

Your fun and easy guide to
creating your very own water resources network and the tools to manipulate it

ArcGIS

Applying Arc Hydro and Utility Network Analyst

FOR

NITWITS

A Reference for All of Us
by
One of Us!

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Get the scoop on
one user's trials
and tribulations

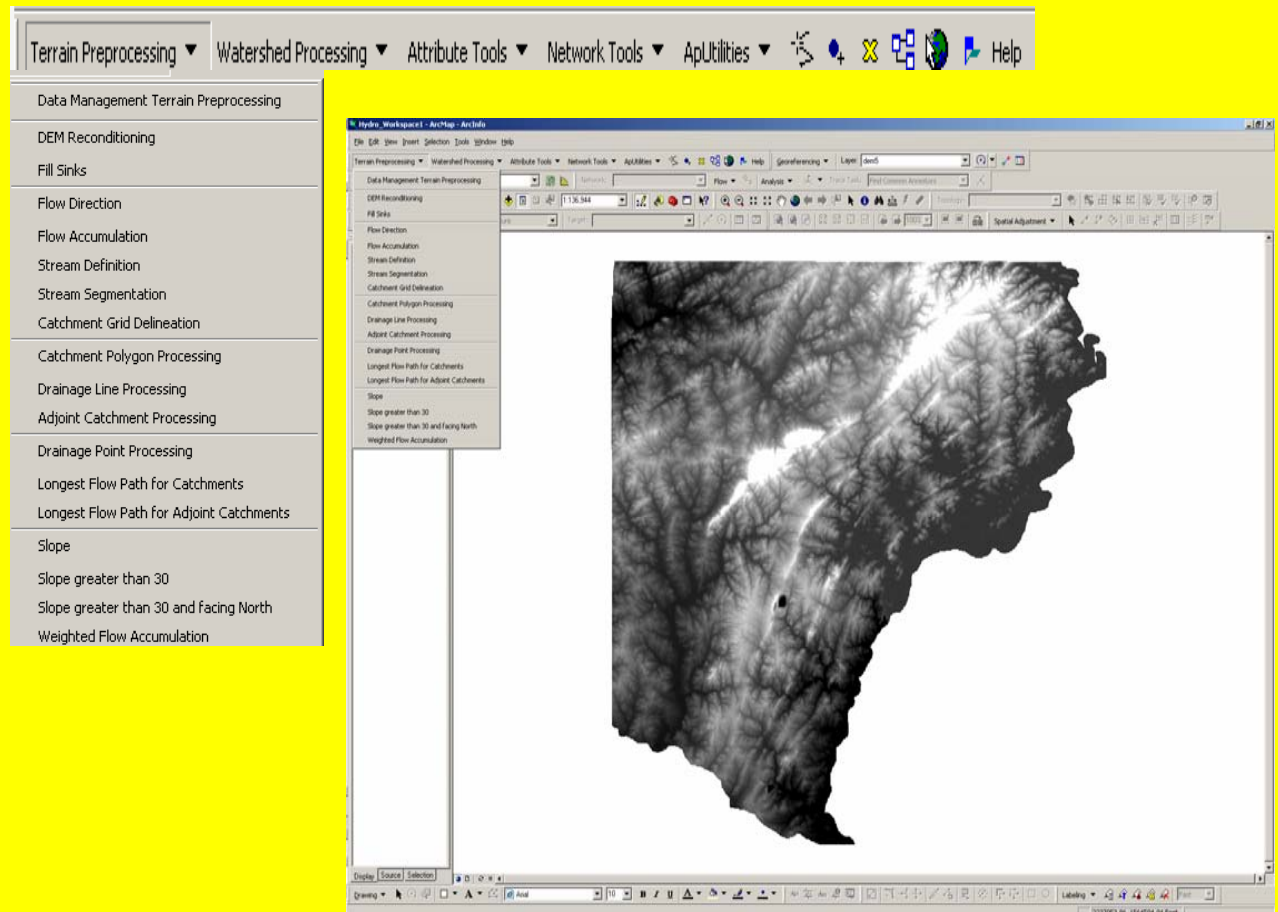


Objectives

- ✓ Present the differences between Arc Hydro and Utility Network Analyst, how they process data
- ✓ Examine the data types used, created and attributes necessary for analysis
- ✓ Present the nuances that plagued implementation
- ✓ Examine the possible uses of both applications independently and in concert
- ✓ Where you can go with the data you have created

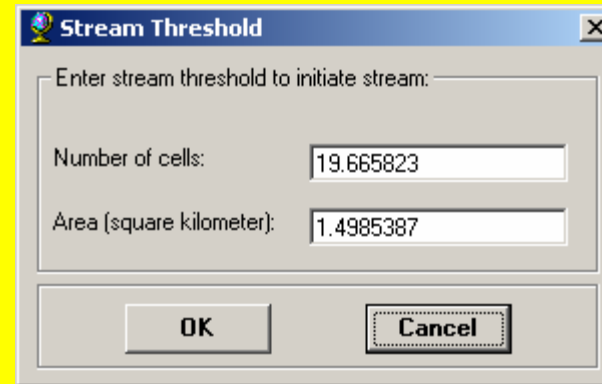
Arc Hydro: Getting Started

- ✓ Use the best resolution digital elevation model available, this example used a 5 foot resolution
- ✓ Tools in Terrain Processing, many are similar to those in Hydrology toolset in ArcToolbox with the exception of Stream Definition and Stream Segmentation
- ✓ All of the processes need to be applied to DEM in order, each process builds on the previous, crucial attributes are generated by several of the processes, skipping a step is detrimental
- ✓ Helpful to have a designated, robust computer for this task, many of the processes require hours to complete
- ✓ Arc Hydro uses elevation as the key attribute, connectivity is determined by water traveling from high to low

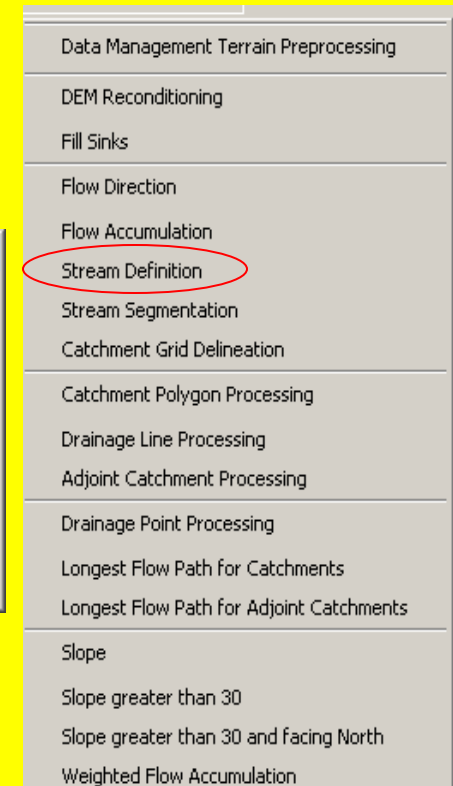


Process of Note: Stream Definition

- ✓ Process defines the dendritic extent of output
- ✓ Default is 1% of flow accumulation of a given area, user has to decide the extent of the area of interest i.e., this example used a 16th of a percent (0.3375 km) which corresponds to 81.9 acre area
- ✓ Default value yields an output that when compared to USGS hydrography dataset is less dendritic, if you want to find potential or seasonal streams then you have to assign a smaller area of accumulation
- ✓ In this example, we ran this process several times to observe the difference in the outputs for different values for the area of accumulation



A screenshot of the 'Stream Threshold' dialog box. It has a title bar with a globe icon and the text 'Stream Threshold'. Inside, there is a label 'Enter stream threshold to initiate stream:' followed by a text input field. Below this, there are two more text input fields: 'Number of cells:' with the value '19.665823' and 'Area (square kilometer):' with the value '1.4985387'. At the bottom, there are two buttons: 'OK' and 'Cancel'.



Process of Note: Stream Segmentation

- ✓ Process that generates GRID ID attribute
- ✓ Each cell of the DEM has a GRID ID and each segment of the generated stream output has the GRID ID that corresponds to the cell from which it originates
- ✓ Permits flow to be interpreted by the Arc Hydro tools
- ✓ If so much as one segment lacks a GRID ID attribute to tool fails to function
- ✓ Basis for to/from node generation
- ✓ This project floundered until this crucial detail was recognized

OBJECTID	GridID	FROM_NODE	TO_NODE	HydroID	NextDownID	DrainID	Enabled	Shape_Length
3377	1033	1043	1088	3541	4880	1033	True	780.381100912104
3378	1033	1043	1088	3542	4880	1033	True	189.450138538838
3379	1376	1378	1470	3543	5188	1376	True	1503.1237801308
3380	1376	1378	1470	3544	5188	1376	True	797.98778416555
3381	69	73	84	3545	3799	69	True	489.853867259896
3382	69	73	84	3546	3799	69	True	861.22036632804
3383	323	336	364	3547	4070	323	True	79.922370002976
3384	323	336	364	3548	4070	323	True	25.7814385781001
3386	356	367	375	3550	19137	356	True	1350.1346226955
3389	365	429	378	3553	19138	365	True	1073.34849214376
3438	261	267	367	3594	4055	261	True	4.19433997609134
3439	366	423	378	3595	19138	366	True	1230.27023819912
1	73	77	107	3802	3818	73	True	801.05319074947
2	76	82	107	3803	3818	76	True	1598.3200127123
3	98	108	99	3804	3794	98	True	535.34276481215
4	85	89	110	3806	3837	85	True	582.5483700225
5	49	53	110	3807	3837	49	True	1609.49009782921
6	53	59	113	3811	3846	53	True	1756.1499532776
7	103	104	113	3812	3846	103	True	403.492402260693
8	65	68	115	3814	3840	65	True	1486.76929103461
9	83	86	115	3815	3840	83	True	707.799523867508
10	29	116	29	3816	3741	29	True	2849.0536753238
11	23	41	119	3817	3822	23	True	4303.08140775326
12	107	107	120	3818	3831	107	True	605.05714225781
13	100	122	101	3819	3795	100	True	673.155026978872
14	116	117	126	3820	3890	116	True	674.489501277268
15	118	121	126	3821	3890	118	True	179.526419490142
16	115	119	127	3822	3850	115	True	241.066037791261
17	63	65	127	3823	3850	63	True	1779.28196494177
18	40	128	44	3824	3750	40	True	4048.10999790561
19	26	130	29	3825	3741	26	True	6023.5003148734
20	59	63	131	3826	3855	59	True	2832.90138685396
21	37	132	57	3827	3758	37	True	3826.9953362709
22	102	133	102	3828	3796	102	True	2008.73669360514
23	120	125	135	3830	3894	120	True	287.738649405533
24	117	120	135	3831	3894	117	True	487.903646028603
25	96	136	97	3832	3791	96	True	1175.6854344003
26	104	137	104	3833	3812	104	True	1008.8059437745
27	128	140	132	3834	3827	128	True	387.02106970218
28	126	138	136	3835	3832	126	True	1637.1194338016

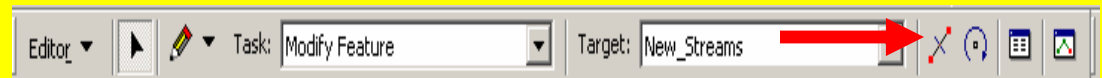
What You End Up With

- ✓ After each of the processes was performed on the DEM this was our raw output
- ✓ Next step was to correct data using aerial photography as ground truth
- ✓ Many of the generated segments were not consistent with actual river and stream locations as depicted in aerial photos
- ✓ Illustrates the difference between DEM depiction/representation of topography and actual ground truth
- ✓ Also illustrates the dynamic nature of hydrologic systems, rivers and stream often times change or modify their course of flow making ground truth measures vital



Editing Process

- ✓ Each of the segments needs to be moved control point (node) by control point (node)
- ✓ Segments that have large amounts of control points (nodes) can be shortened using the split tool on the editor toolbar
- ✓ This lengthy editing process is necessary, moving the segments maintains the integrity of the attributes associated with the segments
- ✓ A mistake I made was to delete segments and to digitize said same segments
- ✓ This was problematic because digitized segments did not have the necessary attributes for the Arc Hydro tools to function, i.e., GRID ID & Hydro ID



Edited Product



Incorporating Utility Network Analyst with Arc Hydro

- ✓ At this point it is necessary to understand the difference between Arc Hydro and Utility Network Analyst
- ✓ Arc Hydro uses elevation at a given point or cell in juxtaposition to another point or cell to determine flow (applied physics, natural laws)
- ✓ Utility Network Analyst uses connectivity (proximity) of the segments as a means of determining flow (engineering as a means of moving water)
- ✓ Utility Network Analyst will function using the river and streams created using the Terrain Processing tools in Arc Hydro, but Arc Hydro tools only function with data created within the parameters of Arc Hydro, i.e., a digitized storm water system will not function using Arc Hydro
- ✓ Due to the differences in the way the tools analyze data it is necessary to “bridge the gap” between the two tools

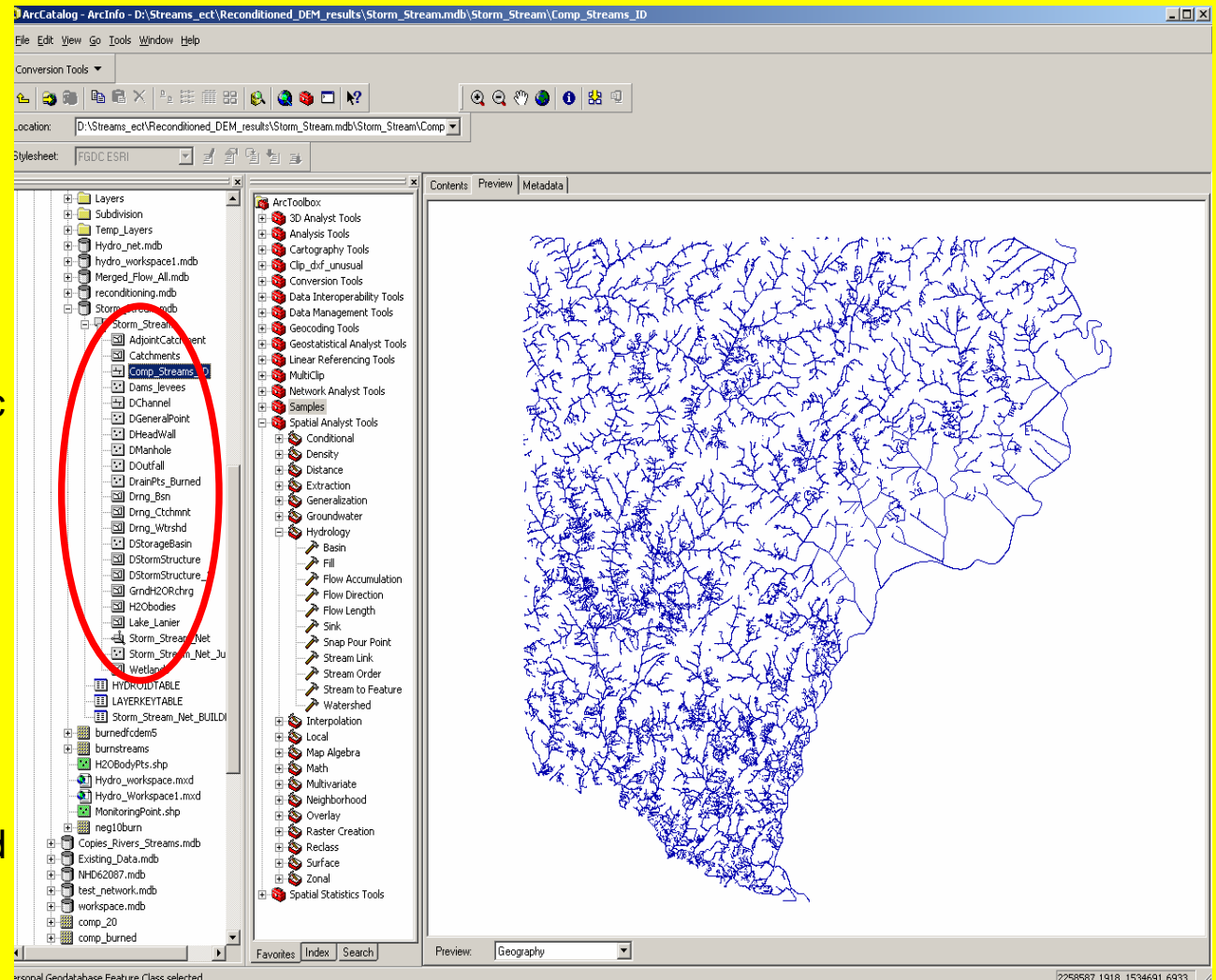
Bridging the Gap

- ✓ For this project, the subject of connectivity was addressed as a question, “If water were to enter the storm water system, **where** and **how** might it come in contact with a fresh water source?”
- ✓ To address this it was necessary to look at each of the storm systems outfalls (discharge points) and the topography of the land between the outfall and the nearest source of fresh water
- ✓ Using the topography as a guide to how water could travel, lines of connection were digitized between the two data sources, the rivers and streams and the storm water system
- ✓ This method was used (there may be others) because it was a methodology that could be sold to engineers (very picky people) as being legitimate and possible

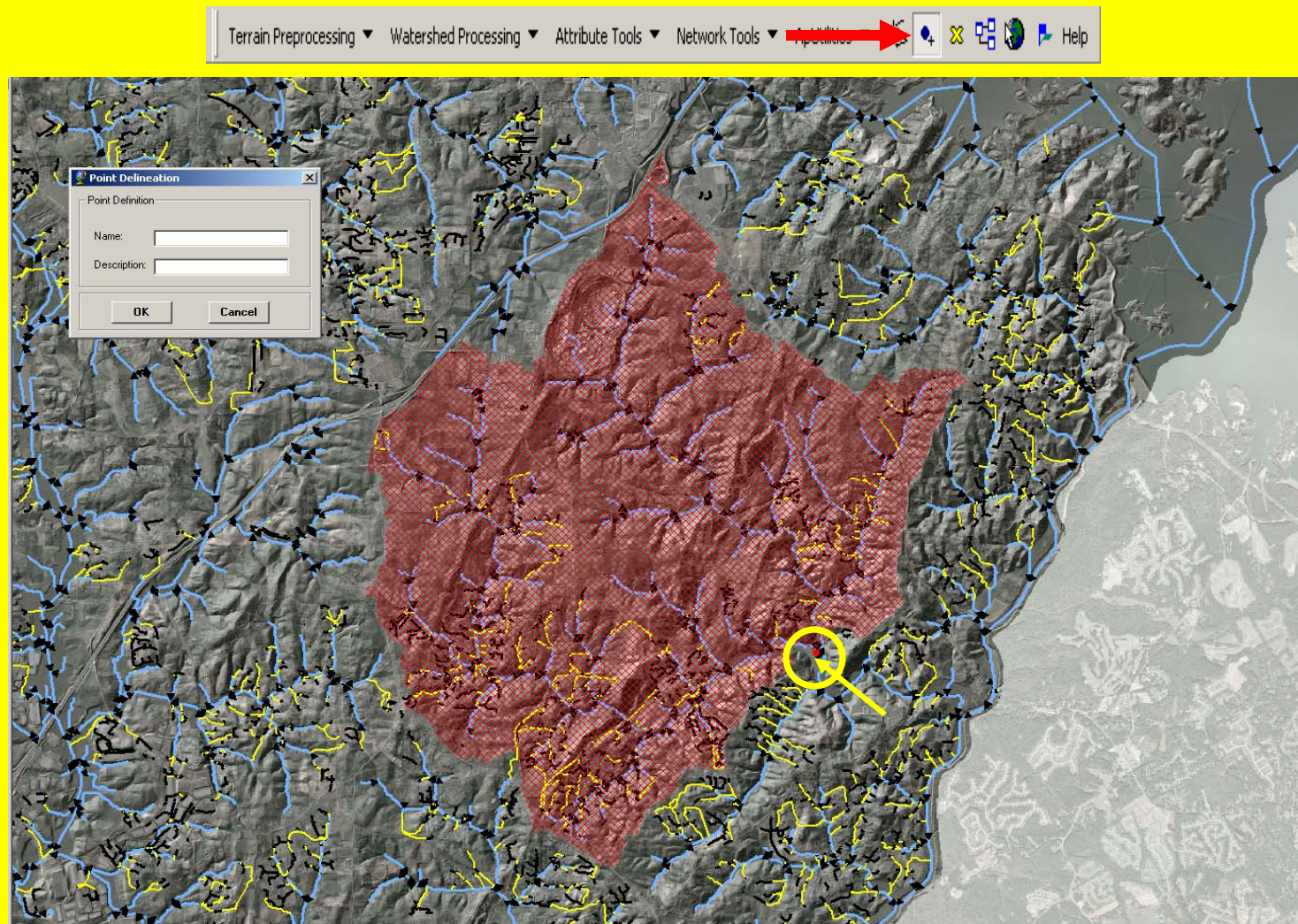


Putting All of the Pieces Together

- ✓ The rivers and stream feature class, the storm water feature class and the connective segments were then merged into a comprehensive feature class
- ✓ Then using ArcCatalog within a personal Geodatabase a geometric network was created incorporating all the desired feature classes
- ✓ There is also a network generation tool within Arc Hydro but this example opted to use the geometric network option
- ✓ Once a network has been created, the tools in both extensions can be applied to the data



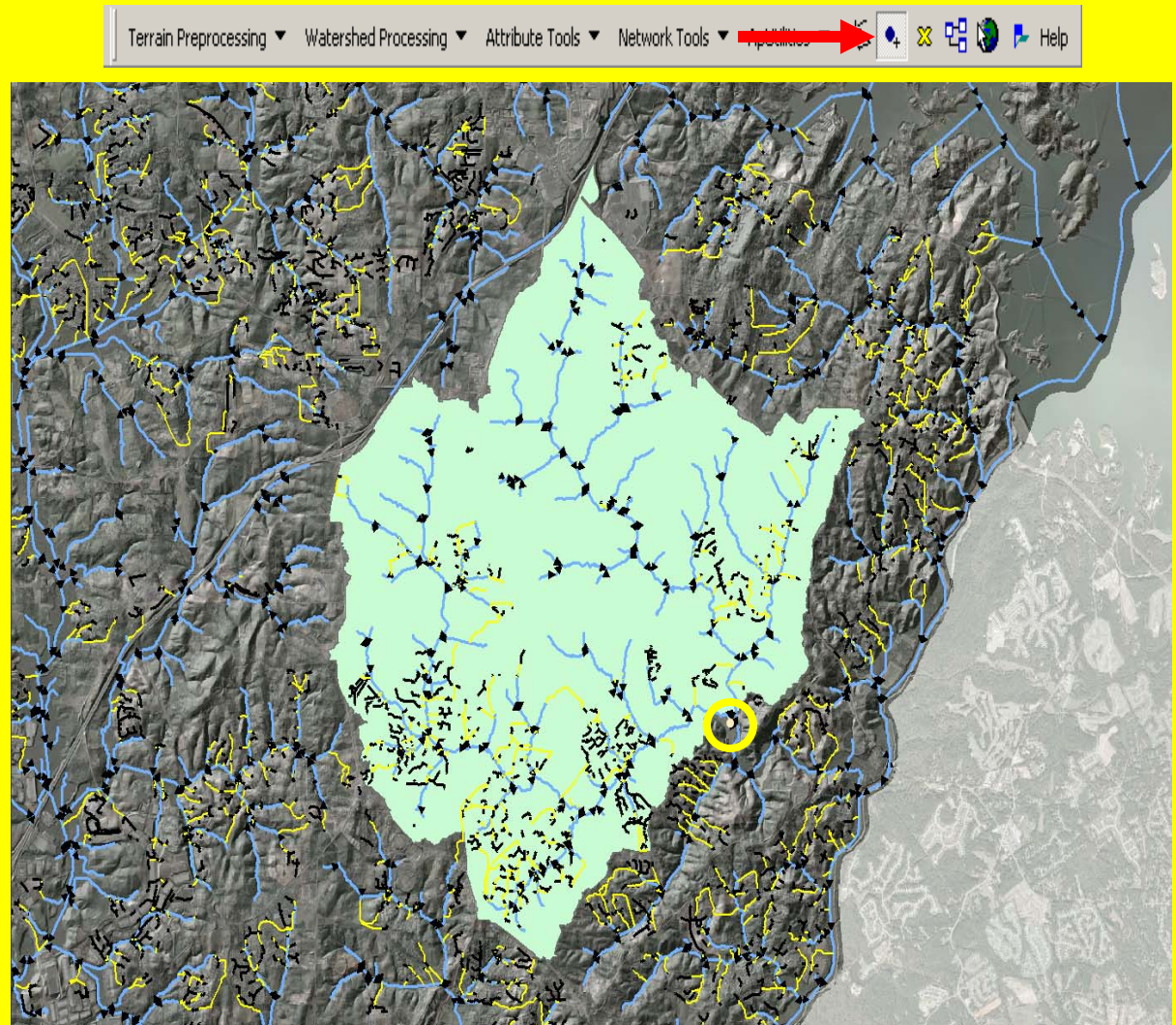
Arc Hydro: Point Delineation



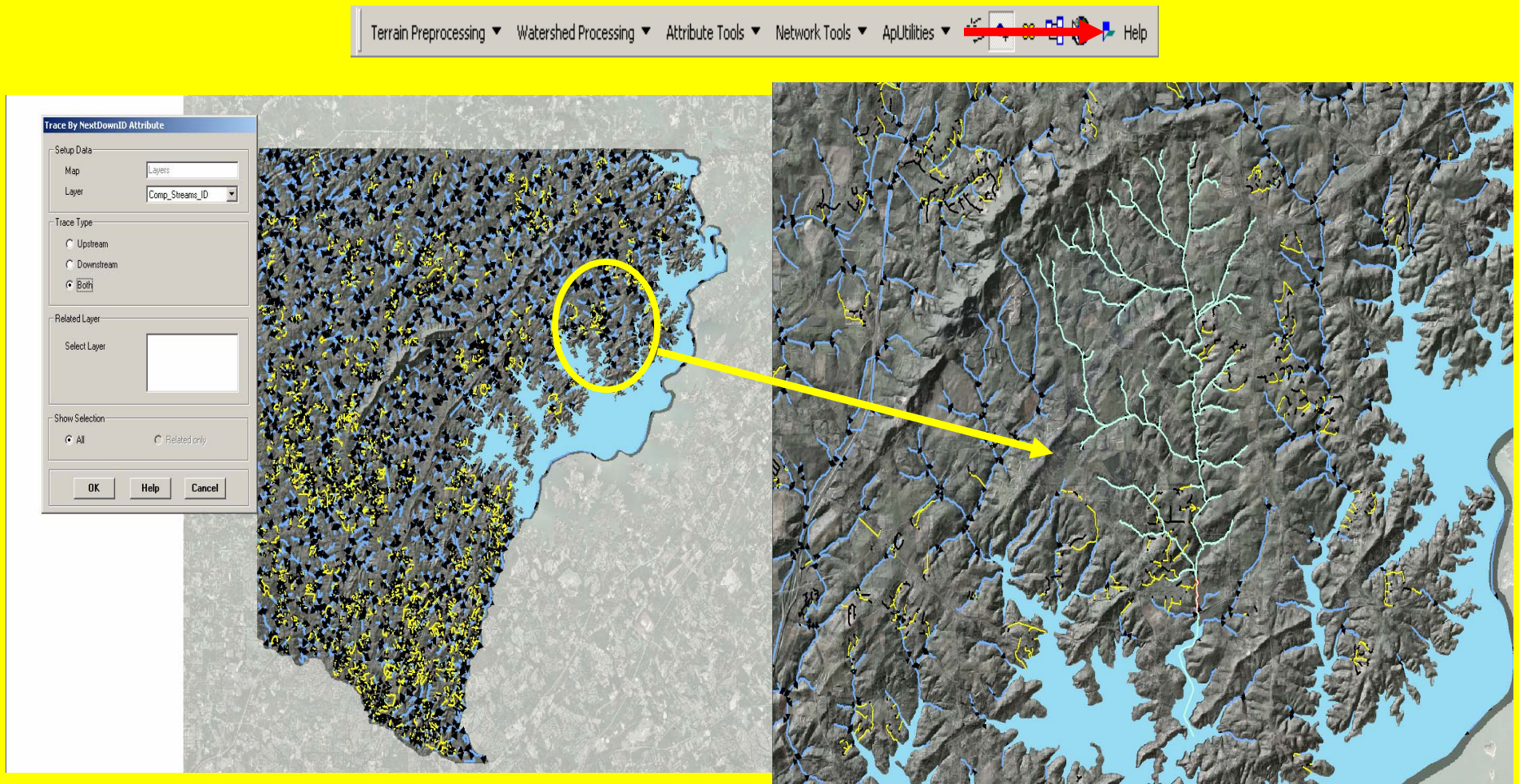
Red point within the yellow circle is the point of delineation, the red hatched region depicts area that drains to the point of interest

Point Delineation

- ✓ The region that supplies the point of delineation (watershed point) depicted in red cross hatches on previous slide is made into a stand alone feature class
- ✓ The point of interest is also made into a stand alone feature class, or watershed point
- ✓ Note, regardless of how the data was generated it is still encompassed within the area of delineation, the incorporation of both fresh and storm water sources
- ✓ Selections can now be performed and other associated operations to accomplish desired result and answer site specific questions

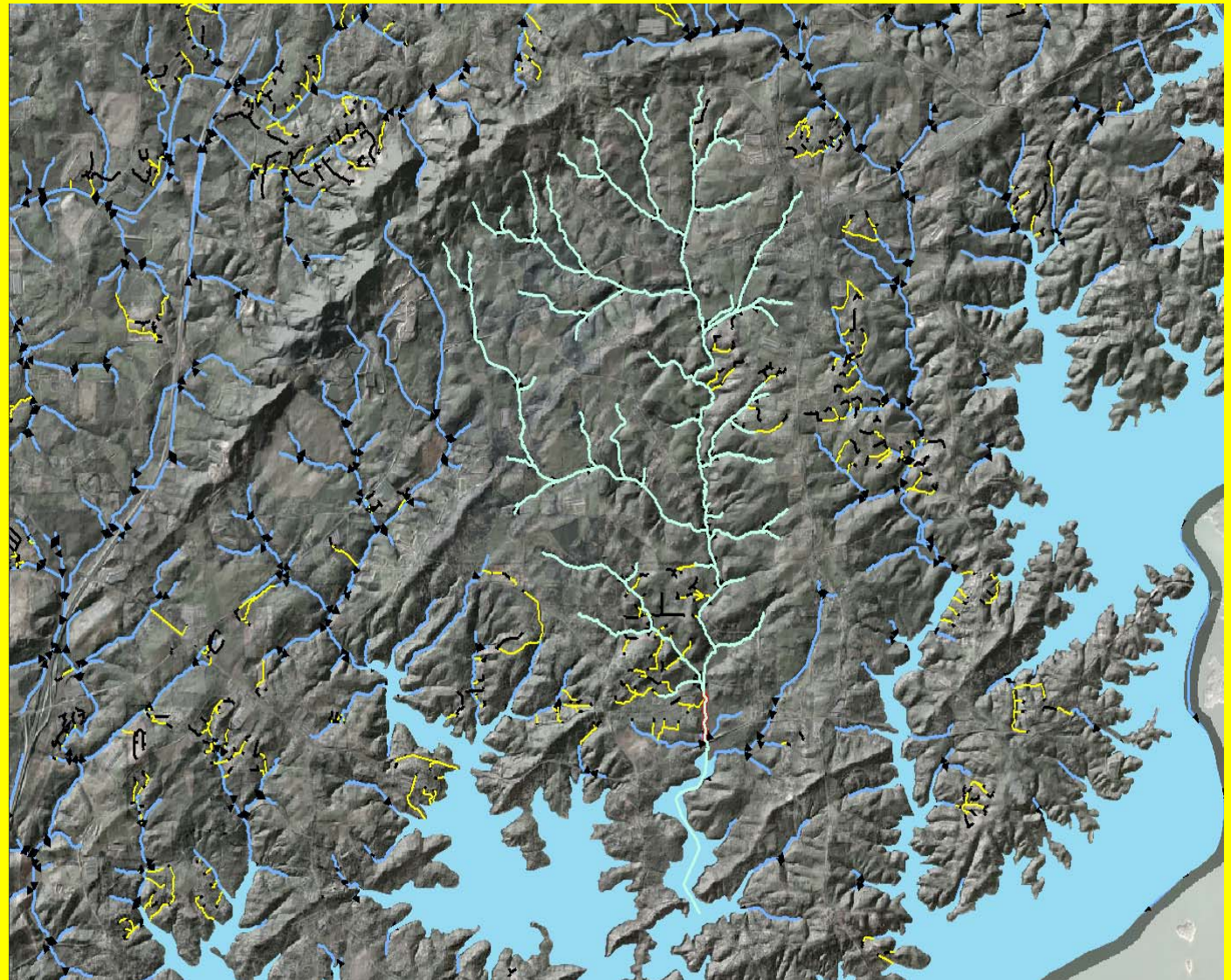


Arc Hydro: Trace by Next Down ID



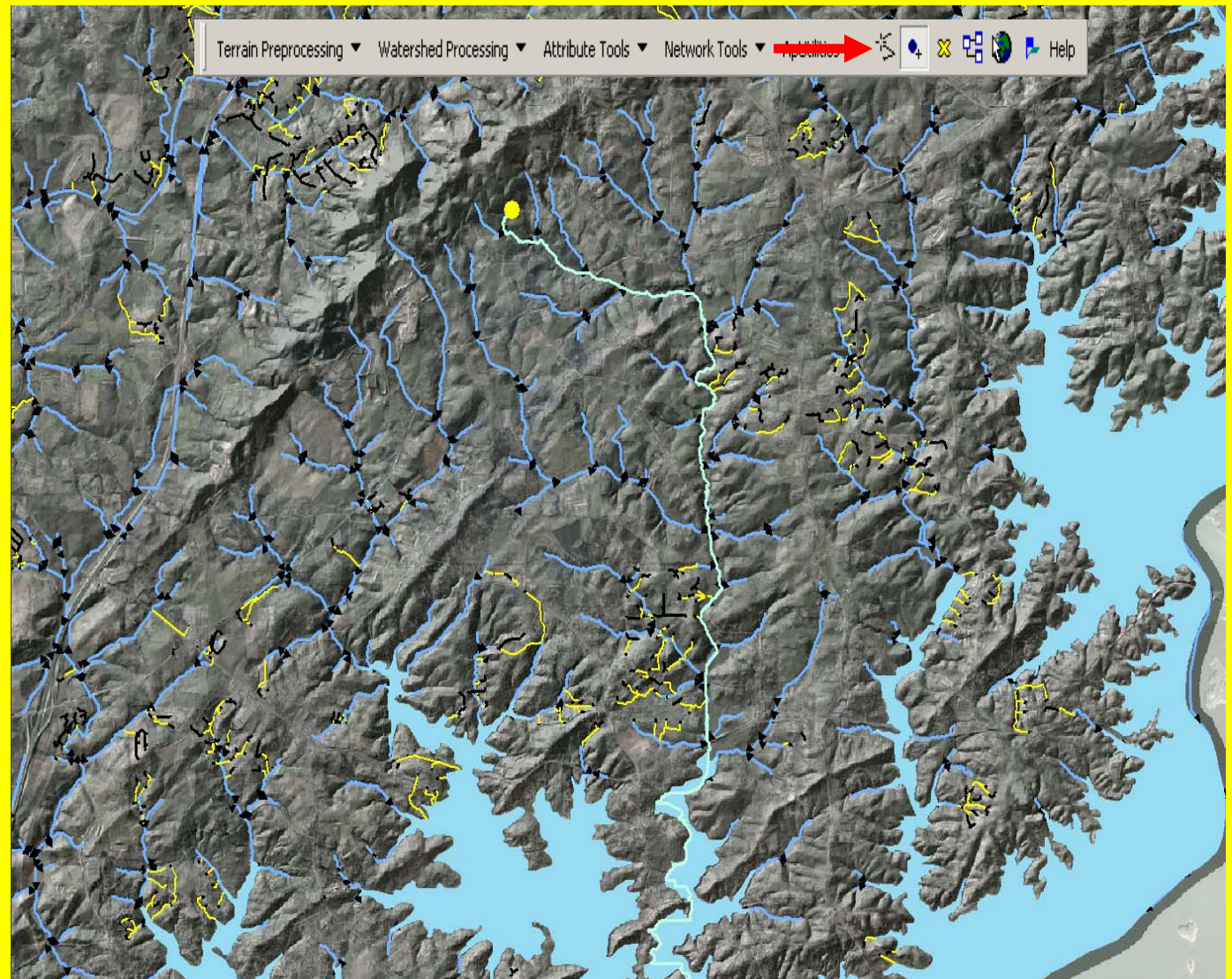
Trace by Next Down ID

- ✓ Only the rivers and streams were included in the up and down stream analysis, storm water portion of the data was excluded
- ✓ This is due to the connectivity attributes discussed earlier and the way the tools process the data in different ways
- ✓ Regardless of a rudimentary knowledge of hydrology, information about the whole network can be garnered from this analysis



Arc Hydro: Flow Path Tracing

- ✓ Yellow dot is the genesis of flow
- ✓ Tool traces entire flow path
- ✓ Tool is repetitive in light of the other Arc Hydro tools
- ✓ Tool only traces flow of rivers and streams, not the storm water portion of the comprehensive network



Utility Network Analyst: Trace Downstream

Network: Storm_Stream_Net Flow Analysis Trace Task: Trace Downstream



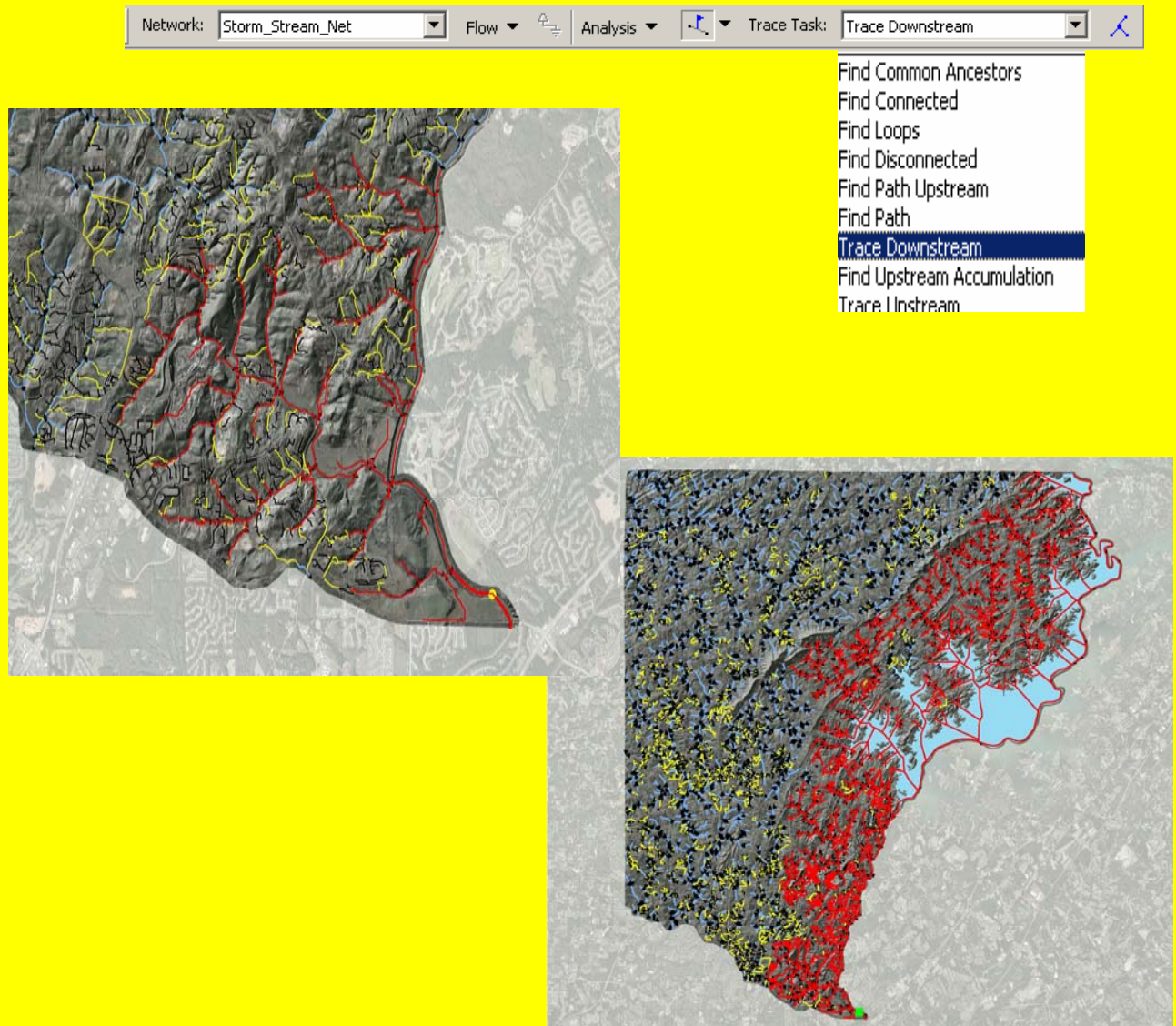
Green square depicts entry point of storm water system



This tool works on the comprehensive network regardless of how it was generated

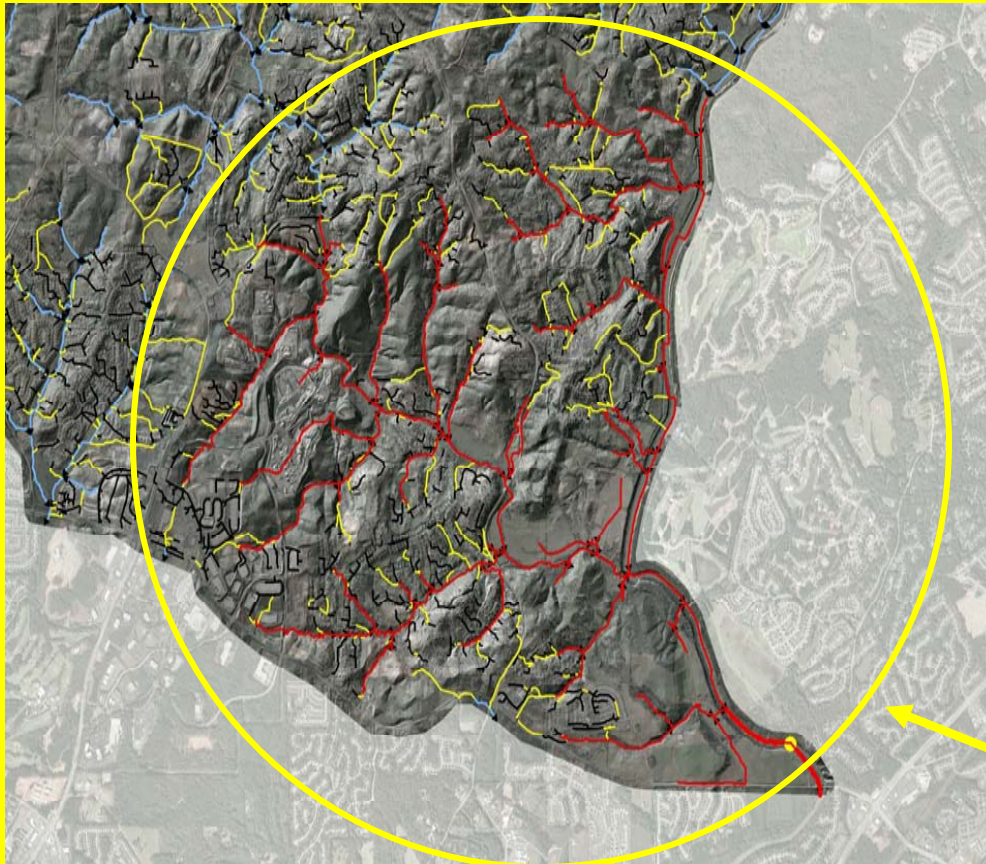
Utility Network Analyst

- ✓ Ability to perform many of the same analyses as Arc Hydro
- ✓ The main difference being that Arc Hydro has a limiting factor of topography and Utility Network Analyst looks only at connectivity independent of elevation
- ✓ This makes understanding your data, and the queries you wish to ascertain, crucial. Choosing to use the incorrect extension could yield erroneous results

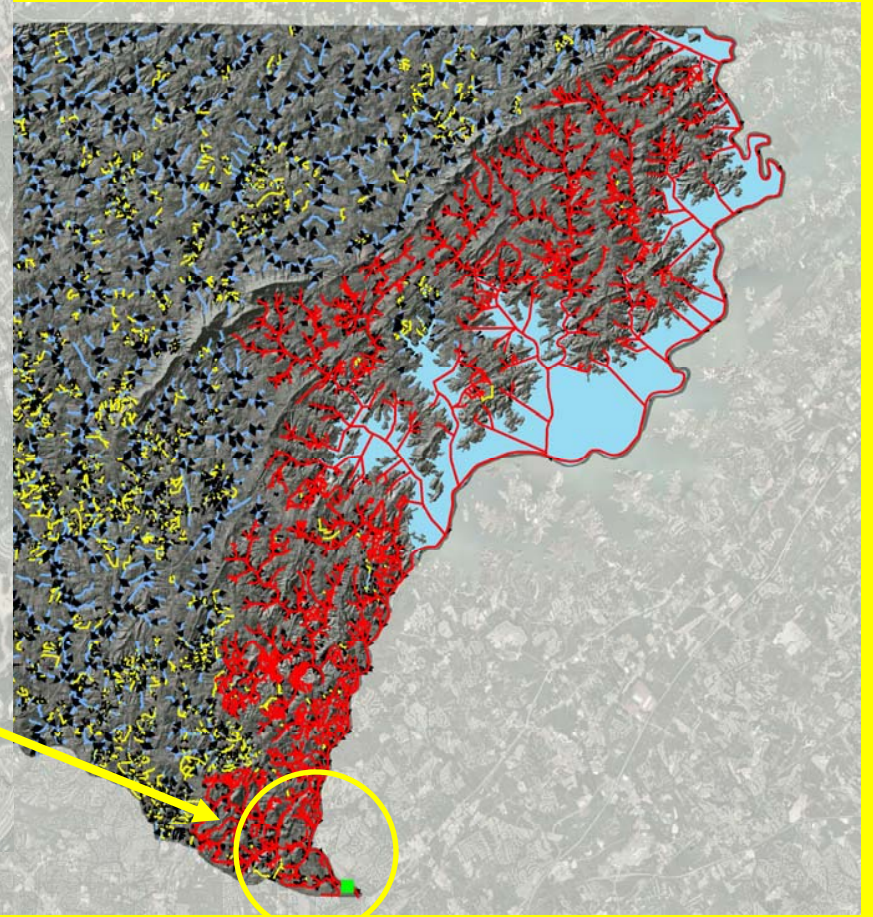


Know the Difference between Extensions

Note the difference between the extensions and how this could be misleading



Arc Hydro Upstream Analysis



Utility Network Analyst Upstream Analysis

Applications For Your Snazzy New Hydrologic Network

- ✓ Watershed delineation
- ✓ Hazmat response
- ✓ EMS applications, response
- ✓ Homeland Security issues
- ✓ Hydrologic Cycle modeling
- ✓ Service area delineation
- ✓ ...and many more, just ponder the possibilities

What Next???

- ✓ The next step for the Forsyth County Hydrologic network is linear referencing the rivers and streams (in progress)
- ✓ This will allow for more complex analyses of not only where but how far and how long

Credit Where It's Due

1. ESRI. 2006. ArcGIS Help, Redlands, California.
2. Maidment, David. R. 2002. Arc Hydro, *GIS for Water Resources*, ESRI Press, Redlands, California. (These guys are sharp)
3. Use of 'for NITWITS' is not associated in any way with the registered trademark 'For Dummies' nor are these materials or documents in any way affiliated, endorsed or sponsored by Wiley Publishing, Inc., or any affiliate thereof.
4. Natalie representing ESRI in Atlanta, who asked me to present in the first place and John (the boss) for footing the bill allowing me to present today