MODELING OF THE MAY 2020 MICHIGAN DAM BREACHES

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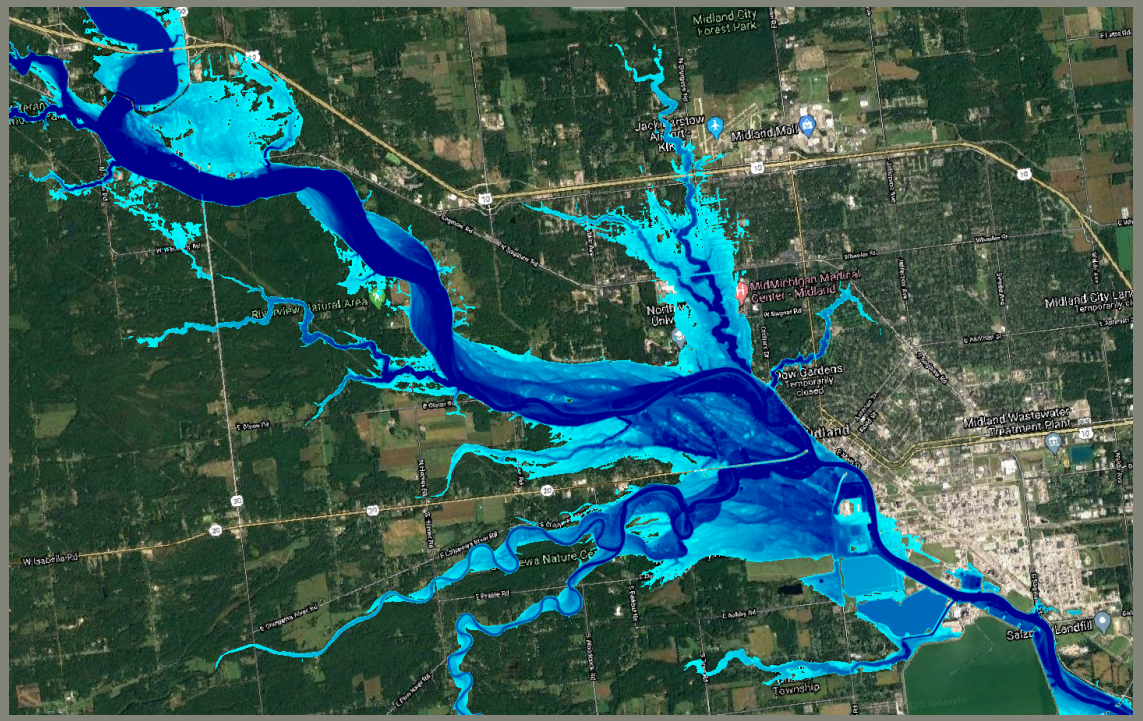
Modeling | Mapping | Consequences



Prepared by:

Ed Stowasser

February 24, 2021

US Army Corps of Engineers

U.S.ARMY

TOPICS

- What is the MMC?
- Background
  - MMC-FIM Cadre Support Role
  - Event Description
- MMC Modeling Effort
  - Data Collection
  - Model Setup & Assumptions
  - Timeline
  - Results (Mapping & Consequences)
- Questions?

MODELING, MAPPING, AND CONSEQUENCE PRODUCTION CENTER

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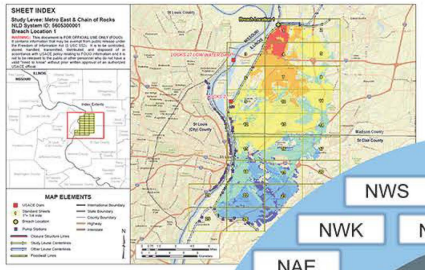
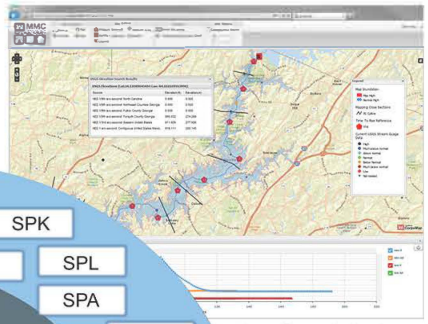
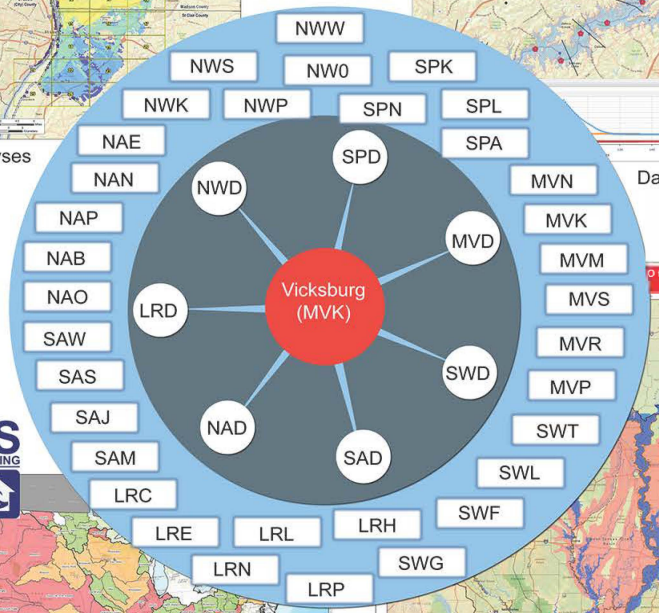


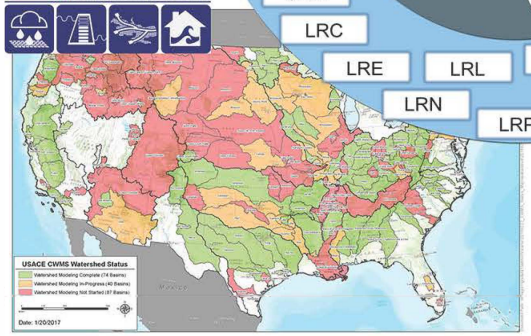
Levee Breach Analyses



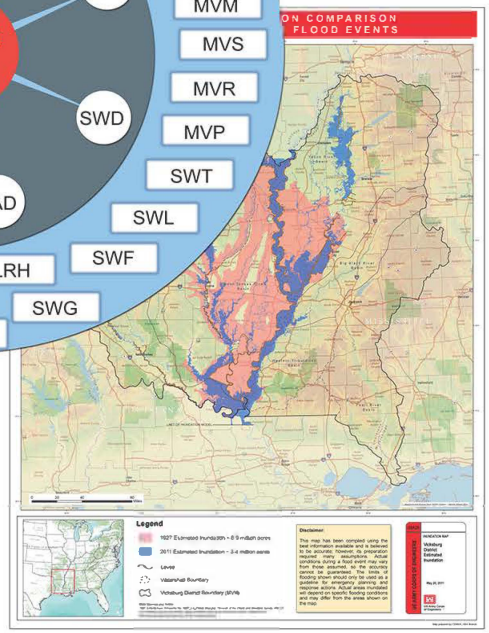
Dam Breach Analyses



CWMS WATERSHED MODELING



Watershed Modeling Status map



Flood Inundation Mapping

Mission

- Conducting hydraulic modeling, consequence assessments, inundation mapping and study reports for USACE projects and flood events
- Implementing Corps Water Management System (CWMS) models for select projects and flood events
- Updating the National Levee Database (NLD) with FEMA data and performing additional system enhancements
- Assisting CIPR with populating the DHS DSAT database
- Providing Flood Inundation Modeling Cadre during significant flood events

* (see ER 10-1-54)

Staff

- Virtual workforce of approximately 278 Hydraulic Engineers, Economists, & GIS professionals from 34 USACE Districts

Products

- Hydraulic Models (HEC-RAS, HEC-HMS, HEC-ResSim) that are geo-referenced
- Emergency action plan map books
- Google Earth animation files
- CorpMaps national database map layers
- Inundation map plots for briefings
- Levee breach contingency maps
- Consequence estimates of potential life loss, population at risk, impacted structures & damage values

Benefits

- Consistent, scalable, and cost effective models, maps, and consequence estimates for all USACE projects
- Comprehensive, reliable mapping products meeting a wide range of objectives
- Advance the technical competency of modeling, mapping, and consequence capabilities across USACE

Founded 1873 Vicksburg District of the Mississippi Valley Division

Value to the Nation

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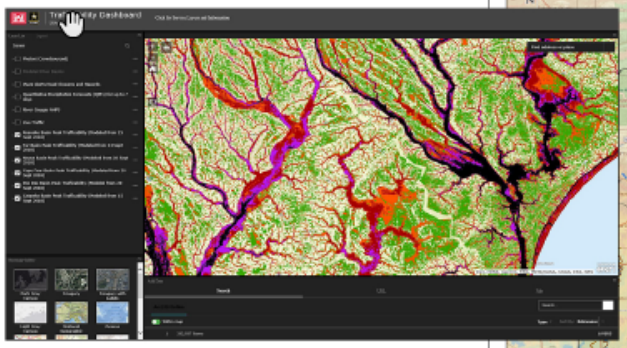
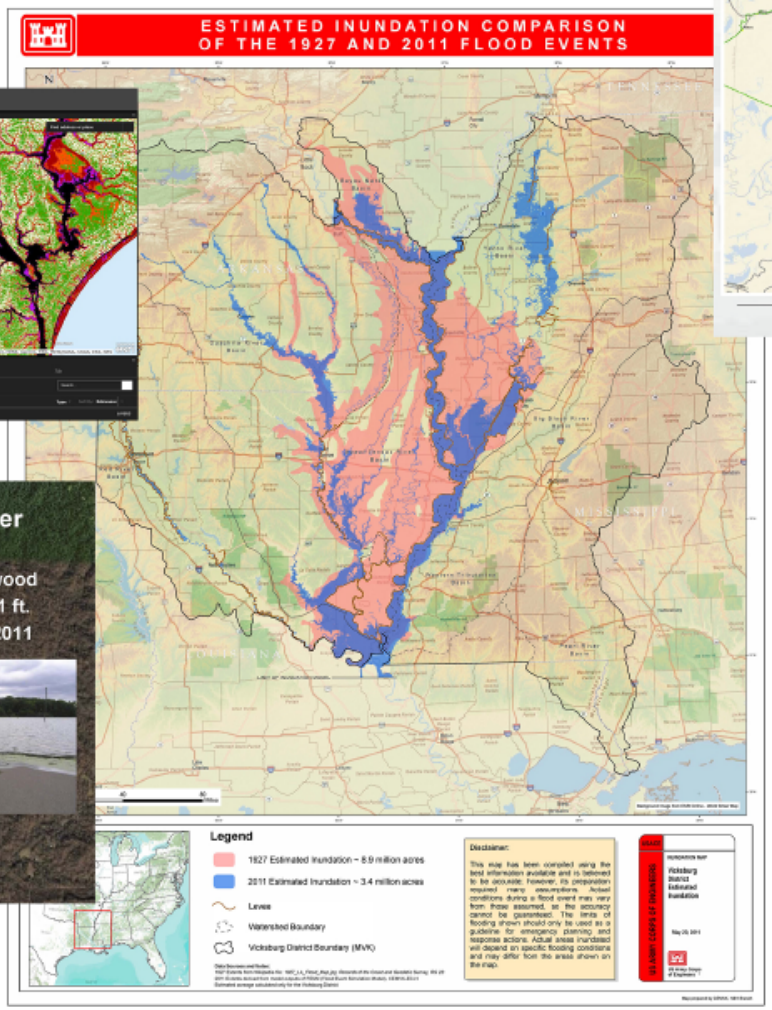
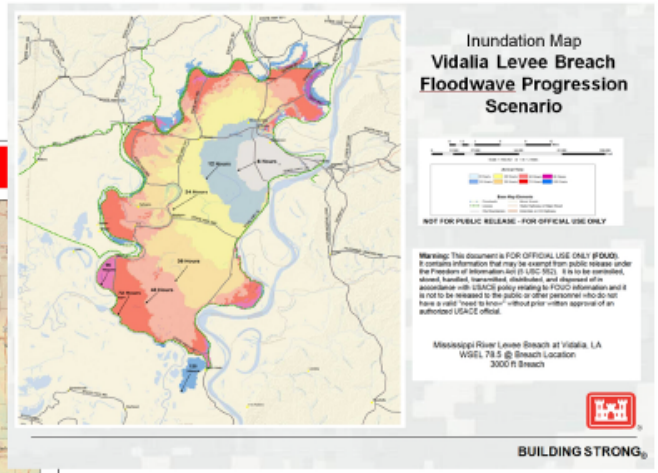
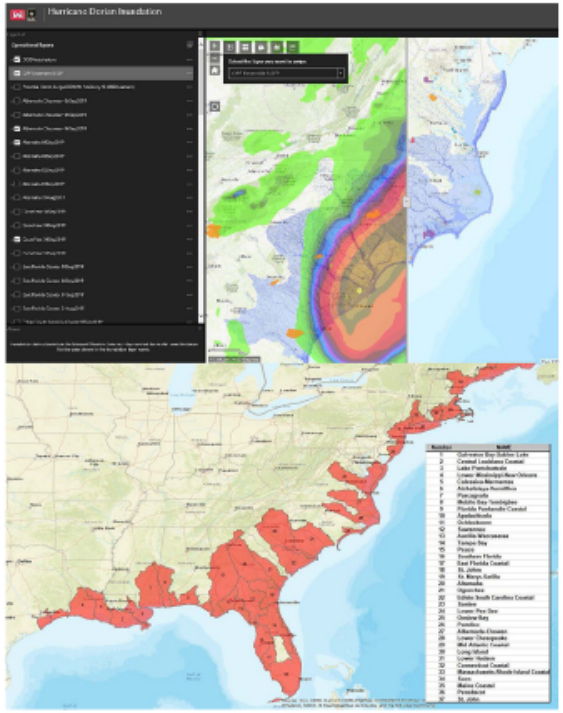
Modeling | Mapping | Consequences

FLOOD INUNDATION MODELING SUPPORT









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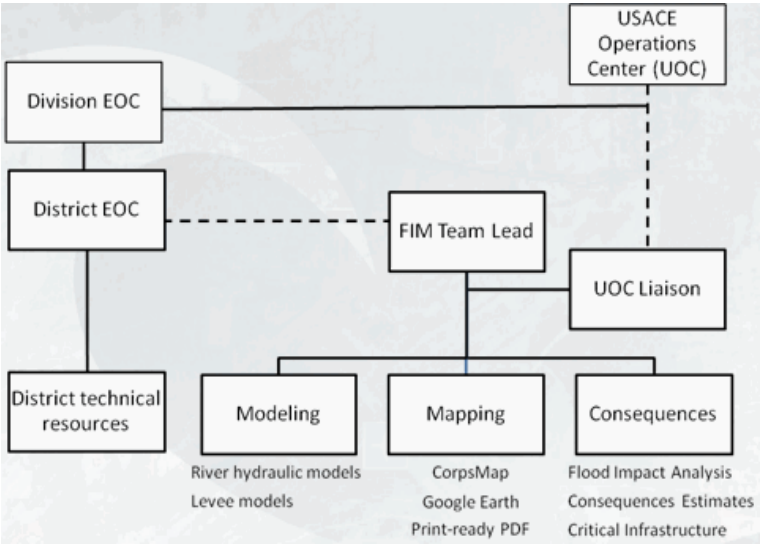
Vicksburg District
FOUNDED 1873

Value to the Nation

FLOOD INUNDATION MODELING (FIM) CADRE

Strategy

- A national team assisting district technical resources and supporting the districts' flood-fighting lead role
- Providing assistance through a national production center while utilizing staff from local districts
- Leveraging existing models from Corps Water Management System (CWMS), District H&H & other agencies
- In the future, establishing full CWMS flood inundation modeling teams at each USACE Division
- Leveraging available flood inundation mapping from NOAA, USGS, and other sources
- Enhancing flood risk information sharing and availability during significant flood events



Innovations

- National coverage and response teams
- Consistent, cost-effective, quality USACE flood inundation products
- Dynamic flood inundation modeling
- Advancements in the state of practice for national flood risk communication
- Heightened awareness of flood risks
- Same-day river stage forecast updates
- Recognition of USACE as a technical leader in the field of flood inundation modeling

Key Products

- Inundation maps in CorpsMap & Google Earth
- Print-ready maps for briefings
- Levee overtopping/breaching maps (*includes flood depths and arrival times*)

Current Activation: Providing technical assistance to Texas, Memphis, New Orleans, and Vicksburg

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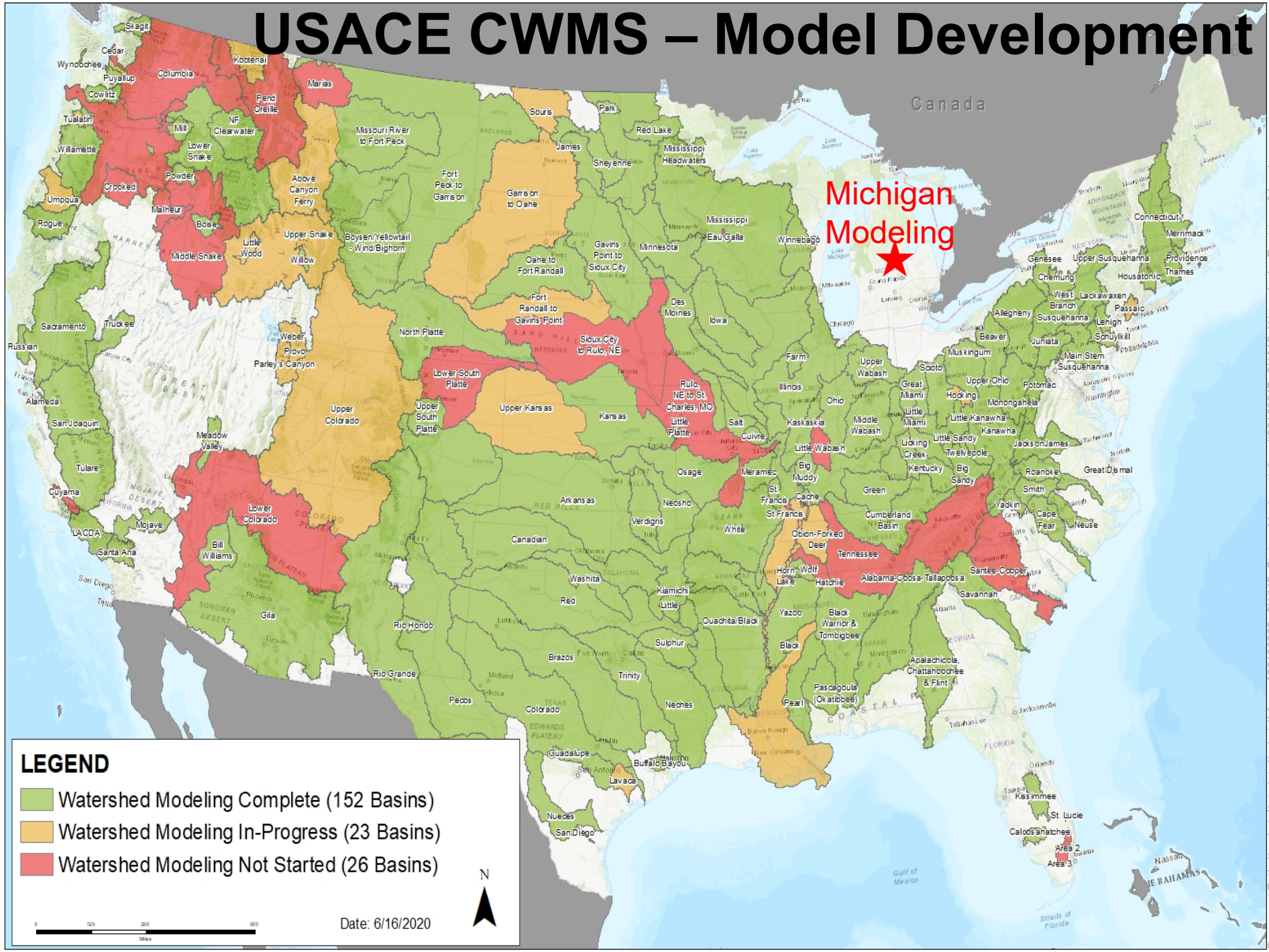
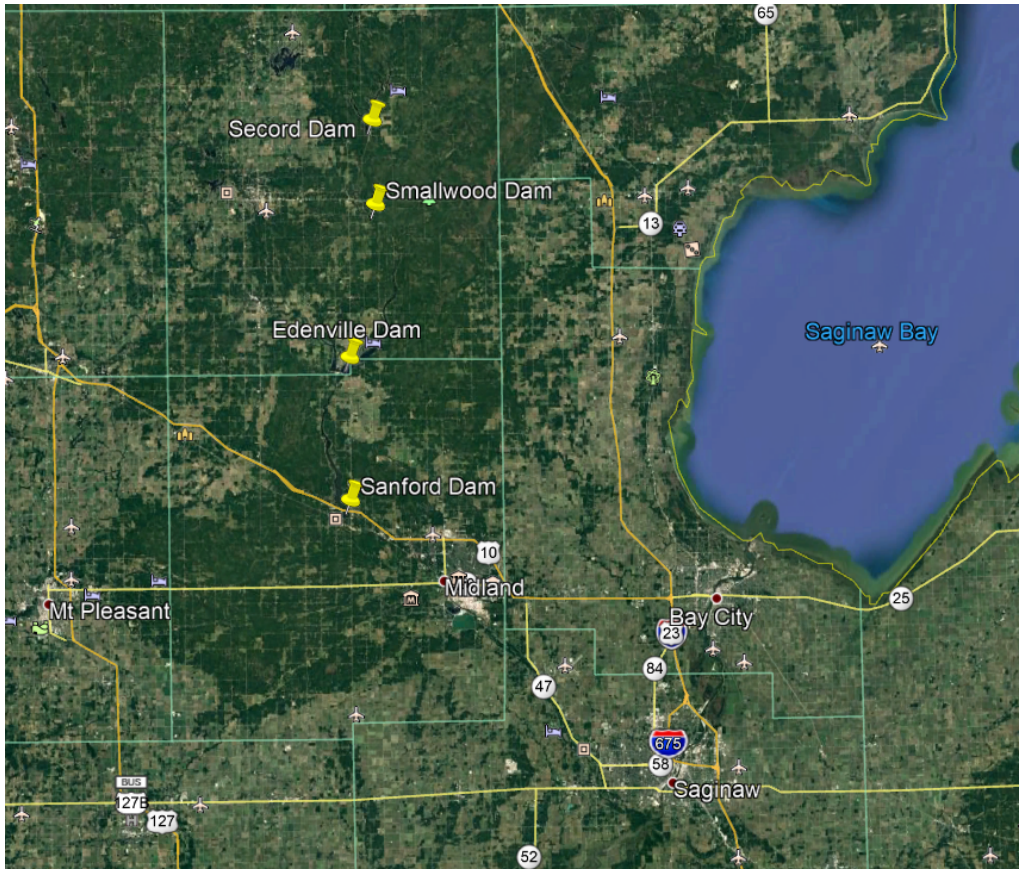
USACE CWMS – Model Development



BACKGROUND – MAY 2020 EVENT

- Not federally owned dams
  - Privately owned structures
  - FERC oversight for hydro power structures
  - State oversight
- MMC Modeling was conducted within 24hrs to establish cursory model.



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PROJECT OVERVIEW AND BACKGROUND

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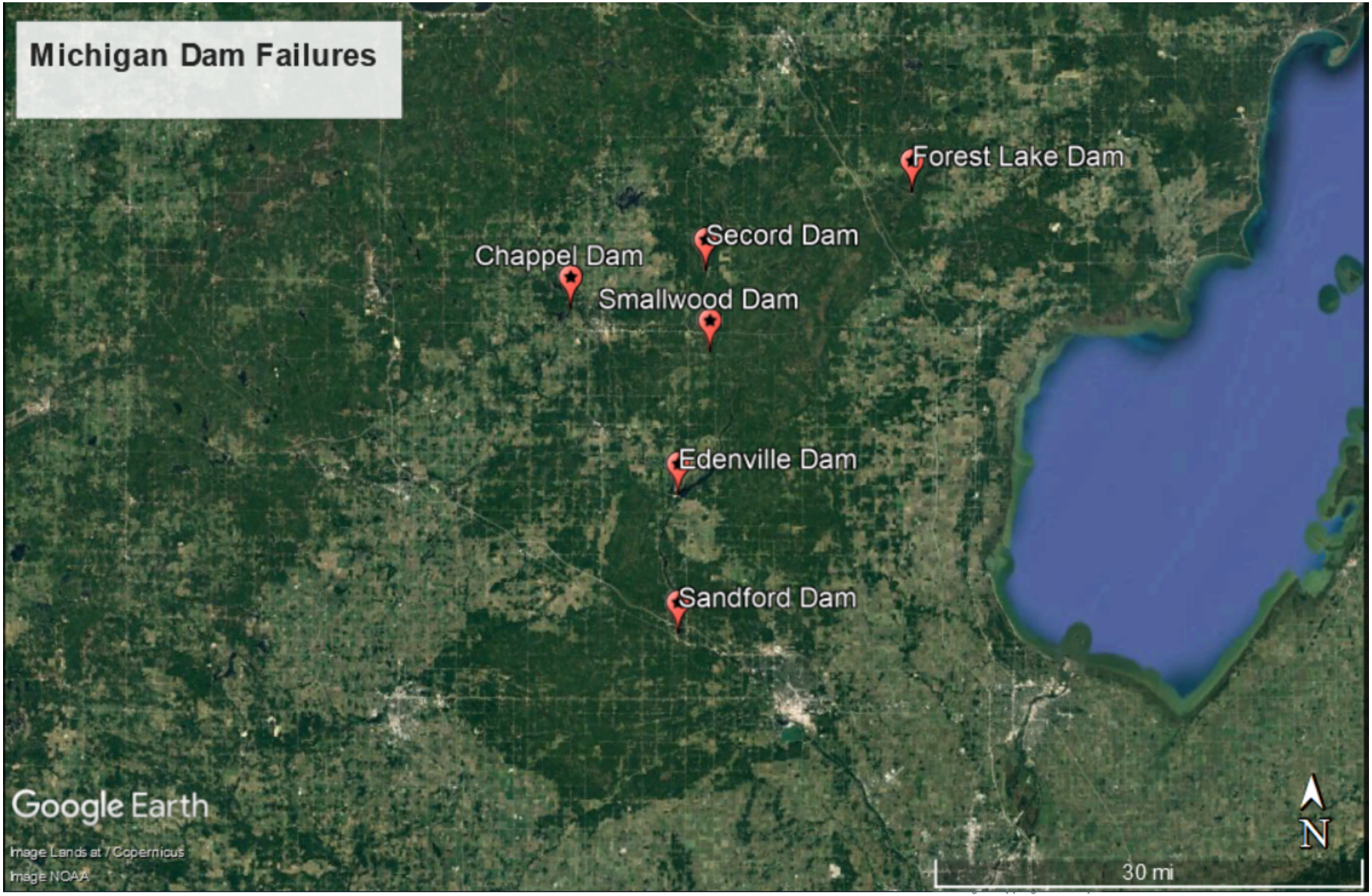
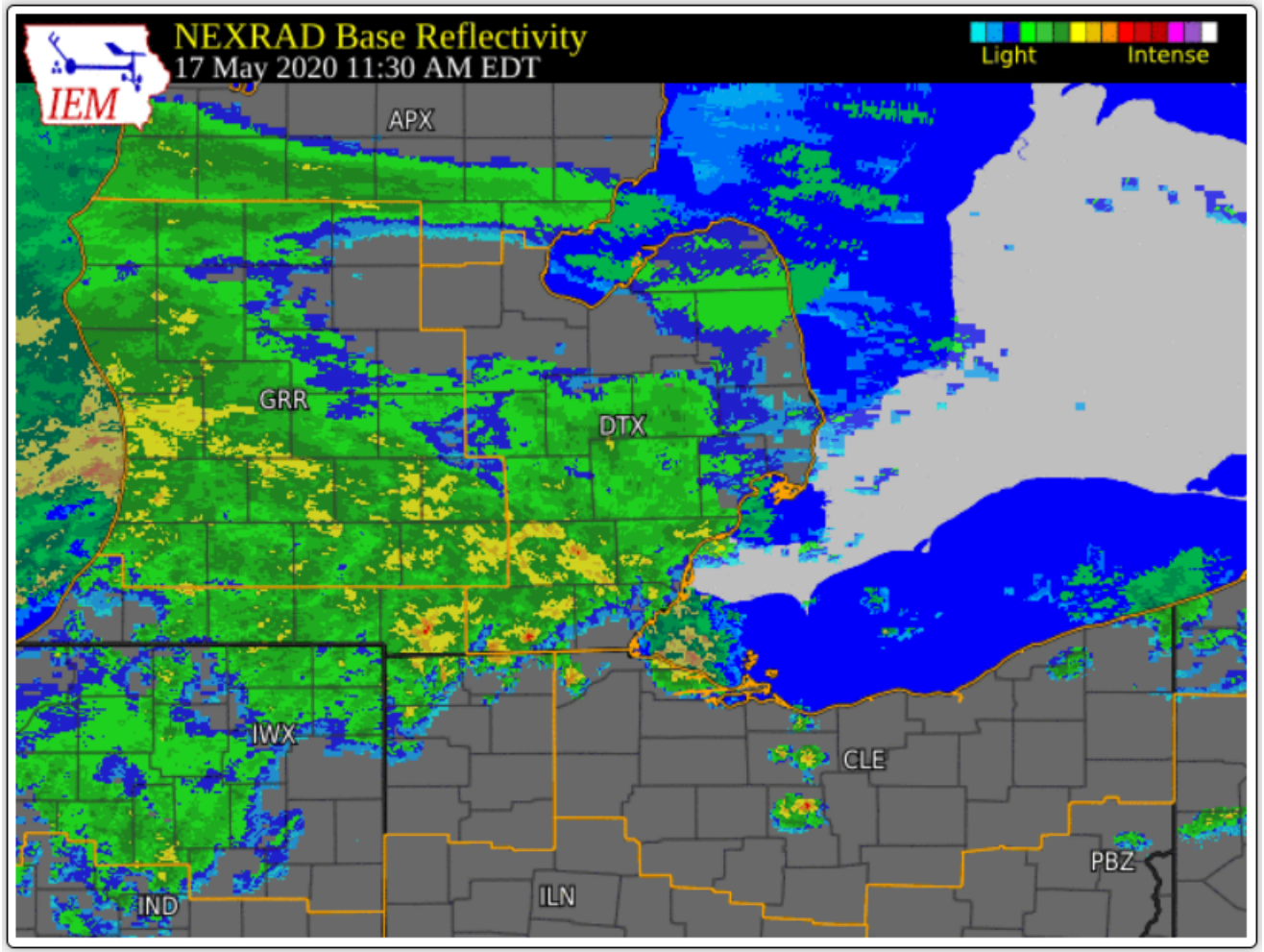
PROJECT OVERVIEW AND BACKGROUND



PROJECT OVERVIEW AND BACKGROUND



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EDENVILLE DAM FAILURE

Aerial photo of site

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EDENVILLE DAM FAILURE

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2 Hours before collapse

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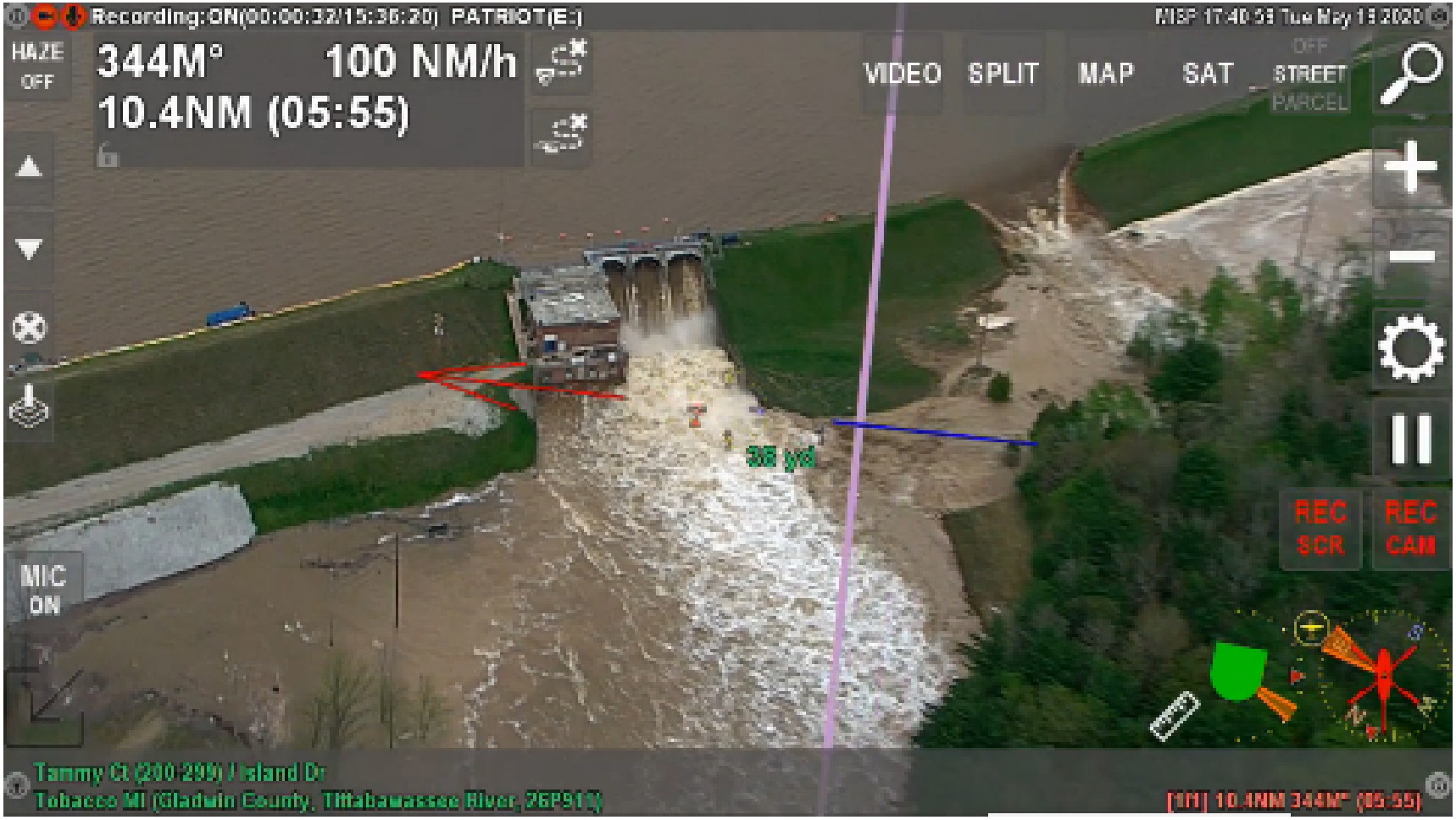
EDENVILLE DAM FAILURE



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Immediately after collapse

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SANDFORD DAM FAILURE

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Prior to overtopping

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SANDFORD DAM FAILURE

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After overtopping

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USACE INVOLVEMENT

- USACE Authority
  - Public Law 84-99, authorizing technical assistance to impacted counties requested by the state of Michigan
- Flood Inundation Mapping
  - Surveying of highwater marks and failure geometry of the dams
  - Flow measurements from failure sites
  - Data acquisition
- Dam Observations
  - 5 Dams that had been impacted by inundation were identified as requiring immediate observation
  - Prior to site visits several had documented damage and attempted stabilization

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INUNDATION MODELING – BACKGROUND

- HEC-RAS model
  - Simulated the conditions leading to the May 19 failures
  - Model was used to create inundation maps and consequences data to simulate additional dam failures (Secord, Smallwood, & Edenville – West) or rainfall (1” to 3” range) over the basin during the emergency response
- Event specific tool
- 10 different scenarios were assessed
  - Provided risk evaluation of a storm forecasted for May 28th, 2020

Photos and cutlines of Lake Sanford and Dam, Michigan – 26 May 2020

Sanford Lake was inundated by floodwaters May 19, 2020, breaching Sanford Dam, emptying most of the lake downstream. The U.S. Army Corps of Engineers is providing dam assessment and inundation modeling to the state of Michigan.

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INUNDATION MODELING – DATA COLLECTION & ASSUMPTIONS

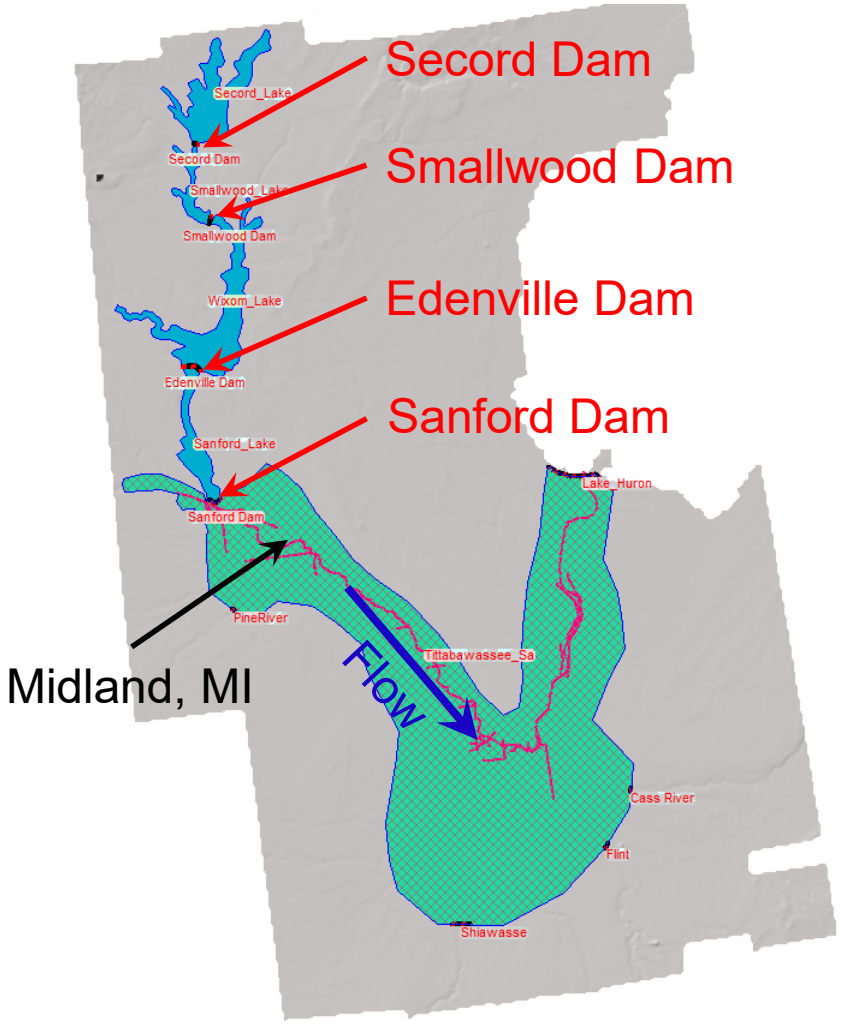
- Rainfall and flow data
  - Observed Gage Data for inflows to Dam Failures
  - NWS Forecasted Inflows and HEC-RAS 2D Precip Grids to bound the inflows for event after Dam Failures
- Reservoir Information
  - Storage Area-Capacity (NID & Google Searches)
- Topographic and Terrain Data
  - 1m LiDAR Data
  - Trapezoidal breach approximations
- Calibration Data
  - Surveyed high water marks at Edenville and Sanford Dam pools
  - Aerial imagery from May 20th from time of peak flood stage at the Tittabawassee River gage at Midland
  - Observed high water mark data collected by USACE field staff and flood damage assessors

MMC MODELING SUPPORT – MICHIGAN

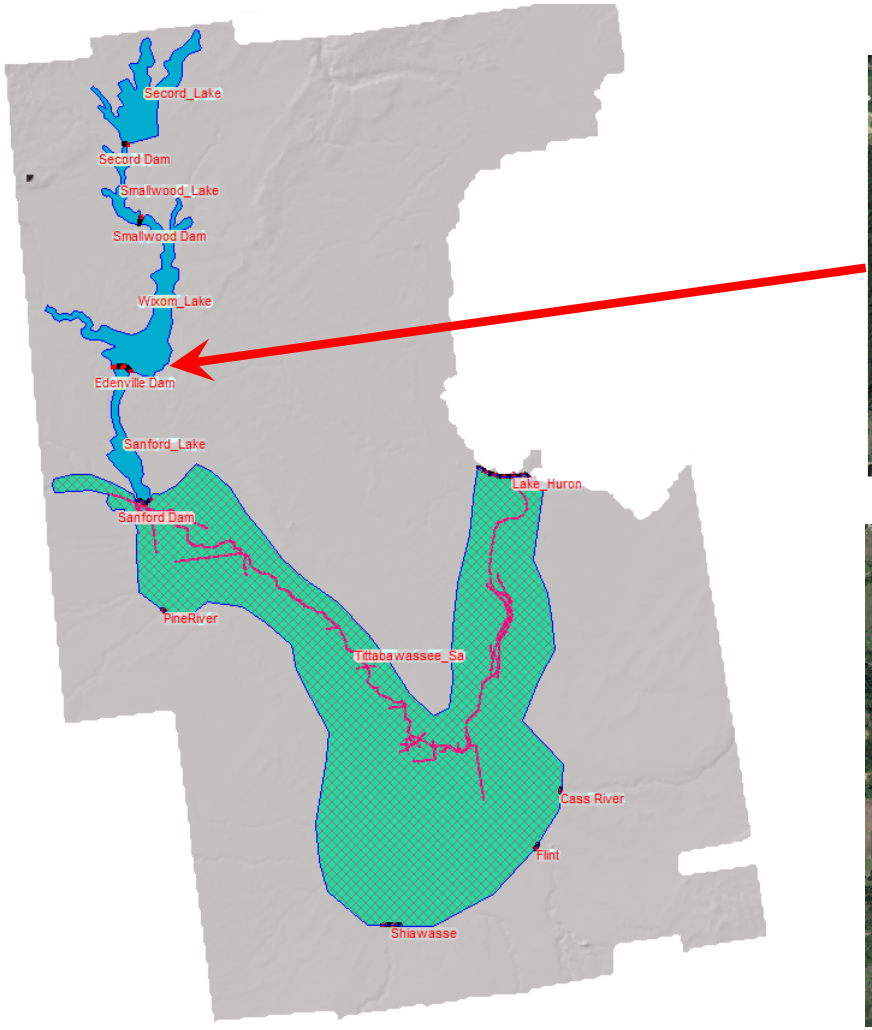
May 19, 2020

On May 19, 2020, 5:46 p.m., due to massive inflow from heavy rains in the area, the eastern side of the Edenville Dam collapsed, prompting immediate evacuations in the towns of Edenville and Sanford.

Sanford Dam in Midland County, downstream of the Edenville Dam, also failed after Edenville's Dam failure causing heavy flooding on the Tittabawassee River. Sanford Dam was overwhelmed by flood waters rushing from the failed Edenville Dam and resulted in an overtopping failure.



Edenville Dam Failure



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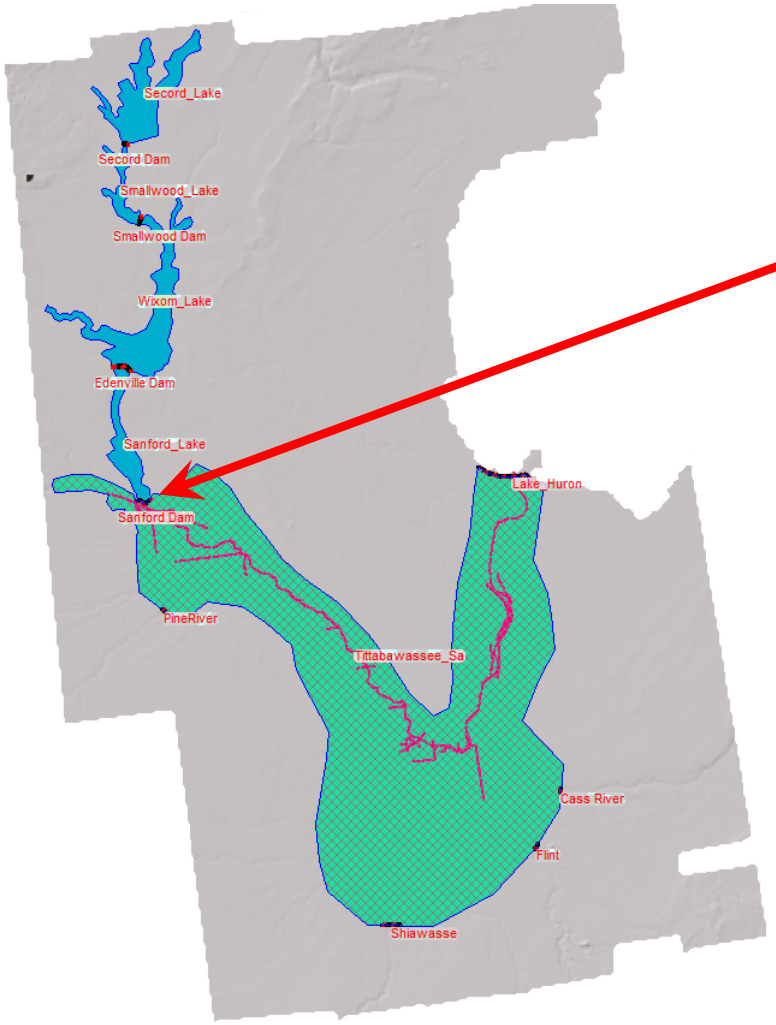
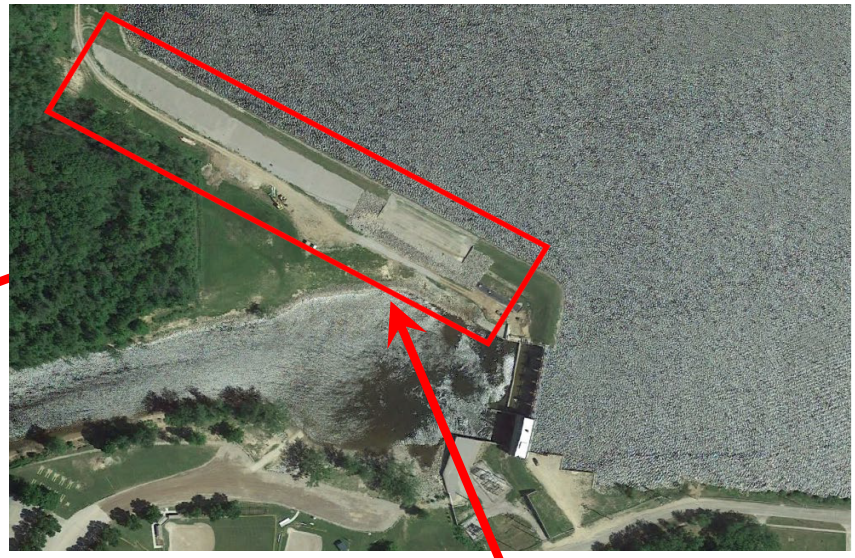
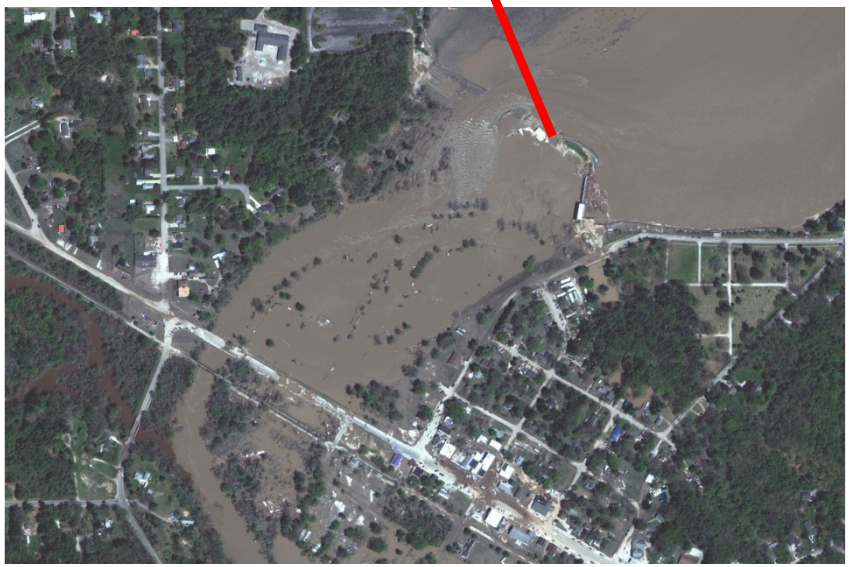
Sanford Dam Failure







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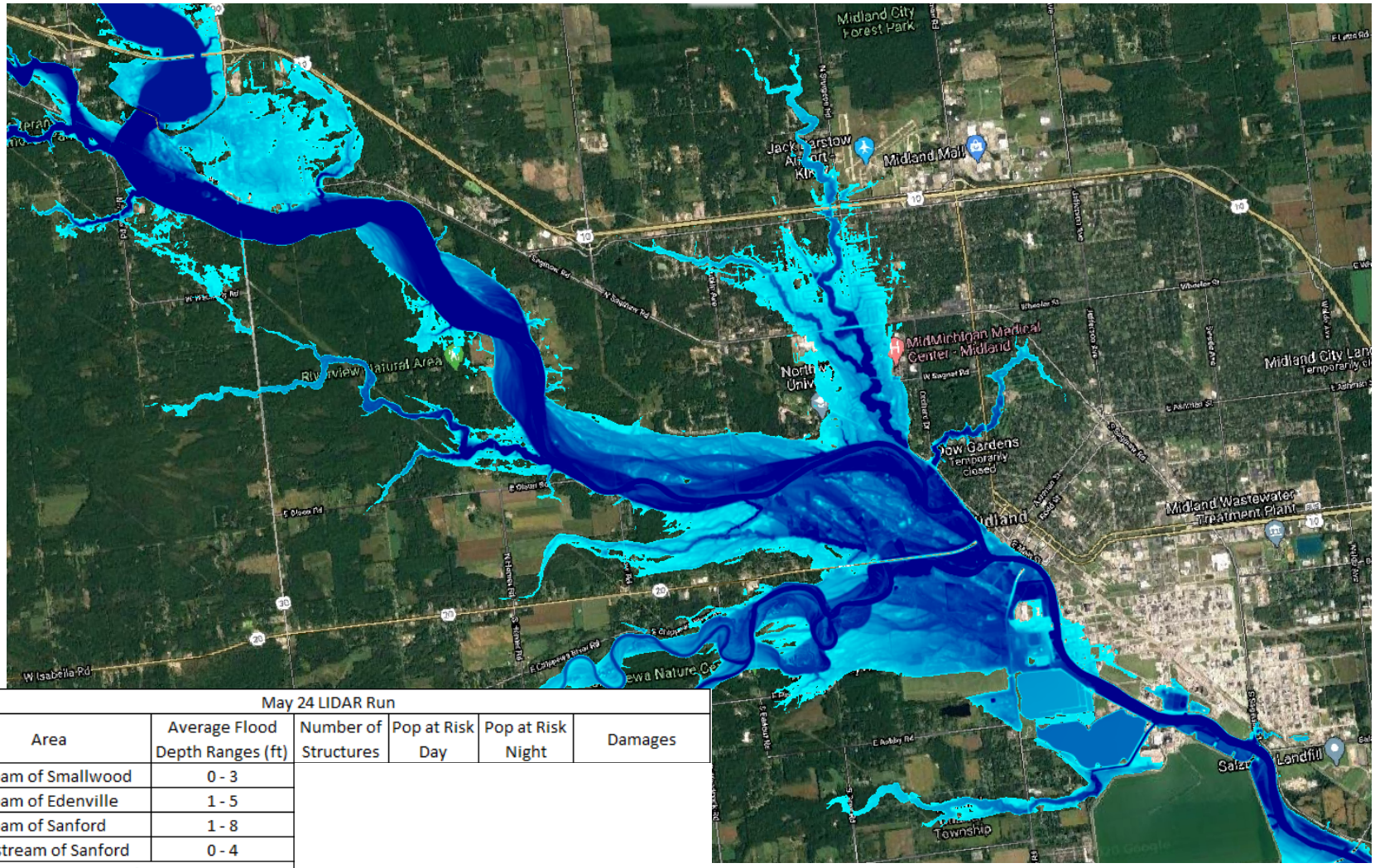
Edenville / Sanford Dam Failures – Max Depth Inundation



May 24 LIDAR Run					
Area	Average Flood Depth Ranges (ft)	Number of Structures	Pop at Risk Day	Pop at Risk Night	Damages
Upstream of Smallwood	0 - 3				
Upstream of Edenville	1 - 5				
Upstream of Sanford	1 - 8				
Downstream of Sanford	0 - 4				
Total					

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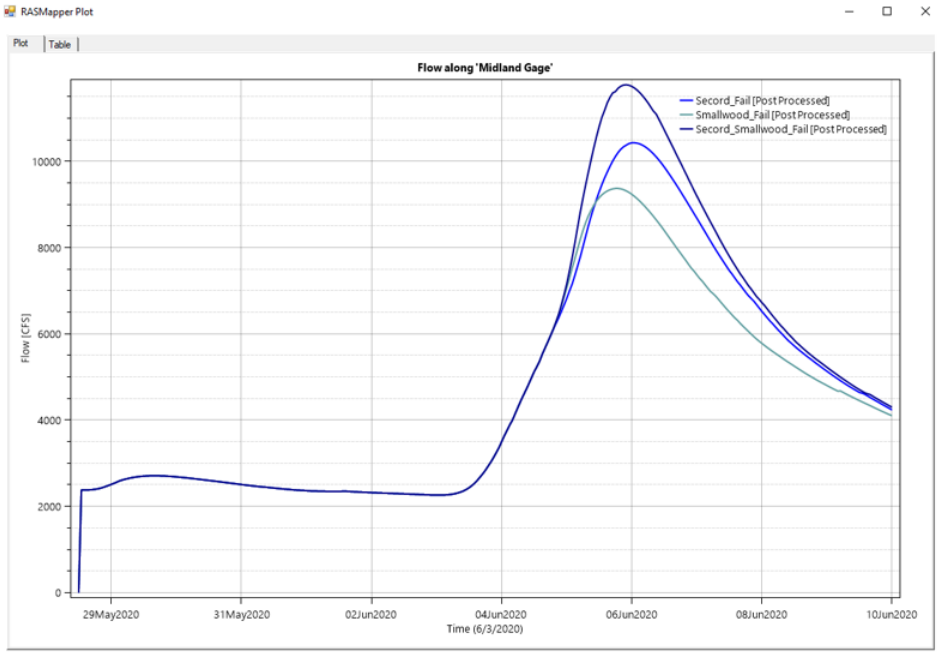
What If Scenarios – Secord / Smallwood Dams

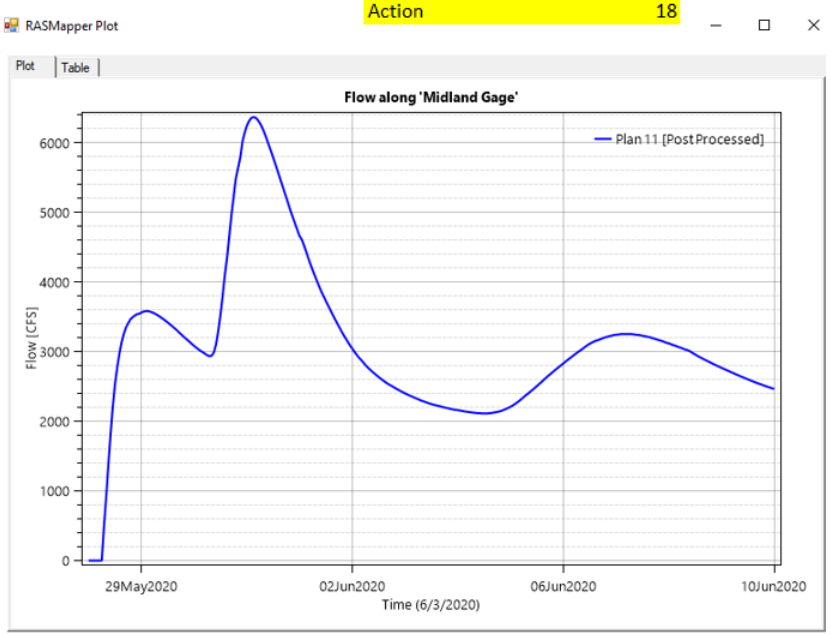
		Stage	Conversion	NWS Gage Zero	Peak Elevation	Peak Flow	Peak Time	Approximate Arrival Time of Peak	Flow Assumption from Rainfall	Rainfall Model
Breach Events	Event	ft	29 to 88	ft - NGVD29	ft-NAVD88	cfs	MM/DD/YYYY HH:MM	hrs		
	Secord Fail	26.8	-0.58	580.28	606.5	10,450	6/6/2020 0:00	36	3"	NWS
	Smallwood Fail	26.3	-0.58	580.28	606.0	9,375	6/5/2020 18:00	30	3"	NWS
	Both Fail	27.4	-0.58	580.28	607.1	11,775	6/5/2020 22:00	34	3"	NWS
	Edenville (West) Fail	24.7	-0.58	580.28	604.4	6,372	5/31/2020 2:00	26	1.3"	RAS

Midland, MI Gage

Flood Stages

Major	28
Moderate	25
Flood	24
Action	18





Secord Dam and Smallwood Dam Failure					
Area	Average Flood Depth Ranges (ft)	Number of Structures	Pop at Risk Day	Pop at Risk Night	Damages
Upstream of Smallwood	0 - 3				
Upstream of Edenville	0 - 0				
Upstream of Sanford	0 - 0				
Downstream of Sanford	0 - 2				
Total					

Edenville West Dam Failure					
Area	Average Flood Depth Ranges (ft)	Number of Structures	Pop at Risk Day	Pop at Risk Night	Damages
Upstream of Smallwood	0 - 0				
Upstream of Edenville	0 - 0				
Upstream of Sanford	0 - 0				
Downstream of Sanford	0 - 2				
Total					

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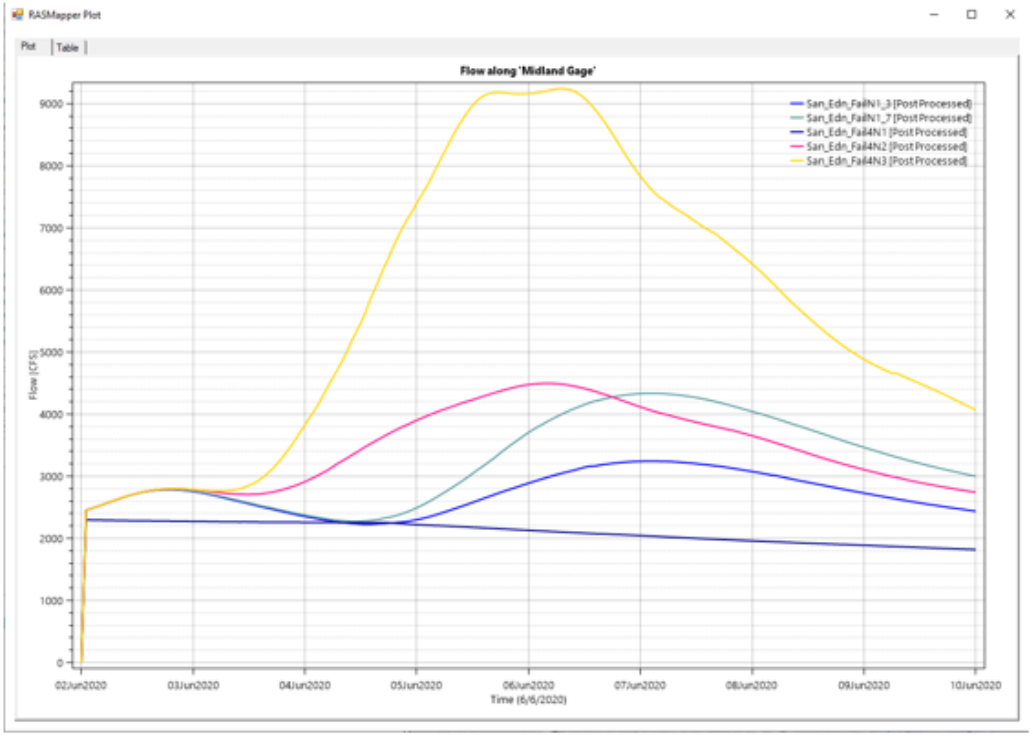
What If Scenarios – NWS Forecasted Precip 1-3”

Midland, MI Gage

		Stage	Conversion	NWS Gage Zero	Peak Elevation	Peak Flow	Peak Time
	Precipitation	ft	29 to 88	ft - NGVD29	ft-NAVD88	cfs	MM/DD/YYYY HH:MM
NWS Inflow Hydrographs	1"	21.3	-0.58	580.28	601.0	2,300	6/6/2020 0:00
	2"	23.5	-0.58	580.28	603.2	4,500	6/6/2020 4:00
	3"	26.3	-0.58	580.28	606.0	9,240	6/5/2020 18:00
	1.3"	22.3	-0.58	580.28	602.0	3,250	6/7/2020 2:00
	1.7"	23.3	-0.58	580.28	603.0	4,350	6/7/2020 3:00

Flood Stages	
Major	28
Moderate	25
Flood	24
Action	18



NWS 3in Rainfall					
Area	Average Flood Depth Ranges (ft)	Number of Structures	Pop at Risk Day	Pop at Risk Night	Damages
Upstream of Smallwood	0 - 0				
Upstream of Edenville	0 - 0				
Upstream of Sanford	0 - 0				
Downstream of Sanford	0 - 4				
Total					

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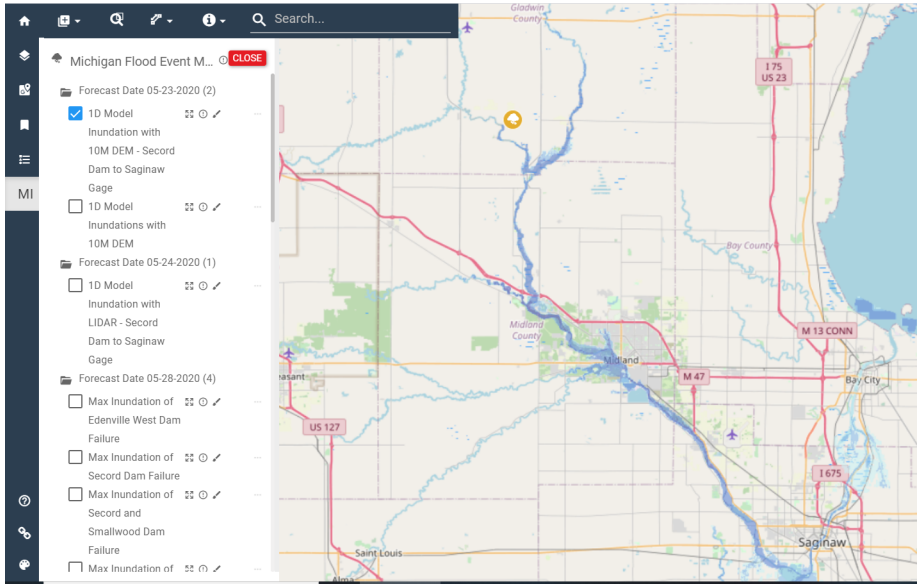
INUNDATION MODELING – OUTCOME

- Final report produced from the modeling
- Immediate answers for use by the state
  - None of the scenarios indicate a return to major flood stage conditions
- Inundation data and estimated consequences also provided to the state
  - The down stream impact to potential additional failures and inundation scenarios were provided



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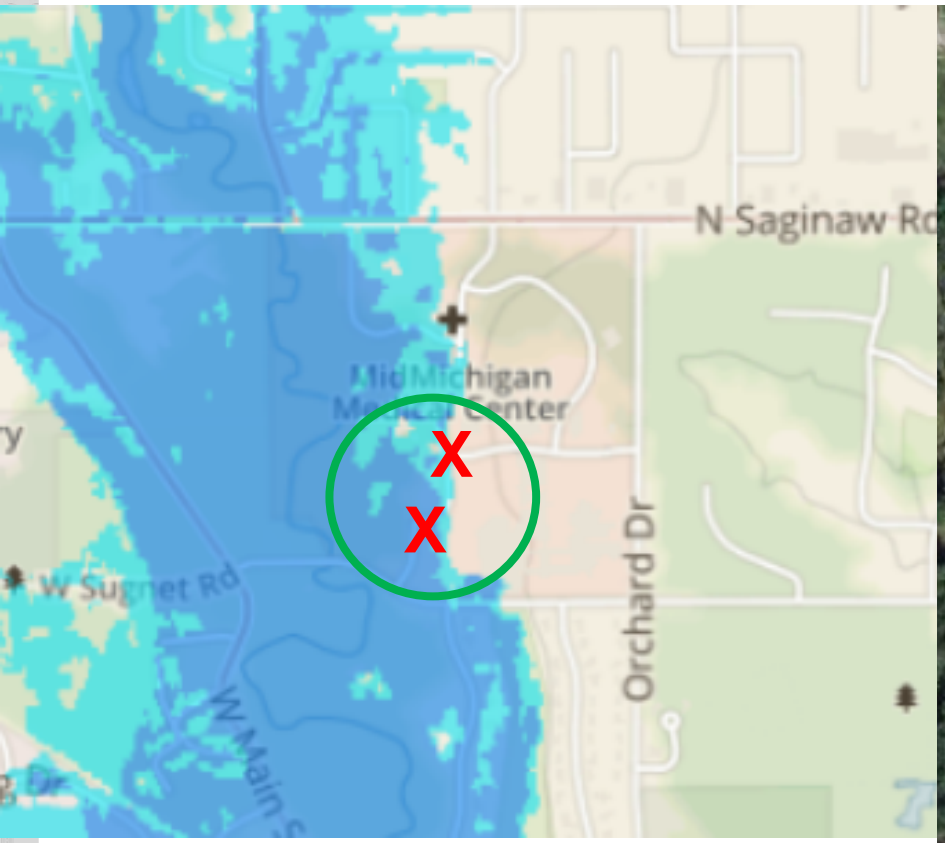
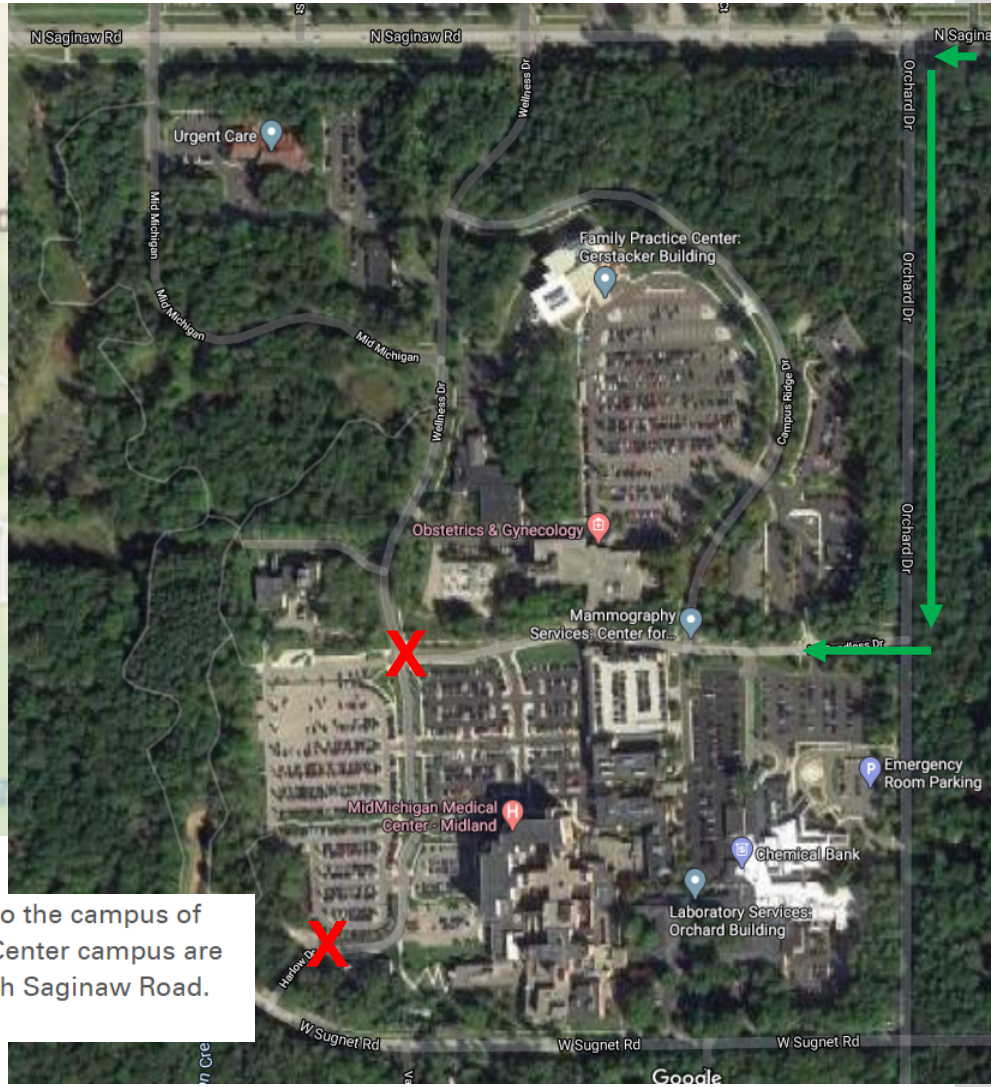
USACE model simulation



Observed Closures



5/20/2020

Rising flood waters have closed Harlow and Wellness Drive entrances to the campus of MidMichigan Medical Center – Midland. Those coming to the Medical Center campus are asked to enter through Orchard Drive west of Eastman Avenue off North Saginaw Road. The Emergency Department and Hospital Entrances remain open.

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Observed Inundation Extents

Source: CNN.com

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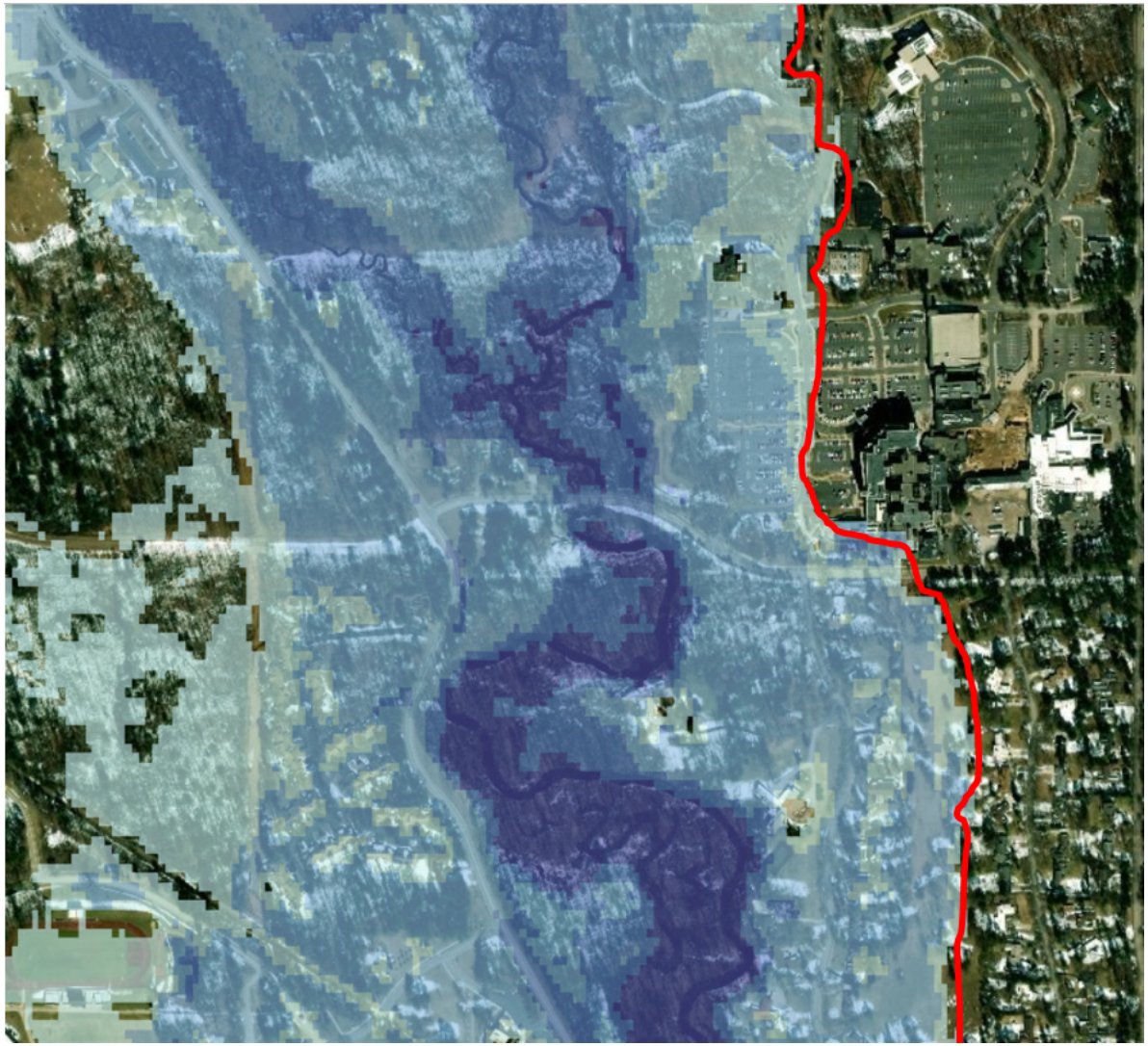
Modeled Extents



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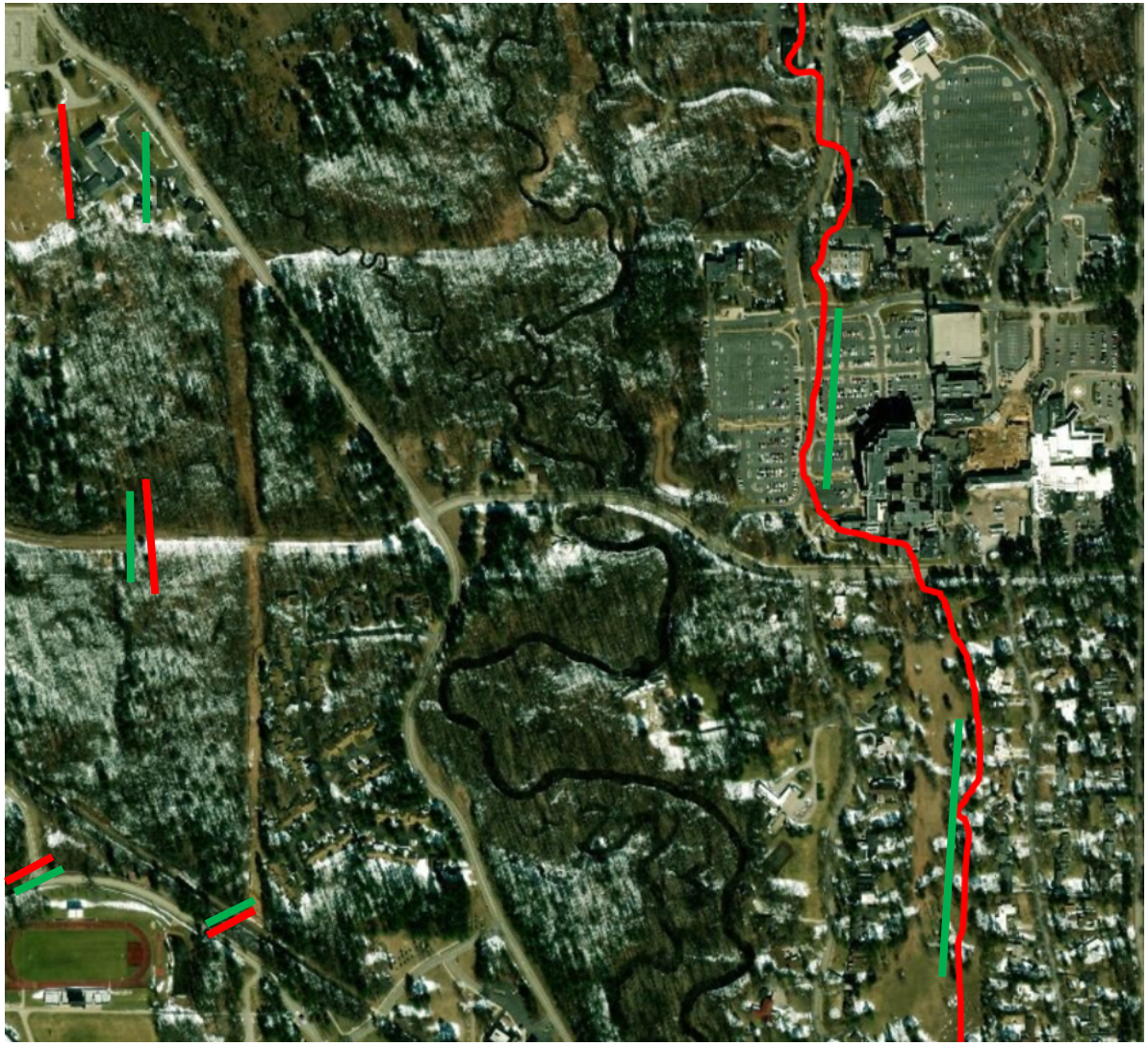

Actual
Modeled

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QUESTIONS?

U.S. Army Corps of Engineers
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