Northern Territory Environment Protection Authority

GUIDELINES ON MIXING ZONES

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1 Introduction

The objective of these guidelines is to assist industries proposing a mixing zone as part of a project undergoing environmental impact assessments, or seeking to apply for a mixing zone as part of a waste discharge licence (WDL) under the *Water Act*, or an environment protection approval (EPA) or licence (EPL) or under the *Waste Management and Pollution Control Act*.

They have been developed with reference to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC 2000).

The guidelines support a consistent approach to mixing zone assessment and management by:

- defining a mixing zone;
- outlining the information required in a mixing zone application;
- explaining how the Northern Territory Environment Protection Authority (NT EPA) will assess an application for a mixing zone;
- specifying the responsibilities of licensees or approval holders as they relate to mixing zones; and
- providing key references, a glossary of terms and answers to frequently asked questions.

2 Legislative Requirements

The NT EPA's expectation is that waterways will be protected, including, but not limited to, those waterways for which beneficial uses have been declared.

Wastewater discharges into waterways, and any associated mixing zones are regulated through:

- waste discharge licences (WDLs) granted under Section 74 of the *Water Act*; or
- environment protection approvals (EPAs) and licences (EPLs) issued under Section 34 of the *Waste Management and Pollution Control Act*, for activities captured under Schedule 2 of this Act.

Licenses and approvals will generally stipulate discharge regimes, incident management practices, reporting and monitoring conditions, and where relevant, conditions to ensure a mixing zone is minimised. A license or approval is also used as a mechanism for systems performance improvement. The NT EPA will work with licensees to apply mechanisms to reduce the size and impact of a mixing zone over time.

These legislative requirements should be considered for projects proposing mixing zones through the environmental impact assessment process.

3 Limitations

This Guidance is:

- confined to generic matters relating to Mixing Zones and does not address more proposal-specific issues that may be of significance;
- not an instrument for predicting outcomes of deliberations by the NT EPA;
- designed to promote a more certain and consistent approach to the assessment of mixing zones; and

- intended to apply to proposals prior to the proponent submitting the proposal to NT EPA for environmental assessment or an application for a WDL, EPA or EPL.

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4 What is a mixing zone?

A mixing zone is a specifically defined area or volume of water around a waste water discharge where the water quality may be below that required to protect environmental values and beneficial uses.

Mixing zones are defined on a site-specific basis giving consideration to:

- pollutants in the discharge;
- the nature of the receiving environment; and
- robust water quality monitoring and hydrological modelling.

Compliance points are developed at the boundary of the mixing zone using an assessment of annualised data and local hydrological records.

Relevant water quality criteria must be met outside of the mixing zone.

5 Why have mixing zones?

The purpose of a mixing zone, as outlined in ANZECC 2000, is to manage the controlled discharge of soluble non-bioaccumulatory toxicants whose impacts on local biota are primarily related to their concentration. Mixing zones allow for a designated zone of impact, typically between a discharge point and a compliance point, rather than prescribing concentration requirements at the discharge point.

Mixing zones only apply to waste water discharges into receiving waters in cases where:

- risks from the discharge pollutants have been assessed (including direct toxicity assessment, where relevant); and
- it has been demonstrated that all reasonable and practical efforts have and are being made on-site to apply the waste management hierarchy of avoidance, re-use and reduction of waste water in order to meet water quality criteria.

6 Applications for a mixing zone

Applications for a mixing zone will be assessed on a case-by-case basis. The NT EPA requires applicants to provide detailed information about the:

- site and facility;
- discharge and release conditions;
- receiving environment;
- exposure pathway between the source and receptor;
- monitoring plan for the discharge, consistent with the NT EPA's Guidelines for Consultants Reporting on Environmental Issues; and

- continuous improvement plan for managing waste water discharge over time, so as to reduce the extent and impact of the mixing zone.

A conceptual site model should be developed to support the application. The model should consider the extent of a mixing zone's impact based on:

- representation of the source of the discharge;
- all flow scenarios, inclusive of:
    - wet and dry season flows;
    - catchment flows; and
    - variations of the discharge volume due to waste water re-use, reduction;
- release and transport mechanisms for nutrients/toxicants away from the discharge and in and away from the mixing zone; and
- a review of potential and actual receptors.

The information required by the NT EPA is outlined in the application forms for WDLs, EPLs and approvals available on the NT EPA web site.

7 Process for assessing mixing zone applications

1. An application is received to incorporate a mixing zone in a license or approval.
2. The information provided in the application is reviewed by the NT EPA.
3. The NT EPA **will not consider the application** for a mixing zone if:
    - toxicity tests show acute effects after initial dilution;
    - toxicity tests demonstrate chronic impact at the boundary of the mixing zone; or
    - the discharge has the potential to cause harm to humans or
    - the discharge has unacceptable impacts on flora and fauna.
4. A mixing zone **may not be considered** where:
    - odours generated by the discharge could adversely affect the use of the surrounding area;
    - the migration of fish or other aquatic organisms is adversely impacted, i.e. the zone should not extend over the breadth, depth or length of a waterway;
    - persistent bioaccumulative or potentially bioaccumulative substances or chemicals (as designated in Table 3.4.1, ANZECC 2000) are present in the discharge;
    - pollutants in the mixing zone may cause fish, other aquatic organisms or any other edible products to be unacceptable for human consumption as determined by National and NT health standards, and any standard in force from time-to-time applying to the sale for human consumption of such products nationally, in the Territory, or overseas; or
    - substances are present in the discharge in concentrations that result in undesirable aquatic life or a dominance of nuisance species.
5. Mixing zones **will not generally be designated** in waters that are:
    - used for primary contact recreation;
    - of identified spiritual or cultural value to Traditional Owners;
    - of recognised significant value as spawning or nursery areas;

- close to areas used for aquaculture;
- close to areas identified as important food gathering sites for Traditional Owners and other recreational users;
- close to potable water supply intakes; and/or
- of high conservation value, outstanding ecological significance or scientific importance (for example, largely undisturbed aquatic ecosystems, World Heritage areas, Ramsar sites).

6. The NT EPA will consider all relevant matters having regard to its obligations under the *Northern Territory Environment Protection Authority Act 2012*, *Waste Management and Pollution Control Act* and *Water Act*. This includes information in the applicant's monitoring and site management plans, and information from Government and relevant non-government agencies.

   The NT EPA must protect the environment having regard to the need to enable ecologically sustainable development (section 7(b) *Northern Territory Environment Protection Authority Act 2012*). This includes observing the precautionary principle, which states that where there are threats of serious or irreversible environmental harm, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental harm. The NT EPA therefore reserves the right to refuse an application for a mixing zone or to impose mixing zone conditions in cases where there is uncertainty in a risk assessment.

7. If deemed appropriate, a mixing zone will be incorporated in a waste water discharge licence or approval. The NT EPA will determine the nature and size of an approved mixing zone based on the applicant's conceptual site model, and in particular, what it reveals about the extent and scale of environmental impact. A mixing zone may be a single size or an "onion ring" arrangement with different mixing zones for different parameters.

8 Responsibilities of licensees or approval holders

The numerical water quality trigger values identified in a licence or approval may be exceeded, as long as there are no:

- acute toxic effects after initial dilution or chronic effects at the boundary of the mixing zone (based on ecotoxicology testing);
- adverse human health effects arising from the discharge;
- unacceptable impacts on marine and freshwater flora and fauna and/or terrestrial flora and fauna (subject to a risk assessment);
- floating debris, hydrocarbon sheen, oil scum or other matter in the discharge that may cause environmental nuisance;
- substances/pollutants in the discharge that produce objectionable colour, odour, taste or turbidity;
- substances/pollutants in concentrations that result in undesirable aquatic life or result in a dominance of nuisance species; and
- adverse impacts on the environmental values and beneficial uses of waters outside of the mixing zone.

Development and assessment of a mixing zone must be clearly linked to the potential risks. For example, assessment of nutrient releases (e.g. nitrogen and phosphorus) needs to include the potential to cause algal blooms.

9 Resources

The following resources may assist with assessment and management of mixing zones:

- National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality, developed by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand (ANZECC 2000) provides:
  - approaches to setting environmental values and beneficial uses, and establishing key protection triggers and indicator values; and
  - a case study for a mixing zone (see Volume 2, Appendix 1)

- NT Department of Land Resource Management
  - beneficial use declarations

- NT EPA
  - Guidelines for Waste Discharge Licenses
  - Guidelines for Consultants Reporting on Environmental Issues
  - Guidelines on Conceptual Site Models

10 Acknowledgements

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11 Further information

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12 Frequently asked questions

Can mixing zones be granted by way of licences or approvals issued under the *Waste Management and Pollution Control Act* as well as the *Water Act*?

Yes. The NT EPA mainly regulates waste water discharges under Section 74 of the *Water Act* through waste discharge licences. Waste water discharges from activities listed in Schedule 2 of the *Waste Management and Pollution Control Act* are regulated by environment protection licences (EPLs) and approvals issued under Section 34 of this Act.

Conditions relating to a mixing zone will be incorporated into the relevant licence or approval.

Will the NT EPA approve a risk assessment?

The NT EPA will expect a proponent to develop a risk assessment consistent with the ANZECC 2000 guidelines or equivalent. It reserves the right to comment on a risk assessment and comments made by the NT EPA will need to be addressed or reflected in any finalised risk assessment report.

Is toxicity testing a prerequisite for proponents seeking to incorporate a mixing zone into the waste water discharge management process?

A mixing zone is generally granted in circumstances where the environmental values and beneficial uses may not always be protected. This means that waste water discharges do not meet acceptance criteria and there is a perception of risk acknowledged by the parties negotiating a mixing zone.

The regulatory agency will, of necessity, need to ensure that the waste water discharges will not result in environmental harm. Direct toxicity assessment will likely be required if the site-specific guidelines are exceeded. Toxicity testing should be consistent with the ANZECC 2000 guidelines, following the process outlined in Figure 3.4.1 (ANZECC 2000).

The NT EPA will **not consider an application** for a mixing zone if toxicity tests show acute effects at the point of discharge, chronic impact at the boundary of the mixing zone, if the discharge has the potential to cause harm to humans, or if there are unacceptable impacts on terrestrial and aquatic flora and fauna.

Are there toxicity test species available for tropical freshwater and marine environments?

Yes. Examples of available test species and available tests include the following:

- Freshwater:
    - 48-h acute with cladoceran *Ceriodaphnia cf dubia* or *Moinadaphnia macleayi*;
    - 7-day reproductive impairment tests with *Ceriodaphnia cf dubia;*
    - 48-h acute test with the midge *Chironomus tepperi;*
    - 72-h micro-algal growth inhibition with *Chlorella* species*;*
    - 96-h acute toxicity with NT freshwater shrimp *Macrobrachium bullatum;*
    - 96-h population growth with *Hydra viridissima*;

- 96-h larval fish imbalance test with rainbowfish *Melanotaenia splendida splendida*; and
- 10-day rainbowfish embryonic development and post-hatch survival with *Melanotaenia splendida splendida.*

- Marine:
  - 72-h micro-algal growth inhibition with *Isochrysis aff. galbana* or *Nitzschia closterium;*
  - 48-h larval development test with the tropical milky or spiny oyster *Saccostrea echinata;*
  - 48-h acute toxicity with the tropical copepod *Parvocalanus crassiostris;*
  - 96-h acute toxicity with 15-day post-larvae of the tiger prawn *Penaeus monodon;*
  - 1-h sea urchin fertilisation success test with *Heliocidaris tuberculata* (temperate species, in use until tropical replacement available);
  - 72-h sea urchin larval development test with the sea urchin *Heliocidaris tuberculata* (temperate species, in use until tropical replacement available);
  - 96-h fish imbalance test with *Lates calcarifer* (barramundi); and
  - 7-d fish imbalance and growth test with the Indo-Pacific spiny chromis (damselfish) *Acanthochromis polycanthus.*

How will the NT EPA assess whether a mixing zone is decreasing?

The NT EPA will assess if a mixing zone is decreasing by using several methods. This includes a weight of evidence approach developed through review of monitoring plans and results. A simple mechanism for investigating a decrease in a mixing zone is to assess water quality concentrations at a compliance point at the boundary of a mixing zone.

What will be expected in a monitoring plan for a mixing zone?

Monitoring plans need to be developed along a multiple lines of evidence approach and be consistent with the NT EPA Guidelines for Consultants Reporting on Environmental Issues, or any updates of this document.

The extent and degree of monitoring can be negotiated with the Regulator as robust monitoring information accrues.

Will a mixing zone be granted for waste water discharges composed of nutrients?

ANZECC 2000 states that a mixing zone is not appropriate for managing nutrient discharges. This is because of the potential for nutrients to cause environmental harm in areas not immediately adjacent to a discharge point. Mixing zones will be used in situations where nutrients clearly exhibit a mixing zone adjacent to a discharge point and there is reason to believe that: 1) environmental harm may occur, and 2) a mixing zone may provide a means to gradually reduce potential for harm over consecutive licenses.

13 Glossary

Key terms relevant to mixing zones are listed below. The definitions are largely reproduced from ANZECC 2000.

Term	Glossary
Acute effects	Usually measured by the EC_{50} in an acute toxicity test being less than 100
Acute toxicity	Rapid adverse effect (e.g. death) caused by a substance in a living organism. Can be used to define either the exposure or the response to an exposure (effect)
Aquaculture	Commonly termed fish farming, but broadly refers to the commercial growing of marine or freshwater animals and aquatic plants
Aquatic ecosystems	Any watery environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment
Beneficial uses	The beneficial uses of water are specified in the NT *Water Act* and include agriculture, aquaculture, public water supplies, environment, cultural, industry, and stock and domestic. Beneficial uses for any given water body do not rule out the possibility that other environmental values may exist or have the potential to exist
Bioaccumulation	General term describing a process by which chemical substances are accumulated by aquatic organisms from water, either directly or through consumption of foods containing the chemical
Bioaccumulative substances	A chemical or substance that can bioaccumulate (Table 3.4.1 of ANZECC 2000 lists chemicals that have the potential to bioaccumulate referenced with a letter “B”)
Bioavailable	The fraction of a total of a chemical in the surrounding environment that can be taken up by organisms. The environment may include water, sediment, soil, suspended particles and food items
Biological assessment	Use and measurement of the biota to monitor and assess the ecological health of an ecosystem
Biota	The sum total of the living organisms of any designated area
Chemicals of concern	Specific chemicals that have been identified for further evaluation through a risk assessment process (e.g. monitoring results over time have shown the concentration of a chemical to be consistently above the ANZECC 2000 levels or an equivalent risk assessment approach)
Chronic effect	Lingering or continuing for a long time, often for periods from several weeks to months. Can be used to define either the exposure of an aquatic species or its response to an exposure (effect). Chronic exposure typically includes a biological response of relatively slow progress and long continuance, often affecting a life stage
Concentration	The quantifiable amount of chemical in mediums such as water, food or sediment
Conceptual site model	A conceptual site model (CSM) serves to practically present the relationship between pollutant sources and receptors through consideration of potential or actual migration and/or exposure pathways (for further information see the NT EPA document explaining conceptual site models)
Criteria (water quality)	Scientific data evaluated to derive the recommended quality of water for different uses

Direct toxicity assessment (DTA)	The use of toxicity tests to determine the acute and/or chronic toxicity of waste water discharges or total pollutant loads in receiving waters. Assesses the combined effect of a number of compounds of unknown identity and concentration, rather than individual chemicals
Effluent	A complex waste material (e.g. liquid industrial discharge or sewage) that may be discharged into the environment
Environmental values	Particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health, and that require protection from the effects of pollution, waste discharges or deposits. In some cases, environmental values may be reflected in beneficial uses of water and declared under the NT *Water Act*. Declared beneficial uses have not been designated for all waterways in the NT
Exposure pathway	The route that a chemical takes between its source and a receptor. For a risk pathway to be identified there must be a source, an exposure medium, an exposure route and a receptor
Hazard	The potential or capacity of a known or potential environmental contaminant to cause adverse ecological effects
Improvement plan	A plan that is developed by the proponent that focuses on measures for improving the quality of water to be discharged. It may include reference to how the waste management hierarchy can be better utilised for a site/activity
Objectionable colour	Colour that is undesirable or objectionable and may impact on environmental values or beneficial uses.
Pollute	Is defined in the NT *Water Act* as: *'…in relation to water, means directly or indirectly to alter the physical, thermal, chemical, biological or radioactive properties of the water so as to render it less fit for a prescribed beneficial use for which it is or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to:* *(a) public health, safety or welfare;* *(b) animals, birds, fish or aquatic life or other organisms; or* *(c) plants.'*
Risk assessment	A process intended to calculate or estimate the risk to a given target organism, system or sub-population, including the identification of attendant uncertainties, following exposure to a particular contaminant. The process should take into account the inherent characteristics of the contaminant as well as the characteristics of the specific target organism, system or sub-population. This is not to be confused with risk management, which is a decision making process involving consideration of political, social, economic and technical factors, with relevant risk assessment information relating to a hazard, to determine the appropriate course of action
Undesirable aquatic life	Aquatic life that proliferates in response to a discharge e.g. algal blooms