GREENHOUSE GAS EMISSIONS ASSESSMENT

ARROWSMITH NORTH SILICA SAND PROJECT

PREPARED FOR:

PRESTON CONSULTING PTY LTD

ON BEHALF OF VRX SILICA LIMITED

23 DECEMBER 2022

KEWAN BOND PTY LTD

ENVIRONMENTAL ACCOUNTING
AND CONSULTING SERVICES

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1. Introduction

Kewan Bond Pty Ltd (KBPL) was commissioned by Preston Consulting Pty Ltd (Preston) to calculate the estimated greenhouse gas (GHG) emissions associated with the proposed Arrowsmith North Silica Sand Project (the Project). The Project is owned by VRX Silica Limited (VRX Silica), who have engaged Preston to assist with project approval processes.

Emission estimates were calculated based on the available project information and through the application of the latest industry-accepted emission estimation techniques. Estimated emissions include consideration of Scope 1, Scope 2 and Scope 3 emissions, although there are no Scope 2 emissions anticipated (i.e. from the consumption of grid-sourced electricity).

2. Project Description

The Project is located approximately 270 km north of Perth, Western Australia. The Project will involve the mining and processing of high-grade silica sand at the Project site, before transporting the product approximately 100km north to the Geraldton Port, for export. The method of transporting the silica sand to Geraldton is yet to be confirmed and will either be via road or rail. Both transport options have been included within the GHG emission estimates. High-grade silica sand is mostly used for the production of glass.

The primary sources of GHG emissions for the Project will be the consumption of electricity and diesel to operate the plant and machinery. Electricity will be generated on site through the construction of natural gas-fired power station. Natural gas is expected to be delivered to site either by establishing a link to the Dampier to Bunbury Natural Gas Pipeline or through truck deliveries of liquefied natural gas. VRX Silica are also investigating the potential for solar electricity to be incorporated with the Project through the construction of an on-site solar farm. The GHG emission estimates have therefore also considered the impacts of renewable energy inputs.

GHG emissions will also result from the clearing of vegetation and the subsequent decomposition of vegetation matter. The disturbance of land for mining will be conducted using the 'Vegetation Direct Transfer' method, which reduces the extent of vegetation destruction.

The Project is expected to have a 30-year operational life, including a production rate of 1 million tonnes per annum for the first 3 years (single shift), and then increasing production to 2 million tonnes per annum thereafter (double shift).

3. Emission Sources

The assessment and calculation of GHG emissions associated with the project include Scope 1, 2 and 3 emissions.

Scope 1 emissions are the emissions released to the atmosphere as a direct result of an activity, or series of activities at a facility level. Scope 1 emissions are sometimes referred to as direct emissions. Scope 1 emissions associated with the Project include:

- Diesel (consumption by mining equipment and vehicles)
- Natural gas (consumption by on-site electricity generation units)

Scope 2 emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity, such as grid electricity that is generated at another facility. Scope 2 emissions from one facility are part of the scope 1 emissions from another facility.

The Project will be generating its own electricity and so will not be consuming grid electricity and will therefore not have associated Scope 2 GHG emissions.

Scope 3 emissions are indirect GHG emissions other than scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. Examples of scope 3 emissions associated with the Project include:

- Diesel used by trucks or trains to transport the silica sand product to Geraldton Port (by a transport company that is not owned or controlled by VRX Silica) – considered outside of VRX's 'operational control' as per reporting procedures under the National Greenhouse and Energy Reporting Scheme (NGERS).
- Fuel used by ships in exporting the product to overseas customers
- Emissions associated with extracting, refining and transporting fuels that are eventually used at the project site
- Fuel used by site personnel commuting to and from site

In addition to emissions from the combustion of fossil fuels, GHG emissions will also result from the clearing and decomposition of vegetation from the project area. After mining, the disturbed land is proposed to be revegetated with local native plant species. This revegetation will result in carbon sequestration and will contribute to offsetting the emissions from the original land clearing.

4. Emission Calculation Methods

The methods adopted by KBPL for calculating the GHG emissions are aligned primarily with the Australian Government's National Greenhouse and Energy Reporting Scheme (NGERS), which is administered by the Clean Energy Regulator. The greenhouse gases that are reported under the NGER Scheme include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6) and specified kinds of hydro fluorocarbons and perfluorocarbons. The main gases expected to be released from activities associated with the project are CO_2, CH_4 and N_2O. These are expressed in units of tonnes carbon dioxide equivalent (CO_2-e), which takes into account the 'global warming potential' (GWP) of each gas. Carbon dioxide has a GWP of 1. Methane has a GWP of 28, such that 1 tonne of methane is expressed as 28 tonnes CO_2-e. Nitrous oxide has a GWP of 265.

Some emission sources are not required to be reported by Australian companies under the NGERS. These include Scope 3 emissions and emissions from vegetation clearing. However, these emission sources have been estimated for inclusion within the Project's GHG emission assessment.

Emissions from the clearing and decomposition of carbon contained in vegetation, debris and soil has been estimated using the 2020 version of the Full Carbon Accounting Model (FullCAM), developed by the Australian Department of Industry, Science, Energy and Resources. FullCAM is

used to calculate Australia's GHG emissions from the land sector, as part of Australia's National Greenhouse Gas Accounts.

Scope 3 emissions have been calculated based on factors from various sources including:

- Australian National Greenhouse Accounts Factors (2020) – for emission factors for the extraction, refining and delivery of fuels consumed on site
- UK DBEIS – for emissions associated with shipping product via bulk carriers
- Aurizon (rail transport company) – for emissions associated with rail transport of product

5. Results

5.1. Land Clearing and Revegetation

Construction of the Project is expected to involve an initial clearing of 21.5 hectares (ha) for access roads and the process plant. Mining is expected to involve the clearing of 11.5 ha per annum of new land within the mining envelope. The disturbance of land for mining will be conducted using the method 'Vegetation Direct Transfer' (VDT) which reduces the destruction of vegetation during mining. VDT increases the rate and success of land revegetation and reduces GHG emissions. For the purposes of emission estimations, it is assumed that the application of VDT will result in only 60% of vegetation destruction/mortality, compared to 100% under conventional land clearing practices.

The calculated emission estimates from FullCAM consider the project location, vegetation types and the timing of events such as clearing and rehabilitation. Figure 1 indicates a gradual increase in cumulative emissions as land clearing occurs throughout the Project's operational phase. Total cumulative emissions are estimated to reach 33,160 tonnes CO2-e during the 30-year operational phase of the Project (5% of total project GHG emissions). Emissions then start reducing when the emission sequestration rates become higher than the emissions resulting from vegetation decomposition. Total cumulative emissions over 100 years are estimated to be 12,126 tonnes CO2-e (2% of total project GHG emissions).

Figure 2 shows that annual emissions generally range between 1,000-1,200 tonnes CO2-e as a result of the initial site clearing in 'Year 0' and the cumulation of vegetation destruction each year for progressive mining activities. The modelling data shows that net carbon sequestration commences from 'Year 36' as the revegetation continues and there is no further land clearing.

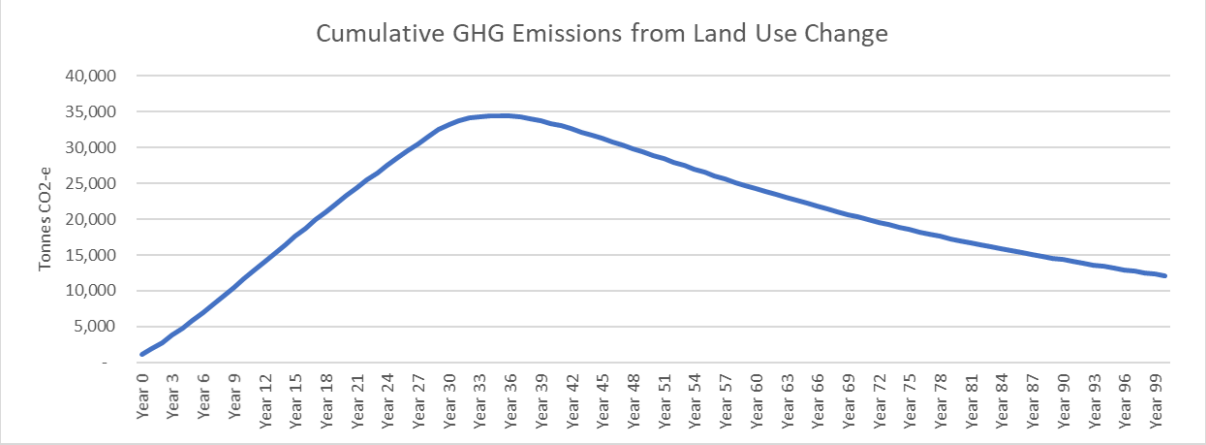

Figure 1 Cumulative emissions from land use change

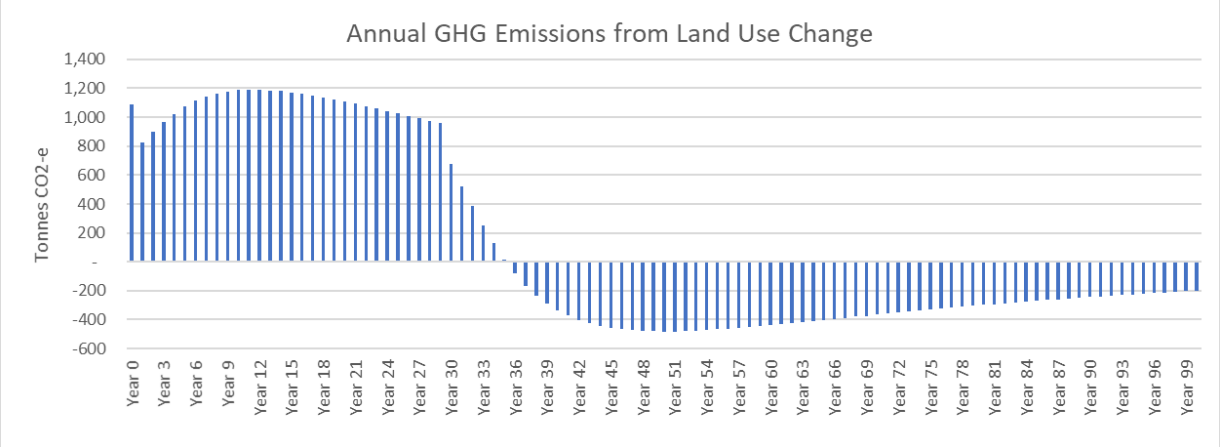

Figure 2 Annual GHG emissions from land use change

5.2. Scope 1 Emissions

Scope 1 emission sources included in the assessment were:

- Natural gas consumed in the gas-fired gensets for electricity generation
- Diesel consumed by mine site equipment (e.g. dozers, front-end loaders, trucks)

Forecast fuel consumption rates were estimated based on information supplied by VRX Silica, including:

- Gas genset installation (5 MW) – high speed reciprocating engines.
- Constant electricity draw (4.5 MW)
- 1 x bulldozer
- 4 x front-end loaders
- 2 x 20-tonne articulated trucks (first 3 years only, until a feeder conveyor is installed)
- Water truck
- Light vehicles

Gas genset efficiency rates (44.5%) were sourced from KPS Power Generation. Fuel consumption rates for earthmoving equipment have been provided by professional estimators, Resource Utilization Consultants (RUC). Figure 3 shows that annual Scope 1 emissions are estimated to range from 11,300 tonnes per annum in the first three years, and then increase to 19,100 tonnes per annum once the project doubles production rates and moves to a 24-hour operation. The majority (86%) of Scope 1 emissions are predicted to be generated from the consumption of natural gas for electricity generation. The remainder (14%) of emissions are generated by diesel consumed by the various earthmoving equipment on site.

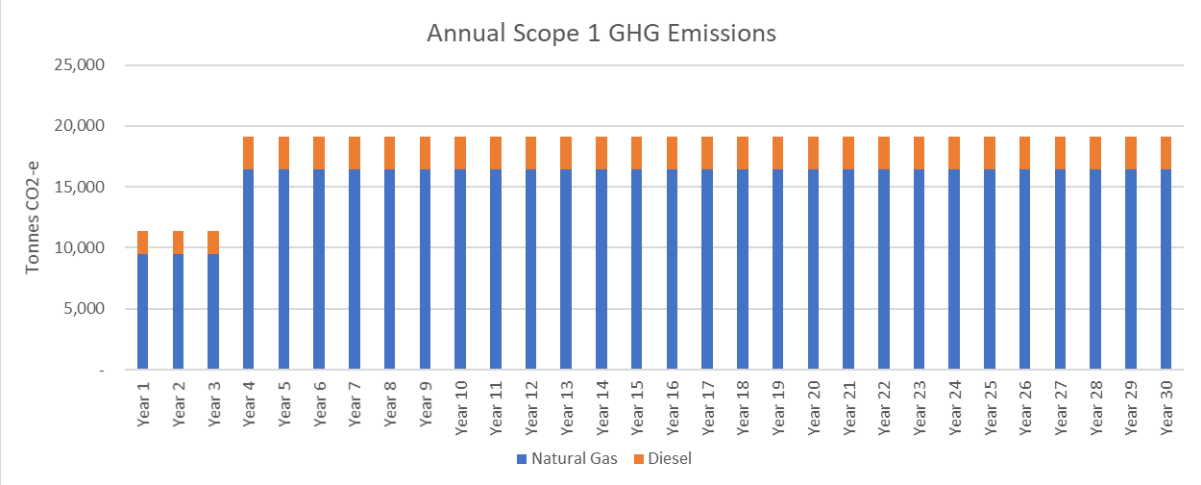

Figure 3 Annual Scope 1 GHG emissions

5.3. Scope 3 Emissions

Scope 3 emission sources included in the GHG emission assessment for the Project include emissions from the following activities, which are considered outside the 'operational control' of VRX Silica:

- Transport of silica sand product from site to Geraldton Port (return trips)
- Transport of silica sand product from Geraldton to overseas customers
- Commuting by site personnel to and from site (drive-in, drive-out)
- Emissions associated with extracting, refining and delivery of fuels used at site

Two alternate methods for transporting silica sand product to the Geraldton Port are being considered by VRX Silica – road and rail. The distance from the Project site to Geraldton is approximately 115 kilometers. The GHG assessment considered the predicted emissions associated with both transport options. Fuel consumption rates by road trains to Geraldton were sourced from a road transport company.

From Geraldton Port, the product will be exported to overseas customers. The most likely destination for the product is expected to be Korea, but it is possible that product could also be exported to other countries (e.g. China, Indonesia, India). Shipping to Korea involves the greater distance and shipping-related GHG emissions compared to China, Indonesia or India. For the purposes of the GHG emission assessment, it has been assumed that all product will be exported to Korea. Emissions associated with shipping from Geraldton to various international ports were sourced from the UK DBEIS Conversion Factors (2020) and assume bulk carriers between 60,000-100,000 dwt.

Site personnel are expected to commute to the Project site each day. Fuel consumption associated with this commuting is included in the calculation of Scope 3 emissions. It is expected that full operations will involve a workforce of eighteen (18) personnel. For the purposes of estimating emissions, it is assumed that half the workforce will commute from Dongara (45 km from site) and half will commute from Geraldton (115 km from site). It is also assumed that each person will drive their own vehicle to site. Emissions would be lower if car-pooling or a bus was adopted for employee commuting.

5.3.1. Product Transport via Road

Figure 4 presents the estimated Scope 3 emissions under the scenario that the silica sand product is transported to Geraldton via truck. During full production (after year 3), Scope 3 emissions are estimated to comprise:

- Road transport of product to Geraldton = 11,643 t CO2-e per annum
- Natural gas extraction, refining and transport = 1,276 t CO2-e per annum
- Diesel extraction, refining and transport = 138 t CO2-e per annum
- Personnel commuting = 517 t CO2-e per annum
- Shipping of silica sand product to overseas customers = 46,897 t CO2-e per annum

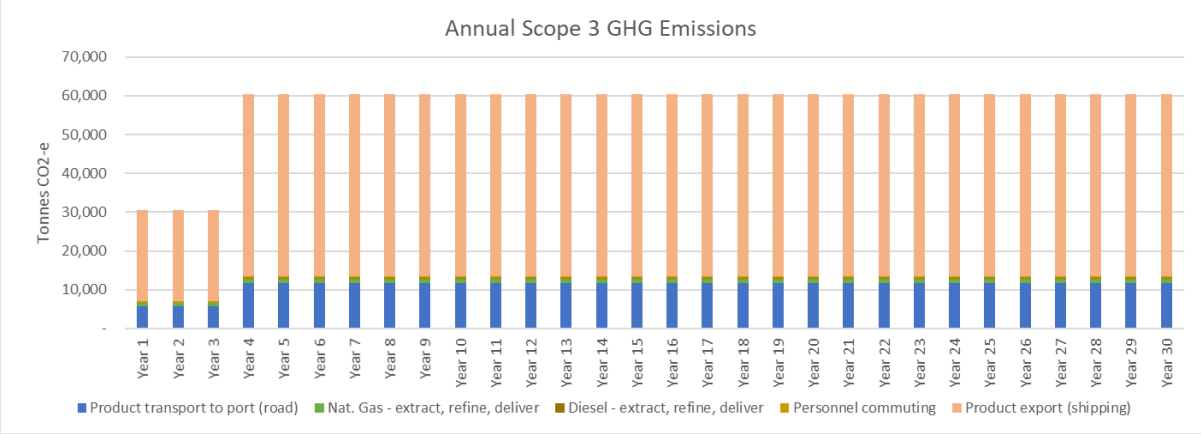

Figure 4 Annual Scope 3 GHG emissions (Road transport)

5.3.2. Product Transport via Rail

Under the scenario that the silica sand product is transported to Geraldton via rail, the Scope 3 emissions would reduce. Compared to the road transport option (11,643 t CO2-e per annum), the rail option would involve emissions of 3,749 t CO2-e per annum under full production rates.

5.3.3. Product Transport as Scope 1 emission

Under the scenario that the transport of silica sand product to Geraldton is conducted under the 'operational control' of VRX, then the associated emissions would be considered Scope 1 rather than Scope 3. This would have effect of up to 11,643 tonnes CO2-e per annum being added to the Scope

1 emissions profile, and being removed from the Scope 3 profile. Under this scenario, Scope 1 emissions for the project would increase to 30,759 tonnes CO2-e per annum (Figure 5).

This scenario is considered unlikely under the current NGERS guidelines regarding the determination of operational control and reporting obligations. It is most likely that emissions associated with product transport to Geraldton will be considered outside of VRX's operational control and therefore a Scope 3 emission (similar to the shipping of the product from Geraldton port to international customers).

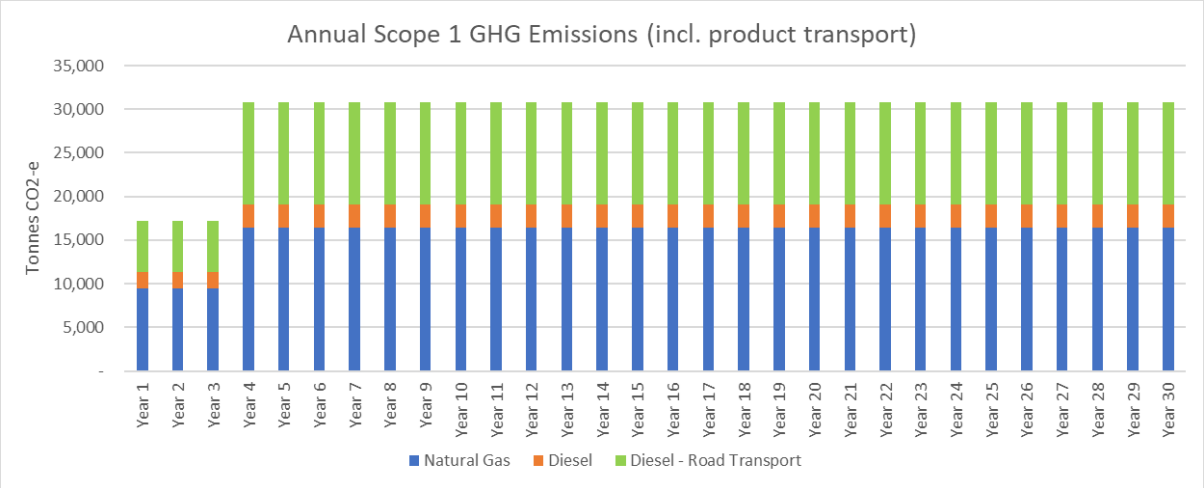

Figure 5 Annual Scope 1 GHG emissions (including product transport as Scope 1)

5.4. Impact of Renewable Energy Options

VRX Silica have indicated an intention to investigate the potential for constructing some solar energy capacity to offset the electricity being generated by the proposed natural gas gensets. The size of the potential solar installation is yet to be determined, but has been estimated at 1 MW for the purposes of calculating the potential GHG emission reductions.

1 MW has been selected as the maximum generation load that could be taken up at short notice by the remaining operating gas gensets in the case of cloud interference. The closest sized system would be 1210 kWp (DC) producing 944kW export (AC). This system with single-axis tracking could be expected to produce 2.65 GWh per annum.

Figure 6 shows that the modelled solar installation would reduce Scope 1 emissions by 2,650 t CO2-e per annum, or 79,500 t CO2-e over the life of the project.

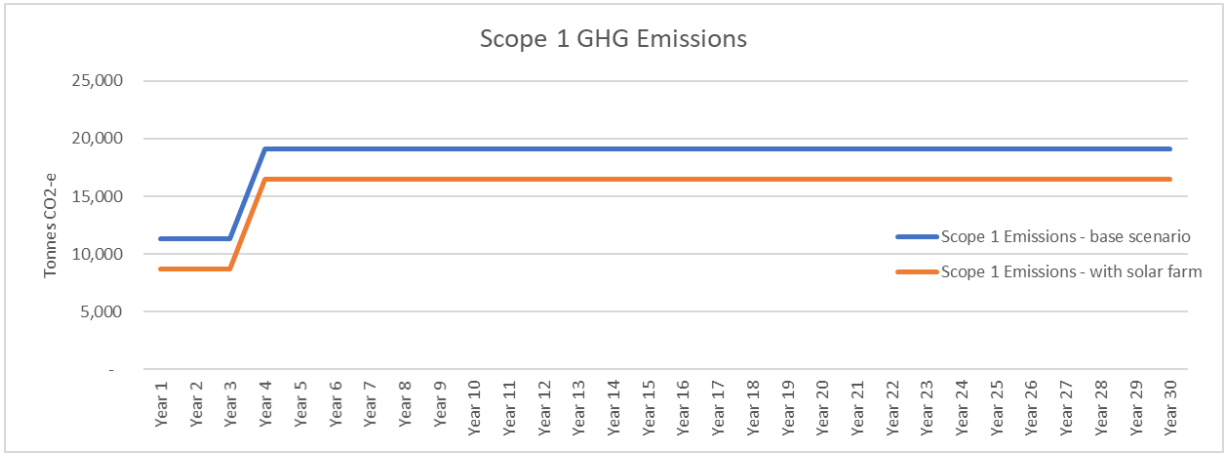

Figure 6 Scope 1 GHG Emissions with 25% Solar Electricity

5.5. Total Emissions Summary

A summary of the estimated emissions inventory is provided in Table 1. Based on information provided by VRX Silica, the Project is expected to generate Scope 1 emissions of 583,330 t CO2-e over its 30-year operational life. This includes 33,160 t CO2-e from the clearing of vegetation, which is not reportable under the current NGERS and will continue to be offset by ongoing carbon sequestration from the revegetation of the area after mining ceases.

The consumption of natural gas for the generation of electricity contributes the majority (81%) of these Scope 1 emissions (Figure 7). Any renewable energy inputs (e.g. solar) to the electricity supply for the Project will reduce the emissions from natural gas consumption.

The sources of Scope 3 emissions included in the GHG assessment are estimated to generate 1,701,255 t CO2-e. Of these emissions, the export shipping of the silica sand product to overseas customers contributes the greatest proportion (77%) - Figure 8.

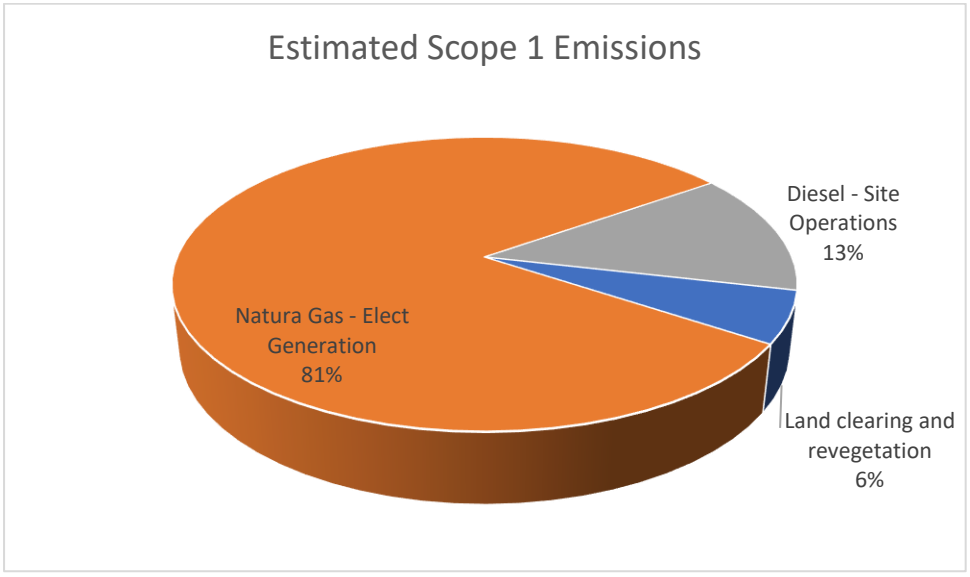

Figure 7 Scope 1 GHG Emissions

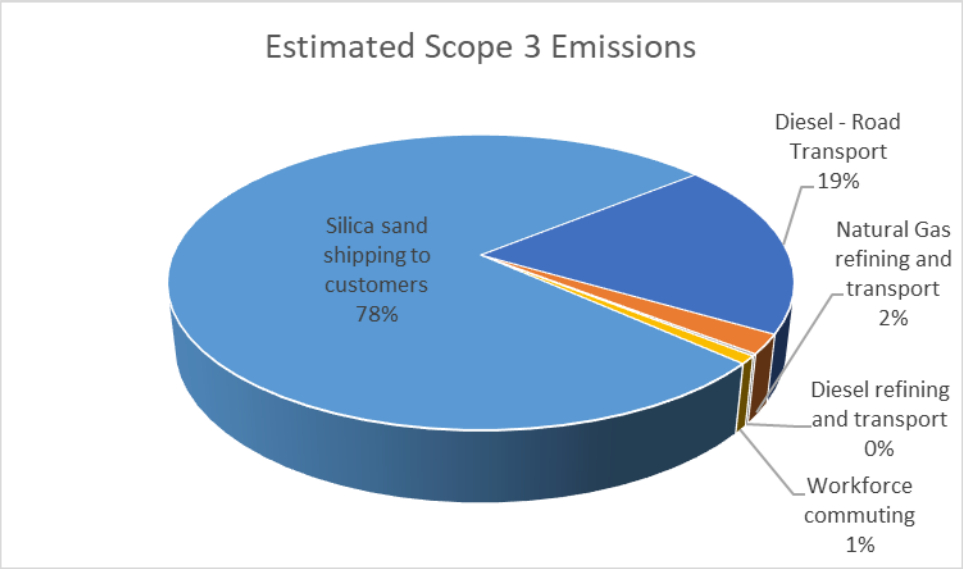

Figure 8 Scope 3 GHG Emissions

Table 1 Arrowsmith North GHG Emission Inventory

	Units	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
SCOPE 1 EMISSIONS																	
Land clearing and revegetation	t CO2e-	1,088	823	897	964	1,022	1,072	1,112	1,142	1,164	1,178	1,187	1,190	1,191	1,186	1,181	1,172
Natura Gas - Elect Generation	t CO2e-	0	9,449	9,449	9,449	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433
Diesel - Site Operations	t CO2e-	0	1,899	1,899	1,899	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683
TOTAL Scope 1 Emissions	**t CO2e-**	**1,088**	**12,171**	**12,245**	**12,312**	**20,138**	**20,188**	**20,228**	**20,258**	**20,280**	**20,294**	**20,303**	**20,306**	**20,306**	**20,302**	**20,296**	**20,287**
SCOPE 3 EMISSIONS																	
Diesel - Road Transport	t CO2e-	0	5,821	5,821	5,821	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643
Nat. Gas refining and transport	t CO2e-	0	733	733	733	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276
Diesel refining and transport	t CO2e-	0	97	97	97	138	138	138	138	138	138	138	138	138	138	138	138
Workforce commuting	t CO2e-	0	316	316	316	517	517	517	517	517	517	517	517	517	517	517	517
Silica sand shipping to customers	t CO2e-	0	23,449	23,449	23,449	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897
TOTAL Scope 3 Emissions	**t CO2e-**	**0**	**30,416**	**30,416**	**30,416**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**

	Units	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	TOTAL
SCOPE 1 EMISSIONS																	
Land clearing and revegetation	t CO2e-	1,161	1,150	1,136	1,122	1,107	1,092	1,076	1,060	1,043	1,027	1,010	993	976	959	677	33,160
Natura Gas - Elect Generation	t CO2e-	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	16,433	472,041
Diesel - Site Operations	t CO2e-	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	2,683	78,129
TOTAL Scope 1 Emissions	**t CO2e-**	**20,277**	**20,265**	**20,252**	**20,238**	**20,223**	**20,208**	**20,192**	**20,176**	**20,158**	**20,143**	**20,126**	**20,108**	**20,092**	**20,075**	**19,793**	**583,330**
SCOPE 3 EMISSIONS																	
Diesel - Road Transport	t CO2e-	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	11,643	331,819
Nat. Gas refining and transport	t CO2e-	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	1,276	36,642
Diesel refining and transport	t CO2e-	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138	4,007
Workforce commuting	t CO2e-	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	14,895
Silica sand shipping to customers	t CO2e-	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	46,897	1,336,566
TOTAL Scope 3 Emissions	**t CO2e-**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**60,470**	**1,723,929**