THE TITANIC'S RUIN: RUST?
A collision with an iceberg crippled the Titanic, but its woes may have started before it left the dock

Yet another theory about why the unsinkable Titanic went down in 1912: The ship was a victim of rust, says Robert Baboian, the retired director of Texas Instruments' corrosion lab. The Titanic was held together by 3 million rivets made with a different type of iron than the hull plates, he notes. And once the hull was finished, the ship sat in seawater for a year while the inside was furnished. The dissimilar metals of the hull and rivets, bathed in electrically conductive seawater, might have created a circuit that slowly flecked away and weakened the rivets. One of the last photos taken before the ship's maiden voyage shows a pattern that suggests the rivets were rusting faster than the hull plates, says Baboian. The Titanic's collision with the iceberg could have popped the weakened rivets, which would explain a clinking sound reported by survivors. The hull did not rip open, but a long opening just an inch wide between the hull plates could have sunk the ship. Video of the wreckage shows a narrow opening in the unburied part of the bow, Baboian says: "It is about at the level where the iceberg would have struck, and it is right where rivet popping could occur. I think that caused the Titanic to sink.

Fenalla Sanders, Discover Magazine, August 2001:pg. 11

DC INTERFERENCE CHALLENGES 2022 WRGC CORROSION TRACK SCOTTSDALE ARIZONA

By Paul Sedlet, Accurate Corrosion Control, Inc.

August 22nd, 2022

SUMMARY OF PRESENTATION

- Cathodic Protection Theory
  - Definition of Cathodic Protection
  - Polarization
  - Pipe-to-Soil Potential Components
  - AMPP (NACE)- Criteria and Other Considerations
- DC Decoupler (DCD) Affect to Potentials
- Metal IR and Long Line Corrosion Cells
- Rectifier Influence- Influence verses Interference

DEFINITION OF CATHODIC PROTECTION
(IT'S NOT JUST A NUMBER ON A METER)

[1]For CP to be entirely effective, the local cathodes on the corroding specimen must be polarized to the potential of the unpolarized local anodes.

[2]Polarize a structure to a potential that is equal to, or more negative than its most active anode

[1]R.B. Mears, R.H. Brown, "A Theory of Cathodic Protection," *Transactions of the Electrochemical Society* 74 (1938): p. 527.

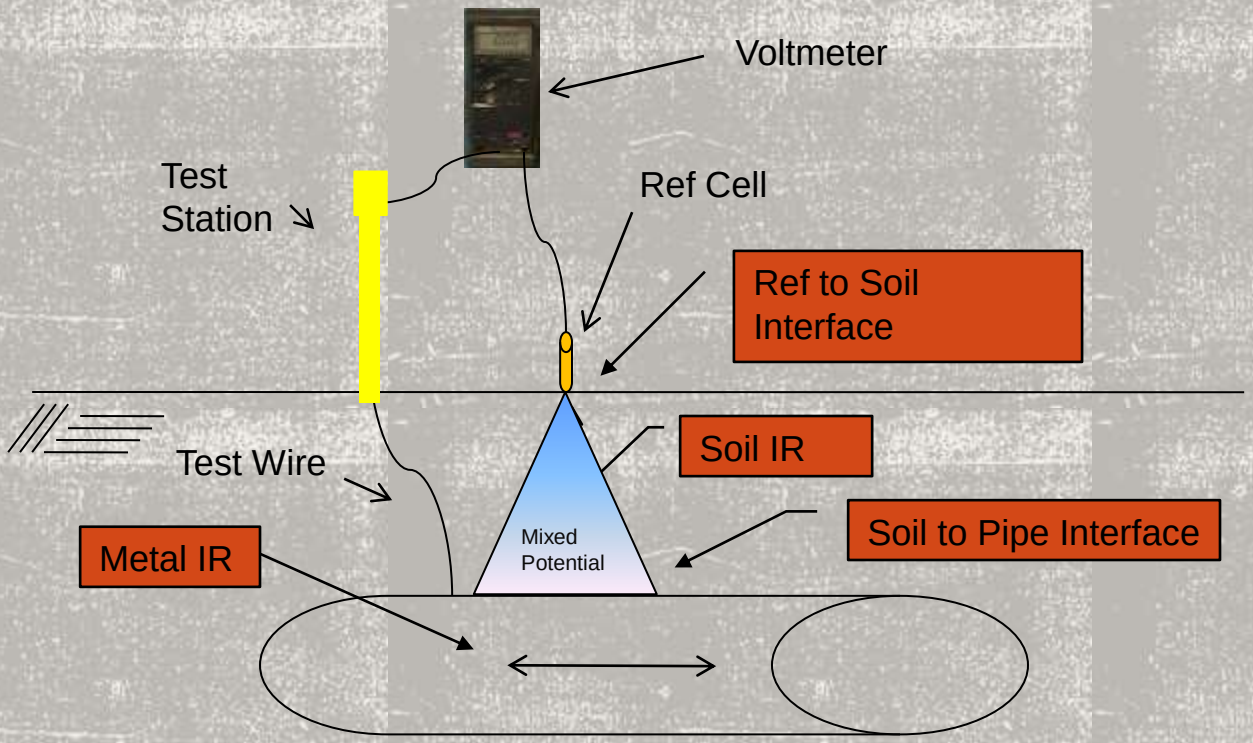
[2]Richard Patterson, verbally every week, practiced CP Engineering 1948 to 2005.

WHAT ARE THE 4-COMPONENTS OF A PIPE-TO-SOIL POTENTIAL

There are 4 components that make up the voltage displayed on the meter.

1. The pipe to soil interface
2. The reference to soil interface
3. The soil IR *(voltage drop due to any current flow in the soil. Not only your company's current flow. Any current flow)*
4. The metal IR *(applies to CIS data)*

PIPE-TO-SOIL POTENTIAL COMPONENTS



SP0169 REFERENCE TO OTHER STANDARDS

- AMPP (NACE) SP0169 discusses criteria for the indication of cathodic protection

Foreword

This standard practice presents procedures and practices for achieving effective control of external corrosion on buried or submerged metallic piping systems. These recommendations are also applicable to many other buried or submerged metallic structures. It is intended for use by corrosion control personnel concerned with the corrosion of buried or submerged piping systems, including oil, gas, water, and similar structures. This standard describes the use of electrically insulating coatings, electrical isolation, and cathodic protection (CP) as external corrosion control methods. It contains specific provisions for the application of CP to existing bare, existing coated, and new piping systems. Also included are procedures for control of interference currents on pipelines.

This standard should be used in conjunction with the practices described in the following NACE standards and publications, when appropriate (use latest revisions):

SP0572[1] RP0177[2] RP0285[3] SP0186[4] SP0286[5] SP0387[6] SP0188[7]
TPC 11[8] TM0497[9]

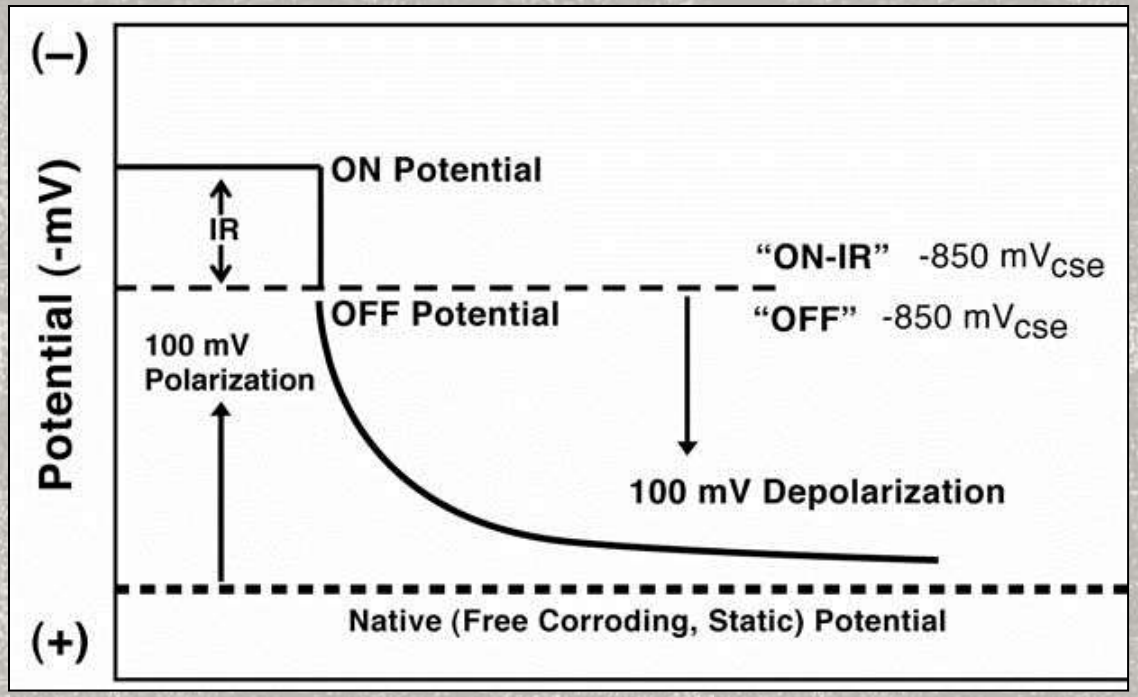
TM0497- OTHER CONSIDERATIONS

Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

Contents

DEPOLARIZATION GRAPH AND COMMON CP CRITERION

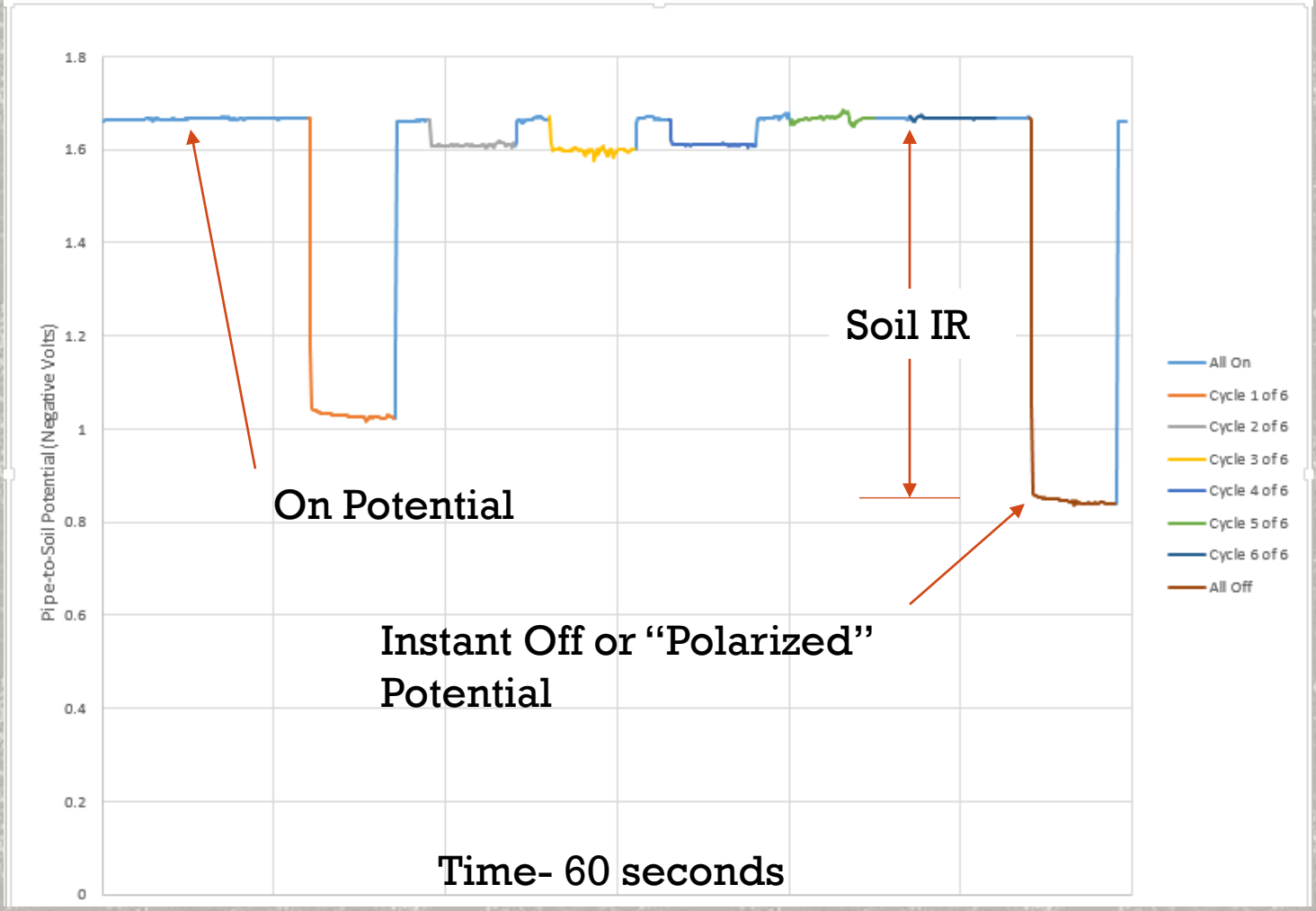
- **-850mV "ON"**
  - With CP applied
  - Knowing which CP systems have influence on this number is helpful
- **-850mV "IRF"**
  - Synchronous current interruption is generally required
  - Knowing and understanding which CP Systems and current sources have an influence on this number **is necessary**
- **100mV Polarization**



WAVEFORM FIELD TESTING- MEASUREMENT AT ONE LOCATION OVER TIME

- Provide more data than a single reading, because polarization characteristic of the pipe at that location is observable
- Typically collected at 20 to 50 readings per second
- Can be collected in a CIS data logger or other type of data logger
- Can be used to measure pipe-to-soil potentials, current spans, or cell-to-cell measurements
- Can be utilized as a tool while performing a Rectifier Influence Study (RIS)

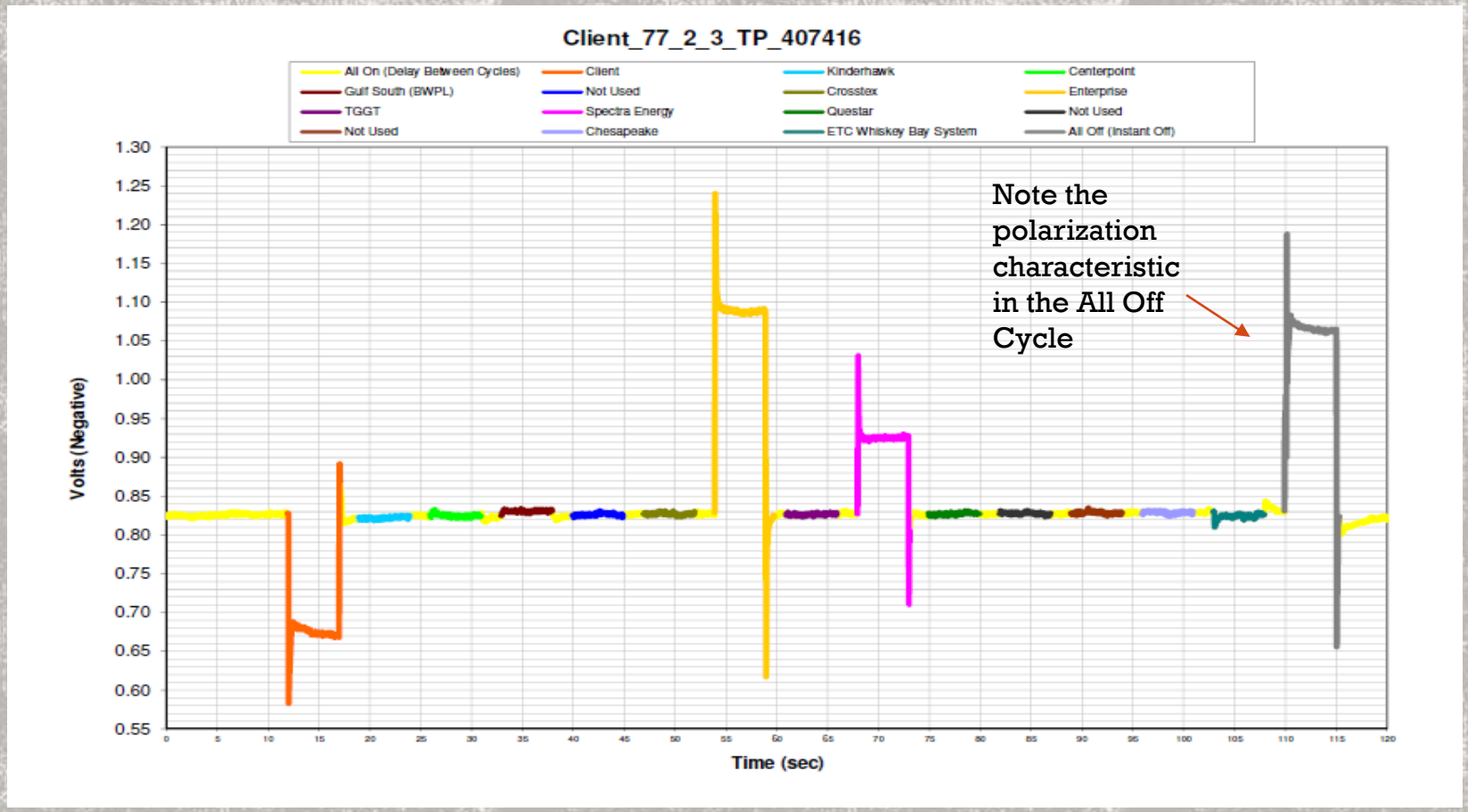
PIPE-TO-SOIL WAVEFORM



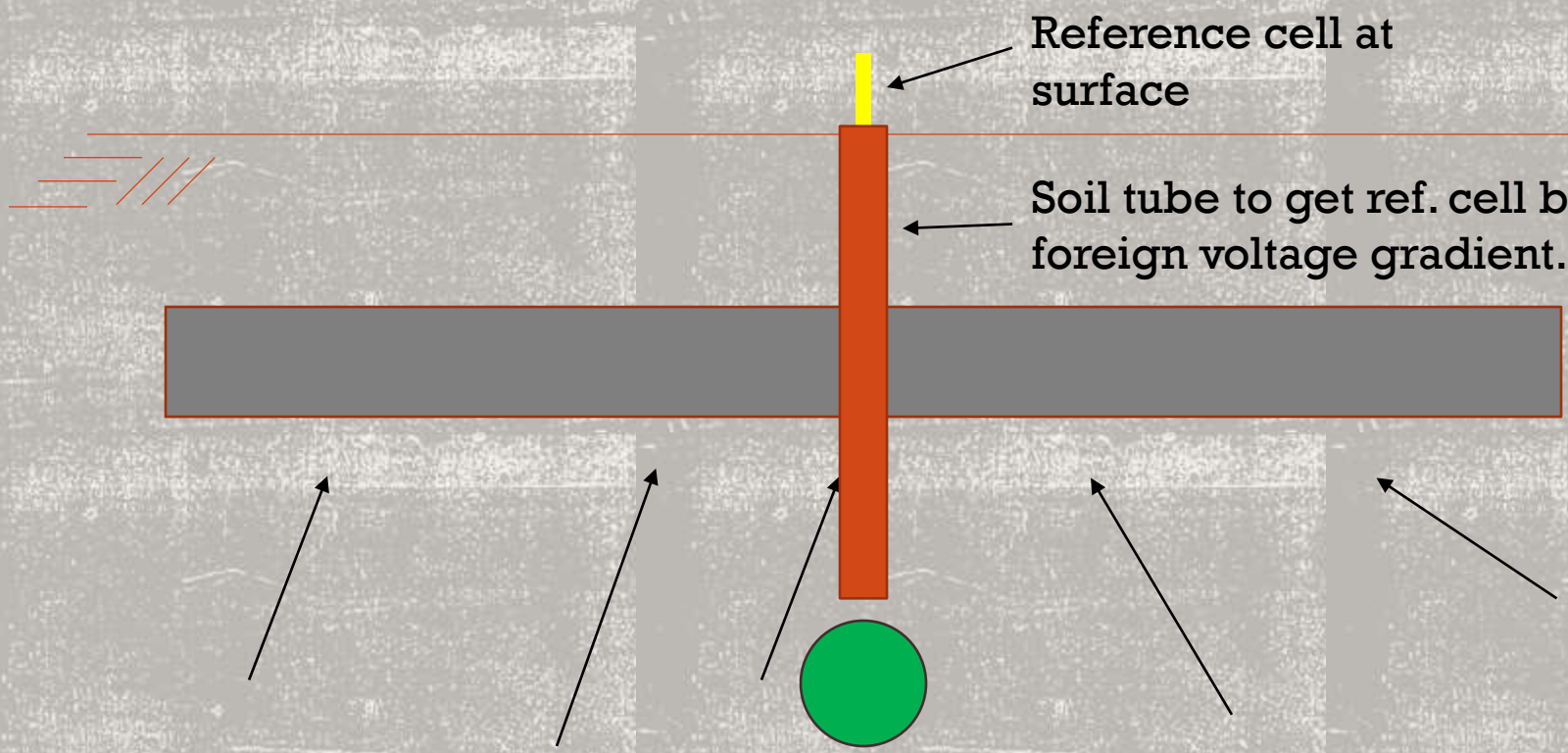
RECTIFIER INFLUENCE STUDY (RIS) TESTING

EXAMPLE- USING RIS TESTING TO DETERMINE INFLUENCE VERSES INTERFERENCE

INVESTIGATION OF A LOW POTENTIAL AND SUPPRESSION AT A FOREIGN LINE CROSSING

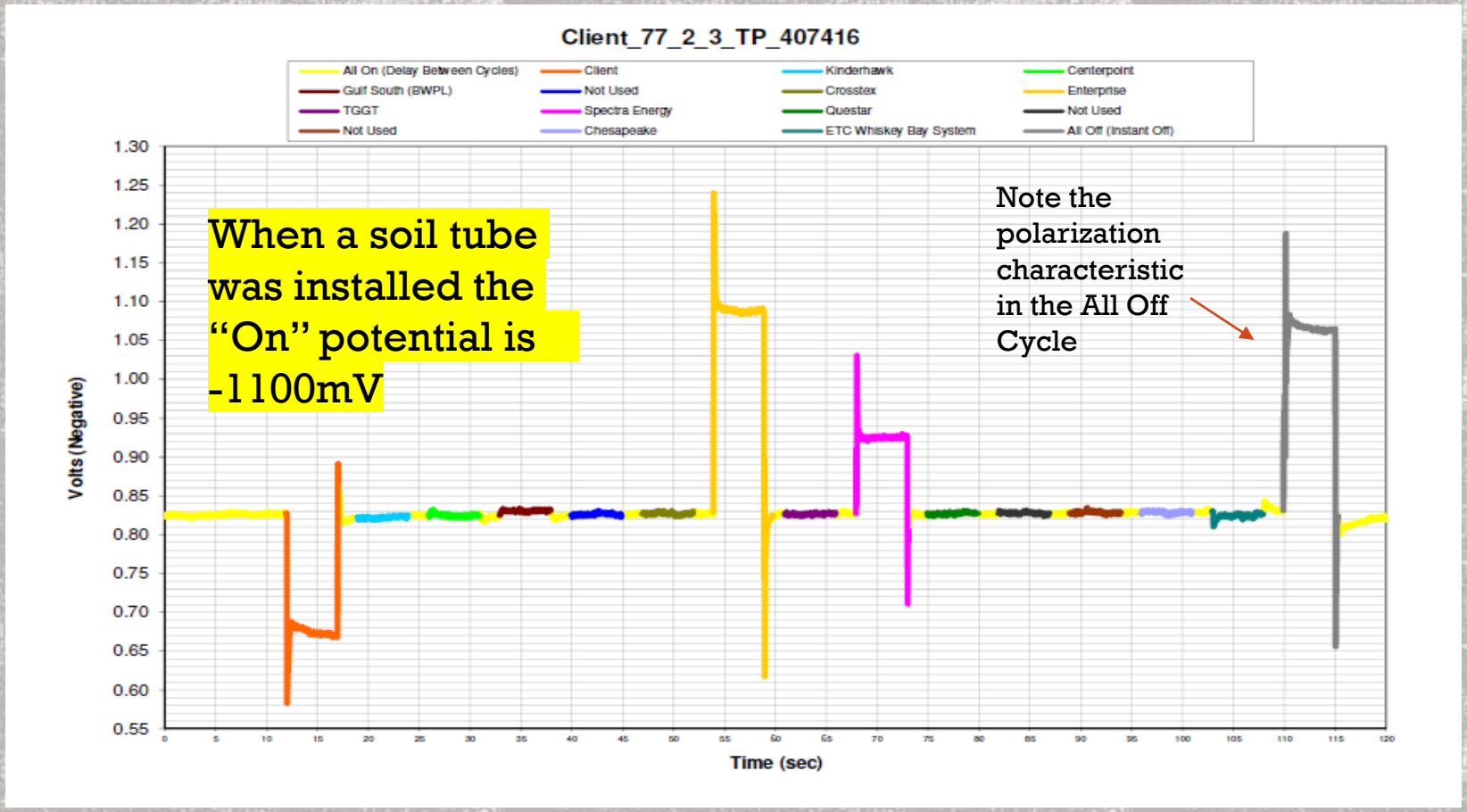


PIPELINE CONFIGURATION AT CROSSING- NEW LINE WAS BORED UNDER EXISTING



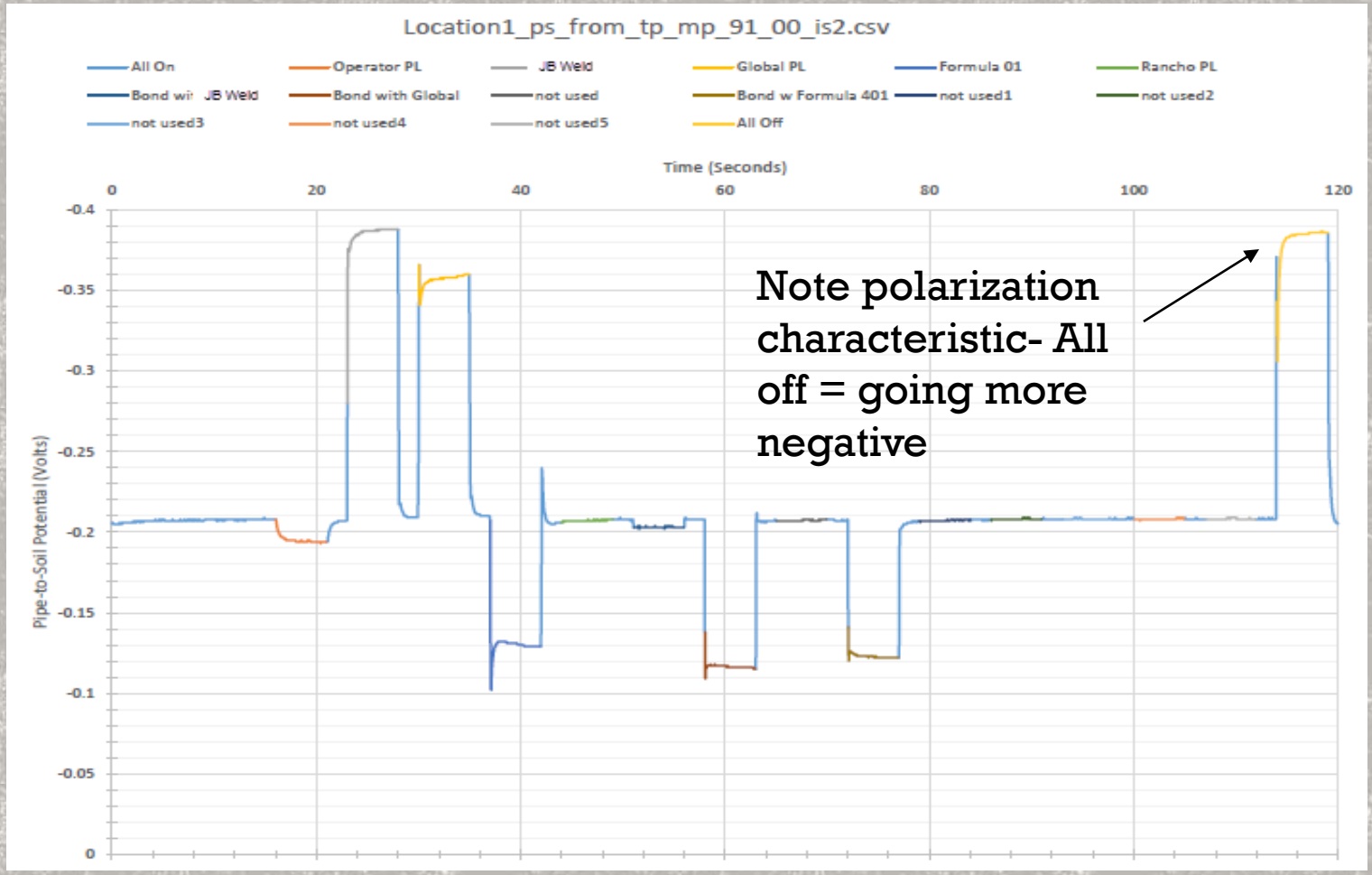
Well coated line bored under poorly coating line. Soil IR from foreign line is a large component of the surface P/S

CONCLUSION- NO STRAY CURRENT INTERFERENCE. JUST INFLUENCE



SO WHAT DOES INTERFERENCE LOOK LIKE IN A PIPE-TO-SOIL WAVEFORM?

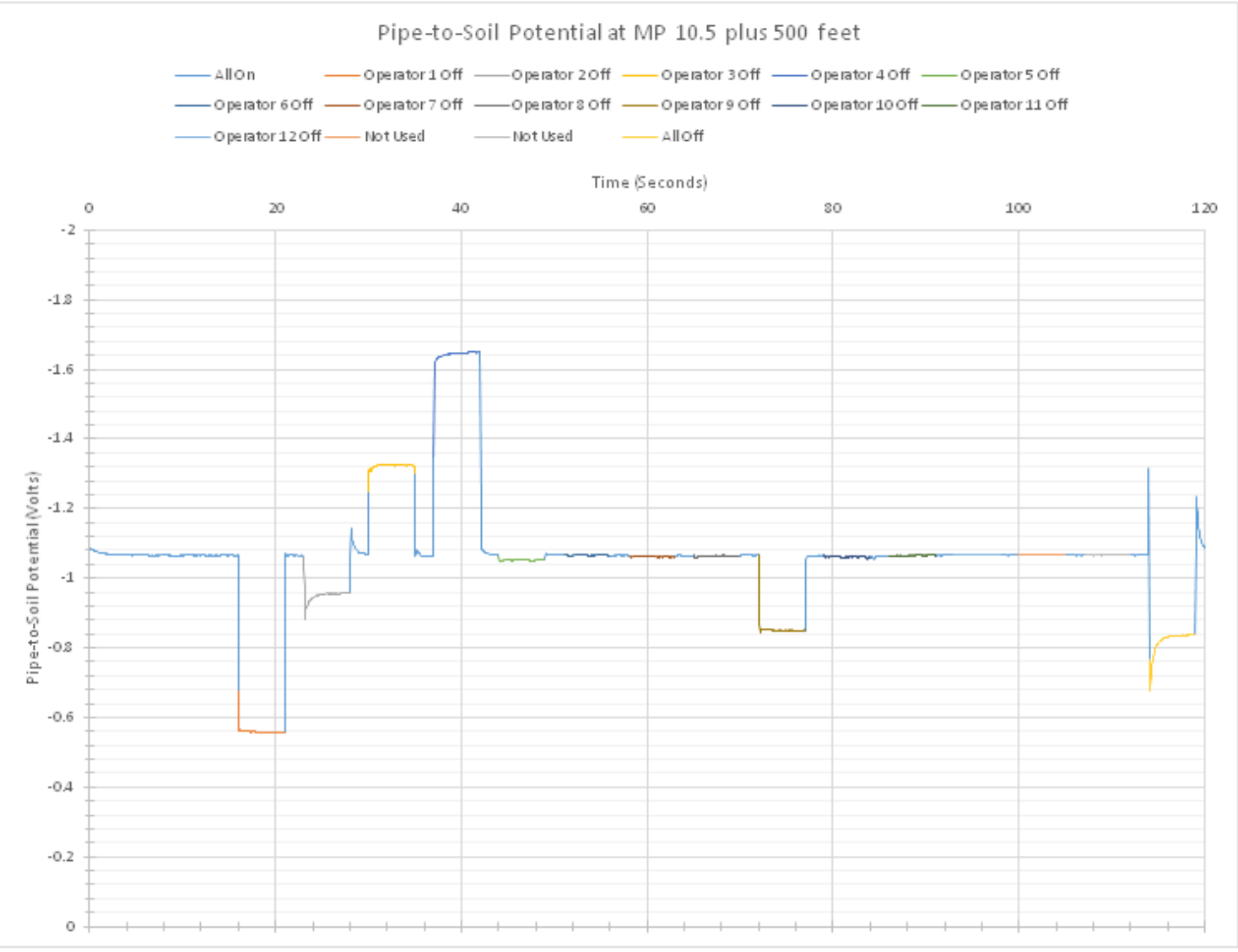
P/S WAVEFORM IN A PIPELINE CORRIDOR- WALL LOSS FOUND WITH ILI



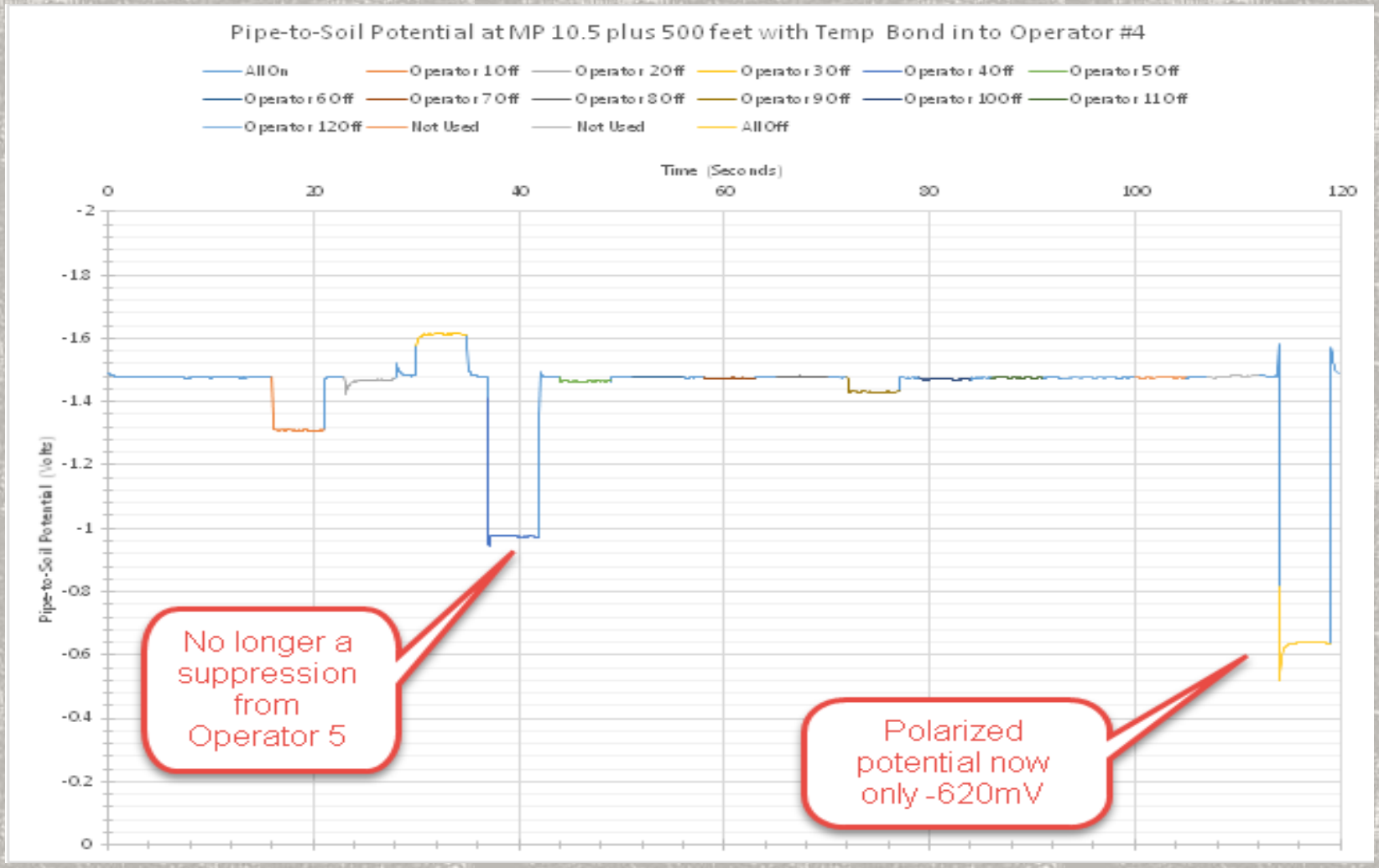
CASE STUDY- TO BOND…….. OR NOT TO BOND

That is the question

AS FOUND P/S WHERE I/O IS < -850MV



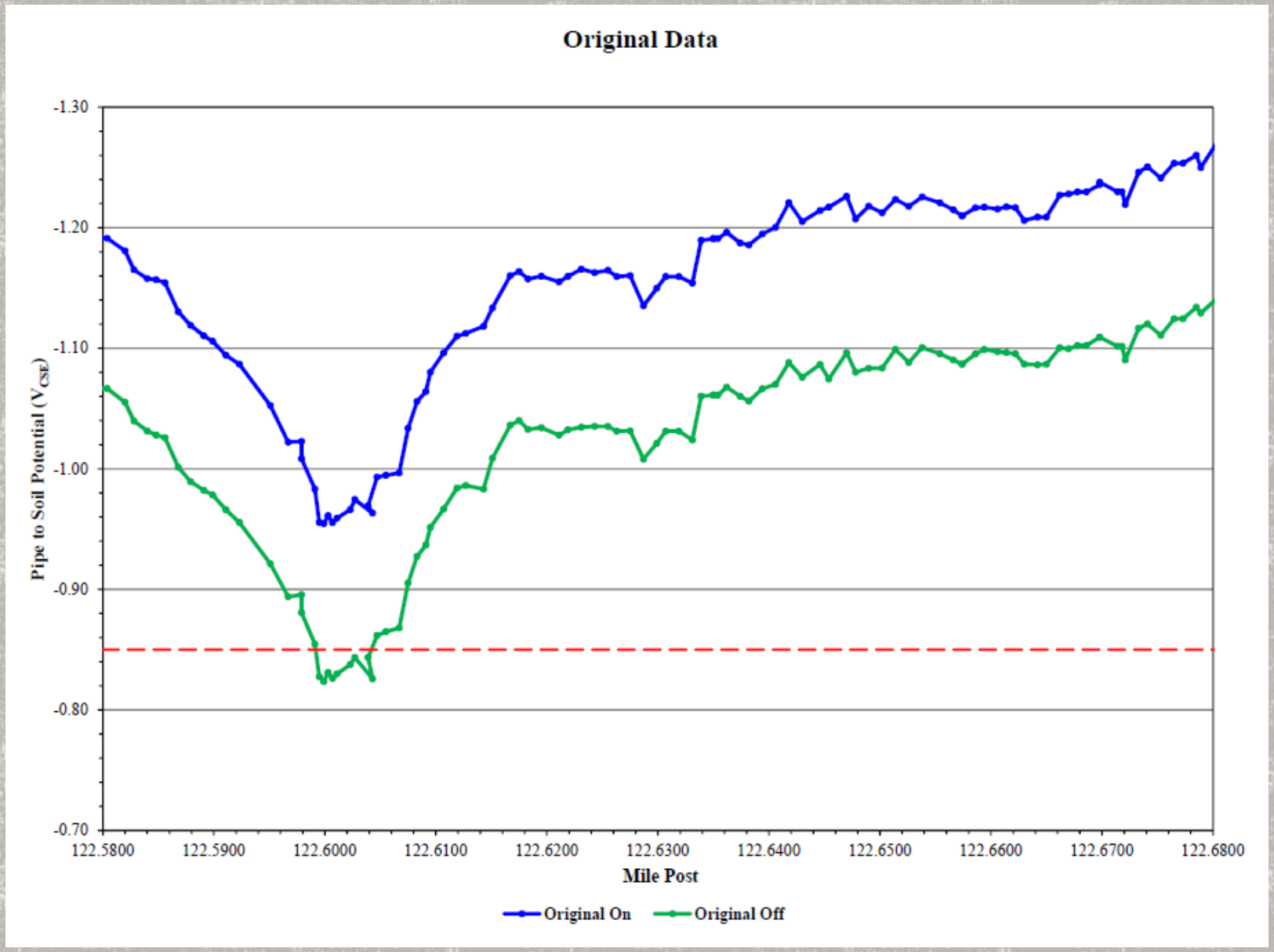
P/S WAVEFORM AT THE SAME TP WITH A TEMP BOND INSTALLED



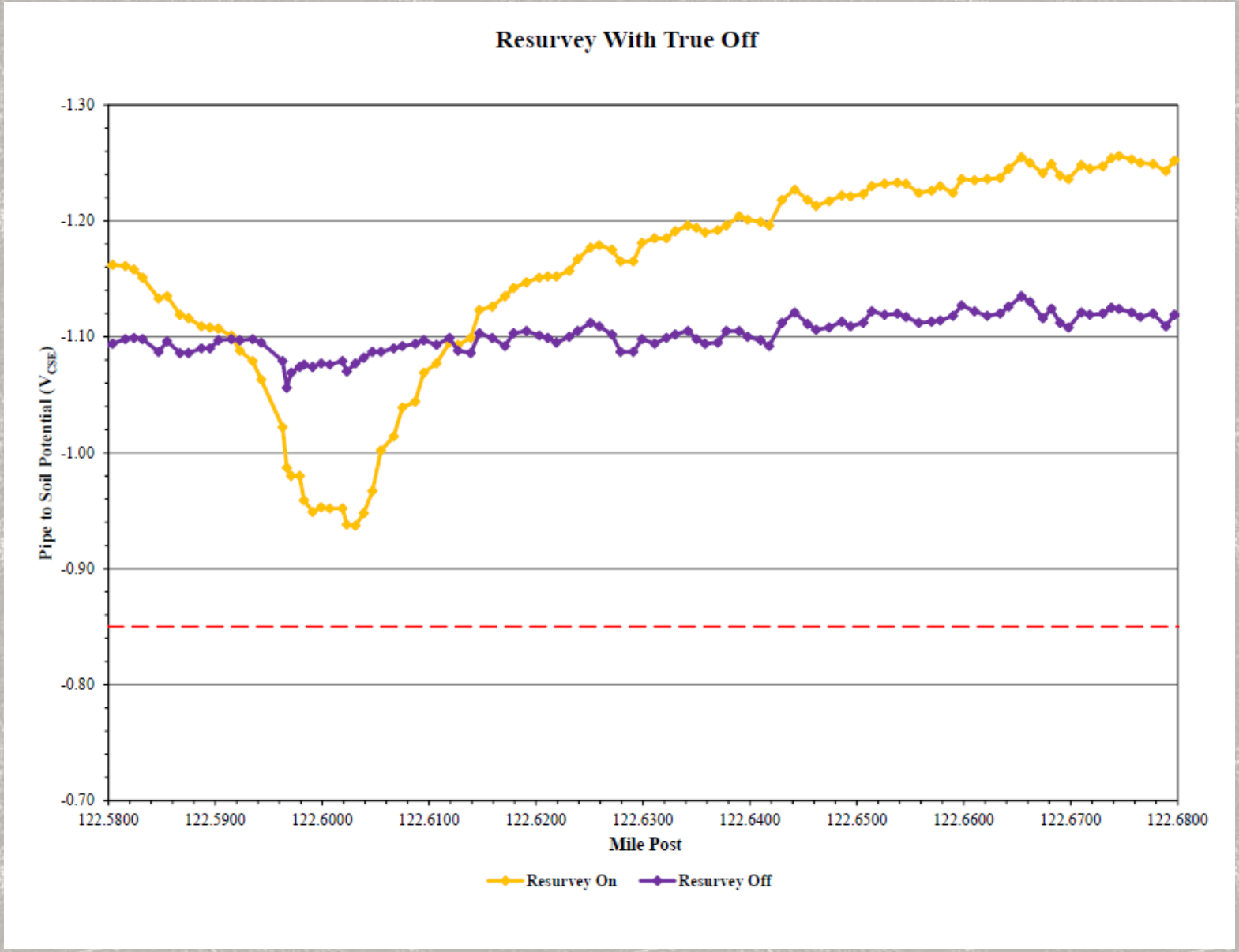
EXAMPLE- CIS INDICATING SUPPRESSION AND POSSIBLE DC INTERFERENCE

- CIS performed on a 30" high pressure gas transmission line
- Only rectifiers on the Company were interrupted
- Foreign rectifiers were NOT included in the interruption plan
- CIS was duplicated, but with interruption of all influencing current sources
- Rectifier Influence Study was performed

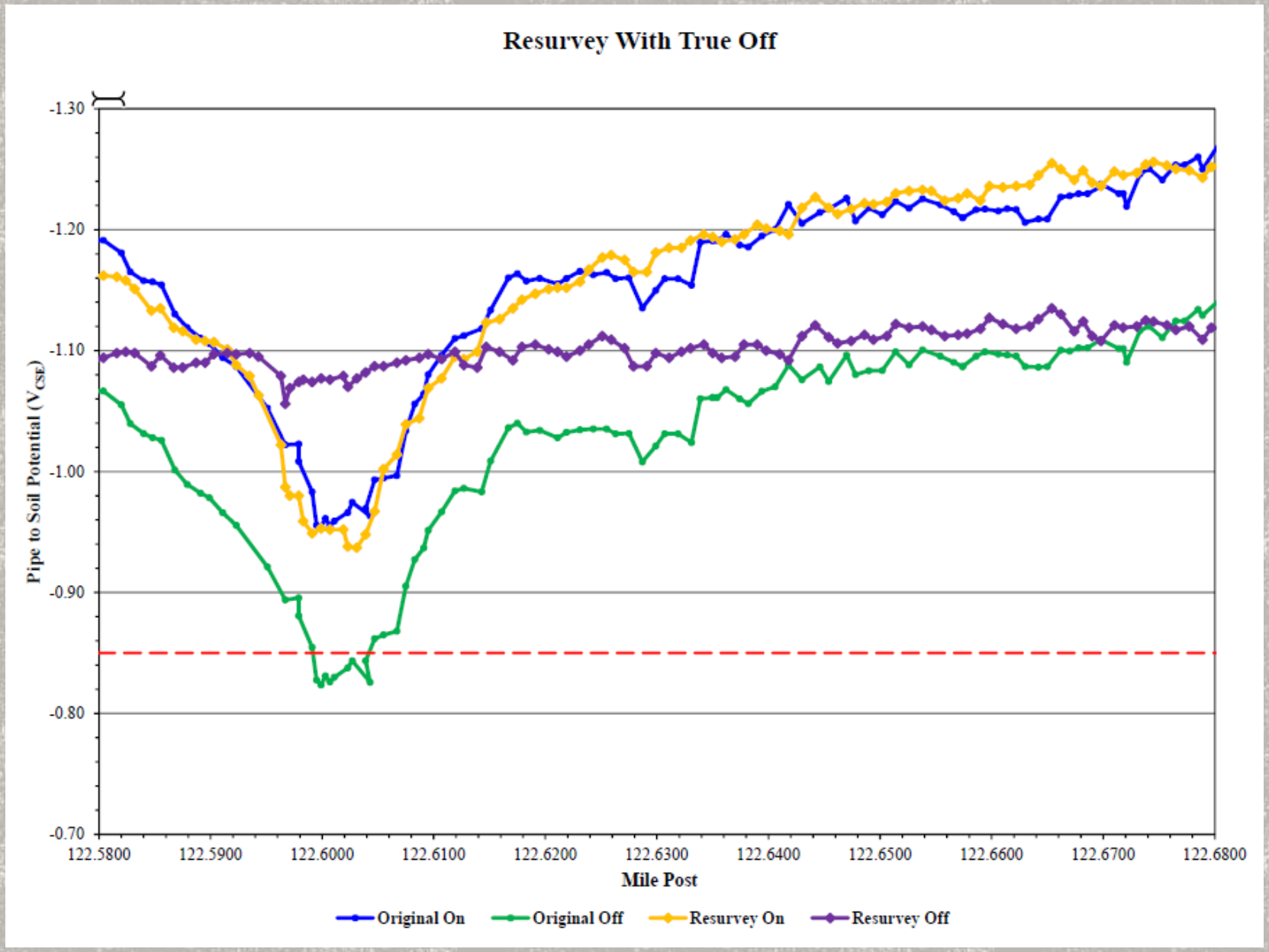
CIS Data at Foreign Crossing- Only Co. Interruption



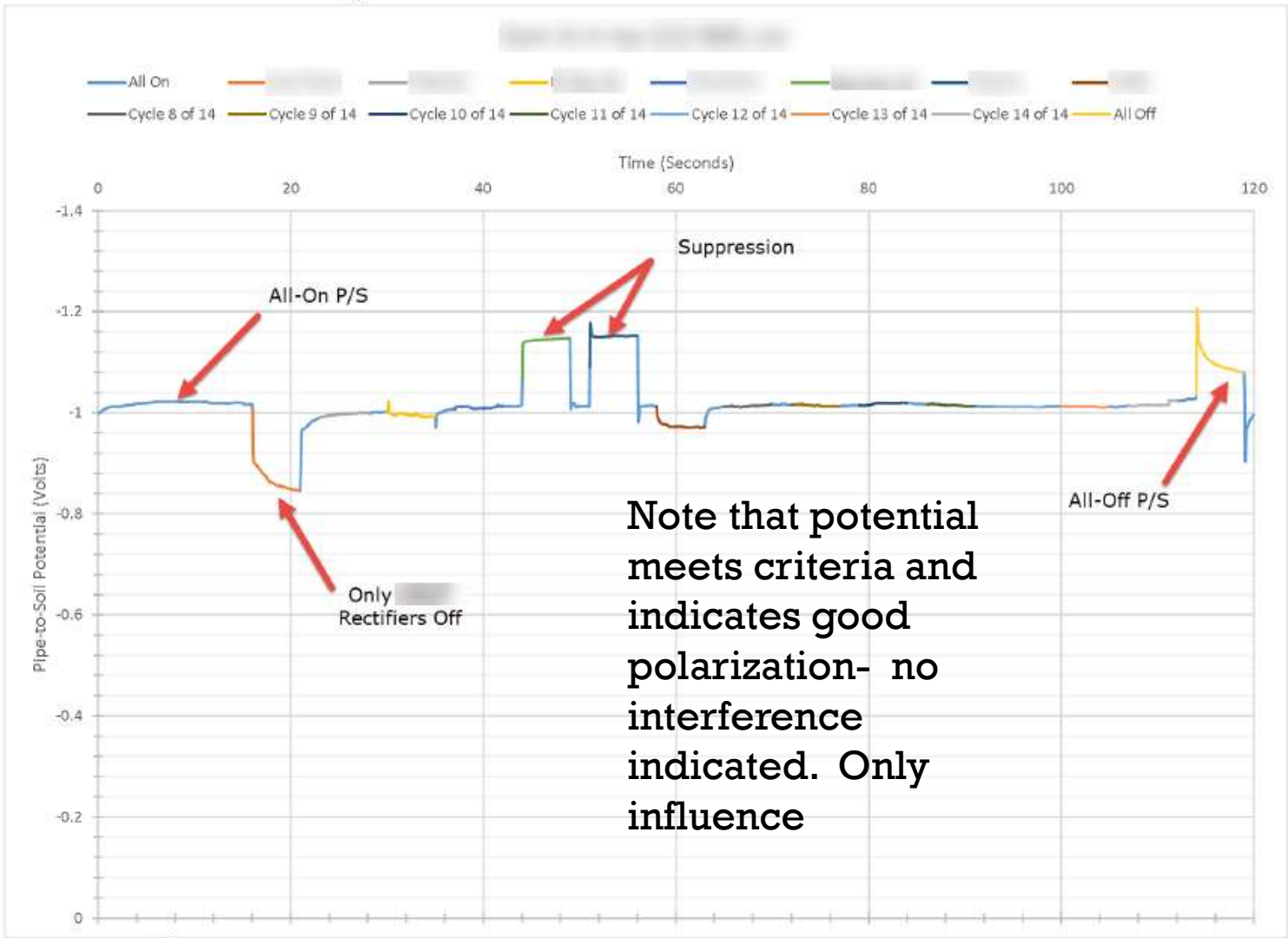
CIS Data at Foreign Crossing- All Sources Int.



CIS Data at Foreign Crossing- Data Overlaid



Potential Waveform at Crossing



EXAMPLE- PIPE-TO-SOIL WAVEFORMS BEFORE AND AFTER INTERFERENCE BOND

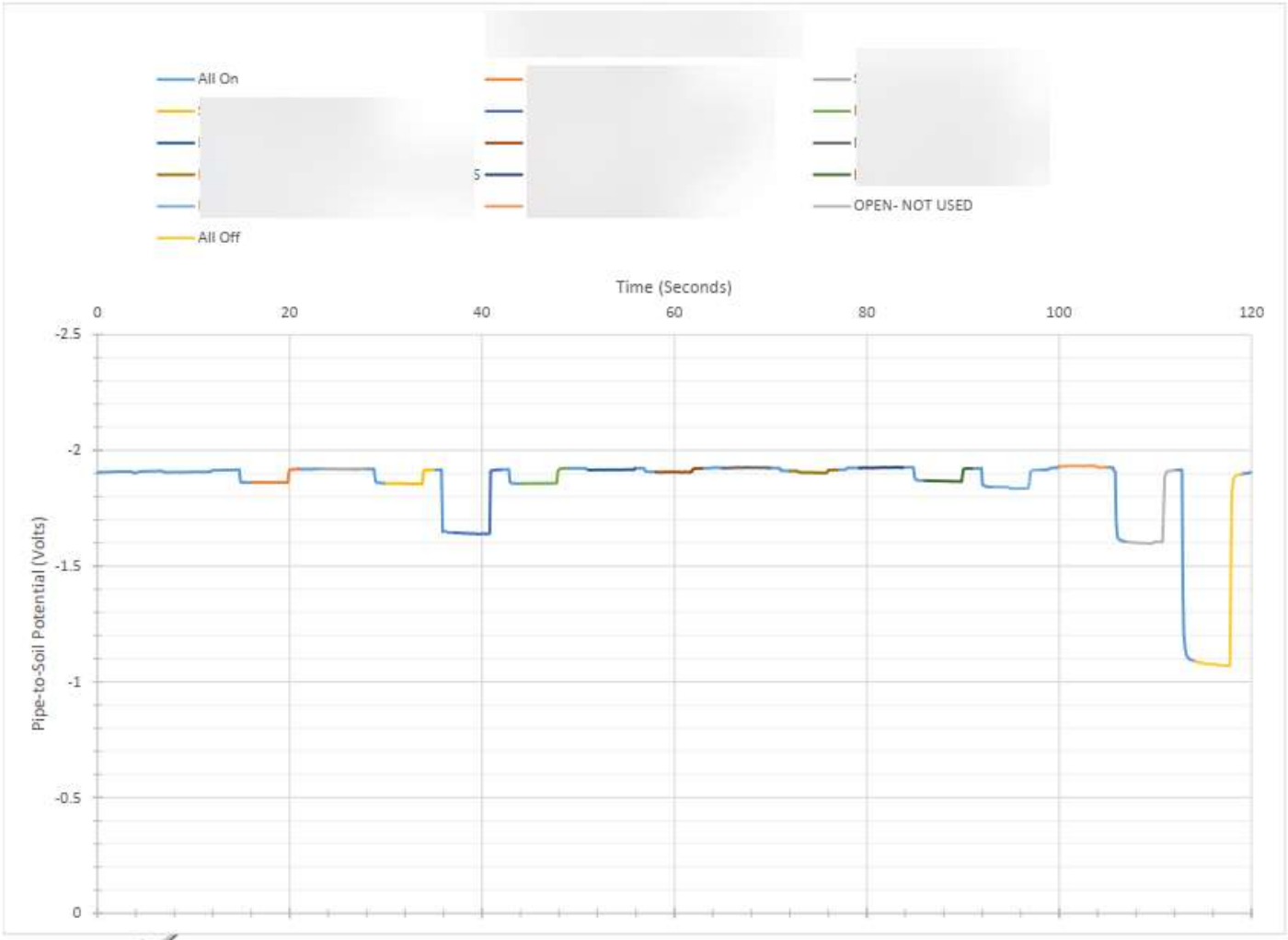
P/S WAVEFORM BEFORE BOND

ACCURATE CORROSION CONTROL, INC

Filename:

Technician:

P/S WAVEFORM AFTER BOND INSTALLED



ACCURATE CORROSION CONTROL, INC

Filename:

Technician:

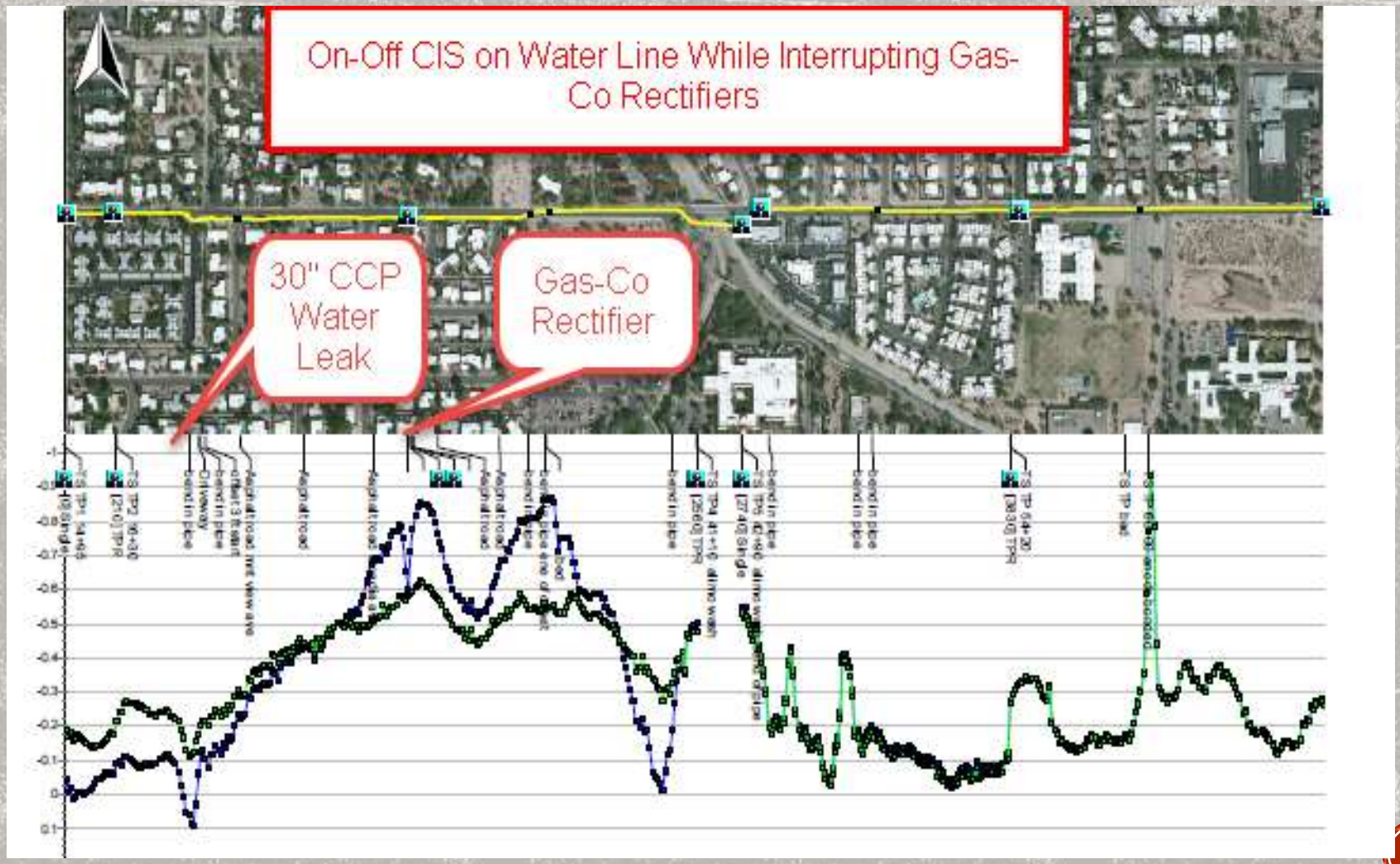
EXAMPLE- 30" CCP WATER LINE MEETS STRAY CURRENT CORROSION

Information:

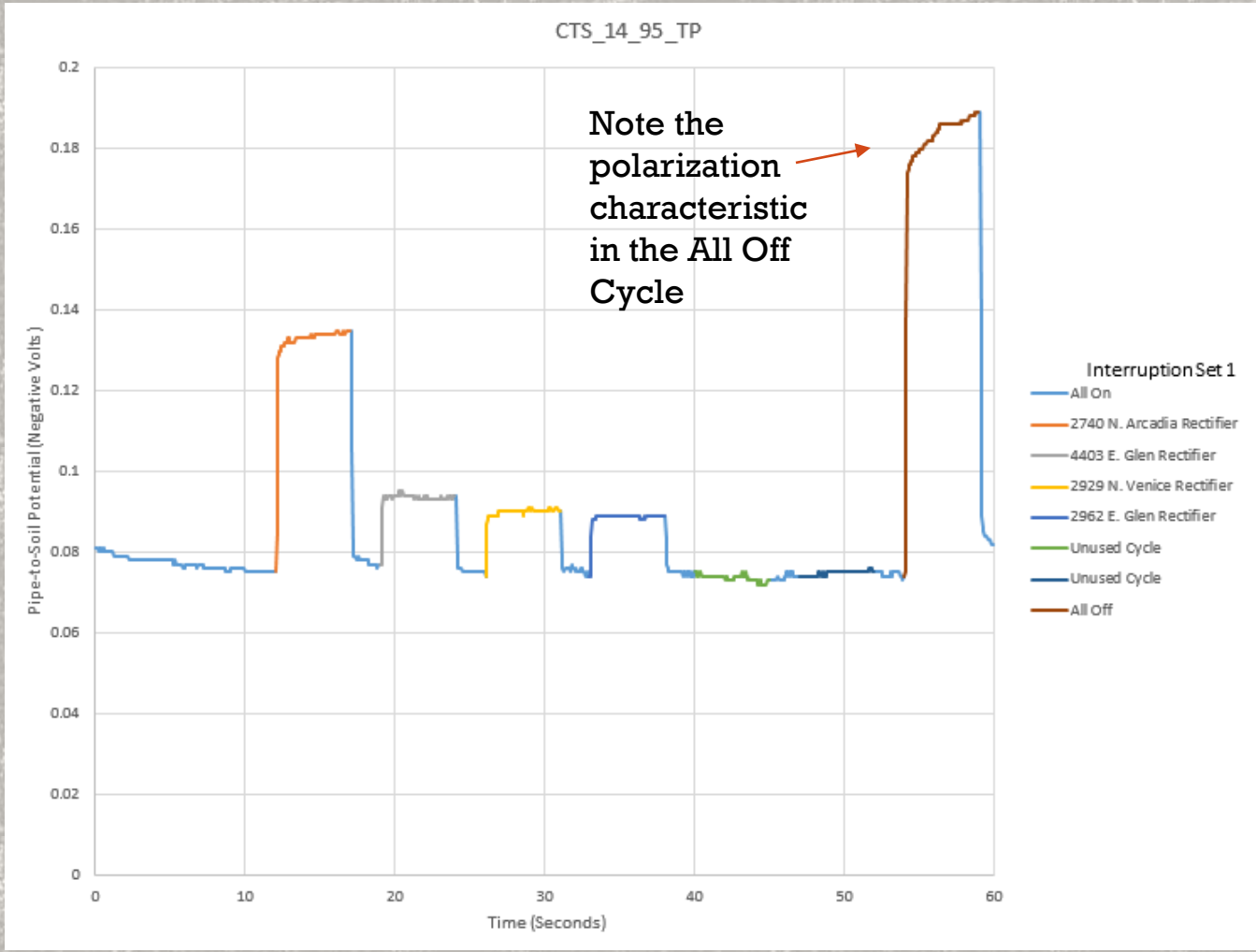
- At failure the Pipe-to-soil was + potential
- Test points at aprox. 1000-foot intervals
- "Bonded joints"
- No CP installed on water line
- Water Line runs parallel to Gas Line with CP in the road.
- Multiple Gas Company Rectifiers/Deep Anodes are in the area

PHOTOS OF PIPELINE FAILURE

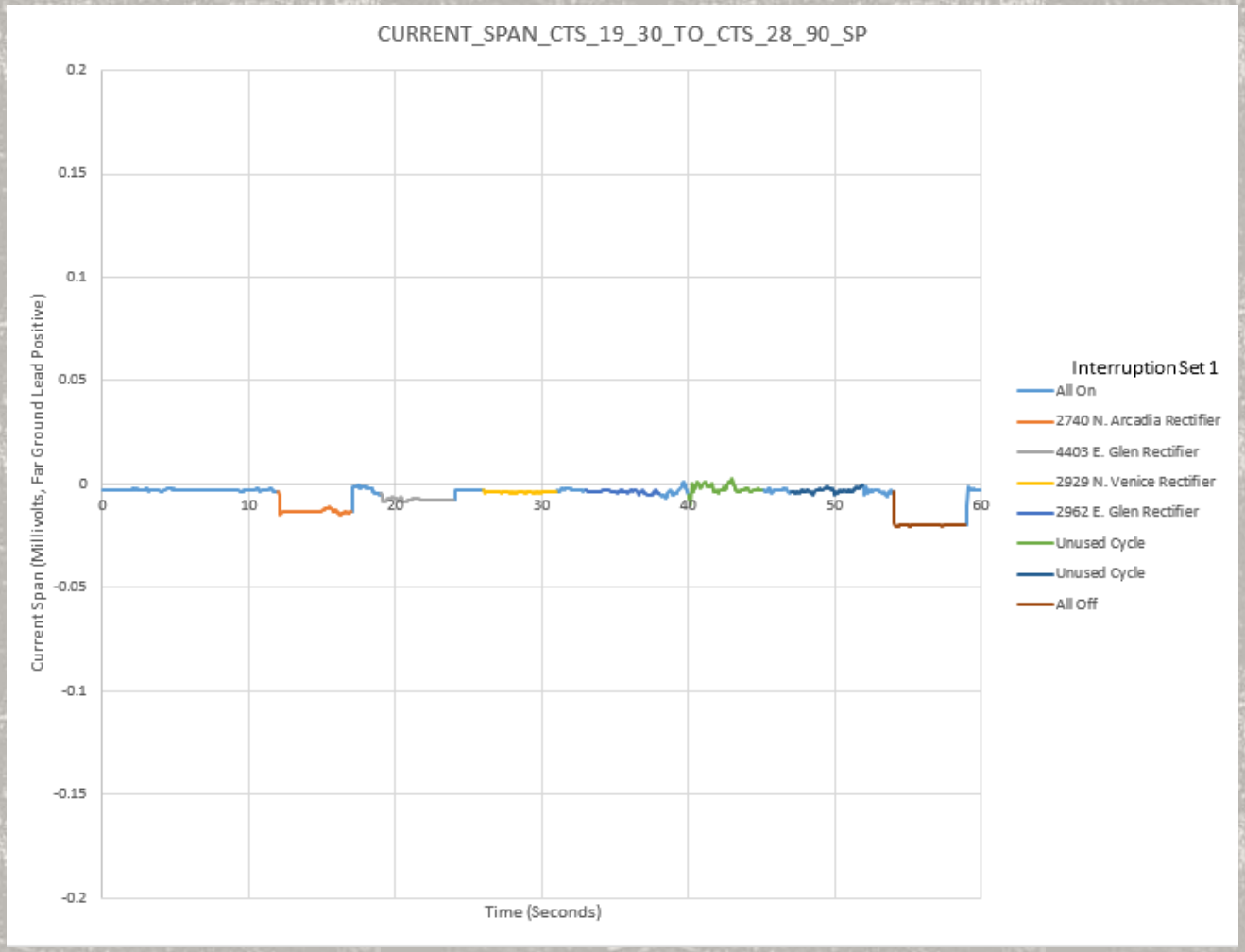
CIS ON H20 LINE WHILE INTERRUPTING GAS COMPANY RECTIFIER



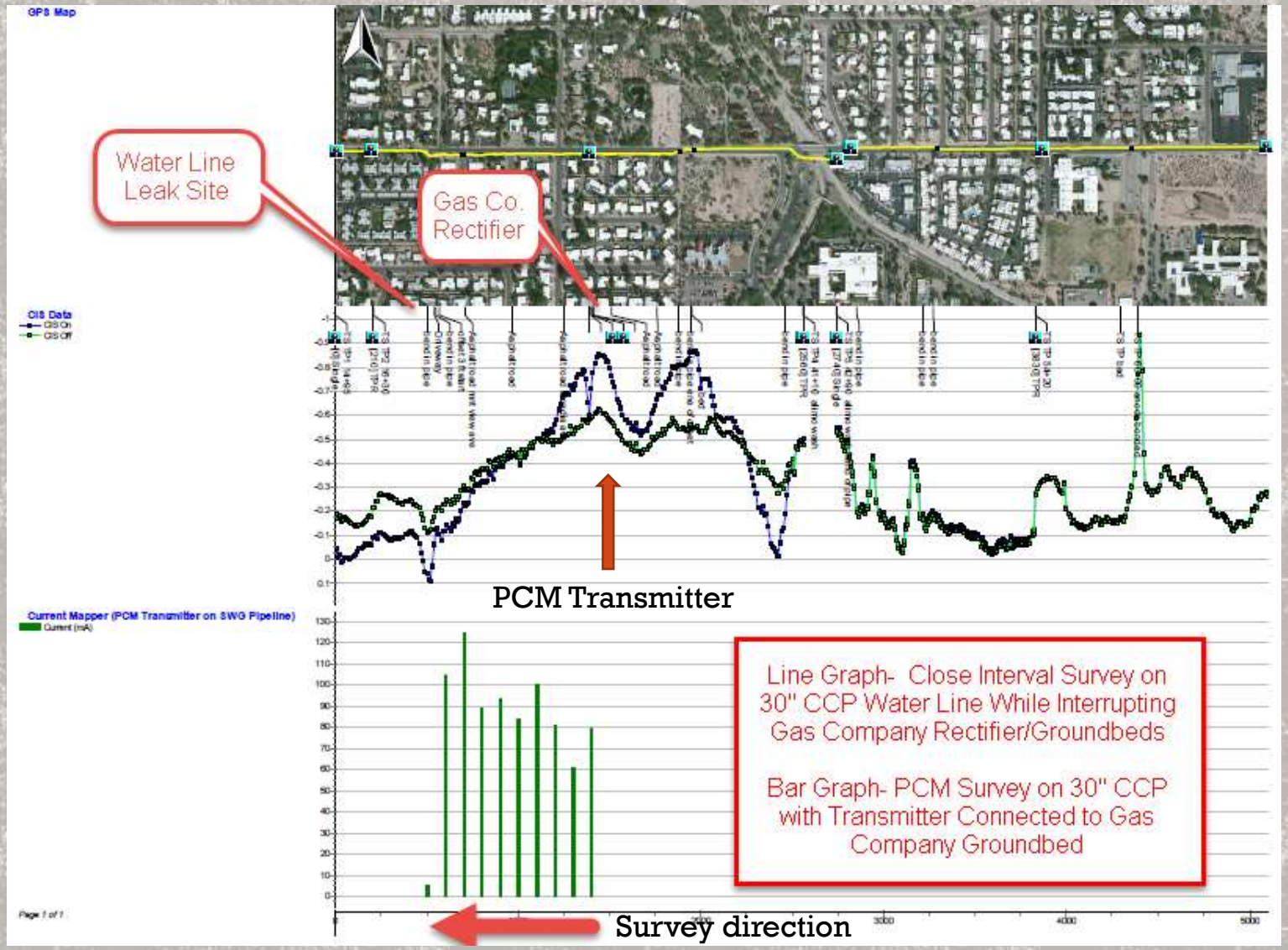
PERFORMING R.I.S. AT LEAK SITE P/S POTENTIAL WAVEFORM



WAVEFORM ON CURRENT SPAN NEAR PREVIOUS LEAK SITE



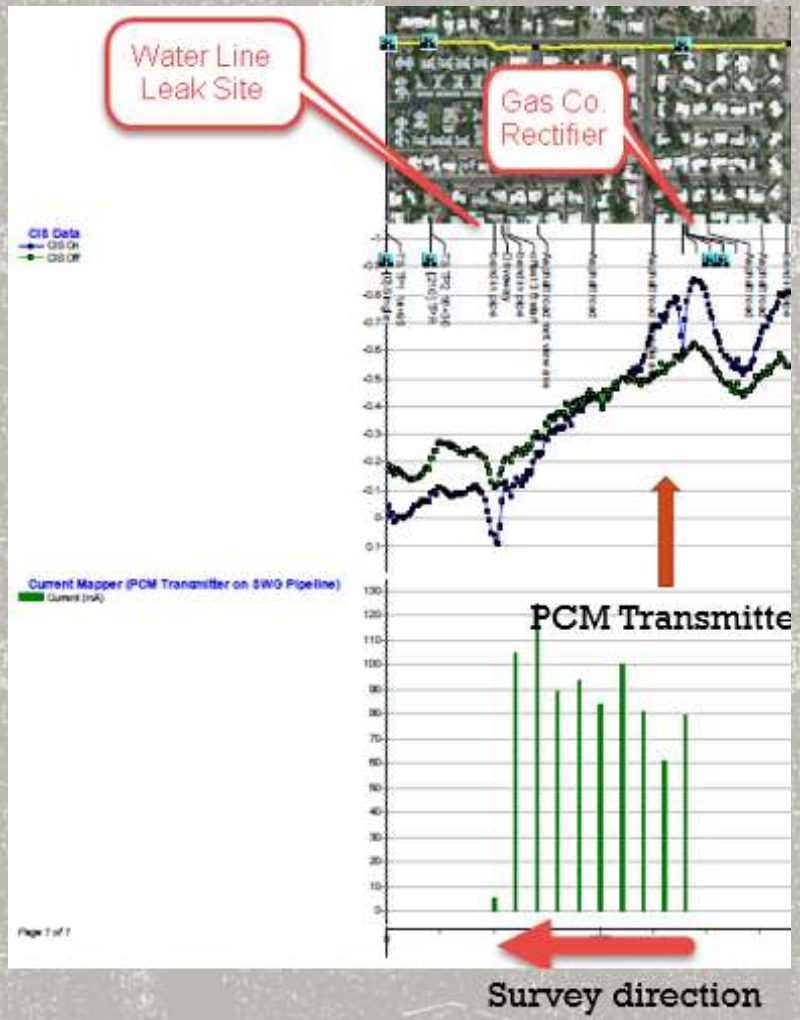
USING PCM TO TEST FOR STRAY CURRENT



USING A 4HZ PIPE LOCATOR TO TEST FOR STRAY CURRENT

Transmitter was installed at gas company rectifier using the deep anode as the ground

Current was picked up on the water line with increasing magnitude towards the failure site



ACCI
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QUESTIONS AND DISCUSSION