

Bioremedial Options*

Dr. Al Jobson, Stantec Consulting Ltd.

Site contamination can involve either organic or inorganic fugitive compound(s) or element(s). This brief review will concentrate on possible bioremedial options for organic pollutants in soil or groundwater, or both.

Certain contaminated sites afford the opportunity, based upon an environmental impact assessment or an environmental risk assessment, to allow “natural processes” to take their course over an extended time period. This is referred to as natural attenuation. This process is primarily biological in nature, but can also involve physical parameters as well, including solution, dilution, evaporation, precipitation, complexing processes and adsorption. Thinking of “non-action” as a remedial option depends upon the nature of the contaminant(s), the microbial population surviving/existing/metabolizing within the contaminated zone, the degree of contamination (existence of free product) and whether the contamination impacts only the vadose zone or both the vadose and the saturated zones.

Undertaking an active in situ bioremedial treatment program can involve a number of options and varying levels of complexity. In its simplest form it might involve the injection of nutrients such as ammonium, nitrate, phosphate, or micronutrients at groundwater depths to stimulate the growth of microorganisms already present in this environment. In some cases air is injected at groundwater depths, or within the vadose (unsaturated) zone in an attempt to provide a more aerobic environment for the existing microbial population. In other cases alternate electron acceptors such as nitrate are injected within the contaminated zone to allow specific microbial groups (denitrifiers) to metabolize contaminants in a manner similar to aerobic organisms without the need for molecular oxygen to be present.

Another technique gaining acceptance is the injection of oxygen releasing compounds at contaminant depths. These compounds gradually liberate molecular oxygen into this environment over several weeks or months and thereby stimulate aerobic microbial growth, which will hopefully be at the expense of the in situ contaminant compound(s).

Bioventing refers to the injection of air at varying depths within a contaminated soil profile in order to cause volatile contaminant compounds to be carried to the soil surface and be “vented” to the atmosphere. In some cases the near surface soil is fertilized to

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stimulate microbial activity which will, in turn, adapt to growing on the stream of volatile contaminants passing through it. This system is sometimes referred to as a biofilter.

A more complex in situ biotreatment option employs a system of harvesting groundwater and soil vapor from a contaminated soil region, passing this material through a fermentation process at the surface and then re-introducing the fermentation liquid back into the contaminated soil zone, usually up-gradient from the region where the contaminated groundwater was originally harvested. When successful, this system allows the captured groundwater to be decontaminated, while at the same time introducing an active, induced and increasingly large microbial population back into the zone of contamination. Such technologies have been given various functional names, including bioslurping and biosparging.

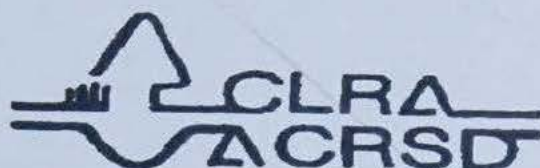
If it is necessary to excavate and treat contaminated soils and groundwaters ex situ, various techniques are again available. Groundwater can be pumped, biotreated in a reactor or a fermenter and then released directly into the environment, or to a sanitary sewer system. Groundwater and often large quantities of contaminant materials can be captured for ex situ biotreatment by means of a high vacuum dual phase extraction system. Although relatively expensive to operate, these systems are capable of harvesting large volumes of contaminated groundwater as well as free contaminant material. In some cases it is a cost-effective option to biologically treat the contaminated co-produced water.

Excavated contaminated soil can be landspread, landfarmed, biopiled, or bioreacted in a constructed bioreactor or a slurry reactor. Microbial treatment via these techniques has proven successful for a wide variety of contaminant organic compounds.

Phytoremediation is an emerging and increasingly recognized bioremedial option. It includes the use of phreatophytic plants to consume large volumes of groundwater, thus preventing net groundwater flow further downgradient. This, in turn, can help to prevent further downgradient movement of contaminant plumes. Phytoremediation also describes the essential role aquatic plants play in the bioremedial capability of constructed wetlands. Phytoremediation also refers to the use of plants (and their root systems) to act as primary hosts for microbial populations which, in turn, have the ability to catabolize contaminant organic compounds. It is theorized that as plant roots push forward in their soil environment the associated microbial population will remove soil organic contaminants which might otherwise prove toxic to these plants. Much still remains to be learned regarding this possible symbiotic activity in circumstances of severe soil contamination.

Perspectives in Land Reclamation and Restoration

Presented by:



Canadian Land Reclamation Association/
Association Canadienne De Réhabilitation Des Sites Dégradés



Including the Canadian Land Reclamation Association's
24th Annual Meeting

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7:00 - 9:00 Registration Booth Open

Tuesday, September 28th

7:15 - 7:45 AM Registration

7:45 - 8:00 AM Bus Loading from Saskatoon Inn Lobby

8:00 AM Field Tour Departure (no delays)

7:00 - 10:00 PM Wine and Cheese, Registration

Wednesday, September 29th

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7:30 Registration

8:00 - 8:05 Introductory Remarks – Saskatchewan Room ‘B’
Tracy Patterson (CLRA) and Theresa Salamone (SEIMA) n/a

8:05 – 8:25 Opening remarks from Saskatchewan Environment and
Resource Management n/a

8:25 – 10:05 Saskatchewan Policy – Saskatchewan Room ‘B’
Session Chair: Lorne Veitch – Saskatchewan Agriculture and
Food, Lands Branch, Swift Current

8:25 – 8:45 Drilling waste management guidelines.
Todd Han, Saskatchewan Energy and Mines..... n/a

8:45 – 9:05 Saskatchewan upstream petroleum sites remediation guidelines.
Todd Han, Saskatchewan Energy and Mines..... n/a

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Lotfi Haji, Cameco..... n/a

3:05 – 3:25 Rare Plant Rescue During Pipeline Construction (*Erigeron*
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the 1998 Foothills Pipe Lines Expansion Project.)
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University of Saskatchewan

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Alvin Anderson and Glenn Padbury, Agriculture and
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Awards

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Dr. Bob Russell, Department of Sociology, University of Saskatchewan n/a

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