

Pluto LNG

Five Year Performance Review Report

November 2017 - December 2022

Ministerial Statement No. 757

Pluto Liquefied Natural Gas Development (Site B Option)

Burrup Peninsula, Shire of Roebourne

March 2023

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1. Purpose and Scope

This Performance Review Report has been prepared to meet the requirements of condition 5-1 of the Ministerial Statement 757 *Pluto Liquefied Natural Gas Development (Site B Option) Burrup Peninsula, Shire of Roebourne* (the Ministerial Statement).

Submitted to the Department of Water and Environmental Regulation (DWER) in March 2023, this is the third Pluto LNG Five Year Performance Report and covers the period of November 2017 to December 2022. The reporting period has been updated to align with the calendar year, in-line with other regulatory reporting requirements. The first and second reports covered 2007 to 2012 and 2012 to 2017 periods respectively (reporting periods of November to October).

This report is split into five sections, as required by condition 5-1 of the Ministerial Statement, to address:

1. The major environmental issues associated with implementing the project; the environmental objectives for those issues; the methodologies used to achieve these; and the key indicators of environmental performance measured against those objectives;
2. The level of progress in the achievement of sound environmental performance, including industry benchmarking, and the use of best available technology where practicable;
3. Significant improvements gained in environmental management, including the use of external peer reviews;
4. Stakeholder and community consultation about environmental performance and the outcomes of that consultation, including a report of any on-going concerns being expressed; and
5. The proposed environmental objectives over the next five years, including improvements in technology and management processes.

2. Environmental Issues Associated with Implementing the Project

The development of Pluto LNG was referred to the Western Australian Environmental Protection Authority (EPA) for assessment in April 2006 and the then Commonwealth Department of Environment and Heritage (DEH) in August 2006 (EPBC 2006/2968). The proposed development was determined by the DEH to be a 'controlled action' under the provisions of the Environment Protection and Biodiversity Conservation (EPBC) Act (24 August 2006). The DEH and EPA subsequently determined that the proposed development should be assessed through a Public Environment Report and Public Environmental Review levels of assessment respectively.

The Public Environment Report (PER) identified and discussed possible environmental issues associated with implementing the project (Woodside Petroleum Ltd., 2006). These included treated waste water marine discharge, sea turtle and marine mammal management, air quality, greenhouse gas emissions, dredge impact management, marine quarantine and cultural heritage. These potential environmental issues have not changed since the PER was published and continue to be the focus of environmental management for Pluto LNG.

Woodside developed and continues to maintain management plans which detail how environmental issues are controlled to reduce impacts and improve environmental outcomes. The management plans describe objectives and methodologies used to achieve these, as well as indicators of performance. Over the reporting period, a number of management plans have been updated to support Pluto expansion activities, including the construction and operation of Pluto Train 2, as well as aligning with best practice and national guidelines.

Table 1 summarises environmental focus areas and key management objectives, methodologies for implementation and performance indicators which are detailed in these management plans. For further information relating to management of environmental issues for Pluto LNG, refer to the current version of the management plans, available at:

[Pluto LNG Environmental Compliance Reporting - Woodside Energy](#)

2.1 Management Plan Revisions

Throughout the reporting period, several management plans were updated in line with management plan triggers and new work scopes (e.g. preparation for Pluto Train 2). Compliance with the previous version of the management plans is demonstrated in the Annual Compliance Report for the relevant year, available at: [Pluto LNG Environmental Compliance Reporting - Woodside Energy](#).

Management plans revised during the reporting period are summarised below.

- The Air Quality Management Plan (AQMP) was revised in 2019. This revision (Revision 4) of the plan reflects updates to support the construction and operation of Train 2 of the Pluto LNG facility, and to ensure that additional emissions of odorous substances and substances with the potential to impact human health from the operation of the second train are managed appropriately.
- The Pluto LNG Facility Greenhouse Gas Abatement Program (GGAP) was updated in 2021 (Revision 3a) to include the construction and operation of Pluto Train 2 and associated infrastructure, in accordance with the requirements of MS 757. This revision of the Pluto GGAP also addresses the Western Australian Government's Greenhouse Gas Emissions Policy for Major Projects (State GHG Policy), as announced in August 2019 to guide Government decision-making for major projects assessed by the Environmental Protection Authority (EPA).

- The Sea Turtle Management Plan (STMP) was updated in 2022. Revision 11 includes the management of potential impacts to sea turtles and marine mammals associated with Pluto LNG Expansion activities. This was in line with the best-practice standards incorporated in the National Light Pollution Guidelines for Wildlife (DAWE, 2020).
- The internal Invasive Marine Species (IMS)/Marine Quarantine Management Plan (2021, Revision 8) was updated on a regular basis throughout the reporting period. These periodic reviews included additional QA/QC processes and updated legislation references aligned to changes in the Biosecurity Act.

The Dredge Impact Management Plan was not relevant as no dredging activities took place in the reporting period.

Table 1: Pluto LNG environmental focus areas, objectives, methodologies, and key performance indicators relevant to the 2017 – 2022 operational phase.

Relevant Management Plan	Environmental Objectives	Methodologies used to achieve objectives	Key indicators of performance
<p>Treated Waste Water Management Plan Revision 4 (2014)</p>	<ul style="list-style-type: none"> • Maintenance of ecosystem integrity with spatially-assigned levels of protection; • Maintenance of aquatic life for human consumption assigned to all parts of the marine environment surrounding the ocean outlet; • Maintenance of primary contact recreation values assigned to all parts of the marine environment surrounding the ocean outlet; • Maintenance of secondary contact recreation values assigned to all parts of the marine environment surrounding the ocean outlet; • Maintenance of aesthetic values assigned to all parts of the marine environment surrounding the ocean outlet; • Maintenance of cultural and spiritual values assigned to all parts of the marine environment surrounding the ocean outlet; and • Maintenance of Industrial Water Supply. 	<ul style="list-style-type: none"> • Waste water collection, treatment and disposal: <ul style="list-style-type: none"> • Site water production, collection and drainage systems; • Treatment and reuse systems including: effluent treatment plant, sludge treatment and disposal, tertiary waste water treatment and sewerage treatment plant; and • Final collection and disposal systems and analysis prior to discharge or reuse on site. • Monitoring during operations including marine monitoring and Whole Effluent Toxicity (WET) testing; and • Contingency Management Plan. 	<ul style="list-style-type: none"> • Achievement of Environmental Quality Objectives as described in the document Pilbara Coastal Water Quality Outcomes: Environmental Values and Environmental Quality Objectives (Department of the Environment, 2006); • Compliance with requirements specified in Part V Licence under the Environmental Protection Act 1986 (WA) when in place (currently L8752/2013/2); • Pluto Treated Waste Water Marine Discharge Management Plan: <ul style="list-style-type: none"> • Compliance with discharge specifications: Waste water Constituents, Sources, Expected and Maximum Concentrations, Australian and New Zealand Environment and Conservation Council (ANZECC) Thresholds and Estimated Annual Loading; and • Compliance with discharge specifications: Waste water Constituents, Sources, Expected and Maximum Concentrations, Australian and New Zealand Environment and Conservation Council (ANZECC) Thresholds and Estimated Annual Loading; • Annual Licence report provided to DER. The report provides a summary of volumes of waste water discharged, levels of chemical constituents governing toxicity, results of annual WET test and full suite compositional analysis, use of alternative measurements if applicable, and an assessment

Relevant Management Plan	Environmental Objectives	Methodologies used to achieve objectives	Key indicators of performance
			against Environmental Objectives; and <ul style="list-style-type: none"> Exception reporting to DER in the event of discharge not meeting approved specification.
Sea Turtle Management Plan Revision 11 (2022)	<ul style="list-style-type: none"> Provide a management framework to manage the project so as to detect as necessary (“mitigate”) any impact upon marine turtles from the project; Identify and implement darkness strategies to reduce as far as practicable, lights or light glow interfering with nesting female turtles and hatchlings; Minimise the impact of waste discharge on sea turtles and marine mammals; Ensure management is in accordance with objectives defined in Ministerial Statement No. 757 and Approval to Take a Controlled Action EPBC2006/2968; Minimise the impact of human presence on sea turtle activity on Holden Beach; and Minimise the impact of dredging activities on sea turtles and marine mammals. 	<ul style="list-style-type: none"> Ongoing sea turtle monitoring at Holden Beach during operations and during maintenance dredging and spoil disposal activities; Implementation of the Pluto Operational Environmental Lighting Specification; Audits of lighting during operations against the protocol; In the event of a hydrocarbon spill, management measures contained within the Woodside Dampier Sub-basin Oil Spill Contingency Plan should be implemented; Restrict human access to Holden Beach; No vehicle access is permitted on Holden Beach; Maintenance of records of sea turtle observations during any future dredging, spoil disposal, rock fill and blasting operation; and Requirements for marine mammal observation and avoidance during relevant operations. 	<ul style="list-style-type: none"> Monitoring of turtle nesting and hatchling tracks on Holden Beach has not identified any impact on hatchling orientation; No turtle deaths associated with Woodside activities (i.e. dredging); No unauthorized access to Holden Beach by Woodside personnel & contractors; Annual and 5-yearly light audits to verify lighting impact and compliance against the objectives in the Light Management Plan; Compilation of monitoring records as outlined in the Sea Turtle Management Plan; Accident, Injury and Incident reports; Annual Turtle Monitoring Report; and Compliance demonstrated in the Annual Environmental Report.
Air Quality Management Plan Revision 4 (2019)	<ul style="list-style-type: none"> Ensure best available practicable and efficient technologies are used to minimise and monitor air emissions from the plant; Minimise environmental impacts associated with air emissions; Minimise impact on Indigenous rock art on the Burrup Peninsula; Ensure management is in accordance with objectives defined in Ministerial Statement No. 757 and 	<ul style="list-style-type: none"> Dry low nitrogen oxides (NOx) emissions control systems on gas turbines; Recovery of waste heat from several gas turbine units; Waste gas from the AGRU treated through a Regenerative Thermal Oxidiser (RTO); Rejection and destruction of BTEX through the RTO; Design for ‘no continuous flaring; 	<ul style="list-style-type: none"> Achievement of air emissions targets and limits specified in Part V Licence under the Environmental Protection Act 1986 (WA) (L8752/2013/2); Part V Licence Audit Report; Air Quality Management Plan reporting; Annual Compliance Report; Annual Environmental Report; Dark smoke events reported to DWER as soon as practicable;

Relevant Management Plan	Environmental Objectives	Methodologies used to achieve objectives	Key indicators of performance
	<p>Approval to Take a Controlled Action EPBC2006/2968; and</p> <ul style="list-style-type: none"> Adopt best practise pollution control measures. 	<ul style="list-style-type: none"> Use of nitrogen to maintain the continuous purge of flare piping; Air monitoring (ambient & point source emissions, dark smoke, nitrogen deposition) to validate expectations; and Reporting of emissions in accordance with legal and other requirements. 	<ul style="list-style-type: none"> Ambient air monitoring program; Participation in the State Murujuga Rock Art Monitoring Program; and Annual reporting to the National Pollutant Inventory (NPI) and National Greenhouse and Energy Reporting (NGER) scheme
<p>Greenhouse Gas Abatement Program Revision 3a (2021)</p>	<ul style="list-style-type: none"> Ensure the plant is designed and operated in a manner which achieves reductions in greenhouse gas emissions as far as practicable; Provide mechanisms for identifying and evaluating emissions improvements; Provide for ongoing greenhouse gas emissions reductions over time; Ensure that through the use of best practice, the total net greenhouse gas emissions and/or greenhouse gas emissions per unit of product from the project are minimised; and Manage greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and consistent with the National Greenhouse Strategy, and consistent with Australia's United Nations Framework Convention on Climate Change (UNFCCC) commitments under the Paris Agreement (formerly the National Greenhouse Strategy). 	<ul style="list-style-type: none"> Design and technology choices i.e. Acid Gas Removal, Thermal Combustion Unit, Waste Heat Recovery, Tandem Dry Gas Seals, optimising nitrogen content in the fuel gas, floating roof Condensate storage tanks, nitrogen flare purging, relief valve minimisation and Main Cryogenic Heat Exchanger redesign, dual boil-off gas compressors to minimise flaring; Pluto Trees Project (carbon offsets) – contract with CO2 Australia to offset reservoir CO2 emissions; and Identify and implement energy efficiency, production optimisation and emission reduction opportunities. 	<ul style="list-style-type: none"> Annual greenhouse gas emissions calculations and reporting as required by the National Greenhouse and Energy Reporting Act 2007 (Cth); Progress against energy efficiency and absolute emissions metrics; Energy efficiency, production optimisation and emissions reduction opportunities implemented; GGAP reporting; Annual Compliance Report; Five yearly revision of the GGAP and associated public summary report – first report due 2026; and Voluntary reporting schemes including the Taskforce for Climate-related Financial Disclosure, Dow Jones Sustainability Index, International Association of Oil and Gas Producers Environmental Indicators, and Annual Sustainable Development Report.
<p>Marine Quarantine Management Plan Revision 8 (2021)</p>	<ul style="list-style-type: none"> Minimise risk of introducing Invasive Marine Species (IMS) into Australian waters; Comply with existing State and Commonwealth legislation in relation to management of IMS; and Reduce the risk of unplanned activity schedule delays and cost 	<ul style="list-style-type: none"> Conduct risk assessments as required by the IMS Management Plan; Depending on the level of risk identified, implement management options such as applying a limit of three entrances into the Invasive Marine Species Management Area, treatment of vessel internal 	<ul style="list-style-type: none"> Compliance with all legal and other requirements relating to marine quarantine management; and No introduction of Invasive Marine Species as a result of Woodside activities.

Relevant Management Plan	Environmental Objectives	Methodologies used to achieve objectives	Key indicators of performance
	<p>increases as a result of unanticipated IMS management response requirements imposed by Government upon entry into Australian waters;</p>	<p>seawater systems, inspection, vessel rejection / replacement or a risk based alternative;</p> <ul style="list-style-type: none"> • Inspections following procedures outlined in the IMS Management Plan; • Notification of relevant authorities if IMS is identified; and • Liaison with qualified IMS Inspector to establish management options if IMS identified. 	
<p>Cultural Heritage Management Plan – Commissioning and Operations (2012)</p>	<ul style="list-style-type: none"> • Prior to ground-disturbing activities, Woodside shall develop, in liaison with the Department of Indigenous Affairs, and submit to DEC, a Cultural Heritage Management Plan. The plan shall address: <ul style="list-style-type: none"> • The inclusion of cultural heritage awareness training in the workforce inductions • Signposting and fencing of nearby heritage sites to prevent unauthorised access, • Monitoring of ground disturbing activities by an anthropologist/archaeologist and representatives of the Traditional Custodians; and • The retrieval and relocation of heritage material which lies within the disturbance footprint in consultation with the Traditional Custodians. • Implement the Cultural Heritage Management Plan; and • Make the Cultural Heritage Plan publicly available. • Contain all operational activities within areas of previous ground disturbance • Comply with: 	<ul style="list-style-type: none"> • Maintain a physical barrier (fence) with prominent signage around ground disturbance zones; • Restrict operational activities to within physical barriers; • Provide ongoing training to all personnel to ensure that all works remain within physical barriers unless appropriate approvals and/or permits are received. Heritage awareness training must be included in the workforce induction; • Update and monitor a heritage managements commitments register and calendar; • Meet all compliance and commitment requirements in accordance with the register; • Engage Traditional Custodians and heritage consultants to conduct heritage audits and provide advice on an ongoing basis; • Use heritage survey reports to inform design and footprint for Pluto LNG; • Engage with Traditional Custodians to refine design and footprint of Pluto LNG; • Engage Traditional Custodians and Archaeologists to oversee the relocation of heritage; 	<ul style="list-style-type: none"> • No unauthorised boundary transgression; • Annual Report (Site B Compliance Report) submitted to Department of Planning, Lands and Heritage containing: <ul style="list-style-type: none"> • Extent to which works have impacted sites or objects located on land; and • Effectiveness of implementation of the Cultural Heritage Management Plan (CHMP). • Internal compliance audits conducted annually; • Incidents are report through Woodside’s incident and hazard reporting procedure; • CHMP is reviewed annually; • Annual heritage audits completed; • Heritage landscape understood; • Woodside has worked closely with Traditional Custodians since October 2005 to gain an understanding of the Indigenous heritage landscape; • The Pluto LNG Foundation Project footprint was designed in consultation with local Indigenous people to avoid 92% of rock art engravings on Pluto leases;

Relevant Management Plan	Environmental Objectives	Methodologies used to achieve objectives	Key indicators of performance
	<ul style="list-style-type: none"> • All approval conditions set out by the Western Australia State and Commonwealth Governments that pertain to Aboriginal cultural heritage; • Woodside's Heads of Agreement with the local Aboriginal groups of the area and where possible, recommendations from the Pluto Heritage survey reports; and • Woodside's Conservation Agreement. • Undertakings under the Burrup and Maitland Industrial Estates Agreement; • Develop a comprehensive understanding of heritage at Pluto LNG Park; • Relocate heritage from footprint to other areas on the Pluto LNG Park without damage; • Protect heritage located in the non-disturbance area from damage; and • To comply with approval and consent conditions, commitments and legislative requirements. 	<ul style="list-style-type: none"> • Install fencing and signage around the disturbance area boundary; • Ensure activities on Pluto LNG site only proceed either with the appropriate permit (containing all necessary protection measures) or within the disturbance area by providing appropriate education (i.e. inductions); and • Maintain a register of heritage commitments and consent conditions. 	<ul style="list-style-type: none"> • The 176 panels with engravings that could not be avoided were safely relocated to a nearby natural setting with the guidance of local Indigenous groups and in accordance with government approvals; and • Compliance with all legal requirements.

3. Progress in Achieving Sound Environmental Performance

3.1 Industry Benchmarking

Benchmarking allows for a comparative analysis to identify the previous and current status of a certain element. **Figure 1** shows the results of the GHG emissions intensity benchmarking study of Pluto LNG facility against comparable LNG facilities. This study was conducted as part of The Pluto LNG Facility GGAP (Woodside Burrup Pty Ltd, 2021).

Comparable benchmarking of an LNG processing plant is difficult to undertake due to the proprietary nature of data relating to plant performance and the difference in greenhouse gas efficiency that occurs due to local and site-specific factors. GHG emissions intensity can be influenced by a range of internal (technology) and external (environmental / policy) factors in design or operational phases, including:

- Relative proportions of gases (including CO₂) in reservoirs;
- Ambient temperature at the location of the facility;
- Major technology decisions, such as the use of air or water cooling which may be governed by factors other than GHG intensity;
- Potential of integration with other facilities (i.e. the integration of utilities across Trains 1 and 2); and
- Capacity for external power generation, including the use of renewable sources.

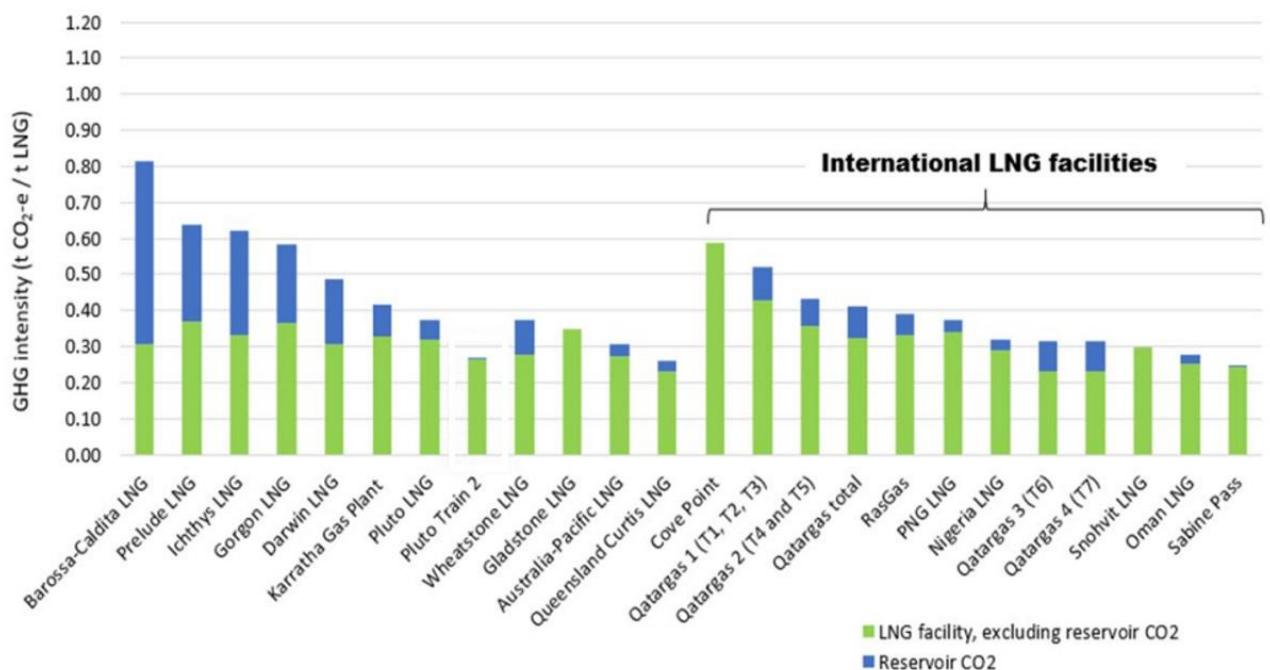


Figure 1: Comparison of Pluto LNG Facility GHG emissions against other comparable projects

The study indicates that the emissions intensity of Pluto LNG and the predicted intensity of Pluto Train 2 is well positioned against the LNG industry’s current average GHG intensity. This is emphasised when the effects of reservoir CO₂ offsets are considered. A detailed discussion on industry benchmarking is featured in Section 5.2 of the Pluto LNG Facility GGAP (Woodside Burrup Pty Ltd, 2021).

3.2 Use of Best Available Technology

Several scopes of work were carried out throughout the operational stage of Pluto LNG, to identify best practice for major plant operation and to minimise environmental impact. Best practice is taken to mean Best Practice Measures as defined in the Western Australian Guidance No. 55 on the Assessment of Environmental Factors, consistent with the *Environmental Protection Act 1986*.

3.2.1 Pluto Train 2 Design

Woodside is progressing the expansion of Pluto LNG through the construction of a second gas processing train, in accordance with MS 757. Pluto Train 2 has a capacity of approximately 5 million tonnes per annum (Mtpa), to help meet the increasing global demand for LNG as a transitional energy source. To date, the project has received Works Approval for construction, as well as relevant revisions to publicly available management plans (e.g. GGAP and AQMP) in line with conditions established in MS 757.

The Pluto Train 2 design is based on a best practice design for emissions efficiency. The two most material decisions in the design process were the LNG technology and selection of aero-derivative gas turbines for liquefaction compressors. Other technology considerations include integration of power supply for both trains, optimisation of the Acid Gas Removal Unit (AGRU) design and Heavies Removal Unit design, Waste Heat Recovery Unit and provision of a Nitrogen Removal Unit.

3.2.2 GHG Efficiency Technology Achievements

Greenhouse gas and energy efficiency opportunities are implemented during ongoing opportunity management and plant optimisation processes. Achievements during the reporting period are as follows:

2017

- AGRU high-rate trial: Trial to debottleneck front-end of the LNG process, increasing maximum rates with proportionally less fuel gas consumption.
- Frame 7 High Efficiency Particulate Air (HEPA) filters: Replacement of standard turbine air filters with HEPA filters to reduce fouling and fuel gas consumption, resulting in an estimated GHG emissions reduction of 1.33%.
- Increase boil off gas (BOG) compressor motor current: Modified maximum electrical current to boil off gas compressors to reduce flaring.

2018

- Main Cryogenic Heat Exchanger (MCHE) C5+: modification to C5+ (heavy hydrocarbons) limit allows additional LNG production with no additional fuel gas consumption.

2019

- MCHE improvements: Tube insets installed to increase the efficiency of mixed refrigerant cooling, and installation of new vent valves addressed the issue of previous valves passing hydrocarbons to flare.
- Increased train pressure: Increased operating pressure of Pluto Train 1 through control changes. Increased feed pressure results in additional cooling capacity, producing more LNG with no additional energy input required.
- Gas Turbine Generator (GTG) all year-round operating strategy: Upgrades to electrical load management system led to adoption of the “GTG winter operating strategy”, year round. This strategy allows one GTG to be turned off reducing the amount of fuel gas burned.

- K1410 Mixed Refrigerant Compressor Advanced Process Control improvements: Adjusting control margins within software used to optimise the LNG train which resulted in an increased flowrate of mixed refrigerant and more efficient LNG production.
- Helper motor power upgrades: Upgrades to helper motors increased the available power from the mixed refrigerant, propane refrigerant, and end flash gas compressors.
- Removal of heavy mixed refrigerant (HMR) and rundown flow constraints: Production previously constrained during cool conditions has now been unlocked by extending the limits of LNG rundown flow and HMR flow.

2020

- Dual BOG compressors: Operation of dual boil-off gas compressors to reduce flaring associated with ship loading.

2021

- End flash compressor upgrades: New controls and piping installed to rerouting the dry gas seals from vent to flare. Estimated reduction of 2400t CO₂ equivalent (CO₂-e) per annum.

2022

- Increased K1430 and RTO performance: Adjusting a set point to maximise the number of online fin fans at the propane refrigerant compressor has increased cooling and resulted in more efficient LNG production.

3.2.3 Technology Solutions

Technology and innovation considerations are essential to long-term sustainability of Woodside's safe and reliable operations. Woodside is pioneering remote support and the application of artificial intelligence, embedding advanced analytics across our operations.

In 2019, work commenced on building a digital twin of the Pluto LNG onshore facility to optimise the use of sensors and robotics. In 2020, the Operations Transformation initiative was launched, targeting operational expenditure reduction of 30% in the next three years. Supporting this vision, the wireless sensor coverage was expanded to the fin fan heat exchangers at the Pluto LNG facility, connected to the FUSE digital twin platform. FUSE brings facility performance data from multiple sources together, aggregating the data into insights and displaying them in a four-dimensional experience. The wireless sensors enable condition-based monitoring to automate fault prediction and maintenance work orders, saving operator time and improving efficiency.

Permanent and continuous robotic surveillance has been deployed at the Pluto LNG facility to improve situational awareness and reduce workforce exposure. This includes introducing two new robots for trial. The ExRobotics ExR-1 robot can operate safely in environments that carry a risk of ignitable substances in the air, and the Boston Dynamics Spot robot offers rapid mobility across uneven terrain.

The Pluto Remote Operations Centre (Moorditj Danjoo) commenced a phased transition to full operations in 2022. The centre is located in Woodside's Perth office, Mia Yellagonga, and remotely operates onshore and offshore Pluto assets, leveraging Woodside's capability to integrate innovation and technology to support operational performance.

3.2.4 New Energy Transition

A solar photovoltaic (PV) power facility is being evaluated approximately 15 km south-west of Karratha in Western Australia. The plan is for the power facility to generate electricity from a large-scale solar PV farm, complemented by a battery energy storage system and other associated infrastructure. Initially, it is anticipated that the proposed facility could supply a total of 100 MW of solar energy to Pluto LNG and other customers located near Karratha, with potential expansion to a maximum capacity of 500 MW. High-voltage DC cables have been installed at Pluto Gas Plant in preparation for a final investment decision.

4. Improvement in Environmental Management

4.1 Methane Emissions Management

Woodside aims to minimise its methane emissions, work with its supply chain and other stakeholders to continue to improve methane management in line with its methane strategy. In 2018, Woodside became a signatory to the Methane Guiding Principles (MGP) to enhance the understanding and management of methane emissions at its facilities and support reductions in the global natural gas value chain. In 2022, Woodside made an additional commitment to minimise methane emissions by becoming the first Australasian company to join the Aiming for Zero Methane Emissions Initiative. By signing the initiative, Woodside is committed to deploying means to minimise emissions from our operated assets by 2030 by treating methane emissions in a similar way to safety.

To deliver methane reduction several scopes have been conducted to better understand our methane emission sources. An understanding of methane emission sources and their materiality is a key prerequisite to enable effective mitigation. In 2020, a methane study was conducted by the National Physical Laboratory at the Pluto LNG Plant. The study deployed differential absorption LIDAR technique to localise and quantify emissions. The insights gained from the study enabled activities to inform and refine operational and maintenance procedures. Following the study, a trial of routine satellite monitoring was commenced. In 2022, a comprehensive study was undertaken on the Pluto LNG Plant combustion-slip sources. This included the direct sampling of methane emissions from combustion equipment and the trial of flare monitoring using video imaging spectrographic radiometry to better understand flare destruction efficiency. Methane sensing drone surveys were also conducted on strategic equipment and erroneous leak points immediately identified and remediated.

The insights gained from these studies have enabled the development of site-specific methane factors and a methane emission inventory. The inventory informs decarbonation activities resultant from methane mitigation using a marginal abatement cost approach. Methane is prioritised by assessing methane abatement opportunities using a 20-year global warming potential (rather than the Intergovernmental Panel on Climate Change standard of 100-years). Combined with our long-term carbon price assumption of US\$80 t CO₂-e (real terms), this enhances the prioritisation of methane opportunities when considering the financial value of abating CO₂-e emissions. Decarbonisation linked to methane is accounted annually by the delivery of methane action plans which are a subset of the asset's decarbonisation plan.

4.2 Greenhouse Gas Abatement

In 2021, Woodside revised the GGAP to address Western Australian Government's Greenhouse Gas Emissions Policy for Major Projects (State GHG Policy), as announced in August 2019 to guide Government decision-making for major projects assessed by the Environmental Protection Authority (EPA). The GGAP includes progressive targets to enable Woodside to meet its aspiration of net zero emissions by 2050 as well as interim and long-term targets to achieve a 30% emissions reduction from approved levels by 2030. The targets incorporate emissions associated with Pluto Train 2.

4.2.1 Decarbonisation Plan

During 2022, Woodside developed a Decarbonisation Plan for each operated asset and project in the heritage Woodside portfolio to identify opportunities to be pursued, including further technology to be developed where needed. These identify potential decarbonisation opportunities prior to the application of technology or cost constraints. The Decarbonisation Plan includes short-term optimisation objectives and larger scale technical abatement opportunities, which follow Woodside's Investment Management Framework. Pluto has several opportunities currently under assessment.

Greenhouse gas abatement programs are typically undertaken by corporate initiatives. These are further detailed in **Section 4.9**.

4.3 **LNG for Transport and Power Generation**

Woodside is assessing markets where LNG reduces emissions. This work commenced in 2019 with the completion of the Woodside-operated Pluto LNG Truck Loading Facility. Displacing diesel and other liquid fossil fuels with LNG leads to cuts in GHG and other emissions. On a lifecycle basis using trucked LNG in power generation instead of diesel is anticipated to reduce GHG emissions by 27%. It is estimated that supply of LNG from the Pluto LNG Truck Loading Facility has the potential to displace up to approximately 100 kt CO₂-e per year from remote diesel fired power generation, providing a further contribution to the State aspiration of net zero emissions by 2050. The Pluto LNG Truck Loading Facility has the potential to contribute up to 200 kt CO₂-e per year if expanded to its full capacity. These opportunities, however, are subject to State policy settings that promote a reduction in the reliance on higher emission fuel sources and incentivisation of lower emissions power generation such as natural gas.

4.4 **Air Quality Management**

Woodside has undertaken or contributed to air monitoring studies of the Burrup Peninsula since 2008 with the objective of measuring our emissions and understanding potential impacts in the region. In advance of potential changes to industrial air emissions on the Burrup Peninsula, Woodside voluntarily recommenced ambient air quality monitoring in 2019 to further understand ambient air quality in the region. In 2021, the Burrup Air Monitoring Program was expanded to include monitoring dry and wet nitrogen deposition that may be associated with emissions from Pluto LNG and Karratha Gas Plant at five monitoring stations. This is enhancing the understanding of potential interactions on the surrounding environment. The Burrup Air Quality Monitoring program extends the historical dataset and complements ambient air quality monitoring conducted under the Murujuga Rock Art Strategy.

Woodside also supports the application for World Heritage listing of the Murujuga and the associated programs that seek to ensure industrial air emissions are not impacting on this Murujuga rock art.

4.5 **Indigenous Engagement**

Woodside places great value on working with Indigenous communities. A continuous improvement model frames principles and focus for effort in engagements with indigenous communities across both current operations, and future projects.

4.5.1 **Operations**

The annual heritage audits of Karratha Gas Plant and Pluto LNG are conducted with Traditional Custodians and the recommendations of this work with regards to ongoing maintenance and land management are being implemented. No new concerns regarding heritage sites have been raised by the Murujuga Aboriginal Corporation (MAC). Additionally, at the request of Traditional Custodians, a visit to the Pluto Conservation Zone was undertaken to inspect heritage sites that are not normally subject to regular heritage audits and to facilitate the ongoing connection of stakeholders with these sites. We also continue to meet with Traditional Owners and Custodians in Karratha and Roebourne on a quarterly basis to discuss cultural heritage management on the Burrup Peninsula, adjacent to the Pluto LNG sites, and other matters including Indigenous contracting and employment, and social investment. In 2020, Woodside commenced a review of the Pluto cultural heritage procedure and management plan through stakeholder engagement and a benchmarking review of our heritage practices.

4.5.2 Murujuga Rock Art Strategy

The Pluto LNG Plant operates in an area of national and global significance due to the quality and abundance of Aboriginal engraved rock art. In 2017, Woodside participated in the Senate Committee's Inquiry concerning the protection of Aboriginal rock art of the Burrup Peninsula. Furthermore, Woodside is one of three organisations committed to undertaking field monitoring, analysis and reporting under the auspices of the Burrup Rock Art Monitoring Program (BRAMP). To date, Woodside continues to participate in the Murujuga Rock Art Strategy as well as the Burrup Ambient Air Quality Monitoring Program.

4.5.3 Community Engagement

Woodside signed new agreements with the Ngarluma Yindjibarndi Foundation Limited (NYFL) and MAC in 2019. The agreements build on existing long-term partnerships with the two organisations and the communities they represent and support our plans to continue operations at the North-West Shelf (NWS) Project and Pluto LNG for decades to come.

Woodside continues to engage with Traditional Custodians to develop cultural heritage management plans for Burrup Hub developments including Pluto Train 2 and Scarborough. In particular, Woodside has developed the Scarborough Cultural Heritage Management Plan, Pluto Expansion Cultural Heritage Management Plan, Scarborough Dredging and Spoil Disposal Management Plan and NWS Extension Project Environmental Referral Document with Indigenous stakeholders. The information gathered through consultation on these management plans has informed revisions to the management plans.

4.6 Sea Turtle Management

4.6.1 Operational Lighting Management Plans and Procedures

Woodside continues to implement the Pluto Operational Environmental Lighting Specification (OELS) and Pluto Light Management Plan which focusses on the mitigation of installed lighting at Pluto LNG, with a focus on the management of defined zones. Woodside verifies the OELS by conducting an annual lighting survey. Where surveys identify areas where light emissions could be reduced further, these are implemented, and compliance demonstrated in the subsequent ACR. Examples of improvement include:

- Reducing low wavelength, high intensity light by installing light filters on fluorescent and LED lights; and
- Reducing overall light glow by automating a process to turn off unnecessary lights when not required for operational reasons.

4.6.2 Five Yearly Light Management Audit

Five yearly light audit of the Pluto LNG Plant Site A was executed in October 2022 to determine compliance with the Pluto Light Management Plan, which included a survey of spectral characteristics, intensity and sources of light spill visible from Holden Beach.

The audit results demonstrated an improvement in the overall light glow, reduction in low wavelength light, directly attributed to the light improvements executed during the reported years.

4.6.3 Sea Turtle Monitoring Program

Woodside continues to implement the seasonal sea turtle monitoring program over the turtle nesting season (September-March). Records are maintained and submitted to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Monitoring methodologies and management actions described in this STMP align with the best-practice standards incorporated within the National Light Pollution Guidelines (DAWE, 2020).

4.7 Mercury Treatment Facility

In 2019, Woodside signed on as a foundation customer of the Contract Resources Mercury Treatment Facility. Woodside worked with specialists to design, build and ensure safe operation of a state-of-the-art mercury recovery facility in Karratha. This reduces the likelihood of people being harmed through accident or mishap, eliminates the need for long-term storage while waiting for Basel Convention permits, ensures quick removal of the material during turnarounds and builds advanced technology in the Pilbara, creating employment opportunities. It provides a cradle-to-grave Australian solution to dealing with this hazardous waste, as processed mercury is sent to Melbourne to be reused as dental fillings by a company that previously imported mercury.

4.8 Community Support

Woodside is committed to receiving feedback on developments, understanding the social impacts of our operations on the Burrup Peninsula, and working with local communities on future projects. During the reporting period, we have reviewed our internal processes associated with social impact assessment and management to ensure alignment with good industry practice.

In 2019, a specialist consultant completed social impact assessments for current operations off the Exmouth coast, Karratha and our Burrup Hub developments. These included Scarborough, Pluto Train 2, Browse and the NWS Extension. This involved more than 12 months of work with relevant communities to understand the potential direct and indirect social effects of these developments. Social impact assessments are being reviewed in 2022 and finalised in 2023.

The Scarborough and Pluto Train 2 will provide a significant contribution to the Australian economy across the life of the project. Most direct opportunities for Pluto Train 2 will be realised in Western Australia, with firm commitments in place will contractors to deliver skills development and training, employment, contracting and Indigenous participation opportunities during the four year construction phase. The projects will continue to support local operations and communities for decades to come.

4.9 Corporate Initiatives & Commitments

Woodside recognises the role of corporate initiatives to further environmental management objectives. Whilst not exclusive to the Pluto LNG Plant, benefits are applied across Woodside's portfolio, and many initiatives and programs are implemented on site.

A commitment to reduce Woodside's net equity portfolio emissions by 15% (by 2025) and 30% (by 2030), below the annual average emissions over the period 2016 – 2020. This commitment subsumes the existing corporate commitment to offset equity reservoir CO₂ emissions from 2021 and to improve energy efficiency by 5% over 2021– 2025. It is important to note that the Woodside equity portfolio commitment is across all Woodside projects globally, including non-operated projects. Woodside will pursue the best available opportunities across its portfolio, and as these may not necessarily be at the Pluto LNG Facility at a given time, it should not be assumed that Pluto emissions will decline at an even pace with the total portfolio.

A collaborative partnership with Greening Australia to plant approximately 7.5 million native trees in 2020. The first seeds in WA's Great Southern Region were planted in May 2020 in a program that will see the planting of more than 3.6 million native trees and shrubs by July 2021. Two sites have been earmarked for planting in the Great Southern region of WA: a 1600ha site about 100km South of Lake Grace called Cowcher; and a 400ha site called Sukey Hill just east of Cranbrook. Woodside recently purchased an additional two properties in the Wheatbelt – properties called Manalling Springs and Windy Lane, totalling 3694ha. These projects are being undertaken by Woodside independently of the Pluto LNG Facility and the resulting carbon credits will be applied to Woodside's portfolio as required.

4.9.1 Climate Related Advocacy

Woodside regularly engages with stakeholders in support of our business strategy, to exchange information, and to inform policy development and decision making. This engagement is undertaken both directly and by working with industry associations, ensuring our own advocacy and the advocacy of our industry associations is aligned with Woodside's Climate Policy.

Woodside also has a staff led community network, Woodside Energy Climate Awareness Network (WECAN), which encourages employees to share knowledge and contribute to Woodside's objective to thrive in the energy transition as a low-cost, lower-carbon energy provider. WECAN has more than 420 members.

4.9.2 Optimisation Reference Plan

Woodside annually prepares an Optimisation Reference Plan (ORP) for the Pluto LNG Facility. The ORP identifies and implements opportunities to improve production and energy efficiency whilst reducing emissions. Opportunities are ranked based on a range of variables including net present value, their contribution to Woodside's corporate GHG reduction initiatives, economic value and environment/strategic merit. Operational phase GHG intensity achievements, identified and implemented via the ORP, are reported in subsequent Pluto GGAP and summary reports. The ORP process supports the Pluto Decarbonisation and Methane Action Plans.

5. Stakeholder and Community Consultation

The table below outlines stakeholder and community consultation that has been carried out for Pluto LNG. Woodside's engagement with stakeholders and the local community is most often carried out by its locally-based Corporate Affairs team. Engagement with regulators is generally undertaken by the Environmental Advisers onsite. Engagement may include regular or as required meetings, site tours, phone calls, fact sheets and emails.

Table 2: Stakeholder and community consultation about environmental performance at Pluto LNG during the reporting period

Stakeholder	Location	Forum/mechanism	Topic of discussion/main messages	Outcome/feedback
City of Karratha - CEO	Karratha	Face to face meetings and phone briefings	Operational updates including planned and unplanned outages, and advice on environmental approvals including Pluto Train 2 and Scarborough.	Information well received and appreciated. Any formal feedback captured as part of Environmental approvals processes.
City of Karratha - Mayor		Face to face meetings and phone briefings		Information well received and appreciated. Formal feedback captured as part of Environmental approvals processes.
City of Karratha - Councillors		Face to face meetings and phone briefings		Information well received and appreciated. Formal feedback captured as part of Environmental approvals processes.
Pilbara Development Commissions - CEO		Face to face meetings and phone briefings		Information well received and appreciated. Formal feedback captured as part of Environmental approvals processes.
Pilbara MLA		Face to face meetings and phone briefings		Information well received and appreciated.

				Formal feedback captured as part of Environmental approvals processes.
Karratha Community Liaison Group (including Pilbara Ports Authority, Dampier Community Association, City of Karratha)		Quarterly presentations and updates, email correspondence		Information well received and appreciated. Formal feedback captured as part of Environmental approvals processes.
State Government agencies (inc. DWER)	Perth	Correspondence	Advice on flaring resulting from unplanned outage (2018)	Information received
City of Karratha Community	Karratha, Dampier, Wickham, Roebourne	Advertising in Pilbara News, local radio and social media posts	Proactive advice on potential flaring impacts as a result of planned maintenance activities	Information well received and appreciated. No formal feedback received
Traditional Custodian Groups	Karratha and Roebourne	Face to face meetings Phone calls Briefings	Cultural Heritage Management Footprint of LNG facility Key Milestones and developments Environmental	Feedback continues to influence heritage management
	Pluto LNG site	Heritage surveys Monitoring of activities Site visits	Operational updates including planned and unplanned outages, cultural heritage management and information on environmental approvals including Pluto Train 2 and Scarborough.	

6. Proposed Environmental Objectives

The environment objectives for the previous five year period (2017-2021) were based on establishing steady state operating conditions and developing baseline data for emissions and discharges, and implementing the greenhouse gas emission improvement initiatives included in the Pluto Greenhouse Gas Abatement Program. Based on experience from Pluto Train 1, it is anticipated that a period of process optimisation will follow the commissioning of Train 2 to realise the emission reductions through design. These objectives and achievements against them are anticipated to be described in the next revision of the Pluto Greenhouse Gas Abatement Program.

Environmental objectives for the next five year period (2023 – 2028) which incorporate improvements in technology and management processes are:

- Continue to implement the management plans as outlined in the MS 757
- Reduce net equity Scope 1 and 2 greenhouse gas emissions by 15% by 2025 and progress towards 30% reduction by 2028, in line with Woodside corporate target of 30% reduction by 2030;
- Realise the efficiencies in Train 2 design and reduce or abate emissions by 30%, based on the Pluto LNG Facility emissions estimate of 4.1 Mtpa CO₂-e (T1 and T2);
- Where sufficient emissions reduction cannot be achieved onsite to reach this 2030 target, the shortfall will be voluntarily offset to achieve the equivalent of 30% emissions reduction; and
- Continued support for Burrup Ambient Air Quality Monitoring Program to support the Murujuga Rock Art Strategy.

Cultural heritage objectives over the next five years include the continued implementation of the Pluto Cultural Heritage Management Plan and activities seeking advice from Traditional Custodians, Archaeologists and Anthropologists as required. The purpose of these tasks is to protect heritage in the Burrup region whilst maintaining compliance with legal and other requirements. Woodside will also continue to build long term, meaningful relationships with communities in Karratha and Dampier.

Continued support for the application for World Heritage Listing, including through funding for Murujuga Aboriginal Corporation and effective heritage management, remains an important heritage priority. The Scarborough, Train 2 and Train 1 modification scopes must be implemented to avoid heritage impacts and ensure legal compliance in a manner that sets Pluto up for ongoing successful management of cultural and heritage values.

Results from the Murujuga Rock Art Monitoring Program are expected to provide guidance on NO_x and other emission levels to manage rock art in the next five year period. Actions to comply with this guidance will be assessed and implemented to keep impacts as low as reasonably practicable.

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APPENDIX A: Acronyms

Acronym	Definition
AGRU	Acid Gas Removal Unit
ANZECC	Australian and New Zealand Environment and Conservation Council
AQMP	Air Quality Management Plan
BOG	Boil Off Gas
BRAMP	Burrup Rock Art Monitoring Program
CHMP	Cultural Heritage Management Plan
CO ₂	Carbon Dioxide
CO ₂ -e	Carbon Dioxide Equivalent
DCCE	Department of Climate Change, Energy, the Environment and Water
DEH	Department of Environment and Heritage
DWER	Department of Water and Environment Regulation
EPA	Environment Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
GGAP	Greenhouse Gas Abatement Plan
GHG	Greenhouse Gas
GTG	Gas Turbine Generator
HEPA	High Efficiency Particulate Air Filter
HMR	Heavy Mixed Refrigerant
IMS	Invasive Marine Species
LNG	Liquefied Natural Gas
MAC	Murujuga Aboriginal Corporation
MCHE	Main Cryogenic Heat Exchanger
MGP	Methane Guiding Principles
MS	Ministerial Statement
Mtpa	Million Tonnes Per Annum

NGER	National Greenhouse and Energy Reporting
NPI	National Pollutant Inventory
NWS	North West Shelf
NO _x	Nitrogen Oxides
NYFL	Ngarluma Yindjibarndi Foundation Limited
OELS	Operational Environmental Lighting Specification
ORP	Optimisation Reference Plan
PER	Public Environment Report
PV	Photovoltaic
RTO	Regenerative Thermal Oxidiser
STMP	Sea Turtle Management Plan
WECAN	Woodside Energy Climate Awareness Network
WET	Whole Effluent Toxicity

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Head Office

Mia Yellagonga
11 Mount Street
Perth WA

Postal address:

GPO Box D188
Perth WA 6840
Australia

T: +61 8 9348 4000

F: +61 8 9214 2777

E: companyinfo@woodside.com.au

