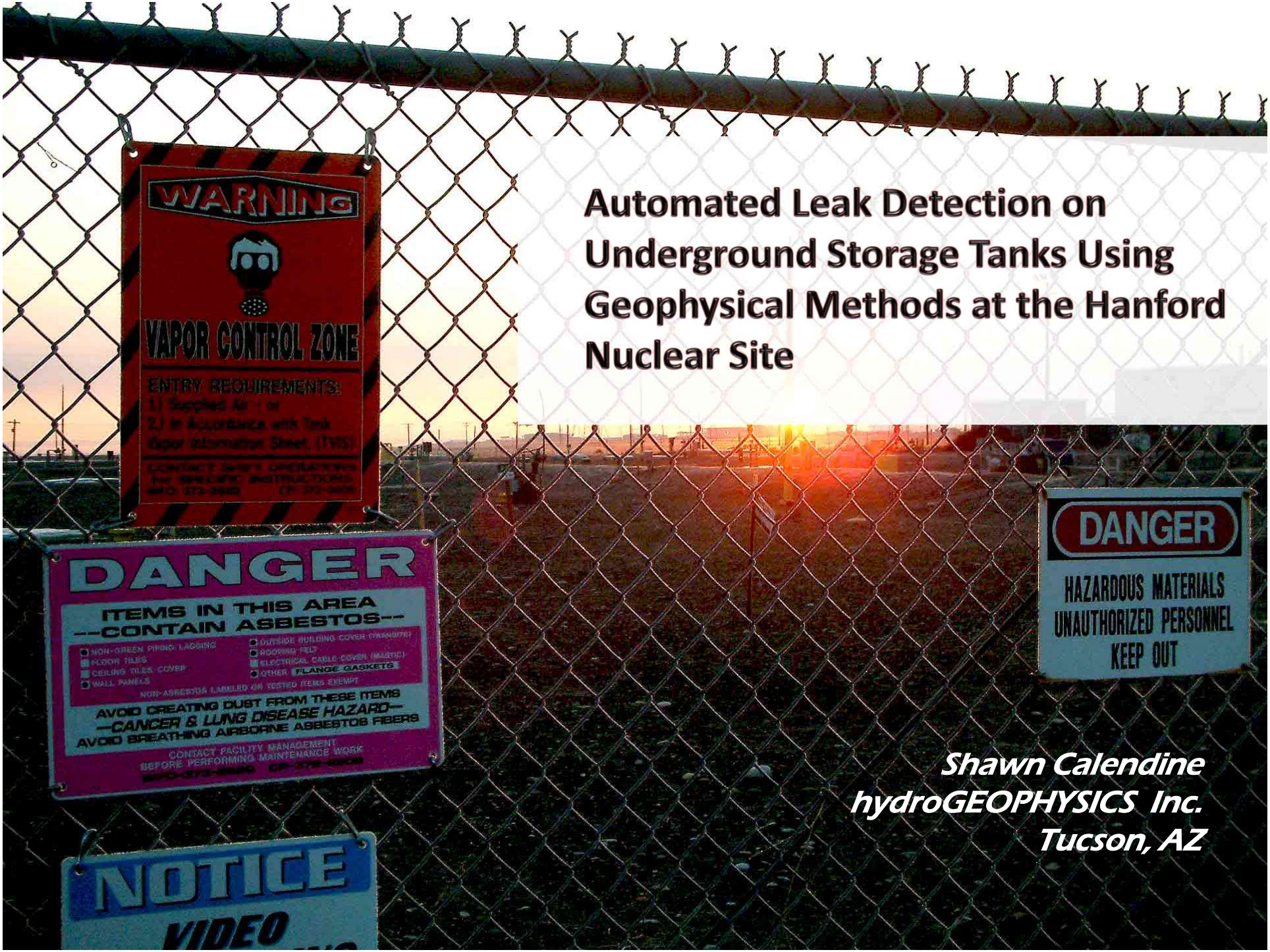

Automated Leak Detection on Underground Storage Tanks Using Geophysical Methods at the Hanford Nuclear Site

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Tucson, AZ

Historical Perspective

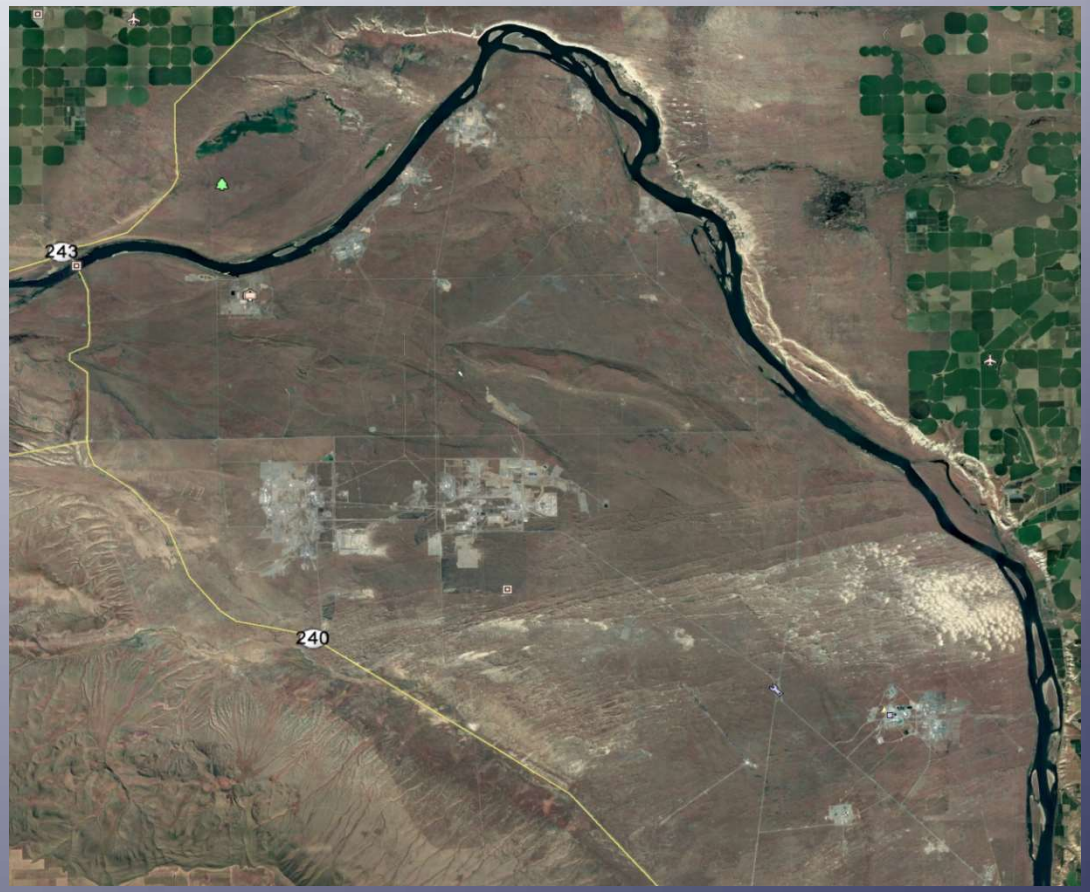
Hanford sites sole purpose was to produce weapons grade plutonium.

The site and its activities have been largely invisible.

Challenge of producing plutonium on a large scale was significant

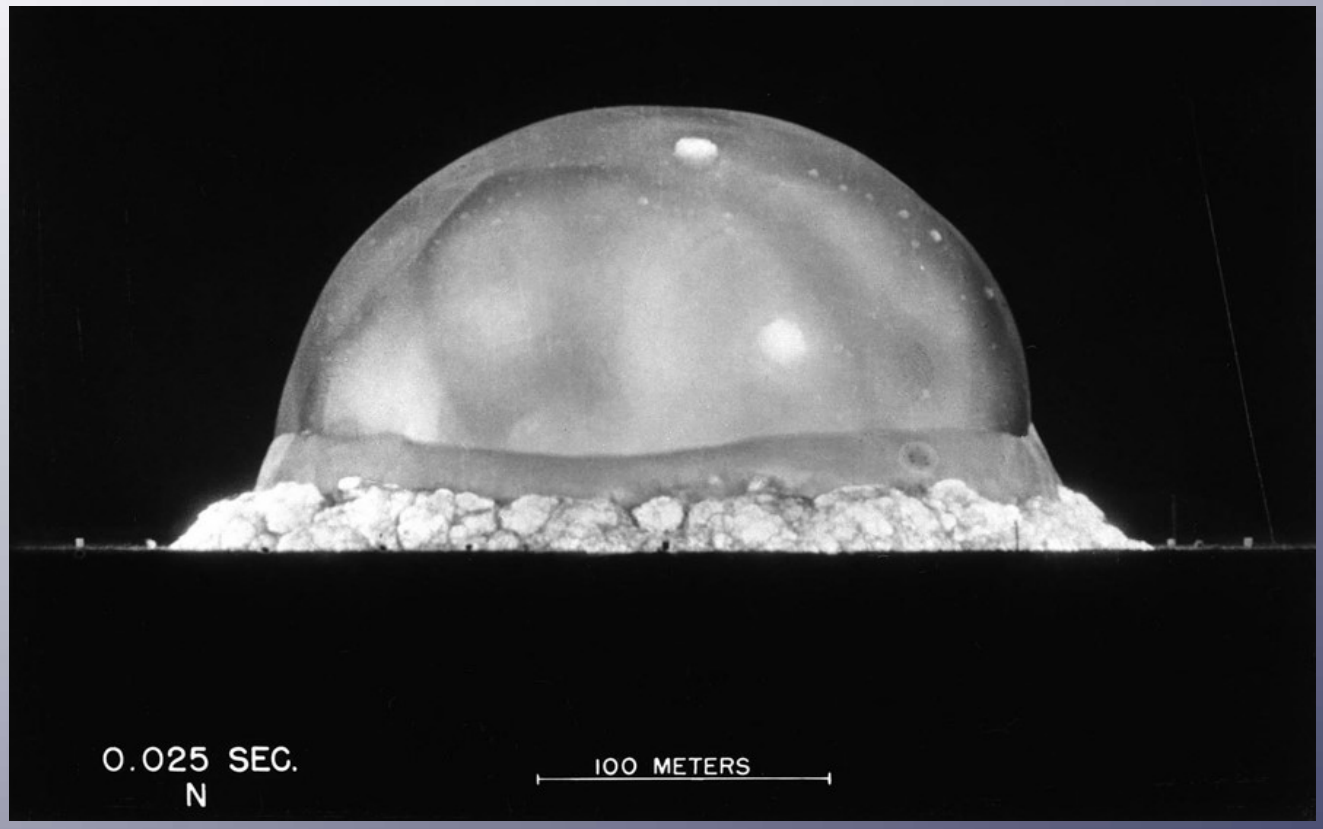
Plutonium produced – approximately 55 metric tons.

9 different reactors
5 different separations plants
Uranium fuel manufacturing
Plutonium production facility



Hanford is located in central Washington State on the shores of the Columbia River – approximate area is 670 square miles.

Trinity explosion, July 16, 1945



Implosion bomb fueled by plutonium from the Hanford site.
Alamogordo Bombing Range NM – Now White Sands Missile Range

Hanford Waste Stream

Type	Volume	Curies
*Tank Waste	54 Million Gal	200 Million
Soil & Ground water	40 Billion ft^3	1 Million
Solid Waste	25 Million ft^3	6 Million
Facilities	175 Million ft^3	10 Million
Nuclear Material	25,000 ft^3	200 Million

***High Level liquid waste was generated at approximately 10,000 gallons per a ton of irradiated fuel processed during WW II -**

Hanford Site Historic District – History of the Plutonium Production Facilities 1943 – 1990
Hanford Cultural and Historic Resources Program U.S. Department of Energy

Background

Starting in 1945, 149 single-shell tanks were built - 94 million gallons of storage capacity.

Tanks size ranged from 55,000 to 1 millions gallons.

1968 – 1986, 28 newer double-shell tanks were constructed - 31 million gallons of capacity.

Total of 18 Tank Farms, On The Hanford Site.

Single-shell tanks (SSTs) built in 1943

Problem

Sixty-Seven Of The Single Shell Tanks Have, Or Are Suspected To Have, Leaked 1 million gallons of Waste Into The Vadose Zone

Single-shell tanks (SSTs) built between 1943 and 1964

Solution

Retrieve the waste and transfer it into more secure DSTs for temporary storage before final treatment.

Double-shell tanks constructed in 1970s

Challenge

- Removing tank waste is extremely difficult.
- Retrieval Methods differ based on tank integrity.
- If structurally sound, waste can be retrieved using high pressure jets and pumps.
- If integrity is questionable more expensive vacuum retrieval systems may be required.
- May be necessary to add solution to mix tank constituents.
- All methods of removal could potentially create new leaks or re-invigorate old leaks.

Waste Retrieval

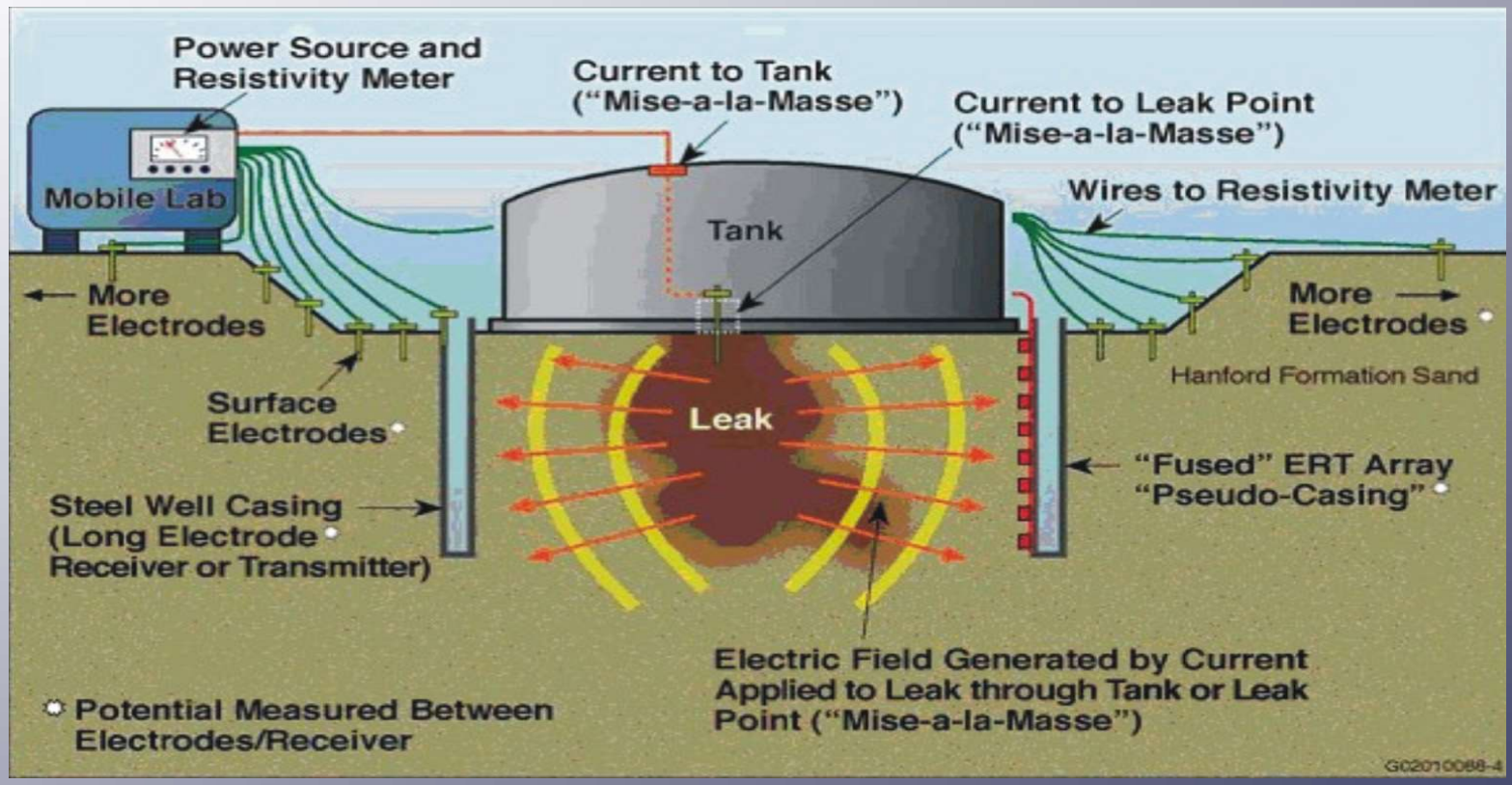
In 2000 Pacific Northwest National Laboratory established the Vadose Zone Transport Field Studies to examine potential technologies.

Two key parameters: technologies utilize existing infrastructure and be noninvasive.

Geophysical methods based on direct current electrical resistivity, were better suited for monitoring.

Construction of a building at the Hanford Vit Plant Site

Geophysical Leak Detection Monitoring



The Monitoring Program Takes Advantage Of Changes In Contact Resistance That Will Occur If Conductive Tank Liquid Leaks Into The Soil.

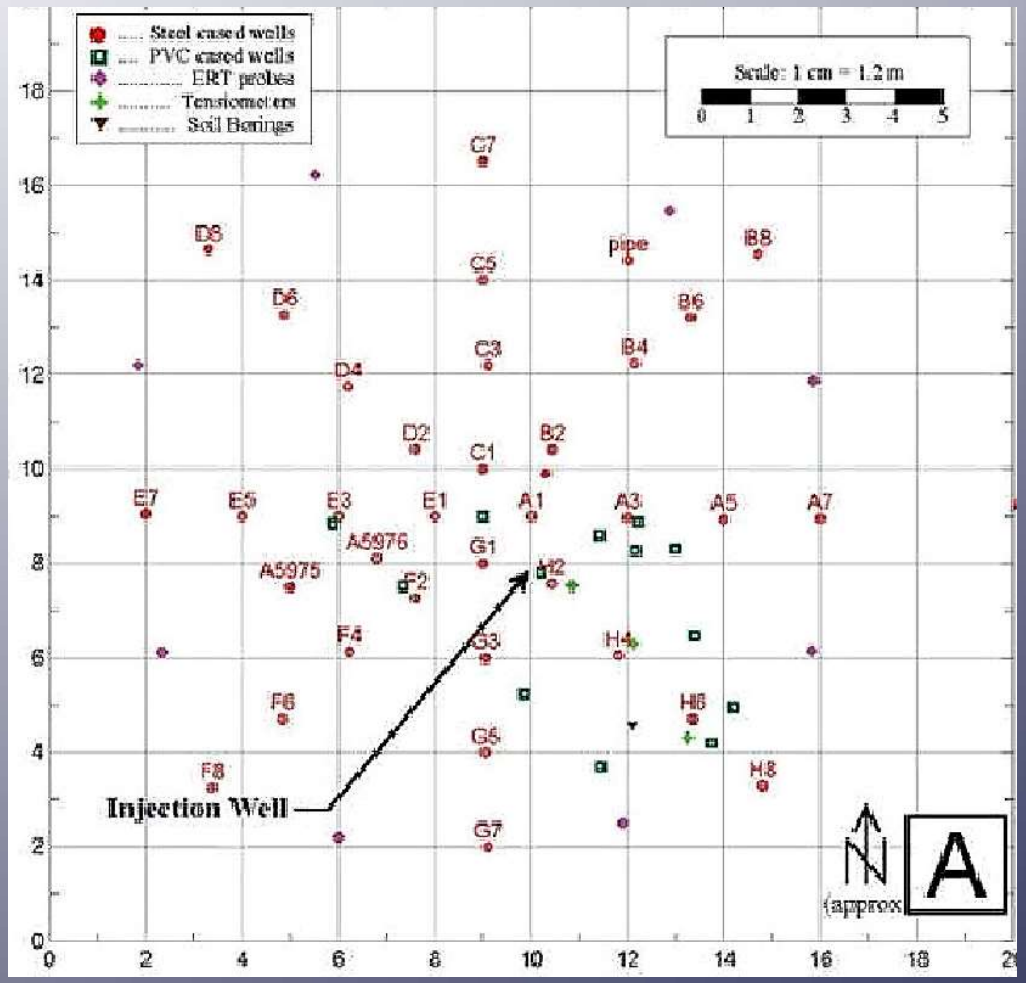
Proof - Of – Concept
Mock Tank Test

Mock Tank Experiment Allowed A Near Continuous Time-Series Dataset To Be Acquired At A Sampling Rate That Showed Detailed Temporal Changes Of The Subsurface

Mock tank testing site on the Hanford Nuclear Reservation

Sisson & Lu Test

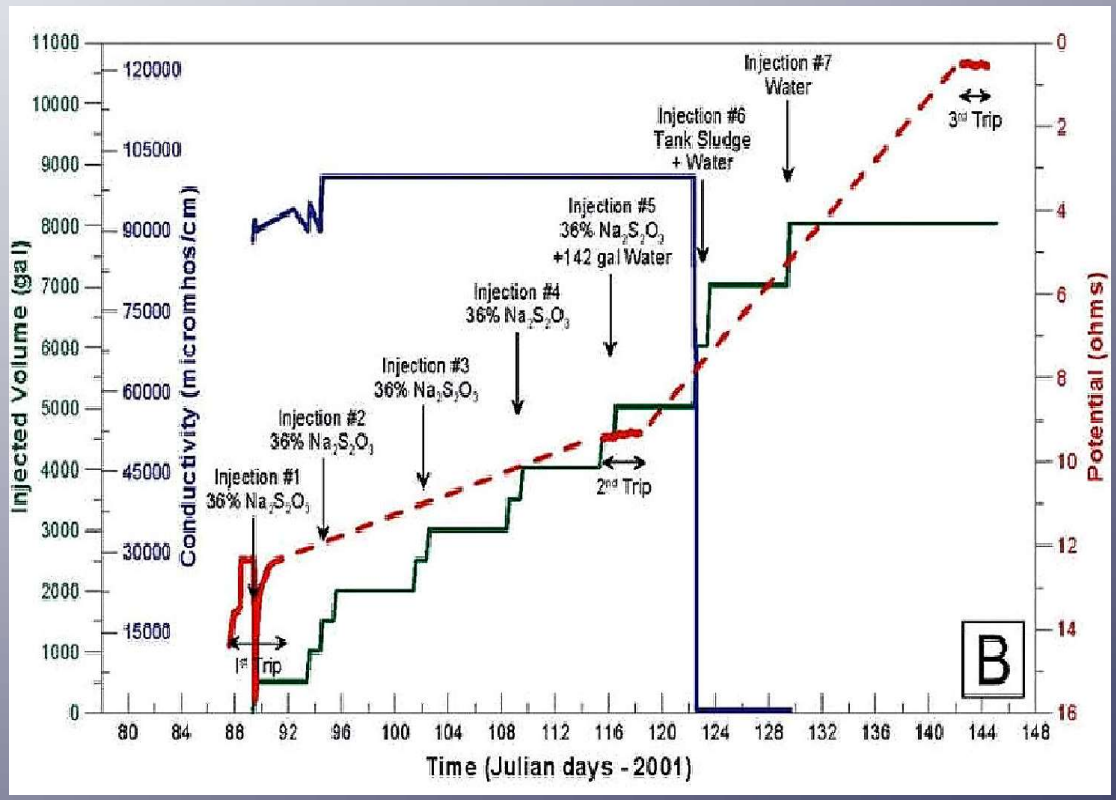
Electrical Resistivity Data Were Acquired On Different Configurations Using Steel-Cased Wells, Injection Wells, Borehole Electrodes, & Surface Electrodes



layout of steel-cased monitoring wells and injection well

Sisson & Lu Test

Two infiltration tests were conducted in 2000 and 2001. Approximately 13,200 L were injected over 10 leak events. Electrical resistivity data were acquired on different configurations using steel-cased wells, the injection well, and electrodes at the bottom of observed wells

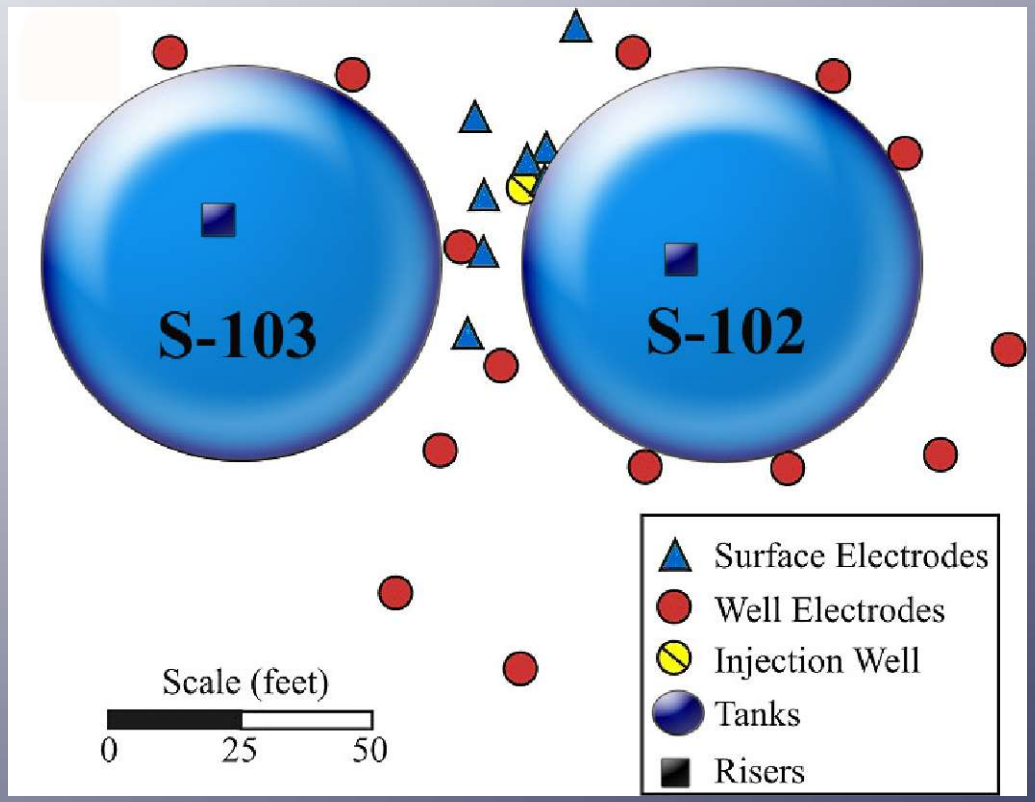


Voltage Potential Shows A Large Change At The Onset Of The Injections.

S-102 Injection Test

Full Deployment of HRR-LDM Data Acquisition System Around Tank S-102

Four Month Leak Injection Test - Results Indicate Eight Of Ten Leaks Detected By System



Layout of LDM electrodes & injection well for tank S-102

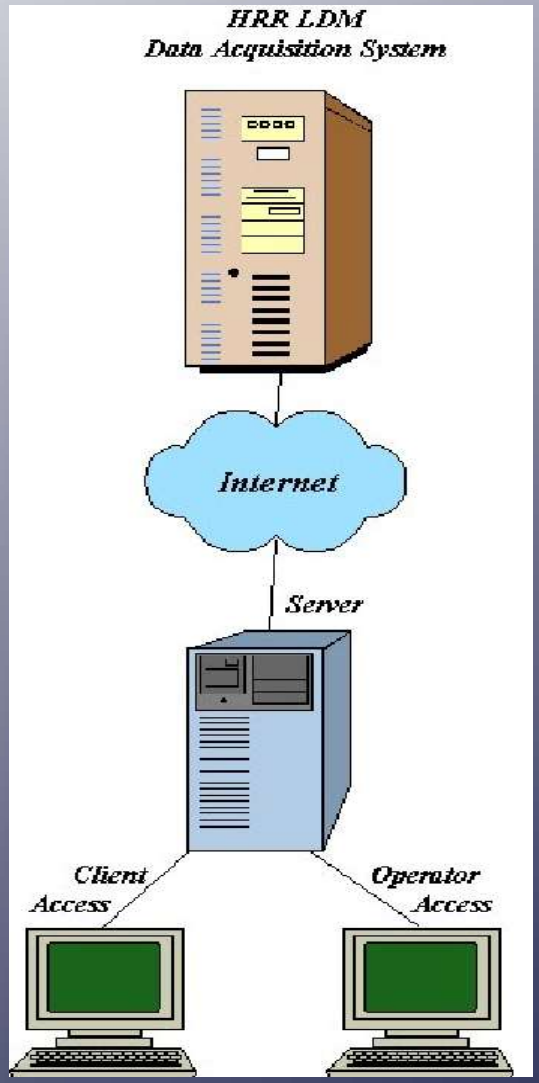
Long-Term Monitoring

LDM technology consists of a data acquisition system (DAS) housed in a small trailer sited adjacent to the tank farm.

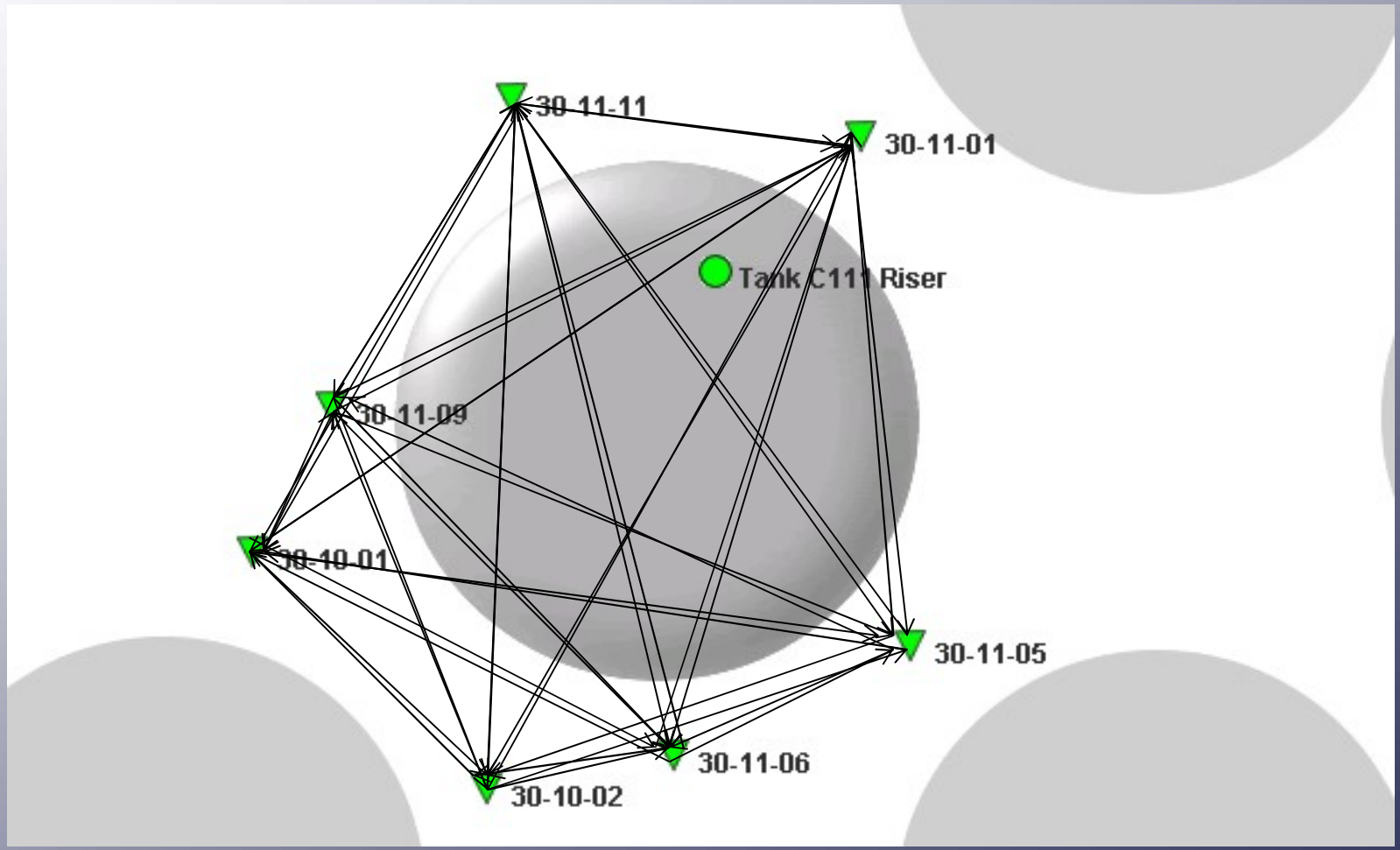
Cables run from the DAS to wells around the target waste tank and to a tank riser.

The DAS controls switching for the various transmitting and receiving electrode pairs.

Data From Multiple Paired Electrode Types Provide Critical Information On Resistivity Changes Occurring Around Hanford Waste Tanks



Geophysical Leak Detection Monitoring



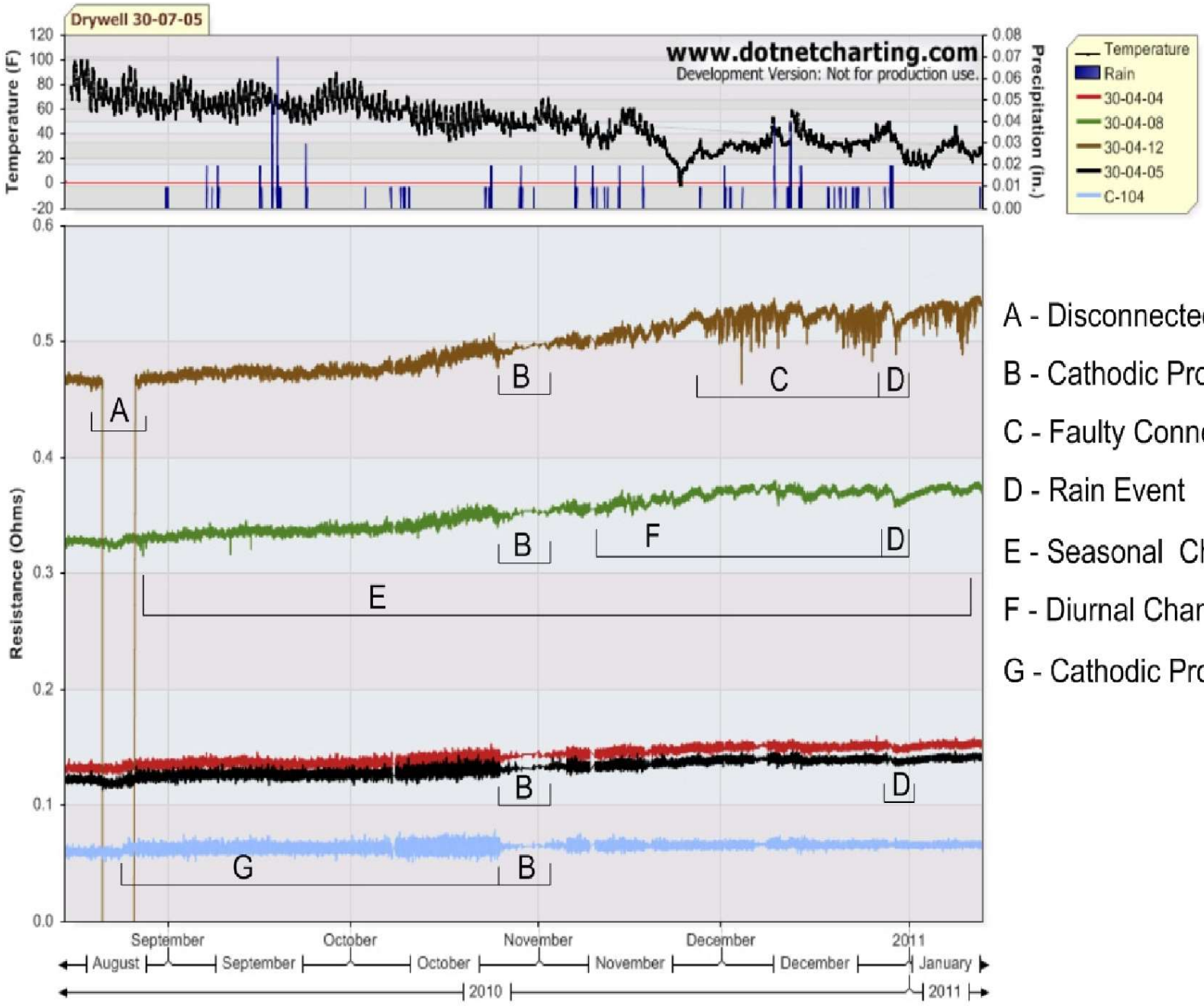
Long-Term Monitoring

- A complete data set contains a data sequence where each electrode acts as both a transmitter and a receiver.

- Each data set is composed of:
  Contact resistance - Transmitting current - Received voltage
  Apparent resistivity - Estimate of measurement error - Self potential.

- Each data type, depending on the electrode, provides critical information on resistivity changes occurring around the tank.

- As the data are acquired and processed, each electrode pair is graphed and trends are evaluated for leaks.



A - Disconnected Cable

B - Cathodic Protection Off

C - Faulty Connection to Well

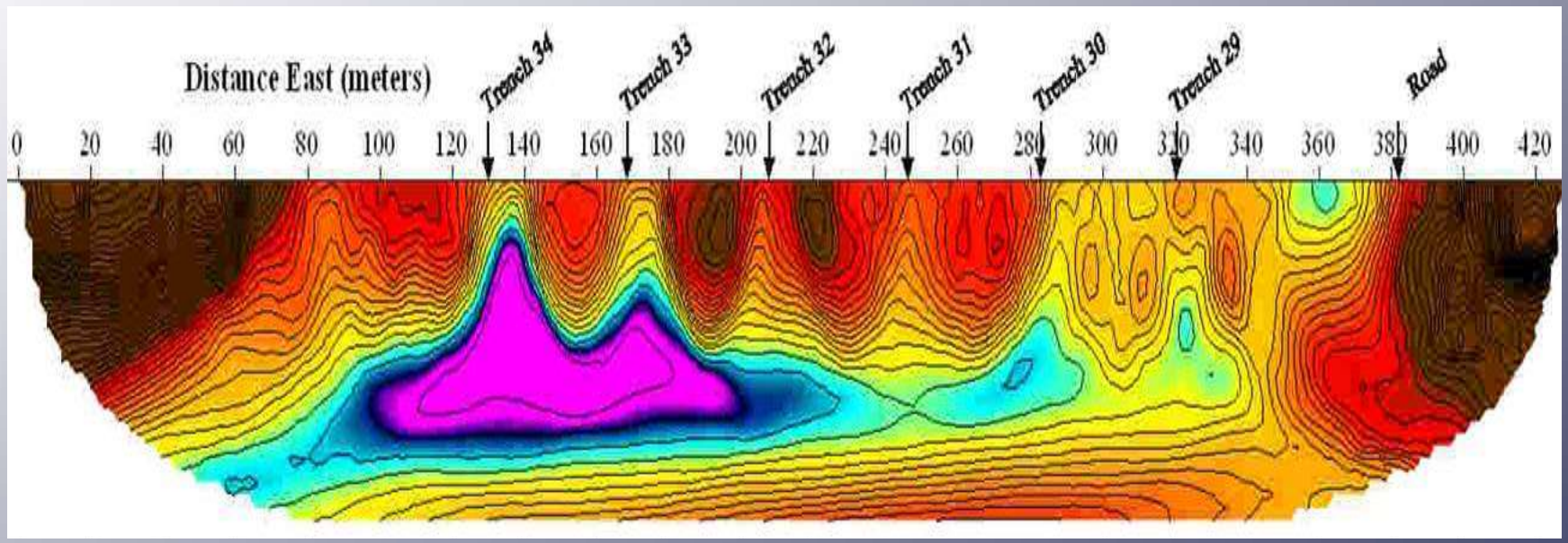
D - Rain Event

E - Seasonal Change

F - Diurnal Change

G - Cathodic Protection On

Target Recognition & Monitoring



Thank you!