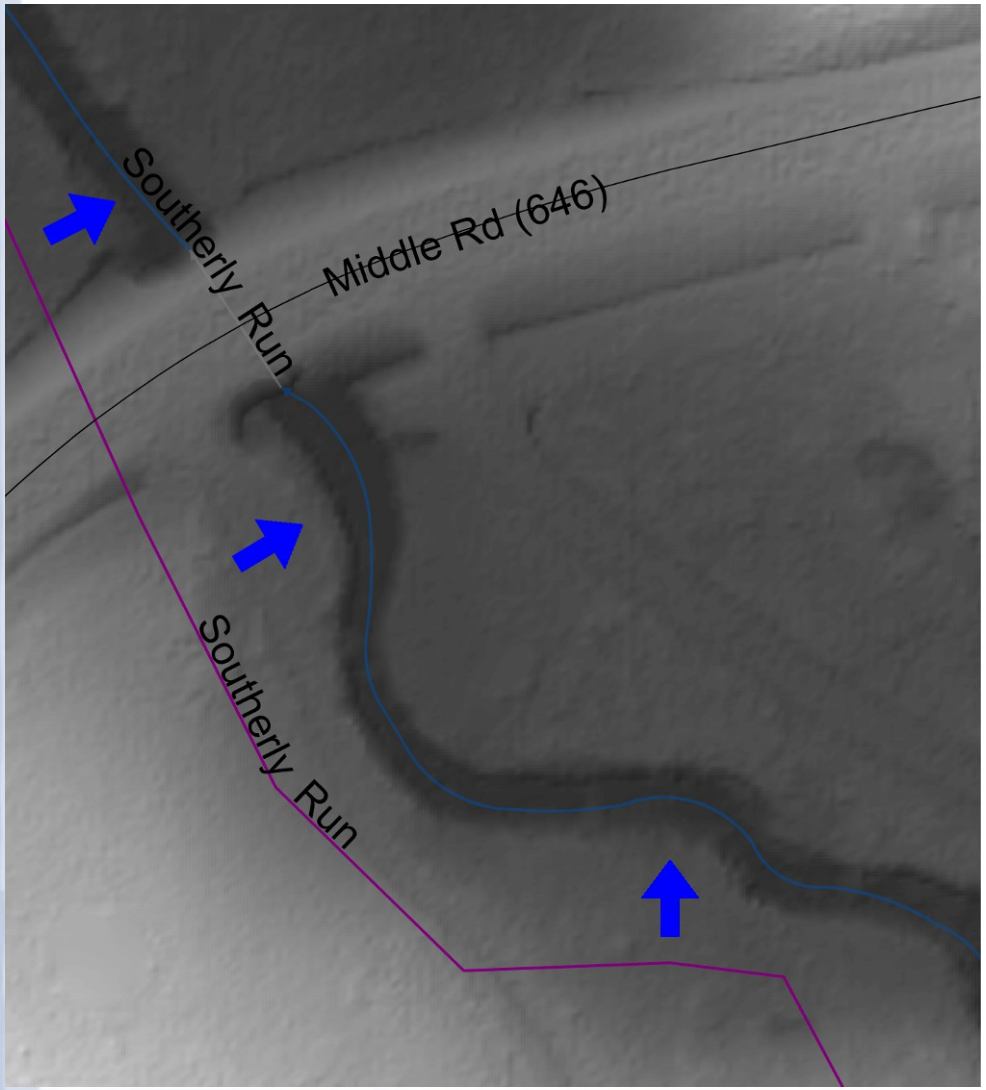
Stream Correction for Local Government GIS



A Practical Guide and Introduction

Nicholas McKenny

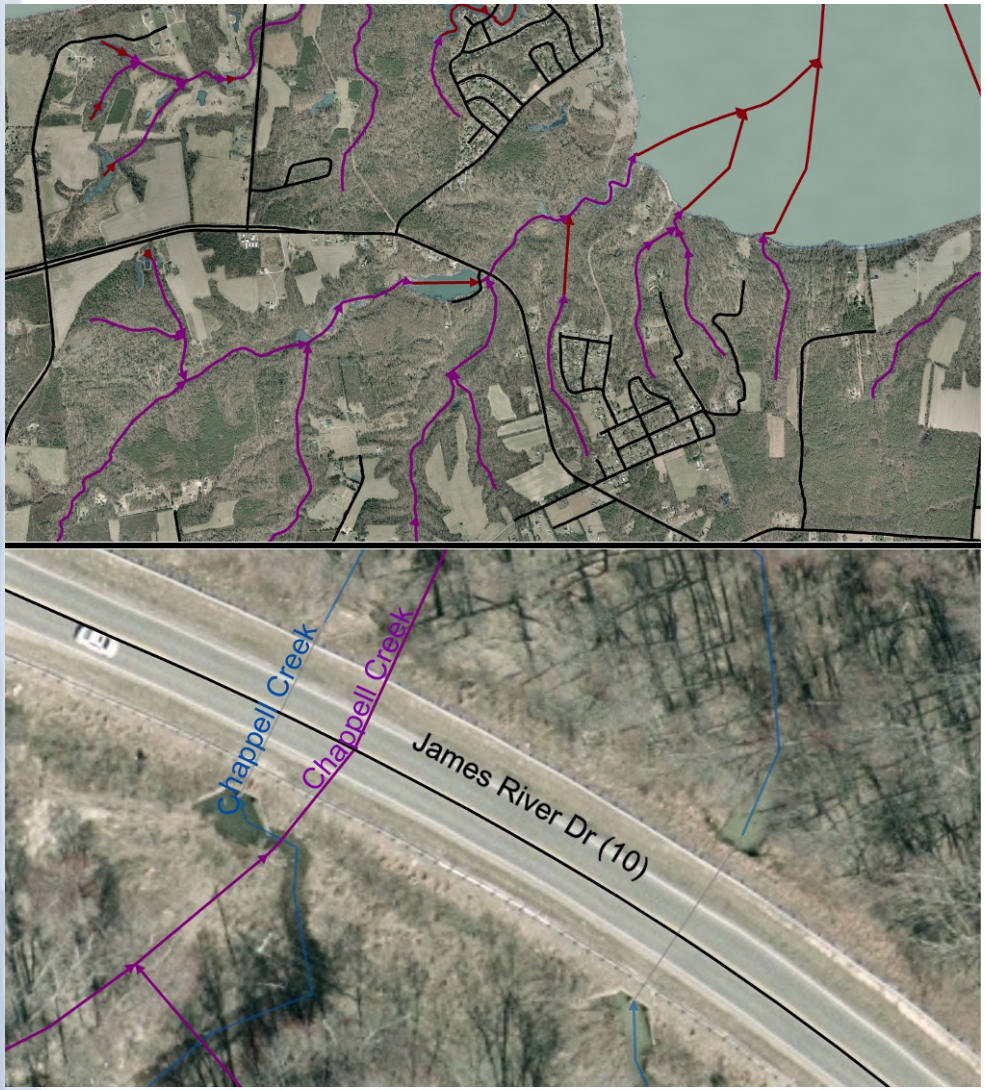
Penn State

Adviser: James O'Brien

Presentation Outline

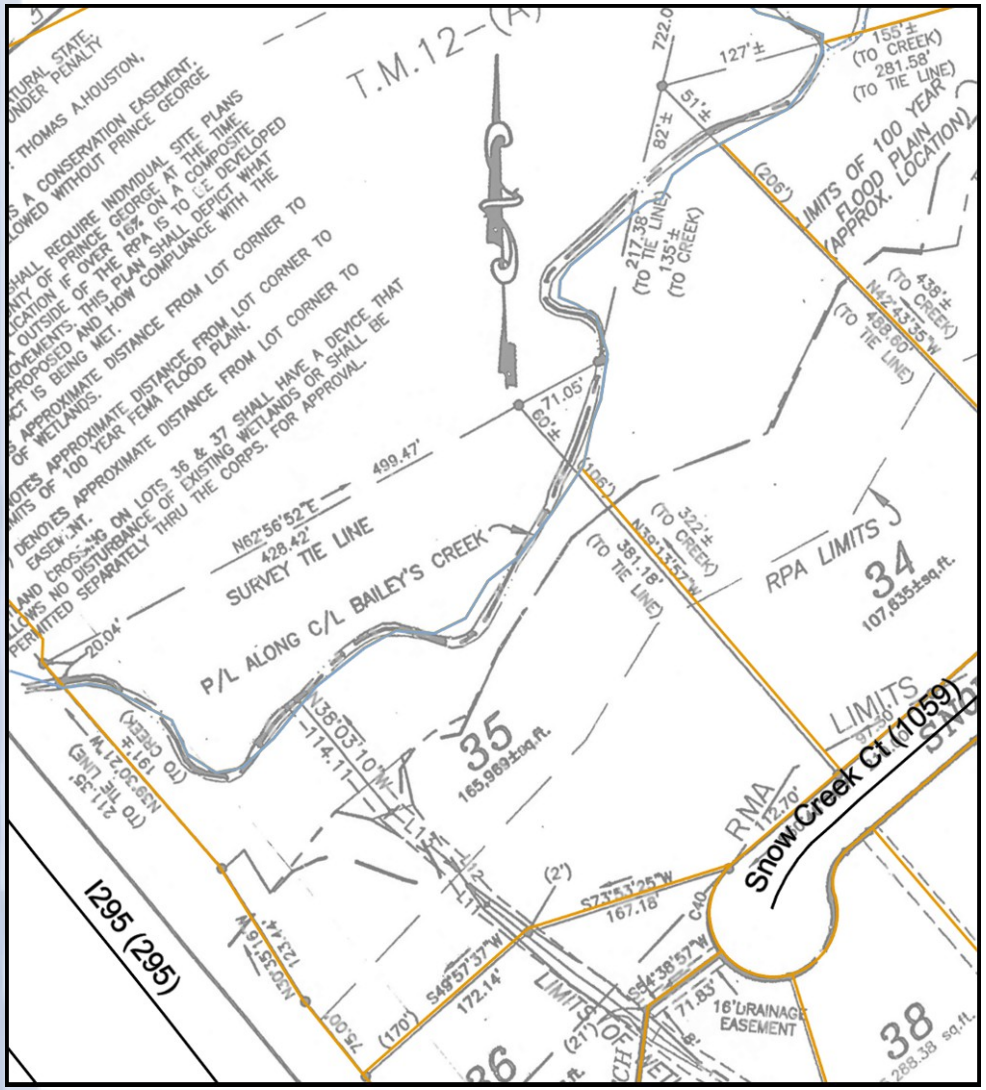
- Existing Situation
- Solution, Goals, & Hopes
- Guide Execution & Design
- Process Overview
- Projected Completion Date & Distribution

Present Situation



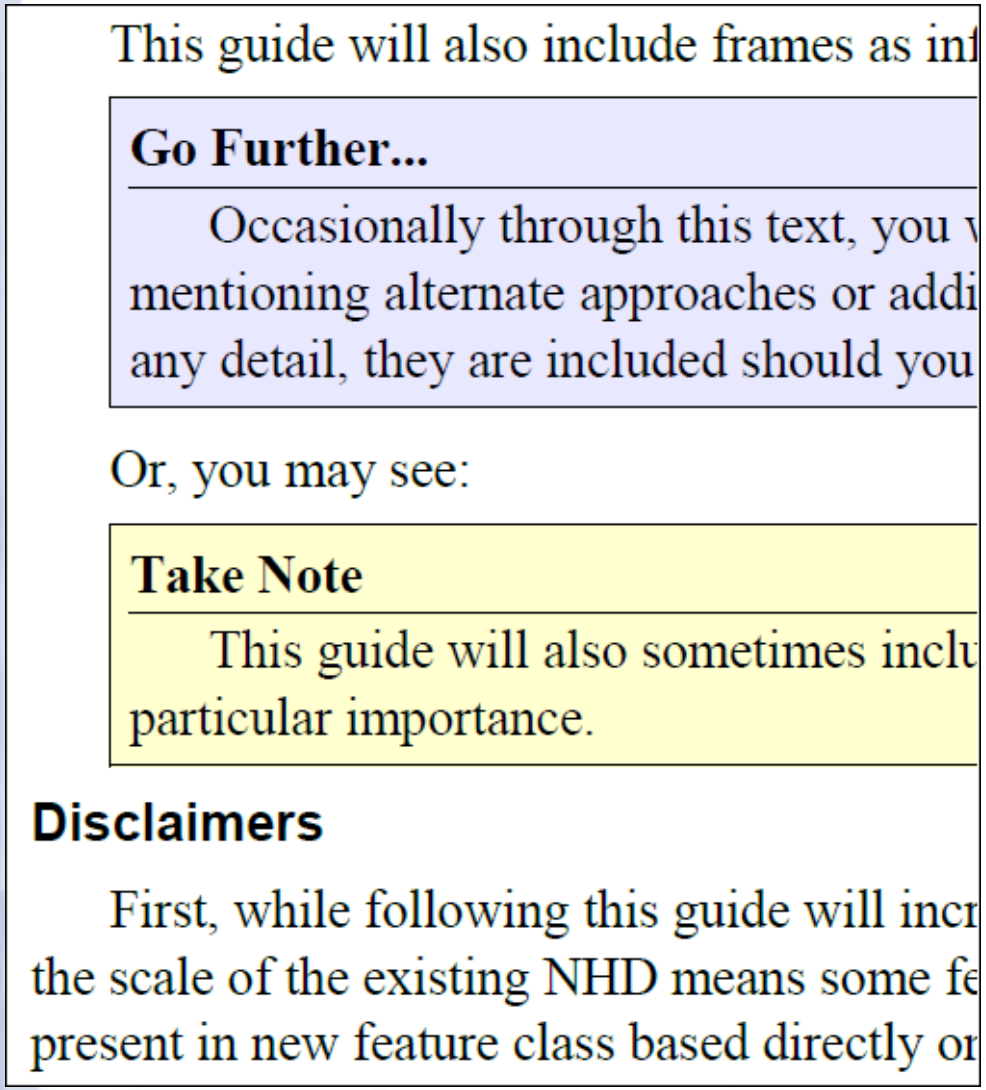
- Public stream lines
  - National coverage
  - Not for local scale
- Local government GIS
  - Ever more common
  - Limited resources
  - Little collaboration

Solution, Goals, & Hopes



- Create guide on updating NHD lines at low cost
- Goals & Hopes
  - Encourage better local stream lines
  - Increase awareness of resources and their applications

Guide Execution & Design



This guide will also include frames as inf

Go Further...

Occasionally through this text, you v mentioning alternate approaches or addi any detail, they are included should you

Or, you may see:

Take Note

This guide will also sometimes inclu particular importance.

Disclaimers

First, while following this guide will incr the scale of the existing NHD means some fe present in new feature class based directly or

Guide Approach

- Keep accessible
- Mention caveats & alternatives
- Focus on context, not just on step-by-step

Guide Execution & Design

Job 1: First Job

Job Overview

Task 1.1: First Task

Task Overview

Steps in ArcGIS 10.2

Steps Overview

Step 1.1.1: First Step

Step 1.1.2: Second Step

Steps in QGIS 2.8.1

Steps Overview

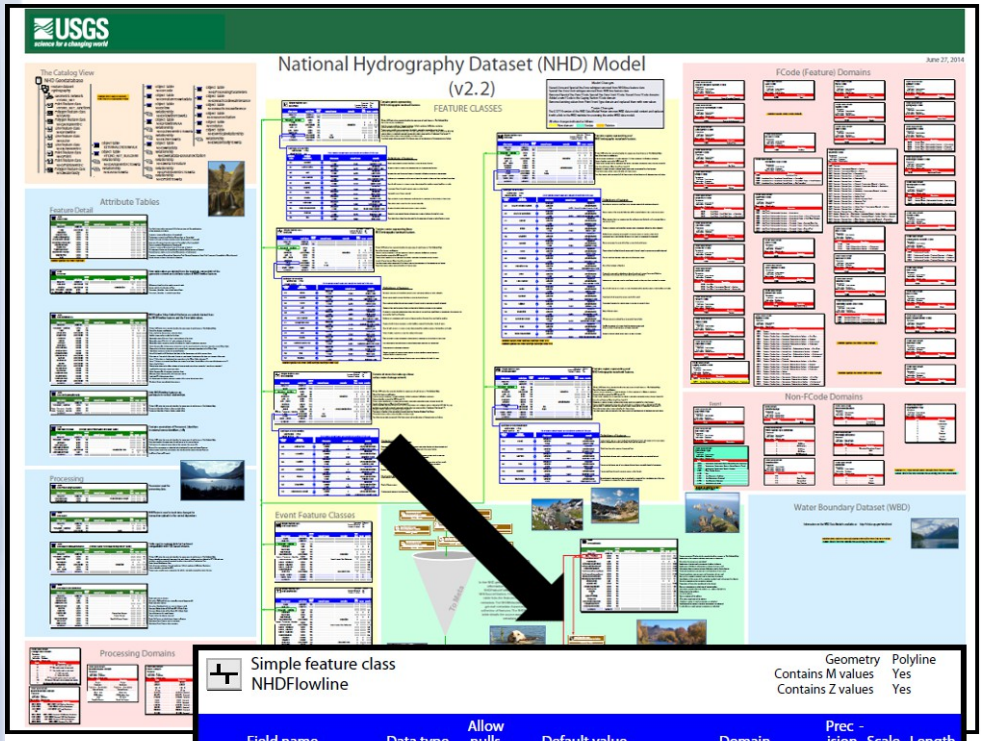
Guide Layout

- High-level jobs
- Mid-level tasks
- Tool-specific steps
  - ArcGIS 10.2.2
  - QGIS 2.8.1

Process Jobs Overview

1. Identify GIS data sources
2. Create hydrologically-enforced DEM
3. Extract seed points for downhill trace
4. Regenerate NHD stream network features
5. Classify stream network features by terrain
6. Generalize and smooth network features
7. Apply NHD attributes to network features

Job 1: Collect Data



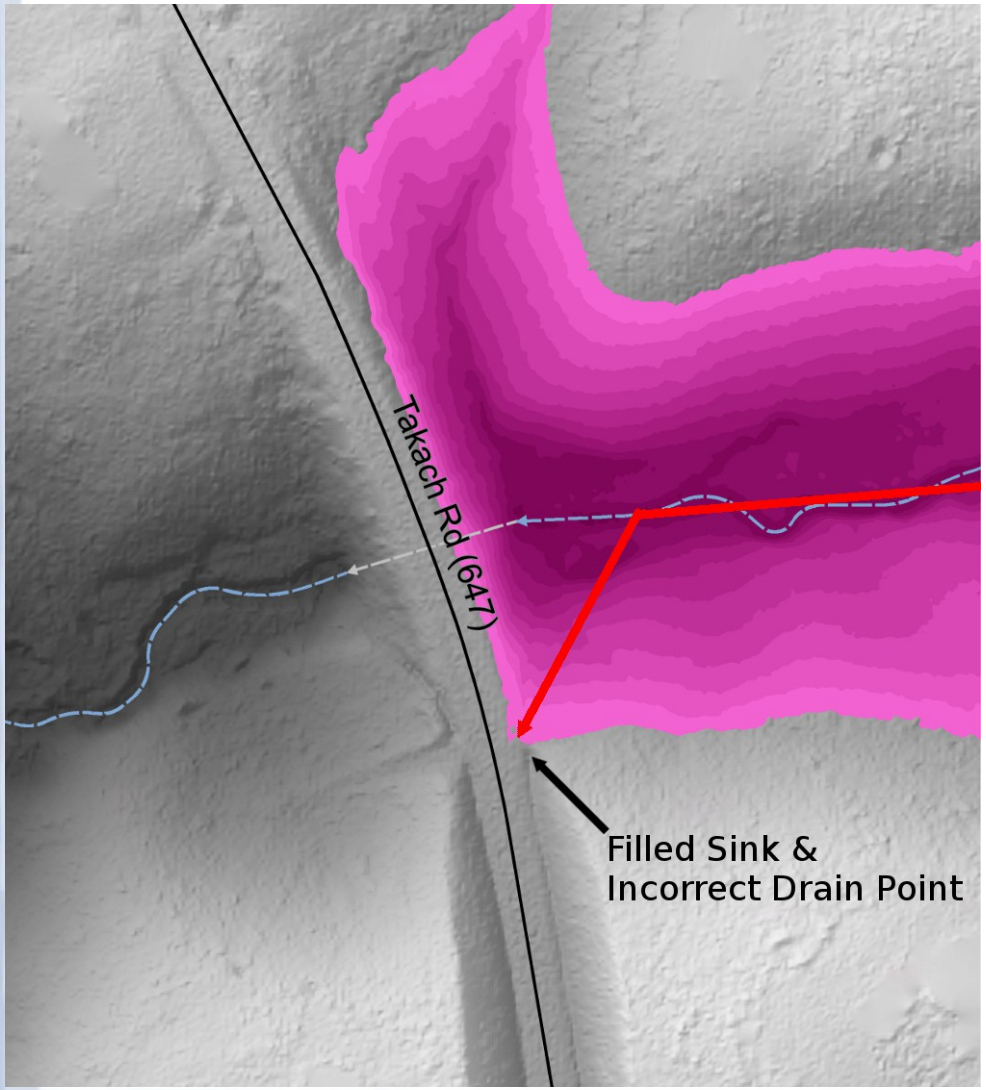
Simple feature class
NHDFlowline

Geometry	Polyline
Contains M values	Yes
Contains Z values	Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec - ision	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						

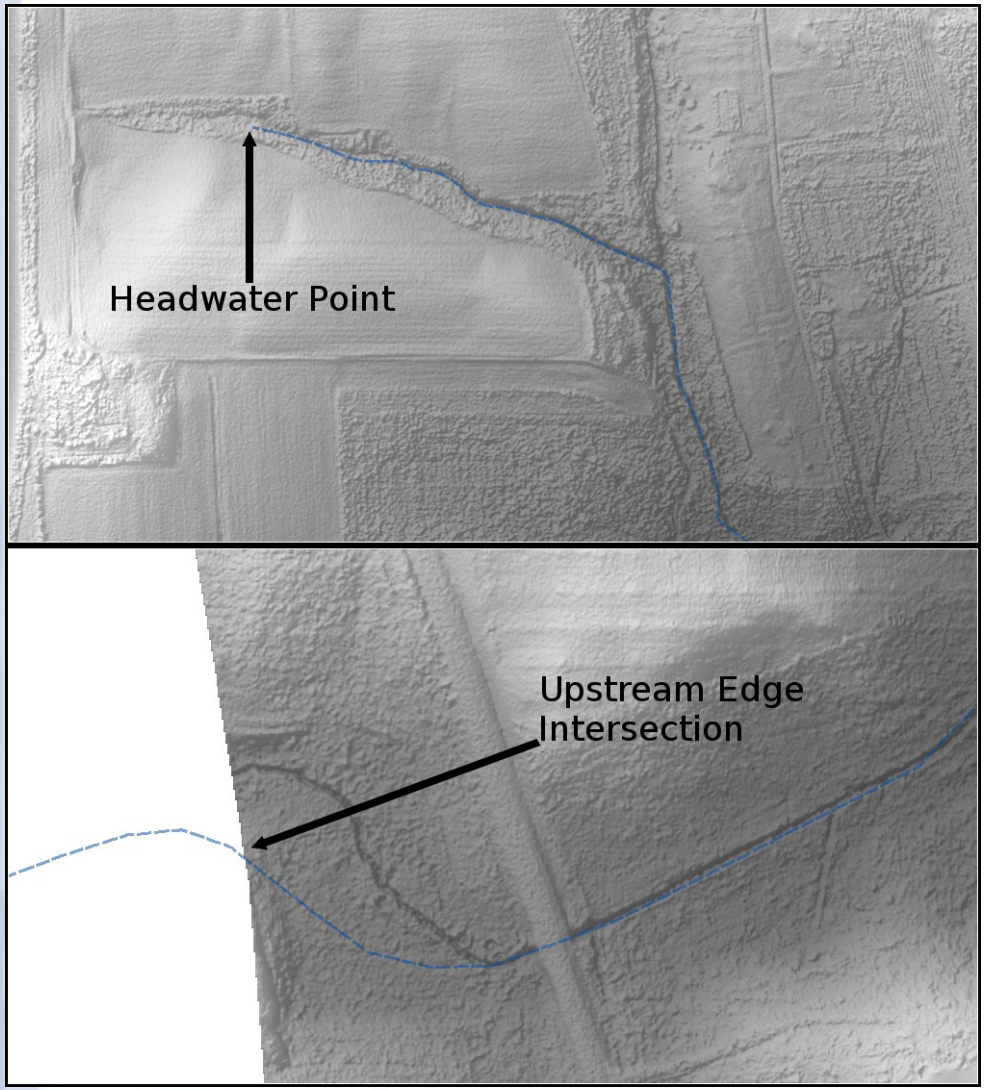
- USGS National Hydrography Dataset (NHDFlowlines)
- High-resolution DEM
- Reference layers
  - Waterbody bounds
  - Aerial orthoimagery

Job 2: Create Hydro-Enforced DEM



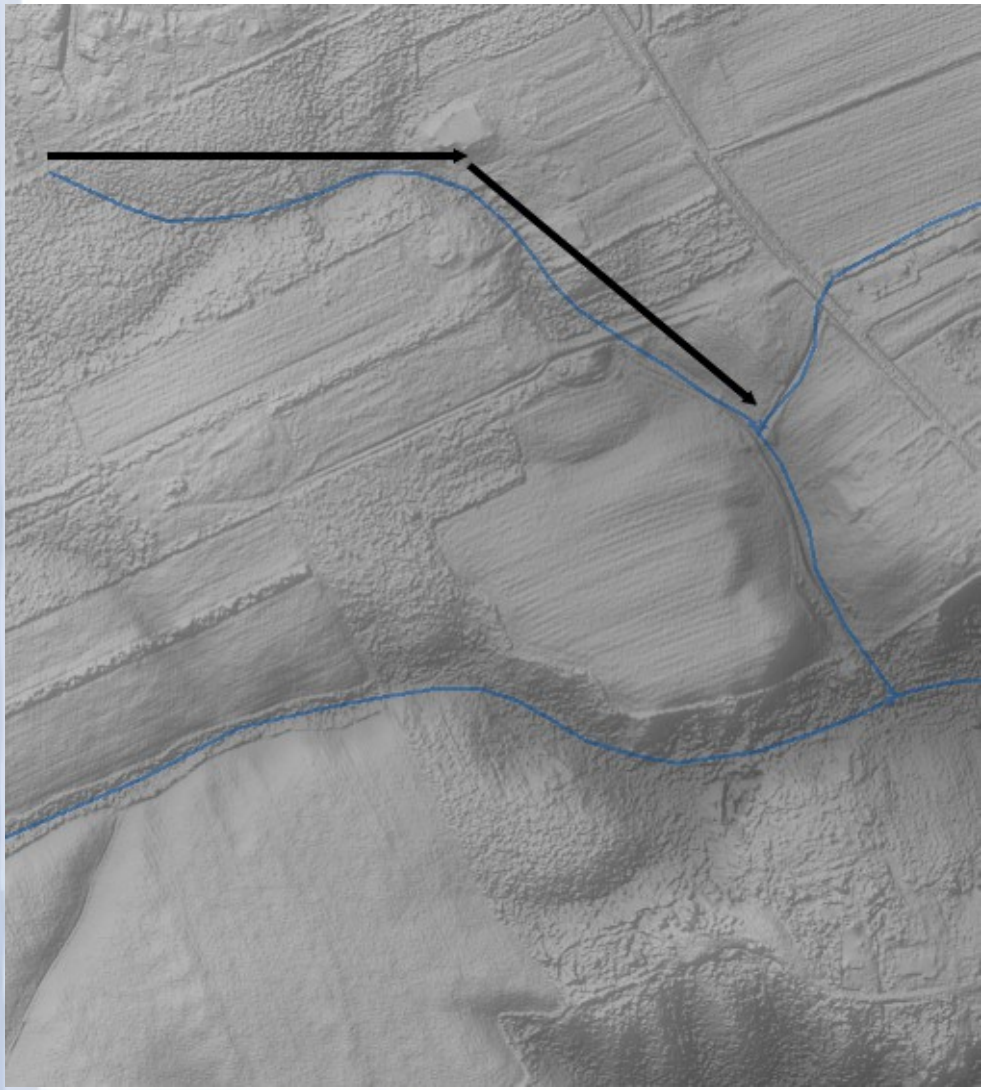
- Ensure continuous flow
  - Fill minor sinks
  - Drain major sinks
    - Locate lowest points in sinks
    - Delineate likely pipe and culvert paths
    - Lower terrain along drain paths

Job 3: Extract Seed Points



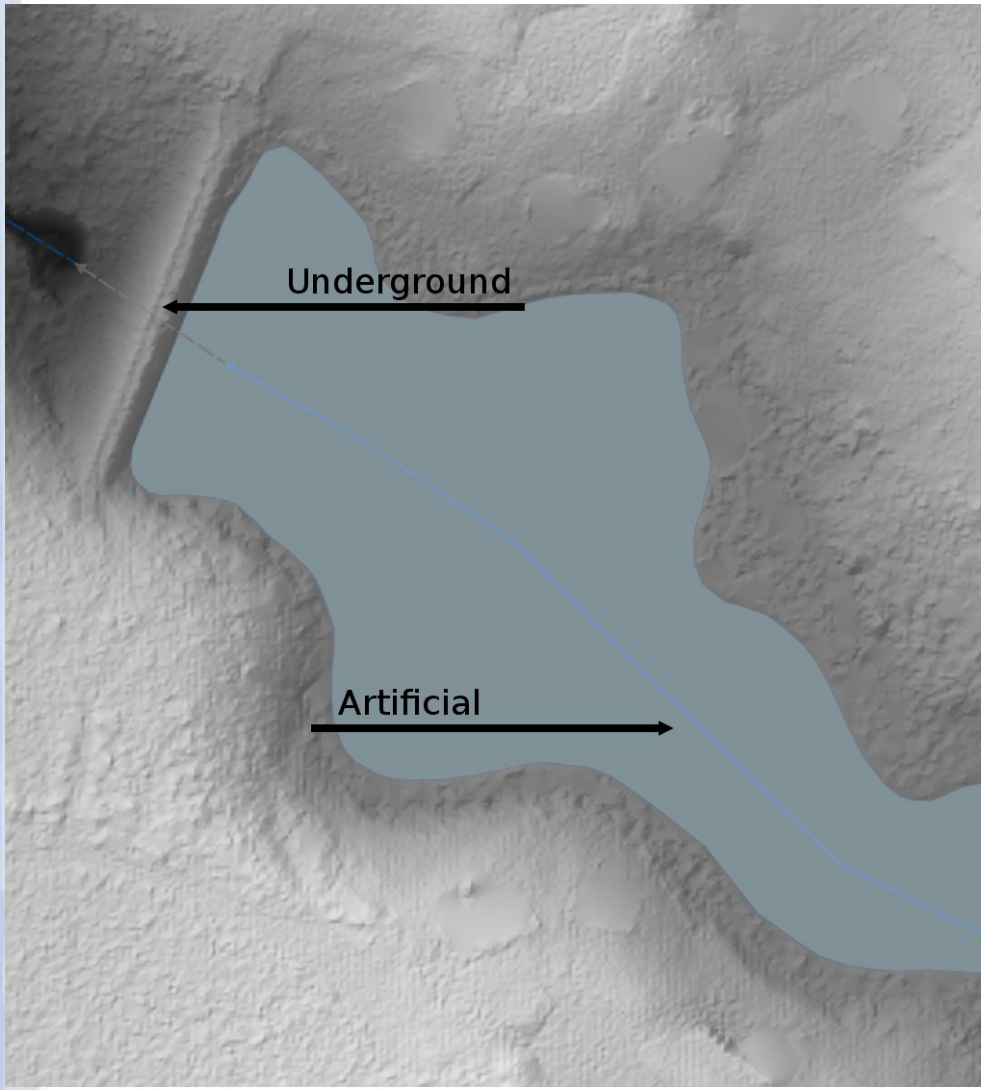
- Create seed points from NHDFlowlines
  - Headwater nodes within DEM
  - Upstream intersections with DEM edge
- Adjust to ensure correct flow direction

Job 4: Regenerate Network



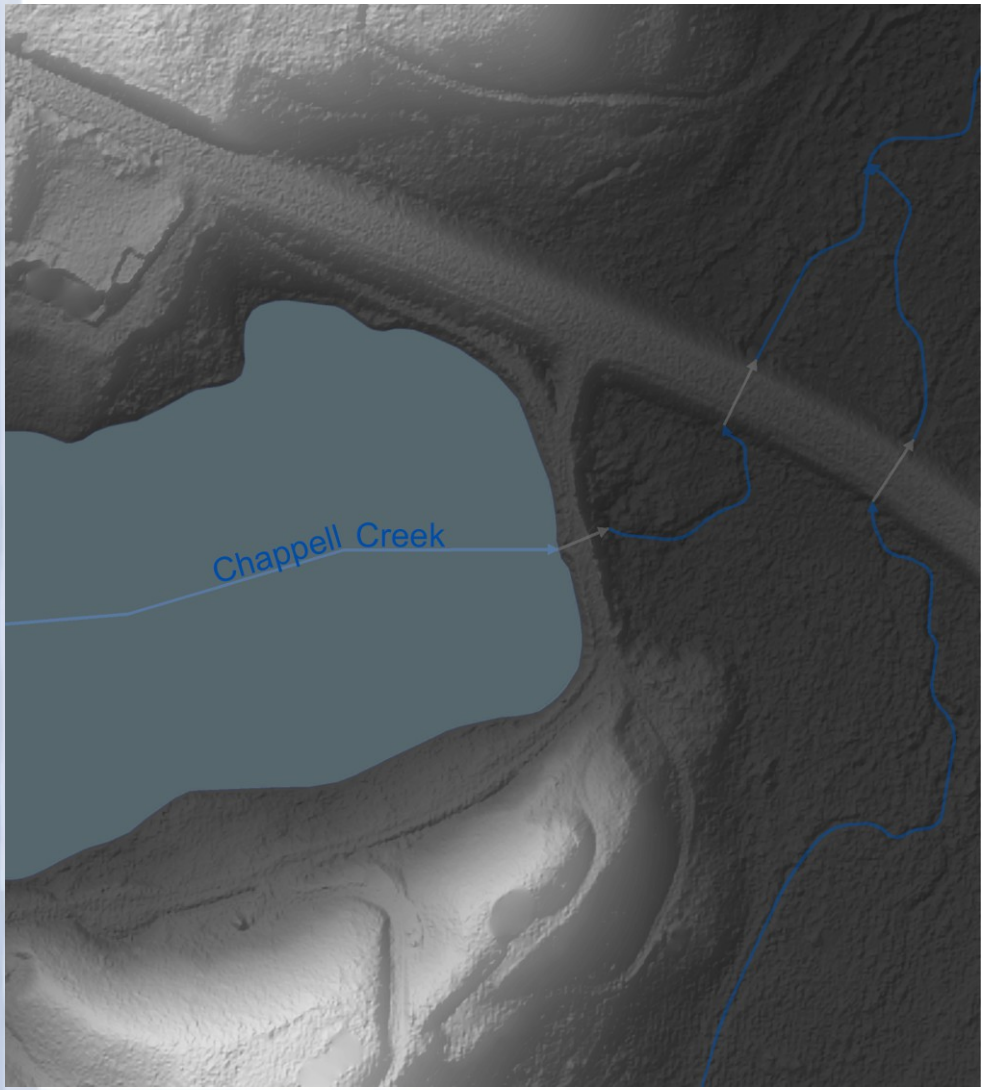
- Fairly simple
- Trace downhill from seed points
  - Reproduce NHDFlowlines network features
  - Attributes and classifications come next

Job 5: Classify Features by Terrain



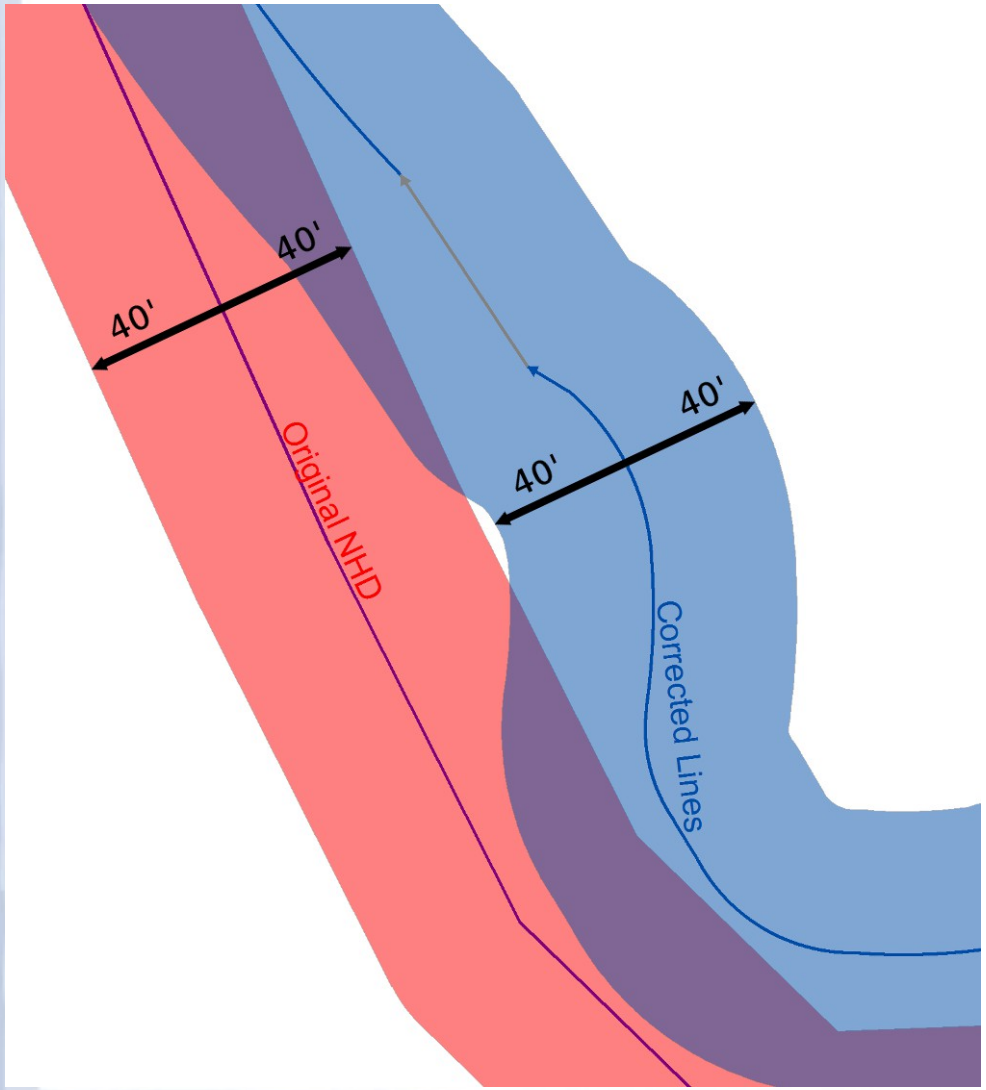
- From high-resolution terrain data
  - "StreamRiver" by default
  - "Underground Conduit" along drainage paths
  - "Artificial Path" across water

Job 6: Smooth/Generalize



- Reduce complexity
- Improve appearance
- Every point not critical
- Varies by classification
  - Smooth, curved streams
  - Short, straight pipes
  - Long, straight waterbody centers

Job 7: Apply NHD Attributes



- Mapped from NHD
  - Basic idea: Identify pairs within mutual buffers
  - Buffer width based on NHD spatial accuracy
  - Implementation varies by tool
- Some data ignored
  - (ex: “Edit Date”)

Completion & Dissemination

- Completion: ~Fall 2015
- Format
  - PDF
  - Available source documents
- Means of Distribution
  - Useless if no one sees it
  - Open to ideas
    - How will people find it?
    - Where can this reside?

Citations and Resources

- Data
  - [1,3,4,9,12-14] Prince George Co., VA (Local Data)
  - [3] Virginia Base Map Program (Orthoimagery and associated Photogrammetric Lines)
  - [1,3,8-14] USGS (NHD; DEMs)
- Reference
  - Poppenga et al. “Hydrography Change Detection”
  - USIEI: coast.noaa.gov/inventory/
  - Wikipedia: National Lidar Dataset (United States)

Stream Correction for Local Government GIS

A Practical Guide and Introduction

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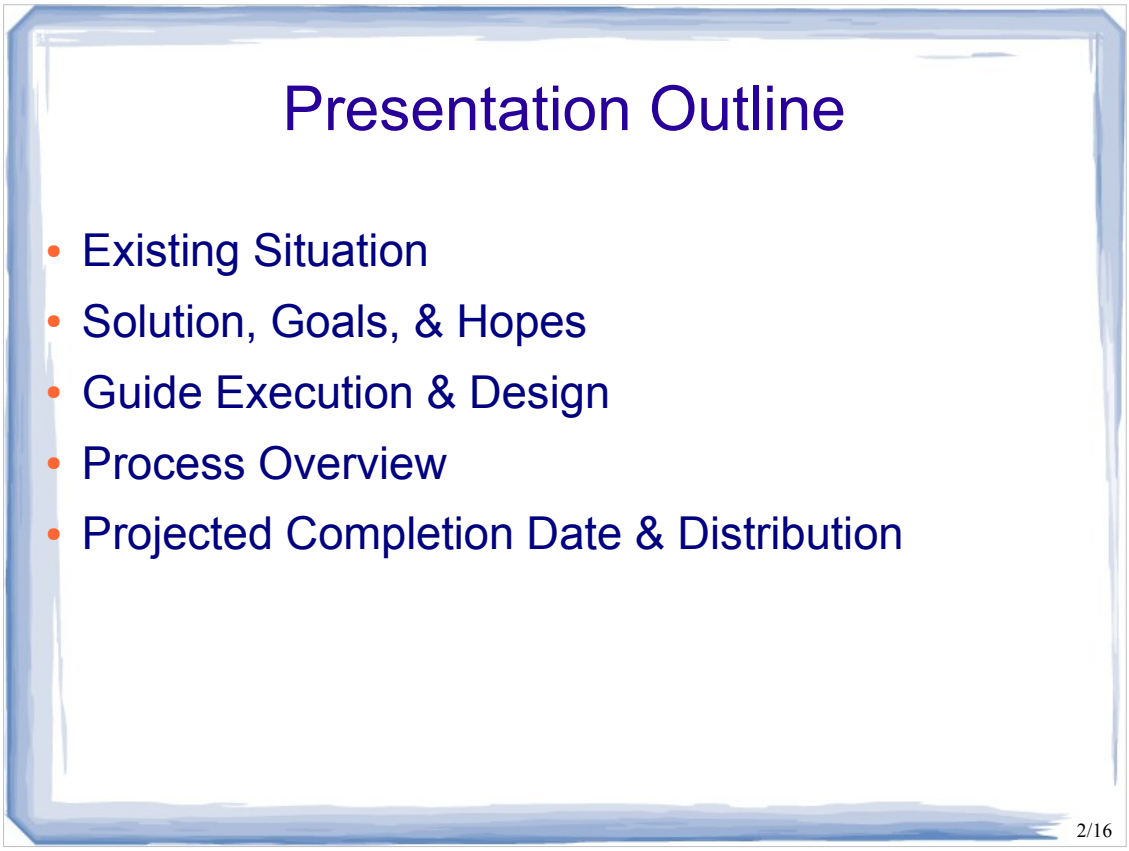
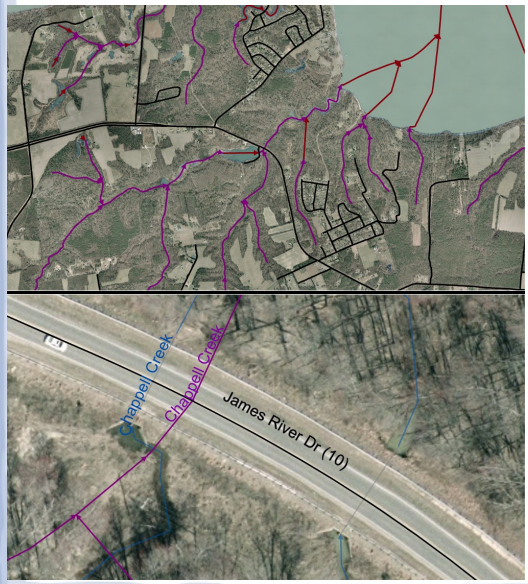
1/16

- Introduce self and (briefly) the project
  - “My name's Nicholas McKenny.”
  - “This presentation is on my project to produce a guide, for national distribution, on improving surface water flow lines for local use.”



- Existing Situation (a.k.a. The Problem)
- (My) Solution, Goals, & Hopes
- Guide Execution & Design
  - Approach
  - Layout
- Process Overview (Jobs)
  - [sub-steps]
- Projected Completion Schedule
- Guide Distribution Plans (or lack there of)
- Questions/Request for Input

Present Situation



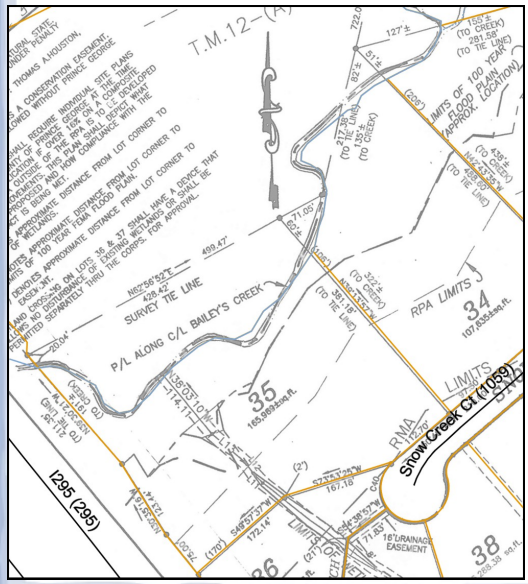
- Public stream lines
  - National coverage
  - Not for local scale
- Local government GIS
  - Ever more common
  - Limited resources
  - Little collaboration

3/16

Present Situation

- USGS offers freely-available surface water flow lines through the National Hydrography Dataset (NHD)
  - National coverage, but not at a local scale (generally)
  - (i.e.: Good at the scale of a county; not at that of a corner lot)
- (Increasingly) Even rural county governments may have a GIS
  - Large area
  - Limited resources
- [My experience] County GIS's don't collaborate; everyone is figuring it out on their own.

Solution, Goals, & Hopes



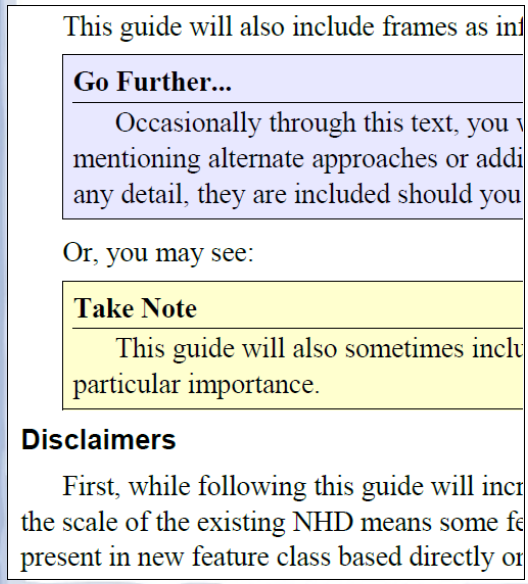
- Create guide on updating NHD lines at low cost
- Goals & Hopes
  - Encourage better local stream lines
  - Increase awareness of resources and their applications

4/16

Solution, Goals, & Hopes

- Solution: Produce guide on updating NHD flow lines to a local resolution and do so using freely-available data and tools.
- Goals & Hopes
  - Encourage a national improvement in local stream lines, especially in more resource-strapped localities.
  - Increase awareness of available resources, data and software, plus offer a glimpse of how they might be used.

Guide Execution & Design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the scale of the existing NHD means some fe
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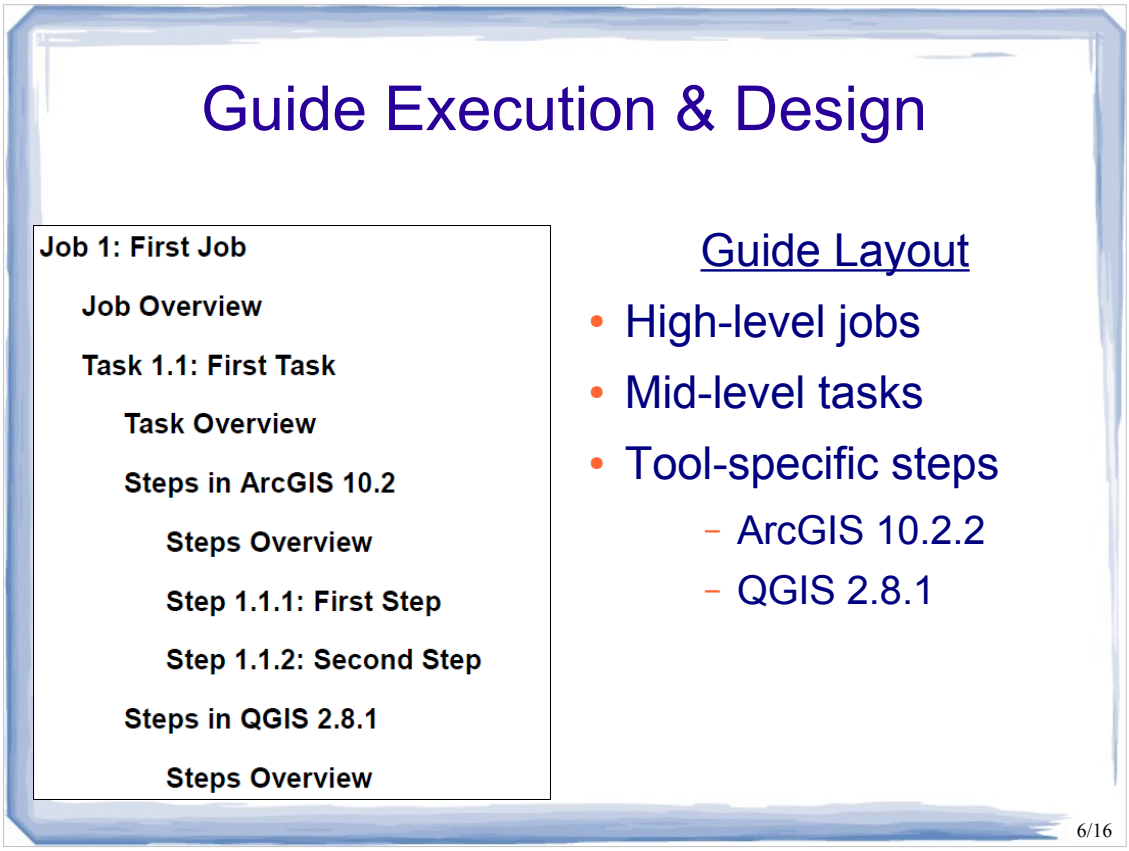
Guide Approach

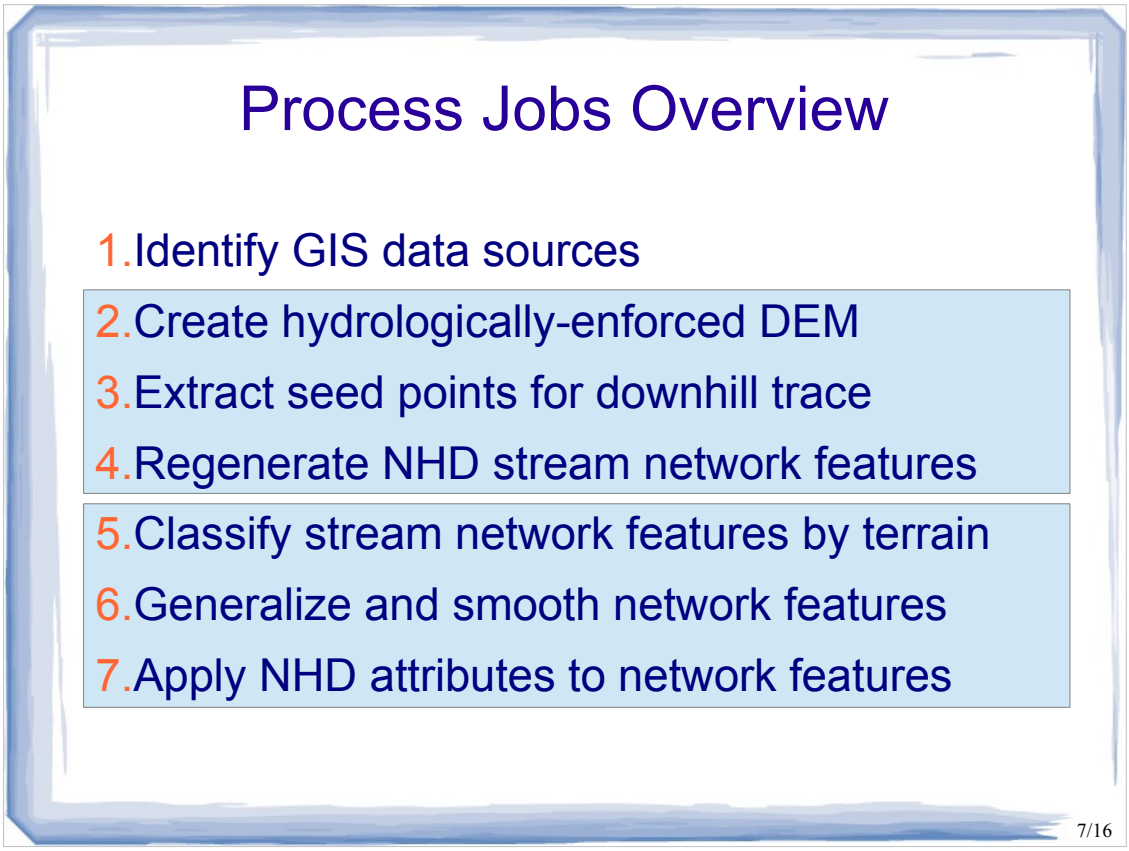
- Keep accessible
- Mention caveats & alternatives
- Focus on context, not just on step-by-step

5/16

- Approach
  - Keep process accessible:
    - (a) through simple, easy-to-follow steps
    - (b) by using relatively common tools.
  - (Briefly) highlight alternate approaches and caveats
    - [Situations vary → No instruction perfectly fits all cases]
  - Focus on explaining the “what and why” to give context to the “how” of the step-by-step instructions.
    - Software-specific steps can rapidly become dated.
    - A basic understanding retains value.



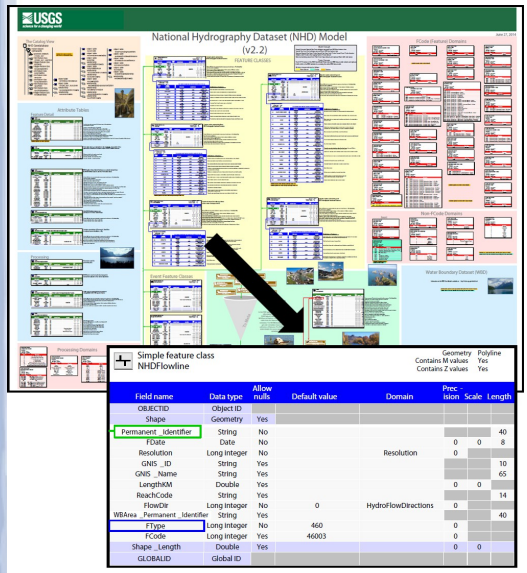
- Layout broken into Jobs → Tasks → Steps
  - Jobs: Broad, high-level overviews
  - Jobs made-up of Tasks, mid-level explanations
    - Jobs and Tasks start with an overview section, looking ahead in broad terms
  - Tasks implemented, in ArcGIS 10.2.2 and QGIS 2.8.1, in software-specific steps



Organized Process into ~7 Jobs
1. Identify GIS data sources
2. Create Hydrologically-Enforced DEM
3. Create Seed Points for Downhill Trace
4. Regenerate NHD Stream Network Features
5. Classify Stream Network Features by Terrain
6. Generalize and Smooth Stream Network Features
7. Apply NHD Attributes to Stream Network Features

- (First!) Follows the method described by Poppenga et al. in "Hydrography Change Detection: The Usefulness of Surface Channels Derived from Lidar DEMs for Updating Mapped Hydrography"
  - Summary: Reproduces the NHD flow network by tracing downhill from headwater seed points

Job 1: Collect Data

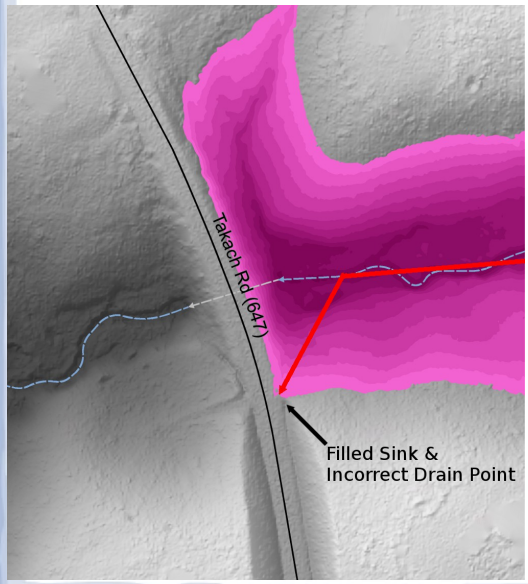


- USGS National Hydrography Dataset (NHDFlowlines)
- High-resolution DEM
- Reference layers
  - Waterbody bounds
  - Aerial orthoimagery

8/16

- Surface flow network layer, NHDFlowlines, from the USGS NHD
  - [NB: Some local resolution data exists (ex: Vermont and New Jersey)]
- Digital Elevation Model
  - High-resolution (lidar-derived)
  - No single point of distribution for finest data
    - US Interagency Elevation Inventory
    - Wikipedia: Lists some additional State Data
- Reference layers
  - (!) Of a comparable resolution, accuracy, and collection date to the DEM
  - Any lidar delivery <u>should</u> include a delineation of water bodies and other features. Ask.
    - [Part of delivering all data and documentation required to reproduce the lidar products.]
  - Aerial orthoimagery collected by state and federal governments

Job 2: Create Hydro-Enforced DEM

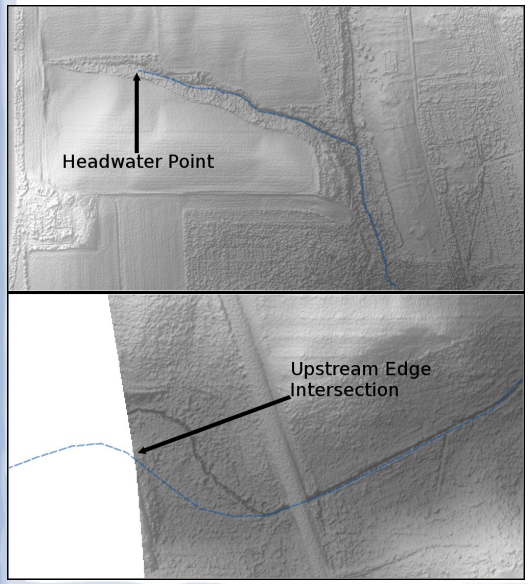


- Ensure continuous flow
  - Fill minor sinks
  - Drain major sinks
    - Locate lowest points in sinks
    - Delineate likely pipe and culvert paths
    - Lower terrain along drain paths

9/16

- 1st big block of jobs: Regenerate the NHD flow line network
- Turn a topographic DEM into one that accommodates a continuous downhill flow
- The big issue is how to deal with terrain sinks (depressions w/ no outward flow)
  - 100' Topographic DEMs
    - Treated as errors
    - Filled-in to preserve flow
  - 2.5' DEMs
    - From unrepresented culverts and pipes
    - Drain sinks to create Hydro-Enforced DEM
      - Locate lowest points in sinks (drain points)
      - Delineate short paths out from these points
      - Lower terrain along drain paths to breach dams

Job 3: Extract Seed Points

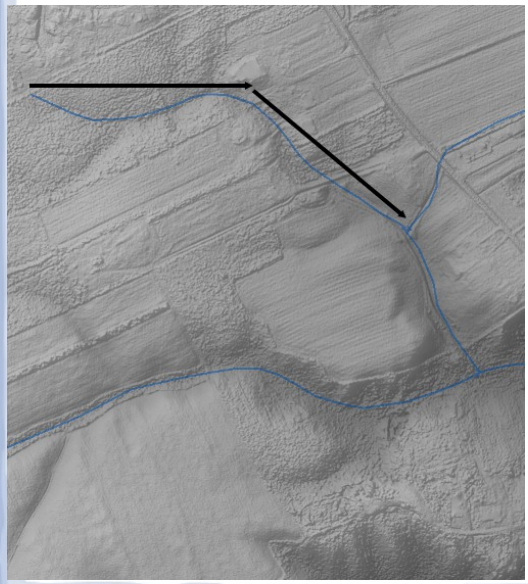


- Create seed points from NHDFlowlines
  - Headwater nodes within DEM
  - Upstream intersections with DEM edge
- Adjust to ensure correct flow direction

10/16

- Create seed points from NHDFlowlines
  - Extract headwater points that lie within the DEM
  - Lines flowing into DEM
    - Extract upstream intersections between NHDFlowlines and the DEM edges.
- (If needed) Adjust seed points positions to ensure flow in the correct direction.

Job 4: Regenerate Network

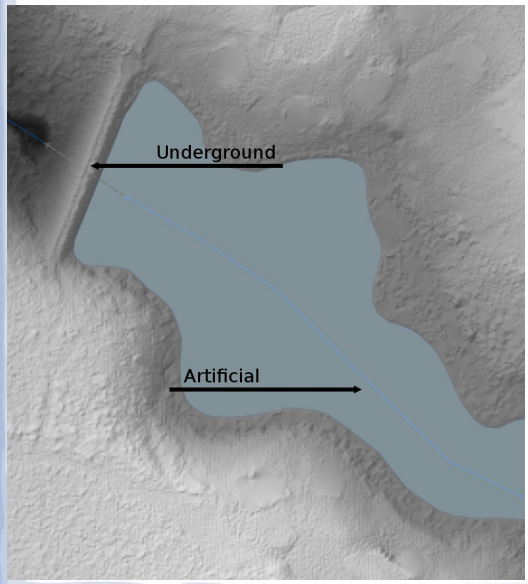


- Fairly simple
- Trace downhill from seed points
  - Reproduce NHDFlowlines network features
  - Attributes and classifications come next

11/16

- Fairly simple
- Trace downhill from seed points
  - Reproduce original NHDFlowlines network features, but at a higher resolution.
  - Attributes and classifications come next

Job 5: Classify Features by Terrain

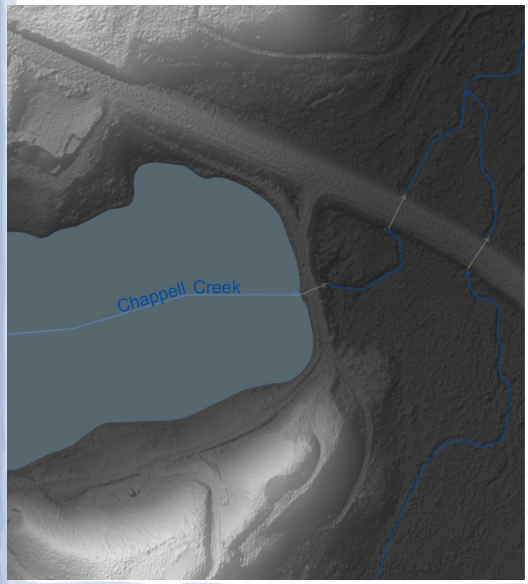


- From high-resolution terrain data
  - "StreamRiver" by default
  - "Underground Conduit" along drainage paths
  - "Artificial Path" across water

12/16

- 2nd big block of jobs: Apply Attributes and Generalization
  - Users should consider own attribute needs.
  - The guide is based on the NHD data model.
- Where possible to discern, split and classify lines based on high-resolution, contemporary data.
  - The delineated drainage paths, created back in Job 2, are a pool of underground segments.
  - Segments crossing waterbodies are artificial paths representing a non-linear connection across such bodies.

Job 6: Smooth/Generalize

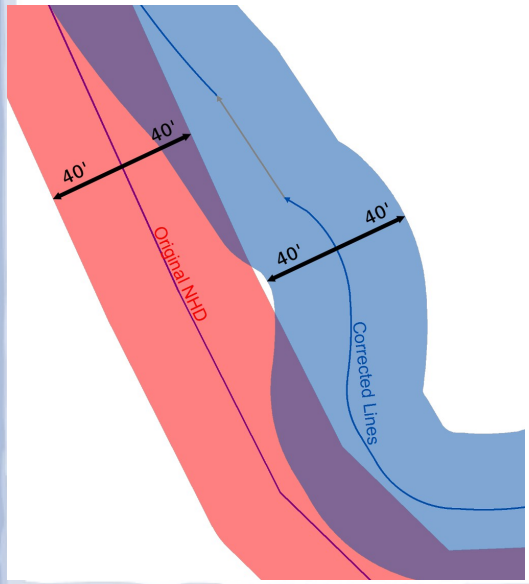


- Reduce complexity
- Improve appearance
- Every point not critical
- Varies by classification
  - Smooth, curved streams
  - Short, straight pipes
  - Long, straight waterbody centers

13/16

- Reduce complexity and improve appearance with little lost.
  - Every point not critical. Line can be (~)+/-2.5', look great, and still be a great improvement.
- Treatment varies by line classification
  - Stream: Smooth curves
  - Pipe/Culvert: A single, straight segment
  - Waterbody: Approximate centerline with large, straight segments
- [Below: Include or Skip?]
- Process dependent on available tools
- Tangential series of Line Segments and Arcs
  - Reflect nature of survey measurements
  - Created product may be more compatible with other tools

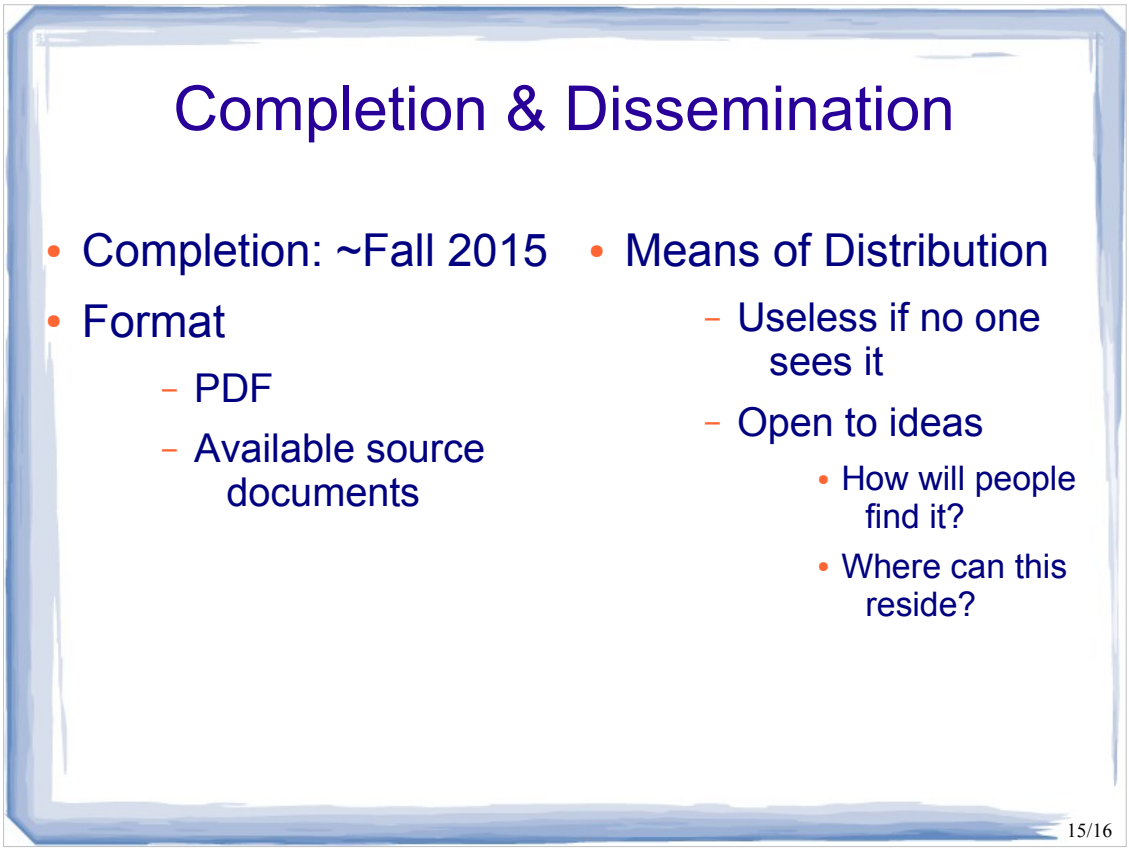
Job 7: Apply NHD Attributes



- Mapped from NHD
  - Basic idea: Identify pairs within mutual buffers
  - Buffer width based on NHD spatial accuracy
  - Implementation varies by tool
- Some data ignored
  - (ex: “Edit Date”)

14/16

- Map attributes from NHD lines
  - Basic idea: Identify pairs within mutual buffers
  - Buffer width based on NHD spatial accuracy
  - Implementation varies by tools and needs
- Some attributes, like edit date, are meaningless. Dissolve line splits based on them.



Completion & Distribution

- Projected completion around Fall 2015
- Guide will be published as a PDF (at least), with available source documents (OpenOffice).
- Guide Availability & Distribution
  - Crucial yet undecided step
  - How would interested parties find or become aware of this guide?
  - Where can the published guide reside?

Citations and Resources

- Data
  - [1,3,4,9,12-14] Prince George Co., VA (Local Data)
  - [3] Virginia Base Map Program (Orthoimagery and associated Photogrammetric Lines)
  - [1,3,8-14] USGS (NHD; DEMs)
- Reference
  - Poppenga et al. “Hydrography Change Detection”
  - USIEI: coast.noaa.gov/inventory/
  - Wikipedia: National Lidar Dataset (United States)

16/16

- Leave off of presentation OR leave off entirely.
- Citations/Footnotes
  - Option 1: Cite images directly.
  - Option 2: Use this page for footnotes
- Thanks/Appreciation
  - James:
  - MGIS Faculty