VHM Limited

VHM.AX – INITIATION OF COVERAGE

MST Access

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23 November 2023

Scale and strategic significance

NEED TO KNOW

- Scalable project with 820Mt Mineral Resource
- Producing 'critical minerals' for energy transition
- Strategic partner for offtake established

One of the world's largest critical minerals deposits: VHM plans a 20-year operation at the Goschen Project, aiming to extract high-grade rare earth minerals (REM), zircon and titania at 5 million tonnes per annum (Mtpa).

Diversified product stream from rare earths and mineral sands: VHM is poised to be a major producer of critical rare earth elements (REEs), with additional revenue from heavy mineral sands. The 100%-owned Goschen Project, a quality asset in Australia's prime mineral sands region, will yield rare earth mineral concentrate (REMC), mixed rare earth carbonate (MREC), and a heavy mineral concentrate (HMC).

Offtake with strategic partner: Shenghe, a leading REM industry player, has entered into a significant offtake MOU with VHM where Shenghe has agreed to purchasing 6,400 tonnes per annum (tpa) of REMC and 100,000tpa of HMC for 3 years, representing ~60% of Goschen's expected production capacity.

Investment Thesis

100% owned long life project with potential for life extension and strategic partner option: The current focus is on 98.8Mt of the 198.7Mt Ore Reserves in Areas 1 and 3, and an initial mine life of 20 years. The Total Mineral Resource provides potential for material production scale up and mine life extension beyond 40 years. The 100% ownership provides strategic flexibility, including enhancing funding options via the partial sale of the project to a strategic partner.

DFS demonstrates high value project: The project's DFS estimates A$1.5bn pre-tax NPV_{10} and 44% pre-tax IRR and annual pre-tax cash flow of A$270m.

Risk reduction from dual product stream and staged construction approach: The diversified product stream reduces revenue risks and VHM's 3-stage approach to developing Goschen, lessens up front capital spend and capital risk. Phase 1 involves producing REMC and zircon-titania while Phase 1A adds a hydromet circuit to refine REMC to a higher value mixed rare earth carbonate (MREC). Phase 2, if pursued, includes constructing a mineral separation plant for further added value to the zircon-titania product.

Exposure to future-facing commodities – current prices not reflecting likely shortages: VHM's products are key inputs into decarbonisation and electrification, especially EVs and wind farms. Market analysts estimate an undersupply of 90kt of rare earth oxide by 2040, with the magnet rare earth oxide market predicted to grow 5X by 2040, driving price rises and volume growth that will increase the market value from US$10.8bn now to US$56.7bn in 2040.

Valuation: A$1.67/share blended valuation, 3x upside

We have used a blended valuation of A$1.67/share based on 1) a 60% probability of a sell-down to a strategic partner in the Goschen project, and 2) a 40% probability of VHM fully funding the project independently through equity and debt (50:50). In the sell-down scenario we assume VHM realises 70% of our NPV for Goschen in the sale, funding the remainder through equity and debt (50:50). We apply risk weightings to both scenarios to account for project risks. Our un-risked, pre-funding valuation is A$3.10 per share.

Risks

Key risks include offtake finalisation, funding for the project, delay in approvals, delays in construction, capital cost inflation and commodity price weakness.

Equities Research Australia

Mining and Energy

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VHM Limited

VHM Limited (VHM) is an Australian owned and operated, listed public mineral sands and rare earth company. VHM is proposing to develop the Goschen Mineral Sands and Rare Earths Project in the Loddon Mallee Region of Victoria, approximately 35km south of Swan Hill in the Gannawarra Shire and 275km north of Melbourne.

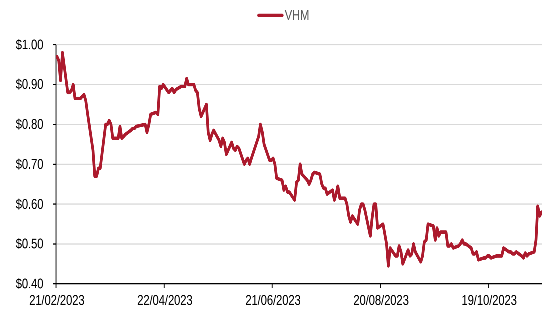
https://www.vhmltd.com.au/

Valuation	A$1.67
Current price	A$0.58
Market cap	A98m
Cash on hand	A$13.9m *(30 September 23)*

Upcoming Catalysts / Next News

Period	
2HCY23	Maiden Resource – Nowie Resource update – Cannie
4QCY23	Finalise offtake with Shenghe
1HCY24	Detailed Design Engineering completed – Goschen, Phase 1

Share Price ($A)

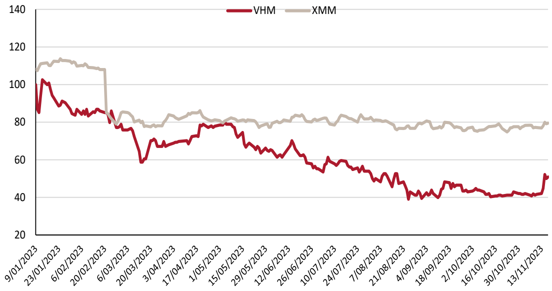


Source: FactSet, MST Access.

Financial Summary: VHM Limited

VHM Limited							VHM.AX
Year end 30 June							
MARKET DATA							
Share Price	A$/sh						0.55
52 Week Low	A$/sh						0.42
52 Week High	A$/sh						1.25
Market Cap (A$m)	A$m						112
Net Debt / (Cash) (A$m)	A$m						(21)
Enterprise Value (A$m)	A$m						91
Shares on Issue	m						203
Performance rights and options	m						10
Shares Issued during Capital Raise	m						529
Potential Diluted Shares on Issue	m						732

12-Month Relative Performance vs S&P/ASX Metals & Mining



INVESTMENT FUNDAMENTALS		Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Reported NPAT	A$m	(9)	(16)	(9)	3	135
Underlying NPAT	A$m	(9)	(16)	(9)	3	135
EPS Reported (undiluted)	¢ps	(7.0¢)	(0.1¢)	(4.6¢)	0.4¢	18.5¢
EPS Underlying (undiluted)	¢ps	(0.1¢)	(0.1¢)	(2.0¢)	0.4¢	18.5¢
P/E Reported (undiluted)	x	n/m	n/m	n/m	151.0	3.0
P/E Underlying (undiluted)	x	n/m	n/m	n/m	151.0	3.0
Operating Cash Flow / Share	A$	(0.03)	(0.05)	(0.01)	0.00	0.31
Price / Operating Cash Flow	x	n/m	n/m	n/m	133.7	1.8
Free Cash Flow / Share	A$	(0.10)	(0.15)	(0.01)	(0.79)	0.11
Price / Free Cash Flow	x	(5.3)	(3.6)	(39.5)	(0.7)	5.2
Free Cash Flow Yield	%	n/m	n/m	n/m	n/m	19.4%
Book Value / Share	A$	0.13	0.32	0.57	0.58	0.76
Price / Book	x	4.33	1.73	0.96	0.95	0.72
NTA / Share	A$	0.13	0.32	0.57	0.58	0.76
Price / NTA	x	4.33	1.73	0.96	0.95	0.72
Year End Shares	m	139	203	732	732	732
Market Cap (spot)	A$m	77	112	403	403	403
Net Cash / (Debt)	A$m	24	21	373	(202)	(138)
Enterprise Value	A$m	52	91	30	605	540
EV / EBITDA	x	n/m	n/m	n/m	n/m	0.4x
Net Debt / Enterprise Value		(0.3)	(0.2)	(4.1)	2.2	1.5

PRODUCTION AND PRICING	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Ore Mined (Kt)	-	-	-	-	4.94
Total Mill Feed (Kt)	-	-	-	-	4.94
HMC production (Kt)	-	-	-	-	168
Realised Z-Ti price (US$/t)	-	-	-	-	530
REMC production (Kt)	-	-	-	-	11.73
MREC production (Kt)	-	-	-	-	-
NdPr Price (US$/kg)	-	-	-	-	176
Realised REE Basket Price (US$/kg)	-	-	-	-	16.49

Profit & Loss (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Revenue	-	-	-	-	404
Expenses	(6)	(11)	(9)	(9)	(198)
EBITDA	**(6)**	**(11)**	**(9)**	**(9)**	**205**
D&A	(1)	(0)	(0)	(0)	(60)
EBIT	**(7)**	**(11)**	**(9)**	**(9)**	**145**
Interest	(2)	(4)	(1)	11	(41)
Tax	-	-	-	1	31
Underlying NPAT	**(9)**	**(16)**	**(9)**	**3**	**135**
Exceptionals					
Reported Profit	**(9)**	**(16)**	**(9)**	**3**	**135**

Balance Sheet (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Cash	24	21	737	162	226
Receivables	1	1	-	-	33
Inventory	-	-	-	-	11
PP&E	11	16	16	594	683
Exploration	27	39	39	39	39
Other	0	1	1	1	1
Assets	**63**	**79**	**794**	**797**	**994**
Creditors	4	3	-	-	62
Debt	-	-	364	364	364
Other	42	11	10	10	10
Liabilities	**46**	**14**	**374**	**374**	**436**
Shareholder's Equity	**18**	**65**	**420**	**422**	**558**

Cashflow (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Receipts from Customers	-	-	1	-	359
Payments to suppliers and employ	(4)	(11)	(12)	(9)	(136)
Interest Received	0	0	0	12	4
Other					
Net Cash From Operations	**(4)**	**(10)**	**(10)**	**3**	**227**
Capex	(0)	(3)	-	(578)	(149)
Exploration	(12)	(20)	-	-	-
Other	2	2	-	-	-
Net Cash From Investing	**(10)**	**(20)**	**-**	**(578)**	**(149)**
Equity	-	29	364	-	-
Borrowings	(2)	(2)	364	-	-
Dividend	30	(0)	(1)	(1)	(45)
Net Cash From Financing	**28**	**27**	**727**	**(1)**	**(45)**
Effects of FX	-	-	-	-	-
Net Increase / (Decrease) in Ca	**13**	**(4)**	**717**	**(576)**	**33**

Source: VHM; MST Estimates

Investment Thesis: High-Value Rare Earth Product; Dual Revenue Stream + Offtake Partner

High-Quality Long-Life Asset
100% Ownership Providing Strategic Options

VHM is on the path to emerge as a major producer of critical and strategic rare earth elements (REEs), complemented by a second revenue stream from heavy mineral sands. VHM holds 100% ownership of the Goschen Project, an advanced pre-production venture in Australia's foremost mineral sands region. This scalable initiative boasts a substantial mineral inventory with room for reserve expansion, positioning Goschen to potentially become a leading rare earth producer.

Full ownership provides funding flexibility and options

The 100% ownership provides strong flexibility, including the possibility of a partial sale of the project to a strategic partner. This enhances VHM's funding options via the injection of cash and reduced capital and equity raising requirements.

Definitive Feasibility Study underscores strong project economics

An updated Definitive Feasibility Study (the 'DFS Refresh'), released in March 2023, underscores the strong economics of the Goschen Project. The inclusion of the nearby Cannie and Nowie Projects, especially with Cannie's significant total rare earth oxide (TREO) Mineral Resource, enhances VHM's attractiveness for potential partners. Coupled with the added contributions of zircon, rutile, and leucoxene, VHM has solidified its position in Victoria's Critical Minerals Province along the Lake Boga granite, amplifying its global standing.

MOU with Shenghe, strong cash position set up VHM for success

Building on this momentum, VHM has signed an MOU with Shenghe Resources, signalling an intent to off-take 60% of Goschen's production for the initial 3 years. With a healthy cash reserve of A$20.6m, VHM is well-equipped to advance the Goschen Project forward, with targets to commence production in 2025. VHM's Goschen is emerging as a strategic and financially attractive investment in the rare earth sector.

Market context: rare earths not yet fully appreciated by the market

Goschen's rare earth minerals, crucial for electric vehicles, predominantly consist of elements like dysprosium, neodymium, praseodymium, and terbium, making up 87% of its basket value. By 2040, a projected undersupply of 90,000 tonnes of NdPr oxide is anticipated, mainly due to scarce new sources post-2023. The magnet rare earth oxide market is set to expand five-fold by 2040, with consumption growing at a 5.2% CAGR, and prices increasing by 3.3–5.2% per annum. Adamas Intelligence forecasts the market value to jump from US$10.8 bn currently to US$56.7 bn by 2040.

China monopolises every step of the rare earth value chain – a fact that is of great concern to Western economies as rare earth minerals are critical for the transition to the new 'green' economy as well as to government-critical sectors such as defence. In 2011 a trade dispute with the US, Japan and Europe and one side and China on the other, and the subsequent hyper-inflated rare earth oxide prices, is a warning of what may lie ahead. Such a situation today, however, would be much more serious, with the value of rare earths to the global economy today much greater than in 2011.

In our view, this political reality will result in significant flows of capital into the rare earths sector. The $1.25bn loan provided by the Australian Government to Iluka for the development of its rare earths refinery is a very positive read through, as it suggests that governments realise the importance of an ex-China supply chain in transitioning to the new 'green' economy.

Asset overview

The Goschen Project: VHM's flagship development

The Goschen Project has an extensive and very high-grade Mineral Resource and Reserve. The Resource comprises 629Mt of ore with a total heavy mineral (THM) and TREO grade of 2.95% and 2.43%, respectively, and a Reserve total of 98.8Mt with THM grade of 4.0%.

The Goschen Project aims to produce rare earth intermediate products and zircon-titania heavy mineral concentrate (HMC). It is designed to have a processing capacity of 5 million tonnes per annum (Mtpa) and a projected mine life of 20.5 years. The dual product stream is extremely attractive from an investing point of view as it provides some downside protection compared to a single commodity exposed company.

The Goschen high-grade deposit will produce ~9.45ktpa of REMC and ~134.5ktpa of zircon-titania HMC over the first 10 years of mine life. However, the REMC is planned to be converted to a mixed rare earth carbonate (MREC) through the introduction of a hydrometallurgical circuit (Phase 1A) in the first six months of operations. This will result in the production of a higher quality and beneficiated product that only requires a relatively small incremental capex outlay. The project will produce ~8.6ktpa of MREC over the first 10 years of production. Phase 2, if pursued, includes constructing a mineral separation plant for further processing of the zircon-titania product.

Approximately 87% of Goschen's rare earth basket value comes from premium dysprosium, neodymium, praseodymium, and terbium oxides, accounting for nearly 70% of the project's revenue. In addition, mineral sands containing zircon and titanium (rutile, ilmenite, leucoxene) offer an alternative revenue source, further enhancing the project's financial stability.

Cannie and Nowie: additional assets helping to attract key partners

Scale and associated pricing power are a significant issue for ex-China rare earth producers as China monopolises the market. VHM has an attractive opportunity in the future to establish itself as a major rare earth player through unlocking the potential of its additional and adjacent projects, Cannie and Nowie.

Drilling and exploration to date has uncovered extremely high-grade ore bodies at Cannie and Nowie. Cannie's Maiden Mineral Resource released by VHM in May revealed exceptional grades of TREO and zircon-titania minerals. Furthermore, the recent drilling program at Nowie also confirmed areas up to two times higher than the highest-grade areas of the Goschen Ore Reserve.

Upcoming catalysts

- 4QCY23 – Finalise contract agreements with offtake partner, Shenghe
- 1HCY24 – Detailed Design Engineering for Goschen Phase 1 completed
- 2HCY23 – Maiden Mineral Resource – Nowie Project
- 2HCY23 – Resource update – Cannie Project
- 2HCY23 - Public Exhibition of EES

Recent milestones

- January 2023 – VHM listed on the Australian Stock Exchange
- March 2023 – VHM releases an Updated DFS (the 'DFS Refresh') for the Goschen Project
- April 2023 – New discovery of high-grade rare earth, titania, and rutile ore body at Cannie Project
- May 2023 – Maiden Resource announced for Cannie Project

Valuation – A$1.67 / share
A$3.10 Unrisked Pre-Funding

We have used a blended valuation based on a 60% probability of a strategic partner coming into the project and the 40% probability of VHM having to fund the project on their own. The blended valuation is A$1.67 per share, based on the following two scenarios:

- Under the scenario of on a strategic partner buying in to the project our valuation of VHM is A$2.05per share. We assume under this scenario that VHM sells 40% of the project (retaining 60% and control) and achieves 70% of NPV for the share. VHM's share of the project capital is funded through 50% debt and 50% equity and we assume that ~A$37m of equity is raised at a 25% premium to the current share price (assuming that confirming strategic partner and debt options will increase the share price),

- Under the scenario of VHM fully funding the project on their own, our valuation is A$1.09 per share. Under this scenario the full cost of the project is funded through 50% debt and 50% equity and we assume that A$364m of equity is raised at a 25% premium to the current share price (assuming that confirming debt options would increase the share price)

We have used a blended valuation of the 2 possibilities, assuming a 60% chance of obtaining a strategic partner and a 40% chance of having to find the entire project independently. Our blended valuation is A$1.67 per share, fully diluted.

We believe the current share price does not adequately reflect the value of the high-quality Goschen deposit and its attractive exploration projects, Cannie and Nowie.

Our unrisked, pre-funding valuation based on the current capital base implies A$3.10/share.

Key risks

Key risks include funding for the project, delay in mining licence approval, offtake agreement finalisation, delays in construction, capital cost inflation and commodity price weakness.

Flagship Goschen Project: 100%-Owned, Advanced Project in Excellent Location

Project overview

VHM owns 100% of the Goschen Project, an advanced pre-production project that aims to extract rare earth elements (REEs) and mineral sands, located in Victoria, a mineral sands-rich region of Australia.

The Goschen Project aims to produce rare earth mineral concentrate (REMC), and mixed rare earth carbonate (MREC) as well as zircon-titania heavy mineral concentrate (HMC). It is designed to have a processing capacity of 5 million tonnes per annum (Mtpa) and a projected mine life of 20 years.

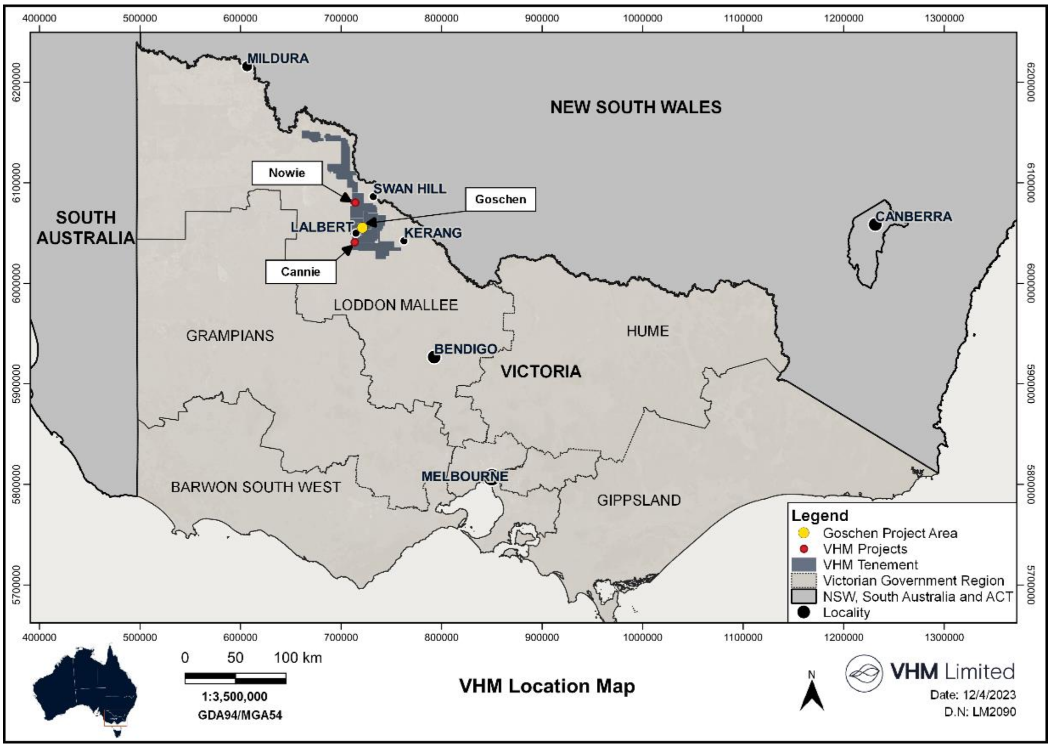
Approximately 87% of the rare earth basket value at Goschen is attributed to high-value dysprosium, neodymium, praseodymium, and terbium oxides. These rare earth minerals will contribute to around 70% of the project's revenue. In addition, mineral sands containing zircon and titanium (rutile, ilmenite, leucoxene) will be extracted and processed.

VHM released a 'DFS Refresh' in March 2023 which updates the original DFS in its prospectus of January 2023. This document outlines updated financial assumptions related to the Goschen Project, which we discuss in further detail later in this report.

Location

The Goschen Project is located in Victoria's Loddon Mallee Region, approximately 35km south of Swan Hill in the Gannawarra Shire and ~275km north of Melbourne (see Figure 1).

Figure 1: Goschen Project location



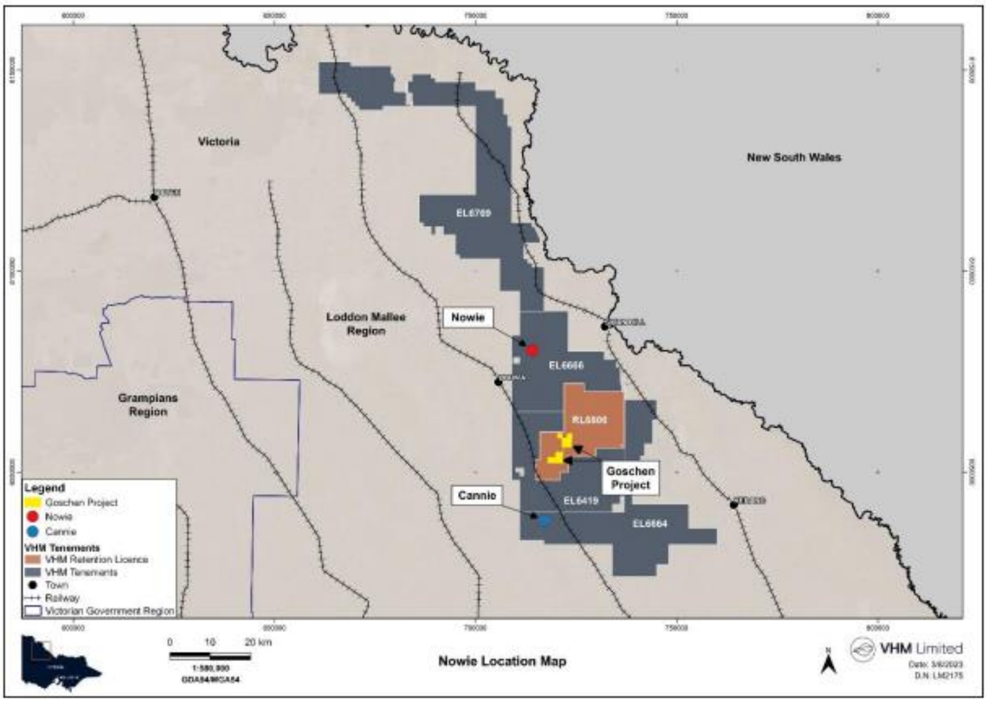
Source: VHM.

Current project status: tenements and permitting

Tenements and licencing

VHM holds RL6806 and Exploration Licence (EL) 6419, which encompass the Goschen Project. Additionally, VHM holds ELs for 3 other areas: EL6666, EL6664, and EL6769. Collectively, these tenements cover an expansive area of approximately 2,860km^2 (see Figure 2).

Figure 2: Location of VHM tenements



Source: VHM.

Permitting for Planning

Primary approvals: VHM presented the project to the State Minister for Planning in September 2018. A month later (the standard requirement for a mining project of this type), an Environment Effects Statement (EES) was mandated for the project. The EES is required to assess impacts on matters of national environmental significance.

VHM has submitted the EES to the Department of Transport and Planning (DTP) for final on 30 March 2023 for the proposed Goschen Mine Site area. The EES has gone on public display as at November 20 2023. Subject to satisfactory completion of that review in the near term, VHM anticipates that the regulatory approvals and permits will be awarded in 1H2024.

Next steps for approval process:

There are essentially 4 final steps for VHM to reach EES approval:

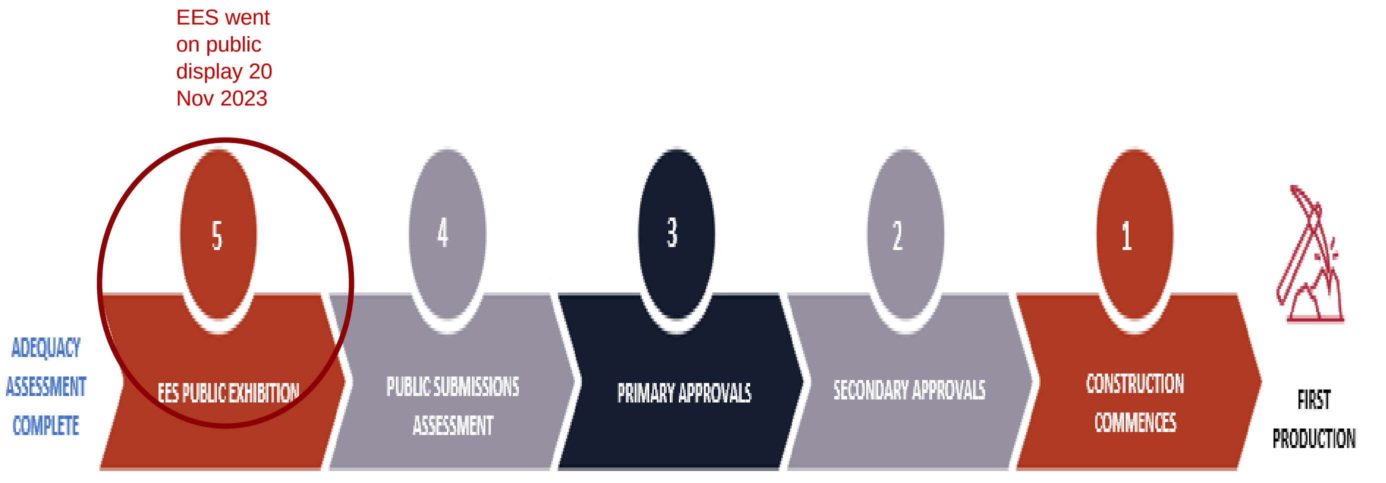
- Public Exhibition (has commenced): 20 November 2023 to 17 January 2024 managed by Planning Panels Victoria (PPV) independent body that reports to Planning Minister.

- Directions Hearing: This is for one day only in February 2024. Purpose is to release dates for panel, duration and make up of panel members.

- Hearing: (Panel) March 2024 (for three weeks if required) Consists of: Goschen Mineral Sands Project Inquiry and Advisory Committee (IAC) (Three independent members as selected by government) VHM Technical Specialists, VHM EGM Ops and VHM legal White and Case

- 6 weeks after Panel Hearing a report is prepared which goes back to the Department of Transport and Planning summarising outcome of the hearing and their recommendations it is then sent to Planning Minister for approval.

Figure 3: Permitting – Countdown to Production



Source: VHM

Secondary approvals: The Goschen Project requires secondary approvals beyond the primary EES process. These include permits and licenses for water management, works licensing, environmental mitigation, and management plans which are essential for regulatory compliance and the project's construction and operation. Subject to the timing of the grant of primary approvals, VHM expects these secondary approvals to be awarded in 2H2024.

Land Access Agreements completed: VHM completed its last Land Acquisition Agreement for the final freehold land parcel required within the proposed Goschen Project mine footprint. The company has thus secured 100% of the proposed Goschen Project mine footprint area. All land purchase arrangements satisfy regulatory requirements to enter into access agreements with affected landowners and address operational requirements during the construction and operational phases.

Site overview

Site layout

The process plant, located on Area 1's western side, north of Bennett Road, comprises the Feed Preparation Plant, Wet Concentrator Plant, Rare Earth Minerals Flotation Circuit, Mineral Separation Plant (if approved), Hydromet Circuit, reagent storage, a tailings thickener with a flocculant plant, and a process water dam. It includes a workshop, administration buildings, ancillary structures, plant machinery, power plant, HMC product and P-flotation stockpiles. Figure 4 (left) shows the proposed site layout. The proposed workflow (with accompanying schematic) for these facilities is discussed later in this section.

Tailings disposal and management

The Goschen Project has been designed to operate without a stand-alone Tailings Storage Facility (TSF).

After mining a specific block, the overburden will be used to create an in-pit bund, forming a cell to contain the deposited tailings. This approach allows for in-pit tailings deposition without requiring a temporary above-ground TSF. The area can be rehabilitated by placing overburden on top of the tailings.

The co-disposal of tailings methodology is widely employed in mineral sands operations worldwide. This approach offers several benefits, including efficient water recovery, accelerated mine rehabilitation, and a reduced mining footprint by eliminating the need for a separate TSF. In this process, both tailings and process waste will be homogenised and reintroduced into the mine's open pit.

Infrastructure

The Goschen Project is situated in a well-serviced agricultural area in northern Victoria. It benefits from existing road, rail, power, and water infrastructure, with nearby communities offering labour and accommodation support.

Access roads will be constructed for the project, taking into account two different ground conditions. In areas with less stable ground, measures like replacing the existing soil with more stable materials or enhancing clay with hydrated lime will be employed.

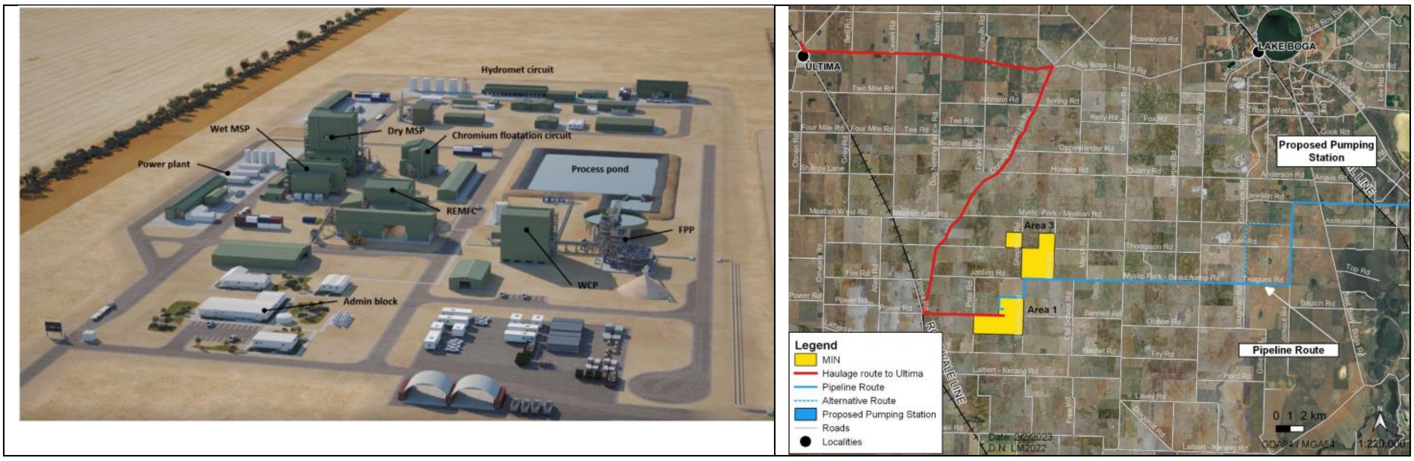
Power supply: The Goschen Project will initially meet its electrical needs for mining and processing through on-site generators powered by a combination of diesel and gas. These generators, provided by a third-party contractor, will consist of 12 units with a total capacity of 12.0MW.

Water will be sourced from Kangaroo Lake through a dedicated 38km pipeline, including 2 electrical 400 kW pumps stationed at the lake. On-site, it is proposed that a treatment plant will convert the water supply into potable water, which will be stored in tanks for distribution as needed. Until the water supply system is fully operational, water will be delivered by truck. The project will recycle as much water as possible.

Transport and logistics

After processing, products will be packaged on-site and sealed in standard 20-foot containers. These will be transported 18km by road to the Ultima Terminal, and then railed to the Port of Melbourne for shipment (see Figure 4, right). A logistics study which was conducted to assess freight costs and supply chain options identified Melbourne as the optimal port for product exports and materials imports.

Figure 4: Proposed site infrastructure (LHS); Transport route for Goschen products to Ultima Intermodal Terminal (RHS)



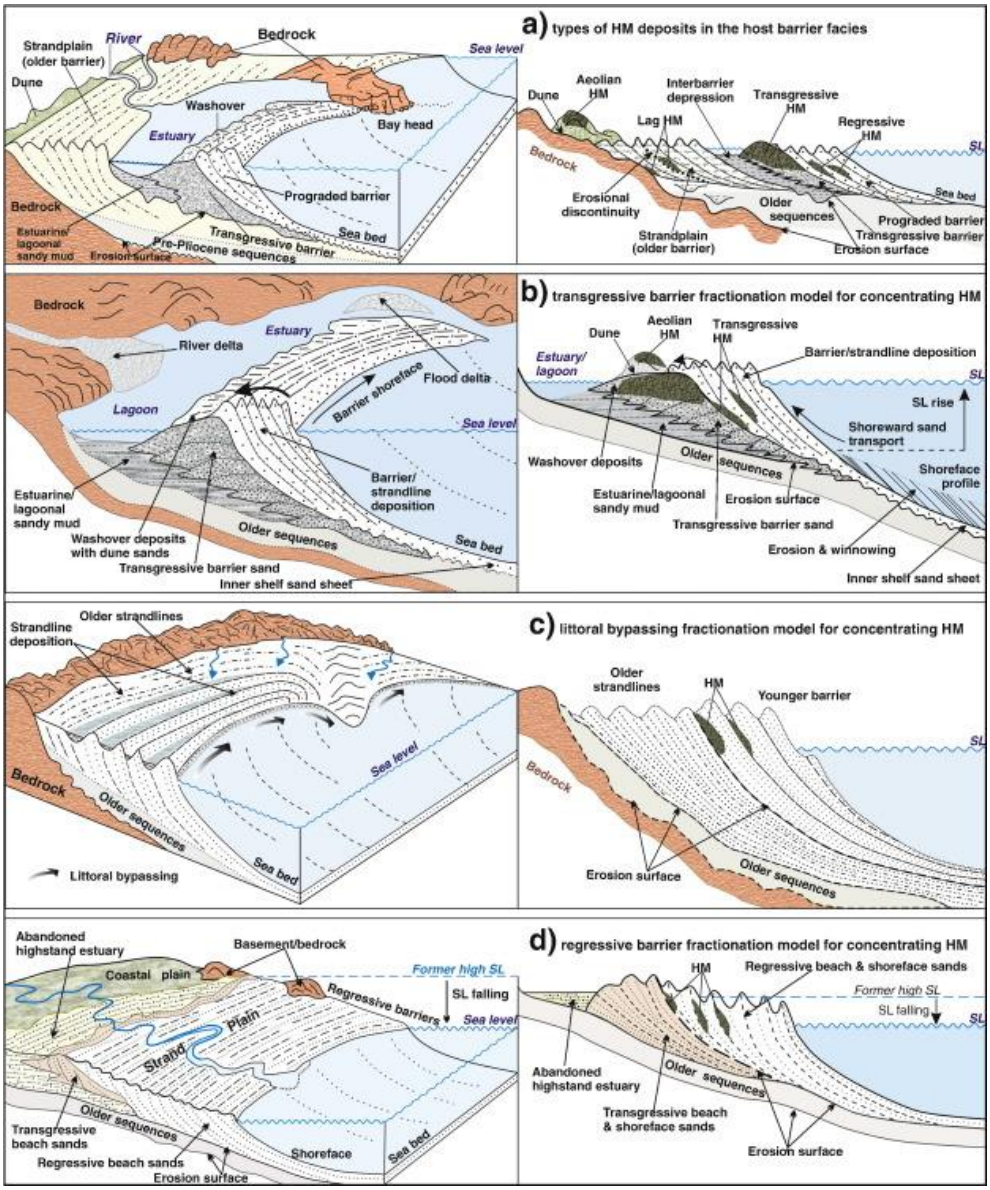
Source: VHM.

Geology

The project is situated within the Murray Basin, a region known for its rich mineralogical diversity and geology, specifically hosting heavy mineral sands (HMSs) and rare earth minerals (REMs).

The resource is identified as a placer monazite-xenotime type. Formed from rock weathering, sediments are moved by water and wind to places such as rivers, streams, and deltas. Here, denser minerals such as monazite and xenotime, rich in rare earth elements (REEs), accumulate. As the energy of the moving medium wanes, these minerals concentrate in specific areas, over time becoming key REE sources.

Figure 5: Geological and exploration models of beach placer deposits



Source: Encyclopaedia Britannica.

Development focus on Areas 1 and 3: an overview

Initial review by VHM selected Four 'Resource Areas' for detailed evaluation: (1) Area 1 East and Area 1 West; (2) Area 2 West; (3) Area 3 and (4) Area 4. The DFS focuses on the potential development of Areas 1 and 3, with other areas offering potential future expansion.

Mineralogy and mineralisation style

The deposit consists of 3 HMSs (rutile, leucoxene, and ilmenite) and 2 REMs (monazite and xenotime). Figure 6 provides the chemical symbols and descriptions of each mineral.

Figure 6: Chemical symbols and descriptions of each mineral

Category	Mineral	Chemical Symbol	Description
Heavy Mineral Sands (Zircon and Titania)	Rutile	TiO_2	Rutile is a reddish-brown to black mineral composed of titanium dioxide. It is used as a pigment in paints, plastics, and ceramics.
	Leucoxene	-	Leucoxene is a term used to describe altered forms of titanium-bearing minerals. It can refer to a range of titanium oxide mixtures resulting from weathering or hydrothermal processes.
	Ilmenite	$FeTiO_3$	Ilmenite is a black iron-titanium oxide mineral used as an ore of titanium. It is a source of titanium dioxide, a white pigment.
Rare Earth Minerals	Monazite	$(Ce,La,Th,Nd,Y)PO_4$	Monazite is a rare-earth phosphate mineral containing thorium, cerium, and other rare-earth elements.
	Xenotime	YPO_4	Xenotime is a rare-earth phosphate mineral containing yttrium and other rare-earth elements.

Source: VHM

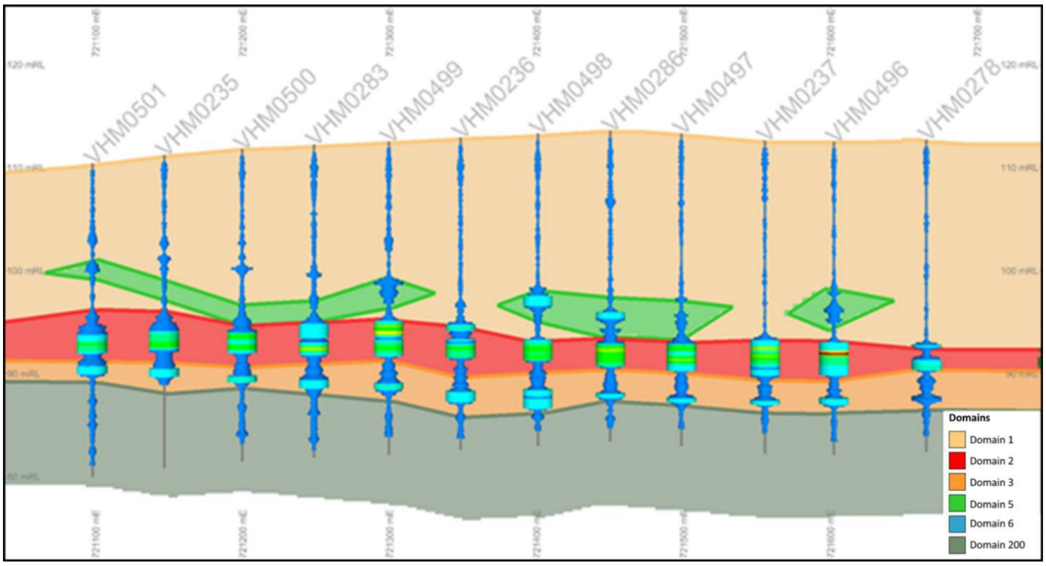
Within the Goschen resource there are two deposit types: sheets (Wimmera-style) and strandlines (beach placer deposits). These have been classified into Area 1 (sheet) and Area 3 (strandline).

Area 1: Sheet mineralisation: The Area 1 deposit is a stacked, sheet-like accumulation of heavy minerals (HMs) found within very fine-grained sand. This deposit can be segmented into two separate areas:

- *Area 1 East* comprises 6 geologically distinct mineralised zones (called 'domains'), with Domains 2 and 3 being key due to their high THM grades and continuity. These domains signify sheet-like mineralisation, occasionally segmented by a discontinuous low-grade waste zone (Domain 1).
- *Area 1 West*, west of the Cannie Fault, includes 5 domains. Domains 2 and 3 feature high THM grades and reasonable continuity, with grades generally increasing westward. These domains form sheet-like deposits, occasionally segmented by a discontinuous low-grade waste zone (Domain 1).

Figure 7 shows a section through Area 1, illustrating the domains and downhole gamma responses[1].

Figure 7: Typical cross-section of Area 1 displaying domains and gamma responses



Source: VHM.

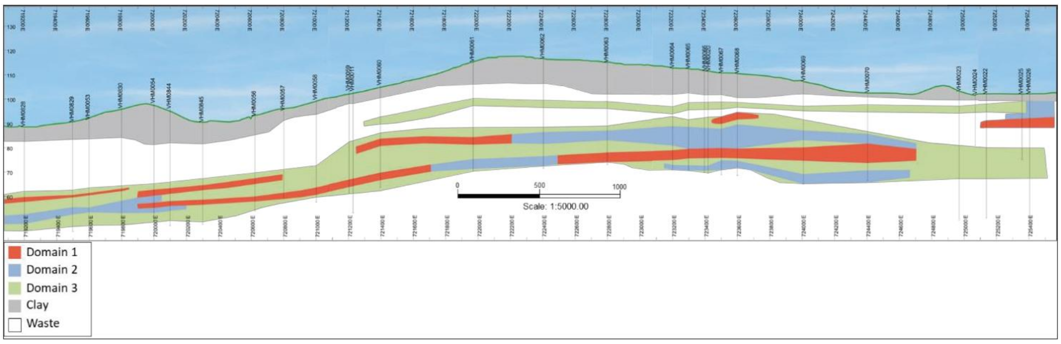
[1] Downhole gamma responses, measurements of gamma radiation emitted by rocks during drilling, offer insights into subsurface geology and radioactive elements. They provide key data on composition and properties, assisting in decisions related to drilling, production, and reservoir management.

Area 3: Strandline mineralisation: Area 3 consists of a combination of high-grade strandlines near the surface and multiple stacked sheet-like deposits. Within this area, 3 distinct mineralised domains have been identified (see Figure 8).

- *Domain 1* – This domain comprises continuous, relatively high-grade sheet-like mineralisation zones extending from the east (Orion deposit) to the west (Area 2 boundary). The high-grade zones typically have a THM content >2% and remain open along all boundaries.
- *Domain 2* – This domain consists of medium-grade zones (typically above 1% THM) located above and below Domain 1.
- *Domain 3* – This domain represents a low-grade THM sequence that extends continuously across the strike, with occasional zones containing over 1% THM.

VHM has completed downhole gamma values and used them with THM grades to identify areas with higher zircon content in Area 3. Visual inspection of sachets containing HMs allowed separation of valuable material from waste. Domain 1 was marked by higher zircon content, while Domain 2 was defined by excluding waste post-sachet scanning. Typically, each drill hole yielded one sample with valuable HMs.

Figure 8: Cross-section of Area 3, showing relative locations of 3 mineralised domains



Source: VHM. Note: vertical exaggeration applied.

Block model

VHM has constructed a block model which maps out 3 mineral-rich domains based on drilling data and metallurgical tests. This model estimates the amount of total heavy minerals (THM), slimes, and oversized materials in each block using a method known as Inverse Distance Weighting Squared (ID^2).

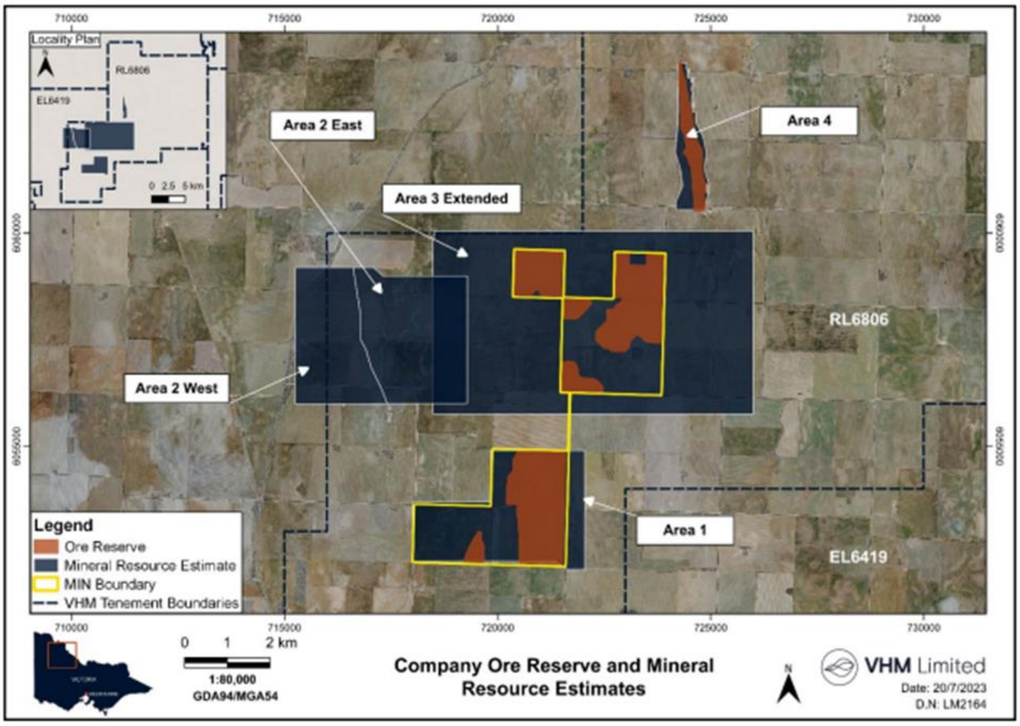
Data for the model was partly sourced from a significant sample from Area 3, Domain 1. Metallurgical tests on this sample using a fine (20µm) screen revealed a substantial mineral grade, outperforming samples tested with a coarser (38µm) screen. This finding suggests that valuable minerals are more effectively recovered from middling particles when they are ground to a finer size which a coarser screen may miss. Thus, this result signifies a higher potential value for the area, indicating the importance of the grinding process in mineral extraction.

Test results for mineral assemblage (MA) and REEs were allocated to Indicated and Inferred Mineral Resources in Domains 1 and 2. Domain 1's bulk sample data was assigned to its Indicated Mineral Resources for THM, slimes, and oversize grades. Drill hole samples were used for remaining estimates in Domains 1 and 2.

Resources – globally significant rare earth mineral inventory

As of 30 June 2023, the VHM holds a deposit of 588kt of TREO and 24.2Mt of THM within a 820Mt Resource, representing a globally significant rare earth and heavy mineral assemblage.

Figure 9: Goschen Project Ore Reserve and Mineral Resource



Source: VHM.

Figure 10: 820.3Mt Mineral Resource Estimate – VHM Total

Area	Date	Class	Ore (Mt)	THM Mt	THM%	ZIR%	RUT%	LX%	ILM%	MON%	XEN%	TREO (%)	CeO_2	Dy_2O_3	Er_2O_3	Eu_2O_3	Gd_2O_3	La_2O_3	Nd_2O_3	Pr_6O_{11}	Sm_2O_3	Tb_4O_7	Tm_2O_3	Y_2O_3	Yb_2O_3
1	Mar-23	Total	92.9	3.2	3.4%	27.7%	11.2%	9.1%	24.9%	4.5%	0.8%	2.94	1.06	0.07	0.05	0.004	0.07	0.51	0.43	0.12	0.08	0.02	0.01	0.48	0.05
2	Mar-23	Total	26.0	0.7	2.8%	22.0%	16.0%	12.0%	25.0%	3.0%	1.0%	1.97	0.66	0.06	0.04	0.003	0.06	0.31	0.28	0.07	0.05	0.01	0.01	0.39	0.04
3	Mar-23	Total	491.8	13.6	2.8%	18.2%	8.9%	7.7%	23.9%	3.0%	0.6%	2.14	0.77	0.05	0.03	0.003	0.05	0.36	0.32	0.09	0.06	0.01	0.01	0.36	0.04
4	Mar-23	Total	18.0	0.8	4.6%	19.0%	11.0%	10.0%	24.0%	3.0%	1.0%	1.90	0.67	0.05	0.03	0.002	0.05	0.32	0.28	0.07	0.05	0.01	0.01	0.33	0.04
Cannie	May-23	Total	191.7	5.9	3.1%	24.5%	15.5%	24.3%	2.1%	4.1%	0.8%	3.00	1.06	0.07	0.05	0.004	0.70	0.49	0.45	0.12	0.08	0.01	0.01	0.49	0.05
Grand Total		**Measured**	30.7	1.8	5.7%	29.9%	10.8%	9.0%	24.7%	4.3%	0.8%	2.72	0.96	0.07	0.05	0.004	0.06	0.48	0.38	0.11	0.07	0.01	0.01	0.47	0.05
		Indicated	310.3	9.9	3.2%	20.5%	10.1%	8.6%	24.9%	3.4%	0.7%	2.27	0.81	0.05	0.04	0.00	0.05	0.38	0.34	0.09	0.06	0.01	0.01	0.38	0.04
		Inferred	479.4	12.5	2.6%	17.2%	8.7%	7.5%	22.7%	2.9%	0.5%	2.10	0.76	0.05	0.03	0.00	0.05	0.35	0.31	0.08	0.06	0.01	0.01	0.36	0.03
		Total	**820.4**	24.2	**3.0%**	**20.2%**	**9.6%**	**8.2%**	**24.1%**	**3.3%**	**0.6%**	**2.25**	**0.81**	**0.05**	**0.04**	**0.00**	**0.05**	**0.38**	**0.33**	**0.09**	**0.06**	**0.01**	**0.01**	**0.38**	**0.04**

	Material	In Situ TREO Grade	In Situ TREO
	(t)	(%)	(t)
Area1, Area2 West,Area 3, Area 4, Cannie	820,364,884	0.07	588,355

Source: VHM.

Reserves – Area 4 Adds Valuable Reserves

The Ore Reserve is shown in Figures 11 and 12. The total reserve was increased as at September 2023 (from previous Reserve at March 2022) with the addition of Area 4, situated 8km to the north of the proposed Goschen processing facility. A preliminary feasibility has begun that will examine whether Area 4 could be mined with a simplified process flowsheet in a shorter timeframe than the main deposit. This would enable faster cash generation for the overall project.

As of September 2023, the VHM's Proven and Probable Ore Reserves total 210.2Mt, with a THM grade of 3.8% and a TREO grade of 2.4%.

The Ore Reserve shows a high grade of valuable heavy minerals (VHM) and a high TREO grade. The bulk of the value in this reserve will come from zircon and the REOs.

Figure 11: Ore Reserve – VHM total heavy minerals and valuable heavy minerals

Area	Date	Class	Ore (Mt)	THM%	ZIR%	RUT%	LX%	ILM%	MON%	XEN%
1	Mar-21	Proved	24.5	5.4%	29.9%	10.8%	9.0%	24.7%	4.3%	0.8%
1	Mar-21	Probable	14.6	3.2%	29.2%	11.7%	9.2%	25.5%	4.5%	0.9%
3	Feb-21	Probable	159.6	3.5%	20.3%	9.4%	8.1%	25.8%	3.4%	0.6%
4	Jul-23	Probable	11.5	5.6%	19.6%	12.2%	10.1%	24.6%	3.0%	0.7%
Total		Proved	24.5	5.4%	29.9%	10.8%	9.0%	24.7%	4.3%	0.8%
		Probable	185.7	3.6%	21.0%	9.8%	8.3%	25.7%	3.5%	0.6%
Grand Total			210.2	3.8%	22.0%	9.9%	8.4%	25.6%	3.6%	0.6%

Source: VHM.

Figure 12: VHM Ore Reserve – TREO

Area	Classification	TREO (%)	CeO2	Dy2O3	Er2O3	Eu2O3	Gd2O3	La2O3	Nd2O3	Pr6O11	Sm2O3	Tb4O7	Tm2O3	Y2O3	Yb2O3
1	Proved	2.720	0.960	0.070	0.050	0.004	0.060	0.480	0.380	0.110	0.070	0.012	0.008	0.470	0.050
1	Probable	2.682	0.957	0.065	0.045	0.003	0.059	0.454	0.398	0.104	0.072	0.012	0.007	0.456	0.050
3	Probable	2.271	0.795	0.056	0.038	0.003	0.055	0.373	0.335	0.091	0.063	0.009	0.006	0.383	0.039
Total	Proved	2.720	0.960	0.070	0.050	0.004	0.060	0.480	0.380	0.110	0.070	0.012	0.008	0.470	0.050
	Probable	2.298	0.806	0.056	0.049	0.003	0.055	0.379	0.339	0.092	0.064	0.009	0.006	0.388	0.040
TOTAL		**2.451**	**0.862**	**0.061**	**0.043**	**0.003**	**0.057**	**0.415**	**0.354**	**0.099**	**0.066**	**0.010**	**0.007**	**0.417**	**0.044**

Source: VHM

Mining

Mining operations

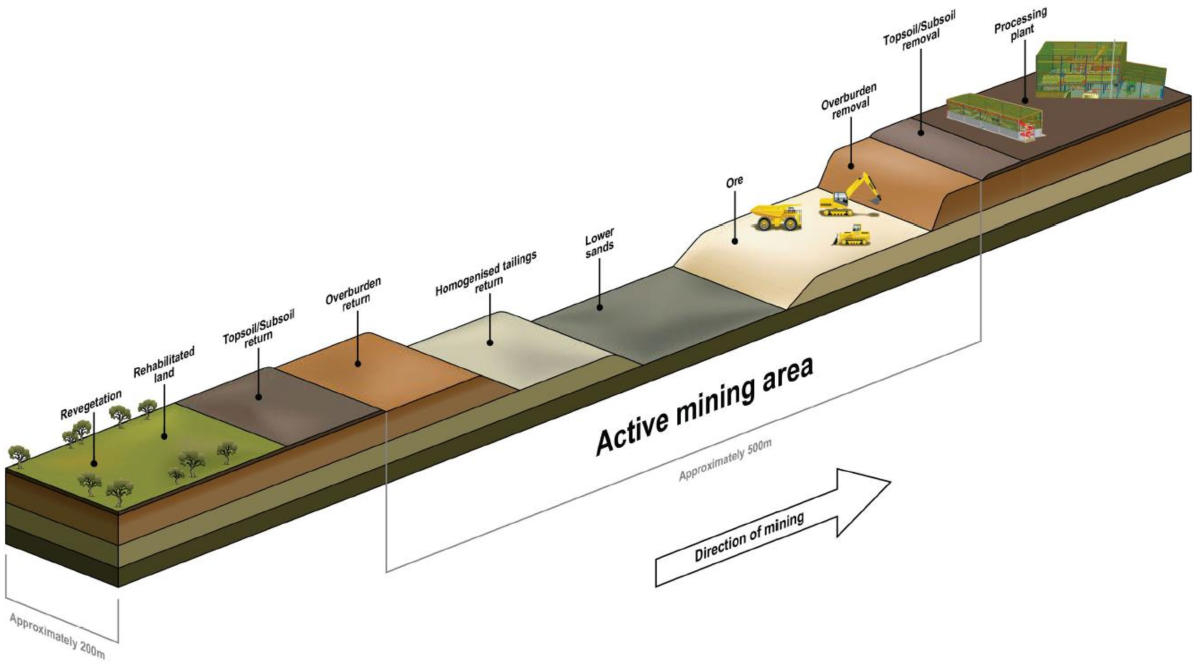
The planned mining operation involves block/strip mining, with mine depths of 30–40 meters (see Figure 13 for a typical cross section). All mining activities will be conducted above the water table, reducing the need for groundwater dewatering.

Each mining segment, or block, measures approximately 250m wide by 500m long. As mining progresses in a segment/block, the pit will be progressively backfilled and rehabilitated.

Mining operations for each segment/block will last for approximately 8–12 months, with no requirements for drilling or blasting indicated. Ore from the initial mining block will be placed on a surface ore stockpile and subsequently fed directly to a Mining Unit Plant.

Process tailings will be deposited in specially constructed tailings cells within the mined areas. Waste materials from the initial mining blocks will be stockpiled on the surface until sufficient space and suitable conditions are available in the mined areas for direct deposition, which may involve creating bunds for the tailings cells or covering consolidated tailings.

Figure 13: Schematic illustration of mining sequence



Source: VHM.

Mining operations will utilise a fleet of excavators (200t and 110t class), rigid off-road trucks (130t), bulldozers, scrapers, and front-end loaders. Dozer cross-ripping will be conducted as needed. The strip ratio will vary from 1:1 to 4.5:1, with annual production rates ranging from 10 Mtpa to 27.5 Mtpa, maintaining a steady 5 Mtpa feed rate to the Mining Unit Plant.

Mining production

The mining production schedule (Figure 14) is divided into 5-year periods. The planned production rate is set at 5 Mtpa of ore. The total heavy mineral (THM) grade varies from 4.9% to 3.3%, resulting in an average THM output ranging from 241 Ktpa to 165 Ktpa.

Only Proved and Probable material is considered in this schedule, with no Inferred material included in the mined ore. VHM intends to operate at its full capacity of 5 Mtpa throughout the Life of Mine (LOM). The total ore mined over the LOM is estimated at 98.6Mt.

The average strip ratio for the LOM is 2.6:1 (waste:ore), with higher strip ratios in the first and last blocks. However, increased mining costs per tonne of ore in these blocks are offset by higher grades. In contrast, the middle blocks have a lower strip ratio of 2.4:1 (waste:ore) and a lower THM grade of 3.4%. The first mining block has a grade of 4.9%, while the last mining block has a grade of 4.3%.

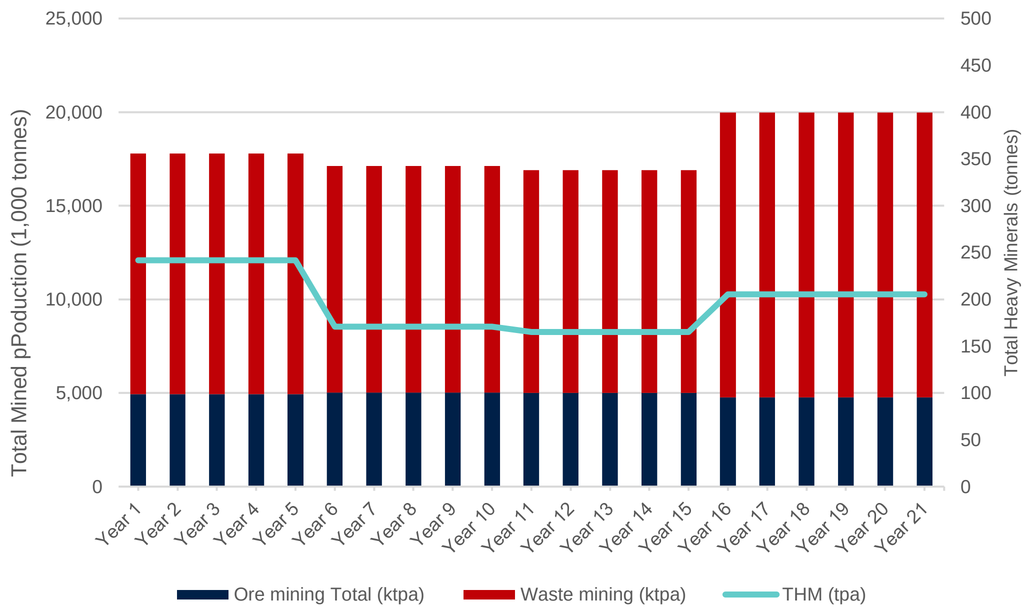
Figure 14: LOM mining schedule

	Year 0-5	Year 6-10	Year 11-15	Year 16-21	LOM
Waste mining - Total (kt)	64,275	60,474	59,489	75,979	260,217
Ore mining - Total (kt)	24,667	25,131	25,021	23,864	98,683
Ore mining – Avg. (ktpa)	**4,933**	**5,026**	**5,004**	**4,773**	**5,000**
Total heavy minerals (THM)	4.90%	3.40%	3.30%	4.30%	3.97%
THM (kt)	1,209	854	826	1,026	3,915
THM – Avg. (tpa)	**241,737**	**170,891**	**165,139**	**205,230**	**186,428**
Zircon	*29.1%*	*23.5%*	*19.3%*	*20.1%*	*23.5%*
Rutile	*11.3%*	*9.9%*	*9.0%*	*9.3%*	*10.0%*
Ilmenite	*25.0%*	*25.1%*	*25.2%*	*25.5%*	*25.2%*
Monazite	*4.2%*	*3.7%*	*3.2%*	*3.3%*	*3.7%*
Xenotime	*0.8%*	*0.7%*	*0.6%*	*0.6%*	*0.7%*
Other heavy minerals	*20.2%*	*28.6%*	*34.7%*	*33.3%*	*28.5%*

Source: VHM.

Figure 15 displays the average production output of waste, ore mined, and THM based on the data provided in the mining schedule.

Figure 15: Yearly production and THM output



Source: MST estimates, using VHM data from DFS Refresh.

Construction: a staged approach

The project's construction will be divided into 3 stages: Phase 1, Phase 1A, and Phase 2. However, Phase 2 is contingent on favourable market conditions, financial rationale, and sufficient funding, and it is not part of the Final Investment Decision (FID).

Phase 1 (concentrator) – processing plant commissioning 13 months post FID

VHM plans to start commissioning the Phase 1 processing plant approximately 13 months after FID. During this phase, the company aims to begin production of both zircon-titania concentrate and rare earths mineral concentrate (REMC) products.

Phase 1A (Hydromet Circuit) – commissioning 6 months post FID

VHM plans to build the hydrometallurgical circuit concurrently with Phase 1, and expects commissioning to commence around 6 months after FID. Post-construction, an additional 13 months will be dedicated to commissioning and ramping up to full production, with wet[2] commissioning occupying the majority of this time frame.

Phase 2 summary (MSP)

If Phase 2 is approved to proceed, VHM expects construction to take around 8 months with commissioning and ramp up scheduled to take a further 7 months.

Processing and product output

Overview of proposed products for Phases 1 and 1A

The Goschen Project (Phases 1 and 1A) will produce a mineral sand product and two different rare earth products. Figure 18 shows the proposed production in each phase for these products.

Rare earth products:

- **Rare earth mineral concentrate (REMC):** In Phase 1 of the project, VHM expects to produce approximately 9.4ktpa REMC for the first 10 years. REMC is a concentrated mineral product with rare earth–bearing minerals. It is a mixture of various REEs, as well as some remaining impurities, in a concentrated form.

The product is obtained after the initial beneficiation and mineral processing stages, where the rare earth-containing ores are separated from unwanted minerals through physical and/or chemical processes (e.g. froth flotation, screening, gravity separation). The processing cost to reach this stage is relatively low, but so is the product's market price due to its lower level of refinement.

- **Mixed rare earth carbonate (MREC):** In Phase 1A of the project, VHM expects to produce approximately 8.5ktpa MREC for the first 10 years. A MREC product is an upgraded carbonate form of REMC, obtained by leaching the REMC which dissolves REEs into a solution. After further purification steps (e.g. solvent extraction), the rare earth solution is combined with a carbonate source, leading to the formation of MREC – a more refined solid composed of REEs in their respective carbonate forms.

Based on ANSTO Pilot Scale Test work, impurities in the MREC product are low, at 2.5–3.0% total impurities. Measurements of the final content of uranium and thorium were also considered exceptionally low. The additional steps raise costs but produces a product closer to individual REEs, thereby enhancing the product's market value.

Mineral sand product – zircon-titania heavy mineral concentrate (zircon-titania HMC): HMC is an upgraded heavy mineral concentrate which has undergone post flotation beneficiation. Phases 1 and 1A of the project will result in the zircon and titania minerals remaining unseparated and contained in the HMC, resulting in a product called zircon-titania HMC. VHM expects the average production of zircon-titania HMC to be 134,500tpa during the first 10 years. There is a ready market for mineral concentrates containing zircon and titania minerals.

Figure 16: Goschen Project – key operational metrics for each phase

Goschen Project key operational metrics (First 10 Yrs)	Phase 1 (tpa)	Phase 1A (tpa)
REMC average production	9,428	–
MREC average production	–	8,568
Zircon-titania HMC average production	134,500	134,500

Source: VHM.

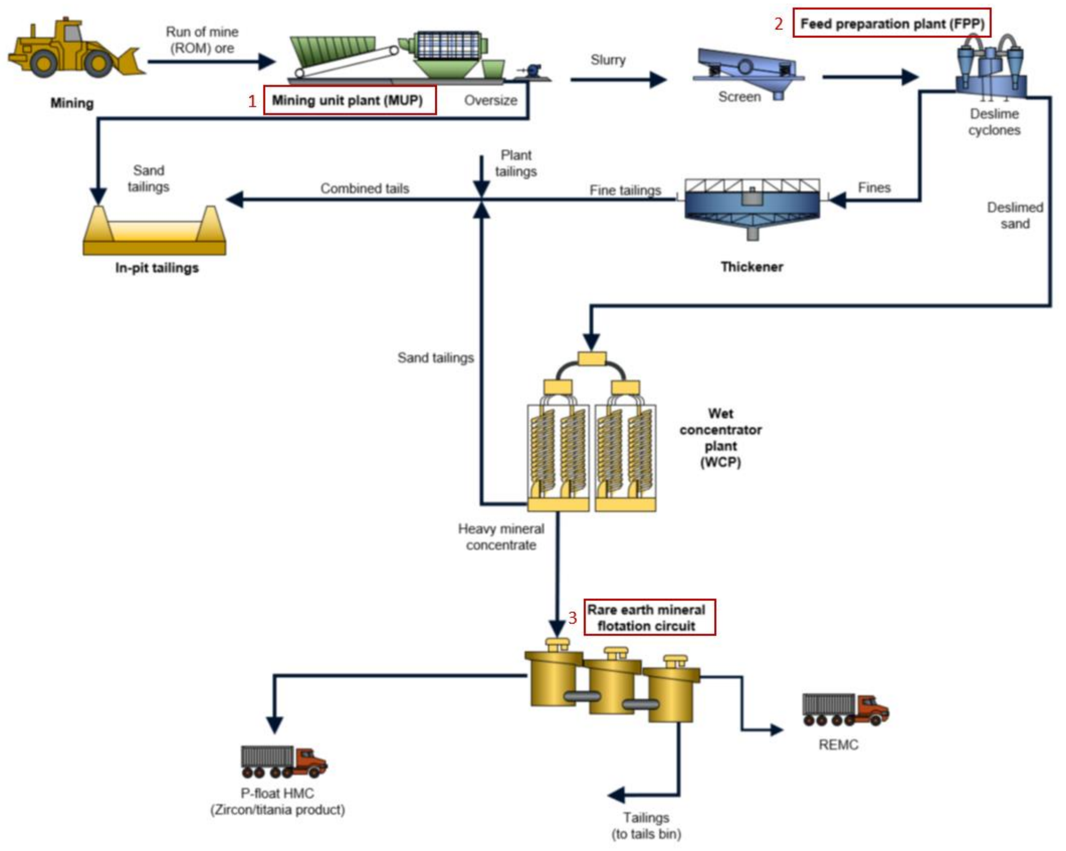
[2] Wet commissioning is the phase where a new plant or facility is tested and operated using actual process fluids or materials to ensure its functionality and performance before full operation.

Processing

Concentrator Circuit for Phase 1

Phase 1 will involve the production of zircon-titania HMC and REMC products. The mining process circuit will consist of a Mining Unit Plant, Feed Preparation Plant, Wet Concentrator Plant, and an REMC Flotation Circuit as seen in Figure 17.

Figure 17: Phase 1 schematic flow sheet



Source: VHM.

- **Step 1: Mining Unit Plant (MUP):** Post-mining, ROM ore will be stockpiled and then processed through the MUP using a loader, which will filter out coarse oversize via a grizzly. Clay and sand clumps will be disintegrated in a scrubber, and the resulting slurry transferred to the Feed Preparation Plant at the main plant.

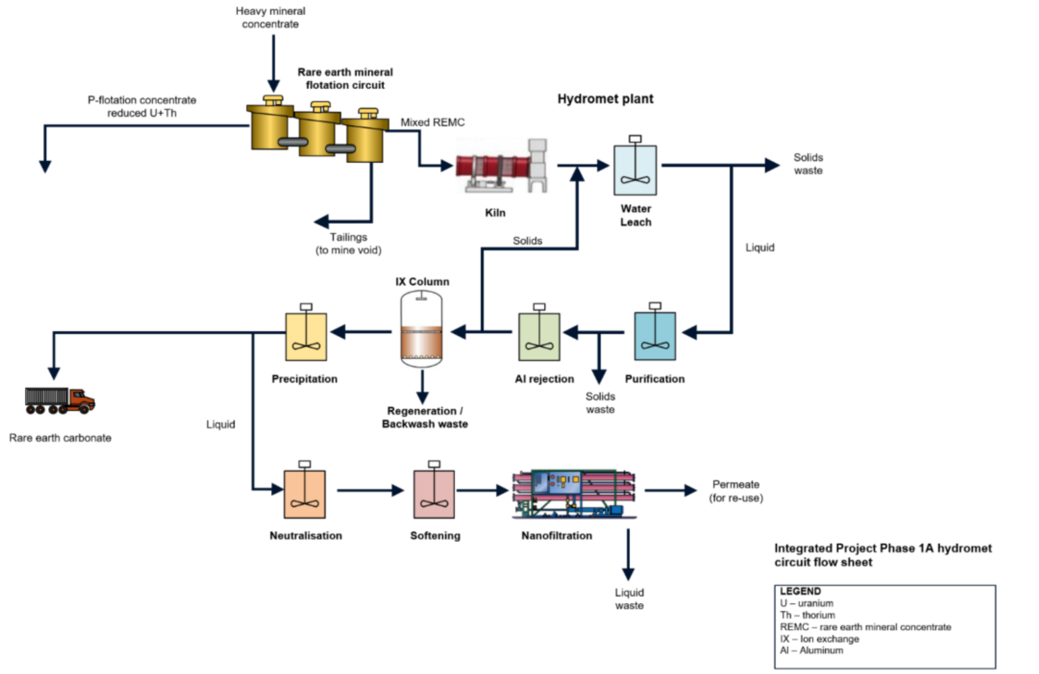
- **Step 2: Feed Preparation Plant and Wet Concentrator Plant (WCP):** The sand portion, rich in heavy minerals, is separated from the clay section, also known as slimes. Once separated and screened, this sand is then pumped to the WCP. The WCP uses spirals to separate heavy minerals from gangue sand based on their specific gravities. HMC is transported to the Rare Earth Mineral Flotation Circuit, while rejected sand combines with slimes, and is pumped back to the pit to backfill the mine void. HMC is screened to eliminate coarse silicates and iron oxides, enhancing the HM grade. Final cleaning increases the HMC grade to approximately 92%.

- **Step 3: Rare Earth Mineral Flotation Circuit:** An REMC will be extracted from HMC via flotation and gravity separation. The REMC is then either sent to the Hydromet Circuit (Phase 1A) for processing or is packaged as the final product. The zircon-titania HMC is either further processed at the Wet MSP (Phase 2, when built), or dewatered, stockpiled, and transferred to the product loading area as the final product.

Hydrometallurgy Circuit added for Phase 1A

The Phase 1A Hydromet Circuit will transform REMC into MREC through a chemical and heat-induced process as portrayed in Figure 18. This process facilitates rare earth extraction.

Figure 18: Phase 1A Hydromet Circuit schematic flow sheet



Source: VHM.

The hydrometallurgical processing system is a multi-stage process:

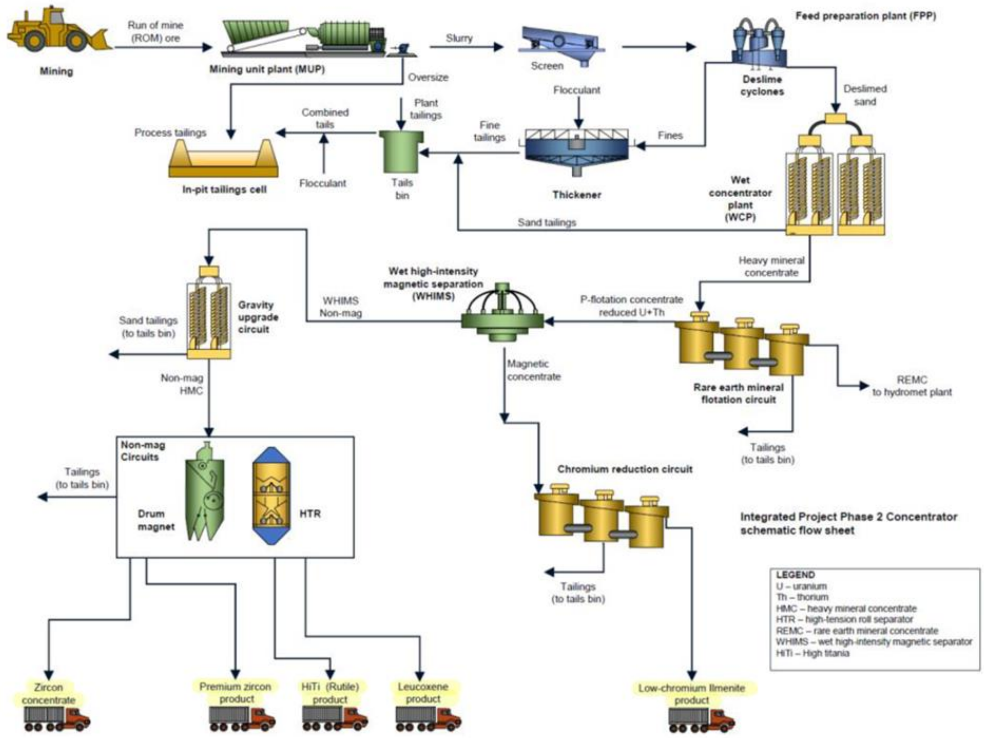
- **Kiln:** The REMC is first dried and treated with sulphuric acid (H_2SO_4) in a high-temperature kiln. This transforms specific minerals into water-soluble sulphates, making the concentrate more amenable to subsequent processing.
- **Leach Tank:** The treated concentrate is transferred to a leach tank where it interacts with recycled water. This process results in a slurry rich in REEs, separated from other minerals and impurities.
- **Thickener:** The leach slurry is densified in a thickener, separating solids from liquids. The overflow from the thickener, rich in dissolved rare earths, undergoes further purification.
- **Purification and second thickening:** The slurry is thickened again. The overflow is treated again for aluminium rejection and uranium removal, creating an even more concentrated product.
- **Ion exchange column and waste management:** The purified leach liquor is directed to an ion exchange column, where rare earth ions are selectively absorbed, and unwanted impurities pass through. Meanwhile, residues from various stages are combined, treated, and disposed of. The resulting solution, primarily containing sodium sulfate, is further processed for reuse or disposal.
- **Precipitation and preparation for shipment:** REEs are precipitated to form a high-purity carbonate precipitate. This precipitate is further thickened, filtered, washed, and readied for shipment at the MREC packing plant.

Processing: Mineral Separation Plant to be built if Phase 2 approved

If Phase 2 gets the green light, an additional facility will be introduced: a mineral separation plant (MSP). The MSP would leverage differences in physical properties, such as size, density, magnetic susceptibility, surface conductivity, and hydrophobicity, to separate p-flotation concentrate into distinct mineral products. Such a plant would typically comprise a wet circuit, dry circuit, ilmenite upgrade chrome removal circuit, zircon hot acid leach (HAL) circuit, and associated non-process infrastructure (NPI).

This additional step would allow for more precise separation of the zircon-titania HMC into final products, specifically zircon, ilmenite, high-titania (HiTi) rutile, and leucoxene mineral products (see Figure 19).

Figure 19: Goschen Project – Phase 2 concentrator schematic flow sheet



Source: VHM.

Offtake agreements: one signed, more in the works

Shenghe, a prominent player in the REM market, has entered into a significant Memorandum of Understanding (MOU) with the Goschen Project. The agreement commits Shenghe to purchasing 6,400 tpa of REMC and 100,000 tpa of HMC over a 3-year term. This purchase commitment amounts to approximately 60% of the Goschen Project's nominal production rate based on the anticipated 5 Mtpa output of the project. The contractual take-or-pay obligations to supply or take monthly contracted tonnages will not commence until production at the plant has achieved at least 90% of the nameplate production rate for a 30-day period. Prior to satisfaction of that completion test, Shenghe will take 60% of actual production.

The MOU is legally binding, subject to standard conditions. VHM is finalising the formal comprehensive offtake agreement based on the detailed MOU. The agreement will be subject to customary conditions precedent, including obtaining necessary development approvals, securing project funding, and finalising a comprehensive offtake agreement within 4 months of the MOU being signed. Once these conditions are met, the offtake arrangements will be binding, transforming the MOU into a comprehensive offtake agreement. VHM, in its recent quarterly, advised that the parties continue contract negotiations and have agreed to extend the formal agreement date to 31 December 2023.

This commitment from Shenghe underscores its confidence in the Goschen Project's potential and serves as a significant milestone towards securing a stable market for the project's REMC and HMC. It represents a mutually beneficial partnership that aligns with the strategic objectives of both parties.

VHM has indicated that it is in discussions with prospective European, Asian, and North American counterparties for further offtake agreements for its REMC, MREC, and HMC products.

DFS Refresh March 2023
Goshen Stands Up as A Robust Project

VHM's DFS estimates shoe the Goschen Project characterised by a comparatively low development capex (~A$606m for Phase 1 and 1A), a long mine life (~20.5 years), and high EBITDA margins (~52%).

The project has a dual-product revenue stream through the production of zircon-titania HMC and REEs. The majority of the revenue over the LOM will come from REEs; however, the relatively stable zircon-titania HMC prices will provide some downside protection for VHM.

DFS Refresh (March 2023):
Updated assumptions across the Goschen Project

VHM released a 'DFS Refresh' in March 2023 which incorporated critical works undertaken in 1QCY23, updating the original DFS in the prospectus of January 2023. Changes included:

- updates to capital and operating cost estimates based on 2023 market conditions and influences
- market study pricing updates (1Q2023) for rare earths, zircon, and titania products
- completion of front-end engineering and design (FEED) optimisation studies for process engineering, and design and optimisation for a mineral separation plant and related process assets
- completion of metallurgical testwork and process design and engineering for the construction and commissioning of a Hydromet Circuit to upgrade the REMC to MREC
- completion of hydrogeology and hydrology studies for surface and sub-surface water management
- progressing geotechnical studies in the areas of pit design, surface waste dump design, foundation engineering and tailings disposal and engineering
- progress toward the Environmental Statement decision, and subsequent Mining License grant
- tailings disposal and management.

VHM's financial analysis shows a pre-tax NPV and IRR of US$1.5b and 44%, respectively, assuming a 10% cost of capital.

VHM's updated financial estimates for the Goschen Project

Capital cost estimates

The 'DFS Refresh' adjusted the capex forecasts from the original DFS to take into account inflationary impacts. It also incorporated a capex breakdown for the Hydromet Circuit that was not originally included in the original DFS. VHM estimates that the incremental capex costs for the Hydromet Circuit will be A$124m (real 2023 dollars). VHM has presented capex forecasts in real dollar terms; however, in its financial model, the company uses nominal values and inflation forecasts provided by the RBA in its 'Statement on Monetary Policy' released in November 2022.

The project will be delivered in a phased approach as presented at a high level in Figure 20.

Figure 20: Overview of phased approach and capex estimates

Category	Scope	CAPEX A$ (real 2023 $)	Expected Date of Initiating Implementation Expenditure
Phase 1	MUP, FPP, WCP, REMC & assoc. NPI	$376m	1H2025
Phase 1	Pre-production mining & other ancillary start-up works	$106m	1H2025
Phase 1A	Hydromet. & assoc. NPI	$124m	2H2025
Phase 2	MSP (incl HAL) & assoc. NPI	$160m	TBC

Source: VHM.

Phase 1: Concentrator Circuit

Phase 1 consists of the construction of the MUP, FPP, WCP and REMC plant. Capital outlay at this stage will enable VHM to produce HMC and REMC. VHM estimates Phase 1 capex will be A$483m (see Figure 21), including a $28m contingency. Phase 1 construction will take approximately 15 months.

Figure 21: Breakdown of Phase 1 capex (as estimated by VHM)

Description	Total (A$m)
Directs	**234.3**
Earthworks	65.1
Civil/concrete	12.2
Buildings and NPI	8.4
Structural steel	22.2
Platework	7.8
Process and mechanical equipment	43.5
Piping and valves	48.9
Electrical, controls and instrumentation	20.9
Spares and first fills	2.6
Mobile equipment	2.5
Indirect	77.6
Engineering services, contractors & expenses	72.9
Owner's costs (labour, expenses & insurances)	4.6
Total capex (excluding line item contingency)	407.9
Value of line item contingency	47.0
Total capex (including line item contingency)	455.0
Value of Project contingency	28.0
Total capex (including Project contingency)	**483.1**

Source: VHM.

Phase 1A: Hydromet Circuit

Phase 1A will involve the construction of the Hydromet Circuit, which will entail additional processing steps to convert the REMC to MREC. The MREC is simply an additional processing step to remove impurities and improve the payability factor of the contained REO. VHM estimates the overall delivery cost of the Hydromet Circuit to be A$124m, including a 7.5% contingency.

Phase 2: Mineral Separation Plant

Phase 2 is the implementation of a Mineral Separation Plant, which would separate the contained minerals inside the HMC and produce 5 separate final products – zircon, premium zircon, rutile, leucoxene and low-chromium ilmenite. The process is subject to further financial analysis by the company to determine the feasibility of the project and whether this is a good allocation of capital.

Operating cost estimates

VHM has broken down its operating cost (opex) estimates similarly to capex, based on a phased approach. The estimates cover operating labour, contracted services, mining services, consumables, maintenance and running costs over the LOM for all related on-site and off-site services.

Opex estimates are based on the following parameters:

- annual ROM ore feed processing rate of 5mtpa
- a full production year based on 7,446 operating hours p.a. (85% plant availability) for the MUP, FPP and WCP
- key costs associated with operations, including
  - site administration and site operational services
  - contract site maintenance services
  - contract mining services
  - tailings and rehabilitation
  - process plant operations and maintenance
  - NPI operations and maintenance
  - electric power generation and diesel consumption
  - reagents and consumables
  - transport and logistics.

As with capital requirements, the opex summary has been broken down into a phased approach. Phases 1 and 1A have a very similar operating cost profile, although Phase 1A includes additional costs for the processing and power costs relating to the Hydromet Circuit.

Figure 22: Breakdown of Annual Phase 1 operating cost (as estimated by VHM)

Area	Cost (A$m)	% (approx.)
Mining contractor	$58.5	40%
Tailings & rehab contractors	5.0	3%
Site management	8.8	6%
Site Services	15.7	11%
Process plant	31.5	21%
Power station	13.8	9%
Water pump station & pipeline	3.5	2%
Product transport & logistics	11.7	8%
Total	**148.6**	**100%**

Source: VHM.

Figure 23: Breakdown of Annual Phase 1A operating cost (as estimated by VHM)

Area	Cost (A$m)	% (approx.)
Mining contractor	58.5	40%
Tailings & rehab contractors	5.0	3%
Site management	8.8	6%
Site services	15.7	11%
Process plant	83.7	21%
Power station	18.4	9%
Water pump station & pipeline	3.5	2%
Product transport & logistics	11.7	8%
Total	**205.3**	**100%**

Source: VHM.

Figure 24: Breakdown of Annual Phase 2 operating cost (as estimated by VHM)

Area	Cost (A$m)	% (approx.)
Mining contractor	58.5	40%
Tailings & rehab contractors	5.0	3%
Site management	8.8	6%
Site services	15.7	11%
Process plant	99.9	21%
Power station	26.0	9%
Water pump station & pipeline	3.5	2%
Product transport & logistics	11.7	8%
Total	**229.1**	**100%**

Source: VHM.

Financial evaluation

Project financial evaluation assumptions

The DFS Refresh conducted by VHM and independent partners included the following assumptions:

- nominal NPV discount rate of 10%
- valuation date of January 2023
- REMC and MREC prices based on January 2023 Adamas Intelligence forecast. Long-term prices beyond 2035 assume the same price as 2035 in 2023 dollars
- mineral sands prices based on January 2023 TZMI forecast. Long-term prices beyond 2030 assume the same price as 2030 in 2022 dollars
- long-term AUD/USD exchange rate of 0.70
- short-term CPI inflation in accordance with RBA published forecasts
- Phase 1 first production in 1H2025
- Phase 1A first production in 2H2025
- capex and opex estimates in real 2023 dollars.

The DFS Refresh (summarised in Figure 25) delivered a pre-tax NPV of A$1.5 bn using these assumptions. The DFS only considers 50% of the identified Ore Reserves; subject to future regulatory approvals, the maximum Ore Reserve Estimate of 198.7Mt would extend the LOM to approximately 40 years and – all else remaining equal – increase the pre-tax NPV to $2.1bn with an IRR of 45%.

Figure 25: Goschen key financial and operational metrics

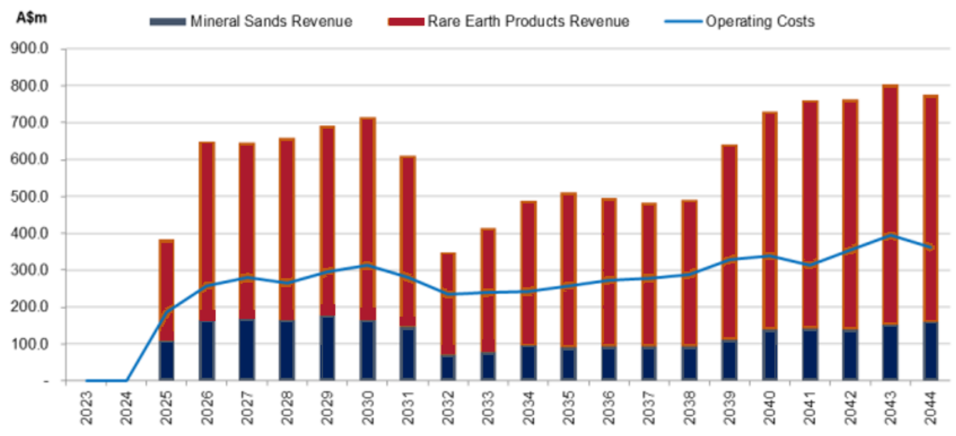
5Mtpa Goschen Project DFS Financial Metrics (Phases 1 and 1A)			
Pre-tax NPV10 (A$m)			1,525
Pre-tax IRR			44%
Payback from commencement of production (years)			2.8
Ore Reserve LoM (years)			20.5
Average ore grade (THM)			4.0%
Average strip ratio (waste:ore)			2.6 : 1
First 10 Years of Mine	**Average Production (tpa)**	REMC	9.428
		MREC	8,568
		Zircon-titania HMC	134,500
	Average revenue per annum (A$m)		564
	Average opex per annum (A$m)		273
	Average EBITDA per annum (A$m)		291
	Average unlevered, pre-tax FCF per annum		270
	Average revenue A$/t ore		118
	Average operating costs A$/t ore		57

Source: VHM.

Revenue, operating cost, and margin

On the basis of these assumptions, we can see the revenue and operating costs associated with the project (Figure 26).

Figure 26: Revenue and operating costs for Phases 1 and 1A



Source: VHM,

Additional Assets Helping to Attract Partners: The Cannie and Nowie Projects

The Cannie and Nowie Projects boost VHM's appeal for potential partners. Cannie's maiden results show a notable Mineral Resource with significant TREO. This, along with additional zircon, rutile, and leucoxene contributions, reinforces VHM's stature in Victoria's Critical Minerals Province along Lake Boga granite, elevating its global prominence.

Additionally, a drilling program at Nowie has revealed that areas of this project contain up to 2X HM than the highest-grade areas of Goschen. VHM has indicated that it will continue to evaluate the results of the drilling program and that it expects that further resource definition will lead to the release of a Maiden Mineral Resource before the end of CY2023.

Cannie Critical Mineral Project: growth optionality

Located 13.5km south of Goschen, Cannie's recently released Maiden Mineral Resource reported:

- a 30% increase in VHM's tonnage to 820Mt
- a 43% surge in TREO + yttrium inventory to 589kt
- additions to zircon and titanium reserves (+1.4Mt zircon, +0.9Mt rutile, +1.4Mt leucoxene).

The TREO update for Cannie is shown in Figure 27. MRE grades for Cannie and Goschen are compared in Figure 28.

Figure 27: Updated TREO inventory – Cannie Project

Project	Mineral Resource Category	Material (Mt)	In Situ THM (Mt)	THM%	TREO + Y2O3 %	In Situ TREO Grade (%)	In Situ TREO (t)
Goschen	Measured	30.7	1.8	5.72	2.72	0.16	48,000
Goschen	Indicated	310.3	9.8	3.19	2.27	0.07	225,000
Goschen	Inferred	287.7	6.7	2.32	2.10	0.05	140,000
Cannie	Inferred	192.0	5.9	3.05	3.00	0.09	176,000
Grand Total	**Measured**	**30.7**	**1.8**	**5.72**	**2.72**	**0.16**	**48,000**
	Indicated	**310.3**	**9.8**	**3.19**	**2.10**	**0.07**	**225,000**
	Inferred	**479.4**	**12.5**	**2.61**	**2.52**	**0.07**	**316,000**
	Total	**820.4**	**24.2**	**2.95**	**2.43**	**0.07**	**589,000**

Source: VHM.

Figure 28: Cannie vs Goschen Mineral Resource

	Mineral	Cannie MRE Grade (Inferred)	Goschen MRE Grade (Measured, Indicated, Inferred)
	THM	3.1%	2.9%
THM Assemblage	TREO + Y2O3	3.0%	2.3%
	Monazite	4.1%	3.3%
	Xenotime	0.8%	0.6%
	Zircon	24.5%	20.2%
	Rutile	15.5%	9.6%
	Leucoxene	24.3%	8.2%
	Ilmenite	2.1%	24.1%

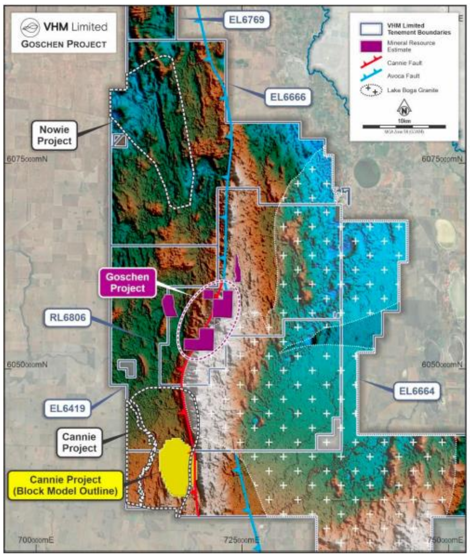
Source: VHM.

The Cannie MRE was informed by 38 drill holes, with results from another 104 pending. Geophysics and geological logging from all 142 holes across 2 ELs ensured spatial continuity. The Cannie Resource spans 7.2km by 4.4km and is open in all directions (see Figure 29). VHM plans to submit an application for a Retention Licence based on the current Inferred Resource in 2H2023.

Cannie's proximity to Goschen plus its successful early drilling results are very exciting for VHM and provide a lot of optionality for VHM to create value for shareholders. Continued successful drilling and expansion of the resource could potentially enable VHM to establish a rare earth hub in Victoria.

With the Cannie and Nowie projects as well as Gossen, VHM has the potential to become a material player in the rare earths market which could attract support from the western Governments (USA and Europe in particular) aiming to significantly reduce their dependence on the Chinese rare earth supply chain that controls critical minerals that are not only essential for the transition to decarbonisation but for government critical industries such as defence. Similar to Iluka, cheap debt funding could be granted to expand downstream and assist in the transition to create 'Westernised' rare earths supply chain.

Figure 29: Cannie Project map



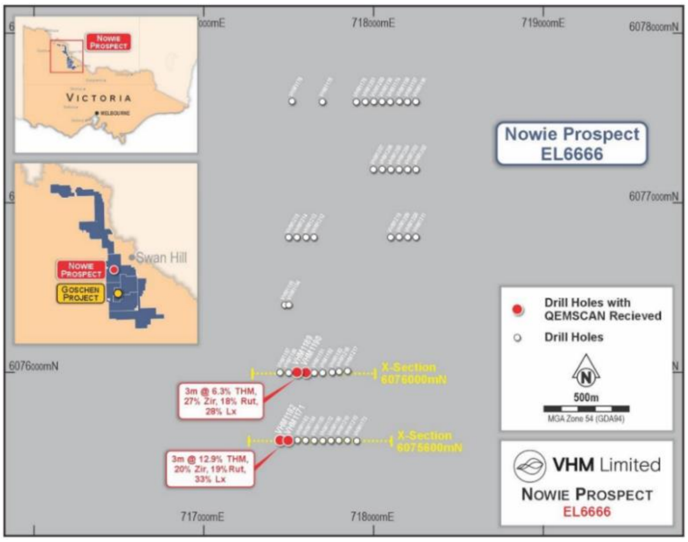
Source: VHM.

Nowie Project: some areas have 2X THM vs. Goschen

The Nowie Project is located 22km north of the Goschen Project. VHM commenced drilling in January 2023 and has completed a 50-hole drilling program. Early results indicate a high-grade ore body with significant total REO, zircon and high-value titanium minerals of rutile and leucoxene (see Figure 30). Geological interpretation concludes that the Nowie deposit is formed from multiple high-grade strandline systems which occur above a thick sequence of moderate THM grade sheet-style mineralisation up to 20m thick. The drilling program revealed that areas of Nowie contain up to 2X more THM than the highest-grade areas of the Goschen Reserve (see Figure 31).

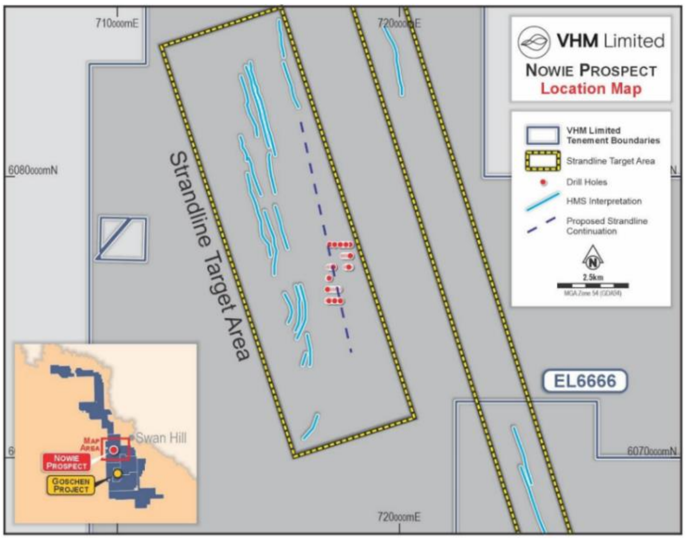
VHM has flagged that it will continue to evaluate the results from the 50 drill holes completed in the drilling program, with the company anticipating that further resource definition will lead to a Maiden Mineral Resource being released in 2HCY23.

Figure 30: Drilling program completed at Nowie



Source: VHM.

Figure 31: Nowie high-grade strandline systems



Source: VHM.

Figure 32: Nowie high-grade zone compares to Goschen Ore Reserve

Area	Material	Total Heavy Mineral (THM)	THM Assemblage						VHM	In Situ VHM
			Zircon	Rutile	Leucosene	Ilmenite	Monazite	Xenotime		
		%	%	%	%	%	%	%	%	%
Nowie	HG Zones	7.5	21.8	16.1	25.1	6.5	2.9	0.7	73.1	5.6
Goschen	Ore Reserve	4.0	23.6	9.9	8.5	25.1	3.7	0.7	71.5	2.9

Source: VHM.

Product Focus – Rare Earths:
From Geology through Production to End-Use

The Goschen Project will produce two types of rare earth products, along with a zircon-titania heavy mineral product. This section provides an overview of rare earths, including their scientific classification, market dynamics and end-uses. In the next section, we provide a similar discussion about heavy mineral sands.

The rare earth elements (REEs) might colloquially be referred to as 'industrial vitamins' because, despite being used in small amounts, they play an important role in various industrial processes and are essential to enabling many modern industrial materials and technologies. The sources of the most valuable rare earths, heavy rare earths, are concentrated in China. This fact is driving efforts to diversify the supply chain for these essential elements.

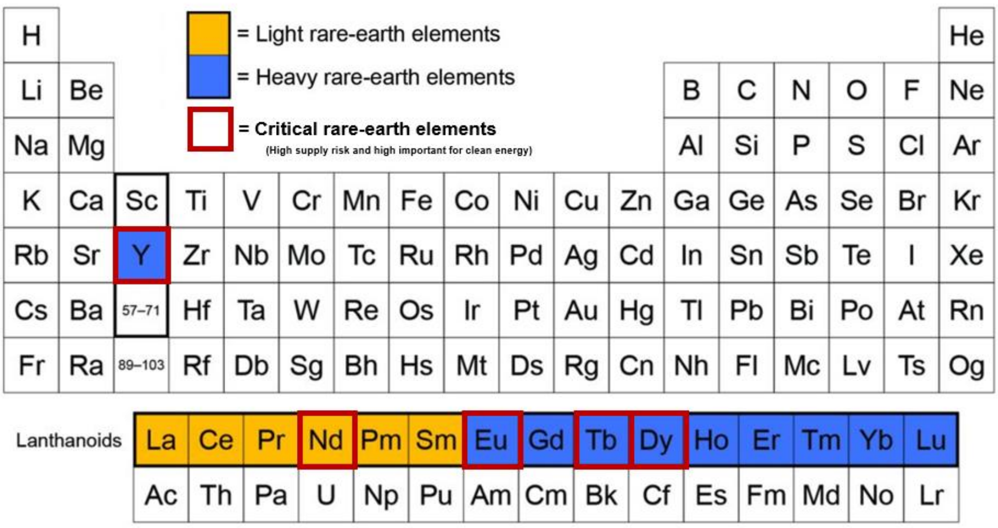
Definition and geology of rare earths – a scientific overview

The REEs are a group of 15–17 metallic elements (see Figure 33) composed of the lanthanides[3] on the periodic table, and sometimes also including scandium and yttrium (non-lanthanides). These elements, while sharing similar chemical properties, possess distinct physical and magnetic characteristics.

REEs are often classified into two main categories—light rare earth elements or oxides (LREEs or LREOs) and heavy rare earth elements or oxides (HREEs or HREOs). This classification is largely determined by their atomic weights and electron configurations. Additionally, within these classifications, there is a subset referred to as the magnetic rare earth elements or oxides (MREEs or MREOs) which are distinguished by their unique magnetic properties. Each of these categories, marked by their unique characteristics, finds significant application across diverse fields including electronics, defence, renewable energy, and transportation.

The REEs are typically abundant in the earth's crust; cerium (Ce) is as abundant as copper, for example. However, because of their geochemical properties, the elements are rarely found in concentrated economic clusters (ore deposits). Typically, economically viable ore deposits will contain concentrations of many or all of the individual REEs.

Figure 33: Rare earth elements (REEs) in the context of the periodic table



Source: Innovation News Network. (2023, May 25). Retrieved from https://www.innovationnewsnetwork.com/

Rare earth minerals – the big 3

While over 250 rare earth minerals are identified, around 95% of the global rare-earth resources are found in just 3 minerals – bastnasite, monazite, and xenotime (Figure 34), excluding a unique ore, ion-adsorption clay, found mainly in China. These are the primary sources for rare-earth extraction, with bastnasite being the most common, followed by monazite, and then xenotime and then clay.

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3 Lanthanides are a group of 15 elements in the periodic table that include cerium, europium, neodymium, dysprosium, terbium, erbium, holmium, thulium, ytterbium, lutetium, and praseodymium.

Figure 34: Major rare earth minerals

Minerals	Chemical formula	REO%	Average density (g/cm³)	Colour
Bastnaesite	(Ce,La,Pr)(CO3)F	74.8	4.97	Yellow, reddish brown
Monazite	$(Ce,La…)PO_4$	65.1	5.15	Brown, colourless, greenish, grey, white, yellow
Xenotime	$Y(PO_4)$	62	4.75	Yellowish brown, greenish brown, grey, reddish brown, brown

Source: VHM

Deposit types

REEs are mainly associated with 4 geological environments: alkaline igneous rocks, carbonatites, placer deposits with monazite-xenotime mineralisation and ion-adsorption clay deposits (see Figure 35). Australian REE resources occur in a range of geological environments.

Figure 35: Geological environment and the main REEs found in each

Geological Environment	Main REEs	Notable Example	Advantages	Disadvantages
Alkaline Igneous Rocks	Neodymium (Nd), Praseodymium (Pr)	Mount Weld (Lynas Corporation)	High concentration of REEs; Can be relatively easy to extract	Often contain radioactive elements; High energy required for processing
Carbonatites	Lanthanum (La), Cerium (Ce)	Cummins Range Rare Earths Project	REEs can be more easily leached and concentrated	Rare globally; Often contain radioactive elements
Placer Deposits (Monazite-Xenotime)	Neodymium (Nd), Dysprosium (Dy)	Mineral sands mining (Iluka Resources)	Easy to mine due to surface location; Low environmental impact	Lower concentration of REEs; Can be limited by availability of deposits
Ion-Adsorption Clay Deposits	Dysprosium (Dy), Terbium (Tb)	Makuutu deposit (Uganda)	Low-cost extraction; High concentration of heavy REEs	Mostly located in China; Environmental concerns due to leaching extraction method

Source: MST.

Despite their name, REEs are not actually ‘rare’. While REEs are present in nearly all types of rocks, extracting them in an economically viable way is the real challenge. The term ‘rare’ refers to the infrequency of these economically feasible, concentrated deposits, rather than the abundance of the elements themselves.

REE categories: classification and terminology

Total rare earth oxides (TREOs): The TREO metric indicates the combined concentration of rare earths in a deposit, encompassing both light and heavy elements. It is vital for gauging the economic potential of a rare earth project. However, the metric can be misleading as it does not reflect the varying values of individual elements. Notably, neodymium (Nd), praseodymium (Pr), dysprosium (Dy), and terbium (Tb) command higher prices due to their essential roles in technologies such as electric vehicles (EVs) and wind turbines. Therefore, while TREOs offer a general perspective, the presence of NdPr and DyTb specifically highlights a deposit's true worth.

Light rare earth oxides (LREOs): Due to their higher abundance in the Earth's crust, LREOs make up over 90% of the TREO content typically found in a rare earth deposit. Consequently, they also constitute the vast majority of the world's annual TREO production. Of the LREOs, praseodymium (Pr) and neodymium (Nd) are of the most economic interest due to their critical role in rare earth permanent magnets. Lanthanum (La) and cerium (Ce) are typically the most abundant in economic LREE deposits but are very low value in comparison and are often discarded.

Heavy rare earth oxides (HREOs): HREOs typically have higher melting/boiling points and tend to be more magnetically and electrically active. They are also generally more costly than LREOs as they are rarer and harder to extract. Some HREOs are facing shortages, especially dysprosium (Dy) and terbium (Tb), due to high demand.

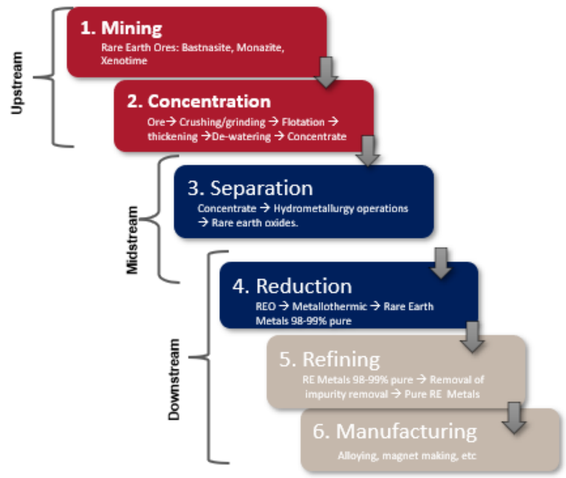
Magnetic rare earth oxides (MREOs): This category refers to the rare earth elements that are particularly important in the production of strong permanent magnets. The main MREOs are neodymium (Nd), praseodymium (Pr), and dysprosium (Dy), although others can also contribute to magnetic properties. MREOs are critical for a range of technologies, including EVs, wind turbines, hard disk drives, and various other electronics and clean energy applications.

Market dynamics: pricing, demand and supply

The rare earths supply chain

REEs go through several stages in their journey from raw ores to essential components in advanced products (see Figure 36). Each stage creates a distinct product that can be sold independently, adding complexity to the REEs market. The value increases at each step in the rare earth supply chain, with the most significant value addition and economic benefit realised in the final stages, often driven by end-user demand.

Figure 36: Stages of the rare earths supply chain



Source: MST.

Pricing: understanding how REEs are priced and sold

Since REEs are largely a niche commodity with bespoke products and end uses, most commercial terms for pricing and sale are negotiated between producers and downstream consumers. In China, the price is more tightly controlled by the few large producers, with annual mining quotas used as a tool to increase or constrain supply in the market (where possible). The product is predominantly sold as:

- rare earth mineral concentrate (REMC)
- mixed rare earth carbonate (MREC)
- separated product – rare earth oxide (REO)
- refined product – rare earth metal.

Many pricing references exist for the variety of REOs and metals, typically referenced in US dollars per metric tonne or per kilogram. Prices can be obtained through various sources, such as industry publications, commodity exchanges, and consulting firms. Some industry publications provide rare earth prices (Asian Metal, Metal-Pages, Shanghai Metals Market and Industrial Minerals), as do consulting firms such as Adamas Intelligence, Argus Metals, Project Blue, CRU, and Wood Mackenzie.

Demand: growth in EVs and wind turbines; NdPr oxide leads, but all REOs gain

Demand projections underscore the significance of the energy transition in driving the demand for REOs and the increasingly central role of REEs in the shift towards renewable energy and EVs.

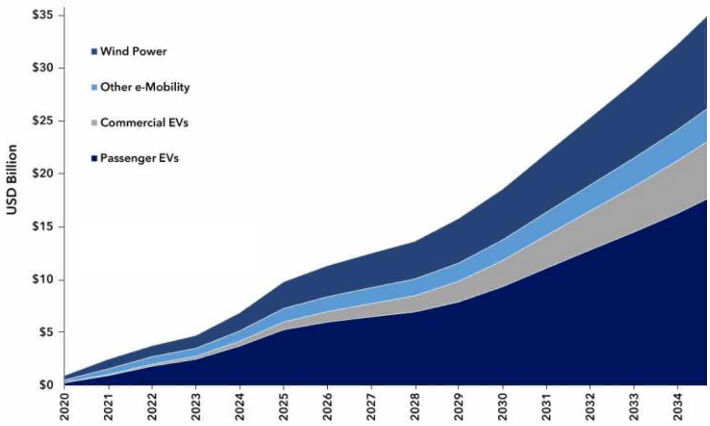
In 2022, the global consumption of magnet rare earth oxides (NdPr, Dy, and Tb) in NdFeB alloys for energy-transition-related applications such as EV traction motors and wind power generators was valued at $3.8 bn, according to Adamas Intelligence.

Adamas forecasts indicate that the value of REOs consumed by energy-transition-related applications is set to rise at a CAGR of 19.1% (2022–2025), increasing from US$3.8 bn in 2022 to a remarkable US$36.2 bn in 2035. This growth, predominantly driven by passenger EV traction motors (contributing over 50% by 2035), is also significantly boosted by wind power generators, contributing an additional 25% to the consumption value (see Figure 37).

The consumption value of NdPr oxide is projected to see the highest increase in the forecast period, anticipated to rise 11-fold by 2035 (see Figure 38). This is due to strong demand growth across all applications, rising prices, and a shift towards using more NdPr in high-grade NdFeB magnets.

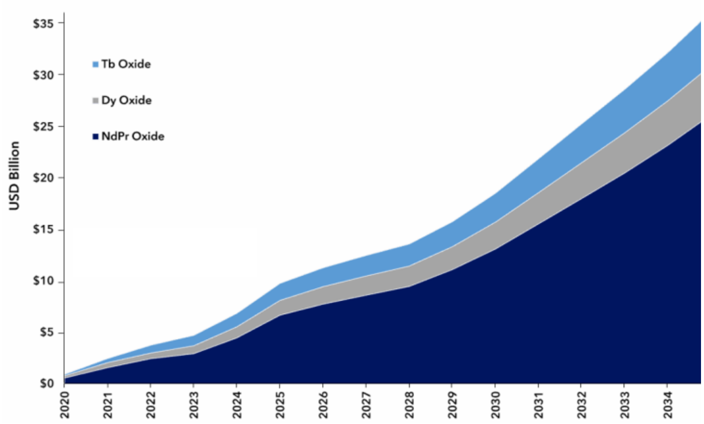
Demand for Dy and Tb oxide is expected to increase at a slightly slower pace, rising 7- to 9-fold over the forecast period. This slower pace is largely attributed to limited supply and technical advancements leading to a reduction in Dy and Tb usage per magnet unit.

Figure 37: Value of rare earths used in energy transition to skyrocket to 2035



Source: Adamas Intelligence, February 2023.

Figure 38: NdPr oxide to benefit most, but the rising tide will lift all boats

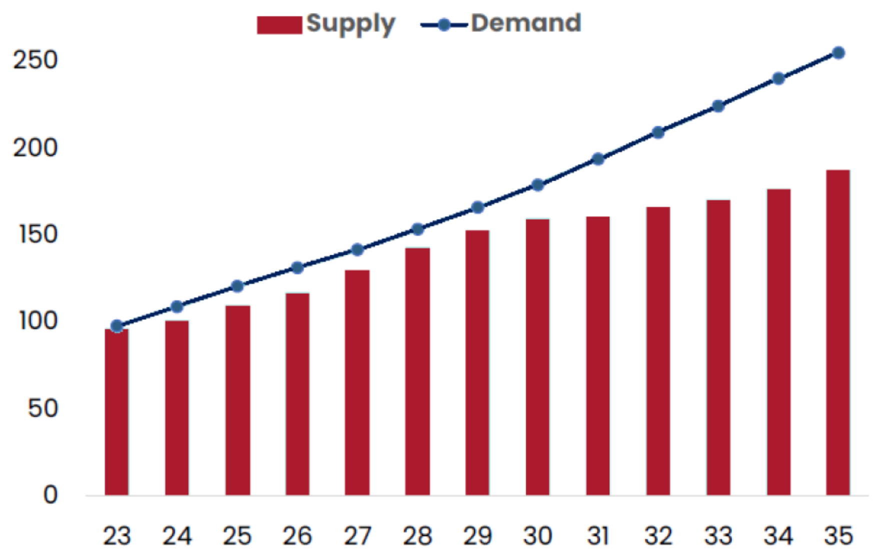


Source: Adamas Intelligence, February 2023.

Supply: a growing deficit

Figure 39 shows that supply deficits of NdPr oxides are expected to commence in 2024 and continue to increase, ultimately creating significant shortages of these critical magnet materials by 2035.

Figure 39: Forecasted NdPr oxide supply–demand balance (ktpa)



Source: VHM, sourced from Adamas Intelligence – Rare Earth Magnet Outlook to 2040, Q2 2023.

Exploring the end-uses of REEs – permanent magnets dominate

REEs have an extensive array of utilities and applications, representing 8 primary end-use categories (see Figure 40). In 2021, over 65% of global TREO consumption by volume (and 95% by monetary value) was attributable to use in permanent magnets (PMs) and catalysts. With increasing demand this share is set to grow even further.

PMs have historically been used in the production of electronics such as mobile phones and laptops, and now the transition to the new 'green' economy is driving a new wave of demand. REEs such as neodymium, praseodymium, dysprosium and terbium are critical elements used in the production of PMs for EVs and wind turbines.

For more on PMs, and specifically NdFeB PMs (the leader in the PM market), see Appendix 2.

Figure 40: Rare earth applications overview

End-Use Category	Elements	Description
1. Permanent Magnets	Nd, Pr, Dy, Tb, Sm	Used in the production of high-strength permanent magnets found in mobile phones, laptops, energy-efficient electric motors and generators, etc.
2. Catalysts	La, Ce	Utilized in catalytic converters for gasoline- and diesel-powered vehicles, as well as in fuel cracking catalysts and additives used by oil refiners.
3. Battery Alloys	La, Ce, Pr, Nd	Used in the production of anode materials for nickel-metal hydride (NiMH) batteries, which are found in hybrid vehicles, consumer electronics, cordless tools, and more.
4. Metallurgy and Alloys	La, Ce, Ho, Gd, Y	Rare earth mischmetal is used in steel production and ductile iron making, as well as in the creation of various alloys.
5. Ceramics, Pigments and Glazes	La, Ce, Pr, Nd, Y	Essential in the creation of various ceramics used in applications such as jet engine coatings, dental crowns, ceramic capacitors, ceramic tiles, etc.
6. Phosphors	Ce, La, Y, Tb, Eu	Used in phosphors for energy efficient lamps, display screens and avionics, and as an anti-counterfeit measure in some fiat currencies.
7. Glass Polishing Powders and Additives	Ce, La, Er, Gd, Y	Used for polishing optical glass, hard disk drive platters, LCD display screens, and gemstones. Additionally, cerium is used as an additive in UV-filtering glass and container glass.
8. Other	La, Ce, Nd, Dy, Tb, Gd, Lu, Tm	Used in various other applications in defense, medicine, health, wellness, aerospace, agriculture, high-tech, and chemical industries.

Source: MST.

Product Focus – Heavy Mineral Sands: Production, Market Dynamics and Key Uses

Definition and geology of mineral sands products: zircon-titania – a scientific overview

The mineral sands industry generally consists of two principal product streams: titanium dioxide minerals and zircon.

Titanium dioxide minerals (titania portion of VHM Concentrate)

Titanium dioxide (titania) minerals (most common being ilmenite and rutile, and lesser extent leucoxene) are used mainly as feedstock for the world's titanium dioxide (TiO_2) pigment industry. Ilmenite accounts for 92% of the world's titanium mineral production.

The content of titanium dioxide varies within HM, typically: ilmenite: 45–63% TiO_2; rutile: 90–96%; and leucoxene: 70–91%.

Processing

In most cases, rutile and leucoxene do not require further upgrading due to the already high TiO_2 content, while ilmenite, with its lower TiO_2 content, requires processing to improve the grade. The ilmenite upgrading processes involves sulphate and chloride slag (75–95% TiO_2 content) and synthetic rutile (92–94% TiO_2 content).

Zircon

Zircon is the name given to zirconium silicate ($ZrSiO_4$). In most mineral sand deposits, zircon is present in lower quantities than titanium dioxide, with the historical average ratio between the two mined product streams is in the range of 1:4 to 1:5.

The main categories of zircon products are:

- premium: 66.0% ZrO_2 (zirconia) min: very low impurities
- universal and standard grade: 66.0% and 65% ZrO_2, impurities vary
- zircon in concentrate: 25–50% zircon range.

Processing

Zircon minerals undergo a similar treatment process as titanium feedstocks. Low-grade zircon is upgraded to improve ZrO_2 content and remove impurities. Zircon in concentrate is upgraded to a final product with a grade of around 55–65%ZrO_2.

Market dynamics: pricing, demand and supply

Phase 1 of the Goschen Project will result in the zircon and titania minerals remaining unseparated and contained in the zircon-titania HMC. There is a ready market for mineral concentrates containing zircon and titania minerals. Targeting sales to Chinese concentrate processors, VHM expects a long-term price of US$530 per tonne Free On Board (FOB) (on a real 2022 dollars basis).

Titanium dioxide minerals

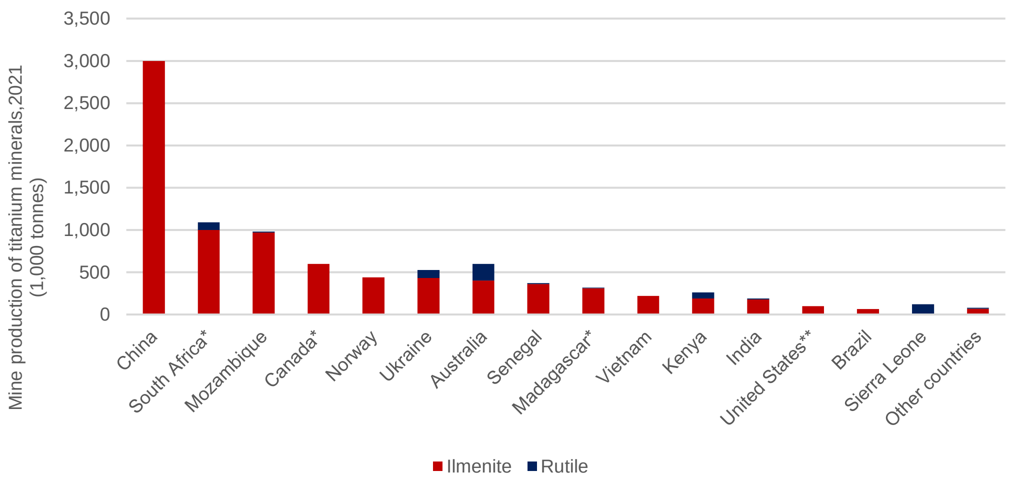
Prices and pricing

Due to a significant contraction in mineral sands pricing over the last ten years, there has been very little investment in new mineral sand deposits. Supply and demand have been relatively balanced historically; however, with the continued deterioration of current reserves and mineral sand grades in existing deposits coupled with no significant mineral sand discoveries (major = 50mt+) in the past 20 years, we forecast upward pressure to pricing in the long term.

Production by country

China is the leading producer and consumer of titanium mineral concentrates, accounting for 33% of the global production of ilmenite and rutile. Mozambique (32%), Australia (14%), and Vietnam (13%) are the leading sources of titanium mineral concentrates in China (see Figure 41).

Figure 41: Global mine production of titanium minerals by country, 2021



Source: MST.

Demand and supply

Per-capita consumption of pigment in developing vs developed countries provides a solid indicator of forecasted demand. For example, paint consumption in India is 0.2 kg per capita and about 2–2.5 kg per capita in Western economies, leaving plenty of room to grow.

We view China's increased pigment consumption per capita in the last 10 years (from 0.5 kg per capita to 1.7 kg in 2022) as providing a solid indicator of expected demand in hyper-growth regions in Asia such as India, Indonesia and South Korea.

Zircon

Prices and pricing

Zircon has two long-term price drivers: supply shortages and increased consumption of tiles in developing countries.

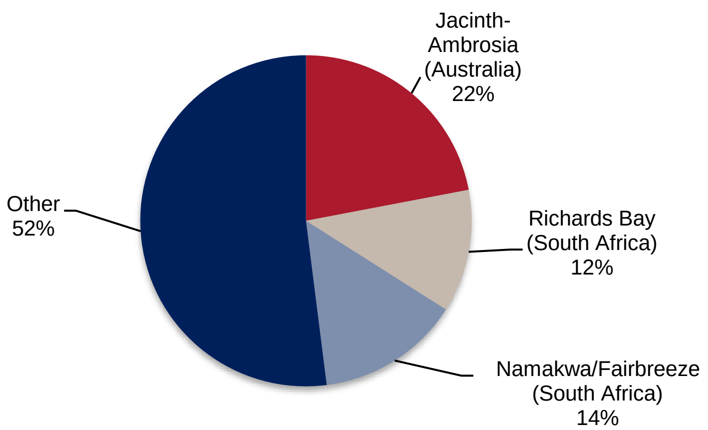
Production by country

Australia has been the world's principal source of zircon since production of mineral sands first started on the country's east coast. However, this production is declining due to depletion of resources and environmental constraints.

Demand and supply

Global zircon supply is concentrated across three mature deposits (see Figure 42). As these mature assets have been depleted, new supply coming online has been very limited, with only a handful of assets being discovered in the last 30 years.

Figure 42: Zircon supply by operation



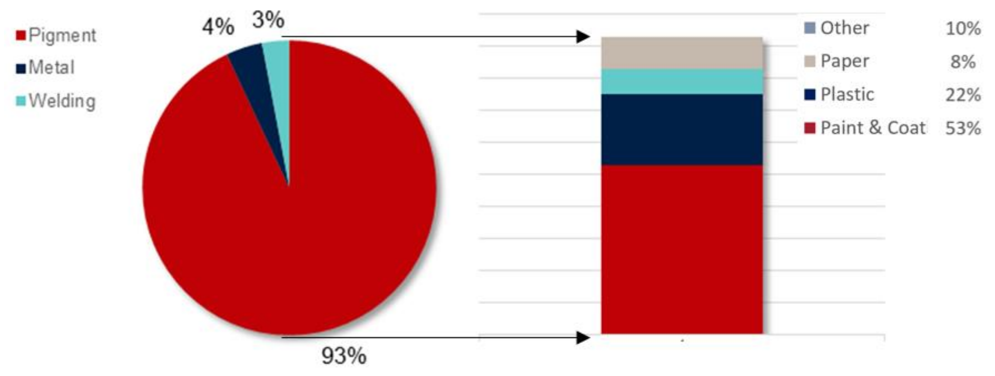
Source: MST.

Exploring the end-uses of heavy mineral sands

Titanium dioxide minerals: application and end-uses

Titanium dioxide feedstock is primarily used as a whitening pigment (~93%) in paints, plastics and paper. The raw minerals are also used in the manufacture of titanium metal (~4%) and welding flux wire cord (3%) (see Figure 43).

Figure 43: Breakdown of titanium dioxide feedstock markets by end-use sector

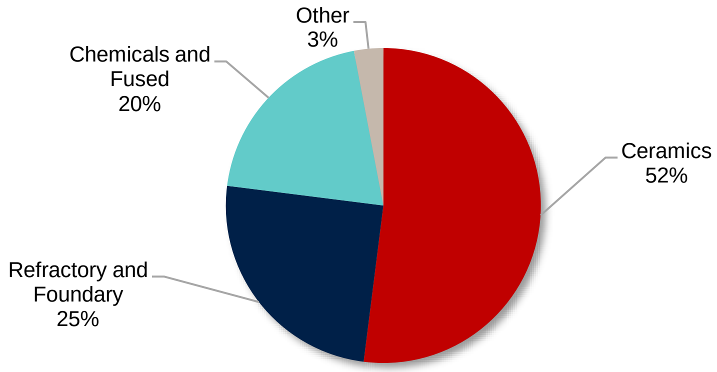


Source: MST.

Zircon: application and end-uses

Zircon is primarily used in the production of ceramic tiles. Other applications include use in refractories and foundry casting and a growing array of specialty applications as zirconia and zirconium chemicals, including in nuclear fuel rods, catalytic fuel converters and water and air purification systems (see Figure 44).

Figure 44: Breakdown of zircon market by end-use sector



Source: MST.

Financing strategy: Multiple Sources Needed

Current status of funding discussions

VHM estimates a capital cost of ~A$607m to build the Goschen Project Phase 1 and 1A (MST estimate A$729m). We forecast capital will be secured through a combination of debt and equity (50/50 split debt and equity).

As of 30 June 2023, VHM had cash reserves of A$25.852m. With a current burn of approximately A$1.5m/month, VHM is well-funded to move forward with its CY23 and CY24 strategy.

VHM will progress discussions with prospective Australian and international commercial lenders over the course of the rest of 2023, with the objective of securing a substantial project debt facility with financial completion achieved on receipt of all regulatory approvals. VHM will also progress opportunities for available government supported grant and debt funding and export credit funding support at the same time.

VHM will seek to raise the remaining capital through an equity raise at or close to the project FID and finalisation of a committed debt facility.

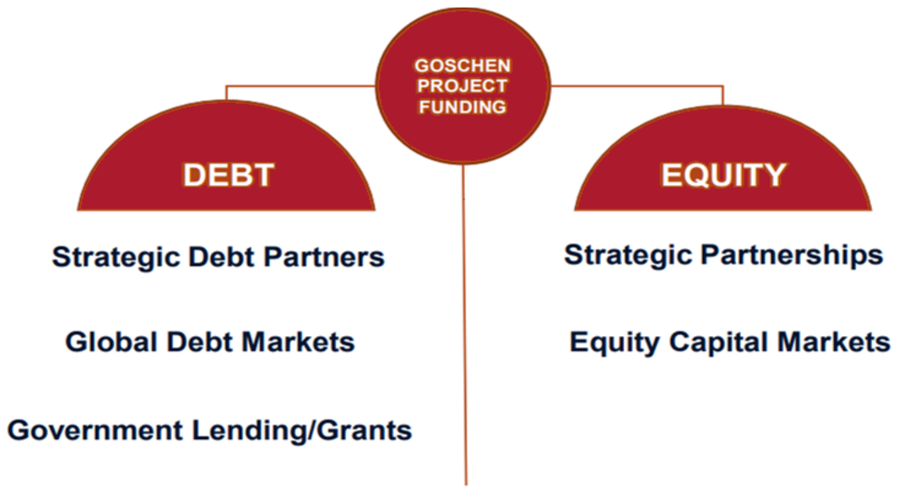
Seeking the best funding mix

VHM is actively exploring a variety of options to secure financing with the goal of achieving the best outcome for shareholders. The options being considered include traditional debt and equity financing, as well as alternative options such as selling offtake rights and divesting a stake at the project level.

High-risk projects of this nature usually raise more capital through equity, as it is cheaper than debt funding which usually commands a very high interest rate and a short payback period. However, the ESG importance of Goschen's products could potentially allow the project access to cheaper funding, which in turn would lower the project's cost of capital and improve its attractiveness from investors' point of view.

We expect the project to attract interest from domestic and international managers of globally substantial volumes of ESG capital, given that the rare earths to be produced by the project are the fundamental building blocks for renewables (particularly EVs and wind farms), as well as the fact that the project has sound financial metrics.

Figure 45: Options for funding the Goschen Project – seeking the best mix



Source: VHM

Governments increasingly interested in critical minerals supply chain investments

Recent news flow highlights governments' growing appetite to invest in critical minerals supply chains:

- April 2022: Iluka receives a $1.05bn debt facility from the Australian Government to build the country's first fully integrated rare earths separation facility. Under the 16-year loan agreement, Iluka will pay interest rates of 3% above the BBSY, with the loan being non-resource to Iluka.
- May 2023: The new Climate, Critical Minerals and Clean Energy Transformation Compact was announced by Australian Prime Minister Anthony Albanese and US President Joe Biden at the G7 meeting in Japan. President Biden offered to give Australian resources companies 'domestic supplier' status under the US$369 bn (A$555 bn) Inflation Reduction Act (IRA). The potential inclusion of Australian resources companies in the IRA could give local projects that wish to join the US supply chain access to more than US$40 bn in cheap loan programs run by the US Department of Energy.

A$1.67/share Blended Valuation; 60% Probability of Strategic Partner and 40% Probability of Funding All of Project

Our base-case risked NPV-based valuation for VHM is A$1.67/share on a fully diluted basis.

Blended risked valuation offers ~3x potential upside

We have arrived at a blended valuation of A$1.67 per share, based on two potential project funding scenarios: a 60% probability of a sale of a stake in the Goschen project to a strategic partner, and a 40% probability of VHM having to fund the project on their own. We have attributed a net asset value (NAV) of A$646m compared with the current market value of ~A$100m.

Scenario 1: Strategic partner buys in (60% weighting in our base case)

Our valuation of VHM based on a strategic partner buying in to the project is A$2.05 per share. We assume under this scenario that VHM sells 40% of the project (retaining 60% and control) and achieves 70% of NPV for the share. VHM's share of the project capital is funded 50% debt and 50% equity and we assume that only ~A$37m of equity is raised at a 25% premium to the current share price (assuming that progressing project approvals, confirming a strategic partner, and progressing debt financing will de-risk development of the project and drive an increase to the share price). We have probability risked-weighted our project valuation in this scenario at 85%.

Scenario 2: VHM funds project on its own (40% weighting in our base case)

Our valuation in the event of VHM fully funding the project on their own is A$1.09 per share. Under this scenario the full cost of the project is funded 50% debt and 50% equity, and we assume that A$363m of equity is raised at a 25% premium to the current share price (again, assuming that progressing project approvals and progressing debt financing will drive an increase to the share price). We have probability risked this valuation at 70% to reflect the increased risk of financing and executing the project independently.

Our un-risked, pre-funding valuation based on the current capital base implies A$3.10/share.

Our valuation scenarios exclude any potential upside from exploration and does not consider potential upside from building Phase 2 of the project, with our modelling and forecasts only taking Phase 1 and 1A into consideration. We believe Rare Earths are under-appreciated with strong structural tailwinds, and we see the potential for tight medium-term fundamentals in the Rare Earth market.

Figure 46: Valuation assuming a sell-down of 40% of project (forming 60% of our Blended Valuation)

VHM				Jun-24
Sell-down valuation	**Discount rate**	**Risk weighting**	**AUD$mn**	**AUD$/sh**
Goschen (60%)	10.0%	**85.0%**	329	1.28
Total operating assets			**329**	**1.28**
Corporate/SG&A			(30)	(0.12)
Net cash/(debt) ($AUD)			47	0.18
Goschen sale proceeds			181	0.70
Net Asset Value			**527**	**2.05**
Current Share Price				0.56
Upside				269%

Financing	
Capex Phase 1/1a (70%)	436.3
Debt	50%
Total Debt	218.2
I/R	12.0%
Equity	50%
Equity Raised	37.4
Issue Price (25% premium)	0.694
Shares Issued	53.9

Source: MST

Figure 47: Valuation assuming Goschen project is fully funded by VHM (20% of our Blended Valuation)

VHM				Jun-24
Diluted post-funding valuation	**Discount rate**	**Risk weighting**	**AUD$mn**	**AUD$/sh**
Goschen (100%)	10.0%	70.0%	452	0.62
Total operating assets			**452**	**0.62**
Corporate/SG&A			(30)	(0.04)
Net cash/(debt) ($AUD)			373	0.51
Net Asset Value			**795**	**1.09**
Current Share Price				0.56
Upside				97%

Financing	
Capex Phase 1/1a	727.2
Debt	50%
Total Debt	363.6
I/R	12.0%
Equity	50%
Equity Raised	363.6
Issue Price (25% premium)	**0.694**
Shares Issued	524.1

Source: MST

Un-risked pre-funding valuation A$3.10/share

Our valuation of the project on an un-risked, pre-funding basis is A$646m (A$630m post corporate outflows and cash) equating to A$3.10/share based on VHM's current capital base. This includes our more conservative forecasts around capex and opex. The pre-funding valuation demonstrates a standalone value that any potential strategic partner may consider in its assessment of the project.

Figure 48: Unrisked pre-funding valuation summary

Pre-construction undiluted unrisked valuation	A$m	A$/sh
Goschen (100%)	**646**	3.18
Corporate/SG&A	-30	(0.15)
Net cash/(debt) ($AUD)	14	0.07
Total Valuation	**630**	**$3.10**

Source: MST estimates.

Key assumptions

Our base-case NPV valuation is built upon a mine plan which largely aligns with the March 2023 DFS Refresh. Our capital cost and operating cost assumptions are ~20% higher than those presented in the DFS. Critical assumptions are shown in Figure 49.

We have used a 10% discount rate (real) and assumed A$727m for Phase 1 and 1A (versus A$607m in the DFS) in initial development capital. Our received basket price (avg. initial 10 years) of US$30.5/kg is post payability assumptions from the REMC and MREC, and reflective of improving underlying separated rare earth oxide pricing as per market expert analysis. We assume project construction commences in mid-2024, with first production for Phase 1 in mid-2025 after a ~12-month construction period. We assume a further ~12 months of construction for Phase 1A first production.

We assume the project will be funded by 50%/50% debt/equity (at a 70c issue price). Importantly, our valuation does not incorporate the benefit of any additional potential project expansions.

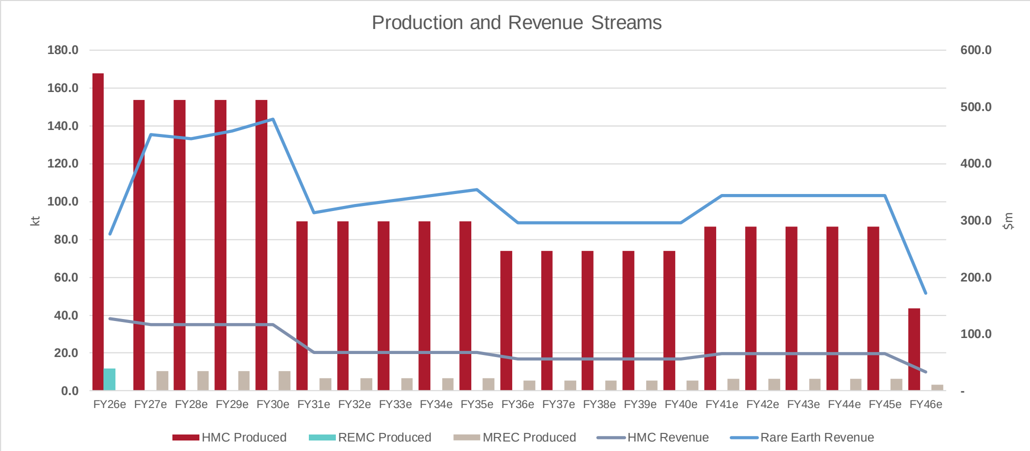
Figure 49: Base-case valuation assumptions

Assumptions	MST
PROJECT ASSUMPTIONS	
Project Ownership (%)	100%
Strip Ratio (waste : ore)	2.6
Ore Reserve Grade (% THM)	3.70%
Ore Reserve Grade (% TREO)	2.45%
Average Material Mined (Mtpa)	12.4
Average Ore Mined (Mtpa)	4.7
Mine Life (years)	20.5
Development Capex (A$m) (Real 2023 $)	727
Debt to equity	50:50
Ore Reserve (kt)	7,352
COST & FINANCING ASSUMPTIONS	
Discount Rate Real (%)	10.0%
Inflation Rate (%)	2.5%
Debt interest rate	12.0%
Share price for Equity raising (A$/share)	0.58
PRICING & EXCHANGE RATE ASSUMPTIONS	
AUDUSD	0.70
LT NdPr Price (Real) (US$/kg) - from 2035	247
Received Basket Price (US$/kg) - Average first 10 years	30.5
Royalty Rate (%)	2.75%
Corporate Tax Rate (%)	30%

Source: MST estimates.

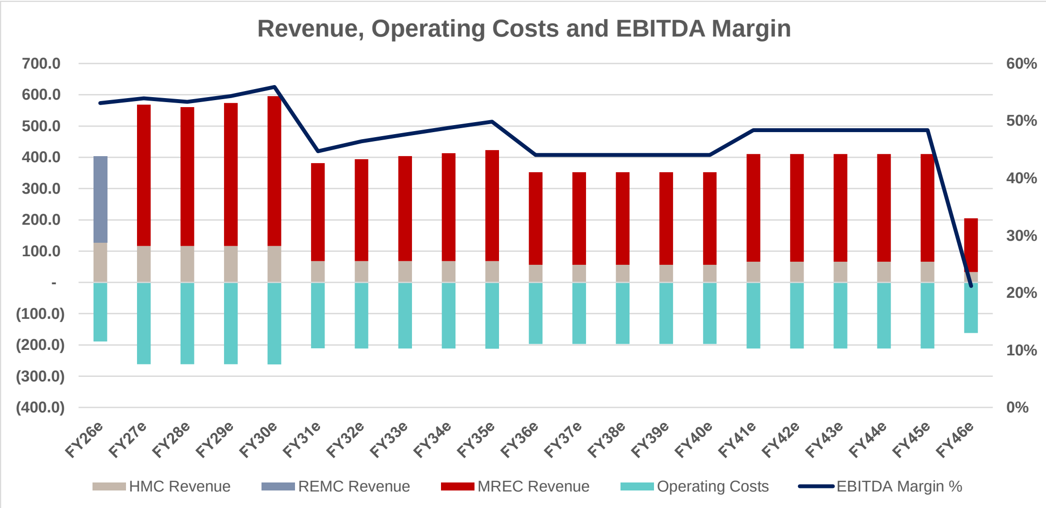
Production, revenue stream and EBITDA forecasts

Figure 50: Production and Revenue Streams



Source: MST estimates.

Figure 51: Revenue, operating costs and EBITDA margin forecasts (100% basis)

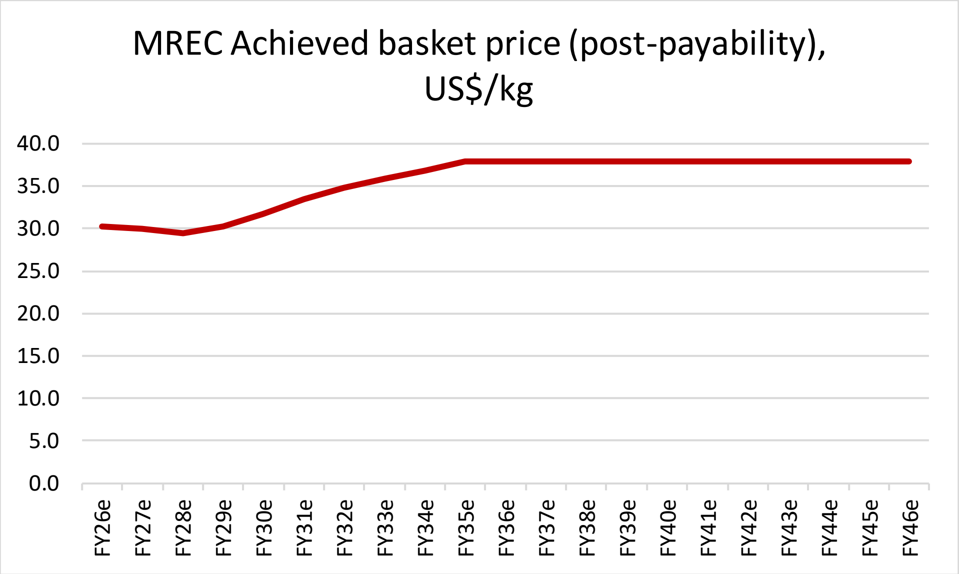


Source: MST Estimates

Pricing forecasts

Our pricing assumptions for VHM's received price for MREC sales from Goschen Project are shown in Figure 52. The increase in basket price value over the time is driven in turn by forecast increases in the underlying valuable REEs particularly (NdPr, Dy, Tb). We use a flat price of US$530/t achieved for the HMC. VHM could see significant upside from higher RE and HM Prices than those that underpin our assumptions.

Figure 52: Forecasted price for MREC – real 2023 $

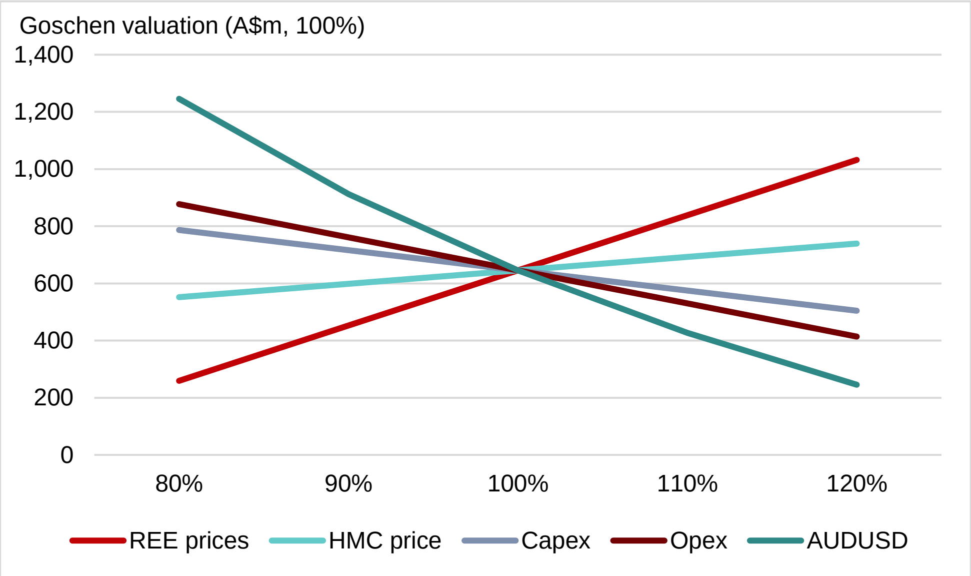


Source: MST estimates.

Key sensitivities

As shown in Figure 53, our valuation is most sensitive to assumptions on the REE price and to a lesser extent the AUD/USD exchange rate.

Figure 53: Key project sensitivities



Source: MST.

Capex (MST estimates v VHM)

We have taken a conservative approach in forecasting pre-development capital costs. While VHM's DFS anticipates a figure of A$607m, we have projected an increase of 20% in capital costs given the extremely tight conditions in the Australian mining industry and global equipment inflation, therefore estimating a cost for Phase 1 and 1A of A$727m (see Figure 54).

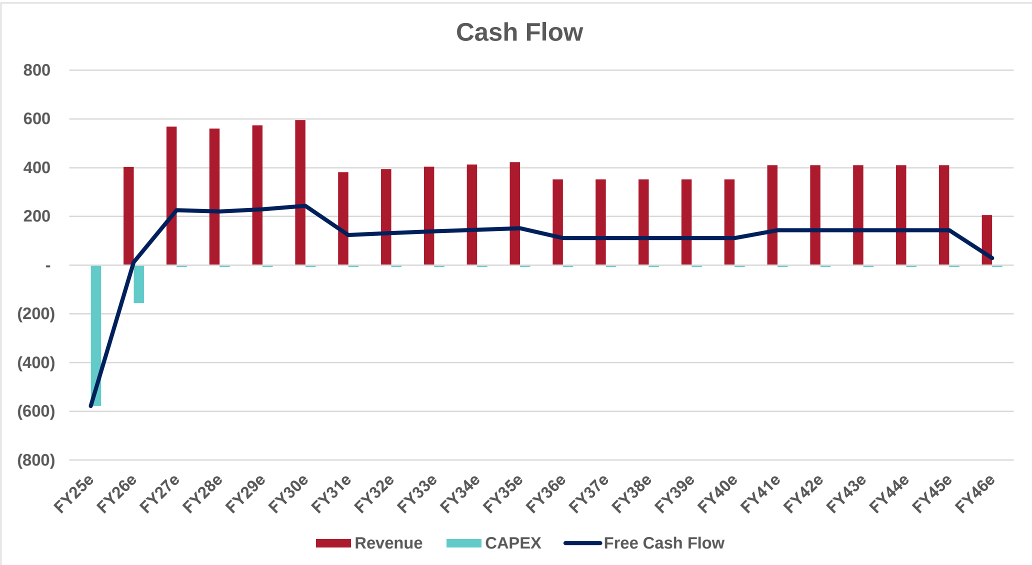
Figure 54: MST vs VHM's estimated project pre-development capex for Goschen Project

Description	Total (A$m) VHM	Total (A$m) MST
Directs	234.3	281.2
Earthworks	65.1	78.1
Civil/concrete	12.2	14.6
Buildings and NPI	8.4	10.1
Structural steel	22.2	26.6
Platework	7.8	9.4
Process and mechanical equipment	43.5	52.2
Piping and valves	48.9	58.7
Electrical, controls and instrumentation	20.9	25.1
Spares and first fills	2.6	3.1
Mobile equipment	2.5	3.0
Indirect	77.6	93.1
Engineering Services, Contractors & Expenses	72.9	87.5
Owner's Costs (labour, expenses & insurances)	4.6	5.5
Total capex (excluding line item contingency)	407.9	489.5
Value of line item contigency	47.0	56.4
Total capex (including line item contingency)	455.0	546.0
Value of Project contingency	28.0	33.6
Total capex Phase 1 (including Project contingency)	**483.1**	**579.7**
Capex Phase 1A	**124.0**	**147.5**
Total Capex Phase 1 and 1A	**607.1**	**727.2**

Source: VHM, MST.

Capex and free cash flow (MST estimates)

Figure 55: MST forecast revenue, capex and free cash flow (100% basis)



Source: MST.

Positive catalysts for share price and valuation

Finalisation of Approvals: Approvals are required prior to any construction going ahead. Victoria's approval system is difficult and slow, so finalisation of approvals will be a strong catalyst for the stock.

Finalisation of Offtake with Shenghe: Binding offtake agreements are key to underpinning projects such as Goschen and increasing funding options. The finalisation of the Shenghe offtake and any other offtake agreements would be a positive catalyst for the stock.

Funding of project: Securing capex for major resource developments is a challenge for small companies; thus, a competitive funding package would significantly de-risk the project.

Exploration upside: Discovering economical deposits of heavy rare earths, fluorspar, niobium, or phosphate at Goschen could greatly enhance its value. Such discoveries would diversify revenue and position the project favourably in a high-demand market, ensuring strong returns for investors.

Asset Sell-Down: Selling a stake in the project to finance its development will mitigate construction risks and minimise dilution.

Other potential share price catalysts:

- **Resource growth**: Drilling at Goschen is being undertaken. An increase in resource would be positive.
- **Price increases:** The valuation is highly sensitive to NdPr prices. Increases in the price of NdPr oxide would positively affect the valuation.

Risks to share price and valuation

We outline the key risks to the share price and valuation below, noting that early-stage mining projects have various critical risks.

Company-and project-specific risks:

- **Approvals –** the key short-term risk is approvals. The Victorian approval process is long and complex and there are risks that approvals will be delayed or not achieved.
- **Offtake Agreements:** Delays or cancellation of offtajke agreement puts at risk sales of product and funding of the project.
- **Access to funding**: The availability of funding for the project is not guaranteed. A lack of sufficient funding could have a negative impact on the stock.
- **Delays to development**: Any delays in moving into construction, post-funding, would be a negative for the stock and would gradually make the information from the BFS less current and thus less reliable.
- **Cost inflation** is a global theme and is particularly concerning in the mining industry. If operational or capital costs increase without a corresponding increase in the commodity price, the project's margins will be reduced, which could impact the economics and viability.
- **Supplying to China**: Tensions between China and other countries could lead to trade embargoes or other restrictions, potentially impacting the VHM's ability to sell its refined products internationally.

Macro risks:

- Rare earth oxide price – this is the key valuation sensitivity
- Foreign exchange rates
- Increasing interest rates and the potential impact on the cost of debt finance

Board of Directors and Management

Ian Smith (Non-Executive Chairman), appointed in August 2023, is an experienced executive and professional director with more than 40 years' work and leadership history at domestic and international mining and mining services companies. He has held some of the most senior positions in Australian resources, including MD and CEO at both Orica and Newcrest Mining, and was instrumental in transforming Newcrest into Australia's largest gold mining company and one of the world's largest gold operators. He has also held senior and executive positions with Rio Tinto, WMC Resources, CRA Limited and Pasminco. He previously served on the boards of Australian Mines & Metals Association and Australian Chamber of Commerce & Industry, and as the Chairman of the Minerals Council of Australia.

Ron Douglas (Executive Director, Interim CEO) was appointed to the board in August 2023 and as Executive Director and Interim CEO effective 1 October 2023. He has extensive experience from a range of both executive and operations roles in 40 years working with publicly listed global mining, energy, and manufacturing companies. He brings valuable construction experience and international operations and compliance knowledge, having worked in the Americas, West Africa, UK, Netherlands, and Australasia and having been responsible for multiple major projects at mining and engineering/construction companies. He has held board positions at publicly listed Rex Minerals, Talbot Group Investments and Highlands Pacific, and has experience in capital program delivery and corporate transaction negotiations.

Maree Arnason (Non-Executive Director) has over 35 years' experience in natural resources, energy and manufacturing with roles at BHP Billiton, Carter Holt Harvey, Svenska Cellulosa AB and Wesfarmers. She has worked across many commodities and has expertise in governance, strategy, sustainability, risk, corporate affairs, divestments and integrations. Ms Arnason is a non-executive director of ASX-200 Gold Road Resources and Chair of its Risk and ESG Committee; a non-executive director of Ardea Resources and a Co-founder and Director of Energy Access Services. She is Chair of Juniper, one of WA's largest aged care community benefit organisations. She has a Bachelor of Arts (Deakin University), is a Fellow of the Australian Institute of Company Directors, a member of AICD's Corporate Governance Committee, an AICD WA Division Councillor, and serves on ASIC's Corporate Governance Consultative Panel.

Graham Howard (Non-Executive Director) started as MD at VHM in 2016 and effective October 2023 transitions to Non-Executive Director. He holds a Bachelor of Science in Geology (University of Canberra, Distinguished Alumni) and is a Fellow of the Australasian Institute of Mining and Metallurgy. His 30+ year career, largely in executive leadership and senior operational management, has provided comprehensive corporate and operations experience and a track record of identifying and delivering multi-billion-dollar resource projects. He served as CEO of ASX-listed Mount Magnet South NL in 2011–2013. He has had key roles in large-scale projects at Newcrest, Telfer (from concept through feasibility, to construction and operations), Boddington (Newcrest), and the Silangan Copper Gold Project (Philippines).

Don Runge (Non-Executive Director) joined the Board in 2017, becoming Chairman in July 2021. He has extensive knowledge of various aspects of the industry from four decades in the mining sector, including operational, project, and construction management. Mr Runge has a particular skillset in feasibility studies, development, construction, and effectively managing both surface and underground mining and processing operations. His leadership abilities have been recognised in his senior managerial positions at Peko Wallsend, Newcrest Mining, North Ltd, and the Silangan Copper Gold Project.

Michael Sheridan (Deputy CEO, CFO) joined VHM as CFO in 2021. He holds a Bachelor of Economics and Laws and a Master of Laws (University of Sydney) and a Graduate Diploma in Applied Finance and Investment (FINSIA/Securities Institute) and completed a Practical Legal Training Course (College of Law, NSW). He has over 25 years of experience in Australian and international resources, including mining, oil & gas, telecommunications, and corporate advisory services. He has held senior management positions in public companies, including CEO and MD of Horizon Oil Limited (ASX:HXN), Executive Assistant to the President of Minera Alumbrera Limited (Argentina), Commercial Manager for RGC Limited (Peru), and Commercial Manager, International Ampolex Limited.

Carly O'Regan (Executive General Manager, Strategy and Corporate Affairs) joined VHM in 2018. As an executive with experience at listed resources and energy companies, she has worked for global Tier-1 producers throughout the asset lifecycle and several capital raises. She has been on both the listed company and investment management sides of the market and has broad commodity experience. Ms O'Regan has held positions in Australia and the UK for Barclays Global Investors (iShares), Chevron Australia, KPMG, Newcrest, and Shell Australia. She has a wealth of business and operational expertise in finance, commercial ventures, mining, and oil & gas, both in Australia and internationally.

Bernie Hyde (Executive General Manager, Operational Readiness) joined VHM in November 2022. He has spent 40+ years in the mining industry, with 25+ years supervisory & management experience in operations and maintenance roles. He has experience in brown coal, black coal, gold, copper and nickel mining and processing at various operations around Australia. He has chaired the Minerals Council of Australia's (MCA) Victorian Safety & Health Working Group for 15+ years.

ESG: Building a Strong Culture of Sustainability

VHM has a strong commitment to environmental, social and governance (ESG) policies and understands that implementing best practice in these areas helps to mitigate risks for the company.

Environment

Rehabilitation

Back-filling of the mined-out areas will occur in a staged manner to allow overburden and topsoil placement in a profile that reinstates the original soil structure. This will return the land to a condition suitable for agriculture within three years of mining.

Water

Water will be required for construction earthworks, processing, dust suppression and rehabilitation. Up to 4.5 gigalitres per annum (Gl/a) of water will be needed for the start-up (12 months), reduced to nominally 3.2 Gl/a thereafter. Water will be sourced from Kangaroo Lake and purchased from Goulburn–Murray Water through the open water market. The water will be delivered to the site via a 38-km underground pipeline to be constructed beneath existing local road easements. The current capacity of the Kangaroo Lake water supply is more than 500Gl/a. The project's water requirements will not place any constraints on availability for existing or future agricultural activities.

Power

Electrical power requirements for mining and processing will be initially met on-site from diesel generators. As soon as practicable, VHM plans to pursue a renewable energy solution to transition Goschen away from diesel generation.

Social

Local community

VHM is implementing a Community and Stakeholder Engagement Plan, which outlines its commitment to establishing long-term, beneficial stakeholder and community relationships. VHM has established working relationships, and communicated about the project, with local, state, and federal government agencies, First Nations peoples, the rural water authority, landholders, and the catchment management authority. VHM is consulting with local Aboriginal Australian communities and Traditional Owners (the Wamba Wemba and Barapa Barapa peoples) and will continue to engage relevant stakeholders and the community. A community benefit program is under development that consists of community sponsorship, grants, training, scholarships, local jobs, and procurement. Community and landowner consultations will inform the program to ensure it is tailored to the community's needs and aspirations.

Governance

VHM has adopted the *Corporate Governance Principles and Recommendations* as published by ASX Corporate Governance Council. Some points regarding the Board to note:

- The Board's qualifications are appropriate for the business.
- The Board has 5 members, 3 of whom we consider independent and of whom are executive / former executive – thus satisfying the ASX guidelines of a Board that is 50% independent.
- The Board has adopted a remuneration structure, risk assessment and policies that are predominantly in line with market practices. The Board has separate risk, nomination, remuneration and audit committees.

Board of Directors

The 5-director Board is responsible for the corporate governance of VHM, developing the company's strategies, reviewing strategic objectives and monitoring the company's performance with respect to these objectives. The specific goals and responsibilities of the Board are outlined in VHM's Corporate Governance Statement.

The Board maintains a Board Skills Matrix to ensure that the Board has the skills to discharge its obligations effectively. The members of the Board have many years of experience in the minerals industry and a strong complementary range of technical, financial, managerial and directorship skills.

Figure 56: Directors Skills and Attributes

Experience Skills and Attributes	Directors				
	Don Runge	Ian Smith	Maree Arnason	Graham Howard	Ron Douglas
Professional and Tertiary Skills					
Geology	✓	✓		✓	✓
Engineering	✓	✓		✓	✓
Commerce and Business	✓	✓	✓	✓	✓
Law			✓		
Financial/Accounting and Governance		✓	✓		
Member of professional body in field of expertise	✓	✓	✓	✓	✓
Industry Experience:					
Resource industry (resources, mining, exploration)	✓	✓	✓	✓	✓
Risk management and compliance	✓	✓	✓	✓	✓
Corporate Governance	✓	✓	✓	✓	✓
Capital raising	✓	✓	✓	✓	✓
Financial acumen	✓	✓	✓	✓	✓
Safety, environment and community relations	✓	✓	✓	✓	✓
Strategy	✓	✓	✓	✓	✓
Leadership	✓	✓	✓	✓	✓

Source: VHM MST

Appendix 1: History of the REE Industry – and How China Became the Largest Producer

Up to the 1960s: discovery and the beginnings of the REE industry

The term *rare earth* was coined in 1788 when a miner unearthed an unusual black rock in Ytterby, Sweden. The ore was called 'rare' because it had never been seen before and 'earth' because that was the 18th-century geological term for rocks that could be dissolved in acid. The rare earth industry began to grow in the early 1960s, when it was discovered that the element europium (Eu) gave an intense red luminescence when exited by electrons – a discovery very quickly used in the development of colour TVs.

1980s–1990s: how China became the dominant player in rare earths

Deng Xiaoping was the architect behind China's dominance of rare earth mining and processing. In a 1992 speech, he said, 'The Middle East has oil. China has rare earth metals.'

In the 1980s, China kicked off two innovative programs in science and technology, accelerating the country's high-tech development. In March 1986, Deng Xiaoping (China's leader at the time) approved Program 863: The National High Technology Research and Development Program, which focuses on biotechnology, space technology, information technology, laser technology, automation, energy technology, and new materials. A very important researcher was Professor Xu Guangxian (1920–2015). Xu is called 'the father of rare earths in China' (*Peking University News*) and is credited with paving the way for the country to become the world's primary exporter of rare earth elements (REEs). Xu applied his previous research in extracting isotopes of uranium to rare-earth extraction and succeeded in developing cutting-edge REE extraction technologies.

As REEs were materials that could provide China with both high profits and geopolitical influence, China focused in the 1980s and 1990s on becoming a world leader in their production. China increased production of REEs by an average of 40% per year in 1978–1989 (Chinese companies profited from a combination of low labour costs and lax environmental regulations relative to the United States. In the 1990s, China's export of REEs grew, causing a significant world-wide drop in prices. The Mountain Pass mine (a rare earths mine in California which was the largest rare earth mine in the world) struggled to remain competitive, and slowly began to curtail production as a result.

2009–today: the REE crisis and global efforts to catch up with China

A trade war between China and the US in 2009–2013 illustrates what potentially lies ahead if the West fails to allocate capital to the REE industry. In 2007, China limited the export of rare earths in order to retain them for the domestic market. This was achieved by raising export duties, which were originally at 10%. Duties were raised to 25% in 2011 for ferro-alloys containing more than 10% REEs. Overall, this resulted in a large drop in China's rare earth exports and hence a strong rise in REE prices. For example, the price of rare earth neodymium – a necessity for a range of products including headphones and EVs – climbed from $42/kg in 2009 to $283/kg in 2011.

China still maintains its monopoly in the REE industry. Despite the term 'rare,' rare earths are abundant in the earth's crust – the difficult part is separating the contained elements and producing a separated oxide. China's IP in this area is extremely valuable, as other countries have not made much progress in this regard, with rare earths having contributed very little to economies outside of China for the past 30 years. However, Western economies are now desperate to establish a position in the rare earths market, as separated rare earths are critical for decarbonisation and other industries such as defence. Lynas is the most advanced rare earths player (with a separations facility in Malaysia), followed by Iluka (currently building a rare earths refining facility in Western Australia). Mountain Pass has begun producing again after being acquired by MP Materials in 2017; the mine is producing a concentrate that is then shipped to China for further processing and refining. MP Materials is developing a refining plant to produce separated rare earth oxides.

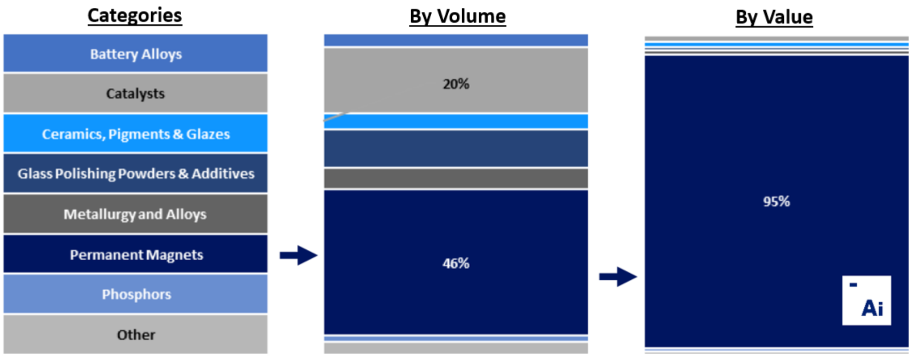
The rare earth industry requires significant capital investment in order for the West to build a commanding position in the market. Competing with China (which controls supply and prices and has limited environmental restrictions) will make it difficult for new entrants. New greenfield projects are seeing significant capex blowouts: for example, Hastings Technology Metals recently reported a +40% revision of its capex budget (A$948m) for its Yangibana project. While raising capital from investors will remain difficult due to China's stranglehold on the market, we expect that governments will intervene and offer cheap debt to prospective projects, given the likely poor effect on global economies from the continuation of the current concentrated rare earths supply.

Appendix 2: A closer look at Permanent Magnets

PMs the key use of REEs – and growing

As discussed in the REEs Product Focus chapter, permanent magnets (PMs) are the key end-use for REEs, with the share of PMs in this market only set to grow further (see Figure 57).

Figure 57: Permanent magnets the largest demand drivers of rare earth elements



Source: Adamas.

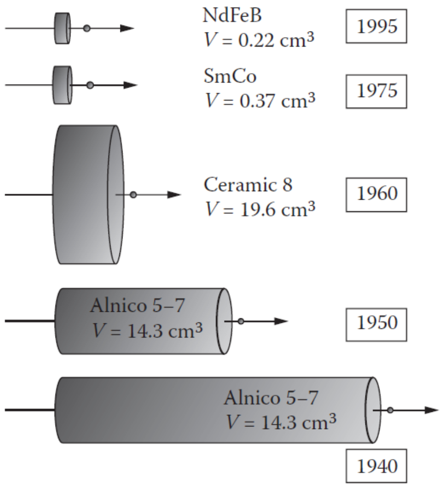
A closer look at NdFeB PMs

Neodymium-iron-boron (NdFeB) is the market leader in the PM market. NdFeB, a PM alloy that was developed and commercialised in the 1980s, has largely replaced alternative PM types including ceramic (ferrite), AlNiCo (aluminium nickel cobalt) and samarium cobalt (SmCo) magnets.

NdFeB alloy is predominately comprised of NdPr, iron and boron with minor concentrations of aluminium, niobium and dysprosium. Compared to other permanent magnets, NdFeB magnets offer substantially stronger magnetic fields per volume, which make them suitable for high-performance products with compact designs. The high strength-to-weight ratio of NdFeB magnets facilitates the miniaturisation of electric motor systems and is the preferred solution when it comes to the trade-off between weight and performance.

In the EV, two main types of motors are in commercial use today: permanent magnet motors (PMMs) and induction motors (IMs). According to Adamas Intelligence, PM traction motors are the most power-dense EV motor available today in terms of kW/kg and/or kW/cm^3, and can be up to 15% more efficient. Importantly, although a permanent magnet motor is more expensive than an alternative induction motor (IM), the weight and volume savings from its greater power density results in lower battery requirements that, at current prices, more than offset the motor's higher cost.

Figure 58: Relative magnet volume for the same magnet energy



Source: Industry

Figure 59: NdFeB composition

Main Elements within NdFeB	Weight Percentage (%)
Neodymium & Praseodymium (75%Nd 25%Pr)	29%-32%
Iron (Fe)	64.2% - 68.5%
Boron (B)	1.0% - 1.2%
Aluminium (Al)	0.2% - 0.4%
Niobium (Nb)	0.5% - 1%
Dysprosium (Dy)	0.8% - 1.2%

Source: Industry

Methodology & Disclosures

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