Heytesbury Underground Gas Storage (HUGS) Pipeline

Attachment F

Greenhouse Gas Assessment Report

GREENHOUSE GAS EMISSIONS ASSESSMENT
PREPARED FOR
LOCHARD ENERGY
464 BOUNDARY ROAD, TIMBOON WEST VIC 3268

Prepared for: Lochard Energy

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Benbow
ENVIRONMENTAL

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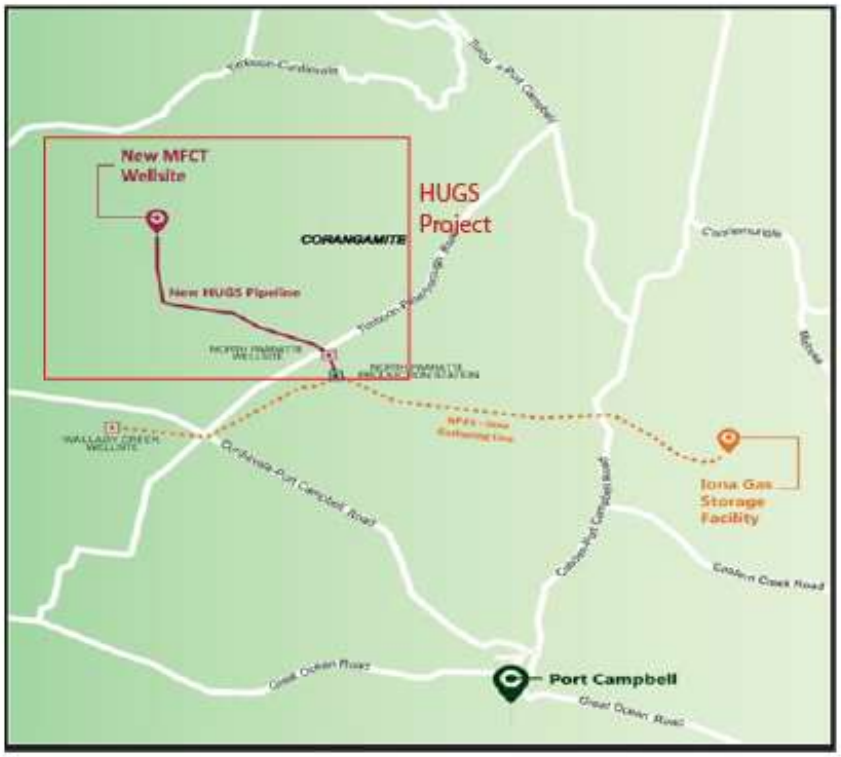
EXECUTIVE SUMMARY

Lochard Energy is the proponent of the Heytesbury Underground Gas Storage (HUGS) Project and the proposed new HUGS Pipeline, which will expand the capacity of the Iona Gas Storage Facility (IGSF). The HUGS Project is located in South West Victoria near the townships of Port Campbell and Timboon. The HUGS Project is designed to provide additional security of supply and reliability to the growing demands for energy storage in the eastern Australian energy market, which will help support the transition to a lower carbon future.

Benbow Environmental has been engaged to prepare a Greenhouse Gas Emissions Assessment (GHG) for the HUGS Project. The assessment provides an overview of the potential greenhouse gas emission impacts associated with the construction and operation of the HUGS Project and proposed new HUGS Pipeline. The GHG Assessment provides an assessment of the project against reporting thresholds under the National Greenhouse and Energy Reporting (NGER) Act, 2007.

Lochard Energy own and operate the Iona Gas Storage Facility (IGSF) which is located in Western Victoria near Port Campbell. The IGSF is a gas storage and processing facility that has a capacity of 570 TJ/d and can store 24.4 PJ of gas.

The HUGS Project will increase the IGSF capacity to 615 TJ/d through the addition of the Mylor reservoir which will be connected back into the IGSF via a new licensed pipeline.



The Mylor reservoir has previously been produced and is located in Petroleum Production License 4 (PPL-4), adjacent to Lochard's existing operations in PPL-1 and PPL-2.

HUGS PROJECT

For the HUGS Project, this report calculates Scope 1, 2 and 3 GHG emissions from the construction and operations phase, as well as scope 1, 2 and 3 GHG emissions for the decommissioning and rehabilitation phases.

The results of this assessment show that GHG emissions from the HUGS Project are primarily from the following sources:

HUGS Project	Scope 1	Scope 2	Scope 3
Construction	• Well pad construction • Drilling • Construction of permanent operating facilities	• Purchased electricity	Embodied emissions associated with: • steel construction material • concrete construction material • piping material
Operations	• Diesel for operations • Diesel for transport • Operational flaring • Operational venting and pigging • Fuel gas for compression and other equipment	• Purchased electricity	N/A
Decommissioning	• Diesel for decommissioning equipment	N/A	• Diesel for vehicles and trucks travelling to and from site
Rehabilitation	• Diesel for rehabilitation machinery • Surface reclamation	N/A	• Diesel for vehicles and trucks travelling to and from site

A summary of the calculated annual GHG emissions for the overall Lochard Energy operations, is shown in the table below.

Project Stage	Scope 1	Scope 2	Scope 3	Total
Construction	12,760 t CO_2-e	-	598 t CO_2-e	13,358 t CO_2-e
Total Operations	*Existing: 67,847 t CO_2-e Incremental: 3,055 t CO_2-e	*Existing: 3,941 t CO_2-e Incremental: 296 t CO_2-e	Incremental: 108 t CO_2-e	75,247 t CO_2-e
Decommissioning	2,786 t CO_2-e	-	110 t CO_2-e	2,896 t CO_2-e
Rehabilitation	695 t CO_2-e	-	32 t CO_2-e	727 t CO_2-e
Total (Incremental)	**19,296 t CO_2-e**	**296 t CO_2-e**	**836 t CO_2-e**	**20,440 t CO_2-e**

NOTE: The existing operational emissions refer to the overall Lochard energy operations (including Iona Gas Storage facility and all related assets). The existing t CO_2-e is based on the average over the past 5 years as emissions are very much influenced by weather and reliability of generation equipment.

Operational emissions as a result of the HUGS project are estimated to increase by approximately 3,055 t CO_2-e per annum post the commencement of HUGS. These emissions are estimated based on an expectation of increase in energy use at the Iona Gas Plant to compress the customer owned gas into and out of underground storage which consumes fuel gas to operate the gas engine and turbine driven compressors. In 2023 Fuel gas which is primarily used for compression accounted for approximately 52% of IGSF Scope 1 CO_2-e emissions. Actual annual emissions due to compression is driven by customer nominations for injection and withdrawal which varies with weather and the performance of other energy infrastructure. The increase in emissions from the HUGS project have been estimated using IGSF historical data regarding fuel gas use and has been increased proportionately (7.5%) to match the increase from 570 TJ/d to 615 TJ/d contracted capacity. The HUGS project will not affect emissions due to venting and flaring at Iona as there is no change to the volume of inventory at Iona that is vented or flared nor the number of initiating events.

Since 1 Jan 2024, electricity purchased for the IGSF will be 100% renewable energy and so any incremental electricity use for processing of HUGS gas will not have associated CO_2-e emissions.

THE HUGS PIPELINE

For the HUGS Pipeline, this report calculates Scope 1, 2 and 3 GHG emissions from the construction and operations phase, as well as scope 1, 2 and 3 GHG emissions for the decommissioning and rehabilitation phases.

The results of this assessment show that GHG emissions from the HUGS pipeline are primarily from the following sources:

HUGS Pipeline	Scope 1	Scope 2	Scope 3
Construction	• Land Clearing • Fuel Use	N/A	• Fuel Use • Construction Materials
Operations	• Fugitive Emissions	N/A	N/A
Decommissioning	• Fuel Use	N/A	• Fuel use
Rehabilitation	• Surface Reclamation	N/A	• Fuel use

A summary of the calculated predicted GHG emissions for the HUGS pipeline is shown in the table below.

	Emission Source	Scope 1	Scope 2	Scope 3	Total
Construction	Land Clearing	53.2 t CO_2-e	-	-	53.2 t CO_2-e
	Fuel Use	433 t CO_2-e	-	107 t CO_2-e	540 t CO_2-e
	Construction Materials	-	-	332 t CO_2-e	332 t CO_2-e
Operation	Fugitive Emissions	62 t CO_2-e	-	-	62 t CO_2-e
Decommissioning	Fuel Use	845 t CO_2-e	-	9 t CO_2-e	854 t CO_2-e
Rehabilitation	Surface Reclamation	40 t CO_2-e	-	-	40 t CO_2-e
	Fuel Use	-	-	6 t CO_2-e	6 t CO_2-e
Total					**1,887.2 t CO_2-e**

Emissions associated directly with the new HUGS pipeline are primarily related to frictional losses in pressure which are a minor contribution to the additional compression energy required. The majority of the pressure losses occur in the wells and gas processing infrastructure at Iona. The HUGS pipeline includes a small number of flanged joints where there is potential for fugitive emissions. Lochard utilises a process of leak detection and repair to reduce fugitive emissions.

COMPARISON AGAINST ANNUAL EMISSIONS

Emissions from the project in terms of its contribution to the state and national totals is shown in the table below.

Comparison of emissions against Australian and Victorian annual emissions

Emission Source	Emissions	% of Australia's total	% of Victoria's total
Australia (2021)	465.7 x 10^6 t CO_2-e	100%	-
Victoria (2021)	80.1 x 10^6 t CO_2-e	17.2%	100%
HUGS Pipeline	1,887.2 t CO_2-e	0.0004%	0.0024%
HUGS Project	20,440 t CO_2-e	0.0044%	0.026%
Iona Gas Processing Facility (Annual Operations)	75,247 t CO_2-e	0.016%	0.093%

The HUGS pipeline estimated construction emissions are estimated to contribute the equivalent of 0.0023% of Victoria's and 0.0004% of Australia's annual greenhouse gas emissions. The HUGS project emissions are estimated to contribute the equivalent of 0.026% of Victoria's and 0.0044%

of Australia's annual greenhouse gas emissions. The facility's estimated annual operation emissions are estimated to contribute the equivalent of 0.093% of Victoria's and 0.016% of Australia's annual greenhouse gas emissions.

The scope 1 emissions do not exceed 100,000 t CO_2-e therefore the site is not a "designated large facility" and therefore the safeguard mechanism does not apply.

The total emissions do not exceed 200,000 t CO_2-e therefore referral to the minister under Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978 is not required.

The project currently triggers the presented requirements under the NGER Scheme where reporting is required as it is part of the broader Lochard Energy business.

The majority of the carbon emissions estimated for the project are projected to occur during the existing gas storage operation phase and in comparison, the overall contribution from the construction and operation of the HUGS Project are not significant.

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Abbreviations

2P	Proved and Probable
bcf	Billion cubic feet
DEECA	Department of Energy, Environmental and Climate Action
EES	Environment Effects Statement
GHG	Green House Gas
GIP	Global Investment Partners
IGP	Iona Gas Plant
IGSF	Iona Gas Storage Facility
Lochard Energy	Lochard Energy (Iona Operations) Pty Ltd
mmscf	Million standard cubic feet
NGERS	National Greenhouse and Energy Reporting Scheme
NPPS	North Paaratte Production Station
NP	North Paaratte
PJ	Peta Joule (1×10^{15} Joules)
QIC	Queensland Investment Corporation
STP	Standard Temperature and pressure
TJ	Peta Joule (1×10^{9} Joules)
tCO_2-e	Tonnes carbon dioxide equivalent
TRSSSV	Tubing retrievable Subsurface Safety Valve
WSV	Working Storage Volume

1. INTRODUCTION

Benbow Environmental has been engaged to prepare a Greenhouse Gas Emissions Assessment (GHG) for the Heytesbury Underground Gas Storage (HUGS) Project.

The greenhouse gas emissions for the phases of construction, operation, decommission and rehabilitation have been assessed. The construction phase involves:

- The construction of a new wellsite (known as the MFCT wellsite)
- Construction of a new 5.3km DN300 licensed pipeline from the MFCT wellsite to NPPS
- Drilling of gas storage wells (including well testing)
- Minor upgrades at the Iona Gas Plant, NP wellsite and NPPS

This report calculates greenhouse gas emissions from the proposed development, as well as make recommendations regarding any necessary measures to reduce greenhouse gas emissions if required.

1.1 LOCHARD ENERGY OVERVIEW

Lochard Energy is the owner and operator of the Iona Gas Storage Facility (IGSF), located in the Otway Basin in Southwest Victoria, near the town of Port Campbell . The IGSF comprises a gas processing facility with 24.4 petajoules of underground gas storage across 4 operating gas storage fields (Iona, North Paaratte, Wallaby Creek and Seamer). Commissioned in 1999, Iona is the largest independent provider of gas storage services to the East Coast gas market. Lochard Energy is backed by Australian superannuation investors (50 percent by Queensland Investment Corporation (QIC)-owned funds and 50 percent by Australian Retirement Trust).

The IGSF is utilised to store gas on behalf of customers during periods of low gas demand. Stored gas is then reinjected into the pipelines as required by customers during high demand periods, such as winter or where energy generation sources are unavailable or operating at reduced capacity.

Iona plays a critical role in energy security and reliability for Victoria and East Coast Australia, with gas stored in our reservoirs able to be called upon during periods of high energy demand or where energy generation is unavailable or operating below capacity. Iona has capacity to supply up to 45 percent of Victoria's peak winter daily gas demand[1].

The IGSF is located within Petroleum Production Licenses (PPL's) 1 and 2 (refer to Figure 1-1).

[1] based on an export rate of 570 TJ/d and an average peak day rate of the last 5 years being 1209 TJ/d for the Victoria DTS (Declared Transmission System (source: AEMO 2024 Gas Planning report).

Figure 1-1: Location Map

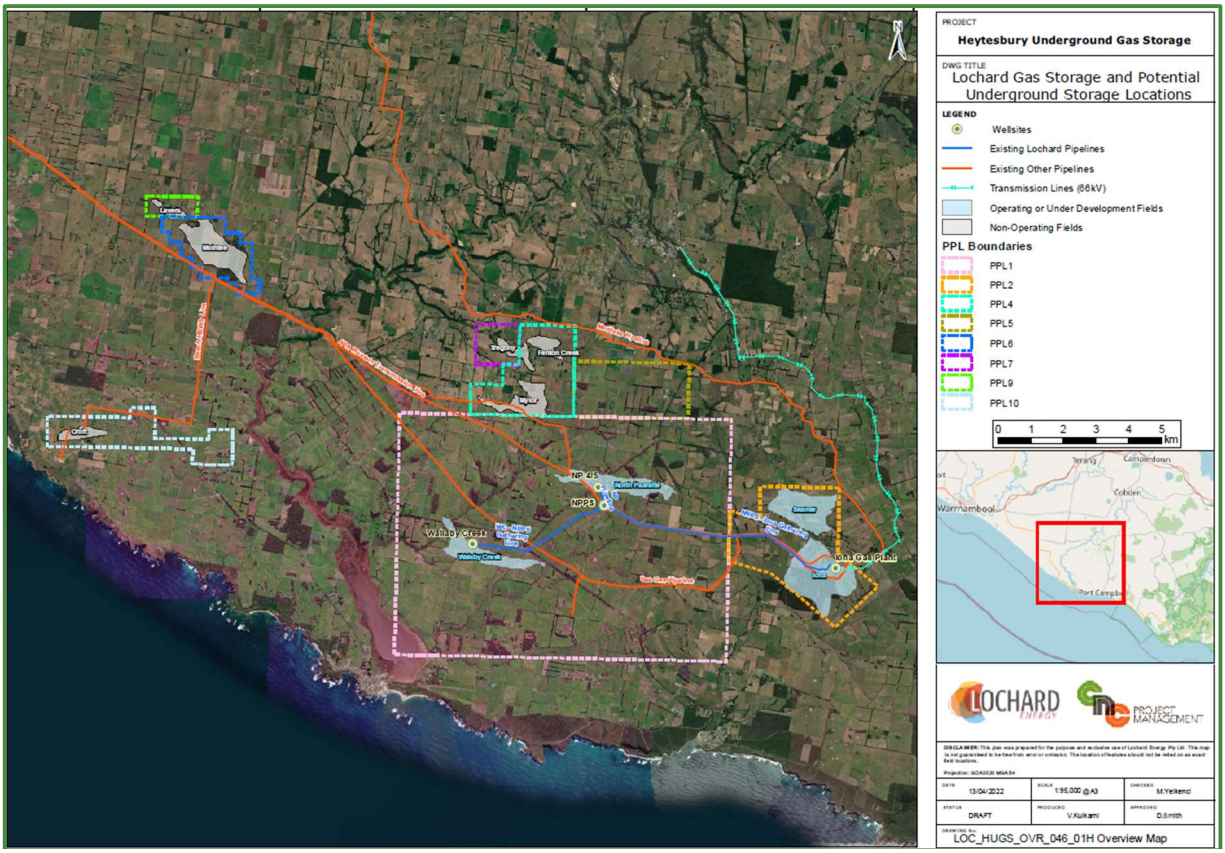
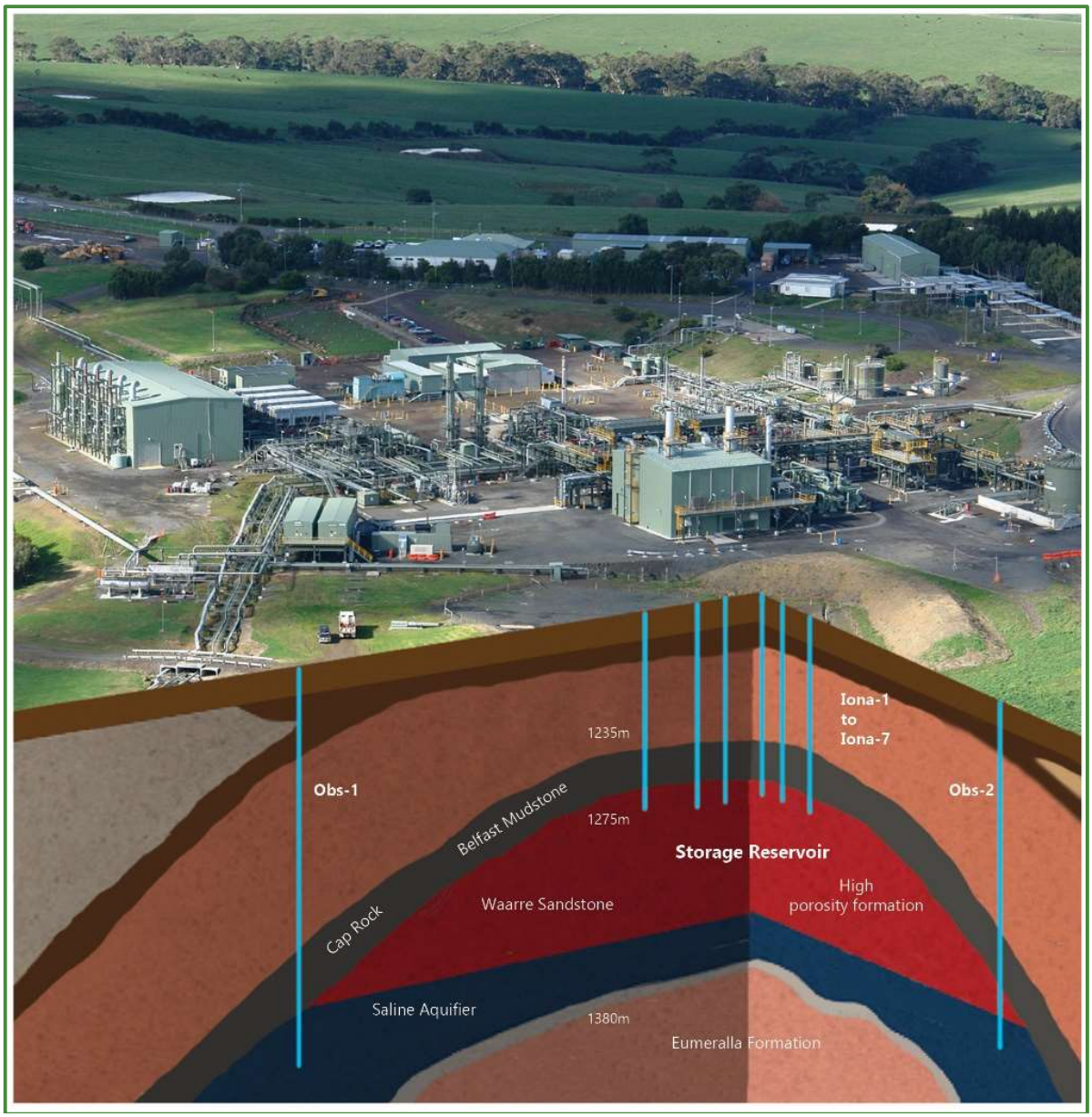


Figure 1-2: Iona Gas plant and representation of gas storage



1.2 BASIS FOR A CAPACITY INCREASE OF THE IONA GAS STORAGE FACILITY (IGSF)

The Australian Energy Market Operator (AEMO) Gas Planning Report 2024 confirmed Victorian gas usage for 2023 was 7.4PJ which is forecast to reduce to as low as 2.8PJ in 2024. It is then forecast to increase in two steps in 2026 and 2028, due to the planned retirements of Eraring coal power station in New South Wales and Victoria's Yallourn coal power station, resulting in a forecast of 9.5PJ in 2028.

Contrasting this expected increase in demand is a projected 10% decrease in peak day supply capacity, including from storage facilities, from 1,471Tj/d in 2023 to 1,324Tj/d in 2024. This will continue to decline to a volume of 882 Tj/d by 2028 (40% lower than 2023 capacity levels).

Forecasted shortfalls remain for 2027 whilst in winter 2028, forecast system demand exceeds expected supply on a 1-in-2 peak day forecast (conditions statistically expected to be experienced 1 in every 2 years).

The Victorian Gas Planning Report produced by the Australian Energy Market Operator in March 2024 outlines the role that the IGSF plays in the security of supply of gas to Victorian users.

Depletion of the Iona inventory impacts both seasonal gas supply and the daily capacity to support peak day demands.

The reliance on IGSF to meet peak demand is expected to remain critical in coming years. Falling 'swing' production capacity from Longford will mean other sources of supply will need to fill an increasing 'wedge' of peak daily supply. The IGSF plays an important role in system security and reliability by allowing our customers to withdraw their stored gas when needed to meet market demand.

In the short to medium term, IGSF is likely to become increasingly important to assist our customers to fill supply gaps in the winter months when demand is at its highest.

In addition, the role of Gas-fired Power Generation (GPG) is changing in the National Energy Market. GPG is becoming 'peakier' in transitioning to playing a 'firming' role in the market in support of renewable energy generation. It is expected that in supplying services to GPG, gas storage will also have a more 'peakier' withdrawal and injection profile when compared to historical trends.

The HUGS Project will provide greater storage capacity and export capacity to assist in flattening out the peaks and troughs of customer gas demand by providing essential supply flexibility into the domestic market.

1.3 HUGS PROJECT OVERVIEW

The storage capacity of the Mylor reservoir has been developed based on the integration of all subsurface data from seismic, regional geology data, well logs, core and fluid samples as well as previous field production performance history from the Mylor-1 well. Static geologic and dynamic simulation models have been built to characterise the reservoir and calibrated against production history.

Mylor's base case storage capacity of 1.8PJ has been assessed using a history-matched dynamic simulation model, with two planned, additional drillwells. The Mylor capacity is also benchmarked against other Onshore Otway Basin storage reservoirs as analogues.

The HUGS Project intends to increase the export capacity of the IGSF from 570TJ/day to 615TJ/day. This will enable the IGSF to help meet predicted greater peak demand for gas within the Victorian market.

The HUGS Project involves the following activities:

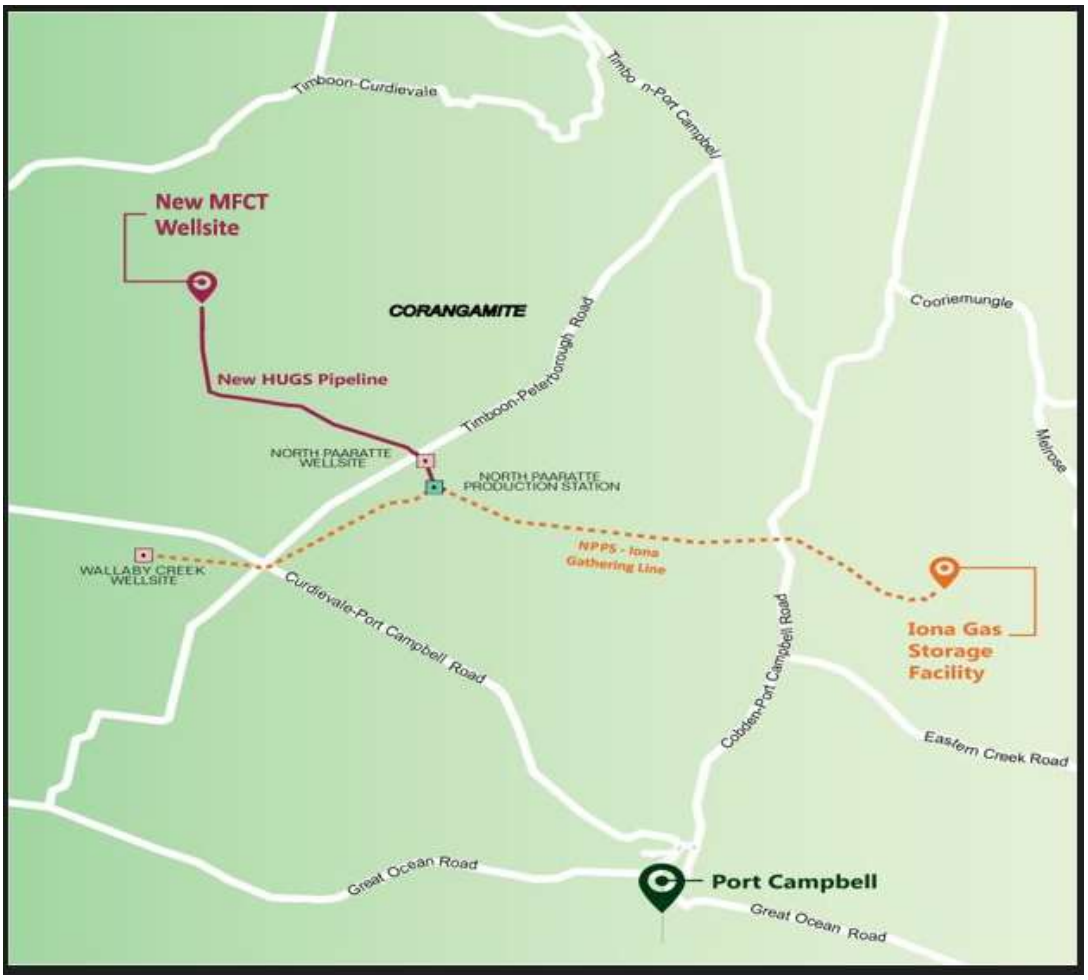
1. **'HUGS Project'**: The emissions calculations associated with the following activities are presented in Section 4 of this report:

- Construction of a new wellsite known as the MFCT wellsite
- Drilling of 2 gas storage wells into the Mylor field
- Minor upgrades at the Iona gas plant

2. **'HUGS Pipeline'**: The emissions calculations associated with the 5.3km licenced pipeline from the existing North Paaratte Production Station (NPPS) to the MFCT wellsite is presented in Section 5 of this report.

Figure 1-3 below displays the project location for information purposes.

Figure 1-3: HUGS pipeline route and location of MFCT wellsite



1.4 REPORT SCOPE OF WORKS

This Greenhouse Gas Emissions Assessment has been limited to the following scope of works:

- Assessment of the project against reporting thresholds under the *National Greenhouse and Energy Reporting (NGER) Act, 2007*;
- Description and identification of direct and indirect GHG emissions;
- Estimation of annual GHG emissions using approved equations and emission factors;

- Calculation of the variation in GHG emissions that would result from Scope 1 and Scope 2 emissions, including transportation of raw materials and waste, loading and unloading practices, fuel and electricity consumption; and
- Preparation of a GHG Assessment Report, including a statement of impacts as a result of the proposed development and recommended measures to reduce GHG emissions if required.

2. PROJECT DETAILS

2.1 MFCT SITE OVERVIEW

The MFCT site is located at 464 Boundary Road, Timboon West VIC 3268. Site identification and land use information are summarised in Table 2-1.

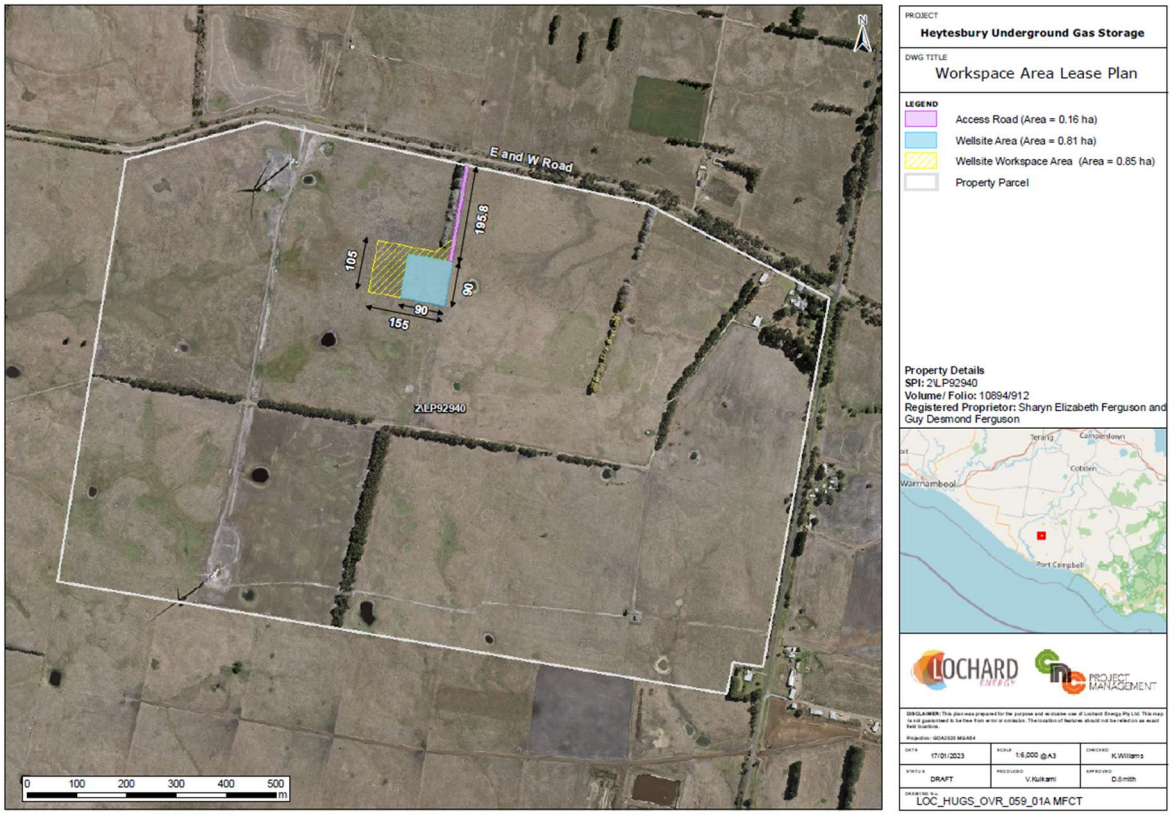
Table 2-1: Site Identification

Lot/Plan No.	Lot 2 LP92940, Lot 1 TP825070, Lot 1 TP866374
Coordinates Lat/Long	-38.57, 143.04
Local Government Area	Corangamite Shire Council
Current Land Zoning	FZ1 – Farming Zone 1

Notes: Source: https://mapshare.vic.gov.au/vicplan/

An aerial view of the site and lot boundaries are shown in Figure 2-1.

Figure 2-1: Site Location



The wellsite will be developed in stages

1. Construction of the well pad to accommodate the drilling rig
2. Drilling and completing two gas storage wells
3. Construction of aboveground gas processing facilities.

The final site will include the following features:

- Security fencing and a dedicated access track
- Flowlines to connect the wells to the HUGS pipeline

- A pipeline pig launcher
- CCTV and gas detection
- Control and shutdown system to allow remote operation from the Iona Gas Plant
- Power for the site will be provided primarily by PV cells and battery. A stand-by diesel generator will also be included for redundancy

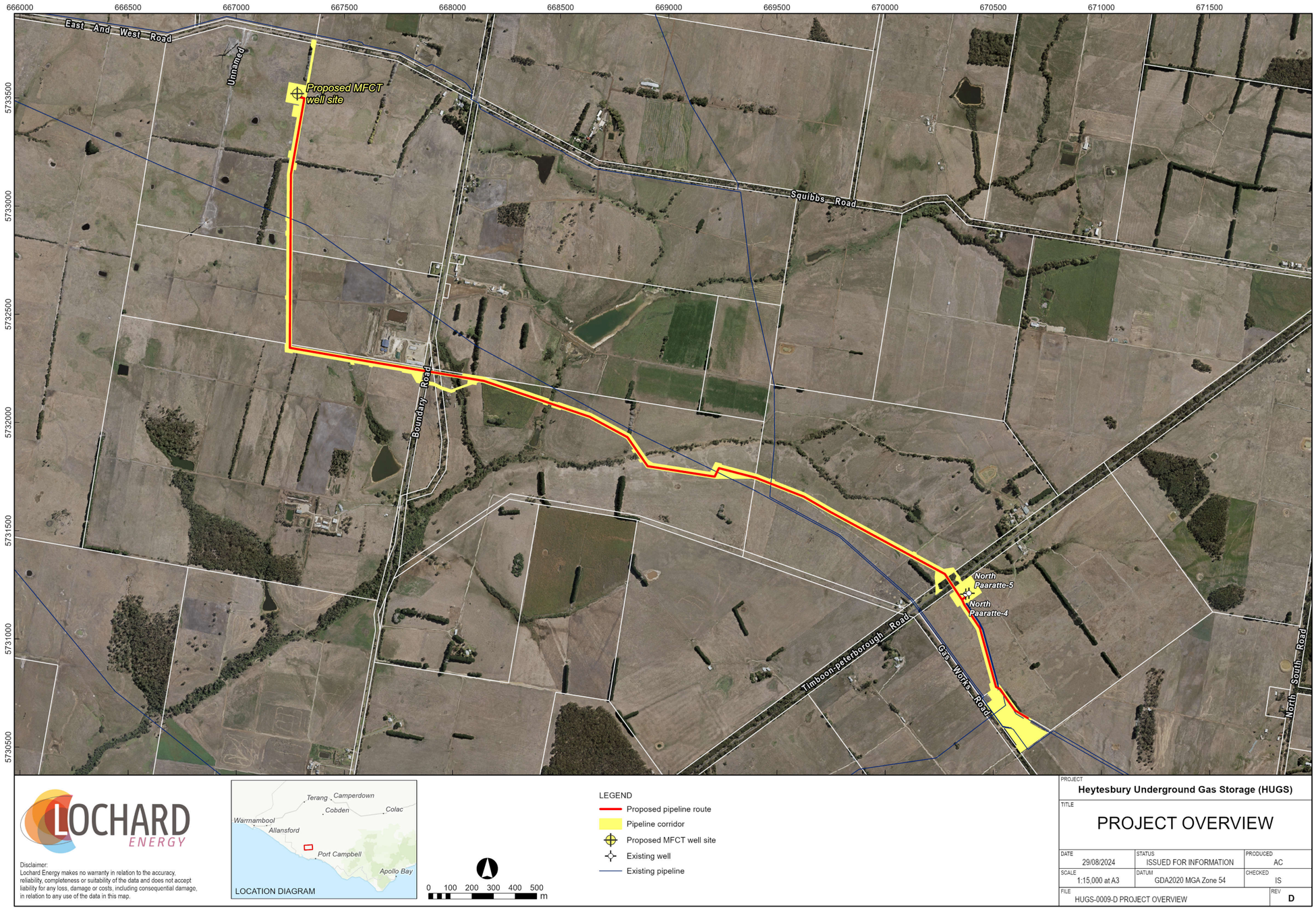
A representation of the wellsite is shown in Figure 2-2

Figure 2-2: Representation of the MFCT wellsite

2.2 PIPELINE ROUTE

The route for the new 5.3 km licensed pipeline route is shown byFigure 2-3. As can be seen by this image, the pipeline route is almost entirely through cleared farmland. An assessment undertaken by EH Partners on behalf of Lochard determined that only 0.13 ha of native vegetation would be required to be cleared for this part of the project.

Figure 2-3: HUGS Pipeline Route



2.3 OTHER WORKS

Minor works are also required at NPPS, North Paaratte Wellsite and the Iona Gas Plant as part of the HUGS Project. These include:

- Upgrade of piping at the North Paaratte wellsite and NPPS to connect to the new HUGS pipeline
- Minor piping augmentation at the Iona Gas Plant to allow for increased rates of injection and withdrawal from storage at North Paaratte, Wallaby Creek and Mylor fields.

Figure 2-4: Representation of the works at the North Paaratte wellsite

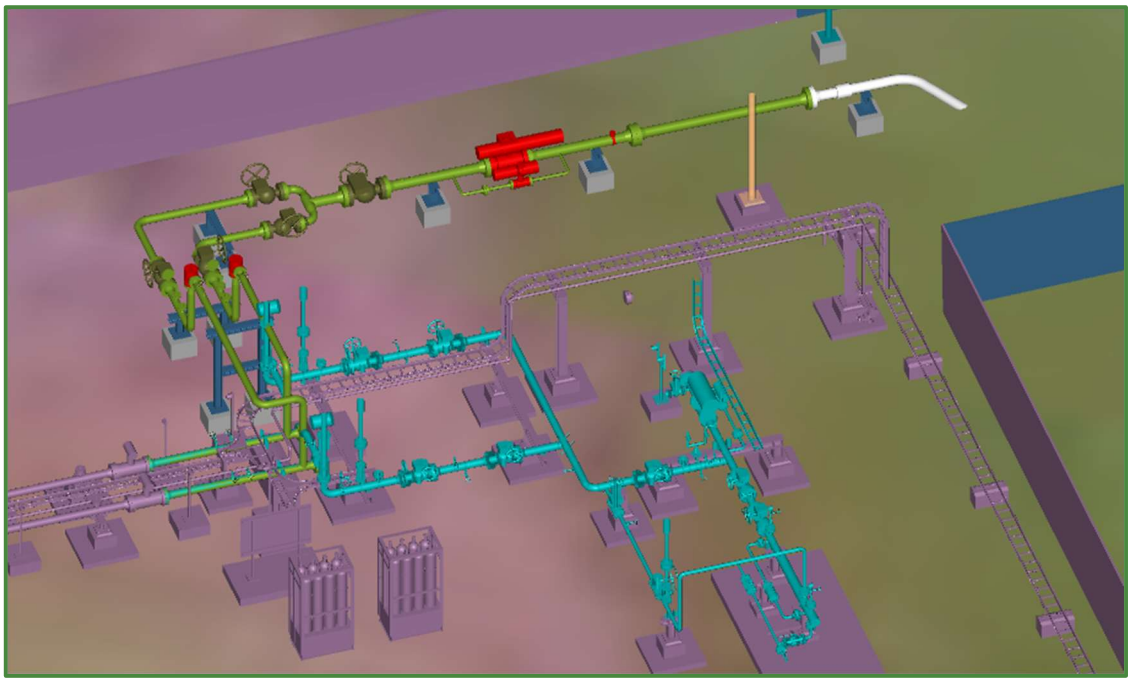
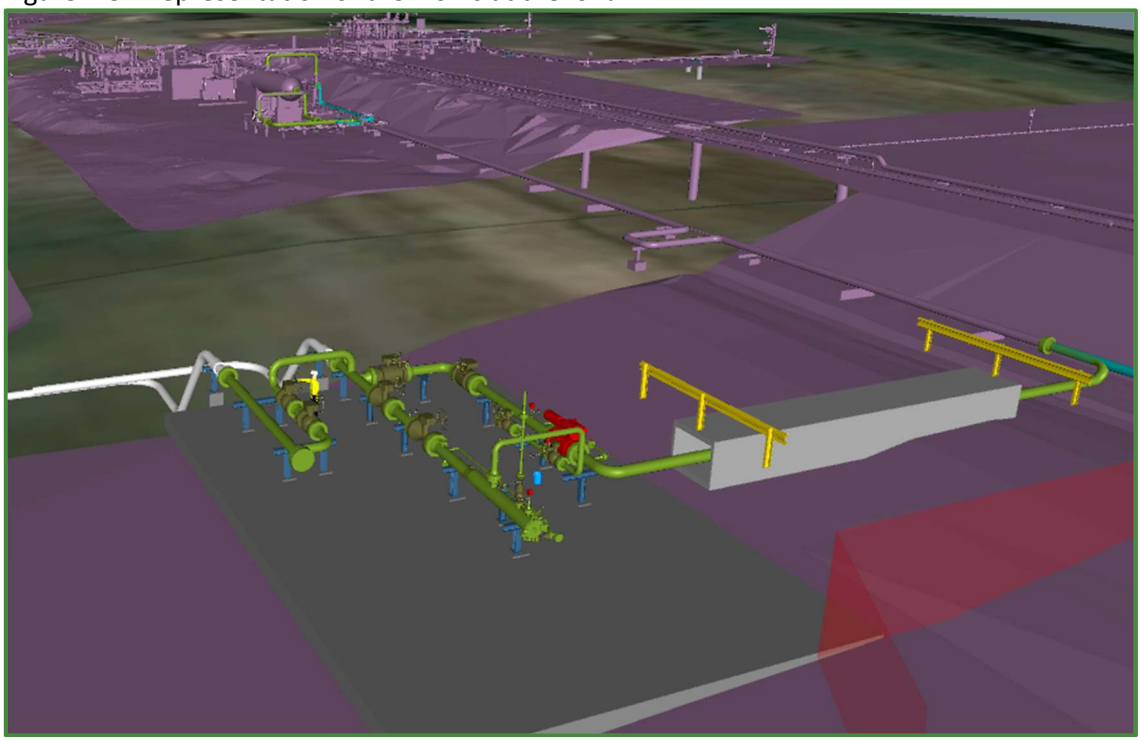


Figure 2-5: Representation of the works at the Iona



3. GREENHOUSE GASES (GHG)

3.1 HUGS PROJECT EMISSIONS

The HUGS Project is expected to produce direct and indirect greenhouse gas (GHG) emissions that are related to construction and operation. Construction emissions are mainly related to the use of diesel fuel, but are also as a result of some minor land clearing. Additionally. the use of construction materials such as concrete and piping contain embedded emissions.

As noted in previous section, the IGSF is utilised to store gas on behalf of customers during periods of low gas demand. Stored gas is then exported into the pipelines as required by customers during high demand periods, such as winter or where energy generation sources are unavailable or operating at reduced.

During operation, the primary source of direct GHG emissions are from natural gas used by the engines and turbines for the gas compressors which are used to compress gas into underground storage and then withdraw the gas for export to pipeline. The actual amount of energy required each year for compression of gas into and out of storage is dependent upon customer nominations which are driven by the demand for gas in the market. Some emissions due to gas use at the IGSF is not expected to change as a result of the HUGS project. This includes emissions associated with venting and flaring at the Iona Gas Plant which will not change as there is no change to the volume of inventory at Iona that is vented or flared nor the number of initiating events.

The emissions associated with compression have been estimated based on an expectation of increase in energy use at the Iona Gas Plant to compress the customer owned gas into and out of underground storage. The HUGS project will increase the contracted level of capacity by 7.5% as the site moves from a contracted level of capacity of 570 TJ/d to 615 TJ/d. In 2023 Fuel gas which is primarily used for compression accounted for approximately 52% of IGSF Scope 1 CO2-e emissions. The increase in emissions from the HUGS project have been estimated using IGSF historical data regarding fuel gas use and has been increased proportionately (7.5%) to match the increase from 570 TJ/d to 615 TJ/d contracted capacity.

Since 1 Jan 2024, electricity purchased for the IGSF will be 100% renewable energy and so any incremental electricity use for processing of HUGS gas will not have associated CO2-e emissions.

The scope of this GHG assessment includes the following:

- Assessment of the project against reporting thresholds under the *National Greenhouse and Energy Reporting (NGER) Act, 2007*;
- Description and identification of direct and indirect GHG emissions;
- Estimation of annual GHG emissions using approved equations and emission factors;
- Calculation of the variation in GHG emissions that would result from Scope 1 and Scope 2 emissions, including transportation of raw materials and waste, loading and unloading practices, fuel and electricity consumption; and
- Recommended measures to reduce GHG emissions.

3.2 GHG STANDARDS & GUIDELINES

The following legislation, standards, sources and guidelines have been used as part of this greenhouse gas (GHG) assessment:

- *National Greenhouse and Energy Reporting Act 2007* (NGER Act);
- Australian Standard AS ISO 14064.1: 2018– "Greenhouse gases" – "Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals";
- Department of Industry, August 2023. *Australian National Greenhouse Accounts – National Greenhouse Accounts Factors;*
- Australian Government, August 2023. *National Greenhouse and Energy Reporting Measurement Determination;*
- Department of Industry, 2023. *Australian National Greenhouse Accounts, Quarterly Update of Australia's National Greenhouse Gas Inventory, March Quarter 2023;* and
- Greenhouse Gas Protocol, revised edition 2015. *Corporate Accounting and Reporting Standard*.
- *Climate Change Act 2022* Australian Federal Parliament
- *Climate Change Act 2017* Victorian Parliament
- *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*
- *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*

3.2.1 National Greenhouse and Energy Reporting Act 2007 (NGER Act)

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) would apply to the development of the subject land. The National Greenhouse and Energy Reporting (NGER) Scheme is a single national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

The NGER Act applies to the entire corporate activities of Controlling Corporations, not individual sites or activities in isolation of the Group.

Corporations that meet a NGER Scheme threshold must register and report each year. Current facility and corporate group thresholds are listed below:

Facility threshold:

- 25 kt or more of greenhouse gases (CO_2-e) (scope 1 and scope 2 emissions);
- Production of 100 TJ or more of energy; or
- Consumption of 100 TJ or more of energy.

Corporate Group threshold:

- 50 kt or more of greenhouse gases (CO_2-e) (scope 1 and scope 2 emissions);
- Production of 200 TJ or more of energy; or
- Consumption of 200 TJ or more of energy.

In addition, in relation to designated large facilities 22XJ(1)(b):

Designated large facility

(1) For the purposes of this Act, a facility is a designated large facility for a financial year if:

(a) the total amount of covered emissions of greenhouse gases from the operation of the facility during the financial year has a carbon dioxide equivalence of a particular number of tonnes; and

(b) that number exceeds the number specified in the safeguard rules.

(2) The Minister must take all reasonable steps to ensure that safeguard rules are in force for the purposes of paragraph (1)(b) at all times on and after the safeguard commencement day.

The following section details the threshold relevant for triggering a designated large facility.

3.2.2 National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015

Under National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 Designated large facility threshold:

For paragraph 22XJ(1)(b) of the Act, the specified number is 100,000.

Therefore, if the facility exceeds 100,000 tonnes CO2-e per annum then the Safeguard Mechanism applies to the facility. Relevant emissions are defined as scope 1 emissions, including direct emissions from fugitive emissions and emissions from fuel combustion, waste disposal, and industrial processes such as cement and steel making.

3.2.3 Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978

Under the Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978:

Referral criteria: individual potential environmental effects Individual types of potential effects on the environment that might be of regional or State significance, and therefore warrant referral of a project, are:

…

potential greenhouse gas emissions exceeding 200,000 tonnes of carbon dioxide equivalent per annum, directly attributable to the operation of the facility.

3.3 DIRECT AND INDIRECT GHG EMISSIONS

Emissions are commonly classified as direct or indirect emissions, which are defined by the GHG Protocol as:

- Direct GHG emissions are emissions from sources within the boundary of an organisation and as a result of that organisations activities; and
- Indirect GHG emissions are emissions generated in the wider economy that are a consequence of the activities of the organisation but occur at sources owned or controlled by another entity.

Direct and indirect emissions are further categorised into three broad scopes:

- Scope 1: All direct GHG emissions;
- Scope 2: Indirect emissions from consumption of purchased electricity; and
- Scope 3: Other indirect emissions from company operations such as transport related activities, outsourced activities, electricity-related activities not covered by Scope 2, or the extraction and production of materials.

3.3.1 Direct Emissions (Scope 1)

3.3.1.1 Scope 1 Emissions

Scope 1 direct GHG emissions from the HUGS Project will be generated from both construction activities and ongoing operations. The full life cycle of the project from construction, through operational life and then decommissioning and rehabilitation has been included.

3.3.2 Indirect Emissions (Scope 2 and Scope 3)

3.3.2.1 Scope 2 Emissions

Scope 2 indirect GHG emissions generated by the HUGS Project include the consumption of electricity through operational life and then decommissioning and rehabilitation of the facility.

3.3.2.2 Scope 3 Emissions

Scope 3 emissions are indirect GHG emissions not outlined in Scope 2 that are linked to the company's operations.

3.4 EMISSION FACTORS

Table 3-1 displays the emission factors adopted for the GHG assessment.

Table 3-1: Greenhouse Gas Emission Factors

	Source	Energy content factor	Emission Factor kg CO_2-e/GJ		
			CO_2	CH_4	N_2O
Scope 1	Natural Gas	0.0393 GJ/m3	51.4	0.1	0.03
	Diesel Oil	38.6 GJ/kL	69.9	0.1	0.2
Scope 2	Electricity (VIC)	-	0.85 kg CO_2-e/kWh		

3.5 ESTIMATION OF GHG EMISSIONS

The full life cycle of the project to from construction, through operational life and then decommissioning and rehabilitation has been included. The following table provides an outline the GHG Assessment for the full life cycle of the project.

Project Stage	Description	Gas Volumes & Sources	Other Sources	Scope 1	Scope 2	Scope 3
				GHG emission from direct activity at site	GHG emission at other location due to supply energy to site or Lochard gas used at other location	Indirect greenhouse gas emissions other than Scope 2 emissions that are generated in the wider economy
Construction	Mobilisation, Wellsite construction, Drilling & Connection, Demobilisation (2024-2025)	57 mmscf Flared	Liquid fuels for motors, transport	Site clearing and site establishment within construction corridor Gas flared	Nil – No Electricity Usage	Fuels associated with construction activity Embodied emissions associated with construction materials (steel and concrete)
Operations	Gas Storage Operations (2026-2041)	Gas storage cycling, fugitive plant pipelines	Electricity, fuel gas compressors, fugitive	Fuel gas driven compressors associated with storage cycling	Nil – Lochard purchases 100% renewable electricity	N/A – Fugitive emissions from operation of the pipeline and compressor station do not contribute significantly to operation impacts.

Decommissioning	Well & site decommissioning (2042)	Minor gas flared with well decommissioning	Fuel for decommissioning vehicles & machinery	Minor emissions associated with decommissioning machinery	Nil – No Electricity Usage	Fuels associated with employee commuting
Rehabilitation	Final rehabilitation of Iona site (2042-2043)	Nil	Fuel for rehabilitation vehicles & machinery	Fuel for rehabilitation vehicles & machinery	Nil – No Electricity Usage	Fuels associated with employee commuting

4. OVERALL HUGS PROJECT EMISSIONS

4.1 METHODOLOGY

The following methodologies were used to determine boundaries, identify GHG emissions sources, and estimate GHG emissions:

HUGS Project	Scope 1	Scope 2	Scope 3
Construction	• Well pad construction • Drilling • Construction of permanent operating facilities **Source:** Estimated using diesel and concrete use in similar projects including the Seamer-2 program	• Purchased electricity **Source:** Construction will use diesel generators for electricity for equipment and offices	Embodied emissions associated with • steel construction material • concrete construction material • piping material **Source:** Estimated use of steel, construction and piping material provided.
Operations	• Diesel for operations • Diesel for transport • Operational flaring • Operational venting and pigging • Fuel gas for compression & other equipment **Source:** Conservative estimate due to increase in fuel gas as the site moved from 570 TJ/d to 615 TJ/d.	• Purchased electricity **Source:** Lochard has moved to purchasing 100% renewable electricity and as such there are no additional emissions associated with electricity use.	N/A

Decommissioning	• Diesel for decommissioning equipment **Source:** Estimated using typical diesel use of machinery required and time taken for this phase of the project.	N/A	• Diesel for vehicles and trucks travelling to and from site **Source:** Estimated using typical diesel use of trucks required and time taken for this phase of the project
Rehabilitation	• Diesel for rehabilitation machinery • Surface reclamation **Source:** Estimated using typical diesel use of machinery required and time taken for this phase of the project. Surface reclamation estimates based on research conducted on land reclamation activities.	N/A	• Diesel for vehicles and trucks travelling to and from site **Source:** Estimated using typical diesel use of trucks required and time taken for this phase of the project

4.2 SCOPE 1 EMISSIONS

4.2.1 Construction Emissions

Construction emissions calculations cover the following activities:

1. Well pad construction
2. Drilling of the gas storage wells (including well testing)
3. Construction activities at Iona and MFCT wellsite to build permanent facilities (excluding pipeline construction)

4.2.1.1 Well pad construction

The first stage of construction is the development of the site so as it can accommodate the drilling rig. This predominantly involves earthworks to create a level hardstand area which will include 2 concrete well cellars. Fencing will be installed around the site. Emissions are therefore predominantly due to the use of construction equipment such as graders, excavators and the transport emissions from the import of additional fill material such as crushed rock.

Table 4-1: Scope 1 GHG calculations for well pad construction

Activity	Assumptions	Quantity	Scope 1 Emissions
Diesel for equipment	Diesel for construction equipment will consist of graders, backhoes, excavators, etc. It is assumed this work will require equipment with a fuel consumption average of 300L/hr for a total of 900 hours.	270,000 L	732 t CO_2-e
Other	2 x concrete well cellars will be installed Concrete use for scope 1 is minimal: 41m^3 of concrete assuming 0.9L onsite diesel per 1m^3 (scope 1).	36.9 L	0.12 t CO_2-e

GHG emissions from activities including the use of operational venting, the use of lube oils and wastes, native gas and condensate production and fugitive emissions including those from any sulphur hexafluoride (SF6) inventories, are considered negligible and are not included in calculations.

4.2.1.2 Drilling of gas storage wells

The HUGS project plans to drill 2 gas storage wells (Mylor-2 and Mylor-3). The assumption is that these wells are drilled in a single stage, including a drill stem test for Mylor-2 and well clean-up for both of Mylor-2 and Mylor 3. The assumptions for this phase are detailed in Table 4.

Table 4-2: Scope 1 GHG calculations for Drilling

Activity	Assumptions	Quantity	Scope 1 Emissions
Mylor well testing and clean-up and production testing.	2 x 8 hr tests flowing at 25–MM SCFD for the drill stem test as part of Mylor-2; 2 x 8 hr tests for the unloading and clean-up of Mylor-2 and Mylor 3 flowing up to 30 MM SCFD per well. This equals 36 MM SCFD total, or 38,700 GJ.	38,700 GJ	1,994 t CO_2-e
Diesel for equipment	Diesel powered equipment will be used for the drilling operations. Diesel consumption for drilling has been scaled off the recent Seamer-2 program which lasted for 45 days (commencement of	467,000 L	1,577.29 t CO_2-e

Activity	Assumptions	Quantity	Scope 1 Emissions
	drilling to release) and consumed approximately 280,000 litres of diesel. A two-well program for Mylor is the most likely case with a duration of ±75 days of rig operations. As such a basis of 467,000 litres is estimated by increasing the usage in proportion with the duration.		
Operational venting.	Venting of hydrocarbon gas will be minimal during the program. It is expected that some venting will be required to test the TRSSSV that is proposed to be installed. On the Seamer-2 program a volume of 81.86 m^3 (STP) was vented as part of this program.	81.86 m^3	0.17 t CO_2-e

GHG emissions from activities including the use of lube oils and wastes, native gas and condensate production and fugitive emissions including those from any sulphur hexafluoride (SF6) inventories, are considered negligible or not applicable and are not included in calculations. Fugitive emissions are captured under operational venting and are not considered significant due to the short term duration of 75 days. The native gas and condensate production is also captured under well testing and GHG emissions are not considered separately.

4.2.1.3 Construction of permanent operating facilities

An estimate has been prepared for the emissions expected as a result of construction of the permanent facilities (excluding pipeline construction) which includes the facilities at the wellsite and upgrades at Iona, NPPS and NP wellsite. Emissions are expected to occur as a result of the following activities:

- Diesel powered equipment (cranes, generators, air compressors, etc)
- Concrete pads and footings
- Offsite fabrication

Table 4-3: Scope 1 GHG calculations for Construction

Activity	Assumptions	Estimated Quantity	Scope 1 Emissions
Diesel for equipment used on site	Diesel powered equipment will be used for the construction of the site. This does not	225,000 L	759 t CO_2-e

Activity	Assumptions	Estimated Quantity	Scope 1 Emissions
	include excavation equipment as this has previously been considered in the well pad construction and primarily consists of fixed structure installation equipment including site cranes forklifts generators, air compressors etc. Assumed 150L/hr total and a total of 1,500 hours.		

GHG emissions from activities including the use of operational venting, the use of lube oils and wastes, native gas and condensate production and fugitive emissions including those from any sulphur hexafluoride (SF6) inventories, are considered negligible and are not included in calculations.

4.2.2 Operation GHG Emissions

Scope 1 & 2 emissions have utilised pro-rata inputs from the overall Iona calculations using the base case increase in contracting of 7.5% as the site moved from 570 TJ/d to 615 TJ/d.

It is worth recognising that the actual amount of gas cycled through the IGSF is dependent on market demand and customer requirements and is not within the direct control of Lochard. A year with a mild winter and a period where other power generation assets are very reliable will have quite different demands on the IGSF than a year with more variable weather and poor reliability of other power generation assets.

A judgement has been used to determine whether this ratio is applicable. For example, for energy used in the compression of gas, this factor has been applied to reflect that it is likely overall energy consumption for compression required to inject and then withdraw gas will increase in line with this assumption given increased storage and contract values. In contrast, GHG emissions due to plant "blowdown" events will not change as the HUGS project does not significantly change the operating inventory of the IGP or significantly change the probability of additional plant "blowdown" events.

Table 4-4: Scope 1 GHG Assessment for Operations

Activity	Assumptions	Existing Quantity	Proposed Quantity	Total Quantity	Existing Scope 1 Emissions		Annual Incremental Scope 1 Emissions (Fuel gas increase by 7.5%)		Total Scope 1 Emissions	
Diesel for operations	No change to Iona diesel consumption as this will not change for increased throughput. Back-up generators are only used when power is cut to Iona and additional throughput will not change electricity use.	217.5 k L	-	217.5 k L	CO2 587 t CO_2-e CH4 90 t CO_2-e N2O 1 t CO_2-e	687 t CO_2-e	-	-	Total Scope 1 Emissions for the Reporting Year 2021-2022 CO2 587 t CO_2-e CH4 90 t CO_2-e N2O 1 t CO_2-e	687 t CO_2-e
Diesel for transport	No change to Iona diesel consumption as this will not change for increased throughput.	15.4 kL	-	15.4	CO2 42 t CO_2-e CH4 - t CO_2-e	42 t CO_2-e	- -	-	CO2 42 t CO_2-e CH4 - t CO_2-e	42 t CO_2-e

Activity	Assumptions	Existing Quantity	Proposed Quantity	Total Quantity	Existing Scope 1 Emissions		Annual Incremental Scope 1 Emissions (Fuel gas increase by 7.5%)		Total Scope 1 Emissions	
					N2O - t CO_2-e		-		N2O - t CO_2-e	
Operational flaring	No change to existing emissions. Flaring of IGP will not be affected by the HUGS project	1,849 t	-	1,849 t	CO2 4992 t CO_2-e CH4 246 t CO_2-e N2O 48 t CO_2-e	5,286 t CO_2-e	-	-	CO2 4992 t CO_2-e CH4 246 t CO_2-e N2O 48 t CO_2-e	5,286 t CO_2-e
Operational venting and pigging	No change to existing emissions. Venting of IGP will not be affected by the HUGS project	-	-	-	CO2 15 t CO_2-e CH4 4,409 t CO_2-e N2O - t CO_2-e	4,424 t CO_2-e	-	-	CO2 15 t CO_2-e CH4 4409 t CO_2-e N2O - t CO_2-e	4,424 t CO_2-e
Fuel gas for compression & other equipment	**This has been increased by 7.5% in line with the maximum additional WSV**. This is considered conservative with some fuel gas use being independent of throughput (ie: blanket gas and flare purge).	792,413 GJ	59,431 GJ	851,844 GJ	CO2 40,627 t CO_2-e CH4 79 t CO_2-e N2O 24 t CO_2-e	40,730 t CO_2-e	CO2 3,047 t CO_2-e CH4 6 t CO_2-e N2O 2 t CO_2-e	3,055 t CO_2-e	CO2 43,674 t CO_2-e CH4 85 t CO_2-e N2O 26 t CO_2-e	43,785 t CO_2-e

Activity	Assumptions	Existing Quantity	Proposed Quantity	Total Quantity	Existing Scope 1 Emissions	Annual Incremental Scope 1 Emissions (Fuel gas increase by 7.5%)	Total Scope 1 Emissions
TOTAL INCREMENT					**3,055 t CO_2-e**	**TOTAL EXISTING & INCREMENT**	**70,542 t CO_2-e**

No changes are expected to the use of diesel for operations, operational venting, flaring and pigging, the use of lube oils and waste and off-site transportation.

4.3 SCOPE 2 EMISSIONS

Table 4-5: Scope 2 GHG Calculations for Construction and Operation

Activity	Activity	Assumptions	Scope 2 Emissions (tCO_2-e)
Purchased electricity	Well Pad Construction	Nil. Construction will use diesel generators for electricity for equipment and offices	-
	Drilling of Gas Storage Wells		
	Construction of permanent Operating Facilities		
	Operation	Lochard has moved to purchasing 100% renewable electricity and as such there are no additional emissions associated with electricity use.	

As all construction phases use diesel generators for electricity for equipment and offices, Scope 2 emissions involving purchased electricity are considered negligible.

4.4 SCOPE 3 EMISSIONS

For the purposes of this assessment, material Scope 3 emissions are limited to:

- Embodied emissions associated with construction materials (steel and concrete).

The following table presents the estimated structural steel and reinforce concrete quantities for the project.

Table 4-6: Concrete and Steel - Construction Quantities

	Concrete (m^3)	Steel (tonnes)
800 Well site and road (exc rehab) pre drilling	41.0	4.0
800 Well site rehab	12.2	2.2
800 Well site drilling/post drilling	57.9	6.2
800 NPPS	37.5	1.6
100 Seamer Tie in	1.2	0.1
300 header extension	7.9	0.3
	57.0	1.6
Grand Total	**214.8**	**16.0**

Table 4-7: Piping Weights

CTRs	Approximate Piping Weights (kg)
100	9,190
300	29,879
600	16,710
800	43,842
Total	**100 tonnes**

Table 4-8: Scope 3 GHG Calculations for Broader HUGS Project

Activity	Assumptions	Estimated Quantity	Scope 3 Emissions
Embodied emissions associated with steel construction material	Based on existing GHG calculations assume 0.2kL diesel/tonne construction materials (using 16 tonnes)	3,200 L	10.8 t CO_2-e
Embodied emissions associated with concrete construction material	214.8m^3 of concrete assuming 0.9L onsite diesel per 1m^3	172 L	0.5 t CO_2-e
Embodied emissions associated with piping	Based on existing natural gas pipeline GHG calculations assume 0.2kL diesel/tonne pipeline materials (using 100 tonnes)	20,000 L	54.2 t CO_2-e

Fugitive emissions from operation of the pipeline and compressor station are unavoidable and do not contribute significantly to operation impacts.

4.5 DECOMMISSIONING AND REHABILITATION

The following assumptions have been used for this aspect of the assessment.

- Any remaining gas is left in the field and not produced. Some minor flaring will be required as part of decommissioning works of the wells
- At end of life, the assets will be decommissioned as follows:
  - All facilities at the MFCT site removed and the site returned to pasture.
  - Gas storage wells plugged and abandoned.
- Incremental upgrades at Iona, NPPS and NP wellsite not included as these works are minor and do not significantly change the rehabilitation works at these sites and have therefore not been included in this calculation.
- Scope 3 emissions released from waste breaking down in landfill and transporting waste to resource recovery / landfill sites are excluded due to unknown quantities and unknown final destinations of the waste.

4.5.1 Decommissioning GHG Emissions

The GHG emissions for decommissioning include minor emissions associated with decommissioning works and the transportation of rig and decommissioning equipment.

Table 4-9: Scope 1 – Decommissioning

Activity	Assumptions	Total Quantity	Total Scope 1 Emissions
Diesel for decommissioning equipment	Diesel powered equipment will be used for the decommissioning of the site. A work-over rig is usually set up on site for approximately 4-6 weeks and may consume anywhere between 20-30 m^3 of diesel per day.	825 kL	2,786 CO_2-e

Table 4-10: Scope 3 – Decommissioning

Activity	Assumptions	Total Quantity	Total Scope 3 Emissions
Diesel for vehicles and trucks travelling to and from site	It is approximated that 150 heavy trucks and 75 light vehicles will be travelling to and from site over the 4-6 weeks. It is assumed that employee vehicles will be travelling from Melbourne around 2-3 times over the decommissioning phase (approx. 400km roundtrip). A diesel usage rate of 12.8L/100km is assumed for light vehicles and a diesel usage rate of 47.75L/100km for heavy vehicles.	32,500 L	110 t CO_2-e

4.5.2 Rehabilitation GHG Emissions

Table 4-11: Scope 1 Rehabilitation

Activity	Assumptions	Total Quantity	Total Scope 1 Emissions
Diesel for rehabilitation machinery	Diesel powered equipment including loaders, excavators, and dozers will be used for the rehabilitation of the site. Rehabilitation is conservatively assumed to be carried out over 50 days with 500 L of Diesel used per day.	25 kL	84 t CO_2-e
Surface reclamation	Research conducted on land reclamation activities suggest that emission levels for surface reclamation varies from anywhere between 136 to 475 t CO_2-e per hectare. Based on architectural drawings, the approximate area of the HUGS project site is around 2 ha.	-	611 t CO_2-e

Table 4-12: Scope 3 Rehabilitation

Activity	Assumptions	Total Quantity	Total Scope 1 Emissions
Diesel for rehabilitation machinery and trucks travelling to and from site	It is conservatively assumed It is assumed that 25 light vehicles and 10 heavy vehicles (to transport equipment and materials) will be travelling from Melbourne 2-3 times over the rehabilitation phase (approx. 400km roundtrip). A diesel usage rate of 12.8L/100km is assumed for light vehicles and a diesel usage rate of 47.75L/100km for heavy vehicles.	9,600 L	32 t CO_2-e

5. HUGS PIPELINE EMISSIONS

5.1 METHODOLOGY

The following methodologies were used to determine boundaries, identify GHG emissions sources, and estimate GHG emissions:

HUGS Pipeline	Scope 1	Scope 2	Scope 3
Construction	Land clearing Fuel Use **Source:** Land clearing emissions estimated using Greenhouse Gas Assessment Workbook for Road Projects. Fuel use estimated from typical diesel use of construction equipment including site cranes, forklifts, generators, air compressors etc.	N/A	Embodied emissions associated with steel and piping material **Source:** Estimated from mass of material provided
Operations	Fugitive Emissions **Source:** Estimated using Method 1 provided by the National Greenhouse Accounts.	N/A	N/A
Decommissioning	Fuel Use **Source:** Estimated using typical diesel use of machinery required and time taken for this phase of the project.	N/A	• Diesel for vehicles and trucks travelling to and from site **Source:** Estimated using typical diesel use of trucks required and time taken for this phase of the project

Rehabilitation	Fuel Use Surface Reclamation **Source:** Estimated using typical diesel use of machinery required and time taken for this phase of the project. Surface reclamation estimates based on research conducted on land reclamation activities.	N/A	• Diesel for vehicles and trucks travelling to and from site **Source:** Estimated using typical diesel use of trucks required and time taken for this phase of the project

5.2 SCOPE 1 EMISSIONS

5.2.1 Construction Emissions

An estimate has been prepared for the emissions expected as a result of construction of the new 5.3 km HUGS pipeline. Emissions are expected to occur as a result of the following activities:

- Clearing of vegetation
- Construction of the HUGS pipeline including materials, material transportation and diesel powered project vehicles

Table 5-1: Scope 1 GHG calculations for HUGS pipeline construction

Activity	Assumptions	Estimated Quantity	Scope 1 Emissions
Land clearing/vegetation removal within construction corridor	0.13 ha of cleared vegetation required for the pipeline construction based on Environmental Due Diligence report completed by EH partners	0.13 ha	53.2 t CO_2-e
Diesel for material transportation equipment and site vehicles	Diesel powered equipment will be used for the construction of the pipeline including site cranes, forklifts, generators, air compressors etc.	160,000 L	540 t CO_2-e

5.2.2 Operating GHG Emissions

As noted in Section 3.1, the operational emissions associated with HUGS are related to incremental fuel gas use for compression of the customer gas into and out of storage. Emissions associated directly with the new HUGS pipeline are primarily related to frictional losses in pressure as the gas transit through the 5.3 km section of new pipeline. The pipeline has been sized to minimise

pressure drop, and these are considered a minor contribution to the additional compression energy required to compressor the customer owned gas into and out of storage. The majority of the pressure losses occur in the wells and gas processing infrastructure at Iona. For the purposes of this assessment, it is considered that potentially up to 10% of total incremental fuel gas use emissions could be attributed to pipeline frictional losses.

The HUGS pipeline includes a small number of flanged joints where there is potential for fugitive emissions. Lochard utilises a process of identification and repair of leaks that result in fugitive emissions.

Table 5-2: Scope 1 GHG Calculations for Operation

Activity	Assumptions	Estimated Quantity	Scope 1 Emissions
Fugitive Emissions	Fugitive emissions from natural gas transmission, for carbon dioxide was estimated using Method 1 provided by the National Greenhouse Accounts.	-	62 t CO_2-e

5.3 Scope 2 Emissions

As all construction phases use diesel generators for electricity for equipment and offices, Scope 2 emissions involving purchased electricity are considered negligible.

Table 5-3: Scope 2 GHG Calculations for Operation

Activity	Assumptions	Scope 2 Emissions (tCO_2-e)
Purchased electricity	Nil. Construction will use diesel generators for electricity for equipment and offices	-

5.4 Scope 3 Emissions

For the purposes of this assessment, Scope 3 emissions are limited to:

- Embodied emissions associated with pipeline construction materials (steel and concrete).

The pipeline estimated mass of material is 612 tonnes.

Table 5-4: Scope 3 GHG Calculations for Construction

Activity	Assumptions	Estimated Quantity	Scope 3 Emissions
Embodied emissions associated with pipeline construction materials	Based on existing natural gas pipeline GHG calculations assume 0.2kL diesel/tonne pipeline materials (using 612 tonnes)	122,400 L	332 t CO_2-e

5.5 Decommissioning and Rehabilitation

The following assumptions have been used for this aspect of the assessment.

- At end of life, the pipeline will be decommissioned and rehabilitated as follows:
    - HUGS pipeline is purged and cleaned, the pipeline risers cut and removed and the pipeline left in-situ and filled with grout. As pipelines are to remain in-situ after decommissioning, limited disposal and recycling of pipeline materials is required.
    - Restoration of cleared land through re-seeding expected within 12 months of removal.
    - Scope 3 emissions released from waste breaking down in landfill and transporting waste to resource recovery / landfill sites are excluded due to unknown quantities and unknown final destinations of the waste. These emissions are expected to make up a relatively low proportion of emissions.

5.5.1 Decommissioning GHG Emissions

The GHG emissions for decommissioning include minor emissions associated with decommissioning works, the transportation of rig and decommissioning equipment and minor emissions from employee travelling to and from site. .

Table 5-5: Scope 1 – Decommissioning

Activity	Assumptions	Total Quantity	Total Scope 1 Emissions
Diesel for decommissioning equipment	Diesel powered equipment will be used for the cleaning and purging of the pipeline and filling the pipeline left in-situ with grout. A utility pig is usually set up on site for the purging/cleaning and grouting machinery for filling in the pipeline. It is approximated that the equipment will be on site for 3-4 weeks and may consume anywhere between 10-20 m^3 of diesel per day.	250 kL	845 t CO_2-e

Table 5-6: Scope 3 – Decommissioning

Activity	Assumptions	Total Quantity	Total Scope 3 Emissions
Diesel for vehicles and trucks travelling to and from site	It is approximated that 15 medium trucks and 8 light vehicles will be travelling to and from site for 3-4 weeks. It is assumed that employee vehicles will be travelling from Melbourne around 1-2 times over the decommissioning phase (approx. 400km roundtrip). A diesel usage rate of 12.8L/100km is assumed for light vehicles and a diesel usage rate of 28.9L/100km for medium trucks.	2,550 L	9 t CO_2-e

5.5.2 Rehabilitation GHG Emissions

Table 5-7: Scope 1 Rehabilitation

Activity	Assumptions	Total Quantity	Total Scope 1 Emissions
Surface reclamation	Research conducted on land reclamation activities suggest that emission levels for surface reclamation varies from anywhere between 136 to 475 t CO_2-e per hectare. Based on the Environmental Due Diligence report, 0.13 ha of vegetation is to be re-seeded during rehabilitation.	-	40 t CO_2-e

Table 5-8: Scope 3 – Rehabilitation

Activity	Assumptions	Total Quantity	Total Scope 3 Emissions
Diesel for vehicles and trucks travelling to and from site	It is approximated that 10 medium trucks and 6 light vehicles will be travelling to and from site for 3-4 weeks. It is assumed that employee vehicles will be travelling from Melbourne around 1-2 times over the rehabilitation phase (approx. 400km roundtrip). A diesel usage rate of 12.8L/100km is assumed for light vehicles and a diesel usage rate of 28.9L/100km for medium trucks.	1,800 L	6 t CO_2-e

6. LIFE OF THE PROJECT

It is anticipated that a 25 year life is for all equipment installed as part of HUGS. That is the MFCT wellsite, pipeline and upgrades to existing facility. An estimated emission for the life of the project is provided in the following table.

Table 6-1: Life of the Project Summary

Approx. Year	Project Stage	Incremental	Existing	Total
2016-2020	Past Operations Estimates	N/A	339,235 t CO_2-e	339,235 t CO_2-e
2024-2026	Construction (2 Years)	13,358 t CO_2-e	375,000 t CO_2-e	388,358 t CO_2-e
2027-2052	Operation (25 Years)	3,055 t CO_2-e per annum	76, 000 t CO_2-e per annum	79,055 t CO_2-e per annum
2052	Decommissioning and Rehabilitation	3,623 t CO_2-e	N/A	3,623 t CO_2-e

7. SUMMARY OF GHG EMISSIONS

7.1 OVERALL PROJECT

A summary of the calculated annual GHG emissions for the overall project is shown in Table 7-1.

Table 7-1: Annual Predicted GHG Emissions for the overall Lochard Energy Operations

Project Stage	Scope 1	Scope 2	Scope 3	Total
Construction	12,760 t CO_2-e	-	598 t CO_2-e	13,358 t CO_2-e
Total Operations (Per Annum)	*Existing: 67,847 t CO_2-e Incremental: 3,055 t CO_2-e	*Existing: 3,941 t CO_2-e Incremental: 296 t CO_2-e	Incremental: 108 t CO_2-e	75,247 t CO_2-e
Decommissioning	2,786 t CO_2-e	-	110 t CO_2-e	2,896 t CO_2-e
Rehabilitation	695 t CO_2-e	-	32 t CO_2-e	727 t CO_2-e
Total (Incremental)	**19,296 t CO_2-e**	**296 t CO_2-e**	**836 t CO_2-e**	**20,428 t CO_2-e**

NOTE: * The existing operational emissions refer to the overall Lochard energy operations (including Iona Gas Storage facility and all related assets). The existing t CO2-e is based on the average over the past 5 years as emissions are very much influenced by weather and reliability of generation equipment.

The scope 1 emissions do not exceed 100,000 t CO_2-e therefore the site is not a "designated large facility" and therefore the safeguard mechanism does not apply.

The total emissions do not exceed 200,000 t CO_2-e therefore referral to the minister under Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978 is not required.

7.2 HUGS PIPELINE

A summary of the calculated GHG emissions for the HUGS pipeline is shown in Table 7-2.

Table 7-2: Predicted GHG Emissions for the HUGS pipeline

	Emission Source	Scope 1	Scope 2	Scope 3	Total
Construction	Land Clearing	53.2 t CO_2-e	-	-	53.2 t CO_2-e
	Fuel Use	433 t CO_2-e	-	107 t CO_2-e	540 t CO_2-e
	Construction Materials	-	-	332 t CO_2-e	332 t CO_2-e
Operation (Per Annum)	Fugitive Emissions	62 t CO_2-e	-	-	62 t CO_2-e
Decommissioning	Fuel Use	845 t CO_2-e	-	9 t CO_2-e	854 t CO_2-e

Rehabilitation	Surface Reclamation	40 t CO_2-e	-	-	40 t CO_2-e
	Fuel Use	-	-	6 t CO_2-e	6 t CO_2-e
Total					**1,887.2 t CO_2-e**

7.3 COMPARISON AGAINST ANNUAL EMISSIONS

Emissions from the project should also be viewed in terms of its contribution to the state and national totals.

Table 7-3: Comparison of emissions against Australian and Victorian annual emissions

Emission Source	Emissions	% of Australia's total	% of Victoria's total
Australia (2021)	465.7 x 10^6 t CO_2-e	100%	-
Victoria (2021)	80.1 x 10^6 t CO_2-e	17.2%	100%
Iona Gas Processing Facility (Annual Operations)	75,247 t CO_2-e	0.016%	0.093%
HUGS Project (Construction & Operation*)	89,733 t CO_2-e	0.019 %	0.11 %
HUGS Project (Decommissioning & Rehabilitation)	3,623 t CO_2-e	0.0008 %	0.0045 %
HUGS Pipeline (Construction & Operation*)	2,475.2 t CO_2-e	0.0005 %	0.0031 %
HUGS Pipeline (Decommissioning & Rehabilitation)	900 t CO_2-e	0.0002 %	0.0011 %

Note: *Operational emissions are assumed to be over the 25 year design life.

The facility's estimated annual operation emissions are estimated to contribute the equivalent of 0.093% of Victoria's and 0.016% of Australia's annual greenhouse gas emissions.

The HUGS project construction and operation emissions are estimated to contribute the equivalent of 0.11% of Victoria's and 0.019% of Australia's annual greenhouse gas emissions. The HUGS project decommissioning and rehabilitation emissions are estimated to contribute the equivalent of 0.0045% of Victoria's and 0.0008% of Australia's annual greenhouse gas emissions.

The HUGS pipeline construction and operation emissions are estimated to contribute the equivalent of 0.0031% of Victoria's and 0.0005% of Australia's annual greenhouse gas emissions. The HUGS pipeline decommissioning and rehabilitation emissions are estimated to contribute the equivalent of 0.0011% of Victoria's and 0.0002% of Australia's annual greenhouse gas emissions.

8. RECOMMENDED ENVIRONMENTAL MANAGEMENT PRACTICES

This section outlines possible controls and management practices that could reduce and minimise overall emissions associated with construction and operation of the HUGS pipeline.

Greenhouse gas emissions can potentially be reduced during construction phase by :

- Using low embodied energy materials where they are of comparable quality.
- Using fuel efficient plant and equipment and used where practicable during construction
- Using locally sourced construction materials to minimise transportation emissions and logistics cost.

Greenhouse gas emissions can potentially be reduced during the operational phase by:

- Monitoring operation greenhouse gas emissions via an audit/monitoring process.
- Implementing industry standards during the design, inspection and maintenance of the HUGS pipeline and Compressor Station to minimise the risk of operational emergencies.
- Performing ongoing maintenance and inspection on the HUGS pipeline to avoid leaks.

9. CONCLUSION

9.1 OVERALL PROJECT

Calculation of emissions over the four project stages (construction, operation, decommissioning and rehabilitation) have found:

- Total Scope 1, Scope 2 and Scope 3 emissions during the construction period have been estimated at 13,358 t CO_2-e.
- Incremental Scope 1, 2 and 3 emissions during the HUGS gas storage operational period are calculated at 3,459 t CO_2-e per annum.
- Total Scope 1 and Scope 3 emissions during the decommissioning and rehabilitation periods are calculated at 2,896 t CO_2-e and 727 t CO_2-e respectively.
- The HUGS project construction and operation emissions are estimated to contribute the equivalent of 0.11% of Victoria's and 0.019% of Australia's annual greenhouse gas emissions.
- The HUGS project decommissioning and rehabilitation emissions are estimated to contribute the equivalent of 0.0045% of Victoria's and 0.0008% of Australia's annual greenhouse gas emissions.
- The facility's estimated annual operation emissions are estimated to contribute the equivalent of 0.093% of Victoria's and 0.016% of Australia's annual greenhouse gas emissions.

The project currently triggers the presented requirements under the NGER Scheme where reporting is required. The majority of the carbon emissions estimated for the project are projected to occur during the existing gas storage operation phase and in comparison, the overall contribution from the construction and operation of the HUGS Project are not significant.

The scope 1 emissions do not exceed 100,000 t CO_2-e therefore the site is not a "designated large facility" and therefore the safeguard mechanism does not apply.

The total emissions do not exceed 200,000 t CO_2-e therefore referral to the minister under Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978 is not required.

9.2 HUGS PIPELINE

Calculation of emissions for the HUGS pipeline have found:

- Total Scope 1, Scope 2 and Scope 3 emissions during the HUGS pipeline construction and operation period have been estimated at 2,475.2 t CO_2-e.
- The HUGS pipeline construction and operation emissions are estimated to contribute the equivalent of 0.0031% of Victoria's and 0.0005% of Australia's annual greenhouse gas emissions.

- The HUGS pipeline decommissioning and rehabilitation emissions are estimated to contribute the equivalent of 0.0011% of Victoria's and 0.0002% of Australia's annual greenhouse gas emissions.

This concludes the report.

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10. LIMITATIONS

Our services for this project are carried out in accordance with our current professional standards for site assessment investigations. No guarantees are either expressed or implied.

This report has been prepared solely for the use of Heytesbury Underground Gas Storage (HUGS) Project, as per our agreement for providing environmental services. Only Heytesbury Underground Gas Storage (HUGS) Project is entitled to rely upon the findings in the report within the scope of work described in this report. Otherwise, no responsibility is accepted for the use of any part of the report by another in any other context or for any other purpose.

Although all due care has been taken in the preparation of this study, no warranty is given, nor liability accepted (except that otherwise required by law) in relation to any of the information contained within this document. We accept no responsibility for the accuracy of any data or information provided to us by Heytesbury Underground Gas Storage (HUGS) Project for the purposes of preparing this report.

Any opinions and judgements expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal advice.

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ATTACHMENTS

Attachment 1: Well Pad Construction Diesel Estimate

Equipment.	No. of	Usage	Usage rate units	Duration /time /measurement	Units	% Utilisation	Consumption (litres)	Comments	Source of assumption
Diesel generator	1	3.6	L/hr	72	Days	100%	3,110	Used to power construction huts. Assume a 20kW, 25 kVA unit that uses a 3.6 L/hr at 75% load	https://www.ablesales.com.au/blog/diesel-generator-fuel-consumption-chart-in-litres.html
Air Compressor (90 cfm)	1	3	L/hr	72	Days	70%	1,814	Assumed consumption. Not required 100% of the time	
Water Truck (13,000 litres)	36	23.2	L/100 km	40	km round trip	100%	334	Assumes heavy rigid (23.2 L/100km) 2 x 20 km round trip for 50% of the time to supply dust suppression	https://www.atap.gov.au/parameter-values/road-transport/appendix-e-detailed-fuel-consumption-coefficients-uninterrupted-flow

Delivery truck (construction materials)	85	38	L/100 km	90	km round trip	100%	2,907	Assumes 85 deliveries of material. 90 km round trip to and from Terang	https://www.atap.gov.au/parameter-values/road-transport/appendix-e-detailed-fuel-consumption-coefficients-uninterrupted-flow
Light vehicles	1	12.8	L/100 km	10,000	km total		980	Assumes 20,000 km total for local travel and site visits from Melbourne based engineers and project team	

Activity	Comments	Source of assumption
Land clearing/vegetation removal	0.13 ha of cleared vegetation required for the pipeline construction based on Environmental Due Diligence report completed by EH partners. Weedy Grassland: 409 t CO_2/ha	Greenhouse Gas Assessment Workbook for Road Projects (Transport Authorities Greenhouse Group) https://www.mainroads.wa.gov.au/globalassets/technical-commercial/technical-library/road-and-traffic-engineering/climate-change/carbon-gauge-workbook-2013.pdf
Diesel Use	Diesel for material transportation equipment and site vehicles. All All fuel assumed to be diesel oil Estimated based on size of project: 160,000 L	Emission Factors: NGER (Measurement) Determination 2008, July 2020
Compressor fuel consumption	Greenhouse gas emissions due to gas consumption at the compressor station, fossil fuel use in vehicles and the use of electricity during operation. Estimated based on size of project: 150 GJ/day	Emission Factors: Scope 1: NGER (Measurement) Determination 2008, July 2020 Scope 3: National Greenhouse Accounts Factors August 2019
Fugitive Emissions	Based on length of pipeline: 5.3 km	Emission Factors: NGER (Measurement) Determination 2008, July 2020