

ASFPM Annual Conference

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~~Knowledge~~ Data is Power

Innovative Applications of Data to Increase Your Watershed Management Intelligence

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ESP Associates, Inc.



Presentation Outline

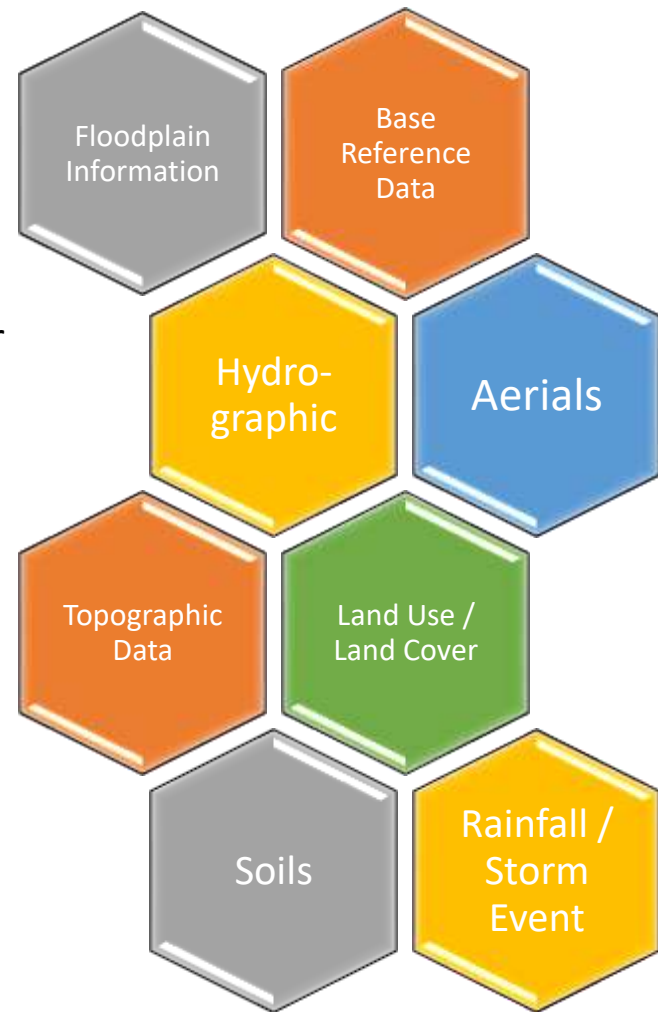
- The Coming of Watershed Data
- Data Resources
- Applications for Watershed Management
- Summary and Conclusions

The Coming of Watershed Data

- **Explosion in availability of data in last decade**
 - Technology has enabled efficient and cost-effective large-scale data collection (e.g. LiDAR)
 - Products have moved from cartographic product focus to digital delivery focus – can directly consume data
 - More communities/agencies are making data accessible on web – data clearing houses, web services, etc.
- **Better data compatibility with more software**
 - Open source software (e.g. QGIS)
 - Open data formats (shapefile, KMZ, NetCDF, geotiff, etc.)
 - Web applications (e.g. StreamStats)
- **Can overcome challenges even in less “data friendly” states**

Great Data Sources

- FEMA Map Service Center – NFHL, DFIRMs, FISs
- USGS National Map, Earth Explorer, NHD, NED
- National Land Cover Database
- Census TIGER / Fact Finder
- NOAA Hydrometeorological Design Studies Center
- Fish and Wildlife – Ipac
- State Historic Preservation Offices
- EPA
- Data.gov
- ESRI Base Maps / Layers
- Google / Bing
- Municipal/State Website
- Council of Governments (COGs)



Applications for Watershed Management

- Key Data for Watershed Management

- Elevation/Topography
- Land Use/Cover/Impervious
- Soils
- Environmental Interest
- Precipitation
- Streamflow

- Key Source Types

- LiDAR, NED, local
- Satellite/Aerial Imagery
- Property Records
- Reports/Studies
- Field/Gage Measurements



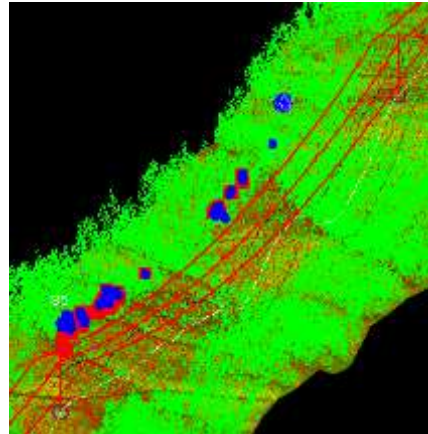
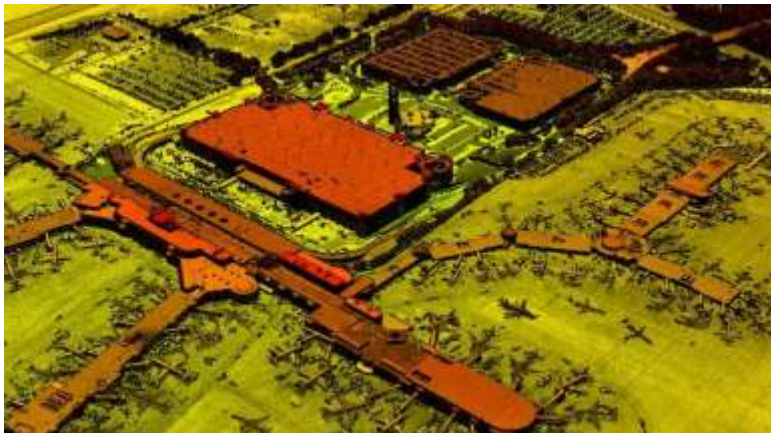
LiDAR is King

- X, Y, Z “dot map” of earth
- Each dot has inherent metadata:
 - Intensity
 - Return
 - Classification (assigned in post-processing)
- Opens up a world of possibilities for watershed management
 - Perform assessments/evaluations that not practical to do before
 - Provides potential significant cost savings on field collection for planning



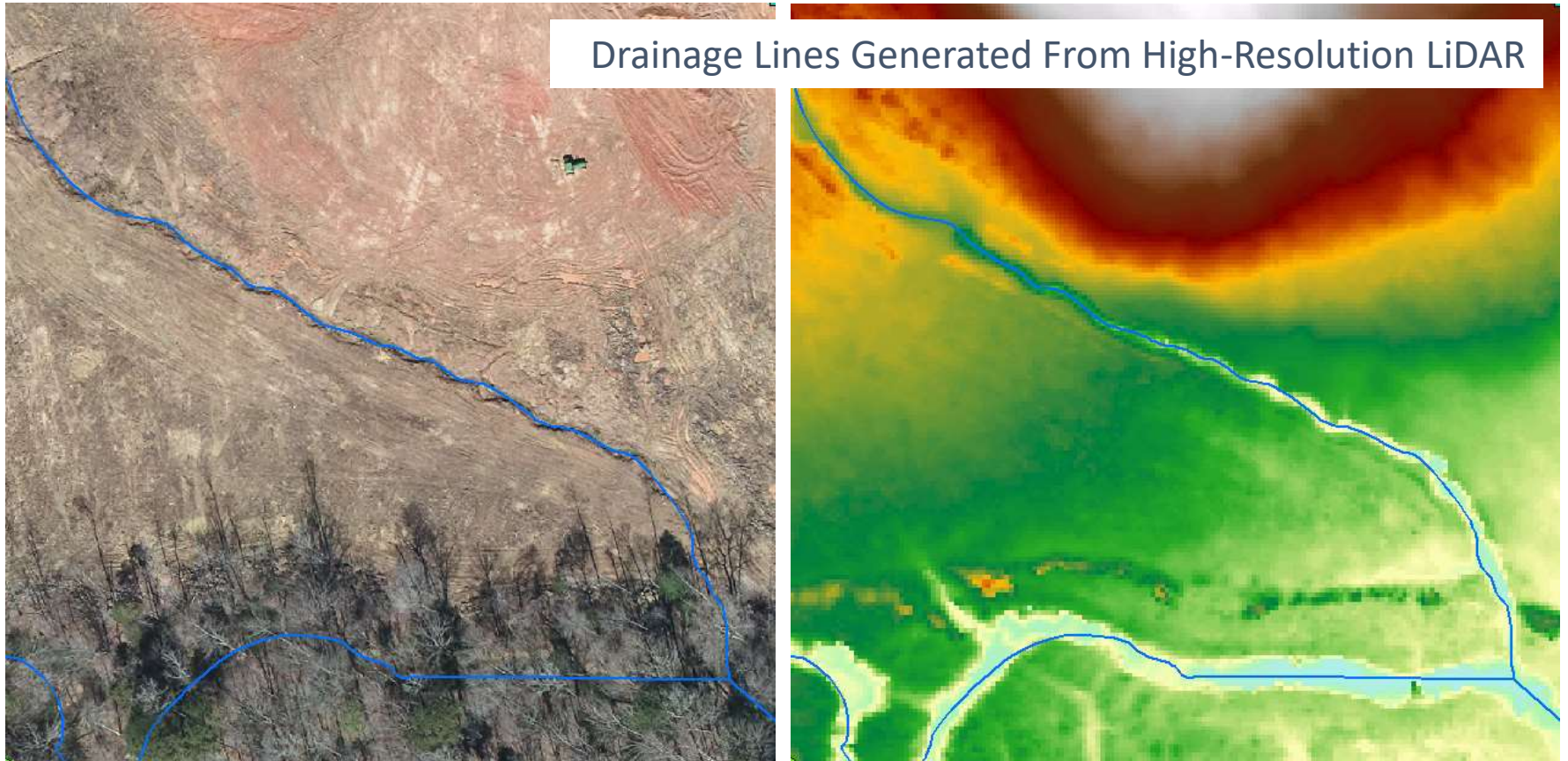
LiDAR

- “Bare Earth” extraction for general topography is most common application
 - LiDAR provides >> density of points versus traditional methods
 - Newer LiDAR often providing multiple points per meter
- Detailed elevation data gives many direct uses:
 - More detailed topographic mapping (e.g. stream channel)
 - Slope analysis
 - Feature elevation assignment/verification (buildings HAG/LAG, road/rail/bridge elevations, drainage structures, etc.)
 - Hillshade

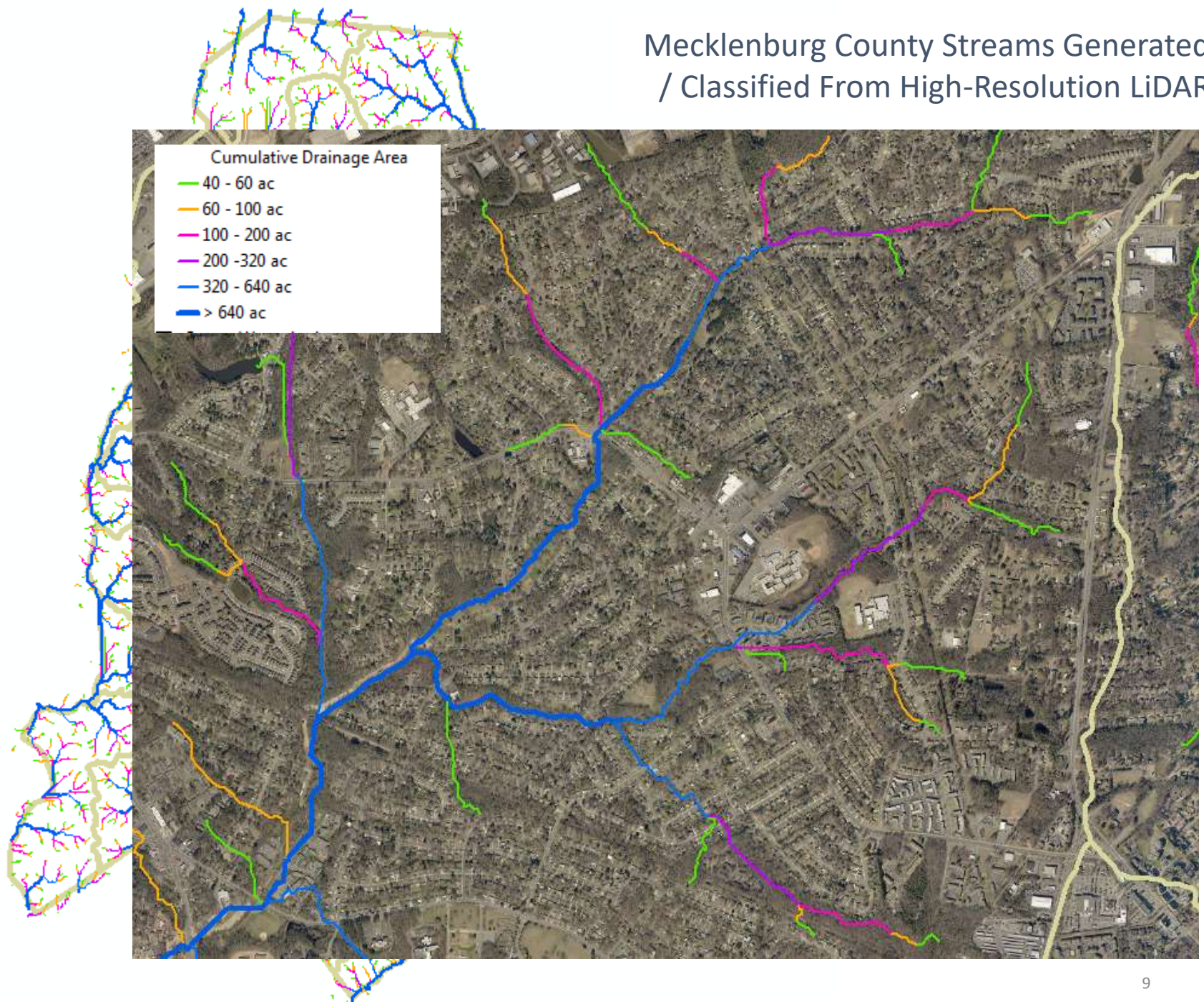


LiDAR

- In addition to direct uses, detailed elevation data can be used to generate powerful derivatives
 - Drainage system (stream, drainage area) delineation and connectivity

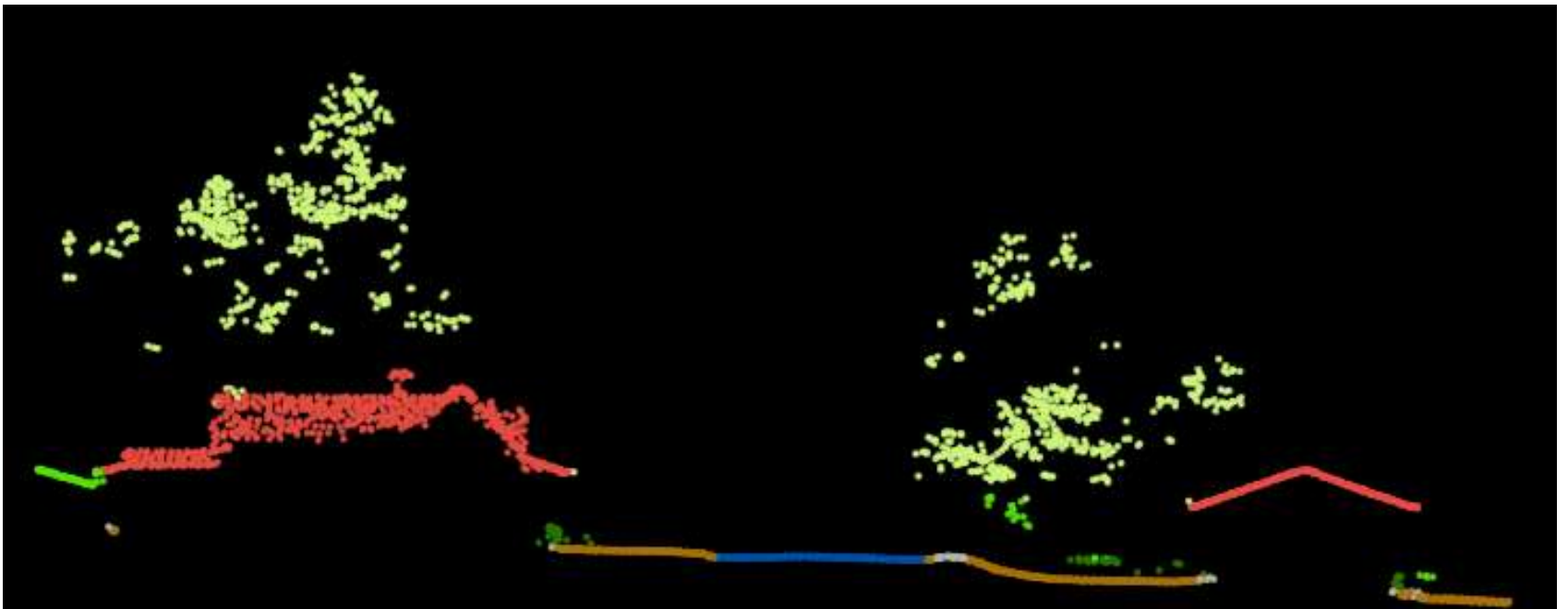
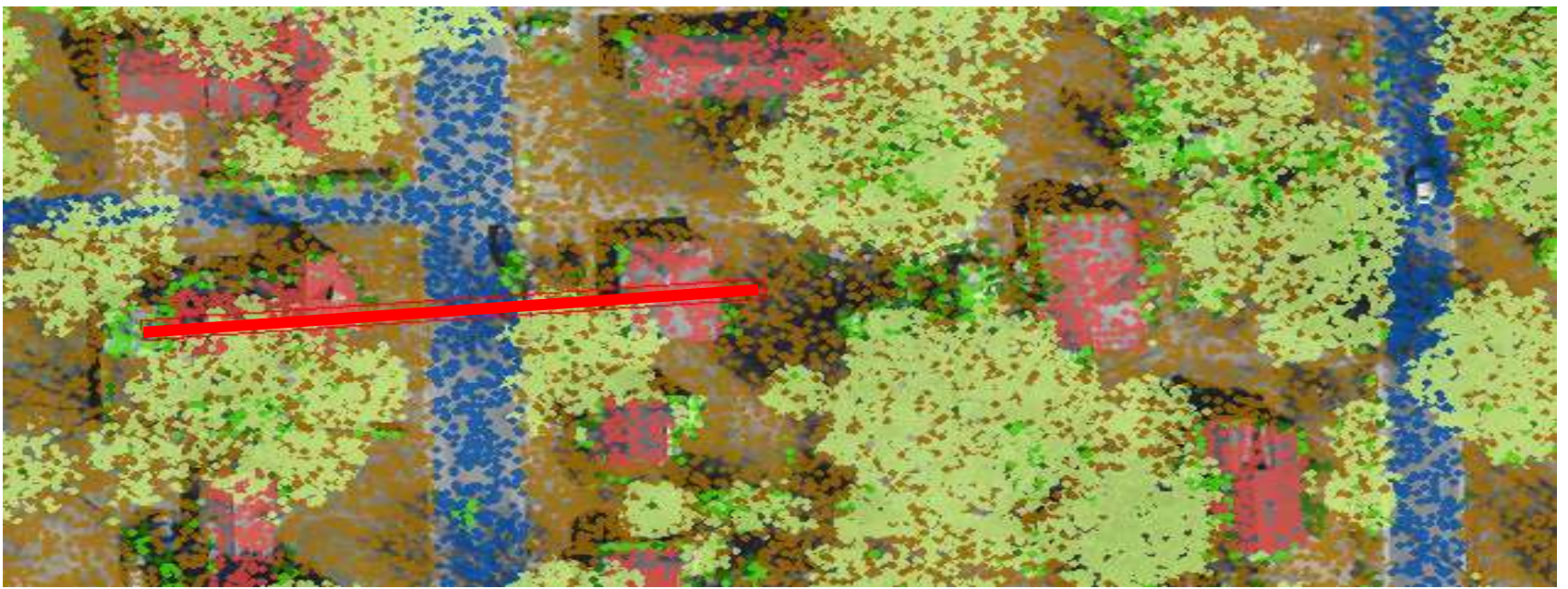


Mecklenburg County Streams Generated / Classified From High-Resolution LiDAR

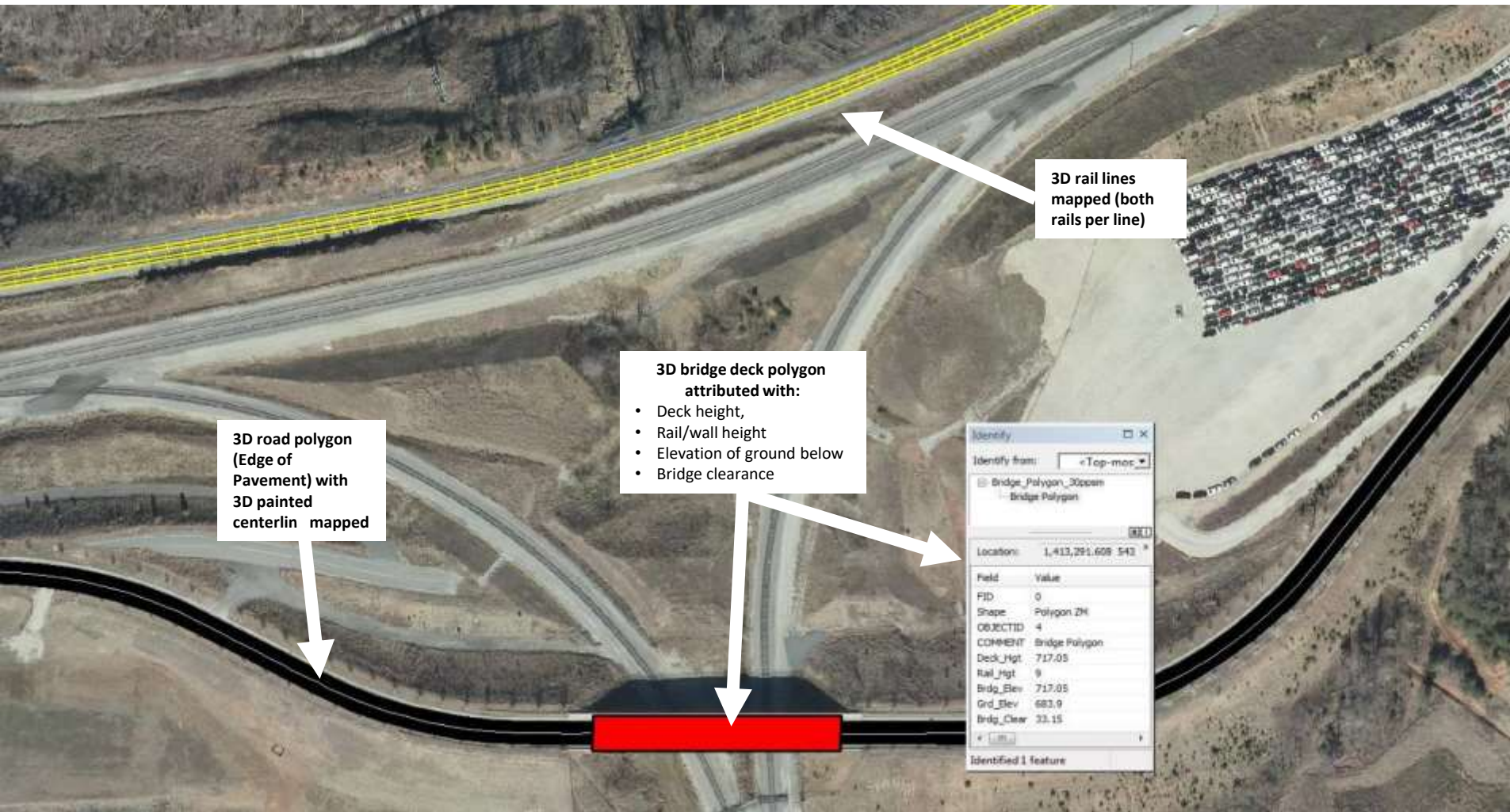


But LiDAR Provides Much More...

- Build algorithms that utilize LiDAR attributes (elevation, intensity, return)
 - ArcGIS has some algorithms (building extraction)
 - Commercial LiDAR processing software
 - Develop your own!
- Utilizing full point cloud can get more direct and derivative uses:
 - Feature classification/extraction/metrics (building heights, roof lines, etc.)
 - Change detection (buildings, land cover, etc.)
 - Vertical clearance (bridges, transmission corridors, etc.)
 - Line-of-Sight/Obstruction Analysis (runway approach, view field, etc.)
 - Many more...



Plan/Profile of Full LiDAR Point Cloud



3D Feature Extraction and Elevation Assignment for Transportation

United States Interagency Elevation Inventory

IDENTIFY BASEMAP SHARE

HIDE LAYERS HOW-TO HELP

ZOOM TO STATE/TERRITORY

ZOOM TO COUNTY/ISLAND

RELATED LINKS

DOWNLOAD MORE INFO FAQ CONTACT

DATA TYPE

DATA INVENTORY CURRENT AS OF MARCH 2018

- Topographic Lidar ☒
- Topobathy Shoreline Lidar ☒
- IfSAR Data ☒
- Bathymetric Lidar ☒
- NOAA Hydrographic Surveys ☒
- USACE Hydrographic Surveys ☒
- Trackline Bathymetry ☐
- Multibeam Bathymetry ☐

MAINTAINED BY

USGS USDA US Army Corps of Engineers FEMA

United States Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service

Viewer Metadata | Contact Us | Privacy Policy | Link Disclaimer | USA.gov

IDENTIFY BASEMAP SHARE

TOPOGRAPHIC 1 BATHYMETRIC 0 TOPOBATHY 0

DATA SET NAME	2014 Phoenix Urban Lidar
DATA ACCESS	AZ National Map Liaison (619-225-6430)
METADATA ACCESS	AZ National Map Liaison (619-225-6430)
COLLECTION DATE	9/30/14 - 10/5/2014
QUALITY LEVEL	2
MEETS 3DEP	No
REASON DATA DOES/DOES NOT MEET 3DEP	Missing USGS Base Spec products
PROJECT STATUS	Complete
RESTRICTIONS	Public

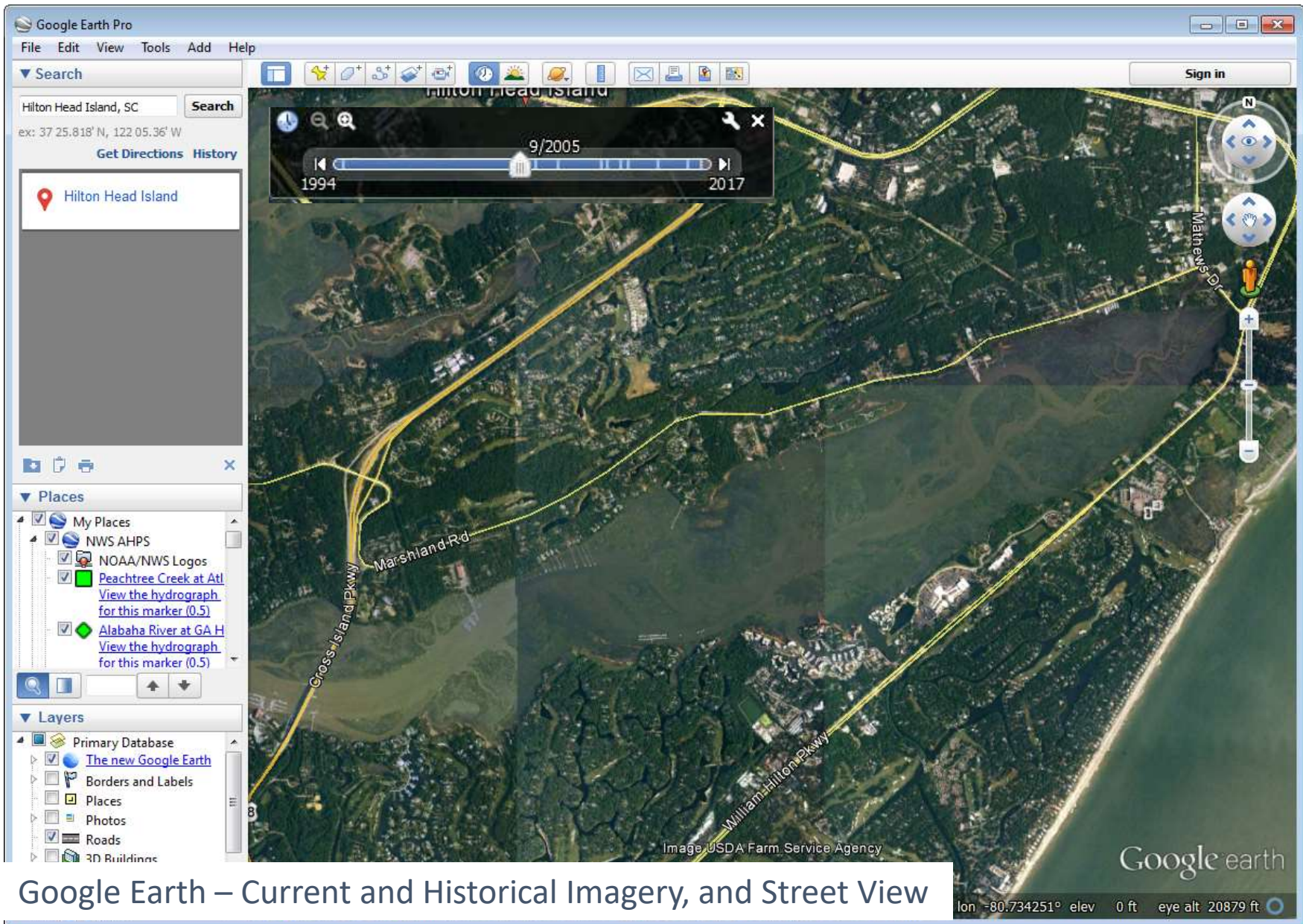


Land Use/Cover is Queen

- Plays integral role for most watershed consideration
 - Development/Impervious
 - Surface runoff
 - Pollutant loading
 - Land planning
 - Future conditions
 - Agriculture/Vegetation/Habitat
- Land use data come in variety of remote and land based sources
 - Aerials – Natural and Color-Infrared
 - Satellite – NLCD
 - Property Records – parcels



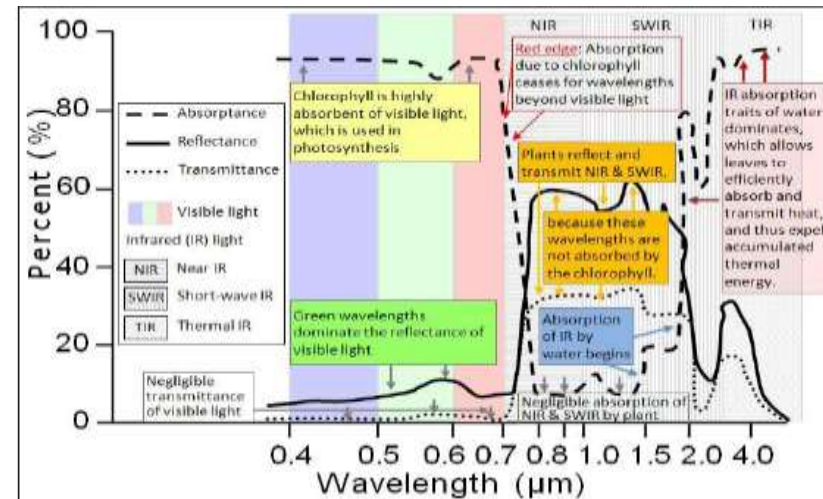
Traditional Aerial Imagery



Google Earth – Current and Historical Imagery, and Street View

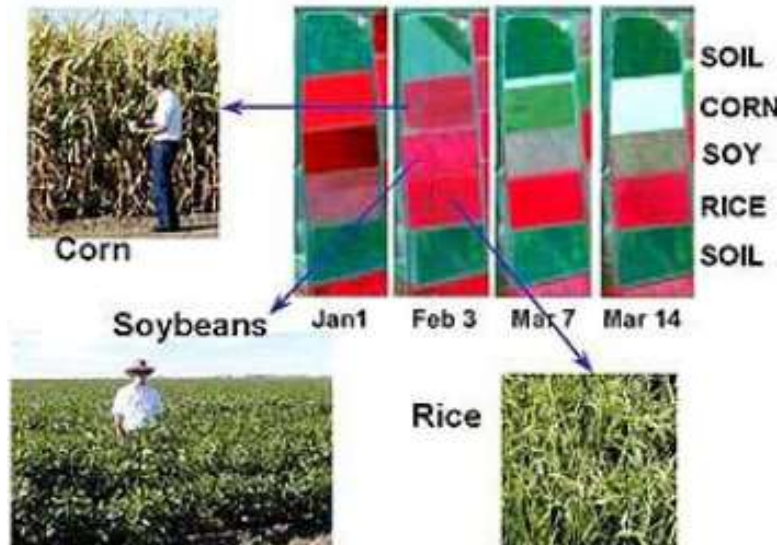
Color Infrared Imagery

- USDA collects color infrared imagery regularly during growing season (“leaf on”)
- Can be used to aid in :
 - Vegetation mapping – areas, types, health, tree canopy
 - Impervious surfaces
 - Soil mapping
 - Change detection



Time Sequence of Hyperion Images

Coleambally Irrigation Area: Farm 33



National Land Cover Database (NLCD)

- Nationwide raster of land cover features from multi-spectral satellite imagery
- 30-meter resolution, 16 classifications
- Updated every 5+ years
- Free to public
- Available products:
 - Land Cover
 - Land Cover Change
 - Percent Imperviousness
 - Percent Impervious Change
 - Tree Canopy, Shrubland



NLCD Land Cover Classification Legend	
11	Open Water
12	Perennial Ice/ Snow
21	Developed, Open Space
22	Developed, Low Intensity
23	Developed, Medium Intensity
24	Developed, High Intensity
31	Barren Land (Rock/Sand/Clay)
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Dwarf Scrub*
52	Shrub/Scrub
71	Grassland/Herbaceous
72	Sedge/Herbaceous*
73	Lichens*
74	Moss*
81	Pasture/Hay
82	Cultivated Crops
90	Woody Wetlands
95	Emergent Herbaceous Wetlands
* Alaska only	

The Rest of the Royal Court

- Storm Event Data (Existing and Forecast)
 - Precipitation – USGS Gages, NOAA/SERF radar, CoCoRaHS, etc.
 - Forecast Precipitation - NOAA
 - Stream flow – USGS/NOAA Gages, National Water Model
 - Coastal Heights – USGS/NOAA Gages, Coastal Emergency Risk Assessments (CERA)
- Environmental
 - Soils – NRCS Soil Survey
 - Endangered Species – US Fish and Wildlife IPaC Application
 - Past Activities – EPA, State Historical Perseveration Office, etc.
- Others
 - To many to list....

Coastal Emergency Risks Assessment

ADCIRC Coastal Circulation and Storm Surge Model + SWAN Wave Model

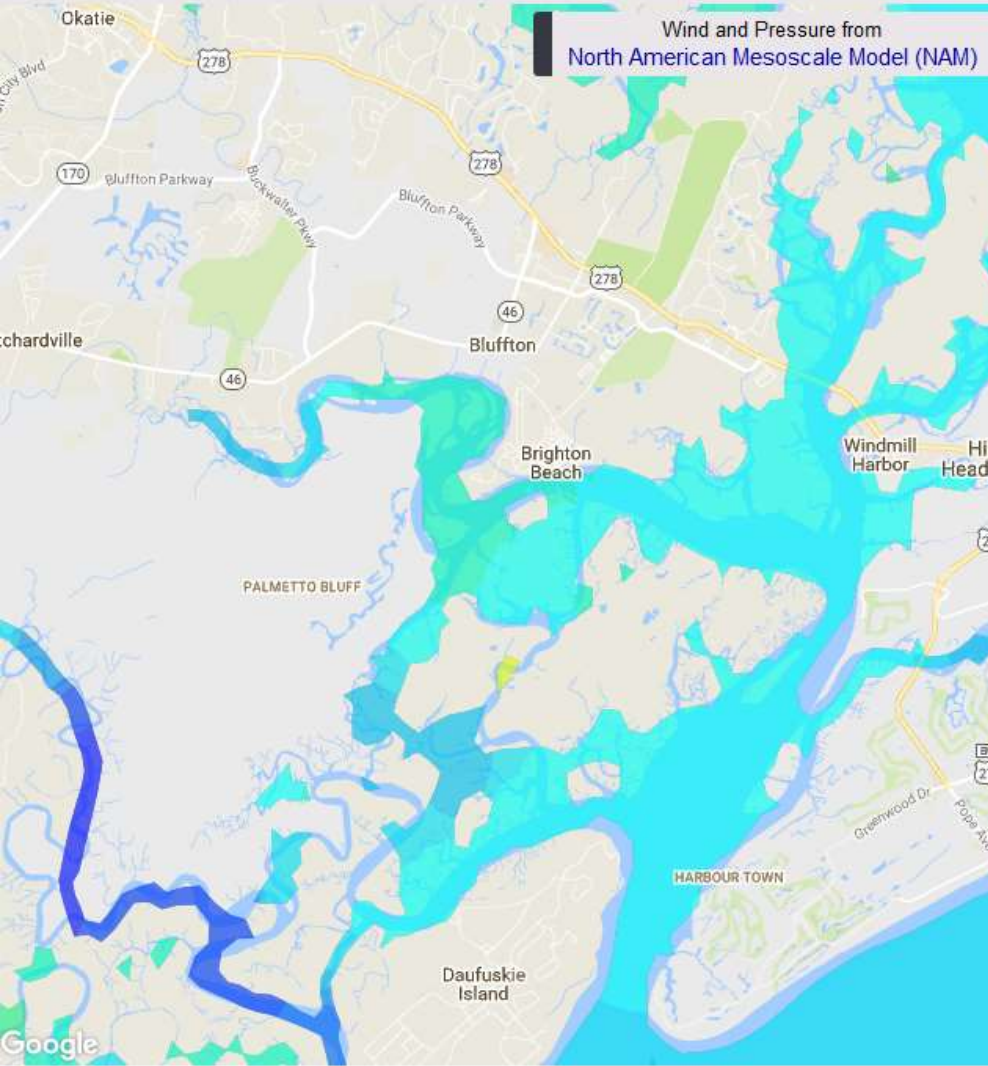
Storm Surge and Wave Guidance for the
Northern Gulf Coast

CERA Homepage

Select by Day Storm | Day 12-Mar-2018 | Model Start Time 4 AM CDT | Best For Atlantic/Gulf

Maximum Water Height
12-Mar-2018, 4 AM - 15-Mar-2018, 1 PM CDT

Wind and Pressure from
North American Mesoscale Model (NAM)



Map Tools

Zoom to a map region:
Gulf / Atlantic

Interact with map:
☐ Click on map for details.
☒ Drag map

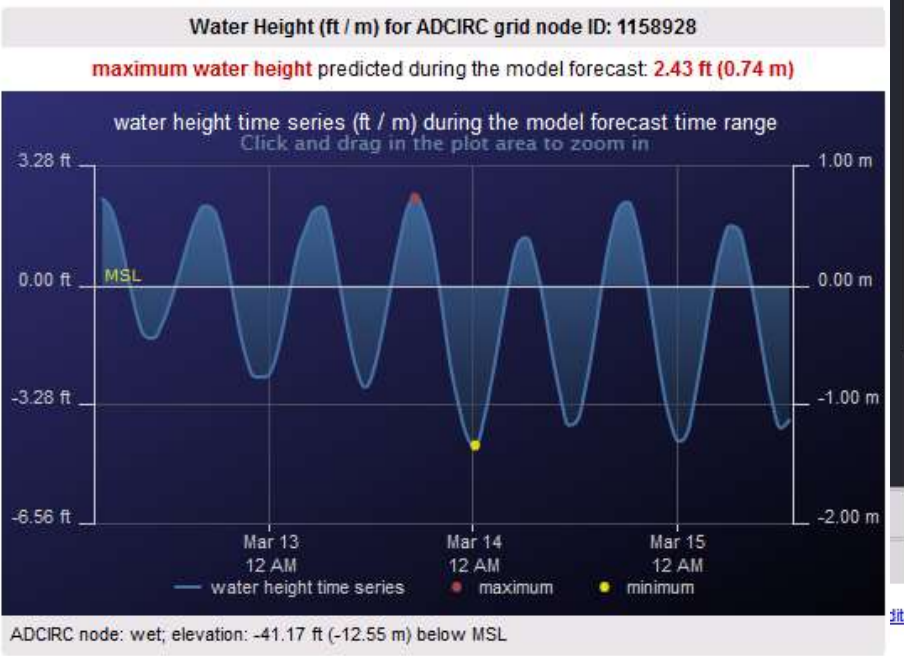
ADCIRC model boundary
Data are not available beyond this line.

Background Map

Water Height above MSL

- ☒ **Maximum Water Height**
The highest water level predicted during the model forecast.
- ☐ **Water Height Time Series**
The water level at a specific time during the model forecast.

Select a Date and Time:
12-Mar-2018 4 AM CDT





Basemaps ▾



Configuration Metadata

Hide

Variable

Time Series ⓘ

Streamflow

Analysis

Short Range

Medium Range

Long Range

Rebuild



JS chart by amCharts

Long Range Medium Range Short Range Analysis



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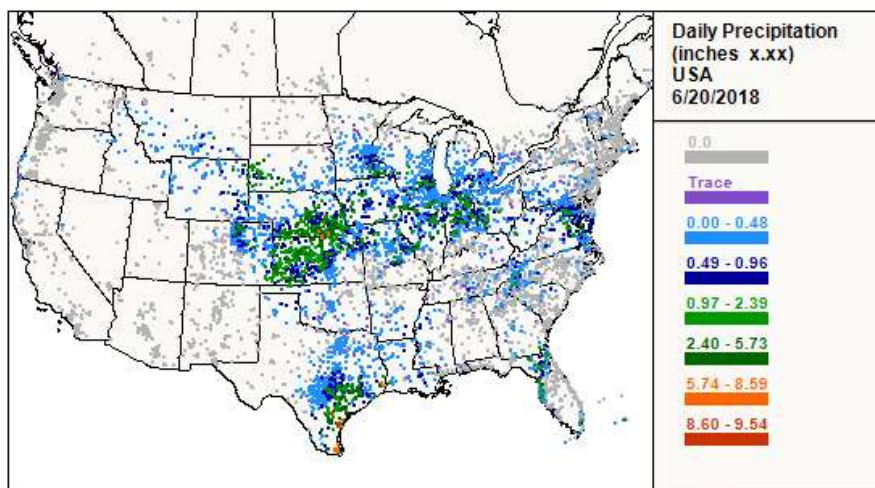
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Reports received today 6/20/2018 as of 12:23 PM EDT

<u>Daily</u>	<u>Multi-day</u>	<u>SigWx</u>	<u>Hail</u>	<u>Condition</u>	<u>ET</u>
9,443	95	1	1	12	117



Purchase an official
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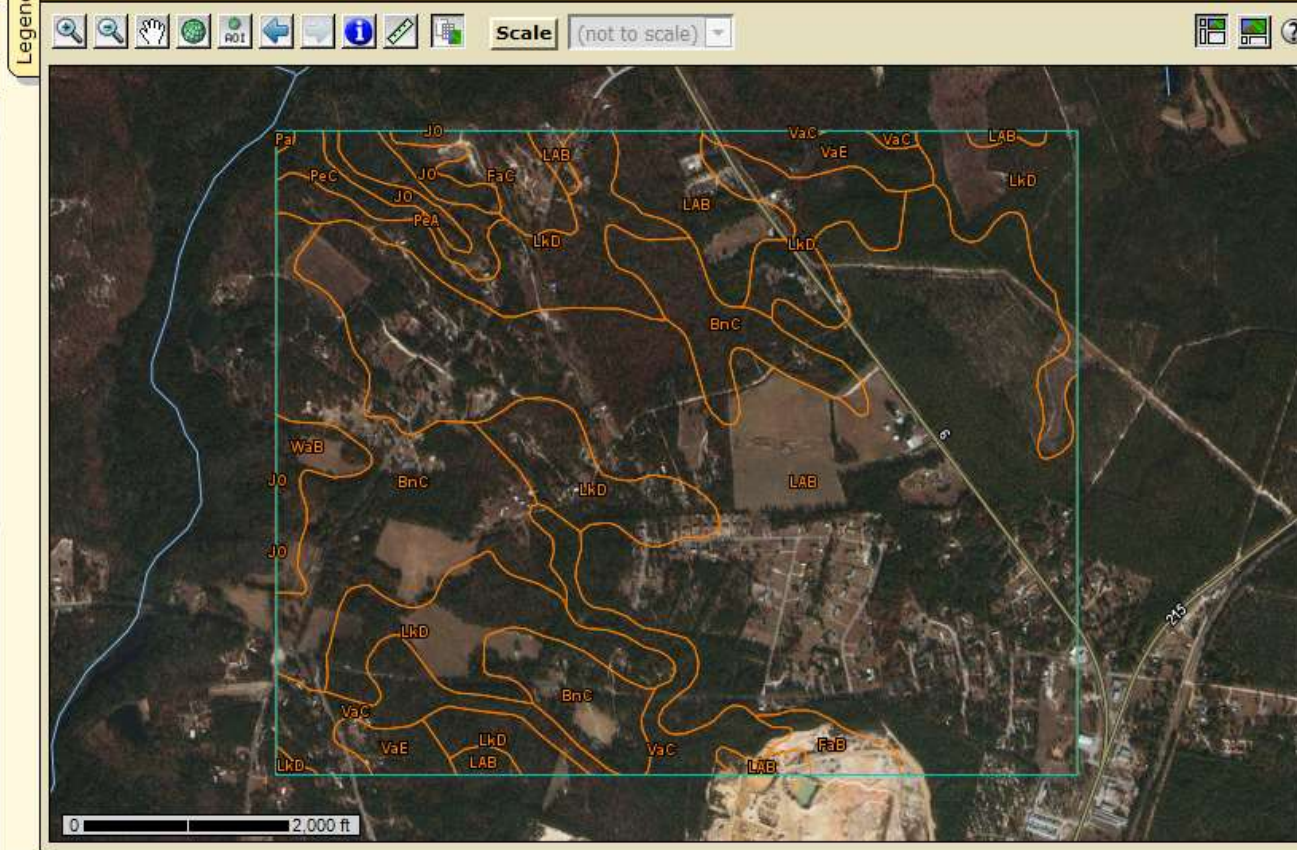
Map Unit Legend

Lexington County, South Carolina (SC063)

Lexington County, South Carolina (SC063)


Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BnC	Blaney sand, 2 to 10 percent slopes	174.7	15.5%
FaB	Fuquay loamy sand, 0 to 6 percent slopes	11.5	1.0%
FaC	Fuquay loamy sand, 6 to 10 percent slopes	19.5	1.7%
JO	Johnston soils	14.0	1.2%
LAB	Lakeland soils, undulating	552.7	49.2%
LkD	Lakeland	226.6	20.2%

Soil Map



Soil Data Available

To see a description of the soil data available for a specific point on the map:

1. Click anywhere in the map. The soil data availability for that point will be shown here.
2. The point you clicked is marked with the identified point icon: 
3. To see a map showing soil data availability for all locations in the U.S. and territories, click the **Soil Survey Status** link in the Navigation Bar above.

1 Find location

2 Define area

3 Confirm

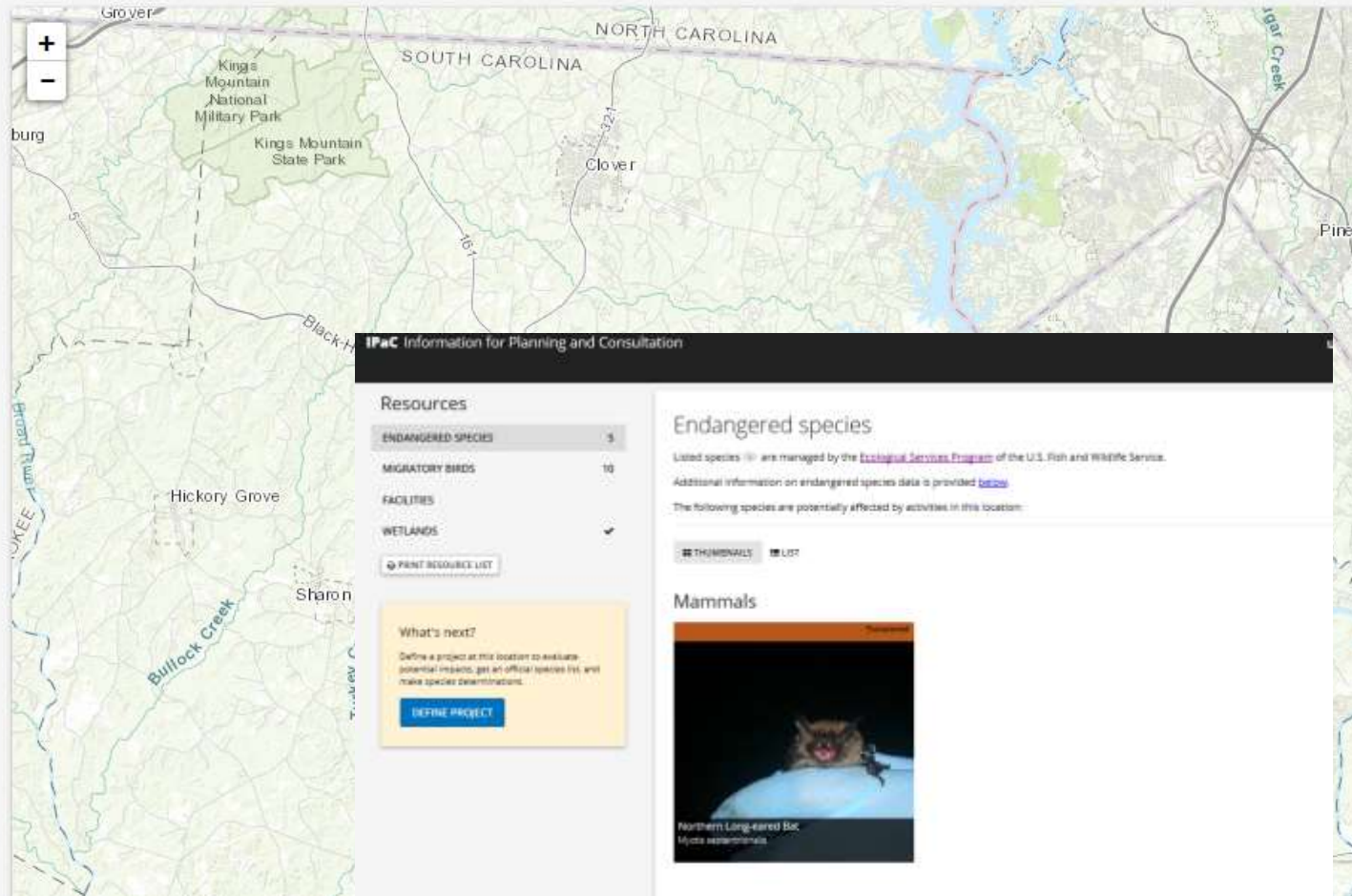
Verify the area where project activities will occur

Modify the shape by clicking and dragging the vertices or clicking on a solid vertex to remove it

AREA: 1.20 mi²

 CONTINUE

START OVER



IPaC Information for Planning and Consultation

Resources

- ENDANGERED SPECIES 3
- MIGRATORY BIRDS 10
- FACILITIES
- WETLANDS

[PRINT RESOURCE LIST](#)


What's next?
Define a project at this location to evaluate potential impacts, get an official species list, and make species determinations.

[DEFINE PROJECT](#)


Endangered species
Listed species are managed by the [Biological Services Program](#) of the U.S. Fish and Wildlife Service. Additional information on endangered species data is provided [below](#).
The following species are potentially affected by activities in this location:

[THUMBNAILS](#) [LIST](#)

Mammals

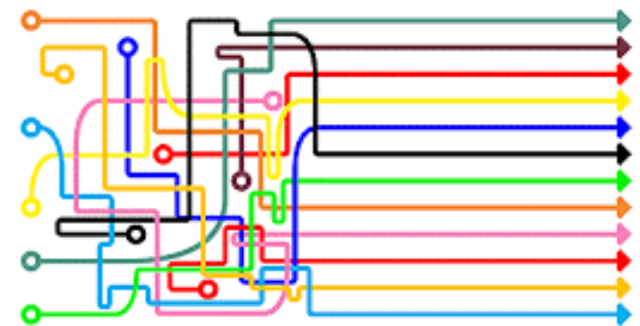

Northern Long-eared Bat
Myotis septentrionalis

Clams


Caroline Hebert's Luchessa clam
Luchessa carolineae

Working the Data

- In most cases lots of data that is already available to help improve watershed intelligence
- The trick(s) is:
 - Knowing where to get it
 - How to consume it
 - How to combine/leverage with other data see big picture
- Bring clarity from chaos - GIS/Data processing to the rescue

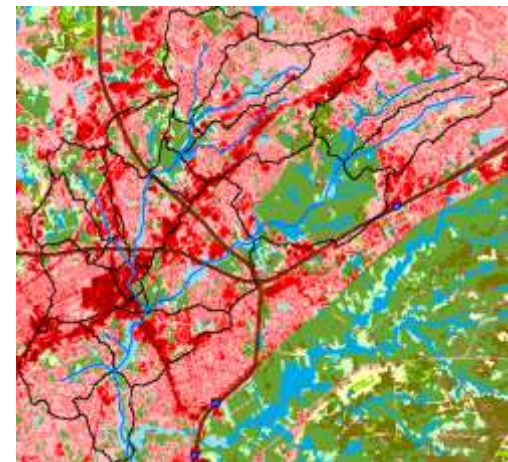
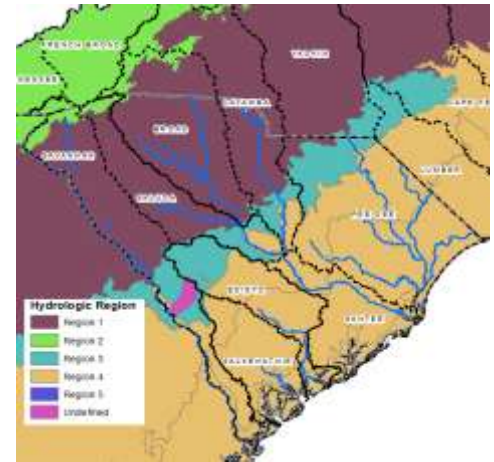


Working the Data

- Most data is available in downloadable format that can be manipulated/integrated to tease out key information
- Common geoprocessing techniques extract data:
 - Spatial overlays – discrete data metrics/summaries
 - General raster processing – continuous data processing
 - Hydrologic raster processing – cumulative and drainage area weighted calculations
 - Geometric network development – upstream/downstream tracing evaluations
- Combine integrated geospatial data with statistical/empirical engineering formulas or decision logic to get the “answer”

Example #1: Statewide Catchment Processing

- Developed 1+/- sq mi catchments statewide with incremental and cumulative drainage area, impervious, development, vegetation, and peak flow information
 - Point and click information for 32,000+ catchments
- Key datasets:
 - NLCD (multi-year land cover and impervious)
 - NHD Plus (catchments, connectivity)
 - USGS physiographic regions
- Added “smarts”:
 - Geoprocessing (multiple steps/processing)
 - USGS rural/urban regression equations
- Developed support CNMS validation, but have used to support variety of initiatives since



SC NHD Plus Catchments

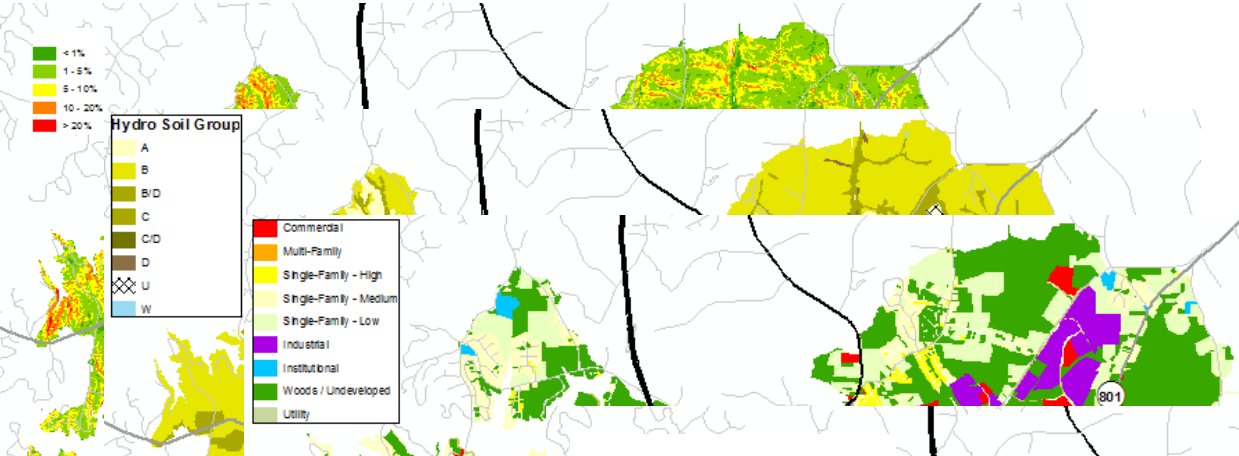
CatchmntswRegFlows
34452

Location: 1,964,911.492 779,270.714 Feet

Field	Value
AreaSqmi	0.9
CumDAsqmi	4.7
PctReg1	0
PctReg2	0
PctReg3	100
PctReg4	0
Q002Yr	83
Q005Yr	141
Q010Yr	185
Q025Yr	242
Q050Yr	284
Q100YrMns	189
Q100Yr	326
Q100YrPlus	462
Q200Yr	374
Q500Yr	429
Urbn1992Ac	419.76
Urbn2001Ac	474.54
Urbn2006Ac	474.98
Urbn2011Ac	493.24
TotAreaAc	595.57
PctUrbn1992	70
PctUrbn2001	80
PctUrbn2006	80
PctUrbn2011	83
PctImp2011	28
PctUrbChg92_11	18
PctUrbChg01_11	4
PctUrbChg06_11	4
CumPctImpv	22
I24H50Y	<null>
UrbnQ002Yr	155
UrbnQ005Yr	245
UrbnQ010Yr	314
UrbnQ025Yr	411
UrbnQ050Yr	488
UQ100YrMns	211
UrbnQ100Yr	577

Example #2: Town Master Planning

- Heavily leveraged available data sets to support watershed master planning and inventory mapping
- Key datasets:
 - High-Resolution LiDAR (QL2 and Geiger (8ppm))
 - Local data (Tax parcels, drainage inventory, built environment)
 - Soils
 - FEMA modeling and mapping
- Added “smarts”:
 - Geoprocessing (multiple steps/processing)
 - Design sufficiency analysis and engineering calculations
 - Ranking logic
- Developed comprehensive database of layers used to support evaluation of 7 elements, problem area identification, and development of CIPs

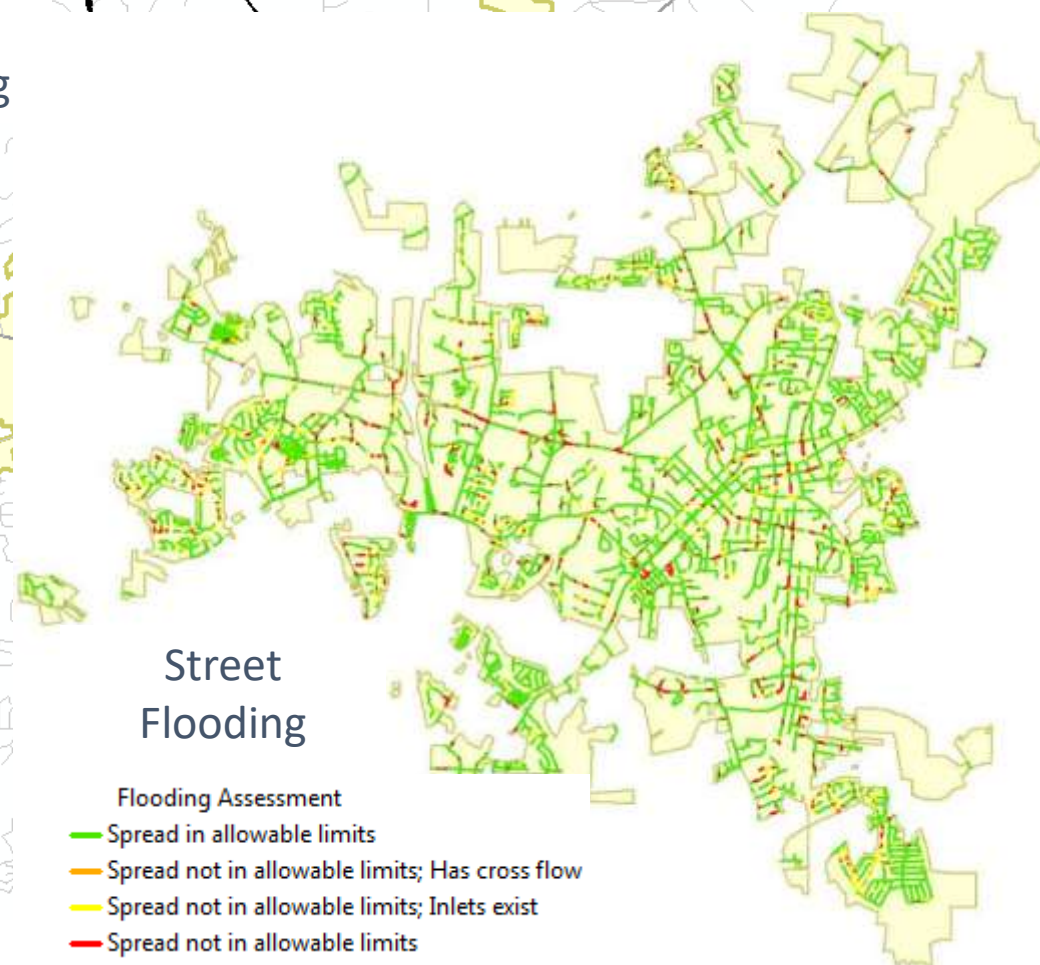


Road
Overtopping

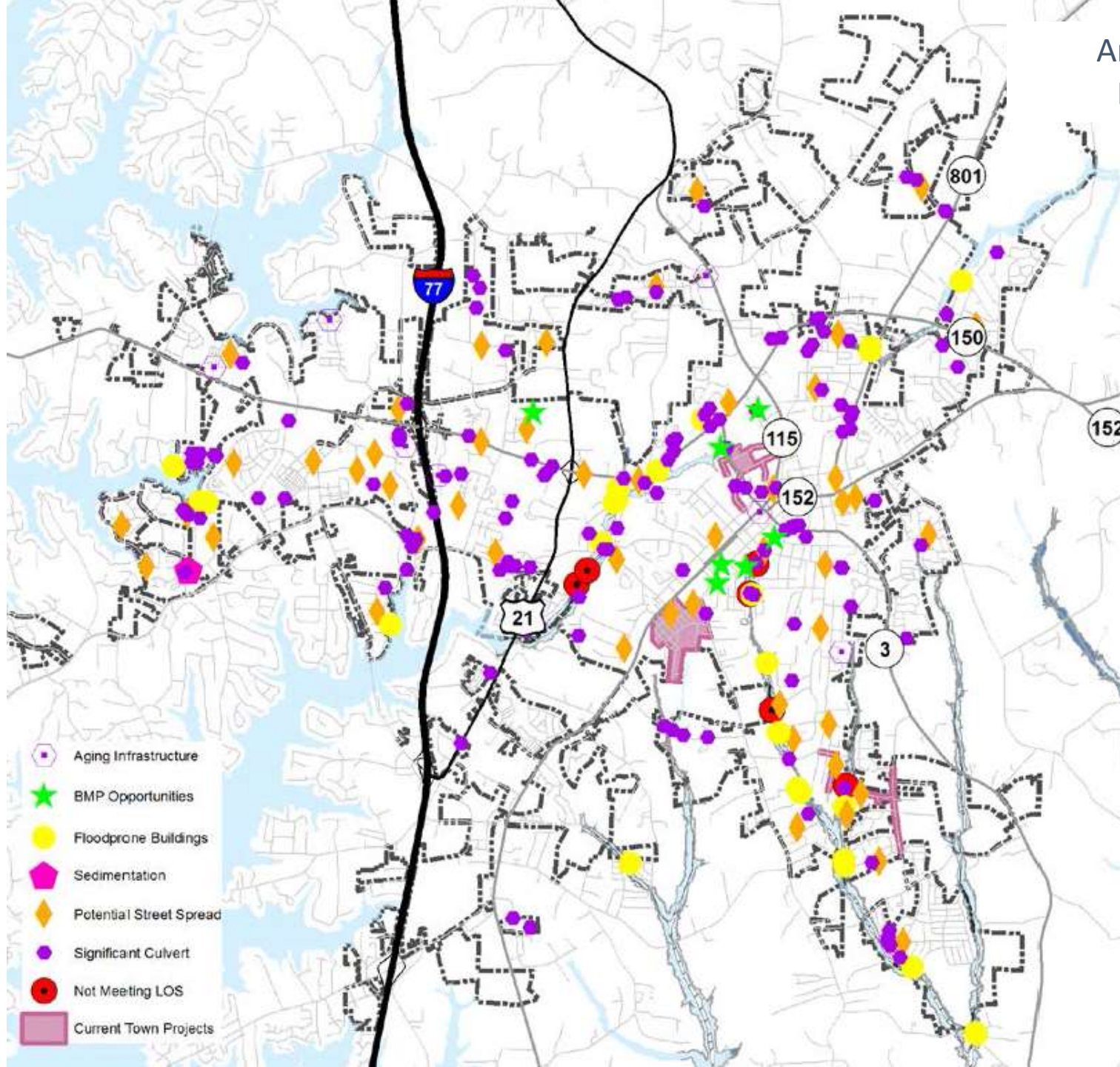
Soils

Land Use

- Meets Level of Service?
- No
 - Yes
 - Undetermined
- 100-yr Flood Depth
- No Flooding
 - < 6"
 - 6" - 24"
 - > 24"



Area of Interest for Drainage Analysis

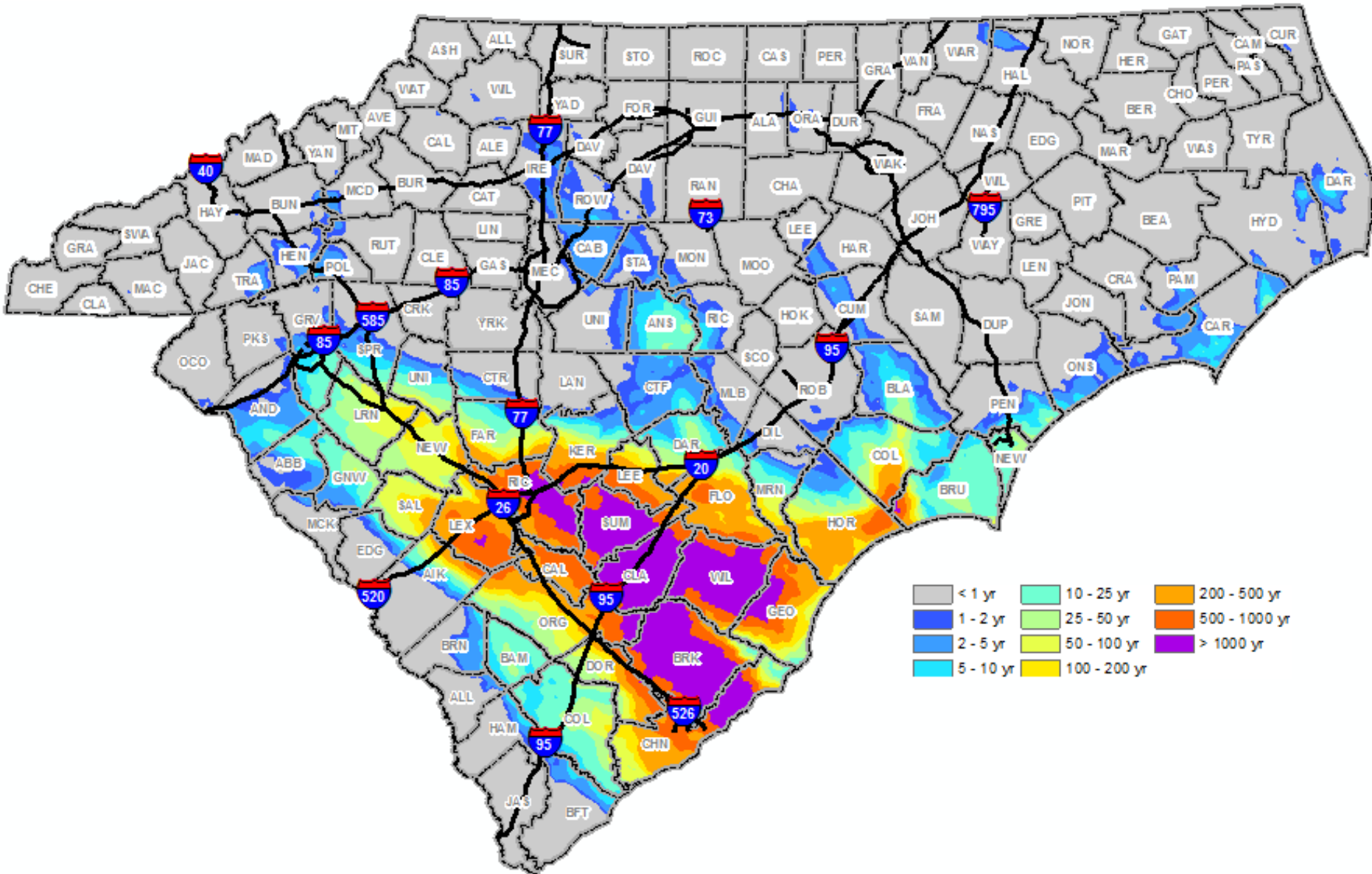


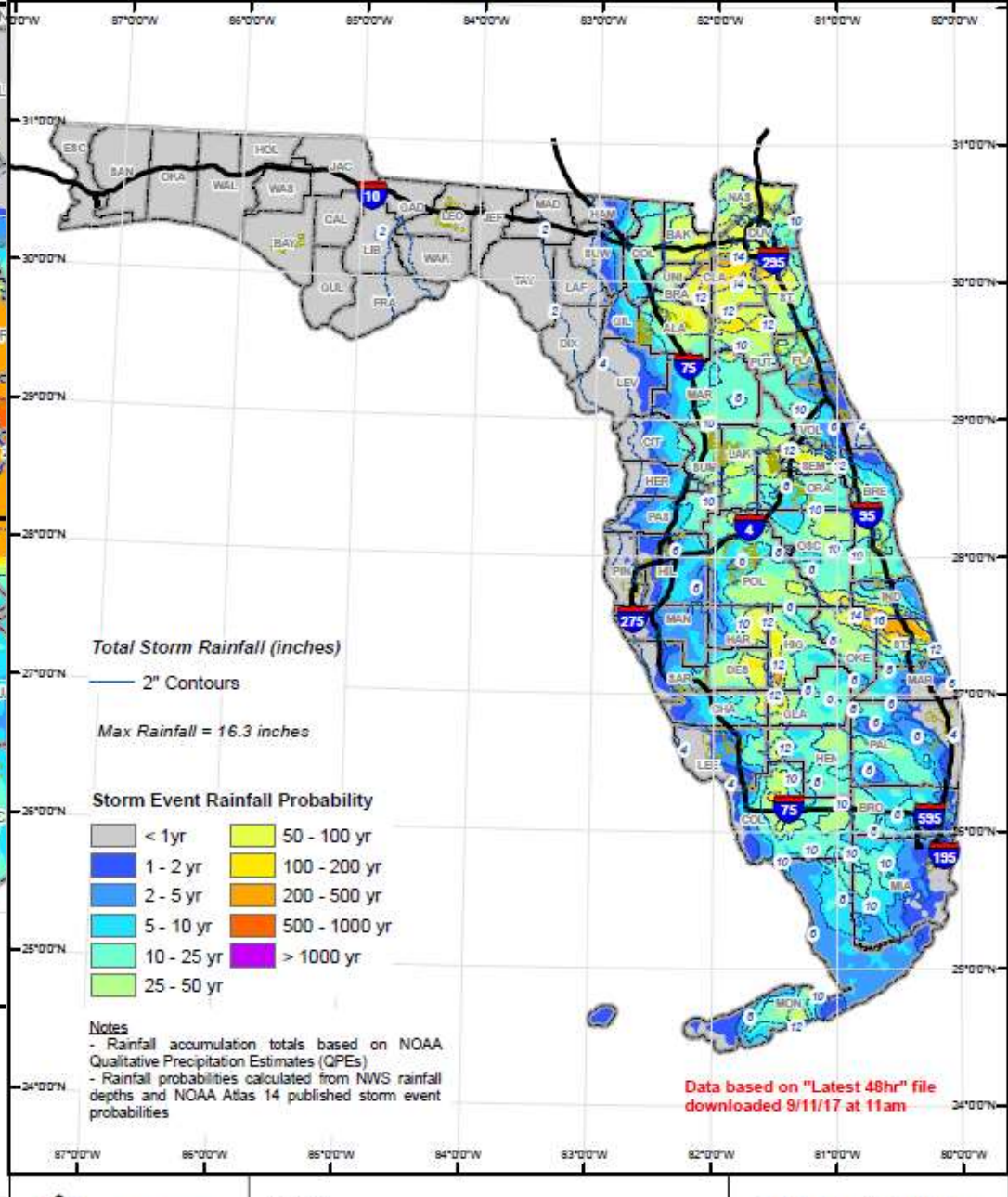
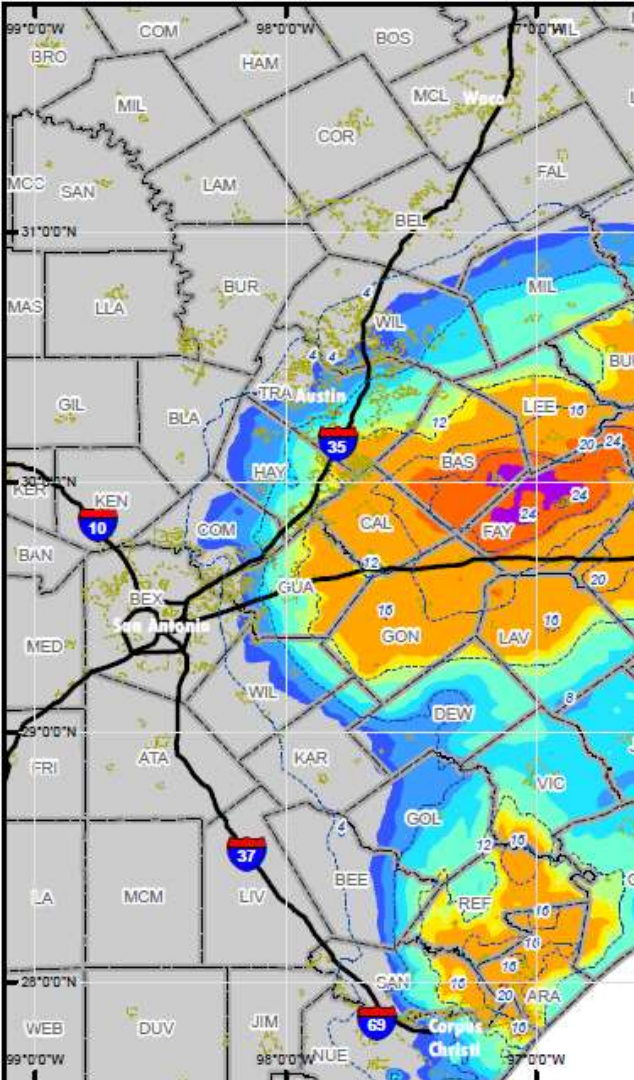
Example #3: Real-Time Flood Warning

- Leverage “real-time” forecast and observed precipitation and stream gages to support real-time flood warning and impact assessments
- Key datasets:
 - NOAA QPF and QPE (hourly/daily) and Atlas 14 estimates
 - USGS/NCER stream gages
 - Built environment
 - LiDAR
 - FEMA non-regulatory products
 - HUC-12 Basins
- Added “smarts”:
 - Geoprocessing preprocessing
 - Calculation/Interpolation logic
 - A bunch of technology
- Two separate (for now) outputs
 - Precipitation ARI mapping
 - NC FIMAN



October 2015 3-Day Precipitation Event Recurrence Interval





Harvey (TX) and Irma
Precipitation Mapping

48-hr Rainfall Map
Hurricane Irma
September 9 - 10, 2017

PROVISIONAL - Map is based on provisional data and should be considered draft for reference only.



Tar River at Greenville Buildings in Inundation Extent

Scenario Stage: 25.6 Ft

Damages Buildings

Building ID	Residential		Commercial		Public	
	Impacted	Est. Damages	Impacted	Est. Damages	Impacted	Est. Damages
104		\$2,063,000	18	\$45,000	0	\$0
107		\$1,475,000	25	\$2,946,000	0	\$0
108		\$339,000	10	\$291,000	0	\$0
5		\$152,000	13	\$1,036,000	1	\$27,000
16		\$305,000	21	\$1,387,000	0	\$0
1		\$386,000	2	\$52,000	0	\$0
2		\$160,000	2	\$72,000	2	\$32,000
112		\$5,499,000	90	\$5,130,000	3	\$60,000



FIMAN Current Flood Impacts Report



Minor Flooding
Trend: Constant

Tar River at Greenville

Site ID: 02084000

Last Updated:
2/10/16 2:45 PM

16.2 ft
12.7 ft (NAVD 88)

Current Stage / Elevation

13100 cfs

Current Flow

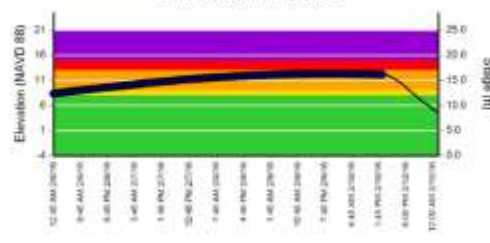
1 Buildings
\$3,000

Impacted Structures / Damages

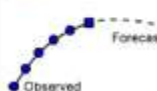
12.7 ft
2/11/16 12:00 AM
1 Buildings
Est. Damages: \$3,000

Forecasted Peak / Impacts

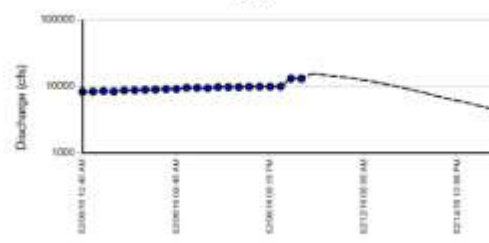
ELEVATION / STAGE



LEGEND



FLOW



Estimated Damages based on Current Flood Elevation of 13 ft (NAVD 88).

Estimated Building Damages

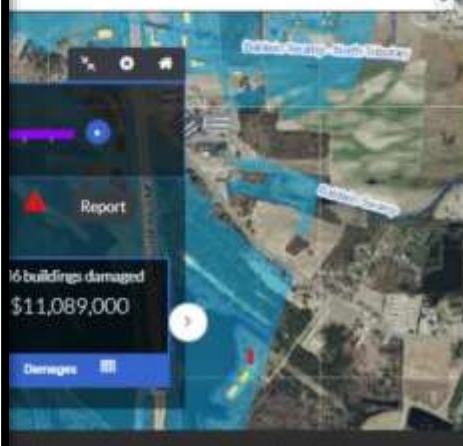
DEPTH	Total		Residential		Public		Commercial	
	Damages	Total Count	Damages	Count	Damages	Count	Damages	Count
Sub Structure	\$3,000	1	\$3,000	1	\$0	0	\$0	0
0 - 1 ft	\$0	0	\$0	0	\$0	0	\$0	0
1 - 2 ft	\$0	0	\$0	0	\$0	0	\$0	0
2 - 3 ft	\$0	0	\$0	0	\$0	0	\$0	0
3 - 4 ft	\$0	0	\$0	0	\$0	0	\$0	0
4 - 5 ft	\$0	0	\$0	0	\$0	0	\$0	0
> 5 ft	\$0	0	\$0	0	\$0	0	\$0	0
TOTAL	\$3,000	1	\$3,000	1	\$0	0	\$0	0

Impact Summary

Road Impact: None reported at this time
Building Impact: 1 buildings impacted \$3,000 estimated damages.
Utilities Impact: None reported at this time
Other Impact: Some farmland flooded. Water overflow lowlands adjacent to river.

Note: Additional buildings may be impacted outside of flood inundation extent. Damages do not include content and inventory.

located outside of the inundation extent.
Buildings inside the FIMAN inundation extent where structural damages may be shown (color coded) in the map indicating extent that may not sustain structural damages due to elevated water conditions.



Summary and Conclusions

- There is a tremendous amount of data and valuable information available to support wide range of watershed management applications
- Individually data/information is helpful, but together very powerful tools for planning and real-time watershed intelligence
- As always, use caution with data from outside sources
 - Understand scope, scale, and limitations of data
 - Data is not always going to be perfectly clean