FAUQUIER COUNTY WATER & SANITATION AUTHORITY

7172 Kennedy Road - Vint Hill Farms
Warrenton, Virginia 20187-3907
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ELECTRICAL RESISTIVITY (ER) IMAGING SURVEY REPORT

ROGUES ROAD, FAUQUIER COUNTY, VA

Prepared by:

RETAW ENGINEERING LLC
2903 Sagecreek Circle
Midlothian, Virginia 23112
Phone: (804 744-1792

&

APEX Companies LLC
8854 Rixlew Lane
Manassas, Virginia 20109
Phone: 703-396-6730

– Task Order # 003 –

Engineering & Hydrogeological Services Contract No. 13-P-99-0201-D

AUGUST 15, 2014

August 15, 2014

Mr. Ignatius Mutoti, PE
Retaw Engineering LLC
2903 Sagecreek Circle
Midlothian, VA 23112

Re: Electrical Resistivity (ER) Survey Report
Rogues Road, Fauquier County, VA
Contract #13-P-99-0201-D, Task Order #003

Dear Mr. Mutoti:

Please find the attached Rouges Road Electrical Resistivity Report for Fauquier County Parcel ID 7914-59-7136-000 located at Rogues Road, Warrenton, Virginia for your review. Based on survey results, please see attached pseudo sections saturated zones and proposed test well locations. The following was noted:

Apparent connectivity that saturated zones in Lines 2 & 3 appear to be hydraulically connected. See proposed Test Well locations selected to minimize surface water recharge potential. Test well depths would be approximately 200 feet (and possibly greater in Test Well #1)
Apparent connectivity of saturated zones Lines 1 & 4 have a potential for surface water impact, but also have potential greater transmissivity and sustained yields.

I look forward to meeting with you and Fauquier County Water and Sanitation Authority to further discuss the survey results and proposed test well locations. Please let me know if you have any questions or require further information on this survey.

Sincerely,
Apex Companies, LLC

John Strecker
Division Manager

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Geophysical Survey
Fauquier County Water and Sanitation Authority
Rogues Road
Fauquier County, Virginia

Prepared For:
APEX Companies LLC
8854 Rixlew Lane
Manassas, Virginia 20109

Prepared By:
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(703) 648-9090

August 2014

FES Project No. 14159

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1. EXECUTIVE SUMMARY

RETAW and Apex Companies was contracted by Fauquier County Water and Sanitation Authority (FCWSA) under Task Order # 003 - Contract No. 13-P-99-0201-D. Apex retained Forrest Environmental Services (FES) to perform a geophysical survey at Fauquier County Parcel ID 7914-59-7136-000 located on Rogues Road, Warrenton, Virginia on the 28th and 29th August 2014.

The survey consisted of an electric resistivity imaging (ER) survey to located saturated fractures that may indicate that the major groundwater path flows to placement of potable wells. Two mostly northwest southeast (ER lines 1 and 2) and two northeast-southwest (ER line 3 and 4) lines were conducted south of Rogues Road. ER lines 1 through 4 used 84 electrodes at 3 meter centers for a total line length of 830 feet. The survey covered an area approximately 3,300 linear feet and approximately 14,500 soundings were collected.

The site is located the Piedmont physiographic province of Virginia. The site is geology consists of the Balls Bluff Siltstone of the Triassic Newark Super Group. The Balls Bluff Siltstone consists of a brownish-red medium bedded argillaceous sandy siltstone.

The objective of the ER survey was to locate saturated fractures that may indicate the major groundwater path flows. The geophysical survey located three saturated zones. The saturated zones appear to be approximately 40 meters below ground surface. ER Line 2 indicates most conductive anomaly. ER Line 3 indicates the deepest conductive anomaly.

2. INTRODUCTION

Forrest Environmental Services (FES) performed a geophysical survey for Fauquier County Water and Sanitation Authority on Rogues Road near Vint Hill, Virginia on the 28th and 29th August 2014. The survey consisted of an electric resistivity imaging (ER) survey to located saturated fractures that may indicate that the major groundwater path flows to placement of potable wells.

Two mostly northwest southeast (ER lines 1 and 2) and two northeast-southwest (ER lines 3 and 4) lines were conducted south of Rogues Road. ER lines 1 through 4 used 84 electrodes at 3 meter centers for a total line length of 830 feet. The survey covered an area approximately 3,300 linear feet and approximately 14,500 soundings were collected.

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Topographically, the site slopes toward the east. The site consists mostly of grassed fields and wooded areas. Survey locations and physical features are shown in Figure 1. Details of the geophysical survey are described in the following sections.

3. EQUIPMENT AND PROCEDURES

The geophysical survey instrument used during this survey was an earth resistivity meter that maps the resistivity changes in the earth. ER is a fundamental parameter of the material that describes how easily the material can transmit electrical current. High values of resistivity imply that the material is very resistant to the flow of electricity, and low values of resistivity imply that the material transmits electrical current very easily.

The primary factors affecting resistivity of earth materials are porosity, water saturation, clay content, and ionic strength of the pore water. The minerals making up soil and rock generally do not readily conduct electric current. Most of the current flow takes place through the material’s pore water in which ER decreases with increasing porosity and water saturation. Clay minerals are conductive because of the availability of free ions in the sheet structure of the clay particles in which ER decreases with increasing clay content. Similarly, dissolved ions in groundwater make the water more conductive to electrical current in which ER decreases with increasing ionic strength.

The ER survey was conducted by introducing a measured current into the earth through two adjacent electrodes and measuring the resultant voltage across two different electrodes at a predetermined distance apart. The voltage across two other electrodes is measured simultaneously with the applied current. At the low currents used, voltage is proportional to the current. The meter measures the voltage/current ratio or resistance in Ohms.

The ER survey was conducted using a Sting R8 earth resistivity meter (Sting), which measures the apparent resistivity of the subsurface employing an artificial source that is introduced through point electrodes. The Sting measures electrical potentials at other electrodes.

The Swift automatic electrode system (Swift) was connected to the Sting to optimize survey efficiency by gathering maximum information with a minimum of electrodes. The Swift also uses redundancies in the data set to reduce the effects of lateral heterogeneities in the earth and to calculate uncertainties in the data. The survey was conducted automatically using the Sting/Swift dipole-dipole array system.

A contact resistance test was conducted before the Sting/Swift dipole-dipole survey commenced. The contact resistance test ensures the stake has good contact with the ground. The Sting produces a current between the first two stakes and measures the voltage. The instrument measures the resistance between the first and second stakes and the ground. The contact resistance is also checked for the measurements consistent for all of the 84 electrodes.

The Swift cable resistance checks the voltage difference signal between two electrodes. Four leads of the Swift cable using two electrodes send a current through a 1 ohm resistor in the Swift box. The test is checked before the first ER survey and after the last ER line for each day.

The Swift switch relays test is performed to check the Swift box is continuous and the relays in the electrodes are working properly. A current is sent through each lead in the Swift cable to make sure the relays are functioning properly and there is no leakage between leads, and to test the relays for sticking. The test is checked before the first ER survey and after the last ER line for each day.

The depth of investigation by Sting is a function of the total distance of the electrode layout was 249 meters (830 feet) for ER lines 1 through 4. The Sting has an effective analysis depth of approximately 75 meters (250 feet) using a 3 meter (10 feet) electrode spacing. This depth is considered sufficient to locate resistive areas that appear to be saturated zones at the Rogues Road site.

4. Interpretation Methods

The ER data were converted into a resistivity depth model using Rapid 2D resistivity inversion model and the least-squares method (RES2DINV). Soundings from each line were modeled to produce the measured apparent resistivity cross-sections. The model calculated the apparent resistivity cross-sections using finite-difference forward modeling. The least-squares optimization technique was used for the inversion routine that calculated the modeled resistivity section. The ER output consists of the inverse model resistivity cross-section. The model fits the measured data to an earth model that represents actual resistivities in the profile. The model is completed by back calculating apparent resistivities from the earth model for comparison to the measured data. The horizontal and vertical scales are in feet.

The cross-section is the inverse model resistivity pseudo-section. The ER data was converted into a resistivity depth model (RES2DINV) using a resistivity inversion model by the least-squares method and is topographically corrected. The ground surface elevations were determined by interpolating between contours from a topographic contour map produced by APEX Companies LLC. RES2DINV confirms the model reliability by calculating the modeled data into empirical data or the calculated resistivity pseudo-section. The difference between the measured and calculated data is the root mean square percent error. The modeled calculated mean root square error averaged approximately 10 rms error which is considered accurate.

Resistive materials resist the flow of electrical current such as sand and gravel. Conductive materials are media that current flows relatively easy such as clay.

Low resistive materials can be caused by certain conductive soils such as clay. High resistive materials are caused generally by wood and air. Low ER values represent thick overburden. Lower ER anomalies are generally found over saturated mine shafts.

Typical resistivities of the overburden (clay) are less than 100 ohm meters (blue). Bedrock resistivities typically range from 100 (green) to 5,000 (red) ohm meters. The saturated zone resistivities typically measure approximately 50 ohm meters (dark blue).

5. Survey Results

The objective of the ER survey was to locate saturated fractures that may indicate the major groundwater path flows. ER cross-sections are provided in Appendix A. The horizontal scale is in meters. The vertical scale is in meters above mean sea level (msl).

ER Line 1 indicates one conductive anomaly centered at approximately 160 meters Southeast approximately 40 meters below ground surface. The conductive anomaly appears to be a saturated zone.

ER Line 2 indicates two conductive anomalies centered at approximately 85 meters South approximately 40 meters below ground surface. The conductive anomaly appears to be a saturated zone.

ER Line 3 indicates one conductive anomaly centered at approximately 140 meters Southwest approximately 40 meters below ground surface. The conductive anomaly appears to be a saturated zone.

ER Line 4 indicates no conductive anomalies.

The geophysical survey located three saturated zones (Figure 2). The saturated zones appear to be approximately 40 meters below ground surface. ER Line 2 indicates most conductive anomaly. ER Line 3 indicates the deepest conductive anomaly.

Photo 1 - ER Equipment at ER Line 4.

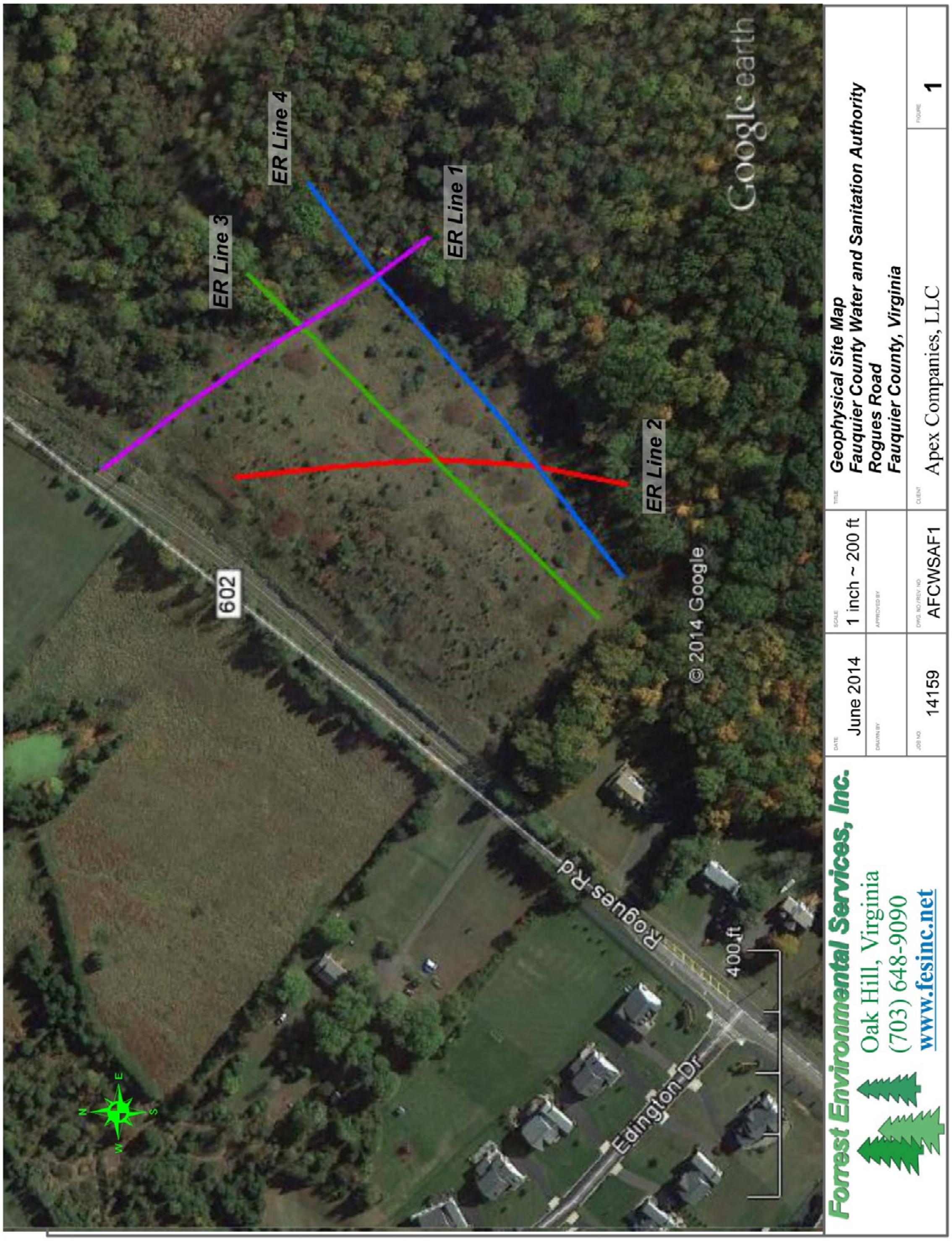


Figure 1 Geophysical Boundary Map

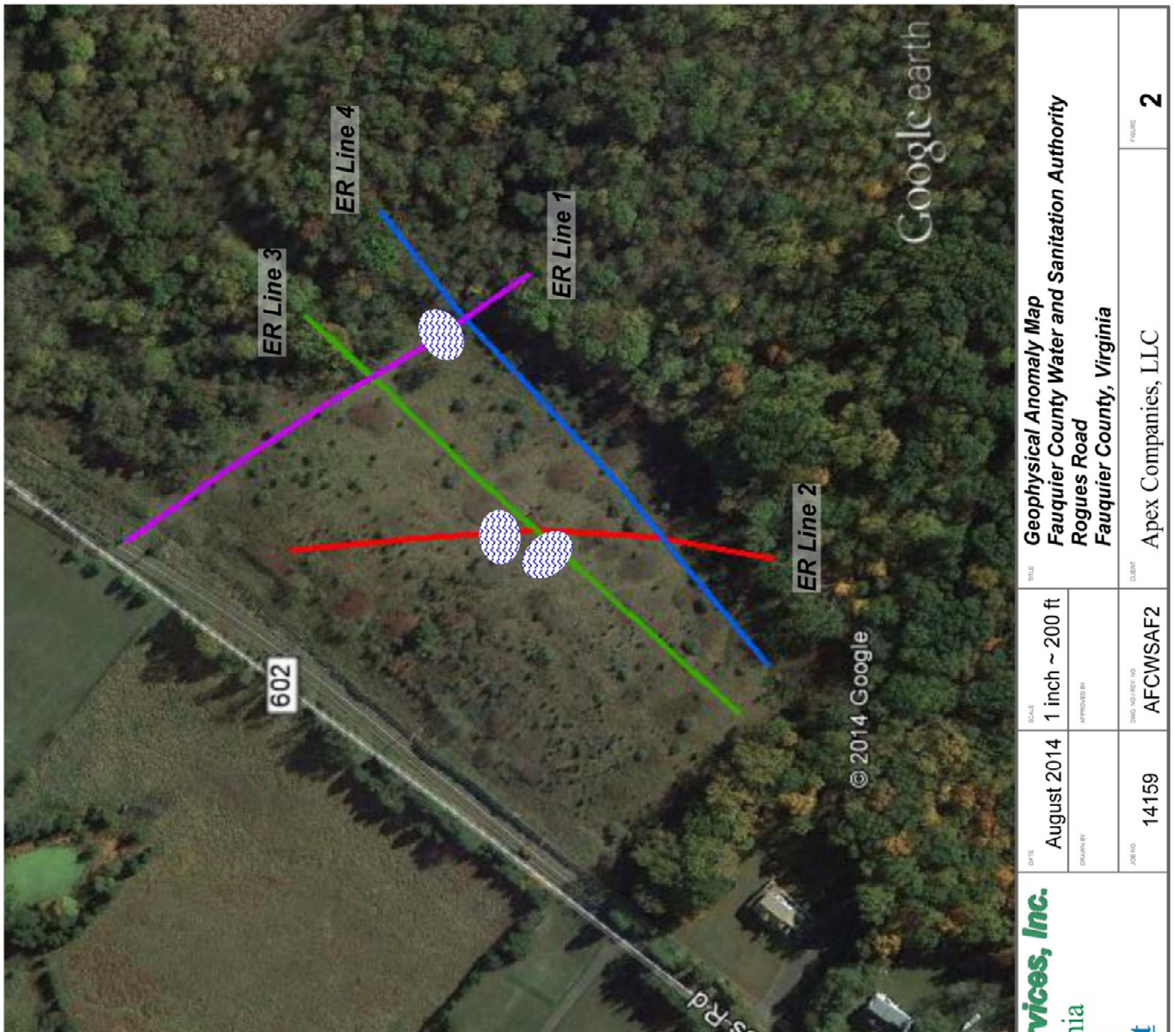
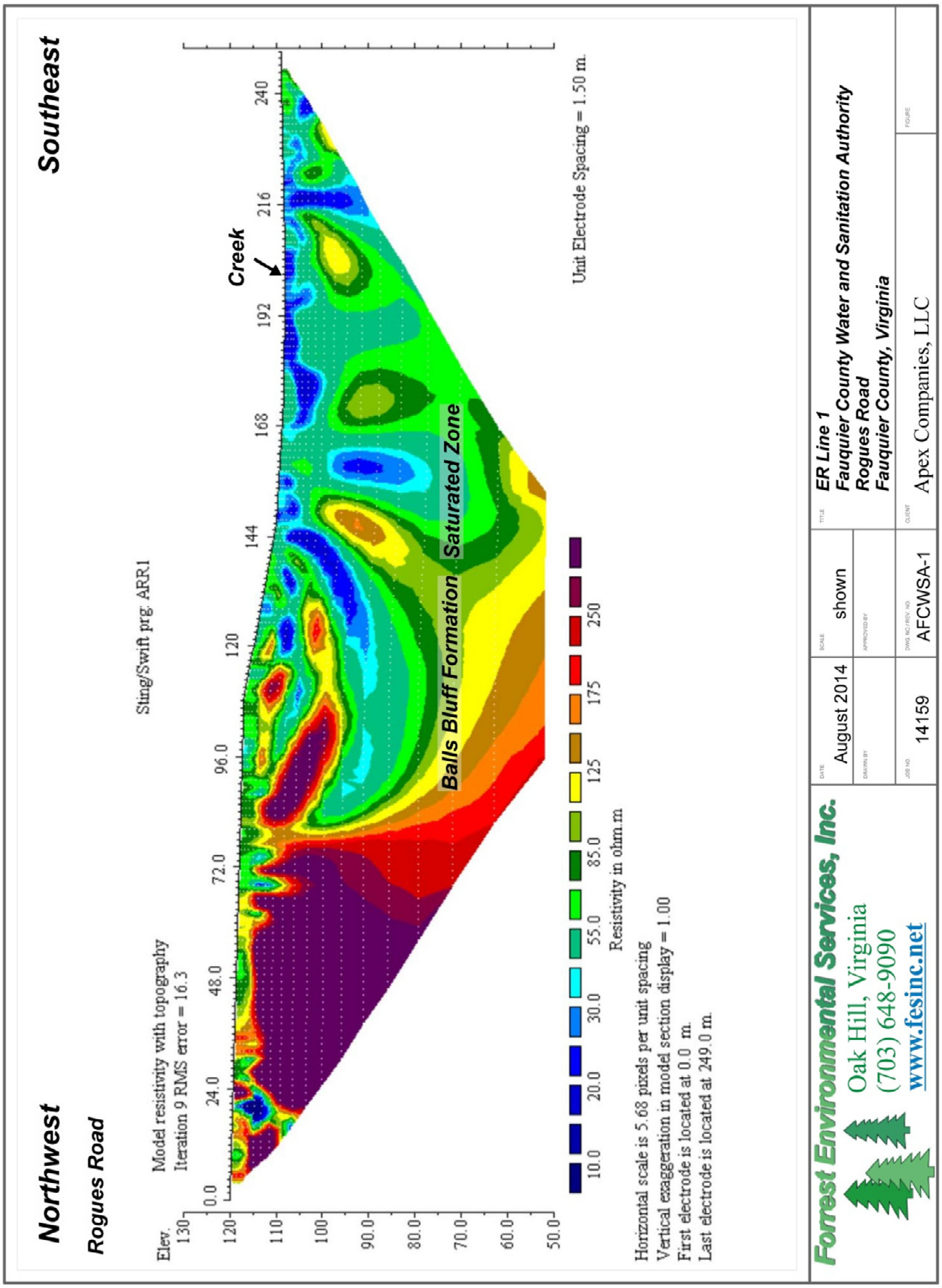
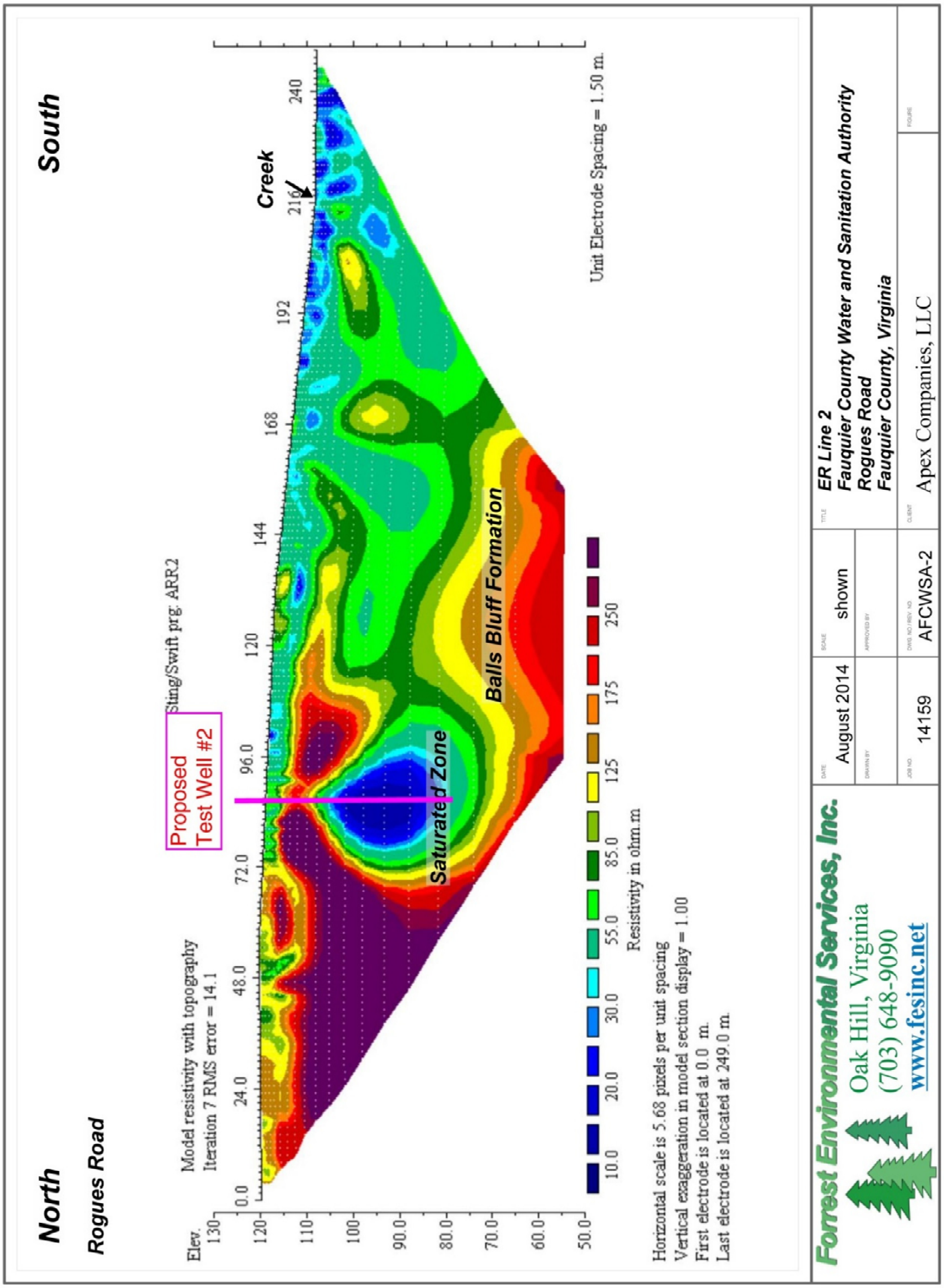


Figure 2 Geophysical Anomaly Map

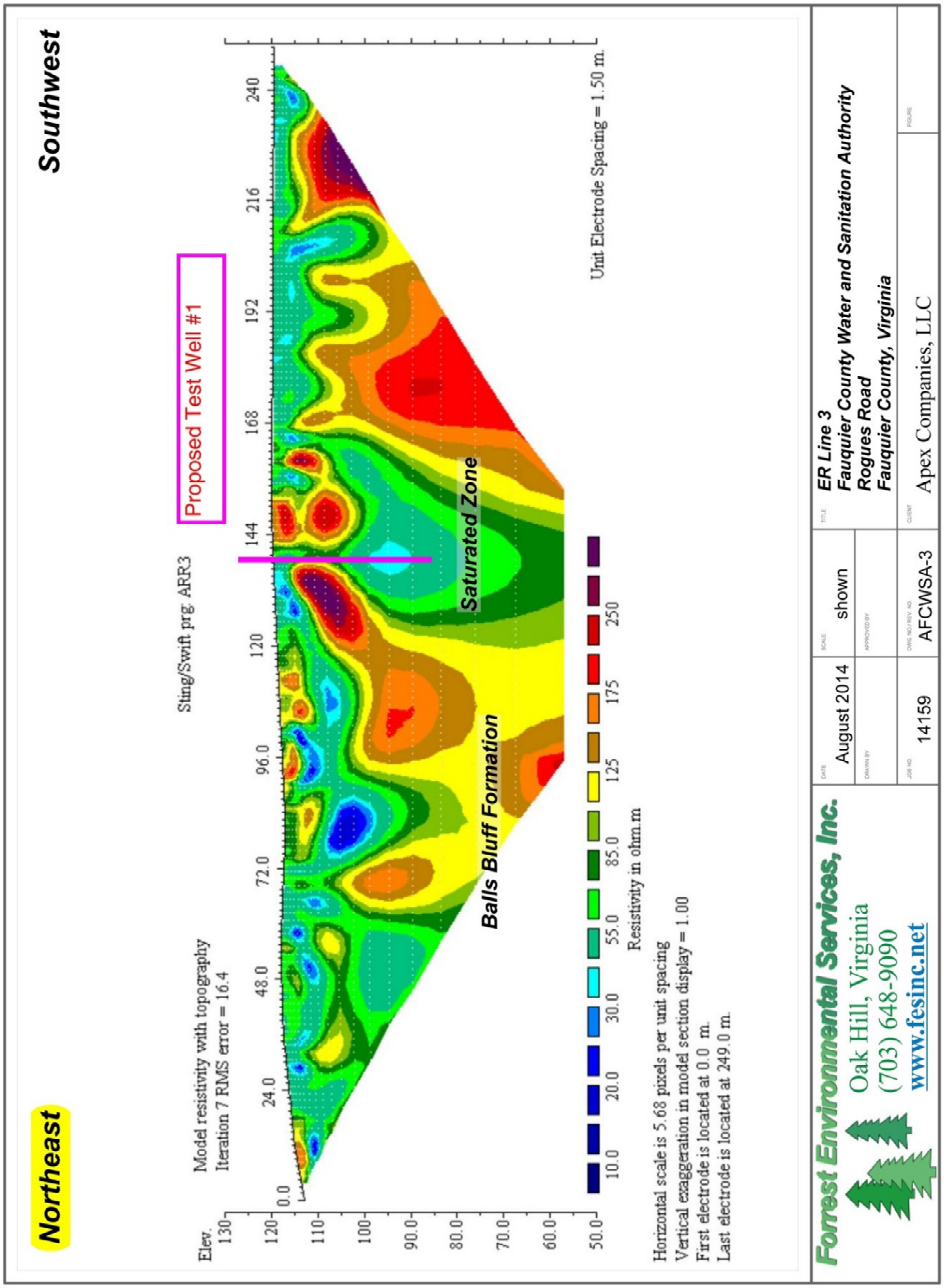
APPENDX A
ER Cross-Section 1



ER Cross-Section 2



ER Cross-Section 3



ER Cross-Section 4