Technical guideline

Licensing

Wastewater release to Queensland waters

This document provides technical information and guidance to officers when assessing and deciding applications for wastewater releases to Queensland waters against the provisions of the Environmental Protection Act 1994 *(EP Act) and subordinate legislation.*

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ABN 46 640 294 485

Queensland Government

1. Introduction

The following guideline is provided to support a risk-based assessment approach to licensing releases of wastewater to surface water and applies the philosophy of the ANZECC & ARMCANZ (2000) Water Quality Guidelines and the intent of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. Decisions made by the administering authority in relation to wastewater release to Queensland waters should be consistent with this approach and based on the latest scientific and technical knowledge, but also allow for flexibility for assessment on a case-by-case basis. Solutions should try to achieve the best environmental outcomes, be cost-effective and consider the broader environmental benefits, not just ‘end of pipe’ impacts.

An overall assessment flowchart is provided in Figure 1. A corresponding generic information requirement list for the assessment is provided in Table 1. A glossary of terms is provided in Appendix 1.

Figure 1—Assessment flowchart

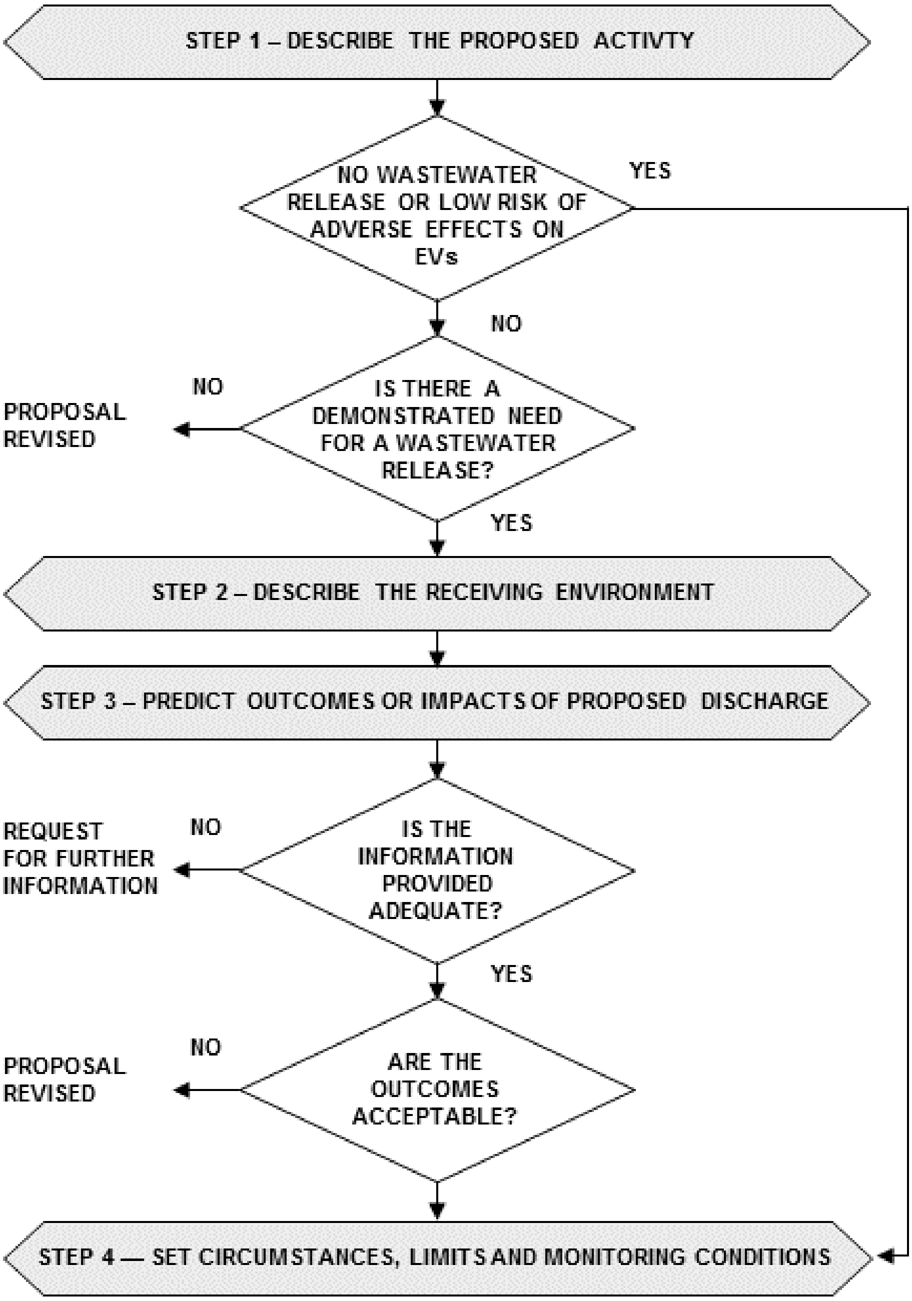


Table 1—Information requirements for assessing wastewater releases

Section	Activity	Consider the following information provided by the applicant
1	Describe the proposed activity	– Define industry type and size (estimated production, current and ultimate). – Identify the potential contaminants of concern in the proposed release. – Assess the characteristics of the proposed release including the concentrations, volume, loads and potential variability. This will form the basis of the approval conditions. – Location and configuration of the proposed release. – Confirm that best practicable measures have been used to avoid or minimise wastewater release (e.g. best practice, source reduction). – Identify if the activity is low risk (based on size, location etc).
2	Describe the receiving environment	– Identify water bodies potentially affected by the proposed release. – Provide all relevant information on the receiving environment based on desktop and field studies (e.g. current, background water quality condition). – Include special consideration for ephemeral streams. – Identify all relevant environmental values (EVs) and water quality objectives (WQOs)—refer to those listed in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water) Schedule 1 (available at **www.legislation.qld.gov.au**) or, WQOs are not scheduled, refer to EVs and WQOs from the Queensland or ANZECC Water Quality Guidelines. – Ensure other sources and loads of relevant contaminants in the catchment (including future discharge). – Ensure all government planning requirements applying to these water bodies have been considered (e.g. RAMSAR wetlands).
3	Predict outcomes or impacts of the proposed wastewater release	– Assess whether contaminants are potentially toxic at end-of-pipe. If so, consider an initial mixing zone and if the size of the mixing zone is acceptable. – Predict the available assimilative capacity and sustainable load of the receiving environment, if required; i.e. consider if WQOs are likely to be exceeded by the proposal. – Provide justification for the choice and application of all predictive methods/models used in the assessment, including model inputs, uncertainty and simulation results. – Consider other potential impacts (other than direct impacts on water quality).
4	Set circumstances, limits and monitoring conditions	– Specify any circumstances related to the approved wastewater release (e.g. limitations or timing issues). – Derive end-of-pipe limits from approved release loads and characteristics (with consideration of achievability). – Include a receiving environment monitoring program (REMP) requirement. – Include reporting requirements, including management actions where limits/triggers/objectives for the approved activity are not achieved.

2. Assessment procedure

Step 1—Describe the proposed activity

The first step requires assessment by the licensing officer of the information provided by the applicant about the proposed activity and release.

Define the industry type and size

The industry type and size will help to classify the potential environmental risk from the proposed discharge. The size of the activity can be specified in production quantities such as area of production for aquaculture farms, tonnes of throughput for processing industries or equivalent persons in the case of sewage treatment. It is important to identify the current and future or ultimate sizes that are relevant to the approval.

Identify the potential contaminants of concern in the proposed release

The first step in assessing the discharge of residual wastewater from the proposed activity is identifying the source waste streams and potential contaminants of concern. Contaminants can be a gas, liquid or solid, an odour, an organism, energy (as in a thermal discharge) or a combination of contaminants. Common industry point source discharges and their likely effects are summarised in Table 2.

It is important to note that particular industries and environmentally relevant activities (ERAs) are associated with classes of aquatic ecosystem contaminants, e.g. wastewater treatment plants and nutrients. The National Pollutant Inventory emission estimation technique manuals (**www.npi.gov.au**) list 90 priority substances on the basis of health and environmental risk, by industry sector, and the USA DES Toxic Release Inventory (**www.des.gov/tri/**) lists 313 priority substances. ANZECC & ARMCANZ (2000) Water Quality Guidelines may also assist in characterising wastewater toxicants that may be associated with specific industry sectors or ERAs.

These inventories and guidelines may assist in determining the likely wastewater contaminants that may be associated with specific industry sectors or ERAs, and any potential issues with release to the environment. The information can also be used as a guide to check information in the application. A search of the academic literature and the Internet could be undertaken for more information on specific activities not mentioned. Contaminants are related to process inputs and outputs and can transfer to aquatic ecosystems from media other than water (e.g. scrubber effluent, leachate from soils or solid wastes, etc.). Contaminants in residual wastewater may also occur as unintended by-products of processes (e.g. dioxins and metal compounds). Depending on the character and resilience of the receiving environment, and the degree of risk, direct toxicity assessment (DTA) may be required on any available laboratory or pilot plant samples. Such analysis more closely resembles the situation in the natural environment (i.e. toxicity of chemical mixtures) than single chemical testing approach. Refer to the ANZECC & ARMCANZ (2000) Water Quality Guidelines—Volume 2, section 8.3.6. available at **www.environment.gov.au**.

Table 2—Potential issues of concern and water quality contaminants

Activity	Potential issues	Water quality contaminants
Sewage effluent	Asphyxiation of aquatic animal life (e.g. low dissolved oxygen levels leading to fish kills), algal blooms, smothering of flora and fauna, impairment of ecosystem structure and function, and public health risks.	Carbonaceous material, nutrients, pathogens, suspended solids, toxicants (metals/metalloids, pesticides, residual disinfectants and pharmaceuticals).
Abattoir effluent	Asphyxiation of aquatic animal life (e.g. low dissolved oxygen levels leading to fish kills), algal blooms, smothering of flora and fauna, impairment of ecosystem structure and function, and public health risks.	Carbonaceous material, suspended solids, nutrients, pathogens, residual disinfectants and toxicants.
Mine releases	Toxicity of salinity, sulphate, acid/alkaline solutions and metals/metalloids. Increased availability of metals due to pH changes, smothering of flora and fauna impairment of ecosystem structure and function. May affect drinking, stock and irrigation water.	Salinity, pH, sulphate, temperature, suspended solids, turbidity, toxicants (metals/metalloids and other chemicals, including fluoride).
Aquaculture releases	Asphyxiation of aquatic animal life (e.g. low dissolved oxygen levels leading to fish kills), algal blooms, smothering of flora and fauna, impairment of ecosystem structure and function, diseases and introduced species.	Carbonaceous material, suspended solids, nutrients and toxicants (biocides, etc). Diseased organisms and antibiotics may be an issue in some operations.
Sugar mill cooling waters	Low dissolved oxygen levels leading to fish kills, elevated temperatures may lead to fish kills and other effects on fauna and flora.	Carbonaceous material, suspended solids, pH, temperature and antifouling agents.
Chemical processing plants	Toxicity of acids, alkalis, metals or industrial chemicals. Increased availability of metals from pH changes, smothering of flora and fauna, algal blooms and low dissolved oxygen levels leading to fish kills.	pH, sulphate, toxicants (ammonia, metals/metal compounds (including sulphides)/metalloids, pesticides, and other chemicals), suspended solids, carbonaceous material, temperature, nutrients and by-products.
Power stations - blowdown water	Toxicity of salinity, metals and metalloids. Smothering of flora and fauna and elevated temperatures.	Salinity, suspended solids, toxicants (metals/metalloids and other chemicals), and temperature.
Coal seam gas (CSG) water	Toxicity of salinity, hydrocarbons, metals/metalloids and drilling/fraccing additives, disturbance of flow regime (particularly continuous releases to ephemeral streams). Salt impact on irrigation land and stock watering. Deficiency of ions (e.g. calcium; soft water) in reverse osmosis treated water.	Salinity, toxicants (metals/metalloids, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), chemicals used in hydrostatic testing; drilling and hydraulic fracturing processes (e.g. biocide, lubricants, surfactants, etc.),

Assess the characteristics of the proposed release

The quality and quantity of the discharge from the proposed activity should be clearly characterised. This must include concentrations, typical averages and worst-case values of all potential contaminants of concern, assuming the treatment technology is working effectively. The quantity of the discharge must be expressed as average, minimum and maximum daily discharge volume, as well as, maximum hourly discharge rate. The proponent should also express whether the discharge will be continuous or intermittent. Wet weather influences must be considered and separate wet weather discharge characteristics defined where applicable. Information on the wastewater discharge regime should be used to estimate resulting contaminant loads.

The method used to estimate these characteristics must be clearly defined and realistically achievable from practical and economic viewpoints. This may be demonstrated with reference to guidelines, pilot plant results or previous applications of the adopted wastewater treatment technology. Alternatively, process models may be used to predict these characteristics.

Check the location and configuration of the proposed release

The location of the proposed discharge is important as it determines the receiving waters potentially affected. Further, the potential impacts of the proposed discharge are influenced by the configuration under which it is operated (for example, some discharges may only occur in the wet season or under slack water, or flood or ebb-tide conditions). A further consideration is the diffuser or outfall configuration. A diffuser may be used to provide better mixing in the initial zone. Outfalls may be submerged to promote mixing or achieve aesthetic goals. The application should explain the rationale behind the proposed discharge location and configuration. Similarly, the rationale for rejecting alternatives to discharge should be explained.

It would typically be necessary and desirable for a discharge pipe to be submerged below spring low water mark, except in cases of denser than ambient wastewaters where submergence may exacerbate adverse environmental effects.

Confirm use of best practicable measures

It is important to ensure that wastewater avoidance measures have been incorporated into the process design where appropriate and to ensure all cost-effective wastewater re-use, recycling and treatment options have been used. The proponent should also describe the wastewater disposal options considered prior to the final design along with diagram(s) of the treatment plant or process.

Quantitative comparisons of the above waste management measures must be made with best practice environmental management for the activity. The definition of best practice environmental management in the EP Act (s. 21) is:

> 'the management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the measures currently used nationally and internationally for the activity.'

This must be considered on a case-by-case basis and the proposal must achieve the best possible environmental outcomes for the least cost. What best practice is will depend on a number of factors including industry type, size and location. There must be a balance between technological solutions with social and economic considerations. Best practice for one discharge is not necessary best practice for all other discharges.

Some examples to aid in assessing best practice:

- Tertiary treatment of effluent released continuously to waters is considered a minimum best practice in most cases.
- Best practice would be considered zero dry weather release (event releases only) where cost-effective. However, a controlled release which reflects the natural flow regime as much as possible is preferable to an uncontrolled release.
- Chlorine disinfection of wastewaters released to waters is not considered best practice due to the potential toxic effects of chlorine in the receiving environment and the production of harmful disinfection by-products. Where chlorine is required to facilitate reuse, measures should be taken to reduce the risks of potential toxic effects, for example, the use of storage ponds or constructed wetlands prior to discharge.

Note that the level of treatment should be determined based on risk.

Activities identified as low risk

If the ERA includes a discharge, but represents a low risk of having an adverse effect on an environmental value, then further detailed steps may not be required. Subject to addressing the matters in describing the proposed activity and discharge, and checking for any matters in the receiving environment that would preclude the discharge, the assessment should proceed to setting residual wastewater discharge release limits and impact monitoring requirements (i.e. requires no further receiving water quality assessment).

A low risk of having an adverse effect on environmental values would generally occur when pollutant loads are decreasing (e.g. reduction in contaminant loads as a result of an upgrade) and are a relatively minor contribution to the receiving water, and when toxicant concentrations in the release are below trigger values listed in section 3.4 of the ANZECC & ARMCANZ (2000) Water Quality Guidelines (**www.environment.gov.au**). Another case may be a relatively infrequent release such as overtopping of wastewater storage during flood conditions.

Where no toxicant trigger values are available but published information suggests a chemical may be of concern, DTA may be required on any available laboratory or pilot plant samples to ensure risks are low. Refer to the ANZECC & ARMCANZ (2000) Water Quality Guidelines — Volume 2, section 8.3.6.

Environmental authority conditions would require monitoring and reporting to annually confirm the absence of adverse effects on environmental values or would prohibit wastewater discharge (in environmental authority applications where no discharge was proposed). Environmental authority conditions would also typically specify the nature of the permitted discharge and require monitoring of discharge volume and quality to ensure the activity was carried out as described in the application. In most cases, conditions also typically prohibit discharge of contaminated stormwater. For some activities, stormwater treated to render it less hazardous may comprise a wastewater stream that is permitted to be discharged subject to conditions.

Step 2—Describe the receiving environment

This step involves describing the receiving environment relevant to the proposed release. For each water body potentially affected by the proposed wastewater release, the applicant should identify any environmental values (EVs) and water quality objectives (WQOs) scheduled under the EPP Water, propose default EVs/WQOs where required, and provide a description of the existing qualities, characteristics and resilience of the aquatic environment.

Identify water bodies potentially affected by the proposed release

The name of the waters proposed to receive the wastewater discharge and a plan or map showing the spatial location and latitude and longitude of the discharge outfall should be supplied. EVs need to be determined on a 'micro' geographical scale for the waters potentially affected by the licensed activity. For example, the affected water body might be a bay, an estuary, a freshwater river or a lake. Different values may apply to different parts of a water body and it is important that these zones are clearly defined for each value. Furthermore, the levels of aquatic ecosystem protection need to be determined for each zone as either high conservation, slightly-to-moderately disturbed or highly disturbed (see Table 3). Levels of protection may be apparent from planning documents for the waters. The default level of protection is generally slightly-to-moderately disturbed.

Table 3—Description of levels of aquatic ecosystem protection

High conservation/ecological value level of protection
The objective for areas where a high conservation/ecological value level of protection is adopted will be no measurable change in the characteristics of the water. An application for a discharge in these areas should be accompanied by local reference data and/or local biological effects data. It is anticipated that the environmental management decision would act to protect 99 per cent of species in the affected water. Water bodies or zones that fall into this area include, for example, marine parks. Areas of high conservation/ ecological value may be identified through federal, state or regional strategies, ecological studies or consultation with interested or affected people.
Slightly-to-moderately disturbed level of protection
The objective for areas where the slightly-to-moderately disturbed level of protection is adopted is that the resulting water quality does not exceed default trigger values. Default trigger values for each region or basin can be determined from local reference data, the Queensland Water Quality Guidelines (2009) or from the ANZECC & ARMCANZ (2000)) Water Quality Guidelines—section 3.4. The triggers to protect 95 per cent of species will generally apply. Alternatively, the applicant may use risk analysis techniques. In this case they should supply all necessary supporting documentation with the application. The licensing officer should seek assistance from Science Division in DES in assessing the validity of the data.
Highly disturbed level of protection
The objectives for areas where the highly disturbed level of protection is adopted are: a) the water quality should improve towards achieving the default trigger values for slightly-to-moderately disturbed systems; and b) the water quality should not measurably deteriorate as a result of the proposed discharge. An application for a discharge into these areas should be supported by local reference data. If the applicant wishes to significantly add to the load in a highly disturbed area, they will be responsible for undertaking public consultation and gaining stakeholder acceptance. Alternatively, the applicant may demonstrate that the quality of the water to be discharged complies with the default trigger values. For toxicants listed in section 3.4 of the ANZECC & ARMCANZ (2000) Water Quality Guidelines, the trigger to protect 90 per cent of species should be used.

Provide all relevant information on the receiving environment

The proponent should provide an adequate description of the receiving environment given the contaminants and risks associated with the proposed discharge. It is essential that ecosystem health and catchment information be obtained to assess the outcomes of the proposed activity. Information should be provided on the character and resilience of the receiving environment, **standard criteria** of the EP Act (Schedule 4; Item (e)). This information may already exist or may need to be collected as part of special investigations for the licensing approval. The information should include current local ecosystem health and water quality information (e.g. the location of any sensitive or important habitat/refugia); potential pollutant sources in the catchment; any weirs/barriers or water uses; and local catchment or water quality issues. The information is required to identify areas of potential risk, for comparing the current condition of the environment to WQOs, for calibration of predictive models used in Step 3—Predict outcomes or impact of the proposed discharge, and for base-lining the current condition against future potential impacts post approval.

Additional Information in describing the receiving environment

There are many other sources of useful information to aid in describing the receiving environment including those provided by government agencies/authorities (Great Barrier Reef Marine Park Authority (GBRMPA)), industry, research organizations (CSIRO Land and Water; Australian Institute of Marine Science), partnerships (e.g. Healthy Waterways Partnership), etc. Some useful information sources are supplied in Table 4.

Note that any sources of information used to assist in characterising the receiving environment by the applicant must be appropriately cited and referenced so that they can easily be searched and checked (for validity; for information quality; etc.) where required.

Table 4—Useful sources of information to describe the receiving environment

Source	Type of information	Link
Australian Government—Department of Sustainability, Environment, Water, Population and Communities	Contains the three elements—policy, process and guidelines—for the National Water Quality Management Strategy (NWQMS).	Search for 'National Water Quality Management Strategy' at **www.environment.gov.au**
Australian Government—Geoscience Australia	The OzCoast estuary database and information on coastal indicators.	OzCoast website **www.ozcoasts.gov.au**
Department of Environment and Science (DES)	Includes stream flow; surface water quality; sub-artesian groundwater level; groundwater quality and/or quantity monitoring. State of the rivers projects provide 'snapshots' of the ecological and physical condition of Queensland riverine systems.	Search for 'Water quantity and quality monitoring networks' at **www.qld.gov.au** Search for 'State of the rivers' at **www.des.qld.gov.au**

Source	Type of information	Link
Department of Environment and Science (DES)—Science Division.	DES monitors ecosystem health in rivers, estuaries and coastal areas throughout the eastern coast of Queensland. In addition, DES collects information on the water quality and quantity of authorized releases to waterways, via the WaTERS database.	Raw data on water quality and aquatic ecosystem health can be requested by emailing **water.data@qld.gov.au** For further information on WaTERS, refer to https://www.qld.gov.au/dsiti/about-us/business-areas/monitoring-water-releases/. Government officers can also accessed this information via RIVERS.
Local governments	Local governments throughout Queensland conduct water quality monitoring programs, including recreational (biological) monitoring.	e.g. Brisbane City Council Water Quality Monitoring Program. Search for 'Water quality monitoring' at **www.brisbane.qld.gov.au**
National Environment Protection Council (NEPC)	Guidance on investigations assessing pre-development groundwater contamination.	Schedule B (1): Guideline on the Investigation Levels for Soil and Groundwater, NEPC (1999) **www.ephc.gov.au** Schedule B(6): Risk Based Assessment of Groundwater Contamination, NEPC (1999) **www.ephc.gov.au**
Ports Corporation of Queensland	Water quality; seagrass; sediment; etc. monitoring programs are carried out for baseline assessment and/or impact assessment around activities (e.g. dredging).	Environmental management section of the North Queensland Bulk Ports Cooperation website **www.pcq.com.au**

Consideration of temporary streams

Temporary streams are defined as streams that do not flow continuously all year round. They include ephemeral streams, which only flow after significant rainfall, as well as intermittent streams, which only stop flowing during extended dry periods. Temporary streams go through a series of hydrological stages, from a wetting stage following rain (including the first flush), through a recessional stage, to a pooled stage or completely dry stage. The importance of maintaining water quality in the small number of permanent pools in ephemeral streams during naturally dry stages includes the protection of these habitats for relict species refugia.

Release of wastewater to temporary streams requires special consideration due to their unique hydrological and ecological characteristics. Such emissions are likely to disrupt the natural ecology and impact the aquatic ecosystem. Continuous or semi-continuous releases during naturally dry stages should be avoided, and wet weather releases occur when receiving water flows are sufficient, from a risk-based assessment, to achieve the receiving WQOs. The nearest upstream gauging station should be used to determine the release period.

Receiving environment WQOs should be based on the most appropriate local reference data collected in the same stream above the release or in a similar stream in the area that is not affected by the release. Monitoring data should ideally cover the wetting stage as well as recessional or pool stages. In the absence of suitable reference data, default values from the Queensland and ANZECC Water Quality Guidelines should be adopted.

Information on methods to assess ephemeral stream water quality is available from http://pandora.nla.gov.au/pan/75829/20070821-1620/www.acmer.uq.edu.au/research/attachments/FinalReportTempWatersSep20042.pdf

Identify all relevant EVs and WQOs

An application to release wastewater to waters must identify the EVs for the water body and demonstrate how the EVs will be protected. An EV is a quality or physical characteristic of the environment that is conducive to ecological health, public amenity or safety (examples include flow conditions, sediment quality and riparian vegetation). The long-term goal is to improve EVs, particularly in disturbed ecosystems under pressure from human impacts. In determining EVs, site specific information is preferred. WQOs are the aspirational targets that have been set to protect EVs. In water bodies not achieving WQOs, the intent of the EPP Water is to progress towards the WQO (where achievable) through a number of catchment management actions and improvements to point sources.

Note that WQOs are not intended for and should not be used as discharge to water release limits. Appropriate release limits must be determined on a case–by-case basis and be established by appropriate water quality modelling or other scientific means (refer to Step 4—Set circumstances, limits and monitoring conditions).

Where specific EVs/WQOs been prescribed for these water bodies

The EPP Water establishes EVs for the fresh, estuarine, coastal and ground waters of Queensland under Schedule 1 of the policy. WQOs have been established for four regions of Queensland under Schedule 1 of the EPP Water. Where EVs and WQOS are listed in Schedule 1 of the EPP Water these should be adopted and considered for the licensing decision.

Where default EVs/WQOs are relevant

Where EVs have not been specifically set for a water body through the EPP Water, the EPP Water prescribes use of default EVs. For those regions where no EVs have been specifically set for a water body refer to section 6(2) of the EPP Water for guidance on how Queensland waters are to be protected or enhanced. If WQOs have not been established, refer to section 11 of the EPP Water. The ANZECC & ARMCANZ (2000) Water Quality Guidelines sets out EVs (in section 2.1.3) that should be considered for licensing.

The ‘Additional Information in describing the receiving environment’ section on page 10 describes a process for using default EVs/WQOs for assessing licensed discharges in this case, but does not constitute ‘accrediting’ either the default EVs or WQOs. For scheduling EVs/WQOs under the EPP Water, the department’s guideline for establishing draft EVs, management goals and WQOs can be referred to.

Ensure other potential sources and loads of contaminants in the catchment are considered

It is important to ensure that proponents have identified and considered the other potential catchment pollutant sources (including future discharges), local catchment issues and the potential for cumulative impacts. A sustainable loads assessment should be conducted for key contaminants, including what proportion of the sustainable load is used by the proposal.

Possible sources of information include development applications, Murray–Darling Basin salinity management plan, local government sewerage planning strategies and catchment plans, Wastewater Tracking and Electronic Reporting System (WaTERS)[1] and the Department of State Development, Manufacturing, Infrastructure and Planning. This aspect is also important because the administering authority would not allocate all available assimilative capacity to a single application (unless it is for an essential service and there is no other alternative), and an application should not seek the release of a contaminant where the proposed load was a significant proportion of the sustainable load.

Sustainable load studies

The sustainable load can be determined by studies of aquatic ecosystem health and modelling to predict the effect of natural catchment and anthropogenic loads (diffuse and point source) on the WQOs of the receiving water. This process is generally undertaken in collaboration with regional natural resource management bodies and other relevant stakeholders. The sustainable load of a particular contaminant is the maximum amount that a water body can receive without adversely affecting EVs. The concept of sustainable load is particularly important for oxygen demanding substances, nutrients, salinity, sediments and toxicants. It should be noted that sustainable loads should relate to an area of influence based on the issues of concern. Toxicants are generally a near-field issue[1] and suspended sediments can have a near-field and far-field (catchment scale) effects[2].

Ensure all government planning requirements applying to the water bodies have been considered

Environmental management objectives and levels of ecosystem protection are often specified in planning designations or codes and may have implications on the proposal.

Examples:

- Commonwealth requirements—RAMSAR wetlands, World Heritage areas, and threatened species, as well as Great Barrier Reef Marine Park requirements and the Great Barrier Reef Water Quality Protection Plan.
- State requirements—state coastal management plan, regional coastal management plans, marine park zoning plans, water resources plans, fisheries reserves and national parks.
- Local government requirements—conservation designations in local government planning schemes.

Note that terrestrial conservation zonings can affect discharge proposals; for example, access for pipelines and potential adverse impacts of effluents on riparian vegetation such as nutrient enrichment promoting weed invasion and high salinity causing plant death.

Step 3—Predict outcomes or impact of the proposed wastewater release

The third step involves predicting the outcomes or impacts of the proposed release. Estimating environmental outcomes or impacts will generally rely on a quantitative assessment(s) using some type of mathematical models such as spreadsheet calculations through to complex numerical modelling software. Such models may be used to describe the proposed processing activity and discharge quality or describe the effects of discharge to the near-field and the far-field receiving environments.

Prediction of the impact of the proposed discharge of residual waste water on receiving water quality should be compared to the WQOs. Existing receiving water quality should be the baseline comparison for impact assessment. Receiving water quality, WQOs and management intent should be based on:

- **For wastewater release to high conservation/ecological value (HEV) receiving waters**: maintain the natural values; including the physico-chemical, biological, habitat and flow attributes.
- **For wastewater release to slightly-to-moderately disturbed (SMD) receiving waters**: either maintain (use some assimilative capacity) or improve (over time).

[1] For example, effects from sediment bound toxicants on benthic communities may be a localised issue.
[2] For example, adsorbed toxicant load can adversely affect pelagic species and benthic fauna and flora directly, as well as indirectly through contamination of food sources (e.g. seagrass and organic detritus).

- **For wastewater release to highly disturbed (HD) receiving waters**: halt the decline and reverse the adverse trend in water quality. HD receiving waters do not have any assimilative capacity. It is recognised that attainment of WQOs for highly disturbed receiving waters is a long-term goal.

If existing WQOs, potentially affected by the proposed discharge, are currently not being met then a significant environment risk is associated with the discharge as further environmental harm is likely to occur. In this case, the EVs will not be protected and the proposed discharge will not be considered favourably as it conflicts with the object of the EP Act. Furthermore, it may not be worthwhile undertaking modelling and the proponent should be advised to consider alternatives such as relocating or redesigning the proposal.

Assess whether contaminants are potentially toxic

The environmental authority application must demonstrate that the contaminants in the proposed residual wastewater release are not toxic to aquatic organisms. This can initially be done considering the maximum end-of-pipe concentrations and comparison to toxicant trigger values in section 3.4 of the ANZECC & ARMCANZ (2000) Water Quality Guidelines. Where potential toxicity exists, an initial mixing zone must be considered—see below.

Consideration of an initial mixing zone

A mixing zone is an area where the wastewater mixes rapidly with receiving waters as a result of momentum, buoyancy and turbulence.

Mixing zones are a mandatory consideration under s.36 of the Environmental Protection Regulation 2019 (EP Reg), especially whether the mixing zone would adversely affect biological integrity or recreational use. **Applications must**:

- consider the ANZECC & ARMCANZ (2000) Water Quality Guidelines (Volume 2, section 2.2.2 and Appendix 1) for mixing zones
- include the results of the baseline water quality monitoring in the area of the proposed mixing zone
- for HEV waters—provide predictive modelling results that demonstrate no or negligible change to the ecological attributes beyond the mixing zone.

A mixing zone is a permitted zone of impact and is primarily for managing soluble toxicants where concentrations in the release are above toxicant trigger values in section 3.4 of the ANZECC & ARMCANZ (2000) Water Quality Guidelines. Where this is the case, further risk assessment including DTA for biological effects, should be considered prior to mixing zone assessment. DTA of effluent would generally apply to residual wastewater treatment plants that have the potential to receive commercial or industrial effluent as part of the trade waste system, or advanced wastewater treatment plants (AWTPs) that produce a reverse osmosis concentrate (ROC), or other similarly concentrated waste streams.

Where the toxicant concentrations in the release are found to not cause toxicity, mixing zone assessment may not be required. Results of DTA will also be used to assess the actual dimensions of the mixing zone. Results of DTA will also be used to assess the actual dimensions of the mixing zone.

Various predictive models are available for estimating initial mixing zones, evaluating outfall diffuser designs and defining areas around the outfall.

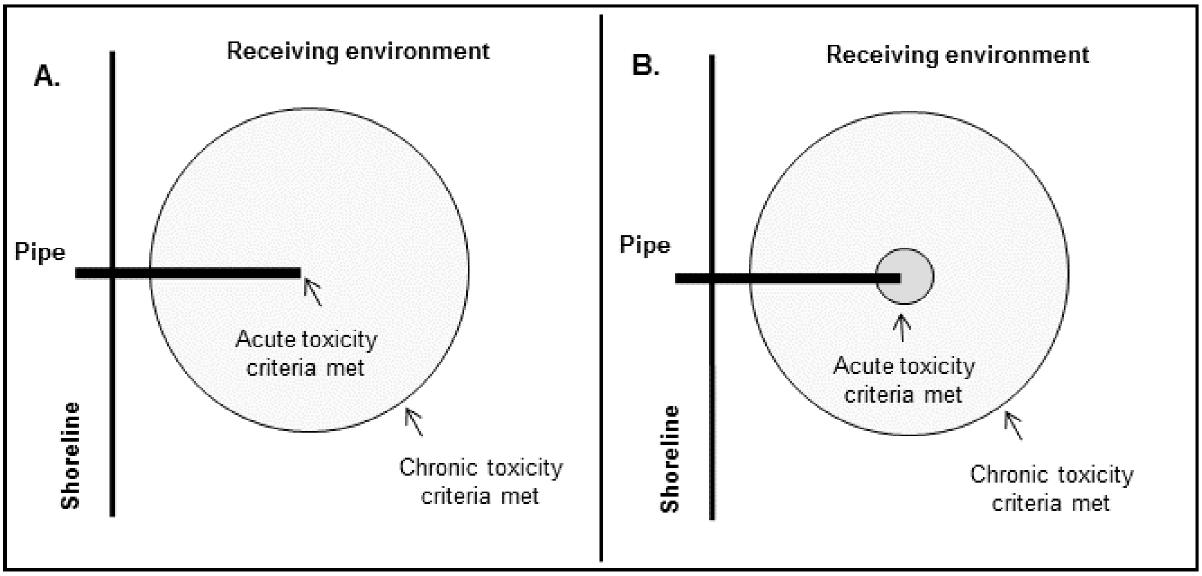
The administering authority would not approve a mixing zone if inclusion would be likely to result in human health impacts, irreversible environmental impacts, unacceptable impacts to biota or where the release of residual wastewater was characterised by a lack of effluent plume dispersion.

Mixing zone considerations include the following:

- only one mixing zone, minimised to the greatest practicable extent, is permitted for an activity
- spatially defining the mixing zone based on compliance with estimated receiving environment concentrations using mean flows and maximum expected toxicant concentrations for the release against chronic toxicant concentration. The diameter (as depicted in Figure 2) should be measured from the diffuser port and should be defined by considering the maximum extent from a range of tidal conditions in tidal areas covering at least slack tides and mid-tide conditions for all toxicants present in the release. In non-tidal streams, the minimum consecutive seven day average flow with a 10-year recurrence interval is recommended as a guide to minimum dilution conditions
- ensuring the mixing zone would not provide a barrier to the migration of aquatic fauna in riverine and estuarine waters, i.e. not take up the width of the stream. As a general rule, the maximum lateral dimension should be the lesser of 50 metre (m) diameter or 30 per cent of the waterway width for riverine and estuarine waters and a radius not exceeding 100 m from the diffuser port for coastal/marine waters
- avoiding overlap of mixing zones from neighboring releases. It is recommended that the edges of the mixing zones be at least 200 m apart. The combined affect should be assessed
- compliance with receiving WQOs should be met within three stream widths or 300 m from the diffuser port, whichever is the smaller
- not impinging on the shore line; for example, based on the mean of the low water spring tide (mean low spring tide)
- the use of mixing zones is not appropriate for managing the release of nutrients, substances that bioaccumulate or particulates
- mixing zones are typically not applicable to waters with significant and regular use for primary contact recreation, existing aquaculture development approvals, areas allocated to aquaculture under planning frameworks, waters of high ecological value, conservation significance or scientific importance or near-potable water intakes
- the release limits should be set such that within the mixing zone the residual wastewater release does not cause odours, surface discolouration, visible floating foam, oils, grease, scum, litter or other objectionable matter
- contaminant concentrations in the mixing zone must not be acutely toxic to fish, other aquatic vertebrates, commercial species or endangered wildlife, cause significant irreversible harm including objectionable bottom deposits, the growth of undesirable aquatic life or the dominance of nuisance species (such as algal blooms). The use of toxicity-based guidelines or site-specific biological effects data is usually required to define the boundary of the mixing zone
- for large flowing freshwater streams where effluent releases are unlikely to have a significant density difference compared with the receiving waters, the effluent plume may extend a considerable distance downstream. The applicant would need to confirm the proposed release does not impact EVs of the receiving waters after full lateral mixing.

When assessing thermal releases and oxygen demanding substances, acute effects should not occur anywhere in the receiving waters, for example no harmful dissolved oxygen sags are caused. In these cases, maximum concentrations and loads should be modelled and assessed to assess potential impacts. Predicted environmental concentrations and levels should be compared to known acute effect levels.

Figure 2—Spatially defining an initial mixing zone



A. Low risk configuration where acute toxicity levels are met end-of-pipe.

B. Configuration that involves a small zone within the mixing zone where acute toxicity criteria may not be met but have a low risk of causing acute toxicity.

When assessing effects of contaminants that are based primarily on a reference condition rather than direct effects, for example nitrogen and phosphorus concentrations, assessment typically requires water quality objectives to be met on a percentile basis (for example median concentration). It is not necessary that such concentrations are met directly at the discharge point as effects of dilution, assimilation and average receiving environment conditions should be considered. Prediction of effects of these discharges is typically a far-field issue and needs to consider the assimilative capacity of the waters.

Monitoring of effects of discharges in these cases is typically undertaken in the centre of waterway channel at various distances from the discharge point. Compliance with reference criteria should be met within three stream widths or 300 m, whichever is the smaller as a general guide. Approval of zones with exceeded water ambient quality objectives greater than this size may be granted in specific cases where social and economic considerations support the discharge of residual waste water and there are no other feasible alternatives. Regardless, localised environmental harm should not occur, for example smothering of corals with benthic algae from nutrients.

Predict the assimilative capacity and sustainable load

Assimilative capacity is the capacity of the receiving waters to receive some human induced input of contaminants, or alteration, while still achieving the water quality objectives.

Release of assimilative capacity in high ecological value (HEV) and slightly-to-moderately disturbed (SMD) waters for discharge of residual waste water

Decisions about the use of assimilative capacity in HEV and SMD receiving waters for the discharge of residual waste water must be considered after all options to manage the waste water have been assessed and managed by the administering authority in the context of sustainable and efficient use of scarce resources.

An environmental authority application should demonstrate that the assimilative capacity of the receiving waters is not exceeded and that some assimilative capacity is preserved for future ecologically sustainable development—the proportion proposed to be consumed should be determined. As a guide, the majority proportion of the assimilative capacity should be retained for future ecologically sustainable development.

The administering authority may consider the role of market-based instruments in managing these issues (for example flexible or incentives based mechanisms).

What are the sustainable loads for key contaminants?

The sustainable load of a particular contaminant is the maximum amount that a water body can receive without failing to meet the WQOs and therefore adversely affecting EVs. The concept of sustainable load is particularly important for oxygen demanding substances, nutrients, sediments and toxicants. It should be noted that toxicants are generally a near-field issue and suspended sediments can have an adsorbed toxicant load which can adversely affect pelagic species and benthic fauna and flora directly, as well as indirectly through contamination of food sources.

Assimilative capacity of HEV water not to be exceeded by discharge of residual waste water

The demonstration of ‘no or negligible change’ to the ecological indicators beyond the mixing zone boundaries also demonstrates that the HEV water assimilative capacity is not exceeded. For HEV waters, the application may include an environmental offset proposal seeking to deliver a net environmental gain to the water as a whole.

Where assimilative capacity is exceeded—prior to assessment

In some slightly-to-moderately disturbed (SMD) waters the assimilative capacity for specific contaminants may already be exceeded. This may be evident from ecological health monitoring and remedial programs may be underway to restore ecological health by reducing loads of specific contaminants. Highly disturbed (HD) waters usually do not have any assimilative capacity. The public interest consideration and other considerations under the standard criteria of Schedule 4 of the EP Act may be important in the assessment of applications proposing the release of residual wastewater to SMD or HD receiving waters, where assimilative capacity is exceeded.

Relevant considerations may include:

- that the proposal provides a public service such as municipal sewage disposal or provides goods or services to the Queensland community to meet an identified demand and there is no alternative option that is capable of meeting that demand
- the above applies and there are no cost-effective alternatives to prevent, control or abate the release of residual wastewater or to mitigate the impacts through alternative release strategies
- applicable environmental impact studies, assessments or reports.

Provide justification for choice and application of predictive methods/models

Information should be provided justifying the choice of method/model used, the application of the model including data inputs/parameters used and the likely uncertainty/reliability of predictions.

Choice of model

The models used should be ‘fit for purpose’ and any work based upon sound science and the best available information. The size and potential risk of the proposed activity will determine the scope and extent of the modelling required.

Predictive tools such as mathematical models are often required when assessing the benefits of various management options (or scenarios). Different types of computer models exist, including hydrodynamic (mixing and flow), water quality (biogeochemical), catchment (export), chemical fate (fate and transport models) and groundwater models. The type of model used will depend on the application, but generally a combination hydrodynamic and water quality models would be required to simulate receiving waters for decisions involving continuous point source releases. Catchment models may be used to provide inputs into receiving water models. Hydrodynamic and water quality models are discussed further below (Table 5).

The choice of hydrodynamic models needs to account for the properties of the release, bathymetry, as well as the local mixing conditions in the receiving waters. Receiving waters may also not be well mixed in all dimensions. For example some estuaries periodically stratify due to salt wedge formation. The model needs to be able to simulate the appropriate density effects or thermodynamic processes for the specific application.

A technical description of the model should be provided to DES covering the history of the model, development history, published articles and details of the conversion of the model into a software package. Details of the experience and training of the model users should be provided. Other requirements include a statement of objective to explain clearly the situation being modelled and the objectives of the modelling study and outputs required from the model. The choice of model should be justified to demonstrate that the model used is suitable for this study including examples of previous applications in similar situations and a conceptual diagram of how the model represents environmental processes.

Table 5—Predictive water quality models

Model type	Description
Mixing zone models	Are used to assess water quality impacts from point source discharges. The most commonly used mixing zone model is Cormix, available through the US DES website. Cormix is a water quality modeling and decision support system designed for environmental impact assessment of mixing zones resulting from wastewater discharge from point sources. Although US focused, the compilation of mixing zone documents provides good background information. To obtain concentration predictions in the mixing zone, background levels need to be added to the dilution predictions. These may be sourced from far-field models or estimates from monitoring.
Catchment models	Typically simulate the flows and loads of suspended sediment, total phosphorus and total nitrogen from freshwater catchments with consideration of land use, rainfall, soil characteristics, vegetation cover, etc. Flows and loads are routed through stream networks, typically to the tidal limits of estuaries. Catchment models are available from a number of sources including the Healthy Waterways Partnership, CSIRO Land and Water, eWATER CRC and regional natural resource management groups.
Receiving water quality models	For estuaries and embayments there are specific and complex models that simulate the hydrodynamic and water quality variations in the water body subject to external inputs. Receiving water quality models enable scenario modeling of water quality to be undertaken to predict the likely impacts of contaminants. The model of choice needs to include the relevant biogeochemical processes relevant to the contaminants in the release and the characteristics of the receiving environment. For example, for carbonaceous matter, the model will need to simulate the heterogenic bacterial activity that breaks down the carbonaceous matter. This process also consumes oxygen and therefore the models need to simulate surface re-aeration and solubility etc. For nutrients, the model will usually need to simulate the growth of algae and primary production. Receiving water quality models are available through major consultant organisations for specific parts of the state, and are required to be used for significant projects.
Box models for estuarine water quality modelling	Provide a simple computational framework that may be used to determine contaminant load estimates (e.g. N and P). Box models are relatively straightforward, available through most consultant organisations, or may be developed for the estuarine waters of interest.

Model application and data inputs

The quality of inputs to the model will greatly affect the predicted outcomes. All modelling assumptions should be stated. Initial assessment should include a review of the flows and contaminant concentrations for the proposed activity and other activities to be modelled. These usually form the basis of the scenarios used for the model runs. How well do they represent the likely release in terms of quantity and variability? For constant concentrations and flows, do they represent average or worst-case condition? For what period of time do the worst-case conditions exist, and how frequently? Further data inputs will include initial conditions (particularly for water quality variables) and boundary conditions (tidal flow and elevations at the seaward or upper catchment boundary of the model) of the model and these should be checked. The choice of environmental data such as rainfall will often be determined by the choice of baseline conditions. It is generally recommended that a statistical dry year is used to assess point source scenarios.

Data used for the modelling study and its source should be clearly defined, including the source, quality assurance and expected errors. Any data manipulation and related assumptions should be detailed. Raw data in electronic form should be made available to the administering authority on request.

Uncertainty of predictions

The ability of the model to make reliable predictions will strongly depend on the above issues and should ideally be tested through both calibration (adjustment of model parameters to reproduce measured data) and validation (a comparison of predicted values against measured data). Validation is used to demonstrate the model accuracy. Without calibration or validation, model prediction should only be used for qualitative comparisons, rather than quantitative comparisons against WQOs. Sensitivity analysis can be used to demonstrate the effect of varying input data or parameters on key output variables. The uncertainty of model predictions should be stated and incorporated into any conclusions made by the applicant.

Consider other potential impacts

The above sections have focused largely on water quality outcomes for aquatic ecosystem health. Numerous other potential impacts can occur as a result of a wastewater release and these should also be assessed. Table 6 presents other potential impacts that may occur as a result of wastewater release(s) along with guidance for impact assessment.

Table 6—Other potential impacts from waste water releases

Environmental value	Potential impact	Guidance for impact assessment
Hydrological	The release of wastewater may have adverse impacts on the hydrology of temporary and permanent surface receiving waters. The impacts relate to the volume and velocity of release relative to natural flows, and may include bed and bank erosion and changes to the particle size distribution of sediments. Other effects may occur on biota where there is insufficient time to complete life cycles due to changed flow regime.	As a general guide, modelling of flow characteristics should be considered where the wastewater flow would exceed 10 per cent of the natural minimum flow of the waterway.
Riparian habitat	Release of wastewater may adversely affect riparian vegetation, e.g. nutrient rich releases may lead to weed infestation of habitats where vegetation is adapted to a low nutrient regime. Similarly saline groundwater released into a freshwater stream or clearing /disturbance may adversely affect riparian vegetation.	Visual recreation is a declared EV of water that is likely to be adversely affected where there is a weed infestation. Water may be treated to remove ions that contribute to salinity (as occurs in the coal seam gas industry). Saline water may also be released during flow events so that the discharge is diluted.

Environmental value	Potential impact	Guidance for impact assessment
Public health	Protection of public health usually requires that multiple barriers between effluent and drinking water or contact water be in place. In some cases these barriers may not be present, for example where: • the effluent is not substantially diluted by a watercourse/ocean prior to public access • persons may come in contact with the effluent (e.g. recreational area) • the waters are essentially fresh, which may encourage children to ingest the waters. Note that he monitoring for typical water quality indicators such as *Enterococcus spp.* is not for pathogenic organisms, but indicators of possible contamination and hence does not necessarily guarantee safe levels	Apart from effluent treatment trains, barriers usually include dilution and significant distances between outfalls and places where potential exposure and water use occurs. Where no barriers are present between effluent and drinking water then alternative release locations should be evaluated, or more specialised public health assessment approaches adopted. Refer to the Guidelines for Managing Risk in Recreational Waters (NHMRC[3] 2008) and Australian Drinking Water Guidelines (NHMRC 2011) for further information on assessing suitability of recreational water quality.
Groundwater	Additional considerations exist when applying the guidelines to groundwater, or to water bodies directly or indirectly affected by groundwater. An example of a **direct impact** is where the groundwater is suitable for drinking. An example of an **indirect impact** is where the groundwater is not directly used but the movement of the groundwater impacts on a secondary water body with defined values.	Where there is a **direct impact** ANZECC & ARMCANZ (2000) guideline values can be applied directly to the groundwater. Where there may be an **indirect impact** case it is necessary to consider the values to be protected, as well as the effects of the attenuation zone, the flux rate of the groundwater and any dilution achieved.

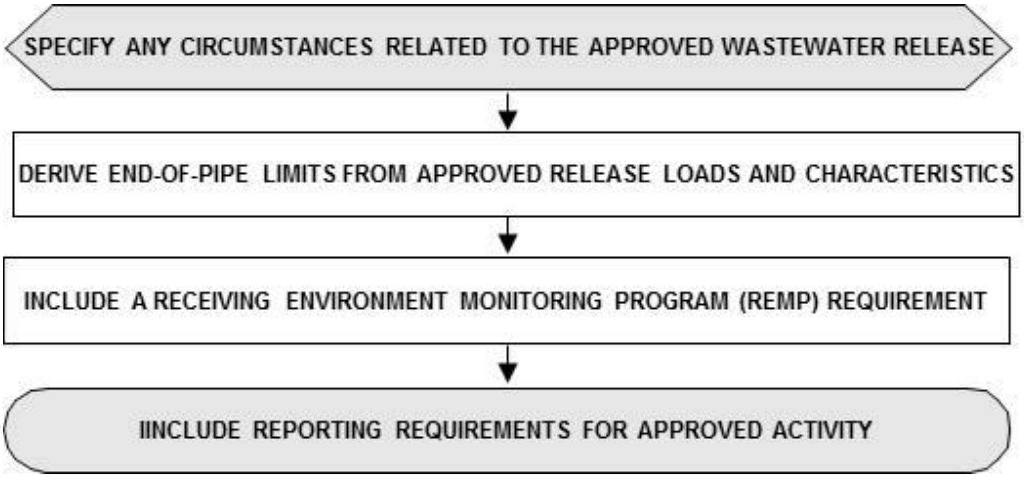
Step 4—Set circumstances, limits and monitoring conditions

Once the outcomes of the proposed activity are deemed acceptable, it is necessary to determine the appropriate discharge limits and performance monitoring requirements for the licence. The derived permit conditions, including release conditions, limits, release circumstance, discharge and impact monitoring requirements should reflect the inputs used in predictions. Other factors include the potential environmental risk of the industry being licensed, the potential impact of the release on the receiving environment and the use of best practice environmental management. The licensing officer should initially refer to agency internal templates available for the industry type and apply the operational policy for environmental authority conditions[4,5].

Appropriate release limits and performance monitoring can be decided upon by undertaking the following steps that are summarised at Figure 3.

[3] National Health and Medical Research Council **www.nhmrc.gov.au**
[4] Guideline (Mining): Model water conditions for coal mines in the Fitzroy basin. Available at **www.qld.gov.au** using the publication number ESR/2015/1561 as a search term.
[5] DRAFT Coal Seam Gas Model Conditions (Version 15/11/2011). This document is available by request from the Department of Environment and Science (DES), Petroleum and Gas Unit

Figure 3—Consideration of specific environmental authority conditions



Specify any circumstances related to the approved wastewater release

The permission to discharge must be constrained to the residual waste streams after waste minimisation measures, and the conditions must state that only approved wastewater may be released. The location of the release (discharge/release point), including any need for submergence or a diffuser, should be specified. Certain limitations or timing issues may also be conditional to the approval, for example, the release may only be permitted at outgoing tides (ebb-tide release), at certain months of the year or only during wet weather flows exceeding a stated level. Outfall submergence below local low water to avoid visual impacts and enhance mixing is generally required, unless the release is not buoyant. Other precautions such as signage may be desirable depending upon the nature and the location of the release.

Derive end-of-pipe limits from approved release loads and characteristics

Appropriate release/discharge limits should be based on the impact assessment undertaken by the applicant, i.e. release limits for end-of-pipe need to be derived from inputs used in predictions. WQOs should not normally be used directly for regulatory purposes instead discharge limits for the end-of-pipe will aid in achieving these WQOs.

The process of deriving the limits can be divided (a) selecting quality characteristics; (b) determining the relevant limit type; (c) choosing the discharge limit and units, and (d) choosing a monitoring frequency.

Selecting quality characteristics

Limits should be placed on any (water, sediment, biota) quality characteristics that can be practically measured at the end-of-pipe and are relevant to the release quality. These might include toxicants, nutrients, oxygen-consuming substances, suspended solids, dissolved oxygen, pH and pathogen indicators such as *Enteroccocus spp*. The wastewater characteristics and the impact assessment of the release would be used as a basis for selecting appropriate indicators.

For waste streams that may vary over time, for example, municipal sewage may receive varied trade waste inputs, an additional qualitative condition that requires that the release must not have any other properties nor contain any other organisms or other contaminants which are capable of causing environmental harm is recommended to address this issue.

Determining the relevant limit type

Licence limits may be a combination of percentiles (e.g. 80^{th} percentile), minimum and maximum values and/or mass load. Activities with substantial releases such as large wastewater treatment plants (WWTPs) would typically be required to meet a long-term percentile (annual), short-term percentile (six week), maximum and minimum limits but this may not be appropriate for a small-scale release as this involves significant sampling effort (for example weekly). In the case of small-scale release, monthly monitoring against maximum limits and annual percentile would be more reasonable. The method of determining maximums and percentiles should incorporate expected and acceptable fluctuations in concentrations and loads. Table 7 provides further guidance on determining the relevant limit type.

Table 7—Guidance on determining the relevant limit type

Limit type	Guidance for Limit types
Maximum	- Maximum values are particularly important for toxicants that have an acute impact on the environment (Table 3.4.1 ANZECC & ARMCANZ (2000) Water Quality Guidelines for trigger values for toxicants to protect 99, 95 and 90 per cent of species). - Values can be applied for compliance monitoring to a single sampling event. - Values ensure a proper standard of treatment applies at all times. Note that different limits should be considered, for maximum discharge volume, under various weather conditions (dry, wet weather flows).
Minimum	- Values are important for parameters such as dissolved oxygen. - Values can be applied for compliance monitoring to a single sampling event. - Values ensure a proper standard of treatment applies at all times.
Percentiles	- Percentiles may be employed when relevant to treatment technology and when percentile performance is used in impact assessment studies to evaluate medium to long term environmental outcomes, for example nutrient loads and risks of nutrient enrichment. - Percentiles are important as they encompass ongoing high quality treatment in the longer term, whilst allowing reasonable fluctuation in the treatment process. - Percentiles can only be applied over a number of sampling events. Note that percentiles are not suitable for some characteristics (e.g. residual chlorine) and should not be applied without relevant maxima or minima in the longer term. Note for percentiles it is very important to include the clear definition of the sampling period.

Choosing the limit

General guidance for setting limits is shown in Table 8.

Limits need to be set for each quality characteristic in appropriate units based on potential effects and available analytical methods. Analytical methods are given in the Water Quality Sampling Manual (DES 2010). Scientific experts should be consulted where required.

Table 8—Guidance for setting limits for indicators/ indicator types

Indicator/ indicator type	Limit type	Guidance for limits
Toxicants	Maximum No observed effect level (NOEL)	Base the limits on ANZECC & ARMCANZ (2000) default toxicity trigger values (TVs) also considering treatment performance, minimum dilutions, and results from DTA/mixing zone assessment. Additional multiplying factors may be used in the case of bio-accumulating and bio-concentrating contaminants. No build-up in sediments, exceeding relevant trigger levels. No build-up in seafood species (Food Standards Code). Irrigation, stockwater and drinking water protected where these are relevant values.
Nutrients	50th percentile Maximum Mass loads	50th percentile to achieve mass load (and prevent local impacts). Maximums to prevent local impacts (generally three times limit for 50th percentile). Mass loads based on systems sustainable load or capacity.
Suspended solids	Mass loads 80th percentile Maximum	Use levels achievable by best practice environmental management (BPEM) (e.g. 50 mg/L) or background water quality.
Salinity	Maximum	Maximum to prevent near-field toxicity or ensure WQOs as outlined in the Queensland Water Quality Guidelines (2009) or EPP Water Schedule 1 are not significantly impacted. .
Pathogenic indicators	Maximum Median	Limits based on Guidelines for Managing Risk in Recreational Waters (NHMRC 2008) and Australian Drinking Water Guidelines (NHMRC 2011)
Temperature	Maximum Minimum	Maximum temperature elevation based on receiving waters.
Residual disinfectant	Maximum Minimum	Maximum based on likely decay time and effects on biota. Chlorination not recommended when discharging to waters.
Dissolved oxygen concentration	Minimum	Best practice environmental management, e.g. 2 mg/L
pH	Range	Usually no greater range than 6–9. Can also be based on receiving environment water type and measured pH range.
Oxygen demand e.g. BOD, COD, TOC	Mass loads 80th percentile Maximum	Maximum mass loads based on systems sustainable load or capacity. 80th percentile concentrations (typically short and long term) to prevent local impacts or based on best practice treatment. Maximums to prevent local impacts (generally two or three times limit for short term 80th percentile).

Include a receiving environment monitoring program (REMP) requirement

The REMP document should be a design document that specifies the proposed monitoring program for the local receiving waters. The intent is that the REMP will provide condition assessment of near-field areas, i.e. local areas likely to be most affected by the wastewater release(s). The spatial extent of the REMP should be specified in the licence/permit. The REMP design document is not an impact assessment document or an environmental management plan but a documented plan detailing what monitoring of the receiving waters will be undertaken and how.

A main objective of the REMP should be reporting against WQOs for relevant waterways potentially affected by the discharge, i.e. to assist in assessing general aquatic ecosystem health. Reasons for requiring ambient monitoring may be to monitor mixing zone characteristics, verify conclusions of an environmental impact assessment, study or report, to decide future disposal strategies or if there is concern about the levels of a particular contaminant in waters.

Ambient monitoring can provide information on regional ecosystem health and other relevant water quality information required to assess EVs. Such programs may be coordinated through regional partnerships comprising groups of stakeholders involved in the catchment. A contribution by the applicant to existing regional ecological health monitoring programs may be an alternate to applicant monitoring. A requirement to monitor wider in the catchment should only be required when the discharge is contributing a large percentage of the contaminant load to that waterway.

Recommended REMP structure

The REMP design document should be consistent with the criteria set out in the permit/licence. The recommended structure and sections of the document should be as follows:

- a brief Introduction stating the clear objective of the document and REMP
- a brief background listing any relevant reports prepared by the proponent or other groups that relate to the receiving environment within which the REMP is proposed
- a brief description of potentially affected receiving waters
- a description of applicable EVs and WQOs
- monitoring design including site locations, indicators, frequency of sampling, sampling methods, proposed data analysis
- reporting to be undertaken, e.g. annually.

Where the results are presented from the REMP (either in the initial REMP report or in subsequent reporting of results) it is recommended that the information include a summary of the relevant data and a brief interpretation and discussion of the results with:

- an assessment of background/reference site data to determine local background/reference values as per the Queensland Water Quality Guideline approach
- a condition/compliance assessment related back to relevant trigger limits or WQOs. Potential causes for non-compliance and potential effects on EVs should be discussed
- long-term trends should be provided in future reports if sufficient data has been accumulated.

Any raw data collected for the REMP should be provided in appendices and made available to DES electronically in a suitable format (such as Microsoft Excel or csv).

Include reporting requirements for approved activity

The provision of monitoring data and reports to the administering authority should be set out as permit conditions. Requirements should include reporting performance against development approval, environmental authority, environmental management plan or environment protection order conditions, prompt notification of breaches of permit conditions and other incidents likely to cause environmental harm; and the assessment of impact monitoring of the effect of wastewater releases.

An example of permit conditions for monitoring report (take note of A6):

(Annual monitoring report (sewage treatment)
(A5) An annual monitoring report must be provided to the administering authority. This report shall include but not be limited to:
- a summary of the previous twelve (12) months' monitoring results obtained under any monitoring programs required under this authority and, in graphical form showing relevant limits, a comparison of the previous 12 month's monitoring results to both this authority limits and to relevant prior results
- an evaluation/explanation of the data from any monitoring programs
- a summary of any record of quantities of releases required to be kept under this authority
- the time, date and duration of equipment malfunctions where the failure of the equipment resulted in the release of contaminants reasonably likely to cause environmental harm
- any uncontrolled release of contaminants reasonably likely to cause environmental harm
- any emergency involving the release of contaminants reasonably likely to cause serious or material environmental harm requiring the use of fire fighting equipment
- an outline of actions taken or proposed to minimise the environmental risk from any deficiency identified by the monitoring or recording programs
- the number and industry type of new trade waste approvals issued during the previous twelve months and the progressive total number of active trade waste approvals and their industry type.
(A6) Information used to prepare the report required by condition A5 must be made available to the administering authority upon request by an authorised person. Such information must be supplied at the times and in the format requested.

Refer to Section 3.10 of DES's Monitoring and Sampling Manual 2009 (https://www.qld.gov.au/dsiti/about-us/business-areas/monitoring-water-releases/) for more information on data custodianship, management and submission for regulatory purposes. .

Disclaimer

While this document has been prepared with care it contains general information and does not profess to offer legal, professional or commercial advice. The Queensland Government accepts no liability for any external decisions or actions taken on the basis of this document. Persons external to the Department of Environment and Science should satisfy themselves independently and by consulting their own professional advisors before embarking on any proposed course of action.

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Version history

Version	Date	Comments
1	18 December 2012	Versioning first added
2.00	12 September 2016	Added publication number ESR/2015/1654 and updated publication number for referenced documents. Updated corporate style, departmental names, legislative references, definition of standard criteria and information about the WaTERS database. Made various corrections of spelling and punctuation.
2.01	25 June 2018	Document rebranded to align with machinery of government changes.
2.02	08 October 2019	Updated to reflect the Environmental Protection Regulation 2019 remake

Appendix 1—Glossary of terms

Administering authority means the administering authority under the *Environmental Protection Act 1994* (EP Act).

Aquatic ecosystems is defined in the ANZECC & ARMCANZ (2000) Water Quality Guidelines as the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. It is predominantly the physical components (for example light, temperature, mixing, flow, and habitat) and chemical components (for example organic and inorganic carbon, oxygen, nutrients) of an ecosystem that determine what lives and breeds in it, and therefore the structure of the food web. Biological interactions (for example grazing and predation) can also play a part in structuring many aquatic ecosystems.

Assimilative capacity means the capacity of the receiving waters to receive some human induced input of contaminants, or alteration, without causing the water quality to deteriorate so the water quality objectives are no longer met.

Basin means the major hydrological drainage basins in the national spatial database provided by Geoscience Australia. Australia is divided into drainage divisions which are sub-divided into water regions which are in-turn sub-divided into river basins. The data, which includes the name and number of each Queensland drainage division, region and river basin, is available at the Australian Government Geoscience Australia website **www.ga.gov.au**.

Best practice environmental management is defined in the EP Act as the management of the activity to achieve an on-going minimisation of the activity's environmental harm through cost effective measures assessed against the measures currently used nationally and internationally for the activity. Section 21(2) lists measures to be regarded in deciding best practice environmental management of an activity. These measures include, but are not limited to, strategic planning, systems and training, product and process design, public consultation, waste prevention/treatment and disposal.

Biological integrity of a water is defined in the EPP Water as the water's ability to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation comparable to the natural habitat of the locality in which the water is situated.

Catchment means the total watershed draining into a river, creek, reservoir or other body of water. The limits of a given catchment are the heights of land (such as hills or mountains) separating it from neighbouring catchments. Catchments can be made up of smaller sub-catchments.

Character, resilience and environmental values of the receiving environment – see **Resilience.**

Complete mixing means, with reference to mixing zone considerations, the effluent is completely dispersed through the receiving waters.

Compliance monitoring means the activity of monitoring the approved release and comparing against the specified environmental authority conditions. This will generally occur at the release pipe. Monitoring can also be required for the receiving environment. Compliance should not be based on the receiving environment monitoring results alone, particularly where other factors in the catchment may contribute to non-compliance.

Contaminant is defined in s. 11 of the EP Act as a liquid, gas, solid or other forms, which is released into the environment.

Cultural resources is defined in the State Coastal Management Plan 2001 as places or objects that have anthropological, archaeological, historic, scientific, spiritual, visual or ecological significance or value.

Environmental authority condition means a condition of an environmental authority imposed by the administering authority under the EP.

Direct toxicity assessment (DTA) means the assessment of the combined effects of a number of compounds of unknown identity and concentration in an effluent. DTA provides an integrated measure of the aggregate/additive toxicity of chemicals and accounts for interactions between compounds.

Ecological health is defined in the ANZECC Water Quality Guidelines as the health or condition of an ecosystem. It is the ability of an ecosystem to support and maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats within a region (also termed ecological integrity). The concept of ecological health is applicable to all complex ecosystems and sustainability is a key element of the concept.

Ecologically sustainable development (ESD) is defined in the EP Act as the protection of Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles for ESD as published in the National Strategy for Ecologically Sustainable Development 1992 (available at **www.environment.gov.au**) are a part of the standard criteria of Schedule 4 of the EP Act and include the precautionary principle. They must be considered when making decisions to grant or refuse an application.

Environmental authority application means an application under the EP Act for an environmental authority.

Environmentally relevant activity (ERA) means a resource activity (defined in section 107 of the EP Act) or a prescribed ERA (defined in sections 19 and 106 of the EP Act and prescribed under section 17 and schedule 2 of the EP Reg).

An environmental authority is required to legally operate an ERA.

Environmental value (EV) is defined in the EPP Water as the qualities of a water that make it suitable for supporting aquatic ecosystems and human water uses. EVs need to be protected from the effects of pollution, waste releases and deposits to ensure healthy aquatic ecosystems and waterways that are safe for community use. Particular waters may have different EVs.

Far-field waters means, in the context of an initial mixing zone, the waters beyond the specified boundaries of the mixing zone.

General environmental duty means the duty that applies to all persons in Queensland to take all reasonable and practicable measures to prevent or minimise environmental harm when carrying out an activity that causes, or is likely to cause, environmental harm. It is defined in s. 319 of the EP Act.

High ecological value (HEV) waters is defined in the Queensland Water Quality Guidelines (2009), as amended, as waters that have the biological integrity of effectively unmodified (intact) ecosystems or waters that are highly valued.

Intergovernmental Agreement on the Environment means the agreement made on 1 May 1992 between the Commonwealth, the States, the Australian Capital Territory, the Northern Territory and the Australian Local Government Association.

Level of protection (for aquatic ecosystems) is defined in the Queensland Water Quality Guidelines (2009), as amended, as the level of aquatic ecosystem condition that the water quality objectives for that water are intended to achieve. The levels of aquatic ecosystem protection are:

- Level 1 High ecological/conservation value aquatic ecosystems—effectively unmodified or other highly valued systems
- Level 2 Slightly-to-moderately disturbed aquatic ecosystems—ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity

- Level 3 Highly disturbed aquatic ecosystems—measurably degraded ecosystems of lower ecological value.

Mixing zone (or initial mixing zone) is defined in the EPP Water as an area where residual wastewater mixes rapidly with surface water because of the momentum or buoyancy of the wastewater and turbulence of the surface water. Within the initial mixing zone dilution of the effluent contaminants takes place, water quality degradation occurs and certain water quality objectives may be exceeded.

Near-field waters means, in the context of an initial mixing zone, the waters immediately adjacent to the specified boundaries of the mixing zone.

Precautionary principle is defined in the National Strategy for Ecologically Sustainable Development 1992 as where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of the precautionary principle, public and private decisions should be guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment and an assessment of the risk-weighted consequences of various options. Decisions to grant or refuse an application must consider the precautionary principle as part of the standard criteria of Schedule 4 of the EP Act.

Public interest may be ascribed as meaning the interest of the public as distinct from the interest of the individual(s).

Queensland Water Quality Guidelines means the Queensland Water Quality Guidelines (2009), as amended, prepared by the former Department of Environment and Science.

Queensland waters is defined in the *Acts Interpretation Act 1954* as all waters that are within the limits of the state or coastal waters of the state.

Resilience of the receiving environment means the ability of an ecosystem to adjust or respond to progressive impacts **and** the ability to recover following cessation of the natural or anthropogenic disturbance. Information on both the recovery and response phases is required to **characterise resilience and the sensitivity of the receiving environment.** In particular, information on the recovery phase is crucial because it is the indicator of reversibility or irreversibility of the impact.

Standard criteria is defined in Schedule 4 of the EP Act as:

(a) the following principles of environmental policy as set out in the Intergovernmental Agreement on the Environment—

(i) the precautionary principle

(ii) intergenerational equity

(iii) conservation of biological diversity and ecological integrity

(b) any Commonwealth or State government plans, standards, agreements or requirements about environmental protection or ecologically sustainable development

(d) any relevant environmental impact study, assessment or report[6]

(e) the character, resilience and values of the receiving environment

(f) all submissions made by the applicant and submitters

[6] Item (c) of the standard criteria definition was deleted from the EP Act, but the remaining items were not renumbered.

(g) the best practice environmental management for activities under any relevant instrument, or proposed instrument, as follows:

   (i) an environmental authority

   (ii) a transitional environmental program

   (iii) an environmental protection order

   (iv) a disposal permit

   (v) a development approval

(h) the financial implications of the requirements under an instrument, or proposed instrument, mentioned in paragraph (g) as they would relate to the type of activity or industry carried out, or proposed to be carried out, under the instrument

(i) the public interest

(j) any applicable site management plan

(k) any relevant integrated environmental management system or proposed integrated environmental management system

(l) any other matter prescribed under a regulation.

Stream order is a standard means of describing streams. The smallest streams in a drainage network have no tributary streams. These are called first order streams. Two first order streams unite to form a second order stream. Second order streams only have first-order streams as tributaries. Third order streams only have second and first order streams as tributaries, etc. As the order of the stream increases, the release increases, the gradient decreases, the velocity increases, and the channel dimensions (width and depth) increase to accommodate the increased release.

Sustainable load of a particular contaminant means the maximum amount of the contaminant that a water body can receive without exceeding the related WQOs, and therefore adversely affecting EVs.

Trigger values (TV) means the numerical criteria that if exceeded require further investigation for the pollutant of concern. If not exceeded, a low risk of environmental harm can be assumed.

Tertiary treatment is often referred to as advanced wastewater treatment in the literature and essentially involves any further treatment after primary (physical) and secondary (usually biological) that further reduces the nutrient or organic load of the treated effluent.

Waste management evaluation procedure in making environmental management decisions about the release of residual wastewater from an ERA means, under the EPP Water, the assessment processes for prioritising waste management practices (waste management hierarchy) to achieve the best environmental outcome.

Wastewater treatment plants (WWTPs) means sewage treatment plants, advanced wastewater treatment plants, water reclamation plants and all other synonyms for treatment plants whose primary function is to treat a water based waste stream.

Wastewater means, under Schedule 2 of the EPP Water, a liquid waste and includes contaminated stormwater.

Water means the whole or any part of surface water or groundwater, tidal or non-tidal, and including any river, stream, lake, lagoon, swamp, wetland, unconfined surface water, natural or artificial watercourse, dam, tidal waters (estuarine, coastal and marine waters to the limit of Queensland waters) and underground or artesian water.

Water quality indicator (for an EV) is defined in the EPP Water as a property that can be measured or decided in a quantitative way. Examples of water quality indicators include physical indicators (for example temperature), chemical indicators (for example nitrogen, phosphorus, metals) and biological indicators (for example macroinvertebrates, seagrass and fish).

Water quality objective (WQO) are the WQOs specified in Schedule 1 of the EPP Water to protect the EVs for waters. WQOs are long term goals for water quality management. They are numerical concentration limits or narrative statements established for receiving waters to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines, but may be modified by other inputs (for example social, cultural, and economic).

Water types means waters with similar characteristics. The water types covered by this document are based on water types established in the Queensland Water Quality Guidelines (2009). Water types include coastal waters (open and enclosed), estuarine waters (lower, middle and upper), tidal canals, constructed estuaries, marinas and boat harbours, freshwaters (lowland, upland and dams/reservoirs), wetlands and ground waters. WQOs applying to different water types are outlined in the documents under Schedule 1 of the EPP Water.