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A Large-Scale Demonstration Project

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In Situ Alkaline Hydrolysis (ISAH) of Insecticides: A Large-Scale Demonstration Project

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Background and Objectives. An estimated 100 tons of the highly acute toxic organophosphorous insecticides ethyl-parathion, methyl-parathion, malathion and ethyl-sulfotep are found in the saturated zone, 3-8 meters below the soil surface at a former chemical dumpsite located on the beach on the west coast of Denmark. The dumpsite, five acres in size, was hydraulically isolated to a depth of 14 meters by an iron sheet piling in 2006 to stop further leaching of the contaminants to the North Sea. The environmental authorities in Denmark have tested a novel soil remediation technique based on in situ alkaline hydrolysis (ISAH) of the insecticides.

The concept of the ISAH method is that organophosphorous insecticides with low aqueous solubility are hydrolyzed in the subsurface under alkaline conditions to water-soluble hydrolysis products that can then be addressed by pump-and-treat. The ISAH technology has not been widely applied as an in situ groundwater remedial tool to date.

A European Commission funded demonstration project (www.northpestclean.dk) was carried out in 2010-2013 with the primary objective to determine the effectiveness of ISAH and to test, in side-by-side field experiments, techniques to enhance delivery and contact between the reagent (caustic soda) and the contaminants in the subsurface.

Approach. The demonstration experiments were carried out in three test cells (10m × 10m) constructed by 15 meter deep iron sheet piles to create hydraulically isolated compartments. The test cells were placed in the hot-spot area of the former chemical dump site.

Prior to the start of the ISAH experiments high resolution site characterization was performed to identify the initial contaminant distribution. Demonstration experiments were initiated by draining the groundwater from the test cells and replacing it with caustic soda (pH 13). After infiltration of caustic soda the alkaline hydrolysis progress was monitored in each test cell by analyzing: (1) water samples collected from 30 depth-discrete monitoring wells for contaminants and hydrolysis products and (2) soil samples for contaminants at the end of each experimental stage.

Three cycles of experiments were performed in the test cells during 2010-2013. In the first cycle of experiments, the test cells were treated “passively” with caustic soda. In the second and third cycles, the effect of different “contact enhancement techniques” (vibration, surfactants, recirculation and air-sparging) were tested for their ability to increase the methods effectiveness by enhancing in situ contact between the caustic soda and the contaminants.

Results. The concept of the ISAHmethod and the final results of the project will be presented, including a critical review of the effectiveness of ISAH in the remediation of the ethyl-parathion, methyl-parathion, malathion, and ethyl-sulfotep contamination.