USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Experimental Analysis and Modeling of Diesel Fuel Bioremediation in a Tidally Influenced Aquifer

Duration: 08/1996 - 07/1997. Continuation: 08/97-07/98.

FY 1996 Federal funds:$ 29,843

FY 1996 non-Federal funds**:** $ 60,891

Principal Investigators' Names and University:

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Congressional district of university where the research is to be conducted:First

Statement of critical regional or State water problems

In many sites world-wide including the United States, soil and groundwater contamination by hydrocarbons has become a serious environmental problem because of its adverse health effects. Examples of such liquids include gasoline, diesel, fuel oil, trichloroethylene (TCE) and tetrachloroethylene (PCE). These products, which are also described as multiphase contaminants, enter soils and groundwater through leaks at chemical product storage and at waste disposal sites and facilities. It is estimated that of the 1.4 million buried tanks, 75,000 to 100,000, are currently leaking, and the final count could reach as high as 350,000 (Brown et al., 1985). For example, in pipeline accidents, 157,760 barrels of gasoline and crude oil were lost to the environment in 233 reported accidents in 1971 (Meyer, 1973). Here in Hawaii, many sites exist where contamination by petroleum products poses a serious environmental threat. Coastal areas includes a number of sites where significant plumes of free products are known to be present in the subsurface. Some of the documented sites are the Gray Line Site, Honolulu Harbor area, Honolulu International Airport, Hickam Air force Base, Pearl Harbor Naval Complex, and Campbell Industrial Park (R.D. Brewer, Hawaii's Dept. of Health; Personal Com., 1996). All of these sites are on the Island of Oahu and are known to have impacted or could potentially impact the sensitive marine areas. An urgent need exists to assess the fate of such products in the subsurface and identify the best remediation strategies. The State agencies will surely benefit directly from such research. Management decisions should include many factors that will be examined by such research. such as the urgency of a remediation process.

In situbioremediation of petroleum hydrocarbon pollutants in aquifers is a technique which is receiving increasing attention as an alternative, or an adjunct, to the costly

pump-and-treat process to decontaminate groundwater and subsurface matrix (Semprini et al., 1991; Devlin and Barker, 1994; Aggarwal et al., 1991).

The Environmental Protection Agency is encouraging the use of bioremediation in the field (Kremer & Kovalick, 1991). Indigenous microbial populations have the potential to transform petroleum hydrocarbons to non-noxious products such as water, carbon dioxide and minerals. However, they must be supplied with enough oxygen and inorganic nutrients (nitrogen, phosphorus, micronutrients) to be able to incorporate the organic carbon into microbial biomass (Aggarwal et al., 1991; Atlas, 1991). The advantage of microbial degradation lies in the ubiquity of microorganisms, which enables them to act on pollutants located in hard-to-reach areas and in areas where the pollutants are trapped in the subsurface matrix. A need exists to examine the suitability of this technique for the cleanup of near-shore aquifers, such as those in the Hawaiian islands.

Statement of results or benefits

This research is critical in assessing the fate of hydrocarbons in a near-shore subsurface environment. A specific and well-documented site will be used in the analysis. The fate of the product and its dissolved phase will be predicted to identify the urgency of remediation. A laboratory bioremediation experiment will be done to assess the potential of such an approach as viable field technique under pertinent conditions. The results are expected to be of great benefit on both the basic and applied research level. The results will be published in scientific journals and will be submitted to local and state agencies, specially the Department of Health, for their use in assessing various contaminated sites of the same nature.

This project is expected to: 1) determine the potential of Hawaii microorganisms to degrade substantially the constituents of diesel fuel contaminant in an aquifer where the water is brackish and the bioremediation process is affected by the tide; 2) shed light on the rapidity of the bioremediation process at 18 degree C when the environmental conditions favor the multiplication of the hydrocarbon degraders (addition of oxygen and nutrients); 3) show the pattern of the decrease of hydrocarbons with time (e.g. a rapid decrease at the beginning followed by a plateau or a slow, linear pattern); 4) identify the fractions of diesel that are more recalcitrant to biodegradation even in the improved environment; 5) identify the extent (if any) of the degradation and the nature of some diesel fractions that may disappear under anoxic conditions (nonaerated controls); 6) provide profiles of growth of hydrocarbonoclastic microorganisms; 7) provide basic data to generate a model of the bioremediation of diesel in aquifers; 8) assess the risk to the marine environment under a no-remediation option, 9) provide recommendations for the development of a protocol to do the *in situ* experiment during the second year and for future similar bioremediation projects.