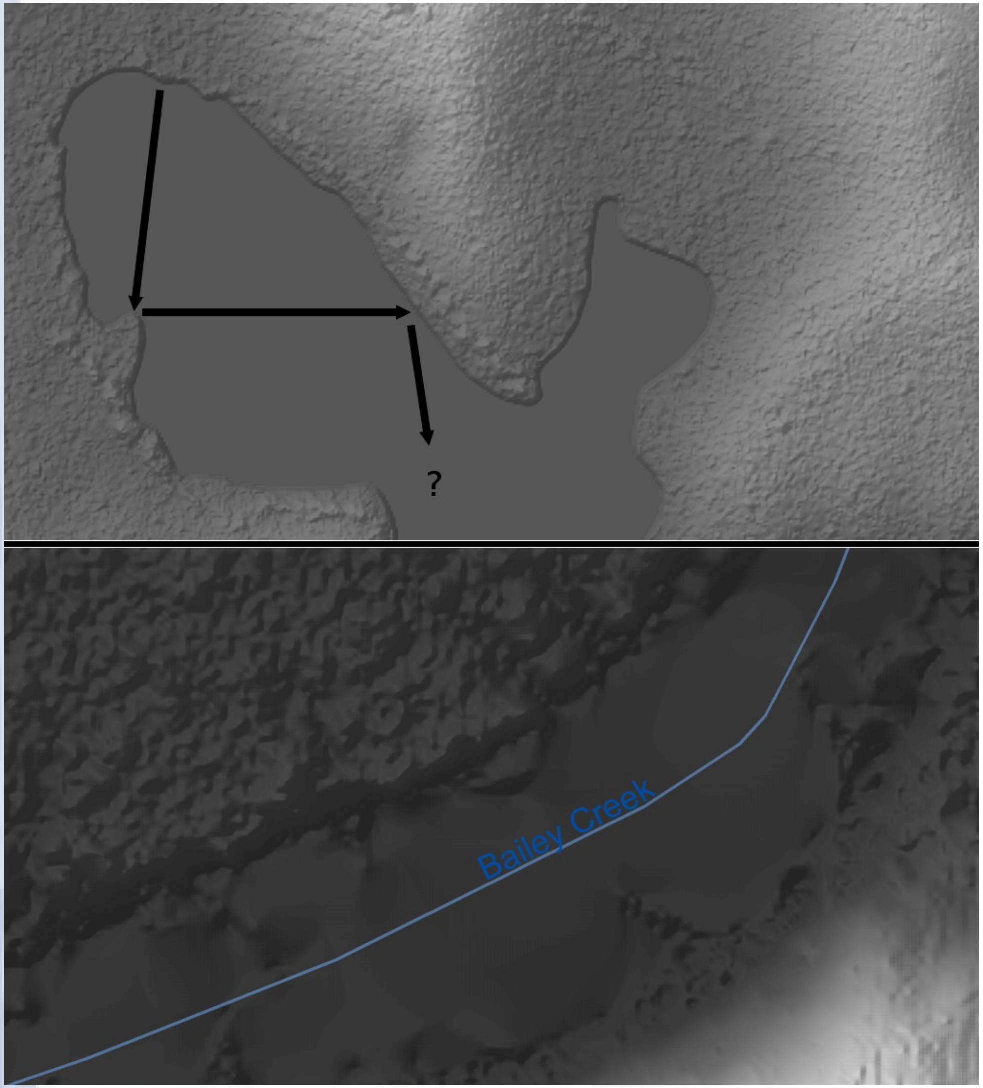
- Established Process
  - D8 Method
  - Follow Method in "Hydrography Change Detection" by Poppenga et al. of the USGS
- High-Resolution DEMs Introduce Issues

Step 2: Generate New Network



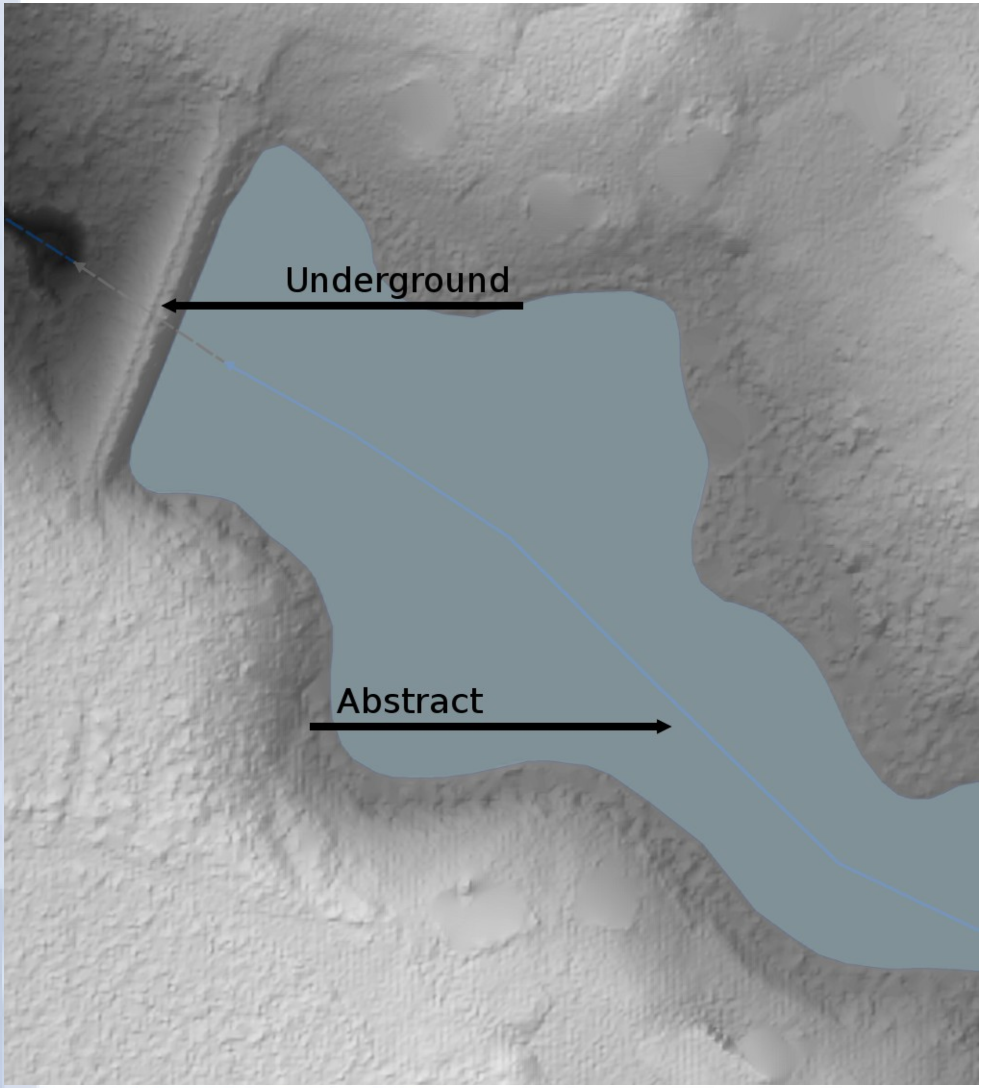
- "Sinks" in Terrain
  - 100' DEMs
    - Treated as Errors
    - Filled-in to Preserve Flow
  - 2.5' DEMs
    - Hidden Culverts and Pipes
    - Identify and Make Hydro Enforced DEM

Step 2: Generate New Network



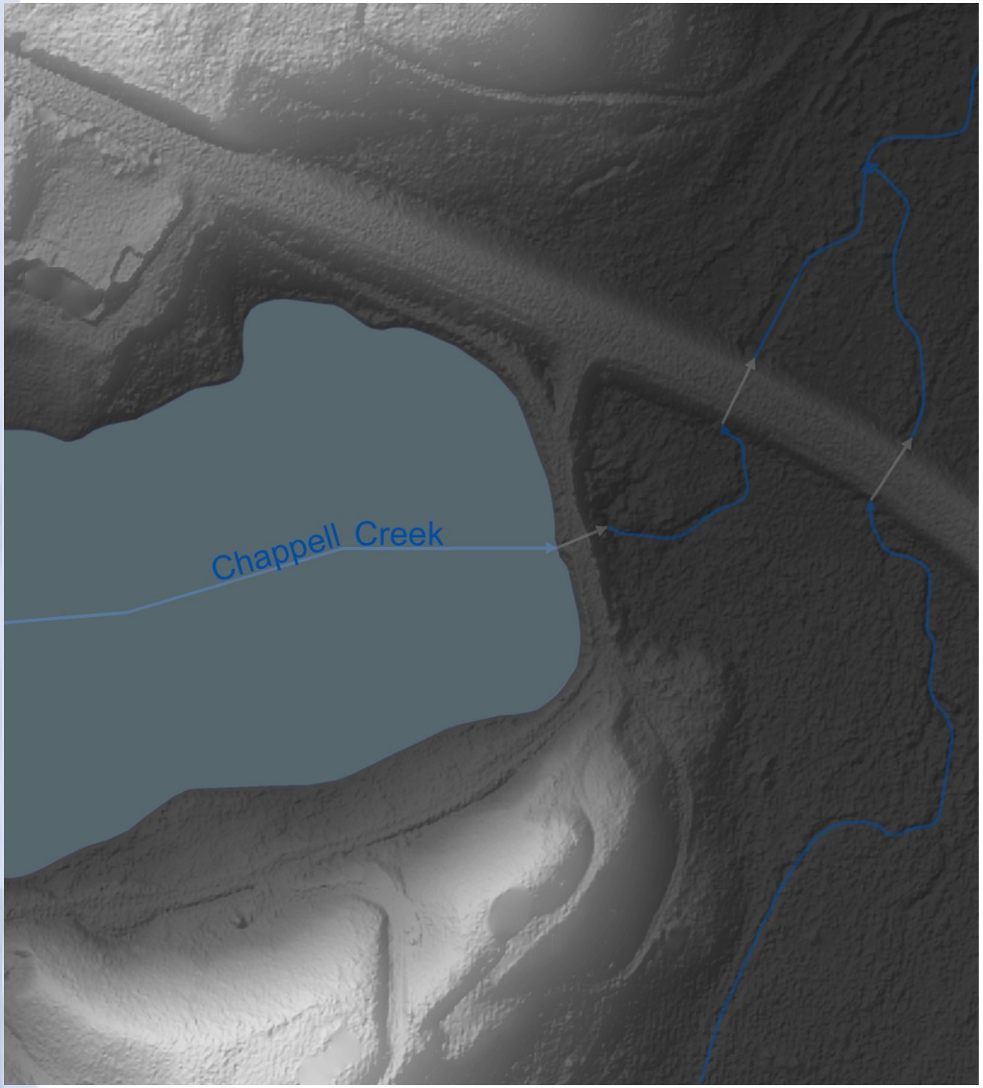
- Water Bodies and Swamps
  - D8 Method's Local Search may not See "Big Picture"
  - Water Surface can Appear Uneven
  - Correct Afterwards with Waterbody Features and Imagery

Step 3: Apply Attributes



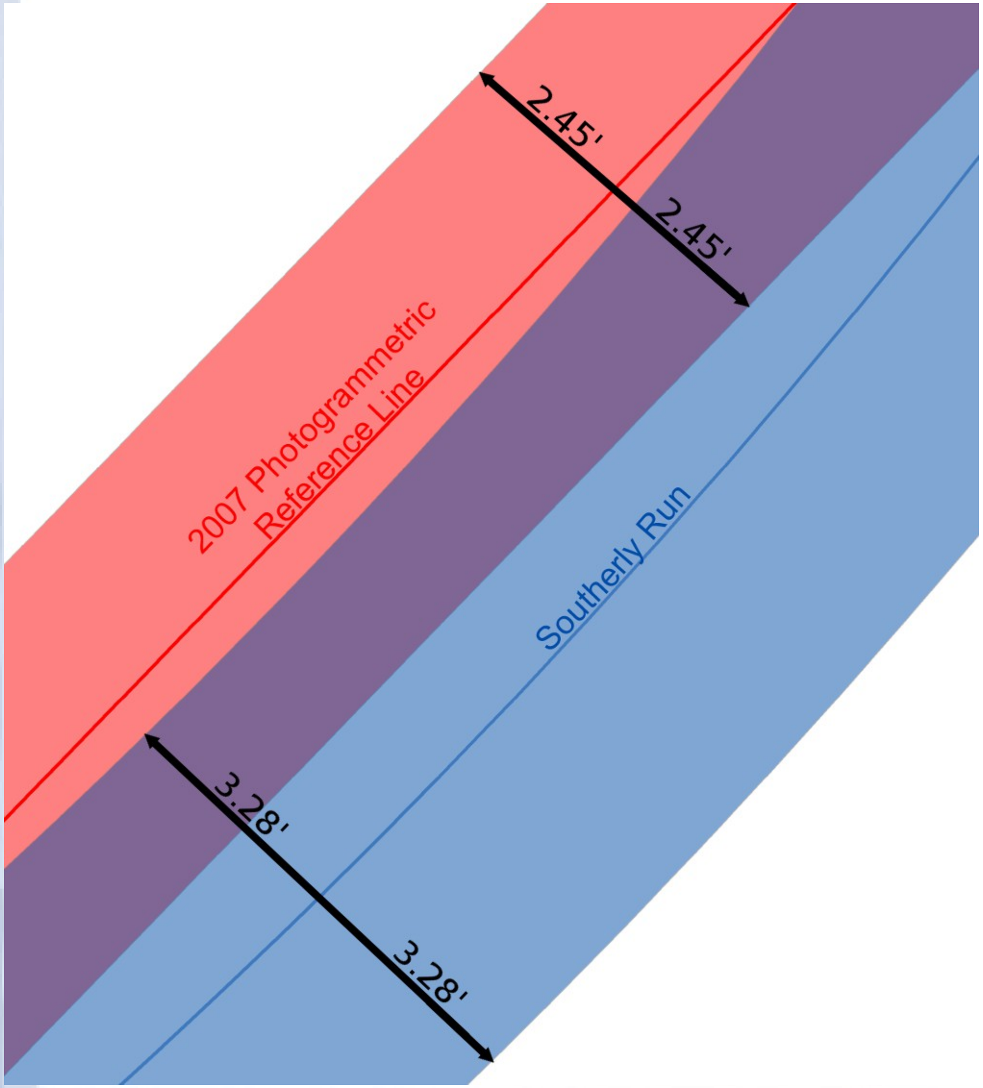
- From High-Resolution Terrain Data
  - “Underground” in Pipes; “Abstract” Across Lakes
- Mapped from NHD
  - NHD GeoConflation
  - ID Pairs within 40'
- Some Data Ignored
  - (ex: “Edit Date”)

Step 3a: Smooth/Generalize



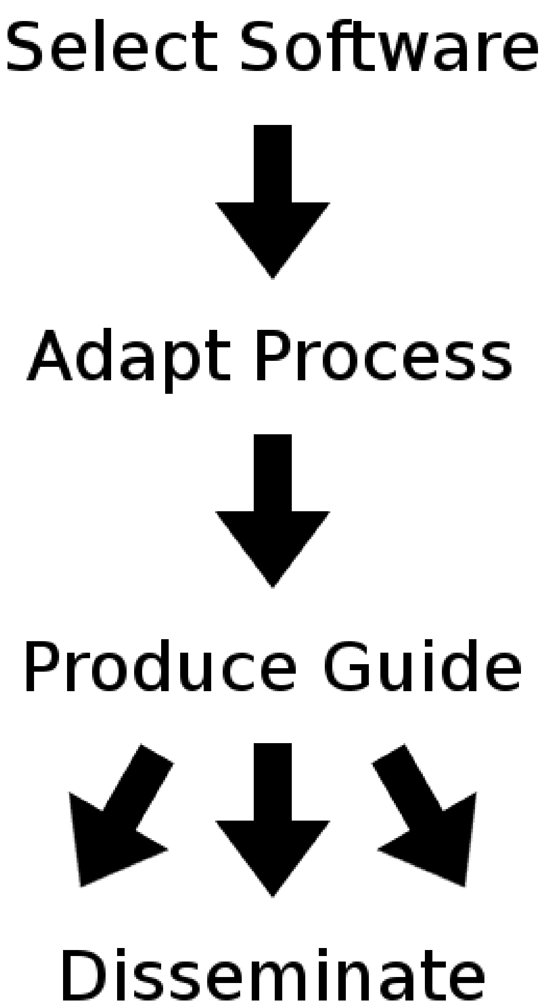
- Point Dense Polylines Need Generalization
- Smooth Curves say, "Hey. I'm a stream."
- Tangential Lines and Arcs, not Bézier curves
- Varies by Line Classification

Step 4: Evaluate Results



- Quantitative
  - Compare Against Photogrammetric Lines
  - Measure Length Outside Buffer
- Qualitative
  - Does It Look Good?
  - Does It Look Like a Stream?

Step 5: Produce Guide



- Adapt to Open-Source Software and Tools
- Produce PDF Guide
  - Keep General; Not Specific to Tools
  - Preface Sections with Explanations
  - Note Opportunities to Go Further
- Dissemination Means?

Project Timeline

- By Feb. 15th – Develop and Test Workflow in ArcGIS
- By Mar. 1st – Implement Workflow on Open-Source Software
- By Apr. 1st – Complete Guide PDF
- Apr. 21st-25th – Present at Association of American Geographers (AAG) Annual Meeting in Chicago, IL

Citations and Resources

- Data
  - [1,3,4,10-14] Prince George Co., VA (Local Data)
  - [3,14] Virginia Base Map Program (Orthoimagery and associated Photogrammetric Lines)
  - [1,3,7,10-13] USGS (NHD; DEMs)
  - [8] NOAA (USIEI)
- Reference
  - Poppenga et al. “Hydrography Change Detection”
  - USIEI: coast.noaa.gov/inventory/
  - Wikipedia: National Lidar Dataset (United States)