

## SEB® Surfactant Enhanced Bioremediation Process Improves F3 & F4 Bioremediation to CCME Guidelines

SEB® Surfactant Enhanced Bioremediation process successfully cleans >4,000 Tons of F3 and F4 hydrocarbon contaminated soils at a remote site in Alberta.

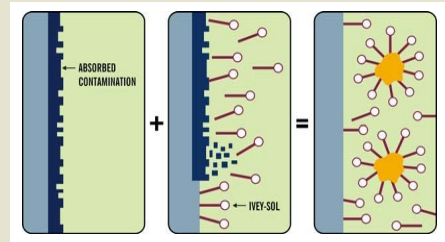
The SEB® process was employed when the subject soils would not respond well to a conventional ex-situ bioremediation treatment. So after a 20 month period of unsuccessful bioremediation; the client and environmental contractor contacted Ivey International Inc. to apply their new SEB® process, which has gained a good reputation as an effective tool for improving heavy-end (F3 & F4) hydrocarbon bioremediation by making the contaminants more Bio-Available to the soil bacteria.

SCOPE: The project goal was to improve the conventional bioremediation process with SEB to achieve the CCME soil clean-up objectives by October of 2006. After application of SEB in mid July 2006, the soils were successfully treated within



4 months to achieve the F3 and F4 CCME soil clean-up goals. The project was a success using SEB!

The principle behind the SEB® process is liberation of the sorbed contaminants off the soils surfaces making them more Bio-Available to the bacteria for mineralization. Typically >95% of all contaminants are sorbed to the soil matrix making them less available to bacteria. This is illustrated below.



Ivey-sol® shown desorbing contamination off a surface. Once liberated, the desorbed contaminants are more Bio-Available to bacteria improving the bioremediation process.

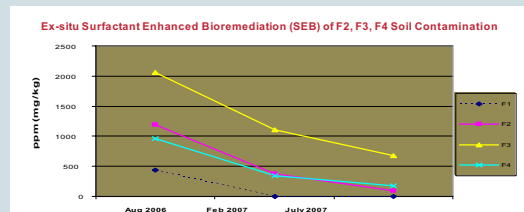
“ After excavating and bio-piling the soil, the surfactant enhanced bioremediation (SEB) treatment was applied and the bio-pile was then covered. Daily aeration was done during the treatment period. After only 12 weeks samples taken from the pile showed that the remediation of the Fuel-oil/Diesel and PAH contamination was completed to the applicable BC Environmental Standards and the soils were safe to re-use on-site. ”

Reference: Tony Robson, former Director, Mining Plant & Equipment  
 Quinsam Coal Corp.; Cell: 1-250-203-4548

## Surfactant Enhanced Bioremediation (SEB) of F2, F3 and F4 Contaminated Soils in Northern Alberta

Ivey International Inc. (Ivey) was retained to apply the SEB (Surfactant Enhanced Bioremediation) technology to remediate 2000 tons of F2, F3, and F4 fine grained contaminated soil at a remote site in northern Alberta. The SEB process enhances the bioremediation of F2, F3, and F4 hydrocarbons by desorbing the contamination and making it more 'bio-available' to the indigenous soil bacteria. F3 and F4 hydrocarbons are well known for their resistance to conventional bioremediation which can take 24 months to achieve remediation objectives. The project was commenced in late August;

just prior to the on-set of colder northern weather in an area know for -20°C to -40°C winter temperatures. The actual period for effective bioremediation in this climate is limited to only 4 to 6 months. The SEB process was effective in achieving the soil remediation goals in <11 months, commencing with average baseline hydrocarbons concentration of F1 441 ppm, F2 1,189 ppm, F3 2,064 and F4 965 ppm. The total per cent reduction in each hydrocarbon fraction was: F1(100%), F2 (91%), F3 (66%), and F4 (80%) to achieve the applicable Alberta Environment Tier 1 Soil Remediation Guidelines.



During the past decade, much discussion has centered on the unavailability of absorbed compounds to soil microorganisms. It is now assumed that desorption and diffusion of bound contaminants to the aqueous moisture phase is required for microbial degradation (W.P. Inskeep, J.M. Wraith, C.G.

Johnston, Hazardous Substance Research Center, 2005). This reality limits the effectiveness of conventional bioremediation for treating absorbed F2, F3 and F4 contamination in soil. SEB overcame these limitations permitting the rapid and economical biodegradation of recalcitrant F3 and F4 compounds.

### SEB Soil Remediation Results

	F1	F2	F3	F4
August 2006	441 ppm	1,189 ppm	2,064 ppm	965 ppm
February 2007	2 ppm	376 ppm	1,107.5 ppm	347.5 ppm
July 2007	n.d.	106.6 ppm	694 ppm	194 ppm