FEMA Mitigation Dam Task Force Strategic White Paper on Dam Risk

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Final Report

FEMA

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1) State Dam Name: Baileys Pond Dam Latitude: 33.594676 Longitude: - 81.285939; Regulator: SCDHEC A-1

2) State Dam Name: Corbett Lake Dam Latitude: 33.648651 Longitude: - 81.21133; Regulator: SCDHEC A-5

2) State Dam Name: Able/ Cobett Pond Dam Latitude: 33.62181631 Longitude: -81.23376209; Regulator: SCDHEC A-10

4) State Dam Name: O E Rose Dam Latitude: 33.80674348 Longitude: - 80.09057333; Regulator: SCDHEC A-13

5) State Dam Name: Lakewood Pond Dam Latitude: 33.7318223 Longitude: - 80.09334774; Regulator: SCDHEC A-19

6) State Dam Name: Chapman's Pond Dam Latitude: 34.42 Longitude: - 79.941666 Regulator: SCDHEC A-25

7) State Dam Name: Cook Pond Dam Latitude: 34.15243939 Longitude: - 80.77560768 Regulator: SCDHEC A-30

8) State Dam Name: Clyburn Pond Dam Latitude: 34.329886 Longitude: - 80.302055 Regulator: SCDHEC A-35

9) State Dam Name: Old Mill Pond Dam Latitude: 33.974641; Longitude: - 81.232641; Regulator: SCDHEC A-42

10) State Dam Name: Barr Lake Dam; Latitude: 33.958512 Longitude: - 81.259604; Regulator: SCDHEC A-52

11) State Dam Name: Gibson's Pond Dam; Latitude: 33.969067 Longitude: - 81.244925; Regulator: SCDHEC A-60

12) State Dam Name: JW Smoaks Pond Latitude: 33.525181; Longitude: - 80.93454; Regulator: SCDHEC A-69

13) State Dam Name: SCNONAME 38036 (Cleveland Street) Latitude: 33.52294114 Longitude: - 80.51387012; Regulator: SCDHEC A-76

14) State Dam Name: Busbees Pond (Hutto's Millpond Dam) Latitude: 33.55656622 Longitude: -81.05704327; Regulator: SCDHEC ***A-81***

15) State Dam Name: Culler Pond (SCNONAME 38070) Latitude: 33.63670829 Longitude: -81.15938027; Regulator: SCDHEC ***A-86***

16) State Dam Name: Lake Elizabeth Latitude: 34.113028; Longitude: -80.987693; Regulator: SCDHEC ***A-91***

17) State Dam Name: Cary's Lake Dam Latitude: 34.048873; Longitude: - 80.957954; Regulator: SCDHEC ***A-99***

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19) State Dam Name: Pinewood Lake Dam; Latitude: 33.94404929, Longitude: - 80.91198374; Regulator: SCDHEC. ***A-111***

20) State Dam Name: Weston Pond Dam; Latitude: 33.883093, Longitude: - 80.768417; Regulator: SCDHEC ***A-118***

21) State Dam Name: Wilson Millpond Dam Latitude: 33.99992669; Longitude: - 80.74288775; Regulator: SCDHEC. ***A-122***

22) State Dam Name: Duffies Pond Dam; Latitude: 33.84433294, Longitude: - 80.85269049; Regulator: SCDHEC. ***A-129***

23) State Dam Name: Ulmers Pond; Latitude: 33.968661; Longitude: -80.89535; Regulator: SCDHEC ***A-135***

24) State Dam Name: Sunview Lake Dam; Latitude: 33.96735 Longitude: - 80.91163; Regulator: SCDHEC ***A-141***

14.25) State Dam Name: Lower Rocky Ford Dam /Rocky Ford Lake; Latitude: 34.036033, Longitude: -80.952343; Regulator: SCDHEC. ***A-146***

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27) State Dam Name: Walden Place Dam; Latitude: 34.11678, Longitude: - 80.84591; Regulator: SCDHEC ***A-162***

28) State Dam Name: Covington Lake Dam; Latitude: 34.13463666, Longitude: - 80.97464885; Regulator: SCDHEC ***A-169***

29) State Dam Name: Beaver Dam/Wildewood Pond #2/Boyd Pond Two; Latitude: 34.096382 Longitude: -80.886478; Regulator: SCDHEC ***A-175***

30) State Dam Name: Clarkson Pond Dam; Latitude: 33.87006 Longitude: - 80.826624; Regulator: SCDHEC ***A-181***

31) State Dam Name: Ellerbees Millpond Dam Latitude: 34.06843763 Longitude: -80.53162143; Regulator: SCDHEC ***A-185***

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1) Executive Summary

From October 1-5, 2015, heavy rainfall over parts of South Carolina resulted in the failure of 31 state regulated dams, one federal dam, two sections of the levee adjacent to the Columbia Canal, and many unregulated dams. A Dam Task Force was deployed by FEMA Mitigation in support of recovery efforts. The group was tasked to assess the dams and provide their expertise and insights to the State of South Carolina, FEMA HQ, FEMA Region IV, and Joint Field Office (JFO) leadership.

Joint Field Office operations during a disaster rarely involve strategic and widespread issues regarding dams. As such, there are many dam-related lessons that can be learned from this disaster. There is an opportunity to document these failures and provide recommendations to inform and enhance recovery efforts in South Carolina and dam risk management activities in other states. This report is limited in scope and provides the context by which risks related to dams and dam failure are managed in South Carolina, with some implications nationwide.

Subsequent sections discuss South Carolina's dam regulations as well as dam- related activities undertaken by FEMA Region IV and the South Carolina JFO. This information will help FEMA leadership, including Hazard Mitigation, to better understand the dam-related issues and improve operations in the future. It also provides general comments and considerations for each state regulated failed dam and the Columbia Canal levee failure. This includes an even broader view summarizing key strategic recommendations for the measures necessary to improve dam coordination, resilience, and communication for reducing future dam risks.

Section 5 highlights various organizations and their involvement with dam-related response and recovery operations. Section 11 provides a general summary of trends and Section 12 features the overall strategic recommendations for improving dam coordination, resilience, and risk communication as well as measures to improve disaster and recovery operations in the future. The recommendations from this study are as follows:

Further Study

General Recommendation 1: Perform Additional Dam Risk Assessment on Select Failed Dams for This Event

The number of state regulated and non-state regulated dam failures during this flooding event was unique. In partnership with the South Carolina Department of Natural Resources (SCDNR), South Carolina Emergency Management Division (SCEMD), and South Carolina Department of Environmental Control (SCDHEC), additional dam analysis on select South Carolina failed dams should occur.

General Recommendation 1a: General Additional Assessment Should Be Performed on Select Failed Dams for This Event.

The Assessment should consider, but not be limited to:

a. The availability of dam insurance for the dam owners.
b. Existing communication channels among federal, state agencies, local governments, and individuals regarding flood risk from dam failure.
c. The number of NFIP insured home owners downstream of the failed dams
d. How dam risk is addressed in State and local Emergency Operation Plans (EOPs).
e. Local emergency management officials access to dam owner Emergency Action Plans.
f. Availability of dam breach inundation maps to local emergency management officials and planners.
g. The local government planning and zoning efforts relative to dam risk management.
h. Dam owner operations and maintenance plans and whether those plans were activated for this event.
i. Availability of technical and risks management training and guidance for the dam owners.
j. Level of community awareness and preparedness regarding dam-related flood risk (including surveillance and early warning protocols).

General Recommendation 1b: Assess Failed Dams Based on Prioritization Criteria

Understanding there is often limited time, resources and funding available, the below criteria may help prioritize which failed dams to analyze. The Dam Task Force recommends limited resources be applied to High hazard (C1) and Significant hazard (C2) dam failures that meet at least one of the following:

i. The dam is part of a watershed having potential cascading dam failures.
ii. The dam is located in an area that received 16+ inches of rain over the 5- day period of this event.
iii. High Water Mark data was collected downstream of the dam.
iv. The dam is known to have deficiencies noted in the last SCDHEC inspection.

General Recommendation 1c: Additional Technical Assessment Should Be Performed on Specific Failed Dams for This Event:

The dams in Table 12.1 should be considered by SDHEC, SCEMD, SCDNR, or other appropriate agencies for additional technical assessment including:

a) Event-specific dam breach consequence analysis.
b) Assessment of the evacuation actions that occurred as a result of the failure.
c) The hazard creep that occurred downstream of the failed dams.

d) Event specific dam failure modeling and incremental consequence assessment to compare flood event versus dam breach inundation.
e) A comparison of dam breach modeling results (HEC-RAS, DSS-WISE, FLO- 2D, etc.) to event-specific high water mark inundation areas downstream.
f) Further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
g) Determining the probable cause of failure because of this event.

Cook Pond Dam
Old Mill Pond Dam
Gibson Pond Dam
Lake Elizabeth Dam
Cary's Lake Dam
Murray Pond Dam
Pinewood Lake Dam
Wilson Millpond Dam
Ulmers Pond Dam
Lower Rocky Ford Dam
Upper Rocky Ford Dam
Walden Place Dam
Beaver Dam
Barr Lake Dam

Table 12.1

Flood Mapping

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 Recommendation 3: Flood Insurance Study (FIS) – National Inventory of Dams (NID) Stream Name Consistency

FEMA Region IV and SCDNR should meet with the state dam safety program to determine their familiarity with the FIS reports, FIS profiles, and Risk MAP products. This should include discussing the benefit of using consistent information in the NID which would facilitate researcher's abilities to more efficiently cross reference.

Regulatory

General Recommendation 4: Review and Strengthen Language within South Carolina's Regulations, Policies and Procedures

South Carolina should consider reviewing key regulations, policies, and procedures for opportunities to improve and strengthen language relating to:

h) The incorporation of dams and dam failure in periodic emergency exercises for flooding scenarios.
i) Periodic exercises of Emergency Actions Plans for High Hazard (C1) dams.
j) Inclusion of local emergency managers into the Emergency Action Plan sharing process for dams in that area.
k) Inspections incorporating operations and maintenance plan reviews and testing out key components, such as outlet gates for their operability.
l) Inundation map requirements for Emergency Action Plans on High Hazard (C1) and Significant Hazard (C2) dams.
m) Coordination of local watershed management plans.

General Recommendation 5: Regulate Columbia Canal Levee

The SCDHEC dam safety office does not regulate this levee. This hydraulic structure should be regulated by the appropriate State agency.

Coordination

General Recommendations 6: FIMA Disaster Contracting Capability and Support

The National Dam Safety Program Manager and the FIMA contracting team for the Production Technical Services (PTS) and Hazard Mitigation Technical Assistance Program (HMTAP) contracts should evaluate the scope of both contract vehicles (as well as other DHS/FEMA strategic contract vehicles) to determine appropriateness and best application to deliver technical assistance to support pre-disaster planning, disaster and post-disaster actions supporting the JFO. Standard Operating Procedures should be established, documented, and approved by leadership to assure that FIMA can expeditiously contract the technical assistance supporting JFO operations.

General Recommendation 7: National Dam Safety Program Technical Assistance during Disaster Operations

FEMA should establish, through the National Dam Safety Program and the Interagency Committee on Dam Safety, a formal mechanism and protocol for deploying Federal dam safety and risk management subject matter experts to support State and local officials during disaster operations involving large and/or multiple dam failures with the potential to adversely impact life and property.

This support should include, but not limited to: data collection, emergency inspections, performance analysis, and post disaster assessments of dam infrastructure and dam risk management effectiveness.

General Recommendation 8: Develop Dam Inundation Mapping

SCDHEC should consider coordinating with dam owners for development of inundation maps for C1 and C2 dams. These maps should be shared with local Emergency Management Agencies (EMA's) to develop evacuation plans. The dam breach inundation maps should also be shared with local planners and decision makers for inclusion in land use planning and zoning for the potentially impacted areas.

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 Recommendation 10: Improve Coordination with Civil Air Patrol (CAP) for Dam-Related Incidents

Civil Air Patrol provides an excellent resource during the initial phase of response operations. It is recommended that FEMA coordinate with the Civil Air Patrol to provide specific dam information. This information would allow CAP to provide photos and additional observations to the state EMA, the state dam regulatory agency, and FEMA during the flooding event. It is also recommended that appropriate parties coordinate in advance with CAP on the criteria for dam photos, the locations of dams, and other important details to inform operations during future flood events.

General Recommendation 11: Develop a JFO Dam Risk Management Framework for the Future

A framework should be developed to enable a unified dams risk management team be stood up at JFOs. This unified task force would include personnel from all relevant organizations and agencies. The Framework should address the lifecycle of response actions and be managed by a single FEMA project manager. A pre- designated point of contact tasked with coordinating response and recovery efforts across multiple agencies will minimize duplicative efforts and ensure a more efficient and effective operation. Currently, such a framework does not exist.

General Recommendation 12: Improve Coordination between the State and FEMA Region IV

Active and more frequent coordination is encouraged for the appropriate state agencies (SCDHEC, SCEMD, SC DNR) and FEMA Region IV regarding dam flood risk in mitigation plans, EAP's, inundation maps, response exercises related to dam failures, Risk MAP, and flood studies. The open dialogue will help facilitate shared resources and ultimately offer more accurate and complete information to communicate and plan for dam flood risk.

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.

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 Recommendation 15: Coordinate SCDNR Activities with Other State Agencies

The state agency responsible for flood studies, SCDNR, should coordinate with other state agencies, SCDHEC, SCEMD, etc., for inclusion of the risks relating to dams in future and on-going flood studies. SCDHEC should share available dam inundation information and dam condition assessments, planned watershed management studies with SCDNR, where applicable, to improve characterization of the flood risk and the impact that dams have on flooding. SCDNR should share their efforts, dam mapping assumptions in flood studies, with SCDHEC in order to improve overall risk reduction and improve dam resilience. SCEMD should share their mitigation strategy as well as the location of funded mitigation projects that may impact the hydrology and/or hydraulics of a stream. Coordinated information sharing will facilitate in identifying those "hot spots" that should be considered for mitigation actions. In addition, information sharing across agencies will allow for a more comprehensive watershed study.

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.

General Recommendation 17: FEMA Region IV and HQ Dam Safety Should Better Coordination with Other Federal Agencies (OFAs)

FEMA HQ and FEMA Region IV should improve their dam-related coordination with the Federal Energy Regulatory Commission (FERC), U.S. Army Corps of Engineers (USACE), Department of Homeland Security Infrastructure Protection (DHS IP), and other appropriate federal agencies in order to develop tactics, strategies, and relationships before future events to maximize efficiencies and effectiveness post event.

Training, Awareness, and Exercises

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.

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 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 floodevents.

General Recommendation 21: Develop a Standard Operating Procedure

The appropriate state agency should develop a Standard Operating Procedure (SOP) to facilitate dam flood risk information sharing and training across state agencies and establish a protocol for utilizing regional and national dam safety expertise during a disaster. This should include developing a process for requesting assistance through the Emergency Management Assistance Compact (EMAC), where applicable.

General Recommendation 22: Provide Additional Technical Assistance

1) FEMA, through the National Dam Safety Program and the National Preparedness Technical Assistance Program should develop and deliver products and services targeted to State and local communities that address specific dam risk management challenges. Products and services could include dam breach consequence assessments; the identification of high-risk dams and development of community and regional preparedness, response, recovery, and mitigation strategies for those risks; evacuation planning; EAP/EOP exercise planning; training on early warning systems; and dam owner training and workshops. In order to meet this need, additional staffing will be required. It is recommended that the National Dam Safety Program be expanded to include twelve additional personnel, two located at FEMA headquarters and one within each of FEMA's ten regional offices.

2) Introduction

From October 1-5, 2015, heavy rainfall over parts of South Carolina resulted in the failure of 31 state regulated dams, 1 federal dam, two sections of the levee adjacent to the Columbia canal, and many unregulated dams. A Dam Task Force was deployed by FEMA Mitigation in support of recovery efforts. The group was tasked to assess the dams and provide their expertise and insights to the State of South Carolina, FEMA HQ, FEMA Region IV, and JFO leadership.

The five member mitigation task force began deploying on October 19, 2015, and is comprised of two staff from HQ, a dam safety expert and a Hazard Mitigation Assistance specialist, two FEMA Region IV dam safety program personnel, and a FEMA RIV civil engineer from the Risk MAP (Mapping, Assessment, and Planning) program. Upon arrival, the task force coordinated their efforts with a number of agencies, including FEMA HQ (Dam Safety, Grants Implementation, Response & Recovery, Risk Analysis), FEMA Region IV (Dam Safety, Mitigation Planning, Risk MAP, RRCC, GIS Resource Center), JFO staff (Operations, Planning, Floodplain Management, Insurance, Geographic Information Specialists (GIS), Federal Disaster Recovery Coordinator (FDRC), Public Assistance (PA), U.S. Army Corps of Engineers (USACE), DHS Infrastructure Protection (IP)), and state agencies (SCDHEC (State Dam Safety Program), SCEMD (State Hazard Mitigation Officer and Natural Hazards Plans Coordinator), SCDNR (State Floodplain Management Coordinator), and the State Disaster Recovery Coordinator (SDRC)). Extensive coordination and collaboration enabled the team to document the 31 state regulated dam failures and the Columbia Canal levee failure within the context of the disaster, affording them the ability to provide preliminary strategic comments and recommendations to improve dam-related coordination at all levels, inform recovery activities, and reduce future dam risk.

Do to the sheer number of failures as a result of this event, there is a heightened interest and concerted effort to determine how best to foster recovery efforts and improve dam planning and resilience in South Carolina and nationwide. JFO operations during a disaster rarely involve strategic and widespread issues regarding dams. As such, there are many opportunities for improvement in risk management relating to dams based on lessons learned and documented from this disaster. This report attempts to provide a holistic snapshot of the many different dam-related activities that occurred at FEMA Region IV and the JFO. This will help FEMA leadership to better understand the dam-related issues for improved operations in the future. It also provides general comments and considerations for each state regulated failed dam and the Columbia Canal levee. The report concludes with overall comments and strategic recommendations for improving dam resilience and communication.

3) Purpose of Report

The purpose of this report is to provide general comments and strategic recommendations to improve dam coordination, resilience, and communication for reducing future risks relating to dams and dam failure.

The report includes:

- A general overview of dams and the role of the state and federal government in reducing risks related to dams and dam failure
- Relevant storm event information
- An account of dam-related actions and activities in response and recovery with a focus on the state regulated failed dams and the Columbia Canal levee failure
- Documentation of existing challenges within the lifecycle of dam risk management based on thirty one state regulated failed dams and the Columbia Canal Levee failure
- Strategic comments and recommendations to help mitigate or improve community resilience to dam failures

The intended audience of this report includes:

- The Joint Field Office (JFO) leadership including the
    - Federal Coordinating Officer (FCO) and appropriate staff
    - State Coordinating Officer (SCO) and appropriate staff
    - JFO Mitigation Branch Director and appropriate staff
    - State Hazard Mitigation Officer (SHMO) and appropriate staff
    - Other state agencies as is appropriate
- FIMA Leadership with further dissemination as is appropriate
- FEMA Mitigation Region IV Leadership with further dissemination as is appropriate
- The National Dam Safety Program
- The Regional Dam Safety Program

3.1 Limitations

Report Limitations:

- This study is limited to the 31 state regulated dams and the Columbia Canal levee.
- Site visits to each of the state regulated failed dams and the Columbia Canal were not undertaken.
- Information on each state regulated dam was culled primarily from the National Inventory of Dams (NID). The NID was referenced for name, stream or river, hazard class, NID ID, dam type, purpose, length, drainage area, surface area,

max discharge, max storage, county, nearest downstream city/town, State ID, owner type, year completed, year modified, height, EAP, and condition for each state regulated failed dam in this report.

- The original National Register of Historic Places Inventory nomination form for the Columbia Canal dated July 17, 1978, was referenced for the stream name, length, county, owner type, year completed, and year modified.
- South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program provided state dam name, latitude, longitude, state hazard classification, and confirmation of failure for each state regulated failed dam in this report.
- SCDHEC confirmed EAP information as annotated for each dam in Appendix A. In a few instances, their information was different than the field from the NID.
- Effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) information, with associated flood modeling, was retrieved from the FEMA Map Service Center.
- This report was developed by the FEMA Mitigation Dam Task Force within a short timeframe.

3.2 Applicability

Many of the recommendations relate to challenges applicable across states, not solely in South Carolina. Recommendations that are national in scope may be beneficial to many states.

4) Methodology

The FEMA Mitigation Dam Task force consisted of five members in all, two from FEMA HQ and three from FEMA Region IV. FEMA HQ provided the lead for the overall team, a civil engineer who is both the program manager for the National Dam Safety Program and the Senior Technical and Policy Advisor for Dam Safety to the FEMA Administrator. FEMA HQ also provided a senior mitigation grants policy specialist. The three regional members were all civil engineers, one with expertise in FEMA flood mapping and the other two from the Regional Dam Safety program.

Due to limited time and resources to complete the strategic assessment, the team focused on ***failed state regulated dams and the Columbia Canal levee failure.*** This provided a much smaller subset of dams to assess. There is also more information available on this subset since SCDHEC permits, inspects and has enforcement authority for these dams.

A state regulated dam is subject to the South Carolina Dams and Reservoirs Safety Act Regulations 72-1 thru 72-9 as amended July 25, 1997. State regulated dams will meet the state definition of a dam and will have a State Identification number for that dam. Dams that were damaged during the event, but were not breached, are in response or repair mode. These damaged dams are under review by FEMA Public Assistance or other state and federal agencies with appropriate authorities.

There are many failed impoundments that do not meet the state definition of a dam and are unregulated. These unregulated failed impoundments are not addressed in this report.

This report provides appropriate context through which readers can better understand the disaster cycle for dam failure events. This includes information on the different agencies involved in dams; the current laws, regulations, and initiatives specific to dams; and how these groups coordinate. The information and insights gathered to help develop this strategic white paper also informed a contract to develop Recovery Advisories and Fact Sheets to aid dam-related recovery efforts in South Carolina. The contract also includes a final report, which will identify National Dam Safety Program capability gaps and provide strategic recommendations for improving dam resilience, public awareness, collaboration, coordination, and communication for dam risk reduction with internal and external partners.

The FEMA lead attended key meetings of state and federal dam stakeholders at the JFO. Information from these meetings was shared with the team and informed research and data gathering efforts.

The team gathered information from:

1) The 2013 National Inventory of Dams (which is the most current NID data) on failed dams
2) SCDHEC list of failed dams from their website
3) SCDHEC pre-storm inspection reports from their website
4) FEMA approved State and Local Mitigation Plans for communities having state regulated failed dams
5) FEMA Mitigation Planning website
6) Google Earth and Google Maps for dam locations
7) Photos from the Civil Air Patrol
8) SCDHEC emergency orders for the failed dams
9) Field notes and photographs by the dam inspection task force (different from this effort) from assessments of the state regulated dam failures. This task force included USACE, SCDHEC, and HDR.
10) FEMA Flood Insurance Study (FIS) data
11) FEMA Flood profiles within the FIS report
12) FEMA Flood Insurance Rate Maps (FIRMs)
13) FEMA Risk MAP data
14) Event flood inundation extents for this event developed by FEMA HQ based on USGS high water mark
15) FEMA National Flood Hazard Layer (NFHL) in GIS
16) SCEMD coordination and event information
17) SCDHEC coordination and event information
18) SCDNR coordination and event information
19) FEMA JFO Public Assistance

20) FEMA JFO Dams Advisory Group
21) FEMA JFO EHP
22) South Carolina dam safety legislation and regulations 23)United States dam safety legislation
24) FEMA dam safety grant requirements
25) FEMA Hazard Mitigation Assistance grant requirements
26) NOAA Precipitation data for this event
27) Preliminary Report for this event by USGS
28) Carolinas Integrated Sciences & Assessments (CISA) at the University of South Carolina report on the South Carolina Floods of October 2015

Comments and considerations relevant to each dam were reviewed to identify trends. The general comments and recommendations are summarized in Section 11 and Section 12 of this report. They are written in actionable, practical language and can be executed to improve dam coordination, resilience, and communication for reducing future dam risk while improving disaster and recovery operations.

5) Other Dam-related Efforts in Response & Recovery

5.1 FEMA Region IV Regional Response Coordination Center (RRCC)

In anticipation of Hurricane Joaquin, FEMA Region IV Regional Response Coordination Center activated on Friday, October 2, 2015 to Level 1 (Full Activation). The focus of the regional response shifted towards heavy rain and flooding with the changing weather predictions. Reports of dam incidents and failures came into the RRCC beginning on Saturday, October 3, 2015.

5.1.1 Civil Air Patrol (CAP)[1]

On October 6, 2015, FEMA mission assigned the Civil Air Patrol to collect domestic digital aerial images of flood-impacted areas as specified by FEMA Region IV Operations.[2] The Civil Air Patrol flew sorties across the state to take damage-assessment photos.[3] Aerial images were collected of some of the failed dams during the course of this mission.

5.1.2 Decision Support System for Water Infrastructure Security (DSS-WISE) Modeling[4]

An individual from the regional dam safety program was deployed to RRCC as an information collection specialist on October 2 and was available to provide subject matter expertise on dams and dam failure. This included coordination with planning to contract with the University of Mississippi National Center for Computational Hydroscience and Engineering (UM-NCCHE) on October 7, 2015, for cascading dam failure

[1] http://www.gocivilairpatrol.com/about/
[2] http://www.scwgcap.org/latest-news
[3] http://fema.maps.arcgis.com/apps/MapJournal/index.html?appid=8aa3d4afc3e14c9bbd3b79881664c37e
[4] http://www.ncche.olemiss.edu/projects/DSS-WISE

modeling for three dams in series in the Gills Creek drainage basin and one single dam failure. The results were provided in a Google Earth file with layers for the maximum depth of flood and the time of arrival for the flood wave. This information was used internally for response planning and shared with South Carolina for use by the state during the disaster.

5.1.3 United States Geological Survey (USGS) High Water Marks[5]

On October 6, 2015, FEMA mission assigned the United States Geological Survey (USGS) to collect roughly 100 stream miles worth of high water marks (HWM) in the affected areas of South Carolina. The collection of this data helped to determine the impacted areas as a result of riverine flooding due to severe storms and heavy rainfall. HWM were collected downstream of Carys Lake Dam, Lakewood Pond Dam, Lower Rocky Creek Dam/Rocky Ford Lake, North Lake Dam, OE Rose Dam, Pinewood Lake Dam, Semmes Lake, Sunview Lake Dam, and Ulmers Pond during the course of this mission. FEMA HQ developed flood inundation areas from the USGS HWM information.

5.1.4 United States Army Corps of Engineers (USACE) Mission Assignments

The US Army Corps of Engineers (USACE) was provided a Mission Assignment by FEMA through the Region IV RRCC on October 7, 2015, to "Request USACE to provide engineers to assess damaged private dams and confronting safety issues". This entailed USACE providing appropriate dam Subject Matter Expertise (SME) for assessments of high and significant hazard dam in assistance to SCDHEC. These were advisory assessments since SCDHEC maintains responsibility for regulating dams in South Carolina. This work was a response effort.

The initial Mission Assignment was amended on October 12 to extend the timeline of the work to October 22. This work continued the response related advisory assessment by USACE. USACE assisted with assessments for 652 high and significant hazard dams, designated C1 and C2 respectively in South Carolina regulations. SCDHEC was responsible for all regulatory measures on dams, not the Army Corps of Engineers.

5.1.4.1 USACE Drone Missions

The US Army Corps of Engineers was provided a Mission Assignment by FEMA through the Region IV RRCC on October 7, 2015, to "*Deploy Unmanned Aerial System (UAS) and operators to provide products including georeferenced high resolution aerial*

[5] http://stn.wim.usgs.gov/Joaquin

imagery in support of FEMA". USACE flew six drone missions in which videos were taken of key sites, to include Andrews Airport, Beaver Dam, Columbia West Canal, Forest Lake Dam, Lake Katherine Dam, and Spring Lake Dam.

5.1.5 Department of Homeland Security Infrastructure Protection (IP)

A civil engineer from DHS IP from the National Capital Region deployed on or around October 6 to South Carolina. He provided dam safety expertise, along with USACE, through assessments of dams to SCDHEC in an advisory capacity. SCDHEC remained the sole regulator of these dams having responsibility in enforcing their regulations.

5.2 South Carolina Emergency Management Division (SCEMD)

SCEMD plans for the "consequence management" aspect of dam failures, breaches, and overtopping of dam structures. Consequence Management occurs at the County Emergency Management level, with SCEMD coordinating state- level resources as needed to support county-level operations. SCEMD, in coordination with South Carolina Department of Health and Environmental Control (SCDHEC), informs county Emergency Management of known issues and concerns.

SCEMD responded initially and proactively as Hurricane Joaquin threatened the South Carolina coast. The increasing threat of an "extreme rain event" caused the full activation of the State Emergency Operations Center (SEOC) on October 3, 2015. The SEOC remained activated until the JFO became fully operational (October 19, 2015). SCEMD coordinated activities associated with supplying of sandbags, public information, responding to power outages, washed out roads, bridges, and road closures, flooding on major interstates (I- 126, I-26, I-95 & I-20), animal rescues, disposal of animal carcasses, swift water rescues, backup power to hospitals, hospital evacuations, wastewater issues, Code Red activations, curfews, sinkholes, fly-over missions, astronomic tides, points of distribution, and preliminary disaster assessments.

SCEMD and the State Emergency Response Team (SERT) maintained awareness, relayed essential information, and coordinated additional resources to support local needs. This included anticipatory and coordinated actions to monitor water levels, conduct coordinated releases, and deployment of USGS Rapid Deployment River Gauges. Other support included monitoring, anticipating, synchronizing, and relaying information to ensure state and local officials (i.e., SCDHEC, FERC dam owners, and counties) were properly notified of the various issues, and were able to respond appropriately. Other emergencies during this time included: a plane crash killing 5 in Lake Hartwell, an oil spill in Union County, a breach in the seawall on Edisto Island, and numerous motor vehicle accidents and traffic accidents. SCEMD also became heavily involved in decisions relating to local disaster declarations, the

Governor's Executive Orders, as well as Executive-level conference calls and Governor's press briefings.

5.3 South Carolina Department of Environmental Control (SCDHEC)

SCDHEC performed response and regulatory functions throughout the life cycle of this event. These functions included performing response operations relating to dams at the SCEMD State Emergency Operation Center (SEOC) on 24 hour operations for roughly two weeks, beginning on Saturday, October 3, 2015. The SCDHEC central office coordinated with their multiple regional offices for performing hundreds of dam inspections as well as with federal, state, and local entities as needed. They also provided 75 emergency orders to dam owners, which included the 31 state regulated failed dams. SCDHEC is responsible for providing permits for construction of new dams, repairs of existing dams, alterations of existing dams, and removal of existing dams. SCDHEC is responsible for providing emergency orders as triggered or In Accordance With (IAW) state dam regulations.[6] SCDHEC also coordinated with the US Army Corps of Engineers as outlined in the Mission Assignments section above, as well as with their contractor, HDR.

5.3.1 FEMA CORPS Supporting SCDHEC Operations

SCDHEC utilized two FEMA CORPS members at their data input and call center. SCDHEC provided pre-scripted information sheets from which the FEMA CORPS personnel called dam owners and asked about their dams to verify and update information for each dam. They also collected response related information on the existing condition, performance during the event, and status of each dam. The FEMA CORPS members updated SCDHEC databases and provided feedback to SCDHEC on the status of the dams. The two FEMA CORPS members performed these duties for roughly 16 days with the assignment ending October 27, 2015.

5.3.2 HDR Contract to SCDHEC Operations

SCDHEC is contracting with HDR to monitor the 75 emergency orders on dams to ensure the dam owners proceed with carrying out the SCDHEC emergency order requirements. If the dam owner does not perform these requirements, then SCDHEC will work with HDR in implementing pumps and siphon operations to reduce water levels, thereby reducing water pressures and dam failure risk. HDR is also contracted to review SCDHEC regulations and statutes and provide information and recommendations to SCDHEC on opportunities for improvements to their operations. HDR will be reviewing the Gills Creek Watershed and providing an overall management strategy plan to SCDHEC for improving the resilience of this watershed.

[6] R.72-1 through R.72-9, Dams and Reservoirs Safety Act Regulations (Effective: July 25, 1997)

There were at least four state regulated dams that failed in this watershed during this flood event.

5.4 FEMA JFO Dams Advisory Group

The purpose of this advisory group was to identify ways that federal agencies might be able to provide assistance for privately owned dams. This interagency group included FEMA, USACE, USDA, SBA, and others. The effort included reviewing federal opportunities for technical assistance, funding, and loans for private dam construction, repair, replacement, mitigation, and removal. A white paper outlining potential federal funding assistance options for privately owned dams was drafted and is intended for outreach by the state.

5.5 FEMA JFO Public Assistance (PA) Efforts on Dams

Public Assistance is carrying out its normal functions and authorities for determining whether the impacted dams are eligible[7] for Public Assistance grants. PA may provide grants to state agencies, local communities, and other eligible dam owners, where consistent with applicable policies and procedures. Unfortunately, many of the dams discussed within this paper are privately owned and ineligible for PA grants. There were public roads on some of the state regulated failed dams. PA will be working closely with these applicants to determine project eligibility.

6) FEMA Flood Mapping regarding Dams

6.1 Risk Mapping, Assessment and Planning (Risk MAP) Overview

FEMA's Risk MAP Program (Mapping, Assessment and Planning) began in Fiscal Year 2009. Its vision is "*through collaboration with State, Local, and Tribal entities, Risk MAP will deliver quality data that increases public awareness and leads to action that reduces risk to life and property*". The Program aims to bring the many facets of mitigation together to better help the public to understand their risk and plan their mitigation strategies accordingly. "*Risk MAP will provide an integrated national assessment of flooding risks based on digital flood hazard data and web-accessible data. This information will enable communities to develop mitigation plans and make informed risk management decisions that maximize loss reduction.*"

6.2 Regulatory Flood Hazard Products

The purpose of the FEMA regulatory products (FIRM, FIS Report, and FIRM database) is to provide the basis for the National Flood Insurance Program (NFIP) mandatory requirements such as insurance purchase and ratings as well as certain minimum prescriptive and performance requirements for structures located in a Special Flood Hazard Area (SFHA). These products are required to

[7] http://www.fema.gov/public-assistance-eligibility

go through a formal due process before becoming effective and being adopted by the community.

The following are the regulatory Flood Hazard Products:

- Flood Insurance Rate Map (FIRM) – the official map of a community that shows Special Flood Hazard Areas (SFHA). The different zones shown on the FIRM depict the differing levels of flood risk and are one of many factors, which influence insurance premiums for structures.
- Flood Insurance Study Report (FIS) – the narrative of the Flood Insurance Study. This report contains the documentation regarding the scope of work, the hydrologic and hydraulic modeling used, summary of discharges, and water surface elevation profiles of the studied streams.
- FIRM Database – houses the geographic layers used to produce the FIRM as well as data used to produce the FIS.

6.3 Risk MAP Non-Regulatory Products

The purpose of the Risk MAP Flood Risk (non-regulatory) is to complement the FIRM, FIS, and FIRM database and help stakeholders visualize their flood risk. These products are not required to be used and are purely voluntary for those communities who wish to use them. These products help community officials improve their understanding of the flood risk and enable them to make better informed decisions regarding project planning to reduce the potential for loss of life and property damage.

The following are non-regulatory products that are available for each funded Risk MAP Flood Project:

- Flood Risk MAP (FRM) – This map provides an overall picture of the watershed/area that was studied. As the size and scope varies from study to study, different categories of information may be shown, i.e., potential damages by census block, areas of mitigation interest, streams to be studied, critical facilities, significant hydrologic or hydraulic infrastructure.
- Flood Risk Report (FRR) – This report is the non-regulatory equivalent of the FIS. It provides the narrative description on a community level of the specific risk information developed during the project. It explains each of the products that are being supplied and provides useful references.
- Flood Risk Database (FRD) – The FRD houses all of the flood risk information developed for the project area. The FRM and FRR use the data from the FRD. Since it is a database, communities are able to use the different elements to fit their specific needs for flood risk awareness and communication. Elements that could be included, but are not limited to:
    - Changes Since Last FIRM (CSLF) – graphical representation of a comparison between the effective and preliminary flood extents.

This product helps identify those areas where additional outreach may be needed as well as highlights those areas with significant increase or decrease in flood risk.

- Areas of Mitigation Interest – highlights those areas where a project may have contributed to a significant change in Special Flood Hazard Area (SFHA) and may help in identifying the need for a mitigation project.
- Flood Depth and Analysis Grids – depict the depth and velocity of floodwaters as well as the probability of an area being flooded over a certain period of time
- Risk Assessment Data provides an estimate of potential financial consequences on structures located in a SFHA to a census block level. Generally, FEMA's Hazards U.S. (HAZUS) model is used for this analysis.

- As mentioned, additional datasets may be created that would be beneficial for the study location and community needs and information availability.

6.4 Risk MAP Regarding Dams

Non-regulated products are a major component of Risk MAP. Unlike the Flood Insurance Rate Maps (FIRM), these products help the user to better visualize and quantify risk: water surface elevation grids, depth grids, velocity grids, areas of mitigation interest, flood risk reports, and watershed maps, to name a few. A Water Surface Elevation (WSEL) grid could be created for dam-related flooding based on a specific flood scenario. Using the specific characteristics of the flooding event along with the dam configurations and hydrologic conditions, WSEL for numerous situations could be modeled and mapped. FEMA documented guidance and policy regarding the hydrologic and hydraulic modeling of dams for a Flood Insurance Study is limited. FEMA's general guidance for handling dams and reservoirs is discussed in *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C: Guidance for Riverine Flooding Analyses and Mapping,*[8] Feb 2002 Version and reads:

"Most large reservoirs on large river systems are operated with outflow controls. In these reservoirs, gates are used for regulating flow through outlet structures. The gates are operated according to established rules that determine the relationship between inflow, outflow, storage, and water demand.

The Mapping Partner that is performing the hydrologic analysis normally shall not consider storage capability below the Normal Pool Elevation of reservoirs operated primarily for purposes other than flood control because the availability of such storage is uncertain. The exception is when all of the following conditions have been met:

- *Operation of the project in accordance with its documented water control plan*

[8] http://www.fema.gov/media-library-data/1392157494364-049f1bff1ba751d5226c8dc63b2f6848/Guidelines%20and%20Specifications%20for%20Flood%20Hazard%20Mapping%20Partners%20Appendix%20C%20Guidance%20for%20Riverine%20Flooding%20Analyses%20and%20Mapping%20(Feb%202002).pdf

could affect the 1-percent-annual-chance flood elevations in a community by 1 foot or more.

- *The storage capability to be considered is totally dedicated to flood control. Where different amounts of storage can be totally dedicated during different parts of the year, the Mapping Partner shall obtain flood discharges from the joint probability combination of frequency curves established for each part of the year that the different storage levels are dedicated. Joint use storage based on forecasted inflow is not acceptable for NFIP purposes.*
- *A project water control plan providing explicit details of operation during flooding conditions is in effect and has been reviewed and approved by FEMA or another Federal agency responsible for Federal flood-control activities. The Mapping Partner that is performing the hydrologic analysis shall contact the RPO to discuss the review and approval process.*
- *A written commitment to dedication of the flood-storage capacity and to the approved reservoir operation plan is assured through a mandatory condition of Federal or State licensing or through a direct agreement between the project operator and FEMA for non-Federal projects."*

The standard practice has been as follows:

1. Review the Operation and Maintenance Plan for the dam.
    a. Where the plan shows that the dam would fail at a certain water surface elevation that is taken into consideration during the model.
    b. Where the plan shows that the dam provides storage to the 1 percent annual chance flood event that information is taken into consideration during modeling.
2. If there is no Operation and Maintenance Plan available, the best engineering judgment must be used to best account for the dam's performance.

As there are many configurations for dams and different types of studies performed for a FEMA Flood Risk Project, there are several options for how a dam should be modeled. As there is no detailed standard documented by FEMA, the policy on how a dam is modeled lies with the state. In reviewing the FIS for

South Carolina, almost all dams were modeled as inline weirs or inline weirs with bridges.

The following should be noted regarding modeling:

- For dams on a Zone A (approximate method) stream, the best available topographic data should be used to represent the top of dam and adjacent spillway.
- For AE (detailed method) streams, survey is collected for the top of dam and outlet structure and modeled appropriately. The scope of work dictates whether or not storage behind the dam is taken into accounted.
    - For these streams, survey should be collected for the top of dam and outlet structure and modeled appropriately.

Several types of dam failure inundation zones may be created: 1) sunny day failure, 2) breach at emergency spillway; generally the emergency spillway elevation is the same or coincides with the 1 percent annual chance flood elevation, 3) overtopping. It should be noted that dam inundation failure zones are not generally shown on the regulatory FIRMs. Some FIRMs have displayed dam break flooding, but it is not typically done unless it can be verified that any 1 percent chance flood would result in failure.

7) FEMA Mitigation Planning[9]

FEMA requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. Specifically:

- All states (including territories and the District of Columbia) and federally- recognized tribes applying directly to FEMA as an applicant must have a FEMA- approved hazard mitigation plan as a condition for receiving non-emergency Public Assistance (Categories C-G), Fire Management Assistance Grants, or Hazard Mitigation Assistance (HMA) project grants through the HMA grant programs. The HMA grant programs include the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) program.
- All tribes or local governments applying through a state as a sub applicant must have a FEMA-approved tribal or local hazard mitigation plan as a condition for receiving HMA project grants through the HMA grant programs. These local plans can be multi-jurisdictional. Developing hazard mitigation plans enables state, tribal, and local governmentsto:

[9] http://www.fema.gov/hazard-mitigation-planning

- Increase education and awareness around threats, hazards, and vulnerabilities;
- Build partnerships for risk reduction involving government, organizations, businesses, and the public;
- Identify long-term strategies for risk reduction that are agreed upon by stakeholders and the public;
- Identify cost effective mitigation actions, focusing resources on the greatest risks and vulnerabilities;
- Align risk reduction with other state, tribal, or community objectives; and
- Communicate priorities to potential sources of funding.

Ultimately, hazard mitigation planning enables action to reduce loss of life and property, lessening the impact of disasters.

7.2 Mitigation Plans in Areas Impacted by Dam Failures during This Event

The FEMA Region IV Mitigation Planning Team assessed the local and multi- jurisdictional mitigation plans for areas impacted by dam failures during this event. This analysis included reviewing the South Carolina State Hazard Mitigation Plan. Each local or multi-jurisdictional plan was reviewed to determine whether or not the failed dams were referenced by name or state ID. Table 9.1 compiles the results of this analysis.

ID	State_ID	Name	County	State Class	Referenced in Mitigation
1	D2034	Baileys Pond	Aiken County	C3	No
2	D2052	Corbett Lake	Aiken County	C3	No
3	D2048	Able / Cobett Pond Dam	Aiken County	C3	No
4	D3487	O E Rose Dam	Clarendon County	C2	Yes - Appen G, as SCNONAME
5	D3490	Lakewood Pond Dam	Clarendon County	C2	Yes - Appen G, as SCNONAME
6	D3533	Chapman's Pond Dam	Darlington County	C2	No
7	D1068	Cook Pond Dam	Kershaw County	C2	Yes - Appen G, p 253
8	D2412	Clyburn Pond Dam	Lee County	C2	Yes - Appen G, as SCNONAME
9	D0958	Old Mill Pond Dam	Lexington County	C1	No
10	D1717	Barr Dam/ Barr Lake Dam	Lexington County	C2	No
11	D0959	Gibson Dam/Gibson's Pond Dam	Lexington County	C2	No
12	D3738	JW Smoaks Pond	Orangeburg County	C2	No

13	D3743	SCNONAME 38036 (Cleveland Street)	Orangeburg County	C3	No
14	D3701	Busbees Pond (Hutto's Millpond Dam)	Orangeburg County	C2	No
15	D3682	Culler Pond (SCNONAME 38070)	Orangeburg County	C3	No
16	D0024	Lake Elizabeth	Richland County	C1	No
17	D0026	Carys Lake	Richland County	C1	Yes (Gills Cr Study)
18	D0595	Murray Pond Dam	Richland County	C2	No
19	D0580	Pinewood Lake Dam	Richland County	C2	No
20	D0593	Weston Pond Dam	Richland County	C3	No
21	D0594	Wilson Millpond Dam	Richland County	C2	No
22	D0600	Duffies Pond Dam	Richland County	C2	No
23	D0581	Ulmers Pond	Richland County	C1	No
24	D0579	Sunview Lake Dam	Richland County	C2	No
25	D0028	Lower Rocky Creek Dam/Rocky Ford Lake	Richland County	C1	Yes (Gills Cr Study)
26	D0029	North Lake Dam/Overcreek Rd. Dam/Upper Rocky Creek	Richland County	C1	Yes (Gills Cr Study)
27	D0572	Walden Place Dam	Richland County	C1	No
28	D0545	Covington Lake Dam	Richland County	C2	No
29	D0567	Beaver Dam Lake/Wildwood Pond #2/Boyd Pond	Richland County	C2	Yes (Gills Cr Study)
30	D0599	Clarkson Pond Dam	Richland County	C3	No
31	D1460	Ellerbees Millpond Dam	Sumter County	C2	Yes - Appen G, p 256

Table 9.1 References to State Regulated Failed Dams in Local or Multi-Jurisdictional Mitigation Plans

Each local or multi-jurisdictional plan was reviewed for references to dams or dam failure. The results of this analysis, including excerpts from these plans, is listed by county. The South Carolina State Hazard Mitigation Plan was reviewed as well.

South Carolina State Hazard Mitigation Plan

Dam/levee failure was listed as a hazard in the State of South Carolina but was eliminated as not relevant to the plan on page 11 and thus not profiled.

Aiken County Local Hazard Mitigation Plan

The Aiken County, South Carolina 2011 Local Mitigation Plan addresses structural projects but did not identify specific dams, identify dam locations, or address risks associated with dam failure and operation. Floods was identified as occurring county wide. The following water bodies have been identified on the FEMA FIRMs that could pose a potential threat: Savannah River, Edisto River, Horse Creek, Little Horse Creek, Bridge Creek, Shaw Creek, Town Creek, Hollow Creek, Cedar Creek,Tinker Creek, Upper Three Runs Creek, Ludlow Lake, Langley Pond, and Reynolds. (Note: water bodies with failed dams are in **Bold.**)

The Plan includes a Structural Projects Strategy or actions that involve the construction of structures to reduce the impact of a hazard. Examples from this strategy include projects that control floodwater, reconstruct dams and seawalls, and construct green roofs.

Clarendon County Local Hazard Mitigation Plan (Consolidated Santee-Lynches Mitigation Plan)

The Consolidated Santee-Lynches 2015 Hazard Mitigation Plan includes Clarendon County. The plan states that Clarendon County has a number of dams within the vicinity of the various watersheds in the County, with three Class 2 dams. The area most at risk for dam failure is the center of the County due to its proximity to the Pocotaligo River. In addition, there are several dams around Lake Marion, the Black River, and Pudding Swamp.

Prior to 2002, there is no record of dam failure in Clarendon County. However, during 2003 several dams failed and caused major flood damage to the Chickwood Mobile Home Park and other establishments in the Manning area.

Appendix G includes a table of dams in the Santee-Lynches Region by county that includes dam number and name, hazard class, height, and storage. The information was obtained from South Carolina Department of Health and Environmental Control – Dams and Reservoirs Safety.

Darlington County Local Hazard Mitigation Plan

Darlington County has numerous small ponds many with overflow type dams. These ponds are located on farms or in residential subdivisions and in the event of failure the dams would pose a localized threat to the immediate area downstream of the ponds. Most of these ponds discharge into small creeks or streams before discharging into larger bodies of water. Two SCDHEC regulated dams are located in Darlington County along Black Creek. These dams are located on Lake Robinson and Prestwood Lake. Two scenarios were considered in more detail for each of these regulated dams, and 3 of the 4 mitigation actions related to dam failure are specific to these dams. The plan's dam failure mitigation actions are as follows:

1) Continue agreements with the H.B. Robinson Stream Electric Plant (HBRSEP) and Sonoco Products to assist in monitoring the lake levels prior to discharging water into Black Creek.
2) Encourage residents that live downstream of both dams to develop emergency plans that include evacuation in the event of dam failure.
3) Consider to pursue efforts with the US Geological Survey and National Weather Service to install monitors on Black Creek in order to monitor creek levels across the county.

4) Encourage the owners of ponds with dams to develop plans to notify public safety agencies and neighbors in the event of a dam failure.

Kershaw County Local Hazard Mitigation Plan

The Consolidated Santee-Lynches 2015 Hazard Mitigation Plan includes Kershaw County. Kershaw County has the most Class I and Class II dams – 4 and 10, respectively, in the Santee-Lynches Region (SL). The overall potential for dam failure based on historical records is low. Kershaw County has Wateree Lake Dam (Duke Power) and fifteen millpond type dams which could cause problems. Flood conditions which occurred in the month of October 1990, however, resulted in the failure of 17 dams and the overtopping of an additional 31 dams. Kendell Mill Pond Dam in the City of Camden was one of these failures. Four people were drowned because of the Kendall Dam failure in Camden, SC.

Appendix G includes a table of dams in the Santee-Lynches Region by county that includes dam number and name, hazard class, height, and storage. The information was obtained from South Carolina Department of Health and Environmental Control
- Dams and Reservoirs Safety.

Lee County

The Consolidated Santee-Lynches 2015 Hazard Mitigation Plan includes Lee County. Lee County has experienced relatively few flood events in the past. However, it does have some flood prone areas, particularly around the Lynches and Black River Basins. As for the two population centers, Bishopville and Lynchburg, they are not at any significant risk for floods. In Lee County, the most flood prone areas are those near the Lynches River, the Black River, and Scape Ore Swamp.

Appendix G includes a table of dams in the Santee-Lynches Region by county that includes dam number and name, hazard class, height, and storage. The information was obtained from South Carolina Department of Health and Environmental Control
- Dams and Reservoirs Safety.

Lexington County

The county and 3 of 13 municipalities have adopted the Central Midlands Regional 2011 Hazard Mitigation Plan (HMP).

Dam Failure is not profiled as a hazard in the Plan; however, the plan does mention that flash flooding can occur from dam failure among other reasons.

Table III-C on page 59 leaves all Dam Failure event data blank. However, paragraph 3 on page 60 states: "*There is no discernible pattern to earthquakes in the county*

and it is a minor natural hazard. The only structure of concern for earthquake damage is the large earthen dam at Lake Murray. It is now being improved and upgraded to withstand a higher Richter scale event."

The county has two action measures related to earthquake causing dam failure: Page 293-294 - "*Ensure that warning signal system works for rapid evacuation from lands downstream of Lake Dam*" and "*Develop clearly marked and explained evacuation routes for dam failure*"

The Lexington County Joint Municipal Water and Sewer Commission also has 3 action measures related to earthquake causing dam failure on page 398:

- "*Work with SCDNR to ensure that dams in the service area are safe*"
- "*Ensure that warning system works for rapid evacuation from lands downstream of larger dams*"
- "*Develop clearly marked and explained evacuation routes for dam failure*"

<u>Orangeburg County</u>

The county and 12 of 16 municipalities have adopted the Orangeburg County 2011 HMP. Dam failure is not profiled as a hazard in the Plan.

In the section on historic occurrences of flooding (p. 63), four significant dam breaks and several minor breaks were mentioned in the August 26, 1995 North Edisto flood.

<u>Richland County</u>

Richland County and Forest Acres have adopted the Central Midlands Regional 2011 HMP; 4 jurisdictions and school systems need to adopt and Eastover did not participate. Dam Failure is not profiled as a hazard in the Plan; however, the Plan does mention that flash flooding can occur from dam failure among other reasons.

Table III-E on page 87 leaves all Dam Failure event data blank; however paragraph 3 on page 79 states: "*The last physically notable earthquake to hit Richland County was in 1971 but it caused very little damage. Earthquakes are a minor natural hazard. The only structure of concern for earthquake damage is the large earthen dam at Lake Murray. It is now being improved and upgraded to withstand a higher Richter scale event*."

The county has seven action measures related to earthquake causing dam failure:

- Page 219 and pages 278, and 279 – "*Ensure that warning signal system works for rapid evacuation. from lands downstream of Lake Dam*" and "*Develop clearly marked and explained evacuation routes for dam failure*"
- Page 231 – "*Work with SCANA to ensure that the Lake Murray Dam withstands future e"quakes*" and "*Ensure that warning signal system works for rapid evacuation from lands downstream of Lake Murray Dam*".

- Page 232 – "*Develop clearly marked and explained evacuation routes for dam failure*".

In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Table 2.19 lists dams in the watershed with dam name, owner type, height, length, year completed, year modified, and hazard class.

Sumter County

Sumter County and three jurisdictions (Mayesville, Pinewood, and Sumter) have all adopted 2015 Santee-Lynches Regional HMP. General information about the causes of failure and classifications is included on page 40 of the Plan. Sumter County is mentioned as having the second most state regulated dams in the region with 14 Class II, 43 Class III, and 57 Total.

Historic occurrences (page 73) listed Second Mill Dam as having failed three times with no failures during the 2010-2014 planning period. The river listed as the most at risk from dam failure due to Pocotaligo River. The City of Sumter is mentioned as having the most risk due to geographic location. Appendix G in the plan lists the dams by county with hazard class, height, and storage.

Appendix G includes a table of dams in the Santee-Lynches Region by county that includes dam number and name, hazard class, height, and storage. The information was obtained from SCDHEC - Dams and Reservoirs Safety.

The Mitigation Strategy Goals include a goal of reducing impact of disasters on new and existing development with a corresponding action measure that mentions dams as such:

"*Priority – Low; Title – Flood Control Projects: Implement flood control projects for areas such as farm drainage, bridge improvements, and repairing dams that are prone to failure. Responsible agency - Public Works; funding mechanism – Manpower / Budget; status – Ongoing*".

8) HMA Grants as Applicable to Dams

Hazard Mitigation Assistance Grants can be used to mitigate private dams. Hazard Mitigation Grant Program (HMGP) projects are prioritized and selected by the State. Those that best fit into the State's overall mitigation strategy and recovery plans are forwarded to FEMA for review.

Mitigation actions will be unique to each site and may include:

- Rehabilitation of the dam, which would mean to reconstruct the dam to a higher protection standard, thereby reducing risk to vulnerable infrastructure and other assets;
- Fortify existing dams;
- Controlled breach and demolition which would reduce or eliminate risk of future breaches to downstream assets;
- Spillway capacity expansion, which could allow better volume control with demonstrated risk reduction;
- Detention-retention components or mitigating downstream structures that may be affected by subsequent failures, including hardening or acquiring at-risk structures

The list above is not all-inclusive. FEMA will consider the eligibility of each proposal on its own merit.

HMGP funds can mitigate privately owned assets, including dams if the project is supported by the sub-applicant and selected by the State, and meets all program eligibility criteria.

Depending on the technical complexity of the project, the applicant may need to obtain or develop additional data to demonstrate feasibility, cost-effectiveness, and environmental compliance. The State can use a portion of HMGP funds (up to 25 percent of the HMGP estimate, limited to $10 million) for advance assistance to collect and evaluate information for potential projects. Discretionary funds (5 percent) can be used for outreach, education, and public awareness. Planning funds can be used to update portions of local mitigation plans to reflect dam risk. In some cases, projects can be phased so the applicant can obtain and incorporate data for environmental consideration, cost effectiveness, project design, and permitting.

Another consideration for the State is whether to capture eligible work that is not being funded by FEMA as cost share (non-federal match) for the disaster. In order to effectively identify potential sources, the proposed work must demonstrate full eligibility with FEMA requirements, in addition to any criteria the funding source may require. FEMA program staff should be consulted to ensure compliance and to preserve eligibility. Additional information is available in the Hazard Mitigation Assistance Guidance.[10]

9) The South Carolina Dam Safety Program Overview

[10] http://www.fema.gov/media-library-data/1424983165449- 38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf

9.1 Overview

The South Carolina Dam Safety Program is located within the Department of Health and Environmental Control, as part of Dams and Reservoirs. Their website includes links on information regarding their dam safety program, permitting process, laws and regulations, and the status updates of state regulated dams damaged or breached during this flooding event. The updates section of their website has a wealth of information, enabling viewers to download the actual emergency orders given to 75 dams owners, non- emergency repair orders, Notice of Violations, SCDHEC Flood related notices, dam inspection reports prior to this event for the state regulated damaged or breached during this event, and updates on the dam failures listed by date.

Below are key excerpts IAW state regulations defining a "dam", the Hazard Potential Classifications for those dams, the regulation and requirements regarding permitting, spillway design requirements, and the exemptions from state regulations. South Carolina regulates C1 (High Hazard), C2 (Significant Hazard), and C3 (Low Hazard) dams. C1 dams have the highest regulatory requirements while C3 dams have very limited requirements.

9.2 South Carolina Dam Inventory

The State updates their own dam database based on information from inspections, reclassifications, new dam constructed, and other information. This revised information is then sent to the U.S. Army Corps of Engineers, the agency responsible for the National Inventory of Dams, as described in the above NID section of this report. The following shows the 2012 South Carolina regulated dam inventory information from the Association of State Dam Safety Officials (ASDSO)[11] compared to the latest information from South Carolina:

ASDSO 2012	**SCDHEC 2015[12]**
State regulated dams: 2,380	State regulated dams: 2,370
High hazard potential: 162	High hazard potential: 176
Significant hazard potential: 463	Significant hazard potential: 476
Low hazard potential: 1,755	Low hazard potential: 1,718
State dam safety FTE's: 2.57	State dam safety FTE's: 6.75
Total Budget: $105,081	**Total Budget: $236,904[13]**

The USACE 2013 NID database has 2,440 dams as being in South Carolina. The NID is updated roughly every two to three years by the Army Corps as they receive information on dams from the regulating state and federal agencies.
Many of the federal agencies regulate their own dams. Some federal agencies fund or construct dams, but do not own, operate, maintain or regulate them. The difference of 60 dams between the state regulated list of dams and the NID can include such factors as:
a) those regulated by Federal agencies

[11] http://www.damsafety.org/map/state.aspx?s=41
[12] Information from SCDHEC
[13] Information from SC application for FY15 FEMA Dam Safety Grant

(including self regulating), b) inaccurate information, and c) information that needs to be updated in the NID. The 2013 NID has SCDHEC as regulating 2,327 dams, federal agencies regulating 95 dams in South Carolina, and 18 other dams that are currently showing no regulator and may need to be updated in the database. This includes some federally owned dams that may not be reported as self- regulating.

9.3 Key Definitions

Below is the definition of a "dam" from the SCDHEC's *Dams and Reservoirs Safety Act Regulations; Regulation 72-1 thru 72-9, Amended July 25, 1997*.[11]

"***Dam*** *- any artificial barrier, together with appurtenant works, including but not limited to dams, levees, dikes or floodwalls for the impoundment or diversion of water or other fluids where failure may cause danger to life or property*."

9.4 Hazard Potential Classifications and Exemptions.

Below are direct excerpts on dam hazard potential classifications and exemptions for dams from the SCDHEC's *Dams and Reservoirs Safety Act Regulations; Regulation 72-1 thru 72-9, Amended July 25, 1997*.

SCDHEC Hazard Potential Classifications

A. General. All dams and reservoirs subject to this regulation shall be classified according to their size and hazard potential. Classifications shall be made in accordance with this section and are subject to final approval by the Department. It may be necessary to reclassify dams as additional information becomes available.

B. Size Classification. The classification for size based on the height of the dam and storage capacity shall be in accordance with the table below. Size classification may be determined by either storage or height, whichever gives the larger size capacity.

Size Classification Table

Category	**Impoundment Storage (Acre-Feet**	**Height (Feet)**
Very Small	<50 and	<25
Small	□50 and <1000 or	□25 and <40
Intermediate	□1000 and <50,000 or	□40 and <100
Large	□50,000 or	□100

Hazard Potential Classification

The classification for potential hazard shall be in accordance with the table below. The hazards pertain to potential loss of human life or property damage in

the event of failure or improper operation of the dam or appurtenant works. Probable future development of the area downstream from the dam that would be affected by its failure shall be considered in determining the classification. Dams shall be subject to reclassification if the Department determines that the hazard has changed.

Hazard Potential Classification Table[14]

Hazard Classification	Hazard Potential
High Hazard (Class I)	Dams located where failure will likely cause loss of life or damage to home(s), industrial and commercial facilities, important utilities, main highway(s) or railroads.
Significant Hazard (Class II)	Dams located where failure will not likely cause loss of life but may damage home(s), industrial and commercial facilities, Secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important public utilities.
Low Hazard damage (Class III)	Dams located where failure may cause minimal property to others. Loss of life is not expected.

Exemptions

Exemptions.[14] The following types of dams are exempt from the Dams and Reservoirs Safety Act and the regulations pertaining thereto:

1. Unless the hazard potential as determined by the Department is such that dam failure or improper reservoir operation may cause loss of human life, any dam which is or shall be (a) less than twenty-five feet in height from the natural bed of the stream or water course measured at the downstream toe of the dam, or twenty-five feet from the lowest elevation of the outside limit of the dam, if it is not across a stream channel or water course, to the maximum water storage elevation and (b) has or shall have an impounding capacity at maximum water storage elevation of less than fifty acre-feet.
2. Any dam owned or operated by any department or agency of the federal government.
3. Any dam owned or licensed by the Federal Energy Regulatory Commission, the South Carolina Public Service Authority, the Nuclear Regulatory Commission, the United States Army Corps of Engineers, or other responsible federal licensing agencies considered appropriate by the Department.
4. Any dam upon which the South Carolina Department of Transportation or county or municipal governments have accepted maintenance responsibility for a road or highway where that road or highway is the only danger to life or property with respect to failure of the dam.

[14] R.72-1 through R.72-9, Dams and Reservoirs Safety Act Regulations (Effective: July 25, 1997)

5. Any dam, which in the judgment of the Department, because of its size and location could pose no significant threat of danger to downstream life or property. Upon request, Certificates of Exemption (SCDHEC Form 2601(6/94)) are available from the Department for dams in this category."

9.5 Permitting[15]

Below are direct excerpts of permitting requirements for dams from the SCDHEC's *Dams and Reservoirs Safety Act Regulations; Regulation 72-1 thru 72-9, Amended July 25, 1997*.

"***Permitting Procedures and Requirements.***

A. General. Any individual who proposes to construct a new dam or repair, alter or remove an existing dam shall apply for and obtain a permit from the Department for the proposed work. A separate application for construction of each new dam or reservoir and for alteration, repair, or removal of an existing dam or reservoir, shall be filed with the Department, except that only one application need be filed for a dam and the reservoir which will contain the water impounded by the dam. See the Regulation on Dam Classification and Exemptions for dams which are exempt from the Dams and Reservoirs Safety Act and the regulations pertaining thereto.

B. Activities Requiring a Permit.

1. Construction of a new dam: Construction of a new dam shall not commence until the owner has applied for and received a permit to construct from the Department, except for any new dam exempt from the statute.

2. Repairs to an existing dam: Repairs to an existing dam shall not commence until the owner has applied for and received a repair permit from the Department to perform the necessary repairs. Repairs proposed voluntarily or pursuant to an inspection and repair order require permitting. Should the owner be uncertain as to whether the proposed work is repair or normal maintenance work, he should contact the Department for clarification. In case of an emergency where the owner finds repairs are necessary to safeguard life or property, the owner may start such repairs immediately but shall notify the Department at once of the proposed repair and work under way.

3. Alteration of an existing dam or reservoir: Alteration of an existing dam or reservoir shall not commence until the owner has applied for and obtained a permit from the Department to perform the proposed alteration. Alteration of a dam or reservoir includes but is not limited to changing the height of a dam, increasing the normal pool or principal spillway elevation, or changing the elevation or physical dimensions of an emergency spillway."

4. Removal of an existing dam: Removal of an existing dam shall not commence until the owner has applied for and obtained a permit from the

[15] http://www.scdhec.gov/environment/WaterQuality/DamsReservoirs/LawsRegulations/

Department to accomplish the proposed removal. Removals proposed voluntarily or pursuant to an inspection and repair order require permitting."

9.6 Spillway Design Requirements[16]

Below is a direct excerpt on the spillway design flood criteria requirements for dams from the SCDHEC's *Dams and Reservoirs Safety Act Regulations; Regulation 72-1 thru 72-9, Amended July 25,1997*.

Table I

SPILLWAY DESIGN FLOOD CRITERIA

Hazard	*Size*	*Spillway Design Flood (SDF)**
High	*Very Small*	*100-yr. to 1/2 PMF*[18]
	Small	*1/2 PMF to PMF*
	Intermediate	*PMF*
	Large	*PMF*
Significant	*Small*	*100-yr. to 1/2 PMF*
	Intermediate	*1/2 PMF to PMF*
	Large	*PMF*
Low	*Small*	*50 to 100-yr. frequency*
	Intermediate	*100-yr. to 1/2 PMF*
	Large	*1/2 PMF to PMF*

**Note: When appropriate, the spillway design flood may be reduced to the spillway discharge at which dam failure will not significantly increase the downstream hazard which exists just prior to dam failure."*

10) Event Overview

10.1 General precipitation Information

From October 1-5, 2015, portions of South Carolina experienced precipitation totals of greater than 20 inches of rainfall.[17] This resulted from the combination of a slow-moving, upper-level low over the Southeastern United States, an area of low pressure at the surface located along a stationary frontal boundary, and tropical moisture associated with Hurricane Joaquin. Figure 10.1

[16] http://www.scdhec.gov/environment/WaterQuality/DamsReservoirs/LawsRegulations/

[17] Probable Maximum Flood (PMF) - represents the largest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year. https://noaa.maps.arcgis.com/apps/MapJournal/?appid=377f5b41e733401ab193680390250c8e

shows the 4-day period maximum rainfall totals[18] and Table 10.1 provides event total rainfall amounts available for the counties with failed dams.

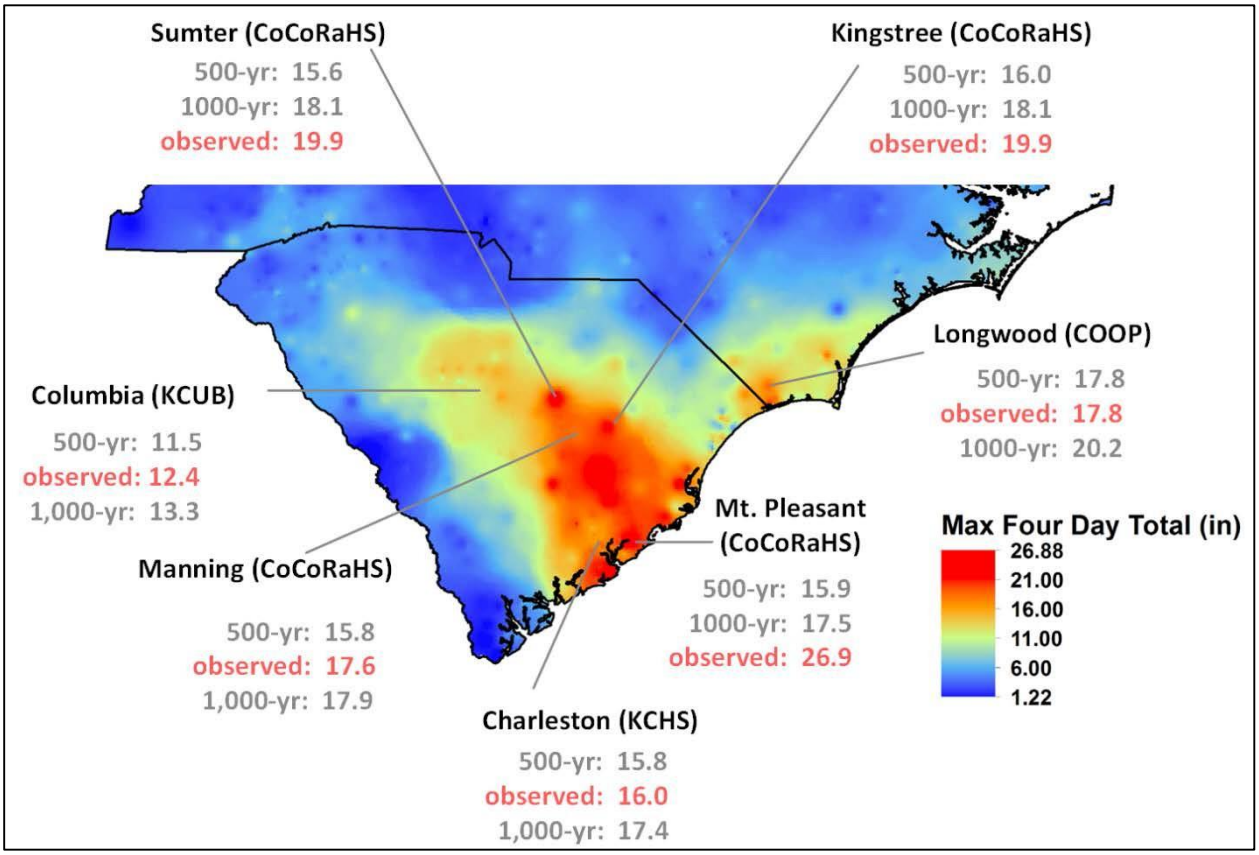

Figure 10.1: 4-Day Period Maximum Rainfall Totals Map; Credit: Carolinas Integrated Sciences & Assessments (CISA) at the University of South Carolina

LOCATION	COUNTY/STATE	AMOUNT (IN.)
GILLS CREEK RCWINDS – COLUMBIA	RICHLAND CO SC	21.49
PUBLIC REPORT – MILLWOOD	SUMTER SC SC	20.75
SUMTER 0.3NNE COCORAHS	SUMTER CO SC	20.77
SUMTER 1.3SE COCORAHS	SUMTER CO SC	20.61
WATEREE RCWINDS	RICHLAND CO SC	20.36
HOLLY HILL 0.4N COCORAHS	ORANGEBURG CO SC	20.28
SHAW AFB - SUMTER ASOS	SUMTER CO SC	19.81
MANNING 8.2S COCORAHS	CLARENDON CO SC	19.25

[18] http://www.cisa.sc.edu/PDFs/October%202015%20Flood%20Event%204%20Pager.pdf

SUMMERTON 5.2SSE COCORAHS	CLARENDON CO SC	19.19
LEESBURG HWY 601 RCWINDS	RICHLAND CO SC	18.36
EASTOVER RCWINDS	RICHLAND CO SC	18.35
SPRING VALLEY RCWINDS – COLUMBIA	RICHLAND CO SC	17.91
FORT JACKSON RCWINDS	RICHLAND CO SC	17.71
WEIR TOWER - FT JACKSON RAWS	RICHLAND CO SC	17.30
CHAPIN 1.4S COCRAHS	LEXINGTON CO SC	17.21
CHESTNUT OAKS MS WEATHERBUG	SUMTER CO SC	17.14
MLK PARK RCWINDS – COLUMBIA	RICHLAND CO SC	16.82
SANTEE NWR RAWS	CLARENDON CO SC	16.74
HOLLY HILL COOP	ORANGEBURG CO SC	16.61
SANTEE 2NE COCORAHS	ORANGEBURG CO SC	16.50
WEDGEFIELD FD WEATHERBUG	SUMTER CO SC	16.26
HOPKINS 3.9NNE COCORAHS	RICHLAND CO SC	15.89
COLUMBIA 6.7N COCORAHS	RICHLAND CO SC	15.71
MCGRADY FT JACKSON RAWS	RICHLAND CO SC	15.71
SANDHILL EXP COOP	RICHLAND CO SC	14.95
SUMTER EMA WEATHERBUG	SUMTER CO SC	14.88
CEDAR CREEK COOP	RICHLAND CO SC	13.39
UNIV OF SC COOP – COLUMBIA	RICHLAND CO SC	12.97
MANNING COOP	CLARENDON CO SC	12.70
LUGOFF COOP	KERSHAW CO SC	12.48
HAMILTON OWENS APT – COLUMBIA	RICHLAND CO SC	12.42
CONGAREE NP RAWS	RICHLAND CO SC	12.41

UNIV OF SC T. BUCKET – COLUMBIA	RICHLAND CO SC	12.37
LAKE MURRAY DAM USGS	LEXINGTON CO SC	11.60
COLUMBIA METRO APT ASOS	LEXINGTON CO SC	11.44
BISHOPVILLE COOP	LEE CO SC	11.35
ORANGEBURG COOP	ORANGEBURG CO SC	11.29
MCTIER CREEK USGS – MONETTA	AIKEN CO SC	10.72
ORANGEBURG APT ASOS	ORANGEBURG CO SC	10.59
WATEREE DAM COOP	KERSHAW CO SC	8.62
BATESBURG COOP	LEXINGTON CO SC	8.60

Table 10.1 National Weather Service Total Rainfall Amounts[19]

The United States Geological Survey (USGS) operates 170 real-time streamgages in South Carolina in cooperation with local, State, and Federal agencies[20]. In addition to the autonomous streamgages, USGS personnel made 140 streamflow measurements at 86 locations in South Carolina during this flood event. A comparison with historical streamflow data indicated that seventeen streamgages recorded new peaks of record. Due to a numbers of factors, such as soil condition, land coverage, and timing of the rain, the recurrence interval of the rainfall may be different from the recurrence interval for the flood event.

USGS is working on estimating the flood recurrence intervals as the streamgage information is finalized.[21]

Gage Number	Gage Location	Oct 2015 Peak (preliminary) cubic	New Record	Previous or Current Record
1	Gills Creek at Columbia	>3000*	Yes*	2,880 (1979)
2	Congaree River near Columbia	185,000	No	231,000 (1936)
3	Saluda River near	>50,000*	Yes*	53,200 (1965)

[19] http://noaa.maps.arcgis.com/apps/MapJournal/?appid=2d473e302db74c3799419d4b89f00d47

[20] http://pubs.er.usgs.gov/publication/ofr20151201

[21] http://water.usgs.gov/floods/events/2015/Joaquin/HolmesQA.html

*Preliminary data at the time of this paper

	Columbia			
4	South Fork Edisto River near Denmark	2,100	No	13,500 (1936)
5	North Fork Edisto near Orangeburg	8,640	No	9,500 (1945)
6	Black River at Kingstree	83,700	Yes	58,000 (1973)
7	Waccamaw River near Longs	16,900	No	28,200 (1999)
8	Little Pee Dee River near Galivants Ferry	8,230	No	27,600 (1964)
9	Wateree River near Camden	50,900	No	168,000 (1936)
10	Saluda River near Greenville	1,660	No	11,000 (1949)
11	Pee Dee River at Pee Dee	30,100	No	220,000 (1945)

Table 10.2: USGS Streamflow Recorded[22]

[22] http://nwis.waterdata.usgs.gov

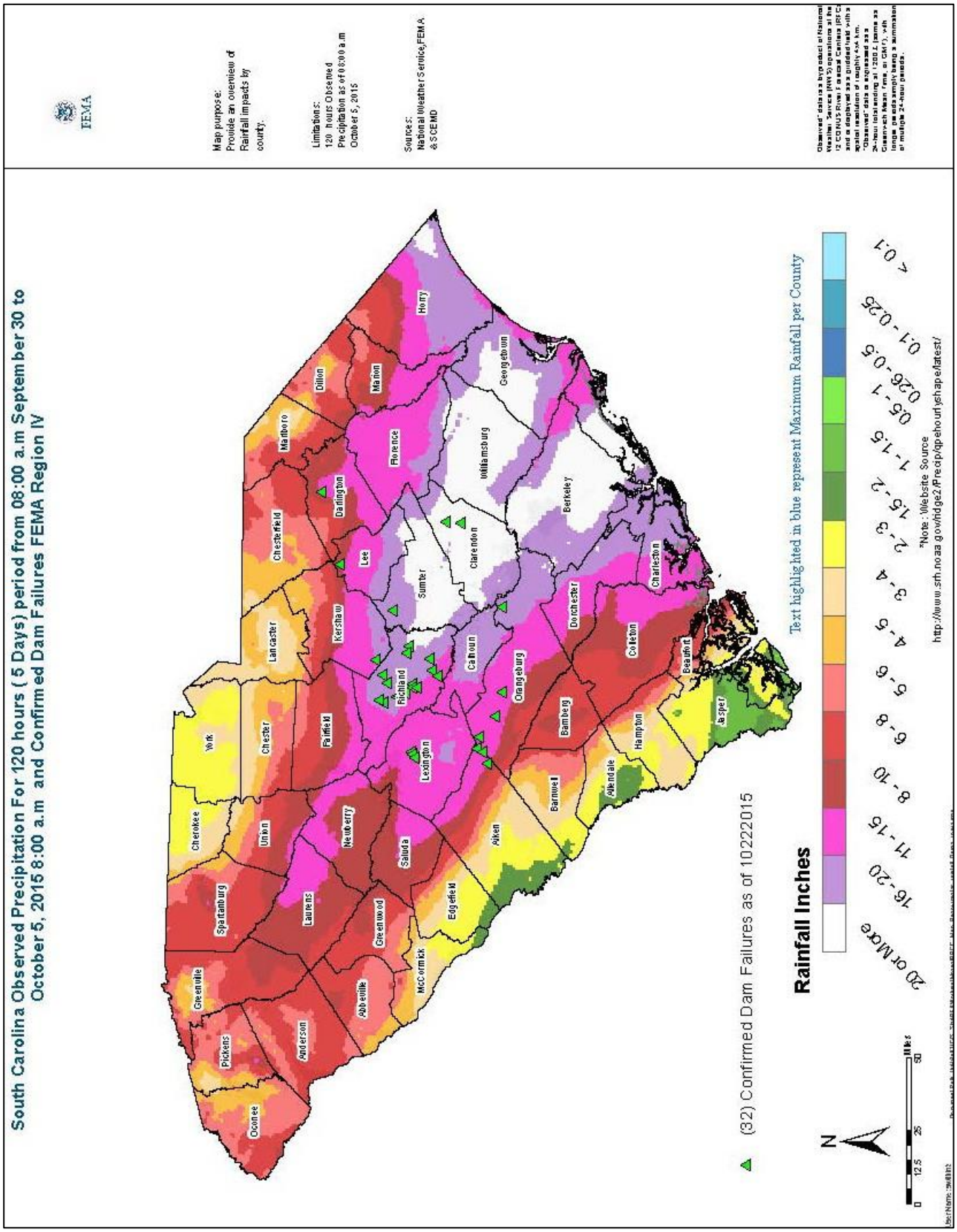

Figure 10.2: Total 5-day Precipitation and Dam Failure Locations

During response at the Regional Response Coordination Center (RRCC), a list of confirmed dam failures was developed to track this information. Each dam failure was confirmed by SCDHEC. This list has been updated for this report with information from SCDHEC and is included as Table 10.3.

10.2 Failed Dams in South Carolina

Confirmed Dam Failures

ID	NID_ID	Name	County	Latitude	Longitude	Owner_Type	EAP
1	SC00305	Baileys Pond	Aiken County	33.5968165	-81.286492	Private	No
2	SC00313	Corbett Lake	Aiken County	33.648651	-81.211334	Private	No
3	SC00370	Able / Cobett Pond Dam	Aiken County	33.6218163	-81.233762	Private	No
4	SC00718	O E Rose Dam	Clarendon County	33.8067435	-80.090573	Private	No
5	SC00731	Lakewood Pond Dam	Clarendon County	33.7318223	-80.093348	Private	No
6	SC00612	Chapman's Pond Dam	Darlington County	34.42	-79.941666	Private	No
7	SC01488	Cook Pond Dam	Kershaw County	34.1524394	-80.775608	Private	Yes
8	SC00498	Clyburn Pond Dam	Lee County	34.329896	-80.302058	Private	Yes
9	SC00143	Old Mill Pond Dam	Lexington County	33.974641	-81.232641	Private	Yes
10	SC00148	Barr Dam/ Barr Lake Dam	Lexington County	33.958512	-81.259604	Local	Yes
11	SC00169	Gibson Dam/Gibson's Pond Dam	Lexington County	33.969067	-81.244925	Local	Yes
12	SC00407	JW Smoaks Pond	Orangeburg County	33.525181	-80.93454	Private	Yes
13	SC00419	SCNONAME 38036 (Cleveland Street)	Orangeburg County	33.5229411	-80.51387	Private	No
14	SC00444	Busbees Pond (Hutto’s Millpond Dam)	Orangeburg County	33.5565662	-81.057043	Private	No
15	SC00447	Culler Pond (SCNONAME 38070)	Orangeburg County	33.6367083	-81.15938	Private	No
16	SC00047	Lake Elizabeth	Richland County	34.113028	-80.987693	Private	No

17	SC00050	Carys Lake	Richland County	34.048873	-80.957954	Private	Yes
18	SC00051	Murray Pond Dam	Richland County	33.9854307	-80.707933	Private	No
19	SC00055	Pinewood Lake Dam	Richland County	33.9440493	-80.911984	Private	Yes
20	SC00056	Weston Pond Dam	Richland County	33.883093	-80.768417	Private	No
21	SC00059	Wilson Millpond Dam	Richland County	33.9999267	-80.742888	Private	Yes
22	SC00064	Duffies Pond Dam	Richland County	33.8443329	-80.85269	Private	No
23	SC00065	Ulmers Pond	Richland County	33.968661	-80.89535	Private	Yes
24	SC00067	Sunview Lake Dam	Richland County	33.96735	-80.91163	Private	Yes
25	SC00069	Lower Rocky Creek Dam/Rocky Ford Lake	Richland County	34.035907	-80.952309	Private	Yes
26	SC00070	North Lake Dam/Overcreek Rd. Dam/Upper Rocky Creek	Richland County	34.040808	-80.951982	Private	Yes
27	SC00073	Walden Place Dam	Richland County	34.11678	-80.84591	Private	Yes
28	SC00079	Covington Lake Dam	Richland County	34.1346367	-80.974649	Private	No
29	SC00100	Beaver Dam Lake/Wildwood Pond #2/Boyd Pond	Richland County	34.096505	-80.886521	Private	Yes
30		Clarkson Pond Dam	Richland County	33.87006	-80.826624	Private	No
31	SC01404	Ellerbees Millpond Dam	Sumter County	34.0684376	-80.531621	Private	No

Table 10.3 Confirmed Dam Failures List

During response at the RRCC, the confirmed dam failures were mapped to provide a visual representation of the situation based on the confirmed dam failure list. This map has been updated for this report with information from SCDHEC and is included as Figure 10.3.

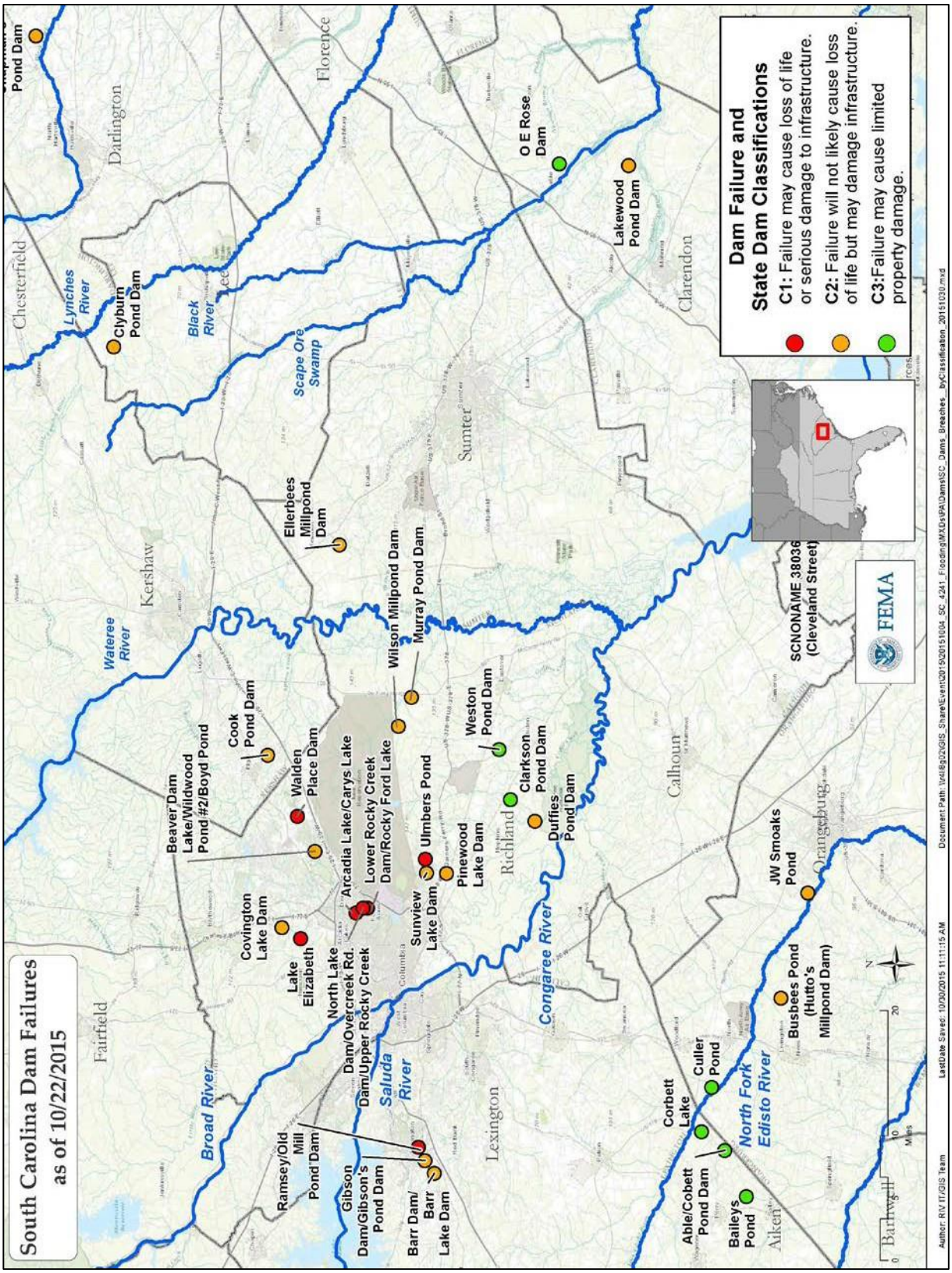

Figure 10.3: Confirmed Dam Failures Map

11) General Comments

Further Study

General Comment 1: Probable Contributing Factors for Dam Failures

The following elements could have contributed, in part, to the failure of these state regulated dams:

1.1 The design and construction requirements of each dam are unknown at this time. Inadequate, or a lack of, design and construction standards could contribute to failure.

1.2 The flood recurrence intervals for each dam site is unknown at this time, as is the capacity of the outlet control system for each dam. A storm event above the design storm could have contributed to failures.

1.3 SCDHEC inspects each C1 and C2 dam. Many of the failed C1 and C2 dams were provided recommendations or requirements on the last SCDHEC inspection report. Failure to address known issues could indicate lack of maintenance or repair, which could contribute to failure.

1.4 The operation of each dam during this storm event, including activation of gates and low level outlets, is unknown at this time. Improper operation or lack of operation could contribute to failure, particularly in drainage basins with interconnected lakes and ponds.

General Comment 2: Interaction of Multiple Dam Failures in a Drainage Basin

There are two drainage basins of particular interest, each having multiple dam failures during this event. There may be more basins of interest.

2.1 Gills Creek Watershed: The Gills Creek watershed experienced five dam failures, including Pinewood Lake Dam, Upper Rocky Creek (Northlake) Dam, Lower Rocky Creek (Rocky Ford Lake) Dam, a federal dam failure that was not addressed in this report, and Cary's Lake Dam. It is unclear to what extent, if at all, dam operations or cascading effects along the entire watershed may have contributed to these failures.

2.2 The Twelve Mile Creek Watershed: This watershed experienced three dam failures, including Old Mill Pond Dam, Gibson Pond Dam, and Barr Lake Dam. It is unclear to what extent, if at all, dam operations or cascading effects along the entire watershed may have contributed to these failures.

General Comment 3: The Consequences of the Dam Failures

The hazard classification for dams is based on the potential consequences as a result of failure. It is unknown the damages that resulted from the flood event versus the dam failures.

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.

Flood Mapping

General Comment 5: FIS limited Dam References

Table 11.1 shows the results of state regulated C1 and C2 dams referenced by dam name in the FIS when compared to the sum of the High Hazard and Significant Hazard dams in the NID by County. Note 1: Below is for state regulated dams only. Note 2: The FIS does not reference dams by the State ID number or the NID ID number. Note 3: Many dam names in the FIS have different names when compared to the NID due in part to ownership changes.

County	# C1+C2* Dams in FIS by name	# High Hazard + Significant Hazard Dams in NID	Percentage of C1+C2 Dams in FIS and NID
Aiken	0	(14/25) = 39	0 %
Clarendon	0	(0/3) = 3	0 %
Darlington	1	(2/12) = 14	7 %
Kershaw	1	(6/10) = 16	6 %
Lee	0	(0/4) = 4	0%
Lexington**	12	(15/15) = 30	40 %
Orangeburg**	0	(6/32) = 38	0%
Richland**	16	(31/36) = 67	24%
Sumter**	2	(0/11) = 11	18%

Table 11.1 Percentage of C1+C2 Dams referenced by name in FIS and NID
*State Regulated
**Some dam names in the FIS are not the same in the NID

General Comment 6: Limited Dam References on FIRM's

Similar to the FIS, very few dams were labeled on the FEMA FIRMs. FIRMs on the Map Service Center (MSC)[23] must be manually searched for this information and, due to the size of the affected area and the number of FIRMs, it was too labor intensive to perform an exhaustive analysis. However, based on the percentage of dams that were named in the FIS reports, it is reasonable to assume a similar percentage exists for dams that are shown on the FIRM as "dam" and even fewer called out by their name. This may be in part attributed to the fact that dam names are often changed with ownership and there may be conflicting documentation on which is correct.

[23] https://msc.fema.gov/portal

Name	Not Shown on FIRM	Shown on FIRM as 'Culvert	Shown on FIRM as 'Dam'	Shown on FIRM by Name
Baileys Pond	X			
Corbett Lake	X			
Able / Cobett Pond Dam	X			
O E Rose Dam	X			
Lakewood Pond Dam	X			
Chapman's Pond Dam	X			
Cook Pond Dam	X			
Clyburn Pond Dam	X			
Old Mill Pond Dam				X
Barr Dam/ Barr Lake Dam				X
Gibson Dam/Gibson's Pond Dam				X
JW Smoaks Pond			X	
SCNONAME 38036 (Cleveland Street)		X		
Busbees Pond (Hutto's Millpond Dam)	X			
Culler Pond (SCNONAME 38070)			X	
Lake Elizabeth			X	
Carys Lake				X
Murray Pond Dam	X			
Pinewood Lake Dam			X	
Weston Pond Dam	X			
Wilson Millpond Dam	X			
Duffies Pond Dam	X			
Ulmers Pond	X			
Sunview Lake Dam	X			
Lower Rocky Creek Dam/Rocky Ford Lake			X	
North Lake Dam/Overcreek Rd. Dam/Upper Rocky Creek	X			
Walden Place Dam			X	
Covington Lake Dam				X
Beaver Dam Lake/Wildwood Pond #2/Boyd Pond	X			
Clarkson Pond Dam	X			
Ellerbees Millpond Dam	X			
Totals	*19*	*1*	*6*	*5*

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 7: Structures Cannot Be Searched Electronically in FIS Flood Profiles

Currently, the FIS profiles and other graphics are not electronically searchable for structure names/labels. This made it very difficult and time consuming to find specific geographic items of interest, including dams.

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.

Regulatory

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 11: Columbia Canal Levee

State regulations, as cited above, include levees in the definition of a dam. However, SCDHEC dam safety stated they do not regulate this levee. After discussions with FEMA PA as well as SCDHEC, neither of them were able to determine, at the time of finalizing this report, what agency, if any, actually regulates this levee. FEMA PA was not able to get any inspection reports from the potential applicant as of the time of this writing.

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 Comment 13: Operation and Maintenance of Private Dams

Upon observation, the Dam Task Force noted that the outlet gates on some of the failed dams were in the closed position. Some gates were also corroded. It is unclear to what degree these dam components are inspected, operated, or maintained.

General Comment 14: Heavy Vegetation Exists on Many Dams

Heavy vegetation on some of the dams was noted in inspection reports, photographs of the dam, or visual observation by the Dam Task Force. Heavy vegetation has been documented previously as an issue that can lead to piping, slope failure due to fallen trees, or other issues. This can contribute to or be the cause of future dam failure.

General Comment 15: Dam Watershed Management Operations

Multiple dams that were in series failed in 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.

Coordination

General Comment 16: FIMA Disaster Contract Support

On Oct 9, 2015, FEMA Region IV coordinated with FEMA HQ regarding contracting to perform comprehensive, strategic post disaster assessments of dams that would provide field assessments and data analysis and deliver products to support the current recovery effort and mitigate future dam-related risks. There was not a common understanding among the CO, COR, and PM on how to expeditiously leverage existing HQ contract vehicles (such as Production Technical Services or Hazard Mitigation Technical Assistance) to support disaster operations at the JFO.

General Comment 17: National Dam Safety Program Technical Assistance during Disaster Operations

One of the Objectives of the National Dam Safety Program is to, "*develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector*." An established mechanism to enable to the ICODS member agencies to provide subject matter expertise support to States and locals for data collection, emergency inspections, performance analysis, and post disaster assessments of dam infrastructure and dam risk management effectiveness does not currently exists.

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 Comment 19: Civil Air Patrol and Dams

Civil Air Patrol (CAP) photos were available for 4 of 31 dams. These included Corbett Lake, Cary's Lake, Lower Rocky Creek and Upper Rocky Creek Dams. Based on the limited photos and the types of photos provided, it is likely limited dam information, if any, was coordinated or provided to CAP for their Mission Assignment.

General Comment 20: Dam Coordination at the JFO

There were many different organizations, groups, and teams at the Joint Field Office (JFO) with a mission involving these failed dams, including Public Assistance (PA), Mitigation, Operations, DHS IP, USACE, FDRC and others, with limited coordination.

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 Comment 22: FIS / NID Stream Name Differences

There are a number of dams that have a discrepancy in stream names when comparing the FIRM/FIS and the NID data. In some instances, FEMA products label tributaries while the NID generally calls out main stem stream only. It is unclear whether this information is simply not being updated or whether regulators aren't actually using FIS and FIS profile information.

Training, Awareness, and Exercises

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 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 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 Comment 26: HMTAP Task Order

The Dam Task Force has coordinated with FEMA HQ to scope a task order under the HMTAP contract. This task order will provide state and local officials with consolidated data about select dams that breached during the storm / flooding event which resulted in disaster declaration DR-4241-SC. This data can be used to identify potential Hazard Mitigation Grant Program (HMGP) projects. It can also inform land use decisions, and may impact other comprehensive recovery options that consider vulnerable critical infrastructure and high value mitigation targets. Specifically, the task order will:

- Assess current condition.
- Coordinate with other stakeholders to identify other activities such as watershed studies, hydraulic and hydrology (H&H) studies or flood map changes that may provide more complete data for state and local recovery decisions. Consolidate this information as it relates to each dam.
- Summarize dam risk and potential consequences of future breaches, to include impacted critical facilities, infrastructure and other assets.
- Identify Recovery / Mitigation options including those that may not be eligible for HMGP such as repair. Potential mitigation actions will be unique to each site and may include rehab-meaning to reconstruct the dam to a higher protection standard, thereby reducing risk to vulnerable infrastructure and other assets; fortifying existing dams; controlled breach and demolition which would reduce or eliminate risk of future breaches to downstream assets; spillway capacity expansion, which could allow better volume control with demonstrated risk reduction; detention-retention components or mitigating downstream structures that may be affected by subsequent failures, including acquiring at-risk structures. HMGP funds can mitigate privately owned assets, including dams if the project is supported by the sub-applicant and selected by the State, and meets all program eligibility criteria.
- Identify and develop Recovery Advisories, Fact Sheets or other documents which state and local officials can use to inform their recovery and mitigation decisions.
- Recommend efficiencies and improvements for Dam risk management efforts among stakeholders.

12) General Recommendations

<u>Further Study</u>

General Recommendation 1: Perform Additional Dam Risk Assessment on Select Failed Dams for this Event

The number of state regulated and non-state regulated dam failures during this flooding event was unique. In partnership with the South Carolina Department of Natural Resources (SCDNR), South Carolina Emergency Management Division(SCEMD), and South Carolina Department of Environmental Control (SCDHEC), additional dam analysis on select South Carolina failed dams should occur.

General Recommendation 1a: General Additional Assessment Should Be Performed on Select Failed Dams for This Event.

The Assessment Should Consider, but Not Be Limited To:

a. The availability of dam insurance for the dam owners.
b. Existing communication channels among federal, state agencies, local governments, and individuals regarding flood risk from dam failure.
c. The number of NFIP insured home owners downstream of the failed dams
d. How dam risk is addressed in State and local Emergency Operation Plans (EOPs).
e. Local emergency management officials access to dam owner Emergency Action Plans.
f. Availability of dam breach inundation maps to local emergency management officials and planners.
g. The local government planning and zoning efforts relative to dam risk management.
h. Dam owner operations and maintenance plans and whether those plans were activated for this event.
i. Availability of technical and risks management training and guidance for the dam owners.
j. Level of community awareness and preparedness regarding dam-related flood risk (including surveillance and early warning protocols).

General Recommendation 1b: Assess Failed Dams Based on Prioritization Criteria

Understanding there is often limited time, resources and funding available, the below criteria may help prioritize which failed dams to analyze. The Dam Task Force recommends limited resources be applied to High hazard (C1) and Significant hazard (C2) dam failures that meet at least one of the following:

i. The dam is part of a watershed having potential cascading dam failures.
ii. The dam is located in an area that received 16+ inches of rain over the 5- day period of this event.
iii. High Water Mark data was collected downstream of the dam.
iv. The dam is known to have deficiencies noted in the last SCDHEC inspection.

General Recommendation 1c: Additional Technical Assessment Should Be Performed on Specific Failed Dams for This Event:

The dams in Table 12.1 should be considered by SDHEC, SCEMD, SCDNR, or other appropriate agencies for additional technical assessment including:

a) Event-specific dam breach consequence analysis.
b) Assessment of the evacuation actions that occurred as a result of the failure.
c) The hazard creep that occurred downstream of the failed dams.
d) Event specific dam failure modeling and incremental consequence assessment to compare flood event versus dam breach inundation.
e) A comparison of dam breach modeling results (HEC-RAS, DSS-WISE, FLO- 2D, etc.) to event-specific high water mark inundation areas downstream.
f) Further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
g) Determining the probable cause of failure because of this event.

Cook Pond Dam
Old Mill Pond Dam
Gibson Pond Dam
Lake Elizabeth Dam
Cary's Lake Dam
Murray Pond Dam
Pinewood Lake Dam
Wilson Millpond Dam
Ulmers Pond Dam
Lower Rocky Ford Dam
Upper Rocky Ford Dam
Walden Place Dam
Beaver Dam
Barr Lake Dam

Table 12.1

Flood Mapping

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 Recommendation 3: Flood Insurance Study (FIS) – National Inventory of Dams (NID) Stream Name Consistency

FEMA Region IV and SCDNR should meet with the state dam safety program to determine their familiarity with the FIS reports, FIS profiles, and Risk MAP products.

This should include discussing the benefit of using consistent information in the NID which would facilitate researcher's abilities to more efficiently cross reference.

Regulatory

General Recommendation 4: Review and Strengthen Language within South Carolina's Regulations, Policies and Procedures

South Carolina should consider reviewing key regulations, policies, and procedures for opportunities to improve and strengthen language relating to:

a. The incorporation of dams and dam failure in periodic emergency exercises for flooding scenarios.
b. Periodic exercises of Emergency Actions Plans for High Hazard (C1) dams.
c. Inclusion of local emergency managers into the Emergency Action Plan sharing process for dams in that area.
d. Inspections incorporating operations and maintenance plan reviews and testing out key components, such as outlet gates for their operability.
e. Inundation map requirements for Emergency Action Plans on High Hazard (C1) and Significant Hazard (C2) dams.
f. Coordination of local watershed management plans.

General Recommendation 5: Regulate Columbia Canal Levee

The SCDHEC dam safety office does not regulate this levee. This hydraulic structure should be regulated by the appropriate State agency.

Coordination

General Recommendations 6: FIMA Disaster Contracting Capability and Support

The National Dam Safety Program Manager and the FIMA contracting team for the Production Technical Services (PTS) and Hazard Mitigation Technical Assistance Program (HMTAP) contracts should evaluate the scope of both contract vehicles (as well as other DHS/FEMA strategic contract vehicles) to determine appropriateness and best application to deliver technical assistance to support pre-disaster planning, disaster and post-disaster actions supporting the JFO. Standard Operating Procedures should be established, documented and approved by leadership to assure that FIMA can expeditiously contract the technical assistance supporting JFO operations.

General Recommendation 7: National Dam Safety Program Technical Assistance during Disaster Operations

FEMA should establish, through the National Dam Safety Program and the Interagency Committee on Dam Safety, a formal mechanism and protocol for deploying Federal dam safety and risk management subject matter experts to support State and local officials during disaster operations involving large and/or multiple dam failures with the potential to adversely impact life and property. This support should include, but not limited to: data

collection, emergency inspections, performance analysis, and post disaster assessments of dam infrastructure and dam risk management effectiveness

General Recommendation 8: Develop Dam Inundation Mapping

SCDHEC should consider coordinating with dam owners for development of inundation maps for C1 and C2 dams. These maps should be shared with local Emergency Management Agencies (EMA's) to develop evacuation plans. The dam breach inundation maps should also be shared with local planners and decision makers for inclusion in land use planning and zoning for the potentially impacted areas.

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 Recommendation 10: Improve Coordination with Civil Air Patrol (CAP) for Dam-Related Incidents

Civil Air Patrol provides an excellent resource during the initial phase of response operations. It is recommended that FEMA coordinate with the Civil Air Patrol to provide specific dam information. This information would allow CAP to provide photos and additional observations to the state EMA, the state dam regulatory agency, and FEMA during the flooding event. It is also recommended that appropriate parties coordinate in advance with CAP on the criteria for dam photos, the locations of dams, and other important details to inform operations during future flood events.

General Recommendation 11: Develop a JFO Dam Risk Management Framework for the Future

A framework should be developed to enable a unified dams risk management team be stood up at JFOs. This unified task force would include personnel from all relevant organizations and agencies. The Framework should address the lifecycle of response actions and be managed by a single FEMA project manager. A pre- designated point of contact tasked with coordinating response and recovery efforts across multiple agencies will minimize duplicative efforts and ensure a more efficient and effective operation. Currently, such a framework does not exist.

General Recommendation 12: Improve Coordination between the State and FEMA Region IV

Active and more frequent coordination is encouraged for the appropriate state agencies (SCDHEC, SCEMD, SC DNR) and FEMA Region IV regarding dam flood risk in mitigation plans, EAP's, inundation maps, response exercises related to dam failures, Risk MAP, and flood studies. The open dialogue will help facilitate shared resources and ultimately offer more accurate and complete information to communicate and plan for dam flood risk.

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.

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 Recommendation 15: Coordinate SCDNR Activities with Other State Agencies

The state agency responsible for flood studies, SCDNR, should coordinate with other state agencies, SCDHEC, SCEMD, etc., for inclusion of the risks relating to dams in future and on-going flood studies. SCDHEC should share available dam inundation information and dam condition assessments, planned watershed management studies with SCDNR, where applicable, to improve characterization of the flood risk and the impact that dams have on flooding. SCDNR should share their efforts, dam mapping assumptions in flood studies, with SCDHEC in order to improve overall risk reduction and improve dam resilience. SCEMD should share their mitigation strategy as well as the location of funded mitigation projects that may impact the hydrology and/or hydraulics of a stream. Coordinated information sharing will facilitate in identifying those "hot spots" that should be considered for mitigation actions. In addition, information sharing across agencies will allow for a more comprehensive watershed study.

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.

General Recommendation 17: FEMA Region IV and HQ Dam Safety Should Better Coordination with Other Federal Agencies (OFAs)

FEMA HQ and FEMA Region IV should improve their dam-related coordination with the Federal Energy Regulatory Commission (FERC), U.S. Army Corps of Engineers (USACE), Department of Homeland Security Infrastructure Protection (DHS IP), and other appropriate federal agencies in order to develop tactics, strategies, and relationships before future events

to maximize efficiencies and effectiveness post event.

Training, Awareness, and Exercises

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.

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 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 Recommendation 21: Develop a Standard Operating Procedure

The appropriate state agency should develop a Standard Operating Procedure (SOP) to facilitate dam flood risk information sharing and training across state agencies and establish a protocol for utilizing regional and national dam safety expertise during a disaster. This should include developing a process for requesting assistance through the Emergency Management Assistance Compact (EMAC), where applicable.

General Recommendation 22: Provide Additional Technical Assistance

FEMA, through the NDSP and the National Preparedness Technical Assistance Program should develop and deliver products and services targeted to State and local communities that address specific dam risk management challenges. Products and services could include dam breach consequence assessments; the identification of high risk dams and development of community and regional preparedness, response, recovery, and mitigation strategies for those risks; evacuation planning; EAP/EOP exercise planning; training on early warning systems; and dam owner training and workshops. In order to meet this need, additional staffing will be required. It is recommended that NDSP be expanded to include twelve additional personnel, two located at FEMA headquarters and one within each of FEMA's ten regional offices.

13) Acknowledgements

This report was developed by the following individuals on the FEMA Mitigation Dam Task Force for DR-SC-4241.

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South Carolina State Government

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Appendix A: Information for Each Breached State Regulated Dam

1) ***State Dam Name: Baileys Pond Dam*** Latitude: 33.594676; Longitude: -81.285939; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 02019	County	Aiken
Stream or River	Goodland Creek	Nearest Downstream City/Town	EAST SALLEY COMMUNITY
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00305	State ID	D2034
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1945
Length (ft)	300	Year Modified	N/A
Drainage Area (sq mi)	2.84	Height (ft)	14
Surface Area (ac)	12	EAP	No
Max Discharge (cfs)	280	Condition	Not Rated
Max Storage (ac ft)	85	Normal Storage (ac ft)	51
Note: FIRM & FIS data are not in the NID		FIS Effective Date	6/19/2012
FIRM Panel	45003C0450E	FIRM Effective Date	6/19/2012

*Provided by SCDHEC

Figure A1.1: Bailey's Pond Nov 2007 pre-event photo; Credit: Google Maps Streetview

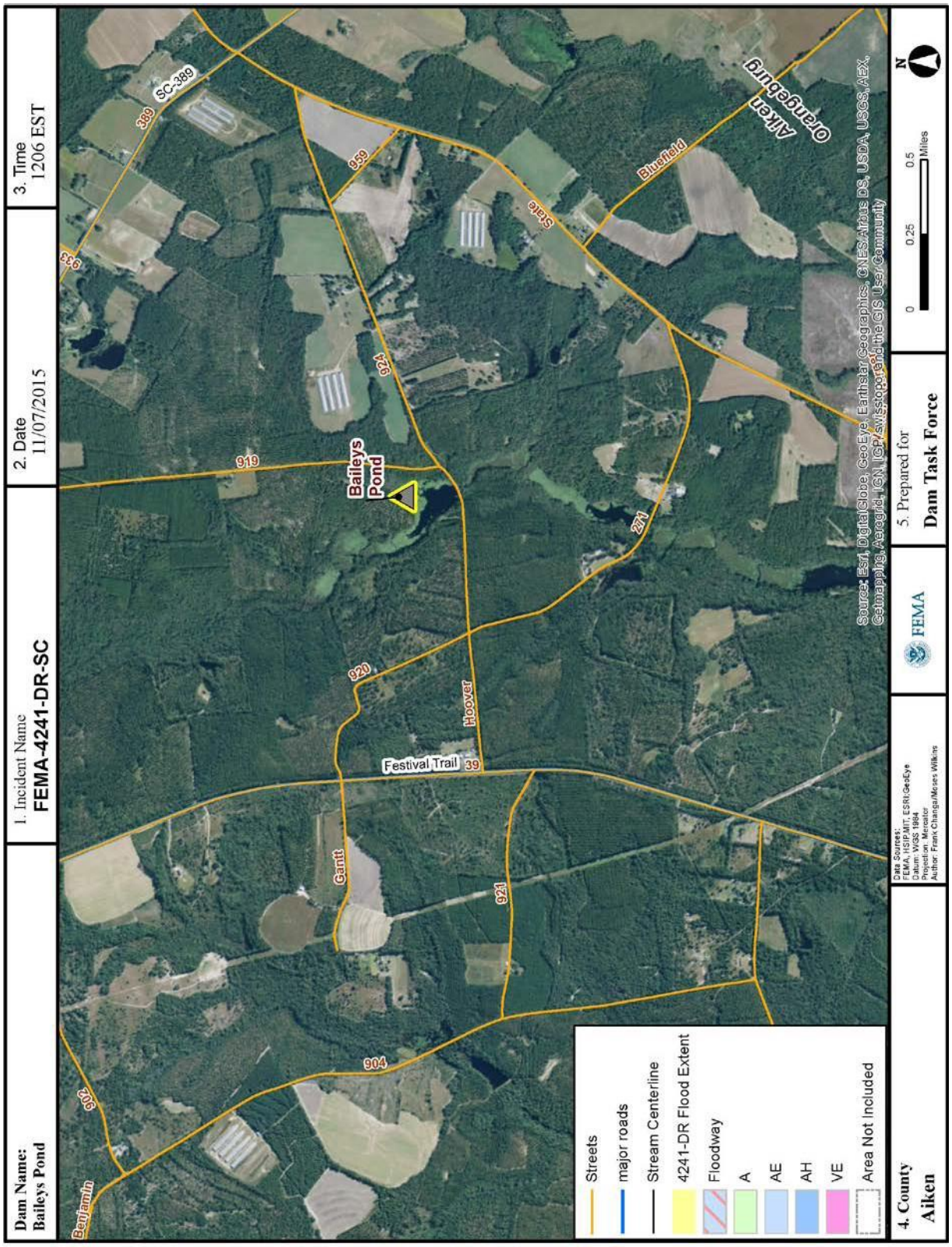

Figure A1.2: Bailey's Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

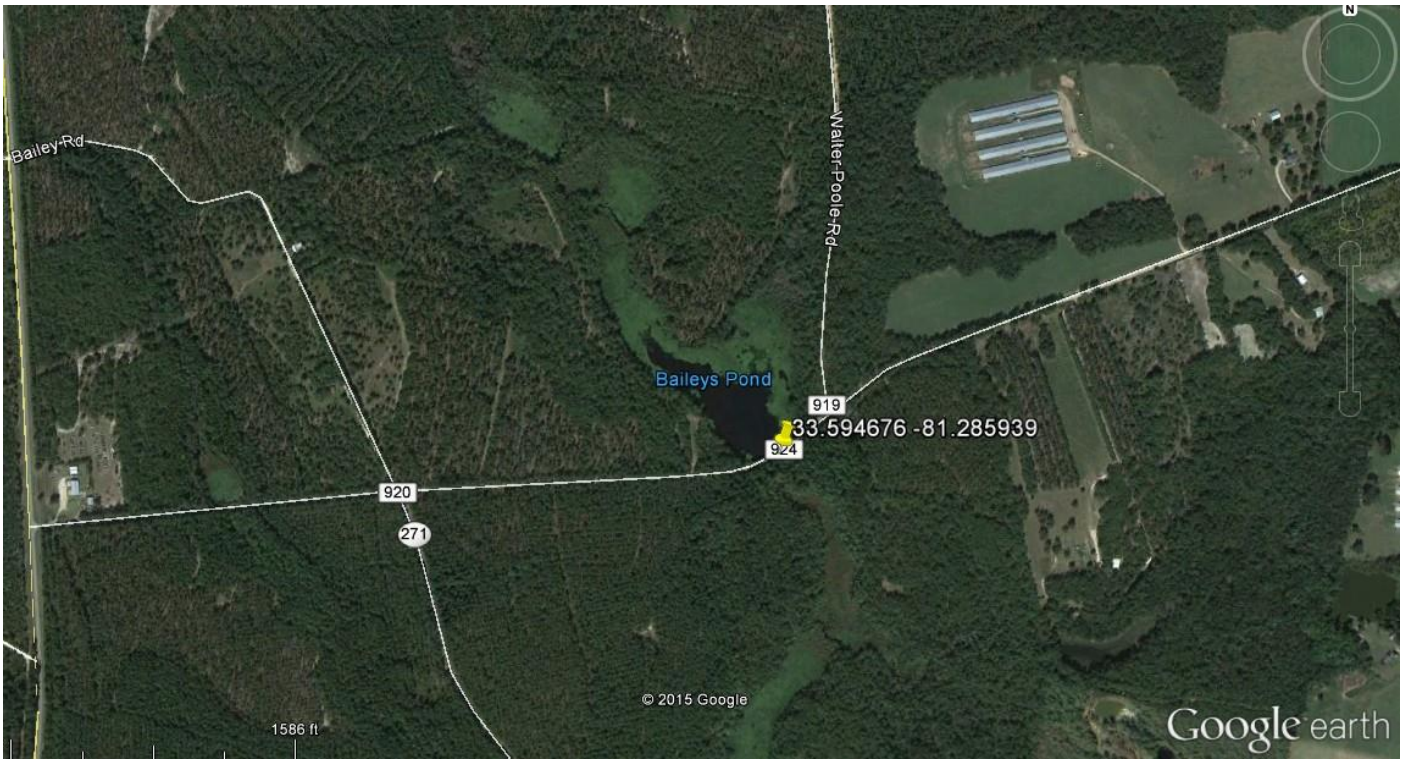

Figure A1.3: Bailey Pond Dam Site Area Map; Credit: Map data: 2015 Google Earth

Figure A1.4: Bailey Pond Dam post-event photo; Credit:

SCDHEC General Bailey Pond Dam Comments:

- This dam is classified as C3 by SCDHEC and inventoried as Low Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded an observed 5-day precipitation in the area of Bailey Pond Dam located on the border of the 8-10" and 11-15" rain contours.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - In searching for "Goodland Creek", "Bailey Pond" and "Dam" on the five different FIS volumes for Aiken County, nothing was found for Bailey Pond Dam.
    - The NID has this dam being on Goodland Creek.
  - No FIS flood profile was found for this Goodland Creek.
  - Specific Hydraulic and Hydrologic modeling was not found for this dam.
  - The FIS for Aiken County states in Volume I, "*All bridges, dams and culverts were surveyed to obtain elevation data and structural geometry*."
- No FIRM panel exists for this dam location. The FEMA FIRM Index, MAP NUMBER 45003CINDOA has an effective date of June 19, 2012. An asterisk is next to FIRM Panel 45003C0450E*. The index defines the asterisk as:
  *PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS
- The Dam Type in the NID is Earthen.
- An EAP does not exist for this dam and none is required by state regulations, since it is C3. DHEC confirmed this dam doesn't have an EAP.
- This dam was not referenced by the Aiken County / Local Mitigation Plan.
- The NID has this dam being completed in 1945 with no modifications since then.
- The 2013 NID has the condition of the dam as being "Not Rated".
  - According to the SCDHEC website for this event in which pre event inspections reports were provided for download, Bailey Pond Dam has the following: "*SC NONAME 02019 (Bailey Pond) D2034 Class 3 Aiken County This is a Class 3 Dam and has no past inspection reports.*"
  - According to a dam assessment performed by USACE on October 5 through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam had already failed. They also observed and reported a failed unregulated dam directly downstream of Bailey Pond Dam. A further check by USACE on October 22 confirmed no work was being done and the dam was breached. SCDHEC reconfirmed on October 29 that there was extensive damage to the dam itself, with a lot of debris and erosion that was blocking the spillway and no water was being impounded, with very little natural flow. No repairs were underway.
- The following imagery was reviewed: Google Earth historical imagery from 1994 from the US Geological Survey, an image from 2005 from the USDA

Farm Service Agency also in Google Earth, a Google Maps image from 2007 and the latest imagery of the dam site area from overhead in the Oct / Nov 2014 time frame. The imagery reviewed indicates minimal to no downstream structures or infrastructure.

- Based on the 2007 Google Map street view of this dam, there is heavy vegetation along the dam crest on both sides.
- Based on the post failure picture, the dam had extensive vegetation around it.

Considerations for Bailey Pond Dam:

- Consider assessing the dam for probable cause of failure as a result of this event, to include whether the heavy vegetation might have been a contributing factor into its failure.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.

2) ***State Dam Name: Corbett Lake Dam*** Latitude: 33.648651; Longitude: 81.21133; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 02027	County	Aiken
Stream or River	Hollow Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00312	State ID	D2052
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1955
Length (ft)	1060	Year Modified	N/A
Drainage Area (sq mi)	15.46	Height (ft)	17
Surface Area (ac)	35	EAP	No
Max Discharge (cfs)	695	Condition	Not Rated
Max Storage (ac ft)	308	Normal Storage (ac ft)	168
Note: FIRM & FIS data are not in the NID		FIS Effective Date	06/19/2012
FIRM Panel	45003C0265E	FIRM Effective Date	06/19/2012

*Provided by SCDHEC

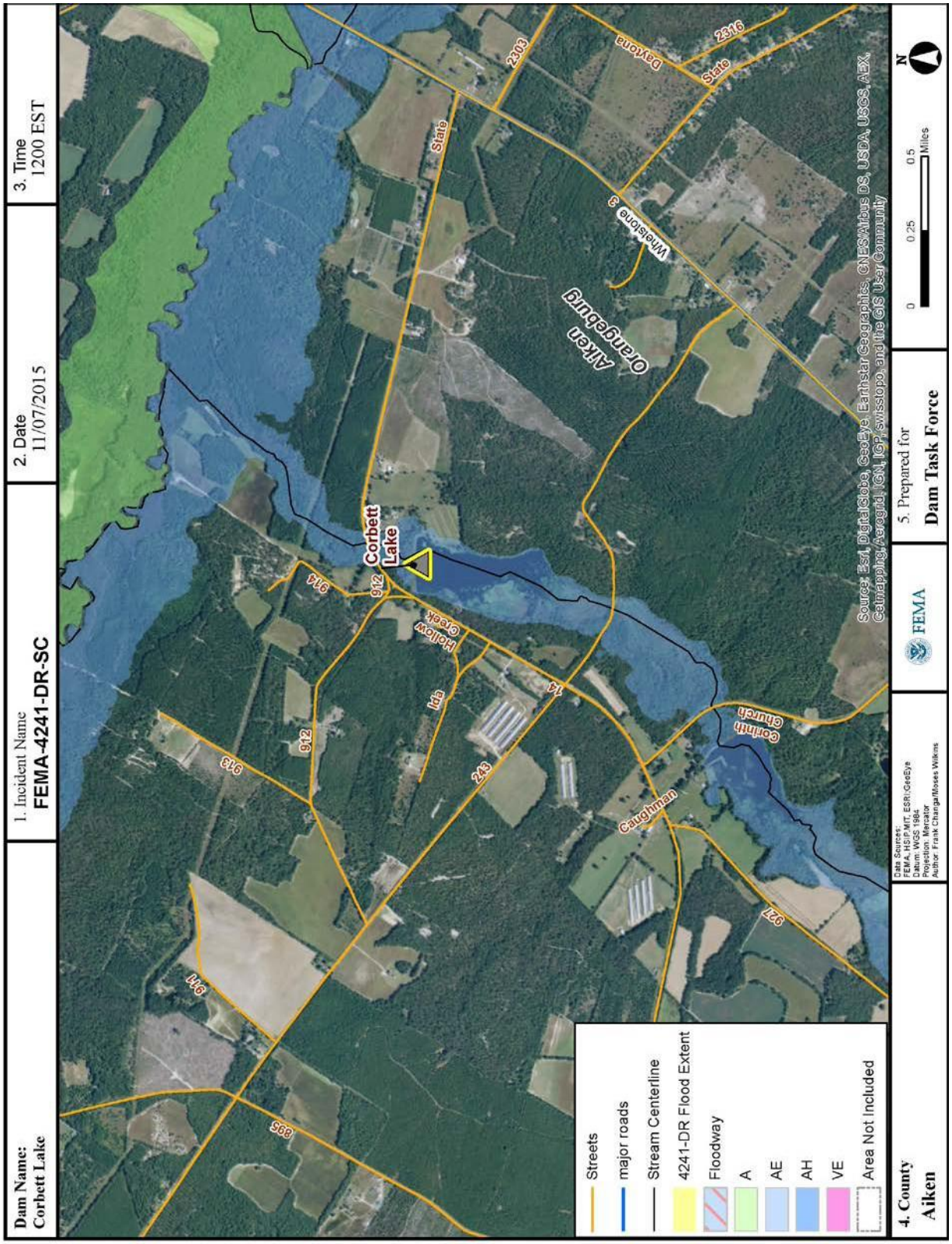

Figure A2.1: Corbett Lake Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

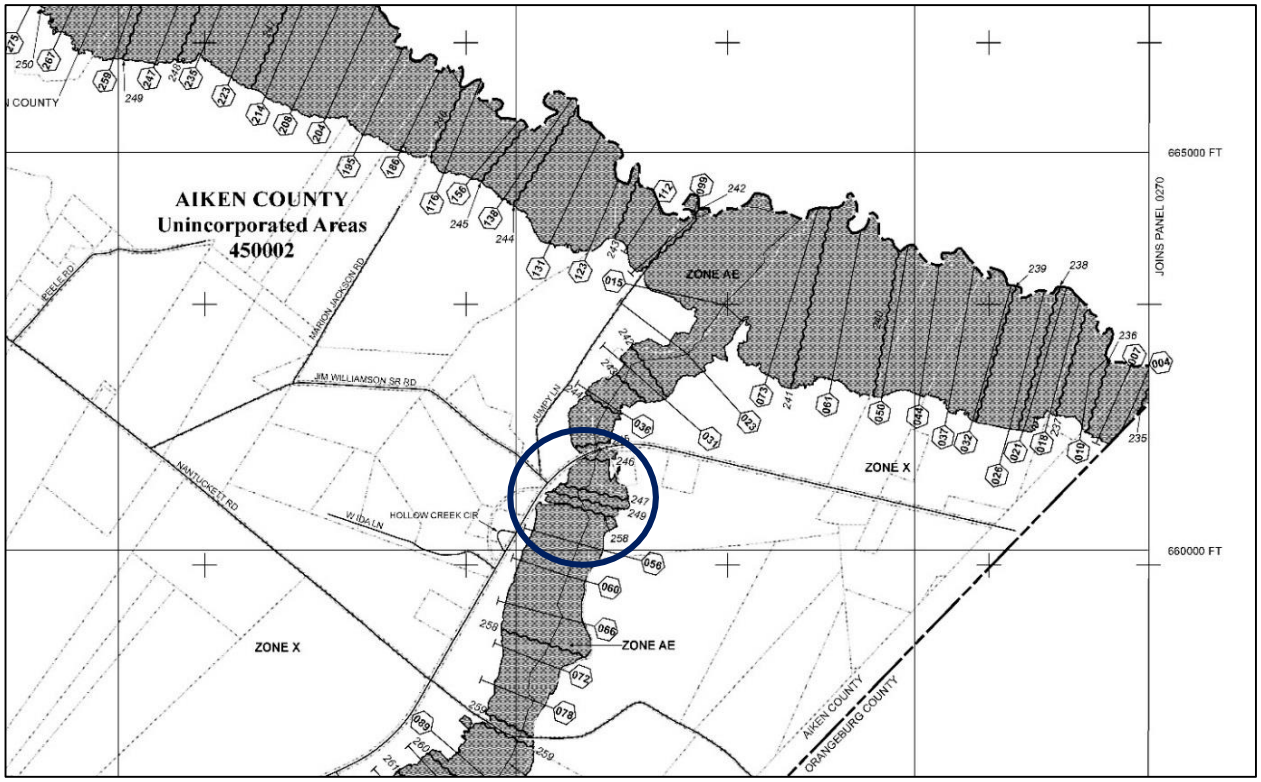

Figure A2.2: Corbett Lake Dam in blue circle; FIRM cropped; detailed above

Figure A2.3: Corbett Lake Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A2.4: Corbett Lake downstream Dam post-event photo; Credit: SCDHEC

General Corbett Lake Dam Comments:

- This dam is classified as C3 by SCDHEC and inventoried as Low Hazard in the 2013 NID.
- A CAP photo for this dam was taken on October 6, 2015, showing a breached condition of the dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around the Corbett Lake dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
    - The FIS only appears to have done a limited flood study for the area in which this dam is located as there is not a flood profile for that particular area.
    - The stream for this dam is listed as Hollow Creek East in FIS Volume 2 TABLE 8—Limited Detail Flood Hazard Data for cross sections 36 through 56. The National Inventory of Dams lists the stream for this dam as simply Hollow Creek Branch. However, the FIS references Hollow Creek West, Hollow Creek West Tributary 10, Hollow Creek West Tributary 11, Hollow Creek West Tributary 12, Hollow Creek West Tributary 12A, Hollow Creek West Tributary 13, Hollow Creek West Tributary 15, among others.

    - On page 25 of the 1st volume of the FIS, it states within section 3.2 Hydraulic Analyses: "*All bridges, dams and culverts were surveyed to obtain elevation data and structural geometry*."
    - According to modeling information for this dam, Regression Equations were used for hydrologic analysis and HEC-RAS 3.1.3 was used for hydraulic modeling, assuming an inline weir on a modeling run on September 1, 2008.
- The Dam Type in the NID is Earthen.
- The 2013 NID has no EAP for this dam, consistent with state regulations not requiring an EAP for C3 dams. DHEC confirmed this dam doesn't have an EAP.
- The NID has this dam being completed in 1955 with no modifications since then.
- The NID has "*Not Rated*" for the condition of this dam.
- According to the SCDHEC website for this event in which pre event inspections reports were provided for download, Corbett Lake Dam states the following, "*This is a Class 3 Dam and has no past inspection reports.*"
    - SCDHEC stated on October 5 assessment Dam partially breached at right abutment. The owner is currently removing boards to continue lowering reservoir as much as possible. SCDHEC stated on October 29 assessment that the primary spillway was intact with moderate flow. The dam breached on the right side. There is a good bit of erosion on the breached path with a little flow through breach. On November 5, SCDHEC revised the assessment and determined that the dam did not breach. The pond emptied by cutting around the dam through a neighbor's property causing massive erosion. The dam is impounding water and the primary spill way is operational. The emergency spillway is overgrown and blocked.
- This dam was not reference by name in the Aiken County / Local Mitigation Plan. The NID has the condition of this dam as "*Not Rated*".
- Corbett Lake is listed as "*SCHOFIELD/POOLE DAM*" under "*Other Dam Name*" in the NID.
- A pre-event photo of the dam was not found in time for this final report.

<u>Considerations for Corbett Lake Dam</u>:

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

3) ***State Dam Name: Able/ Cobett Pond Dam*** Latitude: 33.62181631; Longitude: -81.23376209; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	ABLE/COBETT POND DAM	County	Aiken
Stream or River	Little Hollow Creek	Nearest Downstream City/Town	Little Hollow Creek Area
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00370	State ID	D2048
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1955
Length (ft)	400	Year Modified	N/A
Drainage Area (sq mi)	3.11	Height (ft)	10
Surface Area (ac)	11	EAP	No
Max Discharge (cfs)	170	Condition	Not Rated
Max Storage (ac ft)	58	Normal Storage (ac ft)	35
Note: FIRM & FIS data are not in the NID		FIS Effective Date	06/19/2012
FIRM Panel	45003C0455E	FIRM Effective Date	06/19/2012

*Provided by SCDHEC

Figure A3.1: Able/ Cobett Pond Dam pre-event photo; Credit: Google Maps Streetview

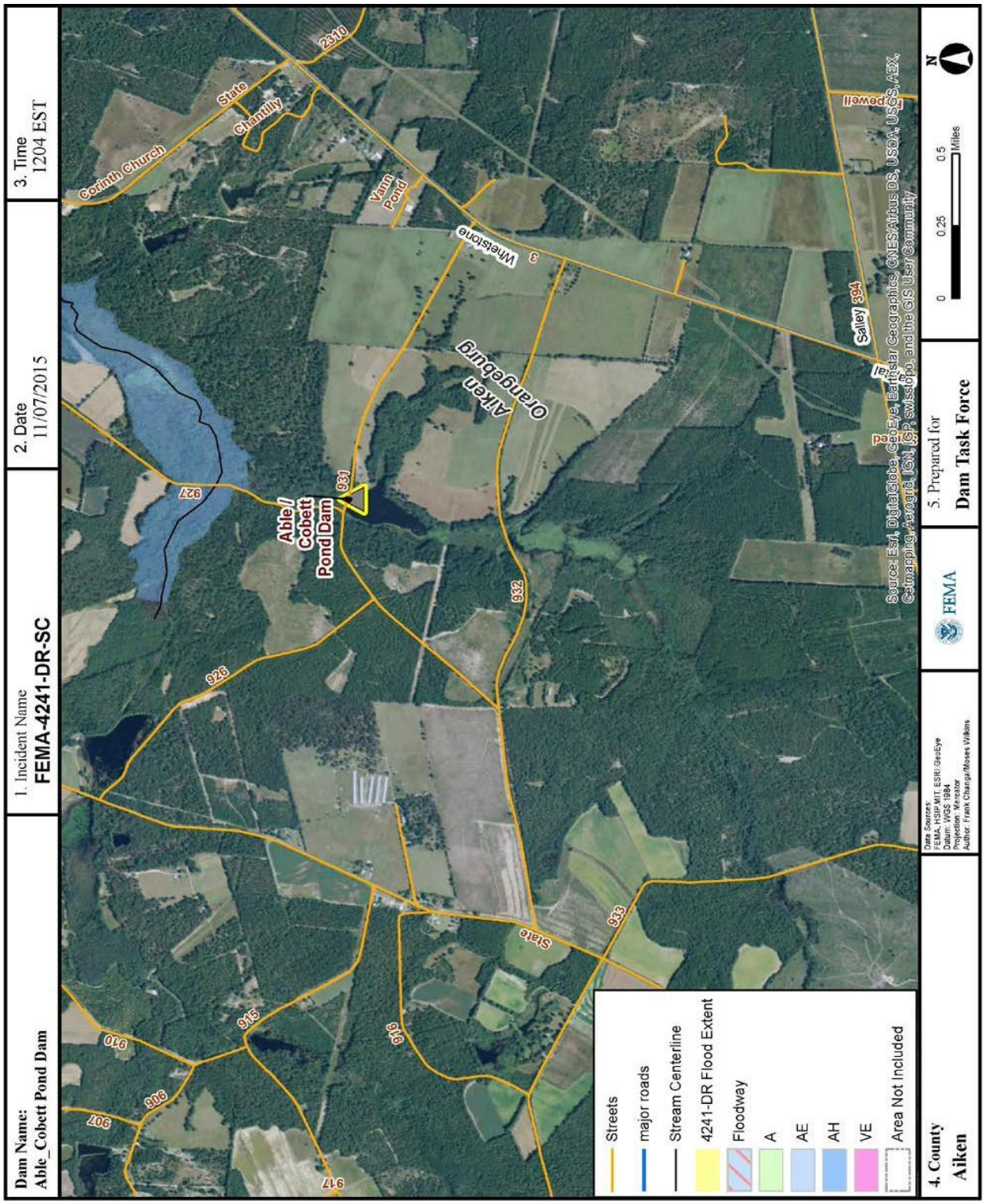

Figure A3.2: Able / Cobett Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

Figure A3.3: Able/ Cobett Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

General Able / Cobett Pond Dam Comments:

- This dam is classified as C3 by SCDHEC and inventoried as Low Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around the Corbett Lake dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - In searching for "Able", "Cobett", "pond", "little hollow creek" and "Dam" on the four different FIS volumes for Aiken County, nothing was found for Able / Cobett Pond Dam.
  - No FIS flood profile was found for this dam.
  - Specific H&H modeling was not found for this dam.
  - The FIS for Aiken County states in Volume I, "*All bridges, dams and culverts were surveyed to obtain elevation data and structural geometry*."
- No FIRM panel exists for this dam location. The FEMA FIRM Index, MAP NUMBER

45003CINDOA has an effective date of June 19, 2012. An asterisk is next to FIRM Panel 45003C0455E *. The index defines the asterisk as: *PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

- The Dam Type in the NID is Earthen.
- The NID shows this dam as not having an EAP, which is consistent with state regulations not requiring an EAP for a C3 dam. DHEC confirmed this dam does not have an EAP.
- This dam was not referenced by name in the Aiken County / Local Mitigation Plan.
- The NID has this dam as being completed in 1955 with no modifications since then.
- The NID has this dam as "*Not Rated*".
- According to the SCDHEC website for this event in which pre event inspections reports were provided for download, the Able/Cobett Pond Dam report states the following, "*This is a Class 3 Dam and has no past inspection reports.*"
- The following imagery was reviewed: Google Earth historical imagery from 1994 from the US Geological Survey, an image from 2005 from the USDA Farm Service Agency also in Google Earth, and the latest imagery of the dam from the Oct / Nov 2014 time frame. The imagery reviewed indicates minimal to no downstream structures or infrastructure.

Considerations for Able / Cobett Pond Dam:

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

4) ***State Dam Name: O E Rose Dam*** Latitude: 33.80674348 Longitude: -80.09057333; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 14001	County	Clarendon
Stream or River	Mill Branch	Nearest Downstream City/Town	Black River Swamp
NID Hazard Class	Low	State Hazard Class*	C2
NID ID	SC00718	State ID	D3487
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1900
Length (ft)	680	Year Modified	N/A

Drainage Area (sq mi)	4.75	Height (ft)	15
Surface Area (ac)	36	EAP	No
Max Discharge (cfs)	462	Condition	Not Rated
Max Storage (ac ft)	263	Normal Storage (ac ft)	137
Note: FIRM & FIS data are not in the NID		FIS Effective Date	
FIRM Panel	45027C0140C	FIRM Effective Date	08/19/2013

*Provided by SCDHEC

Figure A4.1: O E Rose Dam pre-event photo; Credit: Google Maps Streetview

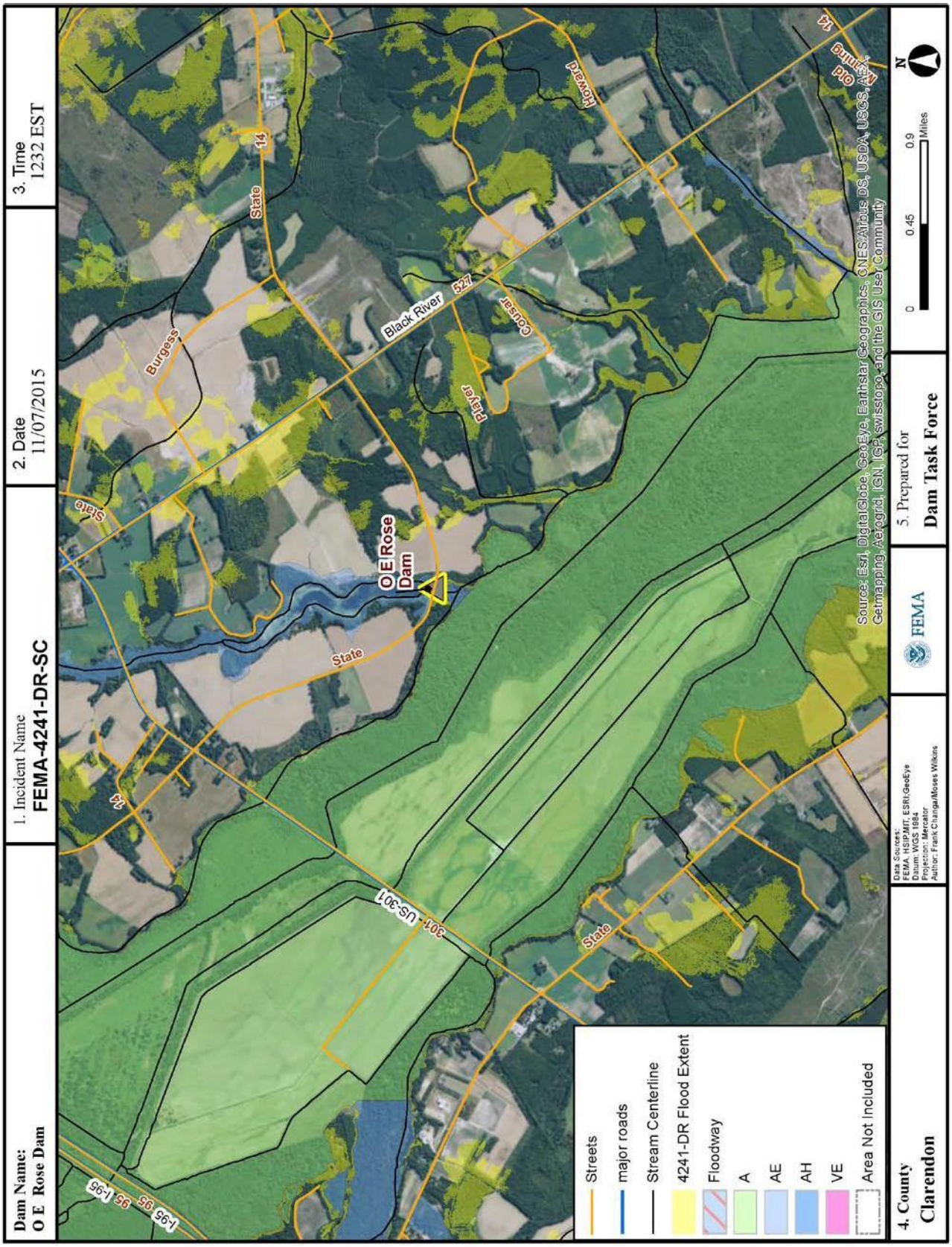

Figure A4.2: O E Rose Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

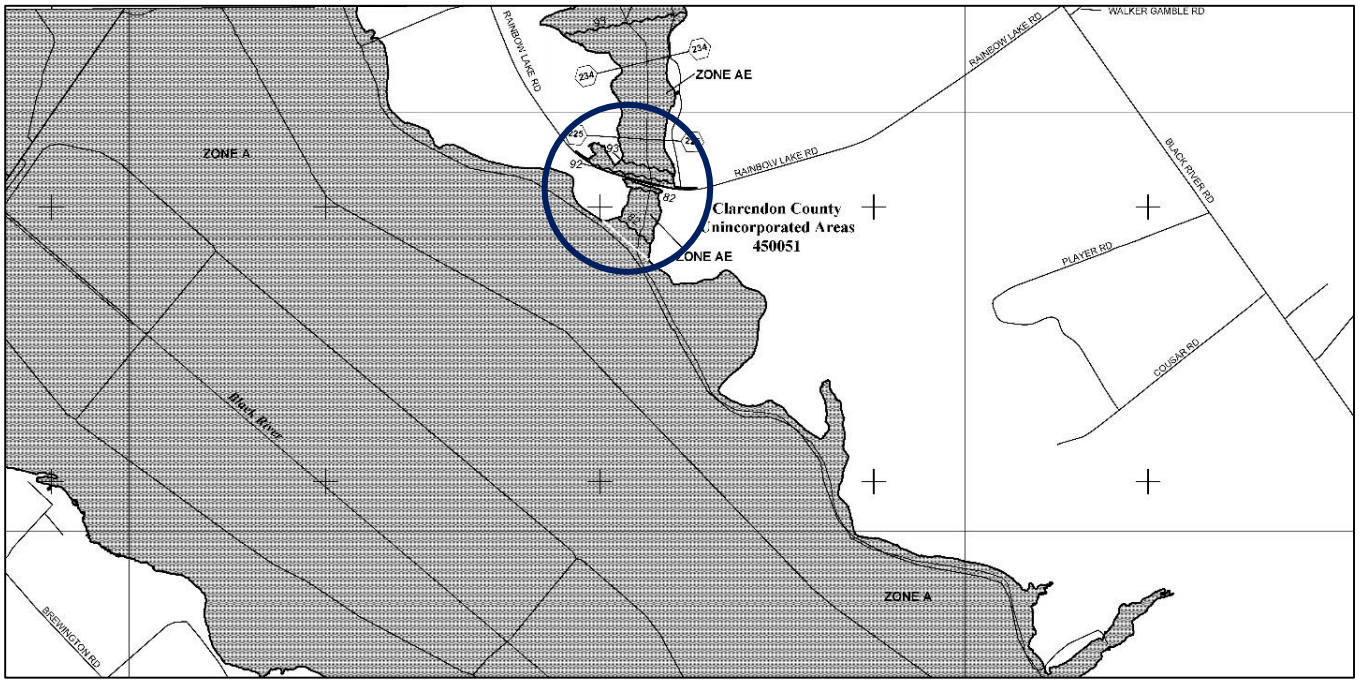

Figure A4.3: O E Rose Dam in blue circle; FIRM cropped; detailed above

Figure A4.4: O E Rose Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A4.5: O E Rose Dam from downstream side post-event photo; Credit: USACE; Mekkers

General O E Rose Dam Comments:

- This dam is classified as C2 by SCDHEC and inventoried as Low Hazard in the 2013 NID.
  - There is a discrepancy between the SCDHEC classification and the NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 20" or more in the area around the O E Rose dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - On page 12 of the Clarendon County FIS, it states "*All bridges, dams and culverts were field surveyed to obtain elevation data and structural geometry*." Many dams in the NID and the state ID list for Clarendon County are not referenced in the FIS at all.
  - In searching for "Rose" and "Dam" on the single FIS volume for Clarendon County, nothing was found for O E Rose Dam.

- It appears this dam is located in an area to which only a Limited Detailed Flood Hazard Data analysis was performed within the FIS on Mill Branch in Table 7 on page 44 for cross section 225 near this dam as shown on the FIRM.
- A flood profile does not exist for this dam.
- According to modeling information for this dam, Regression Equations were used for hydrologic analysis and HEC-RAS 3.1.3 was used for hydraulic modeling, assuming an inline weir on a modeling run on February 1, 2011.

- A FIRM panel does exist on which O E Rose dam can be located, as shown in Figure A4.3 above. However, O E Rose dam is not named on the FIRM panel.
- The Dam Type in the NID is Earthen.
- The NID shows that an EAP does not exist for this dam.
- This dam is referenced by name in Appendix G of the Clarendon County / Local Mitigation Plan.
- The NID has this dam being completed in 1900 with no modifications since then.
- The NID has a condition rating for this dam of "*Not Rated*". A December 11, 2014 SCDHEC inspection report states the condition as being "*Poor*".
  - A January 11, 2013, inspection report from SCDHEC states the dam should be upgraded to significant based on Rainbow Lake Road would be washed out were the dam to fail. This explains the discrepancy from above and it is a normal lag time for the NID update.
  - The December 11, 2014 inspection report raises multiple concerns, including 1) vegetation preventing adequate inspection of the dam, 2) erosion and sloughing seen on upstream and downstream slopes of the dam, 3) the gate of the spillway or objects near it seemed to inhibit water flow through the spillway, 4) Small and large trees downstream of the spillway could fall and block the channel.
  - USACE assessed the dam on October 12th and advised SCDHEC it was breached in two locations with an overtopping failure on downstream slope in another. The pool was empty and road was closed. SCDHEC confirmed again on October 30 that the dam was still breached and not holding water.

<u>Considerations for O E Rose Dam</u>:

- Consider research on the discrepancy between the hazard classifications by the state and the information in the NID.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.

- Consider assessing the dam for probable cause of failure as a result of this event.

5) ***State Dam Name: Lakewood Pond Dam*** Latitude: 33.7318223; Longitude: 80.09334774; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 14015	County	Clarendon
Stream or River	Lakewood Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Low	State Hazard Class*	C2
NID ID	SC00731	State ID	D3490
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1955
Length (ft)	685	Year Modified	N/A
Drainage Area (sq mi)	4.31	Height (ft)	9
Surface Area (ac)	24	EAP	No
Max Discharge (cfs)	280	Condition	Not Rated
Max Storage (ac ft)	144	Normal Storage (ac ft)	48
Note: FIRM & FIS data are not in the NID		FIS Effective Date	08/19/2013
FIRM Panel	45027C0280C	FIRM Effective Date	08/19/2013

*Provided by SCDHEC

Figure A5.1: Lakewood Pond Dam pre-event photo; Credit: Google Maps Streetview

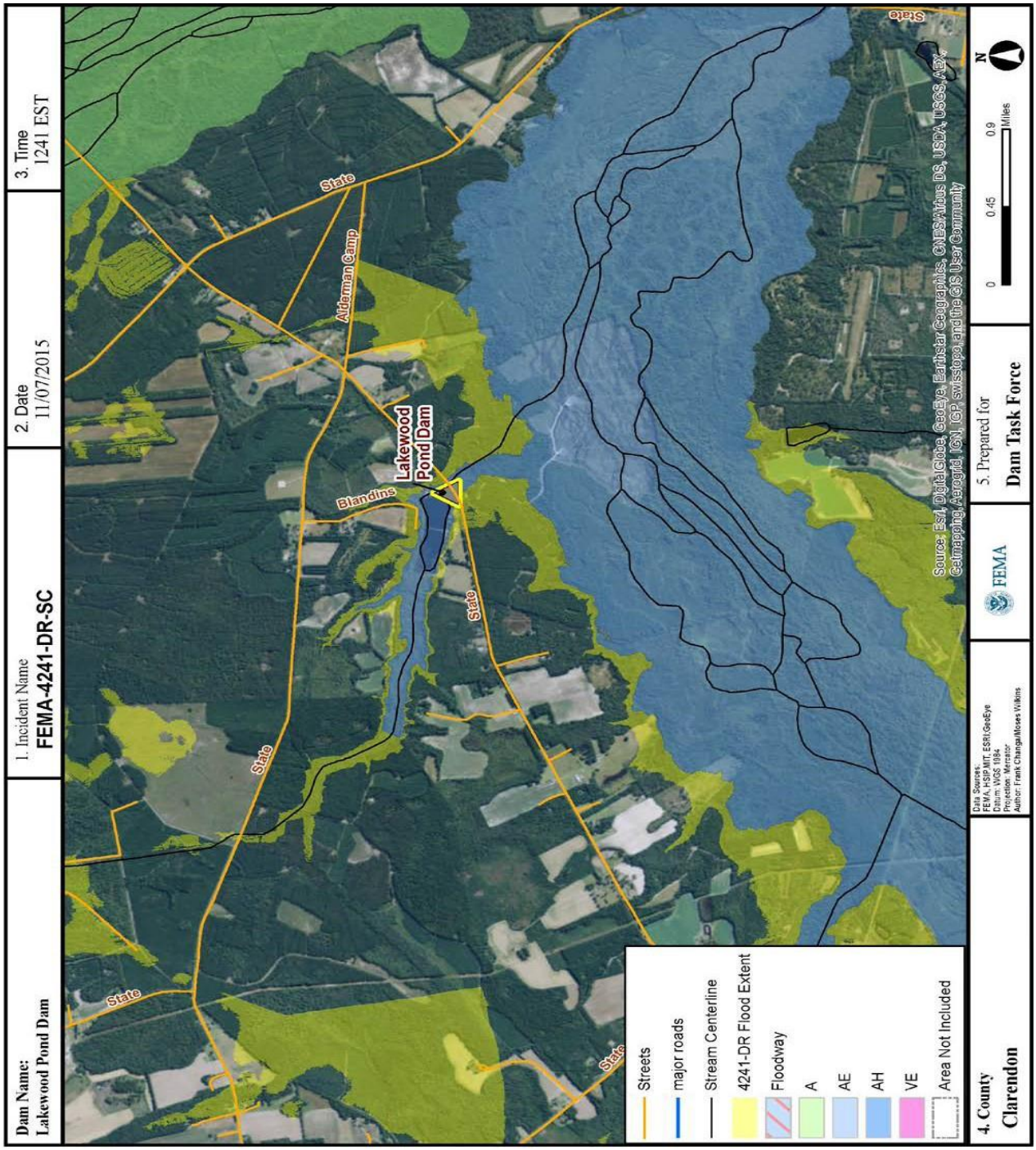

Figure A5.2: Lakewood Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

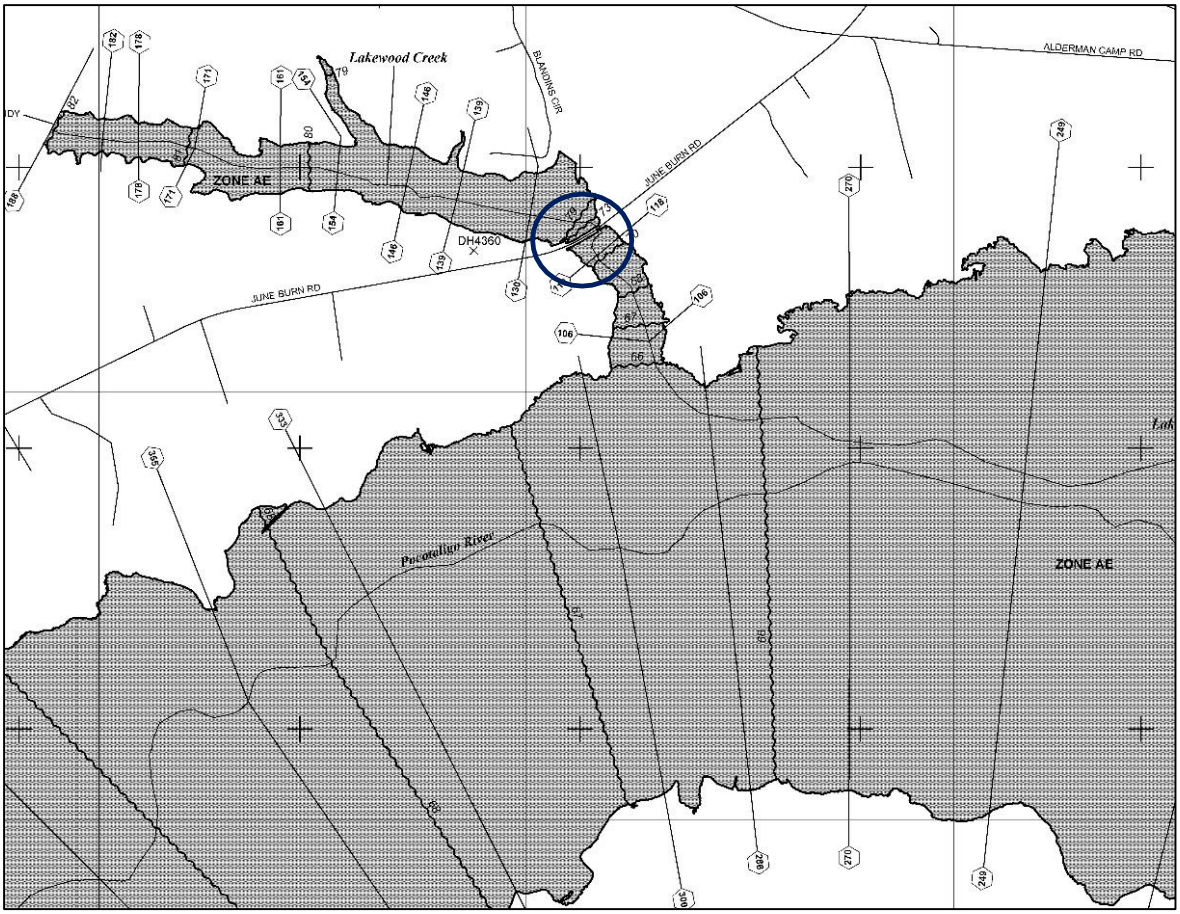

Figure A5.3: Lakewood Pond Dam in blue circle; FIRM is cropped, detailed above

Figure A5.4: Lakewood Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A5.5: Lakewood Pond Dam from downstream side post-event photo; Credit: USACE; Schuman

<u>General Lakewood Pond Dam Comments</u>

- Lakewood Pond Dam is classified as C2 by SCDHEC and inventoried as Low Hazard in the 2013 NID.
  - There is a discrepancy between the SCDHEC classification and the NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 20" or more in the area around the Lakewood Pond dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - In searching for "Lakewood", "Pond" and "Dam" on the single FIS volume for Clarendon County, nothing was found for Lakewood Pond Dam.
  - According to modeling information for this dam, Regression Equations were used for hydrologic analysis and HEC-RAS 3.1.3 was used for hydraulic modeling, assuming an inline weir on a modeling run on February 1, 2011.
  - A flood profile does not exist for this dam.
  - Within the Hydraulic Analyses section on page 12, it states, "*All bridges, dams and culverts were field surveyed to obtain elevation data and structural geometry.*"
  - The NID references this dam being on Lakewood Creek. In Table 7 on page 43 of the FIS, cross sections 118-130 where this dam is located can be found under the Lakewood Creek.
- A FIRM panel does exist on which Lakewood Pond dam can be located, as shown in Figure A5.3 above. However, Lakewood Pond Dam is not named on the FIRM panel.
- The Dam Type in the NID is Earthen.
- The NID shows that an EAP does not exist for this dam. SCDHEC confirmed there is no EAP for this dam.
- This dam is referenced by name in Appendix G of the Clarendon County / Local Mitigation Plan.
- The NID has this dam being completed in 1955 with no modifications since then.
- The NID has the condition as being "Not Rated".
  - A January 11, 2013 SCDHEC inspection report recommends this dam be upgraded to "significant hazard" due to June Burn Road would be washed away if the dam were to fail. This explains the discrepancy from above and it is a normal lag time for the NID update.
  - A December 11, 2014 SCDHEC inspection report rates the dam as "Fair" with the following concerns; 1) Heavy vegetation on the downstream slope preventing an appropriate inspection, 2) erosion and sloughing on the upstream slope, 3) requesting the owner fill out the EAP form provided and send in to the central SCDHEC office in Columbia.
- Nearest Downstream City/Town is inputted as "Secondary Road" in the NID.

- The following imagery was reviewed: Google Earth historical imagery from 1994 from the US Geological Survey, an image from 2005 from the USDA Farm Service Agency also in Google Earth, and the latest imagery of the dam from the Oct / Nov 2014 time frame. The imagery reviewed indicates minimal to no downstream structures or infrastructure.

Considerations for Lakewood Pond Dam:

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

6) ***State Dam Name: Chapman's Pond Dam*** Latitude: 34.42; Longitude: 79.941666; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 16006	County	Darlington
Stream or River	Seed Branch	Nearest Downstream City/Town	CROSSING OF RD 397 & 36
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00612	State ID	D3533
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1957
Length (ft)	850	Year Modified	N/A
Drainage Area (sq mi)	10.32	Height (ft)	20
Surface Area (ac)	28	EAP	No
Max Discharge (cfs)	320	Condition	Unsatisfactory
Max Storage (ac ft)	357	Normal Storage (ac ft)	113
Note: FIRM & FIS data are not in the NID		FIS Effective Date	02/06/2013
FIRM Panel	45031C0165C	FIRM Effective Date	02/06/2013

*Provided by SCDHEC

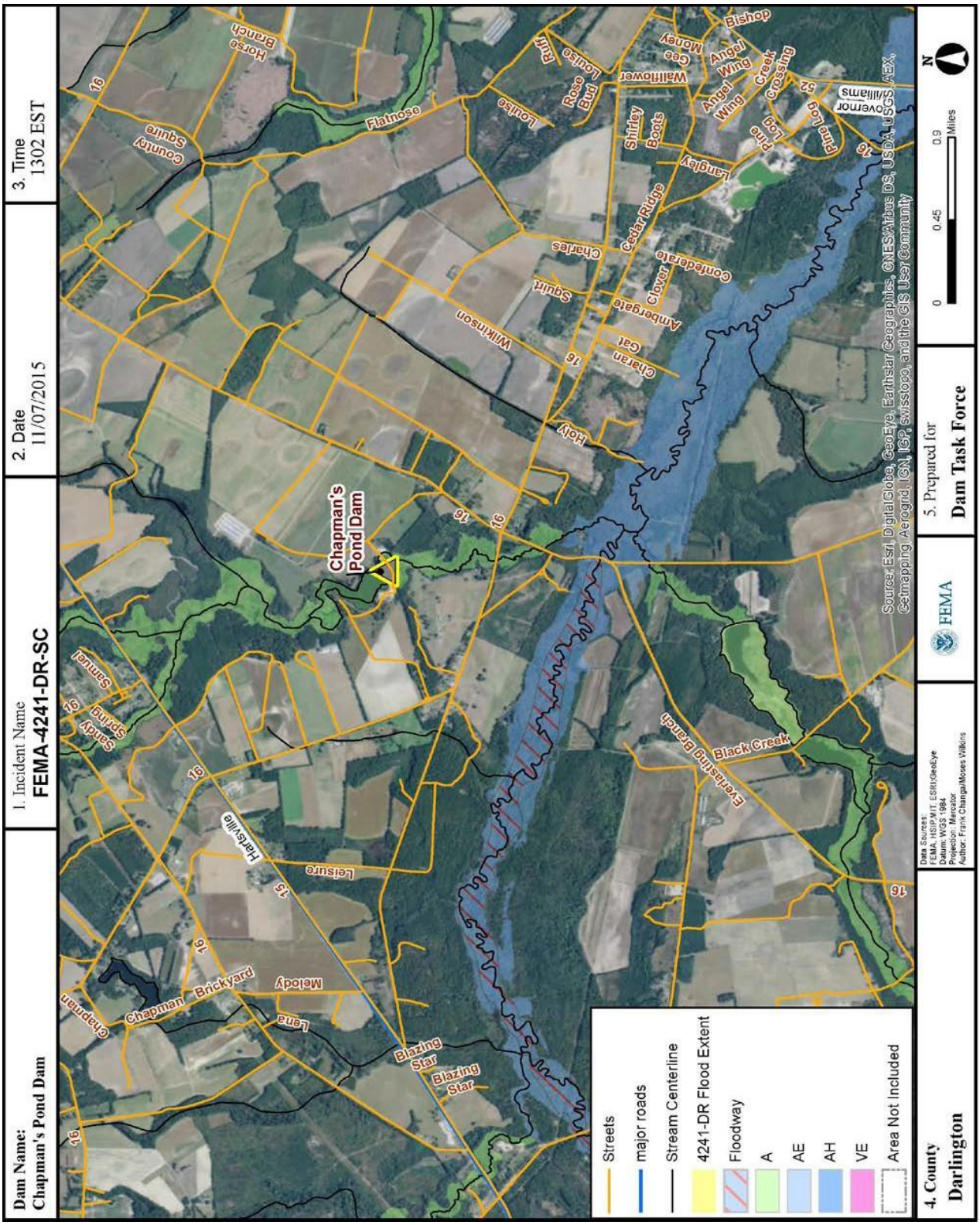

Figure A6.1: Chapman's Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

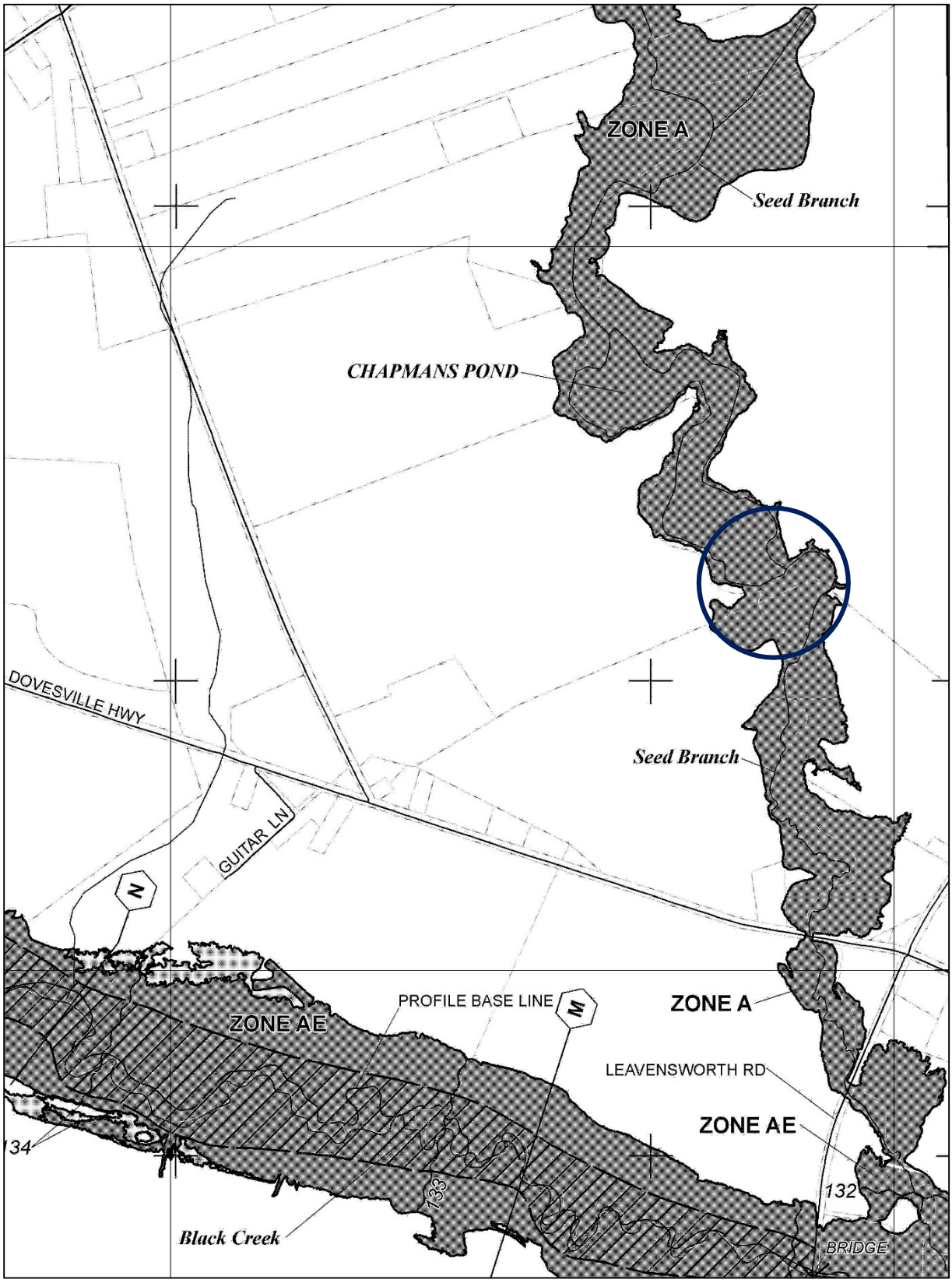

Figure A6.2: Chapman's Pond Dam in blue circle; FIRM is cropped, detailed above

Figure 6.3: Chapman's Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

General Chapman's Pond Dam Comments

- Chapman's Pond Dam is classified as C2 by SCDHEC and inventoried as Significant Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around the Lakewood Pond dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - It does not appear specific H&H modeling was performed on this dam.
  - In searching for "Chapman", "Pond" and "Dam" on the single FIS volumes for Darlington County, nothing was found for Chapman's Pond Dam.
  - Seed Branch information, on which Chapman's Pond is located, is not in the FIS. The FIRM does reference Seed Branch as Zone A on which Chapman's Pond (but not the dam) is referenced with a leader on the map.
  - A flood profile does not exist for this dam.
- A FIRM panel does exist on which Lakewood Pond dam can be located, as shown in Figure A6.2 above. However, Chapman Pond Dam is not named on the FIRM panel.
- The Dam Type in the NID is Earthen.

- The NID shows that an EAP does not exist for this dam. SCDHEC confirms that there is no EAP for this dam
- This dam was not referenced by name in the Darlington County Local Mitigation Plan.
- The NID has this dam being completed in 1957 with no modifications since then.
- The NID shows the condition of the dam as "Unsatisfactory".
  - SCDHEC provided a letter to the dam owner on December 22, 2010, confirming their meeting on the same day in which the owner stated the dam was in a breached condition for over 10 years to that meeting date.
  - SCDHEC inspected the dam on December 5, 2014 and found the dam to be in "poor" condition. The following concerns were raised, 1) The spillway was under construction, 2) The emergency spillway was under construction, 3) The inspector documented for checking with the central office to determine whether a valid work permit existed to accomplish the work being performed, 4) Sloughing and erosion existed on the downstream slope of the dam, 5) Large trees located downstream of the slope needed to be removed, 6) The owner was not able to be reached for the EAP
  - SCDHEC sent a letter dated December 8, 2014, raising the following concerns:
    1) "*The primary and emergency spillways are currently under repair/construction. Please call this office or Bureau of Water Dam Safety Program if you have not applied for a permit*."
    2) *"Brush and weedy vegetation on the downstream slope of the dam make it difficult to monitor the area for seeps, erosion, and other signs of deterioration of the structure. Clearing the downstream face of low- growing vegetation will allow inspectors to better monitor the structure*."
    3) "*Accumulation of woody debris on the trash rack/spillway inhibits flow. Debris should be removed from the trash rack*." The letter also asked the owner to provide their "Emergency Notification and Action Plan" by December 19, 2014.
    4) A USACE assessment on October 11th annotated a new breach through emergency spillway flow/erosion. A November 4th inspection by SCDHEC Bryant stated dam was still breached and no new activity since visit on October 29th.
- Nearest Downstream City/Town is inputted as "CROSSING OF RD 397 & 36" in the NID.
- The following imagery was reviewed: Google Earth historical imagery from 1994 from the US Geological Survey, an image from 2005 from the USDA Farm Service Agency also in Google Earth, and the latest imagery of the dam from the Oct / Nov 2014 time frame. The imagery reviewed indicates minimal to no downstream structures or infrastructure.

Considerations for Chapman Pond Dam

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

7) ***State Dam Name: Cook Pond Dam*** Latitude: 34.15243939; Longitude: 80.77560768; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	COOK POND DAM	County	Kershaw
Stream or River	TR Kelly Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC01488	State ID	D1068
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1963
Length (ft)	400	Year Modified	N/A
Drainage Area (sq mi)	0.61	Height (ft)	13
Surface Area (ac)	7	EAP	Yes
Max Discharge (cfs)	4	Condition	Poor
Max Storage (ac ft)	53	Normal Storage (ac ft)	25
Note: FIRM & FIS data are not in the NID		FIS Effective Date	12/19/2006
FIRM Panel	45055C0419E	FIRM Effective Date	12/19/2006

*Provided by SCDHEC

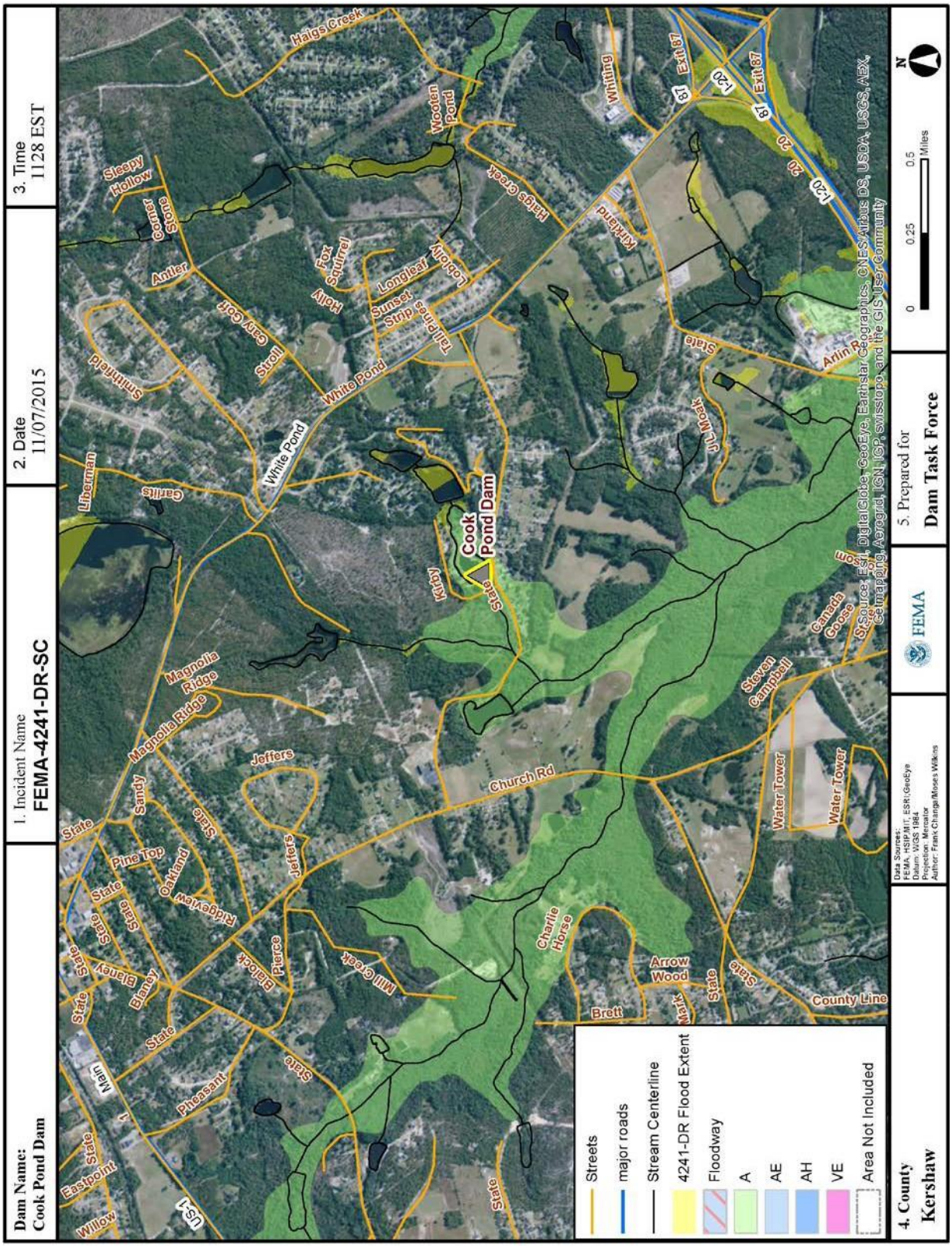

Figure A7.1: Cook Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

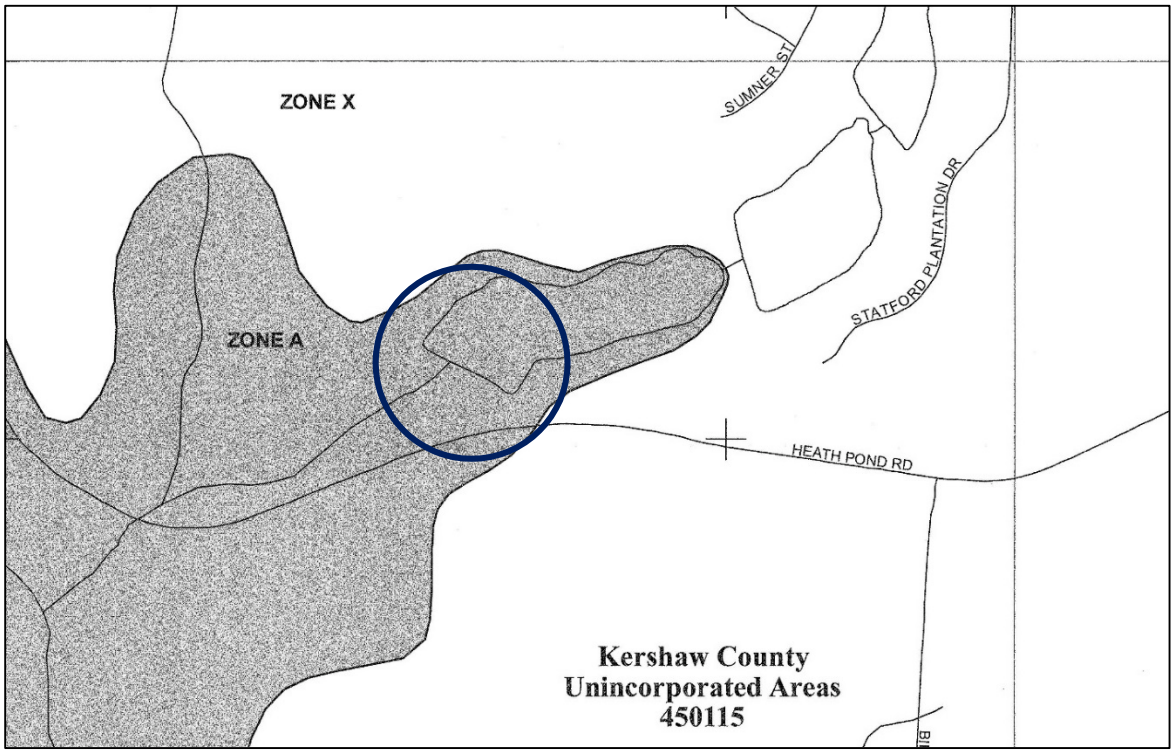

Figure A7.2: Cook Pond Dam in blue circle; FIRM is cropped, detailed above

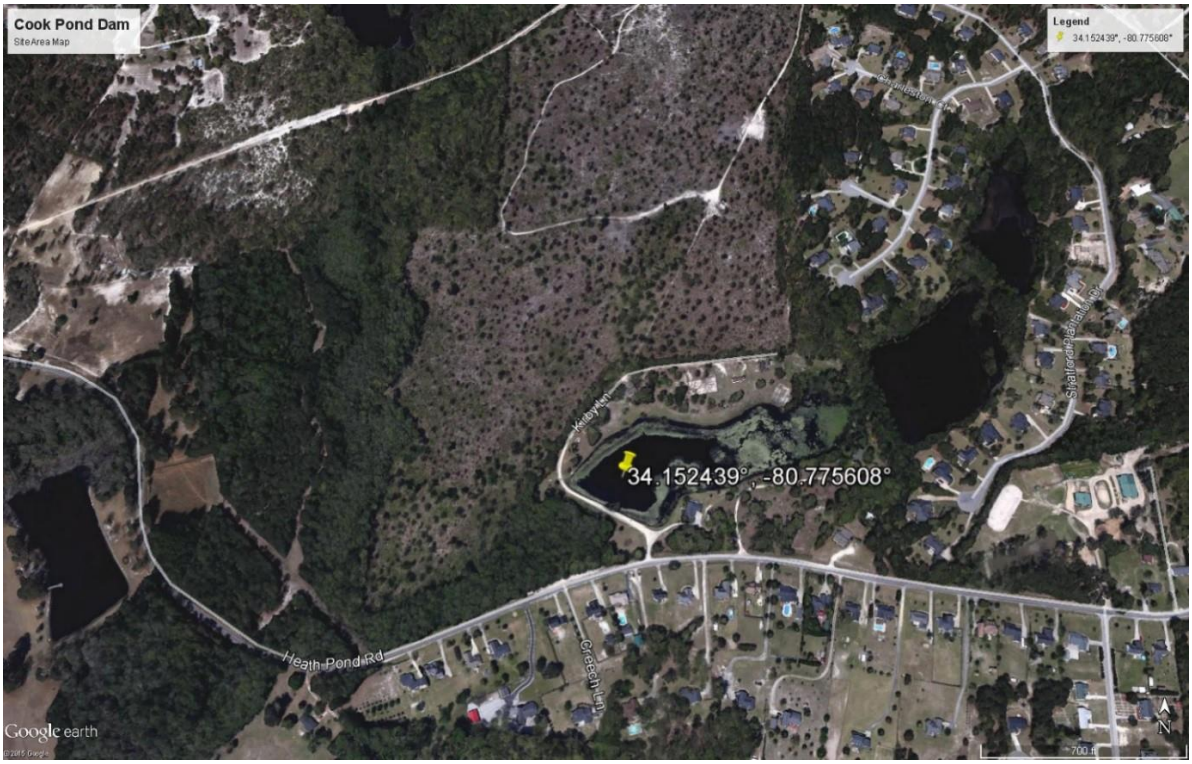

Figure A7.3: Cook Pond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A7.4: Cook Pond Dam from downstream side post-event photo; Credit: USACE; Papiernik

General Cook Pond Dam Comments

- Cook Pond Dam is classified as C2 by SCDHEC and inventoried as Significant Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 16-20" in the area around the Cook Pond dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - Specific H&H modeling does not appear to have been performed on this dam.
  - A flood profile does not exist for this dam.
  - In searching for "Cook", "Pond", "Dam", "TR", "Kelly" on the single FIS volume for Kershaw County, nothing was found for Cook Pond Dam.
- A FIRM panel does exist on which Cook Pond dam can be located, as shown in Figure A7.2 above. However, Cook Pond Dam is not named on the FIRM panel.

- The Dam Type in the NID is Earthen.
- The NID shows that an EAP exists for this dam. SCDHEC confirmed there is an EAP.
- This dam is referenced by name in Appendix G of the Kershaw County / Local Mitigation Plan.
- The NID has this dam being completed in 1963 with no modifications since then.
- The NID has the condition assessment of this dam as "Poor".
    - Letters from SCDHEC name it, "Kirby Pond Dam" due to the owner being "Ms. Kirby". A letter from SCDHEC dated December 21, 2007, referenced various issues of concern during that inspection, which included, 1) general lack of maintenance, 2) a blocked 4" pipe, 3) no spillway existing on the dam, 4) vegetation was too thick to enable an inspection on the downward slope and for the owner to provide SCDHEC with an updated EAP by January 15, 2008.
    - Inspection on December 23, 2010 states the status of the dam was largely unchanged since the last inspection was performed in December 2007, described above. The inspection report had a question mark next to "Yes" for whether the EAP was updated.
    - A letter from SCDHEC was sent to the owner (Kirby) on Dec 30, 2010, summarizing the issues from the December 23, 2010 inspection and requesting an EAP be provided by January 31, 2011.
    - An inspection on February 20, 2013 stated the dam was "Fair." It raised concerns on upstream slope vegetation with one large tree, an area near the outfall having erosion that needed to be watched and an EAP to be provided by the owner.
    - A letter from SCDHEC was sent to the owner (Kirby) on March 12, 2013, summarizing the issues from the February 20, 2013 inspection and requesting an EAP be provided by April 12, 2013.
    - A USACE assessment on October 10 stated the dam already breached. On November 4 SCDHEC confirmed the pond was still drained and no change in status.

<u>Considerations for Cook Pond Dam</u>

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.

- Consider assessing the dam for probable cause of failure because of this event.

8) ***State Dam Name: Clyburn Pond Dam*** Latitude: 34.329886; Longitude: -80.302055; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 31009	County	Lee
Stream or River	Turkey Creek	Nearest Downstream City/Town	County Road
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00498	State ID	D2412
Dam Type	Earth	Owner Type	Private
Purpose	Irrigation	Year Completed	1930
Length (ft)	940	Year Modified	1998
Drainage Area (sq mi)	6.48	Height (ft)	15
Surface Area (ac)	24	EAP	Yes
Max Discharge (cfs)	165	Condition	Fair
Max Storage (ac ft)	312	Normal Storage (ac ft)	192
Note: FIRM & FIS data are not in the NID		FIS Effective Date	11/19/2008
FIRM Panel	45061C0035C	FIRM Effective Date	11/19/2008

*Provided by SCDHEC

Figure A8.1: Clyburn Pond Dam pre-event photo; Credit: Google Maps Streetview

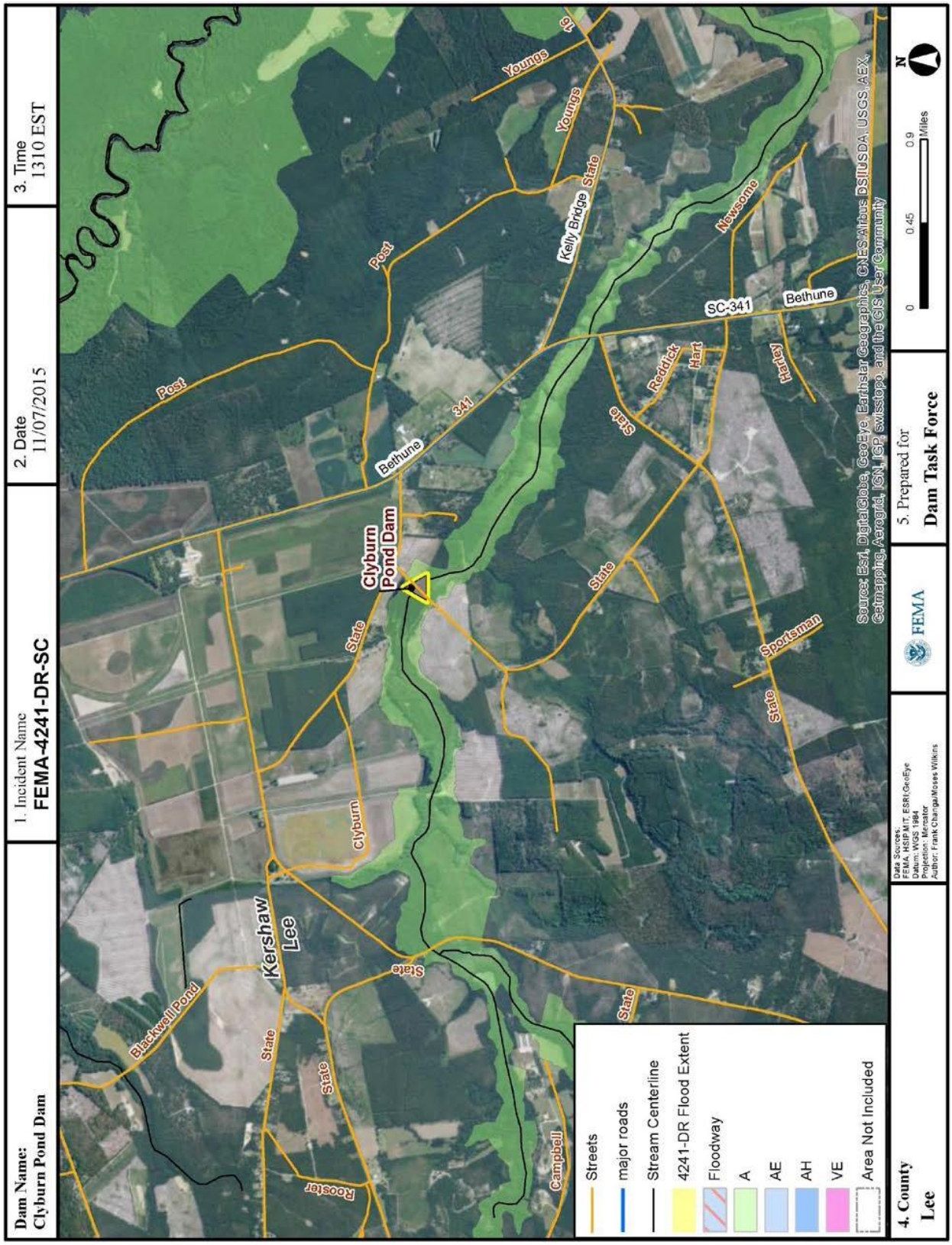

Figure A8.2: Clyburn Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

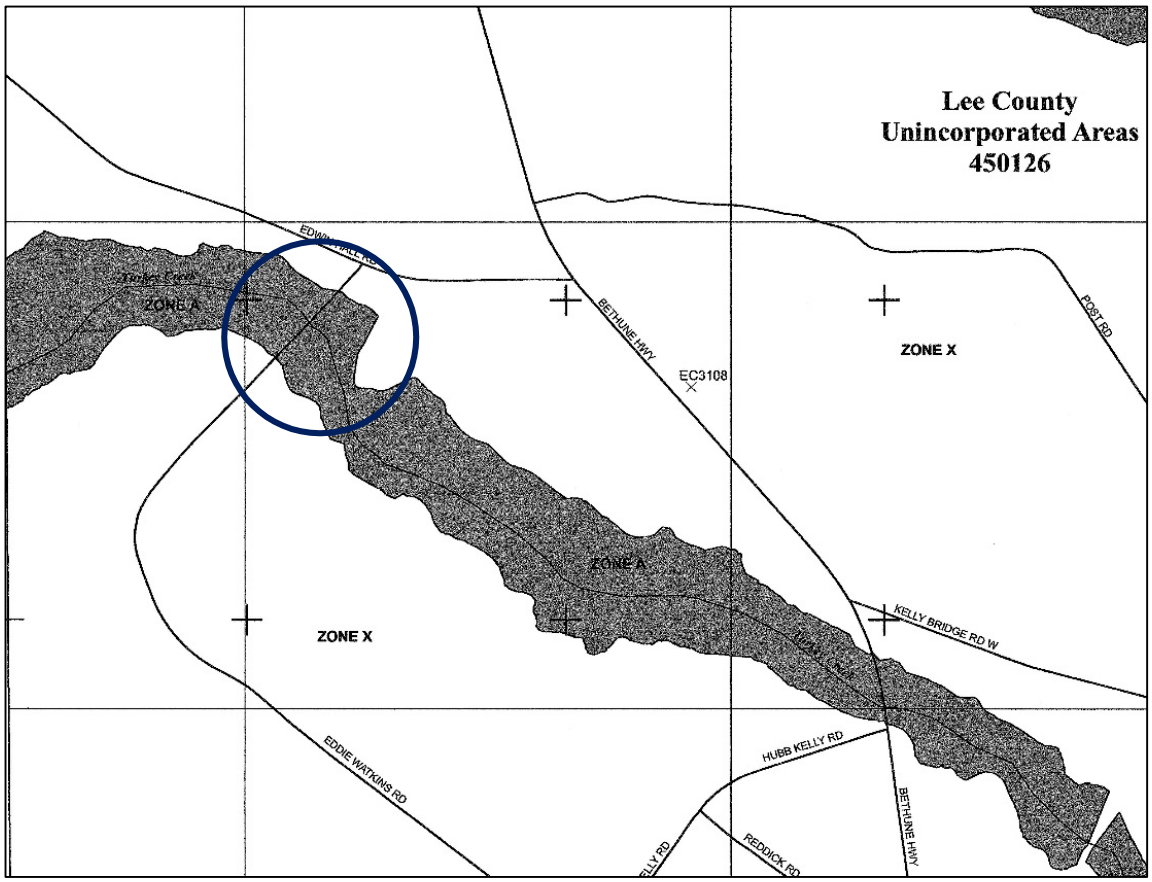

Figure A8.3: FIRM cropped; Clyburn Pond Dam in blue circle; detailed above

Figure A8.4: Clyburn Pond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A8.5: Clyburn Pond Dam post-event photo; Credit: SCDHEC Bryant

General Clyburn Pond Dam Comments

- Clyburn Pond Dam is classified as C2 by SCDHEC and inventoried as Significant Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded an observed 5-day precipitation of 8-10" in the area around Clyburn Pond dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - It does not appear specific H&H modeling was performed on this dam.
  - In searching for "Clyburn", "Pond", and "Dam" on the single FIS volume for Lee County, nothing was found for Clyburn Pond Dam.
  - On Page 6 within the Pre-County Analyses, it says, "*All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry*."
  - Turkey Creek is not referenced in the FIS report.
  - A flood profile does not exist for this dam.

- A FIRM panel does exist on which Clyburn Pond dam can be located, as shown in Figure A8.3 above. However, Clyburn Pond Dam is not named on the FIRM panel.
- The Dam Type in the NID is Earthen.
- The NID shows that an EAP exists for this dam. SCDHEC confirmed that an EAP exists. It is unclear whether the EAP was activated for this event.
- This dam was referenced by name in Appendix G of the Lee County / Local Mitigation Plan.
- The NID has this dam being completed in 1930 with modifications in 1998.
- The NID has a condition assessment of "Fair".
    - SCDHEC inspected this dam on February 8, 2005 and followed up with a letter dated February 17, 2005 to the dam owner, stating the following: "*The dam appeared stable and in good condition. Fill had been added at the end of the outlet pipe and no under cutting was taking place.*" The inspection report itself also mentioned two trees started to grow on upslope. An Emergency Notification Plan was requested to be filled out by the owner and sent back to SCDHEC by April 1, 2005 and kept current.
    - SCDHEC inspected the dam again on October 15, 2008 and followed up with a letter dated October 20, 2008 to the dam owner, stating the following: "*The dam appeared stable and in good condition. The water level was down due to the dry weather conditions for the last few years.*" SCDHEC also requested an Emergency Notification Plan was requested to be filled out by the owner and sent back to SCDHEC by November 15, 2008 and kept current.
    - SCDHEC inspected the dam again on January 23, 2012 and followed up with a letter dated February 8, 2012 to the dam owner, stating the following: "*The dam appeared to be in good condition*". SCDHEC also requested an Emergency Notification Plan was requested to be filled out by the owner and sent back to SCDHEC by March 8, 2012 and kept current. The letter also stated that any alteration or major repairs of the dam require a permit from the agency (SCDHEC). The actual inspection report dated January 23, 2012 states the following in the notes section, "*Dam and appurtenant works in good shape. Owner plans to reinstate auxiliary spillway in future. Auxiliary spillway was eliminated when highway over dam was paved by SC DOT."*
    - SCDHEC inspected the dam again on September 30, 2015 and assessed it as in "Fair" condition. Although there were specific comments regarding various elements of the dam, the report summarized the overall dam with these notes, "*Dam appears in good condition, appears to be proactive on maintenance. One area of dumped wood chips on downstream side of steep dam slope, likely from slope clearing.*" An auxiliary spillway did not exist as annotated in this inspection report.

o SCDHEC confirmed on October 10that the dam was breached. There were reports of the breach on October 5 and 6 earlier in the week. SCDHEC confirmed that dam was still breached on October 29 and no change in status.

- "County Road" was inputted for the Nearest Downstream City/Town field.

Considerations for Clyburn Pond Dam

- Consider research regarding whether or not the SC DOT work on this dam was coordinated with SCDHEC.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred, especially in light of the auxiliary spillway being eliminated by paving operations.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.

9) ***State Dam Name: Old Mill Pond Dam*** Latitude: 33.974641; Longitude: 81.232641; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	Lexington Mill Pond Dam	County	Lexington
Stream or River	Twelve Mile Creek	Nearest Downstream City/Town	Lexington (Hwy 1)
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00143	State ID	D0958
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1900
Length (ft)	475	Year Modified	N/A
Drainage Area (sq mi)	33.08	Height (ft)	20
Surface Area (ac)	28.5	EAP	Yes
Max Discharge (cfs)	457	Condition	Satisfactory
Max Storage (ac ft)	440	Normal Storage (ac ft)	325
Note: FIRM & FIS data are not in the NID		FIS Effective Date	02/20/2002
FIRM Panel	45063C0251G	FIRM Effective Date	02/09/2000

*Provided by SCDHEC

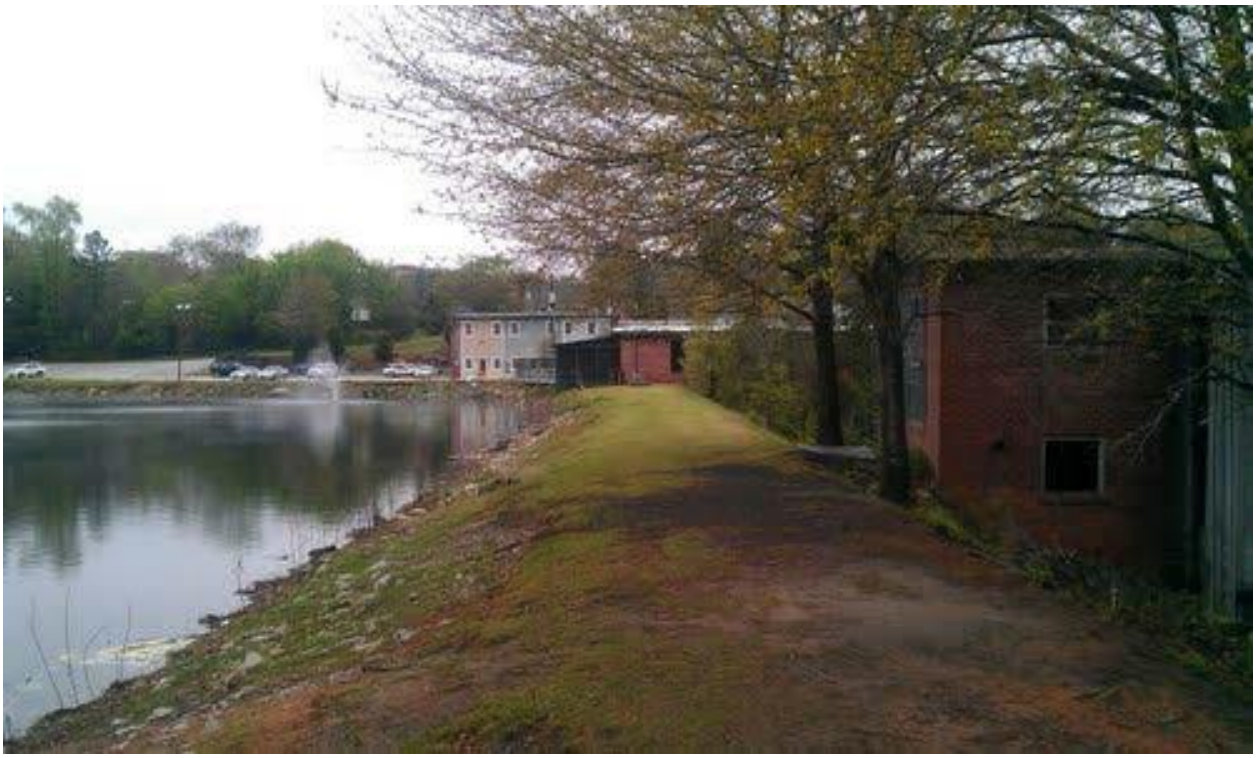

Figure A9.1: Old Mill Pond Dam pre-event photo; Credit: Google Maps Streetview

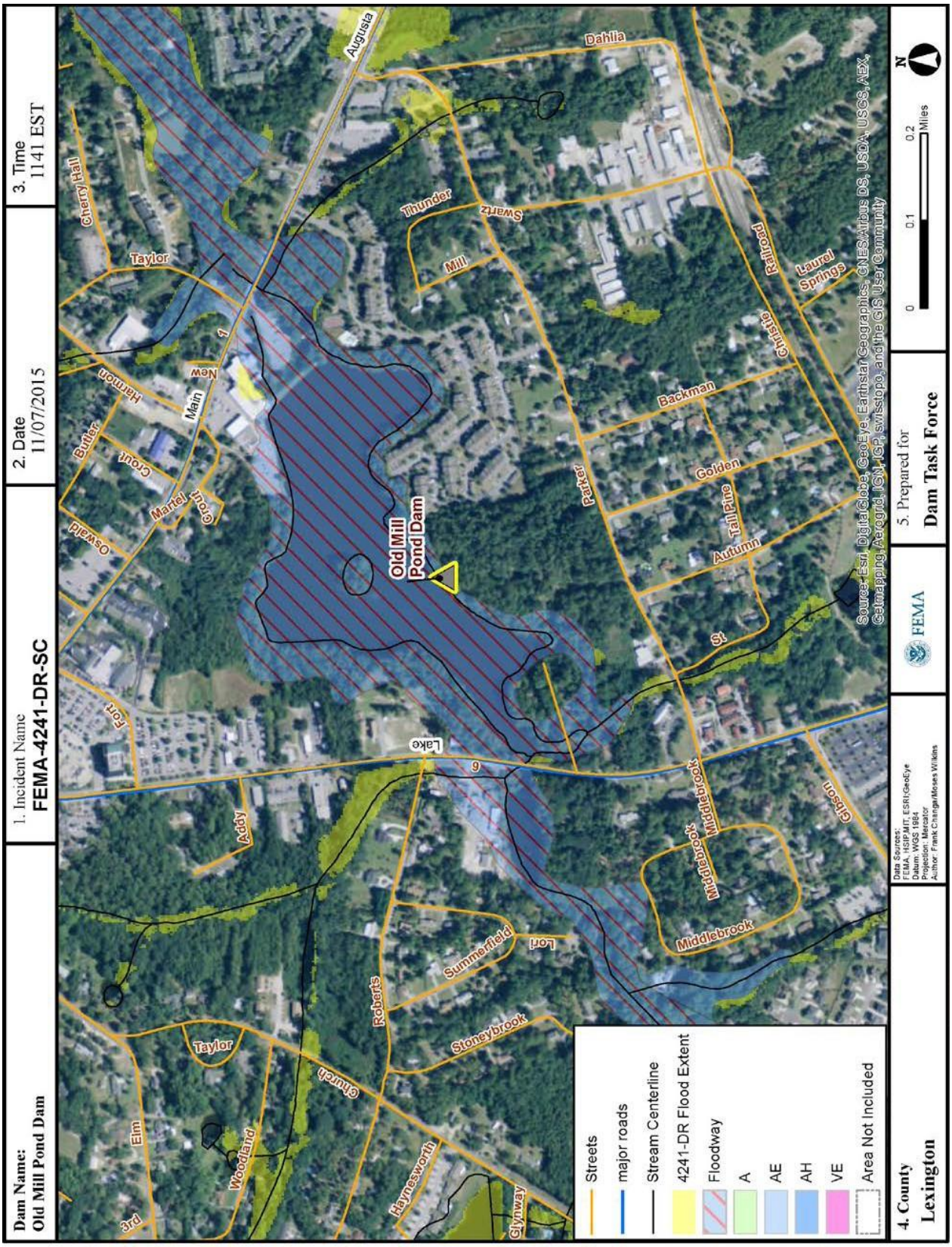

Figure A9.2: Old Mill Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

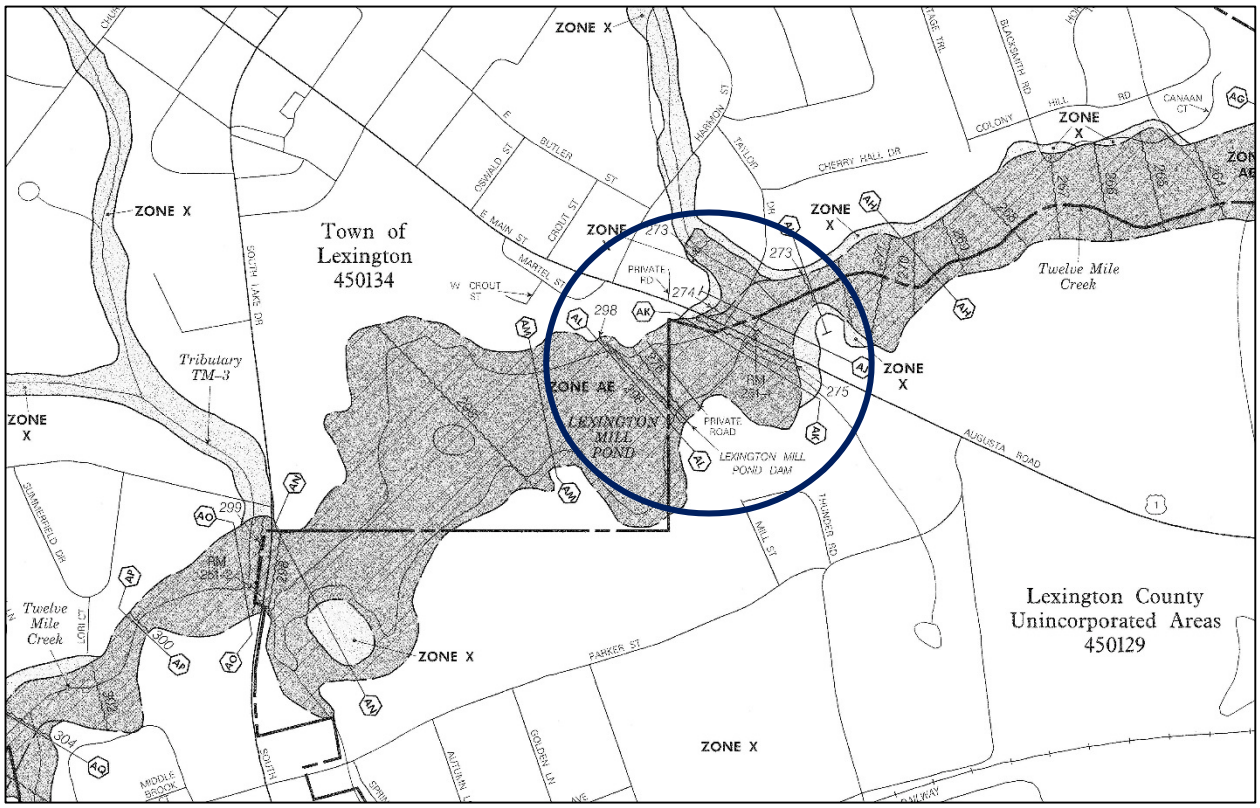

Figure A9.3: FIRM cropped; Old Mill Pond Dam in blue circle; detailed above

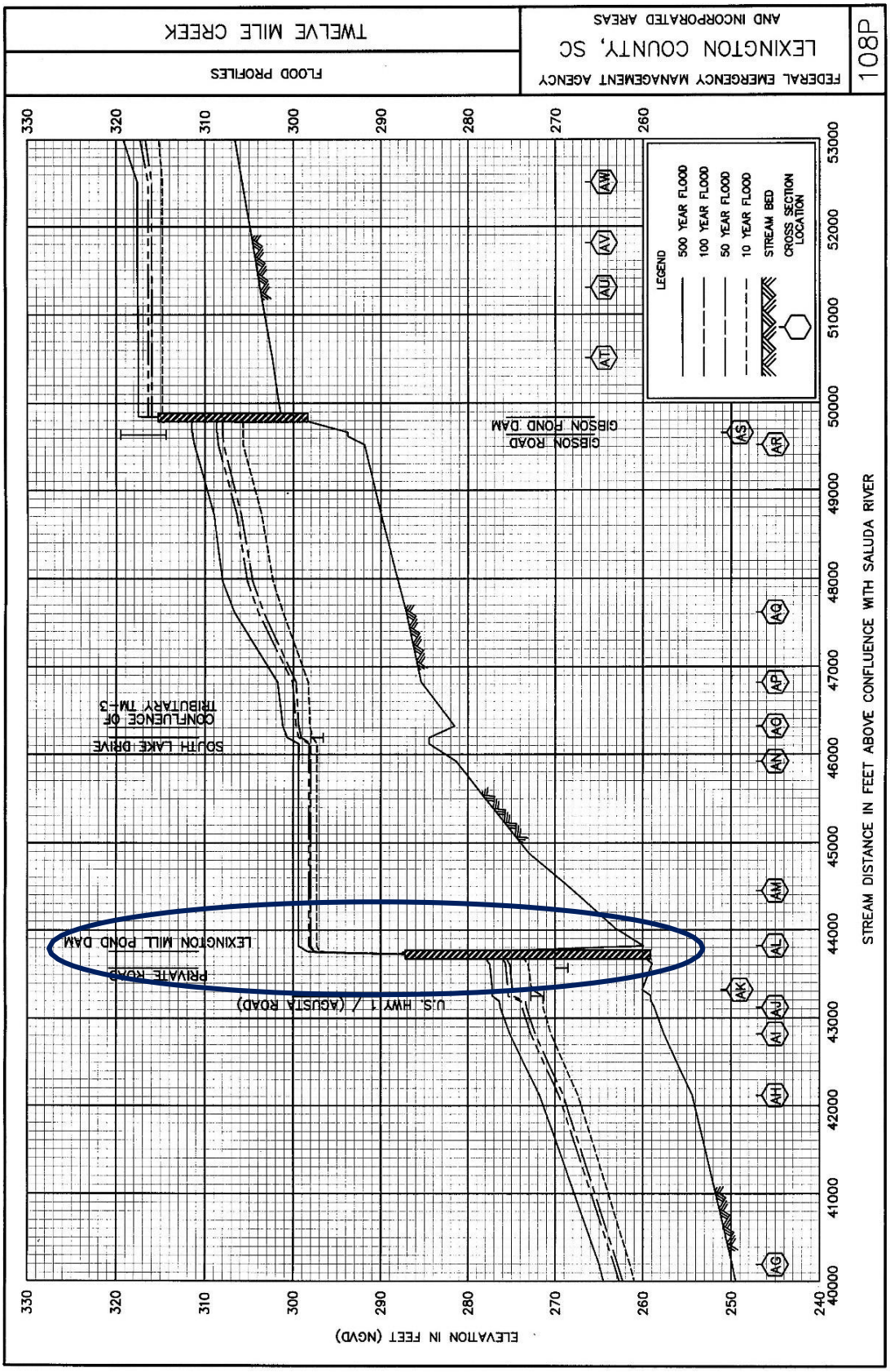

Figure A9.4: FEMA Flood Insurance Flood Profile for Old Mill Pond Dam

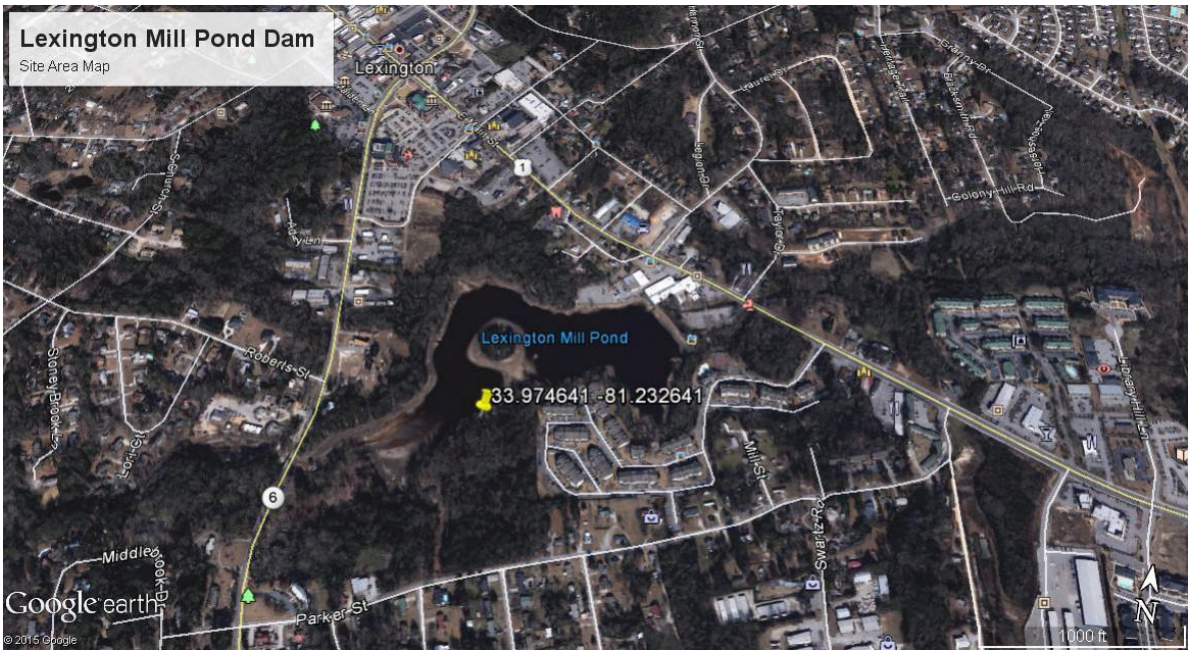

Figure A9.5: Lexington Mill Pond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A9.6: Old Mill Pond Dam from upstream side post-event photo; Credit: SCDHEC Berresford & Yon

<u>General Old Mill Pond Dam Comments</u>

- Old Mill Pond Dam is classified as C1 by SCDHEC and inventoried as High Hazard in the 2013 NID.

- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around the Old Mill Pond Dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - HEC-1 was used for the hydrologic modeling, HEC-2 for the hydraulic modeling, which were performed on October 1, 1992. The FIS states in Hydraulic Section 3.2 on page 26 that dam failures were considered but due to historical data, assumed that they would not occur.
  - The NID has this dam being on Twelve Mile Creek, as does the FIS.
  - The NID shows this dam as being constructed in 1900 with no information for year modified. However, according to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18): "*There is very little historic flood data available on Twelve Mile Creek. Interviews with local residents indicated that the dams forming Gibson Pond and Lexington Mill Pond failed during a flood in April 1936. There was no development in the reach between the ponds, but a store and several cabins located below Lexington Mill Pond were washed away. Both dams were reconstructed and no failures have occurred for the past 40 years. Reconstruction of Lexington Mill Pond Dam included a manually operated emergency spillway, a feature which the original structure did not have. These gates can be opened to lower the pond when flood warnings are received."*
  - According to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18) "*Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures, such as Gibson Pond Dam, Lexington Mill Pond Dam, and Corley Mill Dam, remain unobstructed, operate properly, and do not fail*."
  - According to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 26 (pdf page 31) "*The hydraulic analyses for the unincorporated areas considered possible failure of the dams at Gibson Pond and Lexington Mill Pond on Twelve Mile Creek. Interviews with local residents produced information indicating that both of these structures failed during a flood in April 1936. Several structures located in the floodplain below Lexington Mill Pond were washed away by the surge. No frequency-discharge or elevation data are available on the 1936 flood. Both dams were rebuilt, and the Lexington Mill Pond Dam reconstruction included a gated spillway which can be manually operated to lower the pond level in the event of a flood.*

The Lexington Mill Pond Dam, with a head differential of 22 feet, appears to be in good condition, and gates appear to be operable.

Approximate methods based on empirical model study results were used to obtain estimates of the effect of total instantaneous failure of both dams at the time of the 100-year flood peak. The results indicated that the additional surge from Gibson Pond would raise the natural 100-year flood peak approximately 4 feet between Gibson Pond and Lexington Mill Pond. The surge from Lexington Mill Pond would raise the natural 100-year flood crest immediately below the dam by approximately 10 feet. These calculations were designed to determine the worst situation that could occur during a 100-year flood to provide upper limits for engineering judgment decisions. On the other hand, if ample flood warnings were received in time for the Lexington Mill Pond gate to be opened and the pond drawn down, the natural l 00-year flood crest below Lexington Mill Pond could be reduced significantly.

If one or both of the dams break during a major flood, the break is likely to be partial and occur in several stages. The break or breaks may occur before, during, or after the flood crest, or in various stages during the entire flood. The flood gate at Lexington Mill Pond may or may not be opened in time to provide relief. If the gate is not opened, and the Lexington Mill Pond does not fail, the flood below the dam will be equivalent to a flood under natural conditions (with no dam). These factors and the fact that no failures have occurred since 1936, were considered in formulating a reasonable basis for floodplain management and flood insurance rates in the floodplain of Twelve Mile Creek.

For determination of flood elevations on Twelve Mile Creek it was assumed that neither Gibson Pond Dam nor Lexington Mill Pond Dam will fail, and that there will be no reduction in flood elevations as a result of natural attenuation or manipulation of the spillway gate at Lexington Mill Pond. Inflow into the system will be equal to outflow."

- According to information in the FIS, this dam was reconstructed sometime after it was heavily damaged in a 1936 flood.
- The 2002 FIS assumed "*For determination of flood elevations on Twelve Mile Creek it was assumed that neither Gibson Pond Dam nor Lexington Mill Pond Dam will fail*".
- The FIS profile shows the Old Mill Pond will overtop by roughly 11 feet during the 1 pecent chance event.

- A FIRM panel does exist on which Old Mill Pond dam can be located, as shown in Figure A9.3 above. The Dam is also specifically named on the FIRM panel.
- The Dam Type in the NID is Earthen.

- The NID shows that an EAP exists for this dam. SCDHEC confirmed this dam has an EAP. It is unclear whether the EAP was activated for this event.
- This dam was not referenced by name in the Lexington County / Local Mitigation Plan.
- The NID has this dam being completed in 1900 with no modifications. See comments above regarding modifications being performed after the flood of 1936.
- The NID has the condition of this dam as being "Satisfactory".
  - SCDHEC inspected the dam on December 20, 2012 and followed up with a letter dated January 15, 2013 to the dam owner having as attachments, the inspection report and the Emergency Notification and Surveillance Plan. The inspection report noted the following:
    "*List of noted deficiencies or items requiring correction/checking: *All vegetation (brush, weeds, etc.) and small trees (less than 6 inches in diameter) should be evaluated for removal from the downstream slope of the dam.*
    Flood gate exercise and maintenance program should be evaluated/implemented. Clear water flowing through rock wall on outlet near building. This should be monitored and checked for possible repair. The outlet pipe near building (to power generator) is leaking and should be repaired or replaced. Note: Dam should remain clear of vegetation year round.
    List of previously noted items still uncorrected and dates previously noted:
    **Spillway system inadequate for half PMF flood (06/79 to present)*
    **Vegetation on downstream slope (10/97, 05/99, 03/00, 05/02, 7/04)*
    Emergency Action Plan Updated Yes- - No -----X- -"
  - An inspection was performed on April 16, 14 having a general condition rating of "Fair" and stated the following for general comments and recommendations: "*Flow outside discharge pipe (near building) should be evaluated by an engineer. Despite flow being clear, it could be channeling around pipe. Trees should be evaluated by an engineer for removal. Grass cover should be established on crest and access Rod. Erosion on upstream slope from wave action – Rip Rap should be replaced (or equivalent). Main spillway slide gate should be checked for functionality and maintained.*"
  - SCDHEC performed a site visit on this dam on June 9, 2015 and followed up with a letter dated June 12th to the dam owner, stating, "*After a site visit conducted Tuesday, June 9, 2015, it was confirmed that this dam is unsafe and in need of repairs. The Department now requires that a detailed inspection of the dam be performed and that the necessary repair plans with specification are submitted to SCDHEC for a review leading to permit approval. As owner of a regulated dam, which has been determined through preliminary inspection to be unsafe and a danger to*

property or life, the detailed inspection of the dam and any repair or removal work are your responsibility. You are now required to perform the actions necessary to either repair or remove the dam in compliance with South Carolina law by November 30, 2015. The first action required is the development of an action plan containing scheduled milestones. This action plan must be received by SCDHEC before the close of business on June 26, 2015. Additionally, a permit application prepared to correct all deficiencies discovered by the engineer during the detailed inspection must be submitted to SCDHEC by July 13, 2015." A list of items required by the owner was provided in the letter, along with dates for their submittal.

  - The Owner responded with their planned actions in a letter to SCDHEC dated June 24, 2015. SCDHEC provided a letter dated September 2, 2015, to the dam owner stating, "*The South Carolina Department of Health and Environmental Control (Department/DHEC) has reviewed your application for a permit to repair the LEXINGTON MILL POND DAM, together with plans prepared by Schnabel Engineering, and your application is approved. Enclosed is your permit NO. 32-0018. This existing dam is classified as high hazard by DHEC due to the likely damages that would result from its postulated failure or improper operation*."
  - SCDHEC confirmed dam breach on October 6 via extensive media coverage. SCDHEC re-confirmed on October 29 complete breach of the dam and again on November 4 that no unauthorized work was being performed.
- Construction to repair this dam began sometime just before this event occurred.
- This dam is roughly 6000 stream feet downstream of the Gibson Pond Dam, which also failed.

<u>Considerations for Old Mill Pond Dam</u>

- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for further assessment of the design and construction of the dam and the 1936 rebuild, including the design and construction standards at the time.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider assessing the dam for probable cause of failure because of this event.

10) ***State Dam Name: Barr Lake Dam***; Latitude: 33.958512; Longitude: 81.259604; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 32008	County	Lexington
Stream or River	Twelve Mile Creek	Nearest Downstream City/Town	Lexington
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00148	State ID	D1717
Dam Type	Earth	Owner Type	Local Government
Purpose	Recreation	Year Completed	1900
Length (ft)	625	Year Modified	N/A
Drainage Area (sq mi)	8.1	Height (ft)	14
Surface Area (ac)	64	EAP	Yes
Max Discharge (cfs)	1044	Condition	Not Rated
Max Storage (ac ft)	359	Normal Storage (ac ft)	243
Note: FIRM & FIS data are not in the NID		FIS Effective Date	02/20/2002
FIRM Panel	45063C0234G	FIRM Effective Date	02/09/2000

*Provided by SCDHEC

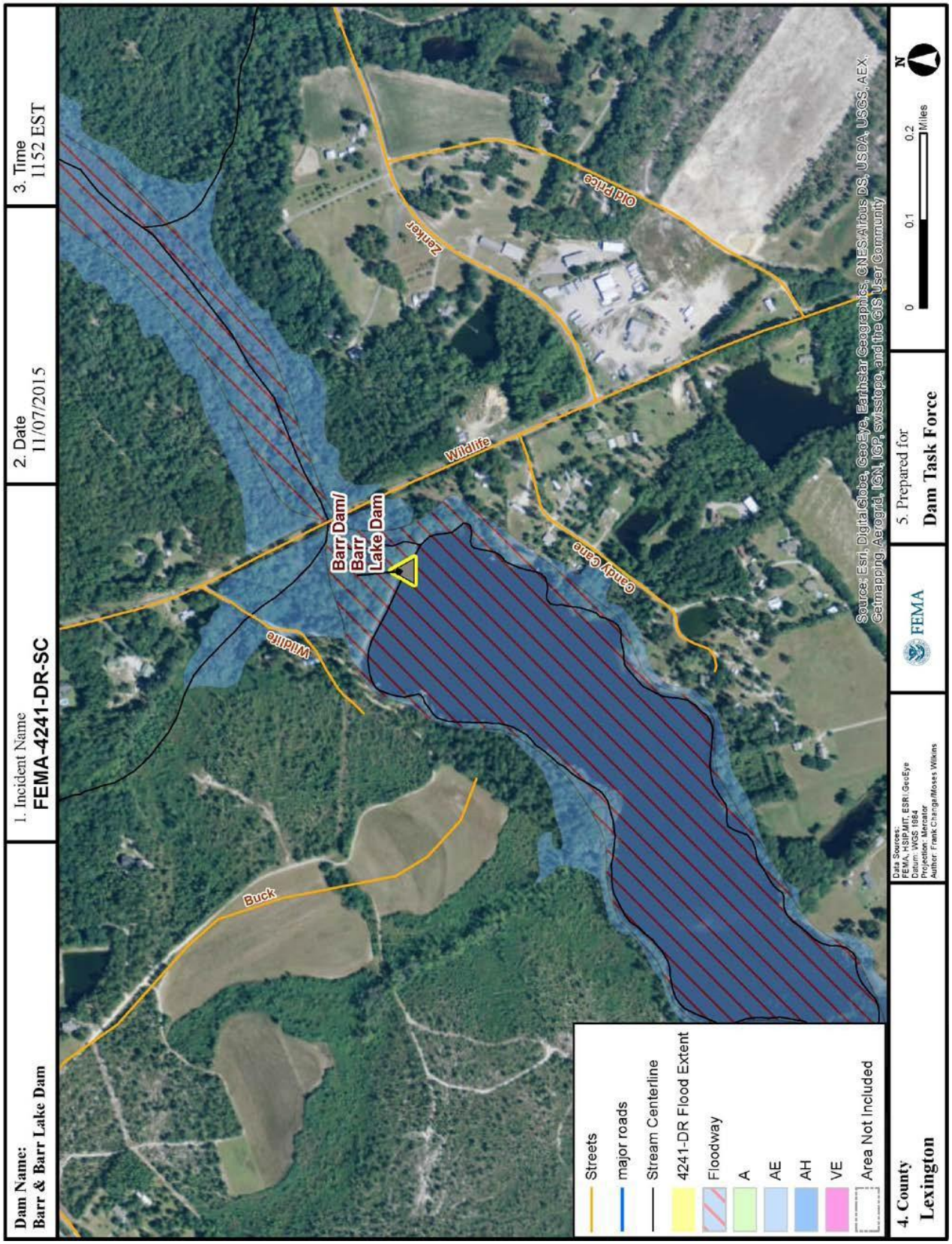

Figure A10.1: Barr Lake Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

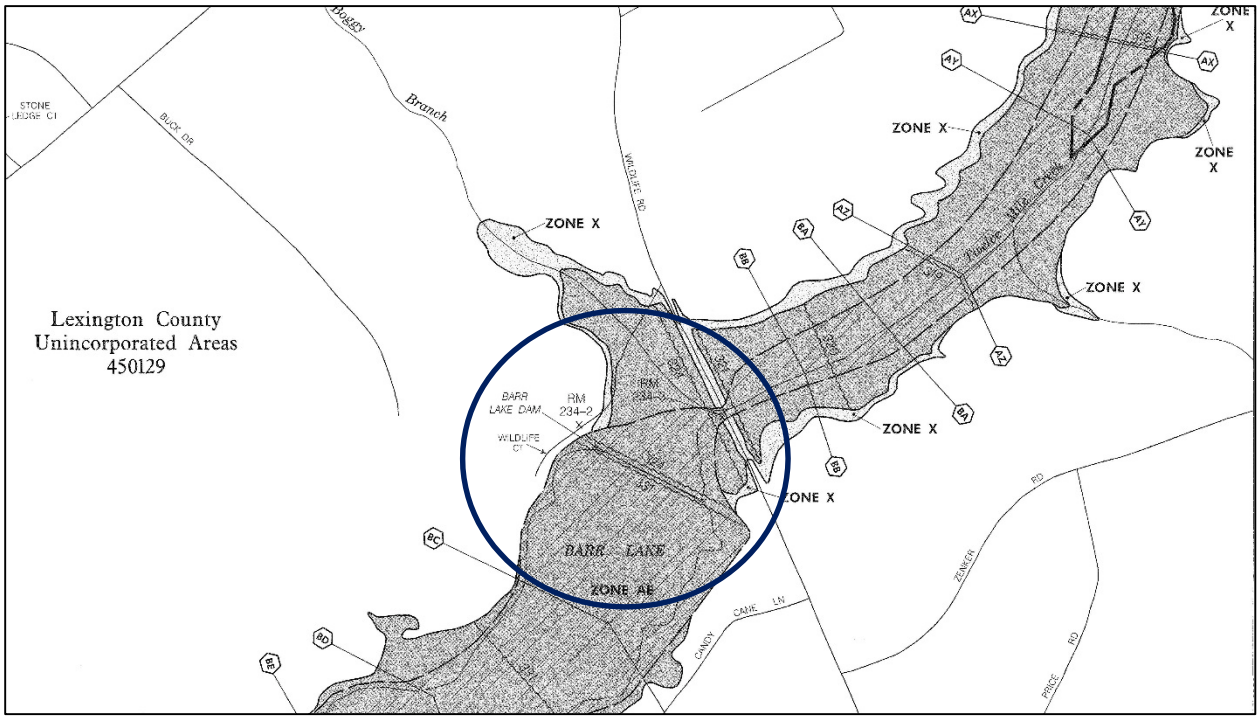

Figure A10.2: FEMA FIRM cropped; Barr Lake Dam in blue circle; FIRM detailed above

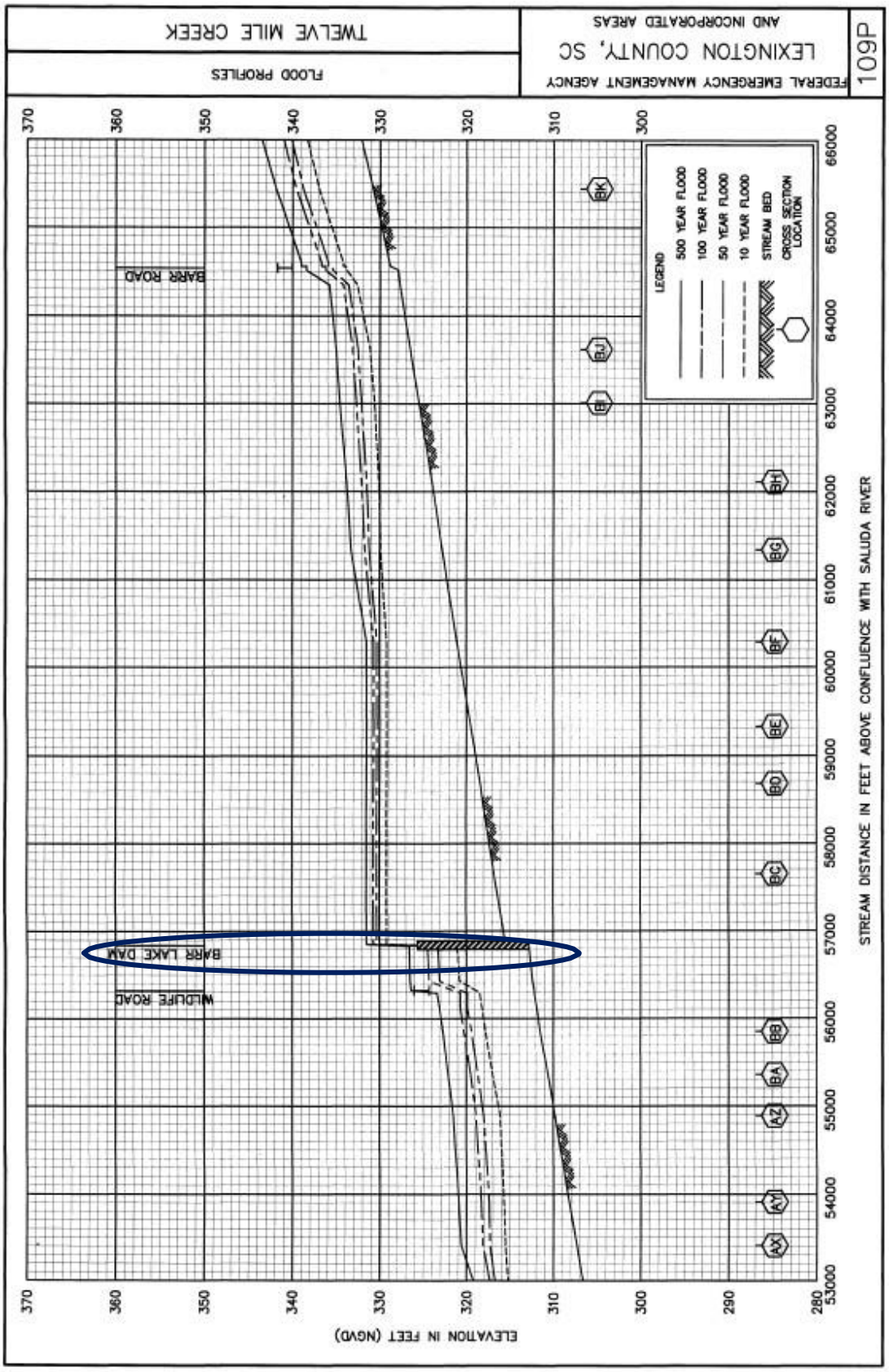

Figure A10.3 FEMA Flood Insurance Flood Profile for Barr Lake Dam

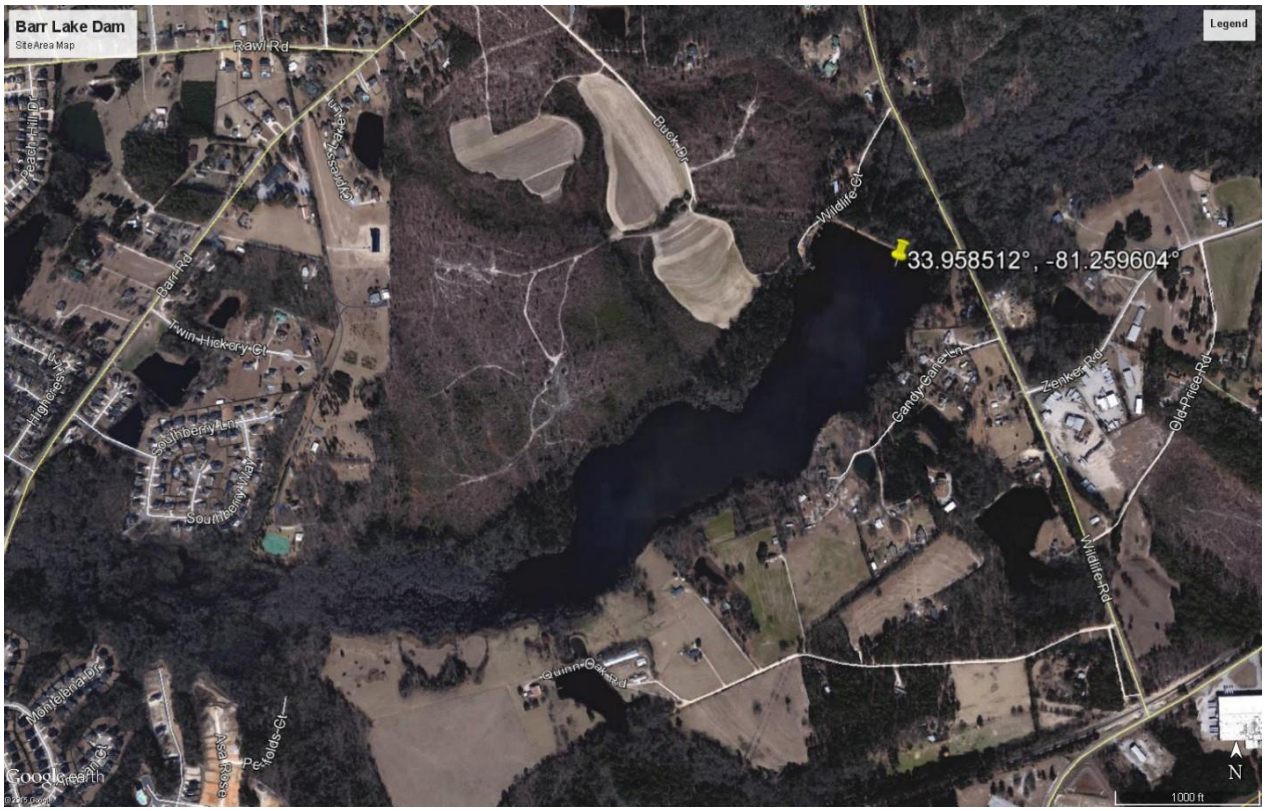

Figure A10.4: Barr Lake Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A10.5: Barr Lake Dam from crest of dam post-event photo; Credit: SCDHEC Berresford

General Barr Lake Dam Comments

- Barr Lake Dam is classified as C2 by SCDHEC and inventoried as Significant Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around the Barr Lake dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - The NID has this dam being on Twelve Mile Creek, as does the FIS.
  - HEC-1 was used for the hydrologic modeling, HEC-2 for the hydraulic modeling, which were performed on August 1, 1996.
  - Only one specific reference was made to Barr Lake Dam in either of the two FIS volumes for Lexington County, SC. In Volume 1 on page 23, In Table 4, Summary of Discharges, a line item exists for "Downstream of Barr Lake Dam". No other reference or information is provided on this dam.

FLOODING SOURCE AND LOCATION	DRAINAGE Area (sq. miles)	PEAK DISCHARGES (cfs)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR

Downstream of Barr Lake Dam	27.1	1,300	2,500	3,220	5,800

- According to the FIS flood profile for Barr Lake Dam, it is anticipated to be overtopped by the 1 percent flood event by roughly 5 feet.
- The NID shows this dam as being constructed in 1900 with no information for year modified. It is unclear what happened to the Barr Lake Dam during the flooding of 1936. However, according to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18):
  "*There is very little historic flood data available on Twelve Mile Creek. Interviews with local residents indicated that the dams forming Gibson Pond and Lexington Mill Pond failed during a flood in April 1936. There was no development in the reach between the ponds, but a store and several cabins located below Lexington Mill Pond were washed away. Both dams were reconstructed and no failures have occurred for the past 40 years. Reconstruction of Lexington Mill Pond Dam included a manually operated emergency spillway, a feature which the original structure did not have. These gates can be opened to lower the pond when flood warnings are received*."
- According to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18)
  "*Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures, such as Gibson Pond Dam, Lexington Mill Pond Dam, and Corley Mill Dam, remain unobstructed, operate properly, and do not fail*."
- This FIS profile shows Barr Lake dam will overtop by roughly 5 feet for the 1 percent chance flood

- A FIRM panel does exist on which Barr Lake Dam can be located, as shown in Figure A10.2 above. Barr Lake Dam is specifically named on the FIRM panel.
- The Dam Type in the NID is Earthen.
- The NID shows that an EAP exists for this dam. SCDHEC confirmed that an EAP exists for this dam. It is unknown whether the EAP was activated for this event.
- This dam was not referenced by name in the Lexington County / Local Mitigation Plan.
- The NID shows this dam as being completed in 1900, with no information for modifications.
- The NID has the condition assessment for this dam as "*Not Rated*".

- An inspection by SCDHEC was performed on December 13, 2010 and provided to the dam owner stating the following: "*List of noted deficiencies or items requiring correction/checking:*

  Barr Lake Dam:

  - *Vegetation on lower part of downstream side of dam impairs through inspection*
  - *Unable to access outlet structure or make downstream pass due to heavy*
  - *Vegetation. Vegetation and brush should be removed*
  - *It is recommended that additional rip rap or similar protection from water erosion be added at the sides of the spillway areas where wash out is present.*
  - *No screen visible on inlet structure*"
- An inspection by SCDHEC was performed on June 27, 2014 and stated the following in the general comments and recommendations section: "*List of noted deficiencies or items requiring correction/checking:*
  - *"Major work performed without a construction permit – Please submit a construction permit application for current work needed and prior to work performed.*
  - *Seepage, trees, holes and erosion of spillway near concrete along with cracks in concrete / exposed rebar should be evaluated for repair by an engineer*."
- SCDHEC confirmed by inspection on October 6th the dam had failed. SCDHEC reconfirmed on October 29th the dam was fully breached and that there were no signs of unauthorized work. This was again reconfirmed on November 4th.

- This dam is roughly 13,000 stream feet downstream of the Lexington Mill Pond Dam and roughly 19,000 stream feet downstream of the Gibson Pond Dam, both of which failed during this event.

<u>Considerations for Barr Lake Dam</u>

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.

- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

11) ***State Dam Name: Gibson's Pond Dam;*** Latitude: 33.969067 Longitude: -81.244925; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	GIBSON'S POND DAM	County	Lexington
Stream or River	Twelve Mile Creek	Nearest Downstream City/Town	SEC ROAD & LEX
NID Hazard Class	Significant	State Hazard Class	C2
NID ID	SC00169	State ID	D0959
Dam Type	Earth	Owner Type	Local Government
Purpose	Recreation	Year Completed	1900
Length (ft)	300	Year Modified	N/a
Drainage Area (sq mi)	3.39	Height (ft)	15
Surface Area (ac)	28	EAP	Yes
Max Discharge (cfs)	857	Condition	Not Rated
Max Storage (ac ft)	240	Normal Storage (ac ft)	128
Note: FIRM & FIS data are not in the NID		FIS Effective Date	02/20/2002
FIRM Panel	45063C0251G	FIRM Effective Date	02/09/2000

*Provided by SCDHEC

Figure A11.1: Gibson's Pond Dam pre-event photo; Credit: Google Maps Streetview

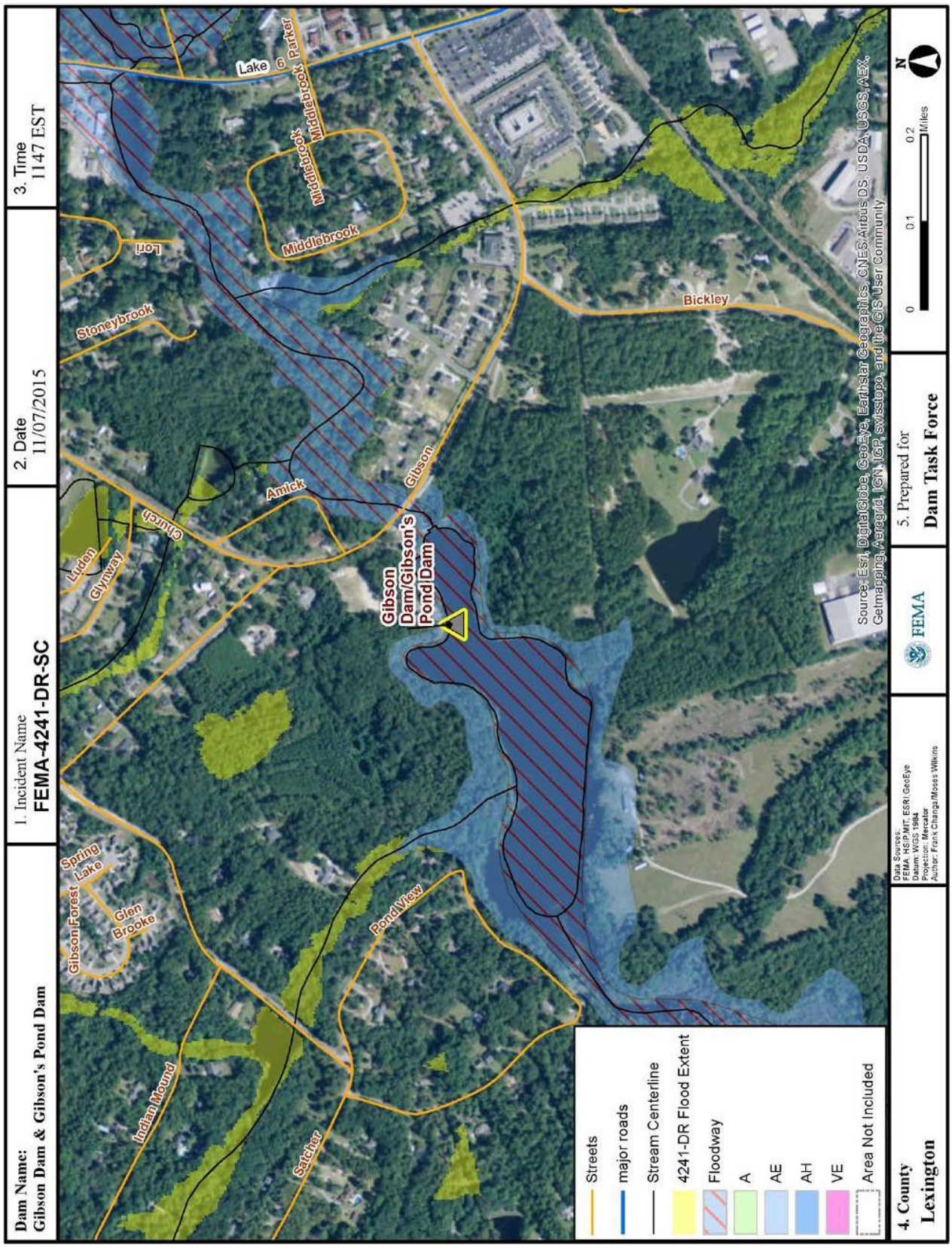

Figure A11.2 Gibson Pond Dam; FEMA Flood Zone and 4241DR Flood Extent Overlay Map

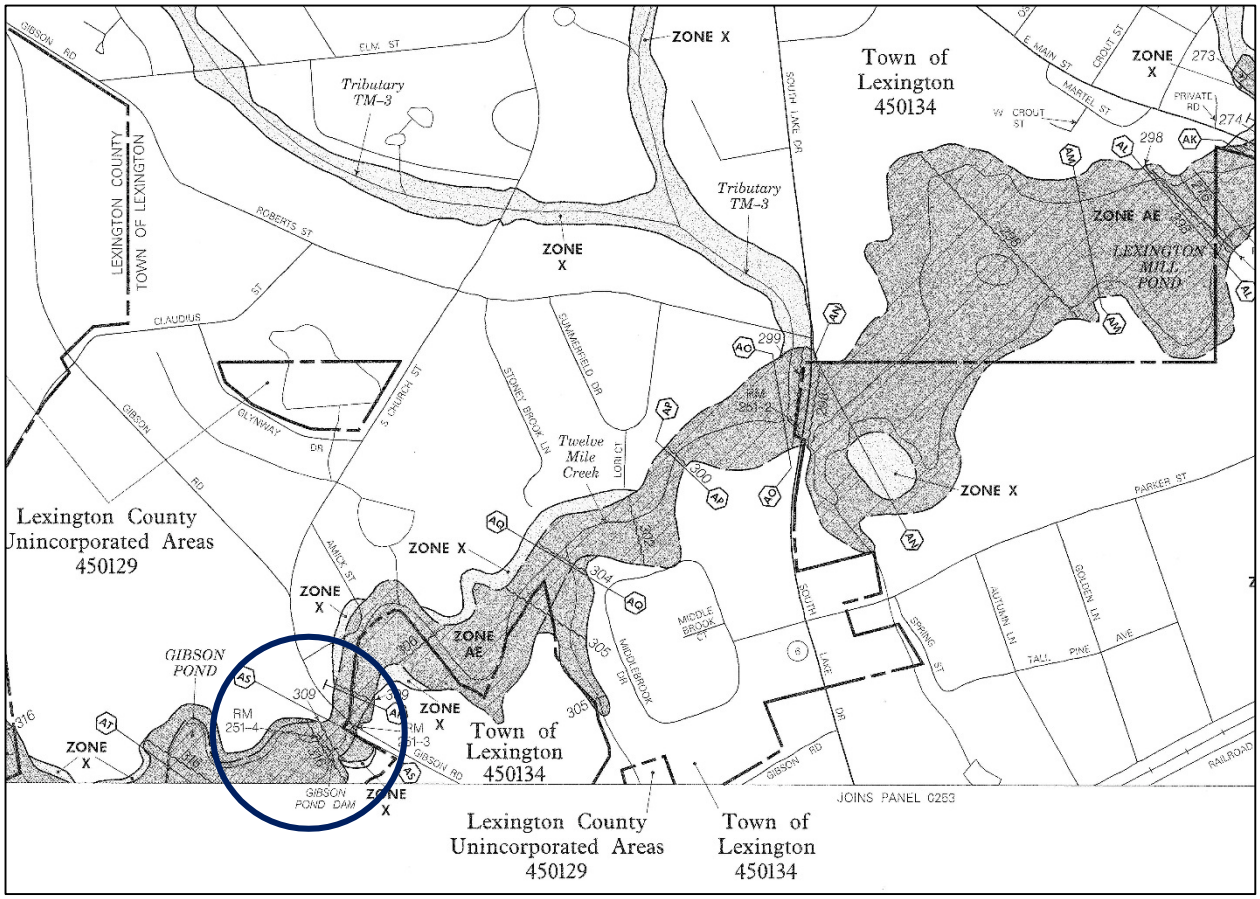

Figure A11.3: FIRM cropped; Gibson Pond Dam circled in blue; FIRM detailed above

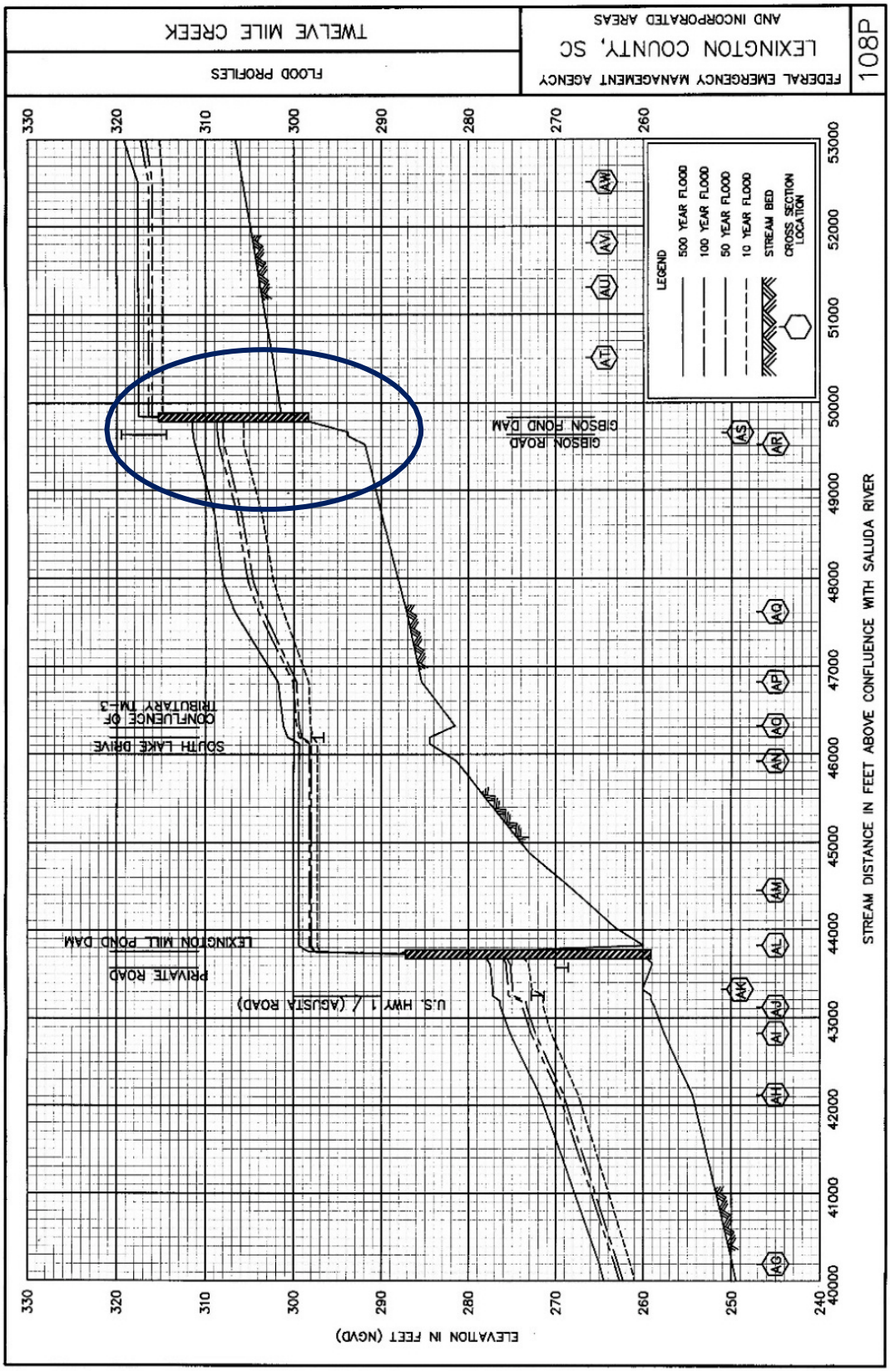

Figure A11.4 FEMA Flood Insurance Flood Profile for Old Mill Pond Dam in blue circle

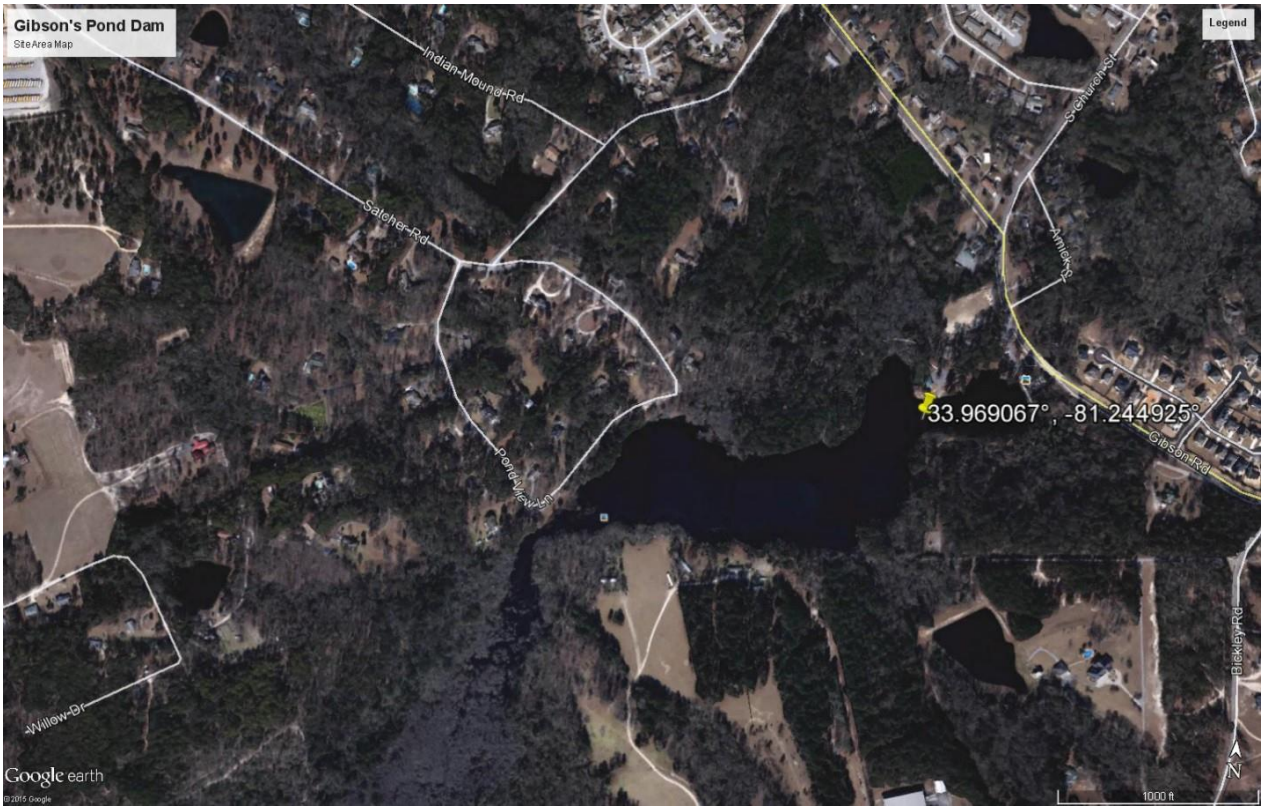

Figure A11.5: Gibson Pond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A11.6: Gibson Pond Dam from upstream side post-event photo; Credit: SCDHEC; Berresford

General Gibson's Pond Dam Comments

- Gibson Pond Dam is classified as C2 by SCDHEC and inventoried as Significant Hazard in the 2013 NID.
- No Civil Air Patrol (CAP) photos were found for this dam.
- NOAA's National Weather Service recorded a 5-day precipitation of 11-15" in the area around Gibson Pond dam.
- A review of the effective FEMA Flood Insurance Study for the dam location indicates:
  - The NID has this dam being on Twelve Mile Creek as does the FIS.
  - HEC-1 was used for the hydrologic modeling, HEC-2 for the hydraulic modeling, which were performed on October 1, 1992. The FIS states in Hydraulic Section 3.2 on page 26 that dam failures were considered but due to historical data, assumed that they would not occur.
  - The NID shows this dam as being constructed in 1900 with no information for year modified. However, according to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18): "*There is very little historic flood data available on Twelve Mile Creek. Interviews with local residents indicated that the dams forming Gibson Pond and Lexington Mill Pond failed during a flood in April 1936. There was no development in the reach between the ponds, but a store and several cabins located below Lexington Mill Pond were washed away. Both dams were reconstructed and no failures have occurred for the past 40 years. Reconstruction of Lexington Mill Pond Dam included a manually operated emergency spillway, a feature which the original structure did not have. These gates can be opened to lower the pond when flood warnings are received."*
  - According to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 12 (pdf page 18) "*Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures, such as Gibson Pond Dam, Lexington Mill Pond Dam, and Corley Mill Dam, remain unobstructed, operate properly, and do not fail*."
  - According to the FEMA FIS for Lexington County, SC from February 20, 2002, the following is stated on page 26 (pdf page 31) "*The hydraulic analyses for the unincorporated areas considered possible failure of the dams at Gibson Pond and Lexington Mill Pond on Twelve Mile Creek. Interviews with local residents produced information indicating that both of these structures failed during a flood in April 1936. Several structures located in the floodplain below Lexington Mill Pond*

were washed away by the surge. No frequency-discharge or elevation data are available on the 1936 flood. Both dams were rebuilt, and the Lexington Mill Pond Dam reconstruction included a gated spillway which can be manually operated to lower the pond level in the event of a flood. The Lexington Mill Pond Dam, with a head differential of 22 feet, appears to be in good condition, and gates appear to be operable.

Approximate methods based on empirical model study results were used to obtain estimates of the effect of total instantaneous failure of both dams at the time of the 100-year flood peak. The results indicated that the additional surge from Gibson Pond would raise the natural 100-year flood peak approximately 4 feet between Gibson Pond and Lexington Mill Pond. The surge from Lexington Mill Pond would raise the natural 100-year flood crest immediately below the dam by approximately 10 feet. These calculations were designed to determine the worst situation that could occur during a 100-year flood to provide upper limits for engineering judgment decisions. On the other hand, if ample flood warnings were received in time for the Lexington Mill Pond gate to be opened and the pond drawn down, the natural l 00-year flood crest below Lexington Mill Pond could be reduced significantly.

If one or both of the dams break during a major flood, the break is likely to be partial and occur in several stages. The break or breaks may occur before, during, or after the flood crest, or in various stages during the entire flood. The flood gate at Lexington Mill Pond may or may not be opened in time to provide relief. If the gate is not opened, and the Lexington Mill Pond does not fail, the flood below the dam will be equivalent to a flood under natural conditions (with no dam). These factors and the fact that no failures have occurred since 1936, were considered in formulating a reasonable basis for floodplain management and flood insurance rates in the floodplain of Twelve Mile Creek.

For determination of flood elevations on Twelve Mile Creek it was assumed that neither Gibson Pond Dam nor Lexington Mill Pond Dam will fail, and that there will be no reduction in flood elevations as a result of natural attenuation or manipulation of the spillway gate at Lexington Mill Pond. Inflow into the system will be equal to outflow."

- According to information in the FIS, this dam was reconstructed sometime after it was heavily damaged in a 1936 flood.
- The 2002 FIS states "*For determination of flood elevations on Twelve Mile Creek it was assumed that neither Gibson Pond Dam nor Lexington Mill Pond Dam will fail*".

- The FIS profile shows the dam being overtopped by roughly 1.5 feet for the 1 percent chance event.

- A FIRM panel does exist on which Gibson Pond dam can be located, as shown in Figure A11.3 above. Gibson Pond Dam is specifically named on the FIRM panel.
- The Dam Type in the NID is Earthen.
- The NID shows that an EAP exists for this dam, which was confirmed by SCDHEC. It is unclear whether the EAP was activated for this event.
- This dam was not referenced by name in the Lexington County / Local Mitigation Plan.
- The NID shows this dam as being completed in 1900 with no information regarding modifications.
- The NID shows the condition assessment for this dam as: "Not Rated"
  - SCDHEC performed a site visit on this dam on December 13, 2007 and followed up with a letter dated December 14, 2007 to the dam owner, noting, "*List of noted deficiencies or items requiring correction/checking:*
  - *Debris piled up on West side (farthest from parking area) of the downslope impedes a complete inspection of that area. Debris should be removed so that all areas are accessible.*
  - *Dense vegetation on the East side (closest to parking area) of the downslope impedes a complete inspection of that area. Vegetation should be present to reduce storm water runoff erosion, however it should not render the area inaccessible. Recommend sod transplant in the Spring. There are moist areas down slope of this East side dense vegetation. Note to check that area again on next inspection.*
  - *Recommend sod to be laid on the top of the dam to cover exposed soil and reduce runoff.*
  - *The spillway has water running underneath the boards and on the East side, the flow is impacting the concrete with considerably more force. This should be repaired*."
  - An inspection by SCDHEC was performed on December 13, 2010 and provided to the dam owner stating the following: "*List of noted deficiencies or items requiring correction/checking:*
    Gibson Lake Dam:
    - *Debris and brush on West side of downslope inhibiting visual inspection-remove*
    - *Dense vegetation of East side needs to be removed.*
    - *Grass sod/seed should be laid on dam crest to reduce sediment erosion*
    - *Water flowing under level boards noticed at time of inspection".*
  - An inspection by SCDHEC was performed on July 10, 2015, annotating a general condition assessment of "Satisfactory" and provided the following general comments and recommendations summarized at the bottom:

- "*Trees should be evaluated for removal by an engineer*
- *Possible seepage (noted in section C.vii) should be evaluated by an engineer*
- *Cracks in concrete supports are old and may be superficial but should be monitored and evaluated by an engineer.*
- *Clean debris in spillway area*"

o SCDHEC inspected on October 6th and stated dam had failed. On October 29th SCDHEC confirmed that the dam fully breached and had no signs of unauthorized work. This was reconfirmed on November 4th.

- This dam is roughly 6000 stream feet upstream of Lexington Mill Pond Dam, which also failed.

Considerations for Gibson's Pond Dam

- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

12) ***State Dam Name: JW Smoaks Pond*** Latitude: 33.525181; Longitude: -80.93454; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 38011	County	Orangeburg
Stream or River	Mill Branch	Nearest Downstream City/Town	Orangeburg
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00407	State ID	D3738
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1920
Length (ft)	900	Year Modified	N/A

Drainage Area (sq mi)	5.22	Height (ft)	13
Surface Area (ac)	15	EAP	Yes
Max Discharge (cfs)	108	Condition	Satisfactory
Max Storage (ac ft)	1125	Normal Storage (ac ft)	62
Note: FIRM & FIS data are not in the NID		FIS Effective Date	01/16/2014
FIRM Panel	45075C0168C	FIRM Effective Date	01/16/2014

*Provided by SCDHEC

Figure A12.1: JW Smoaks Pond Dam pre-event photo; Credit: Google Maps Streetview

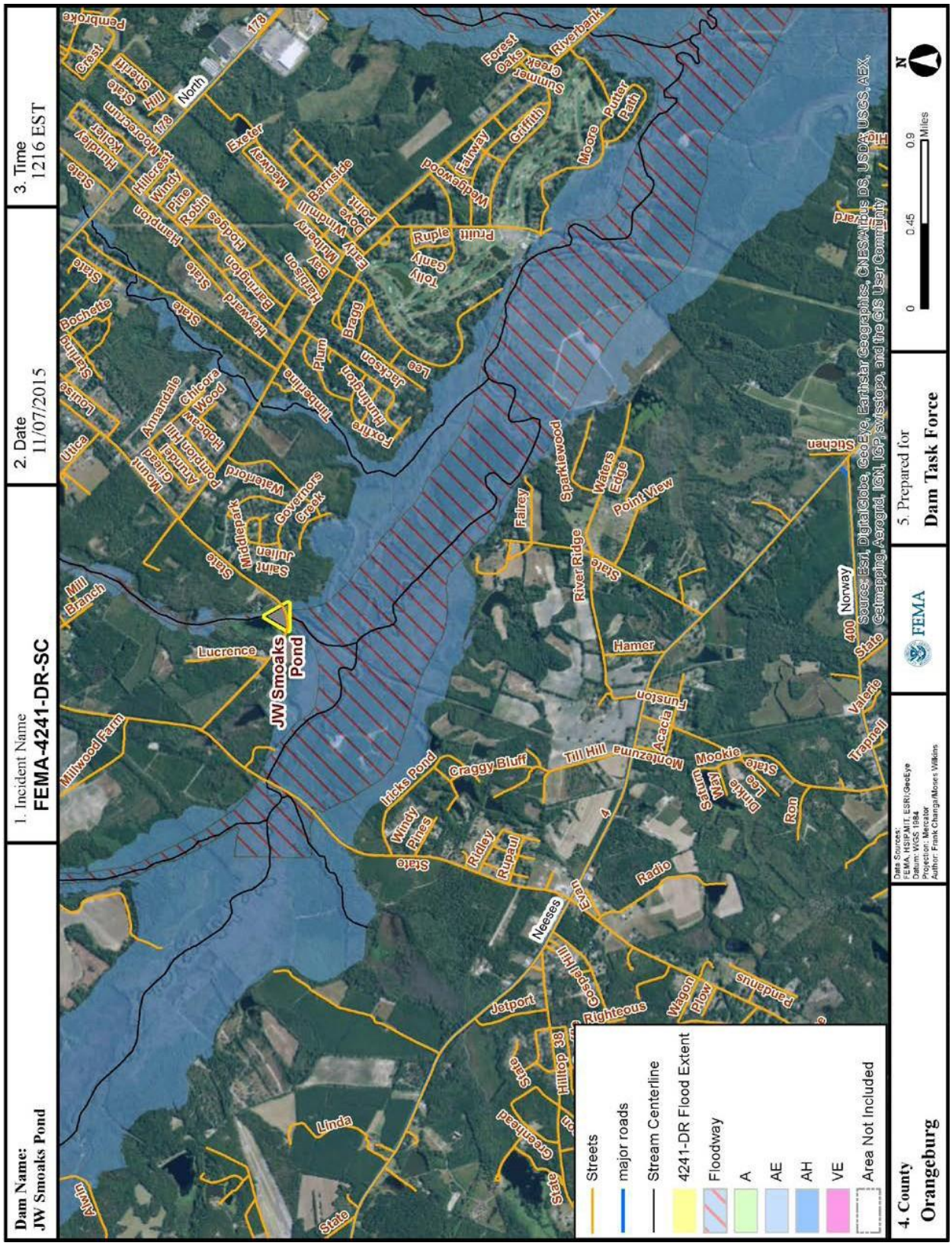

Figure A12.2: JW Smoaks Pond FEMA Flood Zone and 4241DR Flood Extent Overlay Map

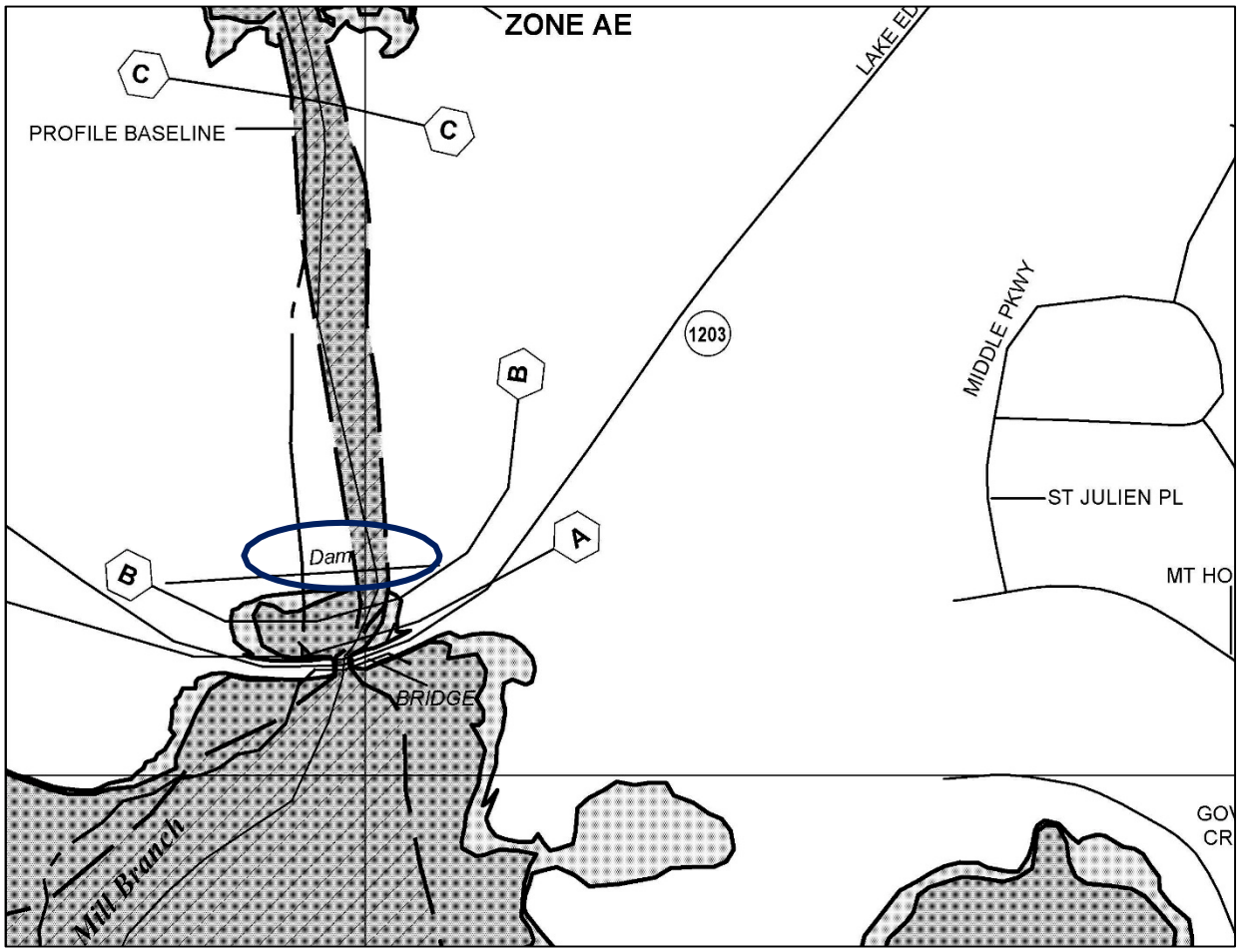

Figure A12.3: JW Smoaks Pond Dam in blue circle; FIRM is cropped, detailed above

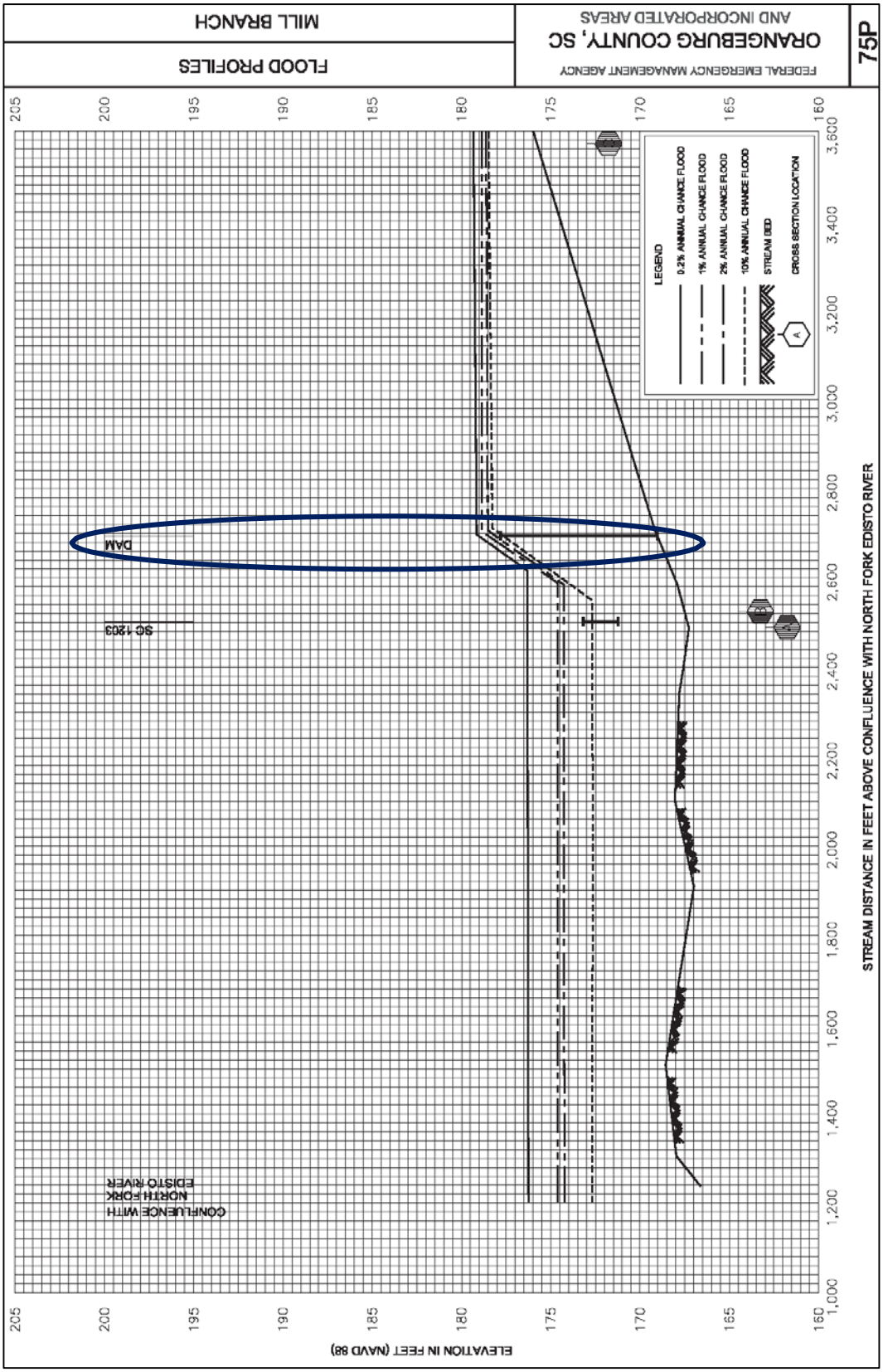

Figure A12.4 FEMA Flood Insurance Flood Profile 75P for JW Smoaks Pond Dam

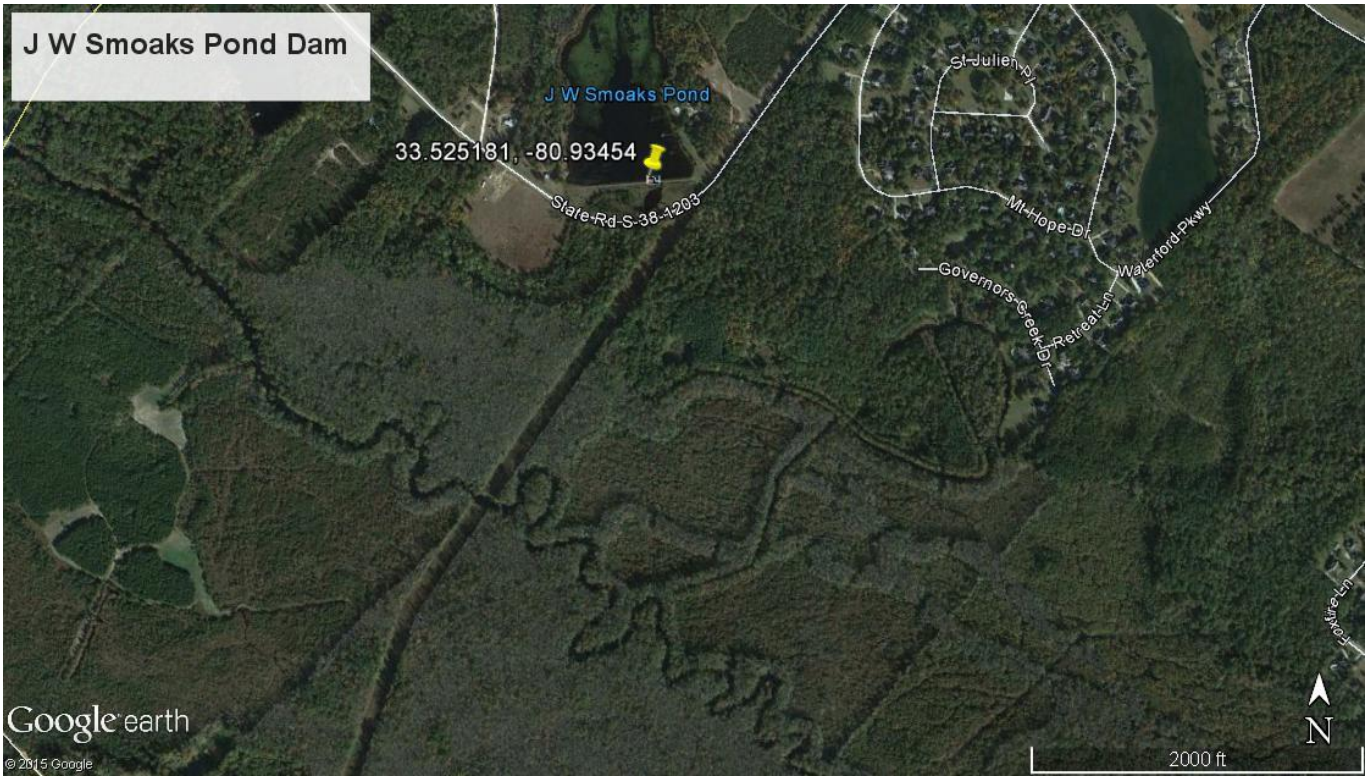

Figure A12.5: JW Smoaks Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure 12.6: JW Smoaks Pond Dam post-event photo; Credit: SCDHEC

General JW Smoaks Pond Dam Comments

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no picture from the Civil Air Patrol of this dam or dam failure.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to JW Smoaks Pond Dam or SCNONAME 38011.
  - The stream for this dam is listed as Mill Creek (Branch). The National Inventory of Dams lists the stream for this dam as Mill Branch.
  - No information is available on the hydrologic and hydraulic modeling of Mill Creek (Branch). The modeling assumptions for this dam are unknown.
  - Based on the Mill Creek (Branch) Profile, JW Smoaks Pond Dam, labeled as '*Dam*', would be overtopped in the 1 percent annual chance event by approximately two feet of water.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as 'Dam'. JW Smoaks Pond is not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from SCDHEC, there was an emergency action plan for this dam. This is consistent with the NID having an EAP for this dam.
- The Orangeburg County 2011 Hazard Mitigation Plan did not profile dam failure as a hazard and does not reference this dam by name.
- The National Inventory of Dams records this dam as completed in 1920 with no modifications.
- During the last pre-event inspection, December 2014, by the South Carolina Department of Health and Environmental Control Dam Safety Program, this dam appeared to be in overall good condition.
- According to the Flood Risk Report Number 01 for Orangeburg County, SC from July 9, 2015, the following is stated on page 61 (pdf page 66): *"Smoak Pond Dam along Northview Branch is classified by Class I risk in NID, which designates the dam as a potential risk to human life and properties."*
- According to a dam assessment performed on October 12th by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam failed on Sunday, October 4th. According to the dam inspection by SCDHEC on October 7th, the dam was breached but the road below was intact.

Considerations for JW Smoaks Pond Dam

- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure as a result of this event.

13) ***State Dam Name: SCNONAME 38036 (Cleveland Street)*** Latitude: 33.52294114; Longitude: 80.51387012; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 38036	County	Orangeburg
Stream or River	Browning Branch	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00419	State ID	D3743
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1960
Length (ft)	650	Year Modified	N/A
Drainage Area (sq mi)	13.58	Height (ft)	10
Surface Area (ac)	32	EAP	No
Max Discharge (cfs)	991	Condition	Not Rated
Max Storage (ac ft)	181	Normal Storage (ac ft)	88
Note: FIRM & FIS data are not in the NID		FIS Effective Date	01/16/2014
FIRM Panel	45075C0245C	FIRM Effective Date	01/16/2014

*Provided by SCDHEC

Figure A13.1: SCNONAME 38036 (Cleveland Street) Dam pre-event photo; Credit: Google Maps Streetview

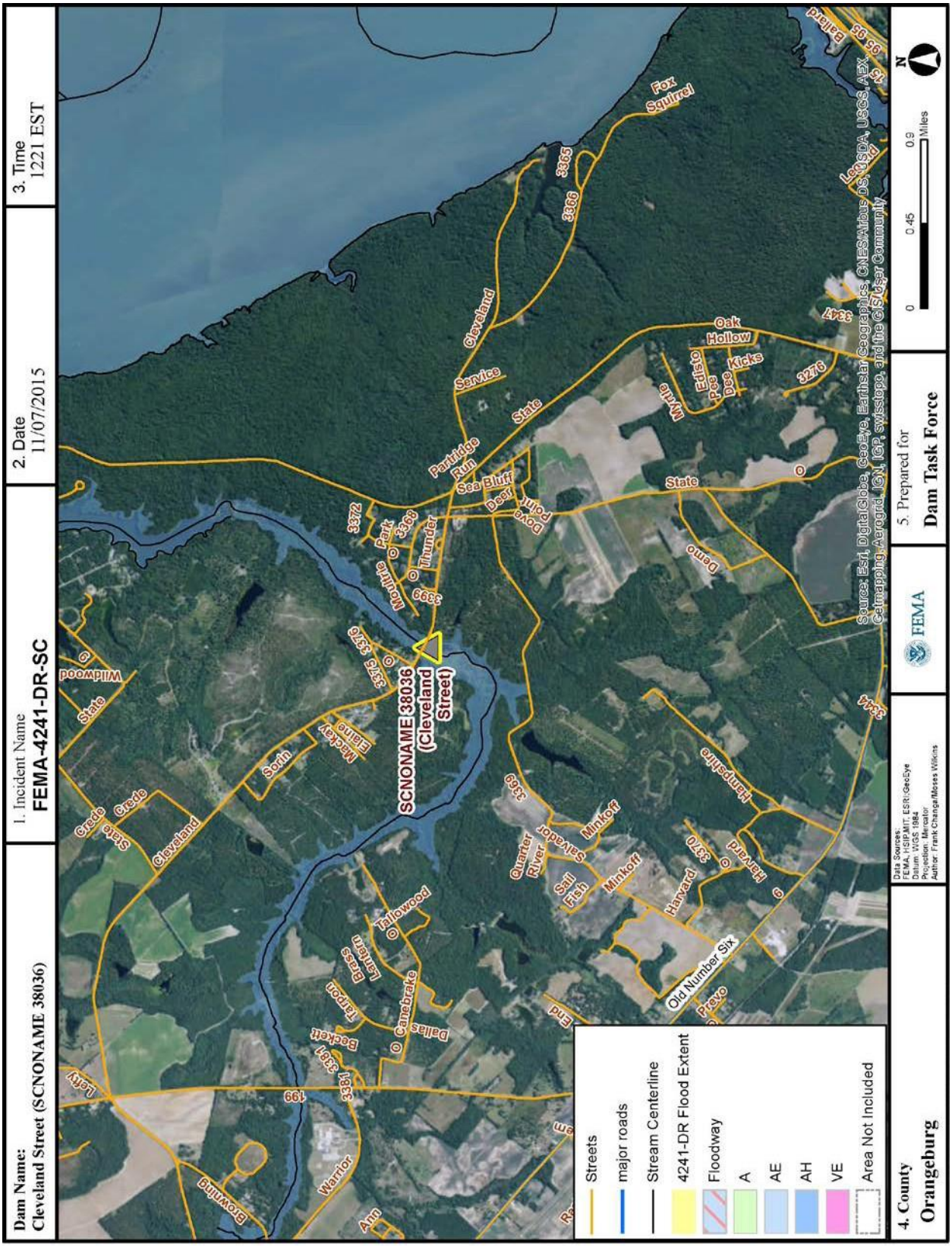

Figure A13.2: SCNONAME 38036 (Cleveland Street) FEMA Flood Zone and 4241DR Flood Extent Overlay Map

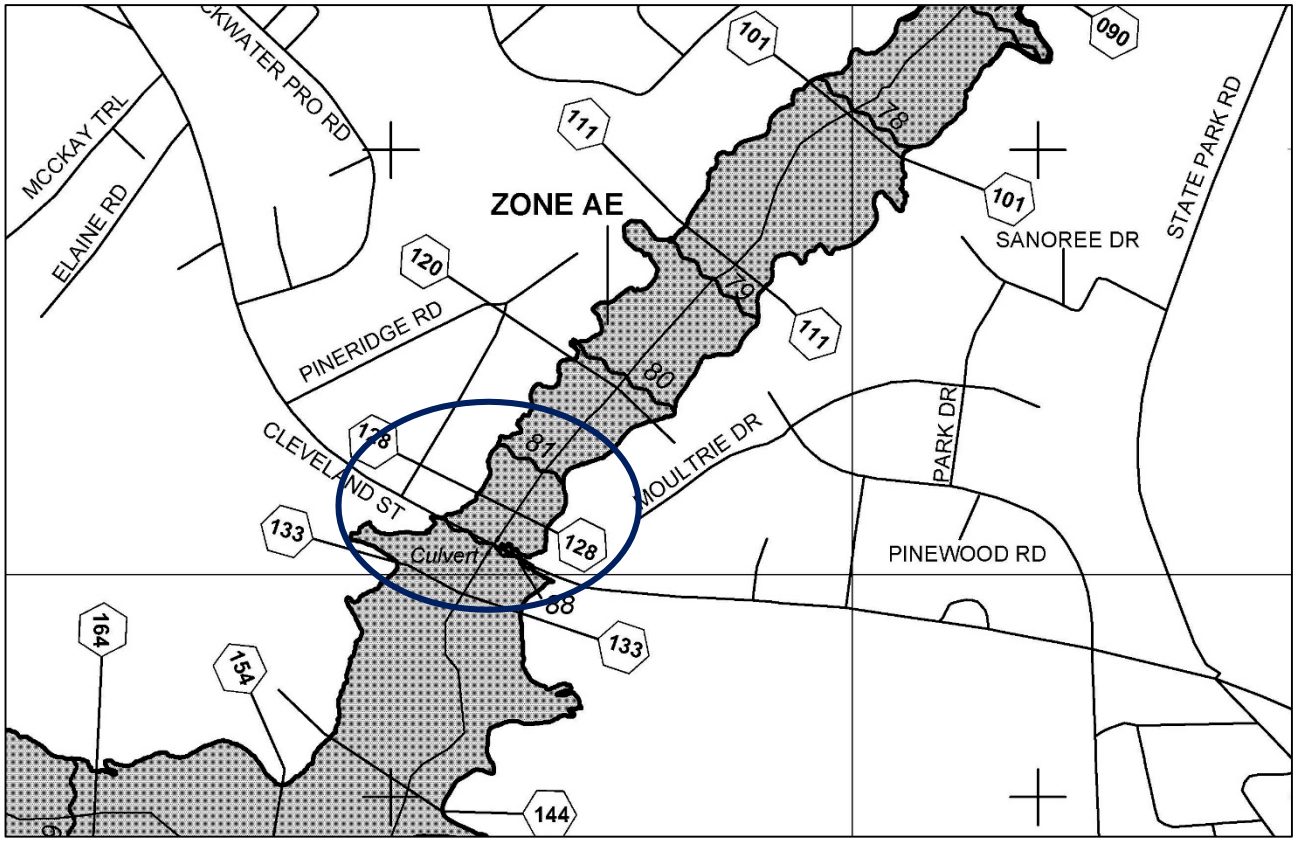

Figure A13.3: SCNONAME 38036 (Cleveland Street) Dam in blue circle; FIRM is cropped, detailed above

Figure A13.4: SCNONAME 38036 (Cleveland Street) Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A13.5: SCNONAME 38036 (Cleveland Street) Dam post-event photo; Credit: USACE Bath

General SCNONAME 38036 (Cleveland Street) Dam Comments

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C3.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to SCNONAME 38036 or Cleveland Street dam.
  - The stream for this dam is listed as Big Poplar Creek. The National Inventory of Dams lists the stream for this dam as Browning Branch.
  - Information regarding the hydrologic and hydraulic modeling of Big Poplar Creek shows that SCNONAME 38036 (Cleveland Street) was included in the model as a culvert.
  - There is no flood profile for Big Poplar Creek.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as '*Culvert*'. SCNONAME 38036 (Cleveland Street) is not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.

- Based on information from SCDHEC, there was no emergency action plan for this dam. This is consistent with the NID having an EAP for this dam.
- The Orangeburg County 2011 Hazard Mitigation Plan did not profile dam failure as a hazard and does not reference this dam by name.
- The National Inventory of Dams records this dam as completed in 1960 with no modifications.
- According to a dam assessment performed on October 12th by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam failed to the right of the primary spillway during flooding. According to the dam inspection by SCDHEC on October 29th, the dam was breached and the bridge was out.

Considerations for SCNONAME 38036 (Cleveland Street) Dam

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

14) ***State Dam Name: Busbees Pond (Hutto's Millpond Dam)*** Latitude: 33.55656622; Longitude: -81.05704327; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 38066	County	Orangeburg
Stream or River	Tampa Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Low	State Hazard Class*	C2
NID ID	SC00444	State ID	D3701
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1960
Length (ft)	575	Year Modified	N/A
Drainage Area (sq mi)	1.02	Height (ft)	13
Surface Area (ac)	8	EAP	NO
Max Discharge (cfs)	410	Condition	Not Rated
Max Storage (ac ft)	182	Normal Storage (ac ft)	81
Note: FIRM & FIS data are not in the NID		FIS Effective Date	01/16/2014
FIRM Panel	45075C0145C	FIRM Effective Date	01/16/2014

*Provided by SCDHEC

Figure A14.1: Busbees Pond (Hutto's Millpond Dam) Dam pre-event photo; Credit: Google Maps Streetview

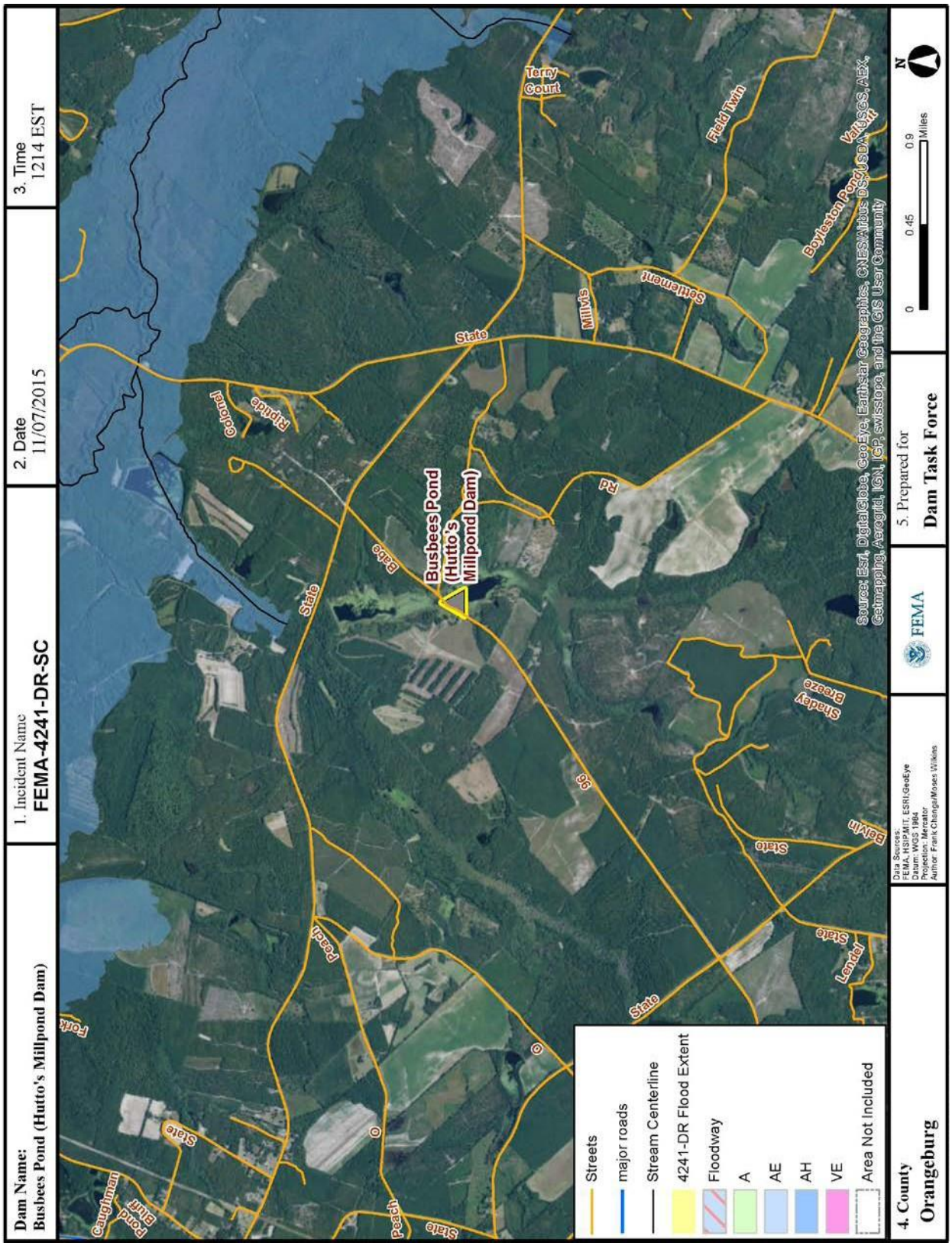

Figure A14.2: Busbees Pond (Hutto's Millpond Dam) FEMA Flood Zone and 4241DR Flood Extent Overlay Map

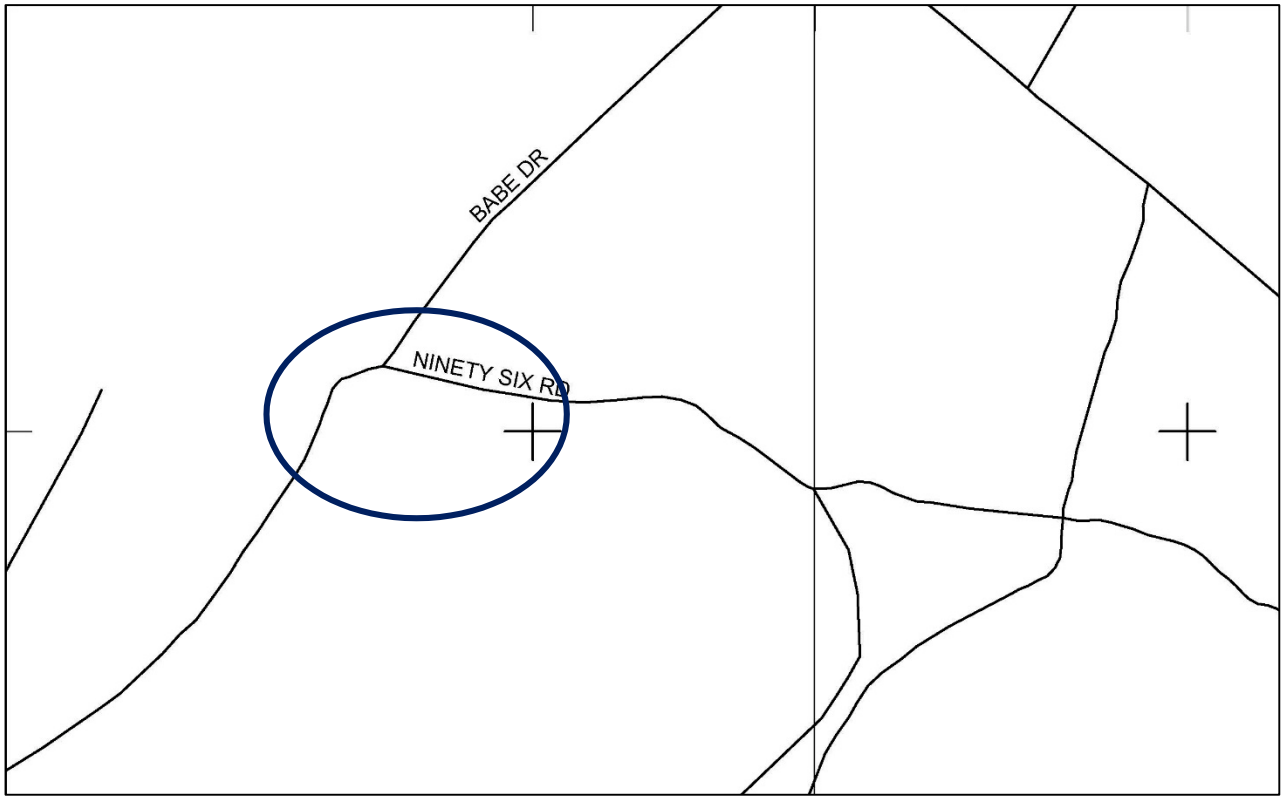

Figure A14.3: Busbees Pond (Hutto's Millpond Dam) in blue circle; FIRM is cropped, detailed above

Figure A14.4: Busbees Pond (Hutto's Millpond Dam) Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A14.5: Busbees Pond (Hutto's Millpond Dam) post-event photo; Credit: USACE Bath

General Busbees Pond (Hutto's Millpond Dam) Comments

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Busbees Pond or Hutto's Millpond dam.
  - The stream for this dam is listed as Gibson Branch. The National Inventory of Dams lists the stream for this dam as Tampa Creek.
  - There is no Information regarding the hydrologic and hydraulic modeling of Gibson Branch. It is unknown as to whether or not Busbees Pond (Hutto's Millpond Dam) was modeled.
  - There is no flood profile for Gibson Branch.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam and Busbees Pond (Hutto's Millpond Dam) are not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from SCDHEC, there was no emergency action plan for this dam. This is consistent with the NID having an EAP for this dam.

- The Orangeburg County 2011 Hazard Mitigation Plan did not profile dam failure as a hazard and does not reference this dam by name.
- The National Inventory of Dams records this dam as constructed in 1960 with no modifications.
- During the last pre-event inspection, December 2014, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, there was vegetation on the upstream and downstream slope that needed to be removed, small trees (less than 4 inches in diameter), and a seep that should be routinely monitored for changes in flow and turbidity.
- Based on the aerial, there is another pond or lake approximately 1,000-feet downstream of this dam.
- According to a dam assessment performed on October 13 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the failure occurred to the right of the primary spillway. According to the dam inspection by SCDHEC on October 29, the dam was rebuilt over the spillway and the lake level was completely full. A backhoe and dump truck were used to fill the spillway. There was also moderate flow over the spillway. SCDHEC on November 2 noted, "*New pipe was installed Saturday to help lower pond level. It is functioning properly and flowing at about 1/3 of its full capacity.*" On, November 6 SCDHEC stated no changes since last visit. The emergency pipe was still functioning properly.

Considerations for Busbees Pond (Hutto's Millpond Dam)

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.

15) ***State Dam Name: Culler Pond (SCNONAME 38070)*** Latitude: 33.63670829; Longitude: -81.15938027; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 38070	County	Orangeburg
Stream or River	Salem Creek	Nearest Downstream City/Town	North Edisto River
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00447	State ID	D3682
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1960

Length (ft)	1005	Year Modified	N/A
Drainage Area (sq mi)	3.62	Height (ft)	14
Surface Area (ac)	12	EAP	No
Max Discharge (cfs)	719	Condition	Not Rated
Max Storage (ac ft)	87	Normal Storage (ac ft)	50
Note: FIRM & FIS data are not in the NID		FIS Effective Date	01/16/2014
FIRM Panel	45075C0020C	FIRM Effective Date	01/16/2014

*Provided by SCDHEC

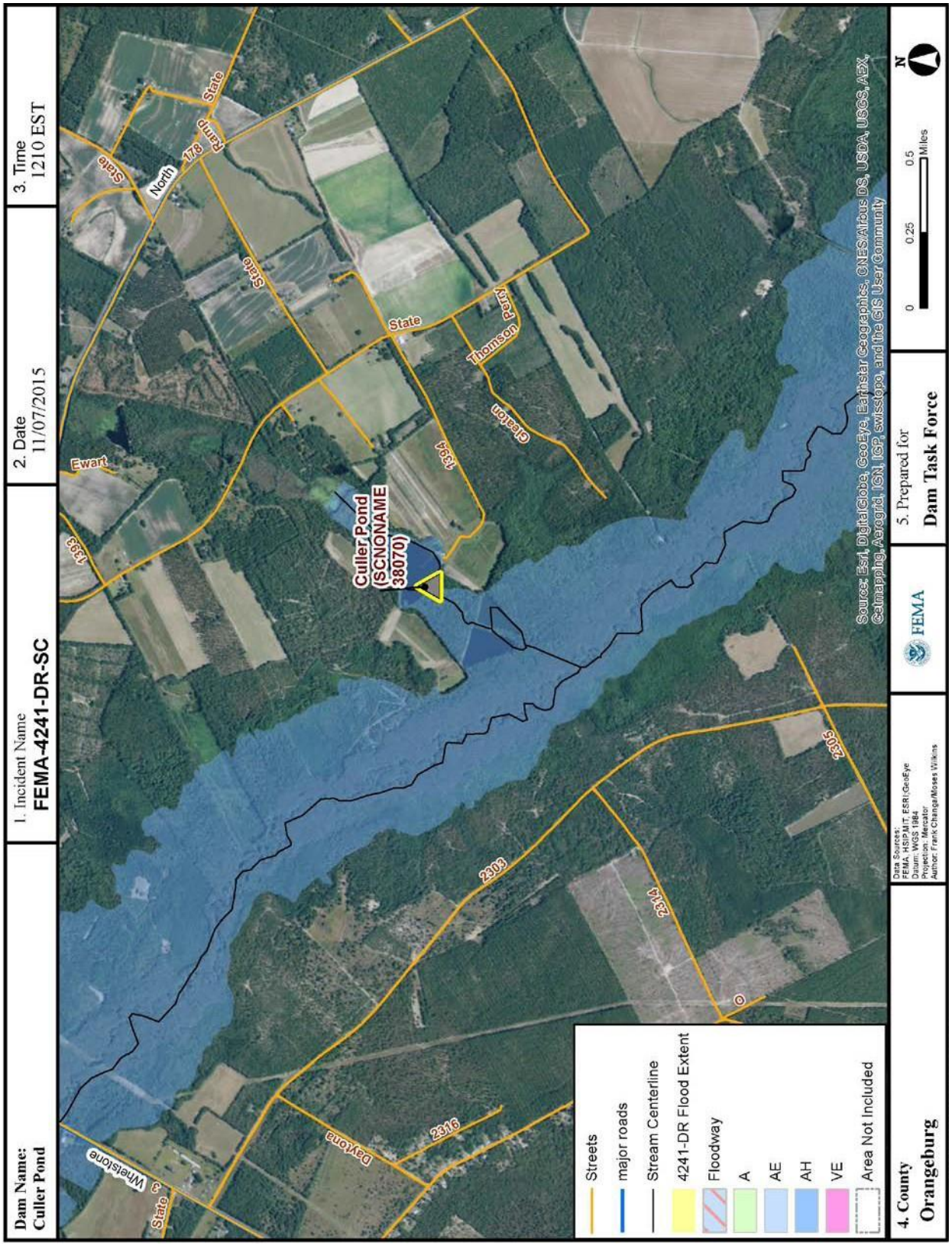

Figure A15.1: Culler Pond (SCNONAME 38070) FEMA Flood Zone and 4241DR Flood Extent Overlay Map

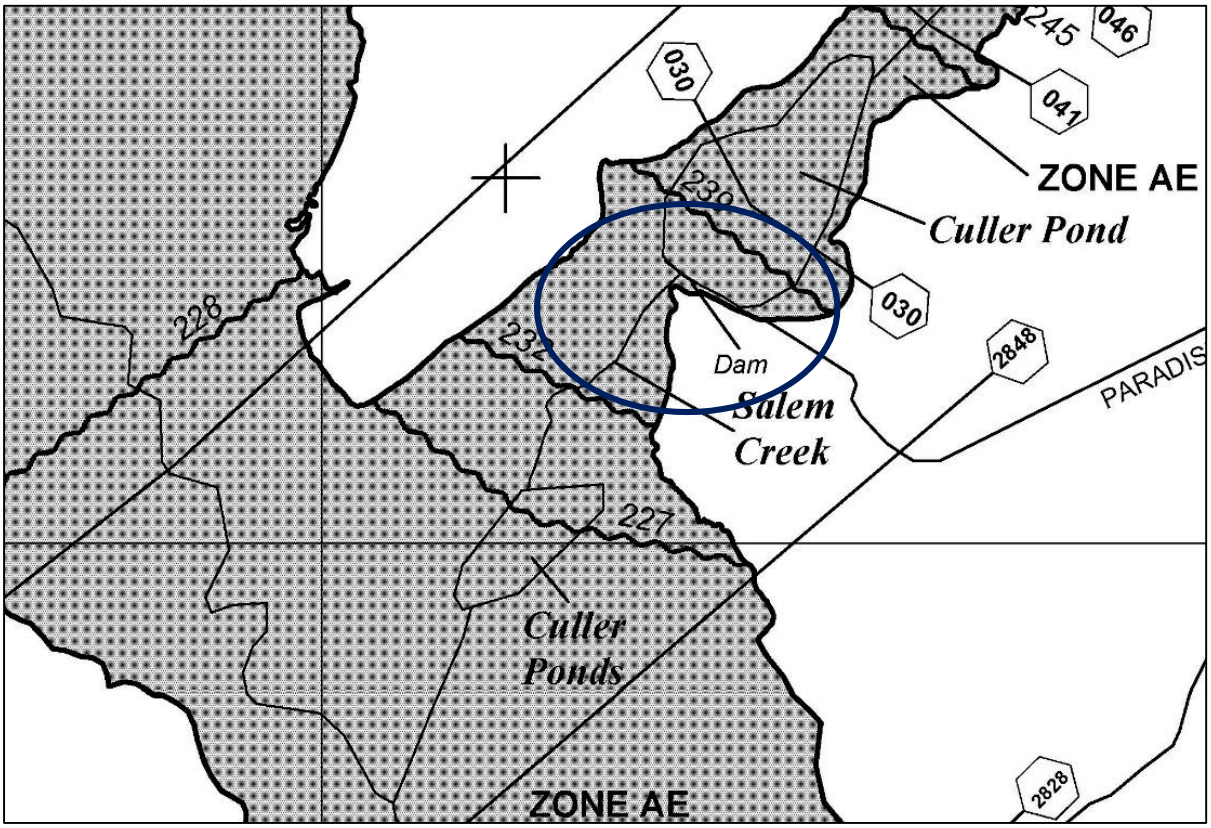

Figure A15.2: Culler Pond (SCNONAME 38070) Dam in blue circle; FIRM is cropped, detailed above

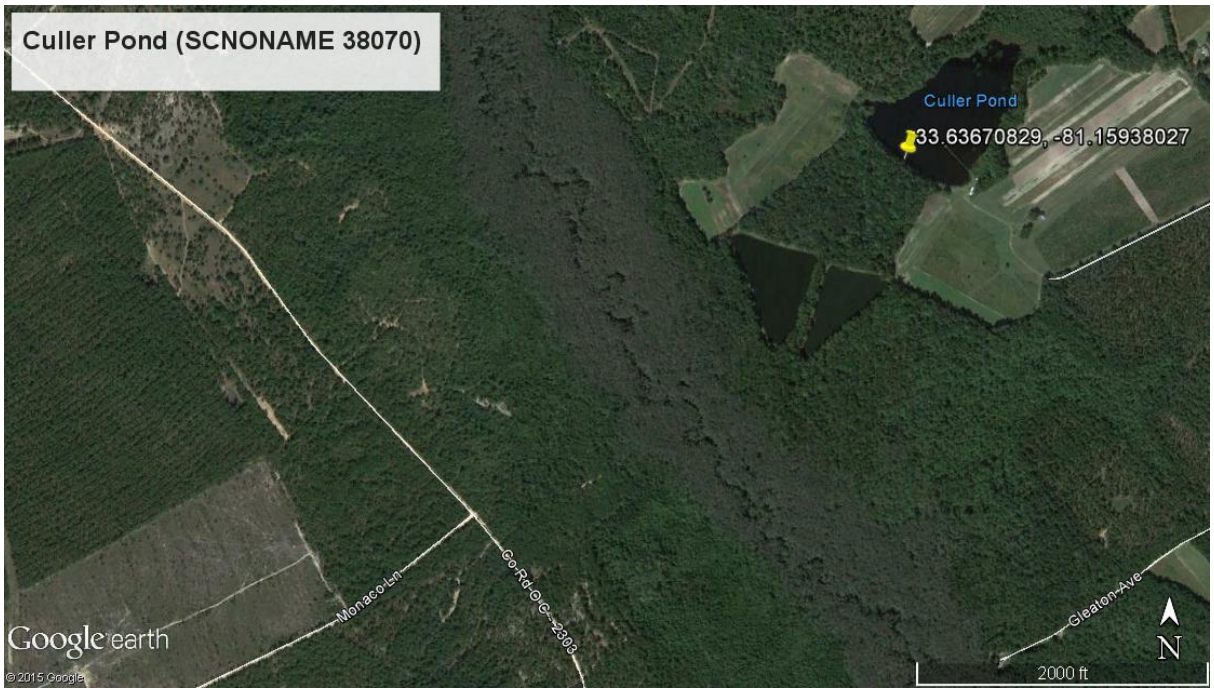

Figure A15.3: Culler Pond (SCNONAME 38070) Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A15.4: Culler Pond (SCNONAME 38070) Dam post-event photo;
Credit: SCDHEC

General Culler Pond (SCNONAME 38070) Dam Comments

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C3.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Culler Pond or SCNONAME 38070 dam.
  - The stream for this dam is listed as Long Branch. The National Inventory of Dams lists the stream for this dam as Salem Creek.
  - Information regarding the hydrologic and hydraulic modeling of Long Branch shows that Culler Pond was included in the model as an in-line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - There is no flood profile for Long Branch or Salem Creek.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as '*Dam*'. Culler Pond is labeled by name.
  - The stream is labeled as Salem Creek.
- The National Inventory of Dams shows this dam as an earthen dam.

- Based on information from SCDHEC, there was no emergency action plan for this dam. This is consistent with the NID having an EAP for this dam.
- The Orangeburg County 2011 Hazard Mitigation Plan did not profile dam failure as a hazard and did not reference this dam by name.
- The National Inventory of Dams records this dam as completed in 1960 with no modifications recorded.
- According to a dam assessment performed on October 13th by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the failure occurred at the primary spillway.

Considerations for Culler Pond (SCNONAME 38070) Dam

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

16) ***State Dam Name: Lake Elizabeth*** Latitude: 34.113028; Longitude: 80.987693; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 40002	County	Richland
Stream or River	Crane Creek	Nearest City/Town Downstream	Columbia
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00047	State ID	D0024
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1900
Length (ft)	560	Year Modified	N/A
Drainage Area (sq mi)	21.11	Height (ft)	10.5
Surface Area (ac)	32	EAP	No
Max Discharge (cfs)	482	Condition	Satisfactory
Max Storage (ac ft)	260	Normal Storage (ac ft)	200
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0255K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A16.1: Lake Elizabeth Dam pre-event photo; Credit: Google Maps Streetview

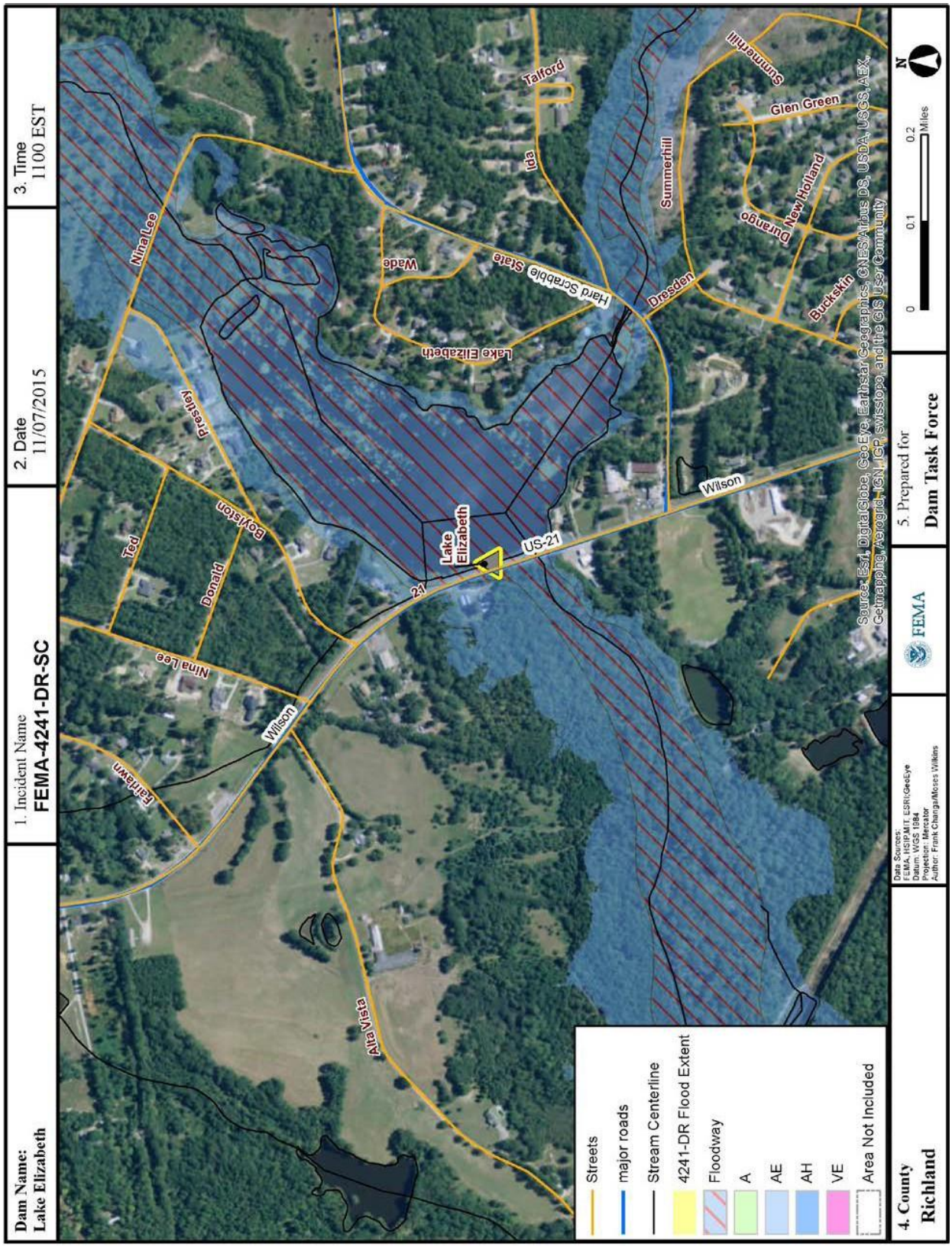

Figure A16.2: Lake Elizabeth Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

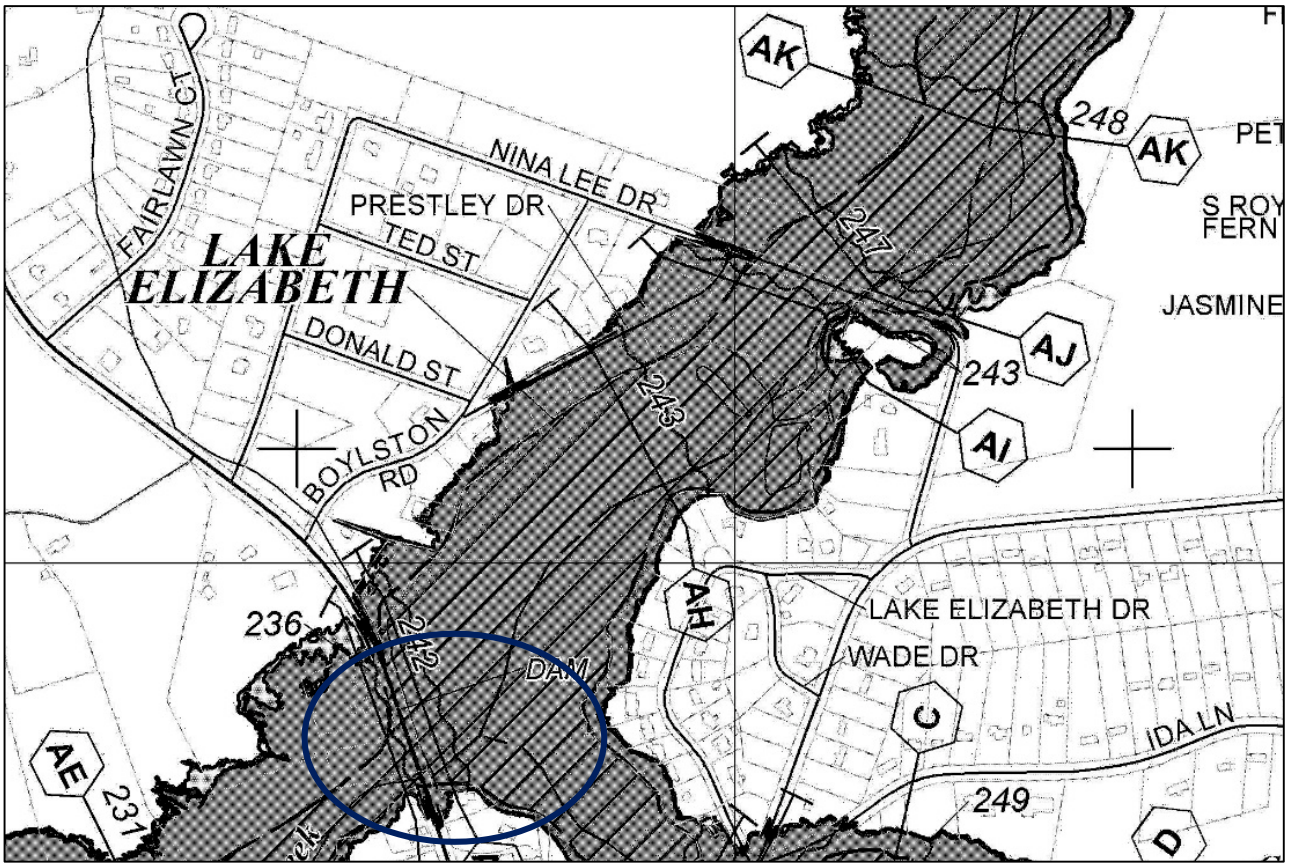

Figure A16.3: Lake Elizabeth Dam in blue circle; FIRM is cropped, detailed above

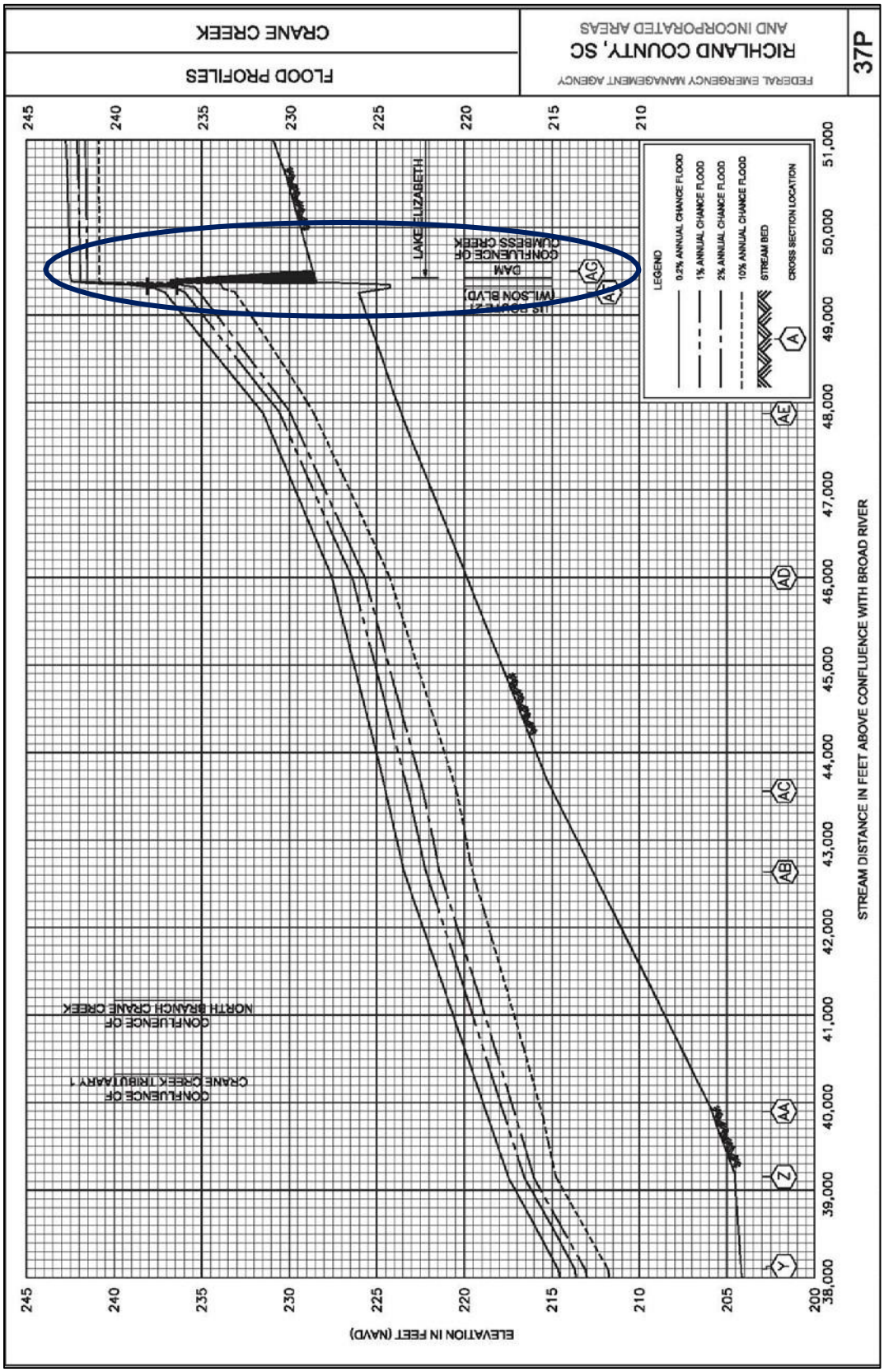

Figure A16.4: FEMA Flood Insurance Flood Profile 37P for Lake Elizabeth Dam

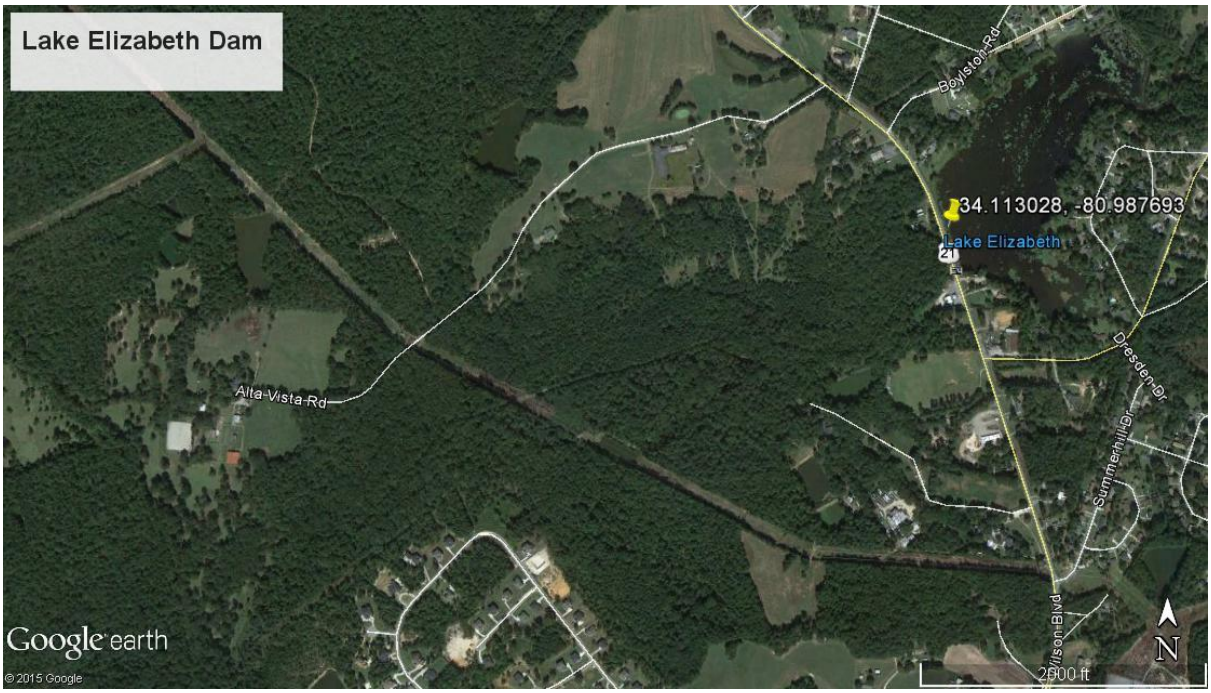

Figure A16.5: Lake Elizabeth Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A16.6: Lake Elizabeth Dam post-event photo; Credit: USACE Saint-Clair

General Lake Elizabeth Dam Comments

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Lake Elizabeth Dam.
  - The stream for this dam is listed as Crane Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Crane Creek shows that Lake Elizabeth Dam was included in the model as an in- line weir. The following was stated on page 22 (pdf page 28):
    "Within the unincorporated areas of Richland County and the City of Columbia, water surface elevations for the following streams were computed using the HEC-2 stepbackwater computer program and the HEC-l Dam Break Program (References 25 and 11): Gills Creek, Crane Creek, Stoop Creek, Nicholas Creek, Swygert Branch, Moccasin Branch, North Branch Crane Creek, Beasley Creek, Cumbess Creek, Roberts Branch, Tributary RB-l, Sorghum Branch, Spears Creek, Tributary SP-l, Sandy Branch, Bridge Creek, Rice Creek, Reeder Point Branch, Tributary RP-l, Smith Branch, and Bay Branch.
    The HEC-2 model was first used to develop elevation-discharge ratings for dams and other hydraulic structures. The HEC-l model was used to route the various floods through the reservoirs and determine the amount of overtopping that would occur at each structure. Criteria contained in Reference 26 were used to determine the amount of overtopping necessary to cause failure and the size and shape of the breach."
  - Based on the Crane Creek Profile from the latest FEMA Flood Insurance Study, Lake Elizabeth Dam would be overtopped in the 1 percent annual chance event by approximately eight feet of water.
  - The following is stated on page 9 (pdf page 15):
    "The flood problems along Gills Creek are compounded by a number of large and small lakes formed by dams across Gills Creek and two tributary streams, Jackson Creek and Little Jackson Creek. In the past some of these dams have failed and others have been purposely breached to prevent failure. Results indicate that Lake Katherine Dam, Forest Lake Dam and several other dams upstream from Forest Lake would fail during floods of 50-year frequency or greater. Dam failures in the upper basin would increase peak flood discharges at Forest Lake and Lake Katherine,

but results indicate that both dams would fail during floods of 50-year frequency or greater even if none of the upstream dams failed. Both Forest Lake Dam and the Lake Katherine Dam failed during major floods in the 1940's and were rebuilt or repaired under military supervision. At the time these events occurred, there was very little development in the downstream floodplain. A major flood under existing conditions would overtop Forest Lake Dam and Lake Katherine Dam. The high water velocities would erode the downstream faces of both dams, causing them to fail. The combined effect of deep flooding and high-water velocities would result in extensive damage to homes, commercial structures and other facilities between Forest Lake and Garners Ferry Road"

- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as '*Dam*'. Lake Elizabeth is labeled by name.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was no emergency action plan for this dam. SCDHEC confirmed there is no EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is not referenced by name in the 2011 plan. In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Lake Elizabeth dam is not listed in the 2015 mitigation plan.
- The National Inventory of Dams records this dam as completed in 1900 with no information populated for year modified.
- During the last pre-event inspection, November 2014, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, further engineering evaluation was recommended for animal holes/sinkholes, clearing and removing trees and brush on the downstream slope, and spillway integrity and gate function.
- According to the dam inspection report by SCDHEC on October 4, the dam failed on Monday, October 5.

<u>Considerations for Lake Elizabeth Dam</u>

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider researching the reasons there was no EAP for this C1 dam.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.

- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure as a result of this event.

17) ***State Dam Name: Cary's Lake Dam*** Latitude: 34.048873; Longitude: -80.957954; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 40005	County	Richland
Stream or River	Jackson Creek	Nearest City/Town Downstream	Columbia Area
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00050	State ID	D0026
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1938
Length (ft)	350	Year Modified	1988
Drainage Area (sq mi)	19.8	Height (ft)	20
Surface Area (ac)	68	EAP	Yes
Max Discharge (cfs)	6000	Condition	Satisfactory
Max Storage (ac ft)	960	Normal Storage (ac ft)	400
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0262K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

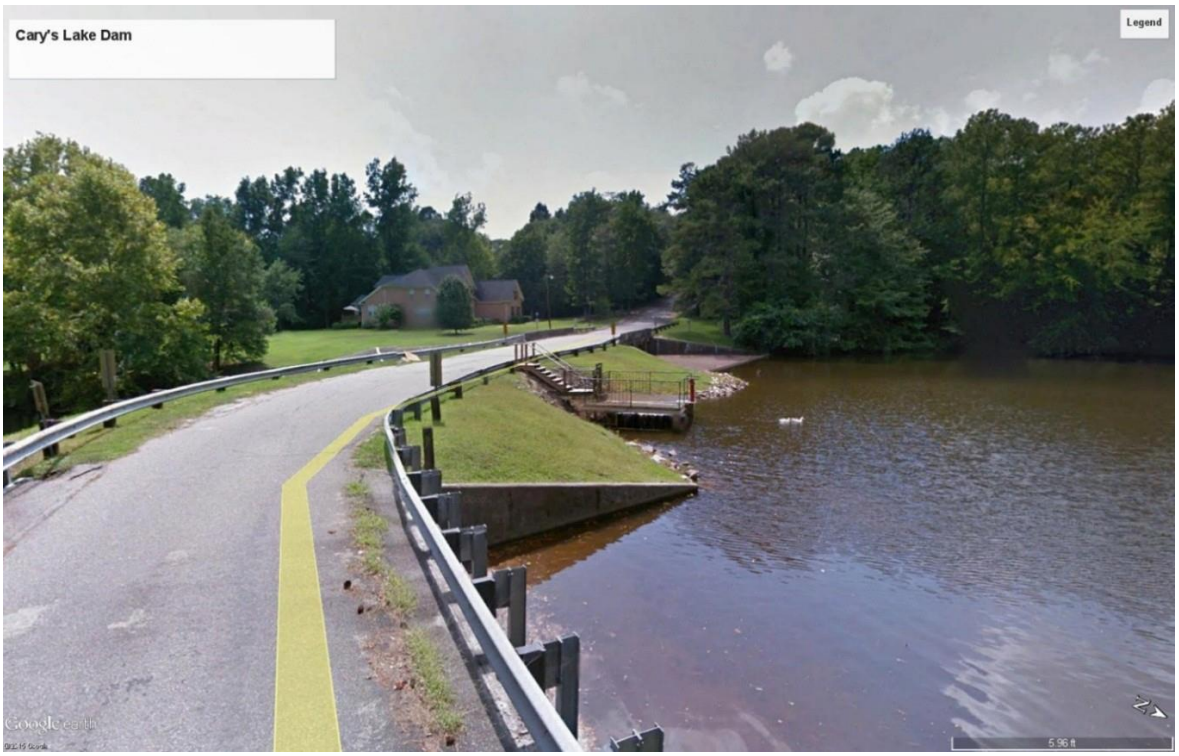

Figure A17.1: Cary's Lake Dam pre-event photo; Credit: Google Maps Streetview

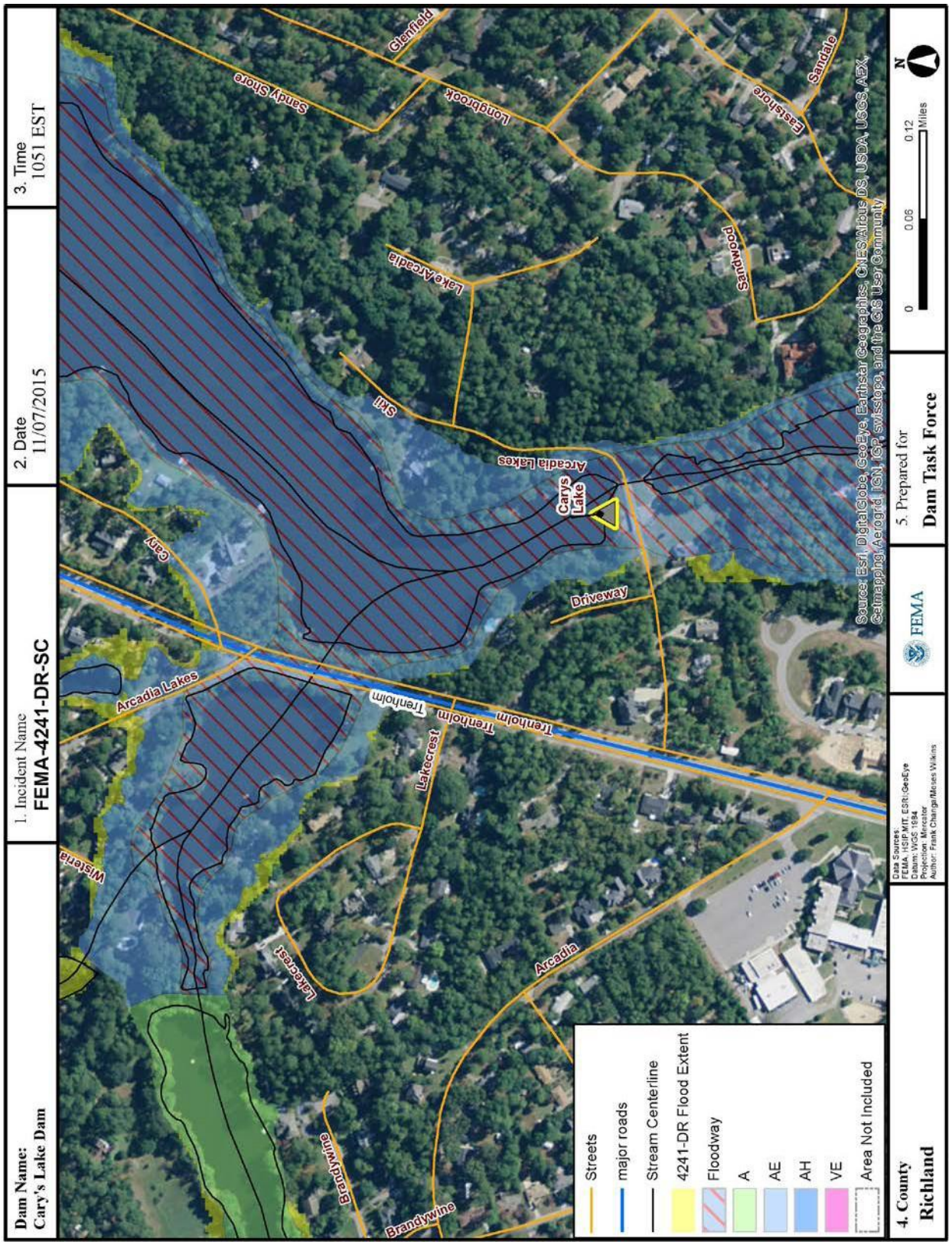

Figure A17.2: Cary's Lake Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

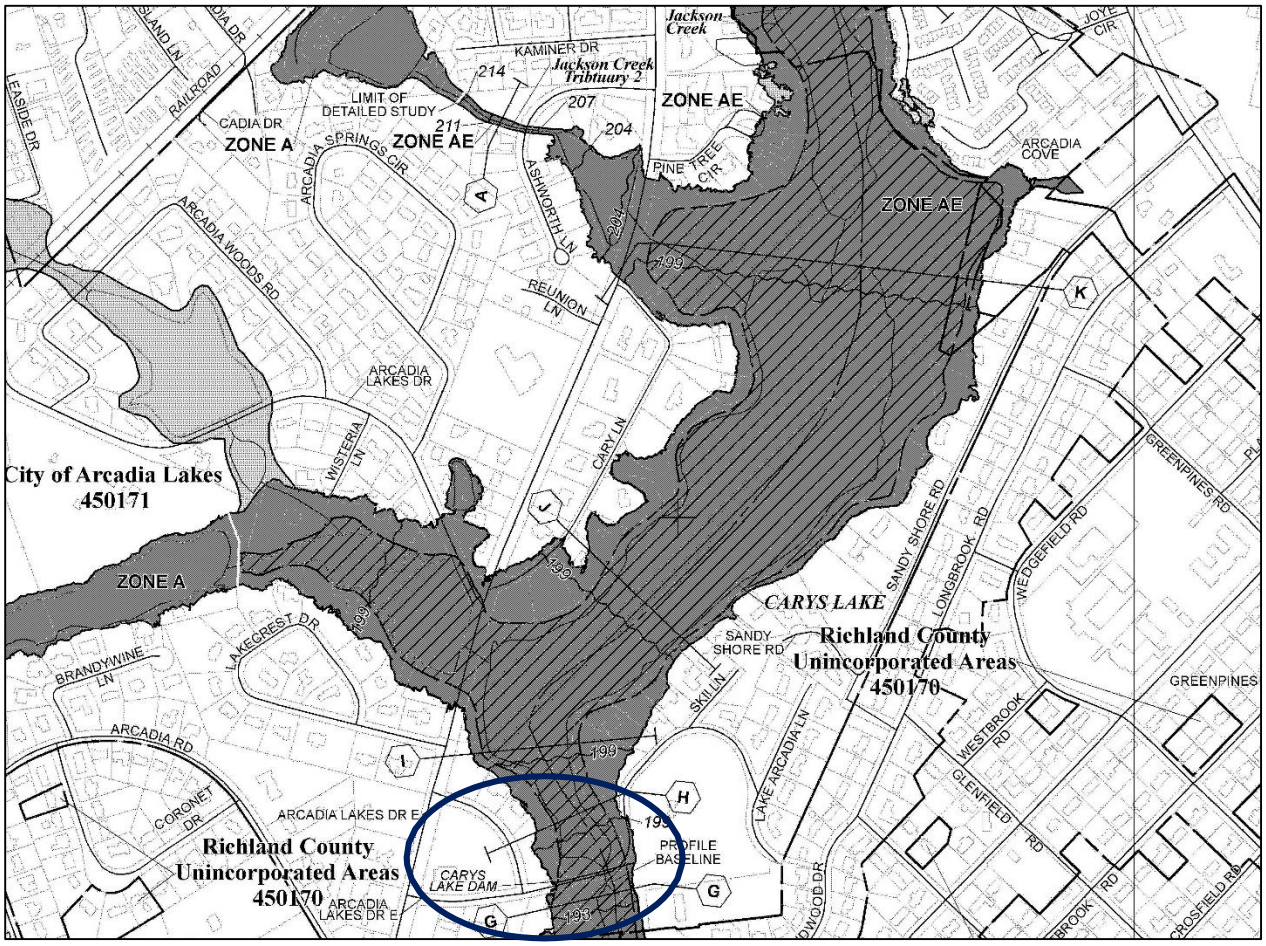

Figure A17.3: Carys Lake Dam in blue circle; FIRM is cropped, detailed above

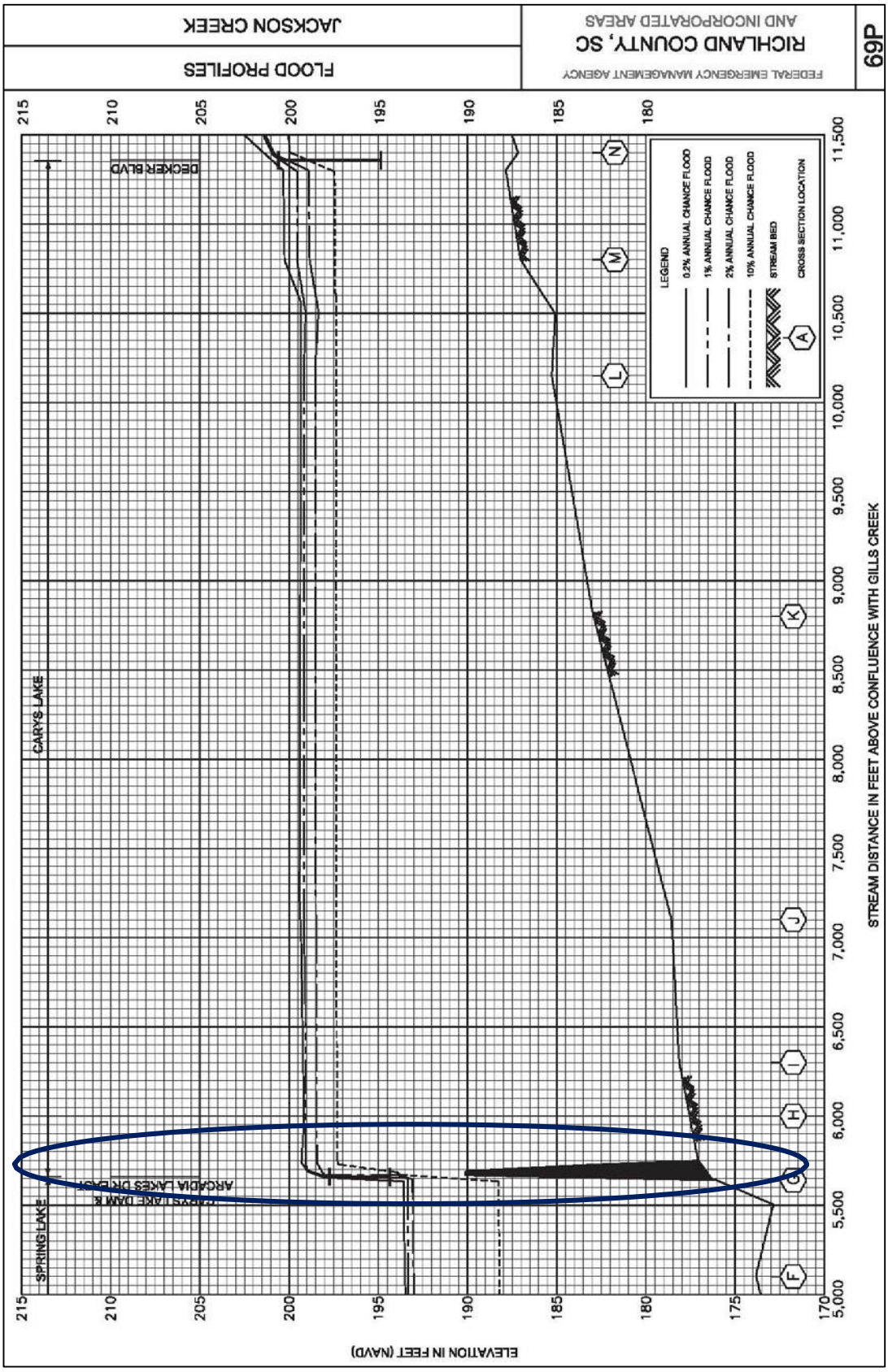

Figure A17.4: FEMA Flood Insurance Flood Profile 69P for Carys Lake Dam

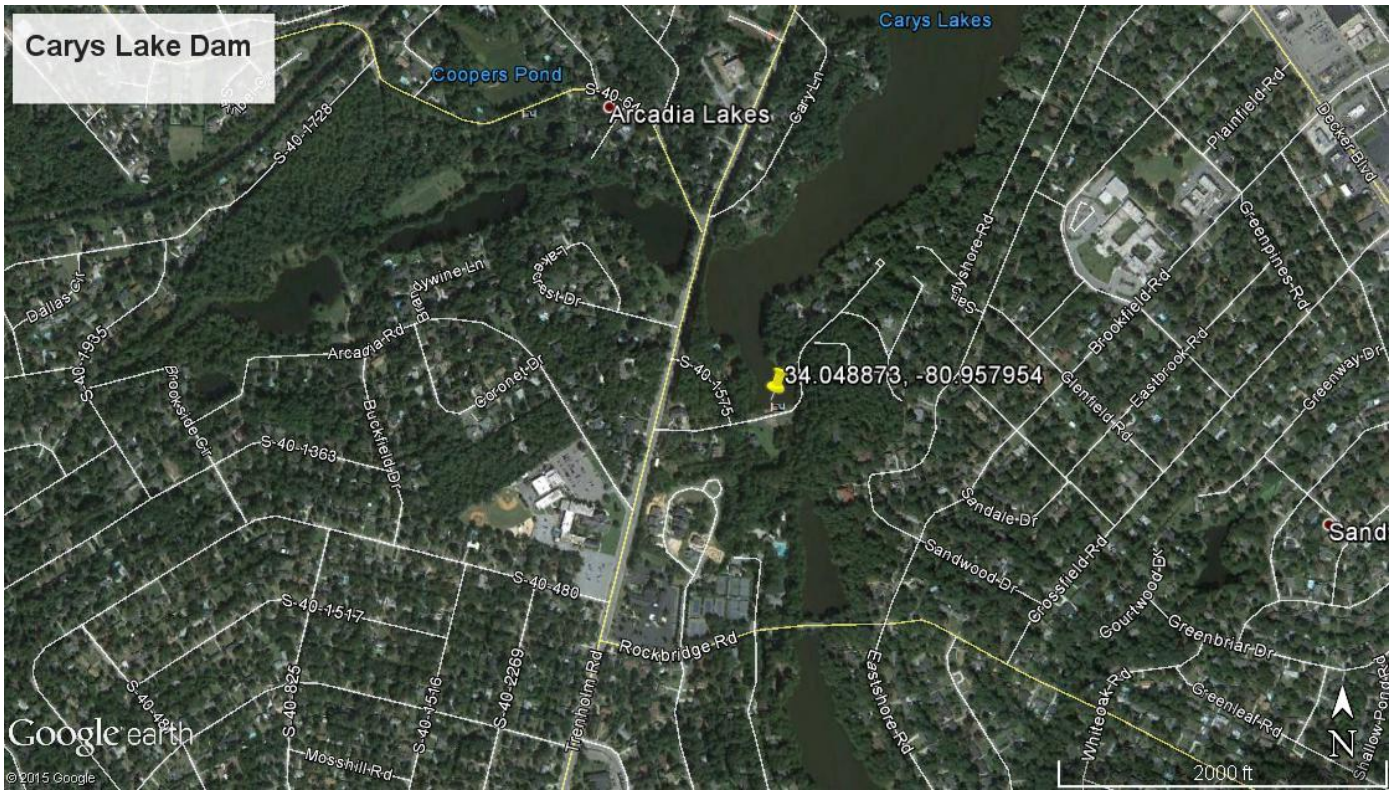

Figure A17.5: Cary's Lake Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A17.6: Cary's Lake Dam post-event photo; Credit: HDR Wingert

General Carys Lake Dam Comments

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are three pictures from the Civil Air Patrol of this dam. Two of the breached dam and one of the empty lake bed.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - Carys Lake Dam is listed in the Summary of Discharges Table.
  - The stream for this dam is listed as Jackson Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Jackson Creek shows that Carys Lake Dam was included in the model as an in-line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - Based on the Crane Creek Profile from the latest FEMA Flood Insurance Study, Carys Lake Dam would be overtopped in the 1 percent annual chance event by approximately two and a half feet of water.
  - The following is stated on page 21 (pdf page 27):
    "For the Town of Arcadia Lakes and City of Forest Acres, there were no high water marks or gage records which could be used to verify the Jackson Creek hydraulic model. However, interviews with local residents indicated that Carys Lake Dam was overtopped and partially breached during the flood of August 1940 and interviews helped establish locations where damages have occurred during past floods. Based on the period of record, the 1940 flood was probably in the 25- to 50-year frequency range. This information verifies the computed 50-year flood which, according to rationale adopted for the Town of Arcadia, will also overtop the dam."
  - The following is stated on page 9 (pdf page 15):
    "The flood problems along Gills Creek are compounded by a number of large and small lakes formed by dams across Gills Creek and two tributary streams, Jackson Creek and Little Jackson Creek. In the past some of these dams have failed and others have been purposely breached to prevent failure. Results indicate that Lake Katherine Dam, Forest Lake Dam and several other dams upstream from Forest Lake would fail during floods of 50-year frequency or greater. Dam failures in the upper basin would increase peak flood discharges at Forest Lake and Lake Katherine, but results indicate that both dams would fail during floods of 50-year frequency or greater even if none of the upstream dams failed. Both Forest Lake Dam and the Lake Katherine Dam failed during major floods

in the 1940's and were rebuilt or repaired under military supervision. At the time these events occurred, there was very little development in the downstream floodplain. A major flood under existing conditions would overtop Forest Lake Dam and Lake Katherine Dam. The high water velocities would erode the downstream faces of both dams, causing them to fail. The combined effect of deep flooding and high-water velocities would result in extensive damage to homes, commercial structures and other facilities between Forest Lake and Garners Ferry Road"

- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as '*Carys Lake Dam*'. Carys Lake is labeled by name.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. This has been confirmed by SCDHEC.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County and Forest Acres have adopted. This dam is not referenced by name in the 2011 plan. In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Carys Lake is listed in a table of dams in this Gills Creek Watershed Flood Mitigation Plan.
- The National Inventory of Dams records this dam as completed in 1938 with modifications in 1988.
- During the last pre-event inspection, November 2014, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, this dam was in good visible condition and the owner needed to keep the small emergency spillway clear of debris.
- Carys Lake Dam is part of a series of dams in the Gills Creek Drainage Basin with the Spring Lake immediately downstream.
- High water marks for this flood event were collected by USGS downstream of this dam failure.
- According to the dam inspection by SCDHEC on October 21, the temporary repairs were stable and construction of a cofferdam was expected soon.
- The Dam Task Force visited this failed dam on November 6 and saw the outlet gate was in the closed position and appeared to be heavily corroded. It is unclear whether it was operable.

<u>Considerations for Carys Lake Dam</u>

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.

- Consider this dam for comparison of dam breach modeling results (HEC- RAS, DSS-WISE, FLO-2D, etc.) to high water mark inundation downstream.
- Consider this dam for further assessment of the original design and construction of the dam and the 1988 modifications, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider further research into the 1940 partial breach of Carys Lake Dam.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.
- Consider further research into whether or not the outlet was operational at the time of this disaster and whether or not it was operated during this event.
- Consider further research into the EAP, whether it was activated and how well the plan and coordination occurred.

18) ***State Dam Name: Murray Pond Dam;*** Latitude: 33.98543068l; Longitude: 80.70793299; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	MURRAY POND DAM	County	Richland
Stream or River	Colonels Creek	Nearest City/Town Downstream	Columbia Area
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00051	State ID	D0595
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1930
Length (ft)	1100	Year Modified	N/A
Drainage Area (sq mi)	42.6	Height (ft)	16
Surface Area (ac)	148	EAP	No
Max Discharge (cfs)	3429	Condition	Not Rated
Max Storage (ac ft)	1310	Normal Storage (ac ft)	710
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0450K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

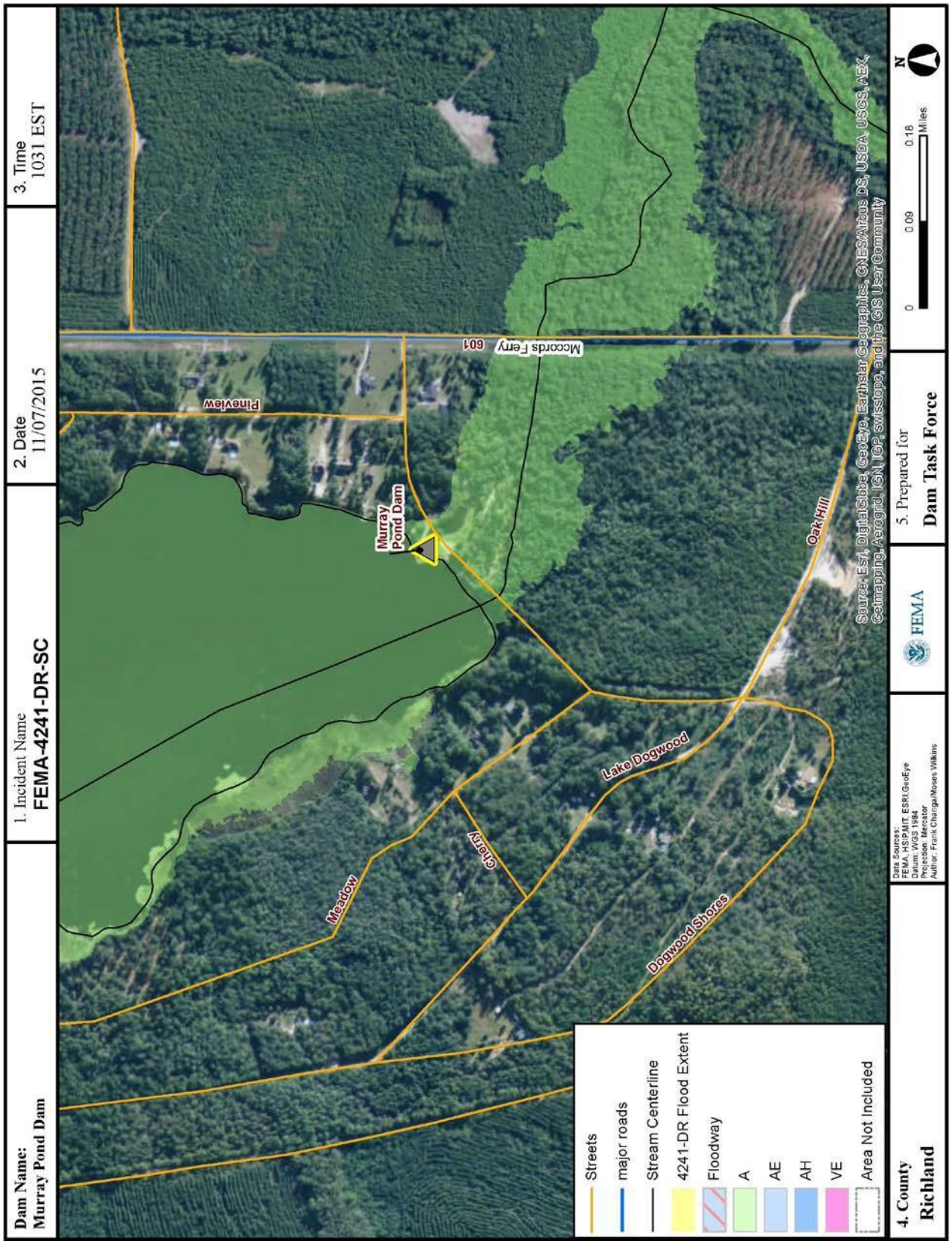

Figure A18.1: Murray Pond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

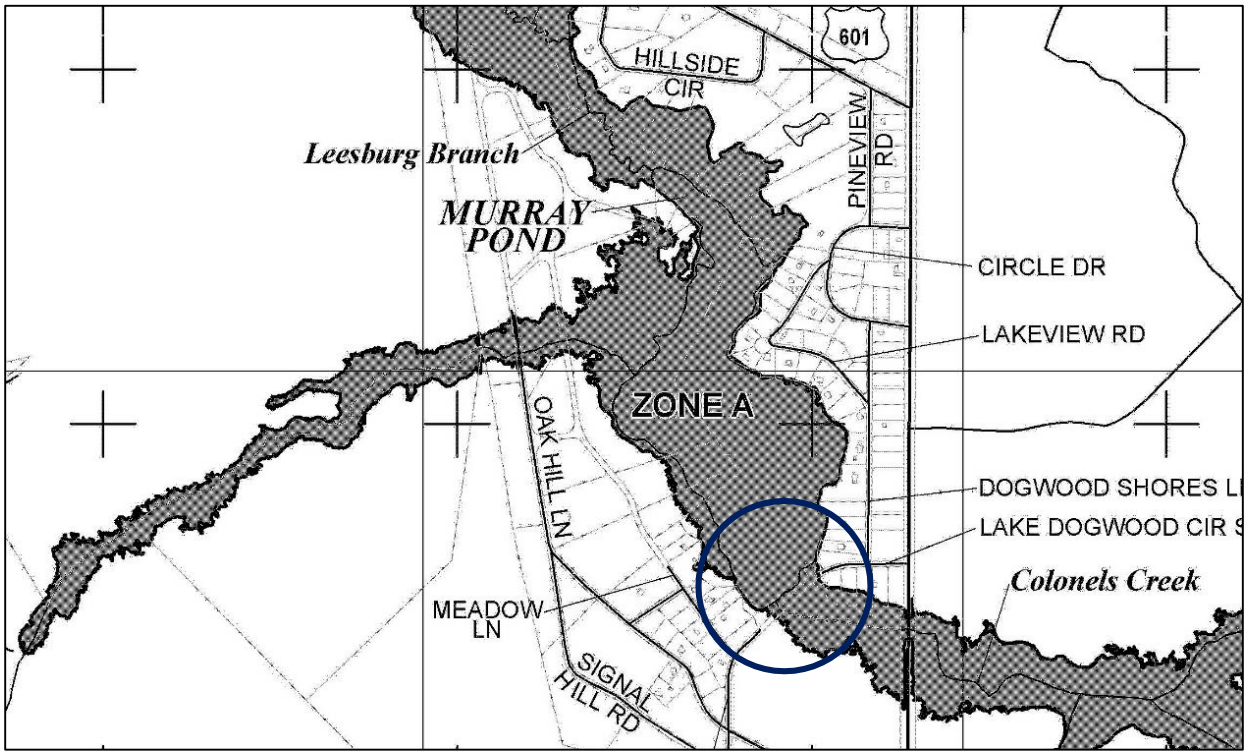

Figure A18.2: Murray Pond Dam in blue circle; FIRM is cropped, detailed above

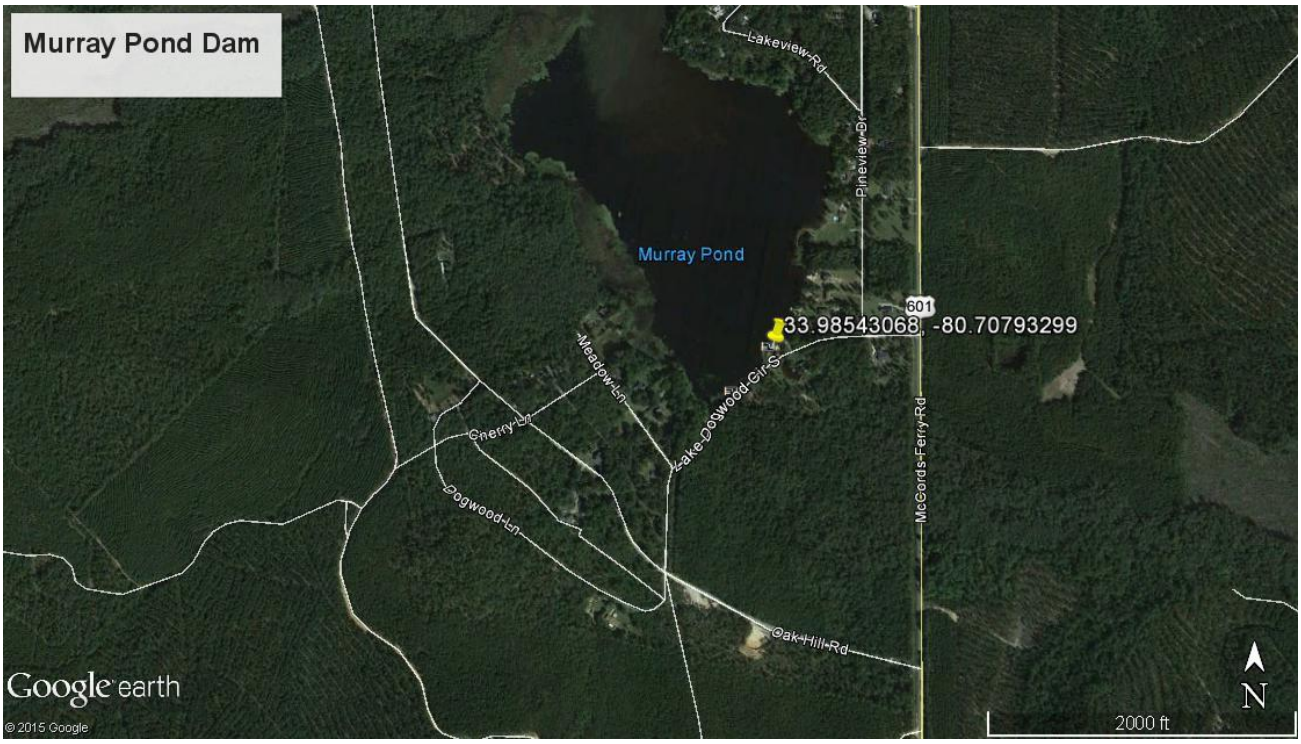

Figure A18.3: Murray Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A18.4: Murray Pond Dam post-event photo; Credit: USACE Bath

General Murray Pond Dam Comments

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 or more inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No Reference to Murray Pond Dam.
  - The stream for this dam is listed as Colonels Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Colonels Creek shows that Murray Pond Dam was included in the model as an in- line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - There is no Flood Profile for Colonels Creek.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled. Murray Pond is labeled by name.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was no emergency action plan for this dam. This was confirmed by SCDHEC

- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam was not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1930 with no modifications recorded.
- During the last pre-event inspection, January 2009, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, this dam appeared to be in good condition and the repairs made in 2007 appeared to be performing very well. This report instructed the owner to cut the trees from the dam and grass the earthen portion of the dam and start a repair fund to rehabilitate the concrete on the emergency spillway drop structure.
- According to a dam assessment performed on October 9 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, there was severe erosion from overtopping and failure to the right of the spillway. According to the dam inspection by SCDHEC on November 5, there were signs of water up to 12' high in the house on the downstream side of the dam next to the stream.

Considerations for Murray Pond Dam

- Consider this dam for further assessment of the original design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.

19) ***State Dam Name: Pinewood Lake Dam***; Latitude: 33.94404929, Longitude: -80.91198374; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	PINEWOOD LAKE DAM	County	Richland
Stream or River	Mill Creek	Nearest City/Town Downstream	Lykesland
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00055	State ID	D0580
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1900

Length (ft)	1050	Year Modified	N/A
Drainage Area (sq mi)	11.46	Height (ft)	14
Surface Area (ac)	35	EAP	
Max Discharge (cfs)	2100	Condition	
Max Storage (ac ft)	263	Normal Storage (ac ft)	193
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0383K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

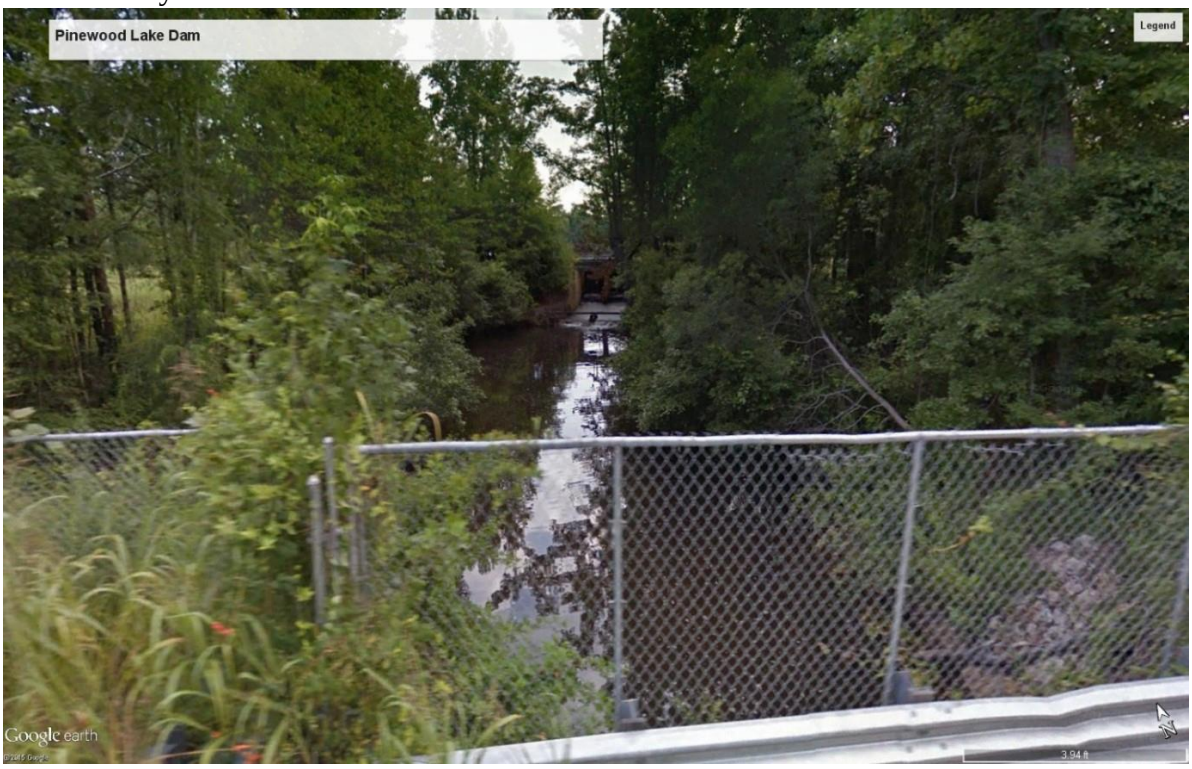

Figure A19.1: Pinewood Lake Dam pre-event photo; Credit: Google Maps Streetview

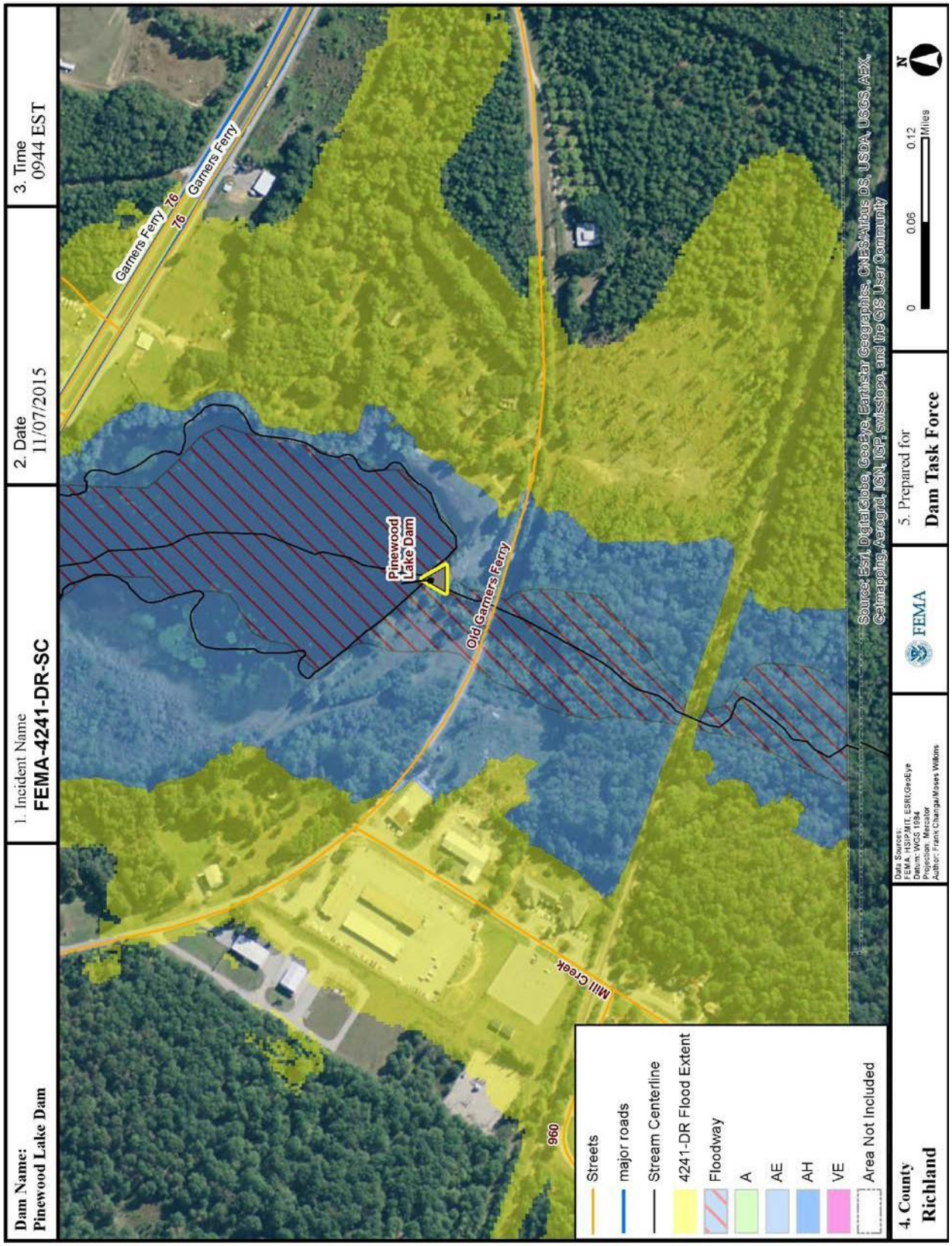

Figure A19.2: Pinewood Lake Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

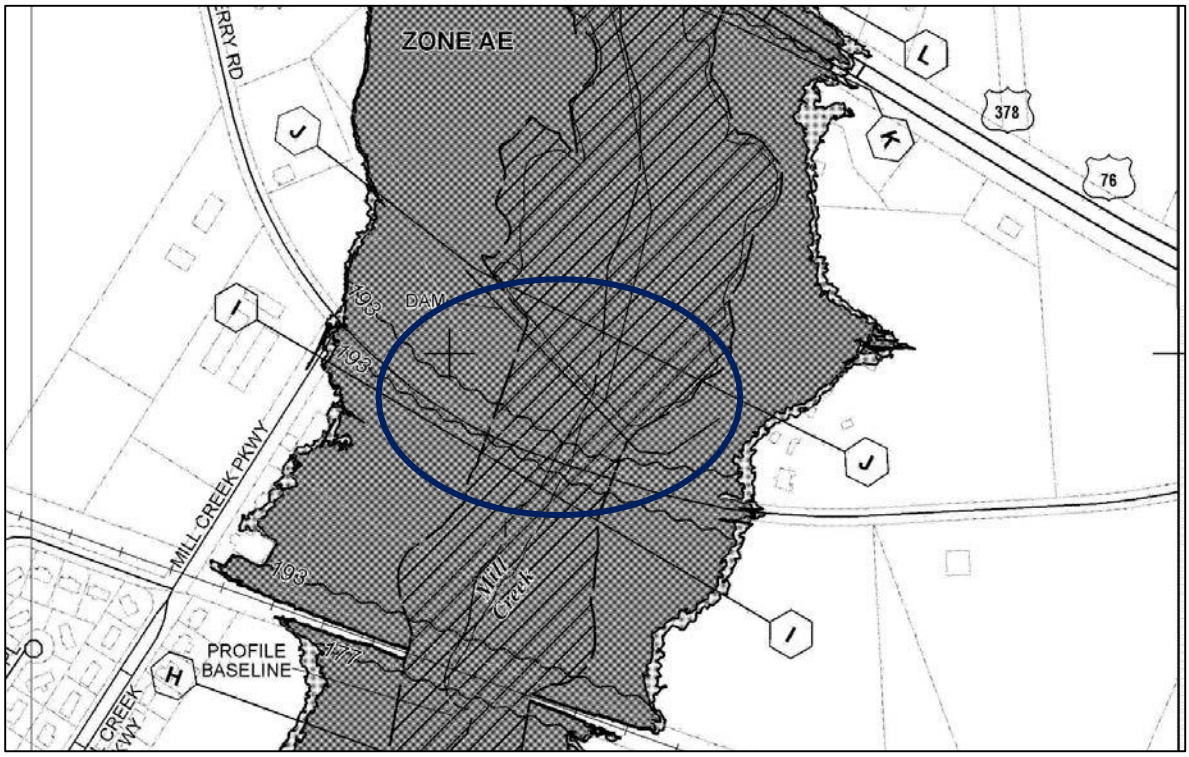

Figure A19.3: Pinewood Lake Dam in blue circle; FIRM is cropped, detailed above

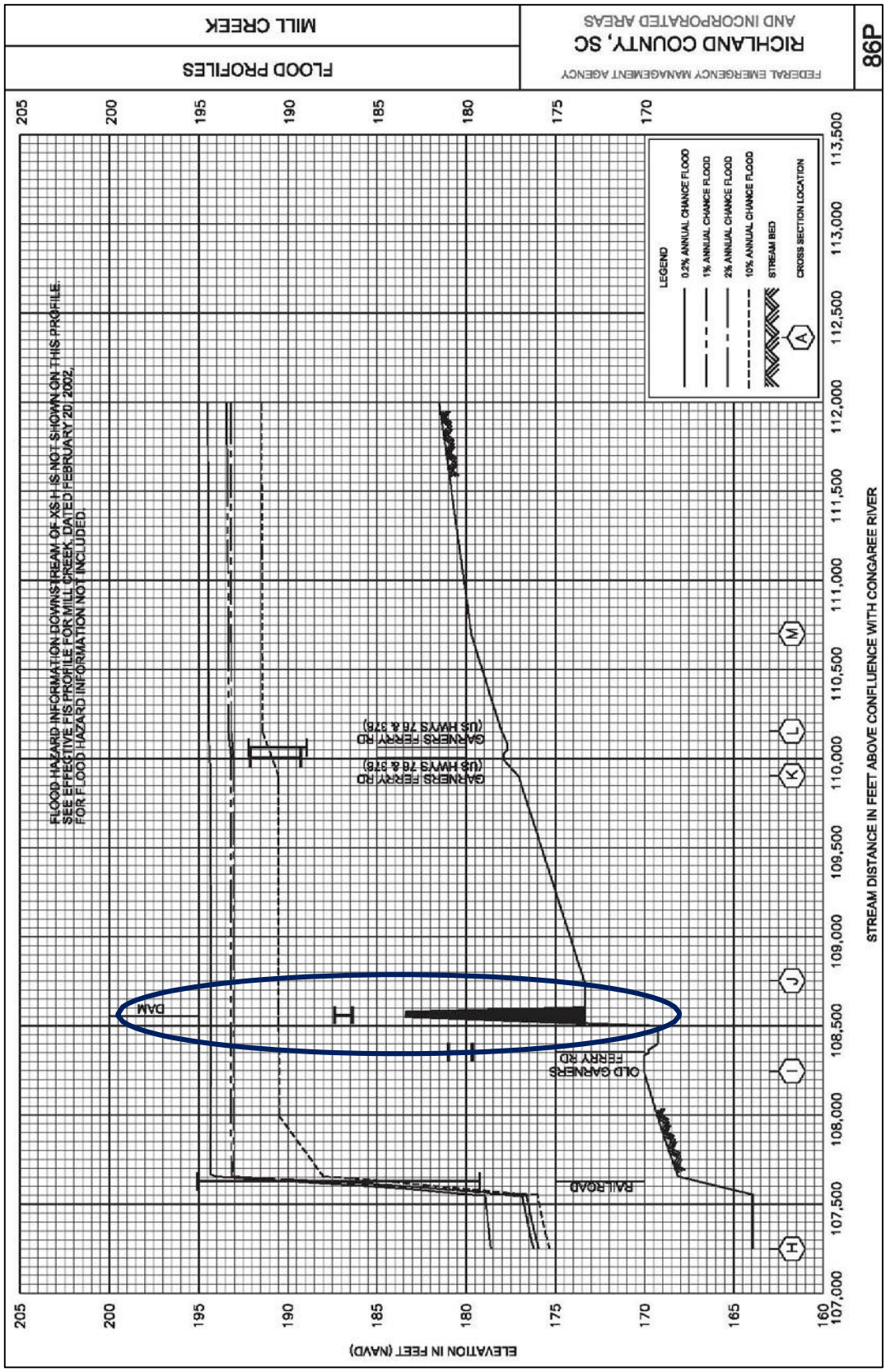

Figure A19.4 FEMA Flood Insurance Flood Profile 86P for Pinewood Lake Dam

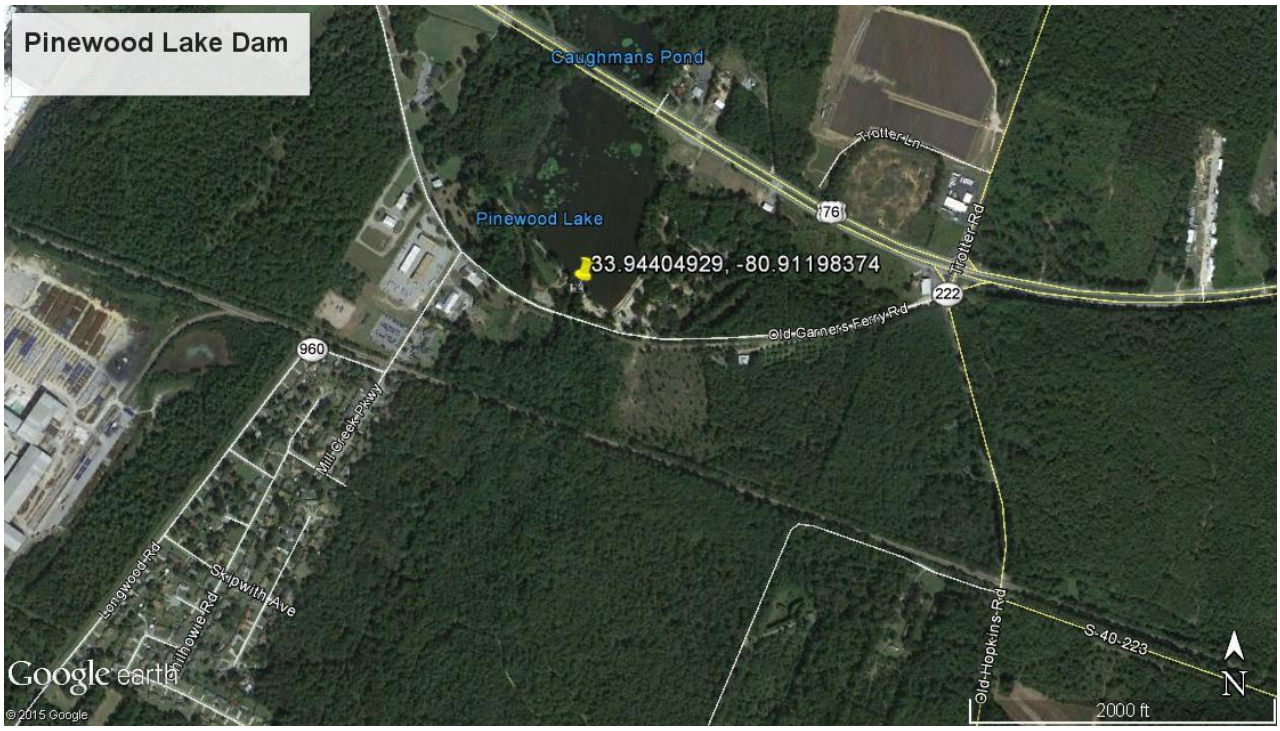

Figure A19.5: Pinewood Lake Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A19.6: Pinewood Lake Dam post-event photo; Credit: USACE Bath

General Pinewood Lake Dam Comments

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No Reference to Pinewood Lake Dam.
  - The stream for this dam is listed as Mill Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Mill Creek shows that Pinewood Lake Dam was included in the model as an in-line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - Based on the Mill Creek Profile, Pinewood Lake Dam would be overtopped in the 1 percent annual chance event by approximately eleven feet of water.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - Pinewood Lake Dam is labeled as 'Dam'. Pinewood Lake is not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. SCDHEC confirmed this dam had an EAP. This was confirmed by SCDHEC.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam was not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1900 and the year modified was not populated.
- During the last pre-event inspection, September 2015, for this dam by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the inspector recommended that grass cover be established to prevent erosion of slopes in a rainstorm, an engineer should evaluate the trees on the upstream and downstream slopes for removal, and that the emergency overflow should remain clear.
- Pinewood Lake Dam is part of a series of dams along Mill Creek and the tributaries to Mill Creek in the Gills Creek Watershed.
- According to a dam assessment performed on October 9 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the

dam failed near the right end. According to a dam assessment performed on October 22 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam overtopped with a breach on the west end.

Considerations for Pinewood Lake Dam

- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the original design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

20) ***State Dam Name: Weston Pond Dam***; Latitude: 33.883093, Longitude: -80.768417; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	WESTONS POND DAM	County	Richland
Stream or River	Toms Creek	Nearest City/Town Downstream	Gadsden
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	SC00056	State ID	D0593
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1932
Length (ft)	950	Year Modified	N/A
Drainage Area (sq mi)	15.4	Height (ft)	13
Surface Area (ac)	40	EAP	No
Max Discharge (cfs)	611	Condition	Not Rated
Max Storage (ac ft)	324	Normal Storage (ac ft)	144
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0420K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

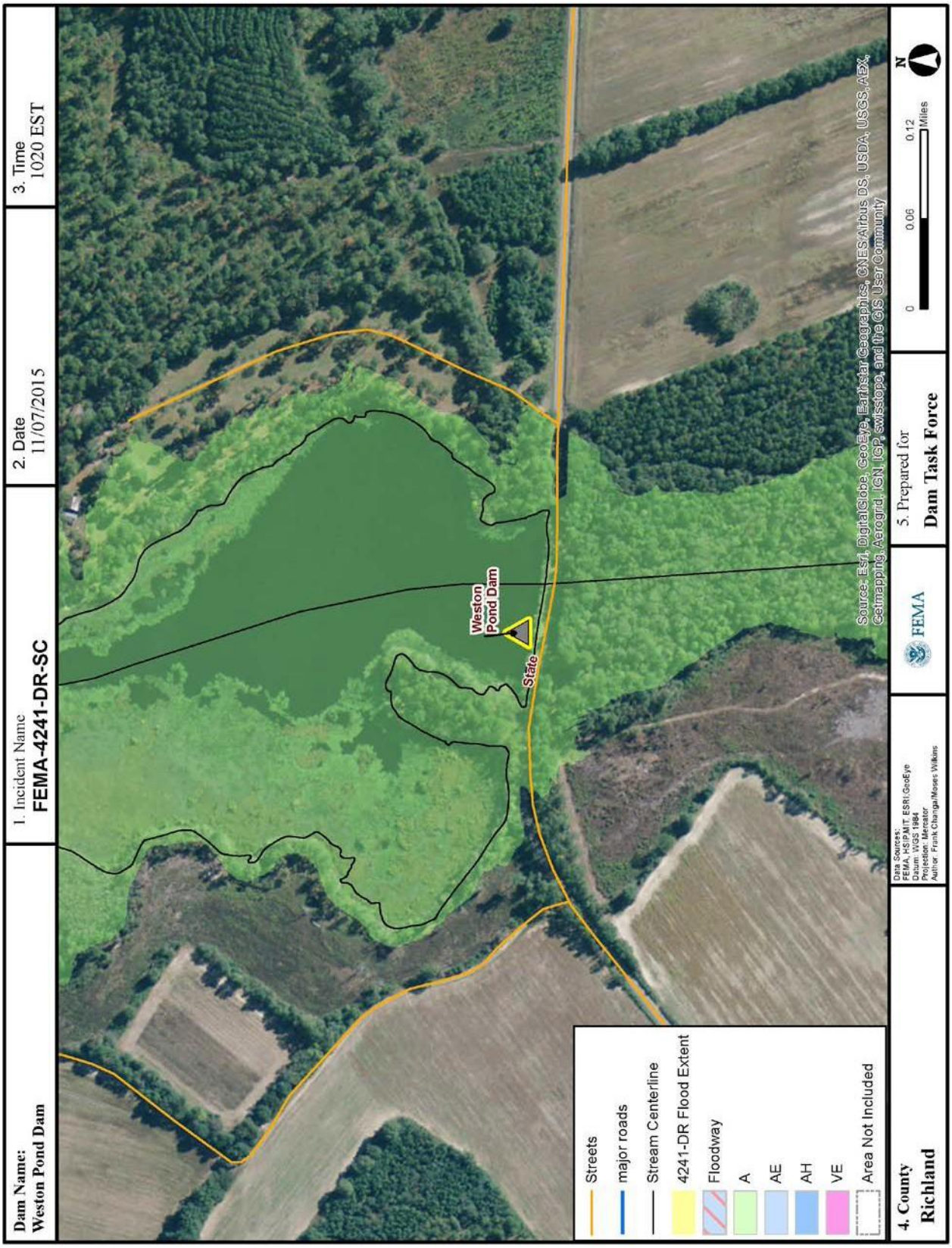

Figure A20.1: Weston Pond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

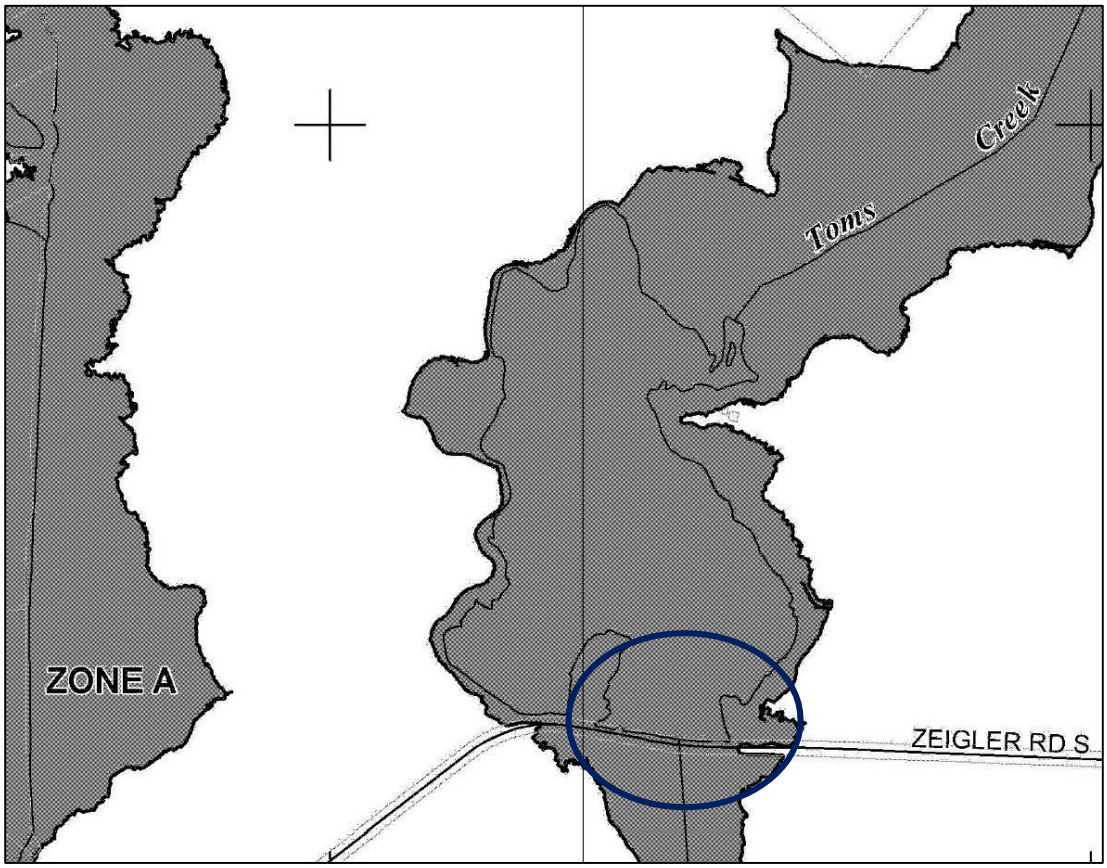

Figure A20.2: Weston Dam in blue circle; FIRM is cropped, detailed above

Figure A20.3: Weston Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A20.4: Weston Pond Dam post-event photo; Credit: USACE Meyer

General Weston Pond Dam Comments

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C3.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No Reference to Weston Pond Dam.
  - The stream for this dam is listed as Toms Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Toms Creek shows that Weston Pond Dam was included in the model as an in- line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - There is no flood profile for Toms Creek.

- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
    - There is no label for Weston Pond or Weston Pond Dam.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was no emergency action plan for this dam. SCDHEC confirmed this dam does not have an EAP.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam was not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1932 with no populated date for modifications.
- According to the dam inspection by SCDHEC on October 8, the owner reported the breach.

Considerations for Weston Pond Dam

- Consider this dam for further assessment of the original design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure because of this event.

21) ***State Dam Name: Wilson Millpond Dam*** Latitude: 33.99992669; Longitude: -80.74288775; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	WILSON MILLPOND DAM	County	Richland
Stream or River	Jumping Run Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00059	State ID	D0594
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1960
Length (ft)	425	Year Modified	N/A
Drainage Area (sq mi)	7.16	Height (ft)	14
Surface Area (ac)	20	EAP	Yes
Max Discharge (cfs)	1212	Condition	Not Rated

Max Storage (ac ft)	134	Normal Storage (ac ft)	72
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0450K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

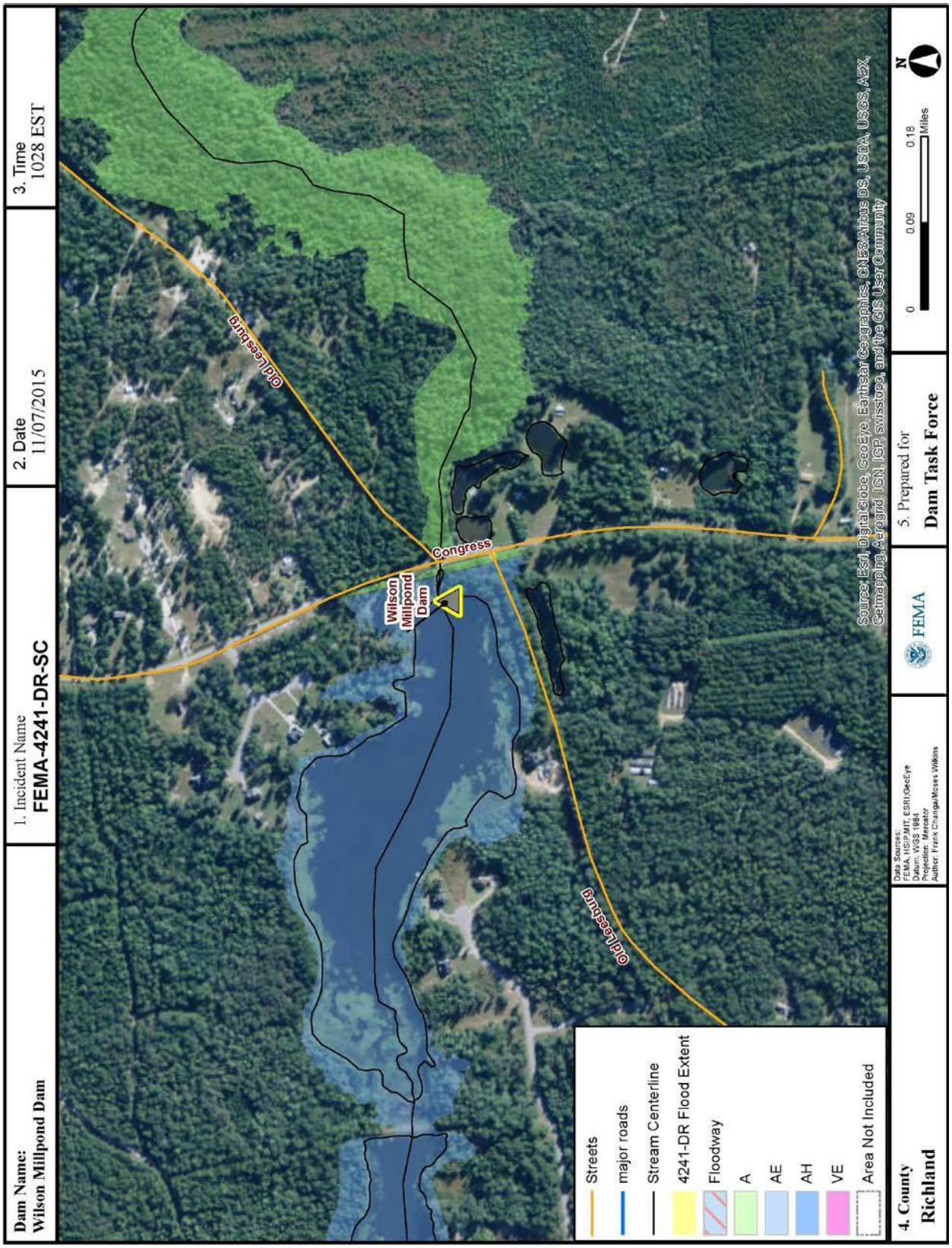

Figure A21.1: Wilson Millpond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

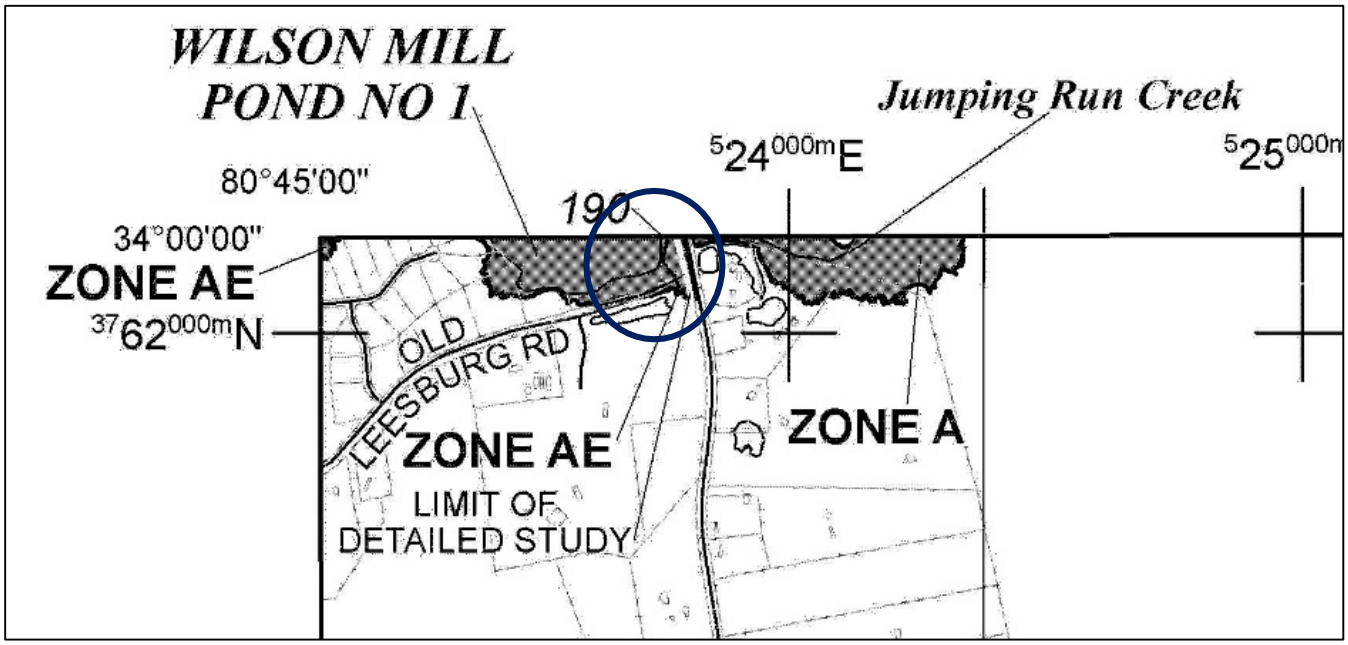

Figure A21.2: Wilson Millpond in blue circle; FIRM is cropped, detailed above

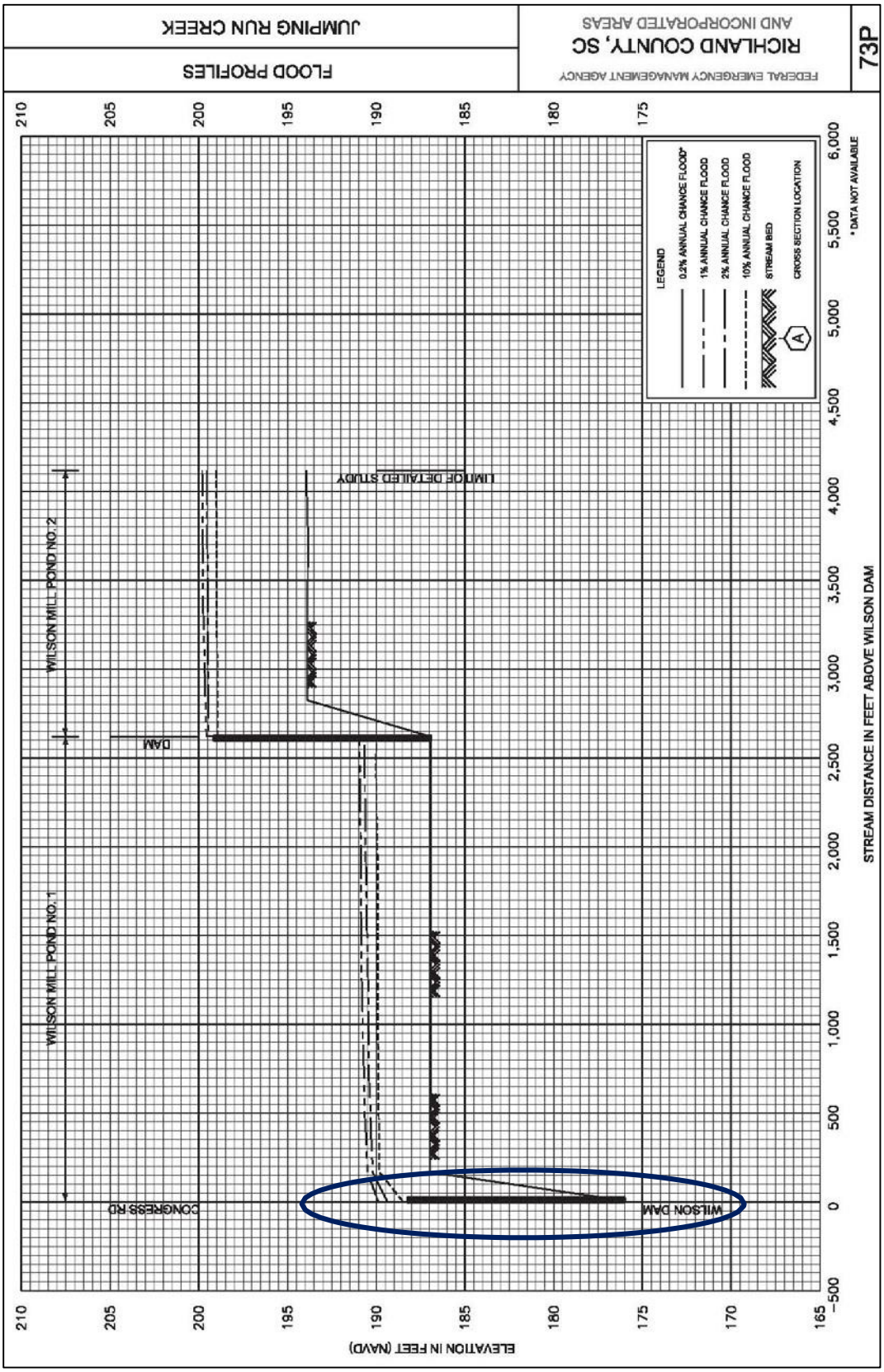

Figure A21.3: FEMA Flood Insurance Flood Profile 73P for Wilson Millpond Dam

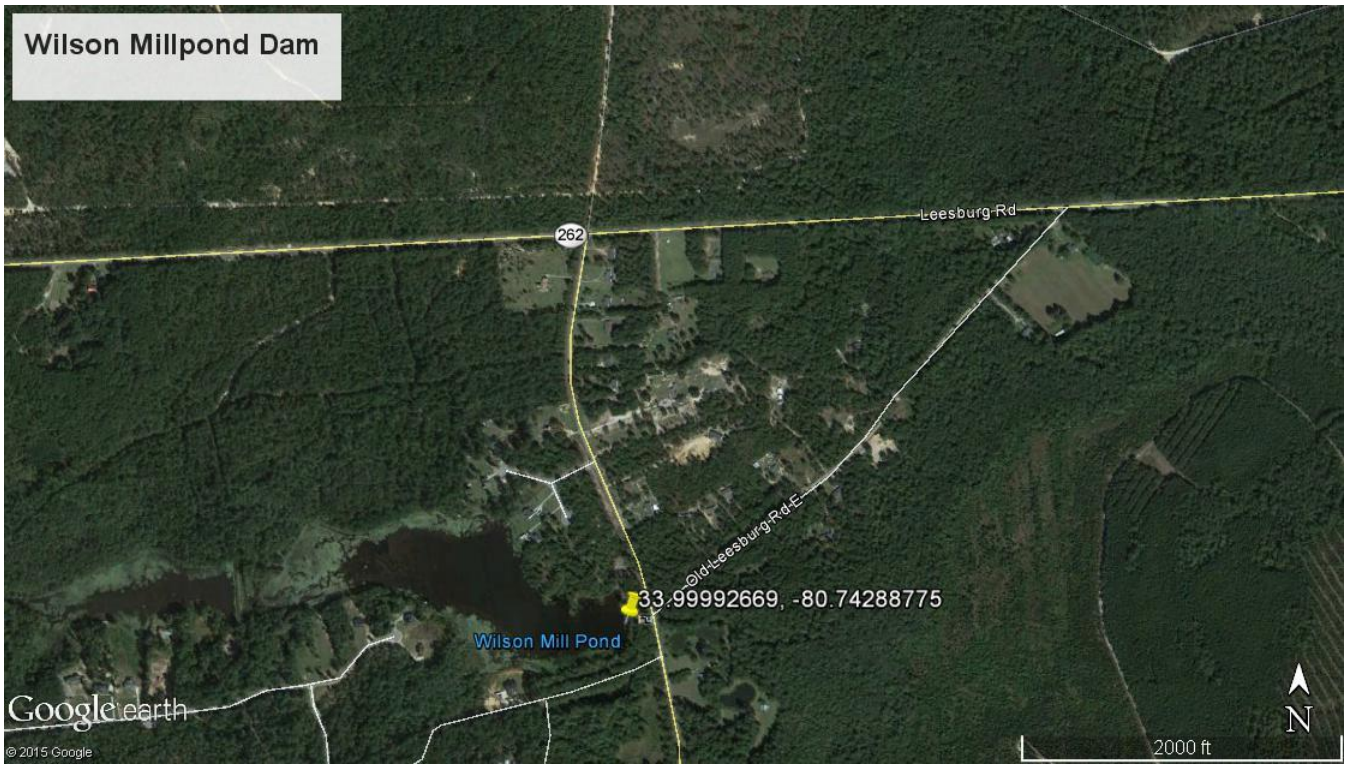

Figure A21.4: Wilson Millpond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A21.5: Wilson Millpond Dam post-event photo; Credit: USACE Bath

General Wilson Millpond Dam Comments

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
  - There is a discrepancy between the NID and SCDHEC classification information.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No Reference to Wilson Millpond Dam.
  - The stream for this dam is listed as Jumping Run Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Jumping Creek shows that Wilson Millpond Pond Dam was included in the model as an in-line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - Based on the Jumping Run Creek Profile, Wilson Millpond Lake Dam would be overtopped in the 1 percent annual chance event by approximately three and a half feet of water.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - There is no label for Weston Pond or Weston Pond Dam.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. This was confirmed by SCDHEC.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam was not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1960 with no date for modifications.
- During the last pre-event inspection, March 2008, for this dam by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the inspector required design plans and supporting information to be submitted for review and approval to repair the dam.
- Wilson Millpond Dam is part of a series of dams along Jumping Run Creek with the nearest dam approximately 2,600 feet upstream.
- According to a dam assessment performed on October 9th by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam failed on the left side.

Considerations for Wilson Millpond Dam

- Consider this dam for further assessment of the original design and construction of the dam and any major rehabilitations, including the design and construction

standards at the time.

- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.
- Consider researching the discrepancy in hazard classification between the NID and SCDHEC.

22) ***State Dam Name: Duffies Pond Dam:*** Latitude: 33.84433294, Longitude: -80.85269049; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	DUFFIES POND DAM	County	Richland
Stream or River	Cedar Creek	Nearest Downstream City/Town	Secondary Road
NID Hazard Class	Low	State Hazard Class*	C2
NID ID	SC00064	State ID	D0600
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1967
Length (ft)	1450	Year Modified	N/A
Drainage Area (sq mi)	25.5	Height (ft)	14
Surface Area (ac)	120	EAP	No
Max Discharge (cfs)	7567	Condition	Not Rated
Max Storage (ac ft)	720	Normal Storage (ac ft)	480
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0550K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A22.1: Duffies Pond Dam pre-event photo; Credit: Google Maps Streetview

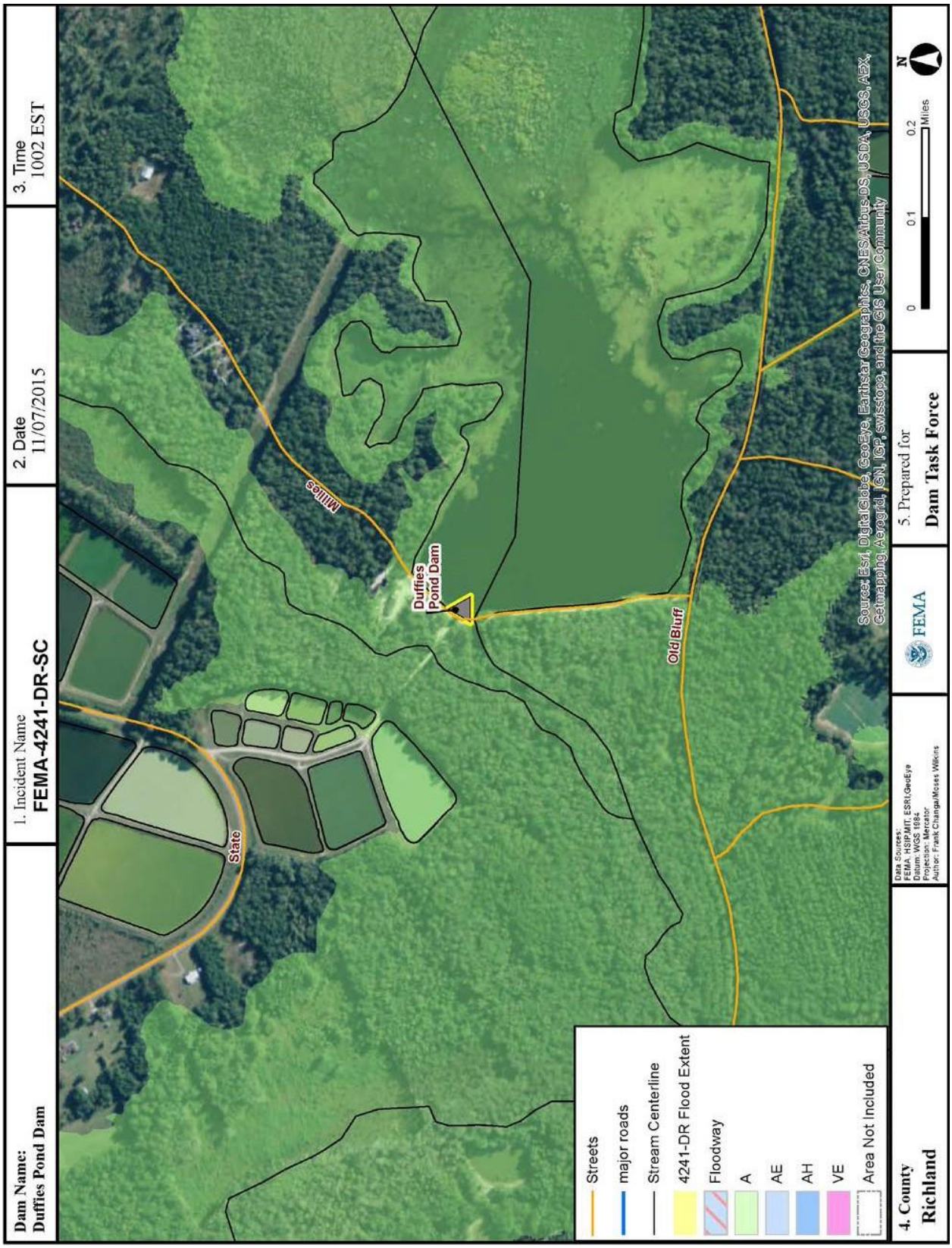

Figure A22.2: Duffies Pond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

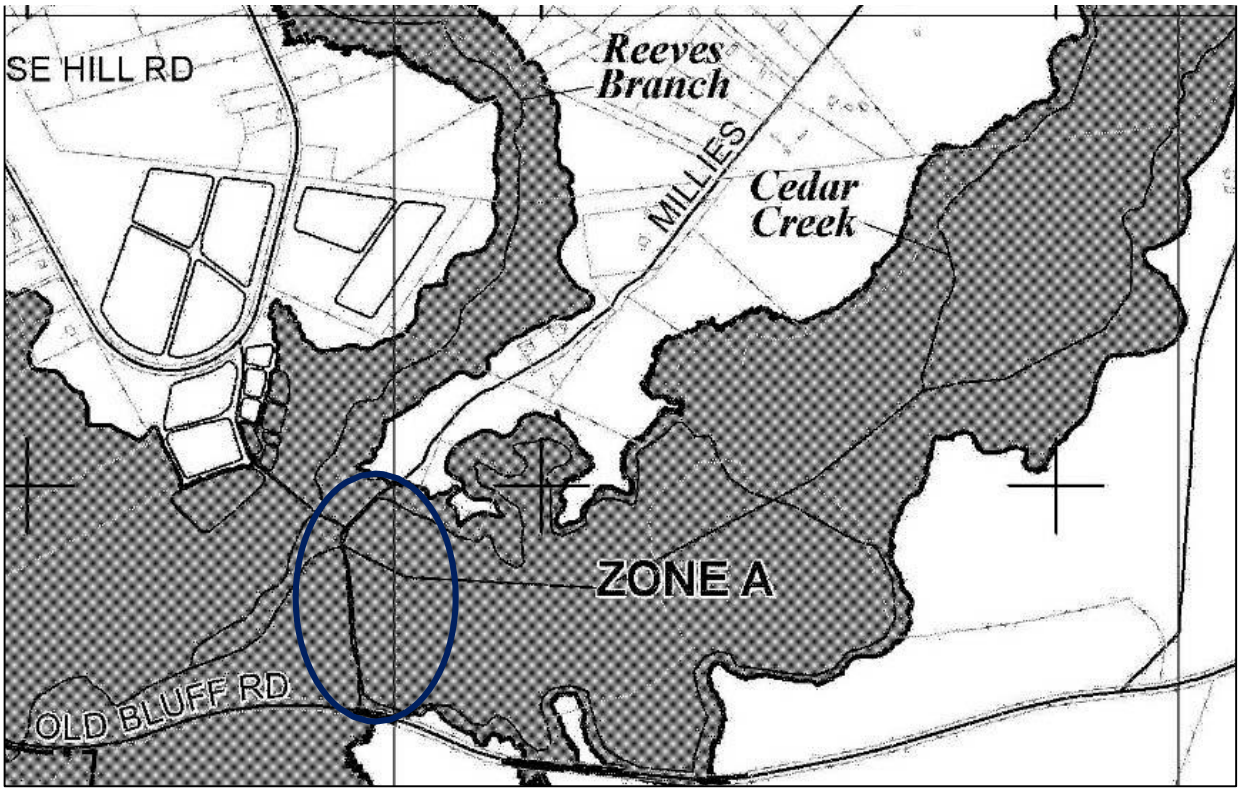

Figure A22.3: Duffies Pond in blue circle; FIRM is cropped, detailed above

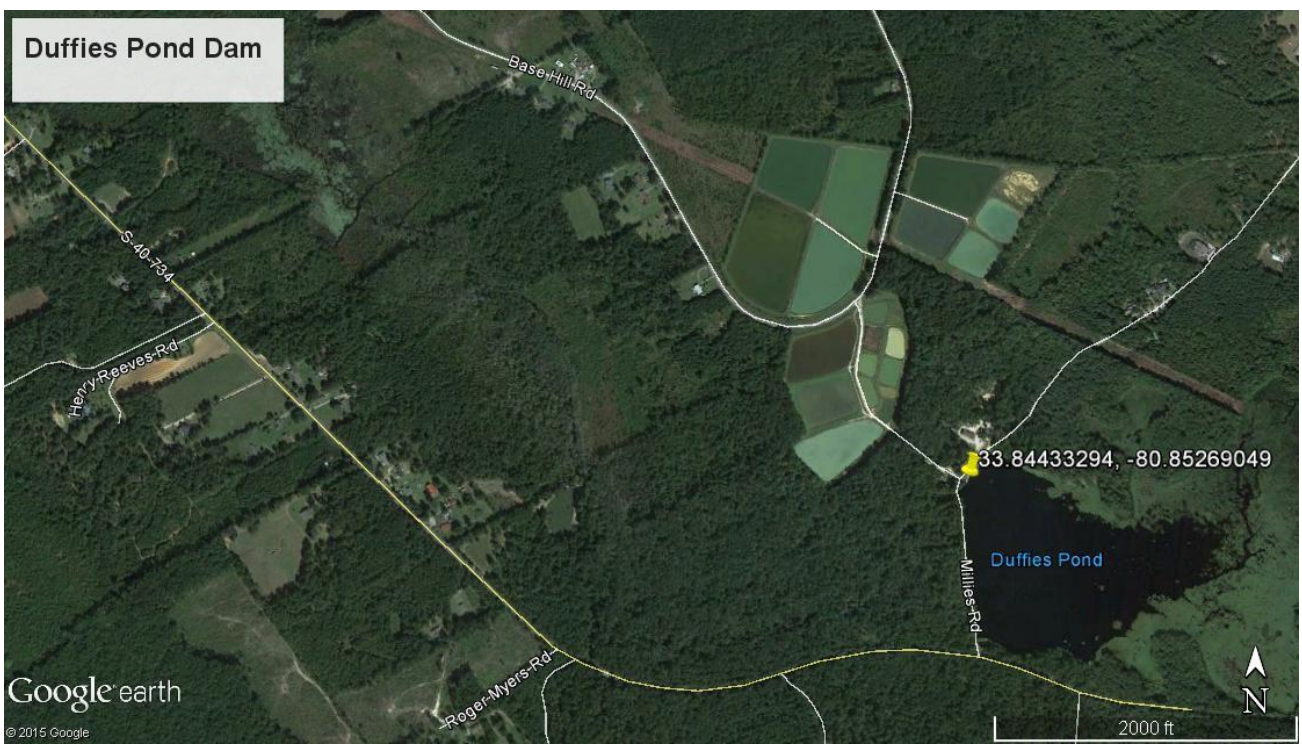

Figure A22.4: Duffies Pond Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A22.5: Duffies Pond Dam post-event photo; Credit: SCDHEC Koon & Nuzum

General Duffies Pond Dam Comments

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-15 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No Reference to Duffies Pond Dam.
  - The stream for this dam is listed as Cedar Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Cedar Creek shows that Duffies Pond Dam was included in the model as an in- line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.

- The Cedar Creek Profile did not extend to Duffies Pond Dam, so the dam was not shown or named.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - There is no label for Weston Pond or Weston Pond Dam.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was no emergency action plan for this dam. SCDHEC confirmed there was no EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam was not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1967 with no modification date populated.
- According to a dam assessment performed on October 22 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the dam was breached and trees were down with erosion. DHEC confirmed on November 5 the dam was fully breached for 200 feet and the pond was almost completely dry except for a small 3-4 foot wide tributary that expands to 8-10 feet at dam breach.

Considerations for Duffies Pond Dam

- Consider this dam for further assessment of the original design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider assessing the dam for probable cause of failure because of this event.

23) ***State Dam Name: Ulmers Pond***; Latitude: 33.968661; Longitude: -80.89535; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	ULMERS POND DAM	County	Richland
Stream or River	Tr-Mill Creek	Nearest Downstream City/Town	Reflections Subdivision
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00065	State ID	D0581
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1940
Length (ft)	420	Year Modified	1994

Drainage Area (sq mi)	3	Height (ft)	17
Surface Area (ac)	17.4	EAP	YES
Max Discharge (cfs)	313	Condition	Satisfactory
Max Storage (ac ft)	96	Normal Storage (ac ft)	64
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0384K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

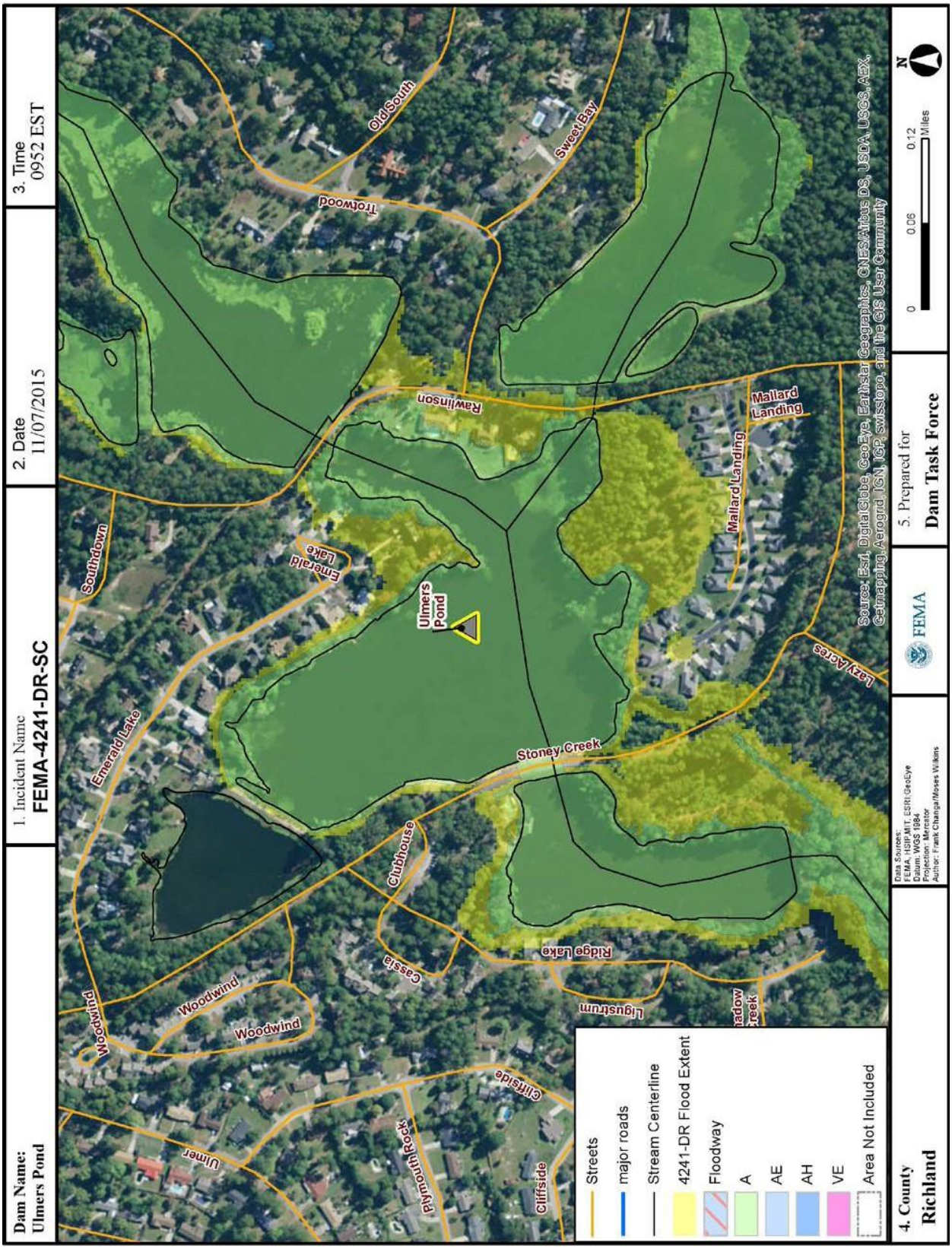

Figure A23.1: Ulmers Pond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

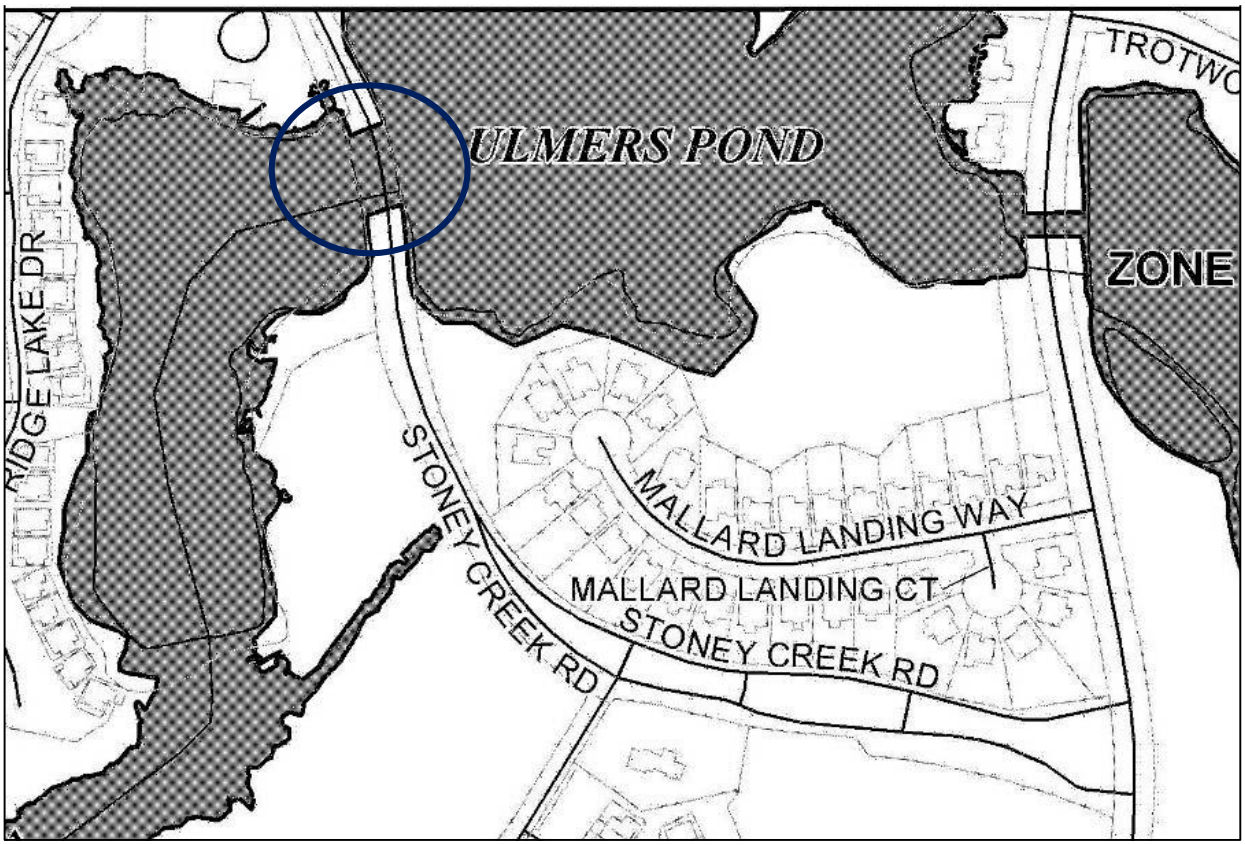

Figure A23.2: Ulmers Pond Dam in blue circle; FIRM is cropped, detailed above

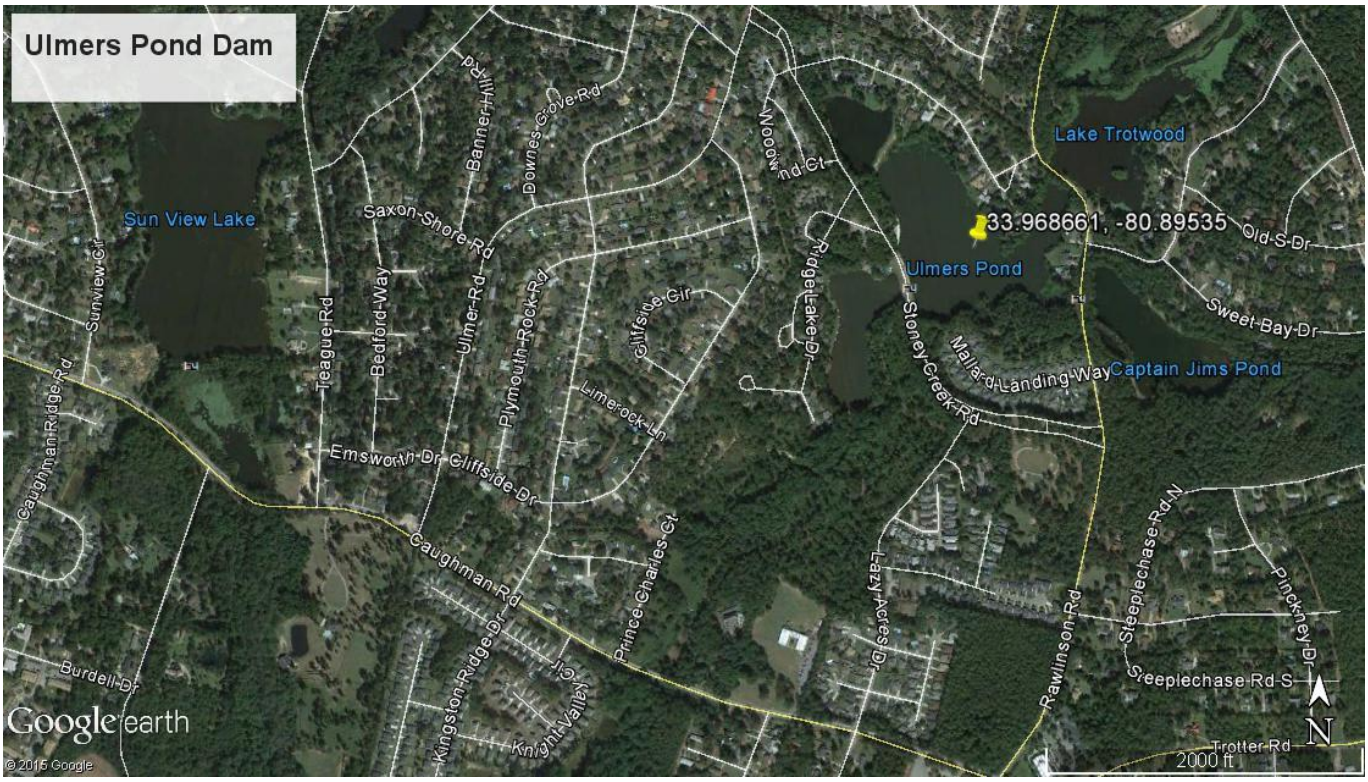

Figure A23.3: Ulmers Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A23.4: Ulmers Pond Dam post-event photo; Credit: USACE Bath

General Ulmers Pond Dam Comments

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Ulmers Pond Dam.
  - The stream for this dam is listed as Mill Creek Tributary 1. The National Inventory of Dams lists the stream as Tr-Mill Creek.
  - Information regarding the hydrologic and hydraulic modeling of Mill Creek Tributary 1 shows that Ulmers Dam was included in the model as an in- line weir. This indicates that the model assumed there was no outlet control structure on the dam and that the water would flow over the dam as if it were a weir.
  - The Mill Creek Tributary 1 Flood Profile does not extend to Ulmers Pond Dam, so this dam is not shown or named on the profile.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled. Ulmers Pond is labeled by name.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. SCDHEC confirmed this dam has an EAP.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County and Forest Acres have adopted. This dam was not referenced by name in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1940 with the year modified as 1994.
- During the last pre-event inspection, December 2014, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the inspector recommended that grass be added to bare spots on upstream slope.
- Ulmers Pond Dam is part of a series of dams along Mill Creek and the tributaries to Mill Creek with two lakes immediately upstream.
- High water marks for this flood event were collected by USGS downstream of this dam failure.
- According to a dam assessment performed on October 7 by USACE through a FEMA Mission Assignment to provide technical advice to SCDHEC, the downside of the dam breached.

Considerations for Ulmers Pond Dam

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for comparison of dam breach modeling results (HEC- RAS,

DSS-WISE, FLO-2D, etc.) to high water mark inundation downstream.

- Consider this dam for further assessment of the original design and construction of the dam and any major modifications, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.

24) ***State Dam Name: Sunview Lake Dam;*** Latitude: 33.96735 Longitude: -80.91163; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SUNVIEW LAKE	County	Richland
Stream or River	Mill Creek	Nearest Downstream City/Town	Lykesland
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00067	State ID	D0579
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1949
Length (ft)	2700	Year Modified	N/A
Drainage Area (sq mi)	6.54	Height (ft)	11
Surface Area (ac)	45	EAP	Yes
Max Discharge (cfs)	260	Condition	Not Rated
Max Storage (ac ft)	234	Normal Storage (ac ft)	144
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0383K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

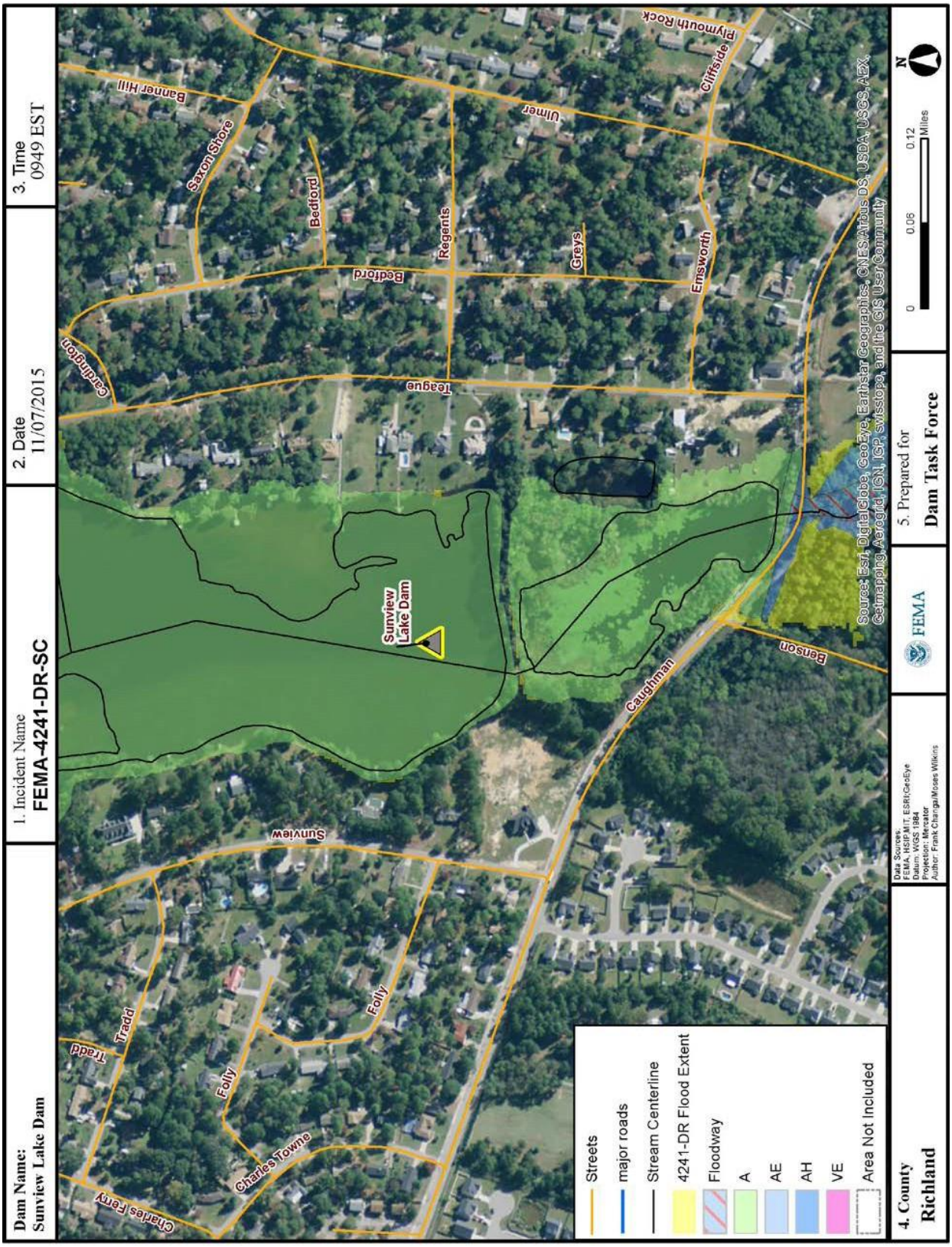

Figure A24.1: Sunview Lake Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

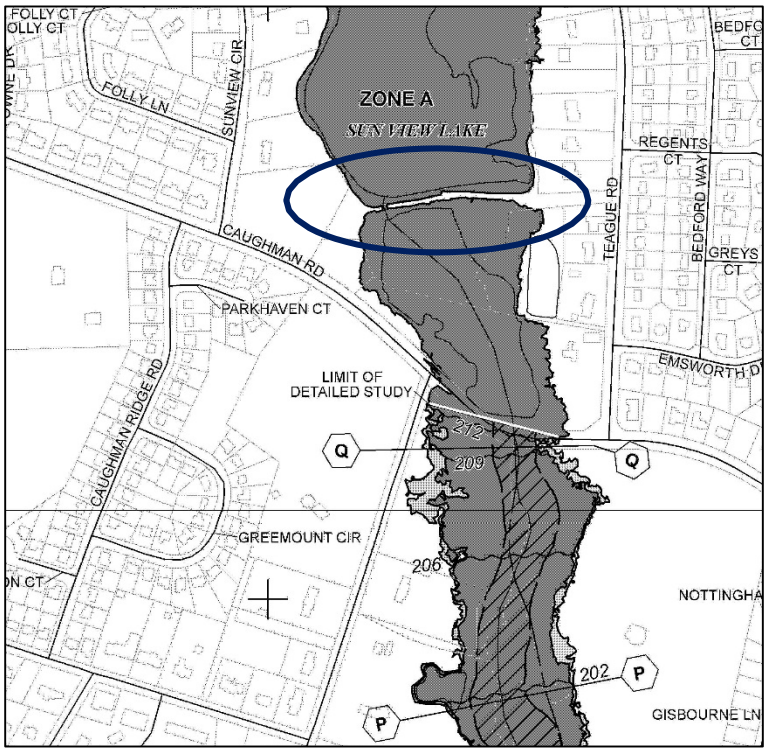

Figure A24.2: Sunview Lake Dam in blue circle; FIRM is cropped; detailed above

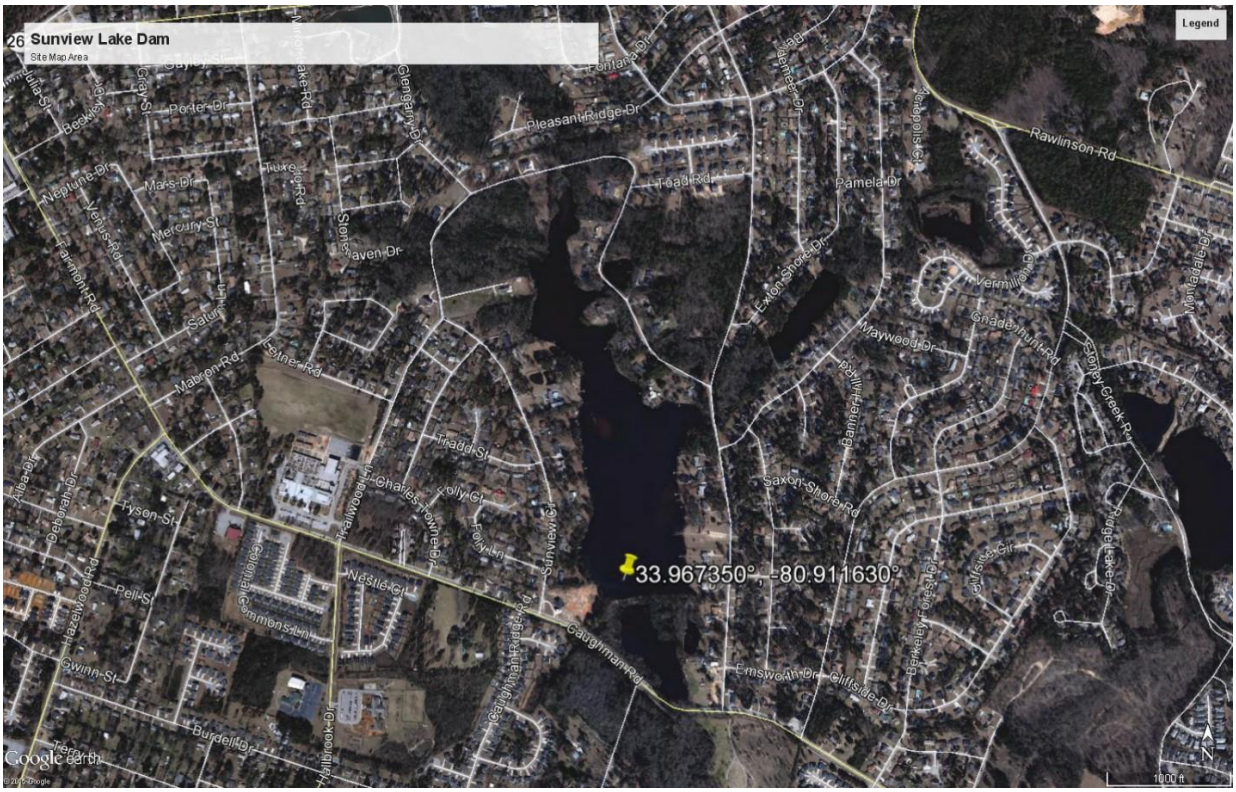

Figure A24.3: Sunview Lake Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

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General Sunview Lake Dam Comments

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Lake Sunview Dam.
  - The stream for this dam is listed as Mill Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - The limit of detailed study along Mill Creek ends downstream of the dam at Caughman Road.
  - Based on the Mill Creek Profile from the latest FEMA Flood Insurance Study, Sunview Lake Dam is located outside of the limit of detailed study and is located in a Zone A.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled as 'Dam'. Sunview Lake is labeled as "Sun View Lake".
- The National Inventory of Dams shows this dam as an earthen dam.

- Based on information from SCDHEC, there was an emergency action plan for this dam. This is consistent with the NID having an EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is not referenced by name in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1949 with no date for modifications populated.
- During the last pre-event inspection, September 2014, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in good condition.
- USACE on an October 8th assessment noted trees have fallen near right side of the dam and taken material from approximately 60 feet of the downstream slope. There was evidence of significant overtopping during flood event with lots of trees on both slopes. The trash racks were noted to have debris problems. On October 9th, a SCDHEC inspection noted Sunview has not fully breached and will if water levels are not kept down. If it sits at normal pool, it will breach. On October 10th SCDHEC noted that boards were removed from the spillway, there was 2-3 feet of freeboard, and the spillway was cleared. USACE noted on October 22nd that the dam was breached in two locations and had overtopped. There was severe downstream erosion & downed trees. The reservoir was still holding significant pool but the inlet was working properly with good flow. The spillway was undamaged and appeared to have functioned properly. SCDHEC stated on November 5th that the water level in the pond had been lowered an additional foot since last week. The spillway output was running at about half pipe at the exit and there were signs of shallow cracks on the dam crest (potential former animal burrowing) and areas from rotted tree roots.

<u>Considerations for Sunview Lake Dam</u>

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure as a result of this event, to include whether the heavy vegetation on both sides, including the trees, were contributing factors to the failure of this dam because of this event.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.

14.25) ***State Dam Name: Lower Rocky Ford Dam /Rocky Ford Lake;*** Latitude: 34.036033, Longitude: -80.952343; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 40026	County	Richland
Stream or River	Gills Creek	Nearest Downstream City/Town	Forest Acres
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00069	State ID	D0028
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1900
Length (ft)	260	Year Modified	N/A
Drainage Area (sq mi)	22.5	Height (ft)	20
Surface Area (ac)	21	EAP	Yes
Max Discharge (cfs)	1730	Condition	Satisfactory
Max Storage (ac ft)	230	Normal Storage (ac ft)	118
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0262K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A25.1: Lower Rocky Ford Dam /Rocky Ford Lake Dam pre-event photo; Credit: Google Maps Streetview

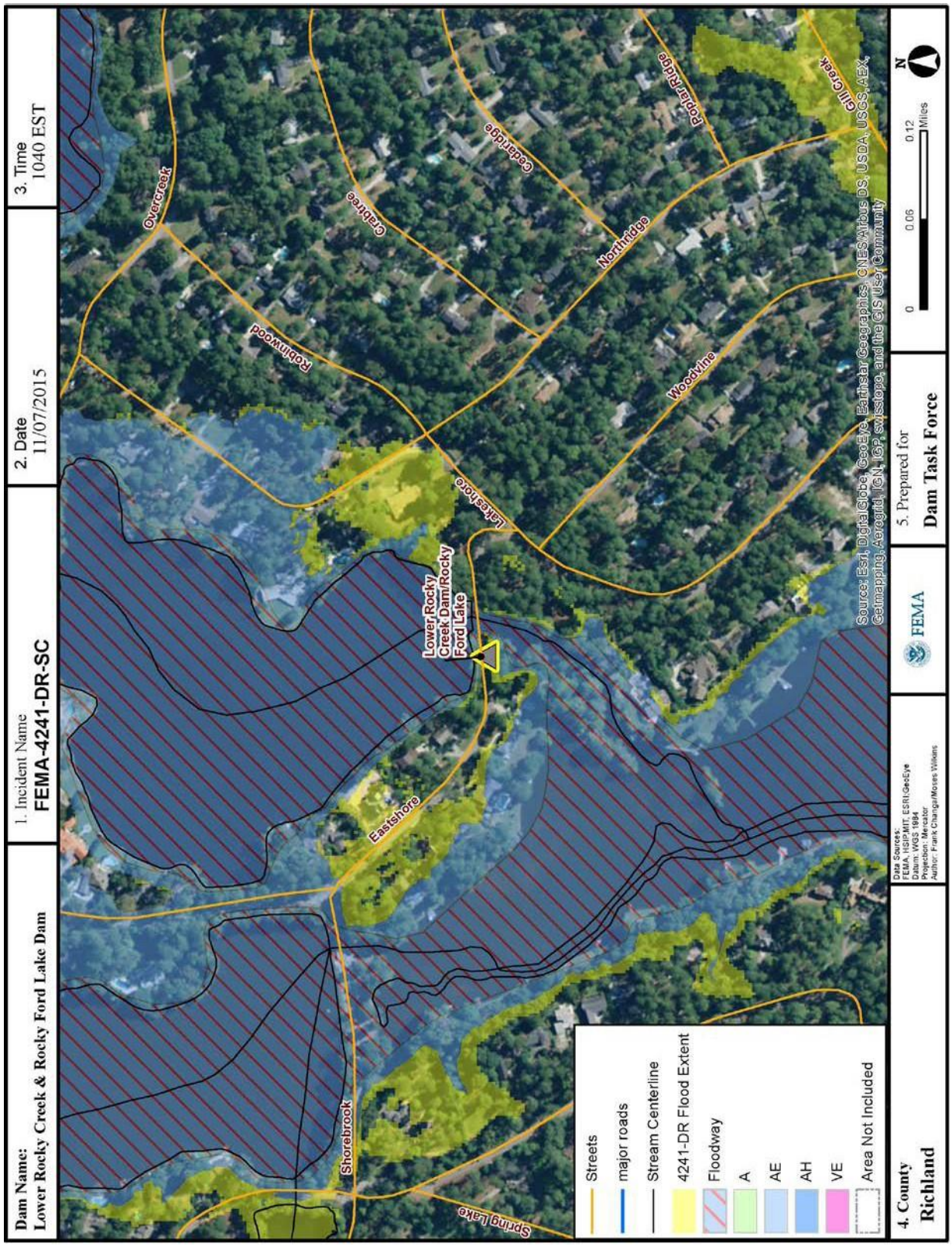

Figure A25.2: Lower Rocky Ford Dam /Rocky Ford Lake FEMA Flood Zone and 4241DR Flood Extent Overlay Map

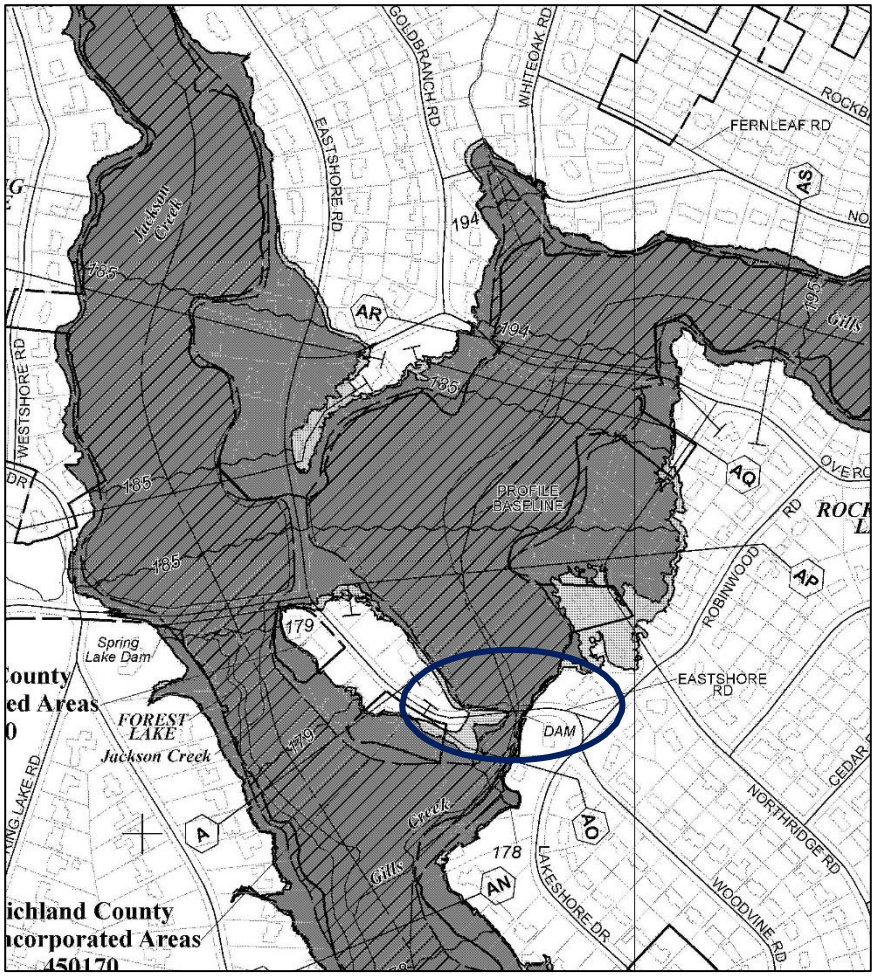

Figure A25.3: Lower Rocky Ford Dam /Rocky Ford Lake in blue circle; FIRM is cropped; detailed above

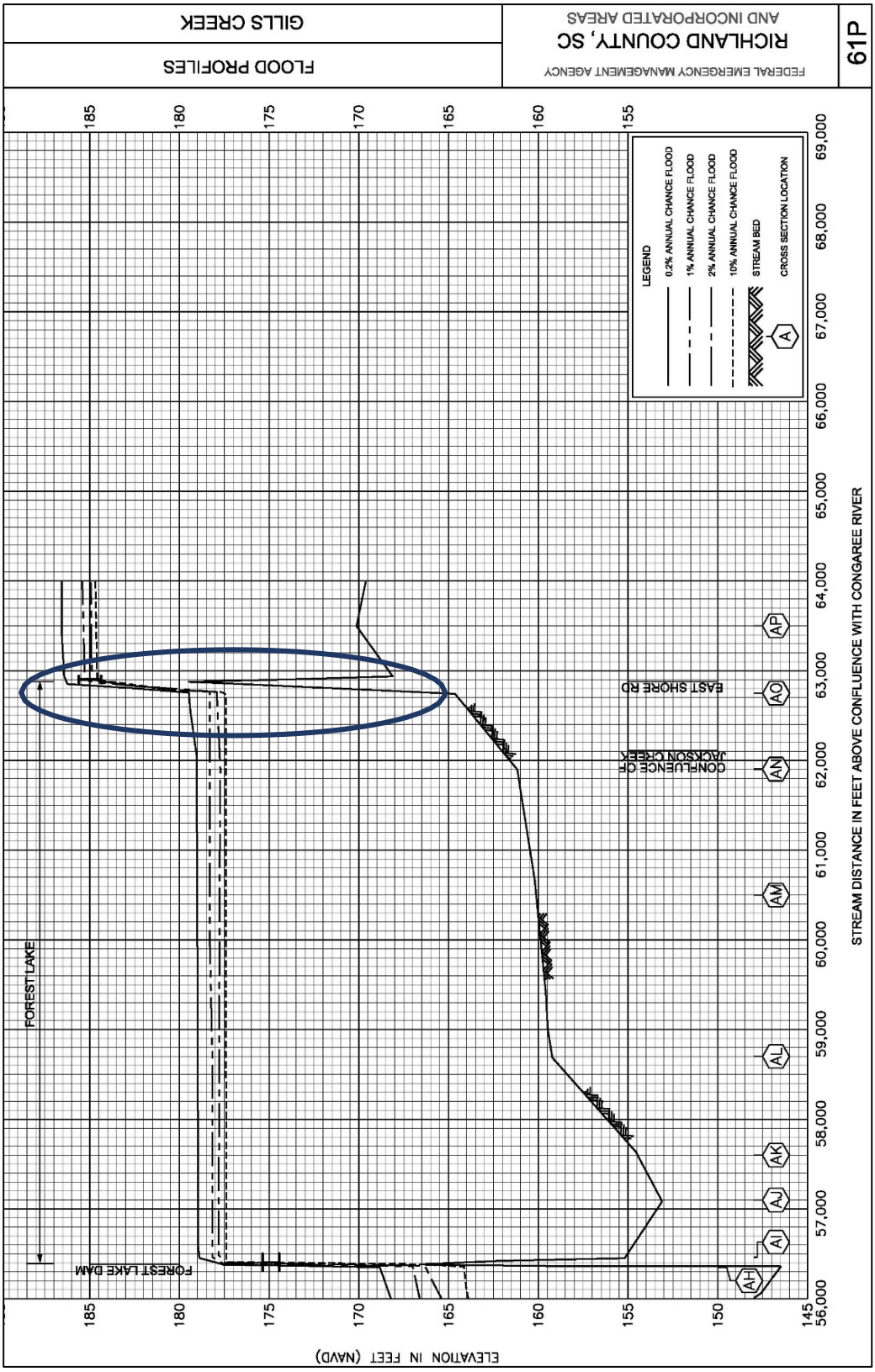

Figure A25.4 FEMA Flood Insurance Flood Profile 61P for Lower Rocky Ford Dam /Rocky Ford Lake

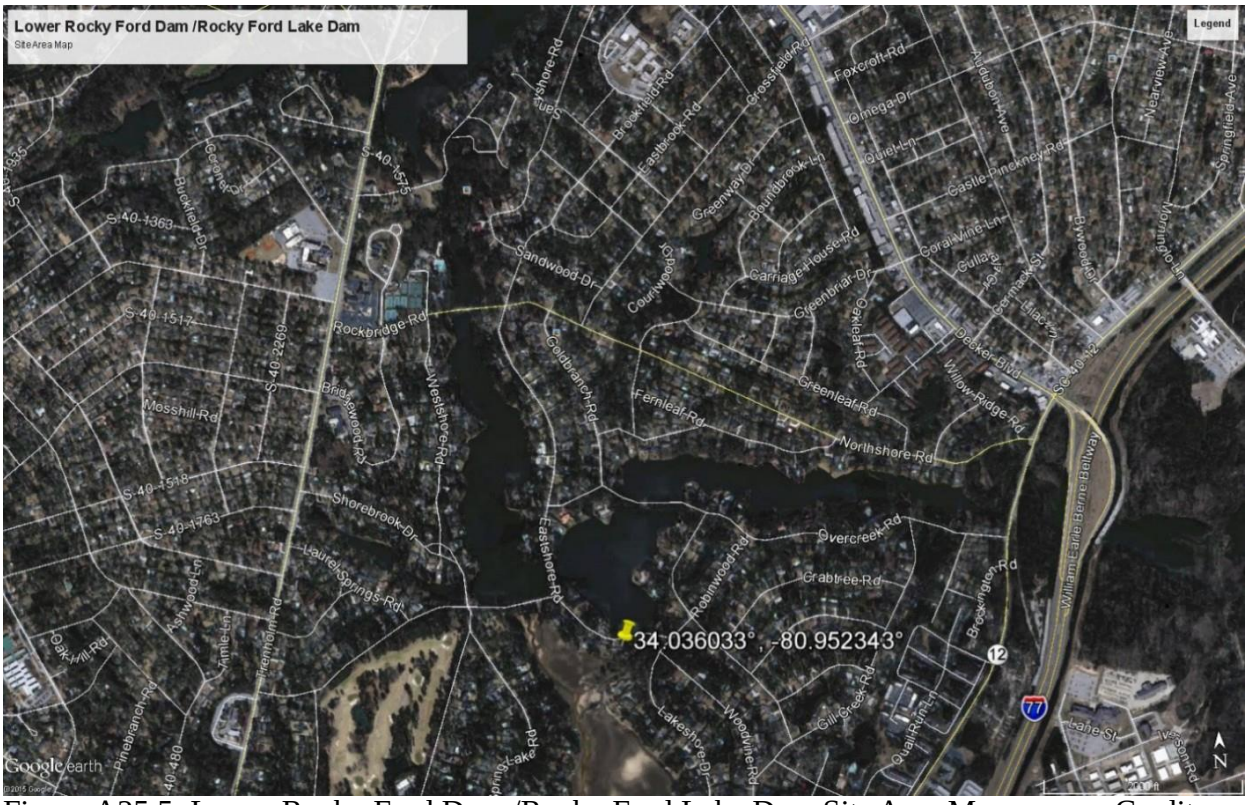

Figure A25.5: Lower Rocky Ford Dam /Rocky Ford Lake Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A25.6: Lower Rocky Ford Dam / Rocky Ford Lake post-event photo; Credit: FEMA-Plisich

General Comments on Lower Rocky Ford Dam / Rocky Ford Lake

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are two pictures from the Civil Air Patrol of this dam. Both are of the dam and its emergency spillway.
- The GIS map shows that there may be HWM inundation areas available downstream of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Rocky Ford Dam / Rocky Ford Lake.
  - The stream for this dam is listed as Gills Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Gills Creek shows that Rocky Ford Dam/Rocky Ford Lake was included in the model as an inline weir and a bridge. The following was stated on page 22 (pdf page 28): *"Within the unincorporated areas of Richland County and the City of Columbia, watersurface elevations for the following streams were computed using the HEC-2 stepbackwater computer program and the HEC-l Dam Break Program (References 25 and 11): Gills Creek, Crane Creek, Stoop Creek, Nicholas Creek, Swygert Branch, Moccasin Branch, North Branch Crane Creek, Beasley Creek, Cumbess Creek, Roberts Branch, Tributary RB-l, Sorghum Branch, Spears Creek, Tributary SP-l, Sandy Branch, Bridge Creek, Rice Creek, Reeder Point Branch, Tributary RP-l, Smith Branch, and Bay Branch. The HEC-2 model was first used to develop elevation-discharge ratings for dams and other hydraulic structures. The HEC-l model was used to route the various floods through the reservoirs and determine the amount of overtopping that would occur at each structure. Criteria contained in Reference 26 were used to determine the amount of overtopping necessary to cause failure and the size and shape of the breach."*
  - Based on the Gills Creek Profile from the latest FEMA Flood Insurance Study, Rocky Ford Lake Dam would have the spillway activated but the road would not be overtopped in the 1 percent annual chance event.
  - The following is stated on page 9 (pdf page 15):
    "*The flood problems along Gills Creek are compounded by a number of large and small lakes formed by dams across Gills Creek and two tributary streams, Jackson Creek and Little Jackson Creek. In the past some of these dams have failed and others have been purposely breached to prevent failure. Results indicate that Lake Katherine Dam, Forest Lake*

Dam and several other dams upstream from Forest Lake would fail during floods of50-year frequency or greater. Dam failures in the upper basin would increase peak flood discharges at Forest Lake and Lake Katherine, but results indicate that both dams would fail during floods of 50-year frequency or greater even if none of the upstream dams failed. Both Forest Lake Dam and the Lake Katherine Dam failed during major floods in the 1940's and were rebuilt or repaired under military supervision. At the time these events occurred, there was very little development in the downstream floodplain. A major flood under existing conditions would overtop Forest Lake Dam and Lake Katherine Dam. The high water velocities would erode the downstream faces of both dams, causing them to fail. The combined effect of deep flooding and high-water velocities would result in extensive damage to homes, commercial structures and other facilities between Forest Lake and Garners Ferry Road"

- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as '*Dam*'. Rocky Ford Lake is labeled as "*Rockyford Lake*".
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from SCDHEC, there was an emergency action plan for this dam. This is consistent with the NID showing an EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Lower Rocky Ford Dam / Rocky Ford Lake is listed in a table of dams in this Gills Creek Watershed Flood Mitigation Plan.
- The National Inventory of Dams records this dam as completed in 1900 with no modifications recorded.
- During the last pre-event inspection, August 2015, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in fair condition and had the following requirements to be met: clearing of vegetation and trees with permit if applicable and update of EAP.
  - SCDHEC noted on October 5th 2015 that a report from the Home Owner's Association and photos showed the dam was not yet breached but failure was imminent. The Road was closed and blocked by downed trees. On October 6th the dam had failed. A USACE assessment on October 22nd noted the dam was breached and water was not pooling behind the box culvert intake. The river was observed to be stable. On October 29th SCDHEC confirmed the dam was still breached and had extreme erosion on the back side and reconfirmed on November 6th the dam was still breached.

- The outlet gate was closed when Dam Task Force members visited this site. It is unclear whether the outlet gate was operable or whether the outlet gate was opened prior to the event to lower the reservoir level.

Considerations Lower Rocky Ford Dam / Rocky Ford Lake

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for comparison of dam breach modeling results (HEC- RAS, DSS-WISE, FLO-2D, etc.) to high water mark inundation downstream.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider further research into whether or not the outlet was operational at the time of this disaster and whether or not it was operated during this event.

26) ***State Dam Name: Upper Rocky Creek/ North Lake/Overcreek Rd.*** Latitude: 34.040808 Longitude: -80.951982; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	SCNONAME 40027	County	Richland
Stream or River	Gills Creek	Nearest Downstream City/Town	Forest Acres
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00070	State ID	D0029
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1955
Length (ft)	700	Year Modified	N/A
Drainage Area (sq mi)	22.4	Height (ft)	20
Surface Area (ac)	25	EAP	Yes

Max Discharge (cfs)	2438	Condition	Satisfactory
Max Storage (ac ft)	297	Normal Storage (ac ft)	138
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0262K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A26.1: Upper Rocky Creek/ North Lake/Overcreek Rd. Dam pre-event photo; Credit: Google Maps Streetview

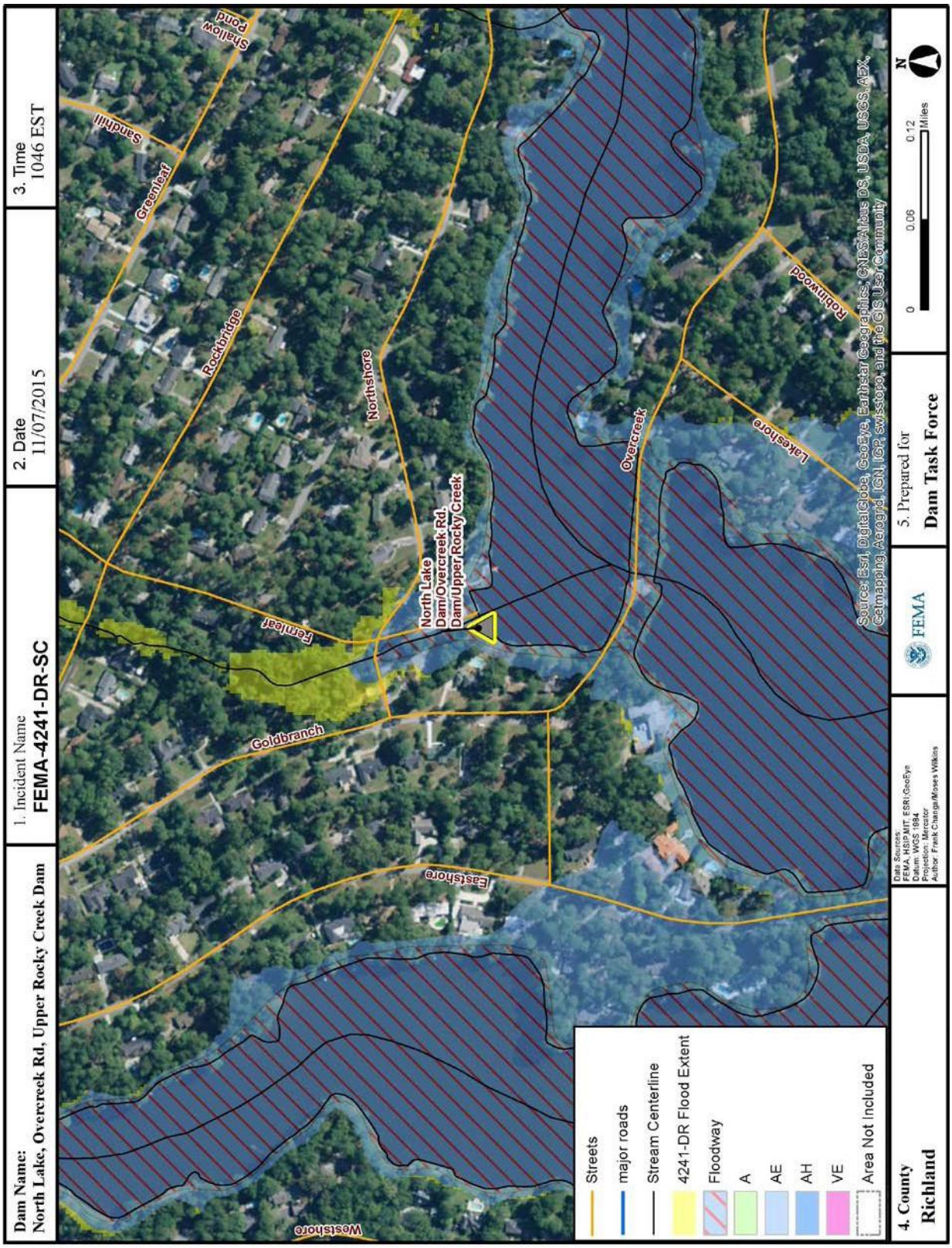

Figure A26.2: Upper Rocky Creek/ North Lake/Overcreek Rd FEMA Flood Zone and 4241DR Flood Extent Overlay Map

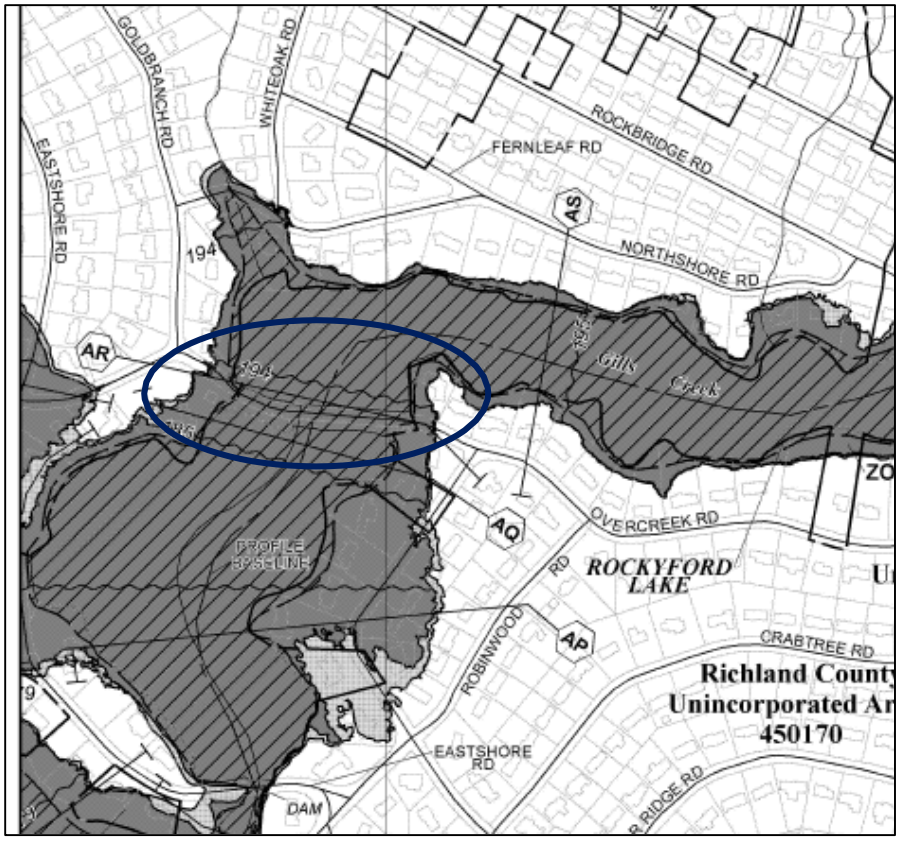

Figure A26.3: Upper Rocky Creek/ North Lake/Overcreek Rd**.** in blue circle; FIRM is cropped; detailed above

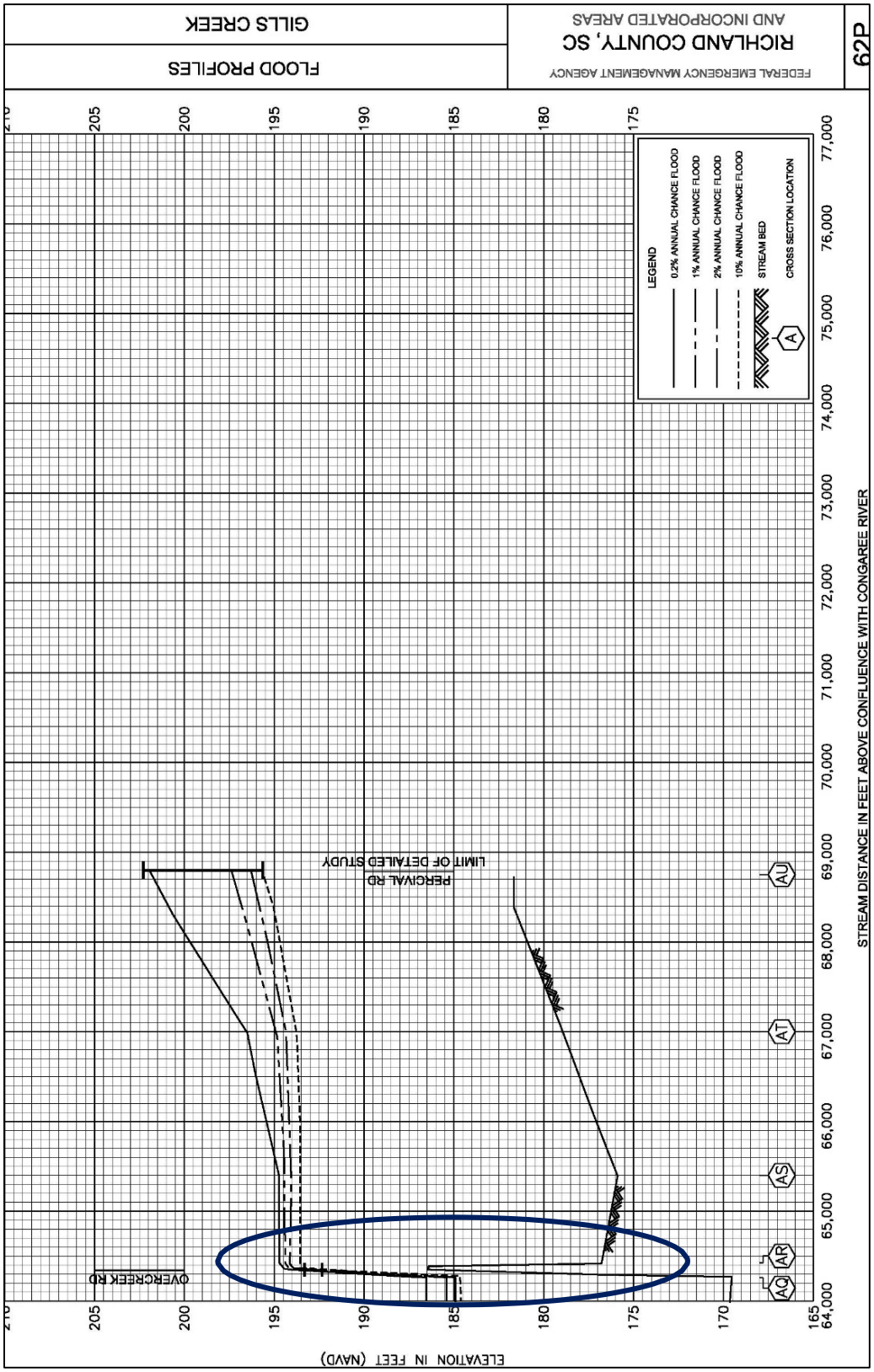

Figure A26.4 FEMA Flood Insurance Flood Profile 62P for Upper Rocky Creek/ North Lake/Overcreek Rd.

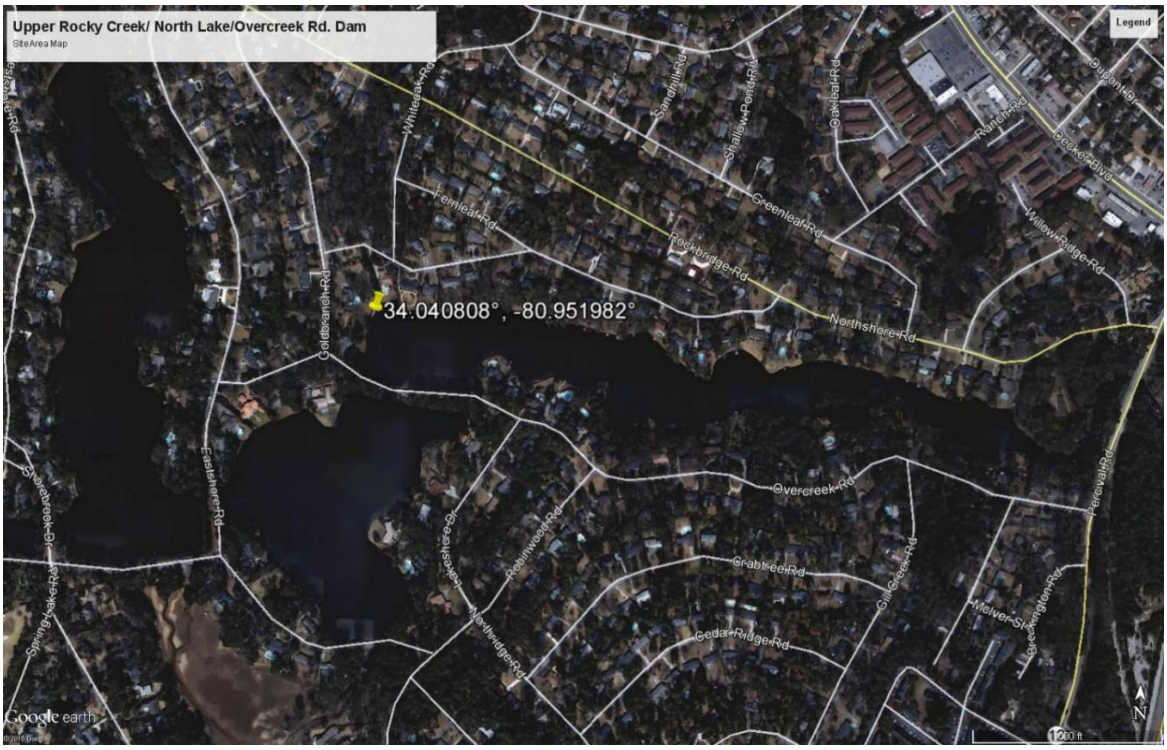

Figure A26.5: Upper Rocky Creek/ North Lake/Overcreek Rd. Dam_Site Area Map
Credit: Map data: 2015 Google; Google Earth

Figure A26.6: Upper Rocky Creek/ North Lake/Overcreek Rd. post-event photo; Credit: SCDHEC; Blalock

General Comments on Upper Rocky Creek/ North Lake/Overcreek Rd

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are 2 pictures from the Civil Air Patrol of this dam. Both are of the failed dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Rocky Ford Dam / Rocky Ford Lake.
  - The FIS profile does not recognize this as a dam. This structure is shown as Overcreek Road on Flood Profile 62P.
  - The stream for this dam is listed as Gills Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Gills Creek shows that Rocky Ford Dam/Rocky Ford Lake was included in the model as an inline weir and a bridge. The following was stated on page 22 (pdf page 28): "*Within the unincorporated areas of Richland County and the City of Columbia, watersurface elevations for the following streams were computed using the HEC-2 stepbackwater computer program and the HEC-l Dam Break Program (References 25 and 11): Gills Creek, Crane Creek, Stoop Creek, Nicholas Creek, Swygert Branch, Moccasin Branch, North Branch Crane Creek, Beasley Creek, Cumbess Creek, Roberts Branch, Tributary RB-l, Sorghum Branch, Spears Creek, Tributary SP-l, Sandy Branch, Bridge Creek, Rice Creek, Reeder Point Branch, Tributary RP-l, Smith Branch, and Bay Branch.*
    The HEC-2 model was first used to develop elevation-discharge ratings for dams and other hydraulic structures. The HEC-l model was used to route the various floods through the reservoirs and determine the amount of overtopping that would occur at each structure. Criteria contained in Reference 26 were used to determine the amount of overtopping necessary to cause failure and the size and shape of the breach."
  - Based on the Gills Creek Profile from the latest FEMA Flood Insurance Study, Upper Rocky Creek/North Lake/Overcreek Rd would be overtopped in the 1 perecent annual chance event by approximately one foot.
  - The following is stated on page 9 (pdf page 15):
    "*The flood problems along Gills Creek are compounded by a number of large and small lakes formed by dams across Gills Creek and two tributary streams, Jackson Creek and Little Jackson Creek. In the past some of these dams have failed and others have been purposely breached to prevent failure. Results indicate that Lake Katherine Dam, Forest Lake*

Dam and several other dams upstream from Forest Lake would fail during floods of 50-year frequency or greater. Dam failures in the upper basin would increase peak flood discharges at Forest Lake and Lake Katherine, but results indicate that both dams would fail during floods of 50-year frequency or greater even if none of the upstream dams failed. Both Forest Lake Dam and the Lake Katherine Dam failed during major floods in the 1940's and were rebuilt or repaired under military supervision. At the time these events occurred, there was very little development in the downstream floodplain. A major flood under existing conditions would overtop Forest Lake Dam and Lake Katherine Dam. The high water velocities would erode the downstream faces of both dams, causing them to fail. The combined effect of deep flooding and high-water velocities would result in extensive damage to homes, commercial structures and other facilities between Forest Lake and Garners Ferry Road"

- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled. Upper Rock Creek/North Lake is not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. SCDHEC confirmed this dam has an EAP.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Upper Rocky Creek / North Lake / Overcreek Rd. is listed in a table of dams in this Gills Creek Watershed Flood Mitigation Plan.
- The National Inventory of Dams records this dam as completed in 1955 with no modifications indicated.
- During the last pre-event inspection, August 2015, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in satisfactory condition and had the following requirements to be met: clearing of vegetation and trees with permit if applicable, establish grass cover, remove pine straw, and pack holes.
- A SCDHEC inspection on October 5 confirmed a report by SCEMD that this dam failed. SCDHEC reconfirmed on November 6 the dam was still breached and Creek run from Boyden Arbor continued to flow through area where the dam was located.

<u>Considerations Upper Rocky Creek / North Lake / Overcreek Rd.:</u>

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for comparison of dam breach modeling results (HEC- RAS, DSS-WISE, FLO-2D, etc.) to high water mark inundation downstream.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

27) ***State Dam Name: Walden Place Dam***; Latitude: 34.11678, Longitude: -80.84591; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	WALDEN PLACE POND	County	Richland
Stream or River	Spears Creek	Nearest Downstream City/Town	Pontiac
NID Hazard Class	High	State Hazard Class*	C1
NID ID	SC00073	State ID	D0572
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1950
Length (ft)	850	Year Modified	N/A
Drainage Area (sq mi)	2.8	Height (ft)	25
Surface Area (ac)	8	EAP	Yes
Max Discharge (cfs)	120	Condition	Not Rated
Max Storage (ac ft)	280	Normal Storage (ac ft)	224
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0280K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A27.1: Walden Place Dam pre-event photo; Credit: Google Maps Streetview

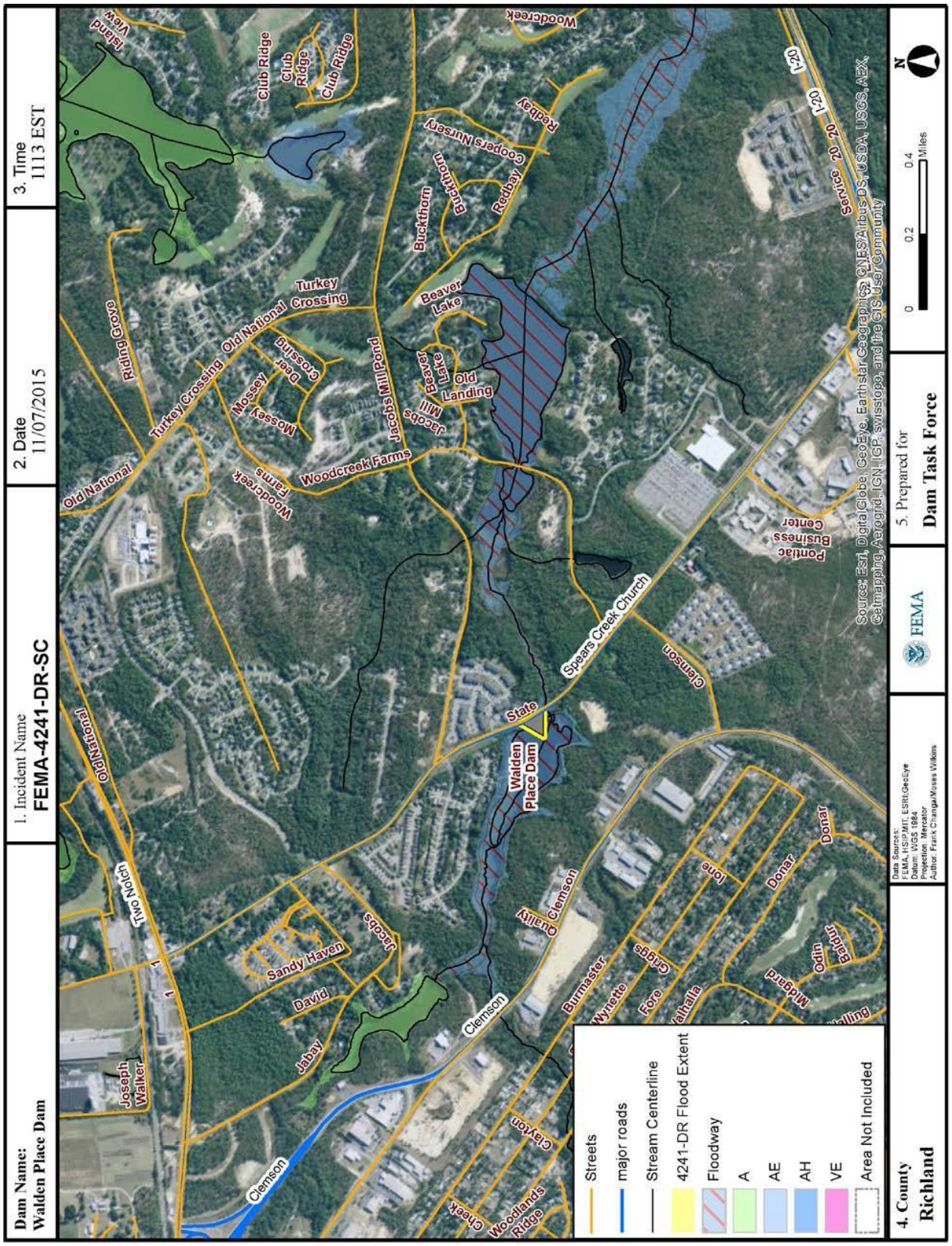

Figure A27.2: Walden Lake Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

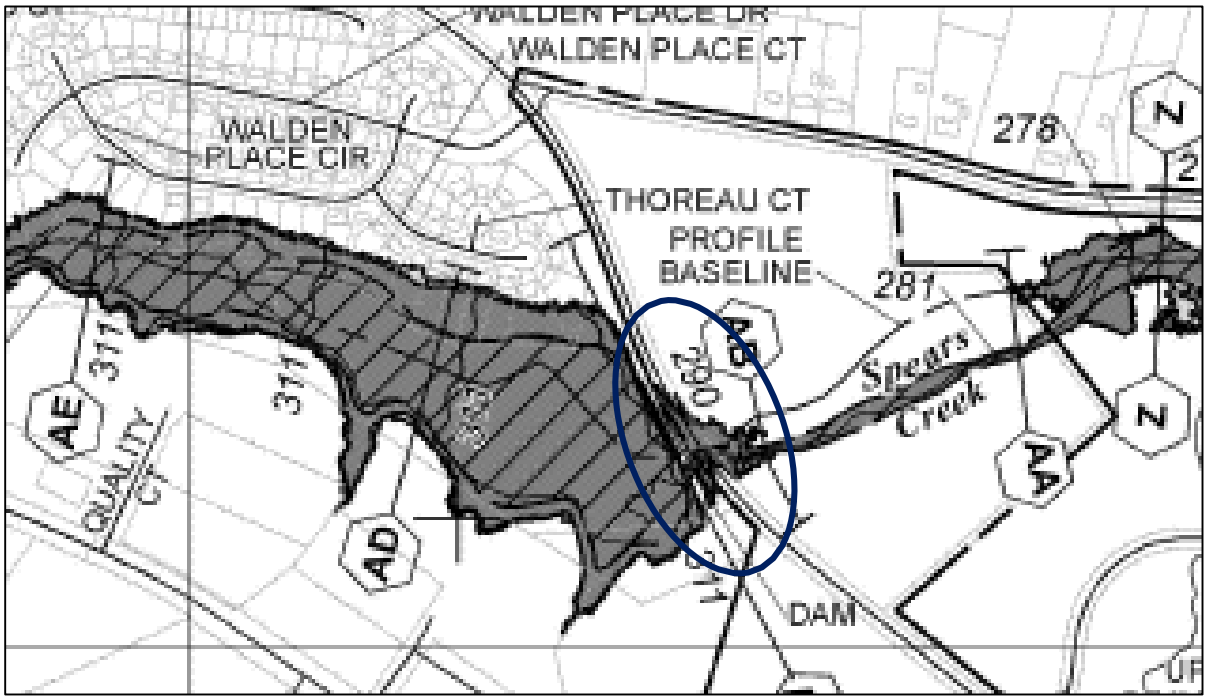

Figure A27.3: Walden Lake Dam in blue circle; FIRM is cropped; detailed above

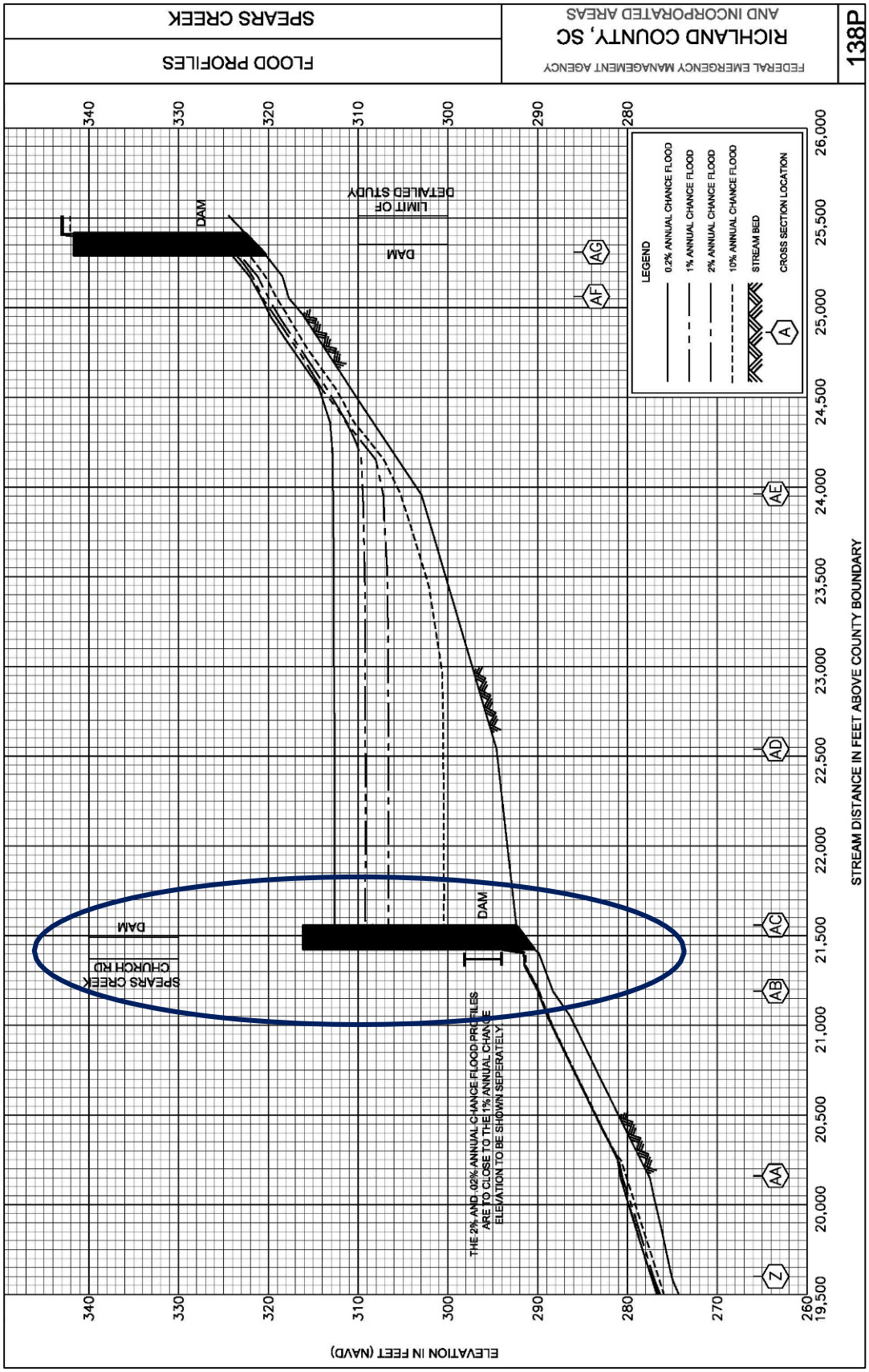

Figure A27.4 FEMA Flood Insurance Flood Profile 138P for Walden Place Dam

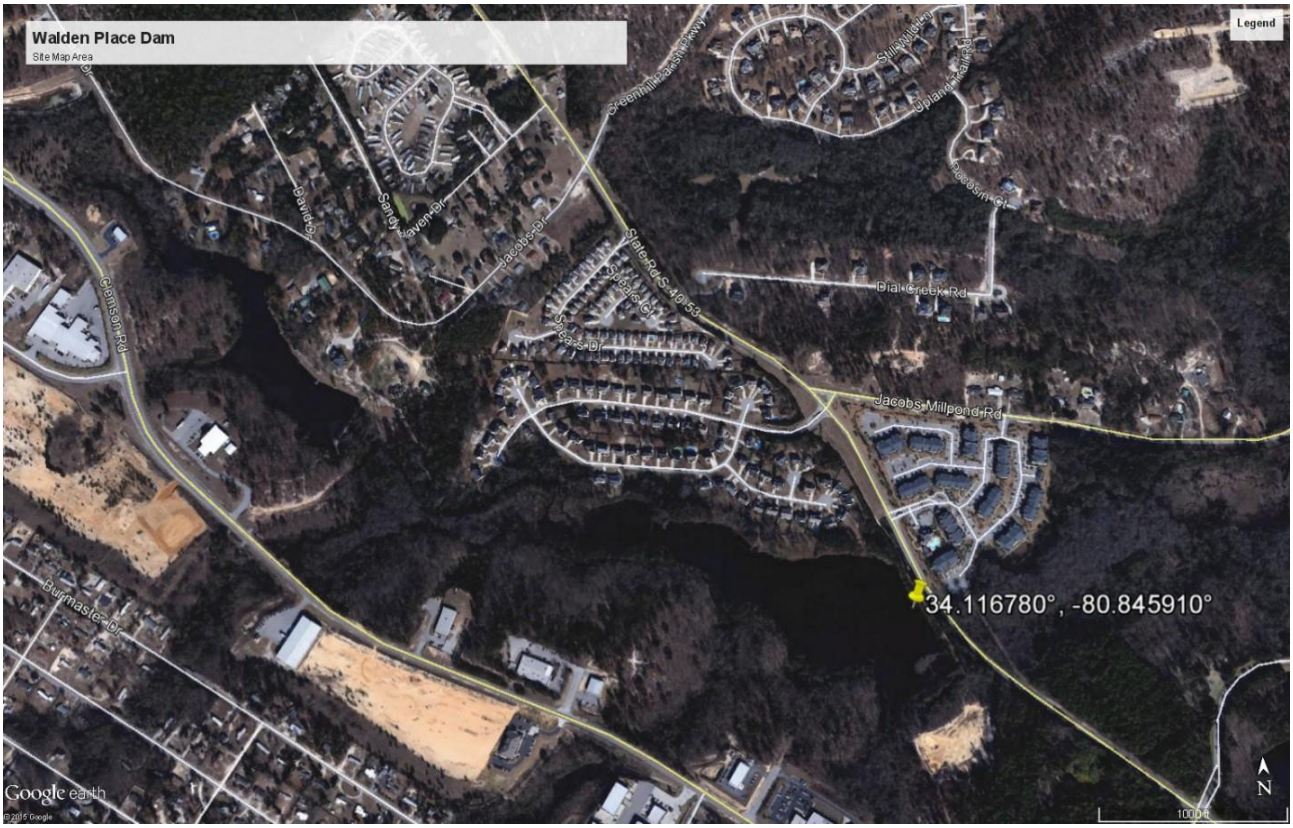

Figure A27.5: Walden Place Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

Figure A27.6: Walden Place Dam post-event photo; Credit: ACOE; Hendren

General Comments on Walden Place Dam:

- The National Inventory of Dams shows this dam as a High Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C1.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - No reference to Rocky Ford Dam / Rocky Ford Lake.
  - The stream for this dam is listed as Gills Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Spears Creek shows that Walden Place Dam (Church Road Dam) was included in the model as an inline weir. The Summary of Discharges shows flow attenuation due to the dam.
  - Based on the Spears Creek Profile from the latest FEMA Flood Insurance Study, Walden Place Dam would not be overtopped in the 1 percent annual chance event.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as "*Dam*". Walden Place Dam is not labeled.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. SCDHEC confirmed there was an EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is not referenced in the 2011 plan.
- The NID records this dam as completed in 1950 with no modifications indicated.
- During the last pre-event inspection, April 2015, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in poor condition and further engineering evaluation was recommended for an area of seepage at the tow of the dam, clearing of vegetation and trees, clearing of brush and vegetation is from the emergency spillway/overflow, and erosion of the crest/lakeside slope near the intake.
    - A USACE assessment on October 8 noted the dam was already breached. A SCDHEC inspection on October 8 confirmed this dam was breached. USACE noted on October 22 only activity was beavers damming the breach with two foot rise. A SCDHEC inspection on October 29 noted the pool level equilibrated with outflow through breach. There was no flow through primary spillway. There was beaver activity at breach. SCDHEC confirmed on November 4 that the beaver dam was getting larger, slowly

raising pool level. There was a hole through the dam continuing to be incised deeper, encroaching on the beaver dam.

Considerations for Walden Place Dam:

- Consider this dam for event specific dam failure modeling and incremental consequence assessment to compare the flood event versus the dam breach inundation.
- Consider this dam for comparison of dam breach modeling results (HEC- RAS, DSS-WISE, FLO-2D, etc.) to high water mark inundation downstream.
- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.
- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

28) ***State Dam Name: Covington Lake Dam***; Latitude: 34.13463666, Longitude: -80.97464885; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	COVINGTONS LAKE DAM	County	Richland
Stream or River	Roberts Branch	Nearest Downstream City/Town	Hollywood Hills
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00079	State ID	D0545
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1950
Length (ft)	550	Year Modified	N/A
Drainage Area (sq mi)	5.09	Height (ft)	16
Surface Area (ac)	10	EAP	No
Max Discharge (cfs)	215	Condition	Not Rated
		Normal Storage (ac ft)	
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0140K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

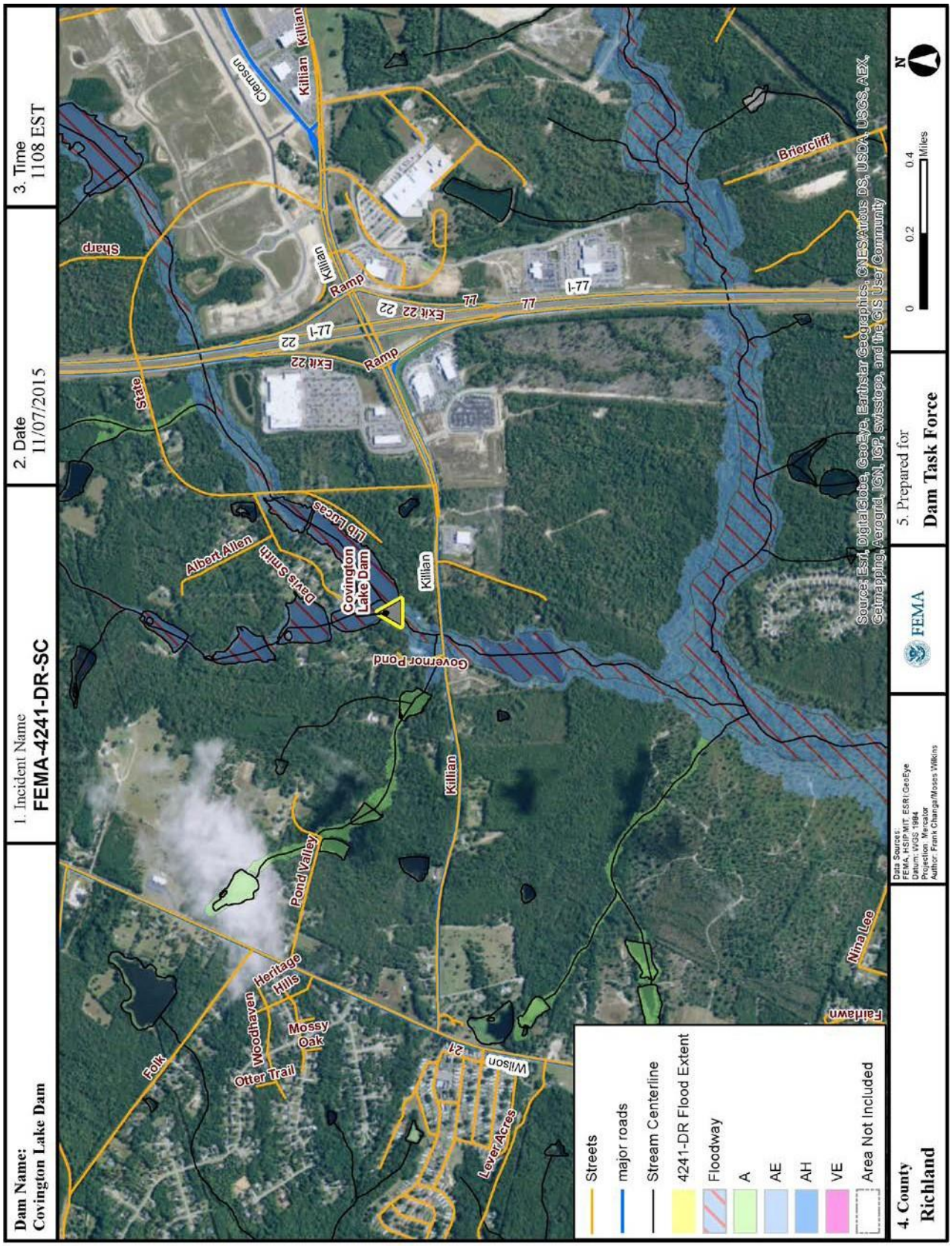

Figure A28.1: Covington Lake Dam FEMA Flood Zone and 4241DR Flood Extent

Overlay Map

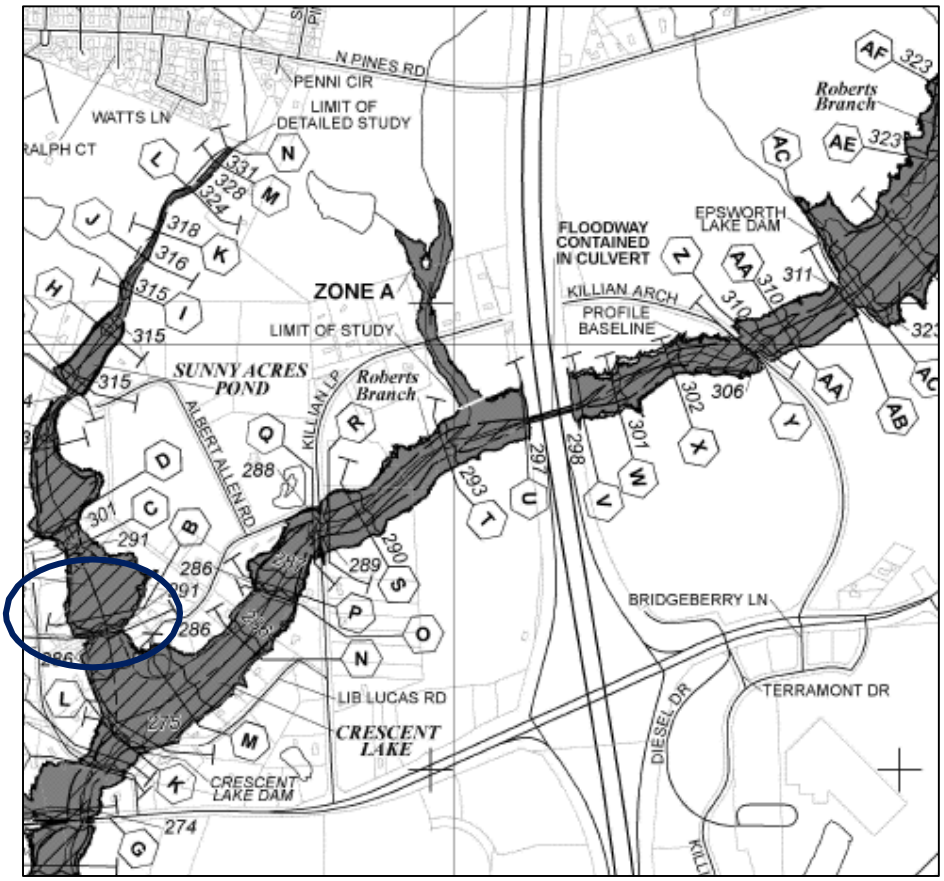

Figure 28.2: Covington Lake Dam in blue circle; FIRM is cropped; detailed above

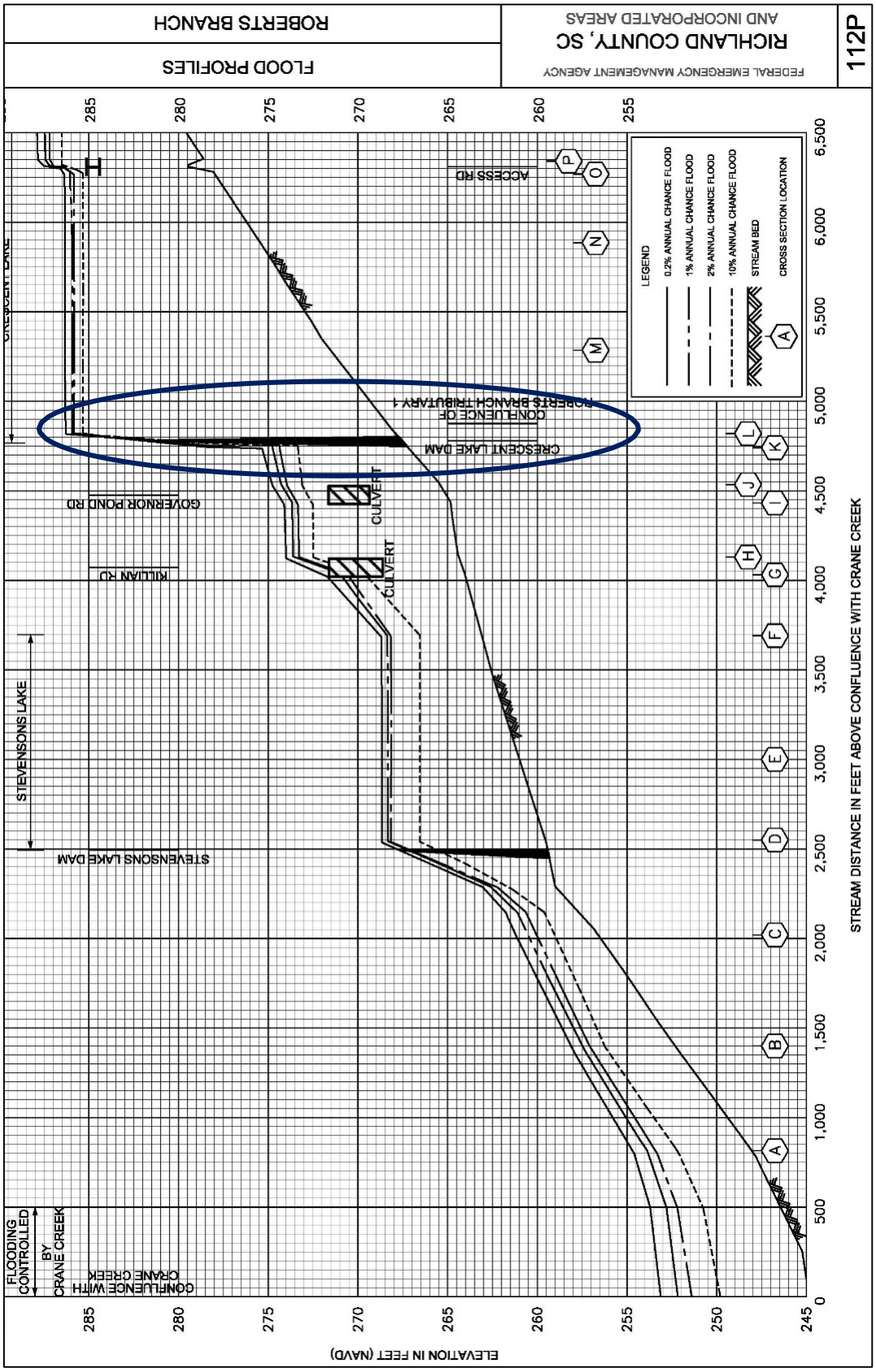

Figure A28.3: FEMA Flood Insurance Flood Profile 138P for Covington Lake Dam

Figure A28.4: Covington Lake Dam Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure A28.5: Covington Lake Dam post-event photo;Credit: ACOE Saint-Clair

General Comments on Covington Lake Dam:

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - Covington Lake is referenced as "Crescent Lake"
  - The stream for this dam is listed as Roberts Branch. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Roberts Branch shows that Covington Lake Dam (Crescent Lake Dam) was included in the model as an inline weir. The Summary of Discharges shows flow changes between the upstream and downstream face of the dam.
  - Based on the Roberts Branch Profile from the latest FEMA Flood Insurance Study, Covington Lake Dam would be overtopped in the 1 perecent annual chance event by approximately five feet.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is labeled as "*Crescent Lake Dam*".
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was not an emergency action plan for this dam. SCDHEC confirmed no EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is not referenced in the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1950 with no modifications indicated.
- During the last pre-event inspection, December 2012, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in fair condition and further engineering evaluation was recommended for clearing of vegetation and trees from the dam and clearing of brush and vegetation is from the emergency spillway/overflow to allow for effective water flow.

Considerations for Covington Lake Dam:

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.

- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.

29) ***State Dam Name: Beaver Dam/Wildewood Pond #2/Boyd Pond Two;***

Latitude: 34.096382 Longitude: -80.886478; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	WILDEWOOD POND #2	County	Richland
Stream or River	An unnamed tributary to Jackson Creek	Nearest Downstream City/Town	Woodfield
NID Hazard Class	Significant	State Hazard Class*	C2
NID ID	SC00100	State ID	D0567
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1963
Length (ft)	725	Year Modified	2010
Drainage Area (sq mi)	0.62	Height (ft)	24
Surface Area (ac)	27	EAP	Yes
Max Discharge (cfs)	90	Condition	Not Rated
Note: FIRM & FIS data are not in the NID		Normal Storage (ac ft)	227
Max Storage (ac ft)	281	FIS Effective Date	09/29/2010
FIRM Panel	45079C0260K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

Figure A29.1: Beaver Dam/Wildewood Pond #2/Boyd Pond Two Dam pre-event photo; Credit: Google Maps Streetview

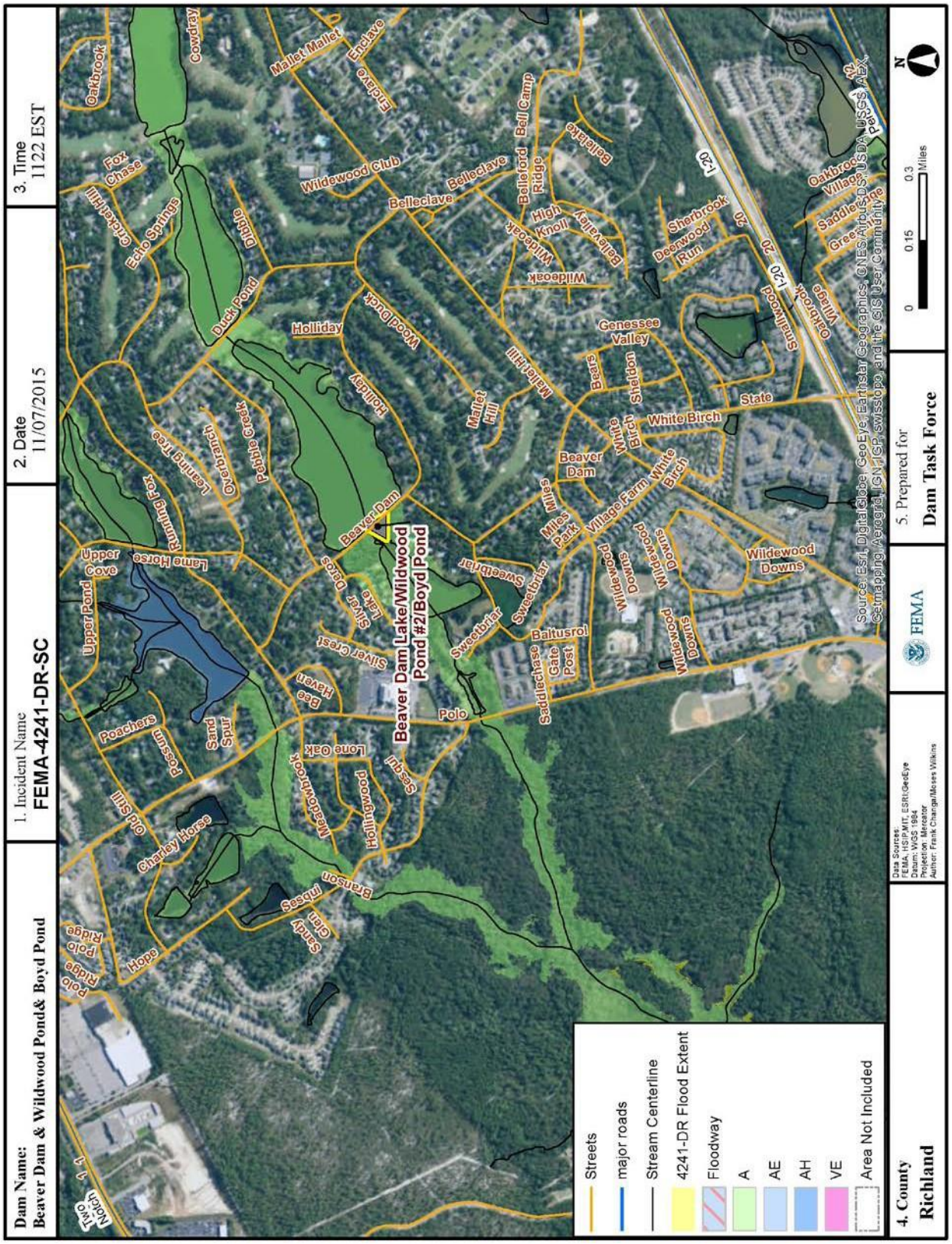

Figure A29.2: Beaver Dam/Wildwood Pond #2/Boyd Pond Two Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

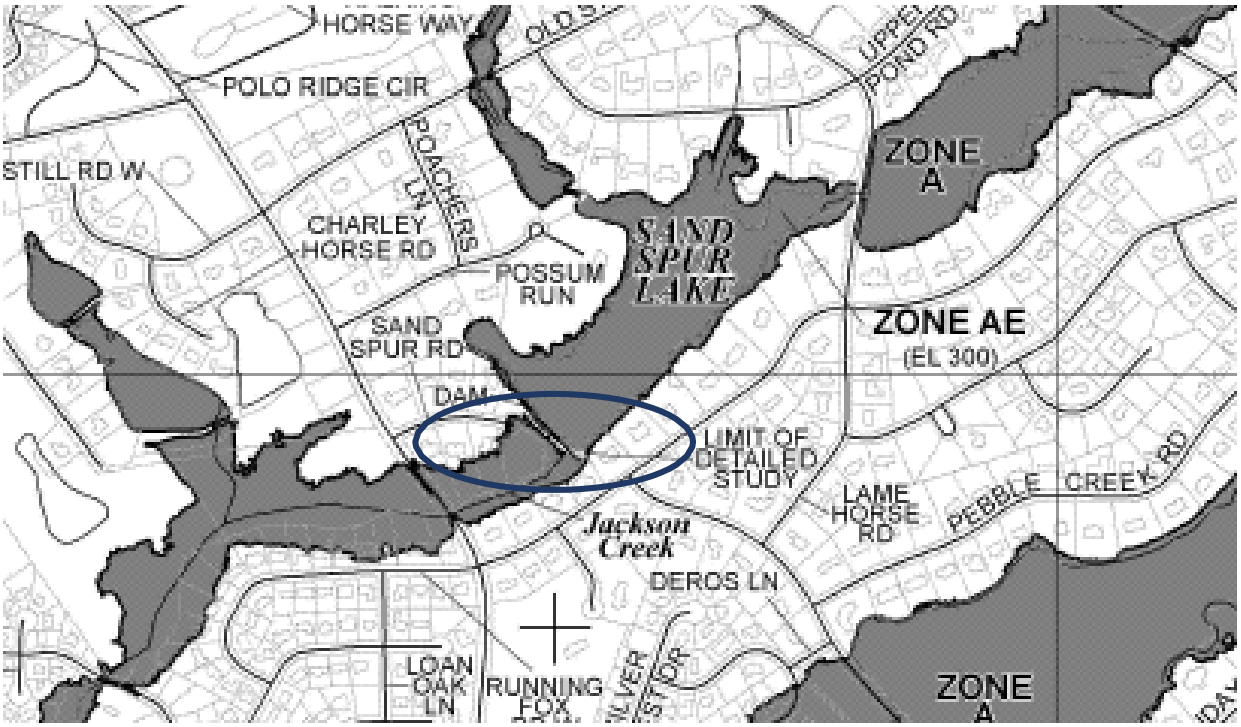

Figure 29.3: Beaver Dam/Wildewood Pond #2/Boyd Pond Two Dam in blue circle; FIRM is cropped; detailed above

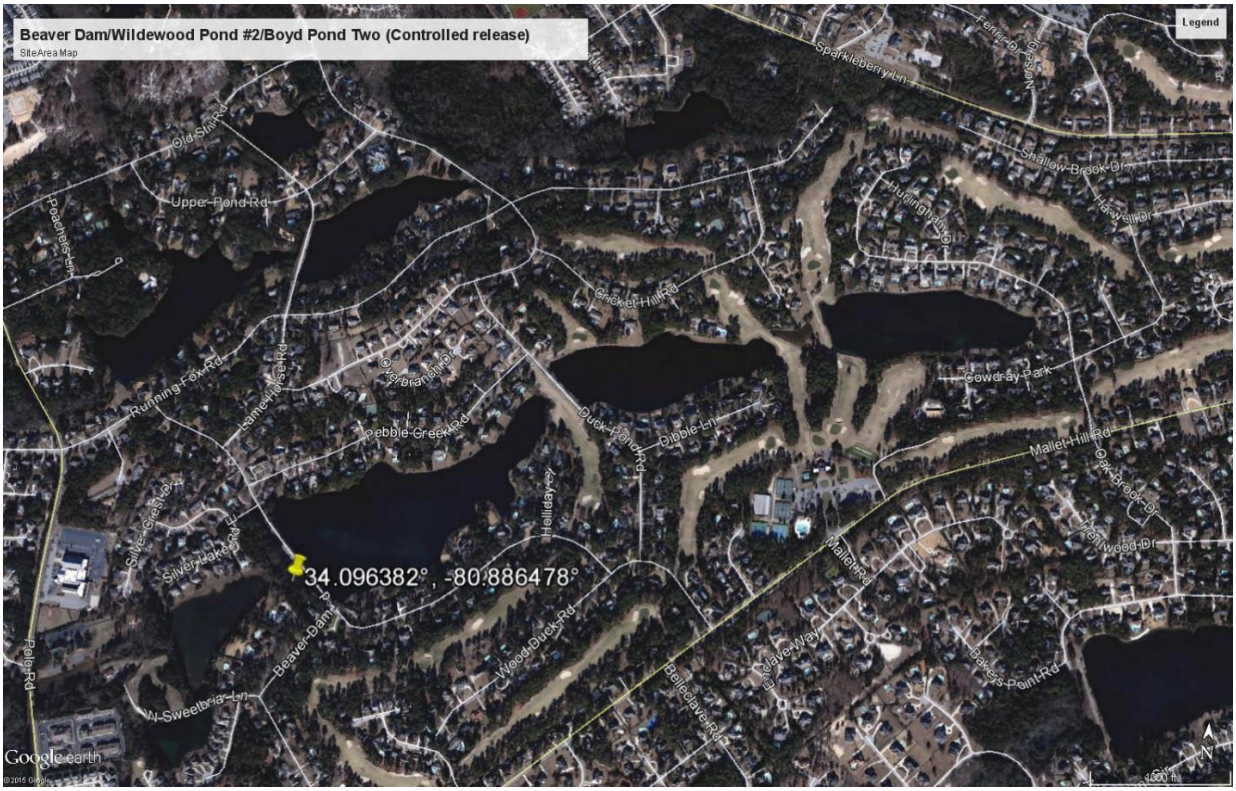

Figure 29.4: Beaver Dam/Wildewood Pond #2/Boyd Pond Two Dam Site Area Map
Credit: Map data: 2015 Google; Google Earth

Figure 29.5: Beaver Dam/Wildewood Pond #2/Boyd Pond Two post-event photo; Credit: ACOE; Schuman

General Comments Beaver Dam/Wildewood Pond #2/Boyd Pond Two:

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - Beaver Dam/Wildewood Pond #2/Boyd Pond Two is not referenced in the FIS
  - The stream for this dam is an unnamed tributary to Jackson Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Beaver Dam/Wildewood Pond #2/Boyd Pond Two is located in an unstudied Zone A area and therefore, no hydrologic or hydraulic data is listed in the FIS.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled or shown.
- The National Inventory of Dams shows this dam as an earthen dam.
- Based on information from the National Inventory of Dams, there was an emergency action plan for this dam. SCDHEC confirmed this dam has an EAP.

- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. In April 2015, the Central Midlands Region submitted a revised Hazard Mitigation Plan to include the recently completed Gills Creek Watershed Flood Mitigation Plan, which discusses past dam failure and dam upgrades in the watershed. Beaver Dam/Wildewood Pond #2/Boyd Pond Two is listed in a table of dams in this Gills Creek Watershed Flood Mitigation Plan.
- The National Inventory of Dams records this dam as completed in 1963 with modifications made in 2010.
- During the last pre-event inspection, December 2011, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam condition was not noted and further engineering evaluation was recommended for clearing of vegetation and trees from the dam.
    - On October 6, SCDHEC was at the dam and the owners were working to initiate a controlled breach. By 8:30 PM, SCDHEC reported conditions at the dam were degrading. This is when reverse 911 calls went out to evacuate downstream. The local Police Department were ordering everyone away from the dam. SCDHEC reported on October 7 that temporary repairs seemed to be stable and construction of the cofferdam was expected to start today. USACE reported on October Oct 8 that the dam was breached. SCDHEC reported on October 29 that the pool level was down approximately 8 ft and the breach appeared to be stable at the primary spillway. The two 18" siphons were not engaged. The controlled breach was stable and not flowing. SCDHEC reported on November 6th that there was several feet of freeboard and the breach appeared to be stable at the primary spillway. There was a trickle of water flowing out of the downstream outfall and two 18" siphons were not engaged. The controlled breach/emergency spillway was not flowing.

<u>Considerations for Beaver Dam/Wildewood Pond #2/Boyd Pond Two:</u>

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider this dam for further analysis of the cascading dam failures for this drainage basin.

- Consider this dam for further assessment of emergency actions taken based on EAP and the results of these actions.

30) ***State Dam Name: Clarkson Pond Dam***; Latitude: 33.87006 Longitude: -80.826624; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	Clarkson Pond Dam	County	Richland
Stream or River	Cedar Creek	Nearest Downstream City/Town	Gadsden
NID Hazard Class	Low	State Hazard Class*	C3
NID ID	N/A	State ID	D0599
Dam Type		Owner Type	
Purpose		Year Completed	
Length (ft)		Year Modified	
Drainage Area (sq mi)		Height (ft)	
Surface Area (ac)		EAP	
Max Discharge (cfs)		Condition	
Max Storage (ac ft)		Normal Storage (ac ft)	
Note: FIRM & FIS data are not in the NID		FIS Effective Date	09/29/2010
FIRM Panel	45079C0550K	FIRM Effective Date	09/29/2010

*Provided by SCDHEC

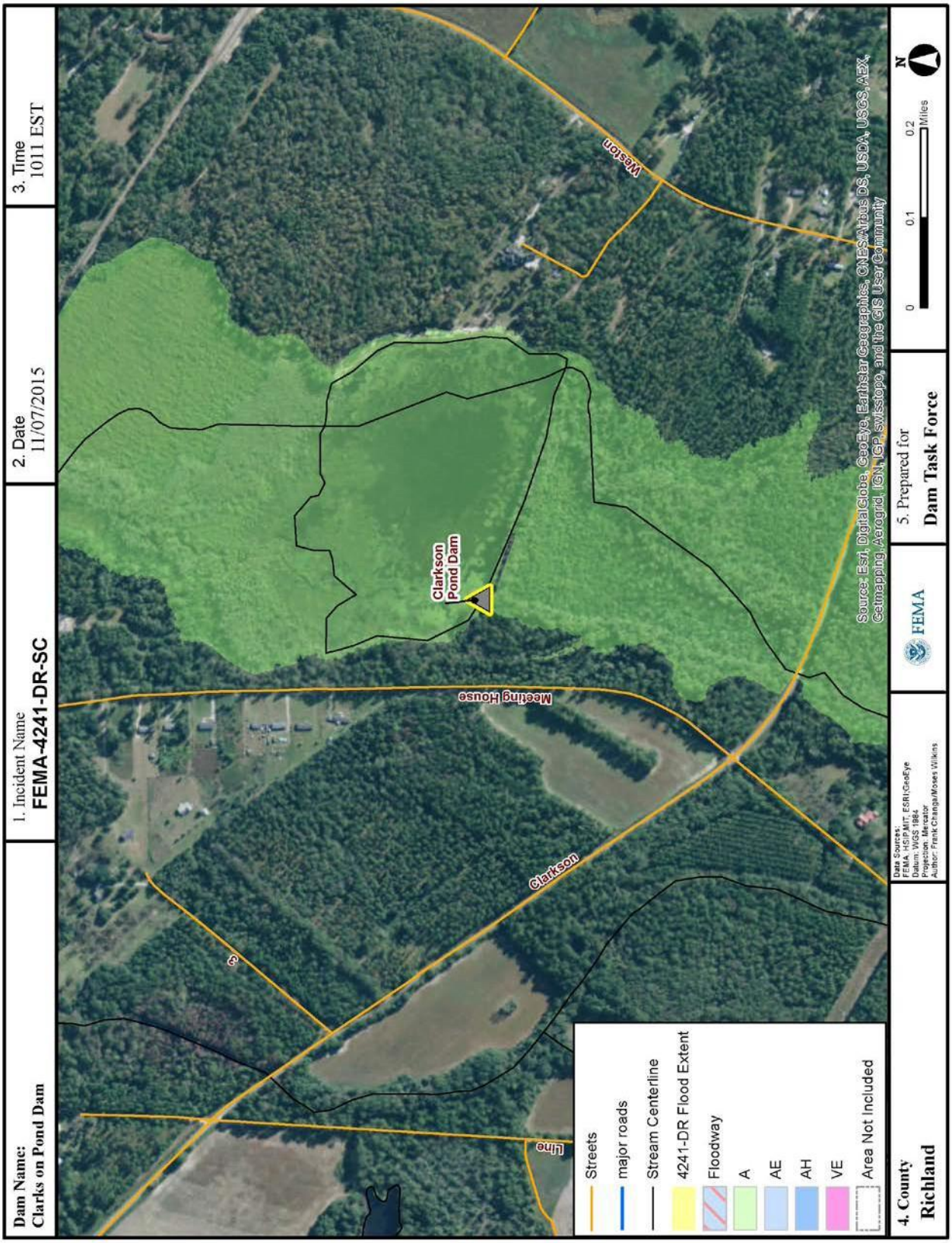

Figure A30.1: Clarkson Pond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

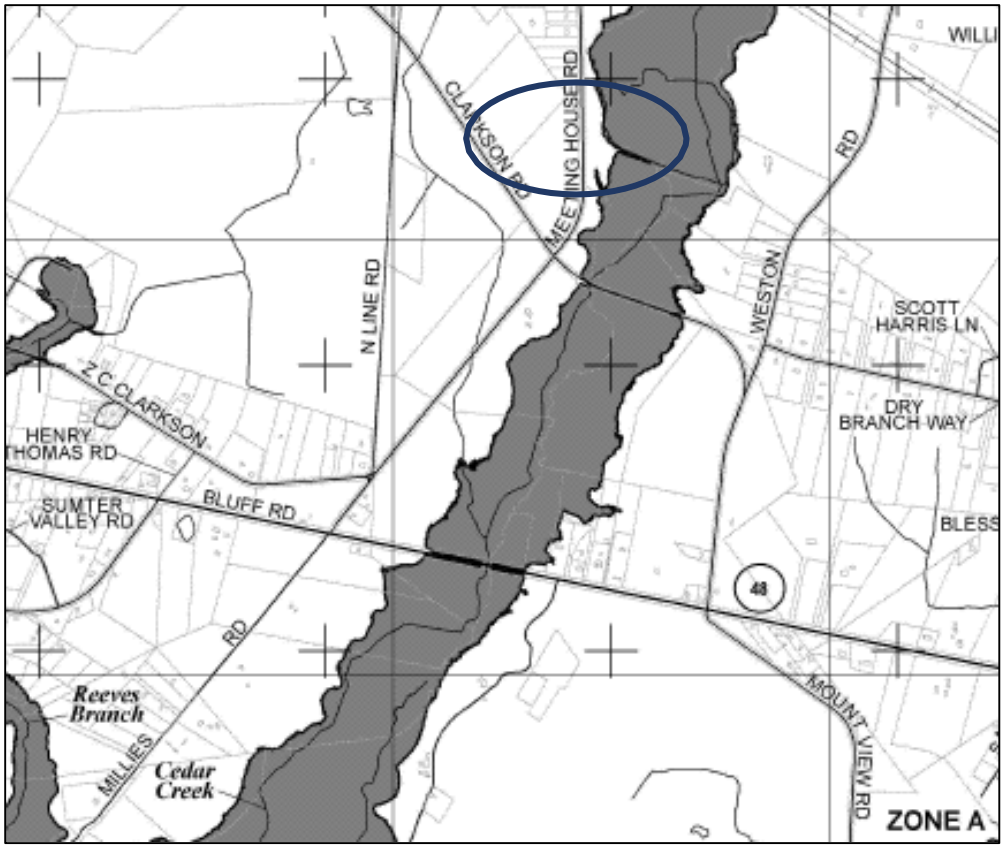

Figure 30.2: Clarkson Pond Dam in blue circle; FIRM is cropped; detailed above

Figure 30.3: Clarkson Pond Dam Site Area Map Credit: Map data: 2015 Google; Google Earth

General Comments on Clarkson Pond Dam:

- The National Inventory of Dams shows this dam as a Significant Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 11-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - Clarkson Pond Dam is not referenced in the FIS.
  - The stream for this dam is listed as Cedar Creek.
  - This dam is not listed in the NID but is a dam and has a State ID Number.
  - Information regarding the hydrologic and hydraulic modeling of Cedar Creek is not listed in the FIS as it is a Zone A stream.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - This dam is not labeled.
- SCDHEC confirmed an EAP does not exist for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is not referenced in the 2011 plan.
- There is very little information available regarding this dam as it is not listed in the National Inventory of Dams records.

- During the last pre-event inspection, March 2000, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was reviewed to see if classification could change. To date it remains a Class 3, low hazard dam.

Considerations for Clarkson Pond Dam:

- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure as a result of this event.
- Consider determining why this dam is not listed in the National Inventory of Dams.

31) ***State Dam Name: Ellerbees Millpond Dam*** Latitude: 34.06843763
Longitude: -80.53162143; Regulator: SCDHEC

NID Field	NID input	NID Field	NID input
NID Dam Name	ELLERBEES MILLPOND DAM	County	Sumter
Stream or River	Rafting Creek	Nearest Downstream City/Town	Rembert
NID Hazard Class	Low	State Hazard Class*	C2
NID ID	SC01404	State ID	D1460
Dam Type	Earth	Owner Type	Private
Purpose	Recreation	Year Completed	1830
Length (ft)	730	Year Modified	N/A
Drainage Area (sq mi)	25.1	Height (ft)	7
Surface Area (ac)	42	EAP	No
Max Discharge (cfs)	205	Condition	Not Rated
Max Storage (ac ft)	151	Normal Storage (ac ft)	67
Note: FIRM & FIS data are not in the NID		FIS Effective Date	02/16/2007
FIRM Panel	45085C0100D	FIRM Effective Date	02/16/2007

*Provided by SCDHEC

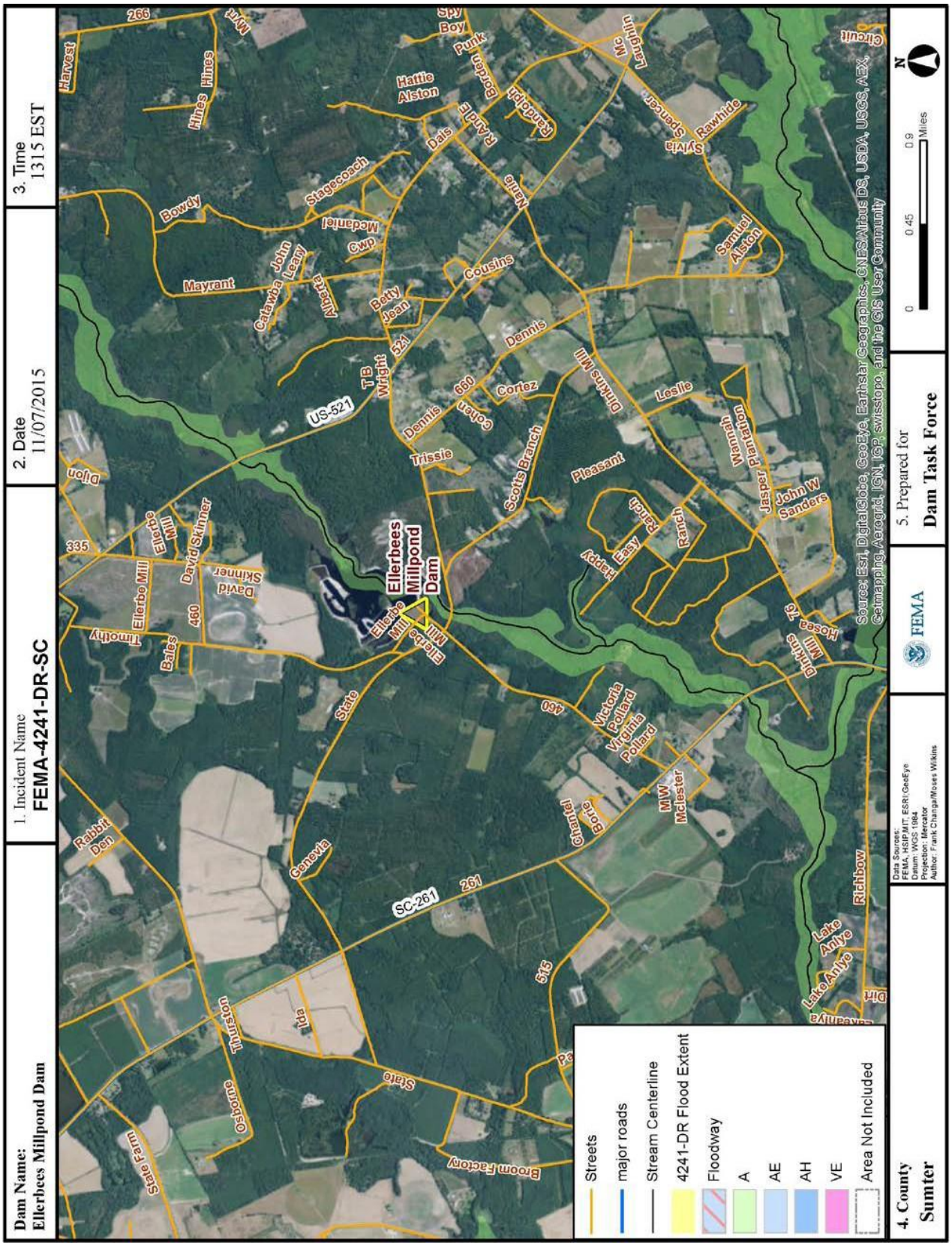

Figure A31.1: Ellerbees Millpond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

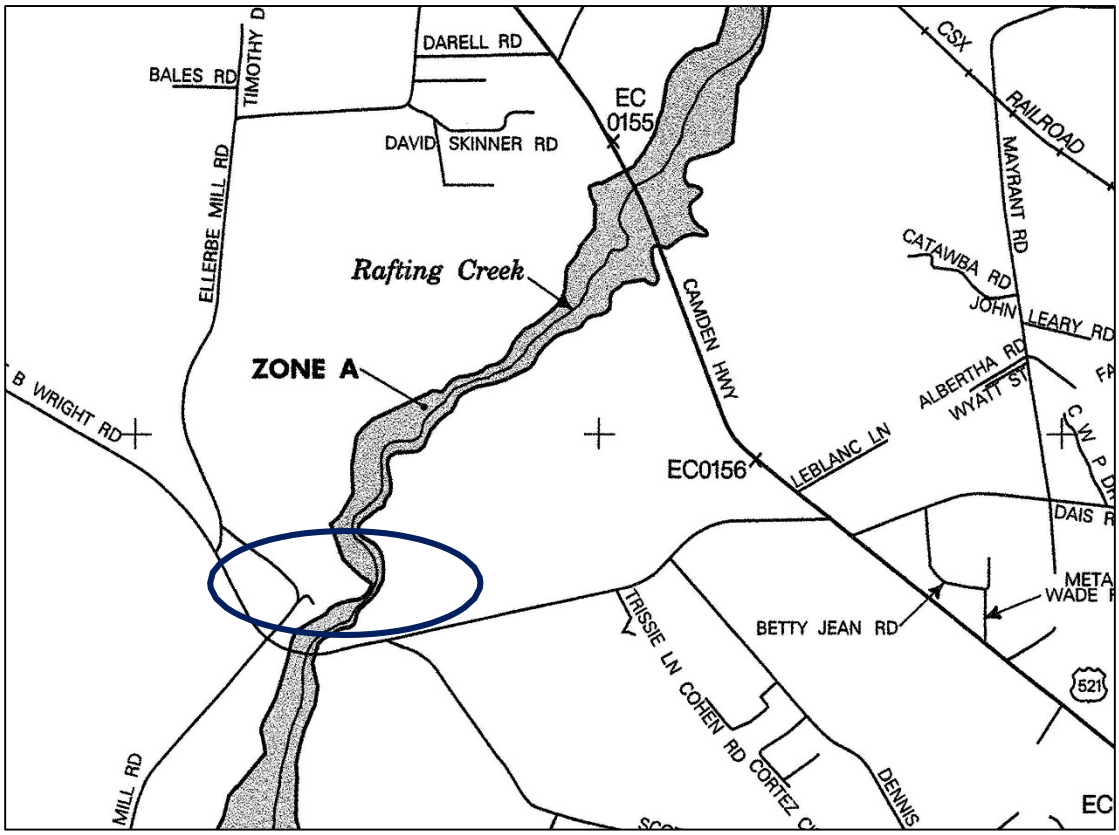

Figure A31.2: Ellersbees Millpond Dam in blue circle; FIRM is cropped; detailed above

Figure A31.3: Ellerbees Millpond Dam FEMA Flood Zone and 4241DR Flood Extent Overlay Map

Figure A31.4: Ellerbees Millpond Dam post-event photo; Credit: SCDHEC; Frazer

General Comments on Ellerbees Millpond Dam:

- The National Inventory of Dams shows this dam as a Low Hazard dam. The South Carolina Department of Health and Environmental Control classifies this dam as C2. There is a discrepancy between the SCDHEC and NID classifications.
- There are no pictures from the Civil Air Patrol of this dam.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16-20 inches in the area of this dam.
- A review of the latest FEMA Flood Insurance Study indicates:
  - Ellerbees Mill Pond is not referenced in the FIS.
  - The stream for this dam is listed as Rafting Creek. This is consistent with the stream listed in the National Inventory of Dams.
  - Information regarding the hydrologic and hydraulic modeling of Rafting Creek is not available as it is a Zone A, approximate Zone A.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
  - Neither the pond nor the dam are indicated on the FIRM.
- The National Inventory of Dams shows this dam as an earthen dam.

- Based on information from the National Inventory of Dams, there was not an emergency action plan for this dam. SCDHEC confirmed there is no EAP for this dam.
- Dam Failure is not profiled as a hazard in Central Midlands Regional 2011 Hazard Mitigation Plan, which Richland County has adopted. This dam is referenced by name in Appendix G (page 256) of the 2011 plan.
- The National Inventory of Dams records this dam as completed in 1830 and no modifications were noted.
- During the last pre-event inspection, December 2012, by the South Carolina Department of Health and Environmental Control (SCDHEC) Dam Safety Program, the dam was in fair condition and further engineering evaluation was recommended for the placement of riprap as appropriate

<u>Considerations for Ellerbees Millpond Dam:</u>

- Consider this dam for further assessment of the design and construction of the dam and any major rehabilitations, including the design and construction standards at the time.
- Consider this dam for further analysis to determine whether or not the spillway system of the dam was adequate to pass the flood event that occurred.
- Consider assessing the dam for probable cause of failure because of this event.
- Consider this dam for further research into whether or not the recommendations provided in the last SCDHEC inspection were addressed.
- Consider researching the reasons why there is a discrepancy in hazard classification between SCDHEC and the NID.

Appendix B: Information for Columbia Canal Levee

Field	Information	Field	Information
Name	Columbia Canal	County	Richland
Latitude	33.998989	Longitude	-81.050993
Stream or River	Congaree River	Owner Type	Public/Private
Length	2.6 miles	Year Completed	1824
FIRM Effective Date	02/20/2010	Year Modified	1891
FIRM Panel	45079C0094H	FIS Effective Date	09/29/2010
		Regulator	None Found to Date

Figure B1: The Columbia Canal Levee pre-event photo; Credit: Google Maps Streetview

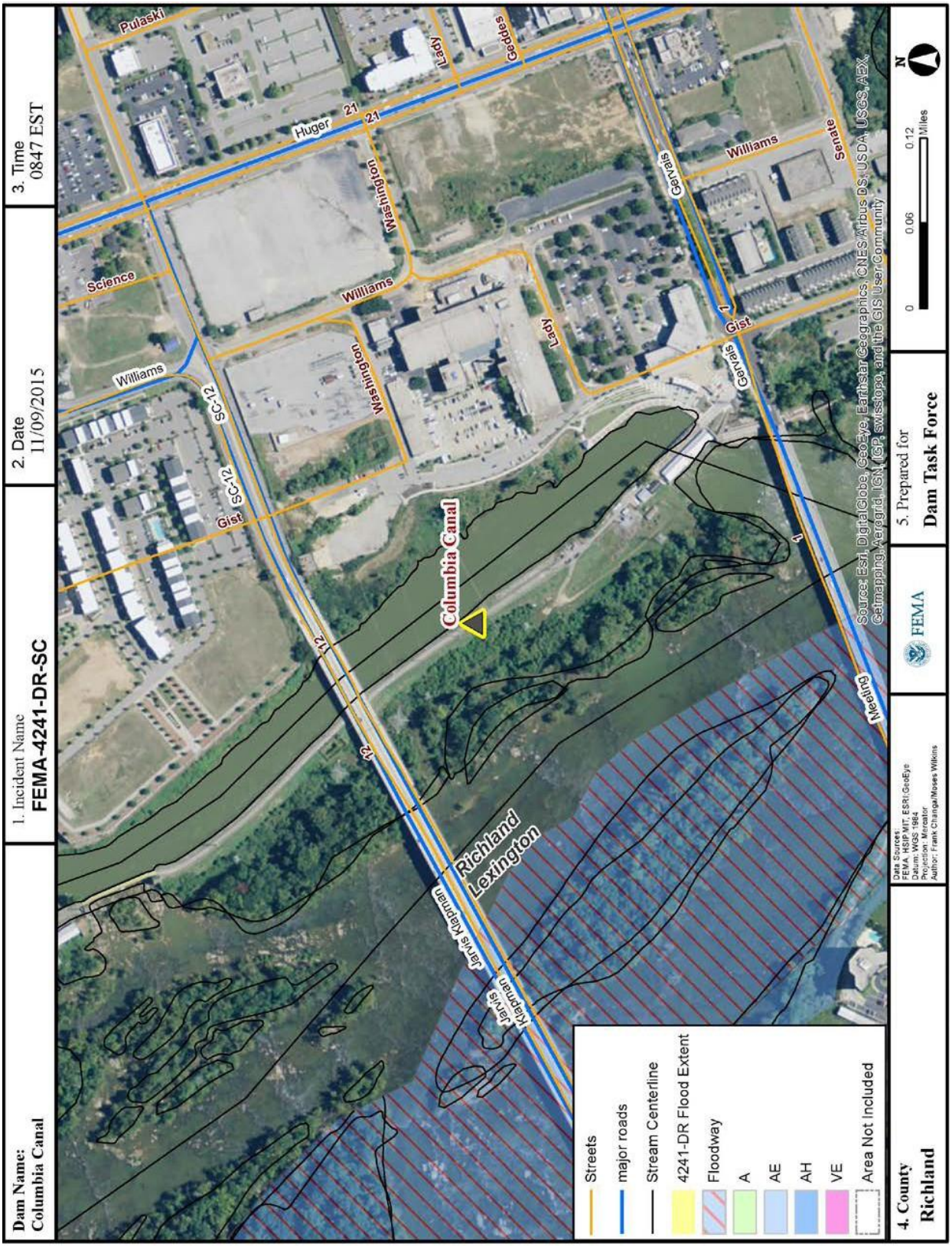

Figure B2: The Columbia Canal Levee FEMA Flood Zone and 4241DR Flood Extent Overlay Map

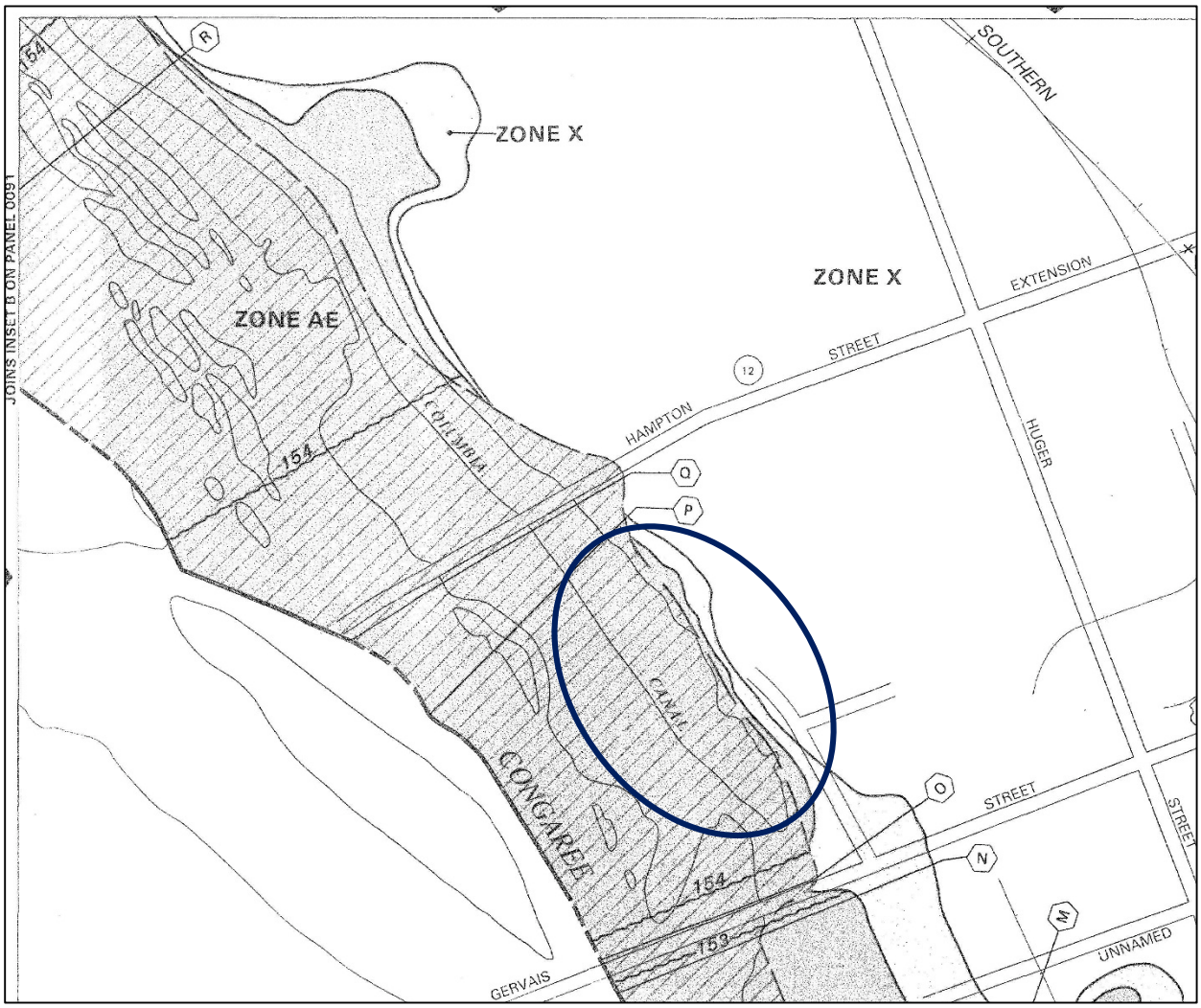

Figure B3: The Columbia Canal Levee in blue circle; FIRM is cropped, details above

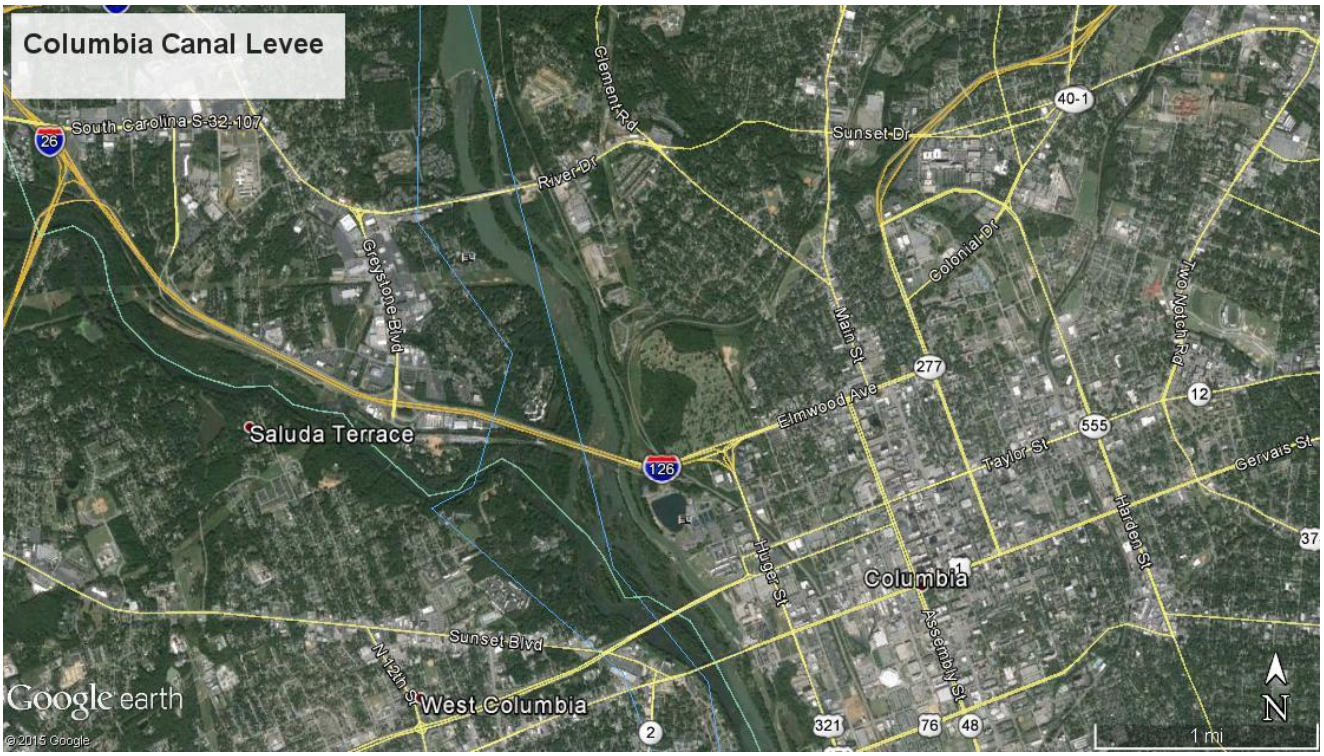

Figure B4: The Columbia Canal Levee Site Area Map; Credit: Map data: 2015 Google; Google Earth

Figure B5: The Columbia Canal Levee post-event photo; Credit: FEMA Carter-Davis

Figure B6: The Columbia Canal Levee post-event photo; Credit: FEMA Carter-Davis

Figure B7: The Columbia Canal Levee post-event photo; Credit: FEMA Carter-Davis

Figure B8: The Columbia Canal Levee post-event photo; Credit: Civil Air Patrol

General Columbia Canal Levee Comments

- The Columbia Canal Levee does not appear to be currently regulated. The State regulations, referenced in section 9.3 of this report, define a dam to include a levee.
- There are many picture from the Civil Air Patrol of the Columbia Canal Levee failure. Five of these pictures are of the two breached areas.
- NOAA National Weather Service recorded an observed 5-day precipitation of 16- 20 inches in the area of this dam.
- As of the final writing of this report, FEMA PA had not received any inspection reports regarding the damaged areas for this canal levee.
- A review of the latest FEMA Flood Insurance Study indicates:
    - No reference to Columbia Canal Levee. The only levee referenced is a different levee south of this canal.
    - The stream for this dam is listed as Congaree River.
    - There are no Flood Profiles for the Congaree River.
- A review of the latest Flood Insurance Rate Map (FIRM) indicates:
    - Columbia Canal is labeled by name.
- The National Registry of Historic Places shows part of the canal as completed in 1824 with an addition completed in 1891

Considerations for Columbia Canal Levee

- Consider further research into the potential lack of regulation of this levee.
- Consider assessing the levee for probable cause of failure because of this event.
- Consider further research into impacts of levee failure to critical infrastructure, including potable water and power generation, and opportunities to improve the resilience for critical infrastructure.

Appendix C: The National Dam Safety Program (NDSP)[1]

Program Overview

The first Federal legislation for dam safety was the National Dam Inspection Act (PL 92-367) enacted in 1972 and codified under Title 33 United State Code, Chapter 9, Subchapter VII. This act authorized the Secretary of the Army to inspect dams across the country, to create the National Inventory of Dams (NID) and to provide recommendations for a national program for the inspection and regulation for the safety of dams.

In 1979, the Federal Guidelines for Dam Safety were prepared by the Ad Hoc Interagency Committee on Dam Safety of the Federal Coordinating Council for Science Engineering and Technology. In 1979, a Presidential Memorandum required the head of each Federal dam safety agency to implement the Federal Guidelines for Dam Safety.
The Federal Emergency Management Agency (FEMA) was created by Presidential Reorganization Plan No. 3 of 1978. However, Executive Order 12127, dated March 31, 1979, actually began implementing the operation of FEMA on April 1, 1979 by transferring various key functions and offices from various organizations to FEMA and abolished those offices in the originating organizations in agreement with the Reorganization plan. Executive Order 12148, Federal Emergency Management, dated July 20, 1979, continued to transfer or reassign key functions, offices and established key responsibilities and delegations to the FEMA Director, among other items. One of the new responsibilities given to FEMA was the responsibility for coordinating Federal Dam Safety activities.

The action of the Executive Branch was followed in 1986 by Federal legislation to address dam safety, the Water Resources Act of 1986. Title XII of this legislation authorized the State assistance program, the establishment of a National Dam Safety Review Board (Review Board), research and training programs, and funds to maintain and update a National Inventory of Dams. Despite this recognition, there was no legislatively mandated National Dam Safety Program (NDSP) until 1996, when Congress enacted Public Law 104-303.

In 1996, the National Dam Safety Program Act, included within the Water Resources Development Act (PL 104-303), was passed with the Director of FEMA designated as the Administrator of the National Dam Safety Program. This act authorized the formation of the National Dam Safety Review Board, financial assistance (in the form of grants) to state dam safety programs, and funding for maintaining the NID, research, and training related to dam safety. The act calls for FEMA to provide education to the public, to dam owners, and others about the need for strong dam safety programs,

[1] http://www.fema.gov/national-dam-safety-program

nationally and locally, and to coordinate partnerships among all stakeholders within the dam safety community to enhance dam safety. The NDSP was reauthorized in 2002 under the National Dam Safety and Security Act, in 2006 and again in 2014 under the Water Resources, Reform and Development Act (WRRDA), Public Law 113-121.

The purpose of the NDSP is to "reduce the risks to life and property from dam failure in the United States through the establishment and maintenance of an effective national dam safety program to bring together the expertise and resources of the Federal and non-Federal communities in achieving national dam safety hazard reduction" (33 U.S.C. § 467).

The objectives of the NDSP are to:

- Ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction;
- Encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness;
- Encourage the establishment and implementation of effective dam safety programs in each State based on State standards;
- Develop and implement a comprehensive dam safety hazard education and public awareness initiative to assist the public in preparing for, mitigating, responding to, and recovering from dam incidents;
- Develop technical assistance materials for Federal and State dam safety programs;
- Provide Federal technical assistance for dam safety to the non-Federal sector; and
- Develop technical assistance materials, seminars, and guidelines to improve security for dams in the United States.

FEMA P-916, Strategic Plan for the National Dam Safety Program for Fiscal Years 2012–2016 (FEMA, 2012b), defines the NDSP vision and mission. Realization of the NDSP mission requires the development and application of knowledge based on research and engineering best practices; making the public more aware of the risks from dam failures; and assisting State, local, and private-sector leaders in the development and adoption of consistent and comprehensive standards and policies.

NDSP Vision: *The benefits and risks of dams are understood and risks are managed to improve public safety, economic strength, national security, and to sustain the environment.*

NDSP Mission: *Reduce risks to life, property, and the environment from dam failure by guiding public policy and leveraging industry best practices across the dam safety community.*

The NDSP identified five goals to advance dam safety in the nation:

- Goal 1: Reduce the likelihood of dam failures. This goal will be advanced by increasing State-regulated dam inspections, increasing reporting on the condition of dams, and providing dam safety grant assistance to States and Federal agencies.

- Goal 2: Reduce the potential consequences resulting from dam failures. Progress toward this goal includes increasing in the number of Emergency Action Plans (EAPs) for State-regulated high-hazard potential and significant-hazard potential dams, developing EAP Guidelines and new hazard mapping tools, and providing training in EAP development.

- Goal 3: Promote public awareness of the benefits and risks related to dams. Efforts toward achieving this goal includes developing and implementing a comprehensive outreach and public awareness campaign that target multiple stakeholders with a role or responsibility in dam risk management.

- Goal 4: Promote research and training for State dam safety and other professionals. FEMA should work to improve capabilities and advance the state of practice in mitigating, preparing for, responding to and recovering from dam hazard risks.

- Goal 5: Align relevant Federal programs to improve dam safety and dam risk management. FEMA will leverage the capabilities, resources and best available data of other Federal agencies to support Tribal, State and local stakeholders in effectively managing their dam risks.

The Strategic Plan for the National Dam Safety Program also describes the requirement to take a collaborative approach to dam safety and dam risk management in alignment with Presidential Policy Directive (PPD)-8, which established the National Preparedness System. PPD-8 provides the approach, resources, and tools for meeting the National Preparedness Goal, "a secure and resilient Nation capable of preventing, protecting against, mitigating, responding to, and recovering from the threats and hazards that pose the greatest risk."

National Inventory of Dams

The National Dam Inspection Act of 1972 (33 U.S.C. § 467) authorized the USACE to inventory dams in the United States. The USACE published the initial NID in 1975 and updated it as resources permitted over the next 10 years. The Water Resources Development Act of 1986 authorized USACE to maintain and periodically publish an updated NID. The Water Resources Development Act of 1996 reauthorized the NID and provided a dedicated funding source. USACE also began close collaboration with FEMA and State regulatory offices to obtain more accurate and complete information. The Dam Safety and Security Act of 2002 reauthorized the NDSP and included the

maintenance and update of the NID by the USACE. The Dam Safety Act of 2006 reauthorized the maintenance and update of the NID.

The goal of the NID is to include all dams in the United States that meet at least one of the following criteria:

- High-hazard potential classification – loss of one human life is likely if the dam fails;
- Significant-hazard potential classification – no probable loss of human life but possible economic loss, environmental damage, disruption of lifeline facilities, or impact on other concerns if the dam fails;
- Equal to or more than 25 feet tall and more than 15 acre-feet in storage capacity; or
- More than 6 feet tall and equal to or more than 50 acre-feet storage capacity.

Most of the dams that meet NID criteria are regulated by Federal or State agencies, which maintain detailed information on the dams in their jurisdictions. USACE maintains the NID by periodically collecting dam characteristics from 49 States (Alabama currently has no dam safety legislation or formal dam safety program), Puerto Rico, and 18 Federal offices.

USACE has developed a web-based application that allows State and Federal agencies to map their local database fields and values to NID database fields and values.
Currently, the NID database consists of 70 database fields that describe the physical and regulatory aspects of a dam. The next NID update is planned for early Spring 2016.

Since the authorization and implementation of the NDSP, it has become increasingly clear that a breadth of information is required to support dam safety. These data needs include:

- Documenting the condition of the Nation's dams;
- Tracking the existence and progress of dam safety programs; and
- Supporting dam safety professionals responsible for evaluating and maintaining the safety of dams in the United States.

FEMA dam safety grants

To encourage the establishment and maintenance of effective of dam safety programs in the States to protect human life and property, FEMA provides grant assistance to States with a legislated dam safety program. For a State to be eligible for assistance, the State dam safety program must be working toward meeting the following criteria:

(i) The authority to review and approve plans and specifications to construct, enlarge, modify, remove, and abandon dams;

(ii) The authority to perform periodic inspections during dam construction to ensure compliance with approved plans and specifications;

(iii) A requirement that, on completion of dam construction, State approval must be given before the operation of the dam;

(iv) The authority to require or perform periodic evaluations of all dams and reservoirs to determine the extent of the threat to human life and property in case of failure;

(v) (I) the authority to require or perform the inspection, at least once every 5 years, of all dams and reservoirs that would pose a significant threat to human life and property in case to failure to determine the continued safety of the dams and reservoirs; and (II) a procedure for more detailed and frequent safety inspections;

(vi) A requirement that all inspections be performed under the supervision of a State-registered professional engineer with related experience in dam design and construction;

(vii) the authority to issue notices, when appropriate, to require owners of dams to perform necessary maintenance or remedial work, install and monitor instrumentation, improve security, revise operating procedures, or take other actions, including breaching dams, when necessary;

(viii) Regulations for carrying out the legislation of the State described in this subparagraph;

(ix) provisions for necessary funds-

(I) to ensure timely repairs or other changes to, or removal of, a dam in order to protect human life and property; and

(II) if the owner of the dam does not take action described in provision (I), take appropriate action as expeditiously as practicable;

(x) A system of emergency procedures to be used if a dam fails or if the failure of a dam is imminent; and

(xi) An identification of-

(I) each dam the failure of which could be reasonably expected to endanger human life;

(II) The maximum area that could be flooded if the dam failed; and

(III) Necessary public facilities that would be affected by the flooding.

In addition to the criteria listed above, for a State to be eligible for grant assistance under the National Dam Safety Program, State appropriations must be budgeted to carry out the State's legislated dam safety responsibilities.

Grant assistance will not be provided to a State under the NDSP for a fiscal year unless the State maintains the aggregate expenditures of the State programs to ensure dam safety for the protection of human life and property at or above a level equal to the average annual level of such expenditures for the 2 fiscal years preceding the fiscal year.

National Dam Safety Program State assistance grants are allocated among the States as follows:

(a) One-third of the total State-assistance grant amount, allocated to the NDSP, is distributed among States that qualify for assistance.

(b) Two-thirds of the total State-assistance grant amount, allocated to the NDSP, is distributed among States that qualify for assistance in proportion to—

(1) The number of dams in the State that are listed as State-regulated dams on the inventory of dams maintained; as compared to

(2) The number of dams in all States that are listed as State-regulated dams on the inventory of dams maintained.

The maximum amount of grant funds awarded to a State may not exceed the amount of funds committed by the State to implement dam safety activities. The grant cannot be used to construct or repair any Federal or non-Federal dam.

Notice of Funding Opportunity (NOFO)

The NOFO for the NSDP grant assistance is restricted to States with legislated dam safety programs. The National Dam Safety Act defines the term State as, "each of the several States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and any other territory or possession of the United States." Currently, 49 States and the Commonwealth of Puerto Rico are eligible for the NDSP grant assistance. Alabama does not have a legislated state dam safety program, so they are only eligible for the 1/3 amount of the state assistance that is evenly distributed across all states. The 2/3 of the state assistance is provide to states with statutory state dam safety programs.

To improve the effectiveness of the State assistance program, FEMA implemented performance-based eligibility criteria in FY 2013 for awarding grant funds. The performance criteria are intended to ensure that grants are awarded only to State dam safety programs that can efficiently and effectively use the funds to improve dam safety and meet NDSP goals and objectives identified in FEMA P-916, *Strategic Plan for the*

National Dam Safety Program Fiscal Years 2012 through 2016. State grant applications must address one or more of the following goals of the Strategic Plan:

- Reduce the likelihood of dam failures;
- Reduce the potential consequences resulting from dam failure;
- Promote public awareness of the benefits and risks related to dams; and
- Promote research and training for State dam safety and other professionals.

States' grant applications must identify dam safety/dam risk management tasks to accomplish in the FY 2013 work plans. Eligible State work plans must clearly identify how the State's proposed tasks relate to the goals provided above. After a State submits its work plan, FEMA will either approve the plan or discuss modifying the plan tasks given the circumstances for that State.

FEMA has implemented the following performance metrics for NDSP State assistance grants:

Metric 1: Safety Inspections

$$\frac{\text{NNNNNNNNNNNN oooo hiiiih– haaaaaaNNaa ppooppNNppppiiaapp aaaaNNdd iippddppNNiippNNaa xx } 100\%}{\text{NNNNNNNNNNNN oooo hiiiih– haaaaaaNNaa ppooppNNppppiiaapp aaaaNNdd aaNNNN ooooNN iippddppNNiippiioopp}}$$

Metric 2: Emergency Action Plans

Metric 3: Condition Assessments

State performance toward each metric is classified as low, intermediate, or high, as follows:

Performance	Metric Value
Low	0 to 49%
Intermediate	50 to 74%
High	75 to 100%

For each low-performing metric, States will dedicate a minimum of 33 percent of the grant award to improving one or more of the low-performing metrics. The work plan will set performance objectives for tasks related to the dedicated funding.

States with no low-performing metrics will, for each intermediate performing metric, dedicate a minimum of 10 percent of the grant award toward tasks that increase performance in the intermediate-performing metric. The work plan will set performance objectives for tasks related to the dedicated funding.

States that do not meet the performance objectives for the tasks that they proposed in their work plans over two consecutive grant cycles may lose their eligibility for dam safety State assistance for the next grant cycle.

Appendix D: The FEMA Region IV Dam Safety Program Overview

On February 6, 2012, Delegation of Authority FDA 0160-1 vested the following authorities to the Regional Administrator to exercise regarding the Dam Safety Program:

1. Implement the following National Dam Safety activities pursuant to Section 8 of the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467f):

    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 Regional Response Coordination Center and/or Joint Field Office during dam-related emergencies and disasters.

2. Support the coordination and provision of training for state dam safety staff and inspectors pursuant to Section 10 of the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467g-1).

3. Conduct financial monitoring and audit resolution activities with respect to National Dam Safety grants pursuant to Section 8 of the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467f).

With the following limitations and reservations:

4. The authorities delegated in paragraphs 8-10 do not include any grant award authority under the National Dam Safety Program Act, Pub. L. No. 92-367 (1972) (codified as amended at 33 U.S.C. § 467 et seq.).

Since 2012, the Dam Safety Program in Region IV is under the Risk Analysis Branch in the Mitigation Division. There is roughly ½ Full Time Equivalent (FTE) employees having regional dam safety program duties as assigned. These responsibilities are split between two individuals in the Branch. The regional Dam Safety Program has a yearly travel budget of $4,000 with additional travel funding from the National Dam Safety Program in FEMA Headquarters as needed.

With these resources, the FEMA Region IV Dam Safety Program has focused on the following activities:

- Relationship building with the state dam safety programs through meeting with each in the region. Whole day initial meetings were conducted to discuss the efforts of the state dam safety programs and provide information to the states on Risk, mitigation planning, disaster operations, Hazus-MH, the FEMA dam safety grant program, FEMA dam safety resources, training opportunities, FEMA's Geospatial Dam Break, Rapid EAP, Consequence and Hazards (GeoDamBREACH), and various other FEMA initiatives.
- Continued relationship building with the state dam safety programs through programmatic management of FEMA state dam safety grants in Region IV. These responsibilities include programmatic review of applications, amendment requests, quarterly and final programmatic progress reports, and other coordination and reviews as needed.
- Relationship building with other organizations (federal, state, local, and private sector representatives) in the dam safety community through participation in the National Dam Safety Review Board Training Work group. Accomplishments of this work group include developing and hosting annual E-274 Dam Safety Technical Seminars, assessing the Training Aids for Dam Safety (TADS) strategic review, recommending TADS updates to the National Dam Safety Review Board (NDSRB), and initiating the TADS revision process with FEMA Headquarters.
- Support of the National Dam Safety Program through review of dam safety publications including DHS Consequence of Dam Failure, Emergency Action Plan Flyer, Living with Dams: Know Your Risk, FEMA P-94: Selecting and Accommodating Inflow Design Floods for Dams, Federal Guidelines for Dam Safety Risk Management, FEMA P-64: Emergency Action Plans, Dams Sector Analysis Tool (DSAT) - Emergency Action Plan (EAP) Module (Beta version), and Contractor Officers Representative (COR) appointment for the TADS module Q (Evaluation of Seepage Conditions) revision and development of the TADS Strategic White Paper.
- Review of Region IV State Hazard Mitigation Plans for the Dam Failure hazard.
- Participated in multiple meetings with Region IV RRCC Watch Center and Region IV GIS Resource Center on dam-related incidents.
- Relationship building with the Tennessee Valley Authority (TVA) through observation of tabletop and functional exercises for their dams and providing comments on their Emergency Action Plans.
- Provided subject matter expertise in the FEMA Regional Response Coordination Center (RRCC) for dam-related emergencies during disaster response under FEMA-3373-EM. This included coordination with planning to contract with the University of Mississippi National Center for Computational Hydroscience and Engineering (UM-NCCHE) for cascading dam failure modeling.

Based on information from the National Inventory of Dams (NID), 23 perecent of dams in the inventory are located in Region IV.

States in Region IV	Total Dams	State Regulated Dams	High Hazard Dams
Alabama	2,241	0	196
Florida	895	890	78
Georgia	5,132	3,915	601
Kentucky	1,114	960	301
Mississippi	3,630	3,847	269
North Carolina	3,262	2,971	1,210
South Carolina	2,439	2,380	205
Tennessee	1,224	661	273
Total	**19,937**	**15,624**	**3,133**

Appendix E: Information Sharing

Information Sharing

The availability and sharing of sensitive information rapidly became an important topic post September 11, 2001. Federal, State and private sector dam owner/operators have become more restrictive regarding public availability of dam risk data and information.
That caution reflects the concern from the Department of Homeland Security Office of Infrastructure that the aggregation of dam risk information from databases, such as the National Inventory of Dams, makes it easier for an adversary to identify vulnerabilities and select high impact targets.

In response to the terrorist attacks of September 11, 2001, there was an increased focus on infrastructure protection nationwide. Following the attacks, the U.S. Army Corps of Engineers removed the NID from public access while the open availability of the NID with 44 fields of information was analyzed. The ICODS NID Subcommittee concluded that most of the NID data did not pose significant security risks to the Nation's dams, and was information that could reasonably be obtained by the general public through other means, such as almanacs. As a result, the Subcommittee recommended to the Corps that the NID be restored to public access. The Corps Headquarters Dam Safety Officer concurred, and the NID was restored to pubic Internet access in August 2002, but with removal of the data fields "Nearest City/Town" and "Distance to Nearest City/Town." Subsequently, two additional fields were later removed from the NID as well, "Hazard Potential Classification" and "Condition Assessment Rating".

In 2004, DHS released the Protection of Critical Infrastructure and Key Resources Information for Dams and Related Facilities Security Classification Guide (DHS SCG OS-003). This guidance document categorized the following type of dam information as For Official Use Only (FOUO): information regarding safety improvements or vulnerability mitigation, information regarding emergency response (such as EAPs, inundation maps and standard operating procedures), risk analysis information (such as, failure causes, consequences estimation and threat assessments), and construction information (such as as-build drawings). The FOUO category is used within DHS to identify unclassified information of a sensitive nature, of which the unauthorized disclosure could adversely impact a person's privacy or welfare, the conduct of Federal programs, or other programs or operations essential to the national interest. FOUO is not to be considered classified information. Although the FOUO categorization is not considered classified information, many dam owner/operators will not share dam risk information with the general downstream population at due to the FOUO categorization of such information in the Security Classification Guide.

In 2005, the DHS Dams Sector, Government Coordinating Council (GCC) released a white paper entitled "Data Security Analysis of the National Inventory of Dams" The white paper recommended continuation of the current security policy prescribed in DHS

SCG OS-003. The GCC was asked to review the existing policy and to provide technical evaluation on the appropriate level of security controls for access to the NID. The GCC tasked the joint Government and Private Sector Information Sharing Sub- work group to evaluate the associated risks and where necessary to present a recommendation with rationale for changes. The Information Sharing Sub-work group, in turn, enlisted the advice and concurrence of the GCC/SCC Asset ID Joint Sub-work group to formulate a sector-wide security recommendation. The following recommendations were presented:

"*The Dam Sector collectively believes that the current security measures for the NID do not adequately protect the information from exploitation by potential adversaries. While the information presented within the NID may be obtainable elsewhere, and the information, on its own, may not be considered as sensitive, the compilation of information within one database aggregates the data. The compiled information reveals associations and relationships that meet the common standards and criteria for a higher level of protection. In keeping with good, commonly accepted security practices, the Sector recommends that availability of the entire NID be limited or restricted to the Dam Sector industry, emergency management, and other defined professionals based on a rigorous need to know basis, via a managed access control system. The Sector firmly believes that the database should not be generally accessible to the public.*

The Sector offers the following potential protection and strategies for consideration:

- *Use a defined domain recognition scheme to control web access. For example, those organizations or individuals who are associated with specific domains (government, specific private sector companies or organizations, federal, state, local governments) are allowed full access to the website; while others are denied open access and must therefore obtain access through an established vetting process.*
- *Password protect the database and establish a User Account Management function that will encompass three primary activities:*
  - *Nominating new users;*
  - *Validating new users; and,*
  - *Reviewing existing users' status periodically for ongoing access and membership.*

This type of account process will require a supporting Help desk function. The Help desk would be required to issue initial user IDs and passwords, as well as to address lost/forgotten user IDs/passwords. Additionally, a protocol will need to be established to allow the Help desk to issue and reissue credentials to users.
Though potentially labor and time intensive, a system of this nature provides greater access protection and improved accountability.

- *Move the NID to the Homeland Security Information Network (HSIN) Dam Sector portal site.*

This type of system would be very secure with a high degree of accountability. However, care must be taken that the private sector has adequate access to HSIN for purposes of access to the NID. HSIN may need to be segmented for those users that have a need to know for the NID, but not the bulk of information contained in HSIN.

- *A combination of a defined domain recognition scheme and an identification and authentication (I&A) scheme.*
  A combination of these methodologies would provide very good security for the NID, as well as support an audit trail of who accesses the database, when, and for what purpose.

In addition, the Sector recommends that the practice of mailing CDs to all requesters be halted. Good security protocols for the distribution of CDs need to be established. Such protocols should include establishment of a vetting system, including individual validation and need to know, for any requests. As this is sensitive information it would be a good practice to encrypt the data to provide an added level of protection prior to providing it to any requesters. This could be easily accomplished with several existing software packages (PGP or WinZip).
Passphrases could then be provided to authorized users via telephone or email.

The Dam Sector feels very strongly that the information compiled in the NID only be available to those with a legitimate, role-based, need-to-know. In the interest of good security, and protection of our critical facilities, appropriate protection strategies need to be taken."

USACE implemented some of Dam Sector recommendations, such as, password control and a vetting/validation process. However, USACE did not integrate the NID into HSIN. USACE has made access to the NID open for the non-government user (with exception of the aforementioned restricted data) with a user name and password. Non-government users can view standard "canned" reports of national and state-by- state statistical information generated from the NID. Non-government users can also query information from the NID database. However, non-government users cannot download the NID data. Federal and State government users may download the NID database, however, must sign the following non-disclosure agreement:

U.S. ARMY CORPS OF ENGINEERS
NATIONAL INVENTORY OF DAMS
FEDERAL, STATE OR LOCAL GOVERNMENT
NON-DISCLOSURE AGREEMENT

1. These provisions govern the use and distribution of the National Inventory of Dams (NID) information maintained by the U.S. Army Corps of Engineers (USACE) provided to a government (federal, state or local) agency Requester who requests internet access to the NID.

2. Definitions - For purposes of these provisions:

a. The terms "Non-Disclosure Agreement" and "NDA" mean this agreement by which requesters certify their understanding that access to the NID is provided pursuant to the terms and restrictions of these provisions, and those such requesters have read the provisions and agree to be bound by them.

b. The term "Recipient" means someone who receives NID data in accordance with the provisions of this Non-Disclosure Agreement.

c. The term "government agency Requester" means someone who requests access to the NID as an employee of a Federal, State or Local government.

3. A government agency Requester shall not be permitted to gain access or view the NID unless the government agency Requester has first agreed to the Government Agency Non-Disclosure Agreement.

4. Any information provided under this agreement is on loan to the Government agency, and must be returned to USACE upon request. This information is not the property of the government agency and is not subject to any Freedom of Information/Public Records acts or similar statutes. The Recipient agrees to notify the USACE NID Manager immediately upon receipt of a request for the information provided under this agreement.

5. A Recipient may only discuss the NID government-restricted fields with other government agencies that have agreed to this NID Non-Disclosure Agreement. The Recipient may check with the NID Manager to determine whether another individual or government agency has previously agreed to this NDA.

6. All NID information shall be maintained by Recipient in a secure place. The Recipient may only share public NID information on a dam by dam basis. The Recipient shall coordinate with the NID Manager before placing any NID information on the internet for public and/or government access. If Recipient receives request for NID information from outside Recipient's government agency, please direct the request to the NID Manager and NID web site.

7. Recipients must destroy/remove or delete NID data within fifteen days of an email request by the NID Manager to do so. Within such time period, each Recipient, if requested to do so, shall also submit to the NID Manager a statement saying that, to the best of its knowledge, all NID data has been destroyed or removed from the Recipient agency's computers.

8. The Recipient remains bound by these provisions unless the NID Manager or USACE rescinds the provisions.

9. The USACE may audit the Recipient's compliance with this non-disclosure agreement.

10. Violation of this non-disclosure agreement may result in criminal or civil sanctions against the Recipient.

11. I hereby certify my understanding that access to National Inventory of Dams (NID) is provided to me pursuant to the terms and restrictions of the above government agency NID provisions, that I have been given a copy of and have read the government agency NID provisions, and that I agree to be bound by them. I understand that the contents of the NID government-restricted fields may only be disclosed within my government agency. I may only share public NID information on a dam by dam basis. I acknowledge that a violation of this agreement may result in negative consequences, including criminal or civil sanctions.

As of April 2015, non-government users no longer need a user name and password to access the NID database. Government users, however, must still obtain a user name and password should they need access beyond the public site to accomplish their official duties, and still sign and submit the aforementioned non-disclosure agreement.

Due to the inconsistency in how the federal agencies are interpreting and implementing the guidance regarding dam information, the Dams Sector Government Coordination Council (GCC), the Sector Coordinating Council (SCC) and the National Dam Safety Review Board (NDSRB) tasked the Dam Sector Information Sharing Work Group to develop a white paper outlining benefits and potential risks associated with sharing Dams Sector safety and security information with sector and cross-sector stakeholders. The scope of the white paper consisted of evaluating the advantages and limitations associated with dissemination of information associated with the safety and security of Dams Sector facilities. To facilitate this, the evaluation was comprised of two phases.
Phase 1 included the completion of a document entitled "Benefits and Disadvantages of Sharing Dam Safety and Security Information". This document was completed and endorsed by the Dams Sector Information Sharing Workgroup and the NDSRB. The document can be used by dam safety and security agencies and entities and assist them in the development of policy and guidance for sharing their dam information.
Phase 2 involved the development of recommendations on what type of dam safety- related information should be shared and which should be safeguarded from the public. At the conclusion of Phase 1, it became clear that the FOUO categorization of emergency action plans (EAP) and inundation mapping has been the most controversial and contentious aspect regarding dams in the Security Classification Guide.

In June 2015, the Dams Sectors Information Sharing Work Group completed the Dams Sector Government Coordinating/Sector Coordinating Councils (GCC-SCC) Information Sharing Workgroup White Paper. The Work Group came to a consensus regarding sharing information to emergency management professionals, but did not come to a complete consensus regarding sharing inundation maps information with the public.
The following is an excerpt from the white paper:

"The Workgroup came to a consensus regarding sharing inundation maps with emergency professionals. In all cases, inundation maps should be shared with all dam regulators, emergency managers, first responders, adjacent critical infrastructure owners and others having roles and responsibilities during emergency conditions related to dam incidents. Sharing the information with emergency professionals decreases the potential impacts resulting from a dam failure, and is believed to outweigh the potential risks of having this information reaching an adversary for exploitation. It is understood that there is a possibility that sensitive information like inundation maps of EAPs, if not properly secured, could be publicly accessed then potentially reach an adversary. Such actions could not only increase the risks to dam safety and security, but more importantly, put people's lives at risk. The owner of the inundation maps should proactively coordinate with emergency management agencies and attempt to establish formal agreements inhibiting those agencies from disclosing the inundation map to the public. Even if this information cannot be guaranteed to be safeguarded from public release, it is believed that the impacts of not sharing inundation maps with emergency management authorities can be severe by putting people's lives at risk, and outweigh the benefits of denying access to emergency professionals.

A majority of the Workgroup agreed that the public should not be able to access information related to inundation maps. The majority of the Workgroup believed that the benefits of sharing inundation maps with the public do not outweigh the potential risks of having this information reaching an adversary for exploitation. As an alternative to releasing inundation maps to the public, it was proposed that risk communication plans incorporating the information be developed and made accessible to the public. These plans should include discussing inundation maps at public meetings and educating the affected downstream communities about their safety risks and emergency evacuation procedures.
The majority believed that public requests for release of inundation maps should be denied, however, there should be proper talking points written and disseminated that go along with the denial to communicate why the maps aren't released. A comprehensive outreach and educational process should be put in place by dam owners, regulators and emergency responders. The public interested in learning about the risks they face should have an opportunity to be informed about these, including whether or not their property is within the estimated inundation area and any resulting risks.

A minority of the workgroup believed that inundation maps should always be made easily accessible since not all of the public would be able to participate in public meetings and they need to have an understanding of potential inundated areas. This group believed that the public should have easy access to information about potential inundated areas. The information could be used to make personal decisions and promotes risk awareness related to living or investing within the inundation zone."

The Information Sharing Work Group white paper recommendations were briefed to the ICODS member agencies' executive leadership during the annual ICODS Senior Leader's Meeting in October 2015. While, the Federal agencies did not reach a consensus regarding sharing inundation maps, there was agreement that communicating dam risk information to populations at risk was critical. The ICODS and the NDSBR were tasked to identify best practices for effectively communicating risks (failure and residual) associated with dams to potentially impacted public.

Appendix F: NID Field Definitions

- *(1) Dam Name (Alphanumeric)*
  The official name of the dam. No abbreviations unless the abbreviation is a part of the official name. For dams that do not have an official name, the popular name is used.

- (4) *State or Federal Agency ID (Alphanumeric)*
  The Official State or Agency identification number for the dam.

- (5) *NID ID (Alphanumeric)*

The official NID identification number for the dam, known formerly as the National ID. This is a required field, and must have an entry for each dam included in the NID. This field is used as the unique identifier for each dam record. The first two characters of the identity are the state two-letter abbreviation, based on the location of the dam. Typically, the last five characters of the identity are a unique number (AB#####); although States are allowed to use alphanumeric combinations in these last five characters.

For saddle dams or dikes, the NID ID is the same as the main dam. See saddle dam definition in Number Separate Structures Field (listed below).

- (11) *County (Alphanumeric)*
  The name of the county in which the dam is located.

- (12) *River or Stream (Alphanumeric)*
  The River or Stream designation may be entered in one of two ways. For the convenience of some organizations, an alternative field entry is provided which is consistent with the "tributary and offstream" designations used in the 1995-96 NID. If the alternative form is used, the NID Data Team will convert it to the standard form prior to inclusion in the national inventory.

  River or Stream Standard Entry: The official name of the river or stream on which the dam is built. If the stream is unnamed, identify it as a tributary to a named river, e.g., *Snake-TR.* If the dam is located offstream, enter the name of the river or stream plus "-OS", e.g., *Snake-OS.*

  River or Stream Alternative Entry: The official name of the river or stream on which the dam is built. If the stream is unnamed, identify it as a tributary to a named river, e.g., *TR-Snake.* If the darn is located offstream, enter the name of the river or stream plus the word, "OFFSTREAM," e.g., *Snake OFFSTREAM.*

- (13) *Nearest Downstream City/Town (Alphanumeric)*

Name of the nearest downstream city, town, or village that is most likely to be affected by floods resulting from the failure of the dam.

- (16) *Owner Type (Alphanumeric)*
  Code to indicate the type of owner: F
  for Federal;
  S for State;
  L for Local Government (defined as have taxing authority or is supported by taxes);
  U for Public Utility;
  P for Private
  X for Not Listed.
  Codes are concatenated if the dam is owned by more than one type. For example, if the dam is owned by a lake association and a public utility, the owner type would be listed as
  PU. For multiple owners under the same type, one code is used. For example, if multiple individuals own one dam, it will list P for private dam ownership.
  Some examples of owner types. Local Government should have taxing authority or is supported by taxes. A Lake District is supported by taxes and considered Local Government. A lake association is supported by association dues and would not be a Local Government owner type but rather Private owner type.

- (19) *Dam Type (Alphanumeric)*
  Codes, in order of importance, to indicate the type of dam: RE
  for Earth;
  ER for Rockfill;
  PG for Gravity;
  CB for Buttress;
  VA for Arch;
  MV for Multi-Arch;
  RC for Roller-Compacted Concrete;
  CN for Concrete;
  MS for Masonry;
  ST for Stone;
  TC for Timber Crib;
  OT for Other.
  Codes are concatenated if the dam is a combination of several types. For example, the entry *CNCB* would indicate a concrete buttress dam type.

- (22) Purposes (Alphanumeric)
  Code(s) to indicate the current purpose(s) for which the reservoir is used: I for
  Irrigation;
  H for Hydroelectric;
  C for Flood Control and Storm Water Management;

N for Navigation;
S for Water Supply;
R for Recreation;
P for Fire Protection, Stock,Or Small Farm Pond; F
for Fish and Wildlife Pond;
D for Debris Control;
T for Tailings;
G for Grade Stabilization;
O for Other.

The order should indicate the relative decreasing importance of the purpose. Codes are concatenated if the dam has multiple current purposes. For example, *SCR* would indicate the primary purposes, *Water Supply,* followed by *Flood Control and Storm Water Management,* and then *Recreation.*

- (23) *Year Completed (Number)*
  Year (four digits) when the original main dam structure was completed. If unknown, and reasonable estimate is unavailable, "0000" is used.

- (24) *Year Modified (Alphanumeric)*
  Year (four digits) when major modifications or rehabilitation of dam or major control structures were completed. Major modifications are defined as a structural, foundation, or mechanical construction activity which significantly restores the project to original condition; changes the project's operation; capacity or structural characteristics (e.g. spillway or seismic modification); or increases the longevity, stability, or safety of the dam and appurtenant structures. Entries should be followed by *one of more of the following codes* indicating type of modification:
  S for structural; F
  for foundation;
  M for mechanical;
  E for seismic;
  H for hydraulic;
  O for other.
  Up to ten modifications can be entered, separated by semicolons.

- (25) *Dam Length (Feet, Number)*
  Length of the dam, in feet, which is defined as the length along the top of the dam. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam, these structures should not be included.

- (26) *Dam Height (Feet, Number)*
  Height of the dam, in feet to the nearest foot , which is defined as the vertical distance between the lowest point on the crest of the dam and the lowest point in the original streambed.

- (30) Maximum Discharge (Cubic Feet/Second, Number)
  Number of cubic feet per second (cu ft/sec) which the spillway is capable of discharging when the reservoir is at its maximum designed water surface elevation.

- (31) Maximum Storage (Acre-Feet, Number)
  Maximum storage, in acre-feet, which is defined as the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.

- (32) Normal Storage (Acre-Feet, Number)
  Normal storage, in acre-feet, which is defined as the total storage space in a reservoir below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage. For normally dry flood control dams, the normal storage will be a zero value. If unknown, the value will be blank and not zero.

- (34) Surface Area (Acres, Number)
  Surface area, in acres, of the impoundment at its normal retention level.

- (35) *Drainage Area (Square Miles, Number)*

Drainage area of the dam, in square miles, which is defined as the area that drains to a particular point (in this case, the dam) on a river or stream.

- (36) *Downstream Hazard Potential (Alphanumeric)*

Code to indicate the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities:

L for Low;
S for Significant;
H for High
U for Undetermined.

Definitions, as accepted by the Interagency Committee on Dam Safety, are as follows:

1. LOW HAZARD POTENTIAL

Dams assigned the low hazard potential classification are those where failure or mis--operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

2. SIGNIFICANT HAZARD POTENTIAL

Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

3. HIGH HAZARD POTENTIAL

Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

3. HIGH HAZARD POTENTIAL

Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more	Yes (but not necessary for this classification)

4. UNDETERMINED HAZARD POTENTIAL

Dams for which a downstream hazard potential, as defined in 1-3 above, has not been designated or is not provided. Note that dams with a code "U" will be considered for NID

inclusion (see Chapter 3) the same as a dam with low hazard potential. If included in the NID, the undetermined classification will be used in publication.

- (37) *Emergency Action Plan (Alphanumeric)*

Code indicating whether this dam has an Emergency Action Plan (EAP) developed by the dam owner. An EAP is defined as a plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood.

Y for
Yes; N
for
No;
NR for Not Required by submitting agency.

If an EAP is required (or not required) and has one, it will be listed Y for Yes. If an EAP is required and does not have one, it will be listed N for No. If there is not an EAP and one is not required, it will be listed NR for Not Required.

FIRM Panel is not part of the NID Database
FIS Effective Date is not part of the NID Database
FIRM Effective Date is not part of the NID database.

- (41) *Condition Assessment (Alphanumeric)*

Assessment that best describes the condition of the dam based on available information.

Satisfactory;
Fair;
Poor;
Unsatisfactor
y
Not Rated.

Definitions, as accepted by the National Dam Safety Review Board, are as follows:

1. SATISFACTORY

No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

2. FAIR

No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.

3. POOR

A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.

4. UNSATISFACTORY

A dam safety deficiency is recognized that requires immediate or emergency

remedial action for problem resolution.

5. NOT RATED

   The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Appendix G: Acronyms

ASDSO – Association of State Dam Safety Officials
CAP – Civil Air Patrol
CISA – Carolinas Integrated Sciences & Assessments
COR – Contractor Officers Representative
CSLF – Changes Since Last FIRM
DHS – Department of Homeland Security
DSAT – Dam Sector Analysis Tool
DSS-WISE – Decision Support System for Water Infrastructure Security
EAP – Emergency Action Plan
EHP – (FEMA) Environmental and Historic Preservation
EMA – (local) Emergency Management Agency
ESF – Emergency Support Function
FCO – Federal Coordinating Officer
FDRC – Federal Disaster Recovery Coordinator
FEMA – Federal Emergency Management Agency
FERC – Federal Energy Regulatory Commission
FIRM – Flood Insurance Rate Map
FIS – Flood Insurance Study
FMA – Flood Mitigation Assistance
FRD – Flood Risk Database
FRM – Flood Risk Map
FRR– Flood Risk Report
FTE – Full Time Equivalent
GeoDamBREACH – Geospatial Dam Break, Rapid EAP, Consequence and Hazards
GIS – Geographical Information System
HAZUS – Hazards United States
HBRSEP – H.B. Robinson Stream Electric Plant
HH – High Hazard
HMA – Hazard Mitigation Assistance
HMP – Hazard Mitigation Plan
HMGP – Hazard Mitigation Grant Program
HWM – High Water Marks
IAW – In Accordance With
ICODS – Interagency Committee on Dam Safety
IP – Infrastructure Protection
JFO – Joint Field Office
MA – Mission Assignment
NDSP – National Dam Safety Program
NDSRB – National Dam Safety Review Board

NFHL – National Flood Hazard Layer
NFIP – National Flood Insurance Program
NID – National Inventory of Dams
NOAA – National Oceanic and Atmospheric Administration
NOFO – Notice of Funding Opportunity
PA – (FEMA) Public Assistance
PDM – Pre-Disaster Mitigation
PMF – Probable Maximum Flood
Risk MAP – Risk Mapping, Assessment and Planning
RPO – Regional Project Officer
RRCC – Regional Response Coordination Center
SBA – Small Business Administration
SCDHEC – South Carolina Department of Health and Environmental Control
SCDNR – South Carolina Department of Natural Resources
SCEMD – South Carolina Emergency Management Division
SCO – State Coordinating Officer
SDRC – State Disaster Recovery Coordinator
SEOC – State Emergency Operations Center
SERT – State Emergency Response Team
SFHA – Special Flood Hazard Area
SHMO – State Hazard Mitigation Officer
SL – Santee-Lynches Region
TADS – Training Aids for Dam Safety
TVA – Tennessee Valley Authority
UM-NCCHE – University of Mississippi National Center for Computational Hydroscience and Engineering
USACE – United States Army Corps of Engineers
U.S.C. – United States Code
USDA – United States Department of Agriculture
USGS – United States Geological Survey
WRRDA – Water Resources Reform and Development Act
WSEL – Water Surface Elevation