Gills Creek Watershed: Assessment of Regulated Dams

Photo of Cary's Lake Dam Breach

February 15, 2016

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REPORT VERIFICATION

PROJECT NAME: Gills Creek Watershed Assessment of Regulated Dams Report

REVISION No.: 0

This is to certify that I, James R Devereaux, P.E., have reviewed and prepared the attached document and have satisfied myself that the work performed was conducted in conformance with generally accepted industry practice.

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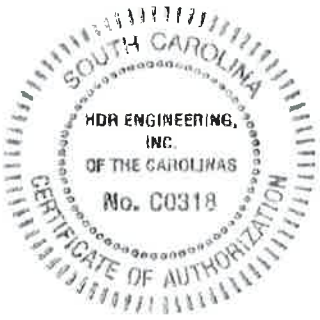

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Executive Summary

The Gills Creek Watershed is a hydrologically complex watershed consisting of Gills Creek and 5 tributaries with 23 regulated dams and an unknown number of smaller, unregulated dams, impoundments, and ponds. Based upon our initial analysis of the 23 dams regulated by DHEC in the watershed, the rebuilding of the water management infrastructure of the Gills Creek Watershed will require close coordination of the design criteria, principal and auxiliary spillway capacity, emergency action plans, and flood plain management.

HDR observed the condition of the regulated dams shortly after the October 2015 flood which exceeded a 1,000-year precipitation event within the Gills Creek Watershed. HDR found that the performance of the dams, summarized in the table below, indicates significant variation in rainfall runoff characteristics within the basin and with the capability of dams to attenuate and safely pass flood events.

Performance of Regulated Dams in Response to October 2015 Flood

Hazard Class	No. of Dams	Dams Overtopped	Breach	Spillway Impairment	High Concern
High Hazard	17	11	3	6	5
Significant Hazard	4	2		1	1
Low Hazard	2	0		1	1
Total	23	13	3	8	7

Seven dams are identified to be of high concern under observed conditions because of increased susceptibility to overtopping or internal erosion potentially resulting in further damage in the event of a future significant rainfall event. Future rainfall events up to the 100-year return interval were evaluated to assess susceptibility of regulated dams under observed conditions. Current South Carolina State dam safety standards require high hazard dams to safely pass a Spillway Design Flood (a.k.a. Inflow Design Flood) between the 50 percent Probable Maximum Flood (PMF) and the full PMF unless the dam is “very small” (impoundment storage less than 50 acre-feet and dam height less than 25 feet). Significant hazard dams should be evaluated for inflows between the 100-year flood and full PMF. The maximum rainfall return period of 100 years was used in this study to evaluate the hydraulic response of the Gills Creek basin as a system of connected impoundments for a significant basin-wide rainfall event. The scope of this study was not to evaluate each dam and impoundment for the Spillway Design Flood (SDF) but to provide a tool that could be used to evaluate future flooding potential and dependency between impoundments for regulating runoff in the basin.

Overtopping of 10 dams classified as high hazard (that pose potential downstream threat to life) indicate these dams may not have adequate spillway capacity in accordance with dam safety criteria required by the DHEC Dam and Reservoirs Safety Act.

HDR’s observations also indicate maintenance practices that are not consistent with prudent dam safety practices, including trees and woody underbrush on embankment

dams, steep embankment slopes, low areas of embankment crests, additional water lines and conduits within the embankment dam that are not associated with the service spillway, and spillways constructed of inadequate and outdated materials (e.g. corrugated metal pipes) that are susceptible to corrosion and subsequent leakage or piping.

The variance in performance of the dams during the October 2015 storm indicates a need to perform a watershed-wide evaluation of the design and health of the Gills Creek Watershed dam/reservoir system and its ability to provide the appropriate capability to safely pass significant storm events. Evaluation of the following dam safety aspects of the Gills Creek Watershed should be considered:

- Hazard Classification
- Spillway Adequacy
- Detailed Condition and Design Assessment
- Maintenance Practices
- Emergency Action Plans

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1 Introduction

HDR performed engineering services for the South Carolina Department of Health and Environmental Control (DHEC) subsequent to an October 2015 storm event that caused flash flooding within the Gills Creek Watershed in Richland County, South Carolina. These services included initial condition assessments and hydrologic evaluations of 23 dams regulated by the DHEC. The storm event resulted in a total accumulation of over 21 inches of precipitation between October 2 and 5 within the Gills Creek Watershed, with a peak 24-hour total of 16.69 inches on October 4. Flooding resulted in the failure of three dams and significant damage to others, thereby compromising their ability to safely pass future flood events. Dams with impaired spillways that have reduced capability to pass floods can be expected to experience elevated pond levels in response to future flood events and increased potential for overtopping. This increased potential for elevated pond levels is a concern at dams that have sustained damage and are now more susceptible to further damage and possible failure under elevated flood levels and overtopping conditions.

The purpose of this report is to provide an overview of the increased potential of elevated flood levels and overtopping of damaged dams due to spillway impairment from flood events up to the 100-year flood. Dams identified to have impaired spillways are associated with spillways for which future operation is considered to be restricted because of damage sustained during the flood, and which are now susceptible to additional damage that could result in further degradation of the spillway or erosion of the embankment dam.

This report and modeling effort is not intended to characterize the incremental damage related to dam failures, nor is it intended to represent a dam breach analysis for inundation mapping. It is a foundational tool for those future modeling activities to support a more robust watershed planning effort should one be implemented.

This report summarizes the overall general condition of the dams based on limited visual observations from site visits conducted between October 15 and October 21, 2015. The condition assessment identifies dams that were observed to have visible damage and spillway impairment sustained from the October flood. A high-level hydrologic model of the Gills Creek Watershed was developed to estimate peak pond elevations that may result from future flood events based on the current condition of the regulated dams, and indicate regulated dams that may be susceptible to overtopping.

In addition to identifying increased susceptibility of damaged dams, the assessments provide an understanding of the overall performance of the regulated dams during the October flood, including apparent deficiencies in their ability to safely pass floods as required by DHEC dam safety regulations. The performance of the dams indicates a need for a comprehensive review of the current health and design of the dams in the context of a more comprehensive dam safety regulation program, and the need for an updated dam design database considering changes in the watershed system including hydrology, resources, land use, and public safety.

1.1 Site Visits

Site visits to regulated dams within the Gills Creek Watershed were conducted to visually assess the overall condition of the dams subsequent to the recent flood event of October 2–5, 2015.

The site visit objectives included:

- Documentation of the general current condition of dams, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of dams and spillways, and impairment of site discharge capacity.
- Documentation of the type of each dam and spillway, and estimates/measurements of existing facilities and features and of damaged areas.
- Documentation of the extent of overtopping that occurred indicated by high-water marks, debris, and other flood damage evidence.
- Documentation of the interim repair and risk reduction measures completed by others.

Detailed site visit reports for the 23 regulated dams are provided in Appendix D.

This information is intended to provide the DHEC with initial information that will allow them to make informed decisions regarding implementation of actions under their authority.

1.2 Hydrologic Evaluations

A HEC-HMS model was developed of the Gills Creek Watershed and system of regulated reservoirs to simulate runoff from future storm events to support an assessment of susceptibility of damaged regulated dams to pass modeler-defined storm inflows. The model does not directly account for unregulated dams and impoundments. The model simulates runoff response to rainfall based on hydrologic characteristics of the watershed, and estimates peak pond levels at identified state jurisdictional dams based on estimates for current active reservoir storage and spillway capacity. The model was developed based on limited information available from DHEC record files and publicly available information, and was augmented by actual site conditions that were visually observed during site visits conducted by HDR subsequent to the October storm event. Field measurements of certain outlet facilities at several sites differed from information shown on file drawings; HDR incorporated file drawing information into the model as those differences have negligible effect on model results. Model parameter approximations consistent with the overall purpose of the model were made by the hydraulic modeler to address missing design and construction information from available dam files or substitute for information not obtainable from visual observation of damaged dam sites. The watershed model was developed to simulate hydraulic connectivity of the regulated dam system within the watershed. The model provides conservative estimates of peak reservoir elevations within the regulated dam system in response to simulated rainfall events without the attenuation effects of non-regulated ponds and reach routing. Should additional data become available for the smaller, unregulated dams and ponds

within the watershed, the model can be further refined to reduce the level of conservatism provided by the current results.

Four 24-hour rainfall events were simulated: 1-inch, 2-inch, 10-year (5.26 inches), and 100-year (8.43 inches). The October 2015 storm had a maximum 24-hour rainfall of 16.69 inches.

The development of the model and results of flood scenarios is summarized in a memorandum in Appendix C.

1.3 Gills Creek Watershed

The Gills Creek Watershed consists primarily of Gills Creek and its tributaries and water bodies—Jackson Creek, Bynum Creek, Rose Creek, Mack Creek, Wildcat Creek, Cary's Lake, and Spring Lake—which encompass over 70 miles of numerous named and unnamed streams and ponds. The Gills Creek Watershed covers 74.5 square miles including parts of Columbia, Forest Acres, and Fort Jackson, a U.S. Army basic combat training center. With its headwaters originating along the local topographic high area located northeast of the intersection of Interstates I-77 and I-20, several smaller creeks converge near Sesquicentennial State Park to form Gills Creek which flows through the northeastern section of the City of Colombia and eventually drains into the Congaree River (reference: Gills Creek Watershed Management Plan, May 2009).

A total of 23 regulated dams are located within the upper 53.8 square miles of the Gills Creek Watershed above Lake Katherine Dam (approximately 72 percent of the total watershed based on DHEC file data). Appendix B provides a watershed map of Gills Creek drainage above Lake Katherine Dam showing the sub-watersheds for each of the regulated dams.

The Gills Creek drainage basin above Lake Katherine Dam is characterized by three general areas:

- The Upper Southern portion of the watershed, with a drainage area of 22.4 square miles (42 percent) upstream of Upper (North) Rocky Ford Lake Dam (a.k.a. North Lake Dam), is generally unregulated and primarily within the boundaries of Fort Jackson with only two dams regulating approximately 2 square miles at the upstream end of the watershed. This sub-watershed has 309 acre-feet of active reservoir storage, which represents about 7 percent of the total active storage of Gills Creek Watershed.
- The Upper Northern portion of the watershed, with a drainage area of 19.8 square miles (37 percent) above Cary's Dam, is highly regulated with 15 dams upstream of Cary's Dam. Active reservoir storage is 2,009 acre-feet, comprising about 46 percent of the entire basin.
- The Lower portion of the basin has an intermediate drainage area of 11.6 square miles between the two upper Northern and Southern portions of the watershed and Lake Katherine Dam; 2.3 square miles of this lower sub-watershed is regulated by three dams. A total active storage of 2,052 acre-feet is provided by these three dams and Lake Katherine, comprising 47 percent of total storage within the Gills Creek drainage basin.

The majority of large impoundments in the watershed are managed by home and Lake Owner's associations. Lake Katherine is the largest reservoir which has a surface area of 142 acres and 1,000 acre-feet of active storage. However, most of the reservoirs are relatively small, with surface areas less than 30 acres and little storage. Four dams impound ponds with surface areas of 7 acres or less. All reservoirs are impounded by embankment dams ranging in height from 13 feet to 30 feet, with lengths between 260 feet and 1,400 feet. These embankment dams are non-overflow structures, except the embankment dam at Forest Lake which was retrofitted with armoring to resist erosion from overtopping. Most dams have a service spillway and an auxiliary spillway, some dams have no service spillway, and some have multiple auxiliary spillways. The dams have a wide range of spillway capacity ranging from 27 cfs (Hughes Dam) to 10,000 cfs (Forest Lake Dam).

1.4 FEMA Guidelines

For the purposes of this assessment HDR has adopted the following guidelines from FEMA P-94 *Selecting and Accommodating IDF for Dams* (August 2013):

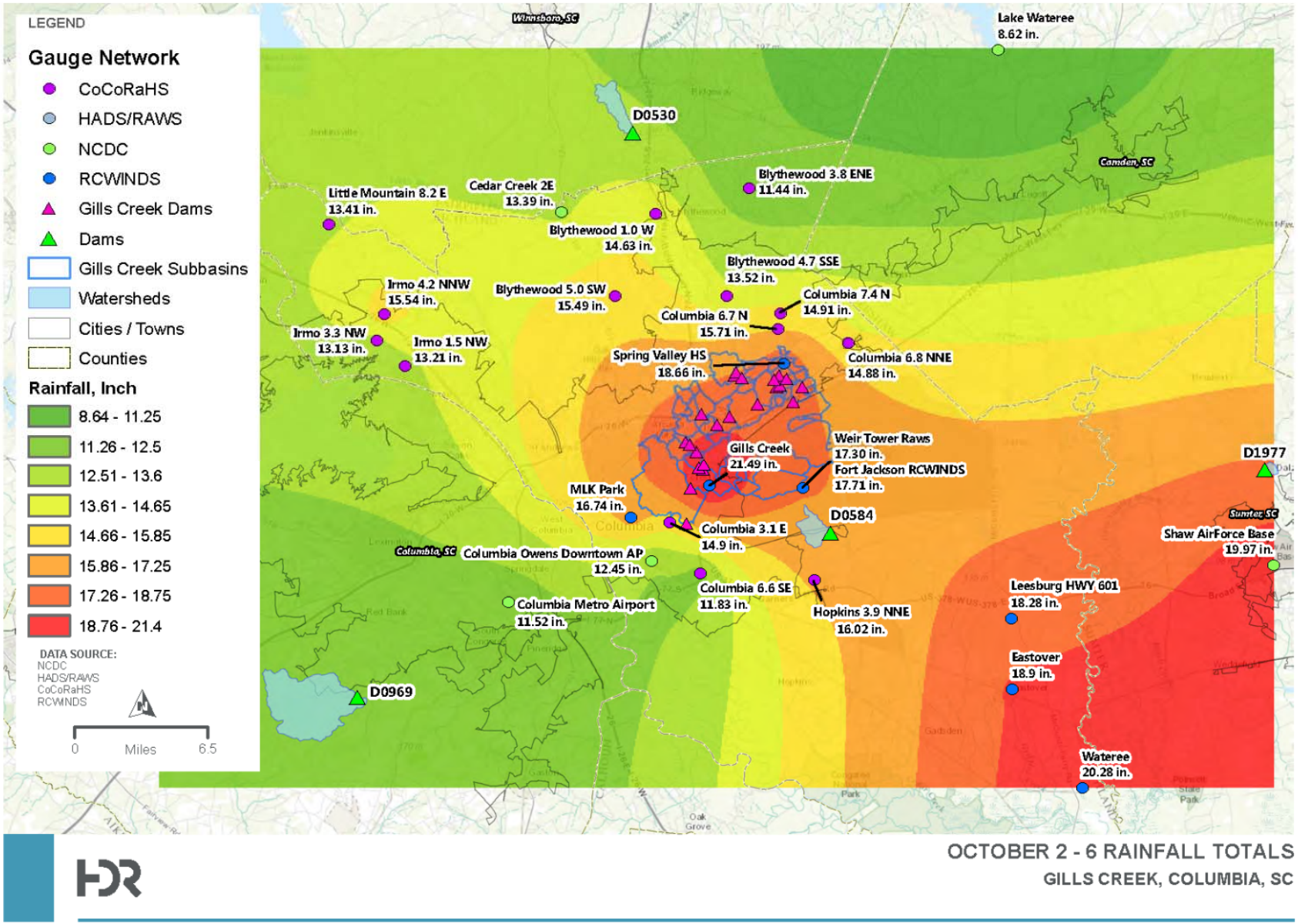
> "Dams and their appurtenant structures should be designed to give satisfactory performance. In addition to distinguishing between controlled and uncontrolled spillways, these guidelines identify three specific types of spillways: (1) service or principal spillways, (2) auxiliary spillways, and (3) emergency spillways. Outlet works can also be used to lower reservoir levels in anticipation of a flood event or to pass floodwaters.
>
> *Service spillways* should be designed for frequent use and should safely convey releases from a reservoir to the natural watercourse downstream of the dam. A service spillway should exhibit excellent performance characteristics for frequent and sustained flows, such as up to the 100-year flood event. In general, service spillways should pass design flows without sustaining any damage.
>
> *Auxiliary spillways* are usually designed for infrequent use. It is acceptable for an auxiliary spillway to sustain limited damage during passage of the IDF [Inflow Design Flood] provided it does not jeopardize the structural integrity of the dam or the function of the spillway. Reference to these spillways as "emergency spillways" should be discontinued. Media references to flow through "emergency spillways" often leads to a misconception by the public that an emergency condition exists at a dam when the dam is safely functioning as designed.
>
> *Emergency Spillways* are not intended to be used for the routing of the IDF. They are provided where there is a desire to protect against a malfunction of another feature required to safely pass the IDF."

1.5 2015 October Storm Event

The October 2015 storm event resulted in a total accumulation of more than 21.49 inches of precipitation between October 2 and 5 as recorded at the Gills Creek gauge maintained by the Richland County Emergency Services Department. The rainfall peaked on October 4 with a 24-hour total of 16.69 inches of precipitation; and the total 48-hour precipitation October 3–4 was 19.92 inches. These precipitation amounts far

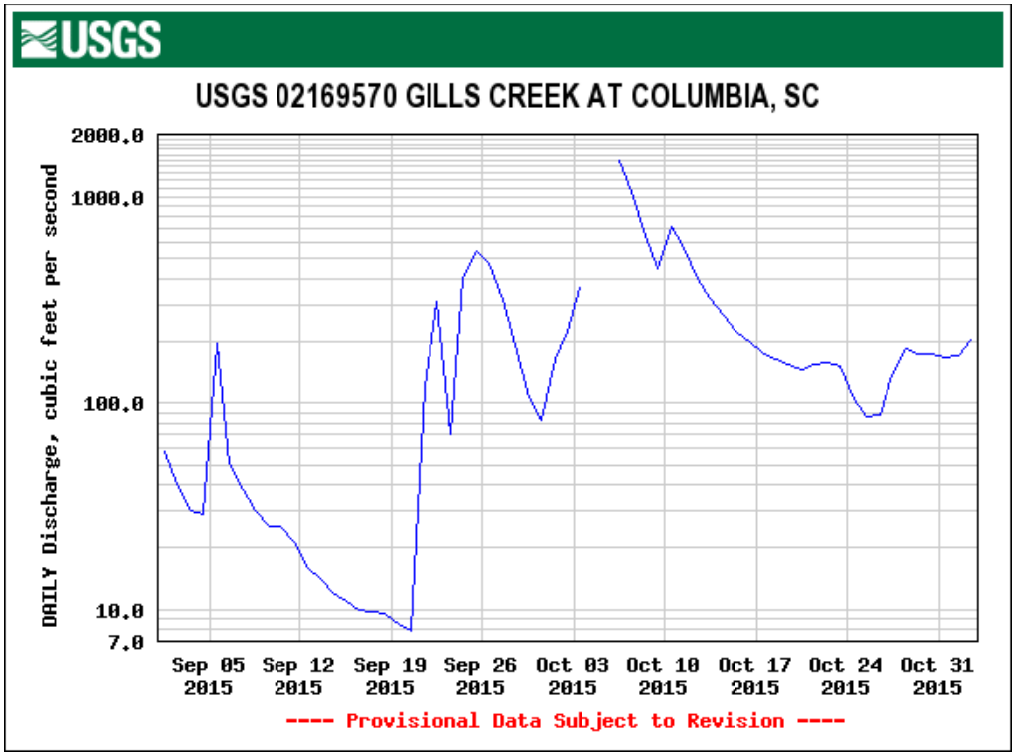
exceed 1,000-year events of 12.8 inches and 14.1 inches, respectively (NOAA Atlas 14, 2006). It is important to note that the distribution of precipitation frequency at the time of establishment of design criteria changes with additional hydrologic record (e.g. the statistical 100-year precipitation event determined in 1970 based on available precipitation records would be expected to be different compared to the current 100-year precipitation event based on frequency analysis of additional 45 years of record through 2015).

Figure 1. October 2–6 Rainfall Totals



The stream flow released from the regulated watershed at Lake Katherine dam during the storm event was recorded at the USGS gage located approximately 900 feet downstream of Lake Katherine Dam and is shown in Figure 2. The stream flow data indicates a maximum flow of about 1,500 cfs was recorded; however, stream flows were not recorded during the period of peak rainfall and runoff on October 4. These stream flow records include storage releases from failed dams upstream of Lake Katherine.

Figure 2. USGS Gage: Gills Creek at Columbia, SC



2 Significant Observations

Significant observations made during the site visits are provided in the HDR Site Observations Summary: SCDHEC Regulated Dams in a table presented in Appendix A. Detailed observations, including photographs and sketches of conditions during the site visits, are provided in the Site Assessment Reports included in Appendix D.

Within the Gills Creek Watershed the October storm event resulted in the breach of three dams and significant impairment of spillway capacity for eight dams. Seven dams were identified as high concern with potential for significant damage or failure in the event of a future significant storm event based on observed conditions of compromised integrity and spillway impairment. Table 1 below summarizes these dams by DHEC hazard classification, and a detailed discussion is provided in Section 3.

Table 1. Summary by Hazard Class

Hazard Class	No. of Dams	Dams Overtopped	Breach	Spillway Impairment	High Concern
High Hazard	17	11	3	6	5
Significant Hazard	4	2		1	1
Low Hazard	2	0		1	1
Total	23	13	3	8	7

2.1 General Observations

Site observations provided an understanding of the general condition of the dams and maintenance practices for assessment of the performance of the dams during the flood event (Section 3). Site observations also revealed discrepancies in the type and configuration of dams and appurtenances compared to information in DHEC files, including drawings and pertinent data.

Embankments - The crest and slopes of embankments were observed to have a wide range of vegetative cover and overall maintenance (including some with bituminous roadways), which provides resistance to surficial erosion. Most of the embankment dams have significant trees and woody vegetative growth, and steep and irregular embankment slopes. Woody growth on embankment dams does not reflect prudent dam safety practices and does not comply with DHEC dam safety requirements due to potential for internal erosion (piping) along voids created by root systems. The crest of several embankment dams appeared to have some low areas. Several embankment dams have water utility, stormwater drainage, or irrigation pipes through or in the vicinity of the dam, which could provide opportunity for internal erosion of embankments resulting from pipe leakage or piping along the conduit.

Service Spillways - All of the dams inspected have a service spillway consisting of a low-level outlet pipe typically with a drop inlet and/or low-level gated inlet. The general condition of visible portions of service spillway drop inlets and outlet pipes ranged from poor to good, with minor to moderate deterioration observed. Drop Inlets were equipped with trash screens; however, several were significantly corroded. Where available, the mechanical operators for low-level inlets to the outlet pipe, which are designed to draw down the pond for maintenance purposes, or in anticipation of a flood event, were observed for many service spillways. However, the operating condition of many of those mechanical operators and low-level inlets could not be safely verified from visual observations made during the site visits due to debris obstruction or submerged conditions.

As discussed in Section 3, some of the low-level outlet pipes may have leaked during the storm event, or experienced piping along the outside periphery of the outlet pipe that may have contributed to internal erosion and embankment crest/slope subsidence/ sloughing. It is unknown how many low-level outlets were attempted to be operated during the storm event.

Auxiliary Spillways – Most of the dams have one auxiliary spillway consisting of an uncontrolled overflow earth channel with grass cover, or a concrete uncontrolled overflow

spillway channel. Of the 23 dams, 7 do not have an auxiliary spillway, 11 have one auxiliary spillway, and 5 have more than one auxiliary spillway. The 5 dams with more than one auxiliary spillway include:

- Lake Katherine Dam (D 0027) that has an earthen uncontrolled auxiliary spillway, a grouted-rockfill overflow spillway, and a low-level gated outlet structure;
- Cary's Lake Dam (D 0026) that had two concrete overflow auxiliary spillways prior to them being breached;
- Forest Lake Dam (D 4434) with its earthen embankment designed with armored overflow protection to pass overtopping flow in addition to the concrete auxiliary spillway;
- Sesquicentennial Park Pond Dam (D 0569) that has two stone dams sequentially located in a bypass channel in lieu of a concrete or earthen auxiliary spillway channel; and
- Springwood Lake Dam (D 0558) that has an auxiliary concrete drop inlet with low-level outlet and a concrete overflow auxiliary spillway.

3 Performance of Dams

Table 2 at the end of Section 3 provides an overview summary of the performance of the dams, including the identification of dams that were overtopped, breached, or experienced significant spillway impairment. Each dam was assigned a level of concern based on judgment of observed conditions and spillway impairment (Appendix B). This reflects the general level of potential for further damage to the dam and appurtenances in the event of future significant rainfall events.

Thirteen dams overtopped, including ten with auxiliary spillways, indicating insufficient spillway capacity to pass the flood flows (either inadequate spillway capacity and/or spillway impairment). Many of these dams sustained only minor erosion, while others had significant erosion, including slope failures and breach of the embankments. The three dams that breached would have contributed to overtopping and/or significant erosion to downstream dams as discussed below.

Several embankments had sloughs on the upstream slope apparently caused by the draw down of the pond after saturation at peak flood levels, indicating slope instability due to excessive pore pressures.

At Rocky Ford Lake Dam and Upper (North) Rocky Ford Lake Dam the concrete overflow auxiliary spillways failed without overtopping of the embankment. Other concrete and grassed auxiliary spillways sustained damage ranging from minor surficial erosion of grassed spillways to undermining and washout of concrete aprons and wingwalls (Windsor Lake and Spring Lake Dams). It should be noted that failure of Upper (North) Rocky Ford Lake Dam auxiliary spillway would have been expected to contribute to the washout of Rocky Ford Lake Dam auxiliary spillway.

Site visit observations of debris accumulations which would reduce spillway capacity were limited to only a few dams and were not a significant concern for future rain events. However, debris accumulation that could have compromised spillway capacity during the

rain event, and could have contributed to overtopping, may have washed away during the flood or been removed after the flood prior to the site visits.

Dams with spillway impairment are associated with spillways where future operation is restricted because of damage sustained during the flood, and which are now susceptible to additional damage to the dam and could result in further erosion of the embankment dam. This includes the following five dams with spillway outlet pipes that may have leaked during the flood event or experienced piping along the outlet pipe which contributed to internal erosion of the embankment dam (detailed inspections of these outlet pipes by an Owner's Engineer are recommended). The pond level was being maintained well below normal level at the time of the site visit to each of these dams.

- Wildewood #4 (D 0564)
- Wildewood Pond #1 (D 0568)
- Beaver Dam/Wildewood Pond #2 (D 0567)
- Pine Springs Lake CMPLX 2 (D 0561)
- Arcadia Woods (D 0557)

3.1 Breached Dams

Three regulated dams within the Gills Creek Watershed were breached during the October storm event resulting in uncontrolled releases of water. A brief summary of each breach is discussed below.

Cary's Lake (D 0026): Cary's Lake Dam and spillways breached from apparent overtopping. It is possible that the breach of an upstream non-regulated dam (Pine Tree Dam), located between Cary's Lake and Windsor Lake Dam, may have contributed to the overtopping. Breached conditions provide natural river channel conveyance of significant runoff events with some constriction due to debris and no attenuation due to the loss of lake storage capacity. Abutments at left and right banks are susceptible to further erosion from significant runoff events, but this erosion would not be expected to contribute to downstream flooding. For these reasons, the overall concern for this site is considered to be low.

Rocky Ford Lake (D 0028): The auxiliary spillway breached, and stream flow is conveyed through the resulting earth channel. Service spillway functionality is undetermined. The remaining earth channel, left earthen slope, and right embankment are susceptible to significant erosion from flow in the auxiliary spillway. This dam is considered to be of moderate concern due to susceptibility of erosion that could lead to further slope failure of the embankment. Runoff to Rocky Ford Lake Dam is from the large, unregulated, northeast portion of the Gills Creek Watershed, with only minimal attenuation of peak runoff flows from Upper Rocky Ford Lake located upstream.

Upper (North) Rocky Ford Lake (D 0029): The auxiliary spillway breached, and stream flow is conveyed through the resulting earth channel. Service spillway functionality is undetermined. The remaining earth channel and left and right embankment slopes are susceptible to significant erosion from river flow. This dam is considered to be of moderate concern due to susceptibility to erosion that could lead to further slope failure

of the embankment, and the consideration that runoff to the dam is from a large, unregulated sub-drainage area.

3.2 Future Significant Rain Events

Rainfall scenarios up to the 100-year rainfall event were evaluated to estimate impacts to the post-flood reservoir system using the HEC-HMS model developed for the watershed (Appendix C). Rainfall events up to the 100-year return interval were considered appropriate for the scope of the study which was to evaluate the susceptibility of regulated dams for near-term rainfall events forecasted for the Columbia, SC area. HDR has been assisting DHEC with monitoring rain forecasts for the State since the October 2015 event. The 50th percentile, first quartile Atlas 14 rainfall distribution, was used for all scenarios. These scenarios include:

- A one-inch rainfall, uniform over the watershed over 24 hours;
- A two-inch rainfall, uniform over the watershed over 24 hours;
- The 10-year Atlas 14 rainfall of 5.26 inches over 24 hours and uniform over the watershed; and
- The 100-year Atlas 14 rainfall of 8.43 inches over 24 hours and uniform over the watershed.

Initial reservoir elevations were set to the primary outlet elevations (normal pool); and current spillway capacities were assumed for the model simulation. Model results are summarized below for rain events that would activate the auxiliary spillway, and events that would bring the pond level within 1.0 foot of the crest of the embankment dam; considering the accuracy of the HEC-HMS model, this would conservatively indicate potential for overtopping of the embankment. The peak elevations estimated by the model indicate potential overtopping of seven dams for 10-year and/or 100-year storm events, which are generally consistent with dams that were observed to have been overtopped during the October storm event which exceeded a 1,000-year rainfall event. One exception included Entrance Lake Dam for which the model estimated potential for overtopping from a 100-year storm. However, there were no indications of overtopping of the embankment observed during the site visit. Conversely, indications of overtopping of the Deer Lake Dam were observed during the field visit even though the HEC-HMS model results did not indicate potential for overtopping for the 100-year storm event. These types of modeling inconsistencies are commonly found when approximations are required to simulate the complex hydraulics found in basins that contain multiple dams and sources of runoff and storage. The results should be viewed as additional information related to understanding the interaction of storage and runoff in the Gills Creek basin but should be treated as approximate results consistent with the extent of available information and the defined scope of the study.

Auxiliary Spillway Activation

1-inch/24-hour rainfall event

The model results indicate that rainfall events equal to or greater than the 1-inch/24-hour rainfall would likely activate the auxiliary spillways for nine dams listed below.

- Lake Katherine Dam (D 0027)
- Forest Lake Dam (D 4434)
- Sesquicentennial Dam (D 0569)
- Spring Lake Dam (D 0025)
- Wildewood Pond Dam 5 (D 0565)
- Wildewood Pond #1 Dam (D 0568)
- Beaver Dam/Wildewood Pond #2 (D 0567)
- Springwood Lake Dam (D 0558)
- Deer Lake Dam (D 0137)

As discussed below in Section 3.3, the Spring Lake Dam is susceptible to further erosion if the flow is discharged through the auxiliary spillway before temporary repairs are completed. The auxiliary spillway activated by the 1-inch rain event at Wildewood Pond #1 Dam and Beaver Dam/Wildewood Pond #2 are excavated temporary emergency earth channels which may result in erosion and sedimentation downstream.

2-inch/24-hour rainfall event

The model indicates that a 2-inch rainfall event would activate the auxiliary spillway at Entrance Lake Dam (D 0450) in addition to the nine dams listed above.

10-year/24-hour rainfall event

The model results indicate that for a 10-year/24-hour rainfall event, the auxiliary spillways of the two additional dams listed below would be activated (a total of twelve dams, including the ten listed above):

- Windsor Lake Dam (D 0571)
- Commons Pond Dam (D 4201)

Site observations of seepage and undermining of the auxiliary spillway at Windsor Lake Dam indicates potential for further erosion from activation of the auxiliary spillway.

100-year/24-hour rainfall event

The model results indicate that an auxiliary spillway will be activated at the Upper Windsor Lake Dam (D 0570) under a 100-year/24-hour rainfall event in addition to the twelve dams listed above.

Potential Embankment Crest Overtopping

The results of the HEC-HMS model indicate that the 1-inch and 2-inch/24-hour rainfall events would not result in pond levels that would result in overtopping of the

embankment crest of any of the regulated dams as the existing service and auxiliary spillways and outlet structures appear to be adequate to pass this inflow.

10-year/24-hour rainfall event

The results of the HEC-HMS model indicate that the 10-year/24-hour rainfall scenario may bring the pond level within 1.0 foot of the embankment crest for three dams, indicating potential for overtopping:

- Spring Lake Dam (D 0025)
- Entrance Lake Dam (D 0450)
- Arcadia Woods Lake Dam (D 0557)

100-year/24-hour rainfall event

The HEC-HMS model indicates the 100-year/24-hour rainfall scenario might result in peak pond elevations within 1.0 foot of the embankment crest indicating potential for overtopping of four dams in addition to the three dams listed above:

- Sesquicentennial Dam (D 0569)
- Wildewood Pond #4 Dam (D 0564)
- Wildewood Pond #1 Dam (D 0568)
- Springwood Lake Dam (D 0558)

3.3 Dams of High Concern

Seven dams that have a reduced ability to pass a future significant rainfall event due to partial failure/significant erosion of the embankment dam and/or significant impairment of spillway capacity are considered to be of high concern.

Spring Lake (D 0025): This high-hazard dam sustained significant damage to the concrete auxiliary spillway and embankment dam due to overtopping. Spring Lake Dam is located downstream of Cary's Lake Dam, so the breach of Cary's Lake Dam may have increased peak overtopping conditions at Spring Lake Dam. The right wing wall of the auxiliary spillway washed out, allowing significant erosion of the abutting embankment dam. Overtopping of the embankment dam resulted in undercutting and significant erosion of the downstream slope of the embankment. This dam is of high concern because the embankment dam section adjacent to the auxiliary spillway would be susceptible to further erosion and failure if flow is discharged through the auxiliary spillway prior to completing temporary repairs. The HEC-HMS model estimates that this could occur for a 1-inch rainfall event or greater, and may be overtopped from a 10-year flood event conservatively assuming the pond is at normal level at the beginning of the rainfall event.

Wildewood #4 (D 0564): This high-hazard embankment dam sustained undercutting and significant erosion of the downstream slope of the embankment in the area of the service spillway outlet. Site conditions indicate overtopping of the embankment had occurred. The pond is maintained at low level to minimize potential for seepage and destabilization of the compromised section of the embankment at elevated pond levels, and to provide additional active storage to attenuate future rainfall events. This dam is of high concern

because of spillway impairment due to potential susceptibility to internal erosion, which increases potential for elevated pond levels during significant rainfall events. There is no auxiliary spillway, and temporary pumps are the only means for discharging flow from the pond. The HEC-HMS model estimates that this dam could be overtopped from a 100-year flood event conservatively assuming the pond is at normal level at the beginning of the rainfall event.

Beaver Dam/Wildewood Pond #2 (D 0567): This significant-hazard embankment dam sustained significant subsidence during the storm event in the area of the service spillway. An emergency channel was excavated at the left abutment during the flood event to minimize overtopping and prevent full breach of the embankment dam. Rock fill was placed in the area of subsidence, and an upstream sheet-pile cofferdam was installed to isolate the damaged area of the embankment. Potential leakage from the service spillway outlet pipe (or piping along the external perimeter of the pipe) may have contributed to the subsidence. Further inspection of the outlet pipe is recommended by an Owner's Engineer to determine the root cause of the subsidence. The pond is maintained at low level to minimize seepage and destabilization of the failed section of the embankment and to provide additional active storage in the pond. Temporary pumps are the only means for discharging flow from the pond until levels reach the temporary excavated emergency spillway channel. The HEC-HMS model estimates that the emergency spillway channel would be activated for a 1-inch rainfall event. This dam site is considered to be of high concern because the emergency structural modifications that were implemented to stabilize the damage sustained from the October flood event, and excavated emergency spillway channel and pumps, are all considered temporary measures that the site must currently rely on to pass flow from a significant rain event.

Wildewood Pond #1 (D 0568): This low-hazard embankment dam sustained undercutting and significant erosion of the downstream slope of the embankment in the area of the service spillway outlet. A temporary emergency spillway channel was excavated, and temporary pumps were mobilized to minimize potential for overtopping during the storm event. Visual observations of site conditions did not clearly indicate if overtopping of the embankment occurred. Internal erosion from potential leakage from the service spillway outlet pipe (or piping along the external perimeter of the outlet pipe) may have been a contributing factor to the slope failure. Further inspection of the outlet pipe is recommended by an Owner's Engineer to determine the root cause of the slope failure. The pond is maintained at low level to minimize potential for seepage and destabilization of the compromised section of the embankment at elevated pond levels. The compromised section of the embankment dam slope failure may be susceptible to further erosion/failure from elevated headpond levels and discharge through the primary spillway outlet pipe. The service spillway is considered to be unusable due to concern for additional erosion. This dam site is considered to be of high concern because the temporary emergency channel and mobilization of temporary pumps are the only means of discharge from the pond. The HEC-HMS model estimates that the temporary channel would be activated for a rainfall event of 1.0 inch or greater, and the dam may be overtopped from a 100-year flood event, conservatively assuming the pond is at normal level at the beginning of the rainfall event.

Pine Springs Lake Complex 2 (D 0561): The upstream slope of the embankment has significant sloughs and cracks above the service spillway outlet pipe alignment. Since

there were no indications that the embankment was overtopped, the sloughs may be indications of internal erosion caused by leakage from, or piping along the external perimeter of the outlet pipe. Further inspection of the outlet pipe is recommended by an Owner's Engineer to determine the root cause of the sloughs. Low pond level is maintained to minimize risk for additional internal erosion of the embankment. Operational capability of the low-level intake of the service spillway could not be verified during the site visit. This dam has no auxiliary spillway. This dam is of high concern due to potential for further internal erosion of the embankment from continued discharge through the service spillway, which has limited hydraulic capacity.

Entrance Lake Dam (D 0450): This dam is of high concern because the HEC-HMS model indicates that a 10-year rainfall event may bring the pond level to within 1.0 foot of the embankment crest, indicating potential for overtopping. (There were no visible indications that the embankment was overtopped by the October storm event during the field observations.)

Arcadia Woods (D 0557): Spillway capacity does not appear to be impaired; however, the integrity of the embankment dam is compromised due to the downstream slope failure which would be a concern at elevated pond levels. The pond was drawn down prior to the storm event per order of DHEC because of deficiencies in the service spillway capacity. Also, the 10-year rainfall event may bring the pond level to within 1.0 foot of the embankment crest, conservatively assuming the pond is at normal level at the beginning of the rainfall event, indicating potential for overtopping.

3.4 Dams of Moderate Concern

Five dams are considered to be of moderate concern. Two of the five dams breached during the storm event and are considered to be of moderate concern when considering that natural stream flow from significant rain events would be conveyed through the breach, with associated potential of further erosion. Those dams are:

Rocky Ford Lake (D 0028): See Section 3.1 and

North (Upper) Rocky Ford Lake (D 0029): See Section 3.1.

Two additional dams noted below have auxiliary spillways that are susceptible to further erosion from future significant flood events:

Windsor Lake (D 0571): Spillway capacity is not impaired, but the auxiliary spillway sustained damaged from the October 2015 storm and is susceptible to further damage, including potential undermining and seepage along the left side of the auxiliary spillway from future spill events. The HMS model estimates that the auxiliary spillway would be activated for a 10-year flood event or greater.

Springwood Lake Dam (D 0558): The concrete overflow auxiliary spillway has minor erosion at the upstream portion of the right wall, and significant erosion and scour at the downstream end of the spillway. The auxiliary spillway would be activated for a rainfall event of 1.0 inch or greater and would be susceptible to further erosion. The dam is of moderate concern also because the 100-year rainfall event would bring the peak pond level to within 1.0 foot of the top of embankment, indicating potential for overtopping.

The fifth dam of moderate concern is Sesquicentennial Dam.

Sesquicentennial Dam (D 0569): The dam is of moderate concern because the 100-year rainfall event would bring the peak pond level to within 1.0 foot of the top of embankment, indicating potential for overtopping.

3.5 Dams of Low Concern

Eleven dams are considered to be of low concern. A total of 11 dams out of the 23 that were inspected do not appear to have sustained significant damage, nor do they have impaired spillway capacity. Also, the HEC-HMS model results indicate these dams would not be expected to be overtopped for a storm with a 100-year return interval. These dams should have the same capability to pass flood events that existed prior to the October flood event. However, this observation is not an indication that spillway capacities of these dams necessarily meet DHEC dam safety spillway requirements

Table 2. Performance of Dams

Dam	Hazard Classification	Maximum Estimated Overtopping (ft)	Breach	Spillway Impairment	Level of Concern	Concern
1 - Lake Katherine Dam	High	4			Low	
2 - Forest Lake Dam	High	3			Low	
3 - Cary's Lake Dam	High	4	Embankment dam and spillways		Low	
4 - Windsor Lake Dam	High	0.5			Moderate	Seepage and undermining of the concrete auxiliary spillway. A 10-year rainfall event would result in flow through the concrete auxiliary spillway.
5 - Upper Windsor Lake Dam	High	2			Low	
6 - Sesquicentennial Dam	High	0.5			Moderate	Overtopping may occur for the 100-year flood or greater.
7 - Spring Lake Dam	High	4		Auxiliary Spillway	High	Potential erosion of embankment from failed auxiliary spillway wing wall. A rainfall event of 1-inch would result in flow through the auxiliary spillway. Overtopping may occur for the 10-year flood or greater.

Table 2. Performance of Dams

Dam	Hazard Classification	Maximum Estimated Overtopping (ft)	Breach	Spillway Impairment	Level of Concern	Concern
8 - Rocky Ford Lake Dam	High	0	Auxiliary Spillway	Auxiliary Spillway	Moderate	Erosion from river discharge through auxiliary spillway channel washout
9 - Upper (North) Rocky Ford Lake Dam	High	0	Auxiliary Spillway	Auxiliary Spillway	Moderate	Erosion from river discharge through auxiliary spillway channel washout
10 - Wildewood Pond Dam 5	High	0			Low	
11 - Wildewood Pond #4 Dam	High	4		Service Spillway	High	Downstream slope failure; discharge limited to temporary pumps due to potential for piping/leakage along low-level pipe. Overtopping may occur for the 100-year flood or greater.
12 - Beaver Dam/Wildewood Pond #2	Significant	0.5	Embankment subsidence	Service Spillway Discharge limited to temporary emergency channel and pumps.	High	Temporarily stabilized embankment isolated by upstream cofferdam. Potential piping along low-level pipe. 1-inch rainfall event as simulated would result in flow through the temporary emergency spillway.

Table 2. Performance of Dams

Dam	Hazard Classification	Maximum Estimated Overtopping (ft)	Breach	Spillway Impairment	Level of Concern	Concern
13 - Wildewood Pond #3	Significant	0			Low	
14 - Wildewood Pond #1 Dam	Low	Field observations do not clearly indicate overtopping occurred.		Service Spillway Discharge only by temporary emergency channel or pumps.	High	Downstream slope failure; potential piping/leakage along low-level pipe. Temporary emergency channel activated for 1-inch rainfall. Modeling indicates overtopping may occur for the 100-year flood or greater.
15 - Entrance Lake Dam	High	0			High	Modeling indicates overtopping may occur for the 10-year flood or greater.
16 - Pine Springs Lake CMPLX 1	High	0			Low	
17 - Pine Springs Lake CMPLX 2	High	0		Service Spillway	High	Existing upstream slope slough; potential piping along low-level pipe.
18 - Lower Spring Valley Lake Dam	Significant	0			Low	
19 - Springwood Lake Dam	High	1			Moderate	Overtopping may occur for the 100-year flood or greater.
20 - Hughes Pond Dam	High	0			Low	
21 - Deer Lake Dam	Significant	0.5			Low	
22 - Commons Pond Dam	Low	0			Low	

Table 2. Performance of Dams

Dam	Hazard Classification	Maximum Estimated Overtopping (ft)	Breach	Spillway Impairment	Level of Concern	Concern
23 - Arcadia Woods Lake Dam	High	1		Service Spillway	High	Existing downstream slope failure; potential piping along low-level pipe. Overtopping may occur for the 10-year flood or greater.

4 Conclusions

The October 2015 flood resulted in significant damage to dams within the Gills Creek Watershed. Of the 23 dams regulated by DHEC, 13 dams were overtopped, 3 dams breached resulting in an uncontrolled release of water, and 8 dams have spillways that are now significantly impaired. Seven dams are identified to be of high concern under observed conditions because of susceptibility to overtopping or internal erosion, potentially resulting in further damage in the event of a future significant rainfall event. Hydrologic modeling estimates that three of these high-concern dams may experience overtopping from a storm equal to or greater than a 10-year rainfall event. Two other dams identified as high concern may experience overtopping for storms greater than a 100-year rainfall event. The two additional high-concern dams exhibit indications of potential internal erosion.

Based on conditions observed during the site visits, dams with similar design and spillway capability were able to pass the flood flows with no apparent significant damage, while others were significantly overwhelmed by the runoff. This indicates significant variation in rainfall runoff characteristics within the basin and with the active storage available within the reservoirs to attenuate flood events.

Insufficient spillway capacity resulted in overtopping and failure or significant erosion of embankment dams. Debris accumulation may have reduced spillway capacity and increased peak flood levels at some dams. Dams that breached would have also contributed to downstream peak flood levels. Some embankment dams that were not overtopped experienced slope failure from internal erosion that is typically associated with leakage from outlet pipes or piping along the conduits. Auxiliary spillways also failed at several dams.

Temporary measures were implemented during the flood event to minimize damage to the dams and to minimize downstream impacts, including temporary pumps, placement of rock fill, installation of a cofferdam, and excavation of emergency channels to convey flood flow downstream. Many of the ponds have been drawn down to reduce destabilizing effects on damaged embankment dams and to allow the performance of needed repairs. Some dams with impaired spillway capacity continue to rely on temporary pumps to discharge water downstream. The drawdown also provides storage to attenuate runoff from a future significant rain event and reduces the potential for overtopping.

Review of the performance of the dams during the rainfall event indicates that many of the dams appear to have inadequate spillway capacity. The October 2015 storm was an extreme rainfall event with maximum 24-hour and 48-hour precipitation that significantly exceeded a 1,000-year storm event. However, the DHEC Dam and Reservoirs Safety Act (72-1 through 72-9) requires that the 17 high-hazard dams within Gills Creek Watershed be capable of safely passing a design flood, established from engineering evaluations, between 50 percent of the Probable Maximum Flood (PMF) and the full PMF. When compared to the October 2015 storm, these design floods are significantly greater volume precipitation events. Based on watershed experience in South Carolina using the NOAA HMR51-52 guidelines for determining the PMP, HDR would estimate

that for the Gills Creek Watershed, a PMP approaching 38 to 40 inches could be expected. (This would be prior to adding the October 2015 rainfall event into the precipitation database). The four significant-hazard dams in Gills Creek Watershed (which meet a "small" dam classification) are required to pass a design flood between the 100-year flood and the 50 percent PMF.

The observed general condition of the dams and appurtenances indicate maintenance practices that are not consistent with prudent dam safety practices. These observations includes trees and woody underbrush on embankment dams, steep embankment slopes, additional water lines and conduits within the embankment dam that are not associated with the service spillway, and spillways constructed of inadequate and outdated materials (CMPs) that are susceptible to leakage or piping.

The variance in performance of the dams during the October 2015 storm indicates a need to perform a watershed-wide evaluation of the design and health of the Gills Creek Watershed dam/reservoir system and its ability to provide the appropriate capability to safely pass significant storm events. Evaluation of the following dam safety aspects of the Gills Creek Watershed should be considered.

1. Hazard Classification – This should include a re-evaluation of the current downstream developments and potential consequences of dam failure for the purposes of hazard classification. This may require performing dam failure and hazard analysis including cascading failure of downstream dams.
2. Spillway Adequacy – Perform site-specific hydrologic evaluations as required to establish the appropriate Spillway Design Flood based on potential downstream hazard. Specific guidelines should be established for determining the IDF. A review of current spillway capacity and active storage capacity should be conducted to ensure spillway adequacy.
3. Detailed Condition and Design Assessment – Detailed condition assessments should be conducted by an independent professional engineer, including detailed dam inspections, review of construction and maintenance records, and review of the design of the dam and appurtenant facilities to assess overall integrity of the structures and facilities. This would require engineering analysis including stability analysis of principal water-retaining structures. A technical review of spillway and outlet structure design and condition, including gate operability, should be conducted to ensure spillway capability. Low-level outlet pipes should be inspected for deterioration and leakage.
4. Maintenance Practices – Specific requirements for low-level outlets should be required at all dams to draw down the pond for maintenance activities, and in anticipation of significant flood events. Specific guidelines should be developed for proper maintenance of earth embankment dams, concrete structures, and appurtenances, including spillways, gates, trash screens, and outlet pipes.
5. Emergency Action Plans – Detailed Emergency Action Plans that include inundation mapping to identify structures and people at risk, notification procedures, preventive measures, and roles and responsibilities should be developed for at least the high hazard dams. Effective preventative measures would include timely draw down of ponds in anticipation of forecasted flood events.

Appendix A. HDR Site Observations Summary: SCDHEC Regulated Dams

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(1) Lake Katherine D 0027 Left and right embankment dam sections Service Spillway riser/low-level outlet Auxiliary Earthen Overflow Spillway at left abutment Overflow grouted rockfill spillway with concrete crest overlay surface and wooden flashboards on crest between left and right embankment sections. Low-level outlet with gated concrete drop inlet at right embankment.	Date of Observations: 10/15/2015 Headpond level approximately 7 feet below embankment dam crest: approximately 4 inches below top of flashboards at the overflow rockfill/concrete spillway. The lower 1-foot-high section of flashboards were observed in place Site discharge was from gated low-level outlet with no apparent downstream channel constrictions. No apparent discharge from submerged service spillway outlet pipe. Backwater at the outlet from apparent downstream sedimentation.	Woody debris blocking approximately 20% of the service spillway intake. Hot tub and dock remnants accumulated adjacent to the gate concrete intake at right embankment partially blocking gated and weir flow. No other spillway impairment.	Embankments in fair condition. Auxiliary Earthen Spillway erosion minor to moderate. Overflow Spillway concrete surface overlay in poor condition. Gated concrete drop-inlet structure appeared to be in good condition.	Embankments overtopped approximately 4 feet; minor erosion. Evidence of high peak-flood tailwater level, approaching crest level. No remnants of upper section of flashboards were observed, indicating only the lower section was in place during the storm event. Auxiliary spillway activated; moderate erosion (up to 2 feet erosion). Jute mat placed on auxiliary spillway. Significant voids and longitudinal cracks in concrete surface of rockfill spillway. Some erosion and undermining along the toe of the spillway is apparent. Significant tree growth on right embankment slopes and along toe of left embankment.	Auxiliary spillway capability to pass significant rain event is intact Service spillway capacity impaired by debris. Concrete/rockfill overflow spillway may be susceptible to damage. Impairments to upstream reservoir storage capacity due to damage to dams and spillways may result in additional runoff reaching Lake Katherine that would have otherwise been attenuated.
(2) Forest Lake D 4434 Left and right embankments with grout bag armoring system; apparently designed for overtopping Overflow gated concrete spillway with low-level outlet. Concrete uncontrolled auxiliary spillway and discharge channel	Date of Observations: 10/15/2015 Headpond level approximately 7 feet below embankment crest. About 1.0 foot below normal. Hinged crest gates were lowered in two bays and in the raised position in two bays. Discharge through low-level outlet; with some discharge at the overflow spillway.	Debris in main spillway appears more than 50% blocked	Armored embankment dam sections appear to be in good condition. Scour of approach and exit channels of the auxiliary spillway have been temporarily repaired. Significant cracks in concrete retaining walls of the spillway channel.	Armored embankment overtopped by approximately 3 feet; appears to have performed satisfactorily. Large riprap placed in significant scoured areas of the earthen channel just upstream and downstream of the concrete auxiliary spillway channel. Cracks both walls of auxiliary spillway. Operation of spillway gates may not be possible because of obstruction to operators from steel guard rail. Downstream right bank erosion.	Embankment armoring system appeared to perform very well. Gated spillway capacity is impaired by debris. Concrete auxiliary spillway may be susceptible to damage.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(3) Cary's Lake D 0026 Pre-existing dam and spillway structures: Concrete overflow auxiliary spillway at left abutment Embankment dam with roadway on crest Low-level concrete service spillway Concrete overflow auxiliary spillway at right abutment	Date of Observations: 10/15/2015 Natural stream level. Riverine conditions; flow through breach with some constriction due to concrete debris and sedimentation. Discharge is natural stream flow.	Remnants of concrete service spillway, asphalt roadway, and overflow spillway in river channel causing some constriction of the natural river channel.	Embankment dam completely breached. Significant erosion of earth slopes adjacent to abutments.	Apparent overtopping failure. Torn seams and holes observed in some grout bags.	Breached conditions provide natural river channel conveyance of significant rain events with some constriction due to debris. Areas at abutments at left and right banks are susceptible to further erosion. Loss of pond storage and capability due the dam breach will result in un-attenuated flow from runoff from future storm events.
(4) Windsor Lake D0571 Embankment dam sections with highway on crest Service spillway low-level outlet with concrete drop inlet Concrete overflow auxiliary spillway/bridge at left abutment	Date of Observations: 10/15/2015 Headpond approximately 5 feet below crest of embankment; at crest of auxiliary spillway. Discharge through service spillway. No downstream channel obstructions.	No apparent spillway impairment	Embankments in generally fair condition with areas of significant erosion of the downstream slope. Auxiliary concrete spillway undermined along left and right sides, with voids and cracks.	Apparent minor overtopping of embankment; temporary erosion control (jute mat) placed in eroded areas of embankment crest. Significant surficial erosion on downstream slope of the right embankment and toe of left embankment. Erosion, undermining and seepage in some areas adjacent to the overflow concrete spillway surface. Significant void and cracks in overflow spillway concrete at the lower right side near sheet-piling. No apparent erosion along toe of overflow spillway.	Spillway capacity is not impaired. Auxiliary spillway is susceptible to further damage. Undermining and emerging seepage along the left side of the auxiliary spillway is a concern.
(5) Upper Windsor (#2) D0570 Embankment dam with abandoned roadway on crest. Service spillway low-level outlet with concrete drop inlet Concrete overflow auxiliary spillway/bridge at left abutment Culvert beyond left abutment	Date of Observations: 10/15/2015 Headpond approximately 5 feet below embankment crest; several feet below crest of auxiliary spillway Low-level outlet submerged so outflow could not be observed. Under current conditions discharge would only be through service spillway. Road culvert beyond left abutment would also pass flow downstream.	Impairment to overall spillway capacity appears to be minor. Some debris accumulation at the service spillway inlet; may cause minor impairment of outflow capacity. Auxiliary spillway has very little debris accumulation.	Embankment is in generally fair condition except areas of significant erosion of the downstream slope; some of this erosion may have been a pre-existing condition prior to the flood event. Significant tree growth on embankment slopes The spillways appear to be in good condition. Headpond appears to be near normal level.	Overtopped by 1-2 feet; minor erosion at spillway bridge abutments. Areas of significant erosion on downstream slope of embankment which is very steep/undercut near the auxiliary spillway. Embankment is heavily wooded.	Impairment of service and auxiliary spillways due to debris is expected to be minor. Significant trees/root systems appear to be contributing to stabilization of areas of near vertical downstream slope of embankment. The embankment crest is wide, so moderate sloughing of downstream slope from rainfall events would not be an immediate concern, except near the auxiliary spillway. The potential for piping from the tree growth on embankment slopes is offset by the overall width of the embankment.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(6) Sesquicentennial Park Pond D 0569 Long embankment dam with pedestrian sidewalk along the crest. Service spillway is a gated low-level outlet pipe. Two sequential stone masonry dams that function as uncontrolled overflow auxiliary spillway.	Date of Observations: 10/15/2015 Headpond just below crest of upper stone masonry dam, approximately 6 feet below embankment crest; about 6 inches below normal pond level. Headpond maintained by low-level outlet controlled discharge.	The intake gate of the low-level outlet is submerged, so any impairment could not be observed. Significant accumulation of tree debris in the area between the stone masonry dams which would result in significant impairment of auxiliary spillway capacity.	The embankment dam is generally in good condition with minor surficial erosion. The service spillway is functional with no apparent damage. The auxiliary spillway stone dams are generally in fair condition with some missing/loose stones in both dams. Stone dam abutments are in fair conditions but show signs of potential displacement of supporting soil.	Embankment overtopping evidenced by general minor surficial erosion of embankment. Several small areas of recent earth fill indicate moderate areas of depressions/erosion. Stone dam overtopping indicated by general minor erosion at abutments, with moderate erosion and sloughing of right embankment slope just downstream of the upper dam. Upper stone dam concrete crest overlay was deteriorated; lower dam concrete crest in good condition. No erosion at toe of dams. Vertical crack/slabbing of left concrete abutment of the lower stone dam. Small tree growing at dam/abutment interface. Crack in left concrete abutment of lower dam.	The service spillway is functional and being used to maintain headpond level. No significant concerns for the embankment. No significant concerns for stone dams during future significant spill events. Concrete spillway crest, stones, abutments, and stream banks would be susceptible to additional deterioration/erosion. Felled trees accumulated in the stream between the stone dams would have significant impact on overflow spillway capacity.
(7) Spring Lake D 0025 Concrete Overflow Auxiliary Spillway Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/15/2015 Headpond level maintained 1 to 2 feet below normal with discharge through service spillway; level is approximately 7 feet below embankment crest and 1 to 2 feet below crest of auxiliary spillway.	Primary spillway is functional with some debris accumulation on the trash screen. Auxiliary spillway is not useable until temporary repairs are completed.	Significant damage of auxiliary spillway and erosion of adjacent left abutment and embankment on the right side. Severe overtopping erosion and headcutting of approximately 100-foot-long section of the embankment dam.	Embankment was overtopped by 3 to 4 feet. Headpond is being maintained below normal pond. Temporary structural repairs are being conducted.	Primary spillway capacity has minor impairment from debris. The auxiliary spillway concrete channel and embankment dam section adjacent to the auxiliary spillway would be susceptible to further erosion and failure if flow is discharged through the auxiliary spillway prior to completing temporary repairs. The embankment dam is compromised by the slough and would be very susceptible to breach if overtopped by a future flood event prior to being repaired.
(8) Rocky Ford Lake D 0028 Concrete Overflow Auxiliary Spillway Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/15/2015 Reservoir drawn down due to wash out of auxiliary spillway. Discharge is through the remaining earth channel in the area of the washed out auxiliary spillway.	Condition of service spillway undetermined. The auxiliary spillway wash out provides conveyance of river flow.	Auxiliary spillway is washed out; adjacent earth abutment and embankment areas significantly eroded. Embankment dam beyond eroded area adjacent to the auxiliary spillway is in good condition. Service spillway could not be observed due to safety considerations.	The embankment was not overtopped. The auxiliary spillway is now an earth channel, with severely eroded native earthen slope on the left side of the channel and earth embankment dam on right side.	Service spillway functionality is undetermined. Discharge is through the remaining earth channel of the auxiliary spillway wash out. The remaining earth channel, left earthen slope, and right embankment are susceptible to significant erosion from flow in the auxiliary spillway. The embankment dam is susceptible to undercutting that could lead to failure.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(9) Upper (North) Rocky Ford Lake D 0029 Left Embankment Dam Concrete Overflow Auxiliary Spillway Right Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/15/2015 Reservoir drawn down about 18 feet below crest due to wash out of auxiliary spillway. Discharge is through the remaining earth channel in the area of the washed out auxiliary spillway.	Discharge is through the remaining earth channel in the area of the washed out auxiliary spillway. The auxiliary spillway wash out provides conveyance of river flow.	Auxiliary spillway is washed out; adjacent earth abutment and embankment areas are significantly eroded. Left and right embankment dam sections beyond eroded area adjacent to the auxiliary spillway are in good condition. Service spillway could not be observed due to safety considerations.	The embankment was not overtopped. The auxiliary spillway is now an earth channel, with severely eroded embankment dam sections along each side of the channel.	River flow is through the channel at the auxiliary spillway wash-out. Service spillway functionality is undetermined. The remaining earth channel and left and right embankment slopes are susceptible to significant erosion from flow in the auxiliary spillway. The embankment dam is susceptible to undercutting that could lead to failure.
(10) Wildewood Pond #5 D 0565 Earthen Auxiliary Spillway Embankment Dam Service Spillway with drop inlet and low-level outlet pipe.	Date of Observations: 10/16/2015 Headpond is being maintained about 1.0 foot below normal with controlled discharge through the service spillway.	Service spillway is functional with no debris accumulation on the trash screen. Auxiliary spillway is useable but is susceptible to additional erosion.	Embankment is in generally good condition. Service spillway in good condition. Auxiliary spillway in fair condition with generally minor surficial erosion and several areas of moderate erosion and a seep at downstream end.	The embankment did not appear to be overtopped. Auxiliary spillway appeared to have performed well; except for erosion at the downstream end. Seepage observed on downstream slope of auxiliary spillway approximately 100 feet from pond, 5 feet below pond level; appears to be piping.	No significant concerns with embankment dam. Existing ability to pass significant rain events through service and auxiliary spillways is not impaired; auxiliary spillway is susceptible to additional erosion.
(11) Wildewood Pond #4 D 0564 Earthen Embankment Dam with roadway on crest Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond is being maintained about 9 feet below embankment crest with temporary pumps (approximately 6 feet below normal pond). The headpond is below the upper intake level of the service spillway.	The low-level inlet for the service spillway is not being utilized, likely due to concerns for effects of discharge in the area of the failed embankment slope.	Embankment dam sustained significant downstream slope failure along alignment of service spillway low-level outlet pipe. Moderate sloughs and erosion on upstream slope of embankment.	Estimated several feet of embankment overtopping. No auxiliary spillway. Roadway on crest of dam.	The pond is maintained at low level to minimize seepage and destabilization of the failed section of the embankment, and to provide additional active storage. Temporary pumps are the only means for discharging flow from the pond.
(12) Beaver Dam/Wildewood Pond #2 D0567 Earthen Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond is maintained about 7 feet below embankment crest with temporary pumps (about 5 feet below normal pond). Service spillway is not operable.	Discharge is from temporary pumps. A trench was excavated at the left end of the embankment dam to function as an emergency spillway.	Significant sinkhole development in the embankment dam with temporary rock fill and upstream cofferdam to stabilize and isolate the compromised area. The primary spillway is isolated from the headpond by the upstream cofferdam.	Estimated several inches overtopping of embankment resulted in general minor erosion. Possible displacement/poor connection between service spillway outlet riser and conduit may have been root cause of internal erosion.	The pond is maintained at low level to minimize seepage and destabilization of the failed section of the embankment; and to provide additional active storage. Temporary pumps are the only means for discharging flow from the pond.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(13) Wildewood #3 D0566 Earthen Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 12 feet below embankment crest; estimated to be about 1-2 feet below top of inlet riser pipe. Discharge is through service spillway low-level outlet pipe	No impairment	Embankment and service spillway is in good condition.	Embankment dam was not overtopped. Surficial erosion and sloughs on downstream slope.	Spillway capacity does not appear to be impaired. No significant concerns with embankment dam.
(14) Wildewood Pond #1 (Class 3) D 0568 Earthen Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 6 feet below embankment crest; about 4 feet below normal pond. No spillway discharge	No spillway discharge capability. The service spillway gate is closed due to concerns of further erosion if water is discharged through the outlet pipe. Flow can only be discharged via temporary channel at right abutment or by pumps.	Embankment dam section in damaged condition from significant slough on the downstream slope along the alignment of the service spillway.	Embankment may have experienced overtopping. Headpond is maintained below normal and service spillway gate is closed to minimize further destabilization of embankment dam slope failure, and to provide additional active storage.	Embankment dam slope failure may be susceptible to further erosion/failure from elevated headpond levels and discharge through primary spillway outlet pipe. Spillway is not usable.
(15) Entrance Lake Dam D0450 Concrete Overflow Auxiliary Spillway Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 4 feet below embankment crest; about 1.0 foot above normal pond. Discharge is through auxiliary spillway.	Service spillway gate was closed. No apparent impairment of spillway capacity, but operational capability of service spillway was not verified.	Embankment generally good condition. The dam did not appear to have overtopped. Service spillway appeared to be in good condition. Auxiliary spillway in fair condition with minor erosion at downstream end.	Embankment did not appear to be overtopped. Small depression on embankment crest above irrigation line.	Spillway capacity does not appear to be impaired, but operational capability of service spillway was not verified. No significant concerns with embankment dam.
(16) Pine Springs Lake Complex 1 D 0560 Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 11 feet below embankment crest; No spillway discharge was observed.	No apparent spillway impairment.	Embankment is in generally good condition; generally minor surficial erosion of the downstream toe; service spillway in good condition.	Embankment not overtopped. Minor surficial erosion on downstream slope of embankment.	Spillway capacity does not appear to be impaired, but operational capability of service spillway was not verified. No significant concerns with embankment dam.
(17) Pine Springs Lake Complex 2 D 0561 Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 11 feet below embankment crest; 9 feet below top of riser inlet. Flow through service spillway could not be observed. It is assumed that flow is controlled by the low-level gate.	No apparent spillway impairment, operational capability of the service spillway is assumed because the headpond is maintained at low levels.	The embankment dam exhibits potential piping conditions indicative of a potential failure mode in the area of the service spillway outlet pipe. The service spillway intake appeared to be in good condition.	No indications that the embankment was overtopped. The upstream slope of the embankment has significant sloughs and cracks below the normal pool level. Indications of piping along the service spillway outlet pipe.	Low headpond level is maintained to minimize risk for embankment failure from potential piping mode. It is assumed that the headpond is being maintained by low-level intake of service spillway.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(18) Lower Spring Valley Lake Dam D 0559 Earthen Auxiliary Spillway Embankment Dam Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately 3 feet below embankment crest; 2 feet below normal pond level. Flow through service spillway Discharge through service spillway	No apparent spillway impairment	Embankment is in generally good condition; no erosion of auxiliary spillway; no evidence of overtopping; service spillway in good condition.	No indications that the embankment was overtopped. Downstream embankment slope is heavily vegetated with trees and underbrush.	Spillway capacity does not appear to be impaired, but operational capability of low-level inlet of service spillway was not verified. No significant concerns with embankment dam.
(19) Springwood Lake Dam D 0558 Embankment Dam Service Spillway with drop inlet and low-level outlet pipe Auxiliary Spillway with concrete drop inlet and low-level outlet pipe Concrete Overflow Auxiliary Spillway	Date of Observations: 10/16/2015 Headpond approximately 4 feet below embankment crest; 1.0 foot above normal pond level. Discharge through service spillway and concrete overflow auxiliary spillway No. 2.	No apparent spillway impairment	The embankment is in generally good to fair condition but with some significant erosion of limited portions of the downstream slope. Spillways appear to be in good condition.	Embankment was overtopped during the flood event. The downstream slope of the embankment has significant tree growth and forest underbrush. Trash screen of auxiliary spillway concrete drop inlet has collapsed. The concrete overflow auxiliary spillway has minor erosion at the upstream portion of the right wall, and significant erosion and scour at the downstream end of the spillway.	Spillway capacity does not appear to be impaired. No significant concerns with embankment dam.
(20) Hughes Pond Dam D 0573 Embankment Dam Earthen Auxiliary Overflow Spillway Service Spillway with drop inlet and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond approximately at normal pond level, about 4.5 feet below embankment crest. Discharge through service spillway.	No apparent spillway impairment	The embankment is in generally good condition; there are several areas of moderate erosion and an area of seepage at downstream end. The spillways are generally in good condition.	No indications that the embankment was overtopped. The downstream embankment slope is in fair condition, but has sparse vegetative cover and areas of significant erosion Wet areas and seepage were observed along the toe of the embankment dam Several voids/depressions were observed along the alignment of the service structure outlet pipe	Spillway capacity does not appear to be impaired. No significant concerns with embankment dam.
(21) Deer Lake D 0137 Embankment Dam Service Spillway with drop inlet and low-level outlet pipe Earthen Auxiliary Spillway	Date of Observations: 10/16/2015 Headpond approximately 0.5 foot above normal pond level, about 3 feet below embankment crest. Discharge through service spillway.	No apparent spillway impairment	The earthen embankment is in generally fair to good condition with several areas of significant erosion due to overtopping. The service spillway is in good condition and fully functional. The earthen auxiliary spillway is in good condition with no impairment of spillway capacity.	The embankment dam experienced several inches of overtopping. Scoured area of downstream slope of the embankment was observed near the service spillway. The downstream slope has significant tree and underbrush growth.	Spillway capacity does not appear to be impaired. No significant concerns with embankment dam.

HDR Site Observations Summary: SCDHEC Regulated Dams

Dam ID and Description [1]	Current Water Levels and Discharge	Spillway Impairment	General Condition	Significant Observations	Conclusions
(22) Commons Pond D 0421 Embankment Dam Service Spillway with concrete intake structure and low-level outlet pipe Earthen Auxiliary Spillway	Date of Observations: 10/16/2015 Headpond approximately 0.5 feet below normal pond level, about 4.4 feet below embankment crest. Discharge through service spillway.	No apparent spillway impairment	The embankment is in generally good to fair condition. Several areas of moderate slumping on upstream face Minor seepage at service spillway outlet headwall, and a depression on downstream embankment slope above the outlet headwall. Spillways are in good condition and functional.	The embankment dam was not overtopped. The downstream slope of the embankment has heavy vegetation and tree growth. Observed seepage and depression on downstream embankment slope is along the alignment of the service spillway outlet pipe.	Spillway capacity does not appear to be impaired. No significant concerns with embankment dam.
(23) Arcadia Woods D 0557 Embankment Dam Service Spillway with concrete intake structure and low-level outlet pipe	Date of Observations: 10/16/2015 Headpond drawn down approximately 10 feet below normal pond level, about 12 feet below embankment crest. Discharge through service spillway.	No apparent spillway impairment	Embankment is in generally poor condition due to significant slope failure on the downstream slope. The service spillway is in good condition and is operational.	It is probable that the embankment was overtopped. The pond was drawn down prior to the storm event per order of DHEC because of deficiencies in the service spillway capacity Roadway on crest of dam.	Spillway capacity does not appear to be impaired. Integrity of embankment dam is compromised due to downstream slope failure. Repairs to crest and road are needed. Investigate CMP at base of failed downstream slope.

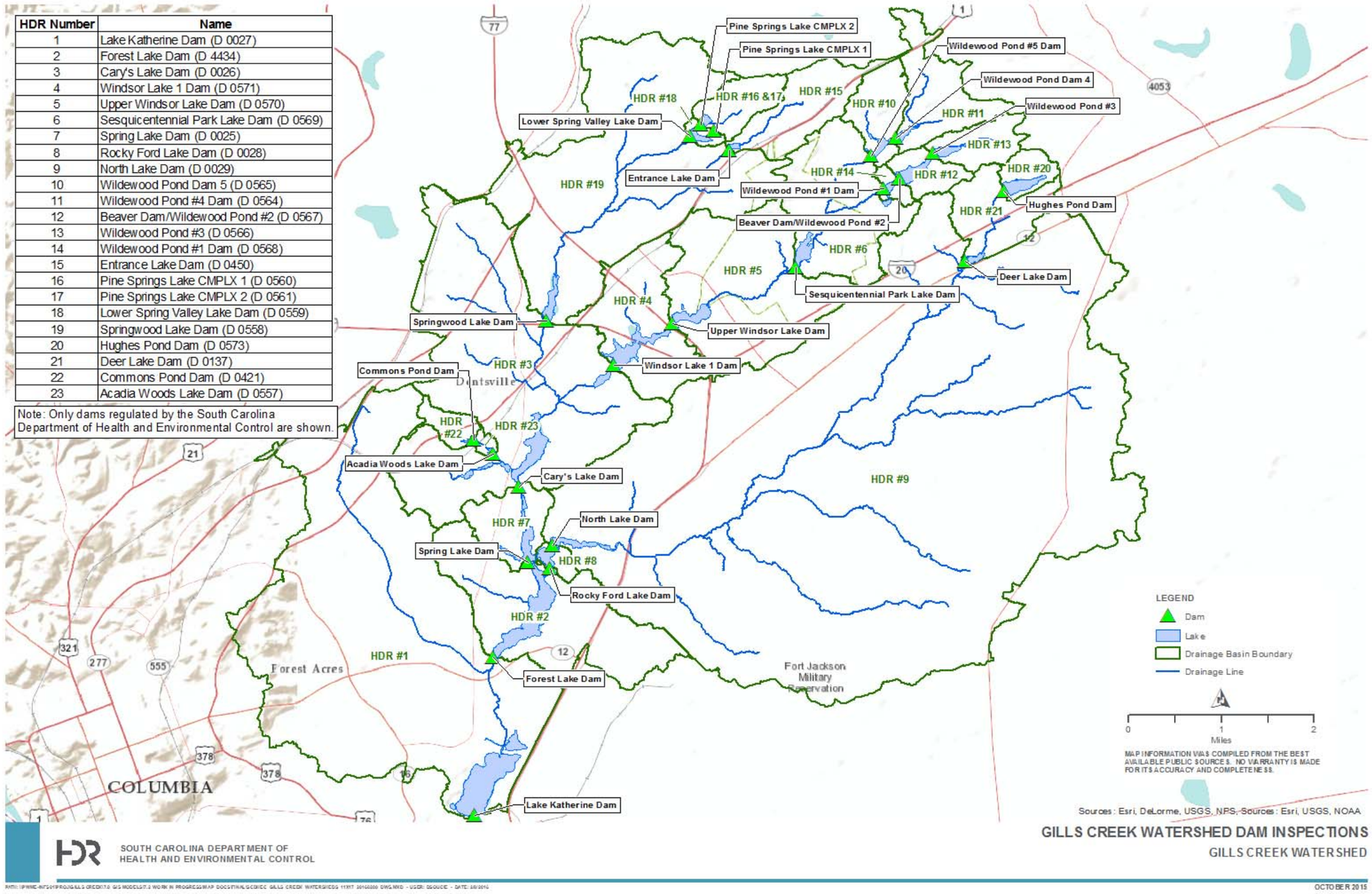
[1] Dam Numbering: For example, in “(23) Arcadia Woods D 0557” above, the (23) is HDR’s numbering system for this report, and the D 0557 is DHEC’s dam numbering system.

Appendix B. Gills Creek Watershed

Gills Creek Watershed

HDR Number	Name
1	Lake Katherine Dam (D 0027)
2	Forest Lake Dam (D 4434)
3	Cary's Lake Dam (D 0026)
4	Windsor Lake 1 Dam (D 0571)
5	Upper Windsor Lake Dam (D 0570)
6	Sesquicentennial Park Lake Dam (D 0569)
7	Spring Lake Dam (D 0025)
8	Rocky Ford Lake Dam (D 0028)
9	North Lake Dam (D 0029)
10	Wildewood Pond Dam 5 (D 0565)
11	Wildewood Pond #4 Dam (D 0564)
12	Beaver Dam/Wildewood Pond #2 (D 0567)
13	Wildewood Pond #3 (D 0566)
14	Wildewood Pond #1 Dam (D 0568)
15	Entrance Lake Dam (D 0450)
16	Pine Springs Lake CMPLX 1 (D 0560)
17	Pine Springs Lake CMPLX 2 (D 0561)
18	Lower Spring Valley Lake Dam (D 0559)
19	Springwood Lake Dam (D 0558)
20	Hughes Pond Dam (D 0573)
21	Deer Lake Dam (D 0137)
22	Commons Pond Dam (D 0421)
23	Acadia Woods Lake Dam (D 0557)

Note: Only dams regulated by the South Carolina Department of Health and Environmental Control are shown.



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

GILLS CREEK WATERSHED

OCTOBER 2015

Appendix C. Gills Creek HECHMS Memo

Memo

Date:	Monday, February 08, 2016
Project:	SC DHEC/RM/Emerg. Response (268356)
To:	Ray Wingert
From:	Ted Shannon
Subject:	Gills Creek HEC-HMS Model Development and Rainfall Scenarios

1. Purpose and Scope

A rainfall event in the Gills Creek watershed in Columbia, South Carolina, ranging from 18.66 inches in the northern portion of the watershed to 21.49 inches in the southern portion, from October 2 to 5, 2015, breached three dams and overtopped ten others. Several other dams in this watershed suffered spillway and primary outlet damage which impaired release capacities.

Based on discussions with South Carolina Department of Health and Environmental Control (SCDHEC) while developing the scope of work for the Gills Creek Watershed, a HEC-HMS model was proposed to be developed to identify connectivity between the regulated dams and reservoirs in the watershed. The initial purpose of this model was to facilitate the immediate needs for emergency response and monitoring of the remaining unbreached dams. Additional uses of the model could be used to evaluate potential reconstruction plans that will be submitted by the dam owners to the DHEC for review prior to significant reconstruction in the watershed. Additional applications of the model may require additional modeling detail and revisions. The model will also provide a tool to assess potential freeboard at surviving dams and reservoirs in the system using future storm events. This memorandum documents the development of the HEC-HMS model and evaluates several possible rainfall scenarios within the watershed.

2. Model Development

The Post-Flood Conditions HEC-HMS model ("model") was developed with selected methods summarized in Table 1. Summary of HEC-HMS Model Methods. Details of these methods, assumptions, and data used are described in further detail in subsequent sections.

The model was developed for the system of regulated reservoirs within the Gills Creek watershed. The model does not directly account for unregulated dams and impoundments. The model simulates runoff response to rainfall based on hydrologic characteristics of the watershed, and estimates peak pond levels at identified state jurisdictional dams based on estimates for current active reservoir storage and spillway capacity. The model was developed based on limited information available from SCDHEC record files and publicly available information; and was augmented by actual site conditions that were visually observed during site visits conducted by HDR subsequent to the October storm event. Field measurements of certain outlet facilities at several sites differed from information shown on file drawings; HDR

incorporated drawing file information into the model as those differences have negligible effect on model results. Certain approximations were made for model development to address lack of adequate information that was consistent with the overall purpose of the model. The model was developed to simulate hydraulic connectivity of regulated dam system within the watershed only. Unregulated lakes, including Pine Tree Lake, were not modeled. The model provides conservative estimates of peak reservoir elevations within the regulated dam system in response to simulated rainfall events without the attenuation effects of non-regulated ponds and reach routing.

There were no interception or surface storage methods used in the model. The interception methods relates to rainfall captured by tree canopy. Surface storage includes runoff captured by pits or depressions. These loss methods were primarily neglected due to lack of information but also conservative for the recovery application of the model. The Green and Ampt method was selected to estimate soil infiltration losses. This method is scientifically robust and used soils data from the detailed soil survey of the area along with remotely sensed land use and impervious area estimates. The SCS Unit Hydrograph, with standard peaking factor of 484, was the selected unit hydrograph method. Supporting data for this method served to estimate the lag time in each area of the watershed.

Reservoir outflow rating curves were developed using two methods. Reservoirs which contain only spillways and dam crests (dam sections not designed to be overtopped) used the outflow structures method. The spillway and dam crest lengths and elevations were directly input to the model. Reservoirs containing drop inlet structures had rating curves separately calculated and input as storage-discharge curves in the model.

Losses from the reservoirs, such as seepage or evaporation, were neglected. This was appropriate for the rainfall scenarios that were considered and also conservative. Baseflow was assumed to be based on the normal flow at the Gills Creek at Columbia, SC gage (USGS 02169570). Reach routing currently is not considered. This is conservative with regards to peak flows reaching each reservoir and neglecting of floodplain storage.

Table 1. Summary of HEC-HMS Model Methods

Method Type	Selected Method	Data Sources
Interception Method	None	n/a
Surface Method	None	n/a
Loss Method	Green and Ampt	USDA Soil Survey NLCD Land Use and Imperviousness
Transform Method	SCS Unit Hydrograph (Peak Rating Factor 484)	NLCD Land Use and Imperviousness LiDAR derived drainage area and flowpaths
Reservoir Outflow Method	Outflow Structures-Dam Crests, Spillway Structures and Calculated Outlet Rating Curves-Dam Crests, Spillway, Riser Structures	SCDHEC Dam Information HDR Surveys from October 2015 USACE Surveys
Elevation-Storage Function	Elevation and Storage data	SCDHEC Dam Information
Main Tailwater	None Assumed	n/a
Dam Seepage	None Assumed	n/a
Dam Evaporation	None Assumed	n/a
Baseflow Method	Constant Monthly	Normal flow at USGS 02169570
Reach Routing Method	None	n/a

2.1. Drainage Area Delineation

The direct drainage area to each dam was developed using the available LiDAR digital elevation model data ("LiDAR DEM") and the ESRI ArcGIS Spatial Analyst Hydrology toolset ("hydrology toolset"). The hydrology toolset traces the flow path through the watershed from any point to the outlet. Tracing flow paths to a common "pour point" located at each dam site generated direct drainage areas captured by that reservoir.

The LiDAR DEM contains roadways and other features that can modify the drainage area. The LiDAR DEM will not include subsurface culverts that conduct flow across roadway, spoil piles, or other embankments. Additionally, high water surface in water features at the time of the LiDAR survey, features obscured by vegetation, or features lost when resampling to a 10-foot grid size may affect flow paths. Hydrologic conditioning is the process of creating a revised LiDAR-based digital elevation model (modified DEM) that incorporates known or assumed flow paths.

Hydrologic conditioning was achieved by developing a set of terrain modification linework. The elevations under these lines were leveled to a constant elevation, which resulted in removing portions of embankments, deepening existing flow paths, or in some cases emphasizing embankments. Terrain modification lines are classified into two types:

- Breach Lines: Breach lines are typically short segments which connect two flow paths through an embankment (for example a roadway embankment). The minimum elevation at either end point is used to flatten elevation grid cells under the line.

- Wall Lines: Wall lines generate an embankment in order to select a preferred flow path when there are two or more competing flow paths. The elevation for a wall line is set from the maximum elevation along the line.

Professional opinion was used based on the DEM and aerial photography as to the possible location of culverts and other features. The delineated drainage areas were not independently reviewed or verified.

Non-contributing areas are drainage areas which empty into a depression, or sink, which can store runoff of a given magnitude. Once identified as non-contributing, the affected drainage area can be removed from further analysis and hydrologic modeling. Areas identified as non-contributing for a frequent storm event may become contributing for less frequent events. For purposes of this study, all drainage areas were assumed to be contributing, which is conservative for the application of the model.

Table 2. Drainage Areas, lists the delineated direct (incremental) drainage areas to each reservoir. The cumulative drainage area of the entire system above Lake Katherine is 52.23 square miles. Some larger drainage areas were subdivided into smaller units on the basis of land use and soil types within the HEC-HMS model.

Table 2. Drainage Areas

HDR Dam Number	Dam Name	Direct Drainage Area [square miles]	Total Drainage Area [square miles]
Gills Creek above Lake Katherine Dam			
1	Lake Katherine Dam D0027	8.46	52.23
2	Forest Lake Dam D4434	2.16	43.77
Gills Creek above Rocky Ford Lake Dam			
8	Rocky Ford Lake Dam 0028	0.11	21.94
9	Upper (North) Rocky Ford Lake Dam 0029	20.87	21.83
21	Deer Lake Dam D0137	0.72	0.96
20	Hughes Pond Dam 0573	0.24	0.24
Jackson Creek above Spring Lake Dam			
7	Spring Lake Dam D0025	0.58	19.67
3	Cary's Lake Dam D0026	5.26	19.09
Tributary to Jackson Creek above Arcadia Woods Lake Dam			
23	Arcadia Woods Lake Dam D0557	0.05	0.25
22	Commons Pond Dam D0421	0.20	0.20
Jackson Creek above Windsor Lake Dam			
4	Windsor Lake Dam D0571	1.32	7.44
5	Upper Windsor Lake Dam D0570	2.39	6.12
6	Sesquicentennial Dam D0569	1.62	3.73
Jackson Creek above Wildewood Pond Dam 5			
10	Wildewood Pond Dam 5 D0565	0.50	1.32
11	Wildewood Pond #4 Dam D0564	0.82	0.82
Tributary to Jackson Creek above Wildewood Pond #1 Dam			
14	Wildewood Pond #1 Dam	0.10	0.79
12	Beaver Dam / Wildewood Pond #2 D0567	0.29	0.69
13	Wildewood Pond #3 D0566	0.40	0.40
Little Jackson Creek			
19	Springwood Lake Dam 0558	4.86	6.14
Tributaries to Little Jackson Creek			
18	Lower Spring Valley Lake Dam D0559	0.08	0.49
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	0.41	0.41
15	Entrance Lake Dam D0450	0.79	0.79

Note: HDR Numbers were assigned for purposes of the emergency response efforts.
HDR 16 and 17 are separate dam structures which impound a single lake.

2.2. Soils and Infiltration

The Green and Ampt soil infiltration method uses soil characteristics of saturated hydraulic conductivity, suction pressure, and porosity. The U.S. Department of Agriculture, Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for Richland County, South Carolina (2014) spatial and tabular data was used to estimate these infiltration parameters. The saturated hydraulic conductivity was calculated using a harmonic mean of the median conductivity to a depth of 40-inches. The suction pressure and porosity was estimated from the USDA soil textures and the generalized values in the HEC-HMS Technical Reference Manual. The Green and Ampt parameters for each soil type were then spatially averaged over the model subbasins. Table 3. Representative Soil Textures, provides the predominant soil

types in each of the model subbasins (the direct drainage area to each reservoir). Soil types were generally sands or loams.

Table 3. Representative Soil Textures

HDR Dam Number	Dam Name	Representative Soil Texture of the Direct Drainage Area
Gills Creek above Lake Katherine Dam		
1	Lake Katherine Dam D0027	Loam
2	Forest Lake Dam D4434	Loam
Gills Creek above Rocky Ford Lake Dam		
8	Rocky Ford Lake Dam 0028	Sandy loam
9	Upper (North) Rocky Ford Lake Dam 0029	Loam, Sand
21	Deer Lake Dam D0137	Sand, Loam
20	Hughes Pond Dam 0573	Sand
Jackson Creek above Spring Lake Dam		
7	Spring Lake Dam D0025	Sand
3	Cary's Lake Dam D0026	Loam
Tributary to Jackson Creek above Arcadia Woods Lake Dam		
23	Arcadia Woods Lake Dam D0557	Loam, Sand
22	Commons Pond Dam D0421	Sand
Jackson Creek above Windsor Lake Dam		
4	Windsor Lake Dam D0571	Loam
5	Upper Windsor Lake Dam D0570	Loam
6	Sesquicentennial Dam D0569	Loam, Sand
Jackson Creek above Wildewood Pond Dam 5		
10	Wildewood Pond Dam 5 D0565	Sand
11	Wildewood Pond #4 Dam D0564	Sand
Tributary to Jackson Creek above Wildewood Pond #1 Dam		
14	Wildewood Pond #1 Dam	Sand, Loam
12	Beaver Dam / Wildewood Pond #2 D0567	Sand
13	Wildewood Pond #3 D0566	Sand
Little Jackson Creek		
19	Springwood Lake Dam 0558	Loam
Tributaries to Little Jackson Creek		
18	Lower Spring Valley Lake Dam D0559	Loam, Sand
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	Loam, Sand
15	Entrance Lake Dam D0450	Loam, Sand

2.3. Impervious Area

The remotely sensed National Land Cover Dataset (NLCD) was used to estimate impervious areas within each reservoir direct drainage area. The year 2011 condition imperviousness and land use were used (USGS, October 2014). The impervious dataset contained an estimate of the impervious area within each drainage area. The water surfaces from the land use dataset was added as a fully impervious area to simulate loss less rain on water. The proportion of impervious areas are provided in Table 4. Model Impervious Areas. Most areas are developed. The drainage to North (Upper) Rocky Ford Lake (HDR Number 9) is mostly undeveloped. It is

assumed that the impervious areas are directly connected to each lake. It is also assumed that any urban best management practices (BMP) will not significantly store runoff.

Table 4. Model Impervious Areas

HDR Dam Number	Dam Name	Impervious Area of the Direct Drainage Area [%]
Gills Creek above Lake Katherine Dam		
1	Lake Katherine Dam D0027	30%
2	Forest Lake Dam D4434	35%
Gills Creek above Rocky Ford Lake Dam		
8	Rocky Ford Lake Dam 0028	39%
9	Upper (North) Rocky Ford Lake Dam 0029	8%
21	Deer Lake Dam D0137	30%
20	Hughes Pond Dam 0573	40%
Jackson Creek above Spring Lake Dam		
7	Spring Lake Dam D0025	30%
3	Cary's Lake Dam D0026	35%
Tributary to Jackson Creek above Arcadia Woods Lake Dam		
23	Arcadia Woods Lake Dam D0557	38%
22	Commons Pond Dam D0421	58%
Jackson Creek above Windsor Lake Dam		
4	Windsor Lake Dam D0571	44%
5	Upper Windsor Lake Dam D0570	18%
6	Sesquicentennial Dam D0569	17%
Jackson Creek above Wildewood Pond Dam 5		
10	Wildewood Pond Dam 5 D0565	37%
11	Wildewood Pond #4 Dam D0564	37%
Tributary to Jackson Creek above Wildewood Pond #1 Dam		
14	Wildewood Pond #1 Dam	29%
12	Beaver Dam / Wildewood Pond #2 D0567	29%
13	Wildewood Pond #3 D0566	29%
Little Jackson Creek		
19	Springwood Lake Dam 0558	26%
Tributaries to Little Jackson Creek		
18	Lower Spring Valley Lake Dam D0559	36%
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	24%
15	Entrance Lake Dam D0450	36%

2.4. Time of Concentration

The time of concentration for each subbasin was calculated using the NRCS TR-55 "Urban Hydrology for Small Watersheds". A longest flow path was determined for the direct drainage area to each reservoir using the ESRI ArcGIS Spatial Analyst Flow Length tool. This longest flow path was divided into sheet, shallow, and channel flow. The first 100 feet of the flow path was assigned to sheet flow. The location of shallow to channel flow was determined from inspection of the LiDAR data based on the presence of a cross sectional channel. Slopes and

cross-sectional channel data was obtained from LiDAR. Land use information was based on year 2013 aerial photography. Table 5. Times of Concentration, provides the time of concentrations within the direct drainage area to each reservoir. The SCS unit hydrograph lag time was estimated at 60% of the time of concentration.

Table 5. Times of Concentration

HDR Dam Number	Dam Name	Time of Concentration of the Direct Drainage Area [hr]
Gills Creek above Lake Katherine Dam		
1	Lake Katherine Dam D0027	1.4
2	Forest Lake Dam D4434	0.5
Gills Creek above Rocky Ford Lake Dam		
8	Rocky Ford Lake Dam 0028	0.1
9	Upper (North) Rocky Ford Lake Dam 0029	3.2
21	Deer Lake Dam D0137	0.3
20	Hughes Pond Dam 0573	0.1
Jackson Creek above Spring Lake Dam		
7	Spring Lake Dam D0025	0.4
3	Cary's Lake Dam D0026	1.1
Tributary to Jackson Creek above Arcadia Woods Lake Dam		
23	Arcadia Woods Lake Dam D0557	0.2
22	Commons Ponds Dam D0421	0.4
Jackson Creek above Windsor Lake Dam		
4	Windsor Lake Dam D0571	0.5
5	Upper Windsor Lake Dam D0570	0.8
6	Sesquicentennial Dam D0569	0.6
Jackson Creek above Wildewood Pond Dam 5		
10	Wildewood Pond Dam 5 D0565	0.5
11	Wildewood Pond #4 Dam D0564	1.1
Tributary to Jackson Creek above Wildewood Pond #1 Dam		
14	Wildewood Pond #1 Dam	0.2
12	Beaver Dam / Wildewood Pond #2 D0567	0.3
13	Wildewood Pond #3 D0566	0.3
Little Jackson Creek		
19	Springwood Lake Dam 0558	0.8
Tributaries to Little Jackson Creek		
18	Lower Spring Valley Lake Dam D0559	0.1
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	0.6
15	Entrance Lake Dam D0450	1.5

2.5. Reservoirs and Dams

Model inputs for the reservoir and dam characteristics are the elevation-storage data and outlet structures.

2.5.1. Elevation and Storage Data

The elevation-storage data for each reservoir for this effort was represented as three values: the elevation at the stream thalweg where the reservoir has no storage; the storage and elevation of the normal pool; and the storage and elevation of the top of dam. The top of dam and normal pool storage was provided by SCDHEC. The top of dam elevation was provided by either SCDHEC, the USACE, or estimated from LiDAR. Normal pool elevation and dam height was provided by SCDHEC or USACE. Table 6. Key Reservoir Elevation and Storage Values, provides the storage information.

2.5.2. Outlet Capacities

Outlet capacities were estimated from data provided by SCDHEC, USACE, or on-site HDR observations. Table 7. Reservoir Outlet Structures, summarizes the characteristics of the outlet structures. Dam structures consisting only of spillways or dam crests were modeled as explicit structure data in the HEC-HMS model. A coefficient of discharge of 3.2 was used for spillways and 2.6 used for dam crests in the weir flow equation. Dam structures including risers had outlet rating curves calculated externally and input as storage-discharge curves.

The outlet structures summarized in Table 7 are pre-flood conditions. In the post-flood condition, Cary's Lake (HDR Number 3), Rocky Ford Lake (HDR Number 8), and North (Upper) Rocky Ford Lake (HDR Number 9) were fully breached. These dams were modeled as having the dam crests located at the thalweg elevation. Primary spillways were damaged for Wildewood 4 (HDR Number 11), Beaver Dam / Wildewood #2 (HDR Number 12), and Wildewood #1 (HDR Number 14). For Wildewood 4 and Beaver Dam / Wildewood #2, a 40 cfs pump was modeled as the primary outlet. A temporary emergency spillway was modeled for Wildewood #1 and Beaver Dam / Wildewood #2. The auxiliary spillway for Spring Lake (HDR Number 7) was damaged, although still operational. The auxiliary spillway for Spring Lake was assumed to operate as in the pre-flood condition.

Table 6. Key Reservoir Elevation and Storage Values

HDR Dam Number	Dam Name	Top of Dam		Normal Pool		Stream Thalweg	Dam Height
		Elevation [ft]	Storage [ac ft]	Elevation [ft]	Storage [ac ft]	Elevation [ft]	[ft]
Gills Creek above Lake Katherine Dam							
1	Lake Katherine Dam D0027	154.8	2000	149.8	1000	140.8	14
2	Forest Lake Dam D4434	176.0	1515	169.0	730	153.0	23
Gills Creek above Rocky Ford Lake Dam							
8	Rocky Ford Lake Dam 0028	186.1	230	181.1	118	166.1	20
9	Upper (North) Rocky Ford Lake Dam 0029	187.5	297	180.5	138	176.1	11.4
21	Deer Lake Dam D0137	275.89	72	272.39	44	262.89	13
20	Hughes Pond Dam 0573	345.89	324	341.89	216	320.89	25
Jackson Creek above Spring Lake Dam							
7	Spring Lake Dam D0025	182.3	445	178.7	290	165.7	16.6
3	Cary's Lake Dam D0026	197.9	960	191.2	400	178.1	19.8
Tributary to Jackson Creek above Arcadia Woods Lake Dam							
23	Arcadia Woods Lake Dam D0557	222.6	64	221.0	57	201.6	21
22	Commons Pond Dam D0421	253.61	45	249.11	30	234.61	19
Jackson Creek above Windsor Lake Dam							
4	Windsor Lake Dam D0571	224.5	690	223.5	500	194.5	30
5	Upper Windsor Lake Dam D0570	230.2	700	225.2	205	205.7	24.5
6	Sesquicentennial Dam D0569	257.8	322	255.5	150	244.8	13
Jackson Creek above Wildewood Pond Dam 5							
10	Wildewood Pond Dam 5 D0565	302.2	204	299.2	151	287.1	15.1
11	Wildewood Pond #4 Dam D0564	314.9	204	311.9	151	298.5	16.4
Tributary to Jackson Creek above Wildewood Pond #1 Dam							
14	Wildewood Pond #1 Dam	297.8	68	295.8	44	279.79	18
12	Beaver Dam / Wildewood Pond #2 D0567	318.6	281	316.8	227	295.4	23.2
13	Wildewood Pond #3 D0566	341.1	152	331.89	152	316.1	25
Little Jackson Creek							
19	Springwood Lake Dam 0558	225.1	233	221.4	191	208.3	16.8
Tributaries to Little Jackson Creek							
18	Lower Spring Valley Lake Dam D0559	297.4	202	294.4	87	277.5	19
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	312.8	362	307.8	250	295.7	17.1
15	Entrance Lake Dam D0450	324.9	133	323.2	82	308.2	16.7

Notes: Elevations are in vertical datum NGVD 29.

Table 7. Reservoir Outlet Structures

HDR Dam Number	Dam Name	Primary Outlet	Auxiliary Spillway	Top of Dam
Gills Creek above Lake Katherine Dam				
1	Lake Katherine Dam D0027	4'x4' drop inlet @ elev. 149.8 feet 2.5 ft diameter outlet @ elev. 140.8 (2.0 ft measured in the field) 10'x10' drop inlet @ 149.8 feet 7 ft diameter outlet @ elev. 139.5 (6 ft. measured in the field)	Earthen: Length 100 feet Elevation 150.3 feet Concrete/Rockfill: Length: 100 feet Sill Elevation 147.8 feet Top of Stop logs 150.3 feet	Length 900 feet Elevation 154.8 feet
2	Forest Lake Dam D4434	Service Spillway Length 77 feet Elevation 169.5 feet	Length 11 feet Elevation 170.3 feet	Length 600 feet Elevation 176.0 feet
Gills Creek above Rocky Ford Lake Dam				
8	Rocky Ford Lake Dam 0028	48" RCP inlet @ elev. 180.6 feet outlet @ elev. 167.8 feet	Service Spillway Length 115 feet Elevation 180.9 feet	Length 260 feet Elevation 186.1 feet
9	Upper (North) Rocky Ford Lake Dam 0029	4 ft diameter inlet @ elev. 180.5 feet 4 ft diameter outlet @ elev. 176.1 feet	Length 90 feet Elevation 187.8 feet	Length 700 feet Elevation 193.5 feet
21	Deer Lake Dam D0137	2 ft diameter inlet @ elev. 272.39 feet 2 ft diameter inlet @ elev. 261.89 feet	Length 8 feet Elevation 272.69 feet	Length 1,400 feet Elevation 275.89 feet
20	Hughes Pond Dam 0573	3 ft diameter inlet @ elev. 341.89 feet 2 ft diameter inlet @ elev. 319.89 feet	Length 50 feet Elevation 344.49 feet	Length 750 feet Elevation 345.89 feet
Jackson Creek above Spring Lake Dam				
7	Spring Lake Dam D0025	6.5'x5.5' drop inlet @ elev. 178.7 feet 4 ft diameter outlet @ elev. 169.7 feet (3 ft measured in the field)	Length 84 feet Elevation 178.65 feet	Length 520 feet Elevation 182.3 feet
3	Cary's Lake Dam D0026	12'x12' drop inlet @ elev. 191.0 feet 6.5'x6.5' box outlet @ elev. 178.1 feet	Length 34 feet Elevation 191.2 feet	Length 350 feet Elevation 197.9 feet
Tributary to Jackson Creek above Arcadia Woods Lake Dam				
23	Arcadia Woods Lake Dam D0557	2 ft diameter inlet @ elev. 220.9 feet 2 ft diameter outlet @ elev. 201.9 feet	n/a	Length 400 feet Elevation 222.6 feet
22	Commons Pond Dam D0421	1.5 ft diameter inlet @ elev. 249.11 feet 1.5 ft diameter outlet @ elev. 234.61 feet	Length 12 feet Elevation 250.61 feet	Length 300 feet Elevation 253.61 feet
Jackson Creek above Windsor Lake Dam				
4	Windsor Lake Dam D0571	6'x6' drop inlet @ elev. 219.5 feet 4 ft diameter outlet @ elev. 205.7 feet	Length 45 feet Elevation 220.7 feet	Length 800 feet Elevation 224.5 feet
5	Upper Windsor Lake Dam D0570	4'x4.6' drop inlet @ elev. 221.3 feet 4 ft diameter outlet @ elev. 205.7 feet Windsor Lake tailwater @ elev. 220.7 feet	Length 35 feet Elevation 226.9 feet	Length 800 feet Elevation 230.2 feet

HDR Dam Number	Dam Name	Primary Outlet	Auxiliary Spillway	Top of Dam
6	Sesquicentennial Dam D0569	24" RCP drawdown pipe (assumed inactive during regular operations)	Length 38 feet Elevation 254.8 feet	Length 984 feet Elevation 257.8 feet
Jackson Creek above Wildewood Pond Dam 5				
10	Wildewood Pond Dam 5 D0565	2.5 ft diameter inlet @ elev. 299.2 ft 2.5 ft diameter outlet @ elev. 287.1 ft (4 ft measured in the field)	Length 80 feet Elevation 299.2 feet	Length 500 feet Elevation 302.2 feet
11	Wildewood Pond #4 Dam D0564	2.5 ft diameter inlet @ elev. 311.9 feet 2.5 ft diameter outlet @ elev. 298.5 feet (Unusable)	40 cfs pump	Length 500 feet Elevation 314.9 feet
Tributary to Jackson Creek above Wildewood Pond #1 Dam				
14	Wildewood Pond #1 Dam	2 ft diameter inlet @ elev. 295.79 feet 2 ft diameter outlet @ elev. 279.79feet (Unusable)	Temporary Spillway: Elevation: 295.79 feet Length: 25 feet	Length 600 feet Elevation 297.79 feet
12	Beaver Dam / Wildewood Pond #2 D0567	3 ft diameter inlet @ elev. 317.4 feet 2.5 ft diameter outlet @ elev. 295 feet (Unusable)	Temporary spillway estimated at 10' base width and 7' below top of dam 40 cfs pump	Length 725 feet Elevation 318.6 feet
13	Wildewood Pond #3 D0566	2.5 ft diameter inlet @ elev. 331.89 feet 2.5 ft diameter outlet @ elev. 309.1 feet	n/a	Length 475 feet Elevation 341.1 feet
Little Jackson Creek				
19	Springwood Lake Dam 0558	Half pipe of 4 ft diameter inlet @ elev. 221.4 feet 2.5 ft diameter outlet @ elev. 204.6 feet	Length 55 feet Elevation 221.7 feet 10x10 riser @ elev. 224.1 feet 7 ft diameter outlet @ elev. 204.6 feet	Length 500 feet Elevation 225.1 feet
Tributaries to Little Jackson Creek				
18	Lower Spring Valley Lake Dam D0559	4 ft diameter inlet @ elev. 294.4 feet 4 ft diameter outlet @ elev. 277.5 feet	Length 40 feet Elevation 296 feet	Length 500 feet Elevation 297.4 feet
16	Pine Springs Lake Complex 1 D0560	1.5 ft diameter inlet @ elev. 307.8 ft 1.5 ft diameter outlet @ elev. 297.8 ft	Length 80 feet Elevation 311.2 feet	Length 275 feet Elevation 312.8 feet
17	Pine Springs Lake Complex 2 D0561	2 ft diameter inlet @ elev. 309.7 feet 2 ft diameter outlet @ elev. 295.7 feet	n/a	Length 440 feet Elevation 311.7 feet
15	Entrance Lake Dam D0450	15" diameter inlet @ elev. 322.5 feet 12" diameter outlet @ elev. 305.7 feet	Service Spillway Length 16 feet Elevation 323.2 feet	Length 420 feet Elevation 324.9 feet

Notes: Elevations are in vertical datum NGVD 29. Source data from SCDHEC record documents with supplemental information from HDR field surveys. HDR Numbers 3, 8, and 9 are modeled post-flood as fully breached. HDR Numbers 11, 12, and 14 are modeled post-flood having the primary outlet removed and implementation of emergency outlet measures. HDR numbers 11 and 12 have a temporary 40 cfs pump, and HDR numbers 12 and 14 have a temporary spillway channel.

2.6. Baseflows

The normal flows within the Gills Creek watershed are largely not measured. Baseflow within the watershed was assumed to be based on the USGS gage 02169570, Gills Creek at Columbia, SC. The median daily flow at this gage for the period of record (October 1, 1966 to February 5, 2016) is 44 cfs. If all reservoir pools within the watershed are set to normal pool, then it is assumed that any inflow to the reservoir is released as the outflow without being stored. The normal flow at the location below Lake Katherine is the cumulative baseflow of the upper watershed.

The normal flow of 44 cfs was divided by the total drainage area of 52.23 square miles to produce a baseflow ratio of 0.84 cfs per square mile. This ratio was multiplied by each subbasin's drainage area to distribute a constant baseflow throughout the watershed.

2.7. Evaluated Rainfall Events

The Atlas 14 rainfall distributions served as the basis of the rainfall scenarios. The 50th percentile for the four quartile distributions was evaluated. Of these, the first quartile appears to generate the highest runoff amounts and was used in subsequent evaluations.

3. Analysis of Post-Flood Reservoir System

Four rainfall scenarios were evaluated to estimate impacts to the post-flood reservoir system. These rainfall scenarios were selected for the initial purposes of immediate emergency response and monitoring of the unbreached dams. These rainfall scenarios are, therefore, focused on frequent storm events.

The 50th percentile, first quartile Atlas 14 rainfall distribution was used for all scenarios. These scenarios were:

- A one-inch rainfall, uniform over the watershed over 24 hours
- A two-inch rainfall, uniform over the watershed over 24 hours
- The 10-year Atlas 14 rainfall of 5.26 inches over 24 hours and uniform over the watershed
- The 100-year Atlas 14 rainfall of 8.43 inches over 24 hours and uniform over the watershed.

The starting reservoir elevations were set to the primary outlet elevations (normal pool). The peak runoff and releases from each dam for these rainfall scenarios are provided in subsequent Tables (Table 8 to Table 11). Table 12. Summary of Rainfall Scenario Effects, lists which of the modeled rainfall scenarios may activate the auxiliary spillway, reduce freeboard below 1.0 foot, or potentially overtop the dam crest for each of the modeled dams.

The model indicates that both the 1-inch/24-hour rainfall and 2-inch/24-hour scenarios might activate the auxiliary spillways for the following dams:

- Lake Katherine Dam D0027
- Forest Lake Dam D4434
- Spring Lake Dam D0025
- Sesquicentennial Dam D0569
- Wildewood Pond Dam 5 D0565
- Wildewood Pond #1 Dam
- Beaver Dam/Wildewood Pond #2 D0567
- Springwood Lake Dam 0558
- Deer Lake Dam D0137

The 2-inch/24-hour scenario might also activate the auxiliary spillway of Entrance Lake Dam (D0450).

The 10-year/24-hour rainfall scenario might activate the auxiliary spillways of:

- Lake Katherine Dam D0027
- Forest Lake Dam D4434
- Windsor Lake Dam D0571
- Spring Lake Dam D0025
- Sesquicentennial Dam D0569
- Wildewood Pond Dam 5 D0565
- Wildewood Pond #1 Dam
- Entrance Lake Dam D0450
- Beaver Dam/Wildewood Pond #2 D0567
- Springwood Lake Dam 0558
- Deer Lake Dam D0137
- Commons Pond Dam D0421

The 10-year/24-hour rainfall scenario might reduce freeboard to less than 1.0 foot for the following dams:

- Spring Lake Dam D0025
- Entrance Lake Dam D0450
- Arcadia Woods Lake Dam D0557

The 100-year/24-hour rainfall scenario might activate the auxiliary spillways of:

- Lake Katherine Dam D0027
- Forest Lake Dam D4434
- Windsor Lake Dam D0571
- Upper Windsor Lake Dam D0570
- Spring Lake Dam D0025

- Sesquicentennial Dam D0569
- Wildewood Pond Dam 5 D0565
- Wildewood Pond #1 Dam
- Entrance Lake Dam D0450
- Beaver Dam/Wildewood Pond #2 D0567
- Springwood Lake Dam 0558
- Deer Lake Dam D0137
- Commons Pond Dam D0421

The 100-year/24-hour rainfall scenario might reduce freeboard to less than 1.0 foot or overtop the following dams:

- Spring Lake Dam D0025
- Sesquicentennial Dam D0569
- Wildewood Pond #4 Dam D0564
- Wildewood Pond #1 Dam
- Entrance Lake Dam D0450
- Springwood Lake Dam 0558
- Arcadia Woods Lake Dam D0557

Table 8. Model Results for One Inch/24-Hour Rainfall Scenario

HDR Number	Name	Reference Reservoir Elevations [ft]				Total Inflow	Total Outflow	Peak Inflow	Peak Outflow	Peak Storage		Impact Analysis		
		Starting Elevation	Primary Outlet Elevation	Auxiliary Spillway Elevation	Top of Dam Elevation	[ac ft]	[ac ft]	[cfs]	[cfs]	Volume [ac ft]	Elevation [ft]	Freeboard (re: Top of Dam) [ft]	Auxiliary Spillway Depth [ft]	Auxiliary Spillway Flow [cfs]
Gills Creek above Lake Katherine Dam														
1	Lake Katherine Dam D0027	150.2	150.2	150.3	154.8	803	787	413	347	1,211.1	150.9	3.9	0.6	133
2	Forest Lake Dam D4434	169.5	169.5	170.3	176.0	655	623	471	323	918.0	170.7	5.3	0.4	81
Gills Creek above Rocky Ford Lake Dam														
8	Rocky Ford Lake Dam 0028	166.1	breached			221	207	150	149	18.0	168.2	0.0	n/a	n/a
9	Upper (North) Rocky Ford Lake Dam 0029	176.1	breached			219	218	148	147	63.8	176.3	0.0	n/a	n/a
21	Deer Lake Dam D0137	272.4	272.4	272.7	275.9	21	21	18	17	46.0	272.9	3.0	0.2	2
20	Hughes Pond Dam 0573	341.9	341.9	344.5	345.9	6	6	7	3	218.5	341.9	4.0	0.0	0
Jackson Creek above Spring Lake Dam														
7	Spring Lake Dam D0025	178.7	178.7	178.7	182.3	401	398	311	283	326.9	179.5	2.8	0.9	233
3	Cary's Lake Dam D0026	179.7	breached			391	388	303	299	84.5	180.2	0.0	n/a	n/a
Tributary to Jackson Creek above Arcadia Woods Lake Dam														
23	Arcadia Woods Lake Dam D0557	220.9	220.9	n/a	222.6	9	8	10	8	58.5	221.1	1.5	n/a	n/a
22	Commons Pond Dam D0421	249.1	249.1	250.6	253.6	7	7	8	8	29.6	249.5	4.1	0.0	0
Jackson Creek above Windsor Lake Dam														
4	Windsor Lake Dam D0571	219.5	219.5	220.7	224.5	139	137	79	73	441.8	220.1	4.4	0.0	0
5	Upper Windsor Lake Dam D0570	221.3	221.3	226.9	230.2	101	101	49	44	175.5	222.1	8.1	0.0	0
6	Sesquicentennial Dam D0569	254.8	n/a	254.8	257.8	71	66	51	33	212.1	255.2	2.6	0.4	33
Jackson Creek above Wildewood Pond Dam 5														
10	Wildewood Pond Dam 5 D0565	299.2	299.2	299.2	302.2	33	33	26	25	152.4	299.3	2.9	0.1	6
11	Wildewood Pond #4 Dam D0564	310.9	310.9	n/a	314.9	21	20	22	15	156.0	311.3	3.6	n/a	n/a
Tributary to Jackson Creek above Wildewood Pond #1 Dam														
14	Wildewood Pond #1 Dam	295.8	n/a	295.8	297.8	16	15	13	11	47.6	296.1	1.7	0.3	11
12	Beaver Dam / Wildewood Pond #2 D0567	311.6	317.4	311.6	318.6	14	14	14	12	179.0	311.6	7.0	0.0	0
13	Wildewood Pond #3 D0566	331.9	331.9	n/a	341.1	8	8	8	8	124.3	332.2	8.9	n/a	n/a
Little Jackson Creek														
19	Springwood Lake Dam 0558	221.4	221.4	221.7	225.1	118	122	96	95	197.8	222.2	2.9	0.5	11
Tributaries to Little Jackson Creek														
18	Lower Spring Valley Lake Dam D0559	294.4	294.4	296.0	297.4	9	9	7	4	89.1	294.4	3.0	0.0	0
16 17	Pine Springs Lake Complex 1 D0560 / Pine Springs Lake Complex 2 D0561	307.8	307.8	311.2	311.7	7	7	7	5	237.8	307.9	3.8	0.0	0
15	Entrance Lake Dam D0450	322.5	322.5	323.2	324.9	19	18	20	7	90.5	322.9	2.0	0.0	0

Notes: Elevations are in vertical datum NGVD 29.

Table 9. Model Results for Two Inch/24-Hour Rainfall Scenario

HDR Number	Name	Reference Reservoir Elevations [ft]				Total Inflow	Total Outflow	Peak Inflow	Peak Outflow	Peak Storage		Impact Analysis		
		Starting Elevation	Primary Outlet Elevation	Auxiliary Spillway Elevation	Top of Dam Elevation	[ac ft]	[ac ft]	[cfs]	[cfs]	Volume [ac ft]	Elevation [ft]	Freeboard (re: Top of Dam) [ft]	Auxiliary Spillway Depth [ft]	Auxiliary Spillway Flow [cfs]
Gills Creek above Lake Katherine Dam														
1	Lake Katherine Dam D0027	150.2	150.2	150.3	154.8	1,400	1,384	915	796	1,299.4	151.3	3.5	1.0	319
2	Forest Lake Dam D4434	169.5	169.5	170.3	176.0	1,116	1,083	925	714	1,004.7	171.4	4.6	1.1	434
Gills Creek above Rocky Ford Lake Dam														
8	Rocky Ford Lake Dam 0028	166.1	breached			333	319	278	277	20.4	168.4	0.0	n/a	n/a
9	Upper (North) Rocky Ford Lake Dam 0029	176.1	breached			328	328	273	273	64.5	176.4	0.0	n/a	n/a
21	Deer Lake Dam D0137	272.4	272.4	272.7	275.9	38	38	35	30	48.2	273.1	2.8	0.4	7
20	Hughes Pond Dam 0573	341.9	341.9	344.5	345.9	11	11	14	6	221.0	342.0	3.9	0.0	0
Jackson Creek above Spring Lake Dam														
7	Spring Lake Dam D0025	178.7	178.7	178.7	182.3	709	706	605	564	349.7	180.1	2.2	1.4	480
3	Cary's Lake Dam D0026	179.7	breached			690	688	586	581	92.5	180.4	0.0	n/a	n/a
Tributary to Jackson Creek above Arcadia Woods Lake Dam														
23	Arcadia Woods Lake Dam D0557	220.9	220.9	n/a	222.6	16	16	19	16	60.0	221.4	1.2	n/a	n/a
22	Commons Pond Dam D0421	249.1	249.1	250.6	253.6	13	13	16	16	29.8	250.0	3.6	0.0	0
Jackson Creek above Windsor Lake Dam														
4	Windsor Lake Dam D0571	219.5	219.5	220.7	224.5	245	243	143	137	447.3	220.4	4.1	0.0	0
5	Upper Windsor Lake Dam D0570	221.3	221.3	226.9	230.2	177	177	107	84	192.0	223.7	6.5	0.0	0
6	Sesquicentennial Dam D0569	254.8	n/a	254.8	257.8	124	119	101	72	225.1	255.5	2.3	0.7	72
Jackson Creek above Wildewood Pond Dam 5														
10	Wildewood Pond Dam 5 D0565	299.2	299.2	299.2	302.2	59	59	51	49	153.8	299.4	2.8	0.2	17
11	Wildewood Pond #4 Dam D0564	310.9	310.9	n/a	314.9	37	37	43	30	160.9	311.6	3.3	n/a	n/a
Tributary to Jackson Creek above Wildewood Pond #1 Dam														
14	Wildewood Pond #1 Dam	295.8	n/a	295.8	297.8	28	28	26	22	49.8	296.3	1.5	0.5	22
12	Beaver Dam / Wildewood Pond #2 D0567	311.6	317.4	311.6	318.6	25	25	28	23	181.2	311.8	6.8	0.2	4
13	Wildewood Pond #3 D0566	331.9	331.9	n/a	341.1	14	14	17	16	125.0	332.3	8.8	n/a	n/a
Little Jackson Creek														
19	Springwood Lake Dam 0558	221.4	221.4	221.7	225.1	206	210	187	186	200.4	222.5	2.6	0.8	23
Tributaries to Little Jackson Creek														
18	Lower Spring Valley Lake Dam D0559	294.4	294.4	296.0	297.4	16	15	13	8	91.5	294.5	2.9	0.0	0
16 17	Pine Springs Lake Complex 1 D0560 / Pine Springs Lake Complex 2 D0561	307.8	307.8	311.2	311.7	12	12	14	10	239.2	307.9	3.8	0.0	0
15	Entrance Lake Dam D0450	322.5	322.5	323.2	324.9	34	33	40	31	95.5	323.7	1.2	0.5	18

Notes: Elevations are in vertical datum NGVD 29.

Table 10. Model Results for 10-Year/24-Hour Rainfall Scenario

HDR Number	Name	Reference Reservoir Elevations [ft]				Total Inflow	Total Outflow	Peak Inflow	Peak Outflow	Peak Storage		Impact Analysis		
		Starting Elevation	Primary Outlet Elevation	Auxiliary Spillway Elevation	Top of Dam Elevation	[ac ft]	[ac ft]	[cfs]	[cfs]	Volume [ac ft]	Elevation [ft]	Freeboard (re: Top of Dam) [ft]	Auxiliary Spillway Depth [ft]	Auxiliary Spillway Flow [cfs]
Gills Creek above Lake Katherine Dam														
1	Lake Katherine Dam D0027	150.2	150.2	150.3	154.8	3,348	3,328	2,807	2,483	1,537.3	152.5	2.3	2.2	1035
2	Forest Lake Dam D4434	169.5	169.5	170.3	176.0	2,618	2,582	2,479	2,092	1,223.7	173.4	2.6	3.1	1924
Gills Creek above Rocky Ford Lake Dam														
8	Rocky Ford Lake Dam 0028	166.1	breached			698	684	700	699	25.3	168.8	0.0	n/a	n/a
9	Upper (North) Rocky Ford Lake Dam 0029	176.1	breached			686	686	687	686	66.3	176.6	0.0	n/a	n/a
21	Deer Lake Dam D0137	272.4	272.4	272.7	275.9	93	92	91	76	56.4	273.9	1.9	1.3	36
20	Hughes Pond Dam 0573	341.9	341.9	344.5	345.9	28	28	35	15	228.9	342.1	3.8	0.0	0
Jackson Creek above Spring Lake Dam														
7	Spring Lake Dam D0025	178.7	178.7	178.7	182.3	1,716	1,713	1,594	1,531	414.0	181.6	0.7	2.9	1437
3	Cary's Lake Dam D0026	179.7	breached			1,666	1,663	1,540	1,531	113.0	181.1	0.0	n/a	n/a
Tributary to Jackson Creek above Arcadia Woods Lake Dam														
23	Arcadia Woods Lake Dam D0557	220.9	220.9	n/a	222.6	39	39	44	42	63.0	222.2	0.4	n/a	n/a
22	Commons Pond Dam D0421	249.1	249.1	250.6	253.6	33	33	42	37	33.0	250.9	2.7	0.3	7
Jackson Creek above Windsor Lake Dam														
4	Windsor Lake Dam D0571	219.5	219.5	220.7	224.5	593	591	312	302	458.5	221.1	3.4	0.4	36
5	Upper Windsor Lake Dam D0570	221.3	221.3	226.9	230.2	423	423	303	111	332.6	226.2	4.0	0.0	0
6	Sesquicentennial Dam D0569	254.8	n/a	254.8	257.8	297	292	245	188	253.8	256.2	1.6	1.4	188
Jackson Creek above Wildewood Pond Dam 5														
10	Wildewood Pond Dam 5 D0565	299.2	299.2	299.2	302.2	144	144	107	106	157.1	299.5	2.7	0.3	52
11	Wildewood Pond #4 Dam D0564	310.9	310.9	n/a	314.9	91	90	113	40	188.8	313.8	1.1	n/a	n/a
Tributary to Jackson Creek above Wildewood Pond #1 Dam														
14	Wildewood Pond #1 Dam	295.8	n/a	295.8	297.8	68	67	68	61	55.5	296.7	1.0	1.0	61
12	Beaver Dam / Wildewood Pond #2 D0567	311.6	317.4	311.6	318.6	59	59	72	59	188.2	312.6	6.0	1.0	32
13	Wildewood Pond #3 D0566	331.9	331.9	n/a	341.1	35	35	43	42	127.2	332.7	8.4	n/a	n/a
Little Jackson Creek														
19	Springwood Lake Dam 0558	221.4	221.4	221.7	225.1	494	498	540	535	209.5	223.6	1.5	1.9	81
Tributaries to Little Jackson Creek														
18	Lower Spring Valley Lake Dam D0559	294.4	294.4	296.0	297.4	37	37	33	20	99.0	294.5	2.9	0.0	0
16 17	Pine Springs Lake Complex 1 D0560 / Pine Springs Lake Complex 2 D0561	307.8	307.8	311.2	311.7	30	29	36	25	244.3	308.2	3.5	0.0	0
15	Entrance Lake Dam D0450	322.5	322.5	323.2	324.9	83	82	103	87	101.8	324.5	0.4	1.3	72

Notes: Elevations are in vertical datum NGVD 29.

Table 11. Model Results for 100-Year/24-Hour Rainfall Scenario

HDR Number	Name	Reference Reservoir Elevations [ft]				Total Inflow	Total Outflow	Peak Inflow	Peak Outflow	Peak Storage		Impact Analysis		
		Starting Elevation	Primary Outlet Elevation	Auxiliary Spillway Elevation	Top of Dam Elevation	[ac ft]	[ac ft]	[cfs]	[cfs]	Volume [ac ft]	Elevation [ft]	Freeboard (re: Top of Dam) [ft]	Auxiliary Spillway Depth [ft]	Auxiliary Spillway Flow [cfs]
Gills Creek above Lake Katherine Dam														
1	Lake Katherine Dam D0027	150.2	150.2	150.3	154.8	5,230	5,194	4,660	4,250	1,734.8	153.5	1.3	3.2	1810
2	Forest Lake Dam D4434	169.5	169.5	170.3	176.0	4,077	4,028	4,060	3,457	1,393.7	174.9	1.1	4.6	3457
Gills Creek above Rocky Ford Lake Dam														
8	Rocky Ford Lake Dam 0028	166.1	breached			1,054	1,039	1,115	1,113	28.2	169.2	0.0	n/a	n/a
9	Upper (North) Rocky Ford Lake Dam 0029	176.1	breached			1,034	1,033	1,092	1,092	67.6	176.8	0.0	n/a	n/a
21	Deer Lake Dam D0137	272.4	272.4	272.7	275.9	146	145	145	123	63.7	274.8	1.0	2.2	81
20	Hughes Pond Dam 0573	341.9	341.9	344.5	345.9	44	44	56	23	236.6	342.1	3.7	0.0	0
Jackson Creek above Spring Lake Dam														
7	Spring Lake Dam D0025	178.7	178.7	178.7	182.3	2,694	2,690	2,531	2,517	455.0	182.5	0.0	3.9	2205
3	Cary's Lake Dam D0026	179.7	breached			2,615	2,612	2,439	2,430	128.5	181.6	0.0	n/a	n/a
Tributary to Jackson Creek above Arcadia Woods Lake Dam														
23	Arcadia Woods Lake Dam D0557	220.9	220.9	n/a	222.6	62	62	67	67	64.1	222.6	0.0	n/a	n/a
22	Commons Pond Dam D0421	249.1	249.1	250.6	253.6	53	53	68	56	37.5	251.4	2.2	0.8	29
Jackson Creek above Windsor Lake Dam														
4	Windsor Lake Dam D0571	219.5	219.5	220.7	224.5	932	929	443	438	466.1	221.5	3.0	0.8	110
5	Upper Windsor Lake Dam D0570	221.3	221.3	226.9	230.2	663	663	512	220	455.6	227.7	2.5	0.8	107
6	Sesquicentennial Dam D0569	254.8	n/a	254.8	257.8	465	460	428	343	283.7	256.9	0.9	2.1	343
Jackson Creek above Wildewood Pond Dam 5														
10	Wildewood Pond Dam 5 D0565	299.2	299.2	299.2	302.2	228	228	232	201	162.6	299.9	2.3	0.7	135
11	Wildewood Pond #4 Dam D0564	310.9	310.9	n/a	314.9	143	143	180	145	205.1	315.0	0.0	n/a	n/a
Tributary to Jackson Creek above Wildewood Pond #1 Dam														
14	Wildewood Pond #1 Dam	295.8	n/a	295.8	297.8	107	106	111	102	60.2	297.1	0.6	1.4	102
12	Beaver Dam / Wildewood Pond #2 D0567	311.6	317.4	311.6	318.6	93	93	115	97	194.0	313.5	5.1	1.9	86
13	Wildewood Pond #3 D0566	331.9	331.9	n/a	341.1	54	54	69	67	129.3	333.1	8.0	n/a	n/a
Little Jackson Creek														
19	Springwood Lake Dam 0558	221.4	221.4	221.7	225.1	773	778	886	874	216.4	224.4	0.7	2.7	139
Tributaries to Little Jackson Creek														
18	Lower Spring Valley Lake Dam D0559	294.4	294.4	296.0	297.4	59	58	49	31	106.0	294.6	2.8	0.0	0
16 17	Pine Springs Lake Complex 1 D0560 / Pine Springs Lake Complex 2 D0561	307.8	307.8	311.2	311.7	46	46	58	37	249.9	308.5	3.2	0.0	0
15	Entrance Lake Dam D0450	322.5	322.5	323.2	324.9	131	130	165	163	107.3	324.9	0.0	1.7	117

Notes: Elevations are in vertical datum NGVD 29.

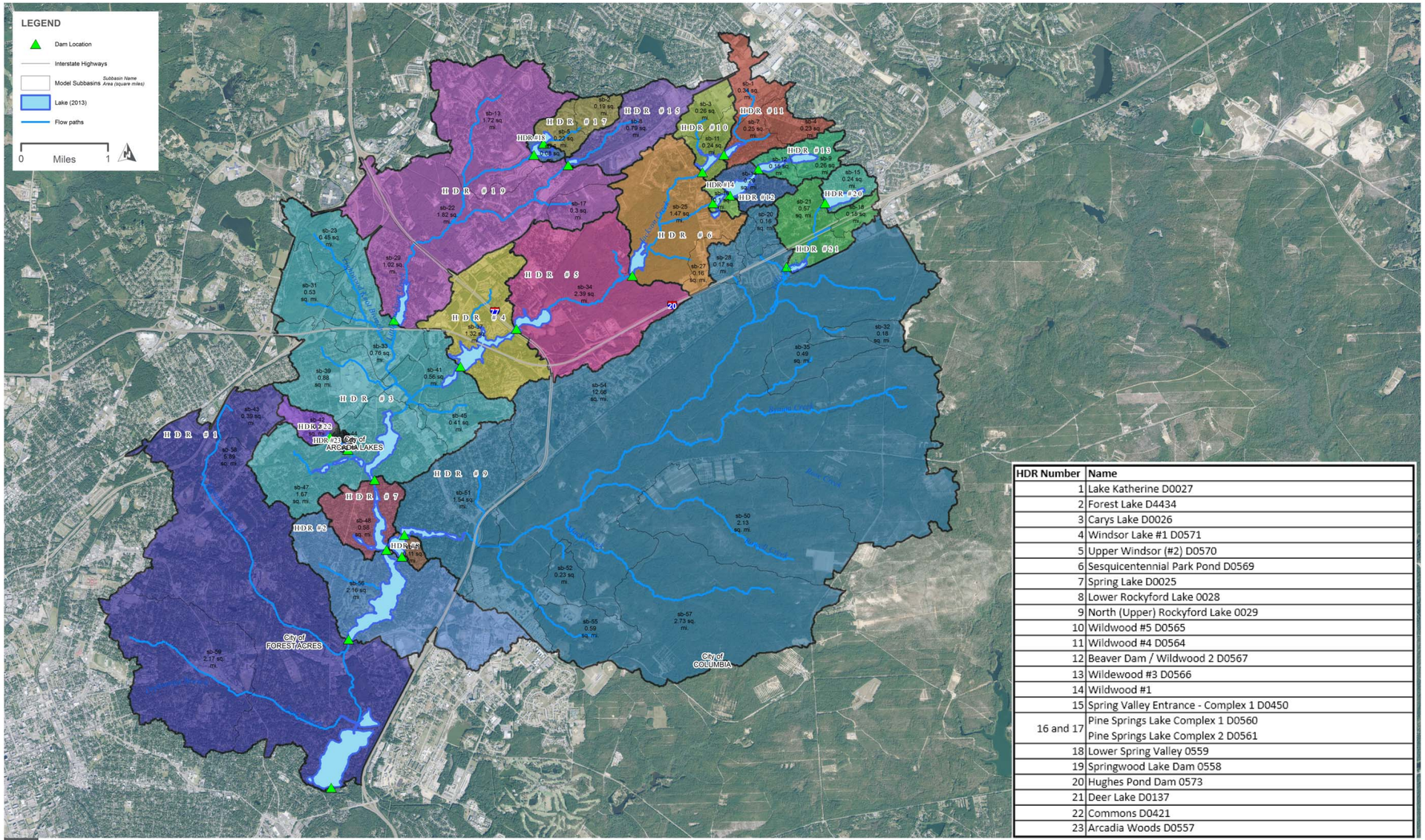
Table 12. Summary of Rainfall Scenario Effects

HDR Dam Number	Dam Name	Rainfall Scenario where:		
		Auxiliary Spillway Activated	Freeboard less than 1 foot	Dam Overtopped
Gills Creek above Lake Katherine Dam				
1	Lake Katherine Dam D0027	1-in/24H	*	*
2	Forest Lake Dam D4434	1-in/24H	*	*
Gills Creek above Rocky Ford Lake Dam				
8	Rocky Ford Lake Dam 0028	n/a	n/a	n/a
9	Upper (North) Rocky Ford Lake Dam 0029	n/a n/a		n/a
21	Deer Lake Dam D0137	1-in/24H	*	*
20	Hughes Pond Dam 0573	*	*	*
Jackson Creek above Spring Lake Dam				
7	Spring Lake Dam D0025	1-in/24H	010Y/24H	100Y/24H
3	Cary's Lake Dam D0026	n/a	n/a	n/a
Tributary to Jackson Creek above Arcadia Woods Lake Dam				
23	Arcadia Woods Lake Dam D0557	n/a	010Y/24H	100Y/24H
22	Commons Pond Dam D0421	010Y/24H	*	*
Jackson Creek above Windsor Lake Dam				
4	Windsor Lake Dam D0571	010Y/24H	*	*
5	Upper Windsor Lake Dam D0570	100Y/24H *		*
6	Sesquicentennial Dam D0569	1-in/24H	100Y/24H	*
Jackson Creek above Wildewood Pond Dam 5				
10	Wildewood Pond Dam 5 D0565	1-in/24H	*	*
11	Wildewood Pond #4 Dam D0564	n/a	100Y/24H	100Y/24H
Tributary to Jackson Creek above Wildewood Pond #1 Dam				
14	Wildewood Pond #1 Dam	1-in/24H	100Y/24H	*
12	Beaver Dam / Wildewood Pond #2 D0567	1-in/24H *		*
13	Wildewood Pond #3 D0566	n/a	*	*
Little Jackson Creek				
19	Springwood Lake Dam 0558	1-in/24H	100Y/24H	*
Tributaries to Little Jackson Creek				
18	Lower Spring Valley Lake Dam D0559	* *		*
16 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561	*	*	*
15	Entrance Lake Dam D0450	2-in/24H	010Y/24H	100Y/24H

Note: * = Not detected with the selected simulated rainfall scenarios.

Appendix

Figure 1. Subbasin Delineations



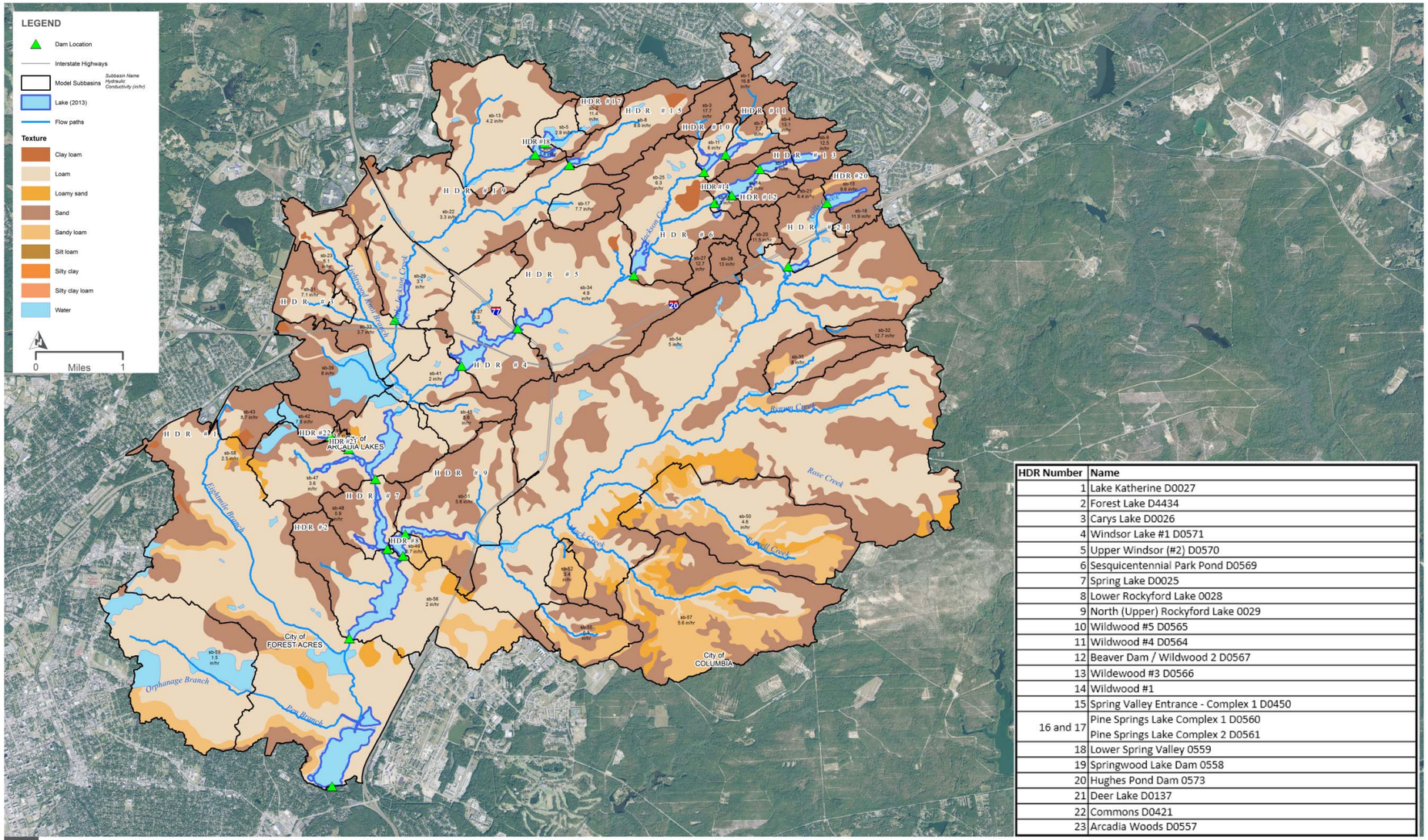
HDR Number	Name
1	Lake Katherine D0027
2	Forest Lake D4434
3	Carys Lake D0026
4	Windsor Lake #1 D0571
5	Upper Windsor (#2) D0570
6	Sesquicentennial Park Pond D0569
7	Spring Lake D0025
8	Lower Rockyford Lake 0028
9	North (Upper) Rockyford Lake 0029
10	Wildwood #5 D0565
11	Wildwood #4 D0564
12	Beaver Dam / Wildwood 2 D0567
13	Wildewood #3 D0566
14	Wildwood #1
15	Spring Valley Entrance - Complex 1 D0450
16 and 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561
18	Lower Spring Valley 0559
19	Springwood Lake Dam 0558
20	Hughes Pond Dam 0573
21	Deer Lake D0137
22	Commons D0421
23	Arcadia Woods D0557

HEC-HMS SUBBASINS
GILLS CREEK
FIGURE 1

PATH: C:\USERS\TSHANNON\DOCUMENTS\ROOT\SCDHEC\GILLSCREEK\DELIVERABLES\MEMORANDUM\FIGURE01_GILLSCREEKSUBBASINMAP_201601JAN14.MXD - USER: TSHANNON - DATE: 2/6/2016

GILLS CREEK WATERSHED: ASSESSMENT OF REGULATED DAMS

Figure 2. Soils Texture Mapping



HDR Number	Name
1	Lake Katherine D0027
2	Forest Lake D4434
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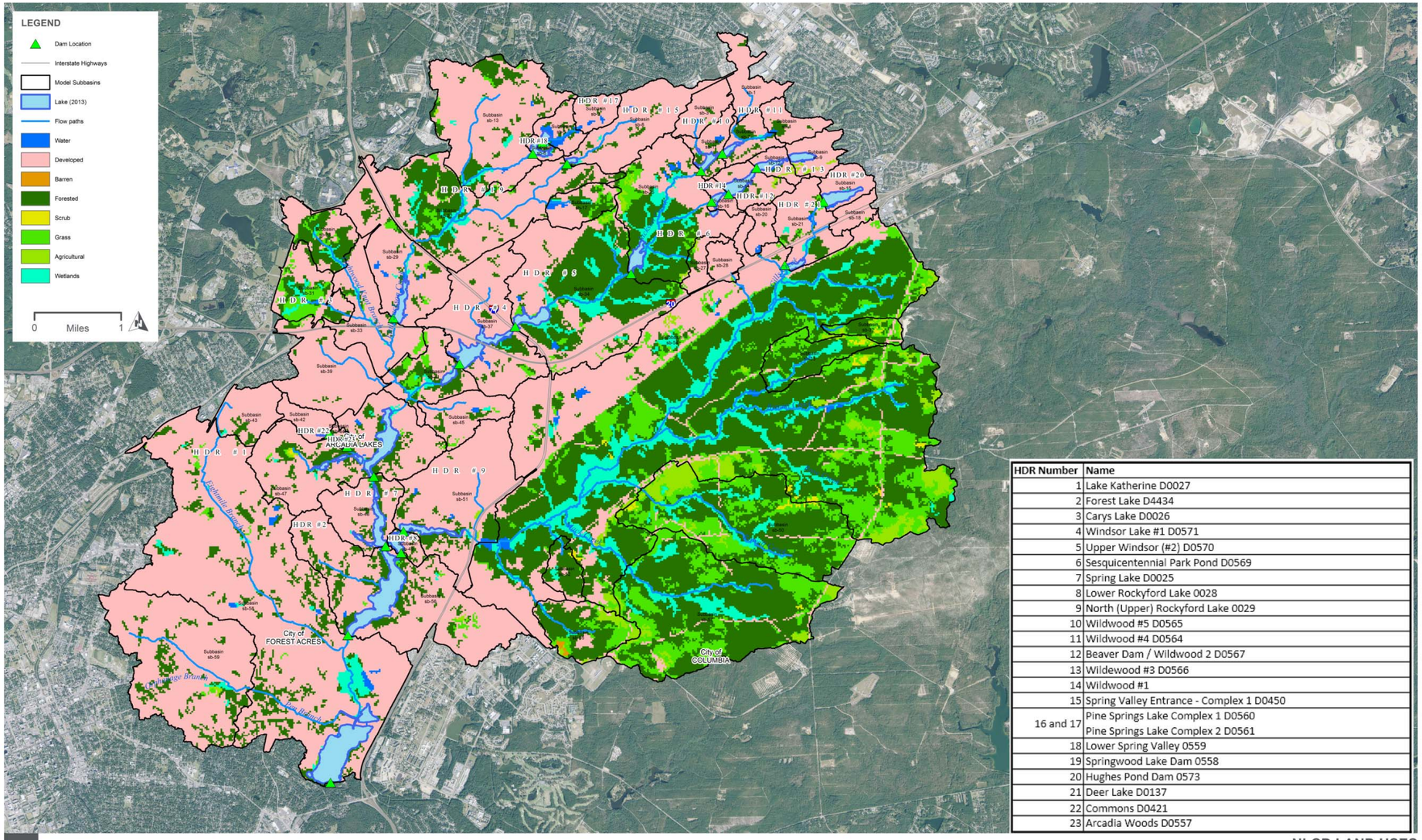
12	Beaver Dam / Wildwood 2 D0567
13	Wildewood #3 D0566
14	Wildwood #1
15	Spring Valley Entrance - Complex 1 D0450
16 and 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561
18	Lower Spring Valley 0559
19	Springwood Lake Dam 0558
20	Hughes Pond Dam 0573
21	Deer Lake D0137
22	Commons D0421
23	Arcadia Woods D0557

USDA SOILS TEXTURE
GILLS CREEK
FIGURE 2

PATH: C:\USERS\TSHANNON\DOCUMENTS\ROOT\SCDHEC\GILLSCREEK\DELIVERABLES\MEMORANDUM\FIGURE02_GILLSCREEKSOILSMAP_201601JAN14.MXD - USER: TSHANNON - DATE: 2/6/2016

GILLS CREEK WATERSHED: ASSESSMENT OF REGULATED DAMS

Figure 3. Land Use Classifications



HDR Number	Name
1	Lake Katherine D0027
2	Forest Lake D4434
3	Carys Lake D0026
4	Windsor Lake #1 D0571
5	Upper Windsor (#2) D0570
6	Sesquicentennial Park Pond D0569
7	Spring Lake D0025
8	Lower Rockyford Lake 0028
9	North (Upper) Rockyford Lake 0029
10	Wildwood #5 D0565
11	Wildwood #4 D0564
12	Beaver Dam / Wildwood 2 D0567
13	Wildewood #3 D0566
14	Wildwood #1
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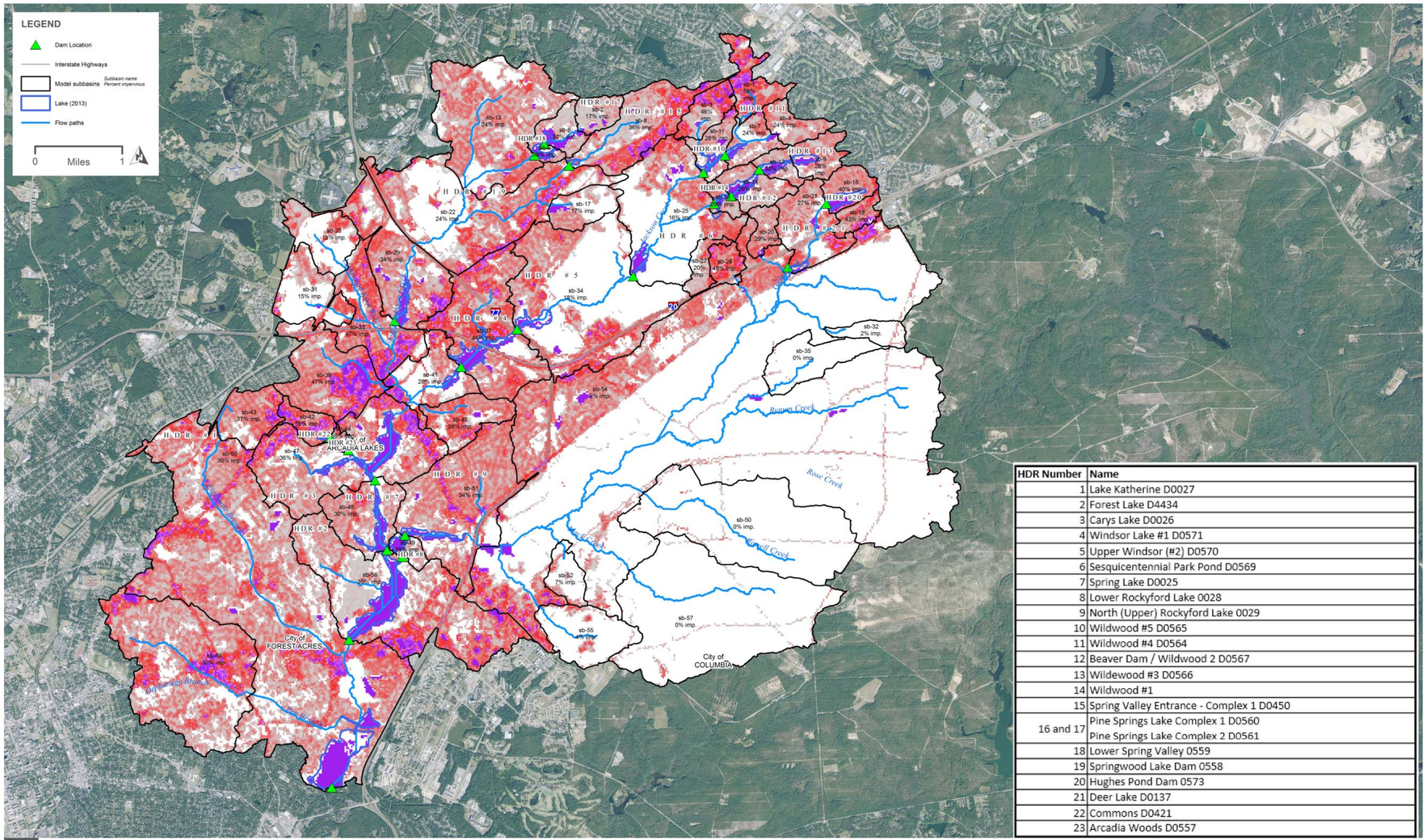
16 and 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561
18	Lower Spring Valley 0559
19	Springwood Lake Dam 0558
20	Hughes Pond Dam 0573
21	Deer Lake D0137
22	Commons D0421
23	Arcadia Woods D0557

Figure 4. Imperviousness



HDR Number	Name
1	Lake Katherine D0027
2	Forest Lake D4434
3	Carys Lake D0026
4	Windsor Lake #1 D0571
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6	Sesquicentennial Park Pond D0569
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15	Spring Valley Entrance - Complex 1 D0450
16 and 17	Pine Springs Lake Complex 1 D0560 Pine Springs Lake Complex 2 D0561
18	Lower Spring Valley 0559
19	Springwood Lake Dam 0558
20	Hughes Pond Dam 0573
21	Deer Lake D0137
22	Commons D0421
23	Arcadia Woods D0557

NLCD IMPERVIOUS AREAS
GILLS CREEK
FIGURE 4

PATH: C:\USERS\TSHANNON\DOCUMENTS\ROOTSCDHEC\GILLSCREEK\DELIVERABLES\MEMORANDUM\FIGURE04_GILLSCREEKIMPERVIOUSMAP_201601JAN14.MXD - USER: TSHANNON - DATE: 2/6/2016

GILLS CREEK WATERSHED: ASSESSMENT OF REGULATED DAMS

Appendix D. Site Assessment Reports

01 Lake Katherine Dam

02 Forest Lake Dam

03 Cary's Lake Dam

04 Windsor Lake Dam

05 Upper Windsor Lake Dam

06 Sesquicentennial Lake Dam

07 Spring Lake Dam

08 Rocky Ford Lake Dam

09 Upper (North) Rocky Ford Lake Dam

10 Wildewood Pond Dam 5

11 Wildewood Pond #4 Dam

12 Beaver Dam/Wildewood Pond #2

13 Wildewood Pond #3

14 Wildewood Pond #1

15 Entrance Lake Dam

16 Pine Springs Lake CMPLX 1

17 Pine Springs Lake CMPLX 2

18 Lower Spring Valley Lake Dam

19 Springwood Lake Dam

20 Hughes Pond Dam

21 Deer Lake Dam

22 Commons Pond Dam

23 Arcadia Woods Lake Dam

01 Lake Katherine Dam

Gills Creek Watershed
Site Visit Assessment Report
Lake Katherine Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Lake Katherine Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing facilities for comparison to data on file, and of damaged areas/indications of distress.
- Understanding of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will allow them to make informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam name: Lake Katherine Dam
Class: C1
DHEC Dam No: D 0027
HDR No: 01
Hazard: High
Long_DD: -80.96603116
Lat_DD: 33.99762632

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Auxiliary Spillway
- Left Embankment Dam
- Concrete/Rockfill Overflow Spillway
- Right Embankment
- Low-Level Outlet with Gated Concrete Intake Structure

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), John Charlton (HDR), Cole Pierce (HDR), Ben Lewis (HDR), Jim Thornton (HDR) Peter Milenkov (SCDHEC), Jamie Ford (SCDHEC), Jeremy VanWyk (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: approximately 7 feet below embankment dam crest; approximately 4 inches below top of flashboards at the overflow rockfill/concrete spillway.
- TWEL: approximately 14 feet below embankment dam crest (measured at toe of overflow rockfill/concrete spillway).
- Discharge: The service spillway pipe was submerged with no apparent discharge. Significant discharge from the gated low-level outlet at the right abutment.

Overall Status: Embankments Generally Fair Condition; Concrete/Rockfill Spillway in Poor Condition. The pond is being maintained below normal pond level with low-level gated outlet.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachment B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1, Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted during site visits after the initial site inspection.

3.1 Embankment Dam

The left and right embankment sections of the dam were overtopped by an estimated 3 to 4 feet with only minor erosion apparent; no significant erosion, sloughs, or slope failures were observed. There were remnants of wooden docks deposited on the embankment crest (Photo 1). The crest is approximately 20 feet wide and vegetated with grass (Photo 2); no areas of significant depressions were observed. The upstream and downstream slopes are generally at 2H:1V, but vary. The upstream and downstream slopes of the left embankment are vegetated with grass and heavy underbrush, with mature trees along the toe of the downstream slope (Photo 1). The upstream and downstream slopes of the right embankment are heavily vegetated with trees and underbrush (Photo 3).

3.2 Left Abutment

The left abutment is a wooded area adjacent to the earthen auxiliary spillway that experienced overland flow during the flood. Minor erosion and some debris accumulation were observed in the wooded area; minor to moderate erosion was observed in the grassed earthen spillway. No significant debris accumulation.

3.3 Right Abutment

The right abutment is the lake shoreline bank that slopes up to a residential grassed yard. The gated concrete intake structure for the low-level outlet is located at the right abutment; no significant erosion was observed in this shoreline bank/grassed area.

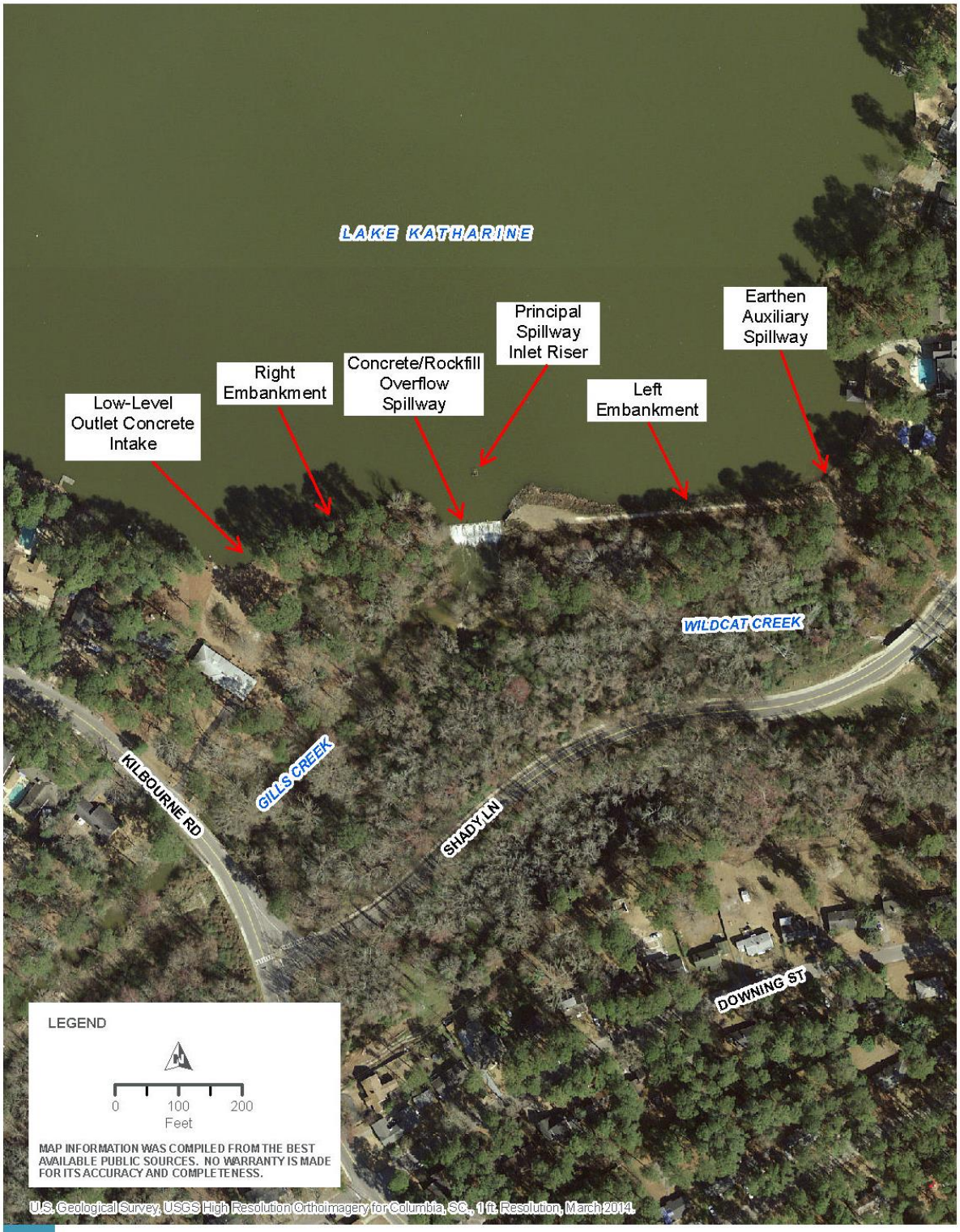
3.4 Service Spillway

The service spillway concrete intake riser is approximately 100 feet upstream of the concrete overflow spillway (Photo 4). Some debris was accumulated on the intake trash screen; estimated blockage is 20 percent. The 24-in. RCP outlet pipe of the service spillway that extends through the concrete/rockfill spillway was submerged with no apparent discharge. Backwater at the toe of the overflow spillway appeared to be caused by downstream sedimentation.

3.5 Auxiliary Spillways/Outlets

- A concrete intake with a low-level outlet (72 in. CMP) is located at the right abutment. The concrete drop-inlet structure is approximately 10-feet-wide by 10-feet-long, equipped by two 4-foot-wide slide gates with chain fall lifts for the low-level inlet and weir upper inlets. The concrete structure and gates appeared to be in good condition. A hot tub, dock remnants, and debris were accumulated at the intake and blocked a portion of the flow through the sluice gates and upper weir (Photo 5). The gates were partially open, and significant flow was discharging through the outlet during the day of the site visit.
- The concrete/rockfill overflow spillway located between the left and right embankment sections (Photo 6) is in poor condition. The crest has provisions for 2-foot-high wooden flashboards; only the lower 1-foot-high flashboards were installed on the day of the site visit. The spillway surface is large aggregate concrete that appears to overlay rockfill. Erosion and undermining along the toe of the spillway was evident (Photo 7), but this may have been a pre-existing condition prior to the flood. The concrete surface exhibited small to significant voids. One void was measured to extend about 4 feet below the surface. Photo 8 shows the area of most significant cracks and voids. There was no significant deterioration noted at either of the abutments of the overflow spillway.
- The earthen auxiliary spillway at the left abutment has a crest length of approximately 100 feet. The spillway generally sustained minor erosion with several eroded areas observed of about 3 to 6 feet wide by 1 foot deep, including at the interface with the left embankment section. The earthen auxiliary spillway was generally in fair condition.

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(1) LAKE KATHERINE DAM D0027

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_DWB.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: Dock remnants on left embankment crest

Photo 2: View of left embankment crest looking toward left abutment.

Photo 3: Right embankment crest looking toward right abutment showing tree growth on upstream and downstream slopes

Photo 4: Service spillway concrete riser intake upstream of concrete/rockfill spillway

Photo 5: Concrete drop inlet at right abutment.

Photo 6: Concrete/rockfill overflow spillway with flashboards

Photo 7: Toe of concrete/rockfill overflow spillway; outlet pipe of service spillway submerged at toe of spillway

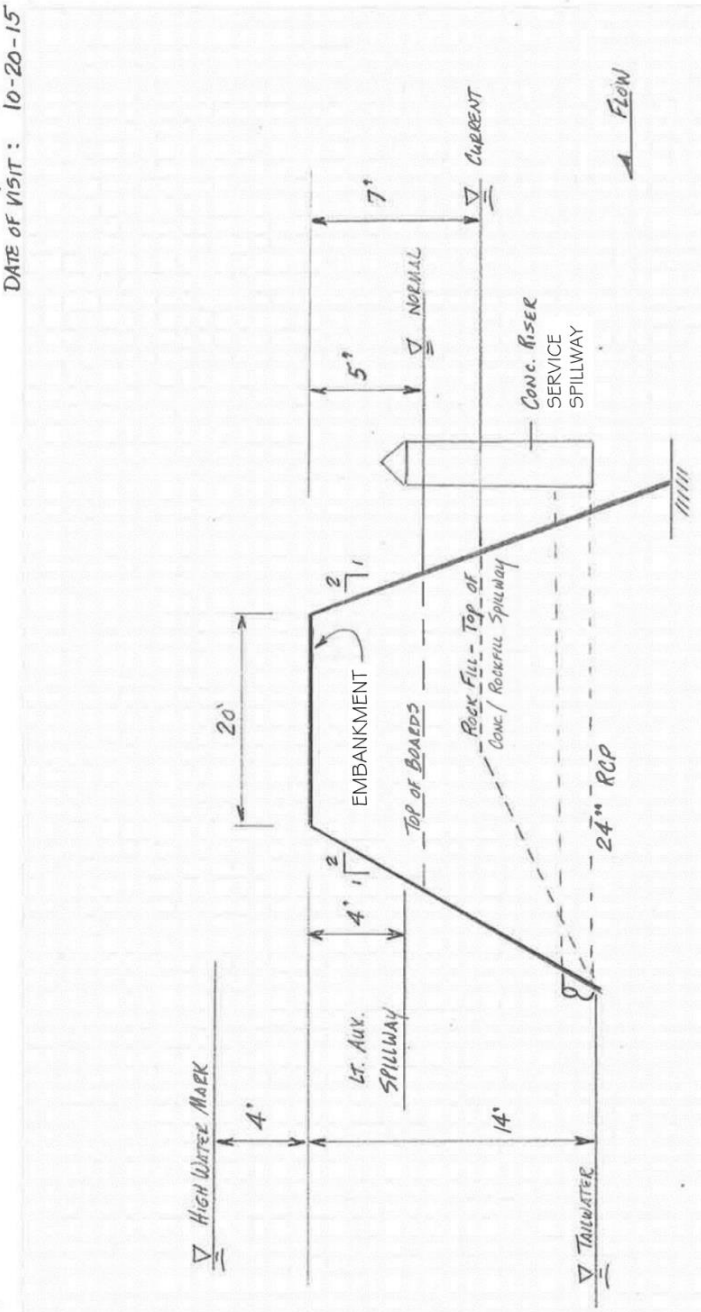
Photo 8: Voids and cracks in concrete/rockfill overflow spillway surface

Photo 9: Auxiliary earthen spillway at left abutment looking toward left embankment

Attachment C: Sketches

Project:	LAKE KATHERINE	Computed: BWL	Date: 10-21-15
Subject:	DAM # D0027	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

DATE OF VISIT : 10-15-15 & 10-20-15



NOTES :
- BOARD HEIGHT = 12 IN (PROVISIONS FOR 24 IN)
- CONC / ROCKFILL SPILLWAY : L = 100 FT.
- 72 IN. CMP LOW-LEVEL OUTLET PIPE CONTROLLED BY INTAKE EQUIPPED W/ 2, 4 FT. WIDE SLIDE GATES W/ SILL APPROX. 5 FT. BELOW CURRENT WATER LEVEL AT RIGHT ABUTMENT (NOT SHOWN)
- LEFT. AUX. SPILLWAY : L = APPROX. 100 FT. (NOT SHOWN)
- ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

02 Forest Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Forest Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Forest Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Forest Lake Dam
Class: C1
DHEC Dam No: D 4434
HDR No: 02
Hazard: High
Long_DD: -80.96280351
Lat_DD: 34.02204537

The dam consists of, from left abutment to right abutment (looking downstream):

- Auxiliary Uncontrolled Concrete Chute Spillway
- Left Embankment Dam with Armoring
- Concrete Gated Overflow Spillway
- Right Embankment Dam with Armoring

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), John Charlton (HDR), Cole Pierce (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Peter Milenkov (SCDHEC), Jamie Ford (SCDHEC), and Jeremy VanWyk (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: approximately 7 feet below embankment crest; about 1.0 foot below normal.
- TWEL: approximately 10 feet below the embankment crest (measured at the toe of the Service Spillway).
- Discharge: through two overflow bays and through the low-level outlet at the concrete, gated, overflow spillway.

Overall Status: Embankment dam sections are generally in good condition. The gated, concrete, overflow spillway is in good condition, but with significant debris accumulation and potential damage to gate operators. Temporary rockfill/riprap repair has been made to the scoured areas at the approach and discharge areas of the auxiliary concrete spillway channel. The pond is being maintained below normal pond level with the overflow gated spillway.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The armored embankment dam sections (Photo 1) were reportedly overtopped by approximately 3 feet of water. The armored embankment dam was observed to be in good condition with no significant indications of damage other than some torn grout bags and minor voids beneath the bags. No significant erosion was observed along the toe of the embankments (Photo 2). Mature trees were observed along the toe of the left embankment. Eroded areas downstream of the right embankment appeared to have been re-graded, and erosion of the right bank was observed with deposition of riprap visible in the stream channel (Photo 3). Mature trees were observed along the dam at the toe, both right and left sides. The dam has an upstream slope of generally 2H:1V to 2.5H:1V. The crest is approximately 10 to 15 feet wide. The downstream slope is approximately 2H:1V.

3.2 Left Abutment

The left abutment is a residential yard situated above the concrete wall of the auxiliary concrete chute spillway. The residential yard was reportedly flooded with damage to the retaining wall noted below.

3.3 Right Abutment

The land comprising the right abutment is generally an open-area, natural, shoreline bank transitioning to a residential yard. No significant erosion was apparent at the interface with the right embankment dam section.

3.4 Service Spillway

The service spillway is a concrete buttress overflow spillway structure with four discharge bays each equipped steel hinged crest gates operated by hand winch. Two gates were lowered and two were upright. The spillway is approximately 77 feet long, and the deck is supported by three piers. Two of the spillway bays were blocked with debris, and the other two were partially blocked; the reduction of spillway capacity is judged to be greater than 50 percent (Photos 4 and 6). The bridge deck guard rail was bent into the hand-winch gate operators that may prevent or restrict operation of the steel crest gates (Photo 5). The concrete wingwall abutments appeared to be in good condition with no signs of erosion at the interface with the embankments.

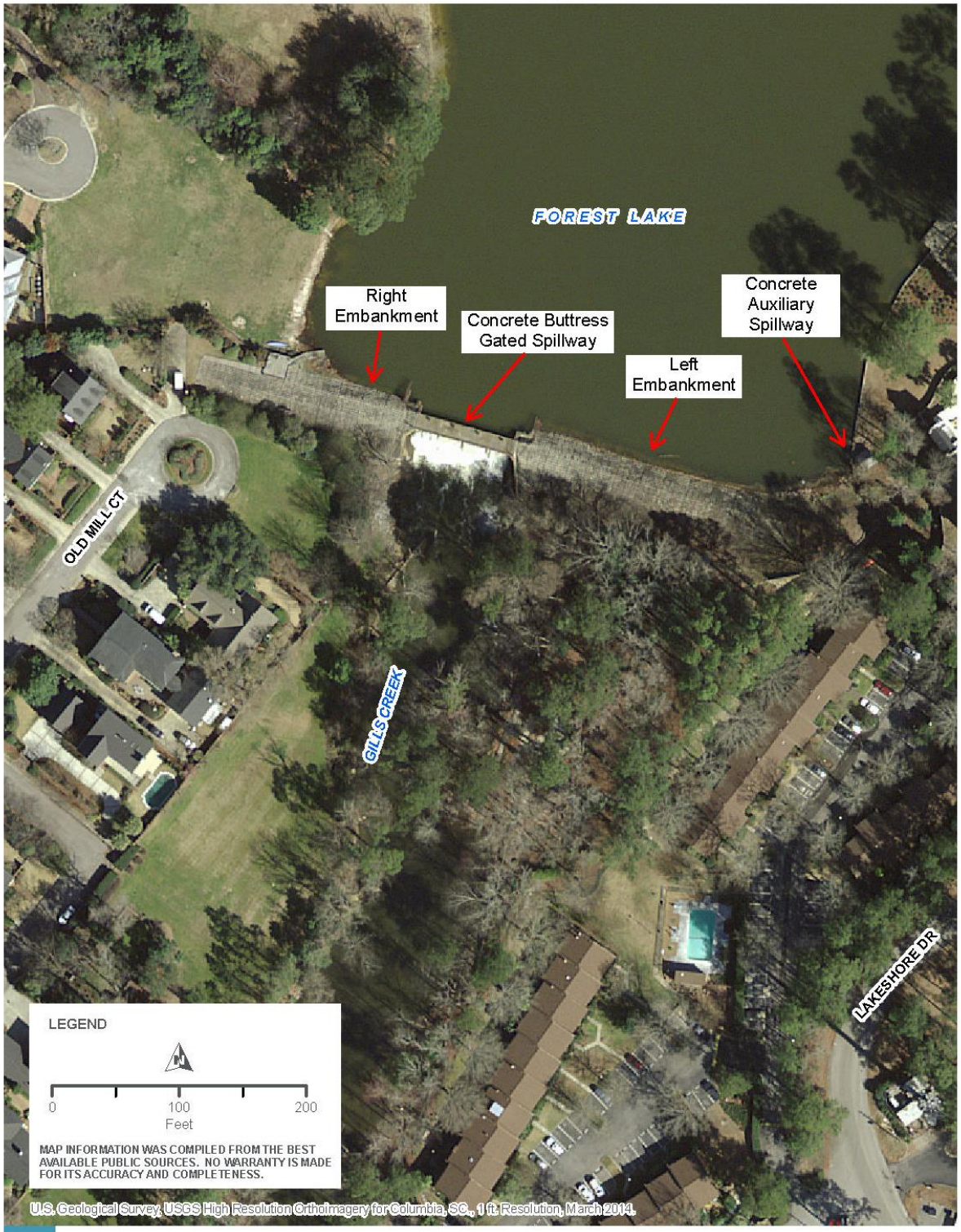
A gate operator and stem was observed on a concrete pedestal at the upstream side of the right concrete wingwall/abutment. File drawings show this is an operator for a 48-inch sluice gate that controls flow to the low-level 4-foot by 4-foot concrete conduit that discharges at the downstream wingwall. Flow was observed discharging from the low-level outlet.

An abandoned elevated pipe was observed downstream of the overflow spillway left wingwall/abutment. A section of this pipe had been removed, and the remaining pipe appeared to be plugged with concrete, indicating it had been abandoned prior to the flood event. Site observations are consistent with the drawings that show a 24-inch CI pipe through the left concrete spillway wingwall/abutment noted as providing water supply to Fort Jackson.

3.5 Auxiliary Spillway

The auxiliary spillway is an uncontrolled concrete channel located at the left dam abutment. The approach to the auxiliary spillway had been significantly scoured just upstream of the concrete slab of the spillway channel; riprap rockfill had been placed in the scour area as a temporary repair (Photo 7). An area of erosion/undercutting at interface between the right concrete spillway wall and the left embankment was also stabilized with riprap (Photo 8). The downstream end of the concrete spillway channel was reportedly severely scoured and temporarily repaired with placement of approximately 175 ton of large riprap in the void (Photo 9). The concrete walls of the spillway channel had several significant vertical cracks (Photo 10).

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(2) FOREST LAKE DAM D4434

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_DAM.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: View of crest and upstream slope of armored left embankment dam looking from the left abutment

Photo 2: View along toe of the left embankment

Photo 3: View of downstream channel with rock deposition and riprap on right bank

Photo 4: Upstream view of gated, concrete-buttress, overflow spillway

Photo 5: Damaged guard rail obstructing crest gate winch operators

Photo 6: Downstream view of gated, concrete-buttress spillway

Photo 7: Approach to auxiliary concrete-chute spillway showing temporary rockfill repair of scour

Photo 8: Temporary riprap repair upstream end of the auxiliary spillway concrete chute

Photo 9: Downstream end of auxiliary spillway concrete chute with temporary rockfill of scour

Photo 10: Crack in left wall of auxiliary spillway.

Attachment C: Sketches

Project:	Forest Lake	Computed:	Date:
Subject:	Dam # 4434	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

Date first visited: 10/15/15

Date last visited: 10/20/15

* Spillway is approximately 77' in length (per recorded drawings)
* Auxillary Spillway - 11'W x 85' L (per field measurement)
* Approx. 8 ft. from dam crest to sill of conc. spillway
* All data shown per field observation / measurements / estimate

03 Cary’s Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Cary's Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Cary's Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Cary's Lake Dam
Class: C1
DHEC Dam No: D 0026
HDR No: 03
Hazard: High
Long_DD: -80.95788627
Lat_DD: 34.04884342

Based on DHEC file information on pre-existing conditions prior to the breach, the dam consisted of, from left abutment to right abutment (looking downstream):

- Left Auxiliary Spillway: Concrete, Uncontrolled, Overflow Spillway
- Earthen Embankment Dam with highway on crest
- Service Spillway: Low-Level Outlet with Concrete-Riser Drop Inlet
- Right Auxiliary Spillway: Concrete, Uncontrolled, Overflow Spillway

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), John Charlton (HDR), Cole Pierce (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Peter Milenkov (SCDHEC), Jamie Ford (SCDHEC), and Jeremy VanWyk (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: natural stream level
- TWEL: natural stream level
- Discharge: natural stream flow

Overall Status: Complete dam breach to streambed; natural river flow through breach with some concrete debris. Based on drawings of the dam, the length of the breach is approximately 300 feet.

3.0 Observations

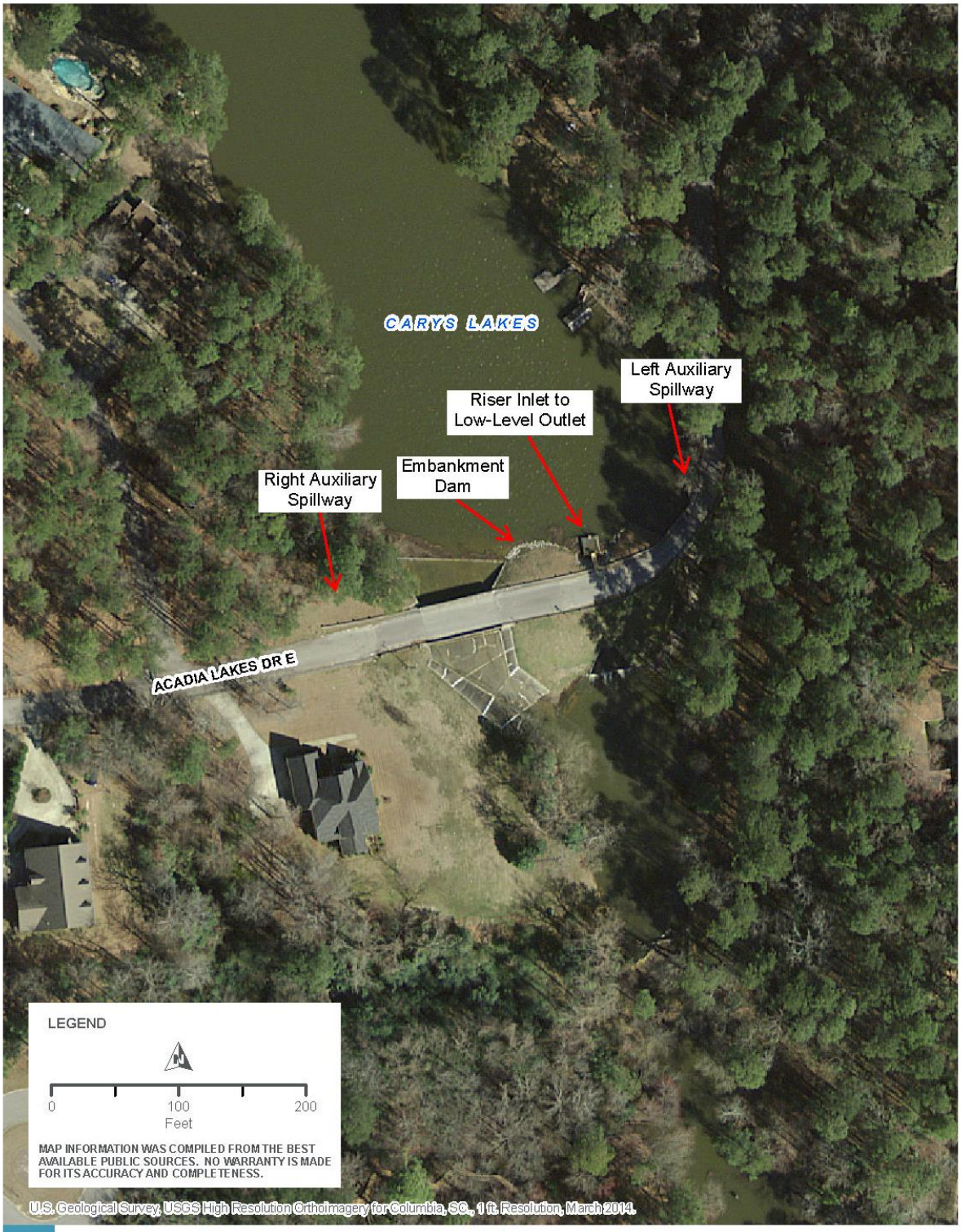
Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos of existing conditions are provided in Attachment B.

3.1 Breach

The dam is completely breached due to flood conditions. Even though significant erosion of areas adjacent to the abutments was not evident, this embankment dam would be susceptible to erosion and head-cutting from overtopping that would result in failure.

As shown in the photos, the entire embankment dam has been washed out, with remnants of a concrete retaining wall at the left abutment, remnants of the low level concrete box culvert in the middle of the stream, and a portion of the concrete channel of the auxiliary spillway at the right abutment.

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(3) CARYS LAKE DAM D0026

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_D0026.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: View of dam breach and left abutment from right abutment.

Photo 2: Remnants of low-level outlet concrete box culvert and discharge structure.

Photo 3: Downstream view of remnants of right concrete channel of the auxiliary spillway.

Photo 4: Upstream view; concrete approach slab of right auxiliary spillway is in the foreground

04 Windsor Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Windsor Lake 1 Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Windsor Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Windsor Lake 1 Dam
Class: C1
DHEC Dam No: D 0571
HDR No: 04
Hazard: High
Long_DD: -80.94002557
Lat_DD: 34.06790961

The dam consists of, from left abutment to right abutment (looking downstream):

- Left Embankment Dam
- Concrete Uncontrolled Overflow Auxiliary Spillway
- Right Embankment
- Low-Level Outlet with Concrete Drop Inlet Structure

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), and Jeremy VanWyk (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: Approximately 5 feet below crest of embankment; at crest of auxiliary spillway
- TWEL: Approximately 25 below embankment crest
- Discharge: 2–3 cfs (estimated)

Overall Status: Embankments are generally in fair condition with some areas of significant erosion. The service spillway appears in good condition with no impairment of hydraulic capacity. The auxiliary spillway is in fair condition with some areas of voids in the concrete, and erosion and seepage adjacent to the spillway. The pond is being maintained at crest of the uncontrolled overflow auxiliary spillway with discharge through the service spillway.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachment B and C, respectively.

3.1 Embankment Dam

The embankment dam crest is approximately 36 feet wide with a secondary road running along the crest. The earthen embankments have an upstream slope of approximately4H:1V but are as steep as 2.5H:1V, and a downstream slope of approximately 2H:1V. The embankment slopes have mature tree growth and tree stumps.

The dam was overtopped during the storm (indicated by erosion on downstream embankment) but there was no clear indication of depth of water over the dam. The embankments were observed to be in fair condition overall with generally minor to moderate erosion, with some areas of significant erosion.

The downstream slope of the embankments was observed to generally have minor to moderate erosion with some areas of significant erosion. Moderate erosion was concentrated at the embankment interface with the bridge (Photo 1). Photo 2 shows one of the several areas of significant erosion of the downstream slope of the right embankment. The embankments also have significant eroded areas along the concrete auxiliary spillway including:

- erosion at the toe of the left embankment adjacent to the auxiliary spillway (Photo 5)
- eroded/filled areas along the right side of the auxiliary spillway channel (Photo 6)

- an area that is undermined along the left side of the auxiliary spillway channel with water emerging from beneath the concrete slab (Photo 8)

3.2 Abutments

The left and right abutments are natural shoreline with mature tree growth. No significant erosion of areas adjacent to the dam was observed.

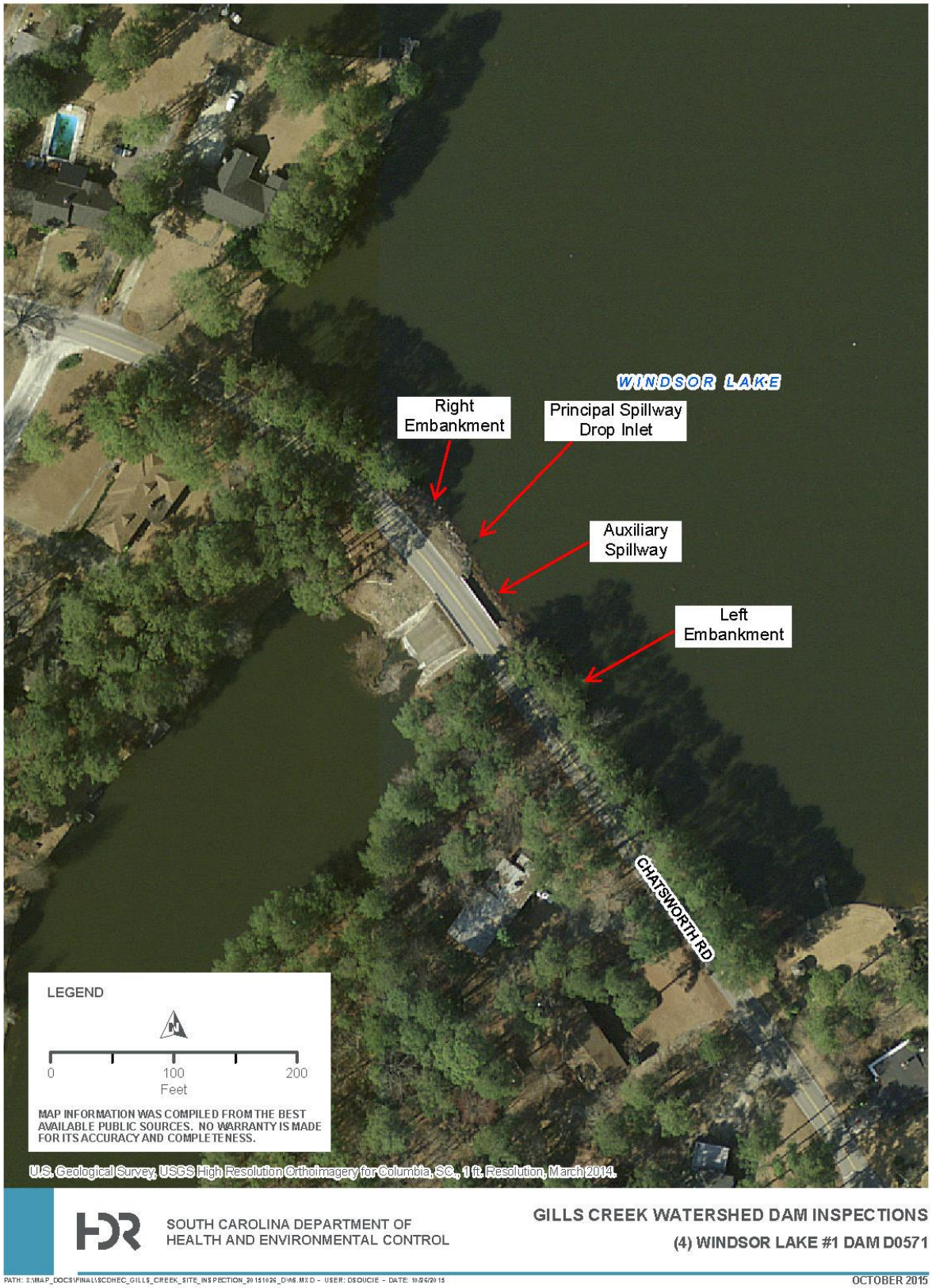
3.3 Service Spillway

The service spillway is a low-level outlet (48-in. RCP) controlled by a concrete drop inlet located approximately 60 feet upstream of the dam. The inlet has a trash screen that appeared relatively free of debris (Photo 9). The outlet discharge is located to the right of the auxiliary spillway (Photo 10). Standing water with red coloration was observed at the headwall of the outlet structure, indicating potential seepage.

3.4 Auxiliary Spillway

The auxiliary spillway is a concrete, uncontrolled, overflow spillway with a crest that is approximately 45 feet wide and about 5 feet below the bridge roadway surface (Photos 4 and 5). The auxiliary spillway generally appeared to be in fair condition, except for some areas of erosion and deterioration. Erosion and undermining with evidence of seepage was observed along each side of the concrete spillway as noted above (Photos 6 and 8). Significant cracks and voids in the spillway concrete were observed in the vicinity of the steel sheet-piling extending across the spillway surface near the toe (Photos 5 and 7).

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: View of downstream slope of right embankment; note the void in concrete near the toe of the auxiliary spillway, and jute mat located adjacent to the bridge to stabilize an eroded area

Photo 2: Erosion on downstream slope of the right embankment

Photo 3: Upstream slope of right embankment with tree stumps and mature trees

Photo 4: Auxiliary spillway

Photo 5: View of auxiliary spillway; note erosion at toe of left embankment

Photo 6: Eroded/filled areas along right side of auxiliary spillway channel

Photo 7: View of sheetpile at toe of auxiliary spillway; note cracks in concrete surface adjacent to sheetpiles

Photo 8: Undercutting and minor seepage along left side of auxiliary spillway concrete channel

Photo 9: Service spillway drop inlet structure

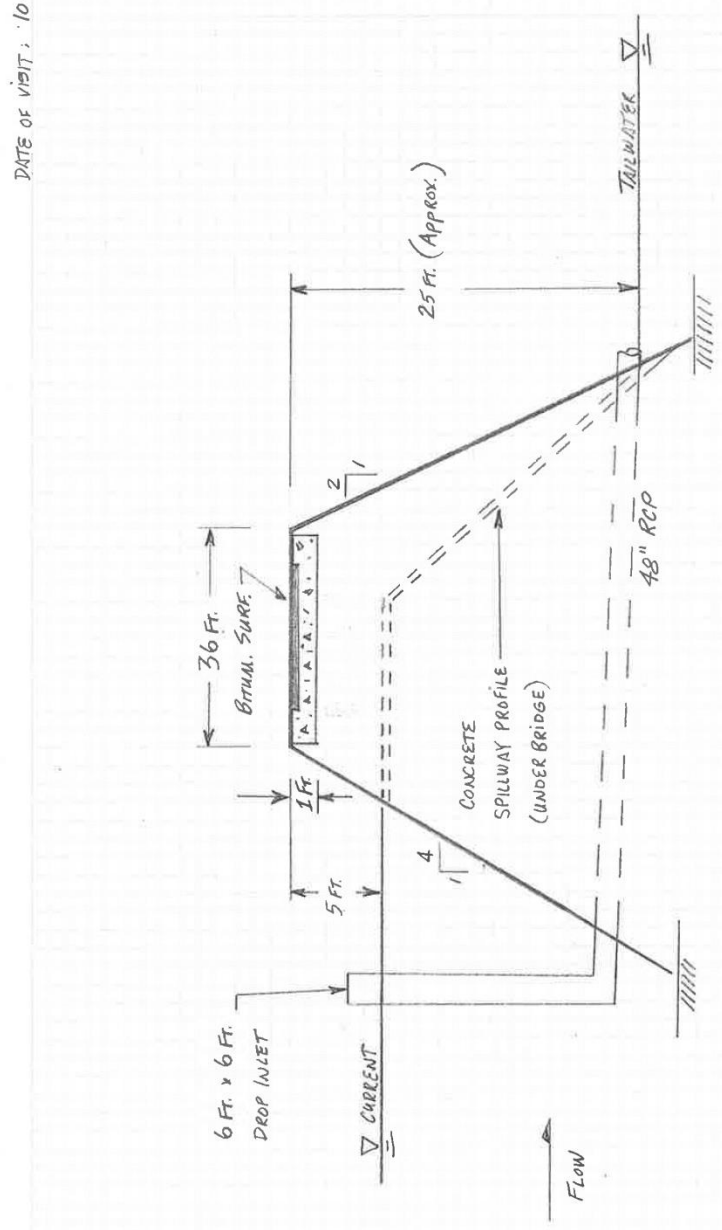
Photo 10: Low-level outlet structure; note discolored water just above the headwall

Photo 11: View looking downstream of the dam (Pine Tree Dam, an unregulated dam that breached, is located downstream beyond the bend).

Attachment C: Sketches

Project:	WINDSOR LAKE # 1	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0571	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

DATE OF VISIT: 10-15-15



NOTES:
- SPILLWAY LENGTH = 45 FT.
- MINIMAL OVERTOPPING EVIDENCE OBSERVED
- WATER FLOWING OVER SPILLWAY AT TIME OF INSPECTION
- CURRENT WATER SURFACE = NORMAL WATER SURFACE
- RISER DIMENSIONS & 48" RCP OUTLET PIPE SHOWN PER RECORDED DRAWINGS
- ALL OTHER DATA SHOWN PER FIELD MEASUREMENTS / OBSERVATIONS / ESTIMATE

05 Upper Windsor Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Upper Windsor Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Upper Windsor Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Upper Windsor Lake Dam
Class: C1
DHEC Dam No: D 0570
HDR No: 05
Hazard: High
Long_DD: -80.92913505
Lat_DD: 34.07437512

The dam consists of, from left abutment to right abutment (looking downstream):

- Concrete Auxiliary Spillway
- Embankment Dam
- Low-Level Outlet with Concrete Drop Inlet

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), and Jim Thornton (HDR)

Site Conditions:

- Weather: Clear, sunny, mild temperature.
- HWEL: approximately 5 feet below embankment crest; several feet below crest of auxiliary spillway.
- TWEL: 12 feet below embankment crest.
- Discharge: Could not be observed because the service spillway outlet was submerged.

Overall Status: Embankment is in generally fair condition except areas of significant erosion of the downstream slope; some of this erosion may have been a pre-existing condition prior to the flood event. The spillways appear to be in good condition with no hydraulic capacity impairment. Headpond appears to be near normal level. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted during site visits after the initial site inspection.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The embankment dam crest is approximately 40 feet wide with an abandoned secondary road running along the crest with mature woody growth on both upstream and downstream slopes (Photos 1 and 2). The earthen embankment has an upstream slope estimated at approximately 2H:1V to 2.5H:1V and a downstream slope of approximately 2H:1V.

Significant erosion observed on the downstream slope of the embankment, and erosion observed at the abutments of the auxiliary spillway, and woody debris on the crest of the embankment indicates the embankment was overtopped during the storm event. However, there was no clear indication of peak depth of water over the dam. A significant area of erosion at the downstream slope of embankment near the auxiliary spillway is shown in Photo 3. Root systems in this area appear to stabilize this near vertical slope.

The potential for piping from the tree growth, and the significant erosion of the downstream slope of the embankment is offset by the overall width of the embankment.

3.2 Abutments

The natural wooded area of the pond shoreline transitions to the embankment at the right abutment. The auxiliary spillway is located at the left abutment. No significant erosion was observed in the abutment areas; some minor erosion was observed at the left abutment of the bridge/auxiliary spillway (Photo 7).

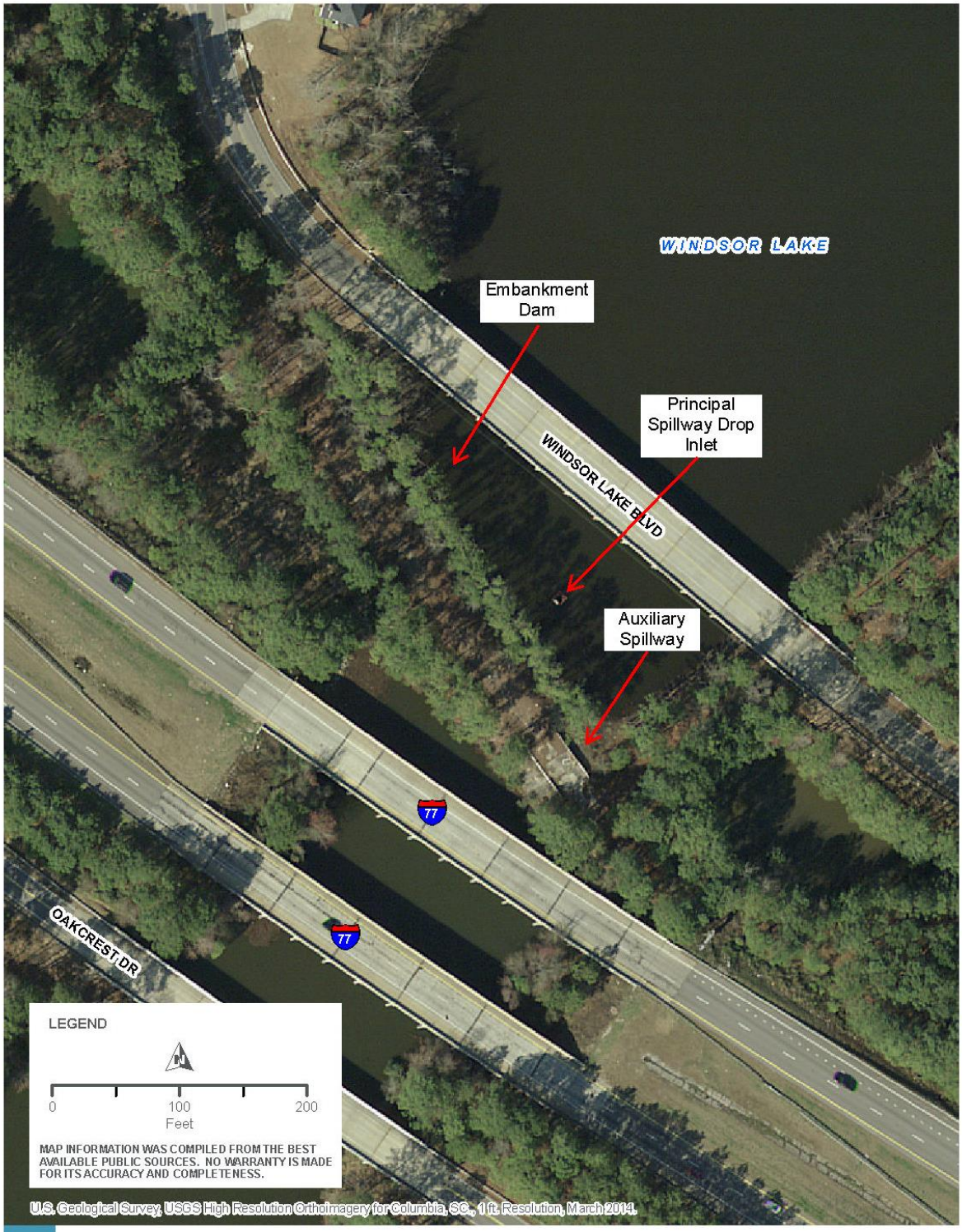
3.3 Service Spillway

The service spillway is a 48-inch-RCP low-level outlet with at concrete drop inlet located about 50 feet upstream of the embankment dam. The drop inlet structure appeared to be in good condition. Some debris accumulation was observed at the inlet trash screen. However, the amount of obstruction was not visible since the intake was on the upstream side of the structure. The outlet pipe was submerged, so discharge could not be observed.

3.4 Auxiliary Spillway

The auxiliary spillway is a concrete, uncontrolled, overflow structure (Photos 5 and 6). The crest length was measured to be 44 feet. The structure appeared to be in good condition with no areas of concrete deterioration. Minor wood debris had accumulated on the spillway. Erosion was noted at all four corners of the auxiliary spillway abutments at the crest (Photo 7). The approach channel to the auxiliary spillway was vegetated but free of accumulated debris (Photo 8).

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Crest of embankment dam looking toward the left abutment. Note mature trees and thick underbrush on embankment slopes.

Photo 2: Tree growth on upstream embankment slope

Photo 3: Significant erosion and undercutting of downstream slope of embankment resulting in a near-vertical slope maintained by root systems.

Photo 4: Service spillway drop inlet

Photo 5: Auxiliary spillway viewed from the downstream side

Photo 6: Auxiliary spillway crest looking toward the right abutment

Photo 7: Erosion at auxiliary spillway/bridge right abutment

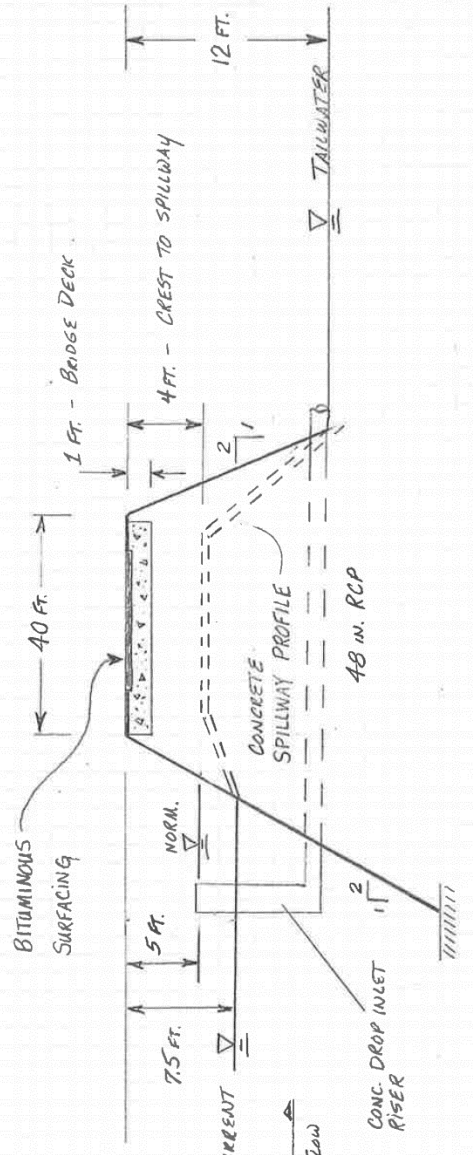
Photo 8: Area upstream of auxiliary spillway

Attachment C: Sketches Drawings

Project:	WINDSOR LAKE # 2	Computed:	Date:
Subject:	DAM # 0570	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

UPPER WINDSOR LAKE DAM

DATE OF VISIT: 10-15-15



NOTES : - ROADWAY & BRIDGE OVER SPILLWAY ABANDONED
- APPROX. 1-2 FT. OVERTOPPING EVIDENCE OBSERVED
- SPILLWAY LENGTH = 44 FT.
- OUTLET PIPE LOCATED BEYOND RIGHT ABUTMENT - OUTLET SUBMERGED
- 48" RCP OUTLET SHOWN PER RECORDED DRAWINGS
- ALL OTHER DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

06 Sesquicentennial Dam

Gills Creek Watershed
Site Visit Assessment Report
Sesquicentennial Park Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Sesquicentennial Park Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Sesquicentennial Dam
Class: C1
DHEC Dam No: D 0569
HDR No: 06
Hazard: High
Long_DD: -80.90564894
Lat_DD: 34.08270691

The dam consists of, from left abutment to right abutment (looking downstream):

- Two Masonry Stone Dams
- Embankment Dam
- Low-Level Outlet (drawdown pipe)

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), and Jeremy VanWyk (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: Approximately 6 feet below embankment crest (about 6 inches below normal)
- TWEL: Approximately 12 feet below embankment crest
- Discharge: Through the low-level pipe

Overall Status: The masonry stone dams are in fair condition with some missing and loose stones; cracks in concrete abutments. The earth embankment dam is in generally good condition with no significant erosion, depressions, or sloughs observed. The headpond was being maintained about 6 inches below the auxiliary spillway crest by discharge through the low-level outlet.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches are provided in Attachments B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted on October 20, 2015.

3.1 Embankment Dam

The earthen embankment dam is approximately 1,000 feet long and is located within Sesquicentennial Park. The crest is approximately 10 feet wide and has a concrete walkway along the crest (Photo 1). DHEC file data indicates the maximum height of the embankment is 13 feet. The earthen embankment has upstream and downstream slopes of approximately 3H:1V. The embankment slopes are sparsely grassed and bare ground with tree duff cover. Photo 1 shows numerous mature trees and some underbrush typical on the upstream side of the embankment. Photo 2 shows mature tree growth and duff ground cover on the downstream slope.

The entire embankment dam was overtopped (per park ranger), but no depth was reported, nor was there any indication of maximum water depth observed. Generally the embankment exhibited minor surficial erosion from the overtopping. No significant signs of erosion were observed. Several small areas of apparent recent fill were observed on upstream and downstream slope areas, presumably in areas of depression/erosion after the flood event. No felled trees were observed.

3.2 Abutments

The right abutment is natural shoreline. Minor surficial erosion was observed similar to the embankment. The left abutment is comprised of the auxiliary spillway discussed below.

3.3 Service Spillway

The service spillway intake is a 24-inch-RCP, low-level outlet, noted on drawings on file as "drawdown pipe". Drawings indicate the inlet to the low-level pipe is near the base of the embankment and is controlled by a slide gate operated by a long-stem hand operator. The outlet of the low-level pipe discharges into the stream just downstream of the lower auxiliary spillway. The outlet of the low-level pipe appeared to be in good condition (Photo 3).

3.4 Auxiliary Spillway

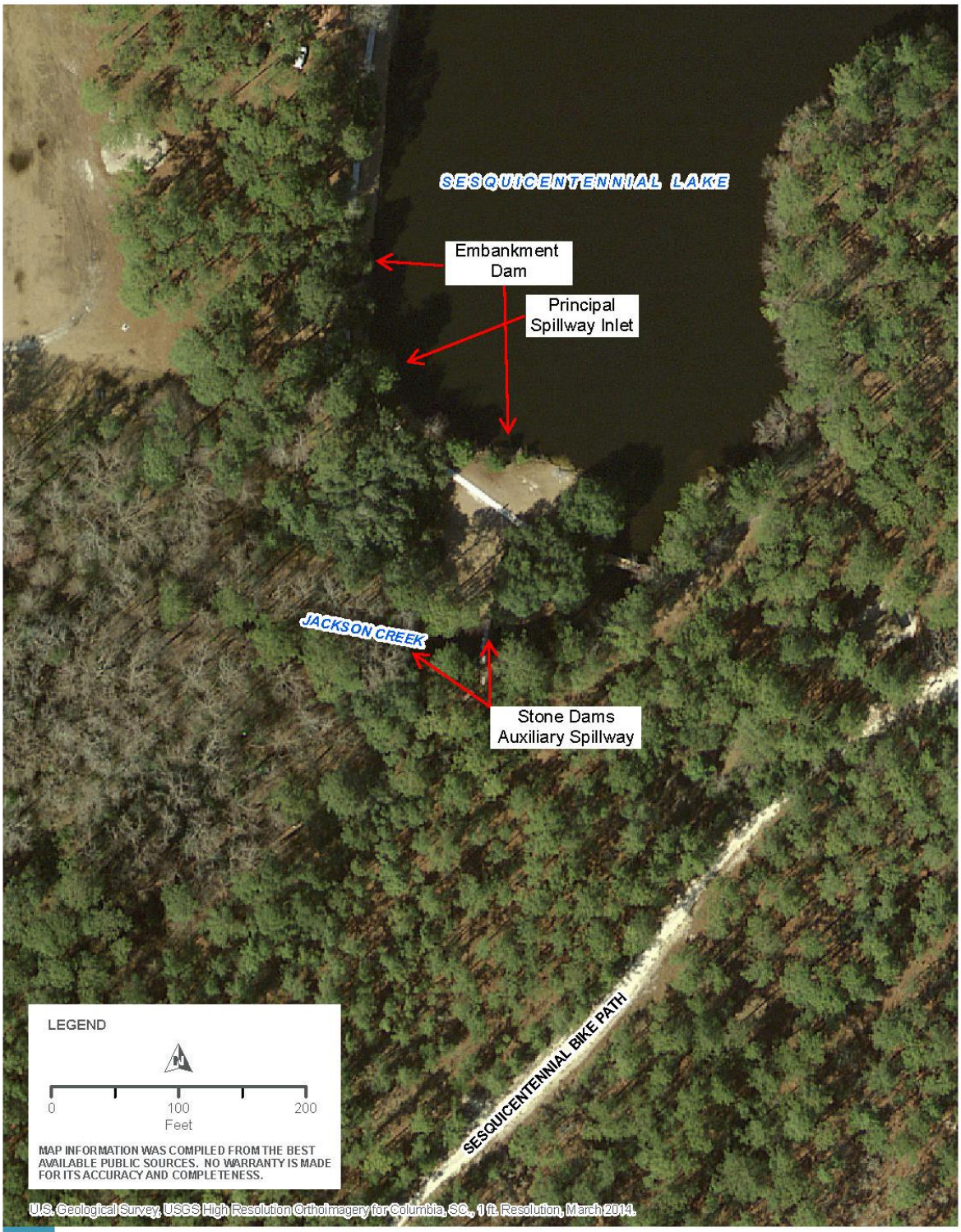
Two masonry stone dams comprise the auxiliary spillway at the left abutment of the embankment dam. The two dams are uncontrolled overflow spillways in sequence, so that flow over the upper dam flows directly to the lower dam. The lower dam creates backwater to the toe of the upper dam. The approach channel to the auxiliary appeared to be clear of debris (Photo 4).

The upper masonry stone dam is shown on the drawings to be about 5 feet in height with crest about 3 feet below the low point of the embankment dam crest. The crest of the lower masonry stone dam is approximately level with the base of the upper dam. The lower masonry stone dam is about 6 to 8 feet in height. Each dam has a crest length measured to be about 38 feet.

Both masonry stone dams are generally in fair condition with missing and loose stones (Photo 5). The concrete overlay of the upper stone dam crest is moderately deteriorated; the concrete crest of the lower dam appeared to be in good condition (Photo 6). No significant erosion was visible at the toe of either dam. There was no indication of displacement of the dams, however the concrete abutments of the stone dams exhibited cracks (Photos 7 and 9), which could be caused by hydraulic loading under flood conditions and/or movement of supporting foundation soil, or woody growth (Photo 8). The abutments may be susceptible to further deterioration under future flood conditions.

Minor erosion of earth at the abutments and along stream banks indicates the stone dams were overtopped during the flood event. The right earthen embankment slope forms the stream bank between the stone dams. This slope is steep and supported by wood timber and concrete walls. Moderate erosion and sloughs of the earth slope was observed (Photo 10). Some of the sloughs/voids in the slope appear to be from felled trees (leaves still green) observed in the area between the two stone dams.

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(6) SESQUICENTENNIAL PARK POND DAM D0569

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_DV6.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: Embankment dam upstream slope and crest with concrete sidewalk

Photo 2: Embankment dam downstream slope and crest with concrete sidewalk

Photo 3: Service spillway outlet works

Photo 4: Approach channel to auxiliary spillway

Photo 5: Auxiliary spillway upper masonry dam

Photo 6: Auxiliary spillway lower masonry stone dam

Photo 7: Crack in left abutment of the upper masonry stone dam

Photo 8: Tree growing in left abutment of the upper masonry stone dam

Photo 9: Vertical crack/slabbing in left abutment of lower stone dam

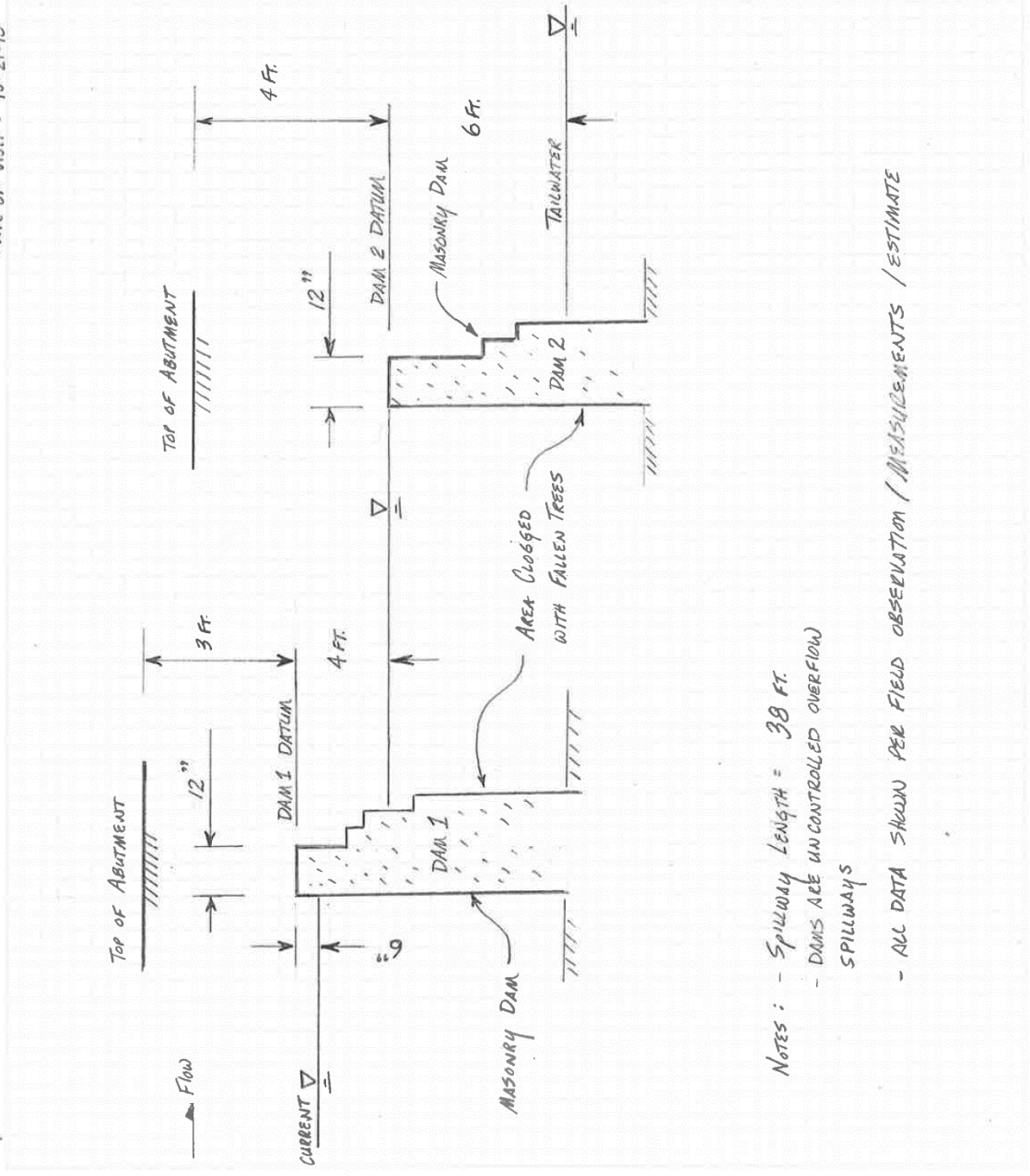
Photo 10: Right bank slump between upper and lower masonry stone dams

Photo 11: Felled trees in auxiliary spillway between upper and lower masonry stone dams

Attachment C: Sketches Drawings

Project:	SESQUICENTENNIAL DAM	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0569	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

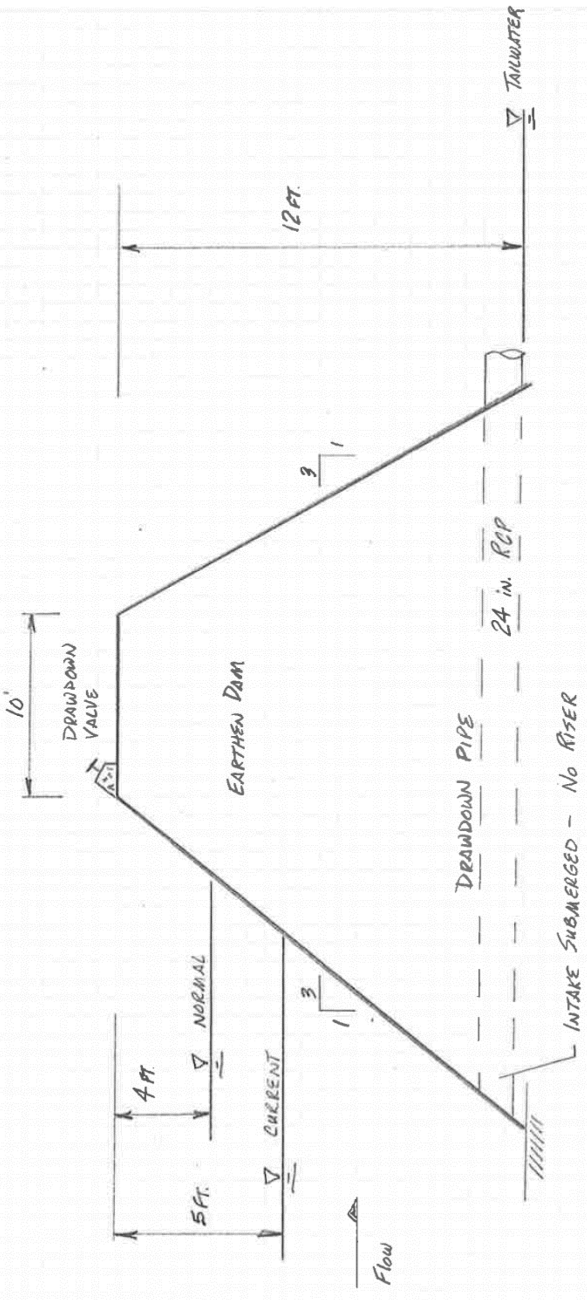
DATE OF VISIT : 10-15-15 ; 10-21-15



NOTES : - SPILLWAY LENGTH = 38 FT.
- DAMS ARE UNCONTROLLED OVERFLOW SPILLWAYS
- ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

Project: SESQUICENTENNIAL DAM		Computed: BWL	Date: 10-22-15
Subject: DAM # D0569		Checked:	Date:
Task:		Page:	of:
Job #:		No:	

DATE OF VISIT: 10-21-15
10-15-15



NOTES:
- DAM OVERTOPPED
- SIDE SLOPES SHOWN PER RECORDED DAM DRAWINGS
- ALL OTHER DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

07 Spring Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Spring Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Spring Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Spring Lake Dam
Class: C1
DHEC Dam No: D 0025
HDR No: 07
Hazard: High
Long_DD: -80.95628655
Lat_DD: 34.03694094

The dam consists of, from left abutment to right abutment (looking downstream):

- Concrete Overflow Auxiliary Spillway
- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and P. Milenkov (SCDHEC)

Site Conditions: Road on crest of dam is closed. Tetratech is performing repairs to auxiliary spillway.

- Weather: Sunny, 75 degrees,
- HWEL: approximately 7 feet below embankment crest; 1 to 2 feet below normal pond (approximate crest of auxiliary spillway.
- TWEL: approximately 15 feet below embankment crest at service spillway outlet (10 inches above outlet pipe invert).
- Discharge: through service spillway outlet pipe

Overall Status: Significant damage occurred from the flood event including damage of the auxiliary spillway concrete apron and side walls; and severe overtopping, erosion, and head cutting of the embankment dam. Temporary structural repairs are being made. The embankment adjacent to the auxiliary spillway is susceptible to further erosion and failure if flow is discharged over the auxiliary spillway before temporary repairs are completed.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted on October 20, 2015.

3.1 Embankment Dam

The embankment dam extends from the right abutment about 400 feet to the auxiliary spillway at the left abutment and has a bituminous roadway along the crest. The embankment dam experienced significant overtopping during the storm event, reportedly 3 to 4 foot depth, which significantly eroded the downstream slope of a section of the embankment extending approximately 100 feet from the auxiliary spillway. Head cutting of the toe of this section of the embankment has resulted in a near-vertical downstream slope (Photos 1 and 2). The roadway remained intact. Trees washed out from the eroded slope were observed downstream of the embankment. The grassed upstream slope of this section of the embankment is in good condition with only minor erosion sustained from overtopping; the pre-existing erosion at normal pond level is evident (Photo 3).

The remainder of the embankment extending approximately 300 feet from the eroded section appeared to be in fair condition with only minor surficial erosion. This section of the embankment has significant tree and underbrush growth on upstream and downstream slopes, which may have provided greater stability from erosion from overtopping (Photo 5).

3.2 Left Abutment

The left abutment has moderate concentrated erosion at the interface with the bridge and auxiliary spillway. Photo 4 shows erosion of the left abutment slope just downstream of the auxiliary spillway.

3.3 Right Abutment

The right abutment is natural grade, vegetated shoreline and appeared to be in good condition with no significant erosion observed (Photo 5).

3.4 Service Spillway

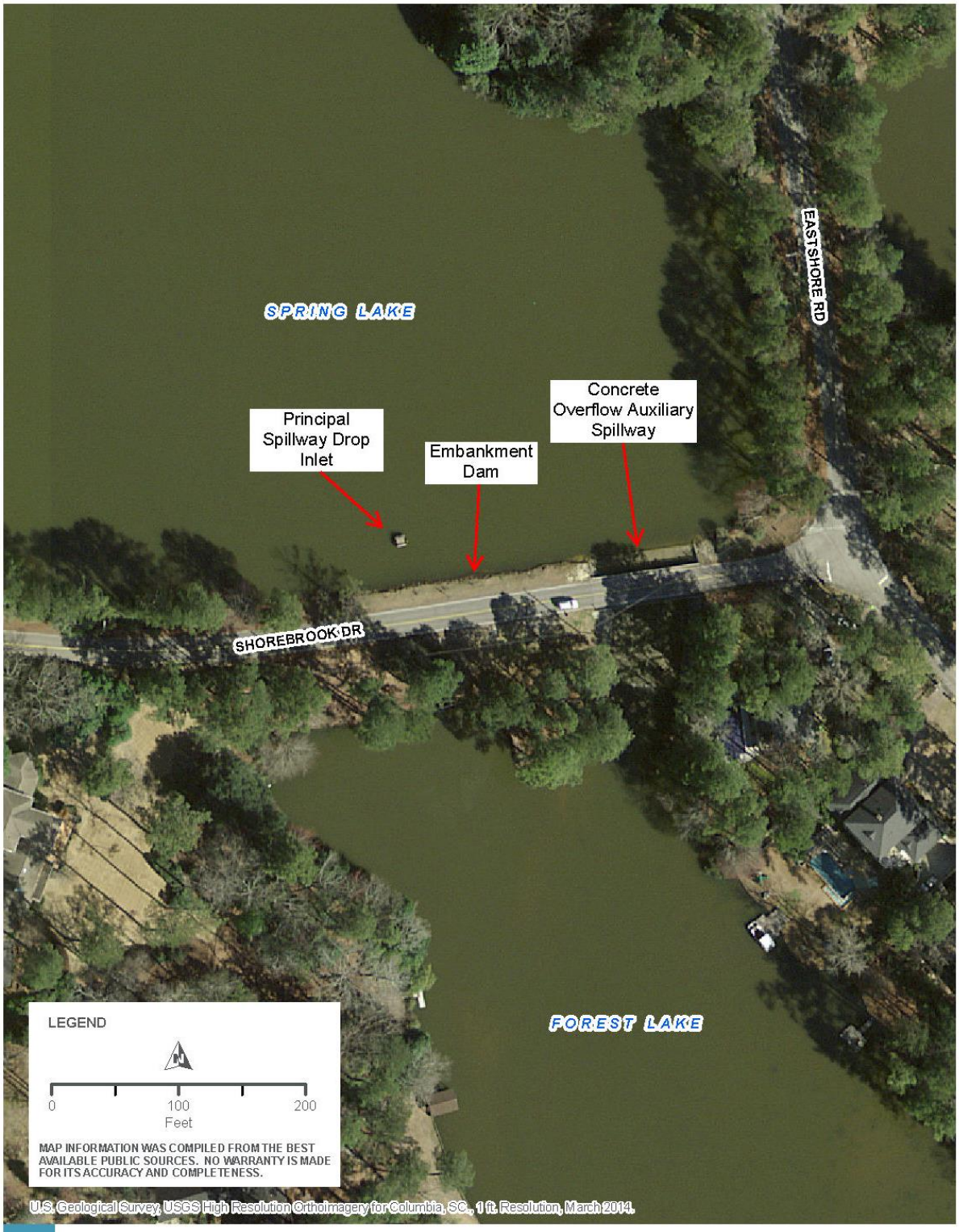
The service spillway is comprised of a low-level pipe with concrete drop inlet equipped with a trash screen; debris was accumulated the screen. The low-level, 36-inch RCP discharges at an outlet structure. Photos 6 and 7 show the spillway inlet and outlet structures, respectively. The service spillway does not appear to be damaged; however, a significant section of the 36-inch RCP from the crest of the dam to the outlet structure is now exposed due to erosion.

3.5 Auxiliary Spillway

The auxiliary spillway concrete channel is severely damaged, including failure and loss of sections of the spillway concrete floor slab and scouring of subsurface material (Photo 4). It is possible that a washout of a section of the concrete spillway at the right side interface with the embankment (Photo 8) may have contributed to undermining and failure of the concrete spillway floor slab. Photo 9 shows rock that deposited at the downstream weir wall. Photo 10 shows the upstream portion of the auxiliary spillway which is in good condition.

The auxiliary spillway is undergoing temporary structural repair.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Erosion and headcutting of downstream slope of embankment dam

Photo 2: Eroded downstream face of embankment dam

Photo 3: View of upstream embankment slope from auxiliary spillway

Photo 4: Auxiliary spillway damage

Photo 5: Crest of embankment viewed from right abutment

Photo 6: Service spillway drop inlet

Photo 7: Service spillway outlet structure

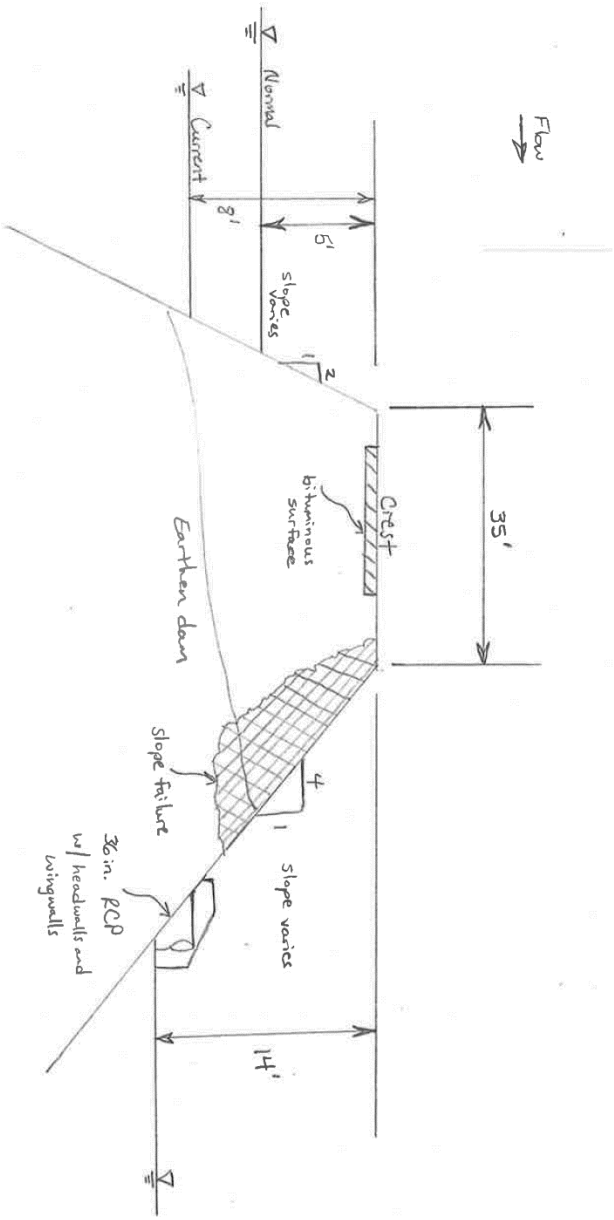
Photo 8: Erosion of concrete of auxiliary spillway adjacent to embankment

Photo 9: Downstream view from bridge over auxiliary spillway

Photo 10: View of auxiliary spillway upstream of bridge

Attachment C: Sketches

Project:	Spring Lake	Computed:	Date:
Subject:	Dam #0025	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



Notes:

* Spillway is approximately 90' in length (complete failure on DS end)

* ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

Date First Visited: 10/15/15

Date Last Visited: 10/20/15

08 Rocky Ford Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Rocky Ford Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Rocky Ford Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Rocky Ford Lake Dam
Class: C1
DHEC Dam No: D 0028
HDR No: 08
Hazard: High
Long_DD: -80.95229287
Lat_DD: 34.03610046

The dam consists of, from left abutment to right abutment (looking downstream):

- Uncontrolled Overflow Concrete Auxiliary Spillway
- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and P. Milenkov (SCDHEC)

Site Conditions: Road on crest of dam is closed. Auxiliary spillway under bridge is completely washed out. The reservoir is empty except for stream flow (Photo 1).

- Weather: sunny, 70 degrees
- HWEL: stream channel, reservoir drawn down
- TWEL: stream channel
- Discharge: stream discharge was through the remaining earth channel at the auxiliary spillway location.

Overall Status: Damaged condition due to failed auxiliary spillway and adjacent slope erosion.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

The concrete auxiliary spillway washed out and adjacent abutment/embankment material eroded during the flood event. Based on the observed conditions, the auxiliary spillway failed before overtopping of the embankment occurred.

3.1 Embankment Dam

Embankment material that supported the concrete auxiliary spillway structure along the right side was eroded after the auxiliary spillway washed out. This erosion extended approximately 50 feet into the embankment right of the spillway. Due to safety considerations, including unstable slopes and debris, access was limited and the extent of erosion could not be accurately quantified.

3.2 Left Abutment

Native soil material adjacent to the auxiliary spillway at the left abutment and along the left side of the spillway channel also experienced significant erosion when the spillway washed out. Photos 2, 4, and 5 show erosion along the left side of the auxiliary spillway, and Photo 3 shows erosion of material from under the left bridge abutment.

3.3 Right Abutment

The right abutment to the embankment dam is native grade with no apparent erosion.

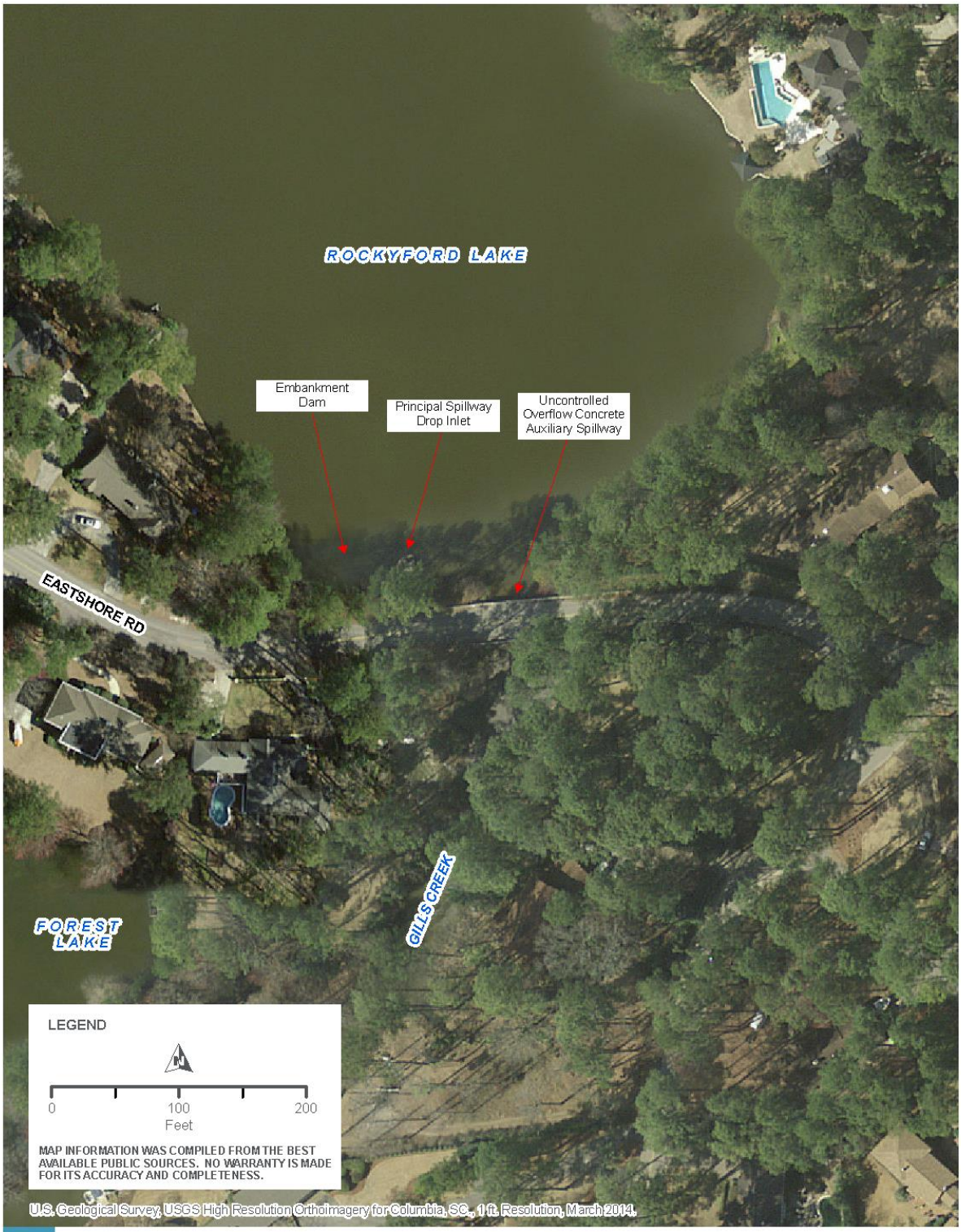
3.4 Service Spillway

The service spillway is comprised of a low-level outlet with concrete drop inlet and outlet structures. The condition of the service spillway outlet could not be observed due to unstable slopes and significant debris in the location of the outlet.

3.5 Auxiliary Spillway

The auxiliary spillway was completely washed out from the flood. Photo 6 shows portions of the concrete spillway in the channel downstream of the bridge.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: View upstream from the auxiliary spillway

Photo 2: Erosion along the left side of approach channel to the auxiliary spillway

Photo 3: Area of auxiliary spillway wash-out at the left bridge abutment

Photo 4: Erosion at the left abutment viewed from the bridge

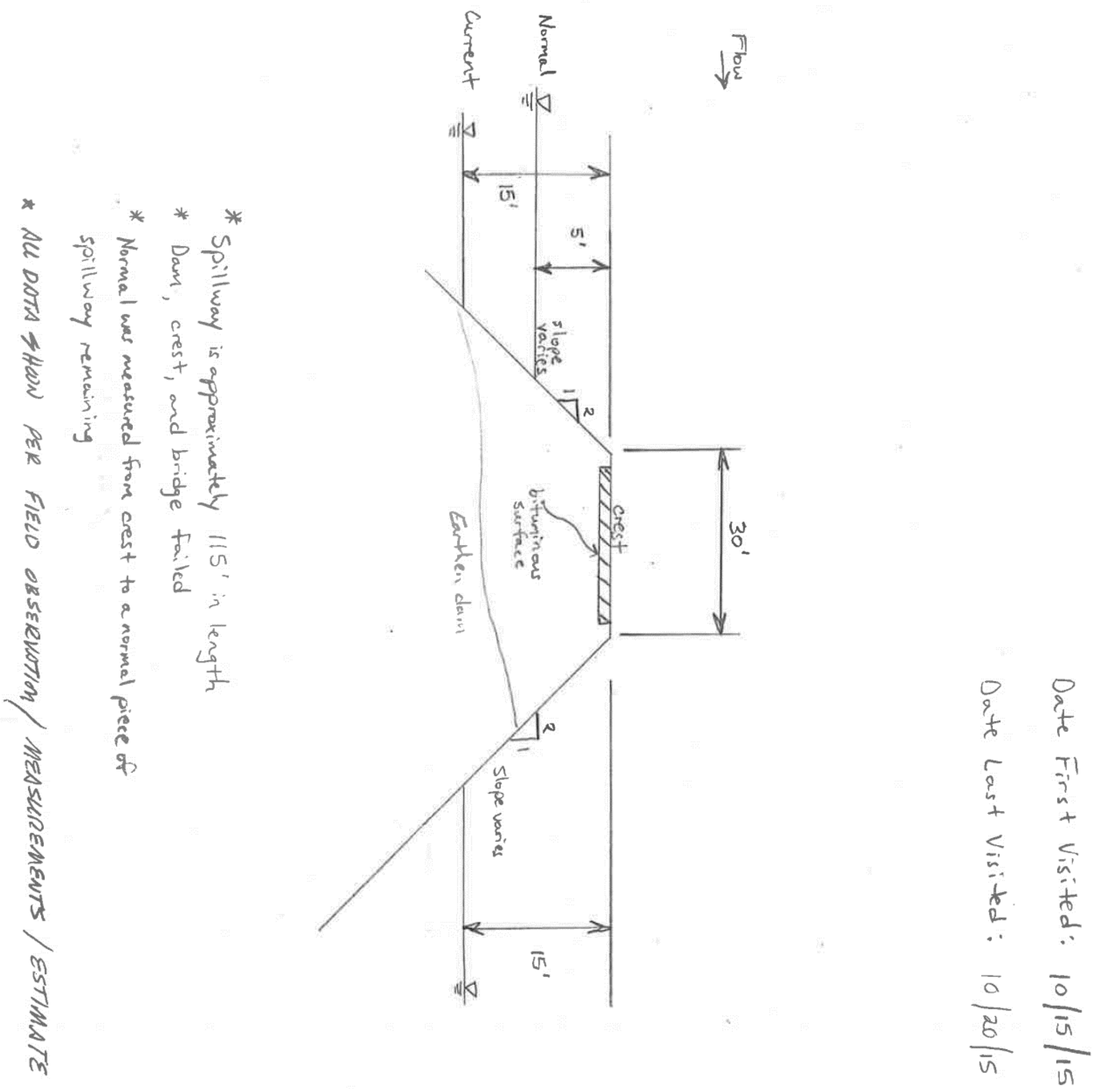
Photo 5: Erosion along the left side of the auxiliary spillway, looking downstream from the bridge

Photo 6: View of the auxiliary spillway looking downstream of bridge; concrete debris is seen in the foreground

Attachment C: Sketches Drawings

HDR

Project: Rocky Ford Lake	Computed:	Date:	
Subject: Dam # 0028	Checked:	Date:	
Task:	Page:	of:	
Job #:	No:		



09 Upper (North) Rocky Ford Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Upper (North) Rocky Ford Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Upper (North) Rocky Ford Lake Dam (a.k.a. North Lake Dam) subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Upper (North) Rocky Ford Lake Dam
Class: C1
DHEC Dam No: D 0029
HDR No: 09
Hazard: High
Long_DD: -80.951958
Lat_DD: 34.0408134

The dam consists of, from left abutment to right abutment (looking downstream):

- Left Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe
- Uncontrolled Overflow Concrete Auxiliary Spillway
- Right Embankment Dam

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 15, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and P. Milenkov (SCDHEC)

Site Conditions: Road on crest of dam is closed. Auxiliary spillway under bridge is completely washed out. The reservoir is empty except for stream flow (Photo 1).

- Weather: Sunny, 70 degrees,
- HWEL: stream channel, about 18 feet below crest
- TWEL: stream channel, about 18 feet below crest
- Discharge: stream discharge was through the remaining earth channel at the auxiliary spillway location.

Overall Status: Damaged condition due to failed auxiliary spillway and adjacent slope erosion.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

The concrete auxiliary spillway washed out and adjacent abutment/embankment material eroded during the flood event. Based on the observed conditions, the auxiliary spillway failed before overtopping of the embankment occurred.

3.1 Embankment Dam

The earth embankment dam material that supported the auxiliary spillway structure on both sides is significantly eroded (Photos 2 and 3). The left and right embankment sections beyond the eroded areas adjacent to the auxiliary spillway generally appear to be in good condition. The upstream and downstream slopes of the embankment have heavy vegetative cover including trees and underbrush. Embankment material was observed to be primarily sand with a small percentage of fines.

3.2 Abutments

The abutments of the left and right embankments are natural grade. No significant erosion of the embankment abutments was observed.

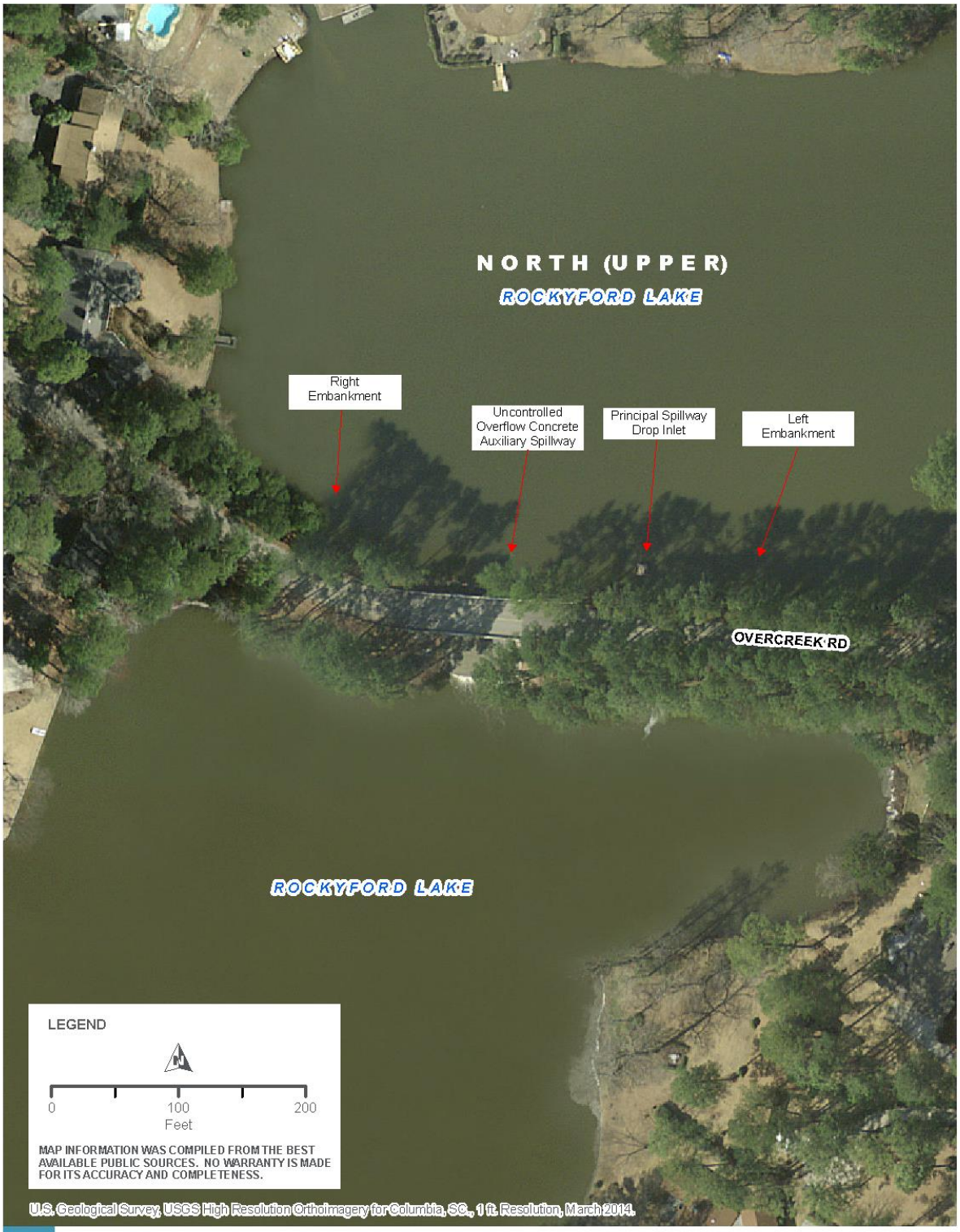
3.3 Service Spillway

The service spillway is comprised of a low-level outlet pipe with a concrete drop inlet equipped with a trash screen, and an outlet structure. Photo 1 shows the inlet structure. There is minor debris on the trash screen and the drop inlet structure appears to be intact. The outlet structure could not be viewed.

3.4 Auxiliary Spillway

The auxiliary spillway was completely washed out during the flood event. Photos 4 and 5 show the washed out auxiliary spillway channel beneath the bridge.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Service spillway drop inlet structure

Photo 2: View of eroded embankment at left abutment of the auxiliary spillway looking downstream

Photo 3: Erosion of embankment at the right abutment of the auxiliary spillway looking downstream

Photo 4: Erosion at bridge abutment

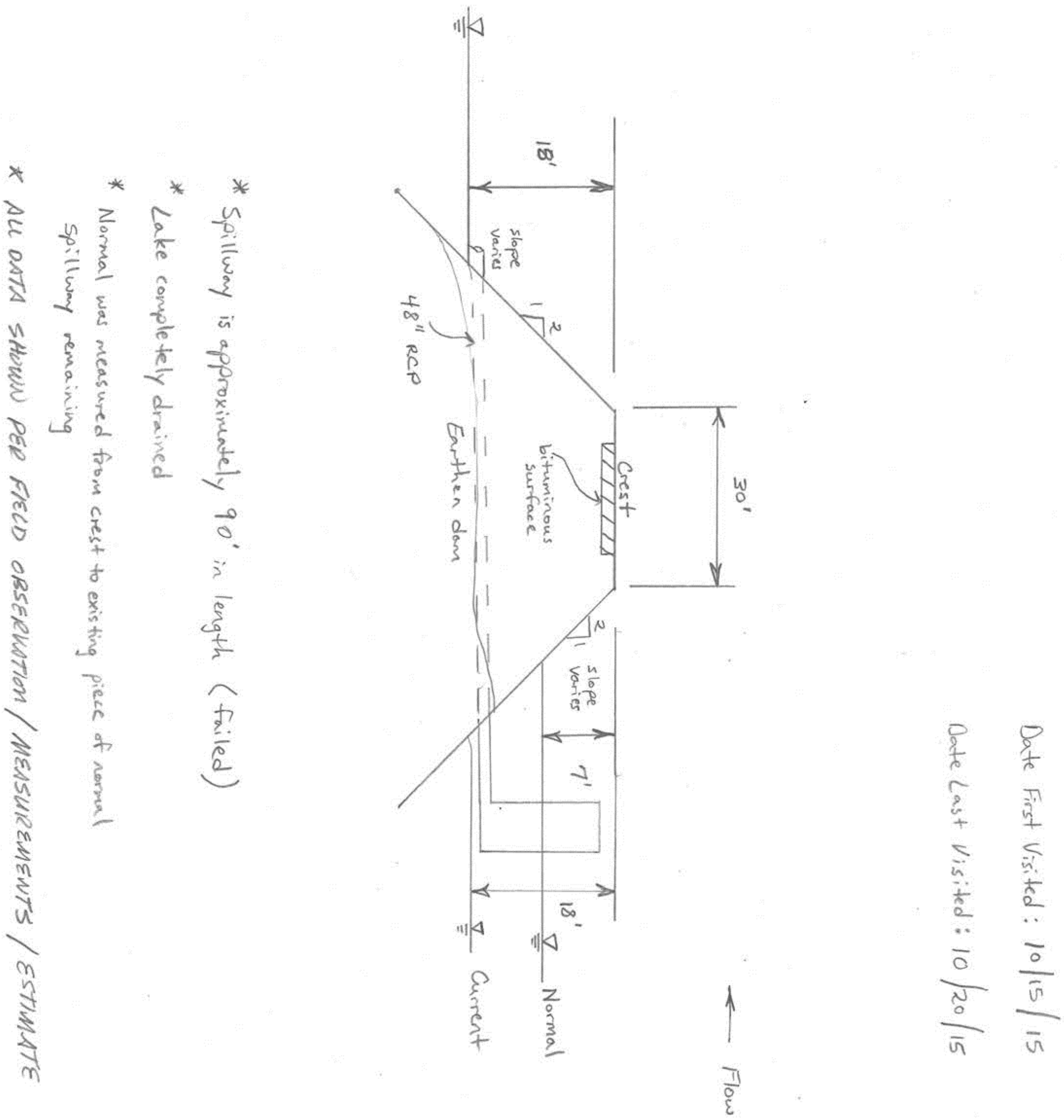
Photo 5: View of eroded auxiliary spillway area beneath the bridge

Photo 6: View upstream of bridge and auxiliary spillway

Attachment C: Sketch

HDR

Project: North Lake		Computed:	Date:
Subject: Dam # 0029		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



10 Wildewood Pond Dam 5

Gills Creek Watershed
Site Visit Assessment Report
Wildewood Pond Dam 5

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Wildewood Pond Dam 5 subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Wildewood Pond Dam 5
Class: C1
DHEC Dam No: D 0565
HDR No: 10
Hazard: High
Long_DD: -80.89153385
Lat_DD: 34.09993415

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Auxiliary Spillway
- Embankment Dam
- Low-Level Outlet with Gated Concrete Intake Structure

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Jeremy VanWyk (SCDHEC), and Peter Milenkov (SCDHEC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: approximately 5 feet below embankment crest; 1 foot below normal
- TWEL: approximately 22 feet below crest
- Discharge: through service spillway

Overall Status: Embankment is in generally good condition; generally minor surficial erosion of auxiliary spillway with several areas of moderate erosion and a seepage at downstream end; service spillway in good condition.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The earthen embankment dam crest is approximately 15 feet wide, grass covered, and free of debris (Photo 1). The upstream slope has grass cover. The downstream slope has grass cover and is free of woody growth except for one area near the auxiliary spillway on the left side (Photo 4). There are mature trees growing the entire length along the downstream toe. The embankment has an upstream slope of approximately 4H:1V and a downstream slope of approximately 4H:1V.

The overall condition of the embankment appears good, with no significant erosion, sloughs, or depressions observed. There were no visible indications that the embankment crest was overtopped during the flood event. Minor surficial erosion of the embankment slope adjacent to the auxiliary spillway was observed, apparently from flow through the auxiliary spillway (Photo 2). A moderate depression of about 1-to-2-feet deep was observed at the toe of the dam along the alignment service spillway outlet pipe; this area has been used as a fire pit (Photo 3).

3.2 Left Abutment

The earthen auxiliary spillway is located at the left abutment. The left abutment is natural grade residential yard (see Photo 8) with no apparent erosion.

3.3 Right Abutment

The right abutment is natural grade residential yard (see Photo 5). No erosion of this area was observed.

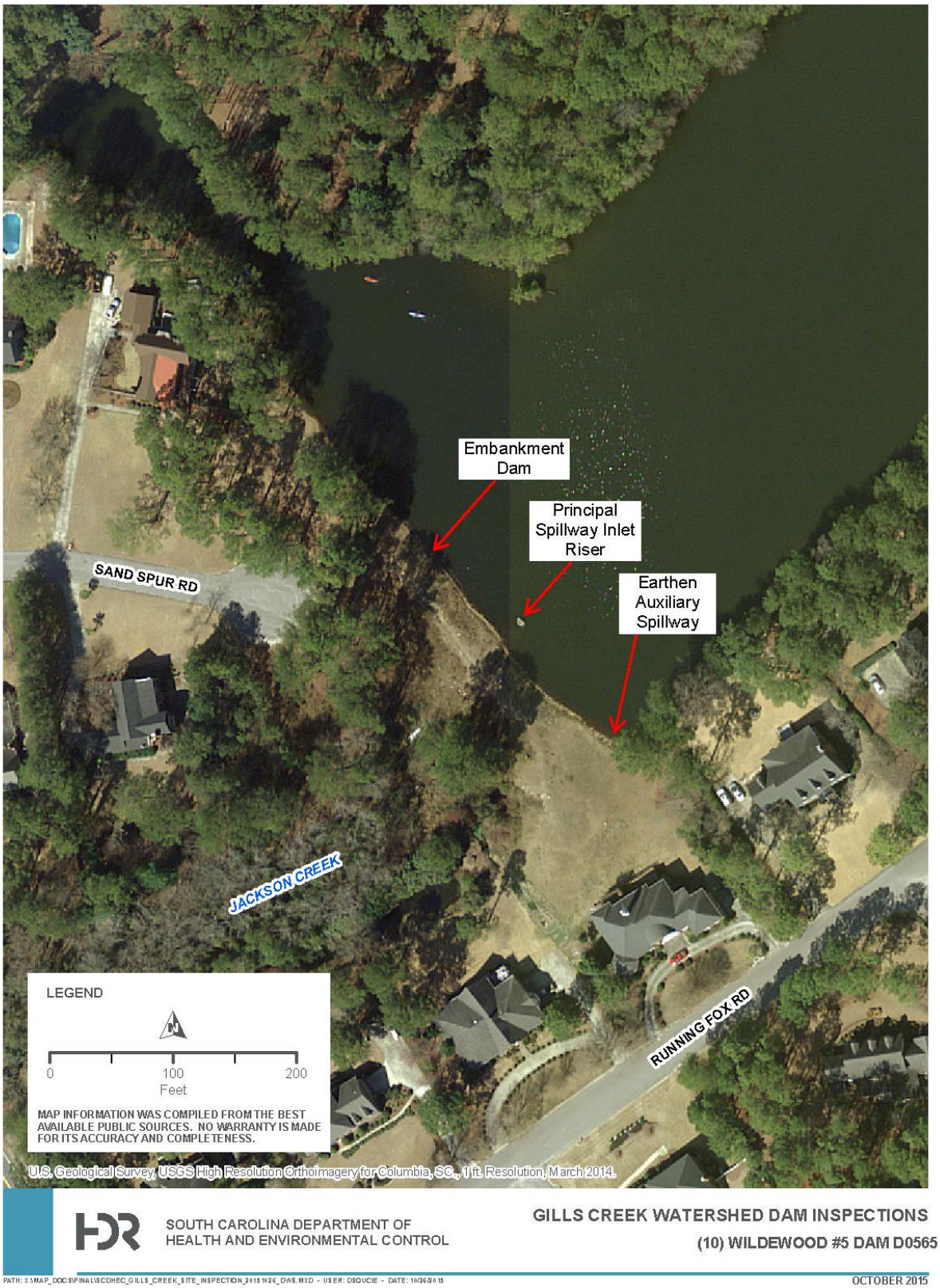
3.4 Service Spillway

The service spillway consists of a low-level pipe (48-inch CMP) with a drop-inlet intake with trash screen located approximately 30 feet upstream of the embankment to the left center of the dam (Photo 6). There was no debris accumulation at the drop inlet. Discharge from the outlet pipe into the stream was observed (Photo 7). The service spillway facilities appeared to be in good condition.

3.5 Auxiliary Spillway

The auxiliary spillway is an earthen-grassed, uncontrolled, overflow channel located at the left abutment. It has a crest length of approximately 80 feet and conveys flow about 200 feet to the stream. Overtopping of the spillway during the flood event to a depth of 1 to 2 feet was evident. The spillway appeared to generally be in good condition (Photo 8) with some minor surficial erosion. Water was observed to be emerging at a location on the downstream slope of the auxiliary spillway about 100 feet downstream from the pond, approximately 5 feet below pond level (Photo 9). This seepage appears to be indication of piping of subsurface red clay material through the auxiliary spillway. A significant erosion channel was developed in the downstream area of the auxiliary spillway which exposed what appears to be a stormwater main (Photo 10).

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Embankment crest viewed from right abutment. Grass cover on upstream slope; trees and underbrush on downstream slope and toe.

Photo 2: Minor erosion of the left downstream embankment.

Photo 3: Depression at toe of embankment

Photo 4: Woody growth on the left downstream slope

Photo 5: Right abutment

Photo 6: Service spillway inlet works.

Photo 7: Service spillway outlet pipe

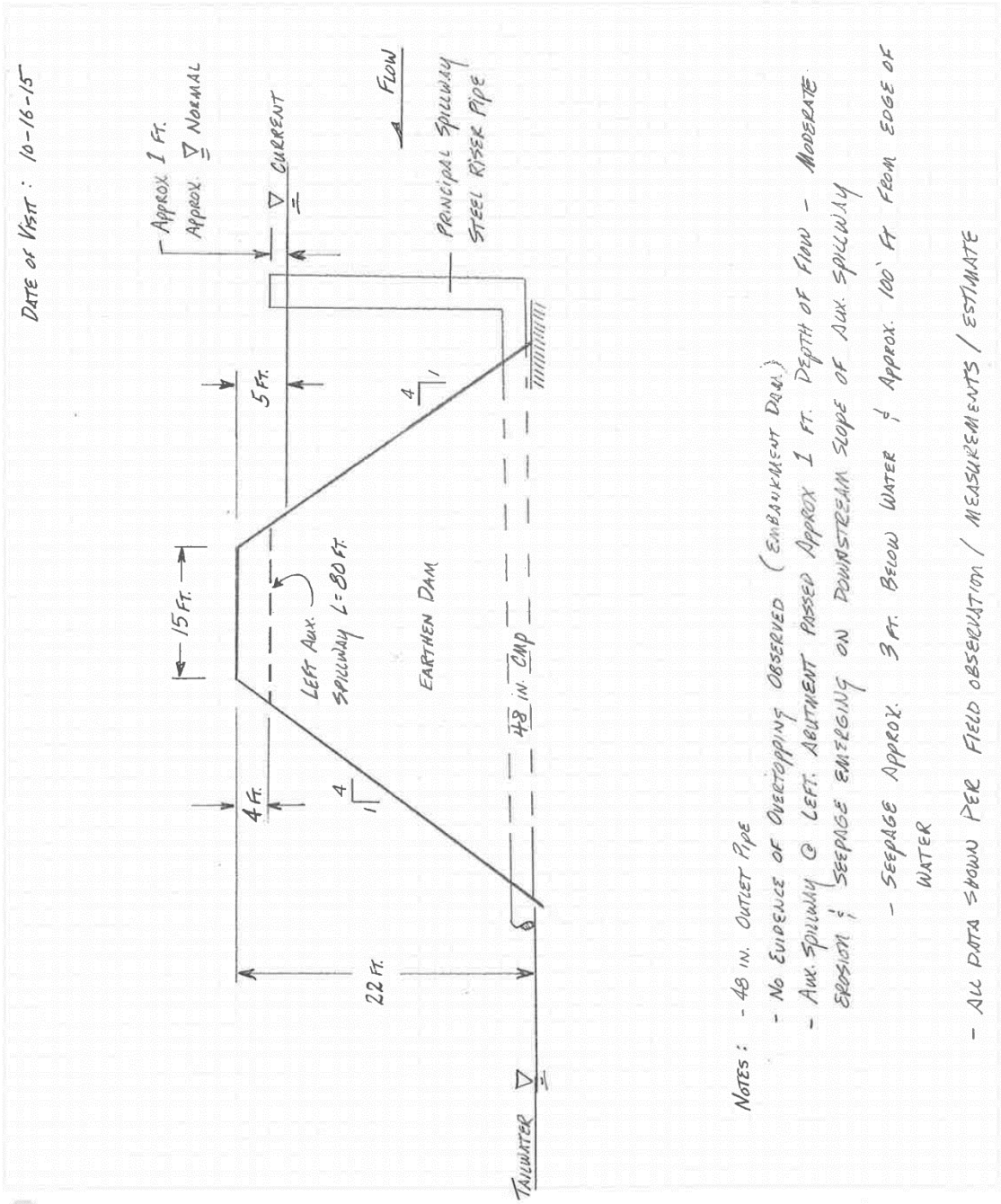
Photo 8: Auxiliary spillway, viewed from embankment crest toward left abutment

Photo 9: Seepage at downstream end of auxiliary spillway

Photo 10: Eroded area at downstream end of auxiliary exposing RCP pipe, presumably a stormwater main

Attachment C: Sketches Drawings

Project:	WILDEWOOD # 5	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0565	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



11 Wildewood Pond #4 Dam

Gills Creek Watershed
Site Visit Assessment Report
Wildewood Pond #4 Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Wildewood Pond #4 Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Wildewood Pond #4 Dam
Class: C1
DHEC Dam No: D 0564
HDR No: 11
Hazard: High
Long_DD: -80.88922528
Lat_DD: 34.10331388

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Embankment Dam
- Principal Spillway with drop inlet and low level discharge pipe

See Attachment A – Aerial Photo

2.0 Site Visit

Date: October 16, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Jeremy VanWyk (SCDHEC), and Peter Milenkov (SCDHEC)

2.1 Site Visit Details

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: approximately 9 feet below embankment crest (about 6 feet below normal)
- TWEL: approximately 18 feet below embankment crest
- Discharge: Pond lowered by temporary emergency pumping system

Overall Status: Embankment dam sustained significant downstream slope failure. Pond was drawn down by temporary pumps.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted during site visits after the initial site inspection.

3.1 Embankment Dam

The earthen embankment dam crest is approximately 30 feet wide with a secondary road along the crest (Photo 1). The dam was overtopped by an estimated 2 to 4 feet of water. The embankment generally exhibited minor surficial erosion and several areas of significant erosion. Overtopping resulted in failure of the downstream slope of the embankment along the alignment of the service spillway low-level outlet pipe that undercut the roadway (Photo 3). The length of the slope failure (left to right) was measured to be about 70 feet. No seepage was observed from the failed slope area.

The upstream slope had two areas of moderate sloughs (Photo 2). A few *crepe myrtle* trees were growing on the upstream slope, and there were mature trees and underbrush on the lower portion of the downstream slope and toe. Riprap was observed on the upper portion of the upstream slope near the right abutment (Photo 4). The earthen embankment has an upstream slope of approximately 2H:1V and a downstream slope of approximately 2H:1V.

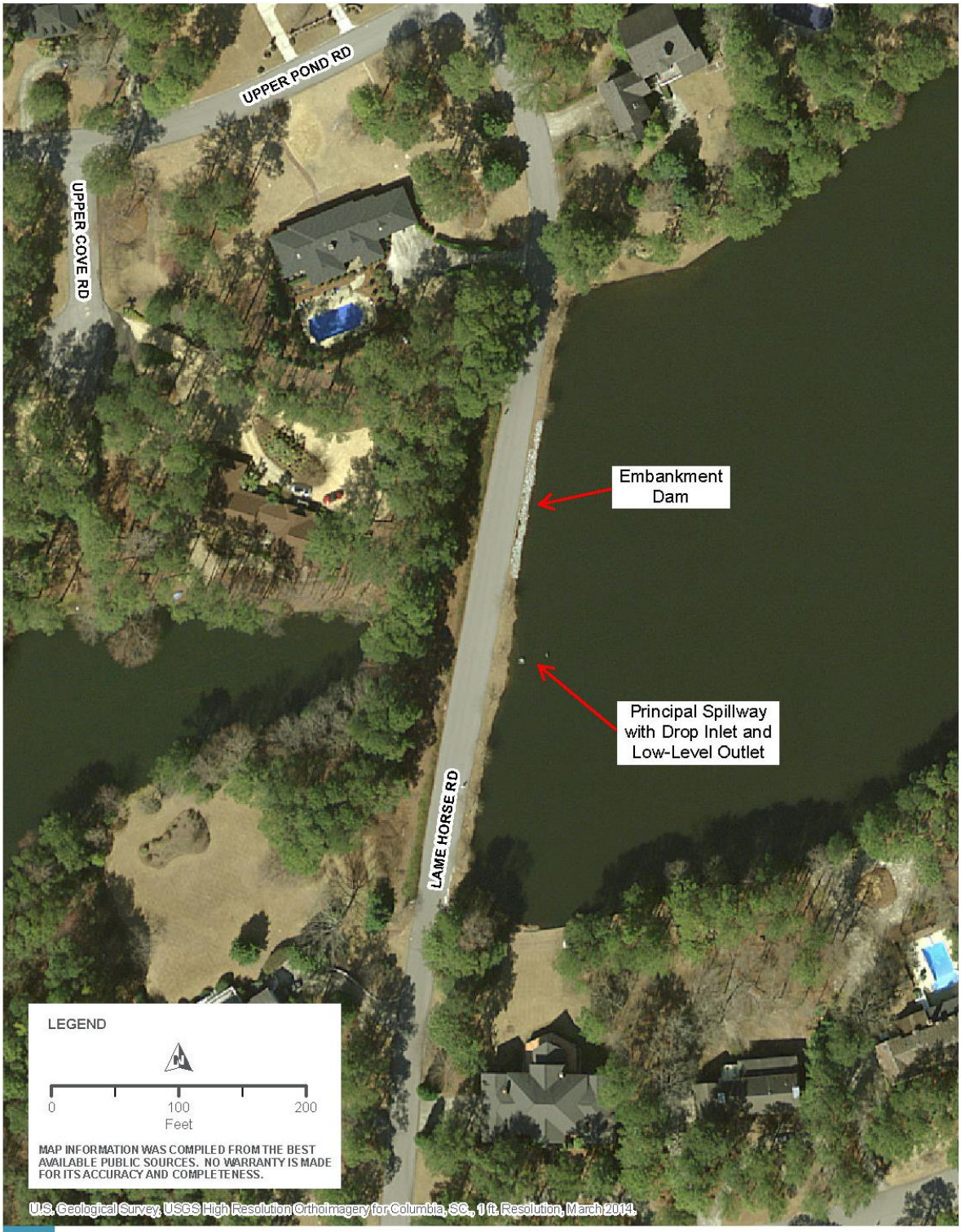
3.2 Abutments

The left and right abutments of the earth embankment dam are residential areas of natural grade. No significant erosion of these areas was observed.

3.3 Service Spillway

The service spillway is a low-level, 30-inch CMP pipe with drop inlet equipped with a trash screen. The trash screen was dislocated. The outlet pipe was submerged, but there was no indication of flowing water. The pond level is below the drop inlet elevation, and it is assumed that the low-level inlet to the service spillway cannot be operated to discharge at lowered pond conditions, or it is prudent not to discharge through the low level outlet due to concerns for effects to the failed slope area. As previously noted, temporary pumps are being used to discharge water from the pond downstream.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Embankment dam crest viewed from the left abutment.

Photo 2: Upstream embankment slope slough

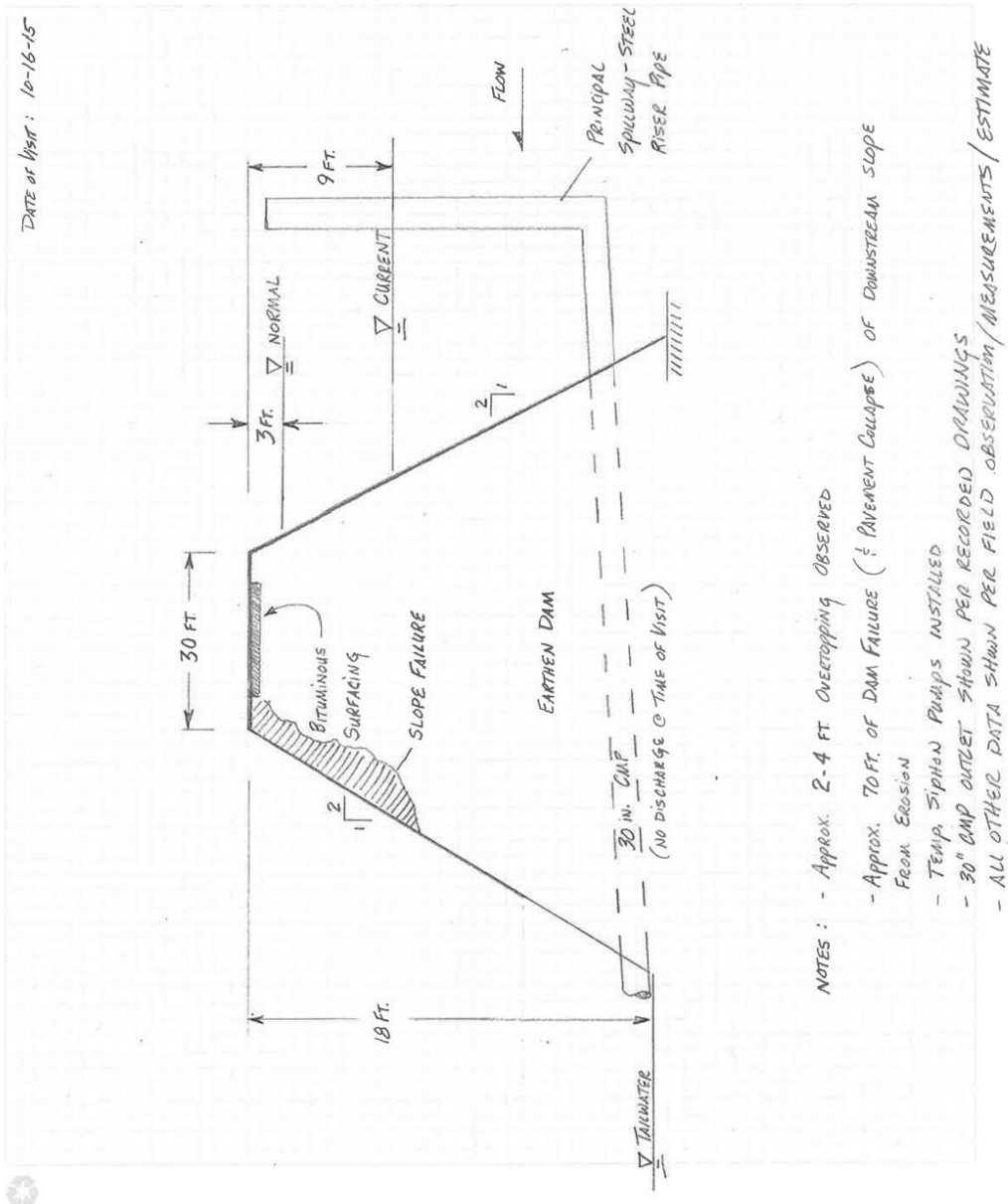
Photo 3: Downstream embankment slope failure along alignment of service spillway low-level outlet

Photo 4: Temporary riprap on upstream embankment slope (looking toward the right abutment).

Photo 5: Service spillway drop inlet

Attachment C: Sketches

Project:	WILDEWOOD #4	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0564	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



12 Beaver Dam/Wildewood Pond #2

Gills Creek Watershed
Site Visit Assessment Report
Beaver Dam/Wildewood Pond #2

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Beaver Dam/Wildewood Pond #2 subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Beaver Dam/Wildewood Pond #2
Class: C2
DHEC Dam No: D 0567
HDR No: 12
Hazard: Significant
Long_DD: -80.88642056
Lat_DD: 34.09650514

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Embankment Dam
- Service Spillway with drop inlet and low level discharge pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Jeremy VanWyk (SCDHEC), and Peter Milenkov (SCDHEC)

Site Conditions:

- Weather: clear, sunny, mild temperature
- HWEL: approximately 7 feet below embankment crest; about 5 feet below normal pond
- TWEL: approximately 29 feet below embankment crest
- Discharge: None. Pond lowered by temporary pumps and by temporary emergency channel that was excavated near the left abutment

Overall Status: Significant sinkhole development in the embankment dam with temporary rock fill and upstream cofferdam to stabilize and isolate the compromised area. The primary spillway is not operable. A trench was excavated at the left end of the embankment dam to function as an emergency channel to convey water downstream. Headpond is maintained below crest with temporary pumps.

3.0 Observations

During the flood event the upstream slope and crest of the earthen embankment subsided near the service spillway outlet pipe alignment. Measures were taken to fill the sinkhole and isolate the area with an upstream steel sheetpile cofferdam. Temporary pumps were mobilized to pump water from the headpond to the receiving stream downstream, and a channel was excavated at the left end of the embankment to function as an emergency channel for conveying water downstream. These measures minimized overtopping of the embankment dam to several inches.

Visual observations of post-flood conditions made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The earthen embankment dam crest is approximately 26 feet wide with a secondary road crossing the dam (Photo 1). The earthen embankment has an upstream slope of approximately 2H:1V and a downstream slope of approximately 4H:1V but varied to shallower configurations across the slope. There is thick growth of mature trees and underbrush on the downstream embankment slope and along the downstream toe (Photo 6).

The dam was overtopped by an estimated 2 to 3 inches that generally resulted in minor surficial erosion, with some areas of moderate erosion on the downstream slope (Photo 7). As discussed above, a section of the embankment crest and upstream slope subsided during the flood event. This area is aligned with the service spillway drop-inlet riser and downstream outlet

pipe. A new riser pipe was installed and connected to the existing low-level outlet pipe in 2010. The reported observations of the subsidence from DHEC suggests development of a sinkhole from loss of material within the embankment that may have been related to displacement or gap in the connection between the new riser pipe and pre-existing low-level discharge pipe. The sinkhole was filled with rock material, and a sandbag cofferdam was initially constructed to isolate the pond from the sinkhole. Subsequently, a sheet pile cofferdam was constructed upstream of the sinkhole to isolate the service spillway and sinkhole area (Photos 3- 5).

An emergency trench was excavated near the left abutment (Photo 2) to function as an emergency channel for conveying water downstream.

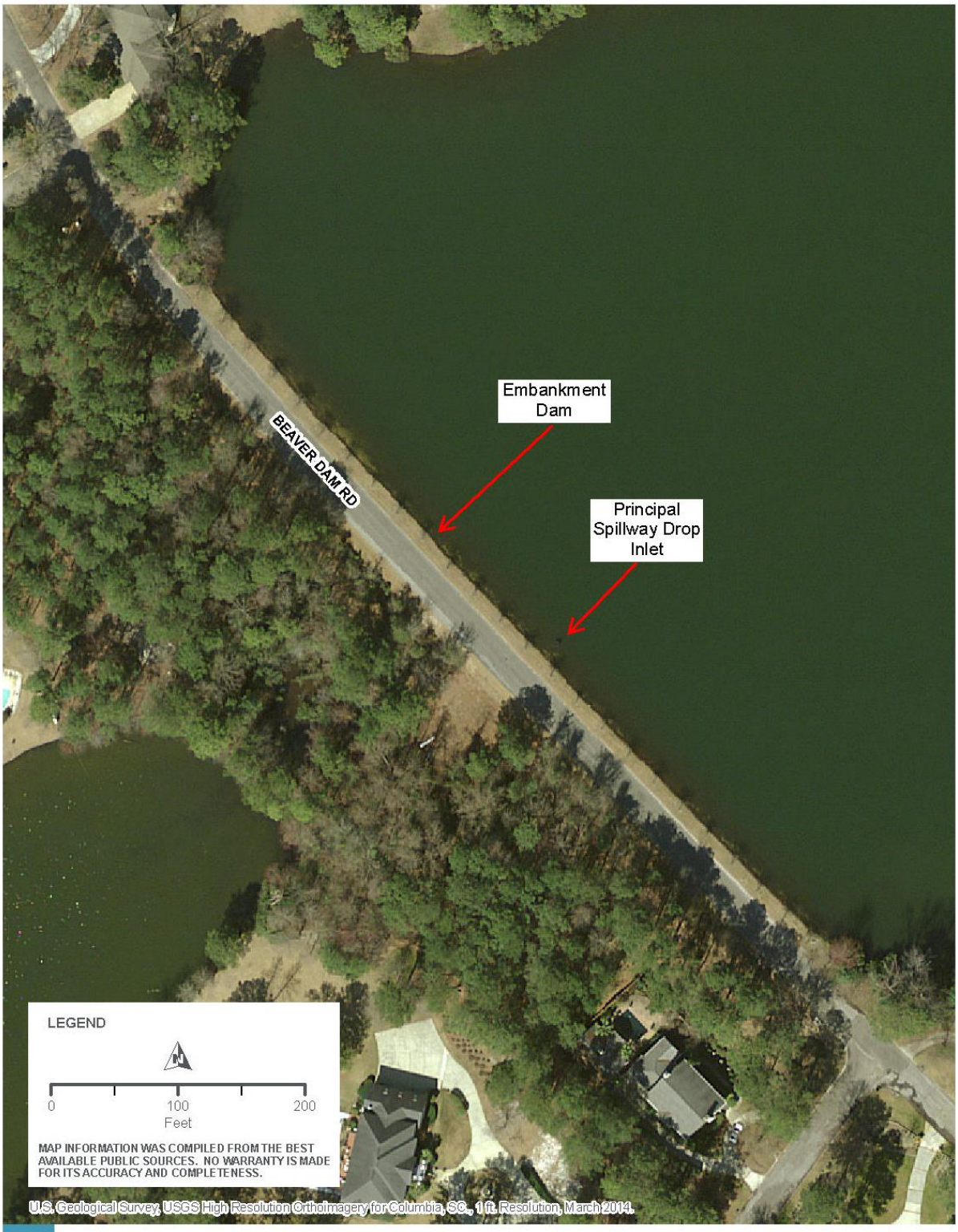
3.2 Abutments

The left and right abutments of the earth embankment dam are residential areas of natural grade. No significant erosion of these areas was observed in the abutment areas; however, the emergency channel excavated in the embankment adjacent to the left abutment conveyed flow to the wooded area downstream of the dam which resulted in some erosion.

3.3 Service Spillway

The service spillway consists of a drop-inlet riser and a low-level discharge pipe. A new 36-inch steel riser equipped with a trash screen was installed in 2010 (Photo 4). The low-level inlet pipe was sealed off during installation of the new riser. The apparent aluminum 30-inch, low-level discharge pipe outlets at the toe of the embankment (Photo 8).

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(12) BEAVER DAM / WILDEWOOD #2 DAM D0567

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_2015 1026_DAMS.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: Roadway along embankment crest viewed from right embankment

Photo 2: Temporary trench excavated to function as an emergency channel near the left abutment

Photo 3: Sinkhole area on embankment crest showing temporary rock fill

Photo 4: Rock fill placed in sinkhole area of upstream embankment slope; service spillway riser is in the foreground

Photo 5: Temporary sheet-pile cofferdam installed to isolate the sinkhole area

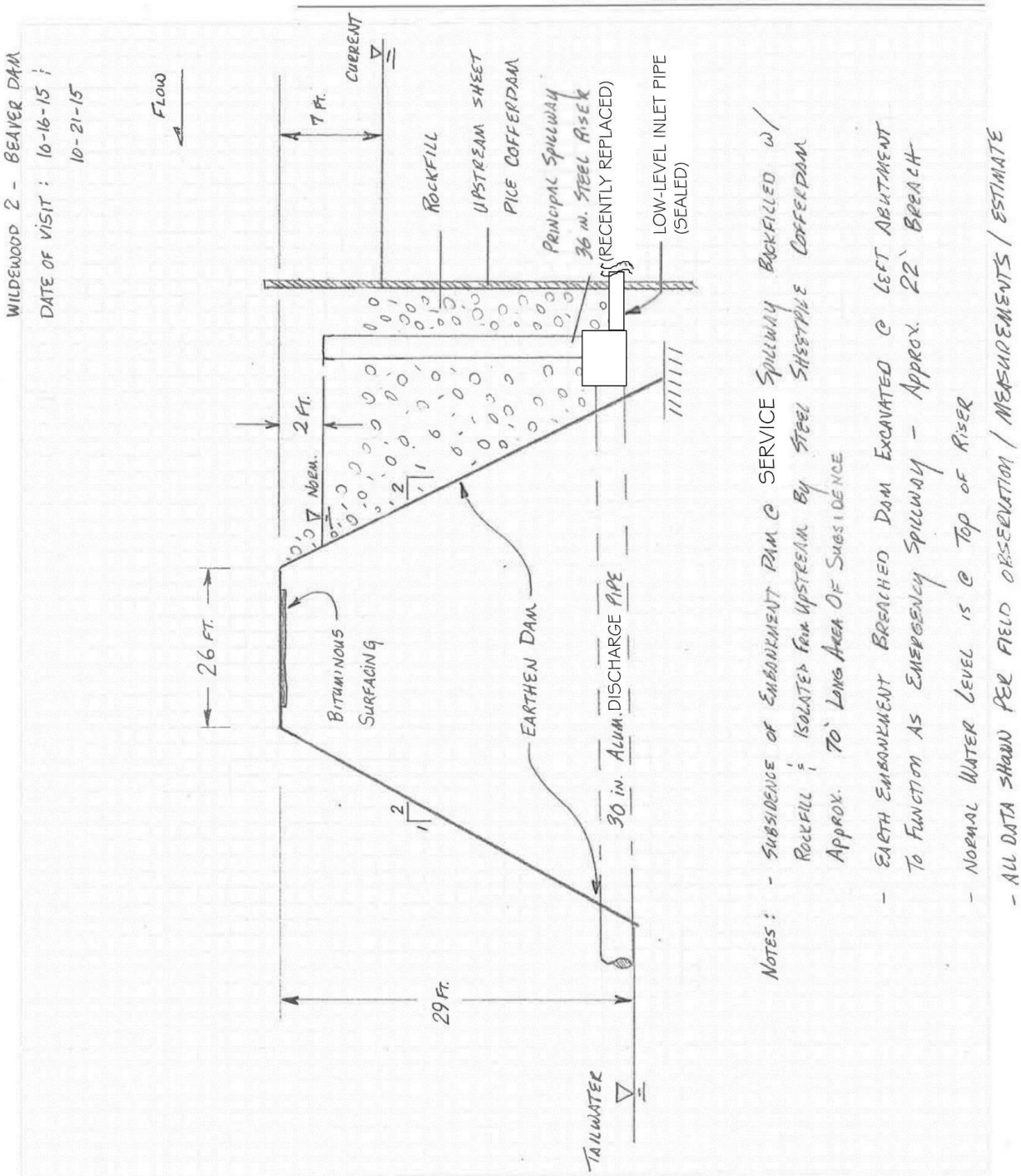
Photo 6: Tree growth on downstream slope of embankment; temporary pump discharge pipes are in the foreground

Photo 7: Erosion on the downstream slope of the embankment

Photo 8: Service spillway outlet pipe

Attachment C: Sketches Drawings

Project:	WILDEWOOD # 2	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0566	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



13 Wildewood Pond #3

Gills Creek Watershed
Site Visit Assessment Report
Wildewood Pond #3

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Wildewood Pond #3 subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Wildewood Pond #3
Class: C2
DHEC Dam No: D 0566
HDR No: 13
Hazard: Significant
Long_DD: -80.88013215
Lat_DD: 34.10048522

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Embankment Dam
- Service Spillway with drop inlet and low level discharge pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Jeremy VanWyk (SCDEHC), and Peter Milenkov (SCDEHC)

Site Conditions:

- Weather: Clear, sunny, mild temperature
- HWEL: approximately 12 feet below embankment crest; estimated to be about 1 to 2 feet below top of inlet riser pipe.
- TWEL: approximately 32 feet below embankment crest
- Discharge: through service spillway low-level outlet pipe

Overall Status: Embankment and service spillway are in good condition.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The earthen embankment dam is located within a golf course and appears well maintained. The embankment crest is approximately 30 feet wide with a secondary road along the crest (Photos 1 and 2). The embankment slopes were estimated to be about 2H:1V and generally have grass cover with several small decorative trees growing on the upstream slope. The embankment dam did not appear to have been overtopped during the flood event and appeared to generally in good condition. A few minor sloughs were observed on the upstream slope (Photo 3).

Erosion of the downstream slope was evident where the grassed slope transitions to a very steep slope vegetated by heavy wetland-type vegetation. Photo 6 shows an area where the slope has eroded to near vertical, exposing the sandy embankment material. The embankment was not overtopped, so this erosion is from surficial runoff and probably existed to some extent and further eroded from the heavy rainfall event. Minor erosion along the toe of the embankment was also observed, which appeared to have resulted from rise and fall of tailwater level (Photo 5).

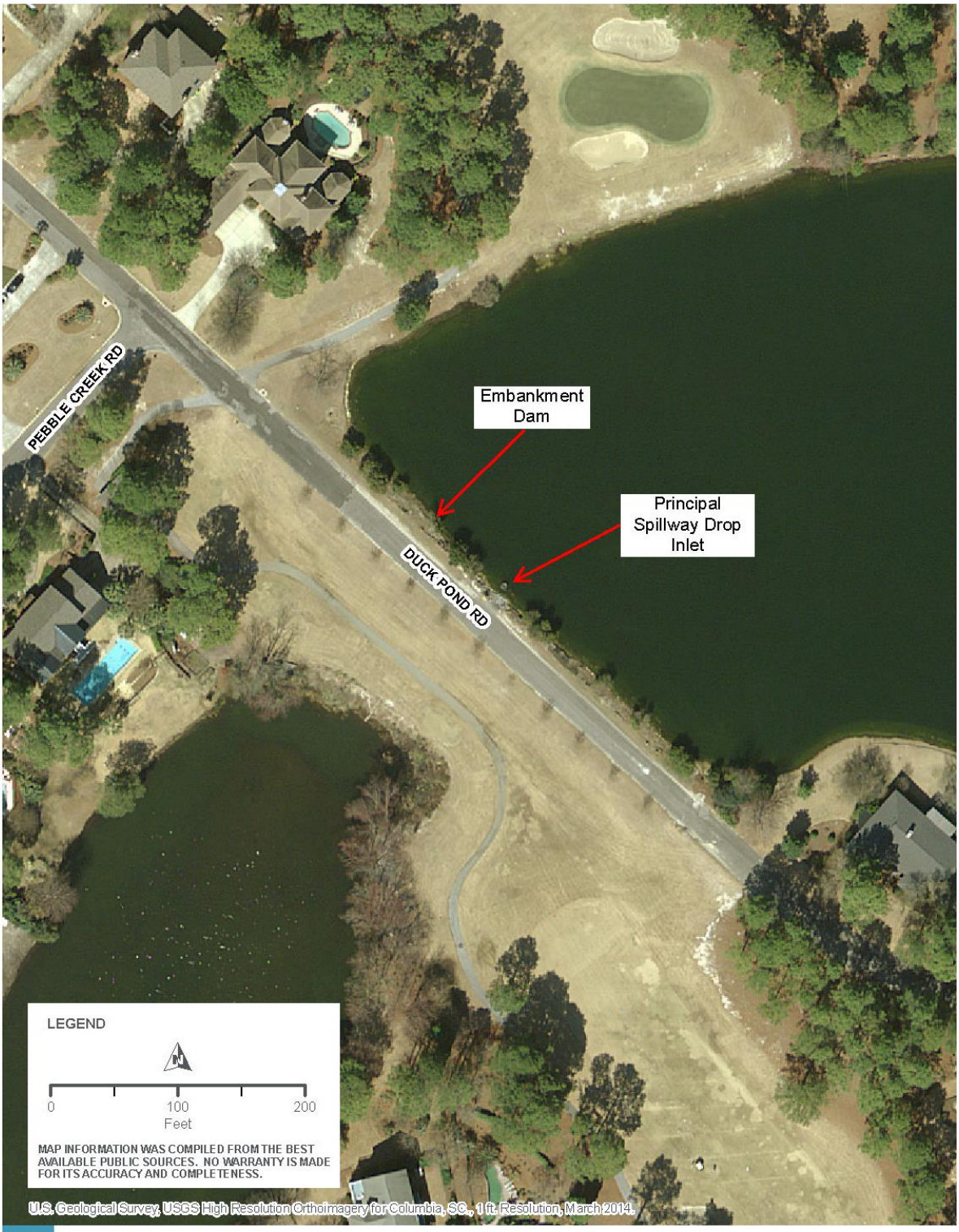
3.2 Embankment Dam Abutments

The abutments to the embankment dam are grassed natural grade areas of the golf course. No significant erosion was observed in these areas.

3.3 Service Spillway

The service spillway is a low-level, 30-inch CMP pipe with drop inlet equipped with a trash screen. The inlet (Photo 4) and outlet pipe (Photo 5) appeared to be in good condition. No debris was observed on the inlet trash screen.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Embankment dam viewed from left abutment

Photo 2: Downstream slope of the embankment dam viewed from left abutment

Photo 3: Slough on upstream slope of the embankment dam

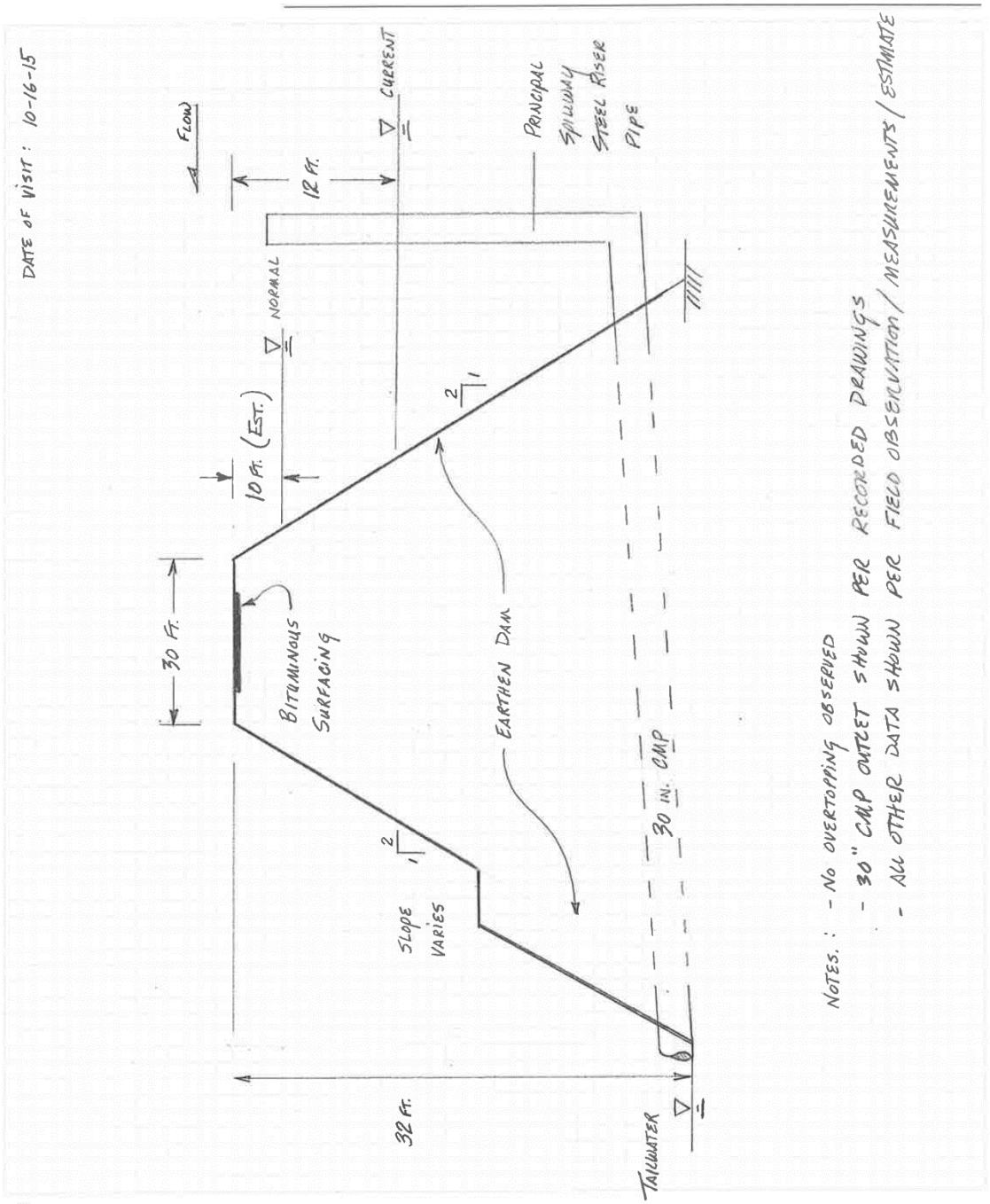
Photo 4: View of pond with service spillway drop inlet in foreground

Photo 5: Service spillway outlet pipe. Note minor erosion around the pipe.

Photo 6: Erosion on downstream slope of embankment, approximately 30 feet upstream of the service spillway outlet

Attachment C: Sketches

Project:	WILDEWOOD # 3	Computed: BWL	Date: 10-19-15
Subject:	DAM # D0567	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



14 Wildewood Pond #1

Gills Creek Watershed
Site Visit Assessment Report
Wildewood Pond #1 Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Wildewood Pond #1 Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Wildewood Pond #1 Dam
Class: C3
DHEC Dam No: D 0568
HDR No: 14
Hazard: Low
Long_DD: -80.888333
Lat_DD: 34.095

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Embankment Dam
- Service Spillway with drop inlet and low-level discharge pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Ray Wingert (HDR), Ben Lewis (HDR), Jim Thornton (HDR), Jeremy VanWyk (SCDEHC), and Peter Milenkov (SCDEHC)

Site Conditions:

- Weather: clear, sunny, mild temperature
- HWEL: approximately 6 feet below embankment crest; 4 feet below normal pond
- TWEL: approximately 18 feet below embankment crest
- Discharge: none; service spillway intake gate closed.

Overall Status: Embankment dam generally in fair condition except for significant sloughing on the downstream slope at the service spillway. The service spillway gate is closed due to concerns of further erosion if water is discharged through the outlet pipe. Flow can only be discharged via the temporary channel at the right abutment or by temporary pumps.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The embankment dam, shown on DHEC file sketches to be approximately 500 feet long, is generally comprised of two sections. The initial 200 feet of the dam extending from the left abutment is upstream of a small pond and terminates at a roadway embankment that extends downstream along the right side of the downstream pond.

The HDR team made observations of the remaining 300 feet of the embankment dam that has a lower crest that is generally15 feet wide, with mature trees and duff ground cover (Photo 1). The slopes of this section of the embankment generally have trees, root systems, and woody growth; heavy underbrush and trees are denser on the downstream slope. This section of the embankment dam appears to be relatively low and gradually transitions to natural grade downstream (Photo 2). This section of the embankment dam appeared to generally be in fair condition with no signs of significant erosion.

The maximum section of the embankment dam (approximately 20 feet high) is in the vicinity of the service spillway. The upstream slope was estimated to be very steep at approximately 1H:1V, and the downstream slope at about 2H:1V. A significant slough of the downstream slope was observed at the location of the service spillway outlet pipe (Photos and 6). The slough shows sandy embankment material that is susceptible to erosion. DHEC personnel stated that upon failure of this slope, a decision was made to shut off flow through the service spillway and excavate an emergency channel at the right abutment to convey flood flow

downstream (Photos 3 and 4) in and effort to prevent the embankment from being overtopped. Temporary pumps were also used to discharge flow downstream. It is possible that the slough was caused by a leak in the outlet pipe.

There are no clear indications that the embankment was overtopped. Some surficial erosion was apparent in the downstream wooded area at the right abutment where the flood water was conveyed by the emergency channel.

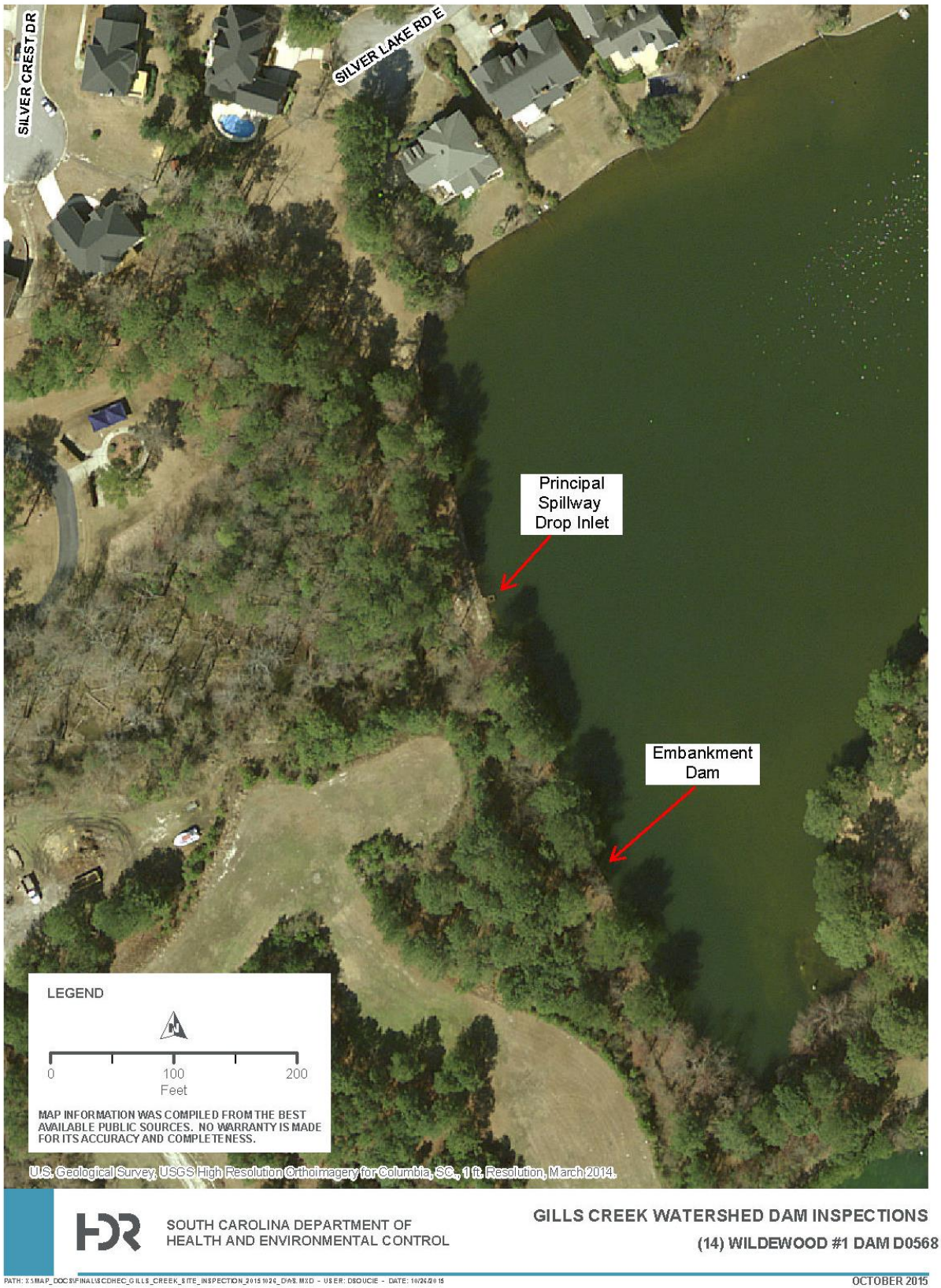
3.2 Embankment Abutments

The left abutment to the left section of the embankment was not observed since this area was significantly higher than the lower embankment section. The right abutment beyond the emergency channel is a shoreline residential area. No significant erosion was observed in this area.

3.3 Service Spillway

The service spillway is a low-level, 24-inch CMP pipe with a concrete drop-inlet structure. The inlet structure appeared to be in fair condition, but the coarse steel bar racks were severely corroded (Photo 7). The inlet gate is operational as indicated by successful closure during the flood. The service spillway outlet pipe appears to be in good condition; significant erosion of the outlet receiving area was noted (Photo 8).

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: View along crest of embankment dam looking toward the left abutment

Photo 2: View of downstream slope of the embankment dam from the service spillway toward the left abutment

Photo 3: View of approach to the emergency channel that was excavated at the right abutment during the flood to convey water downstream

Photo 4: Temporary channel viewed from the embankment

Photo 5: Slough of downstream slope viewed from embankment crest

Photo 6: View of slough of embankment from downstream

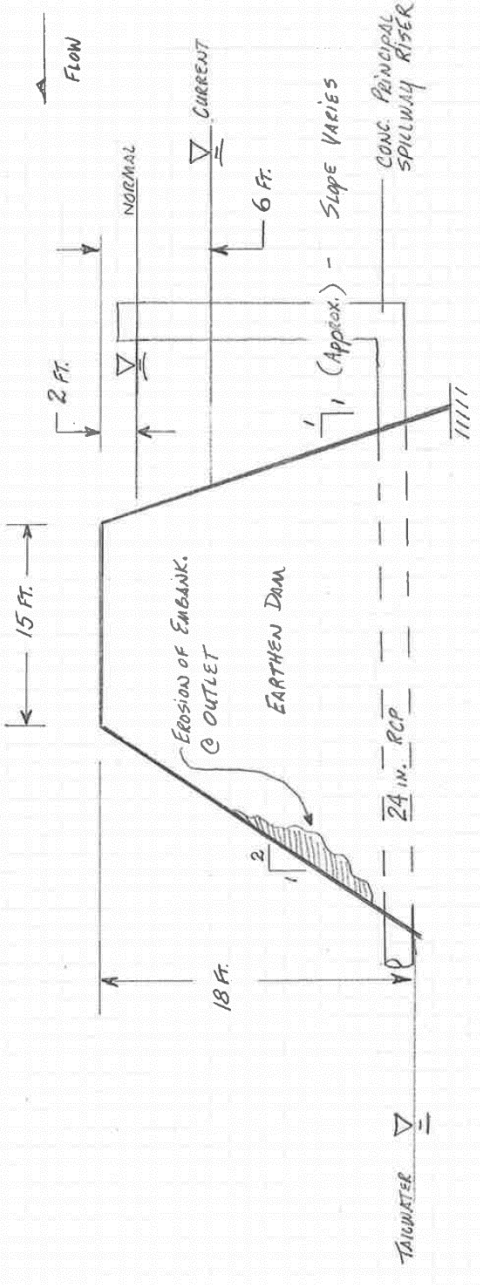
Photo 7: Service spillway drop inlet

Photo 8: Service spillway outlet

Attachment C: Sketches Drawings

Project:	WILDEWOOD # 1	Computed: BWL	Date: 10-19-15
Subject:	Cl. III - BELOW BEAVER DAM	Checked:	Date:
Task:	NO DAM # (NON-REGULATED)	Page:	of:
Job #:		No:	

DATE OF VISIT: 10-15-15



Notes:

- NO EVIDENCE OF OVERTOPPING
- EMERGENCY SPILLWAY CHANNEL EXCAVATED @ RIGHT ABUTMENT DURING STORM EVENT TO CONVEY FLOOD DISCHARGE : EMERGENCY SPILLWAY L = APPROX. 25 FT.
- SIPHON PUMPS INSTALLED (TEMPORARY)
- 24" RCP OUTLET SHOWN PER RECORDED DRAWINGS
- ALL OTHER DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

15 Entrance Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Entrance Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Entrance Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Entrance Lake Dam
Class: C1
DHEC Dam No: D 0450
HDR No: 15
Hazard: High
Long_DD: -80.91852956
Lat_DD: 34.1016265

The dam consists of, from left abutment to right abutment (looking downstream):

- Concrete-Lined Auxiliary Spillway
- Embankment Dam
- Low-Level Outlet with Intake Structure (type of intake not verified due to inundation)

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and J. Ford (SCDHEC)

Site Conditions:

- Weather: clear, sunny, 55 degrees,
- HWEL: approximately 4 feet below embankment crest, 1.0 foot above normal pool
- TWEL: approximately 20 feet below crest
- Discharge: through auxiliary spillway

Overall Status: Embankment generally good condition. The dam did not appear to have overtopped.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted during site visits after the initial site inspection.

3.1 Embankment Dam

The embankment dam has an upstream slope was estimated to be generally 2.5H:1V with variation; and has large pine trees growing on it. The crest is approximately 10 feet wide at its minimum section and has sparse vegetation. Photo 1 presents a view of the upstream slope, and Photo 2 shows the crest from the right abutment. The downstream slope is approximately 2H:1V but varies across the slope and is heavily vegetated with trees and typical forest undergrowth such as ivy and vines. Photo 3 presents a view of the downstream slope from the right abutment.

The only observed sign of distress in the embankment is a 8-inch-diameter and 1.0-foot-deep depression on the crest that is in line with what appears to be an irrigation line that runs from upstream of the dam, through the dam approximately 5 feet below the crest, and to a pump set on the downstream face of the dam that is connected to PVC pipe that leads away from the pump. Photo 4 shows the depression, and Photo 5 shows the view from the depression to the pump.

3.2 Left Abutment

The left abutment appears to be in good condition and shows no evidence of erosion.

3.3 Right Abutment

The right abutment also appears to be in good condition and shows no signs of erosion or damage.

3.4 Service Spillway

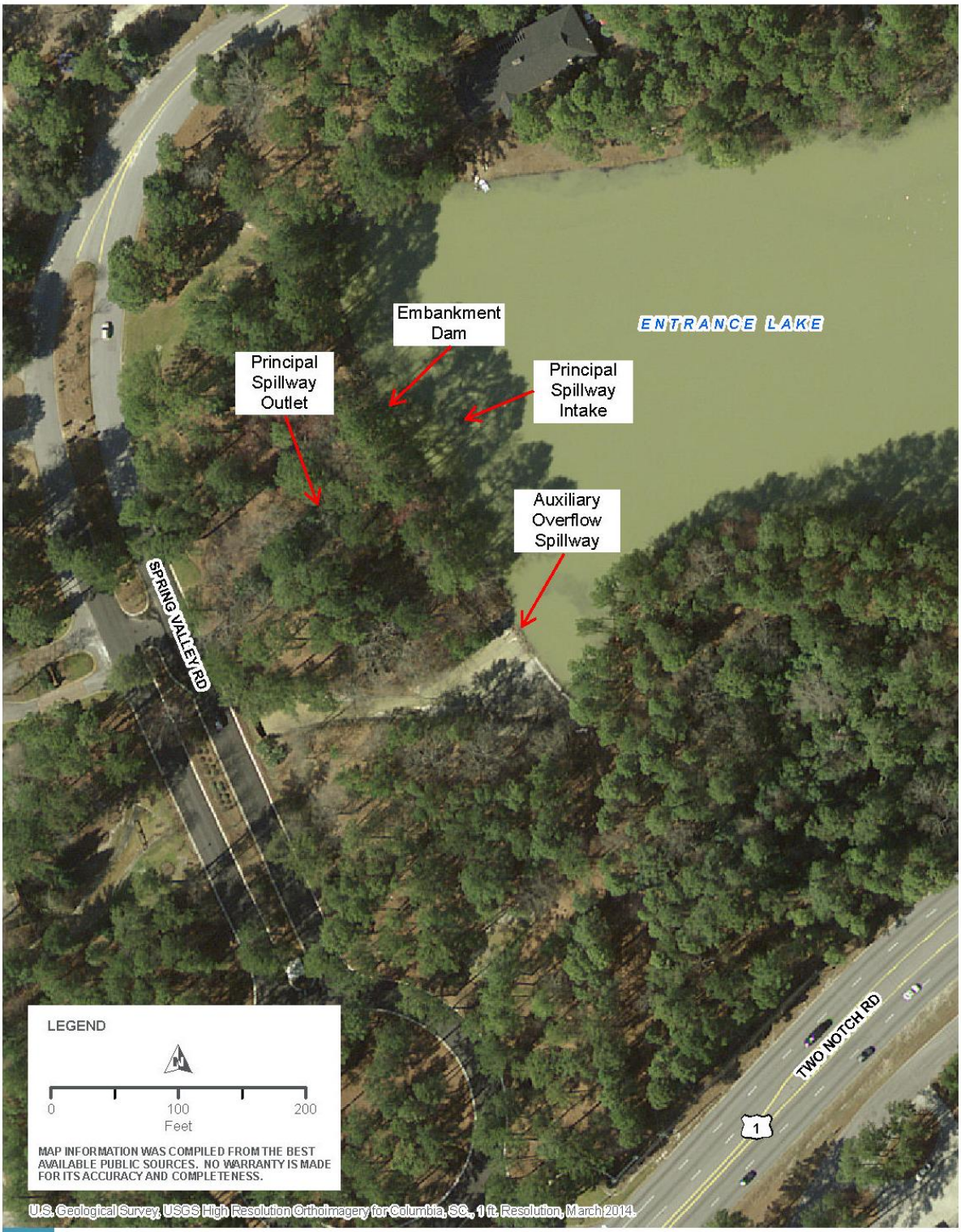
The SCDHEC file drawings show the service spillway consists of a 15-inch diameter CMP inlet riser with a 12-inch diameter CMP outlet pipe. The service spillway also has a low-level inlet

with a control valve. The 15-inch riser pipe was not observed during the site visit and was presumed submerged; however, the platform for the low-level inlet control valve was visible (Photo 6). The 12-inch diameter outlet was not found during the site visit. A 2-inch PVC irrigation pipe outlet with shut-off valve was observed (Photo 7). There was no discharge from the irrigation pipe. The irrigation pipe outlet drains into a ditch that travels downstream transverse to the dam. Photo 8 shows the outlet drain ditch. Minor seepage was noted in the ditch approximately 20 feet downstream from the toe of the dam. This seepage did not appear to be originating from around the irrigation pipe outlet.

3.5 Auxiliary Spillway

The auxiliary spillway is a concrete-lined overflow channel, approximately 80 feet wide, that extends from the left extent of the embankment to the left abutment. The spillway has two sections with one section nearest the left abutment approximately 8 inches higher in elevation than the interior section. Photo 9 shows the auxiliary spillway. The debris in the lower section has resulted in the elevation of the reservoir being elevated. The consistent placement of the debris may be the work of beavers. At the downstream end of the auxiliary spillway there is significant erosion and structural damage where water is conveyed under the road in two 48-inch and two 24-inch culverts. Photos 10 and 11 show the damage to the end of the spillway next to the road.

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(15) SPRING VALLEY ENTRANCE - COMPLEX #1 DAM D0450

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_D#6.MXD - USER: DSOUCIE - DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: Entrance Lake viewed upstream from the right abutment

Photo 2: Embankment dam crest viewed from the right abutment

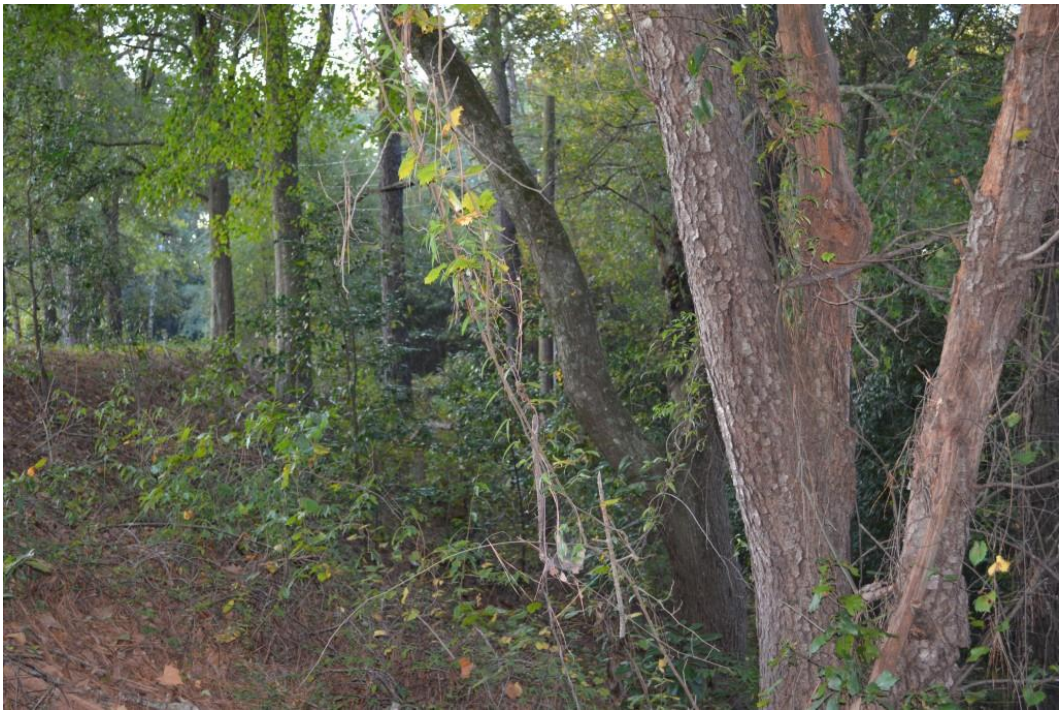


Photo 3: Downstream slope of embankment dam viewed from the right abutment

Photo 4: Depression on embankment crest

Photo 5: Pump house (in background) viewed from area of depression on embankment crest shown in Photo 4

Photo 6: Service spillway intake platform

Photo 7: Irrigation pipe outlet

Photo 8: Irrigation pipe outlet channel

Photo 9: Auxiliary spillway with debris

Photo 10: Damage at downstream end of auxiliary spillway

Photo 11: Erosion at end and left of auxiliary spillway

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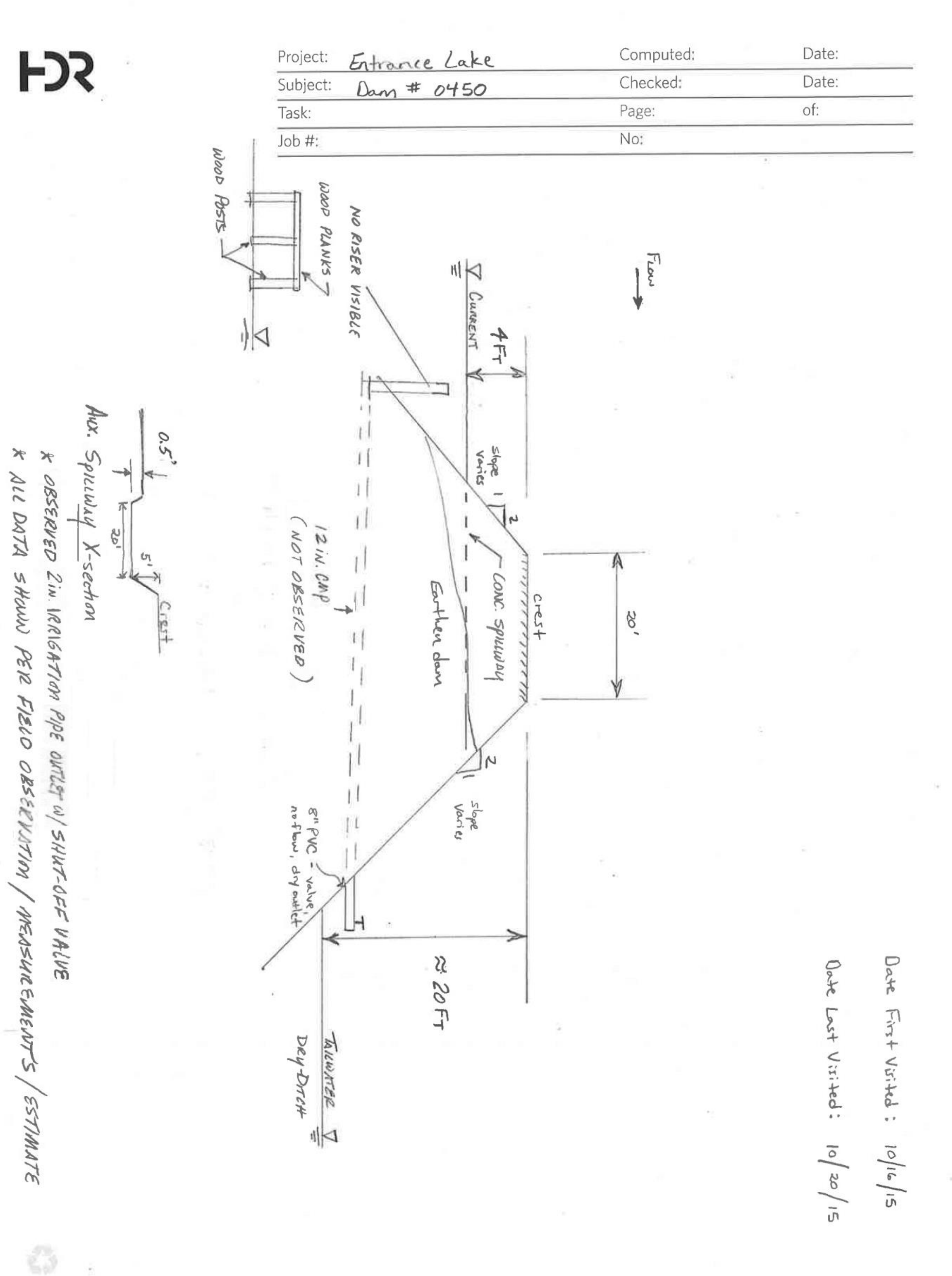
Attachment C: Sketches Drawings



16 Pine Springs Lake CMPLX 1

Gills Creek Watershed
Site Visit Assessment Report
Pine Springs Lake CMPLX 1

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Pine Springs Lake CMPLX 1 subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Pine Springs Lake CMPLX 1
Class: C1
DHEC Dam No: D 0560
HDR No: 16
Hazard: High
Long_DD: -80.91721508
Lat_DD: 34.10675674

The dam consists of, from left abutment to right abutment (looking downstream):

- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (HDR), Cole Pierce (HDR), John Charlton (HDR)

Site Conditions:

- Weather: clear, sunny, 60 Degrees
- HWEL: approximately 11 feet below embankment crest
- TWEL: approximately 15 feet below crest of dam at outfall
- Discharge: None observed

Overall Status: Embankment is in generally good condition; generally minor surficial erosion of the downstream toe; service spillway in good condition.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Note that water levels shown on the sketch were estimated during a second visit conducted on October 21, 2015.

3.1 Embankment Dam

The embankment has an approximately 30-foot-wide crest, upstream slope varying from 2H:1V to 3H:1V, and downstream slope of 2H:1V to 2.5H:1V. The dam was not overtopped during the flood event. The upstream slope is in good condition having full grass cover to the normal pool level. The crest supports an asphalt road with grass and gravel cover over the shoulders of the road. The downstream slope has grass growth through a geotextile fabric. The downstream slope is generally in good condition but does show erosion at the toe just below the geotextile fabric. Photo 1 presents a view of the upstream slope looking to the left abutment. Photo 2 shows the dam crest and road, and Photo 3 shows the downstream slope. Photo 4 shows the limited areas of erosion on the downstream slope below the geotextile.

3.2 Left Abutment

The left abutment is in good condition, has grass and tree cover, and shows no to minimal signs of erosion.

3.3 Right Abutment

The right abutment is in good condition, has grass and tree cover, and shows no signs of erosion.

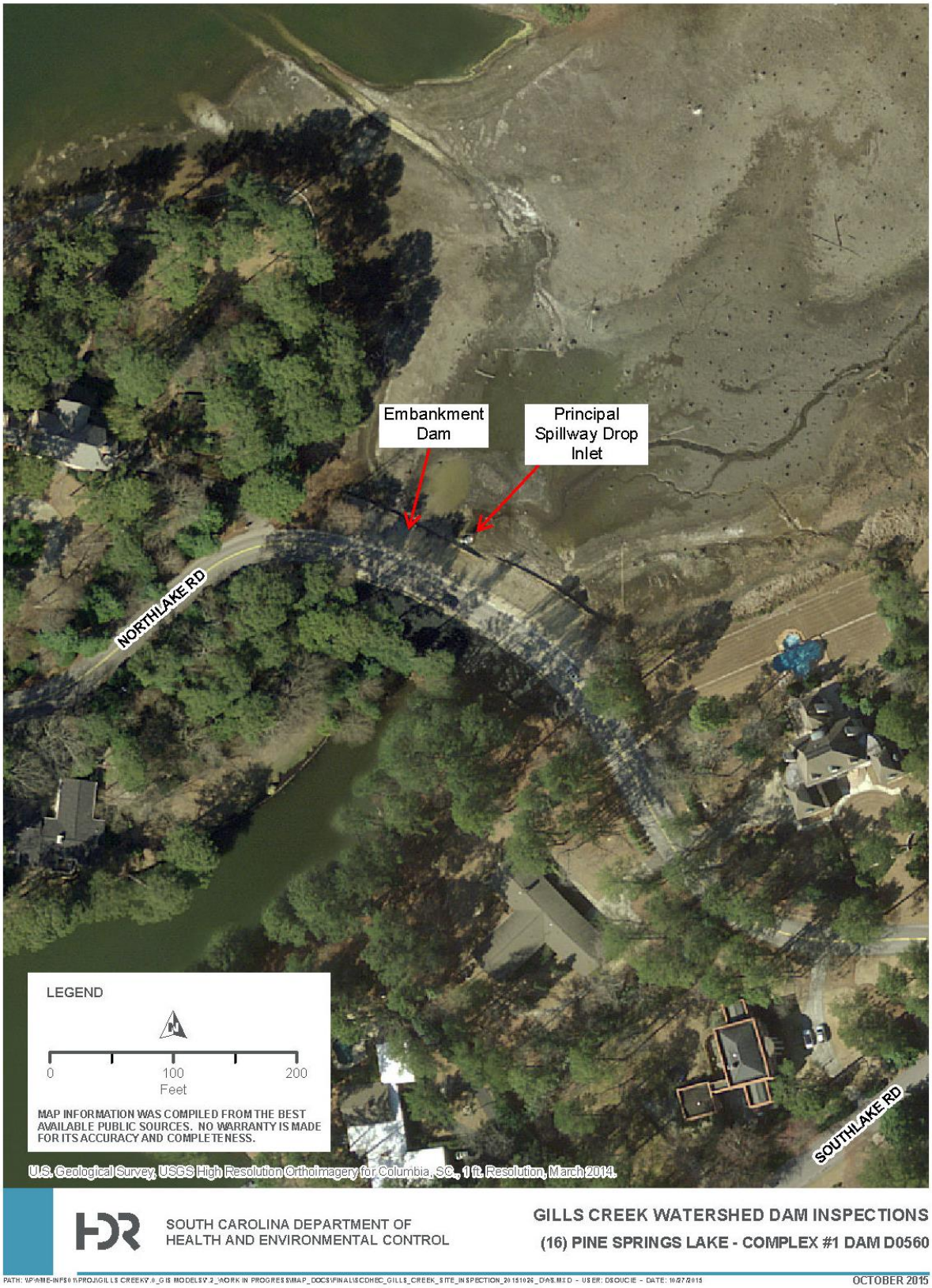
3.4 Service Spillway

The service spillway is comprised of a drop inlet located approximately 30 feet upstream of the dam. The drop inlet appeared to be 18-inch-diameter corrugated metal pipe with 30-inch corrugated steel pipe and trashrack set over the 18-inch pipe. There was no debris on the drop inlet. Photo 5 presents the principal drop inlet. The outfall of the spillway is 18-inch concrete pipe. Photos 6 and 7 show the low-level outlet pipe and tailwater.

3.5 Auxiliary Spillway

There was no auxiliary spillway observed at this dam.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Upstream embankment slope

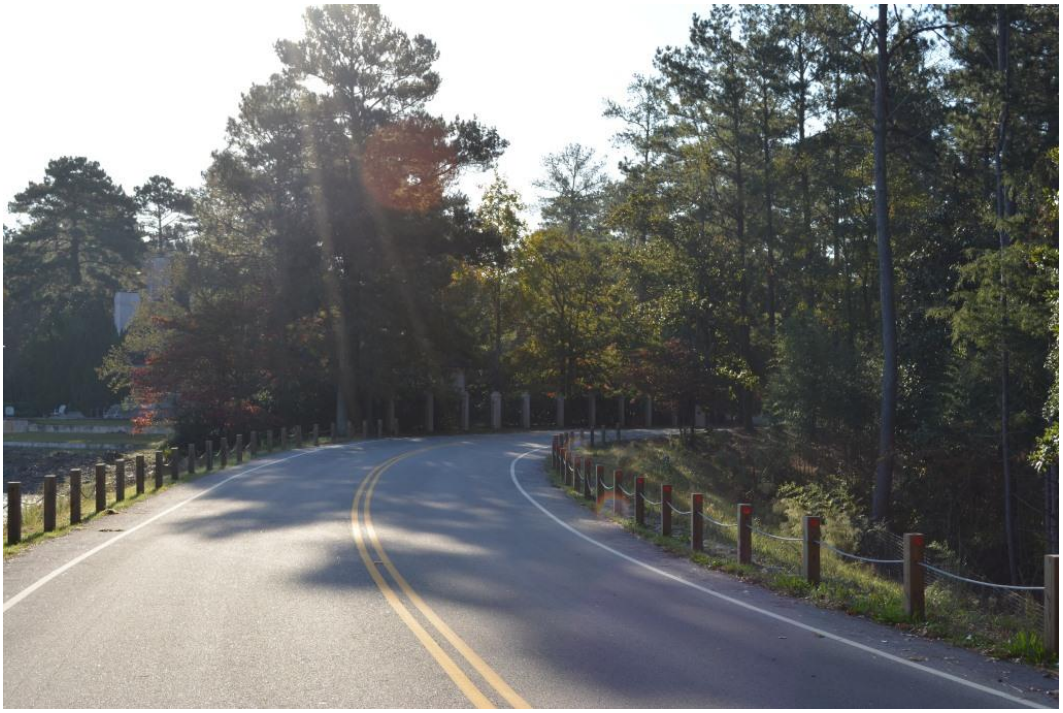


Photo 2: Roadway on embankment crest

Photo 3: Downstream embankment slope

Photo 4: Erosion on downstream slope

Photo 5: Service spillway intake

Photo 6: Tailwater and outlet pipe

Photo 7: Service spillway outlet

.

Attachment C: Sketches Drawings

Project:	Pine Springs Lake Complex 1	Computed:	Date:
Subject:	Dam # 05611 West	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

Date First Visited: 10/16/15

Date Last Visited: 10/21/15

* Highwater = 1.5' below top of riser inlet

* Tailwater is Lower Spring Valley Lake

* All data shown per field observation / measurements / estimate

17 Pine Springs Lake CMPLX 2

Gills Creek Watershed
Site Visit Assessment Report
Pine Springs Lake CMPLX 2

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Pine Springs Lake CMPLX 2 subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Pine Springs Lake CMPLX 2
Class: C1
DHEC Dam No: D 0561
HDR No: 17
Hazard: High
Long_DD: -80.92332349
Lat_DD: 34.10505198

The dam consists of, from left abutment to right abutment (looking downstream):

- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (HDR), Cole Pierce (HDR), John Charlton (HDR)

Site Conditions:

- Weather: clear, sunny, 60 Degrees
- HWEL: approximately 11 feet below embankment crest; 9 feet below top of riser inlet.
- TWEL: approximately 16 feet below embankment crest
- Discharge: Submerged outlet, flow could not be observed; assumed flow is controlled by low-level gate

Overall Status: The embankment dam exhibits potential piping conditions indicative of a potential failure mode in the area of the service spillway outlet pipe. The service spillway intake appeared to be in good operating condition.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Note that water levels shown on the sketch were estimated during a second visit conducted on October 21, 2015.

3.1 Embankment Dam

The embankment has an approximately 25-foot-wide crest, upstream slope that varies from 2.5H:1V to 2.0H:1V, and downstream slope varying from 2.5H:1V to 2H:1V. The embankment crest supports an asphalt road and grass and gravel cover over the shoulders of the road. The dam was not overtopped during the flood event. The downstream slope has heavy tree growth and typical forest vegetation such as ivy, azaleas, and vines. The downstream face generally shows no signs of erosion except for the depression discussed below. Photo 1 presents a view of the upstream slope looking to the right abutment. Photo 2 shows the dam crest and road, and Photo 3 shows the downstream slope and heavy tree cover. The toe of the embankment at the deepest section of the topography could not be observed due to backwater from the lower dam.

The upstream slope is generally in good condition having full grass cover down to the normal pool level. However, the embankment has significant sloughs and cracks below the normal pool level. Longitudinal cracks, apparently caused by slope subsidence, were observed that are up to 4 inches wide and 1 foot deep that extend from the service spillway 20 feet toward the right abutment. Embankment Photos 4 and 5 show the slough in the upstream slope near the service spillway, and an example of longitudinal cracks in the slope, respectively. Embankment material exposed at the sloughs appeared to be sandy soil (Photo 4).

Observations were made that indicate potential seepage through the dam in the area of the service spillway. Movement of water toward the upstream embankment slope in line with the service spillway pipe was observed at the location of the upstream slope failure as shown in Photo 7. Also, depressions in the downstream slope of the embankment were observed located over the service spillway pipe alignment (Photo 8). These observations may indicate potential seepage through the dam along the outlet pipe that may result in piping of embankment material. Wet areas or additional indications of seepage were not observed in open areas;

heavy vegetation made observations difficult in adjacent areas. These limited observations are considered to be indications of a potential failure mode for Pine Springs Lake Complex 2 Dam. Maintaining the lowered reservoir level is a mitigation strategy reducing the potential for piping. An increase in reservoir level could accelerate the piping process and result in failure of the dam if not evaluated and remediated.

3.2 Left Abutment

The left abutment is in natural grade along the road, has grass and tree cover, and shows no to minimal signs of surface erosion.

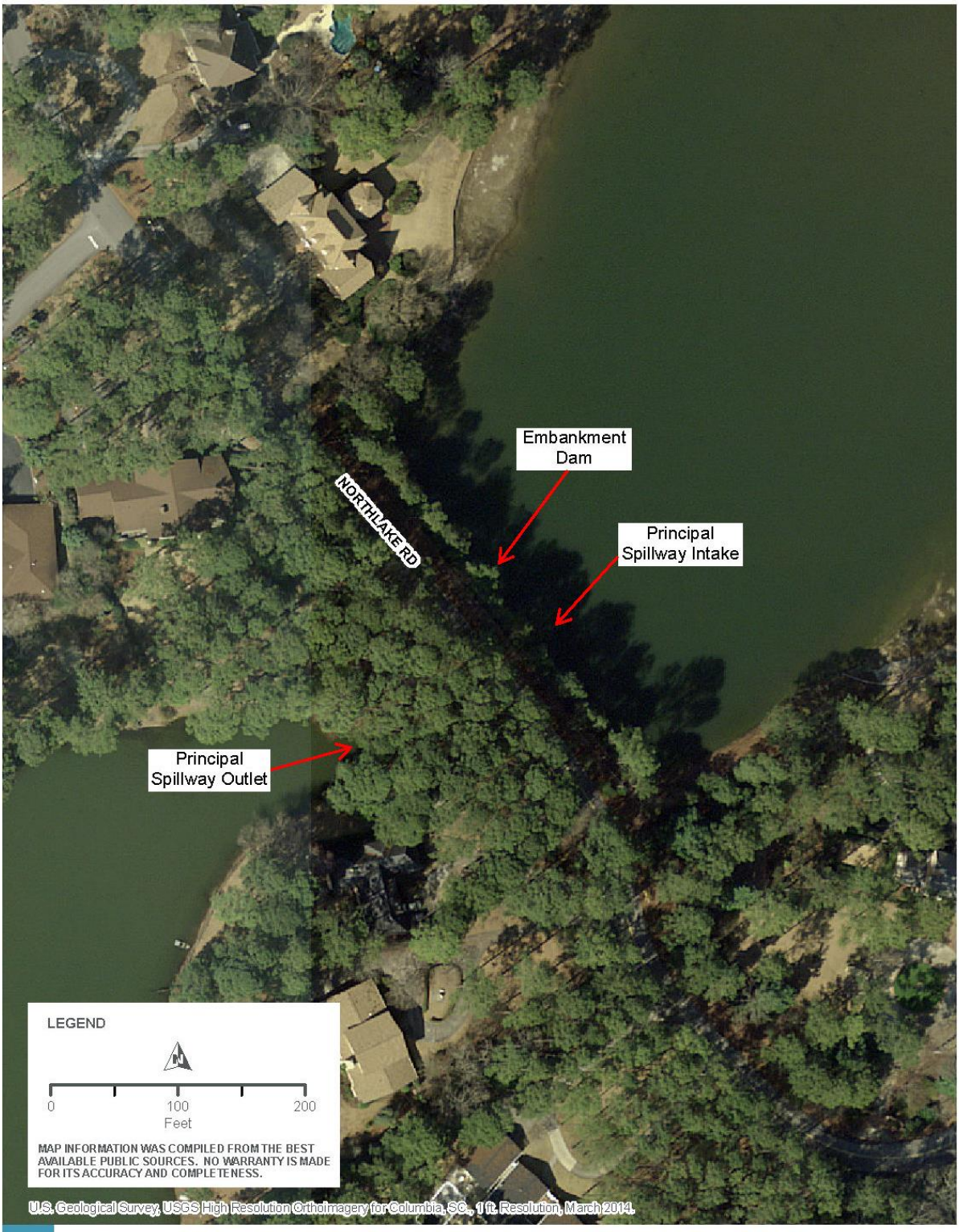
3.3 Right Abutment

The right abutment is in good condition, has grass and tree cover, and shows no signs of surface erosion.

3.4 Service Spillway

The service spillway is a drop-inlet design comprised of a 18-inch CMP vertical riser with a 24-inch CMP trash rack assembly that connects to a low-level pipe that runs laterally through the dam and discharges downstream into the natural channel. A low-level valve operating stem and wheel were observed adjacent and upstream of the riser (Photos 1 and 6). There was minimal debris on the intake trash rack. Photo 6 presents the service spillway intake. The outfall of the spillway could not be located and is presumed to be submerged by Lower Spring Valley Lake.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Upstream slope and service spillway intake

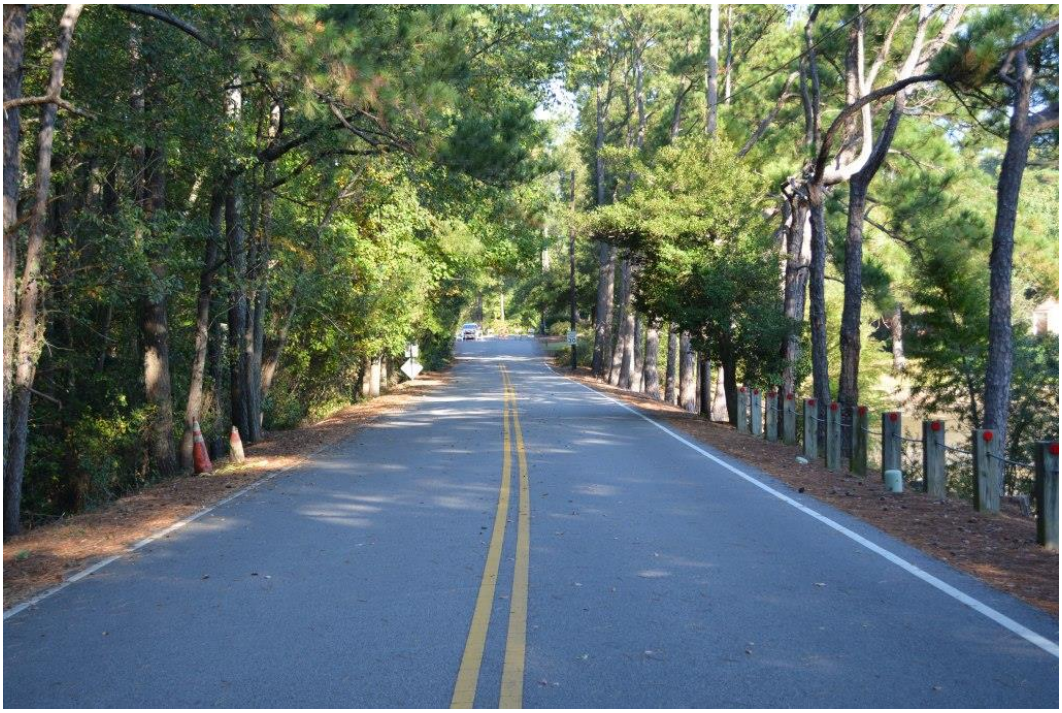


Photo 2: Roadway along embankment crest

Photo 3: Downstream embankment slope

Photo 4: Upstream embankment slope failure

Photo 5: Longitudinal cracks in upstream embankment slope indicated with red lines

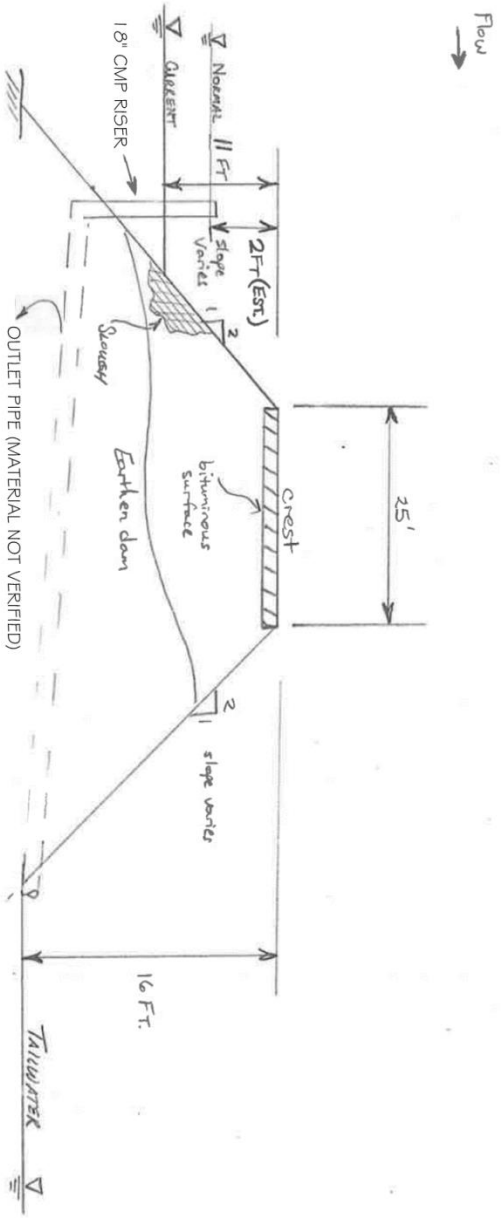
Photo 6: Service spillway intake

Photo 7: Upstream slope failure along service spillway alignment

Photo 8: Depression on downstream slope above spillway alignment

Attachment C: Sketches Drawings

Project:	Pine Springs Lake Complex 2	Computed:	Date:
Subject:	Dam # 0561 East	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



Date First Visited: 10/16/15

Date Last Visited: 10/21/15

* ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

18 Lower Spring Valley Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Lower Spring Valley Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Lower Spring Valley Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority..

1.2 Dam ID

Dam Name: Lower Spring Valley Lake Dam
Class: C2
DHEC Dam No: D 0559
HDR No: 18
Hazard: Significant
Long_DD: -80.9252899
Lat_DD: 34.10310796

The dam consists of:

- Earthen Auxiliary Spillway
- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and J. Ford (SCDHEC)

Site Conditions: The dam impounds Lower Spring Valley Lake and is less than 200 feet from the entrance road.

- Weather: clear, sunny, 65 degrees
- HWEL: approximately 3 feet below embankment crest
- TWEL: approximately 18 feet below crest
- Discharge: through service spillway

Overall Status: Embankment is in generally good condition; no erosion of auxiliary spillway; no evidence of overtopping; service spillway in good condition.

3.0 Observations

Observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The embankment dam has an upstream slope that varies from 2H:1V to 3H:1V that has large pine trees growing on it. The embankment crest has sparse vegetation and a thick covering of pine needles. Photo 1 presents a view of the upstream embankment slope, and Photo 2 shows the crest from the left abutment. The downstream slope is approximately 2H:1V and is heavily vegetated with trees and typical forest undergrowth such as ivy and vines. There is a chain link fence on the crest that prevented walking the downstream slope and toe.

The embankment appeared to generally be in good condition with no observed erosion. There was no indication that the embankment was overtopped during the flood event.

3.2 Left Abutment

The left abutment appears to be on natural grade and in good condition showing no evidence of erosion.

3.3 Right Abutment

The right abutment is on natural grade and also appears to be in good condition and showings no signs of erosion or damage. The auxiliary spillway is located at the right abutment.

3.4 Service Spillway

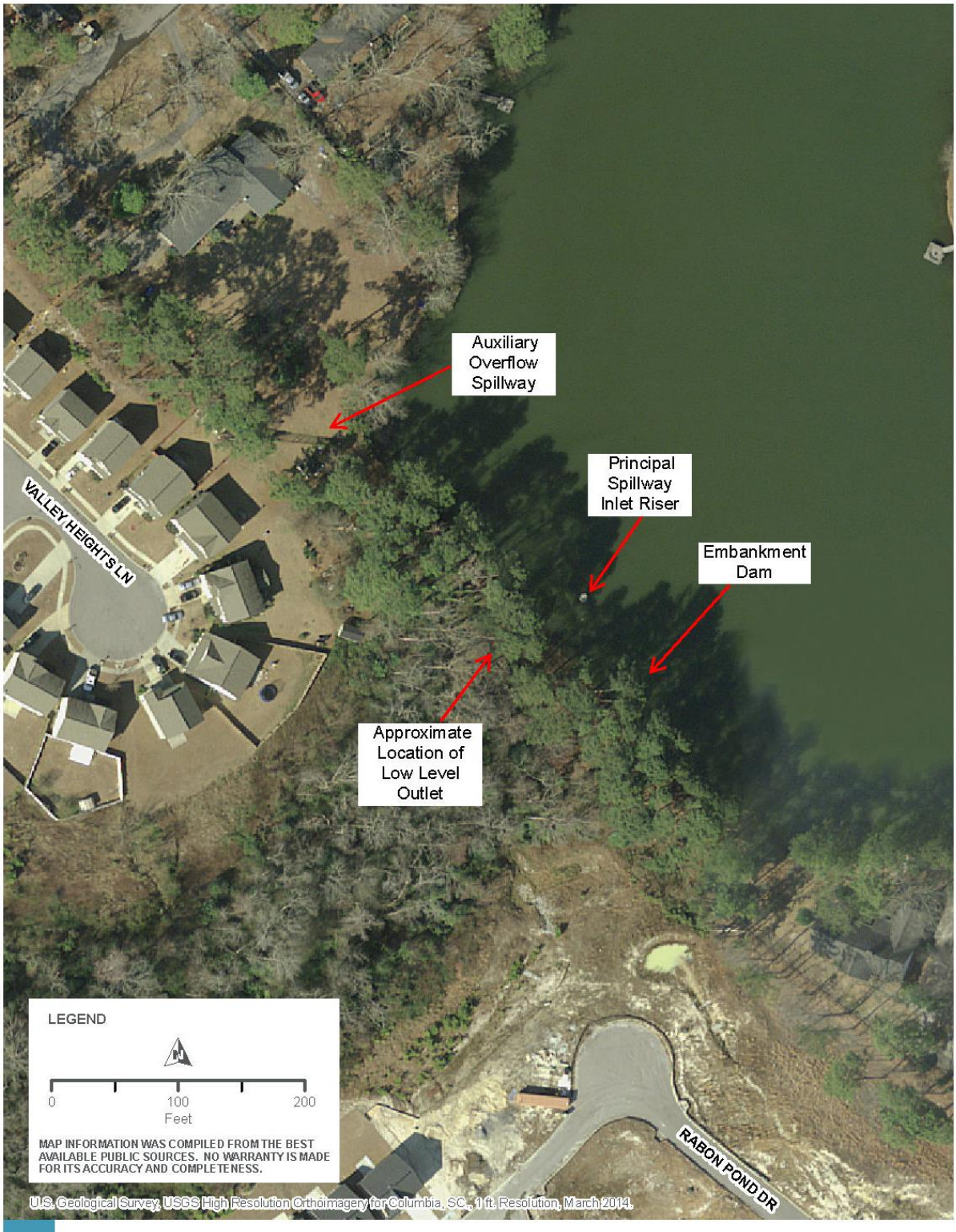
The service spillway is comprised of low-level pipe with drop-inlet intake approximately 70 feet upstream of the dam with a 48-inch-diameter corrugated-metal cover and trash screen. There was only minor debris on the drop inlet trash screen. Photo 3 presents the service spillway inlet. The outlet size could not be assessed due to the inability to walk the downstream slope.

Photo 4 shows a view of the outlet from upstream of the chain link fence. Although not visible, water spilling from the outlet and into the plunge pool was audible.

3.5 Auxiliary Spillway

The auxiliary spillway is an earthen grass-lined uncontrolled overflow channel that is approximately 1.5 to 2 feet lower in elevation than the crest (Photo 5). The auxiliary spillway is located in a residence's back yard. The auxiliary spillway did not show any evidence of overflow such as vegetation bent in the downstream direction or debris in the spillway and is in good condition.

Attachment A: Aerial Photo



SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

GILLS CREEK WATERSHED DAM INSPECTIONS

(18) LOWER SPRING VALLEY LAKE DAM D0559

PATH: X:\MAP_DOCS\FINAL\SCDHEC_GILLS_CREEK_SITE_INSPECTION_20151026_DAM.MXD – USER: DSOUCIE – DATE: 10/26/2015

OCTOBER 2015

Attachment B: Inspection Photos

Photo 1: Lower Spring Valley Lake viewed from left abutment; the upstream embankment slope is in the foreground

Photo 2: Embankment dam crest viewed from the left abutment

Photo 3: Service spillway intake

Photo 4: Service spillway outlet pipe

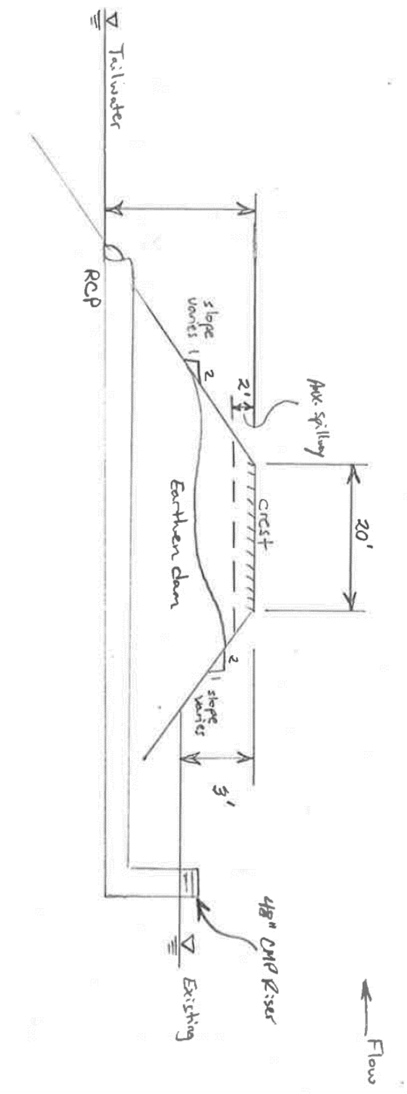
Photo 5: Auxiliary spillway at right abutment

Photo 6: Auxiliary spillway looking upstream

Attachment C: Sketches Drawings

HDR

Project: Lower Spring Valley Lake	Computed:	Date:
Subject: Dam # 0559	Checked:	Date:
Task:	Page:	of:
Job #:	No:	



Date first visited : 10/16/15

Date last visited : 10/21/15

* Auxiliary Spillway through backyard of property and approximately 2' below crest (Length ≈ 40')
* High water mark 1' below top of riser inlet
* Normal is about 1' above existing
* Outfall blocked by fence - COULD NOT ACCESS FOR PIPE ; TAILWATER
* ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENT / ESTIMATE

19 Springwood Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Springwood Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Springwood Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing facilities for comparison to data on file, and of damaged areas/indications of distress.
- Understanding of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will allow them to make informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Springwood Lake Dam
Class: C1
DHEC Dam No: D 0558
HDR No: 19
Hazard: High
Long_DD: -80.95261902
Lat_DD: 34.07468631

The dam consists of:

- Service Spillway with drop inlet and low-level outlet pipe
- Low-Level Outlet with Concrete Drop Inlet Structure (Auxiliary Spillway No. 1)
- Concrete Overflow Spillway (Auxiliary Spillway No. 2)
- Embankment Dam

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (SCDHEC), Cole Pierce (HDR), and John Charlton (HDR)

Site Conditions:

- Weather: clear, sunny, mild temperature
- HWEL: approximately 4 feet below embankment crest; one foot above normal pond
- TWEL: approximately 18 feet below embankment crest of dam at service spillway outlet
- Discharge: through concrete overflow auxiliary spillway No. 2 and service spillway.

Overall Status: The embankment is in generally good to fair condition but with some significant erosion of limited portions of the downstream slope; concrete overflow auxiliary spillway no. 1 is in good condition; auxiliary spillway no. 2 in good condition but the trash screen has collapsed; service spillway appears to be in good condition.

3.0 Observations

Observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Water levels shown on the sketch in Attachment C may vary from that noted in Section 2.1. Site Visit Details since Section 2.1 includes water levels on the day of the site inspection, and the sketch in Attachment C includes water levels noted during site visits after the initial site inspection.

3.1 Embankment Dam

The earth embankment dam has an approximately 30-foot-wide crest. The embankment slopes vary, with upstream slope generally at 2.5H:1V to 2H:1V, and downstream slope generally 2.5H:1V to 2H:1V. The dam was overtopped during the flood event by approximately one foot based on the high water mark of debris on trees immediately downstream of the crest. The upstream slope is generally in good condition having full grass cover. A chain link fence was pushed down during overtopping. The embankment crest has an asphalt road, with grass and gravel cover along the shoulders of the road. The crest shows minimal signs of erosion at the edge of the road pavement in some locations. Photo 1 presents a view of the upstream slope and crest from the left abutment. The downstream slope has significant tree growth and forest undergrowth such as vines, ivy, and weeds. The downstream slope is significantly eroded in limited areas but is in overall fair condition. Photo 2 shows the downstream portion of the crest and tree growth on the downstream slope. Photos 3 and 4 show the limited areas of significant erosion and sloughs on the downstream slope.

3.2 Left Abutment

The left abutment is in good condition, has grass cover, and shows no to minimal signs of erosion.

3.3 Right Abutment

The right abutment is in good condition, is apparently on natural grade, has grass cover, and shows no to minimal signs of erosion.

3.4 Service Spillway

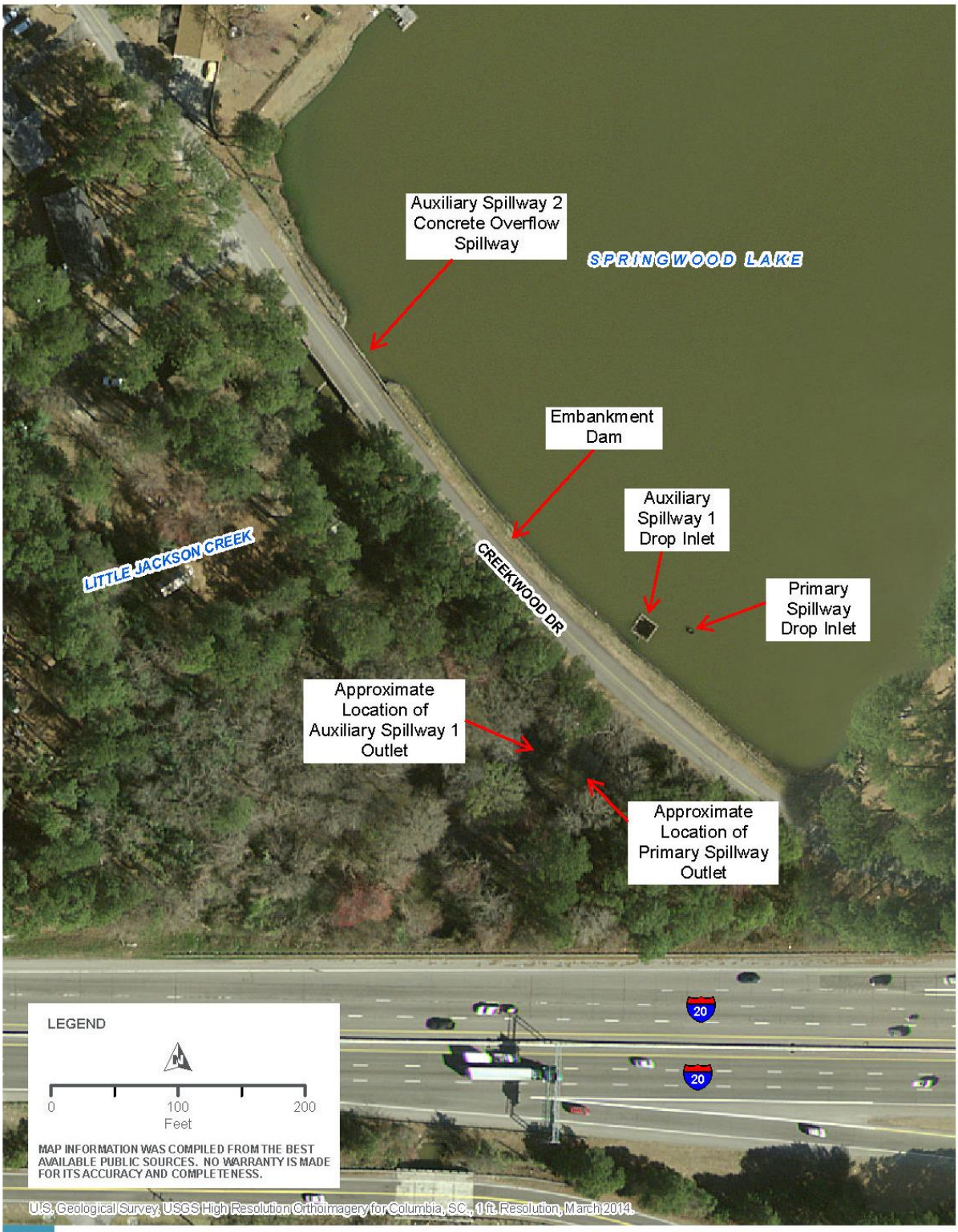
The service spillway consists of a low-level pipe with a drop-inlet intake located approximately 60 feet upstream of the embankment to the left center of the dam (Photo 5). The upper portion of the drop inlet that was visible above the pond level is an estimated 48-inch-diameter corrugated-steel-pipe that was displaced at an angle from vertical, presumably by the flood water. This portion of the inlet is assumed to be a cover equipped with a trash screen for a vertical riser pipe that would connect to a low level outlet pipe. Water flowing into the spillway inlet was audible. The exact dimension of the outlet pipe could not be measured because the pipe was submerged by approximately one foot of water (Photo 6).

3.5 Auxiliary Spillway

Auxiliary spillway No. 1 is an uncontrolled, vertical concrete drop intake structure approximately 10-foot square (Photo 8) that appeared to be in good condition. There was no debris accumulation on at the intake, but the rebar trash screen had been bent and pushed down into the intake. Reservoir level was approximately 4 inches below the intake elevation at the time of the inspection. The discharge pipe for the spillway is a corrugated-metal pipe with a diameter of approximately 7 feet that appeared to be in good condition. This pipe discharges downstream of the toe of the embankment dam approximately 50 feet to the right of the service spillway discharge pipe. No seepage was observed along the toe of the dam in the area of the principal and auxiliary discharge pipes.

There are two auxiliary spillways. Auxiliary spillway No. 2 is an uncontrolled concrete overflow spillway located near the right abutment of the dam. The spillway is approximately 55 feet wide. The spillway appeared in good condition with only minor erosion at the upstream portion of the right wall. Significant erosion and scour at the downstream extent of the spillway and plunge pool was observed. Photo 7 presents a view of this eroded area. The toe of the spillway could not be directly observed to check for erosion or undermining due to water flowing out of the spillway into the plunge pool.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Springwood Lake Dam crest and upstream slope viewed from left abutment

Photo 2: Embankment crest and downstream slope

Photo 3: Downstream embankment slope erosion

Photo 4: Slough and debris on downstream slope

Photo 5: Service spillway intake

Photo 6: Service spillway outlet shown under water

Photo 7: Erosion at plunge pool of auxiliary spillway no. 2

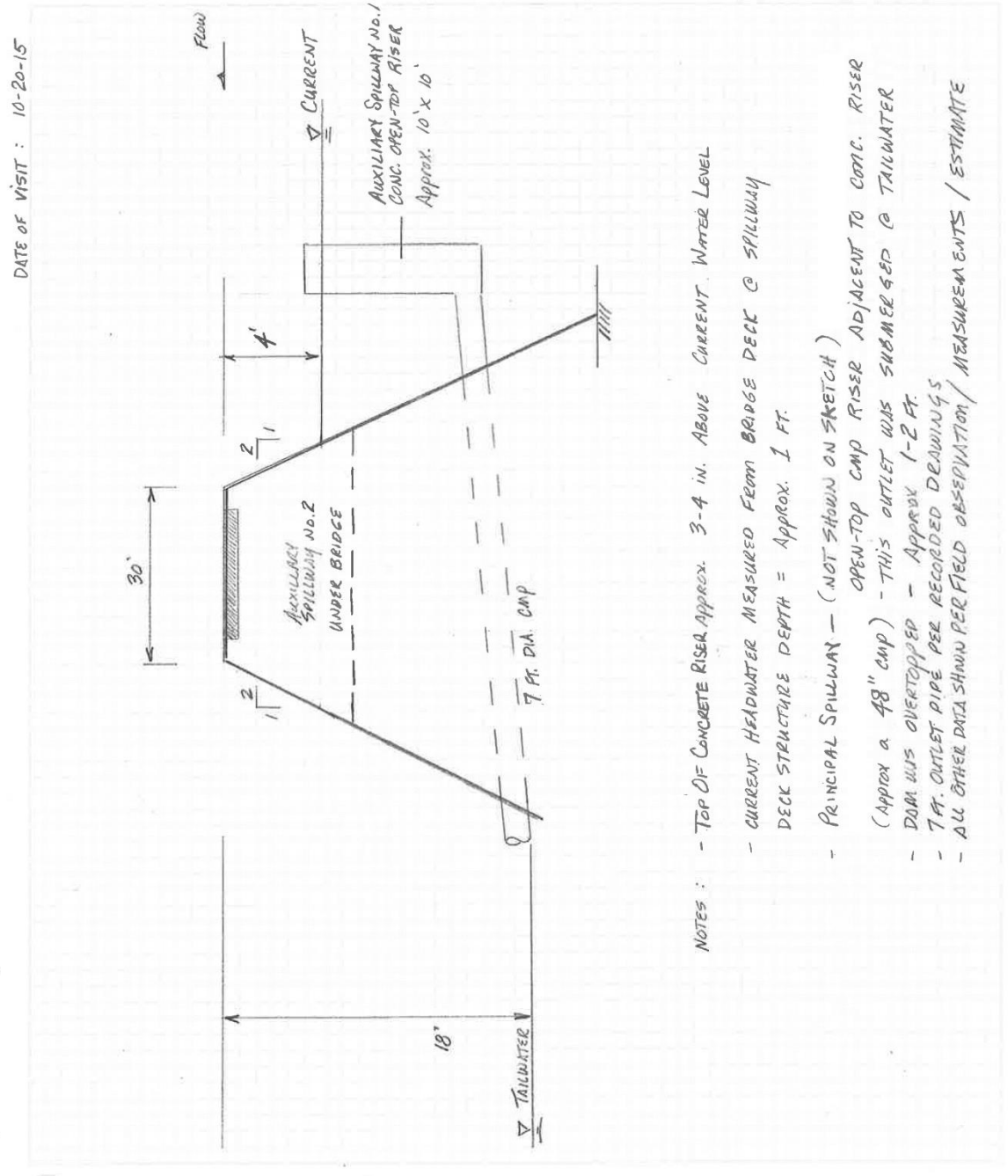
Photo 8: Auxiliary spillway no. 1 intake structure

Photo 9: Auxiliary spillway no. 1 pipe (no debris)

.

Attachment C: Sketches Drawings

Project:	Springwood Lake	Computed: BWL	Date: 10-21-15
Subject:	Dam # D0558	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



20 Hughes Pond Dam

Gills Creek Watershed
Site Visit Assessment Report
Hughes Pond Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Hughes Pond Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Hughes Pond Dam
Class: C1
DHEC Dam No: D 0573
HDR No: 20
Hazard: High
Long_DD: -80.86670061
Lat_DD: 34.09486126

The dam consists of, from left abutment to right abutment (looking downstream):

- Earthen Auxiliary Overflow Spillway
- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (SCDHEC), Cole Pierce (HDR), and John Charlton (HDR)

Site Conditions:

- Weather: clear, sunny, with mild temperature
- HWEL: 4.5 feet below embankment crest, approximately at normal pool
- TWEL: approximately 26 feet below crest of dam at outfall
- Discharge: through service spillway

Overall Status: The embankment is in generally good condition; there are several areas of moderate erosion and an area of seepage at downstream end; the service spillway is in good condition. The auxiliary overflow spillway is in good condition.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively.

3.1 Embankment Dam

The embankment has an approximately 20-foot-wide crest, an upstream slope that varies from 3H:1V to 2H:1V, and a downstream slope of 2.5H:1V to 3H:1V. The upstream slope is in good condition having full grass cover with the growth of large bushes at the waterline. The crest has grass cover over 80 percent and shows no signs of settlement or erosion. Photo 1 presents a view of the upstream slope and crest from the right abutment. The downstream slope is in fair condition, but has sparse vegetative cover and areas of significant erosion. Photos 2 and 3 show the condition of the downstream slope and examples of erosion. Based on conditions such as absence of debris or vegetation pushed in a downstream direction, it is apparent that the dam did not experience overtopping during the flood event.

Wet areas were observed along the toe of the embankment dam between approximately 200 feet left of the right abutment to 500 feet left of the right abutment. The seepage was minimal, with no notable flow. Several pine trees are located at the toe of the dam.

3.2 Left Abutment

The left abutment is on native grade, in good condition, has grass cover, and shows no to minimal signs of erosion.

3.3 Right Abutment

The right abutment is in good condition, on native grade, has grass cover, and shows no to minimal signs of erosion. The right abutment also serves as the auxiliary overflow spillway.

3.4 Service Spillway

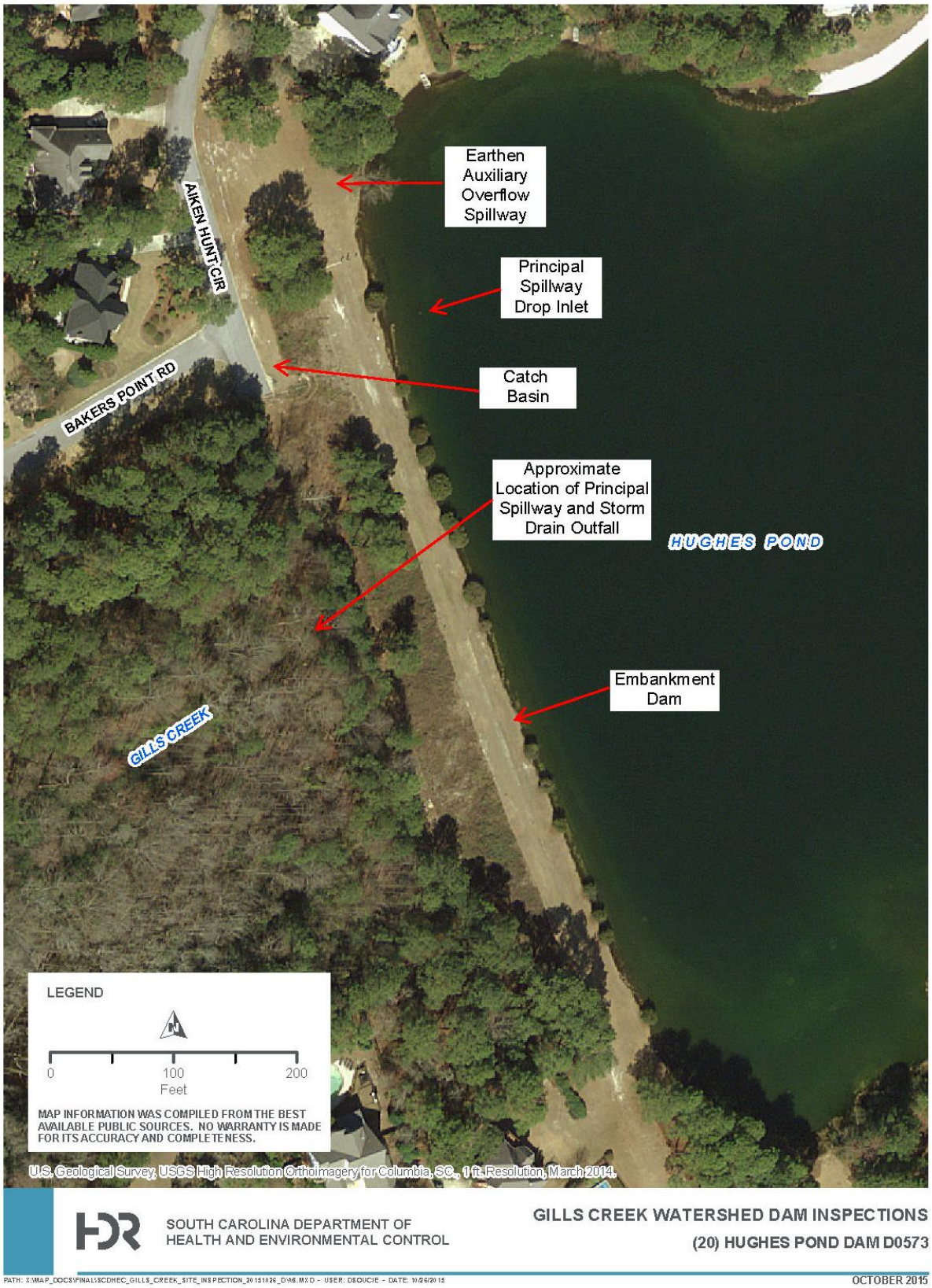
The service spillway is comprised of a drop inlet located approximately 20 feet upstream of the dam. The inlet was observed to be corrugated-steel pipe (approximate 36 inch diameter) with a trash screen cover (Photo 4). Moderate debris including pine needles and twigs were observed on the trash screen. A concrete pipe extends from the spillway inlet to a storm drain catch basin located downstream at the groin of the dam and right abutment. A concrete drain pipe extends

from the catch basin along the toe of the dam to another catch basin (Type 9) located approximately 400 feet left of the right abutment. A 24-inch CMP drain pipe extends approximately 100 feet downstream from the Type 9 catch basin to the outfall discharge to the receiving drainage-way (Photo 7). A hole approximately 2.5 feet deep was observed adjacent to the catch basin, just downstream from a wet area observed at the toe of the dam (Photo 5). This void appears to have developed from loss of soil material associated with potential leakage from the pipe near the connection with the catch basin and/or seepage through the embankment. A depression/void was also observed above the approximate alignment of the drain pipe approximately 50 feet right of the Type 9 catch basin toward the right abutment (Photo 6).

3.5 Auxiliary Spillway

The auxiliary spillway is located on the right abutment of the dam. The spillway is approximately 50 feet wide and is a grass-lined earthen overflow spillway with a 1.5-foot-high training berm on the left of the spillway. Photo 8 shows the auxiliary spillway from downstream of the spillway crest looking upstream into the reservoir. The spillway did not show evidence of flow.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Embankment crest viewed from right abutment

Photo 2: Downstream slope of embankment

Photo 3: Downstream slope of embankment

Photo 4: Service spillway intake and control

Photo 5: Hole adjacent to catch basin at toe of embankment

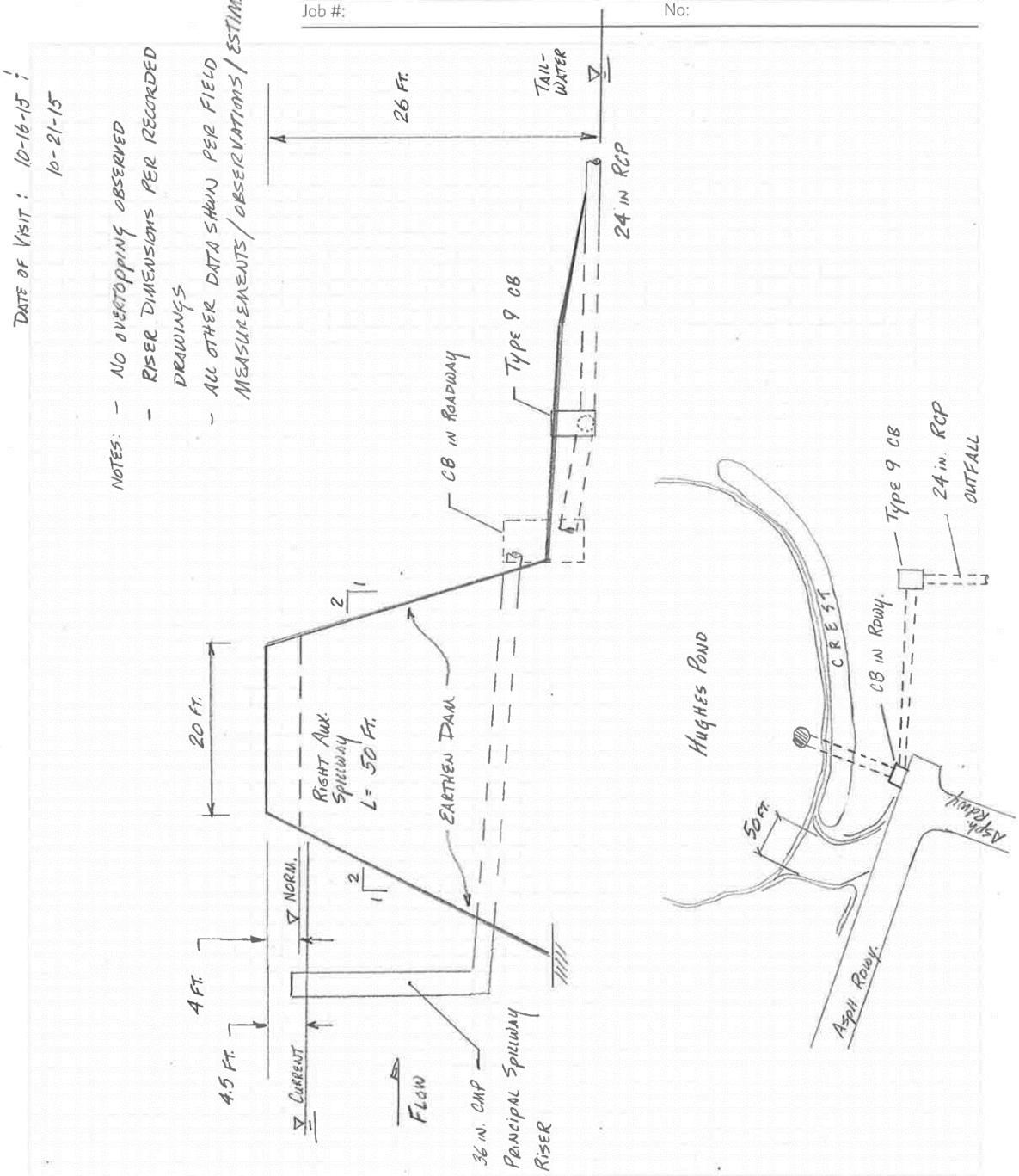
Photo 6: Depression at embankment toe along alignment of the service spillway outlet pipe

Photo 7: Service spillway outfall

Photo 8: View of auxiliary spillway looking upstream

Attachment C: Sketches Drawings

Project:	Hughes Pond	Computed: BWL	Date: 10-22-15
Subject:	DAM # D0573	Checked:	Date:
Task:		Page:	of:
Job #:		No:	



21 Deer Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Deer Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Deer Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Deer Lake Dam
Class: C2
DHEC Dam No: D 0137
HDR No: 21
Hazard: Significant
Long_DD: -80.87406593
Lat_DD: 34.08359988

The dam consists of, from left abutment to right abutment (looking downstream):

- Embankment Dam
- Service Spillway with drop inlet and low-level outlet pipe
- Earthen Auxiliary Spillway

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: John Charlton (HDR), Cole Pierce (HDR), and Jamie Ford (SCDHEC)

Site Conditions:

- Weather: sunny, 70 Degrees
- HWEL: 3 feet below crest, approximately 0.5 foot above normal pool
- TWEL: approximately 14 feet below crest of dam at outfall
- Discharge: through service spillway

Overall Status: The earthen embankment is in generally fair to good condition with several areas of significant erosion due to overtopping. The service spillway is in good condition and fully functional. The earthen auxiliary spillway is in good condition with no impairment of spillway capacity.

3.0 Observations

Visual observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Note that water levels shown on the sketch were estimated during a second visit conducted on October 21, 2015.

3.1 Embankment Dam

The embankment has an approximately 10-foot-wide crest, upstream slope that varies from 3H:1V to 2H:1V (Photo 1); and downstream slope of 2.5H:1V to 2H:1V. The crest of the dam is not level as indicated by visual evidence that some areas of the crest were overtopped during the flood event by approximately 3 to 4 inches, including the area at the service spillway. The upstream slope appears to be in good condition having moderate grass cover. The crest has grass cover over approximately 60 percent of the surface. Photo 1 presents a view of the upstream slope and crest from the left abutment. The downstream slope has significant tree growth as well as forest undergrowth including vines, ivy, and weeds. The downstream face is generally in good condition; however, a scoured area was observed near the service spillway where the dam experienced overtopping. Photo 2 shows the downstream portion of the crest and tree growth on the downstream slope. Photos 3 and 4 show the limited areas of significant erosion on the downstream slope, and debris accumulation from overtopping.

3.2 Left Abutment

The left abutment is in good condition, has grass cover, and shows no to minimal signs of surface erosion.

3.3 Right Abutment

The right abutment is in good condition, has grass cover, and shows no to minimal signs of surface erosion.

3.4 Service Spillway

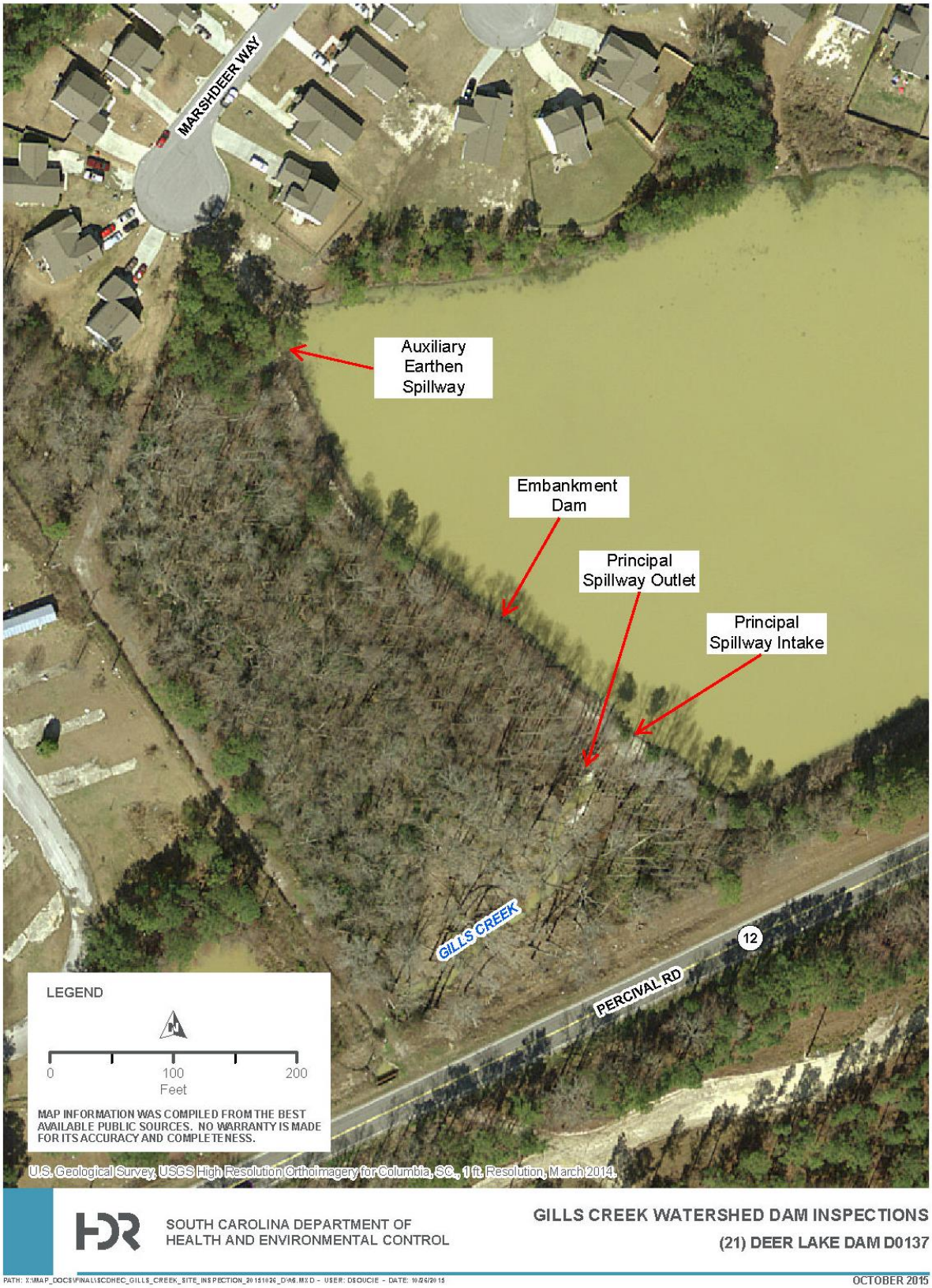
The service spillway is comprised of an inlet located at the upstream slope of the embankment dam that connects to a low-level, 24-inch RCP pipe that extends through the dam. The inlet is a standard storm-drain inlet with a manhole cover that is active and assumed to be the primary inlet for the service spillway (Photo 5). Flow into the intake was visible and accumulation of leaves and wood debris at the intake was observed.

A second concrete box-inlet structure with an open, upstream-face, inlet structure was observed approximately 60 feet upstream of the dam (Photo 6). There was no flow into this inlet, and operational condition of this intake is unknown; it may be an active secondary inlet to the service spillway or an abandoned intake. Photo 7 shows discharge from the low-level outlet pipe.

3.5 Auxiliary Spillway

The auxiliary spillway is located at the right abutment. The spillway is an earthen, rock-lined, 20-foot-wide, overflow spillway that is approximately 2.5 to 3.0 feet below the crest of the dam. The auxiliary spillway channel is free of debris, except for debris from a wooden bridge deposited approximately 70 feet downstream; this debris would not result in impairment of spillway capacity.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Deer Lake embankment dam crest and upstream slope

Photo 2: Vegetation along downstream embankment slope

Photo 3: Debris accumulation on downstream embankment slope due to overtopping

Photo 4: Scour on downstream embankment slope

Photo 5: Service spillway intake

Photo 6: Intake structure (possibly abandoned)

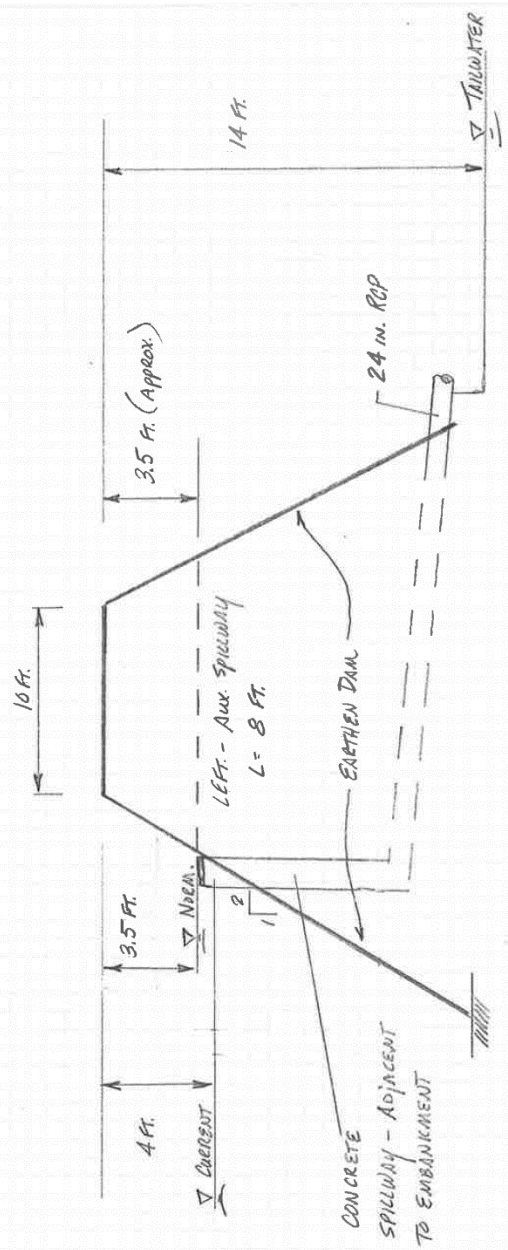
Photo 7: Service spillway outfall

Photo 8: Auxiliary spillway view looking downstream

Attachment C: Sketches Drawings

Project:	DEERLAKE DAM	Computed: BWL	Date: 10-22-15
Subject:	DAM # D0137	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

DATE OF VISIT: 10-16-15 & 10-21-15



NOTES: - ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

22 Commons Pond Dam

Gills Creek Watershed
Site Visit Assessment Report
Commons Pond Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Commons Pond Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Commons Pond Dam
Class: C3
DHEC Dam No: D 4201
HDR No: 22
Hazard: Low
Long_DD: -80.966667
Lat_DD: 34.055

The dam consists of, from left abutment to right abutment (looking downstream):

- Embankment Dam
- Service Spillway with concrete intake structure and low-level outlet pipe
- Earthen Auxiliary Spillway

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (SCDHEC), Cole Pierce (HDR), and John Charlton (HDR)

Site Conditions:

- Weather: sunny, 70 Degrees
- HWEL: 4.4 feet below crest, approximately 0.5 foot below normal pool
- TWEL: approximately 20 feet below crest of dam below outfall
- Discharge: through service spillway

Overall Status: The embankment is in generally good to fair condition; generally minor surficial erosion with several areas of moderate slumping on upstream face; minor seepage at outlet headwall, and depressed area on downstream face above headwall; service spillway in good condition; auxiliary earthen spillway in good condition; no impairment of spillway capacity.

3.0 Observations

Observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Note that water levels shown on the sketch were estimated during a second visit conducted on October 21, 2015.

3.1 Embankment Dam

The embankment has an approximately 8-to-10-foot-wide crest, upstream slope that varies between 1H:1V to 1.5H:1V and downstream slope of approximately 2.5H:1V to 3H:1V. The dam was not overtopped during the flood event; based on the accumulated debris the flood level reached within 6 inches of the crest of the dam (Photo 2). Photos 1 and 2 present views of the upstream slope and crest looking toward the left abutment showing grass cover on the crest and heavier vegetation on the upstream slope. The crest generally appeared to be in good condition with no surface erosion or signs of settlement. During the site inspection two beavers were observed swimming in and near the vegetated slope; which indicate wildlife activity and potential for animal burrows; but presence of burrows could not be observed due to the vegetation. A slough was observed on the upstream slope approximately 100 feet to the right of the left abutment (Photo 3). The downstream slope of the embankment has heavy vegetation and tree growth (Photo 4).

3.2 Left Abutment

The left abutment is in good condition on what appears natural grade in a residence back yard, has grass cover, and shows minimal signs of surficial erosion.

3.3 Right Abutment

The right abutment is in good condition, is adjacent to road grade, has grass cover, and shows no signs of surficial erosion.

3.4 Service Spillway

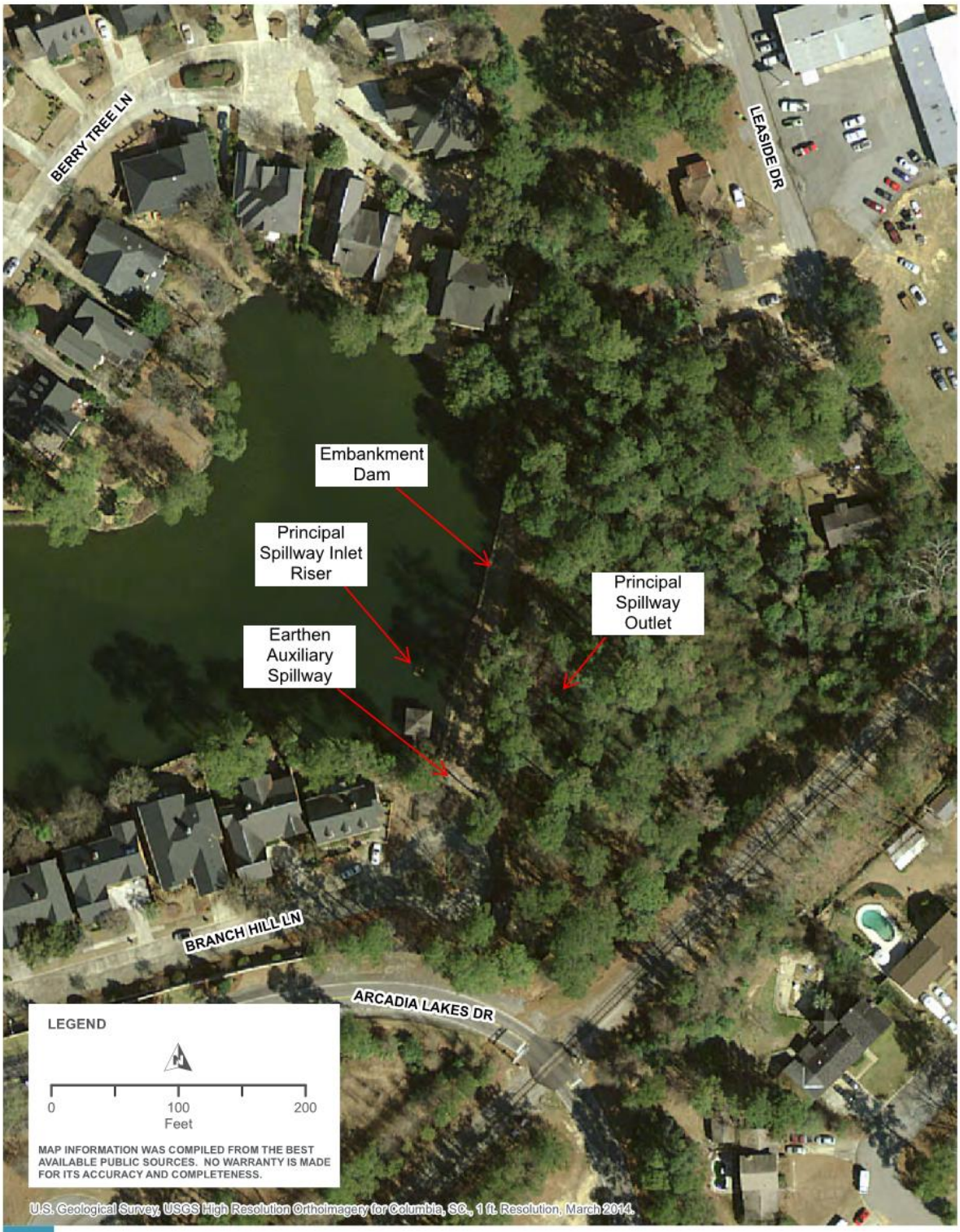
The service spillway is comprised of a concrete intake located approximately 40 feet upstream of the dam. The intake is a concrete box structure equipped with a trash screen (Photo 5). Significant pine straw debris was observed on top of the trash screen. The low-level outlet of

the service spillway is 18-inch HDPE pipe with more than 1-inch thickness. The area above the headwall of the spillway outfall and to the right of the headwall was wet indicating seepage (Photo 6). Seepage was minor and did not show evidence of sediment transport. A 4-by-4-foot depression was observed on the downstream slope, directly above and in line with the service spillway outlet pipe alignment (Photo 7). Loss of soil material resulting in this depression may be associated with piping along the service spillway pipe.

3.5 Auxiliary Spillway

The auxiliary spillway is located at the right abutment. The spillway is an earthen-bottom spillway with rock-lined slopes and is approximately 10 to 12 feet wide. The auxiliary spillway did not exhibit signs of surficial erosion and is free of debris.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Crest and upstream slope of embankment

Photo 2: Upstream embankment slope and debris indicating peak flood level

Photo 3: Slough on upstream face

Photo 4: Downstream embankment slope

Photo 5: Service spillway intake

Photo 6: Service spillway outlet pipe and seepage

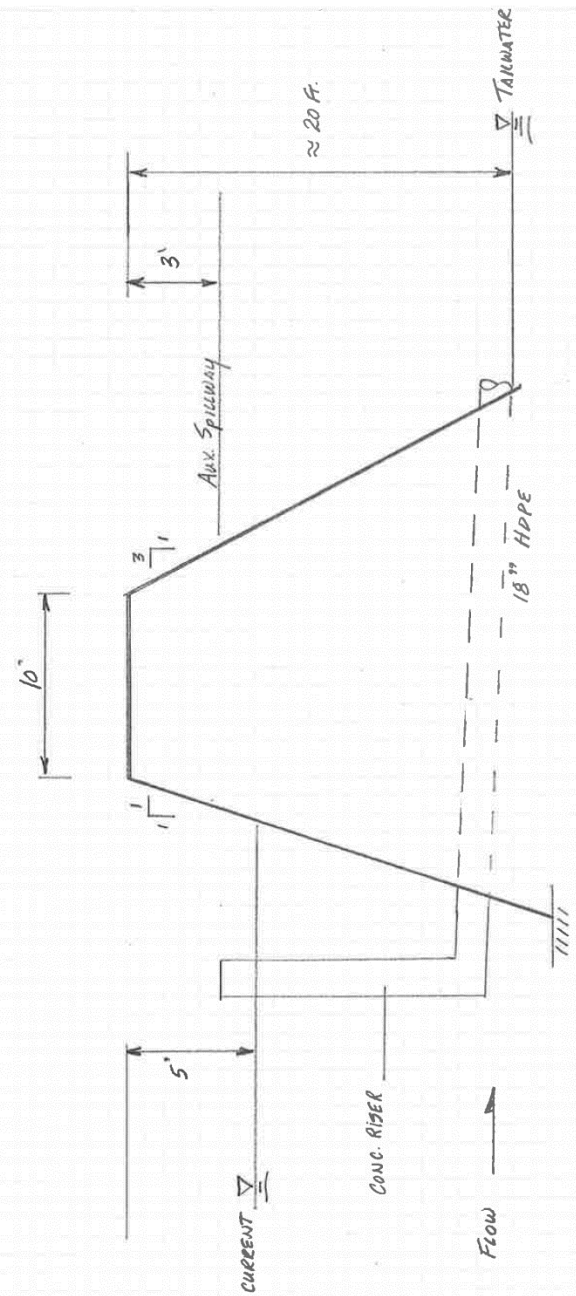
Photo 7: Depression on downstream face above principal outlet pipe

Photo 8: Commons Pond auxiliary spillway viewed from right abutment

Attachment C: Sketches Drawings

Project:	Commons Pond	Computed: BWL	Date: 10-21-15
Subject:	DAM # D4201	Checked:	Date:
Task:		Page:	of:
Job #:		No:	

DATE OF VISIT : 10-20-15



NOTES :-
- NORMAL WATER LEVEL OBSERVED TO BE ABOUT 6 IN. ABOVE CURRENT LEVEL
- AUX. SPILLWAY L = 12 FT.
- HIGH WATER MARK UP TO CREST, BUT NO OVERTOPPING
- ALL DATA SHOWN PER FIELD OBSERVATION / MEASUREMENTS / ESTIMATE

23 Arcadia Woods Lake Dam

Gills Creek Watershed
Site Visit Assessment Report
Arcadia Woods Lake Dam

1.0 Introduction

1.1 Purpose

The purpose of the site visit was to assess the overall condition of Arcadia Woods Lake Dam subsequent to the recent flood event of October 2–5, 2015. The site visit objectives included:

- Documentation of the general current condition of principal water retaining structures, spillways, and adjacent areas, including current headpond and tailwater levels.
- Identification/observations of damage and indications of distress of principal water retaining structures, and impairment of site discharge capacity.
- Estimates/measurements of existing dams and appurtenances for comparison to data on file, and of damaged areas/indications of distress.
- Estimate of extent of overtopping that occurred, and measures that have been taken to repair damage and reduce risk for overtopping/failure in the event of a future significant rain event.

This information is intended to provide the DHEC with initial information that will facilitate informed decisions regarding implementation of orders/actions under their authority.

1.2 Dam ID

Dam Name: Arcadia Woods Lake Dam
Class: C1
DHEC Dam No: D 0557
HDR No: 23
Hazard: High
Long_DD: -80.96301563
Lat_DD: 34.05384377

The dam consists of, from left abutment to right abutment (looking downstream):

- Embankment Dam
- Service Spillway with concrete intake structure and low-level outlet pipe

See Attachment A – Aerial Photo

2.0 Site Visit

2.1 Site Visit Details

Date: October 16, 2015

Team: Jamie Ford (SCDHEC), Peter Milenkov (SCDHEC), Cole Pierce (HDR), and John Charlton (HDR)

Site Conditions:

- Weather: clear, sunny, mild temperature
- HWEL: approximately 12 feet below embankment crest, approximately 10 feet below normal pool
- TWEL: approximately 22 feet below crest of dam below outfall
- Discharge: through service spillway

Overall Status: Embankment is in generally poor condition due to significant slope failure on the downstream slope. The service spillway is in good condition and is operational.

3.0 Observations

Observations made during the site visit are summarized below by each dam structure and spillway. Photos and sketches of existing conditions are provided in Attachments B and C, respectively. Note that water levels shown on the sketch were estimated during a second visit conducted on October 21, 2015.

3.1 Embankment Dam

The embankment has an approximately 30-foot-wide crest, upstream slope of 2.5H:1V to 2H:1V and downstream slope of 2.5H:1V to 2H:1V. The upstream and downstream slopes have significant tree and vegetative cover. The crest has an asphalt road and narrow shoulder with guard rails installed. Photo 1 presents a view of the upstream slope and crest looking toward the left abutment. Photo 2 presents a view of the crest looking toward the right abutment. Photo 3 shows the downstream slope of the embankment.

A significant slope failure was observed on the downstream slope that is approximately 25 feet in width, extends 12 feet upstream into the dam, and has a maximum depth of 11 feet (Photos 4 and 5). SCDHEC personnel informed HDR that this area has had recurring problems and that SCDOT has made repairs to the subgrade and pavement. Based on discussion with a property owner that lives downstream, the dam was not overtopped during the flood event. However, it is possible that the embankment experienced overtopping based on the high water level indicted by the position of leaf and pine needle debris on the fence where the downstream slope failure occurred (Photo 5).

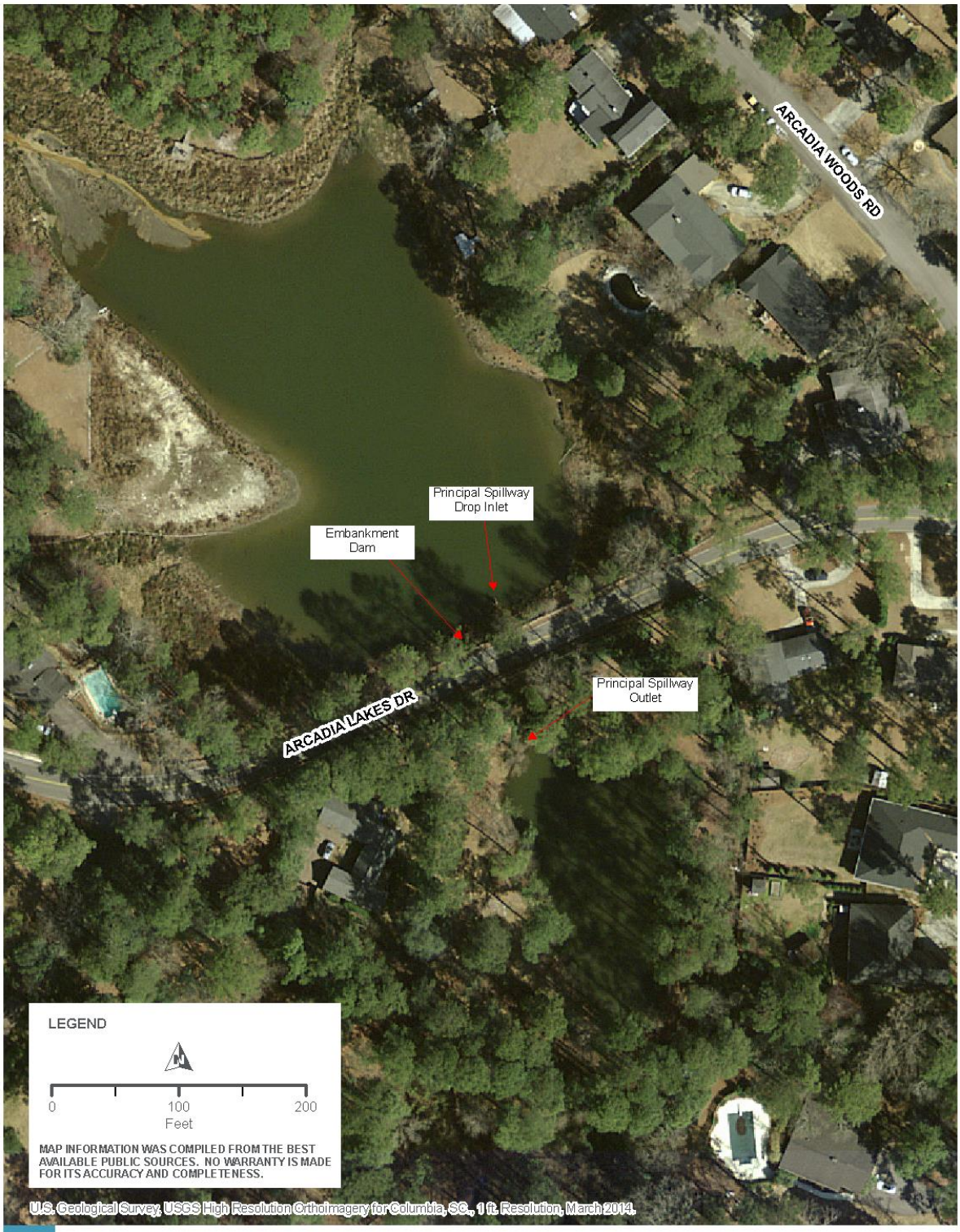
3.2 Abutments

The abutments appear to be in good condition and show no to minimal signs of surficial erosion. The road pavement, shoulders, and slopes do not exhibit any significant erosion or signs of distress such as slope failure.

3.3 Service Spillway

The service spillway is comprised of a concrete drop inlet located approximately 40 feet upstream of the dam that connects to a 24-inch RCP low-level discharge pipe. No trash screen could be observed. SCDHEC staff informed HDR that boards on the upstream side of the intake regulate lake level. The boards had been removed per a SCDHEC order prior to the storm event to lower lake level as a precaution due to deficiencies in the service spillway capacity. Water flow into the service spillway inlet was audible, and Photo 6 shows the service spillway inlet. Photo 7 shows the service spillway low-level outlet area. Photo 8 shows a view of the reservoir.

Attachment A: Aerial Photo



Attachment B: Inspection Photos

Photo 1: Upstream embankment dam slope

Photo 2: View of roadway on embankment crest from left abutment

Photo 3: View of embankment downstream slope from crest

Photo 4: Slope failure on downstream slope of embankment

Photo 5: View of failed slope looking downstream

Photo 6: Service spillway drop inlet

Photo 7: Service spillway outlet

Photo 8: Reservoir

Attachment C: Sketches Drawings