Pyramid Project # 2005177

GEOPHYSICAL INVESTIGATION REPORT

ELECTRICAL RESISTIVITY INVESTIGATIONS

Pimmit Run & Minnehaha Creek Trail Bridges

Brookmont, Virginia & Glen Echo, Maryland

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Report prepared for: **Khalid T. Mohamed, PE**
Division Geotechnical Engineer
Eastern Federal Lands Highway Division
Sterling, Virginia 22304

Prepared by: ___________________________________
Mark J. Denil, PG (Project Geophysicist)

Reviewed by: ___________________________________
Doug Canavello, PG (Project Manager)

PYRAMID ENVIRONMENTAL & ENGINEERING, P.C.
700 NORTH EUGENE ST.
GREENSBORO, NC 27401
(336) 335-3174

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1.0 INTRODUCTION

Pyramid Environmental & Engineering, PC conducted geophysical investigations for the Eastern Federal Lands Highway Division on August 31, 2005 at the Pimmit Run Bridge located on the George Washington Parkway near Brookmont, Virginia and at the Minnehaha Creek Trail Bridge in Glen Echo, Maryland. The geophysical surveys were conducted to evaluate or identify the foundation/subsurface material underlying the Bridge Pier No. 2 (GWMP Structure No. 330-005P) at the Pimmit Run Bridge and the northwestern bridge pier (GWMP Structure No. 3300-045T) at the Minnehaha Creek Trail Bridge. A site location map and diagrams of the two bridge sites are presented in Figure 1.

Electrical resistivity surveys were conducted by Pyramid Environmental & Engineering, PC to evaluate the subsurface material beneath and adjacent to the bridge piers. The survey conducted at each location consisted of one dipole-dipole resistivity array having a maximum length of 270 feet. Eastern Federal Lands Highway Division engineer, Mr. Khalid Mohamed, PE, identified the areas of concern and provided assistance and guidance to Pyramid's consulting geophysicist, Mr. Mark J. Denil, PG during data acquisition on August 31, 2005.

2.0 FIELD METHODOLOGY

Prior to conducting the geophysical electrical resistivity investigation at each site, 28 stainless steel stakes were driven into the ground at 10-foot intervals along the survey line, resulting in a 270-foot long resistivity array. The passive electrode cables were then attached to the metal stakes and connected to the Advanced Geosciences Inc. (AGI) SuperSting R1 resistivity meter and associated switch box. A brine solution was poured around each of the steel stakes to enhance ground contact with stakes.

A dipole-dipole resistivity survey consisting of 230 data points was then conducted at each site. Data were digitally collected and then downloaded to a field computer. The resistivity data were processed using the AGI EarthImager 2D software program. EarthImager uses an inversion process that produces an apparent resistivity model. Photos of the geophysical equipment and a model of the resistivity array are presented in Figure 2.

3.0 DISCUSSION OF RESULTS

3.1 Pimmit Run Bridge – Pier No. 2

The resistivity results for the Pimmit Run Bridge are presented in Figure 3. Pier No. 2 is located between survey line coordinates 126 feet to 143.5 feet. The resistivity survey line was placed approximately five feet from Pier No. 2. The resistivity data were processed through five inversion iterations yielding a root mean square (RMS) error of 10.8%.

High apparent resistivity values of 600 ohm/meters or greater (contours shaded in yellow, orange, and red) are recorded from survey line coordinates 0 feet to 120 feet and from 155 feet to 220 feet, suggesting the presence of dense competent bedrock within the depth interval of 0 to -40 feet. In contrast, resistivity values of less than 300 ohm/meters (contours shaded in green) are recorded immediately beneath and adjacent to Pier No. 2.

The resistivity survey suggests that soil and or highly fractured, broken or weathered rock underlies the pier from a depth of -15 feet to approximately -22 feet. This type of soil and/or highly fractured, broken bedrock may erode or scour if exposed to normal stream flow. If the base of the pier lies within the survey line depth interval of –10 to –20 feet, the pier may be resting upon unconsolidated soils or highly broken rock that may not provide adequate long-term support for the pier.

Higher resistivity values of 400 to 1200 ohm/meters are recorded beneath the pier within the depth interval of –22 to –40 feet. These values suggest the presence of slightly fractured to dense competent bedrock that may not erode or scour if exposed to normal stream flow. If the base of the pier lies at a survey line depth of –20 to –22 feet, then the resistivity survey suggests that the base of the pier probably rests on fairly competent bedrock that may provide adequate support for the pier. Furthermore, the high resistivity values recorded adjacent to the pier walls suggests the presence of competent bedrock that may provide lateral support for the pier. Additional details of the resistivity for the Pimmit Run Bridge site are provided in Figure 3.

NOTE: All statements referring to soil and rock strength/support capability are based on non-determinate interpretation of resistivity data. Actual soil/rock strength may vary from the interpretive results.

3.2 Minnehaha Creek Trail Bridge – Northwestern Pier

The resistivity results for the Minnehaha Creek Trail Bridge are presented in Figure 4. The northwestern pier is located between survey line coordinates 128 feet to 141 feet. The resistivity survey line was placed approximately 10 feet northwest from the pier. The resistivity data were processed through four inversion iterations yielding a root mean square (RMS) error of 7.7%.

Areas of exposed bedrock are present along the portion of the survey line located northeast of the bridge pier (from survey line 0 to 128 feet). However, based on information obtained from the park ranger, the stream embankment located southwest of the pier (from survey line 142 to 270 feet) was excavated forming an approximate 2:1 slope along the survey line. Due to the excavation activities, bedrock outcrops may have been cut or removed and are not seen along this portion of the survey line. Furthermore, an unknown amount or thickness of fill material may have been used to “re-form” this portion of the stream bank.

High apparent resistivity values of 600 ohm/meters or greater (contours shaded in yellow, orange, and red) are recorded from survey line coordinates 0 feet to 116 feet, suggesting the presence of dense competent bedrock within the depth interval of 0 to -40 feet. Exposed outcrops along this portion of the survey line confirm the resistivity results. In contrast, resistivity values of less than 300 ohm/meters (contours shaded in green) are recorded beneath and adjacent to the pier. The low resistivity values suggest the presence of soil and/or highly fractured, broken or weathered bedrock.

Assuming the base of the pier lies at a survey line depth of -10 feet (near the base of the stream bed), the resistivity survey suggests that unconsolidated soil and/or highly fractured, broken, or weathered rock underlies the pier from a depth of -10 feet to more than -40 feet. The low resistivity values recorded beneath the base of the pier suggest that the soil and/or highly fractured rock may not provide adequate support for the bridge pier and that undercutting, erosion, or scouring of the soil/rock by normal stream flow may occur. Visual observations of the exposed base of the pier show the stream is undercutting and removing the sediment/rock beneath the pier, thus supporting the resistivity results.

Low resistivity values of less than 300 ohm/meters are also recorded from survey line coordinates 145 feet to 260 feet, suggesting the near surface consists of soil and/or highly fractured, broken, or weathered bedrock. The low resistivity values may also be attributed to the unknown fill thickness of the steep slope. Because the stream bank in this area has an approximate 2:1 slope, the surface fill layer probably has an exaggerated thickness when measured in a true vertical direction. Because the resistivity values are measurements of the subsurface in a vertical direction, the presence of possible adjacent bedrock that may lie several feet into the stream embankment may not be detected by the survey results.

A zone of higher resistivity ranging from 400 to 2000 ohm/meters located between survey line coordinates X=165 to Y=215, suggests the presence of competent bedrock sloping to the southwest within the survey line depth interval of -10 to -40 feet.

The resistivity results along with visual observations suggest that the dense, competent bedrock is present northeast of the pier. However low resistivity values suggest unconsolidated soil or highly fracture rock underlies the base of the pier. The low resistivity values recorded beyond the base of the pier suggest that at least 10 to 20 feet of soil or highly broken rock may be present beneath the base of the pier.

Additional details of the resistivity results for the northwestern pier of the Minnehaha Creek Trail Bridge are provided in Figure 4.

4.0 CONCLUSIONS

Our evaluation of the dipole-dipole resistivity surveys conducted along the two bridge sites provides the following summary:

- The electrical resistivity surveys appear to have provided information pertaining to the soil and rock conditions beneath and adjacent to Pier No. 2 at the Pimmit Run Bridge and to the northwestern pier at the Minnehaha Creek Trail Bridge.

- Resistivity values of less than 300 ohm/meters are recorded beneath and adjacent to Pier No. 2, suggesting the presence of soil and/or highly fractured, broken or weathered rock beneath the base of the pier within the depth interval of –15 feet to –22 feet.

- Higher resistivity values of 400 to 1200 ohm/meters are recorded beneath Pier No. 2, within the depth interval of -22 feet to -37 feet, suggesting the presence of slightly fractured to dense, competent bedrock.

- Based solely upon the low resistivity values, the probable soil and/or highly fractured, broken bedrock that lies immediately beneath the assumed base of the pier may erode or be undercut by normal stream flow.

- At the Minnehaha Creek Trail Bridge, resistivity values of less than 300 ohm/meters are recorded beneath and adjacent to the northwestern pier from the interval of 0 to –40 feet. The low resistivity values suggest the presence of soil and/or highly fractured, broken or weathered bedrock.

- The low resistivity values recorded beneath the base of the pier indicate that the soil and/or highly fractured rock may not provide adequate support for the bridge pier and that erosion or scouring of the soil/rock by normal stream flow may occur.

- The low resistivity values recorded beyond the base of the pier suggest that at least 10 to 20 feet of soil or highly broken rock may be present beneath the base of the pier. Erosion or scouring of this possible soil/rock interval may occur if exposed to normal stream erosion.

- The electrical resistivity surveys performed appear to give results of general rock competence in the vicinity of the bridge abutments. The method appears to be limited in its ability to see actual foundation placement, therefore it is difficult to determine what the soil/rock competence is at the foundation - soil/rock interface.

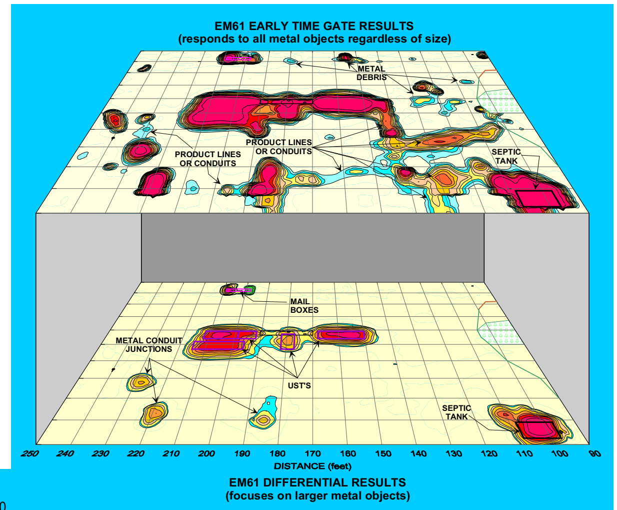
POSSIBLE SOURCES OF ERROR

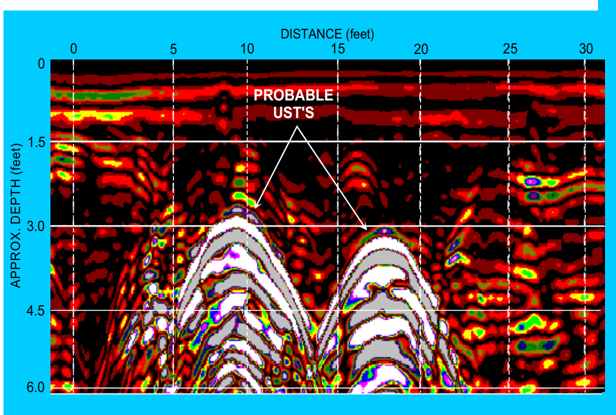
As with any quantitative measuring techniques, there are some potential sources of error that should be recognized. The following are potential sources of error for this geophysical investigation

- Contact resistance values between the steel electrodes and the surrounding ground were higher than optimum at several locations
- RMS error associated with data processing – optimum range is 5-10%

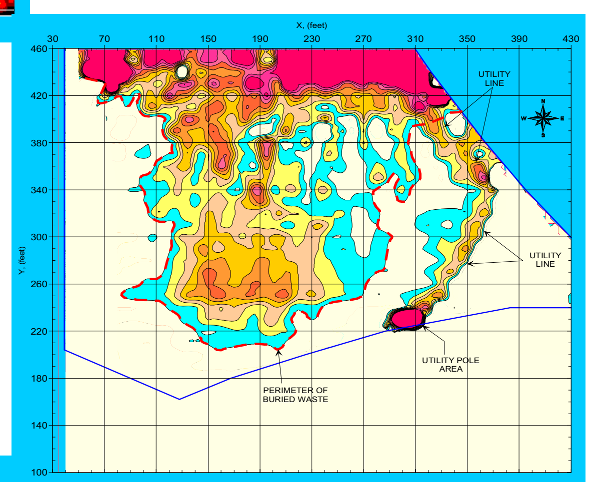
5.0 LIMITATIONS

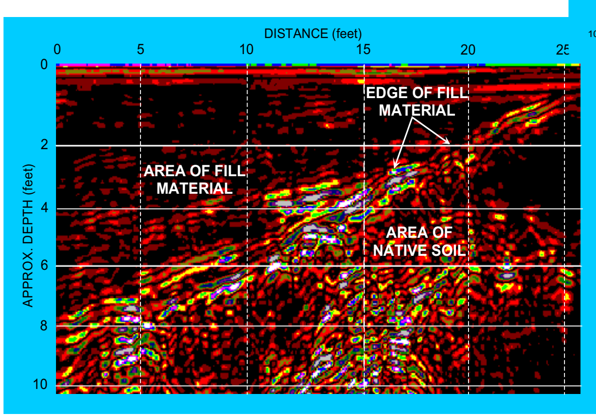
Dipole-dipole electrical resistivity surveys have been performed and this report prepared for the Eastern Federal Lands Highway Division in accordance with generally accepted guidelines for resistivity surveys. It is generally recognized that the results of the geophysical surveys are non-unique and may not represent actual subsurface conditions. The resistivity results obtained for this project do not conclusively determine the type of soil or rock conditions that may exist within the depth interval of 0 to 40 feet below surface, but only suggest what the soil and rock character may be.

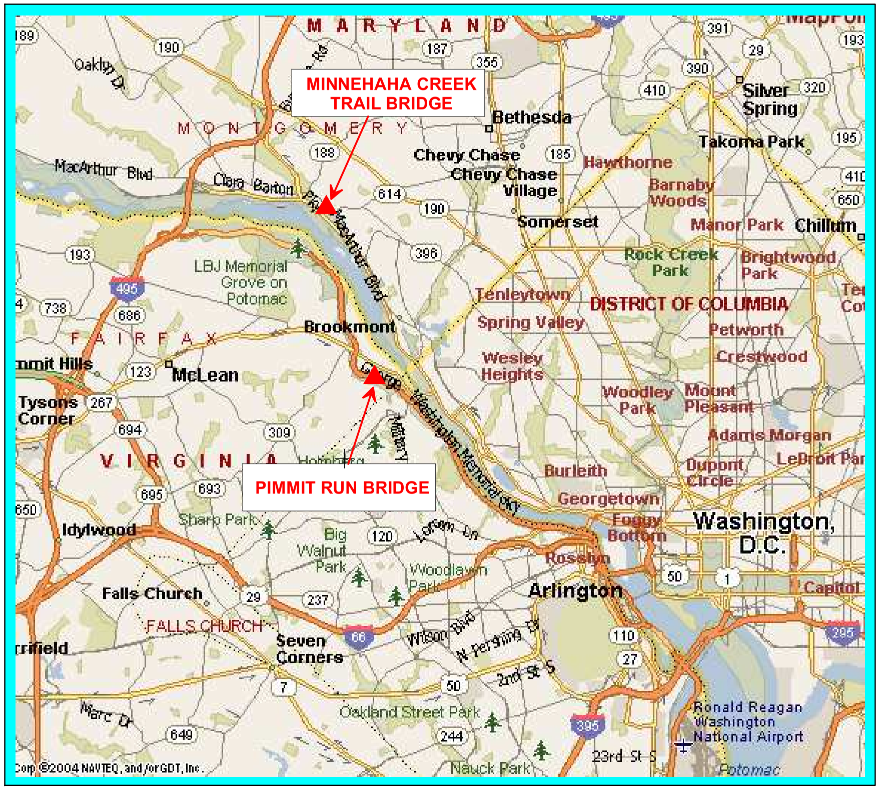

EM61 EARLY TIME GATE RESULTS
(responds to all metal objects regardless of size)
METAL DEBRIS
PRODUCT LINES OR CONDUITS
PRODUCT LINES OR CONDUITS
SEPTIC TANK
MAIL BOXES
METAL CONDUIT JUNCTIONS
UST'S
SEPTIC TANK
250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90
DISTANCE (feet)
EM61 DIFFERENTIAL RESULTS
(focuses on larger metal objects)


DISTANCE (feet)
0 5 10 15 20 25 30
APPROX. DEPTH (feet)
0 1.5 3.0 4.5 6.0
PROBABLE UST'S

FIGURES

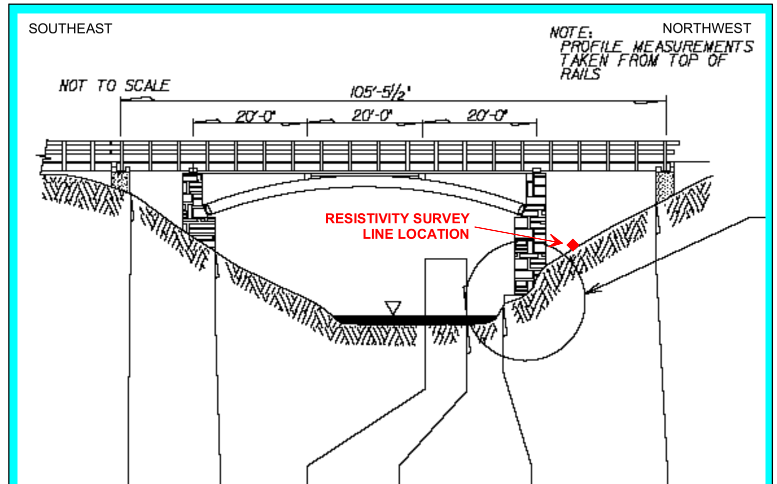

X, (feet)
30 70 110 150 190 230 270 310 350 390 430
Y, (feet)
460 420 380 340 300 260 220 180 140 100
UTILITY LINE
UTILITY LINE
UTILITY POLE AREA
PERIMETER OF BURIED WASTE


DISTANCE (feet)
0 5 10 15 20 25
APPROX. DEPTH (feet)
0 2 4 6 8 10
EDGE OF FILL MATERIAL
AREA OF FILL MATERIAL
AREA OF NATIVE SOIL



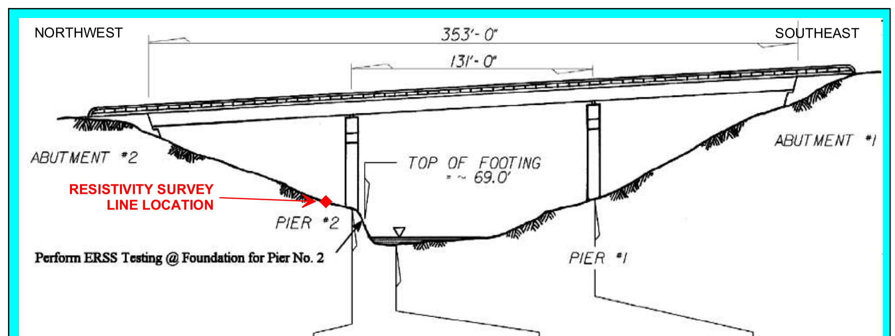
Note: The map shows the locations of the Minnehaha Creek Trail Bridge and the Pimmit Run Bridge. The diagrams of the two bridges were obtained from the Federal Highway Administration and shows the resistivity survey locations that were conducted on August 31, 2005.

MINNEHAHA CREEK TRAIL BRIDGE



DATE			T/W		U/S	D/S	
4/97	5.5'	18.0'	27.5'	28.1'	26.5'	——	9.8'
4/99	5.6'	17.0'	28.0'	28.1'	26.5'	22.7'	9.6'
7/01	4.9'	17.6'	27.6'	28.6'	26.3'	22.7'	9.6'

PIMMIT RUN BRIDGE



DATE			
3/95	64.7'	77.8'	——
4/97	66.8'	80.8'	57.7'
5/99	——	——	——
7/01	69.6'	80.1'	57.8'
7/03	69.9'	80.5'	57.5'

CLIENT	FEDERAL HIGHWAY ADMINISTRATION
SITE	PIMMIT RUN & MINNEHAHA CREEK TRAIL BRIDGES
CITY	WASHINGTON D.C. AREA
STATE	VIRGINIA & MARYLAND
TITLE	
DATE	9/05/05
LAY	
DWG	
J-NO.	2005-177
DRAWN	MJD
CHKD	
FIGURE	
GRAPHIC SCALE IN METERS	

SITE LOCATION MAP
& BRIDGE DIAGRAMS

FIGURE 1

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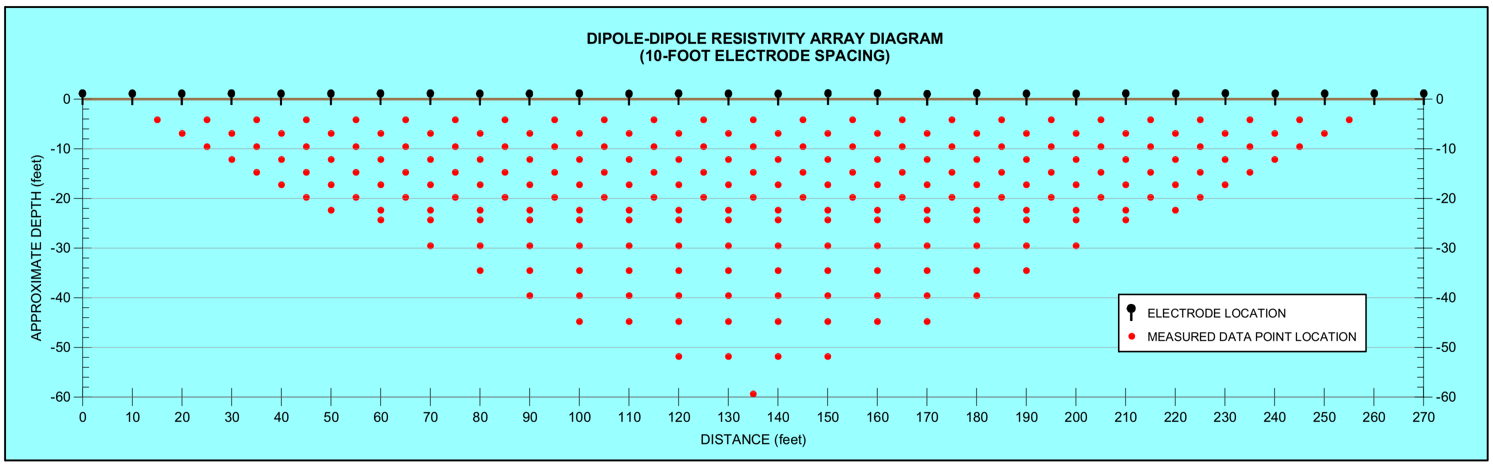
THE PHOTO SHOWS THE AGI SUPERSTING R1 RESISTIVITY METER ALONG WITH THE SWITCH BOX AND 12-VOLT BATTERY USED TO CONDUCT THE GEOPHYSICAL SURVEYS

THE PHOTO SHOWS A PORTION OF THE RESISTIVITY CABLE ALONG THE SURVEY LINE. THE CABLE IS ATTACHED TO STEEL STAKES SPACED AT 10-FOOT INTERVALS (RED FLAGS).



THE ABOVE DIAGRAM ILLUSTRATES THE RESISTIVITY ARRAY THAT WAS USED TO CONDUCT THE DIPOLE-DIPOLE SURVEY ALONG THE BRIDGE PIERS. BASED UPON THIS SETUP, THE LOCATION OF RESISTIVITY DATA POINTS ARE SHOWN AS RED DOTS.

CLIENT	FEDERAL HIGHWAY ADMINISTRATION
SITE	PIMMIT RUN BRIDGE - PIER NO.2
CITY	GWPK, MCCLEAN
STATE	VIRGINIA
TITLE	
DATE	9/05/05
DRWN	MJD
LAY	
CHK'D	
DWG	
J-NO.	2005-177
FIGURE	

GRAPHIC SCALE IN METERS

PYRAMID ENVIRONMENTAL & ENGINEERING, P.C.

GEOPHYSICAL EQUIPMENT & ARRAY DIAGRAM

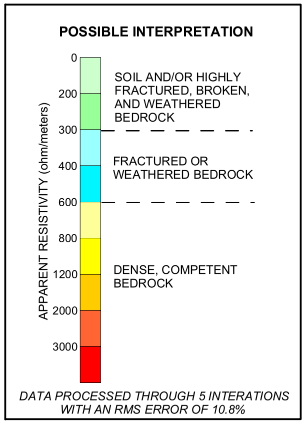
FIGURE 2

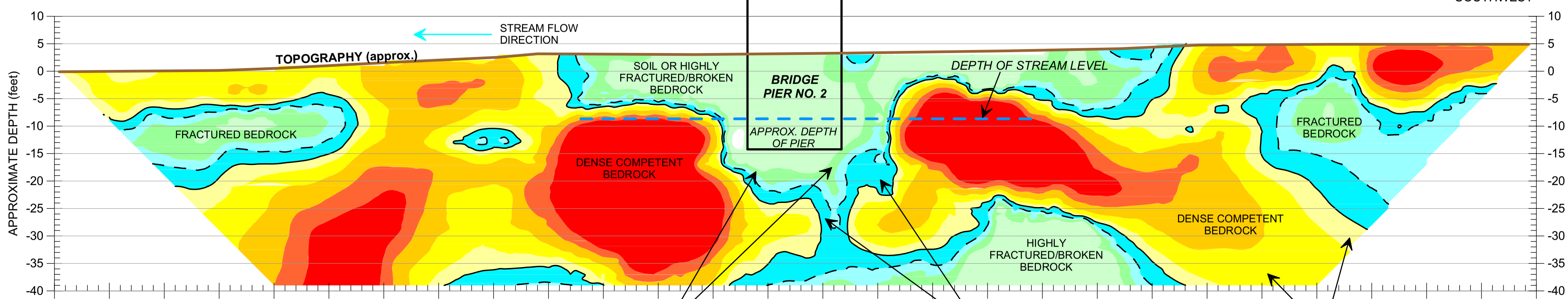
PIMMIT RUN BRIDGE - PIER NO. 2
(STRUCTURE NO. 3300-005P)
GEORGE WASHINGTON PARKWAY

NORTHEAST — SOUTHWEST

APPROXIMATE LOCATION AND ORIENTATION OF RESISTIVITY LINE

SOUTHWESTWARD-LOOKING VEW OF THE BRIDGE PIER NO. 2 SHOWING A PORTION OF THE RESISTIVITY LINE





Note: The contour cross-section shows the dipole-dipole resistivity results obtained along Pier No. 2 at the Pimmit Run Bridge.The resistivity survey was conducted on August 31, 2005 using an AGI-SuperSting resistivity meter. Data were collected along 28 electrodes spaced 10 feet apart resulting in a total array distance of 270 feet.

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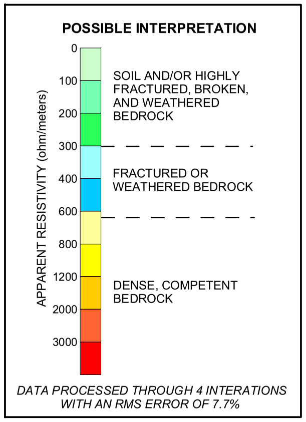
CLIENT	FEDERAL HIGHWAY ADMINISTRATION	DATE	9/05/05	DRWN	MJD
SITE	PIMMIT RUN BRIDGE - PIER NO. 2	LAY		CHKD	
CITY	BROOKMONT	STATE	VIRGINIA	DWG	
TITLE	RESISTIVITY RESULTS	J-NO.	2005-177	FIGURE	

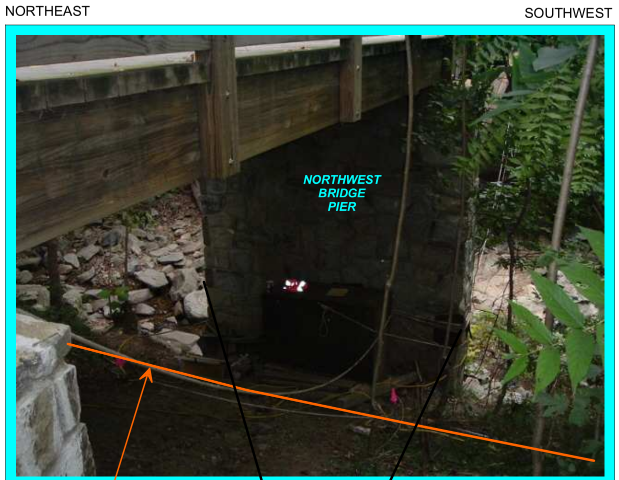
GRAPHIC SCALE IN METERS

DIPOLE-DIPOLE
RESISTIVITY RESULTS

FIGURE 3

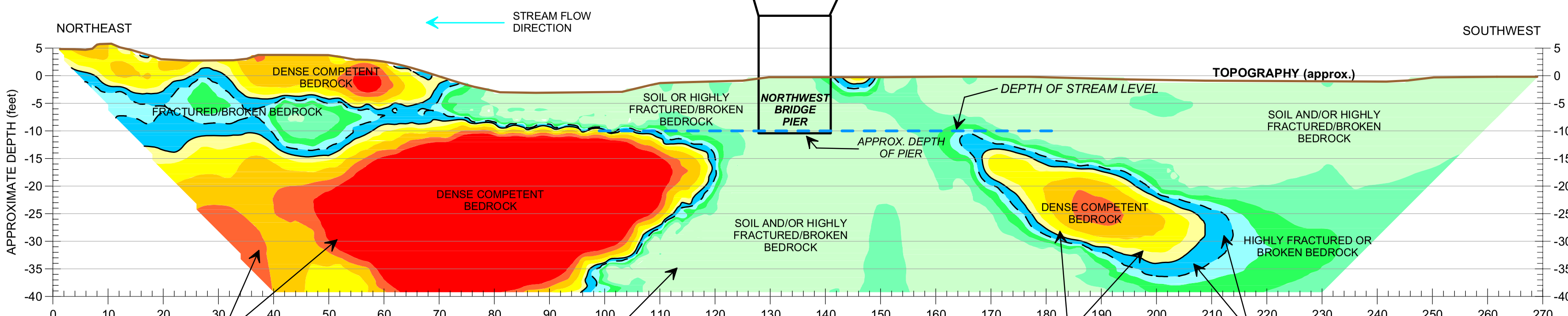
MINNEHAHA CREEK TRAIL BRIDGE
(STRUCTURE NO. 3300-045T)
ECHO PARK, MARYLAND





APPROXIMATE LOCATION AND ORIENTATION OF RESISTIVITY LINE

NORTHWESTWARD-LOOKING VEW OF THE BRIDGE PIER SHOWING PORTION A OF THE RESISTIVITY LINE LOCATION



Note: The contour cross-section shows the dipole-dipole resistivity results obtained along the western pier of the trail bridge over Winnehah Creek.The resistivity survey was conducted on August 31, 2005 using an AGI-SuperSting resistivity meter. Data were collected along 28 electrodes spaced 10 feet apart resulting in a total array distance of 270 feet.

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CLIENT	FEDERAL HIGHWAY ADMINISTRATION	DATE	9/05/05	DRAWN	MJD
SITE	MINNEHAHA CREEK TRAIL BRIDGE - WESTERN PIER	LAY		CHKD	
CITY	ECHO PARK	STATE	MARYLAND	DWG	
TITLE	RESISTIVITY RESULTS	J-NO.	2005-177	FIGURE	

GRAPHIC SCALE IN METERS

DIPOLE-DIPOLE RESISTIVITY RESULTS

FIGURE 4