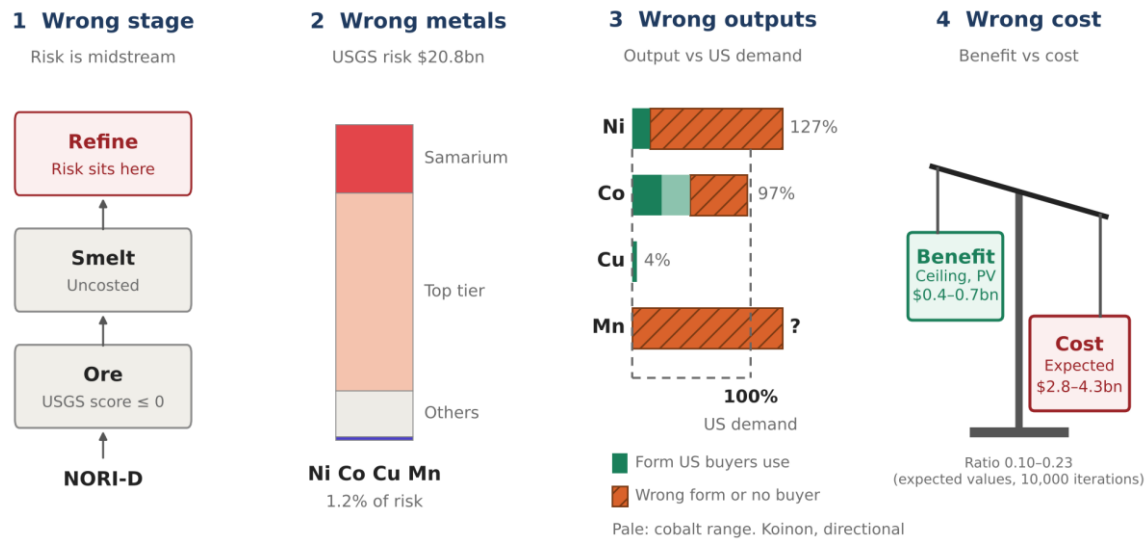
What Backing NORI-D Buys the United States

Four findings on the mineral-security case for TMC USA's consolidated application to NOAA

16 OCTOBER 2026

Prepared for the Natural Resources Defense Council, in connection with its comment on NOAA docket NOAA-NOS-2026-1751



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1. Purpose and status

This note asks what backing NORI-D would buy the United States in mineral security, measured against the federal government's own recent statements of where its supply risk lies and against the other ways the same money could be spent. It is written to support the feasibility sections of NRDC's comment under 15 CFR 971.214(d), and it rests on four public records: the applicant's documents; the USGS methodology behind the November 2025 List of Critical Minerals; the USGS Mineral Commodity Summaries of February 2026, the Survey's annual statistical digest of US and world mineral supply, cited below as MCS 2026; and the Commerce Department's Section 232 finding of January 2026.[1]

The question is one the applicant raises. The application presents the Brownsville plant as "the first step in the Nodule City vision" for "a reliant domestic supply chain for critical minerals", finances it with about 30% equity and about 70% "debt and government incentives", and says TMC USA is "actively pursuing complementary government support".[2] If public money is to be sought on security grounds, the security it buys can be measured, and the government has lately published the instruments for measuring it.

Each finding is stated in section 2 and argued in sections 3 to 6. Section 7 lists questions NOAA could put to the applicant. The appendices carry the USGS method and scores, the US supply statistics, the costings and the cost–benefit arithmetic. Footnotes carry the citations and the arithmetic.

Where a figure is a Koinon computation rather than a published one it is labelled as such, and its method is in Appendix E. Modelled figures come from a single run of 10,000 iterations, run v2.3 of Koinon_NORI-D_UnitEconomics_Model.xlsm, the run behind Koinon's Unit Economics note of 16 October 2026. One class of figure is directional only and is marked so wherever it appears: Koinon's costing of the Brownsville smelter, which no published study has costed. The computations are offered as tests of the record, not as findings about anyone's conduct.

2. Summary of findings

Within the past twelve months the United States has said, with unusual precision, where its mineral-supply risk lies. In November 2025 the USGS ranked 84 mineral commodities by the expected annual cost to the US economy of a supply disruption, stage by stage. The Commerce Department found that processed critical minerals threaten national security, and located the threat in processing and refining. Set against those two statements, the NORI-D project supplies the wrong stage of the wrong metals, in quantities the domestic market cannot absorb, at a public cost that the government's own figures for the benefit cannot cover (Figure 1).

[1]The four records are: TMC USA LLC, Consolidated Application for an Exploration License and Commercial Recovery Permit, TMC USA-A, published by NOAA 19 August 2026 as NOAA-NOS-2026-1751-0002 (the Application), with AMC Consultants' Technical Report Summary of Prefeasibility Study of NORI Area D, effective 4 August 2025, TMC Form 10-Q Exhibit 96.1 (the PFS); Nassar, N.T. and others, Methodology and technical input for the 2025 U.S. List of Critical Minerals, USGS Open-File Report 2025-1047 (OFR 2025-1047), behind the Final 2025 List of Critical Minerals, 90 FR, 7 November 2025; USGS, Mineral Commodity Summaries 2026, February 2026 (MCS 2026), nickel, cobalt and copper chapters; and Proclamation 11001 of 15 January 2026, Adjusting Imports of Processed Critical Minerals and Their Derivative Products, 91 FR, 20 January 2026 (the Section 232 proclamation). Section and table references are to these.

[2]Application s.7.4 ("Nodule City vision", "reliant domestic supply chain"), s.7.4.3 (capital structure "~30% equity and ~70% as debt and government incentives"), s.6.3.8 ("currently working with partners to secure U.S. Government support to design, build, and operate a new processing plant").

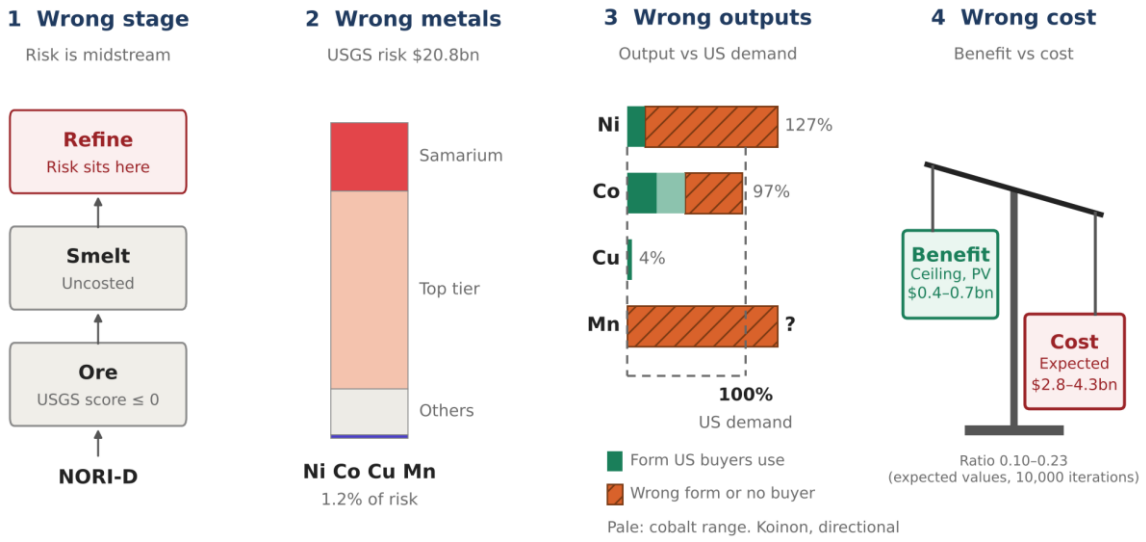


Figure 1. The four findings on one page. (1) The USGS scores every ore or mined form of the four nodule metals at or below zero and every refined or chemical form above zero; NORI-D supplies ore. (2) All ten forms of the four metals carry 1.2% of the US$20.8 billion expected annual loss across 84 commodities. (3) NORI-D output at 12 Mtpa as a share of US apparent consumption, divided by whether US buyers use the product form: nickel sulphate can serve at most the share of demand outside steels and alloys (about 15%), and cobalt sulphate 25–49%, from chemical uses alone to all uses outside superalloys; copper cathode meets about 4%; the manganese silicate has no stated US buyer. Koinon estimates, directional (Appendix E). (4) The benefit is the present value of the USGS expected loss the project could remove, measured in US GDP, at 2–7% real, as a ceiling; the cost is the expected cost to the public, its share of the loss to lenders in present value; the ratio is mean benefit over mean cost across 10,000 iterations on the applicant's schedule (section 6.3). Sources: OFR 2025-1047; MCS 2026; Koinon computation (sections 3 to 6).

Finding	What the record shows	Consequence
1. The risk is midstream; the project supplies ore	USGS scores every ore or mined form of the four nodule metals at zero or below and every refined form above zero. Commerce's Section 232 finding is confined to processed minerals. The nodules are ore; the processing the application proposes for them is uncosted, unpartnered and, by the applicant's own account, dependent on majority public funding.	Whatever security value NORI-D has lies in the Brownsville plant, not the seabed. A plant can be fed without a seabed licence.
2. The four metals sit in the middle of the government's list	All ten USGS forms of nickel, cobalt, copper and manganese together carry an expected loss of about US$240 million a year. The thirteen commodities in the top tier carry about US$17.6 billion, and all 84 about US$20.8 billion; samarium alone US$4.5 billion. The four metals are 1.4% of the top tier and 1.2% of the whole.	Money aimed at the top tier addresses twenty to sixty times the risk per commodity. On the government's own scale NORI-D is a small target.
3. Domestic demand caps the contribution	At 12 Mtpa NORI-D's nickel would exceed US primary consumption and its cobalt would nearly match it, and the nickel would be battery sulphate for a market that is 85% stainless steel. Its copper would meet about 4% of US consumption. Its manganese silicate has no stated US buyer. Present imports of all three metals come from allies.	The benefit is bounded by a market the project would saturate, not by the resource. Beyond that bound the output is sold on the world market and buys no security.

Finding	What the record shows	Consequence
4. The benefit does not cover the cost	On the applicant's own schedule, application Table 44 as the collectors deliver it, the present value of the security benefit is at most US$0.4–0.7 billion on the government's own discount rates, counting only what US buyers can use in the forms offered (US$0.7–1.2 billion if physical supply is credited in full), against public exposure of US$6.3–8.8 billion at face. On Koinon's modelling the loans are repaid in full in about one case in four. The expected cost to the public is US$3.1–4.3 billion in present value at 2% real, and the benefit is 0.16–0.23 of it, or 0.10–0.14 at 7% (Figure 2). As an annual return the benefit is 0.6–0.9% on the public money, against the 7% the government requires of capital taken from the private sector. The cause is the sequence: smelter first, refinery later, both tied to the seabed, where a refinery alone, fed by contract, buys most of the benefit at a third of the capital and none of the seabed risk.	On the government's own figures, the security benefit covers the public's expected cost in none of the cases run, at either discount rate. The security argument is asked to carry a project the commercial case cannot, and the weaker the commercial case, the larger the public cost, because loans that will not be repaid are grants.

The result in one figure. Koinon took the applicant's own schedule, application Table 44 as the collectors deliver it, through a model of 10,000 iterations in which prices, costs, availability, capital overrun, the USGS scores and the share of each score the project could earn all move at once (section 6.3, Appendix D). Default on public loans is not assumed: the operating surplus repays lenders before equity, and they lose what it cannot cover. On that modelling the loans are repaid in full in about one case in four. The measure is the benefit-cost ratio: the expected present value of avoided GDP loss over the expected cost to the public. It is 0.16–0.23 at the government's most generous discount rate and 0.10–0.14 at its 1992 rate of 7% real; on the schedule as filed it is barely higher, and counting only the Probable reserve it falls to 0.04–0.07. On the value-for-money bands British practice uses, every case is "poor".

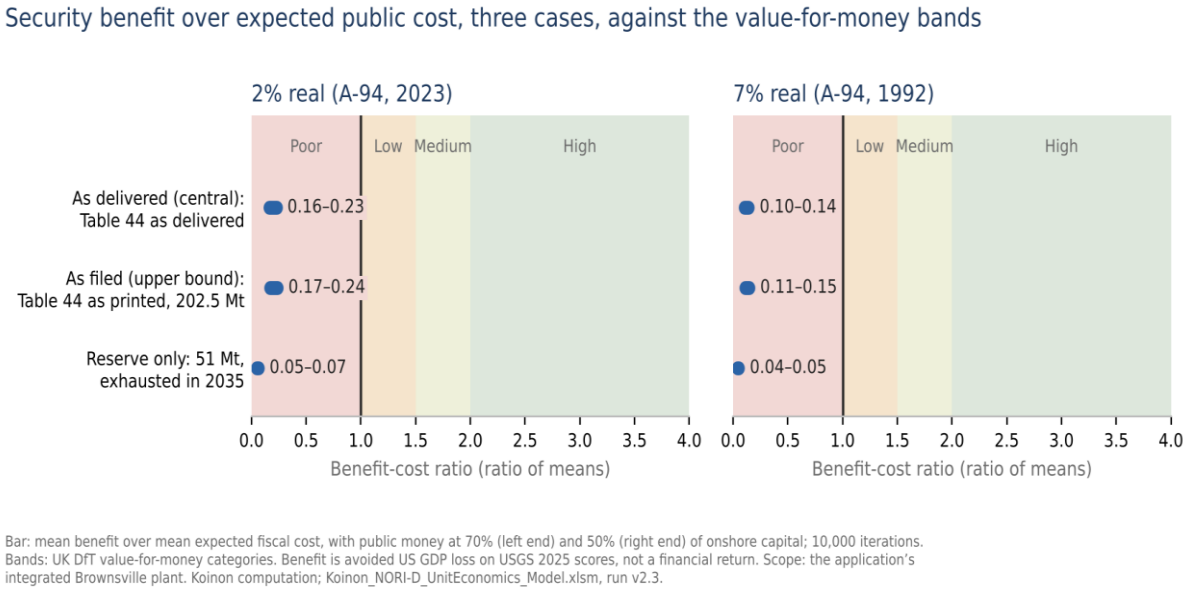


Figure 2. Security benefit over expected public cost for three cases, at 2% and 7% real. Each bar runs from the ratio with public money at 70% of onshore capital to the ratio at 50%; ratios are of means over 10,000 iterations (Table 7). Koinon computation on USGS 2025 scores, OMB discount rates and the application's own schedule and financing plan; Koinon_NORI-D_UnitEconomics_Model.xlsm, run v2.3.

That the United States treats mineral supply as a matter of national security is its stated policy, and that nickel, cobalt, copper and manganese belong on its list is likewise its official position: all four are on the 2025 list. The argument is about stage, scale and sequence: which link in the chain is weak,

how much of that weakness this project could remove, and whether a government that wanted the result would start from here.

3. Finding 1 — The risk is midstream; the project supplies ore

Claim. The two federal assessments of the past year locate the United States' mineral-supply risk at the processing and refining stage. The nodules are ore. Whatever security value the project has lies in the processing plant proposed for Brownsville, which no published study costs, no counterparty has committed to build, and the applicant says will not be built without a majority of public funding.

3.1 What the USGS measured

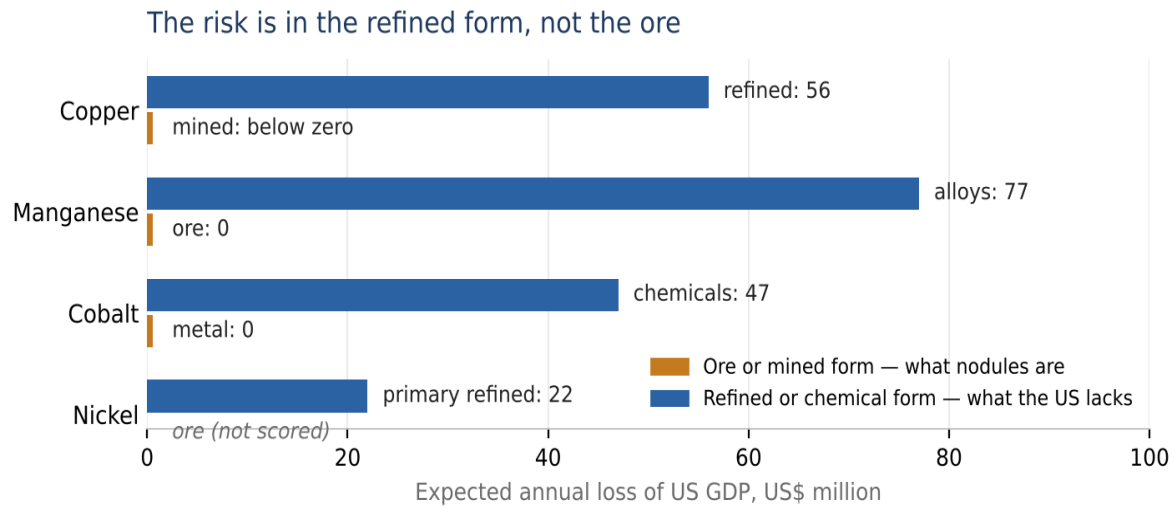
For the 2025 list the USGS constructed, for each of 84 mineral commodities, the scenario in which each supplying country stops its net exports to the United States for a year; ran the resulting price and quantity changes through an input–output model of 402 US industries; and weighted each scenario's loss of GDP by the probability of that country imposing such a restriction, taken from its record of export bans, quotas and licensing. Seventeen scenarios involving China were set at 100% because the restriction already exists. The sum across countries is the commodity's score: the expected annual loss of US GDP from supply disruption.[3]

The design distinguishes stages. Copper is scored as mined copper and as refined copper; manganese as ore, alloys, metal, dioxide and high-purity sulphate; cobalt as metal and as chemicals. Thirty-one of the 84 entries are stages or forms of eleven supply chains. For the four nodule metals the result is uniform (Table 1).

Form	Rank of 84	Expected loss, US$m a year	Category
Manganese alloys	25	77	Elevated
Copper, refined	29	56	Elevated
Cobalt chemicals	34	47	Elevated
Manganese sulphate, high-purity	41	29	Elevated
Nickel, primary refined	44	22	Moderate; sole domestic producer
Manganese metal	53	9	Moderate
Cobalt metal	65	0	Limited
Manganese dioxide	67	0	Limited
Manganese ore	72	0	Negligible
Copper, mined	78	below zero	—

Table 1. USGS 2025 scores for every form of the four nodule metals. A score below zero means a disruption would raise US GDP, domestic producers gaining more from higher prices than users lose. Source: OFR 2025-1047.

[3]OFR 2025-1047, sections on scenario quantification, equilibrium displacement modelling and economic impacts; equation (19) defines the score as the probability-weighted net decrease in US GDP summed across scenarios. Over 1,200 scenarios across 84 commodities. Probabilities follow Ryter and Nassar (2025); 17 China scenarios are set at 100% because the Ministry of Commerce has already restricted or banned those exports to the United States; pairs with no history are assigned the 4% mean. Appendix A gives the category thresholds.



Source: USGS Open-File Report 2025-1047. Nickel ore is not scored separately; US mine output is exported as concentrate.

Figure 3. Each metal at its ore or mined stage against its refined or chemical stage. Source: OFR 2025-1047; Koinon chart.

The category labels are the USGS's own. They are set by a statistical break in the distribution of the 84 scores, not by any absolute standard, and the distribution is steep: half the commodities score below about US$2 million a year, eleven at or below zero. Against that field US$56 million is "Elevated"; against the total of about US$20.8 billion across all 84 it is 0.3%. This note relies on the ranks and the dollar figures, not on the labels.

Every ore or mined form scores at or below zero; every refined or chemical form scores above it. The method also shows why. The probabilities are set by the history of trade barriers, and the countries that have imposed them on these metals have done so on processed forms. What the United States imports in nickel, cobalt and copper is overwhelmingly refined metal and chemicals, from Canada, Norway, Chile and Finland; what it lacks is the capacity to refine.

3.2 What Commerce found

On 15 January 2026 the President issued Proclamation 11001 on the Commerce Department's Section 232 investigation into processed critical minerals and their derivative products. The Secretary found a threat to national security from reliance on foreign sources for processing and refining, from insufficient domestic processing capacity, and from price volatility that deters domestic investment. The investigation was confined to processed minerals; mining was outside its scope. The acute cases named were samarium and the heavy rare earths. The remedy chosen was negotiation with supplying countries, with price floors held in reserve, rather than tariffs.[4]

Domestic price support has been considered, and used. The proclamation keeps price floors and minimum import prices in reserve. In July 2025 the Department of Defense agreed a ten-year price floor for MP Materials' neodymium-praseodymium oxide, at US$110 a kilogram, as part of an equity, loan and offtake package for a domestic rare-earth magnet chain. The instrument exists; it has been applied at the top of the list, to rare earths, and not to base metals.[5]

[4]Proclamation 11001, 15 January 2026, on the Secretary of Commerce's report under section 232 of the Trade Expansion Act of 1962 into processed critical minerals and their derivative products. The findings quoted are the proclamation's own: reliance on foreign sources "particularly for processing and refining", "insufficient domestic processing capacity", and price volatility discouraging domestic investment. Commerce and USTR were directed to negotiate agreements, which may include price floors, within 180 days, with minimum import prices and other remedies reserved.

[5]Price floors and minimum import prices: Proclamation 11001. The MP Materials agreement of 10 July 2025 with the Department of Defense, as publicly reported: a US$110 per kilogram floor for NdPr oxide for ten years, with a DoD equity stake, loans and a magnet offtake commitment. Terms from public reporting; not verified against the agreement.

The two agencies, working independently and by different methods, arrive at the same place: the weak link is midstream. The USGS adds the practical corollary. Tellurium was removed from the 2025 list because the United States went from 95% import-reliant in 2021 to a net exporter in 2023 once domestic recovery capacity was built; the ore had always been there.[6]

3.3 What the application supplies

The nodules are ore. The application's flowsheet takes them through a rotary kiln and electric furnace to an alloy, through Peirce-Smith converters to a matte, and through a sulphuric-acid leach to nickel sulphate, cobalt sulphate and copper cathode, with manganese leaving the furnace as a silicate slag. Smelting has been trialled at PAMCO's Hachinohe works in Japan on about 1,200 t of nodules and 450 t of calcine; refining has been tested at laboratory scale.[7] What has been demonstrated is bounded: smelting at industrial scale for a few weeks on about 1,200 t of nodules, under 5% of a single day's throughput in the proposed plan, refining only in the laboratory, and no commercial plant of either kind anywhere. Beyond the trials, the onshore chain is a plan on paper.

The PFS of August 2025 placed the smelting in Indonesia and Japan under toll agreements and the refining in two US plants costed at US$4.43 billion; it carried no smelting capital at all.[8] The application of August 2026 moves the smelting to Brownsville, Texas, where an "integrated processing facility" is to receive nodules directly, beginning with a 3 Mtpa plant producing matte from 2028 and adding metal refining in later stages. No published study costs this plant; Koinon's directional estimate is US$6.9–8.1 billion for the integrated smelter and refinery (section 6.3, Appendix C). The application lists the processing technology licensor, the onshore joint-venture partner, the EPC contractor and the onshore feasibility consultant as "counterparty not yet finalized", and TMC has stated that onshore construction is contingent on a majority of its funding coming from US government sources.[9]

The security asset, in other words, is a plant that does not yet exist on paper, to be paid for mainly by the public. Whether that plant needs a seabed licence to be worth building is the subject of Finding 4.

4. Finding 2 — The four metals sit in the middle of the government's list

Claim. On the USGS ranking the four nodule metals, in every form, carry an expected loss of about US$240 million a year between them. The thirteen commodities the USGS places in its top tier carry about US$17.6 billion. A dollar of public money aimed at the top of the list addresses twenty to sixty times the risk per commodity.

[6]OFR 2025-1047: tellurium was removed because the United States "moved from being over 95 percent net import reliant in 2021 to being a net exporter of tellurium in 2023" after domestic recovery from copper refining residues came on stream.

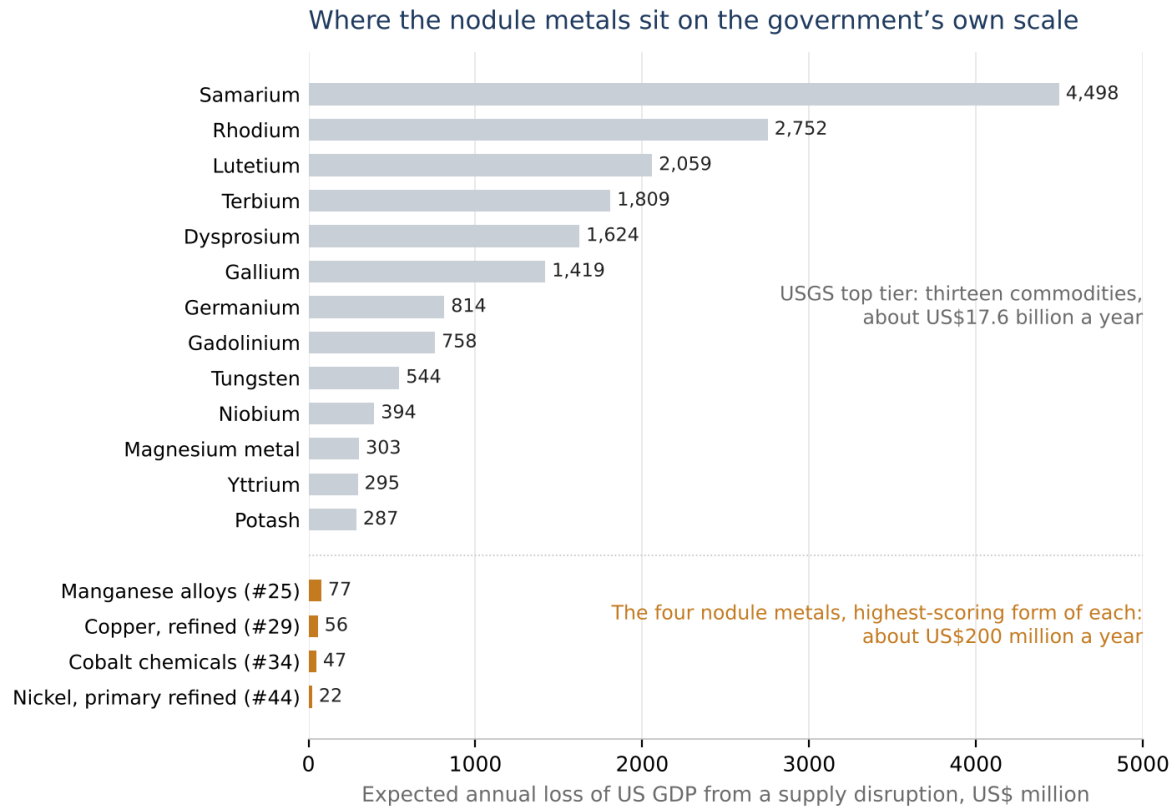
[7]Application s.4.8.1 (RKEF to alloy, Peirce-Smith converters to matte, sulphuric-acid leach to nickel sulphate, cobalt sulphate and copper cathode; manganese silicate to silico-manganese producers), s.4.8.4 (bench and pilot work; Hatch refining test work at laboratory scale), s.6.3.8. Industrial trials at PAMCO, Hachinohe: about 1,200 t of nodules calcined in September 2024 and about 450 t of calcine smelted in January–February 2025 (TMC releases of 9 September 2024 and 18 February 2025).

[8]PFS s.18.5 and Tables 18.1, 18.2 and 18.9: offshore system #1 US$544.8 million net of the Allseas credit; two US refineries at US$2,213.0 million each, US$4,426.0 million together, each sized for 6 million wet tonnes a year of nodule equivalent and including US$281.1 million of port works; project capital US$4,971 million including escalation. Smelting was to be toll-treated in Indonesia and at PAMCO with no processing capital (s.18.5.4, s.12.2.14). Production systems #2–4 at US$1,454.2 million each are recovered through operating cost and sit outside project capital; Koinon treats them as capital at cost, US$4,362.6 million in all, as in the unit-economics note.

[9]Application s.7.4.1 (735 acres under negotiation, 731 more available; up to 12 Mtpa), s.6.4.2 and Table 44 (first integrated facility 3 Mtpa; Phase 1 Stages 1–2 matte, Stage 3 metals; Phase 2 metal), s.6.3.8, and the table of anticipated agreements in s.2 (processing technology licensor, onshore joint-venture partner, onshore EPC contractor and onshore feasibility consultant each "counterparty not yet finalized"). The statement that onshore construction is contingent on a majority of funding from US government sources is TMC's, in its Q4 2025 results (March 2026) and Q2 2026 update (13 August 2026), as recorded in Koinon's PFS Freight Extract v1.7, Part B8. No published study costs the Brownsville plant.

4.1 The ranking

The USGS places thirteen commodities in its “High” category, above US$206 million a year (Figure 4; the full scores are in Table A2). The USGS names China as the leading contributor to the expected loss for 46 of the 84 commodities, including every rare earth in the top tier. None of the four nodule metals in any form reaches the top tier; the highest, manganese alloys, ranks 25th.



Source: USGS Open-File Report 2025-1047, probability-weighted net decrease in US GDP, 2025 List of Critical Minerals. Rank of 84 in brackets.

Figure 4. The USGS top tier and the four nodule metals, highest-scoring form of each, on one scale. Source: OFR 2025-1047; Koinon chart.

4.2 Scale

The sum of the top tier is about US$17.6 billion a year, and of all 84 commodities about US$20.8 billion; the four nodule metals, in all ten forms, about US$240 million, 1.4% of the top tier and 1.2% of the whole. Samarium alone, at US$4.5 billion, carries nineteen times the four metals combined. The comparison is not between projects, since the USGS did not assess projects, but between the sizes of the problems a project could address. A measure that removed one tenth of the samarium risk would be worth more each year than one that removed the entire risk in nickel, cobalt, copper and manganese.

4.3 What the scores leave out, and which way it cuts

Three limits of the method should be stated. First, the scores are expected values; a single severe scenario could cost more in one year than the probability-weighted figure, and the method does not report the tails. Second, the scores are built on the country of export. They do not see ownership: Indonesian nickel, two thirds of world mine output, is counted as Indonesian whether or not the plant that processes it is Chinese-owned, and much of it is. Third, the scores measure GDP, not defence need; a shortfall in a superalloy input can matter more than its share of output.

The first and third limits apply equally to every commodity on the list and do not change the ranking. The second raises the nickel and cobalt figures by an amount the method cannot state, and it bears

on future battery-grade supply rather than on today's imports, which come from Canada, Norway, Australia and Brazil for nickel and from Norway, Finland, Canada and Japan for cobalt.[10] This note reports the ownership point as directional and does not quantify it.

5. Finding 3 — Domestic demand caps the contribution

Claim. The security value of a domestic source is bounded by domestic need. At the application's 12 Mtpa of wet nodules, NORI-D's nickel output would exceed US primary consumption and its cobalt output would nearly match it; its copper would meet about 4% of consumption; its manganese would exceed any domestic use. Beyond the domestic bound the metal is sold on the world market and buys no security at all.

5.1 US consumption and supply, 2025

Metal	US apparent consumption	US primary refined output	Net import reliance	Principal import sources, 2021–24	NORI-D at 12 Mtpa, recovered (Koinon model)
Nickel	90 kt primary; 220 kt with scrap	None; last refinery closed 1985	41%; nearly 100% excluding scrap	Canada 44%, Norway 11%, Australia 8%, Brazil 7%	114 kt, as sulphate
Cobalt	9.6 kt	None; 2.0 kt from scrap	79%	Norway 26%, Finland 16%, Canada 14%, Japan 14%	9.3 kt, as sulphate
Copper	2,200 kt refined	850 kt (790 primary)	57%	Chile 68%, Canada 16%, Peru 7%, Mexico 6%	85 kt, as cathode
Manganese	not assessed here	none	—	—	2.7 Mt, in 6.3 Mt of silicate

Table 3. The four metals in the US market. Sources: MCS 2026, nickel, cobalt and copper chapters. The NORI-D column is recovered metal at full scale: 12 Mt wet a year at 28% moisture, the application's grades (Table 5: 1.40% nickel, 1.14% copper, 0.14% cobalt and 31.15% manganese, dry) and sulphate-route recoveries (Table 37, note 9); Koinon_NORI-D_UnitEconomics_Model.xlsm, sheet Output (Appendix E). The column assumes all 12 Mt is refined. On the application's schedule (Table 44) the plant makes only matte in 2028–29, begins metal refining in 2030 and reaches 12 Mt in 2032, and 1.5 Mt a year stays as matte throughout, so refined output at full scale is about seven-eighths of the column; the benefit in section 6.3 counts refined tonnes only.

5.2 Nickel

US primary nickel consumption in 2025 was about 90,000 t, of which more than 85% went to stainless and alloy steels and nickel alloys; scrap supplied about 60% of total consumption. The product NORI-D would make is nickel sulphate for battery cathodes, which stainless steel does not use. The sulphate must therefore find battery-precursor buyers, few of which are in the United States; the price gap between sulphate and Class 1 metal, and the cost of converting one into the other, is a second misalignment; Koinon's Unit Economics note (16 October 2026, section 4.1) sets sulphate against Class 1 metal per wet tonne. Imports come from allies. The USGS records a global primary nickel surplus in every year since 2022, 189,000 t in the first nine months of 2025, and a 2025 average price down 11% on 2024. It also records three companies considering nickel refineries in Missouri, Oklahoma and Texas and a pilot refinery already built in Oklahoma, each a route to the same end without a seabed. The administration's Project Vault stockpile, announced in early 2026, names nickel among its focus materials. It is sized at US$10 billion of EXIM financing with about US$2 billion of

[10]MCS 2026, nickel: primary nickel import sources 2021–24 Canada 44%, Norway 11%, Australia 8%, Brazil 7%. Cobalt: metal, oxide and salts, Norway 26%, Finland 16%, Canada 14%, Japan 14%. Indonesia mined 2.6 of the world's 3.9 Mt of nickel in 2025 (MCS 2026, nickel, world table). Argus (19 December 2025) names Ningbo Lygend, GEM and Huayou, with Indonesian partners, as the principal operators of Indonesian mixed-hydroxide capacity; Koinon has not quantified the ownership share and reports it as directional.

private capital, run by a private company, VaultCo; its allocation by mineral has not been published, so nickel's share is unknown. A stockpile buys refined metal, not ore.[11]

5.3 Cobalt

Cobalt is the one nodule metal with a concentration problem at the mine. Congo (Kinshasa) produced 73% of the world's cobalt in 2025 and Indonesia 14%, and Congo's export quotas of up to 96,600 t a year for 2026–27 followed a temporary ban. US apparent consumption was about 9,600 t, half of it in superalloys for aircraft engines, with a total value of US$320 million. NORI-D's 9.3 kt would nearly match it, but as sulphate, where superalloys take metal. The one federal procurement signal in the record runs the other way: a 2025 solicitation to buy 7,480 t over five years for the National Defense Stockpile was cancelled before the year's end, and the FY2026 Annual Materials Plan was not released.[12]

5.4 Copper

Copper is the one metal of the four in which the United States has a large and growing deficit: 2,200 kt consumed against 850 kt refined, a net import reliance that rose from 44% in 2021 to 57% in 2025. It is a refining deficit: US mines produced about 1,000 kt. NORI-D's 85 kt would meet about 4% of consumption. The USGS scores mined copper below zero and refined copper at US$56 million; copper's problem is smelter capacity, and the IEA records world treatment charges at zero in January 2026, with China doing about half of world smelting.[13] Concentrate is not easily bought either: a treatment charge of zero means smelters are bidding against one another for scarce feed, so a US copper smelter would compete in a tight market. That bears on the copper leg of Route B in Finding 4, not on the nodule case, since a nickel-matte refinery does not take copper concentrate.

5.5 Manganese

Manganese is the largest product by weight and the least needed. The application's silicate would go, for upwards of 90%, to silico-manganese producers, whom the application does not locate; the USGS scores manganese ore at zero and manganese alloys at US$77 million. The quantity, about 2.7 Mt of manganese a year in 6.3 Mt of silicate, is about an eighth of world mine output.[14]

5.6 Market access

A further bound is market access. The application seeks recovery under US domestic law in an area the United States does not regulate under the Law of the Sea Convention, which it has not ratified. The ISA Secretary-General and several member states have stated that recovery outside the ISA

[11]MCS 2026, nickel: 2025 apparent primary consumption 90,000 t, apparent total 220,000 t, scrap about 60% of apparent consumption, stainless and alloy steel and nickel alloys more than 85% of domestic consumption; net import reliance 41% of total apparent consumption, "nearly 100%" excluding scrap; the Port Nickel refinery in Louisiana, the last primary refinery, closed in 1985; three companies considering refineries in Missouri, Oklahoma and Texas and a pilot-scale refinery built in Oklahoma; International Nickel Study Group surpluses of 98,500 t (2022), 170,000 t (2023), 182,000 t (2024) and 189,000 t in the first nine months of 2025; 2025 LME cash price down about 11% on 2024. The chapter notes Executive Order 14285 of April 2025 on seabed minerals. Project Vault is described in the USGS news release of 6 February 2026 accompanying MCS 2026.

[12]MCS 2026, cobalt: 2025 apparent consumption 9,600 t (estimated 8,000 t), net import reliance 79%, value of consumption US$320 million, 51% superalloys, 25% chemical applications, 15% other metallic, 9% cemented carbides; Congo (Kinshasa) 73% and Indonesia 14% of world mine production; quotas of 18,125 t for the rest of 2025 and up to 96,600 t a year for 2026–27 including 9,600 t for national reserves; the 7,480 t National Defense Stockpile solicitation "was cancelled before the end of the year"; "for fiscal year 2026, the Annual Materials Plan was not released". The chapter also records a USGS estimate of about 5 billion t of cobalt in seafloor nodules worldwide.

[13]MCS 2026, copper: 2025 mine production about 1,000 kt, refinery production 850 kt (790 primary, 60 secondary), apparent consumption of primary refined copper and copper from old scrap 2,200 kt, net import reliance 57% (44% in 2021); refined copper 88% of unmanufactured imports, from Chile 68%, Canada 16%, Peru 7%, Mexico 6%. IEA commentary of 2 March 2026: benchmark treatment and refining charges settled at US$0 per tonne in January 2026; China about 50% of world smelting.

[14]Application s.4.8.5.2: silico-manganese producers "expected to consume upwards of 90% of material"; the SINTEF value-in-use study is cited; no location is given. Scores from OFR 2025-1047. The manganese quantity is from the Koinon model (Appendix E). World mine output of about 20 Mt of contained manganese in 2025, led by South Africa (7.6 Mt), Gabon (5.0), Ghana (2.0) and Australia (1.6): MCS 2026, manganese.

regime would be unlawful, and the European Union and others have supported a precautionary pause. More than sixty companies, among them BMW, Volvo, Volkswagen, Renault, Rivian, Google, Samsung SDI and Philips, have signed the WWF statement undertaking not to source minerals from the deep seabed until the risks are understood; several are the battery and vehicle makers who would buy nickel and cobalt sulphate. Metal produced under a unilateral licence may therefore sell at a discount, to a narrower set of buyers, or not at all in some markets. The effect is not priced in the PFS or the application, Koinon's Unit Economics note carries it as a discount of 10–40% on non-US sales, and this note records it as directional.[15]

5.7 The bound

The pattern across the four metals is the same. Where the United States has a deficit, in copper, the project's contribution is small. Where the project's contribution is large, in nickel and cobalt, the deficit is small, allied-supplied, or in a different product. Where the project's output is largest, in manganese, there is no deficit at all. The security benefit of NORI-D is bounded by that pattern, and Finding 4 prices the bound.

6. Finding 4 — The benefit does not cover the cost

Claim. Priced on the government's own loss figures and its own discount rules, the security benefit of NORI-D is worth at most US$0.4–0.7 billion today against public exposure of US$6.3–8.8 billion and an expected public cost of US$2.8–4.3 billion across discount rates of 2–7% real, a ratio of 0.10–0.23 in the expected case, and an annual return below the hurdle the government sets for public capital. The reason lies in the order of construction. A government that wanted what both agencies describe, domestic capacity to refine nickel, cobalt and copper, would build or back a refinery first, review its feed second, add a smelter only if the feed review required one, and consider the seabed last, as one of several sources of smelter feed. The application runs that order backwards, and each reversal adds cost and risk.

6.1 The application's order

Table 44 of the application schedules Brownsville as Phase 1, Stage 1: matte; Stage 2: matte; Stage 3: metals; Phase 2: metal, with the first 3 Mtpa matte plant in 2028 and the full 12 Mtpa by 2032.[16] Smelting therefore comes first and refining later, and every stage is tied to nodule delivery. Table 4 sets out what each route entails.

Route	What is built	Feed	Onshore capital	Seabed exposure
A. Refinery alone	Matte-to-metal refinery for nickel, cobalt and copper	Bought matte or concentrate: allied, Indonesian, domestic sulphide, recycled	About US$2.2 billion per 6 Mtpa-equivalent plant (PFS Table 18.2)	None
B. Smelter and refinery	RKEF smelter feeding A	Bought laterite ore or sulphide concentrate	A plus about US$2.45–3.65 billion (Koinon, directional)	None
C. The application	B plus seabed collection, trans-Pacific transport and a 12 Mtpa park	Nodules only	About US$6.9–8.1 billion (Koinon, directional), plus offshore systems #1–4, about US$4.9 billion, all treated here as capital	Whole

[15]The United States is not a party to the 1982 Convention; the Deep Seabed Hard Mineral Resources Act of 1980 is the domestic basis. ISA Secretary-General statements of April and May 2025 on unilateral recovery; the WWF Global Deep-Sea Mining Moratorium business statement and its signatory list, as published by WWF; the EU position at ISA Council sessions. Signatory names and count as reported on the published list in 2025. Market-access discounts are not quantified here.

[16]Application Table 44, "Expected Onshore Processing Quantities", 2028–2047: 0.5 Mt in 2028 rising to 12.0 Mt from 2032, 202.5 Mt cumulative; rows headed Phase 1 Stage 1: Matte, Stage 2: Matte, Stage 3: Metals, Phase 2: Metal.

Table 4. Three routes to the same refined products. The PFS costed only the refineries; the 2021 Initial Assessment costed an integrated smelter and refinery at US$4.79 billion for 6.4 Mtpa dry, location undetermined. Koinon's figures scale that estimate and are directional; Appendix C.[17]

6.2 What each step adds

Route A addresses the stage both agencies identify and can be built by any of the firms that refine nickel–copper–cobalt matte today, among them Glencore at Kristiansand, Vale at Long Harbour, Sumitomo Metal Mining at Niihama and Sherritt at Fort Saskatchewan. The applicant brings no refining capability of its own: the application names PAMCO, Mariana Minerals, Korea Zinc and Glencore as partners and leaves the technology licensor, the joint-venture partner and the EPC contractor unnamed. A refinery built now can take nodule matte later, if nodules ever arrive; the one design consequence is a larger copper circuit, since nodule matte carries nearly as much copper as nickel.[18]

Route B is needed only if the feed review finds that matte cannot be contracted. That is the applicant's strongest ground and should be stated fairly: battery-grade intermediates outside Chinese ownership are scarce, Indonesian capacity is largely Chinese-owned, and Indonesia has cut its 2026 ore quota by about a third.[19] A smelter fed by allied laterite or domestic sulphide concentrate meets that case without a seabed.

Route C adds the seabed, and with it the technical risk of an untested collector, the permitting and international-law risk of the licence, the logistics of 12 Mt a year across the Pacific, and a plant with no alternative feed if collection fails and a feed with no alternative buyer if the plant fails. What it adds in security is one thing only: ownership of the ore rather than a contract for it. Section 6.3 prices that.

6.3 Pricing the seabed premium

Benefit. The benefit is the USGS expected loss the project could remove, credited only for what US buyers can use in the forms the project offers: nickel sulphate up to US nickel demand outside steels and alloys, about 12% of output; cobalt sulphate up to US use of cobalt chemicals, 26–51% of output; copper cathode in full, at its 4% share of consumption; and manganese alloys only for silicate sold in the United States beyond the ore it would displace. On that basis the benefit at full scale has a median of US$53 million a year (P10–P90 US$40–68 million). Crediting the physical supply instead, whether or not a US buyer can use it, gives a median of US$92 million a year (US$58–173 million). The difference is the value of output that no US buyer takes in the form offered; this note uses the first basis and shows the second for comparison, and the conclusions below hold on either. Both are ceilings rather than estimates: they assume that in a disruption the plant runs, US buyers take its output and nothing substitutes from allies, and they score nickel sulphate as if it were the refined nickel the USGS assessed. The ownership adjustment of section 4.3 would not close the gap to the hurdle below. Taken year by year over the applicant's schedule and discounted to 2026 at the rates OMB Circular A-94 provides, the present values are as in Table 5.[20]

[17] Initial Assessment of the NORI Property, AMC Consultants, 17 March 2021 (TMC Form S-4 Exhibit 96.1): "On-shore project costs consist principally of the construction of the minerals processing pyrometallurgical plant and hydrometallurgical refinery", US$4,786 million for Project One at 6.4 Mtpa dry; location and host country "not yet determined"; no split between smelter and refinery. Koinon scaling in Appendix C.

[18] Named from public company descriptions of each plant; capacities are not relied on here. The application's grades of 1.40% nickel and 1.14% copper (Table 5) give a copper-to-nickel ratio near 0.8, against ratios well below 0.5 in most nickel sulphide mattes; the refinery's copper circuit would be sized accordingly. The copper ratio is a Koinon observation, not a design study.

[19] Argus, 19 December 2025: Indonesian mixed-hydroxide output about 482,000 t of contained nickel in 2025, capacity forecast at 862,000 t for 2026, surplus 288,000 t. Mysteel, December 2025: Indonesia's 2026 ore quota planned at about 250 Mt against 379 Mt in 2025. MCS 2026, cobalt, for Congo's quotas. The US ally position is stronger for present imports than for future battery-grade intermediates, which is where the applicant's case is strongest.

[20] Benefit components (OFR 2025-1047), each multiplied by a USGS score factor drawn between 0.7 and 1.3 and by the share of US use the project's usable output would cover, capped at one: nickel primary refined US$22 million against 90 kt of primary consumption, crediting 12% of the nickel; cobalt chemicals US$47 million against 2.4 kt of chemical use, crediting 26–51% of the cobalt; copper refined US$56 million against 2,200 kt, crediting all the copper; manganese alloys US$77 million against 480 kt of manganese in alloy imports, crediting only silicate sold in the United States beyond the 185 kt of manganese in ore imports

Present value, US$ billion	2% real (A-94, 2023)	3% real	7% real (A-94, 1992)
Ceiling, credit for usable forms (this note): median (P10–P90)	0.69 (0.52–0.88)	0.61 (0.46–0.78)	0.39 (0.29–0.50)
Ceiling, physical-supply credit, for comparison	1.23 (0.77–2.48)	—	0.70 (0.44–1.46)

Table 5. The benefit in present value. US$ billion; ceilings, as explained in the text; 10,000 iterations: applicant's schedule (application Table 44) as the collectors deliver it, discounted to 2026. Physical-supply credit was not run at 3%. Koinon_NORI-D_UnitEconomics_Model.xlsm, sheet Security_Benefit; Appendix D.

Cost. The applicant's own financing plan makes the public the majority funder of onshore construction. Pre-feasibility estimates of first-of-a-kind plants also run to systematic understatement: the reference-class evidence on large projects puts typical overruns well above the escalation in the costings, which is why the run carries an onshore overrun averaging 45%. Koinon's Unit Economics note (16 October 2026, Finding 5) takes the applicant's financing plan through the same 10,000-iteration run that produces the benefit, so both sides of the comparison come from the same draws. Onshore capital after overrun and interest during construction has a median of US$12.5 billion. Public money is taken as 50% to 70% of it, from a bare majority to the whole non-equity tranche: a gross exposure at face of US$6.3–8.8 billion at the median. What that exposure costs depends on the instrument. A grant or an equity stake costs its face. A loan or guarantee costs its expected loss, which is how the federal budget itself accounts for credit. In the run that loss is not assumed. Debt is repaid before equity from the operating surplus, and lenders lose only what the surplus cannot service: nothing in 27% of iterations, and on average 49% of the debt. The public share of that loss, valued in 2028 when processing begins and discounted to 2026 with the benefit, is the expected fiscal cost. That loss is not independent of the security argument. The argument is called on because the commercial case is weak, and a weak commercial case is what turns loans into grants. Table 6 sets out both measures.[21]

Public cost, US$ billion	Gross exposure at face	Expected fiscal cost, 2% real	3% real	7% real
Public money at 50% of onshore capital	6.3 (4.3–9.3)	3.1 (0–7.0)	3.0 (0–6.9)	2.8 (0–6.4)
Public money at 70% of onshore capital	8.8 (6.0–13.0)	4.3 (0–9.8)	4.2 (0–9.6)	3.9 (0–8.9)

Table 6. The public cost. Gross exposure: median (P10–P90) at face, undiscounted. Expected fiscal cost: mean (P10–P90) in present value, the public share of the loss to lenders, valued in 2028 and discounted to 2026; the tenth percentile is nil because lenders are repaid in full in 27% of iterations, and the medians at 2% are US$2.7 billion and US$3.8 billion. If the support were a grant or equity, the cost would be the exposure itself, US$6.0–8.4 billion at the median in present value at 2%. 10,000 iterations; Koinon_NORI-D_UnitEconomics_Model.xlsm, sheets Capital and Security_Cost.

Three cases, from one run. The cases differ only in the schedule over which the benefit is counted; every other uncertain input moves at once in each iteration, from prices and operating cost to availability, capital overrun, the USGS scores and the shares US buyers can use (Appendix E). The central case is the applicant's schedule, application Table 44, as the collectors deliver it. The upper

it would first displace. The physical-supply comparison drops the usable shares and credits manganese against alloy imports whenever the US market is won. Year by year over application Table 44 as the collectors deliver it, discounted to 2026 (Appendix D). Rates: OMB Circular A-94 (1992) 7% real; A-94 as revised November 2023, real Treasury-based rates; OMB M-25-08 (January 2025) real rates 1.9% at 10 years and 2.3% at 30 years for cost-effectiveness analysis. Both rates are reported, so the result does not depend on which is in force.

[21]The federal government accounts for its own loans this way: under the Federal Credit Reform Act of 1990 the budget cost of a direct loan or guarantee is its subsidy cost, the present value of expected cash flows to and from the government net of repayments and defaults. A loan to a borrower expected to default is a grant in all but name. Onshore capital: the PFS refineries and Koinon's directional smelter cost, after overrun and interest during construction; median US$12.5 billion (P10–P90 US$8.6–18.6 billion). Debt, loss to lenders and its public share as in Koinon's Unit Economics note (16 October 2026), sections 7.2 and 7.3, and Appendix D.3. Public money is counted on the onshore plant only, as the application describes it; if public lenders or guarantors also back the offshore systems, the liability is larger. Marginal cost of public funds 1.2–1.3 is the conventional range in cost-benefit practice; Appendix D.

bound is the schedule as filed, 202.5 Mt over 2028–2047. The reserve-only case stops when the 51 Mt Probable reserve has been processed, in 2035 on the delivered schedule. The public cost is the same in all three, because the Brownsville plant and its financing do not change with what the seabed delivers. The ratio is the mean benefit over the mean expected fiscal cost: what the public can expect to gain against what it can expect to pay.

Case	Benefit at 2%, median (P10–P90), US$bn	Benefit at 7%, median (P10–P90), US$bn	Ratio of means at 2%	Ratio of means at 7%	Draws with benefit ≥ cost at 2%
As delivered (central): application Table 44 as the collectors deliver it	0.69 (0.52–0.88)	0.39 (0.29–0.50)	0.16–0.23	0.10–0.14	31–33%
As filed (upper bound): Table 44 as printed, 202.5 Mt	0.72 (0.54–0.92)	0.41 (0.30–0.52)	0.17–0.24	0.11–0.15	31–33%
Reserve only: as delivered, stopping at the 51 Mt Probable reserve in 2035	0.20 (0.15–0.26)	0.15 (0.11–0.19)	0.05–0.07	0.04–0.05	28–29%

Table 7. Three cases from one run. Benefit: ceilings, credit for usable forms, present value in 2026. Ratios: mean benefit over the mean expected fiscal cost of Table 6, the lower figure with public money at 70% of onshore capital and the higher at 50%. Crediting physical supply raises the central ratio to 0.35–0.50 at 2% and 0.23–0.32 at 7%; if the support were a grant, it is 0.08–0.11 at 2%. Public cost is the same in every case. 10,000 iterations; Koinon_NORI-D_UnitEconomics_Model.xlsm, sheets Security_Benefit and Security_Cost; Figure 2 draws the ratio columns.

The schedule as filed is the most favourable case and still fails the test: the security value the public can expect is a fifth to a quarter of what it can expect to pay at the most generous rate, and a ninth to a seventh at the 1992 rate. Counting only the reserve cuts the ratio to 0.04–0.07. Benefit reaches cost in about a third of draws, almost all of them draws in which lenders are repaid in full and the public pays nothing; where lenders lose money, the benefit covers the cost in 5–7% of draws at 2% and 3–4% at 7%.

Comparison. In no case, at no rate and on neither basis of credit does the expected benefit reach the expected cost; the closest, physical-supply credit at 2% with public money at half of onshore capital, is 0.50. The marginal cost of public funds, conventionally 1.2 to 1.3 per dollar raised, would lower every ratio further. And a ratio of one is not the test. Public money is rationed; the project competes against the alternatives in the same budget, including Routes A and B, and against a top tier in which one tenth of one commodity's risk exceeds the whole of this project's. Section 6.4 sets out what the alternatives are expected to return.

6.4 What public investment is expected to return

A dollar of public capital and a dollar of GDP are not the same thing, and Tables 5 and 6 should not be read as if they were. The USGS score is a flow: a loss of output avoided each year. The public cost is a stock: capital committed at construction. Two comparisons are legitimate. The first sets the annual flow against the return the government expects on its capital. The second sets the present value of the flow against the present value of the capital, as a benefit-cost ratio, and compares that ratio with the ratios other public investments achieve. Table 8 collects the benchmarks the government and its peers use.

Benchmark	Figure	Source
Required return on public capital that displaces private capital	7% real a year	OMB Circular A-94, 1992
Average return on productive federal investment	About 5% a year, half CBO's estimate for private investment	CBO, The Macroeconomic and Budgetary Effects of Federal Investment, 2016

Benchmark	Figure	Source
Short-run demand effect of public investment in a downturn	Investment of 1% of GDP raises GDP by about 2.7% within two years	IMF Fiscal Monitor, October 2020
Value-for-money bands for transport schemes	Benefit-cost ratio below 1 poor; 1–1.5 low; 1.5–2 medium; 2–4 high; above 4 very high	UK Department for Transport, Value for Money guidance, 2024–25
Discretionary infrastructure grants	Benefit-cost ratio above 1 required; applicants ranked on it	US Department of Transportation, benefit-cost analysis guidance

Table 8. What public investment is expected to return. The IMF figure is a short-run demand multiplier in conditions of slack and uncertainty; it is not a return on capital and applies equally to any public spending, so it does not discriminate between projects.[22]

As an annual return. A benefit ceiling with a median of US$53 million a year on public exposure of US$6.3–8.8 billion is a return of 0.6–0.9% a year, and 1.0–1.5% on physical-supply credit, far below the 7% hurdle and below the 5% average CBO assigns to federal investment generally. The hurdle alone would require US$440–610 million a year, more than the entire expected loss the USGS attaches to every form of the four metals together.

As a benefit-cost ratio. With benefit and cost drawn from the same run (Tables 6 and 7, Figure 2), the applicant's schedule as delivered returns 0.16–0.23 of its expected cost at 2% and 0.10–0.14 at 7%; crediting physical supply in full raises this to 0.35–0.50 at 2%, and if the support were a grant it falls to 0.08–0.11. On the transport bands every case is "poor". The point of the bands is that public money is rationed to the ratio: a scheme at 1.0 is funded only when nothing better is on offer, and the USGS list says a great deal better is on offer.

Two cautions apply to both comparisons. The benefit side counts only the security value; the project's own commercial return, if any, belongs to its investors and is what would repay the loans, so it appears here through the loss to lenders rather than as a benefit. And the comparison is Koinon's construction on published inputs, offered as a frame for the question rather than as a finding about the project.

6.5 What follows

If the project were commercially sound, it would carry a mild security benefit as a by-product: bounded by domestic demand, substitutable from allies, and mid-table on the government's own ranking. Mineral security itself is better bought directly, at the stage both agencies identify, and no one buying it would choose this path. If the project is not commercially sound, the loans become grants. On Koinon's modelling they are repaid in full in about one case in four; in the rest the public carries the loss, and the security case is asked to justify US$6.3–8.8 billion against a benefit the government's own figures cap at US$0.4–0.7 billion in present value, and at US$1.2 billion even if every tonne were credited. Either way the security argument cannot carry the project: sound, it is not needed; unsound, it is not enough. A government that wanted the benefit would buy a refinery, contract its feed and keep the seabed as an option. The application asks it to buy the option first.

[22]OMB Circular A-94 (1992), s.8: 7% real as the approximate marginal pretax rate of return on an average investment in the private sector. CBO, The Macroeconomic and Budgetary Effects of Federal Investment, June 2016: productive federal investment "an average annual rate of return of about 5 percent, or half of the agency's estimate of the average rate of return on private investment". IMF, Fiscal Monitor, October 2020, chapter 2: in advanced and emerging economies, increasing public investment by 1 percent of GDP could raise GDP by 2.7 percent and private investment by 10 percent within two years, in conditions of high uncertainty. UK DfT, Value for Money Framework (May 2025) and supplementary guidance on categories (November 2024). USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, current edition; the requirement that benefits exceed costs is stated there and the ranking on ratio is practice. Ratios in the text: mean benefit over mean expected fiscal cost, Table 7. Annual returns: median benefit of 53 (92 on physical-supply credit) over median exposure of 6,270–8,770, US$ million; the hurdle is 7% of the same.

7. Questions NOAA could put to the applicant

- A costed plan for the Brownsville smelter and refinery, by stage, stating the capital assumed to come from federal sources, in what form (grant, loan, guarantee, offtake), and which agencies have been approached (Finding 1).
- The product specification and offtaker for each product: whether nickel and cobalt would be sold as sulphate or as metal, and where the manganese silicate would be smelted (Finding 3).
- The applicant's own assessment of the project against the USGS 2025 list and the Section 232 finding: which risk, in which form, the project is intended to reduce, and by how much (Findings 1 and 2).
- Whether the Brownsville refinery is designed to accept feed other than nodule matte, and what its value would be if nodule supply were interrupted or ceased (Finding 4).
- The basis on which the applicant prefers owned nodule feed to contracted matte or concentrate for the same refinery, with the cost and risk of each (Finding 4).
- Whether any federal agency with a security remit, the USGS, Commerce, Defense or Energy, has assessed the project's contribution to mineral security, and with what result (Findings 1 to 4).

Appendix A. How the USGS measures supply risk

The 2025 methodology replaced the 2022 list's qualitative screens with a quantified economic test. For each of 84 mineral commodities and each supplying country, the USGS modelled a year-long complete restriction of US net imports from that country; computed the post-disruption price and quantity from price elasticities of supply and demand and the excess capacity in the rest of the world; and ran the result through US input–output tables for 402 industries to estimate the change in GDP. Each scenario's GDP change was multiplied by the probability of the restriction, estimated by a classifier trained on the history of trade prohibitions, quotas and licensing; China scenarios already in force were set at 100%; pairs with no history were assigned the 4% mean. The commodity's score is the sum across its scenarios. A commodity was included on the list if its score reached the Moderate category or if its supply chain relied on a sole domestic producer representing a single point of failure. The final list of 7 November 2025 names 60 minerals, among them copper, newly added, and nickel, cobalt and manganese.

Category	Expected loss, US$m a year	Commodities
High	above 206	13
Elevated	22 to 206	includes manganese alloys, refined copper, cobalt chemicals, high-purity manganese sulphate
Moderate	2 to 22	includes primary refined nickel, manganese metal
Limited	0.06 to 2	includes cobalt metal, manganese dioxide
Negligible or negative	0.06 and below	includes manganese ore, mined copper

Table A1. The USGS categories, set by Jenks natural breaks in the distribution of the 84 scores. Source: OFR 2025-1047.

Rank	Commodity	Expected loss, US$m a year	Category
1	Samarium	4,498	High
2	Rhodium	2,752	High
3	Lutetium	2,059	High

Rank	Commodity	Expected loss, US$m a year	Category
4	Terbium	1,809	High
5	Dysprosium	1,624	High
6	Gallium	1,419	High
7	Germanium	814	High
8	Gadolinium	758	High
9	Tungsten	544	High
10	Niobium	394	High
11	Magnesium metal	303	High
12	Yttrium	295	High
13	Potash	287	High
	Top tier, thirteen commodities	about 17,560	
25	Manganese alloys	77	Elevated
29	Copper, refined	56	Elevated
34	Cobalt chemicals	47	Elevated
44	Nickel, primary refined	22	Moderate
	Four nodule metals, all ten forms	about 240	

Table A2. The USGS top tier and the four nodule metals. Source: OFR 2025-1047; the two totals are Koinon's sums of the published scores. The sum across all 84 commodities is about US$20.8 billion.

Appendix B. US salient statistics, 2021–2025

Nickel, tonnes of contained nickel	2021	2022	2023	2024	2025e
Mine production	18,400	17,500	16,400	7,490	10,000
Primary imports	108,000	127,000	112,000	105,000	100,000
Apparent consumption, primary	97,500	117,000	98,500	90,300	90,000
Apparent consumption, total	254,000	270,000	238,000	211,000	220,000
Net import reliance, % of total	38	43	41	43	41
LME cash price, US$/t	18,476	25,815	21,495	16,812	15,000

Table B1. Nickel. Source: MCS 2026. Refinery by-product output is withheld; the United States has had no primary nickel refinery since 1985.

Cobalt, tonnes of contained cobalt	2021	2022	2023	2024	2025e
Mine production	650	500	500	200	300
Secondary production	1,800	1,920	2,030	2,050	2,000
Imports for consumption	9,790	10,500	9,500	10,800	14,000
Exports	4,930	5,360	5,110	4,880	4,500
Apparent consumption	6,650	7,150	6,440	7,960	9,600
Net import reliance, %	73	73	69	74	79
LME cash price, US$/lb	23.17	28.83	15.48	11.84	15

Table B2. Cobalt. Source: MCS 2026. The 2025 rise in imports and stocks followed Congo's export ban.

Copper, thousand tonnes of contained copper	2021	2022	2023	2024	2025e
Mine production	—	—	—	1,050	1,000
Refinery production	—	—	—	921	850
Refined imports	48	27	29	72	110
Reported consumption, refined	1,750	1,720	1,580	1,580	1,700
Apparent consumption, refined and old scrap	1,970	1,810	1,680	1,860	2,200
Net import reliance, %	44	41	42	45	57

Table B3. Copper. Source: MCS 2026; mine and refinery figures for 2024–25 from the world production table, earlier years not extracted. Refined imports in the chapter are quoted in thousand tonnes.

Appendix C. The onshore chain and the counterfactual costings

C.1 The PFS chain and the application's chain

	PFS, August 2025	Application, August 2026
Smelting	Indonesia (to be arranged) and PAMCO, Japan (about 4% of life-of-mine tonnage); toll-treated; no capital	Brownsville, Texas; integrated with refining; first 3 Mtpa plant producing matte from 2028
Refining	Two TMC-owned US plants receiving matte; US$4,426 million	Brownsville, later stages; no cost published
Transport	Capesize (200,000 dwt) CCZ to Indonesia; Handymax matte to Texas from 2033	DP Neo-Panamax (125,000 dwt) nodules direct CCZ to Brownsville
Site	—	Option to lease 735 acres at the Port of Brownsville, 731 more available; channel deepened to 52 ft in June 2026
Funding	Project capital US$4,971 million	About 30% equity, about 70% debt and government incentives; onshore construction contingent on majority federal funding (TMC)

Table C1. Sources: PFS ss.12.2.14, 18.1–18.5; Application ss.6.4.1–6.4.2, 7.4; Koinon PFS Freight Extract v1.7, Part B.

C.2 Koinon's costing of the Brownsville smelter

No published study costs smelting at Brownsville. Koinon's figure scales the one integrated estimate in the record, the 2021 Initial Assessment's US$4,786 million for a combined smelter and refinery at 6.4 Mtpa dry, as follows.

- Throughput: 12 Mt wet a year at 28% moisture is 8.64 Mt dry, 1.35 times the 2021 basis.
- Scaling: at a 0.6 economy-of-scale exponent, 1.35 raised to 0.6 is 1.20, giving US$5.7 billion; at straight-line scaling, US$6.5 billion.
- Escalation: 20–25% for construction cost inflation from 2021 to 2026, giving US$6.9–8.1 billion for the integrated plant.
- Smelter alone: the integrated figure less the PFS refining cost of US$4.43 billion, US$2.45–3.65 billion, with US$3.04 billion as the most likely value (the mean of the two scalings at 22.5% escalation).
- Limits: the 2021 estimate has no engineering design and no location; US construction costs exceed those of the Chinese-built RKEF lines in Indonesia; nodule smelting produces an unusually large slag volume per tonne of nickel; the exponent and the escalation are

assumptions; and first-of-a-kind estimates understate final cost systematically. The figure is directional and is offered only to show the order of magnitude the application has not supplied.

Appendix D. Cost–benefit arithmetic

D.1 Discount rates

The discount rate converts a stream of future benefits into a present value and is distinct from the interest rate on any concessional loan, which is a term of the financing and belongs on the cost side. The federal reference is OMB Circular A-94. The 1992 circular prescribes 7% real, the pre-tax return on private capital displaced by public spending. The November 2023 revision replaced it with real Treasury-based rates, about 2% at the maturities relevant here; OMB's January 2025 memorandum M-25-08 gives real rates of 1.9% at 10 years and 2.3% at 30 years for cost-effectiveness and lease-purchase analysis. Regulatory practice under Circular A-4 has long reported 3% and 7% together. The result does not depend on whether the 2023 revision remains in force under the current administration: this note reports 2%, 3% and 7% and treats 7% as the conservative case, since the public money in question displaces private capital. Risk is carried in the probability weighting of the USGS scores and in the loss to lenders, not in the discount rate.

D.2 Present value of the benefit

In each iteration the benefit is computed year by year over 2028–2047 on the schedule of the case, and each year is discounted to 2026 at 2%, 3% or 7% real: present value = Σ benefit in year t ÷ (1 + r)^(t − 2026). Tonnes sold as matte earn no credit, since no US buyer takes matte. Tables 5 and 7 report percentiles and means of the 10,000 present values.

D.3 Public exposure and expected fiscal cost

Gross exposure is the public share of onshore capital, 50% or 70%, at face, with capital taken after overrun and interest during construction. Expected fiscal cost is the public share of the loss to lenders. Debt of 70% of the same capital is serviced at 7% over 15 years from the operating surplus of the iteration; the debt the surplus can carry is the surplus divided by the debt's capital recovery factor, and the loss to lenders is the remainder, nil when the surplus suffices. The public bears the loss pro rata: 71% of it when public money is 50% of capital, all of it at 70%. The loss is valued in 2028, the first year of processing in application Table 44, and discounted to 2026 at the rate used for the benefit. Default is therefore not an assumption: it follows from the prices, costs, availability and capital drawn in the same iteration as the benefit. Expressed as a subsidy rate, the mean loss is 49% of the debt. If the support were given as grant or equity, the cost is the exposure itself, discounted the same way. Public money is counted on the onshore plant only, as the application describes it. The ratios in Table 7 are the mean benefit over the mean cost across the 10,000 iterations.

D.4 Flow against stock

The USGS score is an annual flow of avoided GDP loss; the public cost is a capital stock. Setting a flow against a stock requires either a required rate of return (section 6.4, Table 8) or a present-value conversion (Tables 5 to 7). A dollar of avoided GDP loss is not a dollar of public spending, and no one-to-one equivalence is assumed anywhere in this note; the equivalence that is assumed is between a dollar of avoided GDP loss and a dollar of GDP gained by any other public investment, which is the basis on which such investments are ranked.

D.5 What is counted and what is not

- The USGS scores already include downstream effects through the input–output model, so the benefit is a whole-economy figure; no further multiplier is applied to it.

- No demand multiplier is applied to the spending, because the alternative uses of the same money carry one too; the cost is the resources used. The marginal cost of public funds, 1.2 to 1.3, would raise the cost side further and is noted but not applied in Tables 5 to 7.
- The project's own commercial value, if any, is not a security benefit; it is assessed in Koinon's Unit Economics note and shows up here only through the loss to lenders.
- Tail risk and defence-specific need are not captured by expected-value scores; they apply to every commodity on the list and do not change the ranking.
- Ownership of foreign processing capacity is not captured by the country-of-export method; it would raise the nickel and cobalt figures by an unquantified amount.

Appendix E. Methods and accuracy of Koinon's computations

- NORI-D output (Table 3): 12 Mt wet a year less 28% moisture is 8.64 Mt dry; multiplied by the application's grades (Table 5: 1.40% nickel, 1.14% copper, 0.14% cobalt, 31.15% manganese) and sulphate-route recoveries (Table 37, note 9: 94.6%, 86.2%, 77.2% and 98.9%), giving 114.4 kt nickel, 84.9 kt copper, 9.3 kt cobalt and 2.66 Mt manganese in 6.34 Mt of silicate a year at full scale. Koinon_NORI-D_UnitEconomics_Model.xlsm, sheet Output.
- Top-tier and four-metal sums (Table 2): arithmetic on the scores printed in OFR 2025-1047; 4,498 + 2,752 + 2,059 + 1,809 + 1,624 + 1,419 + 814 + 758 + 544 + 394 + 303 + 295 + 287 = 17,556; 77 + 56 + 47 + 29 + 22 + 9 + 0 + 0 + 0 + 0 = 240. The all-84 total of about US$20.8 billion is the sum of the report's Table 1 and is approximate.
- Copper share (Finding 3): 85 kt of 2,200 kt is 3.9%.
- Figure 1, panel 3: output as a share of US apparent consumption, nickel 114 kt of 90 kt primary (127%), cobalt 9.3 kt of 9.6 kt (97%), copper 85 kt of 2,200 kt (4%); the usable share is 15% of US nickel demand (12% of output; demand outside stainless and alloy steels, MCS 2026) and 25–49% of US cobalt demand (26–51% of output; from chemical uses alone to all uses outside superalloys); manganese has no stated US buyer. Panel 2: 240 of 20,800. Panel 4: the benefit range of Table 5 and the expected fiscal cost of Table 6, US$2.8–4.3 billion across rates and public shares; ratio 0.10–0.23 from Table 7.
- Manganese quantity (Finding 3): 2.66 Mt recovered to silicate, against world mine output of about 20 Mt of contained manganese in 2025 (MCS 2026, manganese).
- Smelter cost (Table 4, Appendix C): scaling and escalation as set out in C.2; directional.
- Present values, public cost and ratios (Tables 5 to 7, Figure 2): Koinon_NORI-D_UnitEconomics_Model.xlsm, run v2.3, 10,000 iterations in ModelRisk; sheets Security_Benefit, Capital and Security_Cost; method as in D.2 and D.3. Benefit and cost are drawn in the same iteration, so the share of draws in which benefit reaches cost is counted draw by draw; ratios are ratios of means.
- Uncertain inputs (Koinon's Unit Economics note, Appendix C): metal prices, the discount on non-US sales, operating-cost overrun, availability and the share of Type 1 nodules, offshore and onshore capital overrun (lognormal, means 1.88 and 1.45), the smelter cost (PERT US$2.45–3.65 billion), the cobalt and manganese shares US buyers can use, whether NORI-D wins the US manganese alloy market, and a factor on the USGS scores (uniform 0.7–1.3). No correlations are imposed between inputs, which understates the spread of the results.
- Refinery capacities named in section 6.2 are not relied on for any figure.

Appendix F. Sources and about this note

TMC USA LLC, Consolidated Application for an Exploration License and Commercial Recovery Permit, TMC USA-A, as published by NOAA 19 August 2026, NOAA-NOS-2026-1751-0002. AMC Consultants Pty Ltd, Technical Report Summary of Prefeasibility Study of NORI Area D, Clarion Clipperton Zone, effective 4 August 2025 (TMC Form 10-Q Exhibit 96.1). AMC Consultants Pty Ltd, Initial Assessment of the NORI Property, 17 March 2021 (TMC Form S-4 Exhibit 96.1). Nassar, N.T. and others, Methodology and technical input for the 2025 U.S. List of Critical Minerals: assessing potential supply chain disruption effects and the vulnerability of the U.S. economy, USGS Open-File Report 2025-1047. Department of the Interior, Final 2025 List of Critical Minerals, 90 FR, 7 November 2025. USGS, Mineral Commodity Summaries 2026, 6 February 2026, nickel, cobalt and copper chapters, and news release of the same date. Proclamation 11001 of 15 January 2026, 91 FR, 20 January 2026. OMB Circular A-94 (1992 and November 2023); OMB Memorandum M-25-08, January 2025. Congressional Budget Office, The Macroeconomic and Budgetary Effects of Federal Investment, June 2016. International Monetary Fund, Fiscal Monitor, October 2020, chapter 2, Public Investment for the Recovery. UK Department for Transport, Value for Money Framework, May 2025, and Supplementary Guidance on Categories, November 2024. US Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs. CSIS, Project Vault Moves from Concept to Execution, 23 September 2026. WWF, Global Deep-Sea Mining Moratorium Campaign business statement and signatories. International Energy Agency, Copper prices have hit record highs, but smelters face mounting strategic pressures, 2 March 2026. Argus Media, Viewpoint: Indonesia’s MHP surge to hit nickel prices, 19 December 2025. Mysteel, Nickel prices surge as Indonesia plans one-third cut in 2026 RKAB quotas, December 2025. TMC releases of 9 September 2024, 18 February 2025, March 2026 and 13 August 2026. Koinon Consulting, The NORI-D Reserve: Four Findings on the Resource and Reserve Estimates, 16 October 2026; Value, Cost and Capital: NORI-D by the Wet Tonne, 16 October 2026; TMC’s Fulfilment of Information Criteria in the NOAA Application, 16 October 2026; NORI-D PFS Freight Extract v1.7, 29 September 2026; Koinon_NORI-D_UnitEconomics_Model.xlsm, run v2.3 (workbook); Case Not Proven: The Economics of Deep-Sea Mining, July 2026.

About this note. Koinon Consulting has advised more than fifteen governments on mining contracts and fiscal terms. It has no relationship with any seabed minerals contractor and holds no interest in any seabed minerals project. This note was prepared for the Natural Resources Defense Council. Koinon’s prior work on deep-sea mining economics, on which it draws, was carried out with the Oceano Azul Foundation, Oceans North, the Deep Sea Conservation Coalition and IUCN, each of which publicly supports a moratorium. We state this plainly because readers are entitled to weigh it. The test we invite is whether the documents say what we report them as saying.