Shovel or Scalpel?
Modern Simulated Distillation, Updated TPH Fraction Methods & Improved Forensic Analysis Tools to Define Contamination and Remediate Effectively

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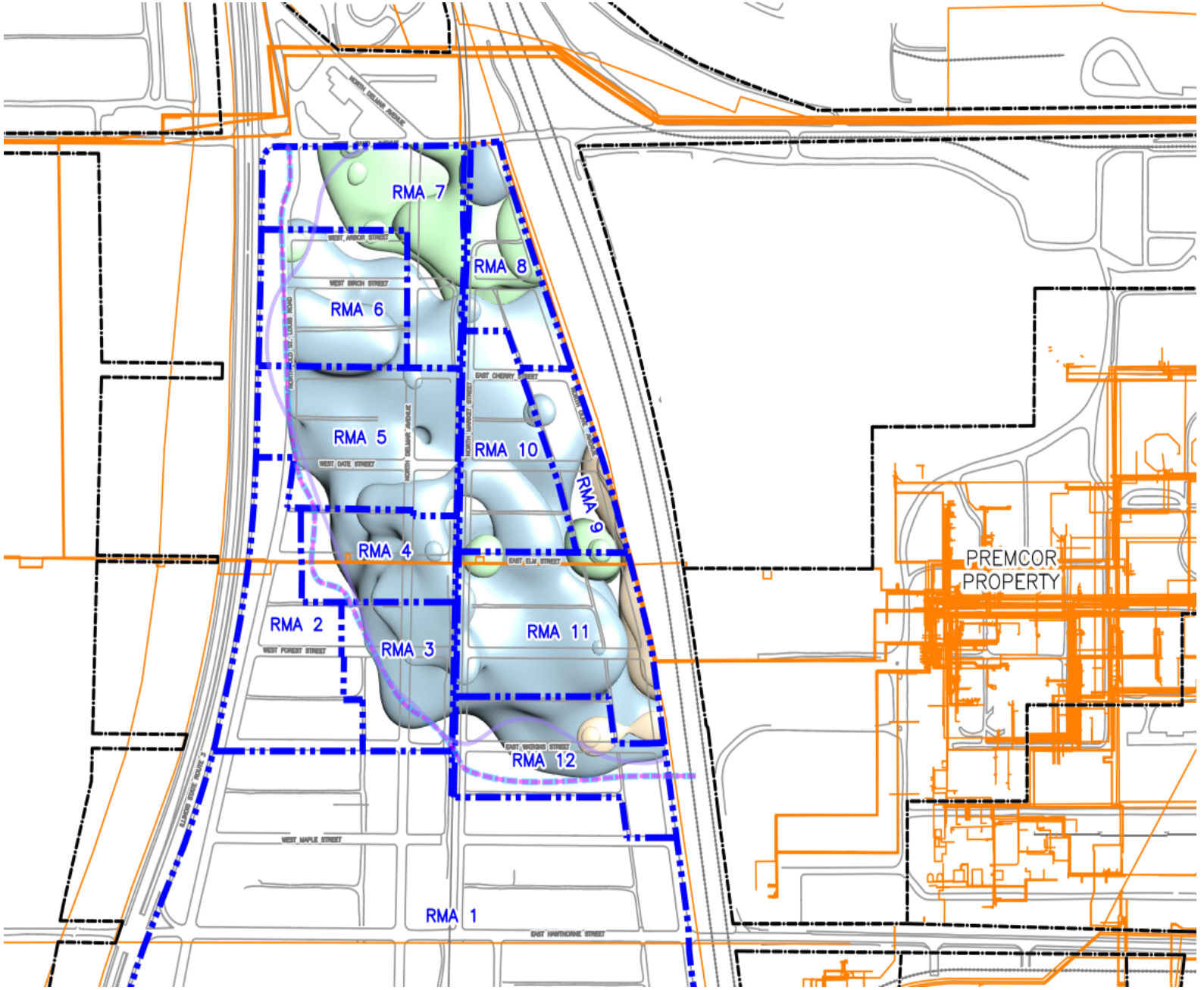
- Residential community surrounded by refinery infrastructure dating back to the early 1900s
- Three refineries to the east
- Bulk storage facility to the north
- River loading and unloading facilities to the west



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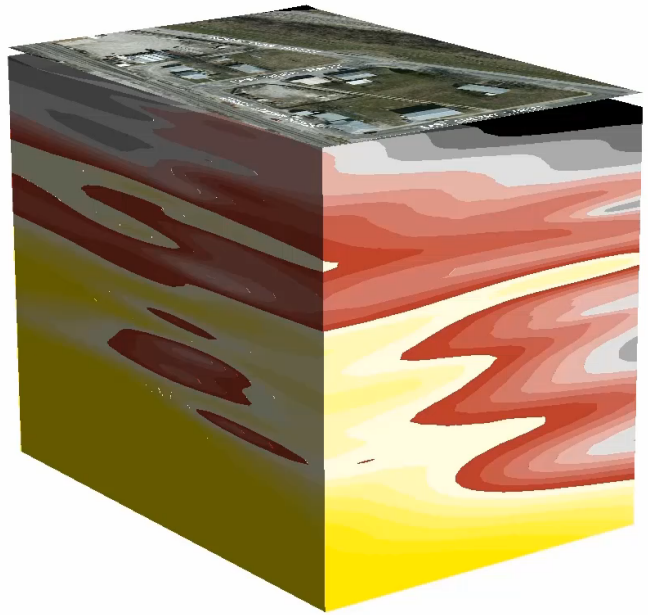
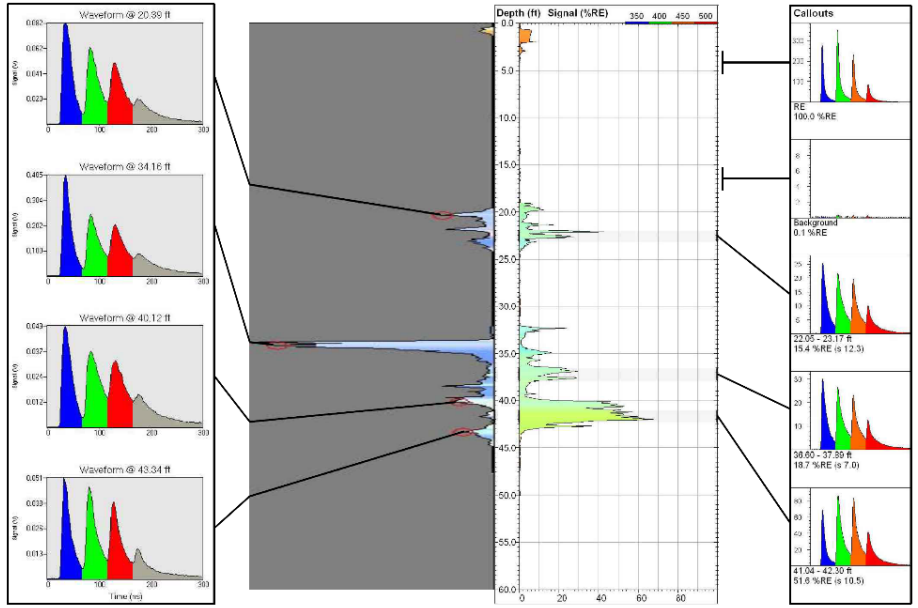
- Highly heterogeneous hydrogeologic setting within the upper 30 feet of the subsurface attributed to reworking of alluvial deposits from the Mississippi River
- Groundwater is present in shallow perched lenses of limited aerial and lateral extent
- Regionally extensive glacial sand deposits below 30 feet
- Nearly continuously saturated with the exception of extreme drought or low river stage conditions
- LNAPL smeared across the subsurface as a result of significant changes in the Mississippi River stage and groundwater elevations
- LNAPL currently resides at low saturations within the deeper glacial outwash deposits

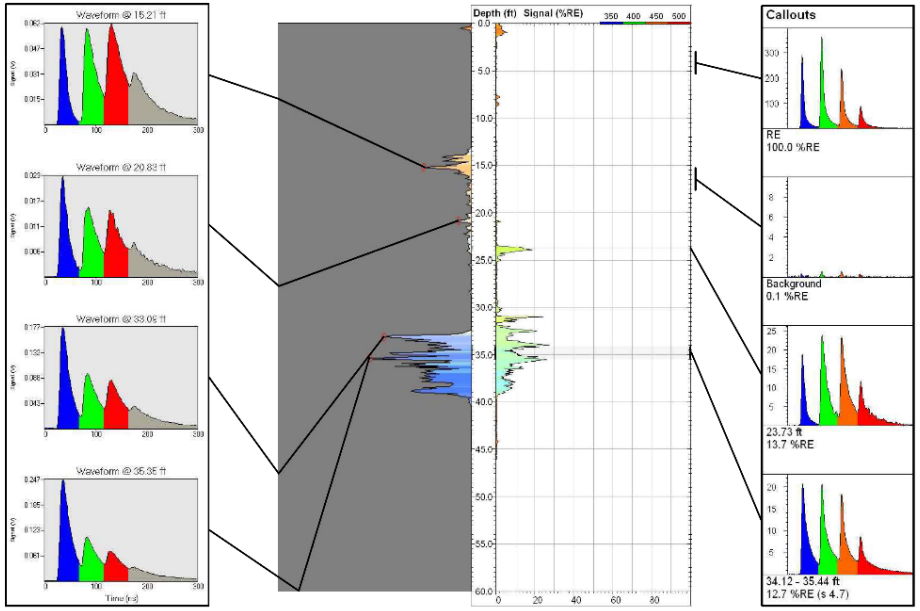


ALL SOIL TYPES



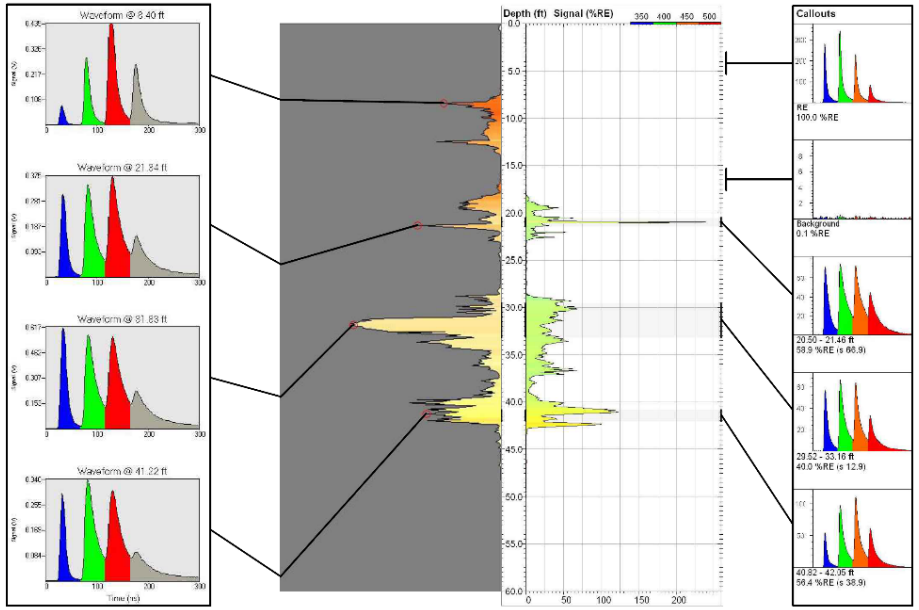
A HROST-039, JANUARY 2004
MIRRORED AND SCALED TO B

B HUVOST-039, SEPTEMBER 2013
SCALE AS SHOWN



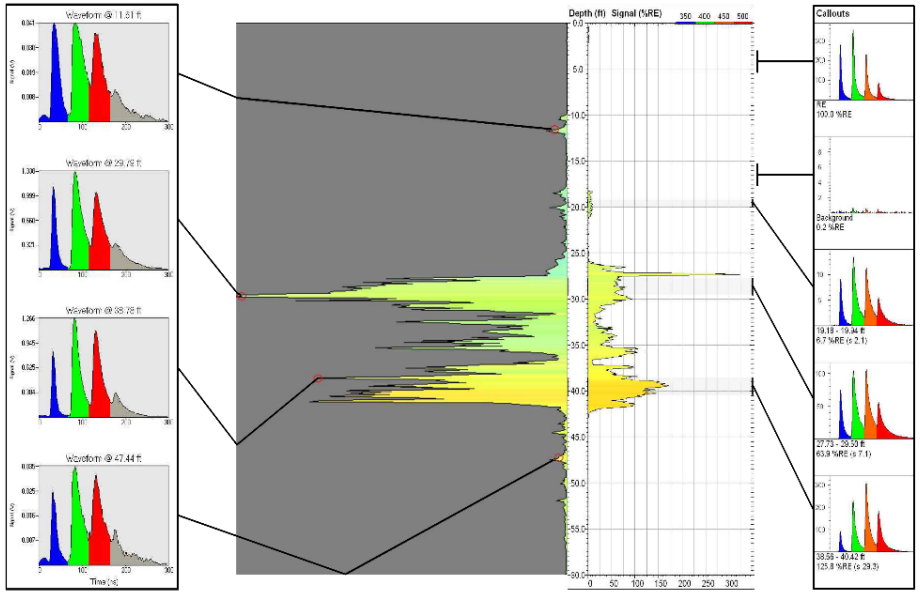
A HROST-052, JANUARY 2004
MIRRORED AND SCALED TO B

B HUVOST-052, SEPTEMBER 2013
SCALE AS SHOWN



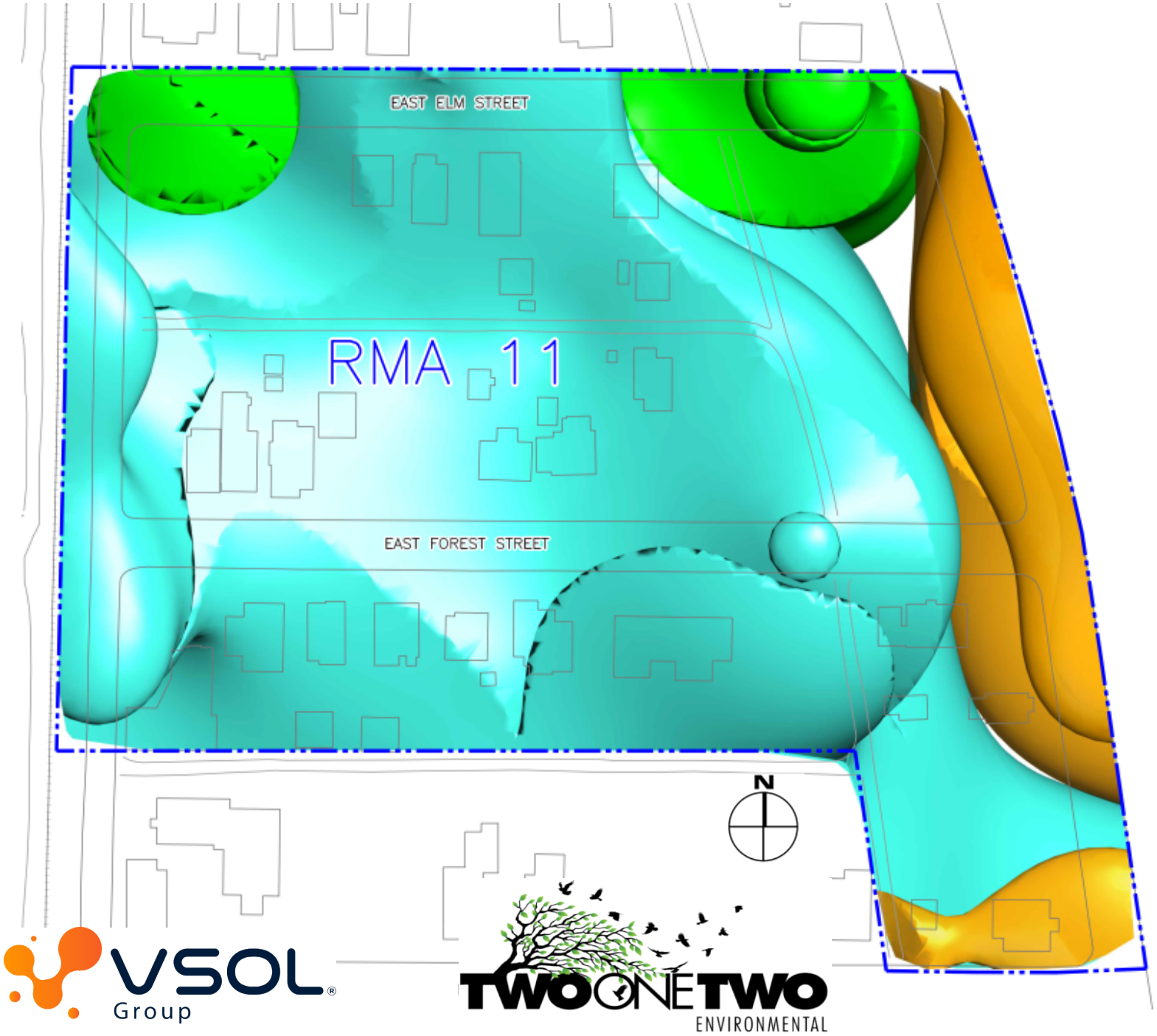
A HROST-040, JANUARY 2004
MIRRORED AND SCALED TO B

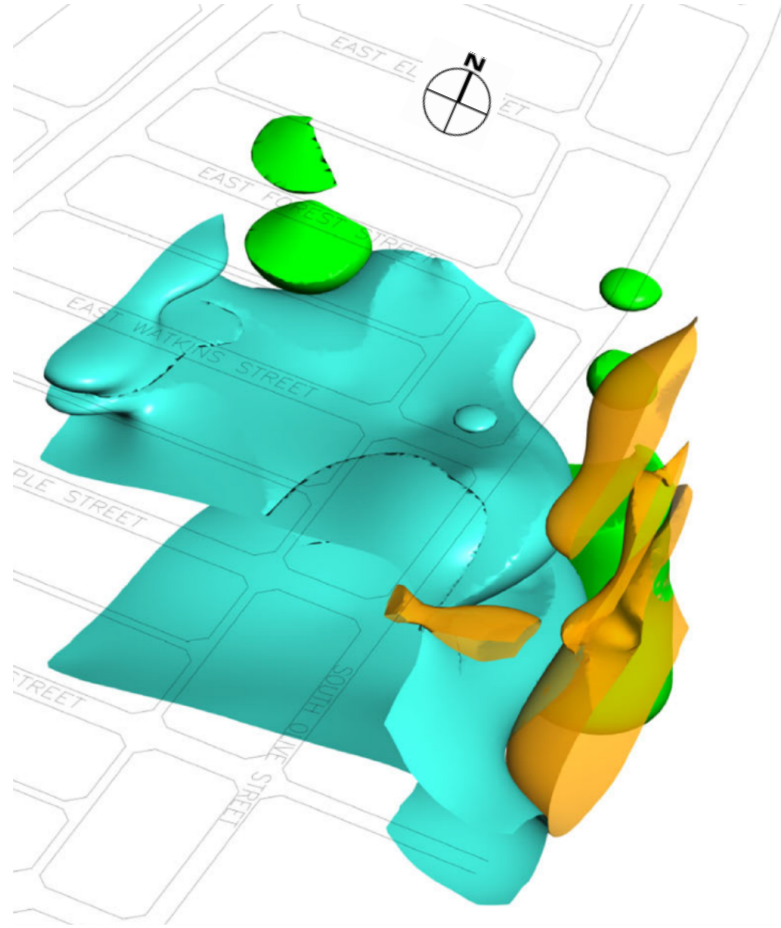
B HUVOST-040, SEPTEMBER 2013
SCALE AS SHOWN



A HROST-113, JUNE 2005
MIRRORED AND SCALED TO B

B HUVOST-113, SEPTEMBER 2013
SCALE AS SHOWN





LIGHT-RANGE LNAPL

MID-RANGE LNAPL

HEAVY-RANGE LNAPL

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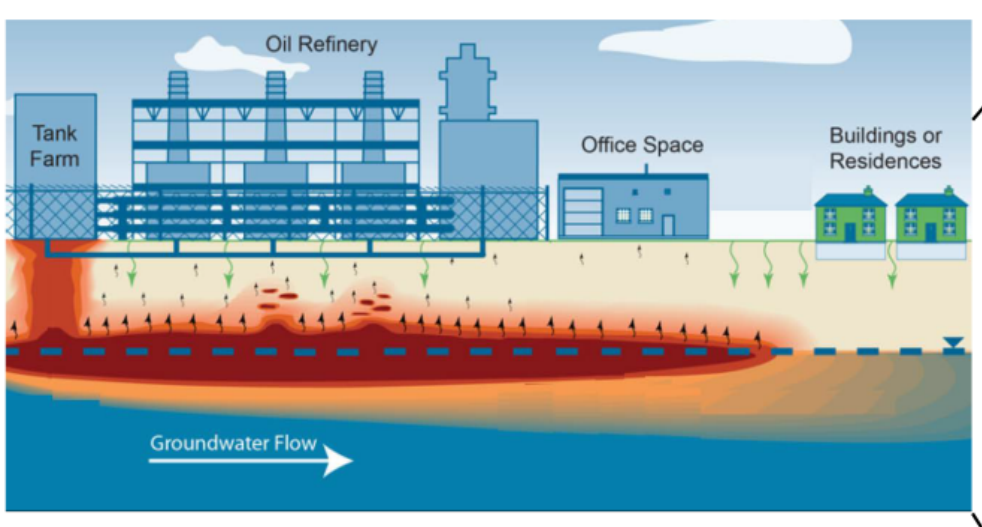
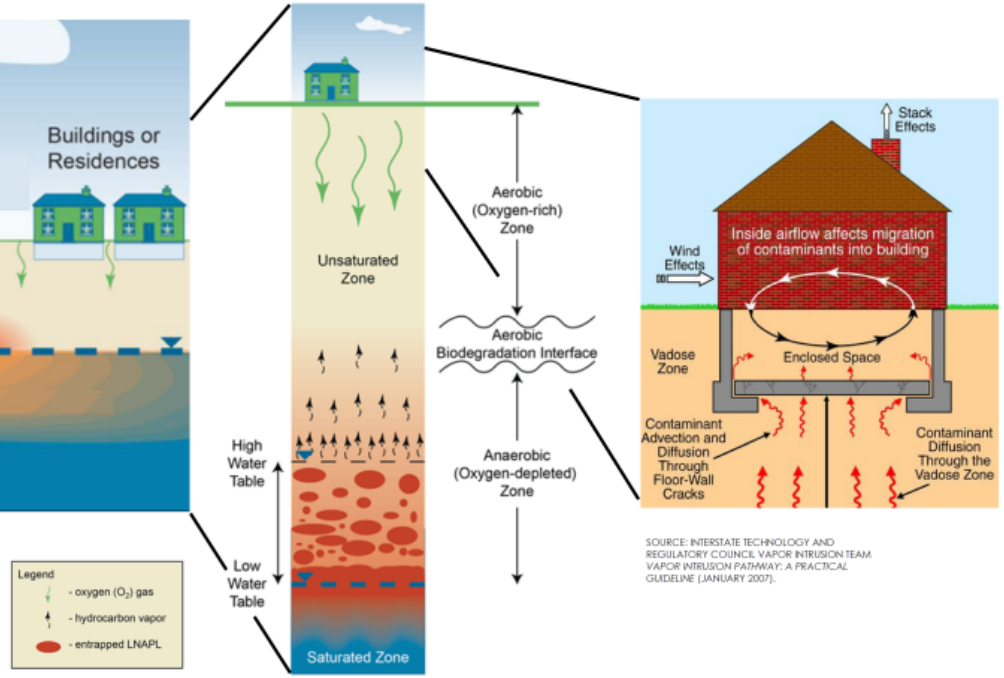


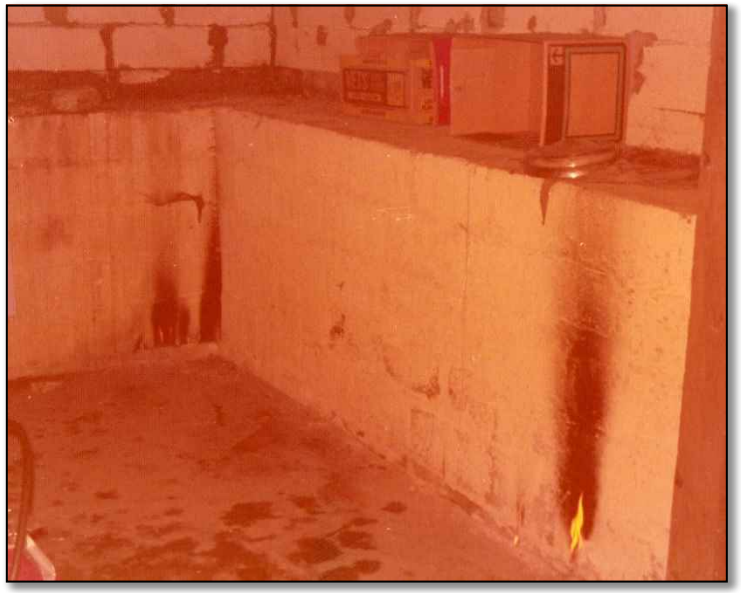
SOURCE: INTERSTATE TECHNOLOGY AND REGULATORY COUNCIL VAPOR INTRUSION TEAM, *PETROLEUM VAPOR INTRUSION PATHWAY FUNDAMENTALS OF SCREENING, INVESTIGATION, AND MANAGEMENT* (OCTOBER 2014).

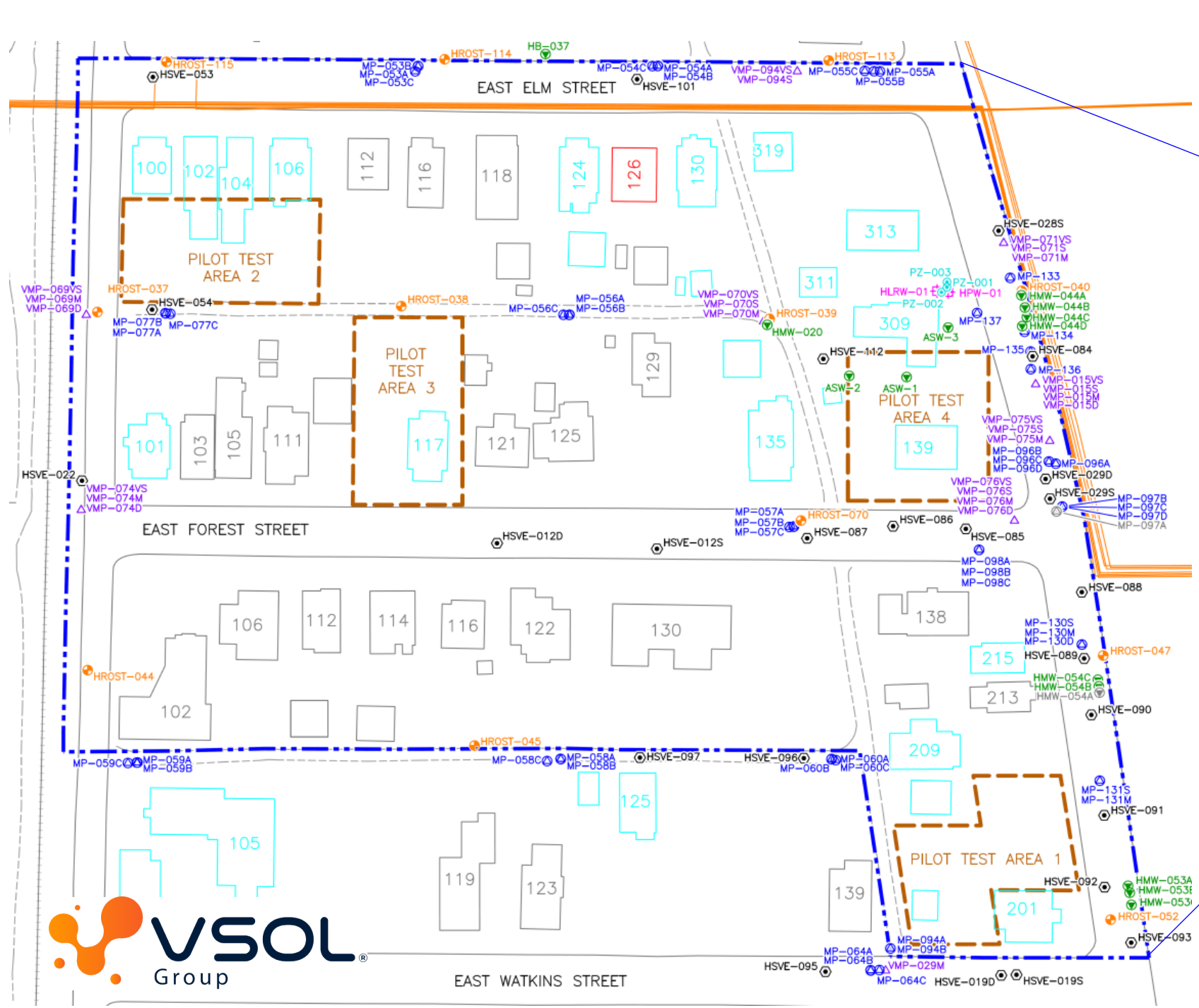


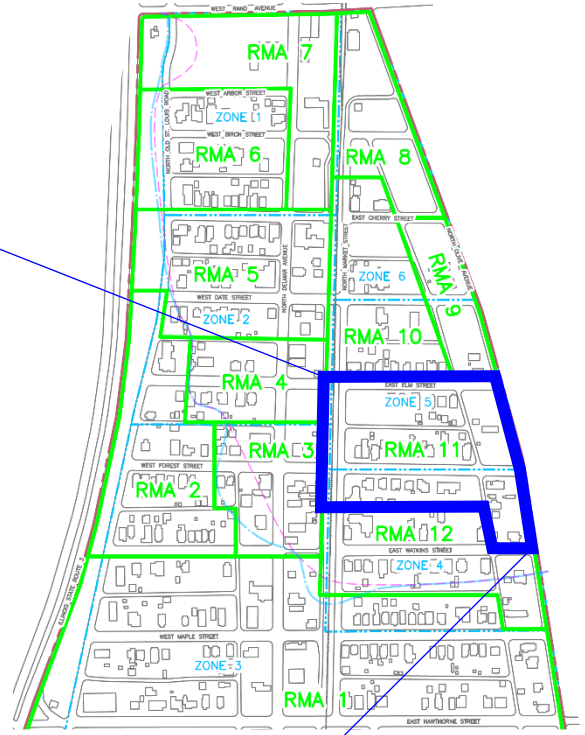
SOURCE: INTERSTATE TECHNOLOGY AND REGULATORY COUNCIL VAPOR INTRUSION TEAM, *PETROLEUM VAPOR INTRUSION PATHWAY FUNDAMENTALS OF SCREENING, INVESTIGATION, AND MANAGEMENT* (OCTOBER 2014).

SOURCE: INTERSTATE TECHNOLOGY AND REGULATORY COUNCIL VAPOR INTRUSION TEAM *VAPOR INTRUSION PATHWAY: A PRACTICAL GUIDELINE* (JANUARY 2007).

- First reported odor complaint in May 1966
- 363 odor complaints occurred since 1966
- More than 25 reported fires occurring along basement walls and floors







EXPLANATION

- STRUCTURE
- DEMOLISHED STRUCTURE
- REMEDIATION MANAGEMENT AREA
- NORTH OLIVE EXTENT
- RAND EXTENT
- MP-053C — HIGH VACUUM RECOVERY LOCATION
- HMW-020 — HIGH VACUUM RECOVERY AND MANUAL LNAPL SKIMMING LOCATION
- MPE-A001 — MULTI-PHASE, DUAL-PHASE AND VAPOR EXTRACTION LOCATION
- HPW-01 — FOCUSED PUMPING DUAL-PHASE EXTRACTION LOCATION

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- Multiple LNAPL types observed both vertically and spatially
- $100 Million dollars spent on mitigation measures, interim corrective action, and pilot testing activities
- Property has little intrinsic value
- Short-term remedial objectives for the final corrective action
  - Reduce mass of LNAPL
  - Alter chemical makeup of the LNAPL
  - Eliminate vapor intrusion pathway

- Simulated Distillation analysis offers means of measuring changes in mass and chemistry of the LNAPL source zone during pilot testing of selected technologies
- Long-term remedial objectives including restoration of groundwater to be achieved via natural source zone depletion

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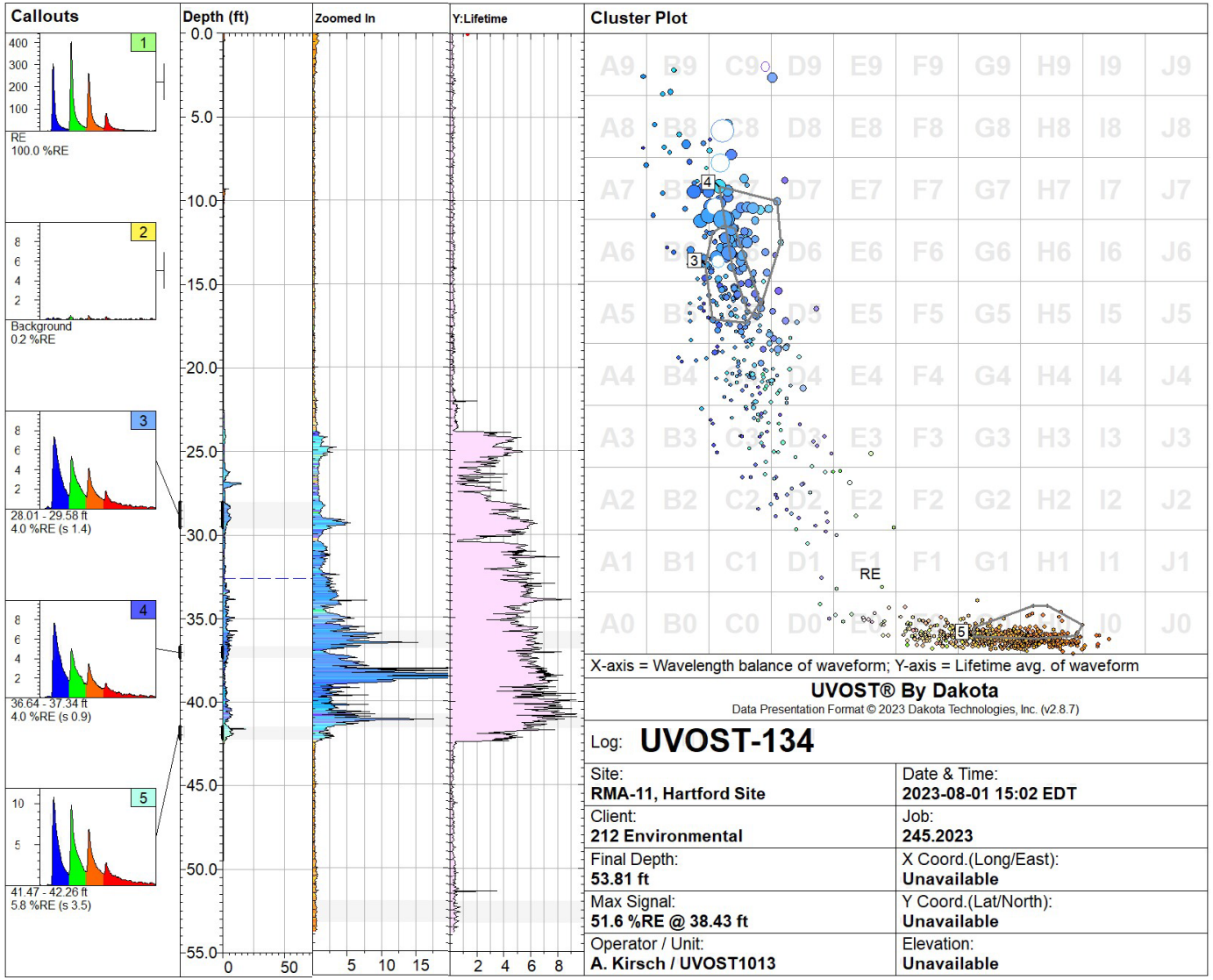

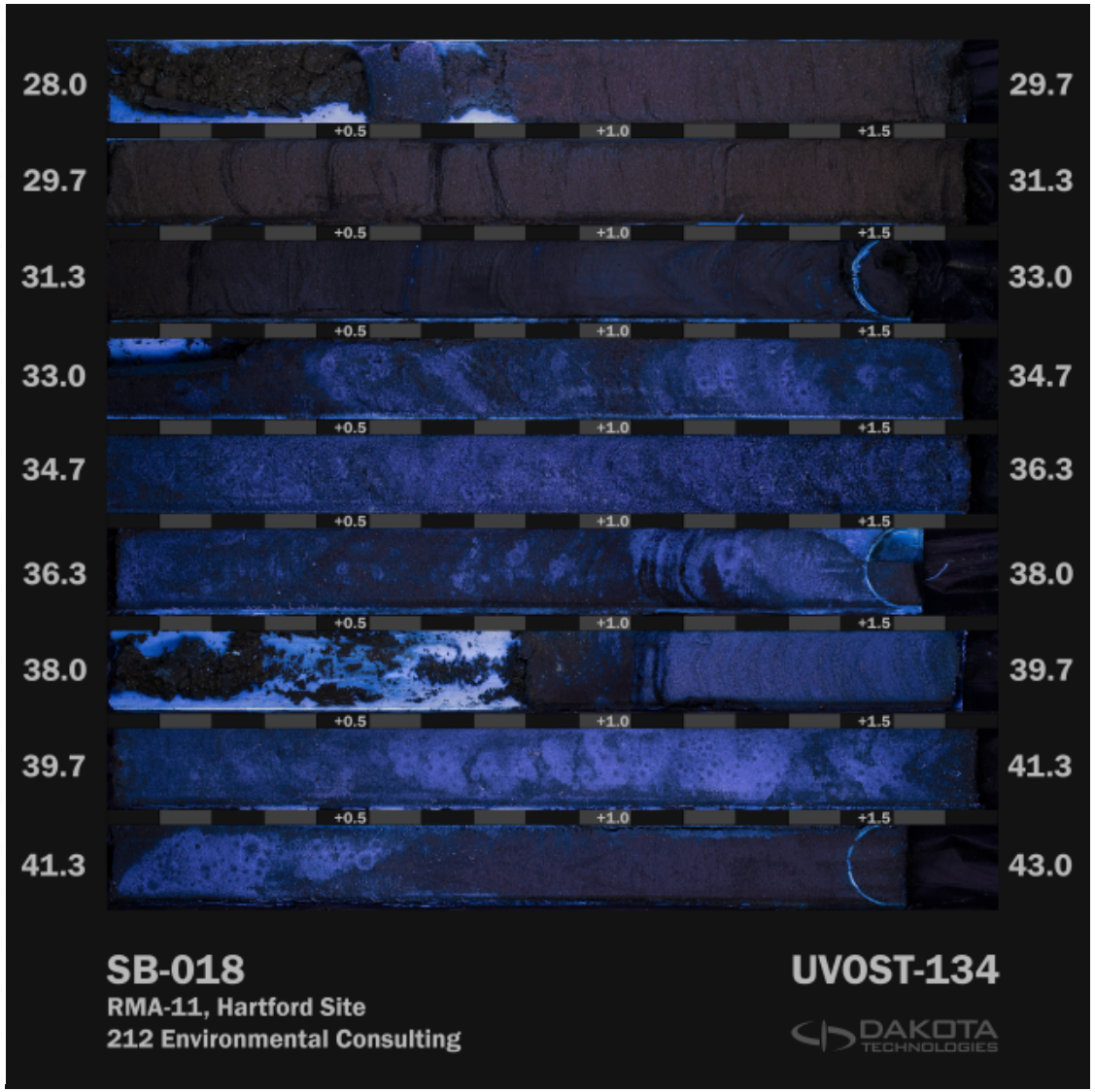

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TWOONETWO ENVIRONMENTAL

Analysis of Petroleum Hydrocarbons in Environmental Media, Volume 1, 1998

MADEP-EPH-04. Method for the determination of extractable petroleum hydrocarbons, May 2004 revision 1.1

ISO/TS 16558-2:2015 Soil quality - Risk-based petroleum hydrocarbons - Part 2: Determination of aliphatic and aromatic fractions of semi-volatile petroleum hydrocarbons using gas chromatography with flame ionization detection (GC/FID).

Performance standard for laboratories undertaking chemical testing of soil, version 4, March 2012

TCEQ Method 1005 TOTAL PETROLEUM HYDROCARBONS TNRCC Method 1005 rev. 3 June 1, 2001

ALL TPH RESULTS ARE NOT CREATED EQUAL

TPH analysis typically measures the concentration of hydrocarbons derived from petroleum sources

- Analytical method
- Calibration standards
- Target range of hydrocarbons varies
- TPH definition quantified can be different between environmental guidelines and Agencies

Carbon Range	Gasolines [1]	Diesel [1]	Residual Fuels [2]
C5-C8 aliphatics	45%	<1%	<1%
C9-C18 aliphatics	12%	35%	<1%
C19+ aliphatics	<1%	43%	75%
C9-C12+ aromatics	43%	22%	25%

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Current EPH TPH Categories (RSL User's Guide)

TPH Fractions	Carbon Range	Equivalent Carbon Number Index	Representative Compound (RfD/RfC)	Representative Compound (Chemical Parameter)
Aliphatic (Low)	C5-C8	EC5 – EC8	Cyclohexane/n-heptane/n-hexane	Average of cyclohexane, n-heptane, n-hexane
Aliphatic (Mid)	C9-C18	EC>8 – EC16	Midrange aliphatic hydrocarbon steams	n-nonane
Aliphatic (High)	C19-C32	EC>16 – EC35	White mineral oil	White mineral oil
Aromatic (Low)	C6-C8	EC6 – EC<9	Benzene	Benzene
Aromatic (Mid)	C9-C10	EC9 – EC<11	1,3,5-Trimethybenzene 1,2,4-Trimethylbenzene and 1,2,3 - Trimethylbenzene	Average - 1,3,5-Trimethybenzene 1,2,4-Trimethylbenzene and 1,2,3 - Trimethylbenzene
Aromatic (High)	C10-C32	EC>11 – EC35	Benzo(a)pyrene	Benzo(a)pyrene

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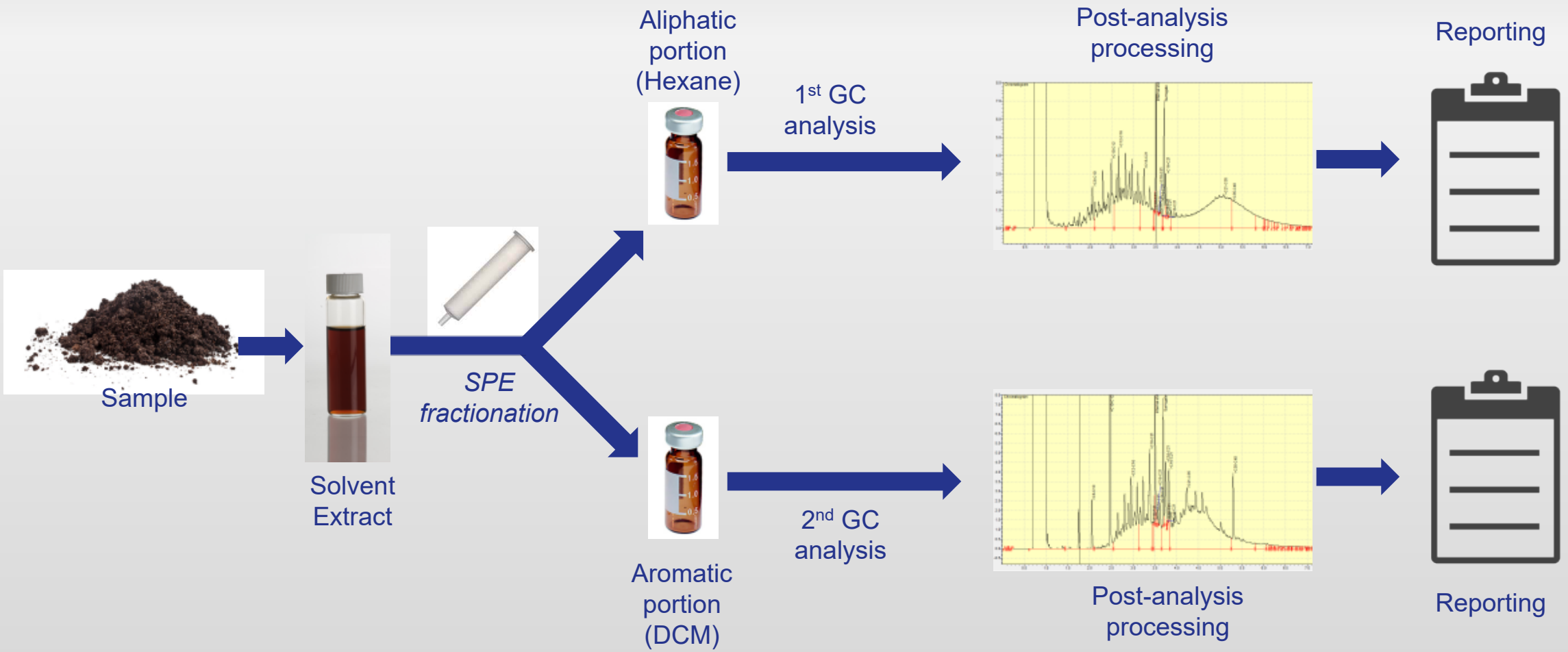
Extractable Petroleum Hydrocarbons

The Traditional Method



A new method …

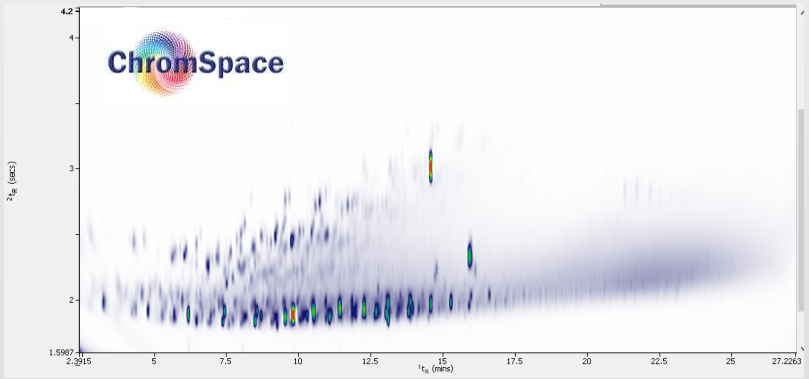
…using GC×GC-FID

- Chromatographic separation of aliphatic and aromatic hydrocarbons in a single run, reducing processing time

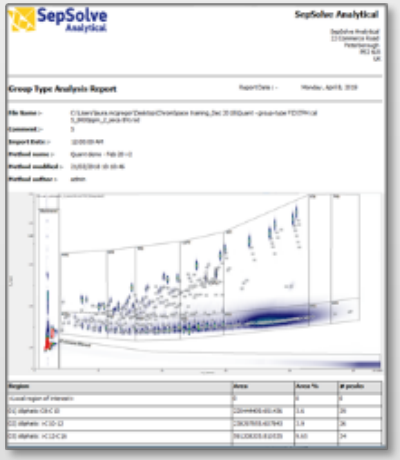
Sample

Traditional solvent extract

Single transfer

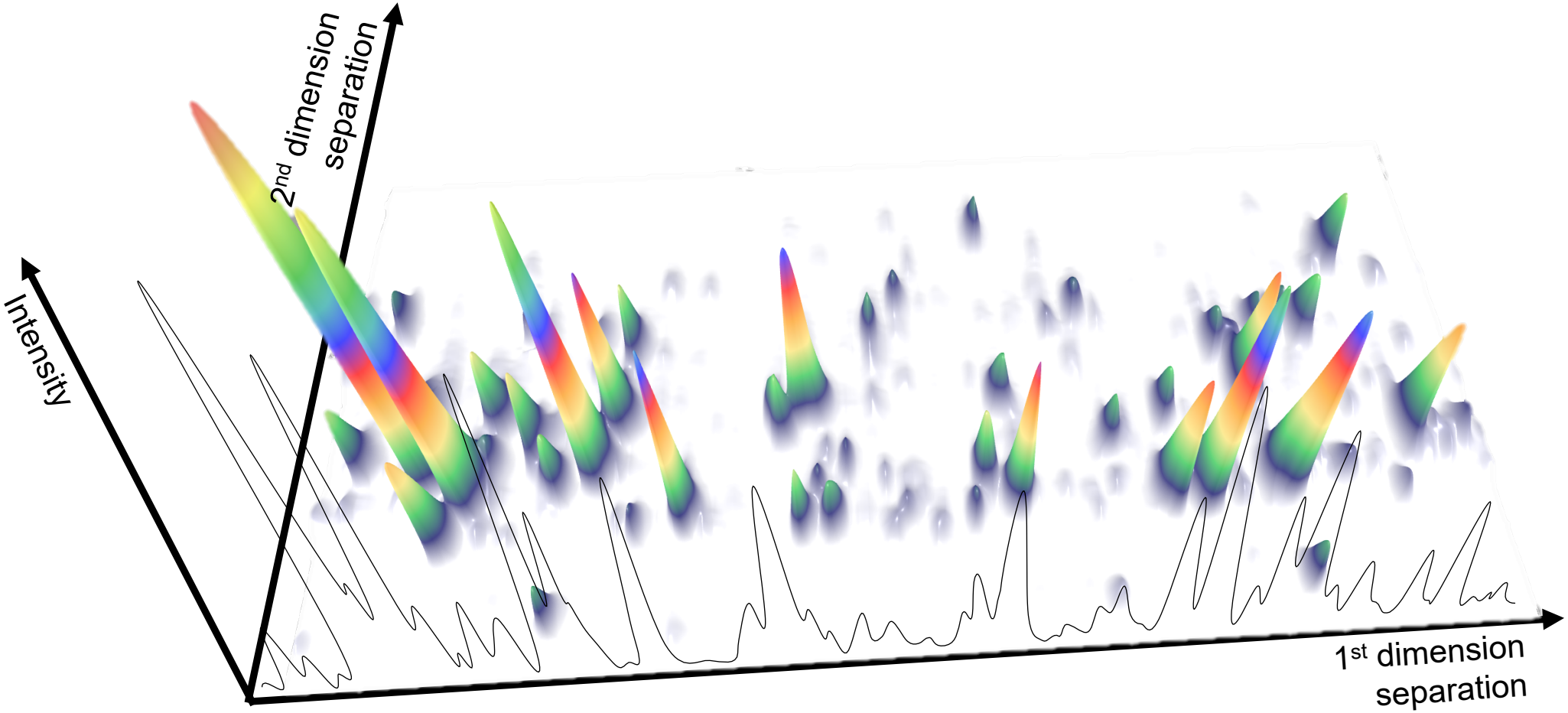


Single analysis AND automated real-time data processing

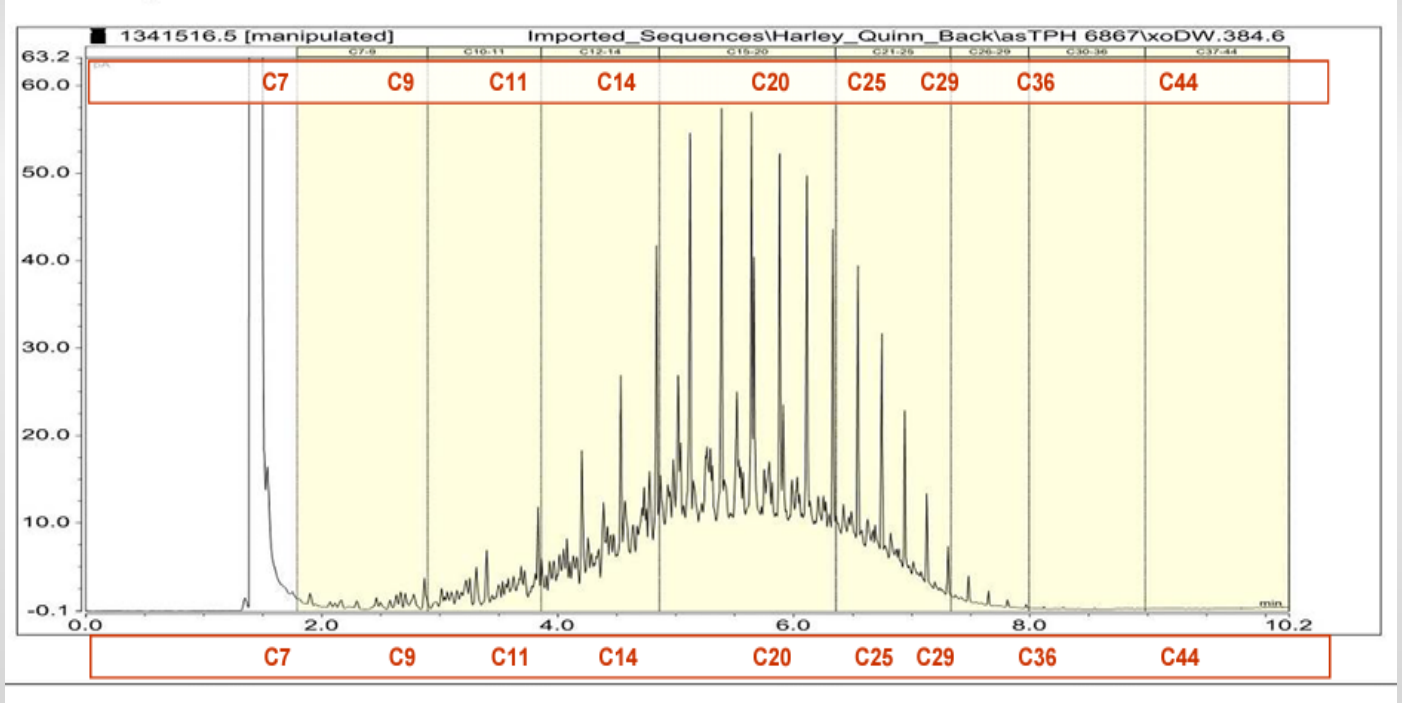


Reporting

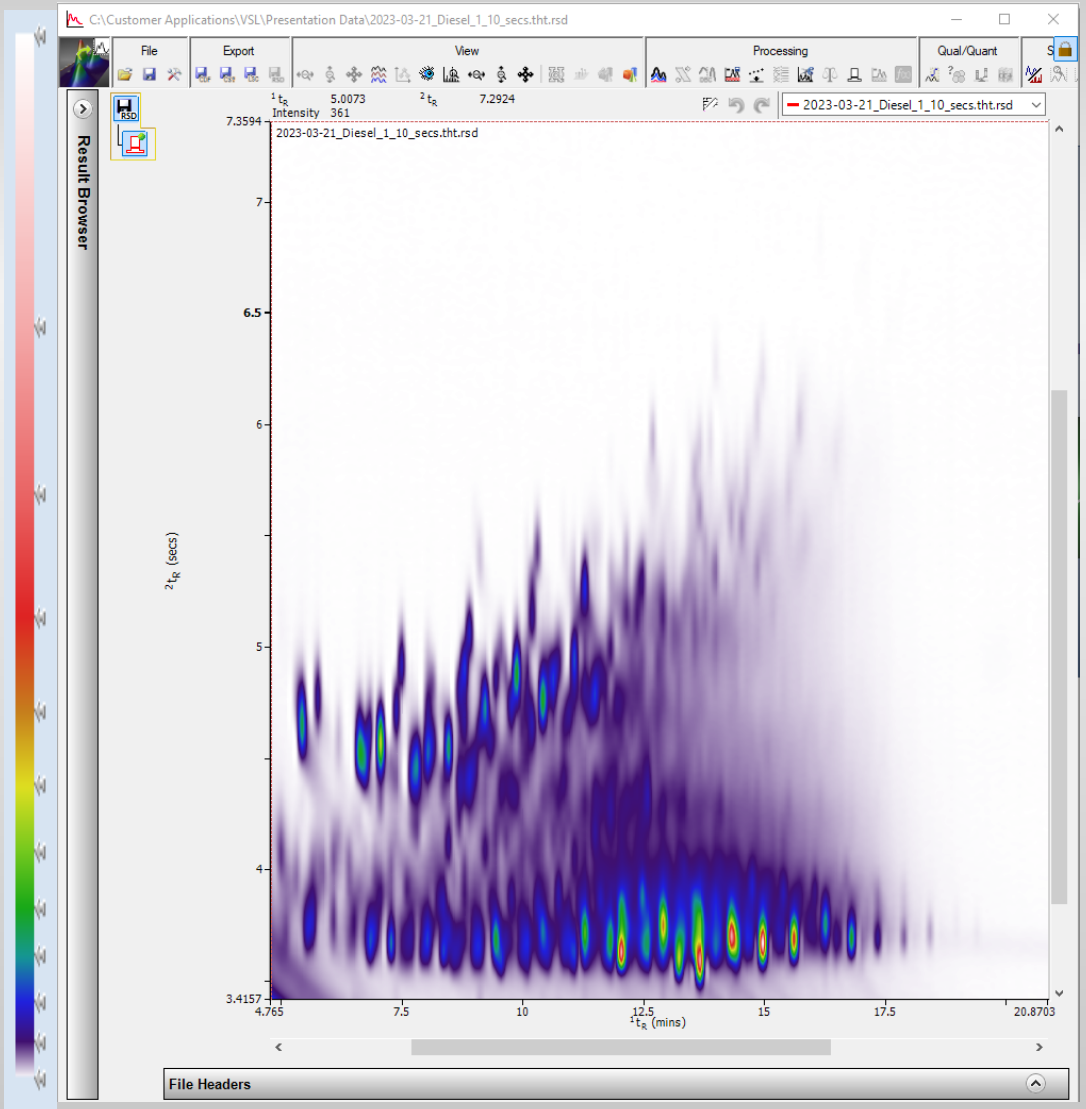
GC x GC - FID Simulated Distillation Analysis



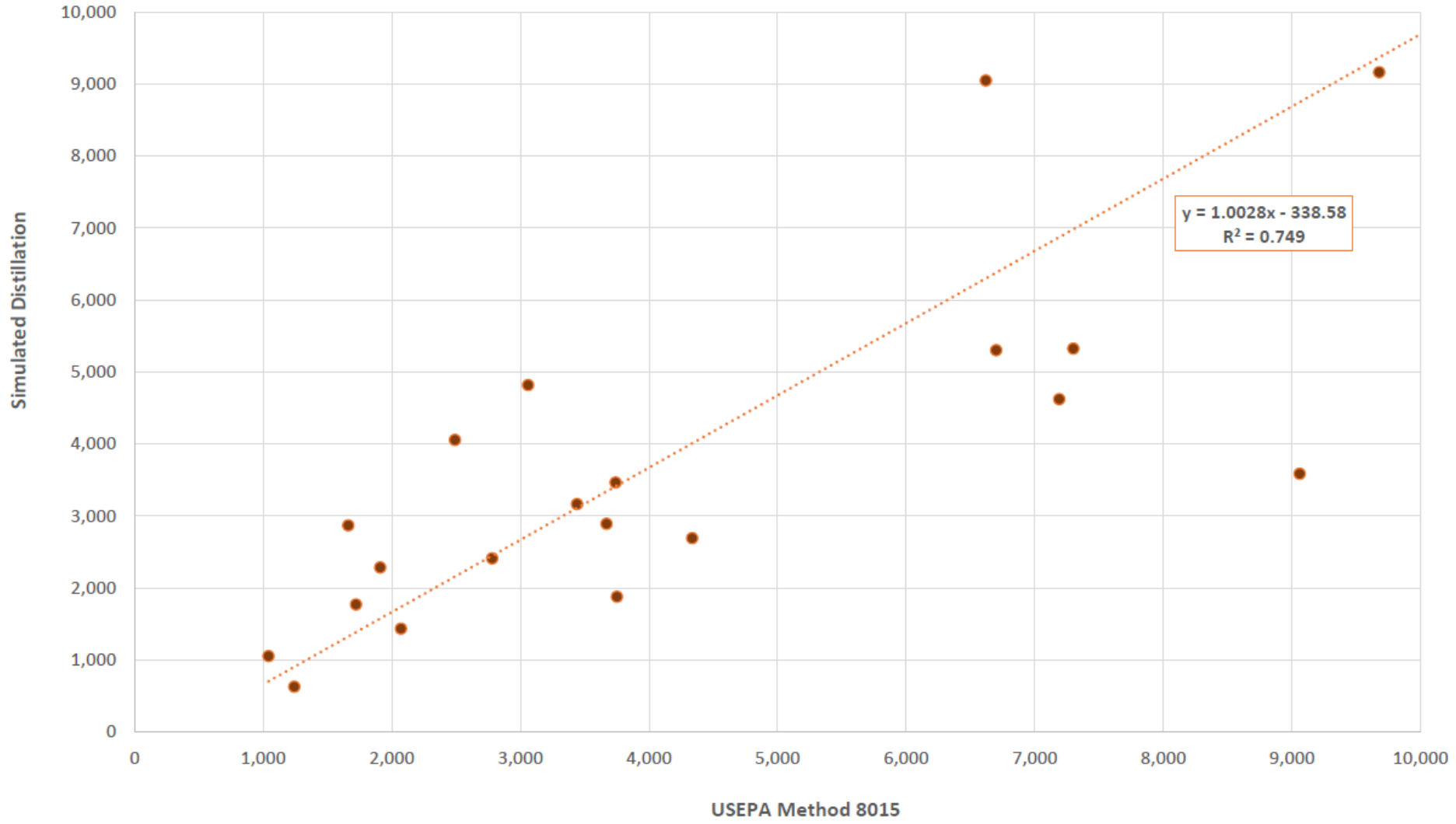
Traditional TPH Analysis – Diesel



Updated 2D Analysis –Diesel



- 24 samples submitted for comparative analysis of total petroleum and simulated distillation results
- Strong correlation between the two methods summing up the total petroleum hydrocarbon concentrations



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AROMATICS

Region	Result (%Volume)	Reporting Limit (%Volume)
C8	0.24	0.050
C9	7.09	0.050
C10	14.7	0.050
C11	12.79	0.050
C12	10.4	0.050
C13	6.84	0.050
C14	1.37	0.050
C15	0.24	0.050
C16	ND	0.050
C17	ND	0.050
C18	ND	0.050
C19	0.07	0.050
C20	0.14	0.050
C21	ND	0.050
C22	0.09	0.050
C23-C24	0.67	0.050
C25-C26	ND	0.050
C27-C28	ND	0.050
C29-C31	ND	0.050
C32-C34	ND	0.050
C35-C37	ND	0.050
C38-C40	ND	0.050

ALIPHATICS

Region	Result (%Volume)	Reporting Limit (%Volume)
C8	3.5	0.050
C9	9.2	0.050
C10	11	0.050
C11	8.8	0.050
C12	6.5	0.050
C13	3.2	0.050
C14	1.1	0.050
C15	0.36	0.050
C16	0.15	0.050
C17	0.10	0.050
C18	0.070	0.050
C19	ND	0.050
C20	ND	0.050
C21	ND	0.050
C22	ND	0.050
C23-C24	0.18	0.050
C25-C26	ND	0.050
C27-C28	ND	0.050
C29-C31	0.077	0.050
C32-C34	0.22	0.050
C35-C37	0.083	0.050
C38-C40	ND	0.050

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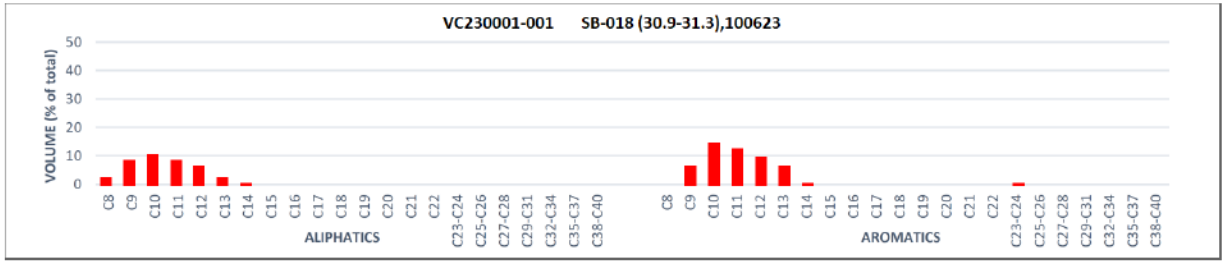
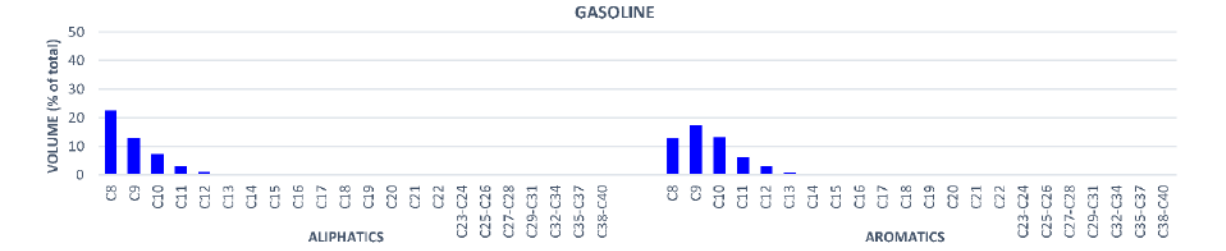
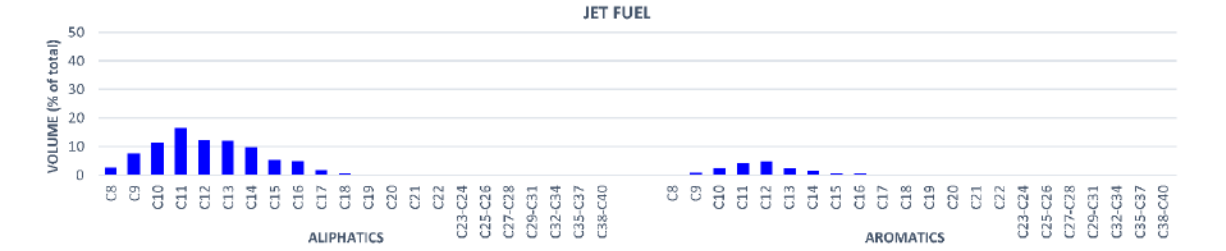
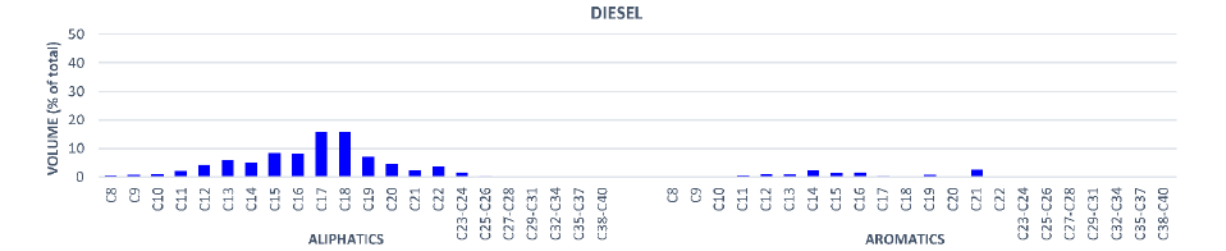
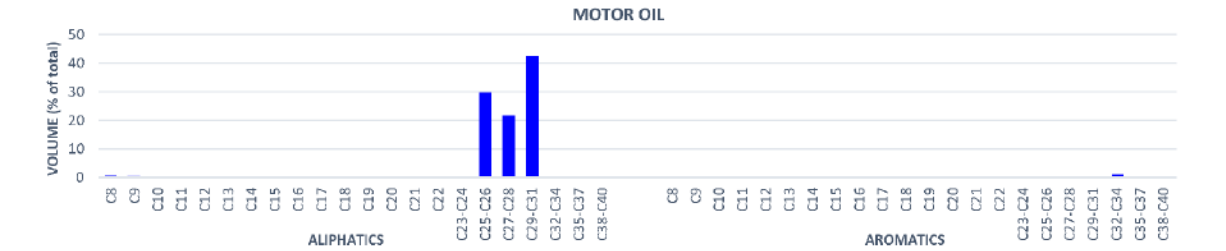
COMPARISON GRAPHS



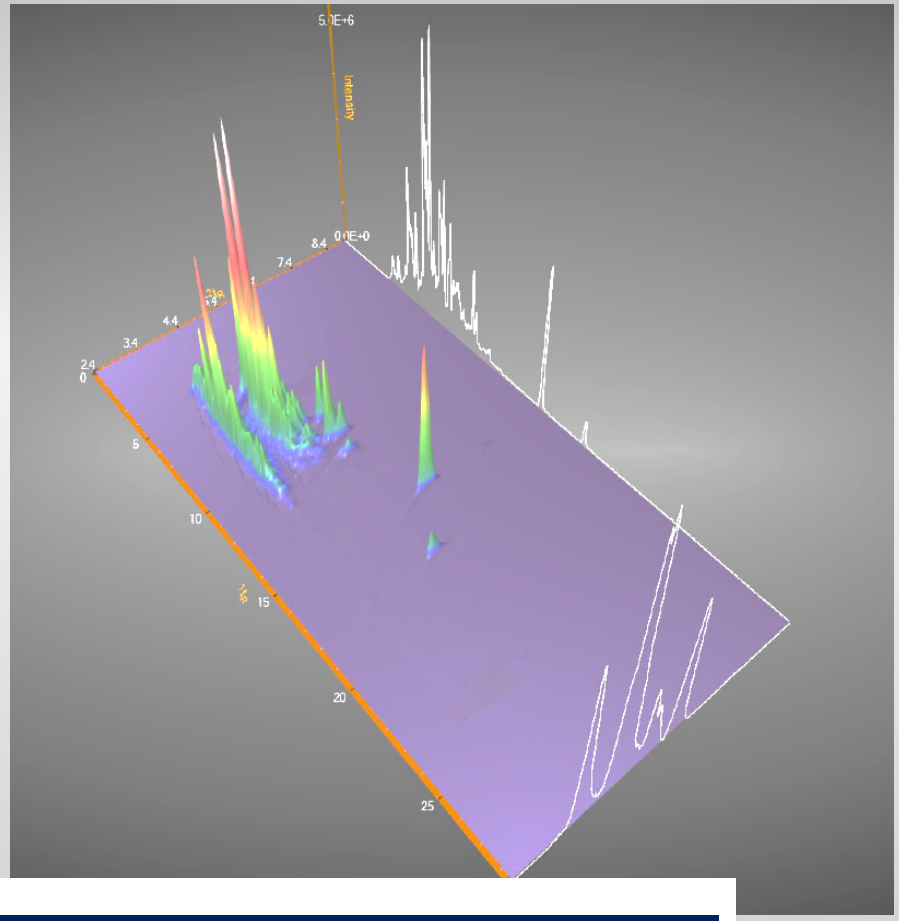






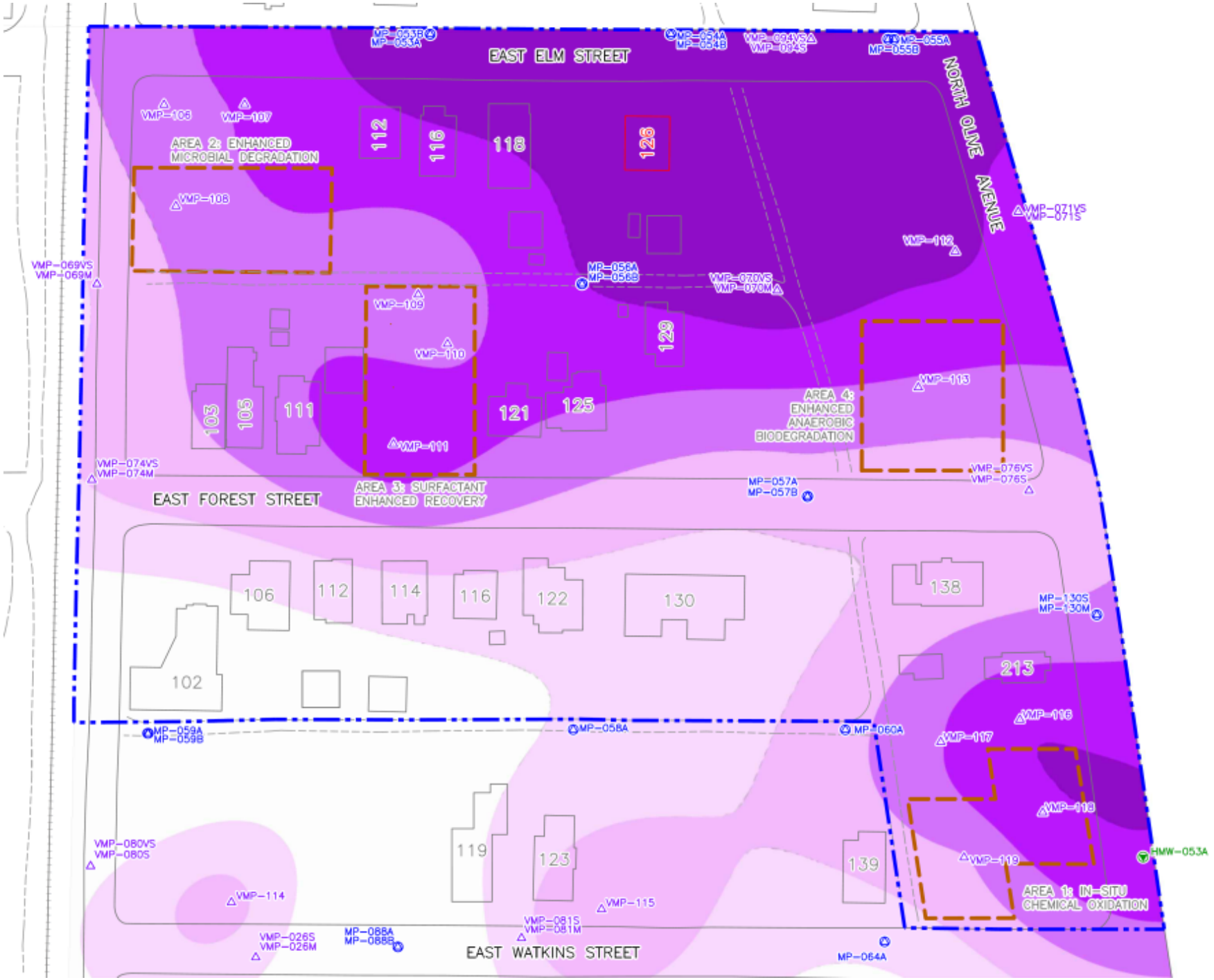


Updated 1D and 2D Compositional Patterns



SB-018 (30.9-31.3)	
Total Aromatic (54%) mg/kg	1,291
Total Aliphatic (46%) mg/kg	1,108
Total Hydrocarbon Concentration (mg/kg)	2,400
LNAPL Saturation	2.4%
Water Content	70%
Gas Content	28%
Porosity	43

- Frozen soil cores will be collected and analyzed from each of the pilot test areas and background locations
  - 90- and 180-days following completion of implementation
- Define the efficacy of each treatment technology
  - LNAPL saturation
  - Source zone chemistry
- Compare to vapor phase monitoring results
- Define cost-effective remedial approach(es) for implementation across remaining portions of the Site



Contact Us With Questions

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