GUIDELINES

GUIDANCE FOR THE DETERMINATION AND ASSESSMENT OF MIXING ZONES

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INTRODUCTION

Any wastewater discharge will result in changes to water quality and biological health in the receiving waters. These changes may be almost unmeasurable or they could be substantial. The extent and magnitude of these changes defines a mixing zone.

A mixing zone is therefore more than just the point at which a discharge physically mixes with the receiving water. It is an area with explicitly defined boundaries where water quality or biological objectives may not be met, but beyond which objectives must be met.

Mixing zones are a tool for responsible management of the environment. The responsibility lies with the discharger to minimise this impact by keeping the mixing zone as small as practicable.

Mixing zones have been applied to wastewater discharges for more than 20 years. However, an increased understanding of environmental processes has led to the need for a renewed approach to the determination and assessment of mixing zones.

The purpose of these guidelines is to assist those in industry who are involved with mixing zones and they aim to provide a clear and objective approach to the determination and assessment of mixing zones. They explain how mixing zones fit into the current legislative framework and places them in the context of the need for continuous improvement, and provide guidance on the process for determining, assessing, monitoring and reporting mixing zones.

LEGISLATIVE FRAMEWORK

A mixing zone is an area with explicitly defined boundaries where *State Environment Protection Policy Waters of Victoria* (SEPP (WoV)) environmental quality objectives or background levels may be exceeded, but beyond which they must be met. The designation of mixing zones is unique to wastewater discharge licencses and needs special consideration in the implementation of a risk assessment.

Mixing zones are used as a tool for responsible management of the environment. They are designed to limit the impact to the environment that would otherwise occur if discharges were allowed to flow unchecked into waterways.

Glenelg River at Dergholm.

There is an order of preference that the Environment Protection Act and associated policies have adopted for the minimisation of waste in Victoria (EPA Victoria 1970, Government of Victoria 2003). According to the waste hierarchy, avoidance and reduction of waste should be the highest priority and disposal of waste should be the last option. There can be long-term gains, both financial and environmental, from using the waste hierarchy to avoid waste disposal wherever possible.

In issuing a licence, EPA may approve a mixing zone where it is not practicable to avoid, reuse, recycle or effectively manage wastewater. However, mixing zones must be kept to the smallest area possible and the size and impact of the mixing zone on the environment needs to be continuously decreased over time.

SEPP (WoV) describes a mixing zone as 'an area contiguous to a licensed waste discharge point and specified in that licence, where the receiving environmental quality objectives otherwise applicable under the Policy do not apply to certain indicators as specified in the licence. This means that some or all beneficial uses may not be protected in the mixing zone'. SEPP (WoV) also states certain conditions that must be met within a mixing zone, including the following:

- Clause 27 (4) – 'EPA will not approve a wastewater discharge that, according to toxicity tests approved by EPA, displays acute lethality at the point of discharge or causes chronic impacts outside any declared mixing zone, except that a waste discharge containing a non-persistent substance that degrades within any declared mixing zone may be approved'.
- Clause 30 (1) – 'EPA will not approve a mixing zone if it will result in: a) environmental risks to beneficial uses outside the mixing zone; b) harm to humans, unacceptable impacts on plants and animals or where it will cause a loss of aesthetic enjoyment or an objectionable odour'.

SEPP (WoV) (Clause 28 (3)) also states circumstances under which EPA will not approve any new discharges. These are:

- aquatic reserves, wetlands and lakes or estuaries and inlets segments or to waters in areas of high conservation significance
- waters in special water supply catchments or where a discharge will impact on authorised potable supplies
- where a discharge would pose an environmental risk to beneficial uses and best management practice has not been adopted.

It is also a requirement that mixing zones do not present barriers to the free movement of aquatic biota, such as barriers to migration of local species, spawning migrations and repopulation of areas with planktonic organisms, aquatic invertebrates and drifting eggs and embryos.

THE DEFINITION OF A MIXING ZONE

A mixing zone is defined depending on background levels as follows:

- if background levels of the waterbody meet or are below SEPP (WoV) environmental quality objectives, the mixing zone is defined as the area adjacent to the licensed waste discharge point where SEPP (WoV) environmental quality objectives levels are not met

or

- if background levels of the waterbody do not meet the SEPP (WoV) objectives, the higher background levels become the criteria to be met at the end of the mixing zone; that is, the mixing zone is defined as the area adjacent to the licensed waste discharge point where background levels are not met.

Where appropriate, a mixing zone can have multiple boundaries according to the different spatial extents over which various aquatic ecosystem and human health SEPP (WoV) environmental quality objectives or background levels are not being met.

When estimating the extent of a mixing zone, the spatial, temporal, chemical, physical and biological variability of the effluent discharge and receiving waters needs to be accounted for, and the mixing zone determined for the sensitive scenarios.

By accurately defining the mixing, businesses can more effectively identify and evaluate management actions to reduce the size and impact of the mixing zone over time.

THE DETERMINATION AND ASSESSMENT OF A MIXING ZONE

Every discharge to the environment presents a unique set of circumstances in terms of discharge characteristics and the nature of the waterway into which it discharges. Therefore, there is no one method that can be used for establishing the extent of all mixing zones; there are simply too many variables. Each mixing zone, therefore, should be analysed on a case-by-case basis. Irrespective of the exact methods, this will involve:

- identifying the beneficial uses and local values of the receiving waters.
- characterisation of the effluent and receiving waterbody
- determining the dilution and dispersion of the effluent
- assessing the impact of the effluent discharge to beneficial uses and local values.

Identifying the beneficial uses and local values of the receiving waters

The beneficial uses and local values of the receiving waters that may be impacted by the discharge need to be identified. Table 1 in SEPP (WoV) outlines the beneficial uses to be protected.

Local waterbody values and their importance (high values) can be identified through state, national and international designations such as aquatic reserves, RAMSAR wetlands, and regional processes such as regional river health strategies and coastal plans. Identification of the relevant beneficial uses and local values may also be done through stakeholder consultation.

Characterisation of effluent and receiving waterbody

Stressors are pollutants in a discharge that may impact the receiving water environment. They include toxicants such as heavy metals, ammonia and organic chemicals, plant nutrients, salinity, oxygen-demanding substances, suspended sediment and pathogens.

Stressor levels in an effluent discharge need to be identified, including any temporal variability. Inputs to the wastewater system will identify most of the likely

stressors; however, a more exhaustive approach may be necessary if the system receives complex industrial influents.

The water quality and biological condition of the receiving waterbody need to be established. The level of the stressors identified in the effluent discharge then need to be determined in the receiving waterbody – including temporal variability.

For rivers and streams the flow regime needs to be characterised, as this is important to assess dilution and mixing. In marine environments the nature of water movements, including tidal flows, must be characterised.

Estimating dilution and dispersion

Critical to assessing the impact of an effluent discharge on beneficial uses and values is understanding the dilution and dispersion of the effluent.

For inland waters this must be calculated under low-flow conditions, taking into account seasonal and climatic variability. Low-flow conditions must be determined from long-term flow data under recent climatic conditions (for example, to allow for drought). This would typically be five to 10 years of flow data. These flow data are used to identify the month with the lowest average flow over the whole data set. The minimum flow for the mixing zone calculation is the 10th percentile value for all observations for that month.

For coastal discharges, characteristics such as tidal and current movements, density and temperature differences, depth of water and rate of flow need to be considered, and appropriate modelling conducted to assess the dilution capabilities of the waterbody under various scenarios.

In both fresh and marine waterbodies the process may involve the use of dilution models and decay rates for proposed discharges. For current discharges this would also include assessment of monitoring data collected on effluent quality and the receiving waterbody.

The levels of chemical, physical and biological stressors that will be likely to occur in the receiving waters can then be determined.

Assessment of impacts on beneficial uses and values

The assessment of impacts on beneficial uses and values is a complex process. Wastewater discharges to waterbodies necessitate the assessment of complex effluents interacting with inherently variable and complex aquatic systems. The process needs to provide an effective means for assessing and managing mixing zones, ensuring that they are kept to the smallest area possible and that the size and impact

Kiewa River at Yikas Point.

of the mixing zone on the environment is continuously decreased over time.

The levels of chemical, physical and biological stressors determined for the mixing zone are used to assess impacts to waterbody values. This includes the level and spatial extent of impact to values from individual stressors (where they operate separately) or combined stressors (where they operate synergistically or have an additive effect on beneficial uses and values).

Biological indicators that directly measure ecosystem health are the key indicators for assessing a mixing zone.

For proposed discharges this assessment would involve various predictive methodologies, including the use of ecological, human health and toxicological models, toxicological testing and/or assessment of cause–effect data and other information in the scientific literature.

For current discharges, this assessment would also involve additional assessment of monitoring data collected on the effluent and the receiving waterbody, and needs to include physicochemical and biological monitoring of the stressors and values.

Based on all the above information, the mixing zone extent and impact on SEPP (WoV) beneficial uses and local values can be defined.

The mixing zone extent will be calculated based on the worst-case scenario; that is, the minimum dilution capacity of the receiving waters for inland waters or maximum load and dispersion characteristics of marine water, and the stressor(s) identified as having the greatest impact on the most sensitive ecosystem or human health responses. There may be a need to define mixing zone boundaries for different stressors, where they are impacting upon beneficial uses and values over different spatial and temporal scales – for

example, one for nutrients, one for certain heavy metals and one for oxygen demand.

MONITORING A MIXING ZONE

Monitoring is not only important for verifying licence compliance, but it also helps those discharging to take responsibility for managing the impacts of their operations and to be able to show that they are managing their environmental responsibilities. An important outcome from the assessment of a mixing zone is the development of a plan of how the discharge will be managed to reduce the extent and impact of the mixing zone continuously over time.

The indicators used in estimating, monitoring and assessing a mixing zone need to be clearly linked to the potential risks and beneficial uses and values they represent. For example, assessment of phosphorus concentrations in inland waters needs to address the potential concentrations that may cause excessive algal or plant growth, which may reduce dissolved oxygen to levels that adversely impact the biota.

Further guidance on developing risk-based monitoring programs is available in *Licence assessment guidelines* (EPA publication 1321).

REPORTING AND COMMUNICATION

All licence-holders must submit an annual performance statement (APS). The statement summarises performance against licence conditions during the reporting year. This includes the conditions relating to mixing zones. Further guidance on APSs is available in *Annual performance statement guidelines* (EPA publication 1320).

RESOURCES

The following documents provide technical information that will be useful for undertaking the determination and assessment of mixing zones.

- ANZECC and ARMCANZ 2000. *National Water Quality Management Strategy — Australia and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand.
  Water quality guidelines and approach to risk based assessment.
- EPA Victoria 2010. *Licence assessment guidelines — Guidelines for using a risk management approach to assess compliance with licence conditions.* EPA publication 1321.
  The risk management process outlined in these guidelines will help licence-holders demonstrate compliance with their licence conditions, through assessing their environmental risks and monitoring their operations.
- EPA Victoria 2010. *Annual performance statement guidelines.* EPA publication 1320.
  These guidelines describe the requirements for annual performance statement (APS) reporting, identify the required form of an APS and provide information to assist licence-holders to prepare their APS.
- EPA Victoria 2009. *Guidelines for risk assessment of wastewater discharges to waterways.* EPA publication 1287.
  Guidelines for undertaking risk assessment of wastewater discharges. Identification of values and indicators and approaches to assessment.
- EPA Victoria 1998. *Point source discharges to streams: protocol for in-stream monitoring and assessment*. EPA publication 596.
  Approach and methods for the assessment, monitoring and reporting of wastewater discharges to inland waters.
- EPA Victoria. *Environment Protection Act 1970*. No. 8056 of 1970.
  Legislative basis for mixing zones and wastewater management.
- EPA Victoria. *State Environment Protection Policy (Waters of Victoria)*. Government Gazette No. S107, 2003.
  Specific water quality and biological objectives and application of the risk-based approach for Victoria. Legislative requirements for mixing zones, wastewater management and water quality assessment and monitoring.
- Catchment management authority (CMA) regional river health strategies (available on CMA websites).
  Identification of specific values for river reaches, particularly ecosystem values. All CMAs have developed a regional river health strategy.
- US EPA 1998. *Guidelines for Ecological Risk Assessment*. US EPA publication No. EPA/630/R-95/002F.
  Detailed processes for undertaking ecological risk assessment.