Water Quality

Testing for toxicity in our aquatic environment

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Using native species to assess the impacts of chemical discharges on ecosystems is set to become a key technique in relation to Water Quality requirements under the Resource Management Act.

THOUSANDS of different chemicals are in daily use. Their purposes range from household cleaning to contributing to large-scale industrial processes. Many will at some stage find their way back into the environment in one form or another. Those not released into the atmosphere may be discharged into streams or rivers or into the sea, perhaps with some kind of "treatment" first (e.g. in oxidation ponds). Some may gradually leach through the soil into watercourses or end up as components of marine or freshwater sediments.

The effect of these chemicals on marine and freshwater ecosystems depends on their concentration, their toxicity to organisms at this concentration, and how long the toxicity persists.

The impacts of high doses of toxic chemicals are often obvious, resulting in fish kills and extensive destruction of aquatic life. However, an increasing challenge for scientists is to assess the effects and fate of low levels of contaminants which are often associated with organic and nutrient enrichment.

Major sources and types of contaminants in New Zealand

Source	Contaminants
Agriculture	ammonia, hydrogen sulphide, cadmium, pesticides
dairy, tannery, piggery	
Mining	heavy metals, suspensoids
Forestry	resin acids, chlorinated organics, dioxins
pulp & paper	copper, chromium, arsenic, PCPs, chlordane
timber treatment	
forestry operations	
Geothermal	mercury, arsenic, boron
Stormwaters	heavy metals, PAH, suspensoids
Harbour dredging	heavy metals, organics
Municipal wastes	ammonia, hydrogen sulphide, pesticides (and numerous others)

Assessing toxicity

Techniques are available for the identification and measurement of many chemical contaminants down to extremely low concentrations, but the only way to measure toxicity is to test the effects of a substance on living organisms. There are two approaches to assessing the potential toxicity of a water or sediment sample. A detailed chemical analysis of the sample can be made, followed by reference to published water quality criteria which give "safe" concentrations for the contaminants identified. Alternatively, toxicity can be assessed directly using a biological toxicity test.

Comparison of chemical measurements versus bioassays for assessing toxicity

Chemical measurements

Advantages:

- Treatment systems are more easily designed to meet chemical requirements because the procedures are well-established.
- The fate of a pollutant can be predicted through modelling.
- Chemical analyses may be less expensive than toxicity testing.

Disadvantages:

- In complex samples, not all potential toxicants may be identified; therefore the control requirements set may be incomplete.
- It is not always clear which compounds are causing toxicity.
- Measurement of individual toxicants can be expensive, especially in complex samples, and for organic chemicals.
- The bioavailability of the toxicants at the discharge site are not assessed, and the interactions between toxicants (e.g., additivity, antagonism) are not measured or accounted for.

Toxicity bioassays

Advantages:

- The aggregate toxicity of all constituents in a complex effluent or contaminated sediment is measured.
- The bioavailability of the toxic constituents is assessed, and the effects of interactions of constituents are measured.
- It is easily understood by the public, and provides tangible evidence of environmental impact (or lack of it).

Disadvantages:

- Properties of specific chemicals (such as potential for bioaccumulation) are not assessed.
- Wastewater treatment engineers cannot identify specific toxic components and current levels of experience limit ability to design or manipulate treatment systems.
- Where there are chemical/physical conditions present (e.g., pH changes, salinity changes, photolysis) that act on toxicants in such a way as to "release" toxicity downstream (or away from the discharge point), such toxicity may not be measured.