



Investigation of Polar and Non-polar Material in the Groundwater of Raudhatain and Umm Al-Aish Fresh Groundwater Fields of Kuwait

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Overview

- Introduction
- Objectives
- Methodology
- Results
- Conclusions

Introduction

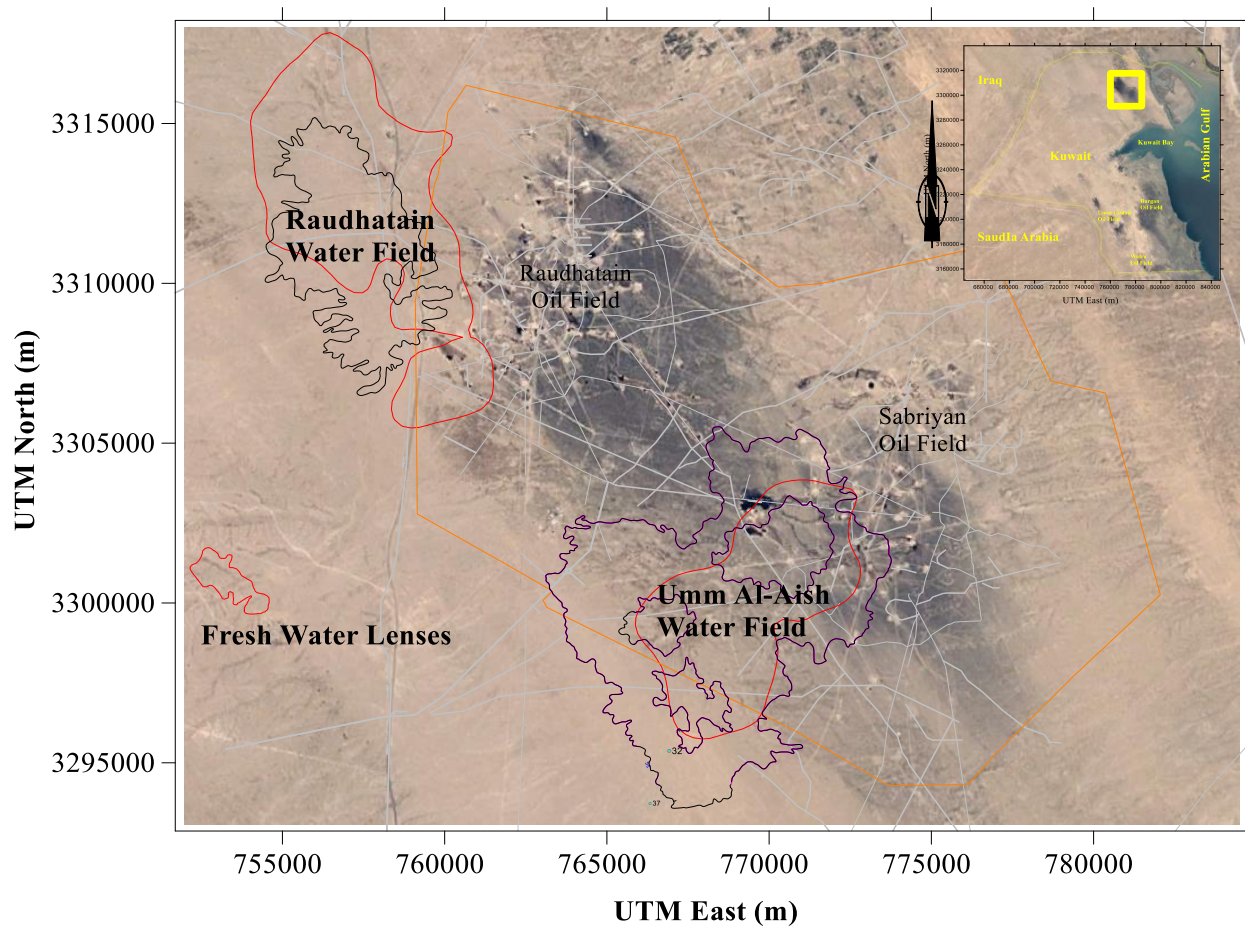
- 1991 Gulf war brought disaster to land, air and sea environments of Kuwait.
- Out of 935 oil wells in different oil fields 751 were damaged due to their detonation.



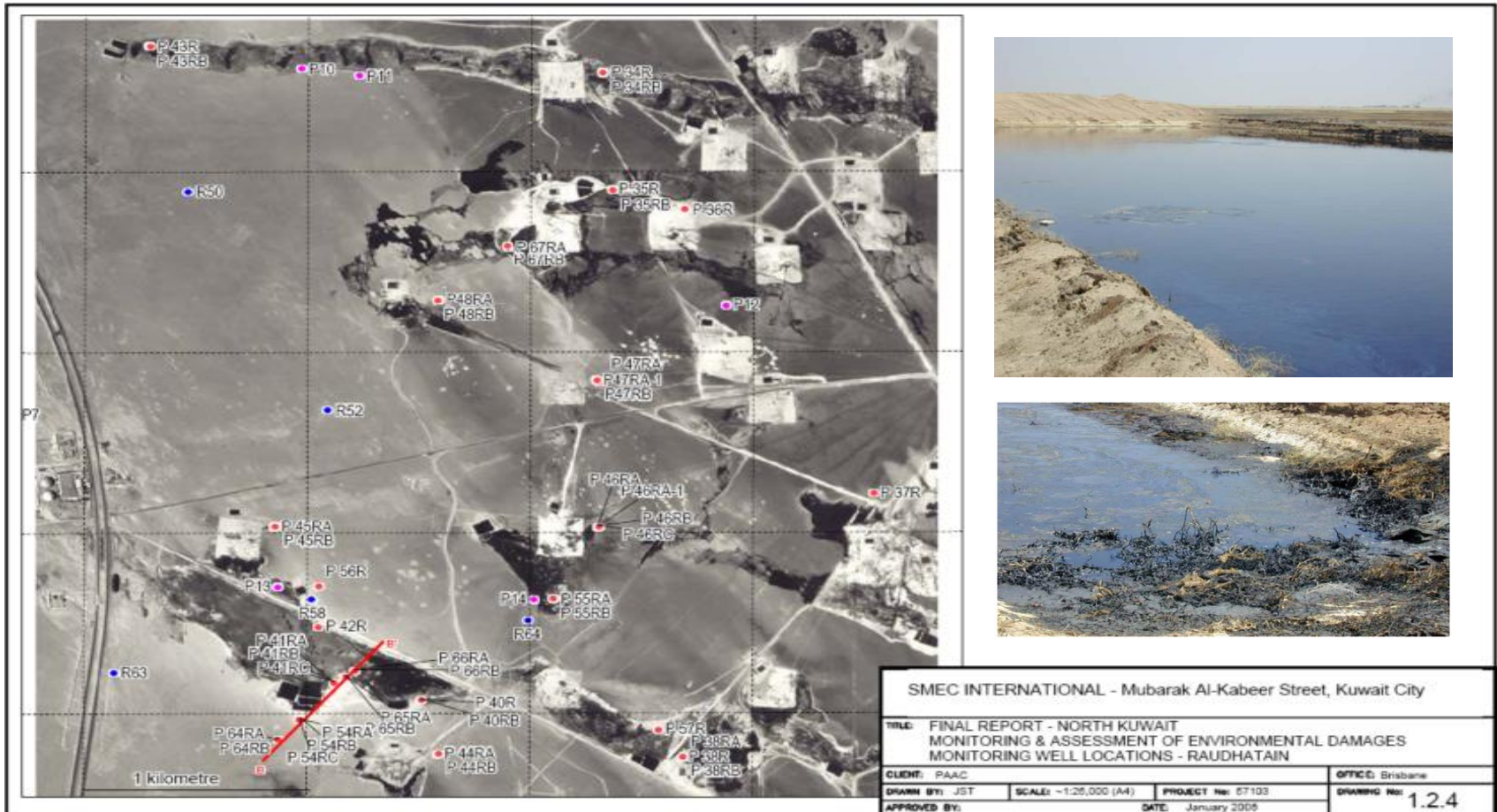
Oil wells on fire in oil field

Introduction

- 101 oil wells in Raudhatain and Sabriya oil fields

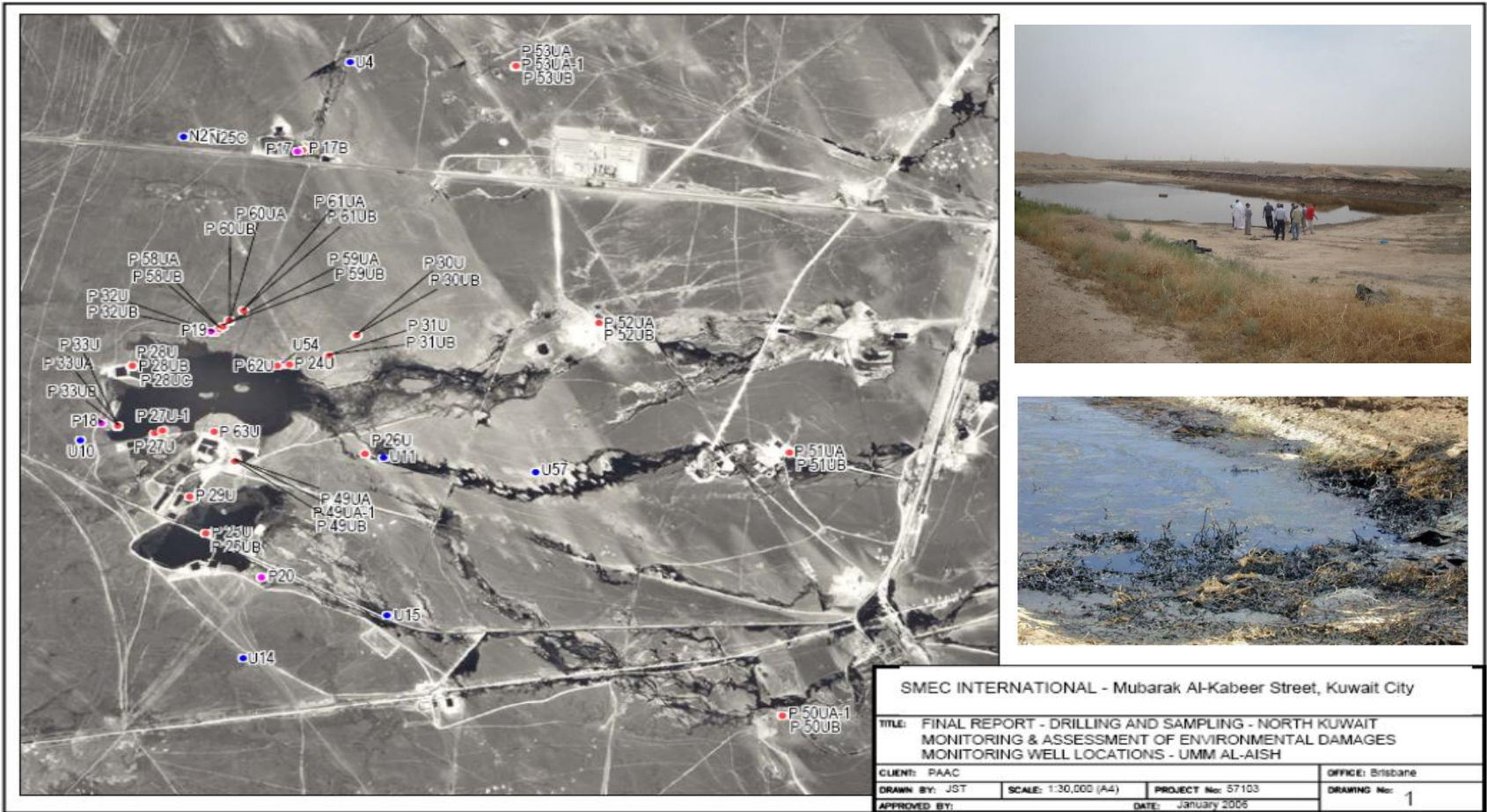


Introduction



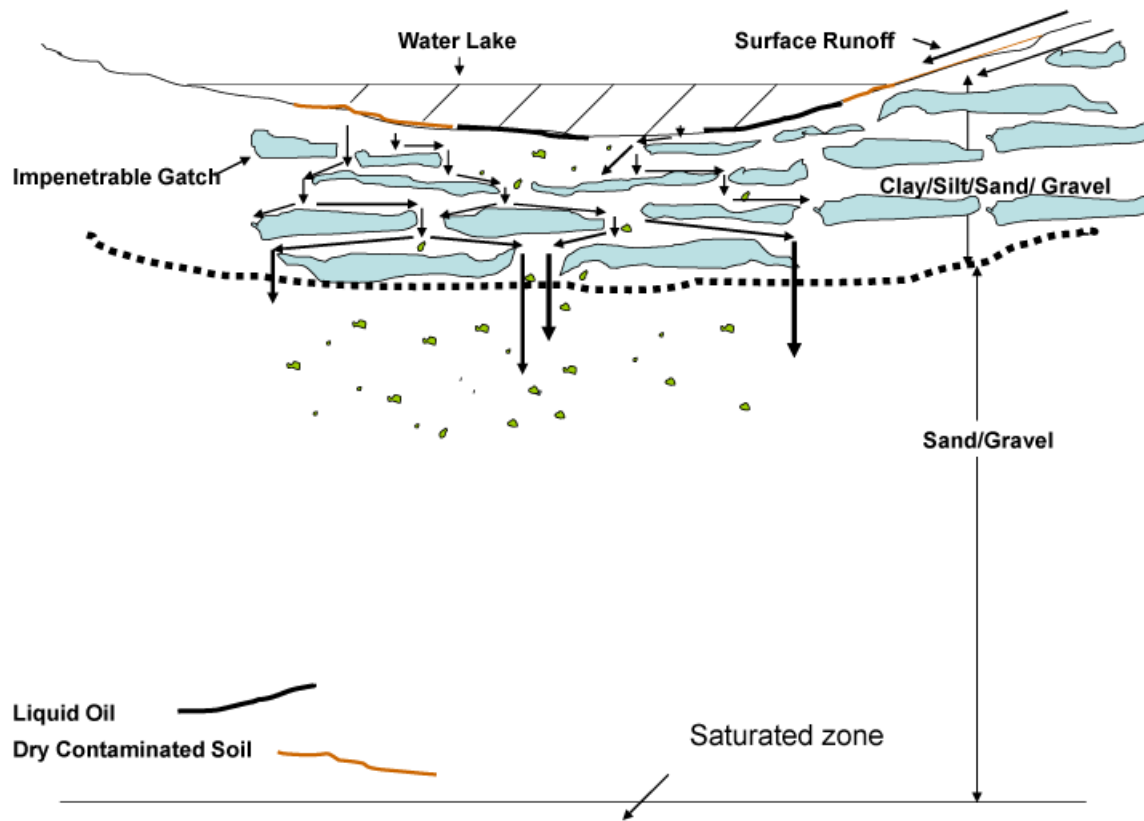
Distribution of sludge, oil lakes and products of combustion in Raudhatain Depression

Introduction



Distribution of sludge, oil lakes and products of combustion in Umm Al-Aish Depression

Introduction



**Schematic of recharge in Raudhatain and Umm Al-Aish depressions
(Source: Qabazard et al., 2009)**

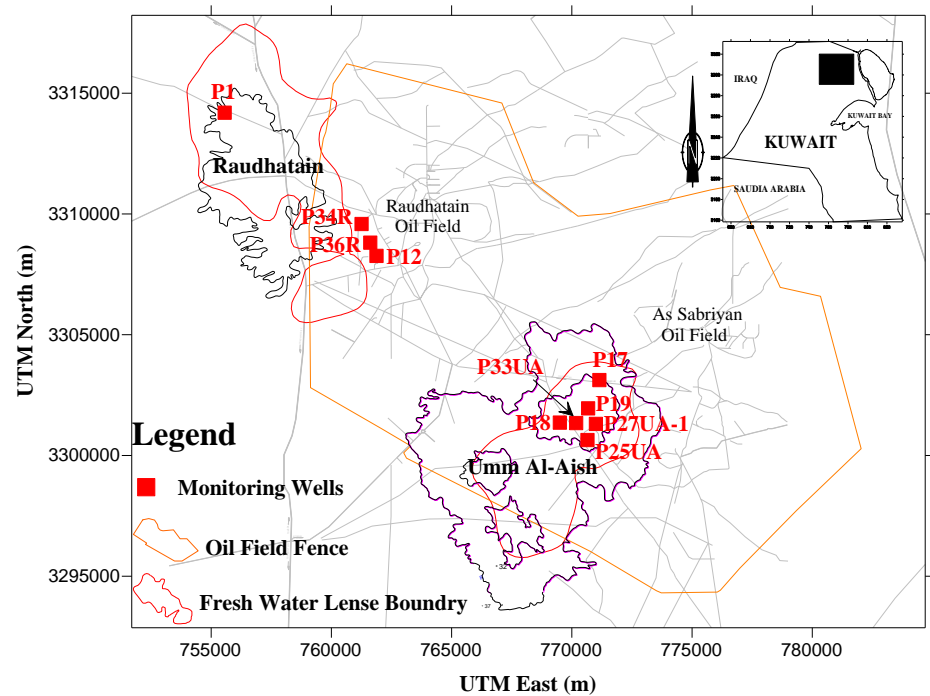
Objective

- Petroleum and refined petroleum products are complex mixtures of hundred to thousands of individual petroleum constituents including hydrocarbons and non-hydrocarbons
 - Hydrocarbons – nonpolar molecules such as paraffin, cycloparaffin and aromatics
 - Non-hydrocarbons – polar constituents with nitrogen, sulfur or oxygen in their molecular structure
 - By products of petroleum degradation such as organic acids, aldehydes, phenols, ketones, alcohols, amines – polar constituents.

Investigation of polar and non-polar material in petroleum hydrocarbon contaminated groundwater.

Methodology

- Collection of groundwater samples
 - 10 groundwater samples
 - 9 contaminated and 1 uncontaminated



Methodology

- Laboratory Analysis
 - TPH
 - TOC
 - Phenol
 - Tannin and Lignin
 - Volatile acids
 - UV-induced Fluorescence



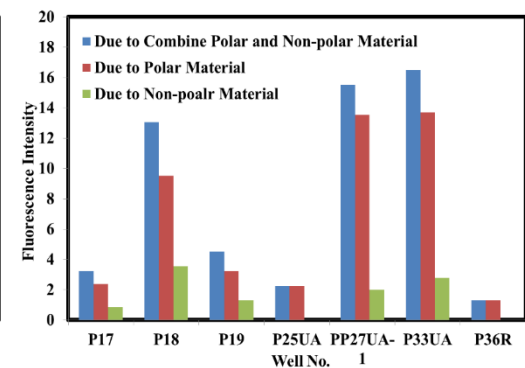
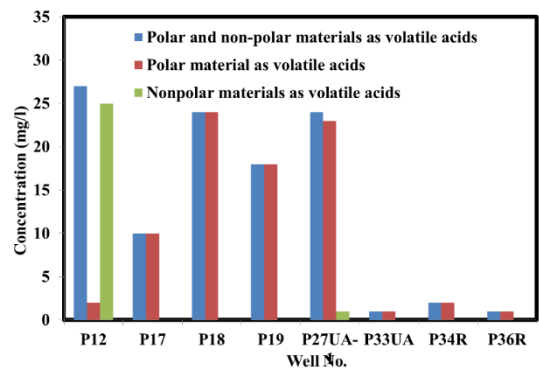
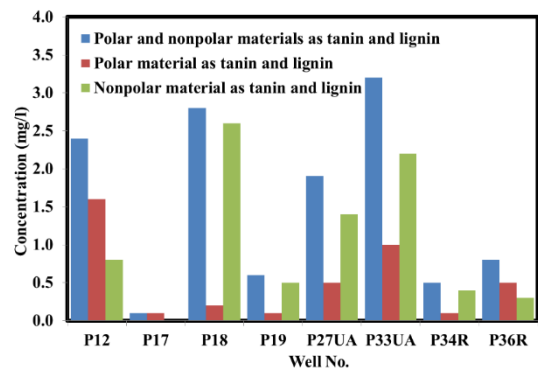
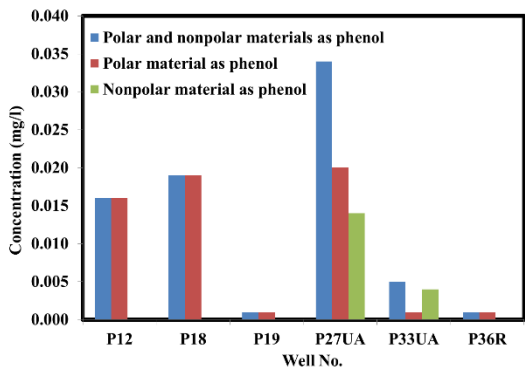
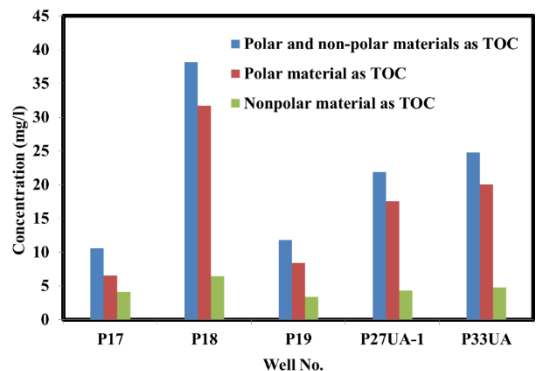
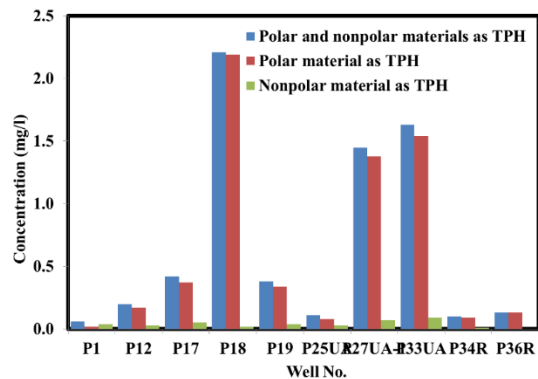
Activated silica gel splits aggregated polar and nonpolar material by adsorbing polar material on its activated surfaces.

Results

Polar and nonpolar material in groundwater samples

Well	TOC (mg/l)			TPH (mg/l)			Fluorescence			Phenol (mg/l)			Tannin and Lignin (mg/l)			Volatile Acids (mg/l)		
No.	P&NP	P	NP	P&NP	P	NP	P&NP	P	NP	P&NP	P	NP	P&NP	P	NP	P&NP	P	NP
PIR	0.74	-	0.80	0.06	0.02	0.04	-	-	-	-	-	-	-	-	-	-	-	-
P12R	1.31	-	1.40	0.20	0.17	0.03	-	-	-	0.016	0.016	0.000	2.40	1.60	0.80	27.00	2.00	25.00
P17U	10.61	6.50	4.11	0.42	0.37	0.05	3.23	2.39	0.84	-	-	-	0.10	0.10	0.00	10.00	10.00	0.00
P18R	38.12	31.69	6.43	2.21	2.19	0.02	13.05	9.51	3.54	0.019	0.019	0.000	2.80	0.20	2.60	24.00	24.00	0.00
P19R	11.80	8.42	3.38	0.38	0.34	0.04	4.53	3.24	1.29	0.001	0.001	0.000	0.60	0.10	0.50	18.00	18.00	0.00
P25UA	0.69	-	0.75	0.11	0.08	0.03	2.24	2.24	-	-	-	-	-	-	-	-	-	-
P27UA-1	21.89	17.57	4.32	1.45	1.38	0.07	15.51	13.53	1.98	0.034	0.020	0.014	1.90	0.50	1.40	24.00	23.00	1.00
P33UA	24.79	20.01	4.78	1.63	1.54	0.09	16.48	13.69	2.79	0.005	0.001	0.004	3.20	1.00	2.20	1.00	1.00	0.00
P33UA-D	24.15	19.48	4.67	1.54	1.47	0.07	16.63	14.08	2.55	0.016	0.005	0.011	3.20	1.00	2.20	1.00	1.00	0.00
P34R	0.53	-	0.60	0.10	0.09	0.01	-	-	-	-	-	-	0.50	0.10	0.40	2.00	2.00	0.00
P36R	0.59	-	0.61	0.13	0.13	-	1.29	1.29	-	0.001	0.001	0.000	0.80	0.50	0.30	1.00	1.00	0.00

Results



Results

Comparison of Polar and Nonpolar material in Groundwater		
Parameter	Polar Material (%)	Nonpolar Material (%)
TPH	86	14
TOC	42	58
Phenol	73	27
Tannin and Lignin	40	60
Volatile Acids	90	10
UV-Induced F. Intensity	84	16

Conclusion & Recommendations

- Analytical results, based on analysis of TPH, TOC, phenol, and volatile acids indicates that contaminants in petroleum hydrocarbon contaminated groundwater are dominantly polar. Whereas tannin and lignin contents are dominantly nonpolar.
- The higher concentration of polar material may be attributed to weathering of sources of contaminants (sludge, crude oil in lakes). Photooxidation and biodegrading could be major processes that produce oxidation products which are more soluble (polar).
- Efforts must be made to identify individual polar and nonpolar contaminants and their concentrations.
- Before implementation of treatment system, its treatment efficiency must be tested at bench-scale and field-scale for both polar and nonpolar material.

Thankyou

