

STANDARD OPERATING PROCEDURES
SUPPORTING TABLES
Pages 8 to 18

for

SOIL, SEDIMENT AND WATER REAL-TIME MEASUREMENT METHOD
FOR PETROLEUM HYDROCARBONS BY ULTRAVIOLET FLUORESCENCE



NJ DEP Certification No. MA013, Sitelab Corporation
Sitelab SOP Revision No. Rev 6.0

Submitted to: New Jersey Department of Environmental Protection
Office of Quality Assurance
P.O. Box 424
Trenton, New Jersey 08625
Attn: Mr. Stuart Nagourney (609) 292-4945

Signed by:

Steve Greason, Laboratory Manager
Sitelab Corporation
86 Coffin Street
West Newbury, MA 01985
(978) 363-2299

Date

JUNE 9, 2011

TABLE 1-A

Sitelab TD-500 and UVF-3100 linear range, detection limits and instrument sensitivity comparing different calibration kits available

Model TD-500	Calibration Product No. ¹	Linear Range of Calibration ⁴	High Standard Calibrator Conc. ³	Low Standard Detection Limit ²	Optimum UVF Sensitivity Range ⁵	UVF Optical Filters to use
Test Performed						
TPH-Oil	CAL-056	0 - 1,000 ppm	100 ppm	5 ppm	18% to 40%	Channel A
PAHs	CAL-061	0 - 1,000 ppb	500 ppb	25 ppb	15% to 35%	Channel A

Model UVF-3100	Calibration Product No. ¹	Linear Range of Calibration ⁴	High Standard Calibrator Conc. ³	Low Standard Detection Limit ²	Optimum UVF Sensitivity Range ⁵	UVF Optical Filters to Use
Test Performed						
GRO	CAL-025	0 - 12 ppm	10 ppm	0.5 ppm	24% to 40%	Slot B Optics
DRO*	CAL-042	0 - 6 ppm	5 ppm	0.1 ppm	14% to 22%	Slot A Optics
TPH-Oil	CAL-057	0 - 20 ppm	15 ppm	0.5 ppm	14% to 22%	Slot A Optics
Total PAHs (EPH)	CAL-060	0 - 2 ppm	1.5 ppm	0.05 ppm	14% to 22%	Slot A Optics
Target PAHs	CAL-060	0 - 2 ppm	1.5 ppm	0.05 ppm	14% to 22%	Slot D Optics

*See Table 1-B for more details.

¹Sitelab Corporation manufactures different calibration kits available for the TD-500 and UVF-3100 analyzers. Each kit contains reusable calibration standards dissolved in methanol solvent with proprietary mixtures of hydrocarbon compounds.

²Detection limits, or lowest quantitation limit, are dictated by the lowest calibration standard supplied with each calibration kit.

³The TD-500 employs a 1-point calibration curve. The UVF-3100 employs a multi-point calibration curve (5-point recommended for maximum performance). Both analyzers must use the highest concentrated standard and are zeroed using clean solvent during the calibration process.

⁴Linear range is dependent on the fluorescence sensitivity and concentration of the highest standard or calibrator. The maximum range is manually set using the UVF-3100 analyzer (typically 20 to 33% higher than the highest standard). The maximum range is automatically set by the TD-500 analyzer (typically much higher compared to UVF-3100 due to LED wavelength, optical filters and photomultiplier used).

⁵UVF sensitivity is automatically generated during the calibration process and is dependent on the fluorescence intensity when measuring the highest standard or calibrator. Sensitivity may vary from instrument to instrument. If or when a calibration is performed and the sensitivity value is outside the sensitivity range, the analyzer is not calibrated properly.

TABLE 1-B

Illustration confirming UVF-3100 analyzer is calibrated properly and how sample results are calculated and reported

UVF-3100 Analyzer Calibrated to DRO using CAL-042 with Slot A Optical Filters
 UVF Sensitivity Value = 16%. Optimum Sensitivity Range = 14% to 22%
 5-point Calibration Curve Linearity R² = 0.999. Optimum R² Range = 0.990 to 1.000

<u>Confirm the analyzer is calibrated properly before testing samples:</u>		<u>Concentration Reading in ppm</u>	<u>Comments on calibration curve¹</u>
Methanol Blank – Zero ppm check		0.002	Solvent close to zero; less than 20% of detection limit (-0.02-0.02)
0.1 ppm Calibration Standard (Detection Limit)		0.110	Good: reading is within 20% of true concentration (0.08 - 1.2 ppm)
0.5 ppm Calibration Standard		0.530	Good: reading is within 20% of true concentration (0.4 - 0.6 ppm)
1 ppm Calibration Standard		1.091	Good: reading is within 20% of true concentration (0.8 - 1.2 ppm)
3 ppm Calibration Standard		3.195	Good: reading is within 20% of true concentration (2.4 - 3.6 ppm)
5 ppm Calibration Standard (High Standard)		5.320	Good: reading is within 20% of true concentration (4 - 6 ppm)
<u>Examples testing 3 soils from a former UST site:</u>	<u>Dilution Tested</u>	<u>Concentration Reading in ppm</u>	<u>Comments on how samples are reported²</u>
Sample No. 1	100X	0.550	Report sample as 55 ppm. Retest sample using a different dilution to check for quenching
Sample No. 1	200X	0.291	Report sample as 58 ppm Good: result is within 20% of 55 ppm. No quenching has occurred
Sample No. 1 Extract Dup	100X	0.954	Report sample as 95 ppm Caution: result is not within 50% of original sample (55 or 58 ppm) Illustrates contamination in sample is poorly homogenized
Sample No. 2	100X	OVER	Reading is above calibration range. Sample contains >600 ppm Retest sample using a larger dilution
Sample No. 2	1,000X	5.850	Sample result is 5,850 ppm Caution: reading is higher than the 5 ppm calibration point Reporting range is 0.1 ppm to 5 ppm. Retest using larger dilution
Sample No. 2	2,000X	2.950	Report sample as 5,900 ppm
Sample No. 3	100X	0.009	Reading is below the 0.1 ppm detection limit for DRO Report as ND = <10 ppm (100X x 0.1) Or retest sample using a smaller dilution
Sample No. 3	2X Extract	0.079	Reading is below the 0.1 ppm detection limit for DRO Report as ND = <0.2 ppm (2X x 0.1)
1 ppm Calibration Standard		1.110	Good: reading is within 20% of true concentration (0.8 - 1.2 ppm) Confirms calibration curve valid at end of sample analysis event
New 1 ppm Calibration Standard using Reference Standard supplied with CAL-042		0.995	Good: reading is within 20% of true concentration (0.8 - 1.2 ppm) Confirms the original calibrators are still valid after 2 months old

¹UVF analyzer was originally calibrated two weeks prior to this testing event. The calibration standards used for calibration were retested and were close to the true concentration (within 20%). The higher concentrations (5% to 10%) detected in all five standards illustrates the degree of instrument drift over time.

²Samples contained high, medium and low contamination. All samples were extracted using 5 grams of soil with 10 mL of methanol solvent (creating a 2X dilution). Each extract was then diluted with the appropriate volume of solvent and measured on the UVF-3100. Final concentrations are calculated by multiplying the concentration reading by the dilution performed.

TABLE 2

Sitelab UVF-3100A performance testing GRO, DRO and TPH in water using blind, proficiency evaluation samples

1. Gasoline Range Organics Sample ID# 0130-08-01.1	Certified Value ¹ 3,470 ug/L	UVF-3100A GRO 3,330 ug/L	Laboratory Mean ² GRO by GC 3,600 ug/L	Acceptance Limits ³ 1,340 – 6,110 ug/L
2. Diesel Range Organics Sample ID# 0130-08-01.2	Certified Value ¹ 3,620 ug/L	UVF-3100A DRO 3,780 ug/L	Laboratory Mean ² DRO by GC 2,600 ug/L	Acceptance Limits ³ 897 – 4,660 ug/L
3A. Total Petroleum Hydrocarbons Sample ID# 0130-08-01.3	Certified Value ¹ 62.5 mg/L	UVF-3100A TPH using Oil ⁴ 80 mg/L Range ⁵ 58-91 mg/L	Laboratory Mean ² TPH by 1664 Gravimetric 51.9 mg/L	Acceptance Limits ³ 28.6 – 90.3 mg/L
3B. Total Petroleum Hydrocarbons Sample ID# 0130-08-01.3	Certified Value ¹ 76.9 mg/L	UVF-3100A TPH using Oil ⁴ 80 mg/L Range ⁵ 58-91 mg/L	Laboratory Mean ² TPH by 418.1 IR 77.7 mg/L	Acceptance Limits ³ 35.7 – 111 mg/L

¹Certified values were developed by Environmental Resource Associates (ERA), Arvada, CO, who provided the water samples to Sitelab Corporation in February 2008. Samples included ERA Catalog No. 762 (GRO), Catalog No. 764 (DRO) and Catalog 600 (TPH). The certified values are the actual 'made-to' concentrations confirmed by ERA analytical verification.

²Laboratory Mean reflects the average concentrations reported by all the participating laboratories during this proficiency evaluation study. 83 laboratories participated in the GRO study, using gas chromatography instrumentation using various EPA Method 8015 and other federal and state regulatory methods. 83 laboratories participated in the DRO study, using gas chromatography instrumentation using EPA Method 8015 and other federal and state regulatory methods. 21 laboratories participated in the TPH study, using EPA Method 1664 by Gravimetric. 10 laboratories participated in the TPH study using EPA Method 418.1 by Infrared (IR).

³Performance Acceptance Limits are based on actual historical data collected by ERA's Proficiency Testing program. ERA calculates the limits using the regression equations and fixed acceptance criteria specified in the US EPA National Standards Criteria Document and/or the NELAC proficiency testing requirements.

⁴TPH reported using the Sitelab UVF-3100A performed by calibrating the analyzer using the same oil used for spiking the water samples, to match the source of contamination. ERA provided the oil to Sitelab Corporation. This oil used for verifying EPA methods 1664 and 418.1 contains vacuum pump oil specified by NELAC. Sitelab's GRO and DRO concentrations were reported using Sitelab calibration kits CAL-025 and CAL-042.

⁵Range of TPH results are based on the lowest and highest TPH result generated, when testing the same water sample each day for 14 days, in order to account for sample homogeneity and sample longevity issues. The average concentration of the 14 results was 80 mg/L used to report TPH to ERA.

TABLE 3

Matrix Spike Recovery, Method Detection, Repeatability and Interference
Performance for Commercial Testing Product
Field Testing US EPA Performance Evaluation Samples

Sample Number & Spike Type:	UVF-3100A (Sitelab Corporation) TPH ¹ : As combined DRO & GRO (mg/Kg)	Certified Value ² (mg/Kg)	Acceptance Limits ³ (mg/Kg)
01 - Gasoline: w/ 5% Moisture	0.4	6.15	0 - 13*
02 - Gasoline: w/ 5% Moisture	0.6	6.15	0 - 13*
03 - Gasoline: w/ 5% Moisture	0.9	6.15	0 - 13*
04 - Gasoline: w/ 5% Moisture	0.7	6.15	0 - 13*
05 - Gasoline: w/ 5% Moisture	0.4	6.15	0 - 13*
06 - Gasoline: w/ 5% Moisture	0.3	6.15	0 - 13*
07 - Gasoline: w/ 5% Moisture	0.6	6.15	0 - 13*
08 - Gasoline: Low	1.0	<2	0 - 2*
09 - Gasoline: Low	0.9	<2	0 - 2*
10 - Gasoline: Low	1.9	<2	0 - 2*
11 - Gasoline: Medium	520	1,090	389 - 1,548
12 - Gasoline: Medium	490	1,090	389 - 1,548
13 - Gasoline: Medium	590	1,090	389 - 1,548
14 - Gasoline: High	1,450	3,120	1,110 - 4,430
15 - Gasoline: High	1,600	3,120	1,110 - 4,430
16 - Gasoline: High	1,650	3,120	1,110 - 4,430
17 - Gasoline: w/ 1,100 ppm MtBE	1,320	2,830	1,010 - 4,020
18 - Gasoline: w/ 1,100 ppm MtBE	1,370	2,830	1,010 - 4,020
19 - Gasoline: w/ 1,100 ppm MtBE	1,560	2,830	1,010 - 4,020
20 - Gasoline: w/ 1,760 ppm MtBE	890	2,490	889 - 3,540
21 - Gasoline: w/ 1,760 ppm MtBE	1,030	2,490	889 - 3,540
22 - Gasoline: w/ 1,760 ppm MtBE	1,030	2,490	889 - 3,540
23 - Gasoline: w/ 2,810 ppm Tetrachloroethylene	1,660	3,030	1,080 - 4,300
24 - Gasoline: w/ 2,810 ppm Tetrachloroethylene	1,910	3,030	1,080 - 4,300
25 - Gasoline: w/ 2,810 ppm Tetrachloroethylene	1,500	3,030	1,080 - 4,300
26 - Gasoline: w/ 13,100 ppm Tetrachloroethylene	1,300	2,800	1,000 - 3,980
27 - Gasoline: w/ 13,100 ppm Tetrachloroethylene	1,370	2,800	1,000 - 3,980
28 - Gasoline: w/ 13,100 ppm Tetrachloroethylene	1,370	2,800	1,000 - 3,980
29 - Gasoline: w/ 2,900 ppm Stoddard Solvent	1,570	2,770	989 - 3,930
30 - Gasoline: w/ 2,900 ppm Stoddard Solvent	1,580	2,770	989 - 3,930
31 - Gasoline: w/ 2,900 ppm Stoddard Solvent	1,490	2,770	989 - 3,930
32 - Gasoline: w/ 15,400 ppm Stoddard Solvent	1,650	2,730	970 - 3,880
33 - Gasoline: w/ 15,400 ppm Stoddard Solvent	2,490	2,730	970 - 3,880
34 - Gasoline: w/ 15,400 ppm Stoddard Solvent	2,010	2,730	970 - 3,880
35 - Gasoline: w/ 2,730 ppm Alpha & Beta-Pinene	1,530	2,950	1,050 - 4,190
36 - Gasoline: w/ 2,730 ppm Alpha & Beta-Pinene	1,410	2,950	1,050 - 4,190
37 - Gasoline: w/ 2,730 ppm Alpha & Beta-Pinene	1,240	2,950	1,050 - 4,190
38 - Gasoline: w/ 12,900 ppm Alpha & Beta-Pinene	1,260	2,620	935 - 3,720
39 - Gasoline: w/ 12,900 ppm Alpha & Beta-Pinene	1,750	2,620	935 - 3,720
40 - Gasoline: w/ 12,900 ppm Alpha & Beta-Pinene	1,260	2,620	935 - 3,720
41 - Gasoline: w/ 17% Moisture	1,720	2,780	992 - 3,950
42 - Gasoline: w/ 17% Moisture	1,670	2,780	992 - 3,950
43 - Gasoline: w/ 17% Moisture	1,590	2,780	992 - 3,950
44 - #2 Diesel: w/ 5% Moisture	18	37.3	18.1 - 47.4
45 - #2 Diesel: w/ 5% Moisture	19	37.3	18.1 - 47.4
46 - #2 Diesel: w/ 5% Moisture	18	37.3	18.1 - 47.4
47 - #2 Diesel: w/ 5% Moisture	16	37.3	18.1 - 47.4
48 - #2 Diesel: w/ 5% Moisture	18	37.3	18.1 - 47.4
49 - #2 Diesel: w/ 5% Moisture	19	37.3	18.1 - 47.4
50 - #2 Diesel: w/ 5% Moisture	19	37.3	18.1 - 47.4
51 - #2 Diesel: Medium	290	454	220 - 577
52 - #2 Diesel: Medium	300	454	220 - 577
53 - #2 Diesel: Medium	300	454	220 - 577
54 - #2 Diesel: High	2,800	3,920	1,900 - 4,980
55 - #2 Diesel: High	3,050	3,920	1,900 - 4,980
56 - #2 Diesel: High	2,600	3,920	1,900 - 4,980
57 - #2 Diesel w/ 3,650 ppm Stoddard Solvent	2,860	3,920	1,900 - 4,980
58 - #2 Diesel w/ 3,650 ppm Stoddard Solvent	3,080	3,920	1,900 - 4,980
59 - #2 Diesel w/ 3,650 ppm Stoddard Solvent	2,830	3,920	1,900 - 4,980

TABLE 3 - Continued

Sample Number & Spike Type:	UVF-3100A (Sitelab Corporation) TPH ¹ : As combined DRO & GRO (mg/Kg)	Certified Value ² (mg/Kg)	Acceptance Limits ³ (mg/Kg)
60 - #2 Diesel w/ 18,200 ppm Stoddard Solvent	2,830	3,920	1,900 - 4,980
61 - #2 Diesel w/ 18,200 ppm Stoddard Solvent	2,520	3,920	1,900 - 4,980
62 - #2 Diesel w/ 18,200 ppm Stoddard Solvent	2,570	3,920	1,900 - 4,980
63 - #2 Diesel w/ 3,850 ppm Alpha & Beta-Pinene	2,830	3,920	1,900 - 4,980
64 - #2 Diesel w/ 3,850 ppm Alpha & Beta-Pinene	2,840	3,920	1,900 - 4,980
65 - #2 Diesel w/ 3,850 ppm Alpha & Beta-Pinene	2,720	3,920	1,900 - 4,980
66 - #2 Diesel w/ 19,600 ppm Alpha & Beta-Pinene	2,270	3,920	1,900 - 4,980
67 - #2 Diesel w/ 19,600 ppm Alpha & Beta-Pinene	2,260	3,920	1,900 - 4,980
68 - #2 Diesel w/ 19,600 ppm Alpha & Beta-Pinene	2,150	3,920	1,900 - 4,980
69 - #2 Diesel: w/ 3,350 ppm 1,2,4-Trichlorobenzene	2,590	3,920	1,900 - 4,980
70 - #2 Diesel: w/ 3,350 ppm 1,2,4-Trichlorobenzene	2,700	3,920	1,900 - 4,980
71 - #2 Diesel: w/ 3,350 ppm 1,2,4-Trichlorobenzene	2,660	3,920	1,900 - 4,980
72 - #2 Diesel: w/ 16,600 ppm 1,2,4-Trichlorobenzene	2,430	3,920	1,900 - 4,980
73 - #2 Diesel: w/ 16,600 ppm 1,2,4-Trichlorobenzene	2,300	3,920	1,900 - 4,980
74 - #2 Diesel: w/ 16,600 ppm 1,2,4-Trichlorobenzene	2,400	3,920	1,900 - 4,980
75 - #2 Diesel: w/ 3,940 ppm Humic Acid	2,430	3,920	1,900 - 4,980
76 - #2 Diesel: w/ 3,940 ppm Humic Acid	2,750	3,920	1,900 - 4,980
77 - #2 Diesel: w/ 3,940 ppm Humic Acid	2,860	3,920	1,900 - 4,980
78 - #2 Diesel: w/ 19,500 ppm Humic Acid	2,560	3,920	1,900 - 4,980
79 - #2 Diesel: w/ 19,500 ppm Humic Acid	2,430	3,920	1,900 - 4,980
80 - #2 Diesel: w/ 19,500 ppm Humic Acid	2,480	3,920	1,900 - 4,980
81 - #2 Diesel: 0% Moisture	2,870	4,320	2,100 - 5,490
82 - #2 Diesel: 0% Moisture	3,350	4,320	2,100 - 5,490
83 - #2 Diesel: 0% Moisture	3,100	4,320	2,100 - 5,490
84 - 3,940 ppm Humic Acid Only	11	3,940	
85 - 3,940 ppm Humic Acid Only	11	3,940	
86 - 3,940 ppm Humic Acid Only	12	3,940	
87 - 19,500 ppm Humic Acid Only	45	19,500	
88 - 19,500 ppm Humic Acid Only	35	19,500	
89 - 19,500 ppm Humic Acid Only	31	19,500	

Method Detection Limit (MDL) reported by U.S. EPA: 3.4 mg/Kg Calculated using samples 44 thru 50 listed above
Source: EPA/600/R-01/080

This table reflects the method performance using a commercial testing product analyzing Performance Evaluation (PE) samples during the US EPA's Superfund Innovative Technology Evaluation (SITE, ETV) program for field measuring total petroleum hydrocarbons (TPH) in soil. TPH concentrations were generated as combined GRO results and DRO results added together. The PE samples contained spiked concentrations of gasoline and diesel fuels as well as other hydrocarbons and potential interferences. Samples were extracted and analyzed in triplicate to account for homogeneity and to measure repeatability. Of the Eighty-nine samples tested by the method, only a few were at or outside the acceptance limits, demonstrating good accuracy. Additionally, no significant impact was observed with samples spiked with interfering compounds (MtBE, humic acid, chlorinated hydrocarbons, etc.). The lower, yet consistent recoveries when compared to the certified value is likely due to sample volatilization and/or quantity of aliphatic hydrocarbon compounds present in the samples, detectable by the GC method, but not by this screening method.

¹Specific GRO and DRO concentrations are not displayed in this table. All results were appropriately adjusted for solvent dilution by percent moisture in each sample.

²Certified values were developed by Environmental Resource Associates (ERA), Arvada, CO. The certified values are the mean concentration found in the soil, based on GC analysis using EPA Method 8105 of three replicates of the standard.

³Performance Acceptance Limits are listed as guidelines for acceptable analytical results given the limitations of US EPA methodologies commonly used to determine this parameter and closely approximate the 95% confidence intervals. The performance acceptance limit is based on analytical verification data generated by ERA and data from ERA's Interlab UST studies.

*Indicates the 95% confidence interval was calculated using the project-specific certified value and standard deviation.

Data are taken from Reference 5.

TABLE 4

Sitelab UVF-3100A performance testing soil for GRO using 6 split samples collected in triplicate during an environmental site assessment located at a former gasoline station and tank farm

Sample Number	UVF-3100A GRO result ¹	Concentrations in ppm (mg/Kg)					
		Laboratory GC-FID EPA Method 8015 GRO Results	Massachusetts DEP VPH Method ² Total VPH	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	Target Analytes (BTEX + MtBE)
Soil 1	176	260	292	45	110	130	6
Soil 2	666	1,500	886	140	350	380	16
Soil 3	1,481	1,500	1,526	99	560	730	137
Soil 4	3,037	2,300	2,665	320	1,000	1,300	45
Soil 5	5,570	8,000	8,103	1,900	2,300	2,400	1,503
Soil 6	5,704	6,000	7,025	1,900	1,700	2,500	925
Linear regression analysis:		UVF vs. GRO R ² = 0.8961 y = 1.1865x	UVF vs. Total VPH R ² = 0.9558 y = 1.3422x	Lab GRO vs. Lab Total VPH R ² = 0.9801 y = 1.0843x			

¹The certified laboratory reported GRO and VPH results in dry weight (mg/Kg). UVF field results shown were adjusted using the laboratory's percent moisture content (approx. 22% for all 6 samples tested). Sitelab UVF-3100A analyzer was calibrated using Sitelab Corporation's Product No. CAL-025 for gasoline range hydrocarbons.

²The Mass DEP VPH method is similar to EPA Method 8015-GRO, using GC-FID instrumentation to separately detect and report two aliphatic hydrocarbon fractions, one aromatic hydrocarbon fraction and target analytes that include benzene, ethylbenzene, toluene, m-xylene, p-xylene, o-xylene (BTEX) and methyl ter-butyl ether (MtBE).

TABLE 5

Sitelab UVF-3100A performance testing soils for DRO using 10 split samples collected during an environmental site assessment located at a former tank farm contaminated by a commingled LNAPL plume of fuel oils

Sample Number	UVF-3100A DRO result ¹	Concentrations in ppm (mg/Kg)				
		Laboratory GC-FID Massachusetts DEP EPH Method ² Total EPH	C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	Sum of 17 Target PAHs
Soil 1	350	241	67	78	96	ND
Soil 2	390	478	270	57	140	11
Soil 3	1,300	2,491	1,600	120	750	21
Soil 4	1,750	2,465	1,600	170	650	45
Soil 5	2,450	2,529	1,700	150	630	49
Soil 6	3,500	5,252	3,200	280	1,700	72
Soil 7	5,050	4,103	2,700	220	1,100	83
Soil 8	6,872	5,692	3,600	290	1,700	102
Soil 9	12,800	12,170	8,800	750	2,400	220
Soil 10	16,420	16,682	12,000	1,100	3,400	182

Linear regression analysis UVF vs. Total EPH: R² = 0.9723, y = 0.9492x 380.6

¹UVF field results shown are reported in wet weight. Laboratory results are reported in dry weight (mg/Kg). Sitelab UVF-3100A analyzer was calibrated using Sitelab Corporation's Product No. CAL-042 for extended diesel range hydrocarbons.

²The Mass DEP EPH method is similar to EPA Method 8015-DRO, using GC-FID instrumentation to separately detect and report two aliphatic hydrocarbon fractions, one aromatic hydrocarbon fraction and 17 target PAH compounds. The 17 PAHs are the same compounds reported by U.S. EPA Method 8270 by GC/MS.

TABLE 6

Sitelab UVF-3100A performance testing U.S. EPA Triad evaluation samples for DRO in soil at the U.S. EPA Region 1 laboratory for samples contaminated with weathered fuel oil, lubricating oil and fly ash at a former power plant site

Surface Soils Tested During Trial Event	Concentrations in ppm (mg/Kg)	
	UVF-3100A DRO result ¹	Laboratory GC-FID Connecticut DEP ETPH Method ² Result
Soil 1	ND <1	19
Soil 2	237	250
Soil 3	271	300
Soil 4	409	450
Soil 5	3,294	1,500
Average of 17 Field Results ³	773	783
CT-DEP's TPH Action Level	500	500

¹UVF field results shown are reported in wet weight. Laboratory results are reported in dry weight (mg/Kg). Sitelab UVF-3100A analyzer was calibrated using Sitelab Corporation's Product No. CAL-042 for extended diesel range hydrocarbons.

²The CT-DEP Extractable Total Petroleum Hydrocarbons (ETPH) method is similar to EPA Method 8015-DRO, using GC-FID instrumentation to report hydrocarbons in the C10 to C36 range.

³See Enclosure 2-1 to "Case Study of the Triad Approach: Expedited Characterization of Petroleum Constituents and PCBs Using Test Kits and a Mobile Chromatography Laboratory at the Former Cos Cob Power Plant Site", EPA Report No. EPA-542-R-04-008, June 2004.

TABLE 7

Performance of Sitelab UVF-3100A testing EPH C11-C22 aromatic hydrocarbons in soil compared to three different laboratories, using split samples collected from a former tank farm contaminated by a commingled LNAPL plume of diesel fuel and No. 6 fuel oil

10 Soils were split 4 times and sent to each laboratory	Concentrations in ppm (mg/Kg)			
	Massachusetts EPH C11-C22 Aromatic Hydrocarbon Fraction			
	UVF-3100A Field Result	Laboratory 1 by GC-FID	Laboratory 2 by GC-FID	Laboratory 3 by GC-FID
Soil 1	16	197	35	4
Soil 2	240	333	280	82
Soil 3	247	196	240	110
Soil 4	1,100	1,130	800	280
Soil 5	2,330	1,730	1,500	510
Soil 6	3,585	4,600	3,000	1,400
Soil 7	4,030	9,580	6,000	1,800
Soil 8	5,275	7,110	3,300	630
Soil 9	7,200	6,820	3,500	1,000
Soil 10	7,200	13,000	9,900	2,300
Linear regression analysis of UVF vs. Laboratories ²		R ² = 0.80	R ² = 0.67	R ² = 0.61

¹UVF field results shown are reported in wet weight. Laboratory results are reported in dry weight (mg/Kg). Sitelab UVF-3100A analyzer was calibrated using Sitelab Corporation's Product No. CAL-060 for polyaromatic hydrocarbon applications using the analyzer's DRO/EPH optical filters.

²The UVF results correlated best to laboratory 1. All three certified laboratories performed the Massachusetts DEP's EPH method for Extractable Petroleum Hydrocarbons, using GC-FID instrumentation to separately detect and report the aromatic from aliphatic fractions found in TPH. This study was performed by Ambient Engineering, Inc. from Concord, MA in 2005.

TABLE 8

Sitelab TD-500D and UVF-3100D performance testing soils and sediment for PAHs at different contaminated sites

Examples of sites with PAH Contamination:	Concentrations in ppm (mg/Kg)		
	TD-500 ¹	UVF-3100D ¹	Lab Method 8270 GC/MS Sum of PAH Compounds
1. UST site with asphalt/urban fill in soil	85	61	69
2. Coal ash in soil from power plant	12	9	10
	33	30	21
3. River sediment from MGP coal tar site	63	44	46
	262	184	174
4. Soils from former tank farm with fuel oils	40	97	82
	80	180	130
	214	370	350
5. Soils from diesel and gasoline storage tanks ²	2.0	8.0	6.8
	2.6	17	15
	12	60	57
6. Soils from former gasoline station ²	0.8	4.4	3.0
	1.5	7.7	6.0
	4.3	30	21

¹UVF field results shown are reported in wet weight. Laboratory results are reported in dry weight (mg/Kg). Sitelab UVF-3100A analyzer was calibrated using Sitelab Corporation's Product No. CAL-060 using the analyzer's Target PAH optical filters. Sitelab TD-500D analyzer calibrated using Product No. CAL-061.

²TD-500D may not be suitable for accurate PAH measurement for gasoline, jet fuel, fresh diesel or other light-end TPH related contaminated sites, as test results may be low and greater than 50% Relative Percent Difference (RPD) compared to the reference method.

TABLE 9-1

Method Detection Limit (MDL) study testing 7 replicate soils for Gasoline Range Organic Hydrocarbons, measuring samples containing low concentrations of fresh, non-weathered gasoline.

Soil spiked with 20 ppm Gasoline ¹	UVF-3100 - GRO 5-Point Calibration Curve ² Results in ppm (mg/Kg):	UVF-3100 - GRO 1-Point Calibration Curve ³ Results in ppm (mg/Kg):
<u>Sample ID:</u>		
GRO - 1	2.50	3.08
GRO - 2	2.42	3.02
GRO - 3	2.20	2.72
GRO - 4	2.00	2.54
GRO - 5	1.86	2.36
GRO - 6	1.66	2.14
GRO - 7	1.30	1.72
Standard Deviation:	0.43	0.49
Std Dev x 3.143:	MDL = 1.34 ppm	MDL = 1.53 ppm

¹Soil sample was prepared by spiking 0.5 mL of a 2,000 ppm standard containing premium unleaded gasoline (93-octane, Hess, Haverhill, MA) and adding it to 50 grams of certified, clean sea sand. The sample was homogenized thoroughly and kept cool for 1 hour prior to use. The soil jar was then opened and 7 sub-samples were prepared by weighing out 5 grams of soil each and adding 10 mL of methanol for extraction. The linear drop in GRO concentrations exhibited is due to volatilization that occurred during the time it took to measure out the seven 5 gram, sub-samples (approx. 5 minutes).

²Sitelab's UVF-3100D analyzer (Serial No. 31-1053) was calibrated to a linear 5-point calibration curve using Sitelab GRO calibration kit, Product No. CAL-025, measured on the analyzer's Slot B optical filters.

³A second analyzer was used to measure the same samples for comparison (Serial No. 7-1831). Instrument was calibrated to a 1-point calibration curve using the same GRO calibration kit. For maximum performance, manufacturer recommends using a 5-point calibration curve. To save time during the calibration process, however, the analyzer can be calibrated to 1-point (plus the blank), which yields test results slightly higher when compared using the multi-point calibration feature.

TABLE 9-2

Method Detection Limit (MDL) study testing 7 replicate soils for Extended Diesel Range Organic Hydrocarbons, measuring samples containing low concentrations of home heating oil (No. 2 fuel oil).

Soil spiked with 5 ppm Home Heating Oil ¹	UVF-3100 - DRO 5-Point Calibration Curve ² Results in ppm (mg/Kg):	UVF-3100 - DRO 1-Point Calibration Curve ³ Results in ppm (mg/Kg):
<u>Sample ID:</u>		
DRO - 1	4.184	4.266
DRO - 2	4.192	4.256
DRO - 3	4.188	4.270
DRO - 4	4.160	4.244
DRO - 5	4.134	4.216
DRO - 6	4.202	4.280
DRO - 7	4.176	4.256
Standard Deviation:	0.02	0.02
Std Dev x 3.143:	MDL = 0.07 ppm	MDL = 0.07 ppm

¹Soil sample was prepared by spiking 0.5 mL of a 500 ppm standard containing home heating oil (Garden City Oil, Newton, MA) and adding it to 50 grams of certified, clean sea sand. The sample was homogenized thoroughly and kept cool for 1 hour prior to use. The soil jar was then opened and 7 sub-samples were prepared by weighing out 5 grams of soil each and adding 10 mL of methanol for extraction.

²Sitelab's UVF-3100D analyzer (Serial No. 31-1053) was calibrated to a linear 5-point calibration curve using Sitelab EDRO Calibration kit, Product No. CAL-042, measured on the analyzer's Slot A optical filters.

³A second analyzer was used to measure the same samples for comparison (Serial No. 7-1831). Instrument was calibrated to a 1-point calibration curve using the same EDRO calibration kit. For maximum performance, manufacturer recommends using a 5-point calibration curve. To save time during the calibration process, however, the analyzer can be calibrated to 1-point (plus the blank), which yields test similar results when compared using the multi-point calibration feature.

TABLE 9-3

Method Detection Limit (MDL) study testing 7 replicate soils for Extractable Petroleum Hydrocarbons, EPH C11-C22 Aromatic Hydrocarbons (or Total PAHs), measuring samples containing low concentrations of home heating oil (No. 2 fuel oil).

Soil spiked with 5 ppm Home Heating Oil ¹	UVF-3100 - EPH 5-Point Calibration Curve ² Results in ppm (mg/Kg):	UVF-3100 - EPH 1-Point Calibration Curve ³ Results in ppm (mg/Kg):
<u>Sample ID:</u>		
EPH - 1	1.07	1.08
EPH - 2	1.08	1.06
EPH - 3	1.07	1.07
EPH - 4	1.07	1.06
EPH - 5	1.06	1.04
EPH - 6	1.09	1.08
EPH - 7	1.07	1.06
Standard Deviation: Std Dev x 3.143:	0.01 MDL = 0.03 ppm	0.01 MDL = 0.04 ppm

¹The same seven soil extracts used for EDRO analysis were re-tested and tested for this EPH MDL study. See Table 9-2 for details.

²Sitelab's UVF-3100D analyzer (Serial No. 31-1053) was calibrated to a linear 5-point calibration curve using Sitelab PAH Calibration kit, Product No. CAL-060, measured on the analyzer's Slot A optical filters.

³A second analyzer was used to measure the same samples for comparison (Serial No. 7-1831). Instrument was calibrated to a 1-point calibration curve using the same PAH calibration kit. For maximum performance, manufacturer recommends using a 5-point calibration curve. To save time during the calibration process, however, the analyzer can be calibrated to 1-point (plus the blank), which yields test results similar when compared using the multi-point calibration feature.

TABLE 9-4

Sitelab Method Detection Limit (MDL) study testing 7 replicate soils for Polycyclic Aromatic Hydrocarbons (Target PAHs), measuring samples containing low concentrations of coal tar from a former Manufactured Gas Plant using the UVF-3100 and TD-500 analyzers.

Soil spiked with 5 ppm MGP Coal Tar ¹	UVF-3100 - Target PAHs 5-Point Calibration Curve ² Results in ppm (mg/Kg):	UVF-3100 - Target PAHs 1-Point Calibration Curve ³ Results in ppm (mg/Kg):	TD-500 - PAHs ⁴ uses similar PAH Cal Kit Results in ppm (mg/Kg)
<u>Sample ID:</u>			
PAH - 1	0.464	0.564	0.270
PAH - 2	0.472	0.566	0.282
PAH - 3	0.464	0.558	0.282
PAH - 4	0.466	0.554	0.280
PAH - 5	0.476	0.580	0.292
PAH - 6	0.474	0.572	0.292
PAH - 7	0.492	0.588	0.298
Standard Deviation: Std Dev x 3.143:	0.01 MDL = 0.03 ppm	0.01 MDL = 0.04 ppm	0.01 MDL = 0.03 ppm

¹Soil sample was prepared by spiking 0.5 mL of a 500 ppm standard containing coal tar from a former MGP site contaminated by DNAPL (Raleigh, NC) and adding it to 50 grams of certified, clean sea sand. The sample was homogenized thoroughly and kept cool for 1 hour prior to use. The soil jar was then opened and 7 sub-samples were prepared by weighing out 5 grams of soil each and adding 10 mL of methanol for extraction.

²Sitelab's UVF-3100D analyzer (Serial No. 31-1053) was calibrated to a linear 5-point calibration curve using Sitelab PAH Calibration kit, Product No. CAL-060, measured on the analyzer's Slot D optical filters.

³A second analyzer was used to measure the same samples for comparison (Serial No. 7-1831). Instrument was calibrated to a 1-point calibration curve using the same PAH calibration kit. For maximum performance, manufacturer recommends using a 5-point calibration curve. To save time during the calibration process, however, the analyzer can be calibrated to 1-point (plus the blank), which yields test results slightly higher when compared using the multi-point calibration feature.

⁴Sitelab TD-500 analyzer was also used in this MDL study (Serial No. 550302). The analyzer is more sensitive to the heavier PAH compounds (4 and 5 rings) when compared to the UVF-3100 model. The instrument was calibrated to Sitelab CAL-061.

TABLE 9-5

Method Detection Limit (MDL) study testing 7 replicate soils for Total Petroleum Hydrocarbons in Oil (TPH-Oil), measuring samples containing low concentrations of crude oil using the UVF-3100 and TD-500 analyzers.

Soil spiked with 5 ppm Crude Oil ¹	UVF-3100 - TPH Oil 5-Point Calibration Curve ² Results in ppm (mg/Kg):	UVF-3100 - TPH Oil 1-Point Calibration Curve ³ Results in ppm (mg/Kg):	TD-500 - TPH Oil ⁴ uses similar TPH Cal Kit Results in ppm (mg/Kg)
<u>Sample ID:</u>			
TPH - 1	7.90	8.62	14.8
TPH - 2	7.96	8.68	15.0
TPH - 3	7.90	8.62	14.8
TPH - 4	8.10	8.82	15.2
TPH - 5	8.00	8.70	14.8
TPH - 6	8.36	9.12	15.8
TPH - 7	8.20	8.94	15.4
Standard Deviation: Std Dev x 3.143:	0.17 MDL = 0.54 ppm	0.19 MDL = 0.59 ppm	0.38 MDL = 1.20 ppm

¹Soil sample was prepared by spiking 0.5 mL of a 500 ppm standard containing crude oil from a refinery (Chevron Texaco, Richmond, CA) and adding it to 50 grams of certified, clean sea sand. The sample was homogenized thoroughly and kept cool for 1 hour prior to use. The soil jar was then opened and 7 sub-samples were prepared by weighing out 5 grams of soil each and adding 10 mL of methanol for extraction.

²Sitelab's UVF-3100D analyzer (Serial No. 31-1053) was calibrated to a linear 5-point calibration curve using Sitelab TPH-Oil Calibration kit, Product No. CAL-057, measured on the analyzer's Slot A optical filters.

³A second analyzer was used to measure the same samples for comparison (Serial No. 7-1831). Instrument was calibrated to a 1-point calibration curve using the same PAH calibration kit. For maximum performance, manufacturer recommends using a 5-point calibration curve. To save time during the calibration process, however, the analyzer can be calibrated to 1-point (plus the blank), which yields test results slightly higher when compared using the multi-point calibration feature.

⁴Sitelab TD-500 analyzer was also used in this MDL study (Serial No. 550302). The analyzer is more sensitive to the heavier PAH compounds (4 and 5 rings) when compared to the UVF-3100 model. The instrument was calibrated to Sitelab TPH-Oil calibration kit, Product No. CAL-056.