Kuwait Environmental Remediation Program (KERP): Oil Lakes Remediation in South East Kuwait

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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.

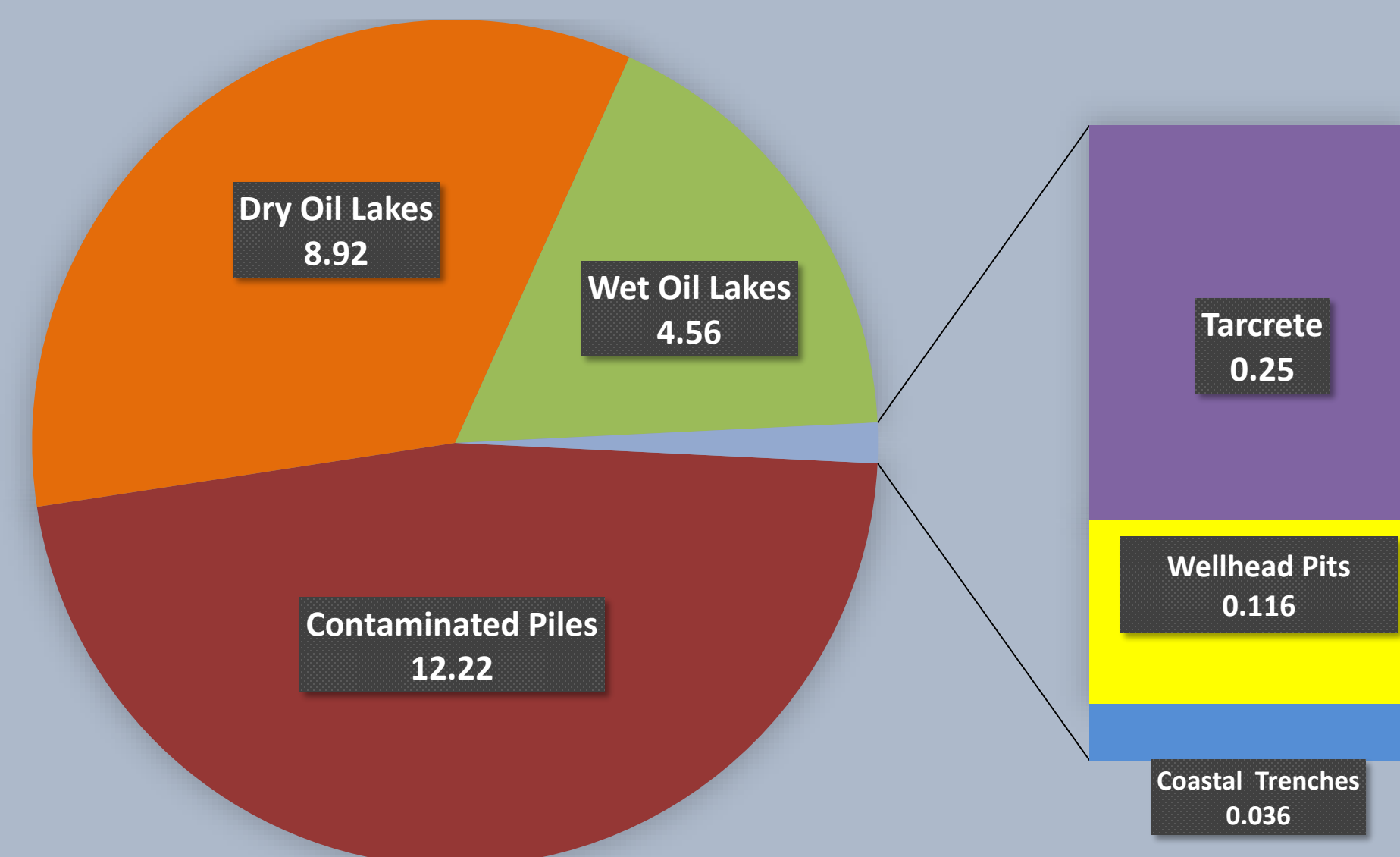- This Unique Program is currently the largest environmental inland cleanup in the world.

Objective

- The objective of this poster is to demonstrate one such type of technology, known as bioremediation treatment for soil contaminated with total petroleum hydrocarbon.

Types of Contamination

- The total estimated volume of contaminations is 26.1 million m³

Dry Oil Lakes 8.92
Wet Oil Lakes 4.56
Contaminated Piles 12.22
Tarcrete 0.25
Wellhead Pits 0.116
Coastal Trenches 0.036

Dry Oil Lakes

- Dry contamination areas cover almost 100 km² of the desert, with an average depth of approximately 25 cm. The surface tar material in areas of dry soil contamination is found to contain mean TPH concentrations of about 7.3%. Underlying contaminated soil is found to contain a mean TPH concentration of 2.5%

Wet Oil Lakes

The distinguishing features of Oil Lakes with a surface area of over 7 km² include a surface layer of weathered crude, oily liquid/ sludge, sometimes covered by a thin, hardened crust. Investigations revealed that the average depth of oil contamination in the wet contaminated areas is approximately 63 cm. Sludge material has been found to contain mean TPH concentrations in excess of 19%. The underlying contaminated soil is found to contain a mean TPH concentration of 3.4%
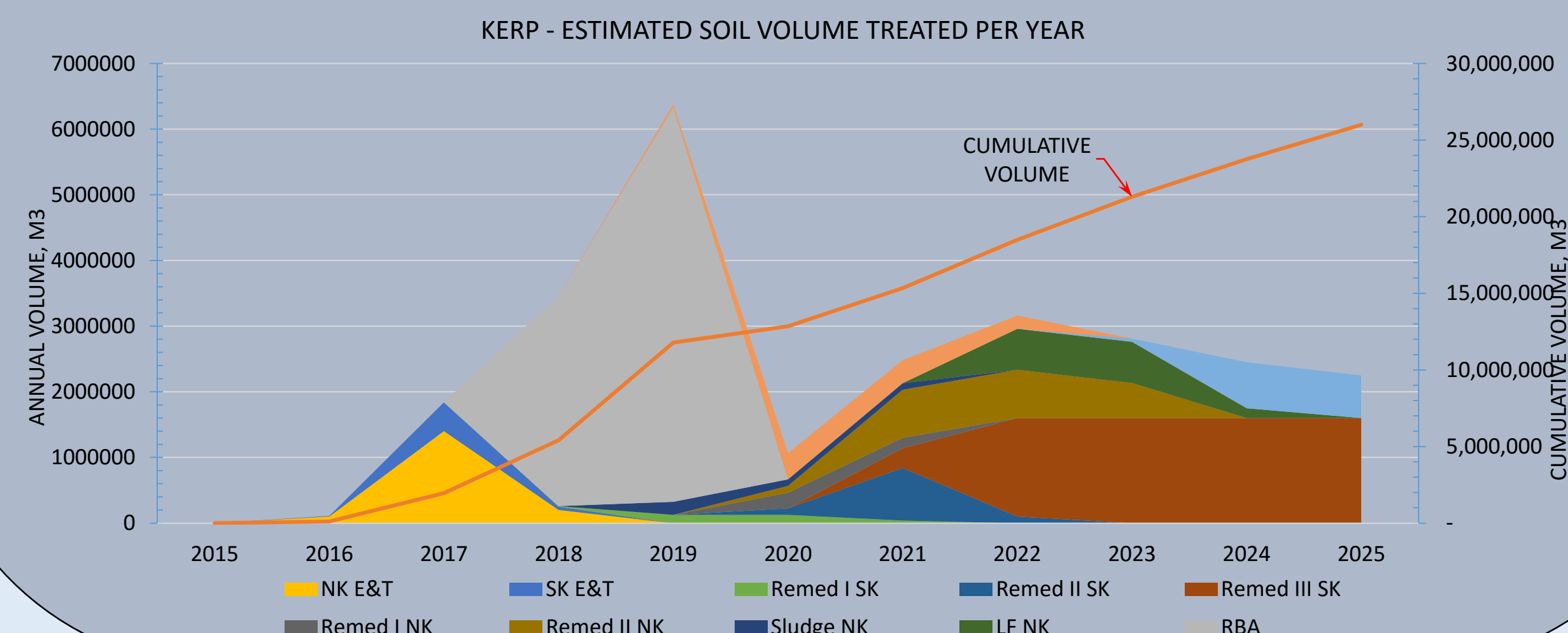
Oil Contaminated Piles

Contaminated piles consolidate oil-contaminated soil and/or liquid oil into mounds. Oil-contaminated pile surface materials are found to contain mean TPH concentrations of about 4.0%. The underlying contaminated soil is found to contain a mean TPH concentration of 4.6%
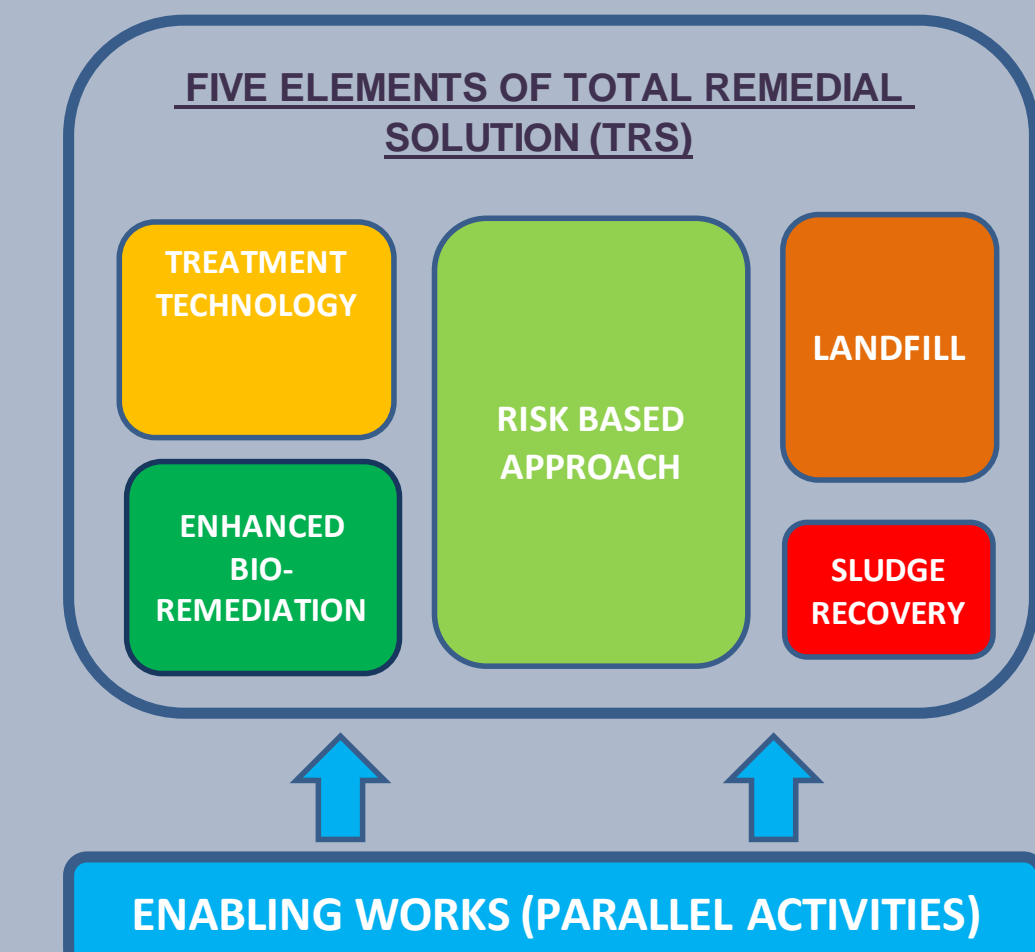
KERP Time Frame

KERP - ESTIMATED SOIL VOLUME TREATED PER YEAR

CUMULATIVE VOLUME

NK E&T, SK E&T, Remed I SK, Remed II SK, Remed III SK, Remed I NK, Remed II NK, Sludge NK, LF NK, RBA

Total Remedial Solution

The TRS will utilize soil remediation technologies together with a reduced scope for soil remediation through use of the Risk Based Approach (RBA). The remedial solutions that make up the TRS comprises of the following five key elements:
1. Risk Based Approach
2. Enhanced Bioremediation
3. Remediation Treatment Technologies
4. Sludge Disposal Via Beneficial Re-use
5. Engineered Landfills

FIVE ELEMENTS OF TOTAL REMEDIAL SOLUTION (TRS)

TREATMENT TECHNOLOGY — RISK BASED APPROACH — LANDFILL — ENHANCED BIO-REMEDIATION — SLUDGE RECOVERY

ENABLING WORKS (PARALLEL ACTIVITIES)

Bioremediation Technologies

Option 2 "Enhanced Bioremediation" is the option to follow for remediation purpose. In-situ bioremediation and Ex-situ bioremediation are examples of bioremediation treatment methods. In-situ bioremediation is used to treat contaminated soils with low TPH level and depth up to 30. On the other hand, Ex-situ bioremediation is used to treat contaminated soils with higher TPH level and depth.

Bioventing (In-situ)
Bioventing is a process of stimulating the natural in situ biodegradation of contaminants in soil by providing air or oxygen to existing soil microorganisms.

Landfarming (Ex-situ)
It is performed in the upper soil zone or in bio treatment cells. Contaminated soils, sediments, or sludge are transported to the landfarming site, incorporated into the soil surface and periodically (Figure 1).

Composting (Ex-situ)
The process depends on mixing the contaminated soil with organic materials, which will enhance and support the microbial growth and present.(Figure 2).

Biopiles (Ex-situ)
Biopiles treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration (Figure 3).

Figure 1   Figure 2   Figure 3

Conclusion

The impact of Iraq invasion in Kuwait environment is still on going. 26 million m³ of Kuwait soil need to be remediated and sseveral technologies of bioremediation treatment methods are available in the market. Determining which treatment methods to use depends on multiple factors such as: cost, TPH target level, and soil characteristics. All of the mentioned technologies will reduce the contaminated soil TPH, which will lead to better environment conditions