Hurricane Joaquin in South Carolina and Hurricane Matthew in North Carolina: Lessons Learned in Risk Communication and Risk Management For Dams

John “Bud” Plisich (Katy Goolsby-Brown); FEMA Region IV Dam Safety
September 18th, 2019
KAMM 2019 Conference – Barkley State Park, Ky
Delegation of Authority
10. Implement the following National Dam Safety activities

a. Act as a liaison between FEMA and federal, state, local, and private partners to identify and assess high risk dams and to work with partners to develop community and Regional preparedness, response, recovery, and mitigation strategies for those risks.

b. Coordinate consideration of dam risks into multi-hazard planning, exercise planning and execution, and emergency operation planning and activities.

c. Work across FEMA Directorates and with federal, state, local, and private partners to develop dam risk communication and public awareness strategies.

d. Provide subject matter expertise in the FEMA RRCC and/or Joint Field Office during dam-related emergencies and disasters.
Key Terminology
What is a Dam?

**DAM** - The term 'dam' -

- Means any artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water, that is **25 feet** or more in height **or** has an impounding capacity for maximum storage elevation **of 50 acre-feet** or more; but does **not** include a levee; or a barrier that is **6 feet** or less in height **or** has a storage capacity at the maximum water storage elevation that is **15 acre-feet** or less **unless** the barrier, because of the location of the barrier or another physical characteristic of the barrier, **is likely to pose a significant threat to human life or property** if the barrier fails.

*Definition from National Dam Safety Act. Definition may be different in state and federal dam safety programs.*

<table>
<thead>
<tr>
<th>Hazard Potential Class</th>
<th>Loss of Human Life</th>
<th>Economic, Env, Lifeline Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>None Expected</td>
<td>Low and generally limited to owner</td>
</tr>
<tr>
<td>Significant</td>
<td>None Expected</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>Probable, one or more expected</td>
<td>Yes (but not necessary for this class)</td>
</tr>
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</table>
Terminology

- **Dam failure**: Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water. There are lesser degrees .... Malfunction, abnormality outside design assumptions or parameters ...
- **Breach**: An opening through the dam resulting in partial or total failure of the dam.
- **Non-Failure Event**: An event at a dam that will not, by itself, lead to a failure, but requires investigation and notification of internal and/or external personnel.
- **Residual Risk**: The risk remaining after decisions are implemented, related to a specific dam safety issue.

*FEMA 148 Federal Guidelines for Dam Safety: Glossary of Terms
Note: [http://www.damfailures.org](http://www.damfailures.org) for dam failure lessons learned, case studies
FEMA Mitigation Dam Task Force
Strategic White Paper on Dam Risk DR-4241-SC
DR-SC-4241 Mitigation Dam Task Force

- Mitigation Dam Task Force at the SC JFO
  - Five member team deployed to JFO starting October 19, 2015
    - 2 from headquarters and 3 from Region IV
  - Produced White Paper on Dam Risk to provide general comments and strategic recommendations to improve dam coordination, resilience, and communication for reducing future risks relating to dams and dam failure
    - Assessed failed state regulated dams and briefed out on recommendations to the JFO leadership, key South Carolina agencies, and FEMA Region IV Mitigation leadership
    - Provided twenty-two recommendations in areas of Further Study, Flood Mapping, Regulatory, Coordination, and Training, Awareness, and Exercises

White Paper on Dam Risk Management: [https://www.fema.gov/media-library/assets/documents/112356](https://www.fema.gov/media-library/assets/documents/112356)
Dam Failure Incidents in South Carolina

SC Dam Failures as of 10/22/2015

- 31 State regulated
- 1 Federal
- Many unregulated dams

<table>
<thead>
<tr>
<th>Hazard</th>
<th># Fail</th>
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<tbody>
<tr>
<td>High / C1</td>
<td>7</td>
</tr>
<tr>
<td>Sig / C2</td>
<td>17</td>
</tr>
<tr>
<td>Low / C3</td>
<td>7</td>
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</tbody>
</table>

*Update: a total of 51 dam failures have now been identified as a result of this incident.
Overview of Comments and Recommendations from White Paper:

- Flood Insurance Studies
- Mitigation
- Preparedness
- Response
- Recovery
- Risk Communication
### General Comment 5: FIS limited Dam References

- 9 Counties with failed dams

<table>
<thead>
<tr>
<th>County</th>
<th># High &amp; Significant Dams in FIS by name</th>
<th># High &amp; Significant Hazard Dams in NID</th>
<th>Percentage of C1+C2 Dams in FIS and NID</th>
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<tbody>
<tr>
<td>Aiken</td>
<td>0</td>
<td>39</td>
<td>0 %</td>
</tr>
<tr>
<td>Clarendon</td>
<td>0</td>
<td>3</td>
<td>0 %</td>
</tr>
<tr>
<td>Darlington</td>
<td>1</td>
<td>14</td>
<td>7 %</td>
</tr>
<tr>
<td>Kershaw</td>
<td>1</td>
<td>16</td>
<td>6 %</td>
</tr>
<tr>
<td>Lee</td>
<td>0</td>
<td>4</td>
<td>0 %</td>
</tr>
<tr>
<td>Lexington</td>
<td>12</td>
<td>30</td>
<td>40 %</td>
</tr>
<tr>
<td>Orangeburg</td>
<td>0</td>
<td>38</td>
<td>0 %</td>
</tr>
<tr>
<td>Richland</td>
<td>16</td>
<td>67</td>
<td>24%</td>
</tr>
<tr>
<td>Sumter</td>
<td>2</td>
<td>11</td>
<td>18%</td>
</tr>
</tbody>
</table>

Cary’s Lake Dam shown by name on profile in FIS
**General Comment 6: Limited Dam References on FIRM’s**

- 31 Failed Dams

---

<table>
<thead>
<tr>
<th>Not Shown on FIRM</th>
<th>Shown on FIRM as ‘Culvert’</th>
<th>Shown on FIRM as ‘Dam’</th>
<th>Shown on FIRM by Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>1</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>
General Comment 8: FEMA Flood Mapping/Modeling Policies and Procedures for Dams
- FEMA currently has minimal policies and procedures in place to address how dams should be mapped and modeled in flood studies. Without this documentation, dams are accounted for inconsistently across the entire nation.

General Comment 9: Risk MAP Non-Regulatory Products
- Risk MAP (Mapping, Assessment and Planning) delivers technical products to help communicate risk based on the hydrologic and hydraulic studies used in creating the FIRM and Flood Insurance Study. These products, such as depth and velocity grids, seem to be currently underutilized when analyzing dam risk.

General Recommendation #2: Incorporate Dam-Related Flood Risk into FEMA Risk MAP Guidance
- FEMA HQ Mitigation involved with Risk MAP, in conjunction with Regional Risk Analysis engineers, should perform a comprehensive review and update of existing FEMA Flood Project modeling, mapping and documentation policies and procedures, and develop guidelines for incorporating dam flood risk in FEMA flood studies. This update should address modeling assumptions and standard practices, mapping guidance for FIRMs and required inclusion in the FIS documentation.
General Comment 12: State, Local, and Multi-Jurisdictional Mitigation Plans

- Dam failure was eliminated as a hazard to analyze in the State Mitigation Plan. The local and multi-jurisdictional mitigation plans for the areas with failed dams reference dams and dam failure but contain no in-depth analysis of the risks associated with dam operation or dam failure.

General Recommendation #13: Include Dams More Comprehensively in State and Local Mitigation Plans

- The state mitigation planners (SCEMD) should coordinate with other state agencies internally (SCDHEC, SCDNR, etc.) to identify and analyze the risks relating to dams and dam failure and the opportunities for mitigation in the state mitigation plan. The FEMA Region IV Dam Safety Program and the FEMA Region IV Mitigation Planning team are available to assist in coordination, training, and technical assistance at the state’s request. The state also should coordinate with local mitigation planners to better identify and analyze the flood risk relating to dams for the area of the local mitigation plan.

NOTE: Since 2015, SC Mitigation Plan now has dams included
General Comment 15: Dam Watershed Management Operations

- Multiple dams that were in series failed in the Twelve Mile Creek Watershed and in the Gills Creek Watershed. This may be a result of the cascading dam failures. It is not evident that a water management plan exists for either watershed to guide and coordinate the timing and quantity for dam water releases through the system.
General Recommendation #16: Develop Watershed Management Plans

- Develop watershed management plans for watersheds having interconnected lakes with dams in series. Dam owners, operators, and key agencies (Federal, State, and local) should work together to share information and develop information sharing and procedures for lowering dam reservoir levels in preparation for major future potential flood events.

*Open gate at Lake Elizabeth (SCDHEC/Long)*
General Comment #4: Land Use Planning Downstream of Dams

- Hazard creep results in changes of hazard classification for dams when there is construction in the dam breach inundation zone downstream of a dam. The extent of land use planning within the downstream breach inundation areas is unknown.

General Comment #10: Dam Inundation Maps; Older Operating Dams

- Many of the C1 and C2 dams do not have inundation maps. According to state regulations, C1 and C2 dams are required to provide inundation maps through the permit application process. However, this process is triggered for new construction, repair, alteration, and removal. Many of these dams were completed long before these requirements. There may be a loophole in the regulations as to the applicability of this requirement for many operating dams.
General Comment 21: Dam Owner Coordination with State/Local Governments/EMA’s

- Emergency Notification and Actions Plans are required to be developed by dam owners and submitted to SCDHEC. It is unclear to what degree coordination and interaction actually occurs between the dam owner and state and local governments/EMA’s regarding the development of these plans.

General Recommendation #9: SCDHEC – Local EMA Dam EAP Coordination

- SCDHEC should consider coordinating more fully with local EMA’s and SCEMD in ensuring the local EMA’s receive EAP’s from dam owners on state regulated High (C1) and Significant (C2) Hazard dams.
General Comment #25: Dam Exercises for State Regulated Dams

- Currently, state regulations do not require the exercise of state regulated dams. Therefore, exercises generally are not performed by owners, SCDHEC or local EMA’s on state regulated dams.

General Recommendation #19: Include Dams in SCDHEC – SCEMD Exercises

- SCDHEC and SCEMD should consider coordinating and developing exercise scenarios to include dam incidents and failures for tabletop exercises with all impacted stakeholders for key dams regulated by SCDHEC.
General Comment 23: Technical and Operational Dam Owner Training

- It is unclear how or what resources and training, if any, have been made available to the dam owners to help them understand and execute the DHEC requirements for dam operation, maintenance, and coordination of emergency notification and EAPs with local emergency management agencies. Many dam owners may not be aware of or participate in technical dam training or EAP exercise design training and may be unaware of the impact that the dam has on their flood risk and may not grasp the importance of the requirements.

General Recommendations 20: Provide Operations and Maintenance Training to Dam Owners

- Create and provide training and resources to dam owners to facilitate a better understanding and the importance of the DHEC requirements regarding dam operation and maintenance and steps for the preparation for potential flood events.
General Comment #18: SCDHEC SEOC Operations

- In discussions with SCDHEC dam safety personnel, they normally do not operate at the State Emergency Operations Center (SEOC) and were invited by SCEMD for this event. SCDHEC dam safety does not have an emergency manual from which to reference for emergency and disaster operations at the SEOC.

General Recommendation #14: SCDHEC Incorporation into State Emergency Operations Center (SEOC)

- SCEMD and SCDHEC should consider greater inclusion of SCDHEC dam subject matter experts during operations for flood events. A routine presence will strengthen dam awareness at the SEOC and improve response information flow across agencies.
General Comment 24: Limited Awareness of Risk Information Relating to Dams and Dam Failure

- Generally, there appears to be a limited awareness of dam-related risk information at the state and local levels of government as well as by residential and non-residential property owners.

General Recommendation #18: Improve Dam Safety Awareness

- Appropriate SCEMD staff should consider collaborating with SCDHEC, SCDNR, and FEMA Region IV Dam Safety in improving education and awareness of dam-related risk to state and local governments, property owners, and other impacted stakeholders.
FEMA dam related products developed after Joaquin in South Carolina
South Carolina Dam Failure Technical Advisories

- Web search, “SC Dam Technical Advisories”
  - Dam Maintenance
  - Educational Resources for Dam Owners
  - Dam Removal
  - Dam Repair
  - Effective Coordination and Communication
    - Embankment Armoring
    - Emergency Action Plans for Dams
    - How and Why Earth Dams Fail
    - Land Use Change Impacts on Dam Safety
    - Sources of Federal Grant Funds for Dams and Downstream of Structures

Effective Coordination and Communication

Purpose and Intended Audience

The purpose of this advisory is to provide an overview of effective coordination and communication methods to improve preparedness and resilience to the potential hazards from dams. Dam owners and local government officials including engineering and emergency management staff are the primary audience for this advisory. Other related audiences in this series include Emergency Action Plans.

Introduction

The severe floods that occurred in South Carolina in October 2015 caused the failure of many dams, most of them privately-owned. However, the dam failures impacted the entire community which highlights the importance of effective coordination and communication among multiple parties. This Recovery Advisory document identifies synergies between dam safety and risk management partners, and provides recommendations for improving coordination and communication.

Presidential Policy Directive 8 (PPD-8): National Preparedness is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the nation, including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters.

Cooperation and communication between dam safety and risk management partners is critical to effectively improve dam safety. As a concept, Whole Community is a means by which residents, emergency management practitioners, organizational and community leaders, and government officials can collectively understand and assess the needs of their respective communities and determine the best ways to organize and strengthen their assets, capacities, and interests. By doing so, a more effective path to societal security and resilience is built. In a sense, Whole Community is a philosophical approach on how to think about conducting emergency management. Refer to “A Whole Community Approach to Emergency Management: Principles, Themes, and Pathways for Action” (PPD-8) and more information.

Dam safety should include stakeholders at all levels including state and federal government agencies, private entities, nonprofit agencies, and most importantly dam owners. Whenever possible, communication and sharing of
FEMA P-1090 Hurricane Matthew in North Carolina Dam Risk Management Assessment Report
Deployed to the Regional Response Coordination Center (RRCC) in Oct 2016
- Provide subject matter expertise on dams and dam breaches
- Coordinate with each of the state dam safety programs in the impacted area
- Coordinate within the RRCC on dams

Deployed to the North Carolina Emergency Operation Center (EOC) during Hurricane Matthew in Oct 2016
- Liaison between FEMA and the different state and Federal agencies, which is an advisory role

Deployed to the North Carolina Joint Field Office (JFO)
- Assess dam risk factors and develop Hurricane Matthew in North Carolina Dam Risk Management Assessment Report
Hurricane Matthew in North Carolina Dam Risk Management Assessment Report - Purpose of Report

- Deployed to NC JFO to assess dam risk factors and develop H. Matthew in North Carolina Dam Risk Management Assessment Report
- Provides general comments & strategic recommendations to improve dam risk management in NC
- To help reduce future risks related to dams and dam failure thru improved coordination, communication, preparedness, mitigation, outreach, and response
- Due to limited time and resources focused on 12 breached state regulated dams and the 8 breached dams that are currently exempt from state regulation

Rhodes Lake Dam (Cumberland County); Credit: NC DEMLR
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<td>Chapter 6</td>
<td>FEMA Mitigation Planning</td>
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<td>Chapter 7</td>
<td>The North Carolina Dam Safety Program</td>
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<td>Chapter 8</td>
<td>Coordinated Response to Reduce Risk at Dams</td>
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<td>Chapter 9</td>
<td>North Carolina Response to Dams during H. Matthew</td>
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<td>Chapter 10</td>
<td>FEMA and Other Federal Agencies Response to Dams during Hurricane Matthew</td>
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<td>Dam-related Efforts in Recovery</td>
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<td>General Comments and Strategic Recommendations</td>
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<td>Information for Each Breached State Regulated and Exempted Dam</td>
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<td>National Inventory of Dams (NID) Field Definitions</td>
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<td>Appendix F</td>
<td>Association of State Dam Safety Officials (ASDSO)</td>
</tr>
</tbody>
</table>
Many of the recommendations relate to challenges applicable across states, not solely in North Carolina. Some recommendations may be applicable or beneficial to other states or organizations.
Hurricane Matthew in North Carolina Dam Risk Management Assessment Report – Response

- **North Carolina Response to Dams during Hurricane Matthew**
  - Provides a brief overview of the NC EOC and The State Dam Safety Program’s role in the EOC
  - Provides information on NC DEQ DEMLR’s pre-event actions and activities at the EOC

- **FEMA and Other Federal Agencies Response to Dams during Hurricane Matthew**
  - Overview of activities at FEMA Region IV RRCC
  - Overview of activities at FEMA NRCC
  - Overview of some of the Federal Response efforts at the NC EOC
  - Overview of USGS dam related High Water Mark efforts (HWM) in NC
Woodlake Dam (Moore County) – Emergency Action Plan (EAP) activated due to damage to the concrete spillway

Interim Risk Reduction Measures by over 15 organizations included:

- Evacuations of roughly 200 people from 116 residences
- Three 8” diameter pumps and five 12” diameter pumps
- 1300 sand bags on key areas of the spillway to reduce erosion of the damaged area
- Opening of two large bottom drains on the dam
- Civil Air Patrol fly over for situational awareness and monitoring
EAP Activations at:
- H.F. Lee Cooling Pond
- Weatherspoon Cooling Pond
- Sutton Cooling Pond
- Lake Benson
- Woodlake Dam

Evacuations downstream of:
- Lake Benson Dam
- Lake Wilson Dam
- Woodlake Dam
Confirmed Dam Breaches in North Carolina and 24 Hour Observed Precipitation

FEMA-4285-DR-NC, Dams and 24 Hour Observed Precipitation
October 9th Thru October 16th 2016 Incident: Hurricane Matthew

- 12 High Hazard Dams*
- 2 Intermediate Hazard Exempt Dams
- 6 Low Hazard Exempt Dams

*One additional High Hazard dam was identified as breached after this report was finalized.
The Report provides 30 General Comments and 30 Strategic Recommendations grouped into:

- Regulation
- Preparedness
- Response
- Recovery
- Mitigation

Breached Tull Millpond Dam (Lenoir County); Credit: NC DEMLR
General Recommendation #2: Current Spillway Design Requirements

NC DEQ DEMLR should consider analyzing the percent Probable Maximum Precipitation (PMP) and recurrence interval experienced at each breached and overtopped dam site and determine whether any updates to the spillway design section of the North Carolina Administrative Code are needed.
Communication of Emergency Action Plans (EAPs) Downstream (General Recommendation #13 in Report)

NC DPS, in coordination with NC DEQ DEMLR, should develop processes and procedures to ensure downstream states, counties, and jurisdictions potentially impacted by inundation from a breached dam are provided EAPs and inundation maps. These should be integrated by locals into their Emergency Operations Plans (EOPs), evacuation planning and maps, and consequence planning.
 Awareness of Emergency Action Plans (EAPs) and Downstream Consequences (General Comment #14 in Report)

It is unclear as to the degree of understanding of EAPs, inundation maps, and the potential downstream consequences associated with dam breaches by dam owners, local officials, county and city engineers, floodplain managers, planners, the general public, and emergency managers. This includes either dam breaches within their local jurisdictions or by dams outside of their jurisdictions that would still impact them.

Emergency Action Plans (EAPs) and Downstream Consequence Education and Training (General Recommendation #14a in Report)

NC DEMLR DEQ, in coordination with NC DPS, with assistance from FEMA Region IV or others if requested, should provide training workshops and outreach materials to dam owners, local officials, and emergency managers to improve awareness of EAPs, inundation and evacuation maps, and the consequences of dam failures with the potential to impact their local jurisdiction.
Assessment of Consequences to Dam Breach (General Recommendation #14b in Report)

NC DPS should consider providing workshops or outreach material to their local EMAs, local officials, or others in analyzing dam owner inundation maps to more fully determine and understand the potential risks, vulnerabilities, and consequences associated with potential dam failures for their given areas. NC DPS should consider coordinating with NC DEQ DEMLR, FEMA Region IV Dam Safety, or others as needed.
General Recommendation #15: Integrate Emergency Action Plans (EAP) and inundation maps into Emergency Operations Plans (EOPs) and Evacuation and Consequence Planning

State and local communities should consider integrating EAP and inundation map information to help inform the development of their EOPs, evacuation maps, and consequence planning.
General Recommendation #25: Public Roads on Private Dams

NC DEQ DEMLR should consider coordinating with NC DPS, NC DOT, or others to develop procedures or protocols for providing information on dams of particular high public safety concern, due to inherent vulnerabilities (i.e. lack of adequate spillway capacity), NODs, or other reasons. These organizations can then use this information as is appropriate for inclusion into general annual budget planning, operations plans, emergency operations plans, mitigation plans, and coordination as needed.
Dams Largely Not Referenced in North Carolina Flood Insurance Studies (FIS), Flood Risk Information System (FRIS), and Flood Inundation Mapping and Alert Network (FIMAN) (General Comment #26 in Report)

Based on the information reviewed for this report, the Flood Insurance Studies (FIS), North Carolina’s Flood Risk Information System (FRIS), and North Carolina’s Flood Inundation Mapping and Alert Network (FIMAN) appear to largely not reference dams, nor analyze dams in the hydraulic modeling. FEMA has minimal policies and procedures in place for incorporating dams and dam risk into Flood Insurance Studies.
Dam Risk Communication in North Carolina Floodplain Management Program (General Recommendation #26 in Report)

Under their own authority, the North Carolina Department of Public Safety, Emergency Management, Risk Management Section (NCEM-RM) should consider coordinating with NC DEQ DEMLR along with FEMA Region IV Risk MAP and Dam Safety to develop a strategy to more effectively capture dam risk. This will better enable communication of this information with appropriate entities in North Carolina. These measures might include, but are not limited to, referencing the dam name or State Dam ID on Flood Insurance Rate Maps (FIRMs), inclusion of dam outlet systems in the hydraulic modeling for the Flood Insurance Studies (FISs), and consideration of dams in hydrologic analysis for FISs. This might also include dams and residual dam risk in non-regulatory flood products and information into FRIS and FIMAN products as appropriate.
Dam Risk and Mitigation Planning (General Comment #27 in Report)

Dam failure is listed as a lesser hazard in the North Carolina Enhanced Mitigation Plan. Based on information reviewed for this report, several of the multi-jurisdictional hazard mitigation plans state the likelihood of occurrence of a dam failure impacting the multi-jurisdictional area is “unlikely”.

Dam Risk and Mitigation Planning (General Recommendation #27 in Report)

NCEM-RM, in coordination with NC DEQ DEMLR, should consider undertaking more robust dam risk analyses and sharing this data with state and local mitigation planners and other relevant stakeholders tasked with updating mitigation plans.
Hurricane Matthew in North Carolina Dam Risk Management Assessment Report - Mitigation

Dam Risk Awareness (General Comment #29 in Report)

Based on the number of inaccurate reports of dam failures and breaches received at the North Carolina EOC, there appears to be a lack of general understanding and awareness of dam terminology, dam incidents, failure modes, basic dam operations, spillway activations, EAP requirements, and other dam-related topics. General Recommendation #29: Dam Awareness Training and Outreach

Dam Awareness Training and Outreach (General Recommendation #29 in Report)

NC DEQ DEMLR, in coordination with NC DPS, should consider providing dam awareness training and outreach on dam terminology, dam operations, spillway types, common failure modes, and EAPs for state and local emergency managers, local floodplain managers, county and city engineers, planners, local officials, and others. FEMA Region IV Dam Safety is available to support these efforts where appropriate and upon request by the state.
Based on information from the state, it is unclear how HOAs with dam ownership are made aware of their dam related responsibilities.

NC DEQ DEMLR, in coordination with NC DPS or others, with support from FEMA Region IV as appropriate, should consider providing training, outreach, and exercises to amenable HOAs in helping them better understand their risks and carry out their responsibilities in maintaining, operating, repairing, rehabilitilitating, or removing their dams. This should include encouraging coordination between HOAs where a dam impacts multiple neighborhoods.
### Appendix A: Table for each breached dam (example)

#### A1) State Dam Name: Loch Lommond Dam
Latitude: 35.07, Longitude: -78.998;
Regulator: NC DEQ DEMLR

Table A1 Loch Lommond Dam 2016 NID and October 2016 NC Dam Inventory

<table>
<thead>
<tr>
<th>NID/State Field</th>
<th>NID/State Value</th>
<th>NID/State Field</th>
<th>NID/State Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NID Dam Name</td>
<td>Loch Lommond</td>
<td>County</td>
<td>Cumberland</td>
</tr>
<tr>
<td>Stream or River</td>
<td>Stewarts Creek</td>
<td>Owner Type</td>
<td>Private</td>
</tr>
<tr>
<td>NID Hazard Class</td>
<td>High</td>
<td>State Hazard Class</td>
<td>High</td>
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<tr>
<td>NID ID</td>
<td>NC02137</td>
<td>EAP</td>
<td>No</td>
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<tr>
<td>Dam Type</td>
<td>Earthen</td>
<td>Year Modified</td>
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<tr>
<td>Purpose</td>
<td>Recreational</td>
<td>Surface Area (ac-ft)</td>
<td>13</td>
</tr>
<tr>
<td>Length (ft)</td>
<td>250</td>
<td>Condition Assessment</td>
<td>Fair</td>
</tr>
<tr>
<td>Drainage Area (sq mi)</td>
<td>3.491</td>
<td>Normal Storage (ac ft)</td>
<td>No Information</td>
</tr>
<tr>
<td>Nearest Downstream City/Town</td>
<td>Fay.</td>
<td>Nearest Downstream City/Town</td>
<td>Fay.</td>
</tr>
</tbody>
</table>
Appendix A: Table for each breached dam

<table>
<thead>
<tr>
<th>NID Field Name</th>
<th>2016 NID Value</th>
<th>State Field Name</th>
<th>State Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Height (ft)</td>
<td>21</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Drainage Area (sq mi)</td>
<td>3.491</td>
<td>Drainage Area (ac)</td>
<td>2234</td>
</tr>
<tr>
<td>Structural Height (ft)</td>
<td>No Information</td>
<td>Structural Height (ft)</td>
<td>21</td>
</tr>
<tr>
<td>State ID</td>
<td>No longer cross references state ID</td>
<td>State ID</td>
<td>CUMBE-025</td>
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<tr>
<td>Year Completed</td>
<td>No information</td>
<td>Year Constructed</td>
<td>No information</td>
</tr>
<tr>
<td>Max Storage (ac-ft)</td>
<td>109.2</td>
<td>max impoundment capacity (ac-ft)</td>
<td>109</td>
</tr>
</tbody>
</table>

**FIRM & FIS data taken from FEMA mapping service center and NC FRIS (Flood Risk Information System) website**

<table>
<thead>
<tr>
<th>FIRM Panel</th>
<th>3720040800J</th>
<th>FIS Effective Date</th>
<th>June 18, 2007</th>
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<tr>
<td>FIRM Effective Date</td>
<td>1/5/2007</td>
<td>Preliminary Date</td>
<td>April 30, 2014</td>
</tr>
</tbody>
</table>

*NC Dam Inventory Information provided by NC DEQ DEMLR*
Appendix A: Further details for each breached dam

- Each dam includes, when available:
  - Table of 20+ dam attributes
  - Photos
    - Pre Event
    - Post Event
  - FEMA FIRM and FIS Profile
  - Site map of the dam
  - Comments and Considerations for dam
FEMA dam related products developed after Hurricane Matthew in North Carolina & South Carolina
NC – SC H Matthew Contract efforts

- NC / SC Hurricane Matthew contract effort and deliverables
  - Technical Advisories; ([https://www.fema.gov/media-library/assets/documents/164575](https://www.fema.gov/media-library/assets/documents/164575))
    - FEMA TA1 Risk Reduction Measures for Dams NC-SC Dec 17
    - FEMA TA2 Risk Exposure n Residual Risk Related to Dams NC-SC Dec 17
    - FEMA TA3 Dam Awareness NC-SC Dec 17

<table>
<thead>
<tr>
<th>State Entity</th>
<th>Authority / Responsibility Relating to Dam Safety</th>
<th>How They Can Help Relating to Dam Incidents</th>
<th>Phone</th>
<th>Email/Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Carolina Department of Public Safety (NC DPS) – Division of Emergency Management</td>
<td>The NC DPS Division of Emergency Management operates the North Carolina EOC. The Division of Emergency Management operates under a modified Incident Command System. During an event, all evacuations, Regional Coordination Centers, County Deployment Teams, and most response and recovery efforts fall under the State Emergency Response Team (SERT) Operations Section. NC DPS uses North Carolina’s State Preparedness and Resource Tracking Application (NCSPARTA) for disaster and emergency management operations. NCSPARTA is used not only to help coordinate information and resources, but also to help track costs incurred from internal and external sources throughout an event, beginning at the state EOC activation phase using the NCSPARTA Finance-Incident Expenditure board.</td>
<td>When local government resources are exhausted or a needed capability does not exist during an event, the local government can call the NC EOC for assistance.</td>
<td>(919) 825-2500</td>
<td><a href="https://www.ncps.gov">https://www.ncps.gov</a> <a href="https://www.fema.gov">https://www.fema.gov</a> <a href="https://www.fema.gov">https://www.fema.gov</a> <a href="https://www.fema.gov">https://www.fema.gov</a> <a href="https://www.fema.gov">https://www.fema.gov</a> <a href="https://www.fema.gov">https://www.fema.gov</a></td>
</tr>
</tbody>
</table>
NC – SC H Matthew Contract efforts

- NC / SC Hurricane Matthew contract effort and deliverables
  - Dam Breach Report
    - FEMA FS 1 Use of Emerging Technologies
    - FEMA FS 2 Notification Methods
    - FEMA FS 3 Benefits of Pre-Event Exercises & Training
    - FEMA FS 4 Proactive Actions
    - FEMA FS 5 Benefits of Post Event Data Collection for Dams
  - Hydrology Report
FEMA Region IV Dam Safety Risk MAP Fact Sheets

• Dam Considerations in Flood Mapping Studies
• Considering the Residual Risk from Dams in Flood Risk Products
• Risk Communication for Dams in Risk MAP
• Dam safety Awareness

FEMA Dam Safety and Risk MAP/Flood Mapping Studies Fact Sheet Series available at https://www.fema.gov/media-library/assets/documents/174682 or search for ‘FEMA Risk MAP dam fact sheets’
Risk Communication for Dam Safety

- FEMA Dam Safety Publications & resources: [https://www.fema.gov/dam-safety-publications-resources](https://www.fema.gov/dam-safety-publications-resources); search “FEMA dam safety pubs”
- National Dam Safety Program Factsheet
- Federal Guidelines for Emergency Action Planning for Dams; FEMA 64
- Pocket Safety Guide for Dams and Impoundments
- Be Aware of Potential Dam Failure in Your Community Fact Sheet