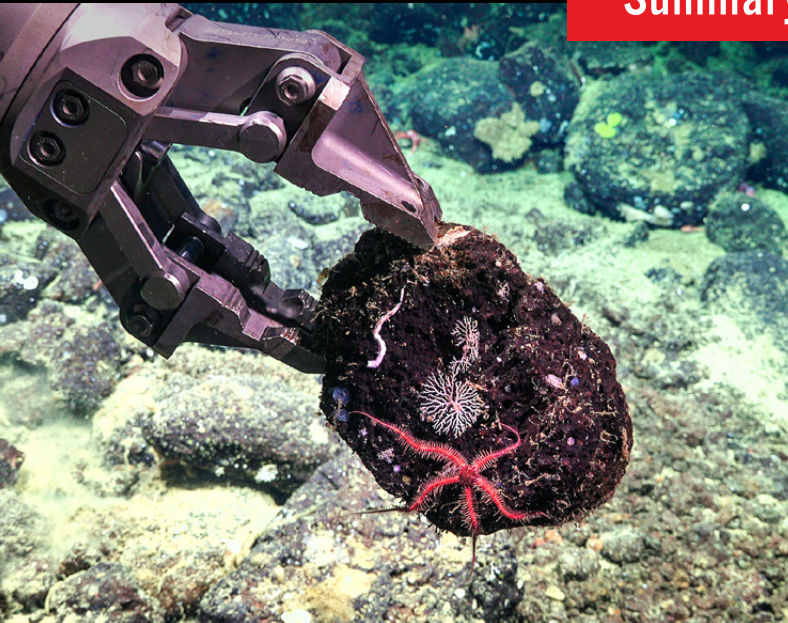


A FINANCIAL VIABILITY REASSESSMENT OF DEEP-SEA MINING UNDER REALISTIC COST AND PRICE ASSUMPTIONS

Summary briefing



deepsea
conservationcoalition

DSMC
Deep Sea Mining Campaign

EJF ENVIRONMENTAL
JUSTICE
FOUNDATION

Background

This briefing summarises the findings of an analysis commissioned by the Environmental Justice Foundation (EJF), the Deep Sea Conservation Coalition (DSCC) and the Deep Sea Mining Campaign (DSMC) to examine the financial viability of deep-sea mining (DSM) under realistic cost and price assumptions.

The analysis presented here shows that the financial projections in the Pre-Feasibility Study (PFS) for The Metals Company's (TMC) proposed NORI-D deep-sea mining project are overly optimistic to the point of not being credible. The Likely and Conservative Scenarios point to a loss-making endeavour, with a rate of return far below what is required given the risk of investing in the project.

We further note additional legal and political hurdles, together with market constraints, each of which compounds and multiplies the risks to investment.

As a case study, the analysis uses The Metals Company's (TMC) proposed NORI-D DSM project, which envisages the extraction of polymetallic nodules containing manganese, nickel, copper and cobalt from the Clarion Clipperton Zone (CCZ), an abyssal plain in the Pacific Ocean. TMC published an Initial Assessment (IA) of the mineral resources in the NORI-D area in 2021¹, and a more detailed technical/economic analysis in a Pre-Feasibility Study (PFS) in July 2025². This followed the completion of test mining in the NORI-D area in 2022.³

The International Seabed Authority (ISA) has granted Nauru Ocean Resources Inc. (NORI), a subsidiary of TMC, a contract for mineral exploration in the CCZ,⁴

but has yet to finalise the regulatory framework for issuing exploitation permits that would allow commercial mining to begin. In 2025, TMC's US subsidiary applied to the US National Oceanic and Atmospheric Administration (NOAA) for a commercial recovery permit for mining in international waters under the US Deep Seabed Hard Mineral Resources Act (DSHMRA), effectively bypassing the ISA.⁵ The US is not a party to the United Nations Convention on the Law of the Sea (UNCLOS) and attends the ISA only as an observer. Many States and observers, as well as the ISA Secretary-General,⁶ consider such unilateral action to be inconsistent with international law.

Aim of study

Deep-sea mining has never been undertaken commercially and few studies exist on the economics of the industry. This study examines the financial viability of the NORI-D DSM project under realistic or more adverse cost and price assumptions, to help inform future decision-making. This is particularly timely given that NOAA is currently reviewing TMC USA's consolidated application for an exploration licence and commercial recovery permit under the DSHMRA. Our findings raise material questions that regulators, investors and other stakeholders should weigh as that process moves toward a decision.



Polymetallic nodules are found at the bottom of the oceans, in the so-called "abyssal" depths, between 4,000 and 5,000 metres deep. Credit: Ifremer (CC BY 4.0)

Methodology

The consultant developed a financial model for the NORI-D project, using the same model inputs (e.g. extraction rates, projected metal prices, capital and operating costs) as set out in the 2025 PFS. The model outputs (total revenue, total cost, Net Present Value – NPV, etc.) were then verified against the corresponding outputs in the PFS to determine the validity of the model and its mechanics.

A number of inputs from the PFS were then adjusted to create a Likely Scenario and a Conservative Scenario.

- The **Likely Scenario** adjusted inputs to more realistic figures based on the scientific literature and neutral price/cost-related projections (based on historical averages or average benchmarks, where possible).
- The **Conservative Scenario** made additional adjustments to the Likely Scenario, reflecting risks considered to be credible, material and plausible, but not necessarily probable. Price or cost-related projections were based on historical lower quartiles or downside prices or costs, where possible.

The key financial indicators were compared for the proposed NORI-D DSM project under each scenario.

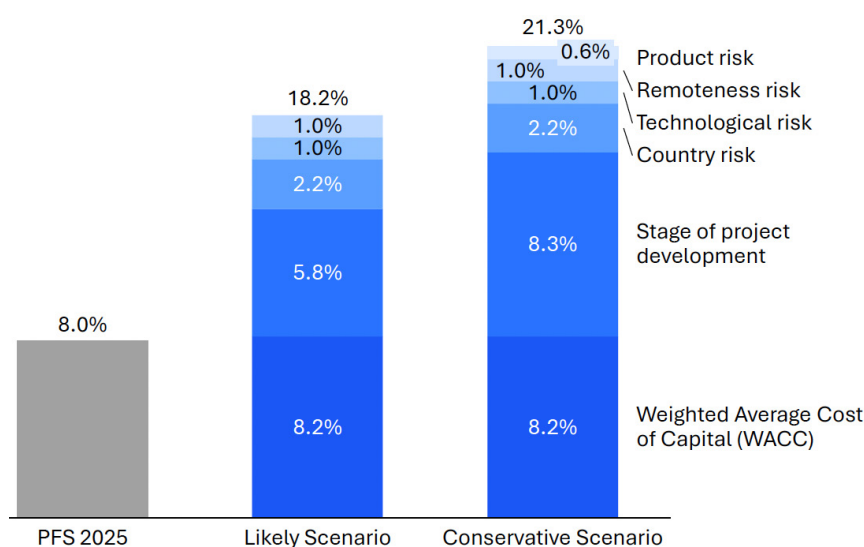
Key assumptions

The following section explains the rationale for the key adjustments to model inputs in the Likely and Conservative Scenarios compared to the inputs in the PFS. Links to the full analysis and financial model, with details of adjustments made to all model inputs and justifications, are available [here](#) and [here](#). See also **Appendix** for a summary of adjustments made in each scenario.

Discount rate

Any project that generates future cash flows carries some risk: the chance that those cash flows turn out lower than expected, or do not materialise at all. To account for this, future cash flows are “discounted”, i.e. reduced by a certain percentage (the discount rate) each year to express their value to an investor today. The discount rate is therefore a modelling input that should reflect the return required by investors for committing capital to the project. This required return is captured by the project’s cost of capital: the return investors demand to compensate them for the risk of investing. A higher risk project will generally have a higher cost of capital and hence a higher discount rate.

Figure 1: Discount rate by scenario, broken down into risk premia



Our modelling suggests a more accurate discount rate would be 18.2% (realistic) and 21.3% (conservative), which would substantially reduce the project’s estimated value in today’s terms.

Notes: The Weighted Average Cost of Capital (WACC) represents the minimum return a company must generate to satisfy both its lenders and shareholders. It blends two financing costs: the cost of debt (interest paid to banks and bondholders) and the cost of equity (the return demanded by shareholders). On top of this we add incremental risk premia for risks specific to this project. The greater those risks, the higher the premia, and the greater the return an investor would demand to take them on.



Pilot nodule collector vehicle designed by Allseas, in partnership with TMC. Credit: Jurvetson (Flickr / CC BY-NC 2.0)

The inherent risks associated with DSM – challenging operating conditions, and novel technology not yet proven at commercial scale – mean investors would typically require a higher return to compensate for the risk that returns are lower than expected, or fail to materialise altogether.

The NORI-D PFS uses an artificially low discount rate of 8% to inflate its Net Present Value. This is lower than that typically applied to land-based mining projects, and roughly comparable to the average discount rate applied across US businesses generally.

In our Likely Scenario, the discount rate is adjusted to 18.2% to reflect the significant risks associated with the NORI-D project.

The NORI-D 2025 PFS applies a discount rate of 8% — implying the project carries less risk than a typical mining company, and comparable risk to an average US business. In the Likely and Conservative Scenarios, the discount rate is adjusted to 18.2% and 21.3% respectively, to reflect the significant risks associated with the NORI-D project. These risk premia reflect factors including the project's early stage of development, the use of technology that remains unproven at commercial scale, and the project's remote location (**Figure 1**). The reliance on manganese for a significant proportion of expected income carries specific risks due, among other things, to the low unit value and abundance of manganese ore relative to demand, opaque pricing, and dependency on steel-making as the main end-use.

Critically, in a departure from standard industry practice, the NORI-D PFS's NPV calculation rests substantially on nodule tonnage that has not yet been classified as mineral reserves. Mineral resources carry a lower level of geological confidence than reserves, and there is no assurance that further exploration or study will result in their conversion to reserves, or that they can be mined economically at all.

As discussed in depth by Emerman (2026), the NORI-D PFS develops a mining plan and economic analysis based on the assumed production of 164.1 million wet metric tonnes of nodules, of which just under a third (51 million wet metric tonnes) has been assigned to the category of mineral reserves.⁷ According to Securities and Exchange Commission (SEC) regulations, as well as regulations in Australia, Canada, Europe and South Africa, only reserves have been demonstrated to be economically mineable and only reserves can serve as the basis for an economically viable mining project.⁸

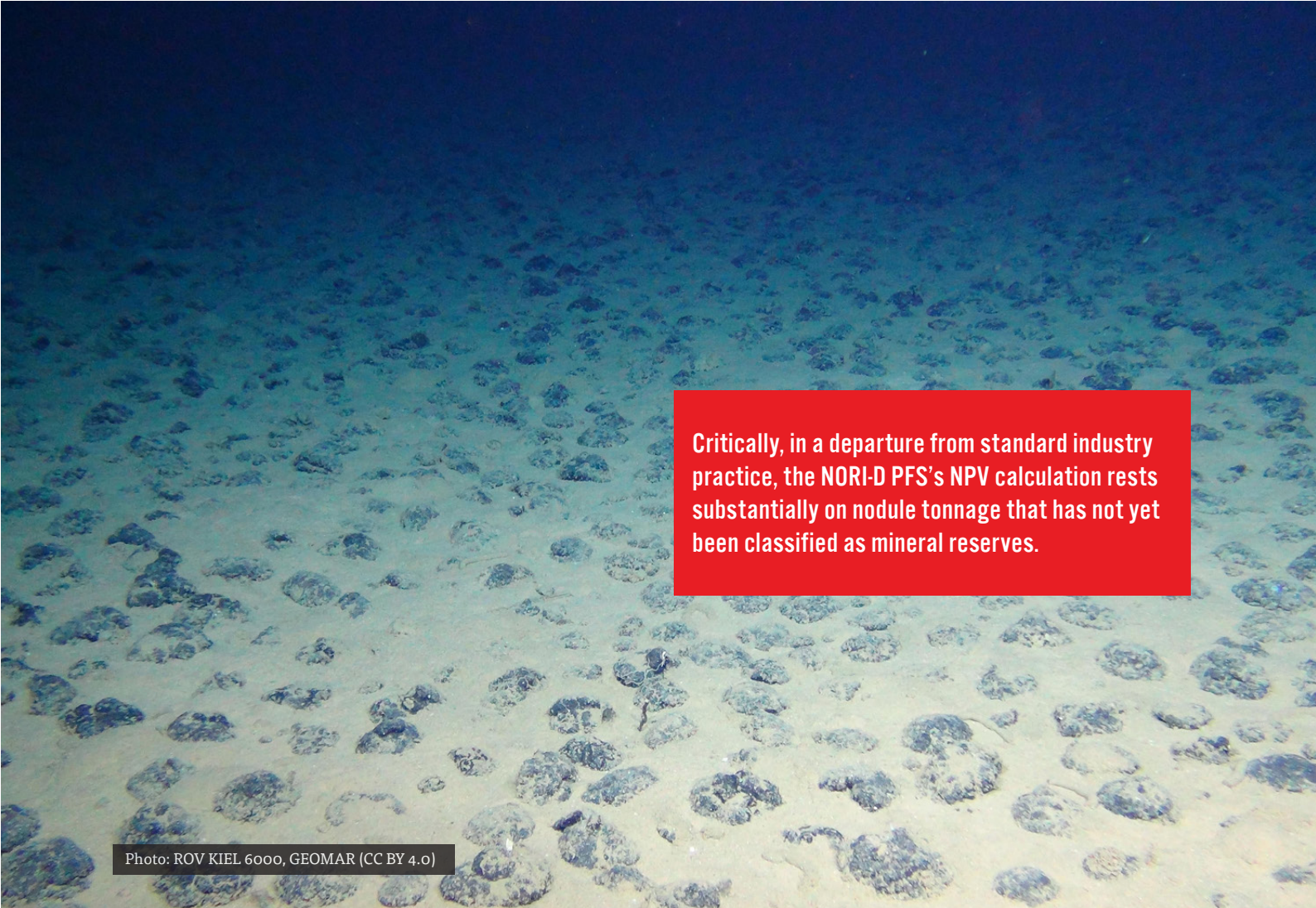


Photo: ROV KIEL 6000, GEOMAR (CC BY 4.0)

Critically, in a departure from standard industry practice, the NORI-D PFS's NPV calculation rests substantially on nodule tonnage that has not yet been classified as mineral reserves.

Further material risks, which were difficult to quantify and thus not reflected in the adjusted discount rate, include the following:

- 1. The political and legal hurdles arising from unilateral action to mine the international seabed outside of UNCLOS and the multilateral governance framework established under the ISA.** These include the risks surrounding the involvement of countries that are Parties to UNCLOS, such as Japan and Indonesia, which TMC identifies as initial processing locations, and the Netherlands and Switzerland, which are respectively the operational base and legal seat of Allseas. Allseas – one of TMC's largest shareholders – owns and operates the Hidden Gem, a deep-sea mining vessel used in TMC's nodule collection trials, and is contracted to operate the collection system planned for commercial production. Recent legal opinions conclude that States Parties are obliged under Articles 137-139 of UNCLOS to take reasonable steps to prevent their nationals, controlled entities and flagged vessels from facilitating unilateral exploration or exploitation, and that failure to do so would breach the Convention.⁹ No court or tribunal has yet ruled on this question.
- 2. The risks associated with the offtaking of manganese silicate, which in the NORI-D PFS accounts for 28% of total revenues over the life of the project.**¹⁰ The market for manganese silicate is significantly smaller, more opaque and less liquid than that of nickel, cobalt and copper and there are questions surrounding the availability of offtakers for the product. Price estimations are prone to uncertainty and there is the potential for oversupply to cause a collapse in prices. As Emerman (2026) notes, "there is currently no silicomanganese facility anywhere in the world that is accepting manganese silicate as a feedstock, which is part of the reason as to why there is no global commodity price for manganese silicate...If manganese silicate cannot be sold as feedstock for steelmaking, then it is suitable only for low-value products."



NORI-D project: exceptional material risks

Metal prices

The NORI-D PFS uses metal price projections which are at the upper end – and in some cases significantly higher – than the price projections used in recent market analyses, including Pre-Feasibility and Feasibility Studies published for other mining projects from the past three years. Prices are adjusted in the Likely Scenario based on a neutral view of the market, using forward curves blended with the four-year historical trailing median price.

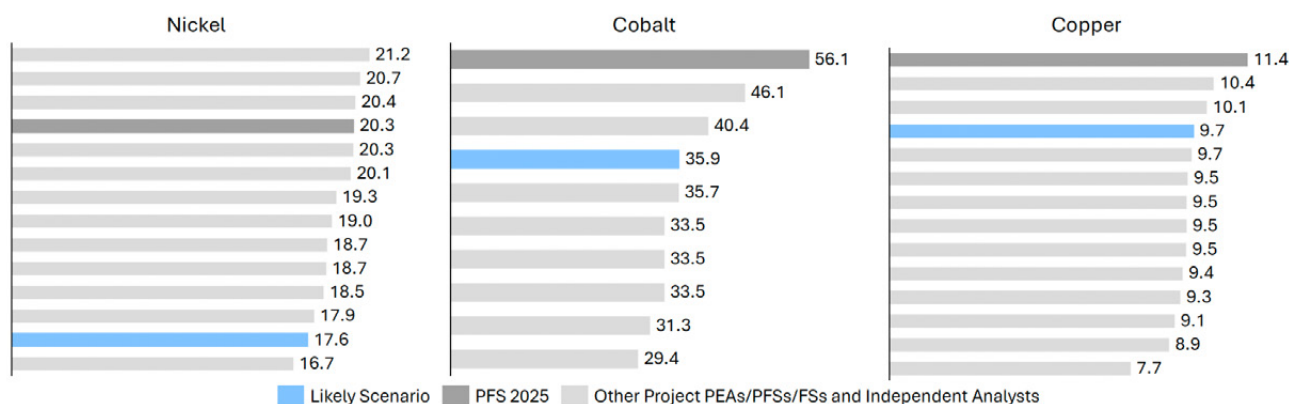
For **cobalt**, the NORI-D PFS assumes a price of US\$56,000 per tonne, which is 56% higher than the price in our Likely Scenario (US\$36,000 per tonne) and US\$10,000 per tonne higher than the next published benchmark (**Figure 2**). For **nickel**, the Likely Scenario projects average prices of US\$17,600 per tonne, significantly below the price of US\$20,295 per tonne set out in the NORI-D PFS.



Manganese nodules. Credit: Hannes Grobe/AWI (CC BY-SA 4.0)

The NORI-D PFS uses metal price projections which are at the upper end – and in some cases significantly higher – than the price projections used in recent market analyses.

Figure 2: Average life of mine metal prices in the NORI-D PFS, Likely Scenario and other benchmarks (thousands of US\$/tonne, real 2025)

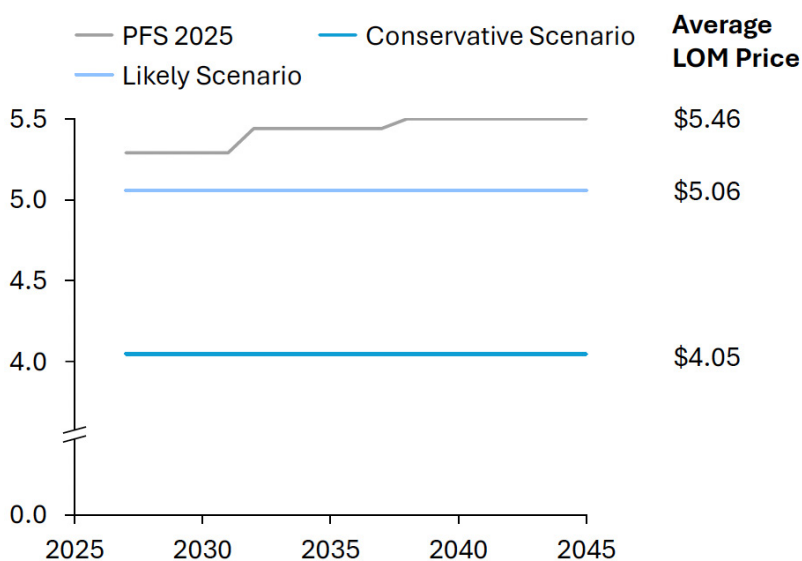


For cobalt, the NORI-D PFS assumes a price of US\$56,000 per tonne, which is 56% higher than the price in our Likely Scenario.

Manganese silicate pricing is treated more conservatively in our analysis given that the market is significantly smaller, more opaque and less liquid than for nickel, copper and cobalt. In the Conservative Scenario, a further discount of 20% is applied to the

Likely Scenario price to reflect uncertainty around customer acceptance, blending requirements (mixing with conventional ore to meet smelter specifications), offtaker availability and the possibility of oversupply causing a collapse in prices (**Figure 3**).

Figure 3: Manganese silicate price projections by scenario (US\$/dmtu, real 2025)





Cobalt sulphate. Credit: iStock/RHJ

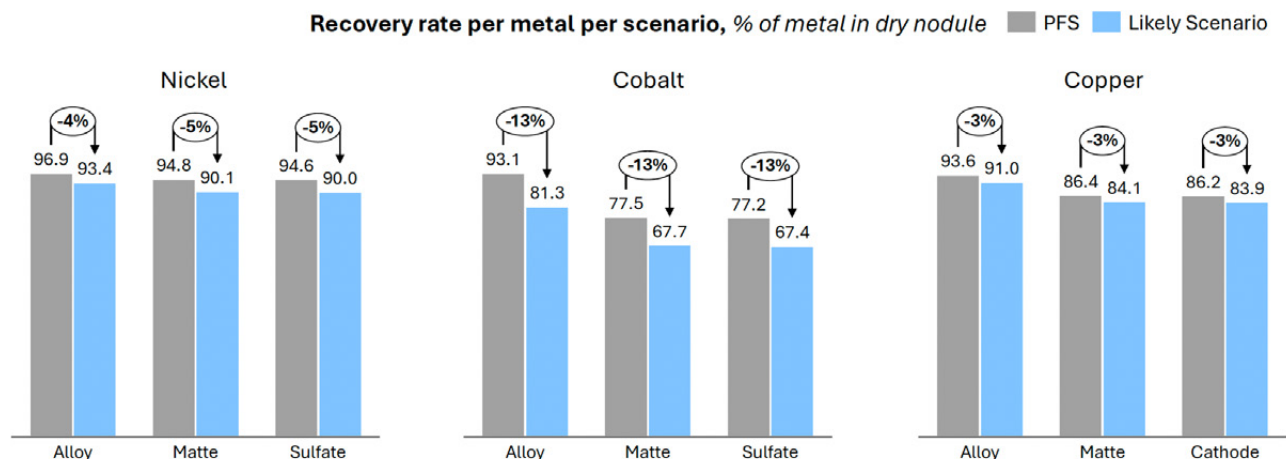
Recovery rates in the NORI-D PFS are higher than suggested by the scientific literature.

Recovery rates

The recovery rate is the percentage of metal in the dry nodule which is remaining following conversion to alloy, matte or sulfate/cathode form. The NORI-D PFS assumes recovery rates for nickel, cobalt and copper that are higher than suggested by the scientific literature.

In our Likely Scenario, we take the average from published scientific studies to propose a new alloy recovery rate, which has a knock-on effect on matte and sulfate/cathode recoveries (**Figure 4**). The case of cobalt is particularly marked: based on the literature, a realistic recovery rate to alloy is estimated at around 81.3%, compared to 93.1% in the NORI-D PFS.

Figure 4: Recovery rate per metal in the NORI-D PFS and Likely Scenario



Contingency costs

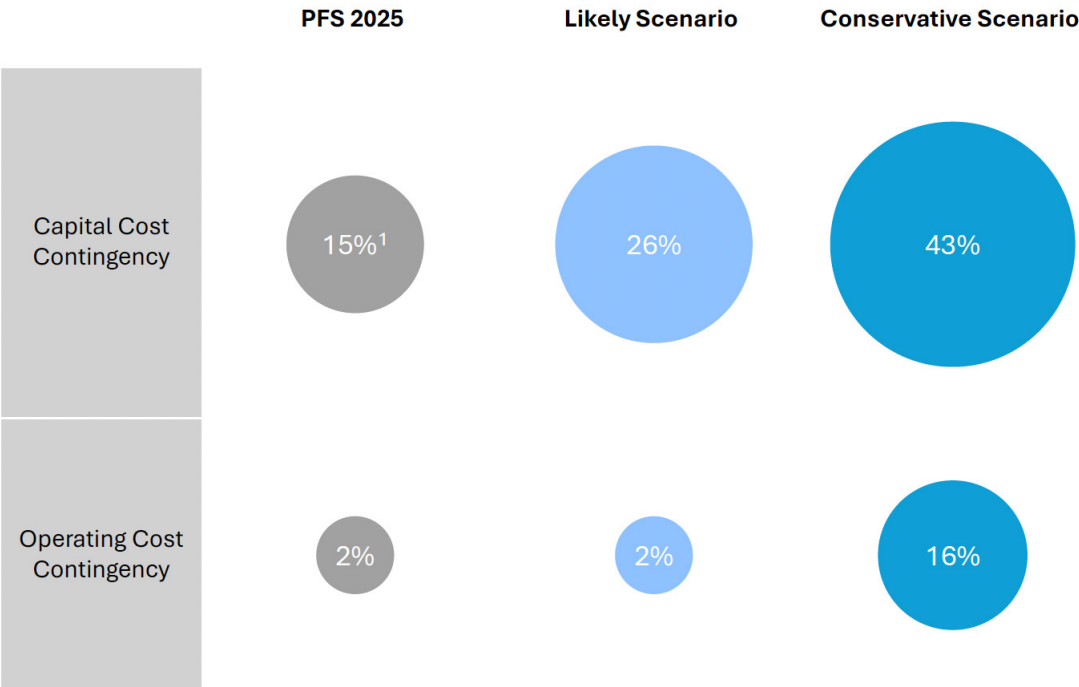
The proposed contingency costs in the NORI-D PFS are below typical mining project cost overruns. In the Likely Scenario, the contingency is maintained at 2% of operating costs, but is adjusted from 15% to 26% for the capital cost contingency, based on typical contingencies and average cost overruns in mining studies/surveys (Figure 5). In the Conservative Scenario, we adjust the operating and capital cost contingencies to 16% and 43%, respectively; according to a study by the Management and Economics Society of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM MES), the typical cost overrun is 40% for a copper mine and 46% for nickel.¹¹ Meanwhile, a 2024 McKinsey study suggests that megaproject cost overruns can be even higher.¹²



“Looking at megaprojects valued at \$1 billion or more, the result is even worse: on average, cost overruns run at least 79 percent higher than initial budget estimates.”

McKinsey and Company (2024)¹³

Figure 5: Capital and operating cost contingencies in the NORI-D PFS compared to the two modelled scenarios



Note: 1. The PFS stated that a 15% contingency was applied. Given the exact contingency figure in the PFS, a 14.9% contingency was applied to System #1 CAPEX and 14.6% to US Refinery CAPEX.

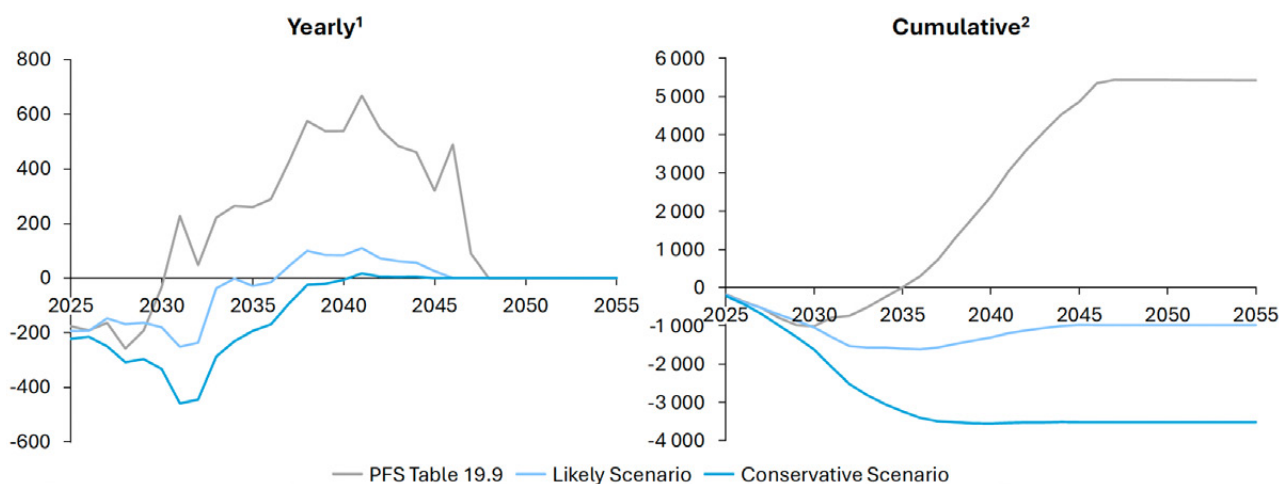
Results

This section provides an overview of the model outputs and resulting financial indicators for the Likely and Conservative Scenarios, compared to those in the NORI-D PFS.

Undiscounted free cash flows fall significantly in the Likely Scenario, and further in the Conservative Scenario, driven largely by a drop in revenues.

Yearly free cash flows remain negative until the late 2030s in the Likely Scenario and until the early 2040s in the Conservative Scenario. Over the lifetime of the project, free cash flows are negative in the Conservative Scenario and, once a discount factor is applied, also in the Likely Scenario (**Figure 6**). Negative total (cumulative) free cash flows indicate that the project is loss-making.

Figure 6: Discounted free cash flows (yearly and cumulative) by scenario (US\$ millions, real 2025 dollars)



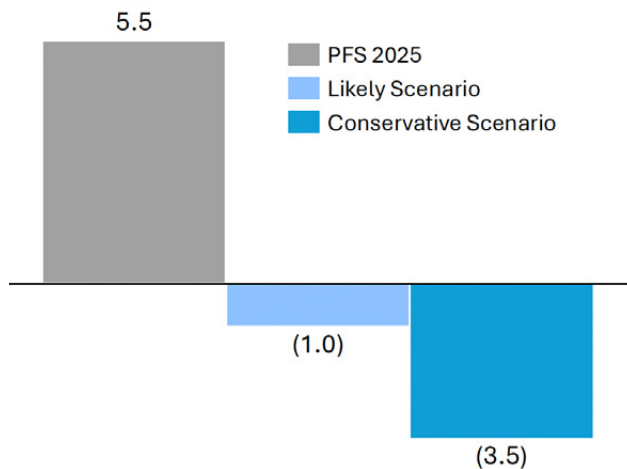
Negative total (cumulative) free cash flows indicate that the project is loss-making.

Notes: 1. Yearly free cash flows are “discounted” at a certain rate to arrive at their equivalent value today. The yearly rate of discounting (known as the discount rate) reflects the yearly return which investors require to invest in this project. Higher-risk projects have higher discount rates as investors demand greater returns to make up for the risk they are taking. For higher risk projects, a certain future cash flow is worth less today than the equivalent cash flow in a lower risk project. 2. Over the lifetime of the project, if cumulative discounted free cash flows are positive, the project has a positive Net Present Value.

The Net Present Value (NPV) of a project represents the sum of all discounted cash flows across the lifetime of the project. A positive NPV means the project is expected to generate more value than the minimum return required by investors, i.e. it creates wealth above

and beyond the cost of capital. In both our Likely and Conservative Scenarios, the NPV is negative: -US\$1.0 billion in the Likely Scenario, and -US\$3.5 billion in the Conservative Scenario, compared to the US\$5.5 billion projected in the NORI-D PFS itself (**Figure 7**).

Figure 7: Net Present Value by scenario
(US\$ billion, real 2025 dollars)



Compared to the US\$5.5 billion NPV projected in the NORI-D PFS, the NPV in both of our modelled scenarios is negative.

Over the lifetime of the project, the NORI-D PFS projects an Internal Rate of Return (IRR) – i.e. an annual return on investment – of 26.8%. In the Likely Scenario, this falls to 8.9%, which is far below the modelled discount rate of 18.2% in this scenario, the rate of return required given the risk of investing in this project. The NORI-D project thus becomes economically unattractive as an investment under assumptions in the Likely Scenario. In the Conservative Scenario, no IRR could be calculated, as the project's discounted cash flows do not recover the initial investment at any discount rate (**Figure 8**).

Figure 8: Internal Rate of Return by scenario

PFS 2025 (Section 19.13)

26.8%

Likely Scenario

8.9%

Conservative Scenario

Negative returns. Unable to calculate an IRR given the model's resulting free cash flows

the
metals company

Conclusion

The analysis shows that the financial projections in the NORI-D PFS are overly optimistic to the point of not being credible. Both our Likely and Conservative Scenarios point to a loss-making endeavour, with a rate of return far below what is required given the risk of investing in the project.

Additional exceptional material risks, including the significant legal and political hurdles arising from TMC's pursuit of a mining permit outside the ISA framework and the credibility of the offtake market for manganese silicate, have not been reflected in our model. Our analysis may therefore understate the true risk facing the project.

The findings suggest that investors should treat the PFS's headline economics with substantial scepticism and approach the project, and any related equity or debt exposure, with caution.

The analysis shows that the financial projections in the NORI-D PFS are overly optimistic to the point of not being credible. Both our Likely and Conservative Scenarios point to a loss-making endeavour, with a rate of return far below what is required given the risk of investing in the project.

Manganese nodule with a deep-sea sponge. Expedition SO242.
Photo: ROV KIEL6000, GEOMAR.



Appendix

Summary of adjustments made in each scenario

Input Variable	NORI-D PFS 2025	Likely Scenario	Conservative Scenario
Discount Rate	8%	18.2%	21.3%
Nickel Grade	1.40%	-	1.28%
Cobalt Grade	0.14%	-	0.12%
Manganese Grade	31.15%	-	30.58%
Nickel Recovery to Alloy	96.91%	93.38%	-
Nickel Recovery to Matte	94.76%	90.13%	-
Cobalt Recovery to Alloy	93.06%	81.25%	-
Copper Recovery to Alloy	93.55%	91.00%	-
Nodule Production – Total (Mwtpa)	164.1	152.9	145.3
Nickel Price (US\$/tonne)	20,295	17,580	16,091
Nickel Sulfate Premium	7.0%	-	1.2%
Cobalt Price (US\$/tonne)	56,117	35,851	29,083
Copper Price (US\$/tonne)	11,440	9,721	9,305
Manganese Silicate Price (US\$/dmu)	5.46	5.06	4.05
Nickel Alloy Payability	65.00%	-	52.00%
Cobalt Alloy Payability	42.00%	-	33.60%
Copper Alloy Payability	59.98%	-	47.98%
Capital Cost Contingency	15%	26%	43%
Operating Cost Contingency	2%	2%	16%
MGO Fuel Price (US\$/tonne)	\$700	\$767	\$894
US Royalty (% of revenues)	None	-	4.4%

Notes: “ – ” indicates the assumption is unchanged from the previous scenario (to its left). Mwtpa - millions wet tonnes per annum; dmtu - dry metric tonne unit.

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