Workpackage K: Novel special-purpose composts for the sustainable remediation of Brownfield sites

Objectives

- To develop a novel sustainable remediation technique that will rely on the use of waste produced materials (composts) combined with naturally occurring minerals (clays, zeolites) in order to enhance the biodegradation and immobilisation capability of the compost.
- To perform a fractional factorial design to optimise the number of special-purpose compost design mixes that will have to be developed, characterised and assessed for their effectiveness during the course of this study.
- To select from the SUBR:IM portfolio, appropriate sites for investigation, soil sample collection and detailed characterisation in order to identify the nature of contaminants for remediation.
- To perform nursery-based trials to evaluate the effectiveness of the technology by monitoring the bio-availability of the contaminants of concerns to plants under specific experimental conditions
- To perform field trials on a selected site subject to external support and funding

Conceptual Model

Soil remediation by the use of compost is an emerging technology that is gaining considerable acceptance due to its success for the treatment of various contaminants and its environmental friendly principles. The relatively high success of this technique strongly suggests that particular activities of compost can be enhanced, thereby increasing its effectiveness. Special-purpose compost can be developed to enhance specific attributes, produced from particular feed stocks to increase activity and sorption. Most of the research published in the field is based on the use of a fairly random selection of un-amended composts. Moreover, substantial literature indicates that naturally occurring minerals play a major role in controlling the environmental fate and availability of both organic and inorganic contaminants. Very little of this work, however, has been applied to improving the remediation capability of organic compost. One particular area of interest is the improvement of both the metal and organic-binding capacity of composts by the addition of inorganic materials. Published research by several investigators indicates that some naturally occurring minerals such as clays and zeolites interact with metals to form a matrix in which the bioavailability of the metals is remarkably decreased. This attribute coupled with the biodegradation capability of the compost could provide a unique and novel remediation technique. The ultimate goal of the technique will be to return the site to its pre-contamination condition, which will include re-vegetation to stabilize the treated soil. In addition to reducing the contaminant levels, the compost will advance this goal by facilitating plant growth and providing soil conditioning and nutrients to a wide variety of vegetation.

Methodology

Task 1 - Development and assessment of zeolite and bentonite-enhanced composts

The first part of the study will aim to use two naturally occurring minerals, natural zeolite in the form of clinoptilolite and a clay material, bentonite. The choice is based on the extensive published literature available on the use of these materials for a wide range of pollution control purposes which will facilitate comparison studies. A detailed physical/chemical characterisation of these two materials will be performed in order to determine their elemental composition and cation exchange capacity. Composts from different waste origins will be collected and screened prior to use. The second phase will involve the use of a fractional factorial design analysis to optimise the number of special-purpose compost design mixes (compost/mineral ratio) that will have to be developed, characterised and assessed for their effectiveness throughout the course of this research programme.

Task 2 - Selection of site, investigation, samples collection and characterisation

Site investigation and soil samples collection will be undertaken on a selection of sites chosen from the SUBR:IM portfolio of sites. Selected soil samples will be collected and characterisation performed in order to identify the nature of the contaminants of concern. This preliminary information is imperative for determining the extent of contamination and subsequently selecting the appropriate plant species and vegetation for the remediation process.

Task 3 - Validation and application of the novel technique via laboratory, nursery/field trials

Biological indicator methodologies using selective plant species will be used and further refined to indicate the efficacy of the technique. Uptake and compartmentalisation of contaminants in the plants biomass will be used to investigate changes in availability. Plant health will be used as an indicator of toxicological response and changes in contaminant speciation, absorption and metabolic breakdown will be monitored using standard sequential extraction techniques. Leaching tests and laboratory-based magnetic resonance imaging studies will be carried out to examine the system dynamics and the controlling factors in the remediation and re-vegetation processes. On-site pilot scale studies will be set up to demonstrate the effectiveness of the developed technique at predicting and improving the environmental benefits and risks. This later part of the work will be carried out ONLY if external support for the set-up of a demonstration unit is found. It is expected that a generic understanding of the technology performance for future large-scale applications will be developed for potential applicability of this sustainable remediation technique as an alternative to the more conventional ones.