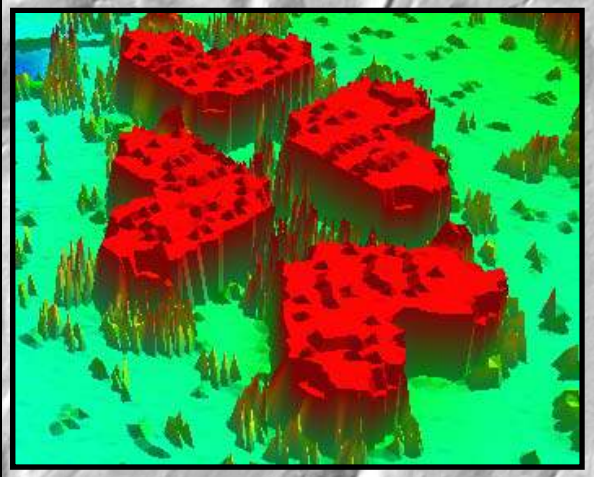
Anne Arundel County DPW WERS Map Layer Updates

LiDAR, Impervious, and Land Cover



MSGIC Quarterly Meeting – April 18, 2013

Jeff Cox, GISP, Engineer III/Model Analyst

DPW WERS

Department of Public Works
Bureau of Engineering
Watershed, Ecosystem, and Restoration Services
Watershed Assessment and Planning Program

WERS also includes the Ecosystem Assessment/Protection Program and Environmental Restoration Project Management.

Rick Fisher, Senior Engineer/Model Administrator
Jeff Cox, GISP, Engineer III/Model Analyst

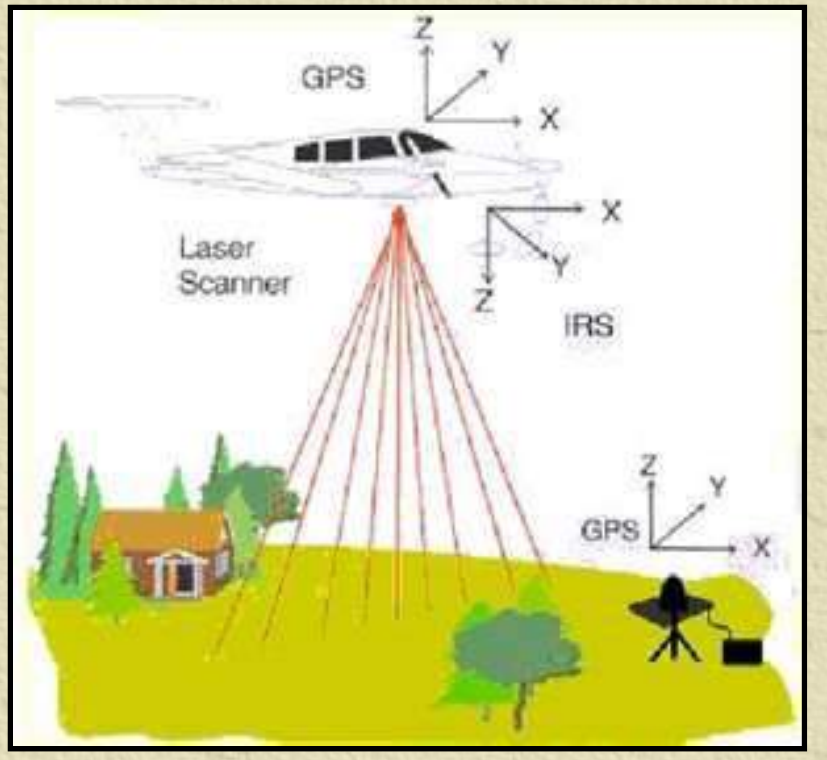
Project Overview

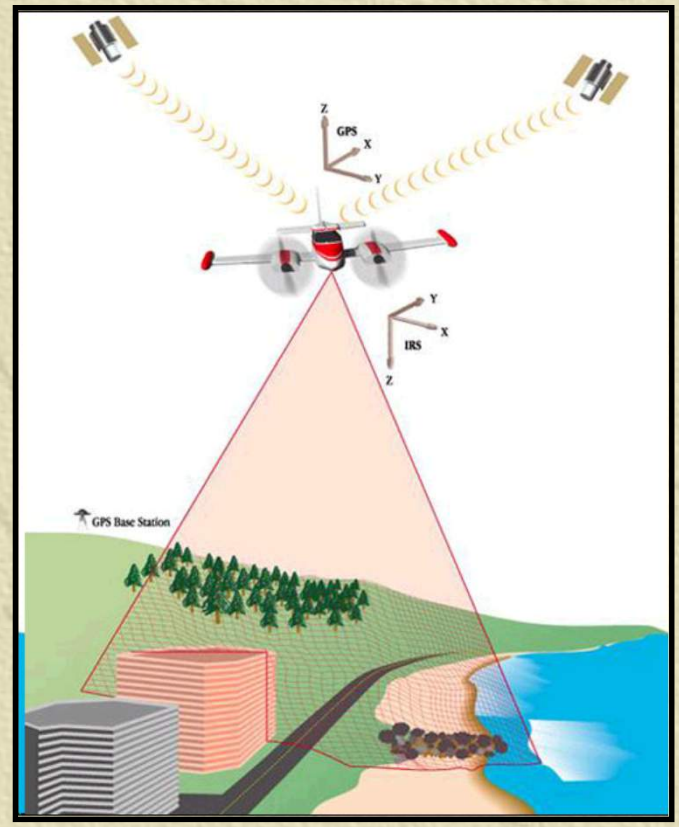
In 2011, DPW WERS purchased consultant services from the Sanborn Mapping Company to collect LiDAR elevation data and create an associated DEM.

Sanborn also updated the County's Impervious Surfaces and Land Cover map layers using the 2011 Statewide Aerial Photos (thanks, Jim Cannistra!).

LiDAR

LiDAR is an acronym for **LI**ght **D**etection **A**nd **R**anging, which is a remote-sensing technology that uses laser pulses to measure distances to reflective surfaces, such as tree canopy, building rooftops, or the ground.





LiDAR

The County last acquired LiDAR in 2004. Substantial development has occurred since 2004, as well as several hurricanes and tropical storms, which can dramatically alter the landscape.

LiDAR

LiDAR specs:

LAS (LASer) format. Binary. Not ASCII like old .txt format.

Flown in March 2011.

Collected the County and a 100 meter buffer outside.

Nominal Pulse Spacing (NPS) of 1-2 meters. Often tighter.

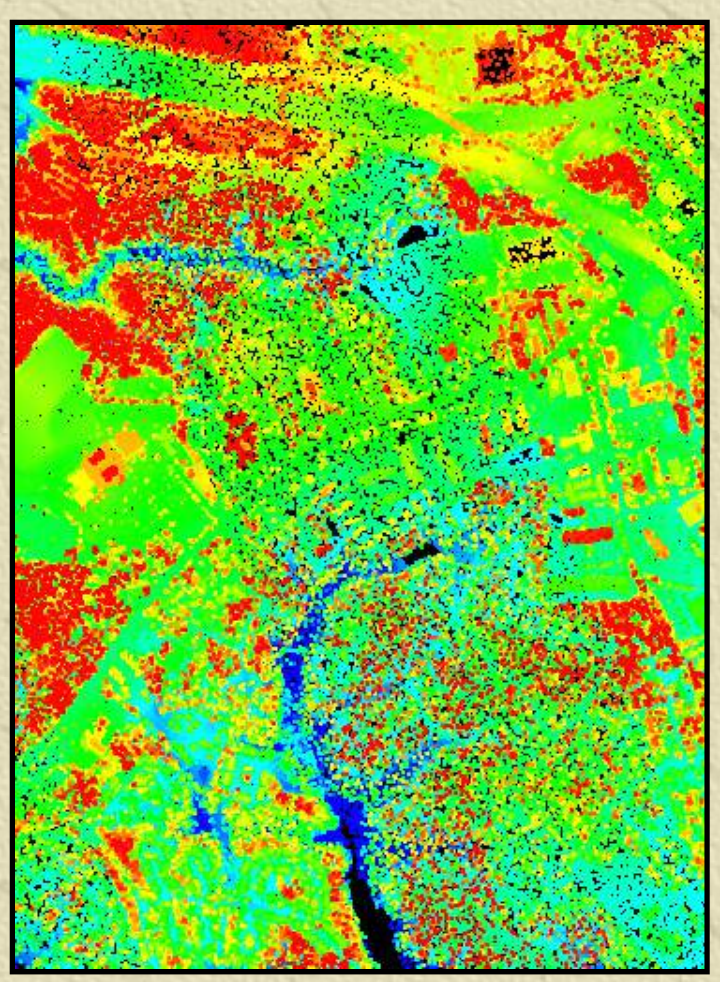
FVA <= 24.5cm, 95% confidence level.

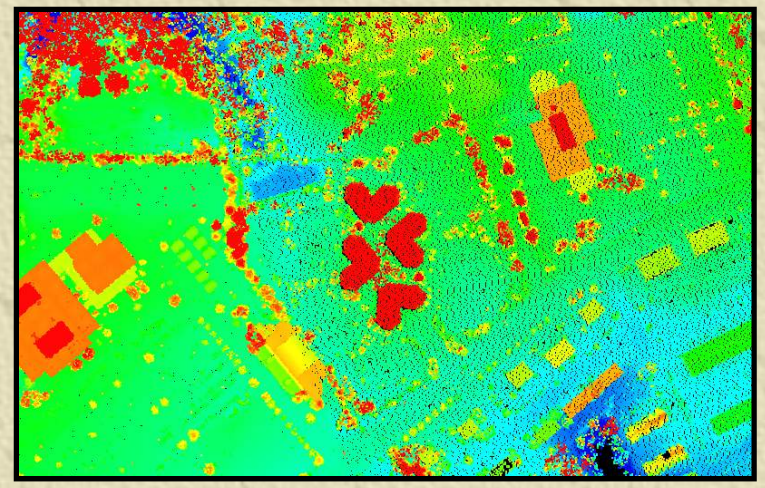
LAS point cloud classifications:

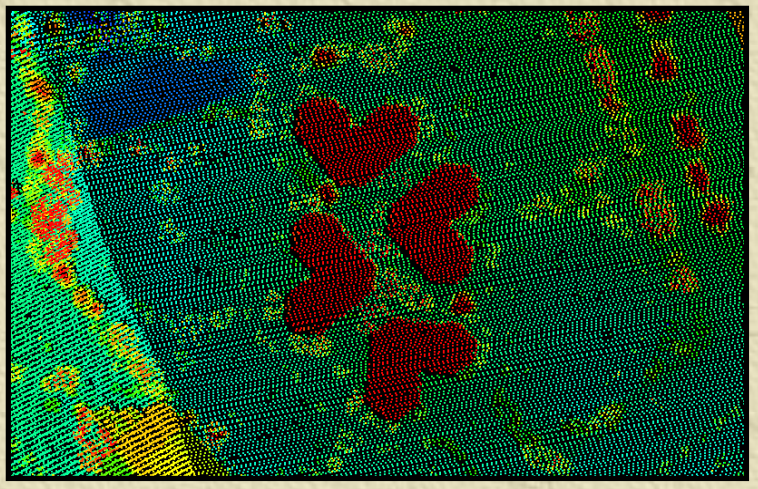
Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored Ground (Breakline Proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

LiDAR

LiDAR examples (Color By Elevation):

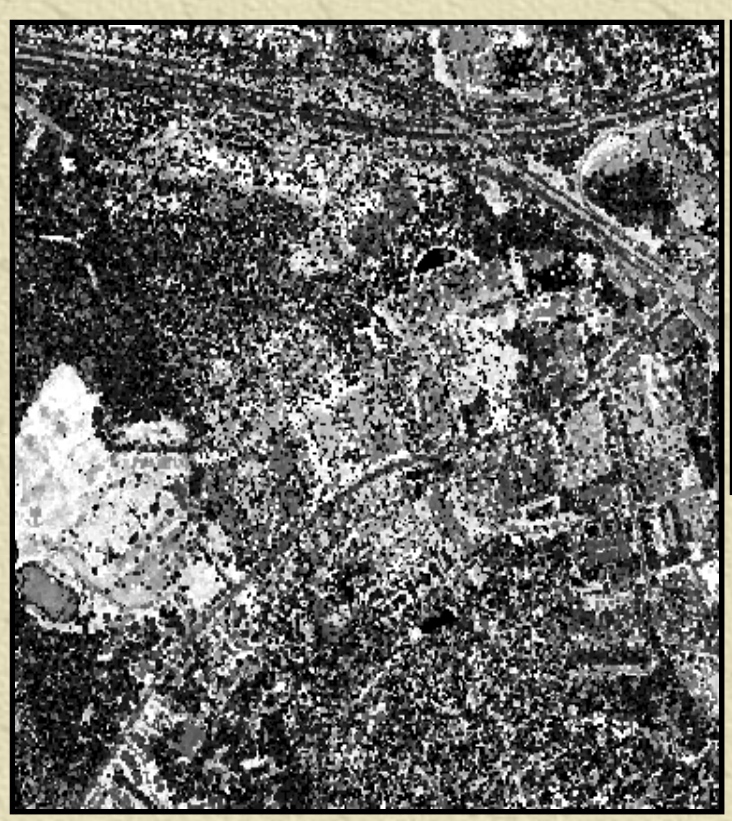


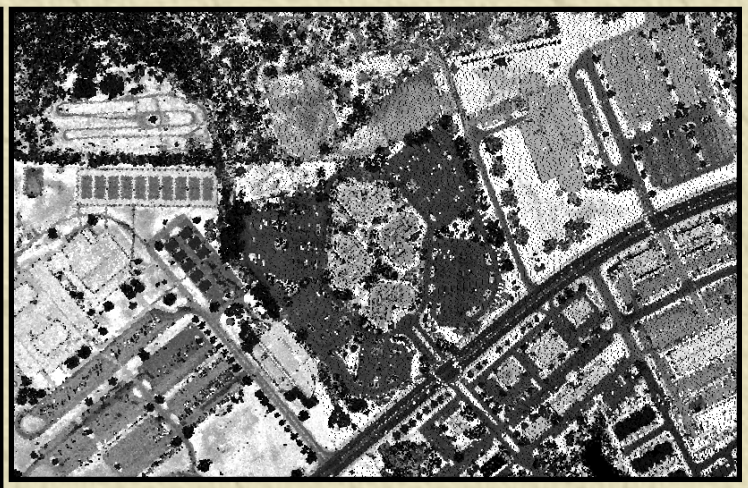


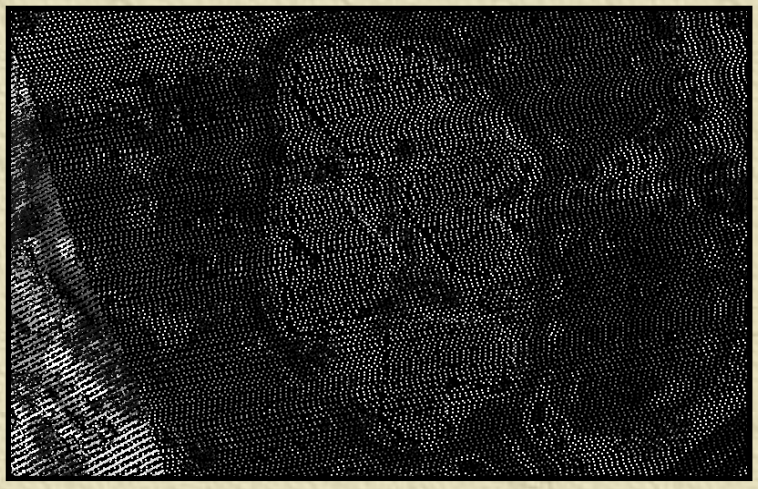


LiDAR

LiDAR examples (Color By Intensity):



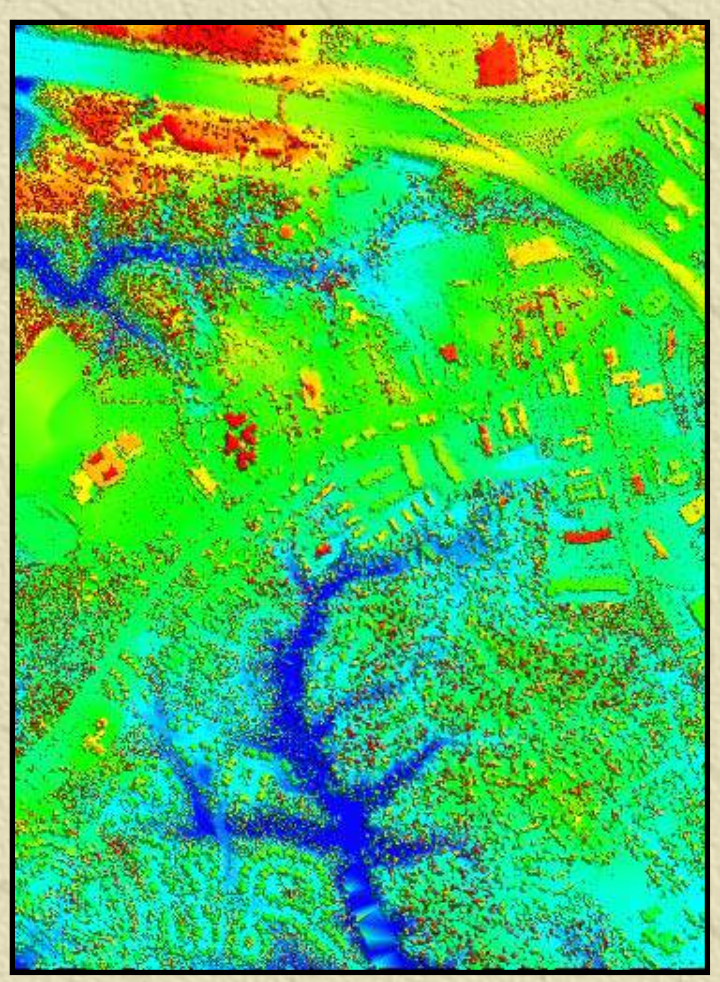


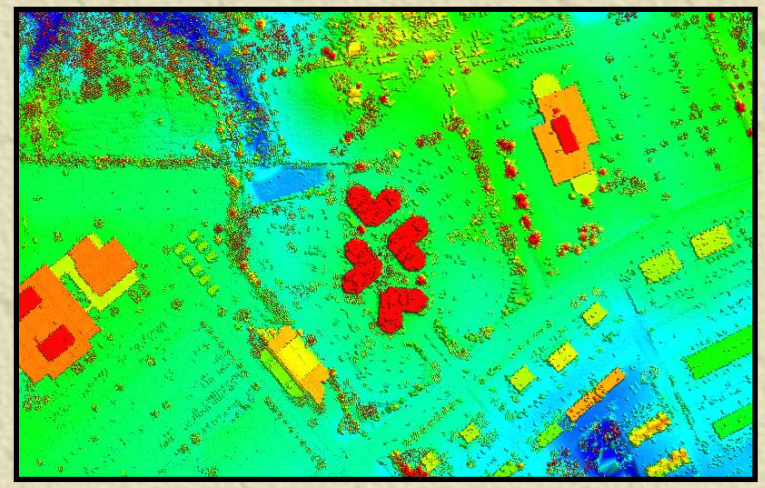


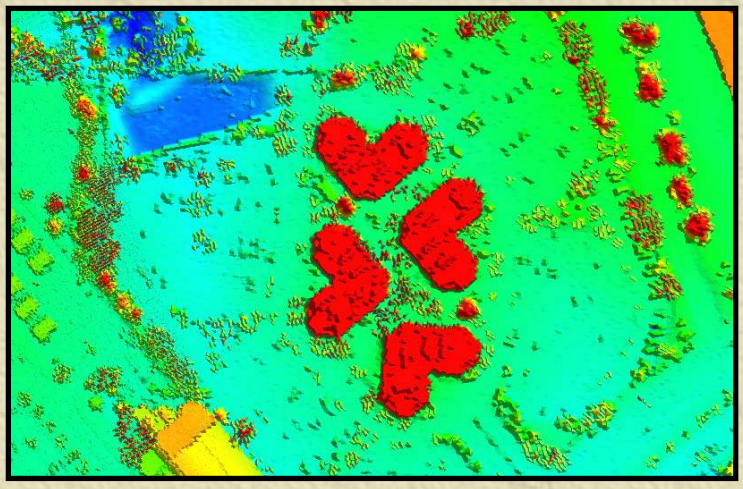
Intensity is a quantitative measure of the intensity for each return. The intensity values range from 0 to 255, where 0 represents the darkest reflections (ex. new asphalt) and 255 represents the brightest reflections (ex. white rooftop).

LiDAR

LiDAR examples (Color By Elevation – 3D):

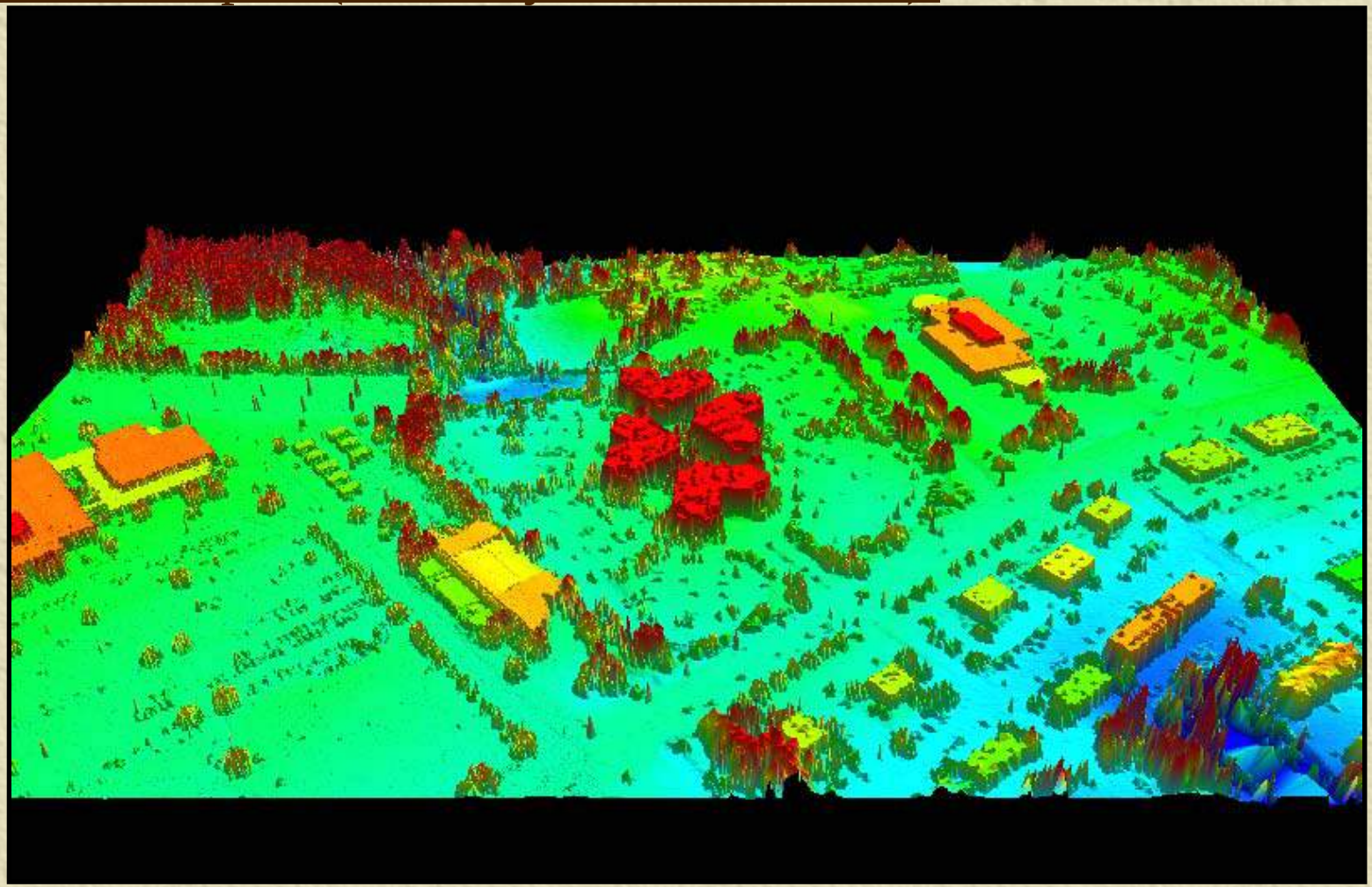






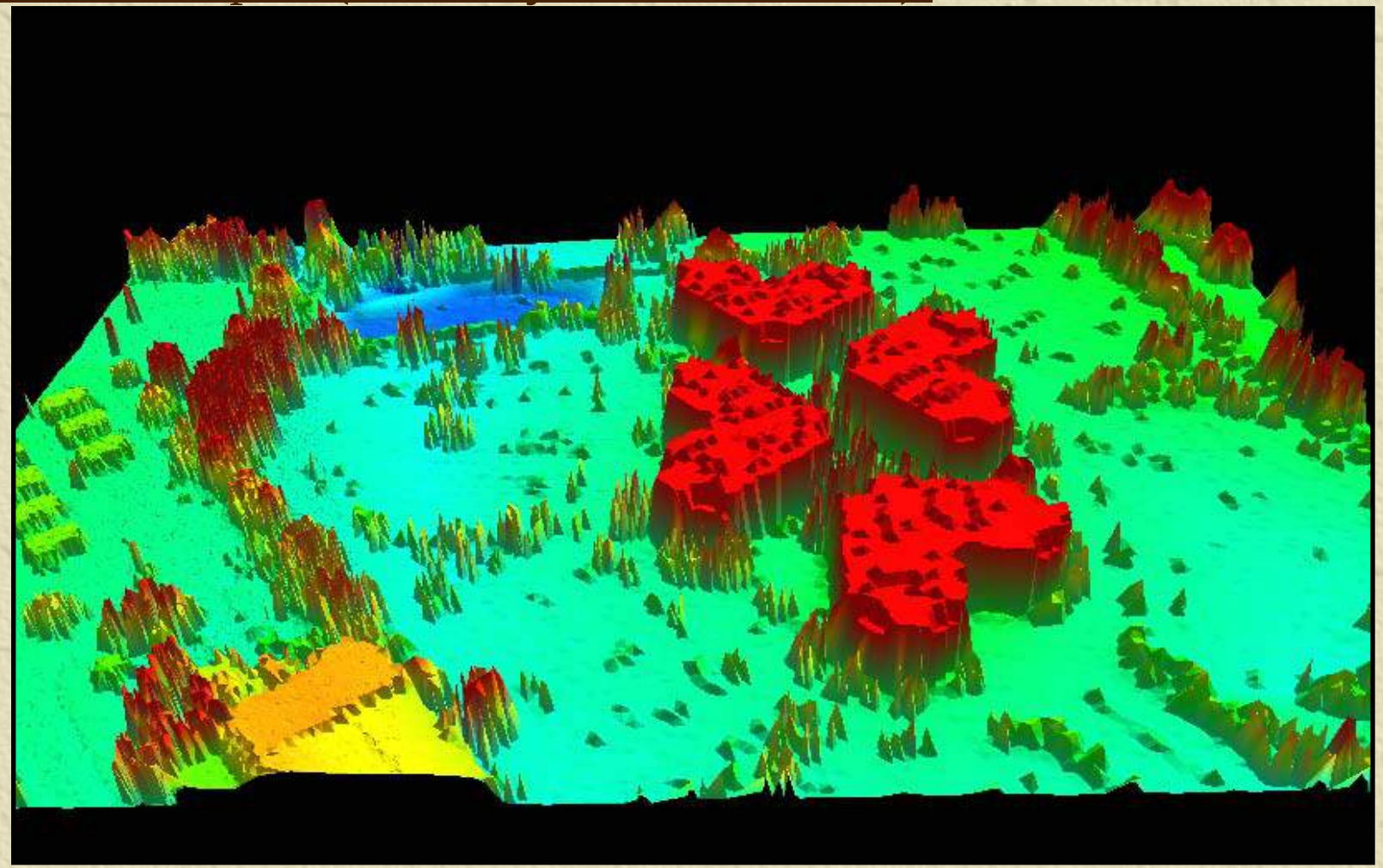
LiDAR

LiDAR examples (Color By Elevation – 3D):



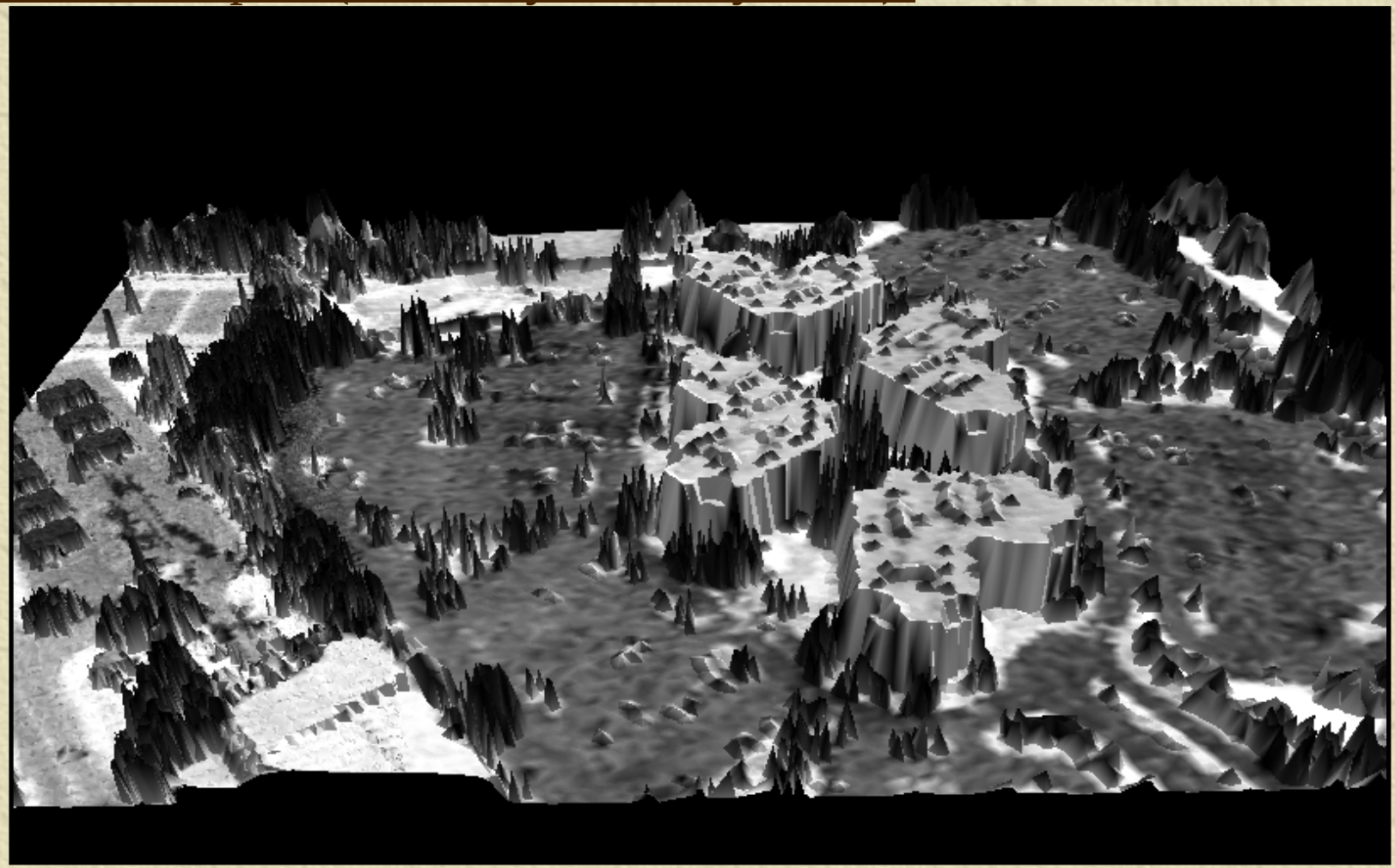
LiDAR

LiDAR examples (Color By Elevation – 3D):



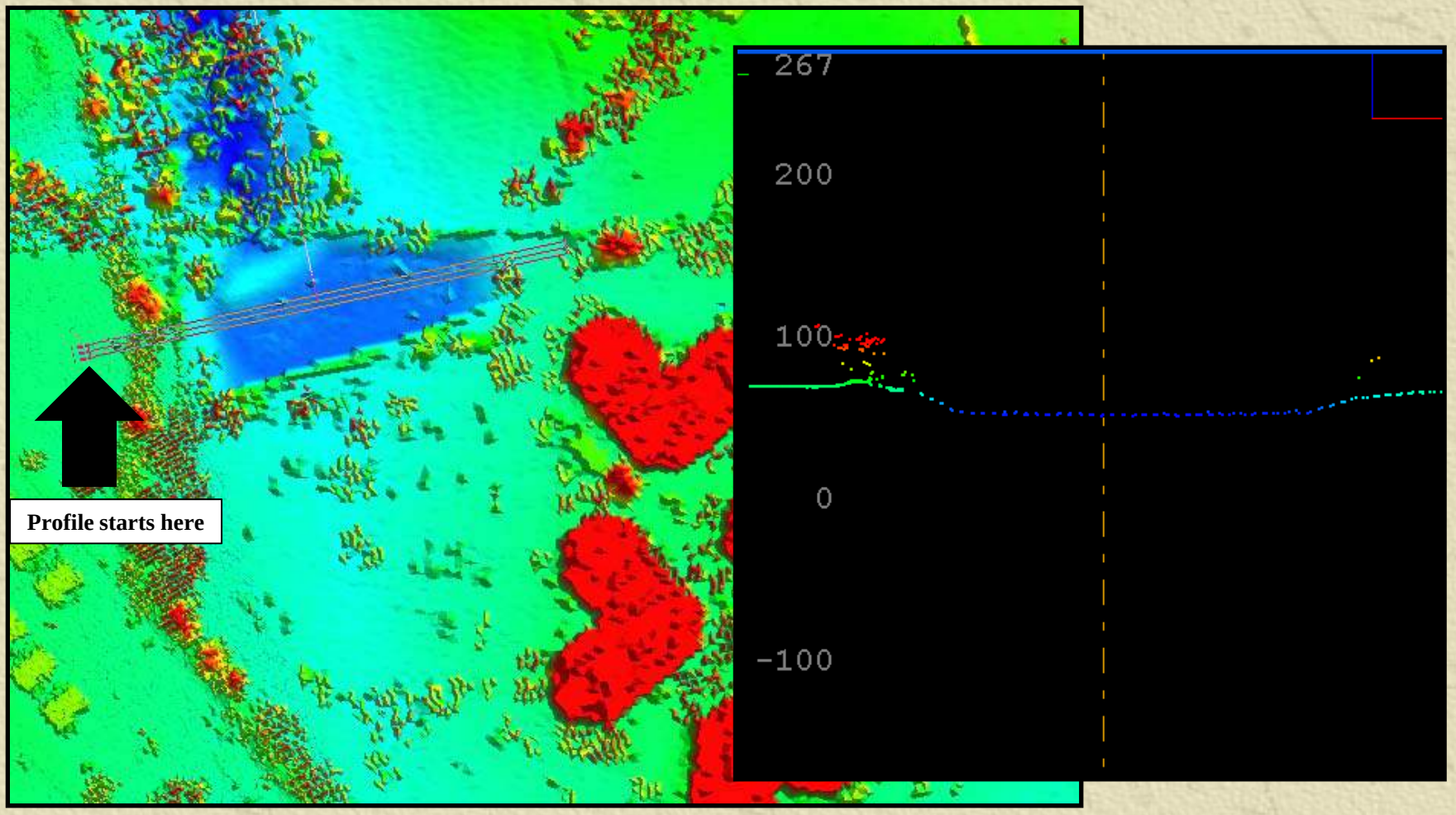
LiDAR

LiDAR examples (Color By Intensity – 3D):



LiDAR

LiDAR examples (3D and Profile View):



LiDAR

LiDAR Notes:

This data can be used for preliminary and planning purposes but does NOT replace the need for an accurate site survey.

Previous examples were created using a trial 30 day evaluation license of a software called MARS7. Also tested QCoherent's LP360.

ArcGIS 9.3.1 can NOT display the LiDAR LAS files.

ArcGIS 10.0 can display them, but very limited multi-point functionality.

ArcGIS 10.1 has enhanced LAS viewing capability but DPW WERS has not tested this yet. However, I saw some great examples of 10.1 LiDAR use at the ESRI Federal UC in late February.

Roughly ~2 million points per tile (636 total tiles, 33 GB total).

DEM

DEM is short for **D**igital **E**levation **M**odel, which is a computer model or 3D representation of a terrain's surface… in this case, the County's surface… that was created from the LiDAR LAS point data.

The DEM is a raster (image) grid consisting of equal sized cells attributed with an elevation value.

The County last acquired a DEM (2 meter resolution) in 2004.

DEM

DEM Specs:

Flown in March 2011.

Collected the County and a 100 meter buffer outside.

3 foot resolution (interpolates LiDAR points and averages).

Considered “bare earth” based on last returns.

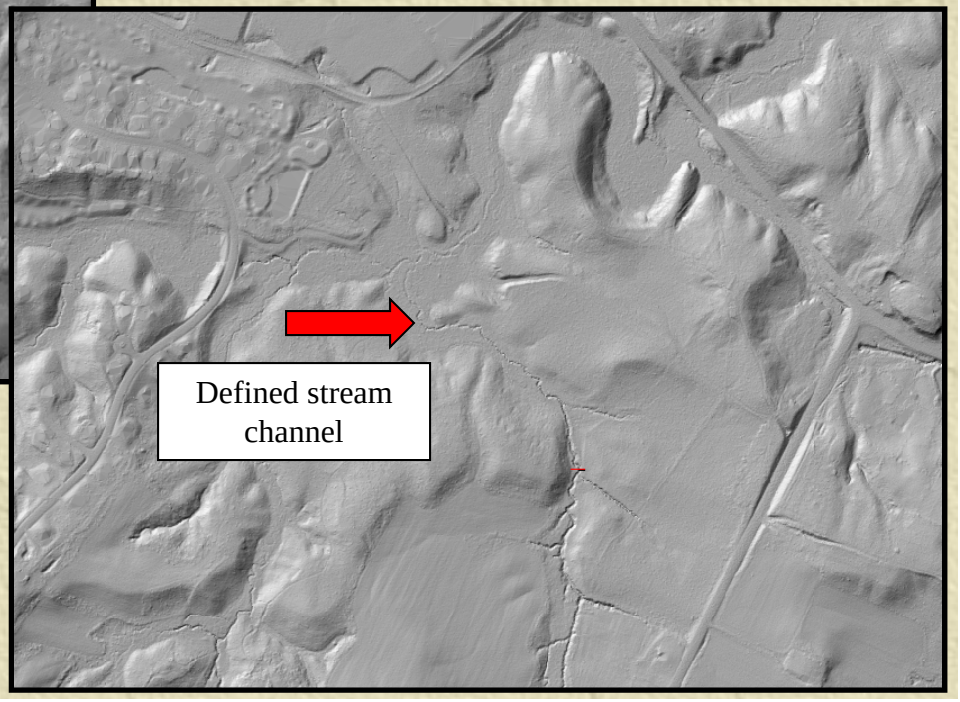
Major bridges removed from the DEM.

DEM

DEM comparison (2004 vs 2011):

2004 DEM hillshade - 2 meter

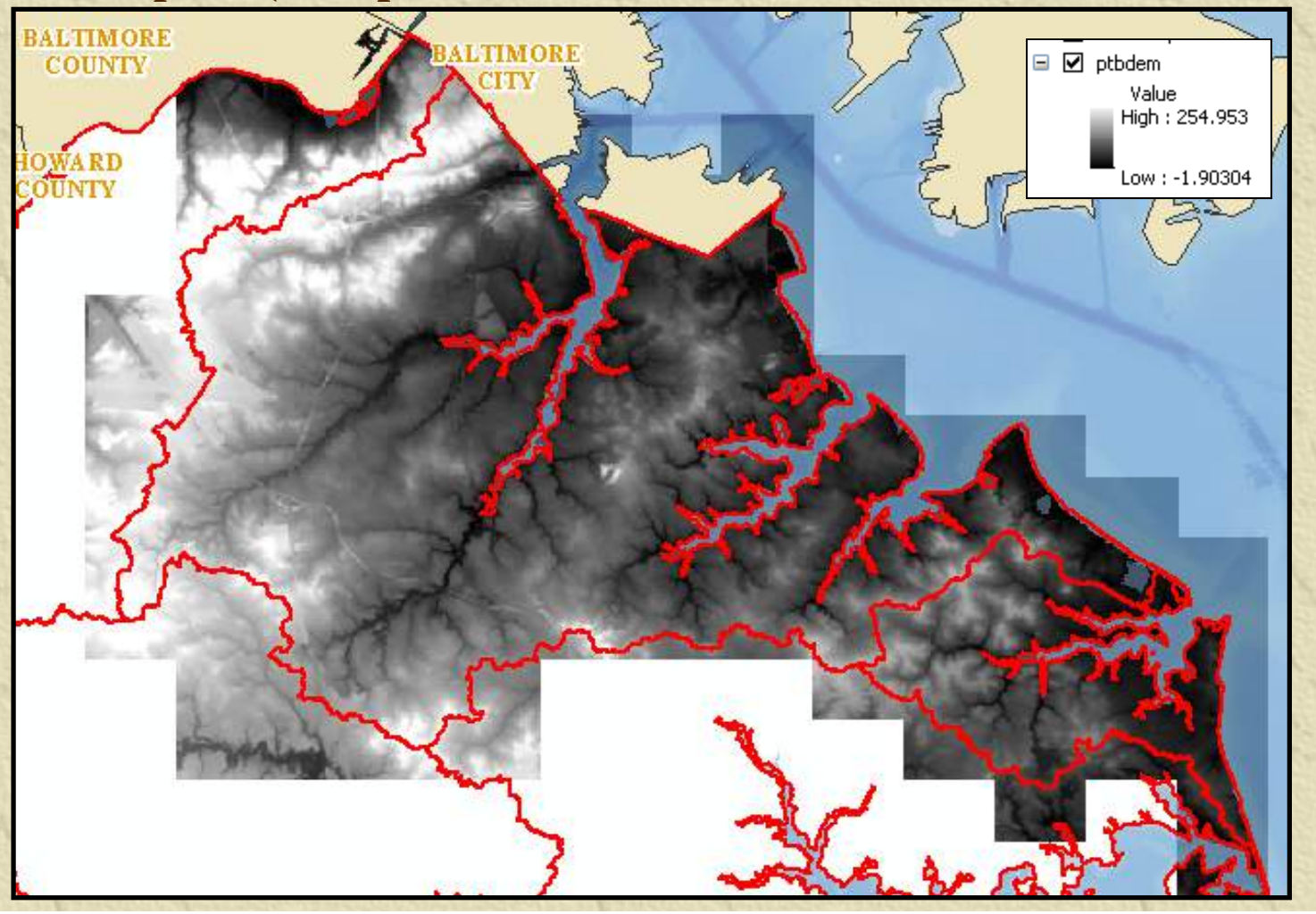
2011 DEM hillshade – 3 feet



Area just west of Muddy Creek Road and MD 214 in the Rhode River watershed.

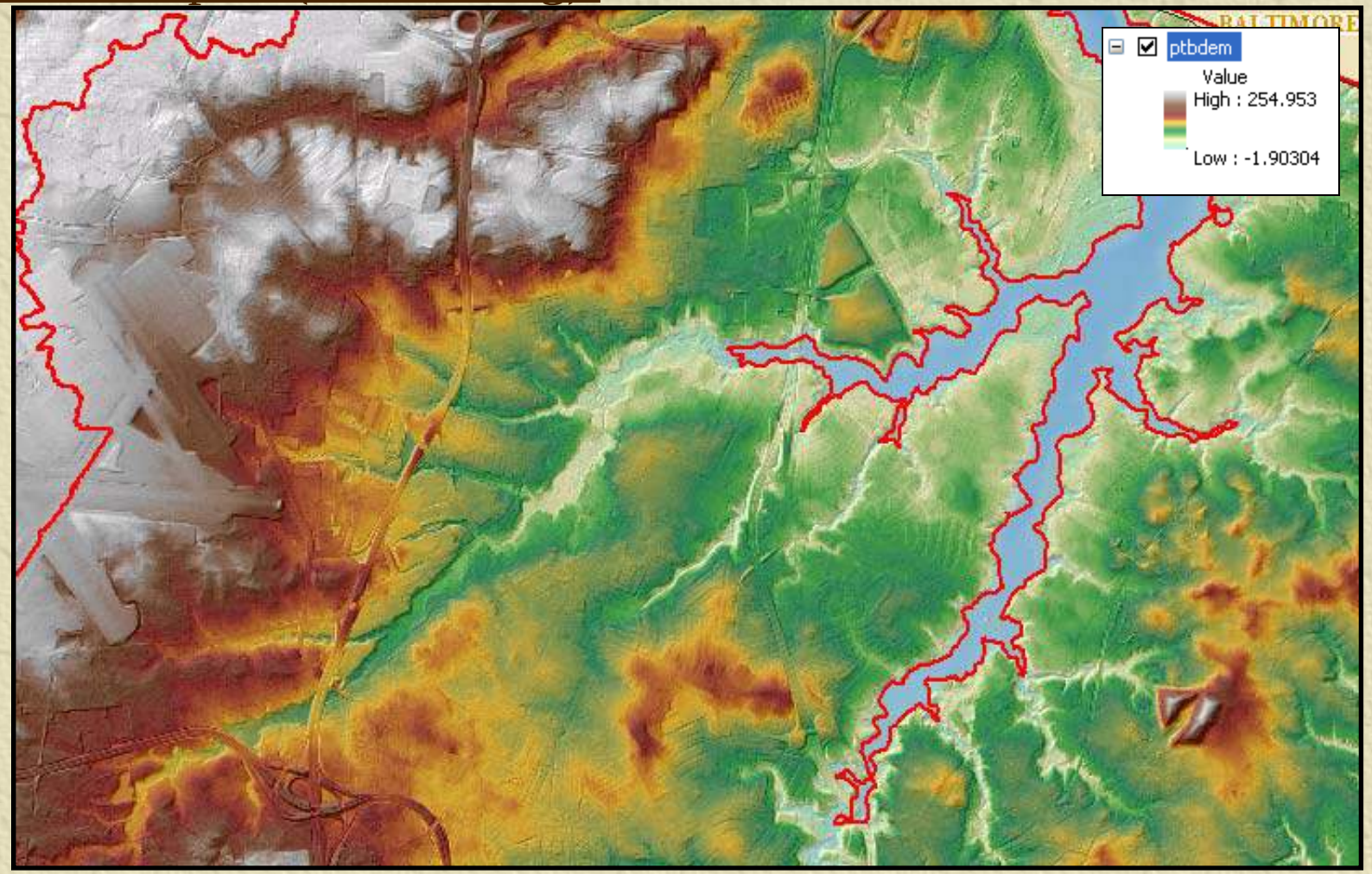
DEM

DEM examples (Patapsco Tidal and Bodkin Creek Watersheds):



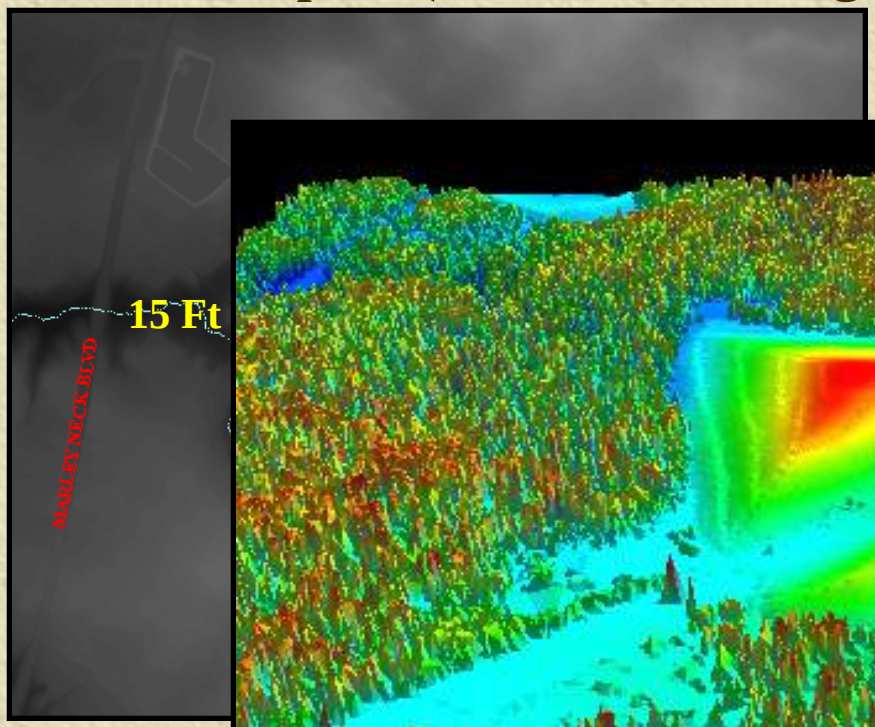
DEM

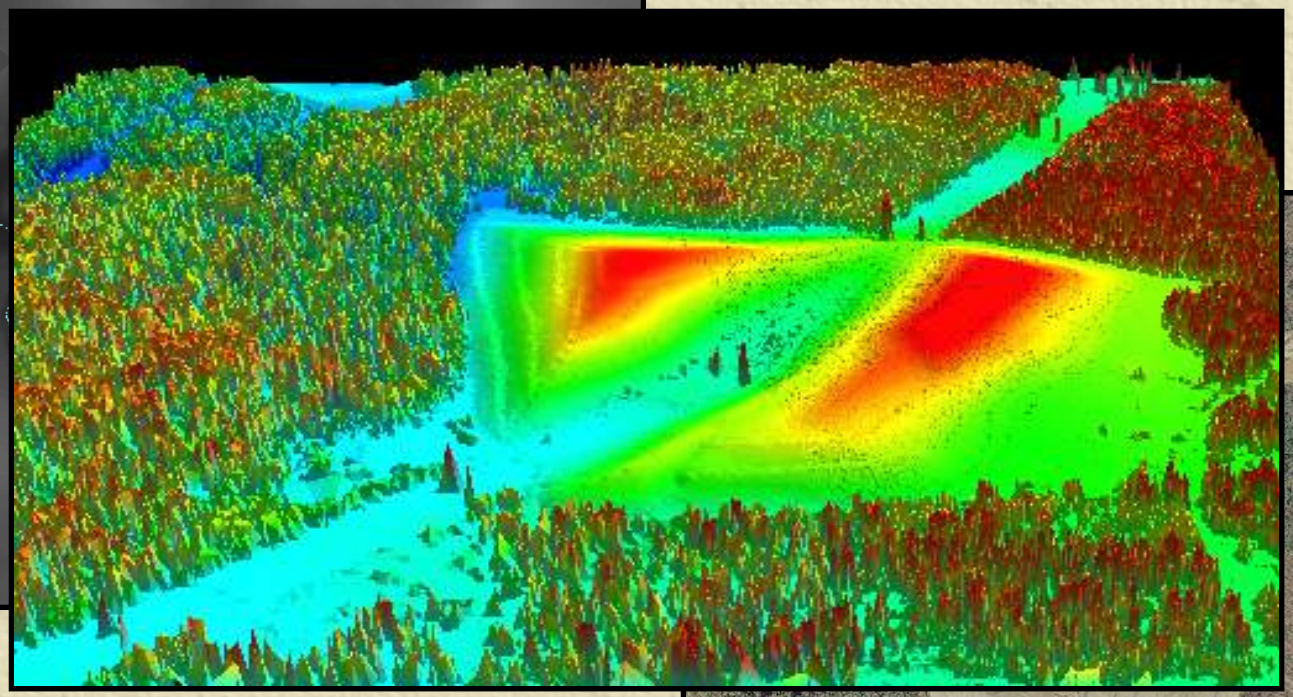
DEM examples (Hillshading):

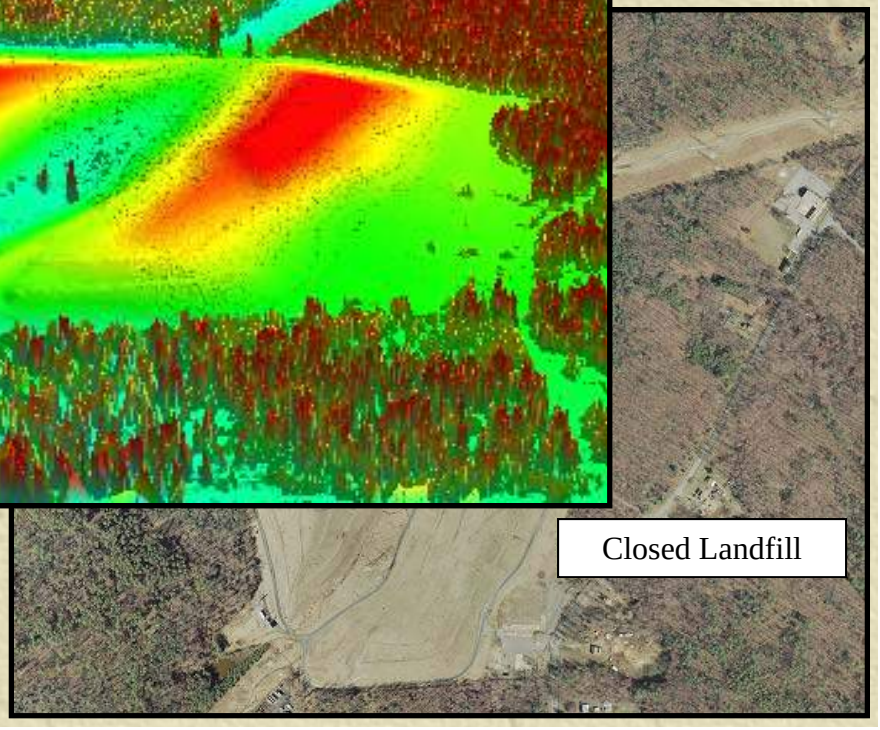


DEM

DEM examples (vs Aerial Photography):

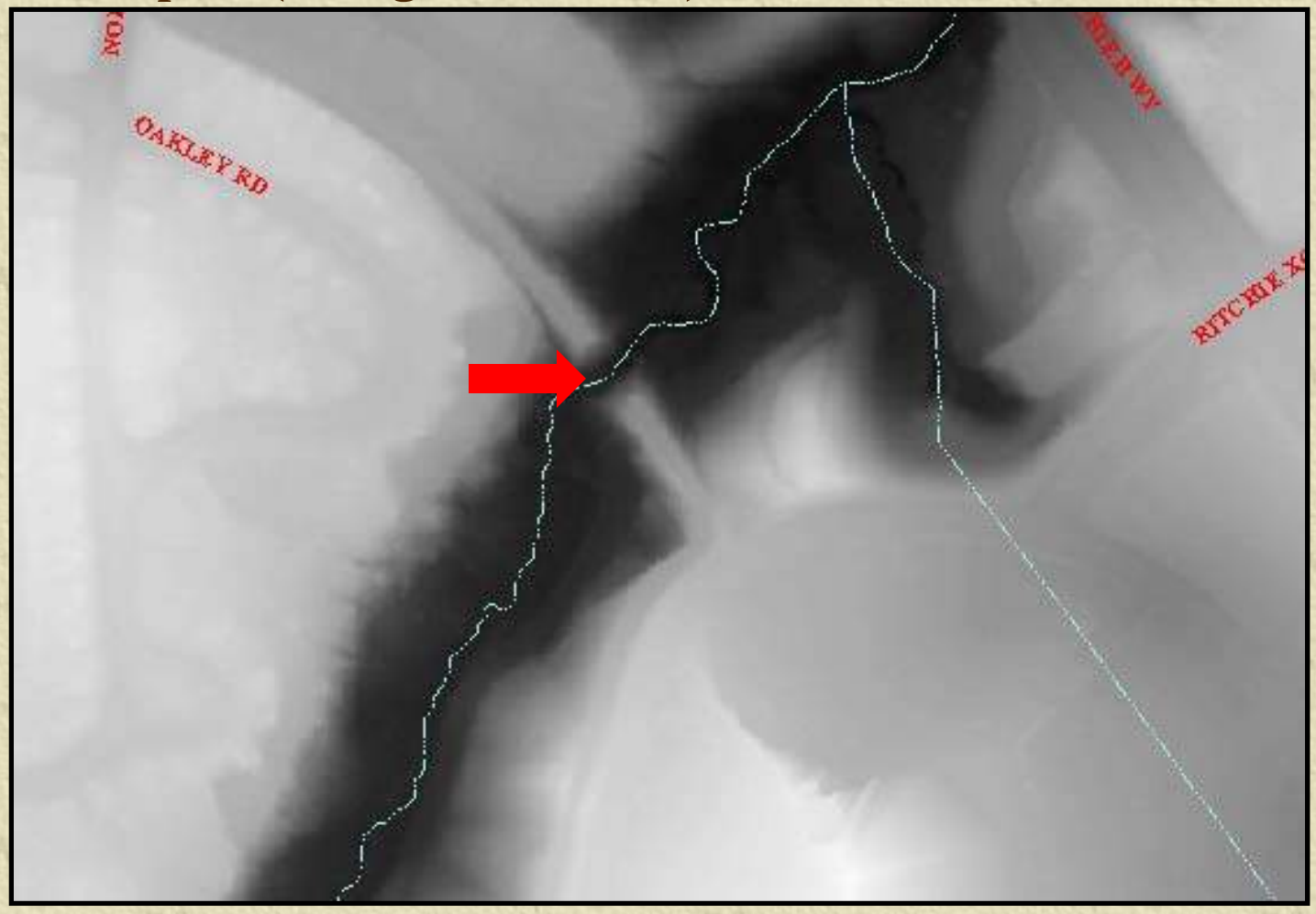






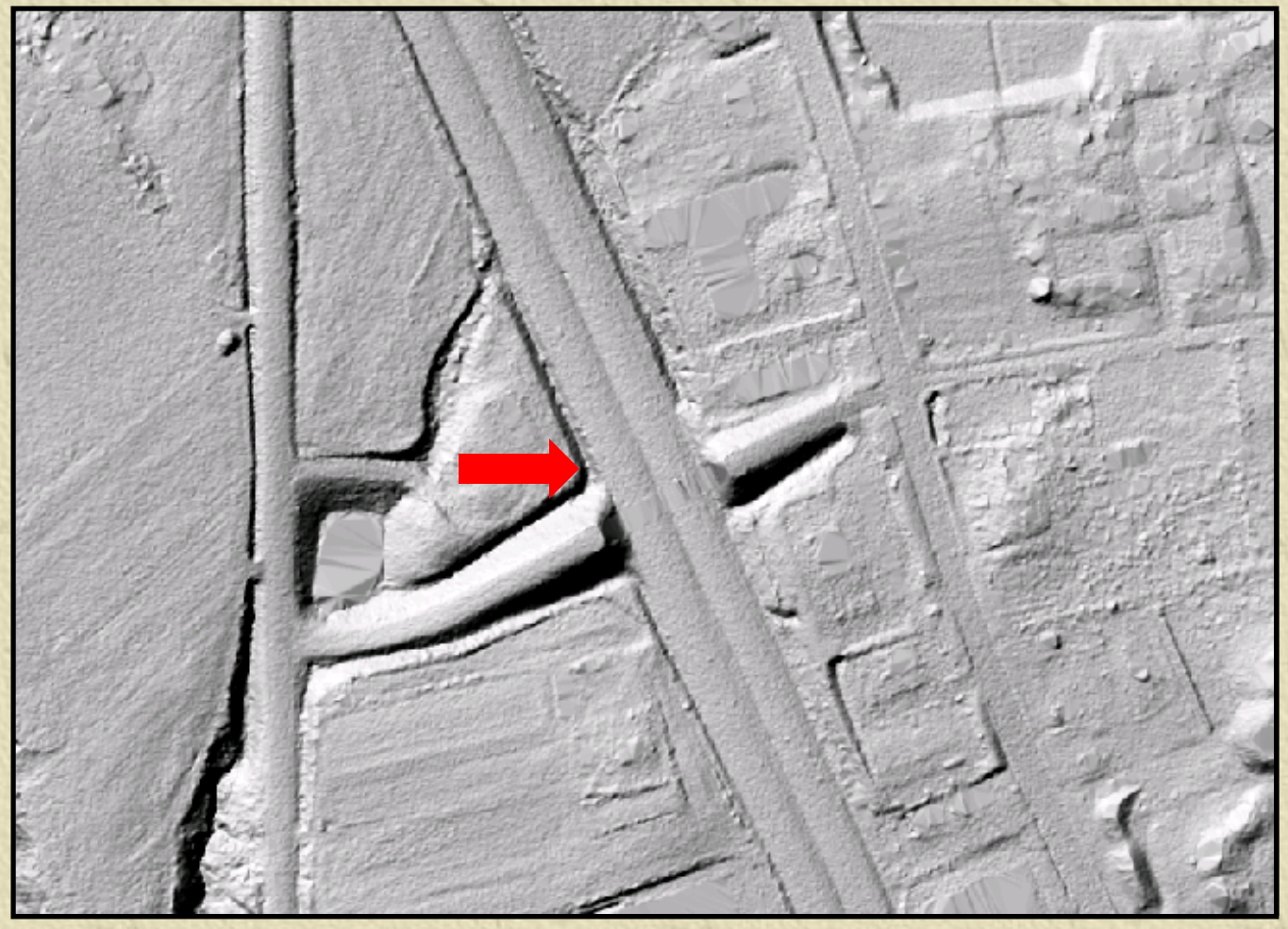
DEM

DEM examples (Bridge Removed):



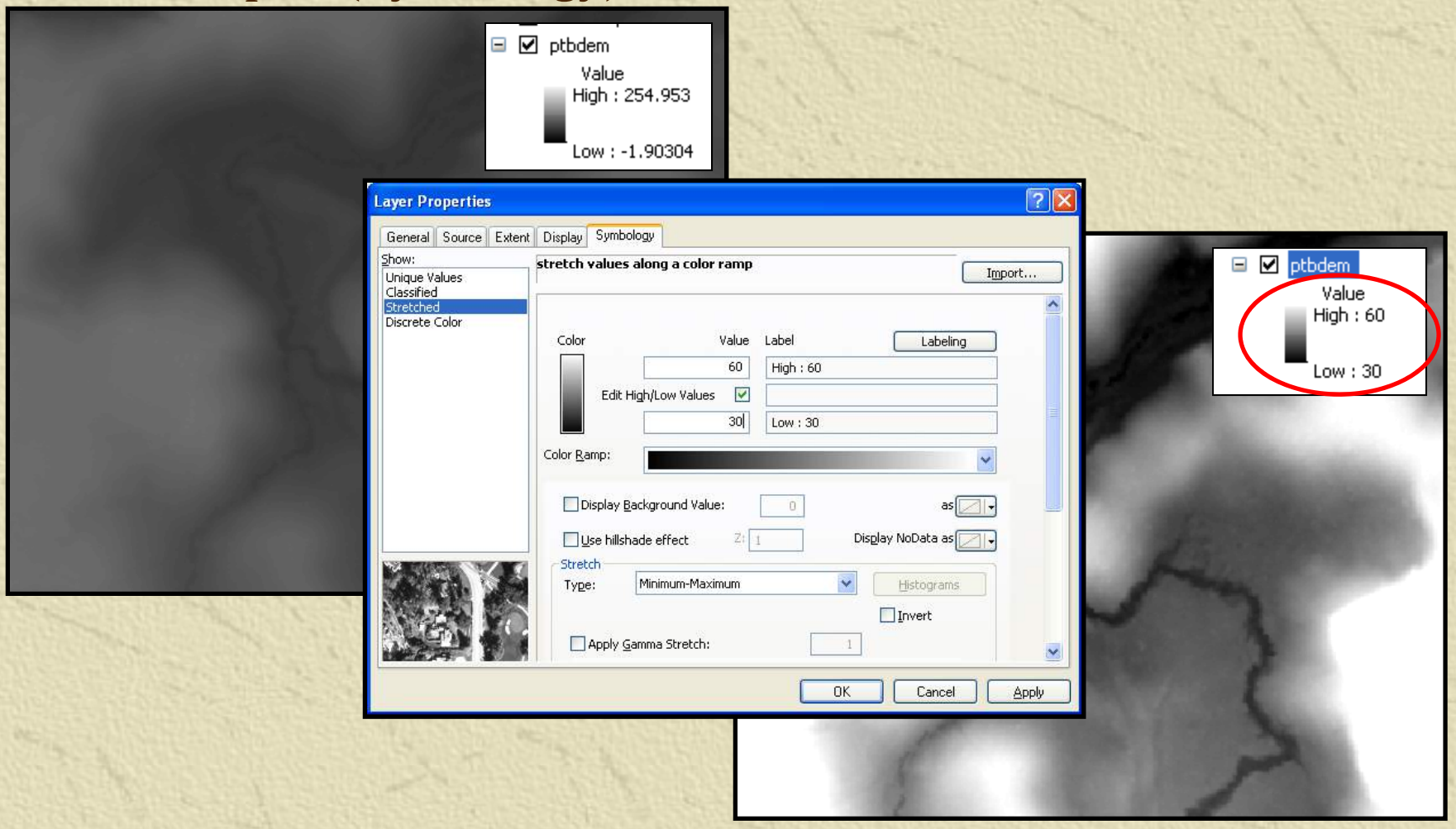
DEM

DEM examples (Bridge Removed):



DEM

DEM examples (Symbology):



DEM

DEM Useage (ArcHydro):

DPW WERS uses an ArcGIS extension called ArcHydro, which is geared to support water resource applications.

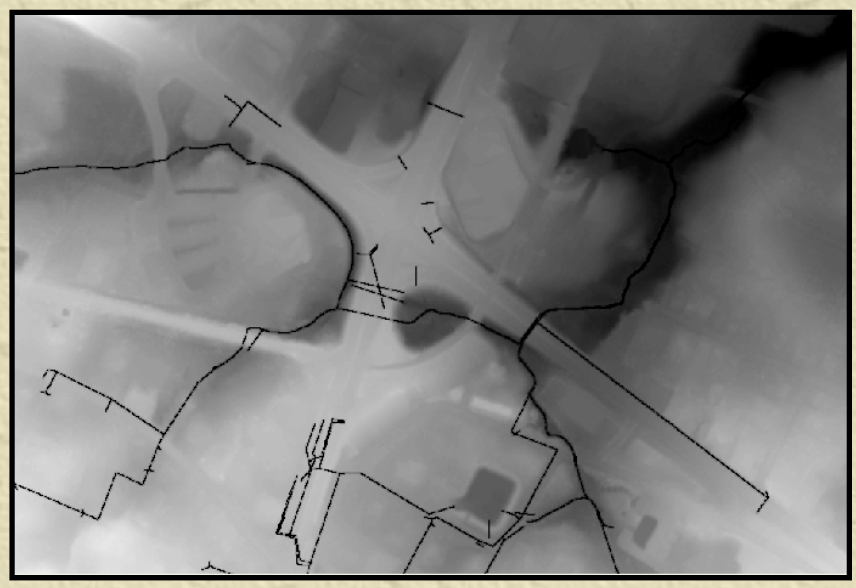
Use the DEM to model water flow, create watershed boundaries, drainage areas, flow path tracings, etc…

Each of the major 12 watersheds has its own dedicated model and each takes at least 1 - 2 weeks to create. Intensive combination of automated and manual processing, plus quality control efforts.

DEM

DEM Useage (ArcHydro):

The DEM must be “reconditioned” using GIS storm pipe and culvert layers (from the County, SHA, Fort Meade, Annapolis City, and adjacent Counties) to effectively model water conveyance under the ground or under the road.



DEM

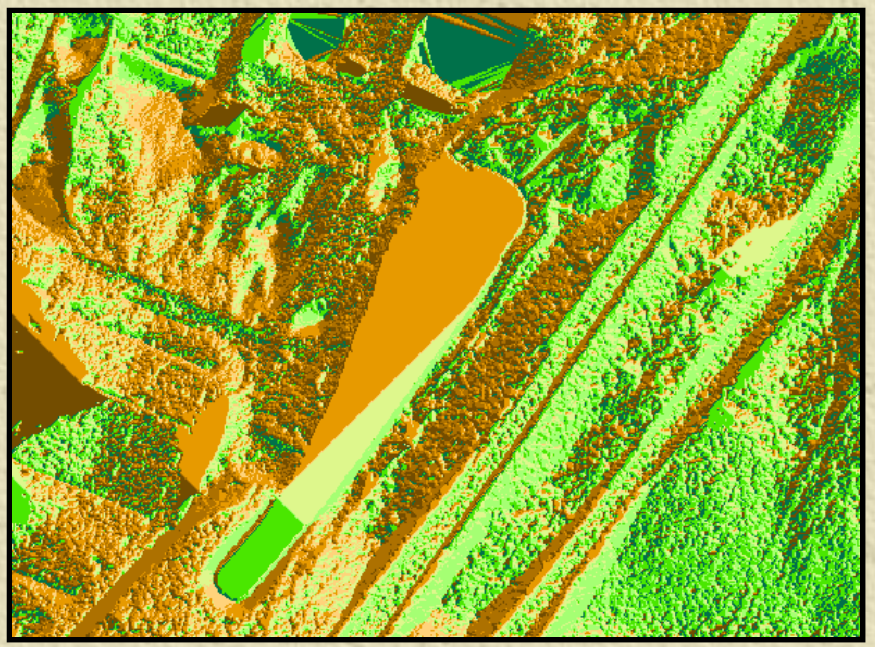
DEM Useage (ArcHydro):

Another non-County culvert example.

DEM

DEM Useage (ArcHydro):

County does not maintain private BMPs/pipes/culverts/outfalls so DPW WERS maintains a “DEM Modifications” layer…

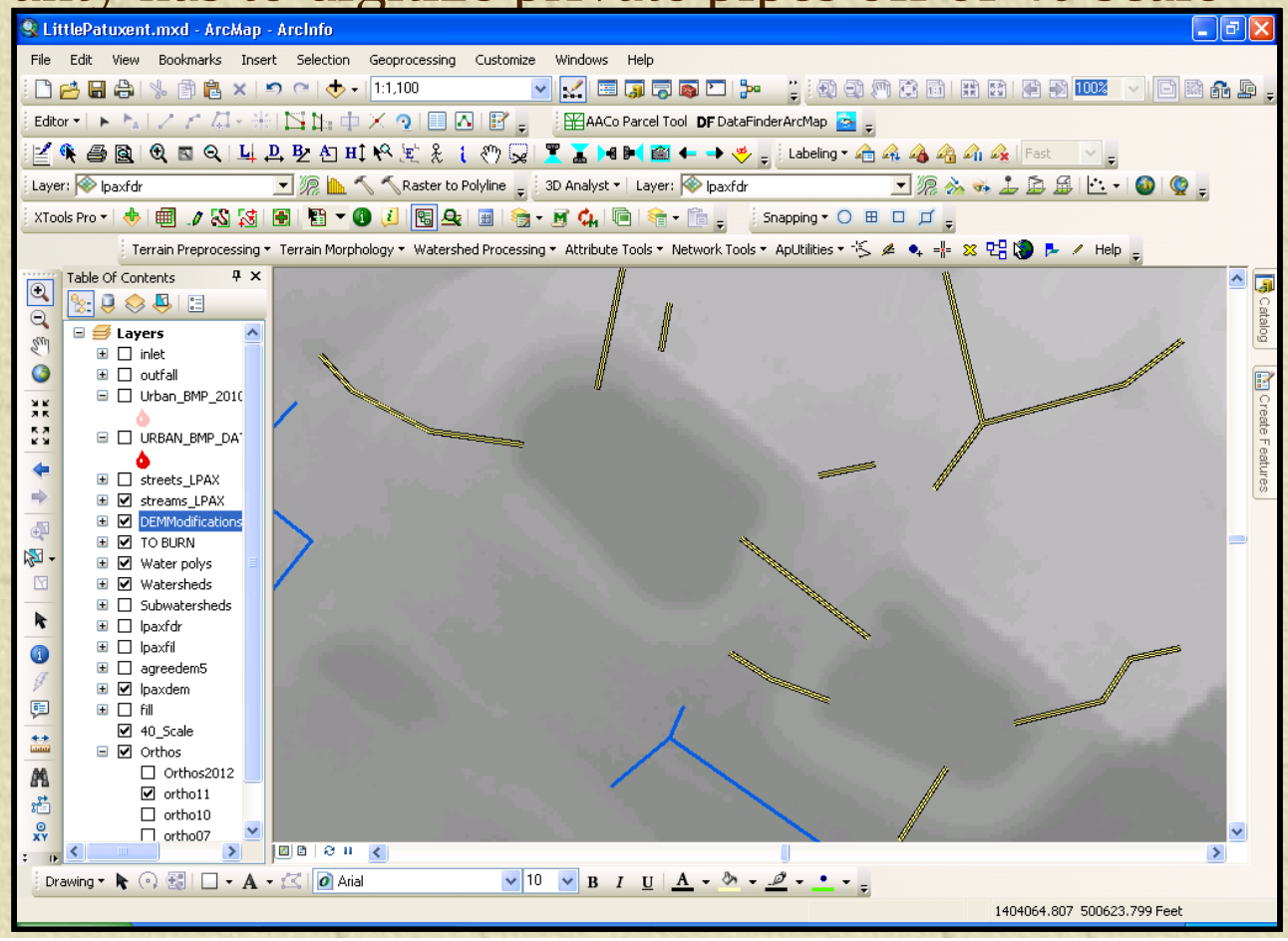


…which allows water conveyance and eliminates ponding.

DEM

DEM Useage (ArcHydro):

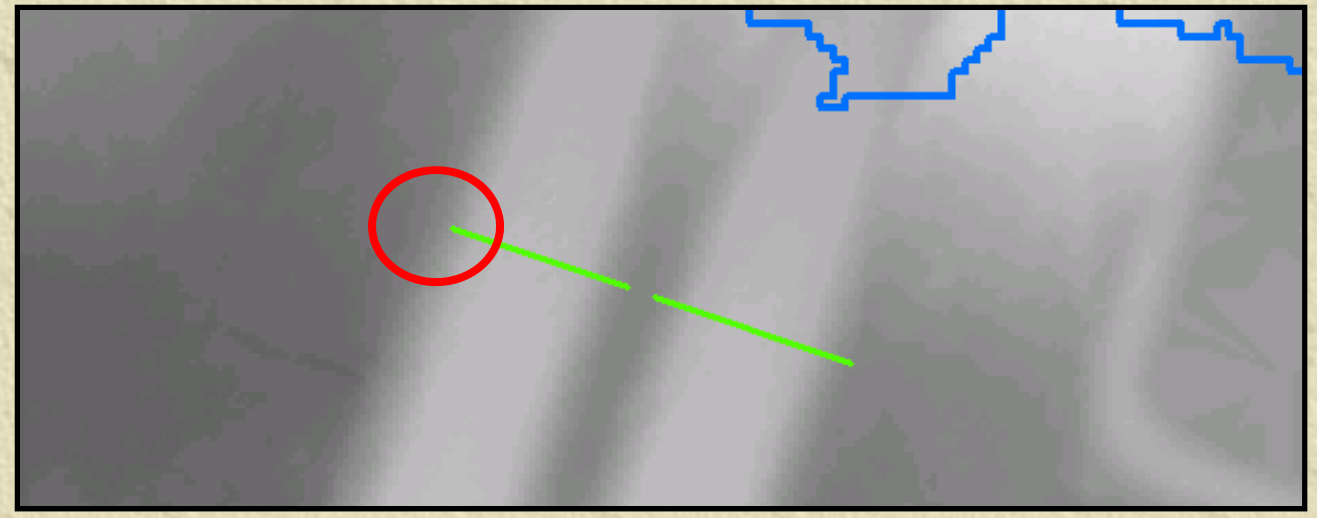
Sometimes the County has to digitize private pipes off of 40 scale operating maps.



DEM

DEM Useage (ArcHydro):

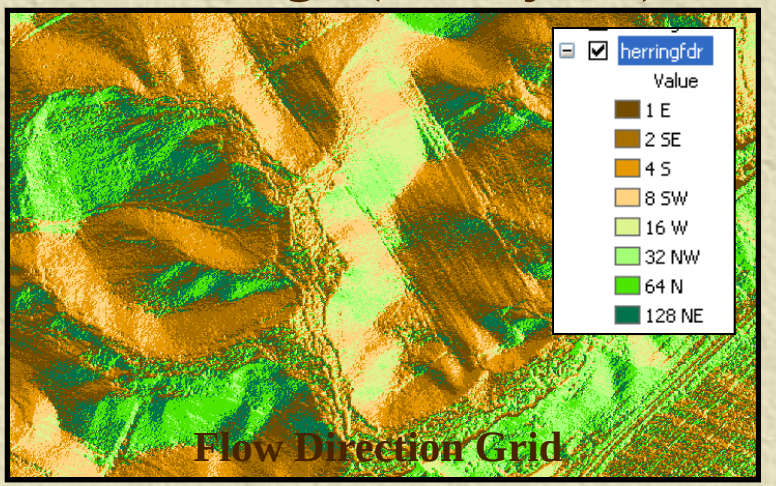
Also, other jurisdictions may capture data at a smaller scale (larger area, less detail) that might not match up well against the County's larger scale data.



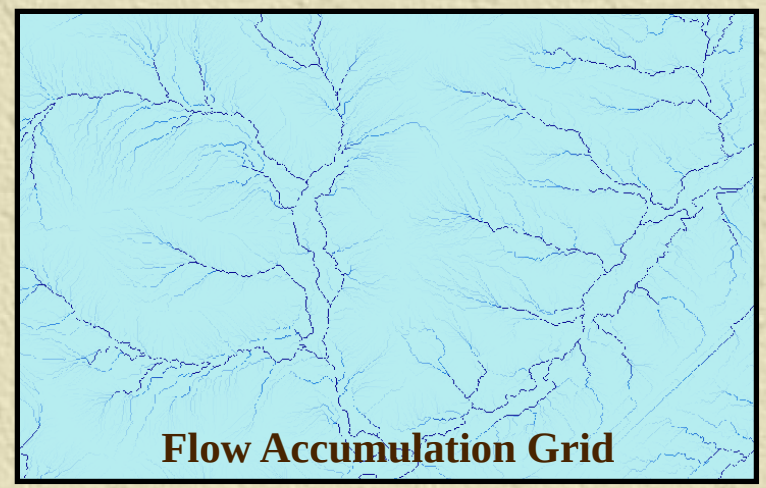
This state culvert does not quite reach the western side of the road, which is a low flow point, so DPW WERS will extend it to avoid a ponding situation and continue flow.

DEM

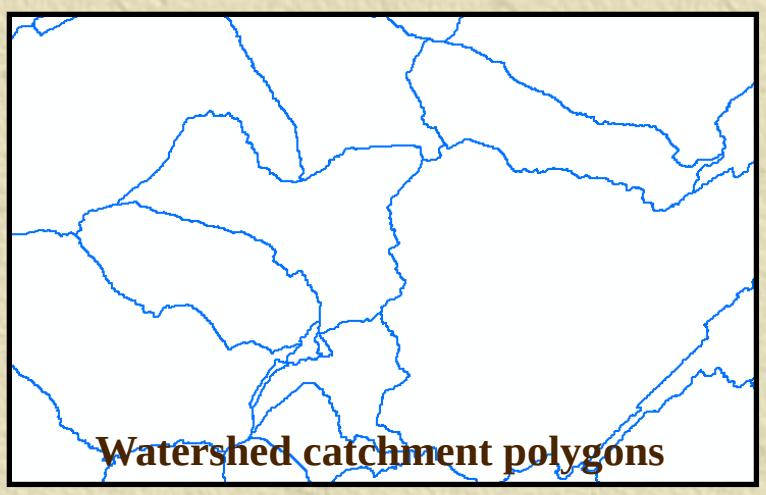
DEM Useage (ArcHydro):



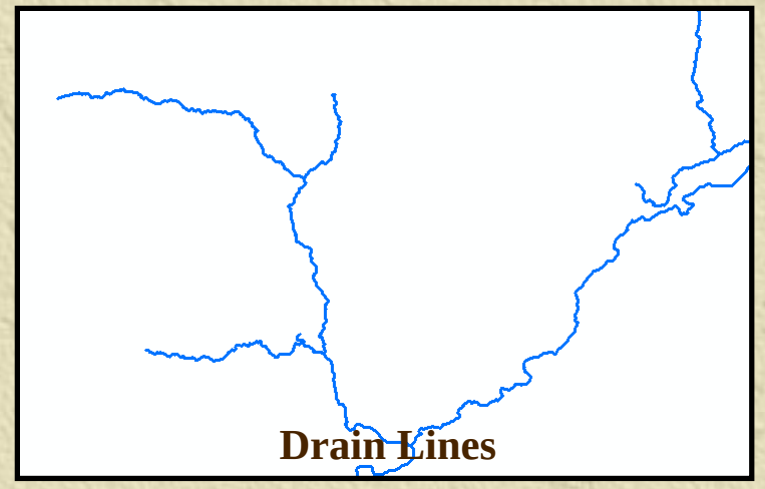
Flow Direction Grid



Flow Accumulation Grid



Watershed catchment polygons



Drain Lines

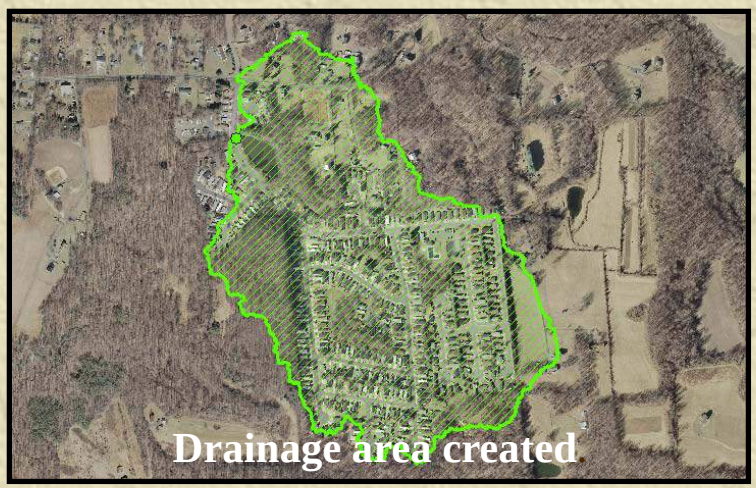
DEM

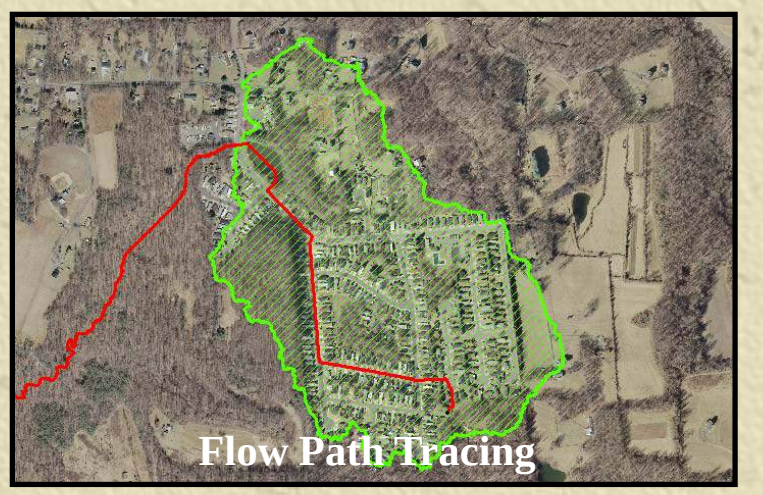
DEM Useage (ArcHydro):

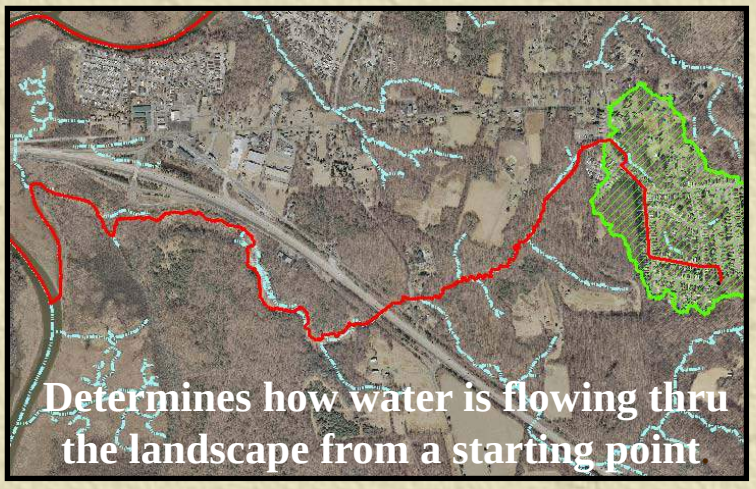
Stormwater Management Pond

DEM

DEM Useage (ArcHydro):







DEM

NOTE: If ArcHydro is not performing properly, ESRI online support suggests deleting the files in the temp directory on the PC local drive associated with your user account. This usually fixes any ArcHydro glitches.

For example:

C:\Documents and Settings\USER\Local Settings\Temp\

DEM

DEM Notes:

Again, there are 636 individual tiles (~534 acres each). 6.5 GB+ total.

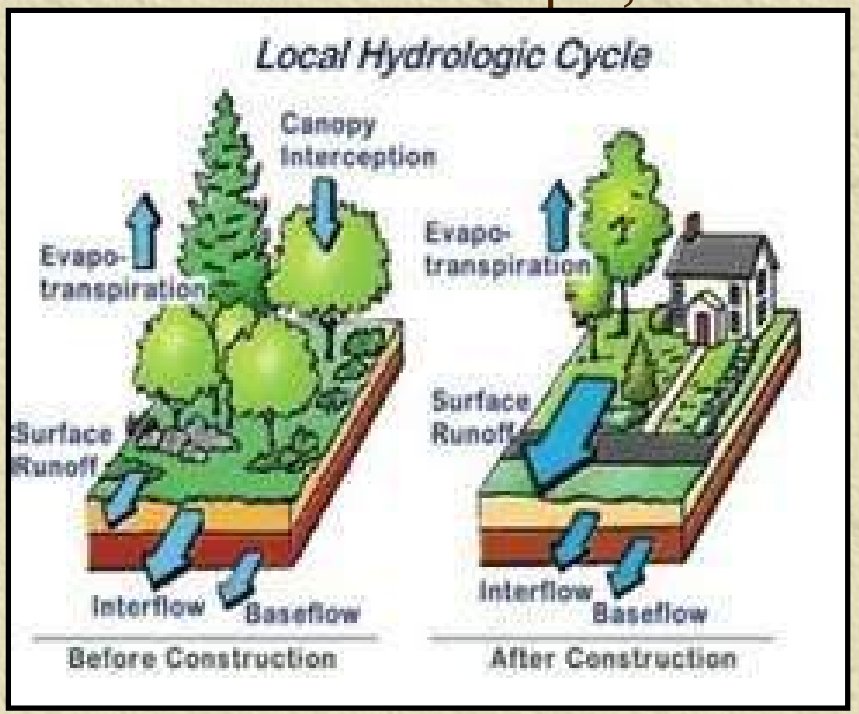
Users may need to “mosaic” the individual tiles to analyze a larger area.

In ArcToolbox, use the “Mosaic To New Raster” tool, which mosaics multiple raster datasets into a new raster dataset. Please note that the regular “Mosaic” tool, which mosaics multiple input rasters into an existing raster dataset, sometimes leaves empty/no data “seams” at the edge of individual tiles.

Many great ArcToolbox tools if you have Spatial/3D Analyst.
3D Interpolation, Line of Sight, Create Profile, Hillshading, etc…

Impervious Surfaces

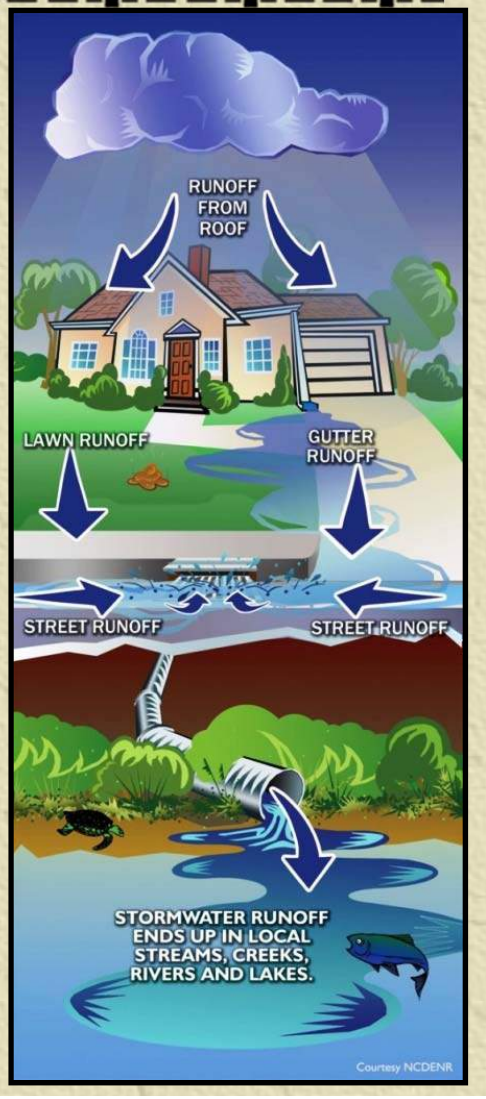
Impervious surfaces are defined as artificial structures that are covered by impenetrable materials, which eliminate storm water infiltration and increase storm water runoff. For example, buildings, parking lots, & roads.



The County last acquired impervious surfaces in 2007 using raster extraction techniques based on the 2007 aerial imagery.

Impervious Surfaces

Increased amounts of impervious surfaces increase the amount of storm water runoff, which can contain pollutants such as pet waste, car oil and gas, lawn fertilizers, trash, etc…



Impervious Surfaces

… that discharge into our streams and Bay causing sediment dumps, algae blooms, and fish kills.

A satellite image shows sediment flowing from the Susquehanna River to the Chesapeake Bay.

In 2011, pollutants associated wth stormwater runoff killed more than 100,000 fish in Marley Creek and the entire Patapsco River Basin.

Impervious Surfaces

Impervious Specs:

Used the 2011 Maryland Statewide Aerial Photography Project imagery.

Unlike previous Countywide impervious layers, this was manually digitized using heads-up processes (not raster extraction). The County last acquired impervious surfaces in 2007 using raster extraction techniques.

Planimetric data acquired by the County via the 2007 imagery was used as basis.

New impervious features not captured in the 2007 planimetrics were added, as well as any major changed surfaces. Impervious features that no longer exist on the ground were deleted.

11 Classifications: athletic fields, buildings, driveways, other paved areas, parking lots, patios/decks, piers, rails, roads/highways, sidewalks, and swimming pools.

Impervious Surfaces

Impervious Comparison (2007 vs 2011):

2011 vector

2007 raster

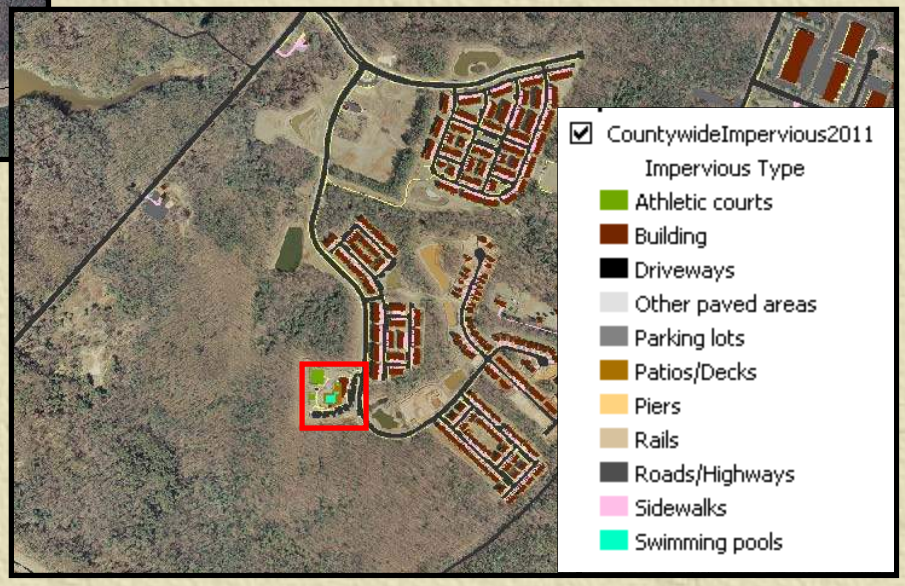
Regatta Bay
off Housley Dr

Impervious Surfaces

Impervious Comparison (2007 vs 2011):

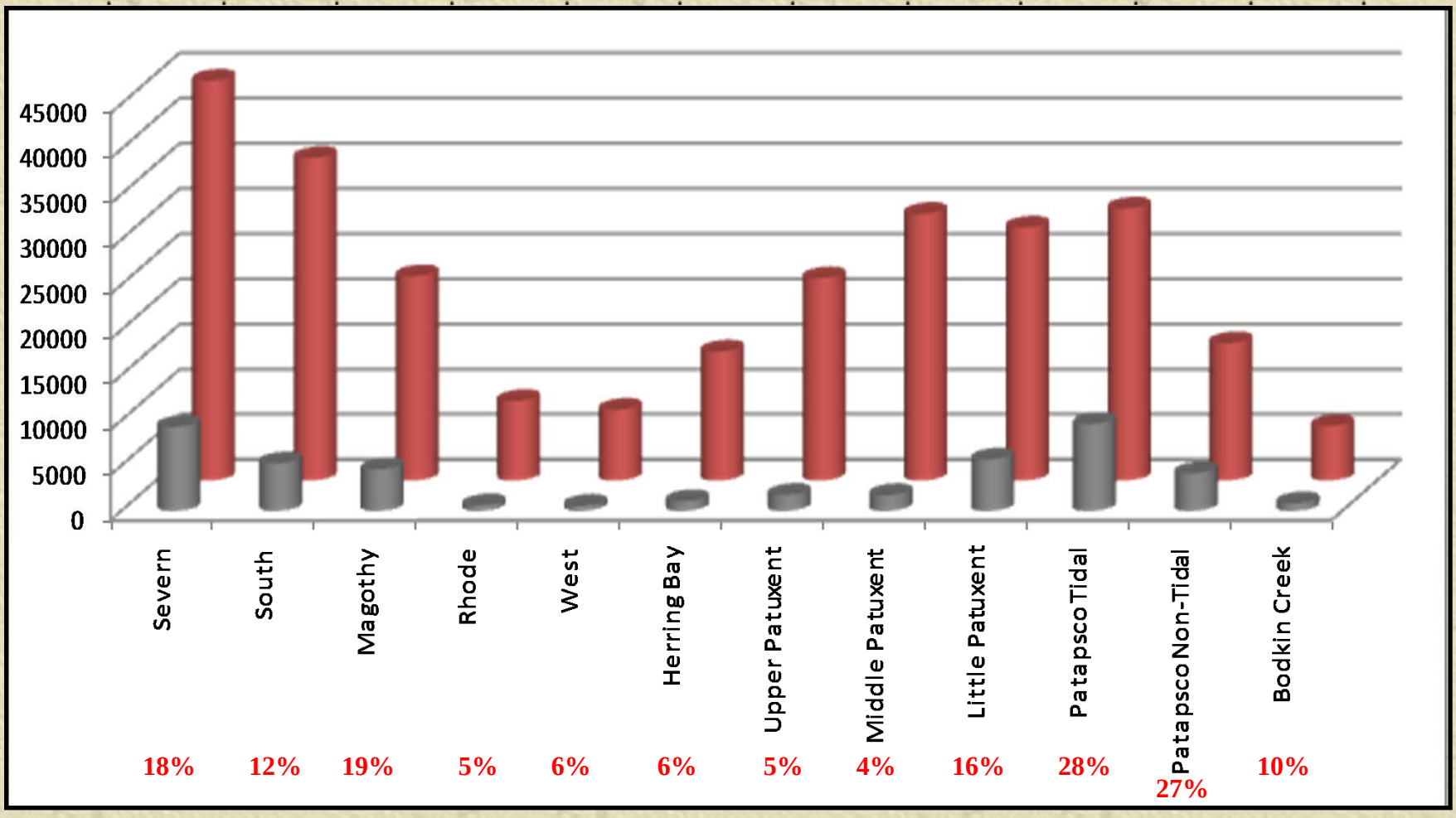
2007 raster

2011 vector



Tanyard Springs – new development

Impervious Surfaces



Impervious Surfaces

Considerations:

What is impervious?

What does the State consider impervious?

Is crushed gravel impervious? Is packed dirt impervious?

Are decks impervious?

Many decks have slats that allow water to flow through.

But there might be a concrete patio below.

Are railroad beds impervious?

Research suggests that most ballasts track beds are pervious.

What portion of a swimming pool is impervious?

The pool itself? Or just the surrounding patio? In vs out-of-ground pools.

Most orthos are flown in the late winter when pool covers are still on.

New astroturf fields at high schools are considered pervious.

Expect discrepancies in TYPE between data capture staff.

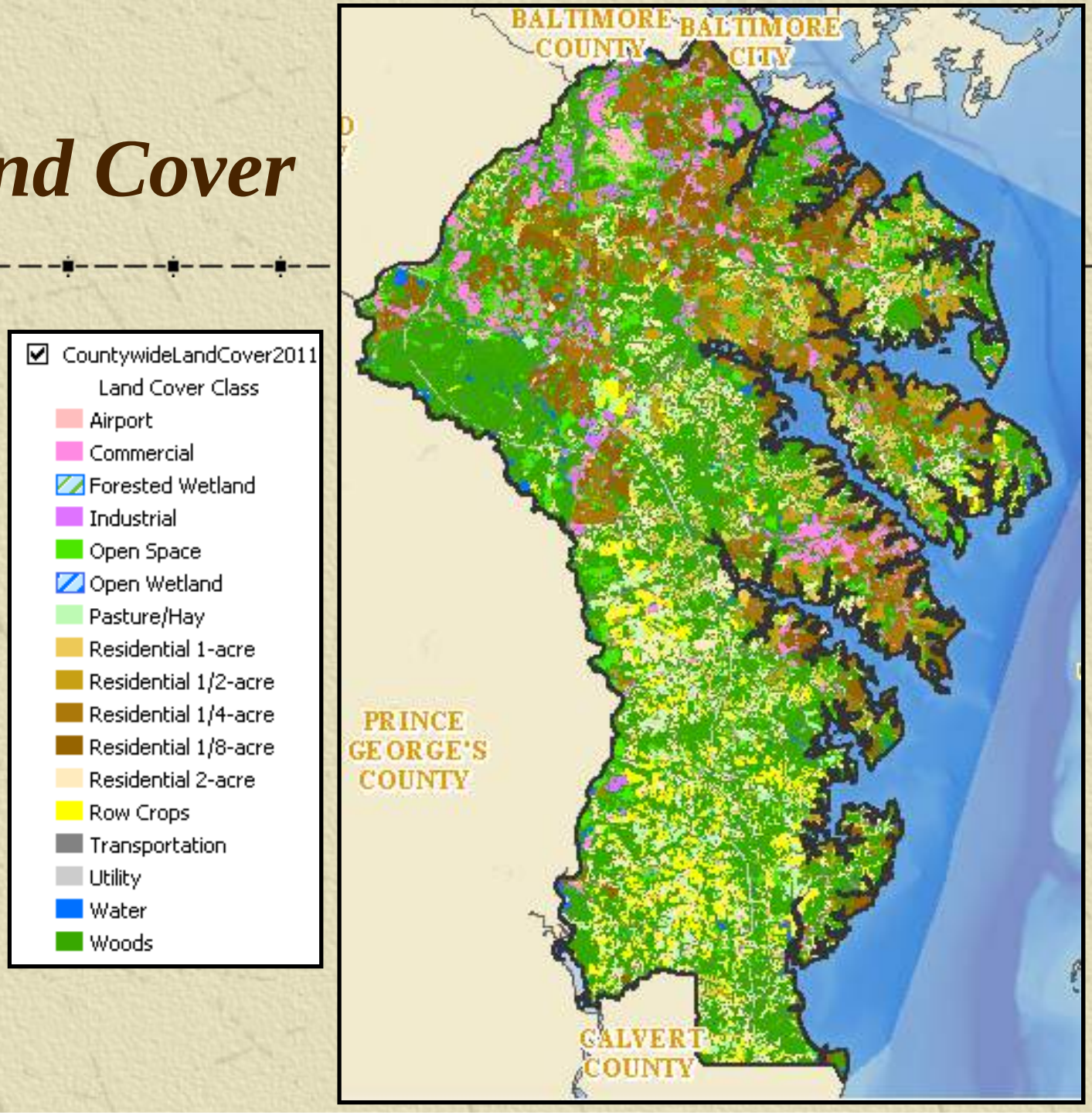
True ortho imagery (no building lean) vs aerial imagery (building lean, shadows).

Land Cover

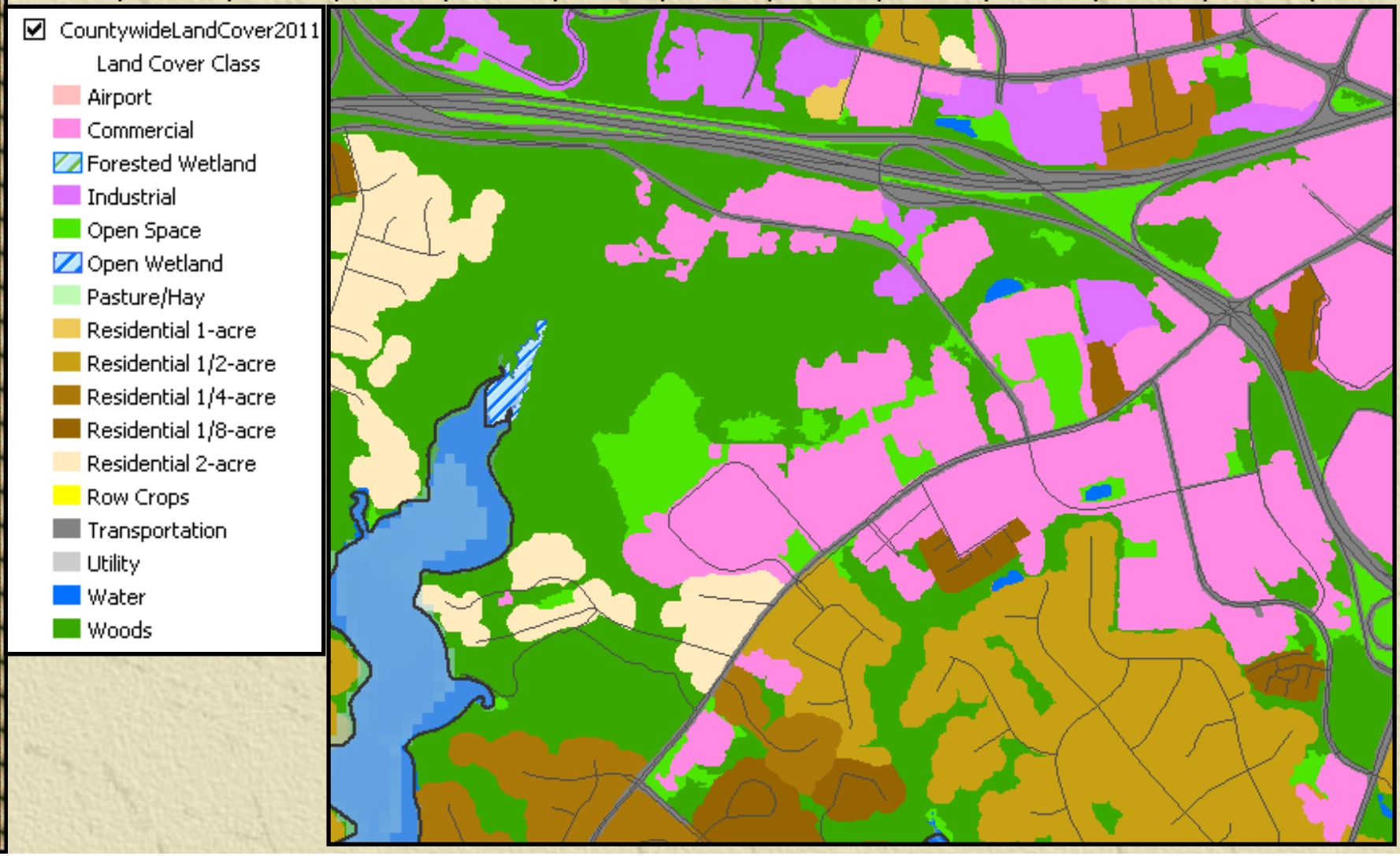
Land Cover can be defined as the classification of land according to the vegetation, material, or man made structures that cover most of its surface.

Not to be confused with Land Use which can be defined as how people utilize the land. For ex, Woods vs Vacant.

Land Cover


CountywideLandCover2011
Land Cover Class
Airport
Commercial
Forested Wetland
Industrial
Open Space
Open Wetland
Pasture/Hay
Residential 1-acre
Residential 1/2-acre
Residential 1/4-acre
Residential 1/8-acre
Residential 2-acre
Row Crops
Transportation
Utility
Water
Woods
BALTIMORE COUNTY
BALTIMORE CITY
PRINCE GEORGE'S COUNTY
CALVERT COUNTY

Land Cover


CountywideLandCover2011
Land Cover Class
Airport
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Forested Wetland
Industrial
Open Space
Open Wetland
Pasture/Hay
Residential 1-acre
Residential 1/2-acre
Residential 1/4-acre
Residential 1/8-acre
Residential 2-acre
Row Crops
Transportation
Utility
Water
Woods

Land Cover

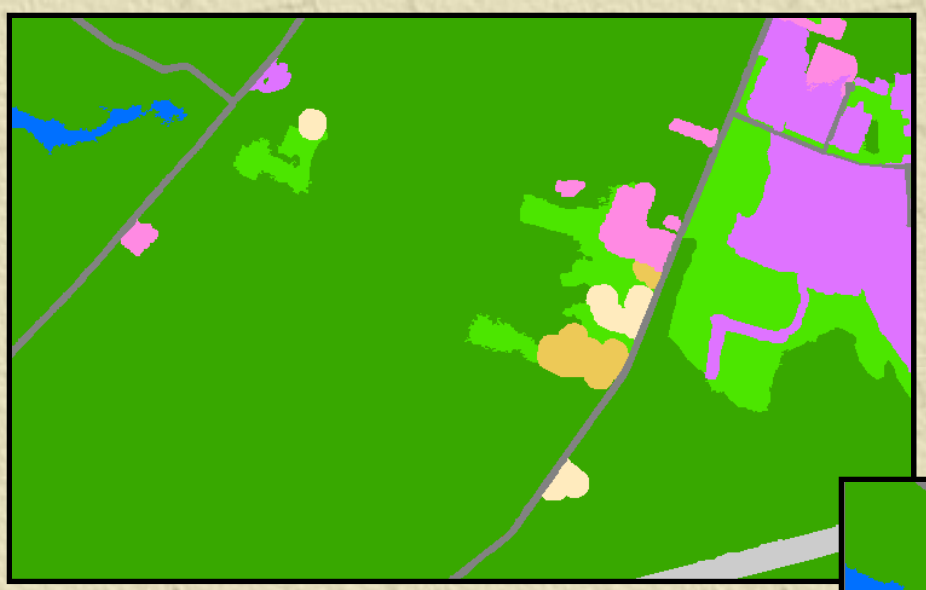
Sanborn was concerned with detection of changed areas through comparison of the 2007 and 2011 aerial photography.

These imagery datasets were processed, along with the 2007 LC dataset, into spectrally homogeneous segments using Definiens Developer software.

Using Sanborn's object change methodology, the segments and their spectral statistics were examined for significant differences which indicated that the area may have changed land cover.

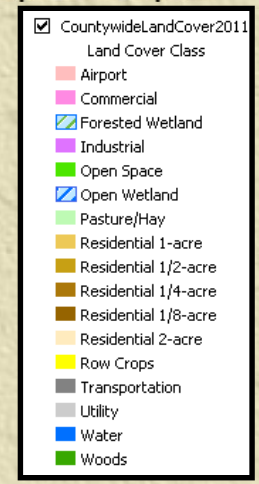
The 4-band imagery, with emphasis on the infrared band, is very sensitive to changes in moisture and vegetation.

Land Cover



2007 Land Cover

2011 Land Cover



Tanyard Springs – new development

Land Cover

Land Cover classifications often vary between organizations. Even within the same organization.

DPW WERS uses a customized classification in support of internal modeling efforts based on estimated EMC (Event Mean Concentrations) values. An EMC is the average concentration of a pollutant measure during a storm runoff event… per Land Cover class.

For ex, the Total Nitrogen value for Row Crops is 16.06 mg/l, while the Total Nitrogen value for Woods is 1.0 mg/l.

Modeling and Analysis

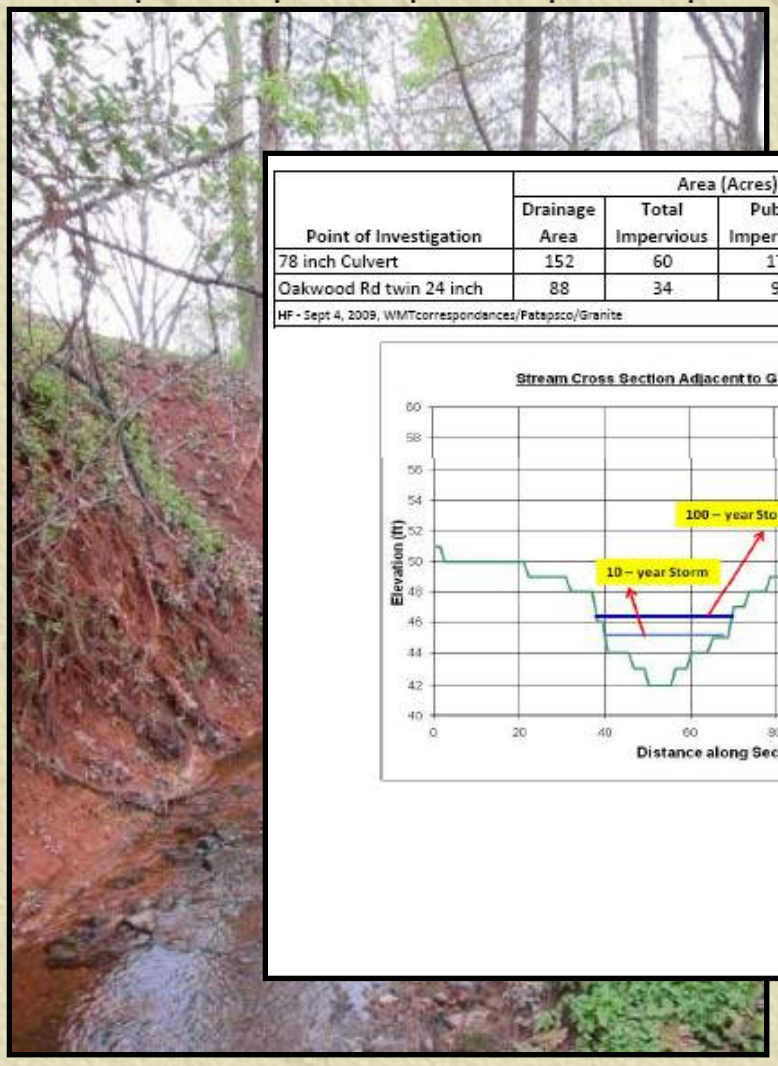
So why do we need these map layer updates?

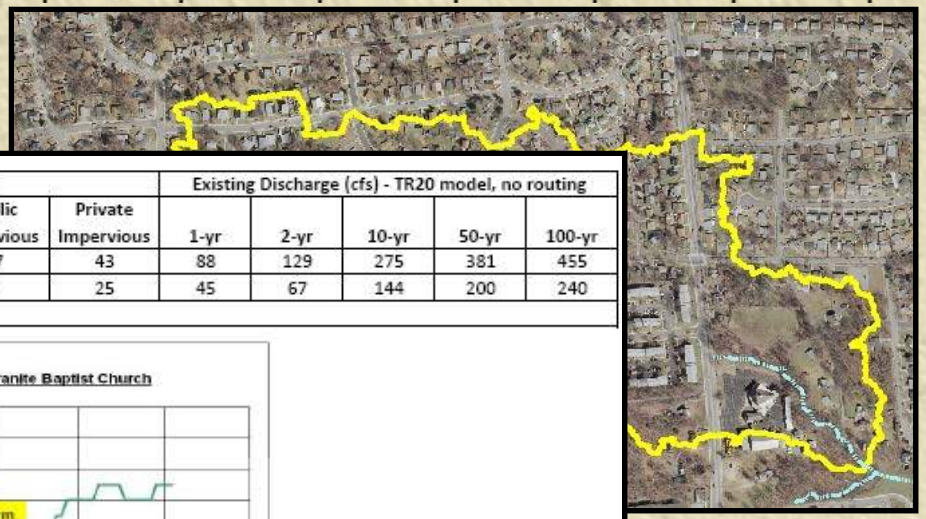
Citizen drainage complaints, flooding issues, restoration of streams, retrofits of BMPs and outfalls.

Input into models, such as TR20/HY8/WMT, for hydrologic analysis, hydraulic engineering and design, water quality and BMP efficiencies, and pollutant load reductions.

ArcGIS Geoprocessing of the Drainage Area, Impervious, and Land Cover plays an integral role.

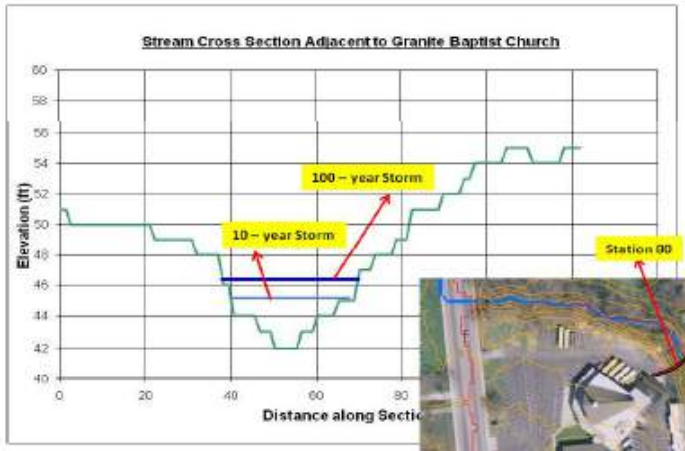
Modeling and Analysis

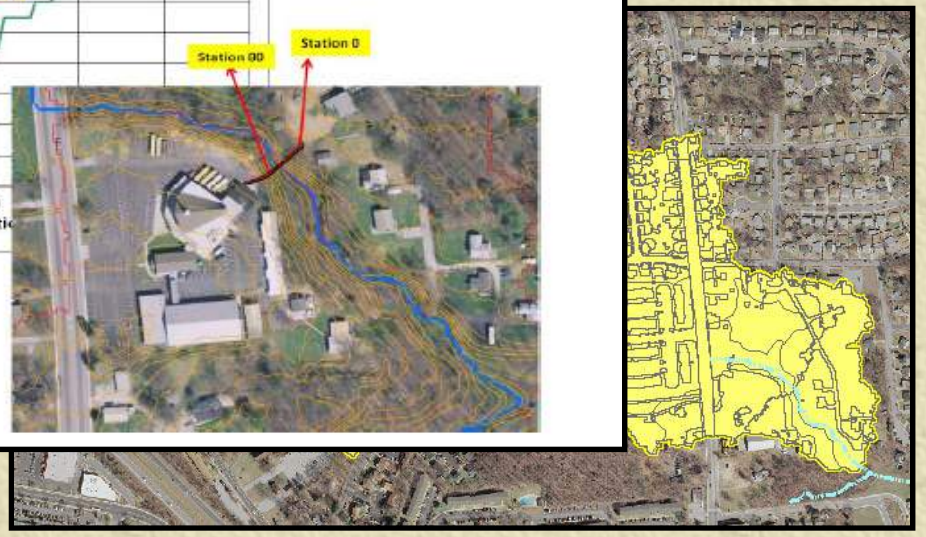




Point of Investigation	Area (Acres)				Existing Discharge (cfs) - TR20 model, no routing				
	Drainage Area	Total Impervious	Public Impervious	Private Impervious	1-yr	2-yr	10-yr	50-yr	100-yr
78 inch Culvert	152	60	17	43	88	129	275	381	455
Oakwood Rd twin 24 inch	88	34	9	25	45	67	144	200	240

HF - Sept 4, 2009, WMTcorrespondances/Patapsco/Granite





Watershed Protection and Restoration Special Revenue Fund and Program

http://www.aacounty.org/DPW/WPRF.cfm

Impervious Surfaces map layer used as the basis for determining amount of impervious on non-residential properties. Not just for internal DPW WERS use anymore… directly impacts citizens and business owners.

Its imperative that the County continue to accurately capture impervious surfaces in a timely manner. Yearly? "Real-time" using development plans, drawings, as-builts, etc...?

Residential properties pay based on zoning and an Equivalent Residential Unit (ERU) calc (2,800 sq ft is the mean amount of impervious on res props):

* High density R10, R15 R22 = $34 (apts and condos, 1 ERU * .4)
* Medium density R2, R5 = $85 (single fam homes, 1 ERU)
* Low density R1, RA, RLD = $170 (larger single fam homes, 1 ERU x 2)

Data Availability

Impervious and Land Cover are posted on the County's GIS Data Download web page:
http://www.aacounty.org/OIT/GIS/GISData.cfm

- Building Footprints - 2011
- BWI 4-mile District
- Councilmanic Districts - 2010
- Critical Area - 2008
- Critical Area Buffer Exemption Areas - 2008
- Digital Elevation Model (DEM) - 2011
- Fences - 2007
- Fire Stations - August 2011
- Glen Burnie Town Center
- Hydrants - October 2012
- Impervious Surface - 2011
- Land Cover - 2011
- Land Use (2009 General Development Plan) - 2009
- Odenton Growth Management Area
- Open Water - February 2009
- Parcels
- Parks - December 2011
- Parole Growth Management Area
- Paths - 2007
- Piers Poly - 2011
- Points of Interest - September 2011
- Priority Funding Areas - January 2013
- Rails - 2010
- Road Edges - 2007
- Road Edges (polygon) - 2007
- School Impact Fee Zones
- Sewer Mains - October 2012

Digital Eleveation Model 2011 Request Form

Please fill out the required information below:

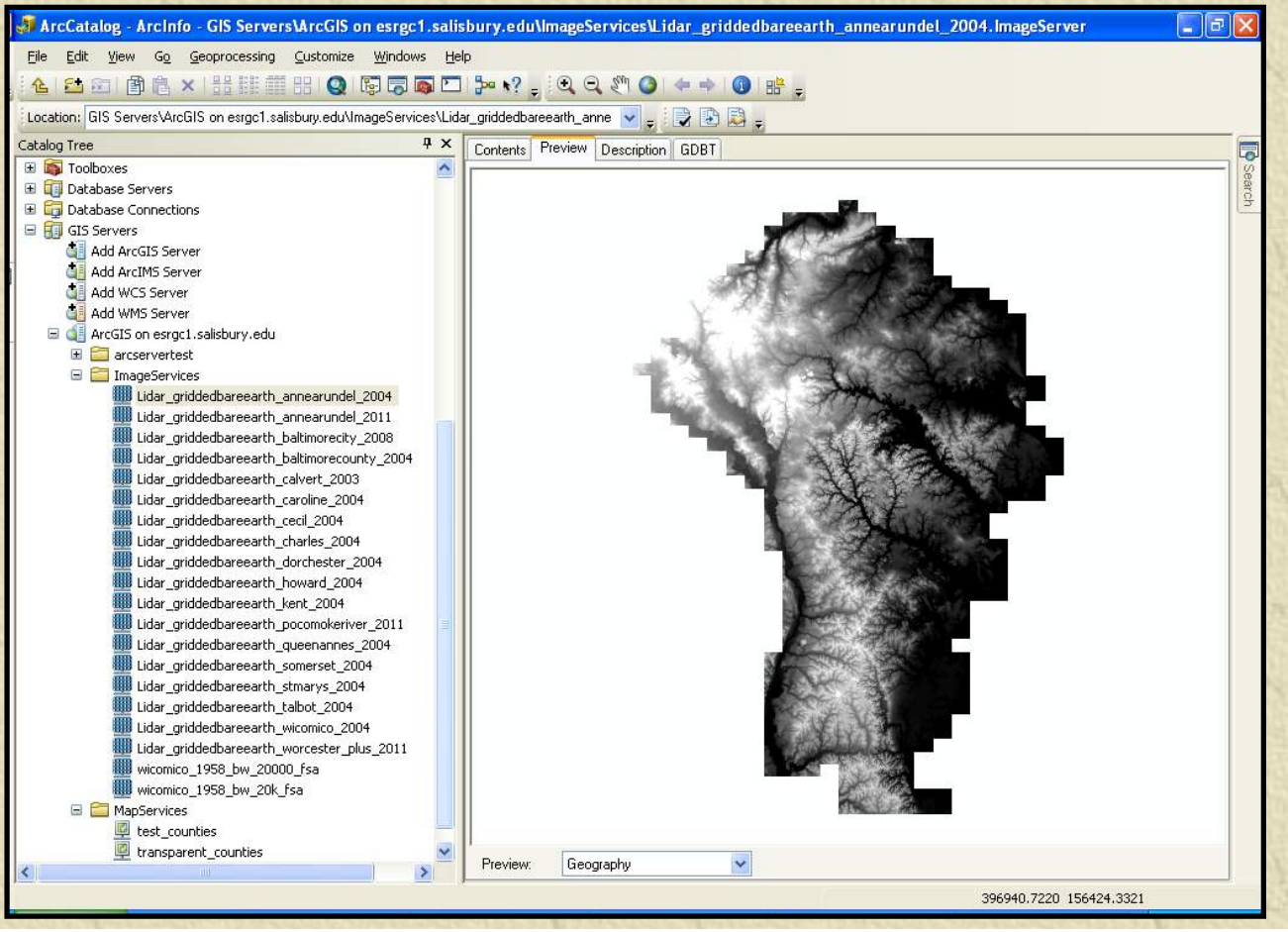
Full Name: *	
Street Address: *	
City: *	
Zip Code: *	
Email Address: *	
Phone Number: *	
Comment Box:	

Submit Form

DEM not posted due to large size (6.5 GB) but an associated request form can be submitted to DPW MGI front counter. LiDAR also not posted. Contact Rick Fisher to request access to this data (33 GB).

Data Availability

DEM is also posted as a service by the Eastern Shore Regional GIS Cooperative (ESRGC). http://www.esrgc.org/mapservices/



Questions?

THANKS!

DPW WERS

410-222-4240

http://www.aacounty.org/DPW/Watershed/