November 2012
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Water and health

New guide helps authorities make better decisions on toxicity tests

A WRC-funded study has led to the development of a guideline for the identification and selection of appropriate toxicity tests.

Toxicity testing

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.*

So toxicity testing excludes measurement of the pollutants themselves, bioaccumulation, biodegradation, and direct effects of turbidity, pH and temperature.

Aquatic toxicity tests

Biological toxicity tests are ideally suited to assess the effects of stressors. A 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, they have not been used to their full extent 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 with some 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 to protect water resources, namely resource-directed measures and source-directed controls. An effect-based approach is apparent in both.

Toxicity 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 in respect of 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 the Department of Water Affairs approaches the implementation of the NWA. For example, much emphasis is placed on the nature of the water users, e.g. as categorised in the South African Water Quality Guidelines (1996).

Water users typically define target systems (i.e. those affected by toxicity like humans, animals, etc.), which provide a natural 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.

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 contexts:

- 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 contexts:

- Pollution prevention;
- Emergency incidents;
- Licence conditions;

Two water resource types were identified, namely, inland water and estuarine water. Three zones were identified, 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);
- 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).

Subjectivity

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 existence of local capacity was not considered. The advantage of this is that the guide will then help 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 of the variety of management contexts an inventory of tests were compiled in spreadsheets. The most appropriate vehicle for the guide was a spreadsheet. An Excel based spreadsheet guides users in the identification and selection of appropriate toxicity tests.

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 has specified their 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.
- *Situation-specific requirements matched automatically.* The user may also specify certain other requirements that shorten the list of toxicity tests based on the management criteria. These requirements are not mandatory.
- *Situation-specific requirements matched by user.* For some supplementary information automatic matching is not done. The user simply uses this information to decide on which tests are most appropriate.

Guidance facility

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

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

Further reading:
To obtain the report, *A Guideline 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.