Unit 01:
Introduction/Overview of DSS-WISE Web

WEB-BASED FLOOD INUNDATION MODELING WITH DSS-WISE WEB

A SHORT COURSE ON RECENT UPDATES WITH HANDS-ON TRAINING

Developed by

NATIONAL CENTER FOR COMPUTATIONAL HYDROSCIENCE AND ENGINEERING

THE UNIVERSITY OF MISSISSIPPI

For

FEDERAL EMERGENCY MANAGEMENT AGENCY

FEMA

Technical Workshop

September 25th, 2025

Huntington Convention Center of Cleveland

1 St Clair Ave NE, Cleveland, OH 44114

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The University of Mississippi

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Special Thanks

Special thanks to FEMA for sponsoring this workshop!

U.S. DEPARTMENT OF HOMELAND SECURITY

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Acknowledgements

1. FEMA National Dam Safety Program
2. USDHS Science and Technology Directorate
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10. Mr. Kyle Pfeiffer from the National Preparedness Analytics Group, Decision and Infrastructure Sciences Division at ANL.
11. Dr. Olufemi Omitaomu and Dr. Amy Rose from the Geographic Information Science and Technology Group, Computational Sciences and Engineering Division at ORNL.
12. U.S. Army Corps of Engineers (USACE), Oak Ridge National Laboratory & Argonne National Laboratory for hosting/monitoring SERRI and DSAT.
13. All the active users of DSS-WISE™ Web for their valuable feedback and support.

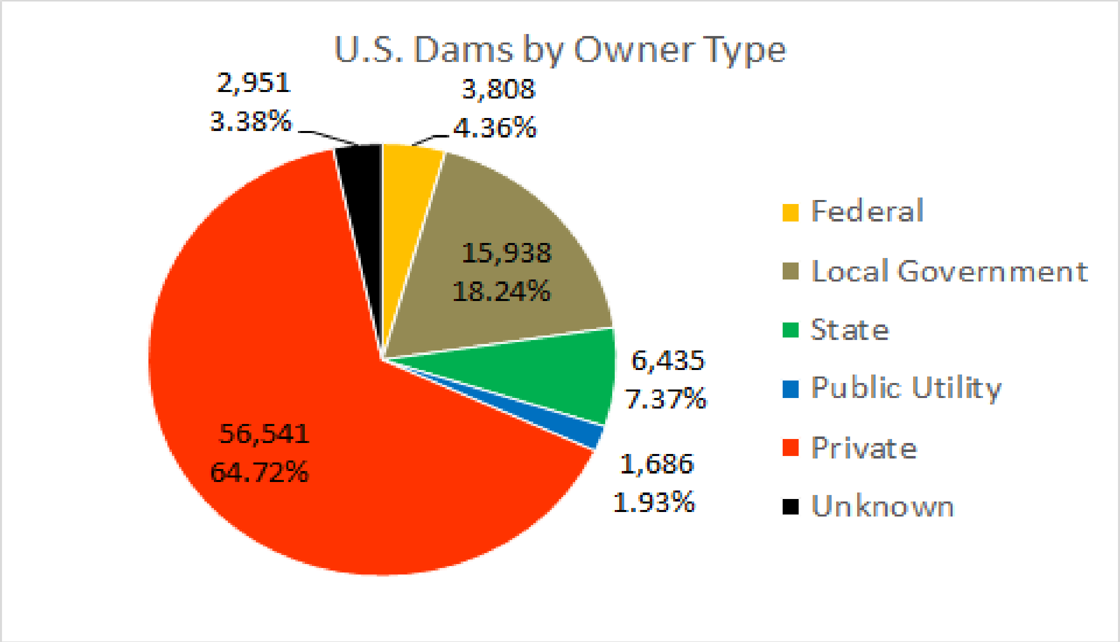
Agenda

Time	Topic
8:30 AM – 9:20 AM	Introduction/Overview of DSS-WISE Web
9:20 AM – 9:45 AM	Simulation scenario setup and data entry
9:45 AM – 9:55 AM	SHORT 10 MINUTE BREAK
9:55 AM – 10:20 AM	Understanding simulation outputs
10:20 AM – 11:20 AM	Hands-on exercises using the new system features
11:20 AM – 11:30 AM	SHORT 10 MINUTE BREAK
11:30 AM – 11:45 AM	Tips and Tricks/Advanced Techniques
11:45 AM – 12:15 PM	Current System Developments for DSS-WISE 4.0 (Beta Version Jan. 2026)
12:15 PM – 12:30 PM	Questions / Discussion

Introduction/Overview of DSS-WISE Web

Introduction and Brief History

A large majority of the dams (**~65%**) listed in the NID are **privately owned**.
Dam safety requires **collaboration with private dam owners**



Many private dam owners **do not fully understand** their personal responsibilities in case of a failure

Many private dam owners **do not have the funds** to hire engineering companies to study their dams and prepare EAPs

The dam safety is under the responsibility of the states.

The **states do not have the budget or the manpower** to closely follow the large number of dams under their jurisdictions, and they lack the judicial authority to impose the EAP studies on private dam owners.

Many people in the United States live in areas considered to be hazardous in the event of a dam failure. The potential for catastrophic floods due to these events is only made worse by aging infrastructure, climate change, and population creep into flood zones of what used to be considered low-hazard dams.

Challenges of Legacy Flood Modeling Solutions and Benefits of DSS-WISE Web

Legacy Dam-break Flood Modeling Challenges:

DSS-WISE Web Solution: User-friendly Fast Free 24/7

Difficult → User-friendly

- **Web-based setup and results download**
- Ph.D. in numerical modeling is not required
- **Fully-automated data preparation with minimal setup**
- Verified and validated 2-D numerical flood model
- GIS compatible results become available as soon as the simulation finishes

Slow → Fast

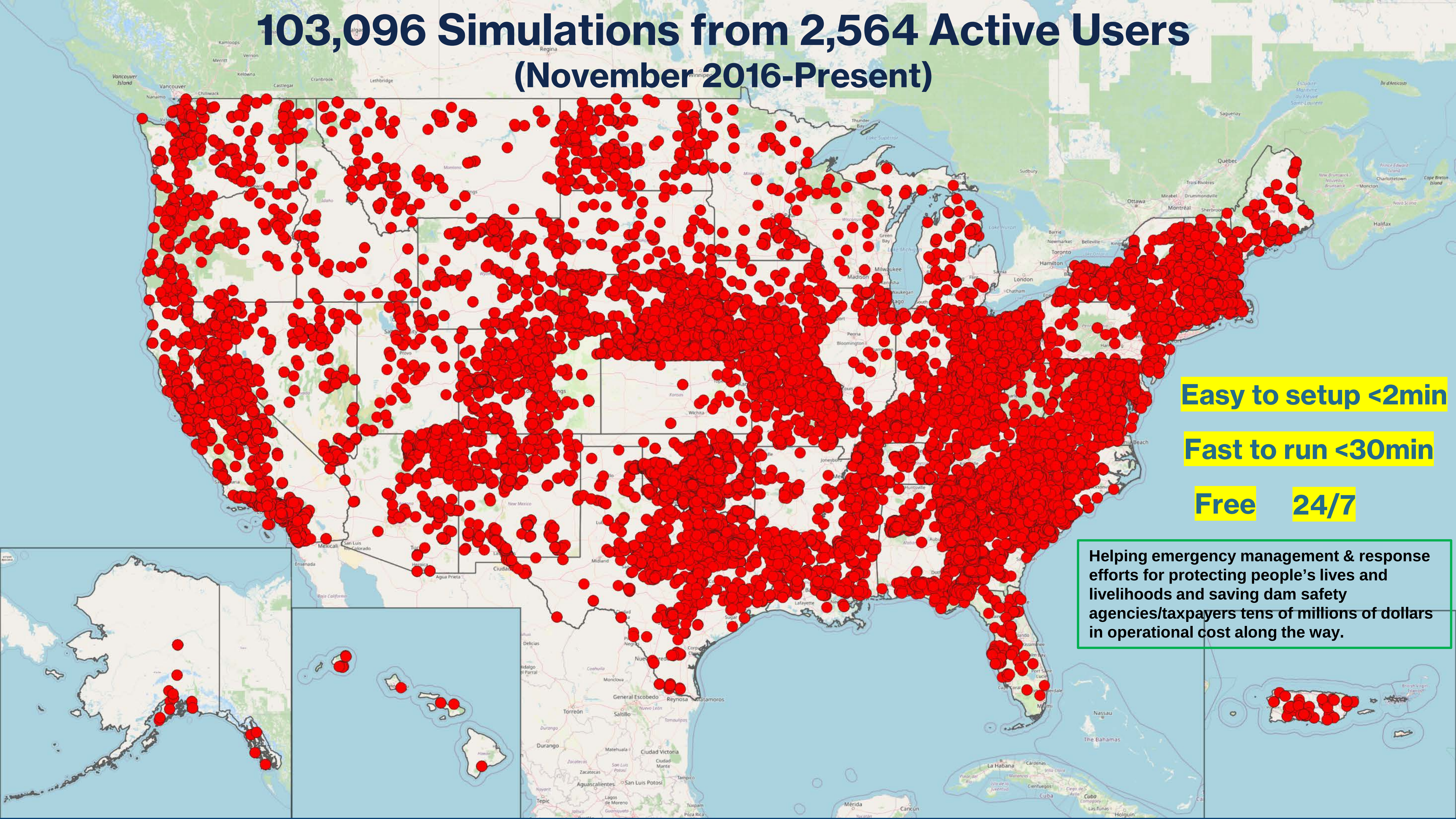
- **Simple simulation setup can be done in < 2 minutes**
- State-of-the-art model uses multithreading to fully take advantage of available compute hardware
- **In 87% of the cases results are returned to the user within 30 minutes and in 92% of the cases within one hour**

Expensive → Free

- **No charge for use**, licensing, or compute time
- Simulations run on NCCHE's servers- no need for expensive hardware
- Expensive engineering company is not required to obtain results
- **Available 24/7**

103,096 Simulations from 2,564 Active Users

(November 2016-Present)



Easy to setup <2min

Fast to run <30min

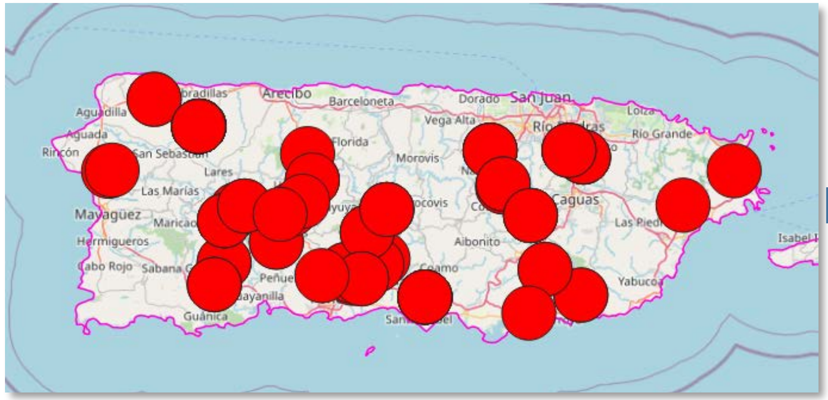
Free 24/7

Helping emergency management & response efforts for protecting people's lives and livelihoods and saving dam safety agencies/taxpayers tens of millions of dollars in operational cost along the way.

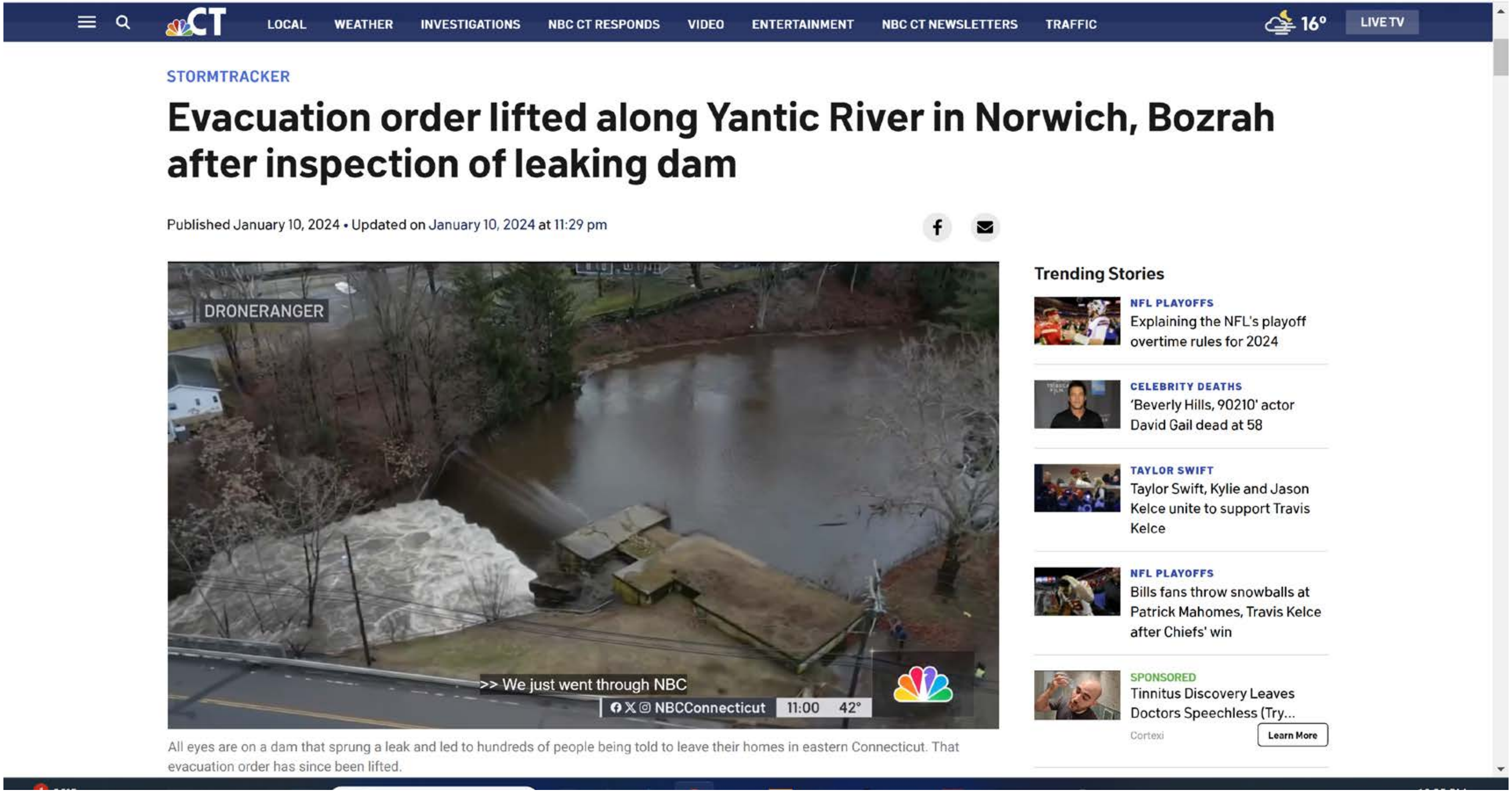
Incidents/Events

- In September of 2017, Hurricane Maria made landfall over Puerto Rico.
- The spillway for Guajataca Dam began to fail, triggering an emergency on top of an emergency.
- 6 engineers from STARR II were able to model all 35 dams in Puerto Rico using 117 DSS-WISE Lite simulations in less than 41 hours (**<u>average simulation run time of 21 minutes</u>**).

Guajataca Dam spillway failure



“Inundation shadow” for all dams in Puerto Rico



25 DSS-WISE Web simulations for the Fitchville Dam by the National Weather Service and Connecticut State Dam Safety Officials in the same morning of the leak (<u>Average simulation run time of 13 minutes</u>).

Additional Incidents/Events

Incidents/Events where Web-based DSS-WISE Lite was Used for Emergency Management and Response

From FEMA/NDSP DSS-WISE Lite Users Survey

2017: Oroville, California

Most notably, DSS-WISE™ Lite was used in the Oroville Dam Incident in 2017. Only an inundation map for the main dam was available at the time. In response to the release of high flows through a damaged spillway and use of an emergency spillway with hillside erosion, over 60 independent model runs were submitted in a 4-day period. DSS-WISE™ Lite was used to model various failure modes and determine appropriate evacuations.

2018: Snelling, California

In California, an Emergency Action Plan (EAP) was activated for Moccasin Lower Dam during a flood event due to inadequate spillway capacity that resulted in high seepage flows at the downstream toe of the dam and potential for dam overtopping. DSS-WISE™ Lite confirmed a dam failure would flood the fish hatchery downstream, impact a highway road, and be absorbed by the downstream reservoir, which led officials to dewater the reservoir through a water supply tunnel to alleviate seepage concerns and prevent overtopping.

2018: South Carolina

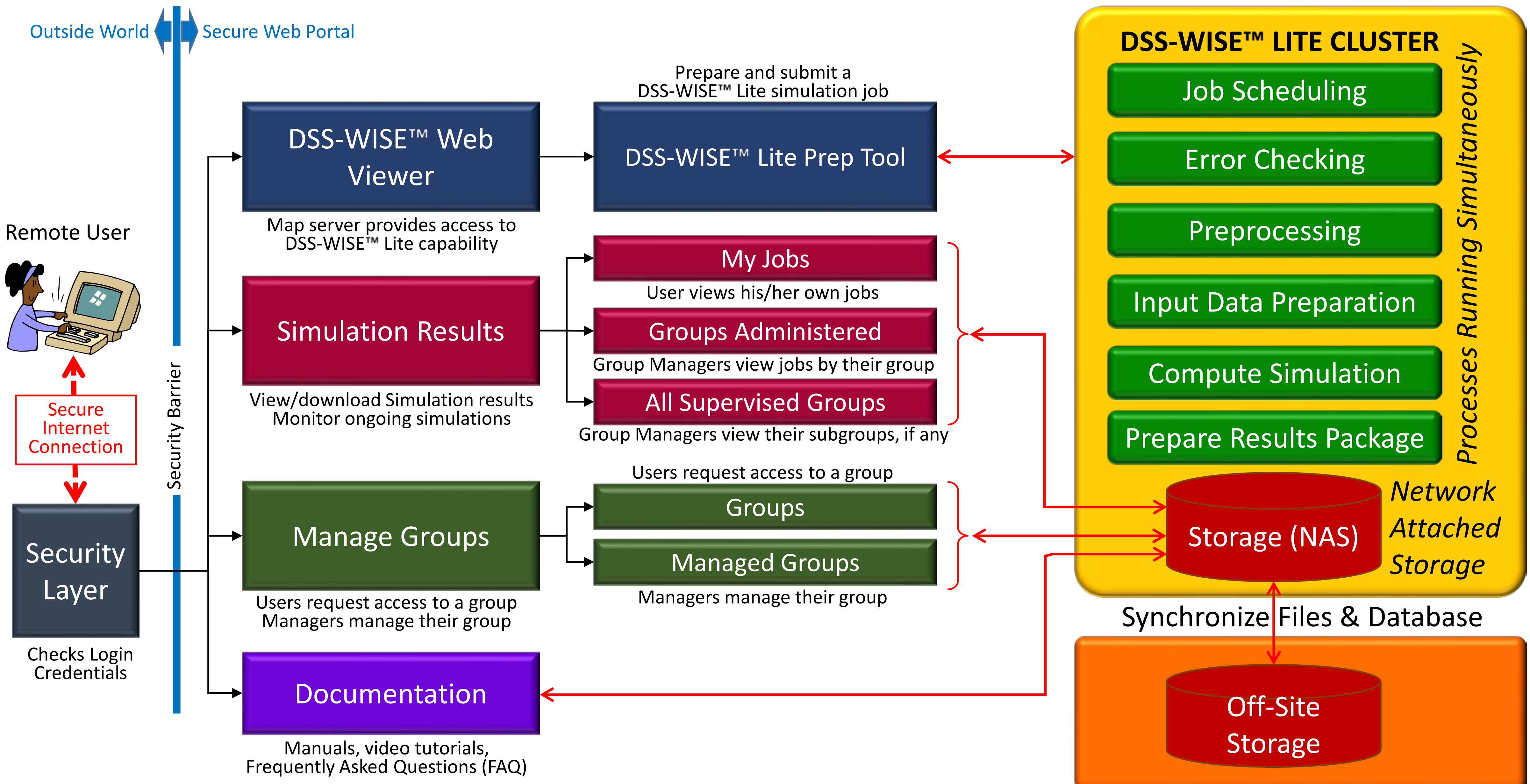
In South Carolina, multiple EAPs were activated for several dams during the approach of Hurricane Florence. Dam Safety Program staff identified dams that were expected to receive the most rainfall and conducted DSS-WISE™ Lite simulations to evaluate hazard classifications and ascertain accurate mapping would be available for distribution to emergency management.

2019: Soda Springs, California

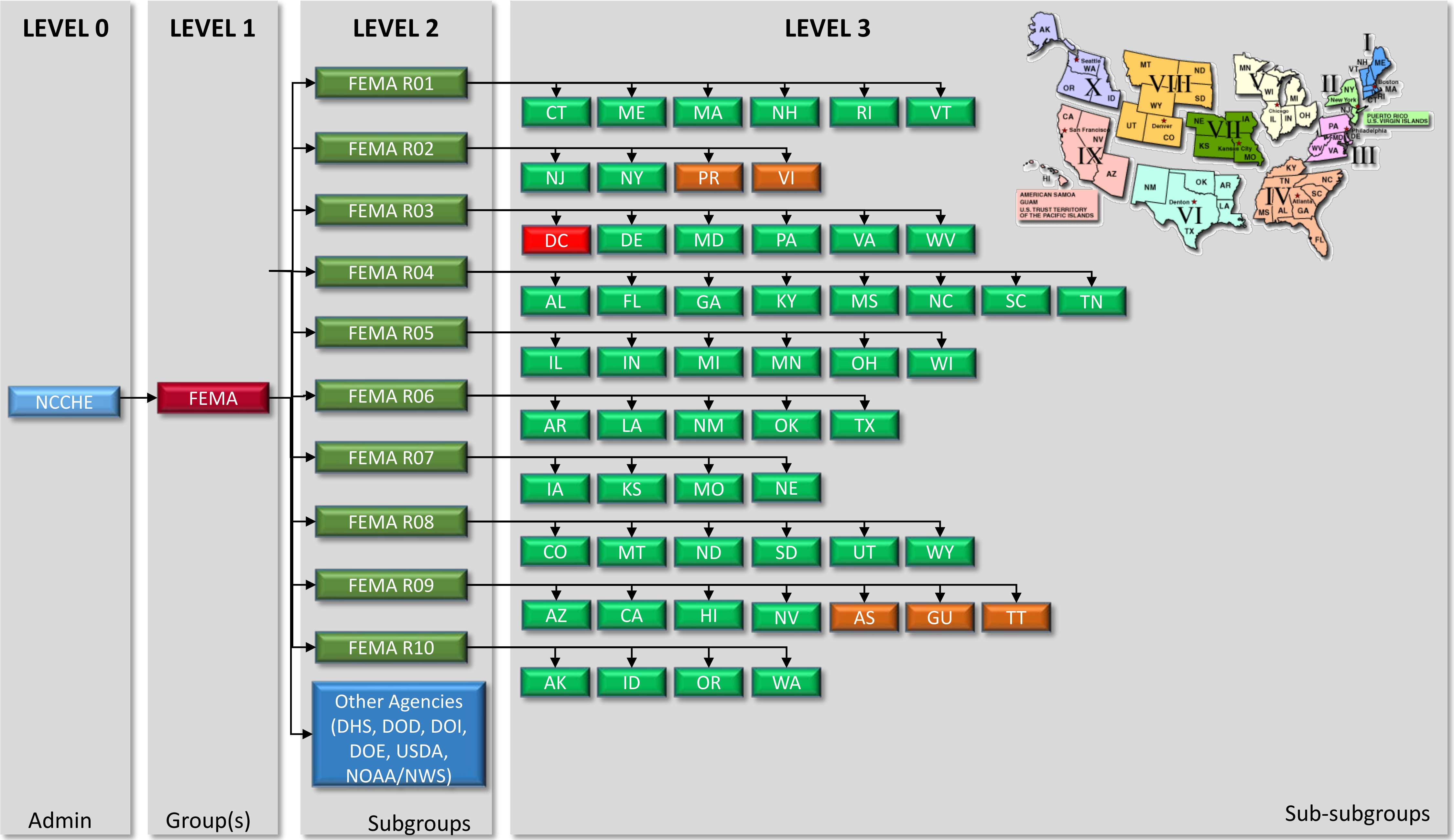
In California, Lake Van Norden Dam suffered damage to the spillway channel concrete liner. The dam owner's approved inundation map was used during the incident, but DSS-WISE™ Lite was used to confirm the owner's inundation area and flood parameters.

System Overview

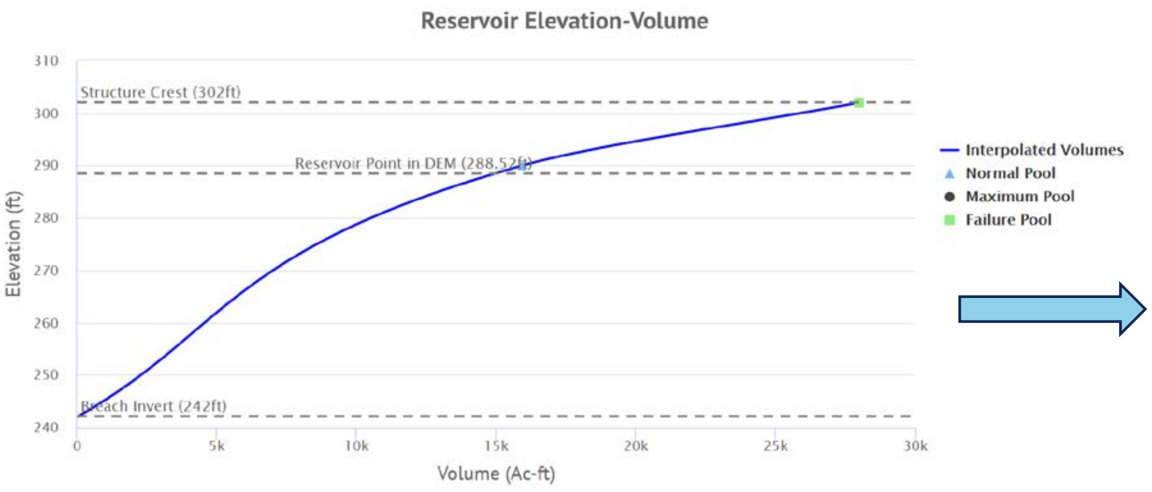
General Flow Diagram of the DSS-WISE Web Portal with Map Server and Graphical User Interface (GUI)

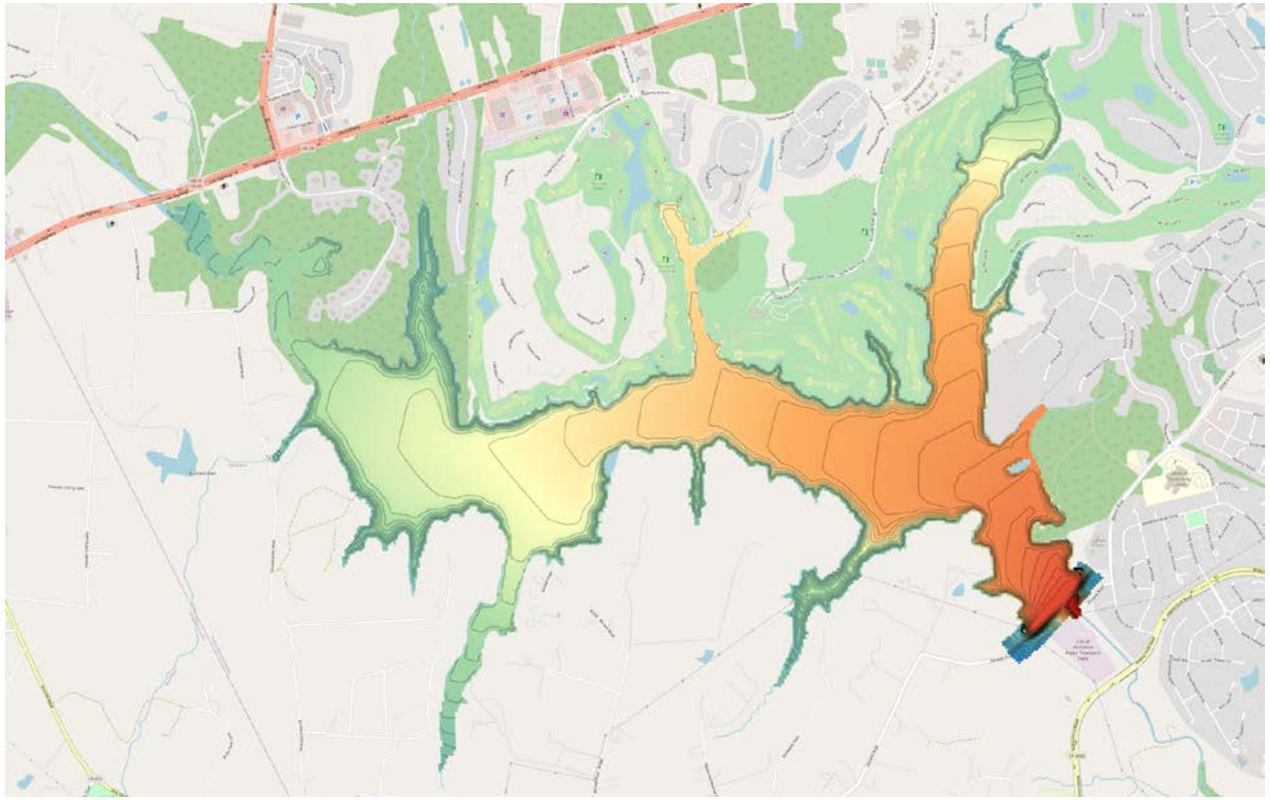


DSS-WISE Lite Group Concept

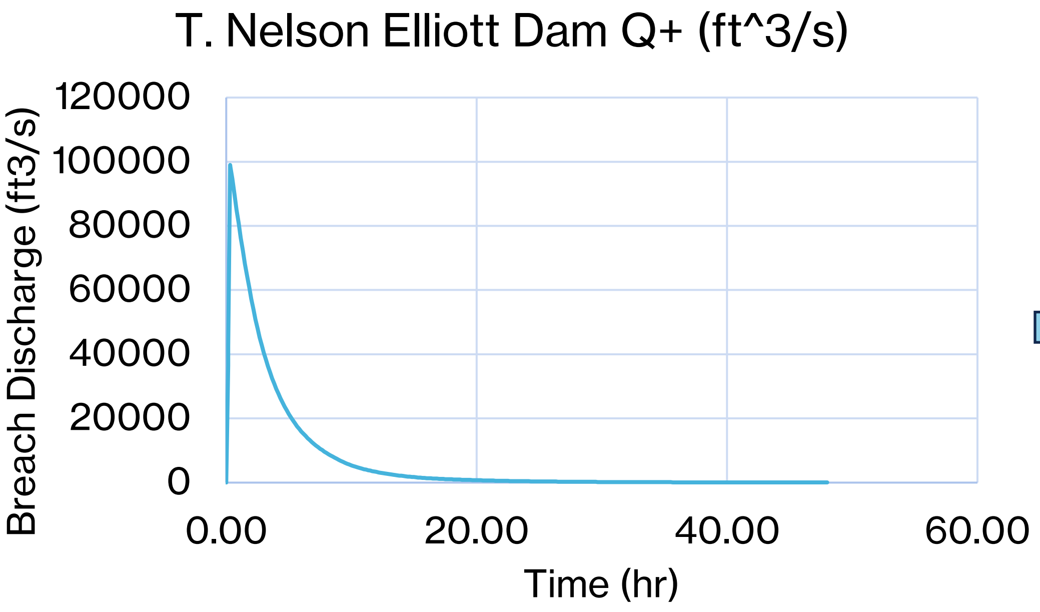


Ability to model sunny-day failures- reservoir is modeled at a given pool level, reservoir bathymetry is automatically spatially interpolated from user-supplied data

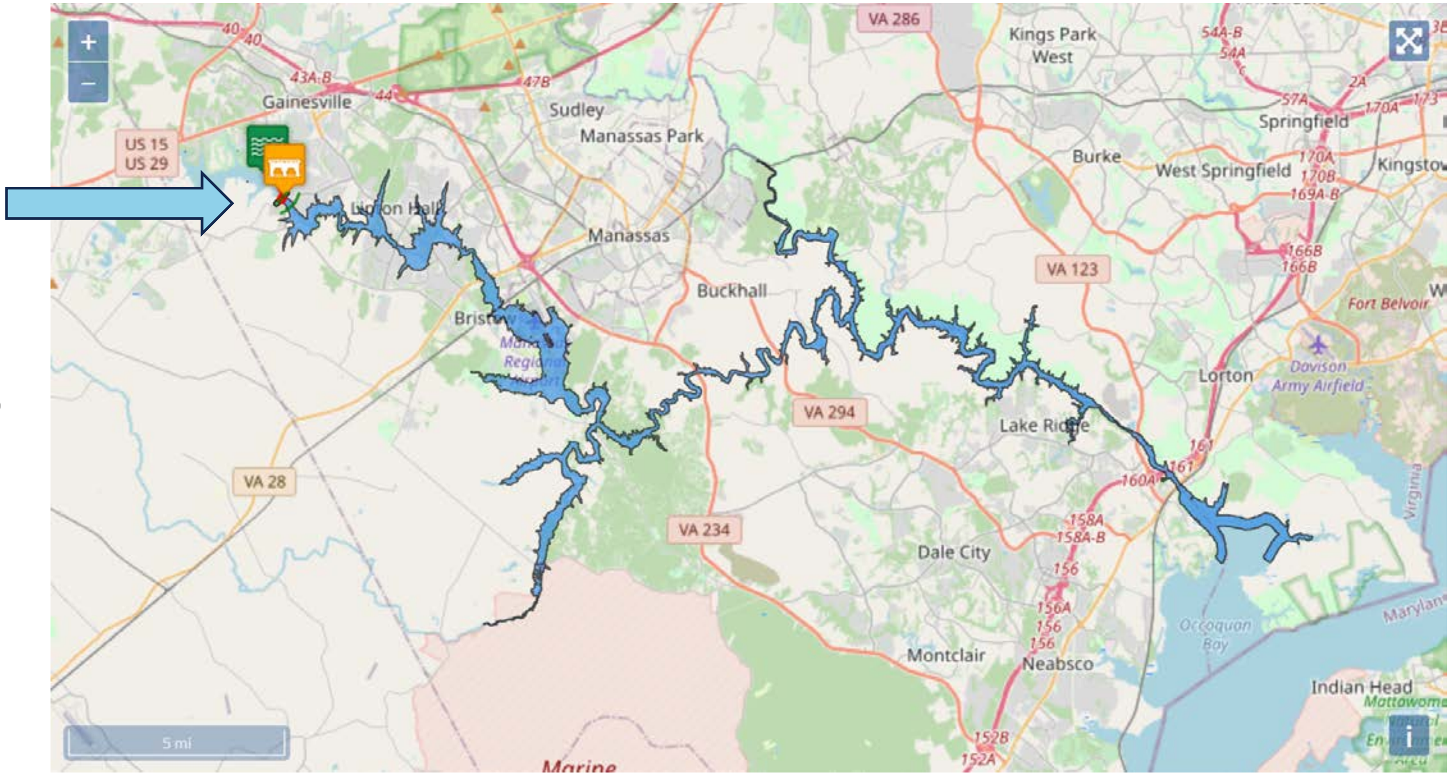




Ability to model a user-supplied breach hydrograph instead of modeling the reservoir

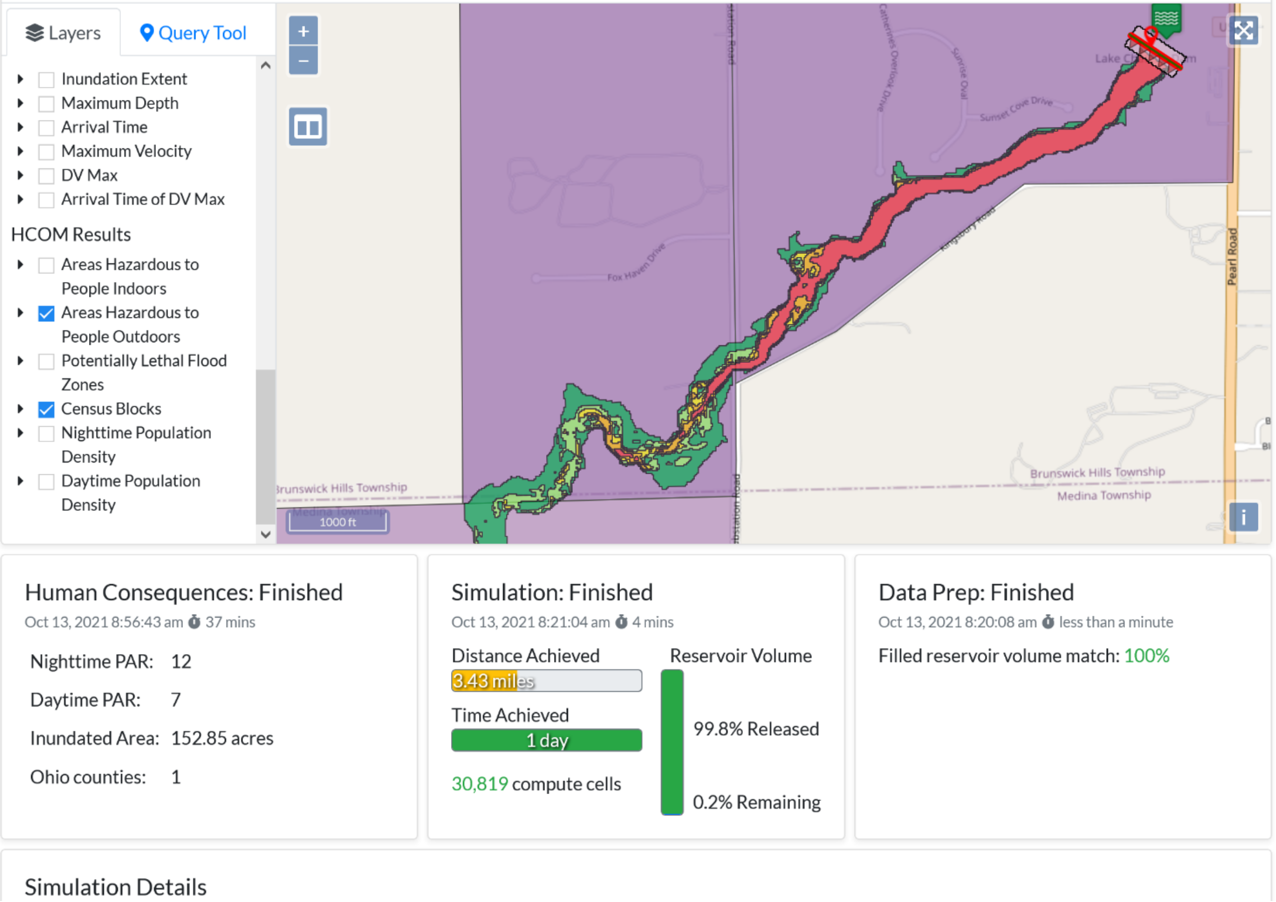


Web-based DSS-WISE Lite Dam Break Flood Inundation Mapping and Consequences Analysis

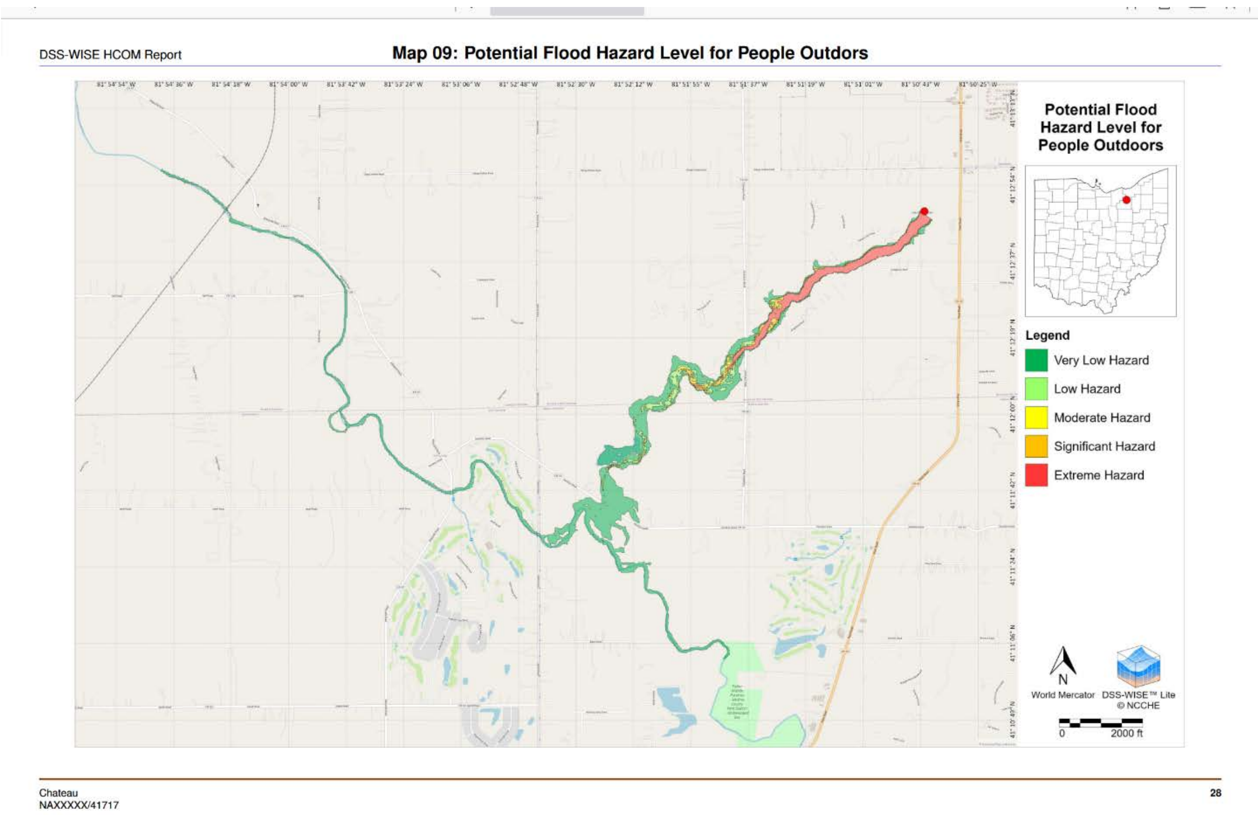


Human Consequences Module (HCOM)

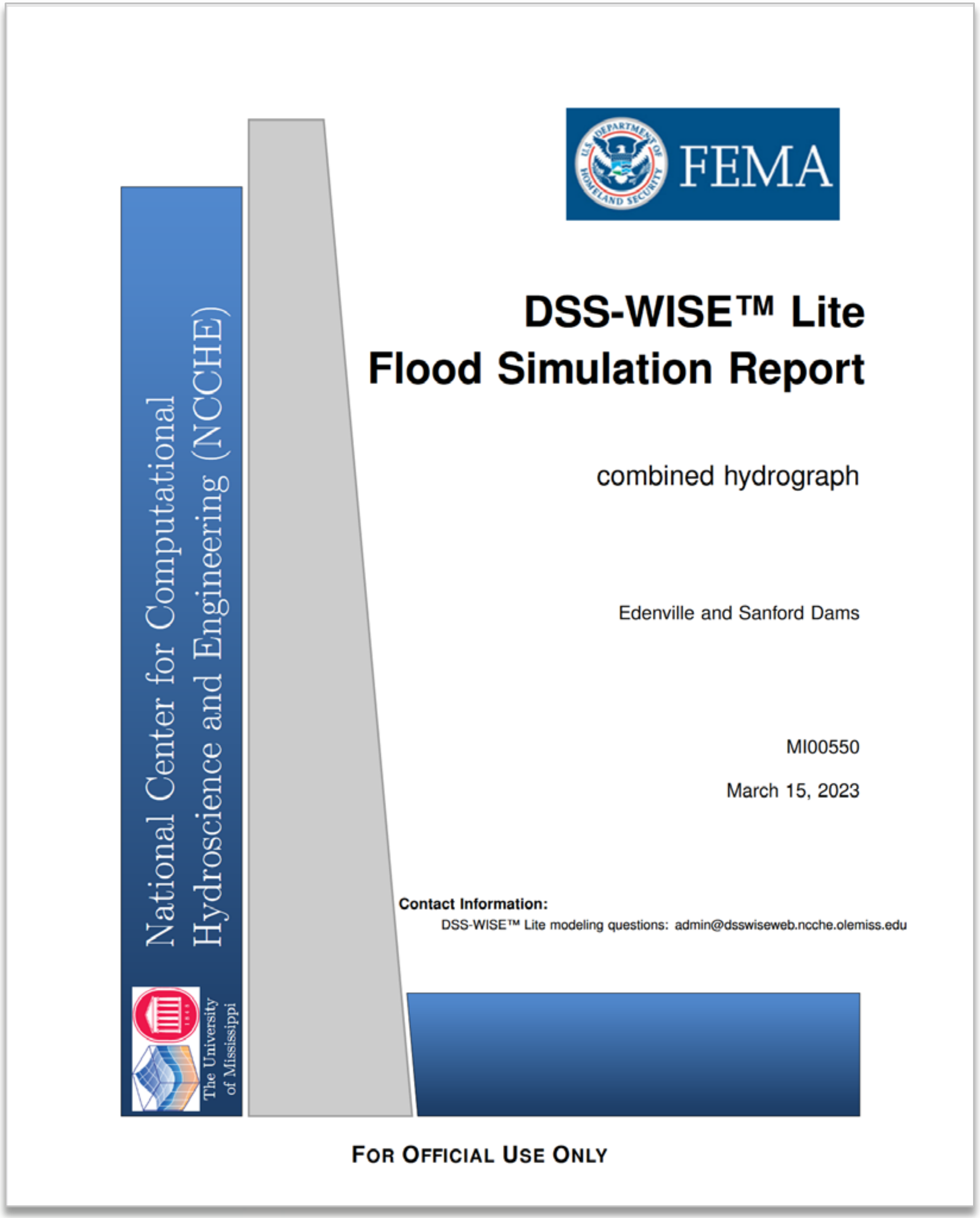
Visualization Tool



Downloadable Results Package and Reports



Users can visualize results/maps via the system's interactive GUI on their personal computers and smart phones, or download them onto their own servers as GIS layers or just as a summarized PDF report to be handed to emergency managers and first responders.



FEMA

DSS-WISE™ Lite
Flood Simulation Report

combined hydrograph

Edenville and Sanford Dams

MI00550

March 15, 2023

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

Contact Information:
DSS-WISE™ Lite modeling questions: admin@dsswiseweb.ncche.olemiss.edu

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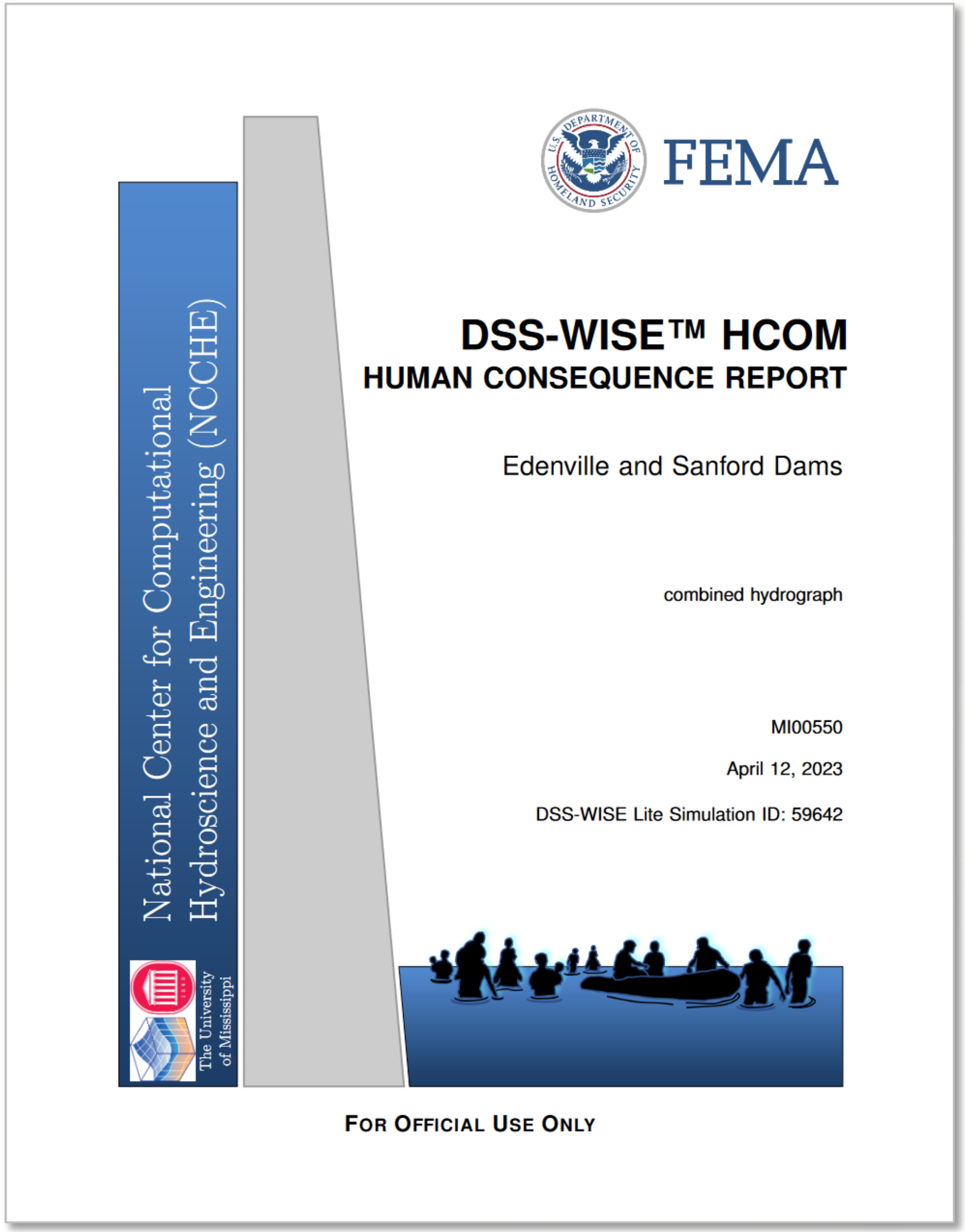

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DSS-WISE™ HCOM
HUMAN CONSEQUENCE REPORT

Edenville and Sanford Dams

combined hydrograph

MI00550

April 12, 2023

DSS-WISE Lite Simulation ID: 59642

National Center for Computational Hydroscience and Engineering (NCCHE)

The University of Mississippi

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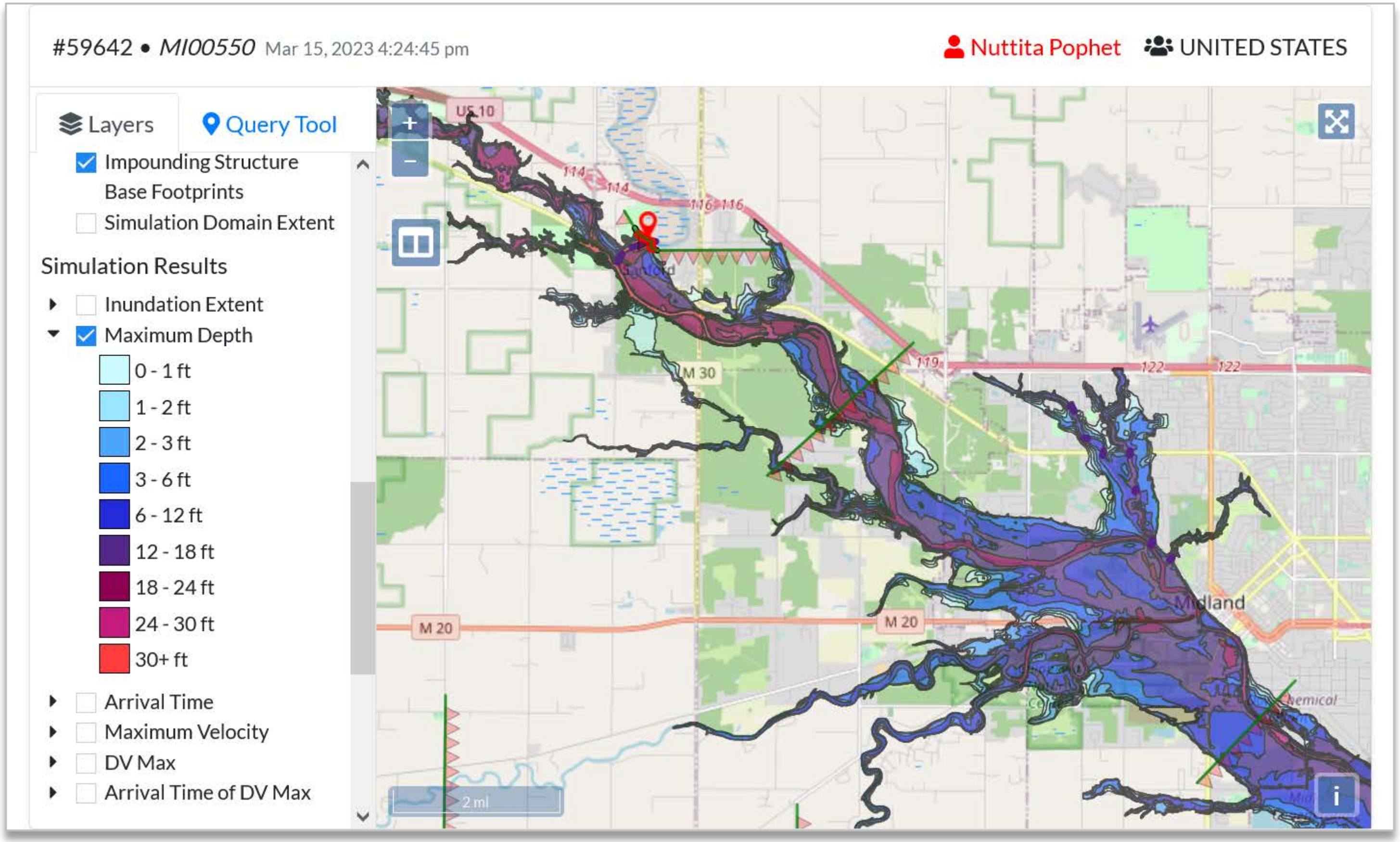
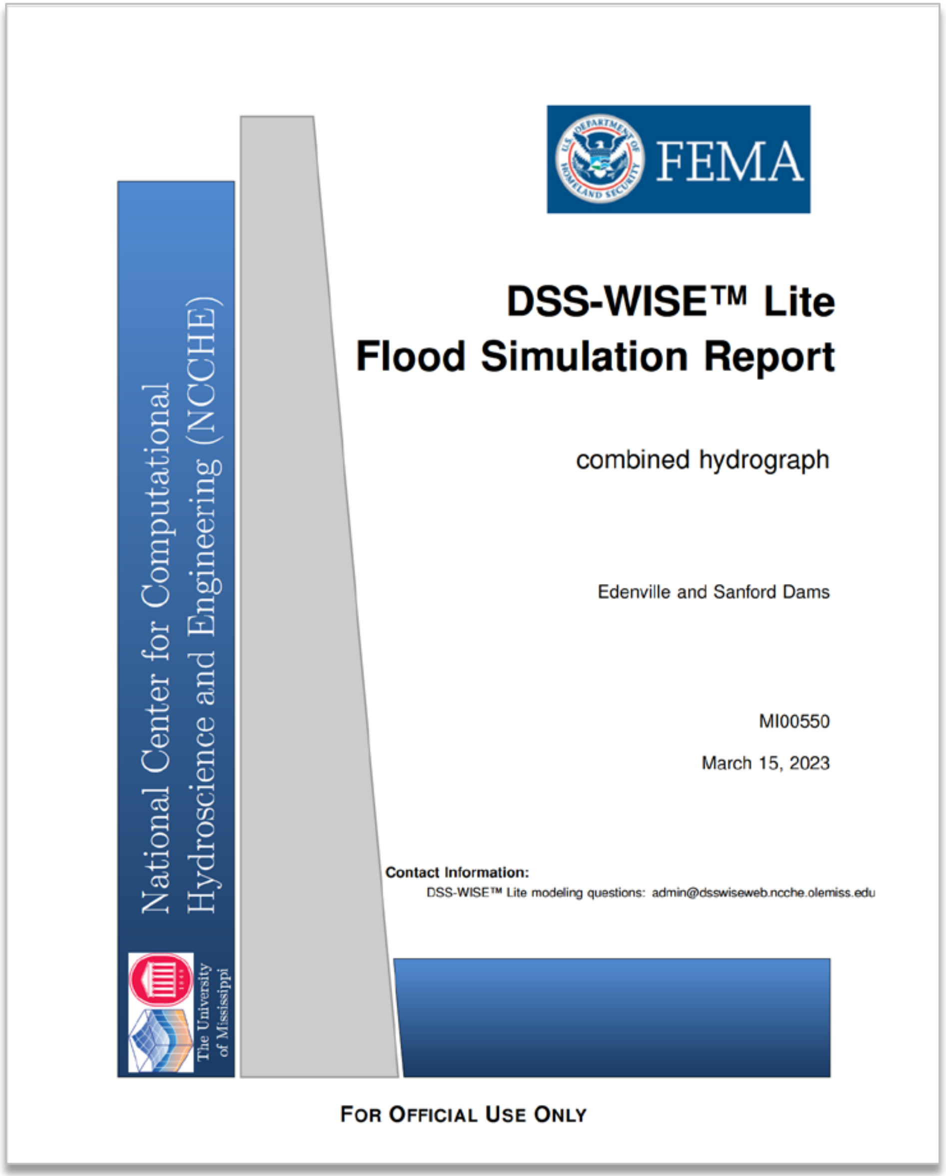
Example of Incident/Event Simulation Results

Edenville and Sanford Dams, Michigan, USA

DSS-WISE Lite Hydrodynamic results

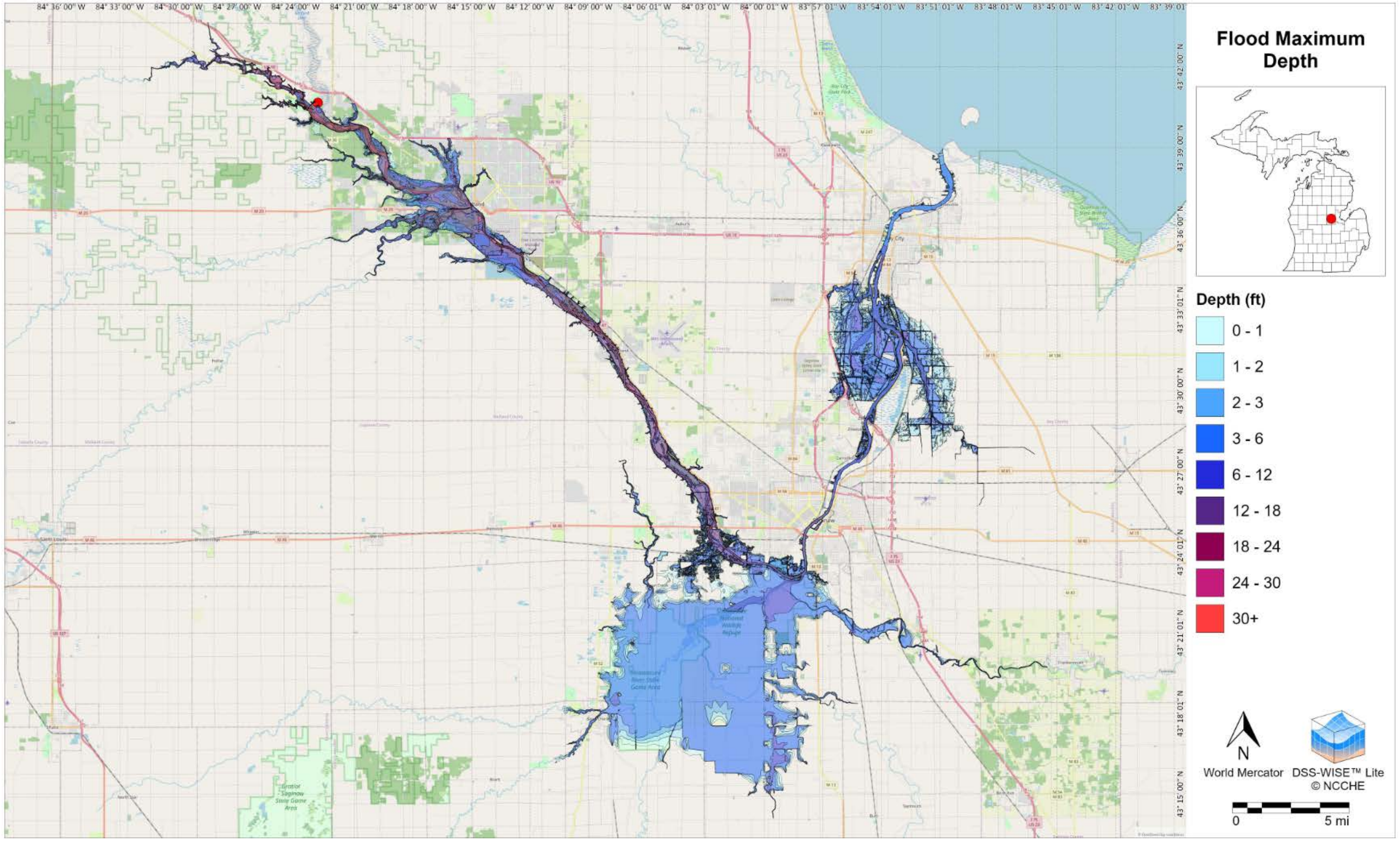




DSS-WISE Lite Results: Flood maximum depth

DSS-WISE HCOM Report

Map 01: Flood Maximum Depth

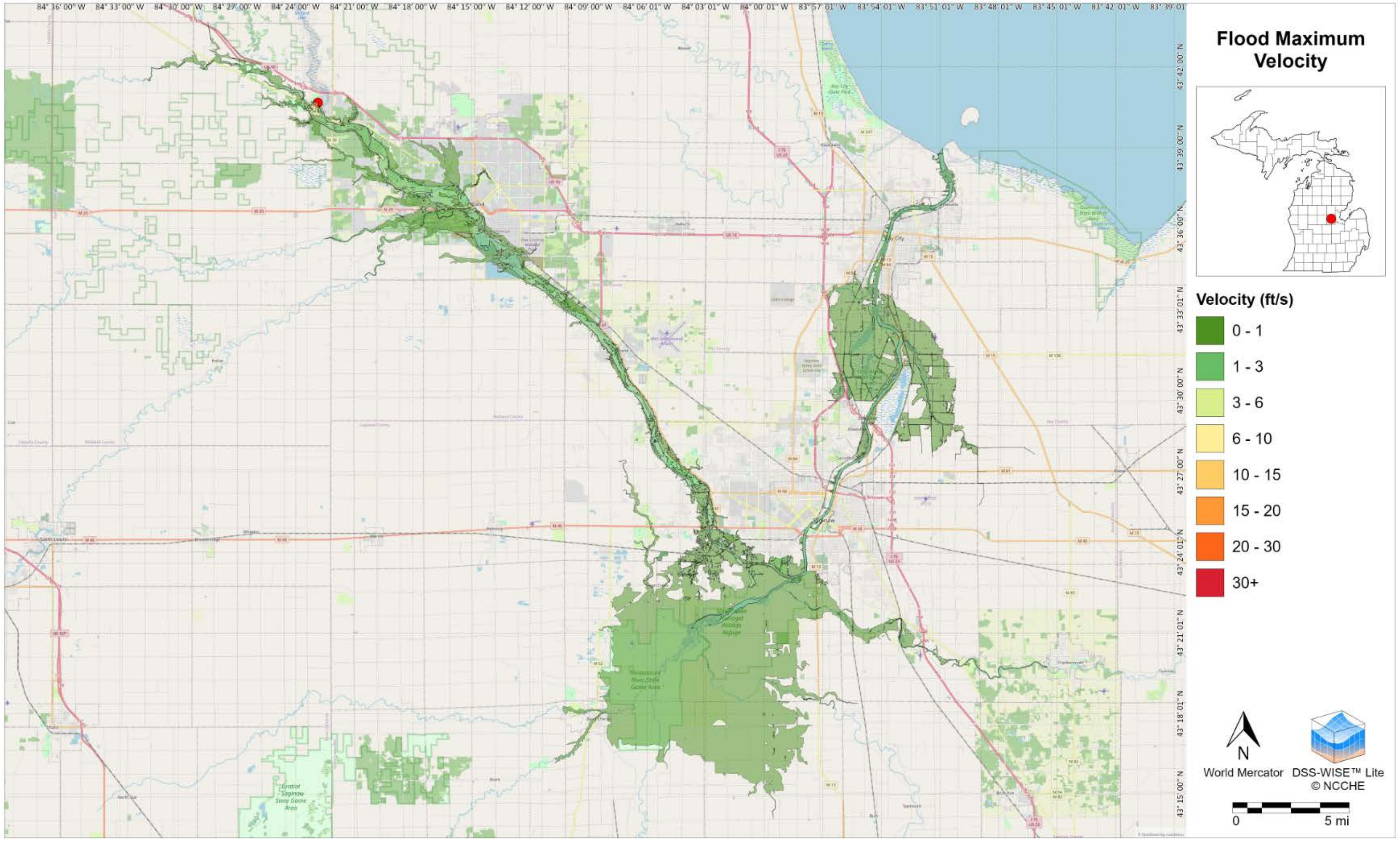


Edenville and Sanford Dams
MI00550/59642

DSS-WISE Lite Results: Flood maximum velocity

DSS-WISE HCOM Report

Map 03: Flood Maximum Velocity



Edenville and Sanford Dams
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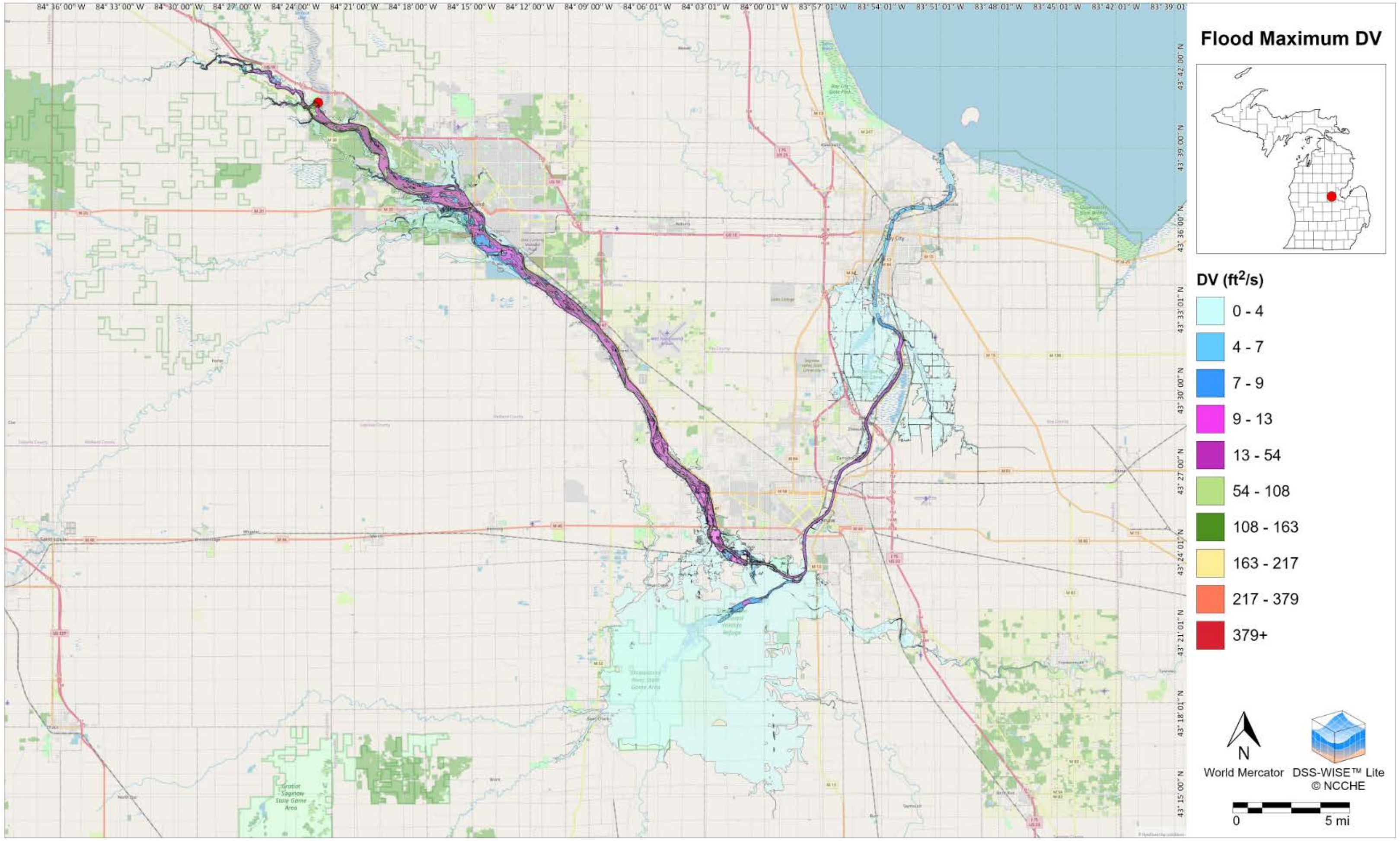
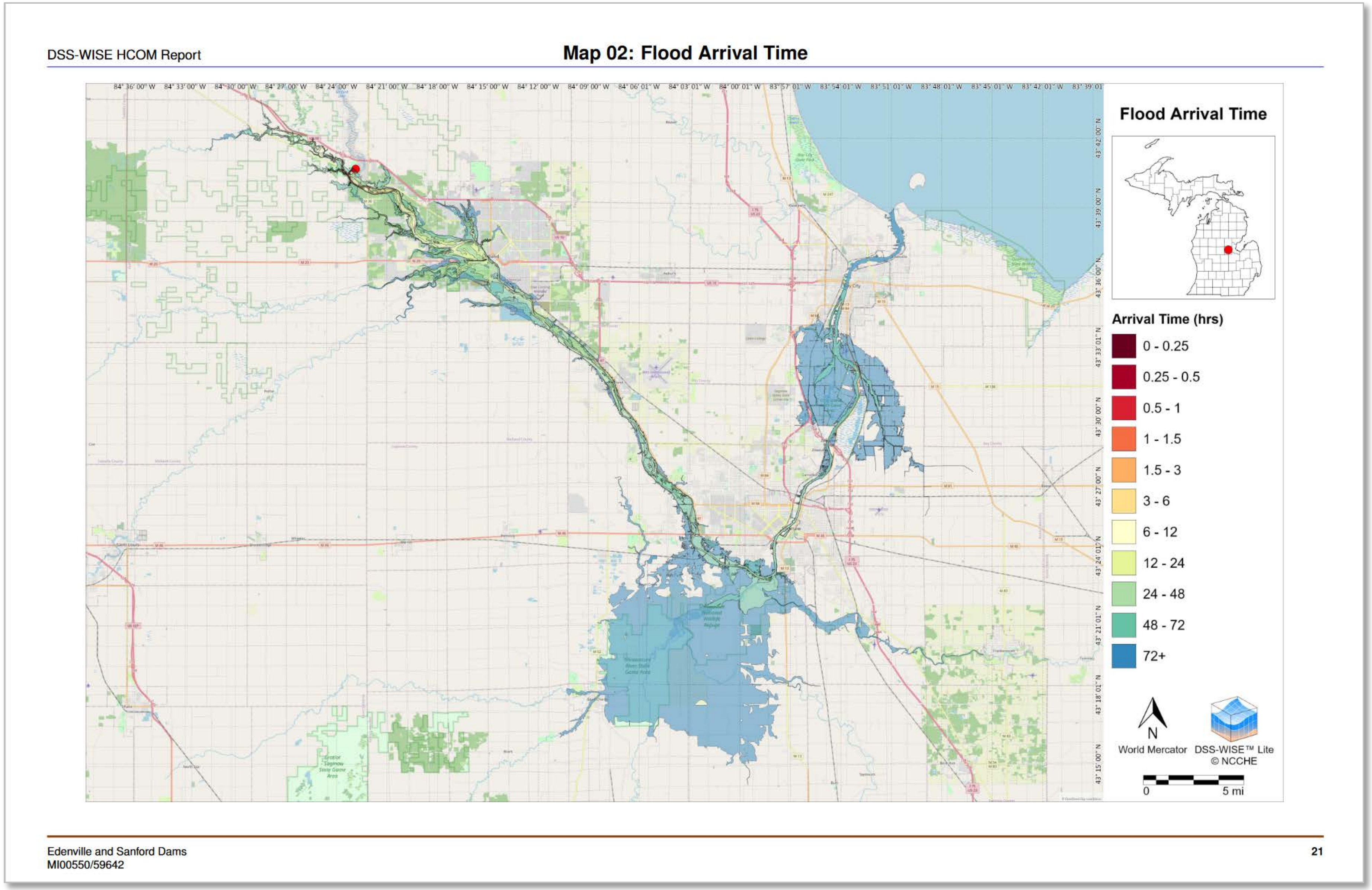
DSS-WISE Lite Results: Flood maximum DV

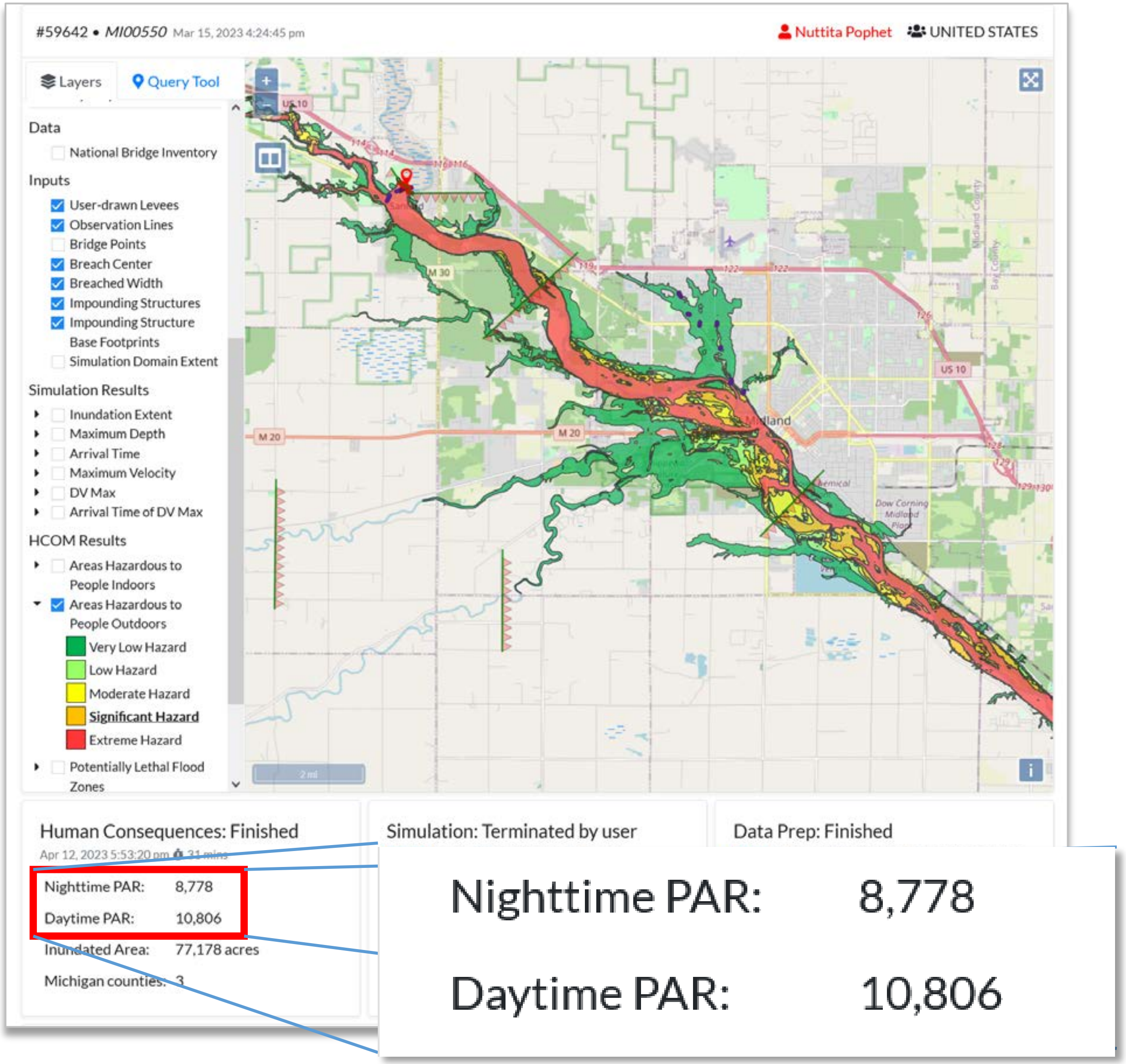
Map 04: Flood Maximum DV

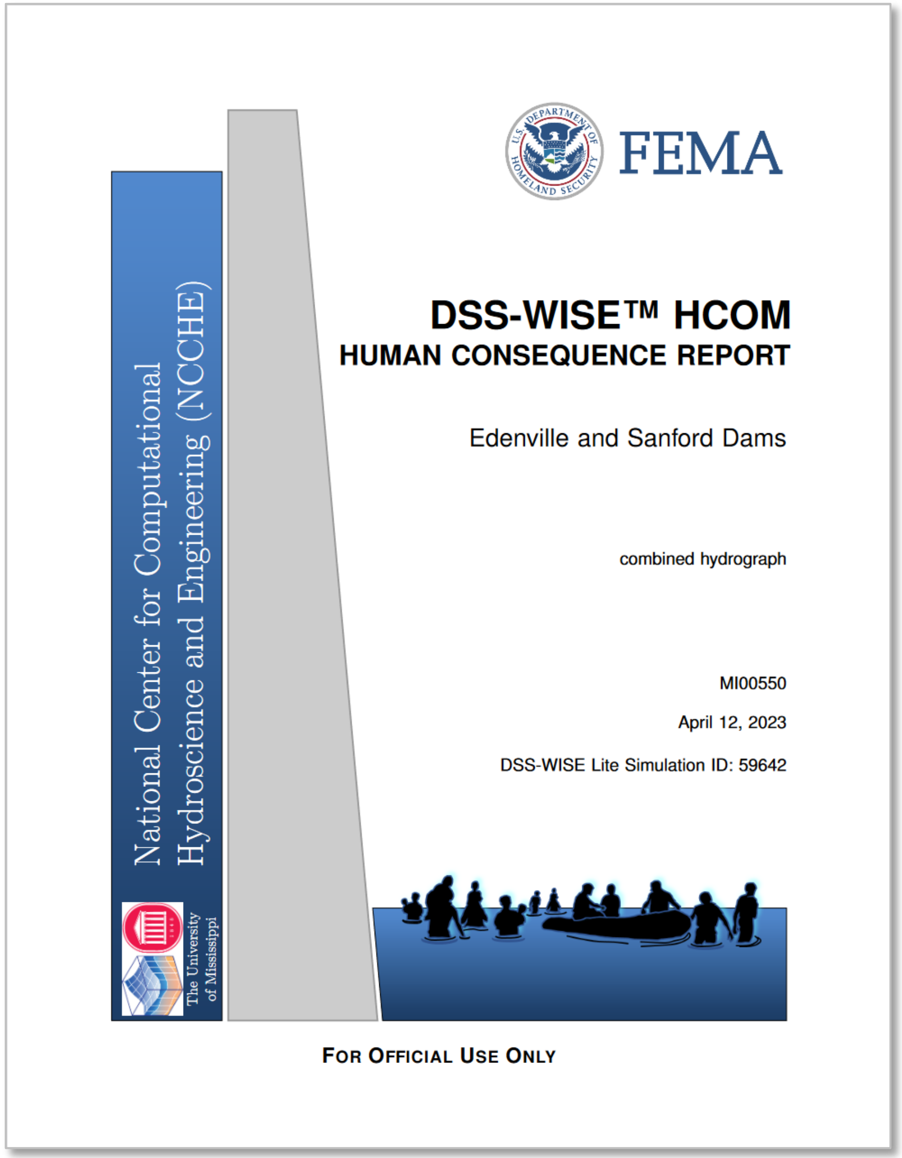


DSS-WISE Lite Results: Flood arrival time



DSS-WISE HCOM: Human Consequences Module





DSS-WISE™ HCOM
HUMAN CONSEQUENCE REPORT

Edenville and Sanford Dams

combined hydrograph

MI00550

April 12, 2023

DSS-WISE Lite Simulation ID: 59642

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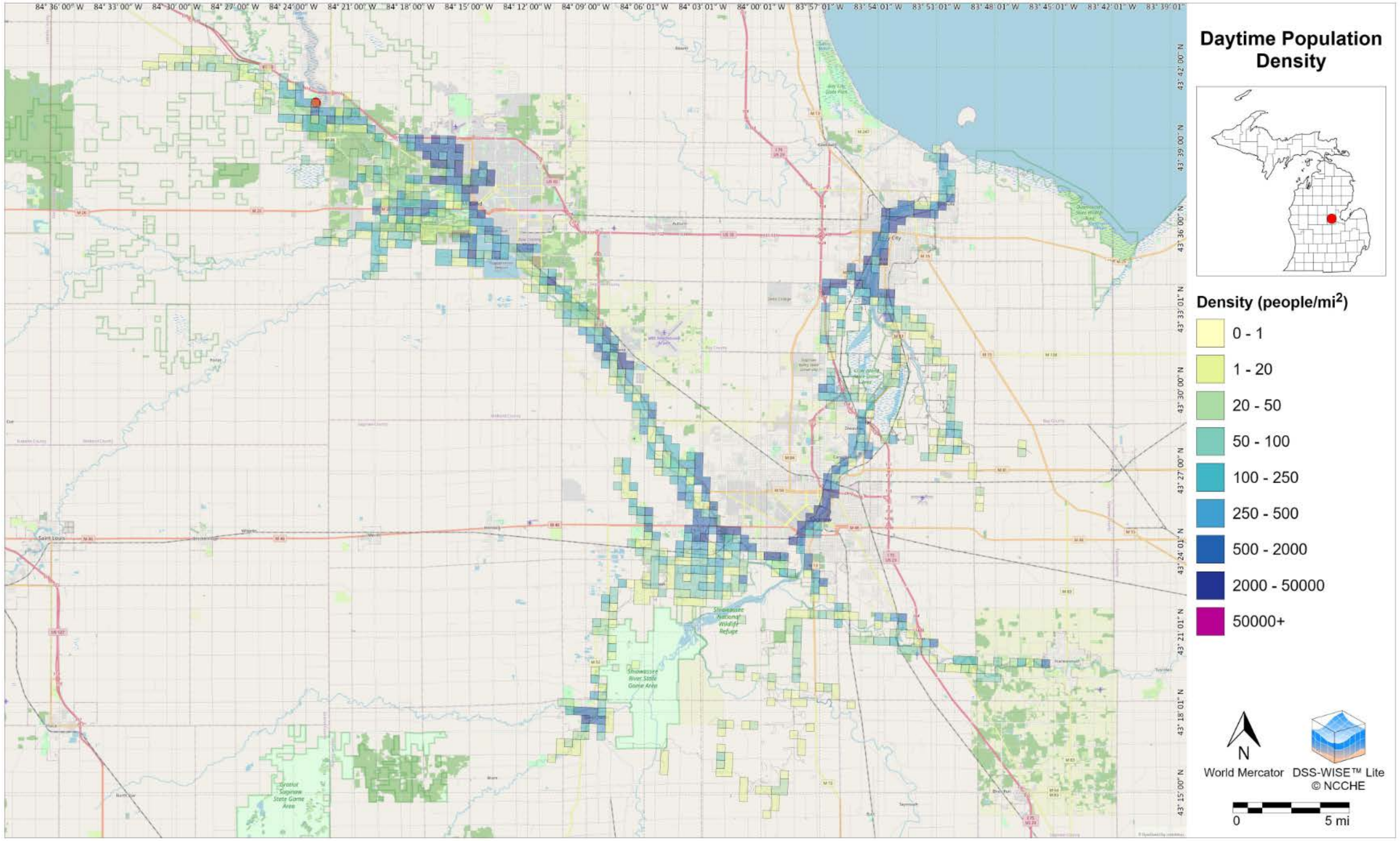
DSS-WISE HCOM Results: Daytime population density (from LandScan USA)

(Daytime PAR)

DSS-WISE HCOM Report

Map 08: Daytime Population Density



Edenville and Sanford Dams
MI00550/59642

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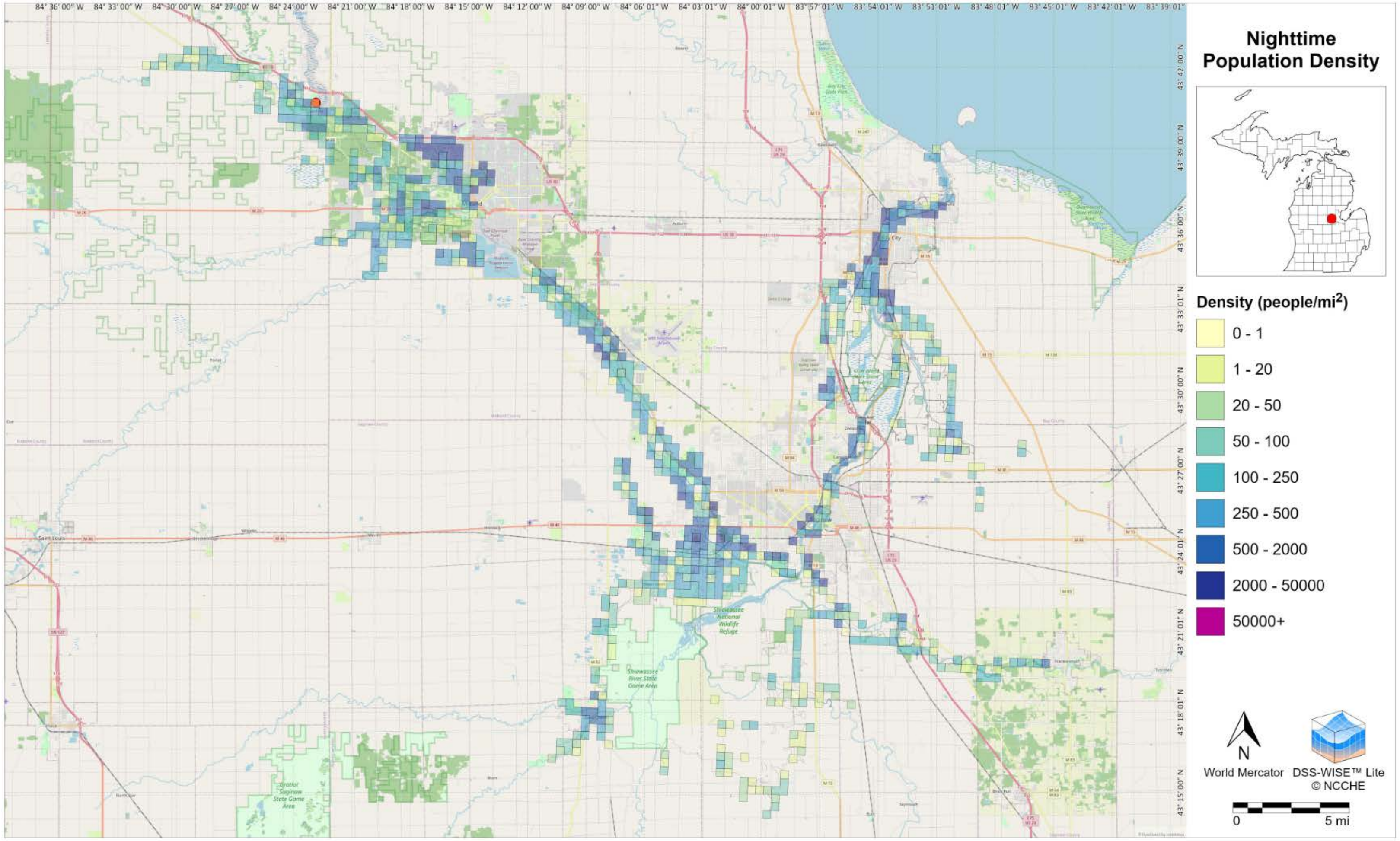
DSS-WISE HCOM Results: Nighttime population density (from LandScan USA)

(Nighttime PAR)

DSS-WISE HCOM Report

Map 07: Nighttime Population Density



Edenville and Sanford Dams
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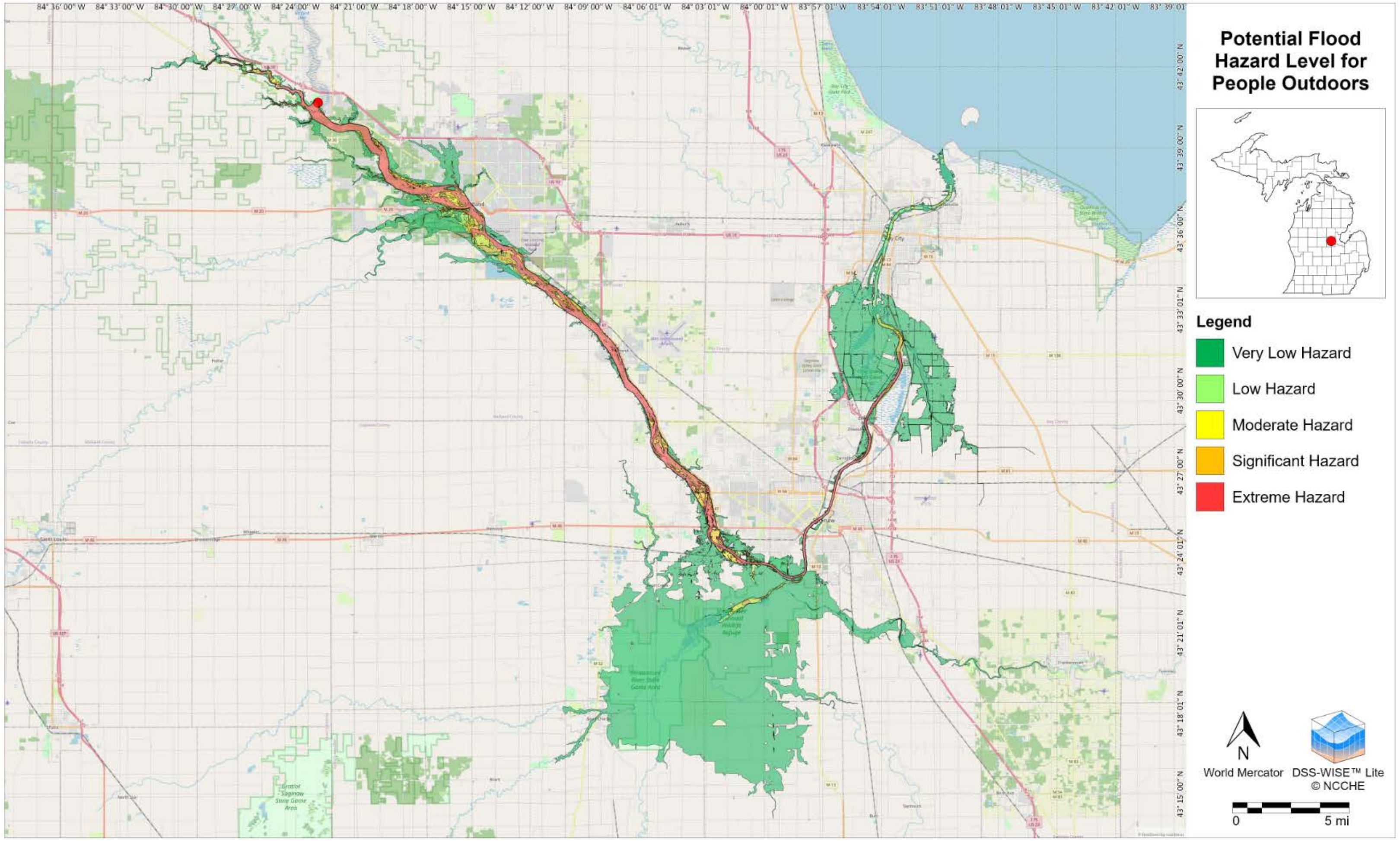
DSS-WISE HCOM Results: Flood hazard level for people outdoors

DSS-WISE HCOM Report

Map 09: Potential Flood Hazard Level for People Outdors



Edenville and Sanford Dams
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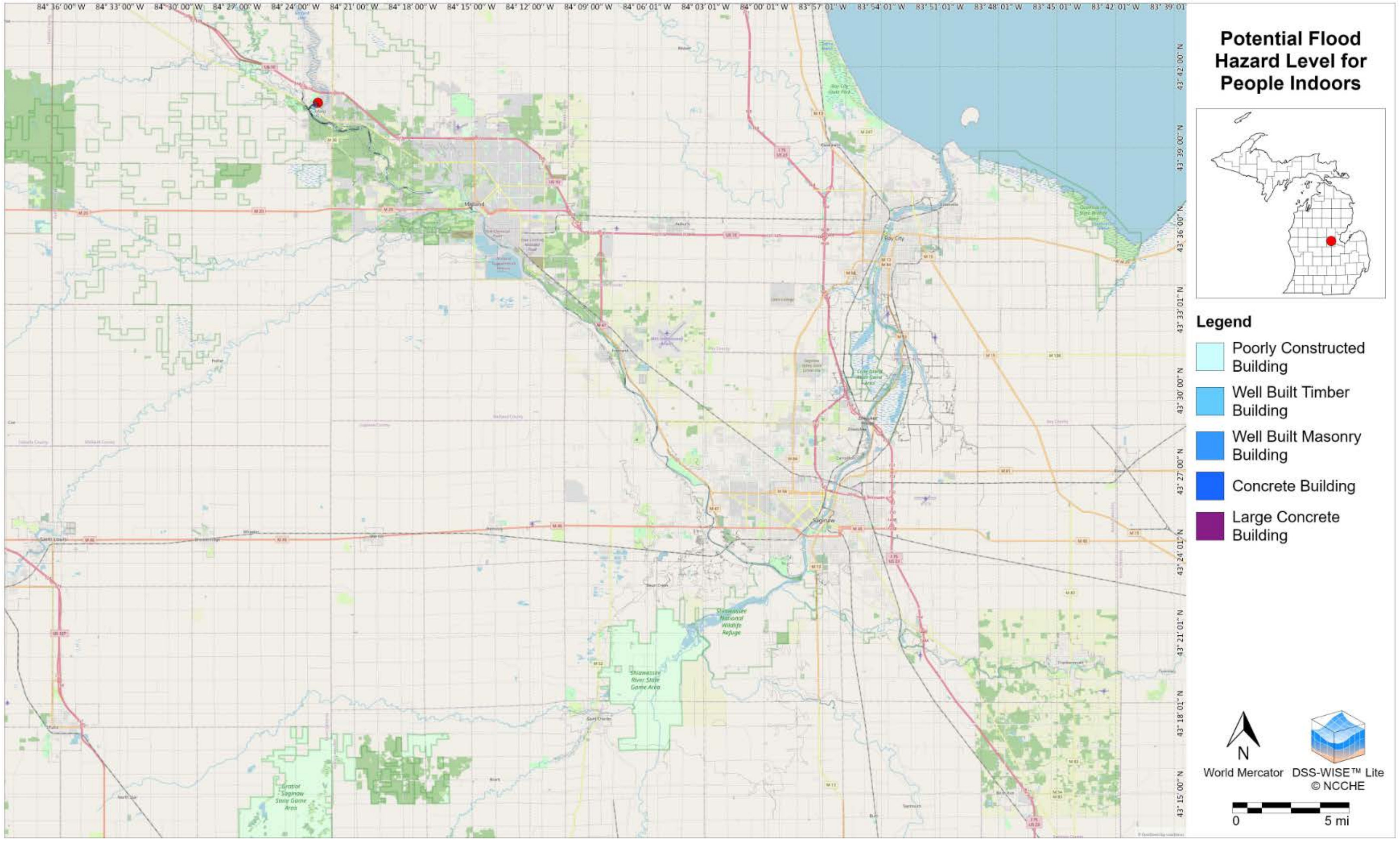
DSS-WISE HCOM Results: Flood hazard level for people indoors

DSS-WISE HCOM Report

Map 10: Potential Flood Hazard Level for People Indoors



Edenville and Sanford Dams
MI00550/59642

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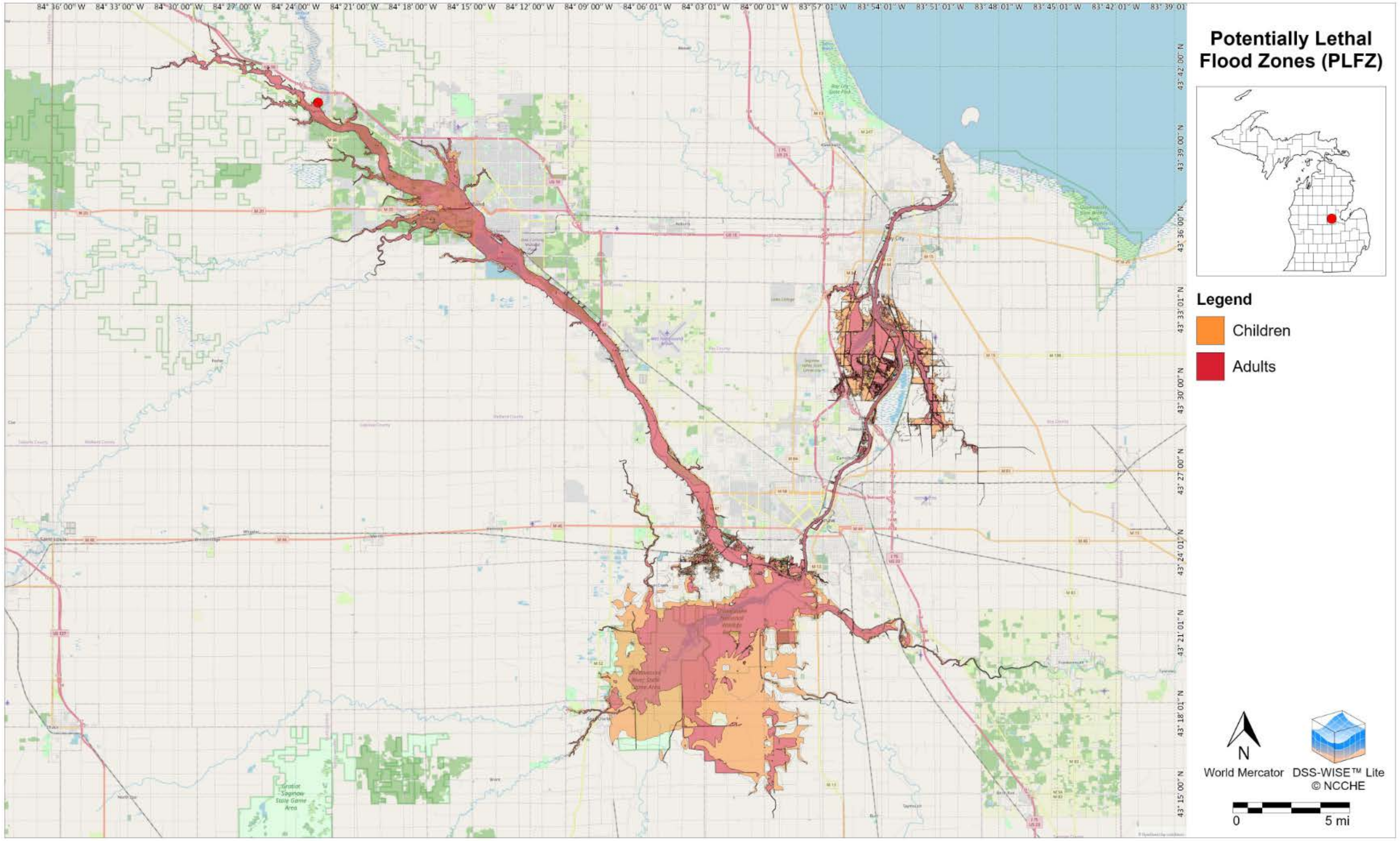
DSS-WISE HCOM Results: Potentially lethal flood zones (PLFZ)

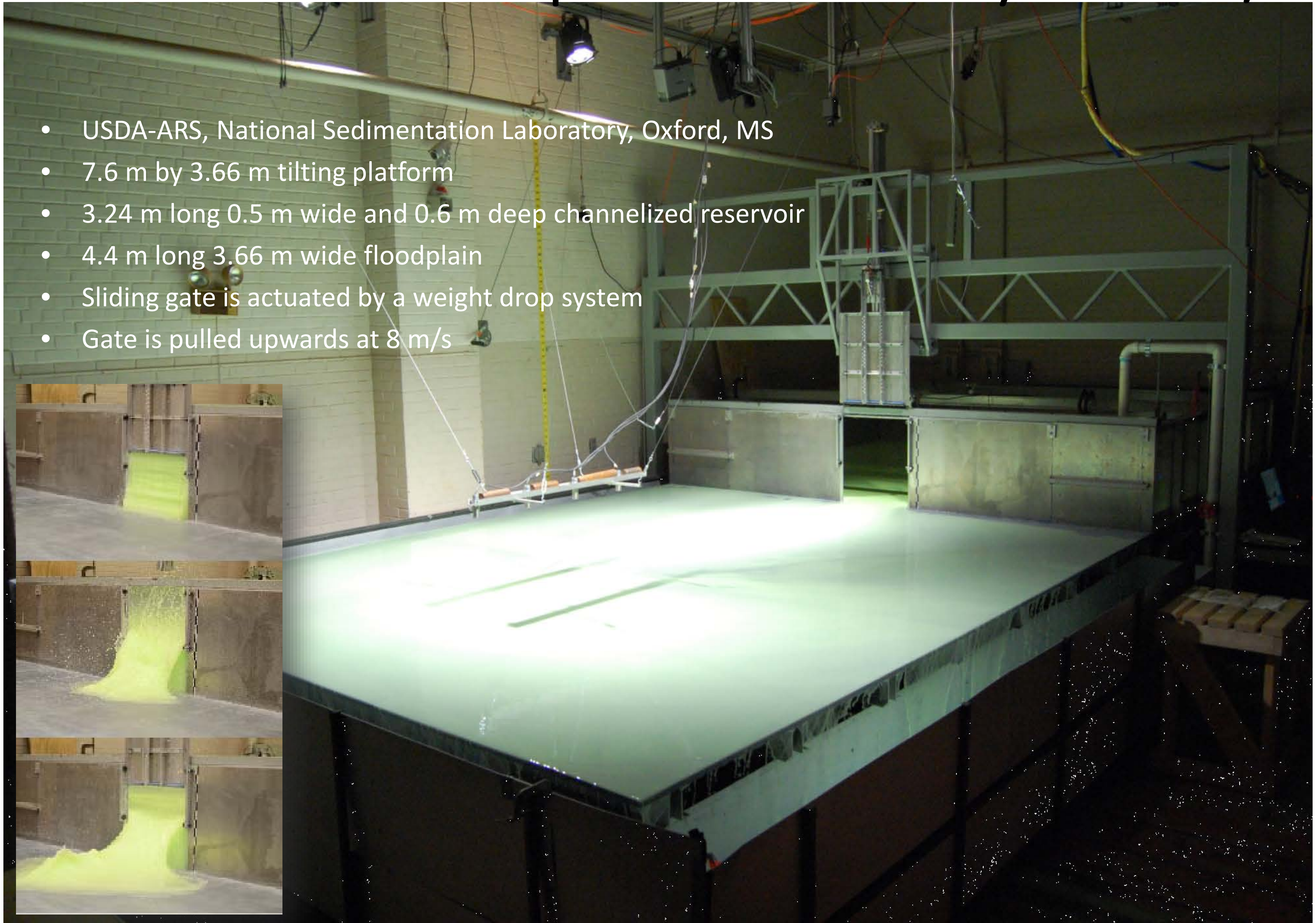
Map 11: Potential Lethal Flood Zones (PLFZ)



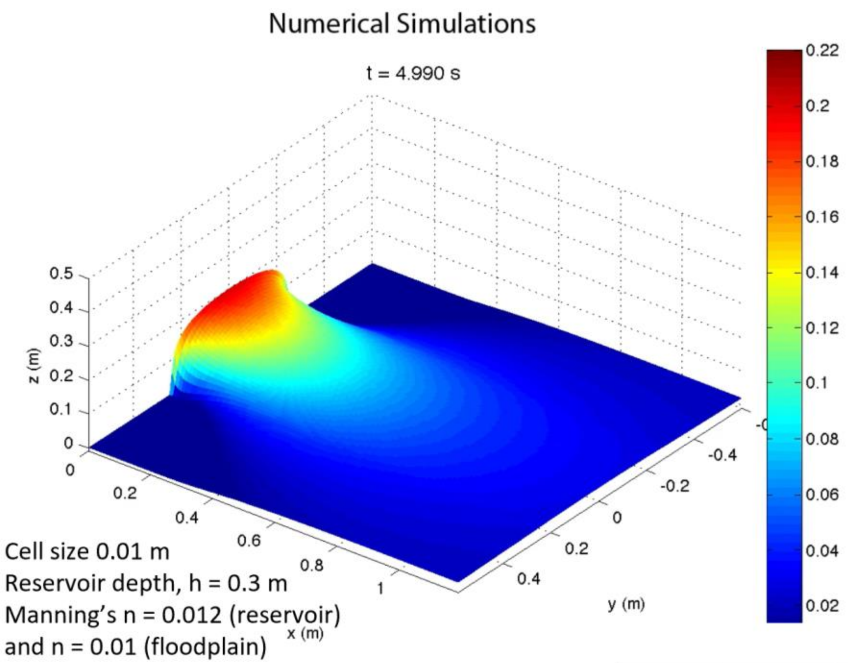
Modeling System Verification/Validation

NCCHE’s Dam-break Experimental Facility at USDA/NSL

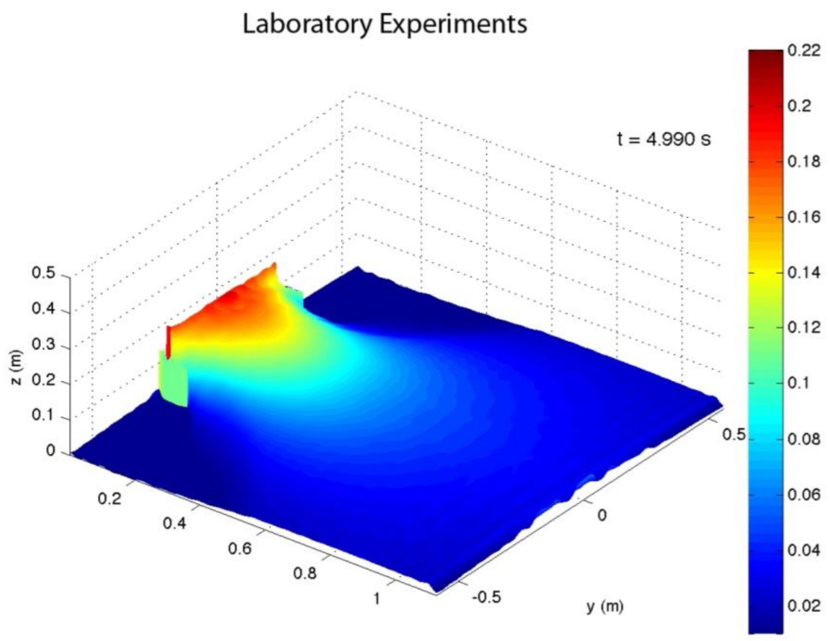
- USDA-ARS, National Sedimentation Laboratory, Oxford, MS
- 7.6 m by 3.66 m tilting platform
- 3.24 m long 0.5 m wide and 0.6 m deep channelized reservoir
- 4.4 m long 3.66 m wide floodplain
- Sliding gate is actuated by a weight drop system
- Gate is pulled upwards at 8 m/s

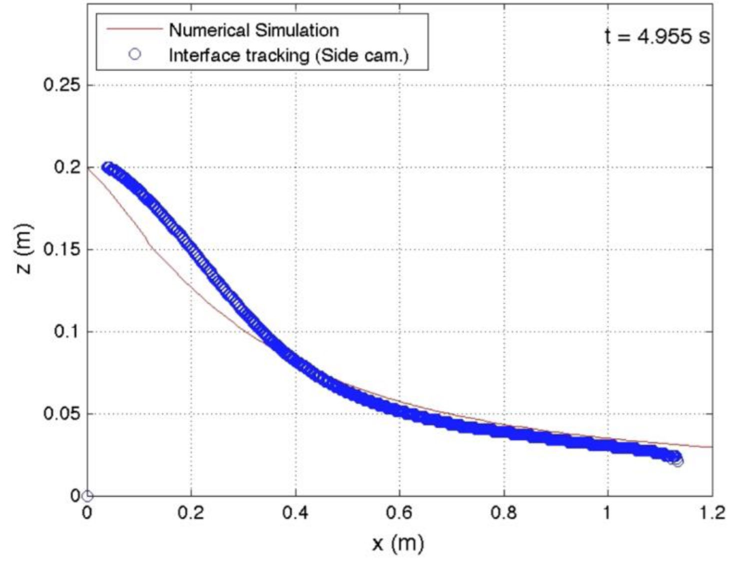


Comparison with DSS-WISE



Cell size 0.01 m
Reservoir depth, h = 0.3 m
Manning's n = 0.012 (reservoir)
and n = 0.01 (floodplain)

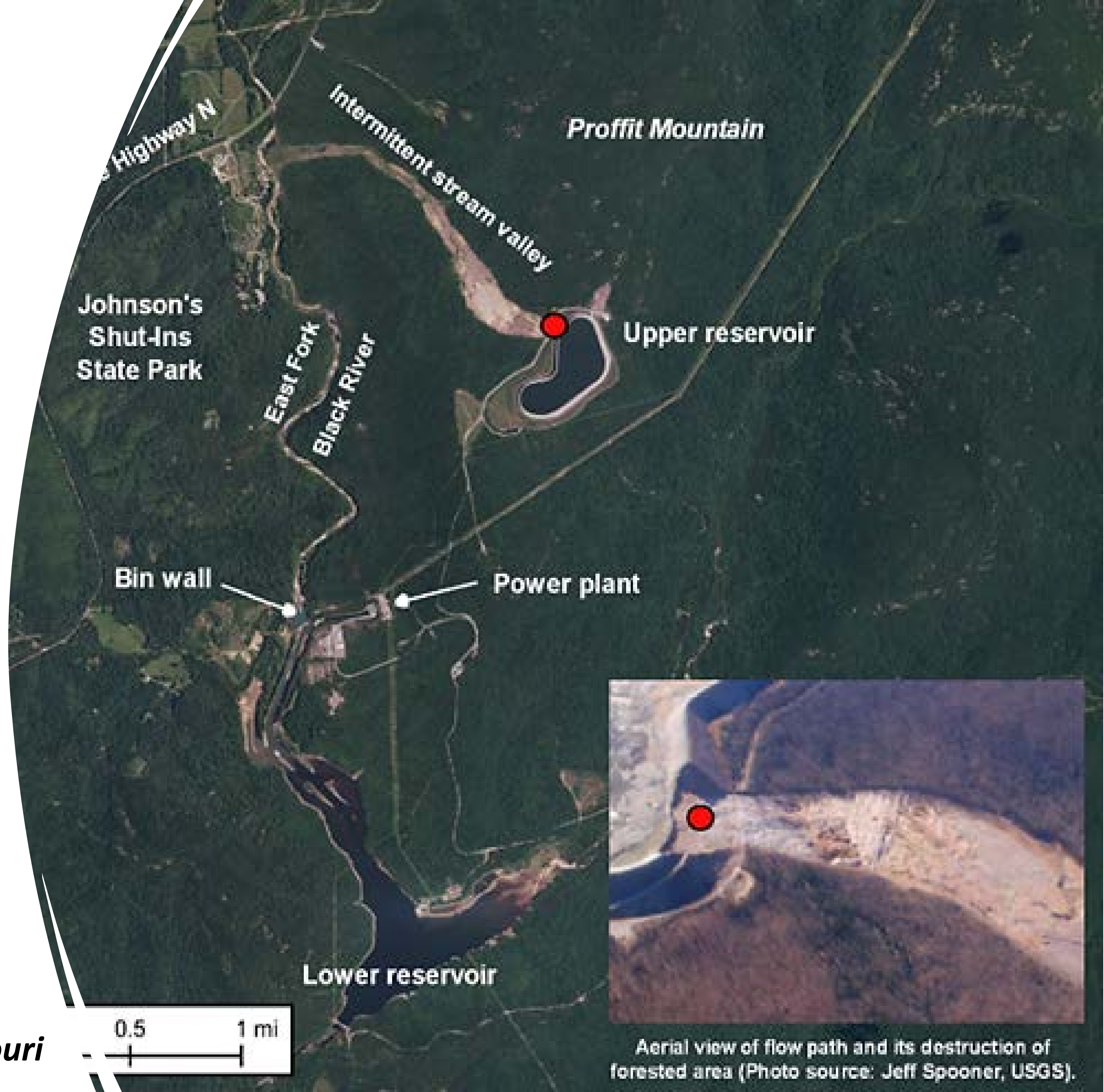




(*Ozeren et al., 2019*)

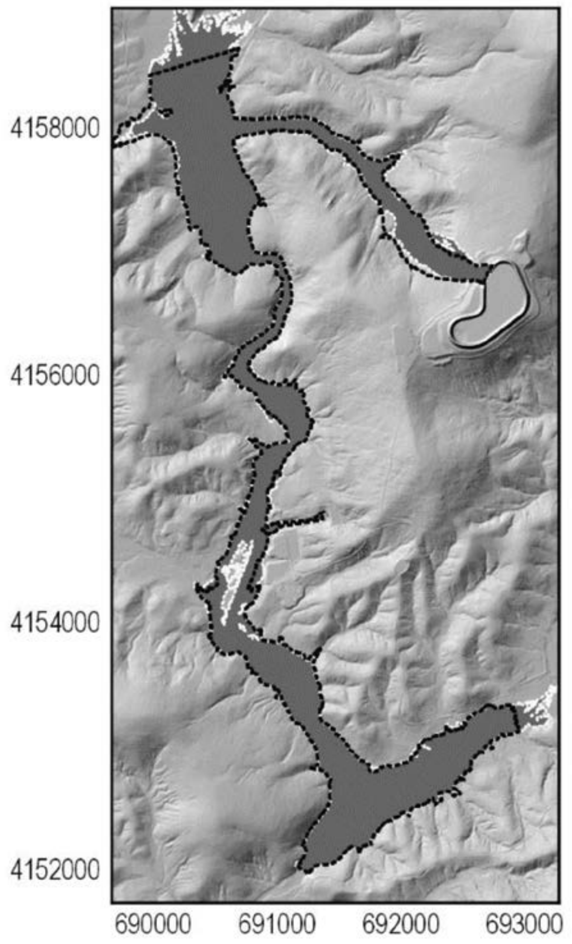
Taum Sauk Dam failure:

- On December 14, 2005, the upper reservoir was overtopped, causing erosion, and breaching the embankment.
- A breach approximately 656 feet wide at the top and 496 feet wide at the base formed, releasing a peak discharge of around 273,000 cubic feet per second.

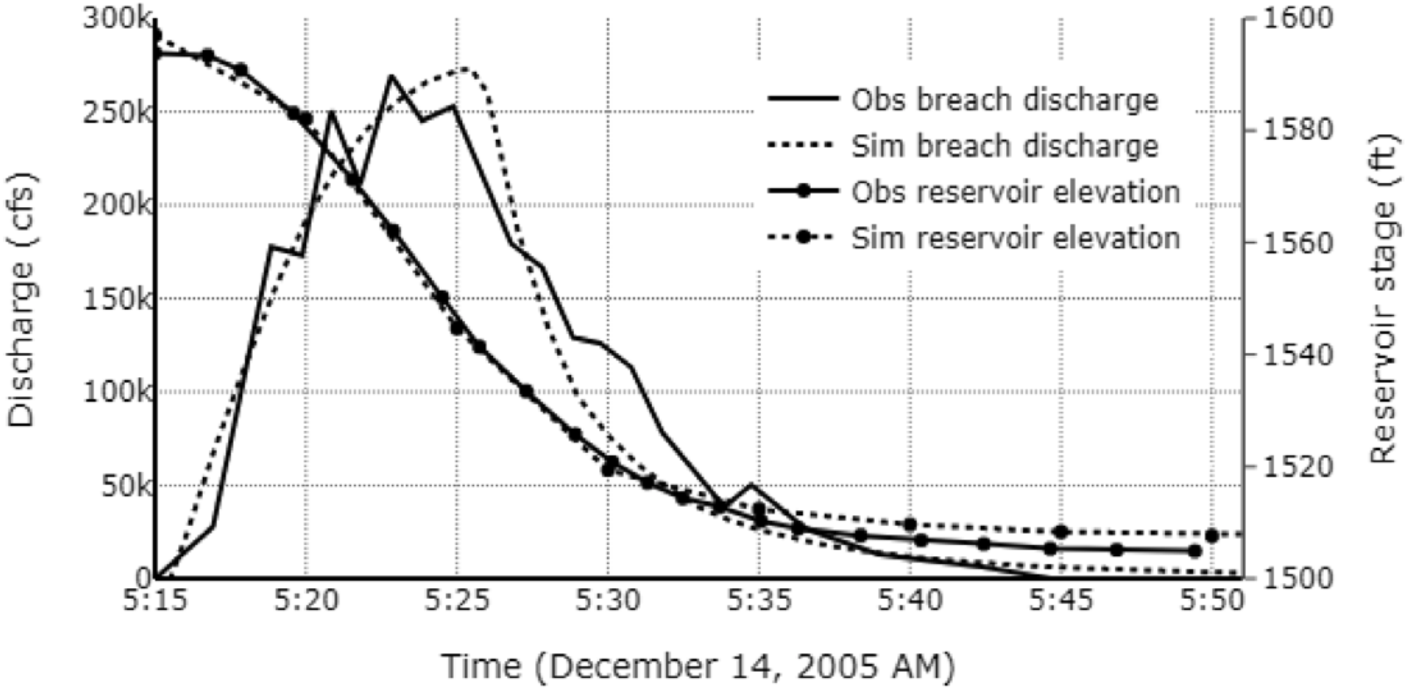


Reynold County, Missouri

Results: Taum Sauk Dam Failure



Comparison of simulated inundation extent (gray fill) with observation for the Taum Sauk Dam Breach.



Simulated and observed breach outflow hydrographs and reservoir stages for Taum Sauk Breach.

(*Pophet et al., 2023*) (*Pophet et al., 2024*)

Overall *F* statistic = 84.1%

*Pophet, N., McGrath, M., Al-Hamdan, M., Smith, P., Inci, G., Demby, J. (2024). A Numerical Study of Historical Dam Failures Using DSS-WISE Lite Web-Based System. *ASDSO Journal of Dam Safety, 21(1)*.

*Pophet, N., McGrath, M., Al-Hamdan, M., Smith, P., Inci, G., Demby, J. (2023). Sensitivity analysis of input parameters to flood characteristics for historical dam failures using DSS-WISE Lite web-based system. *Proceedings of the ASDSO Dam Safety 2023 Annual Conference*, (pp. 1–8).

TABLE 2 TAUM SAUK FLOODED AREA STATISTICAL COMPARISON RESULTS

METRIC	% DSS-WISE LITE	% FLOOD2D-GPU (KALYANAPU ET AL., 2011)	% FIT2D (JUDI, 2009)
F	84.1	75.1	76.3
Commission	12.2	15.3	16.6
Omission	4.7	13.1	9.5

(*Pophet et al., 2023*) (*Pophet et al., 2024*)

*Pophet, N., McGrath, M., Al-Hamdan, M., Smith, P., Inci, G., Demby, J. (2024). A Numerical Study of Historical Dam Failures Using DSS-WISE Lite Web-Based System. *ASDSO Journal of Dam Safety*. 21(1).

*Pophet, N., McGrath, M., Al-Hamdan, M., Smith, P., Inci, G., Demby, J. (2023). Sensitivity analysis of input parameters to flood characteristics for historical dam failures using DSS-WISE Lite web-based system. *Proceedings of the ASDSO Dam Safety 2023 Annual Conference*, (pp. 1–8).

Figure 2 Edenville and Sanford Dam Locations and Images of (a) Edenville Dam Breach (*Coleman, 2020*), (b) Edenville Dam After the Failure (*Google Earth, 2022*), (c) the Fuse Plug Spillway of Sanford Dam Being Overtopped (*CFI Media (Checkered Flag Interactive Media), 2020*), and (d) the Entire Embankment of Sanford Dam Being Overtopped (Michigan Drone Services)

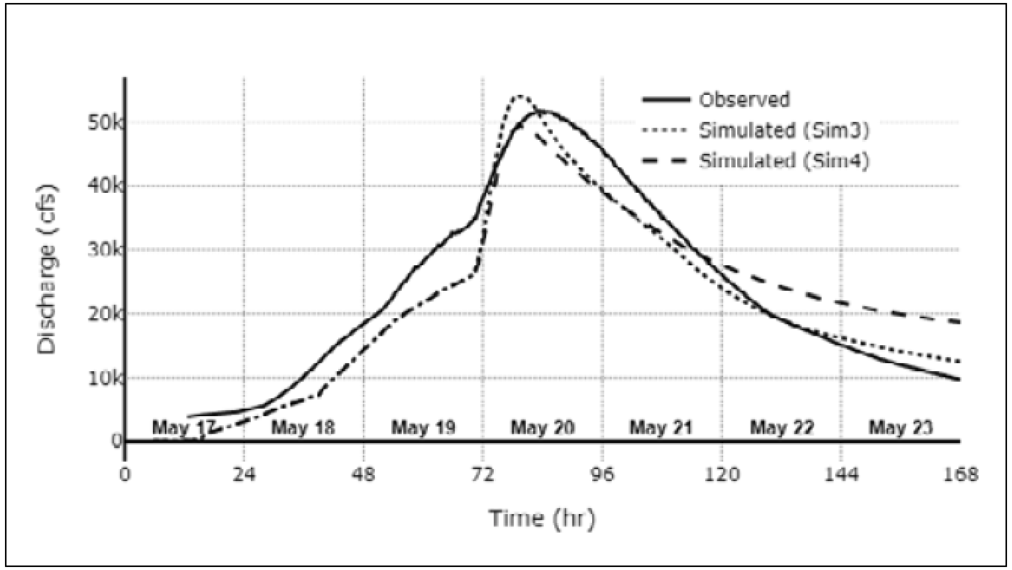
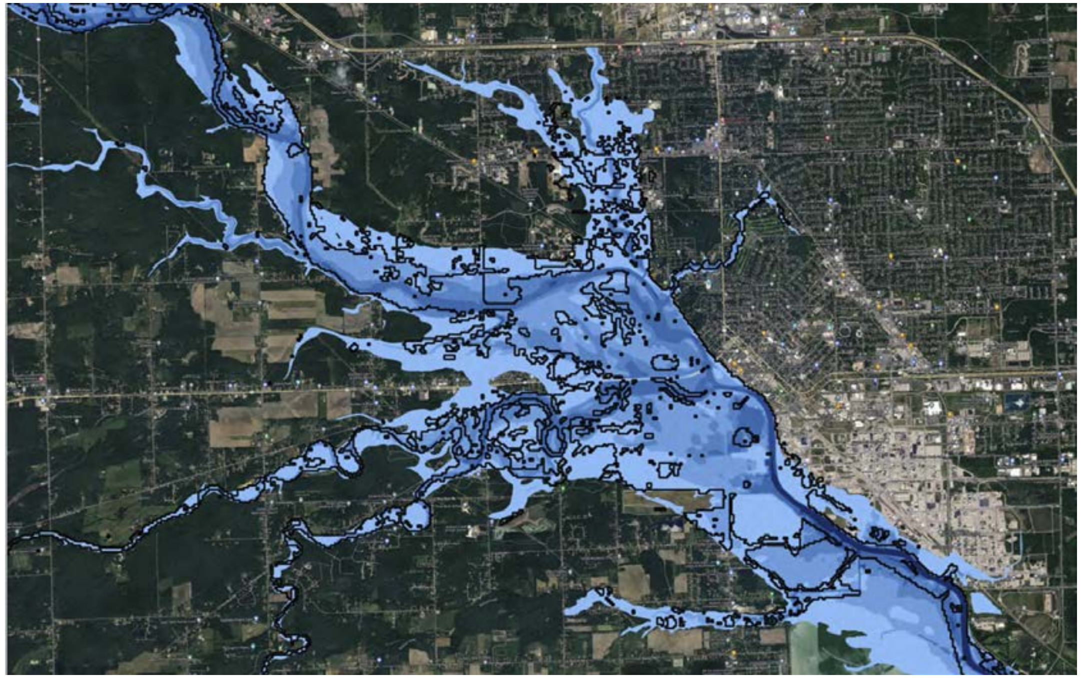
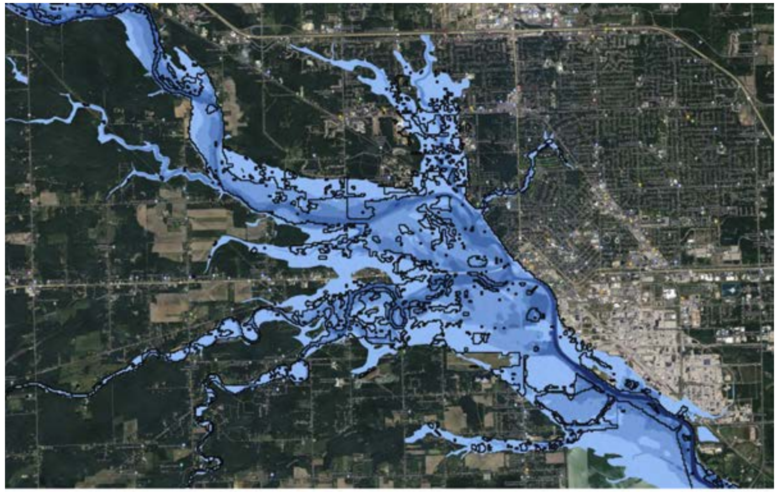


Figure 6 Simulated and Observed Discharge Hydrographs at the USGS Gage Station 04156000 Tittabawassee River at Midland, MI



Pophet, N., McGrath, M., Al-Hamdan, M., Smith, P., Inci, G., Demby, J. (2024). A Numerical Study of Historical Dam Failures Using DSS-WISE Lite Web-Based System. *ASDSO Journal of Dam Safety*. 21(1).



A Numerical Study of Historical Dam Failures Using DSS-WISE Lite Web-Based System

Nuttita Pophet, PhD | Marcus McGrath, MS | Mohammad Al-Hamdan, PhD
Paul Smith | Gokhan Inci, PhD, P.E. | James Demby

ABSTRACT

In the context of dam safety, understanding past dam failures through numerical modeling holds significant importance. This not only helps unravel the complexities and consequences of historical incidents but also plays a crucial role in enhancing our preparedness for potential future events. This study used the Decision Support System for Water Infrastructural Security Lite (DSS-WISE™ Lite) web-based system to investigate two historical dam breach incidents: the 2005 Taum Sauk Upper Dam failure and the 2020 Edenville Dam and Sanford Dam failure. The numerical simulations were conducted using two-dimensional modeling techniques, considering distinct scenarios for each incident. For the Taum Sauk Upper Dam failure case, simulations were performed for a sunny-day scenario, focusing on the breach of only the upstream dam in a two-dam series. The results showed a high level of agreement between the simulated and observed inundation extents, with an overall F statistic value of 84.1%. In the case of the Edenville Dam and Sanford Dam failure, simulations were executed for a wet-day scenario involving cascading failures of two dams. The cascading characteristic is currently not supported by the DSS-WISE Lite web-based version due to its restriction to breaching only one structure per simulation. To address this limitation, two approaches were employed to study the 2020 Edenville Dam and Sanford Dam cascading failure case. The first approach

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Nuttita Pophet is a post-doctoral research associate at NCCHE. Her expertise spans numerical modeling of tsunami wave propagation, wind-generated random sea phenomena, wave breaking in deep ocean waters, and dam-break flows of grain-water mixtures. During her time at NCCHE, she has contributed to multiple projects, including the Decision Support System for Water Infrastructural Security (DSS-WISE), focused on flood simulation, and the Web-Based Agricultural Integrated Management System (AIMS), aimed at watershed management. She has significant experience in hydraulic and hydrologic modeling.

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Marcus earned his BS and MS at the University of Mississippi. During his time at the National Center for Computational Hydroscience and Engineering at the university, he has worked on numerous projects in the field of dam and flood safety, resilience, hazard mitigation, and numerical flood model development. He is the lead developer and technical administrator of DSS-WISE Web, a web-based, automated, dam-break flood inundation modeling and mapping system supported by FEMA and DHS S&T.

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Paul Smith earned his BSc in computer science at the University of Mississippi in 1998. He joined NCCHE in May 1999 as a computing facilities specialist and was appointed to coordinator of computing facility operations in January 2001. His current research interests include parallel hardware systems (GPGPU), SMP and load-balancing systems, Linux networking, and network penetration testing. Throughout his time at NCCHE, Mr. Smith has also worked on various projects as DevOps engineer and systems programmer. These projects include the DSS-WISE (Decision Support System for Water Infrastructural Security) Web system, as well as the AIMS (Agricultural Integrated Management System) project.

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Dr. Inci is a graduate of Bosporus University (BS), University of New South Wales (BEngSc), and Wayne State University (PhD). His major was in civil engineering, and he specializes in dams and other infrastructure. After 15 years of practice in industry analyzing, inspecting, or designing more than 70 water and waste retaining dams, including large international projects, he joined FEMA. He is contributing to the success of the program as an emergency manager, contracting officer representative, research lead, and subject matter expert.

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ASDSO Peer Reviewers

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"While HEC-RAS and DSS-WISE Lite employ different numerical schemes and computational methods, …results are very similar."

"…DSS-WISE Lite is the model of choice for fast run time, ease of use, and low computational demand…"

-Dr. Danielle Salt

Salt, D. V. (2019). A comparison of HEC-RAS and DSS-WISE Lite 2D hydraulic models for a Rancho Cielito Dam breach. California State University: Sacramento, CA, USA.

Current System Developments for the Upcoming DSS-WISE 4.0

- **Levee-break module** with ability to estimate levee breach hydrograph.
- Ability to utilize a **hybrid cloud solution** for DSS-WISE Web simulations.
- Ability to submit **high-priority simulations** that run on the fastest available compute nodes.
- Integrating **updated USGS 3D Elevation Program's (3DEP)** 1-meter DEM dataset.
- Ability to model **cascading dam failures**.
- Ability to **load the results of a previous simulation** on the Viewer during setup.
- Ability for users to **upload their own GIS overlay data** onto the Viewer during simulation setup.
- **User-supplied inflow hydrographs** for wet-day scenarios, Integration of **USGS stream gauge data**.
- Enhancement of **the way simulations model culverts**.
- Improving **map image outputs** for PDF report for **increased spatial awareness and fidelity**.
- Adding **Potential Loss of Life estimations** to HCOM.