A Flood Warning System

Can It Solve ALL of Your Problems?

OFMA OKLAHOMA
FLOODPLAIN MANAGERS ASSOCIATION

OFMA 2025 Annual Conference – Midwest City, OK

September 22, 2025

Brandon Claborn, PE, CFM – WSB

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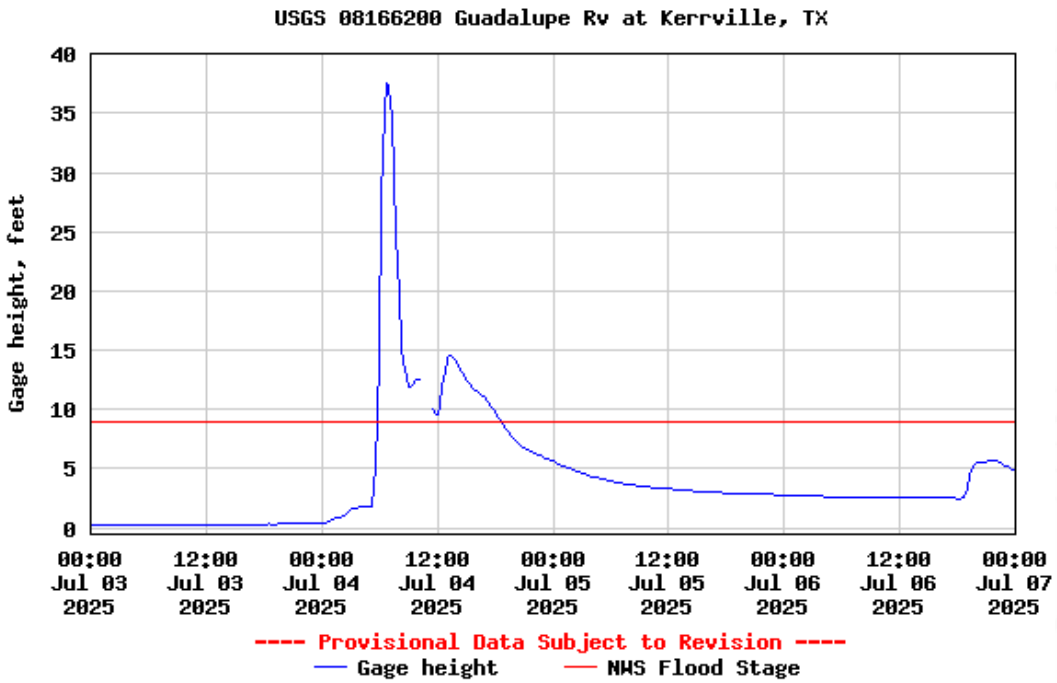
Why Flood Warning…



“We don’t burn out because of what we do…

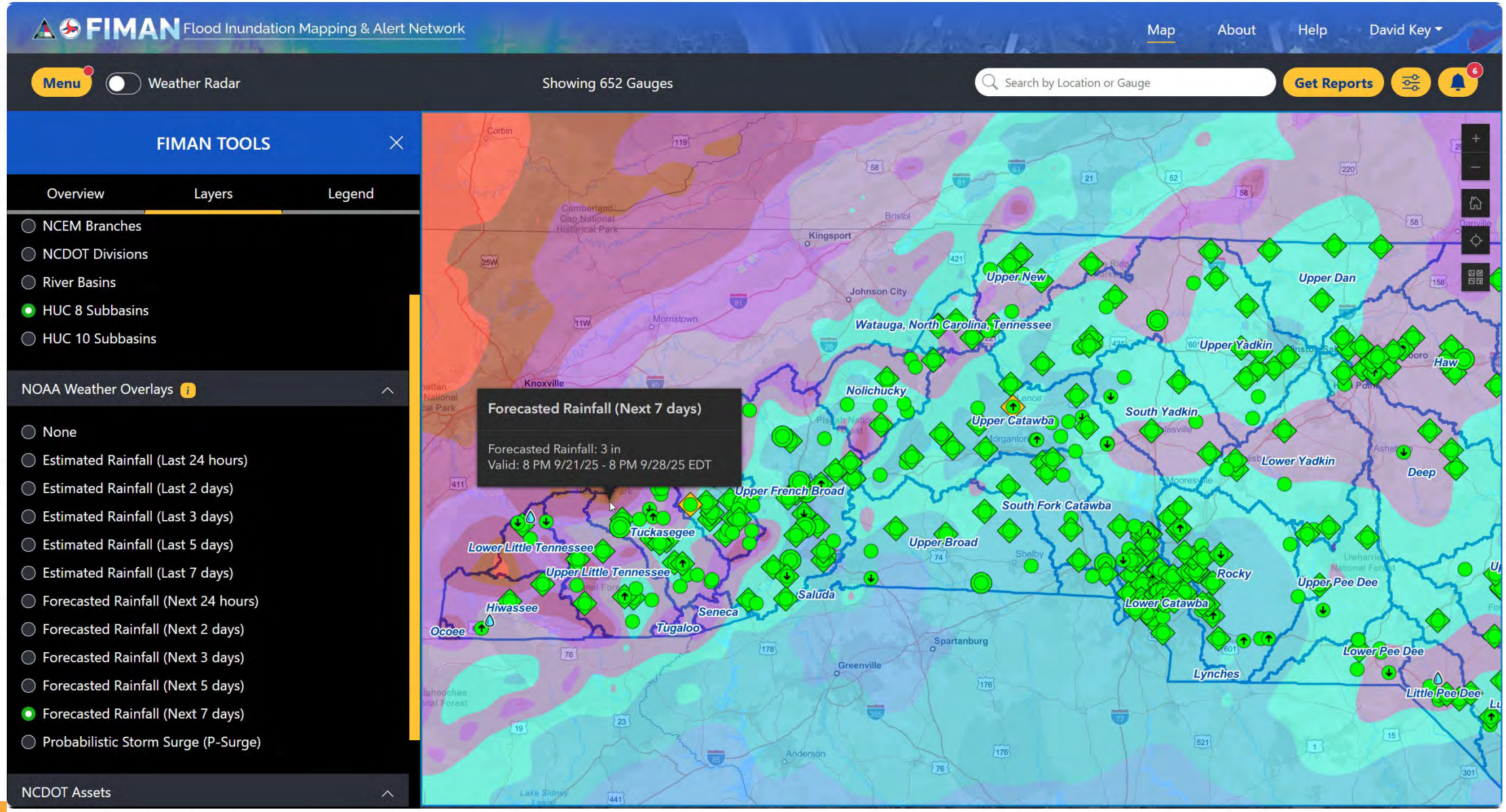
We burn out because life makes us forgot <u>WHY</u> we do it.”

- Inky Johnson

Presentation Outline

- FIMAN – Quick Overview
- System Planning
- Modeling and Inundation Mapping
- Use Cases / Success Stories *(Pre, During, Post-event)*
- Outreach, Training & Maintenance
- “The Gap” and The Future

FIMAN

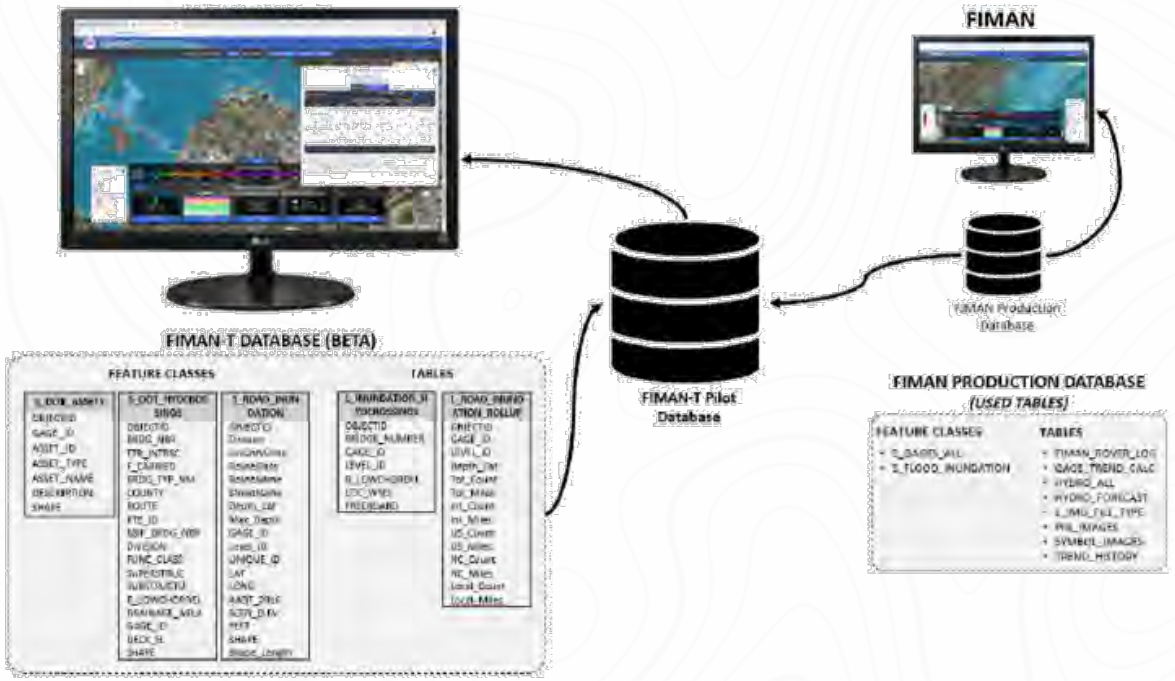

FIMAN Flood Inundation Mapping & Alert Network
Map
About
Help
David Key
Menu
Weather Radar
Showing 652 Gauges
Search by Location or Gauge
Get Reports
FIMAN TOOLS
Overview
Layers
Legend
NCEM Branches
NCDOT Divisions
River Basins
HUC 8 Subbasins
HUC 10 Subbasins
NOAA Weather Overlays
None
Estimated Rainfall (Last 24 hours)
Estimated Rainfall (Last 2 days)
Estimated Rainfall (Last 3 days)
Estimated Rainfall (Last 5 days)
Estimated Rainfall (Last 7 days)
Forecasted Rainfall (Next 24 hours)
Forecasted Rainfall (Next 2 days)
Forecasted Rainfall (Next 3 days)
Forecasted Rainfall (Next 5 days)
Forecasted Rainfall (Next 7 days)
Probabilistic Storm Surge (P-Surge)
NCDOT Assets
Forecasted Rainfall (Next 7 days)
Forecasted Rainfall: 3 in
Valid: 8 PM 9/21/25 - 8 PM 9/28/25 EDT
Upper New
Upper Dan
Watauga, North Carolina, Tennessee
Upper Yadkin
Nolichucky
Upper Catawba
South Yadkin
Lower Yadkin
Deep
Haw
Upper French Broad
South Fork Catawba
Tuckasegee
Lower Little Tennessee
Upper Little Tennessee
Upper Broad
Rocky
Upper Pee Dee
Lower Catawba
Saluda
Hiwassee
Seneca
Ocoee
Tugaloo
Lower Pee Dee
Lynches
Little Pee Dee
Kingsport
Johnson City
Morristown
Knoxville
Spartanburg
Greenville
Anderson

SYSTEM PLANNING

System Planning

Planning: Requirements

- Meetings, Meetings, Meetings
- System Requirements
- User Types
- Alerting Requirements
- IT Requirements
- Database Design
- Software
- Web Hosting
- Costing / Funding Options



Planning: Database Design

North Carolina Emergency Management
NC_FIMAN Database Dictionary

GAGES_ALL

This feature class is a spatial dataset that describes the location of all stream gages used in the FIMAN system. This feature class necessary gage properties for FIMAN to function.

Field	Description	Data Type	Length	Precision	Scale	Required
OBJECTID	ESRI Object	Integer	0	10	0	Yes
SITE_ID	Site Identification (number or string) for the Gage. This is the FIMAN Gage ID	Text	255	0	0	Yes*
NAME	Local or descriptive name for the FIMAN Gage	Text	255	0	0	Yes*
LATITUDE	Latitude (decimal degrees)	Numeric	0	38	8	Yes*
LONGITUDE	Longitude (decimal degrees)	Numeric	0	38	8	Yes*
GAGE_DATUM	Reference datum elevation assigned to each gage (NAVD 88 ft) this elevation usually represents the stream bottom for riverine sites.	Numeric	0	38	8	Yes*
DRAINAGE_AREA	The drainage area of the gage (sq. mile). (Null if coastal)	Numeric	0	38	8	If applicable
COUNTY	County Name where with gage is located	Text	20	0	0	Yes*
BANK_FULL	Flood elevation at which the risk rating "Monitor" occurs (NAVD88 ft).	Numeric	0	38	8	Yes*
MINOR	Flood elevation at which the risk rating "Minor" occurs (NAVD88 ft)	Numeric	0	38	8	Yes*
MODERATE	Flood elevation at which the risk rating "Moderate" occurs (NAVD88 ft)	Numeric	0	38	8	Yes*
MAJOR	Flood elevation at which the risk rating "Major" occurs (NAVD88 ft)	Numeric	0	38	8	Yes*
STAGE_ID	The stage sensor ID of the gage.	Text	255	0	0	If applicable
STREAM_ELEV_ID	The water surface elevation sensor ID of the gage.	Text	255	0	0	If applicable
SVC_MIN_ELEV	Minimum elevation in the gage's inundation library (NAVD88 ft)	Numeric	0	38	8	If applicable
SVC_MAX_ELEV	Maximum elevation in the gage's inundation library (NAVD88 ft)	Numeric	0	38	8	If applicable
RIVER_BASIN	The name of the river basin in which the gage is located	Text	30	0	0	Yes*
SEND_ALERT	Are alerts able to be sent for this gage? (yes/no – 1/0)	Integer	0	10	0	Yes*
IN_SERVICE	Is the gage currently in service? (yes/no – 1/0)	Smallint	0	5	0	Yes*
OWNER	Gage owner (example NCEM, USGS, etc)	Text	250	0	0	Yes*
IS_COASTAL	This field is used by FIMAN to designate sites that report in FIMAN with water surface elevation values only and no "stage" values. Is this site an "elevation only" site? Yes/no – 1/0. For more information, ***please see Note 1*** below this table.	Smallint		5	0	Yes*
SRV_INT	The interval of the elevations available in the inundation library (NAVD 88 ft).	Numeric	0	1	2	If applicable
IS_SCENARIO	Does the gage have an inundation library? (yes/no – 1/0)	Bit	0	0	0	Yes*

North Carolina Emergency Management
NC_FIMAN Database Dictionary

S_FLOOD_INUNDATION

This is a spatial feature class containing polygon features for the map library flood inundation areas at each FIMAN gage. Individual features should be contained for each gage library elevation.

Field	Description	Data Type	Length	Precision	Scale	Required	PK	PK Name
OBJECT_ID	ESRI ObjectID	Object id				Yes		
SITE_ID	Site Identification Number or String for the Gage. This is the FIMAN Gage ID. (an example Site ID for Black River at NC 210 is BCUN7)	Text	255			Yes*	Yes	
USER_FLAG	The corresponding gage elevation (NAVD 88 ft) for each flood inundation polygon in the library.	Numeric		38	8	Yes*		
Shape	ESRI Field – not used by FIMAN	Geometry				Yes*		
Shape.STArea()	ESRI Field – not used by FIMAN	Geometry				Yes*		
Shape.STLength()	ESRI Field – not used by FIMAN	Geometry				Yes*		

**Field allows nulls, but is required for the FIMAN application to operate properly*

North Carolina Emergency Management
NC_FIMAN Database Dictionary

L_DAMAGE_RESULTS_FL

A lookup table used to store the cached damage results for flooding hazards at each map library elevation.

Field	Description	Data Type	Length	Precision	Scale	Required	PK	PK Name
OBJECTID	Object identifier	Integer	0	10	0	Yes		
BLDG_ID	Building identifier	Text	25	0	0	Yes*		
HAZARD_ID	Hazard identifier	Integer	0	10	0	Yes		
ST_CST_100	Structure losses from the map library flood event ($). This value is populated when "RISK" (flood loss estimates) are computed.	Numeric	0	38	8	Yes*		
CT_CST_100	Content losses from the map library flood event ($). This value is populated when "RISK" (flood loss estimates) are computed.	Numeric	0	38	8	Yes*		
OT_CST_100	Other losses from the map library flood event ($). This value is populated when "RISK" (flood loss estimates) are computed.	Numeric	0	38	8	Yes*		
USER_FLAG	The corresponding gage map library elevation (NAVD 88 ft) for each building damage record.	Text	255	0	0	Yes*		
GageID	Site Identification Number or String for the Gage. This is the FIMAN Gage ID.	Text	150	0	0	Yes*		
DEPTH	Flood depth in building relative to First Floor Elevation (Ft).	Numeric	0	38	8	Yes*		

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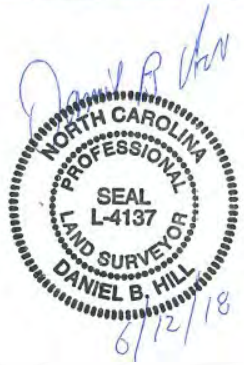
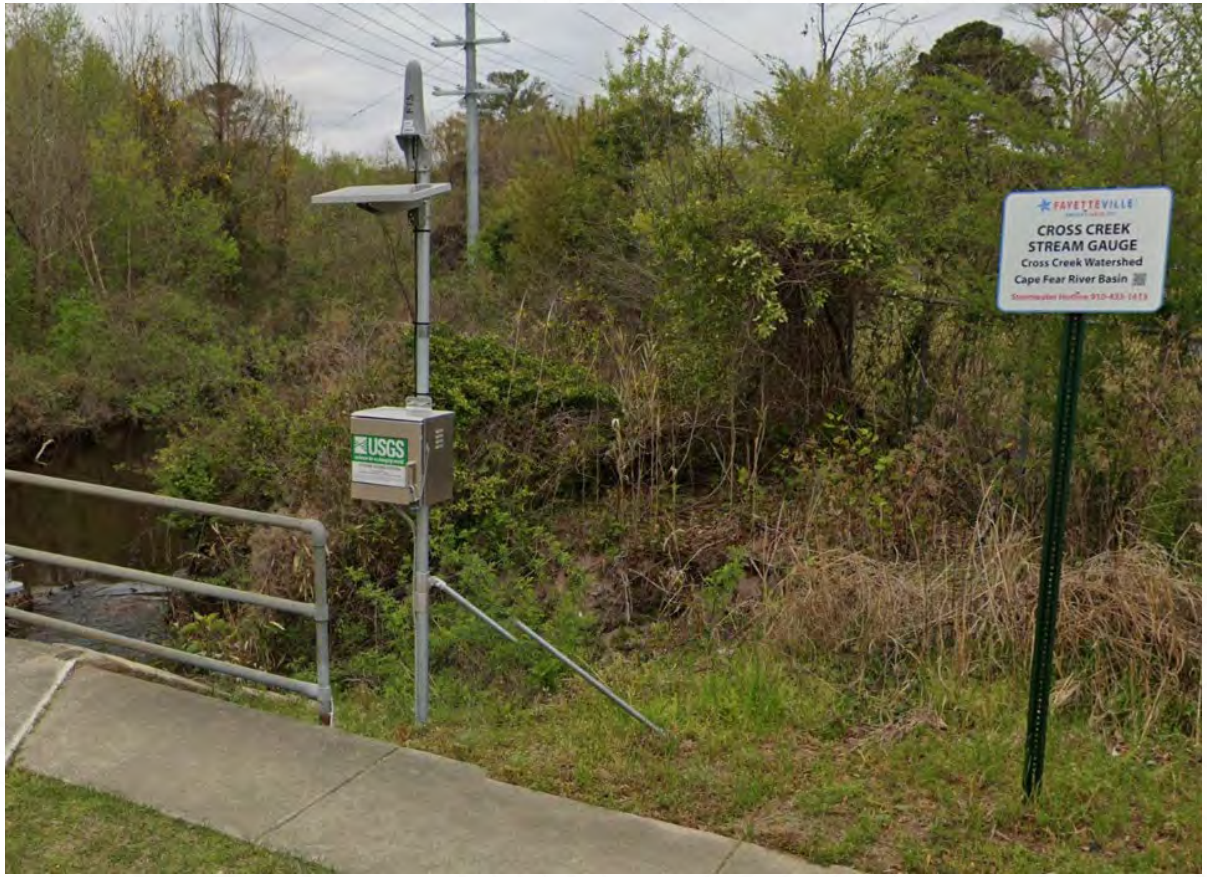
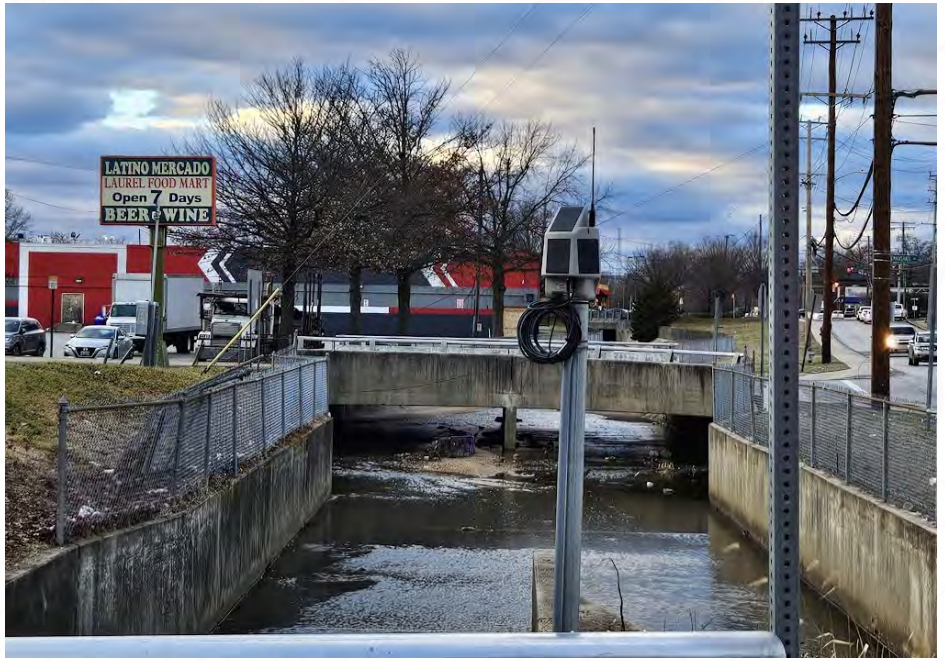
Planning: Hardware

- Sensor Type
  - Traditional Custom-Made Gage
  - All-in-one Low-Cost Sensors
- Data Collection and Communication
  - Frequency and Telemetry Speed
  - What works for your geography
  - Redundancy
- Installation
- Site Datum Surveys (important)



Sensor Types





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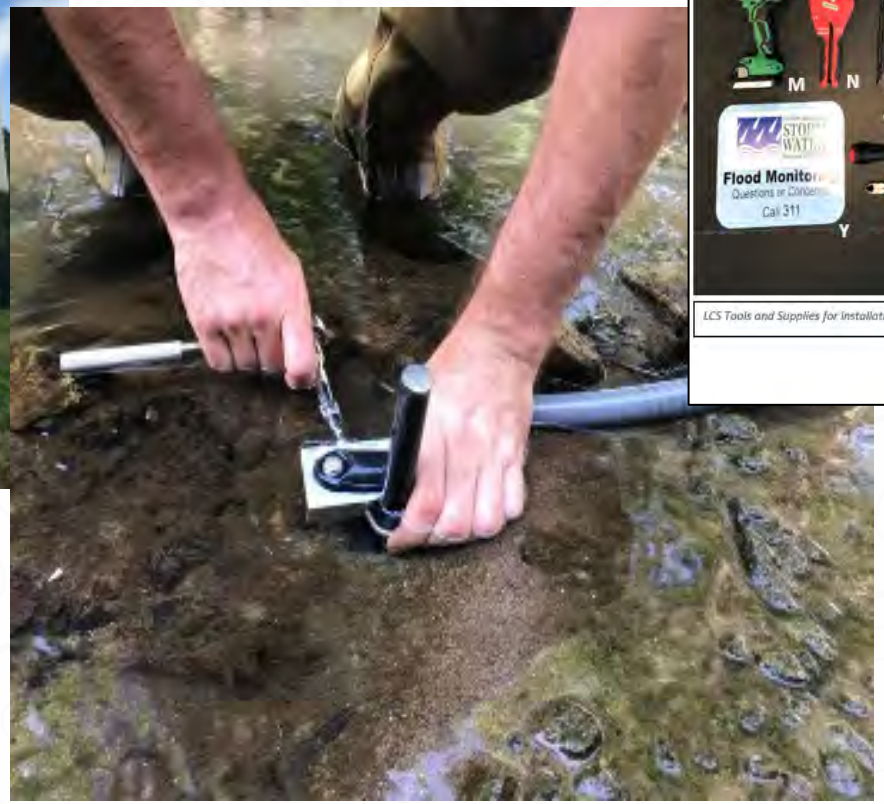
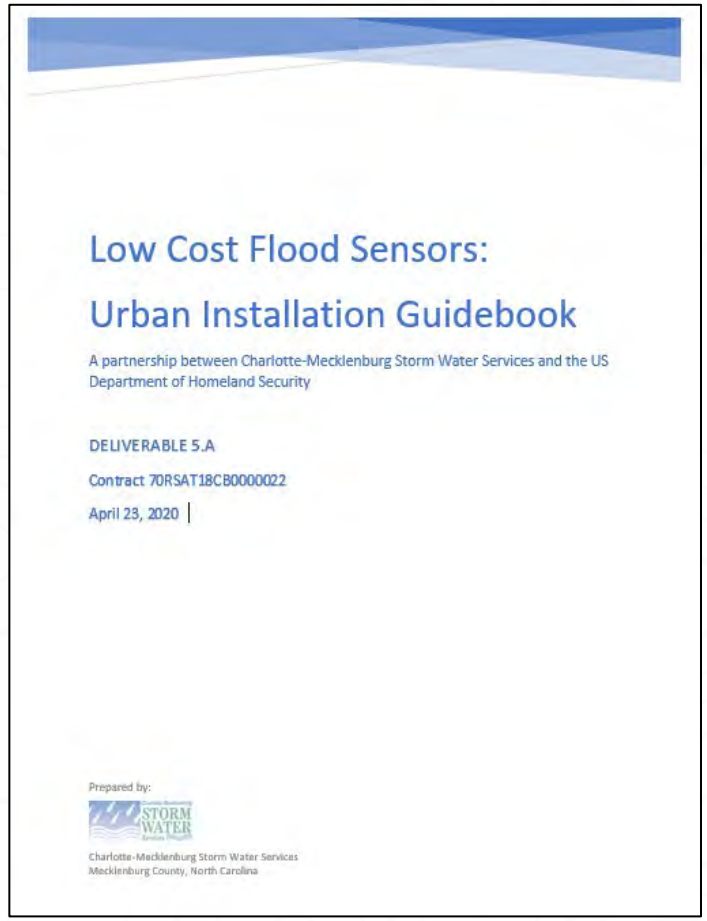
Installation



LCS Tools and Supplies for installation and maintenance.

Hardware Components and Installation Tools:

A. Post Driver (if installing post in ground)
B. Metal Banding and Clip (B & C, if securing post to preexisting structure)
C. Metal Banding Tool
D. Stake Driver
E. Round Steel Stake ¾" x 24"
F. 5-lb Hammer
G. ¾" Non-Metallic Flexible PVC Conduit
H. Head Unit of LCS – for harvesting and providing power, as well as processing and communicating sensor data *(these units can be found from various vendors)*
I. Water Level Pressure Sensor (pressure sensors are produced by various vendors)
J. Camera (if applicable)
K. Antennas for H
L. Head Unit Mounting Bracket (vendor specific)
M. Impact Driver
N. 2 ½" Conduit Cutter
O. Zip-Ties
P. Aluminum Angle Bracket (1" x 2" x 4")
Q. 1 ½" Hose Clamp
R. 5/16" Stainless-steel U-bolt
S. 9 Gauge Steel 9" x 1" x 9" Square Top Professional Grade Landscape Staples
T. 5/16" SS Lock Nuts
U. ¼" x ¾" SS Hex Head Bolt
V. T10 Torx Mounting Screws
W. 1" Galvanized Self-Drilling Screws
X. Fence Post Cap
Y. Sign with Ownership and Contact Information
Z. Diagonal Snips
AA. T10 Torx Screw Driver



Low Cost Flood Sensors:

Urban Installation Guidebook

A partnership between Charlotte-Mecklenburg Storm Water Services and the US Department of Homeland Security

DELIVERABLE 5.A

Contract 70RSAT18CB0000022

April 23, 2020

Prepared by:

Charlotte-Mecklenburg Storm Water Services
Mecklenburg County, North Carolina

Installation Guidebook

Google "FEMA Urban Installation Guidebook"

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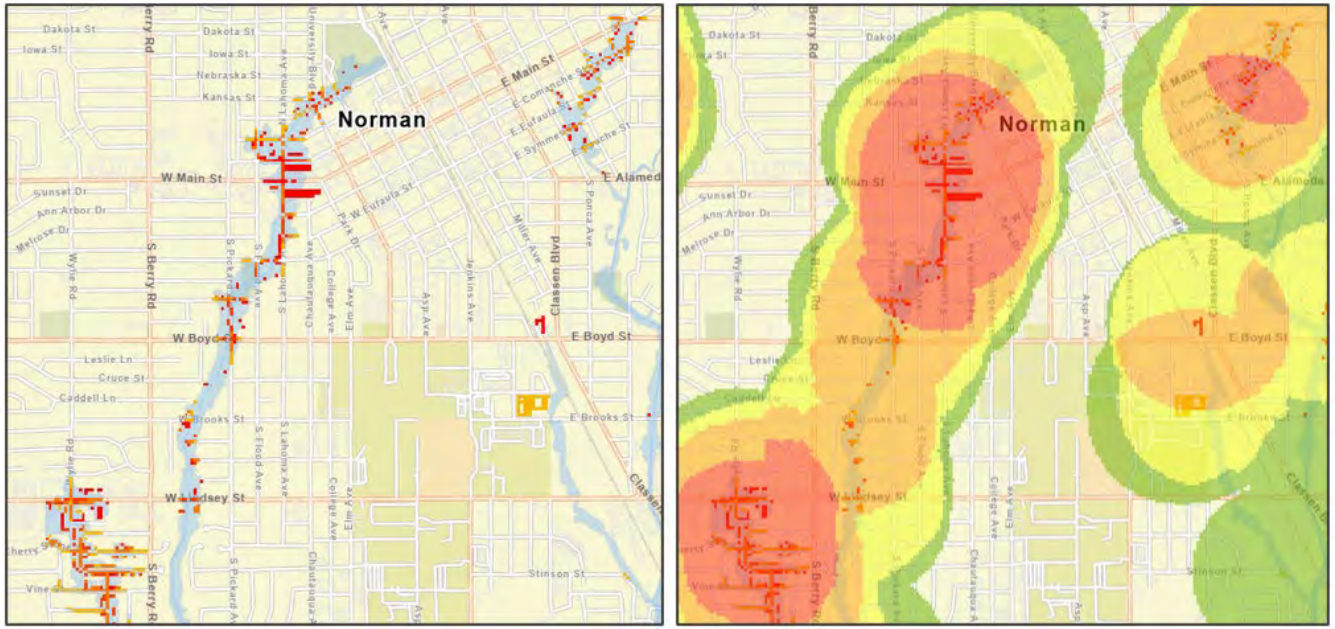
Planning: Where To Install Sensors?

CITYWIDE RANKING STEPS

- Quantitative Assessment of Project Area (City, County, Watershed, State)
- Installation Goal = At Roadway Crossings
  - Right of Way
  - Installation Logistics
  - Maintenance
- Risk Score per Crossing
  - Flood Risk
  - Building
  - Road
  - Critical Facilities
  - Network Connectivity
  - Drainage Area / Impervious
  - Etc.

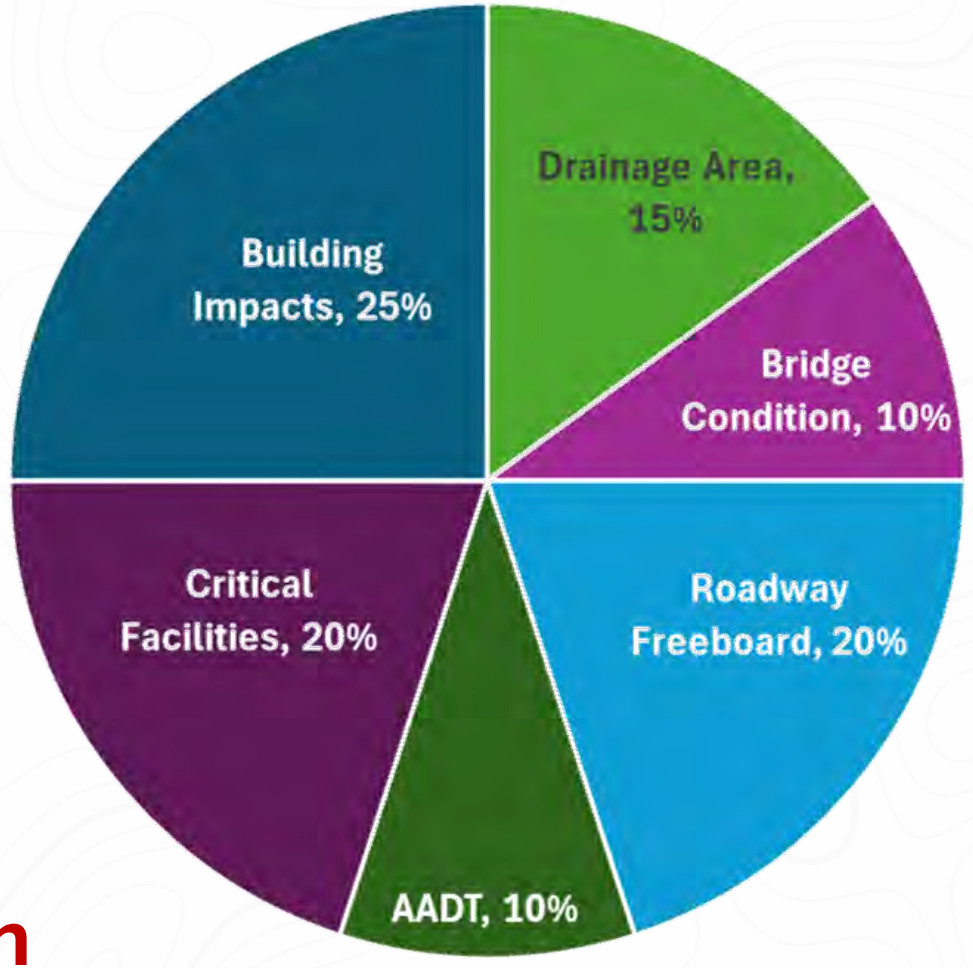


Planning: Where To Install Sensors?

Statewide Ranking Steps

1. ID Vulnerable Municipalities
2. Calculate Building Impacts
3. Damage Aggregation
4. Calculate Roadway / Bridge Impacts
5. Collect Critical Infrastructure

Develop Weighted Ranking System



SCORE WEIGHTS

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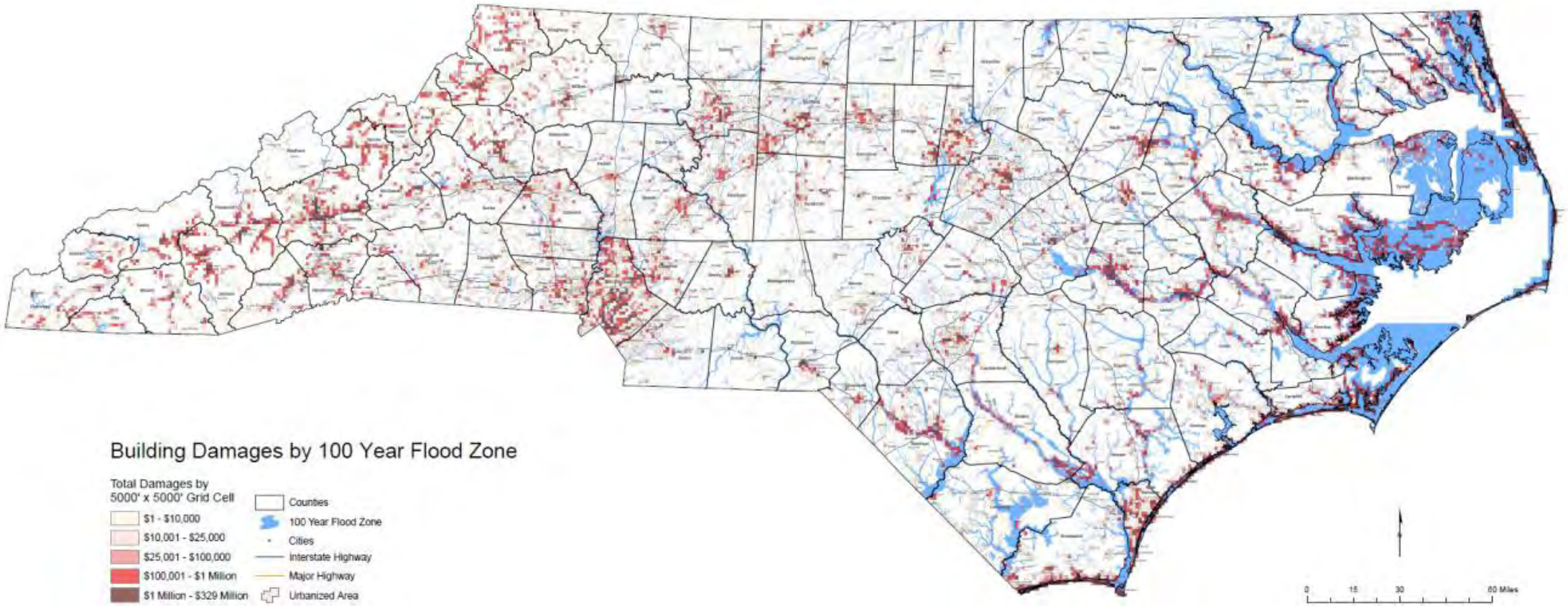
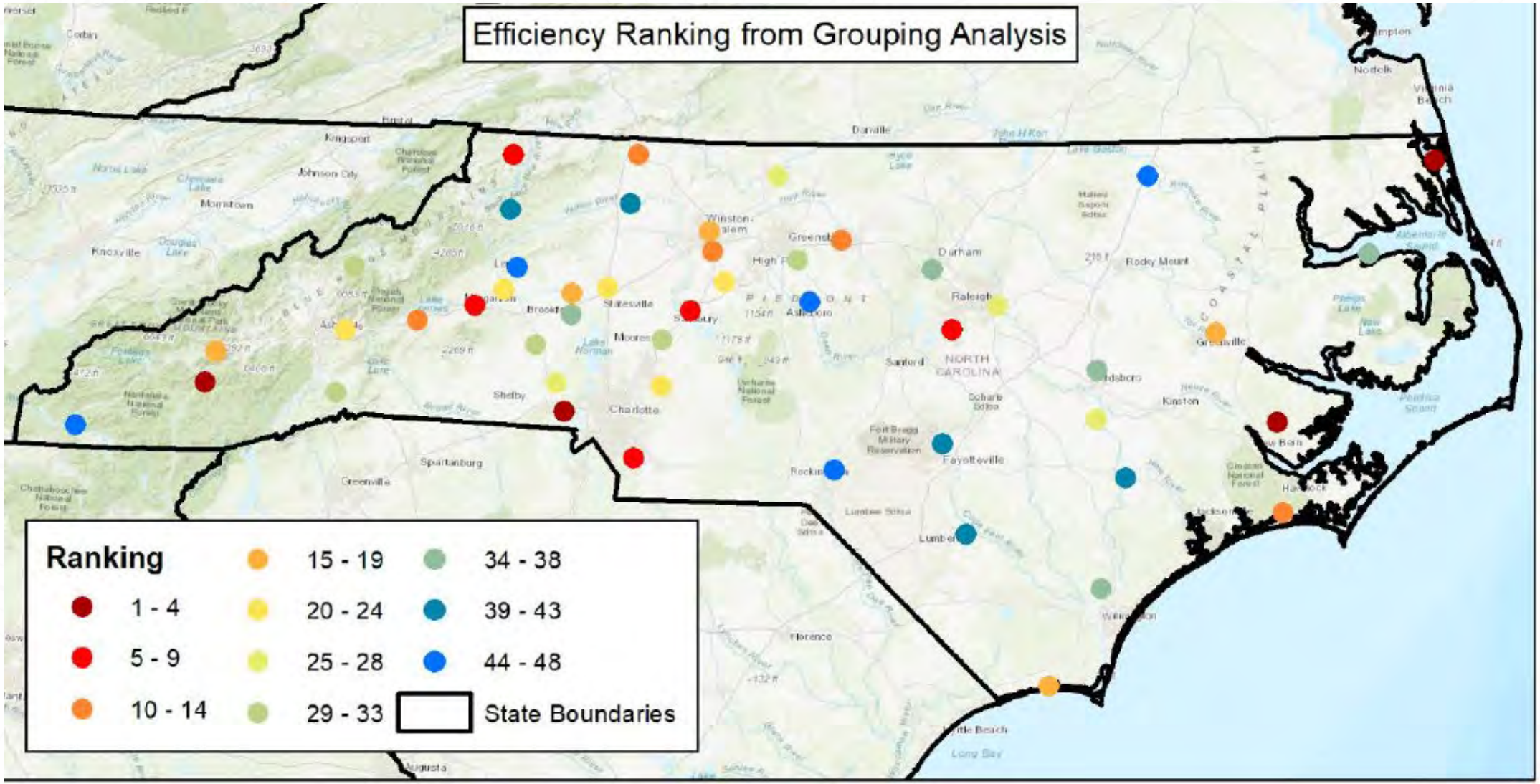
Planning: Where to Install Sensors?

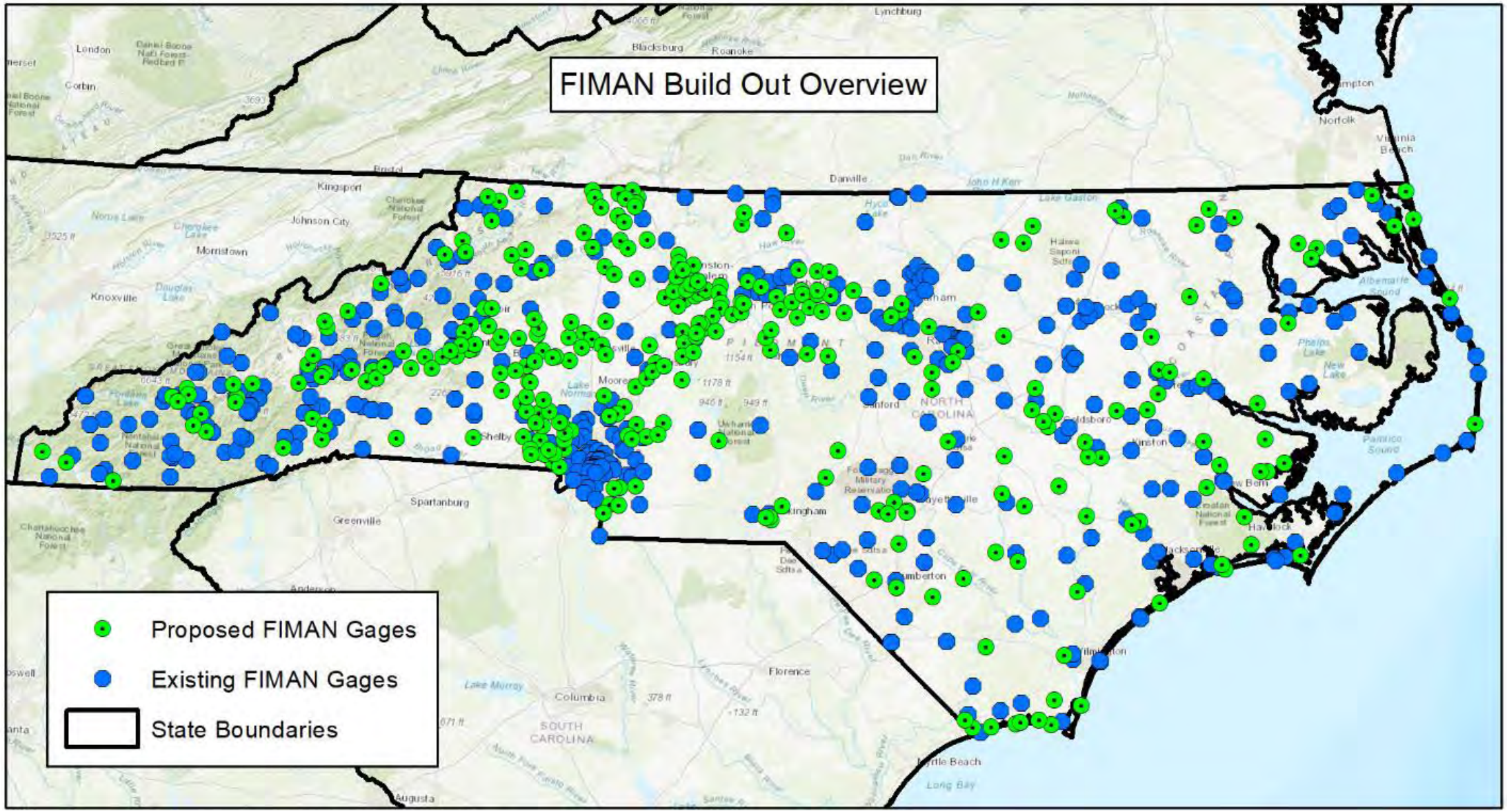


Planning: Where To Install Sensors?



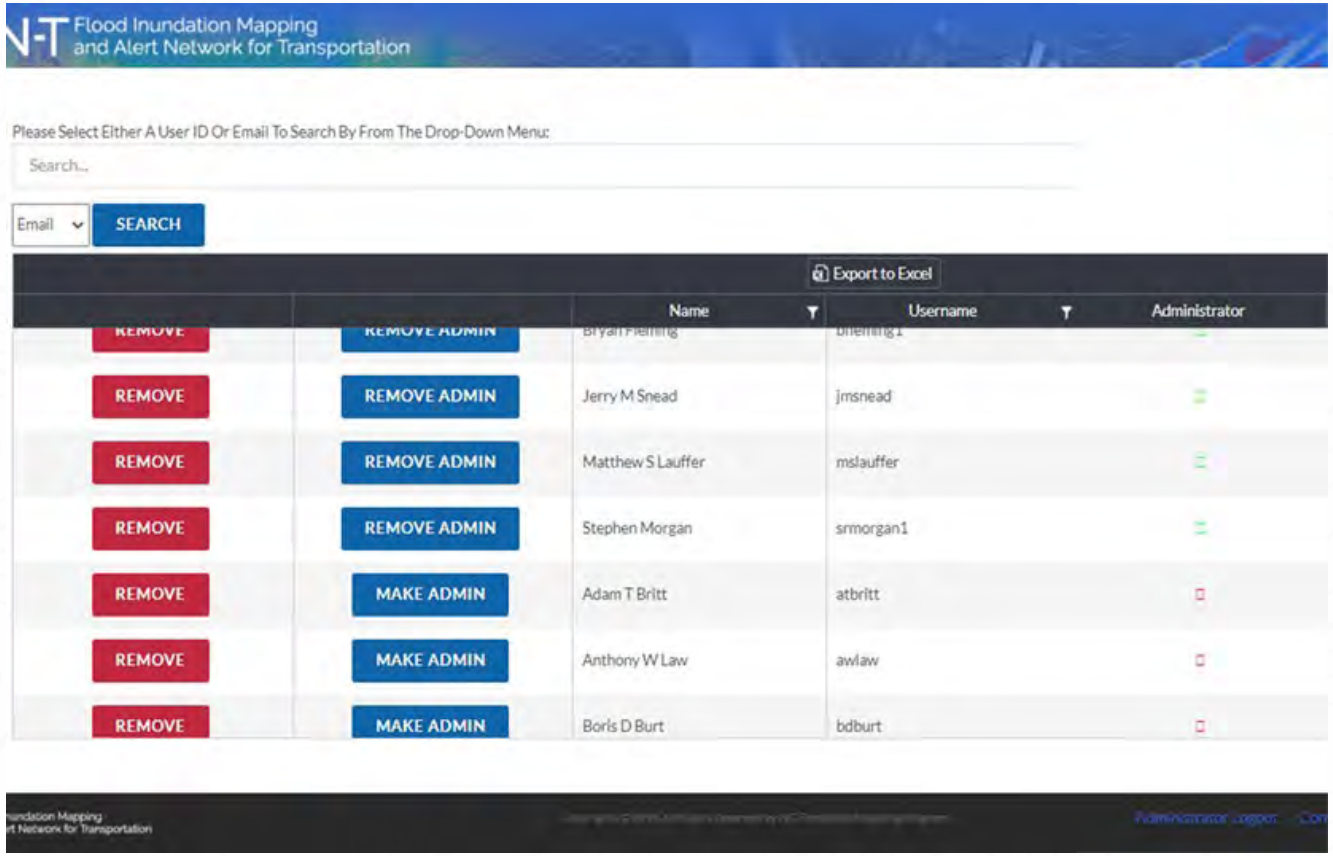
Planning: Ranking

Water Name	ore	Overall Ranking
MILLS BRANCH	816	1
LONG CREEK	804	2
WATAUGA RIVER	789	3
BRYANT SWAMP	781	4
PIGEON RIVER	774	5
SOUTH PRONG BAY RIVER	759	6
ATLANTIC OCEAN	750	7
NEUSE RIVER	746	8
ATLANTIC OCEAN	740	9
OCONALUFTEE RIVER	738	10
ATLANTIC OCEAN	715	11
TRENT RIVER	710	12
PAMLICO RIVER	708	13
PAMLICO SOUND	700	14
ATLANTIC OCEAN	700	15
SOUTH FORK MUDDY CREEK	692	16
CULLOWHEE CREEK	678	17
NEUSE RIVER	670	18
ATLANTIC OCEAN	656	19
SALEM CREEK	654	20
CATAWBA RIVER	653	21
NEUSE RIVER	652	22
KENDRICK CREEK	644	23
SOUTH YADKIN RIVER	622	24
SOUTH FORK CATAWBA RIVER	620	25
GRANTS CREEK	618	26
SOUTH FORK CATAWBA RIVER	610	27
SOUTH FORK NEW RIVER	609	28
JACOB SWAMP	607	29
JONATHAN CREEK	606	30
LUMBER RIVER	603	31
SALEM CREEK	602	32
BIG HORSE CREEK (Gage on Old	602	33
NC 42 CANAL	601	34
ATLANTIC OCEAN	600	35
ROCKY RIVER	600	36
NEWPORT RIVER	595	37
ATLANTIC OCEAN	590	38
ATLANTIC OCEAN	590	39
LITTLE ALAMANCE CREEK	588	40
SINGLETREE SWAMP	585	41
PAMLICO SOUND	584	42
YADKIN RIVER	582	43
MORAVIAN CREEK	577	44
SOUTH PRONG BAY RIVER	577	45
SOCO CREEK	574	46
CAPE FEAR RIVER	571	47



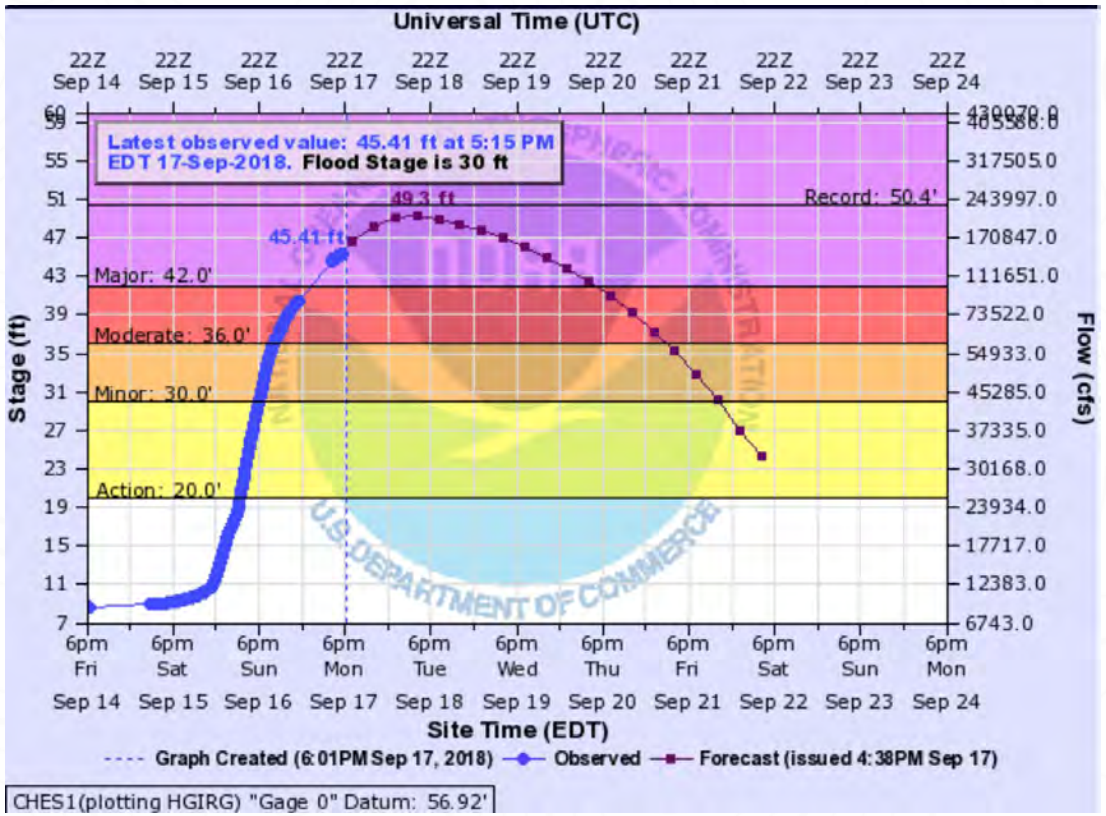
Planning: Flood Warning Users

- User Roles Planning
  - Public
  - Stakeholders
  - Emergency Management Staff
- Role Based Views / Reports
- System Admin Redundancy

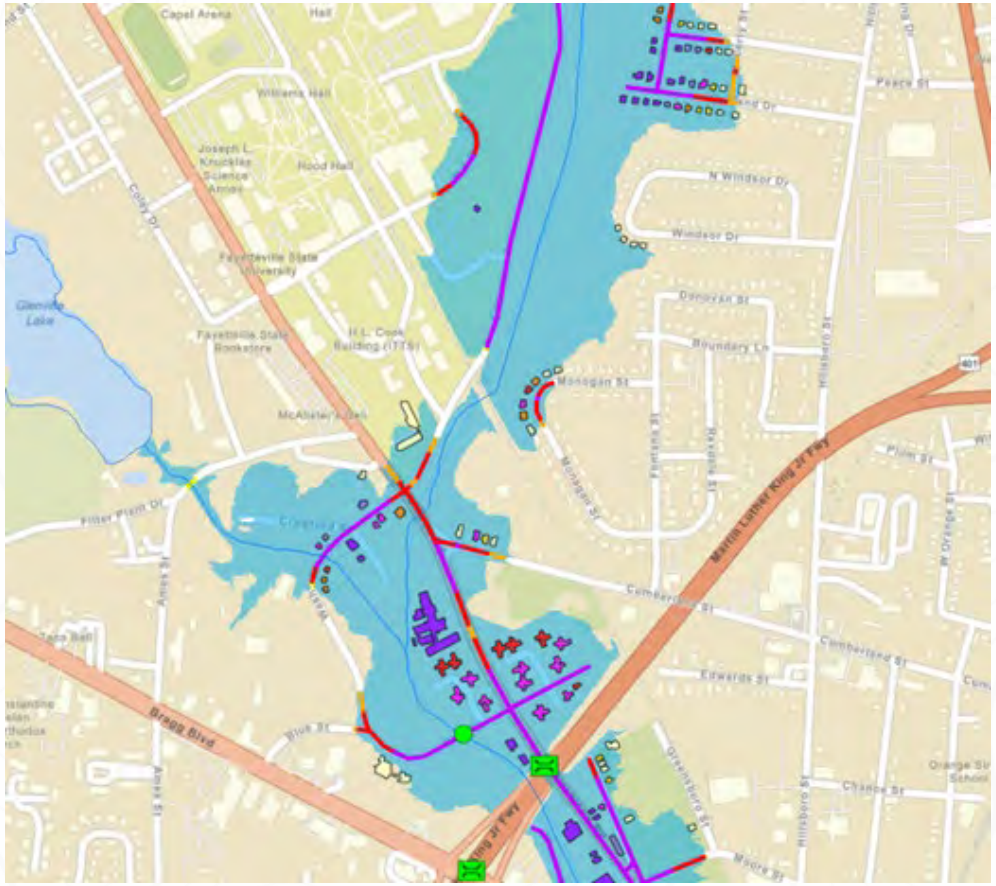


MODELING AND INUNDATION MAPPING

Modeling and Inundation Mapping

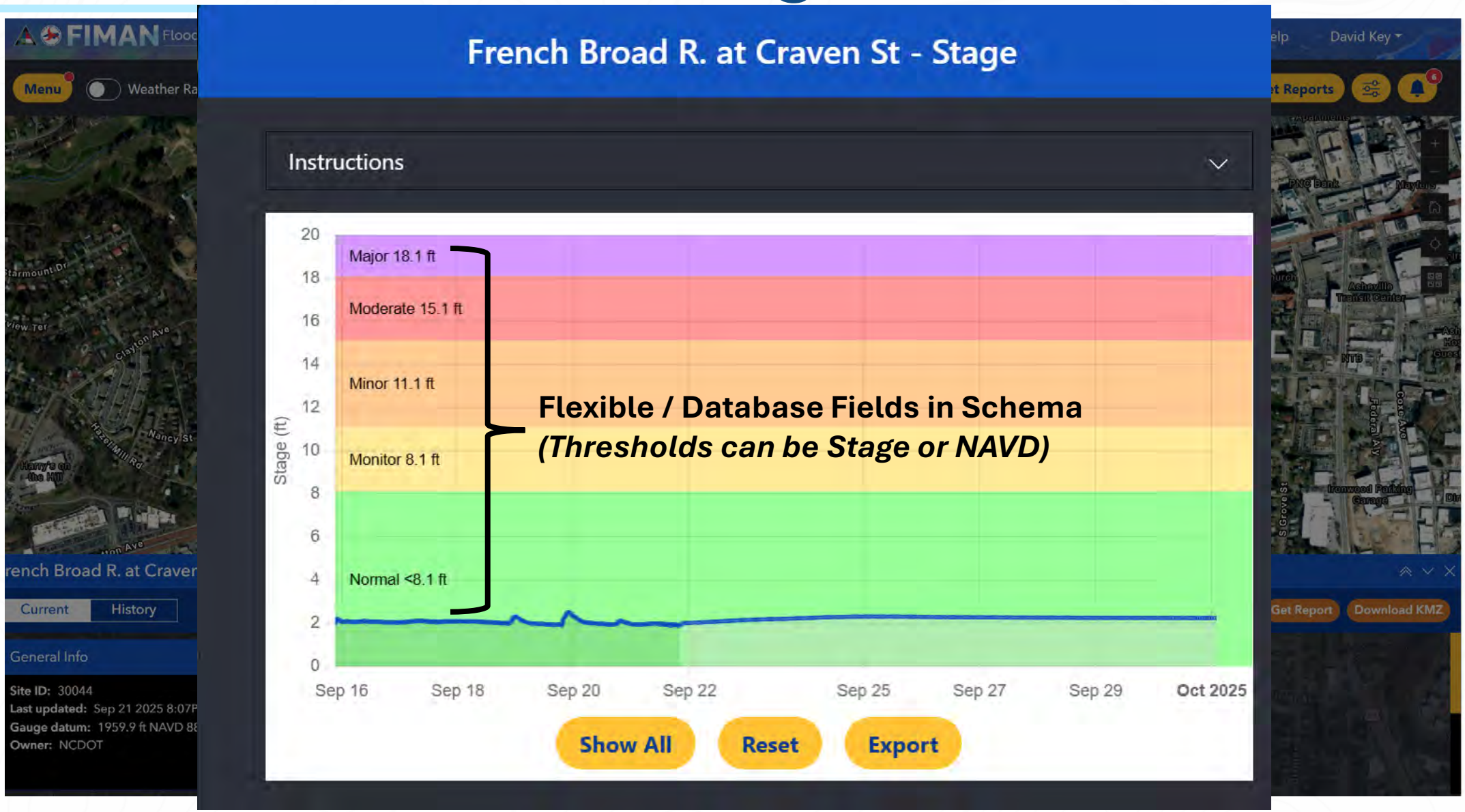


GOOD

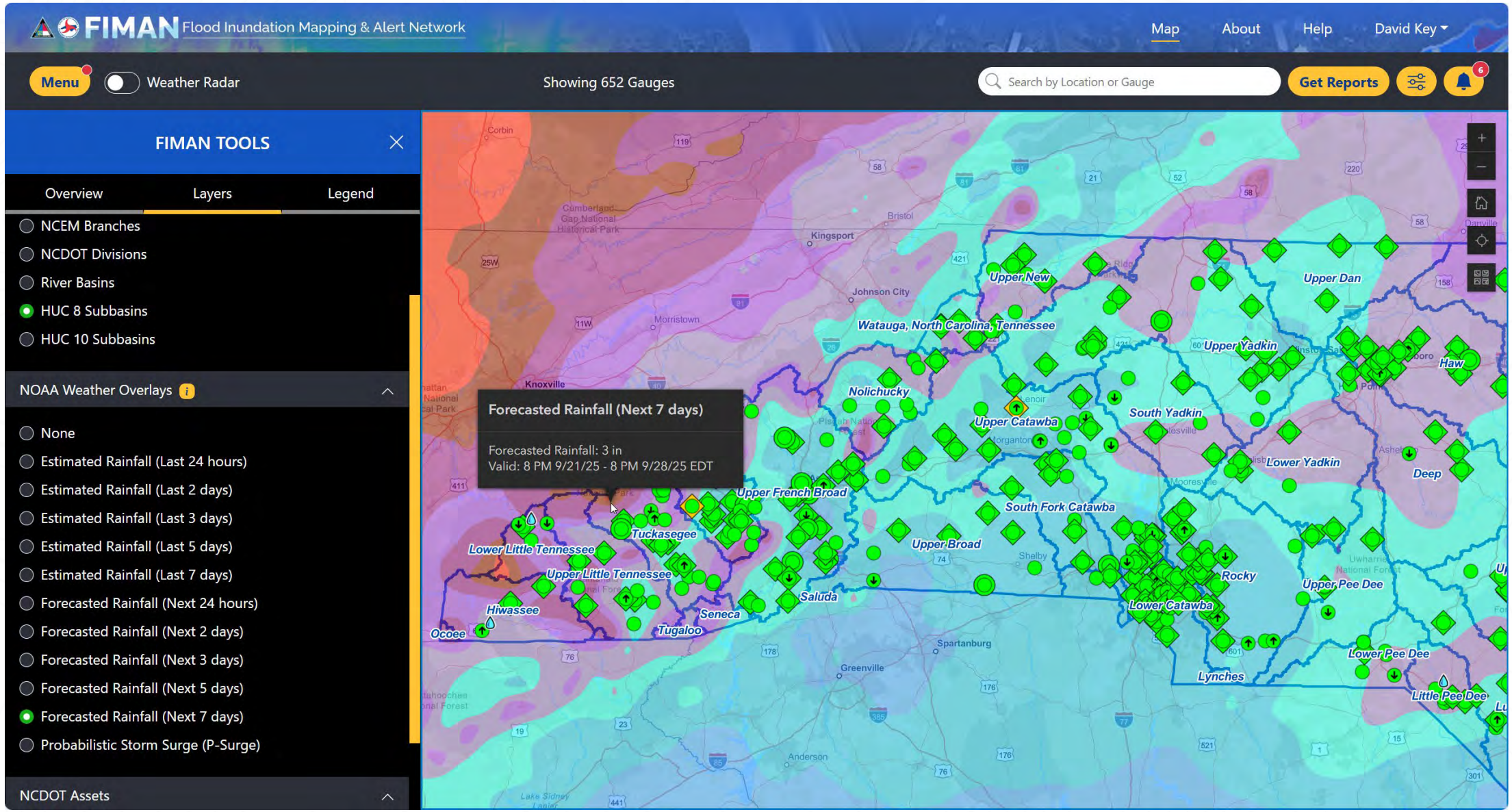


GREAT

Site Threshold Settings



New Feature: QPF Overlays



Types of Modeling / Inundation Mapping

Type	Pros	Cons
Real time – Rain on Grid Modeling and Mapping	Highly Accurate with good rainfall data and pre-built model Incorporates some forecast into peak mapping	Processor Intensive Modeling and Mapping Time Cost
Site Specific Flood Inundation Library Development	Established system Low Cost Easy to Explain Relatively Good Validation	Limited Mapping Extents May not accurately represent flood hydrograph Confluence complications
Probabilistic "Seamless" Inundation Mapping	Provides seamless mapping for entire reach / basin Relatively Good Validation	Extensive modeling required Risk Raster Datasets required Model maintenance may be costly Difficult to Explain

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Inundation Library Modeling

"Library" of flood inundation mapping near gaging stations

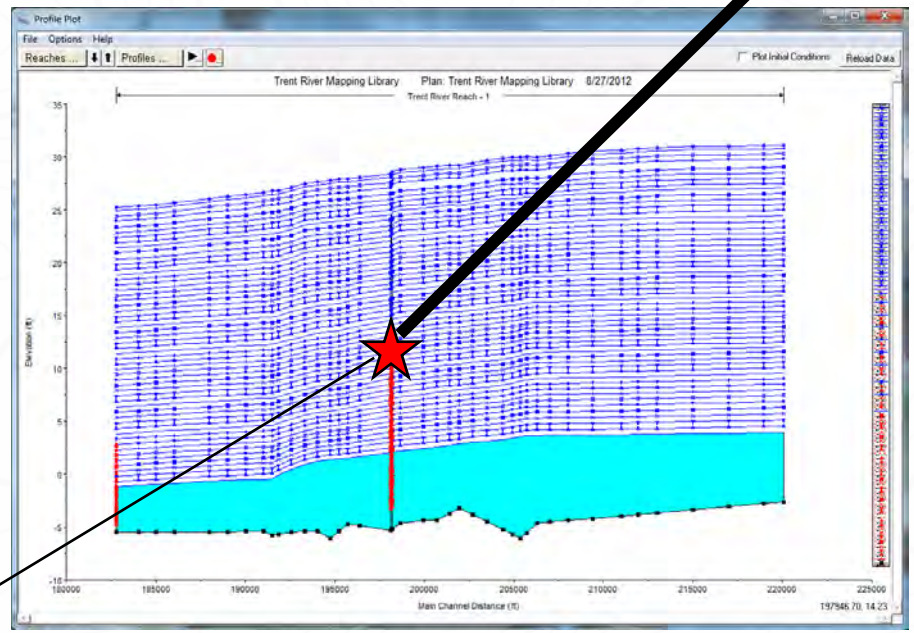
+ Gaging Stations
+ Telemetry
+ Pre-made inundation libraries
+ Web tool to efficiently communicate

Real-time flood mapping solution

Start with Hydraulic model

Add Survey / Calibrate

Iterative Modeling for all "Stage Targets"



"Stage" target in each model.

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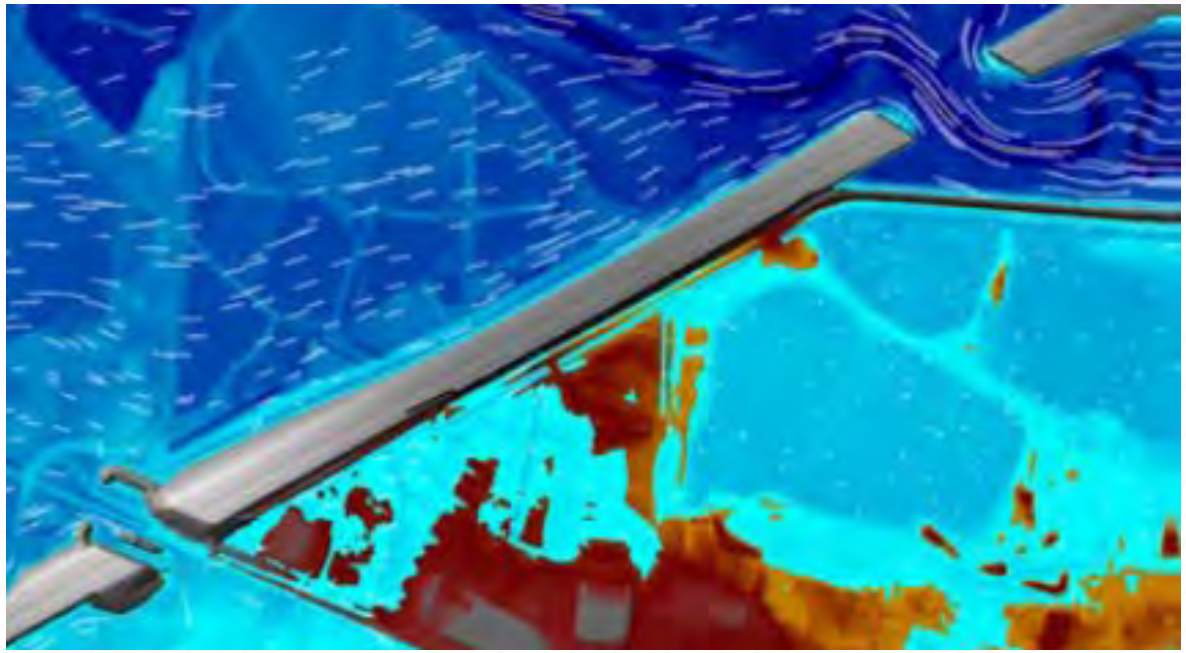
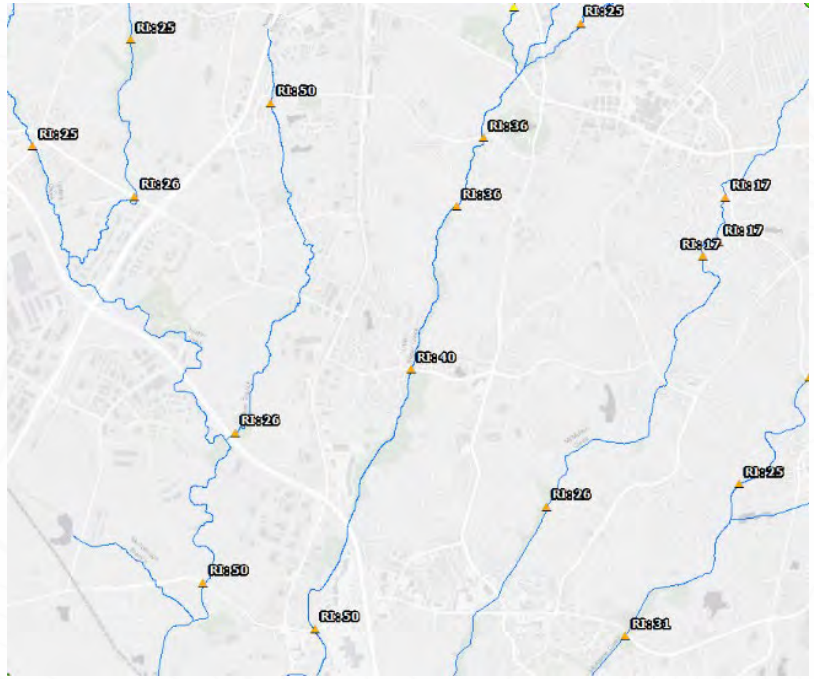
New: 2D Inundation Libraries

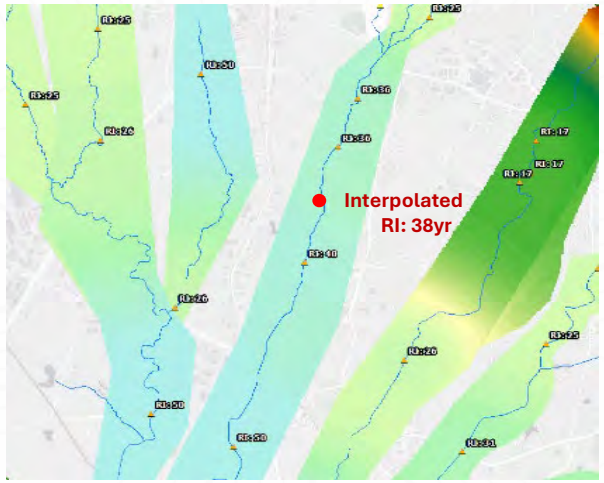
- Most Inundation Libraries Do well with 1D Modeling
- 2D modeling is being used for Sites with:
  - Complex Flow Situations
  - Multiple Tributaries and Split Flow
  - Backwater Areas
  - Dual Opening Bridges
  - Closed System Conveyances
  - Highly Urbanized Areas



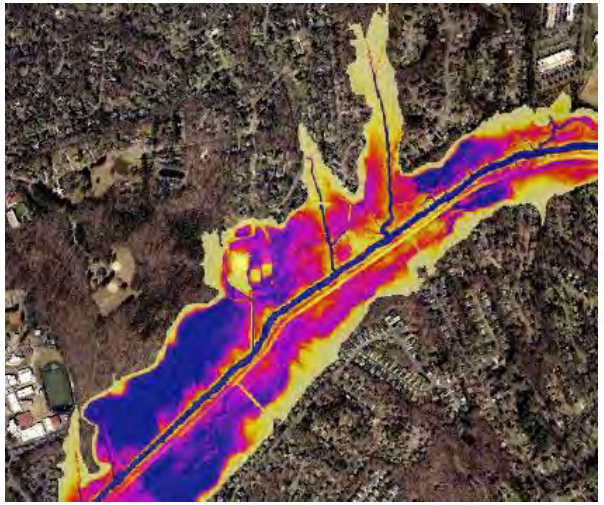
Probabilistic “Seamless Mapping”

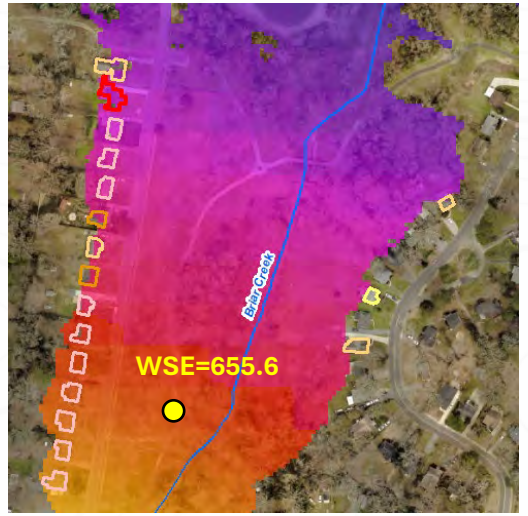
Gage Processing, Interpolation Surface Development, and PAC Extraction

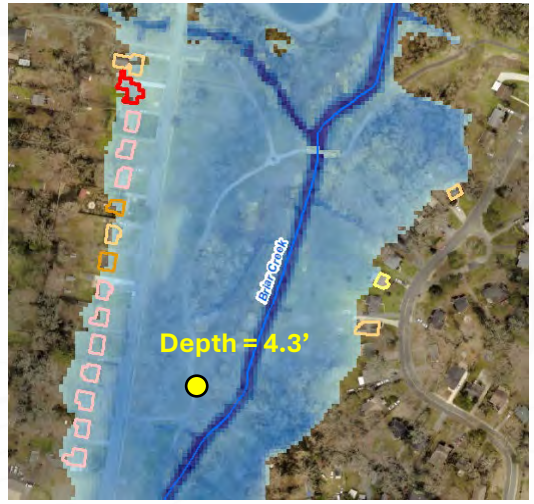




MINUS

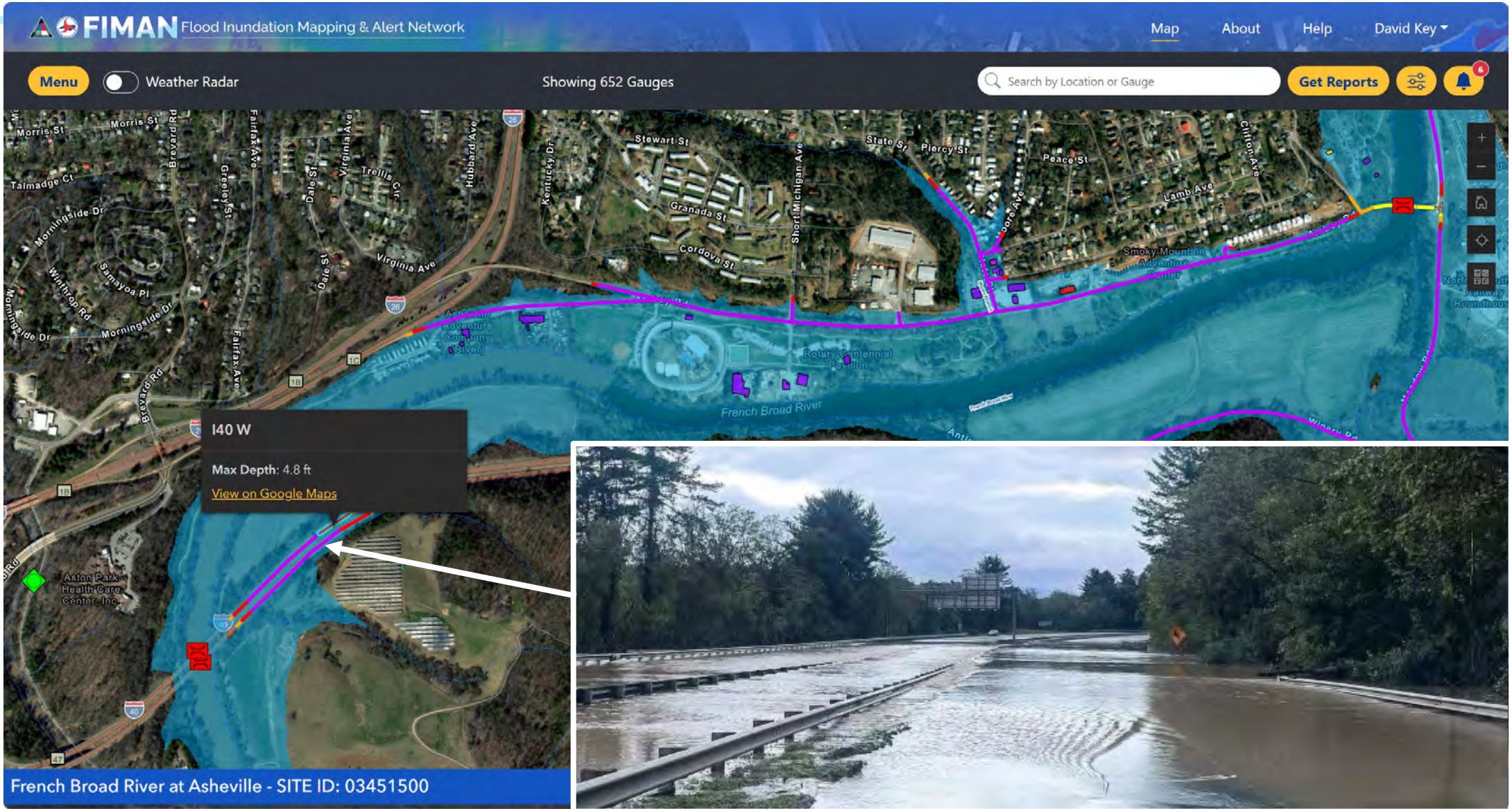






USE CASES / SUCCESS STORIES

During the Event: Helene Success Stories



During the Event: Helene Success Stories

(If you can call it that at all…)

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ESP

During the Event: Helene Success Stories

First Floor Elevations tied to each Building

Recommended Gage Alert matching FFE Flooding

FIMAN Ale… Elevation Flooding

November 4th, 2022

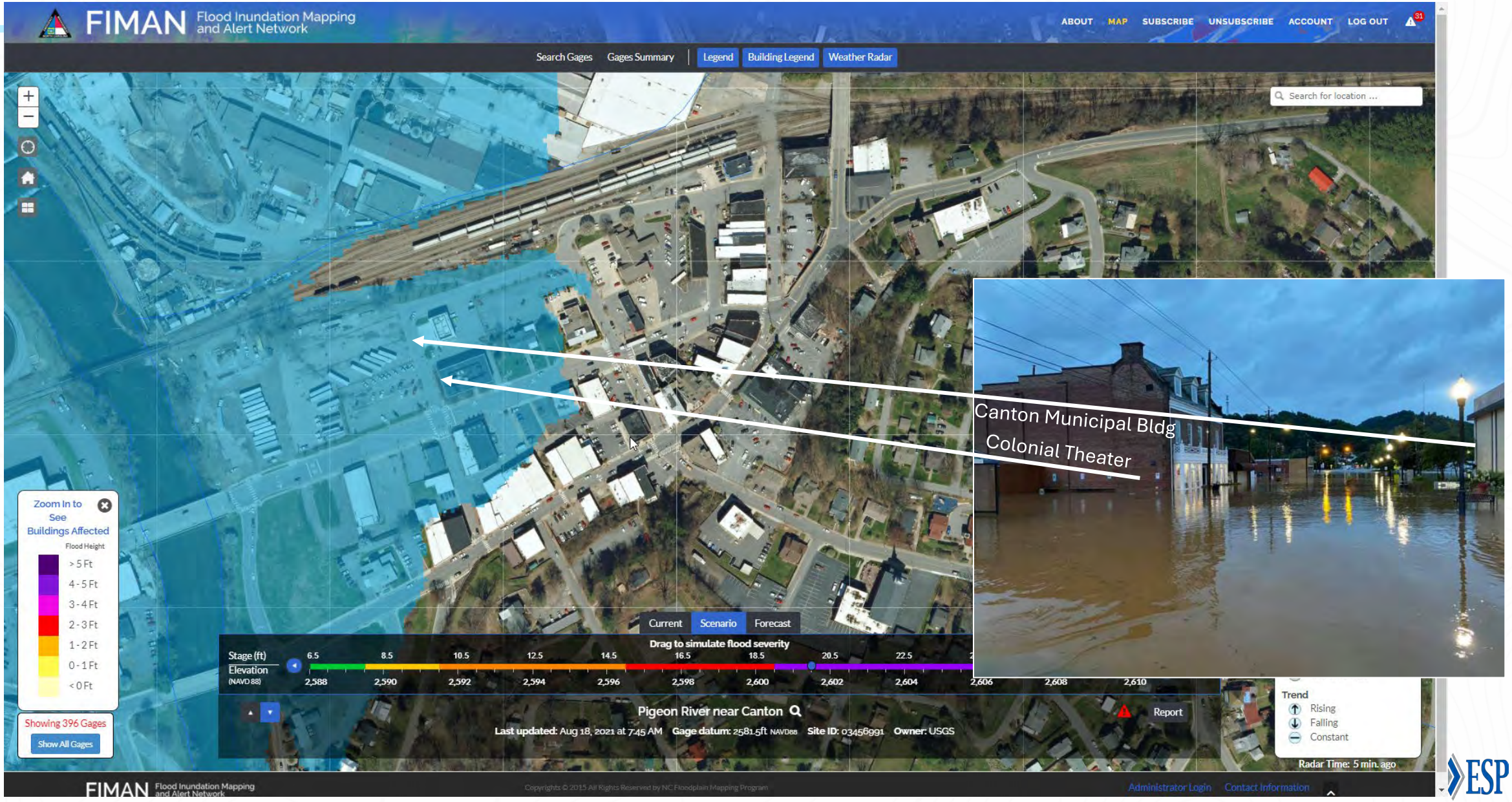
	Address	Estimated First Floor Elevation	Recommended Alert Level
1	326 RIVERSIDE DR	1972.9	1962.5
2	318 RIVERSIDE DR	1971.7	1961.5
3	327 RIVERSIDE DR	1972.1	1962
4	314 RIVERSIDE DR	1973.5	1963
5	290 RIVERSIDE DR	1975.7	1963.5
6	291 RIVERSIDE DR	1981.1	1968.5
7	174 W HAYWOOD ST	1981.2	1968.5
8	166 W HAYWOOD ST	1982.6	1969
9	151 W HAYWOOD ST	1988.1	1974
10	189 RIVERSIDE DR	1976.5	1964
11	159 RIVERSIDE DR	1972.0	1961
12	122 RIVERSIDE DR	1977.8	1964.5
13	99 RIVERSIDE DR	1971.2	1960.5
14	90 RIVERSIDE DR	1974.5	1961.5
15	95 ROBERTS ST	2024.9	1971
16	95 ROBERTS ST	2024.9	1971
17	95 ROBERTS ST	2024.9	1971
18	109 ROBERTS ST	2017.2	1972
19	111-129 ROBERTS ST	2008.1	1973
20	140 ROBERTS ST	2015.7	1976.5
21	146 ROBERTS ST	1991.8	1975
22	7 RIVER ARTS PL	1974.9	1961.5
23	8 RIVER ARTS PL	1974.7	1960.5
24	9 RIVER ARTS PL	1975.5	1962.5
25	3 RIVER ARTS PL/170 LYMAN ST	1978.6	1964.5
26	175 LYMAN ST	1975.9	1962.5
27	175 LYMAN ST	1974.6	1960.5
28	171 LYMAN ST	1979.6	1965
29	175 LYMAN ST	1976.4	1963
30	288 LYMAN ST	1972.2	1960.5
31	288 LYMAN ST	1975.2	1961
32	280 LYMAN ST	1974.4	1960.5
33	280 LYMAN ST	1976.4	1962.5
34	280 LYMAN ST	1978	1964.5
35	284 LYMAN ST	1985.8	1969.5
36	284 LYMAN ST	1975.5	1961
37	302 LYMAN ST	1977.5	1962.5
38	302 LYMAN ST	1989.2	1972.5
39	304 LYMAN ST	1976.8	1962
40	304 LYMAN ST	1974.7	1960.5
41	347 DEPOT ST	1994	1976.5
42	349 DEPOT ST	1995.5	1972
43	351 DEPOT ST	1995.5	1972
44	355 DEPOT ST	1995.5	1972
45	357 DEPOT ST	1995.5	1972
46	357 DEPOT ST	1995.5	1972
47	375 DEPOT ST	1984.7	1969

The recommended alert levels provided on this map for buildings within the Asheville River Arts District should be considered planning-level and are based on river levels at the USGS Gage 03451500 at Pearson Street farther downstream. These planning-level alert levels may be used in FIMAN for alert notifications to help inform decision making during flood events. Accuracy of the provided recommended alert levels is not guaranteed and actual flooding impacts to buildings may occur at different flood levels than those indicated.

wsb

ESP

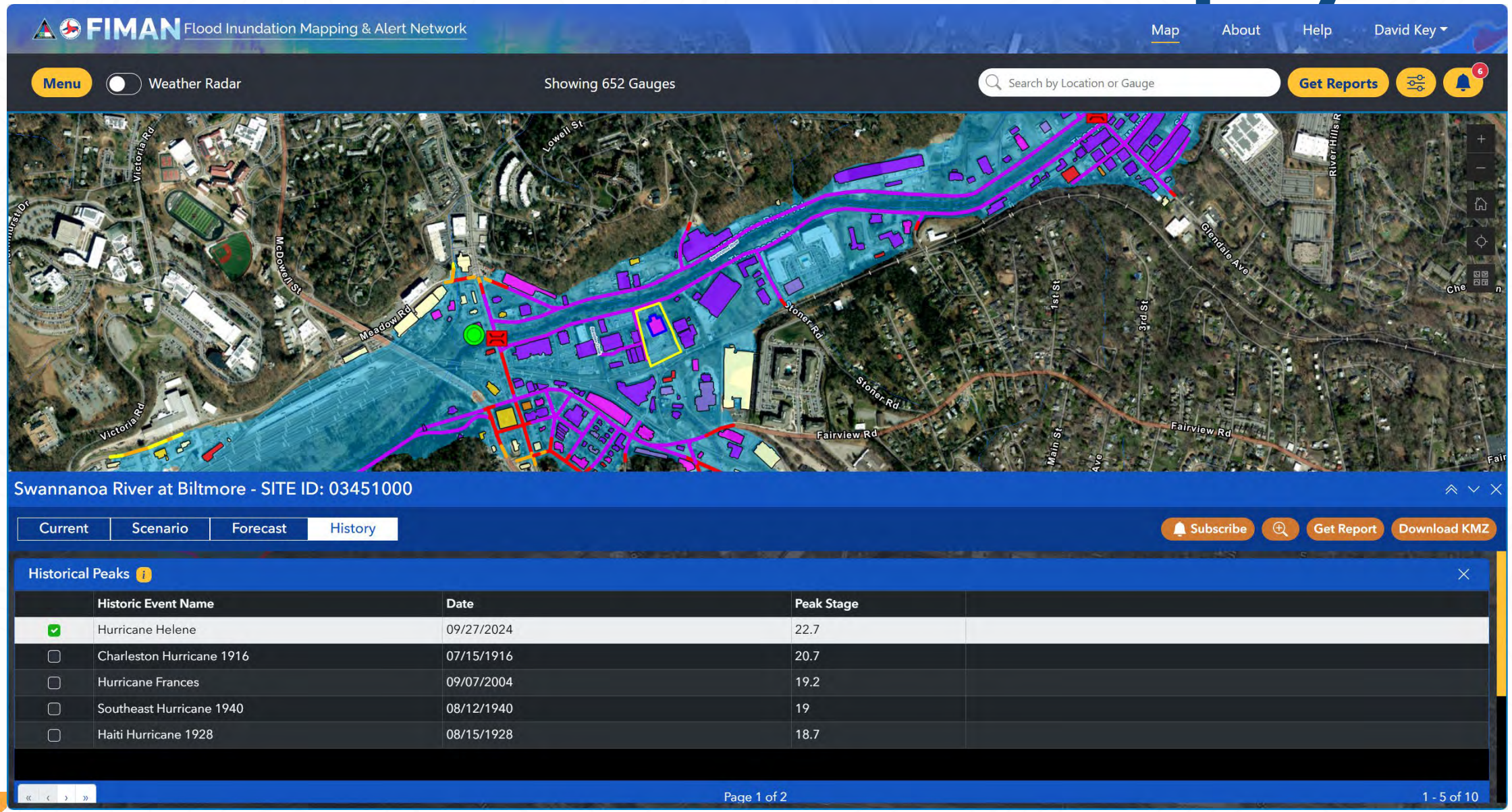
Post Event: Validation



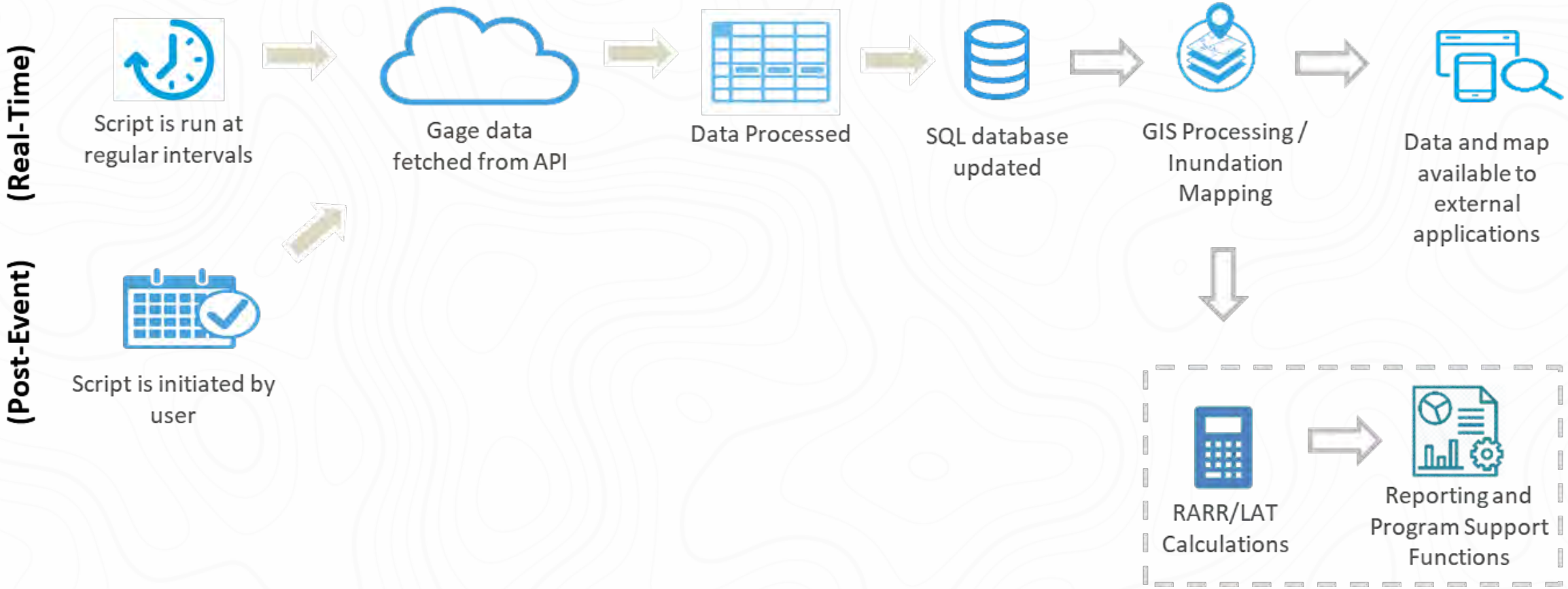
wsb

ESP

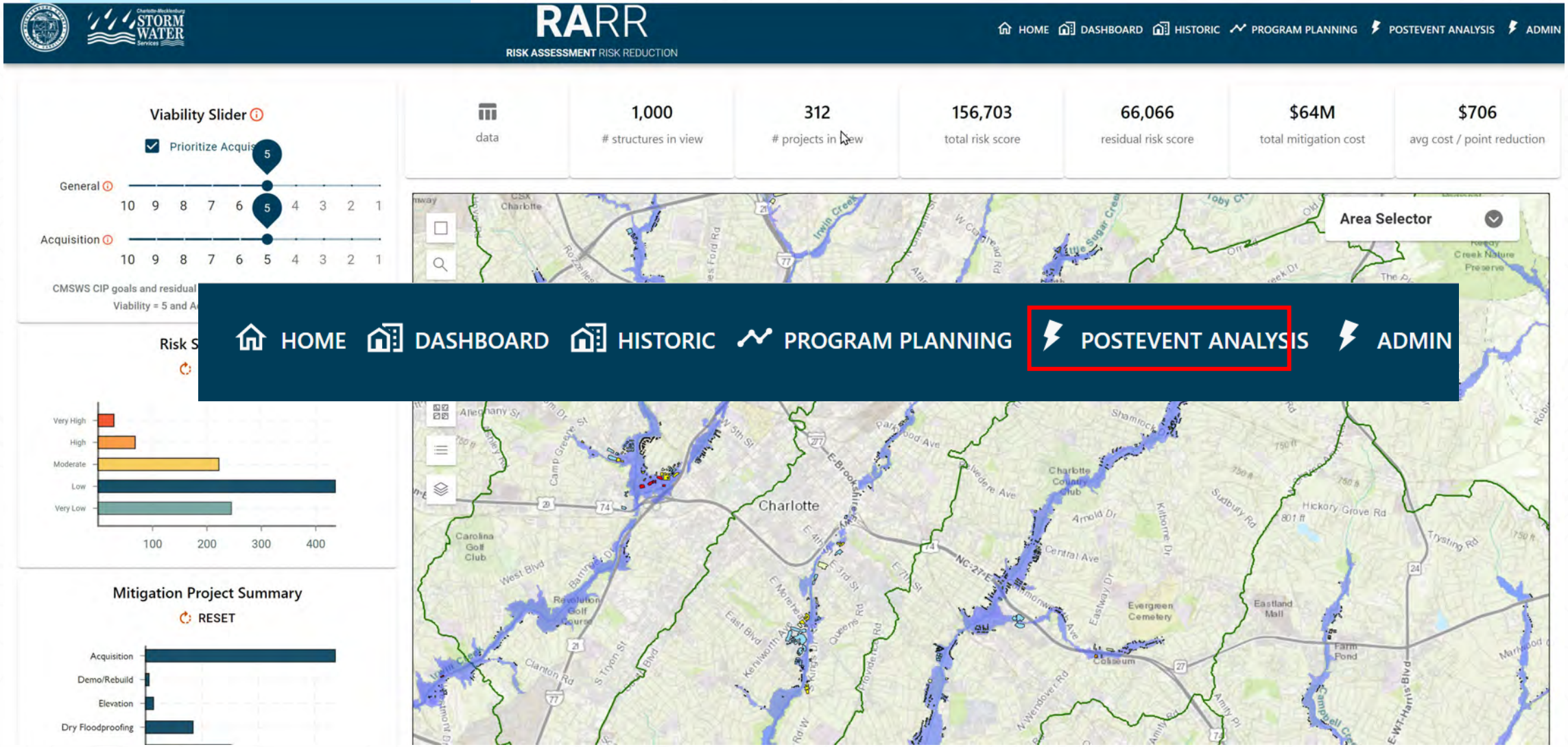
Post Event: Historical Storm Display



Post Event: Post Event Mapping



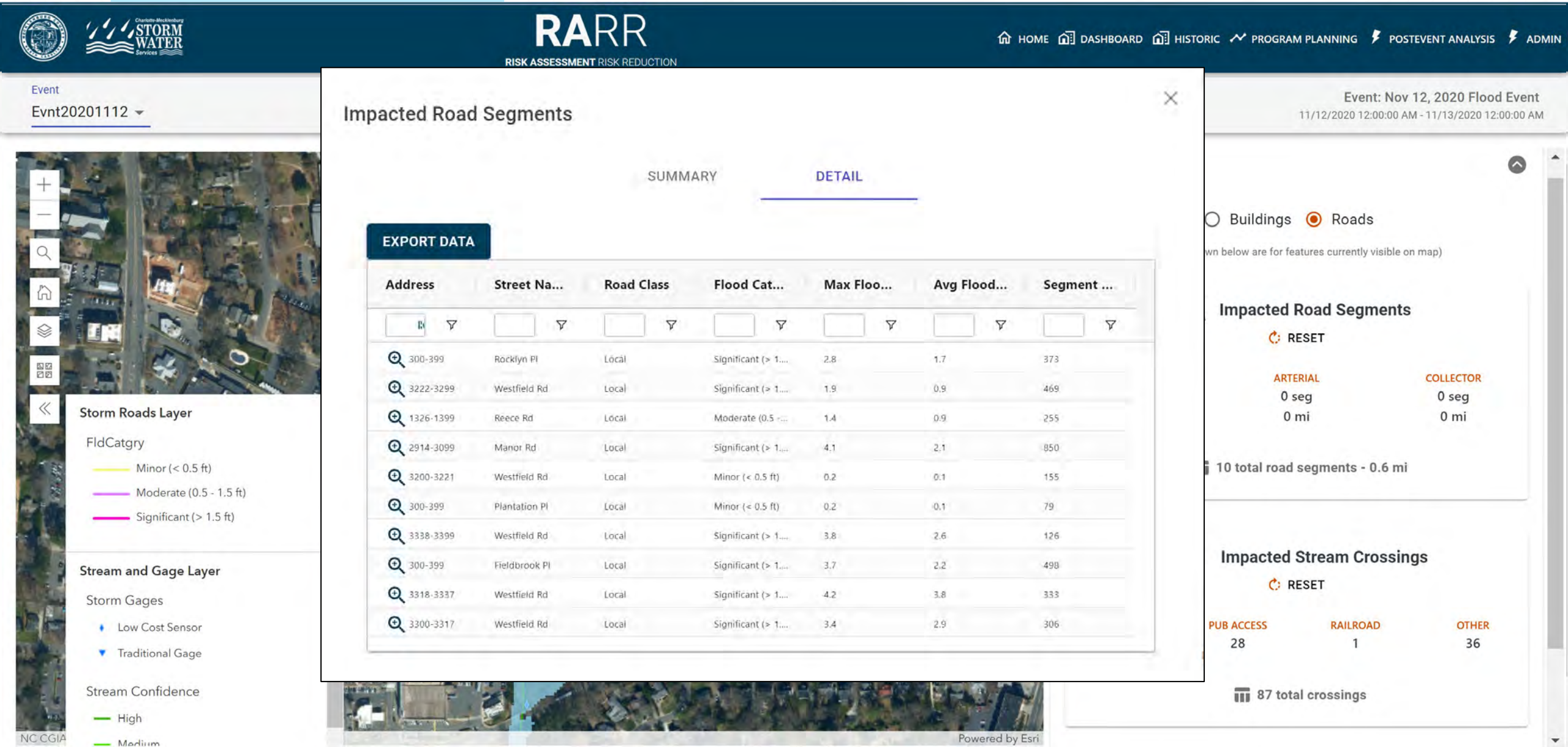
Post Event: Post Event Mapping



wsb

ESP

Post Event: Post Event Mapping

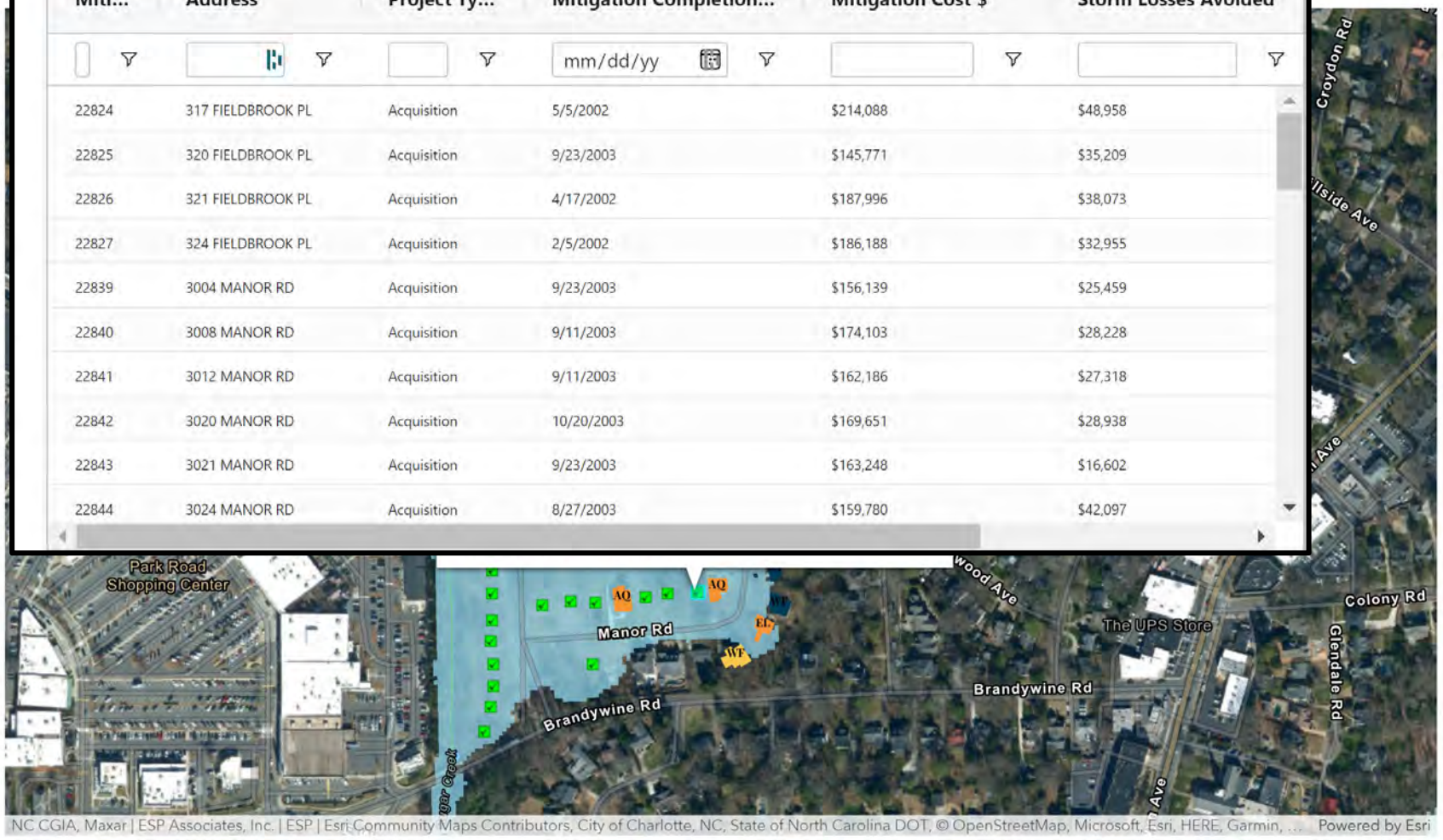


Post Event: Losses Avoided

Event Impact on Mitigated Buildings

EXPORT DATA

Miti...	Address	Project Ty...	Mitigation Completion...	Mitigation Cost $	Storm Losses Avoided
			mm/dd/yy		
22824	317 FIELDBROOK PL	Acquisition	5/5/2002	$214,088	$48,958
22825	320 FIELDBROOK PL	Acquisition	9/23/2003	$145,771	$35,209
22826	321 FIELDBROOK PL	Acquisition	4/17/2002	$187,996	$38,073
22827	324 FIELDBROOK PL	Acquisition	2/5/2002	$186,188	$32,955
22839	3004 MANOR RD	Acquisition	9/23/2003	$156,139	$25,459
22840	3008 MANOR RD	Acquisition	9/11/2003	$174,103	$28,228
22841	3012 MANOR RD	Acquisition	9/11/2003	$162,186	$27,318
22842	3020 MANOR RD	Acquisition	10/20/2003	$169,651	$28,938
22843	3021 MANOR RD	Acquisition	9/23/2003	$163,248	$16,602
22844	3024 MANOR RD	Acquisition	8/27/2003	$159,780	$42,097



HOME | DASHBOARD | HISTORIC | PROGRAM PLANNING | POSTEVENT ANALYSIS | ADMIN

Event: Nov 12, 2020 Flood Event
11/12/2020 12:00:00 AM - 11/13/2020 12:00:00 AM

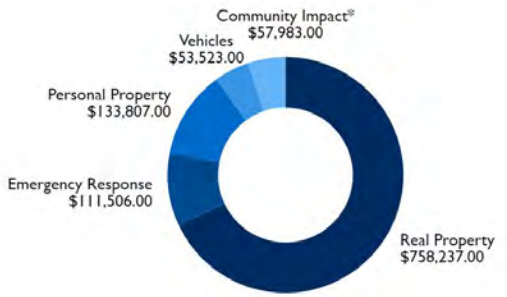
Event Mitigation Options

Event Losses Avoided Data

(values shown below are for features currently visible on map)

49	$1.1M	$1.5M
# of buildings	estimated losses avoided	cumulative losses avoided

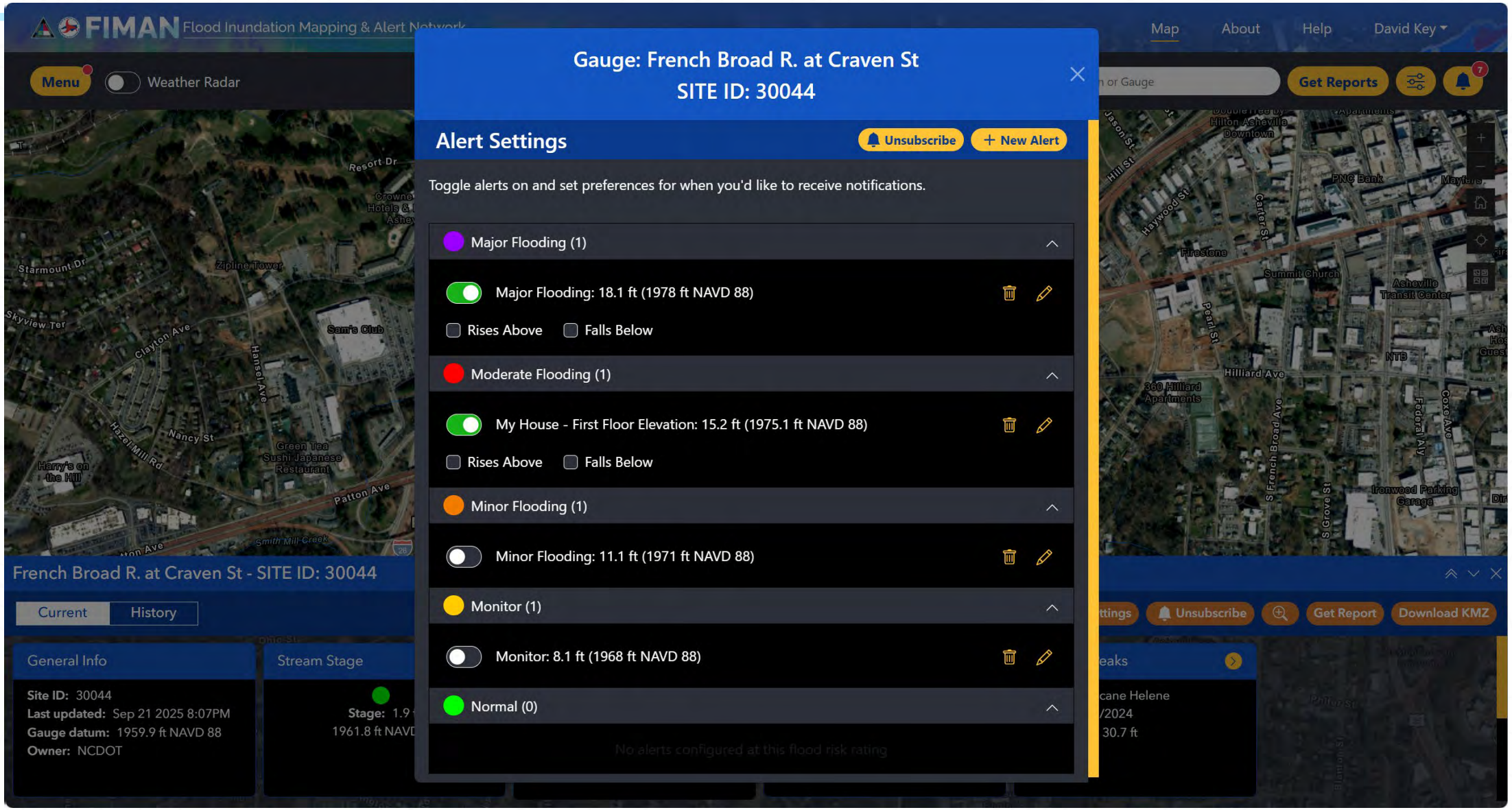
Losses Avoided by Category



*Accounts for social, economic, and environmental impacts

OUTREACH, TRAINING & MAINTENANCE

Alert Types


FIMAN Flood Inundation Mapping & Alert Network
Map
About
Help
David Key
Menu
Weather Radar
Get Reports
Gauge: French Broad R. at Craven St
SITE ID: 30044
Alert Settings
Unsubscribe
+ New Alert
Toggle alerts on and set preferences for when you'd like to receive notifications.
Major Flooding (1)
Major Flooding: 18.1 ft (1978 ft NAVD 88)
Rises Above
Falls Below
Moderate Flooding (1)
My House - First Floor Elevation: 15.2 ft (1975.1 ft NAVD 88)
Rises Above
Falls Below
Minor Flooding (1)
Minor Flooding: 11.1 ft (1971 ft NAVD 88)
Monitor (1)
Monitor: 8.1 ft (1968 ft NAVD 88)
Normal (0)
No alerts configured at this flood risk rating
French Broad R. at Craven St - SITE ID: 30044
Current
History
General Info
Site ID: 30044
Last updated: Sep 21 2025 8:07PM
Gauge datum: 1959.9 ft NAVD 88
Owner: NCDOT
Stream Stage
Unsubscribe
Get Report
Download KMZ

Custom Alert Worksheets

"FRONT"

BEAVER CREEK AT Morganton Rd (SR 1404)

FAYETTEVILLE
AMERICA'S CAN DO CITY

Site Information

Site ID (NCEM): 30006
County: Cumberland
Latitude: 35° 04' 25.6"
Longitude: -78° 58' 36.68"
Record: 2019 - present
Drainage Area: 10.9 sq. mi.
Datum: 150.0 (NAVD88 ft)

SUGGESTED ALERT WARNINGS

This section gives initial suggestions as to when alerts might be necessary for the City of Fayetteville. These alerts are based on reviewing the site inundation, bridge conditions, building and roadway impacts. Custom alerts can be established in the FIMAN application to notify stakeholders via email or text messages when these conditions occur at the site.

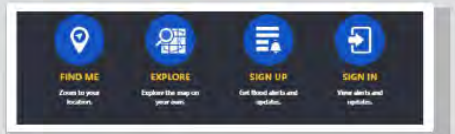
Sensor Stage (ft)	Elevation (NAVD)	Conditions
12	162	Homes/structures along Stewart Creek under risk of flooding due to backwater from Beaver Creek.
13	163	Homes/structures along Persimmon Creek under risk of flooding due to backwater from Beaver Creek.
14.5	164.5	Risk of Overtopping Morganton Rd.
15	165	Homes/structures along Beaver creek just south of SR 1404 should be monitored for potential flooding.
15.5	165.5	Risk of Overtopping Yadkin Rd.

Instructions for setting up basic and custom FIMAN alerts are included on the reverse page.

"BACK"

SETTING UP ALERTS IN FIMAN

1 **Step 1.** Sign up or sign in to NC FIMAN at https://fiman.nc.gov/



2 **Step 2.** After signing in, select *My Profile* in the top right corner. Check that the email is correct, and *Email Alerts* are toggled *ON*. (Optional: Users may add a phone number by clicking *Edit*.)

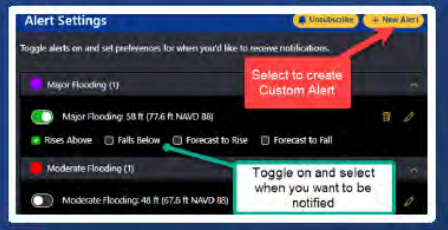
3 **Step 3.** Search for the gauge of interest by using the search bar or by panning to the gage in the FIMAN application.

4 **Step 4.** When a gauge has been selected, use the *Scenario* tab to assess various impacts based on sensor stage values. This can provide guidance for setting custom alerts.

5 **Step 5.** Select *Subscribe* on the right side on the screen.

6 **Step 6.** First, users will see the predefined alert levels. To receive notifications for these levels, toggle *ON* alerts and select notification options.

7 **Step 7.** In addition to the FIMAN predefined alerts, users may also create custom alerts by selecting *New Alert*.



8 **Step 8.** When creating a custom alert, specify the sensor stage of interest. Options for alerting include when the sensor stages *Rises Above* or *Falls Below* for both current conditions and forecasted conditions. Note: Forecast alert options are only available for sensors where a forecast is provided by the River Forecast Center (NOAA).

wsb

ESP

Maintenance

- Maintenance is Critical
- “Maintenance Champion”
- Firmware Updates (Annual)
- Daily / Weekly “Health Checks”
  - Battery Levels (Critical)
  - Past Stage Readings
  - Telemetry / Cell Signal
- Focus before / after “Flooding Seasons”

wsb

ESP

LOCAL EFFORTS

What Can We Do Without a Flood Warning System?

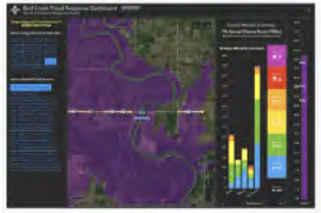
Tulsa County and Tulsa Area Emergency Management Agency

Bird Creek Flood Monitoring Applications

Bird Creek Flood Response Dashboard - AVANT

Dashboard developed to monitor and predict flooding along the Bird Creek in Tulsa County

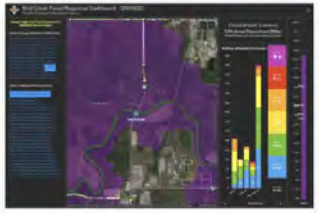
Explore



Bird Creek Flood Response Dashboard - SPERRY

Dashboard developed to monitor and predict flooding along the Bird Creek in Tulsa County

Explore



Bird Creek Flood Response Dashboard - OWASSO

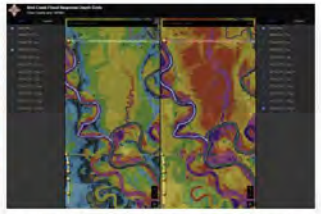
Dashboard developed to monitor and predict flooding along the Bird Creek in Tulsa County

Explore

Bird Creek Depth Grid Analysis Viewers

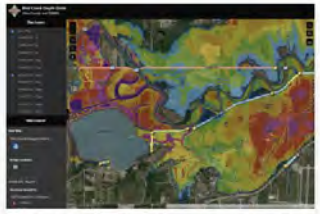
Bird Creek Flood Response Depth Grids

Explore



Bird Creek Flood Response Depth Grids COMPARE

Explore

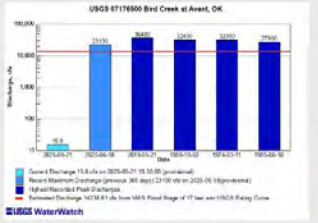


Bird Creek Flood Response Depth Grids MOBILE

Explore

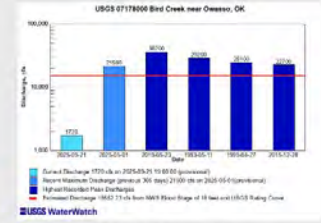
Tulsa County and Tulsa Area Emergency Management Agency

Bird Creek Discharge Summary (Current and Historical)



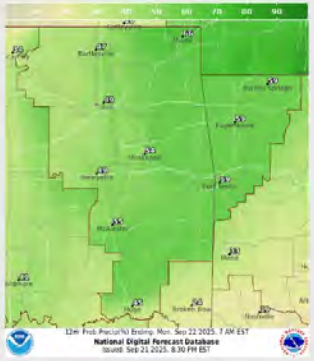
Bird Creek Gauge at Avant

Bird Creek Gauge at Sperry



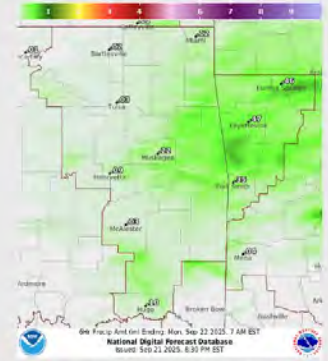
Bird Creek Gauge at Owasso

Tulsa Area National Weather Service (NWS) Graphical Forecasts



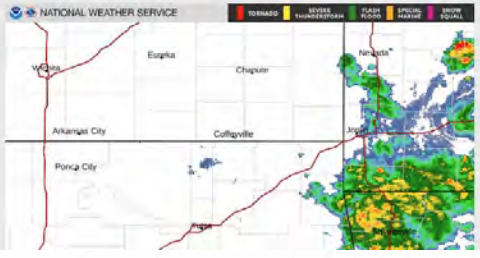
12Hr Probability Precipitation

Quantitative Precipitation Forecast (QPF) 1

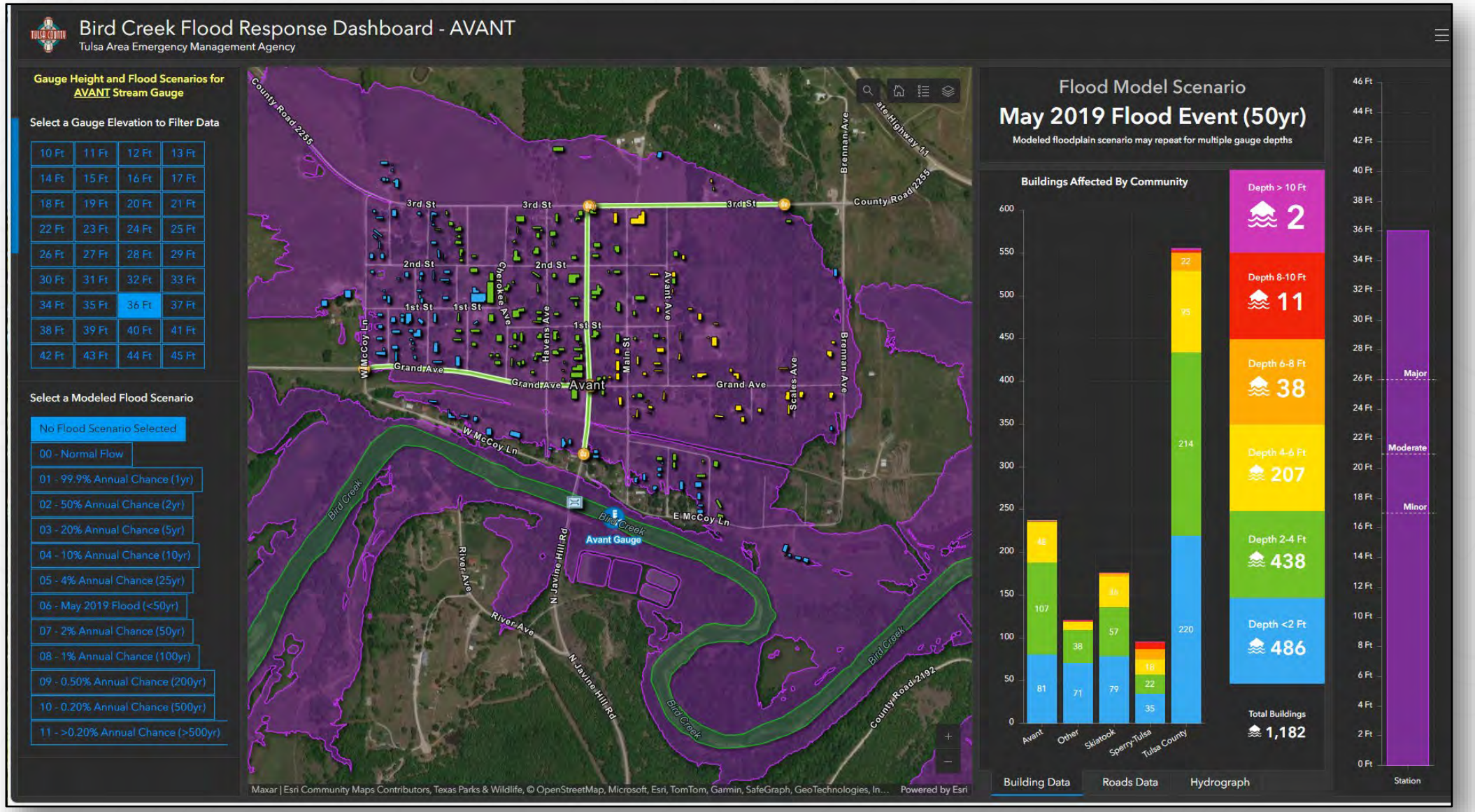


Quantitative Precipitation Forecast (QPF) 2

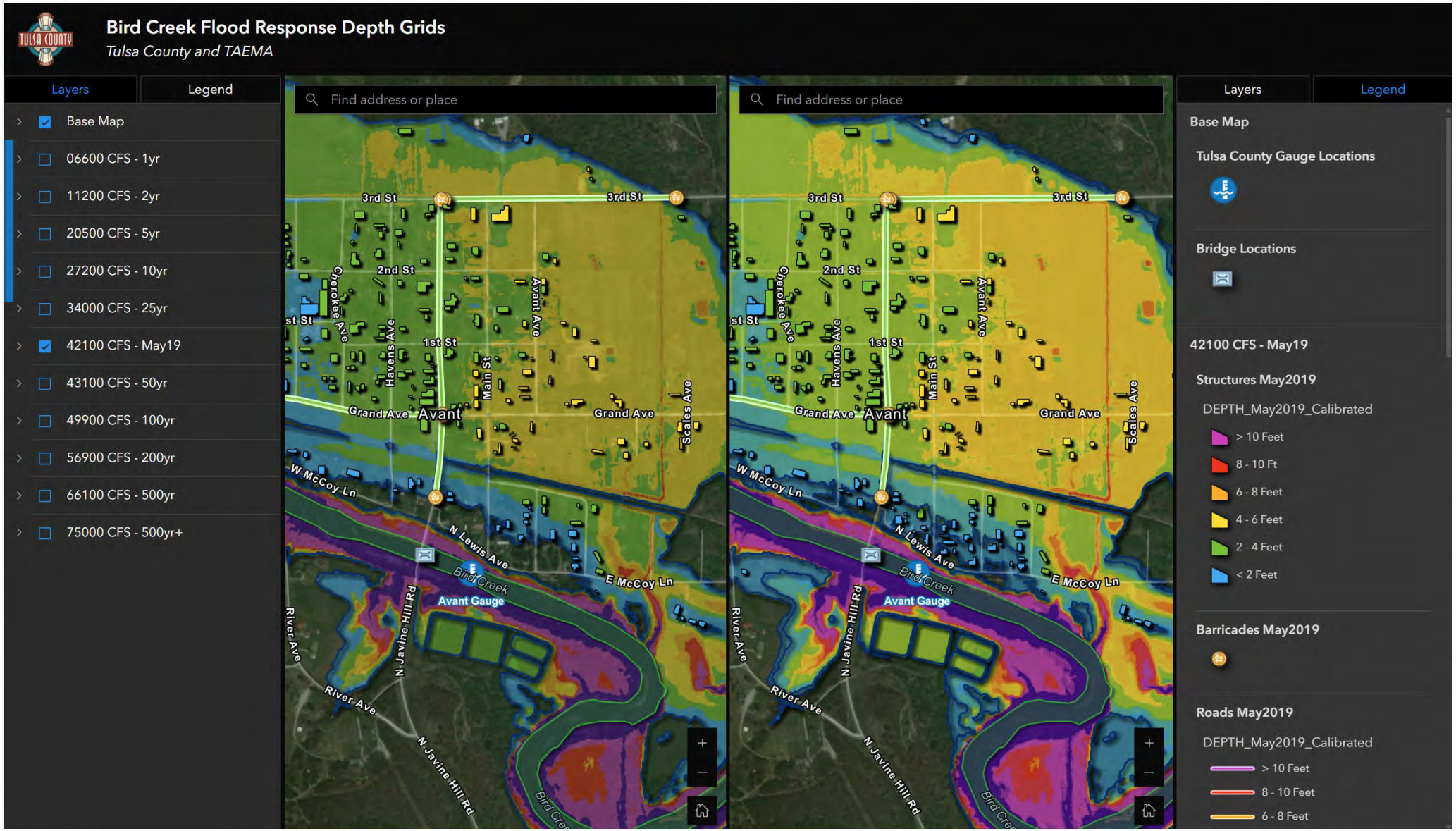
Tulsa Area National Weather Service (NWS) Weather Radar



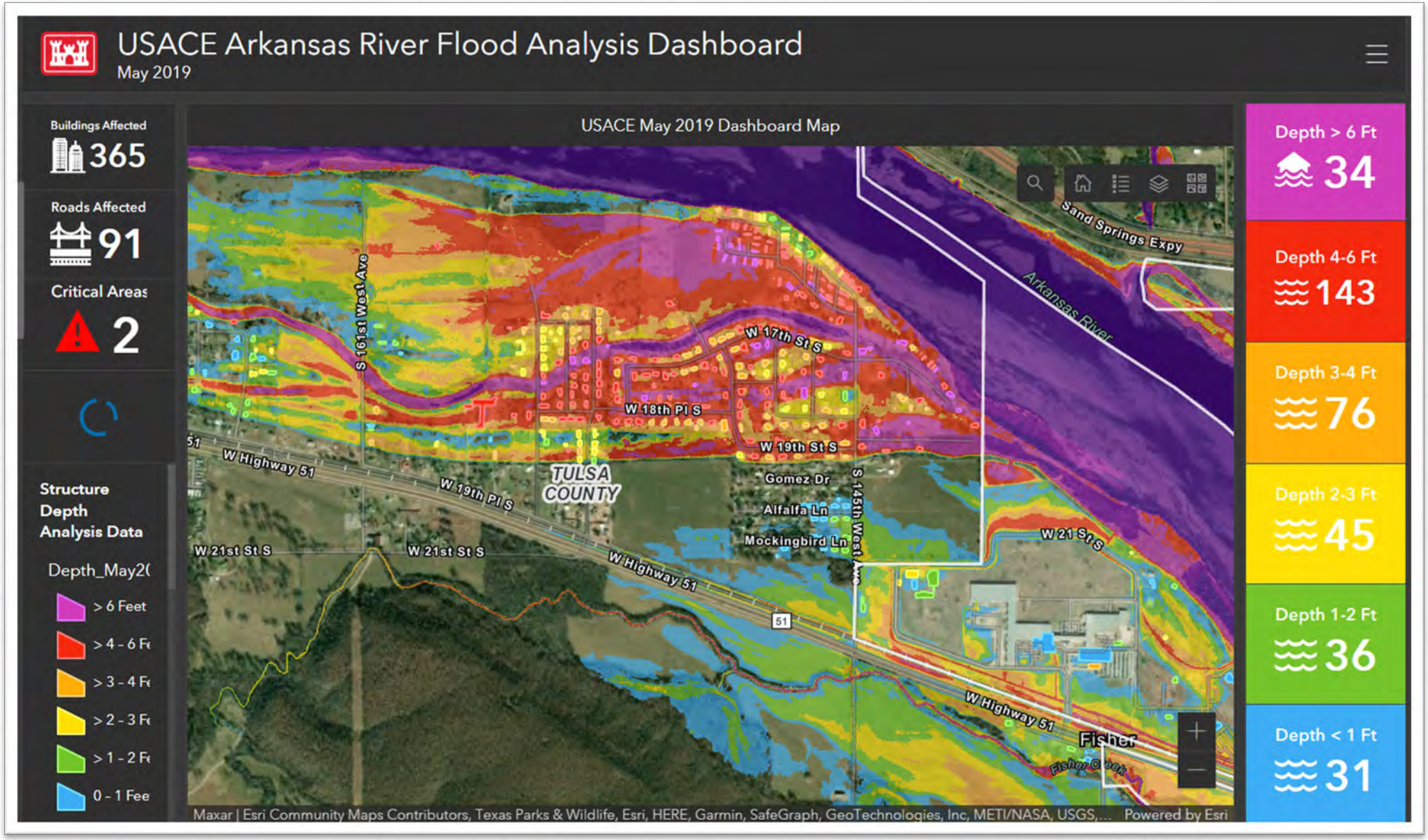
What Can We Do Without a Flood Warning System?



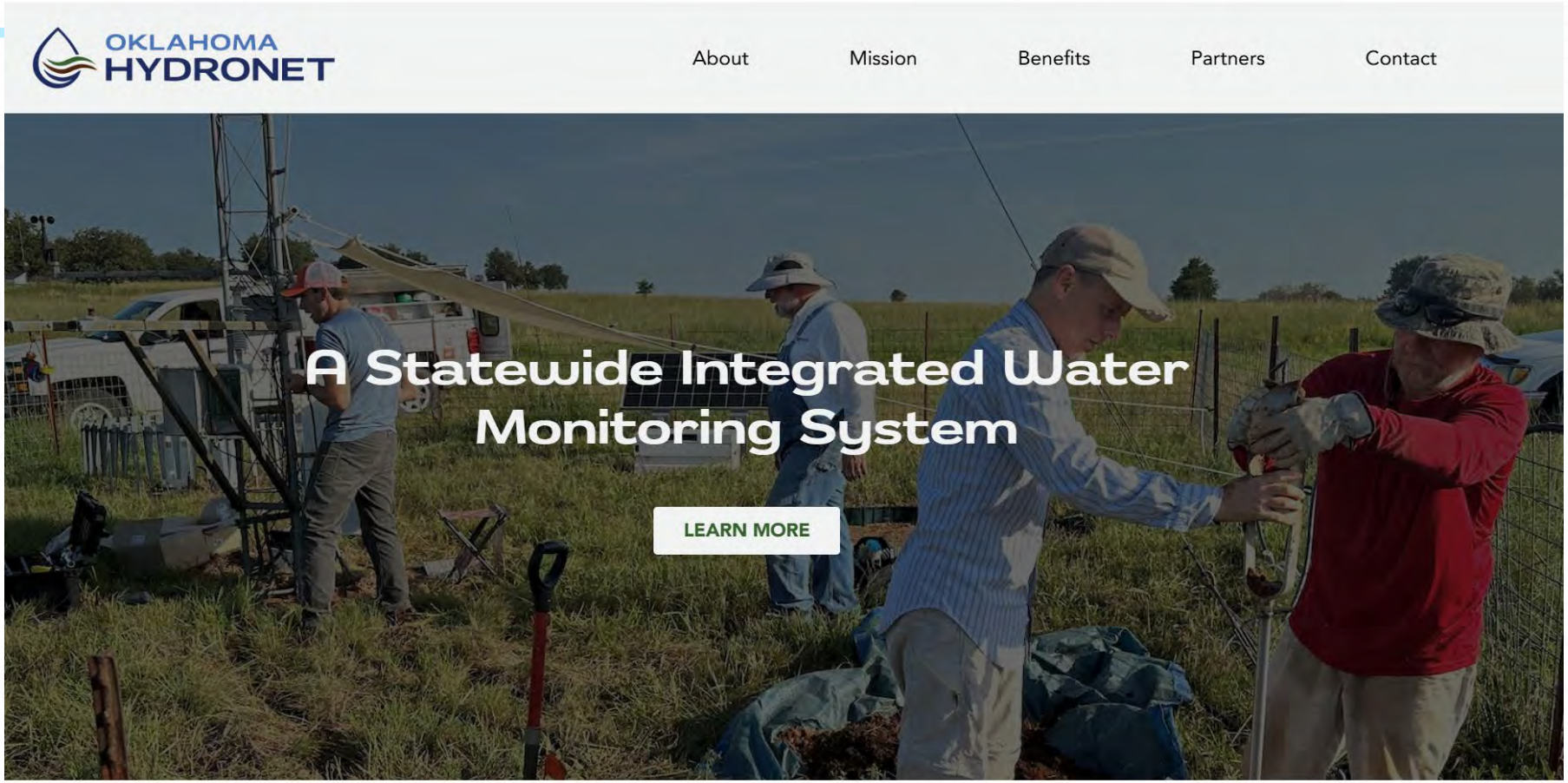
What Can We Do Without a Flood Warning System?



May 2019 Post Flood Analysis – USACE



Oklahoma Hydronet

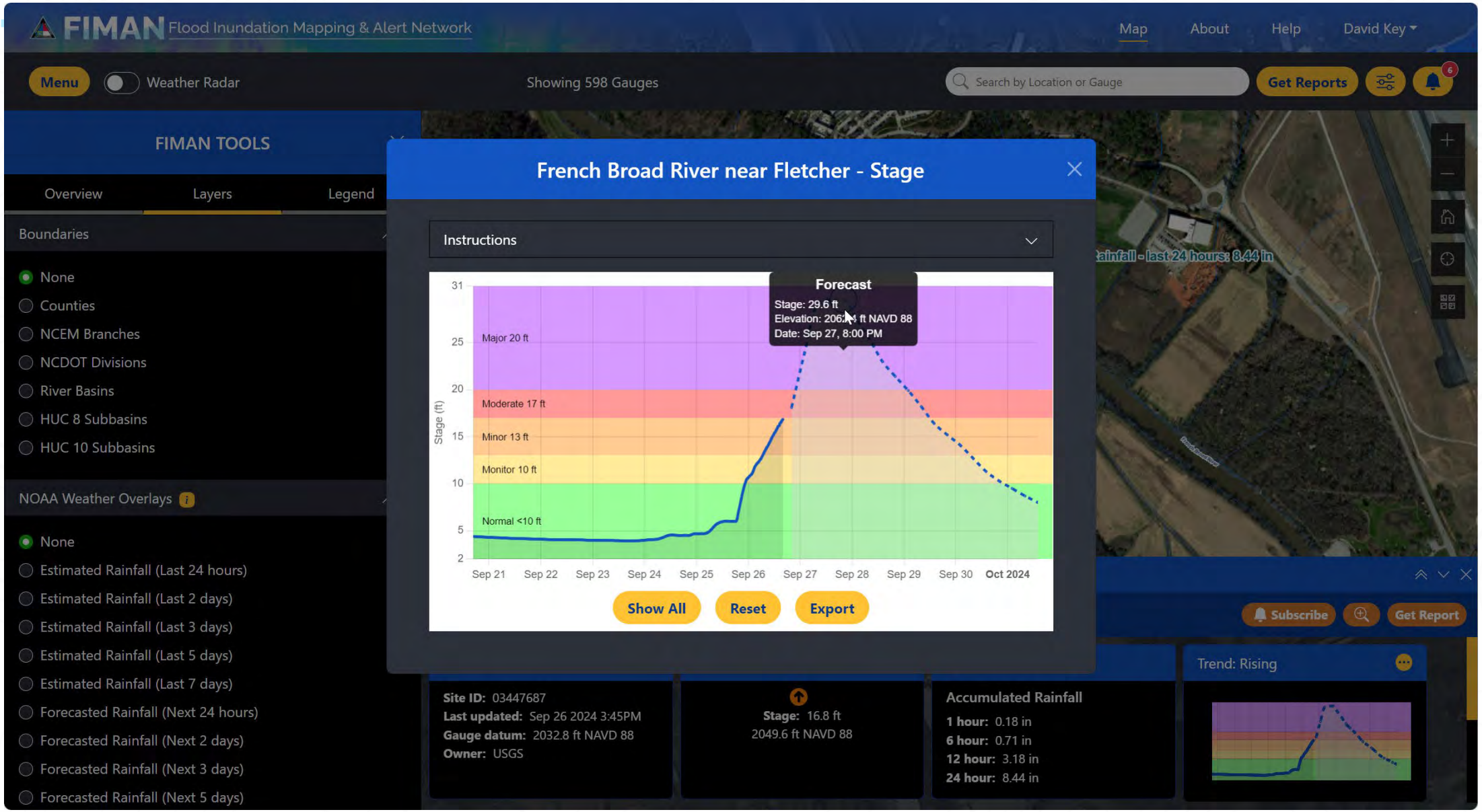


WHO WE ARE

Oklahoma Hydronet

“THE GAP” AND THE FUTURE

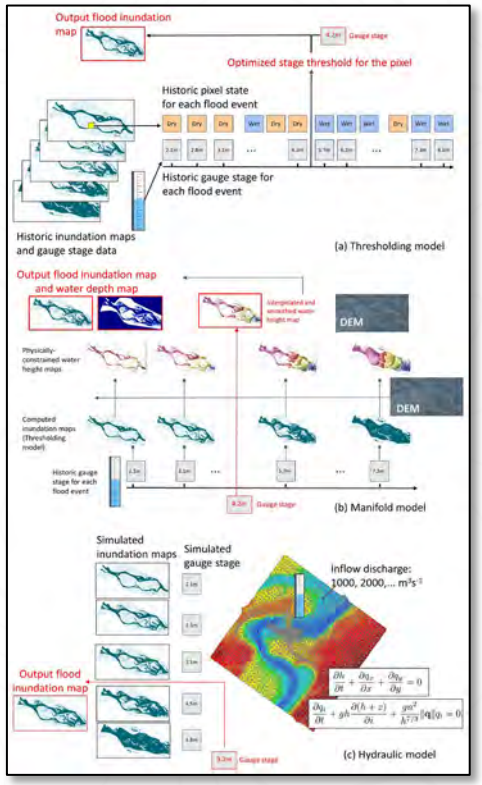
“The Forecast Gap” & The Future

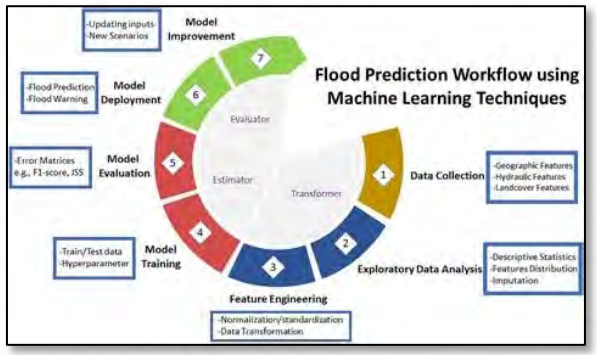


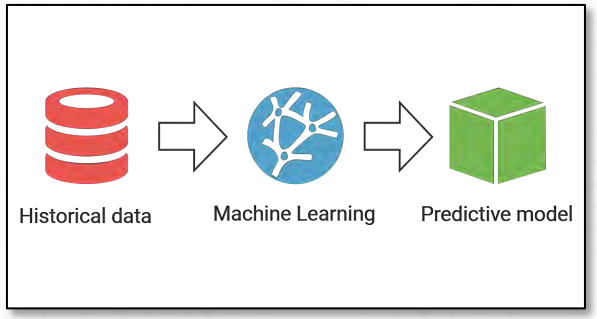
wsb

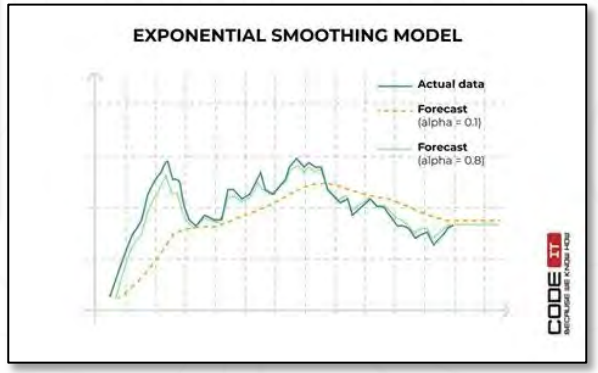
ESP

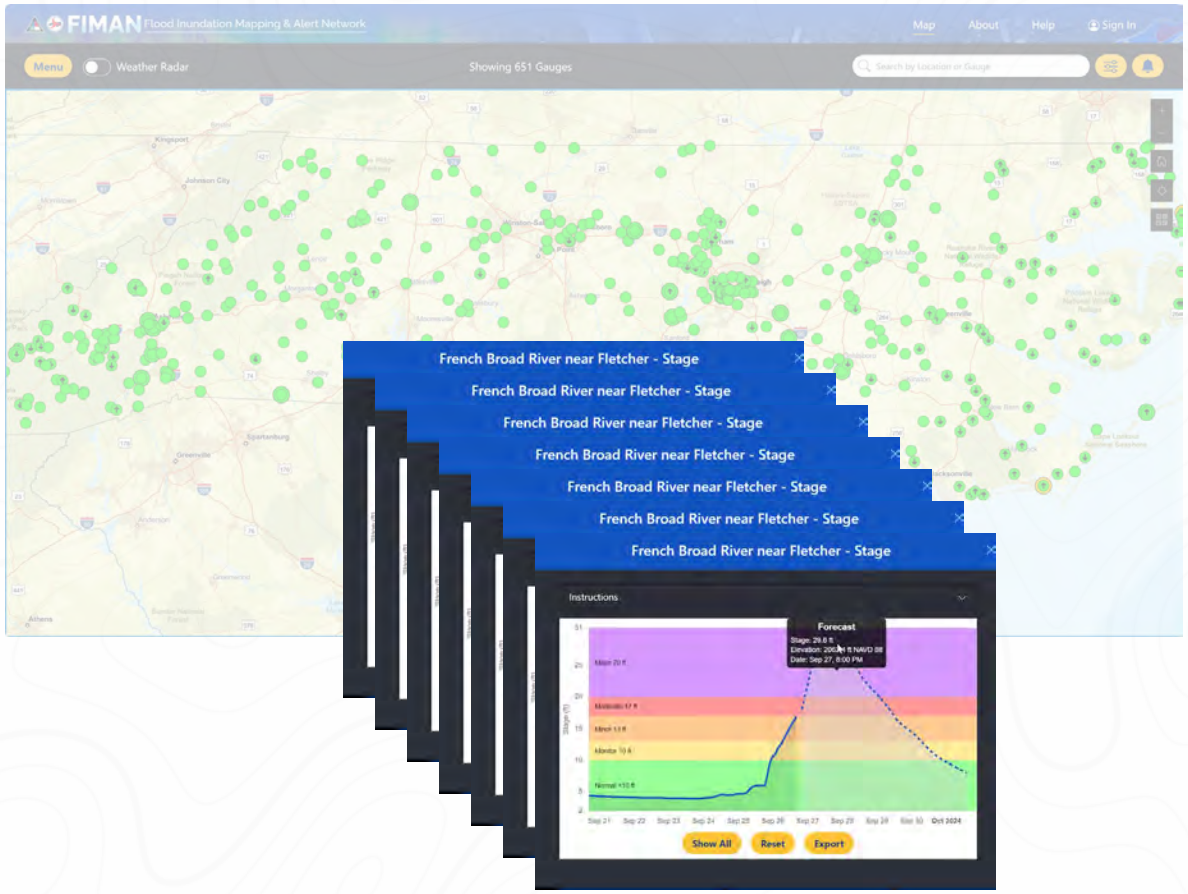
The Future


Output flood inundation map
Optimized stage threshold for the pixel
Historic pixel state for each flood event
Historic gauge stage for each flood event
Historic inundation maps and gauge stage data
(a) Thresholding model
Output flood inundation map and water depth map
DEM
DEM
(b) Manifold model
Simulated inundation maps
Simulated gauge stage
inflow discharge: 1000, 2000,... m³s⁻¹
Output flood inundation map
(c) Hydraulic model


Flood Prediction Workflow using Machine Learning Techniques
Model Improvement
Model Deployment
Model Evaluation
Model Training
Data Collection
Exploratory Data Analysis
Feature Engineering
Evaluator
Estimator
Transformer
-Updating inputs -New Scenarios
-Flood Prediction -Flood Warning
-Error Matrices e.g., F1-score, ISS
-Train/Test data -Hyperparameter
-Geographic Features -Hydraulic Features -Landcover Features
-Descriptive Statistics -Features Distribution -Imputation
-Normalization/standardization -Data Transformation


Historical data
Machine Learning
Predictive model


EXPONENTIAL SMOOTHING MODEL
Actual data
Forecast (alpha = 0.1)
Forecast (alpha = 0.8)


FIMAN Flood Inundation Mapping & Alert Network
Map
About
Help
Sign In
Menu
Weather Radar
Showing 651 Gauges
French Broad River near Fletcher - Stage
French Broad River near Fletcher - Stage
French Broad River near Fletcher - Stage
French Broad River near Fletcher - Stage
French Broad River near Fletcher - Stage
French Broad River near Fletcher - Stage
Instructions
Forecast
Show All
Reset
Export

Concluding Thoughts | Questions

OFMA OKLAHOMA
FLOODPLAIN MANAGERS ASSOCIATION

Brandon Claborn, PE, CFM | WSB | brandon.claborn@wsbeng.com

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