Aurecon Group

Victoria Energy Terminal Project Greenhouse Gas Preliminary Assessment

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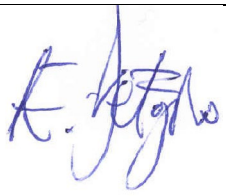
Reviewed	Enzo De Fazio, Director – Environment & Safety	Draft		30/11/2022

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Executive Summary

Edge Group Pty Ltd (Edge) was commissioned by Aurecon Group (the Client) for VOPAK to prepare a Greenhouse Gas (GHG) Preliminary Assessment in response to the proposed development of a floating liquid natural gas (LNG) facility, the Victoria Energy Terminal (VET) Project in Port Philip Bay to help secure energy supply as part of Victoria's energy transition. The VET Project will consist of an offshore floating storage and regasification unit (FSRU) terminal, a new 29 kilometres pipeline, a Gas Receiving Station (GRS), 132 kilovolt (kV) powerline, substation and 66kV electricity cable.

For the purposes of this Preliminary Assessment (Assessment), Edge:

- reviewed existing VOPAK documentation provided to Edge by the Client
- conducted a desktop search of relevant state and federal compliance obligations
- conducted a review and gap analysis of key comparable LNG projects

Based on the Assessment, it was concluded that the VET Project is unlikely to exceed 200,000 tonnes of carbon dioxide (CO_2) emissions, and therefore does not trigger a referral under the *Environmental Effects Act 1978* (EE Act).

A summary of recommendations based on the scope of this Assessment is provided below:

- Consider Scope 3 emissions in the design of infrastructure and development of the VET Project. Explore mitigation measures including the offset of identified Scope 3 emissions to reduce the VET Project's emissions.
- Estimate scope, likelihood and associated risks of GHG emissions to the environment and human health, which should be included in further GHG assessments.
- Ensure compliance *with the (Safeguard Mechanism) Rule 2015, the National Greenhouse and Energy Reporting (Measurement) Determination 2008 under the NGER Act 2007, Environment Protection Act 2017 (EP Act 2017)* in the circumstance of further investigation into GHG impacts of the VET Project.

1 Introduction

1.1 Background

VOPAK has proposed to develop a floating liquid natural gas (LNG) facility, the Victoria Energy Terminal (VET) Project, in Port Philip Bay to help secure energy supply as a part of Victoria's energy transition. The VET Project consists of an offshore floating storage and regasification unit (FSRU) terminal, a new 29 kilometre pipeline, a Gas Receiving Station (GRS), 132kV powerline, substation and 66kV electricity cable.

The objective of the VET Project is to provide energy security to the Victorian and east coast gas market in anticipation of the depletion of nearby gas fields.

1.2 Purpose

The purpose of this Preliminary Assessment (the Assessment) is to review existing VOPAK documentation and conduct a desktop search of relevant state and federal legislation to determine if the VET Project triggers a referral under the *Environmental Effects Act 1978* (EE Act), in relation to the relevant GHG criteria, in accordance with the *Ministerial Guidelines under the Victorian Environment Effects.*

The Assessment will also provide advice on the scope for further greenhouse gas (GHG) assessments.

1.3 Project Description

Vopak proposes to build a floating LNG import terminal with the aim to help secure energy supply as a part of Victoria's energy transition.

The VET Project would utilise a FSRU moored at an existing anchorage point in Port Phillip Bay, approximately 19 kilometre directly offshore from Avalon. Edge understands the FSRU would receive LNG from import tankers, re-gasify it and supply the gas directly into the Victorian Transmission System via a new 29 kilometre pipeline comprising of approximately 19 kilometre of pipe under Port Phillip Bay, 2 kilometre of pipe within a trenchless shore crossing and 9 kilometre of pipe trenched onshore.

Prior to entering the Victorian Transmission System, gas quality would be monitored at a Gas Receiving Station (GRS) on land adjacent to the Princes Freeway (between Point Wilson Road and English Road).

A new 132 kV Powerline, substation and electricity cable would supply electricity for the operation of the VET Project.

1.4 Scope of Work

Teaming with Aurecon Group, Edge provides this Assessment to support a referral under the EE Act. The aim of the Assessment is to provide a sensitivity analysis or a high-level perspective of the extent of GHG emissions in terms of the development's operation. Respective GHG emissions associated with construction has also been considered.

1.4.1 Greenhouse Gas Desktop Assessment

The following scope of work applies to the GHG assessment conducted by Edge:

- Review of relevant reports for recent EE Act referrals in Victoria and more widely in Australia;
- Review the new Environment Protection legislation that came into force on 1 July 2021 and determine its relevance to the VET Project in terms of GHG emissions;
- Review other relevant legislation and policy at Commonwealth, State and local levels;
- Compare emissions of similar LNG regasification projects in Australia and provide an approach for GHG assessment for the VET Project; and
- Provide a statement as to the likely contribution (percentage) of the VET Project to state and federal annual emissions.

1.5 Boundaries for Legislation Desktop Review

This report includes a review of relevant legislation and policy at national, state and local level, and a desktop review of relevant baseline data, reports and case studies.

GHG emissions were assessed based on emission factors available at the time of the assessment and future changes in emission factors were not considered. The most current available data from 2019 were used. Nevertheless, the data remains current as at the time of this Assessment in November 2022.

A summary of the compliance obligations that have been reviewed are provided below and are discussed in Section 4.

- *Ministerial Guidelines for assessment of environmental effects, Environmental Effects Act 1978,* Publication 7, 2006
- *Environmental Protection Act*, 2017
- *The Victorian Climate Change Act* 2017
- *Publication 824: Protocol for Environmental Management (PEM): Greenhouse Gas Emissions and Energy Efficiency in Industry 2002*
- *6E. National Greenhouse and Energy Reporting Act* 2007
- *Australian Standard Energy Audit:* AS/NZS 3598:2000
- *Greenhouse Gas Protocol Corporate Accounting and Reporting Standard* 2004

Outside the scope of this report was to consider the requirements of the *Victorian Climate Change Act 2017*. This requires the EPA as the decision maker under the Environment Protection Act 2017 and subordinate legislation to have regard to the potential impacts on climate change and potential contribution to Victoria's GHG emissions associated with the decision or action.

2 Methodology

The methodology of the Assessment included review of applicable national and state compliance obligations, comparable case studies in Victoria and Australia, and existing VOPAK documentation. Specific details of this information are provided below.

2.1 Analysis of Relevant Compliance Obligations

Edge analysed relevant compliance obligations to help provide a suggested approach for further assessment of the VET Project. The applicable compliance obligations (e.g., Acts, Regulations, EPA Publications, etc) that were reviewed are detailed in Section 3.

2.2 Existing VOPAK Documentation

This Assessment is based on design information provided by the Client in October and November 2022. The VOPAK documentation that was reviewed primarily consisted of the VET Project's proposed details of operation. This included a predicted production capacity of LNG, the estimated length of pipeline, and berthing parameters.

2.3 Assumptions

2.3.1 Benchmark Case Studies

Production capacity and technological design of the facilities influence the amount of GHG emissions produced. All case studies used in this Assessment assume an increase in production capacity results in an increase in GHG emissions. The Assessment therefore assumes that production capacity has a positive linear relationship (rather than an exponential one) where an increase in capacity results in an increase in GHG emissions.

2.3.2 Production Capacity

The VET Project is assumed to have a nameplate capacity in the range of 4 MTPA and a production capacity of between 400 (guaranteed) and 600 (peak) million standard cubic feet per day (mscfd).

Depending on demand (typically highest in winter), the FSRU may leave the marine berth during periods of low demand for asset utilisation.

2.3.3 Design of the Victoria Energy Terminal Project

Design of the VET Project is variable and mainly consists of a FSRU, gas pipeline riser, pipeline, gas metering station, powerline, and substation (refer to Section 1.3 for more detail). Other infrastructure associated with power generation includes a HV substation, an onshore HV cable, a cable shore crossing and a HV submarine pipeline to the FSRU.

Key assumptions of the design include:

- 29 kilometre pipeline comprising of approximately 19 kilometre of pipe under Port Phillip Bay, 2 kilometre of pipe within a trenchless shore crossing and 9 kilometre of pipe trenched onshore.
- 132 kV overhead powerline.
- Construction life span is assumed to be 12 months.
- Lifespan of the VET Project is expected to be approximately 20 years.
- Power to operate the VET Project will be from onshore renewable sources.

2.3.4 'Open loop', 'combined' and 'closed loop' operations

'Open loop' refers to the process of drawing seawater into the FSRU which is then passed through heat exchangers to vaporise the LNG. The vaporisation process causes a drop in seawater temperature, which is then discharged externally on a continuous basis.

'Closed loop' typically refers to the heating of an intermediate fluid (e.g., seawater, freshwater/glycol mixture or propane) by the combustion of natural gas before being passed through the LNG vaporisers. The intermediate fluid is then recirculated back to the heaters.

A closed loop system will be used in which electrical steam boilers heat a circulating mix of seawater and glycol within the FSRU. This acts as an intermediate heating medium for heat exchange in the LNG regasification trains. Approximately 500 cubic metres of seawater would be required to fill the FSRU heat exchange piping. Instead of being regularly discharged from the FSRU as per open loop mode, the seawater is continually circulated in the process. The seawater-glycol mix would be transported via a vessel to a local treatment facility for treatment.

Electric boilers utilise the conductive and resistive properties of water to carry electric current and generate steam. An alternative current flows from an electrode of one phase to ground using the water as a conductor. The chemicals in the water provide conductivity and as a result, the current flow generates heat directly in the water. The more current that flows, the more heat is generated, and the more steam produced. Almost all the electrical energy is converted into heat with no transfer losses.

For both open and close loop operations, the VET Project would use an electrical boiler fed by an onshore renewable power source. As mentioned, electrical boilers are known to be more efficient compared to oil or gas fed boilers due to less energy (heat) lost during boiler operation.

Edge understands VOPAK would purchase renewable electricity to power an electric boiler in open and closed loop operation through a Power Purchase Agreement (PPA).

The Client has requested this option to be the only source of electricity generation included in the Assessment to determine operational GHG emissions. Thus, alternative power supply options have not been considered in this Assessment.

3 Relevant Compliance Obligations

3.1 Legislation[1]

3.1.1 Environment Effects Act 1978

An Environment Effects Statement (EES) requires a risk-based assessment to be conducted that describes the potential impacts of a proposed project. This is carried out using an approach that is consistent with Australian/New Zealand Standard AS/NZS ISO 31000:2018 *Risk Management Process*.

A written referral is sent to the Minister for Planning and an EES is referred when a proposed project is determined to have potentially significant environmental effects.

Generally, the potential for a significant effect on the environment will reflect the following factors:

- Significance of the environmental assets affected, in relation to:
    - character of the potentially affected environmental assets
    - geographic occurrence of the environmental assets
    - values or importance of the environmental assets, based on expert knowledge, relevant policy and evidence of social values
- Potential magnitude, extent and duration of adverse effects on environmental assets in the short, medium and longer term, because of the development, operation and where relevant, decommissioning of a project.
- Potential for more extended adverse effects in space and time, because of interactions of different effects and environmental processes affecting environmental assets.

Key sections of an EES include:

- A description of the proposed development.
- An outline of public and stakeholder consultation undertaken during investigations and the issues raised.
- A description of the existing environment that may be affected.
- Predictions of significant environmental effects of the proposal and relevant alternatives.
- Proposed measures to avoid, minimise or manage adverse environmental effects.
- A proposed program for monitoring and managing environmental effects during a project's construction and operation.

3.1.2 General Environmental Duty, Environment Protection Act 2017

The EPA regulates discharges to air by a system of development and operating licenses. Any discharge to air during the construction or operation of a project must be in accordance with the requirements of the EPA. The Environment Protection Act 2017 (EP Act) creates a General Environmental Duty (GED), which requires that all reasonably practical steps be taken to minimise impacts from the construction and operation of a project.

Sections 25-27 of the EP Act discuss the GED. This duty requires businesses to put in place reasonably practicable (i.e., proportionate) controls to mitigate and minimise the risk of harm caused by emissions and measures to eliminate or reduce the risks of harm to people and the environment from pollution and waste.

The GED is breached in circumstances where a risk of harm has not been proportionately managed. This duty requires active consideration of how to eliminate the source of harm, measuring likelihood and degree of harm, assessing existing knowledge of the risk, and consideration of the availability and suitability of control measures, including the cost of such controls.

Examples of GHG hazards defined in the GED include:

[1] *Note, this report does not constitute legal advice*

- Land clearing and site civil works
- Operating poorly maintained machinery and vehicles (e.g., fumes or smoke)
- Equipment leaks (for example, fuel or chemicals)
- Improper handling of gases such as carbon monoxide or acetylene

To reduce risks associated with GED, the business must:

- Consider the risk of harm arising from activities that it will be engaged in. ensure systems are in place to identify, assess and minimise these risks; and
- Train those involved to identify and respond appropriately to 'unexpected finds'.

Section 44 of the EP Act describes the legal basis of development licenses, which replaced the Works Approvals.

3.1.3 Victorian Climate Change Act 2017

The Victorian Climate Change Act 2017 (CC Act) outlines the Victorian state's commitment and pathway to net-zero emissions by 2050, consistent with the Paris Agreement to keep global temperature rise below two degrees Celsius above pre-industrial levels.

Part 3 (17) states that Ministerial decision-makers must have regard to climate change when making considering the potential impacts to climate change (Section 3) and potential contribution to the State's greenhouse gas emissions (Section 4).

The relevant considerations for a person deciding or taking an action regarding the potential impacts of climate change are:

a) Biophysical impacts,
b) Long and short term economic, environmental, health and other social impacts,
c) Beneficial and detrimental impacts,
d) Direct and indirect impacts; and
e) Cumulative impacts.

The relevant considerations for a person deciding or taking an action regarding the potential contribution to the State's greenhouse gas emissions are:

a) Short-term and long-term greenhouse gas emissions,
b) Direct and indirect greenhouse gas emissions,
c) Increases and decreases greenhouse gas emissions; and
d) Cumulative impacts of greenhouse gas emissions.

3.1.4 National Greenhouse and Energy Reporting Act 2007

The National Greenhouse and Energy Reporting (NGER) Act 2007 outlines requirements for the reporting and dissemination of information related to GHG emissions, projects, energy production and energy consumption.

The NGER Act obligates the Australian Government to publish GHG emissions and energy consumption data for corporations that exceed the corporate and facility emissions thresholds stated in the NGER Act. GHG emissions must be reported if they exceed the current facility threshold for Scopes 1 and 2 emissions of 25,000 tonnes of carbon dioxide emissions equivalent (tCO_2-e), or production of 100 TJ or more of energy. If this threshold is exceeded, there is an obligation to deliver annual reports of the facility's operational emissions (Scopes 1 and 2) to the Australian Government.

Under Section 54 of the NGER Act, the Clean Energy Regulator (CER) defines 'facility' as an activity or series of activities that involve the production of greenhouse gas emissions, the production of energy or the consumption of energy.

The definition of 'facility' only includes an activity, or series of activities, in the exclusive economic zone (200 nautical miles from Australia's coastline, in accordance with the *Seas and Submerged Lands Act 1973*) if it is an oil or gas extraction activity or a series of oil or gas extraction activities.

Scope 3 emissions are not required to be reported under the NGER Act.

Schedule 1 of the NGER Act states the use of renewable energy commodities is required to be reported where it is used to generate reportable electricity production.

Consumption of these energy commodities is required to be reported in circumstances where they are used to generate reportable electricity production (that is, in a generating unit exceeding the reporting threshold).

3.1.4.1 NGER (Safeguard Mechanism) Rule 2015

The *NGER (Safeguard Mechanism) Rule 2015* sets out the details that establish compliance rules and procedures for administering the safeguard mechanism (commenced on 1 July 2016). It is a sub-section (Section 22XS) of the NGER Act 2007.

The *Direct Action Plan & Safeguard Mechanism* (Safeguard Mechanism) applies to 'designated large facilities'. Under *Section 22XJ of* the NGER Act and Section 8 of the Safeguard Mechanism, these are facilities where the total direct greenhouse gas emissions from the operation of the facility during a financial year exceed a threshold of more than 100,000 tCO_2-e.

Part 27, Section 58(2) of the safeguard mechanism cites that the default emissions intensity for applicable facilities (including 'designated large facilities') is 0.254 tCO_2-e per petajoule-kilometre.

Part 27, Section 58(3) states the energy content of natural gas:

- must be measured as the higher heating value energy content; and
- may include the energy content of hydrogen included in the natural gas so long as the natural gas mixture meets applicable standards for gas within the network (such as Australian Standard 4564:2020)

Part 28, Division 2, 60(3) states that the default emissions intensity for designated large facilities is 11.62 tCO_2-e per pipeline kilometre.

3.1.4.2 National Greenhouse and Energy Reporting (Measurement) Determination 2008

Sections 7B and 10 of the NGER Act describe the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*. This describes how to measure emissions released from the operation of a facility (Section 1.12 of the NGER Act).

Part 1.1, Division 1.1.1 – 1.3(4) defines fuel combustion as emissions "which deals with emissions released from fuel combustion" and fugitive emissions as emissions "from fuels, which deals with emissions mainly released from the extraction, production, processing and distribution of fossil fuels".

Division 3.3.7 should be applied to calculate fugitive emissions from natural gas transmission activities.

Section 3.75 of Division 3.3.7 describes two methods for measuring GHG emissions. Section 3.76 describes method one, in which the length of pipeline (measured in kilometres) is multiplied by the emissions factor for gas type. This produces the sum of fugitive emissions. Section 3.77 describes method two, in which more information, such as quantities of natural gas measured in tonnes that pass through each equipment type, is needed to calculate GHG emissions.

The efficiency and quality of equipment, including pipeline age, is not mentioned as a variable under the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

3.2 Guidelines

3.2.1 Publication 824: Protocol for Environmental Management: Greenhouse Gas Emissions and Energy Efficiency in Industry 2002.

The Protocol for Environmental Management (PEM) provides guidance on the management of GHG emissions and energy consumption (primarily clause 33 (1), (2) and (3)). The protocol offers insight into how EPA assesses compliance related to energy efficiency and GHG emissions.

Steps of compliance as described in Section 2.1 of PEM for new license applicants are as follow:

Step 1: Estimate energy consumption. This includes annual energy consumption by energy type and associated GHG emissions

Step 2: Estimate direct (non-energy related) GHG emissions

Step 3: Identify and evaluate opportunities to reduce greenhouse gas emissions

Step 4: Document the information generated in Steps 1 – 3

With respect to the (new) 2021 EPA legislation, the content of Publication 824 may contribute to the state of knowledge to inform, as appropriate:

- EPA regulatory activities and actions under the EP Act consistent with the EP Act, ERS, Regulations and guidance
- The standard of conduct expected of a person conducting an activity to meet their duties; and
- Permissions applications.

3.2.2 Australian Standard (AS/NZS 3598:2000) Energy Audit

This standard sets out minimum requirements for commissioning and conducting energy audits that identify opportunities to improve energy efficiency and effectiveness.

Facilities that adopt this standard and which produce greater than 1,400 tCO_2-e are required to undertake a minimum Level 2 energy audit. This involves:

- Identifying the source(s) of energy used on-site
- Identifying the amount of energy used and the purposes for which it is used
- Identifying areas where energy usage can be reduced
- Providing recommended measures to be taken; and
- Providing a statement of costs and potential savings.

3.2.3 International Standard ISO:50001 Energy Management Systems

The ISO:50001 is an international certification for energy management systems and provides a framework for energy efficiency and continuous improvement in energy management. The standard is considered global best practice and adheres to the 2015 Sustainable Development Goals (SDGs) through continuous improvement of energy performance and efficiency, and reductions in GHGs.

3.2.4 Greenhouse Gas Protocol Corporate Accounting and Reporting Standard 2004

The Greenhouse Gas Protocol (GHG Protocol) provides a guide for companies to use in quantifying and reporting their GHG emissions. It recommends GHG assessments be broken into three categories:

- Scope 1 for direct emissions
    - Direct emissions occur from sources that are owned and controlled by the company.
- Scope 2 for electricity indirect emissions
    - Electricity indirect emissions accounts for emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company.
- Scope 3 for other indirect emissions
    - Scope 3 emissions accounts for the treatment of all other indirect emissions not included in Scope 2 emissions. This includes emissions that are a consequence of the activities of the company but occur from sources not owned or controlled by the company (e.g., 'upstream' emissions associated with transport and product use from customers).

4 Greenhouse Gas Assessment

The following assessment aims to provide a preliminary estimate of GHG emissions that will result from the VET Proejct. This is done by analysing similar proposed facilities that have comparative qualities.

The most recent data on national and state emissions are also reviewed and an estimate of the likely contribution of the VET Project's emissions to state and national emissions is provided. Australia's national and state GHG emissions data have been sourced from the National Gas Greenhouse Inventory. As stated on the Federal and Victorian Government websites, there is a 2-year lag between each reporting year and when emissions data are released. The latest national and state GHG emissions data, published in 2021, are for the 2019 reporting year.

4.1 Proposed Organisational Emissions Boundary

Organisational emissions boundaries have been established to determine the extent of Scope 1 and Scope 2 emissions that should be considered in the GHG assessment. Table 1 describes the boundaries for each scope.

Table 1: Emissions boundaries for the VET Project and associated construction and operation emission sources

Scope	Boundary Description	Emissions sources associated with construction	Emissions sources associated with operation
Scope 1 emissions	Emissions produced because of the direct use of energy.	Combustion of diesel fuel for construction vehicles Combustion of diesel fuel for trucks delivering construction materials. Land clearing.	Emissions produced because of the direct use of energy to operate on-site infrastructure and site vehicles that is both onshore and offshore.
Scope 2 emissions	Emissions resulting from purchased energy to operate on-site infrastructure that is both onshore and offshore.	Energy used for the construction phase.	Purchased energy to operate on-site infrastructure that is both onshore and offshore.

4.2 Benchmarking Emissions

4.2.1 Case Study Analysis

Three proposed FSRU projects were reviewed as part of a comparative study to estimate GHG projections of the VET Project:

1. Crib Point Gas Import Jetty, AGL, Victoria;
2. Port Kembla Gas Terminal, Australian Industrial Energy (AIE), NSW; and
3. Energy Import Terminal, Viva, Geelong, Victoria.

These proposed facilities have comparable production capacities to the VET Project. Generation capacities between the three projects range between 80 to 140 petajoules (PJ), or 27,882,293 million standard cubic feet per day (mmscfd) to 48,794,013 mmscfd per annum.

In all cases, GHG emissions are assumed to increase with an increase in production capacity.

Analysis of the three case studies also highlighted key aspects of the EES process, and requirements identified under the EE Act. Relevant information regarding the approvals process associated with the three case studies are reviewed in detail below.

4.2.1.1 Crib Point Gas Import Jetty, AGL

The (once) proposed[2] Crib Point Import Jetty at Crib Point, Victoria reflects similar construction requirements of the proposed VET Project. The Crib Point Import Jetty proposed the construction of a 57 kilometre pipeline.

The Crib Point GHG assessment (August 2018) presented four scenarios for GHG emissions:

- **Scenario A:** no gas send-out during the year with all boil-off gas burnt at the combustor, equivalent to 120,319 tCO_2-e per annum.
- **Scenario B:** continuous year-round operation of the FSRU at an average of 382 mmscfd high pressure gas send-out requiring 40 LNG carrier deliveries, equivalent to 58,143 tCO_2-e per annum.
- **Scenario C:** FSRU operating for 51% of the year at a maximum capacity of 750 mmscfd (three processing trains) gas send-out requiring 40 LNG carrier deliveries, equivalent to 101,955 tCO_2-e per annum.
- **Scenario D:** continuous year-round operation of the FSRU in 'combined mode' (with boiler support) at 750 mmscfd high pressure gas send-out requiring 78 LNG carrier deliveries, equivalent to 190,925 tCO_2-e per annum.

In addition, *AGL gas import jetty greenhouse gas assessment* (March 2018) presents similar GHG emission scenarios. To understand the impact of using closed loop or combined mode with boiler support, in comparison to open loop mode with no boiler support, Scenario B and C of this document (referred to as Scenario B^1 and Scenario C^1 in this Assessment) are presented below:

- **Scenario B^1:** continuous year-round operation of the FSRU in open loop mode (no boiler support, sea water heat only) at an average of 500mmscfd high pressure gas send-out requiring 52 LNG carrier deliveries, equivalent to 61,806 tCO_2-e per annum.
- **Scenario C^1:** continuous year-round operation of the FSRU in combined mode (with boiler support) at an average of 500 mmscfd high pressure gas send-out requiring 52 LNG carrier deliveries, equivalent to 170,133 tCO_2-e per annum.

Scenario B^1 and Scenario C^1 feature equivalent production capacities and the same number of LNG carrier activity. Scenario B^1 uses open loop mode with no boiler support, and Scenario C^1 uses combined mode with boiler support. As a result, the use of a combined mode system and boiler support results in an additional 108, 327 tCO_2-e per annum. It should be noted the energy input of Scenario C^1 is not known.

Scenario B closely reflects the emissions of the VET Project if open loop mode is used and it is operating at minimal capacity. However, Scenario B's production capacity is lower than the minimum of the VET Project (382 mmscfd compared to 400 mmscfd).

Scenario C^1 more closely reflects the production capacity and operational activities of the VET Project if closed loop with boiler support is used. Therefore, this is also referenced when estimating the VET Project's GHG emissions.

In July 2020, an EES was submitted for the Minister's assessment. A preliminary review of the Crib Point EES was conducted by an Inquiry and Advisory Committee (IAC) under Section 9(1) of the EE Act. Following review, the IAC requested additional information to determine a conclusion. Information relevant to GHG emissions included:

- Exploration and advise on best options to offset GHG emissions, particularly for operational activities.

[2] The Crib Point Gas Import Jetty, AGL is no longer proceeding in its current form.

- Explanation of Scope 3 emissions in the context of the Crib Point Import Jetty's overall emissions compared with Victoria's annual GHG emissions.
- An estimation of downstream Scope 3 emissions for the Crib Point Import Jetty.
- Provision of a percentage of commercial, industrial and household uses and the proportion that would be "double counted" as third-party gas users triggered to report under the *NGER Safeguard Mechanisms* which applies to facilities with direct (Scope 1) operational emissions greater than 100,000 tCO_2-e.

The key construction phase activities, associated with potential GHG emissions, will be the installation of a high-pressure gas flowline along the jetty to transport natural gas to the connection with the VET Project. The natural gas pipeline from the VET Project's FSRU mooring to the VTS is proposed to be buried/placed underground. Like the Crib Point Import Jetty, GHG emissions associated with construction activities are considered not significant compared with the operational footprint of the VET Project and consequently construction GHG emissions are not quantified.

4.2.1.2 Port Kembla Gas Terminal, AIE

The proposed Port Kembla Gas Terminal involves the expansion of a refinery pier, installation of a treatment facility and the construction of a new pipeline approximately 6 kilometres in length. Production capacity ranges between 100 to 140 PJ/a.

Appendix P - Greenhouse Gases of a Report for AIE, Port Kembla Gas Terminal (2018) estimates total construction emissions are 8,314 and operation emissions total 44,145 tCO_2-e annually. Construction time was estimated at 10-12 months.

The Port Kembla Gas Terminal report does not consider upstream emissions associated with transport of the LNG to the Port Kembla Gas Terminal site, nor Scope 3 emissions including downstream emissions associated with the use of NG product. Further, the report does not state whether a closed loop or open loop system will be used during the operation phase.

Port Kembla Gas Terminal's estimated breakdown of GHG emissions during operation is listed below.

Table 2: Breakdown of emissions during operation (Appendix P, Report for AIE Port Kembla Gas Terminal 2127477, 2018)

Operational Activity	Percentage of total emissions
Diesel: commuting	Not considered
Diesel emergency generator	0.3%
MDO: electricity generation	1.4%
LNG-NG: electricity generation	85%
LNG – NG: LNG transfer	7.4%
LNG – NG: auxiliary border	0.8%
LNG – NG: fugitives	5.1%
Natural gas transmission - operations	0.1%

4.2.1.3 Energy Import Terminal, Viva

The Viva Energy Impact Terminal includes the construction of a FSRU and a 7 kilometre gas pipeline. Production capacity is estimated at 160 PJ per annum, delivering up to 45 LNG carriers into the terminal.

Operation emissions in open loop mode are estimated at 48,210 tCO_2-e annually, and 65,574 tCO_2-e annually if using a 'combined system' such as the AGL Crib Point Import Jetty. Closed loop operations were calculated to estimate worst case GHG emissions scenarios and is estimated at 178,985 tCO_2-e annually.

In 2020, the Victorian Minister for Planning determined that the Viva Energy Impact Terminal required an EES under the EE Act (Viva EES). The reasons for the decision included the potential for contributing to GHG emissions (as well as other reasons beyond the scope of this Assessment).

The Viva EES process highlighted that the GHG impact assessment did not address some Scope 3 emissions, including: the operation of the FSRU, the liquefaction of natural gas prior to delivery to the Viva FRSU or the downstream consumption and upstream transportation of natural gas (Scope 3 emissions). The Scope 1 and 2 emissions during the construction period were estimated at 6,878 tCO_2-e. Total construction emissions were 62,168 tCO_2-e. This considers Scope 3 emissions associated with the materials of construction.

A 2021 Technical Studies Summary on GHG Emissions for Viva Energy stated that an energy management system would be implemented in accordance with ISO:50001.

4.2.1.4 Case Study Analysis - Summary Table

A summary of the benchmark case studies is provided in Table 3. This outlines each case study's production capacity and associated construction and operational emissions data for open loop and combined mode (excludes closed loop mode).

Emissions associated with the closed loop operation of Crib Point Gas Import Jetty, AGL and the Energy Import Terminal, Viva increased by a factor of 3.7 when compared to open loop emissions estimates.

Table 3: Summary of benchmark case studies (Source: Various as quoted throughout this report)

Facility Name	Location	Description	Production Capacity (PJ/a)	Emissions Data (tCO_2-e)
Crib Point Gas Import Jetty, AGL	Crib Point, VIC	FSRU, Refinery Pier extension, Treatment Facility and gas pipeline (subsea and onshore).	140 to 300	Construction emissions unknown. Scenario B: 58,143 tCO_2-e annually. Scenario C[1]: 170,133 annually.
Port Kembla Gas terminal (AIE)	Port Kembla, NSW	FSRU, Refinery Pier extension, Treatment Facility and gas pipeline (subsea and onshore).	100 to 140	8,314 (construction) and 44,145 (operations) annually.
Energy Import Terminal, Viva	Geelong, VIC	FSRU, Refinery Pier, Treatment Facility and gas pipeline (subsea and onshore).	160	6,878 (construction) and 48,210 to 65,574 (operations) annually.

4.3 Estimated Operation GHG Emissions

The VET Project is expected to have a similar production capacity to the three case studies.

The expected sources of emissions from the VET Project are expected to be comparable to the breakdown of Port Kembla Gas terminal (AIE). The process of converting LNG to NG is split into four components and is expected to be the main source of Scope 1 and total VET Project emissions.

Edge understands VOPAK is considering the use of shore-based electricity or renewable energy as a power source for its closed loop and/or open loop system. The use of renewable energy is expected to decrease operational annual emissions (i.e., due to no electrical boiler support) for both an open loop and closed loop system.

The use of renewable energy as a power source for its open loop system is likely to decrease overall Scope 2 emissions by approximately 86% and is expected to be significantly lower when compared to a closed loop system powered with shore-based non-renewable electricity.

Further, emissions from electricity use to facilitate LNG conversion to NG is estimated to be negligible under the condition renewable energy will power the VET Project's electric boiler.

Consideration of a diesel emergency generator is included in the estimation of operational GHG emissions. In the circumstance this is installed as backup power to the renewable energy generator, it is estimated to produce approximately 132 tCO_2-e annually if in open loop mode.

Fugitive emissions were estimated from the VET Project's FSRU based on Section 3.72 of the NGER (Measurement) Determination. This method applies a set leak factor to equipment based on the estimated total gas throughput.

Potential sources of GHG emissions during operation of the VET Project and associated emissions from each activity are provided in Table 3. The operational activities described in this table are assumptive and may not be relevant to the VET Project, pending further design and development of the VET Project's facilities and associated infrastructure.

Table 3: Potential sources of the VET Project's operational GHG emissions

Operational Activity	Estimated amount of annual tCO_2-e - open loop mode*	Estimated amount of annual tCO_2-e - closed loop mode*
NG Transmission	44	163
Diesel Emergency Generator	132	488
LNG-NG Fugitives	2,251	8,329
LNG-NG Transfer	3,267	12,088

**Values have been rounded to the nearest whole number where applicable.*

Based on the above data, GHG emissions associated with operation are unlikely to exceed 5,694 tCO_2-e annually if the VET Project is operated in open loop mode.

GHG emissions associated with operation of the VET Project are estimated to increase by a factor of 3.7 if operated in closed loop mode. This is approximately 21,068 tCO_2-e annually.

GHG emissions associated with commuting of VET Project staff and workers are not considered.

4.4 Estimated Construction GHG Emissions

Construction emissions are estimated to be greater than the case studies due to a longer subsea and onshore pipeline and an overhead powerline.

Construction emissions associated with the proposed Crib Point Gas Jetty AGL were not quantified in the GHG Emissions Assessment by Jacobs (August 2018). This increases uncertainty when determining an estimate of construction sourced GHG emissions for the VET Project.

Construction GHG emissions for the proposed Port Kembla Gas Terminal, AIE and Energy Import Terminal, Viva range between 6,878 and 8,520 tCO_2-e annually until construction is complete.

The VET Project's pipeline is two to three times longer while construction time is estimated to be similar to both the Port Kembla Gas Terminal, AIE and the Energy Import Terminal, Viva. In addition, the VET Project will consist of an overhead power cable that extends approximately 30 kilometres inland. Considering this, construction emissions for the VET Project are estimated to be greater than the above case studies. Due to the scope of this Assessment, estimated GHG emissions are provided as a range.

Estimated GHG emissions generated during construction of the VET Project ranges between 8,314 and 9,000 tCO_2-e. This range allows a range for a higher pipeline length and electricity cable associated with the VET Project and an additional two months construction time for the VET Project (compared to the Port Kembla Gas Terminal, AIE).

Based on the data reviewed, it is estimated that the inclusion of fuel transport emissions would increase the VET Project's total GHG emissions by 4 to 12 times higher than the above reported figures, depending on the gas source. This increase is not intended to occur for the life of the VET Project and is relevant for the 12 months during construction of the VET Project (i.e., it will be short-term and is not relevant during VET Project operations or based on its lifespan, which is yet unknown but expected to be 20 years).

4.5 Scope 3 Emissions

Scope 3 emissions are all emissions beyond the Scope 1 and Scope 2 organisational boundaries. That is, all emissions beyond the direct operations and electricity use, including supply-chain operations and end-product usage by customers.

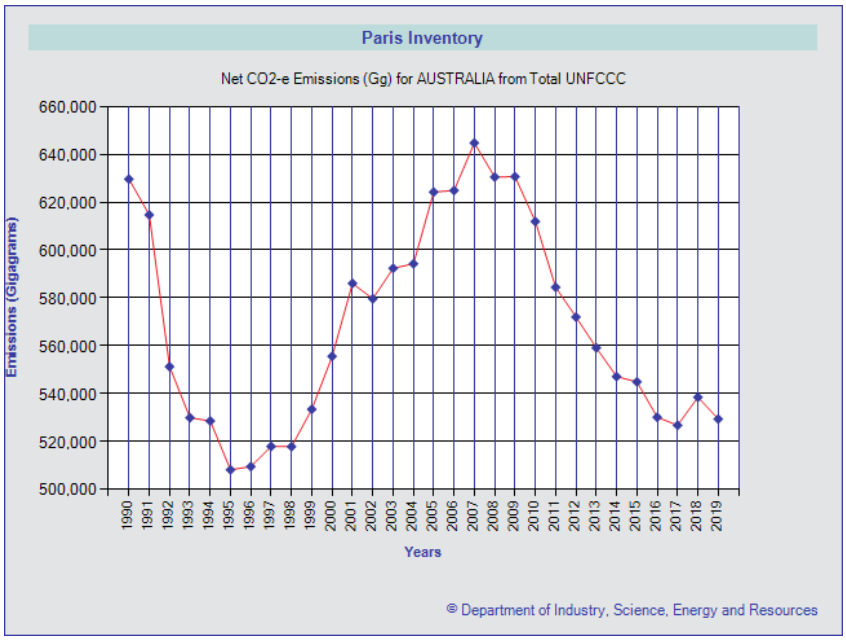
Scope 3 emissions are omitted from this Assessment upon request of the Client. The consideration of Scope 3 emissions in future GHG assessments for the VET Project is subject to further design and development of the VET Project.

4.6 National Greenhouse Gas Emissions

In 2019, Australia's national GHG emissions totalled 529,297,700 tCO2-e (529,298 gigagrams as displayed in Figure 2). Australia has committed to the 2015 Paris Agreement, which aims to reduce global warming by 1.5 to 2 degrees Celsius. The 2015 Paris Agreement provides a carbon budget for each country. The carbon budget is the maximum amount of carbon dioxide equivalent (AR5) that can be emitted to maintain a 2-degree Celsius warming. Australia's carbon budget is 6,161 million metric tonnes (Mt) CO_2-e between 2021-2050.

Figure 1: National GHG emissions from 1990-2019 (National Greenhouse gas inventory, 2022).

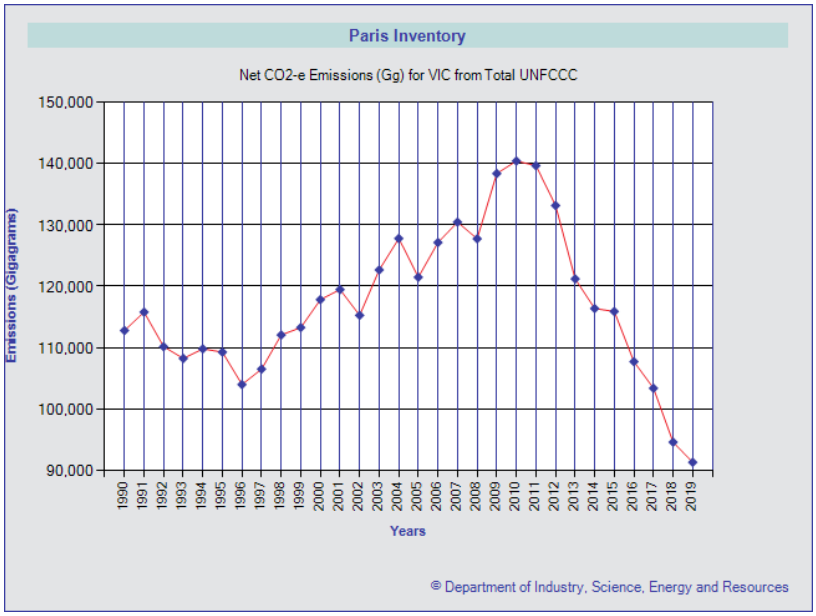
State Greenhouse Gas Emissions



In 2019, Victoria's Scope 1 and Scope 2 GHG emissions totaled 91.4 $MtCO_2$-e. Victoria's energy industries (i.e., direct combustion) accounted for 51 percent of total emissions, or 46.8 $MtCO_2$-e.

According to Victoria's CC Act 2017 and Australia's national commitment to the 2015 Paris Agreement, Victoria has a carbon budget of 1,851 $MtCO_2$-e for between 2017-2050.

Figure 2: State GHG emissions from 1990-2019 (National Greenhouse gas inventory, 2022)



4.7 Discussion

Assessment of GHG emissions shows annual emissions from the VET Project if in open loop mode are expected to account for less than 1 percent of State (0.02) and Federal (0.002 to 0.003) annual emissions for both the construction and operational phases, with the use of renewable electricity to power the electric boiler.

Annual GHG emissions from the VET Project if in closed loop mode are also expected to account for less than 1 percent of State (0.03) and Federal (0.005 to 0.006) annual emissions for both the construction and operational phases, with the use of renewable electricity to power the electric boiler.

Scope 1 emissions associated with the VET Project are predicted to be below the carbon emissions threshold of 25,000 tCO_2-e per annum. Therefore, the VET Project is unlikely to be required to undertake annual reporting obligations under the NGER Act (see Section 3.1.5).

Review of the *Ministerial Guidelines for Assessment of Environment Effects* under the EE Act identified relevant criteria that could trigger a referral under the EE Act.

This includes the referral criteria 'individual potential environmental effects':

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

The estimated total annual GHG emissions associated with the VET Project's operation, in both open and closed loop mode, are estimated to be less than the 200,000 tCO_2-e per annum trigger for a referral under the EE Act as set out in the *Ministerial Guidelines for Assessment of Environment Effects under the Environment Effects Act 1978.*

A targeted review of past case studies that had triggered a referral under the EE Act was conducted to identify the specific reasons for referral. It was found that the case studies were required to acknowledge and address transport and downstream activities (Scope 3 emissions) as a key source of GHG emissions upon request of the Ministerial Independent committee after review of the EES. Therefore, it is predicted that in the circumstance the VET Project triggers a referral under the EE Act, similar follow up requirements may be applied.

4.8 Mitigation

Mitigation measures can be implemented to minimise or avoid GHG emissions where possible. The implementation of mitigation measures reduces the likelihood of risks associated with the emission of GHGs.

To address relevant mitigation measures, consideration can be given to:

- The prefabrication of key materials such as pipe and pipe fittings before supplying to site for installation, and monitoring of key equipment to avoid additional emissions associated with transport and handling of materials.
- Identifying opportunities for sustainable resource management practices to avoid the inefficient use of materials, fossil fuels, and electricity.
- Under the voluntary *AS/NZS 3598:2000* standard, conducting a minimum level 2 audit on the VET Project's FSRU operation annually to identify inefficiencies.
- Identifying and implementing opportunities for GHG emissions reduction.
- Annual reporting of measures to the Victorian EPA for the life span of the VET Project.
- Identify and minimise fugitive emissions from LNG transfer, storage and transmission infrastructure.

4.9 Uncertainties

4.9.1 Scope 3 Emissions

The case studies used in the benchmarking analysis vary in their inclusions of Scope 3 emissions. The determination of projected GHG emissions for the VET Project excludes the consideration of Scope 3 emissions as per the request of the Client.

The inclusion of Scope 3 emissions is subject to further design plans and development of the VET Project. Scope 3 emissions are dependent on how the VET Project boundary is defined and the materiality (or impact) of the emissions.

5 Recommendations

The purpose of the Assessment was to review existing VOPAK documentation and conduct a desktop search of relevant state and federal legislation.

Based on the Assessment, it was concluded that the VET Project is unlikely to exceed 200,000 tCO_2-e, and therefore does not trigger a referral under the Environment Effects Act 1978 (EE Act), for this criterion.

A review of past case studies and the circumstances under which they triggered a referral under the EE Act, including a requirement to address transport and downstream emissions (considered Scope 3 emissions) assisted in the forming the recommendations provided below.

- Consider Scope 3 emissions in the design and development stage of the VET Project. This includes mitigation measures to reduce these emissions if relevant following further design of the VET Project.
- Estimate the scope, likelihood, and associated risks of GHG.
- Ensure compliance with the *(Safeguard Mechanism) Rule 2015, the* National Greenhouse and *Energy Reporting (Measurement) Determination 2008 under the* NGER Act 2007, EP Act.

6 Limitations

Edge Group Pty Ltd prepared this report for Aurecon Group.

The findings of this report are based on the scope of work outlined in Edge's proposal (Edge ref: 20210012-P-01 & 20220386-P-01). Edge performed the services in a manner consistent with the expected level of care and expertise exercised by those in the environmental profession.

No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the proposal.

Although normal standards of professional practice have been applied, the methodology adopted and sources of information used by Edge are outlined in this report. Edge has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found during our assessment that information contained in this report as provided to Edge was false.

This report was prepared in October and November 2022 for Aurecon Group and is based on the conditions encountered and information reviewed at the time of preparation.

All conclusions and recommendations made in the report are the professional opinions of the Edge personnel involved with the assessment. While normal checking of the accuracy of data has been conducted, Edge assumes no responsibility or liability for errors in data obtained from regulatory agencies or any other external sources, nor from occurrences outside the scope of this assessment.

7 References

- Environment Protection Act 2017. Act Number 51/2017
- Victoria State Government, *Victoria's greenhouse gas emissions and targets* (February 2022)
- Australian Industrial Energy, *Port Kembla Gas Terminal Greenhouse Gas Assessment Appendix P* (November 2018).
- Viva Energy, *EES Technical Studies Summary Greenhouse gas emissions* (September 2021)
- Jacobs, AGL Wholesale Gas Limited, *Greenhouse Gas Emissions Assessment (including Climate Change) IS210700-EP-RP-011,* (August 2018)
- Jacobs, *Fact sheet: AGL gas import jetty greenhouse gas assessment,* (March 2018)
- Viva Energy, *Technical Report C Greenhouse Gas Impact Assessment* (February 2022)
- Federal Register of Legislation, *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (July 2017)
- Federal Register of Legislation, *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015* (October 2021)
- Meinshausen, M. Robiou, Y. Talberg, A. Australian-German Climate & Energy College, *Greenhouse Gas Emissions Budgets for Victoria Briefing Paper* (2017)
- Dept. Environment & Sustainability (Seventh Edition), *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978* (2006)

Appendix A

Site Location and Proposed Pipeline Route

260000 265000 270000 275000 280000 285000 290000 295000 300000 305000

5800000 5795000 5790000 5785000 5780000 5775000

LEGEND

- Project area
- Indicative onshore pipeline route
- Indicative shore crossing pipeline route
- Indicative subsea pipeline route
- Indicative electricity cable (option 1a underground)
- Indicative electricity cable (option 1b underground)
- Indicative electricity cable (option 2 overhead)
- Indicative electricity cable shore crossing
- Indicative subsea electricity cable
- Indicative powerline
- Indicative Gas Receiving Station site
- Indicative substation
- Indicative FSRU location
- Marine berth area
- Boat ramp
- Railway station
- Railway line
- Arterial road
- Sub-arterial road
- Watercourse
- Waterbody
- Existing gas pipeline
- Cadastral boundaries
- Local government area

MAP SHEET 3: Onshore Powerline

MAP SHEET 2: Onshore Pipeline

MAP SHEET 1: Offshore

WYNDHAM CITY COUNCIL
GREATER GEELONG CITY COUNCIL
GOLDEN PLAINS SHIRE COUNCIL
HOBSONS BAY CITY COUNCIL

HOPPERS CROSSING
WERRIBEE
WERRIBEE RACECOURSE
LITTLE RIVER
LARA
CORIO
MOORABOOL
NORTH SHORE
NORTH GEELONG
GEELONG
GEELONG SOUTH
BREAKWATER
FYANSFORD
GEELONG (CITY)
DRYSDALE
PORTARLINGTON

Heaths Rd
Dunnings Rd
Cheetham Creek
Skeleton Creek
Sneydes Rd
Point Cook Rd
South Saltworks Moat
Point Cooke
Werribee West Drain
Lollypop Creek
Tarneit Rd
Derrimut Rd
Werribee River
Bulban Rd
Princes Fwy
WESTERN SG LINE REGIONAL RAIL LINK
Duncans Rd
Aviation Rd
Point Cook Creek
Diggers Rd
Campbells Cove
Cherry Creek
Little River
You Yangs Rd
Little River Rd
Farrars Rd
Branch Rd
Old Melbourne Rd
Beach Rd
Wedge Point
Beacon Point
Kirk Point
Forest Rd North
Forest Rd South
Howells Creek
Elcho Drain
Ballan Rd
Princes Hwy
Steiglitz Rd
Geelong Ring Rd
Shell Pde
Point Abeona
Point Wilson
Cowies Creek
Cox Rd
Station St
Mooraboool River
Ballarat Rd
Anakie Rd
Thompson Rd
Melbourne Rd
Vines Rd
Fyansford - Cheringhap Rd
Hamilton Hwy
Barwon River
Aberdeen St
Ryrie St
Fyans St
Carr St
Scenic Rd
Shannon Av
Barrabool Rd
Bellarine Hwy
Portarlington Rd
Corio Bay
Geelong Harbour
Point Henry
Limeburners Point
Stingaree Bay
White Woman Reef
Point George
Hood Rd
Geelong Rd
PENNINGTON LINE

PROPOSED WORKS

Vopak

Disclaimer: Vopak makes no warranty in relation to the accuracy, reliability, completeness or suitability of the data and does not accept liability for any loss, damage or costs, including consequential damage, in relation to any use of the data in this map.

PROJECT: Victoria Energy Terminal		
DATE: 29/11/2022	STATUS: DRAFT	PRODUCED: MVC
SCALE: 1:125,000 at A3	DATUM: GDA2020 MGA Zone 55	APPROVED: MDG
FILE: VET-EES-03-C Proposed Works		REV: C

0 1 2 3 4 5 km