

Gannett Fleming Site Remediation

Practice Leadership Team (PLT) Technology Transfer Meeting

Rapid Optical Screening Tool™ (ROST™) to Define LPH

Presented By

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Rapid Optical Screening Tool™ (ROST™) to Define LPH

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Outline

- ROST™ background (what is it really?)
- Site conditions (physical description and property owner relations)
- Safety considerations (utility clearance and night work)
- Methods of investigation (calibration and site verification)
- Investigation results (fluorescence response and waveforms)
- Data interpretation (3D model, interpretation and programs used)
- Conclusion (did it help? would we do it again? total costs?).



Rapid Optical Screening Tool™ (ROST™) to Define LPH

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ROST™ Background

- Rapid Optical Screening Tool™, also known as Laser-Induced Fluorescence (LIF)
- Originally developed at the North Dakota State University with USAF support
- The original developers formed Dakota Technologies, Inc. (DTI), which helped to mature and commercialize the technology
- ROST™ is commercially available through Fugro Geosciences, Inc.



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ROST™ Background

- ROST™ is able to detect petroleum liquid phase hydrocarbons (LPH) *in situ* through the use of optical sensors
- ROST™ uses a tunable ultraviolet laser at a specific frequency, which is pulsed (50 pulses/sec) through a fiber optic cable and emitted through a sapphire window on a standard cone penetrometer testing (CPT) system
- The light causes the polycyclic aromatic hydrocarbon (PAH) constituents of petroleum LPH in the soil to fluoresce
- The emitted fluorescence is transmitted via a second fiber optic cable to measurement system within the CPT truck.



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ROST™ Background

- The fluorescence signals are collected at approximately 1 per 2cm
- The signal is displayed by a fluorescence versus depth (FVD) graph
- Color variations on the FVD generally indicate composition change of the LPH
- ROST™ can operate at a single wavelength or a multi-wavelength (MWL) mode to create a waveform (340, 390, 440, and 490 nm)
- The waveforms can be used to interpret product type
- Requires direct contact with the soil
- The tool detects LPH, not dissolved phase hydrocarbons.

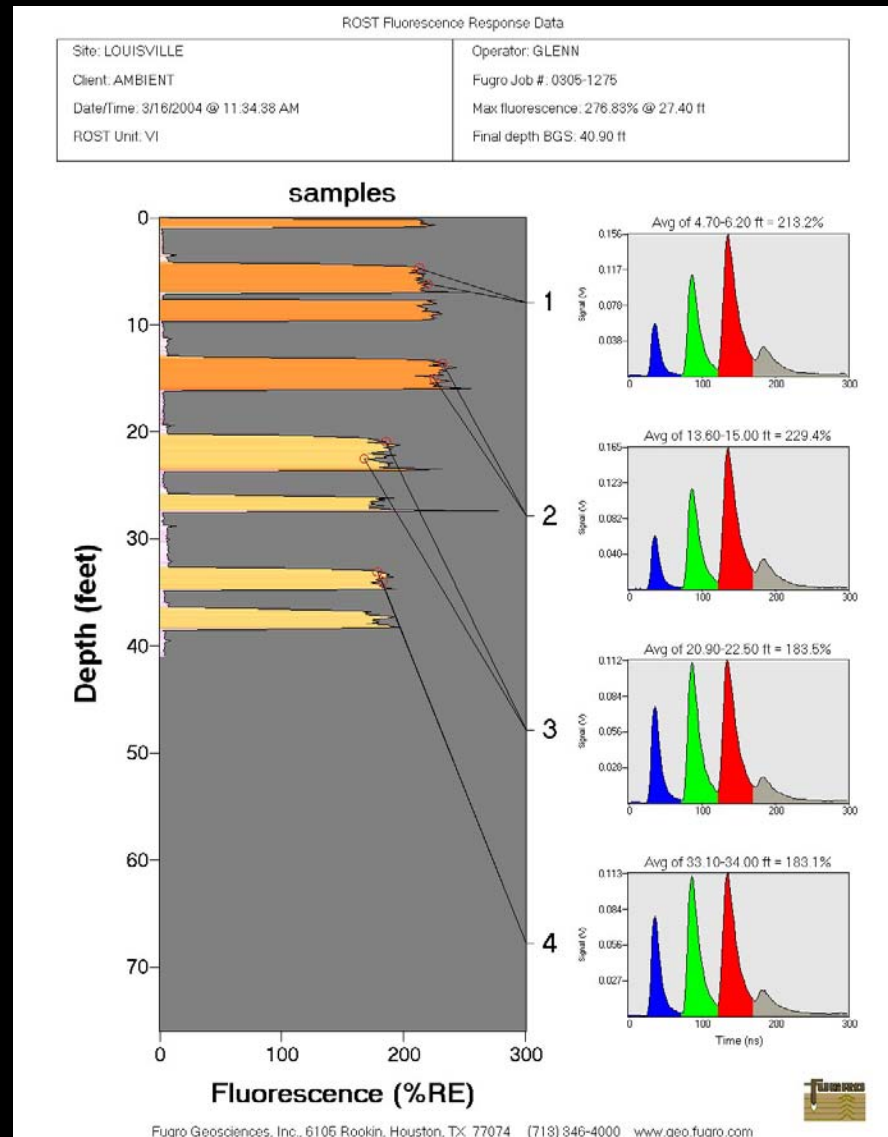


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Fluorescence versus Depth Chart

- Waveforms demonstrate diesel LPH



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Site Conditions

- Site is a flat stretch of land in industrial Baltimore, MD
- The site is used as a salt storage and distribution lot
- There is heavy truck traffic during most of the year
- The investigation area is paved with up to
- 8 inches of asphalt underlain by highly compacted gravel, oyster shells and other fill.



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Site Conditions

- There were two pipelines running parallel to Holabird Avenue that leaked LPH over several decades
- The product detected in the well network was typed as primarily diesel, with lesser percentages of gasoline
- Groundwater is approximately 5 feet below ground surface (bgs)
- Prior to ROST™ investigation, LPH was largely undefined to the south
- Investigation area was about 4 acres.



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Site Conditions

- The current property owner heavily uses the investigation area during most of the year
- Property owner requested minimal to zero disturbance to site operations.



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Safety Considerations

- Typical borehole clearance procedures were not followed because direct contact was needed between the soil, the instrument and the shallow groundwater
- A utility locating service was hired to map out all utilities
- A interview with the site owner was conducted to confirm findings
- All work was conducted at night to avoid traffic hazards
- In order to enhance site security, a guard was onsite at all times.



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Methods of Investigation

- Efforts were needed to validate findings to the Maryland Department of the Environment (MDE)
- Two LPH samples from the site were sent to Fugro for confirmation of detection prior to mobilization
- Prior to each test, the tool was calibrated using a M-1 sample (Mobil One with other additives)
- Site verification was performed by collocation (MW-8) and installation and gauging of temporary piezometers.

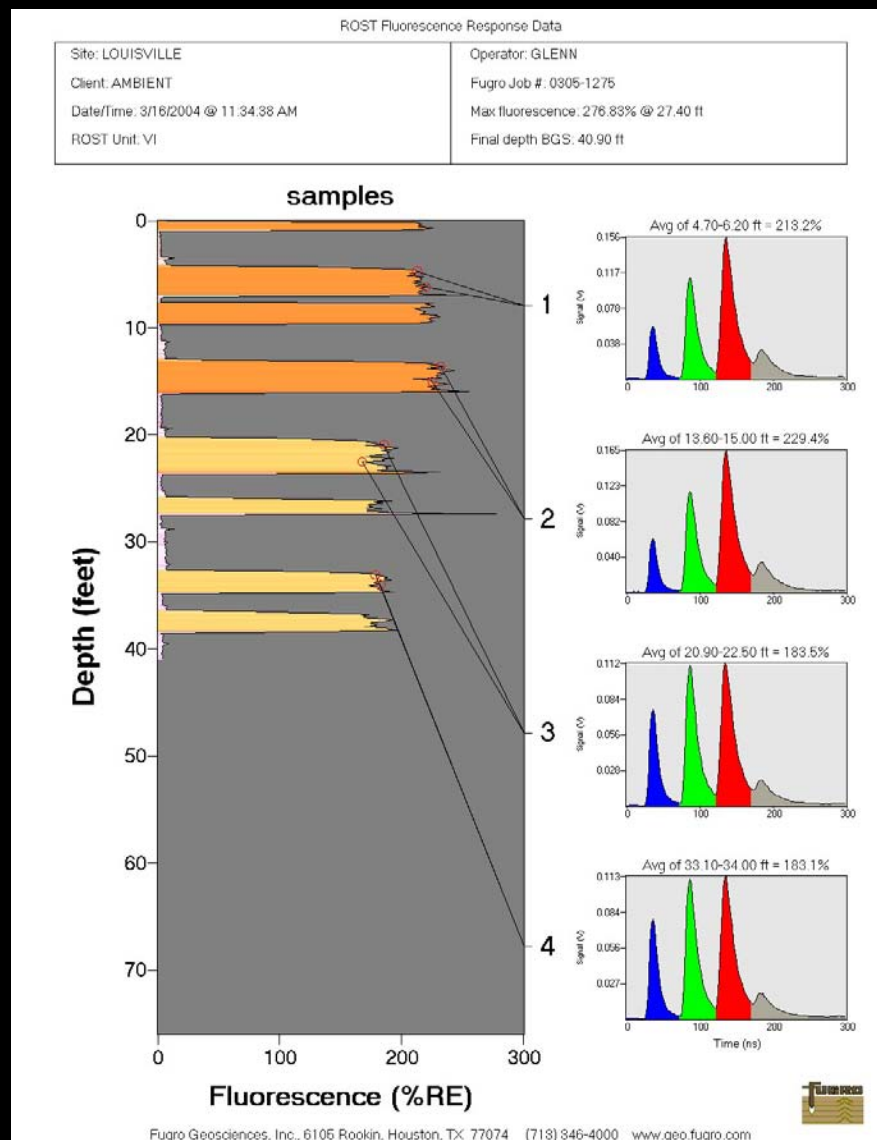


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FVD Chart for LPH Samples

- Peaks 1 and 2 were collected from MW-11, which was a 85:15 weathered diesel to gas mixture
- Peaks 3 and 4 were collected from MW-24, which was a 80:20 less weathered diesel to gas mixture.



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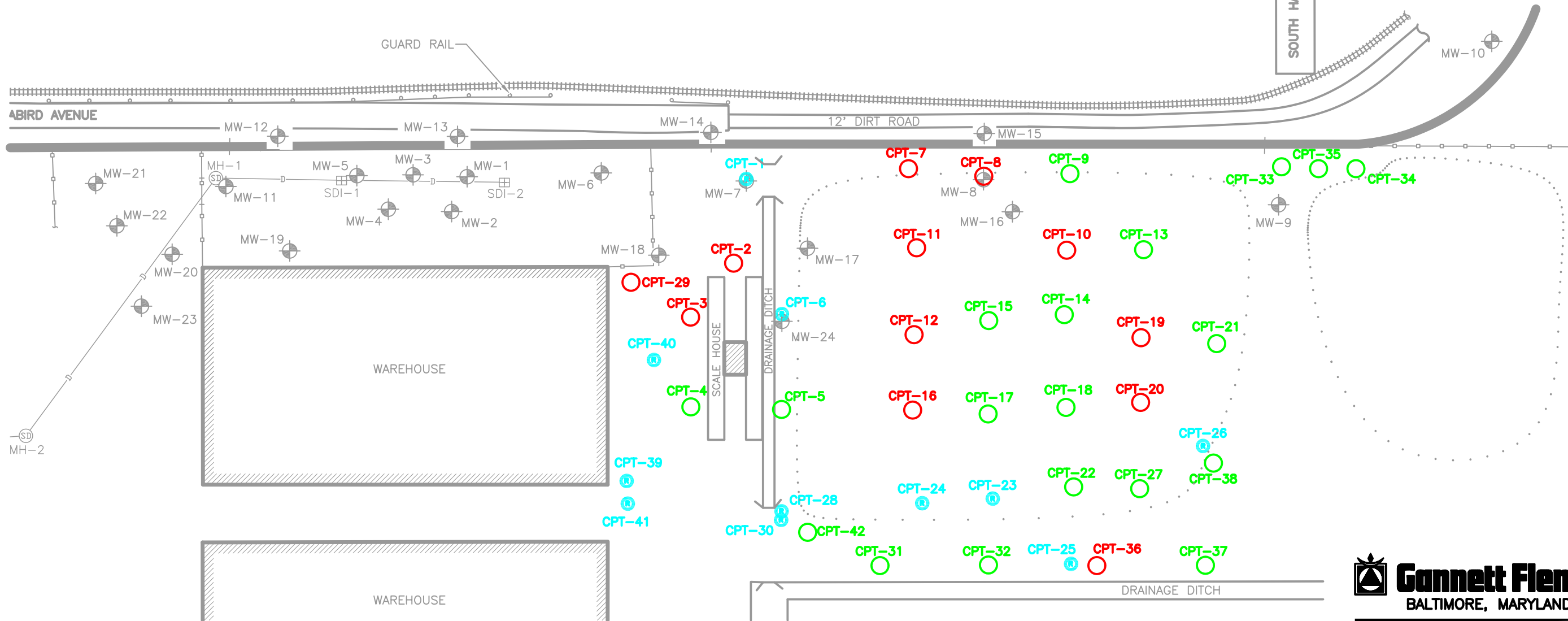
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Methods of Investigation

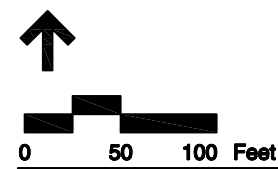
- The CPT/ROST™ was driven into the subsurface approximately 20 ft bgs, or until refusal
- A temporary piezometer was installed by hand (0.75-inch diameter by 0.02-inch slot screen)
- Piezometers were gauged periodically with an oil/water interface probe
- A concrete corer was used to clear to 3 feet bgs after difficulties with first event
- All locations were filled with grout and topped with hot asphalt.



Legend	
	ROST LOCATION
	ROST LOCATION WITH CONFIRMED LPH *
	ROST LOCATION WITH REFUSAL
	APPROXIMATE SALT OUTLINE **
	MONITORING WELL
	STORM DRAIN INLET
	STORM DRAIN MANHOLE
	"WARNING GAS LINE" SIGN
	APPROXIMATE LOCATION OF PIPELINES
	FENCE
	STORM DRAIN



Notes:
 1. Figure sources: Hicks Engineering; Wilson, Deagan, & Associates; and Gannett Fleming.
 2. CPT sample locations were based upon field measurements.
 * LPH confirmed in field with a O/W interphase probe through a temporary piezometer.
 ** Salt outline was approximated based on September 15, 2004 site conditions.



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Investigation Results

- Based on the site verification procedures, the technology was verified to work at the site
- A fluorescence of roughly 20 percent indicated a positive measurable detection of LPH in temporary piezometers
- Previous ROST™ usage at other sites offered mixed results, but clearly worked here.



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ROST Location	Maximum Fluorescence and Depth	Screen Depth (feet)	Time Since Installation (HH:MM)	Depth to LPH (feet)	Depth to Water (feet)	LPH Thickness (feet)
CPT-2	139% at 5.4 feet	8	09:05	5.06	5.50	0.46
CPT-3	19% at 11.4 feet	6	08:30	4.27	4.67	0.40
CPT-4	27% at 11.6 feet	6.5	08:00	-	3.57	-
CPT-5	14% at 2.6 feet	9	07:15	-	4.64	-
CPT-7	307% at 10.5 feet	15	00:55	6.10	6.87	0.77
CPT-8	529% at 7.6 feet	10	00:30	6.15	6.88	0.73
CPT-9	9% at 0.7 feet	11	02:30	-	6.60	-
CPT-10	124% at 7.4 feet	8	01:50	5.40	5.97	0.57
CPT-11	101% at 14.3 feet	12	01:00	5.08	5.50	0.42
CPT-12	35% at .4 feet	9	00:25	4.73	5.13	0.40
CPT-13	13% at 2.6 feet	12	08:00	-	5.35	-
CPT-16	25% at 4.3 feet	8	04:20	4.26	4.41	0.15
CPT-19	44% at 6.7 feet	8.5	00:45	5.25	5.27	0.02
CPT-20	16% at 1.0 feet	6.5	02:00	4.84	4.96	0.12
CPT-21	11% at 0.5 feet	8	01:10	-	5.08	-
CPT-29	106% at 5.3 feet	9	06:25	4.42	4.84	0.42
CPT-33	78% at 5.7 feet	9	03:05	-	5.60	-
CPT-36	77% at 3.9 feet	9	01:45	3.57	3.75	0.18



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Investigation Results

- The ROST™ provides the user with a real time data readout that allows for investigation guidance in the field
- Both predominately diesel and predominately gasoline LPH were detected
- The deepest detections were in closer proximity to the pipelines
- LPH delineated by ROST™ was found primarily below the salt storage lots.

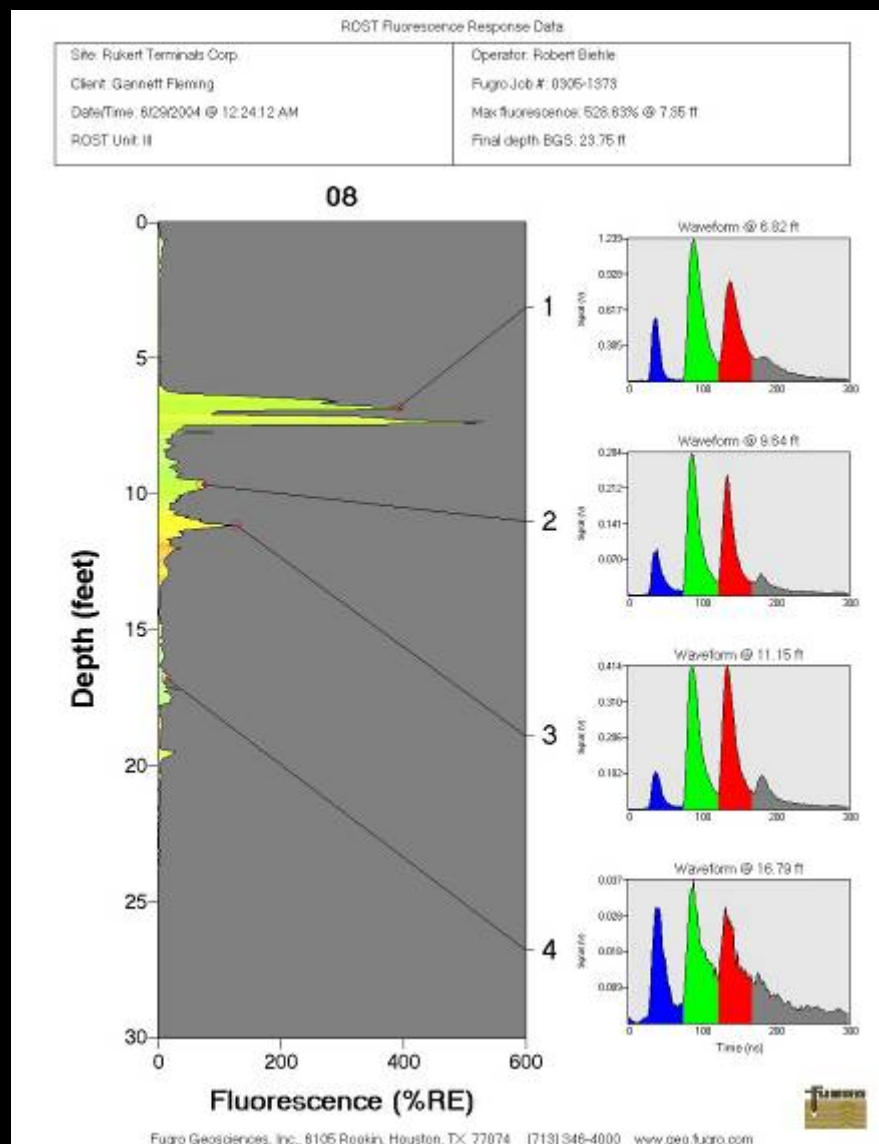


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Fluorescence versus Depth Chart

- Wavelength form demonstrates diesel LPH (1, 2, and 3).

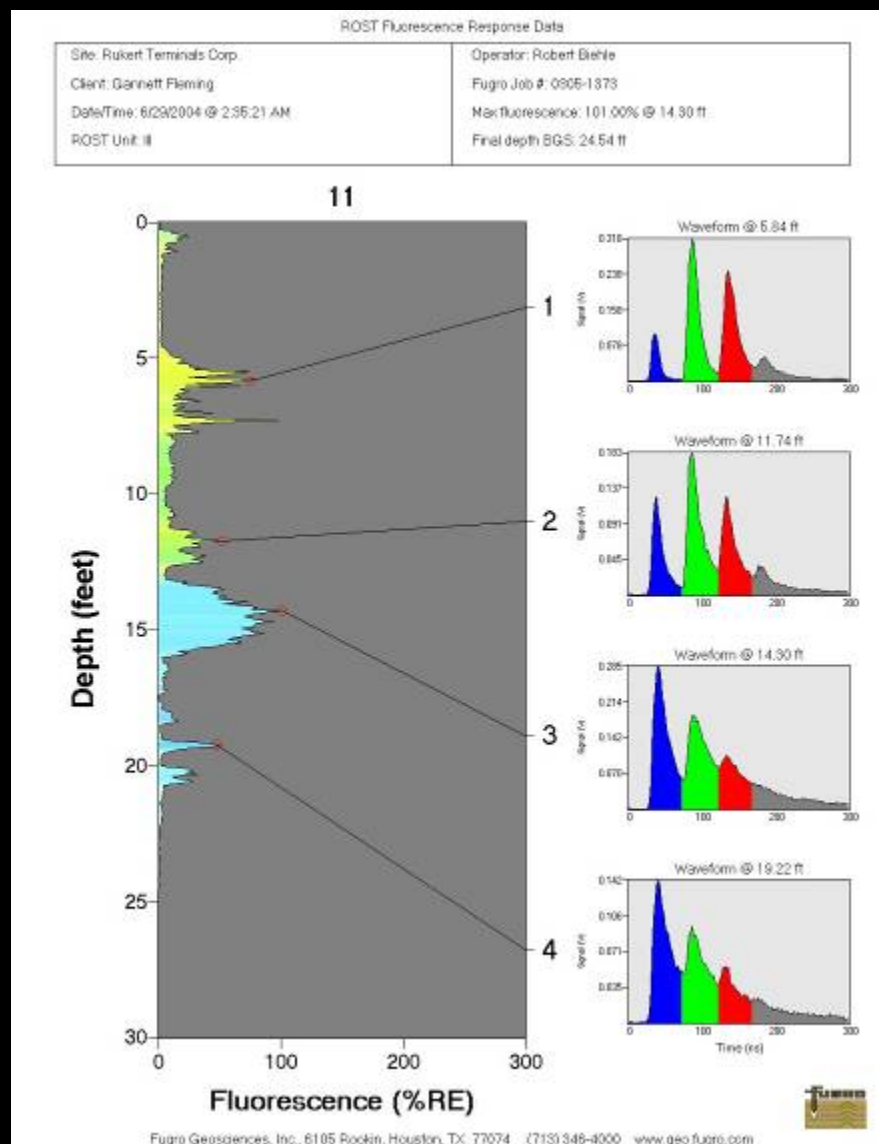


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Fluorescence versus Depth Chart

- Wavelength forms demonstrate diesel LPH (1 and 2) and gasoline LPH (3 and 4).



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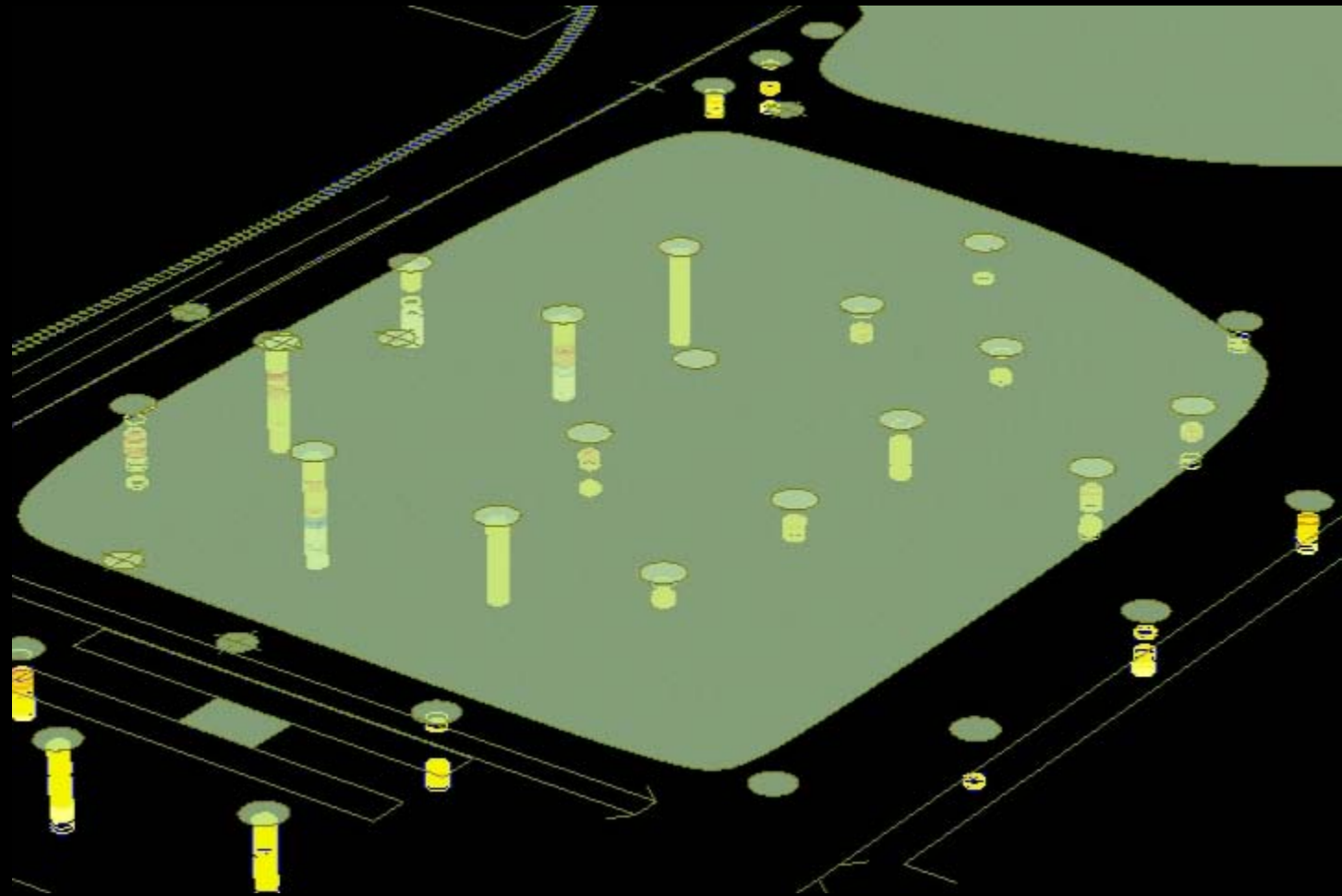
Data Interpretation

- There were not readily available programs or vendors to produce a comprehensive view of the data
- A combination of Excel, Microstation, AutoCAD, and ArcScene were used to create a 3D model that differentiated between LPH types
- Identified gasoline versus diesel waveforms
- Removed all data with fluorescence of 5 or less
- 3D model helped all parties to visualize investigation results and determine placement of compliance wells.



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Conclusion

- The ROST™ technology worked at this site as advertised
- The ROST™ investigation was not a significantly higher cost than the subsequent well installation, despite difficulties
- Had the site conditions been better, the investigation would have been quicker and more cost efficient
- Had the status quo been followed, there would be in the neighborhood of 8 additional wells onsite.



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Conclusion

	GF	Subs	Direct	Total
ROST™ 1	\$15,950	\$4,000	\$24,650	\$44,600
HSA²	\$17,200	\$20,650	\$0	\$37,850

1. There were a total of 42 ROST locations over 5 days and 2 mobilizations
2. There were 8 monitoring wells installed over 5 days.



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Conclusion

- Considering the large area of the site and the uncertainty with the LPH extents, ROST™ was very effective
- ROST™ is the right tool when used in the right application.



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For more information,
Contact Environmental Scientist,
Christopher Ralston

