

**ACOUSTICAL TESTING REPORT  
FOR THE  
SALUDA RIVER WARNING SYSTEM  
COLUMBIA, SOUTH CAROLINA  
S&ME PROJECT NO. 1614-04-198**

Prepared For:

**SOUTH CAROLINA ELECTRIC & GAS COMPANY  
COLUMBIA, SOUTH CAROLINA**

Prepared By:



134 Suber Road  
Columbia, South Carolina 29210

June 24, 2004



June 24, 2004

South Carolina Electric & Gas Company  
111 Research Drive  
Mail Code MC K61  
Columbia, South Carolina 29203

ATTENTION: Mr. Bill Argentieri

Reference: **ACOUSTICAL TESTING REPORT**  
Saluda River Warning System  
Columbia, South Carolina  
S&ME Project No. 1614-04-198


Dear Mr. Argentieri:


S&ME, Inc. (S&ME) is pleased to provide this report of the acoustical testing of the Saluda River Warning System at the Riverbanks Zoo and Saluda Shoals locations in Columbia, South Carolina. Our work was conducted in general accordance with our proposal No. 1614-3390-04 dated February 23, 2004.

S&ME appreciates the opportunity to be of service to you and SCE&G on this important project, and we look forward to future opportunities to be of service. Please do not hesitate to contact us with any questions.

Sincerely,

S&ME, Inc.

  
John Whitehead, P.G.  
Senior Hydrogeologist

  
Kenneth Warren, CIH  
Senior Industrial Hygienist

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## INTRODUCTION

The Saluda River Warning System is comprised of two sirens, one located to the west of Riverbanks Zoo and the other located at the Hope Ferry Landing across from Saluda Shoals Park. The Zoo siren system consists of three Federal Signal Corporation Directional Speaker Array (DSA) sirens. Two DSA-6 (six re-entrant speakers) are positioned in the upstream and downstream directions with one DSA-2 (two re-entrant speakers) in the river direction. According to the Federal Signal Corporation literature, the DSA-6 is rated at 121 dBC at 100 feet, and the DSA-2 is rated at 111 dBC at 100 feet. The Saluda Shoals siren system consists of three Federal Signal Corporation DSA sirens. Two DSA-2 (two re-entrant speakers) are positioned in the upstream and downstream directions with one DSA-2 (two re-entrant speakers) in the river direction. These sirens are used to alert people in and along the river of water level rises in the Saluda River. Water level rises can be caused by precipitation and runoff or by releases of water through the Lake Murray Dam at the Saluda Hydroelectric Plant.

The following description of activation was provided by South Carolina Electric & Gas Company (SCE&G). The Riverbanks Zoo area siren is activated anytime there is a three-inch rise of the water level in the Saluda River. The Saluda Shoals area siren is activated at an initial rise of 2 inches and any rise of two feet thereafter, or after 16 minutes if the river continues to rise another 2 inches. This 16-minute delay was programmed to keep the Saluda Shoals siren from activating too often due to the narrow channel at that location. The 16 minutes corresponds to the same time the strobe light is on. This test was only performed to determine an adequate volume level for both sirens; it did not verify the activation of the sirens based on water level rises in the river.

Prior to the testing, both sirens were set at minus 20 decibels (dB) below the factory setting.

## FIELD METHODS

On April 20, 2004, representatives of S&ME, SCE&G and Kleinschmidt met at the Riverbanks Zoo to determine possible test locations for the zoo and Saluda Shoals areas. The testing locations were subsequently discussed with an S&ME Certified Industrial Hygienist (CIH) and approved for the project.

### Riverbanks Zoo

On May 24, 2004, representatives of S&ME, SCE&G and Kleinschmidt were present at the Riverbanks Zoo to conduct acoustical testing of the warning system. Weather conditions were clear with ambient temperatures in the high 80s with a slight breeze. At approximately 7:30 a.m., SCE&G began releasing water through the Saluda Hydroelectric Plant to create an increase in the water level within the Saluda River. Maximum discharge during the testing was over 4000 cubic feet per second (cfs).

Each S&ME employee was equipped with a two-way radio and a Quest Model 2100 Type II sound level meter, which was calibrated according to the manufacturer's instruction prior to deployment to the testing locations. The approximate testing locations for the Riverbanks Zoo are shown on Figure 1.

Background sound level measurements were recorded on both the A and C scales at the Riverbanks Zoo beginning at 8:00 a.m. Background measurements were collected at 15 minute intervals until the alarm sounded at approximately 9:58 a.m. Once the alarm sounded, sound level measurements were recorded on both the A and C scales at 15 second intervals for the duration of the alarm cycle (approximately three minutes). A total of three sets of sound level measurements were collected for three different alarm cycles.

After completing the initial testing, the test data were reviewed by S&ME and SCE&G. Based on the data review, personnel at Station No.1 and Station No. 3 were repositioned to Station No.

1A and Station No. 3A as shown on Figure 1. A series of background sound level measurements on both scales (A and C) were collected while the alarm was adjusted to minus 15 dB below the factory setting. At that point, the alarm was sounded and sound level measurements were recorded on both scales at 15 second intervals for the duration of the alarm cycle. The alarm was then readjusted to minus 18 dB below the factory setting and sounded. Sound level measurements on both scales were then recorded at 15 second intervals for the alarm cycle.

Field data sheets for the Riverbanks Zoo area are included in Appendix A, and a summary of the sound level measurements are presented in Table 1.

### **Saluda Shoals**

After completing the testing at the Riverbanks Zoo, personnel mobilized to the Saluda Shoals area to conduct testing of the warning system. The approximate testing locations are shown on Figure 2.

Background sound level measurements were recorded on the A and C scales beginning at 2:48 p.m. for a period of five minutes. The alarm was sounded at 2:53 p.m. Sound level measurements on both scales were collected at 15 second intervals during the alarm cycle. After the initial alarm, a series of background measurements were collected on the A and C scales until 3:09:30 p.m., when the alarm was sounded. A second set of sound level measurements were recorded on the A and C scales during the alarm cycle at 15 second intervals. No adjustments to the alarm sound level were made at this location.

After completing the testing, the data from the Saluda Shoals area was reviewed by SCE&G and S&ME. The data was acceptable and the testing was terminated. Each sound level meter was then calibrated according to the manufacturer's instructions. No adjustments to the sound level meters were made after post-testing calibration because each meter calibrated within acceptable ranges.

Field data sheets from the Saluda Shoals testing are included in Appendix B, and a summary of the sound level measurements are presented in Table 2.

### **GPS Data Collection**

On May 25, 2004, representatives of S&ME and SCE&G met at the Riverbanks Zoo to collect global positioning system (GPS) coordinates of the testing locations. The GPS coordinates were collected with a hand held Trimble® GeoXT Model No. 49050-20 GPS unit. After completing the Riverbanks Zoo testing locations, GPS coordinates were collected at the Saluda Shoals testing locations. The GPS coordinates for the testing locations and sirens are shown on the field data sheets and on Figure 1 (Riverbanks Zoo) and Figure 2 (Saluda Shoals). Coordinates for the sirens at the Riverbanks Zoo and Saluda Shoals were provided by SCE&G. The GPS unit arrived pre-calibrated, and according to the supplier's instruction, additional calibration was not necessary.

## TEST RESULTS

### Riverbanks Zoo

Two sets (morning and afternoon) of background sound level measurements were collected at the Riverbanks Zoo. Sound level measurements for six alarm cycles were also collected. Summaries of the average sound level measurements at the testing locations are presented in Table 3.

Using the average of the background measurements collected, morning background sound levels on the A scale ranged from 51.4 dB at Station No. 3 to 61.7 dB at Station No. 1. The average morning background measurements on the C scale ranged from 62.3 dB at Station No. 3 to 68.1 dB at Station No.1. The average afternoon background sound level measurements on the A scale ranged from 59.1 dB at Station No. 2 to 68.1 dB at Station No. 3A. Average sound level measurements on the C scale ranged from 63.5 dB at Station No. 2 to 69.0 dB at Station No. 5.

During the morning hours, three sets of sound level measurements were collected for three alarm cycles. During the first alarm, average sound level measurements on the A scale ranged from 53.9dB at Station No. 4 to 73.8 dB at Station No. 5. On the C scale, average sound levels measurements ranged from 61.3 dB at Station No. 4 to 75.9 dB at Station No. 5.

It should be noted that our personnel at Station No. 4 reported that they did not hear the alarm at any point during the testing (morning or afternoon). Station No. 4 was the most down stream location and furthest from the alarm horn. Sound level measurements from Station No. 4 were collected at regularly spaced intervals, and the data used from this location were selected at times when the alarm was sounding.

During the second morning alarm, average sound level measurements on the A scale ranged from 59.2 dB at Station No. 3 to 76.1 dB at Station No. 5. On the C scale, average sound level measurements ranged from 64.7 dB at Station No. 3 to 77.5dB at Station No. 5.

During the final morning alarm, average sound level measurements ranged from 58.4 dB at Station No. 3 to 73.3 dB at Station No. 5 using the A scale. Average sound level measurements on the C scale ranged from 64.5 dB at Station No. 3 to 75.3 dB at Station No. 5.

As previously mentioned, the morning test results were reviewed by SCE&G and S&ME. It was determined to reposition personnel at Station No.1 and Station No.3 to location identified as Station No. 1A and Station No. 3A.

Beginning in the early afternoon, a fourth alarm was sounded and data was collected from Station Nos. 1A and 2. In addition, sound level measurements collected at Station No. 4 also corresponded with the sounding of the fourth alarm. Sound level measurements on the A scale ranged from 60.3 dB at Station No. 4 to 63.1 dB at Station No. 1A. On the C scale, sound level measurements ranged from 63.2dB at Station No. 4 to 67.9 at Station No. 1A. Again, our personnel at Station No. 4 reported that they did not hear the alarm.

After repositioning our personnel and collecting the afternoon background sound level measurements, the alarm was adjusted to minus 15 dB from the factory setting. A fifth alarm was sounded, and average sound level measurements on the A scale ranged from 61.9 dB at Station No.1A to 91.5 dB at Station No. 3A. Average C scale measurements ranged from 67.3 dB at Station No. 1A to 92.2 dB at Station No. 3A.

The alarm was then adjusted to minus 18 dB from the factory setting and sounded. Average sound level measurements on the A scale ranged from 60.5 dB at Station No. 1A to 87.4 dB at Station No. 3A. Average C scale measurements ranged from 66.0 dB at Station No: 4 to 87.8 dB at Station No. 3A.



### Saluda Shoals

After arriving on site and positioning our personnel, a series of background sound level measurements were collected. Average A scale sound levels ranged from 36.1 dB at Station No. 4 to 56.4 at Station No. 2. Average C scale sound levels ranged from 56.1 dB at Station No. 3 to 63.1 dB at Station No. 2.

The first alarm was sounded at 2:53 p.m. Average sound levels measurements on the A scale ranged from 53.5 dB at Station No. 4 to 77.9 dB at Station No. 2. Average sound level measurements on the C scale ranged from 58.5 dB at Station No. 1 to 80.1 dB at Station No. 2.

A second set of background measurements were collected after the first alarm. Average sound levels on the A scale ranged from 32.1 dB at Station No. 4 to 51.2 dB at Station No. 2. Average sound levels on the C scale ranged from 55.7 dB at Station No. 4 to 58.5 dB at Station No. 3.

Finally, a second alarm was sounded, and average A scale sound levels ranged from 48.8 dB at Station No. 4 to 81.4 dB at Station No. 2. Average C scale sound levels ranged from 56.8 dB at Station No. 1 to 81.7 dB at Station No. 2.

A summary of the average sound level measurements from the Saluda Shoals site is included in Table 4.

## DISCUSSION

There are no specific federal or state regulations that we are aware of that apply to warning alarms used to warn persons in or near a river prior to rapid water level rises. The Federal Emergency Management Agency (FEMA) provides guidance to aid public officials in determining the requirements for outdoor warning systems, FEMA CPG1-17, March 1, 1980, *Outdoor Warning Systems Guide*. This documents reports, "studies have shown that the level of sound from a warning device must be about 9 dB higher than the level detectable under laboratory conditions in order to attract the attention of otherwise preoccupied observers." The guidelines also recognizes that sound is attenuated by distance, divergence, ground effects and topography, barriers, foliage and weather.

In addition to concerns that an alarm is sufficiently loud to warn persons in or near the river prior to rapid water level rises, the annoying effect of the noise on residents and business in the vicinity of the alarm must be considered. The Saluda River alarms may be sounded day or night for three minutes in duration and repeated several times. Therefore, the loudness, frequency and duration can cause complaints from residents and businesses in the area.

Areas selected for measurement were chosen based on river access points primarily used by the general public, potential for annoying the public and to determine the range of the siren. SCE&G and S&ME recognize that the alarms in place are not intended to warn persons in all locations on the Saluda River. Primary or "high" river access points were in the vicinity of Riverbanks Zoo (Stations 3A, 4 and 5) and Saluda Shoals boat ramp (Station 2). Areas selected to determine the potential for annoying residents and businesses were Station 6 (Riverbanks Zoo vicinity) and Station 4 (Saluda Shoals vicinity). Areas selected to determine the range of the sirens were Stations 1, 1A, 2 & 3 (Riverbanks Zoo vicinity) and Stations 1 & 3 (Saluda Shoals vicinity).

For purpose of comparison, S&ME compared average sound levels as measured on the C-weighted frequency (dBC) as measured on the slow response of a Type II sound level meter for background and alarm conditions as recorded during the testing. This comparison is included in

Table 5. The C-scale was chosen based on the FEMA guidelines. Average sound levels measured during the alarms were compared to average background levels measured prior to the initial alarm as persons would be less likely to enter the river during elevated water levels when background noise levels may be higher.

## RECOMMENDATIONS

After considering the guidelines provided in FEMA CPG1-17, March 1, 1980, *Outdoor Warning Systems Guide*, the following recommendations are provided:

The alarm setting of minus 18 dB from factory preset was recommended by S&ME for the Riverbanks Zoo alarm. This was an increase from the alarm setting in place prior to the testing (minus 20 dB alarm setting). See Table 5. This alarm setting provides greater than 9 dBC increase at the high access areas, excluding Station 4, without causing excessive noise levels at nearby residences and businesses.

The alarm could not easily be detected at Station 4 (east of the zoo) at this setting, and S&ME recommends that an additional alarm be installed in this area to alert persons in this high access area; and

The alarm setting of minus 20 dB from factory preset for the Saluda Shoals area appeared adequate based on the sound level increase measured in the high access area around the boat ramp. See Table 5. This alarm setting provides greater than 9 dBC increase in the high access areas, without causing excessive noise levels at nearby residences.

**TABLES**

Table 1  
 Summary of Sound Level Measurements (decibels)  
 Riverbanks Zoo Location - May 24, 2004  
 S&ME Project No. 1614-04-198

Event	Start Time	Station															
		No.1		No.1A		No.2		No.3		No.3A		No.4		No.5		No.6	
		A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
Background No.1 Ranges	8:00:00	58.1 - 65.0	66.0 - 70.2	---	---	50.5 - 70.6	60.3 - 71.5	49.8 - 54.1	61.0 - 63.8	---	---	50.4 - 55.0	60.9 - 65.4	55.6 - 58.5	63.8 - 66.6	55.4 - 75.9	64.1 - 72.3
Background No.1 Average		61.7	68.1	---	---	54.8	63.4	51.4	62.3	---	---	52.3	63.4	57.5	65.0	54.1	67.3
Alarm No.1 Ranges	9:59:00	62.5 - 66.2	67.9 - 70.1	---	---	58.4 - 68.2	60.3 - 69.4	56.1 - 61.8	62.5 - 68.0	---	---	53.9	61.3	67.9 - 76.5	73.7 - 79.5	62.2 - 71.3	66.8 - 72.7
Alarm No.1 Average		63.5	68.9	---	---	63.5	64.2	57.3	64.6	---	---	---	---	73.8	75.9	66.4	69.8
Alarm No.2 Ranges	10:09:00	62.3 - 64.8	67.5 - 69.6	---	---	59.9 - 66.6	64.0 - 68.5	56.1 - 65.5	62.7 - 68.8	---	---	---	---	70.0 - 79.3	69.3 - 80.0	61.0 - 72.9	65.9 - 71.0
Alarm No.2 Average		63.6	68.7	---	---	63.3	66.2	59.2	64.7	---	---	---	---	76.1	77.5	65.3	67.7
Alarm No.3 Ranges	10:17:00	64.0 - 66.5	68.9 - 70.2	---	---	58.9 - 69.1	62.1 - 67.3	55.9 - 64.5	62.2 - 67.5	---	---	---	---	70.3 - 75.5	73.7 - 78.4	59.0 - 69.9	68.1 - 73.8
Alarm No.3 Average		65.2	69.7	---	---	63.6	65.0	58.4	64.5	---	---	---	---	73.3	75.3	65.2	69.6
Alarm No.4 Ranges	12:13:00	---	---	61.8 - 67.0	67.1 - 70.0	57.6 - 62.7	61.5 - 66.4	---	---	---	---	60.3	63.2	---	---	---	---
Alarm No.4 Average		---	---	63.1	67.9	60.4	63.3	---	---	---	---	---	---	---	---	---	---
Background No.2 Ranges	12:38:00	---	---	57.5 - 62.4	65.6 - 69.2	54.2 - 73.1	68.3 - 74.5	---	---	66.4 - 71.5	68.3 - 74.9	59.8 - 62.1	64.2 - 65.7	63.3 - 64.4	68.0 - 70.4	58.7 - 60.5	66.1 - 69.3
Background No.2 Average		---	---	60.9	67.6	59.1	63.5	---	---	68.1	72.6	60.7	64.8	63.7	69.0	59.7	67.5
Alarm No.5 Ranges	13:16:00	---	---	60.0 - 64.3	66.4 - 68.4	65.5 - 73.1	68.3 - 74.5	---	---	88.4 - 95.5	85.5 - 95.3	---	---	86.2 - 90.1	84.8 - 90.6	74.9 - 83.0	76.2 - 84.0
Alarm No.5 Average		---	---	61.9	67.3	70.0	71.2	---	---	91.5	92.2	---	---	87.8	87.9	78.8	80.2
Alarm No.6 Ranges	13:36:00	---	---	59.2 - 62.8	66.0 - 70.7	65.9 - 70.3	70.8 - 77.1	---	---	86.0 - 89.1	85.7 - 89.3	61.4	66.0	80.1 - 82.6	79.5 - 83.0	69.8 - 78.2	73.7 - 81.0
Alarm No.6 Average		---	---	60.5	67.5	68.2	74.2	---	---	87.4	87.8	---	---	81.0	81.4	74.1	76.4

Table 2

Summary of Sound Level Measurements (decibels)

Saluda Shoals Location - May 24, 2004

S&ME Project No. 1614-04-198

Event	Start Time	Station							
		No.1		No.2		No.3		No.4	
		A	C	A	C	A	C	A	C
Background No.1 Ranges	14:48:00	40.6 - 47.6	56.6 - 61.2	46.2 - 66.4	58.1 - 68.1	40.0 - 46.2	51.1 - 59.9	32.0 - 47.3	54.5 - 60.3
Background No.1 Average		42.7	58.4	56.4	63.1	42.5	56.1	36.1	58
Alarm No.1 Ranges	14:53:00	49.6 - 61.7	56.8 - 60.9	70.9 - 83.5	73.5 - 84.7	60.3 - 68.5	56.5 - 68.9	47.6 - 62.1	53.3 - 62.2
Alarm No.1 Average		54.8	58.5	77.9	80.1	64.3	63.1	53.5	58.9
Background No.2 Ranges	15:06:00	39.9 - 43.0	56.1 - 57.8	48.6 - 52.5	35.1 - 76.5	37.6 - 40.9	54.1 - 64.8	31.7 - 32.5	54.5 - 56.1
Background No.2 Average		42.7	58.4	51.2	58.2	39.1	58.5	32.1	55.7
Alarm No.2 Ranges	15:09:30	48.1 - 61.0	58.7 - 63.8	78.8 - 83.3	78.6 - 83.3	56.8 - 71.3	59.2 - 74.7	45.5 - 51.2	55.4 - 58.5
Alarm No.2 Average		55.6	60.9	81.4	81.7	65.8	65.5	48.8	56.8

Table 3  
 Summary of Average Sound Level Measurements (decibels)  
 Riverbanks Zoo Location - May 24, 2004  
 S&ME Project No. 1614-04-198

Event	Station							
	No.1	No.1A	No. 2	No.3	No. 3A	No.4	No.5	No.6
<b>Morning Background</b>								
A Scale	61.7	---	54.8	51.4	---	52.3	57.5	54.1
C Scale	68.1	---	63.4	62.3	---	63.4	65.0	67.3
<b>Afternoon Background - Increased River Noise due to Constant Discharge</b>								
A Scale		60.9	59.1		68.1	60.7	63.7	59.7
C Scale		67.6	63.5		72.6	64.8	69.0	67.5
<b>Morning Alarms - Alarm Set at -20 db From Factory Preset</b>								
Alarm 1	No.1	No.1A	No. 2	No.3	No. 3A	No.4	No.5	No.6
A Scale	63.5	---	63.5	63.5	---	53.9	73.8	66.4
C Scale	68.9	---	64.2	64.2	---	61.3	75.9	69.8
Alarm 2								
A Scale	63.6	---	63.3	59.2	---	---	76.1	65.3
C Scale	68.7	---	66.2	64.7	---	---	77.5	67.7
Alarm 3								
A Scale	65.2	---	63.6	58.4	---	---	73.3	65.2
C Scale	69.7	---	65.0	64.5	---	---	75.3	69.6
<b>Afternoon Alarms</b>								
Alarm 4	No.1	No.1A	No. 2	No.3	No. 3A	No.4	No.5	No.6
A Scale	---	63.1	60.4	---	---	60.3	---	---
C Scale	---	67.9	63.3	---	---	63.2	---	---
Alarm 5 - Alarm Set at -15 db From Factory Preset								
A Scale	---	61.9	70.0	---	91.5	---	87.8	78.8
C Scale	---	67.3	71.2	---	92.2	---	87.9	80.2
Alarm 6 - Alarm Set at -18 db From Factory Preset								
A Scale	---	60.5	68.2	---	87.4	61.4	81.0	74.1
C Scale	---	67.5	74.2	---	87.8	66.0	81.4	76.4



Table 4  
 Summary of Average Sound Level Measurements (decibels)  
 Saluda Shoals Location - May 24, 2004  
 S&ME Project No. 1614-04-198

Event	Station			
	No.1	No. 2	No.3	No.4
<b>First Background</b>				
A Scale	42.7	56.4	42.5	36.1
C Scale	58.4	63.1	56.1	58.0
<b>Second Background</b>				
A Scale	42.7	51.2	39.1	32.1
C Scale	58.4	58.2	58.5	55.7
<b>Alarms</b>				
<b>Alarm 1</b>				
A Scale	54.8	77.9	64.3	53.5
C Scale	58.5	80.1	63.1	58.9
<b>Alarm 2</b>				
A Scale	55.6	81.4	65.8	48.8
C Scale	60.9	81.7	65.5	56.8

Table 5  
 Comparison of C Scale Sound Levels (decibels)  
 Saluda River Warning System  
 Columbia, South Carolina  
 S&ME Project No. 1614-04-198

Riverbanks Zoo - minus 18 dB alarm setting					
Station No.	Description	Average Background	Average Alarm	Increase	
1/1A	Minimum Access Area	68.1	67.5	None	
2	Minimum Access Area	63.4	74.2	10.8	
3A	High Access Area	72.6	87.8	15.2	
4	High Access Area (Alarm Not Heard)	---	---	None	
5	High Access Area	65.0	81.4	16.4	
6	Residences/Businesses (No Access)	67.3	76.4	9.1	
Saluda Shoals Area - minus 20 dB alarm setting					
Station No.	Description	Average Background	Average Alarm	Increase	
1	Minimum Access Area	58.4	60.9	2.5	
2	High Access Area	58.2	81.7	23.5	
3	Minimum Access Area	58.5	65.5	7.0	
4	Residences (No Access)	55.7	56.8	1.1	

**FIGURES**



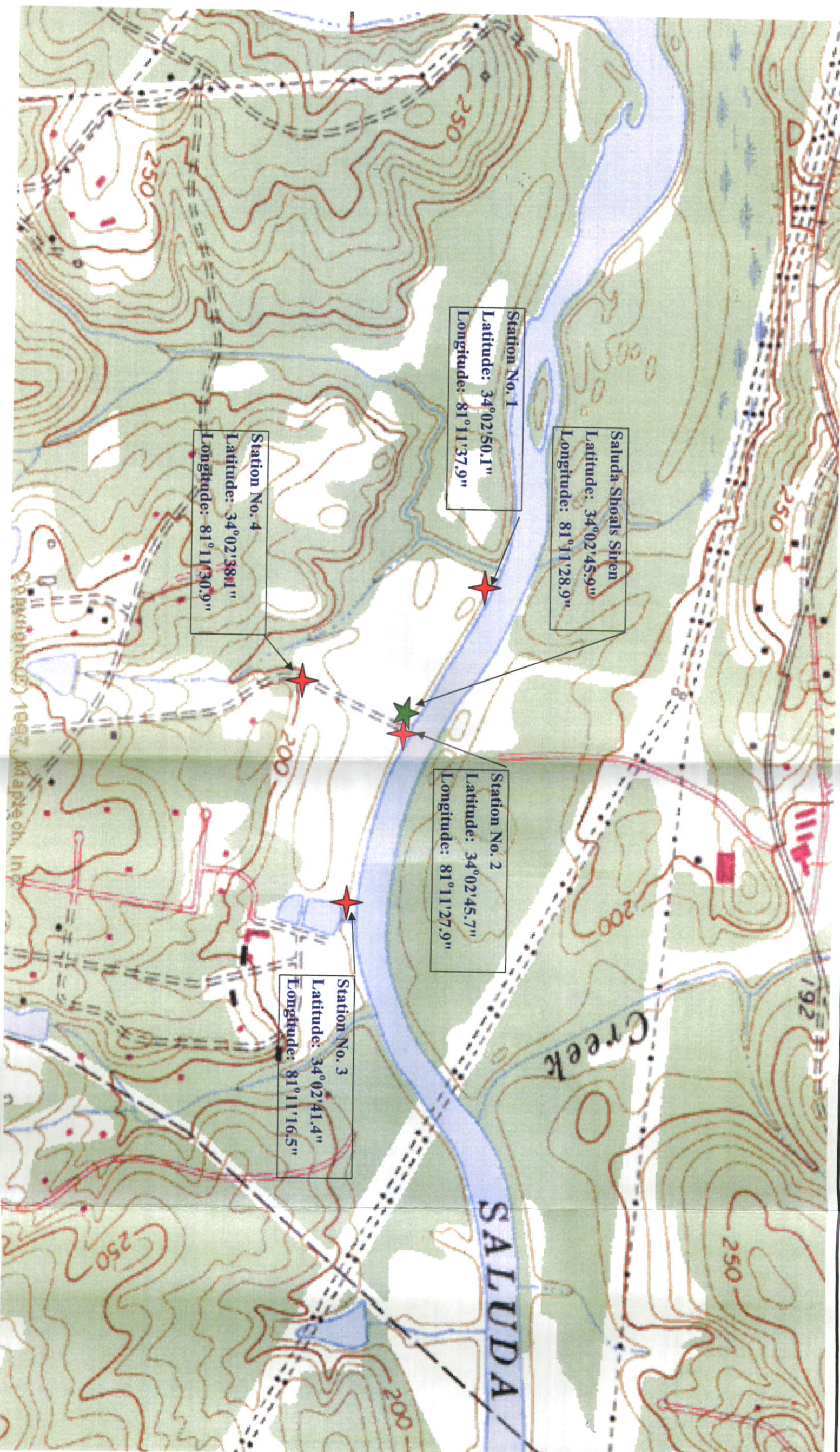
SOURCE: USGS 7.5-MINUTE TOPOGRAPHIC QUADRANGLE MAP  
COLUMBIA NORTH, SOUTH CAROLINA - 1972 (REVISED 1990)

SCALE: 1" = 700'  
CHECKED BY: JWV  
DRAWN BY: JWV  
DATE: 5/21/2004



**RIVERBANKS ZOO TOPOGRAPHIC MAP**  
Saluda River Alarm System  
Columbia, South Carolina  
JOB NO. 1614-04-198

FIGURE NO. 1



SOURCE: USGS 7.5-MINUTE TOPOGRAPHIC QUADRANGLE MAP  
IRMO, SOUTH CAROLINA - 1971 (REVISED 1990)

SCALE: 1" = 675'  
CHECKED BY: JWW  
DRAWN BY: JWW  
DATE: 5/21/2004



SALUDA SHOALS TOPOGRAPHIC MAP  
Saluda River Alarm System  
Columbia, South Carolina  
JOB NO. 1614-04-198

FIGURE NO. 2

**APPENDIX A**  
**Field Data Sheets – Riverbanks Zoo**

Saluda River Alarm System  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 1  
 Date: May 24, 2004  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'39.6"/81°04'54.7"  
 Distance from River 10 feet

Sound Level Meter: Quest 2100  
 Serial No.: DAD040017

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
6:45:00			Calibration - Passed
8:00:00	61.5	69.7	Background
8:15:00	65.0	70.2	
8:30:00	63.2	70.1	
8:45:00	62.3	67.5	
9:00:00	61.3	67.4	
9:15:00	60.0	66.9	
9:30:00	58.1	66.9	
9:45:00	62.0	66.0	Average A = 61.7 Average C = 68.1
9:58:45	62.5	69.0	Alarm Sounded
9:59:00	62.7	68.7	
9:59:15	62.6	68.5	
9:59:30	63.2	68.6	
9:59:45	63.9	68.2	
10:00:00	63.8	68.7	
10:00:15	66.2	69.1	
10:00:30	62.6	68.7	
10:00:45	63.0	67.9	
10:01:00	63.4	70.1	
10:01:15	63.8	69.8	
10:01:30	63.9	69.5	Alarm Ended Average A = 63.5 Average C = 68.9
10:05:00	62.6	67.0	Background
10:08:45	64.1	69.6	Alarm Sounded
10:09:00	64.8	69.1	
10:09:15	63.9	69.6	
10:09:30	63.8	68.9	
10:09:45	63.6	68.4	
10:10:00	62.5	68.3	
10:10:15	64.2	68.3	
10:10:30	63.5	67.5	
10:10:45	63.4	68.2	
10:11:00	62.3	69.1	
10:11:15	63.6	68.4	
10:11:30	63.1	68.7	Alarm Ended Average A = 63.6 Average C = 68.7
10:15:00	63.0	67.5	Background
10:16:45	64.2	68.9	Alarm Sounded
10:17:00	64.6	70.1	
10:17:15	65.0	70.0	
10:17:30	65.2	69.8	
10:17:45	65.5	69.5	
10:18:00	65.8	70.2	
10:18:15	65.9	69.9	
10:18:30	66.5	69.4	
10:18:45	65.4	69.8	
10:19:00	65.8	69.4	
10:19:15	65.0	69.6	
10:19:30	64.0	69.4	Alarm Ended Average A = 65.2 Average C = 69.7

Saluda River Alarm System  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 1A  
 Date: May 24, 2004  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'40.2781"04'57.4"  
 Distance from River 10 feet

Sound Level Meter: Quest 2100  
 Serial No.: DAD040017

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
			Repositioned Station No. 1 Approximately 200 Northwest
12:12:45	67.0	68.1	Alarm Sounded
12:13:00	64.6	67.2	
12:13:15	63.2	68.9	
12:13:30	62.7	68.3	
12:13:45	61.8	67.2	
12:14:00	62.7	67.5	
12:14:15	62.0	68.3	
12:14:30	63.3	67.6	
12:14:45	62.4	70.0	
12:15:00	62.6	67.2	
12:15:15	62.0	67.2	
12:15:30	62.5	67.1	Alarm Ended Average A = 63.1 Average C = 67.9
12:38:00	62.0	69.2	Background Increased River Noise
12:39:00	62.4	68.3	
12:40:00	61.0	66.2	
12:41:00	61.1	67.2	
12:42:00	61.2	68.0	
12:43:00	61.2	68.4	
12:44:00	61.3	67.3	
12:45:00	61.8	68.4	
12:46:00	61.0	67.2	
12:51:00	61.8	68.6	
12:56:00	58.5	66.6	
13:15:00	57.5	65.6	Average A = 60.9 Average C = 67.6
13:16:30	62.5	66.7	Alarm Sounded Alarm Adjusted to -15 Decibels
13:16:45	61.6	66.5	
13:17:00	61.5	66.5	
13:17:15	61.5	66.9	
13:17:30	61.2	68.4	
13:17:45	60.0	67.1	
13:18:00	61.6	67.8	
13:18:15	60.5	67.5	
13:18:30	64.3	68.1	
13:18:45	63.2	67.8	
13:19:00	62.8	67.6	
13:19:15	61.6	66.4	Alarm Ended Average A = 61.9 Average C = 67.3
13:35:45	59.7	66.1	Alarm Sounded Alarm Adjusted to -18 Decibels
13:36:00	60.1	66.0	
13:36:15	59.2	67.2	
13:36:30	60.8	66.8	
13:36:45	61.6	67.0	
13:37:00	59.4	70.7	
13:37:15	62.8	68.9	
13:37:30	60.9	68.6	
13:37:45	59.8	68.1	
13:38:00	60.6	67.1	
13:38:15	59.7	67.1	
13:38:30	61.4	66.5	Alarm Ended Average A = 60.5 Average C = 67.5
15:25:00			Calibration - Passed



Saluda River Alarm System  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 2  
 Date: May 24, 2004  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'34"/81°04'45"  
 Distance from River 10 feet

Sound Level Meter: Quest 2100  
 Serial No.: DAD050002

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
6:45:00			Calibration - Passed
8:00:00	70.6	64.1	Background
8:15:00	51.2	62.3	
8:30:00	52.3	65.2	
8:45:00	53.4	60.6	
9:00:00	55.1	71.5	
9:15:00	51.0	61.5	
9:30:00	50.5	60.3	
9:45:00	54.5	61.6	Average A = 54.8 Average C = 63.4
9:58:45	58.4	60.7	Alarm Sounded
9:59:00	66.9	66.4	
9:59:15	67.3	63.9	
9:59:30	64.6	62.3	
9:59:45	68.2	69.4	
10:00:00	61.1	64.6	
10:00:15	59.4	61.1	
10:00:30	63.6	65.8	
10:00:45	60.7	65.6	
10:01:00	61.7	67.6	
10:01:15	63.5	62.6	
10:01:30	67.1	60.3	Alarm Ended Average A = 63.5 Average C = 64.2
10:05:00	56.0	60.3	Background
10:08:45	66.6	67.5	Alarm Sounded
10:09:00	64.1	65.3	
10:09:15	61.2	66.5	
10:09:30	65.9	66.1	
10:09:45	63.8	67.2	
10:10:00	59.9	64.6	
10:10:15	63.9	67.0	
10:10:30	62.1	65.2	
10:10:45	61.8	64.0	
10:11:00	62.0	64.3	
10:11:15	62.8	68.5	
10:11:30	66.0	68.7	Alarm Ended Average A = 63.3 Average C = 66.2
10:15:00	56.5	62.3	Background
10:16:45	69.1	67.3	Alarm Sounded
10:17:00	66.1	65.0	
10:17:15	65.9	64.1	
10:17:30	58.9	63.9	
10:17:45	62.4	65.3	
10:18:00	64.0	66.6	
10:18:15	61.1	65.4	
10:18:30	65.5	64.7	
10:18:45	63.8	64.9	
10:19:00	63.1	64.9	
10:19:15	64.5	65.9	
10:19:30	58.9	62.1	Alarm Ended Average A = 63.6 Average C = 65.0

**Saluda River Alarm System**  
**S&ME Project No. 1614-04-198**

Station No.: Riverbanks Zoo No. 2  
 Date: May 24, 2004  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'34"/781°04'45"  
 Distance from River 10 feet

Sound Level Meter: Qtest 2100  
 Serial No.: DAD050002

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
12:12:45	61.2	60.3	Alarm Sounded
12:13:00	57.6	62.9	
12:13:15	59.6	61.5	
12:13:30	61.2	63.4	
12:13:45	60.0	63.2	
12:14:00	59.5	63.0	
12:14:15	60.8	64.8	
12:14:30	59.3	65.0	
12:14:45	60.2	62.0	
12:15:00	62.7	63.8	
12:15:15	60.9	66.4	
12:15:30	61.4	63.7	Alarm Ended Average A = 60.4 Average C = 63.3
12:38:00	63.0	65.6	Background Increased River Noise
12:39:00	62.0	64.1	
12:40:00	56.9	62.4	
12:41:00	56.9	64.2	
12:42:00	76.0	63.4	
12:43:00	56.4	63.0	
12:44:00	54.2	62.7	
12:45:00	56.4	66.1	
12:46:00	55.2	61.5	
12:51:00	57.0	64.5	
12:56:00	56.2	62.5	
13:15:00	59.2	62.2	Average A = 59.1 Average C = 63.5
13:16:30	70.3	70.8	Alarm Sounded Alarm Adjusted to -15 Decibels
13:16:45	68.1	74.5	
13:17:00	69.7	69.0	
13:17:15	68.0	69.1	
13:17:30	73.1	74.3	
13:17:45	65.5	72.2	
13:18:00	70.1	71.1	
13:18:15	71.3	73.1	
13:18:30	69.7	69.4	
13:18:45	71.2	73.3	
13:19:00	71.5	69.5	
13:19:15	71.7	68.3	Alarm Ended Average A = 70.0 Average C = 71.2
13:35:45	70.1	74.9	Alarm Sounded Alarm Adjusted to -18 Decibels
13:36:00	65.9	70.8	
13:36:15	68.1	76.2	
13:36:30	69.5	74.1	
13:36:45	70.3	72.3	
13:37:00	69.3	74.9	
13:37:15	67.3	74.1	
13:37:30	67.6	73.4	
13:37:45	66.8	73.5	
13:38:00	70.2	77.1	
13:38:15	67.4	76.6	
13:38:30	65.9	72.3	Alarm Ended Average A = 68.2 Average C = 74.2
15:25:00			Calibration - Passed

Saluda River Alarm System  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 3                      Sound Level Meter: Quest 2100  
 Date: May 24, 2004                                      Serial No.: DAD040018  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'30.1" 781°04'35.6"  
 Distance from River: Over the River on Zoo Bridge

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
6:45:00			Calibration - Passed
8:00:00	54.1	63.8	Background
8:15:00	52.2	63.6	
8:30:00	51.2	62.7	
8:45:00	50.3	62.7	
9:00:00	50.4	62.3	
9:15:00	51.5	61.3	
9:30:00	49.8	61.3	
9:45:00	51.3	61.0	Average A = 51.4    Average C = 62.3
9:58:45	60.6	68.0	Alarm Sounded
9:59:00	56.1	65.3	
9:59:15	57.1	66.0	
9:59:30	56.8	67.4	
9:59:45	56.2	63.9	
10:00:00	56.2	62.5	
10:00:15	57.7	63.1	
10:00:30	57.4	63.6	
10:00:45	61.8	65.0	
10:01:00	56.1	63.8	
10:01:15	55.7	63.4	
10:01:30	56.2	63.6	Alarm Ended    Average A = 57.3    Average C = 64.6
10:05:00	57.2	68.5	Background
10:08:45	65.5	62.7	Alarm Sounded
10:09:00	57.2	64.7	
10:09:15	59.3	64.3	
10:09:30	59.9	63.4	
10:09:45	56.9	64.5	
10:10:00	56.1	63.7	
10:10:15	58.8	63.7	
10:10:30	58.2	64.1	
10:10:45	58.6	64.4	
10:11:00	56.7	66.8	
10:11:15	60.6	65.0	
10:11:30	62.2	68.8	Alarm Ended    Average A = 59.2    Average C = 64.7
10:15:00	60.9	68.0	Background
10:16:45	64.5	63.1	Alarm Sounded
10:17:00	58.8	64.9	
10:17:15	57.0	62.2	
10:17:30	56.8	67.5	
10:17:45	57.6	65.2	
10:18:00	57.8	63.8	
10:18:15	60.7	65.1	
10:18:30	57.3	62.5	
10:18:45	59.7	63.0	
10:19:00	55.9	64.3	
10:19:15	57.2	65.8	
10:19:30	56.9	67.0	Alarm Ended    Average A = 58.4    Average C = 64.5

Saluda River Alarm System  
 S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 3A  
 Date: May 24, 2004  
 Weather: Sunny and Warm  
 Lat./Long: 34°00'44.9"81°04'47.1"  
 Distance from River 10 feet

Sound Level Meter: Quest 2100  
 Serial No.: DAD040018

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
			Repositioned Station No. 3 Approximately 1900 Northwest
12:38:00	68.0	68.3	Background Increased River Noise
12:39:00	69.5	74.5	
12:40:00	69.1	73.5	
12:41:00	68.7	73.5	
12:42:00	69.0	73.9	
12:43:00	66.9	72.6	
12:44:00	68.0	74.9	
12:45:00	66.4	71.9	
12:46:00	71.5	72.6	
12:51:00	66.6	71.2	
12:56:00	66.7	72.3	
13:15:00	66.4	72.1	Average A = 68.1 Average C = 72.6
13:16:30	90.0	93.1	Alarm Sounded Alarm Adjusted to -15 Decibels
13:16:45	90.0	90.3	
13:17:00	91.7	92.6	
13:17:15	88.4	91.0	
13:17:30	91.2	91.8	
13:17:45	90.8	92.0	
13:18:00	90.1	92.9	
13:18:15	91.7	92.8	
13:18:30	92.9	95.3	
13:18:45	95.5	94.6	
13:19:00	92.9	94.1	
13:19:15	93.3	85.5	Alarm Ended Average A = 91.5 Average C = 92.2
13:35:45	86.7	87.1	Alarm Sounded Alarm Adjusted to -18 Decibels
13:36:00	85.5	85.7	
13:36:15	88.9	88.3	
13:36:30	85.5	87.2	
13:36:45	88.4	88.9	
13:37:00	88.5	89.3	
13:37:15	89.1	89.3	
13:37:30	87.4	86.1	
13:37:45	88.4	89.3	
13:38:00	86.0	87.7	
13:38:15	87.4	87.4	
13:38:30	86.6	87.0	Alarm Ended Average A = 87.4 Average C = 87.8
15:25:00			Calibration - Passed



**Saluda River Alarm System**  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 5  
Date: May 24, 2004  
Weather: Sunny and Warm  
Lat./Long: 34°00'42"/81°04'44.9"  
Distance from River 10 feet

Sound Level Meter: Quest 2100  
Serial No.: DAD040016

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
6:45:00			Calibration - Passed
8:00:00	58.5	66.6	Background
8:15:00	57.9	65.6	
8:30:00	58.5	66.1	
8:45:00	57.8	65.1	
9:00:00	55.6	64.2	
9:15:00	58.3	64.2	
9:30:00	56.6	64.3	
9:45:00	57.3	63.8	Average A = 57.6 Average C = 65.0
9:58:55	74.5	77.7	Alarm Sounded
9:59:30	76.5	75.0	
9:59:50	76.5	76.5	
10:00:15	75.7	73.7	
10:00:45	67.9	74.5	
10:01:20	71.4	74.2	
10:01:45	74.2	79.5	Alarm Ended Average A = 73.8 Average C = 75.9
10:05:00	58.7	64.7	Background
10:08:30	70.0	69.3	Alarm Sounded
10:09:45	76.9	77.0	
10:09:55	77.6	79.0	
10:10:15	74.7	78.2	
10:10:30	77.6	77.9	
10:10:45	79.3	79.7	
10:11:00	74.6	79.2	
10:11:30	77.8	80.0	Alarm Ended Average A = 76.1 Average C = 77.5
10:15:00	60.6	66.5	Background
10:17:15	75.0	78.4	Alarm Sounded
10:17:30	73.1	74.9	
10:17:45	70.3	74.2	
10:18:00	71.8	74.0	
10:18:30	72.1	73.7	
10:19:00	75.5	74.9	
10:19:30	75.2	77.3	Alarm Ended Average A = 73.3 Average C = 75.3
10:24:00	77.1	75.3	Alarm Sounded
10:25:15	73.4	75.0	
10:25:45	73.5	75.6	
10:26:00	71.8	73.9	
10:26:30	71.8	73.6	
10:27:00	70.8	72.4	
10:27:30	71.8	72.8	Alarm Ended Average A = 72.9 Average C = 74.1
10:30:00	61.5	65.3	Background
10:34:15	79.7	81.1	Alarm Sounded
10:34:45	80.4	82.2	
10:35:00	81.4	82.9	
10:35:15	79.7	79.8	Alarm Ended Average A = 80.3 Average C = 81.5
10:37:00	66.5	71.6	Background



Saluda River Alarm System  
S&ME Project No. 1614-04-198

Station No.: Riverbanks Zoo No. 6  
Date: May 24, 2004  
Weather: Sunny and Warm  
Lat./Long: 34°00'43.8"781"04'42.6"  
Distance from River: 300 feet

Sound Level Meter: Quest 2100  
Serial No.: DAD040002

Time (h/m/s)	Sound Level Readings		Remarks
	A Scale	C Scale	
12:38:00	60.0	66.3	Background Increased River Noise
12:39:00	59.6	67.4	
12:40:00	59.5	67.6	
12:41:00	58.7	67.7	
12:42:00	60.1	66.1	
12:43:00	59.3	66.5	
12:44:00	59.1	67.7	
12:45:00	59.6	69.3	
12:46:00	59.7	67.8	
12:51:00	60.5	68.3	
12:56:00	59.3	67.1	
13:15:00	60.0	68.5	Average A = 59.7 Average C = 67.5
13:16:30	77.9	78.2	Alarm Sounded Alarm Adjusted to -15 Decibels
13:16:45	75.4	77.9	
13:17:00	80.8	81.7	
13:17:15	75.1	76.2	
13:17:30	74.9	78.9	
13:17:45	72.3	80.1	
13:18:00	82.3	84.0	
13:18:15	83.0	82.1	
13:18:30	79.9	81.5	
13:18:45	80.5	81.0	
13:19:00	81.0	81.9	
13:19:15	82.4	79.3	Alarm Ended Average A = 78.8 Average C = 80.2
13:35:45	69.8	74.8	Alarm Sounded Alarm Adjusted to -18 Decibels
13:36:00	76.5	74.7	
13:36:15	75.4	78.1	
13:36:30	74.0	77.6	
13:36:45	74.0	75.7	
13:37:00	73.2	74.7	
13:37:15	72.6	73.7	
13:37:30	69.8	75.8	
13:37:45	78.2	77.4	
13:38:00	77.5	79.3	
13:38:15	70.7	74.2	
13:38:30	77.1	81.0	Alarm Ended Average A = 74.1 Average C = 76.4
15:25:00			Calibration - Passed



**APPENDIX B**  
**Field Data Sheets – Saluda Shoals**







