EPA VICTORIA | Environment Protection Authority Victoria

Applied Science Advice

1 REQUEST DETAILS

REQUEST DETAILS		
PORTAL/ IBIS NO.	4242	
CLIENT	Leo Crasti	
CAN ADVICE BE ADDED TO KNOWLEDGE BANK?	☐Yes ☒No	
CONFIDENTIALITY	☐Yes ☒No	
ENVIRONMENTAL SEGMENT / DISCIPLINE	☐Wastewater ☐Landfill ☐Odour ☐Noise ☐Air	☐Waste ☒Water ☐Groundwater ☐Land ☐Human health
ISSUES/ACTIVITIES	Nutrient Discharge to Stormwater	
EXPERT(S)	Mason Bonacci	
PEER REVIEW REQUIRED/RECOMMENDED *(use decision matrix in SOP)*	☒**Yes** If yes, level recommended: ☐high ☐medium ☐low	☐**No** If no, why not: ☐standard advice ☐low risk/low complexity ☐not available ☐other:
PEER REVIEW REQUEST: SCOPE AND TYPES	**Scope**: <what's recommended for peer review>	**Types**: ☒technical ☒language and style ☒science communications ☐strategic alignment
PEER REVIEWER(S)	Simon Sharp	
PEER REVIEW DETAILS	Specialist Applied Scientists – Freshwater, ESU	

2 BACKGROUND

Request details:
Enviro Australis Pty Ltd (Enviro) is an Australian owned and operated company that develops and produces fully integrated stormwater pollution control systems that include devices applicable to oil/water separation for catchments where a risk of oil spillage exists.

VICTORIA State Government

Recently we received feedback from several councils that indicates that the definition of total nitrogen has been narrowed to the dissolved fraction. Our enquiry of your organisation is to confirm our interpretation of TN.
We understand that the intent of legislation is to cause reduction in materials transported by stormwater to be reduced to generic, or to a minimum sustainable level. In the case of trash, the desired reduction is obviously 100% as plastics and other such manufactured materials were not present in the original environment. However, in the case of nutrients the original environment had a background level which was in balance with the organisms present in land and aquatic ecosystems.
A misunderstanding that we seek to amend is that some LGA officers are working on the principle that TN is mostly comprised of dissolved fractions up to levels of 70 and 80% of TN. This conclusion is drawn from reports on stormwater sampling. Enviro does not doubt the accuracy of the analysis however; we believe the misunderstanding originates from an assumption that what has been retrieved by samplers directly into sample bottles, is an accurate reflection of TN. Our Technical Manual has additional information on various aspects associated with this assumption, which includes the nitrogen cycle and limitations of samplers.
In summary, we ask for your concurrence with our definition; being that TN is intended to represent the total nitrogen load regardless of species and furthermore that such determination of load be recognised as variable and subject to factors such as catchment activity, soil type and rainfall among many other factors.

3 SUMMARY AND CONCLUSIONS

3.1 Background on Nutrients

Organisms require nutrients for growth and natural concentrations present in waters supply food for primary producers (plants and algae). Nutrients, including forms of nitrogen, are also environmental stressors and potential toxicants – see Default Guidelines Values (DGVs) for nitrate and ammonia (ANZG, 2018 - http://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/).

When present in excess concentrations, nutrients can cause eutrophication (state of enrichment) and disrupt the natural food supply, resulting in rapid growth of certain organisms (e.g. algae), which ultimately disrupt and outcompete other organisms (e.g. aquatic plants and those organisms which feed on them). Rapid algae growth in nutrient-rich waters require higher amounts of oxygen as they die off and begin to decompose.

Dissolved Inorganic Nitrogen (DIN) (nitrate + nitrite + ammonium) is often the greatest focus, as it is a more bioavailable form of nitrogen which can be readily assimilated by algae and plants. However, re-mineralisation of Phosphorus) (P) and Nitrogen (N) may mean that Total P phosphorus (TP) and Total Nitrogen (TN) concentrations give a better indication of ultimate bioavailability than the dissolved forms, and TP and TN can closely relate to algal biomass moreso than just dissolved inorganic P or N. Overall, TP and TN are routinely monitored for nutrient as they provided more data used to derive objectives used by waterway managers. An accepted definition of TN based on Standard Methods for the examination of Water and Wastewater (American Public Health Association (APHA)), is defined as:

TN = Total Kjeldahl Nitrogen (TKN = Ammonia(NH4/NH3) + Organic Nitrogen) + Nitrite (NO2) + Nitrate (NO3))

3.2 Summary of Requirements for Stormwater Management

- Any discharge to the stormwater system should be managed to meet the objectives and clauses outlined in the SEPP. If water quality meets SEPP environmental quality indicators, this would demonstrate water quality is likely to be suitable to discharged to stormwater, in the absence of more detailed sampling (i.e. of the receiving waterway).
- It is advised parties responsible for stormwater management locate the point/s of discharge for the stormwater system to identify the receiving waters and the corresponding beneficial uses under the SEPP. The background conditions of the receiving waterway will further inform decision making about water quality.
- The default guideline values (DGVs) for toxicants are listed in the Australian and New Zealand Guidelines for Fresh & Marine Water Quality (ANZG, 2018).
- Duty holders should conform with the Waste Control Hierarchy of the EP Act 1970. This means that before a discharge to the environment is considered, efforts must be made to avoid, reuse and recycle wastewater.
- Discharge cannot be toxic, create an environmental hazard or contain noxious substances. According to the EP Act an environmental hazard is defined as state of danger to human beings or the environment whether imminent or otherwise resulting from the location, storage or handling of any substance having toxic, corrosive, flammable, explosive, infectious or otherwise dangerous characteristics.

3.3 Conclusions

- An accepted definition of Total Nitrogen (TN) = Total Kjeldahl Nitrogen (TKN = Total Ammonia (NH_4/NH_3) + Organic Nitrogen) + Nitrite (NO2) + Nitrate (NO3))
- Concentrations provide a measure of the availability of nutrients to biota, with DIN often indicating the more immediate bioavailable nitrogen forms. Nutrient loads are more applicable to endpoints (e.g. lakes, reservoirs), where nutrients tend to accumulate, and sediments can be a major source of nutrients. The intended use of SEPP environmental water quality objectives and indicators for rivers and streams necessitates they are provided primarily as concentrations rather than loads.
- To minimise the risks of diffuse and point source pollution on the beneficial uses of marine and estuarine waters, pollutant load targets are set out in Schedule 4 of the SEPP. This provides for quantitative targets for the protection of beneficial uses by reducing pollutant loads generated from point and diffuse sources entering Lake Wellington, Corner Inlet, Western Port and Port Phillip Bay. The overarching pollutant load targets are provided in clauses 2–5 and are described in terms of quantity (e.g. mass) rather than concentration.
- SEPP (clause 34) sets out requirements for managers new development (under the Victorian Planning Provisions), catchments and water assets to reduce pollutant concentrations and loads through the use of Best Practice Environmental Management Guidelines (BPEMG) for Urban Stormwater (CSRIO, 1999)
- The BPEMG for Urban Stormwater set **treatment objectives** for stormwater, including **meeting SEPP** concentrations and achieving **retention targets** of 45% for total nitrogen and total phosphorus, 80% for total suspended solids and 70% for litter, compared with the typical urban load.

- The sampling methodology adapted for waters, wastewaters and sediments should be performed in accordance with EPA Publication *Industrial Waste Resource Guidelines 701 (IWRG701): Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*.
- In conclusion, stormwater must be managed to minimise the risks to beneficial uses of receiving waters, so far as reasonably practicable, by reducing the impacts of flow, sediment, nutrients, pathogens, toxicants, litter and other pollutants on those receiving waters in accordance with the SEPP and ANZG. Effective management of water that meets SEPP and ANZG objectives would minimise the risks to beneficial uses making any discharges acceptable. Water that fails to meet SEPP and ANZG must be managed appropriately.

4 REVIEW PROCESS

Documents provided for review:

- 190506 Mason Bonacci EPA

EPA Victoria ("EPA")

EPA is the principal environment agency responsible for administering the EP Act and regulating all activities relating to the discharge of waste, including emissions to stormwaters and waterways.

This advice is provided within the broad context provided by:

Acts administered by EPA

Environment Protection Act 1970
Environment Protection Act 2017 (the 2017 Act)
Pollution of Waters by Oils and Noxious Substances Act 1986
National Environment Protection Council (Victoria) Act 1995

The Principles of Environment Protection, introduced in an amendment to the EP Act, must be considered in the EPA's decision-making.

- *Environment Protection Act 1970* (**EP Act**).

In 2017 the Victorian Parliament passed the *Environment Protection Act 2017* (Vic) ("**EP Act 2017**") that introduced a new objective for the EPA to "protect human health and the environment by reducing the harmful effects of pollution and waste".
Human and environmental health are key concerns for decisions made under the EP Act 2017.

- *Environment Protection Act 2017*

The proposed reforms to the EP Act (2018), which come into effect from 1 July 2020, include an overhaul of the licensing and works approval regime, and the addition of a **general duty** to minimise risks that may give rise to risk of harm to human health or to the environment; contravention of this duty would be an offence.

- *Environment Protection Amendment Act 2018*

State environment protection policies

EPA's decisions must be based on state environment protection policies (SEPPs) and waste management policies (WMPs) (ss 16–19 EP Act). These policies set overall environmental

standards and objectives. SEPPs contain fixed and ambient standards that maintain and protect "beneficial uses" of the environment.

- *State Environmental Protection Policy* (*Waters*) ("SEPP")

Management of urban stormwater

Clause 34 in SEPP (Waters) requires that stormwaters must be managed to minimise risks to beneficial uses of receiving waters, so far as reasonably practicable, by reducing impacts of flow, sediment, nutrients, pathogens, toxicants, litter and other pollutants on receiving waters.

Objectives for environmental management of stormwater are set out in *Best Practice Environmental Management Guidelines for Urban Stormwater (BPEMG)*. The BPEMG establishes stormwater quality objectives to help determine the level of stormwater management necessary to meet the State Environment Protection Policy (Waters) objectives.

Clause 34, subclause (3) in SEPP (Waters) lists provisions for owners and managers of assets created to protect water quality to renew or replace these assets when they are damaged, are no longer functional, or have effectively reached the end of their operational life, with substitute assets that meet equivalent environmental standards.

Clause 34, subclause (4) in SEPP (Waters) lists the responsibilities of councils, in consultation with EPA, water corporations (Melbourne Water has functions under the **Water Act 1989** in respect of water supply, sewerage and waterway management), landowners, Catchment Management Authorities (CMAs) and the community to develop and implement stormwater management plans to manage impacts from urban stormwater runoff on receiving waters.

- Urban stormwater best practice environmental management guidelines (BPEMG)

The **Water Quality Guidelines** are a joint initiative of the Australian and New Zealand governments, in partnership with the Australian states and territories. SEPP (Waters) adopts the risk-based approach of the ANZ Guidelines (ANZG) for the purposes of using the environmental quality indicators and objectives in this Schedule to assess whether a beneficial use is at risk.

- ANZG (2018) Australian & New Zealand Guidelines for Fresh & Marine Water Quality, http://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants/arsenic-2000 (ANZG); accessed 18 April 2019.
- EPA Publication 792.1 Nutrient Objectives for Rivers and Streams – Ecosystem Protection

Sampling and analysis of waters, wastewaters, soils and wastes Environmental samples are analysed for a range of purposes such as meeting statutory requirements of the Environment Protection Act 1970, Pollution of Waters by Oils and Noxious Substances Act 1986. SEPP (Waters) require that the environmental quality objectives must be assessed using monitoring protocols or guidance published or approved by EPA. This guidance forms part of the Industrial Waste Resource Guidelines (IWRG), which offer guidance for wastes and resources regulated under the Environment Protection (Industrial Waste Resource) Regulations 2009 (the Regulations).

- EPA Publication Industrial Waste Resource Guidelines 701 (IWRG701): Sampling and Analysis of Waters, Wastewaters, Soils and Wastes.

Analytical Methods for the Examination for the Examination of Water and Wastewater

APHA (2017) *Standard Methods for the Examination of Water and Wastewater 23rd Edition*, American Public Health Association, American Water Works Association, Water Environment Federation.

5 RATIONALE

5.1 Stormwater Management Requirements

Urban stormwater management is outlined in the Clause 34 of the SEPP. This clause confirms that discharges of wastewater to surface waters must comply with the principle of the waste hierarchy in the *Environment Protection Act 1970* (The Act). This means that before a discharge to the environment is considered, efforts must be made to avoid, reuse and recycle wastewater. Where wastewater discharge cannot be avoided, the Duty Holder should contain water onsite at all times until characterisation of the wastewater quality is completed.

Any water discharged to a stormwater drain will eventually flow into surface waters. Whether water is discharged directly to surface waters, or reaches surface waters indirectly via stormwater drains, the quality of water discharged needs to be carefully managed to minimise impacts. Any releases to a stormwater system should meet the objectives of the *State Environmental Protection* Policy (Waters) ("SEPP"). If water quality meets SEPP environmental quality objectives and indicators for the associated environmental segment this would demonstrate water quality is suitable to be released to stormwater, in the absence of more detailed sampling (i.e. of the receiving waterway). It is advised that parties responsible for the management of stormwater locate the points of discharge for the stormwater system to identify the receiving waters and the corresponding beneficial uses under the SEPP. The background conditions of the receiving waterway will further inform decision making about required water quality. If environmental quality objectives are not able to be attained due to natural levels the background level will become the objective. The default guideline values (DGVs) for toxicants are listed in the Australian and New Zealand Guidelines for Fresh & Marine Water Quality (ANZG).

According to Clause 34 of the SEPP "Councils, as the responsible authority, must ensure all new development meet the objectives for environmental management of stormwater as set out in the *Best Practice Environmental Management Guidelines for Urban Stormwater (BPEMG)* to minimise… the pollution of stormwater".

The BPEMG establishes stormwater quality objectives to help determine the level of stormwater management required to meet SEPP (Waters) objectives. According to Chapter 2 of the BPEMG the objectives for environmental management of stormwater are:

- suspended solids (SS) - 80 per cent retention of the typical urban annual load
- total phosphorus (TP) - 45 per cent retention of the typical urban annual load
- total nitrogen (TN) - 45 per cent retention of the typical urban annual load
- litter - 70 per cent retention of typical urban annual load
- flows - maintain discharges for the 1.5 year ARI at pre-development levels.

Treatment **best practice performance objectives** relate to stormwater pollutant profiles for a catchment, which are determined largely by land-use and stormwater management. Pollutants of concern should be identified by assessing receiving water quality, impacts from catchment land-use, and current management practices. Further field validation for new stormwater treatment systems showing reduced concentrations of nutrients and suspended solids and long-term performance monitoring of stormwater treatment measures is also needed.

Estimating urban loads and stormwater quality improvements required to meet SEPP objectives and protect beneficial uses is achieved by 1) monitoring; 2) modelling; or 3) generic mean urban stormwater quality values (BPEMG, Section 2.3).

5.2 Nutrient Objectives for Waters

Nutrient guidelines ultimately focus attention on the management of point source and non-point source nutrient inputs to receiving waters. Nutrient management forms part of a larger goal of maintaining or restoring water quality which reflects ecological integrity and sustainability and minimises toxicity to organisms. The guidelines are therefore based on this ecological goal.

The **nutrient status** of waters is usually determined by either estimating total loads, or characterising concentrations. **Concentrations** provide a measure of the immediate availability of nutrients to biota. Nutrient **loads** are more applicable to endpoints, such as lakes and reservoirs, where nutrients tend to accumulate, and sediments can be a major source of nutrients to the water column. The intended use of the guidelines necessitates their presentation in a form which is readily understandable, able to be monitored, and easily related to stream ecosystem effects, in particular algae and other plant growth. The guidelines and objectives are therefore provided primarily as concentrations rather than loads.

However, to minimise the risks of diffuse and point source pollution on the beneficial uses of marine and estuarine waters, pollutant load targets and responsibilities of agencies for implementing actions to achieve the targets are set out in Schedule 4 of the SEPP. This provides for quantitative targets for the protection of beneficial uses in order to reduce pollutant loads generated from point and diffuse sources entering Lake Wellington, Corner Inlet, Western Port and Port Phillip Bay. The nutrient load targets for waterways are expressed as a minimum and maximum range in tonnes per year and represent the range of loads that must not be exceeded within a single year between 2017–2027 to protect beneficial uses. Between 2017 and 2027 pollutant loads from waterways, including inputs from stormwater and run-off, are predicted to increase significantly in response to the pressure of increasing population growth and land-use change. Measures to maintain or reduce nutrient input levels to achieve these targets are outlined in the SEPP and are regionally specific. It is therefore important to understand the requirements under the SEPP for bodies receiving stormwater runoff.

It is recognised that dissolved pollutants (such as nutrients) and suspended sediment loads increase greatly during high-flow periods, and that the nutrients contributed during these events will add to ecosystem stress. Indeed, the bulk of a stream's total nutrient load is transported during these infrequent, high flow events. However, from a monitoring perspective, high-flow events are comparatively rare, and nutrient concentrations during these events are strongly influenced by the magnitude of the high-flow, rainfall intensity, and which part of the catchment receives the rainfall.

Monitoring during high-flow events is also complicated as to how many samples to collected during the event and which period of the flow hydrograph is sampled (e.g. accession vs recession). For a detailed example of effective monitoring and assessment of contaminants entering waterways from stormwater, see EPA Publication 1539 (https://www.epa.vic.gov.au/~/media/Publications/1539.pdf)

Loads retention is a concept used for effective treatment of stormwater technology as applied for BPEMG. However, for practical purposes of monitoring in streams, it is clearer and more useful to set guidelines for baseflow conditions, which are more stable and generally prevail.

Performance of stormwater treatment devices can be assessed by field monitoring or is sometime done using controlled laboratory conditions with real or artificial stormwater used to show the level of retention and reduction (performance removal) for particular water quality paraments (i.e. nutrients, TSS, litter). For an example of performance evaluations, see https://www.stormwater.asn.au/ - Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP), (Stormwater Australia, 2018) https://www.stormwater.asn.au/images/SQIDEP_report_v1.3.pdf.

The design of a treatment train, selection of devices and implementation of stormwater treatment and Water Sensitive Urban Design (WSUD) should be based on monitoring, modelling or generic mean urban stormwater quality values to show effective reduction of pollutants (BPEMG, 1999). For an example, see Melbourne Water's planning and building stormwater management WSUD https://www.melbournewater.com.au/planning-and-building/stormwater-management. Fundamental to successfully applying **WSUD** principles to urban development is an understanding of the **performance** capabilities of structural **stormwater** management strategies, their life cycle costs and market acceptance https://ewater.org.au/archive/crcch/archive/pubs/pdfs/industry200210.pdf.

Nutrient management forms part of the overall goal of maintaining or restoring water quality, which affects waterway ecological health and sustainability. The most direct measure of a waterway's ecological health lies in the aquatic biota that live within it. While nutrients and other physical and chemical indicators, such as turbidity, toxicants, and oxygen, can contribute substantially to understanding of the ecosystem and its maintenance requirements, their direct relationships with ecosystem health may not always be well understood. Therefore, nutrient and other water quality objectives should be considered as only one of a range of measures used in the protection or restoration of Victoria's waterways.

The SEPP outlines environmental quality indicators and objectives for the protection of beneficial uses, including for total phosphorus (TP) and total nitrogen (TN). There is some debate over what forms of nutrients provide the most appropriate measures of bioavailability. According to EPA Victoria Publication 792.1 *Nutrient Objectives for Rivers and Streams –Ecosystem Protection*, TP and TN were chosen because:

- Re-mineralisation of P and N may mean that TP and TN concentrations give a better indication of ultimate bioavailability than the dissolved forms;
- TP and TN have been found to relate more strongly to algal biomass than dissolved inorganic P or N;
- TP and TN are the most routinely monitored forms of these nutrients. Therefore, they provided a far larger pool of data for deriving the objectives and will also be the most use to resource managers.

Furthermore, an accepted definition of Total Nitrogen (TN) is based on the standard methods of analysis for TN in water as defined in the *Standard Methods for the examination of Water and Wastewater,* published by the American Public Health Association (APHA).
The accepted definition for concentration TN is defined as:

Total Kjeldahl Nitrogen (TKN = NH_3 + Organic Nitrogen) + Nitrite (NO_2) + Nitrate (NO_3))

Concentrations provide a measure of the availability of nutrients to biota, with Dissolved Inorganic Nitrogen (DIN) (nitrate + nitrite + ammonium) often the greatest focus, as it is a more bioavailable form of nitrogen which can be readily assimilated by algae and plants.

Excerpt from APHA (2017):

> "In this manual, organic nitrogen is referred to and reported as organic N, nitrate nitrogen as NO3–-N, nitrite nitrogen as NO2–-N, and ammonia nitrogen as NH3-N. Total nitrogen can be determined through oxidative digestion of all digestible nitrogen forms to nitrate, followed by quantitation of the nitrate. Two procedures, one using a persulfate/UV digestion (Section 4500-N.B), and the other using persulfate digestion (Section 4500-N.C) are presented. The procedures give good results for total nitrogen, composed of organic nitrogen (including some aromatic nitrogen-containing compounds), ammonia, nitrite, and nitrate.

Molecular nitrogen is not determined and recovery of some industrial nitrogen-containing compounds is low."

Caveats

- The sampling methodology adapted for the monitoring of waters and sediments should be performed in accordance with EPA Publication *Industrial Waste Resource Guidelines 701 (IWRG701): Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*
- State Environmental Protection Policy (Prevention and Management of Contamination of Land in Victoria) may be relevant when considering the disposal of sediment and litter.
- To fully understand the specific analysis used for any compliance testing of waters and wastewaters refer to NATA and accredited lab methods of TN analysis.

6 DOCUMENT APPROVAL AND PEER REVIEW TRACKING

Version control and details				
Date	**Expert**	**Draft/Final**	**Summary of Changes / Peer Review Details**	**Peer Reviewer**
23/05/2019	*Mason Bonacci*	*Peer-review*	*First draft, addition of BPEMG and WSUD, DIN, and stormwater treatment and testing advice*	*Simon Sharp*