
SK EU2016
Slovak Presidency of the Council
of the European Union

# Personal Introduction:

Want to serve my country by trying to improve the environment. Want to bring the best out of me by using my experience and want to take challenging tasks. God made earth green; it is my desire to keep it Green,,,,,

•**Name** : **Dr. MESHARI ALMUTAIRI**

**PERSONAL INFORMATION:**

•**Profession** **:** Civil and environmental Engineer

•**Qualification** :

B.E. Kuwait University – Civil Engineer, Main Environmental (2004)

M.S.C Portsmouth University – Civil Engineer and Environmental Engineer (2009)

Phd Civil Engineer & Environmental Engineer (2015).

# Evaluation of a Multi-stage Strategy For Remediation of Kuwaiti Oil lakes

Dr. Meshari Almutairi, LOTHAN COMP, Kuwait, CLK2001@hotmail.com
Cooperated with:
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Eng. Shaimaa Ali, Kuwait National petroleum Company (KNPC), s.ameen@knpc.com

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SK EU2016

## Main Topics:

- **Case Study**
- **Technology Development Status**
- **Filed Pilot Test**
- **Memorandum of Understanding (MOU) with Kuwait National Petroleum Company (KNPC)**
- **Scope of The Pilot**
- **Result of The Pilot**
- **Commercial Consideration**
- **Using treated sand in engineering application**:
- **Conclusion**

## Introduction

The State of Kuwait sustained significant and widespread environmental damage resulting from the Iraqi invasion in August 1990 and the 1991 Gulf War. The occupation of Kuwait by the Iraqi army caused substantial damage to Kuwait's environment.

# Case Study

- Gulf War in 1991

- 700 wells destroyed during the war

Lakes were formed at more than 500 different locations, covering a total area initially estimated at 49 km²

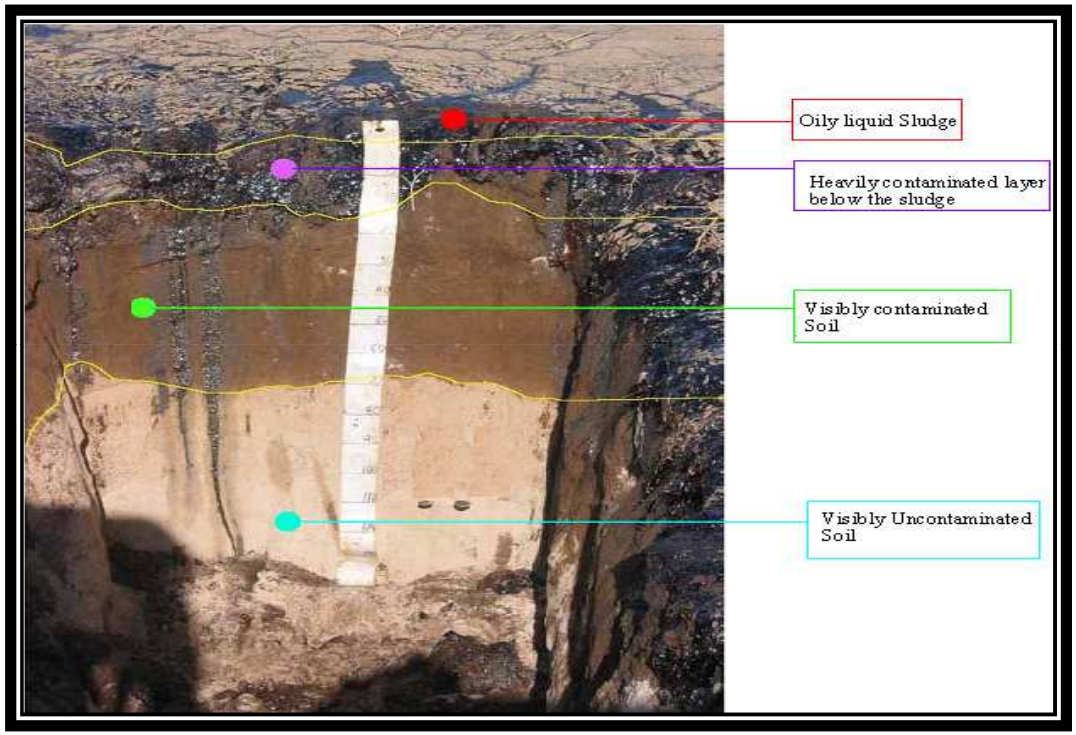
The surrounding environment is exposed to the oil lakes with all the contaminants left on the surfaces

22.7 million m³ of contaminated soil remains,

**threatening pollution of precious groundwater resources if not treated**

# The Situation of the Oil Lake

- The oil lakes containing crude oil and partially combusted oil with soot,
- Most of the oil lakes are now “dry,” i.e., the contamination now comprises a black, moderately hard, tar-like dry surface layer.
- Even at 70 cm below ground, the contamination can be seen



Evaluation of oil lakes in Kuwait desert (Al-Awadhi et al., 2000).

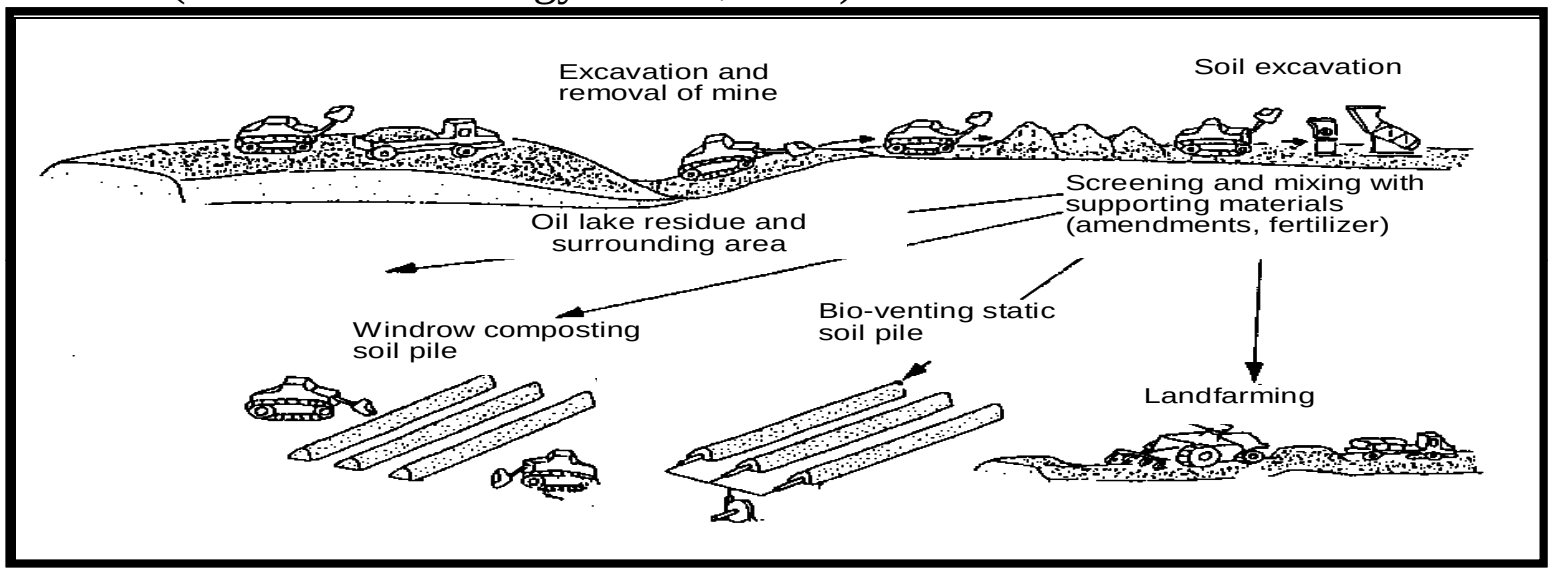
| Area | Number of oil lakes | Description |
|---|---|---|
| Fresh groundwater | 172 | Lakes in north oil field |
| Residential areas and operational areas | 69 | Lakes within 1 km from residential areas, i.e., Ahmadi & the Ja'aidan garden and within 1 km of operational areas |
| Road, wells and pipelines | 71 | All lakes within 0.5 km paved road and in which wells lie and over which pipelines cross |
| Burgan oil field | 123 | Lakes in the Burgan oil field |
| Unclassified | 79 | Lakes in southern fields |

Studies conducted by and Gevao, et al. (2006) & Al-Awadi, et al. (2009) showed that:

If the oil lakes remain untreated, its considered as a PAHs reservoir that will maintain feeding the atmosphere and groundwater.

## Pervious Work

- Japan Petroleum Energy Center (PEC) with the Kuwait Institute for Scientific Research (KISR) has been researching for the remediation of oil-contaminated soil, since 1993. Schematic diagram for bioremediation process in Kuwait contaminated soil (Petroleum Energy Center, 1999).




Due to the different types of contaminants, it is necessary to apply more than one remediation technique to reduce the concentrations of pollutants to acceptable levels

## Remediation of hydrocarbon contamination

- Remediation of hydrocarbon-contaminated land can occur by removing the source of the pollution or by breaking the pathways to the receptors.
- Pollution can be removed physically by the removal of contaminated soils; installation of physical barriers; vapour extraction; soil washing and thermal treatment.
- Bioremediation involves engineering measures to intensify and enhance the natural degradation processes in the soil. This can be achieved by adding microbial seeds, mechanical aeration pumps to increase the oxygen levels and by the addition of fertilisers.

# Approach for selection among several soil remediation methods.

## Desktop study

* Literature review

## Decision making tool

*Multi criteria analysis

**Compilation of characteristic of various soil remediation techniques from previous studies (* Less Suitable, ** Suitable, *** More Suitable).**

| Remedial Option / Parameters | Land-farming | Windrow | Phyto-remediation | Vermi-remediation | Bioventing | Soil Washing | Bio-piles | Electro-remediation (in) | Solidification/ stabilisation |
|---|---|---|---|---|---|---|---|---|---|
| Sandy soil "Homogeneous soil" Implement in surface soil | [1] *** | [1]*** | [1]*** | [1]*** | [1]* [1]* | [1]*** | [1]*** | [1]* | [1]*** |
| Further treatment require | - | - | - | - | - | * | - | - | - |
| Air emission | * | * | * | *** | * | *** | * | * | *** |
| Leaching wastewater | * | *** | * | * | *** | * | * | * | *** |
| Compound removal | TPH >C30 are less degradable, PAH e.g. 2-4 rings [1,2,4,5] *** | TPH >C30 are less degradable, PAH e.g. 2-4 rings [1,2,4,5] *** | TPH >C30 are less degradable, VOCs, SVOCs, heavy metals and PAH e.g. 2-4 rings [1,5] *** | TPH >C30 are less degradable, VOCs, SVOCs, heavy metals, and PAH e.g. 2-4 rings [6] *** | TPH >C30 are less degradable, VOCs, SVOCs, and PAH e.g. 2-4 rings [1,2,5] *** | Separate the organic compound. Soluble inorganic and metals salts. [1,2,3,5] ** | TPH >C30 are less degradable, VOCs, SVOCs, and PAH e.g. 2-4 rings [1,2,4,5] *** | Heavy metals, inorganic and soluble organic. [1,5] * | Immobilise contaminant, such as: heavy metals, organic and inorganic compound [4,5] * |
| Time for clean-up | 6-24 months [2,4,5] * | 6-12 months [2,4,5] ** | 12 months > [3] ** | 6-12 months [6] ** | 30 months [2] * | 2-3 months [3] *** | < 6 months [5] *** | 6-12 months [1,5] ** | 6 -12 months [2,4] * |
| Cost £ / Tonne | 5 – 30 [2] *** | 8 – 20 [2] *** | 15 – 60 [4] *** | 20 [6] *** | 12 – 65 [5] * | 20 – 40 [4] *** | 20 – 60.5 [5] * | 52.5 – 158 [5] * | 60.5 – 161 [5] * |

[(1) Koning et al. (2000); (2) Lodolo, (2005); (3) Mike *et al.* (2006); (4) Nathanail & Bardos (2004); (5) USEPA (1991); (6) Sinha *et al.* (2010)]

Soil washing method was selected

# ***Technology Development Status***

*Due to the different types of contaminants, it is necessary to apply more than one remediation technique to reduce the concentrations of pollutants to acceptable levels . (USEPA, 2002).*

•challenge is not only to investigate the most effective method with respect to the practical applicability:

•Lab scale started to use bioremediation form Dec 2010

(During PhD study)

•Lab scale started to use soil washing form August 2011

(During PhD study)

•Pilot scale started from 2014

(During PhD study-until June 2016)

# Filed Pilot Test

**Soil washing** is a treatment technology that uses water and a mechanical process to remove hazardous contaminants from soil.

Docket No. 32900.46
Customer No. **37833**

HONORABLE COMMISSIONER OF PATENTS
ALEXANDRIA, VA 22313-1450
SIR:

Transmitted herewith for filing is the utility patent application of:

First Named Inventor: **MESHARI ALMUTAIRI**

Applicant: **MESHARI ALMUTAIRI, Inventor**

for: **SYSTEM AND METHOD FOR REMEDIATION OF OIL-CONTAMINATED SAND**

Enclosed are:

1. Application Data Sheet (PTO/AIA/14 EFS-Web)
2. Patent Application, 19 pages.
3. 4 sheets of Formal Drawings Containing 6 Figures
4. Combined Declaration and Power of Attorney, 1sheet
5. Micro Entity Certification
6. Information Disclosure Statement
7. Form PTO-1449 w/1 reference
8. Filing fee in the amount of $400.00

The filing fee has been calculated as shown below:

| | | |
|---|---|---|
| BASIC FEE | MICRO ENTITY | $400.00 |
| TOTAL CLAIMS | (20 - 20 = 0) X$20 | $0.00 |
| IND. CLAIMS | (3 - 3 = 0) X 105.00 | $0.00 |
| TOTAL | | $400.00 |

Additional fees due for this filing only, if any, may be charged to Deposit Account No. 12-1662 of the undersigned.

Respectfully submitted,

Robert B. Lyons
Registration No. 40,708
Patent Law Building
8955 Center Street
Manassas, VA 20110
(703) 486-1000
Attorney for Applicant

## Phases


The phase of this project are the following:

**A Phase**
SA Enhance the efficiency of soil washing method to remediate Kuwait Oil Contaminated Sand.

**B Phase**
SB Select the suitable method to treat the residue “oily wastewater” obtained from soil washing method.

## Memorandum of Understanding (MOU) with Kuwait National Petroleum Company (KNPC)

- **Memorandum of understanding (MOU) is signed with Kuwait National Petroleum Company (KNPC) for** the pilot project for "*Remediation of hydrocarbon contaminated soil*".

**Aim**

To evaluate the performance of the system and method for oil contaminated sand Technology developed by Dr. M. Al-Mutairi

شركة البترول الوطنية الكويتية
KNPC

Date: 25th April 2016 Ref. No.: MAB-MRT(A)-16-0185

Dr. Meshari Al-Mutairi
Lothan International Company

Dear Dr. Al-Mutairi,

Subject: MOU for the project entitled "Technology for Remediation of Hydrocarbon Contaminated soil"

Reference to the above mentioned subject, please find attached the duly signed MOU between KNPC and Lothan International Com. General Trading And Contracting Company for your retention and records.

This is for your information and necessary action.

Best regards,

Dr. Suad Al-Radwan
Manager R&T

# Scope of the Pilot

- To give general overview of the technology (soil washing) that I have develop
- To share with you the result of the field pilot which was conducted in which KNPC witness
- Derive the operational indices as an indicative parameter for the design of commercial plant.

## Procedure of the pilot:

1. **Pre-treatment:** Wet screens to remove oversize materials (> 25 mm “mass particles)

2. **Soil washing system (SWS):** Contaminated soil is washed without chemical agents for 2 h

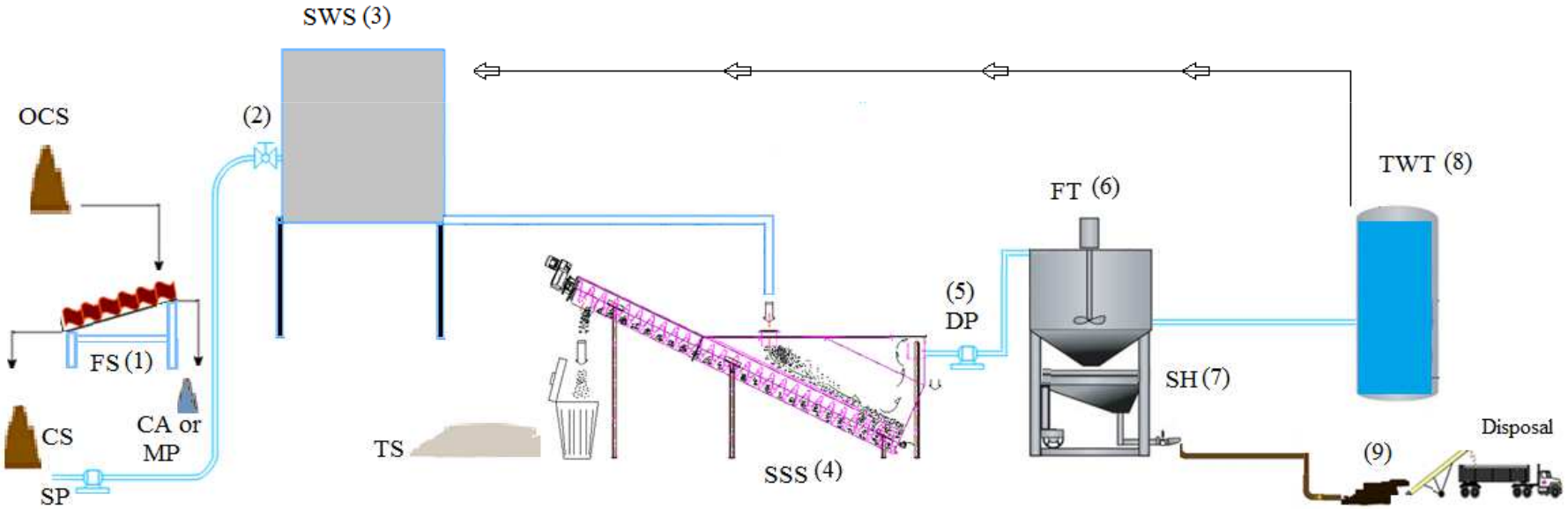
3. **Sand separator:** Sand separator is used to separate treated sand from oily wastewater

4. **water Treatment:** Wastewater is treated using flocculation tank ***Treated Water is recycled***

**5.Oil residue generated**: “Zero Waste Discharge” send it to cement factory /road construction.

# Procedure of the Pilot:

**(1) FS**: Feed sieve:***OCS**: Oil Contaminated Sand
**(2) SP**: Solid pump. ***CA**: Coarse aggregate& **MP**: Mass particle
**(3) SWS**: Soil Washing System: ***TS**: Treated Sand
**(4) SSS**: Sand Separated System
**(5) DS**: Dewatering Pump
**(6) FT** : Flocculation Tank
**(7) SH** : Sludge Hopper
**(8) TWT**: Treated Water Tank



## Pilot Project: Initial Remedial Design

Three different samples of oil contaminated sand had been given by (KNPC) within three weeks, whereby:

- Light contaminated oily sand has been given in the 1st week

The concentration of light contaminated sample = **8,645.0 mg/kg**

- Heavy contaminated oily sand has been given in the 2nd week

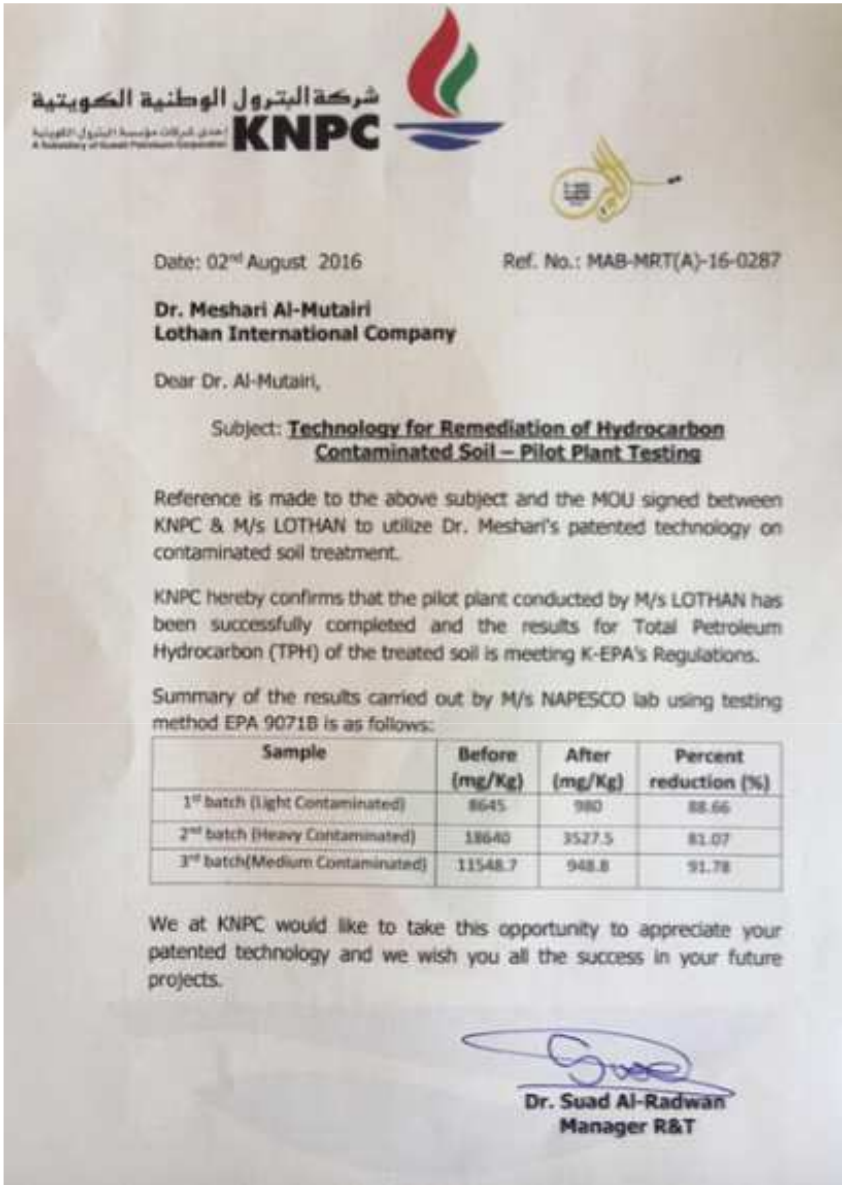
The concentration of heavy contaminated sample = **18,640.0 mg/kg**

- Medium contaminated of oily sand has been given in the 3rd week

The concentration of medium contaminated sample = **11,548.7 mg/kg**

# **Pilot Project:**
Soil Remediation

| Description | Parameters | |
|---|---|---|
| Capacity of the system | 150 kg of OCS<br>200 L of water | Time: 2 h |
| Sand separator system | Hydrocyclone is not used in the pilot so we need to wait for:<br>*30 min to settle the sand.<br>*10 min to suck up the wastewater to the the treatment tank using a suction pump<br>*15 min to separate the sand from SSS | |
| Wastewater treatment Tank | Around 160 – 170 L of water<br>*3h to settle the oily sludge | Alum weight:<br>150 - 300 mg/L<br>150 - 300 g/ 1000 L |
| Oily sludge | Oily sludge is collected in the separator drums<br>Light contamination 30 L<br>Heavy contamination 64 L<br>Medium contamination 45 L | |



شركة البترول الوطنية الكويتية
KNPC

Date: 02nd August 2016 Ref. No.: MAB-MRT(A)-16-0287

**Dr. Meshari Al-Mutairi**
**Lothan International Company**

Dear Dr. Al-Mutairi,

Subject: **Technology for Remediation of Hydrocarbon Contaminated Soil – Pilot Plant Testing**

Reference is made to the above subject and the MOU signed between KNPC & M/s LOTHAN to utilize Dr. Meshari's patented technology on contaminated soil treatment.

KNPC hereby confirms that the pilot plant conducted by M/s LOTHAN has been successfully completed and the results for Total Petroleum Hydrocarbon (TPH) of the treated soil is meeting K-EPA's Regulations.

Summary of the results carried out by M/s NAPESCO lab using testing method EPA 9071B is as follows:

| Sample | Before (mg/Kg) | After (mg/Kg) | Percent reduction (%) |
|---|---|---|---|
| 1st batch (Light Contaminated) | 8645 | 980 | 88.66 |
| 2nd batch (Heavy Contaminated) | 18640 | 3527.5 | 81.07 |
| 3rd batch(Medium Contaminated) | 11548.7 | 948.8 | 91.78 |

We at KNPC would like to take this opportunity to appreciate your patented technology and we wish you all the success in your future projects.

**Dr. Suad Al-Radwan**
**Manager R&T**

# *Result of The Pilot*

| Period | Trial No. | TPH (mg/kg) Soil Before | Average TPH (mg/kg) Soil After | Witnessed by KNPC Eng. Moemen Abbass | Taken by Eng. Moemen Abbass |
|---|---|---|---|---|---|
| Day 1 | 1 | Light Contaminated 8645 | 980 | | |
| Day 2 | 2 | | | | |
| Day 3 | 3 | | | | |
| Day 4 | 4 | | | | |
| Day 5 | 5 | | | | |
| Day 6 | 1 | Heavy Contaminated 18640 | 3527.5 | | |
| Day 7 | 2 | | | | |
| Day 8 | 3 | | | | |
| Day 9 | 4 | | | | |
| Day 10 | 5 | | | | |
| Day 11 | 1 | Medium Contaminated 11548.7 | 948.8 | | |
| Day 12 | 2 | | | | |
| Day 13 | 3 | | | | |
| Day 14 | 4 | | | | |
| Day 15 | 5 | | | | |

## Commercial Consideration

The upscaling of the pilot to achieve similar results is inevitable for the following reasons:

1) The process is quite simple i.e. no chemical and is thermal – independent

2) The pilot scale yielded better result than the lab test of the technology, hence, the upscale test is likely to yield the same or even better results.

3) The commercial plant, therefore, will simply be add-on units of 25 tonne each.

4) Hence, the efficiency level achieved during the pilot will likely be achieved during the upscale plant.

Needless to say, governmental approval for having commercial plant will be based on KEPA. In addition, all government licenses including the environmental Impact study will be obtained

**Using treated sand in engineering application**:

The result of average waster absorption test performed after curing for 28 days is illustrated in Table below:

| Specimen No | Wet Weight (g) | Dry Weight (g) | Measured absorption (%) by weight (5 % of oil) | Wet Weight (g) | Dry Weight (g) | Measured absorption (%) by clean sands |
|---|---|---|---|---|---|---|
| 1 | 1448.2 | 1439.2 | 0.63 | 1433.5 | 1415.7 | 1,20 |
| 2 | 1456.6 | 1447.4 | 0.64 | 1447.6 | 1432.1 | 1.07 |
| 3 | 1461.4 | 1452.2 | 0.63 | 1421.4 | 1405.2 | 1.13 |
| Average | 1455.4 | 1446.3 | 0.63 | 1434.17 | 1417.7 | 1.14 |

- The crude oil that is present in the concrete sand helps to enhance the water resistant and penetrability to chloride of the Kuwait oily sand concrete.
- Improve the concrete durability by means of protecting the steel from corrosion and minimize water passage.

## Conclusion

- The pilot generates comprehensive information on the remediation efficiency of oil contaminated soil, as well as relevant data on associated soil properties after and before the treatment.
- Cost saving for operator unlike other technology
- Process works better with fines soils while the majority of contamination associated with fine particles
- All sand fractions can be treated
- Contaminant moved into wash-waters
- Water treatment possible
- Meeting KEPA standard in the treated soil

- Zero emission of hazard material and the result residue can be utilised for other industries.
- This Pilot is considered as straight process because of non-requirements (chemical or biological system).
- Commercial plant will yield similar result.

# Thanks for your time – Questions are most welcome