



**Stray Voltage Study**  
**Truxtun Park Marina Final Report**  
**City of Annapolis, Maryland**

**Project Number 24E-08-27000**

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**July 18, 2024**

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## Contents

|  |    |
|--|----|
| Introduction .....   | 3  |
| Methods .....  | 3  |
| 1. Voltage Testing in the Water at Truxtun Park .....                    | 3  |
| Long-Term Stray Voltage Testing in The Water .....                       | 3  |
| Short-Term Stray Voltage Testing in Water .....                          | 4  |
| 2. Voltage Testing on Coastline at Truxtun Park.....                     | 5  |
| Long-Term Stray Voltage Testing on Land .....                            | 5  |
| Short Term/Instantaneous Voltage Measurements Taken at Truxtun Park..... | 5  |
| Results .....  | 6  |
| 1. Voltage Testing in the Water at Truxtun Park .....                    | 6  |
| Long-Term Stray Voltage Testing in Water .....                           | 6  |
| Short-term Stray Voltage Testing in Water.....                           | 7  |
| 2. Voltage Testing on Coastline at Truxtun Park.....                     | 7  |
| Long-Term Stray Voltage Test on Land (UTC time).....                     | 7  |
| Short Term/Instantaneous Voltage and Amperage Measurements on Land.....  | 7  |
| Measurements on Grounding System .....                                   | 7  |
| Electric Currents and Voltage Gradients.....                             | 7  |
| Analysis .....   | 8  |
| Conclusions .....  | 9  |
| Recommendations .....  | 10 |
| Literature Review .....  | 11 |

### APPENDICES

|   |                                     |
|---|-------------------------------------|
| A | MAP OF TEST LOCATIONS AROUND MARINA |
| B | GRAPHS OF STRAY VOLTAGE IN WATER    |
| C | VOLTAGE TESTING ON COASTLINE        |

## Introduction

On February 22, 2024, the City of Annapolis (The City) engaged Engineering Design Technologies, Inc. (EDT) to investigate the Truxtun Park Boat Ramp and Dock for electrical hazards. In coordination with the City, EDT investigated stray voltages on the land and the in water in the vicinity of the Truxtun Park boat ramps, docks, and the “rickety” footbridge. A history of reports from civilians reporting shock sensations in the water indicates an electrical hazard may be present in the water at Truxtun Park. The City of Annapolis requested the assistance of multiple organizations including BGE who collected a reading of between 4-6 Amps on the grounding system at the dock. Due to a lack of information including where and how these measurements were taken, EDT was not able to reproduce these measurements and could not come to any conclusion as a result. EDT did measure 2-4 amperes flowing on the grounding system on the circuit breaker panel for the dock when all power to the panel was turned off. It is believed this test was performed at the same location as the BGE testing which produced the higher amperage, though it is uncertain. The City informed EDT that BGE had informed them of adjustments to their system which may account for the variation in results.

EDT performed an independent investigation into possible sources of a shock sensation in the water at Truxtun Park. Both long-term and short-term/instantaneous voltage tests were carried out in the water and on land to detect dangerous levels of current. Electrodes used to collect measurements taken in the water were spaced about 5-6 feet apart to approximate the size of a person. These tests were performed in both March and June-July which captured the spring lows, and the summer heights of boating and water activity in the area. The electrical system was also analyzed to determine any influence it might have on the voltages in the water.

No evidence of hazardous voltages was recorded in the water at the Harbormaster’s docks and Park’s boat ramps during this investigation. No voltages were detected coming from the electrical system powering the Harbormaster’s docks. There were millivolts (thousandths of a volt) which were recorded in the soil which appear to be manmade but do not exhibit a pattern which is easily identifiable. There were 2-4 Amps found coming flowing through the ground for the breaker box when power sources were off, however, this was not investigated further due to the absence of concurrent voltages in the water, time constraints, and the need for coordination with BGE.

The intent of this study was to identify a source of an overall voltage gradient and follow those readings. Testing revealed voltages that were too inconsistent to identify a source.

## Methods

### 1. Voltage Testing in the Water at Truxtun Park

#### Long-Term Stray Voltage Testing in The Water

Starting on June 27, 2024, and ending on July 3, 2024 testing was performed in the vicinity of the dock to establish the levels of, and flow direction of any AC and DC stray voltages. Silver chloride reference electrodes (industry standard electrochemically stable electrodes designed to be used in brackish water) were placed alongside of the Jet Dock on the left side of the walkway to the floating dock. (The Jet Dock is the black plastic support structure used under the inflatable harbor boat).

Three electrodes were suspended close to the surface approximately six feet apart along two sides of the floating dock to approximate the exposure of a swimmer to stray voltages. These reference electrodes formed a right angle with the center electrode at the corner of the angle. A fourth electrode was placed at the bottom of the water on the soil beneath the leftmost reference electrode. An additional two electrodes were suspended from the footbridge which crosses the inlet between Pump House Road and the path leading to the intersection of Silopanna and Acton Roads which is elsewhere referred to as the “Rickety footbridge”.

Four GPS time-synchronized Mobiltext CorTalk®uDL1 AC/DC dataloggers were used to measure and record voltages between the reference electrodes once per second over a period of more than five days from Thursday, June 27th to Wednesday, July 3rd making sure to include a weekend to help distinguish any patterns that may arise in the data as a result of power grid usage changes due to weekday and weekend routines.

This arrangement of three reference cells was used to perform long-term stray voltage tests #1-3 at the Truxtun Park dock. The three reference cells that were floated just below the water's surface comprised tests #1 and #2 which were perpendicular to each other so that the magnitude and direction of any concerning readings could be calculated. From the center electrode, Test #1 points to the Northwest and Test #2 points to the Southwest. Test #3 utilized one floating reference cell and the sunken reference cell so that voltage differences that might affect a person standing in water could be analyzed. The two reference cells used on the foot bridge were used for the fourth stray voltage test. This was intended to determine if this inlet might be safer for water activities than the Truxtun Park boat ramp as requested by the City of Annapolis. See **Appendix A** for test site location information.

#### Short-Term Stray Voltage Testing in Water

EDT recorded AC and DC voltage values in the water at various distances from the dock on March 20<sup>th</sup>, 2024 with a Mobiltext CorTalk®uDL1 AC/DC datalogger with silver/silver chloride reference cells. The voltage values were recorded using a data logger that collected one reading per second. The distance of the electrodes during the test was kept at approximately 5 ft to resemble the length of a human body. EDT crew used a small inflatable boat to access the water and measure the voltages in two separate trips. The first set of data was collected at more remote locations around the inlet encompassing the boat ramps, and the second set of data was collected around the perimeter of the dock. Locations were tracked with a Geode GPS receiver.

During the first trip (from 11:46 am to 12:17 pm) the voltages of 21 locations were measured. EDT crew started from point 1 and moved toward point 21 while staying approximately 1 minute for the data collection at each of the points. During the whole trip, the electrodes were kept in the water and the voltage values between the points were recorded by the data logger continuously. During the second trip (from 12:49 pm to 13:09) the voltages of 26 locations (from point A to point Z) in the perimeter of the dock were measured. The same procedure as the first trip was followed by the EDT crew. The map showing the locations and the graphs showing the recorded AC and DC voltage values at each location are presented in **Appendix A** and **Appendix B** respectively.

## 2. Voltage Testing on Coastline at Truxtun Park

### Long-Term Stray Voltage Testing on Land

A long-term stray voltage test was performed on land to record the magnitude of voltages in the ground near the water. These voltages are analyzed for magnitude and patterns such as those indicative of power grid fluctuations that would suggest leakage from the electrical system may be contributing to the shock hazard in the water. Ground surface voltage data were collected over a period of 5 days with a Mobiltext CorTalk® uDL1 AC/DC datalogger connected to two copper-copper sulfate reference electrodes (electrochemically stable industry standard soil-contact electrodes) which were placed about 25' apart in the woods to the Southwest of the dock. AC and DC voltages were recorded with the rate of one reading per second for five days from March 20th to 25th, 2024 with North-to-South direction.

Note that voltages discussed in this part of the analysis were NOT measured in or around the water. Rather, they were measured on the soil over fifty (50) feet away from the water and only indicate that there are possible manmade electrical currents (caused by voltages) in the vicinity. They do not pose any hazard to people or animals.

### Short Term/Instantaneous Voltage Measurements Taken at Truxtun Park

Short term and Instantaneous measurements were taken on land and on the grounding system at Truxtun Park. A high impedance (sensitive) digital Fluke 87V multimeter was used to collect individual voltage readings (and one frequency measurement) between the electrical equipment grounding system (two ground rods bonded to the electrical panel on a pole) and a ground contact probe in the area between the water and the sidewalk to the southwest of the dock (approximately 2,000 square feet).

Additional measurements were taken on the grounding system and the breaker panel near the dock to determine if there is a detectable fault in the system that might explain a shock hazard in the water. This testing was performed at the same time as the data loggers were in the water so that the response of the electrical system can be recorded in the water to detect a hazard.

A Southwire 21050T clamp-on AC DC meter was zeroed and clamped on the two ground wires between the electrical breaker panel on the pole by the walkway and the ground rods. All the circuit breakers were turned off, and then turned on one at a time. Electrical currents were observed during the entire process. Voltages were recorded in the water during the long-term stray voltage test on the dock so that any influence of the breaker switching could be detected in the water. All measurements are reported in **Appendices B and C.**

## Results

This section covers the readings taken during the tests described above. Table 1 below summarizes these results.

Table 1: Summary of Results

| Test                              | AC Max (mV) | AC Min (mV) | DC Maxv (mV) | DC Min (mV) | Comments                          |
|-----------------------------------|-------------|-------------|--------------|-------------|-----------------------------------|
| Long Term Testing in Water        |             |             |              |             |                                   |
| Location #1                       | 24.1        | 2.9         | 14.9         | 0           |                                   |
| Location #2                       | 3.2         | 0           | 5.8          | 0           |                                   |
| Location #3 (Vertical Test)       | 0           | 0           | 8.4          | 1.3         |                                   |
| Location #4 (Rickety Foot Bridge) | 752.6       | 6.8         | 63.8         | -87         | Peak happened during thunderstorm |
| Short Term Testing in Water       |             |             |              |             |                                   |
| AC and DC in boat across inlet    | 50          | 0           | 5            | -5          |                                   |
| AC and DC in boat around dock     | 85          | 0           | 5            | -7          |                                   |
| Long Term Testing on Land         |             |             |              |             |                                   |
| 5-Day Stray Voltage Test          | 115         | 16          | 35           | -11         | Patterns indicate human activity  |
| Instantaneous measurements        |             |             |              |             |                                   |
| Short Term Testing on Land        | 790         | 50.1        |              |             | Measured 179 Hz                   |
| Grounding System Measurements     | 4.6         | 3.237       |              |             |                                   |

### 1. Voltage Testing in the Water at Truxtun Park

#### Long-Term Stray Voltage Testing in Water

The data loggers recorded 5 days, 17 hours, 8 minutes of AC and DC voltage readings every second at locations #1-4 as seen in the map in **Appendix A**. This data has an accuracy of +/- 3mV due to the chosen 20Vpeak setting and the calibration. For test #1, a minimum AC voltage of 2.9mV and a maximum of 24.1mV was recorded, and a minimum DC voltage of 0 and a maximum of 14.9mV was recorded (See **Appendix B**).

For test #2 which was perpendicular on the surface of the water at the dock to test #1, the minimum AC voltage of 3.2mV and the maximum AC voltage of 3.2mV were recorded. The minimum DC voltage of 0.0 and the maximum of 5.8 mV were recorded (See **Appendix B**).

For test #3 which spanned the height of the water column at the dock, all the readings recorded AC voltage differences of 0.0mV. The minimum DC reading was 1.3mV and the maximum DC reading was 8.4mV (See **Appendix B**).

For test #4 which was installed on the "Rickety" foot bridge at the end of Pump House Road, the minimum AC reading was 6.8mV and the maximum was 752.6mV (a spike lasting about 2 seconds). The minimum DC reading was -87mV and the maximum reading was 63.8mV (See **Appendix B**).

## Short-term Stray Voltage Testing in Water

For both the first and second boat trips, the DC voltage values were generally between -5mV to +5mV with no distinguishable peak. Also, the majority of AC voltage values were between 0 to 50mV with the highest value of 80mV which was measured between locations J and K during the second trip at about 12:58pm. (See **Appendix B**).

## 2. Voltage Testing on Coastline at Truxtun Park

### Long-Term Stray Voltage Test on Land (UTC time)

Most of the collected DC values are between 15 to 35mV except for the values that were recorded from March 23<sup>rd</sup> at 6:40 am through Marh 24<sup>th</sup> at about 4:00 am. The maximum and minimum values for the recorded DC voltages are 35.1 mV and -11.6 mV respectively. See **Appendix C** for the graphs. Note that steady-state (unvarying) DC voltages are not likely to be detected by humans.

Most of the recorded AC voltage values are between 20 mV to 50 mV with four distinguishable peaks exceeding 50 mV on Thursday March 21<sup>st</sup> around 10:12 am (duration ~2 hours), Friday March 22<sup>nd</sup> around 10:23 am (duration 20 minutes), Saturday March 23<sup>rd</sup> around 7:03 am (duration a few seconds), and Sunday March 24<sup>th</sup> around 10:03 am (duration ~2 hours). While the sources of these peaks are unknown, the onset and pattern of the peaks suggest that they are likely manmade. The maximum and minimum measured voltage values are 114.6 mV and 15.8 mV (See **Appendix C**).

### Short Term/Instantaneous Voltage and Amperage Measurements on Land

Out of the 2,000 square foot section analyzed with ground reference cells, the maximum and minimum AC voltage readings were 0.790 V and 0.0501 V respectively. The frequency was found to be 179 Hz, which is very close to 180 Hz. This (180 Hz) is the third harmonic of 60 Hz. A reading of 60 Hz was observed in the same location on July 3, 2024. The third harmonic (180 Hz) is commonly found on power systems connected to non-linear power supplies like those used by computers and motor controllers. This indicates an electrical power issue is present in this community. See **Appendix C** for details of this survey and the readings.

### Measurements on Grounding System

On July 3, 2024, two electrical current readings taken on the electrical grounds (wires between the electrical panel and ground rods in the earth) were 1.36 Amps AC and 0.09 Amps AC. These readings were lower than would be expected if the electrical power issue originated at this pole. Additional testing was performed on July 8, 2024, with all power to the circuit breaker panel turned off; and over four amperes were measured on the electrical grounds. The current observed was slowly changing at the rate of a few milliamperes per second between 3.237 and 4.6 amperes even with all circuit breakers turned off.

## Electric Currents and Voltage Gradients

The fact that current (alternating or direct) can flow through water is well known. Understanding how it flows is often a challenge. Voltage gradients can indicate the direction of current flow similar to how topographic lines depict a slope. Voltage measurements between reference electrodes are used to demonstrate current flow based on Ohm's law (i.e. voltage is equal to current multiplied by resistance).

This section discusses the effects of electrical current on the human body.

The following information is taken from “Conduction of Electrical Current to and Through the Human Body: A Review by: Raymond M. Fish, PhD, MD, FACEP and Leslie A. Geddes, MS, PhD, DSc. The full document can be found online at: [Conduction of Electrical Current to and Through the Human Body: A Review - PMC \(nih.gov\)](#).

EDT selected the following information due to its application to the perceptions of swimmers and the effects of electric currents. Note that this document does not discuss the effects of voltages on the human body because voltages do not directly cause sensation, nor do they cause (peer-reviewed) quantified damage to organic tissue. Rather, it is an electrical current through tissues which is felt and which damages tissue. In this article, voltage is discussed in terms of damage to tissues in the context of the amount of voltage necessary to overcome the resistance of different tissues. By starting from the understanding that the human body has a resistance of approximately 300 Ohms in water, convert the milliamperes (mA) used in this paper to millivolts (mV) measured during this testing program. The authors of the paper chose 300 Ohms to be conservative.

Table 2: Estimated Effects of 60 Hz AC

| <i>Current</i> | <i>Equivalent Voltage (Based on 300 ohms of Body Resistance)*</i> | <i>Effect on the Body</i>                                    |
|----------------|---|--|
| <i>1 mA</i>    | <i>(300 mV)</i>   | <i>Barely perceptible</i>                                    |
| <i>16 mA</i>   | <i>(4,800 mV)</i>   | <i>Maximum current an average man can grasp and “let go”</i> |
| <i>20 mA</i>   | <i>(6,000 mV)</i>   | <i>Paralysis of respiratory muscles</i>                      |
| <i>100 mA</i>  | <i>(30,000 mV)</i>  | <i>Ventricular fibrillation threshold</i>                    |

\*Column added by EDT

***Why immersion in water can be fatal with very low voltages***

- 1 Immersion wets the skin very effectively and greatly lowers skin resistance per unit area*
- 2 Contact area is a large percentage of the entire body surface area*
- 3 Electric current may also enter the body through mucous membranes, such as the mouth and throat*
- 4 The human body is very sensitive to electricity. Very small amounts of current can cause loss of ability to swim, respiratory arrest, and cardiac arrest*

**Analysis**

The tests performed in the water over various periods of time at Truxtun Park indicate the voltages from the long-term test were mostly zeroes with one peak of 752.6mV which occurred for only a few seconds on one out of four concurrent stray voltage tests. Upon review of historical weather data, this

measurement may have been collected as a storm was passing over Annapolis. Besides this reading, all other recorded voltages were well below the barely perceptible limit of 300 mV (See Tables 1 and 2).

The tests performed on land indicate a voltage change throughout the week. The daily periodicity of the peaks, which occur at different times and last for different durations, indicates a human-activated device was the cause but the source could not be identified. For example, regular peaks would be observed as a result of electric rail travel. Increases in the morning, at noontime, and in the evening would indicate that the source was residential power usage. Peaks in weekly working hours might indicate manufacturing facilities as the source.

The patterns of the voltages were not detected in the water at any time or location. The measurements taken on the grounding system additionally indicated an anomaly which is not related to the use of power at the docks. These grounding systems should have a reading of 0mA, but this system showed values between 2-4A. This is much higher than expected and cannot be explained through any of our testing. The analysis of the grounding system was performed while the data loggers were recording the voltages in the water. During the systematic shutdown and startup of the power to the Harbormaster's dock, there were no recorded voltage changes in the water, concurrent with the operation of the circuit breakers, or as a result of the fluctuations in the grounding system's currents.

Again, in theory, there should be no current present on the grounding system's wires except during a ground fault (an unintentional connection between a powered wire and an electrically conductive material in contact with soil or water). Small amounts of current can be caused by the degradation of wire insulation in motors and other devices. Large amounts of current can be caused by damage to wire insulation caused by conduit failure, or other unusual events. Large amounts of current will typically trip circuit breakers. However, in this case all the power was turned off therefore the current is not coming from the circuit breaker panel.

## Conclusions

No evidence of voltages that would be perceptible or dangerous were detected during this study, except for the 2 second peak near the Rickety Bridge noted above. Evidence of possible manmade electrical currents were detected. The periodicity of these readings being irregular with no distinguishable pattern in duration, (day of the week or time) but the time of daily onset (except Sunday) indicates they are likely manmade. The amplitude and duration of these voltages can change over time. The grounding system at the dock was found to have between 2-4 Amperes on it, but the reason could not be identified.

Additionally, the presence of multiple electrical power sources throughout the vicinity of the marina can become opportunities for other electrical shock hazards. Therefore, it is imperative that precautions be maintained indefinitely. Remote equipment can cause stray voltages at a distance. Therefore, any complaints of shock sensations must be immediately responded to and investigated.

Even though the electrical systems on and around the dock were functioning at the time of this program are working correctly, all materials are subject to degradation and must be regularly inspected and maintained. Storms, and vehicle impacts can accelerate the degradation of electrical equipment so that additional attention to the inspection of the equipment should be implemented after these events.

## Recommendations

The following are EDT recommended next steps to mitigate the effects of, and monitor stray voltages.

Install signage in compliance with the National Fire Protection Association (NFPA) 70 National Electric Code, articles 555.10 and associated references.

*"555.10 Signage Permanent safety signs shall be installed to give notice of electrical shock hazard risks to persons using or swimming near a docking facility, boatyard, or marina and shall comply with all of the following:*

*The signage shall comply with 110.21 (B) (1) and be of sufficient durability to withstand the environment. (2) The signs shall be clearly visible from all approaches to a marina, docking facility, or boatyard facility.*

*(3) The signs shall state "WARNING - POTENTIAL SHOCK HAZARD ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."*

Inspect and maintain all electrical systems, including conduit, boxes, switches, and fixtures. Any damaged, or disconnected conduit must be taken out of service until repairs and inspections are completed.

All impressed current cathodic protection systems (corrosion control systems powered by electricity) must be tested and repaired or disconnected when found to be out of specification.

The plastic floating dock can generate an electrical charge in the same way that some carpets do. If people are experiencing a one-time static shock when touching metal or the water after walking on the dock, an anti-static coating can be applied to the dock's surface and sides so that static charges are drained into the water.

Future investigations into the voltage gradients should incorporate specific details of time and location where shocks were felt to focus testing on the locations of concern, interviews with BGE representatives, and maintenance personnel for adjacent properties and electric equipment.

## Literature Review

### City of Annapolis records

8436\_175251UKH 1188\_2023\_4\_17.icp

8436\_175251UKH 1188\_Recording\_TP4.icp

Advanced Measurements + Time (GTC-00118076-20230423-1-10).pdf

Advanced Measurements + Time (GTC-00118076-20230423-1-6).pdf

BGE Letter to Clinton Pratt (11022022).pdf

Capture recording 2 TP.pdf

Georgia Power\_brochure\_StrayVoltageDocks r4\_.pdf

GTC-00118076-20230419.icp

GTC-00118076-20230420AEMC6417recorded data down load.icp

GTC-00118076-20230712.icp

KCI\_dwg\_Truxton Park Docks Piers Boat Ramp Repairs\_200812.pdf

Pratt\_Memo to David from Clint-Revised (1)\_2022-03-01.pdf

Pratt\_Memo to Michael Mallinoff Truxton Park Update\_Redacted\_2023-09-05.pdf

Pratt\_MichaelMallinoffApril2023TPStrayCurrentMEMEO\_2023-04-20.pdf

Pratt\_Truxton Park Stray Current Update\_2023-04.pdf

Qualistar\_Truxtonpark DEC 5 2022 recording data\_2022-12-05.pdf

Qualistar\_Truxtonpark DEC2023 recording data\_2022-12-05.pdf

Qualistar\_Truxtonpark FEB2023 recording data\_2023-02-06.pdf

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Qualistar\_TruxtonparkMARCH2023 recording data\_2023-03.pdf

Qualistar\_TruxtonParkMarchEXEMPLAR\_2023-04-14.pdf

QualistarPlus (8436\_175251UKH 1188\_Recording\_2).dvw

QualistarPlus (8436\_175251UKH 1188\_Recording\_TP1).dvw

QualistarPlus (8436\_175251UKH 1188\_Recording\_TP2)\_2022-12-12.pdf

QualistarPlus (8436\_175251UKH 1188\_Recording\_TP3 ).dvw

QualistarPlus (8436\_175251UKH 1188\_Recording\_TP4\_2).dvw

QualistarPlus (Recording\_8436\_175251UKH 1188\_2023\_4\_17\_EXEMPLAR\_1\_2023-04-14.pdf

scan\_ccp\_2023-07-11-10-37-53\_2021-07-14.pdf

scan\_ccp\_2023-07-11-10-39-41\_2021-07-28.pdf

scan\_ccp\_2023-07-11-10-40-46\_2021-07-30.pdf

scan\_ccp\_2023-07-11-10-41-39\_2021-08-03.pdf

TuxtonparkDEC 12 2022 recording data.pdf

#### **Other documents**

US Coast Guard “Key Ways to Prevent Electric Shock Drowning | Boating Safety (boatingsafetymag.com)”

ESD a Hidden Killer “<https://www.nfpa.org/news-blogs-and-articles/blogs/2023/03/28/electric-shock-drowning-esd-a-hidden-killer>”

The Science Behind Electric Shock Drowning “<https://www.ecmweb.com/safety/shock-electrocution/article/20904099/the-science-behind-electric-shock-drowning>”

Navigating NEC Requirements for Marinas and Boatyards <https://www.ecmweb.com/national-electrical-code/code-basics/article/21139730/navigating-nec-requirements-for-marinas-and-boatyards>

ELECTRIC SHOCK DROWNING PREVENTION ASSOCIATION

<https://www.electricshockdrowning.org/>

“Established and Non-Established Levels of Concern for Contact Voltages  
Prepared by EPRI Knoxville, TN / USA  
Principal Investigator Douglas Dorr”



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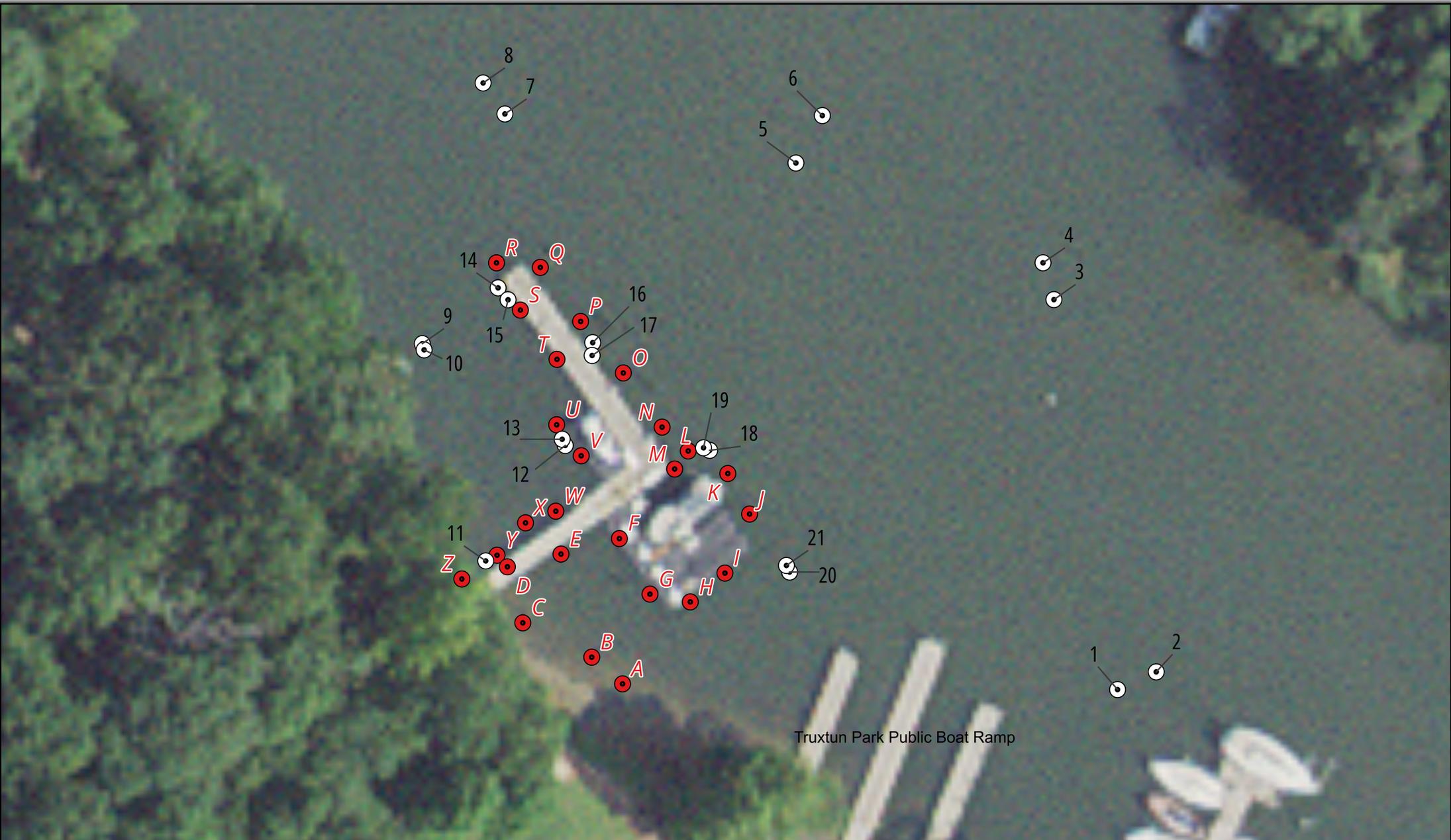
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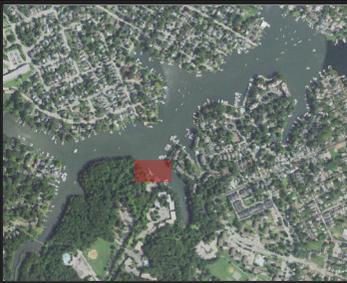
## **Appendix A**

### **Map Of Test Locations Around Marina**



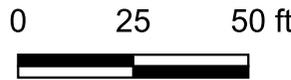
**Truxtun Park Stray Voltage Tests**

Project Manager: Gwen Sullivan  
 Project Number: 24E-08-27000  
 Office: 410.344.7200  
 500 McCormick Dr., Suite E  
 Glen Burnie, MD 21061



Projection:  
 NAD83(2011) / Maryland (ftUS)EPSG:6488  
 Lambert Conformal Conic

Data Source(s): NAIP Imagery Server, EDT



In-Boat Stray Voltage Tests 

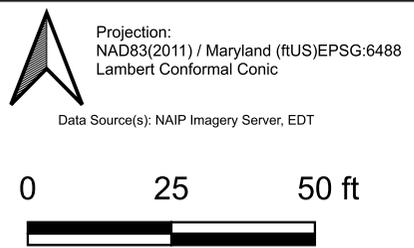
Dockside Stray Voltage Tests 





Truxtun Park Public Boat Ramp

**Truxtun Park**  
**Long Term Stray Voltage**  
**Testing in Water**  
 Project Manager: Gwen Sullivan  
 Project Number: 24E-08-27000  
 Office: 410.344.7200  
 500 McCormick Dr., Suite E  
 Glen Burnie, MD 21061



Projection:  
 NAD83(2011) / Maryland (ftUS)EPSG:6488  
 Lambert Conformal Conic

Data Source(s): NAIP Imagery Server, EDT

Vertical Stray Voltage Test ●  
 Horizontal Stray Voltage Tests —





## **Appendix B**

### **Graphs of Stray Voltage in Water**

**Part 1: Long-Term Stray Voltage Test in the Water**

**Part 2: Short-Term Stray Voltage Test in the Water**



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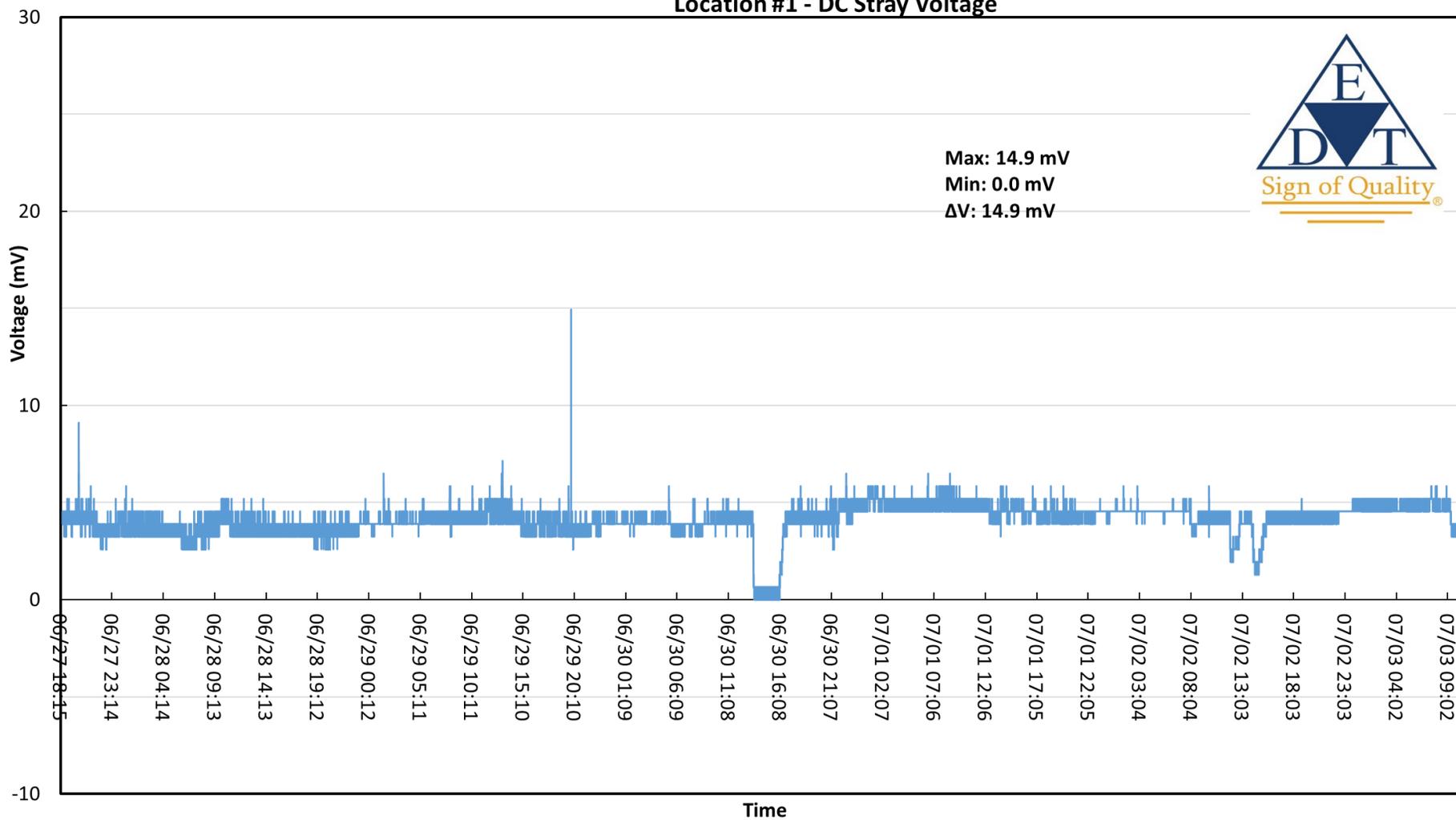
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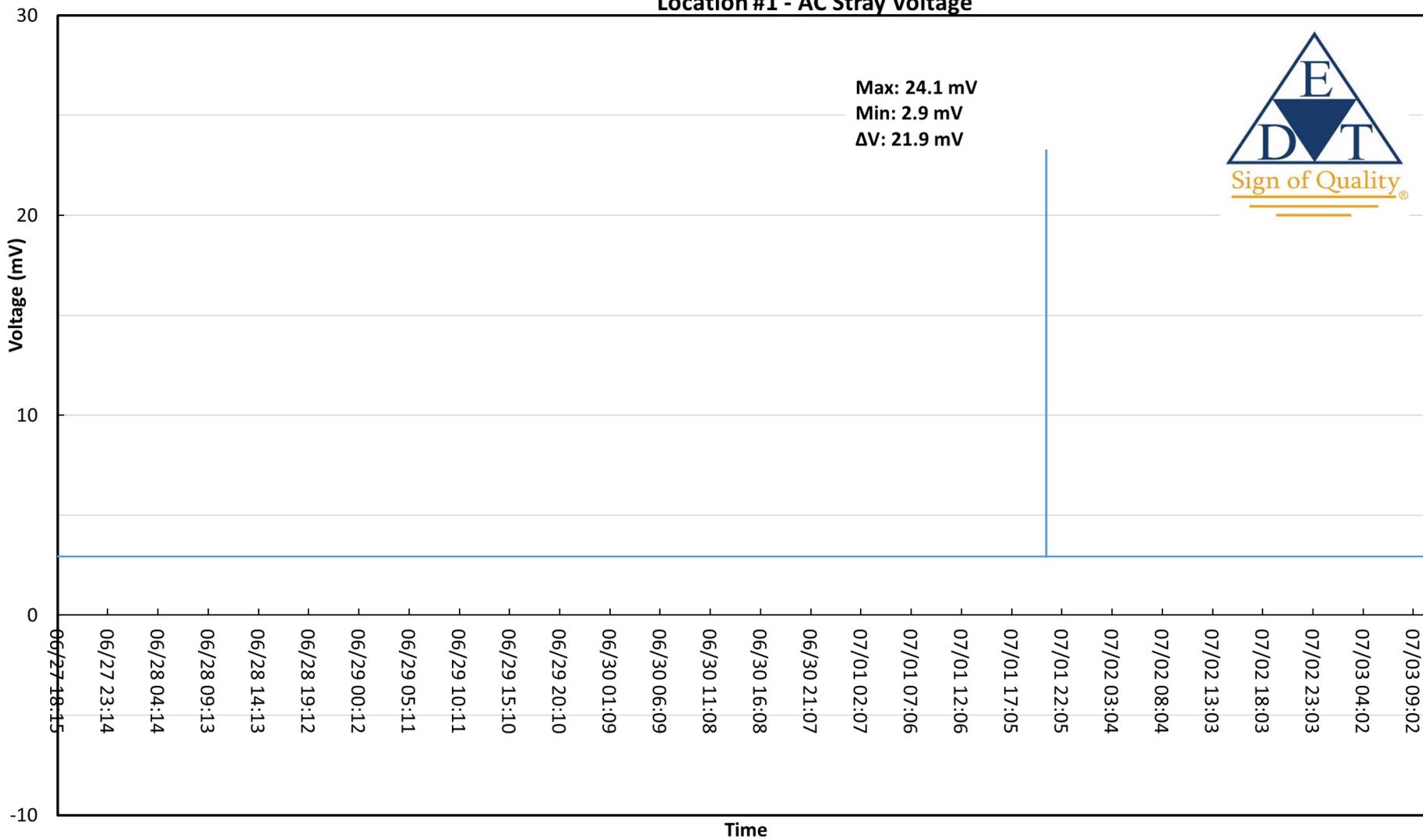
[www.edtinc.net](http://www.edtinc.net)

## **Part 1: Long-Term Stray Voltage Test in the Water**

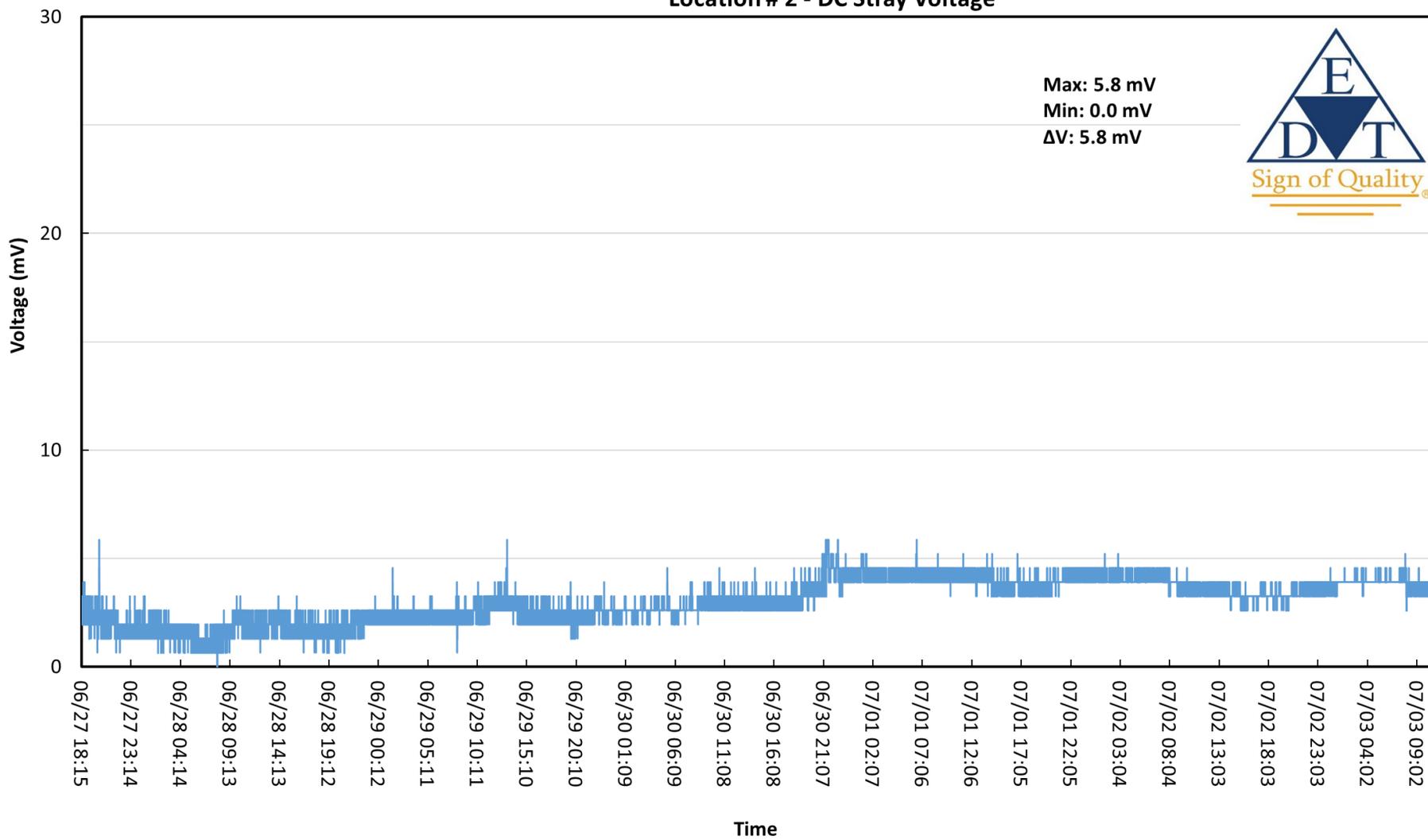
### Location #1 - DC Stray Voltage



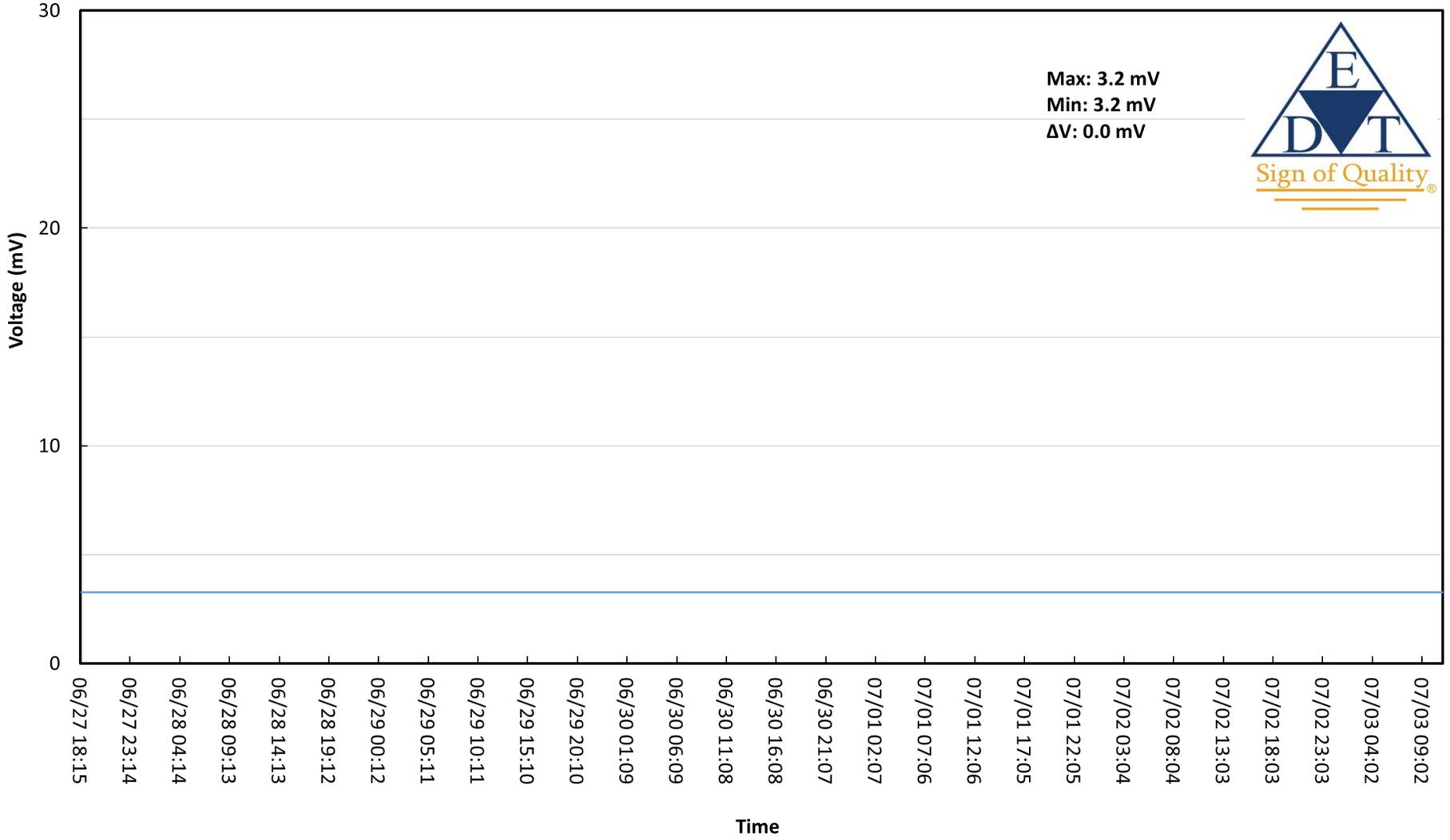
### Location #1 - AC Stray Voltage



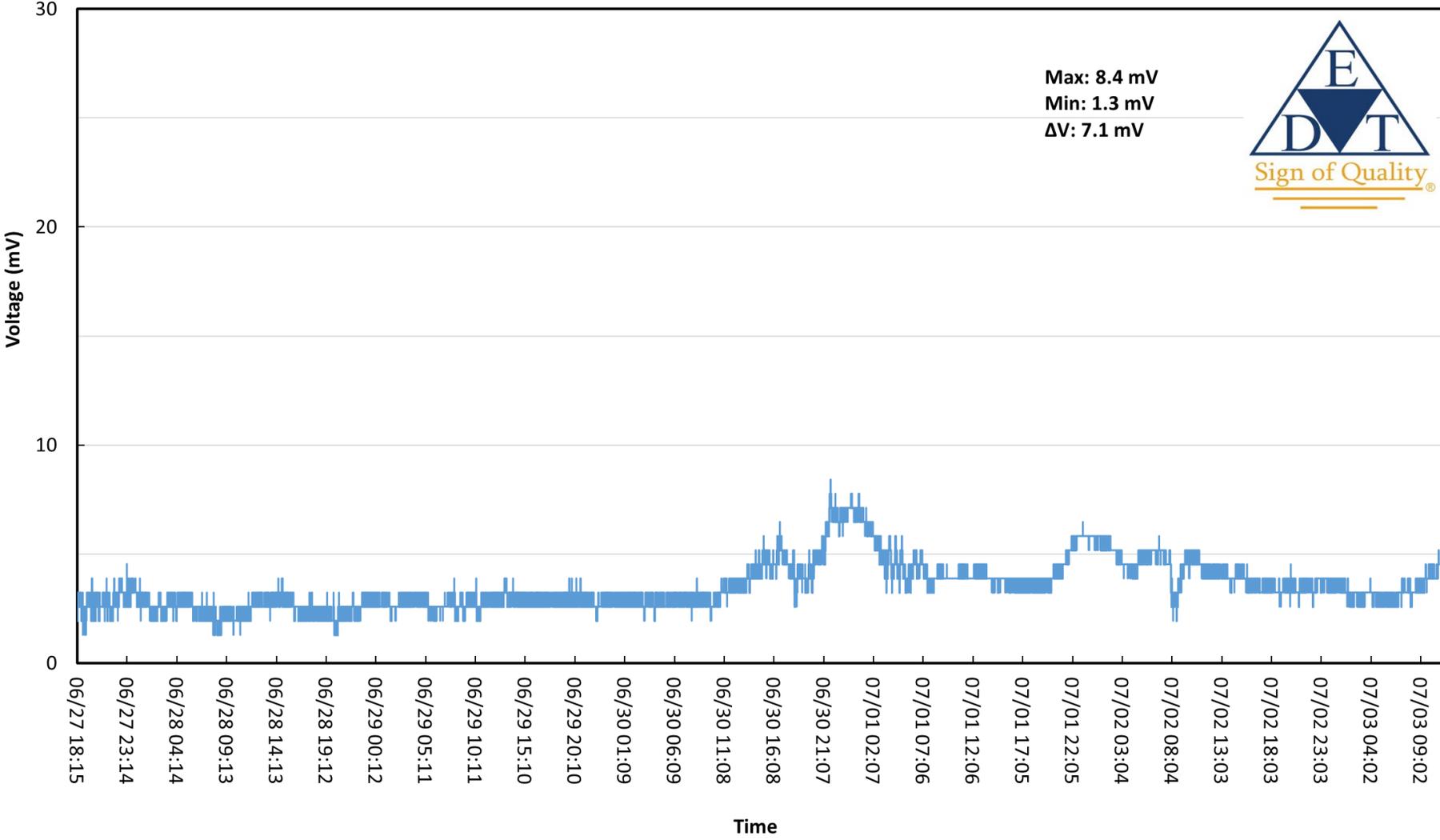
### Location # 2 - DC Stray Voltage



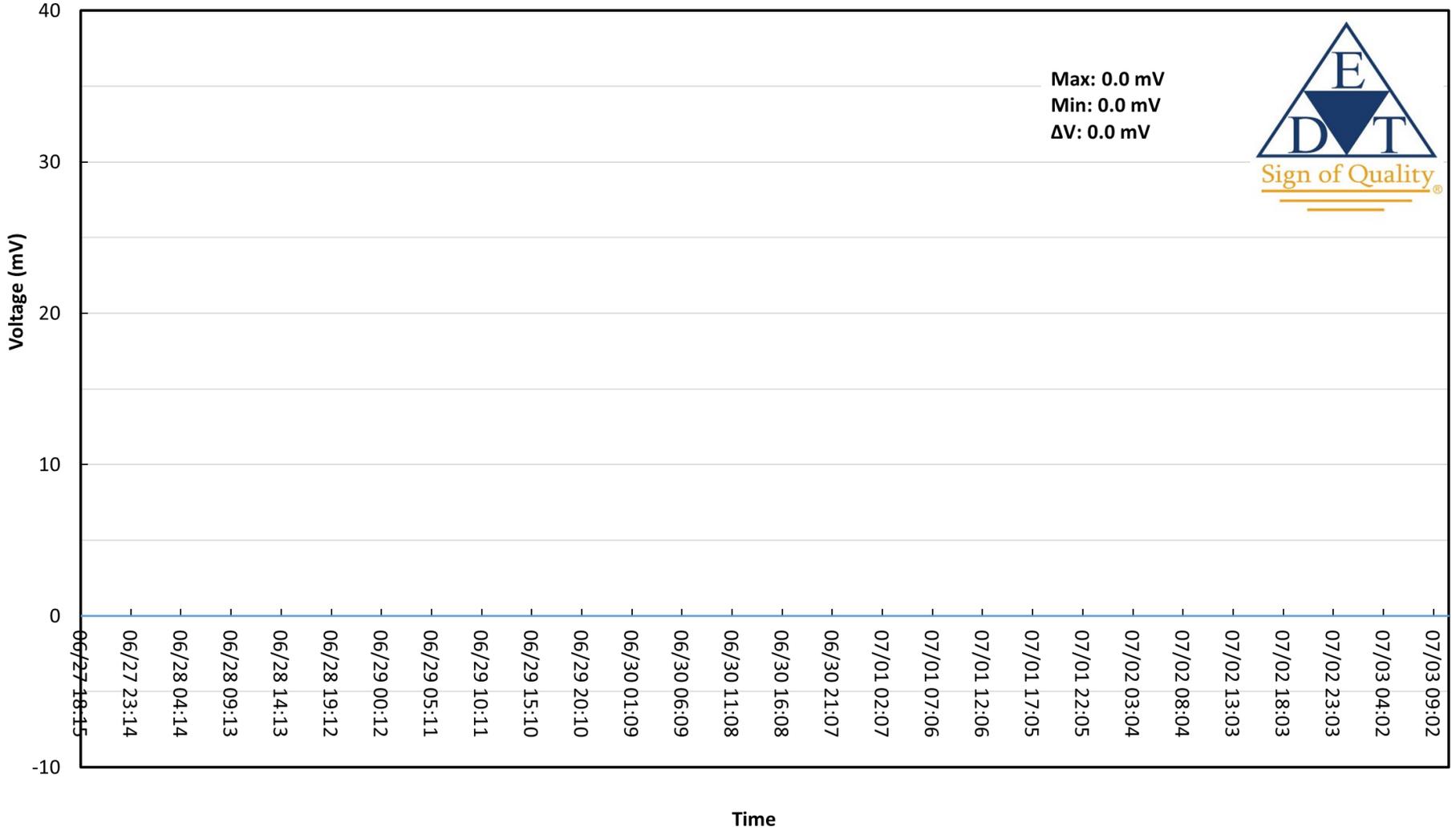
### Location #2 - AC Stray Voltage



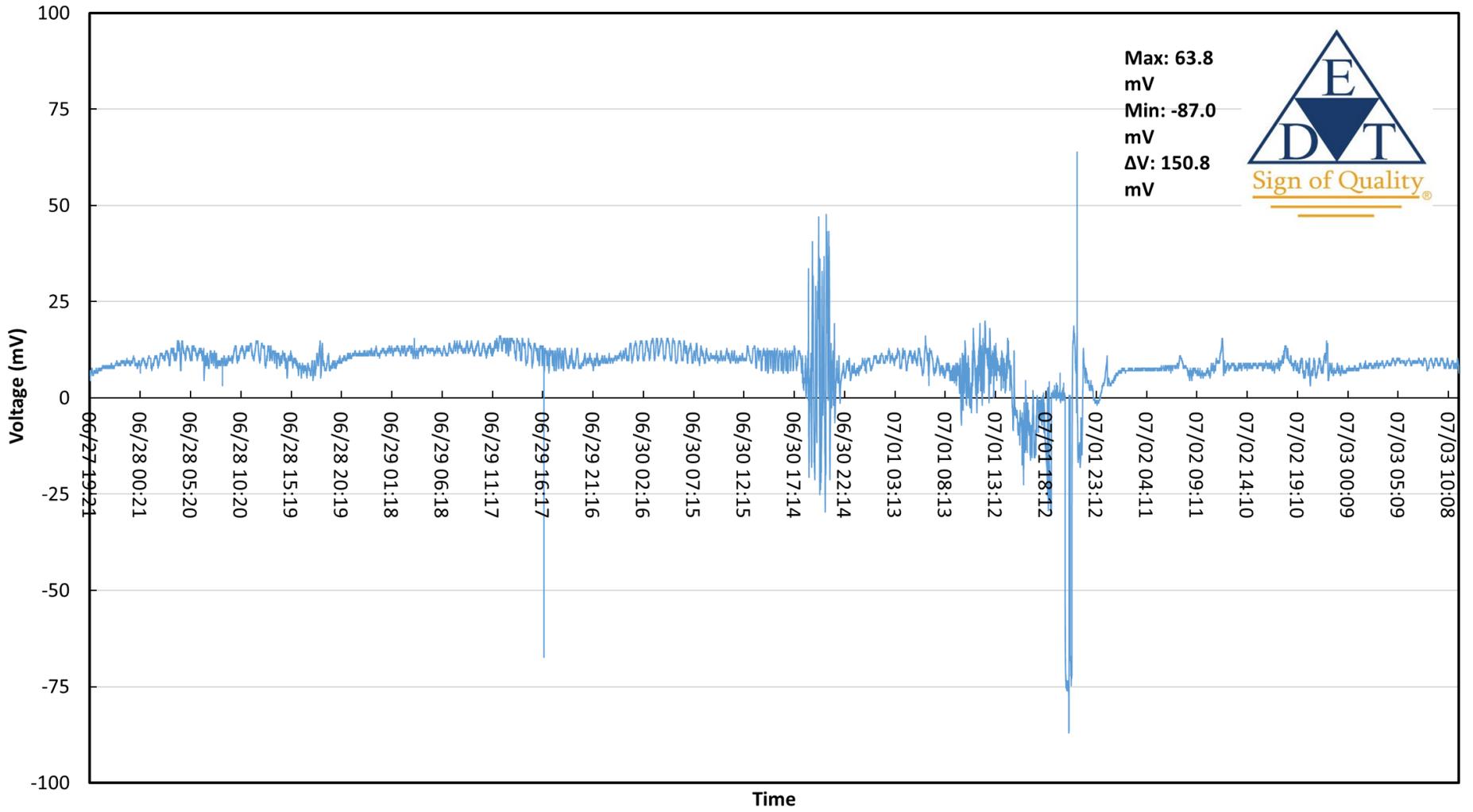
Location #3 - (Vertical) DC Stray Voltage



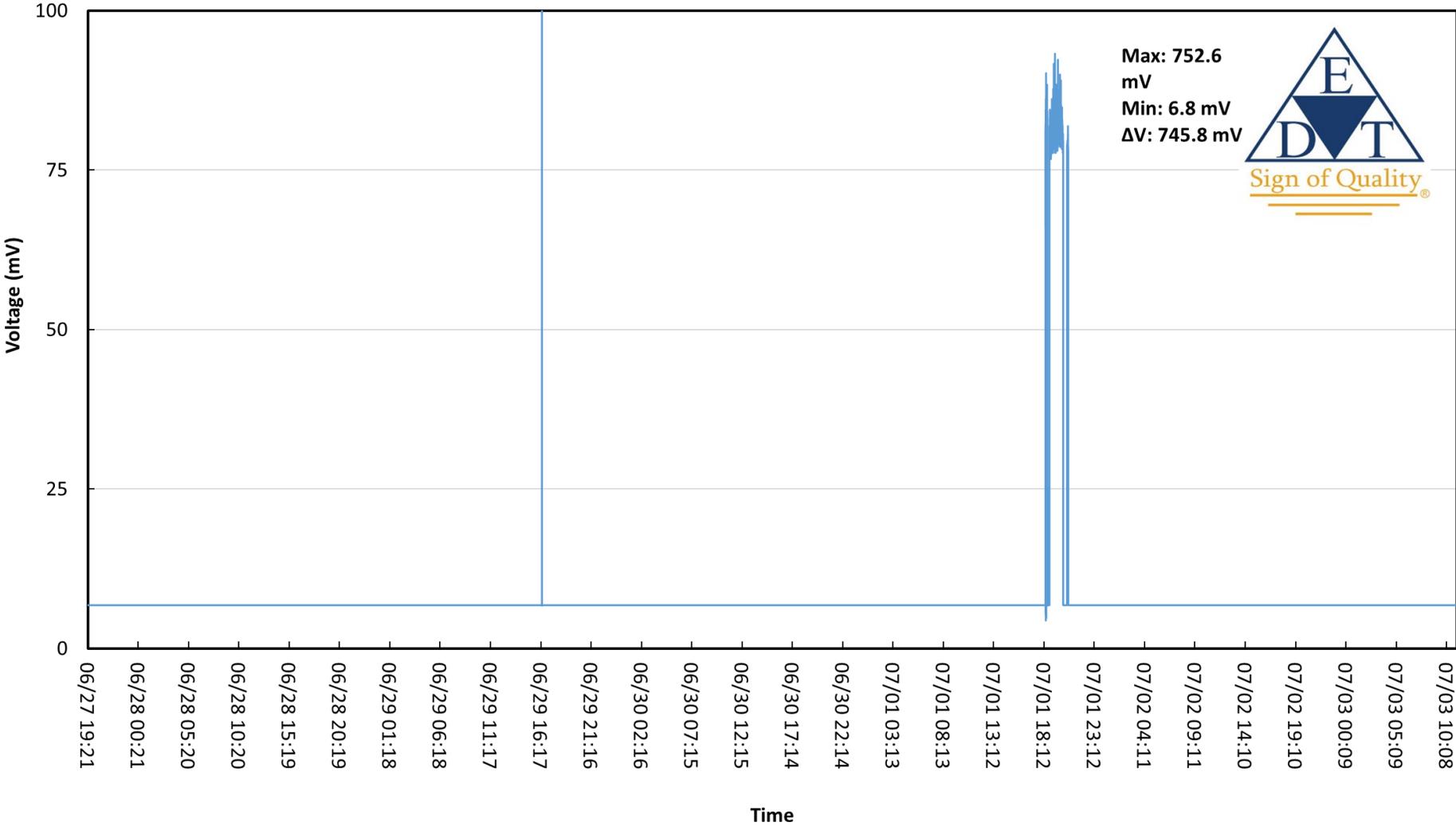
### Location #3 - (Vertical) AC Stray Voltage



### Location #4 (Rickety Bridge) - DC Stray Current



Location #4 (Rickety Bridge) - AC Stray Current





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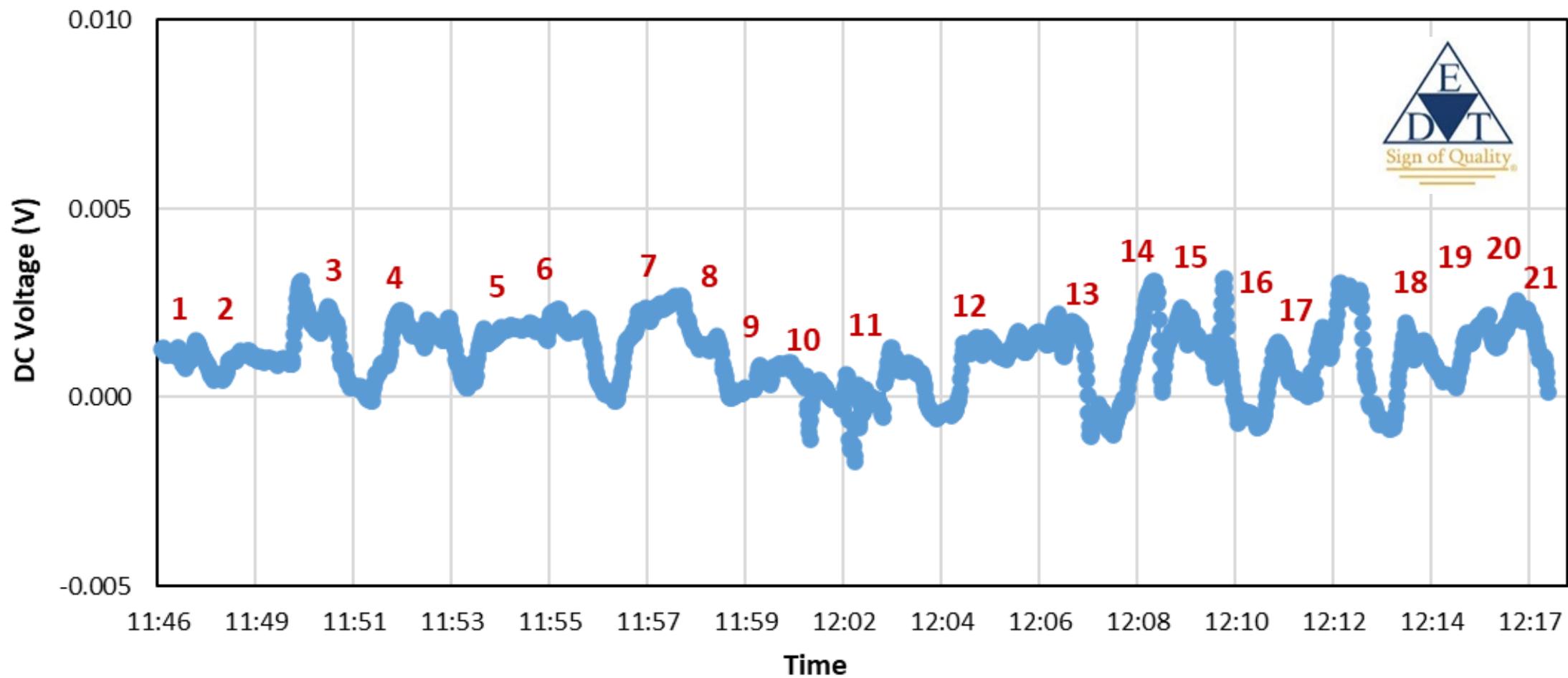
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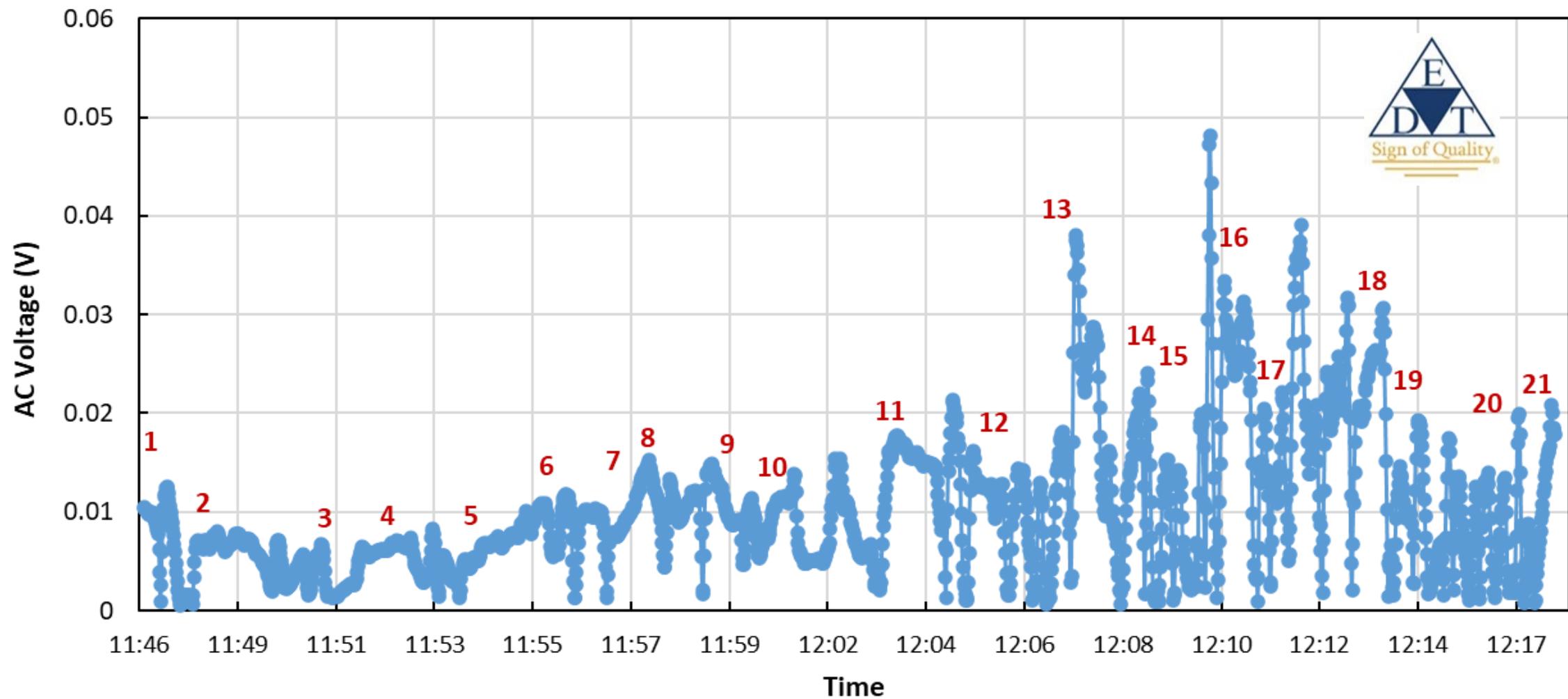
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## **Part 2: Short-Term Stray Voltage Test in the Water**

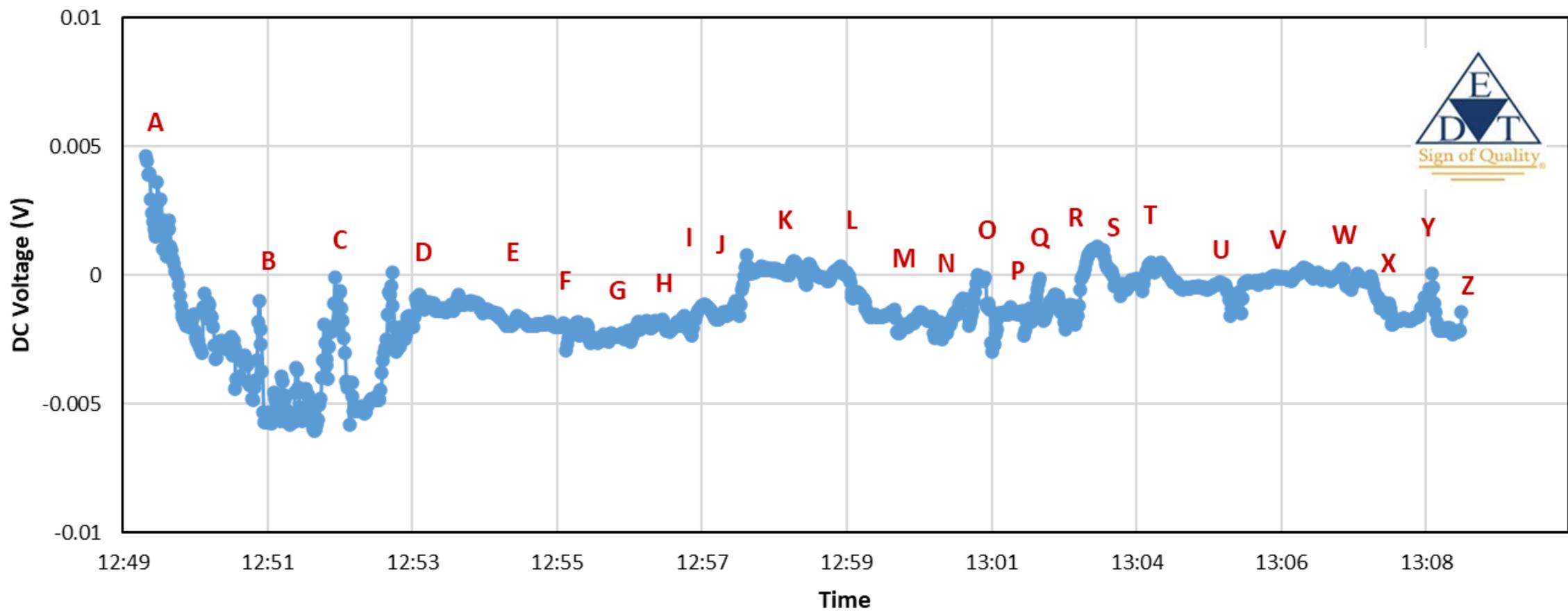
## DC Voltage Readings in Water at Remote Locations Around the Inlet



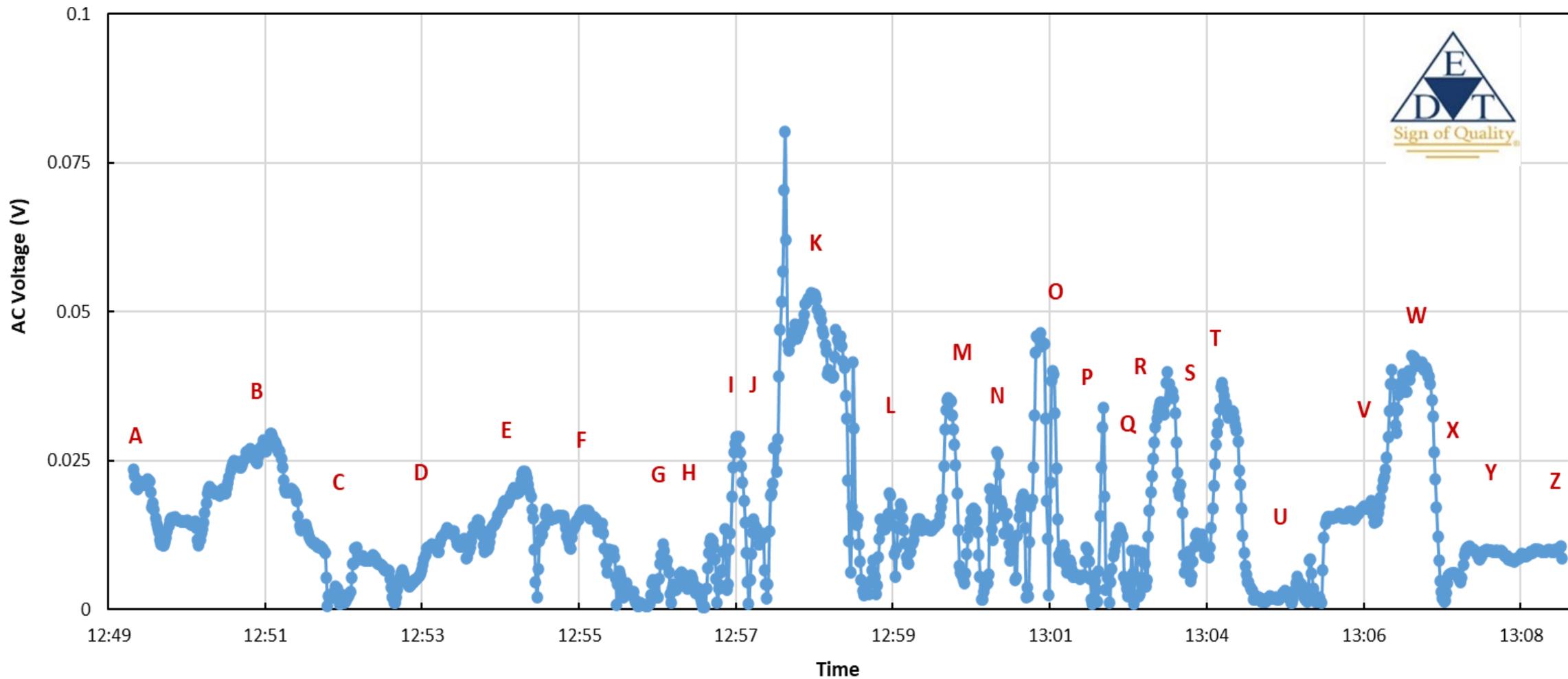
## AC Voltage Readings in Water at Remote Locations Around the Inlet



### DC Voltage Readings in Water Around the Dock



# AC Voltage Readings in Water Around the Dock





## **Appendix C**

### **Voltage Testing on Coastline**

**Part 1: Long-Term Stray Voltage Test on Land**

**Part 2: Short-Term/Instantaneous Voltage and Amperage Measurements on Land**



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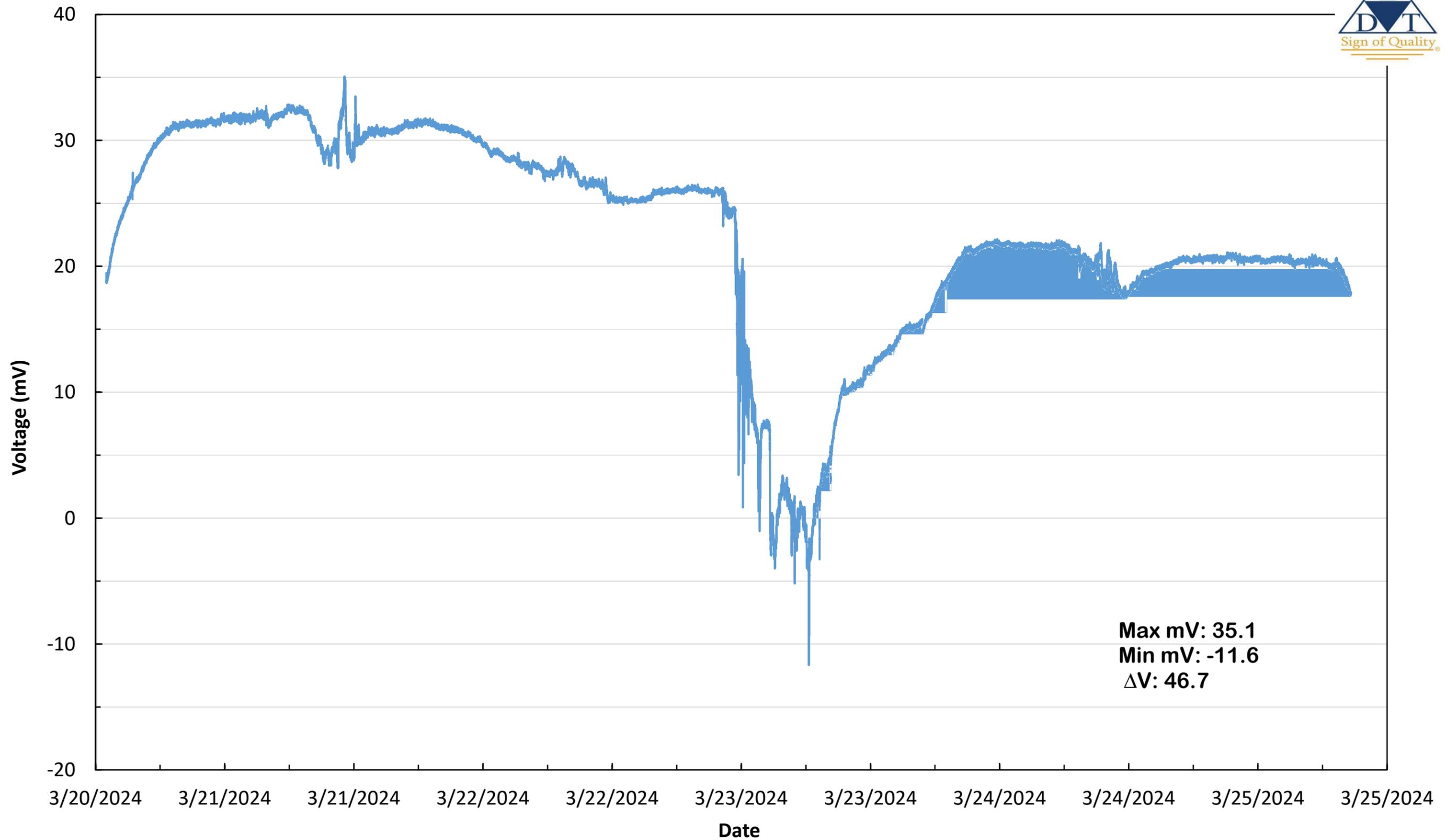
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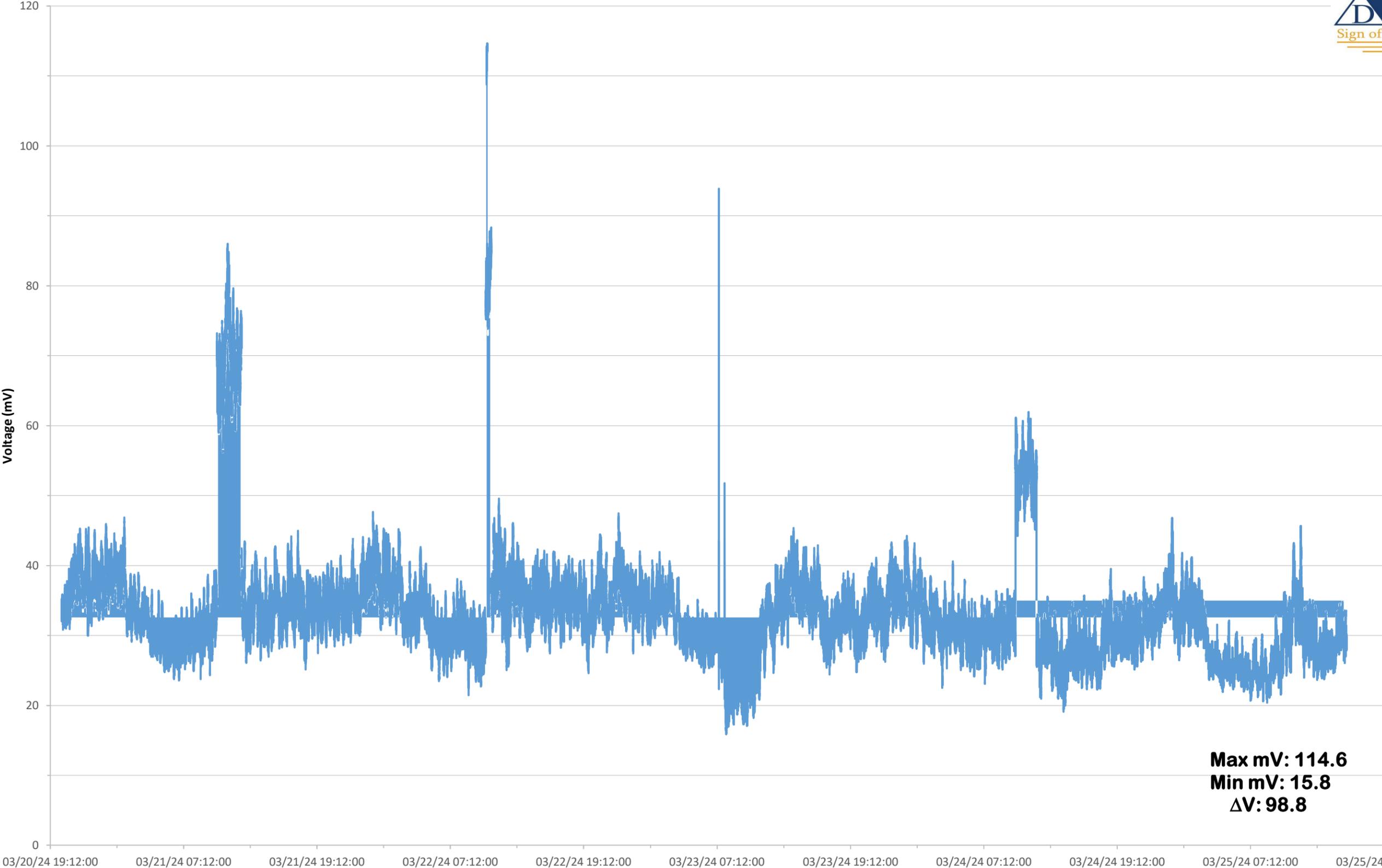
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## **Part 1: Long-Term Stray Voltage Test on Land**

DC-Stray Current Testing ID Location: Annapolis Truxtun Park\_3/20/24 to 3/25/24



AC-Stray Current Testing ID Location: Annapolis Truxtun Park\_3/20/24 to 3/25/24





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## **Part 2: Short-Term/Instantaneous Voltage and Amperage Measurements on Land**

Truxtun Park electrical ground to soil AC potentials

3/15/2024

By: T Gibb

Equipment: DMM Fluke Model 87 V, SN: 42490044

Calibrations:

DMM 1/5/2024

MIN 0.0501 MAX 0.79

| ACV    | Hz     | NOTES   |
|--------|--------|---|
| 0.7840 |        |   |
| 0.7540 |        |   |
| 0.7260 |        |   |
| 0.7390 |        |   |
| 0.7540 |        |   |
| 0.7480 |        |   |
| 0.7440 |        |   |
| 0.7390 |        |   |
| 0.7430 |        |   |
| 0.6890 |        |   |
| 0.6860 |        |   |
| 0.6920 |        |   |
| 0.6910 |        |   |
| 0.6390 |        |   |
| 0.6450 |        |   |
| 0.5697 |        |   |
| 0.0761 |        |   |
| 0.4908 |        |   |
| 0.4310 |        |   |
| 0.4777 |        |   |
| 0.4797 |        |   |
| 0.7140 |        |   |
|        |        | at picnic bench   |
| 0.7600 | 179.09 | This frequency is close to the third harmonic of 60 HZ, which is 180 HZ. It is commonly found on power systems connected to non-linear power supplies like those used by computers, and motors. |
| 0.7900 |        |   |
| 0.0501 |        |   |
| 0.0507 |        |   |
| 0.7400 |        |   |
| 0.6440 |        |   |
| 0.6750 |        |   |
| 0.5500 |        |   |
| 0.4330 |        |   |
| 0.7700 |        |   |
| 0.7260 |        |   |

Truxtun Park

AC Current in Ground wires at breaker panel by dock

Date: 7/8/2024

| Breaker # | State | Elapsed Time (Seconds) | Minimum (Amps) | Maximum (Amps) |
|-----------|-------|------------------------|----------------|----------------|
| ALL       | off   | 120                    | 3.77           | 4.26           |
| 1/3       | on    | 120                    | 3.98           | 4.6            |
| 2/4       | on    | 120                    | 3.95           | 4.6            |
| 5         | on    | 170                    | 3.6            | 4.11           |
| 9         | on    | 247                    | 3.38           | 3.95           |
| 10        | on    | 183                    | 3.25           | 3.69           |
| 11        | on    | 114                    | 3.237          | 3.58           |
| 12        | on    | 123                    | 3.8            | 3.74           |
| Main      | off   | 124                    | 4.09           | 4.41           |