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Comparison of Site Characterization of Contaminated Soil in South & East Kuwait Oil fields

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Kuwait Geographical Information

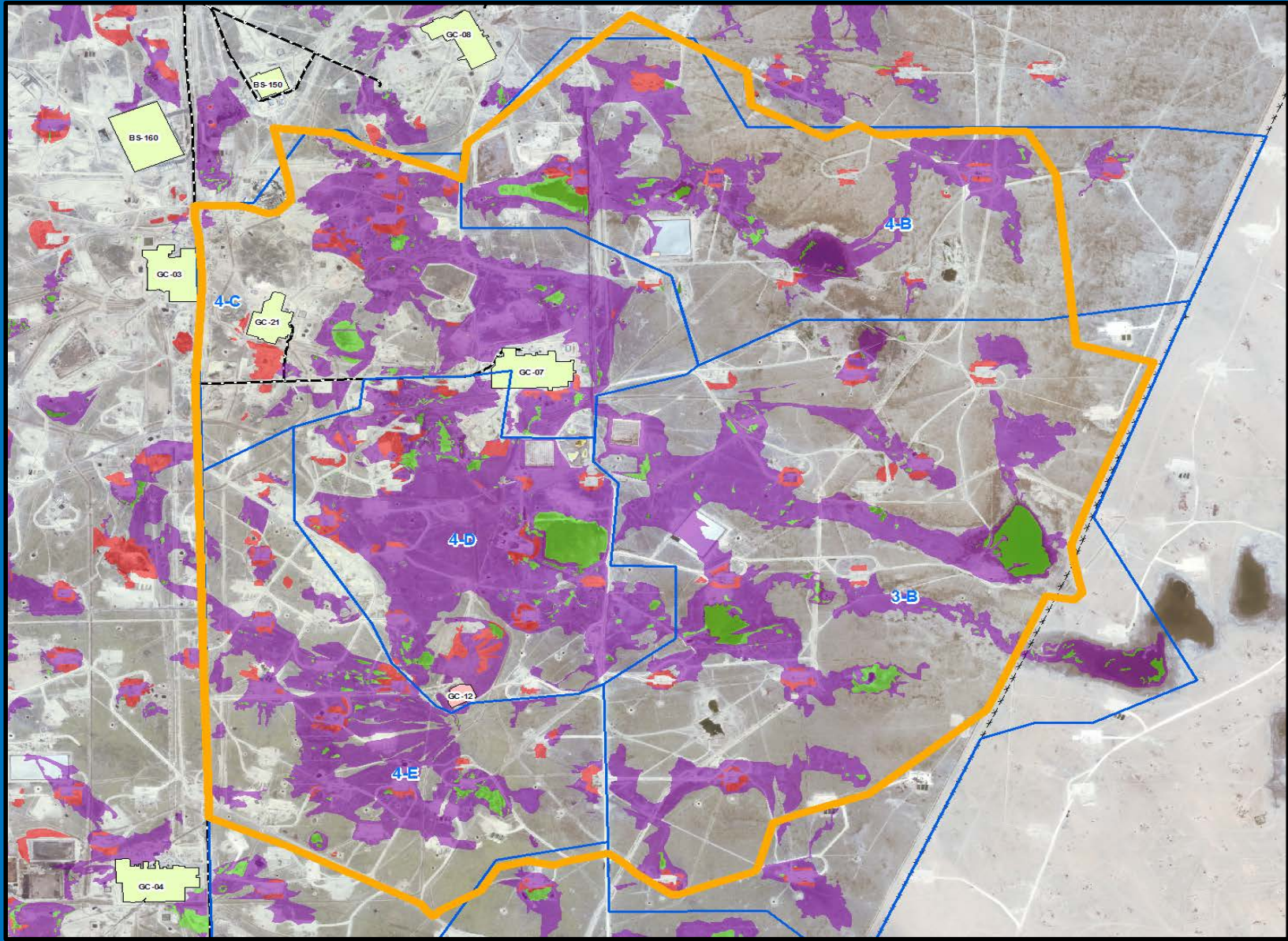
- The State of Kuwait is located in the northeast corner of the Arabian Peninsula.
- Kuwait is one of the smallest countries in the world in terms of land area.
- The flat, sandy Arabian Desert covers most of Kuwait.
- Kuwait includes several offshore islands, the largest of which is Bubiyan, near the Iraqi border.



Background

- After the Gulf war, in February 1991, Kuwait's oil wells were damaged and set on fire, resulting in oil contamination of the land.
- Environment Contamination occurred from oil spreading over the land surface and penetrated the soil to varying depths forming oil lakes.
- These large oil lakes and other contaminated features still exist today in KOC field with an estimated volume of 26 million cubic meters.
- This Unique Programme is currently the largest environmental inland cleanup in the world.





KIPCO/ROK/Al-Firdos

KERP - KOC Claim Elements Awarded

The following Environmental Claim elements were awarded to KOC by United Nations Compensation Commission under Decision 258.

Claim No. 5000259

(Coastal & Marine Resources)

Claim No.5000450

(Remediation of areas in and around wellhead pits and Tarcrete)

Claim No. 5000454

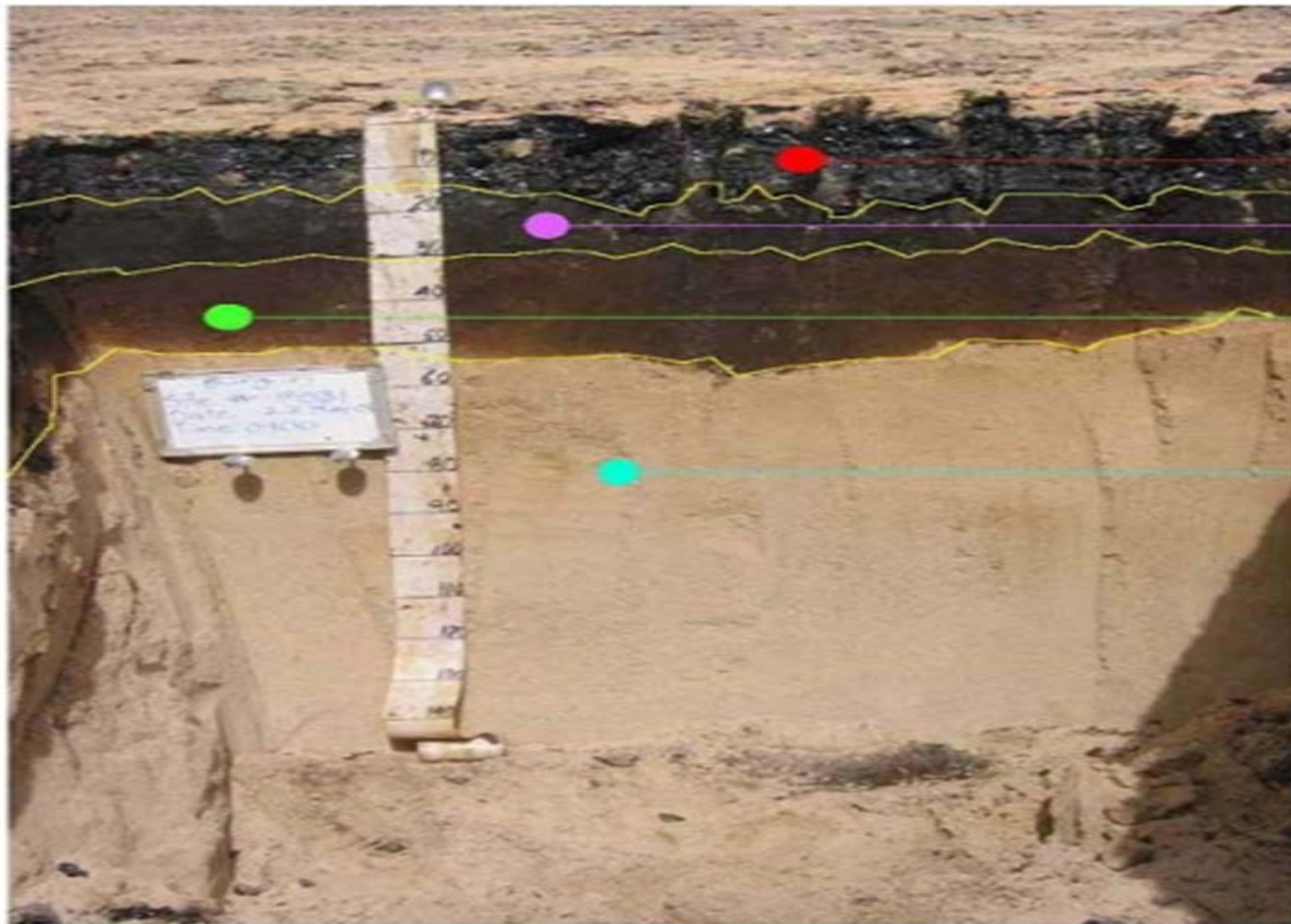
(Remediation of areas damaged by oil lakes, oil-contaminated piles, oil trenches & oil spills)

KERP – Wet Oil Lake

- Areas covered with black liquid (highly weathered oil) and semi solid oil saturated material resulting from oil flow damaged oil wells.
- Occur in areas where large liquid oil accumulated because of local topography and micro relief.
- Investigations revealed that the average depth of oil contamination in the wet contaminate areas is approximately 63 cm.



Wet Oil Contaminated Soil



Oily liquid sludge-Layer 1

Heavily contaminated layer
below the sludge

Visibly contaminated
soil- Layer 2

Visibly uncontaminated
soil

KERP – Dry Oil Lake

- Dry oil lakes are generally found in shallow depressions and/or flat areas.
- The dry contamination areas cover almost 100 square Km of the desert, with an average depth of approximately 25 cm.



Dry Oil Contaminated Soil



Heavily contaminated
surface layer -1

Visibly contaminated
layer -2

Visibly uncontaminated layer

Discussion of Data Analysis for Different decades

1. Historic Data in S&EK fields:

- In 2003, Kuwait's monitoring and assessment consultants analysed data and performed mapping and analytical sampling surveys to delineate the extent of the oil lakes (wet and dry).
- The sampling survey involved collecting soil samples in to different depths/ layers (layer 1, contaminated surface; layer 2, subsurface contaminated layer.
- A total of approximately 850 samples were collected and analysed from various contaminated features at various locations in South and East Kuwait (S&EK).



Discussion of Data Analysis for Different decades

Historic Data (CIC-2002) in S&EK fields :

Table 1 : Minimum, maximum & Mean for TPH level in Layers-1&2 of Wet and Dry oil lakes					
Material Type / Analysis	Minimum (mg/kg)	Maximum (mg/kg)	Geometric Mean (mg/kg)	Arithmetic Mean (mg/kg)	Standard Deviation (mg/kg)
Wet Oil Lake					
Layer 1	64,700	163,000	106,286	113,850	7,564
Layer 2	14,600	30,600	21,614	22,600	986
Dry Oil Lake					
Layer 1	11,300	353,000	62,103	92,990	30,887
Layer 2	1100	83,000	16,435	21,541	5,106

Discussion of Data Analysis for Different decades

2. Limited Scope Investigation in S&EK fields

- KOC conducted a limited soil characterization study in November and December 2014.
- The focus of the limited investigation was to characterize soils that may be suitable for treatment technologies and to update the current understanding of soil contaminants levels and refine the aerial and vertical extent with carbon brandings to support remediation strategy.
- The sampling was focused on features known as 'Dry Oil Lakes' and 'Wet Oil Lakes' features. The summary data for TPH analysis has been split into feature type, (i.e., wet oil and dry oil lake features), and into different layers: Layer 1 and Layer 2 which represents underlying visually clean soils.

Discussion of Data Analysis for Different decades

Limited Scope Investigation –Burgan in South East Kuwait :

Table 2 : Minimum, maximum & Mean for TPH level in Layers-1&2 of Wet and Dry oil lakes					
Material Type / Analysis	Minimum (mg/kg)	Maximum (mg/kg)	Geometric Mean (mg/kg)	Arithmetic Mean (mg/kg)	Standard Deviation (mg/kg)
Wet Oil Lake					
Layer 1	94,835	166,171	133,373	135,557	25,310
Layer 2	11,585	87,450	32,847	39,749	24,840
Dry Oil Lake					
Layer 1	718	126,811	17,576	27,847	10,271
Layer 2	9,923	35,126	23,660	28,507	4,847

Discussion of Data Analysis for Different decades

3. Recent Petroleum Hydrocarbons investigation in S&EK fields

- The most recent environmental analytical data relates to total petroleum hydrocarbon (TPH) analysis conducted in during the period of 2016 to 2017.
- The samples were collected from different locations layer 1 & layer 2 in SEK Burgan fields.
- A total of approximately 200 soil samples were collected and analysed from various soil feature locations in South and East Kuwait (S&EK).



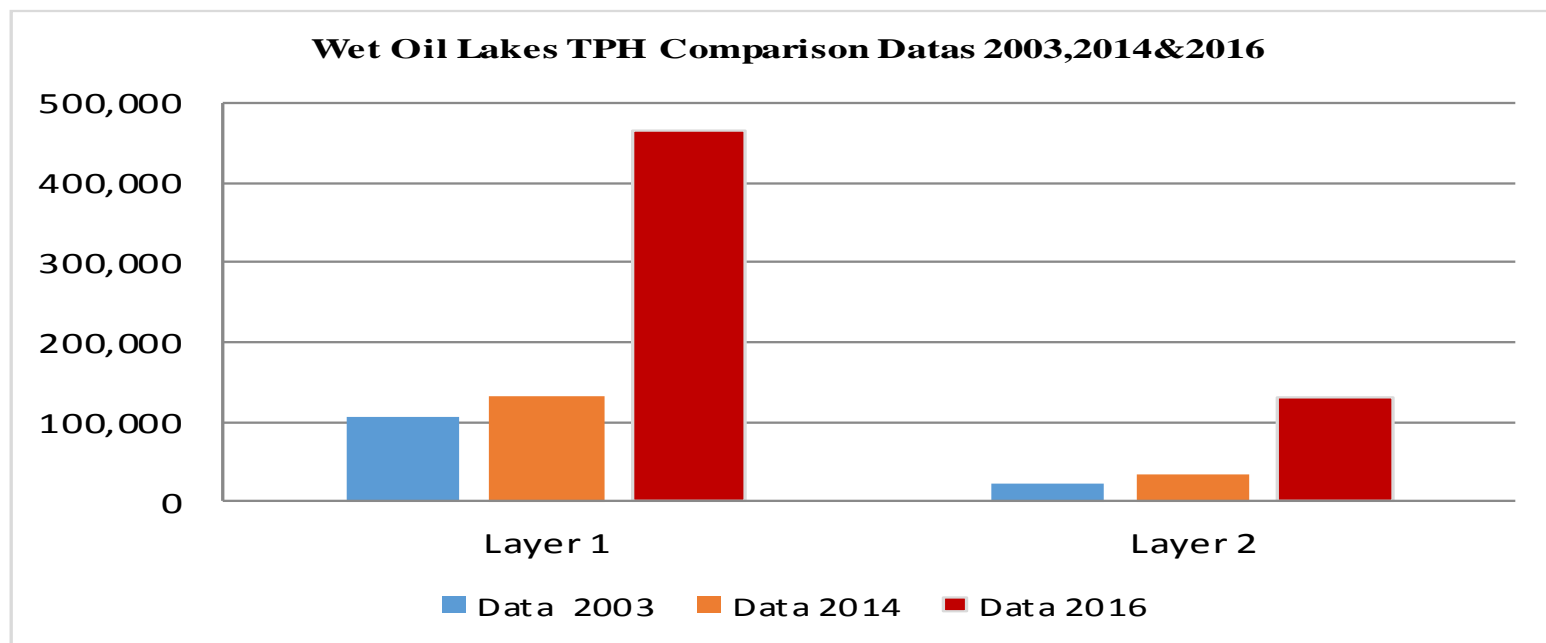
Site Soil Characterization -Data Analysis for Different decades

Recent Petroleum Hydrocarbons Investigations in S&EK fields:

Table 3 : Minimum, maximum & Mean for TPH level in Layers-1&2 of Wet and Dry oil lakes					
Material Type / Analysis	Minimum (mg/kg)	Maximum (mg/kg)	Geometric Mean (mg/kg)	Arithmetic Mean (mg/kg)	Standard Deviation (mg/kg)
Wet Oil Lake					
Layer 1	305,816	624,513	466,424	480,068	13,644
Layer 2	73,941	169,045	131,966	13,6521	4,555
Dry Oil Lake					
Layer 1	1,074	326,421	62,440	89,456	27,016
Layer 2	9,866	203,760	30,310	40,052	9,742

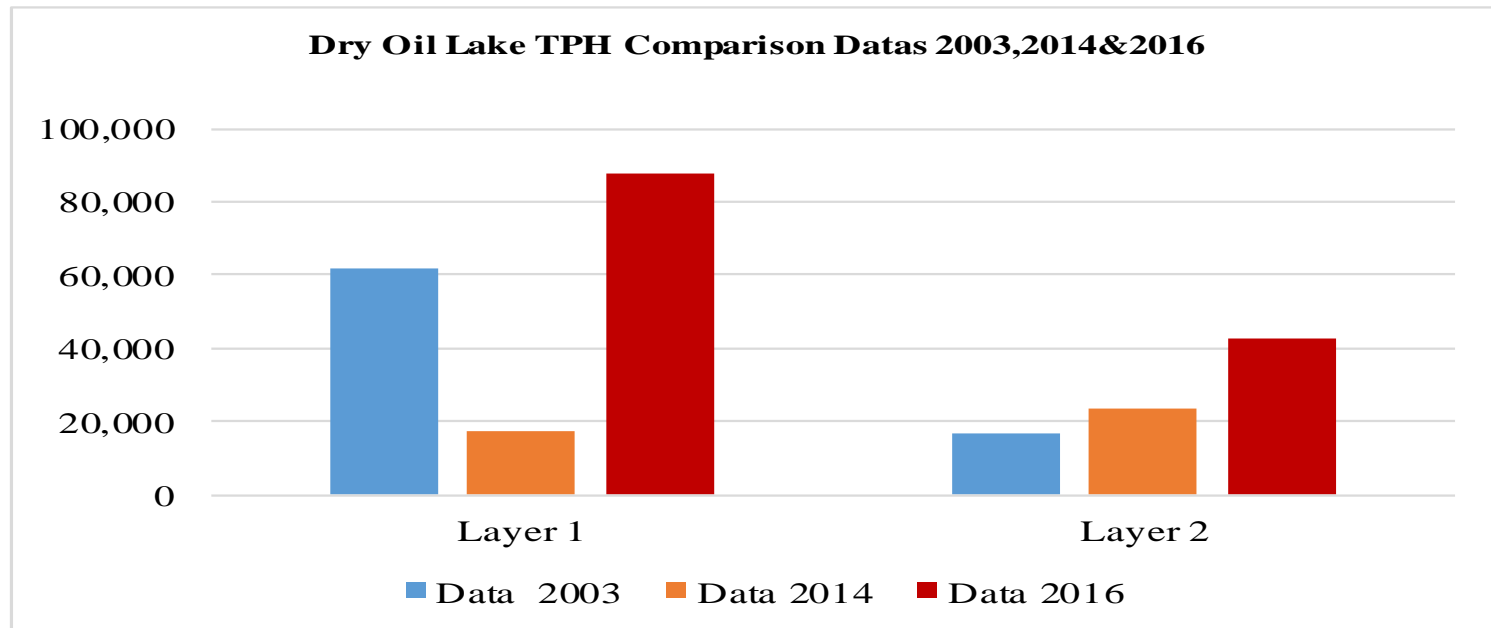
TPH Comparison for Different decades

Wet Oil Lakes (WOL) in S&EK fields:



TPH Comparison for Different decades

Dry Oil Lakes (DOL) in S&EK fields:



Analysis and Conclusion

- During the Gulf War in 1990, highly contaminated oil lakes were formed covering a large area of Kuwait's desert area. As a result of oil presence, soil properties were negatively affected.
- No natural degradation has been observed in all crude oil constituents in terms of TPH levels in both WOL and DOL features. Although considerable evaporation, photo-oxidation and weathering processes have taken place since the war, the TPH levels have increased drastically.
- The graphs indicate there are upward trends of TPH levels over these periods and which cannot be easily explained from initial to the latest studies. However, it is speculated that multiple factors could have contributed to these observations:
 - * The depths of sampling collection
 - * Variable laboratory analysis methods, data interpretations
 - * Multiple laboratories used and/or under-estimations of TPH levels during initial soil studies.

Thank you

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Reference

1. W.D Al-Shuiab, D.H.Al-Gharabally, A.S.Al-Barood, “Kuwait Environmental Remediation Program (KERP): 2015 2nd International Conference on Substantial Environmental Engineering (ICSEE 2015) Hong Kong, 27-28 August, 2015,
2. Dana and Ahmad, Characterization of oil contaminated soil, Kuwait oil lakes, Proceedings of the 2nd International Conference on Environmental Science and Technology, Singapore, Vol. 6, PP 439-442, 2011.
3. M. Alsarawi, M. S. Massoud and S. A. Wahba, Physical Properties as indicators of oil penetration in soils contaminated with oil lakes in the Greater Burgan Oil Fields, Water, Air, and Soil Pollution, Kuwait, Vol. 102, PP 1-15, Nov. 1996.
4. Literature Review for UNCC Compensated Claim No. 5000454 – Remediation of Areas Damaged by Oil Lakes, Oil-Contaminated Piles, Oil Trenches, and Oil Spills. Kuwait Focal point and Kuwait University College of Engineering and Petroleum, 2011, PP 1-18.
5. Oil lakes and soil contamination demonstration work plan (field demonstration implementation plan) Report, Kuwait University College of Engineering and Petroleum, PP 1-29, 2011.
6. Consortium of International Consultants (CIC) monitoring and assessment of the environmental damages South East Kuwait report Aug 2003.
7. Limited Scope Site Soil Characterization- summary report, Project Management Consultancy Services For Kuwait Environmental Remediation Projects (KERP), 2014, PP 1-17.
8. Results of Laboratory Scale, Field Demonstration, and Comparative Studies of Effective Technologies, Oil Lakes, vol.2, 2003, PP 1-40.