# Whole-sediment ecotoxicology

## CSIRO provides a specialist capability for bioavailability and ecotoxicology assessment of contaminated sediments.

Sediments are the ultimate resting place for the many contaminants that enter our waterways. Once contaminants are present in n an ecosystem they remain a potential hazard to organisms that use sediments as a refuge, a habitat or a source of food. The sediment quality guidelines (SQG) framework within the Australia and New Zealand Water Quality Guidelines [1] provides guidance for assessing the severity of sediment contamination and assists in the management of sediments [2].

The framework uses a tiered decision-tree approach, first using sediment chemical anal lyses to determine whether any contaminant concentrations exceed a guideline value (GV). The exceedance of a GV usually triggers additional assessment steps to provide lines of evidence to determine whether there is indeed a risk posed by the contaminant [1, 2]. These usually first involve assessing the bioavailability of the contaminants of potential concern (COPCs), the en examining whole-sediment toxicity tests to assist in determining the likelihood for ecological effects from sediment contaminants that exceed the GV [1, 2]. The examination of benthic ecology and bioaccumulation are further lines of evidence that can be evaluated in a weight-of-evidence approach [3, 4].

The sensitivities of benthic organisms to contaminants will differ between species and contaminants due to differences in organism behaviour (burrowing, feeding, life-cycles), contaminant exposure pathways (filter or deposit feeders), and the properties of the contaminant (partitioning and bioavailability) (Figure 1).

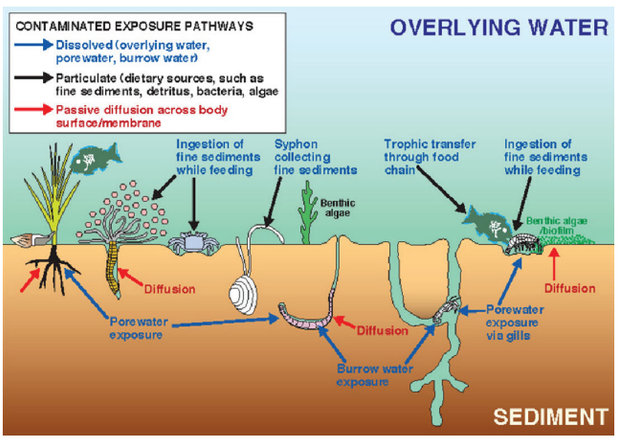


**Figure 1. Conceptual models of receptors organisms and their potential exposure routes in sediments.**

**Amphipod**
***Melita plumulosa***

**Harpacticoid copepod**
***Nitocra spinipes***

**Bivalve *Tellina deltoidalis***

## Assessing sediment toxicity

For sediment ecotoxicology assessments, it is therefore important to select test species to cover all potential routes of exposure. Sub-lethal, organism-level endpoints, such as reproduction (number of offspring produced), are generally more sensitive and more relevant for assessing risk than acute lethality endpoints (e.g. survival). Sub-lethal responses are generally considered as chronic endpoints and provide greater information on the potential for long-term effects at the individual and population level. Within Australia, a range of robust and well-established sub-lethal, but relatively rapid (10-day) whole-sediment bioassays are available for ecotoxicology assessments. For marine sediments, the benthic alga, *Entomoneis* cf *punctulata* [5] the amphipod, *Melita plumulosa* [6, 6] the bivalve, *Tellina deltoidalis* [8], and the harpacticoid copepod, *Nitocra spinipes* [7, 9], are used a as test organisms. For freshwater sediments, the chironomid, *Chironomus teperri* is used and further methods are under development, e.g. with the bivalves and snails.

The estuarine-marine amphipod a and copepod species are amenable to testing for the effects of contaminants in a full spectrum off sediment types (sand to silt, high to low organic carbo on) [7]. Both species are proving to be robust organisms for assessing sediment toxicity, providing suitable sensitivity to contaminants and yielding useful information on contaminant bioavailability (Figure 2a). The benthic microalgal bioassay is particularly suitable for assessing the toxicity of metal- and hydrocarbon contaminated sediments and pore e waters (Figure 2b) [10].

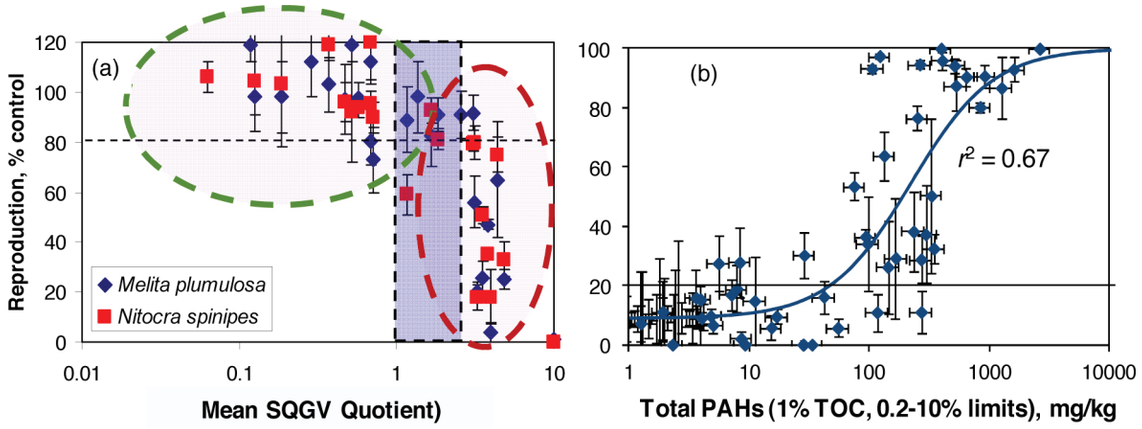


**Figure 2. Toxic effects of sediments to (a) the reproduction of the amphipod *M. plumulosa* and copepod *N. Spinipes* [6], and (b) the benthic alga *Entomoneis* cf *punctulata* [9]. The chemical hazard quotient is the ratio of the contaminant concentration and corresponding guideline value (mean of all contaminants).**

## Specialist applications

The CSIRO Centre for Environmental Contaminants Research (CECR) situated at Lucas Heights, in Sydney, were primarily responsible for the development of the Australian and New Zealand sediment quality guidelines and continue to be at the forefront of international sediment research [11, 12]. CECR offers a comprehensive range of toxicity tests within quarantine-approved premises as part of sediment quality and environmental impact assessments for both government and industry, to:

- determine the risk of chronic toxicity from marine and freshwater sediments
- evaluate the acceptability of sediment dredging and dredged sediment disposal
- derivation of site-specific management limits
- identify contaminants responsible for sediment toxicity, and
- identify areas in need of modified management or remediation.

Quarantine Approved Premises (QAPs)

## References


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