STANDARD AND GUIDELINES FOR NATIONAL REPORTING OF OUTFALL DATA

National Outfall Database

clean ocean foundation

Australian Government

Marine Biodiversity Hub

National Environmental Science Programme

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EXECUTIVE SUMMARY

Clean Ocean Foundation (COF) under the auspices of the Marine Biodiversity Hub has been tasked to establish a draft Standards and Guidelines for National Reporting of Outfall Data.

These guidelines are intended to apply to all outfalls discharging waste from domestic sewage treatment plants. For dedicated industrial outfalls or outfalls that receive a significant component of discharge that has its origins in trade waste extra consideration into appropriate reporting standards will be necessary.

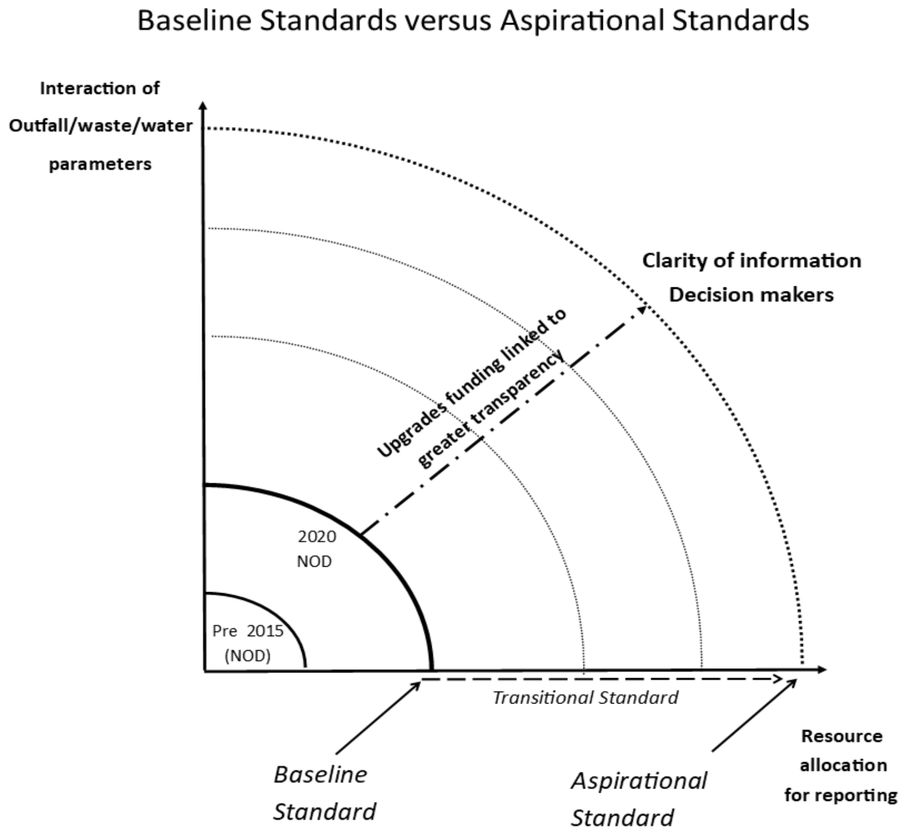
There are significant benefits of a creating guidelines for reporting standards related outfalls and their related wastewater treatment plants. Across Australia there exists a broad spectrum of rigor in monitoring and reporting of ocean outfalls.

Key drivers of improved transparency include a greater awareness and more sophisticated community expectations relating to the environmental impact of pollutants, ongoing advances in technology and opportunities from both and economic and water security perspective to recycle wastewater.

Decision makers at both a regional, state and federal level will need greater clarity when allocating resources for water and wastewater infrastructure and the opportunity to compare projects against a clear set of standards will be essential. These standards can provide both a set of:

- Baseline national standards - minimum acceptable standards in reporting expected that most responsible agencies already supply to the National Outfall Database (NOD)
- Aspirational standards – more comprehensive standards that agencies should strive for over a reasonable time period or required very quickly if additional national funding for infrastructure upgrades was to be made available.

Figure 1. NOD Reporting Standards implementation towards the clarity of information for decision makers.



As well as providing a greater understanding of the impacts of wastewater on a marine environment, recreational users and local communities, the emerging circular economy approach to water sector demands a more sophisticated response in terms of transparency.

At present, in each state and territory what parameters are monitored and reported is determined by state or territory-based Environmental Protection Authorities (EPA). In terms of license conditions their focus is primarily on environmental impact. There are significant differences in individual licenses and the parameters readily available varies significantly. As each license comes up for renewal (this frequency varies also depending on local factors) new conditions or reporting criteria may be included depending on changed environmental concerns and values.

However suitable these reporting standards are, it is difficult for researchers, community and also instrumentalities to gain a clear picture of how their wastewater treatment plant compares with others around the country. In terms of comparing technology, cost of disposal, recycling efficiencies, evaluating risk of emerging contaminants, quantities, and qualities of effluent streams the available data is sparse and lacks detail.

Furthermore, new perspectives on wastewater can be developed when there is greater transparency. For example: the economic benefits of upgrading water treatment plants were not immediately obvious and available until recently. This is now the case the use of the National Outfall Database (NOD) data and a Clean Ocean Foundation (COF) commissioned cost benefit analysis of the nation's outfalls (Blackwell and Gemmill 2019a).

In these standards, we provide further details of improved economic instruments for managing wastewater treatment and disposal in Australia including a tradeable permits scheme, taxes, quotas and hybrid approaches to reducing wastewater disposal to coastal waters.

Building from the NOD begun in 2015, these voluntary guidelines should be seen as an attempt to classify and prioritize what needs to come next to fully realize the benefits of a circular economy approach to the water sector as well as keeping the community safe and preserving our marine environment .

PART 1 THE GUIDELINES

1 Introduction

1.1 Aim of these standards

The aim of these standards is ensuring transparency in order to attain the best outcomes in terms of water supply and ocean pollution that properly reflects societies evolving values and expectations.

The standards seek to establish a clear framework through which this transparency can be achieved.

This will enable the identification, standardization and delivery of important information that the community and stakeholders need to:

- properly understand outfall dynamics
- safely manage outfalls to minimise the negative impacts on the environment and health of the community.
- evaluate potential intrinsic and extrinsic benefits of alternatives for each individual outfall discharges using comparative data

1.2 Need for higher standards

Both the 2017, the National Water Reform Inquiry and Infrastructure Australia's 2019 urban water reform publication identified emerging pressures including:

1. Meeting the needs of a growing population.
2. Improving resilience and managing the impacts of climate change.
3. Maintaining, renewing, and replacing ageing infrastructure.
4. Reflecting changing community expectations.
5. Keeping services affordable for customers and minimizing costs to taxpayers.

Many billions of dollars have been allocated around Australia in past decades related to water and wastewater infrastructure and this will continue. It could be argued that historically, information has been "managed" by water authorities to ensure any community engagement arrives at a predetermined outcome in many water infrastructure decisions.

Since its inception in 2000 COF's experience being the peak advocate mirroring community concerns has been that key areas of conflict between communities and water authorities is the result of a complex interaction between a variety of factors. Looking forward, areas where policy friction will continue include:

- Wastewater discharges
- Water security
- Water recycling
- Desalination
- Biodiversity
- Privatisation

Where the community is engaged and well informed, a positive outcome without acrimony is much more likely. For example, there is the recent positive experience in WA relating to the introduction of recycled wastewater into Perth's potable water supply. It has shown the benefit in providing clear and unambiguous information. To properly address the pressures outlined above a national standard is imperative in order that all parties can use equivalent, evidence-based arguments supplied by a system that strives for transparency.

At present each state/territory EPA determines the monitoring parameter standards and reporting requirements for wastewater treatment plant (WWTP) (DPIPWE, 2001, EPA NSW, 2013, EPA SA, 2016). This has resulted in inconsistencies in reporting and a lack of transparency between authorities, often even those in the same state/territory jurisdiction. For this reason, the COF under the auspices of the Marine Biodiversity Hub has been tasked to establish a draft Standards and Guidelines for National Reporting of Outfall Data. National standards can provide further legal directive to reduce WTP effluent impacts to the marine environment and improve health outcomes for recreational users and enhance business output (European Commission, 2017, European Commission, 2019, World Bank, 2018). This national standard will redefine parameters, monitoring methods and reporting requirements in an effort to expand Australia's efforts in enhancing biodiversity protection and achieving Sustainable Development Goal 14.

Many countries have already implemented national wastewater standards in order to protect their aquatic and marine environments. The European Commission (EC) has developed the Urban Wastewater Treatment Directive (UWWTD) (91/271/EEC) in 1991 (European Commission, 1991; 2019). The Directive is directly related to Water Framework Directive (WFD) 2000/60/EC and Environmental Quality Standards Directive (EQSD) 2013/39/EU, for setting up the water quality parameter concentration limits. It lays down four main obligations, planning, regulation, monitoring and reporting. The UWWTD has helped these countries successfully to reuse the water and maintain the cleanliness of the rivers by having high rates (85%) of recycled water (European Commission, 2019, Pistocchi et al., 2019). The EC invested approximately EUR 25 million each year for the UWWTD framework development, implementation, wastewater infrastructures, drinking water supply and water conservation (European Commission, 2017).

In Canada the United States, they developed a water portal as a single window for reporting standard purposes [REF, REF]. The main objectives of the water portal development between these countries was similar, which is reducing administrative cost and paperwork of regulatory compliance [REF, REF]. The portal also helps to streamline and simplify environmental reporting requirements [REF, REF]. This portal provides a centralized data repository for WTP monitoring data allowing for the centralized analysis, reporting and display of water quality data across the United States. Similar to the NOD, the portal has a standardized format data upload, presentation, analysis and mapping.

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2 Responsibility

Briefly National/State/Regional Discuss/summarise areas of responsibility

· National – which departments are involved and which should be involved and how?water, infrastructure, environment EPBC , health, indigenous. Under the act that relate to Australia's treaty obligations etc.

· State responsibility primarily and regulatory. Eg: EPA, Water

Table 1. Number of relevant water authorities which interacted with the NOD.

State	No. of water authorities	No. of outfalls
New South Wales	12	34
Northern Territory	1	14*
Queensland	17	51
South Australia	1	10
Tasmania	2	41
Victoria	8	19
Western Australia	1	12

*Number of outfalls recorded according to Power and Water licenses are 14, data received by NOD is 4.

Individual WTA – briefly describe role in each state.

3 Wastewater treatment technology

3.1 Engineering data and process design

Having access to a simplified process flow chart detailing main components in each wastewater treatment plant including design capacity will aid understanding in variations in treatment efficiencies and capacity constraints as well as underlying trends based on plant design. Provision of this design information would be initially more taxing given resource constraints within treatment authorities, but once established would only require updates when plant modification was undertaken. The general terms for treatment are well understood although within each type of process the specifics characteristics of equipment use can produce individual variations in performance and effluent quality. The types of processes are explained as follows (Figure 2).

Preliminary – Raw sewage screening and grit removal (and oil and grease removal if applicable) are generally referred to as preliminary treatment.

Primary – Capture of settleable solids from the screened and degritted sewage stream.

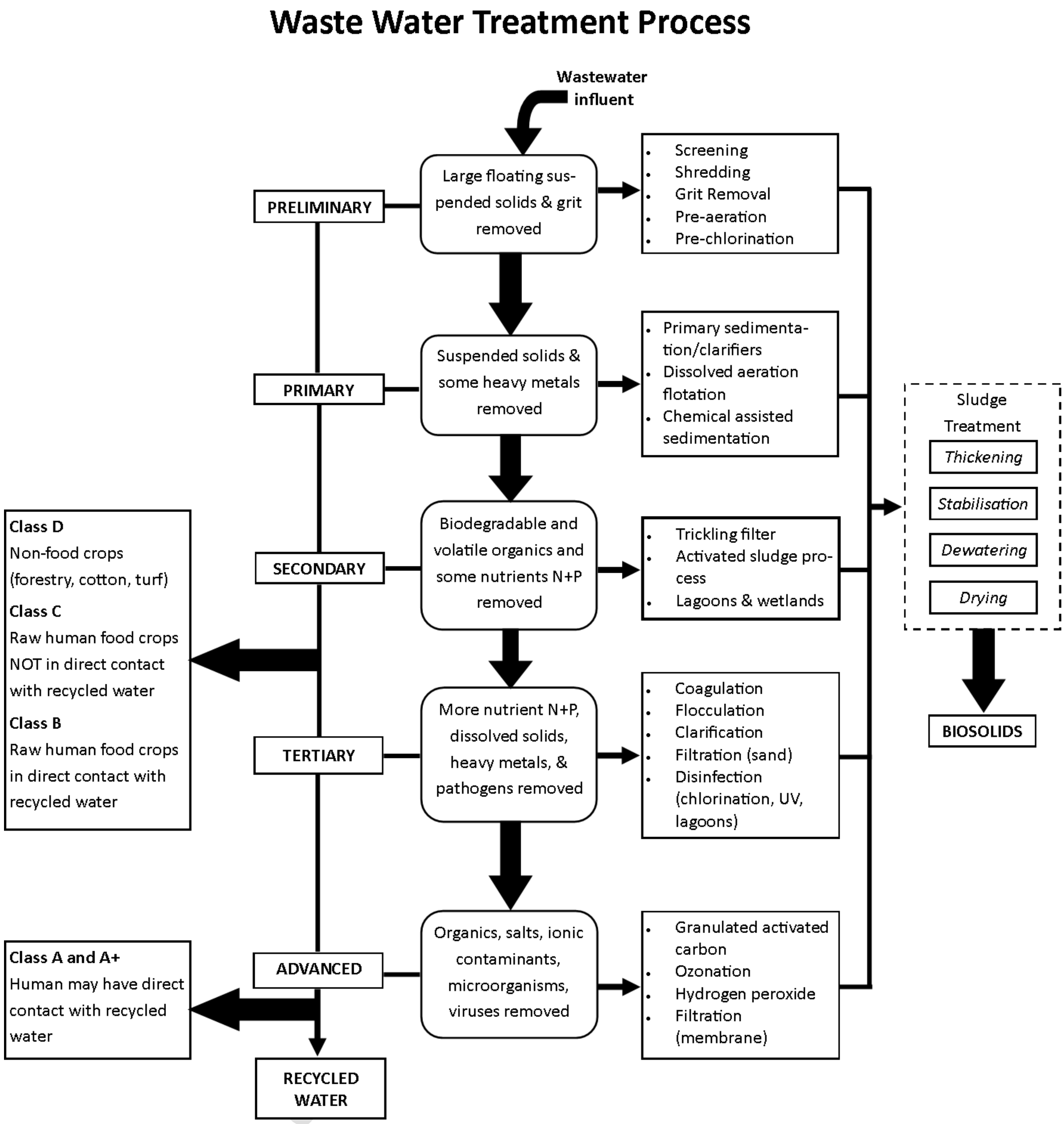
Secondary – Biological treatment to remove BOD, suspended solids (i.e. biomass and residual suspended solids carried forward from primary treatment), and nitrogen and phosphorus as applicable.

Tertiary – Tertiary treatment is effectively further processing to improve the water quality, and can incorporate filtration (of various types), tertiary clarification (for P removal), and disinfection processes.

Enhanced Processes – These processes are used to denote treatment that brings water to quality close to a significantly higher level of purity. This quality generally makes the water a safe source for a wide range of non-potable applications.

Potable Treatment Process – Similar to Enhanced Process but involves more stringent testing and fail safes to ensure safety and provide confidence in supply, for example Perth's aquifer recharge with recycled water.

Figure 2. Details of wastewater treatment process.



Wastewater Treatment Plant	Yes/No
Is there a simplified and standardized process chart with key elements of each WTP publicly available?	

3.2 Outfall design and monitoring

Outfall or discharge point

After some discussion the NOD settled on defining outfalls in three different ways. First there are the **ocean outfalls** (Figure 1). These are outfalls that discharge water from a wastewater treatment plant directly into the open ocean environment. Examples of this include submerged outfalls such as the Bondi outfall managed by Sydney water. The Bondi outfall diffuser sits at 63m depth in the Pacific Ocean, 2.2 kilometres from the shoreline. Another example includes the North Head ocean outfall also managed by Sydney Water. This outfall is located 3.7 kilometres from the shoreline east of Blue Fish Point near Manly in 65 m of water. These ocean outfalls typically service major metropolitan areas. The second type of outfall are **estuary/river outfalls** (Figure 2). These outfalls discharge into brackish estuarine/riverine environments that typically exchange water with the open ocean. An example of this type of outfall is the Ti-tree Bend Outfall on the Tamar estuary in Northern Tasmania. Combined sewage and storm water runoff discharge 60 m off of the shoreline of the 200m wide estuary. Effluent is moved by tidal action and seaward flow away from the point of discharge. Another example is the Gibson Island outfall in Queensland. The outfall discharges via a diffuser into a 450m wide, tidally influenced section of the Brisbane River. Lastly are **coastal outfalls** (Figure 3). These outfalls discharge directly into the coastal environment near the shore. They are not located within estuaries and rivers and are also not located at some distance from the shoreline in the open ocean. For example, the Luggage Point outfall, managed by the Queensland Urban Utilities, discharges directly into the ocean at the mouth of the Brisbane River. Another example of a coastal outfall is the Port Welshpool outfall in Victoria. It also discharges directly into coastal waters of Corner Inlet southeast of Melbourne.

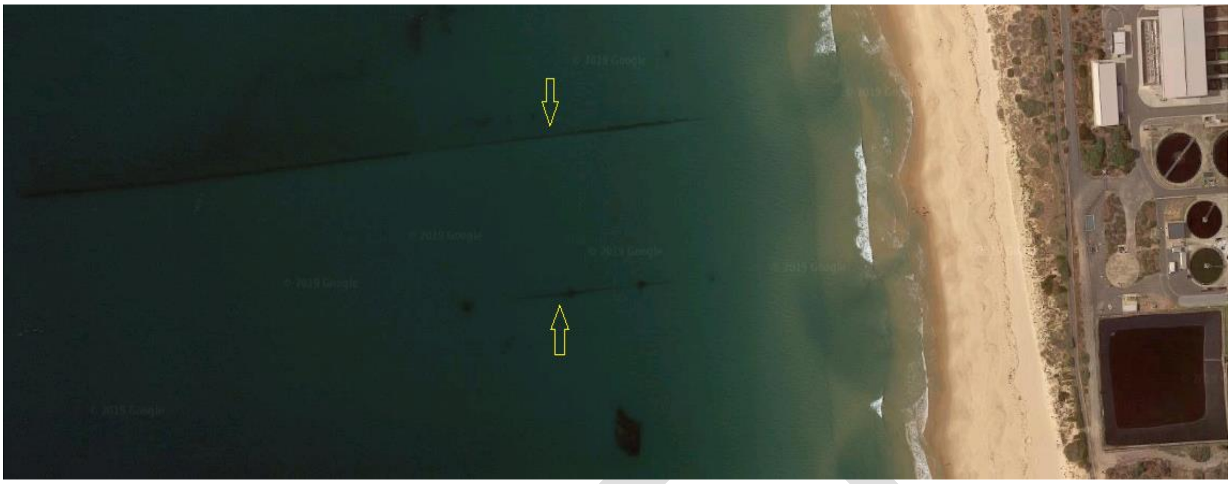
Figure 3. An example of a deepwater ocean outfall.

Source: Surfrider Foundation (2015)

Figure 4. An example of a river/estuary outfall from Ti-tree Bend WWTP, Tasmania.

Source: Google Maps (2019b).

Figure 5. An example of a coastal outfall for Christies Beach WWTP, South Australia.



Yellow arrows point to the two outfalls (black line). (Source: Google Maps (2019a)).

Wastewater plants that discharge into a coastal system have been identified by the NOD. Mainly this is an individual WWTP although in some instances there may be a combination of effluent from several WWTP eg,. (Elanora and Merrimac, City of Gold Coast). Location of these outfalls vary significantly in relation to the marine environment:

Types of outfalls are poorly defined in the literature available. Broadly they fall into the following categories:

Outfall	Comments
River/Estuarine outfalls	
Shoreline marine outfalls	
Offshore ocean outfalls	Also called deep ocean outfalls

The intention of effective outfall design is to ensure that pollutants discharged do not negatively affect the beneficial uses of the receiving environment. Outfall design parameters will stipulate maximum concentrations of key indicators along with volume that a WWTP will need to comply with to achieve the theoretically desired level of mixing. The depth of an outfall as well as the diffuser arrangement are also critical design parameters and need to achieve a significant mixing of effluent with receiving waters within a prescribed distance (vertically and horizontally) from the outfall.

Verification of this mixing may be done by sampling offshore waters, biological testing of flora and fauna and physical inspection. The frequency of this verification varies significantly between different outfalls as determined by the licensing authority.

On a more regular basis, volumes and compositions of discharge of outfall effluent are tested and required to meet certain levels. Within these regimes there is often some latitude for transitory levels to exceed recommended levels, provided they return to acceptable levels within a certain time frame. There may be transitory exceptions or variations granted to these parameters because of seasonal fluctuations

3.3 Wastewater treatment plant performance data

Baseline Data

This comprehensive list is presented as a form (Excel spreadsheet) in which values can be entered.

Display Picture of Filled out example form here

Table 2. Filled out example form of baseline data.

Parameter	Unit	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Outflow volume (Total)	ML	13.89276	22.71845	13.38923	10.3442	13.36997	11.26433	9.165033	7.427511	7.650821	8.530422	12.09125	16.9815
pH	pH	8	7.9	7.8	7.8	7.8	7.9	8	7.6	8.2	7.4	7.9	8
Total Dissolved Solids	mg/L	300	270	240	260	300	340	340	380	460	410	400	260
Total Suspended Solids	mg/L	13	3.6	7.5	26.75	11.6	15.75	24.6	74.25	74	66	16.8	8
Total Phosphorus	mg/L	5.2	4	3.5	3.4	5.9	5.6	6	8.7	9.4	8.3	8.6	5.6
Total Nitrogen	mg/L	32	28	22	22	24	26	15	18	17	21	25	34
Oil and Grease	mg/L												
Surfactants (MBAS)	mg/L												
E-coli	org/100mL	333.75	230	35	46.75	140.8	18.25	54	550	10	817.75	8.4	15.25
Enterococci	org/100mL												
Faecal Coliforms	org/100mL												
Turbidity	NTU												
Colour	Pt. Co. Units												
Algal blooms	Cells/mL	130050	38650	119400	125050	68500	123000	253415	2310804	1278258	597020	231861	184730
Blue Green algal bloom	Cells/mL	57150	10250	10600	11100	11100	51100	165365	2268104	1254908	554470	207761	102930

Aspirational Data

A comprehensive list of influent/effluent parameters and the rationale as to what areas of inquiry these are important for. (Item 1)

This comprehensive list is then presented as a form (Excel spreadsheet) in which values can be entered.

Allocated the value of a parameter according to the area of relevance and priority within each area (High, Medium and Low). These areas represented below:

Area of relevance/research and importance of parameter rankings.	
Environment	High, Medium, Low
Engineering	High, Medium, Low
Recycling	High, Medium, Low
Economics	High, Medium, Low
Health and Community	High, Medium, Low

It should be noted that a significant overlap of areas of concern occurs in relation to many parameters and this emphasizes the importance of this information for a variety of purposes. A key consideration also is frequency of measurement reporting. With advances in technology, a requirement for greater accountability is not unrealistic if appropriately balanced against net benefits of a more comprehensive approach.

Data Availability - Recommended frequency of data provision	
1= Currently Provided	Provided by most WTAs to the National Outfall Database
2 = Desirable/Reasonable	Probable to be readily accessible at the discretion of WTA's
3= Ambitious	Maybe collected or technically feasible to obtain but not easily supplied with current resources of WTA.
NP= Not Practical	Not technically feasible to obtain.

Table 3. Comprehensive list of influent/effluent parameters and the rationale.

Parameter			Value					Data Availability						
	Description	Units	Environment	Engineering	Economics	Recycling	Health & Community	Recorded	Publicly Available	Reasonable	Daily	Yearly	Monthly	24/7
								C= Continuously D= Daily W= Weekly Y = Yearly	Yes/No Sometime (S)	Yes/No	1= Currently Provided 2 = Desirable/Reasonable 3= Ambitious NP= Not Practical			
Influent Wastewater Loads														
Volumetric Flow Received at Plant														
	Average Dry Weather Flow	kL/d	LOW	HIGH	HIGH	HIGH	HIGH	Y	No	Yes	3	2	2	NP
	Average Flow	kL/d	LOW	HIGH	HIGH	HIGH	HIGH	Y	No	Yes	3	2	2	NP
	Peak Daily Influent Flow	kL/d	LOW	HIGH	HIGH	HIGH	HIGH	Y	No	Yes	3	2	2	NP
	Peak Instantaneous Influent Flow	L/s	LOW	HIGH	HIGH	HIGH	HIGH	Y	No	Yes	3	2	2	NP
Sewage overflows in Catchment														
	Number in period	No.	HIGH	HIGH	MED	MED	HIGH	Y	No	Yes	NP	2	2	NP
	Estimated Volume	kL	HIGH	HIGH	MED	MED	HIGH	Y	No	Yes	NP	2	2	NP
Influent Wastewater Loads														
Suspended Solids	Total Suspended Solids (TSS or NFR)	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
Organic matter	5-Day Biological Oxygen Demand (Total BOD5 (uninhibited))	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
	5-Day Biological Oxygen Demand (Carbonaceous BOD5, inhibited))	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
	Chemical Oxygen Demand	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
Nitrogen Species	Ammonia (NH3 as N)	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
	Total Kjeldahl Nitrogen (TKN)	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP
	Total Nitrogen (TN)	mg/L	LOW	HIGH	LOW	HIGH	LOW	W	No	Yes	NP	2	3	NP

Phosphorus Species	Ortho-Phosphate (PO4 as P) or Reactive Phosphorus (FRP)	mg/L	LOW	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Total Phosphorus (TP)	mg/L	LOW	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
Effluent Flow Discharged to Environment / Reuse														
Volumetric Flow to Receiving Environment														
	Average Dry Weather Flow	kL/d	HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
	Average Flow	kL/d	HIGH	HIGH	HIGH	HIGH	MED	Y	Yes	Yes	NP	1	2	3
	Peak Daily Discharge	kL/d	HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
	Peak Instantaneous Discharge Flow	L/s	HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
	Number of Process Bypass Events	No.	HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
	Volume of Effluent that Bypassed Process in Period	kL	HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
	Volume of Effluent discharged to alternative location or emergency discharge		HIGH	HIGH	HIGH	HIGH	MED	Y	No	Yes	NP	2	2	3
Volumetric Flow to Water Recycling / Reuse														
	Reuse applications (list)	(list)	HIGH	HIGH	HIGH	HIGH	MED	Y	S	Yes	NP	1	2	3
	Volume of Flow Reused in Period	kL	HIGH	HIGH	HIGH	HIGH	MED	Y	S	Yes	NP	1	2	3
Effluent Flow Discharged to Environment / Reuse														
Suspended Solids	Total Suspended Solids (TSS or NFR)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
Organic matter	5-Day Biological Oxygen Demand (Total BOD5 (uninhibited))	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	5-Day Biological Oxygen Demand (Carbonaceous BOD5, inhibited))	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Chemical Oxygen Demand	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
Nitrogen Species	Ammonia (NH3 as N)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Total Kjeldahl Nitrogen (TKN)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Total Nitrogen (TN)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	Yes	Yes	3	2	3	NP
Phosphorus Species	Ortho-Phosphate (PO4 as P) or Reactive Phosphorus (FRP)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP

	Total Phosphorus (TP)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	Yes	Yes	3	2	3	NP
Dissolved Oxygen		mg/L	HIGH	HIGH	LOW	MED	MED	W	No	Yes	3	2	2	3
pH		pH Units	HIGH	HIGH	LOW	MED	MED	D	No	Yes	3	2	2	3
Microorganisms														
	E. coli	cfu/100mL or MPN/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Thermotolerant Colforms (Faecal Coliforms)	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Total Coliforms	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Enterococci	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Clostridium Perfringens	orgs/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	fRNA phage	pfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Somatic Coliphage	pfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Other		HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
Oil and Grease		mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
Chlorine Residual														
	Free Chlorine (as Cl)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP
	Total Chlorine (as Cl)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP
Conductivity		mS/cm	HIGH	HIGH	LOW	HIGH	HIGH	D	No	Yes	3	2	3	3
Total Dissolved Salts		mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	Yes	Yes	3	2	3	NP
	Parameter		Value					Data Availability						
	Description	Units	Environment	Engineering	Economics	Recycling	Health & Community	Recorded	Publicly Available	Reasonable	Daily	Yearly	Monthly	24/7
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Influent Wastewater Loads														
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Effluent Flow Discharged to Environment / Reuse														
Suspended Solids	Total Suspended Solids (TSS or NFR)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
Organic matter	5-Day Biological Oxygen Demand (Total BOD5 (uninhibited))	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	5-Day Biological Oxygen Demand (Carbonaceous BOD5, inhibited))	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Chemical Oxygen Demand	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
Nitrogen Species	Ammonia (NH3 as N)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Total Kjeldahl Nitrogen (TKN)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	S	Yes	3	2	3	NP
	Total Nitrogen (TN)	mg/L	HIGH	HIGH	LOW	HIGH	LOW	W	Yes	Yes	3	2	3	NP
Phosphorus Species	Ortho-Phosphate (PO4 as P) or Reactive Phosphorus (FRP)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP
	Total Phosphorus (TP)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	Yes	Yes	3	2	3	NP
Dissolved Oxygen		mg/L	HIGH	HIGH	LOW	MED	MED	W	No	Yes	3	2	2	3
pH		pH Units	HIGH	HIGH	LOW	MED	MED	D	No	Yes	3	2	2	3
Microorganisms														
	E. coli	cfu/100mL or MPN/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Thermotolerant Colforms (Faecal Coliforms)	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Total Coliforms	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP

	Enterococci	cfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Clostridium Perfringens	orgs/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	fRNA phage	pfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Somatic Coliphage	pfu/100mL	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
	Other		HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
Oil and Grease		mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	NP	2	3	NP
Chlorine Residual														
	Free Chlorine (as Cl)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP
	Total Chlorine (as Cl)	mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	No	Yes	3	2	3	NP
Conductivity		mS/cm	HIGH	HIGH	LOW	HIGH	HIGH	D	No	Yes	3	2	3	3
Total Dissolved Salts		mg/L	HIGH	HIGH	LOW	HIGH	HIGH	W	Yes	Yes	3	2	3	NP
Alkalinity	Equivalent amount CaCo3	mg/l	HIGH	HIGH	LOW	HIGH	LOW	Y	No	Yes	NP	2	3	NP
Temperature	Degree Celsius		HIGH	LOW	LOW	LOW	LOW	-	No	Yes	2	2	3	3

3.4 Energy and Emission Data.

This section is waiting for contribution.

4 Public Access

Providers of public access to information need to give consideration to ensuring the information is provided useful, in a readily accessible format and that is culturally appropriate to the relevant community it is informing.

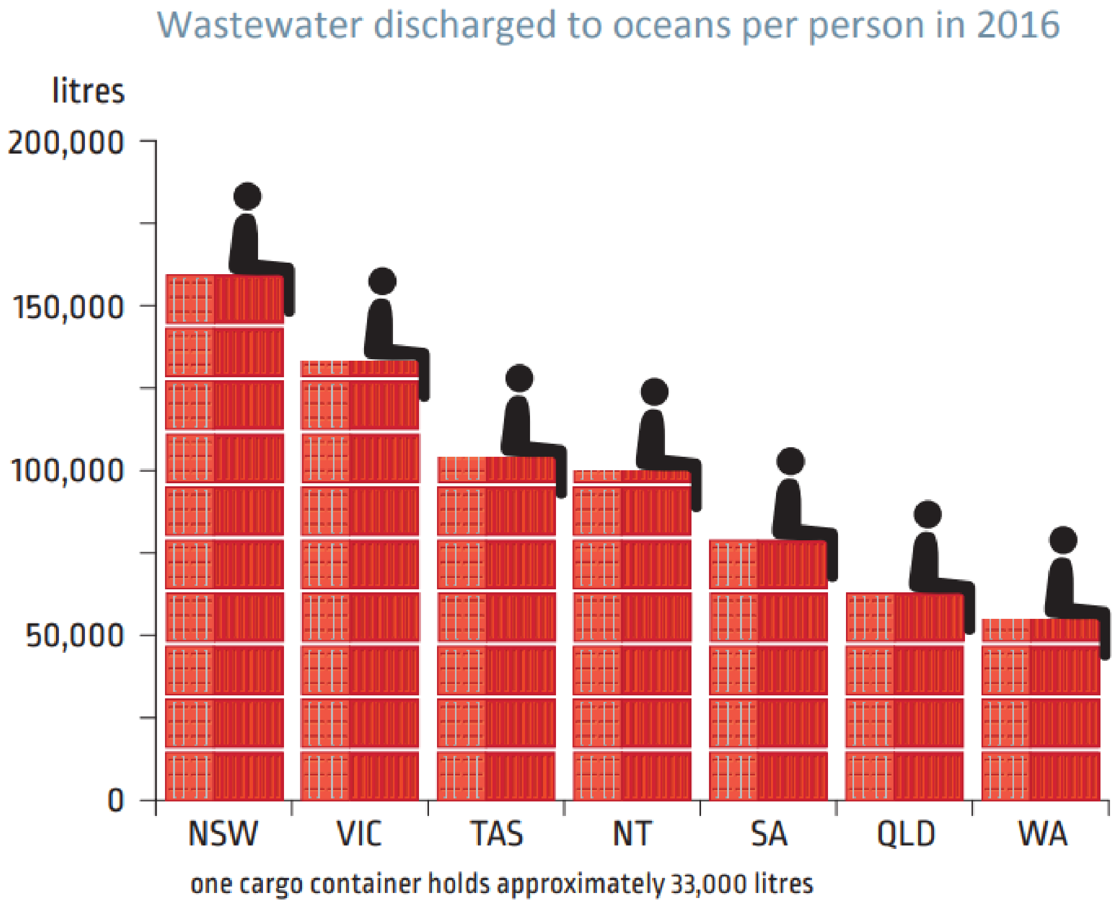
For example, the NOD water quality data is publicly accessible through two sites:

General Public:

https://www.outfalls.info/

The website consists details information of each outfall as well as monthly pollutants data, which is easily extractable. It also provides one-page downloadable summary sheets of the information collected annually presented from a national perspective (Figure 3).

Figure 6. Summary of wastewater discharge per capita during 2016.



Metadata UTAS:

https://catalogue.aodn.org.au/geonetwork/srv/eng/metadata.show?uuid=21448123-0170-4aff-9b56-2b6aa21c73ed

Public Access Considerations	Comments
Which community receives this information.	Different cultures or interests
What information do they want?	Education, Health, Adverse Events, Performance etc.
What languages is the information in?	E.g. migrant fisherman or tourists visiting an area for the first time
Is it accessible?	E-Media, Pamphlet, Personal Contact.
Is it linked to accessible databases for research and community access?	For Example: Do WTA display links to National Outfall Database for comparison purposes?
Is it provided in a timely manner or a frequency that is agreed upon?	Yearly, Monthly, Episodic.
Is it in a format they can understand?	Jargon or Layperson or Engineer/Scientist?

5 Water for Re-use

Communities expect that outfall discharges will be kept to minimum in terms of volume of water and pollution load to the receiving environment where possible. One major option to achieve this aim is the further treatment of wastewater to a higher standard (reducing the pollution load). This can then make the effluent stream more attractive for reuse.

Classification of water for reuse

Water for from WTPs is often defined by the type of reuse (fit for purpose) it is considered suitable for.

Standard classes of water for reuse from WTPs are.

WATER CLASSIFICATION			
Class	**Comments**	**Treatment**	**Parameter**
Potable	Stringent testing and process control.	Requires higher level of filtration and other treatment dependant on source water.	
Non-Potable			
A +	Class A+ is produced at Eastern Treatment Plant (Melbourne). It is suitable for all non-potable uses.	Tertiary reduces pathogens	Nitrogen: <5 mg/L Coliform: 1 cfu/100 mL pH: 6 - 9 BOD/SS: <5 - 10 mg/L Chlorine: 1 mg/L Turbidity: 2 NTU
A	Class A has the widest range of uses including those which involve direct human contact. These include clothes washing, closed system toilet flushing, garden watering and firefighting. It can be used to irrigate food crops that consumed raw or sold to consumers uncooked or processed as well as for all the uses allowed for Classes B, C and D.	Tertiary and pathogen reduction	Nitrogen: <5 mg/L Coliform: 10 cfu/100 mL pH: 6 - 9 BOD/SS: <5 - 10 mg/L Chlorine: 1 mg/L Turbidity: 2 NTU
B	Class B recycled water may be used to irrigate sports fields, golf courses and dairy cattle grazing land. It can also be used for industrial wash down as well as for the uses listed for classes C and D, but has restrictions around human contact.	Secondary and pathogen reduction	Nitrogen: <10-30 mg/L Coliform: 100 cfu/100 mL pH: 6 - 9 BOD/SS: <20-30 mg/L

C	Class C may be used for a number of uses including for cooked or processed human food crops including wine grapes and olives. It can also be used for livestock grazing and fodder and for human food crops grown over a meter above the ground and eaten raw such as apples, pears, table grapes and cherries. It can be used by councils for specific purposes but there are restrictions around human contact.	Secondary and pathogen reduction	Nitrogen: <10 - 30 mg/L Coliform: 1000 cfu/100 mL pH: 6 - 9 BOD/SS: <20 - 30 mg/L
D	Class D has received the least amount of treatment of all four classes and may be only used for non-food crops such as instant turf, woodlots and flowers.	Secondary	Nitrogen: <10 - 30 mg/L Coliform: 10000 cfu/100 mL pH: 6 - 9 BOD/SS: <20 - 30 mg/L
References: https://www.epa.vic.gov.au/about-epa/publications/464-2 https://www.dews.qld.gov.au/__data/assets/pdf_file/0019/45172/water-quality-guidelines.pdf			

Class A+ water requires a significant reduction in pathogens (see table below). There may be requirements to adjust levels of nutrient (phosphorus and nitrogen) and salt level.

Table 4. Queensland water quality guidelines outlining reduction from sewage to Class A+ (DEWS, 2013).

Pathogens	**Examples**	**Indicator**	**Class A+**
Bacteria	*Salmonella, Campylobacter,* Pathogenic *Escherichia coli,* Atypical *Mycobacteria, Shigella, Yersinia, Legionella, Vibrio cholerae, Staphylococcus aureus, Pseudomonas aeruginosa, Helicobacter pylori*	*E. coli*	5 log
Viruses	Enterovirus, Adenovirus, Rotavirus, Norovirus, *Hepatitis A,* Calicivirus, Astrovirus, Coronavirus	F–RNA bacteriophages, Somatic coliphages	6.5 log
Protozoa	*Cryptosporidium, Giardia, Naegleria fowleri, Entamoeba histolytica*	*Clostridium perfringens*	5 log
Helminths	Taenia, Ascaris, Trichuris	*Clostridium perfringens*	5 log

As mentioned in (Community Engagement Section), driving forces for consideration of upgrading or expanding wastewater treatment capacities inevitably occur through the life of a water treatment plant.

Having an updated, publicly accessible cost/benefit analysis for water reuse scenarios would ensure all stakeholders were aware of the impact of water security, environmental concerns, and engineering advances in wastewater treatment on WTP options into the future.

Table 5. WTP discharge alternative use analysis.

Class	WTP Discharge ML/Day	Recycled ML/Day	Cost to Upgrade per ML
A+			
A			
B			
C			
D			

Table 6. Projected Proportion Recycled over a 10 Year Period.

	WTP Effluent Volume	Volume Discharged	Volume Recycled (in house)	Volume Recycled Elsewhere
-4				
-3				
-2				
-1				
Current Year				
+ 1 Predicted				
+2 Predicted				
+3 Predicted				
+4 Predicted				
+5 Predicted				

6 Economics

6.1 Introduction

Australia's understanding of the economics of the water cycle is far from complete - we tend to focus on our immediate and present needs without considering the full cycle of our decisions over the use of water (Blackwell 2008). Indeed, we rarely contemplate that our decisions in our home have adverse and long lasting consequences for our natural water supply and disposal systems, our rivers, lakes, coastal waters and their associated ecosystems and environments - including those that provide food (e.g. fisheries) and fibre (e.g. horticulture) and a range of other ecosystem goods and services. Given that over two and half Sydney Harbours are disposed of annually through our nation's wastewater outfalls, representing 62% of Australian urban water use (Blackwell and Gemmill 2019b, slide 21), strongly demonstrates our wasteful use of water and its associated wastewater (which is 99.9% pure water) in what is a predominantly dry continent susceptible to drought with nutrient poor soils. Waste in economics is referred to as inefficiency and the lack of reuse and recycling at the end of our water cycle, the disposal of wastewater and nutrients into coastal waters, is particularly pernicious and wasteful. The NOD has allowed us to measure just how much water and nutrients we are wasting with our coastal outfalls - however, the amount of waste that is occurring inland could double this waste. This is an area to which the NOD (in press) Strategy is directed to create further efficiencies (reduced waste) in our water cycle.

From this introduction we can see that there are problems at the end of our water cycle in terms of waste disposal and the flip side of disposal which is recycling and reuse.

6.2 Waste Disposal

We have already seen that there is significant waste in the volume of water disposed to receiving waters with two and half Sydney harbours of water being disposed of into Australia's coastal waters annually - currently equating to 64% of Australia's urban water use - a significant untapped resource of 'new' water in a dry continent such as Australia (Blackwell and Gemmill, in press). Added to this volume of water are the nutrients and other constituents that comprise the wastewater, referred to elsewhere in these standards but also presenting a key opportunity for resource recovery which are now in favour with state governments with new agencies responsible for raising targets (e.g. see Queensland Government 2020; NSW Government 2020). Added to these are the energy requirements of pumping water and nutrients to disposal points and this is a significant waste of energy resources as well. Where desalination plants are used to provide additional water, these are more costly, renowned for their very high energy requirements and impact on the carbon cycle.

6.3 Water Recycling

By recycling the wastewater through higher levels of treatment or reuse before the water goes back to a treatment plant (e.g. through closed-loop greenfield developments) will considerably reduce this waste and inefficiency, especially where treatment plants are upgraded to A+ tertiary treatment standard. The capturing and reuse of nutrients, typically phosphorous and nitrogen also provides opportunities for further waste reduction.

CBA of wastewater upgrades

Blackwell and Gemmill (2019a) provides a strong case for the upgrades of coastal outfalls across the nation. The net benefits of doing so were found to be in the tens of billions with a lower bound estimate of around $10 billion and an upper bound estimate of approximately $30 billion. This demonstrates that with moving all outfalls to tertiary level class A+ treatment (from lower levels of treatment at primary and secondary level - where most schemes are at), reduces waste and improves the efficiency of our water use, reuse and wastewater disposal. Some states and outfalls however, present negative net benefits from upgrades, but there are sufficient net benefits from other schemes to offset these net losses and for Australia as a whole to be better-off as a result of the upgrades. This demonstrates a *prima face* case for having minimum standards of wastewater upgrades and disposal across Australia, such that those poorly performing schemes are helped to meet the standard through some form of public funding of upgrades.

The Benefits of Upgrades and Willingness to Pay

The benefits were assessed using the latest available information from a survey of households across Sydney for recycle water use in western Sydney (Blackwell and Gemmill 2019a). The work relied on a cutting-edge methodology for assessing people's willingness to pay for recycled water called 'choice modelling' (CM). CM presents people with a series of choices over the availability of wastewater recycled including trade-offs with the cost of their rates. Because the choices are repeated but in subtly different ways, it can be tested to ensure the tradeoffs mimic realistic choice and tradeoffs in household family budgets. By doing so CM provides valid, reliable and realistic estimates of people's willingness to pay for recycled water.

Furthermore, these benefits are conservative. They only represent those associated with recycled water use, they do not include the full spectrum of benefits in the water cycle from reduced disposal in coastal waters to reduced take of water from ecosystems. Benefits to coastal recreation, coastal fisheries production and the other benefits are not included.

6.4 Monitoring, Measurement and Reporting

Having a NOD is critical for accounting for how our wastewater systems are performing - it provides important baseline data but also an ongoing resource for better managing our water and other resource use, recycling and disposal management and planning. Without the

NOD, the first CBA of coastal outfalls (Blackwell and Gemmill 2019a) in Australia could not have been undertaken. It is therefore critical that the NOD forms a critical ongoing component of consistently and transparently reporting the performance of coastal outfalls (and inland water should the NOD be expanded). There is an inherent cost of continuing the NOD and ensuring that outfall agencies continue to report but was a consistent online system and framework and given the advances in big data and analytics this process and the costs involved could be reduced significantly. Added to this, these costs represent a very small amount, orders of magnitude less than the net benefits from wastewater treatment plant upgrades (hundreds of thousands of dollars versus tens of billions of dollars annually).

6.5 Economic Instruments

There are a range of economic instruments that can be used to better manage and provide strong incentives to those in the wastewater cycle (from agencies that treat the water to users whom first use the water) to reduce the amount of water and other resources wasted in coastal disposal. These instruments could be designed to be congruent with these standards. These instruments are briefly outlined in Table 7 with their respective advantages and disadvantages.

Tradable permits or credits to dispose of wastewater to receiving waters or elsewhere, is a well-known system in the carbon market called a ‘cap and trade’. Under this system, the amount of wastewater disposed is reduced through the allocation of permits or quotas to dispose of wastewater which are tradeable. Polluters must hold a required number of permits depending on the volume and or quality of waste disposed. Where polluters dispose of less than the quotas they hold, through undertaking upgrades and reusing wastewater, they can sell these on the market. Where a polluter holds fewer quotas that they require, they can undertake an upgrade or purchase required quotas on the market, whichever is cheaper. These mechanisms lead the market to the least cost approach to reducing the amount and type of wastewater disposed through the overall quota.

The geographical/hydrographical domain (e.g. local, regional, state, or national level) for a given quota needs to be determined at the outset. The broader this spatial domain, then the greater the number of participants and the improved efficiencies from a market mechanism for trading the permits or credits. Many states and territories in Australia now have a range of these tools in place to help manage natural resource and environmental issues (e.g. see NSW Government (2020) Biodiversity Credit system which is due to move to an online trading system). Again, with advances in big data and analytical systems, an online trading scheme could provide further efficiencies.

Table 7. Economic Instruments.

Instrument	Brief Details	Advantages	Disadvantages
Tradeable permits/credits/licenses	- Total quota (cap) is placed on the amount of pollution to reduce to desired level over given period/s - Polluters only allowed to pollute to the amount that they hold quotas for. They trade to gain/dispose of required quotas	- Reduces pollution at least cost to society - Allocations of quotas can be used to raise funds for running the system/for providing upgrades to historically poorly performing outfalls to meet equity goals - Effective, efficient and can be equitable	- Provides a entitlement to pollute which can run contrary to logic (but overall pollution levels are reduced - More complex than a tax or quota (but with online system these complexities can be simplified and automated) - Ideally requires a large number of traders
Quota	- Place total quota on amount of pollution - reduced over time - Each polluter has an individual quota which is not tradeable	- Simple - Can meet required target immediately or over a given period if well enforced	- Not least cost approach to meeting a given pollution reduction - Price or cost of reducing pollution not explicit
Tax	A tax per unit of pollutant is implemented and agencies pay this tax	- Simple, but not as simple as a quota - Provides a source of revenue to help fund upgrades or address equity concerns	- Not least cost approach to meeting pollution reduction - Quantity of pollution reduction not explicit
Hybrid	Tradable permits with a minimum tax	Provides a limit and greater certainty on the cost of reducing pollution through the tax but provides further cost savings through tradability of quotas	A little more complex conceptually to tax or tradeable permits

The quota and tax instruments are very similar to the cap trade but place a control on the quantity (or quality) or price of a unit of pollution respectively. They are potentially simpler and easier for people to understand but are likely to result in a more costly approach to meeting a given desired reduction in wastewater disposal. Quotas are very similar to the setting of minimum standards - that is wastewater must meet certain standards in quantity and quality regardless of the cost of doing so - that is, cost is less explicit through a simple quota or standards system. In contrast, with a tax, the cost is more explicit through the amount of the tax per unit of pollutant. With a tax, the quantity (or quality) of wastewater disposed is less explicit but various taxes could be set for various levels of treatment, which can also be implemented in a cap and trade scheme (with different permits for different levels of wastewater treatment). The tax maybe preferred because it provides a clear message about cost and provides needed revenue to support upgrades over time such that agencies reach their wastewater reduction targets.

There is also the opportunity to mix these various instruments. One is where a tax and cap and trade scheme are developed. This was suggested by Warwick McKibbin (2018) to help Australia meet its carbon reduction targets. It has the advantage of providing certainty to polluters through the tax being used to minimise the cost of pollution reduction. The cap and trade then provide further cost savings.

6.6 Conclusion

There is clear evidence that we are not using our water resources (and resources contained in the disposed water) efficiently with the NOD and CBA of Australia's wastewater treatment upgrades report. This is particularly alarming in a dry continent such as Australia. The CBA provides a relatively clear pathway for where upgrades could begin and how poorly performing systems can also be improved, which provides a beginning for a NOD strategy. The standards are critical in this process by rapidly identifying those schemes that can reap the benefits and those that need help through some form of public funding to deliver a minimum standard of tertiary level A+ treatment. We have also outlined a range of economic instruments that can be used to meet a minimum standard of volume and quality of wastewater disposed of. These range from a quota (standards for volume and quality) system, to a tax, tradable permits (cap and trade) and hybrid systems. Each has advantages and disadvantages, but a cap and trade can meet a given standard at least cost, particularly given an online and easily available and transparent trading platform. A hybrid tax and cap and trade system provide certainty to treatment agencies by ensuring a minimum cost of reducing wastewater outfall. Which instrument is used will depend on the appetite of the given community and the ability to convince people of the relative virtues.

7 Pollutants

Reference Recreational guidelines re-pollutants or update?

7.1 Common

1. Nitrogen is another potential contaminant from the wastewater effluent. The source of organic nitrogen usually from human excreta, food waste, and industrial waste. Nitrogen has a positive relationship with phosphorus, which means higher nitrate may be affected by higher phosphorus. Moreover, high rises of nitrogen pollution are believed could severely affect the marine environment which leads the increases of algal bloom. Total nitrogen is a compound of ammonia, nitrate, nitrite and organic nitrogen.

   Types of nitrogen:

   a. Ammonia

   Ammonia is present naturally in surface and wastewaters. Its concentration generally is low in groundwaters because it adsorbs to soil particles and clays and is not leached readily from soils. It is produced largely by deamination of organic nitrogen-containing compounds and by hydrolysis of urea. At some water treatment plants ammonia is added to react with chlorine to form a combined chlorine residual. Ammonia concentrations encountered in water vary from less than 10 µg ammonia nitrogen/L in some natural surface and groundwaters to more than 30 mg/L in some wastewaters.

   Ammonia (NH_3) is a nitrogenous compound that is oxidized in a process called nitrification. The nitrification of wastewater is necessary to remove or reduce the amount of nitrogen compounds in wastewater; these compounds act as environmental pollutants in the receiving stream. Nitrification occurs when nitrifying bacteria, *Nitrosomonas spp*. convert ammonia and other nitrogen compounds into nitrite (NO_2-) and *Nitrobacter spp*. convert nitrite into nitrate (NO_3-). The nitrification process uses about 2.04 kilograms (4.5 pounds) of molecular oxygen (O2) for every kilogram of ammonia that is nitrified. The nitrification process can occur at dissolved oxygen levels as low as 1 mg/L.

   b. Nitrite

   Nitrite is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate. Such oxidation and reduction may occur in wastewater treatment plants, water distribution systems, and natural waters. Nitrite can enter a water supply system through its use as a corrosion inhibitor in industrial process water. Nitrite is the actual etiologic agent of methemoglobinemia. Nitrous acid, which is formed from nitrite in acidic solution, can react with secondary amines

(RR′NH) to form nitrosamines (RR’N-NO), many of which are known to be carcinogens. The toxicologic significance of nitrosation reactions in vivo and in the natural environment is the subject of much current concern and research.

c. Nitrate

Nitrate generally occurs in trace quantities in surface water but may attain high levels in some groundwater. In excessive amounts, it contributes to the illness known as methemoglobinemia in infants. A limit of 10 mg nitrate as nitrogen/L has been imposed on drinking water to prevent this disorder. Nitrate is found only in small amounts in fresh domestic wastewater but in the effluent of nitrifying biological treatment plants nitrate may be found in concentrations of up to 30 mg nitrate as nitrogen/ L. It is an essential nutrient for many photosynthetic autotrophs and in some cases has been identified as the growth-limiting nutrient.

d. Organic nitrogen

Organic nitrogen is defined functionally as organically bound nitrogen in the trinegative oxidation state. It does not include all organic nitrogen compounds. Analytically, organic nitrogen and ammonia can be determined together and have been referred to as ‘‘kjeldahl nitrogen,’’ a term that reflects the technique used in their determination. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea, and numerous synthetic organic materials. Typical organic nitrogen concentrations vary from a few hundred micrograms per liter in some lakes to more than 20 mg/L in raw sewage.

Nitrogen measurement:

- River
-
- Coastal

2. Phosphorus:

Phosphorus occurs in natural waters and in wastewaters almost solely as phosphates. These are classified as orthophosphates, condensed phosphates (pyro-, meta-, and other polyphosphates), and organically bound phosphates. They occur in solution, in particles or detritus, or in the bodies of aquatic organisms. These forms of phosphate arise from a variety of sources. Small amounts of orthophosphate or certain condensed phosphates are added to some water supplies during treatment. Larger quantities of the same compounds may be added when the water is used for laundering or other cleaning, because these materials are major constituents of many commercial cleaning preparations. Phosphates are used extensively in the treatment of boiler waters. Orthophosphates applied to agricultural or residential cultivated land as fertilizers are carried into surface waters with storm runoff and to a lesser extent with melting snow. Organic phosphates are formed primarily by biological processes. They are contributed to sewage by body wastes and food residues, and also may be formed from orthophosphates in biological treatment processes or by receiving water biota.

Phosphorus in the wastewater comes from several sources, such as fertilizer, biological wastes, and cleaning liquids. The presence of phosphorus is needed in biological (secondary) treatment to help the microorganisms stay alive and break down the organic matter in the wastewater. However, when phosphorus levels are high in the wastewater effluent, proliferation of microorganisms may result and can affect other aquatic organisms.

Phosphorus measurement:

3. Oil and grease

Oil and grease (O&G) pollutants come from cooking oil, animal fats and vehicle lubricants, which have been poured into the sink or a stormwater drain. It has hydrophobic characteristics, which means it will keep floating and drift along with surface current and wind. Oils from the outfalls might disperse to other places, and its physical and chemical properties might be altered depending on the chemical reactions with oxygen, sunlight, and water as well as with microorganisms. O&G can block the sewer pipes and cause flooding, and for the marine ecosystems, it makes the water aesthetically unattractive, reduces sunlight penetration and surface re-aeration of water. It also promotes the concentration of other harmful hydrophobic chemicals such as pesticides, polychlorinated biphenyls, and other aromatic compounds, many of which are either carcinogenic or endocrine disrupting.

Oil and grease measurement:

Summary and discuss , include types and costs and shortcomings in measurement.

Discussion of common pollutants and variability of measurements amongst WTPs. Can use data compiled from NOD (Ayu's paper)

Table 8. Initial request of water quality data parameter for 2015 data.

Parameter	Unit
Flow volume	**ML**

pH	pH
Total Dissolved Solids	mg/L
Total Suspended Solids	mg/L
Total Phosphorus	**mg/L**
Total Nitrogen	**mg/L**
Oil and grease	mg/L
Surfactants (MBAS)	mg/L
E. coli	org/100mL
Enterococci	org/100mL
Faecal coliforms	org/100mL
Turbidity	NTU
Colour	Pt. Co. Units
Algal blooms	Frequency
Blue Green algal bloom	Frequency

Water quality parameters collected by all WWTPs appear in bold.

7.2 Emerging

Summary and discuss , include types and costs and shortcomings in measurement implications for future policy decisions.

Emerging contaminants, such as antibiotics, pharmaceuticals, personal care products, hormones, and artificial sweeteners, are recognized as new classes of water contaminants due to their proven or potential adverse effects on aquatic ecosystems and human health.

Many are found to various degrees in both influent and effluent streams from WTPs and most are not currently tested for on a regular basis or have discharge limits set by licensing authority. Such an arrangement is unlikely to be considered acceptable for much longer by both health authorities, scientific bodies and the general community.

As has been found for example with Per- and polyfluoroalkyl substances (PFAS) pfas contamination, removal from the environment is problematic and expensive. Management and removal of emerging contaminants in the future may become a critical issue in selecting/upgrading appropriate treatment processes. Sharing data and fostering an evidenced based understanding of the complex nature of these pollutants is recommended.

Put in list of emerging contaminants here article cited mentions 60 (probably influent)

Table 9. Emerging contaminants questionnaire for outfalls parameter data.

Emerging Contaminants

Are any tests done to identify emerging contaminants in influent?	Yes/No
Are any tests done to identify emerging contaminants effluent?	Yes/No
Are these results publicly available?	Yes/No
What strategies are in place to review treatment and monitoring related to emerging contaminants on a regular basis?	Descibe

8 Community and Environment

“Data is not information, information is not knowledge, knowledge is not understanding, understanding is not wisdom.” – Clifford Stoll

Community interest in the impact of outfalls on the local environment is constantly evolving. A greater awareness of the science related to the impact of pollutants, changing behaviours of recreational water users and the complex relationship between water security and wastewater discharges all contribute to thirst by the general public for a better understanding and effective representation in the roles and activity related to the WTP process.

Transparency of WTA and WTP is a critical factor in how this infrastructure is seen by the community. But transparency means different things to different people.

With limited resources both the community and WTA must develop and agree on what is critical to be represented in a timely manner.

All participants need to acknowledge that proper transparency is not a panacea, as the process of wastewater treatment is naturally a friction point consisting of changing values related to what is ethically, economically, and technically possible.

But by constructive engagement with stakeholders, the context of this friction can be harnessed to drive an informed process of review and reform rather than one based on a somewhat technocratically elite view of outfall issues that still exist in some sections of the water sector.

Community awareness and concern can be a critical factor in influencing decisions relating to WTAs operations. Factors influencing this include:

8.1 Lifecycle of a WTP

Understanding the above dynamic at work can provide stakeholders with the opportunity to effectively plan for community engagement. This might be broadly represented by:

EXPECTED: NORMAL LIFE-CYCLE OF PLANT	TIME (YEARS)	Description	Operating Performance	Community Concern
	0.5	**Construction**		Relates to old system
	1	**Commissioning**	May have teething issues	Minor provided informed and mitigation measure in place

	20	**Normal Operation** Operation within Capacity	Negligible	Minimal
	10	**Towards End of life** Under capacity (increases in connections), Equipment failure or obsolescence	Increasing frequency of operational challenges	Mitigation, notification, calls for upgrades, better monitoring, transparency etc. Potential for increasing dissatisfaction and polarisation
	2-5	**Up to Expansion or Upgrade or Closure**	Negotiation, Action plan developed, Funding received	Increasing dissatisfaction. Less tolerance for out of license events.
EXCEPTIONAL	Variable	**Adverse Event** Extreme Weather/Adverse Events, Pandemic eg Covid19 in discharge	Out of License,	Concern for more recycling, health and aesthetic etc.
	Variable	**Change in Awareness** eg emerging contaminants		Microplastics, PFAS contamination, COVID19

8.2 Historical relationship with Community

What history (negative or positive) does the WTA have with local communities?

Considerations will include:

1. Experience during normal operation and

2. Experience during an adverse event

Relationship with Community	
Have there been issues resulting in discord between the community and WTA related to outfalls in the last five years.	Yes/No
Are these issues related to:	
Experience during normal operation?	Yes/No
Describe	
Experience during an adverse event?	Yes/No
Describe for each adverse event?	
Does the WTA have a clearly defined policy of managing adverse events?	Yes/No
Describe	
How well does this policy match the expectations of community groups?	Describe
Does the notification of these events meet the needs and expectations of the community to be properly informed?	Describe

How often do adverse events/breach of license conditions occur?	Describe
Are these communicated to the community in a timely manner	Yes/No
How responsive is WTA to community concerns relating to these events?	Describe
How does the WTA evaluate and represent community satisfaction with the process of engagement and resolution?	Describe

8.2.1 Environmental Monitoring

Most WTP's as part of their EPA license conditions are required to engage in environmental monitoring. As well as a significant variation in variables measured there is large variation in how much of this data and in what form (if any) is made public.

The only legitimate impediments to public provision of this data are sufficient resources to collect and present data in a meaningful form in a timely manner.

Having well established procedures that all stakeholders understand and have the opportunity to critique and review will contribute to better community outcomes.

Community stakeholders can significantly contribute their understanding of the local environment, conditions and behaviour of recreational users. This can be extended to opportunities to use stakeholders for citizen science to gain a more comprehensive understanding of the complex interaction WTPs, outfalls and their surroundings.

Some considerations include:

Does an Environmental Monitoring Plan (EMP) exist and is it accessible publicly?

Does the EMP comply Australian Recreational Water Guidelines?[1]

[1] https://www.nhmrc.gov.au/about-us/publications/guidelines-managing-risks-recreational-water

Table 10. Environmental monitoring satisfaction.

Environmental Monitoring	Yes/No
Does an Environmental Monitoring Plan (EMP) exist and is it accessible publicly?	Yes/No
Does the EMP comply Australian Recreational Water Guidelines?[2]	Yes/No
Is the community involved in the development of the EMP	Yes/No
Is there an independent audit of EMP process on a regular basis?	Yes/No
	Describe
Is this audit released for public consumption	Yes/No
Is there opportunity for community involvement to improve the environmental monitoring process?	Describe
Is the community satisfied with this process?	Yes/No
How is community satisfaction assessed?	Describe

[2] https://www.nhmrc.gov.au/about-us/publications/guidelines-managing-risks-recreational-water

8.2.2 Recreational Users

Recreational use of waters near outfalls poses significant challenges for outfalls.

Due to advances in technology and increases in leisure time, there is an ever-expanding array of activities that may be conducted on or near waters close to outfalls. Recreational activities that may occur around an outfall can include:

- Surfing, bodysurfing, paddle boarding, kitesurfing, windsurfing
- Swimming, snorkelling, scuba diving
- Beachcombing, beach-based leisure activities
- Sailing, kayaking, fishing, boating

These relatively recent activities have increased the likelihood of incidental exposure to outfall pollutants whilst in many cases WTAs are still required to continue to operate plants designed several decades ago based on outdated criteria that would now be considered unacceptable.

The notification of recreational users of changes in conditions is an important responsibility in relation to risk management (Figure 5). The process needs to be timely and provide enough information for recreational users to make an informed decision on their activities near and outfall. The process as to when and how this occurs varies widely. This is complicated by the complex chain of authorities involved in the process of collecting, analysing, preparation and dissemination of the information.

That said, having recreational users frequenting the area near outfalls also provides the opportunity to engage in useful citizen science research and build constructive relationships between community and WTA's.

Opportunity for effective communication through citizen science

Recreational users can be of immense use in detecting abnormalities in the marine environment that may or not may not be related to outfall discharge. Early reporting to experts from engaged recreational users can ensure prompt attention to problems and also help quickly allay unfounded concerns when an issue is not related to discharge from outfalls. This can be relatively inexpensive such as engaging recreational users to assist with low level monitoring and reporting of water quality around outfalls. With advances in technology (such as Eyeonwater) this is now far more practical.

Alternatively, when a problem is discovered this can be a time to engage with volunteer recreational users to do more complex tasks or to have them assist licensed environmental testers. Such a pilot scheme was proven feasible at Warriewood outfall NSW.

Need explanation about the flow chart here.

Figure 7. Flow chart of citizen science for greater transparency and engagement.

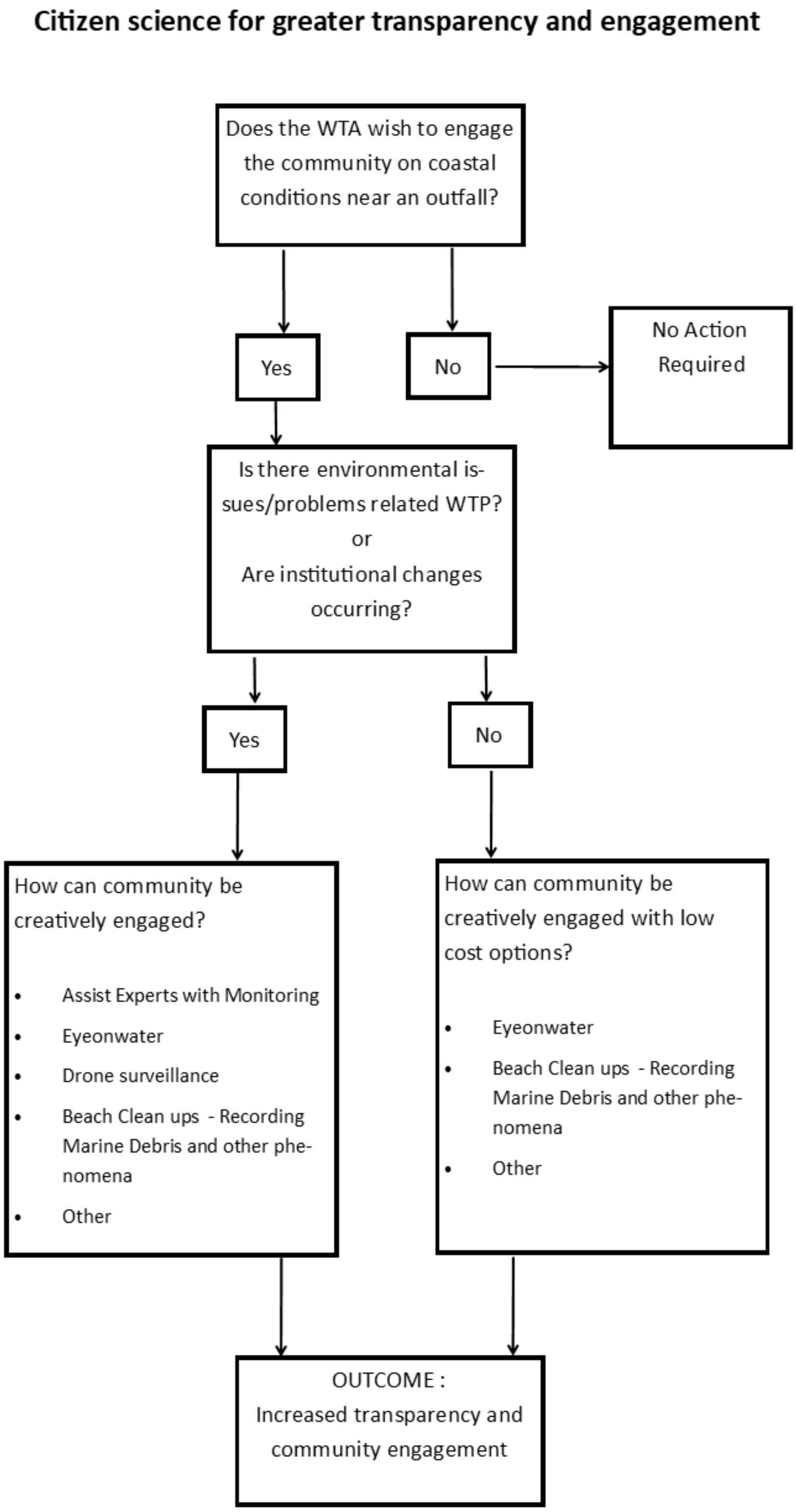
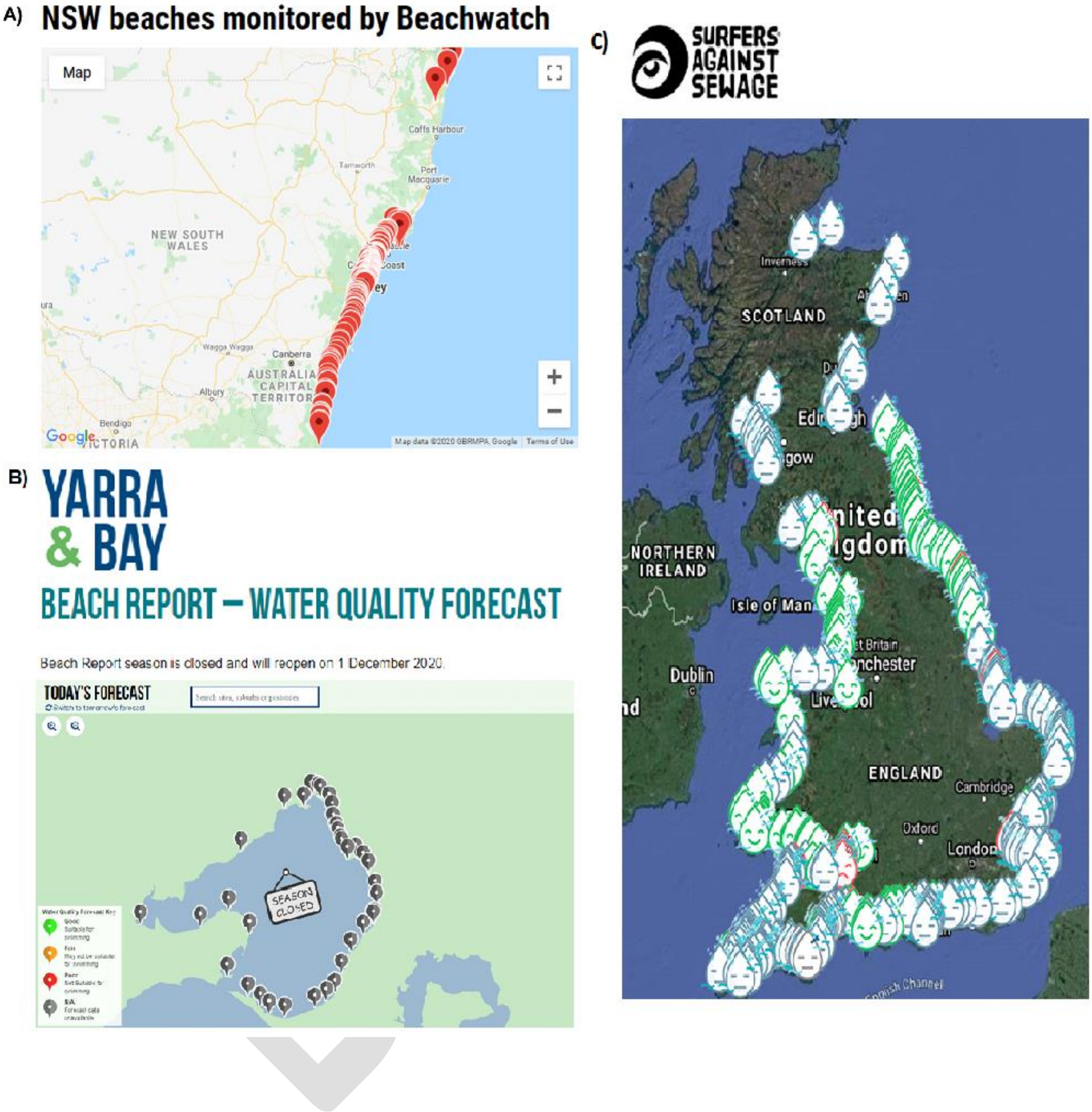


Figure 8. Variance in delivery of information to recreational users: Victoria, NSW, England. A) NSW beaches monitored by Beachwatch available from Illawara to Sydney to Hunter Coast and North Coast. B) VIC Yarra and Bay beach report forecast on summer only available for Port Philip Bay areas. C) UK Surfers Againts Sewage pollution report available over 350 locations around the UK coastlines for all recreational users.



Some important factors to consider are:

Are there any special procedures in place for risk management?

What are the recreational activities that occur near the outfall and when do they occur?

Are their local clubs /associations /businesses that can assist with effectively?

Communication?

Are there informal networks that can be notified.

How are these notified of events etc. Is there a list of users and associations?

What is reasonable time between adverse event (or prediction of) and public being notified?

How does e-media interact with these users and associations?

Table 11. Recreational user notification for marine environment users.

Recreational User Notification	**Yes/No**
Are there any special procedures in place for risk management?	Yes/No
List of Recreational Activities near outfall.	Comment
List of Recreational Activities near outfall.	List
List of Clubs/Associations.	List
List of informal networks.	List
What is the process of notification for each?	Comment
What is considered a reasonable time between adverse event (or prediction of) and public being notified?	Comment
How does e-media interact with these users and associations?	Comment
How often are these procedures reviewed?	Comment

Figure 9. Example Warriewood Treatment Plant (Sydney Water) bypass events involve notification SMS of local Surfrider committee members who then place sign on the beach.

8.2.3 Aesthetic Aspects

Recreational Water aesthetic aspects are discussed in [Guidelines for managing risks in recreational water](), Section 10.

Aesthetic aspects are those that the community and in particular recreational users will generally be most sensitive to.

By opting to proactively engage with the community to monitor these aesthetic aspects using low cost equipment around an outfall, WTA can build significant levels of rapport and understanding within the local community. Eye on Water: CSIRO recruits citizen scientists to monitor water quality with new app

8.2.4 Indigenous communication

The area affected by WTP outfall discharge may be of relevance to local indigenous communities. Their views will need to be taken into account.

Table 12. Questionnaire for the Indigenous communities' input into the Outfalls Standard.

Indigenous Participation	
Have relevant indigenous groups been considered in respect of communication of issues relating to outfalls?	Yes/No
What processes support effective indigenous community involvement in governance and development of a two-way communication process?	Comment
Have the relevant indigenous communities been identified and how?	Comment
How has it been ensured that information is delivered in a culturally appropriate and effective manner?	Comment
Does the process provide the culturally appropriate opportunity for indigenous feedback?	Comment
How is indigenous community satisfaction with these processes assessed and reported?	Comment

9 Reporting and Governance

9.1 Governance and community input

Budgetary decisions by governing bodies determine:

- major changes to WTP infrastructure (capital expenditure)
- WTP's maintenance
- the ability to cope with adverse events can all impact on outfall discharge quality.
- Alterations to licensing arrangements

Evolving community expectations provide a significantly different perspective from a narrow institutional approach that revolves around to cost minimization to meet budgetary constraints. By transparently informing and integrating this alternate view into an institution's decision-making process, the institution gains the support of the local community for its activities and expenditure and policy development.

Some key considerations are:

Table 13. Key consideration for the community governance.

Community Governance	
Is the community familiar with the governance structure?	Yes/No
Does the community feel properly represented within that structure?	Yes/No
How is this known?	Comment
Are there community members in this structure?	Yes/No
How many?	Number
What percentage of the board are the community members?	Number
If so, how does the community appoint them?	Comment

9.2 Time scales

Provision of basic data by WTAs related to outfalls to the National Outfall Database on an annual data has been established since 2015. For most organisations the most convenient form is data collated in a financial year. This data should be provided by the end of October each calendar year.

9.3 Licensing

New licenses or variation in operation can be required due to increase in population, changes in geographical areas serviced or new/expanded trade waste contracts WTA wish to enter into.

These can raise a variety of ethical and economic issues that require decision makers to ensure the community have significant input on water policy, not just expansion of volume for increased population, adverse event management etc.

The variation to license conditions need to actively facilitate community input and awareness.

A key interest of the community will be the opportunity for any increase in the amount of water recycled and would this result in a reduced pollution load (quantity and or quality) on the coastal environment?

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APPENDIX A –

Appendix B –