CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

REPORT ON 2003 RESEARCH PROJECTS

ENVIRONMENTAL RESEARCH ADVISORY COUNCIL

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REMEDIATION OF HYDROCARBON-CONTAMINATED SITES BY MONITORED NATURAL ATTENUATION

WHAT IS THE PURPOSE OF THIS PROJECT?

Recent U.S. studies have shown that many petroleum industry subsurface contaminants do not migrate as far as expected. Contaminant plumes often stabilize or shrink due to a series of naturally-occurring physical, chemical and biological processes. These attenuation processes can include dilution, sorption, volatilization, chemical transformation, plant uptake and biodegradation. Monitored natural attenuation (MNA) describes how such natural processes reduce the environmental impacts of these contaminants over time and meet cleanup goals without human intervention.

The purpose of this five-year project is to evaluate MNA as a cost-effective method for remediating contaminated sites to acceptable environmental levels at upstream oil and gas sites in Alberta. At many such sites, the subsurface soils and groundwater have been contaminated by BTEX, condensate, crude oil, other soluble processing chemicals and salts.

Investigate monitored natural attenuation of hydrocarbon contamination as a cost-effective method of cleaning up sites in Alberta's upstream petroleum industry.

A major focus of this study is to better understand how attenuation processes work in different situations – various contaminants in different soils and geological formations – so as to better predict where this approach will work in a timely fashion. If MNA proves effective, it would offer an economical alternative, in many cases, to more aggressive interventions such as intercepting or excavating the contamination plume. The monitoring aspect of this approach is important to confirm that natural attenuation processes are indeed working, and that contaminant plumes are not threatening nearby landowners or sensitive ecosystems.

HOW IS THE PROJECT BEING CONDUCTED?

The study is being conducted by the Consortium for Research on Natural Attenuation (CORONA), out of the University of Alberta. The CORONA study began in 2000 with researchers evaluating monitoring data from approximately 125 upstream Alberta sites containing contaminant plumes. Based on this review – which provided clear, but indirect, evidence of natural attenuation - three Alberta sites were selected for detailed field studies. The studies include detailed site characterization, evaluation of groundwater sampling systems and comparison of tests to measure biological activity. Considerable research is focused on comparing sampling methods and understanding influences related to well construction, seasonal variations, natural variability and influence of well purging.

Laboratory studies are also examining the effects of adding nutrients and terminal electron acceptors on anaerobic biodegradation of petroleum hydrocarbons at two of the contaminated sites. As well, a method is being developed to analyze biodegradation metabolites, or byproducts, to provide direct evidence of biodegradation. As all of this data is gathered and processed, it will be used in geostatistical and groundwater modeling work to gain insight regarding MNA.

In one parallel study conducted jointly with National Water Research Institute-Burlington, sulphate amendment was injected into a second field site in 2003 to test its ability to enhance biodegradation. Monitoring of the first site (amended in 2002) also continued. A second, parallel study being conducted with the University of Saskatchewan is comparing two methods for identifying bioactivity. A third study by University of Calgary researchers is evaluating an improved way of measuring dissolved gases, which are an indicator of biodegradation.

WHAT ARE THE RESULTS?

- In the field, sulphate injections showed promise as a means of enhancing biodegradation.
- Diffusion samplers made from dialysis membranes developed during the study worked well in early testing at both sites, and the dissolved gas sampling system was a significant improvement over standard testing methods.
- Winter inhibition of biodegradation appears to be a factor in shallow groundwater at one study site, but does not appear to be significant at the other sites where water is present at three to six metres deep.
- Purging does not seem to affect sampling results at some sites but appears to have a negative influence at others.
- One site shows considerable variation in analyte concentrations from closely-spaced sampling wells.
- The initial biological activity assessments have not produced enough data to be conclusive.

Overall, monitored natural attenuation appears to be a viable remediation strategy for some of Alberta's upstream oil- and gas-contaminated sites. However, there are still considerable differences in results from one site to another and even within sites, depending on such things as groundwater depth and stratigraphy. Questions remain about how best to collect appropriate data to determine if natural attenuation will occur on any given site.

WHAT HAPPENS NEXT?

Detailed sampling will likely conclude in 2004. Computer models are being developed to help evaluate natural attenuation processes, taking into account uncertainties in geology, water flow, chemistry and microbiology. Guidelines must still be established for how best to sample and evaluate MNA, and to examine how long it takes, on average, for contaminated sites to be considered sufficiently remediated by natural attenuation.

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