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National Outfall Database: Outfall ranking based on 2023/2024 nutrient load discharge

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Cover images: (L-R) three dolphins jumping out of the water (Holly Nettle), leafy sea dragon (Holly Nettle), starfish on the sand (Holly Nettle).

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Executive summary

This report provides an analysis of the Australian coastal outfalls and ranks them according to the total flow volume and nutrients (nitrogen and phosphorus) load to prioritise the potential degree of impact of each source to the environment and human health.

Wastewater quality data was collected from 41 out of 43 water authorities (WTAs) with 177 out of 192 outfall sites (93%) around Australia by either downloading the water quality data reports directly from WTA websites or by formally requesting the data through email.

The pollutant contribution index, based on nitrogen and phosphorus loads, was calculated for each outfall. Nitrogen and phosphorus loads were calculated according to the Load Calculation Protocol of New South Wales Department of Environment and Climate Change. Outfalls were ordered from lowest to highest index value to rank them according to their relative pollutant contribution to the coastal and marine environment. The index is based on a total nutrient load discharge using the variables of flow, nitrogen and phosphorus.

The results show that the outfalls released 1,552 gigalitres of effluent into the marine environment between July 2022 to June 2023. The total nutrient load from individual outfall sites around Australia ranged from 0 to 5,375,025 kg with a mean of 131,116 kg, and nutrient load per person ranged between 170 mg to 79 kg. The ranked loads throughout Australia were mapped by quartiles. The outfalls in the bottom 25% quartile were more prevalent in regional areas and discharge less nitrogen and phosphorus loads into the coastal and marine environment. The top 25% quartile, on the other hand, with higher nutrient loads, principally occur around the major cities. The phosphorus concentrations contribute less to the overall outfall nutrient load and vary less between outfall sites. Nitrogen, on the other hand has a higher median contribution and high variability across the sites.

In general, the outfalls contributing higher nitrogen and phosphorus loads varied more than those discharging lower loads. There may be many reasons for this, but it could be related to treatment plant capacity, population growth, and licensing requirements, resulting in increased discharge at metropolitan outfall sites. There are some exceptions to this pattern where rural/regional sites contributed higher nutrient loads than urban areas (e.g., Warrnambool, VIC). The reasons may vary; however, the main contributor is the level of technology employed to remove nutrients. This ranking of nutrient loads from Australian outfalls by site at a national scale can therefore be useful in prioritising treatment upgrade resources to manage risk of biodiversity impacts and human health concerns.

1. Introduction

The discharge of treated wastewater has the potential to be a major contributor of marine environment pollution, globally. High concentrations of nutrients, pathogens, microplastics, organic and inorganic pollutants from wastewater discharge can threaten coastal ecology, biodiversity and affect the health of marine environment users, depending on the sensitivity of the receiving environment. (Wear et al., 2021, Boehm et al., 2017, Chahal et al., 2016, Ziajahromi et al., 2016). High loadings of nutrients may cause increased water eutrophication leading to hypoxic events that promote the mortality of marine organisms, including coral reefs (Altieri et al., 2017, Cheng et al., 2019, Whitehead et al., 2015). Harmful algal blooms (HABs), which can be caused by excess nutrient, can pose a threat to human health via direct contact with water, consumption of contaminated seafood and inhalation of the aerosolised algal toxins (Lim et al., 2023, Berdalet et al., 2023). In addition, eutrophication and HABs may also lead to economic losses for the local businesses that rely on the marine environment (Berdalet et al., 2023, Lemée et al., 2012). Recent findings of the Australian Senate inquiry into South Australia's 2025 Harmful Algal Bloom (HAB) underline this risk as "Inquiry evidence shows that elevated nutrient loads are a key enabling factor, meaning that in nutrient-saturated coastal waters even minor climatic shifts can trigger major ecological impacts."

To manage and safeguard aquatic and marine environments around Australia from the impacts of wastewater effluent, state/territory governments have each established Environment Protection Authorities (EPA). Each EPA acts as an independent environmental protection regulator to prevent and control pollutant impacts to human health and the environment. For example, in Victoria the EPA was established under section 5(1) of the Environment Protection Act of 1970. In New South Wales, the Protection of the Environment Administration Act (1991) (POEA Act) served as the mechanism to establish the environmental protection regulator. With regards to wastewater effluent each state or territory EPA has a role in regulating wastewater treatment plant (WWTP) discharges. For example, in New South Wales, the EPA regulates water pollution through the establishment of conditions in environmental protection licences. These licences take into account several factors, such as the community value of a waterway, the community's uses of a waterway and practical measures to prevent deterioration of waterway values and uses (EPA NSW, 2013). Any activity that may produce a discharge of waste that by reason of volume, location or composition that adversely affects the quality of any segment of the environment will require a licence from the Authority (DECC NSW, 2009). The basic requirement of the licence consists of an explanation of the activity; pollutant loads and discharge limits. The actual load of a pollutant is the mass (in kilograms) of the pollutant (e.g., nitrogen, phosphorus, total suspended solids, oil and grease) released into the environment from the potential emission sources. Throughout each state and territory, emission sources are required to monitor their discharges and to comply with conditions set out in their licences. Each WWTP is required to conduct monitoring within the vicinity of their outfalls, analyse the samples and report the results to the EPA (DECC NSW, 2009, EPA VIC, 2009).

The National Outfall Database (NOD), developed by the Clean Ocean Foundation in collaboration with state and territory governments, provides policy makers with a guide to help prioritise outfall reform and identify public and private sector opportunities for wastewater recycling (Marine Biodiversity Hub, 2015). In collaboration with the National Environmental Science Program, the NOD also provides Australian water authorities and the public an accessible database to help identify pollutant loads and assess any potential health and environmental impact risks of wastewater outfalls on the marine environment and surrounding communities. The NOD provides an unprecedented national collection of water quality data, collected by water authorities and local governments according to guidelines set out in Environment Protection Authority (EPA) licences. Given the NOD's centralised collection of national scale water quality data, the opportunity to examine the comprehensive impacts of wastewater outfalls at regional scales becomes possible.

The aim of this report is to present a collection of discharge monitoring data between July 2023 and June 2024 from outfalls across Australian coastal regions. This report also ranks each outfall according to the total flow volume and nutrients load per capita to prioritise the potential degree of impact of each source to the environment. In general, the results of this analysis will provide stakeholders and the general community a better understanding of the relative pressures of outfalls to their coastal waterways and provide policy makers and managers evidence to prioritise outfall infrastructure reform and wastewater recycling initiatives.

2. Methods

2.1 Data collection

Wastewater quality data were collected from water treatment authorities (WTAs) around Australia (Figure 1) by either downloading the water quality data reports directly from WTA websites or by formally requesting the data through email. WTA monitoring requirements varied depending on EPA licence requirements. Therefore, the type of pollutant data monitored varied across all outfall locations. In this report, we assess only nitrogen, phosphorus and flow volume (Table 1), for nutrient load calculation purposes. The population data of each outfall catchment were also gathered from the Australian Bureau of Statistics (2025) to calculate the amount of nutrient released per capita.

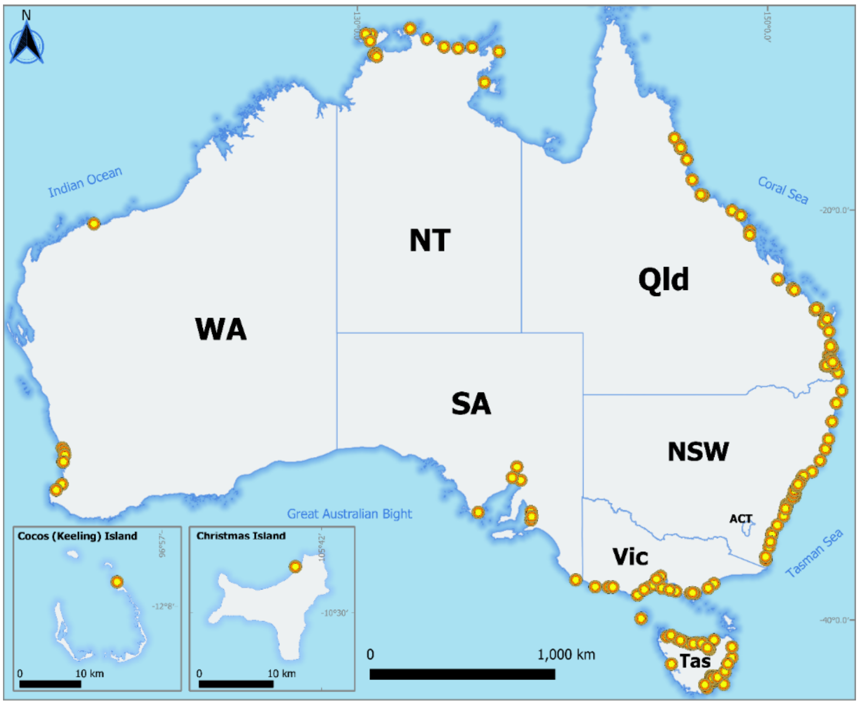

Figure 1. Australian outfall sites across six states and the Northern Territory over 43 water authorities. Cocos Keeling and Christmas islands are misplaced for illustrative purposes and do not reflect true geographic locations.

2.2 Data Analysis

The pollutant contribution index, based on nitrogen and phosphorus loads, was calculated for each outfall (Figure 1). Outfalls were ordered from lowest to highest index value to rank them according to their relative pollutant contribution to the coastal and marine environment. The index is based on a total nutrient load discharge (see below) using the variables of flow, and nitrogen and phosphorus concentrations.

Nitrogen and phosphorus (nutrient) load was calculated based on the Load Calculation Protocol (DECC NSW, 2009) using

$$L_d(kg) = \sum(V_d * C_d) \quad (1)$$

$$C_{fw}(ML/kg) = \frac{L_d}{\Sigma(V_{d-i})} \quad (2)$$

$$N_l(kg) = C_{fw} \times VT \quad (3)$$

where, N_l is the total nutrient load in kilograms, calculated for the observed load (L_d) of nitrogen and phosphorus concentrations (C_d) and V_d, the day's total volume of discharge from each outfall in megalitres (ML) (1). Nitrogen and phosphorus observed loads were summed and divided by the total volume (V_{d-i}) for those days which resulted as flow-weighted concentration (C_{fw}) (2) and multiplied by total volume (VT) of the licence fee period (ML) (3).

Nutrient load values were sorted and ranked for each outfall location and grouped into four quartiles, top 25% quartile (least nutrient load released), 50% quartile, 75% quartile and bottom quartile (most nutrient load released). All outfalls were further calculated by population to examine the amount of nutrient load per person. A few outfalls, which service the same areas and population, have the final nutrient load values combined. These include Sorell and Midway Point (Tasmania), Busselton North and South wetlands (Western Australia) and Christies Beach Northern and Southern (South Australia). Those sites with only nitrogen or only phosphorus monitored for 2022/2023 financial year were not considered in the final nutrient load ranking.

3. Results

NOD has been consistently collecting data from the WTAs since 2015. As for 2023/2024 financial year, wastewater quality data were collected from 39 out of 43 WTAs with 173 out of 191 outfall sites (91%). Despite the complexity having various individual WTAs in Victoria and New South Wales, the NOD has effectively collected wastewater quality data for the 2023/2024 financial year (Table 1). Due to various circumstances, the Northern Territory, Coffs Harbour (NSW) and Gippsland Water (VIC) experienced difficulties in providing the requested information. Coffs Harbour and Gippsland Water provided data in previous years; this is the first year that they will not be included in the annual report.

Table 1. Outfalls wastewater quality data collected for 2023/2024 financial year.

States/Territory	Number of outfalls	Data collected (%)
New South Wales	33	97
Northern Territory	14	0
Queensland	55	100
South Australia	10	100
Tasmania	47	100
Victoria	17	89
Western Australia	12	100

There were 144 out of 191 outfall sites analysed in this report (Table 2). This is due to several combined outfalls (4), one fully recycled site (Beaconsfield, Tasmania), 18 missing sites and 25 sites with either phosphorus or nitrogen only data. The 2023/2024 financial year data shows that 879 gigalitres effluent were released, introducing a total nutrient load of 14,685 tonnes. Total nutrient load from individual outfall sites ranged from 0 to 4,204,556 kg with a mean of 99,226 kg, and nutrient load per person ranged between 0.000043 to 158 kg. Each quartile is represented by 37 outfall sites (Appendix A – Table 4). Table 2 shows the top quartile was dominated by Tasmania outfall sites (23), followed by Queensland (6) and New South Wales (6), Victoria (1) and South Australia (1). The bottom quartile (highest nutrient load) was represented by New South Wales (9) followed by Western Australia (7), and Victoria (8), South Australia (7) and Queensland (5).

Table 2. top 25% (red) and bottom 25% (green) quartiles of outfall ranking for 2023/2024 financial year data. BMS = Boneo, Mt Martha and Somers and WTP = Western Treatment Plant.

RANK	STATE	LOCATION	Total nutrient (kg)
1	Victoria	Port Phillip Bay (WTP)	4204556.8
2	Victoria	Boags Rock (ETP)	2975364.9
3	Western Australia	Beenyup	1443590.5
4	Western Australia	Woodman Point	1190246.1
5	Western Australia	Subiaco	584915.0
6	South Australia	Bolivar WWTP	487989.9
7	Western Australia	Point-Peron	457811.2
8	New South Wales	North-Head	445741.2
9	South Australia	Glenelg	309105.3
10	Queensland	Luggage-Point	279232.2
11	New South Wales	Bondi	167985.1
12	Victoria	Black Rock WRP	158446.4
13	Victoria	Boags Rock (BMS)	117440.9
14	South Australia	Christies Beach North	116254.5
15	New South Wales	Malabar	107050.8
16	Victoria	Welshpool	100581.1
17	South Australia	Bolivar high salinity	99633.0
18	New South Wales	Potter Point (Cronulla)	95734.4
19	New South Wales	Kincumber	76479.3
20	Queensland	Kawana	68470.9
21	Victoria	Altona	55275.3

22	New South Wales	Bombo	54899.2
23	Western Australia	Bunbury	43036.3
24	New South Wales	Wollongong	37442.2
25	South Australia	Finger Point	32362.6
26	Western Australia	East Rockingham	30916.7
27	New South Wales	Warriewood	24508.8
28	Victoria	Port Fairy	23197.4
29	Western Australia	Alkimos	23177.8
30	Victoria	Philip Island	21634.3
31	Queensland	Loganholme	21613.2
32	Queensland	Oxley	20760.2
33	South Australia	Port Pirie	18963.1
34	South Australia	Whyalla	16016.8
35	Queensland	Coombabah	14462.8
36	South Australia	Port Augusta East	12916.1
37	New South Wales	Shell Harbour	11423.0
110	Queensland	Bargara	207.4
111	New South Wales	Camden Haven	196.1
112	Queensland	Port Douglas	195.0
113	Queensland	Millbank	171.8
114	Tasmania	Bridport	166.1
115	New South Wales	Diamond Bay North	162.6
116	Tasmania	Turners Beach	162.2

117	Tasmania	Beauty Point	161.7
118	Tasmania	Risdon East	157.3
119	Tasmania	Cambridge	126.2
120	Queensland	Karana-Downs	121.2
121	New South Wales	Diamond Bay South	115.8
122	Tasmania	East Strahan	102.4
123	Tasmania	Bicheno	101.2
124	Tasmania	Swansea	92.8
125	Queensland	Bowen	88.3
126	Tasmania	Cressy	81.3
127	Tasmania	Geeveston	81.1
128	Queensland	Cooroy	79.7
129	New South Wales	Bermagui	76.4
130	Tasmania	Somerset	75.3
131	Tasmania	Triabunna	68.2
132	Tasmania	Stanley	64.5
133	Tasmania	Orford	55.9
134	Tasmania	Midway Point	41.8
135	New South Wales	Ballina	29.0
136	Tasmania	Sorell	23.3
137	New South Wales	Iluka	20.3
138	Victoria	Portland	19.6
139	Victoria	Toora	18.9

140	Tasmania	Dover	17.6
141	Tasmania	Sisters Beach	17.2
142	Tasmania	Currie	14.7
143	Tasmania	Cygnet	12.8
144	Tasmania	St-Helens	12.3
145	Tasmania	Rokeby	11.8
146	Tasmania	Boat Harbour	10.8
147	South Australia	Christies Beach South	6.4

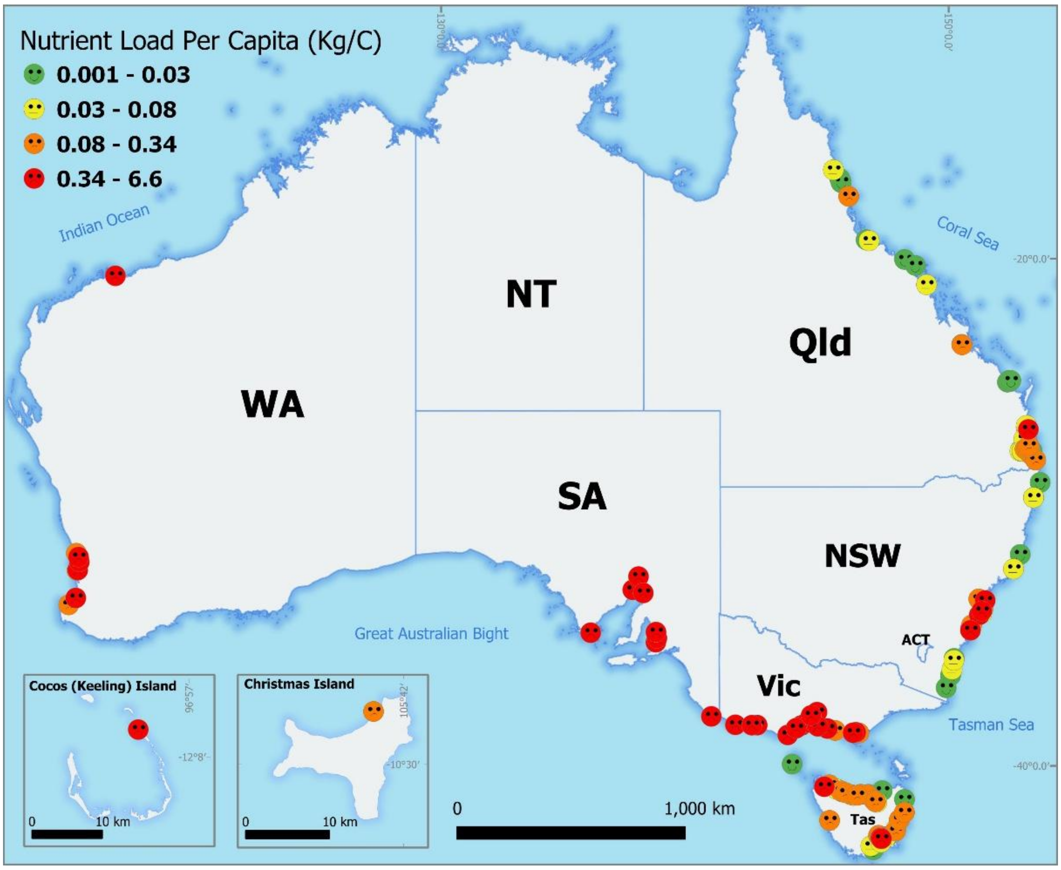

Figure 2. Nutrient load per capita for 2023/2024 financial year. Cocos (Keeling) Island and Christmas Island not in position.

Table 3. Bottom ten outfalls with highest total nutrient in 2023/2024 FY. BMS = Boneo, Mt Martha and Somers, WTP = Western Treatment Plant

Rank	STATE	OUTFALL	Total nutrient (kg)	Nutrient/Capita (kg)
1	Victoria	Port Phillip Bay (WTP)	4204556.8	1.68
2	Victoria	Boags Rock (EPT)	2975364.9	1.57
3	Western Australia	Beenyup	1443590.5	1.95
4	Western Australia	Woodman Point	1190246.1	1.51
5	Western Australia	Subiaco	584915.0	1.95

6	South Australia	Bolivar WWTP	487989.9	0.55
7	Western Australia	Point Peron	457811.2	32700.80
8	New South Wales	North Head	445741.2	0.33
9	South Australia	Glenelg	309105.3	1.07
10	Queensland	Luggage Point	279232.2	0.34
11	New South Wales	Bondi	167985.1	0.53
12	Victoria	Black Rock WRP	158446.4	0.65
13	Victoria	Boags Rock (BMS)	117440.9	0.7
14	South Australia	Christies-Beach-North	116254.5	0.78
15	New South Wales	Malabar	107050.8	0.06

Queensland and Tasmania had the highest number of outfalls of all participating states with 45 and 42 outfalls respectively, approximately 29% and 31% of total coastal outfalls, however the total nutrient (phosphorus and nitrogen) contribution was the two lowest with 0.3% and 3% respectively (Table 4). Additionally, Victoria has the third lowest number of outfalls (16) falling behind South Australia (10) and Western Australia (11) accounting for 11% of total outfalls, however, was responsible for 56% of total nutrient for coastal outfalls. Western Australia despite only having 11 outfalls, contributed 26% of total nutrients for coastal outfalls. These two states individually contributed more nutrients than the other four states (NSW, QLD, SA and TAS) combined (Table 4).

Table 4: comparative analysis of total nutrient contribution (%) per state compared with the total number of outfalls (%) for the 2023/24 financial year.

	NSW	WA	QLD	SA	VIC	TAS	Total %
Number of outfalls (%)	16	7	31	7	11	29	100
Total Nutrient Contribution (%)	7	26	3	7	56	0.3	100

4. Discussion

Nitrogen, phosphorus, and flow volume data were collected from 173 (91%) coastal outfall sites across six states, Queensland, New South Wales, Western Australia, South Australia, Victoria and Tasmania. These outfalls were ranked according to their total nutrient load (nitrogen and phosphorus). General patterns show that the highest nutrient loads tend to occur through those outfalls serving metropolitan and surrounding areas. Lower nutrient loads outfalls seem to occur in regional areas; however, the loads varied across individual outfalls. Sites with higher discharge load of nitrogen exhibited greater variability in discharge, compared to sites with lower discharge. This trend is most likely due to high population levels in urban areas which cause increasing in general discharge at metropolitan outfall sites. However, it seems that in metropolitan areas, outfalls tend to release higher nutrient (phosphorus and nitrogen) load compared to regional population areas. In addition, higher nutrient loading could be related to high levels of industrial influent to WWTPs within service areas, such as in Smithton, Tasmania; Warrnambool, Victoria; and Point Peron, Western Australia.

Licence conditions are determined by a variety of factors, including the condition of the waterway being discharged to, and the community uses of the waterway (EPA NSW, 2013, EPA VIC, 2017). For instance, although it is required to monitor, Pardoe does not have a concentration limit condition for nitrogen and phosphorus, compared to Macquarie Point, TAS that has the concentration limit of 38 mg/L and 8 mg/L for nitrogen and phosphorus, respectively (EPA Tasmania, 1998, EPA Tasmania, 2013). In addition to existing conditions and the uses of waterways, available resources for treatment plant upgrades and community pressure may also contribute to WWTP loading. For example, Boags Rock outfall, serving ETP and BMS, were under significant community pressure in the past and upgraded to tertiary treatment in 2012 (Melbourne Water, 2022). Another example related to the community pressure is the VCAT order for Warrnambool WWTP to upgrade the current wastewater treatment by 31 December 2025 (VCAT, 2021).

Several outfall sites that ranked in the bottom quartile do not have concentration limits for nitrogen and phosphorus in their licence conditions. Despite having no concentration limits, these sites are not considered to be breaching their licences regardless the amount of nitrogen and phosphorus loading into the marine and coastal environments. For example, the Eastern Treatment Plant in Victoria has no nitrogen concentration limit restriction listed in its license (EPA VIC, 2023). This, however, is a tertiary treatment plant which tends to be more efficient at the removal of bacteria and the further reduction of organics, turbidity, nitrogen and phosphorus (Roberts et al., 2010, EPA VIC, 2002, ANZECC and ARMCANZ, 1997). In addition, this plant has been consistently listed in the Top quartile in the last five years, including current 2022/2023 financial year data, due to high flow volume (Rohmana et al., 2019, Rohmana et al., 2020a, Rohmana et al., 2021, Rohmana et al. 2023).

This ranking and the identification of nutrient loads by site can therefore be useful in prioritising treatment upgrade resources. In addition, the discrepancies in treatment level and license conditions, as well as wastewater reuse policies, warrant further examination at a national scale. This may indicate that top quartile outfalls should be the primary target for an upgrade in order to achieve the greatest benefit of water investment (Blackwell and Gemmill, 2019, Blackwell and Gemmill, 2020, Rohmana et al., 2020b). In addition, some sites (e.g., Beaconsfield in Tasmania and Lucinda in Queensland) reported almost zero discharge (NOD, 2023, Fitzgibbon, 2022). These sites are already fully recycling and diverting their wastewater to agricultural use, highlighting the success of a program that could be implemented in other areas.

In 2016 NSW EPA, issued a Pollution Reduction Program to Sydney Water regarding three discharge locations at Vaucluse and Diamond Bay. Previously these outfalls discharged raw wastewater into the ocean, but the new proposed initiative "Refresh Vaucluse Diamond Bay" would reroute these outfalls during dry weather to the Bondi Wastewater Treatment Plant (Sydney Water 2020). The project was initially anticipated to be completed in 2022, however as of November 2025 construction is still ongoing. The outcome of the project is to reduce the discharge of raw wastewater from these outfalls by 93% with the other 7% coming from wet weather overflow. As it stands, the nutrient input from two of the three discharge points rank in the top 25% of all outfalls, with Diamond Bay (South) ranking 27th contributing a total of 121kg of total nutrients in the previous financial year (2023/24). Diamond Bay (North) ranking 33rd with 172kg. Vaucluse was ranked in the second quartile (48th) with a total nutrient input of 413kg an increase of 20kg from the previous financial year (393kg).

Perhaps the most interesting finding of this report is the overall nutrient contribution per state. Instead of an even spread of nutrient contribution per number of outfalls, two states (Queensland and Tasmania) with the highest number of outfalls contributed the lowest percentage of nutrients (Table 4). Western Australia had the second lowest number of outfalls has the second highest nutrient contribution and Victoria with the third lowest number of outfalls had the highest nutrient contribution. The only state that had equal nutrient contribution to total percentage of number of outfalls was South Australia, accounting for 7% of all outfalls and 7% of total nutrient contribution (Table 4). As it stands, a national perspective on nutrient discharge from outfalls is only available upon collection by the National Outfall Database on behalf of the Clean Ocean Foundation. Unless state EPAs are communicating and comparing outfall nutrient data, it would be difficult for these agencies to do this without aid from a federal counterpart. This data highlights the strong need for the new federal EPA to provide an overview of discharges so that underperforming outfalls are identified quickly, and improved restrictions are placed on the outfalls to lower the nutrient levels prior to outfall discharge. particularly in the light of the recent findings related to South Australia's 2025 Harmful Algal Bloom (HAB) that states, "Inquiry evidence shows that elevated nutrient loads are a key enabling factor, meaning that in nutrient-saturated coastal waters even minor climatic shifts can trigger major ecological impacts."

5. References

ALTIERI, A. H., HARRISON, S. B., SEEMANN, J., COLLIN, R., DIAZ, R. J. & KNOWLTON, N. 2017. Tropical dead zones and mass mortalities on coral reefs. *The Proceedings of the National Academy of Sciences,* 114**,** 3660-3665.

ANZECC & ARMCANZ 1997. Australian guidelines for sewerage systems: effluent management. *National Water Quality Management Strategy.* Canberra, ACT: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

AUSTRALIAN BUREAU OF STATISTICS. 2021. *Data by region* [Online]. Canberra, Australia: Australian Bureau of Statistics. Available: https://dbr.abs.gov.au/ [Accessed 29 March 2023].

BERDALET, E., CHINAIN, M., KIRKPATRICK, B. & PATRICIA A. TESTER 2023. Harmful algal blooms cause ocean illnesses affecting human health. *In:* FLEMING, L. E., CREENCIA, L. B. A., GERWICK, W. H., GOH, H. C., GRIBBLE, M. O., MAYCOCK, B. & SOLO-GABRIELE, H. (eds.) *OCEANS AND HUMAN HEALTH: Opportunities and Impacts.* Academic Press,.

BLACKWELL, B. D. & GEMMILL, J. 2019. Coastal Outfall System Upgrades in Australia: Benefits, Costs, and Improved Transparency – Final Report. Wonthaggi, Victoria: Clean Ocean Foundation.

BLACKWELL, B. D. & GEMMILL, J. 2020. Chapter 11: 'New Water' for a dry continent: Costs, benefits and improved transparency for Australia's coastal wastewater outfall upgrades. *In:* WASHINGTON, H. (ed.) *Ecological Economics: Solutions for the Future.* Washington.

BOEHM, A. B., ISMAIL, N. S., SASSOUBRE, L. M. & ANDRUSZKIEWICZ, E. A. 2017. Oceans in Peril: Grand Challenges in Applied Water Quality Research for the 21st Century. *Environmental Engineering Science,* 34**,** 3-15.

CHAHAL, C., VAN DEN AKKER, B., YOUNG, F., FRANCO, C., BLACKBEARD, J. & MONIS, P. 2016. Pathogen and Particle Associations in Wastewater: Significance and Implications for Treatment and Disinfection Processes. *Advances in Applied Microbiology,* 97**,** 63-119.

CHENG, B., XIA, R., ZHANG, Y., YANG, Z., HU, S., GUO, F. & MA, S. 2019. Characterization and causes analysis for algae blooms in large river system. *Sustainable Cities and Society,* 51**,** 101707.

DECC NSW 2009. Load Calculation Protocol. Department of Environment and Climate Change NSW.

DES 2022. Licensed Data: WaTERS release point monitoring data for coastal and estuarine STPs 2020/2021 financial year. State of Queensland: Department of Environment and Science (DES).

EPA NSW 2013. Using environment protection licensing to control water pollution. *In:* ENVIRONMENT PROTECTION AUTHORITY OF NEW SOUTH WALES (ed.). Sydney, NSW.

EPA TASMANIA 1998. Permit Conditions - Environmental (Pardoe Wastewater Treatment Plant). *In:* DEPARTMENT OF ENVIRONMENT AND LAND MANAGEMENT (ed.). Hobart: EPA Tasmania.

EPA TASMANIA 2013. Environment Protection Notice No. 8880/1 (Macquarie Point Wastewater Treatment Plant). Hobart.

EPA VIC 2002. Guidelines for environmental management: Disinfection of treated wastewater. Victoria: Environment Protection Authority of Victoria.

EPA VIC 2009. Industrial waste resource guidelines: Sampling and analysis of waters, wastewaters, soils and wastes. Environment Protection Authority Victoria.

EPA VIC 2017. Licence Management. *In:* ENVIRONMENT PROTECTION AUTHORITY VICTORIA (ed.). Carlton VIC: Environment Protection Authority Victoria.

EPA VIC 2023. Melbourne Water Corporation Licence. Victoria: Environment Protection Authority of Victoria, State Government of Victoria.

FITZGIBBON, G. 2022. Environmental Reporting - Beaconsfield STP. Tasmania: TasWater.

LEMÉE, R., MANGIALAJO, L., COHU, S., AMZIL, Z., BLANFUNE, A., CHOMERAT, N., GANZIN, N., GASPARINI, S., GROSSEL, H., GUIDI-GUIVARD, L., HOAREAU, L., DUFF, F. L., MARRO, S., SIMON, N., NEZAN, E., PEDROTTI, M.-L., SECHET, V., SOLIVERES, O. & THIBAUT, T. 2012. Interactions between Scientists, Managers and Policy Makers in the Framework of the French MediOs Project on Ostreopsis (2008–2010). *Cryptogamie, Algologie,* 33**,** 137-142.

LIM, C. C., YOON, J., REYNOLDS, K., GERALD, L. B., AULT, A. P., HEO, S. & BELL, M. L. 2023. Harmful algal bloom aerosols and human health. *eBioMedicine,* 93.

MARINE BIODIVERSITY HUB. 2015. *Project C4 - National Outfall Database* [Online]. NESP Marine Biodiversity Hub. Available: http://www.nespmarine.edu.au/project/project-c4-national-outfall-database [Accessed 15 March 2016].

MELBOURNE WATER. 2022. *Eastern Treatment Plant* [Online]. Melbourne: Melbourne Water. Available: https://www.melbournewater.com.au/water-and-environment/water-management/sewerage/eastern-treatment-plant [Accessed 15 March 2023].

NOD 2023. Lucinda Outfall. Australia: National Outfall Database.

ROBERTS, P. J. W., REIFF, F. M., LABBE, A., SALAS, H. J., LIBHABER, M. & THOMSON, J. C. 2010. *Marine Wastewater Outfalls and Treatment Systems,* London, UK, IWA Publishing.

ROHMANA, Q. A., FISCHER, A., GEMMILL, J. & CUMMING, J. 2019. National Outfall Database: Outfall Ranking Report 2017-2018. *Report to the National Environmental Science Program, Marine Biodiversity Hub.* Australia: Clean Ocean Foundation.

ROHMANA, Q. A., FISCHER, A., GEMMILL, J. & CUMMING, J. 2020a. National Outfall Database: Outfall Ranking Report 2018/2019 Financial Year. *Report to the National Environmental Science Program, Marine Biodiversity Hub.* Australia: Clean Ocean Foundation.

ROHMANA, Q. A., FISCHER, A. M., CUMMING, J., BLACKWELL, B. D. & GEMMILL, J. 2020b. Increased Transparency and Resource Prioritization for the Management of Pollutants From Wastewater Treatment Plants: A National Perspective From Australia. *Frontiers in Marine Science*.

ROHMANA, Q. A., FISCHER, A. M. & GEMMILL, J. 2021. National Outfall Database: Outfall Ranking Report 2019/2020 Financial Year. *Report to the Department of Agriculture, Water and Environment.* Australia: Clean Ocean Foundation and University of Tasmania.

ROHMANA, Q. A., FISCHER, A. & GEMMILL, J. 2023. National Outfall Database: Outfall ranking based on 2021/2022 nutrient loads discharge. *Report to the National Science Program*: Clean Ocean Foundation and University of Tasmania.

SENATE ENVIRONMENT AND COMMUNICATIONS REFERENCES COMMITTEE 2025. Algal blooms in South Australia, Chapter 2, p. 15, Parliament of Australia, Canberra

SYDNEY WATER. 2020 Review of Environmental Factors Refresh Vaucluse Diamond Bay. Available at https://www.sydneywater.com.au/content/dam/sydneywater/documents/review-of-environmental-factors-.pdf

VCAT 2021. VCAT REFERENCE NO. P11348/2021. *In:* VICTORIAN CIVIL AND ADMINISTRATIVE TRIBUNAL (ed.). Victoria: VCAT.

WEAR, S. L., ACUNA, V., MCDONALD, R. & FONT, C. 2021. Sewage pollution, declining ecosystem health, and cross-sector collaboration. *Biological Conservation*, 1-9.

WHITEHEAD, P. G., BUSSI, G., BOWES, M. J., READ, D. S., HUTCHINS, M. G., ELLIOTT, J. A. & DADSON, S. J. 2015. Dynamic modelling of multiple phytoplankton groups in rivers with an application to the Thames river system in the UK. *Environmental Modelling & Software,* 74**,** 75-91.

ZIAJAHROMI, S., NEALE, P. A. & LEUSCH, F. D. L. 2016. Wastewater treatment plant effluent as a source of microplastics: review of the fate, chemical interactions and potential risks to aquatic organisms. *Water Science and Technology,* 74**,** 2253-2269.

Appendix A Outfall Rankings

Table 5: Outfall rankings based on the total nutrients (kg) for the 2023/2024 financial year data. BMS = Boneo, Mt Martha and Somers, ETP = Eastern Treatment Plant, WTP = Western Treatment Plant, SWOP = Saline Water Outfall Pipe.

RANK	STATE	LOCATION	TOTAL NUTRIENT (KG)	Population (ABS 2023)	TOTAL NUTRIENT/POP (KG)
1	Victoria	Port Phillip Bay (WTP)	4204556.8	2,500,000	1.68
2	Victoria	Boags Rock (ETP)	2975364.9	1,900,000	1.57
3	Western Australia	Beenyup	1443590.5	740,000	1.95
4	Western Australia	Woodman Point	1190246.1	790,000	1.51
5	Western Australia	Subiaco	584915.0	300,000	1.95
6	South Australia	Bolivar WWTP	487989.9	895,000	0.55
7	Western Australia	Point Peron	457811.2	14	32700.80
8	New South Wales	North Head	445741.2	1,360,000	0.33
9	South Australia	Glenelg	309105.3	290,000	1.07
10	Queensland	Luggage Point	279232.2	830,000	0.34
11	New South Wales	Bondi	167985.1	316,000	0.53
12	Victoria	Black Rock WRP	158446.4	245,000	0.65
13	Victoria	Boags Rock (BMS)	117440.9	168,000	0.7
14	South Australia	Christies Beach North	116254.5	150,000	0.78
15	New South Wales	Malabar	107050.8	1,700,000	0.06
16	Victoria	Welshpool	100581.1	250	224.42
17	South Australia	Bolivar high salinity	99633.0	59,250	1.68
18	New South Wales	Potter Point (Cronulla)	95734.4	241,000	0.40
19	New South Wales	Kincumber	76479.3	160,000	0.48
20	Queensland	Kawana	68470.9	150722	0.45
21	Victoria	Altona	55275.3	150,000	0.37
22	New South Wales	Bombo	54899.2	16,000	3.43
23	Western Australia	Bunbury	43036.3	76,500	0.56
24	New South Wales	Wollongong	37442.2	210,000	0.18
25	South Australia	Finger Point	32362.6	29,500	1.10
26	Western Australia	East Rockingham	30916.7	135,500	0.23
27	New South Wales	Warriewood	24508.8	74,500	0.33
28	Victoria	Port Fairy	23197.4	3,500	6.63
29	Western Australia	Alkimos	23177.8	205,000	0.11
30	Victoria	Philip Island	21634.3	15,500	1.40
31	Queensland	Loganholme	21613.2	300,000	0.07
32	Queensland	Oxley	20760.2	315,000	0.07
33	South Australia	Port Pirie	18963.1	13,000	1.46
34	South Australia	Whyalla	16016.8	21,000	0.76
35	Queensland	Coombabah	14462.8	360,000	0.04
36	South Australia	Port Augusta East	12916.1	13,950	0.93
37	New South Wales	Shell Harbour	11423.0	77,500	0.15
38	Queensland	Gibson Island	11402.0	68,000	0.17

39	Queensland	Elanora	9700.3	100,000	0.10
40	Queensland	North Rockhampton	7593.7	45,000	0.17
41	Tasmania	Pardoe (Devonport and Latrobe)	7101.7	37,000	0.19
42	Queensland	Bundamba	6925.3	133,000	0.05
43	Western Australia	Busselton	6726.4	40,600	0.17
44	Tasmania	Macquarie Point	5791.0	35,700	0.16
45	South Australia	Port Lincoln	5566.2	16,300	0.34
46	Tasmania	Ti Tree Bend	5564.7	22,070	0.25
47	Queensland	Caboolture	4979.4	73067	0.07
48	Victoria	Baxters Beach	4933.7	16,700	0.30
49	Queensland	Merrimac WWTP	4677.4	150,000	0.03
50	Queensland	South Rockhampton	4645.3	25,000	0.19
51	Queensland	Cleveland Bay	4633.6	126,000	0.04
52	Victoria	Foster	4566.1	1,500	3.04
53	Queensland	Beenleigh	4533.7	55,000	0.08
54	Tasmania	Prince of Wales	4292.3	32,200	0.13
55	Queensland	Burpengary	4167.2	65546	0.06
56	Queensland	Maroochydore	3670.5	86459	0.04
57	Queensland	Mt St John	3637.2	106,000	0.03
58	Queensland	Sandgate	3522.2	125,000	0.03
59	Queensland	Redcliffe	3435.4	65377	0.05
60	Queensland	Goodna	3323.2	60,000	0.06
61	Queensland	Noosa Coastal	3262.3	56298	0.06
62	Western Australia	Wickham	3202.5	2,300	1.39
63	Tasmania	Rosny	3108.4	793	3.92
64	Tasmania	Blackmans Bay	3082.0	38,000	0.08
65	Queensland	Murrumba Downs	3075.0	147003	0.02
66	Tasmania	Burnie	3063.9	19,900	0.15
67	Victoria	Boags Rocks (EPT)	2975.4	1,600,000	0.00
68	Queensland	Wacol	2777.2	37,000	0.08
69	Tasmania	Smithton Pelican Point	2635.5	3,900	0.68
70	Queensland	Wynnum	2208.2	45,000	0.05
71	Queensland	Nambour	2039.3	49102	0.04
72	Queensland	Coolum	2002.0	31106	0.06
73	Tasmania	Green Point	1754.9	522	3.36
74	Queensland	Southern	1500.9	71,851	0.02
75	Victoria	Anglesea_WRP	1333.0	3,200	0.42
76	Queensland	Carole Park	1332.1	23,000	0.06
77	Queensland	Fairfield	1301.4	15,200	0.09
78	Victoria	Apollo_Bay	1136.8	2,300	0.49
79	Tasmania	Selfs Point	1126.6	1463	0.77
80	Queensland	Thorneside	1093.8	30,000	0.04
81	Victoria	Lorne	1040.8	1,350	0.77
82	Tasmania	Ulverstone	995.4	11,600	0.09
83	Queensland	Mackay North	990.4	20,000	0.05
84	Queensland	Landsborough	968.8	11805	0.08
85	Tasmania	Wynyard	961.0	6,900	0.14

86	New South Wales	Forster	887.0	14,700	0.06
87	Queensland	Victoria Point	881.8	34,000	0.03
88	Queensland	Innisfail	880.0	9,600	0.09
89	Queensland	Capalaba	864.5	30,000	0.03
90	Tasmania	Hoblers Bridge	831.9	11,000	0.08
91	New South Wales	Skennars Head (Lennox Head)	827.0	28,000	0.03
92	Queensland	Rubyanna	821.9	50,000	0.02
93	Tasmania	Riverside	803.4	12,000	0.07
94	Tasmania	Newnham	791.7	13,600	0.06
95	Tasmania	Legana	631.3	4,800	0.13
96	Tasmania	Port Sorell	511.7	5,200	0.10
97	New South Wales	Batemans Bay	497.9	18000	0.03
98	Queensland	Marlin Coast	413.5	30,740	0.01
99	Queensland	Edmonton	411.1	24,814	0.02
100	New South Wales	Yamba	374.5	7,000	0.05
101	New South Wales	Vaucluse	328.7	3500	0.09
102	Tasmania	Cameron Bay	326.3	18,800	0.02
103	Queensland	Cannonvale	309.3	10,700	0.03
104	Western Australia	Home Island	265.4	400	0.66
105	Western Australia	Christmas Island	249.0	1,692	0.15
106	New South Wales	Merimbula	238.5	15,500	0.02
107	New South Wales	Tomakin	226.8	6,000	0.04
108	New South Wales	Narooma	226.0	6,300	0.04
109	Victoria	Warrnambool	211.3	35,000	0.01
110	Tasmania	George Town	209.3	7,000	0.03
111	Queensland	Bargara	207.4	9,500	0.02
112	New South Wales	Camden Haven	196.1	18,500	0.01
113	Queensland	Port Douglas	195.0	5582	0.03
114	Queensland	Millbank	171.8	14,000	0.01
115	Tasmania	Bridport	166.1	15,000	0.01
116	New South Wales	Diamond Bay North	162.6	3500	0.05
117	Tasmania	Turners Beach	162.2	3,400	0.05
118	Tasmania	Beauty Point	161.7	1,300	0.12
119	Tasmania	Risdon East	157.3	3171	0.05
120	Tasmania	Cambridge	126.2	2,900	0.04
121	Queensland	Karana Downs	121.2	6,000	0.02
122	New South Wales	Diamond Bay South	115.8	3500	0.03
123	Tasmania	East Strahan	102.4	700	0.15
124	Tasmania	Bicheno	101.2	1,050	0.10
125	Tasmania	Swansea	92.8	1,000	0.09
126	Queensland	Bowen	88.3	9,900	0.01
127	Tasmania	Cressy	81.3	1149	0.07
128	Tasmania	Geeveston	81.1	2,000	0.04
129	Queensland	Cooroy	79.7	4801	0.02
130	New South Wales	Bermagui	76.4	6,000	0.01
131	Tasmania	Somerset	75.3	4,000	0.02
	Tasmania	Triabunna	68.2	900	0.08

132	Tasmania	Stanley	64.5	600	0.11
133	Tasmania	Orford	55.9	680	0.08
134	Tasmania	Midway Point	41.8	14,000	0.00
135	New South Wales	Ballina	29.0	47,935	0.00
136	Tasmania	Sorell	23.3	7000	0.00
137	New South Wales	Iluka	20.3	1,764	0.01
138	Victoria	Portland	19.6	11,200	0.00
139	Victoria	Toora	18.9	700	0.03
140	Tasmania	Dover	17.6	900	0.02
141	Tasmania	Sisters Beach	17.2	500	0.03
142	Tasmania	Currie	14.7	750	0.02
143	Tasmania	Cygnet	12.8	1,700	0.01
144	Tasmania	St Helens	12.3	2,200	0.01
145	Tasmania	Rokeby	11.8	14,500	0.00
146	Tasmania	Boat Harbour	10.8	450	0.02
147	South Australia	Christies Beach South	6.4	150,000	0.00

Appendix B – Distribution List

Clean Ocean Foundation	John Gemmill
University of Tasmania	Andrew Fischer
Federal	
Minister for Environment and Water	Senator the Hon. Murray Watt
Minister for Agriculture, Fisheries and Forestry and Emergency Management	The Hon. Julie Collins MP
Minister for Infrastructure, Transport, Regional Development and Local Government	The Hon. Catherine King MP
Minister for Health and Aged Care	The Hon. Mark Butler MP
Senator for Victoria	Senator Lisa Darmanin
Victoria	
Minister for Environment	The Hon. Steve Dimopoulos MP
Minister for Water	The Hon. Gayle Tierney MP
EPA Victoria	Joss Crawford
EPA Victoria Victoria's Chief Environmental Scientist	Dr Jen Martin
Barwon Water	Luke Christie
Greater Western Water (Previously City West Water)	Joshua Mah
Gippsland Water	Boon Huang Goo
Melbourne Water	Marcus Mulcare
South East Water	Ben Spedding
South Gippsland Water	Bree Wiggins
Wannon Water	Jimena Harrington

Westernport Water	Johanna Randall
New South Wales	
Minister for Environment	The Hon. Penny Sharpe, MLC
Minister for Water	The Honourable Rose Jackson MLC
EPA New South Wales – Chief Executive Officer	Tony Chappel
Bega Valley Shire Council	Ken McLeod
Ballina Shire	Thomas Lees
Clarence Valley	Greg Mashiah
Coffs Harbour	Sam Pinnuck
Kempsey	Bobbie Brenton
Port Macquarie Hastings Shire	Belinda Green
Midcoast City Council	Craig Dowler
Hunter Water	Darren Cleary
Sydney Water	Sharmila Lakshmanaa
Shoalhaven City Council	Daniel Page
Eurobodalla Shire Council	Tim Neenan
Central Coast Council	Stephen Shinners
Queensland	
Minister for the Environment and Tourism	The Hon. Andrew Powell MP
Minister for Water	The Hon. Anne Leahy MP
Department of Environment and Science (WaTERs)	Patricia O’Callaghan

Northern Territory	
Minister for Water Resources	The Hon. Joshua Burgoyne MLA
EPA Northern Territory	Dr Paul Vogel AM
Power and Water Corporation	Ms Djuna Pollard
Western Australia	
Minister for Environment	The Hon. Matthew Swinbourn MLC
Minister for Water	The Hon. Don Punch MLA
EPA Western Australia Director General of the DWER	Alistair Jones
EPA Western Australia	Anne Marie Homes
Water Corporation	Gillian Griffin
South Australia	
Minister for Climate, Environment and Water	The Hon. Lucy Hood MP
EPA South Australia	Dr Jon Gorvett
SA Water – Chief Executive Officer	David Ryan
SA Water	Julia De Cicco
Tasmania	
Minister for Environment	The Hon. Madeleine Ogilvie MP
Minister for Primary Industries and Water	The Hon. Gavin Pierce MP
EPA Tasmania	Jason De Weys
TasWater	Kate Westgate

Other Bodies	
Australia Institute	Richard Dennis
Australia New Zealand Society for Ecological Economics	Dr Boyd Blackwell
Australian Conservation Foundation	Liana Downey
Environment Victoria	Tyler Rotche
Friends of the Earth	Cam Walker
Ocean Decade Australia	Jas Chambers
ORCV	Tim Boucat
SO Shire	Sarah Jo Lobwein
Surfrider Australia	Damien Cole
Water Services Association Australia	Adam Lovell
Western Sydney University	Assoc Professor Ian Wright
Western Sydney University	Katherine Warwick

Marine and Coastal

National Environmental Science Program

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