

Ludmilla Wastewater Treatment Plant WDL 150-06

IMPROVEMENT PLAN

JUNE 2019



Document Details and History

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Cover photographs

East Point Outfall and effluent channel formed at extreme low tide (outfall at centre of photo): PWC collection

Abbreviations and Glossary

AA	Administering Agency
AS	Australian Standard
BOD	Biochemical Oxygen Demand
BPEM	Best Practice Environmental Management
Cfu	Colony Forming Units
SOC	Site of Conservation Significance
Controller	Controller as specified in the Waste Discharge Licence. In this case, DENR
DAF	Dissolved Air Flotation – A process for treating effluent, in which particulate matter (solids such as algae) is removed from the wastewater through movement of particles attached to small bubbles of air. The bubbles and particles float to the surface where they can be physically removed.
DEWHA	Department of Environment, Water, Heritage and the Arts (DEWHA)
DENR	Department of Environment and Natural Resources
Effluent	Treated Wastewater
EMP	Environmental Management Plan
EP	Equivalent Persons
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ES	Environmental Services
ESO	Essential Service Officer
Licence	Waste Discharge Licence 147 Issued under the Water Act
MEB	Medical Entomology Branch
NEPC	National Environment Protection Council
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and Safety Commission
NRMMC	Natural Resource Management Ministerial Council
NT	Northern Territory
PIR	Performance Improvement Report
PPE	Personal Protective Equipment
PWC	Power and Water Corporation
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
WDL	Waste Discharge Licence
WIMS	Work Information Management System
WM	Weeds Management
WMPC Act	Waste Management and Pollution Control Act (NT)
WQO	Water Quality Objectives
WRP	Water Reclamation Plant
WSP	Waste Stabilisation Pond
WWTP	Wastewater Treatment Plant

Executive Summary

Discharges from the Ludmilla Wastewater Treatment Plant (LWwTP) are regulated under conditions specified in a Waste Discharge Licence (WDL) 150-06, granted under Section 74 of the Water Act 1992.

Conditions 40 of the licence requires the Licensee (Power and Water Corporation) to update the Ludmilla Performance Improvement Plan 20117 to include actions that will be undertaken towards achieving the full design capacity of 1000 L/sec to the East Point rising main to reduce the likelihood of discharges to Ludmilla Creek; to detail reasonable and practicable measures to improve the discharge quality in order to achieve the water quality objectives for Darwin Harbour, insofar as background water quality allows. Condition 39 requires that the updated Performance Improvement Plan is submitted to the Administering Agency by 30 June 2019.

The influent and effluent volumes for the Ludmilla WwTP display a distinctive seasonal pattern associated with rainfall in the sewerage catchment and infiltration of stormwater into the sewerage system.

In the period from July 2018 to 31 May 2019, 99.59% of the total discharge was to Darwin Harbour via the East Point Outfall compared to 98.49% for the period from July 2016 and 92.05 for the period from June 2012 31 May 2019 (Larrakeyah outfall closure). For the 2018/19 dry season 99.79% of the discharge from the LWwTP was via the East Point Outfall compared to 99.89% for the period from July 2016.

During the period from August 2016 onwards the conditions under which discharges can occur to Ludmilla Creek has increased from 300 L/sec to the current inflow rate of 900 L/sec. During this period the percentage of total inflow going to Ludmilla creek has reduced from 7.7 percent to 1.55 percent of the total discharge and from 1.64 percent of dry season discharge to 0.017%. This represents a significant discharge that cannot be attributed to the poor 2018/19 wet season alone. It is unclear how much of a further reduction will occur in going from 900 L/sec to 1000 L/sec.

The discharge of treated effluent from the Ludmilla Wastewater Treatment Plant results in Darwin Harbour water quality at the East Point Outfall exceeding the ANZECC Water Quality Guidelines for the toxicants copper and ammonia and the NHMRC and Darwin Harbour Water Quality Objectives for pathogens are exceeded E.coli, (aquaculture) and enterococci (swimming)

The Darwin Harbour water quality nutrient indicators phosphorus and nitrogen exceed, however the process indicator, chlorophyll-a, is not exceeded at any Darwin Harbour site.

An extensive receiving water monitoring program indicates that 'slightly to moderately impacted' toxicant water quality objectives are met by the first receiving water site which is 300 metres west north west of the East Point Outfall. Finer scale benthic infauna assessment has confirmed that the impact zone for the current discharge into Darwin Harbour is restricted to a zone with a maximum radius of 200 metres where impacts associated with increased numbers of potential indicator biota were identified as one site between 100 and 200 metres from the East Point Outfall.

Water quality in Ludmilla Creek is not protective of the Declared Beneficial Uses, however as less than 2% of the effluent is discharged to the creek and less than 0.07% of the dry season discharge is to the creek, and the treated effluent discharged is not the primary cause of the water quality being unsuitable for the Declared Beneficial Uses. The water quality in Ludmilla Creek is similar to most urban creeks in that uses such as swimming, aquaculture and the collection of aquatic animals for food may not be appropriate, particularly in the wet season. This is consistent with water quality monitoring at other urban creeks in the Darwin region, irrespective of waste water discharges.

This Improvement Plan includes a range of action to continue implementation of PWC Darwin Harbour Water Quality Protection plan actions and specific Ludmilla WwTP improvement actions that will be progressively implemented in the period between 2019 and the end of 2020 to improve the hydraulic and treatment performance of the LWwTP and move towards achieving 1000 Litres/sec inflow capability to the East Point rising main, with many actions ongoing into the next licence period.

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1 Introduction

Power and Water is established by the *Power and Water Corporation Act 2002* and is a Northern Territory Government Owned Corporation under the *Government Owned Corporations Act 2001*. Power and Water owns and operates the large dams and groundwater fields to deliver clean drinking water to households and businesses and receives and treats wastewater before disposing of it in an environmentally responsible manner.

1.1 PWC Statement of Corporate Intent 2019 to 2020

PWC's Statement of Corporate Intent 2019-20 covers the four year period from 1 July 2019.

In accordance with the Government Owned Corporations Act, Power and Water's objectives are to:

- Operate at least as efficiently as any comparable business; and
- Maximise the sustainable return to the Northern Territory Government on its investment in the Corporation.

This is supported by Our Vision of being a best practice, commercially focused and customer centric multi-utility respected by the community for our contribution to the NT economy and the pursuit of the long-term interests of the community.

In achieving these objectives Power and Water acknowledges that it has an important role in facilitating the efficient delivery of the NTG social and economic agenda and working constructively with key stakeholders.

In relation to the discharge of treated wastewater from the LWwTP, 'the Activity', Power and Water conducts a number of relevant operations as specified in the Statement of Corporate Intent:

Water Services plans, constructs, operates and maintains sewerage infrastructure assets for the long term to provide safe, reliable and efficient water and sewerage services to five major and five of the fifteen minor centres, with the remaining minor centres provided with water services only.

Power and Water's stated purpose is to enrich the future of the Territory for our customers and for each other. To achieve our purpose

- Enrich the future of the NT and the community in which we operate, supporting economically sustainable growth and prosperity.
- Enriching the future of our people by providing growth and development opportunities that enable them to do new things, champion change and make a difference in the work we do.
- Enrich the future for our customers by being easy to deal with and providing knowledge and choice.

This is supported by our vision of being a best practice, commercially focused and customer centric multi-utility respected by the community for our contribution to the NT economy and the pursuit of the long-term interests of consumers.

To achieve PWC's corporate objectives, PWC has established overarching strategic framework for the five key result areas (KRAs) and has defined goals for each of the KRAs. The KRAs are Health and safety; people and culture; financial performance; operational performance; customer service.

The KRA of particular relevance to the LWwTP discharge relate to operational performance:

Key Result Area 4: Operational performance:

Goal: An efficient provider of services to our customers supported by strong asset management, governance and protection of the environment. The key strategies are:

- 4.2: Identify and adopt best practice methodologies across the organisation and leverage synergies across the multi-utility business; and
- 4.5: Ensure prudent, effective risk and governance practices including environmental management.

A key performance indicator is that all Sewerage Treatment Plant discharges are licenced, and consistent with PWC's Environmental Management Policy comply with all relevant legal requirements including the requirements of the discharge licence. To support compliance with our legal obligations PWC is continuing to refine the frameworks and procedures relating to risk assessment, risk management and governance processes and capabilities.

1.2 PWC Water Services Specific Goals

Water Services plans, constructs, operates and maintains water and sewerage infrastructure assets for the long-term to provide safe, reliable and efficient water and sewerage services to five major and five of the fifteen minor centres, with the remaining minor centres receiving water services only. In addition water and sewerage services are provided to geographically isolated and dispersed aboriginal communities and outstations across the NT, to 72 communities and 66 outstations, with fifteen receiving water services only.

While the provision of safe drinking water is a prime focus, in relation to the Activity, the provision of effective and efficient sewerage treatment and disposal is another key focus. With the completion of major works at the Leanyer-Sanderson Wastewater Treatment Plant the focus is to assess the benefits and determine what further works are required.

To drive changes and meet PWC's Goals Water Services will improve asset management processes through the ongoing implementation of the Asset Management Improvement Plan and the Portfolio Management Plans to deliver a comprehensive approach to asset management, maintenance and asset construction, renewal or replacement.

Water Services 2019 to 2023 Key Strategies and Initiatives

In relation to sewerage services Water Service's focus is aligned ensuring operational performance is best practice by aligning the Asset Management Framework to ISO 55000 to strengthen all asset management processes ensuring reliable and resilient asset infrastructure to deliver levels of service and sustainability of safe water services including encouraging and assisting customers in efficient water use through the delivery of demand management programs and the 'smart communities' program.

Water Services Capital Investment Program

Sewerage:

The proposed sewerage capital program is focused on delivering capacity improvements to meet increased demand and compliance requirements. The capital program totals \$80.9 million over the four year SCI period of which \$12.6 million is included in the 2019-2020 budget. The 2019-2010 program includes:

- **Renewal/Replacement:**

Upgrade of current asset infrastructure to meet optimum levels of service: works are planned to improve the reliability of the distribution and treatment system across the NT through main sewer relining, pump replacement and desludging programs and other sewer reticulation improvements.

- **Service Improvement:**

Improve the efficiency of service delivery: planning continues for the inlet works to the Ludmilla Wastewater Treatment Plant

- **Compliance:**

Meet increased regulatory and licensing requirements; the focus remains on Leanyer-Sanderson to support compliance with the WDL, including hydraulic improvements and pond repairs.

Key Risks

The Power and Water SCI recognises key risks and threats including:

- **Major Compliance Breaches:**

There is a risk that PWC may fail to identify and or breach its legal and regulatory compliance obligations which could result in financial sanctions and reputational damage. Strategies to mitigate this risk are:

PWC will implement an improved governance and compliance framework to ensure ongoing alignment with the utilities Commission's compliance Framework and Reporting Guidelines and ISO/Australian standards for compliance management.

- **Environmental Harm:**

Due to multiple potential causes, such as fuel spills, cultural heritage impacts, sewerage odours, there are threats which could result in harm to the environment and people, financial, legal and reputational impacts. To mitigate these risks:

PWC will continue to comply with environmental regulation; continue to implement the PWC environmental management system; implement the Darwin Region Waste Water Management Strategy and support the NTG to pursue the 50% renewable energy target.

1.3 PWC Environmental Management Policy

PWC's vision of being recognised as a 'performer in environmental management' is further defined in the Policy and PWC has committed to being recognised as a solid performer in environmental management within 5 years.

Protecting the health and wellbeing of staff, contractors, general public and the environment is one of PWC's core values. In demonstrating commitment to this value PWC is focused on minimising our own adverse environmental impact and implementing programs to reduce resource use.

PWC aim is to exceed our compliance obligations by adopting an approach of continual improvement. This approach is the backbone of Australian and International standards in terms of management of environmental, safety, and quality risk. The PWC Environmental Management System is progressively being implemented through the PWC Environmental Strategy, Policy and Procedures.

Our mission is to be recognised as a respected utility provider to the community. To achieve these outcomes PWC's environmental policy commitment is that it will:

- Comply with legislation, standards and industry codes of practice relevant to the Corporation.
- Prevent pollution and minimise waste as much as is practicable to do so.
- Minimise any adverse impact on the environment from operations and activities.
- Ensure employees and contractors have the necessary information, training and supervision to meet regulatory requirements and PWC's environmental expectations.
- Undertake regular monitoring and strive for effective continuous improvement of environmental systems and processes.
- Develop and review meaningful objectives and targets in line with the Statement of Corporate Intent to measure performance.
- Ensure this policy is actively communicated, displayed and made available to employees, relevant stakeholders and the public.
- Ensure employees understand how their individual actions can make a difference and will work together to continually improve our environmental performance.
- Periodically review this policy so that it remains relevant and appropriate to the Statement of Corporate Intent.

1.4 Provision of Sewerage Services

While all commitments in the Statement of Corporate Intent and the PWC Environmental policy are important, commitments to complying with legislation, preventing pollution and minimising waste as much as is practicable and minimising any adverse impacts on the environment from operations and activities are of particular relevance to managing the impacts of the LWwTP discharge.

Power and Water Corporation (PWC) is responsible for the provision of services for the collection, treatment and disposal of treated wastewater in communities across the Territory.

Contact with untreated sewage is a major public health risk, in the Northern Territory, Power and Water has primary responsibility for the provision of sewerage services to Territory community. The LWwTP receives and treats wastewater from residential and commercial premises in central Darwin and the inner suburbs of Larrakeyah, the Gardens, Parap, Stuart Park, Fannie Bay, Ludmilla, Coconut Grove, Nightcliff and Winnellie (see Figure 1). Ludmilla WwTP is PWC's only wastewater treatment facility operating exclusively as a treatment plant; all other PWC wastewater treatment facilities in the NT provide at least secondary treatment through the incorporation of waste stabilisation ponds into the treatment process.

Once treated the effluent is discharged to the environment via the authorised discharge points. In 2018/2019 more than ninety nine percent of the total effluent was discharged to Darwin Harbour via the East Point intertidal outfall, when the inflow exceeds the transfer capacity of the East Point rising main, excess treated effluent was discharged to Ludmilla Creek via a constructed drain. Signs are in place at East Point and Ludmilla Creek to warn of the potential risks associated with exposure to treated effluent.

LWwTP provides a centralised facility for the treatment of sewage, reducing the public health risk within communities located in the Ludmilla, Winnellie, Coconut Grove and CBD sewerage catchments. The treatment plant provides a treatment barrier that prevents direct faecal contamination of receiving waters consistent with the NHMRC (2008).

2 Ludmilla Wastewater Treatment Plant

The Ludmilla Wastewater Treatment Plant (LWwTP) was commissioned in 1977 and underwent a \$25 million upgrade in 2012 to allow for the additional inflow of wastewater following the closure of the Larrakeyah Outfall in May 2012. The upgrade works were completed in December 2012 and commissioned during between January 2013 and June 2014.

The 2012 upgrade to LWwTP expanded the plant's hydraulic and chemical treatment capacity to cater for an average dry weather inflow (ADWF) of 17.5 mega litres (ML) per day, representing a connected equivalent population of approximately 57,000 meeting the community's needs until at least 2030.

The LWwTP provides primary treatment including screening, odour control by disinfection through chlorination and chemically assisted sedimentation using polymer and coagulants to reduce the suspended solids, pathogen and chemical contaminant content of the wastewater prior to disposal to Darwin Harbour via the East Point Outfall (EPO). Biosolids produced from sedimentation are dried by centrifugation, liquid returned to the treatment process and biosolids transported off site for further treatment. During periods of high inflow or in emergency events, excess treated wastewater may be discharge to Ludmilla Creek.

sensitive species the Monitoring and Management Plans approved by the Commonwealth Minister for the Environment continue and are used to assess the environmental impact associated with the discharge (CEE 2018 and CEE 2019 and PWC 2018).

Options for reducing the environmental impact zone include outfall relocation to a subtidal location and further enhancement of the treatment efficiency to reduce contaminant loads.



Figure 2: Ludmilla Wastewater Treatment Plant Dick Ward Drive Ludmilla

2.1 Ludmilla Wastewater Treatment Plant Discharge Licensing

While the wastewater treatment process reduces the public health and environmental risks associated with the discharge of treated wastewater (The Activity) risks to the declared Beneficial Uses remain; unless authorised under provisions of the *Water Act*, discharges are considered as pollution of waters.

The discharge of treated wastewater from the LWwTP is authorised through provisions of a Waste Discharge Licence (WDL) under provisions of Section 74 of the *Water Act 1992* (NT).

The *Water Act 1992* (NT) prohibits a person from allowing waste to come into contact with water or to pollute waters, except where specifically authorised to do so through the granting of a Waste Discharge Licence (WDL).

Under the *Water Act*, to pollute means to directly or indirectly alter the physical, thermal, chemical, biological or radioactive properties of the water so as to render it less fit for a prescribed beneficial use for which it is, or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to public health, safety or welfare; animals, birds, fish or other aquatic life or other organisms; or plants.

The current licence applying to the LWwTP is WDL 150-06, issued on 1 November 2018. The licence specifies a number of general and specific requirements for PWC as the Licensee in relation to the Activity.

In addition to provisions associated with the WDL issued in accordance with the *Water Act*, provisions of the *Waste Management and Pollution Control Act 1989* (NT) (WMPC Act) apply. Section 12 of the WMPC Act assigns responsibilities and obligation to prevent or minimise pollution arising from an

action or activity. In fulfilling its statutory obligations PWC's compliance and governance framework and Environmental Policy acknowledges that activities must be undertaken in compliance with the legal framework applying in the Northern Territory, including the requirements of any licence issued under the *Water Act* and with the General Environmental Duty as specified in the WMPC Act.

2.2 Discharge Licence Provisions

General Conditions of WDL150-06

Except as expressly provided for in the Licence the Licensee must not:

- cause environmental harm either directly or indirectly;
- cause waste to come into contact with water; or
- cause water to be polluted.

Without limiting the conditions of the licence, in conducting the activity, the licensee must do all things reasonable and practicable to:

- Prevent or minimise the likelihood of pollution occurring as a result of, or in connection with, the activity;
- Prevent or minimise the likelihood of environmental harm occurring as a result of, or in connection with, the activity;
- Effectively respond to pollution and the risk of pollution occurring as a result of, or in connection with, the activity;
- Effectively respond to pollution and the risk of pollution occurring as a result of, or in connection with, the activity; and
- Apply the principles of ecologically sustainable development.

This is, in effect, a restatement of the General Environmental Duty that applies to all persons under the WMPC Act.

WDL 150-06 Specific Condition Requirements

WDL150-06 includes a number of amendments to conditions compared to WDL150-05 and these changes have been considered in preparing this document.

Most changes are not substantive and represent a change in condition numbers or minor wording changes, these changes will not be discussed however the requirements remain in the Goals.

A number of new conditions and reworded conditions are included below and will be specifically within the management goals where there is the need to modify programs to accommodate the change.

Condition 17: requires that:

The Licensee must ensure that any plant or equipment used in conducting the activity:

- 17.1 Is reasonably fit for purpose and uses to which it is put;
- 17.2 Is maintained; and
- 17.3 Is operated by a person trained to use the plant and equipment.

Condition 22; 23 and 24: specify that:

The licensee must conduct surface water monitoring; sediment and biota monitoring in accordance with Appendix 1; Appendix 2 and Appendix 3 respectively

The appendices specify the sampling frequency, location and assessment and reporting criteria applicable to the licence.

Appendix 4 (figure 3 below) shows the monitoring site locations applicable to the licence.

Condition 38 requires that:

"The Licensee must progress implement and comply with the actions identified in the Ludmilla Wastewater Treatment Plant WDL150-05 Improvement Plan 2017.

Condition 39 requires that:

The licensee must submit an updated Ludmilla Wastewater Treatment Plant WDL150-05 Improvement Plan by 30 June 2019.

Condition 40 requires that:

The updated performance improvement plan must include:

- 40.1 actions that will be undertaken towards achieving full design capacity of 1000 L/s to the East Point Rising Main to reduce the likelihood of discharges to Ludmilla Creek; and
- 40.2 detailing reasonable and practicable measures that the licensee will undertake to improve the discharge quality and/or discharge location in order to achieve the water quality discharge objectives for Darwin Harbour, insofar as background water quality (i.e. water quality that would prevail in the absence of any discharge from the Ludmilla Wastewater Treatment Plant) allows.

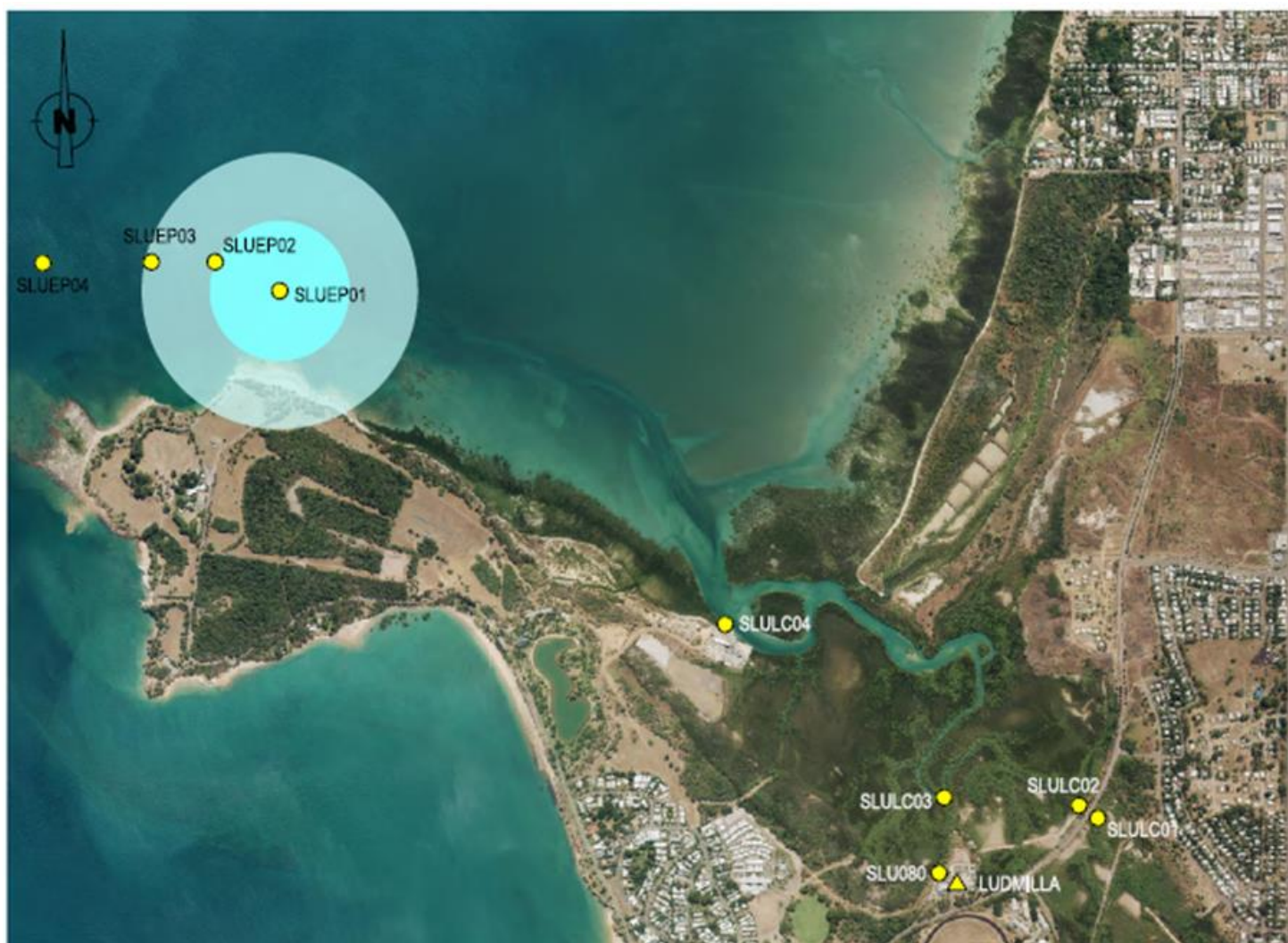


Figure 3: Ludmilla WwTP and East Point Outfall location map

3 Ludmilla Wastewater Treatment Plant Impacts

3.1 Discharge Characteristics

Wastewater characteristics at Ludmilla WwTP are influenced by both the influent sewage characteristics and the efficacy of treatment processes within the plant. The chemical characteristics of both the influent and effluent are detailed in Tables 1 in Appendix 2.

Between July 2011 and May 2019 approximately 89.7% of the total LWwTP discharge occurred via the East Point Outfall with approximately 10.3% discharging to Ludmilla Creek and only 1.8% of the discharge to Ludmilla Creek occurred during the dry season. (Figure 4) (PWC 2018a; PWC monitoring data 2011 to 2019).

The treatment process reduces the contaminant load from the influent to the discharge quality, some residual environmental and public health risk may still be associated with the discharge (PWC 2018a and 2018b).

Figure 3 shows that the volume of wastewater received and treated effluent discharged has increased following the closure of the Larrakeyah Outfall in May 2012, however Table 1 shows that over the period from 2011-12 to 2015-16 the upgrade of the treatment process at the LWwTP commissioned in 2013-2014 has reduced the overall contaminant load discharged to Darwin Harbour from the LWwTP (PWC 2016c). The improved effluent quality coupled with the redirection of the Larrakeyah Outfall effluent to Ludmilla for treatment represents an even greater reduction in the contaminant load discharged to Darwin Harbour than shown by the LWwTP data.

Discharge volumes:

The influent and effluent volumes for the Ludmilla WwTP display a distinctive seasonal pattern associated with rainfall in the sewerage catchment and infiltration of stormwater into the sewerage system.

In the period from July 2018 to 31 May 2019 99.59% of the total discharge was to Darwin Harbour via the East Point Outfall compared to 98.49% for the period from July 2016 and 92.05 for the period from June 2012 to 31 May 2019 (Larrakeyah outfall closure). For the 2018/19 dry season 99.79% of the discharge from the LWwTP was via the East Point Outfall compared to 99.89% for the period from July 2016. The wet season 2018/19 discharge was 99.51 % to Darwin Harbour via the East Point Outfall compared to 97.99% for the period from July 2016. The almost 2% reduction in discharges to Ludmilla creek during the 2018/2019 dry season reflect the low frequency of significant rainfall events during this period. While small overflow events did occur to Ludmilla Creek during the 2018/2019 wet season these do not reflect the monsoonal event of previous wet seasons (see Figure 4).

During the period from August 2016 onwards the conditions under which discharges can occur to Ludmilla Creek has increased from 300 L/sec to the current inflow rate of 900 L/sec. During this period the percentage of total inflow going to Ludmilla creek has reduced from 7.7 percent to 1.55 percent of the total discharge and from 1.64 percent of dry season discharge to 0.017%. This represents a significant discharge that cannot be attributed to the poor 2018/19 wet season alone. It is unclear how much of a further reduction will occur in going from 900 L/sec to 1000 L/sec.

Discharge loads:

Between the 2011-2012 financial year and the 2017-18 financial years there have been an 11% increase in inflow to the Ludmilla WwTP and a 1.9% increase in the total effluent discharged. During the same period the discharge to Ludmilla Creek has reduced by 78%. (PWC 2018 a)

The improved treatment capacity has resulted in a reduction in the loads of the majority of contaminants discharged including reductions of 13% for ammonia (free); 30% for total nitrogen; 67% for total phosphorus; 69% for suspended solids; 64% Cu; and 74% Zn. The only contaminants to increase over this period was oxides of nitrogen which increased by 69% from 0.59 tonnes per year to 1.0 tonnes per year. For most contaminants the improvements in treatment performance continued from the period following commissioning of the treatment plant upgrade which concluded in June 2014.

Water Quality:

The 2018 Licence Report (PWC 2018a) and Environmental Risk Assessment (PWC 2018b) show the water quality and environmental risk to the declared Beneficial Uses associated with the discharge from the LWwTP to Ludmilla Creek and East Point. Key findings are summarised below.

The dissolved oxygen levels at the upstream site in Ludmilla Creek are consistently significantly below the site-specific trigger value of a minimum level of 80% saturation however this was not associated with discharges from the treatment plant as the highest percent saturation at the site were during the periods of discharge to the creek.

The pathogens indicators (E. coli and enterococci) are above the levels for the protection of the declared beneficial uses of swimming (cultural) and food collection and food production in Ludmilla Creek and at the East Point Outfall.

All monitoring sites exceeded at least one of the secondary nutrient objectives; the only site exceeding the primary objective (chlorophyll-a) was the Ludmilla Creek discharge point site where the chlorophyll-a level of 4.58 µg/L exceeds the Darwin Harbour water quality objective (median in mid-estuary creek of 4 µg/L).

Copper and ammonia exceed the objectives for slightly to moderately disturbed ecosystems (95% species protection) in the effluent channel (SLu080) and at the East Point Outfall (SLuEP01); both contaminants meet the disturbed ecosystem (90% species protection levels) at the outfall.

Sediment and pore water:

All sediment samples met the ANZECC ISQG-Low criteria for toxicants and where no guidelines exist (sediment nutrients) all samples were below the twice the 80th percentile of reference sites value.

Ammonia in pore water remains elevated at the East Point Outfall however all sites were lower than in previous sampling events. Copper and zinc met the ANZECC 95% species protection levels at all sites.

Ecotoxicology:

An assessment of effluent toxicity was conducted in September 2018 and it was identified that to obtain a 95% species protection level a dilution of 1:17.5 is required.

Treated effluent from the Ludmilla WwTP remains toxic, as both ammonia species and copper are above the 95% species protection level in the effluent it is possible that this is a factor in the toxicity. The 2018 results have improved from requiring a 1:80 dilution in 2014, in 2018 to meet no effects a 1:29 dilution is required.

The Benthic infauna:

In 2018 Benthic infauna and seagrass was monitored in accordance with the approved BIMMP monitoring and management plan (EPBC 2009-5113). The 2018 monitoring program was conducted in April (wet season) and September (dry season) and the report is in preparation and is yet to be received from the contractors. The report will be provided once it is approved for submission by the independent technical assessor.

Monthly inflow and outflow data for Ludmilla Wastewater Treatment Plant 1 July 2011 onwards

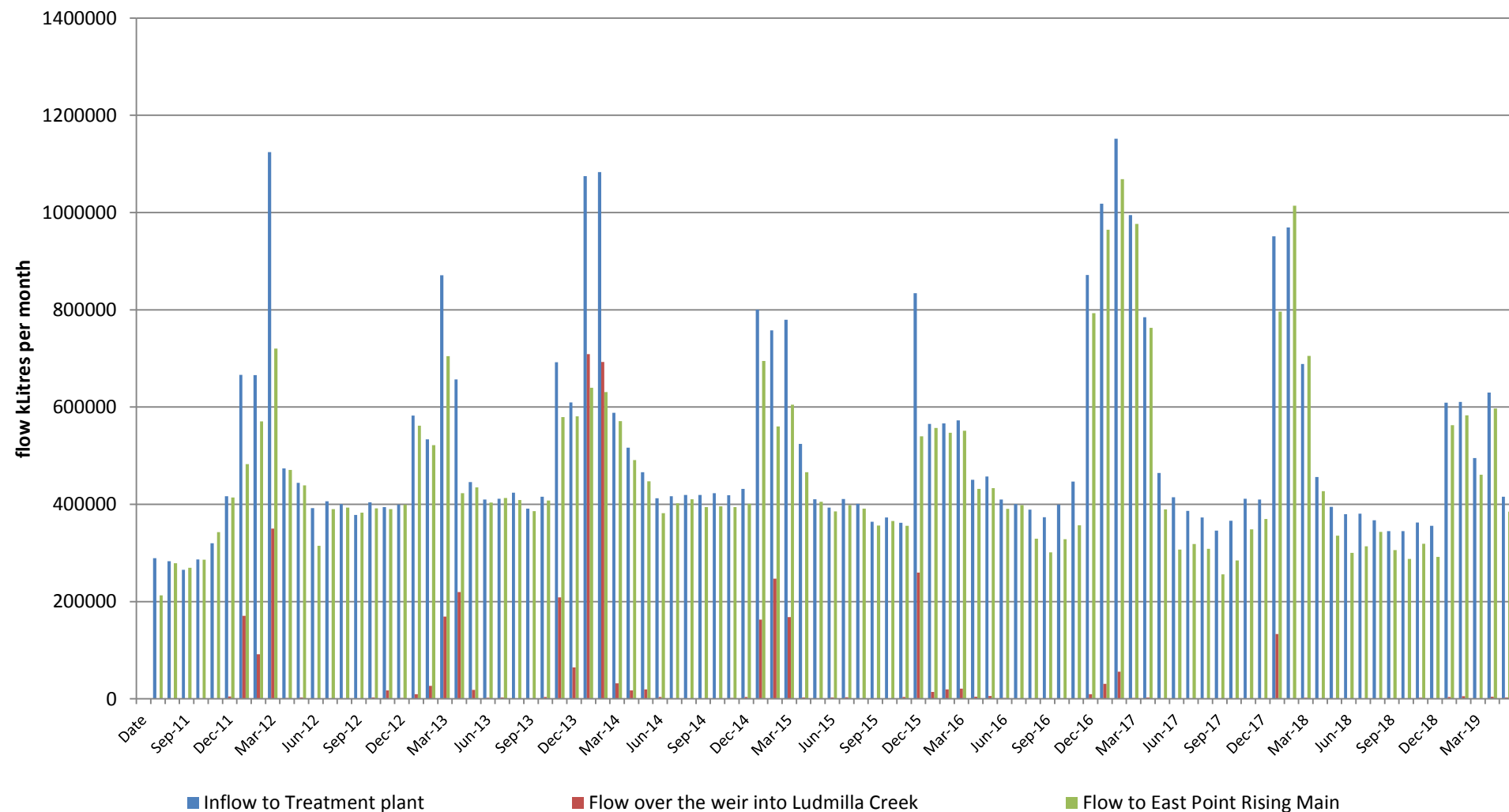


Figure 4: Monthly Inflow and Outflow Ludmilla WwTP August 2011 to May 2019 (Source: PWC discharge data to 31 May 2019)

3.2 Discharge Environment

The majority of the discharge from the LWwTP enters Darwin Harbour via the East Point Outfall (EPO) (Figure 3 and PWC 2018a and PWC 2018b). The EPO discharges to the intertidal zone approximately 350 metres from the northern shoreline of East Point. The immediate vicinity of the EPO consists of intertidal sand and mud-flats, with inshore rocky reefs and sparse ephemeral seagrass beds within 500 metres of the outfall.

A secondary discharge point enters Ludmilla Creek via a concrete lined drain running along the western boundary of the LWwTP. Ludmilla Creek is a tidal creek in the wet season and a tidal inlet in the dry season. The creek is fringed by an intact mangrove forest from the discharge point to upstream of Dick Ward Drive and downstream to the creek mouth where the sandbanks line the creek providing migratory bird habitat.

As indicated in Figure 3 the overwhelming majority of discharges to Ludmilla Creek occur during the wet season when inflow to the treatment plant is above 300 L/sec due to infiltration and inflows from the catchment into the sewerage system. During the wet season catchment inflow to Ludmilla Creek results includes significant freshwater inflow from the Narrows Catchment, the upper reaches of the tidally influenced section of the creek is to just downstream and to the east of Namarluk Drive. Monitoring during 2015 indicated that the catchment inflow during the wet season were a significant source of contamination with pathogen indicators considerably higher than discharge.

The East Point Outfall discharges into the intertidal zone; under very low tide conditions the effluent forms a channel providing no dilution of the discharge. An environmental impact statement assessing options for relocating the outfall to a subtidal location which will allow for more effective dilution and dispersal is currently on hold due to budgetary considerations and therefore options to improve the hydraulic and treatment performance within the plant are the current focus for impact reduction.

In the four year period following the development of the Ludmilla Wastewater Treatment Plant Management Goals 2015 (PWC 2015 a) relevant strategies for the protection of Darwin Harbour have not change. The background information provided in PWC 2015a will not be repeated here and the management aims and methodology for their determination remain as stated in LWwTP Management Goals 2015 and are restated in the 2017 and 2019 Management Goals (PWC 2015 a; PWC 2017a and PWC 2019).

The key requirement is that the Management Goals for the discharge must be consistent with the licence requirement to 'do all things reasonable and practicable in conducting the Activity to not adversely affect the Declared Beneficial Uses and objectives as declared from time to time for the Darwin Harbour Region'.

The receiving waters into which the LWwTP discharges and the discharge location and relevant Declared Beneficial Uses and Water Quality Objectives remain unchanged from those described in PWC 2015a and in the various risk assessments prepared in relation to the discharge.

As indicated in PEC 2015a the NWQMS (ANZECC 2000) defines three levels of protection:

High conservation or high ecological value systems (99% species protection):

essentially intact ecosystems, effectively unmodified, typically in national parks or conservation reserves;

Slightly to Moderately disturbed systems (95% species protection):

ecosystems in which the aquatic biodiversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically marine ecosystems adjacent to metropolitan areas;

Highly disturbed systems (80% species protection):

measurably degraded ecosystems of lower ecological value, they may retain some ecosystem values or may, after rehabilitation have ecological or conservation values.

The level of protection is a level of quality desired by stakeholders and implied by the selection of management goals and water quality objectives. The current criteria as specified in Appendix 1 of the licence is to define all elements of the receiving environment, including the East Point Outfall as

slightly to moderately disturbed, the inclusion of this designation for the outfall is not consistent with the ANZECC Water Quality Guidelines definitions and while the designation of 80% species protection at the outfall is not supported by the monitoring data, the area is disturbed (90% species protection), this is unsurprising following more than 40 years of discharge.

The monitoring data and the selection of water quality objectives for the waters of Darwin Harbour (NRETAS 2010) support the belief that beyond the immediate impact zone for the outfall Darwin Harbour Saline waters are most accurately described as a 'Slightly to Moderately' disturbed system. This is consistent with the assessment of Darwin Harbour as being measurably impacted by human activity but with largely intact ecosystem.

4 Declared Beneficial Uses and Water Quality Objectives

4.1 Beneficial Uses

Darwin Harbour in the vicinity of East Point is the receiving waters for the LWwTP and the high inflow discharge goes to Ludmilla Creek downstream of Dick Ward Drive.

The upstream site in Ludmilla Creek is considered to have an 'Upper Estuary' type water quality (residence time >32 days) and all other sites are considered to represent the 'Mid-Estuary' water type within the Darwin Harbour, saline waters region.

The Beneficial Uses declared in 2010 (NTG G27 7 July 2010), under Section 73(1) of the Water Act, for the Darwin Harbour Region, saline waters between Gunn Point and Charles Point inclusive of Ludmilla Creek and the waters adjacent to East Point, bounded by the upper limits of the high water mark of tidal waterway are: Environment; Cultural; and Aquaculture

4.2 Water Quality Objectives

The Beneficial Use declaration also specifies the objectives which apply in relation to water quality in the Darwin Harbour Region. The objectives are those specified in tables 8 and 9 of the report 'Water Quality Objectives for the Darwin Harbour Region Background Document (DHWQO)' and where an objective is not specified in the above report the objectives of Chapters: 3; 4; and 5 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) 2000 triggers apply. The NWQMS (ANZECC 2000) defines three levels of protection:

High conservation or high ecological value systems: essentially intact ecosystems, effectively unmodified, typically in national parks or conservation reserves;

Slightly to Moderately disturbed systems: ecosystems in which the aquatic biodiversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically marine ecosystems adjacent to metropolitan areas;

Highly disturbed systems; measurably degraded ecosystems of lower ecological value, they may retain some ecosystem values or may, after rehabilitation have ecological or conservation values.

Darwin Harbour Saline waters are generally described as a '**Slightly to Moderately**' disturbed system. This is consistent with the assessment of Darwin Harbour as being measurably impacted by human activity but with largely intact ecosystems.

4.3 Darwin Harbour Water Quality at East Point

The Ludmilla WWTP licence monitoring reports (PWC 2017b and PWC 2016c) and the 2016 and 2018 Environmental risk assessment (PWC 2016; PWC2018b) and the Benthic Infauna Monitoring and Management Plan (PWC 2016a) and Benthic Infauna Monitoring Report 2018 CEE 2018) and Water Quality Monitoring and Management Plan (PWC2016b) and Environmental Risk Assessment (PWC 2018b) indicates that at PWC monitoring sites in Darwin Harbour, including the East Point Outfall all Darwin Harbour Water Quality Objectives (DHWQO) are met for physico-chemical indicators (NRETAS 2010). The ANZECC 2000 95% species protection toxicant triggers for copper and ammonia are exceeded at the East Point Outfall, where the triggers for a 'Moderately Impacted' ANZECC 90%

species protection are met. All other Darwin Harbour sites meet the 'Slightly to Moderately' impacted water quality triggers (95% species protection) for all assessed toxicants.

All Darwin Harbour sites meet the DHWQO for chlorophyll-a, however nutrient objectives are not met at the East Point outfall for filtered reactive phosphorus, total phosphorus, ammonia, total nitrogen or nitrates and in the receiving waters the total phosphorus objective is not met at any site, including the offshore reference site which is not impacted by the discharge. The WQMMP monitoring indicates that total nitrogen is exceeded at one site (SLuEP07) and filtered reactive phosphorus was exceeded at two sites (SLuEP07 and SLuEP09) both to the northwest of the outfall and out of the plume dispersion path.

Pathogen indicators were exceeded at the East Point Outfall with the enterococci data indicating the water quality is not suitable for swimming and the E.coli data indicating the water quality of the effluent is not suitable for aquaculture. All other Darwin Harbour sites met all pathogen objectives.

4.4 Ludmilla Creek Water Quality

The 2017 licence report (PWC 2017b) indicates that, despite less than 6% of the total discharge being to Ludmilla Creek and approximately 0.3% of the discharge occurring to the creek in the dry season, water quality in Ludmilla Creek was poor. Beneficial Uses are therefore not fully protected in the creek with water quality unsuitable for swimming at all Ludmilla Creek monitored sites; unsuitable for aquaculture upstream and at the discharge point. The poor water quality does not correlate to discharges from the treatment plant and is more closely associated with catchment inputs.

The 2017 and 2018 Licence monitoring report (PWC 2017b and PWC 2018a) reported consistently poor water quality at the Ludmilla Creek upstream site, with dissolved oxygen levels consistently below the site specific trigger values and at times below the toxic threshold of 30% saturation. The monitoring reports and risk assessment confirm that the poor water quality in Ludmilla Creek, including at the upstream site is unrelated to discharges from the LWwTP.

All Ludmilla Creek sites exceeded the DHWQOs for TP and the ANZECC low reliability triggers for arsenic, discharge and upstream ammonia, FRP; TN. The discharge point in Ludmilla Creek exceeded the DHWQO for chlorophyll-a indicating phytoplankton growth however the increases in chlorophyll-a did not correlate to periods following discharges to the creek.

Discharge data indicates that the poor water quality in Ludmilla Creek was similar to other urban catchment creeks and was generally not associated with the LWwTP discharge to the creek.

5 Management Goals for the LWwTP Discharge

Consistent with the PWC Statement of Corporate Intent 2019-20 PWC is committed to providing safe and reliable wastewater treatment services at least cost over the life of the asset, to our customers. There is also a strong corporate commitment to being compliant with all legal obligations. The framework that guides the management of the LWwTP is to:

Provide safe and reliable sewerage services by operating the LWwTP to provide an effective barrier that prevents direct faecal contamination of the receiving waters of Darwin Harbour and Ludmilla Creek.

Provide a sewerage service that is consistent with the NWQMS (ANZECC 2000) process in that the discharge of treated wastewater occurs under a strategy that is accepted by the community after considering social, economic and environmental factors.

To meet PWC's Environmental Management Policy the discharge from the LWwTP is managed to ensure that impacts associated with the licensed activity are minimised and management of the discharge is undertaken within the legal framework provided by the licence.

Meeting the legal framework provided by the licence requires PWC to meet their General Environmental Duties under Section 12 of the W MPC Act (NT) 1998 W MPC Act) and conditions of the Waste Discharge Licence issued under Section 74 of the Water Act.

The management objective and management goals for the LWwTP discharge sit beneath the overarching legal obligations for PWC to provide an effective wastewater treatment system to

minimise the risks to public health associated with people coming into contact with untreated wastewater.

The Management Objective for the activity (the discharge of treated wastewater) from the LWwTP is for the discharge to be compliant with all legal requirements of the Waste Discharge Licence.

To achieve this PWC has the following goals:

Management Goal 1: Beyond the immediate vicinity of the 'authorised discharge points' identified in the Waste Discharge Licence, the discharge will cause no harm to public health or to the declared Beneficial Uses for which the waters may reasonably be expected to be used.

Except as expressly provided for in WDL150-06 PWC will:

- not cause environmental harm either directly or indirectly;
- not cause waste to come into contact with water; or
- not cause water to be polluted.

For the LWwTP discharge this means that, as far as is reasonable and practicable and except as permitted by Waste Discharge Licence 150-06 the discharge will not cause pollution or as to render the water less fit for a prescribed beneficial use for which it is or may reasonably be used, or to cause a condition which is hazardous or potentially hazardous to, public health, safety or welfare; animals, birds, fish or aquatic life or other organisms; or plants.

As far as is reasonable and practicable the treatment plant will be managed to maintain water quality triggers in the discharge within levels demonstrated through benthic infauna monitoring to have minimum measureable impacts in the receiving environment beyond the immediate discharge zone.

Management Goal 2: The impact zone for the East Point Outfall discharge is maintained as no greater than the previously identified primary impact zone of a 250 metre radius around the outfall and reasonable and practical steps will be undertaken to progressively reduce the size of the impact zone.

PWC will do all things reasonable and practicable to ensure the discharge of wastewater from the LWwTP does not adversely affect the Declared Beneficial Uses and objectives applying to the saline waters, mid and outer estuary zone of the Darwin Harbour Region.

In managing the activity to ensure the activity does not adversely impact on the declared Beneficial Uses, consideration of options to reduce the zone of influence include consideration of options for the relocation of the East Point Outfall to a subtidal location or hydraulic or treatment improvements.

Any proposed for relocation of the outfall is subject to the budgetary constraints associate with NT budget repair program and with requirements of the Environmental Impact Assessment process which will consider the environmental, social and economic factors associated with moving the outfall or, alternatives to maintain or potentially reduce the risks associated with the increase in wastewater discharged via the current intertidal outfall. The zone of influence will continue to be monitored.

Management Goal 3: Discharges only occur via the authorised discharge points.

PWC will manage the LWwTP discharge in accordance with the requirements of WDL150-06, to ensure that, where reasonable and practical discharges only occur via the authorised discharge points of East Point Outfall and the overflow weir to Ludmilla Creek (Condition 18). PWC will ensure that monitoring systems are maintained to provide early warning of potential non-compliant discharges to ensure discharges only occur via the authorised discharge points.

Management Goal 4: Discharges to Ludmilla Creek will only occur following periods of wastewater inflow above the East Point rising main discharge capacity.

PWC will, as far as is reasonable and practicable, manage the LWwTP to ensure that discharges to Ludmilla Creek only occur when inflow to the treatment plant is above 900 L/sec as specified in Conditions 20 of the licence.

5.1 Progress towards meeting management goals:

Monitoring data for East Point Outfall, Ludmilla Creek and Darwin harbour indicates that the effluent discharged via the East Point Outfall met the water quality objectives specified in the WDL150-05 however changed assessment requirements in WDL 150-06 have designated the outfall to be a **'slightly to moderately impacted'** environment requiring compliance with 95% species protection criteria, while simultaneously designating chronic exposure criteria to be used as acute impact assessment criteria. Power and Water consider this to be an inappropriate classification and inconsistent with the application of the ANZECC Water Quality Criteria and the Darwin Harbour Water Quality Objectives and a request to amend has been made as the designation cannot be complied with and it is neither reasonable nor practicable to implement plant upgrades that would allow compliance. The risk to the protection of the declared Beneficial Uses is low as the impact is localised and limited to low tide conditions as water quality, sediment and benthic infauna monitoring indicate that beyond 200 metres from the outfall all water quality objectives are met to at least the 95% species protection level and within the immediate vicinity of the outfall water quality meets the criteria for a moderately impacted environment (90% species protection) for ammonia and copper with all other parameters meeting the background water quality objective for Darwin Harbour of 95% species protection (slightly to moderately impacted) which is considered to be typical of waterways adjacent to urban environments. During the WDL150-05 licence period Darwin Harbour Water Quality Objectives; NHMRC Guidelines for the protection of recreational waters and ANZECC objectives were not met at the East Point Outfall or in Ludmilla Creek therefore at the East Point Outfall and in Ludmilla Creek the Management Goals were not met (PWC 2018a).

6 Improvement Plan Actions:

Tables 1 and 2 below include actions proposed to improve the performance of the Ludmilla Wastewater Treatment Plant and progressively reduce the impact of the Activity on the receiving environments of Darwin Harbour at East Point and Ludmilla Creek. Actions are split across two tables with Table 1 being PWC commitments to implement Darwin Harbour Water Quality Protection Plan (DLRM 2014) actions and Table 2 focusing on improved hydraulic and treatment of the LWwTP.

The implementation of the Improvement Plan will assist in meeting the objectives of the Ludmilla Wastewater Treatment Plant's management goals which are summarised above and are discussed in the WDL150-06 Ludmilla WwTP Management Goals Report 2019-20 (PWC 2019a).

In 2014 the Department of Land Resources Management released the Darwin Harbour Water Quality Protection Plan, the Plan included a number of actions to be implemented by PWC, and progress against these actions is listed in Table 1.

To accommodate the additional wastewater treated at Ludmilla following the closure of the Larrakeyah Outfall in May 2012 the Ludmilla Wastewater Treatment Plant was upgraded in 2012 and commissioned in 2013.

To meet the increased hydraulic load requirements the Territory and Commonwealth Government approval to augment the East Point rising main and associated pumping infrastructure was received in 2013 and works completed in 2015 with final approval to commission the works received from the Commonwealth Department of Environment in August 2016.

The program to commission the pumps and rising main commenced in 2016 and in the 2017 wet season a number of defects were identified with the main yet to achieve the design performance criteria specified of 1000 litres per second. Actions identified by an independent review of the hydraulic performance of the main and pumping infrastructure are being progressively implemented with the objective of meeting the design criteria. Reasonable and practicable actions have been included in the implementation plan and listed in Table 2 and will be implemented within budgetary and resourcing constraints which may, from time to time, alter organisational priorities.

This improvement Plan is submitted in response to the requirements of Condition 43 of the discharge licence and is provided as evidence of compliance with this licence requirement. Implementation will be ongoing throughout the licence period with some actions extending beyond the 2 year licence.

Table 1: Darwin Harbour Water Quality Protection Plan (DHWQPP) 2014: Power and Water Actions

Action	Action Area DHWQPP	Action Progress	Time Frame	Complete/ongoing	= ✓
				In progress	= ✓
				No progress, reprioritised	= ✗
				Action is not applicable and will not be progressed for this site	= NA
No.	Water Management Actions Identified			Status	
1.1	Site Specific Trigger Values	Developed 2014 and ongoing implementation via WDL 150-03 and included in EPBC 2009/51113 approved Water Quality Monitoring and Management Plan 2016	Ongoing	✓	
1.2	Routine Water Quality Monitoring (Aim: to assess impact zone and ensure no increase in zone of impact: Compliance with WDL and WQMMP)	Ongoing since 2011: WDL program 4 Creek and 3 East Point ongoing since 2012 ensure licence compliance (Figure 2)	Ongoing	✓	
		Water Quality Monitoring and Management Plan: compliance assessment for East Point Outfall 12 sites (PWC 2018b)	Ongoing	✓	
1.3	Targeted Sediment Monitoring	Ongoing since 2012	Ongoing	✓	
1.4	Routine Biota monitoring (Aim: to define the zone of impact on the protection of beneficial uses and sensitive receptors: Compliance with WDL and BIMMP and WQMMP)	Ludmilla Creek: Infauna; Stable isotopes and bioaccumulation	2014-2016	Completed	
		East Point: Benthic Infauna Monitoring and Management Plan (Environmental Approval 72 and EPBC 2009/5113).	2014 ongoing	✓	
		East Point Stable Isotopes	2014 to 2016	Completed	
		East Point Toxicity	2013 ongoing	✓	
		Bioaccumulation	2014 to 2016	Completed	
2	Hydrodynamic model (Aim: understand impact zone)	East Point: dye study and Hydrodynamic model developed and ongoing application in East Point Outfall EIS	Ongoing	✓	
3	Assessment of condition of local waters receiving sewage treatment plant discharges	Monitoring reports prepared annually that benchmark water quality to SSTVs and default Darwin Harbour water quality objectives	Ongoing	✓	
4	Darwin Regional Sewage Strategy	PWC is developing a Darwin Region Sewerage Strategy with progress occurring on a catchment by catchment basis. The strategy will document the vision for wastewater treatment, disposal and recycling reforms to a 2030 planning horizon. The strategy will:: Provide capacity for a growing population and industry base; Improve the performance of the region’s wastewater treatment and disposal facilities; and Reduce potential impacts on the environment from sewerage operations.	Strategy development continues on a sub-catchment basis with Ludmilla catchment scheduled for 2010/21	✓	

Action	Action Area DHWQPP	Action Progress	Time Frame	Complete/ongoing	= ✓
				In progress	= ✓
				No progress, reprioritised	= ✖
				Action is not applicable and will not be progressed for this site	= NA
7	Living Water Smart Program	Program to reduce water use and effluent discharge volume	ongoing		✓
8	Sludge and Biosolids management strategy	Biosolids Management Strategy developed and submitted to DENR (NT EPA) for endorsement: PWC Management Strategy and Site Action Plans in preparation; NT Code of Practice in preparation (GHD for DENR and PWC)	Ongoing:		✓
9	Contribute to Integrated monitoring in Darwin Harbour	Ongoing contribution to program through membership of Darwin Harbour Integrated Monitoring Program	Ongoing		✓
		Ongoing provision of data to Darwin Harbour Report Card	Ongoing		✓
PWC	Infrastructure Management Action				
3.1	Larrakeyah Closure Plan implementation	Redirect wastewater from Larrakeyah outfall to Ludmilla	Completed 2012	Completed	
3.2		Upgrade treatment capacity at Ludmilla WwTP	Ongoing	✓	
3.3		Augmentation (Duplication) of East Point Rising Main			
		Construction	Completed 2014	Completed ✓	
		Commonwealth Minister’s Approval to commission main	August 2016	Completed ✓✓	
		Commissioning commenced and defects correction options under consideration for implementation of plant upgrade	ongoing	✓	
3.4		East Point Outfall relocation including Environmental Impact Statement in preparation with technical assessment of options for outfall impact reduction under development to assess environmental, economic and social considerations	On hold	✓	
		Technical assessment of impact reduction options	2018	✓	
		Economic; social and environmental assessment of options	2018	✓	
		Submission of EIS for consideration	2019	On hold	
		EIS decision	2019/20	On hold	
	Implementation of EIS decision	Beyond 2020	On hold		
3.10	Operational improvement plan	Asset management plan for Darwin Sewerage System 2017. Ongoing review and updating.	Dec 2017 ongoing	✓	
		WDL 150-05 Improvement Plan updated: 150-06 this plan	June 2019	✓	
		WDL Improvement Plan implemented	ongoing	✓	

Table 2: Improved Hydraulic and Treatment Performance Ludmilla Wastewater Treatment Plant

Item	Action Area Description and linkages	Action Progress	Timeframes	Complete/ongoing	= ✓
				In progress	= ✓
				No progress, reprioritised due to budgetary constraints	= ✖
				Action is not applicable and will not be progressed for this site	= NA
1	Improved hydraulic performance of the treatment plant and East Point Outfall	Objective: improved hydraulic performance of the Ludmilla WwTP to maintain treatment performance and compliance with discharge licence requirements.			
		Action: Commence commissioning of augmented East Point rising main and associated pump augmentation.	January 2017 and ongoing	✓	
		Action: assess performance for new pumps and augmented East Point rising main against design criteria.	Feb 2017 and Ongoing	✓	
		Action: Identify options to remediate non-conformances and defects through independent expert assessment.	June 2017 and ongoing	✓	
		Action: Subject to budgetary and resourcing constraints develop a program to progressively assess and where appropriate implement reasonable and practicable measures of defect corrections to progress to acceptance of the Augmentation of the East Point rising main and pump augmentation against the design criteria (1000 litres/second)	Dec 2017 and progressive implementation Ongoing	✓	
		Action: Identify, assess and implement reasonable and practicable actions to improve the sewage flow regime into the LWwTP; effluent screening and the removal of gross pollutants, to improve influent pumping, odour control and chemical dosing and improve the hydraulic performance at the inlet.	Dec 2017 and ongoing	✓	
		Action: Develop a Site Specific Asset Management Plan consistent with ISO55000 developed for LWwTP	2019/2020	✓	
	Action: undertake actions to improve effluent flow through the CAS tanks by removing shot-cutting and dead zones	2019/2020	✓		

Item	Action Area Description and linkages	Action Progress	Timeframes	Complete/ongoing	= ✓
				In progress	= ✓
				No progress, reprioritised due to budgetary constraints	= ✖
				Action is not applicable and will not be progressed for this site	= NA
2	Treatment Plant Process Improvement:	Objective: continuous improvement of treatment process to maintain and where necessary increase compliance with WDL150 and health and safety requirements.			
		Action: increased understanding of influent and effluent quality through monitoring and assessment of options to reduce the risk of WDL non-compliance associated with low inflow and outflow periods.	January 2017 and ongoing	✓	
		Action: develop a program to assess options/ opportunities to further improve process performance to ensure continued compliance with WDL 150 licence requirements.	Jan 2018 and ongoing	✓	
		Action: Assess discharge impact and report on implementation of the licence monitoring program and the Water Quality and Benthic Infauna Monitoring and Management Plans.	Jan 2017 and ongoing	✓	
		Action: undertake actions to improve effluent flow through the CAS tanks by removing shot-cutting and dead zones	2019/2020	✓	
		Action: Assess options to improve the chemical performance of the plant with improved chemical treatment to improve contaminant removal	2019/2020 and ongoing	✓	
3	Improved asset management	Objective: to reduce the residual risk of operational failure to no greater than medium.			
		Action: Review the Darwin Regional Asset Management Plan and develop a site specific asset management program of monitoring; inspection and condition assessment consistent with the Darwin Regional Asset Management Plan’s objective of reducing the risks associated with the Ludmilla Wastewater Treatment Plan from high to no greater than medium	Ongoing	✓	
4	Environmental Management Plan developed for LWwTP	Action: to support more comprehensive environmental management of LWwTP; develop a site specific Environmental Management Plan for the plant for the Activity	2019/2020	✓	

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