Reducing Remediation Costs While Improving Site Delineation

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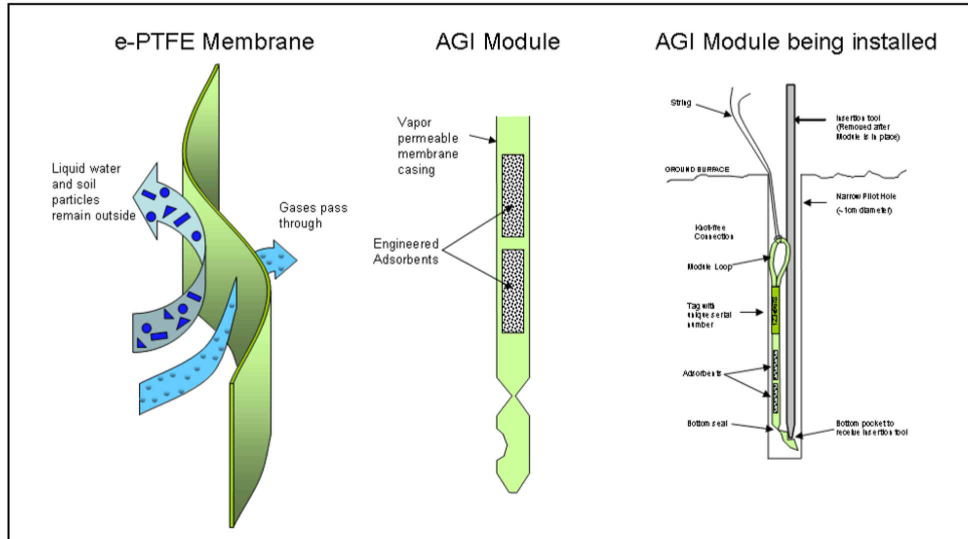
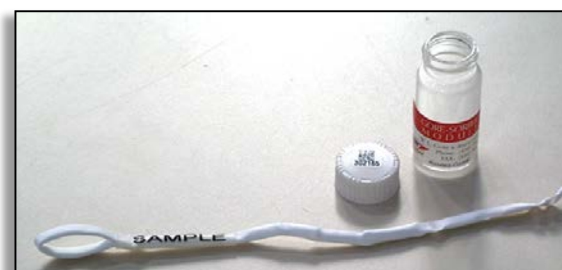
Modules

- **Patented, passive, sorbent-based**
  - Chemically-inert, waterproof, vapor permeable
  - Direct detection of organic compounds
  - Sample integrity protected
- **Engineered sorbents**
  - Consistent sampling medium
  - Minimal water vapor uptake
- **Time-integrated sampling**
  - Minimize near-surface variability
  - Maximize sensitivity (up to C20)
  - Avoids variables inherent in instantaneous sampling
- **Duplicate samples**
- **Effective in air, soil and water**
- **Collects VOCs/SVOCs**
- **Lower total sampling costs**
- **No refrigeration for shipping**
- **Time integrated sampling gives ppt sensitivity**
- **US EPA ETV Verification of the method for soil gas and groundwater**



AGI Module and Installation Schematic (onshore)



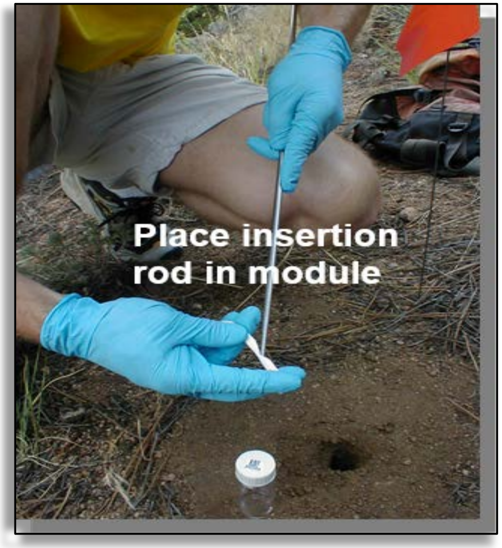
AGI Passive Module Installation

Field personnel drill a 1” diameter hole ~3 ft deep using a battery operated hand drill.

The AGI module is lowered into the hole and remains in place for 1 week or less for pipeline integrity & remediation projects.

By remaining in the ground for 1 week, the hydrocarbons concentrate on the absorbers within the module to provide a 1,000-fold increase in concentration.

This provides detection limits in the low parts per billion (ppb) range **which is unique and critical for nascent leak detection capabilities**.



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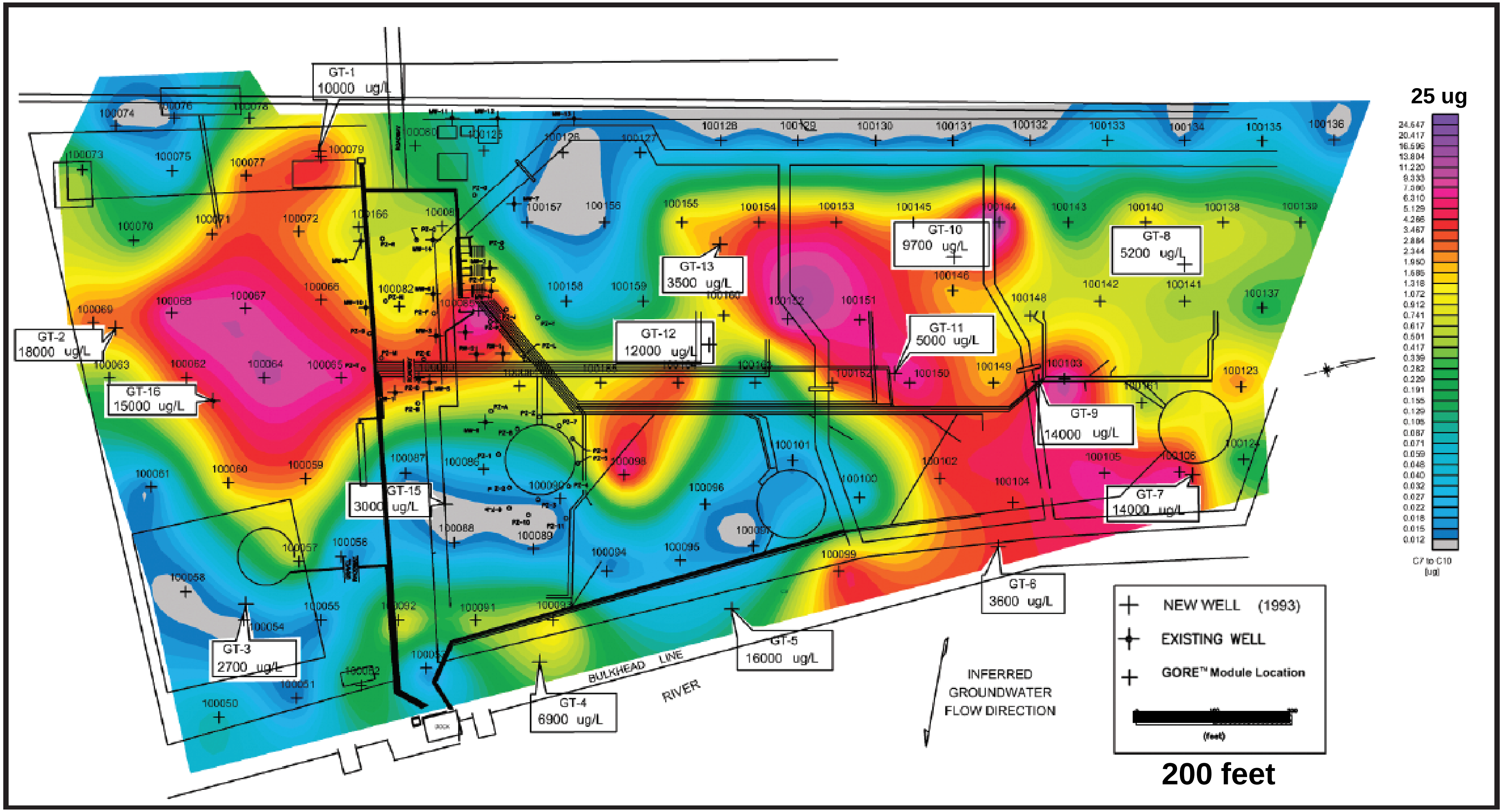
Active Fuel Storage Terminal

- Location Northeastern U.S.
- Petroleum terminal site with middle distillate hydrocarbons ranging from C_7 to C_{10}.
- The site covered 33 acres.
- Groundwater from 1 to 7 meters below ground surface
- With conventional soil and groundwater data in hand, property owners were facing the hefty cost of installing 33 monitoring at a cost of $285,000.
- Follow-up with quarterly monitoring of well samples for many years thereafter.

Anomaly Map for Middle Distillate Results

Middle Distillates (C_7-C_{10}) Intensity Map



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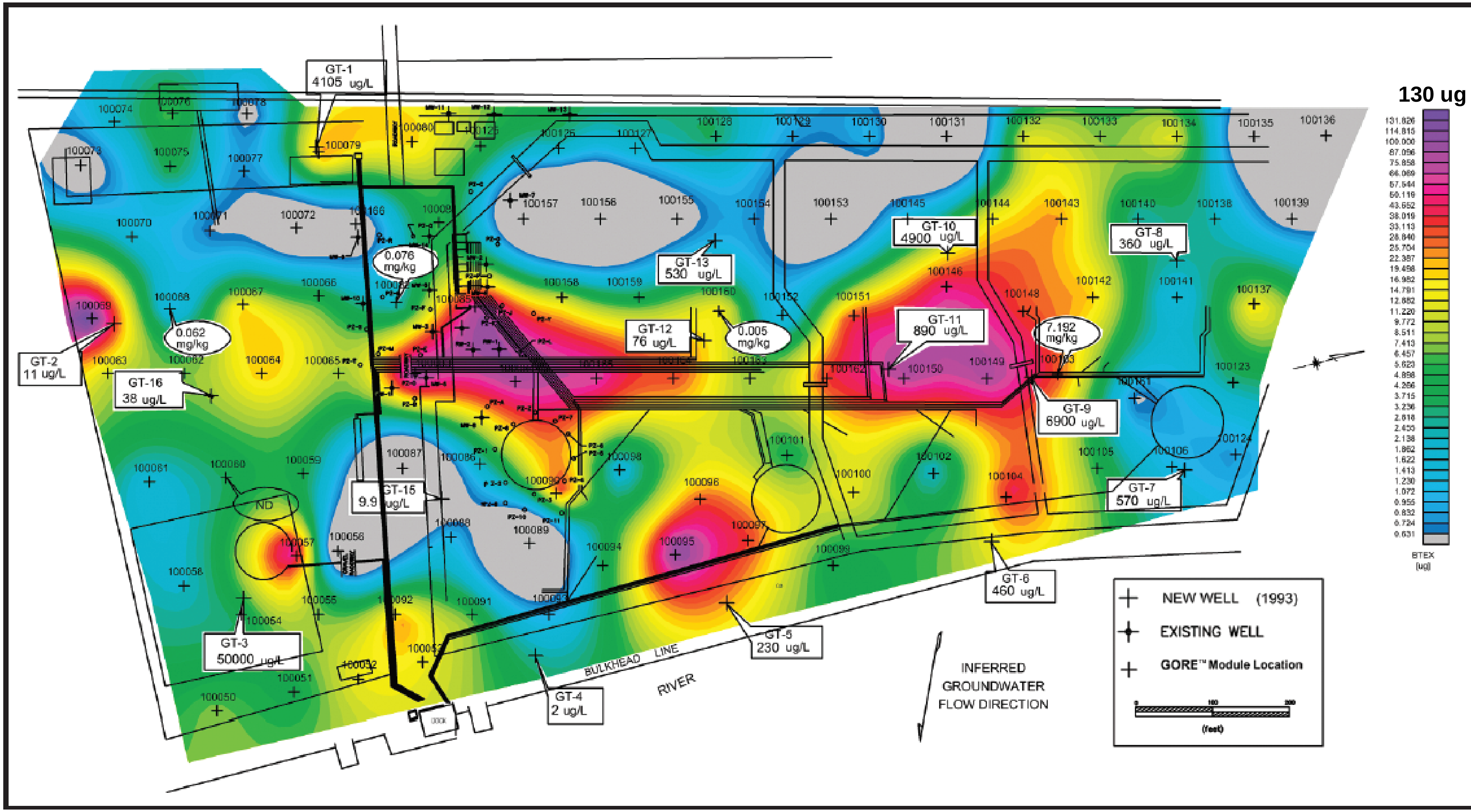
Anomaly Map for BTEX Results

BTEX Intensity Map



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Results

- Number of regulator-required monitoring wells was reduced from 33 to 15, **resulting in a ~$100K installation savings**.
- The reduction in the number of wells **resulted in $100K annually** for the client.

Pipeline Leakage Monitoring

Key Benefits

- Pipeline pigs normally only detect leaks after they become significant and costly,
- Pressure testing may determine a leak but not the location,
- This method can verify pipeline leak within feet vs miles,
- **Pipeline stays in service**
- Inexpensive compared to other methods,
- Due to the sensitivity of the method and the **method can detect nascent leakage points**,

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Leaking Gas Pipeline Case Study

The Columbia pipeline leak detection case study in Washington County, PA.

Survey location, south of Pittsburgh, in Washington County, PA.

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Columbia Pipeline Project Objectives

Objectives:

- Examine the variation of compound patterns along the pipeline for evidence of natural gas leakage
- Examine potential detection of nascent leaks
- Compare results with pipeline maintenance history

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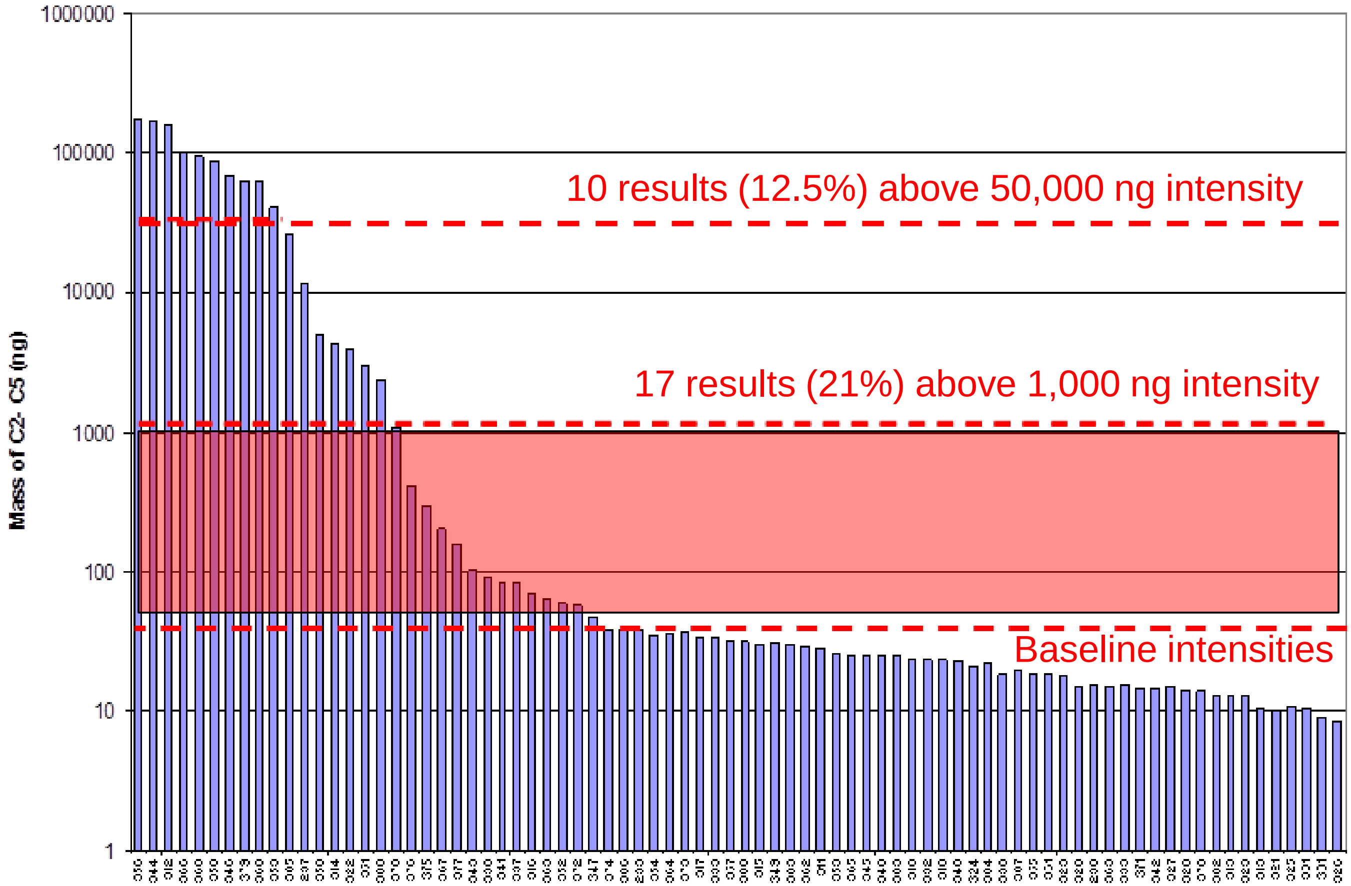
C_3 – C_5 Mass Distribution for all Samples

- The data clearly indicates 11 samples above the 10,000 ng level, **quickly identifying 11 potential significant leak points along the pipeline**.
- The data also indicates 5 samples between 1,000 – 10,000 ng which may be moderate leaks or areas of previous leaks.
- Due to the sensitivity of the method, the histogram clearly establishes a baseline mass level for the pipeline.
- The samples between 80 – 1,000 ng **may be indicative of nascent leak points along the pipeline, that would be undetectable by other methods.**



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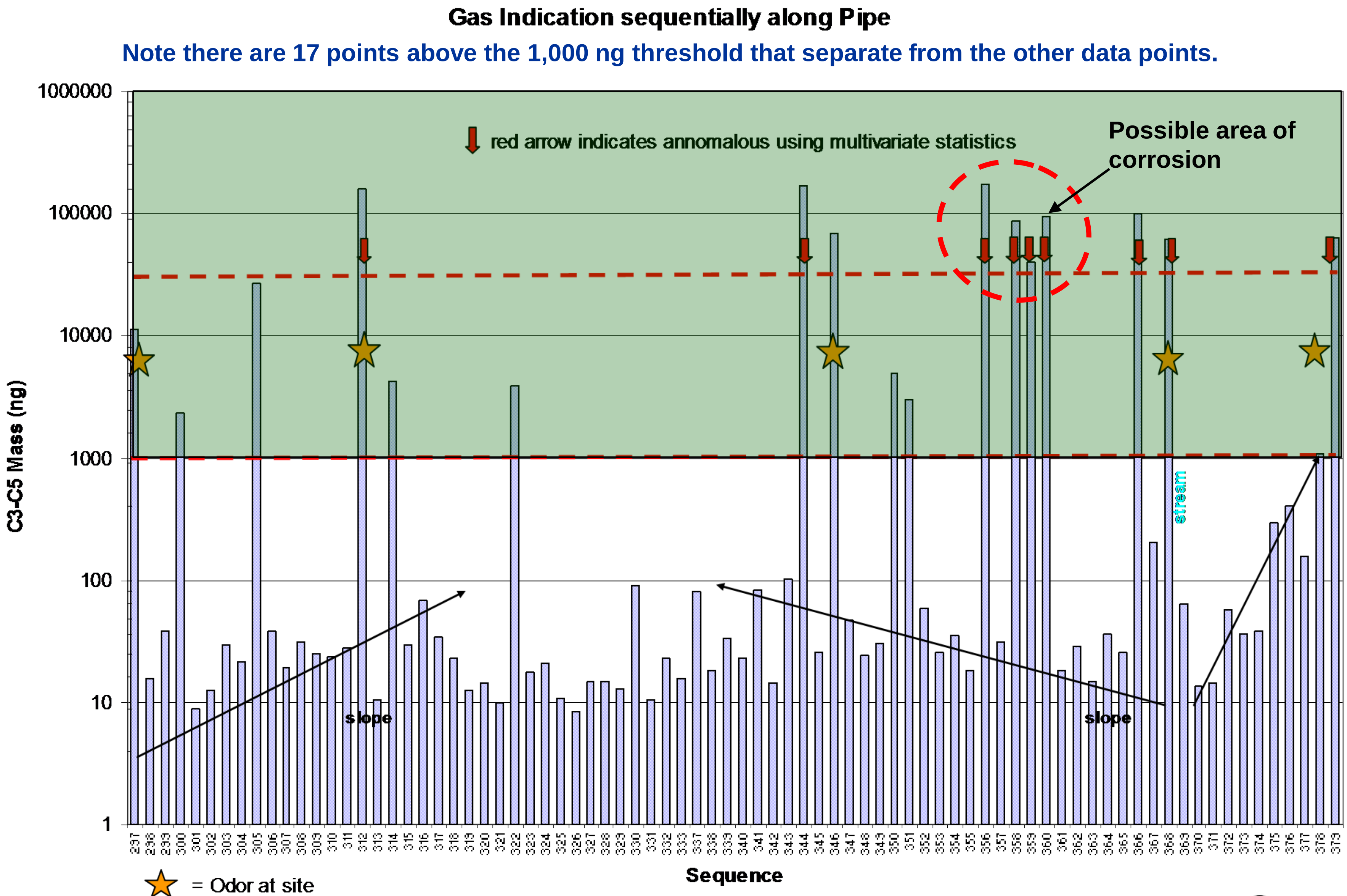
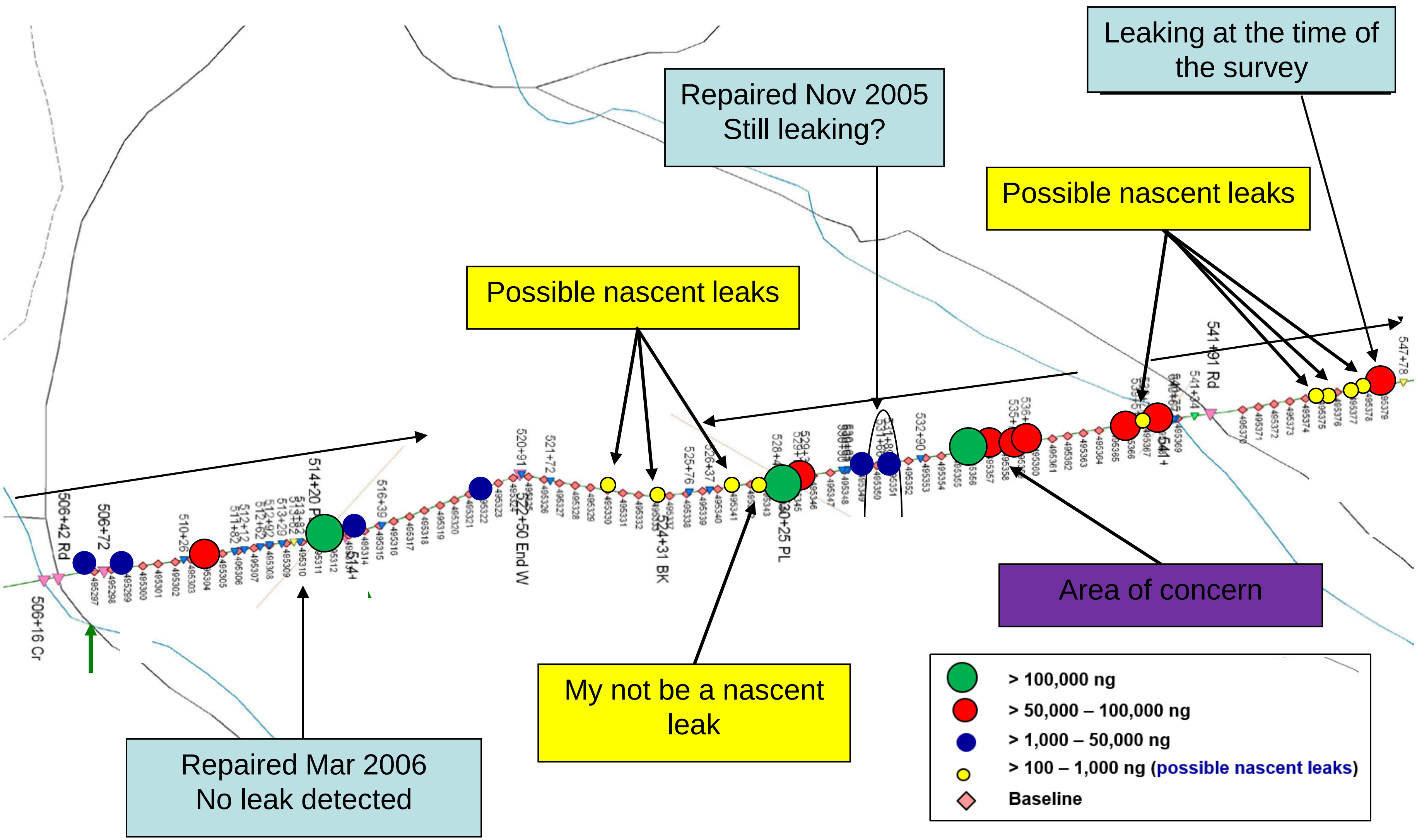
AGI Intensities for Each Sample



Map View of the Pipeline Sample Results

Survey conducted early 2007



Case Study Conclusions

- Several pipeline locations had strong potential as leakage points .
- **Hand-held sniffers** and olfactory receptors were **not adequate for detecting potential leakage** areas.
- The results were ground-truthed with a known leak point at the time of the survey.
- The data **helped to monitor the efficiency of pipeline repair work** by showing one previous leak point to no longer have elevated amounts of hydrocarbons while another may still be leaking.
- Due to the sensitivity of the method baseline levels of hydrocarbons could be determined to define areas with no contamination.
- Due to the sensitivity of the method and the fact leakage areas were also identified, **the method could detect nascent leakage points that could not be identified by other methods**.
- Once leaks are identified a follow-up mini-survey could be implemented to map the extent of contamination (i.e. map the contaminant plume).

Site Characterization of a Vehicle Maintenance Garage

- Location Northeastern U.S.
- 18,000 sq. ft. L-shaped survey.
- Silty clays
- Groundwater depth: 10 - 20 ft.; apparent southerly flow.
- 27 AGI passive samplers
- Modified EPA method 8260/8270 GC/MS analysis at AGI labs

Project Objectives

Objectives:

Located within a residential area, this commercial site was a suspected source of groundwater contamination, possibly the result of leaking fuels from USTs.

The objective of this survey was to:

- delineate a suspected BTEX plume from two 5,000 gal. USTs
- identify the optimum placement of monitoring wells.

Anomaly Map for BTEX & MTBE Results

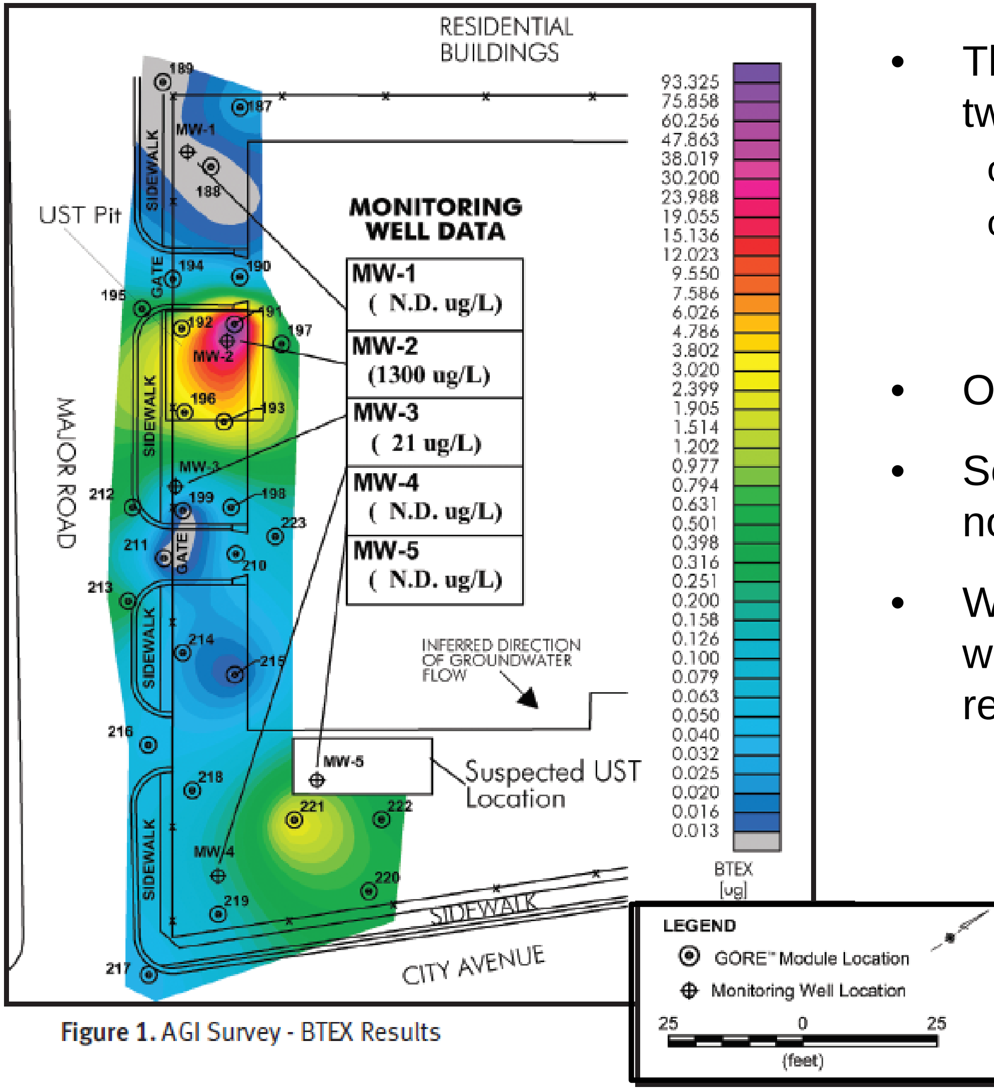


Figure 1. AGI Survey - BTEX Results

- The survey revealed the presence of two BTEX plumes:
  - one in an area of known USTs;
  - the other, a less intense BTEX plume, in an area where an older UST was later identified.
- Optimized installations sites
- Soil borings analyzed for BTEX yielded non-detectable levels.
- Water quality data from the monitoring wells compared favorably with the AGI results.

Anomaly Map for BTEX & MTBE Results

- MtBE was also observed in the soil gas and appeared to "lead" the BTEX plume.

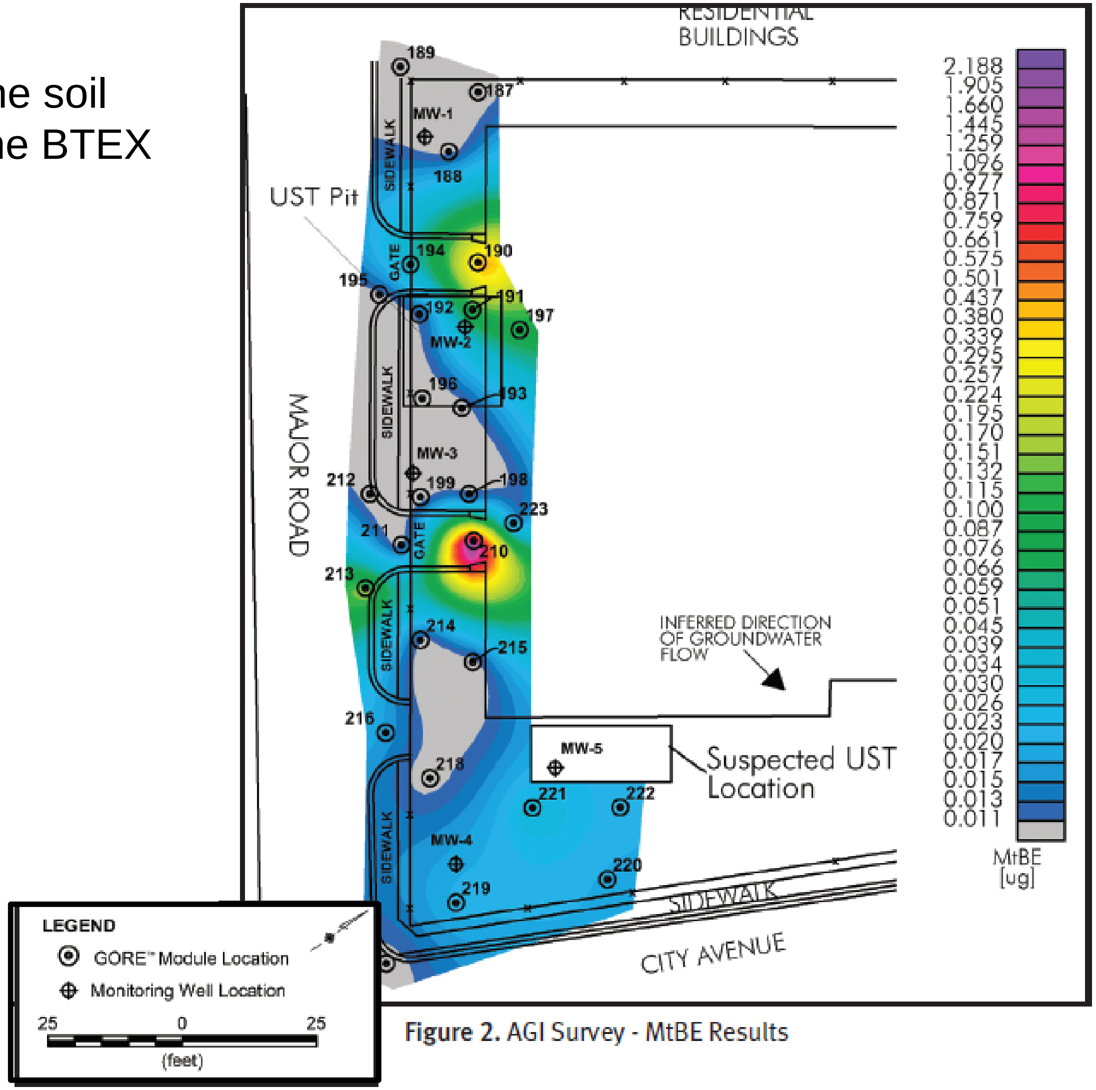


Figure 2. AGI Survey - MtBE Results

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Conclusions

- A powerful screening tool:
  - Reduces the scope of excavation – thereby reducing costs
  - Eliminates RUSH laboratory charge – thereby reducing costs
  - Can reduce the number of monitoring wells – thereby reducing costs
  - Can reduce quarterly and annual monitoring costs – thereby reducing costs
- Can be more accurate than traditional methods:
  - Concentrations obtained from equilibrium time in the soil, not just a single spot in a single sample
  - Field deployment is so cheap & easy, sample density can be very high
- Systems do not have to be taken off line for sampling or testing or the time can be greatly reduced:
  - Pipelines
  - Water vaults

Example: Water vault removal

ch2m

ERM

amec foster wheeler

TOTAL

Anadarko
Petroleum Corporation

TETRA TECH

noble energy

Brown AND Caldwell

ارامكو السعودية
Saudi Aramco

bp

REPSOL

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