



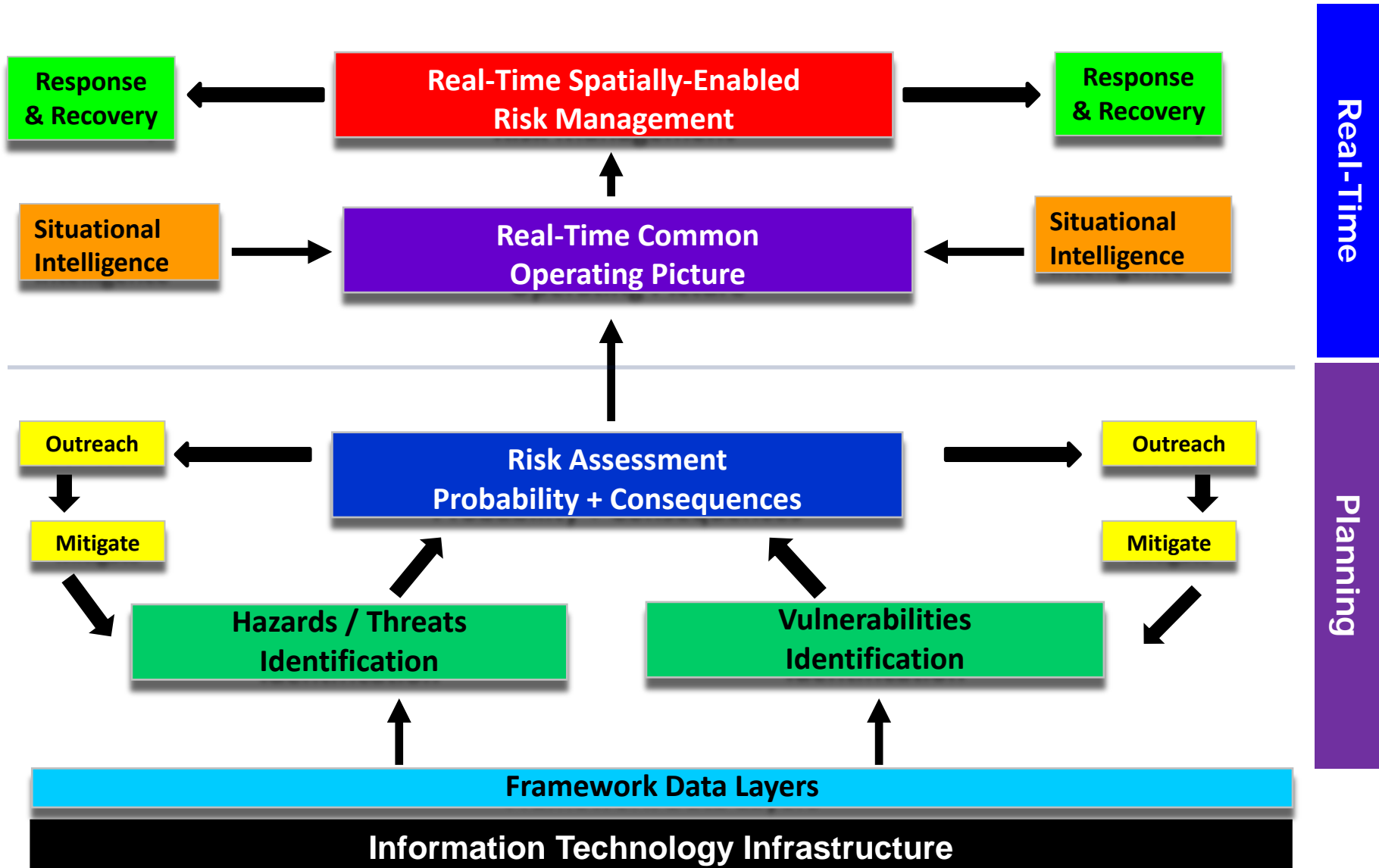
THE PURSUIT OF RISK

Products, Progress, Partners

ECU / NCEM Hurricane Workshop
May 22, 2013

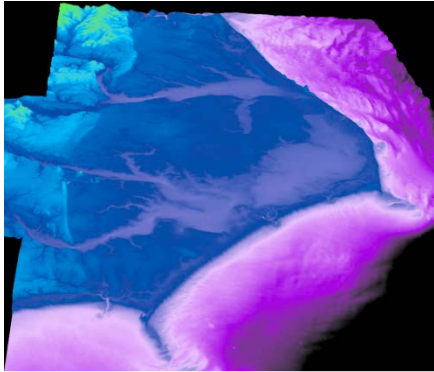
NC Risk Management Framework

prevent, prepare, protect, respond, recover

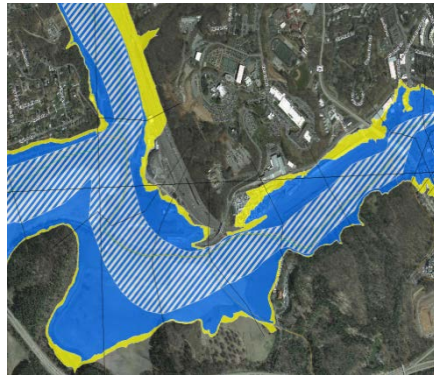


Hazard Risk Management – Progressive Steps

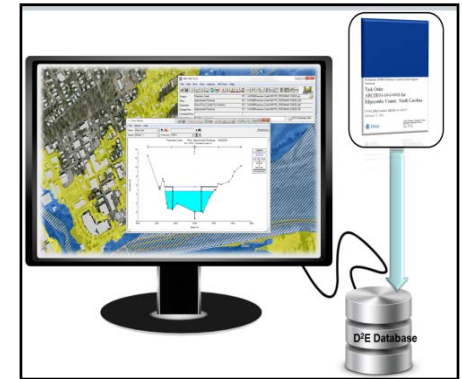
Framework Data Acquisition



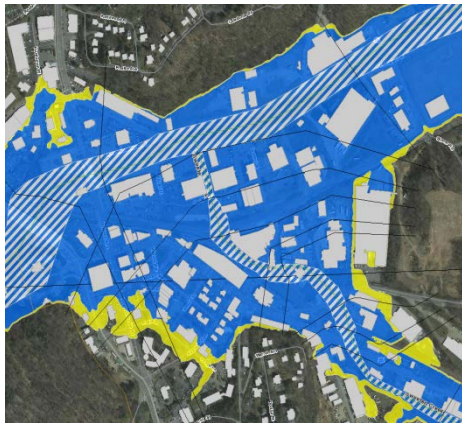
Hazard Mapping



Digital Display



Exposure Acquisition



Risk Assessment



IHRM



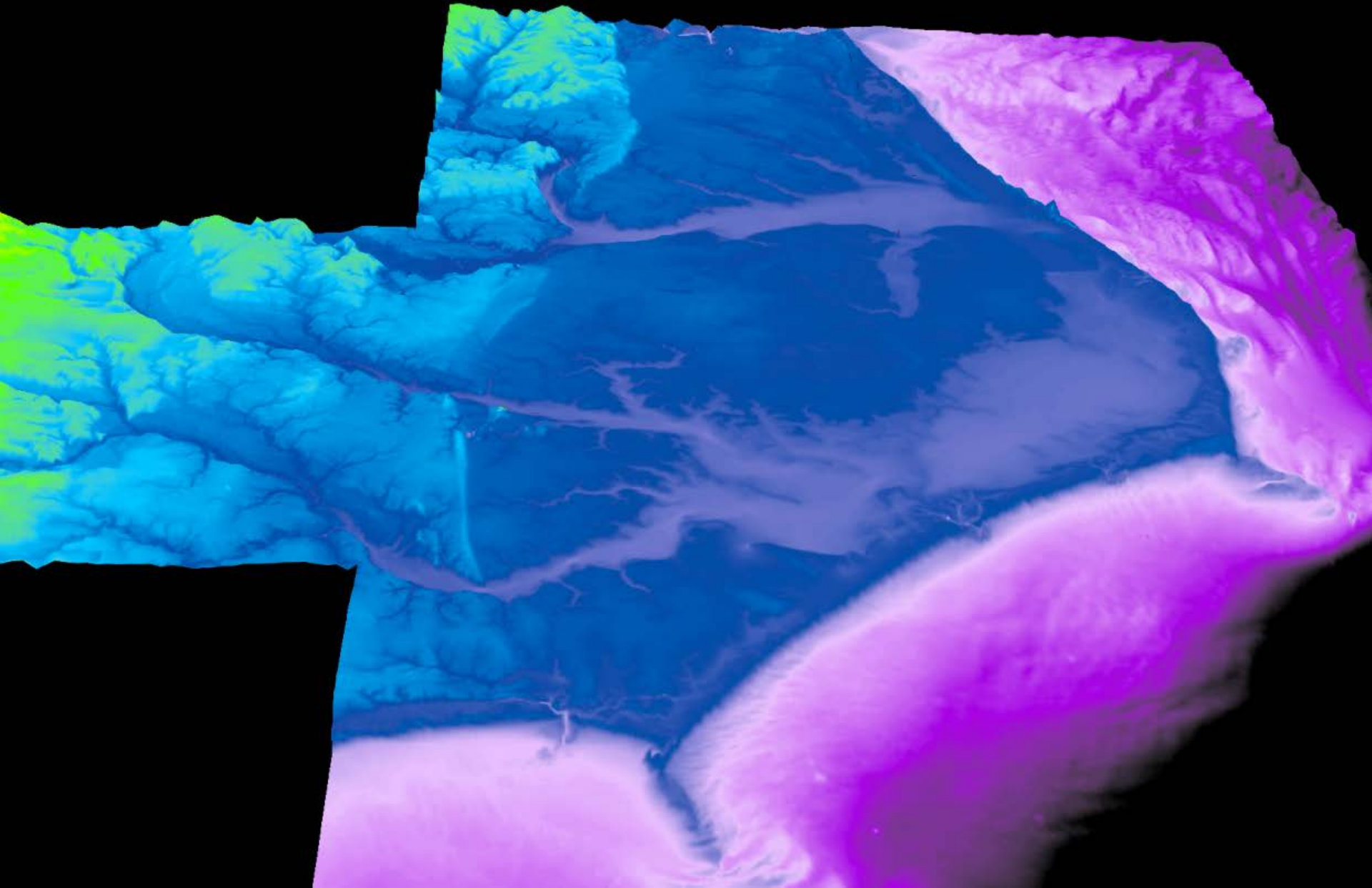
An aerial photograph of a campus or institutional site. The central feature is a roundabout with a circular island in the middle. Several large, dark-roofed buildings are clustered around the roundabout. To the right, there is a large, paved parking lot filled with cars. In the bottom left, a green football field is visible with the name 'CAMPBELL' and the number '50' on it. The surrounding area includes more buildings, parking lots, and some wooded areas on the left side.

Aerial Base Mapping

Partners:

- NC 911 Commission
- NC Department of Transportation

Digital Topo-bathymetric Model



ACQUISITION / GENERATION - Statewide Building Footprints



ACQUISITION / GENERATION – Finish Floor Elevations



100YR Flood Elevation = 13 ft.

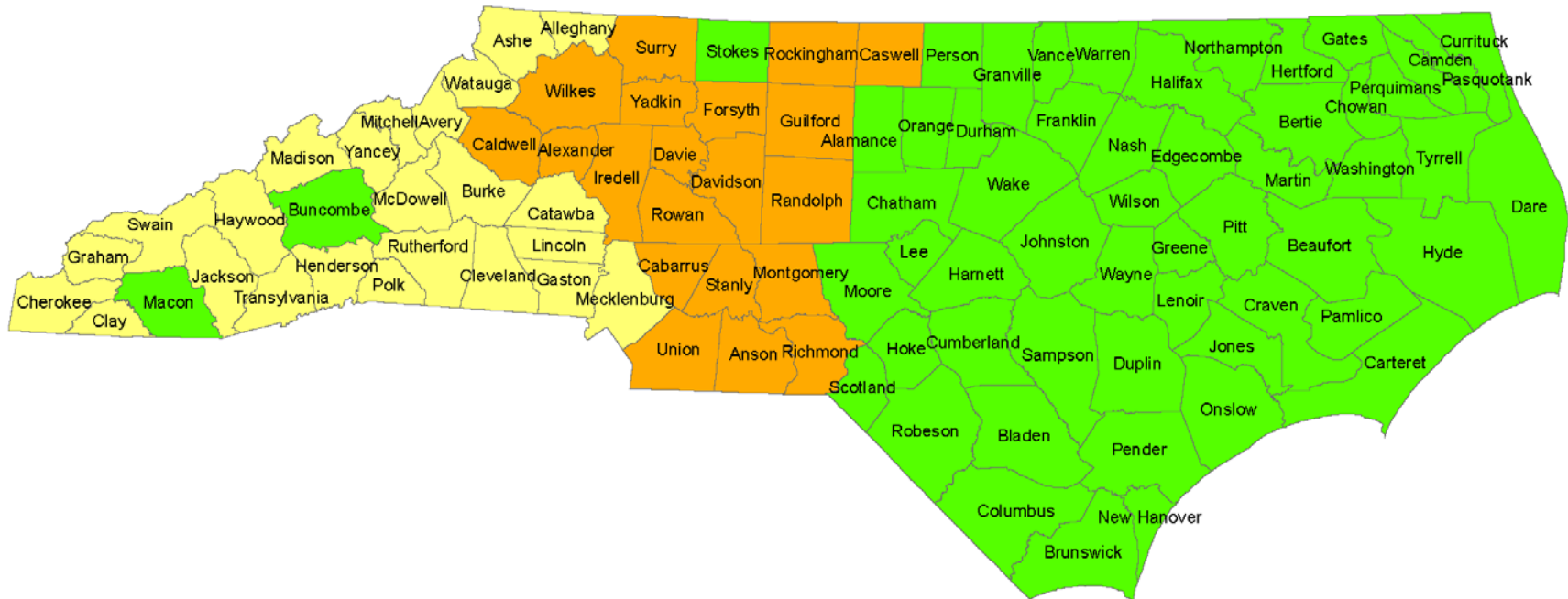
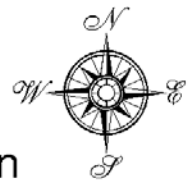
FFE = 5.2 ft.

Field	Value
OBJECTID	75038
Shape	Polygon
BUILD_ID	371292010081975038
PID	<null>
FFE_REMOTE	5.21276
ELEV_CONF	HIGH
FFE_SERT	<null>
FFE_LIDAR	7.079811
LAG_LIDAR	3.188972
HAG_LIDAR	4.679811
FFE_TYPE	Laser Endrometer Derived
FFE_CONF	<null>
VAL_CONF	<null>
TOT_CONF	<null>
FOUND_TY	Slab
N_STORIES	2
ROOF_SH	Flat
ROOF_SL	Flat
STATIC	YES
BLDG_VAL	-9999
BLDG_SRC	<null>
PHOTOFILE	30545.jpg
METAID	FFEBPP1
Shape_Length	460.723374

North Carolina Floodplain Mapping Program Current Status

Building Footprint updates (2010 imagery) and First Floor Elevation Collection

April 26, 2013



Legend

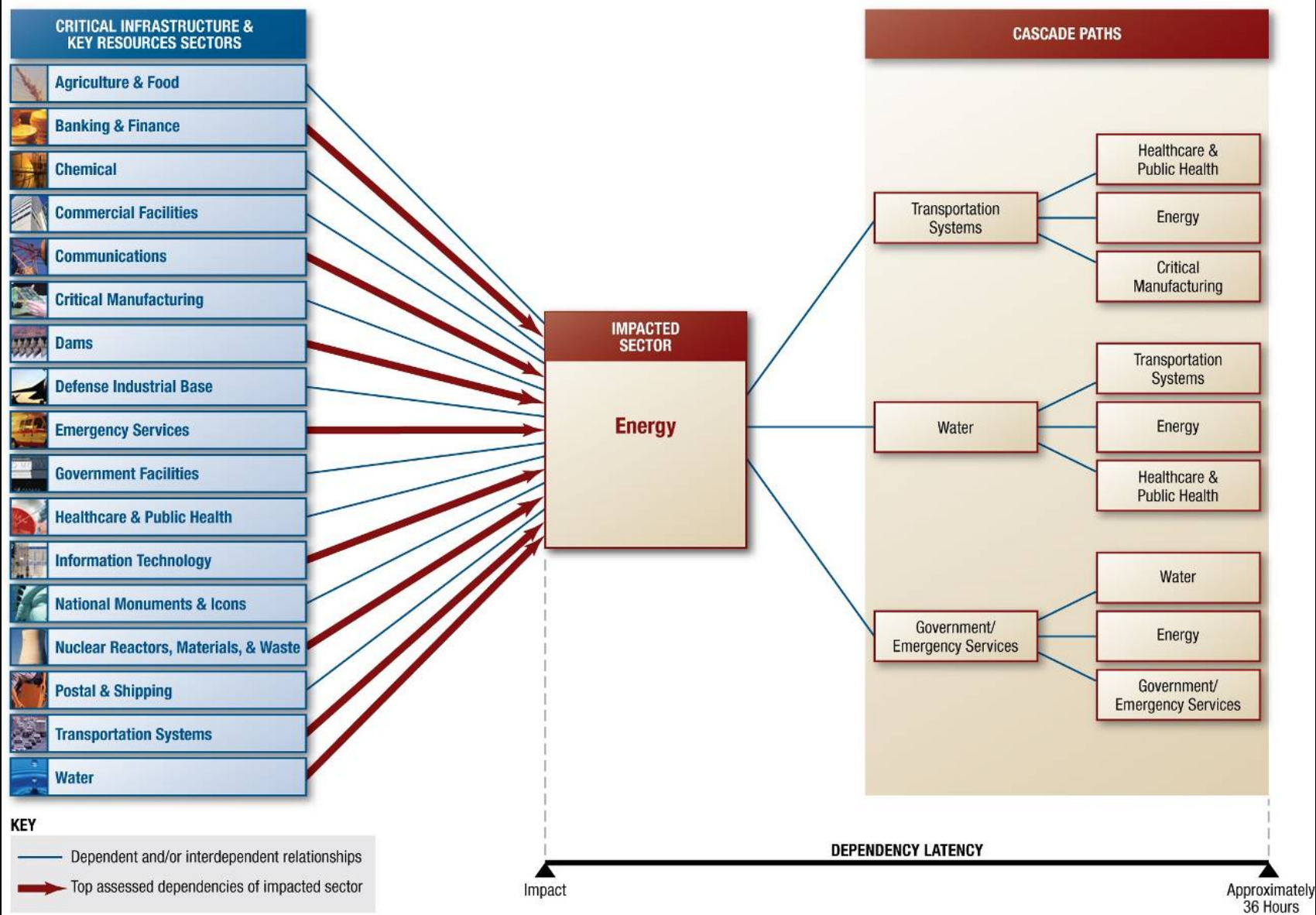
- Complete
- Complete November 2013
- Complete April 2014



- Field Collection**
- First Floor Elevation
- Foundation Type
- Roof Shape
- Roof Slope
- Number of Stories
- Parcel Conflation**
- Occupancy Type
- Building Value
- Year Built
- Heated Sq Ft
- Roof Shape
- HAZUS Block Conflation**
- Roof Cover Type
- Roof Cover Quality
- Water Resistance
- Roof Deck Attachment
- Roof Deck Age
- Roof Wall Connection
- Roof Frame Type
- Hurricane Shutters
- Roof Tie Downs
- Window Area
- Masonry Reinforcing
- Joist Spacing
- Number of Units



ACQUISITION / GENERATION - CIKR / Interdependencies

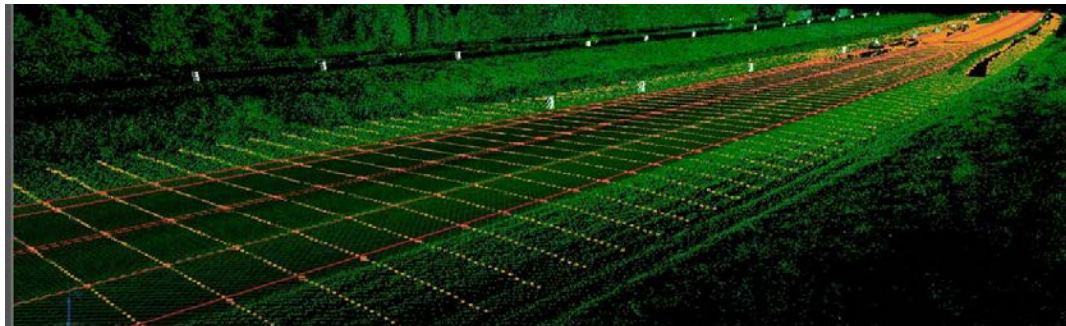


ACQUISITION / GENERATION – Mobile LiDAR Road Data

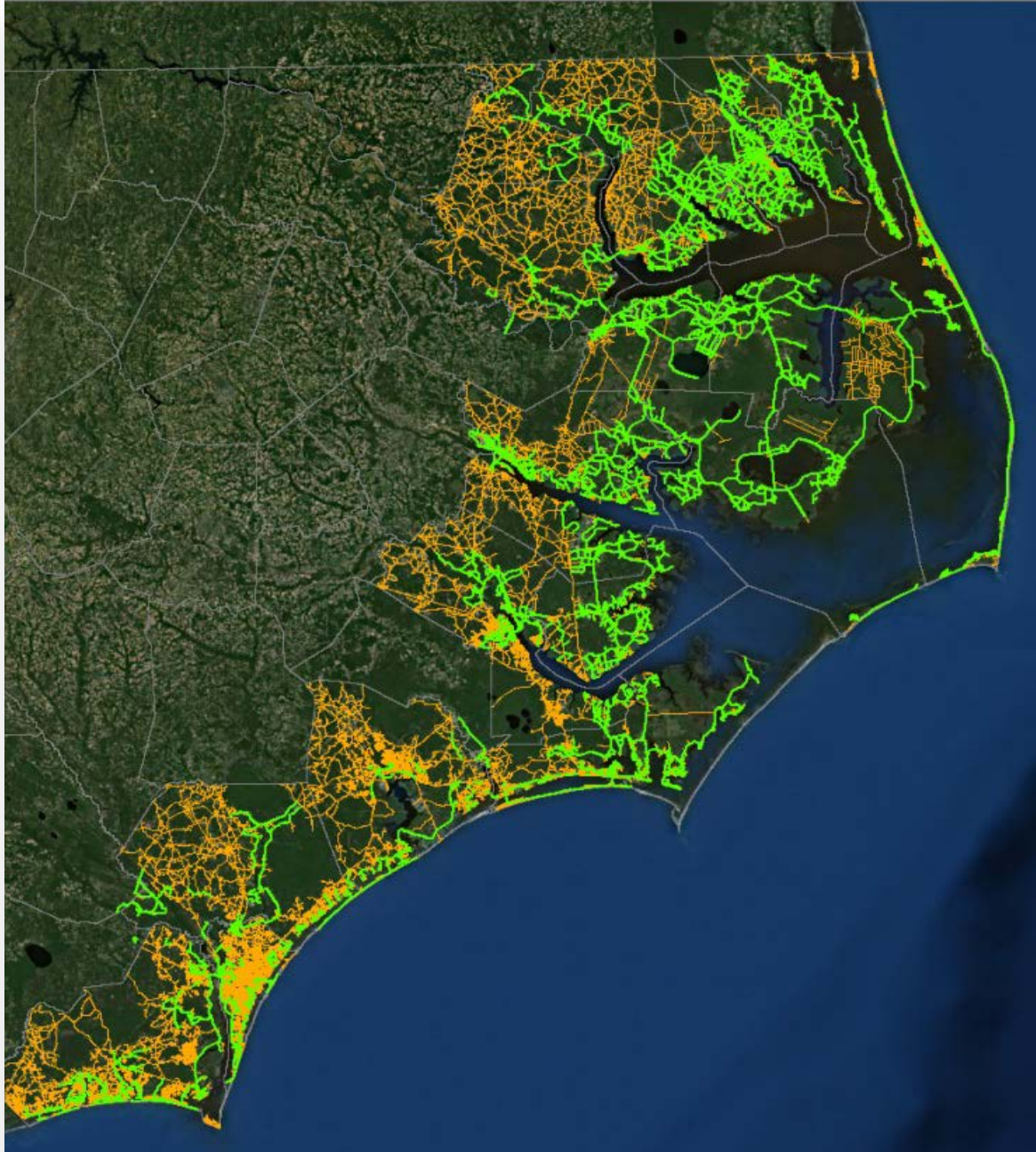


GTMO has acquired new transportation / roadway spatial data. This entails:

- Mobile LiDAR collection – 4,300 miles
- State Maintained Roads < 16 feet (NAVD 88)
- Real-time Inundation Metrics
- Evacuation Route Planning

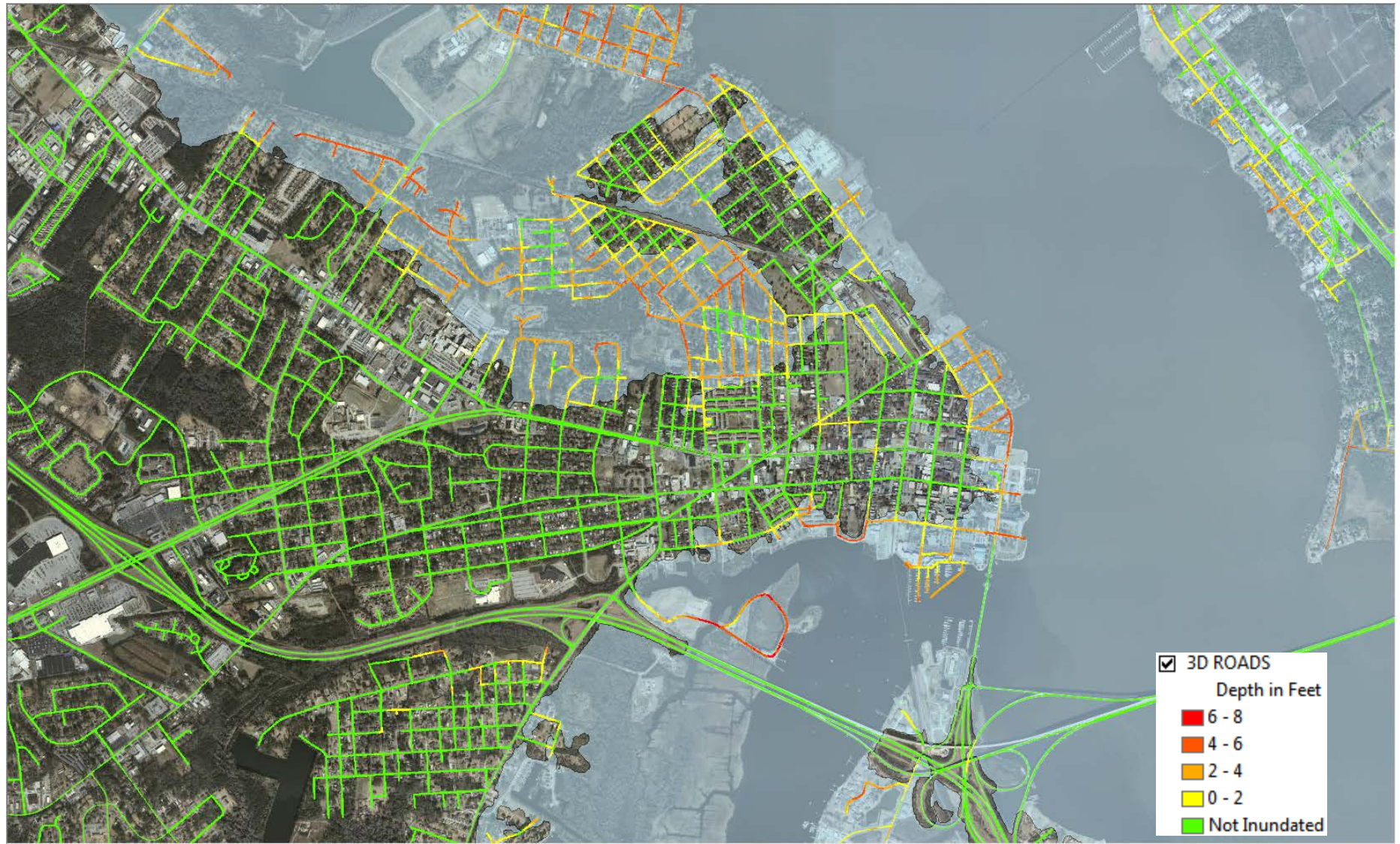


ACQUISITION / GENERATION – Mobile LiDAR Road Data



ACQUISITION / GENERATION – Mobile LiDAR Road Data

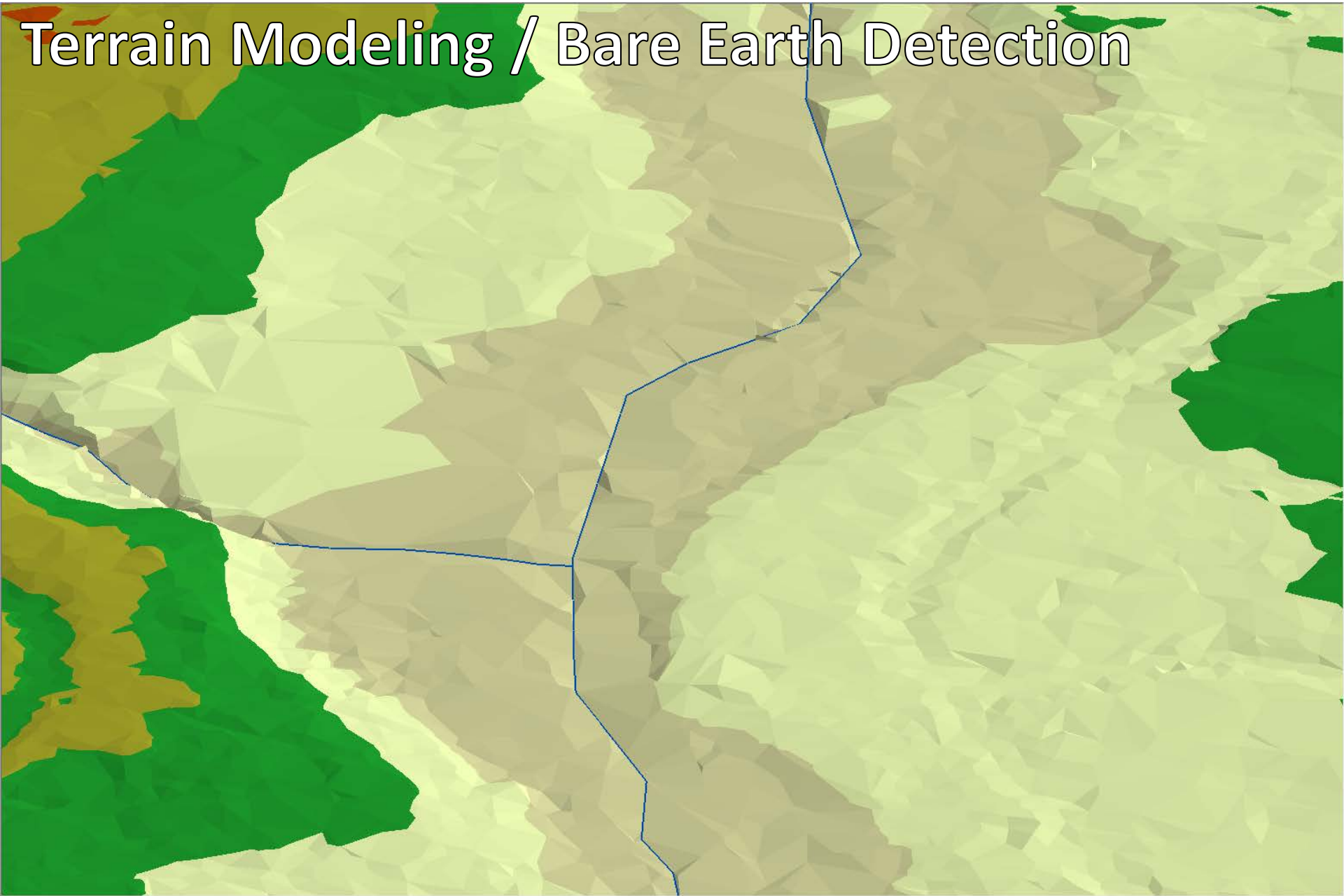
- Inundation Analysis for Storm Surge (Roadway Depth)
- Case Example of 8 feet of Storm Surge



ACQUISITION / GENERATION – Mobile LiDAR Road Data

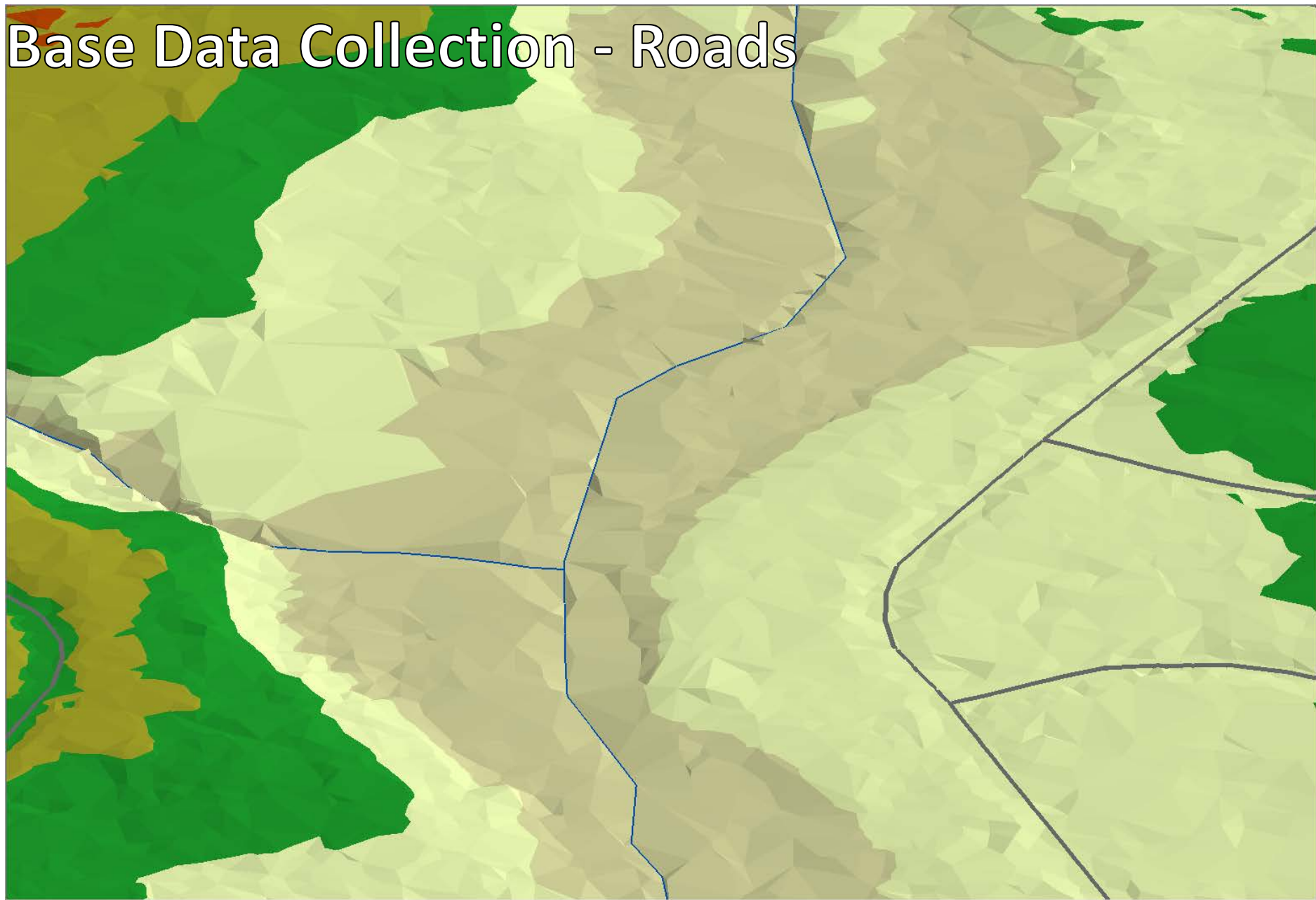
- Inundation Analysis for Storm Surge (Roadway Depth)
- Case Example of 12 feet Of Storm Surge



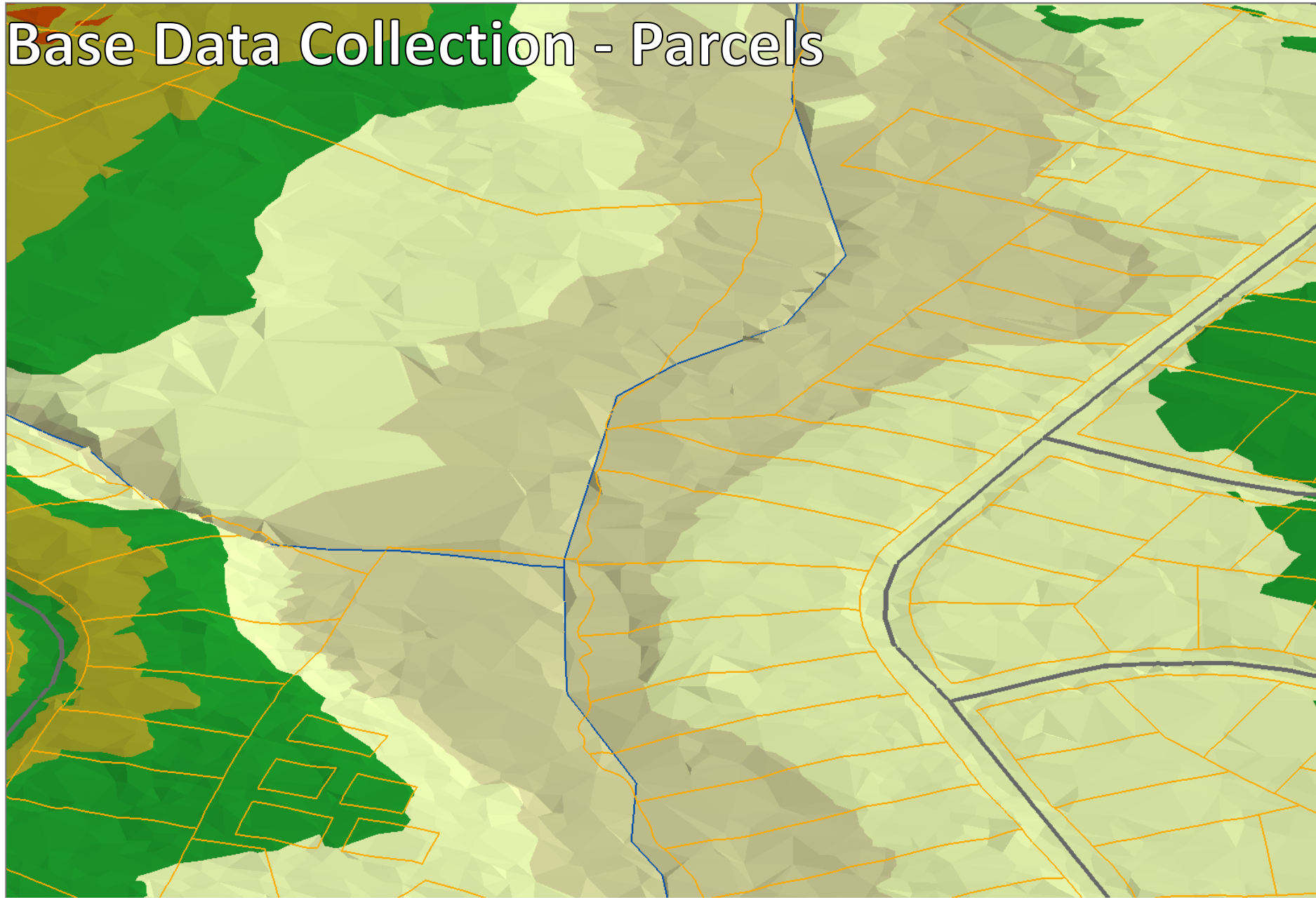


Terrain Modeling / Bare Earth Detection

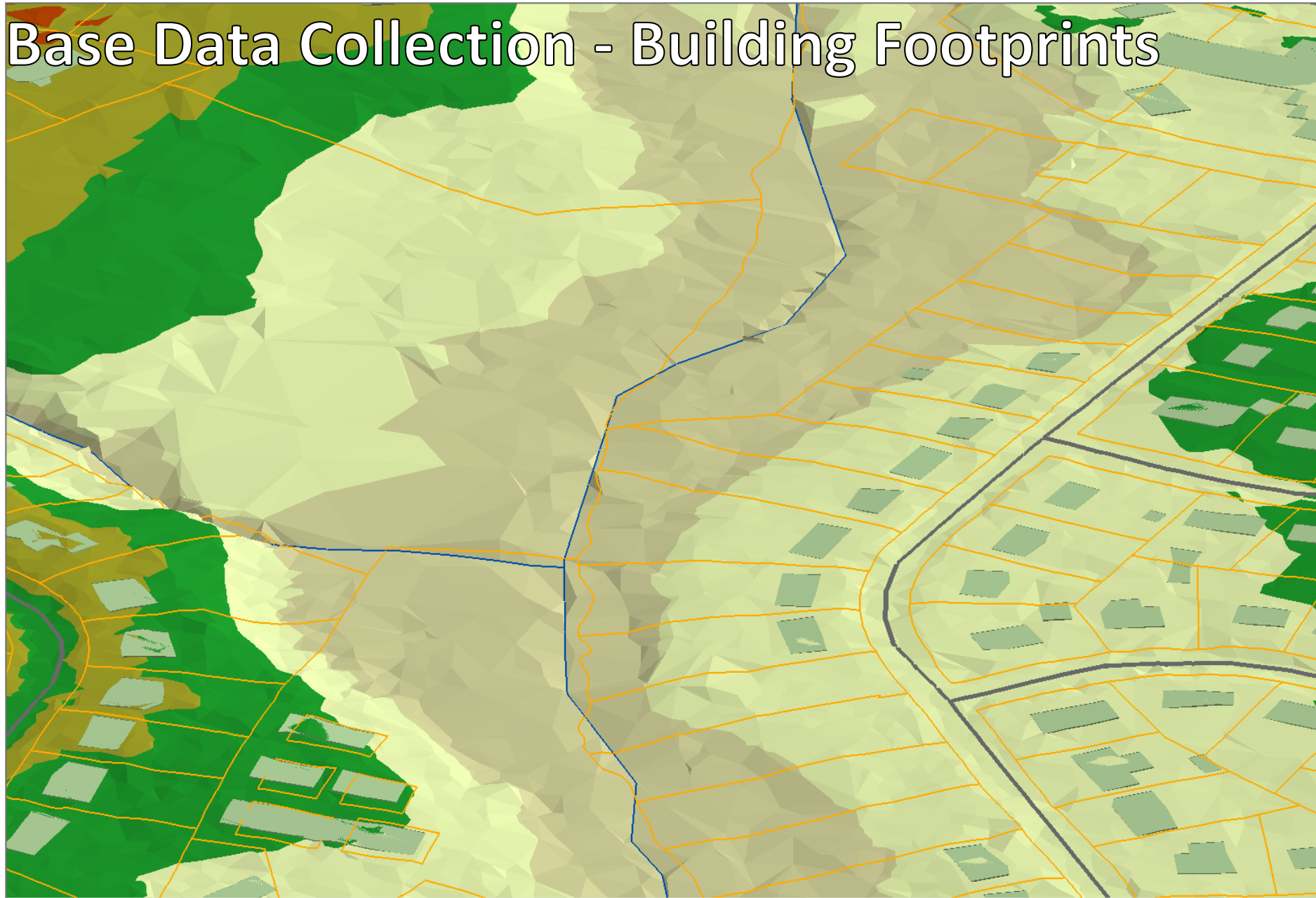
Base Data Collection - Roads



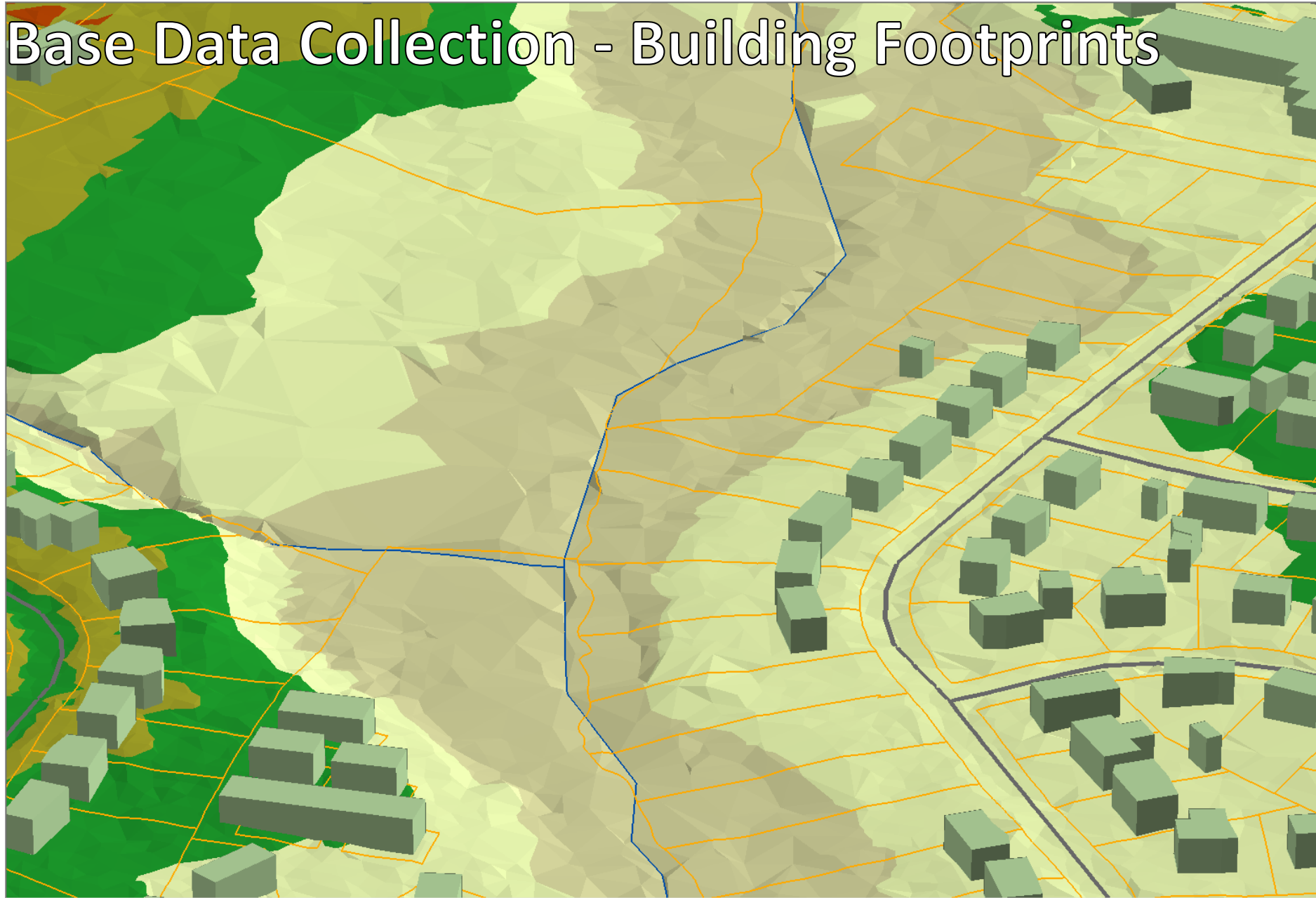
Base Data Collection - Parcels



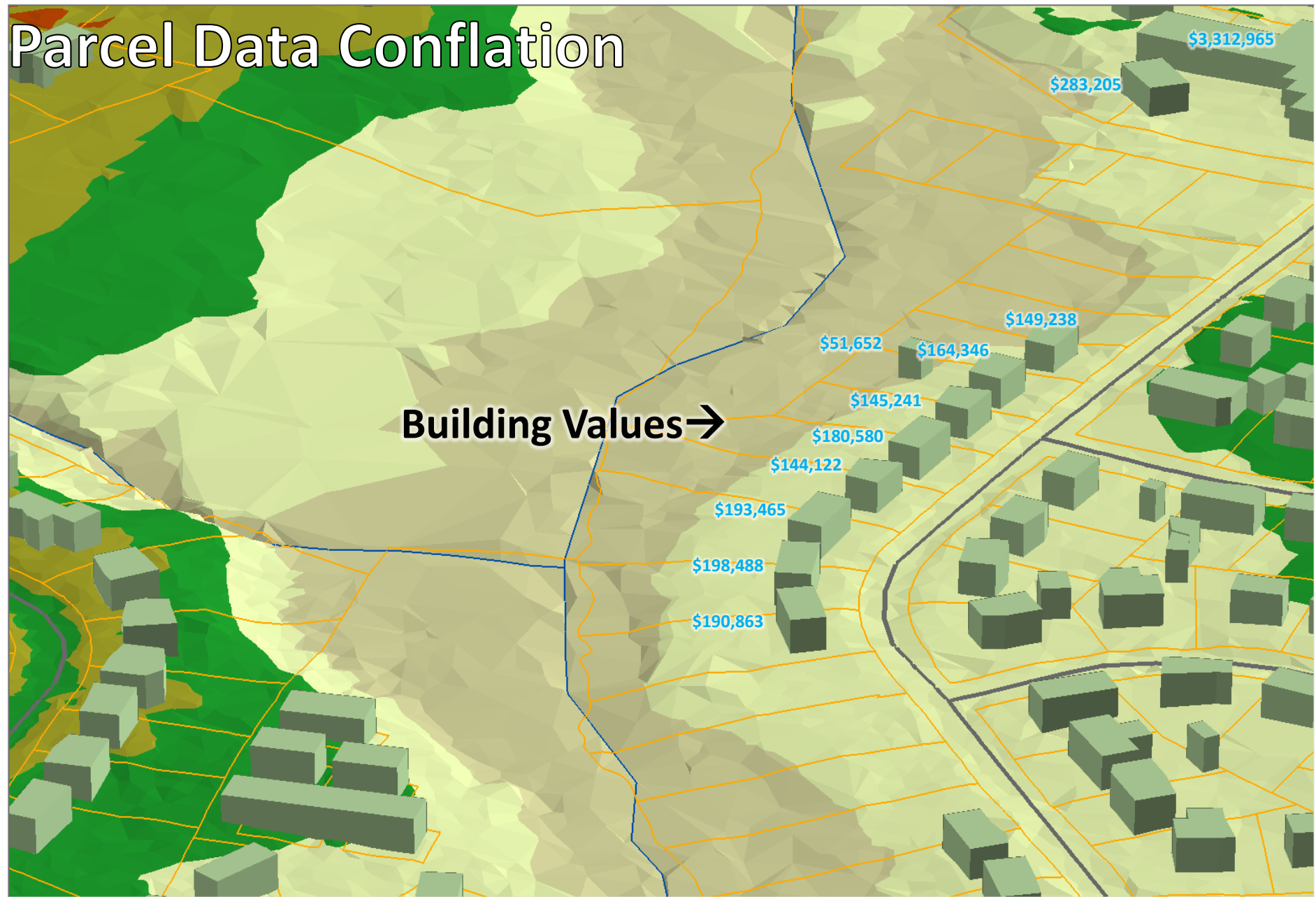
Base Data Collection - Building Footprints



Base Data Collection - Building Footprints

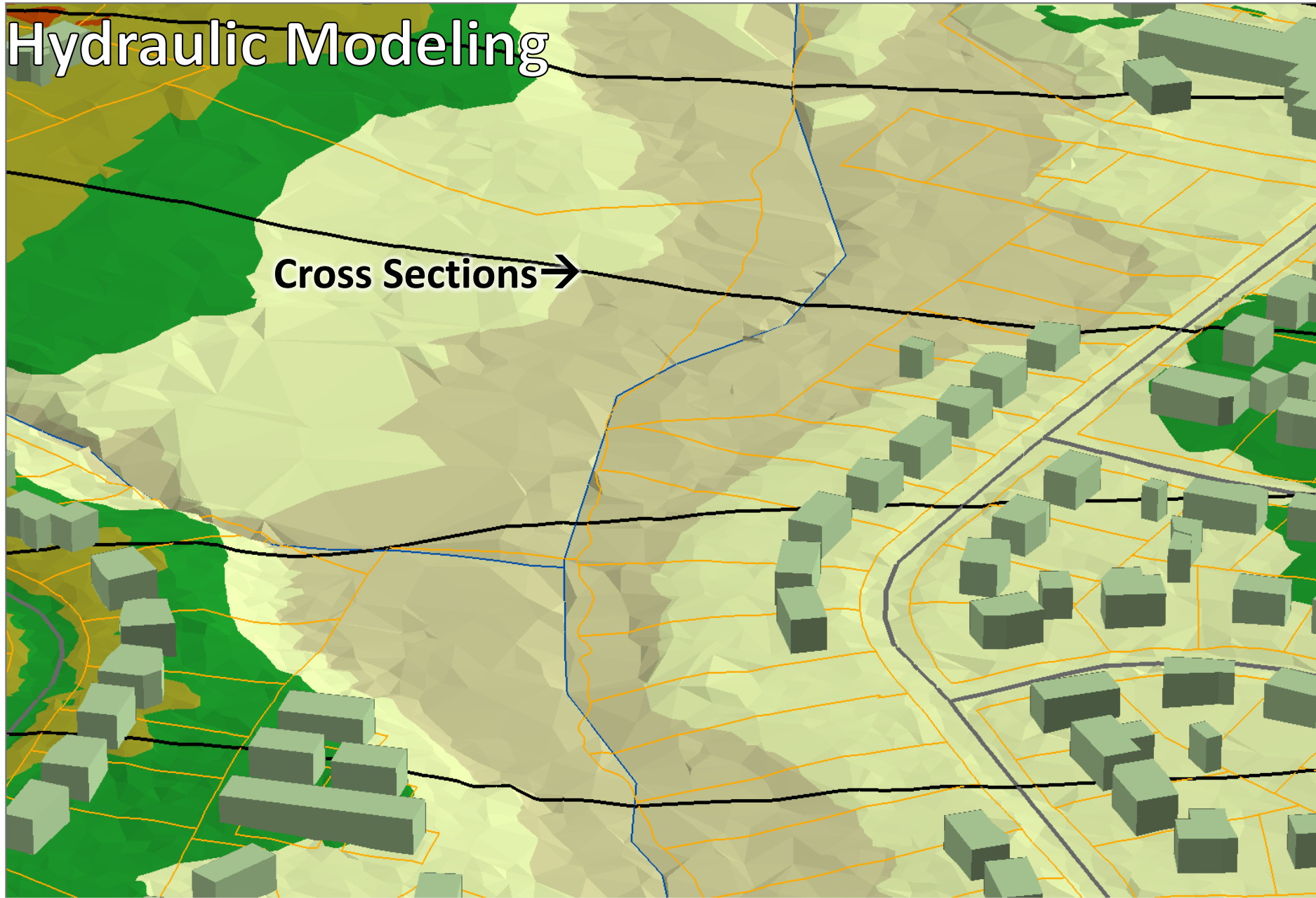


Parcel Data Conflation

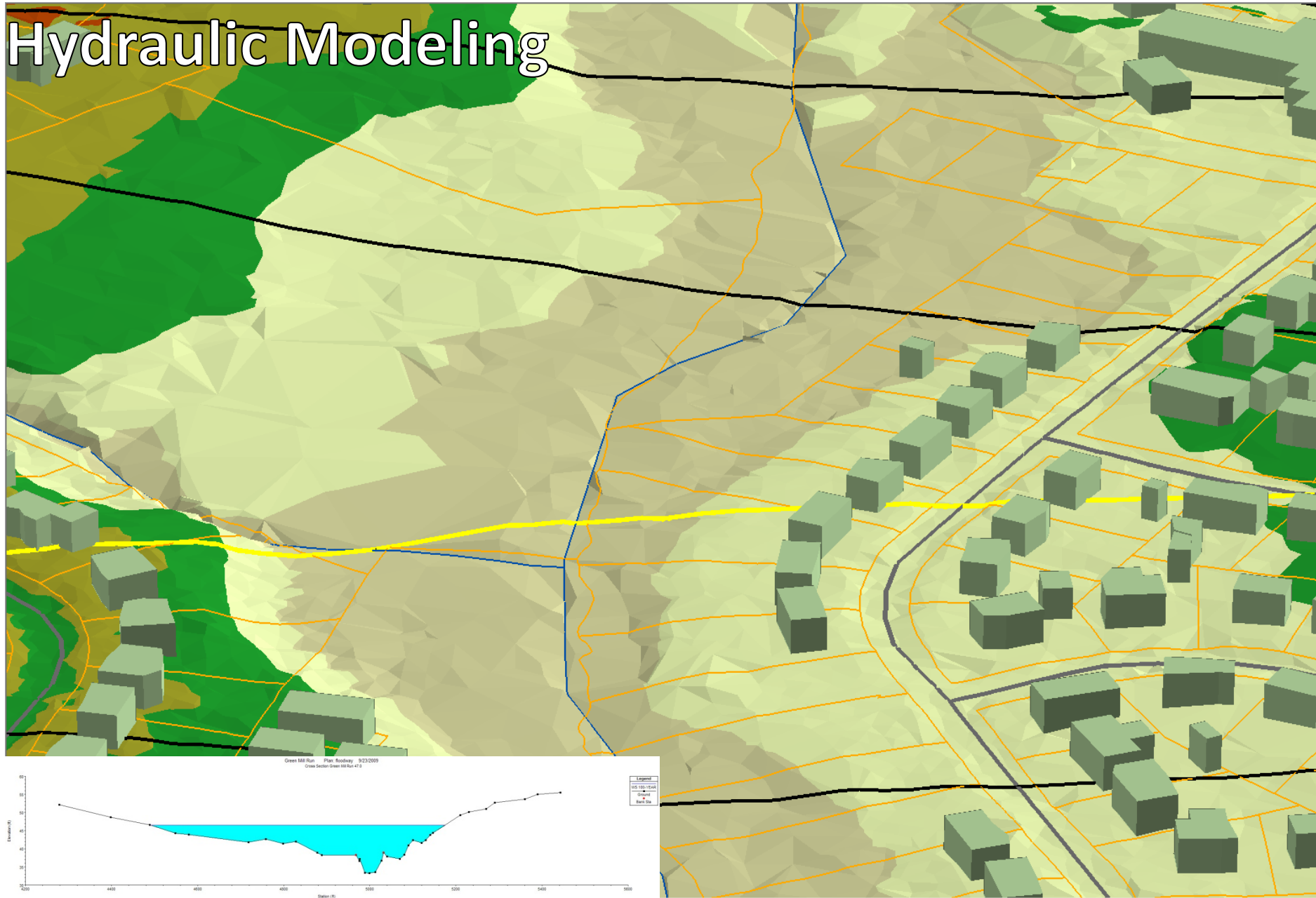


Hydraulic Modeling

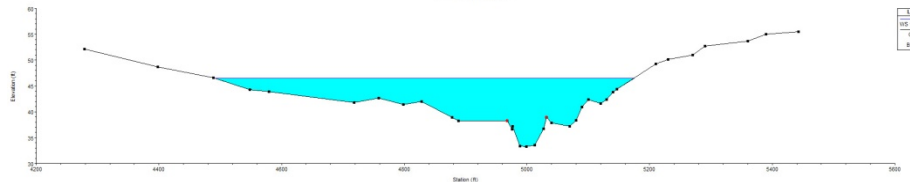
Cross Sections →



Hydraulic Modeling



Green Hill Run - Plan - 8/23/2009
Cross Section Green Hill Run #12

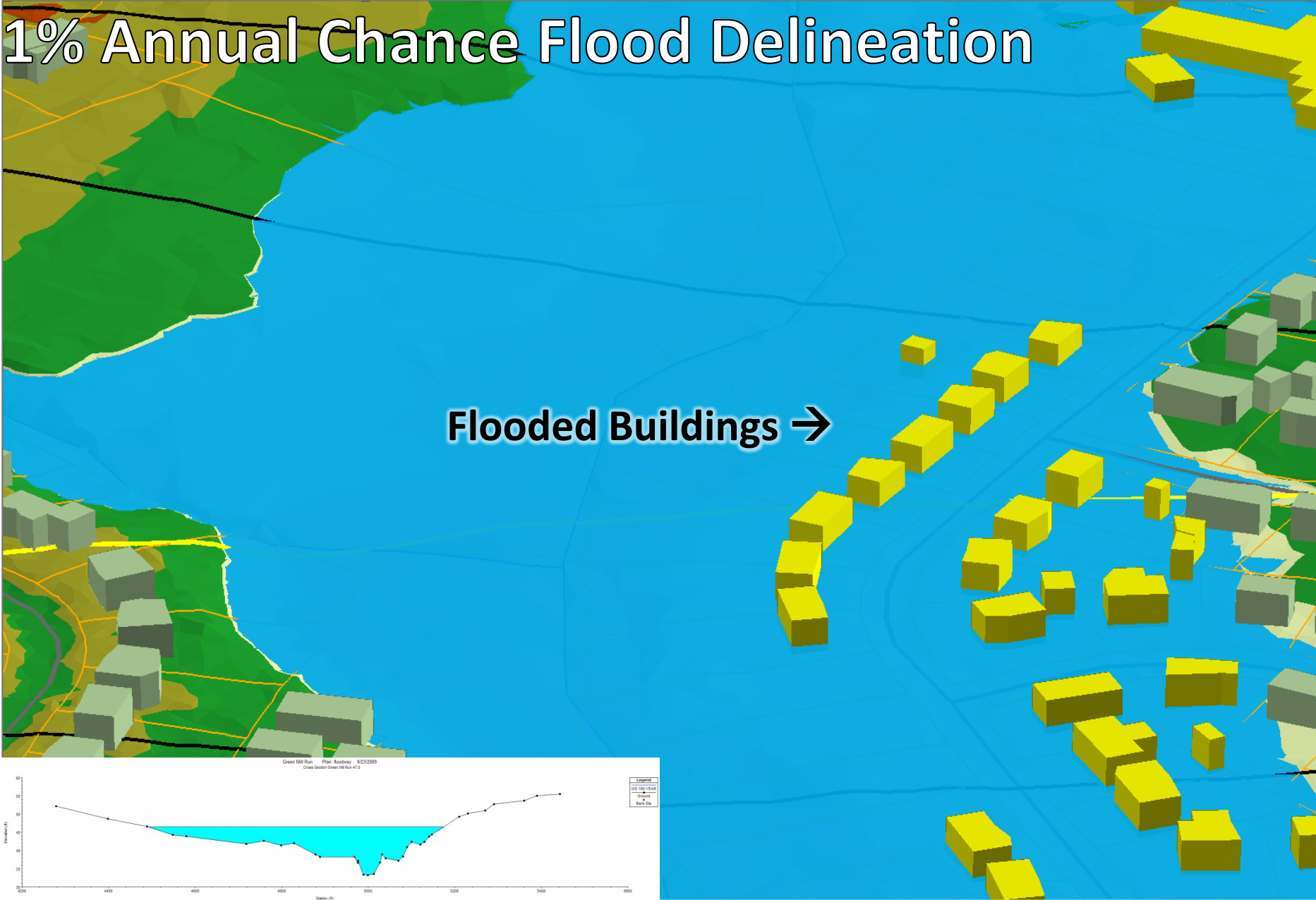


Legend

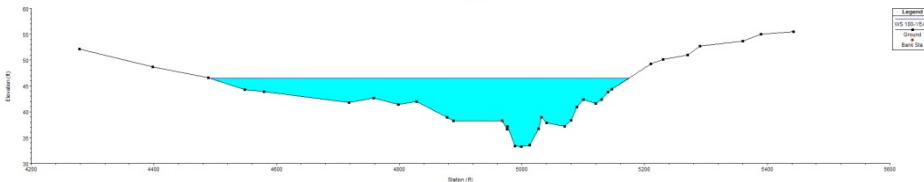
- 100 100' (1:240)
- Channel
- Flow
- Bank Sta.

1% Annual Chance Flood Delineation

Flooded Buildings →

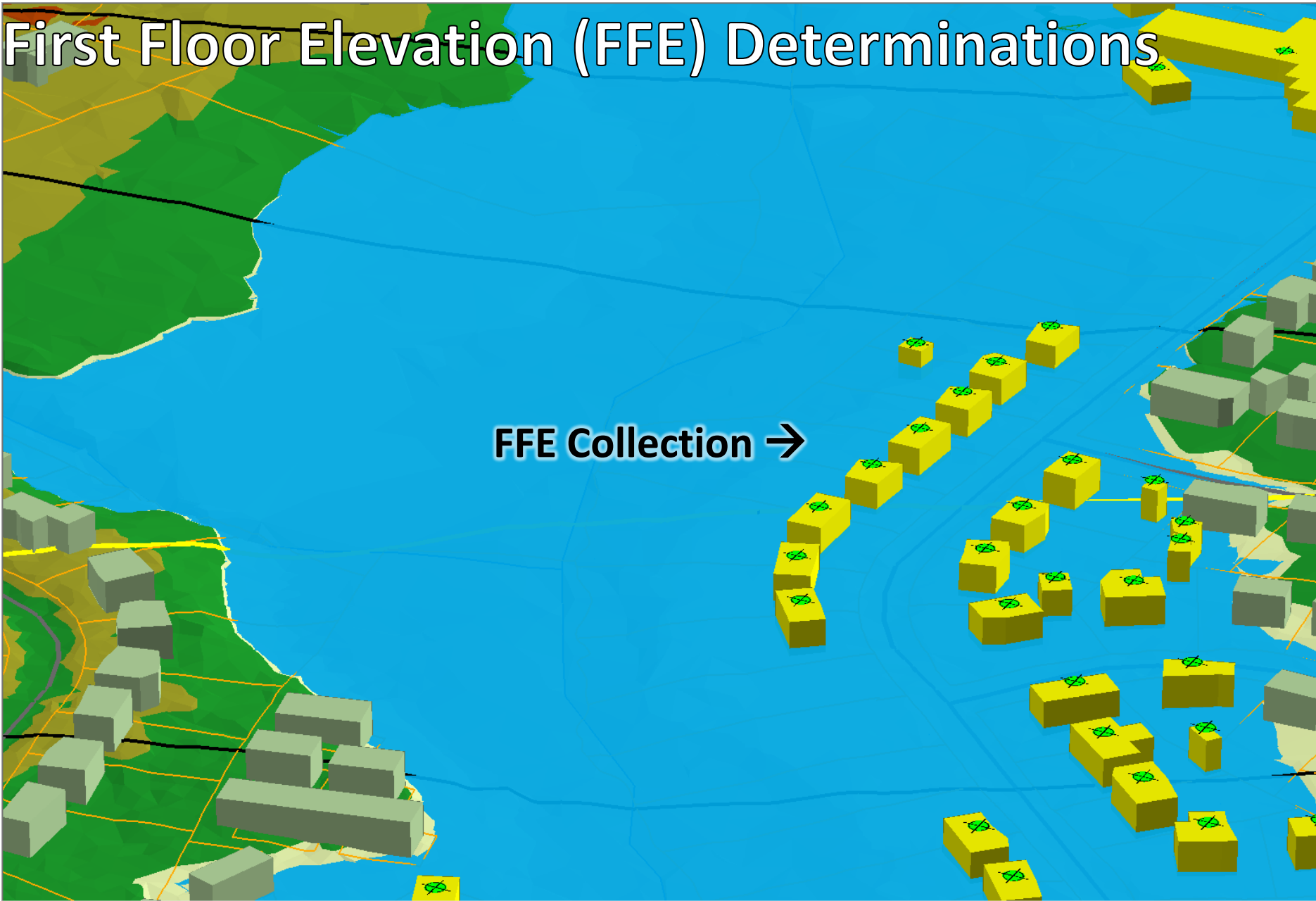


Green Hill Run Plan: Roadway 3/23/2009
Cross Section: Green Hill Run #12



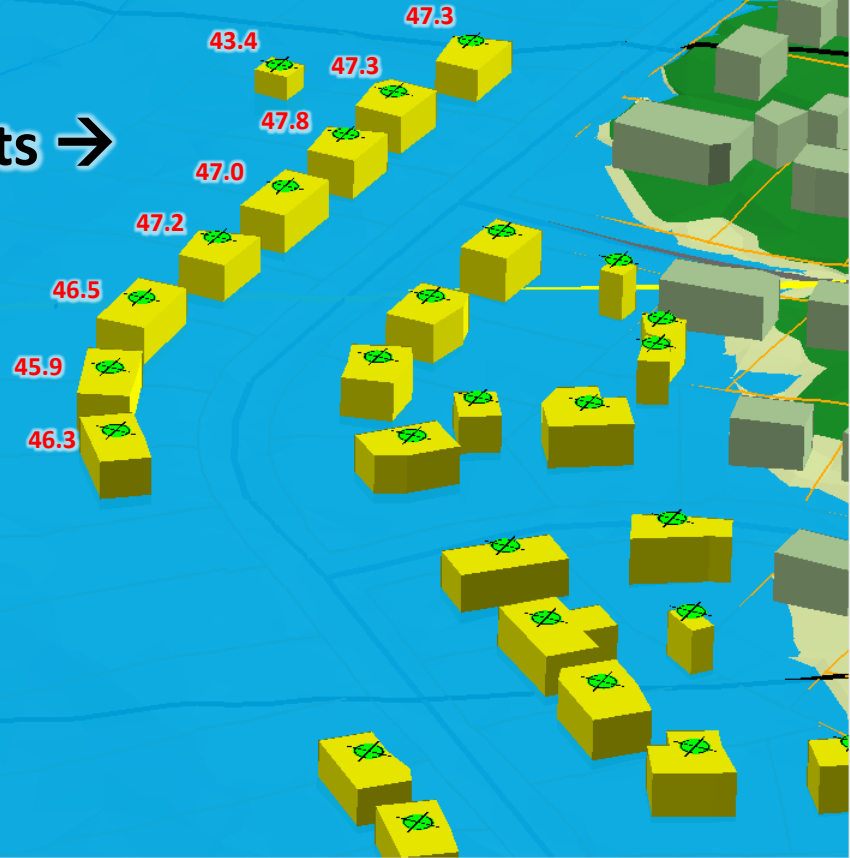
First Floor Elevation (FFE) Determinations

FFE Collection →



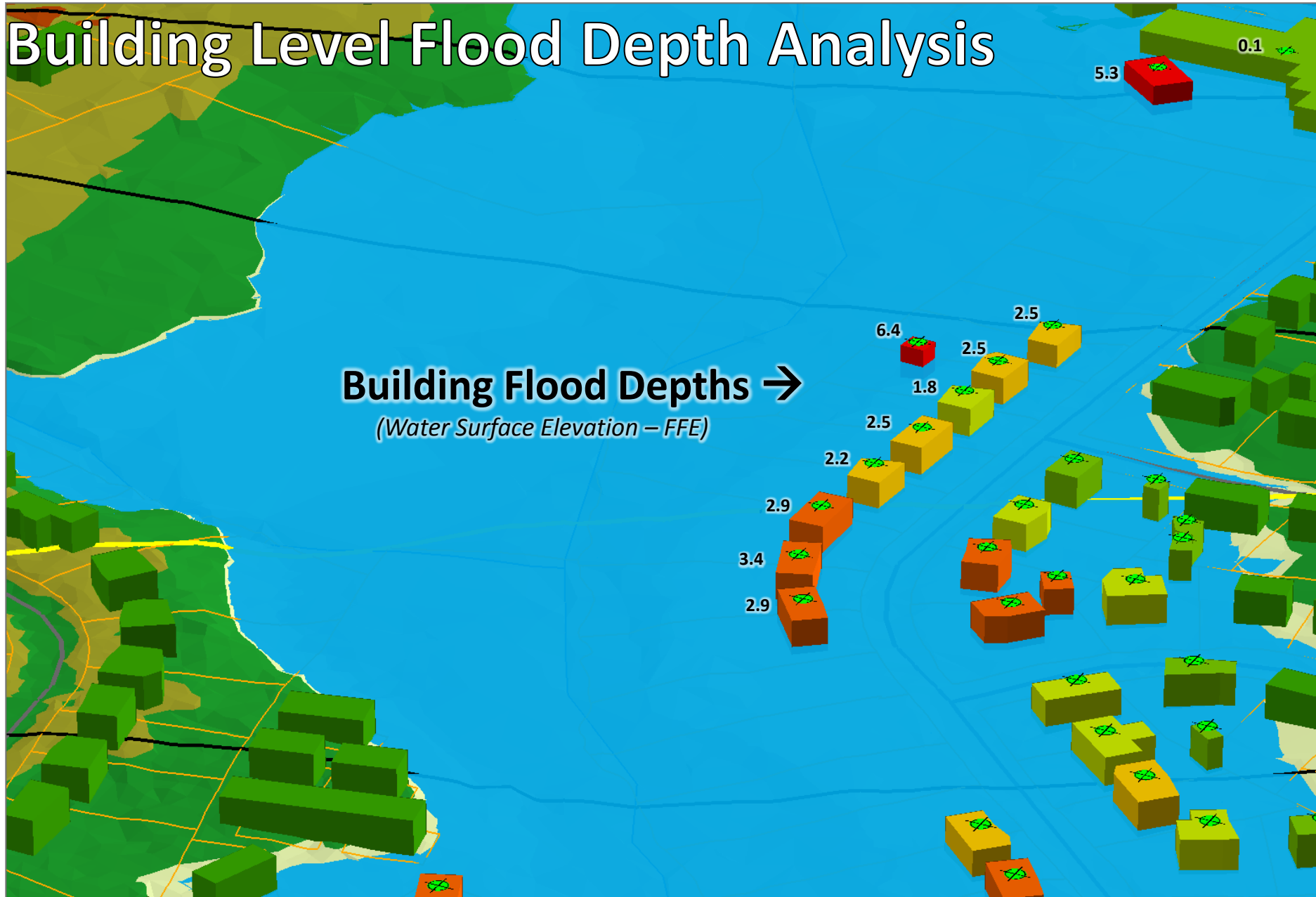
First Floor Elevation (FFE) Determinations

FFEs applied to Building Footprints →



Building Level Flood Depth Analysis

Building Flood Depths →
(Water Surface Elevation – FFE)

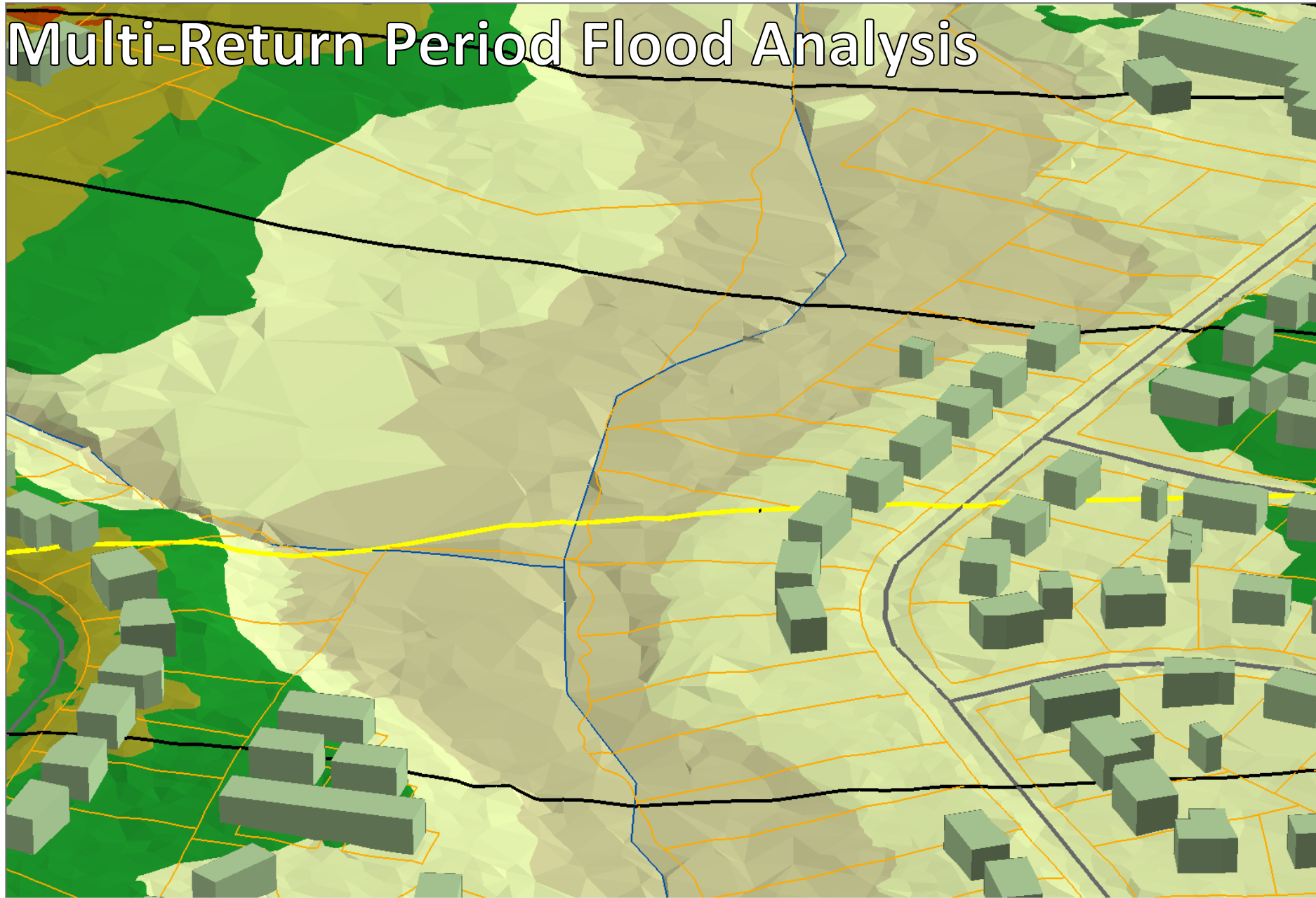


Building Level Flood Damages

Building Damages \$\$\$→

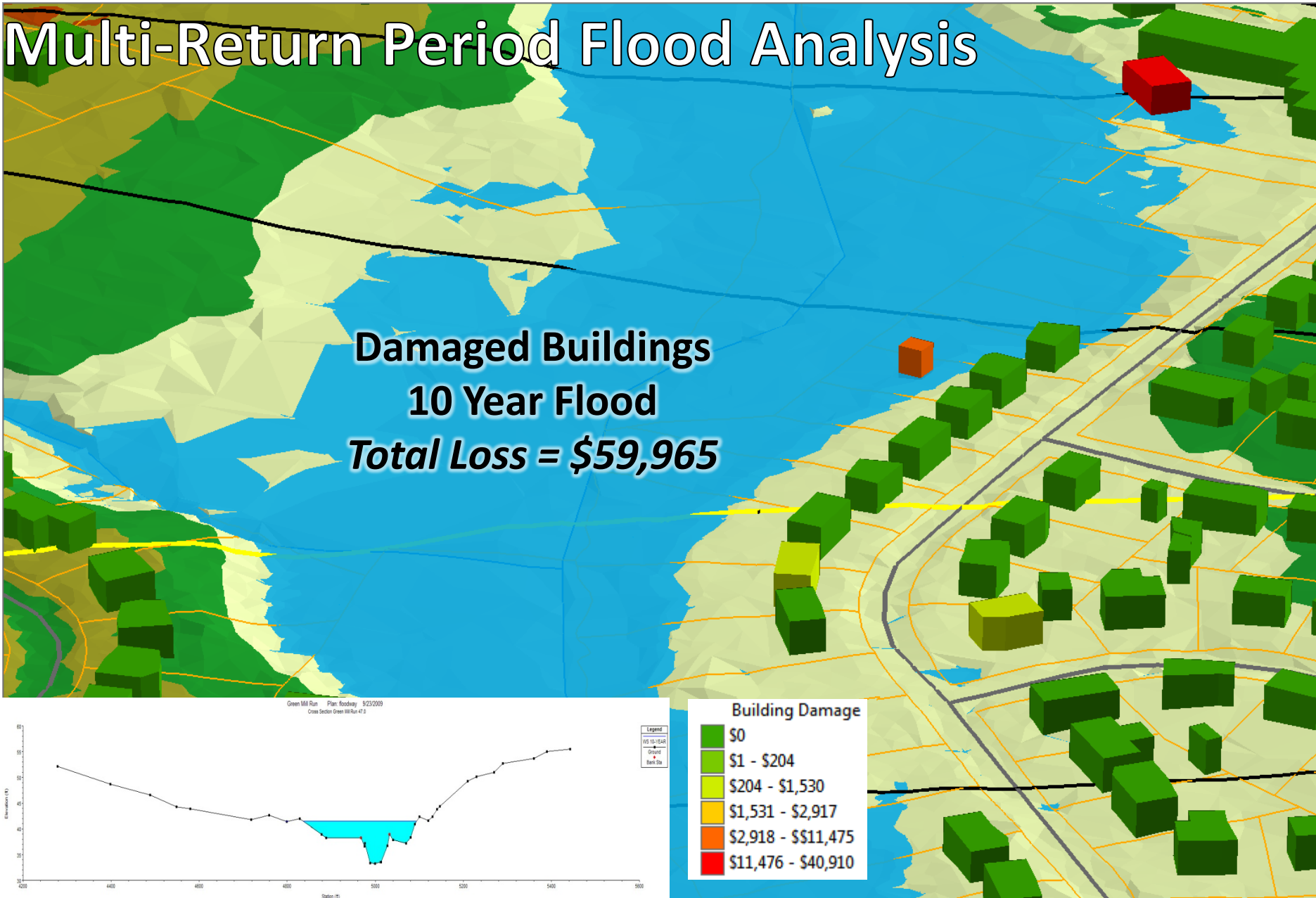


Multi-Return Period Flood Analysis



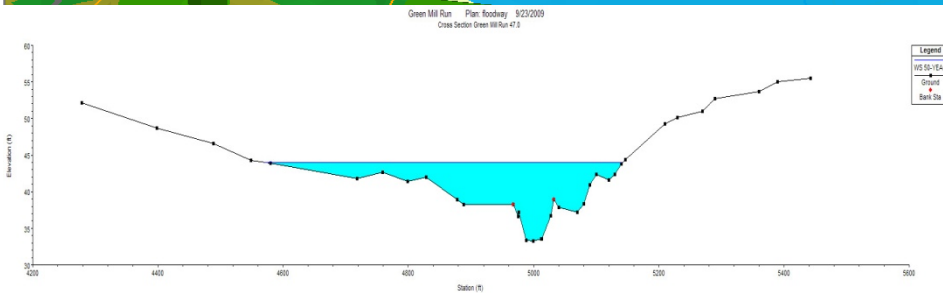
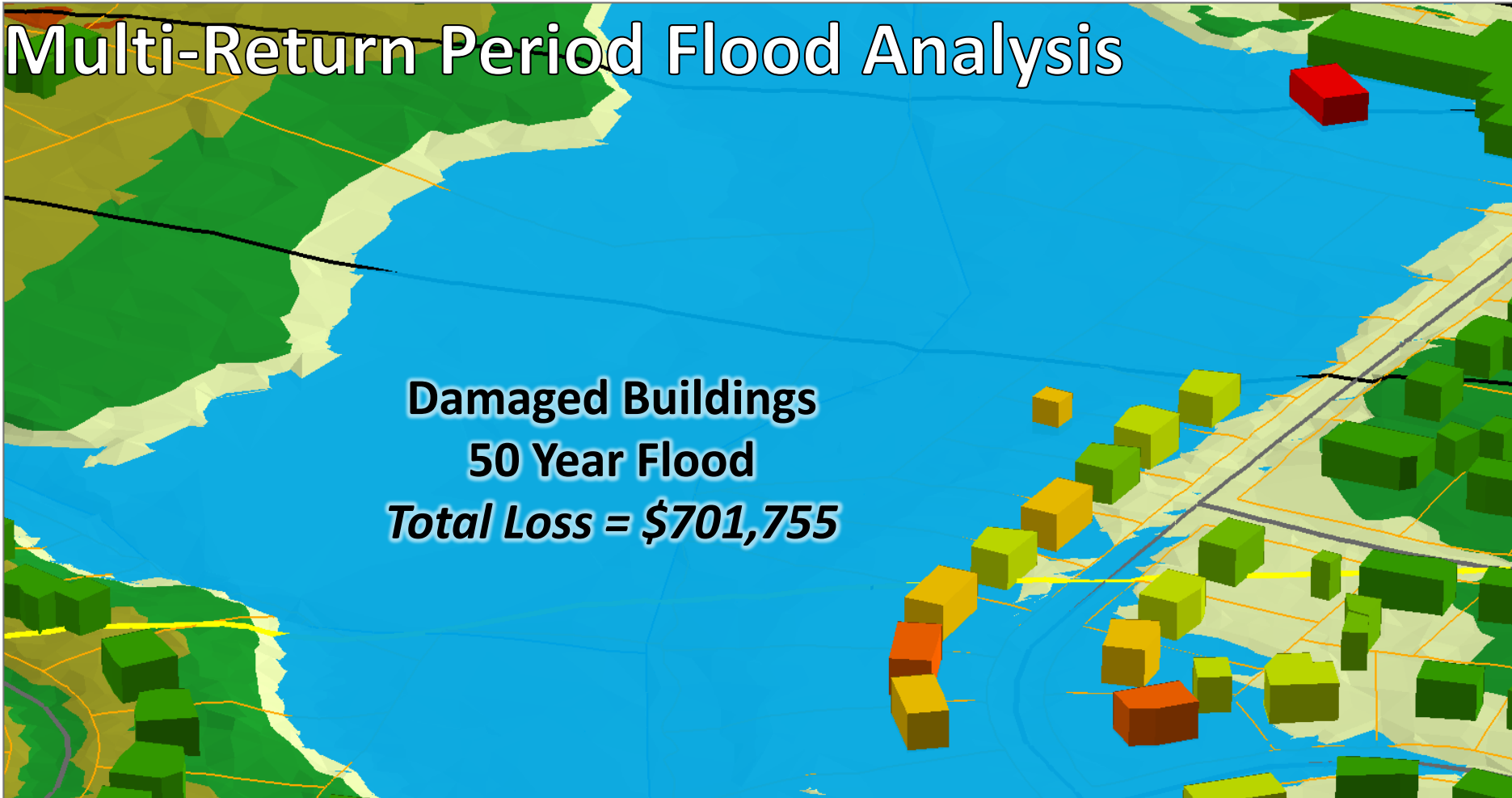
Multi-Return Period Flood Analysis

Damaged Buildings
10 Year Flood
Total Loss = \$59,965



Multi-Return Period Flood Analysis

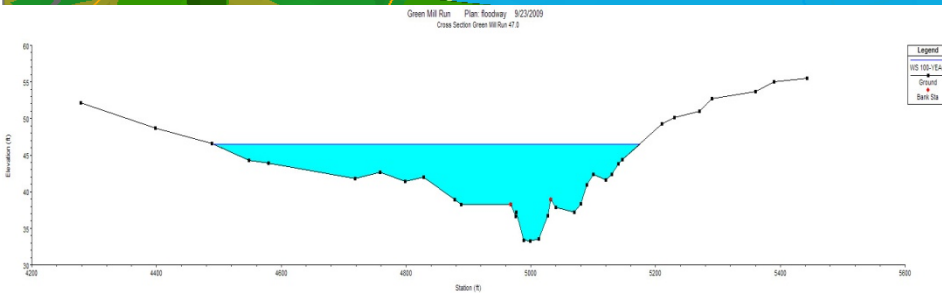
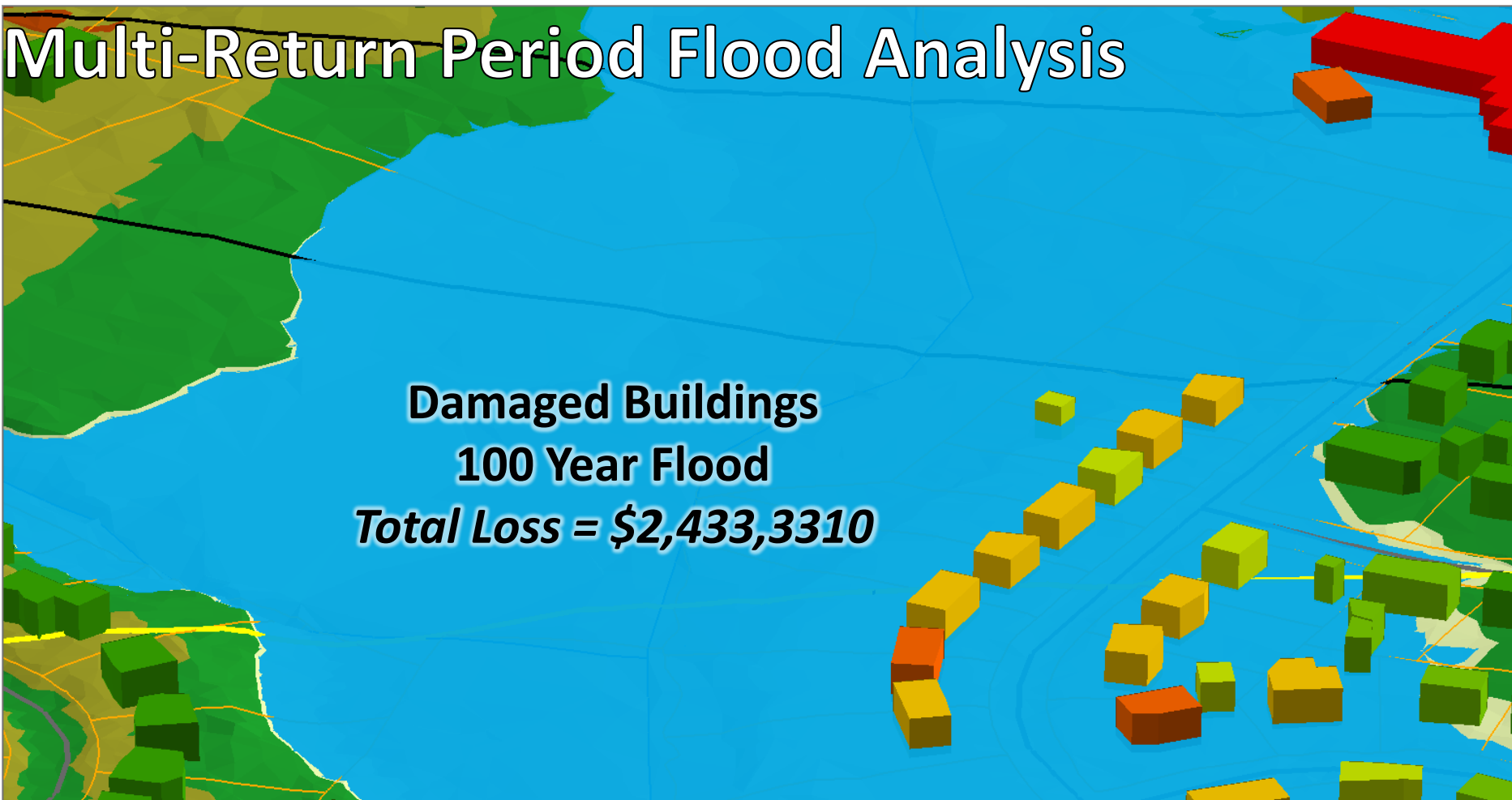
Damaged Buildings
50 Year Flood
Total Loss = \$701,755



Building Damage	
Green	\$0
Light Green	\$1 - \$1,610
Yellow-Green	\$1,611 - \$3,963
Yellow	\$3,964 - \$9,260
Orange	\$9,261 - \$21,187
Red	\$21,188 - \$67,474

Multi-Return Period Flood Analysis

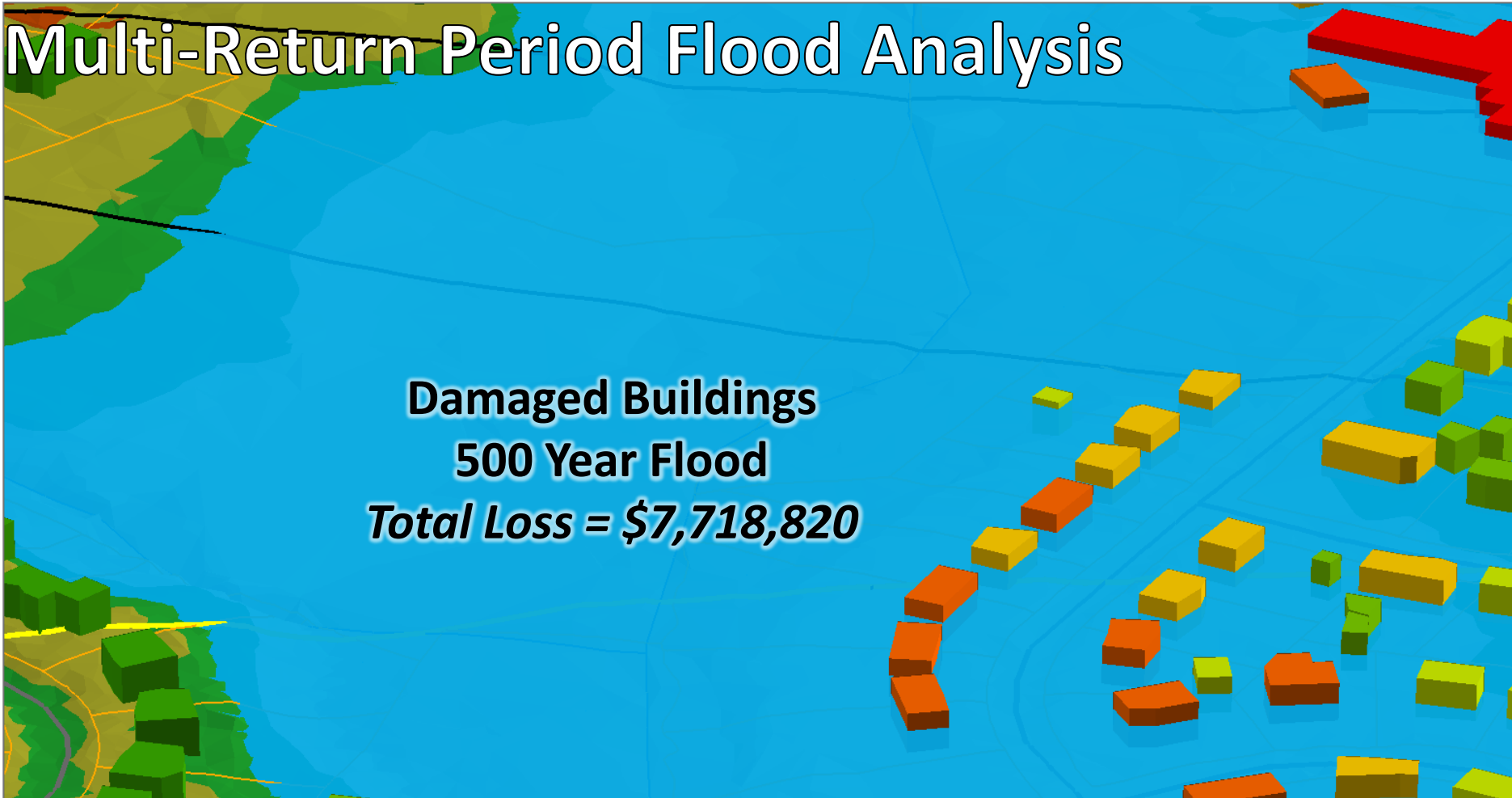
Damaged Buildings
100 Year Flood
Total Loss = \$2,433,3310



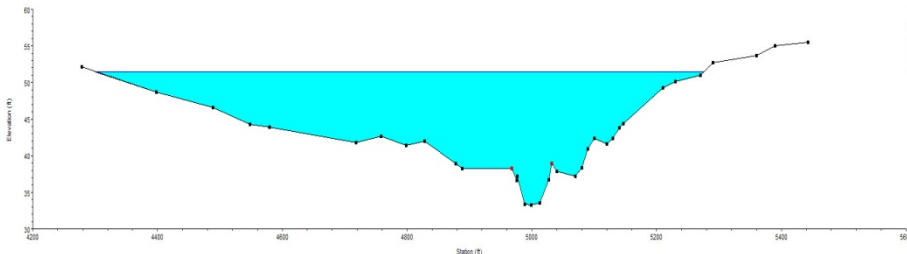
Building Damage	
Green	\$0
Light Green	\$1 - \$19,690
Yellow-Green	\$19,691 - \$38,220
Yellow	\$38,221 - \$64,491
Orange	\$64,492 - \$138,090
Red	\$138,091 - \$396,231

Multi-Return Period Flood Analysis

Damaged Buildings
500 Year Flood
Total Loss = \$7,718,820

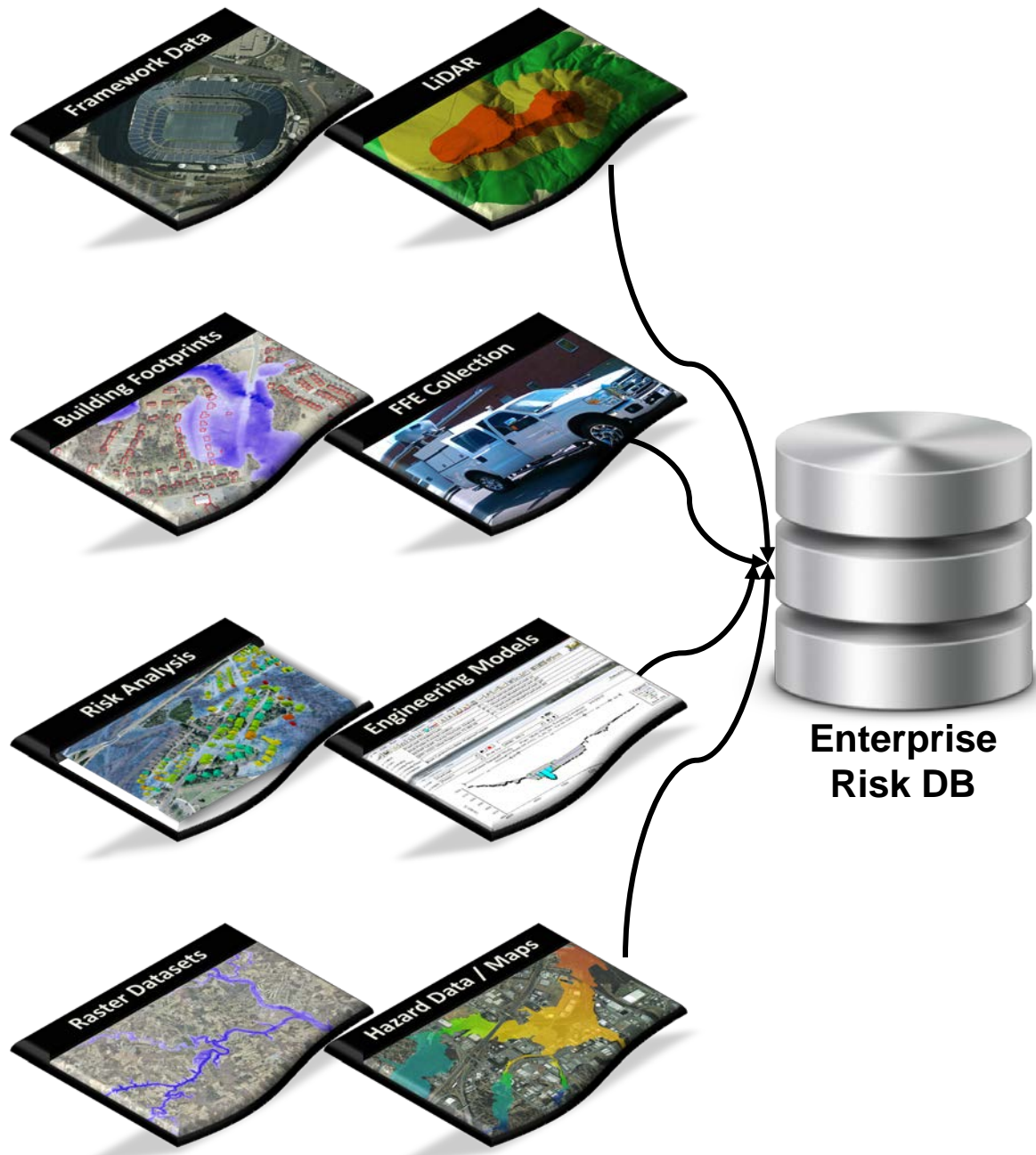


Green Mt Run - Plan: floodway 5/23/2009
Cross Section Green Mt Run #13

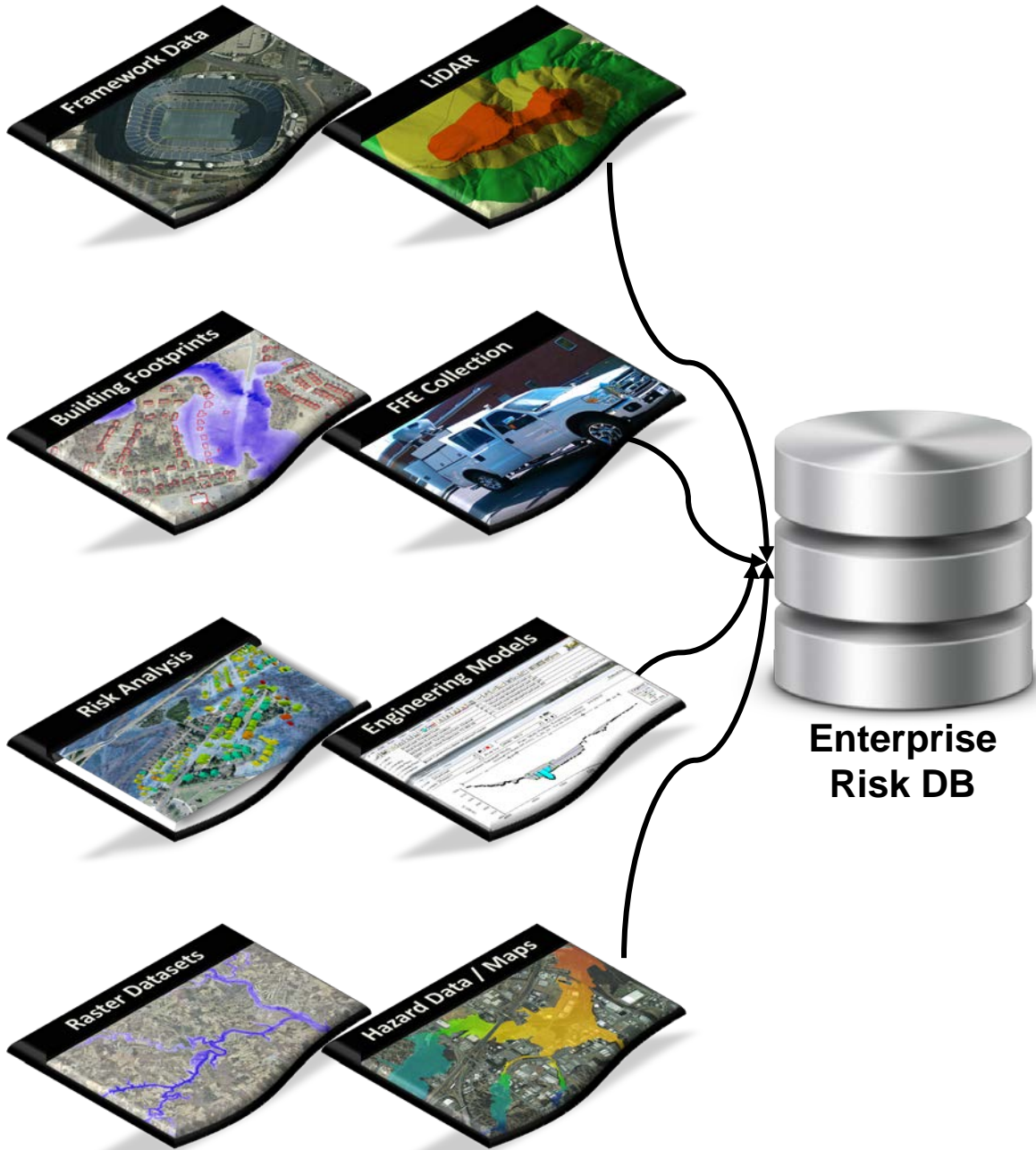


Legend
100 500-YEAR
Ground
Bank Sta

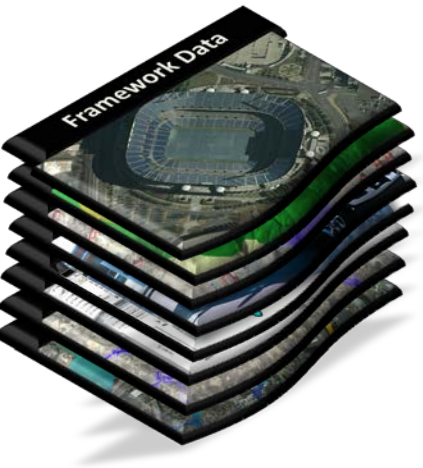
Building Damage	
Green	\$0
Light Green	\$1 - \$37,609
Yellow-Green	\$37,610 - \$65,775
Yellow	\$65,776 - 98,501
Orange	\$98,502 - \$206,555
Red	\$206,556 - \$1,555,934



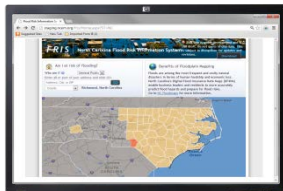
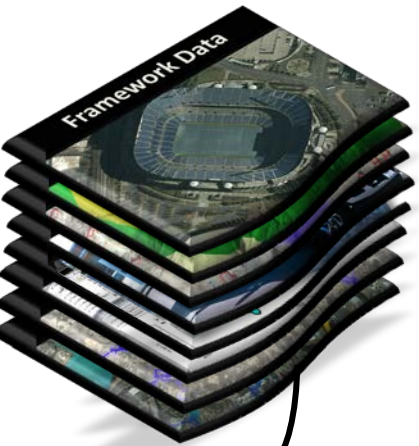
**Enterprise
Risk DB**



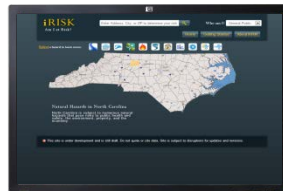
**Enterprise
Risk DB**



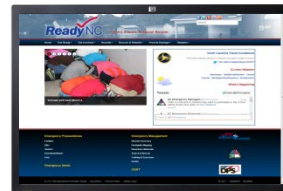
**Enterprise
Risk DB**



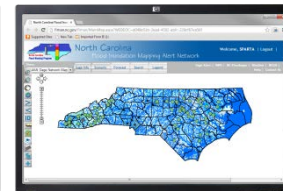
FRIS



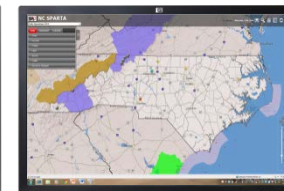
iRisk



ReadyNC



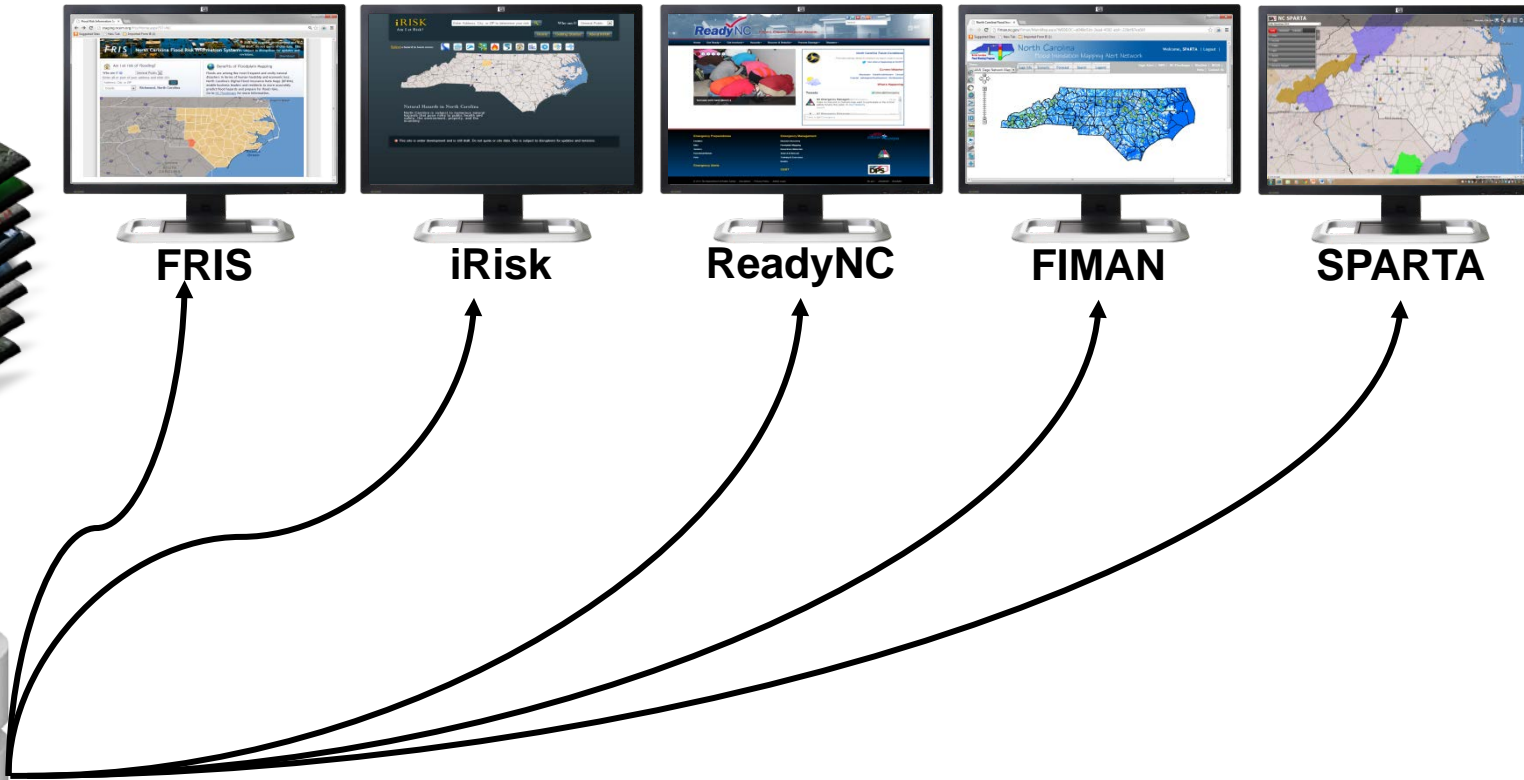
FIMAN

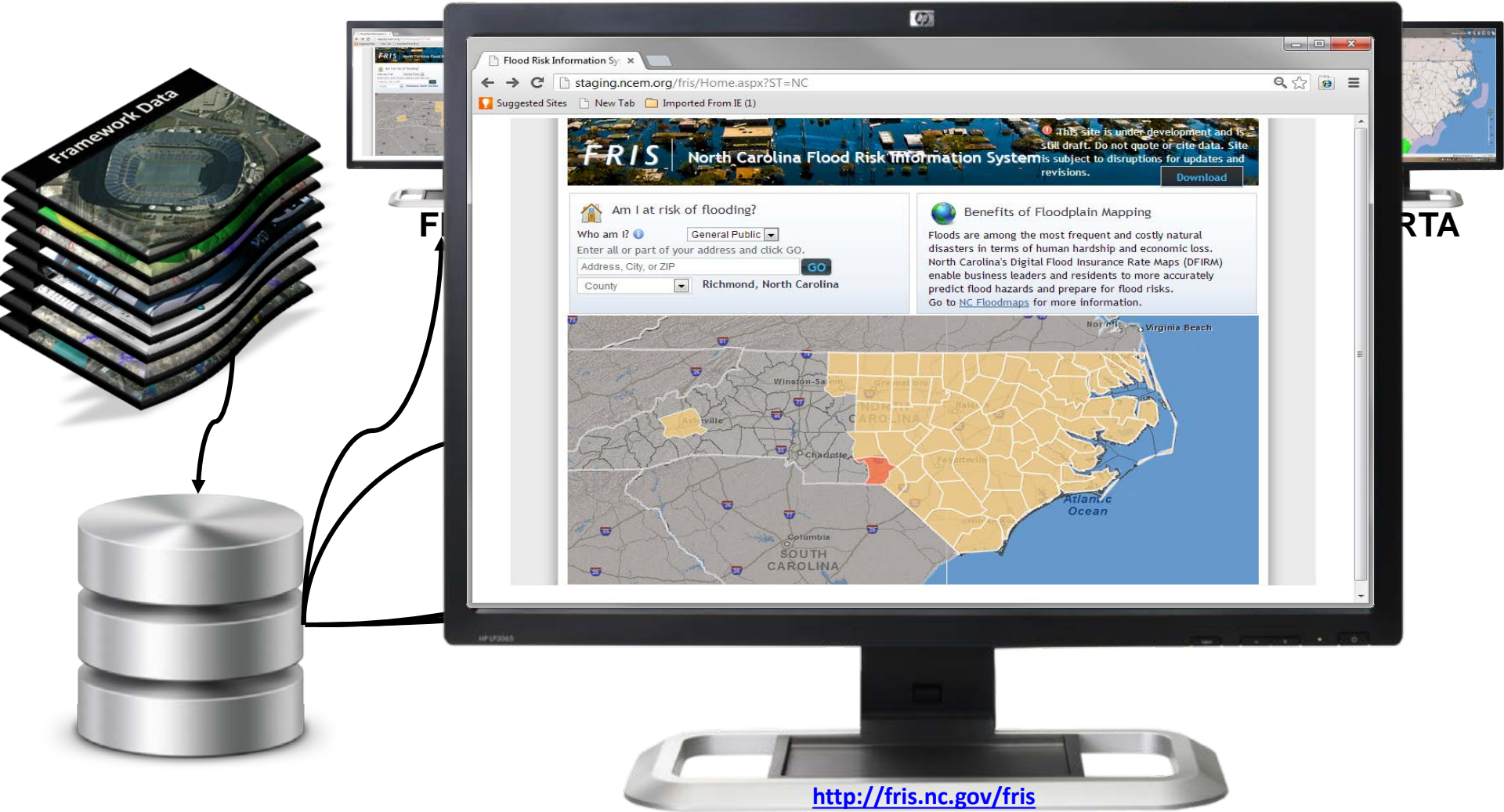


SPARTA

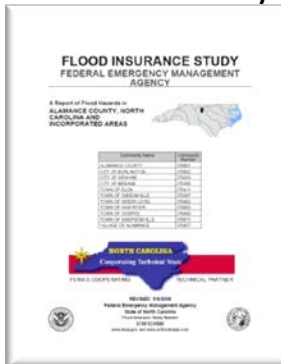


**Enterprise
Risk DB**

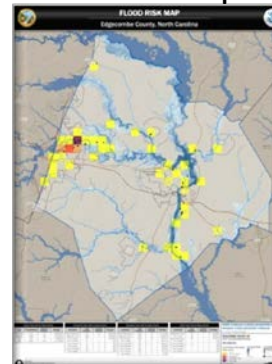




Flood Insurance Study

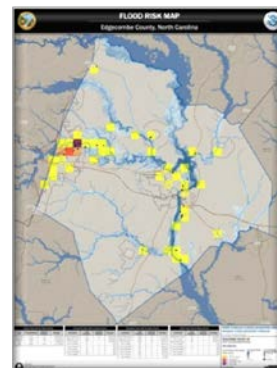
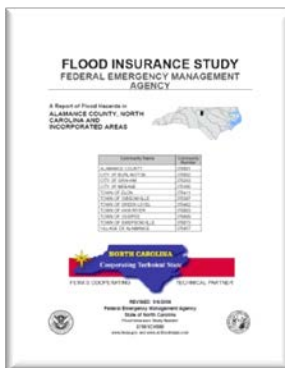
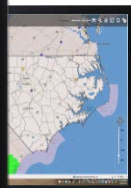
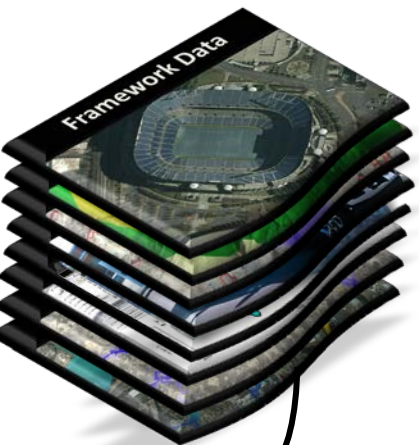


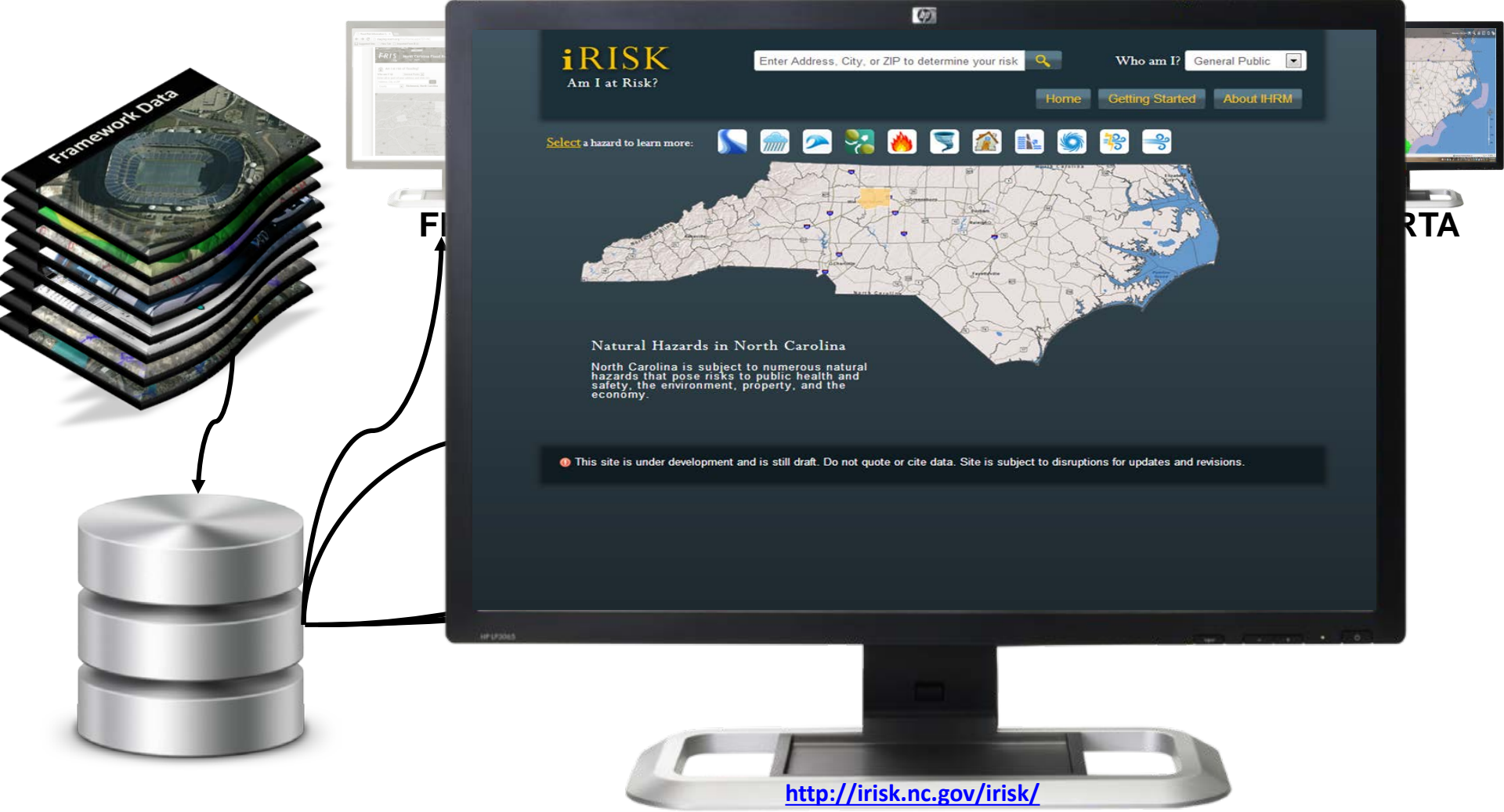
Flood Risk Map



Flood Risk Report

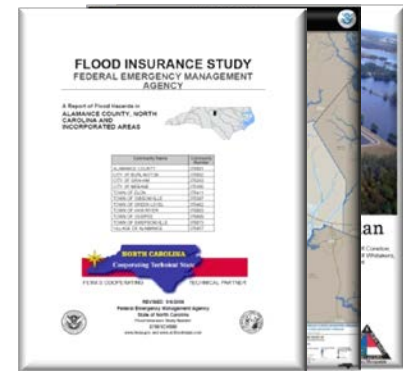
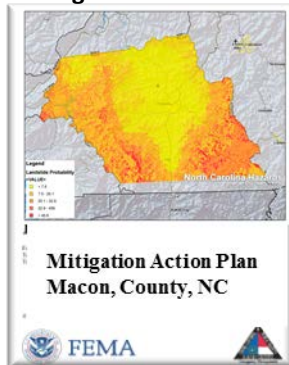


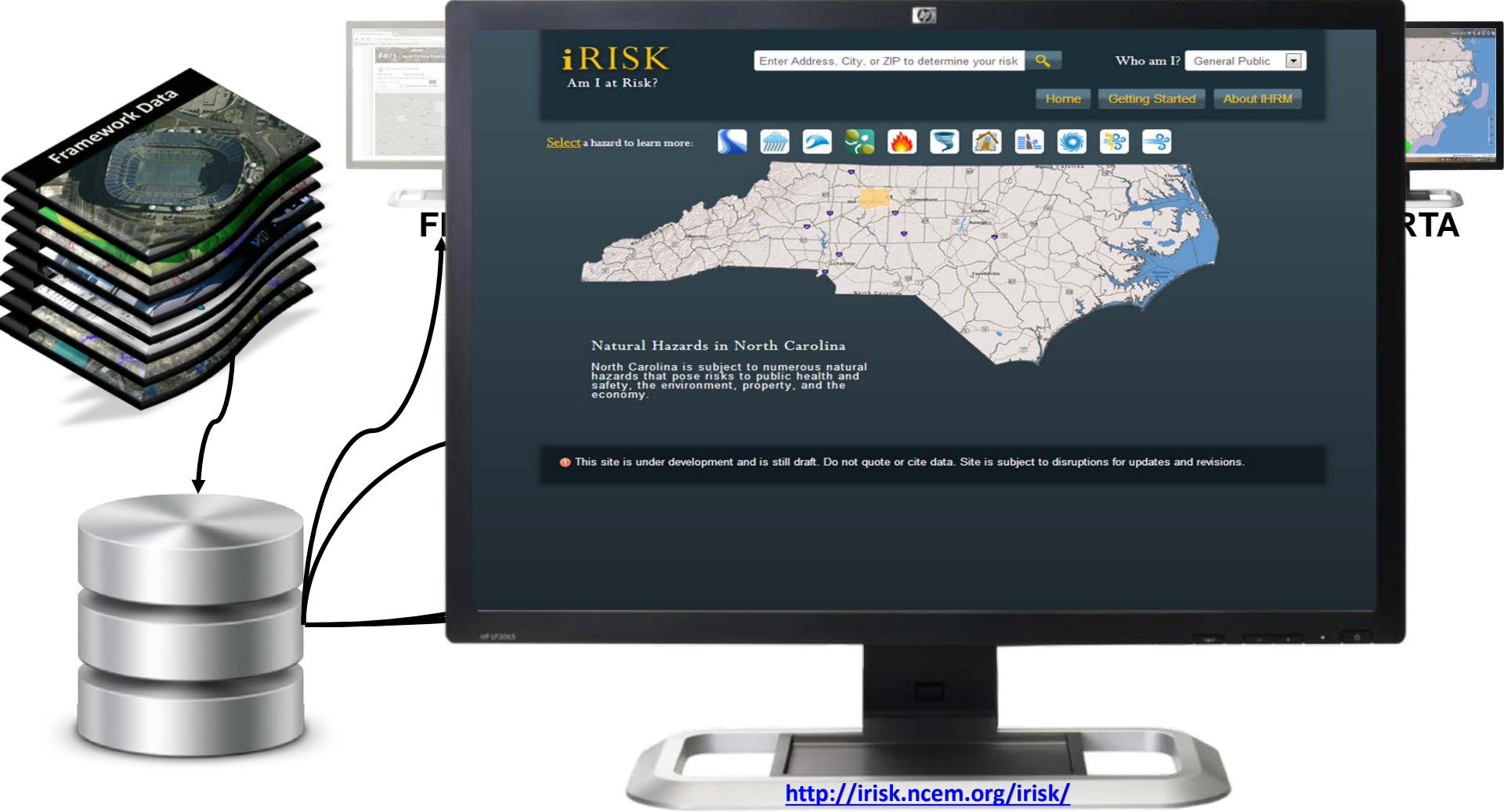




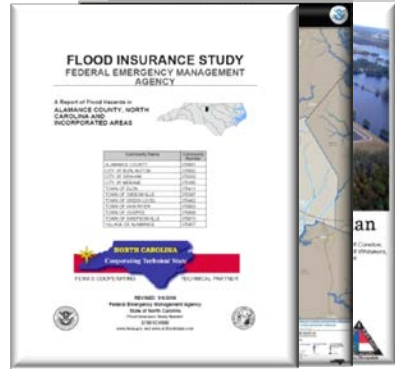
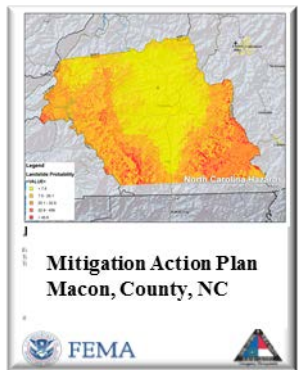
<http://irisk.nc.gov/irisk/>

Mitigation Action Plan

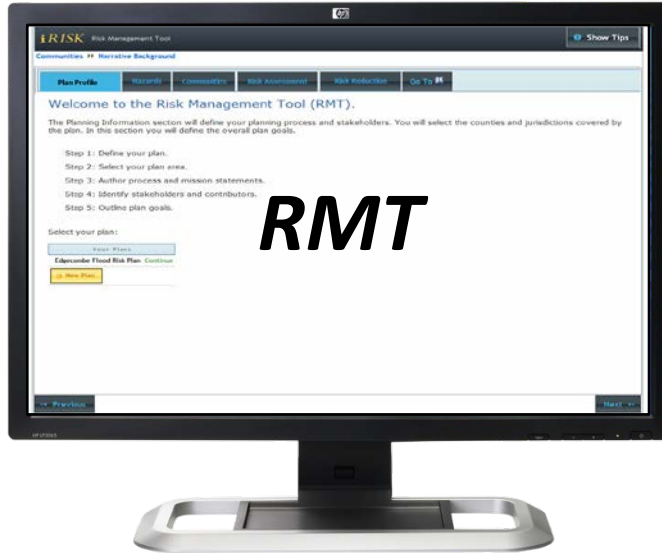




<http://irisk.ncem.org/irisk/>



FRIS & iRISK



Flood Risk Management Plan
Durham County, NC

Prepared for:
North Carolina Floodplain Mapping Program
4105 Reedy Creek Road
Raleigh, NC 27607

Prepared by:
ESP Associates
1121 Kingston Way - Suite 208
Raleigh, NC 27607

Flood Risk Mgmt. Plan

Drought Management Plan
Durham County, NC

Prepared for:
North Carolina Floodplain Mapping Program
4105 Reedy Creek Road
Raleigh, NC 27607

Prepared by:
ESP Associates
1121 Kingston Way - Suite 208
Raleigh, NC 27607

Drought Plan

OLD STONY CREEK DAM

EMERGENCY ACTION PLAN (EAP)
State ID: AL-ASMA-014
Allamance County, North Carolina

July 28, 2012

Owner/Operator Information:
City of Burlington Water Resources
1122 Bennett Street
Burlington, NC 27215
City Manager: (336) 222-0136
Planning Phone: (336) 634-2206

NORTH CAROLINA

Old Stony Creek Dam

Prepared for:
North Carolina Floodplain Mapping Program
4105 Reedy Creek Road
Raleigh, NC 27607

Prepared by:
ESP Associates
1121 Kingston Way - Suite 208
Raleigh, NC 27607

Dam Emrg. Action Plan

Landslide Management Plan
Macon County, NC

Prepared for:
North Carolina Floodplain Mapping Program
4105 Reedy Creek Road
Raleigh, NC 27607

Prepared by:
ESP Associates
1121 Kingston Way - Suite 208
Raleigh, NC 27607
November 2011

Other Hazards

NEW HANOVER COUNTY
NORTH CAROLINA

MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

SEPTEMBER 2004

FRIS & iRISK



RMT



Overall Hazard Mitigation Plan

Flood Risk Management Plan
Durham County, NC

Prepared for:
North Carolina Floodplain Mapping Program
4105 Beards Creek Road
Raleigh, NC 27607

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ESP Associates
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Flood Risk Mgmt. Plan

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Drought Plan

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Other Hazards

NEW HANOVER COUNTY
NORTH CAROLINA
MULTI-JURISDICTIONAL
HAZARD MITIGATION PLAN

SEPTEMBER 2004

Prepared for:
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4105 Beards Creek Road
Raleigh, NC 27607

Prepared by:
ESP Associates
5121 Kingston Way - Suite 208
Raleigh, NC 27607

November 2013



Am I at risk of flooding?

State: ▼

Click the map to select a state



Benefits of Floodplain Mapping

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. The Regional Flood Risk Information System allows states to share and distribute flood risk information more effectively.



This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for update and revisions.

Who Am I : Advanced

Flood Information

Click the map to view information.

106 Higbee St, Durham, NC
Google Street View

Map Location

Flood Zone: AE

Flood Source: Ellerbe Creek

Base Flood Elevation: 309.6 ft

County: Durham

Political Area: City Of Durham

CID: 370086

Panel: 0832

Map Number: 3720083200J

Panel Effective Date: 05/02/06

Latitude: 36.01614

Longitude: -78.89212

Impacted Structure

Parcel ID: 0832-13-14-8890

Intersecting Flood Zone: AE

Risk Information

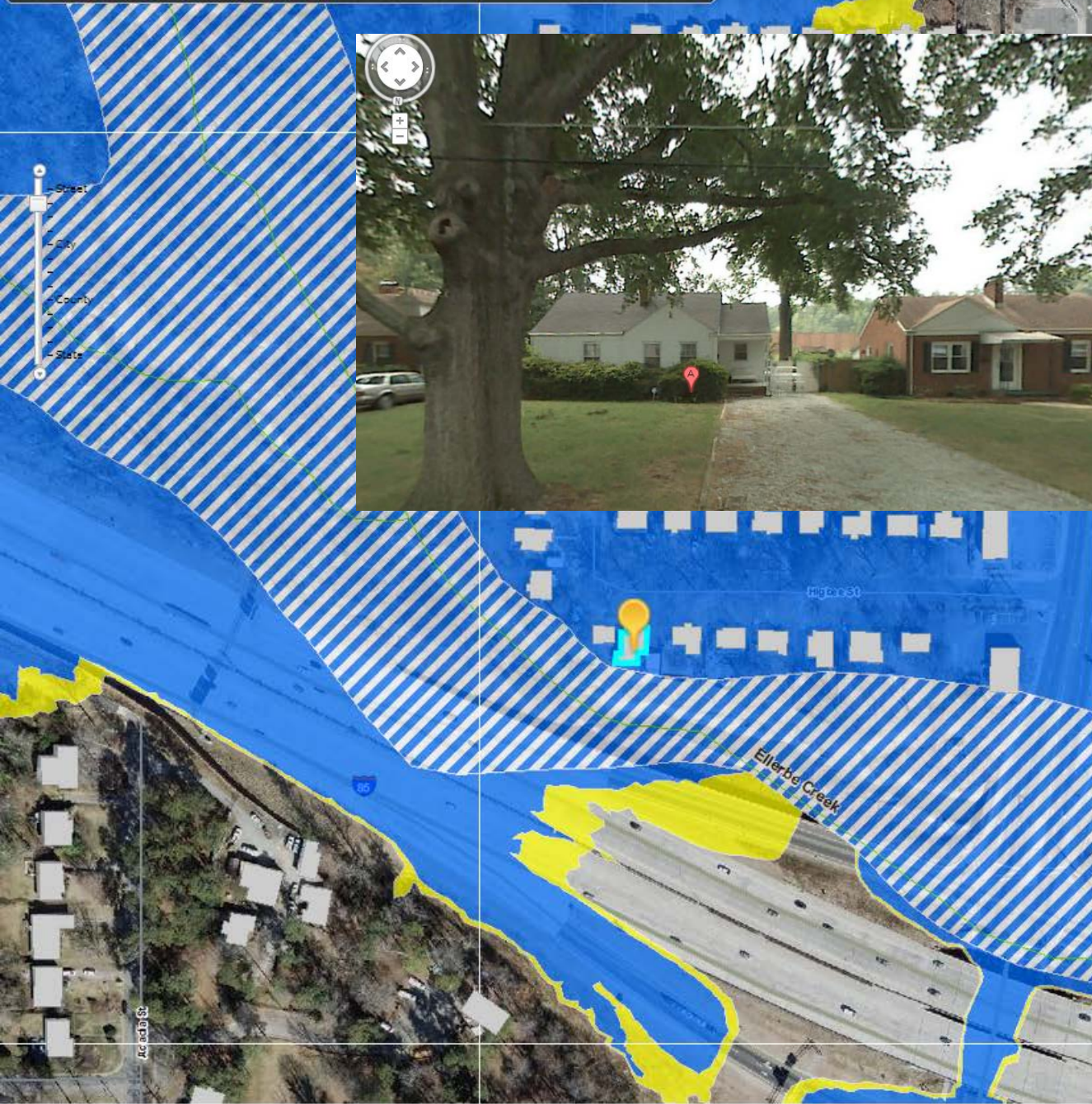
Financial Vulnerability

FIS Reports

Engineering Models

Map Export

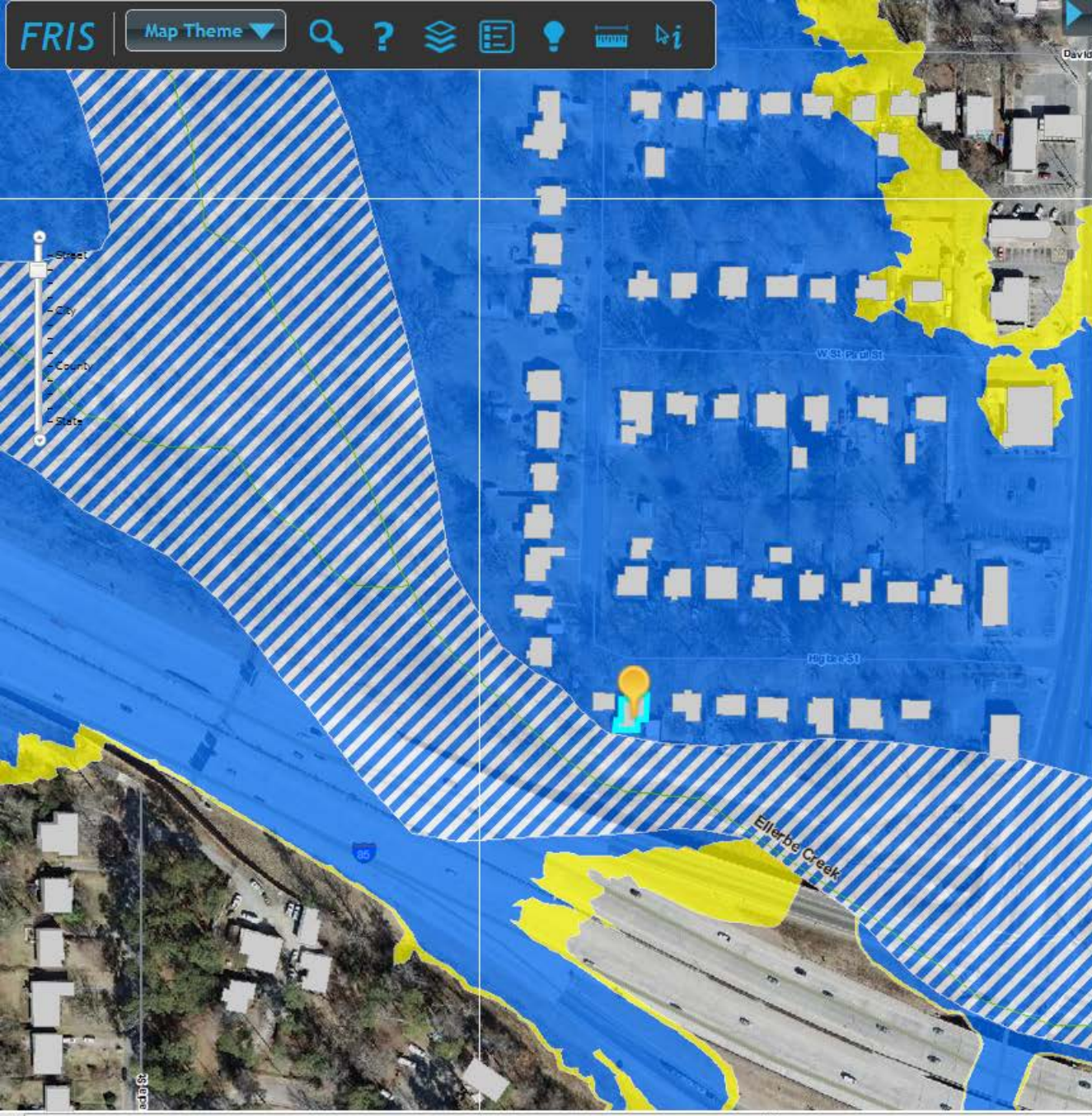
Data Export



Academy St

Ellerbe Creek

Higbee St



- Street
- City
- County
- State

This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for update and revisions.

Who Am I : Advanced

Flood Information

Risk Information

Risk is not calculated for this county.

106 Higbee St, Durham, NC

Google Street View

Property

Building Value (\$):

Stories:

Square Feet (ft):

Foundation:

Occupancy Type:

The river flooding hazard is rated **High** for this location.

Annual Chance of Flood	Depth Above Finished Floor (in feet)	Damage	Building Losses
10 %	-2.2	1%	\$737
4 %	N/A	0%	N/A
2 %	0.3	8%	\$6,790
1 %	0.9	9%	\$7,954
.2 %	2.8	17%	\$15,618

Reduce My Risk



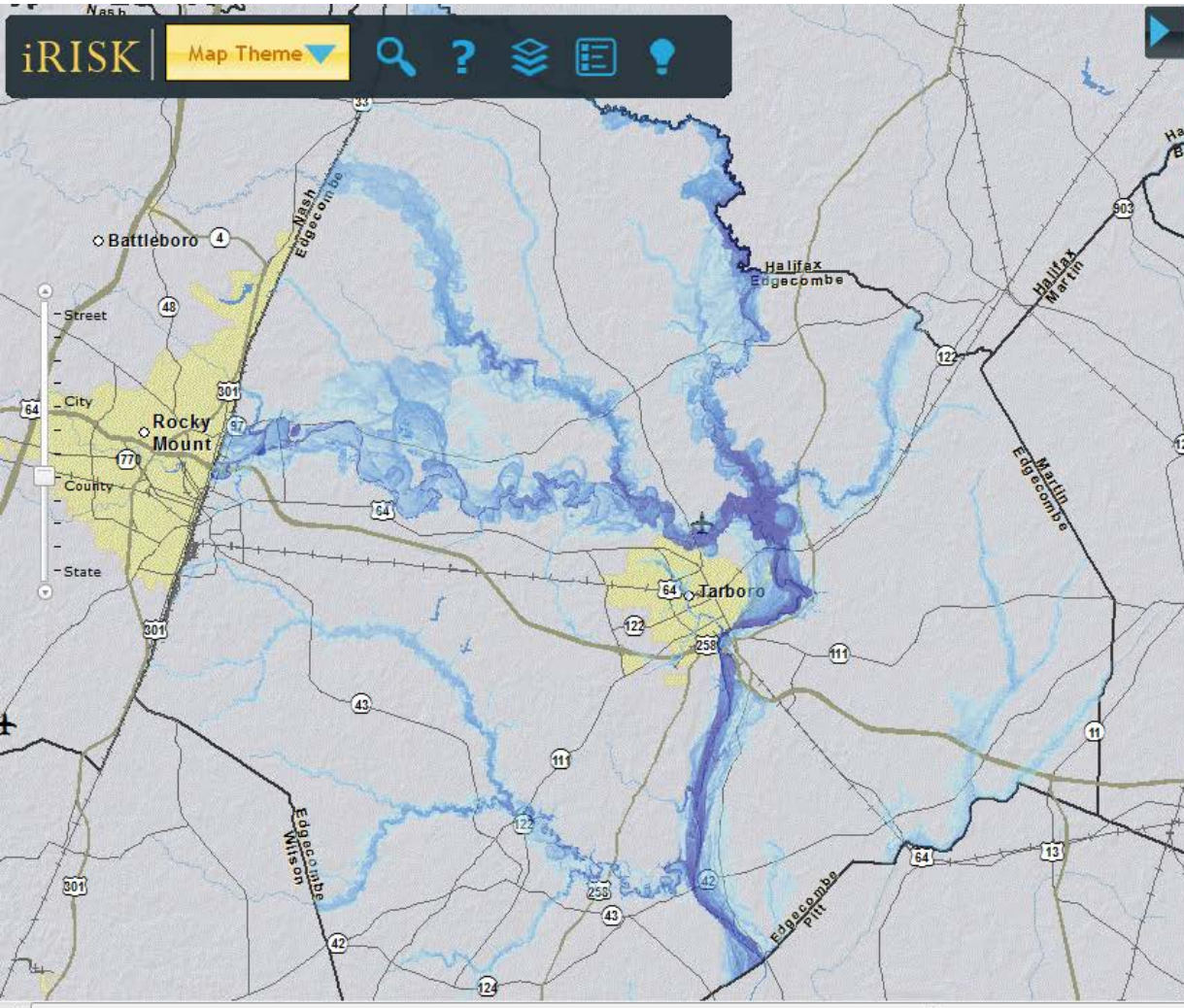
Select a hazard to learn more:



Natural Hazards in North Carolina

North Carolina is subject to numerous natural hazards that pose risks to public health and safety, the environment, property, and the economy.

ⓘ This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.



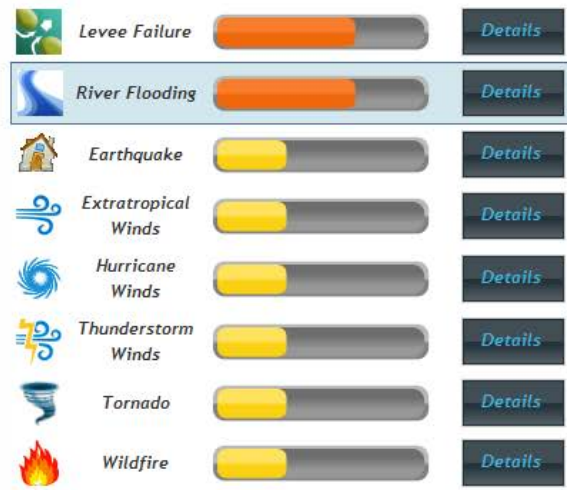
This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

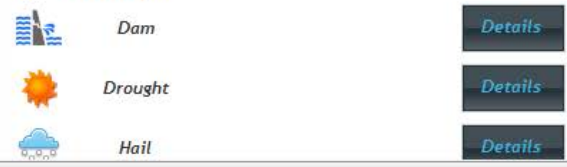
What are my county risks?

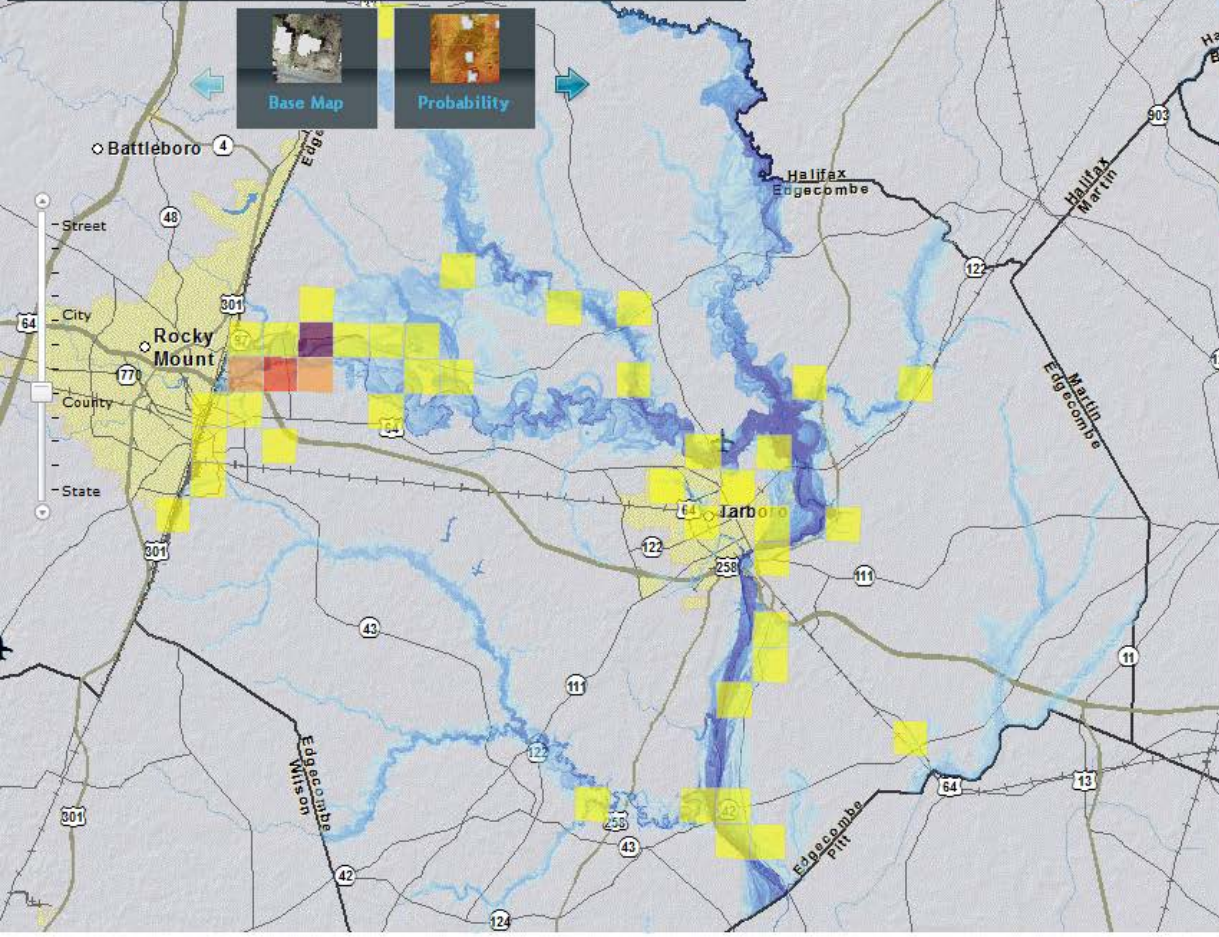
Edgemoor

Hazard Risk



Hazard Impact





This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

- [▶ How does river flooding impact this property?](#)
- [▶ What are my county risks?](#)

County Information

Edgecombe

Number of buildings potentially affected: 1,453

River Flooding

Choose a Return Period (in years)

- 10
 25
 50
 100
 500

- [Damages](#)
[Jurisdictions](#)
[Sectors](#)
[Top Lists](#)

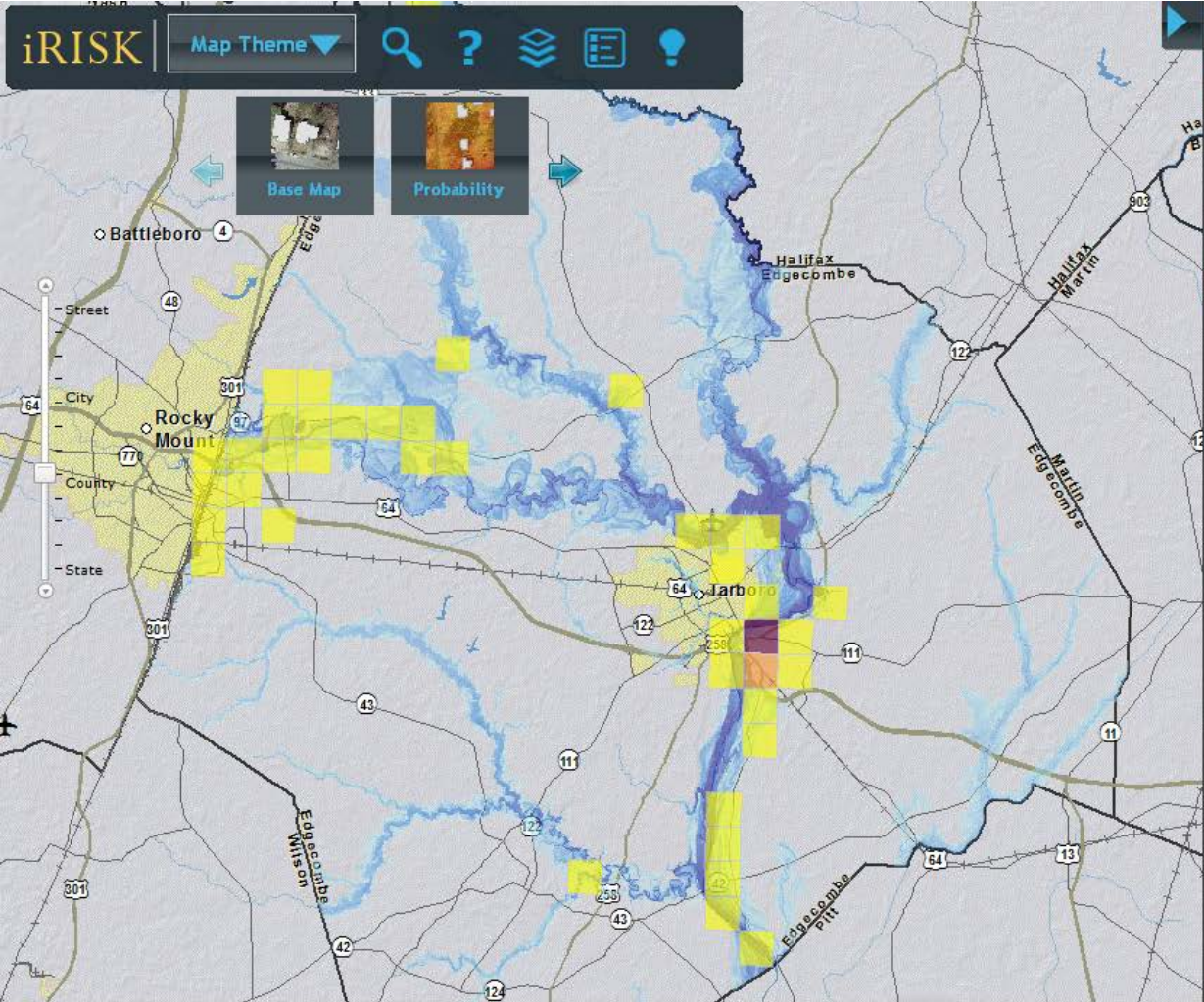
Map: River Flooding (100 year)
Building Damage Hot Spots


The legend colors represent the range of damages.

Total Damage Relative Losses

- 0 - 19% (Low)
- 20 - 39% (Low-Medium)
- 40 - 59% (Medium)
- 60 - 79% (Medium-High)
- 80 - 100% (High)

[County Mitigation Wizard](#) ▶



 This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

- [▶ How does river flooding impact this property?](#)
- [▶ What are my county risks?](#)

County Information

Edgcombe 

Number of buildings potentially affected: 3,328

 River Flooding

Choose a Return Period (in years)

- 10
- 25
- 50
- 100
- 500

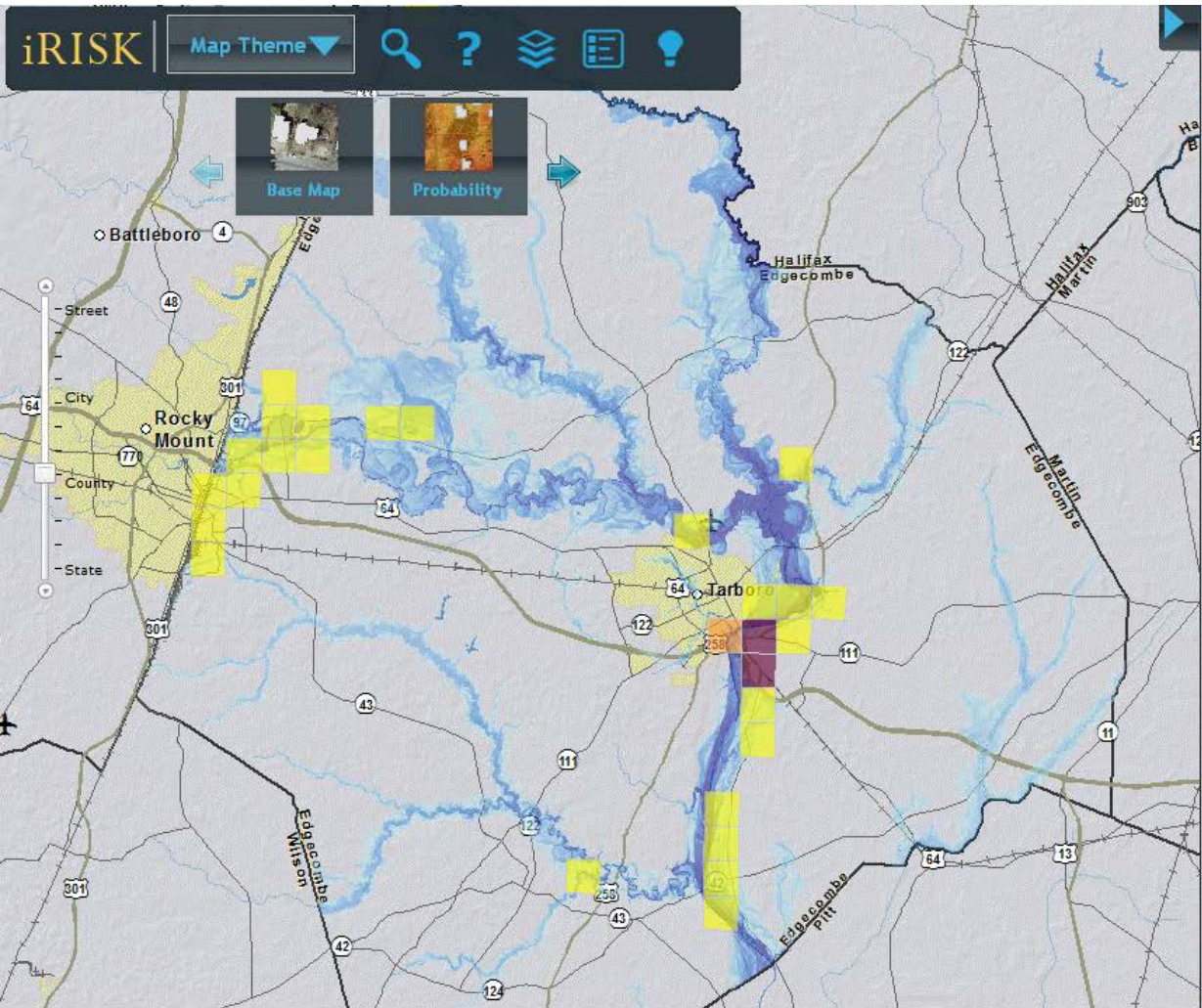
- [Damages](#)
- [Jurisdictions](#)
- [Sectors](#)
- [Top Lists](#)

Map: River Flooding (500 year)
Building Damage Hot Spots

The legend colors represent the range of damages.

- Total Damage Relative Losses**
- 0 - 19% (Low)
 - 20 - 39% (Low-Medium)
 - 40 - 59% (Medium)
 - 60 - 79% (Medium-High)
 - 80 - 100% (High)

[County Mitigation Wizard](#) ▶



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User Feedback

- ▶ How does river flooding impact this property?
- ▶ What are my county risks?

County Information

Edgecombe

Number of buildings potentially affected: 3,328

River Flooding

Choose a Return Period (in years)

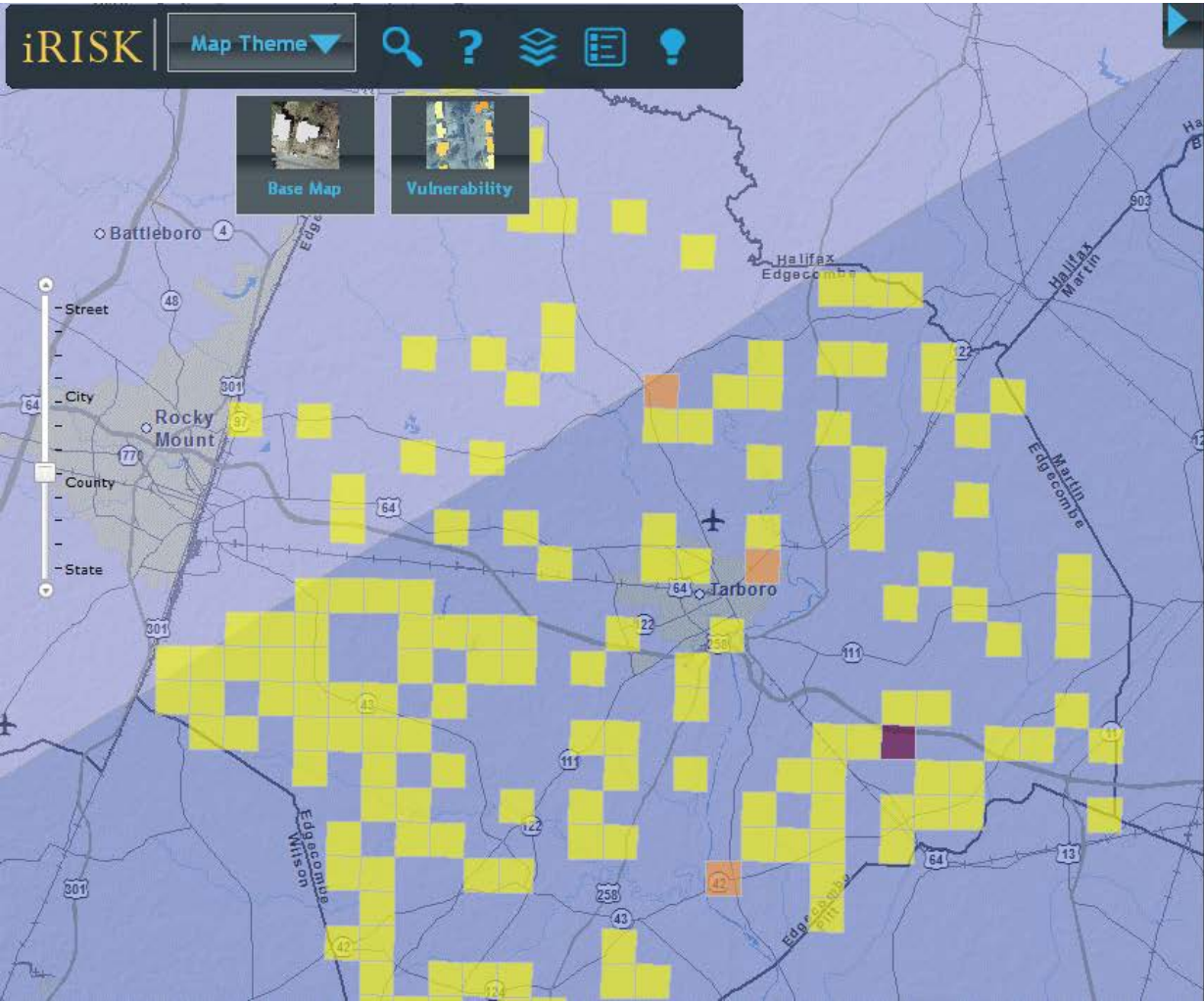
- 10
- 25
- 50
- 100
- 500

- Damages
- Jurisdictions
- Sectors
- Top Lists

Map: River Flooding (500 year)
Sector: Commercial Facilities

Click a sector name to view map hotspots.

Sector	Damages (\$)	Buildings Affected
Agriculture and Food Distribution	1,024,513	45
Banking and Finance	105,315	4
Commercial Facilities	5,267,795	136
Government	1,126,216	11
Healthcare and Public Health	609,909	11



This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

- ▶ How do hurricane winds impact this property?
- ▶ What are my county risks?

County Information

Edgcombe

Number of buildings potentially affected: 30,315

Hurricane Winds

Choose a Return Period (in years)

- 25
- 50
- 100
- 300
- 700

- Damages
- Jurisdictions
- Sectors
- Top Lists

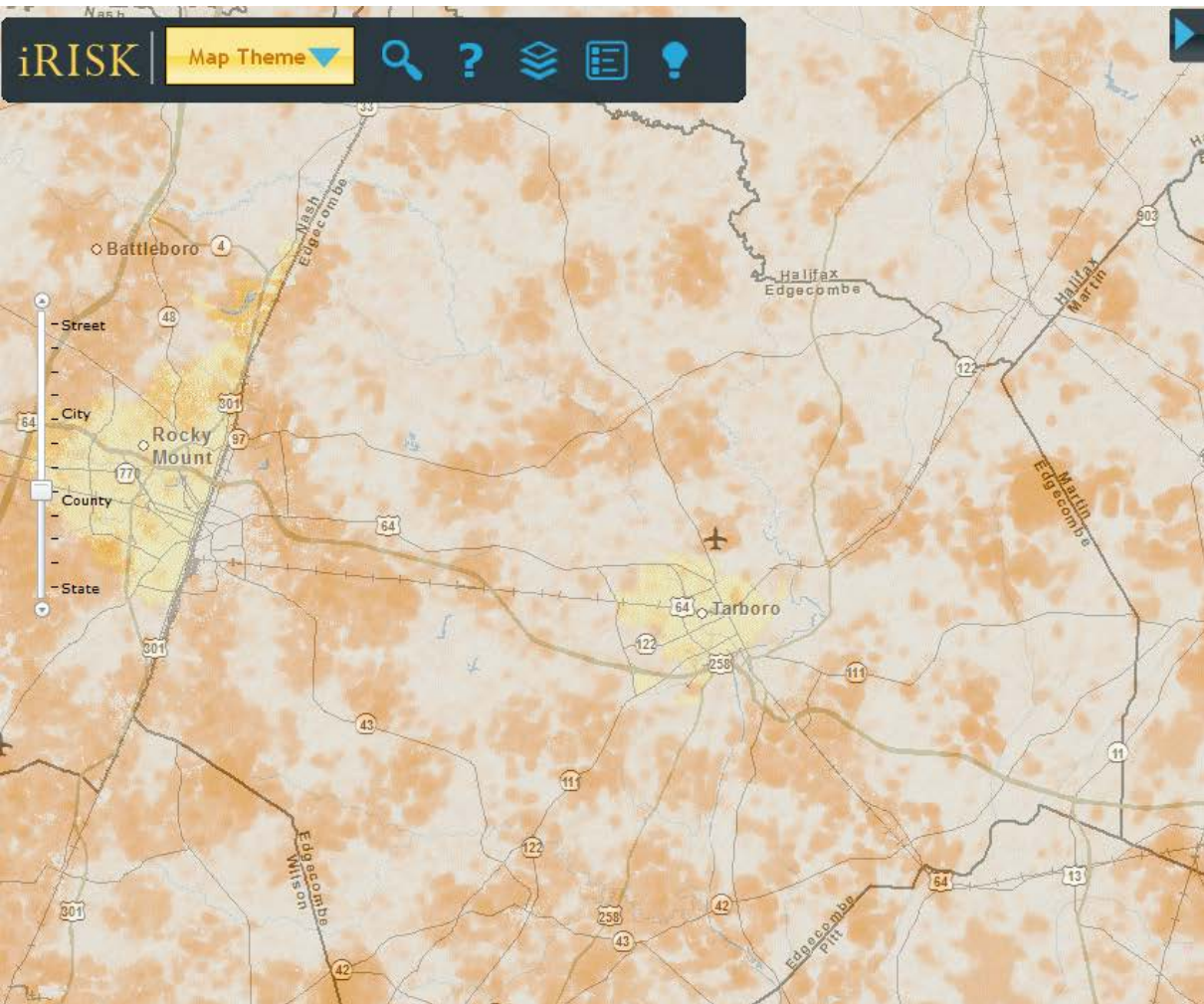
Map: Hurricane Winds (100 year)
Building Damage Hot Spots

The legend colors represent the range of damages.

Total Damage Relative Losses

- 0 - 19% (Low)
- 20 - 39% (Low-Medium)
- 40 - 59% (Medium)
- 60 - 79% (Medium-High)
- 80 - 100% (High)

County Mitigation Wizard ▶



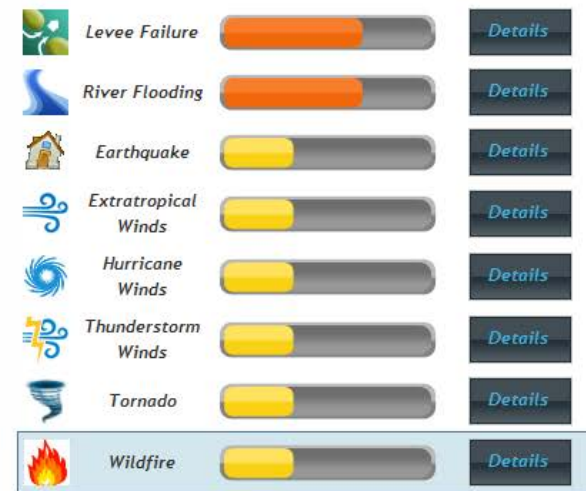
! This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

What are my county risks?

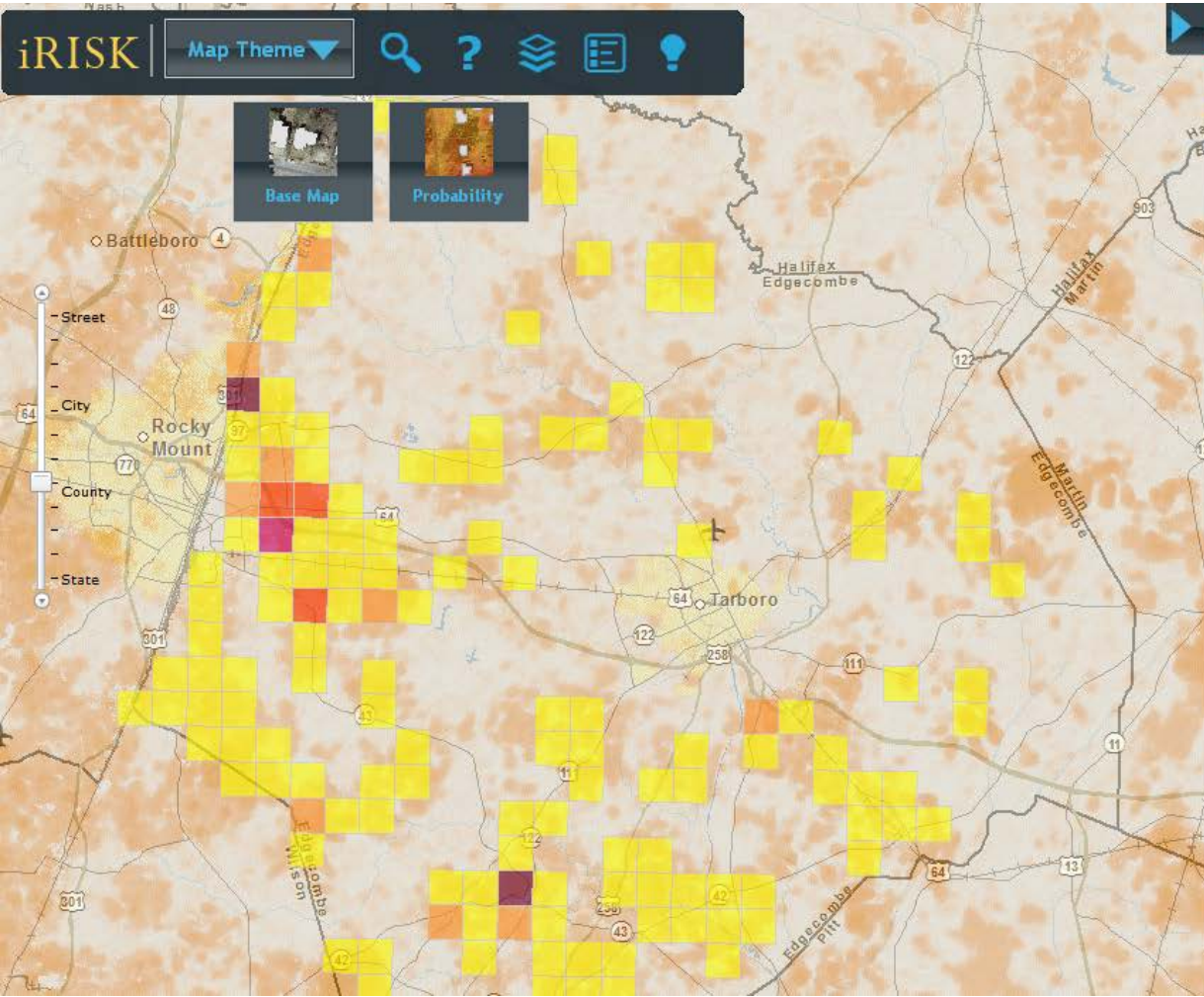
Edgecombe


Hazard Risk



Hazard Impact





 This site is under development and is still draft. Do not quote or cite data. Site is subject to disruptions for updates and revisions.

User Feedback

- [▶ How does wildfire impact this property?](#)
- [▶ What are my county risks?](#)

County Information

Edgecombe 

Number of buildings potentially affected: 3,659



- [Damages](#)
- [Jurisdictions](#)
- [Sectors](#)
- [Top Lists](#)

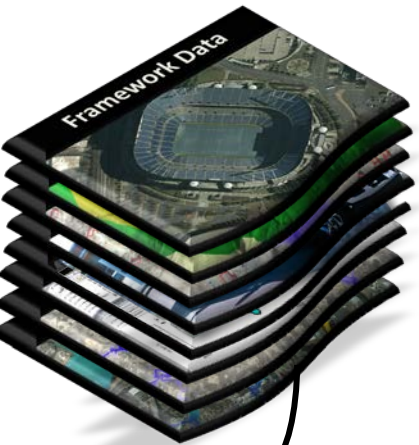
Map: Wildfire
Building Damage Hot Spots

The legend colors represent the range of damages.

Total Damage Relative Losses

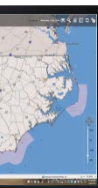
- 0 - 19% (Low)
- 20 - 39% (Low-Medium)
- 40 - 59% (Medium)
- 60 - 79% (Medium-High)
- 80 - 100% (High)

[County Mitigation Wizard](#) ▶



FR

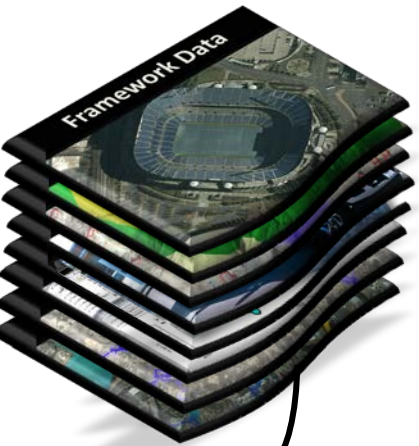
<http://www.readync.org>



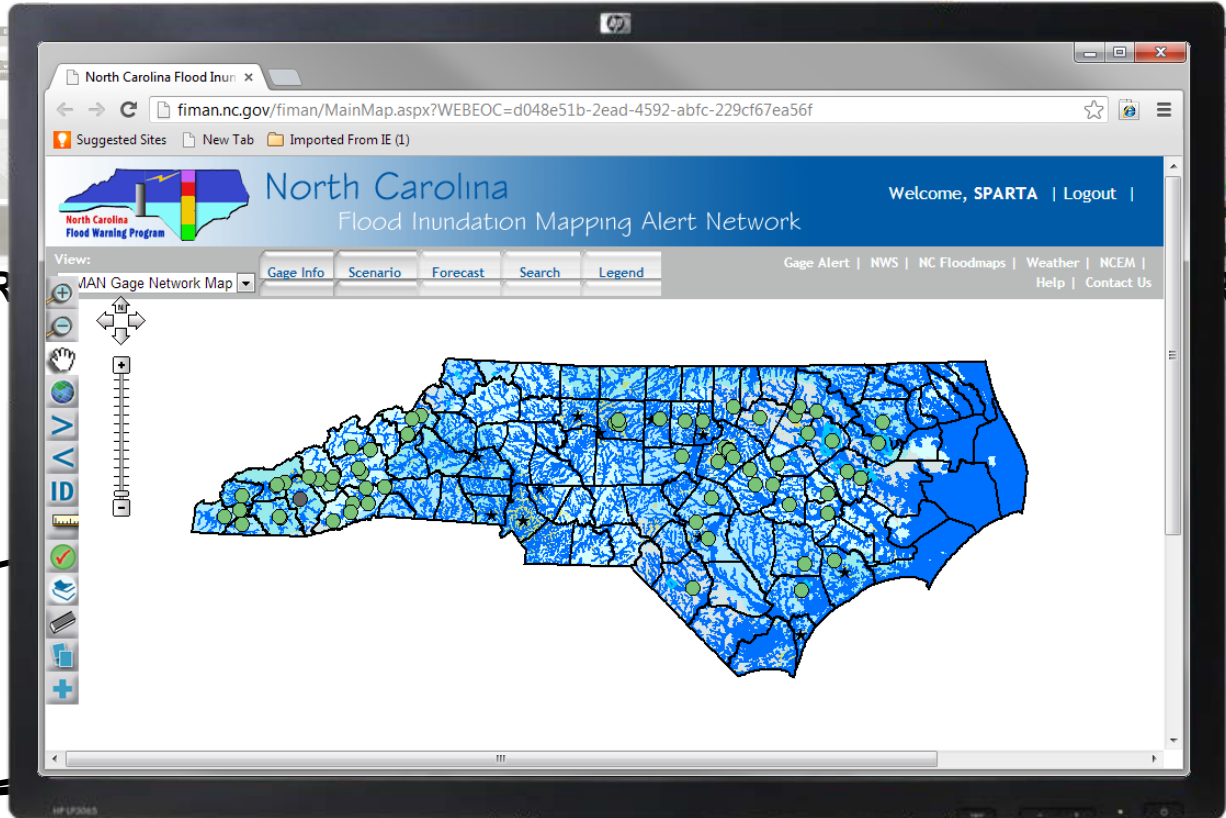
TA

**Mitigation Action Plan
Macon, County, NC**

FEMA



FR



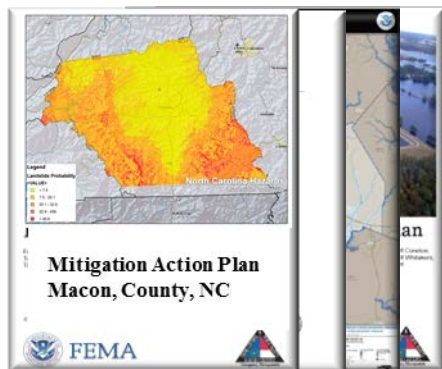
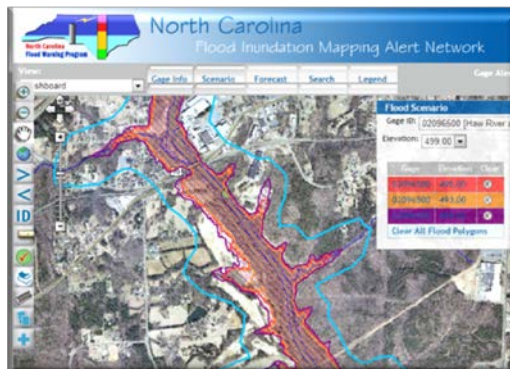
SPARTA

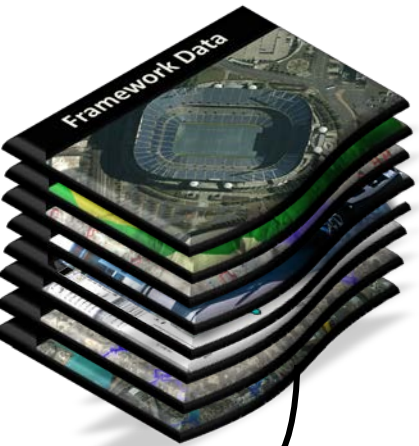
<http://fiman.nc.gov/fiman/>

Flood Inundation Mapping

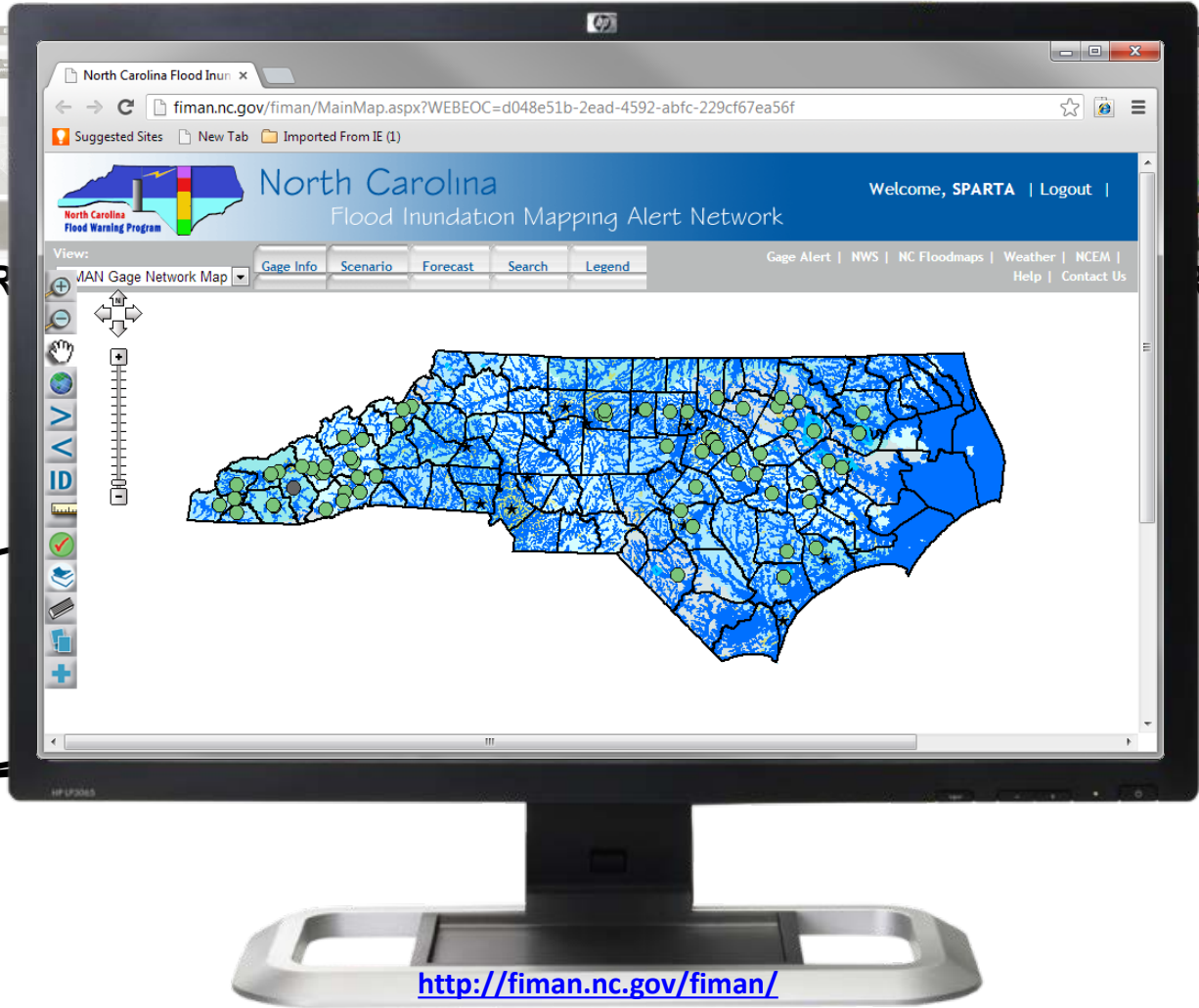


Stream Gauge Reports





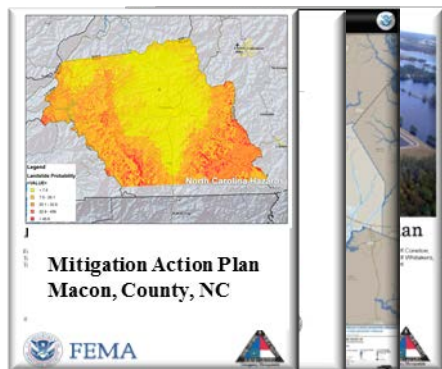
FR



RTA



Stream Gauge Reports



Coastal Gage - Profile



Weather sensors

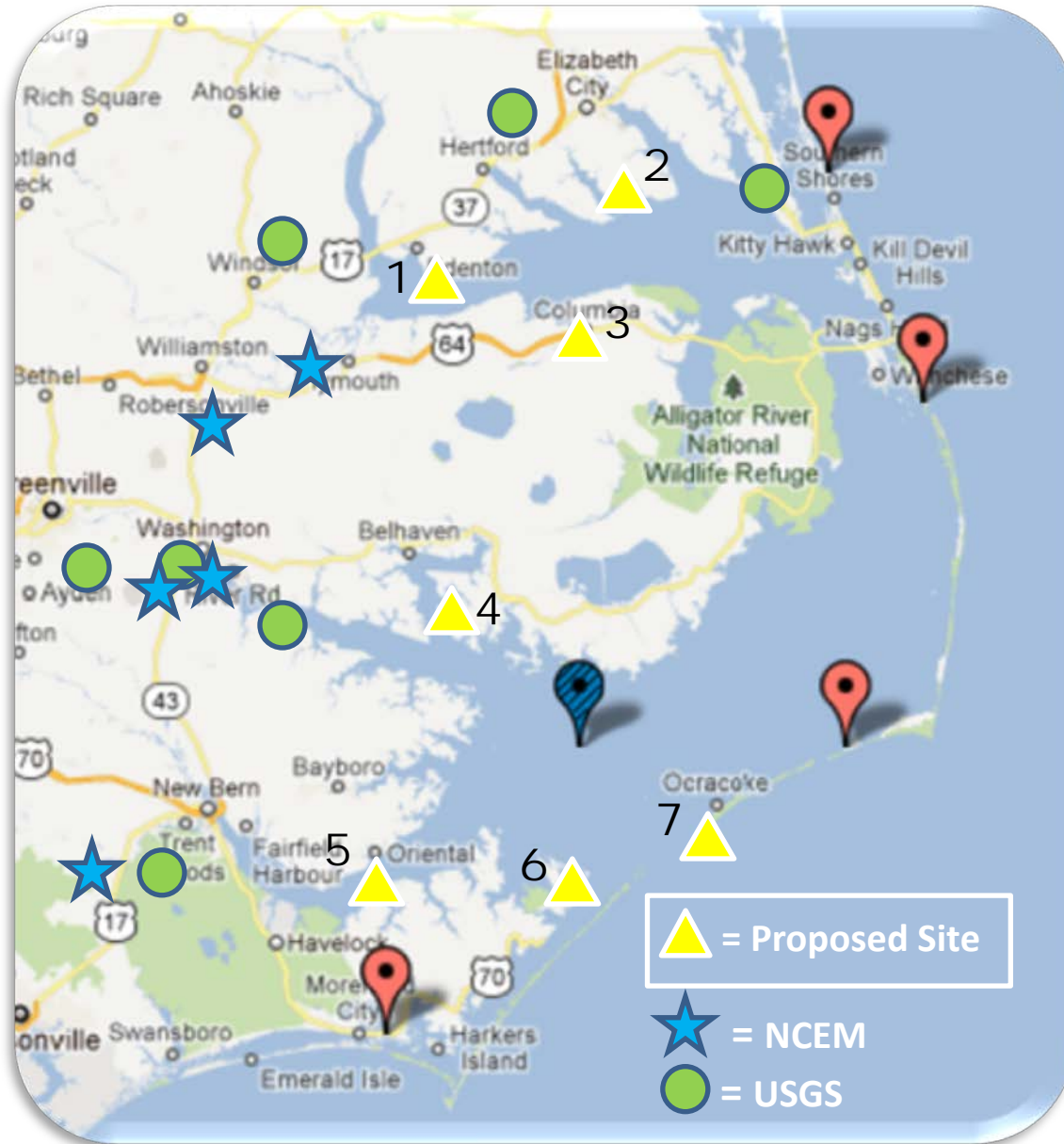
Transmission antenna

GPS receiver

Solar panel provides power to the battery

Aluminum box contains sensor devices, data collector, satellite transmitter and battery

Locations of Coastal Gages



Albemarle

1. Edenton
2. Elizabeth City
3. Columbia

Pamlico

4. Belhaven
5. Oriental
6. Cedar Island
7. Ocracoke

Waterfront Park, Albemarle Sound

Edenton, NC



Coastal Inundation Mapping and Impact Analysis - **Edenton**

Waterfront Park Site/Edenton



Waterfront Park Site/Edenton

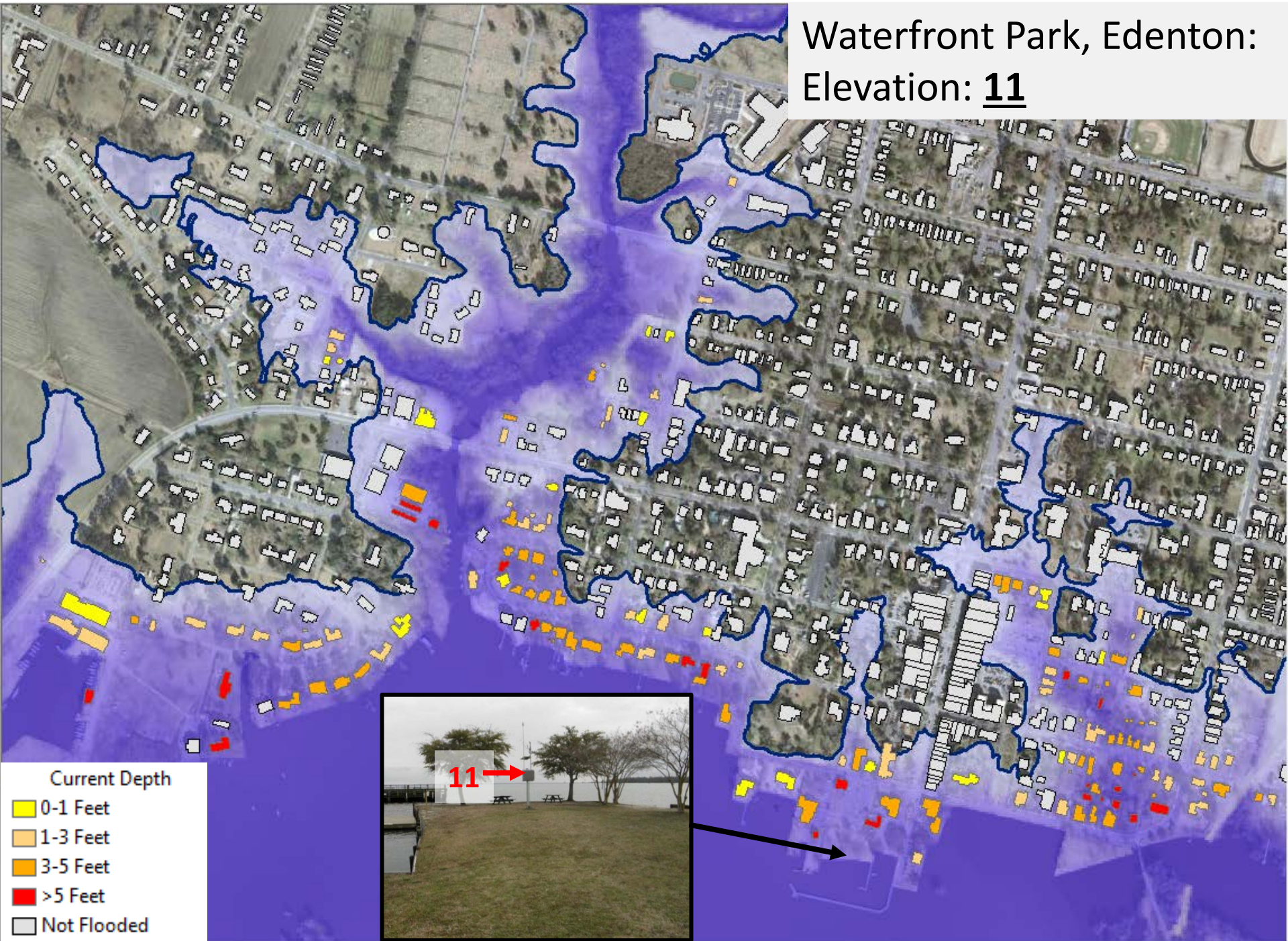
Waterfront Park, Edenton: Elevation: 6



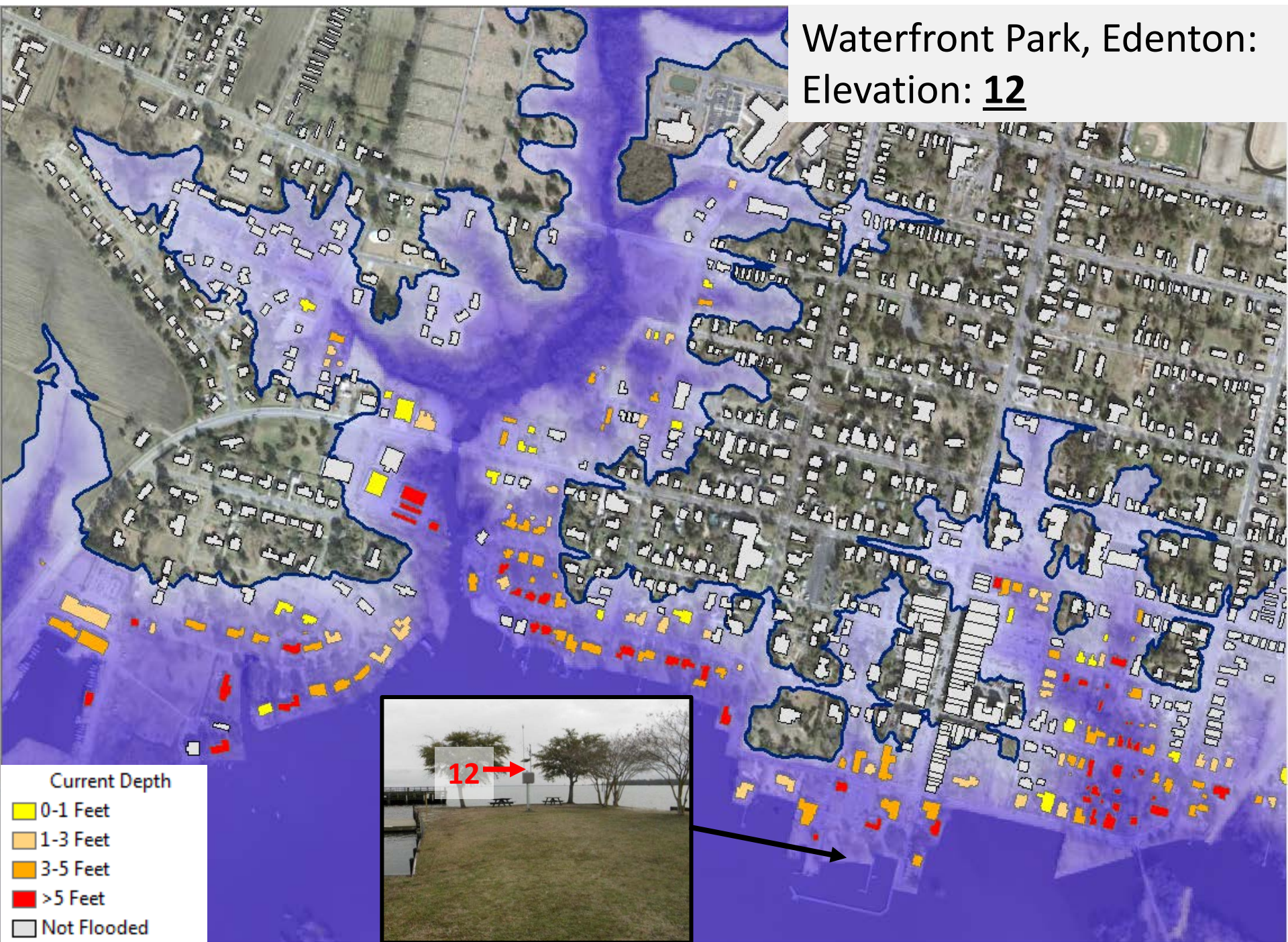
Waterfront Park, Edenton: Elevation: 8



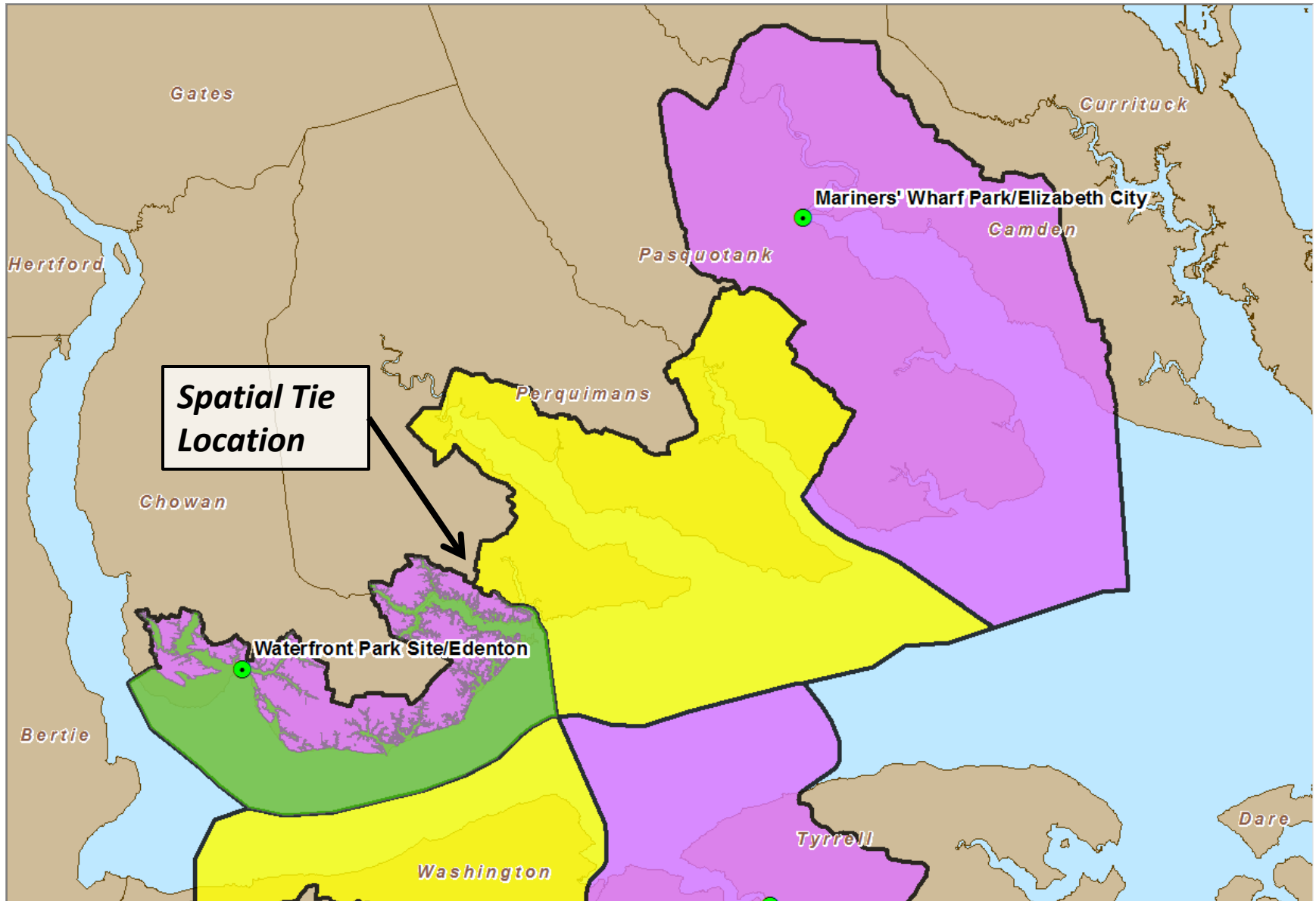
Waterfront Park, Edenton: Elevation: 11



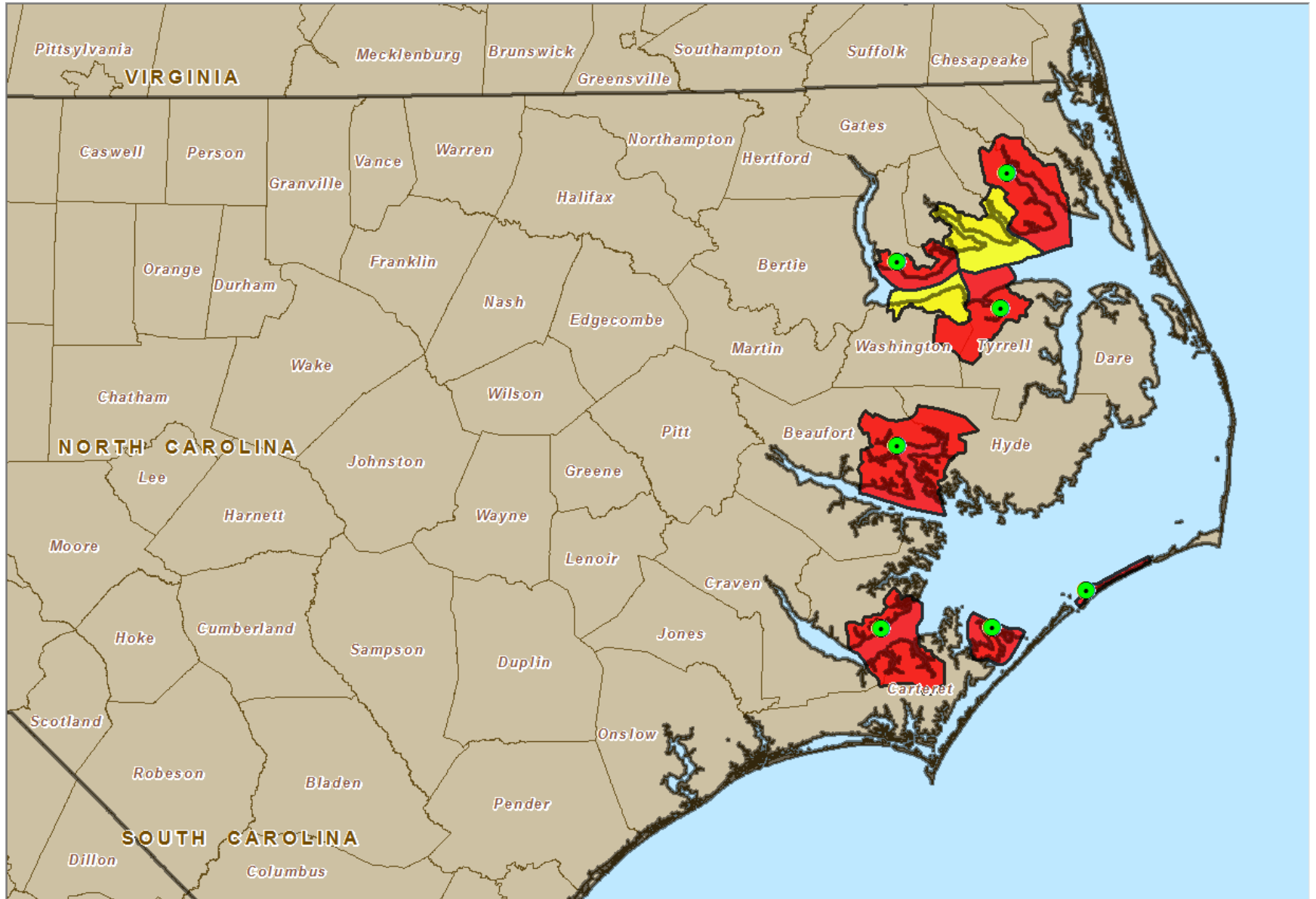
Waterfront Park, Edenton: Elevation: 12

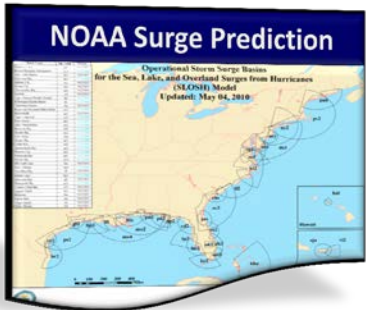
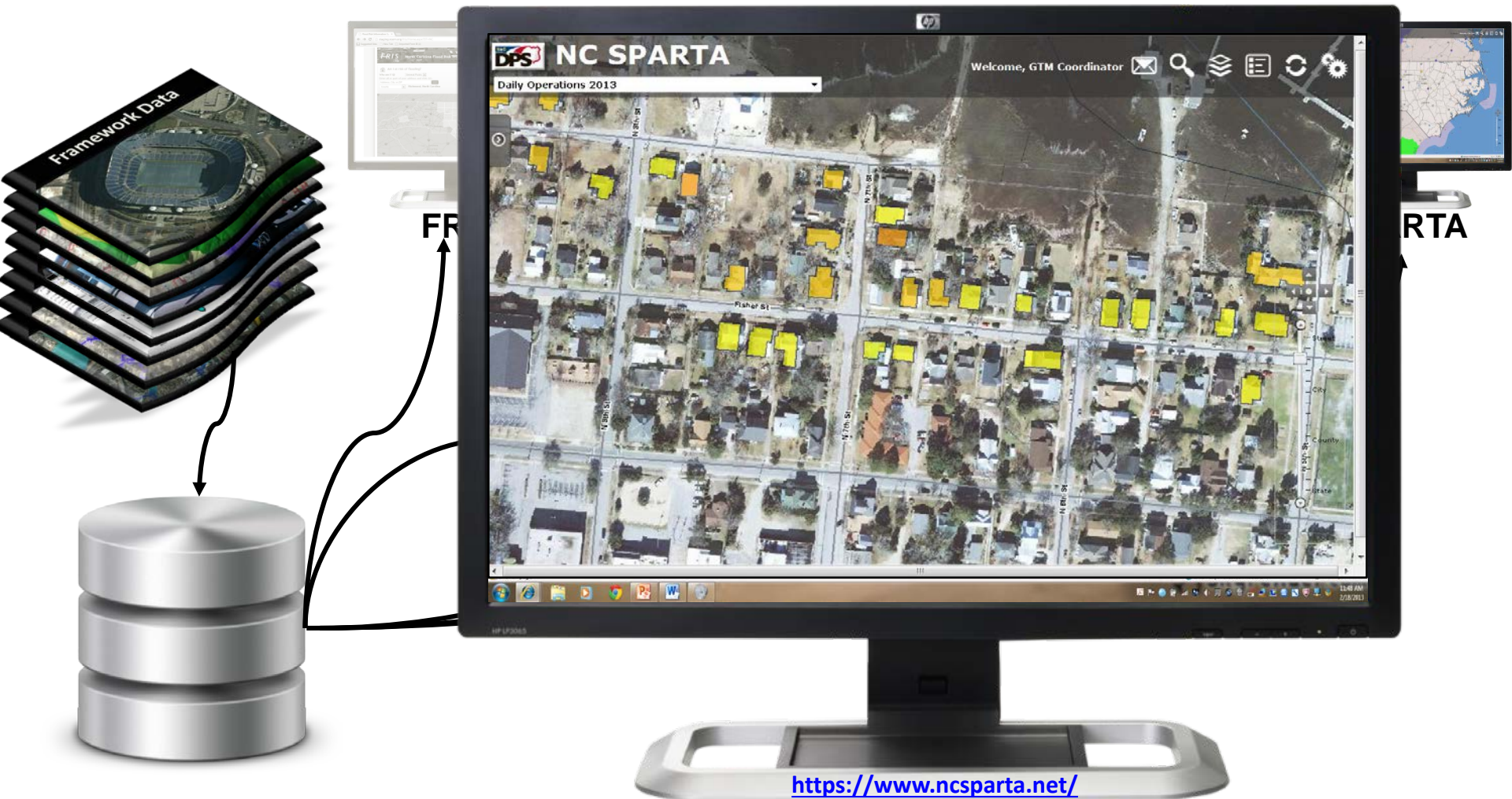


Synthetic Library Approach



Coastal Inundation Gages and Map Libraries - Locations





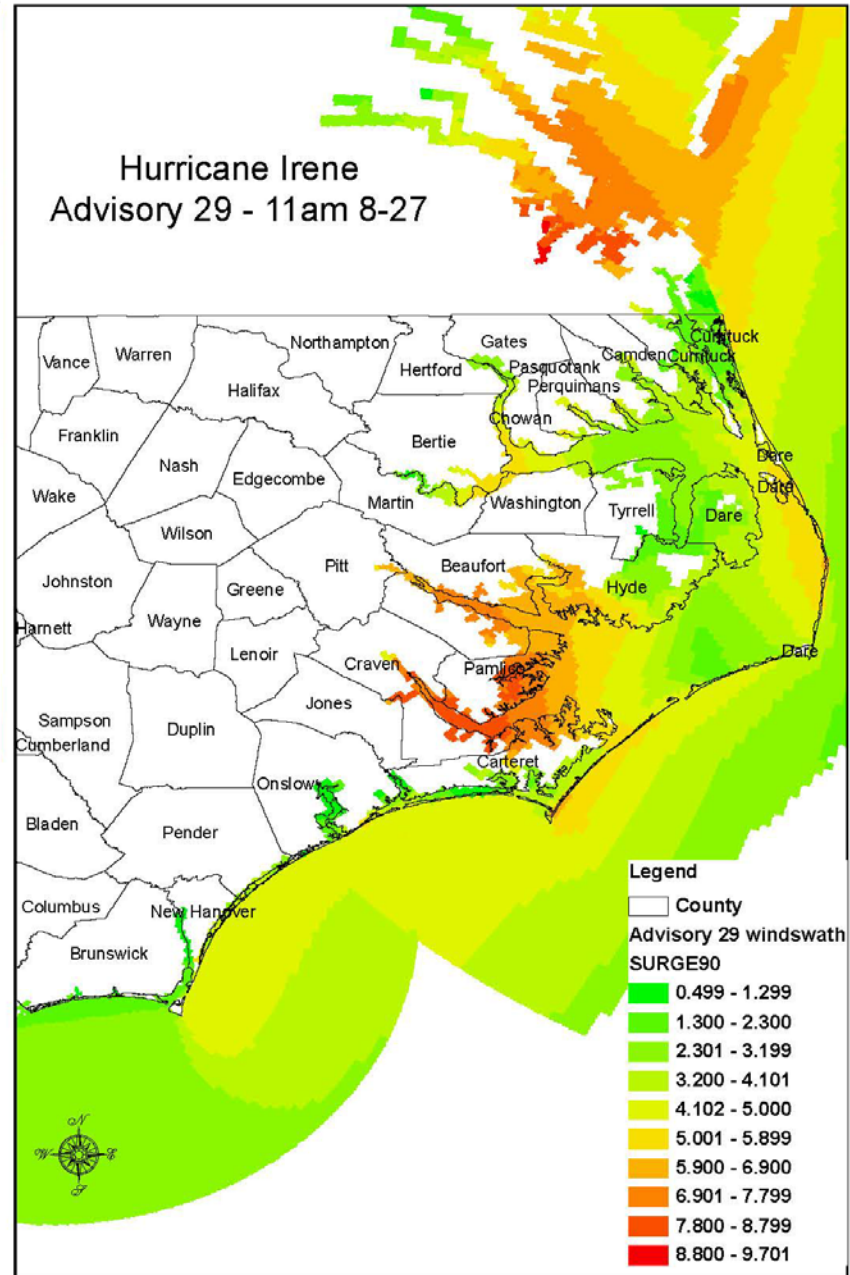
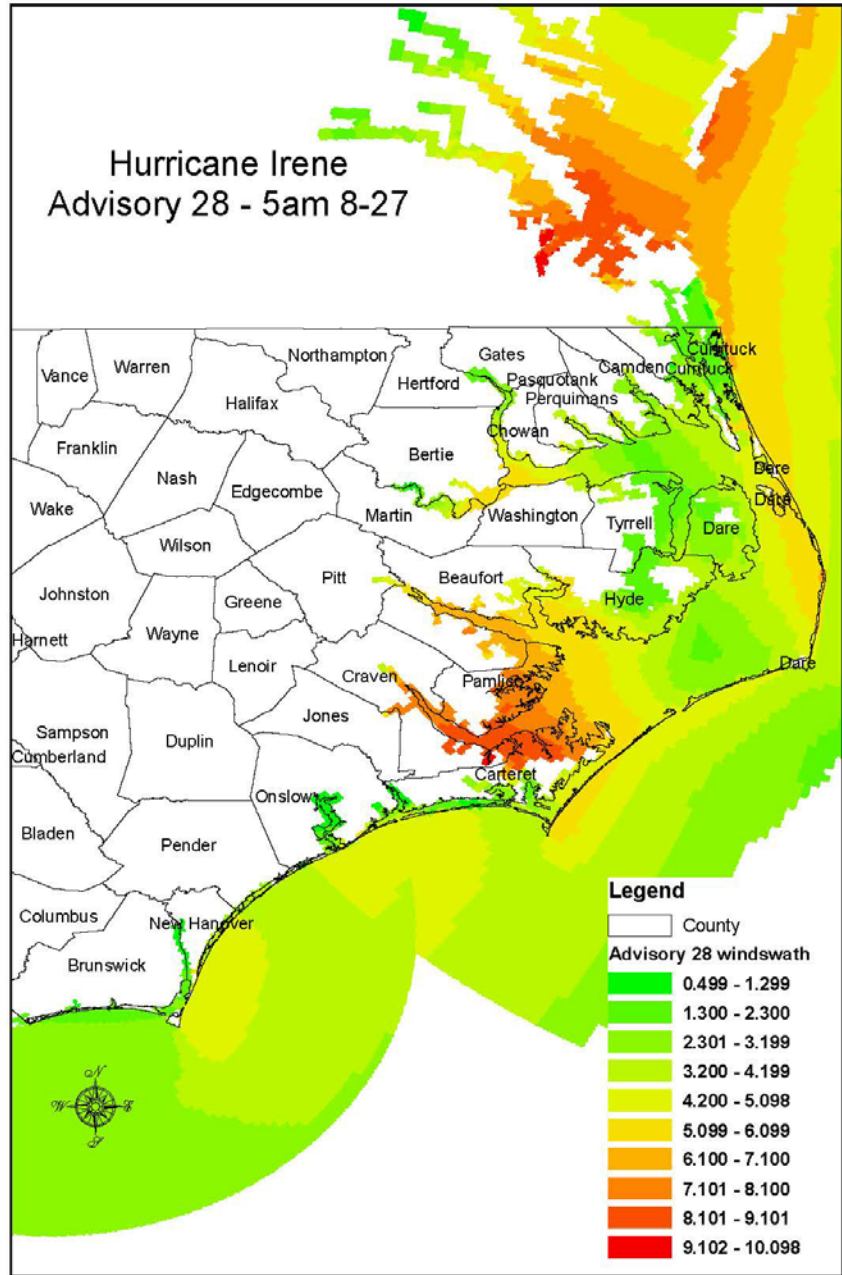
County Hotspot Report



North Carolina Department of Public Safety
Emergency Management
Hurricane Irene - Potential Damage Hotspot Report

County	Hotspot Count	Hotspot Area (sq. miles)	Hotspot Population
Albemarle	1	1.2	15,000
Ashe	2	2.5	30,000
Beaufort	3	3.8	45,000
Bladen	4	4.8	55,000
Chatham	5	5.8	65,000
Craven	6	6.8	75,000
Currituck	7	7.8	85,000
Dare	8	8.8	95,000
Davidson	9	9.8	105,000
DeWitt	10	10.8	115,000
Dobson	11	11.8	125,000
Franklin	12	12.8	135,000
Gates	13	13.8	145,000
Granville	14	14.8	155,000
Hertford	15	15.8	165,000
Hoke	16	16.8	175,000
Johnston	17	17.8	185,000
Jones	18	18.8	195,000
Lee	19	19.8	205,000
Lenoir	20	20.8	215,000
Martin	21	21.8	225,000
McCurry	22	22.8	235,000
Mecklenburg	23	23.8	245,000
Morris	24	24.8	255,000
Murray	25	25.8	265,000
Nash	26	26.8	275,000
Northampton	27	27.8	285,000
Onslow	28	28.8	295,000
Orange	29	29.8	305,000
Perquimans	30	30.8	315,000
Person	31	31.8	325,000
Ramsey	32	32.8	335,000
Robeson	33	33.8	345,000
Rockingham	34	34.8	355,000
Rowan	35	35.8	365,000
Sampson	36	36.8	375,000
Scotland	37	37.8	385,000
Swain	38	38.8	395,000
Taylorsville	39	39.8	405,000
Tobacco	40	40.8	415,000
Wake	41	41.8	425,000
Wayne	42	42.8	435,000
Yamhill	43	43.8	445,000

Real-Time Risk Analysis and Response Planning



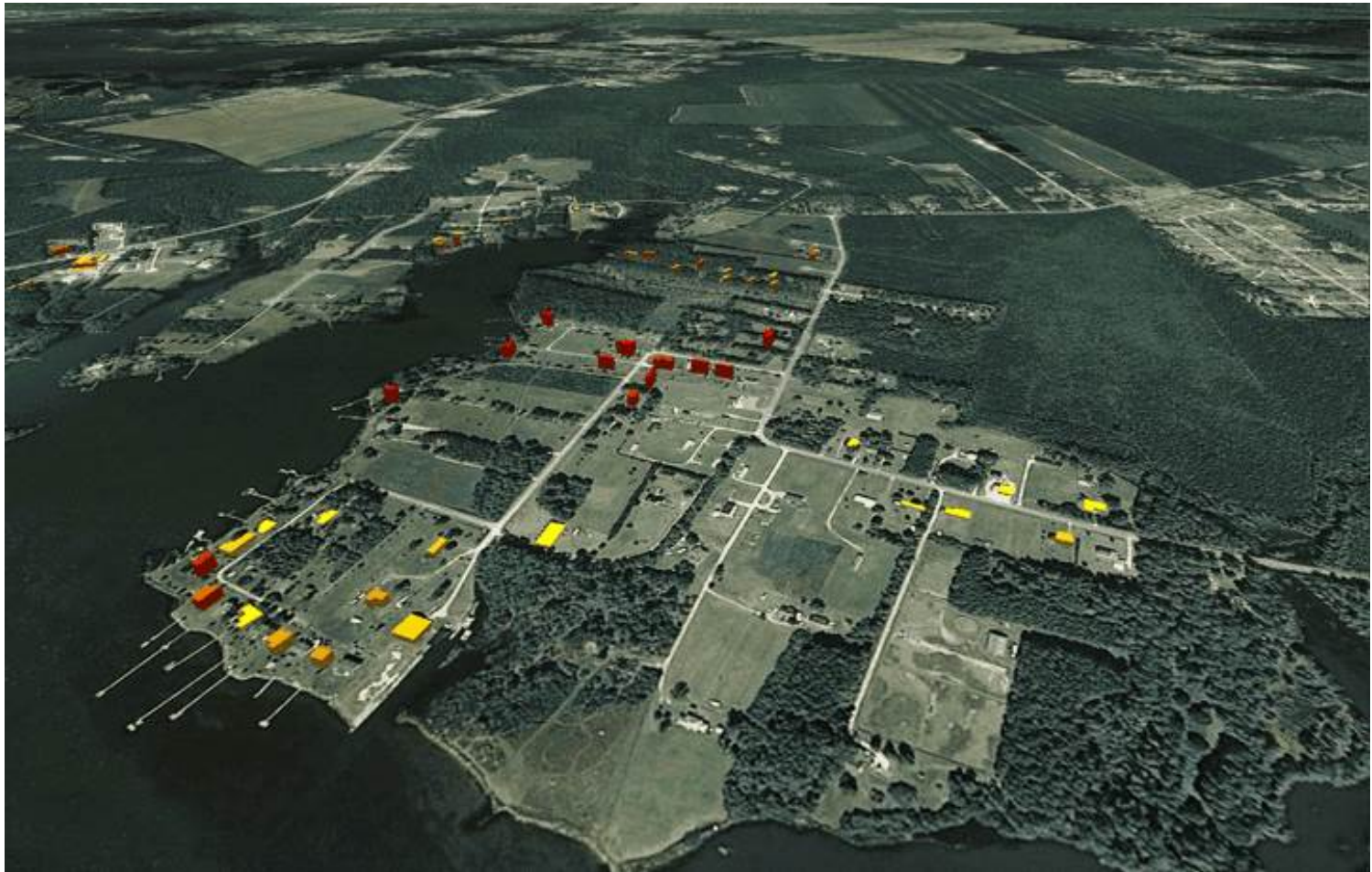
SLOSH compared to Buildings



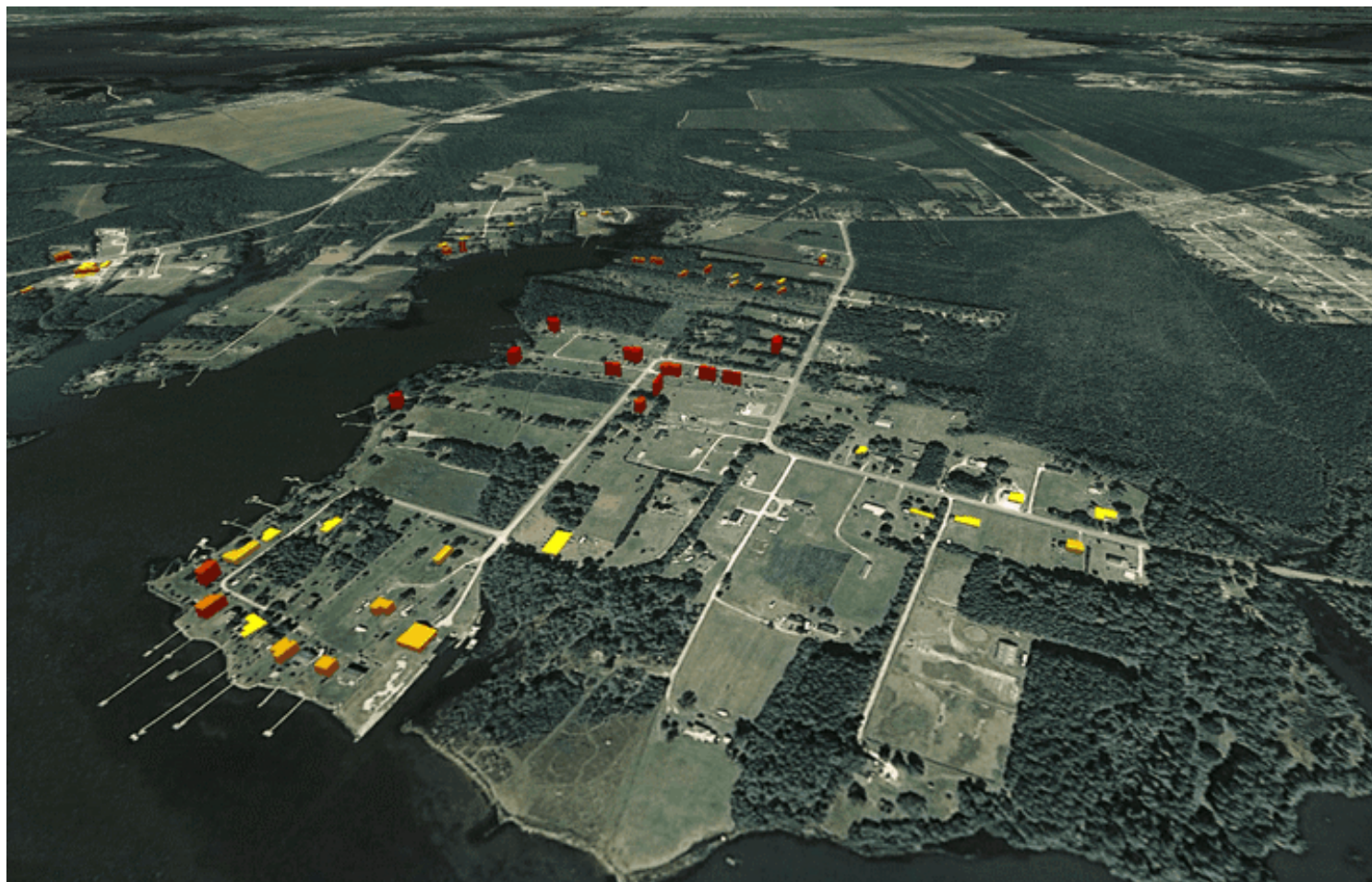
- SLOSH Polygon is compared to the building footprints
- The SLOSH elevation and first floor elevation of the building are known.
- Simple Subtraction will give us the depth of flooding in each structures.



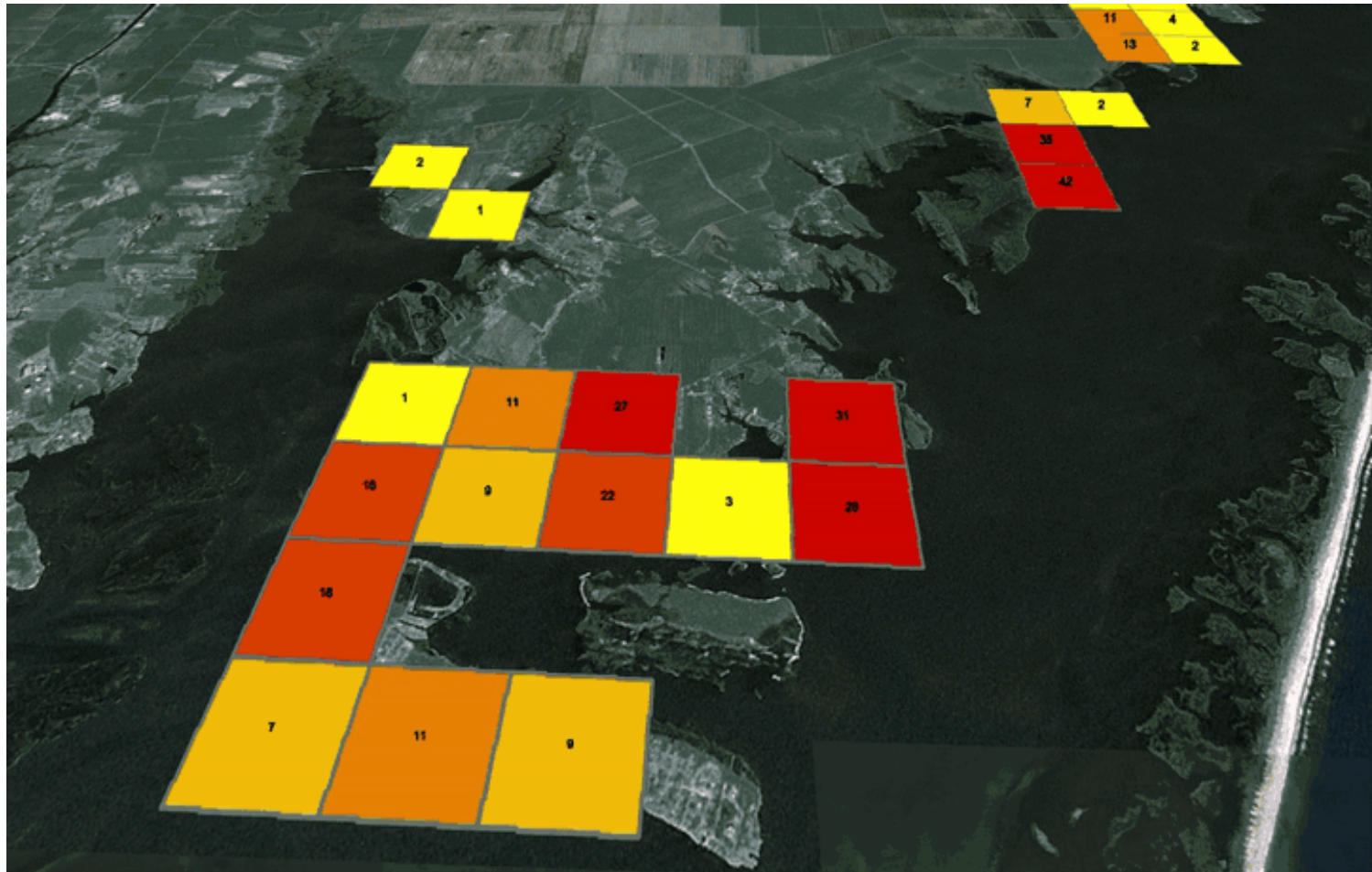
SLOSH compared to Buildings



Flooded Buildings Count by 5000ft Grid



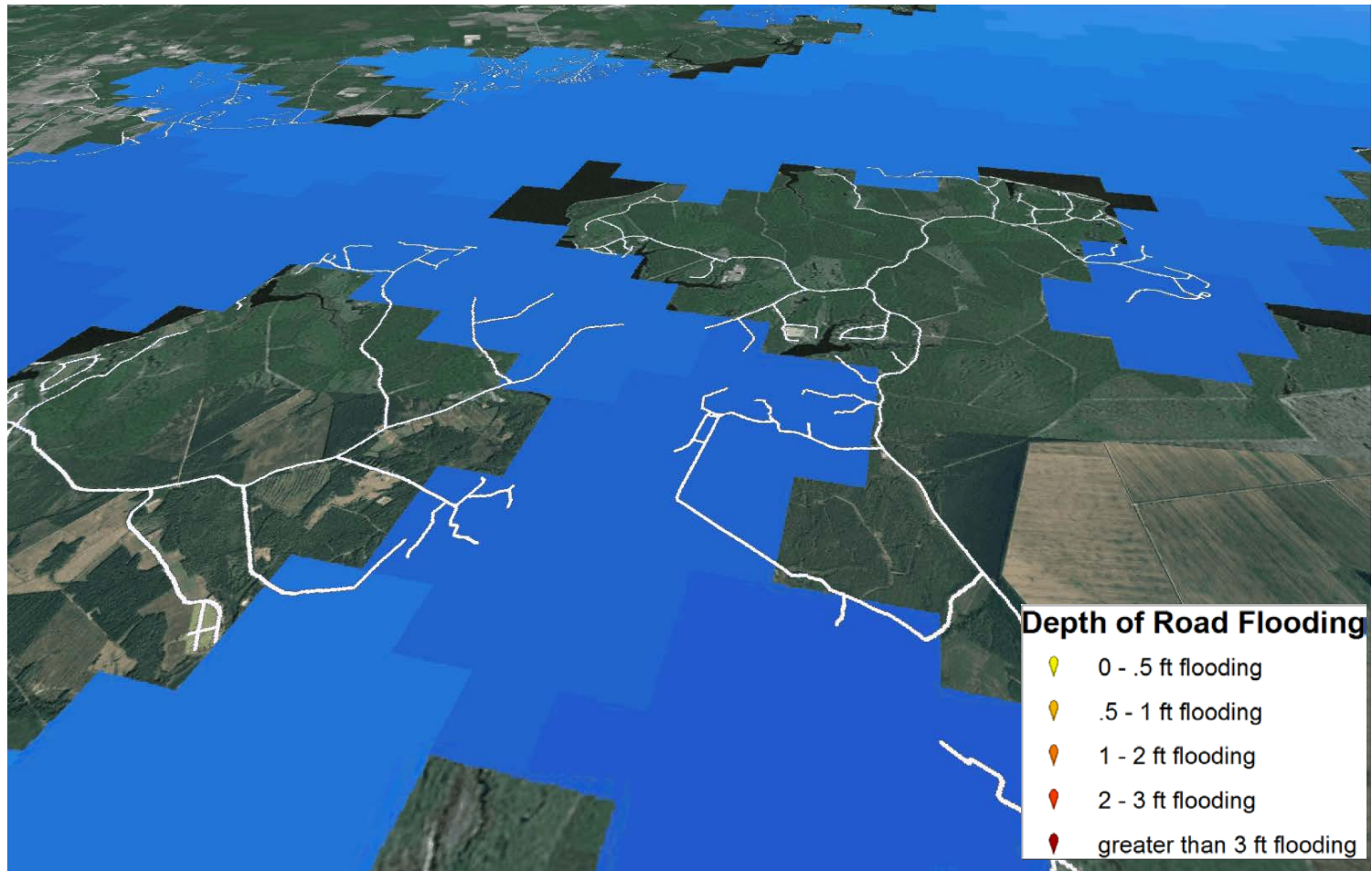
Flooded Buildings Count by County



Raster Intersected With Roads (beta)



Depth of Road Flooding (beta)



Counties Impacted

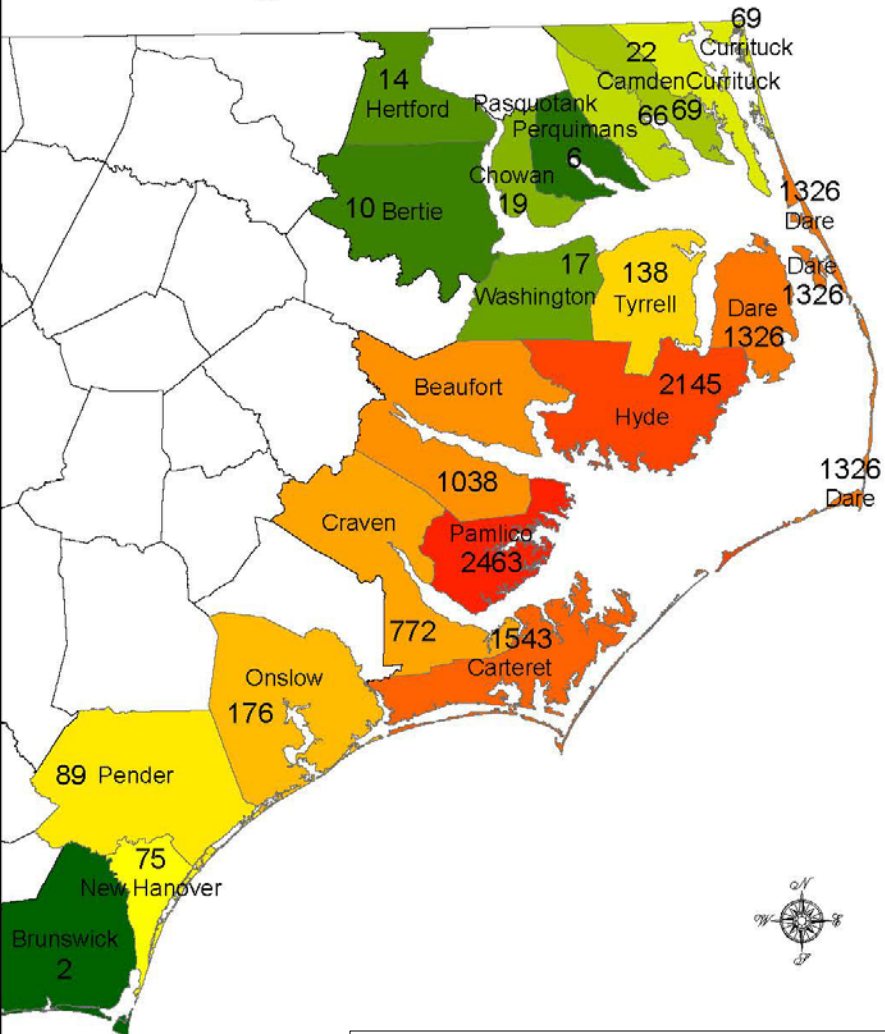
Height of flooding

	0-1ft	2ft	3ft	4ft	5ft	>5ft	Advisory 29 structures per county	Advisory 28 structures per county
Total								
	4469	2303	1327	882	649	1352	10982	9991
Beaufort	742	418	254	143	58	10	1625	1038
Bertie	5	2	2	2	0	0	11	10
Brunswick	2	0	0	0	0	0	2	2
Camden	20	5	1	0	0	1	27	22
Carteret	558	354	193	159	75	48	1387	1543
Chowan	13	6	1	1	0	0	21	19
Craven	435	204	101	50	30	12	832	772
Currituck	39	4	3	1	0	0	47	69
Dare	845	164	61	26	17	21	1134	1326
Gates	0	0	0	0	0	0	0	0
Hertford	6	0	3	1	7	0	17	14
Hyde	935	509	303	281	264	543	2835	2145
New Hanover	23	16	23	10	4	0	76	75
Onslow	109	67	12	2	0	3	193	176
Pamlico	519	497	343	201	194	709	2463	2464
Pasquotank	54	15	8	3	0	1	81	66
Pender	65	25	12	1	0	0	103	89
Perquimans	13	0	1	0	0	0	14	6
Tyrrell	82	15	3	1	0	4	105	138
Washington	4	2	3	0	0	0	9	17

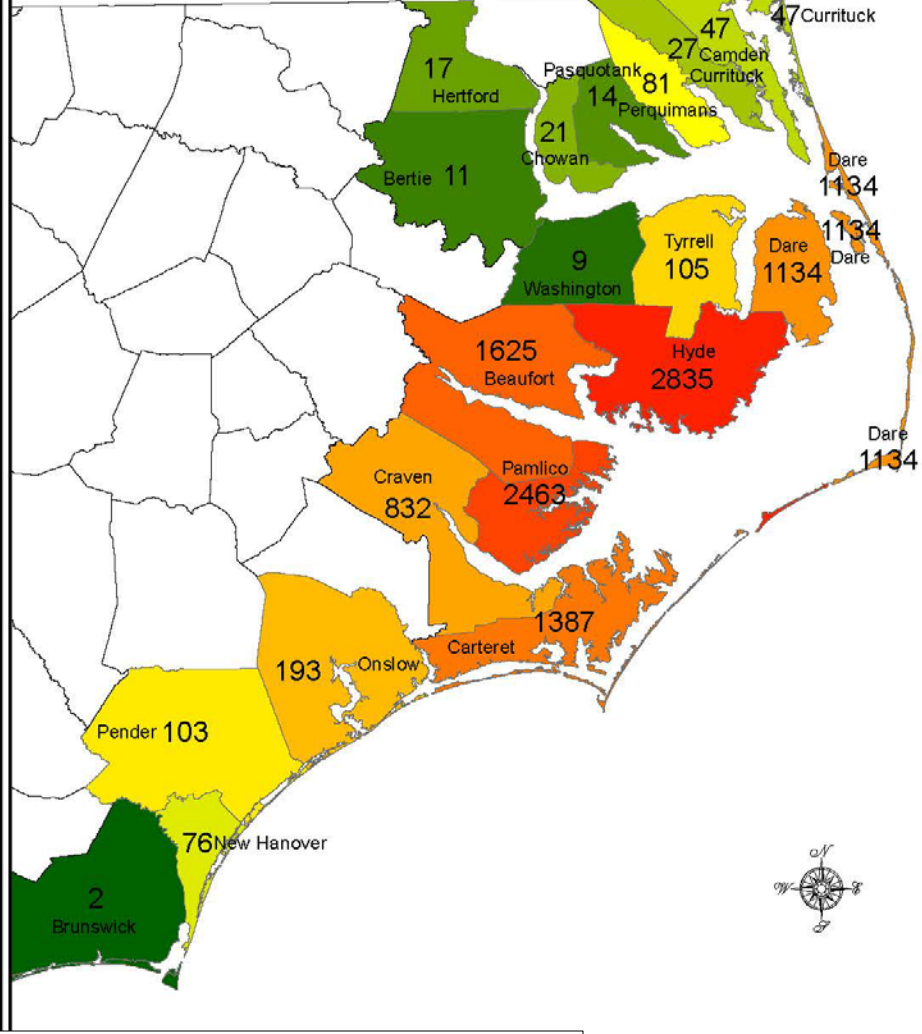
Total Building
Count by county
of flooded
structures by
depth of
flooding



Hurricane Irene: Storm Surge Probabilistic



Advisory 28

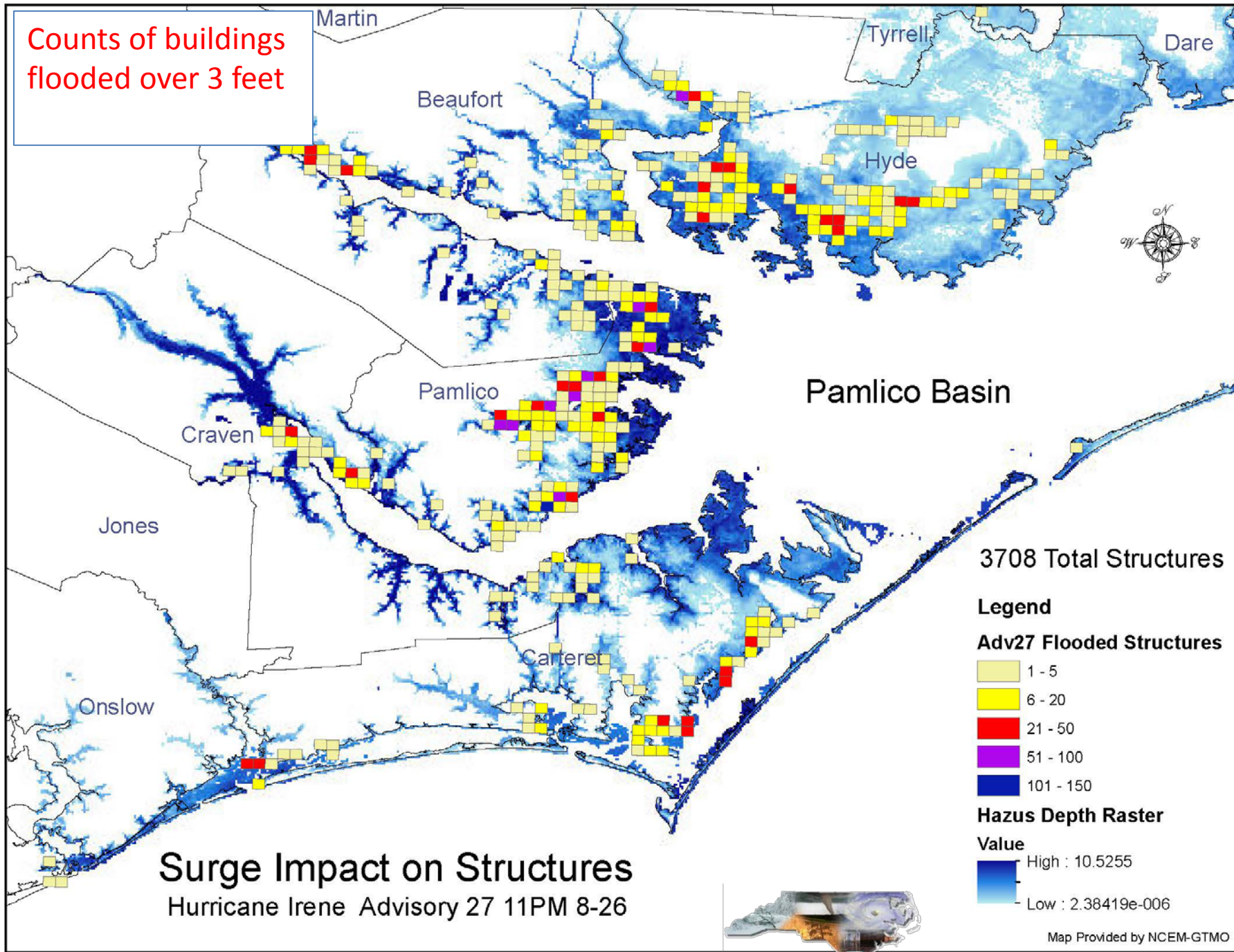


Advisory 29

Total Building Count of flooded structures



Counts of buildings
flooded over 3 feet



Advisory Number

Advisory 28

Advisory 27

Total Population	Total Number In Wind Swath	
Total Population	3585787	3884198
Median Income (US Dollars)	37272.59	37154.23
Structures	1909607	2119734

Critical Infrastructure:

Chemical	2321	2521
Dams	1481	1935
Gas stations	3602	3923
Grocery stores	1918	2074
Pharmacies	761	817
Nuclear Sites	2	2
Shelters	322	350

Functionally Fragile Medical Facilities:

Age 65 +	389623	435240
Assisted living	1569	1758
Correctional Facilities	146	157
Hospitals	3843	3991
Nursing Homes	161	178
Under 5 yrs of age	248369	267695

Agricultural Livestock:

Cattle Ranches	26	50
Horse Ranches	3	3
Poultry Farms	18	18
Swine Farms	2350	2384
Livestock Lagoons	3954	4051

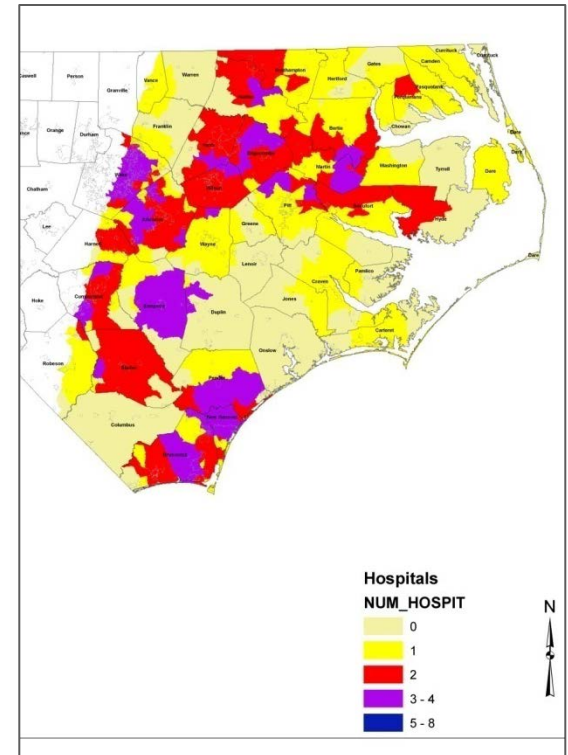
Hurricane Irene

08/27/2011

5:00AM

**Hurricane Irene, Advisory 28
8-27-2011 5:00AM**

**Estimated Total
Affected per Census Block Group**





Questions

John.Dorman@ncdps.gov