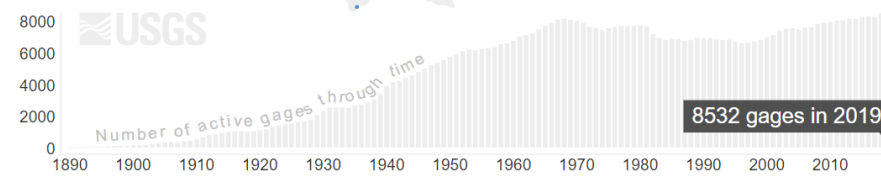
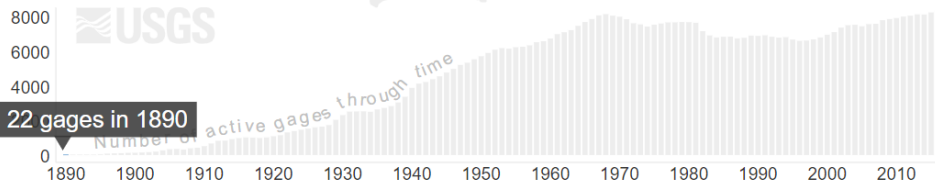
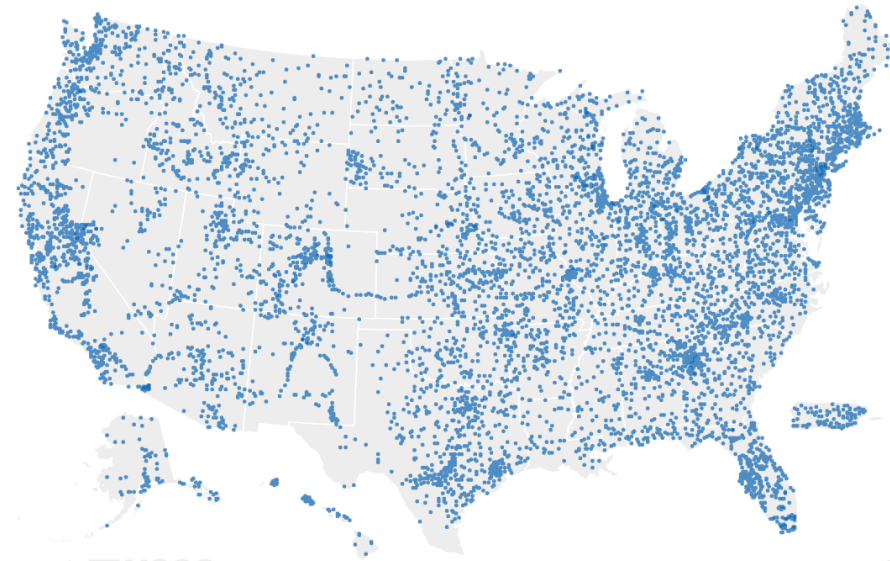
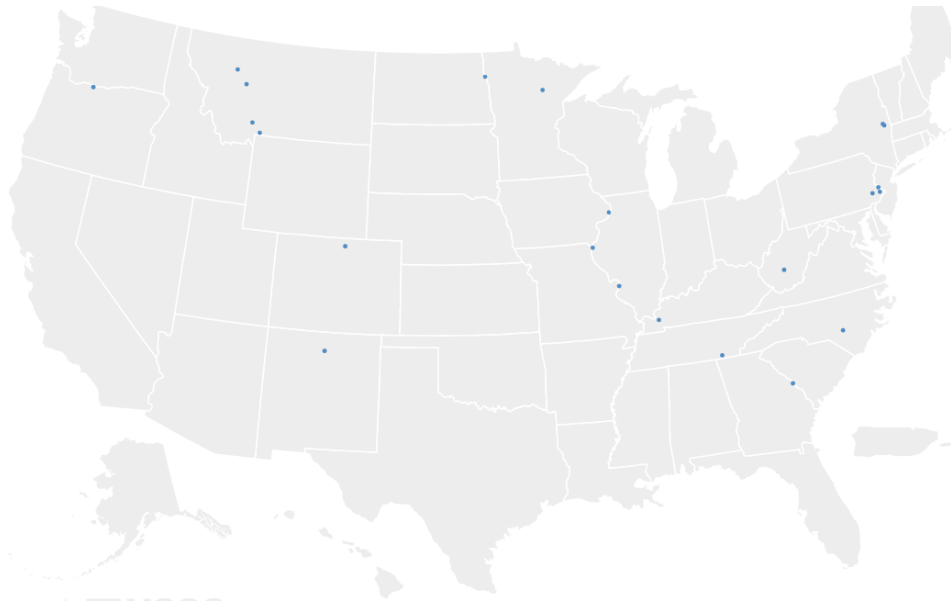


Gages Through the Ages

How the history of streamgaging reflects the evolving water needs of the nation





***Science for a Changing World:
Your Evolving Water Resource Data Needs***

**Kristine Blickenstaff
NWC Annual Meeting
October 27, 2022**

InFRM

Interagency Flood Risk Management (InFRM) Team -

- FEMA Region 6 - Sponsor
- U.S. Army Corps of Engineers (USACE)
- U.S. Geological Survey (USGS)
- National Weather Service (NWS)



Collaborating Nationally and Empowering Locally

A Web Presence for InFRM



Interagency Flood Risk Management

Collaborating Nationally. Empowering Locally.

Flooding remains the leading cause of natural-disaster loss across the United States. The Interagency Flood Risk Management (InFRM) team brings together Federal Partners with mission areas of hazard mitigation, emergency management, floodplain management, natural resources management or conservation to leverage the skillsets, resources and programs to determine the needs of communities and define solutions and implement measures to reduce long term flood risk throughout the States of Arkansas, Louisiana, New Mexico, Oklahoma and Texas.

In 2014, the Federal Emergency Management Agency (FEMA) began sponsorship of the InFRM team initiative to allow Federal teams across the States of Texas, Oklahoma, New Mexico, Louisiana and Arkansas to better align and integrate. Currently, the InFRM team is comprised of FEMA, US Army Corps of Engineers, US Geological Survey, and the National Weather Service. No single agency has all the answers, but through a coordinated effort of multiple programs and various perspectives, a cohesive solution can be found. By applying their shared knowledge, the InFRM team can also enhance response and recovery efforts when flood events do occur.

While floods are impossible to prevent completely, and there is no way to guarantee protection of property, loss of life can be greatly reduced when communities have access to good data, practice sound land use, floodplain management and development practices and incorporate warning systems. Local communities can partner with the InFRM team to investigate solutions to reduce their communities flood risk.



Projects – estBFE Viewer

Welcome to the

Estimated Base Flood Elevation Viewer

Base Level Engineering assessments are produced using high resolution ground data to create technically credible flood hazard information that may be used to expand and modernize FEMA's current flood hazard inventory.



High Flood Risk

 This location is in a 1% (100 year) flood zone.

 [View Report](#)

[Zoom](#) [Close](#)

Property Look Up

Where data are available, produce a property-specific report with estimated base flood information.



What's My Flood Risk?



View Base Level Engineering Data

Access all available Base Level Engineering data without GIS software.



I Want to Explore

| File Name | Size | |
|-------------------------|----------|--------------------------|
| 12030106_Models.zip | 383.9 MB | Download |
| 12030106_Depth01.zip | 82.8 MB | Download |
| 12030106_Depth002.zip | 91.3 MB | Download |
| 12030106_Elev01.zip | 19.5 MB | Download |
| 12030106_Elev002.zip | 20.1 MB | Download |
| 12030106_VectorData.zip | 263.7 MB | Download |

Download Datasets & Models

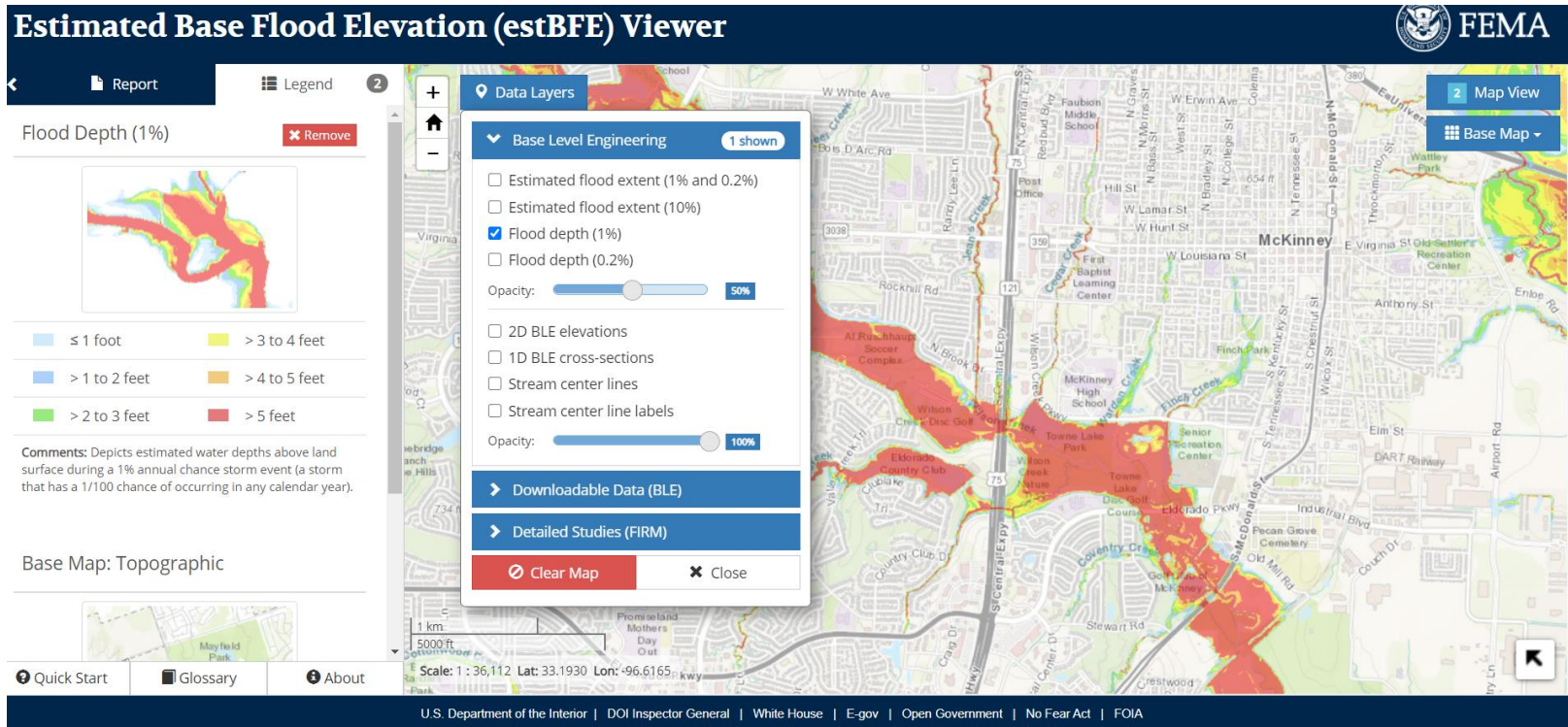
Download the Base Level Engineering data presented in the viewer.



I Want to Download



estBFE Viewer – View Base Level Engineering Data



- **Base Level Engineering** – *approach to flood risk reduction that combines high-resolution ground elevation data and modeling advancements to create engineering models and flood hazard data on a watershed-level scale*



estBFE Viewer – Multi-functionality InFRM

- Base Level Engineering Data visualization
- Point, click & download
- Search functionality
- My estBFE report

The screenshot displays the estBFE Viewer interface. It features two maps: 'Estimated Flood Extent' on the left and 'Estimated 1% Flood Depth' on the right. Below the maps is a table with the following data:

| Flood Event | Estimated Flood Depth* | Estimated Base Flood Elevation* |
|------------------------|-----------------------------|---------------------------------|
| 1 Percent (100 Year) | 0.6 feet above land surface | 481.6 feet NAVD 1988 |
| 0.2 Percent (500 Year) | 1.1 feet above land surface | 482.2 feet NAVD 1988 |

* The information included in this report is based on the location marker shown in the map. Results are not considered an official determination.

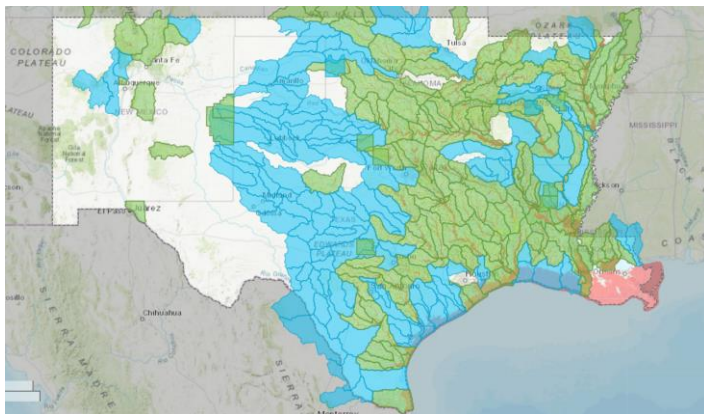
Information made available from the Estimated BFE Viewer needs to be accepted by local community officials to be used for insurance rating purposes.

Knowing Your Risk

Base Level Engineering data availability and analysis information is important because it can be used to:

- Inform floodplain management decisions and ordinance administration;
- Identify significant floodplain changes;
- Serve as base modeling for map revisions; and
- Support the Zone A BFE information for a Letter of Map Amendment (LOMA) request.

Graphic is not to scale.



InFRM Projects – Watershed Hydrology Assessments (WHAs)

Watershed Hydrology Assessments

As hydrology remains the single largest source of uncertainty in our understanding of flood risk, the InFRM team has been performing Watershed Hydrology Assessments to update flood risk estimates in large, complex river basins using suites of models developed by USACE.

The InFRM Watershed Hydrology Assessments (WHAs) are performed by an expert team of engineers and scientists from multiple federal agencies using the latest advances in hydrologic science and technology. The watershed assessments examine the hydrology across the entire basin, reviewing non-stationary influences, such as regulation, land use changes, and wet/dry climate variation, to ensure all variables affecting flood risk in the watersheds are considered. The multi-layered analysis employs a range of hydrologic methods, including rainfall runoff modeling, statistical hydrology, and reservoir simulations, and then compares the results of those methods to one another.

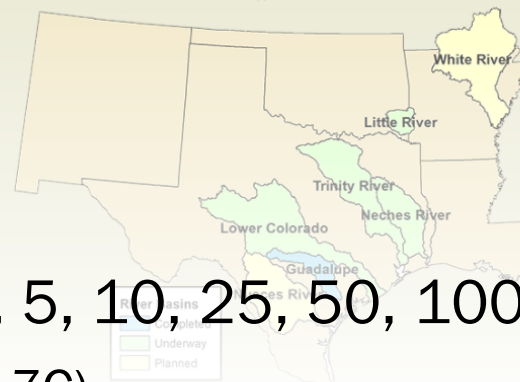
The goal of the watershed hydrology assessments is to produce consistent 1% annual chance (100-yr) and other frequency flows across the river basin, based on all available hydrologic information. The results of the hydrology assessments represent the best available estimate of flood risk across the entire river basin and provide suggestions for areas where the current flood hazard information may need to be updated.

River basins within the region are selected for hydrology assessments based on watersheds where USACE already had sufficiently detailed modeling products available as a starting point for the assessments and where FEMA had future floodplain mapping activities scheduled.

InFRM watershed hydrology assessments are currently underway for the following river basins:

- the Guadalupe,
- the Trinity,
- the Neches, and
- the lower Colorado River basins in Texas, and
- the Little River basin in Oklahoma.

Additional basins will be added to the program as funding allows.



DOCUMENTS

InFRM Hydrology Report for the San Marcos River Basin
Summarizes new analyses completed to estimate frequency flows for various stream reaches in the San Marcos River Basin.

InFRM Watershed Hydrology Assessment for the Guadalupe River Basin
Summarizes new analyses completed to estimate frequency flows, for various stream reaches in the Guadalupe River Basin.

InFRM Watershed Hydrology Assessments Factsheet
Highlights and description of the Watershed Hydrology Assessments

InFRM Watershed Hydrology Assessment for the Trinity River Basin
Summarizes new analyses completed to estimate frequency flows for various stream reaches in the Trinity River Basin.

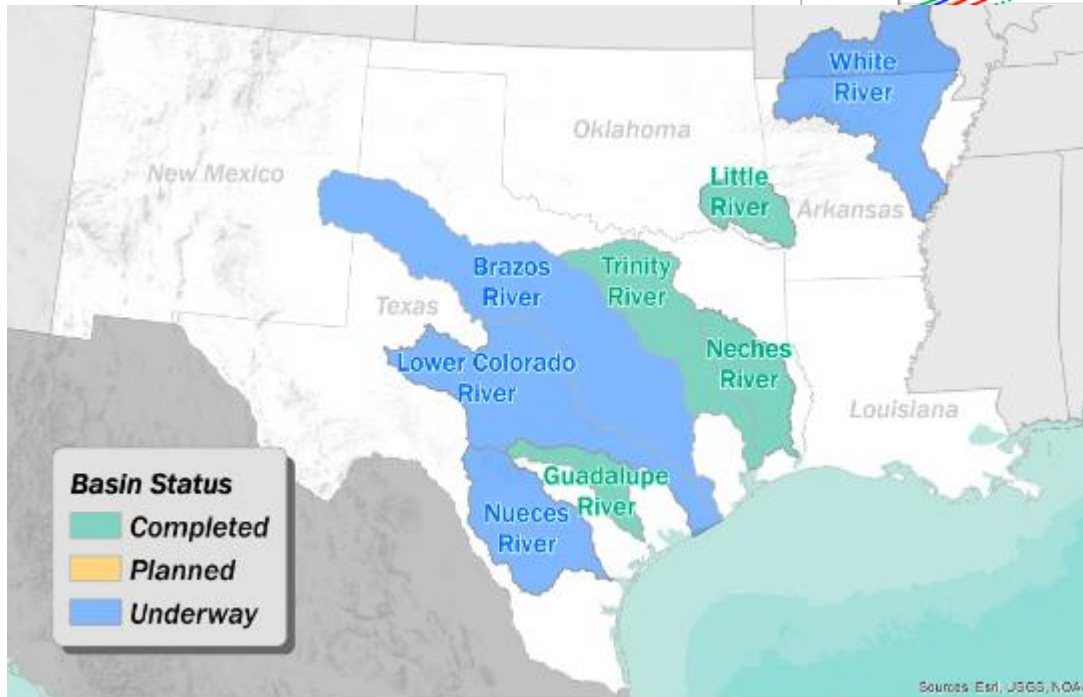
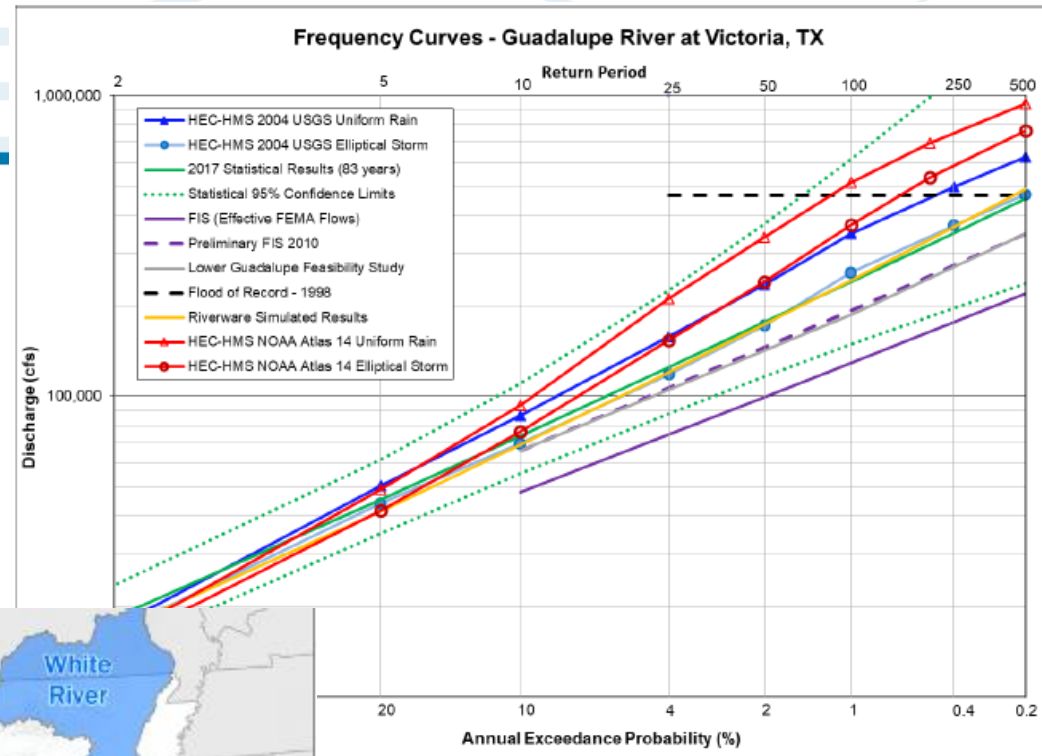
[Report](#) [Appendices](#)

- Flood flow frequency for 2, 5, 10, 25, 50, 100, 250, and 500 yr
 - Statistical analysis (Bulletin 17C)
 - Rainfall-runoff modeling (CWMS)
 - RiverWare generated period of record



WHA - Results

- Statistical flood frequency results compared to previous effective flows, basin models to produce recommended results.
- Reports available at infrm.us

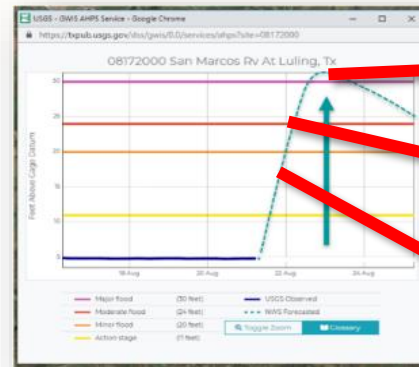
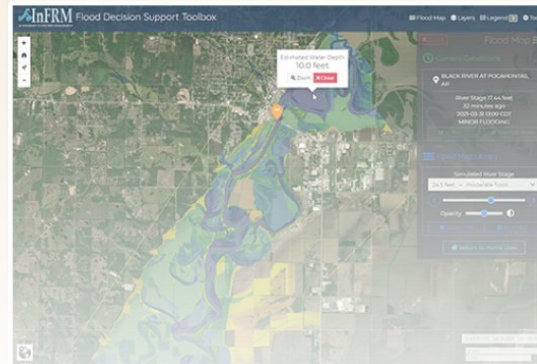


InFRM Projects – Flood Decision Support Toolbox (FDST)

Flood Decision Support Toolbox

The InFRM [Flood Decision Support Toolbox \(FDST\)](#) is an interactive web application (WebApp) which:

- visualizes current flood-related weather conditions in FEMA region 6 (Arkansas, Louisiana, New Mexico, Oklahoma, Texas),
- allows peace-time analysis by emergency planners, local governments, and other stakeholders preparing for potential response activities (such as planned evacuation routes, identification of vulnerable areas requiring road closure, and resource planning in advance of flood events),
- leverages federal, state, regional and local engineering model information to develop pre-positioned flood inundation libraries for micro-level efforts (neighborhood level),
- connects National Water Model predictions for macro-level planning (community, county, state level)
- **Pre-positioned map libraries**
- uses pre-positioned map libraries to show inundation areas in relation to a field reported streamgauge height.
- Tied to:
 - USGS streamgauge data
 - NWS River Forecasts
 - NWS Flood Categories
- Scenario Planning
- Historical Flood viewing
- Print Map Generation



DOCUMENTS



FDST User Guide

How to use FDST for estimating flood extent and depth for possible flood scenarios based on the underlying models.



FDST Executive Summary and Submittal Guidance

Provide standardized guidelines, quality assurance checks, and data input format for submitting flood inundation data for inclusion on the FDST viewer.



The Flood Decision Support Toolbox

Flooding in the South-Central U.S. A better warning system is needed!

Harvey 2017



Mississippi River 2019



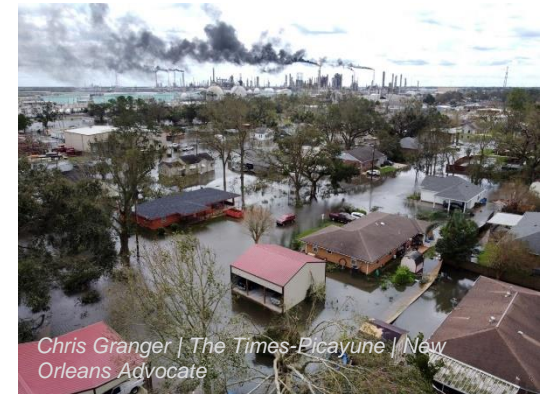
TS Imelda 2019



Wimberly 2015



Ida 2021



FDST Functionality

InFRM Flood Decision Support Toolbox
INTERAGENCY FLOOD RISK MANAGEMENT

Click a river measurement station to select a Flood Map Library

E FK SAN JACINTO RV NR
CLEVELAND, TX
River Stage 4.54 feet
53 minutes ago
NOT FLOODING

Scale 10,169,114 Lat 30.5639 Lon -94.9149
300 km
200 mi

Privacy Policy | Legal | Accessibility | Site Map | Contact USGS | USGS Provisional Statement
U.S. Department of the Interior | DOI Inspector General | White House | E-Gov | USA.gov | No FEAR Act Data | FOIA

Follow

FDST Functionality

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map shows a satellite view of Cleveland, TX, with a simulated river stage overlay in yellow. A green location pin is placed on the map. A teal information box in the upper center reads: "Select a river stage from the Flood Map Library to view flood maps." with an "Off" button. The right sidebar contains a "Flood Map" section with a "CLOSE" button, "Current Conditions" for "E FK SAN JACINTO RV NR CLEVELAND, TX" showing a river stage of 4.54 feet (55 minutes ago, 2021-08-31 09:45 CDT) and "NOT FLOODING". Below this is the "Flood Map Library" section with a "Simulated River Stage" dropdown set to "Select Stage", a slider for "Opacity", and buttons for "Library Info", "Print Map", and "Return to Home View". A scale bar at the bottom right shows 3 km and 2 mi. The bottom of the interface includes a footer with "Privacy Policy | Legal | Accessibility | Site Map | Contact USGS | USGS Provisional Statement" and "U.S. Department of the Interior | DOI Inspector General | White House | E-Gov | USA.gov | No FEAR Act Data | FOIA", along with social media icons and the text "Follow".

FDST Functionality

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map shows a flood risk assessment for Cleveland, Ohio, with various colored zones representing different flood stages. A simulated river stage of 19.0 feet is selected, resulting in a 'minor flood' stage. The map library panel on the right allows users to adjust the simulated river stage and opacity. The current conditions panel shows a river stage of 4.53 feet at the E FK SAN JACINTO RV NR CLEVELAND, TX, with a timestamp of 2021-08-31 10:45 CDT and a status of 'NOT FLOODING'. The interface also includes a home button, a legend, and a tools menu.

Privacy Policy | Legal | Accessibility | Site Map | Contact USGS | USGS Provisional Statement
U.S. Department of the Interior | DOI Inspector General | White House | E-Gov | USA.gov | No FEAR Act Data | FOIA

Follow

15

Map library extends from **NWS Minor Flood** stage to maximum expected flood (**max observed OR 500-year event**)

FDST Functionality

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map shows a flood risk assessment of Cleveland, Ohio, with various flood stages overlaid in different colors (purple, blue, green, yellow, orange, red). A legend on the right side of the map lists the following flood stages and their corresponding descriptions:

- 19.5 feet - minor flood
- 20.0 feet - minor flood
- 20.5 feet - minor flood
- 21.0 feet - moderate flood
- 21.5 feet - moderate flood
- 22.0 feet - moderate flood
- 22.5 feet - moderate flood
- 23.0 feet - major flood
- 23.5 feet - major flood
- 24.0 feet - major flood
- 24.5 feet - major flood
- 25.0 feet - major flood
- 25.5 feet - major flood
- 26.0 feet - major flood
- 26.5 feet - major flood
- 27.0 feet - major flood
- 27.5 feet - major flood
- 28.0 feet - major flood
- 28.5 feet - major flood
- 29.0 feet - major flood

The legend also includes a 'CLOSE' button at the top left and a 'Return to Home View' button at the bottom. Below the legend, there are controls for 'Opacity' and buttons for 'Library Info' and 'Print Map'. A scale bar at the bottom right indicates 500 m and 2000 ft. The interface also features a top navigation bar with 'Flood Map', 'Layers', 'Legend', and 'Tools' options, and a bottom footer with links to 'Privacy Policy', 'Legal', 'Accessibility', 'Site Map', 'Contact USGS', 'USGS Provisional Statement', and social media icons.

Map library extends from **NWS Minor Flood** stage to maximum expected flood (**max observed OR 500-year event**)

FDST Functionality

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map area shows an aerial view of a residential area with a flood overlay. A callout box over a house indicates an estimated water depth of 0.7 feet, with 'Zoom' and 'Close' buttons. The interface includes a top navigation bar with 'Flood Map', 'Layers', 'Legend', and 'Tools'. A right-hand panel shows 'Current Conditions' for 'E FK SAN JACINTO RV NR CLEVELAND, TX', with a river stage of 4.53 feet, a timestamp of 2021-08-31 10:45 CDT, and a status of 'NOT FLOODING'. Below this is a 'Flood Map Library' section with a 'Simulated River Stage' dropdown set to '25.0 feet - major flood' and an 'Opacity' slider. A 'Return to Home View' button is at the bottom of the right panel. The bottom of the interface features a footer with links for 'Privacy Policy', 'Legal', 'Accessibility', 'Site Map', 'Contact USGS', 'USGS Provisional Statement', and social media icons.

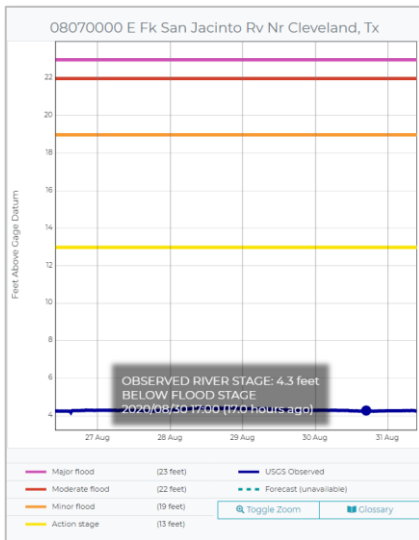
Select anywhere in the map to view estimated water depth

FDST Functionality

Hydrograph:

- Tied to USGS streamgage data, NWS AHPS prediction service
- Stage forecast*
- Flood categories*

* If available



X CLOSE
Flood Map

Current Conditions

E FK SAN JACINTO RV NR CLEVELAND, TX

River Stage 4.53 feet
14 minutes ago
2021-08-31 10:45 CDT
NOT FLOODING

Hydrograph
 Historical Peaks

Flood Map Library

Simulated River Stage

25.0 feet - major flood v

<

●

>

Opacity
●
 ☾

Library Info
 Print Map

Return to Home View

Historical Peaks:

- Top 10 historical stages
- Enables user to view the effects of a historical flood as if it were to happen today

Top 10 Historical Peak Stages

E Fk San Jacinto Rv nr Cleveland, TX

| | | | |
|-----------------|------------|----------------|--------------------------------|
| Sun Aug 27 2017 | 27.17 feet | MAJOR Flood | View Flood Map |
| Wed Jan 07 1998 | 24.57 feet | MAJOR Flood | View Flood Map |
| Mon Oct 17 1994 | 24.57 feet | MAJOR Flood | View Flood Map |
| Sat Nov 23 1940 | 24.1 feet | MAJOR Flood | View Flood Map |
| Wed Jun 13 1973 | 23.92 feet | MAJOR Flood | View Flood Map |
| Sat May 04 1935 | 23.6 feet | MAJOR Flood | View Flood Map |
| Fri Nov 13 1998 | 21.72 feet | MODERATE Flood | View Flood Map |
| Fri May 27 2016 | 20.85 feet | MINOR Flood | View Flood Map |
| Sat May 21 1983 | 20.68 feet | MINOR Flood | View Flood Map |
| Sat Apr 18 1959 | 20.38 feet | MINOR Flood | View Flood Map |

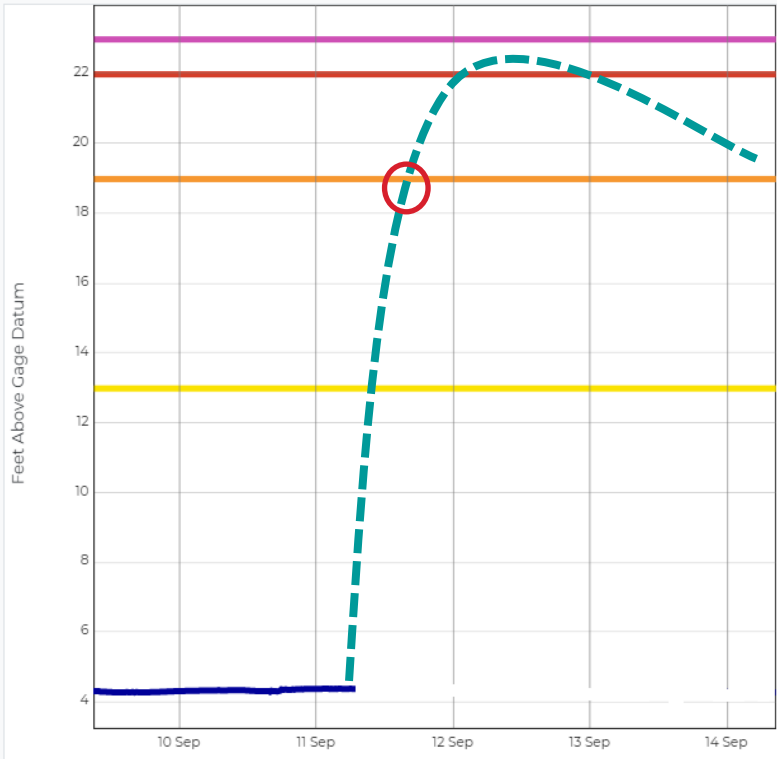
[USGS Station Website](#)
[NWS Station Website](#)

[Stages reported in feet above gage datum, which is 107.96 feet above NAVD88]

Close

FDST Functionality

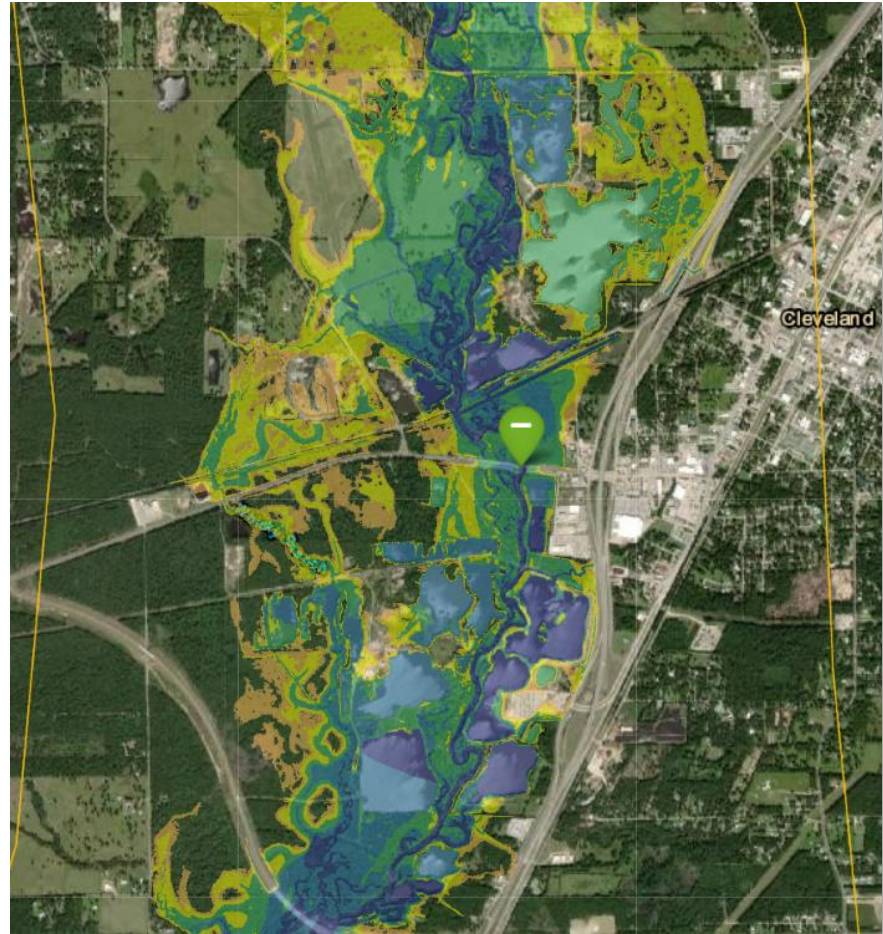
08070000 E Fk San Jacinto Rv Nr Cleveland, Tx



- | | | |
|--|-----------|--|
| — Major flood | (23 feet) | — USGS Observed |
| — Moderate flood | (22 feet) | - - - Forecast (unavailable) |
| — Minor flood | (19 feet) | |
| — Action stage | (13 feet) | |

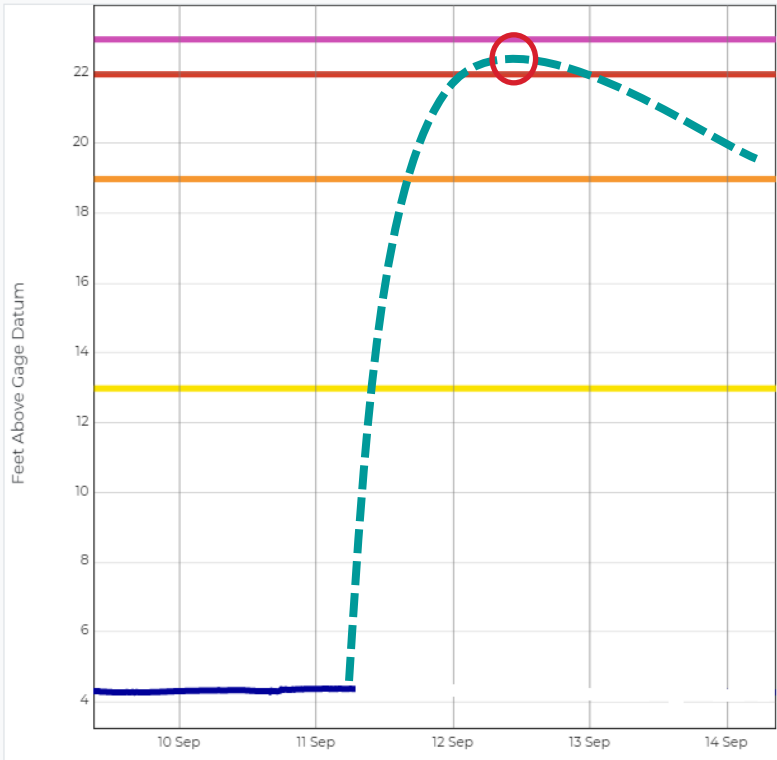
[Toggle Zoom](#)

[Glossary](#)



FDST Functionality

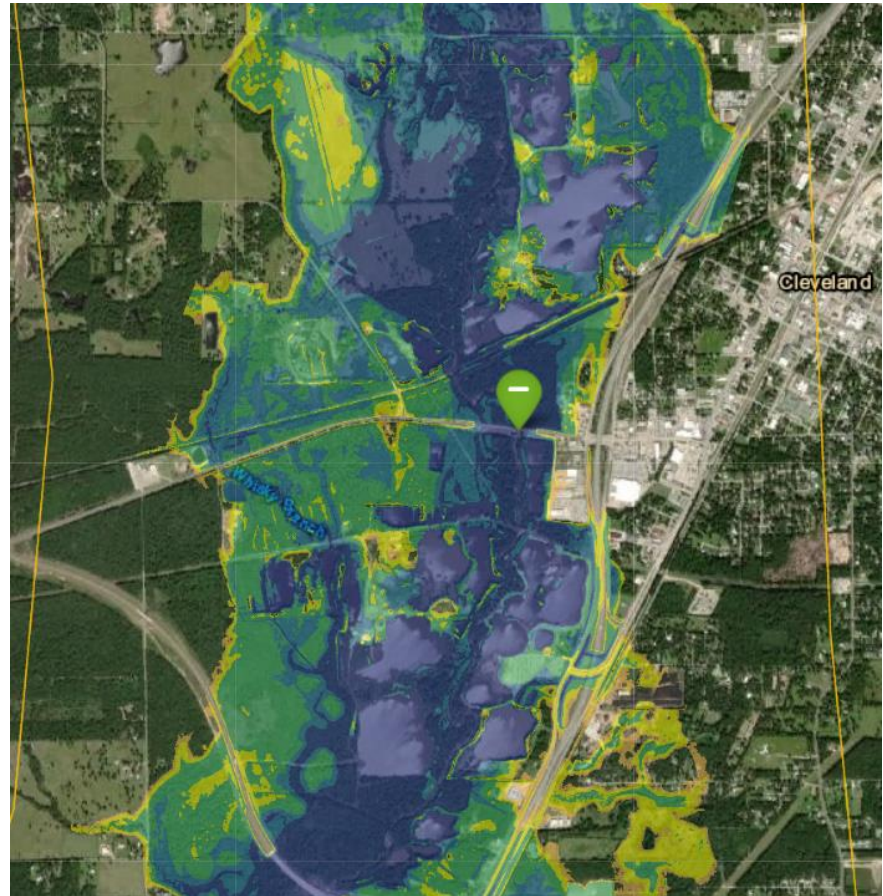
08070000 E Fk San Jacinto Rv Nr Cleveland, Tx



- Major flood (23 feet)
- Moderate flood (22 feet)
- Minor flood (19 feet)
- Action stage (13 feet)
- USGS Observed
- Forecast (unavailable)

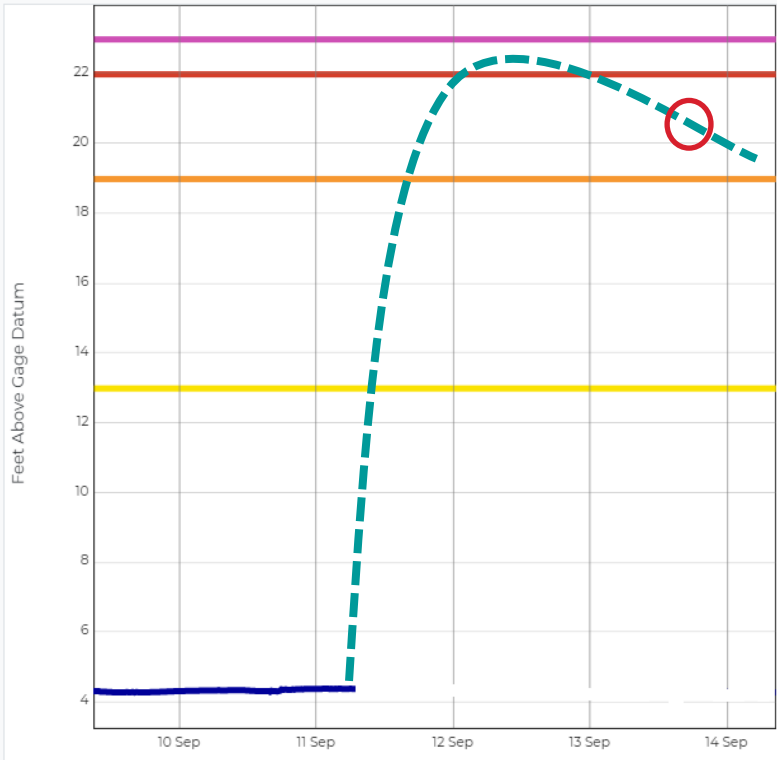
[Toggle Zoom](#)

[Glossary](#)

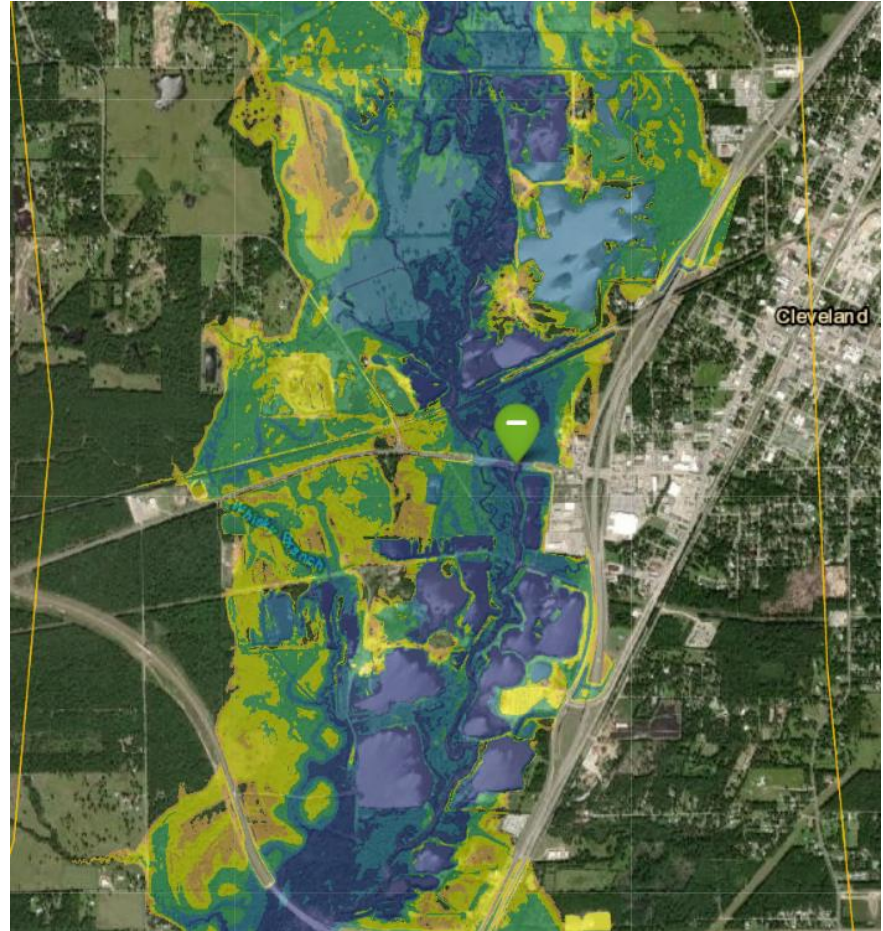


FDST Functionality

08070000 E Fk San Jacinto Rv Nr Cleveland, Tx



- | | | |
|----------------|-----------|------------------------|
| Major flood | (23 feet) | USGS Observed |
| Moderate flood | (22 feet) | Forecast (unavailable) |
| Minor flood | (19 feet) | |
| Action stage | (13 feet) | |
- [Toggle Zoom](#)
[Glossary](#)



FDST Functionality

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map shows the United States with various data layers overlaid, including streamflow and stream stage data points. A detailed popup window is open for station 08412500 Pecos RV nr ORLA, TX, showing real-time streamflow and stream stage data for 2020-09-09 11:15:00 CDT. The popup includes a 'Graph' button for each data type and a 'Close' button. The interface also features a search bar, a 'Layers' panel on the right, and a 'Clear Map' button at the bottom. A red circle highlights the 'Layers' button in the top right corner, with a white mouse cursor pointing to it.

08412500 Pecos RV nr ORLA, TX
REAL-TIME STREAMFLOW
65.7 cfs
2020-09-09 11:15:00 CDT
Normal for this Day-of-Year

REAL-TIME STREAM STAGE
1.93 feet
2020-09-09 11:15:00 CDT
Remaining steady

[Data](#) [Subscribe](#) [Close](#)

Pecos RV nr Orla, TX
Flow: 65.7 cfs

[Clear Map](#)

Layers Panel:
USGS Stations
Weather Conditions
STORM WATCH
RADAR (Static, ON)
RECENT RAINFALL
RAINFALL FORECAST
SNOW
CLOUD COVER
Hydrology
Base Maps

FDST Functionality – Texas

- New buildings layer in Texas viewer shows buildings likely to be inundated and estimated total cost of damage
- Damage estimates were derived from depth-damage relations for structures from the USACE
- Building footprint data created from Open Street Map buildings layer and Microsoft AI buildings layer
- Where possible, building categorical info was obtained from local County Appraisal Districts

Flood Map

Flood Map Library

Simulated River Stage
38.0 feet - major flood

Opacity

Library Info Print Map

Buildings

Select Layer
All buildings

ON

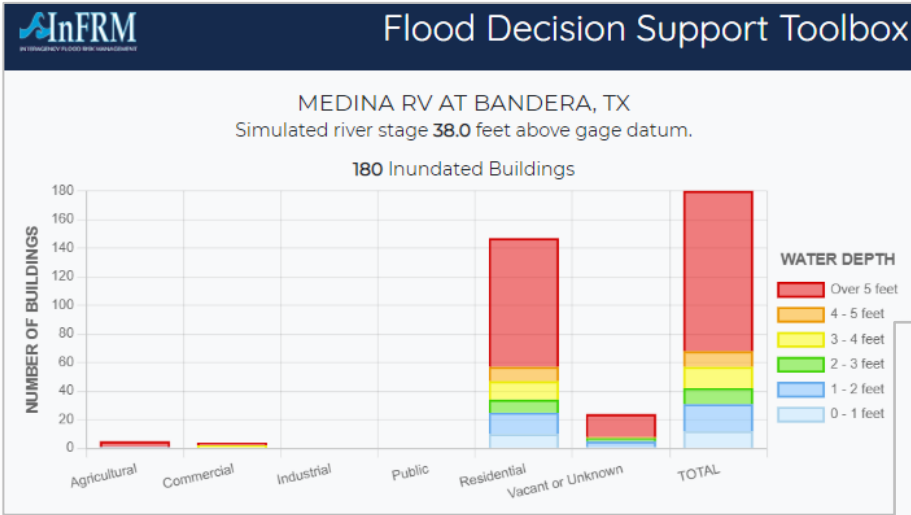
DAMAGE ESTIMATES

Inundated Buildings: 180
Estimated Total Cost: \$6,816,000

Report

Return to Home View

FDST Functionality – Texas



Buildings

Select Layer

All buildings

ON

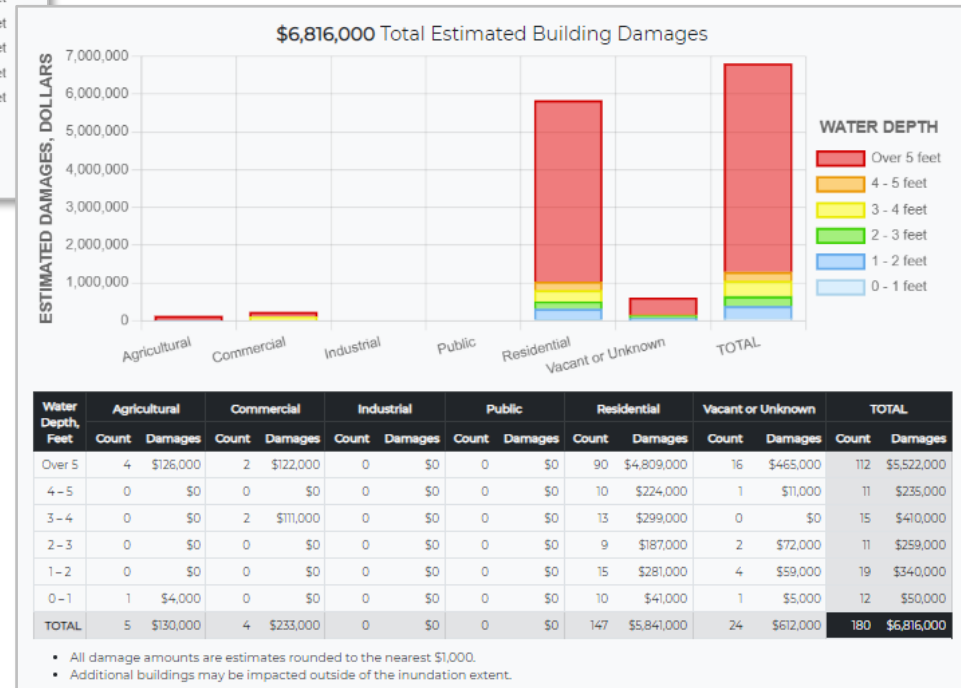
DAMAGE ESTIMATES

Inundated Buildings: 180

Estimated Total Cost: \$6,816,000

[Report](#)

- Click 'Report' to see more details on estimated building damages and estimated costs
- Print Map function also summarizes building damage in Texas
- **NOTE: costs CANNOT be tied back to individual buildings**



• All damage amounts are estimates rounded to the nearest \$1,000.
 • Additional buildings may be impacted outside of the inundation extent.

FDST Functionality – Texas

InFRM Texas Water Development Board Flood Decision Support Toolbox

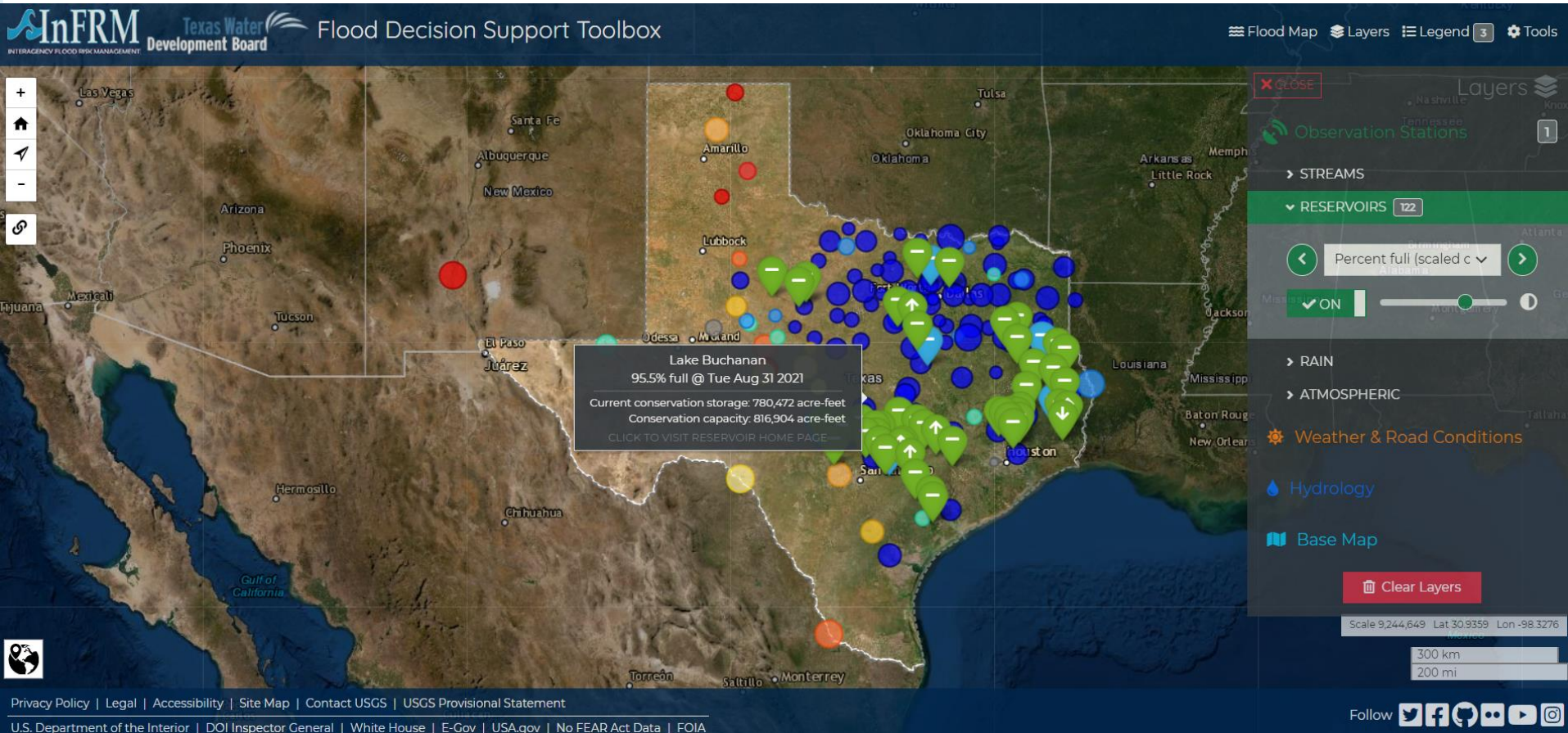
Layers

- Observation Stations
- Weather & Road Conditions 1
 - STORM WATCH
 - RADAR
 - RECENT RAINFALL
 - RAINFALL FORECAST
 - SNOW
 - CLOUD COVER
 - ROAD CONDITIONS 537
 - All
 - All
 - Accidents
 - Closures
 - Construction
 - Road damage
 - Flooded roads
 - Other
 - Hydrology
 - Base Map

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U.S. Department of the Interior | DOI Inspector General | White House | E-Gov | USA.gov | No FEAR Act Data | FOIA

- Texas viewer shows TXDOT road conditions

FDST Functionality – Texas



- Reservoir status available through *Water Data for Texas* (% full and % flood height)

FDST Functionality – Texas

Recent changes
2013-06-19: The vertical datums of gauge, conservation pool and dead pool elevations for this lake have been adjusted to NGVD29+0.01ft.

Lake Buchanan: 95.5% full as of 2021-08-31

Legend: Dead Pool (orange), Conservation Pool (teal), Flood Pool (red)

Reservoir Storage (thousand acre-feet) vs. Time (Oct 2020 to Aug 2021)

The elevation-storage rating curve used to produce the storage hydrograph is made of two segments: (1) the segment up to the conservation pool top (below the red line) is based on measured data, and (2) the segment in the flood pool (above the red line) is an extrapolation from the first segment and shouldn't be relied upon for flood storage information.

Historical Data

- Reservoir status available through **Water Data for Texas** (% full and % flood height)

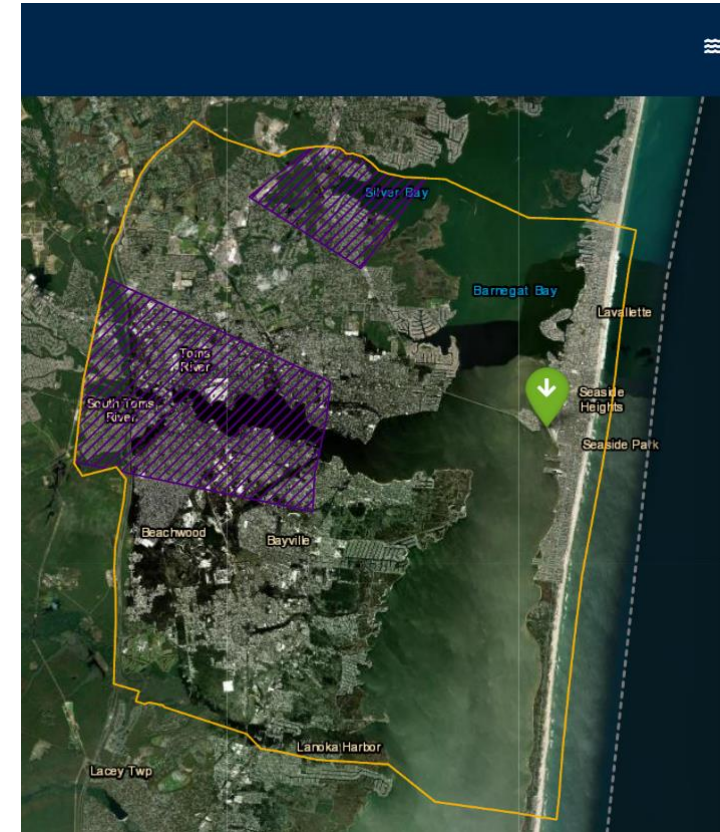
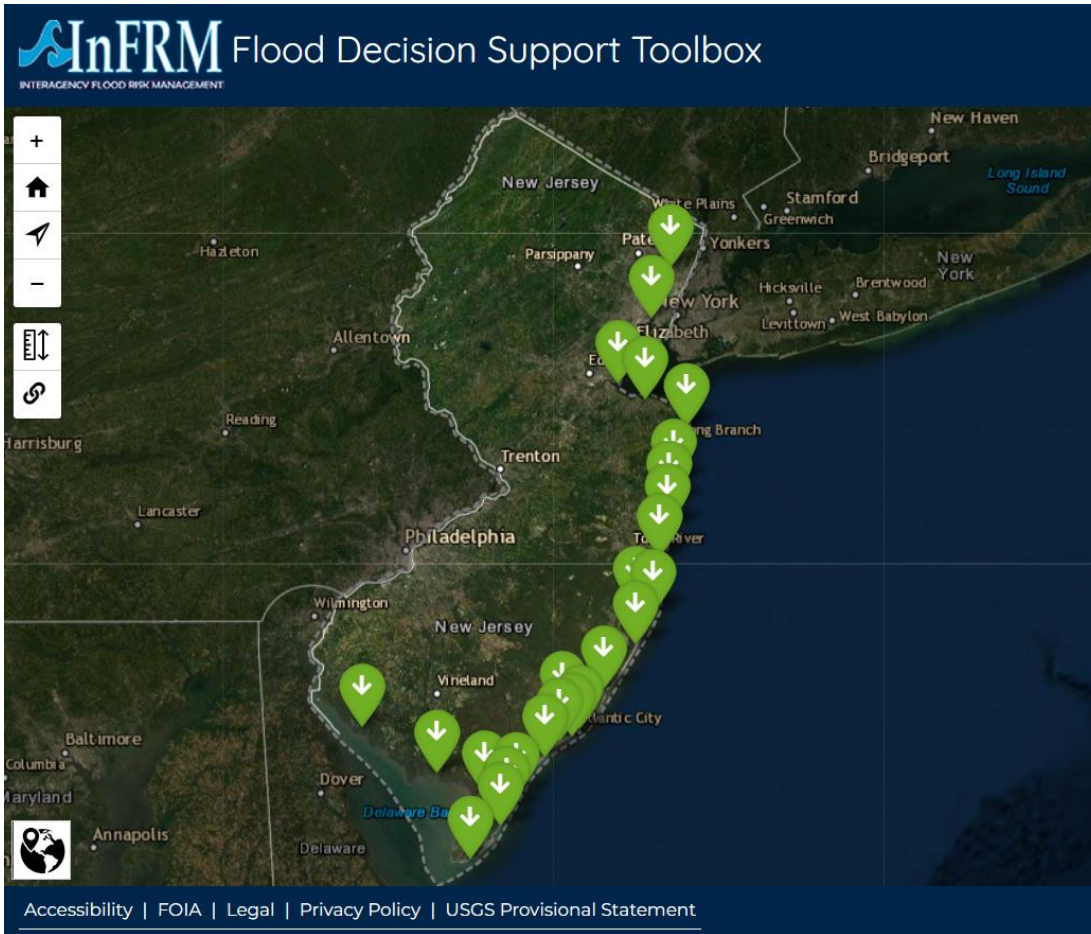
FDST Functionality – Texas

The screenshot displays the InFRM Flood Decision Support Toolbox interface. The main map shows a simulated river stage of 37.0 feet, resulting in major flooding. A pop-up window for Waco Lake provides the following information:

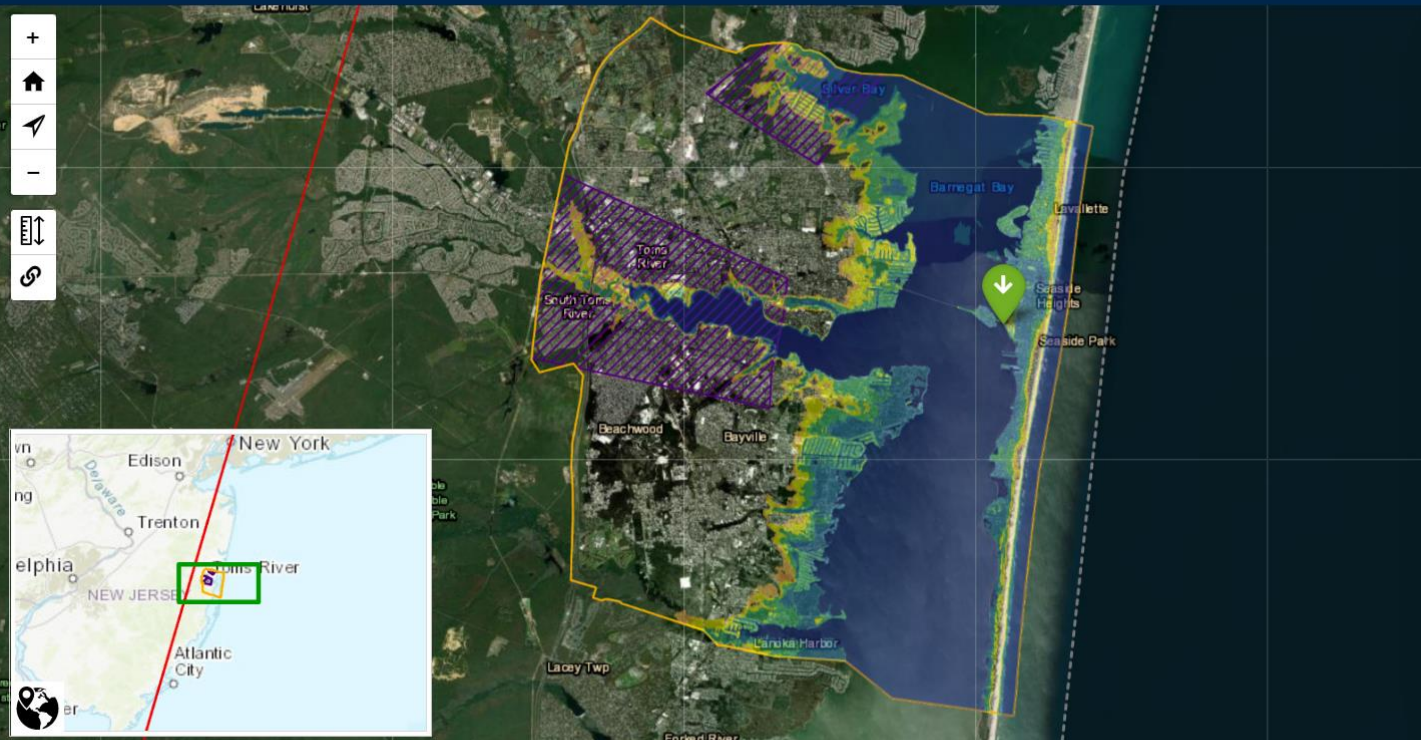
- Waco Lake
- 57.1% full @ Wed Oct 26 2022
- Current conservation storage: 108,171 acre-feet
- Conservation capacity: 189,418 acre-feet
- CLICK TO VISIT RESERVOIR HOME PAGE

The interface includes a top navigation bar with the InFRM logo, Texas Water Development Board, and Flood Decision Support Toolbox. The right sidebar contains a 'Flood Map' section with 'Current Conditions' (River Stage 1.61 feet, NOT FLOODING) and a 'Flood Map Library' section with 'Simulated River Stage' (37.0 feet - major flooding) and 'Buildings' (Inundated Buildings: 2,170, Estimated Total Cost: \$140,818,000). The bottom of the interface features a footer with accessibility and legal information, and social media icons.

FDST Functionality – New Jersey



FDST Functionality – New Jersey



Flood Map

River Stage 10.0 feet
19 minutes ago
2022-10-25 13:48 EDT
NOT FLOODING

Hydrograph Historical Peaks

Flood Map Library

Select Flood Map Library

Change FEMA Storm ID NJA0705

Simulated River Stage

10.0 feet – major flooding

Opacity

Library Info Print Map

Return to Home View

FDST Functionality – New Jersey

Available Flood Map Libraries



Barnegat Bay at Route 37 bridge near Bay Shore NJ

Library Name **Description**

FEMA Storm ID NJA0705 Modeled storm NJA0705 is a synthetic tropical storm scenario making landfall in Ocean City, NJ with a maximum wind speed of 108.95 knots within a radius of 19.88 nautical miles, and a central pressure of 941.7 millibars. The Holland B (broadening) parameter is 1.48 with a scale pressure radius of 28.9 nautical miles.

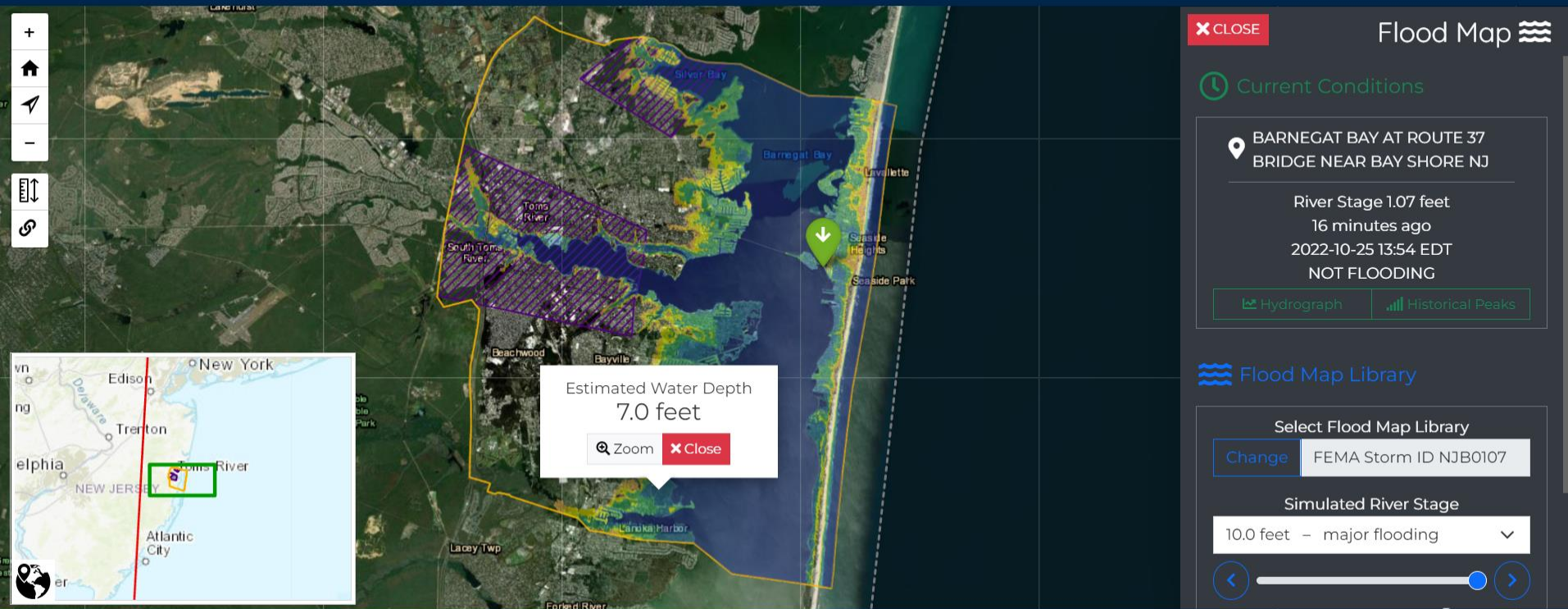
✓ Select

FEMA Storm ID NJB0107 Modeled storm NJB0107 is a synthetic tropical storm scenario making landfall in Margate City, NJ with a maximum wind speed of 88.67 knots within a radius of 27.35 nautical miles, and a central pressure of 940.8 millibars. The Holland B (broadening) parameter is 1.1 with a scale pressure radius of 33.3 nautical miles.

✓ Select

✗ Cancel

FDST Functionality – New Jersey





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