

**Paschal Golf Course (Richland Creek)  
Stream Restoration Site  
Final Baseline Monitoring Report Addendum  
Project # 276  
SCO# 02-05911-02A  
Wake County, North Carolina**



Submitted to:

**North Carolina  
Division of Mitigation Services**

1652 Mail Service Center, Raleigh, NC 27699-1652

**Submitted: May 2016**



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KCI Project No: 16133502D**

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## **1.0 Executive Summary**

### **1.1 Site Description**

The North Carolina Division of Mitigation Services (DMS) restored approximately 2,919 linear feet of stream on Richland Creek, which flows through the Paschal Golf Course in Wake Forest, North Carolina. The site was originally constructed in mid-2010, with original baseline monitoring conducted that same year. Since that time, multiple problem areas were tracked over the course of monitoring. A maintenance design was completed in 2015 and maintenance construction was completed in March 2016. This report details the results of that maintenance.

### **1.2 Adaptive Management Needs**

Since construction, the majority of the stream channel has remained stable, but there has been significant bank erosion and structural failure in six select locations. The large amount of erosion has resulted in vertical banks and loss of most vegetative protection. In some areas failed structures caused a realignment of the thalweg towards these vertical and actively eroding banks.

The six repair areas identified in 2015 were designated as Areas 1-6. The pre-construction conditions and the corrective repairs are described below.

### **1.3 Repair Goals and Objectives**

The project accomplished the goals of this repair by implementing the objectives as described below.

#### **Goals:**

- Stabilize six actively eroding portions of Richland Creek on the project site.

#### **Objectives:**

- Build stable banks along the eroded sections of Richland Creek using vegetated soil lifts.
- Realign the thalweg to the channel center to alleviate near bank stress where necessary.

### **1.4 Additional Project Information**

Summary information/data related to the repair design approach and conceptual plan, including a narrative background and supporting information, can be found in the conceptual repair plan, and preceding project information can be found in the original mitigation and restoration plan documents available on the DMS website.

## **2.0 Repair Approach**

### **2.1 Description**

In October 2014, KCI conducted a site survey and assessment at the Paschal Golf Course (Richland Creek) Site. This assessment collected detailed visual and topographic information at six actively eroding areas. The information from this survey and assessment was used to develop a Conceptual Repair Plan (December 2014) and final construction plans (April 2015) to correct the actively eroding, unstable parts of the

channel. The repairs began in late-February 2016 and were completed by late-March 2016.

### **2.1.1 Stream Repairs**

Area 1 consisted of an actively eroding outer bank. The bank had eroded through the bench and was eroding the terrace. Additionally, a mid-channel bar had formed in this location, which split the flow and caused additional erosion along the right bank of the downstream riffle. This was fixed by building vegetated soil lifts on a stone foundation along the outer bank, grading the inner bank back, and developing a new pool. The bank was built out towards the channel, but not as far as the original bank. This structure was tied to a downstream constructed riffle with adjacent soil lifts.

Area 2 also focused on an eroding outer bank. Unlike Repair Area 1, the erosion had not cut back to the terrace and there were no problems with deposition in this area. A vegetated soil lift with a stone foundation was installed in this location.

Area 3 consisted of an eroding outer bank, similar to Repair Area 2. The erosion stopped at a boulder single vane structure. Similar to the other repairs a vegetated soil lift with a stone foundation was installed in this location. The stones in the vane structure were removed up to where the vane tied into the bank, which was incorporated into the foundation for the lifts.

Additionally, Repair Area 3 has a side drain that comes from a small stormwater culvert just downstream of the bank to be repaired. This drain, which alternates between filling with sand and then washing back out, was stabilized with riprap at the confluence with the channel.

The most minor repair area was Repair Area 4, which consisted of an actively eroding outer bank. Similar to Repair Area 3, there is a boulder structure at the downstream end of the erosion that halted any further erosion. This structure has a better angle and was left in place. A vegetated soil lift with a stone foundation was installed in this location.

Area 5 consisted of an actively eroding outer bank downstream of the golf cart bridge. A 4" PVC drain pipe had been exposed and was hanging from this bank. A non-functioning single boulder vane was also located in the middle of this bank. A vegetated soil lift with a stone foundation was installed in this location. The PVC pipe is connected to an active drain line and was incorporated into the soil lifts. The vane arm was removed and the boulders were reused in the foundation.

Area 6 was in the same state as Repair Area 3, with an eroding outer bank and non-functioning boulder vane. The repair approach was the same.

For site photos and repair locations depicted in the record drawings and contractor's as-built, see Appendices A, B, and C, respectively.

### **2.1.2 Vegetated Soil Lifts**

Vegetated soil lifts were used throughout the repair to stabilize eroding banks. These were installed as designed, with a stone foundation that extends 0.2-0.5' above the water line, approximately three one-foot lifts, and live whips installed above the stone base and between the lifts. The species utilized for the whips were harvested onsite and include black willows (*Salix nigra*), silky willows (*Salix sericea*), and silky dogwoods (*Cornus amomum*).

### **2.1.3 Transplants**

There were few viable native trees and shrubs to transplant in the disturbance area. Most of the trees were pine. Only three trees were transplanted during construction.

### **2.1.4 Additional Planting**

Additional planting of containerized native trees and shrubs was conducted throughout the easement where there was disturbance from construction at a minimum density of 320 stems/acre. A total of 270 trees and shrubs were planted. Trees were planted outside of the utility easement and play over areas and included equal numbers of river birch (*Betula nigra*), sycamore (*Platanus occidentalis*), and willow oak (*Quercus phellos*). Shrubs were planted within the utility easement and play over areas and included equal numbers of silky dogwood (*Cornus amomum*), spice bush (*Lindera benzoin*), and buttonbush (*Cephalanthus occidentalis*).

All disturbed areas were seeded with permanent seeding as specified in the repair design plans.

### **2.1.5 Contractor Warranties**

The contractor is responsible for maintaining a survival density of 320 stems/acre on all areas cleared and planted for the duration of the first growing season following installation. The contractor will incur the cost of replacement through this period. At least thirty days prior to the end of the first growing season an on-site inspection will be conducted and the Contractor will be directed accordingly on mortality and replacement requirements, if necessary.

The contractor also guarantees materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve months following the final acceptance of the work. The contractor will replace any defective materials or workmanship without cost to the owner.

## **2.2 Restoration Components**

The repairs restored the planform of the prior-restored stream and have not caused any changes to the site's mitigation assets. See Table 1 for the current credit calculation.

# TABLES AND FIGURES

<b>Table 1. Project Restoration Components</b>						
<b>Project Number and Name: 276 - Richland Creek (Paschal) Stream Restoration Site</b>						
<b>Project Component</b>	<b>Restoration Level</b>	<b>Original Linear Feet</b>	<b>Post Repair Linear Feet</b>	<b>Original Stationing</b>	<b>Post Repair Stationing</b>	<b>Comment</b>
Richland Creek	Restoration	2,919	2,919	10+00 to 39+80	10+00 to 39+80	No changes from repair work.

<b>Table 2. Post-Repair Component Summations</b>							
<b>Project Number and Name: 276 - Richland Creek (Paschal) Stream Restoration Site</b>							
<b>Restoration Level</b>	<b>Stream (lf)</b>	<b>Riparian Wetland (Ac)</b>		<b>Non-Riparian (Ac)</b>	<b>Upland (Ac)</b>	<b>Buffer (Ac)</b>	<b>BMP</b>
		<b>Riverine</b>	<b>Non-Riverine</b>				
Restoration	2,919					3.84	
Enhancement							
Enhancement I							
Enhancement II							
Creation							
Preservation							
HQ Preservation							

<b>Table 3. Project Contacts Table</b>	
<b>Project Number and Name: 276 - Richland Creek (Paschal) Stream Restoration Site</b>	
<b>Site Repair/Maintenance</b>	
<b>Design Firm</b>	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266
<b>Construction and Planting Contractor</b>	Fluvial Solutions, Inc. PO Box 28749 Raleigh, NC 27611-8749 Contact: Mr. Peter Jelenevsky Phone: (919) 605-6134

**APPENDIX A**

**PROJECT PHOTO LOG**



3/31/2016 – Repair Area 1. Looking upstream at the vegetated soil lifts on the outer bank in the background and the constructed riffle with vegetated soil lifts in the foreground.



3/31/2016 – Repair Area 2. Looking downstream at the vegetated soil lifts on the outer bank.



3/31/2016 – Repair Area 3. Looking upstream at the vegetated soil lifts on the outer bank.



3/31/2016 – Repair Area 3. Looking downstream at the stone stabilization installed along the drainage ditch. Fine materials from upstream have washed into the riprap.



3/31/2016 – Repair Area 4. Looking downstream at the vegetated soil lifts on the outer bank.



3/31/2016 – Repair Area 5. Looking downstream at the vegetated soil lifts on the outer bank. Note the white PVC pipe that drains the golf course to the stream.

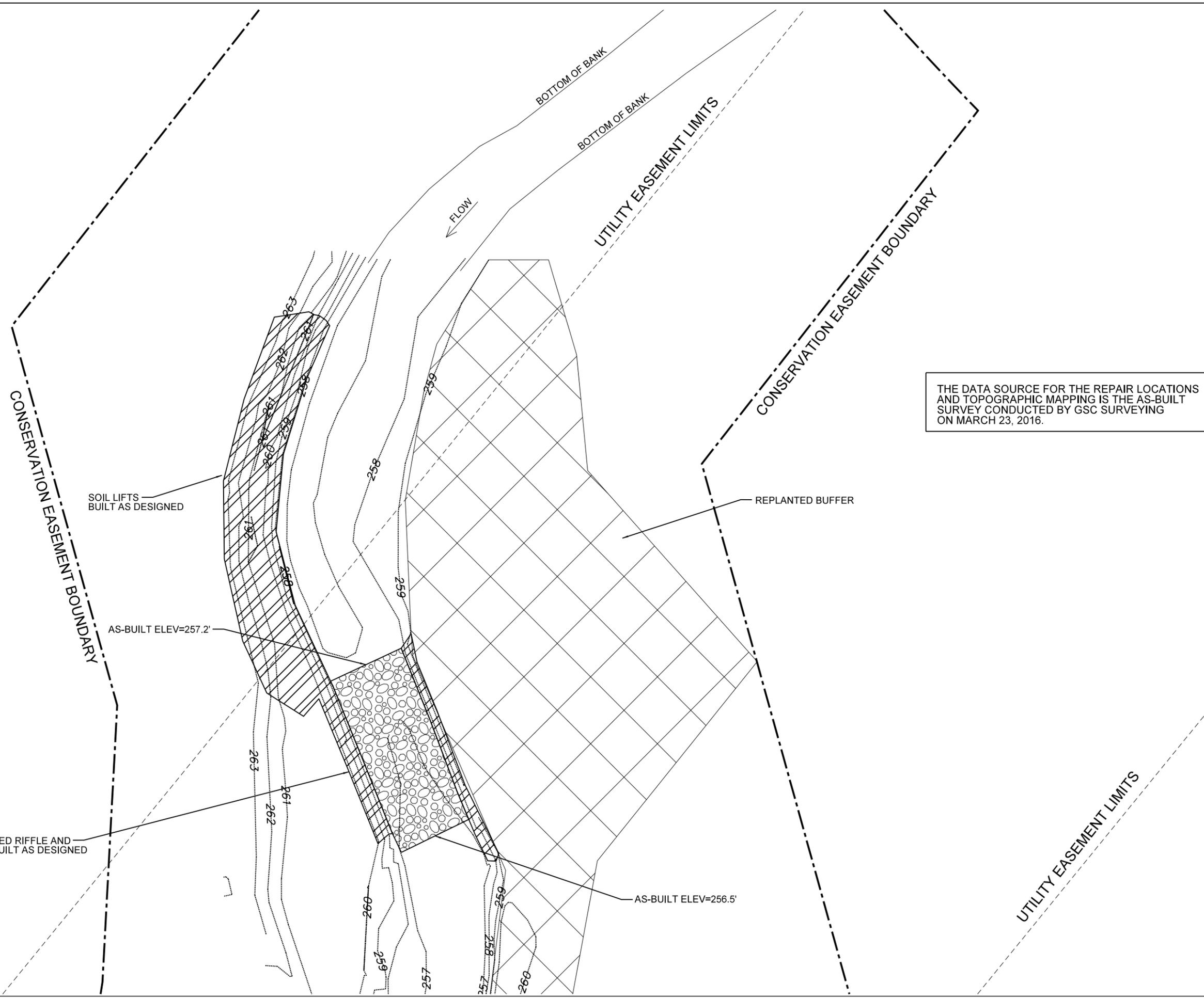
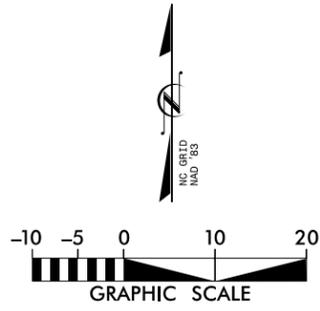


3/31/2016 – Repair Area 6. Looking downstream at the vegetated soil lifts on the outer bank.

**APPENDIX B**

**RECORD DRAWINGS**





THE DATA SOURCE FOR THE REPAIR LOCATIONS AND TOPOGRAPHIC MAPPING IS THE AS-BUILT SURVEY CONDUCTED BY GSC SURVEYING ON MARCH 23, 2016.

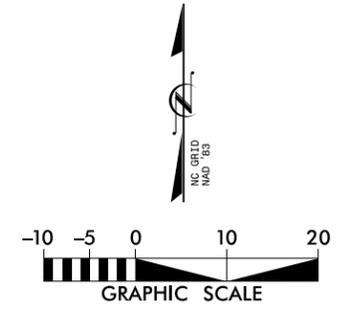
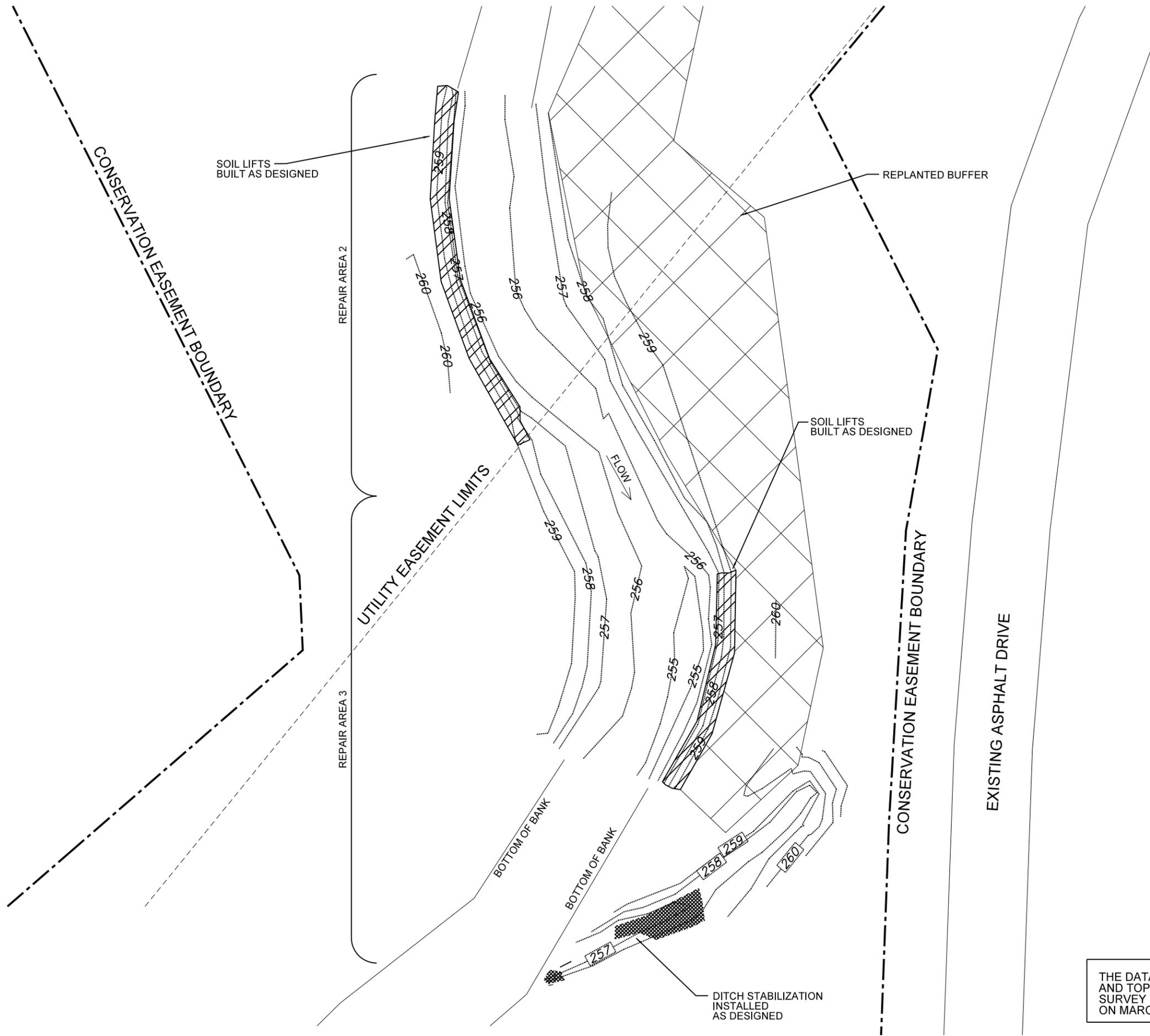
NO.	DATE	REVISIONS

**NCDEQ DIVISION OF MITIGATION SERVICES**

**KCI**  
ASSOCIATES OF NC  
ENGINEERS • PLANNERS • SCIENTISTS  
4601 SIX FORKS ROAD, SUITE 220  
RALEIGH, NORTH CAROLINA 27609

**RICHLAND CREEK  
STREAM RESTORATION REPAIR  
DMS #276**  
WAKE FOREST, WAKE COUNTY, NORTH CAROLINA

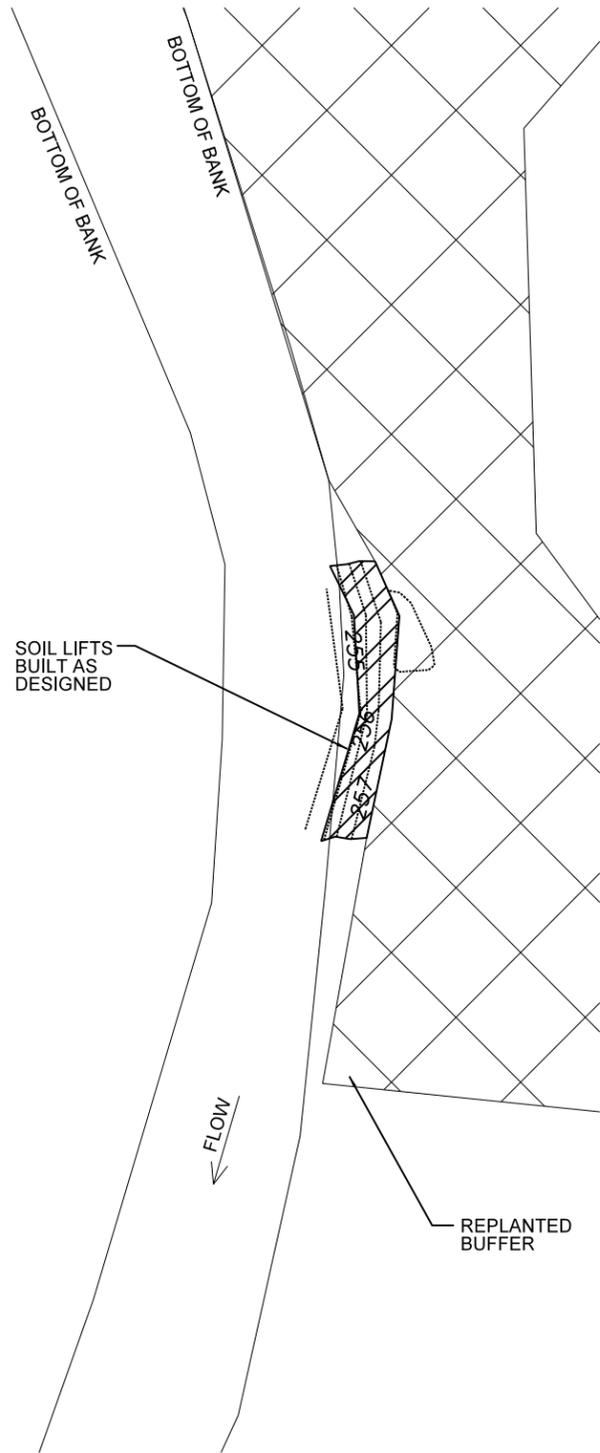
DATE: MAY 2016  
SCALE: GRAPHIC  
**RECORD DRAWINGS AREA 1**  
SHEET 2 OF 4



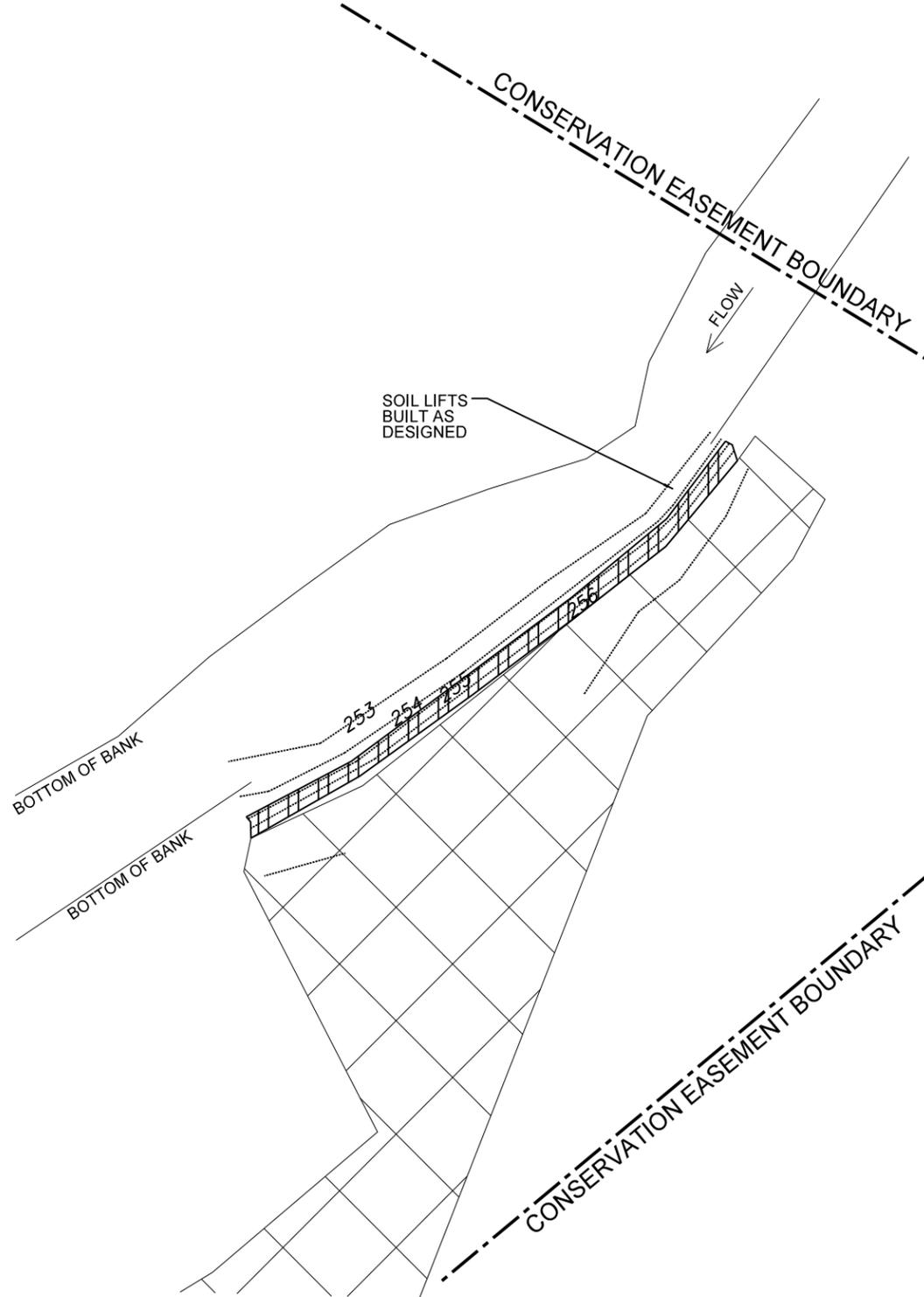
THE DATA SOURCE FOR THE REPAIR LOCATIONS AND TOPOGRAPHIC MAPPING IS THE AS-BUILT SURVEY CONDUCTED BY GSC SURVEYING ON MARCH 23, 2016.

 ENGINEERS • PLANNERS • SCIENTISTS 4601 SIX FORKS ROAD, SUITE 220 RALEIGH, NORTH CAROLINA 27609		NCDEQ DIVISION OF MITIGATION SERVICES	REVISIONS
RICHLAND CREEK STREAM RESTORATION REPAIR DMS #276		WAKE FOREST, WAKE COUNTY, NORTH CAROLINA	
DATE: MAY 2016 SCALE: GRAPHIC		RECORD DRAWINGS AREAS 2 & 3	
SHEET 7 OF 4		REVISIONS	

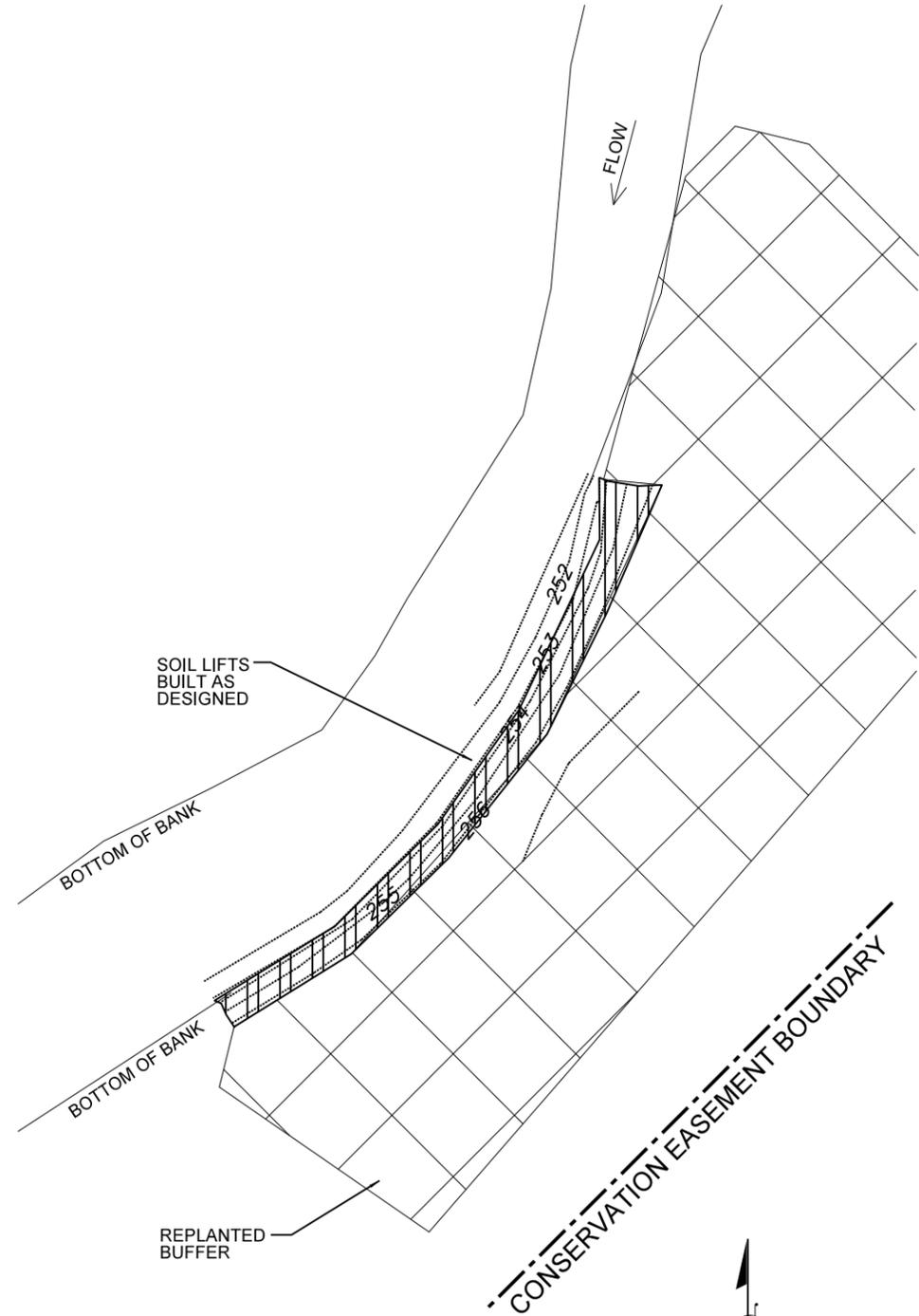
### REPAIR AREA #4



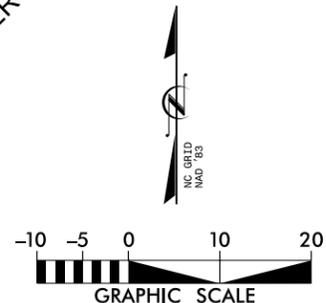
### REPAIR AREA #5



### REPAIR AREA #6



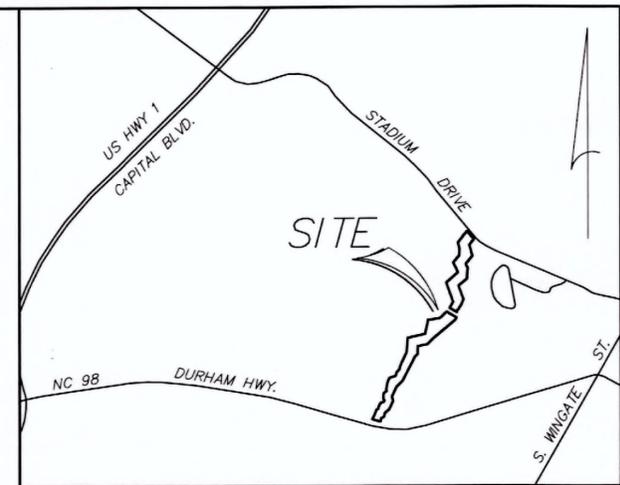
THE DATA SOURCE FOR THE REPAIR LOCATIONS AND TOPOGRAPHIC MAPPING IS THE AS-BUILT SURVEY CONDUCTED BY GSC SURVEYING ON MARCH 23, 2016.



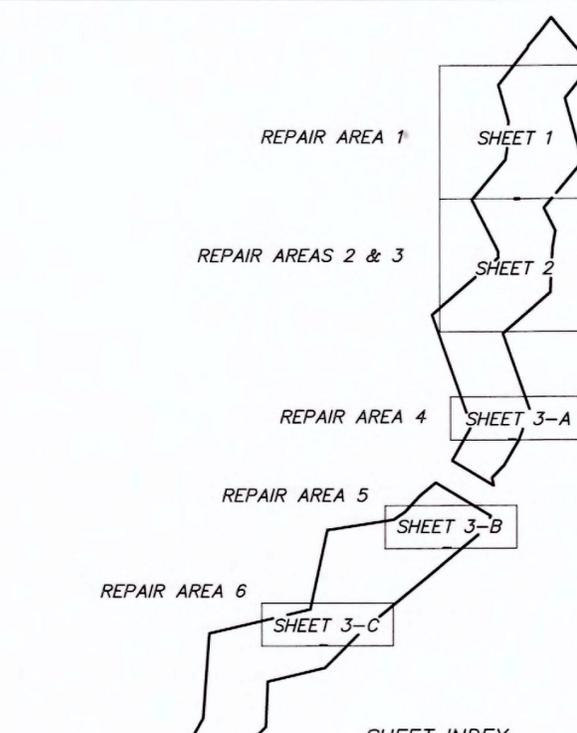
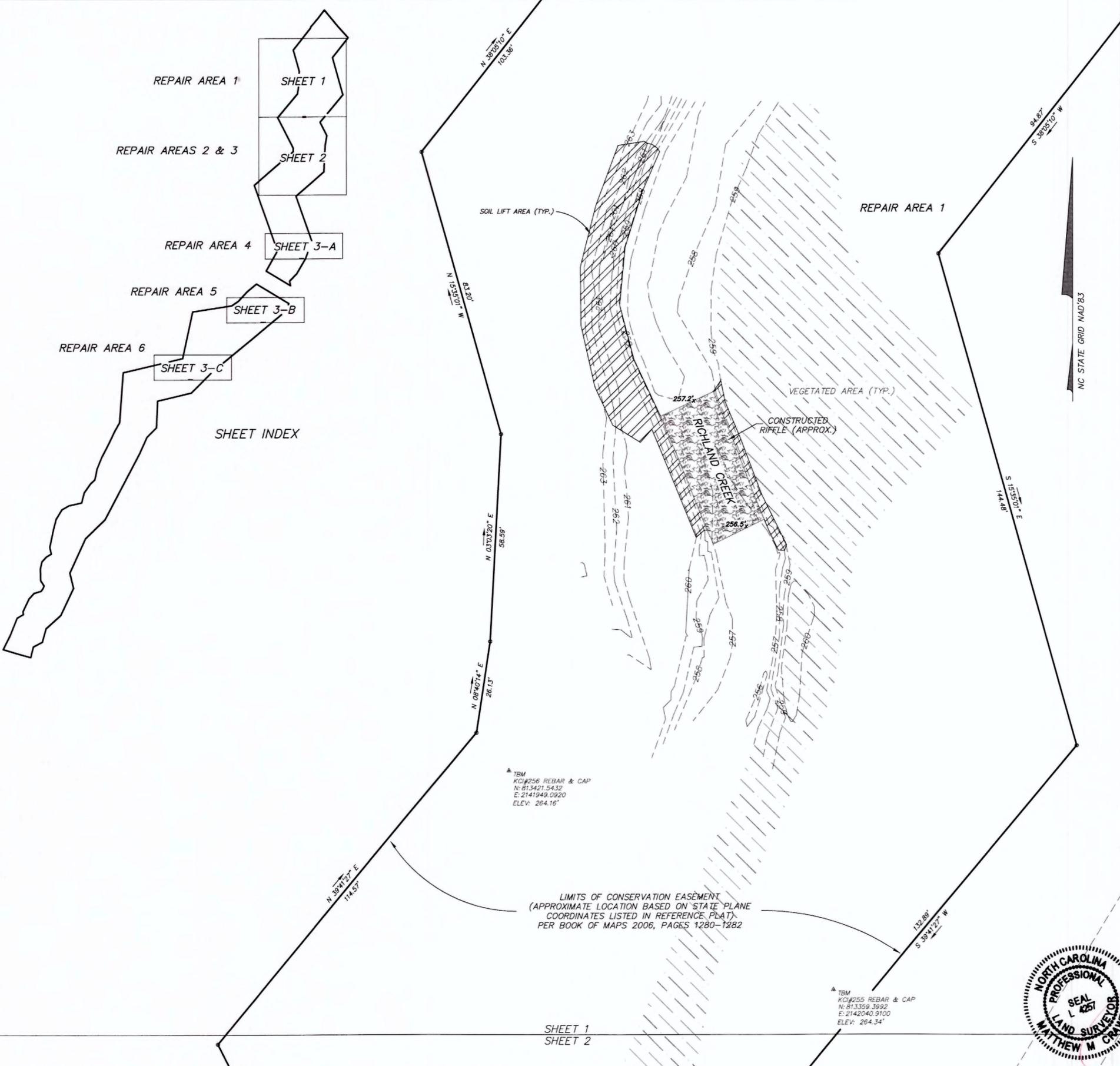
REVISIONS	
NCDEQ DIVISION OF MITIGATION SERVICES	
 ENGINEERS • PLANNERS • SCIENTISTS 4601 SIX FORKS ROAD, SUITE 220 RALEIGH, NORTH CAROLINA 27609	
RICHLAND CREEK STREAM RESTORATION REPAIR DMS #276 WAKE FOREST, WAKE COUNTY, NORTH CAROLINA	
DATE: MAY 2016	SCALE: GRAPHIC
RECORD DRAWINGS AREAS 4, 5, AND 6	
SHEET 4 OF 4	

**APPENDIX C**

**CONTRACTOR'S AS-BUILT**



VICINITY MAP NOT TO SCALE



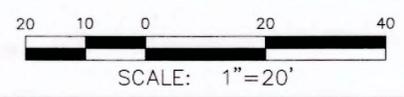
**SURVEY NOTES**

1. PREPARED FOR NCDEQ DIVISION OF MITIGATION SERVICES.
2. HORIZONTAL IS BASED ON NC STATE GRID, NAD-83 (2011), AND VERTICAL CONTROL IS BASED ON NAVD'88, AS ESTABLISHED BY KCI ASSOCIATES OF NC.
3. CONTOUR INTERVAL IS ONE FOOT (1.0').
4. THIS SURVEY DOES NOT VERIFY THE EXISTENCE OF, NOR CERTIFY THE LOCATION OF, ANY JURISDICTIONAL WETLANDS THAT MAY EXIST ON THIS PROPERTY.
5. BOUNDARY AND EASEMENT INFORMATION AS SHOWN HEREON IS BASED ON REFERENCE PLATS OF RECORD AND IS APPROXIMATE. NO PROPERTY CORNERS HAVE BEEN LOCATED BY THIS SURVEY.

**SURVEYOR'S CERTIFICATION**

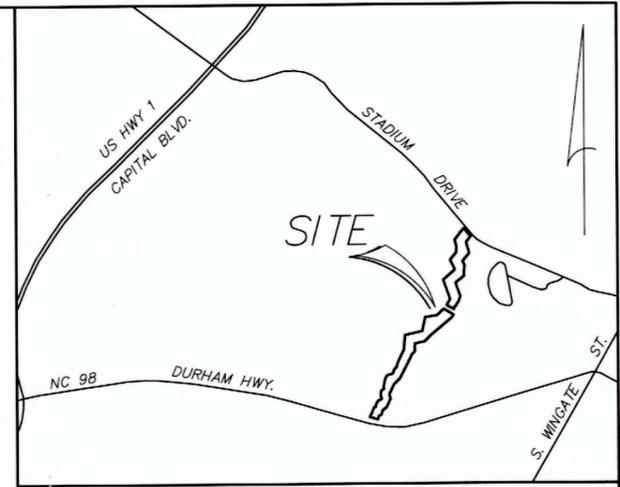
I, MATTHEW M. CRAWFORD, CERTIFY THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM A SURVEY MADE UNDER MY SUPERVISION; THAT THIS MAP DOES NOT REPRESENT AN OFFICIAL BOUNDARY SURVEY AND HAS NOT BEEN PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED.

*Matthew M. Crawford*  
 MATTHEW M. CRAWFORD, NCPLS No. L-4257 DATE: **APRIL 12, 2016**



<p>4072 BARRETT DRIVE          RALEIGH, NC 27609          PHONE (919) 787-5805 * FAX (919) 787-5806          NC CORPORATE LICENSE No. C-2335</p>	ASBUILT SURVEY OF PORTIONS OF <b>RICHLAND CREEK          STREAM RESTORATION &amp; REPAIR          REPAIR AREA 1</b> TOWN OF WAKE FOREST WAKE COUNTY, NORTH CAROLINA	
	DATE: MAR 23, 2016	SCALE: 1" = 20'

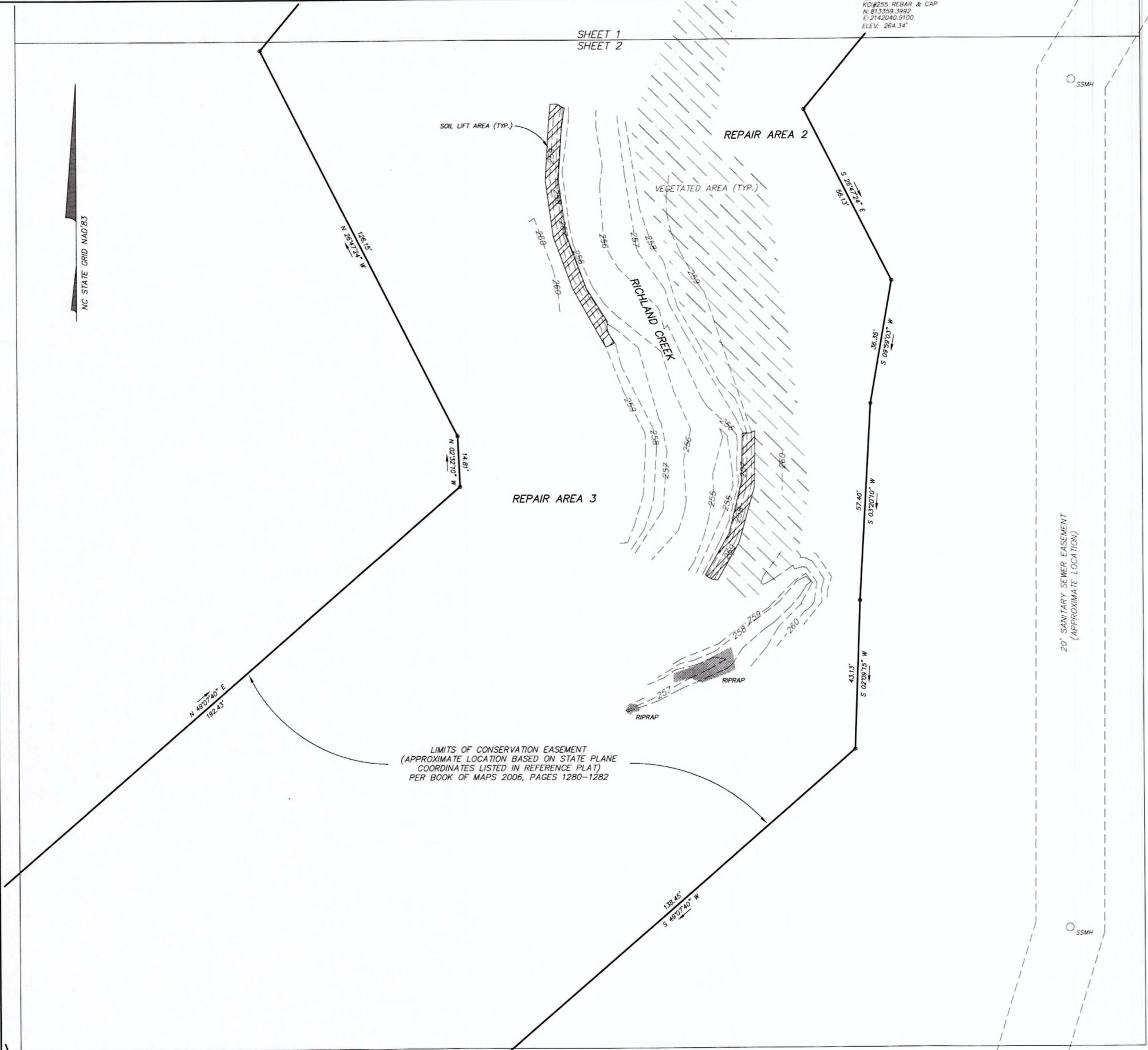
GSC PROJECT: 16-006



KO#255 REBAR & CAP  
 N: 813359.3992  
 E: 2142040.9100  
 ELEV: 264.34'

SHEET 1  
 SHEET 2

NC STATE GRID NAD'83

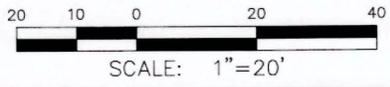


LIMITS OF CONSERVATION EASEMENT  
 (APPROXIMATE LOCATION BASED ON STATE PLANE  
 COORDINATES LISTED IN REFERENCE PLAT)  
 PER BOOK OF MAPS 2006, PAGES 1280-1282



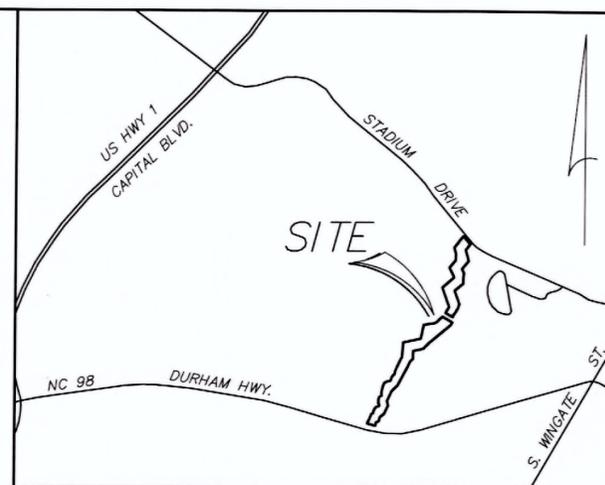
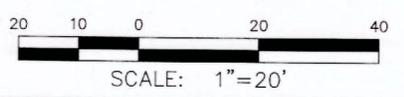
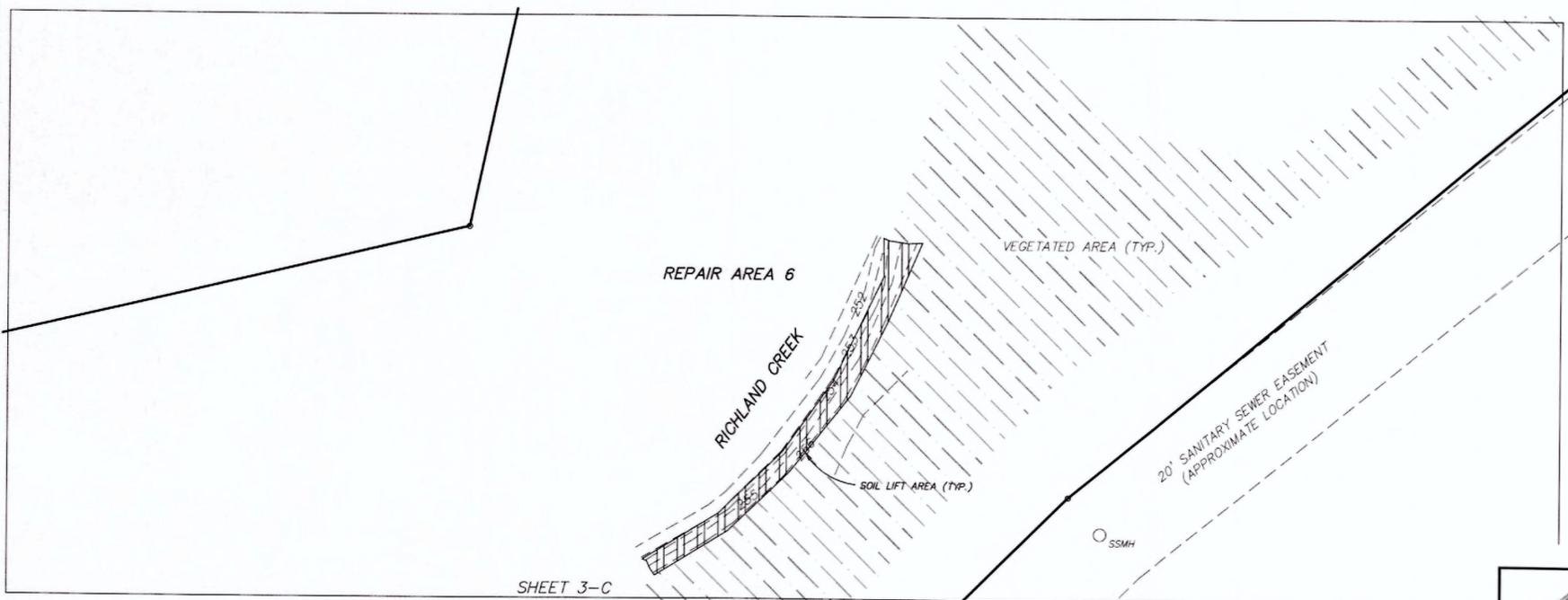
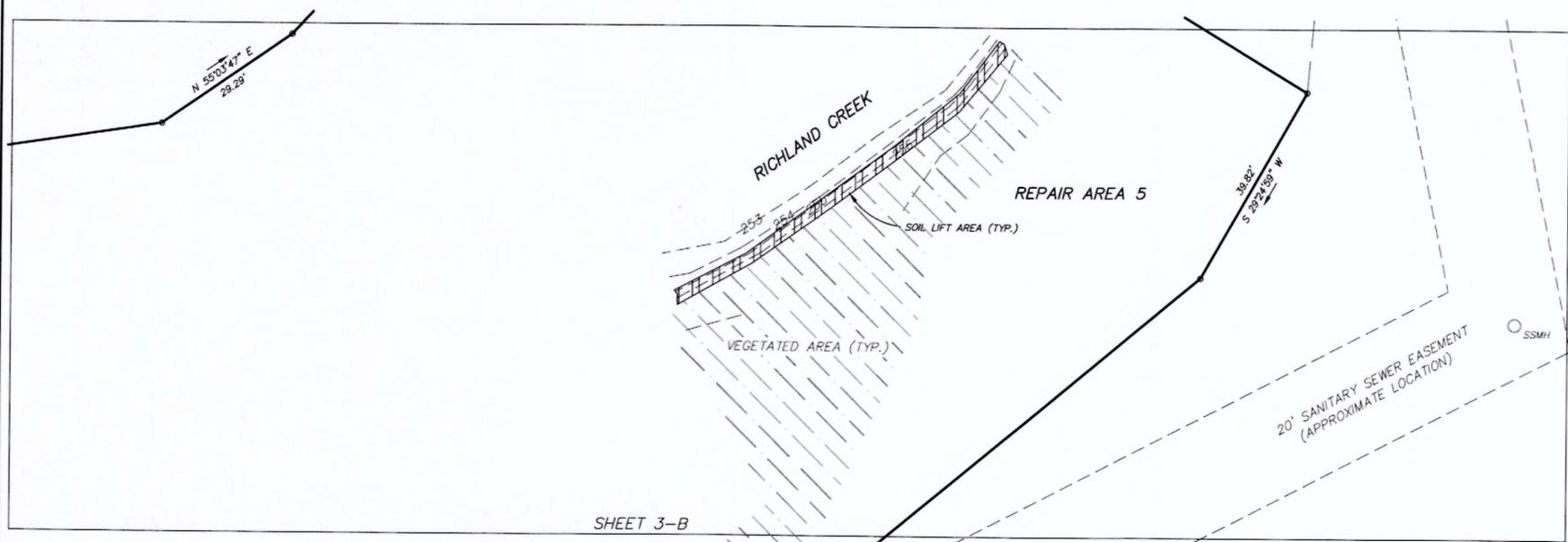
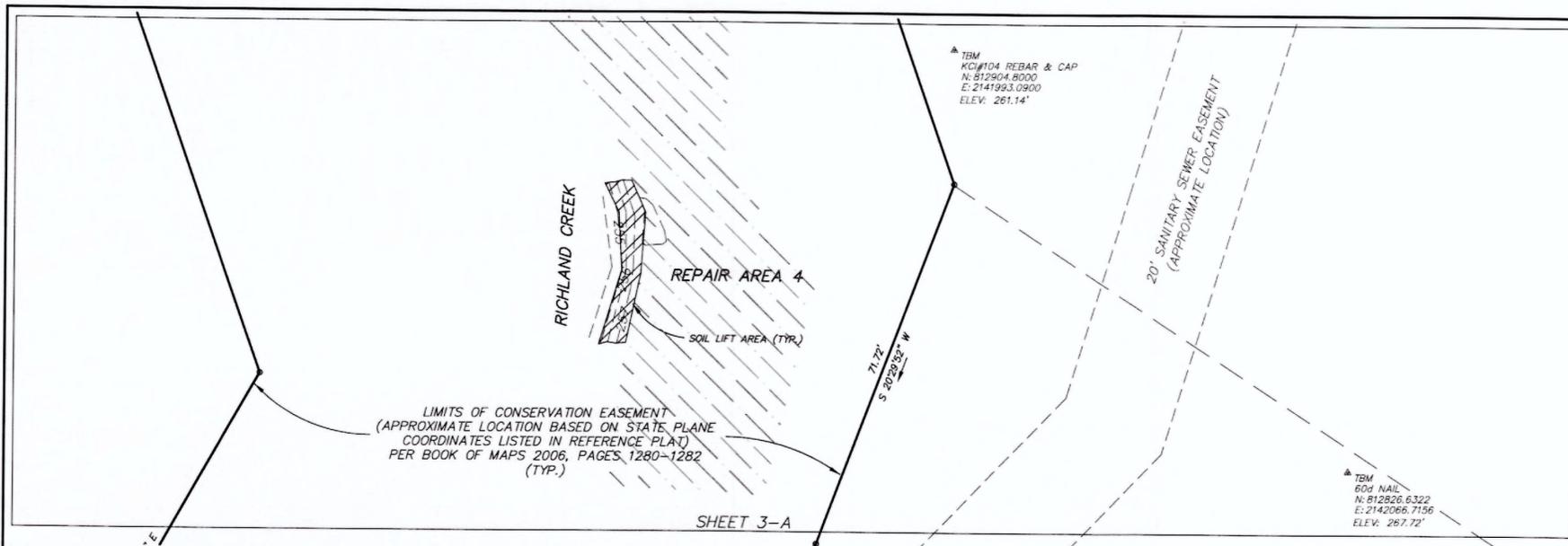
APR 17, 2016

GSC PROJECT: 16-006



**GSC SURVEYING**  
 4072 BARRETT DRIVE  
 RALEIGH, NC 27609  
 PHONE (919) 787-5805 \* FAX (919) 787-5806  
 NC CORPORATE LICENSE No. C-2335

ASBUILT SURVEY OF PORTIONS OF RICHLAND CREEK STREAM RESTORATION & REPAIR REPAIR AREAS 2 & 3 TOWN OF WAKE FOREST WAKE COUNTY, NORTH CAROLINA		
DATE: MAR 23, 2016	SCALE: 1" = 20'	SHEET: 2 OF 3



*April 12, 2016*

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GSC PROJECT: 16-006		
ASBUILT SURVEY OF PORTIONS OF <b>RICHLAND CREEK      STREAM RESTORATION &amp; REPAIR      REPAIR AREAS 4, 5 &amp; 6</b>		
TOWN OF WAKE FOREST WAKE COUNTY, NORTH CAROLINA		
DATE: MAR 23, 2016	SCALE: 1" = 20'	SHEET: 3 OF 3