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**West Erregulla Field Development Program – Greenhouse Gas Emissions Estimates**

## 1. Background

Strike West Pty Ltd (Strike Energy; the Proponent) is proposing to construct and operate a gathering system to connect its West Erregulla gas field and convey the extracted gas to an upstream separating facility, collectively known as the West Erregulla Field Development Program (the Proposal).

The Proposal will enable the supply of the gas to a third party operated gas processing facility which is subject to separate approvals. The Proposal is located in the Shires of Three Springs and Mingenew in the Midwest region of Western Australia approximately 50 km southeast of Dongara and 234 km north of Perth.

Greenhouse gas (GHG) emissions will be generated by the Proposal as a result of changes to land use (clearing of vegetation), combustion of fuel in plant and vehicles, ongoing operational activities, and during flaring activities.

This memo describes the estimation and assessment of emissions associated with the Proposal and has been prepared to support the assessment of the Proposal by the Environmental Protection Authority (EPA).

## 2. EPA objective

The objective of the EPA for greenhouse gas emissions is:

> *To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change.*

## 3. Receiving environment

Australia along with many other global regions is experiencing a changing climate including warming trends and extreme weather events (CSIRO and Bureau of Meteorology, 2021). Specifically, the impacts of climate change already experienced in Western Australia include:

- Increase average temperature of 1.3°C since 1910;
- Decline in rainfall in the far west and southwest while an increase has been recorded over most of Western Australia;
- Increase in number of days with high bushfire risk conditions; and
- Decline in tropical cyclones over the period 1981/82 – 2017/18.

Future climate change projections predicted for Western Australia by mid-century include:

- A continued rise in temperatures (projections dependent on global GHG emissions scenario);
- A projected increase in the number of very hot days (> 40 °C) in Perth from 1.5 to 5 per year;
- A longer fire season with 40% more high fire danger days;
- A rise in sea level of 24 cm;
- Increased intensity of extreme rainfall events;
- As a whole, Western Australia is likely to become drier - Rainfall change is unclear in the monsoonal north, but ongoing significant declines in southwest Western Australia are likely; and
- A projected 12% decrease in tropical cyclones.

### 3.1.1 Policy and guidance

A summary of the relevant policy and guidance for GHG emissions is provided in Table 3.1.

**Table 3.1: GHG policy and guidance**

| Author | Title | Year of Publication |
|---|---|---|
| EPA | Statement of Environmental Principles, Factors and Objectives (EPA, 2020) | 2020 |
| | Environmental Factor Guideline: Greenhouse Gas Emissions (EPA, 2020) | 2020 |
| Government of Western Australia | Western Australian Climate Policy (DWER 2020) | 2020 |
| | Greenhouse Gas Emissions Policy for Major Projects (Government of Western Australia, 2019) | 2019 |
| Commonwealth | *National Greenhouse and Energy Reporting Act 2007* (NGER Act) | 2007 |
| | National Greenhouse and Energy Reporting (Measurement) Determination 2008 | 2008 |
| | National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 | 2015 |

## 4. Potential impact

The Proposal will result in GHG emissions which will contribute to global GHG concentrations and contribute to climate change influenced by changes to global GHG emission concentrations.

### 4.1 Estimated GHG emissions

National and international greenhouse gas reporting standards delineate sources and associated responsibilities by apportioning GHG emissions to distinct scopes (Australian Government Clean Energy Regulator, 2021).

The scopes are:

- Scope 1 – emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level;
- Scope 2 – GHG emissions are the emissions from the consumption of an energy product from a third party supplier; and
- Scope 3 – indirect GHG emissions, other than Scope 2 emissions, generated in the wider community as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business.

Proposal GHG emissions for the construction and production phases of the Proposal have been determined using the methodologies described by the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (Australian Government, 2020). Emission factors from the National Greenhouse Accounts Factors (NGA) have been used (Australian Government Department of Industry, Science,Energy and Resources, 2021).

## 4.2 Construction GHG emissions

### 4.2.1 Construction Scope 1 emissions

Key activities generating Scope 1 emissions associated with the construction phase of the Proposal include:

- Diesel consumption by mobile plant required for activities including:
  - Clearing of vegetation;
  - Drilling (wells and monitoring bores);
  - Trenching;
  - Road construction;
  - Earthworks associated with well construction;
  - Project trucks and light vehicles (used on-site);
  - Mini-camp generator;
  - Camp generator;
- Flaring of gas (associated with well production testing); and
- Loss of biomass due to vegetation clearing.

#### 4.2.1.1 Diesel consumption

Diesel consumption during the construction phase was estimated by the Proponent to be 55 kL over a six month period. GHG emissions generated from the diesel fuel consumption were estimated using the following formula (from NGA Factors Section 2.1.3):

$$E_{ij}\text{t CO}_2 - \text{e} = \frac{Q_i \times EC_i \times \Sigma EF_{ijoxec}}{1000}$$

Where:

Eij is the sum of the emissions of gas type (j) (carbon dioxide, methane or nitrous oxide), from fuel type (i) ($CO_2$-e tonnes).

$Q_i$ is the quantity of fuel type (i) combusted for stationary energy purposes (kilolitres).

$EC_i$ is the energy content of the fuel type (i) (gigajoules per kilolitre) for stationary energy purposes.

$EF_{ijoxec}$ is the sum of the emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kilograms $CO_2$-e per gigajoule).

Diesel used for construction was assessed using the emission fuel combustion factors for diesel for stationary energy (non-transport) from NGA factors part 2 energy content for diesel of 38.6 GJ/kL and emission factors of 69.9, 0.01 and 0.2 kilograms $CO_2$-e per gigajoule for $CO_2$, $CH_4$ and $N_2O$ respectively.

The calculated Scope 1 emissions for fuel consumption during construction are estimated to be up to 149 t $CO_2$-e.

#### 4.2.1.2 Flaring and venting

Flaring of natural gas will occur during the connection of the four existing and two new wells to the gas gathering system flowlines. Natural gas will also be flared during the production well testing of the two new wells (wells G and J) for a period of between 5 to 7 days post confirmation of commercial viability. A total of 6,371,292 $m^3$ of natural gas is expected from all flaring activities.

GHG emissions generated from flaring were estimated using the following formula:

$$E_{ij} = Q_i \times EF_{ij}$$

Where:

Eij is the emissions of gas type (j) (carbon dioxide, methane or nitrous oxide) from fuel type (i) ($CO_2$-e tonnes).

$Q_i$ is the quantity measured in tonnes of gas flared.

$EF_{ij}$ is the emission factor for gas flared (2.7, 0.133 and 0.026 t $CO_2$-e/ tonnes flared for $CO_2$, $CH_4$ and $N_2O$ respectively[1])

A small amount of gas will also be vented to atmosphere; this has also been accounted for in the calculation of GHG emissions.

The calculated Scope 1 emissions for flaring and venting are estimated to be up to 13,798 t $CO_2$-e.

#### 4.2.1.3 Clearing of vegetation

The calculation of GHG emissions resulting from clearing associated with the Proposal is based on the following conservative assumptions and exclusions:

- Vegetation was mature without any disturbance;
- Above and below ground biomass would be cleared from a total of 38.53 ha of land in the Development Envelope;
- The above ground biomass estimate derived from the maximum biomass density inside the Proposal area in the Maximum Above Ground Biomass (also known as M) spatial layer developed for the Full Carbon Accounting Model (FullCAM) is representative of vegetation in the Development Envelope;
- A root to shoot ratio of 2.8 derived from Intergovernmental Panel on Climate Change (IPCC guidance) for shrubland [2] is representative of the vegetation in the Development Envelope;
- The default IPCC value of carbon fraction of biomass dry matter of 0.5 is representative;
- All carbon in biomass removed would all be released as $CO_2$; and
- Soil carbon loss was not accounted for.

[1] Emission factors from National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Section 3.69) Method 1 referred to by NGA. This method does not separately account for the $CO_2$ in the gas stream however is considered a conservative approach.

[2] Table 3A.1.8 shrubland IPCC 2003 https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

The carbon sequestration loss from vegetation clearing ($\Sigma E_v \mathrm{t\ CO_2}$) was estimated from the following formula[3]:

$$\Sigma E_v \mathrm{t\ CO_2} - \mathrm{e} = \mathrm{A} \times \mathrm{AGB\ x\ (1 + R)\ x\ CF\ x\ CD}$$

Where:

| parameter | Description | Value | Source |
|---|---|---|---|
| A | area to be cleared in hectares | 38.53 ha | - |
| AGB | above ground biomass | 43 t dry matter/ha | Maximum Above Ground Biomass (also known as M) spatial layer |
| R | root to shoot ratio to estimate below ground vegetation biomass | 2.83 | Table 3A.1.8 shrubland IPCC 2003 Good Practice Guide for Land Use, Land Use Change and Forestry |
| CF | IPCC default carbon fraction of biomass | 0.5 | IPCC Guidelines for National Greenhouse Gas Inventories |
| CD | ratio of the molecular weight of carbon dioxide to carbon | 3.67 | Molecular weight $CO_2$ (44) / Molecular weight C (14) |

Using the above values, the potential GHG emissions from clearing of vegetation and loss of bio-sequestration capacity for the Proposal would be 11,634 t $CO_2$-e.

Following the completion of construction activities, cleared areas that are not required for ongoing operational requirements will be rehabilitated to pre-disturbance conditions. No less than 30 ha of vegetation cleared to facilitate construction will be rehabilitated. Rehabilitation is expected to commence within two years of construction and reach pre-clearing biomass load within a further five years.

The overall permanent loss of biomass sequestration associated with the Proposal is therefore a total of 2576 t $CO_2$-e.

Scope 1 emission during the year of construction are estimated to be 21,907 t $CO_2$-e. Following rehabilitation of vegetation the total Scope 1 emissions attributable to construction of the Proposal, including diesel usage, flaring and venting and residual loss of biomass are estimated to be reduced to 16,529 t $CO_2$-e.

### 4.2.2 Construction Scope 2 emissions

There are no Scope 2 emissions associated with the construction phase of the Proposal; electricity requirements will be met by on-site diesel generators, the emissions from which are accounted for in Scope 1.

### 4.2.3 Construction Scope 3 emissions

Scope 3 emissions associated with construction of the Proposal are limited to the embedded emissions associated with the materials used for physical construction. These emissions are considered to be insignificant in comparison to the total GHG emissions from the Proposal and have been excluded from the assessment.

[3] IPCC 2006 equation 2.14

### 4.3 Production GHG emissions

#### 4.3.1 Production Scope 1 emissions

Scope 1 emissions associated with the production phase of Proposal are limited to diesel consumption (5 kL/year) resulting in 13 t $CO_2$-e/year (using the calculation method described in Section 4.2.1.1).

Emission from emergency flaring could occur; however, given the low likelihood of these events occurring, they have are not considered further in this assessment.

Fugitive natural gas emissions associated with gas production infrastructure and maintenance emissions may also occur. Fugitive emissions will be an insignificant contributor to GHG emission from the Proposal and will be minimised by implementation of an ongoing monitoring and maintenance program.

Over the minimum 20 year production life of the Proposal, the total production Scope 1 emissions from biomass loss and diesel consumption would be 270 t-$CO_2$-e.

#### 4.3.2 Production Scope 2 emissions

There are no Scope 2 emissions associated with the production phase of the Proposal; any electricity required will be sourced from solar powered generation systems.

#### 4.3.3 Production Scope 3

Key Scope 3 emissions sources associated with the proposal include:

- Reservoir $CO_2$ emitted during processing;
- Gas processing; and
- Gas combustion by the end user.

GHG emissions associated with fugitive emissions during transmission, processing and storage would also occur; however, as the specific nature of the downstream processing networks are not known, and are subject to a separate EP Act Part IV referral by another proponent, these emissions have not been estimated.

Reservoir $CO_2$ will be released during processing. The $CO_2$ content of the Proposal reservoir is assumed to be 6.53 mol % (Eco Logical, 2021) and it is conservatively assumed that all $CO_2$ would be emitted to atmosphere; this maybe excessively conservative given the maximum specification for $CO_2$ is 4 mol% (Gas Supply (Gas Quality Specifications) Amendment Regulations 2015).

The intensity of the processing of the gas, including removal of reservoir $CO_2$ and processing activities, has been estimated as 2.93 t $CO_2$-e/TJ (Eco Logical, 2021). Therefore, the maximum Scope 3 emissions associated with processing of the gas generated from the Proposal are estimated to be 96,319 t $CO_2$-e/year.

Scope 3 emissions associated with consumption of natural gas by the end user are calculated using an emissions factor of 51.4, 0.1 and 0.03 kilograms $CO_2$-e per gigajoule for $CO_2$, $CH_4$ and $N_2O$ respectively[4].

Using these factors, emissions associated with the combustion of natural gas by the end user were estimated (using the equation presented in Section 4.2.1.1) to be 1,636,335 t $CO_2$-e/annum.

4 National Greenhouse and Energy Reporting (Measurement) Determination 2008 Schedule 1 Part 2 item 17 and NGA 2020 Table 2

Total Scope 3 emissions associated with the production phase of the Proposal are therefore estimated to be 1,732,654 t $CO_2$-e/annum or 34,653,083 t $CO_2$-e over the minimum 20 year life.

## 5. Assessment of impacts

The estimated maximum Scope 1 emissions of 25,587 t $CO_2$-e generated during the first year when construction is carried out and production commences, and be reduced to 16,529 t $CO_2$-e following rehabilitation of vegetation by year seven, is well below the 100,000 t $CO_2$-e per year threshold defined by the EPA for detailed assessment (EPA 2020).

Furthermore, the contribution of the Proposal to reported total GHG emissions for Western Australia (91.9 Mt $CO_2$-e in State and Territory Greenhouse Gas Inventories 2019[5]) is very small and no significant residual impact is identified.

Consequently, it is considered that the EPA's objective for Greenhouse Gas Emissions will be met.

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