APPENDIX B
NORTH WEST SHELF PROJECT EXTENSION GREENHOUSE GAS MANAGEMENT PLAN

Revision 1

Woodside

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Revision 1

G2000RF1401194400

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1. Summary

Woodside Energy Ltd (Woodside), as operator for and on behalf of the North West Shelf (NWS) Joint Venture (NWSJV), is the proponent for the North West Shelf Project Extension Proposal (the Proposal).

In summary, the Proposal is for the ongoing operation of the NWS Project to enable the long-term processing of third-party gas and fluids and NWSJV field resources through the NWS Project facilities until around 2070. The Proposal is described in its entirety in Section 2 of the NWS Project Extension Environmental Review Document (Woodside, 2019) and is duplicated into **Section 2.1.1** of this Greenhouse Gas Management Plan (GHGMP) for ease of reference.

This GHGMP was prepared in accordance with the 'Instructions on how to prepare *Environmental Protection Act 1986* (WA) (EP Act) Part IV Environmental Management Plans' published April 2018 by the Western Australian (WA) Environment Protection Authority (EPA) (EPA, 2018).

This GHGMP details the measures that are required to manage Greenhouse Gas (GHG) emissions from the Proposal**. Table 1-1** summarises the information contained in this GHGMP.

Table 1-1: GHG Management Plan Summary Table

Title of Proposal	North West Shelf Project Extension
Proponent Name	Woodside Energy Ltd., as operator for and on behalf of the NWSJV
Purpose of the GHGMP	This GHG Management Plan identifies management and mitigation measures to ensure impacts from GHG emissions associated with the Proposal are not greater than predicted.
Key Environmental Factor/s and Objective/s	**Key Environmental Factor**: Air Quality **EPA Objective:** To maintain air quality and minimise emissions so that environmental values are protected (EPA, 2016)
Key Provisions in the GHGMP	Management of the contribution to global GHG concentrations from the emission of Scope 1 and Scope 2 emissions through the implementation of the following key provisions: • Adoption of practicable and efficient technologies to reduce GHG emissions of the Proposal. • Annual fuel and flare targets. • Routine emission monitoring and reporting in accordance with the National Greenhouse and Energy Reporting Act • Monitor relevant changes and modifications to Proposal to prevent GHG emissions from exceeding 7.7 mtpa • Implementation of the KGP Energy Management Plan to manage GHG emissions • Compliance with National Safeguard Mechanism to maintain emissions within the NWS Project Baseline • Adherence to Methane Guiding Principles

2. Context, Scope and Rationale

2.1 Introduction

The NWS Project is one of the world's largest liquefied natural gas (LNG) producers, supplying oil and gas to Australian and international markets from offshore gas, oil, and condensate fields in the Carnarvon Basin off the north-west coast of Australia. For more than 30 years, it has been WA's largest producer of domestic gas.

Woodside proposes to operate the NWS Project to around 2070 as an LNG facility that is commercially capable of accepting gas for processing from other resource owners. Therefore, this Proposal includes processing third-party gas and fluids and any remaining or new NWSJV field resources.

The Proposal is described in its entirety in Section 2 of the NWS Project Extension Environmental Review Document (Woodside 2019) and is duplicated in **Section 2.1.1** of this GHGMP for ease of reference.

This GHGMP will be implemented following receipt of approval under the *Environmental Protection Act 1986* (WA) (EP Act) and *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act). In the interim, the NWS Project will continue to operate under current licence conditions and management practices.

2.1.1 Proposal

To enable the future operation of the NWS Project and the ongoing supply of gas and fluids to domestic and international markets, the Proposal seeks approval to transition the Existing NWS Project facilities to a new phase of the NWS Project; which is commercially capable of accepting gas for processing from other resource owners. The NWS Project Extension Proposal is seeking approval for the:

- long-term processing of third-party gas and fluids and NWSJV field resources through the NWS Project facilities, including:
  - changes to feed gas composition including changed content of inerts, hydrocarbons and other components
  - changes to the composition of environmental discharges and emissions, although annual volumes of emissions and discharges are expected to be in line with current levels
  - modifications to the Karratha Gas Plant (KGP) onshore receiving facilities (that would not otherwise be undertaken if not for the Proposal) to accommodate third-party gas and fluids, as well as upgrades to metering to facilitate processing of third-party gas and fluids
  - potential construction of additional operational equipment to accommodate changes to feed gas composition or management of discharges and emissions
- ongoing operation of the NWS Project (from the date of the approval of this Proposal) to enable long-term processing at the NWS Project facilities, currently expected to be until around 2070, including:
  - ongoing use of existing NWS Project facilities to process third-party gas and fluids and NWSJV field resources
  - inspection, maintenance, and repair (IMR) and improvement programs for trunklines (TL), 1TL and 2TL
  - maintenance dredging associated with jetties and berthing pockets
  - replacing equipment, plant, and machinery as required that would not otherwise be replaced if not for the Proposal.
  - ongoing, additional (and cumulative to existing approvals) emissions and discharges to the environment

- monitoring and management of environmental impacts.

2.2 Scope of the GHGMP

Purpose of Management Plan

This GHGMP outlines how GHG emissions are monitored and managed for the Proposal so that the relevant environmental values are protected. Where the Proposal has potential impacts to environmental values, but those impacts are managed under other regulatory instruments, those impacts and environmental values have not been considered in this GHGMP.

Scope

This GHGMP applies to Scope 1 emissions from activities associated with the Proposal that are within the operational control of Woodside (as defined under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act)). Other air emissions (e.g. oxides of nitrogen, ozone etc) are addressed in the NWS Project Extension Air Quality Management Plan (AQMP) (Woodside ID G2000RF1401194398).

This GHGMP manages the Proposal's contribution to global GHG concentrations from the emission of Scope 1 and Scope 2 emissions.

2.3 Key Environmental Factors

This GHGMP specifically relates to the 'Air Quality' environmental factor, as defined by the EPA. The objective for this factor is:

To maintain air quality and minimise emissions so that environmental values are protected.

At the time of writing, the 'Air Quality' environmental factor includes GHG emissions. The Environmental Factor Guideline - Air Quality requires the characterisation of GHG emission sources in accordance with the NGER Act and an analysis of GHG intensity, which are presented within this GHGMP.

2.3.1 Proposal Activities Potentially Affecting Key Environmental Factors

The major emission types of GHG emissions from KGP are carbon dioxide (CO_2), nitrogen oxide (N_2O) and methane (CH_4). The principal sources of GHG emissions include:

- gas turbine compressors: operating gas turbine compressors used to compress refrigerant to liquefy natural gas.
- acid gas removal: removing CO_2 from the gas stream through Acid Gas Removal Unit (AGRU) venting. This vent stream also includes some residual methane, volatile organic compounds (VOCs) and other incidental substances associated with gas processing.
- electricity generation: operating gas turbine generators that use gas from the Proposal to generate electricity to run the Proposal.
- flaring: flaring is required to safely dispose of hydrocarbons.
- fugitive emissions: small emissions of gas to the atmosphere from various areas throughout the Proposal, such as flanges, valves and process safety vents.

An estimate of Scope 1, Scope 2 and Scope 3 emissions associated with the NWS Project are:

- Scope 1 and 2 emissions are up to 7.7 mtpa CO_2e predominantly from the sources described above (based on an LNG production of 18.5 million tonnes per annum (mtpa)).
- Scope 2 emissions are approximately 0.002 mtpa CO_2e from electricity consumption at King Bay Supply Base (KBSB), as per the 2017 - 2018 National Greenhouse and Energy Reporting period. All electricity consumed at the KGP is generated on site and therefore GHG emissions

associated with this electricity generation is considered in the Scope 1 emissions detailed above. There are currently no other Scope 2 emissions associated with the Proposal.

- Scope 3 emissions are approximately 80.19 mtpa CO_2e predominantly associated with final combustion and use of LNG, LPG, Domgas and condensate products. Emissions associated with transport and distribution of LPG and condensate products are considered to be negligible when compared to the total Scope 3 emissions estimate and therefore have not been included in these calculations.

2.4 Rationale and Approach

This GHGMP outlines how GHG emissions from the Proposal are monitored and managed to minimise the Proposal's contribution to global GHG emissions. This objective acknowledges that planned, continuous emissions to air from the Proposal occur and that the impacts from these can be mitigated by implementing this GHGMP.

To determine whether there is a risk of activities failing to minimise emissions to protect environmental values, emission-impact pathways were reviewed, and the following criteria applied:

- where mitigation is implemented for the activity under other regulatory instruments, the risk was determined to be sufficiently managed (refer to existing regulatory requirements in **Section 3.2**)
- where the activity required management through design controls and those controls are already in place at the NWS Project, the risk was determined to be sufficiently managed.

Through this review it was demonstrated that no additional specific provisions are required to manage GHG emissions at the NWS Project. This rationale is based on NWS Project facilities existing systems and management controls which are implemented and maintained through the environmental management system embedded at the NWS Project to successfully monitor, reduce and manage GHG emissions, aligned with the principle of waste minimisation.

In accordance with Woodside's commitment to implementing its Climate Change Strategy and Policy and using existing management controls, greenhouse gas reduction initiatives and projects are driven at a corporate level with oversight of operational level processes (described in **Section 3.1**).

2.4.1 Studies and Surveys

A GHG benchmarking assessment was undertaken in 2019 to compare the GHG emissions performance of the KGP against other comparable Australian and International LNG facilities. In total, 10 Australian and 8 International LNG facilities were selected for benchmarking and comparison with the KGP, including Gorgon LNG, Darwin LNG, Gladstone LNG, Australia-Pacific LNG, Snohvit LNG, Qatargas and Cove Point. This provides a range of different aged facilities with varying production capacity with which to compare KGP against. GHG emission performance was assessed using the GHG intensity (t CO_2-e/t LNG) for each facility.

The benchmarking assessment considered Scope 1 emissions with the following considered to be out of scope:

- GHG emissions from upstream operations associated with the extraction and compression of raw gas, i.e. upstream of the Trunkline Onshore Terminals (TOT1 and TOT2).
- Scope 2 emissions.
- Scope 3 emissions.
- Emissions associated with handling, transport and use of gas product downstream of the fiscal product meter.

The assessment found that the GHG emissions intensity of KGP, excluding reservoir CO_2 (0.33 t CO_2-e/t LNG) is slightly higher than the average for the Australian facilities analysed (0.31 t CO_2-e/t LNG). When assessed against International LNG facilities, the GHG performance of the KGP was found to be very similar to those facilities located in a similar climate and of similar age.

3. Internal and Regulatory Framework

3.1 Internal Management Mechanisms Relevant to this GHGMP

Woodside supports the global effort to reduce GHG emissions and accepts it has a responsibility to minimise the GHG impact of its own operations. Woodside's key priority is to reduce GHG emissions at source, either through energy efficiency improvements or technological solutions. Woodside has already achieved significant emission reductions on 'business as usual' projections and continues to invest in a range of GHG abatement measures.

3.1.1 Woodside Management System

The Woodside Management System (WMS) defines how Woodside delivers business objectives and the boundaries within which all Woodside employees and contractors are expected to work. Environmental management is one of the components of the overall WMS.

The overall direction for Environment is set through Woodside's Corporate Health Safety, Environment and Quality (HSEQ) Policy. The policy provides a public statement of Woodside's commitment to minimising adverse effects on the environment from its activities and to improving environmental performance. It sets out the principles for achieving the objectives for the environment and how these are to be applied. The policy is applied to all Woodside's activities, and employees, contractors and Joint Venture partners engaging in activities under Woodside operational control.

Woodside's Climate Change Policy outlines that Woodside recognises the scientific consensus on climate change and the challenge of providing safe, clean, affordable and reliable energy whilst reducing emissions. A key principle of this policy states that Woodside will set and publish targets to encourage innovation and drive reductions in Woodside's carbon footprint and energy use.

3.1.2 Environmental Performance

Environmental performance requirements are applicable to all Woodside developments and production assets with projected GHG emissions in excess of 25,000 tonnes of CO_2e per annum. In general, environmental performance requirements consider:

- design and operation to minimise GHG emissions and energy intensity.
- monitoring and measuring GHG emissions.
- consideration of carbon price (as per Woodside or Joint Venture approved economic assumptions) in development/production asset economics.
- identification of opportunities to reduce GHG emissions and energy intensity.

3.1.3 Opportunity Management Process

Each potential new third-party gas source to be introduced under the Proposal, will be assessed under Woodside's Opportunity Management Process which aims to find the best way to develop an identified opportunity, present a compelling business case for execution and then realise the value. The process outlines a framework for structured decision making, planning, governance and delivery approach to ensure opportunities are matured based on good decisions, and that those decisions are knowledge based and account for uncertainty and residual risk. An opportunity lifecycle typically consists of:

- Assess whether there is commercial merit in progressing the opportunity and select the optimum development solution in line with project objectives.
- Define the concept for development of the opportunity; and develop an execution plan and a team ready to deliver the project to the promised outcomes.
- Handover the assets and operations organisation ready for start-up at the execute phase.

Under the Opportunity Management framework, an opportunity process may consider the following activities in relation to GHG emissions:

- Review of existing approvals to identify any additional requirements. This contemplates the impact of an opportunity on existing environmental approvals and relevant regulatory limits.
- Risk assessment which identifies any additional gas components which may impact the character of an existing emission and/or discharge.
- Studies, such as modelling which may assist with predicting likely or possible outcomes which can then be interpreted in the context of the existing environment to quantify impact. Modelling may also be used to evaluate alternative designs.
- Engineering assessment which consider requirements for emission monitoring requirements.

3.1.4 Energy Management Framework

Woodside's Energy Management Framework aims to improve energy efficiency across Woodside's operations in order to:

- Add significant value to our business and maximises shareholder returns.
- Minimise environmental impacts through reduced GHG emissions which contribute to climate change.
- Enhance our reputation as a partner of choice.

The Energy Management Procedure (Woodside ID WM0000PG1400343649) defines the minimum mandatory requirements for energy management at Woodside to deliver continuous improvement in energy performance. Requirements for energy management are outlined in the Opportunity Management Framework (Refer to **Section 3.1.3**). The Energy Management Framework requires that an Energy Management Plan is established, implemented and maintained for each operating asset or group of assets which are required to measure, analyse and communicate energy performance.

Opportunities to improve energy performance are to be identified and captured in accordance with the Production Optimisation and Opportunity Management Procedure (refer to **Section 3.1.5**), such that energy opportunities are considered alongside other opportunities and constraints.

The KGP has an Energy Management Plan (Woodside ID 1400355329) which is implemented to achieve the following objectives:

- Improve energy efficiency monitoring and reporting
- Promote energy efficiency improvements by:
  - Identifying and utilising efficiency 'handles' to maximise efficiency at any given production rate; and
  - Identifying opportunities to change processes or equipment to improve the maximum efficiency of the plant.

3.1.5 Production Optimisation Process

In accordance with the Production Optimisation and Opportunity Management Procedure (Woodside ID W0000PP10115808), the KGP is required to develop an Optimisation Reference Plan (ORP) (Woodside ID G2000RG1401116495) which identifies and implements opportunities to improve production and energy efficiency whilst reducing emissions. The ORP recognises that any reduction in emissions is also identified as a production opportunity, as gas that can be diverted from fuel or flare streams can potentially be turned into a saleable product.

The ORP, prepared annually, delivers a ranked list of opportunities used to justify further study/implementation of each opportunity listed. Results are then incorporated into relevant plans to ensure consideration for funding / resourcing. A decision to progress/implement opportunities is based on a number of economic and environmental considerations:

- opportunities are prioritised based upon Net Present Value (NPV), their contribution to Woodside corporate initiatives for GHG reduction, and the confidence of return (CoR) to ensure efficient capital allocation. The CoR is estimated based upon maturity, complexity, technology novelty and ease of implementation
- NPV and value / investment ratio (VIR) are calculated using the NWS Project Gas Economic Screening Portal, which is used to estimate the benefit for each opportunity
- production enhancing opportunities need to meet set criteria to be considered economic and reviewed for recommendation. Opportunities may not be recommended if economics are marginal and there is low probability of success, however opportunities that do not meet the economic criteria can still be recommended if there is environmental/strategic merit (e.g. emissions reduction benefit).

The full ORP Opportunity Lifecycle process is shown in **Figure 3-1**.

Figure 3-1: Optimisation Reference Plan - Opportunity Lifecycle Process

3.1.6 Corporate Initiatives

Methane Guiding Principles

In April 2018, Woodside became a signatory to the Methane Guiding Principles[1], an initiative to reduce methane emissions across the natural gas value chain. Woodside's methane emissions are approximately 4% of total operated emissions (CO_2-equivalent basis). Reducing methane emissions supports the goal of reducing (net) emissions.

[1] Reducing methane emissions across the natural gas value chain guiding principles: https://files.woodside/docs/default-source/sustainability-documents/climate-change/reducing-methane-guiding-principles-april-2018.pdf?sfvrsn=a92de0bd_6

Each signatory is committed to undertake the principles and implement them by way of a defined action plan. Woodside's priority activities to deliver on the Guiding Principles in the near term include:

- Conducting a methane emissions survey at the KGP;
- Delivering methane emissions reductions through the ORP; and
- Improving leak detection and repair programs across all facilities.

3.2 Regulatory Management Mechanisms Relevant to this GHGMP

3.2.1 Commonwealth Regulation and Policy

3.2.1.1 National Greenhouse and Energy Reporting (NGER)

The NGER Act was introduced in 2007 and is a single national framework for reporting and disseminating company information about GHG emissions, energy production, energy consumption. and other information specified under the NGER Act.

The objectives of the NGER Scheme are to:

- inform government policy and the Australian public
- help meet Australia's international reporting obligations
- assist Commonwealth, State and Territory government programs and activities
- avoid duplicating reporting requirements in the states and territories.

The methods and criteria for calculating GHG emissions and energy data under the NGER Act are detailed in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (DoEE, 2008). NWS Project emissions are reported annually under the NGER Scheme.

Safeguarding Mechanism Baselining

The Emissions Reduction Fund (ERF) is the central component of the Commonwealth Government's Climate Solutions Package, which has a primary goal to deliver on Australia's nationally determined contribution under the Paris Agreement, to 'reduce emissions by 26 – 28% below 2005 levels by 2030'. The ERF is enacted through the *Carbon Credits (Carbon Farming Initiative) Act 2011.* The ERF has three key elements: crediting, purchasing, and safeguarding emission reductions.

The Safeguard Mechanism (SGM) seeks to impose limits on large GHG-emitting facilities to ensure that net emissions are kept below a defined baseline in accordance with the National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (SGM) administered by the Clean Energy Regulator. The SGM applies to facilities with Scope 1 emissions (covered emissions) of more than 100,000 tonnes of CO_2e per year.

Baselines have been set by either taking the historical highpoint of emissions between FY 2009/10 to FY 2013/14 (for existing facilities) or by site-specific emission factors based on production forecasts (for new facilities). Currently, the NWS Project (defined as KGP, offshore platforms and a floating production storage offloading facility) has a baseline of 7.57 mtpa CO_2e per financial year (SGM baseline). If emissions exceed this baseline, the NWS Project can either use one of the compliance clauses within the SGM (if eligible) or purchase allowable offsets to bring net emissions number below its baseline.

The SGM was amended in March 2019 and will require all large emitters to re-apply for a new baseline before October 2020. This updated baseline will be published after approval from the Clean Energy Regulator.

3.2.2 State Regulation and Policy

In August 2019, the Western Australian Government announced its Greenhouse Gas Emissions Policy for Major Projects (State GHG Policy) to guide Government decision making for major projects

that are assessed by the EPA. The Minister for the Environment will consider the particular characteristics of each project and the advice and recommendations of the EPA.

In this context, Woodside has included this GHGMP as an Appendix to the ERD for the Proposal to be reviewed by EPA, key DMAs and the general public as part of the assessment process for the ERD. **Table 3-1** details how the contents of a GHG Management Plan (as defined by the State GHG Policy), is proposed to be addressed.

Table 3-1: Addressing Contents of GHGMP per State GHG Policy

State GHG Policy on Contents of the Plan	Woodside response
The policy supports the development of GHGMPs for proponents which: Outline strategies to avoid, reduce, mitigate and offset the project's direct (Scope 1) emissions contributing towards the State's aspiration of net zero by 2050	The NWS Project Extension is a significant opportunity for Western Australia that will enable the development of further natural gas resources and the use of established processing infrastructure for decades to come. The additional pipeline gas that the State will receive under its Domestic Gas Reservation Policy will contribute to the State's 2050 net zero target by extending access to natural gas. Natural gas is both the lowest carbon fossil fuel and also enables greater use of renewables by matching their intermittent nature with dispatchable power.Strategies to avoid, reduce and mitigate Scope 1 emissions from the Proposal are outlined in **Section 4**. They include LNG Train Design considerations, improvement opportunities, and the setting of annual fuel and flare targets. The Proposal scope is for an extension in duration of operation rather than construction of new infrastructure (i.e. LNG Trains). This use of established infrastructure means that wholesale reductions in emissions are difficult to achieve. Strategies to offset emissions are encompassed in the Proposal's compliance with the Safeguard Mechanism. The supporting regulations of the Safeguard Mechanism establish the allowable methodologies for valid offsets. Woodside anticipates that additional emissions reductions may be achieved via ongoing application of the ORP process; agreed by the NWSJV on an annual basis.
Are unique to a proposal's specific circumstances	The Proposal for extension of life of an existing facility designed to produce low emissions natural gas fuel into domestic and international markets. The costs associated with modifying an existing operating facility are significantly higher than for modifying the design of a new facility. Despite this, emissions from the Proposal are not significantly greater than emissions from the most recently constructed Australian LNG facilities. The Proposal will deliver pipeline and export natural gas will contribute to meeting the world's energy needs and reduce emissions by avoiding the use of higher-carbon fuels whilst also partnering with renewables, as a dispatchable power source that can enable their greater use. These downstream customer benefits (Scope 3 benefits) are outside the scope of this regulatory approval but inform consideration of the Proposal's specific circumstances.
Allow proponents to take account of opportunities at either facility level or across national operations	The Proposal is made by the NWSJV, which itself does not have additional operations. Its respective owners may do, but these are not part of the scope of this document.
Allow proponents to propose their own timeframes and targets;	The current Commonwealth requirements are included in the Federal Government's Climate Solutions Package which sets out how Australia will meet its initial Nationally Determined Contribution (NDC) (to 2030) under the Paris Agreement. The Safeguard Mechanism sets the limits (baselines) allowable for industrial emitters such as the Proposal that are consistent with achieving the NDC.

Include requirements for periodic public reporting against their targets; and Account for and align with Commonwealth requirements.	The revised baseline for the Proposal under the Safeguard Mechanism is currently being determined. Further targets may be established as part of the Commonwealth's future consideration of further NDCs under the Paris Agreement. Reporting will be undertaken in accordance with the NGER Act. This GHGMP includes a Management Action to implement greenhouse reduction initiatives that either avoid, reduce or offset 330,000 tonnes CO_2e from the Karratha Gas Plant by 2030.
Consistent with the Government's focus on economic development and diversification, plans that include undertakings to develop Western Australian expertise, carry out research, pilot new initiatives and technologies, and support local communities are encouraged.	Woodside will ensure benefits to local communities and local industry participation via the NWS Project Extension Proposal.

4. EMP Provisions

This section describes the provisions of this GHGMP, which when implemented, will achieve the objective of the air quality (greenhouse gas emissions) environment factor and the objective of this GHGMP, uphold the relevant environmental values and manage impact to air quality from the Proposal. Woodside has incorporated a suite of contemporary best practice management and mitigation measures (each included as Management Actions) to ensure ongoing, long-term reduction in Greenhouse Gas emissions will be achieved. **Table 4-1** lists the management-based provisions that will be implemented with the Proposal. These are based on the rationale and approach described in **Section 2.4**.

4.1 Management Based Provisions Summary

Table 4-1: Management-based Provisions

Management Actions	Targets	Monitoring	Reporting
MA1: Establish and achieve an interim emissions target.	Implement greenhouse reduction initiatives that either avoid, reduce or offset 330,000 tonnes CO_2e annually from the Karratha Gas Plant by 2030.	Performance against targets will be monitored. The magnitude of any reductions achieved by each reduction initiative is to be independently verified by an auditor accredited under the NGER Act.	Reporting on outcomes of reduction initiatives within the Annual Environment Report.
MA2: Continue to identify and adopt practicable management and mitigation measures to reduce GHG emissions from the Proposal	Optimisation and opportunity management processes will continue to be implemented to identify and prioritise enhancement opportunities including improving energy efficiency, reducing fuel use and intensity and minimising flaring.	Identify and assess opportunities in accordance with the Production Optimisation and Opportunity Management Procedure.	Identified opportunities tracked in the relevant optimisation reference plan. A summary of delivered opportunities will be presented in the Annual Environment Report (AER).
MA3: Fuel and flare targets are set annually to drive continuous improvement	Annual targets for the amount of gas to be flared and fuel to be consumed by the Proposal will be established.	Performance against targets will be monitored. Potential sources or causes for exceedance will be explained.	Performance against flare and fuel targets summarised in AER
MA4: Routine emissions monitoring and reporting is undertaken in accordance with the National Greenhouse and Energy Reporting Act	Direct GHG emissions (e.g. fuel, flare, fugitive and venting emissions) from the proposal will be measured and reported in accordance with the NGER Act.	Scope 1 and 2 emissions will be measured in accordance with the requirements of the National Greenhouse and Energy Reporting Measurement Determination. Monthly compositional analysis of fuel gas in compliance with NGER Act.	Annual reporting of emissions is performed in accordance with the NGER Act. Emissions from the NWS Project (including offshore and FPSO) will be reported annually through the SGM.

Management Actions	Targets	Monitoring	Reporting
MA5: Monitor relevant changes and modifications to Proposal to prevent GHG emissions from exceeding 7.7mtpa	Potential GHG emissions changes will be assessed in accordance with the opportunity management process or Management of Change to ensure that changes or modifications will not result in total GHG emissions exceeding 7.7 mtpa CO_2e	Any relevant changes or modifications will be reviewed and impact on GHG emissions generation will be assessed.	Exceedance of the Scope 1 emissions limit will be reported to DWER in the Annual Audit Compliance Report.
MA 6: Implement KGP Energy Management Plan to manage GHG emissions	The KGP Energy Management Plan (or equivalent) covering material energy sources from the Proposal will be implemented to improve energy efficiency monitoring and describes the process for executing improvement opportunities.	Performance against management measures within the Energy Management Plan will be tracked at frequency appropriate to the nature of the measure through established internal reporting mechanisms.	Performance against management measures within the Energy Management Plan will be reported internally
MA 7: Comply with Safeguard Mechanism to maintain emissions within NWS Project baseline	Proposal emissions will be managed to ensure net emissions are below the SGM baseline. Allowable offsets will be purchased and surrendered equivalent to the amount of emissions above the baseline level.	Monitoring of net emissions performed in accordance with MA 3. Monitoring of annual volume of offsets required, purchased and surrendered in accordance with SGM.	Summary of purchase and surrender of allowable offsets included in AER and published as part of annual SGM data tables by the Clean Energy Regulator.
MA 8: Adherence to Methane Guiding Principles	Management of methane emissions performed in accordance with the Methane Guiding Principles.	Methane reduction initiatives monitored through the implementation of the ORP	Performance against the Methane Guiding Principles will be monitored internally. Methane emissions reported annually in Woodside Sustainability Report.
MA 9: Undertake 5-yearly assessment of reasonable and practicable emission reduction equipment and technologies that could be implemented to	Assessment will identify practicable and reasonable opportunities and their feasibility of implementation to improve GHG	Any relevant changes or modifications will be reviewed and impact on GHG emissions generation will be assessed.	Summary of assessment presented in AER every 5 years.

Management Actions	Targets	Monitoring	Reporting
improve GHG emissions.	emissions performance.		

4.2 Management Actions

4.2.1 MA 1 - Establish and achieve an interim emissions target.

Woodside has a demonstrated history of implementing emissions reduction opportunities at the Karratha Gas Plant and continues to identify new opportunities each year. Woodside has identified all reasonable and practicable management measures, emissions reduction equipment and technologies for GHG emissions reductions.

Woodside is making a commitment to avoid, reduce or offset 330,000 tpa CO_2e from the Karratha Gas Plant by 2030. As part of this GHGMP, Woodside will achieve demonstrable emissions reductions from KGP equivalent or greater than this by 2030. There are a range of other emissions opportunities being pursued by Woodside, particularly through the ORP process (MA2), but have not undergone sufficient engineering or design stages to provide certainty as to the magnitude of the expected reduction or their expected timing.

This emissions reduction target is complemented by the 8 other management actions within this plan, all of which aim to achieve ongoing reductions in greenhouse gas emissions and improvements to emissions intensity, as has been demonstrated consistently throughout the operation of the NWS to date.

The quantity of emissions avoided, reduced or offset in accordance with MA1 will be reported annually in the Annual Environment Report. To verify the accuracy of values reported against MA1, an Auditor on the Register of Greenhouse and Energy Auditors, established under section 75A of the NGER Act, will be commissioned to conduct an independent review of reported figures. This is to independently verify the accuracy of reported values.

4.2.2 MA 2 – Continue to identify and adopt practicable and efficient technologies to reduce greenhouse gas emissions from the Proposal

Process for Continuous Identification of Additional Emission Reduction Opportunities

The ORP process is used to identify cost efficient and practicable efficiency opportunities at NWS Project facilities. Energy efficiency opportunities can be identified at any time, however annual workshops are the major contributor to opportunity/idea generation. Opportunities are evaluated by the value of the proposition and the confidence of return, in accordance with the Production Optimisation Process (refer to **Section 3.1.5**), while considering other emissions reduction requirements (i.e. methane guiding principles). These workshops are typically conducted annually, enabling the output to feed into the following year's budgeting cycle. Each budget approved opportunity is then planned for execution, and implementation tracked and reported as part of the ORP process.

A summary of opportunities that have been recently implemented or to be implemented are presented in **Table 4-2.**

Table 4-2: Emission Reduction Opportunities identified under the Optimisation Reference Plan (ORP)

Trains	Opportunities Identified under the ORP	Estimated Emission Savings
Implemented		
LNG Trains 1-3	Stage 1 of the LNG 1 - 3 Mixed Refrigerant Optimisation Project was implemented at the KGP. The project increased LNG Production on LNG 1 - 3 through installing a pressure gauge at the base of the main cryogenic heat exchanger (MCHE) on each train to observe liquid level and implementing modifications to the APC system. The project delivered an increase in production and improvement to energy efficiency for no extra power demand.	Emission Intensity Improvement Opportunity

Trains	Opportunities Identified under the ORP	Estimated Emission Savings
LNG Trains 4 - 5	Efficient Particulate Air Filters (EPAs) installed on LNG 5 to reduce turbine axial air compressor fouling to improve efficiency of turbines and increase available power. The project delivered an increase in available power for no additional emissions.	Emission Intensity Improvement Opportunity
	Optimisation of operating conditions for the LNG 4 - 5 AGRU process in order to increase methane recovery and reduce vented methane from this system.	12 kt CO_2e per year
Domgas	A Domgas K2420 (compressor) was switched off over the 2018/19 summer period for fuel gas savings when capacity was not required. During winter months when LNG rates are higher and therefore HP fuel gas production is higher, it is required to have two K2420's online to avoid backing out the HP fuel gas header and causing excessive flaring.	12 kt CO_2e per year
Considered for Implementation		
All trains	Woodside is investigating an opportunity to reduce fuel gas consumption at KGP by reducing power generation spinning reserve to a permanent N + 1 – 10MW philosophy. Fuel gas savings can be achieved by biasing loading from the Frame 5 Gas Turbine Generators (GTGs) to the more efficient LM 6000's GTGs. Reducing fuel gas usage can deliver substantial CO_2e savings. Final decision regarding the opportunity will include, but not be limited to, consideration of safety risk, potential production impact, fuel gas savings and economic and environmental impacts.	Forecasted average of 44 kt CO_2e per year

LNG Train Design Considerations

Due to the nature of major infrastructure developments such as the KGP, the most efficient timing for implementing emissions reductions is during the design phase of a project lifecycle. There are significant additional costs incurred in retrofitting an existing, active operational facility. As demonstration to the significant reductions achieved in the design of KGP, **Table 4-3** summarises key design elements that have been incorporated into the NWS Project LNG trains.

Table 4-3: Design Emission Reduction Technologies

Trains	Emission Reduction Technologies Applied during Design	Potential mt CO_2e Savings (annually)
	Avoid	
LNG Trains 1 - 3	• Re-route of flash gas generated during the acid gas removal process, to prevent gas being flared and instead be utilised as a low pressure fuel source.	0.5
	Minimise	
	• Solvent change-over from sulfinol to activated methyl diethanolamine (aMDEA), to significantly reduce the co-absorption and subsequent venting of methane.	0.35
LNG Trains 4 - 5	**Avoid**	
	• Propane pre-cooled / mixed refrigerant (C3/MR) liquefaction process employing high efficiency Frame 7 gas turbines with power recovery via hydraulic turbines.	0.552

	• Use of high-efficiency, aero-derivative gas turbines for electrical power generation to reduce generation of GHG emissions.	0.148
	• Installation of a waste heat recovery unit (WHRU) on the exhaust of the Frame 7 gas turbine driving the propane compressor. The WHRU provides heat to the process via the heated water system, and to regenerate the molecular sieve adsorber beds, used for feed gas dehydration. Harvesting of waste heat avoids the need for separate fired heaters, fuel gas consumption and emissions.	0.171
	• Routing flash gas from the horizontal three phase separator of the AGRU to the low pressure fuel gas system, avoiding flaring.	0.489
	Minimise	
	• The use of activated methyl diethanolamine (aMDEA) to reduce co-absorption of hydrocarbons in the AGRU	~ 0.001
	• Routing the start-up vent from the AGRU to the flare system, rather than direct venting of the gas stream to atmosphere therefore reducing GHG emissions.	0.001
	• Utilisation of dry gas seals, or double oil seals, with seal gas losses routed back to compressor suction, to reduce venting to atmosphere.	0.060

4.2.3 MA 3 – Fuel and flare targets set annually

Corporate GHG emissions intensity target is set to support Woodside's objectives stated in the Climate Change Policy by reducing emissions intensity from a company-wide perspective incorporating emissions reduction from the ORP process.

The emissions intensity target incorporates major Scope 1 GHG emissions across Woodside operated assets whilst also considering fugitive emissions streams. Scope 2 emissions from grid-connected electricity consumption are not included in this target. Emissions estimates utilise the best available data, sourced from the fuel and flare targets, production forecasts and engineering calculations where applicable for the year in question.

Fuel and flare targets, set at a facility level, support of the achievement of the corporate target. KGP fuel and flare targets are developed annually, according to the requirements set out in Woodside's Greenhouse Gas, Energy and Flare Target Setting Guideline (Woodside ID WM0000MH1400512800). Flaring and fuel gas intensity targets are included on the monthly KGP asset scorecard and asset report.

4.2.4 MA 4 – Routine emissions monitoring and reporting is undertaken in accordance with the National Greenhouse and Energy Reporting Act

Monitoring, auditing, and reporting of GHG emissions for the Proposal is used to measure ongoing performance and provide data that aids in the identification of improvement opportunities. Monitoring, and reporting of GHG emissions is carried out in accordance with the requirements of the NGER Act.

The effectiveness of the greenhouse management minimisation measures is monitored on an ongoing basis. During monitoring, actions may be identified for improvement. Monitoring and reporting regarding completion of ORP initiatives is undertaken at a site level. Woodside currently carries out reporting to meet a number of statutory requirements. Woodside will address GHG reporting via existing procedures established to meet the requirements of the NGER Act.

Auditing of the environmental and GHG emission performance of the Proposal will include:

- internal and external environmental audits of compliance to its statutory obligations and management plans

- external auditing (as required) of GHG emissions data reporting as required under the NGER Act.

4.2.5 MA 5 – Monitor relevant changes and modifications to Proposal to prevent GHG emissions from exceeding 7.7 mtpa

The amount of CO_2e vented from KGP depends on the composition of feed gas and the CO_2e content of the hydrocarbon reservoir from which the feed was sourced. Minor modifications to the plant can also affect the amount of CO_2e venting.

Potential GHG characteristic changes from the introduction of third party gas or minor modifications to the facility will be managed in accordance with the Opportunity Management Process to ensure that gas received will not lead to GHG emissions from the NWS Project exceeding 7.7 mtpa CO_2e. This may include:

- Review of existing approvals to identify any additional requirements.
- Risk assessment which identifies any additional gas components which may impact the character of an existing emission and/or discharge.
- Engineering assessment which consider requirements for emission monitoring requirements.

4.2.6 MA 6 – Implement KGP Energy Management Plan (or equivalent) to manage GHG emissions

Woodside's Energy Management Framework requires that the KGP maintains an Energy Management Plan (or equivalent). The Energy Management Plan aims to improve efficiency monitoring and reporting, focussing including identifying opportunities to change processes or equipment to improve the maximum efficiency of the plant.

Energy efficiency improvements can be made in two key areas; process improvements and capital improvements. Both require understanding of the efficiency of current operations and efficiency losses that are being incurred, if any. Once these have been identified, improvements are required to the way these are evaluated and opportunities for improvement are executed.

4.2.7 MA 7 – Comply with Safeguard Mechanism to maintain emissions within NWS Project baseline

Under the SGM, the NWS Project is to measure its GHG emissions performance against its baseline. This baseline represents NWS Project's gross covered emissions and includes the KGP, offshore platforms and floating production storage offloading facilities. If emissions exceed this baseline, the facility can either use one of the compliance clauses within the SGM (if eligible) or purchase allowable offsets to bring net emissions number below its baseline.

4.2.8 MA 8 - Adherence to Methane Guiding Principles

Woodside is a signatory to the Methane Guiding Principles[2]. These principles, developed by the Climate and Clean Air Coalition, address priority areas for action and focus on reducing methane emissions across the natural gas value chain. In pursuing significant emission reductions through these principles, signatories will consider cost effectiveness and efficiency of the measures. Relevant guiding principles that apply to this GHGMP are:

- Principle 1 – Continually reduce methane emissions
- Principle 3 – Improve accuracy of methane emissions data

[2] Further information on the Methane Guiding Principles is available from: https://www.ccacoalition.org/en/resources/reducing-methane-emissions-across-natural-gas-value-chain-guiding-principles

- Principle 5 – Increase transparency

Woodside is preparing to undertake a methane leak detection program in Q1 2020 that will be used to inform future targeted maintenance activities.

4.2.9 MA 9 - Undertake a 5-yearly assessment of reasonable and practicable emission reduction equipment and technologies that could be implemented to improve GHG emissions.

In addition to the ORP which routinely analyses KGP operations to identify reasonable and practicable efficiency opportunities, Woodside will undertake a 5-yearly assessment of potential equipment and technologies to improve KGPs GHG emissions performance. This assessment may include consideration of best practice equipment and technology and its feasibility for implementation. Outcomes of this assessment will be summarised in the relevant annual environment report.

5. Adaptive Management and Review of the GHGMP

In line with the concept of adaptive management, the management actions presented in this GHGMP shall be monitored, reviewed, evaluated and updated, as required, considering:

- outcomes of any technical review of and evaluation of any routine emissions monitoring
- new and relevant data/information gained as a result of implementing this GHGMP, or from external sources
- effectiveness of internal processes and procedures to reduction and management of GHG emissions
- changes in State or Commonwealth legislation or policy.

With relevant updates included in a revised GHGMP. In addition, this GHGMP may be reviewed:

- based on EPA and decision-making authorities (DMAs) comments during the Environmental Review Document (ERD) approval process
- after any new or revised operating licence is issued under Part V of the EP Act
- if a new process or activity is proposed to be introduced that has the potential to alter the emissions from the Proposal (and that is not in accordance with this GHGMP)

Technical review and evaluation of the management actions outlined in this GHGMP will be conducted every five years[1] (if not initiated prior to that time) to ensure the management actions are adequately addressing the key risks and meeting EPA objectives. If, as a result of any review, any significant changes are required to be made to the monitoring program or any other aspect of this GHGMP, a revised GHGMP will be provided to the EPA for approval.

When the five-yearly review cycle is triggered, or if a significant change to either the facility, activity, or risk is identified, a revised GHGMP will be submitted to the EPA. When approved, the revised plan will be made publicly available.

[1] Frequency no more than annually.

6. Stakeholder Consultation

This GHGMP is included as an Appendix to the ERD for the Proposal (Woodside, 2019) and therefore is to be reviewed by the EPA, key DMAs, and the general public as part of the assessment process for the ERD. Comments received from the EPA and DMAs during the initial review are incorporated into this GHGMP before publication of the ERD (and associated management plans) for public review and comment. All comments received during the public review period that relate to this GHGMP are to be considered, and changes made to this GHGMP where required.

7. References

Department of Environment and Energy (DoEE) 2008. *National Greenhouse and Energy Reporting (Measurement) Determination 2008.* Australian Government, Canberra ACT. Available from: https://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/nger/determination [Accessed June 2019]

Department of Justice 2019. *Environmental Protection Act 1986.* Government of Western Australia, Perth WA. Available from: https://www.legislation.gov.au/Details/C2019C00044 [Accessed May 2019]

Environment Protection Authority (EPA) 2016. *Environmental Factor Guideline: Air Quality.* Environmental Protection Authority, Perth WA. Available from: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Guideline-Air-Quality-131216_3.pdf [Accessed May 2019]

Environmental Protection Authority (EPA) 2018a. *Statement of Environmental Principles, Factors and Objectives.* Environmental Protection Authority, Perth WA. Available from: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Statement%20of%20Environmental%20Principles%2C%20factors%20and%20objectives_29062018.pdf [Accessed May 2019].

Environmental Protection Authority (EPA) 2018b. *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans*. Environmental Protection Authority, Perth WA. Available from: http://epa.wa.gov.au/sites/default/files/Forms_and_Templates/Instructions%20and%20template%20-%20Part%20IV%20EMPs%20260418.pdf [Accessed April 2019]

Environmental Protection Authority (EPA) 2019. *Ministerial Statement 0536 – North West Shelf Gas Project Additional Liquefied Natural Gas Facilities.* Environmental Protection Authority, Perth, Western Australia. Available from: http://www.epa.wa.gov.au/0536-north-west-shelf-gas-project-additional-liquefied-natural-gas-facilities [Accessed May 2019].

Office of Parliamentary Counsel 2019. *National Greenhouse and Energy Reporting Act 2007*. Federal Register of Legislation, Government of Australia, Canberra ACT. Available from: https://www.legislation.gov.au/Details/C2019C00044 [Accessed May 2019]

Woodside 2004. *LNG Expansion Project Greenhouse Gas Management Plan*. Woodside Energy Limited, Perth, WA. Woodside ID: L0000AH152154

Woodside 2018a. *Karratha Gas Plant Energy Management Plan.* Woodside Energy Limited, Perth WA. Woodside ID: 1400808750

Woodside 2018b. *North West Shelf Optimisation Reference Plan.* Woodside Energy Limited, Perth WA. Woodside ID: G2000AG1400621738

Woodside 2019. *North West Shelf Project Extension Environmental Review Document.* Woodside Energy Limited, Perth, WA. Woodside ID: G2000RF1401194374

8. Terms

Terms	Definitions
CO_2	Carbon dioxide
CH_4	Methane
CO_2e	Carbon dioxide equivalent
DMP	Department of Mines and Petroleum
DoE	Former Western Australian Department of Environment (now Department of Water and Environmental Regulation)
DEC	Department of Environment and Conservation
DMIRS	Western Australian Department of Mines, Industry Regulation and Safety
DoEE	The Commonwealth of Australia's Department of the Environment and Energy
DPLH	Western Australian Department of Planning, Lands and Heritage
DWER	Western Australian Department of Water and Environmental Regulation
EP Act	*Environmental Protection Act 1986* (Western Australia)
EPA	Western Australian Environmental Protection Authority
ha	Hectare
HVAC	Heating, Ventilation and Air Conditioning.
KGP	Karratha Gas Plant
km	Kilometre
ktpa	Thousand tonnes per annum
LNG	Liquefied natural gas
MCHE	main cryonic heat exchanger
MS	Ministerial Statement (Western Australian)
mtpa	Million tonnes per annum
NGER	National Greenhouse and Energy Reporting
N_2O	Nitrous oxide
NO_x	Nitrogen oxides
NWS	North West Shelf
NWS Project	The North West Shelf (NWS) Project is one of the world's largest LNG producers, supplying oil and gas to Australian and international markets from

Terms	Definitions
	offshore gas, oil, and condensate fields in the Carnarvon Basin off the north-west coast of Australia. The NWS Project is owned by the NWSJV participants and for more than 30 years, it has been WA's largest producer of domestic gas. The NWS Project currently processes resources owned by the NWSJV and CNOOC NWS Private Limited; it is proposed to also process third-party gas and fluids as part of the NWS Project Extension Proposal.
NWSJV	North West Shelf Joint Venture. A joint venture comprising six companies: Woodside Energy Ltd. (operator), BHP Billiton Petroleum (North West Shelf) Pty Ltd, BP Developments Australia Ltd, Chevron Australia Pty Ltd, Japan Australia LNG (MIMI) Pty Ltd, and Shell Australia Pty Ltd. The NWSJV owns the infrastructure used as part of the NWS Project and, together with CNOOC NWS Private Limited, the NWSJV owns the resources processed as part of the NWS Project.
ORP	Optimisation Reference Plan
State Agreement	North West Gas Development (Woodside) Agreement Act 1979 (WA) (State Agreement)
t	Tonne
Third-party gas and fluids	Gas and associated fluids from sources other than those produced by the NWSJV and CNOOC NWS Private Limited. The processing of third-party gas and fluids is subject to the necessary commercial arrangements being in place between the NWSJV and the relevant third parties as well as all relevant joint venture and regulatory approvals being obtained.
WA	Western Australia
WEL	Woodside Energy Limited
Woodside	Woodside Energy Ltd., the operator of the NWS Project on behalf of the NWSJV.

North West Shelf Project Extension Greenhouse Gas Management Plan

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