

## Summary: Biological Test Methods for Assessing Contaminated Land

Stage 2: A demonstration of the use of a framework for the ecological risk assessment of land contamination. P5-069/TR1/S

The Environment Agency has developed a scientific framework for assessing the risk of significant harm to an organism, animal or whole ecosystem on potentially contaminated land sites. The framework demonstrates best practice in Ecological Risk Assessment (ERA), which plays an increasingly important part of the decision-making process for managing environmental problems. It will help ensure a consistent approach within the UK to fulfilling the requirements of a number of regulatory regimes in assessing the risks of land contamination.

The ERA framework is primarily for use by Local Authorities, Agency staff, industry and other experienced ERA practitioners to assess potentially contaminated sites in a transparent, consistent and rigorous way. It is **not** an 'expert system' for use by other practitioners. The complexity of the data accrued by an ERA, and the importance of auditing and justifying decisions taken at every step, mean that it is **not** appropriate as an 'expert system' for other practitioners. In addition, the framework is designed only for assessing risks from soil contaminants, and does not address the effects of other stressors, such as physical soil structure, climate change and alteration of land use.

Though primarily intended for use in Part IIA of the Environmental Protection Act, 1990, the framework could also be used to support other regimes where ecological protection is the objective, such as the Town and Country planning acts and the Habitats Directive.

The use of a comprehensive ERA framework will ensure:

- Early identification of risks to (and contamination of) the terrestrial environment;
- A clear decision-making process on managing (and reducing) risks from land contamination;
- Enforcement of the 'polluter pays principle' to the management of land contamination;
- Safe re-use of brownfield sites.

This project developed a four tier decision-making framework to identify sites where chemical contaminants may pose risks to organisms or whole ecosystems. It will enable the Agency and others to focus effort and resources on the sites of most concern. The Agency hopes that this approach will lead to transparent decision making and form the basis for discussion about a proposed course of action between relevant parties, such as site owners, regulatory authorities and the local community.

The framework consists of four tiers which increase in complexity as you progress through them. The early tiers of the framework help identify sites with potentially significant risks and screen out sites with minimal risks. The proposed framework has defined entry and, importantly, exits at each tier, so that successive tiers are used only when a decision regarding potential risk cannot be reached at a lower tier.

To make a defensible decision about the potential risk of a site to the ecoreceptors present, the following categories of data should be collated and assessed:

- chemical data on contaminants present at a site, their form and concentration;
- biological data i.e. microbial, plant and invertebrate tests;
- ecological survey data on the extent and condition of populations and individual organisms of concern.

This combination of chemical, biological and ecological data (often referred to as a triad approach) provides a sound basis for decision making and site management.

Traditional chemical and toxicity assessments cannot by themselves fully answer questions about the ecological integrity of a contaminated site. The biological tests in the higher tiers of the framework detect the potential for harmful effects on organisms *before* those effects occur. By identifying specific molecular, biochemical, physiological and behavioural changes in populations of animals and plants following contaminant exposure, biological tests may provide an early warning of impending ecological change.

The large number of possible soil contaminants and the wide ranging sensitivities of wildlife in an ecosystem mean that it is not possible to recommend a single biological test for use in all circumstances. A key aspect of the framework is the inclusion of a suite of biological tests that can be used to help to determine if organisms present at a site are at risk of harm from soil contaminants. It is also impossible and, in some instances, illegal (where protected species are concerned) to toxicity test every organism in every ecosystem. The use of surrogate species in ERA is the only way forward at present. For example, the earthworm is a standard toxicity test organism because it is a robust laboratory animal, it lives in intimate contact with the soil and represents a key ecological organism in the functioning of soil processes.

The tests use a range of microorganisms, soil invertebrates and plants. The following tests were assessed:

- An acute earthworm toxicity test;
- A chronic springtail reproduction test;
- A germination and root growth test with a monocotyledon crop plant such as barley;
- A germination and root growth test with a dicotyledon plant such as cress;
- A microbial nitrogen mineralisation test;
- A microbial carbon mineralisation test;
- Microbial toxicity test with *Vibrio fischeri* (for example Microtox™);

Biological tests can be used in both generic and site-specific assessments within an ERA. The early tiers of the risk assessment could be carried out using simple, relatively inexpensive generic tests such as Microtox™. These tests can help to determine which sites warrant further investigation. Higher tiers employ tests that are more site-specific. The extra effort and expense of these tests will be offset by the generation of data that is more relevant and specific to organisms of concern.

The framework and the suite of tests were trialled at two real sites in the UK; one site contaminated by metals and another by petroleum hydrocarbons.

The performance of the framework and the suite of tests was assessed to determine their potential usefulness within Part IIA of the Environmental Protection Act, 1990. The criteria included a judgement on the reproducibility, responsiveness, robustness and relevance of the biological tests i.e. do they consistently provide useful information on which to make a decision. A proposed use within the ERA framework has been suggested, highlighting those tests that performed best and where they could most usefully be used.

The suite of tests suggested for use within the framework include the Microtox™ test, plant and earthworm tests. A number of the other trialled tests will need some modifications before their routine use can be recommended.

This Summary relates to information from Science Project P5-069 reported in detail in the following output:-

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