

# NEW TECHNOLOGY USED TO CREATE INUNDATION MAPS

The owner of a High-Hazard Potential (HHP) dam has the legal liability and social responsibility to provide an Emergency Action Plan (EAP). A crucial component of a comprehensive EAP is an accurate map of the area that would be inundated if the dam were to breach. Advanced geospatial technology is now being used in many states to prepare inundation maps that owners of state-regulated HHP dams can use with their EAPs.

The cost of an engineer’s breach analysis study and creation of the inundation maps can be very expensive for dam owners. In years past inundation mapping required surveyors to walk the land below a dam and use traditional instruments to determine the boundaries of where water from the dam would flow, at what velocity, when it would arrive at certain points, and its depth.

New technology is now providing ways to create inundation maps that are highly accurate and yet do not require weeks of field time by survey crews. In many applications, high-resolution LiDAR (Light Detection and Ranging) data is being used in combination with U.S. Army Corps of Engineers software and limited field surveys, to enable detailed breach analyses in shorter time at lower cost.

In a few states, inundation maps are created for dam owners by state dam safety experts or hydrologists contracted by them. In other states the cost of inundation mapping remains the responsibility of dam owners unless grant funds become available from the state or federal agencies.

Public support can be helpful in convincing governmental units of the value that inundation mapping provides in creating high quality EAPs. When the maps are completed, reviewed for technical compliance, and added to EAPs, emergency managers have a comprehensive view of areas that might need to be notified or evacuated if a dam breaches. Without the maps these functions may be hampered or incomplete.



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## EMERGENCY RESPONDERS NEED THESE MAPS

State and local emergency management agencies rely heavily on breach inundation maps. The maps and Emergency Action Plans (EAPs) must contain sufficient and accurate information to assure adequate warnings and evacuation of all people at risk.

Local emergency managers must understand the maps – including the terms used, the evacuation area, and how much time they would have to evacuate the residents. Depending on the severity of the breach, the evacuation zone may be greater than or less than the area depicted by inundation maps. Maps should use terms accepted by and useful to the emergency responders and local residents.

Inundation maps and EAP information should be periodically updated to include new downstream development such as streets, bridges, and subdivisions.

More examples of inundation maps may be found online at [www.damsafetyaction.org](http://www.damsafetyaction.org). The website also includes downloadable versions of this and other brochures and information about EAPs. Supported by the National Dam Safety Review Board, [damsafetyaction.org](http://damsafetyaction.org) is part of an outreach program produced as an information and educational resource for dam owners and the public.

**Be an involved citizen.**  
**Lives depend on Emergency Action Plans  
and accurate breach inundation maps.**

**QUESTIONS OR COMMENTS**  
Phone toll-free 877-410-3551  
eMail: [info@damsafetyaction.org](mailto:info@damsafetyaction.org)

# INUNDATION MAPS MAKE EMERGENCY ACTION PLANS MORE EFFECTIVE



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# INUNDATION MAPS ASSURE EFFICIENT EMERGENCY RESPONSE

Accurate dam breach analyses and inundation mapping are critical components for constructing useful EAPs. Dam safety officials point out that “It is critical for emergency managers to focus their limited resources where they are needed most in the event of a dam failure. The objective of accurate inundation mapping is to facilitate this focus.”

Several states have encouraged the use of Simplified Inundation Maps (SIMS) where appropriate for a smaller dam. SIMS identify at-risk structures and roads without a detailed engineering analysis and/or modeling. An aerial photo-based map such as a Google Earth image in conjunction with topographical maps of the area are preferred. Find more information on SIMS at [www.damsafetyaction.org](http://www.damsafetyaction.org).

Inundation mapping of a dam breach is very different from what is seen on the 100-year flood maps for the same area. A dam breach and subsequent flood wave develop over time and flow dynamically through the downstream environment rather than being a steady-state backwater rise. A dam’s flood waves may travel very swiftly. Inundation mapping shows the downstream environment zone structures that are inundated by at least two feet of water during the time of maximum water surface elevation.

With an inundation map, emergency managers can add to their emergency operations plans the locations of businesses, schools, hospitals, nursing homes, residences, and highways at risk in a dam failure, along with the locations of shelters and emergency resources. Evacuation routes can be developed. Providing this information is not the responsibility of the dam owner.

Without an inundation map, it is very difficult for emergency managers to be certain that everyone at risk from a dam breach has been identified and can be notified or evacuated. Often the maps will include boundaries of different levels of flooding that may result from a dam emergency. This helps make the emergency response more efficient.

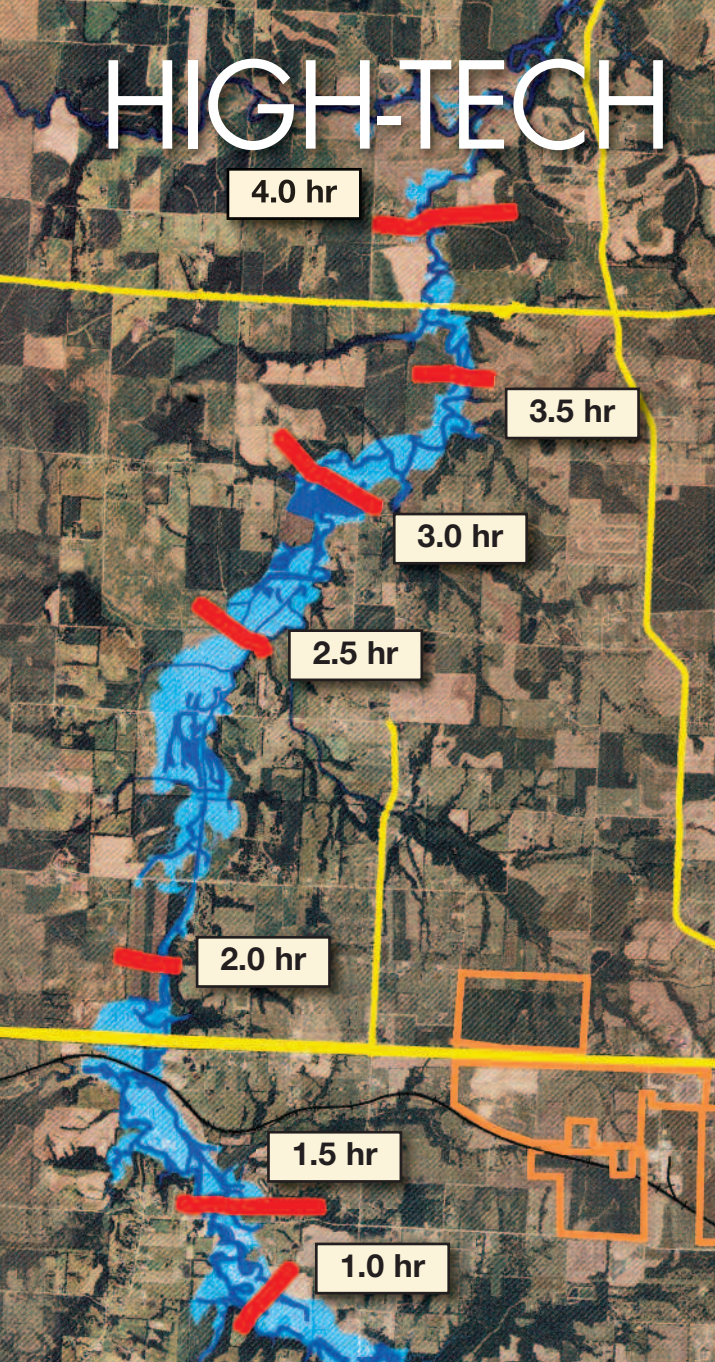
**INUNDATION MAP VS. EVACUATION AREA**  
Inundation maps are developed from the best available information using reasonable assumptions and standardized methods. They are approximations of the maximum water surface extents resulting from a complete dam breach and draining of the full reservoir. Inundation maps are empirical hydrologic and hydraulic simulations which can only be field verified in the event of an actual breach.  
Evacuation areas and emergency call lists based on these maps should take into consideration the anticipated local impacts of flooding, knowledge of local infrastructure, both occupancy and ownership of property, and potential interrupted services or cut-off access caused by a dam failure. Depending upon actual circumstances, appropriate alert and evacuation areas could be more or less extensive than the simulated inundation zones shown on the maps.

This inundation map sample is one of four contiguous maps prepared by the USDA Natural Resources Conservation Service (NRCS) for the EAP of a HHP dam. The dam was built as part of a USDA conservation program. USDA requires EAPs and inundation maps for all HHP dams built with USDA funds.  
In this map, the dam and reservoir are at the upper left. The impact area that could be flooded includes some areas of a city, with risk to offices, a health clinic, a meeting facility, an auto

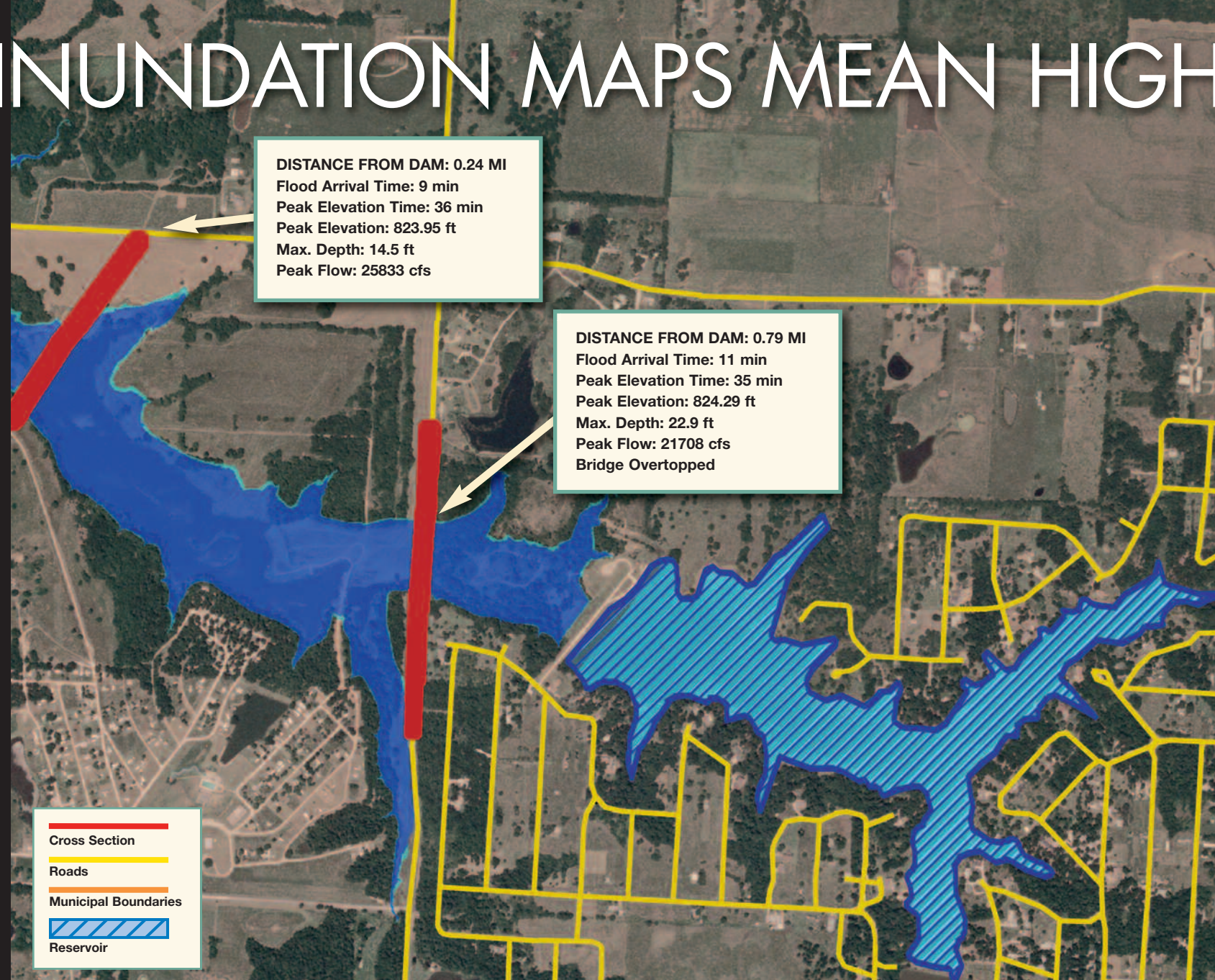
dealership, city parks, and several residences, including public housing units and more than a dozen homes.  
The blue dotted line is the stream channel below the dam. The red hatch marks inside them indicate the potential inundation area if the dam were to fail. The yellow lines correlate with floodwater elevations expected at specific locations below the dam. The maps include street names and other details omitted from this reproduction.



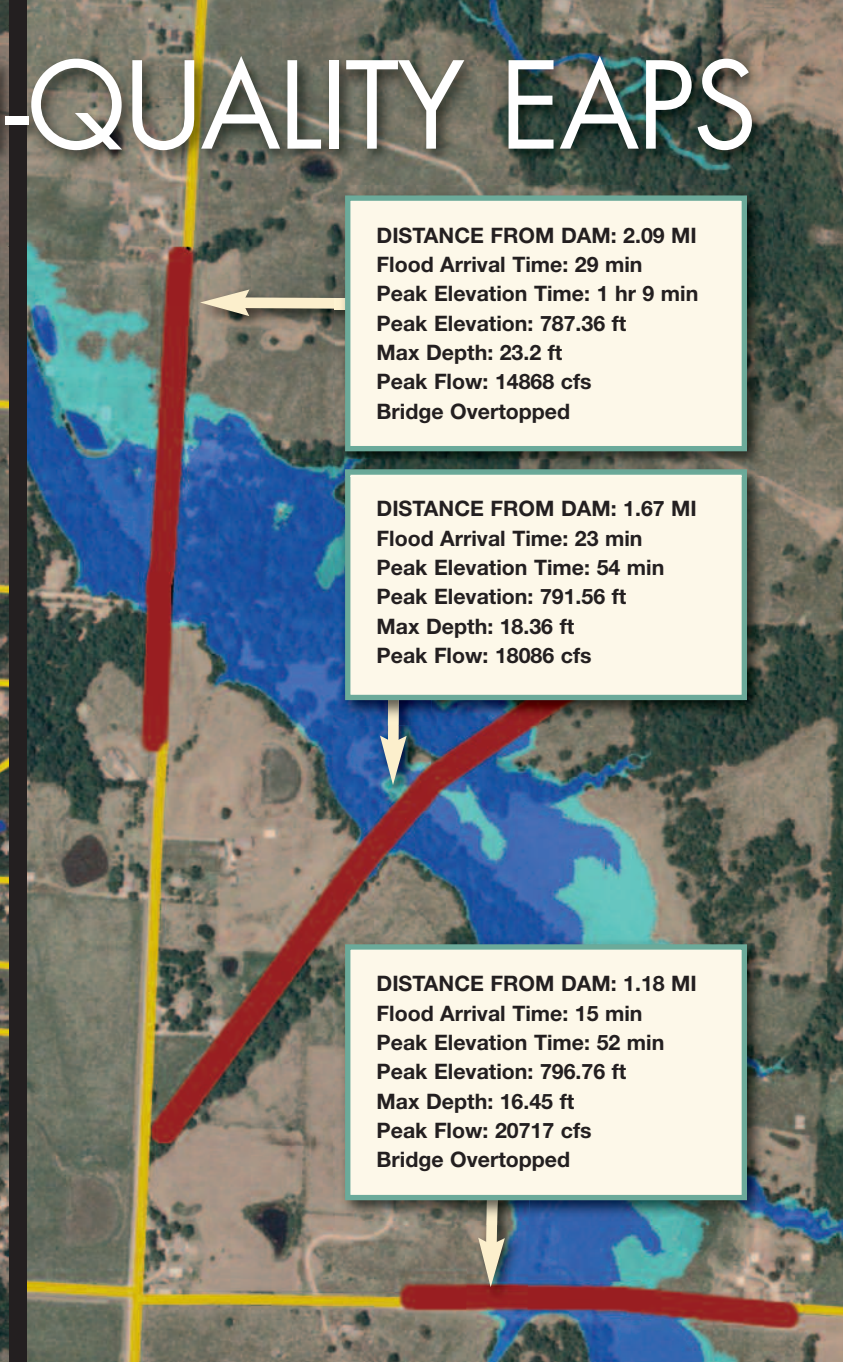
# HIGH-TECH INUNDATION MAPS MEAN HIGH-QUALITY EAPS



Map 1



Map 2



Map 3

These are inundation maps for a dam that is more than 40 feet high and holds back about 1,000 acre feet of water. The first map shows the length of time before flood waters would reach various downstream points. A separate, highly focused inundation map was created for each of those segments. The other two maps shown are for the first of those segments and show vital information such as roads that would be overtopped, arrival time of flood waters at key points, peak water elevation time after the breach, volume of water expected and its depth. LiDAR data was used to create the flood water flow analysis.

These inundation maps show downstream structures that would be inundated by at least two feet of water during the time of maximum water surface level. Other map examples will be found on the website [www.damsafetyaction.org](http://www.damsafetyaction.org), click on Inundation Mapping.

In the procedure that resulted in these inundation maps, field surveys were augmented with highly sophisticated imaging and geospatial software and equipment. These systems include:

- The U.S. Army Corps of Engineers' Hydrologic Engineering Centers River Analysis System (HEC- RAS). HEC-RAS software allows extensive modeling of different water flow patterns, sediment movement, and other factors that play out during an inundation.

- GeoRAS, a set of procedures, tools, and utilities for processing geospatial data to depict images of hills, valleys and other geometric configurations within the inundation zones.
- High-resolution LiDAR (Light Detection and Ranging) imaging data captured by laser equipment aboard aircraft. LiDAR data is often available in developing inundation maps for some of the most populous counties. LiDAR imaging can cut through trees and foliage to reveal very precise ground contours and elevations.
- Advanced topographical maps plus Digital Elevation Model (DEM) data from the U.S. Geological Survey. This combination of technologies provides highly reliable inundation maps in a shorter time period. This approach may be best for smaller dams with less development in the inundation zone than larger or more urban dams.

In various combinations customizable and suitable for each dam, these and other technologies can provide detailed, accurate floodplain maps. These maps facilitate the development of preparedness and warning requirements, computations of flood damage, and information to help ecosystem restoration after the water recedes.

## Learn More About Inundation Maps

For more information on dam breach analysis and mapping, download a copy of Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures (FEMA P-946, 16.58 mb), at [www.fema.gov/media-library/assets/documents/34193](http://www.fema.gov/media-library/assets/documents/34193).