

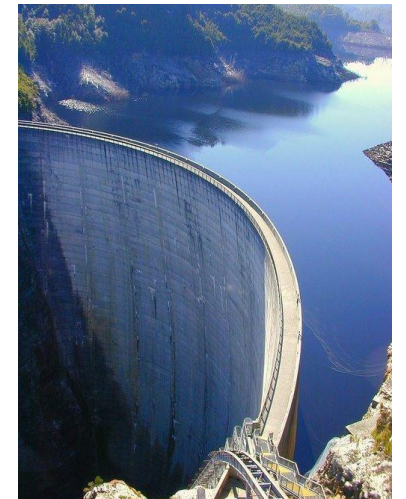
Dam Breach Analysis using HEC-RAS

Cordero Ortiz

Geography 593

A Brief History of Dams

- First dam was built in Mesopotamia circa 3,000 BCE
- 50,000 dams worldwide; 5,500 exist in the United States
- Design range from earthen gravity dams to modern concrete arch-gravity
- Largest advances in dam engineering and safety in the last 100 years
- 900 dams removed in the U.S. since 1990!



What would happen if...

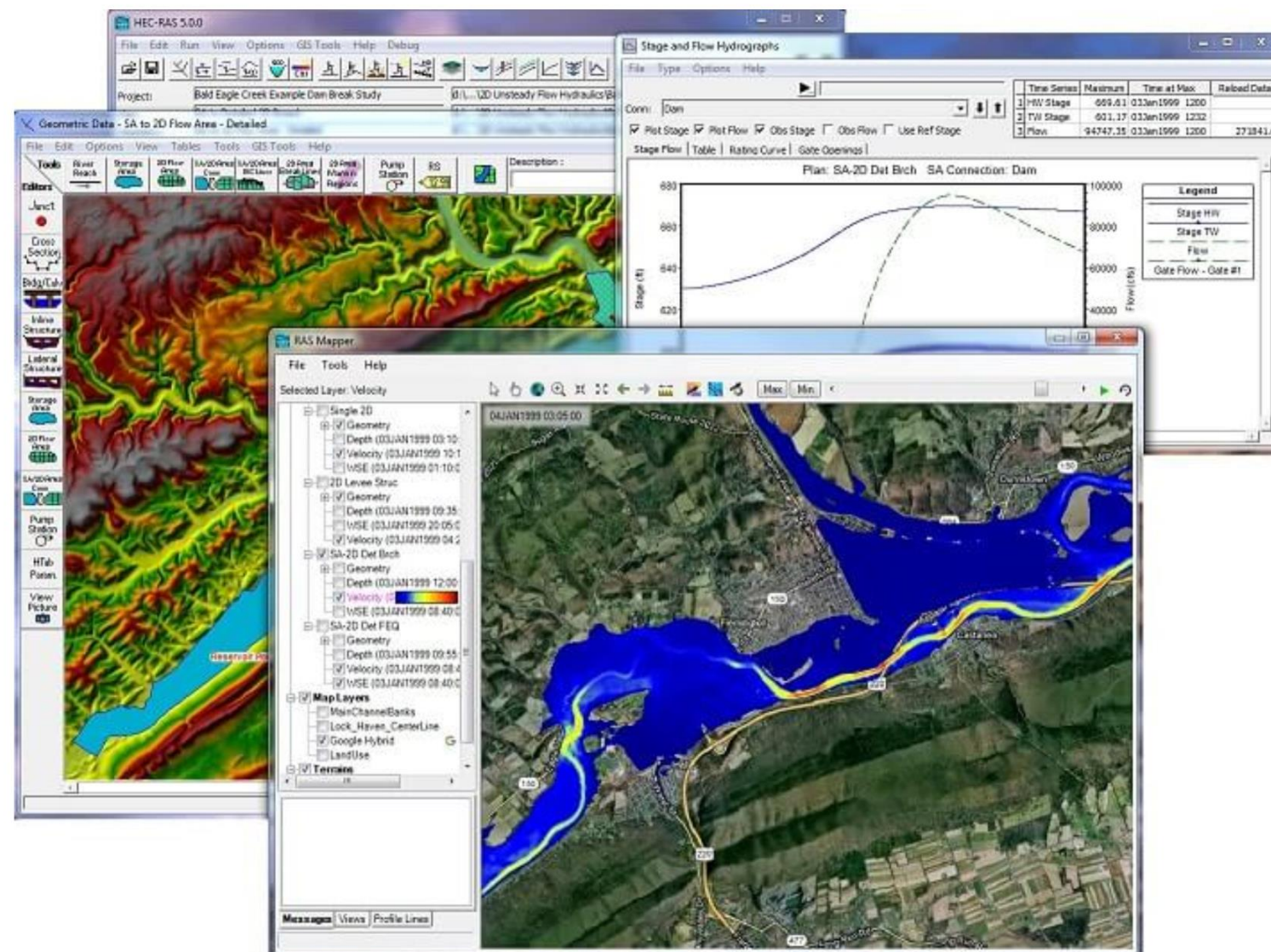




HEC-RAS

[HEC-RAS](#)[Features](#)[What's New](#)[Downloads](#)[Documentation](#)[FAQs](#)[Known Issues](#)[Bug Report](#)[Suggestions](#)[Demo](#)[Sponsors](#)[Collaborators](#)[Support Policy](#)

Welcome to the Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) website. This software allows the user to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling.



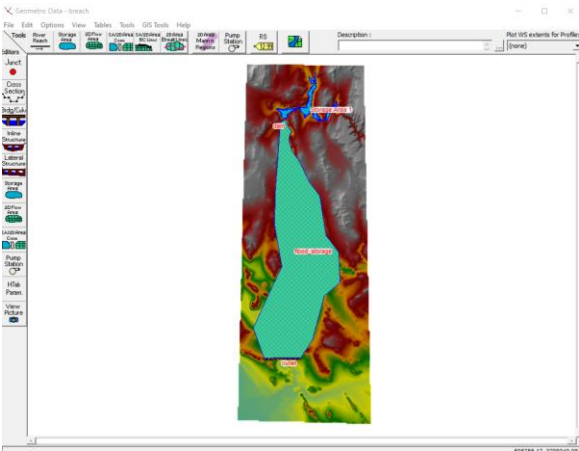
Hoover Dam

- Type: Concrete arch-gravity dam
- Location: Black Canyon of the Colorado River (NV-AZ Border)
- Built: 1931-1936
- Impounds: Lake Mead (640 km²)
- Height: 221 meters
- Crest Width: 14 meters
Base Width: 200 meters
- Weight: 6.6 million tons
- Capacity: 3.5 trillion m³
- Annual Power Generation: 4.2 TWh

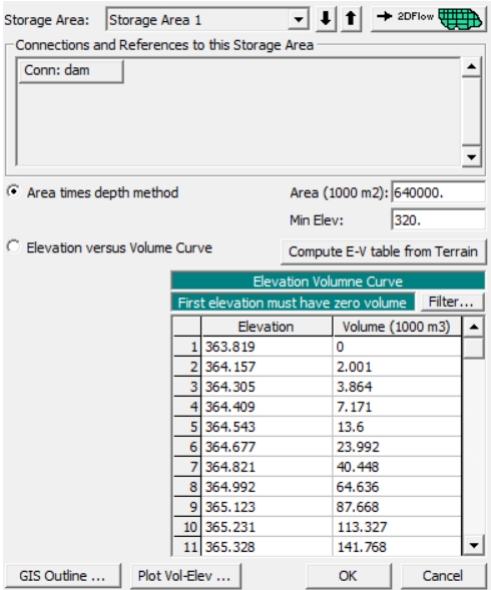


Dam Breach Model Considerations:

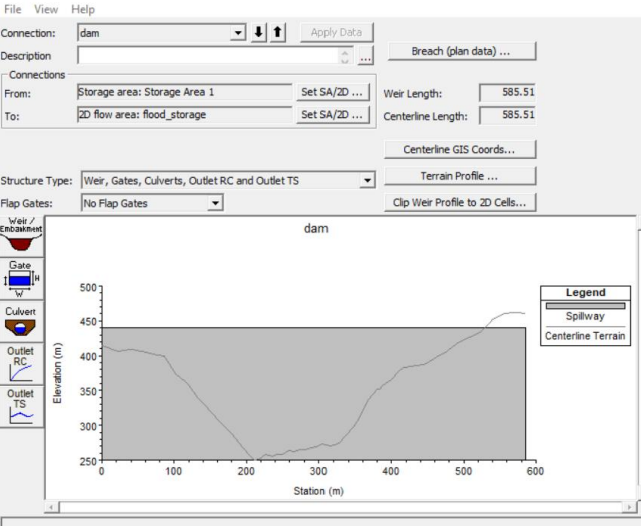
- Reservoir Drawdown and Flow Area
 - 1D Steady Flow Reservoir Drawdown to 2D Unsteady Flow Downstream Routing
 - Flow Area Computational Mesh: 1.8 million 100m² computational mesh
 - Major Assumption: No other hydraulic features exist downstream of the Hoover Dam (False)
- Dam Breach Parameters
 - Type of Dam: Concrete Gravity-Arch
 - Breach Mode: Overtopping
 - Speed of Breach formation: Instantaneous
 - Shape/Size of Breach: ~80% Breach
 - Flow from breach: Ideally, full flow is achieved nearly instantaneously
 - Linear buildup was used to avoid model instabilities
- Topography and Manning's Roughness Coefficients (Friction Surfaces)
 - DEM: 30-meter NED DEM was reconditioned using AGREE method in ArcHydro
 - Manning's N: Roughness coefficients were assigned to 2016 NLCD dataset based on USGS Guidelines
- Desired Complexity and Computational Time
 - Simulation time: 72 Hours
 - Computational Interval: 30 seconds
 - Ideally, 1 second or less for dam breach analysis
 - 1 second computational interval would have required 36 hours of computational time on my machine!



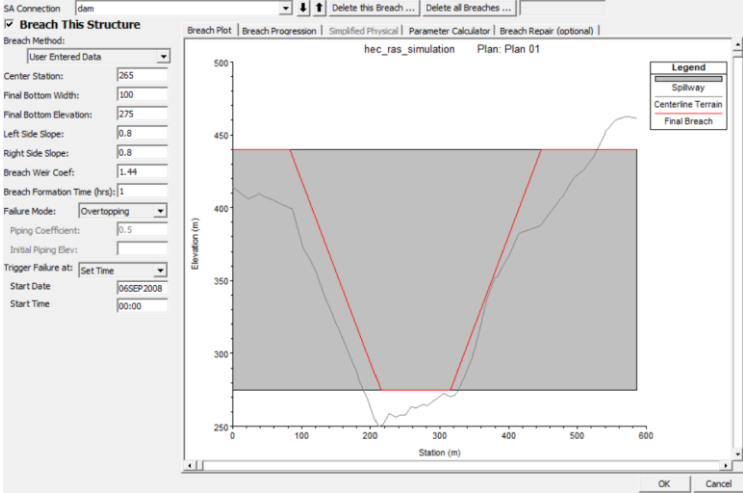
Storage Area Editor



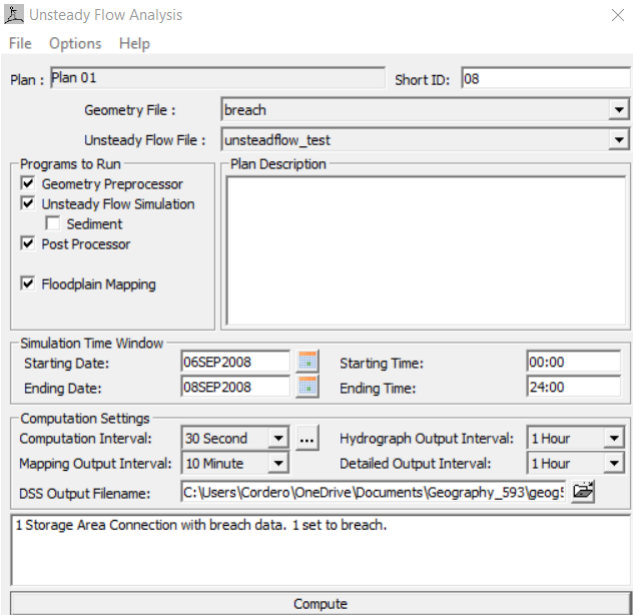
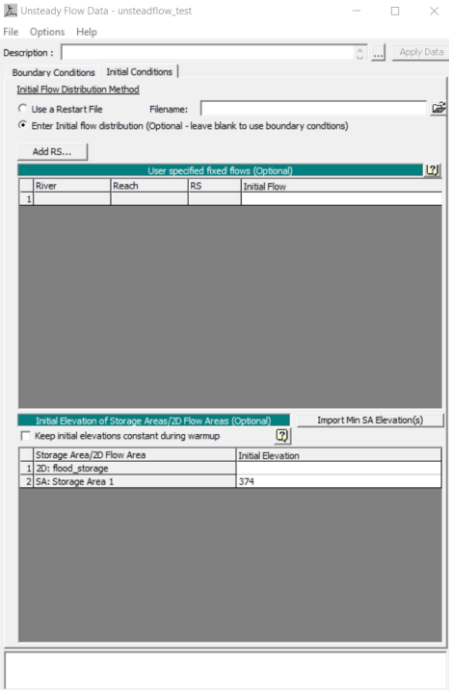
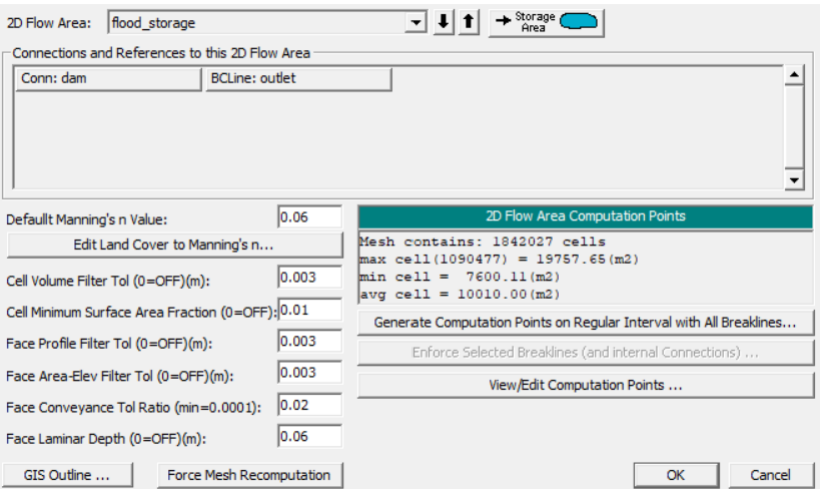
Connection Data Editor - breach

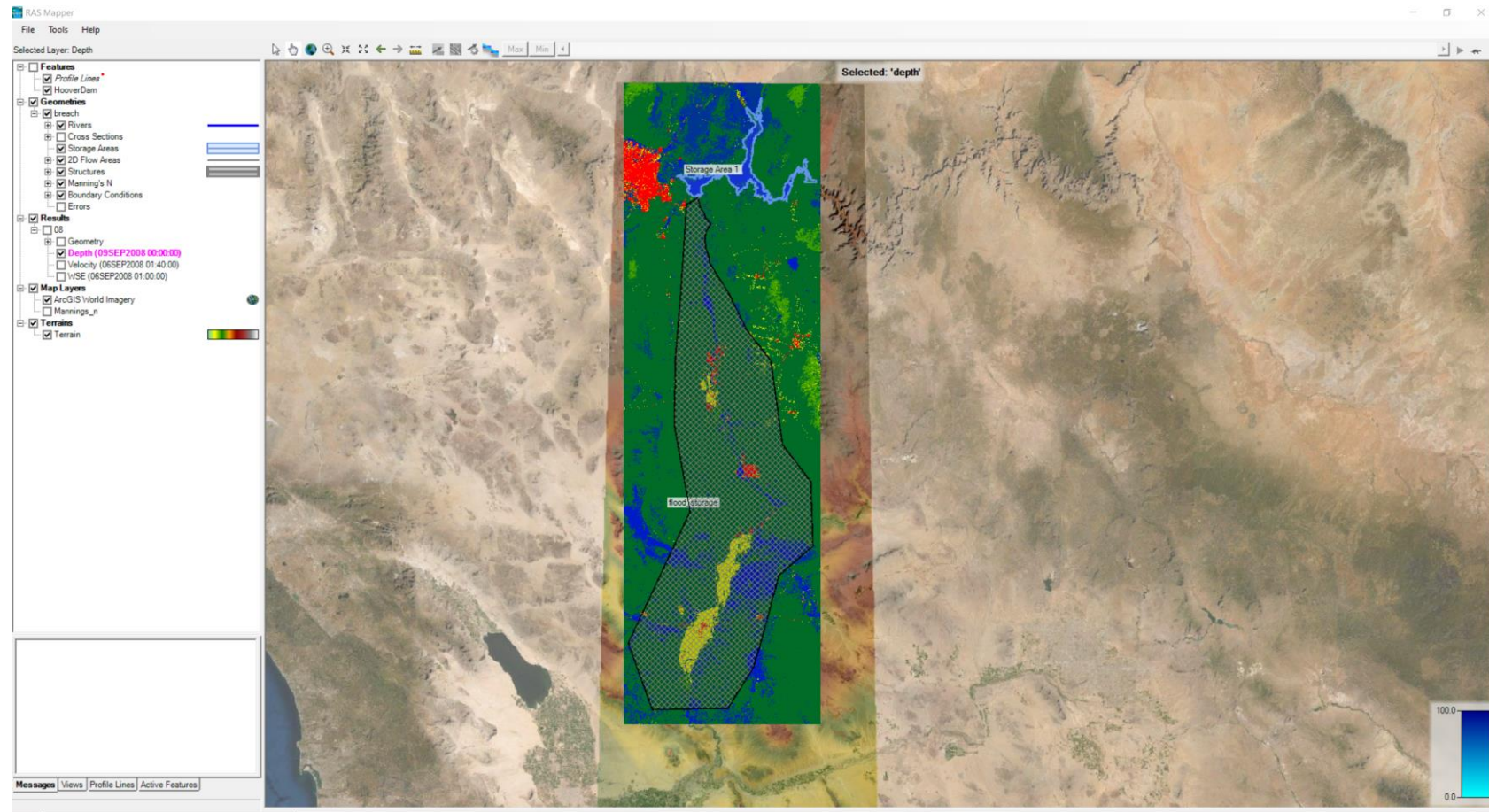


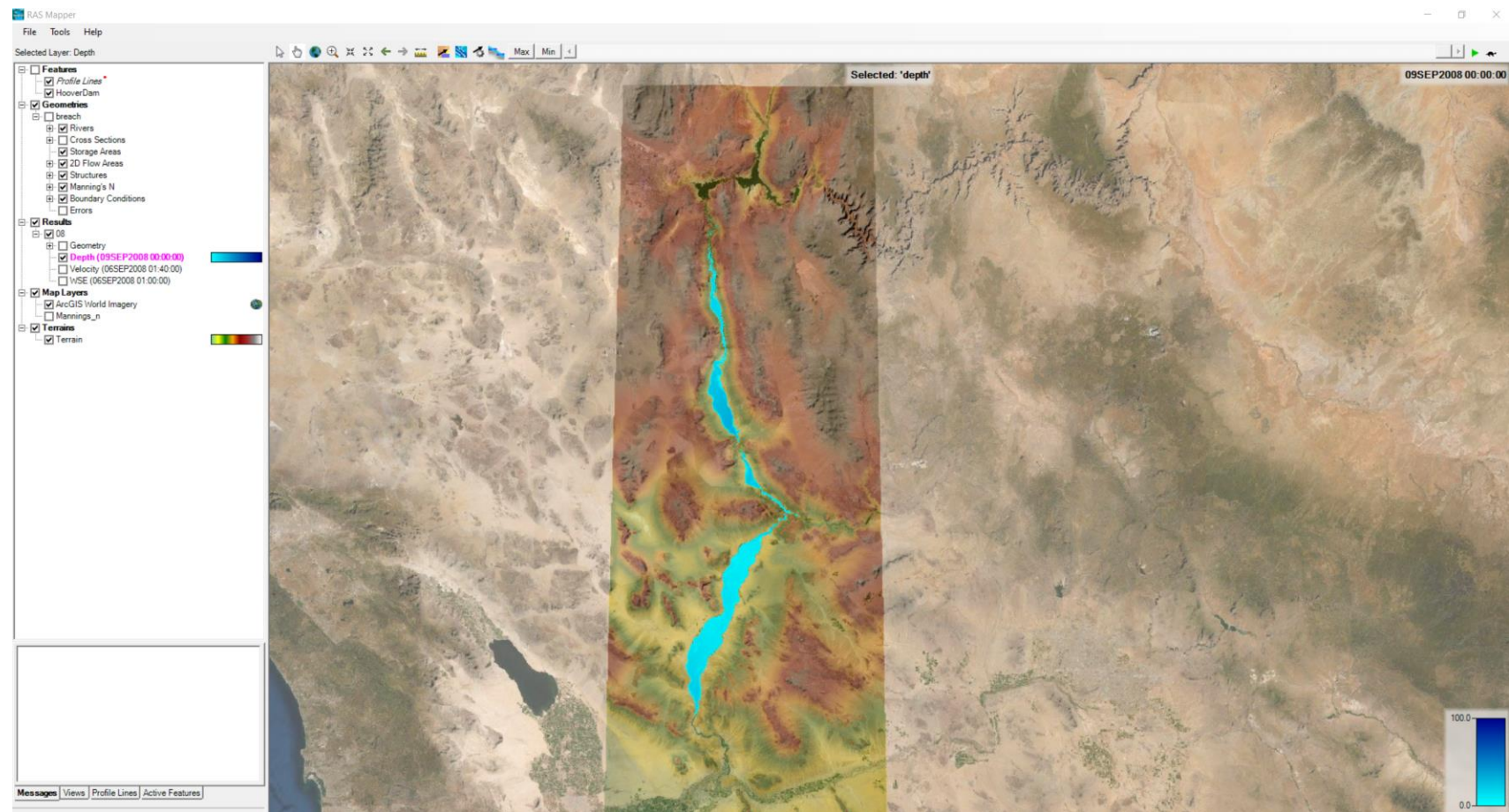
Storage Area Connection Breach Data



2D Flow Areas







Conclusions and Future Work

- A breach of the Hoover Dam would be devastating
 - Luckily, it was built to last
- HEC-RAS is a powerful hydraulic modeling software for analyzing and visualizing hydraulic events to varying degrees of complexity
- Outputs from this model could be used for:
 - Flood Inundation mapping (outputs seem to favor CAD systems)
 - Contingency Planning (e.g., evacuation times downriver from a dam breach)
 - Dam Repair/Removal Planning
 - Much more!