

Water & health

A Guideline for the selection of toxicity tests

The WRC has established a guide for the selection of toxicity tests that support the information requirements of the National Water Act.

Toxicity test

The term 'toxicity test' often has different meanings for scientists and water quality managers. To ensure a common understanding for project execution, the following definition was adopted: A toxicity test is defined as an experimental procedure that measures, under defined conditions in the laboratory or in the field, the toxic effects of chemical pollutants in water on a group of living organisms, or a cellular, or a sub-cellular system. The scope of toxicity testing was further delineated by detailing the capabilities of testing, but also highlighting the features that are excluded from toxicity testing.

Aquatic toxicity tests

Biological toxicity tests are ideally suited to assess the effect of stressors. A number and variety of toxicity tests internationally available for aquatic toxicity testing have been established for South African use. However, because of the limited appreciation of their application potential, toxicity tests have not been used to their full potential to set the standards for source-directed controls under the National Water Act (NWA) or to elicit site or situation specific responses to a stressor.

It was thus deemed necessary to contextualise the tests available in South Africa and elsewhere, and to identify the gaps regarding specific tests, and to establish a guide for the selection of toxicity tests in order to satisfy the information requirements of the NWA.

Resource-directed measures and source-directed controls

The NWA makes provision for two inter-dependent and complementary strategies of resource-directed measures and source-directed controls to protect water resources. An effect-base is apparent in both the resource directed measures and the source-directed controls. Effect assessments could be applied within a law enforcement context, namely to set standards used

in source directed controls. An effect assessment could also be applied to elicit a site- or situation specific response to a stressor. This will be required where objectives are set in resource directed measures. Each of these applications have a different set of test requirements with reference to precision, test organism/test material choice, exposure time, etc.

Information requirements

The NWA was carefully examined to identify contexts that could potentially benefit from information from toxicity tests. Considerable insight was obtained during discussions on how DWA approaches the implementation of the NWA. For example, much emphasis is placed on the nature of the water use, *e.g.* as categorised in the South African Water Quality Guidelines (1996). Water uses typically define target systems (*i.e.* those affected by toxicity like humans, animals, etc.), which provide a useful link with effect-based thinking. The Water Quality Guidelines were thus also examined for inputs into the information requirements.

While perusing the NWA and Water Quality Guidelines various generic water sources were identified that could serve as origins of samples for toxicity tests. A series of management contexts were identified that would require toxicity test information, involving both the identified NWA contexts and the generic water sources. In Addition, a series of management criteria were identified and defined. These included generic management criteria and other criteria. Classification options associated with each generic management criterion were also identified. Finally, each management context was allocated an appropriate classification for each generic management criterion.

NWA contexts

The following were identified to benefit from toxicity test information:

- Resource context – Classification and setting resource quality objectives;
- Reserve determination – basic human needs;
- Reserve determination – aquatic ecosystems;

- Monitoring ecosystem health;
- Monitoring compliance with resource quality objectives;
- National status and trends monitoring;
- Source context – Pollution prevention;
- Emergency incidents;
- Licence conditions;
- Generic water sources- the water resource types, inland water and estuarine water (divided into zones, namely water body, sediment and groundwater).

Management context

The generic management criteria that were defined for the management contexts (NWA contexts and generic water sources) are as follows:

- Legally defensible (classification – yes or no);
- Effect manifestation period (classification – short term or long term);
- Target kingdom (classification – animal or plant);
- Target kingdom to be 'protected' (classification – animal or plant) and optional criteria relating to specific chemical groups (e.g. heavy metals, pesticides, etc.) present in water (specificity) (classification – yes or no);
- Sample properties (e.g. very dark colour, etc.) that can interfere with toxicity tests
- (interferences) (classification – yes or no);
- Maximum turnaround time (days).

The most appropriate criteria classifications for each generic management criterion (for both the resource and source contexts) were captured in two spreadsheet matrices.

Subjectivity

To limit subjectivity of the users of the guide, the guide is presented in a format that limits subjectivity. The focus was on the type of information that toxicity tests can provide in terms of NWA requirements. The advantage of this approach was that the ultimate guide will identify gaps in current capacity and thus help focus future research and development.

Identification and selection

Because of the multi-dimensional nature of the information and because of the management contexts an inventory of tests were compiled in spreadsheets. The most appropriate means to produce the guide was in spreadsheet format. An Excel-based spreadsheet guides users in the identification and selection of appropriate toxicity tests to use in the NWA contexts related to water resources (only) or discharge sources and associated water resources for a specific application.

More than 100 toxicity tests, their test criteria and other

information which affects a test's suitability for a specific application have been captured. After a user selects the appropriate water quality management criteria for a specific application, the matching process is carried out automatically. Those tests that match all the criteria for the specific management context are deemed to be the most sensible tests to perform.

The following general approach to matching is taken.

- **Compulsory requirements.** An exact match between all the compulsory management requirements is enforced. The user has no control over these other than to define the NWA context (i.e. classification and resource quality objectives, or reserve determination, or ecosystem monitoring or compliance monitoring etc.), water resource type (i.e. inland water resource or estuary), and zone (i.e. water body, sediment or groundwater).
- **Situation-specific requirements matched automatically.** The user may also specify certain other requirements that only serve to shorten the list of toxicity tests based on the management criteria. Specifying these requirements is not mandatory.
- **Situation-specific requirements matched by user.** For some requirements (supplementary information), it is not appropriate to attempt automatic matching. In these cases, the guiding principles are provided for the user's consideration but not enforced in the spreadsheet interface. The user, therefore, decides which of the recommended tests are appropriate.

Guidance facility

It is expected that the guidance facility will be a valuable educational tool. It is hoped that it would stimulate interest amongst biological students to follow a career in aquatic toxicology and that it would sensitise water resource and source managers to the importance of toxicity testing in water quality management.

It was recommended that the WRC acts as custodian of the guidance facility. This entails that any updating or expansion of the facility is arranged and guided by the WRC. The latest version of the facility will, therefore, be available from the WRC.

All the information collected, produced and integrated during the study is captured in the electronic guide, a copy of which is enclosed in CD format in the back of the report.

Further reading:

To obtain the report *Guidance for the Selection of Toxicity Tests in Support of the Information Requirements of the National Water Act* (Report No: 1211/1/11), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.