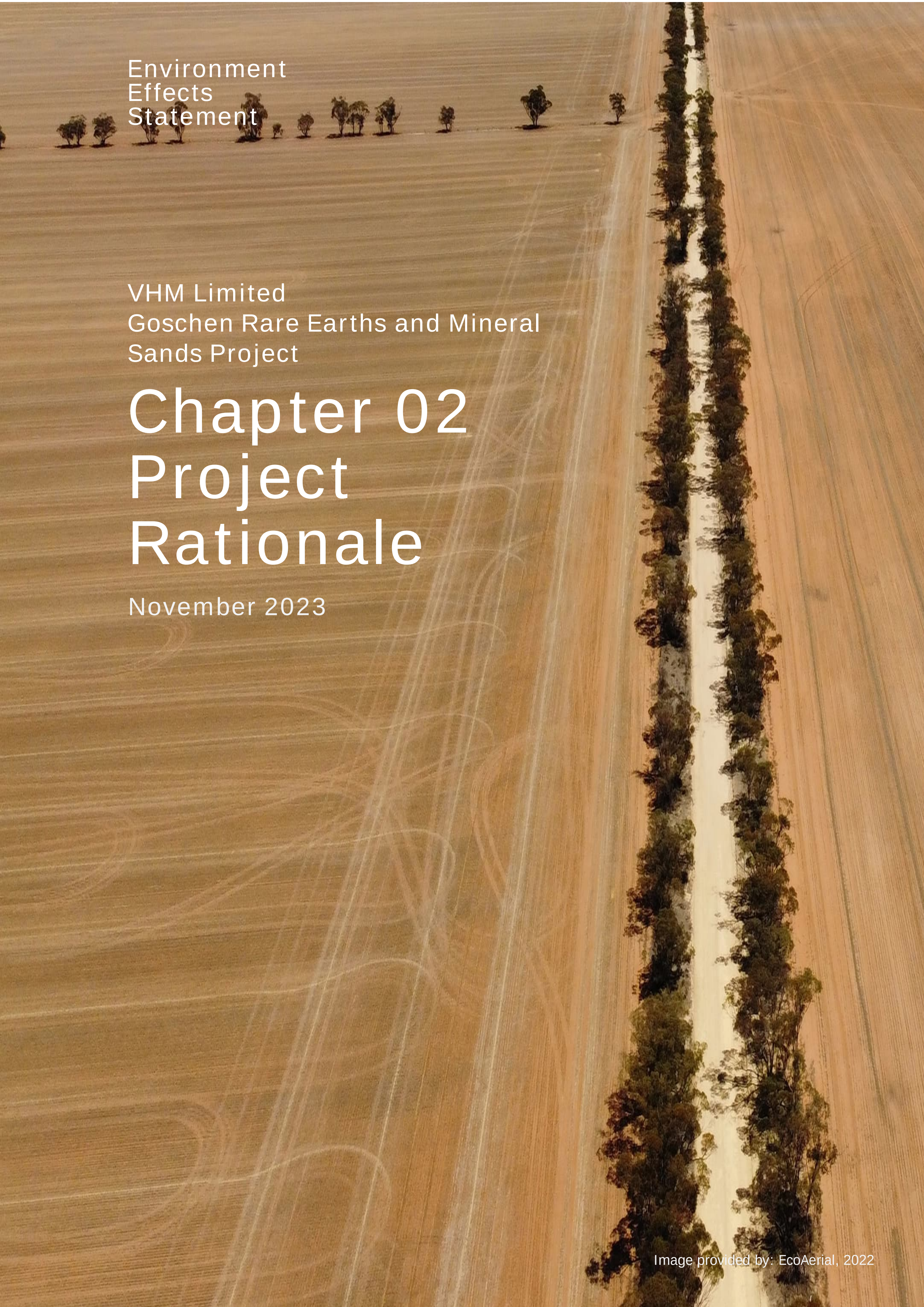
Environment
Effects
Statement

VHM Limited
Goschen Rare Earths and Mineral Sands Project

Chapter 02 Project Rationale

November 2023



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2. Project Rationale

The Goschen Rare Earths and Mineral Sands Project (the Project) is a new and globally significant mineral sands and rare earth project. The Project is located approximately 4 hours' drive (275 kilometres) northwest of Melbourne and 30 minutes (35 km) south of Swan Hill within Gannawarra Shire.

The Project consists of a heavy mineral sand mining and processing operation that would produce several heavy mineral concentrates (HMC) and a range of critical rare earth minerals. The rare earth mineral deposit contains a significant proportion of critical rare earth metals which include high concentrations of neodymium and praseodymium as well as significant levels of dysprosium and terbium. VHM has been developing the Project to produce a number of "Critical Minerals" which are essential for the manufacturing of electric vehicles (EVs) and other technologies at the forefront of the global green energy transition. Ideally positioned at the start of this curve, VHM is now able to produce rare earth and mineral concentrates (REMC) as by-product credits when producing HMC (zircon and titanium).

The demand for EVs, and therefore rare earth minerals, is forecast to grow materially over the next decade. The International Energy Agency forecasts that, based only on the stated existing policy ambitions and targets that have been legislated for or announced by governments around the world, the number of EVs on the road would grow from 10 million in 2020 to almost 150 million in 2030 (IEA, 2021).

The Project's rare earth and zircon deposit is unique as the mineralisation occurs in the form of fully liberated sands near the surface. This is unlike many other deposits in Australia which are hosted within hard rock. This translates to significant cost benefits in both the mining and processing operations when compared to other rare earth mineral projects which require handling and processing of large quantities of material through crushing and grinding circuits.

A reflection of the above was that VHM's Goschen Project was recognized with "Major Project Status" by the Federal Government in 2021. Commissioning Goschen would be a nationally significant opportunity, with the potential to elevate Australia's position as a global trade partner for supply of critical minerals.

2.1 Strategic framework

Victoria is a proven mineral sands province that provides a valuable contribution to the Australian mineral sands industry. Since the 1990s, the state has played a significant role in Australia's production of mineral sands. In 2012, Victoria was estimated to have 34.5% of Australia's economic demonstrated resource[1] of zircon and nearly 42.8% of Australia's rutile (Geoscience Australia, 2014).

The Project presents a significant opportunity to further enhance the mineral sands industry in Victoria and to grow the Victorian economy by creating significant new opportunities for employment and procurement. State government policy encourages the sustainable exploitation of mineral resources. The *Mineral Resources (Sustainable Development) Act 1990* (Vic) (MRSD Act) is the principal legislation regulating mining in Victoria. Its purpose is:

> *…to encourage economically viable mining and extractive industries which make the best use of resources in a way that is compatible with the economic, social and environmental objectives of the State.*

One of the objectives of the MRSD Act is:

> *…to encourage and facilitate exploration for minerals and foster the establishment and continuation of mining operations….*

[1] Australia's Bureau of Statistics defines economic demonstrated resource as 'a measure of the resources that are established, analytically demonstrated or assumed with reasonable certainty to be profitable for extraction under defined investment assumptions'.

The Victoria Planning Provisions, which are incorporated in the Gannawarra Planning Scheme and the Swan Hill Planning Scheme[2], set out the state planning policy for resource exploration and extraction (Clause 14.03-1S). The policy objective reflects the MRSD Act's objectives as follows:

> *To encourage exploration and extraction of natural resources in accordance with acceptable environmental standards….*

The development of the Project is a natural extension of mineral sands development in Victoria, which has focussed to date on the Murray Basin mineral sands province in the northwest of the state.

The Project also demonstrates compatibility with key policies relevant to the mining sector, including the Victorian Government – *State of Discovery: Mineral resources strategy 2018-2023*. This strategy delivers a whole-of-government approach across the mining lifecycle. The goals and objectives of the strategy are to:

- Build community confidence in social, environmental and economic performance of mineral exploration and development
- Improve Victoria's attractiveness for minerals investment
- Strengthen Victoria's position as a global mining and mining service centre.

The strategy develops action areas to achieve the goals and objectives, including the following which are directly relevant to the Project:

- Action area 1: Confident communities and responsible explorers – VHM has engaged in early consultation with the community throughout the preferred option selection process and continues to keep the community and stakeholders informed and proactively consulted throughout the development of the Project. Consultation has been carried out in accordance with the Community and Stakeholder Engagement Plan prepared for the Project. The EES will also be on public display for the community and stakeholders to comment on the Project.
- Action area 2: Advancing geoscience and encouraging mineral exploration and development – The Project contains a significant proportion of critical rare earth metals which include high concentrations of neodymium and praseodymium as well as significant levels of dysprosium and terbium. The Project will further industry knowledge of geological and mineral systems, which will inform future development of other Victorian projects.
- Action area 3: Victoria as a global mining hub – As stated above, the demand for EVs, and therefore rare earth minerals, is forecast to grow materially over the next decade. The Project's rare earth, titanium and zircon deposit is therefore a unique opportunity to ensure Victoria's mining services exports continue to grow as a proportion of total exports.

The Loddon Mallee North Regional Growth Plan also identifies opportunities to encourage and accommodate growth and address challenges over the next 30 years. The plan also acknowledges that mineral sands and other extractive mining have become a driver of economic growth, and outlines strategies to maximise the local and regional benefits of emerging economic opportunities associated with the future growth in mining.

The Project is also supported by Australia's Critical Minerals Strategy 2023-2030[3] to grow the critical minerals sector and to set out the long term-plan to leverage growing global demand for critical minerals. The strategy aims to achieve the following objectives:

- create diverse, resilient and sustainable supply chains through strong and secure international partnerships
- build sovereign capability in critical minerals processing
- use our critical minerals to help become a renewable energy superpower
- extract more value onshore from our resources, creating jobs and economic opportunity, including for regional and First Nations communities.

The Australian Trade and Investment Commission (Austrade) is the Australian Government's lead trade and investment facilitation agency. It contributes to Australian critical minerals strategy by developing commercial partnerships that connect Australian companies with targeted sources of offtake and investment. Austrade works closely with the Critical Minerals Office, Department of Foreign Affairs and Trade, and state and territory investment agencies, as well as counterpart trade and investment facilitation agencies in other countries (Australian Trade and Investment Commission, 2022).

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[2] While mining proposed as part of the Project will be wholly located within Gannawarra Shire Council, the Project also includes proposed upgrades to road intersections within Swan Hill Rural City Council.

[3] https://www.industry.gov.au/publications/critical-minerals-strategy-2023-2030/strategy-glance

The Project has been assessed against the legislative and policy requirements set by the Victorian and Commonwealth governments (see EES Chapter 05: Legislation and approvals). The design of the Project has evolved through the assessment process, and mitigation measures have been developed so that the Project is compatible with the state's economic, social and environmental objectives.

Further details on planning and strategic policies are provided in EES Technical report K: Land use and Planning.

2.2 The rare earth market and products

The Project will produce REMC that includes high concentrations of neodymium (Nd) and praseodymium (Pr) as well as significant levels of dysprosium (Dy) and terbium (Tb).

Rare earth elements are typically used in small amounts but are necessary for hundreds of different technologies, materials, and chemicals worldwide, for commercial, industrial, social, medical, and environmental applications. The applications of rare earth elements can be divided into the eight end-use categories, as shown in Table 2-1 below:

Table 2-1 Rare earth element end-use categories

End-use category	Description
Battery alloys (La, Ce, Pr, Nd)	Rare earth elements are used to produce anode materials for nickel–metal hydride (NiMH) batteries. NiMH batteries are used in hybrid electric vehicles, consumer electronics, cordless shavers, cordless power tools, baby monitors and other applications of rechargeable batteries.
Catalysts (La, Ce)	Rare earth elements, such as cerium and lanthanum, are used in catalytic converters of gasoline and diesel powered vehicles, as well as for fuel-cracking catalysts and additives used by oil refiners to break down crude oil into lighter distillates, such as gasoline, diesel, kerosene, and others.
Ceramics, pigments, and glazes (La, Ce, Pr, Nd, Y)	Rare earth elements are used to produce decorative ceramics, functional ceramics, structural ceramics, bioceramics and many other types of ceramic used in everything from jet engine coatings, ceramic cutting tools, dental crowns, ceramic capacitors, ceramic tiles and more.
Glass polishing powders and additives (Ce, La, Er, Gd, Y)	Rare earth elements, such as cerium, are used to polish optical glass, hard disk drive platters, LCD display screens and gemstones, among a long list of applications. Cerium is also used as an additive in UV-filtering glass and container glass, whereas lanthanum, yttrium and gadolinium are used to produce high-quality optical glass used in camera lenses, microscopes, and telescopes.
Metallurgy and alloys (La, Ce, Ho, Gd, Y)	Rare earth mischmetal (a mixture of light REE metals) is used during production of some types of steel, as well as ductile iron making. Rare earth elements are also used to produce a variety of alloys, such as ferro-cerium, ferro-holmium, ferro-gadolinium, and a growing list of others.
Permanent magnets (Nd, Pr, Dy, Tb, Sm)	Rare earth elements are used to produce high-strength permanent magnets that have enabled the production of ubiquitous gadgets and electronics, such as mobile phones and laptops, as well as power-dense, energy-efficient electric motors and generators used in electric vehicles, wind turbines, energy-efficient appliances, and hundreds of other applications.
Phosphors (Ce, La, Y, Tb, Eu)	Rare earth elements are used in phosphors for energy-efficient lamps, display screens and avionics, and are added to fiat currency in some nations as an anti-counterfeit measure.
Other (La, Ce, Nd, Dy, Tb, Gd, Lu, Tm)	Aside from the above-described end uses and categories, rare earth elements are used in a long list of other end uses and applications, including many in defence, medicine, aerospace, agriculture, and the high-tech and chemical industries.

Despite accounting for only 42% of the overall rare earth element usage by volume, the permanent magnet category is by far the most valuable of all eight categories, accounting for 93% of global Total Rare Earth Oxides (TREO) consumption by value in 2020. The share is expected to increase further due to the importance of these permanent magnets in growing clean energy initiatives globally and growth in demand for electronic gadgetry.

2.2.1 Demand for rare earth elements

Demand for rare earth elements is expected to grow on a compound annual growth rate (CAGR) of 5.7% until 2030. The demand for rare earth minerals is expected to grow materially over the next decade. The International Energy Agency (IEA) forecasts the number of electric vehicles (EVs) will grow from 10 million in 2020 to almost 150 million in 2030 (IEA 2021).

Driven by growing demand for NdFeB (neodymium magnet) permanent magnets used in electric vehicle (EV) traction motors, wind-power generators, consumer appliances and other end-use applications, the global TREO demand for permanent magnet production is estimated to grow at 8.6% CAGR from around 65,500 tonnes in 2020 to more than 148,000 tonnes in 2030. By 2030, permanent magnets will drive 51% of global TREO demand by volume and over 90% of the market's value each year.

Within the permanent magnet category, the anticipated gradual adoption of the EV industry will lead the demand for NdFeB-based magnets, driven by commercial EV traction motors (40.2% CAGR), passenger EV traction motors (20.9% CAGR) and other 'e-mobility' segments such as electric bicycles, scooters, motorcycles, and low-speed passenger EVs (14.4% CAGR). Collectively this EV end-user segment is expected to be responsible for 23% of global TREO demand for permanent magnets. Considering additional uses of NdFeB magnets in EVs, including micromotors, sensors and loudspeakers, EVs are estimated to drive one-quarter of global TREO demand for permanent magnets annually by 2030.

The proliferation of NdFeB magnets and the growing push for both gadgetry and clean energy applications imply demand for rare earth elements is likely to be skewed towards those such as neodymium, praseodymium, dysprosium, and terbium. As such, demand for these four rare earth elements is expected to grow faster than demand for all other rare earth elements, challenging the ability of the supply side to keep up.

With China's rare earth production expected to increase modestly in the years ahead, and few alternative sources of supply expected to come on stream, the availability of certain rare earth elements are predicted to grow increasingly scarce from 2022 onwards.

From 2022 to 2030, the global rare earth industry is expected to consistently under produce neodymium, praseodymium, dysprosium, and terbium oxides (or oxide equivalents), resulting in the depletion of historically accumulated inventories and, ultimately, shortages of these critical magnet materials if supply is not increased beyond levels currently anticipated.

The Project offers strong economic exposure to the rare earth permanent magnet sector, which is the fastest growing end-use category and most in need of additional rare earth supplies.

2.3 Heavy minerals sands market and products

The Project will produce two heavy mineral sands concentrates – namely zircon and titanium concentrates.

2.3.1 The zircon market products

The zircon market consists of a diverse range of end uses dominated by ceramics, predominantly tiles and sanitaryware, which account for approximately half of global consumption. End-uses also include refractory, foundry and specialty chemical and materials as well as other minor uses.

Demand for zircon was within the range of 1.15 to 1.24 million tonnes per annum for the years 2015 to 2019. The onset of COVID-19 disrupted the market in 2020 with demand decreasing to 1.02 million tonnes. Demand recovered in 2021 to an estimated 1.19 million tonnes.

Most zircon is produced as a by-product of titanium feedstock production. Supply of zircon has been relatively closely matched to demand over the period from 2015 to 2021. However, supply from existing operations is predicted to decline over the period to 2030. In addition, development of new sources of supply has been slower than expected leading to an expected deficit over the period to 2030 without new supply sources.

If demand grows at a CAGR of 2.4% through to 2030 and no new projects are brought into production, then an estimated 0.7 million tonne deficit could result.

2.3.2 The titanium market products

The titanium feedstock minerals are defined by their titanium dioxide (TiO2) content. Ilmenite (35-65% TiO2) is the most abundant. Rutile (90-95% TiO2) is the mineral with the highest TiO2 content. Leucoxene is an altered ilmenite product containing from 65% to over 90% TiO2.

The vast majority of titanium feedstock minerals are exported to TiO2 pigment manufacturers around the globe. TiO2 pigment is used as an opacifier, brightener, whitener, and/or UV protector in paint, industrial coatings, plastics, laminate materials, and paper. Titanium feedstock minerals are also used in the welding electrode and titanium metal industries.

Demand for titanium feedstocks has grown from 6.7 million TiO2 units in 2015 to an estimated 7.7 million TiO2 units in 2020. Growth from 2020 to 2030 is expected to be at a CAGR of 3.2%.

Demand for lower TiO_2 grade feedstocks is currently supported by increasing demand from China to supply beneficiation operations. Demand for higher TiO_2 grade feedstocks is currently supported by a structural supply deficit.

2.4 Sensitivity of commodity prices

A sensitivity analysis of the Project economics has been carried out considering the forecast product prices, AUD/USD foreign exchange rates, mining, and processing opex and capex costs. Given the Project's high revenue margin derived in US dollars, largely from sales of rare earth products, the Project's forecast net present value (NPV) is sensitive to rare earth price movements and exchange rate movements. Conversely the sensitivity analyses indicate that the Project is relatively less sensitive to variances in capital costs, and operating costs, largely as a result of comparatively low development capital costs and low project operating costs.

The impact of commodity price fluctuations on project sustainability are applied to key project estimates and assumptions. Favourable and unfavourable movements relative to the Project's net present value are illustrated in Figure 2-1 below, where NPV10 refers to the net present value using a 10% forward discount rate. Net present value is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present.

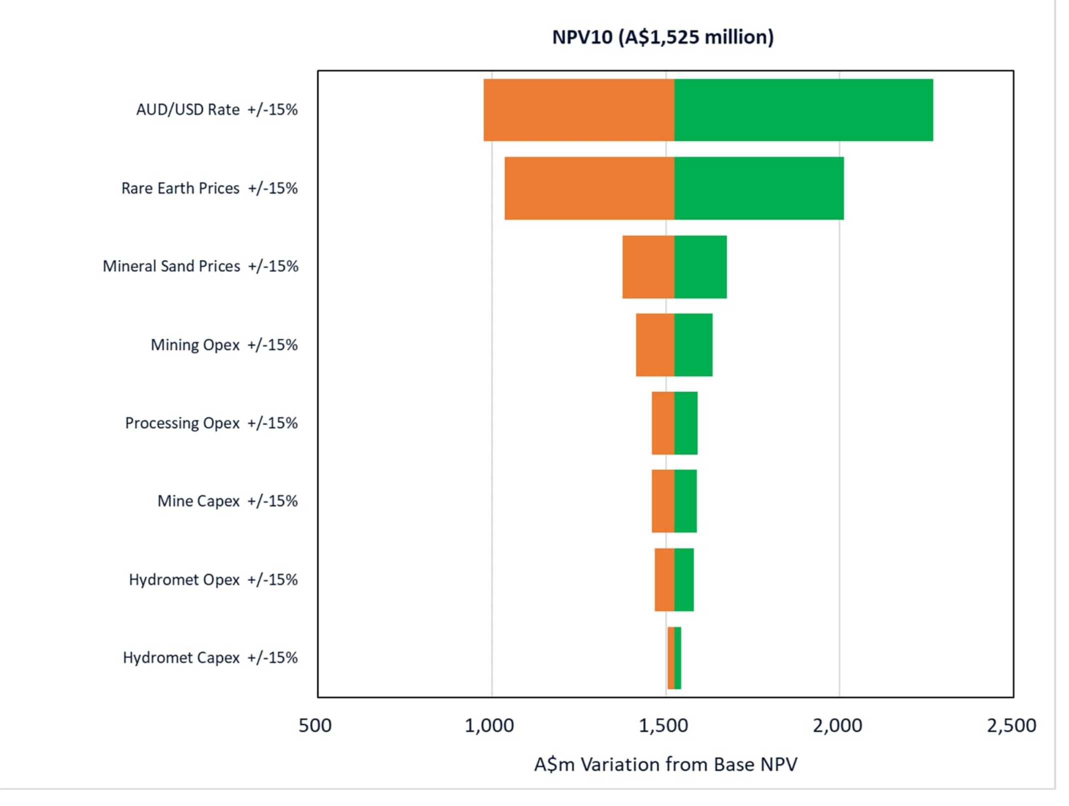

Figure 2-1 Sensitivity of NPV applied to key project estimates and assumptions

2.5 Benefits of the Project

The Project would deliver significant direct and indirect employment, and a wide range of flow-on benefits to rural and regional economies. The creation of a vertically integrated rare earth products operation in the Australian market would provide a viable and sustainable path for national growth. The Project would provide a foundation for this new national industrial capability in Australia.

Consumer demand and government policy are driving global economies to a low carbon footing, and this has focused attention on rare earth minerals – the building blocks of sustainable technologies, including renewable energy, electric vehicles, and e-mobility alternatives. As a future supplier of high-quality rare earth minerals, fundamental to electric vehicle production, VHM is well placed to contribute to managing this growing international demand.

VHM would produce critical mineral products which are essential for the automotive industry to transition from internal combustion engine vehicles to battery electric vehicles and plug-in hybrid electric vehicles to meet strict new regulatory standards and achieve publicly stated aspirational targets for creating carbon-neutral industries by 2030.

Additional benefits to the local community would be created through use of services and infrastructure to support the construction and operation of the Project.

2.5.1 Economic benefits

The Project has the potential to bring economic benefits to Victoria. Between 2022 and 2044, VHM is estimated to invest a total of approximately $626 million in development capital expenditure in the mine and processing facility while the on-going operational and sustaining capital expenditure is forecast to total $2.8 billion over this 22 year period.

The estimate covers the design and construction of the Project with all related on-site and off-site infrastructure. The estimate reflects the capital to complete a facility capable of operating at the annual run of mine (ROM) ore processing rate of 5 Mtpa.

The operating expenditure (OPEX) estimate for the Project has been compiled and estimated following the Association for the Advancement of Cost Engineering (AACE) International and Australasian Institute of Mining and Metallurgy (AusIMM) guidelines which are aligned to industry standards. The estimates have been compiled on the assumption that the Project would be fully commissioned and instated into operations in January 2024.

The expenditure profile for the Project grows rapidly in the early part of the project reflecting the large scale of investment required in developing, constructing, and establishing the Project. Development capital expenditure subsides after five years, and operational and sustaining capital expenditures remain relatively constant between $150 million and $200 million per annum – reflecting a steady production profile.

As demonstrated in Figure 2-2, the Project generates strong and stable production and processing levels over the Project mine life, with mining of higher-grade ore at the start of the Project envisaged to cater for the critical rare earth global market.

The construction and ongoing operations at the Project are estimated to add significant economic benefits to the local Loddon-Mallee economy and the Victorian economy, relative to the base case. For the mining sector located in the Loddon-Mallee region, the Project represents an increase of over 20% in output.

The employment benefits are measured by the average net increase per annum in full-time equivalent (FTE) jobs associated with the Project and include both direct and indirect jobs. It is important to note that the estimate of FTE jobs take account of potential ‘crowding out’ effects on the labour market in both the Project Area and the State (i.e. to reflect the potential for people to be drawn away from other industry sectors and/or regions to take up jobs created by the Project). The FTE job estimates are higher for the Project Area than for the State because the employment benefits will be concentrated in the Project Area and because most of the crowding out impacts are likely to be experienced in other parts of Victoria.

The following economic stimuli are anticipated to result from the Project as shown in Table 2-2:

Table 2-2 Economic impact generated by the Project

Region	Total increase in Gross State Product /Gross Regional Product	Average annual increase in Gross State Product /Gross Regional Product	Average increase in Full Time Equivalent per annum
Project Area	$2.0b	$206.5m	478
Victoria	$1.3b	$126.3m	226

Source: Deloitte 2022

In addition to the benefits outlined above, the construction and operation of the Project is anticipated to provide an economic stimulus through the generation of royalties and income tax. Royalties would flow from the Project to the State of Victoria.

Further details of the expected economic benefits of the Project are set out in EES Attachment IV – Economic Assessment

2.5.2 Social benefits

The Project would generate notable benefits for the Loddon Mallee region, in the form of employment, wealth generation and the extraction and utilisation of a productive resource. The employment created by the Project would assist in attracting and retaining young adults to the region and in doing so, contribute to the viability of community services. The uplift in demand for community facilities and services associated with imported workers would be relatively small, and geographically dispersed. The Project would not place an unmanageable burden on existing facilities and services but rather would contribute to the ongoing viability of services in the region, including in Swan Hill, Kerang and smaller towns near the Project where staff would be predominantly based.

A Workforce Accommodation Strategy and Code of Conduct would be implemented, limiting exposure of small communities to disproportionate influxes of mine workers and also establishing high behavioural standards for workers when interacting with members of existing communities. As a result, perceived public order and safety would not be materially affected. A managed influx of workers would contribute to economic and social vibrancy in the region.

Further details of the expected social benefits (and impacts) of the Project are set out in EES Chapter 18 – Socio-economics.

2.6 Implications of not proceeding with the Project

As stated in Section 2.2, if the Project does not proceed and supply levels of certain rare earth elements are not increased beyond current levels, then the availability of those elements will grow increasingly scarce by 2030. In addition, the expected benefits of the Project as described in Section 2.5 will not be achieved.

At a local level, the local community would fail to realise the benefits expected to arise from investment and ongoing employment and service opportunities associated with the construction and operation of the Project.

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